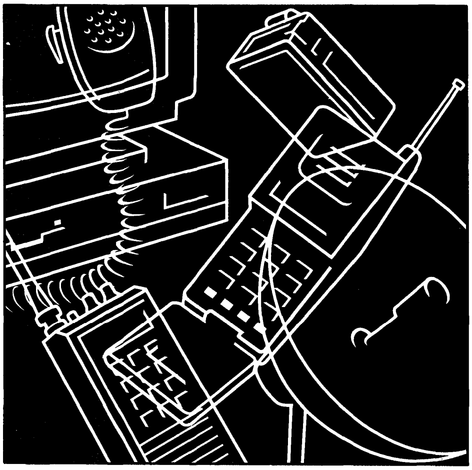
MOTOROLA

DL110/D
REV 5

RF
Device Data

MOTOROLA RF DEVICE DATA

Q1/94
DL110
REV 5



MOTOROLA

RF Device Data

This publication presents technical information for the several product families that comprise the Motorola portfolio of RF Products. The product families include bipolar, LDMOS, MOSFET RF Power, and gallium arsenide chip technologies in a variety of ceramic and plastic surface mount packages. Discrete components, hybrid modules, and integrated circuits provide different levels of complexity in an effort to provide RF solutions to our customers' RF needs.

This edition encompasses a considerable number of changes that have occurred since our last printing. Attempts have been made to update global standard product offerings in one book. In addition, many devices have been eliminated from this book due to package eliminations, aging technology, low sales, or new technology replacements. The changes are detailed on the following page "About this revision."

All devices are in alphanumeric order in the **Device Index** of this book. Just turn to the appropriate page for technical details of the known device. If you are seeking a "closest replacement" for a competitor's part, then turn to the **Cross Reference** section for information. Finally, if you need to identify a device that meets your functional performance requirements of frequency, output power, gain, or other parameters, then utilize the **Selector Guide** section of the book.

The information in this book has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies. Please consult your nearest Motorola Semiconductor sales office for further assistance regarding any aspect of Motorola RF Products.

Printed in U.S.A.

ABOUT THIS REVISION

Extensive changes have been made to this edition of the **RF Device Data Book**. Both format and content have been significantly revised. Some of the changes are as follows:

- The new book has been reduced to one volume. This has been accomplished by removing the Applications Portion of the book and making it a separate piece of literature. An **RF Applications Handbook** will be forthcoming.
- Many outmoded devices have been added to our "Not Recommended for New Design" list.
- Products introduced since our last printing have been added to the portfolio. These new standards are identified as "Preferred Devices."
- The Tuning, Hot Carrier, and PIN Diode Data Sheet section of the book has been removed. Support of these products is coordinated through the Signal Products Division's Product Marketing organization.
- There will continue to be two sections of products — Discrete Transistors and Amplifiers. Devices will be categorized accordingly. This is similar to the previous Volume I and II format.
- The Cross Reference is being modified. Previously, we identified Motorola replacement devices either as direct or similar, depending on how easily they can be substituted for other devices. New chip technologies drive new packaging concepts which lead to uniquely new products. Because few of these new products are direct replacements, a "closest replacement" listing has been created. Functional similarity probably best defines the meaning of closest replacement.

DATA CLASSIFICATION

PRODUCT PREVIEW

Data sheets herein contain information on a product under development. Motorola reserves the right to change or discontinue these products without notice.

ADVANCED INFORMATION

Data sheets herein contain information on new products. Specifications and information are subject to change without notice.

FORMAL

For a fully characterized device there must be devices in the warehouse and price authorization.

DESIGNER'S

The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

MOTOROLA DEVICE CLASSIFICATIONS

In an effort to provide up-to-date information to the customer regarding the status of any given device, Motorola has classified all devices into three categories: "Preferred" products, "Current" products and "Not Recommended for New Design" products.

PREFERRED PRODUCTS

A Preferred Type is a device which is recommended as a first choice for future use. These devices are "preferred" by virtue of their performance, price, functionality, or combination of attributes which offer the overall "best" value to the customer. This category contains both advanced and mature devices which will remain available for the foreseeable future.

"Preferred Devices" are identified in the Selector Guide Section and the Data Sheet Sections.

CURRENT PRODUCTS

Device types identified as "current" may not be a first choice for **new** designs, but will continue to be available because of the popularity and/or standardization or volume usage in current production designs. These products can be acceptable for new designs but the preferred types are considered better alternatives for long term usage.

Any device that has not been identified as a "preferred device" is a "current" device.

NOT RECOMMENDED FOR NEW DESIGN PRODUCTS

Products designated as "Not Recommended for New Design" have become obsolete as dictated by poor market acceptance, or a technology or package that is reaching the end of its life cycle. Devices in this category have an uncertain future and do not represent a good selection for new device designs or long term usage.

The RF Device Data book does not contain any "Not Recommended for New Design" devices.

DEVICE INDEX

TRANSISTORS

TRANSISTORS — continued

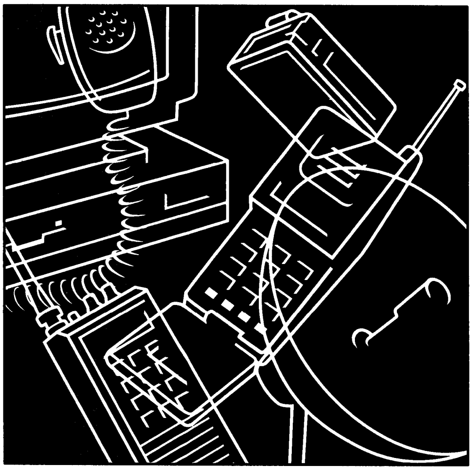
TRANSISTORS — continued

TRANSISTORS — continued

TRANSISTORS — continued

AMPLIFIERS

AMPLIFIERS — continued



Selector Guide

1

NOT RECOMMENDED FOR NEW DESIGN PRODUCTS

Products designated as "Not Recommended for New Design" have become obsolete as dictated by poor market acceptance, or a technology or package that is reaching the end of its life cycle. Devices in this category have an uncertain future and do not represent a good selection for new device designs or long term usage.

Table 1. Not Recommended for New Design Products

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER	NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER	NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
2C2857	—	2N6305	—	CA4800	CA4800C
2C3866	—	2N6603	MRF901	CA4800H	CA4800CS
2C4957	—	2N6604	MMBR911LT1	CA4812	CA4812C
2C5108	—	2N6618	—	CA4812H	CA4812CS
2C5109	—	2N6679	—	CA4815	CA4815C
2C5160	—	ACR900-30E	—	CA4815H	CA4815CS
2C5583	—	AMR175-60	—	CA5001R	MHW5182R
2N2857	MMBR5179L	AMR225-60	—	CA5100R	MHW5182R
2N3553	—	AMR440-60	—	CA5101R	MHW5182R
2N3839	MMBR5179LT1	AMR470-60	—	CA5200R	MHW5182R
2N3866	MRF3866	AMR900-60	—	CA5201R	MHW5182R
2N3866A	MRF3866	AMR900-60A	—	CA5800	CA5800C
2N3924	MRF5003	ATV5030	—	CA5800H	CA5800CS
2N3948	MRF4427	ATV5090B	—	CA5815	CA5815C
2N3959	MRF9011LT1	ATV7050	—	CA5815H	CA5815CS
2N3960	MRF9011LT1	ATV7060	ATV6060	CA7901	—
2N4427	MRF4427	BFR91	MMBR911LT1	CR2424	CR2424A
2N4428	MRF3866	BFR92	BFR92ALT1	CR2424H	CR2424A
2N4957	MMBR4957LT1	BFR93	BFR93ALT1	CR2425	CR2425A
2N4958	MMBR4957LT1	BFRC90	—	CR3424	CR3424A
2N4959	MMBR4957LT1	BFRC91	—	CR3424H	CR3424A
2N5031	MMBR5031LT1	BFRC96	—	CR3425	CR3425A
2N5032	MMBR5031LT1	BFW92A	—	CR820	—
2N5108	—	BFX89	—	DHP02-36-40	—
2N5109	MRF5943	BFY90	—	DHP05-18-20	—
2N5160	—	BRFC96	—	DHP05-36-10	—
2N5179	MMBR5179LT1	BT500	—	DHP10-14-15	—
2N5583	MRF5583	BT500F	—	DHP10-32-08	—
2N5590	MRF2628	CA2800	CA2818C	FF124	MFF124B
2N5591	MRF1946/A	CA2810CH	CA2810C	FF124B	MFF124B
2N5636	MRF321	CA2813C	CA2810C	FF224	MFF224B
2N5641	MRF134	CA2813CH	CA2810C	FF224B	MFF224B
2N5642	MRF166C	CA2818	CA2818C	JO2015A	2N6439
2N5643	MRF137	CA2818H	CA2818C	JO3037	MRF658
2N5835	MRF9011LT1	CA2820	—	JO3501	MRF892
2N5836	MRF951	CA2820H	—	JO3502	MRF894
2N5837	MRF951	CA2830	CA2830C	JO4036	MRF1946
2N5849	—	CA2830H	CA2830C	JO4045	MRF1946/MRF247
2N5862	MRF316	CA2832	CA2832C	LT1001A	MRF5812
2N5943	MRF5943	CA2832H	CA2832C	LT1814	—
2N5944	MRF5003	CA2833	CA2833C	LT1817	—
2N5945	MRF652	CA2842	CA2842C	LT1839	—
2N5946	MRF653	CA2842H	CA2842C	LT2001	MRF581
2N6080	MRF5003	CA2850R	CA2850CR	LT3005	MRF581
2N6081	MRF2628	CA2851R	CA2851CR	LT3014	MRF581
2N6082	MRF1946/A	CA2870	CA2870C	LT3046	MRF5812
2N6083	MRF1946/A	CA2870H	CA2870C	LT5817	—
2N6084	MRF1946/A	CA2875R	CA2875CR	LT5839	—
2N6166	MRF173	CA3220R	MHW5182R	MD4957	—
2N6197	MRF134	CA4220R	MHW5182R	MHW10000	—
2N6304	—	CA4418R	MHW5182R	MHW10001	—

1

Table 1. Not Recommended for New Design Products (continued)

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
MHW10002	—
MHW10003	—
MHW1184	—
MHW1184R	—
MHW2001-15	—
MHW5141A	MHW5142A
MHW5162A	MHW5172A
MHW5171A	MHW5172A
MHW5181A	MHW5182A
MHW5185	MHW5185B
MHW5205R	—
MHW5222R	—
MHW5225R	—
MHW5332A	MHW5342A
MHW590	—
MHW591	—
MHW592	—
MHW593	—
MHW596	—
MHW597	—
MHW6141	MHW6142
MHW6171	MHW6172
MHW6181	MHW6182
MHW6185	MHW6185B
MHW703	MHW704
MHW709-1	—
MHW709-2	—
MHW709-3	—
MHW710-1	—
MHW710-2	—
MHW710-3	—
MHW720-1	MHW720A1
MHW720-2	MHW720A2
MHW801-1	MHW851-1
MHW801-2	MHW851-2
MHW801-3	MHW851-3
MHW801-4	MHW851-4
MHW807-1	—
MHW807-2	—
MHW820-1	—
MHW820-2	—
MHW820-3	—
MM4018	MRF5583
MM4049	MMBR536LT1
MM8000	MRF5943
MM8001	MRF5943
MM8002	—
MM8009	—
MMBR2060L	BFS17LT1
MMBR2857L	MMBR5179LT1
MMBR930L	MMBR911LT1
MMC4049	—
MPS1983	MPS901
MRA0500-19L	—
MRA0510-50H	—
MRA0610-18A	—
MRA0610-18H	—
MRA0610-3	—

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
MRA0610-3H	—
MRA0610-40A	—
MRA0610-9	—
MRA0610-9H	—
MRA1000-3.5L	—
MRA1014-12	—
MRA1014-12H	—
MRA1014-2	—
MRA1014-2H	—
MRA1014-35	—
MRA1014-6	—
MRA1014-6H	—
MRA1214-55H	MRF10120
MRA1300-10L	—
MRA1417-11	—
MRA1417-11H	—
MRA1417-2	—
MRA1417-25A	—
MRA1417-2H	—
MRA1417-6H	—
MRA1600-13	—
MRA1600-2	—
MRA1600-30	—
MRA1600-50H	—
MRA1600-6	—
MRA1618-35H	—
MRA1720-2	—
MRA1720-20	—
MRA1720-5	—
MRA1720-9	—
MRAL1417-11	—
MRAL1417-2	—
MRAL1417-25	—
MRAL1417-6	—
MRAL1720-2	—
MRAL1720-5	—
MRAL1720-9	—
MRAL2023-1.5	—
MRAL2023-1.5H	—
MRAL2023-12	—
MRAL2023-12H	—
MRAL2023-18H	—
MRAL2023-3H	—
MRAL2023-6H	—
MRAL2327-1.3	MRA2023-3
MRAL2327-12H	—
MRAL2327-6	—
MRF1001A	MRF5812
MRF10030	MRF10031
MRF1008MA	—
MRF1008MB	—
MRF1150M	MRF10150
MRF1250M	MRF10350
MRF1325M	MRF10350
MRF172	MRF173
MRF207	—
MRF208	—
MRF212	MRF2628

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
MRF216	MRF247
MRF220	—
MRF221	MRF5015
MRF226	MRF5015
MRF227	MRF5003
MRF229	MRF5003
MRF232	MRF2628
MRF233	MRF2628
MRF234	MRF1946/A
MRF2369	MRF0211LT1
MRF237	MRF5003
MRF238	MRF1946/A
MRF240A	MRF1946
MRF245	MRF247
MRF260	—
MRF261	—
MRF262	—
MRF264	—
MRF314A	MRF314
MRF315A	MRF315
MRF338	MRF393
MRF340	—
MRF342	—
MRF344	—
MRF390	MRF177
MRF401	MRF426
MRF406	—
MRF4070	MRF247
MRF410	—
MRF4217A	—
MRF421MP	—
MRF422MP	—
MRF4239A	—
MRF427	MRF138
MRF427A	MRF138
MRF428	MRF429
MRF429MP	—
MRF430	MRF157
MRF433	MRF2628
MRF449A	MRF1946/A
MRF450	MRF455
MRF450A	MRF455
MRF455A	MRF455
MRF458	MRF454
MRF464A	MRF464
MRF466	MRF138
MRF475	—
MRF476	—
MRF477	—
MRF479	—
MRF485	—
MRF486	—
MRF492A	MRF492
MRF497	—
MRF501	MMBR5179LT1
MRF502	MMBR5179LT1
MRF511	MRF587
MRF515	MRF559

1

Table 1. Not Recommended for New Design Products (continued)

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
MRF5160	—
MRF517	—
MRF5174	—
MRF5175	—
MRF522	MRF521
MRF524	MRF521
MRF525	MRF5003
MRF531	—
MRF532	—
MRF534	MPS536
MRF536	MPS536
MRF542	—
MRF543	—
MRF544	—
MRF545	—
MRF546	—
MRF547	—
MRF548	—
MRF549	—
MRF572	MRF571
MRF580	MRF581
MRF580A	MRF581A
MRF586	MRF5812
MRF604	MRF4427
MRF607	—
MRF627	—
MRF629	MRF5003
MRF630	MRF5003
MRF646	MRF650
MRF648	MRF650
MRF660	—
MRF750	MRF557
MRF752	MRF5003
MRF754	—
MRF838	MRF557
MRF838A	MRF557
MRF839	MRF840
MRF841	—
MRF841F	—
MRF846	MRF847
MRF873	—
MRF873S	—
MRF904	MRF9011LT1
MRF905	MR5812
MRF911	MRF571
MRF914	MRF571
MRF931	MRF9331LT1
MRF942	MRF941
MRF952	MRF951
MRF961	MRF951
MRF962	MRF951
MRF965	BFR96
MRF966	—
MRFC2369	—
MRFC521	—
MRFC544	—
MRFC545	—
MRFC559	—

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
MRFC572	—
MRFC581	—
MRFC581A	—
MRFC901	—
MRFC904	—
MRFC941	—
MRFC951	—
MRFC966	—
MRFQ19	BFR96
MRW2001F	MRW2001
MRW2003F	MRW2003
MRW2005F	MRW2005
MRW2010F	MRW2010
MRW2015	—
MRW2015F	—
MRW2020	—
MRW2020F	—
MRW2301	—
MRW2301F	—
MRW2304	—
MRW2304F	—
MRW2307	—
MRW2307F	—
MRW3001F	MRW3001
MRW3003F	MRW3003
MRW3005F	MRW3005
MRW52001	—
MRW52101	—
MRW52102	MRW52602
MRW52104	MRW52604
MRW52201	—
MRW52202	MRW52602
MRW52204	MRW52604
MRW52401	—
MRW52402	MRW52602
MRW52501	—
MRW52502	MRW52602
MRW52504	—
MRW52601	—
MRW53001	—
MRW53101	MRW53601
MRW53102	—
MRW53201	MRF53601
MRW53202	—
MRW53401	MRW53601
MRW53402	MRW53502
MRW53501	—
MRW53505	—
MRW53602	—
MRW53605	—
MRW54101	—
MRW54201	—
MRW54501	—
MRW54602	—
MWA0204	—
MWA0211L	—
MWA0270	—
MWA0304	—

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
MWA0311	—
MWA0311L	—
MWA0370	—
MWA110	—
MWA120	—
MWA130	—
MWA131	—
MWA210	—
MWA220	—
MWA230	—
MWA310	—
MWA320	—
MWA330	—
MX20-1	MHW720A1
MX20-2	MHW720A2
PAA0105-29-6L	—
PAA0105-45-25L	—
PAA0105-50-50LAS	—
PAA0200-34-1.5L	—
PAA0200-34-3.1L	—
PAA0450-33-0.4L	—
PAA0500-17-1.0L	—
PAA0500-17-2.0L	—
PAA0500-35-1.0L	—
PAA0510-25-6L	—
PAA0810-24-5L	—
PAA0810-31-25L	—
PAA0810-32-10L	—
PAA0810-38-100AB	—
PAA0810-38-5LAS	—
PAA0810-40-50L	—
PAA0810-40-50LAM	—
PAA0810-52-100AB	—
PAA0810-52-100AM	—
PAA0810-54-50LAS	—
PAA0810-54-50LSM	—
PAA1000-14-0.6L	—
PAA1000-14-1.3L	—
PAA1000-30-0.6L	—
PAA1000-42-5L	—
PAA225-42-10L	—
PAM0105-29-6L	—
PAM0105-6-50L	—
PAM0105-7-25L	—
PAM0510-25-6L	—
PAM0810-24-3L	—
PAM0810-24-5LA	—
PAM0810-6-50L	—
PAM0810-7-25L	—
PAM0810-8-10L	—
PAM225-42-10LA	—
PT4572A	MRF587
PT4579	MRF5812
PT9701B	MRF321
PT9702	MRF323
PT9702B	MRF321
PT9703	MRF321
PT9703B	MRF321

1

Table 1. Not Recommended for New Design Products (continued)

NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER	NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER	NOT RECOMMENDED FOR NEW DESIGN PART NUMBER	RECOMMENDED REPLACEMENT PART NUMBER
PT9704	MRF325	TP2330F	MRF1946/A	TP63601	—
PT9704A	MRF325	TP2335	MRF1946/A	TP63602	—
PT9704B	MRF163	TP2502	MRF652S	TP64601	—
PT9730	MRF161	TP251	—	TP64602	—
PT9731	MRF314	TP3004	TP3006	TP9380	—
PT9732	MRF321	TP3007	—	TP9383	—
PT9733	—	TP3009	MRF557	TP9386	—
PT9734	MRF323	TP3009S	MRF557	TPM401	—
PT9790	MRF429	TP3010	MRF557	TPM4040	—
PT9798	MRF429	TP3010S	MRF557	TPM405	—
PTE801	MRF890	TP3012	MRF842	TPM4100	—
RF1029	MRF1029	TP3015	MRF842	TPM4130	—
RF1030	MRF1030	TP3019	—	TPM425	—
RF1031	MRF1031	TP3022A	TP3022B	TPV3100	—
RF1032	MRF1032	TP3024A	TP3024B	TPV364	—
SHP02-36-20	—	TP3030	—	TPV375	—
SHP05-20-10	—	TP3031	—	TPV376	—
SHP05-22-04	—	TP3040	TP3061	TPV385	—
SHP05-34-04	—	TP3060	TP3061	TPV387	—
SHP06-18-04	—	TP3098	—	TPV394A	—
SHP10-15-08	—	TP3400	—	TPV5051	—
SHP10-15-08-15	—	TP3401	MRF587	TPV590	—
SHP10-17-04	—	TP3401S	MRF581	TPV591	—
SHP10-17-04-15	—	TP3402	—	TPV593	—
TP1940	MRF151G	TP5002	—	TPV657	TPV595A
TP2033	MRF1946/A	TP5025	—	TPV693	—
TP2037	MRF1946/A	TP5040	—	TPV695B	TPV5055B
TP2317	MRF1946/A	TP5050	TP5051	TPV698	TPV598
TP2325	MRF1946/A	TP5060	—		
TP2330	MRF1946/A	TP62602	—		

1

RF Power MOSFETs

Motorola RF Power MOSFETs are constructed using a planar process to enhance manufacturing repeatability. They are *N-channel field effect transistors* with an oxide insulated gate which controls vertical current flow.

Compared with bipolar transistors, RF Power FETs exhibit higher gain, higher input impedance, enhanced thermal stability and lower noise. The FETs listed in this section are specified for operation in RF Power Amplifiers and are grouped by frequency range of operation and type of application. Arrangement within each group is first by order of voltage then by increasing output power.

Table 2. To 150 MHz HF/SSB

For military and commercial HF/SSB fixed, mobile, and marine transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} Typical Gain dB @ 30 MHz	Typical IMD d_3 dB	Typical IMD d_{11} dB	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts							
MRF138	30	0.6	17	−30	−60	1.5	211-07/2
MRF140	150	4.7	15	−30	−60	0.6	211-11/2
V_{DD} = 50 Volts							
MRF148	30	0.5	18	−35	−60	1.5	211-07/2
MRF150	150	2.9	17	−32	−60	0.6	211-11/2
MRF154	600	12	17	−25	—	0.13	368/2
MRF157	600	6	20	−25	—	0.13	368/2

Table 3. To 225 MHz VHF AM/FM

For VHF military and commercial aircraft radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Eff., Typ %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF134	5	0.2	14/150	55	10	211-07/2
MRF136	15	0.38	16/150	60	3.2	211-07/2
MRF166	20	0.5	16/150	60	3.2	211-07/2
MRF136Y	30	1.2	14/150	54	1.8	319B/1
MRF137	30	0.75	16/150	60	1.8	211-07/2
MRF171	45	1.4	15/150	60	1.5	211-07/2
MRF173	80	4	13/150	65	0.8	211-11/2
MRF173CQ	80	4	13/150	65	0.8	316-01/2
MRF175LV	100	4	14/225	65	0.65	333/1
MRF174	125	8.3	11.8/150	60	0.65	211-11/2
MRF141	150	10	10/175	55	0.6	211-11/2
MRF175GV	200	8	14/225	65	0.44	375/2
MRF141G	300	13	10/175	55	0.35	375/2
V_{DD} = 50 Volts						
MRF151	150	7.5	13/175	45	0.6	211-11/2
MRF176GV	200	4	17/225	55	0.44	375/2
MRF151G	300	7.5	16/175	55	0.35	375/2

Devices listed in bold, italic are Motorola preferred devices.

Table 4. To 500 MHz UHF AM/FM

For VHF/UHF military and commercial aircraft radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Eff., Typ %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF158	2	0.02	20/400	55	13.2	305A/2
MRF158R	2	0.02	20/400	55	22	79-05/7
MRF161	5	0.4	13.5/400	45	10	244/3
MRF162	15	0.65	13.6/400	50	3.5	244/3
MRF166C	20	0.4	17/400	55	2.5	319/3
MRF164W	20	0.4	17/400	50	1.5	412/1
MRF163	25	1.6	12/400	50	2	244/3
MRF175LU	100	10	10/400	55	0.65	333/1
MRF175GU	150	9.5	12/400	55	0.44	375/2
MRF177	100	6.4	12/400	60	0.65	744A/2
MRF177M	100	6.4	12/400	60	0.65	390B/1
V_{DD} = 50 Volts						
MRF176GU	150	6	14/400	50	0.44	375/2

1

Table 5. To 520 MHz

Designed for broadband & UHF commercial and industrial applications. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 12.5 volt mobile and base station operation.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
MRF5003★	3	0.336	10.5/512	14	430/2
MRF5015★	15	1.3	11.5/512	3.5	319/3
MRF5035★	35	4.7	7.5/512	1.8	316-01/1

Table 6. To 1.0 GHz

For HF/VHF/UHF military and commercial radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Eff., Typ %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF182★	30	1.5	13/1000	55	2.1	360B/1
MRF183★	45	2.8	12/1000	55	1.5	360B/1

★New Product

Devices listed in bold, italic are Motorola preferred devices.

RF Power Bipolar Transistors

Motorola's broad line of bipolar RF power transistors are characterized for operation in RF power amplifiers. Typical applications are in military and commercial landmobile, avionics and marine radio transmitters. Groupings are by frequency band and type of application. Within each group, the arrangement of devices is by major supply voltage rating, then in the order of increasing output power. All devices are NPN polarity except where otherwise noted.

HF Transistors

Table 7. 1.5 – 30 MHz, HF/SSB

Designed for broadband operation, these devices feature specified Intermodulation Distortion at rated power output. Applications include mobile, marine, fixed station, and amateur HF/SSB equipment, operating from 12.5, 13.6, 28, or 50 volt supplies.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 30 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 or 13.6 Volts					
MRF421	100 PEP/CW	10	10	0.6	211-11/1
V_{CC} = 28 Volts					
MRF426	25 PEP/CW	0.16	22	2.5	211-07/1
MRF464	80 PEP/CW	2.53	15	0.7	211-11/1
MRF422	150 PEP/CW	15	10	0.6	211-11/1
V_{CC} = 50 Volts					
MRF429	150 PEP/CW	7.5	13	0.8	211-11/1
MRF448	250 PEP/CW	15.7	12	0.6	211-11/1

Table 8. 14 – 30 MHz, CB/Amateur Band

These HF transistors are designed for economical, high-volume use in CW, AM and SSB applications.

V_{CC} = 12.5 or 13.6 Volts

MRF455	60	3	13	1	211-07/1
MRF454	80	5	12	0.7	211-11/1

Table 9. 27 – 50 MHz, Low-Band FM Band

For use in the FM "Low-Band," for Mobile communications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 50 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 or 13.6 Volts					
MRF492	70	5.6	11	0.7	211-11/1

VHF Transistors

Table 10. 30 – 200 MHz Band

Designed for Military Radio and Commercial Aircraft VHF bands, these 28-volt devices include the all-gold metallized MRF314/15/16/17 high-reliability series.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRF314	30	3	10/150	2.2	211-07/1
MRF315	45	5.7	9/150	1.6	211-07/1
MRF316(2)	80	8	10/150	0.8	316-01/1
MRF317(2)	100	12.5	9/150	0.65	316-01/1

(2)Internal Impedance Matched

Devices listed in bold, italic are Motorola preferred devices.

VHF Transistors (continued)

Table 11. 136 – 174 MHz High Band

The "workhorse" VHF FM High-Band is served by Motorola with the broadest range of devices and package combinations in the industry.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 175 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
MRF4427	1	0.016	18(19)	125(1)	751/1
MRF553	1.5	0.11	11.5	25	317D/2
MRF2628	15	0.95	12	4	244/1
MRF1946	30	3	10	1.6	211-07/1
MRF1946A	30	3	10	1.8	145A-09/1
MRF224	40	14.3	4.5	2.2	211-07/1
MRF240	40	5	9	2.2	145A-09/1
MRF247(2)	75	15	7	0.7	316-01/1

1

UHF Transistors

Table 12. 100 – 400 MHz Band

Stringent requirements of the UHF Military band are met by MRF325, 326, 327, 329 and 2N6439 types, with all-gold metal systems, specified ruggedness and programmed wirebond construction, to assure consistent input impedances for internally matched parts.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 400 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRF325(2)	30	4.3	8.5	2.2	316-01/1
MRF326(2)	40	8	9	1.6	316-01/1
2N6439(2)	60	10	7.8	1.2	316-01/1
MRF327(2)	80	14.9	7.3	0.7	316-01/1
MRF329(2)	100	20	7	0.7	333/1
MRF392(3)	125	19.8	8	0.7	744A/1
2N6985(3)	125	19.8	8	0.7	382/1

Table 13. 100 – 500 MHz Band

Similar to the 100–400 MHz transistors, these devices have bandwidth capabilities allowing their use to 500 MHz. All have nitride passivated die, gold metal systems, specified ruggedness and controlled wirebond construction to meet the stringent requirements of military space applications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRF313	1	0.03	15/400	28.5	305A/1
MRF321	10	0.62	12/400	6.4	244/1
MRF323	20	2	10/400	3.2	244/1
MRF393(3)	100	18	7.5/500	0.7	744A/1
2N6986(3)	100	18	7.5/500	0.7	382/1

(1)$R_{\theta JA}$. Thermal Resistance. Junction to Ambient.
(2)Internal Impedance Matched
(3)Internal Impedance Matched Push-Pull Transistors
(19)Typical

Devices listed in bold, italic are Motorola preferred devices.

UHF Transistors (continued)

Table 14. 400 – 512 MHz Band

Higher power output devices in this UHF power transistor series feature internally input-matched construction, are designed for broadband operation, and have guaranteed ruggedness under output mismatch and RF overdrive conditions. Devices are specified for handheld, mobile and base station operation.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
MRF581 (4)	0.6	0.03	13/500	40	317/2
MRF555	1.5	0.15	10/470	25	317D/2
MRF652	5	0.5	10/512	7	244/1
MRF652S	5	0.5	10/512	7	249/1
MRF653	10	2	7/512	4	244/1
MRF653S	10	2	7/512	4	249/1
MRF641(2)	15	2.5	7.8/470	4	316-01/1
MRF654 (2)	15	2.5	7.8/512	4	244/1
MRF644(2)	25	5.9	6.2/470	1.7	316-01/1
MRF650 (2)	50	15.8	5.0/512	1.3	316-01/1
MRF658 (2)	65	25	4.15/512	1	316-01/1
V_{CC} = 24 Volts					
TP5002S	1.5	0.075	13/470	21	249-05/1
TP5015	15	1.34	11/470	7	319/2
TP5051	50	6	9/470	1.2	333A/2

(2)Internal Impedance Matched
(4)Small signal gain. P_o is Typ.

Devices listed in bold, italic are Motorola preferred devices.

1

900 MHz Transistors

Table 15. 806 – 960 MHz Band

Designed specifically for the 900 MHz mobile radio band, types MRF840 through MRF847 offer superior gain and ruggedness, using the unique CS-12 package, which minimizes common-element impedance, and thus maximizes gain and stability. Devices are listed for mobile and base station applications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts — Class C — Si Bipolar					
MRF559(5)	0.5	0.08	8/870	50	317/2
MRF581(5)	0.6	0.06	10(19)/870	40	317/2
MRF837(5)	0.75	0.11	8/870	40	317/1
MRF8372(5)	0.75	0.11	8/870	45	751/1
MRF557(5)	1.5	0.23	8/870	25	317D/2
MRF839F(5)	3	0.46	8/870	9	319/2
MRF840(2)(6)	10	2.5	6/870	3.1	319/1
MRF842(2)(6)	20	5	6/870	1.5	319/1
MRF844(2)(6)	30	9	5.2/870	1.5	319/1
MRF847(2)(6)	45	16	4.5/870	1	319/1

Device	P_{out} Output Power Watts	Class	P_{in}(Max) Input Power Watts	Gp (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 24 Volts — Si Bipolar						
MRF890	2	C	0.25	9/900	25	305/1
MRF890S	2	C	0.25	9/900	25	305A/1
TP3019S	2	AB or A	0.25	9/960	14	305A/1
TP3007S★	2	AB	0.25	9/960	21	305C/1
MRF896	3	AB or A	0.3	10/900	7	305/1
MRF896S	3	AB or A	0.3	10/900	7	305D/1
TP3008★	4	AB	0.28	11.5/960	5	319/2
MRF891	5	AB	0.63	9/900	7	319/2
MRF891S	5	C	0.63	9/900	7	319A/2
TP3021	10	AB or A	1	10/960	5	319/2
MRF892(2)	14	C	2	8.5/900	3.5	319/1
MRF894(2)	30	C	6	7/900	1.5	319/1
MRF897(3)	30	AB	3	10/900	1.7	395B/1
TP3034★	35	AB	7	7/960	2.3	319/2
MRF898(2)	60	C	12	7/900	1	333A/1
V_{CC} = 26 Volts — Si Bipolar						
TP3020A	2.2	A	0.28	9/960	20	244/1
TP3005	4	AB or A	0.57	8.5/960	7	319/2
TP3006	5	AB	0.63	9/960	7	319/2
TP3022B	15	AB	2.12	8.5/960	6	319/2
TP3032	21	AB	4	7.5/960	3.3	319/2
TP3024B(3)	35.5	AB	6.35	7.5/960	3	395/1
TP3061(2)	45	AB	7.13	8/960	1.2	333A/2
TP3064	50	AB	8.9	7.5/960	1.2	333A/2
TP3062(3)	60	AB	12	7/960	1.2	398/1
MRF880(3)	90	AB	12.7	8.5/900	1.3	375A/1
TP3069★	100	AB	18	7.5/960	0.7	375A/1
MRF899(3)	150	AB	24	8/900	0.8	375A/1

(2)Internal Impedance Matched
(3)Internal Impedance Matched Push-Pull Transistors
(5)Common Emitter Configuration
(6)Common Base Configuration
(19)Typical
★New Product

Devices listed in bold, italic are Motorola preferred devices.

1.5 GHz Transistors

Table 16. 1400 – 1600 MHz Band

Device	P_{out} Output Power Watts	Class	P_{in}(Max) Input Power Watts	Gp (Min)/Freq. Power Gain dB/MHz	$θ_{JC}$ °C/W	Package/Style
MRF15030★	30	A, AB	3.1	9/1490	1.4	395C/1
MRF15090★	90	A, AB	10.8	7.5/1490	0.7	375A/1

Microwave Transistors

Table 17. L-Band Pulse Power

These products are designed to operate in short pulse width, 10 μs, low duty cycle, 1%, power amplifiers operating in the 960–1215 MHz band. All devices have internal impedance matching. The prime application is avionics equipment for distance measuring (DME), area navigation (TACAN) and interrogation (IFF).

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	Gp (Min) Gain @ 1090 MHz dB	$θ_{JC}$ °C/W	Package/Style
V_{CC} = 18 Volts — Class A & AB Common Emitter					
MRF1000MA	0.2	0.02	10	25	332-04/2
MRF1000MB	0.2	0.02	10	25	332A/2
V_{CC} = 35 Volts — Class B & C Common Base					
MRF1002MA	2	0.2	10	25	332-04/1
MRF1002MB	2	0.2	10	25	332A/1
MRF1004MA	4	0.4	10	25	332-04/1
MRF1004MB	4	0.4	10	25	332A/1
V_{CC} = 50 Volts — Class C Common Base					
MRF1015MA	15	1.5	10	10	332-04/1
MRF1015MB	15	1.5	10	10	332A/1
MRF1035MA	35	3.5	10	5	332-04/1
MRF1035MB	35	3.5	10	5	332A/1
MRF1090MA	90	9	10	0.6	332-04/1
MRF1090MB	90	9	10	0.6	332A/1
MRF1150MA	150	25	7.8	0.3	332-04/1
MRF1150MB	150	25	7.8	0.3	332A/1

Table 18. L-Band Long Pulse Power

These products are designed for pulse power amplifier applications in the 960–1215 MHz frequency range. They are capable of handling up to 10 μs pulses in long pulse trains resulting in up to a 50% duty cycle over a 3.5 millisecond interval. Overall duty cycle is limited to 25% maximum. The primary applications for devices of this type are military systems, specifically JTIDS and commercial systems, specifically Mode S. Package types are hermetic.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 1215 MHz dB	$θ_{JC}$ °C/W	Package/Style
V_{CC} = 28 Volts — Class C Common Base					
MRF10005	5	0.71	8.5	8	336E/1
V_{CC} = 36 Volts — Class C Common Base					
MRF10031	30	3	10	3	376B/1
MRF10120	120	19	8	0.6	355C/1

★New Product

Devices listed in bold, italic are Motorola preferred devices.

Microwave Transistors (continued)

Table 18. L-Band Long Pulse Power (continued)

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 1215 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 50 Volts					
MRF10070	70	7	10(7)	0.4	376C/1
MRF10150	150	15	10(7)	0.25	376B/1
MRF10350	350	45	9(7)	0.11	355E/1
MRF10500	500	56	9(7)	0.12	355D/1
MRF1375	375	80	6.7	0.12	355G/1
MRF1500	500	151	5.2	0.1	355G/1

Table 19. 2 GHz Narrowband CW

The MRW2000 Series of NPN Silicon microwave power transistors are designed for common base service in amplifier or oscillator applications in the 1–2.3 GHz frequency range.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 2 GHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts — Class B & C Common Base					
MRW2001	1	0.13	9	35	328A-03/1
MRW2003	3	0.48	8	15	328A-03/1
MRW2005	5	0.8	8	8.5	328A-03/1
MRW2010	10	2	7	6	328A-03/1

Table 20. 3 GHz Narrowband CW

The MRW3000 Series are the industry's first 100% VSWR tolerant 3 GHz devices. They are common-base configured in hermetic packages and rated for 28 volt operation.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 3.0 GHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRW3001	1	0.2	7	35	328A-03/1
MRW3003	3	0.75	6	17	328A-03/1
MRW3005	5	1.6	5	8.5	328A-03/1

Table 21. 0.6 – 2.7 GHz Broadband Common Base

The MicRoAmp transistor employs MOS capacitors and other matching elements to transform the input, and in some devices, the output impedance, to a more manageable level prior to the point where package parasitics can reduce the bandwidth capability (U.S. Patent 3,713,006). These devices are assembled in common-base configuration and include an all-gold metal system and diffused ballast resistors for long life.

Device	Instantaneous Frequency Range F_L-F_H (MHz)	Output Power Min Watts	Gain Min dB	θ_{JF} °C/W	Package/Style
V_{CC} = 22 Volts					
MRAL1720-20	1700–2000	20	6	2.5	394/1
MRAL2023-3	2000–2300	3	8	16	394/1
MRAL2023-6	2000–2300	6	6.8	8	394/1
MRAL2023-18	2000–2300	18	6.5	2.5	394/1
MRAL2327-3	2300 - 2700	3	6.6	16	394/1
MRAL2327-12	2300–2700	12	7	4.5	394/1
V_{CC} = 28 Volts					
MRA1417-6	1400–1700	6	7.4	8	394/1

(7)Typical @ 1090 MHz

Devices listed in bold, italic are Motorola preferred devices.

Microwave Transistors (continued)

Table 22. Power Oscillator

This oscillator device, a **common collector** configuration with diffused ballast resistors, gold metallization and hermetic package, provides high reliability in severe environmental conditions and is fully characterized for power oscillator applications.

Device	Operating Conditions V_{CE}/I_C V/mA	Output Power (Typ) — Watts/@ Freq. — GHz				Package/Style
		Minimum	P_o @ Low f	P_o @ Mid f	P_o @ High f	
TP62601	20/220	1.25/2	1.85/2	1.35/2.5	0.85/3	328A-03/5

Linear Transistors

The following sections describe a wide variety of devices specifically characterized for linear amplification. Included are medium power and high power parts covering frequencies from 100 MHz–4 GHz.

1

Table 23. To 1 GHz, Class A

These devices offer a selection of performance and price for linear amplification to 1 GHz. The "MRA" prefix parts are input matched and feature high overdrive and extreme ruggedness capability.

Device	P_o @ 1 dB Comp. Point Watts	G_{SS} (Min)/Freq. Small Signal Gain dB/MHz	Bias Point (Vdc/A)	θ_{JC} °C/W	Package/Style
V_{CC} = 19 Volts					
MRA1000-7L	7	9/1000	19/1.2	4	145A-09/1
MRA1000-14L	14	8/1000	19/2.4	2.1	145A-09/1
V_{CC} = 25 Volts					
MRF1029(9)	1.5	8/1000	25/0.2	12	244/1
MRF1030(9)	3	7.5/1000	25/0.4	6	244/1
MRF1031(9)	4.5	7/1000	25/0.6	3.5	244/1
MRF1032(9)	6	6.5/1000	25/0.85	3.5	244/1

Table 24. To 2 GHz, Class A

These parts offer low cost alternatives to matched devices used primarily as pre-drivers to 2 GHz.

Device	P_o @ 1 dB Comp. Point Watts	G_{SS} (Min)/Freq. Small Signal Gain dB/MHz	Bias Point (Vdc/A)	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
MRF3094(9)	0.5	10.5/2000	20/0.12	40	328A-03/1
MRF3104(9)	0.5	10.5/2000	20/0.12	40	305A/1
MRF3095(9)	0.8	9/2000	20/0.12	35	328A-03/1
MRF3105(9)	0.8	9/2000	20/0.12	35	305A/1
MRF3096(9)	1.6	9/2000	20/0.24	22	328A-03/1
MRF3106(9)	1.6	9/2000	20/0.24	22	305A/1
MRF2000-5L(10)	5	7/2000	19/0.6	10	360A/1

(9)Former Prefix was "RF"
(10)Former prefix was "MRA."

Devices listed in bold, italic are Motorola preferred devices.

Linear Transistors (continued)

Table 25. UHF Ultra Linear For TV Applications

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band IV and Band V. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P_{ref}(Min) Watts	Gp (Min)/Freq. Small Signal Gain dB/MHz	3 Tone IMD(8) dB	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
TPV596A	0.5	11.5/860	−58	20	244/1
TPV597	1	10.5/860	−58	9	244/1
TPV598	4	7/860	−60	5	244/1
V_{CC} = 25 Volts					
TPV595A	14	8.5/860	−47	2.5	395/1
TPV695A	14	9.5/860	−47	2.5	395B/1
TPV7025	25	8.5/860	−45	1.5	398/1
TPV6030	20/35(11)	9.5/860	−51/–	1.1	375A/1
V_{CC} = 28 Volts					
TPV5055B	50(11)	7/860	—	1.5	398/1
TPV8100B	100(11)	8.5/860	—	0.7	398/1
TPV8200B	150(11)	8/860	—	0.7	375A/1

1

Table 26. Microwave Linear For PCN Applications

The following devices have been developed for linear amplifiers in the 1.5−2 GHz region and have characteristics particularly suitable for PCN base station applications.

Device	P_{out} Watts	Class	Bias Point Vdc/mA	Gain (Typ)/Freq dB/MHz	θ_{JC} °C/W	Package/Style
MRF6401(12)★	0.5	A	20/80	10/1880	30	305C/1
MRF6402(13)★	4	AB	26/40	10/1880	5	319/2
MRF6406(14)★	12	AB	26/100	7.5/1880	4.5	319/2
MRF6403(15)★	25	AB	26/250	6.5/1880	2.5	395/1
MRF6404(16)★	30	AB	26/150	9/1880	1.4	395C/1

Table 27. Microwave Linear Power

Common emitter microwave devices are offered for a wide variety of uses in small and medium signal, Class A, AB and C applications up to 4 GHz. The use of all-gold metal systems, diffused ballast resistors and hermetic packaging results in devices that display excellent reliability even in a military environment.

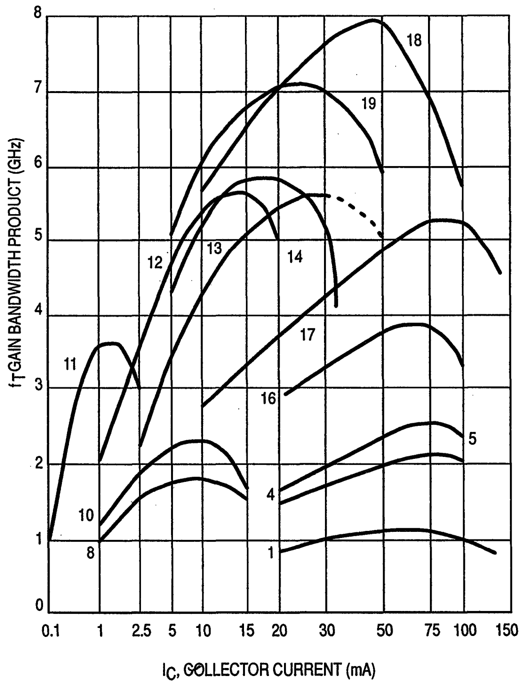
Device	G_{SS} (Min) @ Freq. Small Signal Gain dB/GHz	1 dB Comp. Watts	P_{sat} Watts	−30 dB IMD Watts	Emitter Current mA	Package/Style
V_{DD} = 20 Volts						
MRW52602	6/2	3.6	5	3	440	328A-03/1
MRW52604	5/2	7.2	10	6	880	328A-03/1
MRW53502	5/3	1.6	2	1.5	230	401/1
MRW53601	6/3	0.8	1	0.8	120	328A-03/1
MRW54001	5/4	0.5	0.8	0.5	120	400/1
MRW54601	6/4	0.5	0.8	0.5	120	328A-03/1

(8)Vision Carrier: − 8 dB; Sound Carrier: − 7 dB; Sideband Carrier: − 16 dB
(11)Output power at 1 dB compression in Class AB
(12)Formerly known as "TP4001S"
(13)Formerly known as "TP4004"
(14)Formerly known as "TP4012"
(15)Formerly known as "TP4025"
(16)Formerly known as "TP4035"
★New Product

Devices listed in bold, italic are Motorola preferred devices.

RF Small Signal Transistor Gain Characteristics

Curve numbers apply to transistors listed in the subsequent tables.



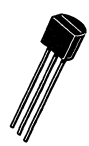
Selection by Package

In small-signal RF applications, the package style is often determined by the end application or circuit construction technique. To aid the circuit designer in device selection, the Motorola broad range of RF small-signal amplifier transistors is organized by package. Devices for other applications such as oscillators or switches are shown in the appropriate preceding tables. **These devices are NPN polarity unless otherwise designated.**

1

Plastic SOE Case

Table 28. Plastic SOE Case

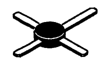
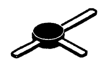
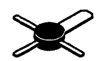
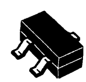
Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 1-16	NF Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 29-04/2, TO-226AA											
MPS536(17)	5	−20	19	4.5	500	14	500	−10	−30	625	
LP1001	5	10	—	2.7	500	12.5	1000	15	—	625	
LP1001A	5	10	—	3.2	1000	12.5	1000	15	—	625	
LP1983	4.5	15	—	2.4	900	12	900	15	30	300	
MPS901(29)	4.5	15	12	2.4	900	12	900	15	30	300	
MPS911(29)	7	30	13	1.7	500	16.5	500	12	40	625	
MPS571(29)	8	50	18	2	500	14	500	10	80	625	
MPS3866(29)	0.8	50	1	—	—	10	400	30	400	625	

(17)PNP
(29)Packaging Options Available in Tape and Reel and Fan Fold Box

Devices listed in bold, italic are Motorola preferred devices.

Selection by Package (continued)

Table 28. Plastic SOE Case (continued)

Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 1-16	NF Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 317/2 — MACRO-X											
MRF521[17]	4.2	−50	—	2.8	1000	11	1000	−10	−70	750	
MRF901	4.5	15	12	2	1000	12	1000	15	30	375	
MRF941	8	15	—	2.1	2000	12.5	2000	10	50	400	
MRF951	7.5	30	—	2.1	2000	12.5	2000	10	100	1000	
MRF571	8	50	18	1.5	1000	12	1000	10	70	1000	
MRF581	5	75	17	2	500	15.5	500	18	200	2500	
MRF581A	5	75	17	1.8	500	15.5	500	15	200	2500	
MRF837	5	75	17	—	—	10	870	16	200	2500	
MRF559	3	100	16	—	—	13	512	18	150	2000	
Case 317A/2 — MACRO-T											
BFR90	5	14	12	2.4	500	18	500	15	30	180	
BFR96	4.5	50	14	2	500	14.5	500	15	100	500	
Case 317D/2,3											
MRF553	—	—	—	—	—	13	175	16	500	3000	
MRF555	—	—	—	—	—	12.5	470	16	400	3000	
MRF557	—	—	—	—	—	9	870	16	400	3000	
Case 318-07/6 — SOT–23											
MMBR521LT1[17]	3.4	−35	—	1.5	500	15	500	−10	−70	312	
MMBR536LT1[17]	5.5	−20	19	4.5	500	14	500	−10	−30	350	
MMBR4957LT1[17]	1.2	−2	10	3	450	17	450	−30	−30	350	
MMBR931LT1	3	1	11	4.3	1000	10	1000	5	5	350	
MMBR5031LT1	1	5	—	2.5	450	17	450	10	20	350	
MMBR5179LT1	1.4	5	8	4.5	200	15	200	12	50	350	
BFR92ALT1	3.4	14	—	3.0	500	15	—	15	25	350	
MMBR920LT1	4.5	14	—	2.4	500	15	500	15	35	350	
MMBR901LT1	4	15	12	1.9	1000	12	1000	15	30	350	
MMBR941LT1	8	15	—	2.1	2000	8.5	2000	10	50	400	
MMBR941BLT1	8	15	—	2.1	2000	8.5	2000	10	50	400	
BFS17LT1	1.3	25	—	5	30	—	—	15	—	350	
BFR93ALT1	3.4	30	—	2.5	30	—	—	12	35	350	
MMBR911LT1	6	30	13	2	500	17	500	12	40	350	
MMBR951LT1	8	30	—	2.1	2000	7.5	2000	10	100	500	
MMBR951ALT1	8	30	—	2.1	2000	7.5	2000	10	100	500	
MMBR571LT1	8	50	18	2	500	16.5	500	10	80	350	

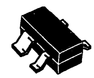
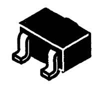
(17)PNP

Devices listed in bold, italic are Motorola preferred devices.

1

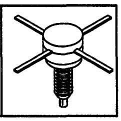
Selection by Package (continued)

Table 28. Plastic SOE Case (continued)

Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 1-16	NF Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 318A/1 — SOT-143											
MRF5211LT1 [17]	4.2	−50	—	2.8	1000	11	1000	−10	−70	580	
MRF9331LT1	5	1	—	2.5	1000	12.5	1000	8	1	50	
MRF9011LT1	3.8	15	12	2.3	1000	10.2	1000	15	30	300	
MRF9411LT1	8	15	—	2.1	2000	9.5	2000	10	50	400	
MRF9411BLT1	8	15	—	2.1	2000	9.5	2000	10	50	400	
MRF9511LT1	8	30	—	2.1	2000	9	2000	10	100	500	
MRF0211LT1	5.5	40	18	1.8	1000	9.5	1000	15	70	580	
MRF5711LT1	8	50	18	1.6	1000	13.5	1000	10	70	580	
Case 419/3 — SC-70/SOT-323											
MRF947T1	8	15	—	2.1	1500	10.5	1500	10	50	175	
MRF947BT1	8	15	—	2.1	1500	10.5	1500	10	50	175	
MRF957T1	8	30	—	2.0	1500	9	1500	10	100	175	
Case 751/1 — SO-8											
MRF5583[17][18]	2.1	−35	5	—	—	1.5	250	−30	−500	1000	
MRF5943 [18]	1.5	35	4	3.4	200	12	250	30	400	1000	
MRF3866 [18]	0.8	50	1	—	—	10.5	400	30	400	1000	
MRF4427[18]	1.6	50	1	—	—	18	175	20	400	1000	
MRFQ17[18]	2.25	50	5	—	—	12	500	25	300	1000	
MRF5812 [18]	5.5	75	17	2	500	15.5	500	15	200	1500	
MRF8372 [18]	5	75	17	—	—	10	870	16	200	1500	

Ceramic SOE Case

Table 29. Ceramic SOE Case

Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 1-16	N Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 244A/1,3											
MRF587	5.5	90	17	3	500	13	500	15	200	5000	

[17]PNP

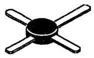
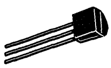
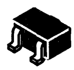
[18]Tape and Reel Packaging Options Available

Devices listed in bold, italic are Motorola preferred devices.

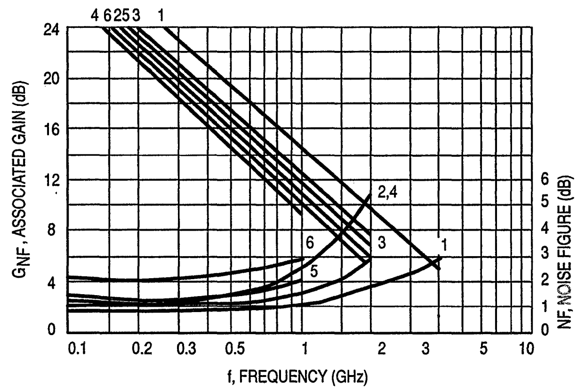
Selection by Application

Table 30. Low Noise

The Small-Signal devices listed are designed for low noise and high gain amplifier mixer, and multiplier applications. Each transistor type is available in various packages. **Polarity is NPN unless otherwise noted.**

Package	Name	Case Number	Curve Number (See figure below)					
			1	2(17)	3	4	5	6
	MACRO-X	317/2	MRF941 MRF951(20)	MRF521	MRF571	MRF581	MRF901	—
	TO-226AA	29-04/2	—	—	MPS571	—	MPS901	MPS911
	SOT-23	318-07/6	MMBR941LT1 MMBR951LT1(20)	MMBR521LT1	MMBR571LT1	—	MMBR901LT1	MMBR911LT1
	SC-70/ SOT-323	419/3	MRF947T1 MRF947BT1 MRF957T1(20)	—	—	—	—	—
	SOT-143	318A/1	MRF9411LT1 MRF9511LT1(20)	MRF5211LT1	MRF5711LT1 MRF0211LT1(17)	—	MRF9011LT1	—
	SO-8	751/1	—	—	—	MRF5812	—	—

(17)PNP
(20)Higher Current Version



Gain and Noise Figure versus Frequency

Devices listed in bold, italic are Motorola preferred devices.

Selection by Application (continued)

Table 31. CATV, MATV and Class A Linear

For Class A linear CATV/MATV applications. Listed according to increasing gain bandwidth (f_T).

Device	Nominal Test Conditions V_{CE}/I_C Volts/mA	f_T Typ MHz	Noise Figure Typ/Freq. dB/MHz	Distortion Specifications 2nd Order IMD dBc	3rd Order IMD dBc	12 Ch. Cross-Mod. dBc	Output Level dBmV	$V_{(BR)CEO}$ V	Package/ Style
MMBR5179LT1	6/5	1500	4/450					12	318-07/6
MRF5943	15/50	1500	3.4/200					30	751/1
MRF5583(17)	10/–100	1500						–30	751/1
MMBR4957LT1(17)	10/–2	2000	3/450					–30	318-07/6
MMBR5031LT1	6/5	2000	1.9/450					10	318-07/6
MRFQ17	12.5/50	2200						25	751/1
MMBR920LT1	10/14	4500	2.4/500					15	318-07/6
BFR96	10/50	4500	2/500					15	317A/2
BFR90	10/14	5000	2.4/500					15	317A/2
MRF581	10/75	5000	2.7/300		–65		+50	18	317/2
MRF581A	10/75	5000	1.8/500		–65		+50	15	317/2
MRF5812	10/75	5000	1.8/500		–65		+50	15	751/1
LP1001		5000	2.7/500					15	29-04/2
LP1001A		5000	3.2/1000					15	29-04/2
MRF587	15/90	5500	3/500	–52	–72		+50	17	244A/1

Table 32. UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing output power.

Device	Test Conditions f MHz	V_{CC} Volts	P_{out} Min mW	f_T Typ MHz	Package/Style
MPS3866	400	15	1000	800	29-04/2
MRF3866	400	15	1000	800	751/1

(17)PNP

Devices listed in bold, italic are Motorola preferred devices.

RF Integrated Circuits

The MRFIC2001 through MRFIC2006 device series is Motorola's first introduction of an integrated solution for the personal communications market. Although designed as a chip set solution for CT2, the partitioning of the functions makes the use of these devices ideal in other 900 MHz personal communications systems such as cordless telephone (915 MHz), GSM, and ISM designs.

To 1.0 GHz

Table 33. Down Converter

Device	RF Freq. Range MHz	IF Freq. Range MHz	Supply Volt. Range V	Supply Current mA (Typ)	Conv. Gain dB (Typ)	Output Level, 1 dB Comp. dBm (Typ)	Package
MRFIC2001★(18)	500–1000	0–250	2.7–5.0	4.7	23	–10	751

Table 34. Upmixer

Device	RF Freq. Range MHz	IF Freq. Range MHz	Supply Volt. Range V	Supply Current mA (Typ)	Conv. Gain dB (Typ)	Output Level, 1 dB Comp. dBm (Typ)	Package
MRFIC2002★(18)	500–1000	0–250	2.7–5.0	5.5	10	–18	751

Table 35. Antenna Switch

Device	Freq. Range MHz	Supply Volt. Range V	Supply Current μA (Typ)	Recommended Input Power dBm	Insertion Loss Port RF1 to RF2 /RF1 to RF3 dB (Typ)	Isolation Port RF1 to RF2 /RF1 to RF3 dB (Typ)	Package
MRFIC2003★(18)	100–1000	2.8–6.0	<10	17	0.8/0.5	23/20	751

Table 36. Driver and Ramp

Device	Freq. Range MHz	Supply Volt. Range V	Supply Current TX/RX mA (Typ)	Small Signal Gain dB (Typ)	Gain Control dB (Typ)	P_{out}, 1 dB Compression dBm (Typ)	Package
MRFIC2004★(18)	800–1000	2.7–4.0	11/0.7	21.5	34	–1	751B

Table 37. Integrated Power Amplifier

Device	Freq. Range MHz	Supply Volt. Range V	Supply Current mA (Typ)	Small Signal Gain dB (Typ)	Return Loss Input/Output dB (Typ)	P_{out}, 1 dB Compression dBm (Typ)	Package
MRFIC2006★(18)	500–1000	1.8–4.0	46	23	15	15.5	751

(18)Tape and Reel Packaging Options Available
★New Product

Devices listed in bold, italic are Motorola preferred devices.

RF Amplifiers

High Power

Complete amplifiers with 50 ohm in/out impedances are available for a variety of applications including land mobile radios, base stations, TV transmitters and other uses requiring large-signal amplification, both linear and Class C. Frequencies covered range from 68–950 MHz with power levels extending to 180 watts.

Land Mobile/Portable

The advantages of small size, reproducibility and overall lower cost become more pronounced with increasing frequency of operation. These amplifiers offer a wide range in power levels and gain, with guaranteed performance specifications for bandwidth, stability and ruggedness.

Table 1. VHF/UHF, Class C

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	G_p Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
68–210 MHz, VHF Band — Class C (Silicon Bipolar Die)						
MHW105	5	0.001	68–88	37	7.5	301K/3
MHW607-1	7	0.001	136–150	38.4	7.5	301K/3
MHW607-2	7	0.001	146–174	38.4	7.5	301K/3
MHW607-3	7	0.001	174–195	38.4	7.5	301K/3
MHW607-4	7	0.001	184–210	38.4	7.5	301K/3
400–512 MHz, UHF Band — Class C (Silicon Bipolar Die)						
MHW704	3	0.001	440 – 470	34.8	7.5	301J/1
MHW707-1	7	0.001	403 – 440	38.4	7.5	301J/1
MHW707-2	7	0.001	440 – 470	38.4	7.5	301J/1
MHW707-3	7	0.001	470 – 500	38.4	7.5	301J/1
MHW707-4	7[23]	0.001	490 – 512	38.4[23]	7.5	301J/1
MHW720A1[22]	20	0.15	400 – 440	21	12.5	700/1
MHW720A2[22]	20	0.15	440 – 470	21	12.5	700/1
MHW720A3	20	0.15	450 – 458	21	12.5	700/1
806–960 MHz, UHF Band — Class C (Silicon Bipolar Die)						
MHW851-1	1.6	0.001	820–850	32	6	301N/1
MHW851-2	1.6	0.001	870–905	32	6	301N/1
MHW851-3	2	0.001	890–915	33	6	301N/1
MHW851-4	1.6	0.001	915–925	32	6	301N/1
MHW803-1	2	0.001	820–850	33	7.5	301E/1
MHW803-2	2	0.001	806–870	33	7.5	301E/1
MHW803-3	2	0.001	870–905	33	7.5	301E/1
MHW804-1	4	0.001	800–870	36	7.5	301F/1
MHW804-2	4	0.001	896–940	36	7.5	301F/1
MHW806A1[22]	6	0.03	820–850	23	12.5	301H/2
MHW806A2[22]	6	0.03	806–870	23	12.5	301H/2
MHW806A3[22]	6	0.04	890–915	21.7	12.5	301H/2
MHW806A4[22]	6	0.04	870–950	21.7	12.5	301H/2
MHW812A3[22]	12	0.1	890–915	20.8	13	301H/2
806 – 960 MHz, UHF Band — Class C (GaAs FET Die)						
MHW9002-1 [22]	1.4	0.005	824–849	24.5	5.8	420A/1
MHW9002-2 [22]	1.4	0.005	870–905	24.5	5.8	420A/1
MHW9002-3 [22]	1.6	0.005	890–915	25	5.8	420A/1
MHW9002-4 [22]	1.4	0.005	898–925	24.5	5.8	420A/1

[22] Designed for Wide Range P_{out} Level Control
[23] P_o @ f = 490 MHz. P_o = 6.5 W @ f = 512 MHz

Devices listed in bold, italic are Motorola preferred devices.

High Power: Land Mobile/Portable (continued)

Table 2. UHF, Linear

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	G_p Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
806–960 MHz, UHF Band — Class AB (Silicon Bipolar Die)						
MHW927A(22)	6(24)	0.001	824–849	37.8	12.5	301AA/1
MHW927B(22)	6(24)	0.001	824–849	37.8	12.5	301AA/1
880–915 MHz (for GSM) — Class AB (Silicon Bipolar Die)						
MHW903(22)	3.5	0.001	890–915	35.4	7.2	413A/1
MHW953(22)	3.5	0.001	890–915	35.4	7.2	301V/1
MHW954(22)	3.5	0.1	890–915	15.4	7.2	301Y/1
MHW909(22)	9	0.1	890–915	19.5	7.2	301T/1
MHW912(22)	12	0.001	890–915	40.8	12.5	301R/1
MHW914(22)	14	0.001	890–915	41.4	12.5	301R/1
MHW915(22)	14	0.1	890–915	21.4	12.5	301T/1
MHW932(22)	32	0.1	890–915	26	12.5	301S/1

1

TV Transmitters

Table 3. VHF Ultra Linear for TV Applications

These amplifiers are characterized for ultra-linear applications in Band IV and Band V TV transmitters.

Device	Frequency MHz	P_{ref} Watts	Gp (Min)/Freq. Power Gain dB/MHz	3 Tone(8) IMD 1 dB	3 Tone(25) IMD 2 dB	V_{CC} Volts	Package/Style
ATV6031	470–860	20	10.5/860	–50	–53	26.5	389B/1
MRFA2600(26)★	470–860	20	10.5/860	–50	–53	26.5	429A/1
ATV6060	470–860	40	9/860	–50	–53	25.5	389U/1
MRFA2602(28)★	470–860	40	9/860	–50	–53	25.5	429C/1
RFA8090B★	470–860	95(11)	8/860	—	—	28	429E/1
RFA8180B★	470–860	180(11)	8/860	—	—	28	429/1

(8)Vision Carrier: – 8 dB; Sound Carrier: – 7 dB; Sideband Carrier: – 16 dB
(11)Output power at 1 dB compression in Class AB
(22)Designed for Wide Range P_{out} Level Control
(24)Average Power; Peak Power is twice average power
(25)Vision Carrier: – 8 dB; Sound Carrier: – 10 dB; Sideband Carrier: – 16 dB
(26)Formerly known as "RFA6031"
(28)Formerly known as "RFA6060"
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power

The following categories describe a wide range of complete amplifier assemblies both hybrid and monolithic for use in CATV distribution systems, instrumentation, communications and military equipment. A variety of power levels and frequencies of operation is offered for many applications.

CATV Distribution

Motorola Hybrids are manufactured using fourth generation technology which has set new standards for CATV system performance and reliability. These hybrids have been optimized to provide premium performance in all CATV systems up to 152 channels.

Table 4. 5–200 MHz Hybrids

Device	Hybrid Gain (Nominal) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test[30] dB	Composite Triple Beat dB 22 CH	Composite Triple Beat dB 26 CH	Cross Modulation dB 22 CH	Cross Modulation dB 26 CH	Noise Figure @ 175 MHz dB	Package/ Style
MHW1134	13	22	+50	–72	–73	–71[19]	–65	–65[19]	7	714/1
MHW1224	22	22	+50	–72	–71	–68[19]	–62	–62[19]	5.5	714/1
MHW1244	24	22	+50	–72	–70	–68[19]	–61	–61[19]	5	714/1

Table 5. 40–450 MHz Hybrids

Device	Hybrid Gain (Nominal) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 60 CH	Cross Modulation dB 60 CH	Noise Figure @ 450 MHz dB Typ	Package/ Style
Conventional Hybrids								
MHW5122A	12	60	+46	–72[31]	–58	–61	7	714/1
MHW5142A	14	60	+46	–74[31]	–61	–62	6	714/1
MHW5172A	17	60	+46	–74[31]	–60	–62	6	714/1
MHW5182A	18	60	+46	–72[31]	–61	–59	5.5	714/1
MHW5183	18	60	+46	–62[31][32]	–58	–57	4.5	714/1
MHW5222A	22	60	+46	–72[31]	–60	–59	4.5	714/1
MHW5272A	27	60	+46	–72[31]	–59	–60	5.5	714/1
MHW5342A	34	60	+46	–72[31]	–59	–59	5	714/1
MHW5382A	38	60	+46	–70[31]	–59	–59	4	714/1
CA97901	21.2[44]	30	+46	–65	–65	–65	5.5	714F/1
Power Doubling Hybrids								
MHW5185B★	18	60	+46	–67[32]	–67	–67	5.5	714/1
MHW5205	20	60	+46	–58[33]	–64	–64	5.5	714/1
MHW5225	22	60	+46	–69[31]	–62	–60	5	714/1
Feedforward Hybrids								
MFF124B	24	60	+46	–84[31]	–79	–75	10[34]	825A/1

(19)Typical
(30)Channels 2 and A @ 7
(31)Channels 2 and M13 @ M22
(32)Composite 2nd order; V_{out} = +46 dBmV/ch
(33)Composite 2nd order IMD, 60 channel flat
(34)Maximum
(44)Hi-Slope Trunk Amplifier. The specified gain is at 450 MHz.
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power: CATV Distribution (continued)

Table 6. 40–550 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 77 CH	Composite Triple Beat dB 87 CH	Cross Modulation dB 77 CH	Cross Modulation dB 87 CH	Noise Figure @ 550 MHz dB Typ	Package/ Style
			Maximum Distortion Specifications							
Conventional Hybrids										
MHW6122	12	77	+44	–74[35]	–56		–62		7	714/1
MHW6142	14	77	+44	–72[35]	–59		–62		6.5	714/1
MHW6172	17	77	+44	–70[35]	–59		–62		6	714/1
MHW6182	18	77	+44	–72[35]	–58		–62		6	714/1
MHW6183	18	77	+44	–58[36]	–58		–58		5	714/1
MHW6222	22	77	+44	–66[35]	–57		–57		5	714/1
MHW6272	27	77	+44	–64[35]	–57		–57		6	714/1
MHW6342	34	77	+44	–64[35]	–57		–57		5.5	714/1
Power Doubling Hybrids										
MHW6185B★	18	77	+44	–65[36]	–65		–68		6	714/1
MHW6185-6★	18	87	+44	–60[36]		–62		–66	5[34]	714/1
Feedforward Hybrids										
MFF224B	24	77	+44	–86[35]	–75		–70		11[34]	825A/1

Table 7. 40–600 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 85 CH	Cross Modulation dB 85 CH	Noise Figure @ 600 MHz dB Max	Package/ Style
			Maximum Distortion Specifications					
Feedforward Hybrids								
Conventional Hybrids[37]								
Power Doubling Hybrids[37]								
MFF324B	24	85	+44	–86[38]	– 73	– 68	12.5	825A/1

[34] Maximum
[35] Channels 2 and M30 @ M39
[36] Composite 2nd order; V_{out} = +44 dBmV/ch
[37] 600 MHz versions of the Conventional and Power Doubling Hybrids are available upon request. Please consult factory.
[38] Channels 2 and M39 @ M48
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power: CATV Distribution (continued)

Table 8. 40–750 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 110 CH	Cross Modulation dB 110 CH	Noise Figure @ 750 MHz dB Typ	Package/ Style
Conventional Hybrids								
MHW7182★	18	110	+44	–62(39)	– 62	– 64	5.5	714/1

Table 9. 40–860 MHz Hybrids

Device	Gain dB	Frequency MHz	V_{CC} Volts	2nd Order IMD @ V_{out} = 50 dBMV/ch	DIN45004B @ f=860 MHz dBµV	Noise Figure @ 860 MHz dB Max	Package/ Style
Conventional Hybrids							
CA901	17	40 – 860	24	–60	120	8	714P/2
CA901A	17	40 – 860	24	–64	120	8	714P/2
Power Doubling Hybrids							
CA902	17	40 – 860	28	–63	123	9.5	714P/2
CA902A	17	40 – 860	28	–67	123	9.5	714P/2
CA922	17	40 – 860	24	–63	123	9.5	714P/2
CA922A	17	40 – 860	24	–67	123	9.5	714P/2
CA912	17	40 – 860	15	–63	123	9.5	714P/3

Table 10. 40–860/1000 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Cross Modulation dB 128 CH	Cross Modulation dB 152 CH	Composite Triple Beat dB 128 CH	Composite Triple Beat dB 152 CH	Noise Figure @ 860 MHz dB Typ	Package/ Style
Conventional Hybrids										
MHW8182★	18	128	+38	–60(40)	–60	—	–60	—	6	714/1
MHW9182★	18	152	+38	–59(40)	—	–59	—	–59	6.5	714/1

(39)Composite 2nd order; V_{out} = +40 dBmV/ch
(40)Composite 2nd Order; V_{out} = +38 dBmV/ch
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power: CATV Distribution (continued)

Table 11. Standard Linear Hybrids

The CA series of RF linear hybrid amplifiers consists of a family of medium power, broadband gain blocks in the CATV industry standard "CA" package. These amplifiers were designed for multi-purpose RF applications where linearity, dynamic range and wide bandwidth are of primary concern. Each amplifier is available in various package options. Eleven parts are available as indicated in a low profile package. Arrangement within the group is in order of increasing maximum frequency.

Device	BW MHz	Gain Flatness Typ ±dB	Gain/Freq. Typ dB/MHz	P_{1dB} Typ dBm	NF/Freq. Typ dB/MHz	3rd Order Intercept Point/Freq. Typ dBm/MHz	VSWR Max 50 Ω/75Ω	V_S/I_S Typ V/mA	Case/ Style
CA2850CR	40–100	0.1	17.5/100	25	4.5/70	40/70	1.3/—	–19/125	714H/1
CA2875CR	40–100	0.1	17.5/100	26	4.5/70	43/70	—/1.1	–19/155	714H/1
CA2830C	5–200	0.5	34.5/100	29	4.7/200	46/200	2/—	24/300	714F/1
CA2832C	1–200	0.5	35.5/100	33	5/200	47/200	2/—	28/435	714F/1
CA2833C	5–200	0.5	34.5/100	29	4.7/200	46/200	2/—	24/300	714G/1
CA2842C	10–400	0.5	22/100	32	4/100	44/300	1.5/—	24/230	714F/1
CA2810C	10–450	1.5	34/50	30	—/300	43/300	2/1.3	24/310	714F/1
CA2818C	10–400	0.5	18.5/50	30	5/200	45/200	2/—	24/205	714F/1
CA2870C	20–450	—	34/100	30	—/300	43/300	2/—	24/310	714M/1
CA2851CR	40 – 100	0.1	17.5/100	25	4.5/70	40/70	1.3/—	–19/125	714L/1
CA4800C[41]	10–1000	1	17.5/1000	26	7.5/1000	38/1000	2.6/—	24/220	714P/2
CA4812C[41]	10–1000	1	17.5/1000	26	7.5/1000	38/1000	2.6/—	12/380	714P/3
CA4815C[41]	10–1000	1	17.5/1000	26	7.5/1000	38/1000	2.6/—	15/380	714P/3
CA5800C[41]	10–1000	1	15.5/1000	30	8.5/1000	40.5/1000	2.6/—	28/400	714P/2
CA5801[41]	50 – 1000	1	17.5/1000	30	8.5/1000	41.5/1000	2.6/—	28/400	714P/2
CA5815C[41]	10–1000	1	15.5/1000	30	8.5/1000	40.5/1000	2.6/—	15/700	714P/3
CA4900[41]	10–1200	1	17.5/1000	26	7.5/1200	38/1000	2.6/—	24/220	714P/2
CA4912[41]	10–1200	1	17.5/1000	26	7.5/1200	38/1000	2.6/—	12/380	714P/3
CA4915[41]	10–1200	1	17.5/1000	26	7.5/1200	38/1000	2.6/—	15/380	714P/3
CA5900[41]	10–1200	1	15.5/1000	30	8.5/1200	40.5/1000	2.6/—	28/400	714P/2
CA5915[41]	10–1200	1	15.5/1000	30	8.5/1200	40.5/1000	2.6/—	15/700	714P/3

[41]Available in thin flange package (714T) by adding suffix "S" after part number, i.e. CA4800CS.

1

Devices listed in bold, italic are Motorola preferred devices.

Low Power (continued)

CRT Drivers

Table 12. Video Amplifiers

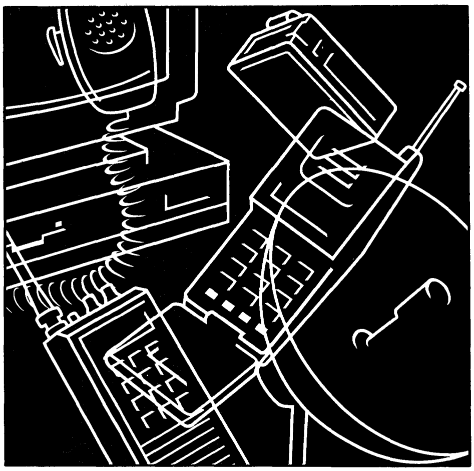
These complete hybrid amplifiers are specifically designed for CRT driver applications requiring high frequency response and high voltage, such as high resolution color graphics video monitors. Gold metallized die and substrates are used to insure high reliability and improved ruggedness.

Device	V_{CC} (nom) Volts	Gain(42) V/V	t_r/t_f (Typ)(43) nsec	3 dB BW (Typ)(43) MHz	V_{out} (Max) Volts	Load	Package/Style
CR2424A	60	12	2.0	145	50 P-P	6 to 20 pF	714G/1
CR2424R	−60	12	2.0	145	50 P-P	6 to 20 pF	714H/1
CR2425A	60	12	2.0	145	50 P-P	6 to 20 pF	714F/1
CR2428★	60	12	2.0	145	50 P-P	6 to 20 pF	431A/1
CR3424A	80	12	2.2	130	70 P-P	6 to 20 pF	714G/1
CR3424R	−80	12	2.2	130	70 P-P	6 to 20 pF	714H/1
CR3425A	80	12	2.2	130	70 P-P	6 to 20 pF	714F/1
CR3428★	80	12	2.2	130	70 P-P	6 to 20 pF	431A/1

(42)Insertion Gain; 50 Ohm Source
(43)Capacitive Load 8.5 pF, V_{out} = 40 V P-P
★New Product

1

Devices listed in bold, italic are Motorola preferred devices.



Discrete Transistor Data Sheets

2

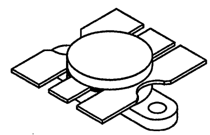
2N6439

The RF Line
NPN Silicon RF Power Transistor

. . . designed primarily for wideband large-signal output amplifier stages in the 225 to 400 MHz frequency range.

- Guaranteed Performance in 225 to 400 MHz Broadband Amplifier @ 28 Vdc
  Output Power = 60 Watts over 225 to 400 MHz Band
  Minimum Gain = 7.8 dB @ 400 MHz
- Built-In Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

**60 W, 225 to 400 MHz
CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR
NPN SILICON**



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS*

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	146 0.83	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS* (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc

(continued)

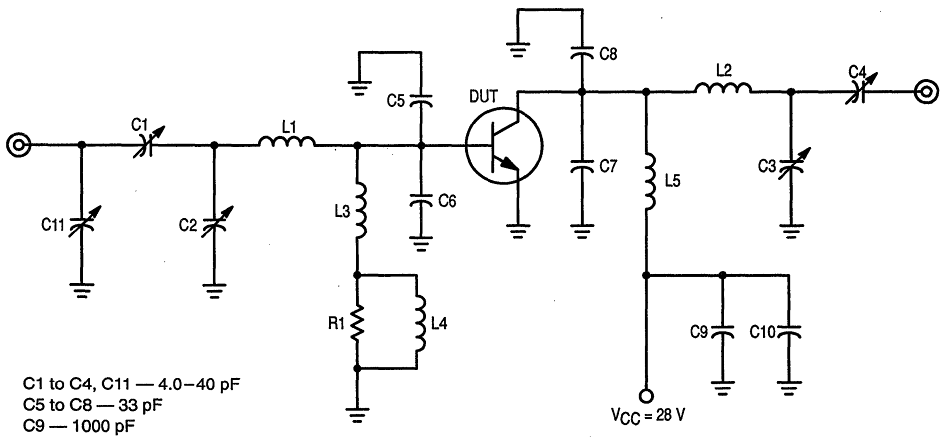
NOTE:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

* Indicates JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS* — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	67	75	pF
BROADBAND FUNCTIONAL TESTS (Figure 6)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 225–400 MHz)	G_{PE}	7.8	8.5	—	dB
Electrical Ruggedness (P_{out} = 60 W, V_{CC} = 28 Vdc, f = 400 MHz, VSWR 30:1 all phase angles)	ψ	No Degradation in Output Power			—
NARROW BAND FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz)	G_{PE}	7.8	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz)	η	55	—	—	%

* Indicates JEDEC Registered Data.



C1 to C4, C11 — 4.0–40 pF
C5 to C8 — 33 pF
C9 — 1000 pF
C10 — 5.0 µF
R1 — 15 Ω
L1, L2 — 3/16″ x 1″ Copper Strap
L3 — 1.5 µH
L4 — 10 µH
L5 — 1 Turn #16 AWG, 5/16″ I.D.

Figure 1. 400 MHz Test Amplifier (Narrow Band)

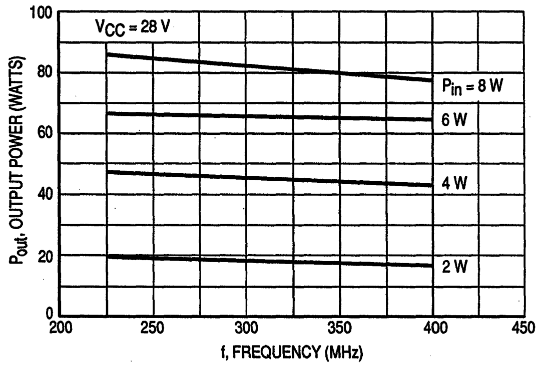


Figure 2. P_{out} versus Frequency

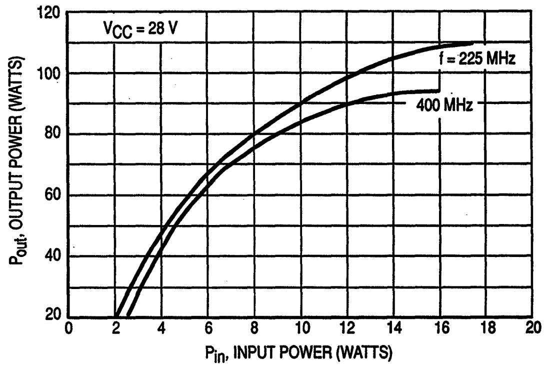


Figure 3. Output Power versus Input Power

2

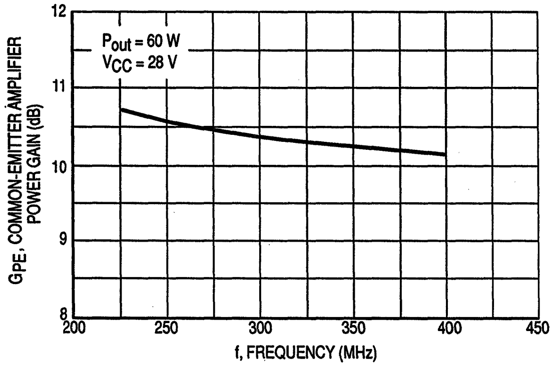


Figure 4. Power Gain versus Frequency

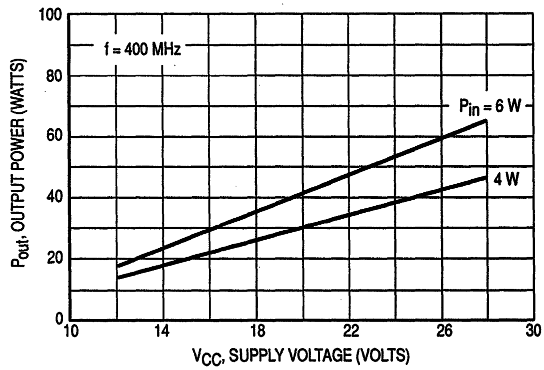


Figure 5. Output Power versus Supply Voltage

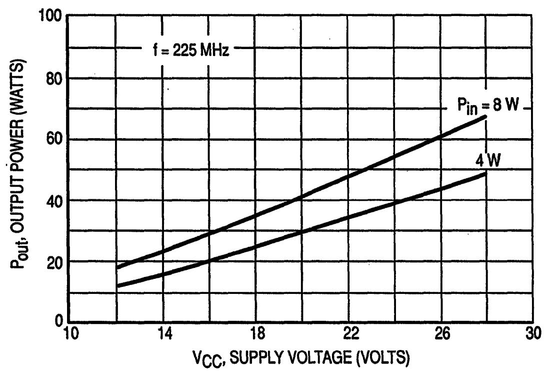
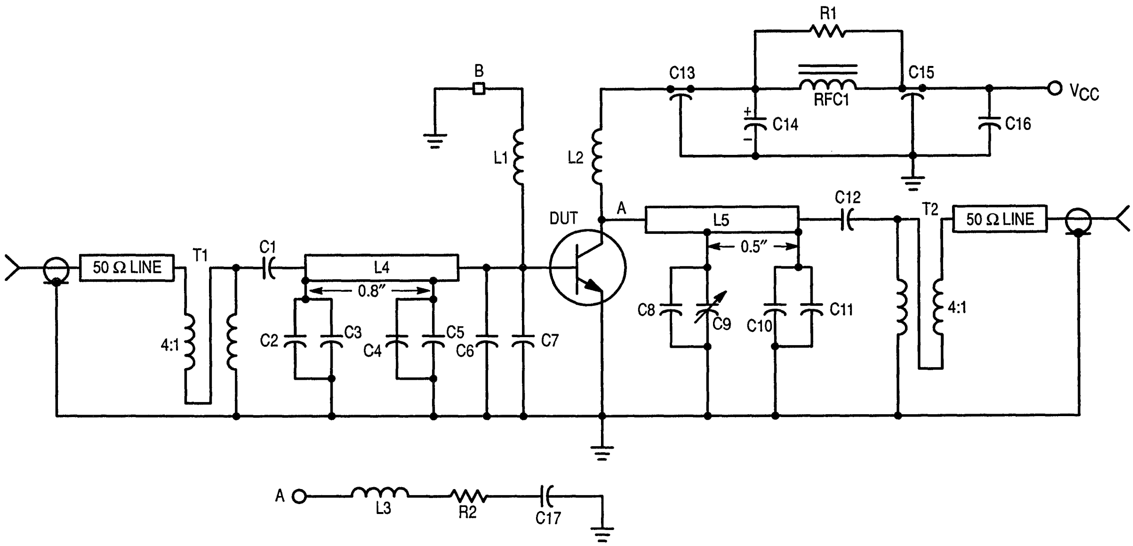


Figure 6. Output Power versus Supply Voltage



C1 — 68 pF
C2, C4, C8, C10 — 27 pF
C3, C5, C11 — 10 pF
C6, C7 — 51 pF
C9 — 1.0–10 pF JOHANSON
C12 — 100 pF
C13, C15 — 680 pF
C14, C16 — 1.0 µF, 35 V Tantalum
C17 — 0.1 µF, ERIE Red Cap

RFC1 — Ferrite Bead Choke, Feroxcube VK200 19/4B
B — Ferroxcube 56-590-65/4B Ferrite Bead
T1, T2 — 25 Ohms (UT25) Miniature Coaxial Cable, 1 turn
R1 — 11 Ω, 1.0 W
R2 — 20 Ω, 1/4 W
L1 — 10 Turns, #22 AWG, 1/8″ I.D.
L2 — 4 Turns, #16 AWG, 1/4″ I.D.
L3 — 6 Turns, #24 AWG, 1/8″ I.D.
L4, L5 — 1″ x 0.25″ Microstrip Line
Board Material 0.031″ Thick Teflon-Fiberglass

Figure 7. 225 to 400 MHz Broadband Test Circuit Schematic

2

BROADBAND DATA (Circuit, Figure 7)

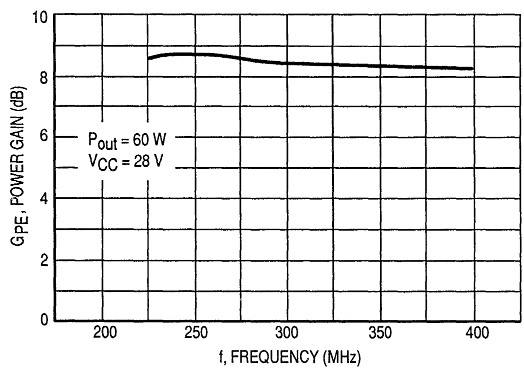


Figure 8. Power Gain versus Frequency

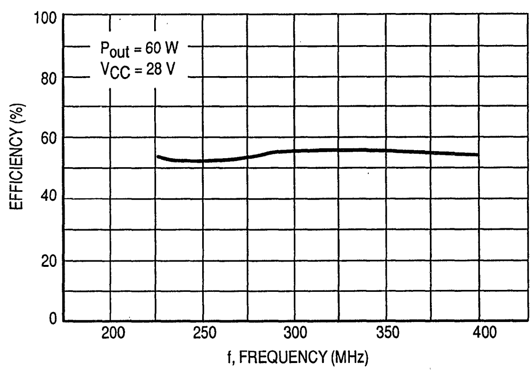


Figure 9. Efficiency versus Frequency

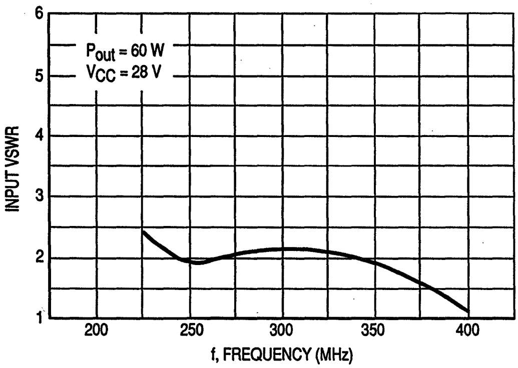
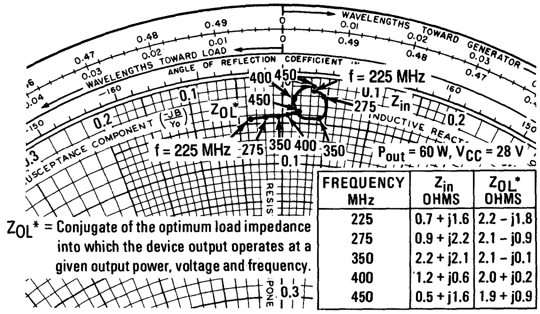


Figure 10. Input VSWR versus Frequency



FREQUENCY MHz	Z_{in} OHMS	Z_{OL}* OHMS
225	0.7 + j1.6	2.2 – j1.8
275	0.9 + j2.2	2.1 – j0.9
350	2.2 + j2.1	2.1 – j0.1
400	1.2 + j0.6	2.0 + j0.2
450	0.5 + j1.6	1.9 + j0.9

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 11. Series Equivalent Input-Output Impedance

2

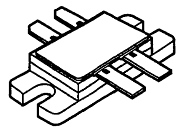
2N6985

The RF Line
NPN Silicon Push-Pull RF Power Transistor

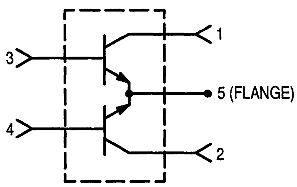
. . . designed primarily for wideband large-signal output and driver amplifier stages in the 30 to 400 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 125 W
  Typical Gain = 10 dB (Class C), 11 dB (Class AB)
  Efficiency = 55% (Typ)
- Hermetic Package to Meet Stringent Environmental Requirements
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch

125 W, 30 to 400 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON



CASE 382, STYLE 1



2

The 2N6985 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

MAXIMUM RATINGS*

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

NOTE:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF push-pull amplifiers.

* Indicates JEDEC Registered Data.

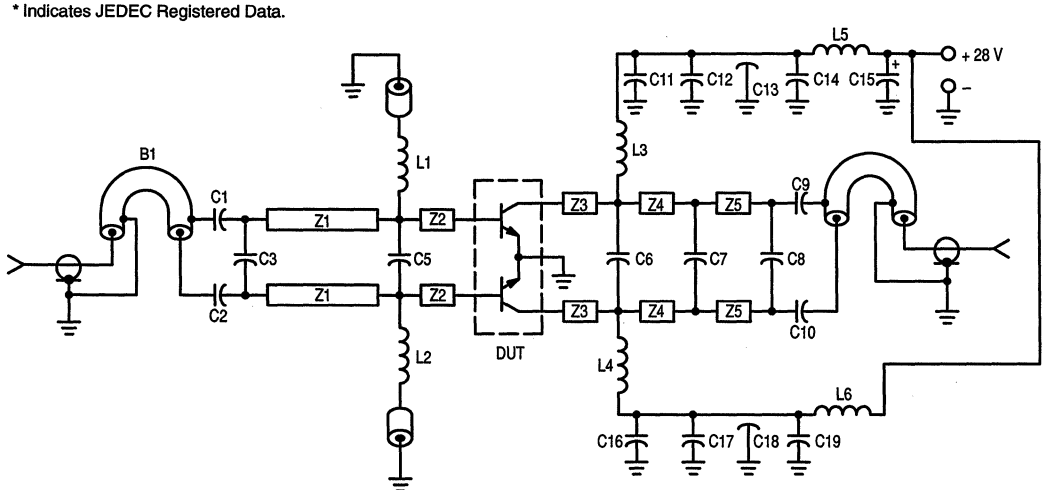
ELECTRICAL CHARACTERISTICS* (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TESTS (2) — See Figure 1					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	G_{pe}	8.0	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz, VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

* Indicates JEDEC Registered Data.

2



C1, C2 — 240 pF, 100 Mil Chip Cap (ATC) or Equivalent
C3 — 4.7 pF, 100 Mil Chip Cap (ATC) or Equivalent
C8 — 12 pF, 100 Mil Chip Cap (ATC) or Equivalent
C5 — 27 pF, 100 Mil Chip Cap (ATC) or Equivalent
C6 — 20 pF, 100 Mil Chip Cap (ATC) or Equivalent
C7 — 12 pF, 100 Mil Chip Cap (ATC) or Equivalent
C9, C10 — 270 pF, 100 Mil Chip Cap (ATC) or Equivalent
C11, C12, C16, C17 — 470 pF 100 Mil Chip Cap (ATC) or Equivalent
C13, C18 — 680 pF Feedthru
C14, C19 — 0.1 µF Erie Redcap or Equivalent
C15 — 20 µF, 50 V
L1, L2 — 0.15 µH Molded Choke With Ferrite Bead
L3, L4 — 2-1/2 Turns #20 AWG, 0.200 ID
L5, L6 — 3-1/2 Turns #18 AWG, 0.200 ID

B1 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2″ L
B2 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2″ L
Z1 — Microstrip Line 650 Mil L x 125 Mil W
Z2 — Microstrip Line 220 Mil L x 125 Mil W
Z3 — Microstrip Line 280 Mil L x 125 Mil W
Z4 — Microstrip Line 300 Mil L x 125 Mil W
Z5 — Microstrip Line 450 Mil L x 125 Mil W
Board Material — 0.06″ Teflon-Fiberglass, ε_r = 2.55, 2 oz. Cu. CLAD, Double Sided

Figure 1. 400 MHz Test Fixture

CLASS C

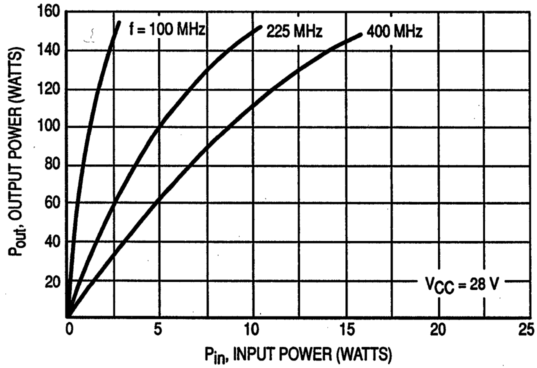


Figure 2. Output Power versus Input Power

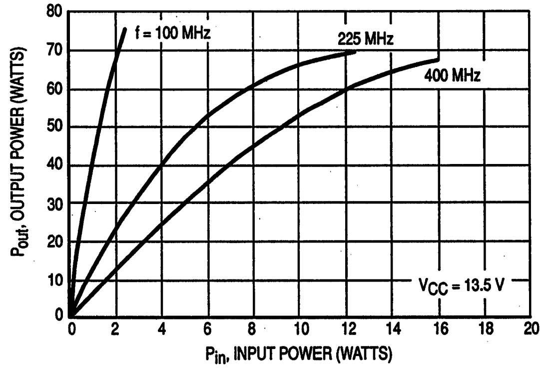


Figure 3. Output Power versus Input Power

CLASS C

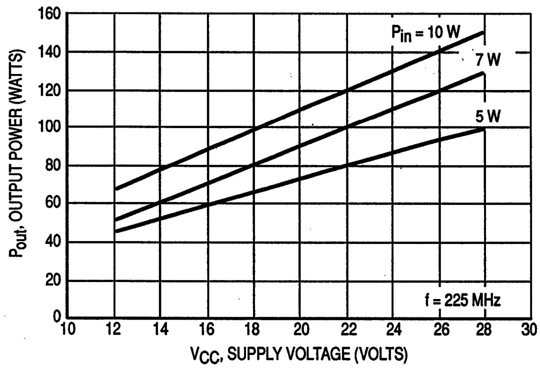


Figure 4. Output Power versus Supply Voltage

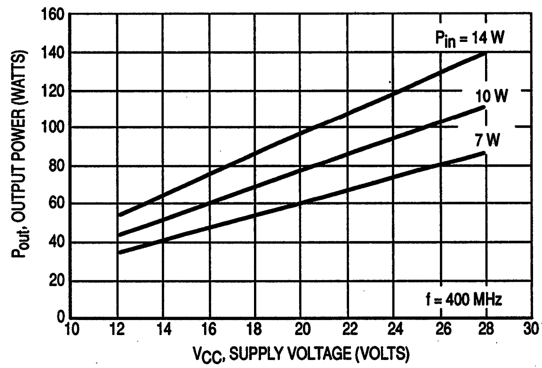
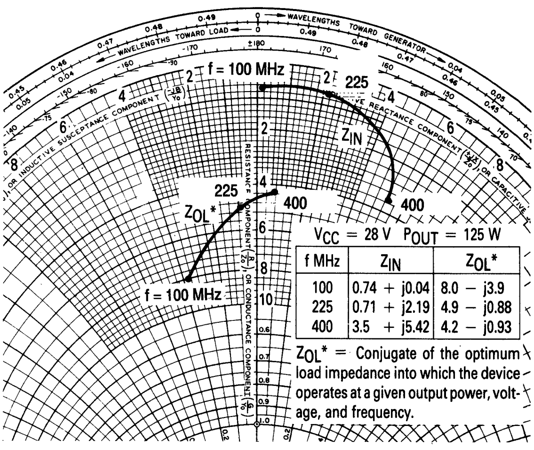


Figure 5. Output Power versus Supply Voltage



f MHz	Z_{IN}	Z_{OL}*
100	0.74 + j0.04	8.0 − j3.9
225	0.71 + j2.19	4.9 − j0.88
400	3.5 + j5.42	4.2 − j0.93

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

Input and output impedances are measured from base to base and collector to collector respectively.

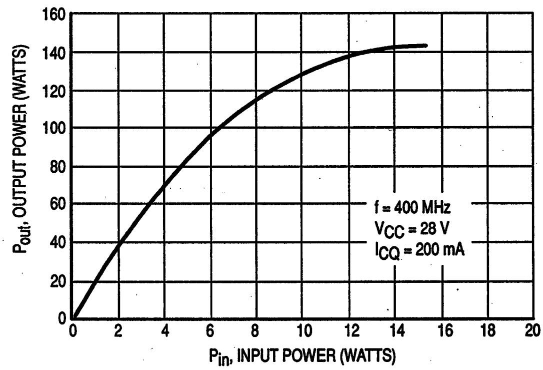


Figure 7. Class AB Output Power versus Input Power

2

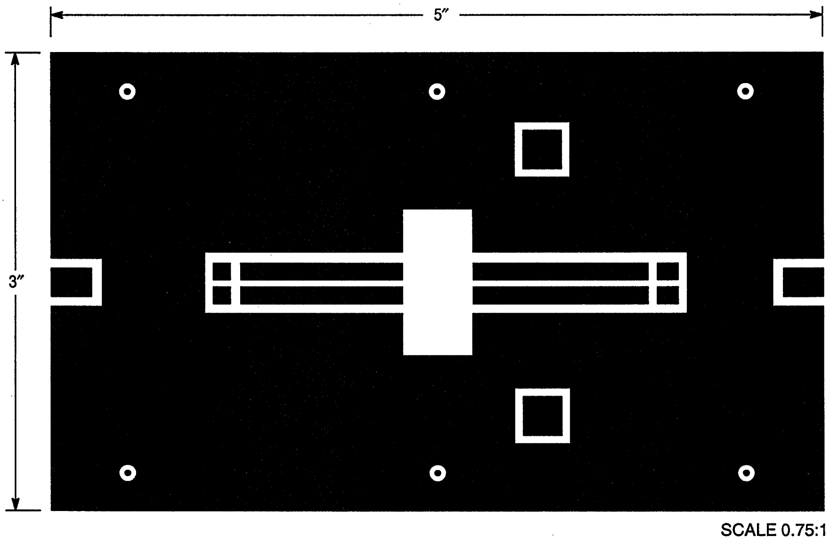


Figure 8. Test Circuit Photomaster

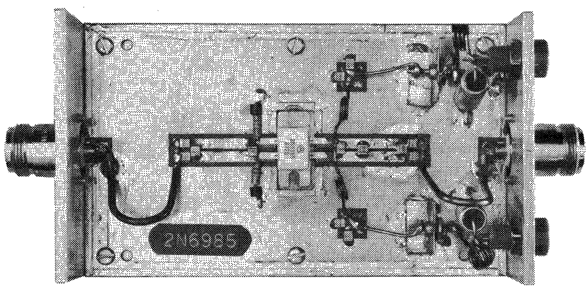


Figure 9. Test Fixture Photo

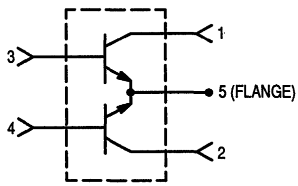
2N6986

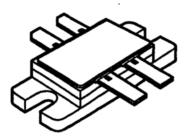
The RF Line
NPN Silicon Push-Pull RF Power Transistor

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 30 to 500 MHz frequency range.

- Specified 28 Volt, 500 MHz Characteristics —
  Output Power = 100 W
  Typical Gain = 10.3 dB (Class AB); 9.0 dB (Class C)
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch
- Hermetic Package to Meet Stringent Environmental Requirements

100 W, 30 to 500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON





CASE 382, STYLE 1

2

The 2N6986 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

MAXIMUM RATINGS*

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

NOTE:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF push-pull amplifiers.

* Indicates JEDEC Registered Data.

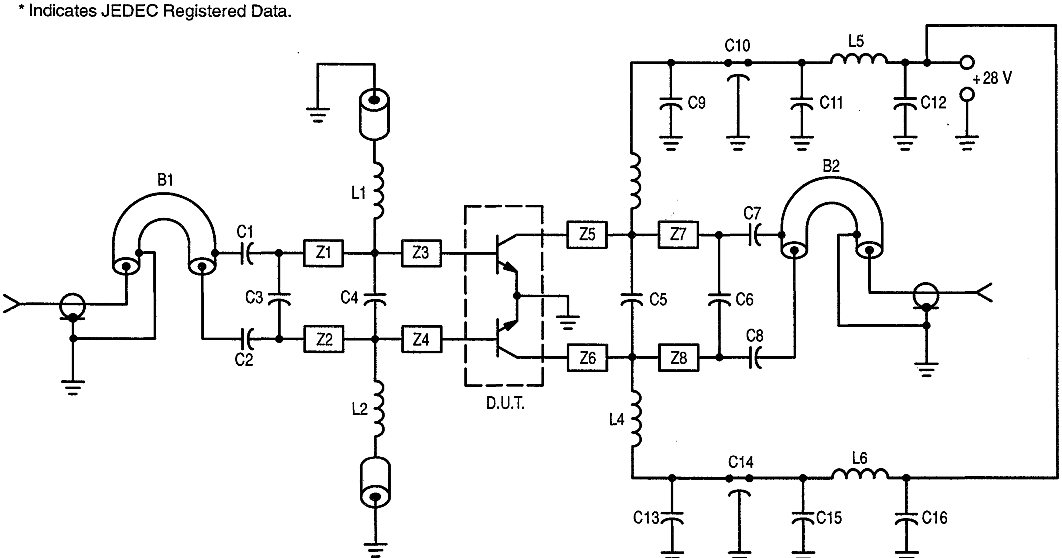
ELECTRICAL CHARACTERISTICS* (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TESTS (2) — See Figure 1					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	G_{pe}	7.5	9.0	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz, VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

* Indicates JEDEC Registered Data.

2



C1, C2, C7, C8 — 240 pF 100 mil Chip Cap
C3 — 12 pF 100 mil Chip Cap
C4 — 10 pF 100 mil Chip Cap
C5 — 36 pF 100 mil Chip Cap
C6 — 12 pF 100 mil Chip Cap
C9, C13 — 1000 pF 100 mil Chip Cap
C10, C14 — 680 pF Feedthru Cap
C11, C15 — 0.1 µF Ceramic Disc Cap
C12, C16 — 50 µF 50 V

L1, L2 — 0.15 µH Molded Choke with Ferrite Bead
L3, L4 — 2-1/2 Turns #20 AWG 0.200″ ID
L4, L5, L6 — 3-1/2 Turns #18 AWG 0.200″ ID
B1, B2 — Balun 50 Ω Semi Rigid Coax, 86 mil OD, 2″ Long
Z1, Z2 — 450 mil Long x 125 mil W. Microstrip
Z3, Z4 — 340 mil Long x 125 mil W. Microstrip
Z5, Z6 — 280 mil Long x 125 mil W. Microstrip
Z7, Z8 — 600 mil Long x 125 mil W. Microstrip
Board Material — 0.03″ Teflon-Fiberglass, ε_r = 2.55, 2 oz. Copper Clad both sides.

Figure 1. 500 MHz Test Fixture

CLASS C

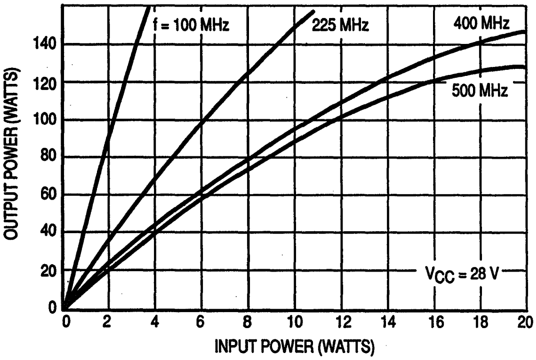


Figure 2. Output Power versus Input Power

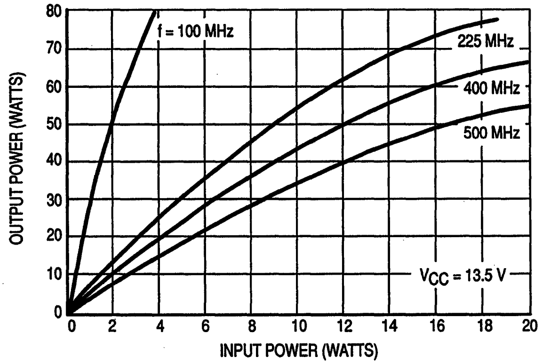


Figure 3. Output Power versus Input Power

CLASS C

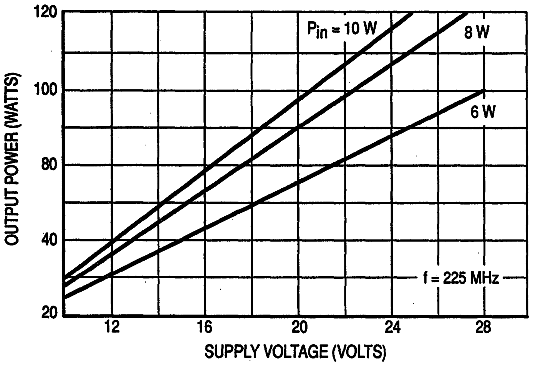


Figure 4. Output Power versus Supply Voltage

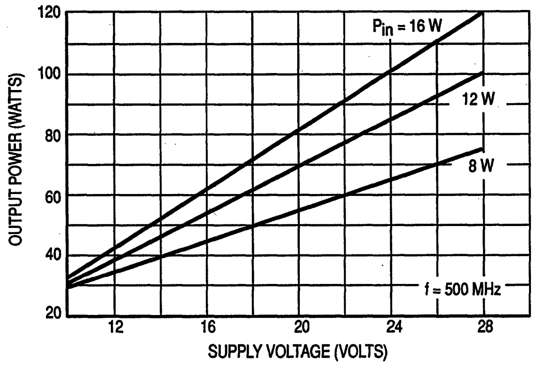
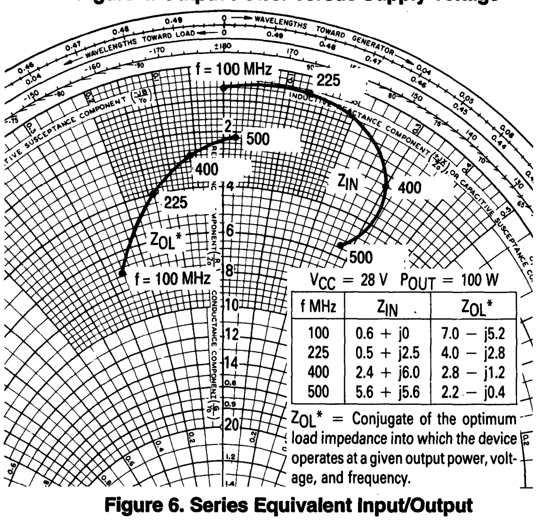


Figure 5. Output Power versus Supply Voltage



f MHz	Z_{IN}	Z_{OL}*
100	0.6 + j0	7.0 − j5.2
225	0.5 + j2.5	4.0 − j2.8
400	2.4 + j6.0	2.8 − j1.2
500	5.6 + j5.6	2.2 − j0.4

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

Input and output impedances are measured from base to base and collector to collector respectively.

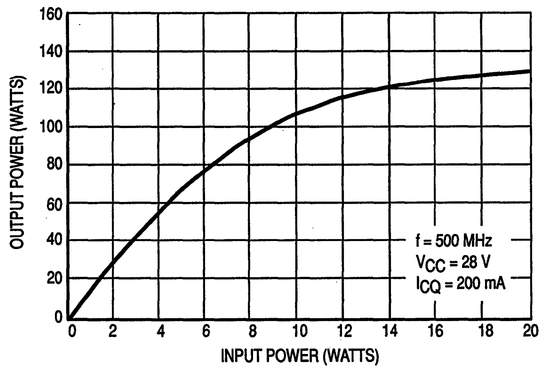


Figure 7. Class AB Output Power versus Input Power

2

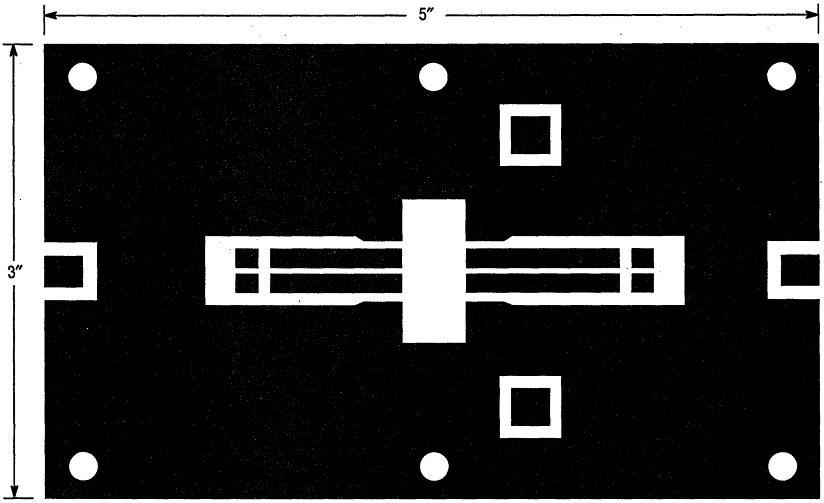


Figure 8. Test Circuit Photomaster

2

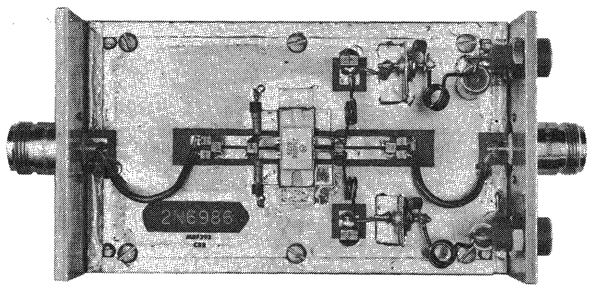


Figure 9. Test Fixture Photo

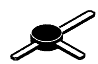
BFR90

The RF Line
NPN Silicon High-Frequency Transistor

... designed primarily for use in high-gain, low-noise, small-signal amplifiers. Also used in applications requiring fast switching times.

- High Current-Gain — Bandwidth Product — f_T = 5.0 GHz (Typ) @ I_C = 14 mA
- Low Noise Figure — NF = 2.4 dB (Typ) @ f = 0.5 GHz
  = 3.0 dB (Typ) @ f = 1.0 GHz
- High Power Gain — G_{max} = 18 dB (Typ) @ f = 0.5 GHz
  = 12 dB (Typ) @ f = 1.0 GHz

**f_T = 5.0 GHz @ 14 mA
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 317A, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc
Total Device Dissipation @ T_A = 60°C Derate above 60°C	P_D	180 2.0	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 14 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	—	250	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	5.0	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.5	1.0	pF
FUNCTIONAL TESTS					
Noise Figure	NF				dB
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		—	2.4	—	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		—	3.0	—	
Power Gain at Optimum Noise Figure	G_{NF}				dB
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		—	15	—	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		—	10	—	
Maximum Available Power Gain (1)	G_{max}				dB
(I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		—	18	—	
(I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		—	12	—	

NOTE: 1. $G_{max} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

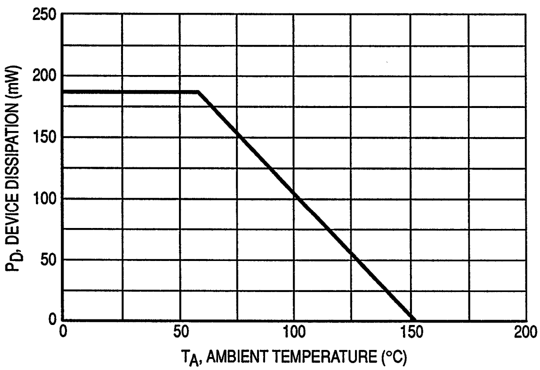


Figure 1. Power Derating

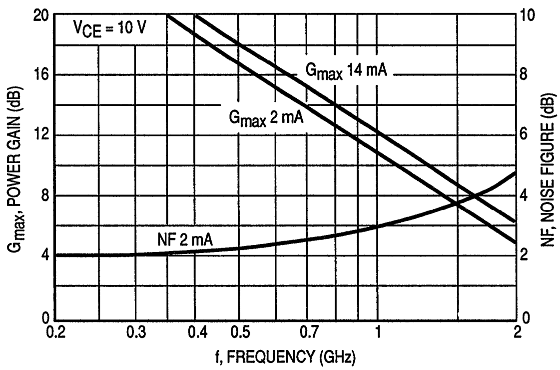


Figure 2. Power Gain and Noise Figure versus Frequency

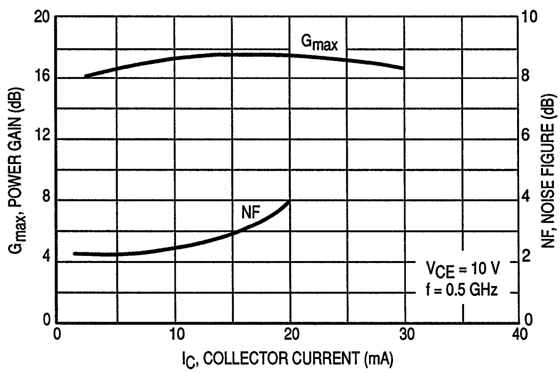


Figure 3. Power Gain and Noise Figure versus Collector Current

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S_{11}	∠ϕ	S_{11}	∠ϕ	S_{11}	∠ϕ	S_{11}	∠ϕ	S_{11}	∠ϕ
5.0	2.0	0.77	−45	0.48	−90	0.33	−125	0.27	−160	0.28	170
	5.0	0.52	−60	0.25	−110	0.18	−150	0.18	170	0.21	145
	10	0.33	−75	0.15	−125	0.13	−175	0.15	150	0.20	130
	20	0.20	−95	0.12	−155	0.14	165	0.17	145	0.22	130
	30	0.17	−116	0.14	−170	0.17	160	0.21	145	0.26	130
10	2.0	0.79	−40	0.50	−80	0.33	−115	0.26	−150	0.25	175
	5.0	0.56	−55	0.27	−95	0.16	−135	0.13	−175	0.17	150
	10	0.39	−65	0.16	−105	0.10	−150	0.10	165	0.15	140
	20	0.25	−75	0.10	−120	0.09	−175	0.12	150	0.18	130
	30	0.25	−75	0.10	−120	0.09	−175	0.12	150	0.18	130

Table 1. S_{11} Parameters

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S_{22}	∠ϕ	S_{22}	∠ϕ	S_{22}	∠ϕ	S_{22}	∠ϕ	S_{22}	∠ϕ
5.0	2.0	0.89	−20	0.69	−30	0.61	−35	0.55	−35	0.52	−45
	5.0	0.75	−25	0.55	−30	0.50	−30	0.47	−30	0.43	−40
	10	0.64	−25	0.49	−25	0.45	−25	0.43	−30	0.40	−35
	20	0.57	−25	0.47	−20	0.44	−25	0.43	−25	0.40	−35
	30	0.55	−20	0.47	−20	0.46	−20	0.44	−25	0.42	−35
10	2.0	0.91	−15	0.74	−25	0.66	−30	0.62	−35	0.59	−40
	5.0	0.79	−20	0.61	−25	0.56	−25	0.54	−30	0.51	−35
	10	0.70	−20	0.56	−20	0.53	−25	0.51	−25	0.48	−35
	20	0.63	−20	0.54	−25	0.53	−20	0.51	−25	0.49	−35
	30	0.63	−15	0.56	−15	0.55	−20	0.54	−25	0.52	−35

Table 2. S_{22} Parameters

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S_{21}	∠ϕ	S_{21}	∠ϕ	S_{21}	∠ϕ	S_{21}	∠ϕ	S_{21}	∠ϕ
5.0	2.0	5.76	140	3.81	105	2.73	90	2.20	75	1.70	60
	5.0	9.92	125	5.24	95	3.50	80	2.80	70	2.10	60
	10	12.33	115	5.82	90	3.79	75	2.90	65	2.20	55
	20	13.62	105	6.00	85	3.88	75	2.95	65	2.25	55
	30	13.41	105	5.80	80	3.74	75	2.85	65	2.15	55
10	2.0	5.77	145	3.88	110	2.80	90	2.25	75	1.75	60
	5.0	10.05	130	5.42	95	3.60	80	2.85	70	2.10	60
	10	12.56	115	6.00	90	3.90	80	3.05	70	2.25	55
	20	13.77	110	6.13	85	3.92	75	3.05	65	2.20	55
	30	13.23	105	5.79	85	3.70	75	2.85	65	2.15	55

Table 3. S_{21} Parameters

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S_{12}	∠ϕ	S_{12}	∠ϕ	S_{12}	∠ϕ	S_{12}	∠ϕ	S_{12}	∠ϕ
5.0	2.0	0.06	65	0.10	55	0.12	55	0.14	55	0.17	60
	5.0	0.05	65	0.08	65	0.12	65	0.15	65	0.19	65
	10	0.04	65	0.08	70	0.12	70	0.15	70	0.20	65
	20	0.04	75	0.08	75	0.12	75	0.15	70	0.20	70
	30	0.03	75	0.07	75	0.11	75	0.15	75	0.19	70
10	2.0	0.05	70	0.03	55	0.11	55	0.12	55	0.15	60
	5.0	0.04	65	0.07	65	0.10	65	0.13	65	0.17	70
	10	0.04	65	0.07	70	0.10	70	0.13	70	0.17	70
	20	0.03	70	0.07	75	0.10	75	0.13	75	0.17	70
	30	0.03	75	0.06	75	0.10	75	0.13	75	0.17	70

Table 4. S_{12} Parameters

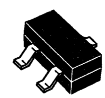
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFR92ALT1

The RF Line
NPN Silicon High-Frequency Transistors

. . . designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

RF TRANSISTORS
NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	25	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation; T_A = 25°C* Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	357	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

BFR92ALT1 = P2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mA)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current BFR92ALT1 (V_{CB} = 10 V)	I_{CBO}	—	50	nA
ON CHARACTERISTICS				
DC Current Gain BFR92ALT1 (I_C = 14 mA, V_{CE} = 10 V)	h_{FE}	40	—	—
Collector-Emitter Saturation Voltage (1) (I_C = 25 mA, I_B = 5.0 mA)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) (I_C = 25 mA, I_B = 5.0 mA)	$V_{BE(sat)}$	—	1.2	Vdc

NOTE:
1. Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 14 mA, V_{CE} = 10 V, f = 500 MHz)	f_T	4.5 (Typ)	—	GHz
Noise Figure (V_{CE} = 1.5 V, I_C = 3.0 mA, R_S = 50 Ω, f = 500 MHz)	NF	—	3.0 (Typ)	dB
Capacitance-Collector to Base (V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{cb}	—	0.7 (Typ)	pF

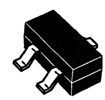
2

BFR93ALT1

The RF Line
NPN Silicon High-Frequency Transistors

. . . designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

**RF TRANSISTORS
NPN SILICON**



**CASE 318-07, STYLE 6
SOT-23
LOW PROFILE**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	35	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C* Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	357	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

BFR93ALT1 = R2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mA)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CE} = 10 V)	I_{CEO}	—	50	nA
Collector Cutoff Current (V_{CB} = 10 V)	I_{CBO}	—	50	nA
ON CHARACTERISTICS				
DC Current Gain (1) BFR93ALT1 (I_C = 30 mA, V_{CE} = 5.0 V)	h_{FE}	40	—	—
Collector-Emitter Saturation Voltage (1) (I_C = 35 mA, I_B = 7.0 mA)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) (I_C = 35 mA, I_B = 7.0 mA)	$V_{BE(sat)}$	—	1.2	Vdc

NOTE:
1. Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 30 mA, V_{CE} = 5.0 V, f = 500 MHz)	f_T	3.0	—	GHz
Noise Figure (V_{CE} = 5.0 V, I_C = 2.0 mA, R_S = 50 Ω, f = 30 MHz)	NF	—	3.0	dB

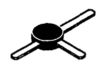
2

BFR96

The RF Line
NPN Silicon High-Frequency Transistor

The BFR96 transistor uses the same state-of-the-art microwave transistor chip which features fine-line geometry, ion-implanted arsenic emitters and gold top metallization. This transistor is intended for low-to-medium power amplifiers requiring high gain, low noise figure, and low intermodulation distortion. The BFR96 is particularly suitable for broadband MATV/CATV amplifiers.

f_T = 4.5 GHz @ 50 mA
HIGH-FREQUENCY TRANSISTOR
NPN SILICON



CASE 317A, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_C = 100°C (1) Derate above T_C = 100°C	P_D	0.5 10	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, Emitter Guarded)	C_{cb}	—	1.2	1.5	pF

NOTE:
1. Case temperature measured on collector lead immediately adjacent to body of package.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF	—	2.0	—	dB
Maximum Unilateral Gain/Insertion Gain (2) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	$G_U(max)$/ $\|S_{21}\|^2$	—/12	14.5/13	—	dB

NOTE: 2. $G_U(max) = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

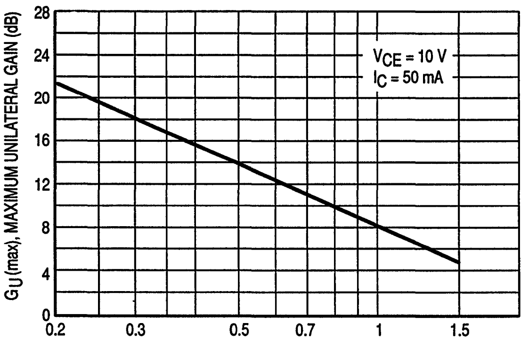


Figure 1. Maximum Unilateral Gain versus Frequency

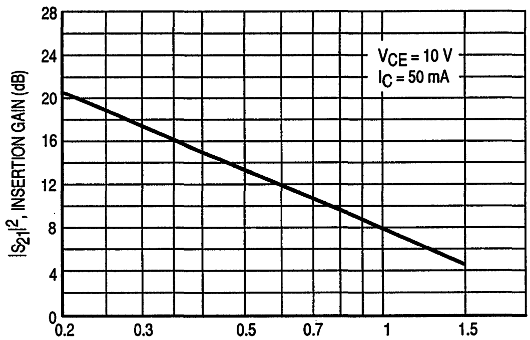


Figure 2. $|S_{21}|^2$ versus Frequency

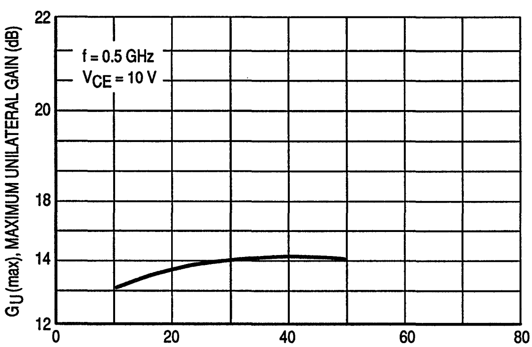


Figure 3. Maximum Unilateral Gain versus Collector Current

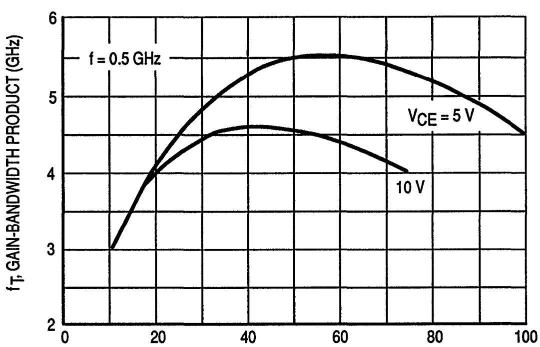


Figure 4. Gain-Bandwidth Product versus Collector Current

2

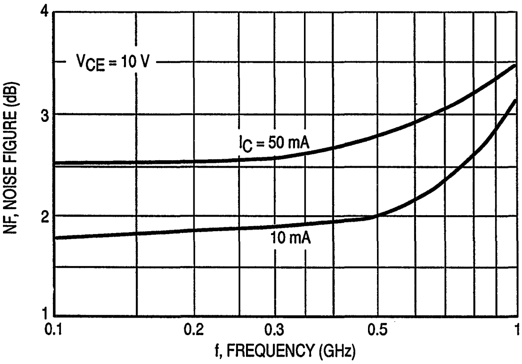


Figure 5. Noise Figure versus Frequency

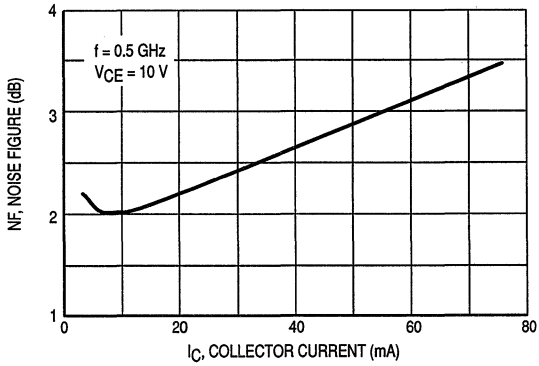


Figure 6. Noise Figure versus Collector Current

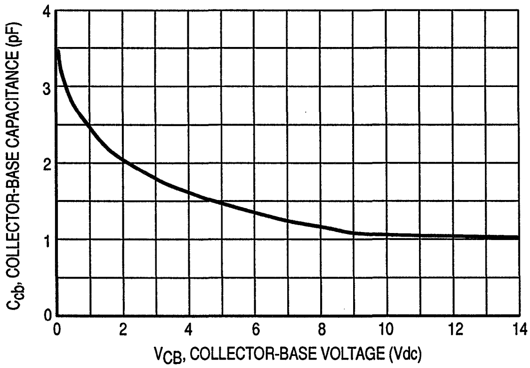


Figure 7. Collector-Base Capacitance versus Collector-Base Voltage

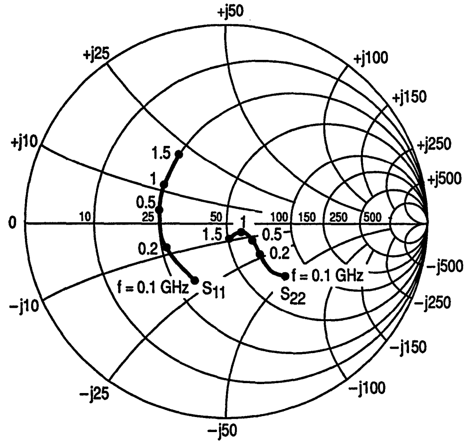


Figure 8. Input/Output Reflection Coefficients versus Frequency (V_{CE} = 10 V, I_C = 50 mA)

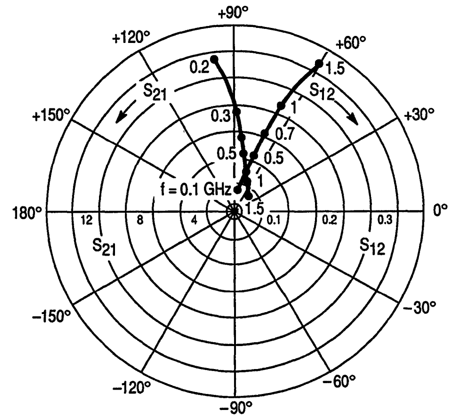


Figure 9. Forward/Reverse Transmission Coefficients versus Frequency (V_{CE} = 10 V, I_C = 50 mA)

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	10	100	0.51	−95	15.04	121	0.047	54	0.58	−48
		300	0.43	−163	5.87	92	0.082	58	0.26	−63
		500	0.46	174	3.61	79	0.120	63	0.19	−63
		700	0.48	162	2.65	68	0.161	63	0.15	−64
		1000	0.48	146	1.92	57	0.220	63	0.12	−79
		1500	0.54	121	1.40	43	0.320	58	0.13	−118
	25	100	0.39	−122	19.41	112	0.037	60	0.42	−68
		300	0.39	−176	6.81	89	0.079	68	0.16	−94
		500	0.42	166	4.11	78	0.129	70	0.10	−103
		700	0.44	156	3.05	69	0.176	68	0.06	−119
		1000	0.44	142	2.20	59	0.244	64	0.06	−159
		1500	0.49	118	1.62	45	0.348	57	0.10	177
	50	100	0.35	−140	21.10	106	0.032	64	0.33	−81
		300	0.38	176	7.11	88	0.081	72	0.13	−116
		500	0.42	162	4.28	78	0.133	72	0.09	−136
		700	0.43	153	3.16	70	0.183	69	0.07	−163
		1000	0.42	140	2.28	60	0.252	65	0.08	165
		1500	0.47	116	1.66	47	0.357	57	0.12	155
10	10	100	0.53	−83	15.96	124	0.039	58	0.65	−36
		300	0.38	−154	6.44	94	0.070	59	0.35	−41
		500	0.41	−179	3.98	81	0.102	64	0.30	−39
		700	0.42	166	2.94	70	0.138	65	0.27	−39
		1000	0.42	151	2.12	60	0.191	66	0.24	−47
		1500	0.49	125	1.50	44	0.278	63	0.22	−72
	25	100	0.38	−104	20.85	115	0.032	60	0.48	−48
		300	0.32	−169	7.54	91	0.070	68	0.23	−48
		500	0.35	170	4.61	80	0.109	71	0.19	−43
		700	0.37	160	3.37	70	0.152	69	0.16	−39
		1000	0.37	146	2.43	61	0.210	67	0.13	−44
		1500	0.43	121	1.73	47	0.304	61	0.10	−74
	50	100	0.33	−119	22.59	109	0.029	63	0.39	−51
		300	0.30	−176	7.74	88	0.069	72	0.19	−47
		500	0.34	166	4.70	79	0.113	73	0.16	−40
		700	0.36	158	3.45	70	0.156	70	0.14	−35
		1000	0.36	144	2.46	61	0.217	66	0.11	−39
		1500	0.42	119	1.75	47	0.310	60	0.08	−72

Table 1. Common-Emitter S-Parameters

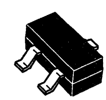
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFS17LT1

The RF Line
NPN Silicon High-Frequency Transistor

Designed primarily for use in high-gain, low-noise amplifier, oscillator and mixer applications. Packaged for thick or thin film circuits using surface mount components.

RF TRANSISTOR
NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C (1)	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient (1)	$R_{\theta JA}$	357	°C/W

DEVICE MARKING

BFS17LT1 = E1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	25	—	—	Vdc
Collector Cutoff Current (V_{CE} = 10 V)	I_{CEO}	—	—	25	nA
Collector Cutoff Current (V_{CB} = 10 V)	I_{CBO}	—	—	25	nA
Emitter Cutoff Current (V_{EB} = 4 V)	I_{EBO}	—	—	100	μA
ON CHARACTERISTICS					
DC Current Gain (I_C = 2 mA, V_{CE} = 1 V) (I_C = 25 mA, V_{CE} = 1 V)	h_{FE}	 20 20	 — —	 150 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(sat)}$	—	—	0.4	V
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{BE(sat)}$	—	—	1	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 2 mA, V_{CE} = 5 V, f = 500 MHz) (I_C = 25 mA, V_{CE} = 5 V, f = 500 MHz)	f_T	 — —	 1 1.3	 — —	GHz
Output Capacitance (V_{CB} = 10 V, f = 1 MHz)	CCB	—	1	—	pF
Noise Figure (I_C = 2 mA, V_{CE} = 5 V, R_S = 50 Ω, f = 30 MHz)	NF	—	5	—	dB

NOTE:
1. Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

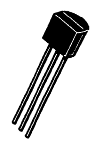
LP1001
LP1001A

The RF Line
NPN Silicon High-Frequency Transistors

LOW NOISE
HIGH-FREQUENCY
TRANSISTORS

The LP1001 is designed for CATV and other Broadband linear applications. This Motorola series of small-signal plastic transistors offers superior quality and performance at low cost.

- High Current Gain-Bandwidth Product
  f_T = 5 GHz (Typ) @ I_C = 10 mAdc
- High Power Gain
  G_{pe} = 12.5 dB (Typ) @ 1 GHz
- Low Noise Figure
  NF = 3 dB (Typ) @ 1 GHz
- Low Feedback Capacitance
  C_{ob} = 0.5 pF (Typ) @ V_{CB} = 10 Volts



CASE 29-04, STYLE 2
TO-226AA
(TO-92)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2	Vdc
Total Device Dissipation @ T_A = 25°C	P_D	625	mW

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance — Junction to Ambient — Junction to Case	$R_{\theta JA}$ $R_{\theta JC}$	200 83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	$V_{(BR)EBO}$	2	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nA
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc) LP1001 LP1001A	h_{FE}	25 50	80 —	— —	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)		C_{ob}	—	—	0.7	pF
Current Gain-Bandwidth Product (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 500 MHz)		f_τ	—	5	—	GHz
FUNCTIONAL TESTS						
Gain @ Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc)	f = 500 MHz	G_{NF}	—	14	—	dB
	f = 1 GHz		—	12.5	—	
Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc)	f = 500 MHz	NF	—	2.7	—	dB
	f = 1 GHz		—	3.2	—	

2

V_{CE}	I_C	f	S_{11}		S_{21}		S_{12}		S_{22}	
(Volts)	(mA)	(MHz)	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
10	3	100	0.75	−25	8.56	152	0.03	70	0.94	−12
		200	0.61	−47	7.06	132	0.05	62	0.84	−21
		300	0.47	−61	5.79	116	0.07	60	0.75	−25
		400	0.37	−74	4.81	105	0.08	58	0.70	−28
		500	0.30	−84	4.11	96	0.09	58	0.66	−30
		600	0.22	−94	3.51	86	0.10	58	0.63	−31
		700	0.16	−155	3.15	78	0.11	57	0.59	−34
		800	0.16	−128	2.85	72	0.13	55	0.57	−38
		900	0.12	−144	2.60	67	0.14	53	0.56	−41
		1000	0.12	−169	2.41	61	0.15	52	0.53	−44
		1100	0.12	179	2.26	56	0.17	51	0.52	−51
		1200	0.12	155	2.10	54	0.18	51	0.52	−51
10	10	100	0.48	−36	16.23	137	0.02	69	0.82	−18
		200	0.33	−55	10.98	115	0.04	68	0.68	−23
		300	0.22	−62	8.05	102	0.06	68	0.60	−25
		400	0.16	−70	6.33	93	0.07	67	0.57	−26
		500	0.12	−73	5.21	87	0.09	68	0.55	−27
		600	0.07	−72	4.39	81	0.10	67	0.53	−27
		700	0.04	−117	3.89	74	0.12	64	0.50	−29
		800	0.04	−142	3.45	67	0.13	61	0.48	−34
		900	0.02	−169	3.14	63	0.14	60	0.47	−37
		1000	0.05	127	2.87	58	0.16	58	0.45	−41
		1100	0.06	130	2.68	53	0.18	56	0.44	−47
		1200	0.08	112	2.49	52	0.19	54	0.44	−47

Table 1. Common Emitter S-Parameters

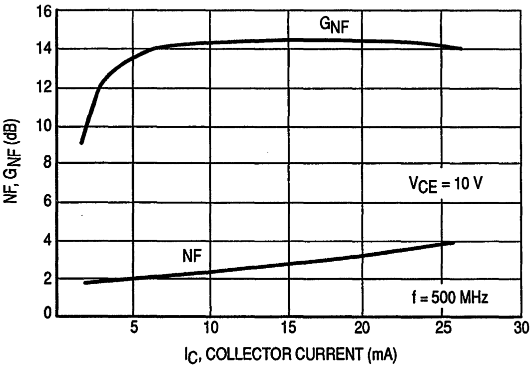


Figure 1. Gain at Noise Figure and Noise Figure versus Collector Current

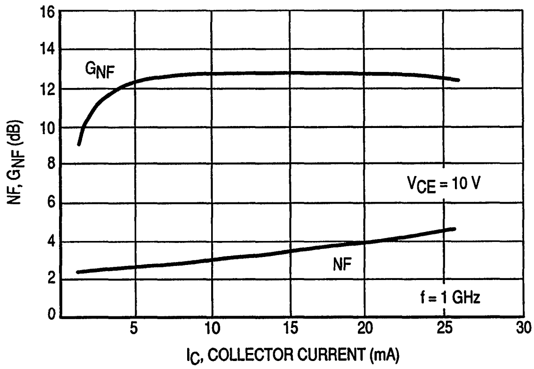


Figure 2. Gain at Noise Figure and Noise Figure versus Collector Current

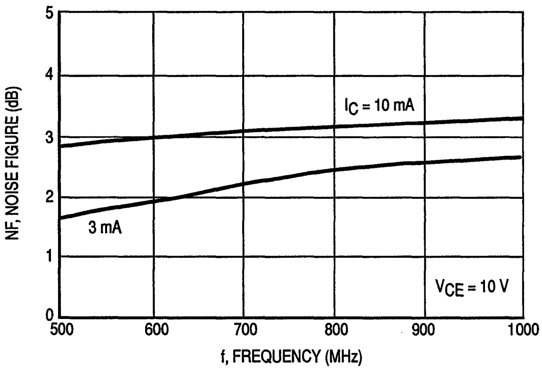


Figure 3. Noise Figure versus Frequency

2

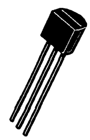
LP1983

The RF Line
NPN Silicon High-Frequency Transistor

I_C = 30 mA
HIGH-FREQUENCY TRANSISTOR
NPN SILICON

. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers.

- High Current-Gain — Bandwidth Product — f_T = 4.5 GHz (Typ) @ I_C = 15 mAdc
- High Power Gain — G_{pe} = 12 dB (Typ) @ f = 900 MHz
- Low Noise Figure — NF = 2.4 dB (Typ) @ f = 900 MHz
- Low Feedback Capacitance — C_{cb} = 0.5 pF (Typ) @ V_{cb} = 10 V
- Die Source Same as MRF901



CASE 29-04, STYLE 2
TO-226AA
(TO-92)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 3.0	mW mW/°C
Operating Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	200	nAdc
Collector Cutoff Current (V_{CE} = 10 Vdc)	I_{CEO}	—	—	10	µA
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	35	80	250	—
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{CE(sat)}$	—	—	0.4	V

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.5	1.2	pF
Noise Figure (Figure 1) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 900 MHz)	NF	—	2.4	—	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Figure 1) (I_C = 10 mA, V_{CE} = 10 Vdc, f = 900 MHz)	G_{pe}	—	12	—	dB
Common-Emitter Feedback Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{re}	—	—	0.7	pF

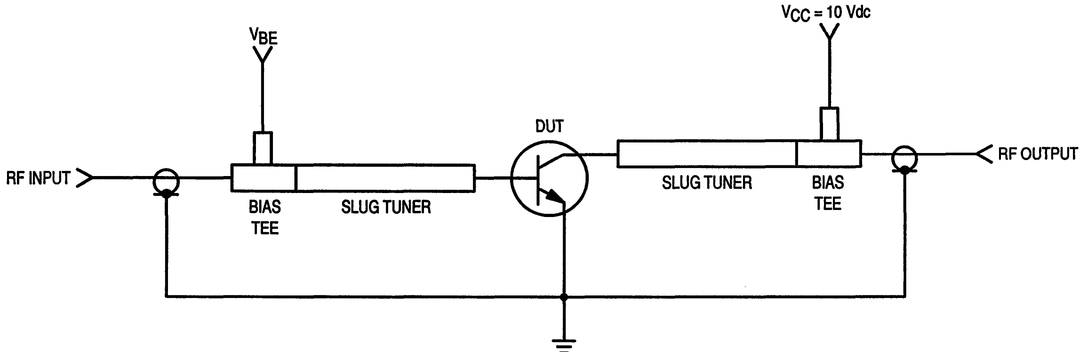


Figure 1. 900 MHz Test Circuit Schematic

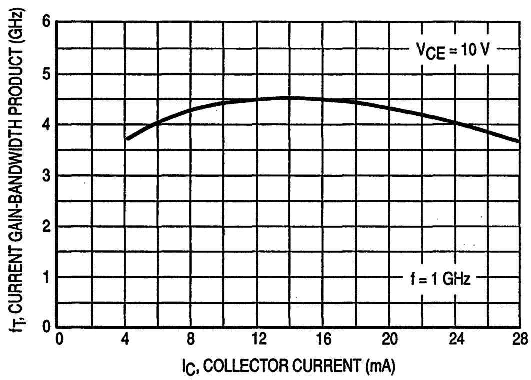


Figure 2. Current Gain-Bandwidth Product versus Collector Current

2

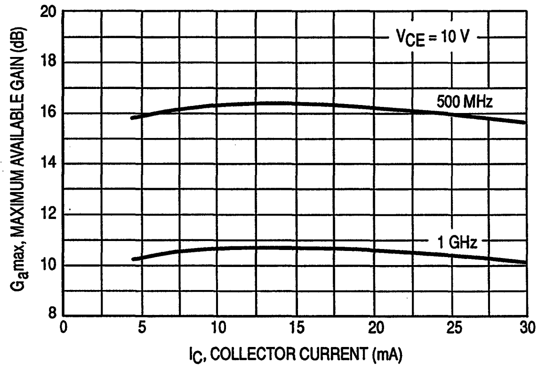


Figure 3. Maximum Available Gain versus Collector Current

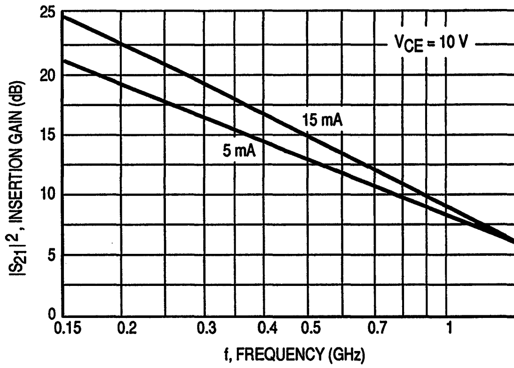


Figure 4. $|S_{21}|^2$ versus Frequency

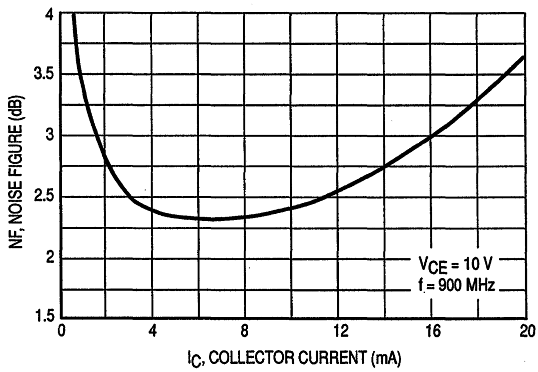


Figure 5. Noise Figure versus Collector Current

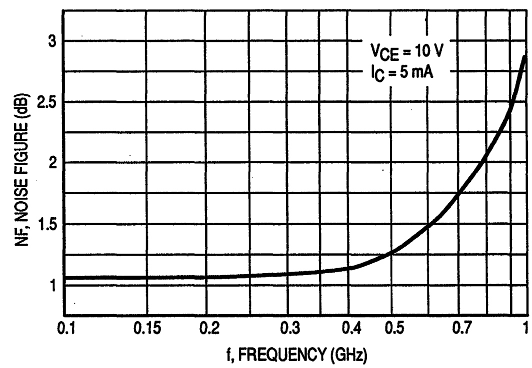


Figure 6. Noise Figure versus Frequency

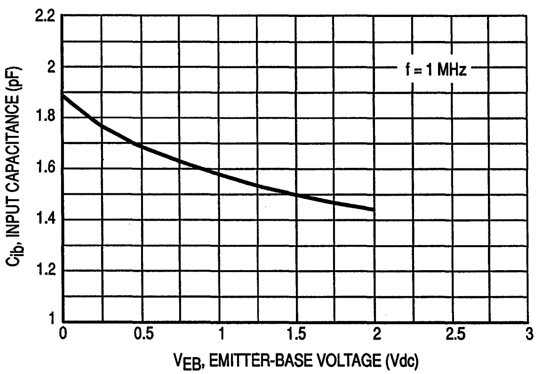


Figure 7. Input Capacitance versus Emitter-Base Voltage

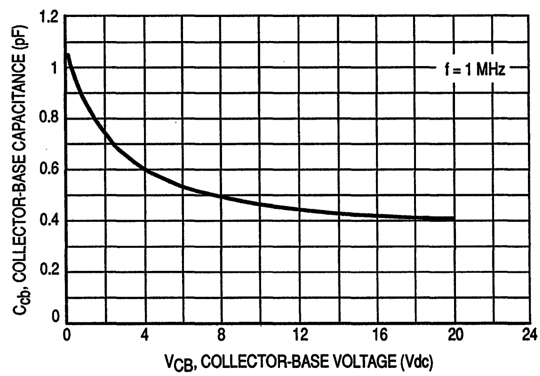


Figure 8. Collector-Base Capacitance versus Collector-Base Voltage

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
5.0	5.0	100	0.76	−35	9.42	142	0.03	67	0.85	−18
		200	0.60	−63	7.98	122	0.05	58	0.70	−26
		500	0.28	−127	4.79	84	0.09	55	0.53	−35
		1000	0.27	148	2.71	50	0.15	51	0.42	−51
		1500	0.43	113	2.02	23	0.21	42	0.28	−79
	10	100	0.57	−51	14.80	131	0.03	65	0.75	−22
		200	0.36	−87	10.80	108	0.04	62	0.60	−26
		500	0.18	−151	5.23	77	0.08	62	0.48	−31
		1000	0.25	136	2.86	47	0.15	55	0.39	−48
		1500	0.42	109	2.12	22	0.22	42	0.25	−75
	15	100	0.42	−67	17.80	123	0.02	66	0.69	−22
		200	0.26	−105	11.50	101	0.04	66	0.56	−23
		500	0.17	−169	5.27	74	0.08	66	0.47	−28
		1000	0.26	131	2.86	46	0.15	57	0.39	−47
		1500	0.43	108	2.12	21	0.22	44	0.25	−73
	20	100	0.33	−82	18.66	117	0.02	67	0.66	−21
		200	0.22	−120	11.54	98	0.03	68	0.55	−21
		500	0.17	−171	5.16	72	0.08	67	0.48	−27
		1000	0.28	129	2.80	45	0.15	58	0.40	−45
		1500	0.45	107	2.07	19	0.22	45	0.27	−71
	25	100	0.28	−103	18.11	113	0.02	68	0.64	−20
		200	0.22	−138	11.03	95	0.03	70	0.55	−19
		500	0.20	169	4.94	71	0.08	68	0.50	−25
		1000	0.32	128	2.68	43	0.15	60	0.42	−44
		1500	0.49	106	1.98	17	0.22	47	0.30	−71
	30	100	0.31	−127	16.10	109	0.02	67	0.64	−16
		200	0.28	−156	9.69	93	0.03	70	0.57	−16
		500	0.28	160	4.32	69	0.07	70	0.53	−25
		1000	0.39	125	2.37	41	0.14	63	0.46	−44
		1500	0.55	104	1.73	15	0.21	51	0.34	−72

Table 1. Common Emitter S-Parameters, V_{CE} = 5.0 V

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
10	5.0	100	0.79	−33	9.36	144	0.03	68	0.88	−15
		200	0.63	−58	7.97	124	0.04	58	0.74	−22
		500	0.28	−117	4.87	86	0.07	57	0.60	−31
		1000	0.23	153	2.80	53	0.13	56	0.50	−46
		1500	0.38	116	2.09	26	0.19	48	0.38	−69
	10	100	0.60	−48	14.87	132	0.02	66	0.79	−18
		200	0.39	−79	11.06	110	0.03	63	0.65	−21
		500	0.16	−135	5.38	79	0.07	64	0.56	−28
		1000	0.20	138	2.97	50	0.13	59	0.47	−44
		1500	0.37	111	2.21	25	0.20	49	0.36	−66
	15	100	0.46	−61	18.20	124	0.02	66	0.74	−18
		200	0.28	−94	11.94	102	0.03	66	0.62	−19
		500	0.14	−154	5.45	76	0.07	67	0.55	−26
		1000	0.22	131	2.97	48	0.13	61	0.48	−42
		1500	0.38	109	2.21	24	0.20	50	0.36	−64
	20	100	0.37	−72	19.38	119	0.02	67	0.71	−17
		200	0.23	−105	11.97	99	0.03	68	0.61	−18
		500	0.14	−172	5.36	74	0.07	69	0.56	−24
		1000	0.23	128	2.91	47	0.13	62	0.48	−41
		1500	0.40	108	2.16	22	0.20	51	0.37	−64
	25	100	0.32	−86	19.40	115	0.02	68	0.70	−16
		200	0.22	−119	11.67	97	0.03	69	0.61	−16
		500	0.19	−176	5.28	74	0.06	70	0.57	−23
		1000	0.26	127	2.82	46	0.13	63	0.50	−41
		1500	0.43	107	2.09	21	0.19	53	0.40	−63
	30	100	0.29	−103	18.29	112	0.02	68	0.70	−14
		200	0.22	−135	10.86	95	0.03	70	0.62	−15
		500	0.20	165	4.82	72	0.06	72	0.59	−22
		1000	0.31	125	2.63	44	0.12	66	0.53	−41
		1500	0.47	106	1.95	19	0.19	55	0.43	−64

Table 2. Common Emitter S-Parameters, V_{CE} = 10 V

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR521LT1*
MRF521
MRF5211LT1

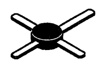
*Motorola Preferred Device

The RF Line
PNP Silicon High-Frequency Transistor

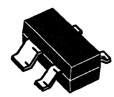
$I_C = -70$ mA
HIGH-FREQUENCY
TRANSISTOR
PNP SILICON

Designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

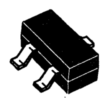
- High Current Gain-Bandwidth Product —
  f_T = 3.4 GHz (Typ) @ I_C = −35 mAdc (MMBR521LT1)
  f_T = 4.2 GHz (Typ) @ I_C = −50 mAdc (MRF521, MRF5211LT1)
- Low Noise Figure @ f = 1.0 GHz —
  $NF_{(matched)}$ = 2.5 dB (Typ) (MMBR521LT1)
  $NF_{(matched)}$ = 2.8 dB (Typ) (MRF521, MRF5211LT1)
- High Power Gain — $G_{pe\ (matched)}$ = 11 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-23 (MMBR521LT1) & SOT-143 (MRF5211LT1) Offer Improved RF Performance
  Lower Package Parasitics
  Higher Gain



CASE 317-01, STYLE 1
MRF521



CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE
MRF5211LT1



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)
MMBR521LT1

2

MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−10	Vdc
Collector-Base Voltage	V_{CBO}	−20	Vdc
Emitter-Base Voltage	V_{EBO}	−2.5	Vdc
Power Dissipation (1) T_C = 75°C, MMBR521LT1 Derate above T_C = 75°C MRF5211LT1	P_D	312 315	mW
Collector Current — Continuous	I_C	−70	mA
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Thermal Resistance, Junction to Case (1) MRF521 MMBR521LT1, MRF5211LT1	$R_{\theta JC}$	 200 240	°C/W
Thermal Resistance, Junction to Ambient MRF521 MMBR521LT1, MRF5211LT1	$R_{\theta JA}$	 355 395	°C/W

DEVICE MARKING

MMBR521L = 7M	MRF5211 = 04

NOTE:
1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. For case temperatures above +75°C: $P_{DISP(max)} = (T_{Jmax} - T_C) / R_{\theta JC}$

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	–10	–12	—	Vdc
Collector-Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	–20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = –50 µAdc, I_C = 0)		$V_{(BR)EBO}$	–2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = –8.0 Vdc, I_E = 0)		I_{CBO}	—	—	–10	µAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = –30 mAdc, V_{CE} = –5.0 Vdc)		h_{FE}	25	—	125	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = –6.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	1.0	1.5	pF
Current Gain — Bandwidth Product		f_T				GHz
(V_{CE} = –8.0 V, I_C = –35 mA, f = 1.0 GHz)	MMBR521LT1		—	3.4	—	
(V_{CE} = –8.0 V, I_C = –50 mA, f = 1.0 GHz)	MRF5211LT1		—	4.2	—	
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure		G_{NFmin}				dB
(V_{CE} = –6.0 V, I_C = –5.0 mA, f = 500 MHz)	MMBR521LT1		13	15	—	
(V_{CE} = –6.0 V, I_C = –5.0 mA, f = 1.0 GHz)	MMBR521LT1		8.0	10	—	
(V_{CE} = –6.0 V, I_C = –5.0 mA, f = 1.0 GHz)	MRF5211LT1		10	11	—	
Noise Figure — Minimum		NF_{min}				dB
(V_{CE} = –6.0 V, I_C = –5.0 mA, f = 500 MHz)	MMBR521LT1		—	1.5	2.5	
(V_{CE} = –6.0 V, I_C = –5.0 mA, f = 1.0 GHz)	MMBR521LT1		—	2.5	3.5	
(V_{CE} = –6.0 V, I_C = –5.0 mA, f = 1.0 GHz)	MRF5211LT1		—	2.8	3.5	

2

TYPICAL CHARACTERISTICS
MMBR521LT1, MRF521, MRF5211LT1

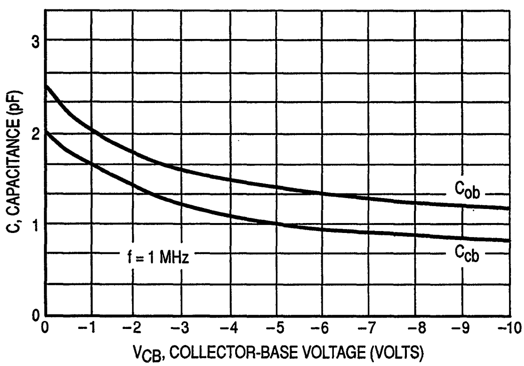


Figure 1. Junction Capacitance versus Voltage

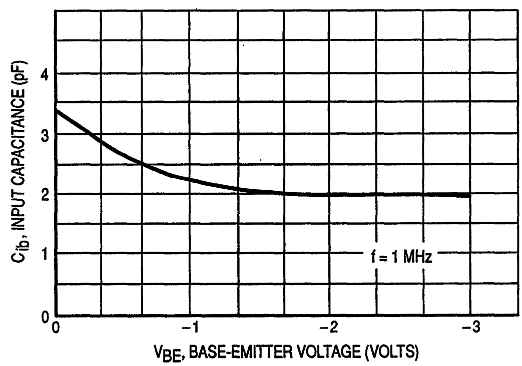


Figure 2. Input Capacitance versus Voltage

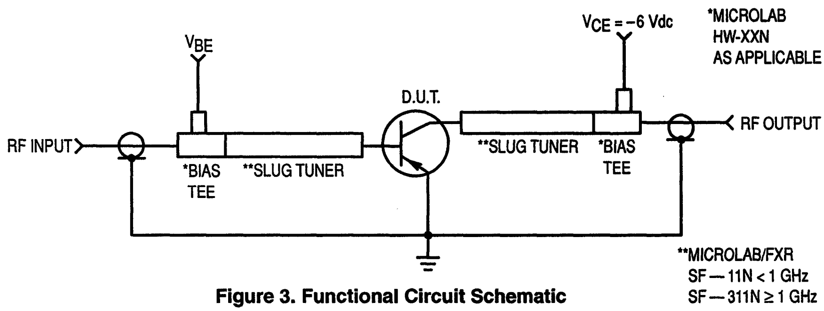


Figure 3. Functional Circuit Schematic

TYPICAL CHARACTERISTICS
MMBR521LT1

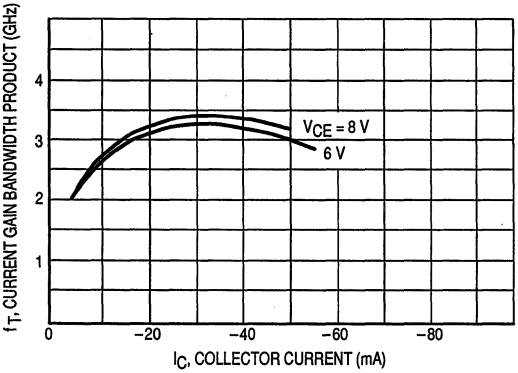


Figure 4. Current Gain Bandwidth Product versus Collector Current

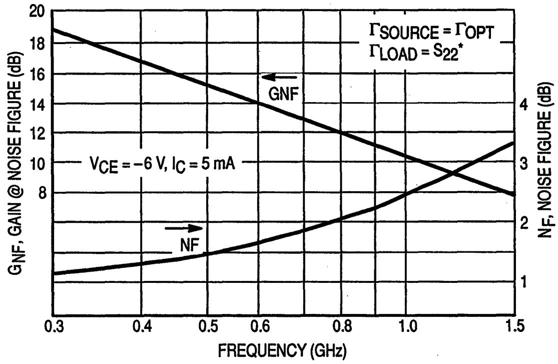


Figure 5. Noise Figure & Gain @ Noise Figure versus Frequency

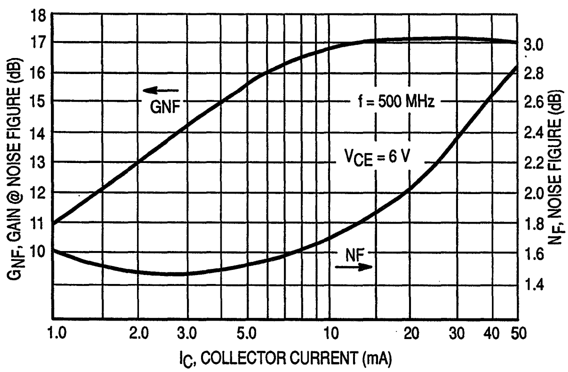


Figure 6. Noise Figure & Gain @ Noise Figure versus Collector Current

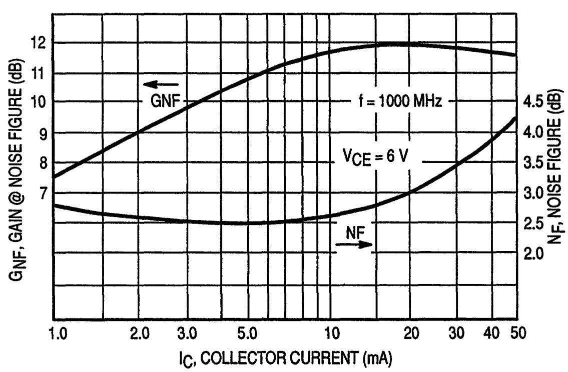


Figure 7. Noise Figure & Gain @ Noise Figure versus Collector Current

TYPICAL CHARACTERISTICS
MRF5211LT1

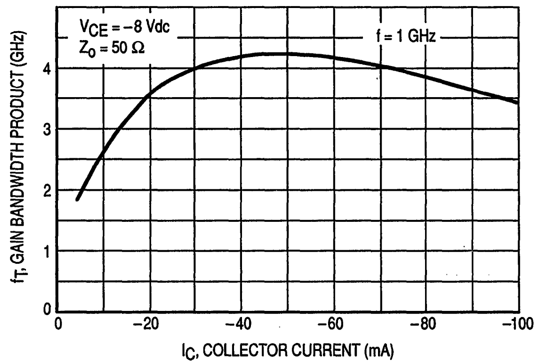


Figure 8. Gain-Bandwidth Product versus Current

GAIN AND NOISE FIGURE versus FREQUENCY

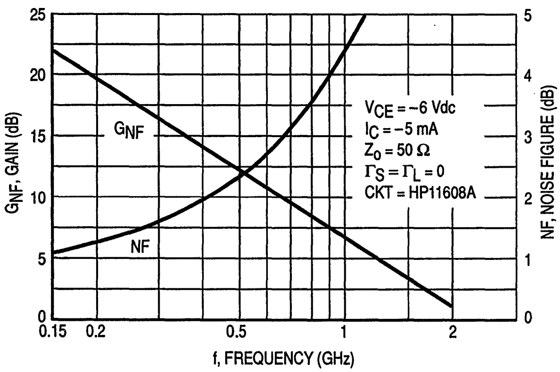


Figure 9. 50 Ohm System

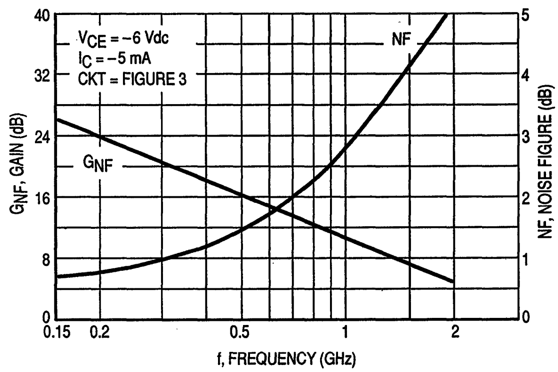


Figure 10. Tuned Circuit

GAIN AND NOISE FIGURE versus CURRENT

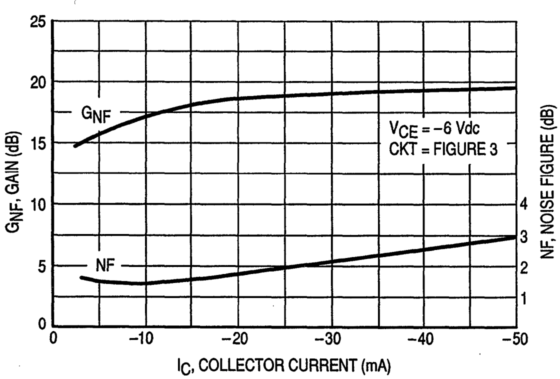


Figure 11. Tuned Circuit — Frequency 500 MHz

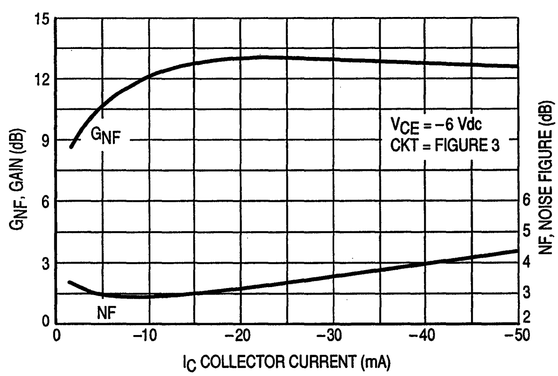


Figure 12. Tuned Circuit — Frequency 1.0 GHz

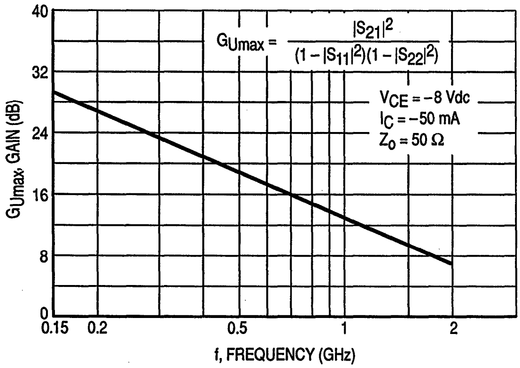


Figure 13. G_{Umax} versus Current

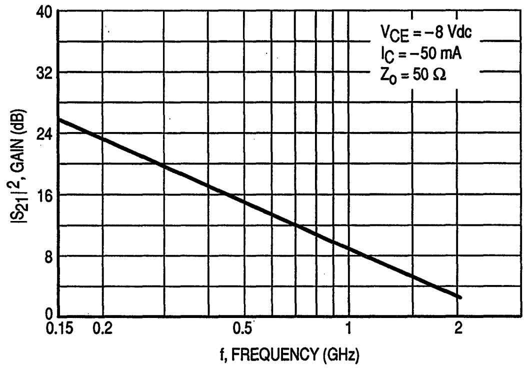


Figure 14. Insertion Gain versus Frequency

2

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
6	5	100	0.754	−67	11.453	141	0.040	59	0.818	−24
		300	0.683	−132	6.106	105	0.065	39	0.549	−37
		500	0.667	−157	3.954	89	0.071	39	0.472	−40
		700	0.660	−171	2.890	78	0.078	44	0.452	−44
		900	0.656	179	2.294	69	0.085	50	0.449	−49
		1000	0.654	175	2.086	65	0.091	53	0.451	−52
		1500	0.641	158	1.442	48	0.130	64	0.480	−66
		2000	0.672	140	1.108	36	0.188	69	0.466	−79
		2500	0.681	124	0.917	26	0.261	66	0.483	−94
		3000	0.681	110	0.793	18	0.343	60	0.493	−110
		3500	0.686	96	0.716	13	0.426	52	0.500	−126
		4000	0.683	84	0.674	9	0.503	43	0.502	−143
		4500	0.678	73	0.653	6	0.568	34	0.503	−160
		5000	0.669	64	0.653	3	0.620	24	0.507	−176
	10	100	0.632	−92	16.621	131	0.032	55	0.694	−33
		300	0.618	−149	7.460	98	0.050	47	0.417	−41
		500	0.618	−168	4.671	85	0.061	53	0.358	−44
		700	0.616	−178	3.392	76	0.076	58	0.346	−47
		900	0.615	173	2.672	68	0.092	62	0.347	−52
		1000	0.613	170	2.429	64	0.100	63	0.352	−55
		1500	0.601	155	1.677	48	0.150	66	0.382	−68
		2000	0.633	138	1.294	36	0.208	66	0.371	−80
		2500	0.642	124	1.078	25	0.273	62	0.391	−94
		3000	0.646	110	0.929	16	0.346	56	0.408	−109
		3500	0.656	98	0.827	10	0.422	49	0.421	−124
		4000	0.662	86	0.756	4	0.494	41	0.431	−141
		4500	0.664	75	0.709	1	0.554	32	0.442	−158
		5000	0.664	66	0.683	−3	0.609	24	0.455	−174
	50	100	0.547	−149	21.107	115	0.017	63	0.441	−43
		300	0.606	−174	7.891	90	0.037	68	0.260	−42
		500	0.616	177	4.811	80	0.058	73	0.239	−44
		700	0.616	171	3.480	72	0.080	73	0.242	−48
		900	0.616	165	2.746	65	0.102	73	0.248	−54
		1000	0.615	163	2.479	61	0.113	72	0.255	−57
		1500	0.606	150	1.717	46	0.169	69	0.293	−71
		2000	0.643	135	1.327	33	0.229	65	0.289	−82
		2500	0.654	122	1.097	22	0.292	60	0.315	−96
		3000	0.662	108	0.940	13	0.359	54	0.337	−110
		3500	0.672	96	0.825	6	0.427	47	0.356	−126
		4000	0.680	84	0.743	1	0.493	39	0.373	−142
		4500	0.682	74	0.688	−2	0.551	31	0.391	−159
		5000	0.679	64	0.658	−5	0.601	22	0.409	−175
10	5	100	0.792	−59	11.498	144	0.036	62	0.848	−21
		300	0.681	−123	6.513	108	0.061	41	0.598	−32
		500	0.652	−150	4.278	91	0.068	40	0.518	−36
		700	0.639	−166	3.142	80	0.073	44	0.496	−39
		900	0.631	−177	2.491	71	0.081	49	0.489	−44
		1000	0.628	179	2.264	67	0.086	53	0.492	−46
		1500	0.616	161	1.560	50	0.120	64	0.514	−58
		2000	0.644	142	1.199	37	0.171	69	0.500	−70
		2500	0.654	126	0.985	26	0.238	68	0.516	−83
		3000	0.661	111	0.843	18	0.314	63	0.523	−98
		3500	0.670	98	0.749	12	0.399	56	0.529	−113
		4000	0.672	85	0.690	8	0.479	47	0.528	−129
		4500	0.671	73	0.656	5	0.549	38	0.524	−146
		5000	0.665	63	0.649	3	0.609	28	0.523	−162
10	10	100	0.666	−80	17.255	135	0.030	58	0.738	−28
		300	0.596	−141	8.143	101	0.047	48	0.465	−37
		500	0.587	−162	5.139	87	0.059	53	0.404	−38
		700	0.581	−174	3.741	78	0.072	58	0.388	−41
		900	0.578	177	2.947	70	0.086	61	0.387	−45
		1000	0.577	174	2.670	66	0.095	63	0.389	−48
		1500	0.565	158	1.856	50	0.139	66	0.413	−60
		2000	0.596	140	1.431	38	0.191	66	0.402	−70
		2500	0.608	126	1.177	26	0.253	64	0.420	−82
		3000	0.619	112	1.008	17	0.319	59	0.434	−96
		3500	0.632	99	0.886	9	0.393	52	0.444	−110
		4000	0.644	87	0.797	3	0.465	44	0.453	−126
		4500	0.652	75	0.732	−1	0.532	36	0.457	−143
		5000	0.654	65	0.694	−4	0.589	28	0.465	−159

Table 1. MMBR521LT1 Common Emitter S-Parameters

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
−6.0	−5.0	200	0.82	−114	7.9	118	0.07	35	0.59	−46
		500	0.81	−158	4.0	88	0.08	21	0.40	−54
		1000	0.79	175	2.0	67	0.08	21	0.37	−68
		1500	0.76	158	1.3	50	0.07	30	0.43	−82
		2000	0.74	143	1.0	38	0.08	47	0.47	−95
	−10	200	0.78	−137	10.6	109	0.05	32	0.43	−63
		500	0.79	−168	4.9	84	0.06	28	0.26	−75
		1000	0.77	169	2.5	66	0.06	39	0.24	−87
		1500	0.74	155	1.6	50	0.08	49	0.29	−97
		2000	0.71	140	1.2	39	0.10	55	0.32	−106
	−50	200	0.77	−167	13.1	99	0.02	45	0.26	−108
		500	0.77	176	5.7	80	0.04	57	0.18	−132
		1000	0.76	161	2.8	65	0.06	65	0.17	−142
		1500	0.73	149	1.9	51	0.08	67	0.19	−137
		2000	0.70	136	1.4	40	0.12	65	0.20	−137
−8.0	−5.0	200	0.82	−109	8.1	119	0.07	36	0.62	−43
		500	0.80	−154	4.2	90	0.08	22	0.42	−52
		1000	0.78	175	2.2	67	0.08	22	0.38	−65
		1500	0.75	159	1.4	50	0.07	31	0.43	−78
		2000	0.72	143	1.0	37	0.09	43	0.46	−89
	−10	200	0.77	−132	11.2	110	0.05	33	0.45	−61
		500	0.77	−167	5.2	86	0.06	29	0.27	−70
		1000	0.76	169	2.6	67	0.06	39	0.25	−81
		1500	0.73	155	1.7	51	0.07	49	0.29	−90
		2000	0.70	140	1.3	39	0.10	54	0.31	−98
	−50	200	0.75	−164	14.2	100	0.02	43	0.26	−101
		500	0.76	178	6.1	82	0.04	55	0.17	−121
		1000	0.75	163	3.1	67	0.06	64	0.15	−131
		1500	0.72	151	2.0	53	0.08	67	0.18	−126
		2000	0.70	139	1.5	42	0.11	68	0.19	−127

Table 2. MRF5211LT1 Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle \phi$	$\|S_{21}\|$	$\angle \phi$	$\|S_{12}\|$	$\angle \phi$	$\|S_{22}\|$	$\angle \phi$
−6.0	−5.0	200	0.75	−116	7.6	117	0.06	36	0.59	−42
		500	0.75	−164	3.9	86	0.07	28	0.42	−51
		1000	0.74	165	2.0	63	0.08	37	0.37	−64
		1500	0.75	144	1.3	45	0.09	53	0.39	−85
		2000	0.74	124	1.0	32	0.14	61	0.43	−101
	−10	200	0.71	−138	10.7	109	0.04	37	0.45	−54
		500	0.72	−175	4.7	82	0.06	40	0.29	−61
		1000	0.72	148	2.4	63	0.08	55	0.20	−73
		1500	0.72	140	1.6	47	0.11	63	0.28	−94
		2000	0.71	122	1.2	34	0.16	61	0.31	−108
	−50	200	0.71	−172	12.9	100	0.02	59	0.26	−77
		500	0.72	170	5.3	78	0.05	68	0.15	−88
		1000	0.72	152	2.7	62	0.09	71	0.13	−99
		1500	0.72	136	1.8	46	0.13	70	0.17	−116
		2000	0.71	118	1.4	63	0.18	63	0.20	−123
−8.0	−5.0	200	0.77	−107	8.3	119	0.06	40	0.64	−38
		500	0.74	−163	4.1	88	0.07	28	0.45	−46
		1000	0.74	167	2.2	64	0.07	39	0.40	−58
		1500	0.74	146	1.4	47	0.08	54	0.42	−79
		2000	0.73	126	1.1	33	0.13	62	0.45	−95
	−10	200	0.69	−133	11.5	111	0.04	39	0.49	−49
		500	0.71	−172	5.1	83	0.05	41	0.32	−55
		1000	0.71	161	2.6	64	0.07	56	0.28	−64
		1500	0.71	142	1.7	48	0.10	64	0.30	−85
		2000	0.70	123	1.3	34	0.15	63	0.33	−98
	−50	200	0.67	−171	13.2	99	0.02	59	0.25	−70
		500	0.70	171	5.8	81	0.04	67	0.17	−74
		1000	0.69	151	2.9	62	0.08	72	0.15	−82
		1500	0.70	136	2.0	38	0.12	70	0.17	−100
		2000	0.68	117	1.5	33	0.17	63	0.20	−109

Table 3. MRF521 Common Emitter S-Parameters

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

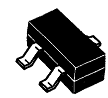
MMBR901LT1
MRF9011LT1

The RF Line
NPN Silicon High-Frequency Transistor

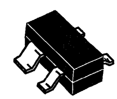
I_C = 30 mA
SURFACE MOUNTED
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON

. . . designed primarily for use in high-gain, low-noise small-signal amplifiers for operation up to 2.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain — Bandwidth Product —
  f_T = 3.8 GHz (Typ) @ I_C = 15 mAdc (MRF9011LT1)
- Low Noise Figure @ f = 1.0 GHz —
  $NF_{(matched)}$ = 1.8 dB (Typ) (MRF9011LT1)
  = 1.9 dB (Typ) (MMBR901LT1)
- High Power Gain —
  $G_{pe(matched)}$ = 13.5 dB (Typ) @ f = 1.0 GHz (MRF9011LT1)
  = 12.0 dB (Typ) @ f = 1.0 GHz (MMBR901LT1)
- Guaranteed RF Parameters (MRF9011LT1)
- Surface Mounted SOT-23 & SOT-143 Offer Improved RF Performance
  Lower Package Parasitics
  High Gain



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE



CASE 318A, STYLE 1
SOT-143
LOW PROFILE

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector-Emitter Voltage		V_{CEO}	15	Vdc
Collector-Base Voltage		V_{CBO}	25	Vdc
Emitter-Base Voltage		V_{EBO}	2.0	Vdc
Collector Current — Continuous		I_C	30	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C		P_D	0.3 3.3	Watt mW/°C
Storage Temperature Range	MMBR901LT1 MRF9011LT1	T_{stg}	−55 to +150 −65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic		Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C (1) Derate above 25°C		P_D	350 2.8	mW mW/°C
Storage Temperature		T_{stg}	150	°C
Thermal Resistance, Junction to Ambient	MMBR901LT1 MRF9011LT1	$R_{\theta JA}$	357 300	°C/W

DEVICE MARKING

MRF9011LT1 = 01	MMBR901LT1 = 7A

NOTE:
1. Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	MMBR901LT1 MRF9011LT1	h_{FE}	50 30	— 80	200 200	—
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	MRF9011LT1	f_T	—	3.8	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MRF9011LT1	C_{cb}	—	0.55	1.0	pF
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MRF9011LT1	G_{NFmin}	—	13.5	—	dB
Noise Figure (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MRF9011LT1	NF_{min}	—	1.8	—	dB
Power Gain in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	MRF9011LT1	G_{NF}	9.0	10.2	—	dB
Noise Figure (V_{CE} = 6.0 Vdc, I_C = 5.0 mA, f = 1.0 GHz) (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	 MMBR901LT1 MRF9011LT1	NF	 — —	 1.9 2.3	 — 3.0	dB
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 Vdc, I_C = 5.0 mAdc, f = 1.0 GHz)		C_{obo}	—	—	1.0	pF
Common-Emitter Amplifier Gain (V_{CC} = 6.0 Vdc, I_C = 5.0 mAdc, f = 1.0 GHz)		G_{pe}	—	12	—	dB

2

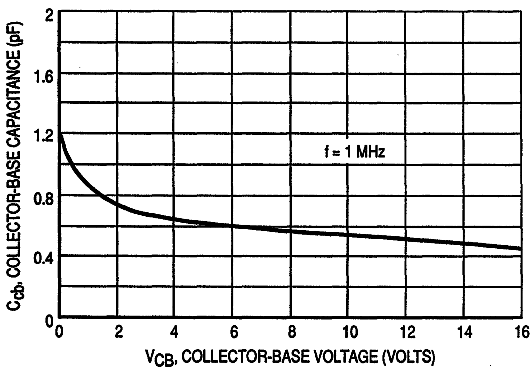


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

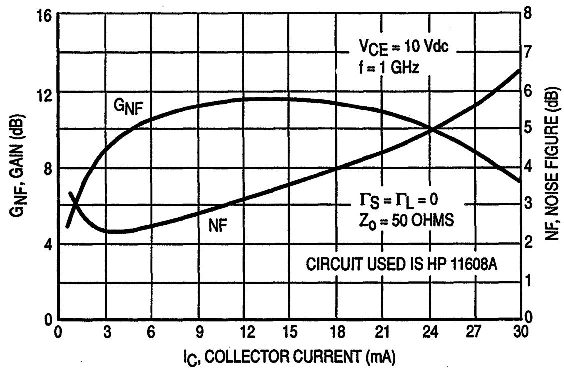


Figure 2. Gain and Noise Figure versus Collector Current

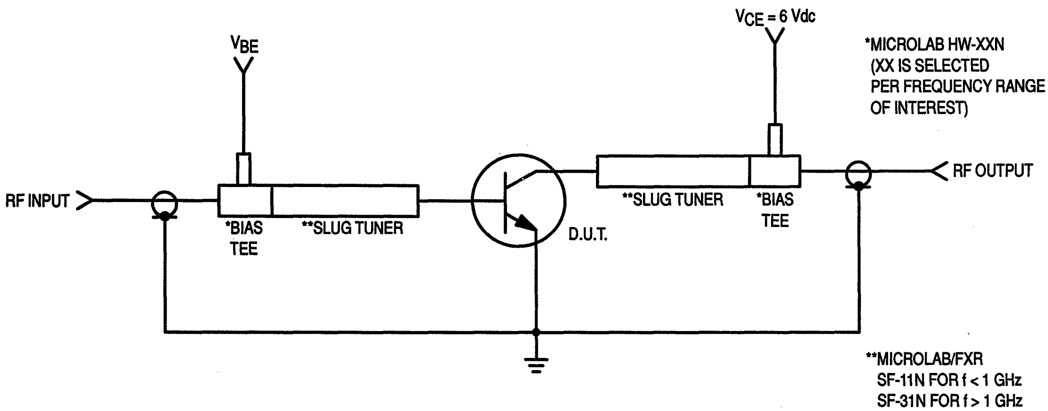


Figure 3. Functional Circuit Schematic

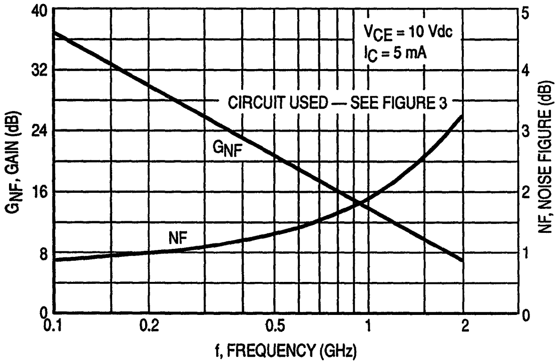


Figure 4. Gain and Noise Figure versus Frequency

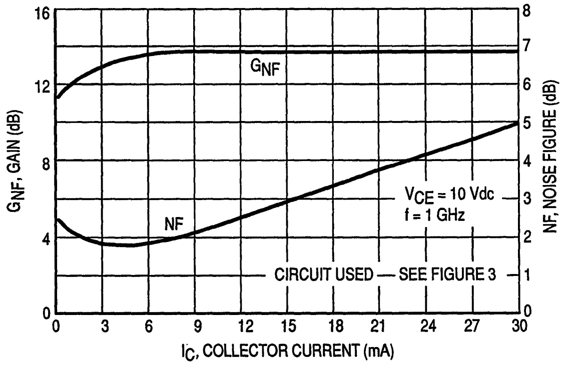


Figure 5. Gain and Noise Figure versus Collector Current

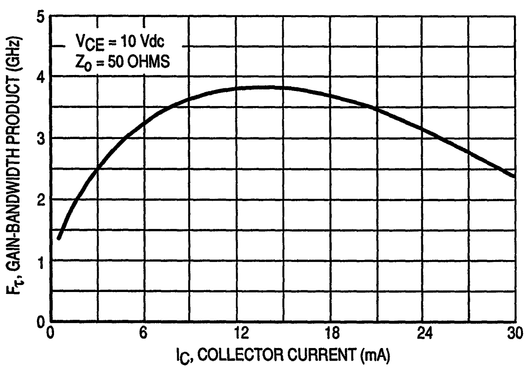


Figure 6. Gain-Bandwidth Product versus Collector Current

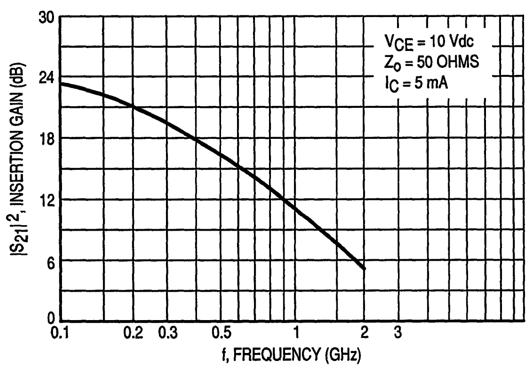


Figure 7. Insertion Gain versus Frequency

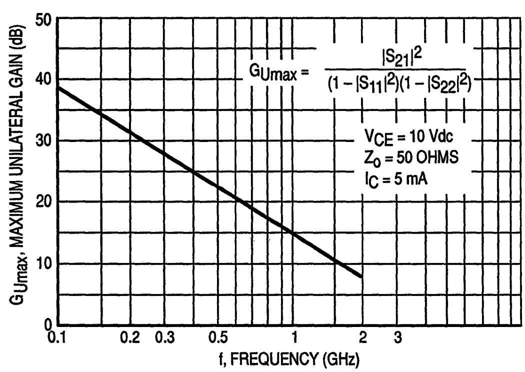


Figure 8. Maximum Unilateral Gain versus Frequency

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	5.0	100	0.85	−41	13.64	153	0.03	65	0.93	−17
		200	0.78	−76	10.77	134	0.05	54	0.80	−29
		500	0.71	−131	6.10	102	0.08	35	0.55	−42
		1000	0.66	−169	3.22	77	0.08	33	0.45	−48
		2000	0.60	152	1.65	47	0.11	46	0.47	−63
	10	100	0.72	−59	20.01	145	0.03	62	0.87	−23
		200	0.70	−100	14.31	123	0.04	49	0.67	−36
		500	0.66	−150	7.03	94	0.06	38	0.44	−43
		1000	0.63	179	3.57	73	0.07	45	0.37	−46
		2000	0.58	147	1.79	46	0.11	57	0.41	−60
	15	100	0.65	−75	23.44	138	0.02	57	0.81	−27
		200	0.66	−118	15.56	116	0.04	46	0.59	−38
		500	0.65	−159	7.10	90	0.05	42	0.40	−40
		1000	0.63	174	3.57	71	0.06	52	0.35	−43
		2000	0.59	144	1.77	45	0.11	62	0.40	−58
	20	100	0.61	−89	24.32	133	0.02	51	0.77	−28
		200	0.66	−130	15.11	111	0.03	43	0.55	−35
		500	0.66	−166	6.68	88	0.04	46	0.41	−34
		1000	0.65	171	3.32	69	0.06	56	0.39	−39
		2000	0.61	143	1.65	43	0.10	65	0.44	−56
	30	100	0.63	−132	13.18	118	0.02	47	0.72	−15
		200	0.68	−157	7.07	104	0.02	44	0.66	−16
		500	0.69	−177	3.23	90	0.03	55	0.62	−24
		1000	0.70	165	1.78	71	0.05	65	0.59	−38
		2000	0.66	138	0.93	42	0.09	79	0.62	−62
10	5.0	100	0.85	−38	13.67	155	0.03	70	0.93	−14
		200	0.80	−71	10.97	136	0.05	56	0.83	−24
		500	0.70	−126	6.35	104	0.07	37	0.60	−35
		1000	0.65	−166	3.39	78	0.07	36	0.51	−40
		2000	0.58	154	1.74	48	0.10	50	0.54	−55
	10	100	0.75	−55	20.12	147	0.02	66	0.88	−19
		200	0.71	−94	14.60	125	0.04	50	0.72	−30
		500	0.65	−145	7.33	96	0.05	39	0.50	−35
		1000	0.62	−177	3.74	74	0.06	46	0.45	−38
		2000	0.57	149	1.88	47	0.10	60	0.49	−53
	15	100	0.68	−68	23.53	140	0.02	61	0.85	−22
		200	0.67	−110	15.90	119	0.03	49	0.65	−31
		500	0.64	−155	7.45	92	0.04	42	0.47	−32
		1000	0.62	177	3.74	71	0.06	53	0.44	−35
		2000	0.58	146	1.90	45	0.09	65	0.50	−51
	20	100	0.64	−79	24.77	135	0.02	56	0.81	−23
		200	0.64	−122	15.81	114	0.03	46	0.62	−29
		500	0.64	−161	7.10	89	0.04	46	0.48	−28
		1000	0.62	174	3.53	79	0.05	56	0.46	−33
		2000	0.59	145	1.75	44	0.09	68	0.53	−50
	30	100	0.61	−114	16.25	123	0.01	48	0.79	−15
		200	0.63	−147	9.10	107	0.02	49	0.71	−15
		500	0.65	−172	4.22	90	0.03	53	0.66	−22
		1000	0.66	168	2.27	71	0.05	63	0.63	−33
		2000	0.63	140	1.15	41	0.08	79	0.67	−53

Table 1. MRF9011LT1 Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

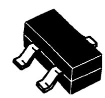
MMBR920LT1

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1.0 GHz.

- High Gain — G_{pe} = 15 dB Typ @ f = 500 MHz
- Low Noise — NF = 2.4 dB Typ @ f = 500 MHz

RF AMPLIFIER TRANSISTOR NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C* Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	357	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR920LT1 = 7B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

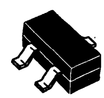
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 14 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	—	250	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	NF	 — —	 2.4 3.0	 — —	dB
Common-Emitter Amplifier Power Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	G_{pe}	 — —	 15 10	 — —	dB

MMBR931LT1

The RF Line
NPN Silicon High-Frequency Transistor

... designed primarily for use in low-power amplifiers to 1.0 GHz. Ideal for pagers and other battery operated systems where power consumption is critical.

RF AMPLIFIER TRANSISTOR NPN SILICON



**CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	5.0	Vdc
Collector-Base Voltage	V_{CBO}	10	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	5.0	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C* Derate above 25°C	P_D	50 0.4	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	2500	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR931LT1 = 7D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.25 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	50	—	150	—
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 1.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	0.5	pF
Noise Figure (I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)	NF	—	4.3	—	dB
Power Gain at Optimum Noise Figure (I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)	G_{NF}	—	10	—	—

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

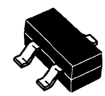
MMBR4957LT1

The RF Line
PNP Silicon High-Frequency Transistor

. . . designed for high-gain, low-noise amplifier oscillator and mixer applications. Specifically packaged for thick and thin-film circuits using surface mount components.

- High Gain — G_{pe} = 17 dB Typ @ f = 450 MHz
- Low Noise — NF = 3.0 dB Typ @ f = 450 MHz

I_C = –30 mA
HIGH-FREQUENCY TRANSISTOR
PNP SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–30	Vdc
Collector-Base Voltage	V_{CBO}	–30	Vdc
Emitter-Base Voltage	V_{EBO}	–3.0	Vdc
Collector Current — Continuous	I_C	–30	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C* Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	357	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR4957LT1 = 7F

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–30	—	Vdc
Collector-Base Breakdown Voltage (I_C = –100 µAdc, I_E = 0)	$V_{(BR)CBO}$	–30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = –100 µAdc, I_C = 0)	$V_{(BR)EBO}$	–3.0	—	Vdc
Collector Cutoff Current (V_{CB} = –10 Vdc, I_C = 0)	I_{CBO}	—	–0.1	µAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = –2.0 mAdc, V_{CE} = –10 Vdc)	h_{FE}	20	150	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_E = –2.0 mAdc, V_{CE} = –10 Vdc, f = 100 MHz)	f_T	1200 (Typ)	—	MHz
Collector-Base Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.8	pF
Common-Emitter Amplifier Power Gain (V_{CE} = –10 Vdc, I_C = –2.0 mAdc, f = 450 MHz)	G_{pe}	17 (Typ)	—	dB
Noise Figure (I_C = –2.0 mAdc, V_{CE} = –10 Vdc, f = 450 MHz)	NF	—	3.0 (Typ)	dB

2

VCE (Volts)	IC (mA)	f MHz	S11		S21		S12		S22	
			IS11I	∠ φ	IS21I	∠ φ	IS12I	∠ φ	IS22I	∠ φ
–5.0	–5.0	0.1	0.61	–37	9.28	148	0.03	72	0.90	–16
		0.3	0.39	–83	5.56	112	0.07	62	0.69	–27
		0.5	0.30	–107	3.73	95	0.09	62	0.62	–30
		0.7	0.26	–125	2.79	84	0.12	62	0.59	–34
		0.9	0.24	–140	2.26	76	0.14	61	0.58	–38
		1.2	0.24	–158	1.78	65	0.17	60	0.58	–45
		1.5	0.23	–172	1.49	55	0.20	60	0.58	–51
		2.0	0.23	156	1.17	43	0.24	60	0.56	–61
		2.5	0.25	133	0.98	33	0.29	59	0.54	–72
		3.0	0.29	105	0.85	26	0.34	58	0.50	–83
	–10	0.1	0.42	–55	11.54	138	0.03	71	0.84	–18
		0.3	0.28	–108	5.81	104	0.06	66	0.64	–25
		0.5	0.25	–132	3.72	90	0.08	67	0.59	–28
		0.7	0.25	–148	2.77	81	0.11	66	0.58	–32
		0.9	0.25	–162	2.23	73	0.13	66	0.57	–37
		1.2	0.26	–177	1.74	62	0.16	65	0.57	–43
		1.5	0.26	170	1.46	54	0.19	65	0.57	–50
		2.0	0.27	142	1.14	41	0.24	65	0.56	–60
		2.5	0.30	122	0.95	32	0.29	64	0.53	–73
		3.0	0.34	97	0.82	26	0.35	61	0.50	–83
	–15	0.1	0.24	–90	6.83	129	0.02	69	0.80	–12
		0.3	0.24	–136	3.17	107	0.05	70	0.72	–19
		0.5	0.27	–153	2.23	96	0.08	69	0.69	–26
		0.7	0.29	–167	1.75	86	0.10	70	0.66	–32
		0.9	0.31	–178	1.47	77	0.12	70	0.65	–38
		1.2	0.32	168	1.20	65	0.15	70	0.64	–46
		1.5	0.32	155	1.03	56	0.18	72	0.63	–53
		2.0	0.34	130	0.83	44	0.24	71	0.60	–65
		2.5	0.36	111	0.71	36	0.31	68	0.57	–78
		3.0	0.41	89	0.64	31	0.37	64	0.51	–90
–10	–5.0	0.1	0.65	–33	9.36	149	0.03	74	0.92	–14
		0.3	0.42	–73	5.77	114	0.06	64	0.72	–25
		0.5	0.31	–95	3.91	98	0.09	63	0.65	–29
		0.7	0.26	–111	2.94	87	0.11	63	0.62	–32
		0.9	0.24	–126	2.39	78	0.14	62	0.61	–37
		1.2	0.23	–144	1.87	67	0.17	60	0.60	–43
		1.5	0.21	–159	1.58	58	0.19	60	0.60	–49
		2.0	0.20	166	1.24	46	0.23	60	0.58	–58
		2.5	0.21	141	1.04	35	0.27	59	0.56	–69
		3.0	0.25	109	0.90	28	0.32	59	0.52	–79
	–10	0.1	0.49	–46	12.33	141	0.03	71	0.87	–17
		0.3	0.30	–91	6.45	107	0.06	67	0.66	–24
		0.5	0.25	–114	4.19	93	0.08	67	0.61	–27
		0.7	0.23	–132	3.10	83	0.11	66	0.59	–31
		0.9	0.22	–147	2.50	75	0.13	65	0.58	–35
		1.2	0.23	–164	1.96	65	0.16	64	0.58	–41
		1.5	0.23	–178	1.63	57	0.18	65	0.58	–47
		2.0	0.23	150	1.27	44	0.23	65	0.57	–57
		2.5	0.25	128	1.06	35	0.28	64	0.55	–67
		3.0	0.30	101	0.92	27	0.33	62	0.51	–78
	–15	0.1	0.38	–57	12.51	135	0.02	71	0.84	–17
		0.3	0.25	–107	5.97	103	0.05	69	0.66	–21
		0.5	0.23	–130	3.84	90	0.08	69	0.63	–25
		0.7	0.23	–147	2.84	81	0.10	68	0.61	–29
		0.9	0.24	–161	2.29	74	0.12	67	0.61	–34
		1.2	0.26	–177	1.80	64	0.15	68	0.60	–41
		1.5	0.26	170	1.50	55	0.18	68	0.61	–47
		2.0	0.27	141	1.17	43	0.23	69	0.59	–57
		2.5	0.29	120	0.97	34	0.28	67	0.57	–68
		3.0	0.34	96	0.84	27	0.34	64	0.53	–79

Table 1. Common Emitter S-Parameters

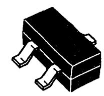
MMBR5031LT1

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1.0 GHz.

- High Gain — G_{pe} = 17 dB Typ @ f = 450 MHz
- Low Noise — NF = 2.5 dB Typ @ f = 450 MHz

RF AMPLIFIER TRANSISTOR NPN SILICON



**CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C* Derate above 25°C	P_D	300 2.4	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	417	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR5031LT1 = 7G

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	10	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)	I_{CBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	25	300	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1,000 (Typ)	—	MHz
Collector-Base Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)	C_{cb}	—	1.5	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	NF	—	2.5 (Typ)	dB
Common-Emitter Amplifier Power Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	G_{pe}	17 (Typ)	25	dB

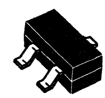
MMBR5179LT1

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for small-signal amplification at frequencies to 500 MHz. Specifically packaged for use in thick and thin-film circuits using surface mount components.

- High Gain — G_{pe} = 15 dB Typ @ f = 200 MHz
- Low Noise — NF = 4.5 dB Typ @ f = 200 MHz

RF AMPLIFIER TRANSISTOR NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	50	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C* Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient*	$R_{\theta JA}$	357	°C/W

* Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR5179LT1 = 7H

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	0.02	µAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1,400 (Typ)	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	—	1.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	25	—	—
Noise Figure (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω, f = 200 MHz)	NF	—	4.5 (Typ)	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 6.0 Vdc, I_C = 5.0 mAdc, f = 200 MHz)	G_{pe}	15 (Typ)	—	dB

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

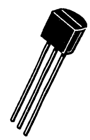
PNP Silicon High-Frequency Transistors

MPS536
MMBR536LT1

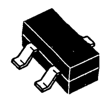
. . . this high current gain-bandwidth transistor makes an excellent RF amplifier and oscillator. It is available in the surface mount SOT-23 as well as the popular TO-92 low cost plastic packages.

- High Current Gain-Bandwidth Product
  f_T = 5.5 GHz (Typ) @ I_C = –20 mA — MMBR536L
  f_T = 4.5 GHz (Typ) @ I_C = –20 mA — MPS536
- High Gain
  G_{NF} = 14 dB (Typ)
- Low Collector-Base Capacitance
  C_{cb} = 0.8 pF (Typ) @ V_{CB} = –5.0 Vdc
- Tape and Reel Packaging Options

I_C = –30 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTORS



CASE 29-04, STYLE 2
TO-92
MPS536



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR536L

MAXIMUM RATINGS

Rating	Symbol	MPS536	MMBR536L	Unit
Collector-Emitter Voltage	V_{CEO}	–10	–10	Vdc
Collector-Base Voltage	V_{CBO}	–15	–15	Vdc
Emitter-Base Voltage	V_{EBO}	–4.5	–4.5	Vdc
Collector Current — Continuous	I_C	–30	–30	mA
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	200* 1.6	mW mW/°C
Storage Temperature	T_{stg}	–65 to +150	–65 to +150	°C

* Free air

DEVICE MARKING

MMBR536LT1 = 7R

ELECTRICAL CHARACTERISTICS (T_C = 25°C *For both package types unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = –2.0 mA, I_B = 0)		$V_{(BR)CEO}$	–10	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = –100 μA, I_E = 0)		$V_{(BR)CBO}$	–15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = –10 μA, I_C = 0)		$V_{(BR)EBO}$	–4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = –10 Vdc, I_E = 0)		I_{CBO}	—	—	–10	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = –20 mA, V_{CE} = –5.0 V)		h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS						
Current Gain-Bandwidth Product (I_C = –20 mAdc, V_{CE} = –5.0 Vdc, f = 1.0 GHz)	MPS536 MMBR536L	f_T	— —	4.5 5.5	— —	GHz
Collector-Base Capacitance (V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	0.8	1.2	pF
FUNCTIONAL TESTS						
Gain @ Noise Figure (I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	f = 500 MHz f = 1.0 GHz	G_{NF}	— —	14 8.0	— —	dB
Noise Figure (I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	f = 500 MHz f = 1.0 GHz	NF	— —	4.5 6.0	— —	dB

2

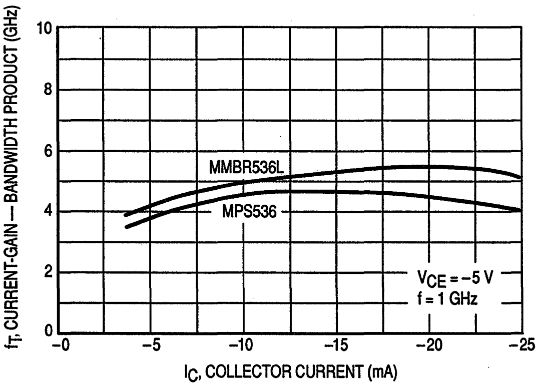


Figure 1. Current Gain-Bandwidth Product versus Collector Current

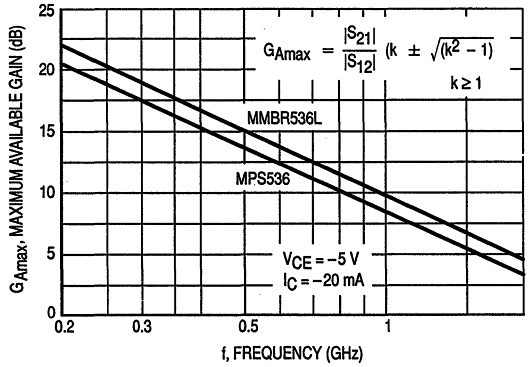


Figure 2. Maximum Available Gain (G_{Amax}) versus Frequency

MPS536

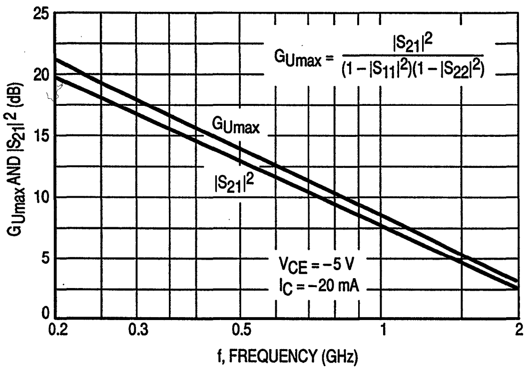


Figure 3. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

MMBR536L

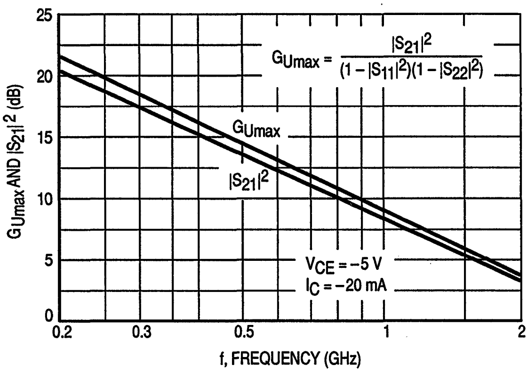


Figure 4. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

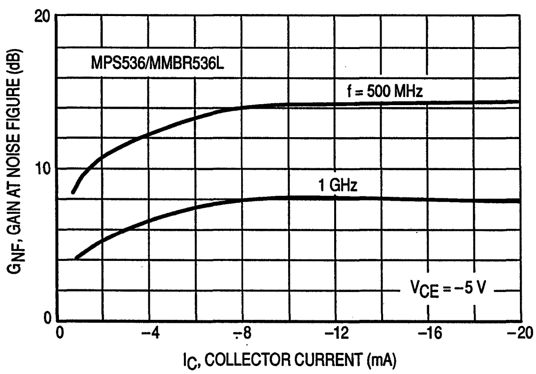


Figure 5. Gain at Noise Figure versus Collector Current

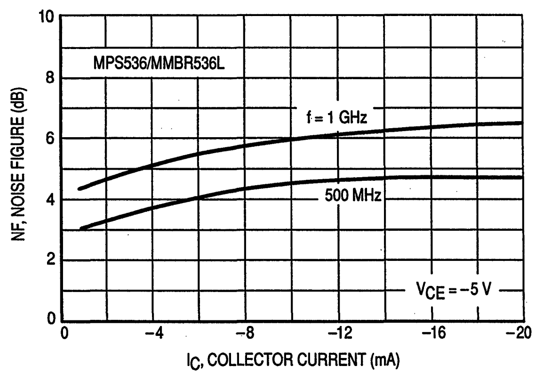


Figure 6. Noise Figure versus Collector Current

MPS536

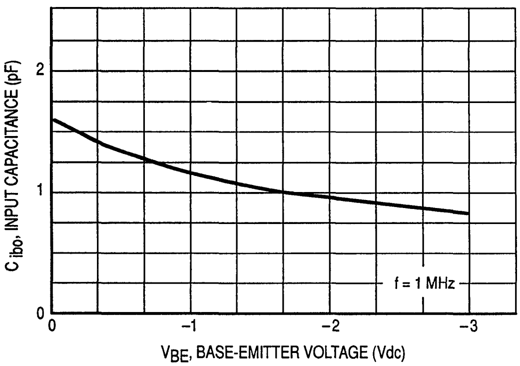


Figure 7. Input Capacitance versus Emitter-Base Voltage

MPS536

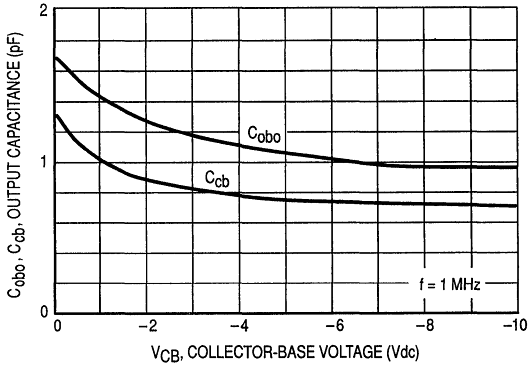


Figure 8. Output Capacitance versus Collector-Base Voltage

MMBR536L

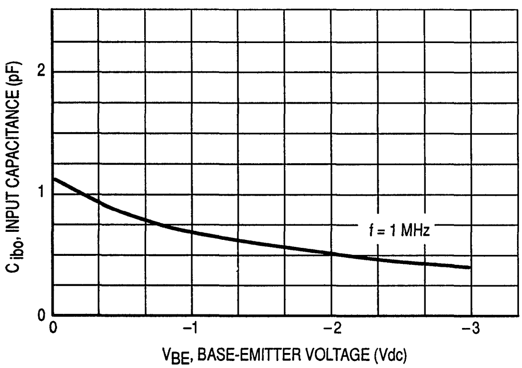


Figure 9. Input Capacitance versus Emitter-Base Voltage

MMBR536L

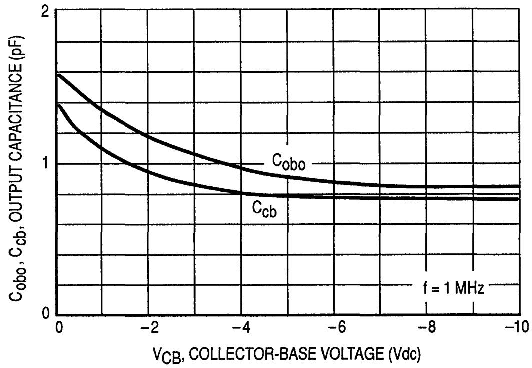


Figure 10. Output Capacitance versus Collector-Base Voltage

2

MPS536

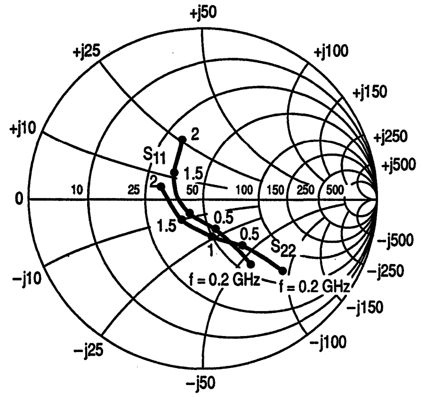


Figure 10. Input/Output Reflection Coefficient versus Frequency
V_{CE} = –10 V, I_C = –10 mA

MPS536

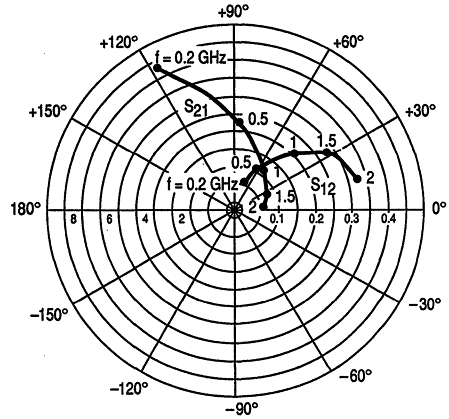


Figure 11. Forward/Reverse Transmission Coefficients versus Frequency
V_{CE} = –10 V, I_C = –10 mA

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	∠ϕ	$|S_{21}|$	∠ϕ	$|S_{12}|$	∠ϕ	$|S_{22}|$	∠ϕ
–10	–5.0	200	0.60	–43	6.60	125	0.07	68	0.71	–35
		500	0.30	–60	3.64	87	0.14	57	0.47	–43
		1000	0.17	–103	2.11	56	0.22	43	0.32	–69
		1500	0.15	156	1.70	28	0.30	28	0.22	–112
		2000	0.28	110	1.29	2.0	0.33	13	0.25	–174
	–10	200	0.48	–52	8.78	118	0.06	69	0.62	–42
		500	0.21	–66	4.31	84	0.12	60	0.37	–46
		1000	0.12	–122	2.40	54	0.20	47	0.24	–73
		1500	0.18	138	1.90	29	0.29	31	0.16	–126
		2000	0.32	104	1.41	4.0	0.33	16	0.23	170
	–20	200	0.38	–59	10.21	112	0.06	70	0.54	–46
		500	0.14	–76	4.72	81	0.12	63	0.30	–47
		1000	0.11	–144	2.58	53	0.20	49	0.19	–74
		1500	0.22	132	1.99	28	0.29	34	0.12	–139
		2000	0.35	103	1.46	4.0	0.33	19	0.22	161

MPS536
Table 1. Common Emitter S-Parameters

MMBR536L

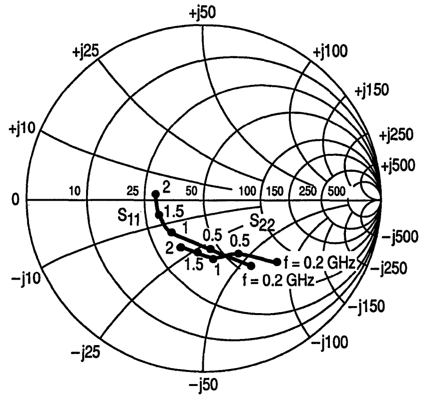


Figure 12. Input/Output Reflection Coefficient versus Frequency
V_{CE} = −10 V, I_C = −10 mA

MMBR536L

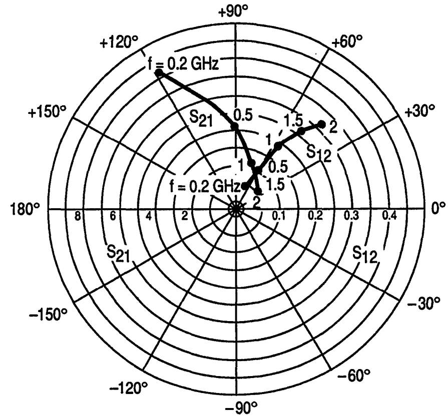


Figure 13. Forward/Reverse Transmission Coefficients versus Frequency
V_{CE} = −10 V, I_C = −10 mA

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
−10	−5.0	200	0.60	−44	6.47	126	0.07	66	0.68	−35
		500	0.37	−70	3.57	97	0.14	60	0.48	−50
		1000	0.27	−105	2.16	74	0.22	53	0.40	−69
		1500	0.24	−138	1.62	58	0.29	46	0.37	−87
		2000	0.22	−166	1.38	44	0.33	42	0.34	−103
	−10	200	0.48	−54	8.65	120	0.06	66	0.58	−40
		500	0.30	−82	4.32	94	0.12	62	0.38	−58
		1000	0.24	−122	2.52	74	0.20	57	0.32	−78
		1500	0.24	−155	1.84	59	0.27	51	0.30	−96
		2000	0.24	178	1.54	46	0.32	47	0.28	−112
	−20	200	0.39	−63	10.10	115	0.06	67	0.49	−50
		500	0.25	−94	4.77	91	0.11	65	0.32	−65
		1000	0.24	−136	2.72	73	0.19	60	0.27	−84
		1500	0.24	−167	1.96	58	0.26	54	0.26	−102
		2000	0.26	168	1.63	46	0.32	50	0.25	−119

MMBR536L
Table 2. Common Emitter S-Parameters

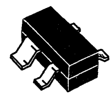
MPS571
MMBR571LT1
MRF5711LT1

The RF Line
NPN Silicon High-Frequency Transistors

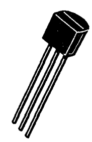
. . . designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic package, as well as the popular TO-226AA (TO-92) package. This Motorola series of small-signal plastic transistors offers superior quality and performance at low cost.

- High Gain-Bandwidth Product
  f_T = 8.0 GHz (Typ) @ 50 mA (MMBR571LT1)
  f_T = 7.5 GHz (Typ) @ 50 mA (MRF5711LT1)
- Low Noise Figure
  NF = 2.0 dB (Typ) @ f = 500 MHz (MMBR571LT1)
  $NF_{(matched)}$ = 1.6 dB (Typ) @ f = 1.0 GHz (MRF5711LT1)
- High Gain
  G_{NF} = 17 dB (Typ) @ 30 mA/500 MHz (MMBR571LT1)
- High Power Gain
  $G_{pe\ (matched)}$ = 13.5 dB (Typ) (MRF5711LT1)
- State-of-the-Art Technology
  Fine Line Geometry
  Ion-Implanted Arsenic Emitters
  Gold Top Metallization and Wires
  Silicon Nitride Passivation

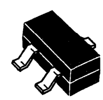
**I_C = 80 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTORS**



**CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE
MRF5711LT1**



**CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS571**



**CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR571LT1**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage MPS571, MMBR571LT1 MRF5711LT1	V_{EBO}	3.0 2.5	Vdc
Collector Current — Continuous MPS571, MMBR571LT1 MRF5711LT1	I_C	 80 70	mA
Power Dissipation @ T_A = 25°C MPS571 MMBR571LT1	P_D	625 200 (Free Air)	mW
Total Device Dissipation @ T_A = 25°C Derate above 25°C MRF5711LT1	P_D	0.58 4.64	Watts mW/°C
Total Device Dissipation (1) @ T_C = 75°C Derate above 75°C MRF5711LT1	P_D	0.58 7.73	Watts mW/°C
Storage Temperature MPS571, MMBR571LT1 MRF5711LT1	T_{stg}	−55 to +150 −65 to +150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient MRF5711LT1	$R_{\theta JA}$	216	°C/W
Thermal Resistance, Junction to Case MRF5711LT1	$R_{\theta JC}$	130	°C/W

DEVICE MARKING

MMBR571LT1 = 7X	MRF5711LT1 = 02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)		$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)		$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 8.0 Vdc, I_E = 0)		I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance		C_{cb}				pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MPS571, MMBR571LT1		—	0.7	1.0	
(V_{CB} = 6.0 Vdc, I_E = 0, f = 1.0 MHz)	MRF5711LT1		—	0.75	1.0	
Current Gain-Bandwidth Product	MPS571	f_T	—	6.0	—	GHz
(V_{CE} = 5.0 Vdc, I_C = 50 mAdc, f = 1.0 GHz)	MMBR571LT1		—	8.0	—	
(V_{CE} = 8.0 Vdc, I_C = 50 mAdc, f = 1.0 GHz)	MRF5711LT1		—	8.0	—	
FUNCTIONAL TESTS						
Gain @ Noise Figure		G_{NF}				dB
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPS571 f = 0.5 GHz		—	14	—	
	f = 1.0 GHz		—	9.0	—	
	MMBR571LT1 f = 0.5 GHz		—	16.5	—	
	f = 1.0 GHz		—	10.5	—	
(I_C = 10 mA, V_{CE} = 6.0 Vdc)	MRF5711LT1 f = 1.0 GHz		—	13.5	—	
Noise Figure		NF				dB
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPS571 f = 0.5 GHz		—	2.0	—	
	f = 1.0 GHz		—	2.6	—	
	MMBR571LT1 f = 0.5 GHz		—	2.0	—	
	f = 1.0 GHz		—	2.6	—	
(I_C = 10 mAdc, V_{CE} = 6.0 Vdc)	MRF5711LT1 f = 1.0 GHz		—	2.2	—	
Noise Figure (V_{CE} = 6.0 V, I_C = 10 mA, f = 1.0 GHz)	MRF5711LT1	NF_{min}	—	1.6	—	dB
Power Gain in 50 Ω System (V_{CE} = 6.0 V, I_C = 10 mA, f = 1.0 GHz)		$\|S_{21}\|^2$	9.0	10	—	dB

TYPICAL CHARACTERISTICS
MPS571, MMBR571LT1

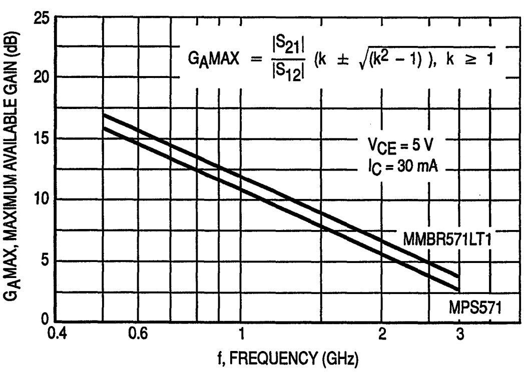


Figure 1. Maximum Available Gain versus Frequency

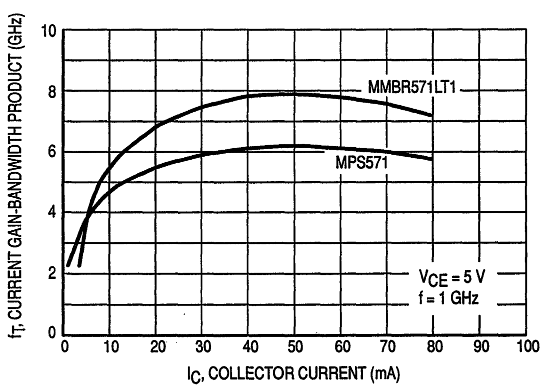


Figure 2. Current Gain-Bandwidth versus Collector Current @ 1.0 GHz

TYPICAL CHARACTERISTICS
MPS571, MMBR571LT1

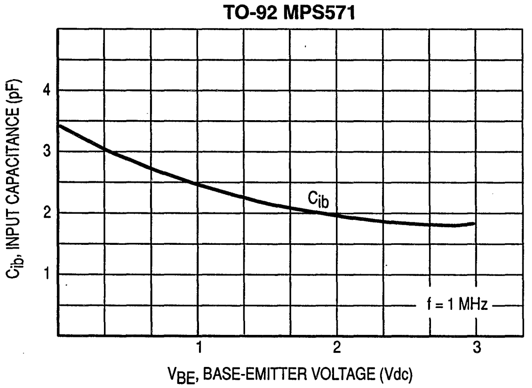


Figure 3. Input Capacitance versus Emitter Base Voltage

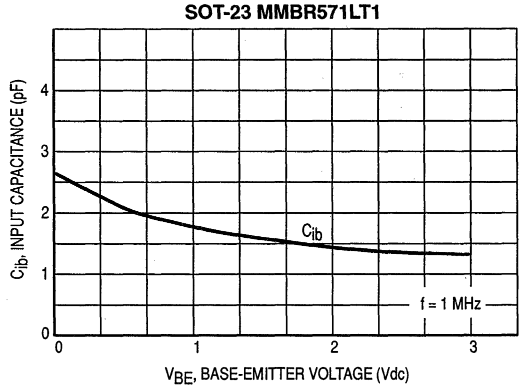


Figure 4. Input Capacitance versus Emitter Base Voltage

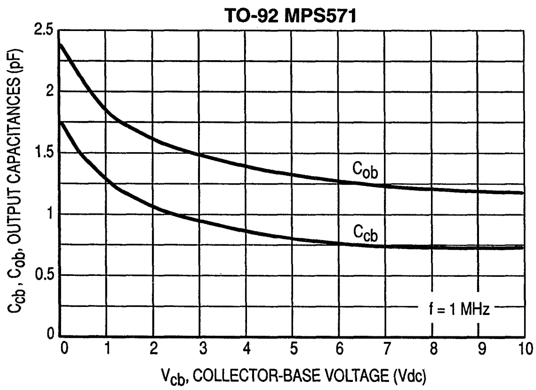


Figure 5. Output Capacitances versus Collector-Base Voltage

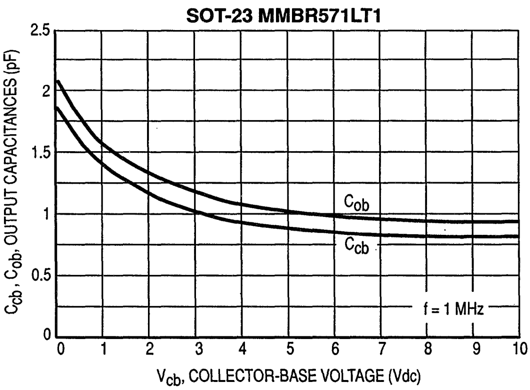


Figure 6. Output Capacitances versus Collector-Base Voltage

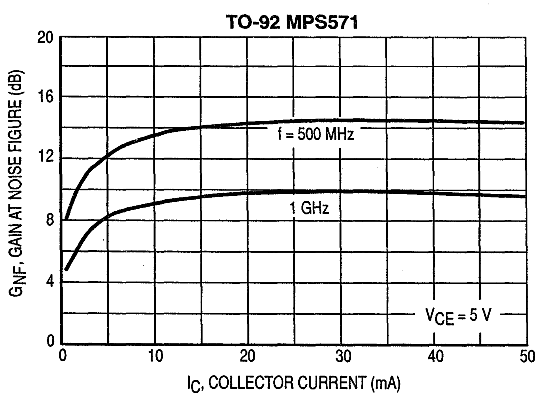


Figure 7. Gain at Noise Figure versus Collector Current

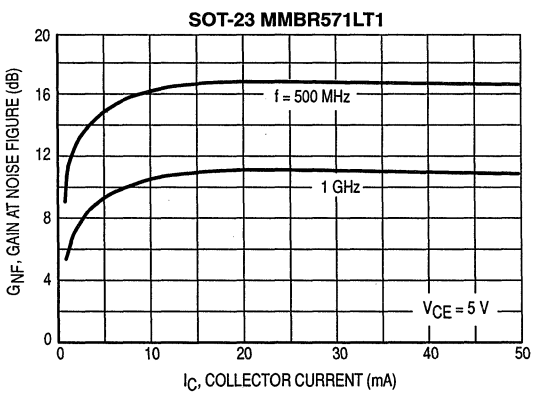


Figure 8. Gain at Noise Figure versus Collector Current

TYPICAL CHARACTERISTICS
MPS571, MMBR571LT1

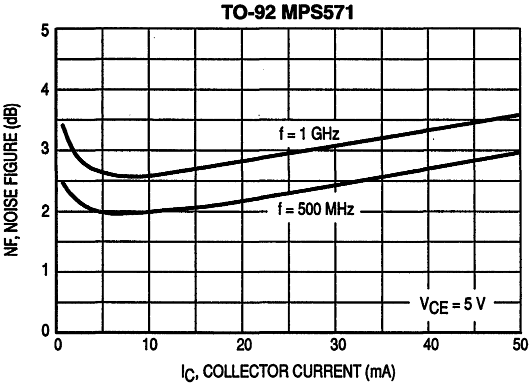


Figure 9. Noise Figure versus Collector Current

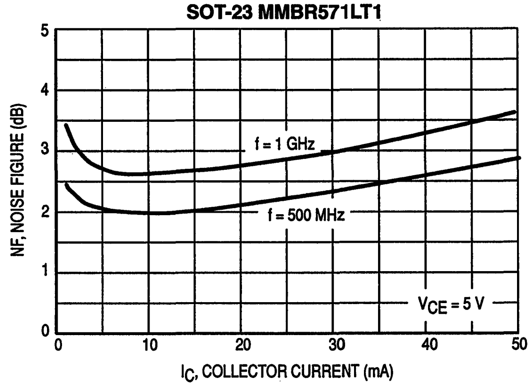


Figure 10. Noise Figure versus Collector Current

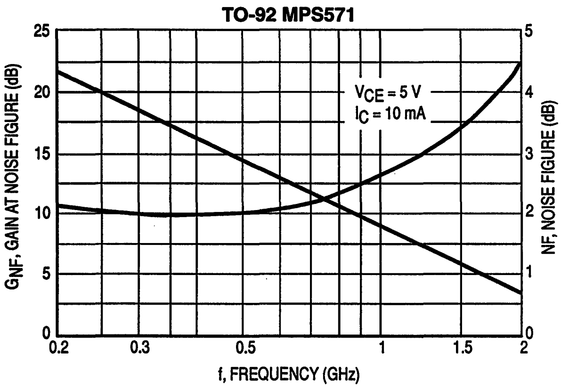


Figure 11. Gain at Noise Figure and Noise Figure versus Frequency

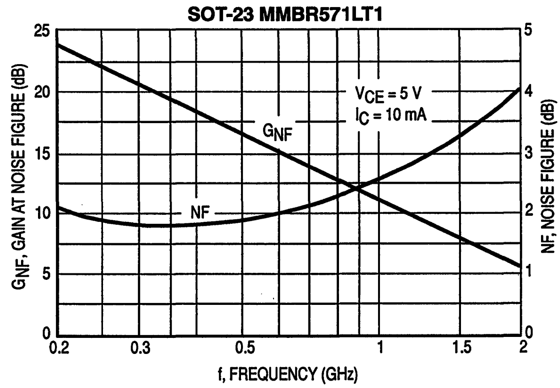


Figure 12. Gain at Noise Figure and Noise Figure versus Frequency

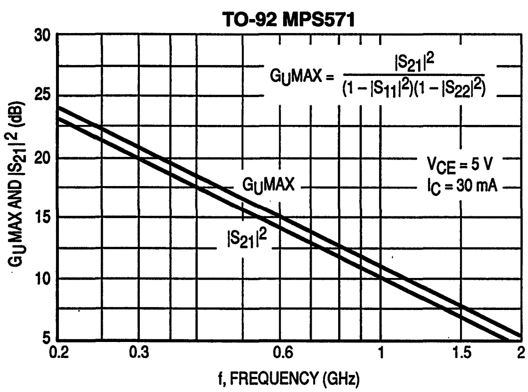


Figure 13. Maximum Unilateral Gain and Insertion Gain versus Frequency

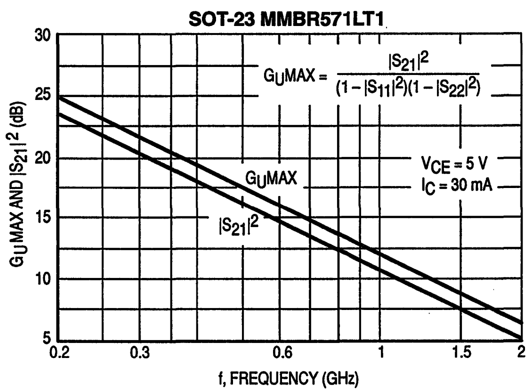


Figure 14. Maximum Unilateral Gain and Insertion Gain versus Frequency

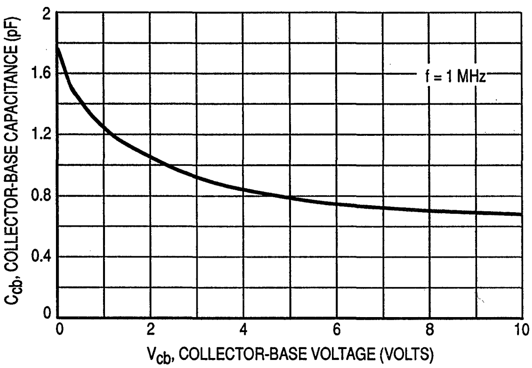


Figure 15. Collector-Base Capacitance versus Collector-Base Voltage

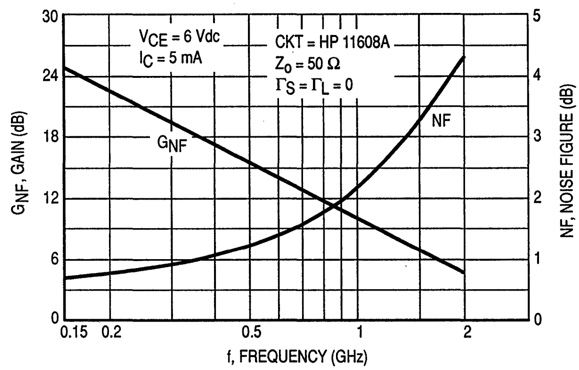


Figure 16. Gain and Noise Figure versus Frequency

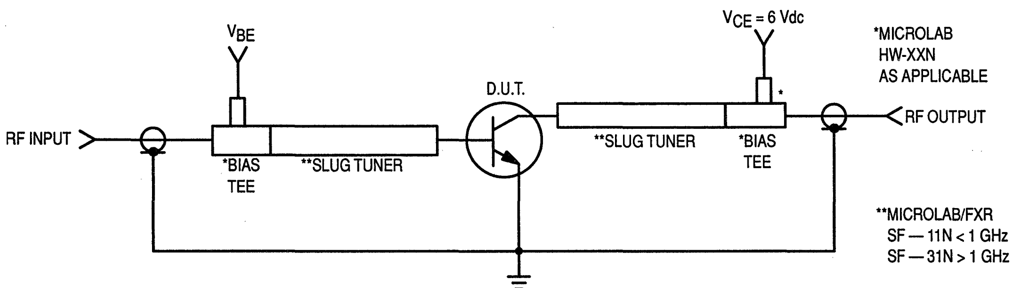


Figure 17. Functional Circuit Schematic

TYPICAL CHARACTERISTICS
MRF5711LT1

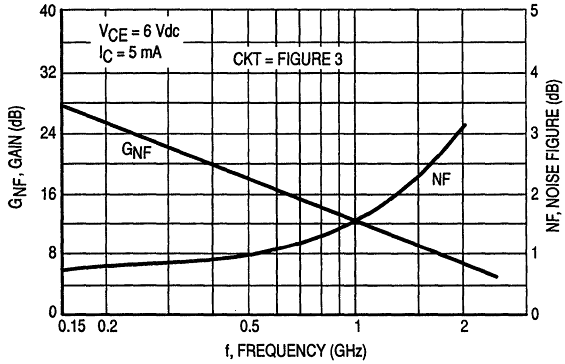


Figure 18. Gain and Noise Figure versus Frequency

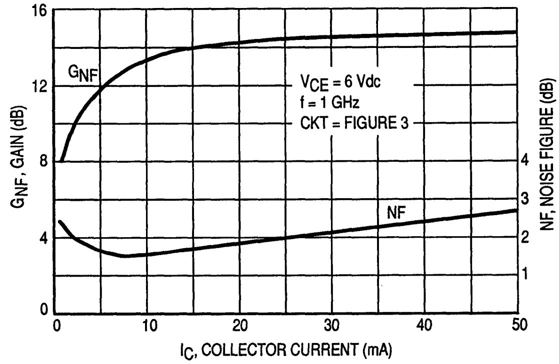


Figure 19. Gain and Noise Figure versus Collector Current

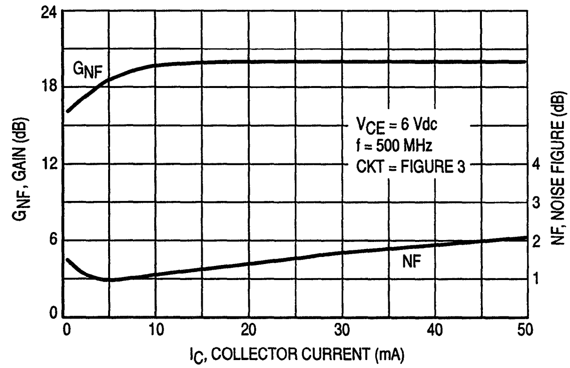


Figure 20. Gain and Noise Figure versus Collector Current

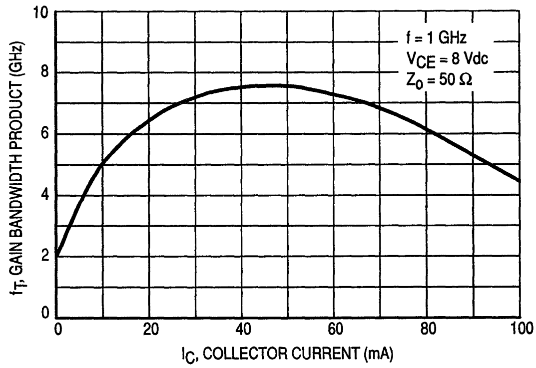


Figure 21. Gain Bandwidth Product versus Collector Current

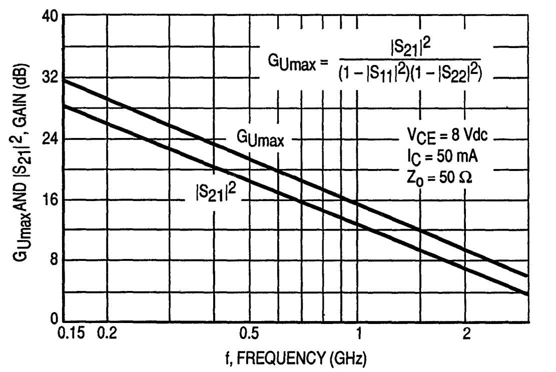


Figure 22. G_{Umax} and $|S_{21}|^2$ versus Frequency

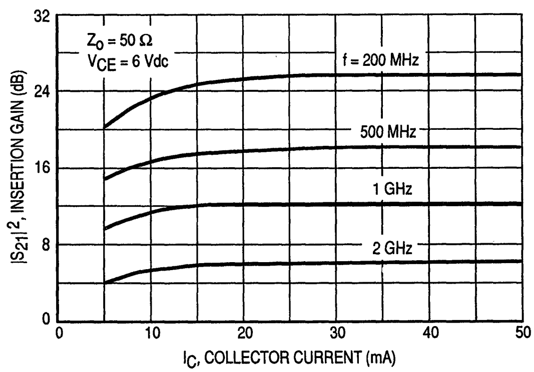


Figure 23. Insertion Gain versus Collector Current

2

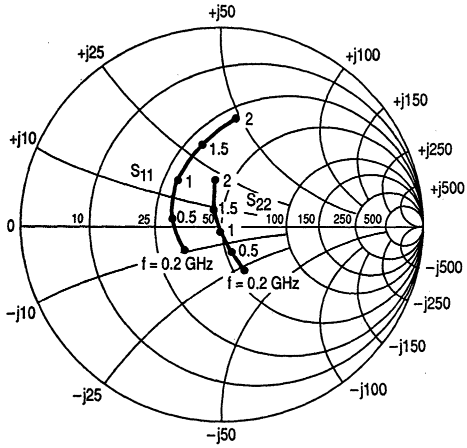


Figure 24. Input/Output Reflection Coefficients versus Frequency
V_{CE} = 5.0 V, I_C = 30 mA

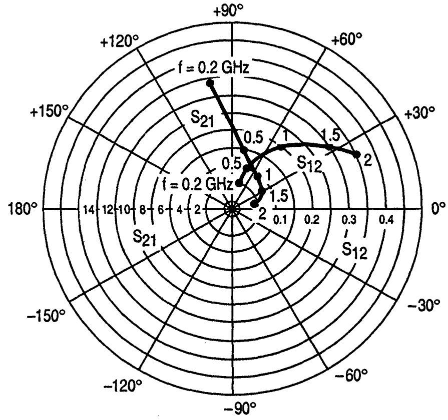


Figure 25. Forward/Reverse Transmission Coefficients versus Frequency
V_{CE} = 5.0 V, I_C = 30 mA

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
5.0	5.0	200	0.62	−80	8.22	122	0.07	56	0.63	−44
		500	0.40	−148	4.52	87	0.11	50	0.36	−58
		1000	0.39	155	2.51	54	0.16	48	0.23	−78
		1500	0.46	122	1.86	32	0.23	42	0.15	−114
		2000	0.59	100	1.50	14	0.31	33	0.14	173
	15	200	0.33	−121	12.88	105	0.05	67	0.37	−59
		500	0.28	−175	5.62	79	0.10	65	0.18	−67
		1000	0.32	143	2.99	53	0.19	55	0.08	−94
		1500	0.40	117	2.14	32	0.27	42	0.07	171
		2000	0.55	95	1.74	17	0.35	30	0.198	117
	30	200	0.23	−143	13.65	99	0.05	75	0.26	−62
		500	0.23	169	5.75	76	0.11	70	0.13	−68
		1000	0.30	130	3.05	50	0.21	55	0.04	−136
		1500	0.41	106	2.11	28	0.29	38	0.12	130
		2000	0.56	85	1.70	11	0.36	23	0.26	102
	50	200	0.21	−158	13.96	96	0.05	79	0.21	−61
		500	0.23	162	5.82	75	0.11	72	0.11	−66
		1000	0.30	128	3.09	49	0.21	56	0.03	−149
		1500	0.41	105	2.11	28	0.29	39	0.12	127
		2000	0.56	84	1.70	11	0.36	23	0.27	100

Table 1. MPS571 Common Emitter S-Parameters

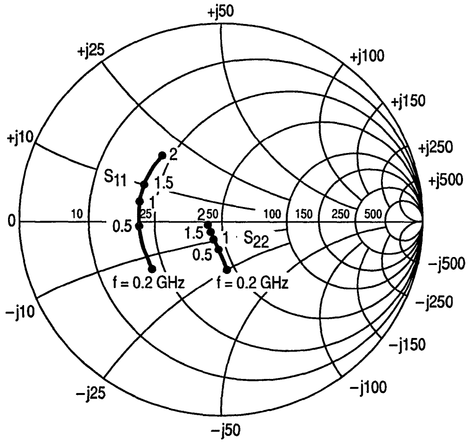


Figure 26. Input/Output Reflection Coefficients versus Frequency V_{CE} = 5.0 V, I_C = 30 mA

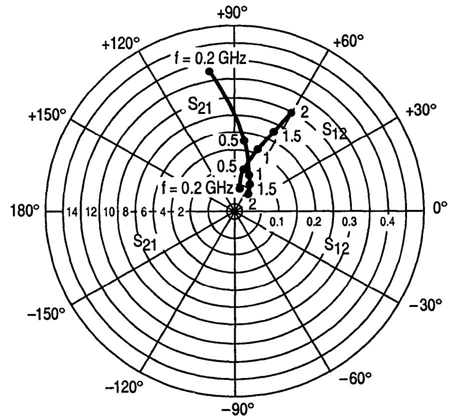
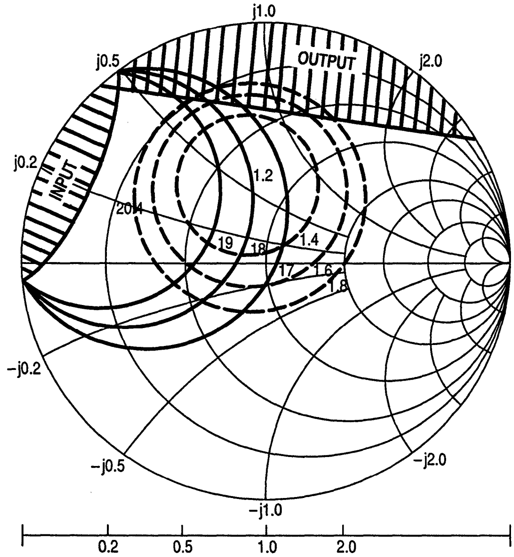


Figure 27. Forward/Reverse Transmission Coefficients versus Frequency V_{CE} = 5.0 V, I_C = 30 mA

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
5.0	5.0	200	0.68	−82	8.41	126	0.07	53	0.61	−45
		500	0.52	−142	4.62	93	0.10	46	0.35	−60
		1000	0.50	179	2.57	72	0.14	53	0.26	−71
		1500	0.51	161	1.82	57	0.19	58	0.24	−77
		2000	0.52	143	1.48	45	0.24	59	0.22	−86
	15	200	0.46	−125	13.65	108	0.05	60	0.35	−73
		500	0.43	−169	6.03	86	0.09	66	0.17	−94
		1000	0.44	168	3.20	72	0.16	67	0.14	−111
		1500	0.45	152	2.21	58	0.22	64	0.11	−118
		2000	0.46	137	1.80	48	0.29	59	0.10	−131
	30	200	0.42	−148	14.79	102	0.04	68	0.26	−87
		500	0.41	−177	6.31	84	0.09	72	0.14	−115
		1000	0.42	165	3.35	71	0.16	70	0.12	−135
		1500	0.44	151	2.29	59	0.23	65	0.11	−144
		2000	0.44	135	1.84	48	0.30	60	0.10	−157
	50	200	0.41	−159	15.14	98	0.04	73	0.21	−96
		500	0.42	179	6.38	83	0.09	75	0.13	−124
		1000	0.43	163	3.35	70	0.16	71	0.12	−143
		1500	0.44	148	2.32	58	0.23	66	0.10	−151
		2000	0.45	134	1.84	48	0.30	60	0.09	−163

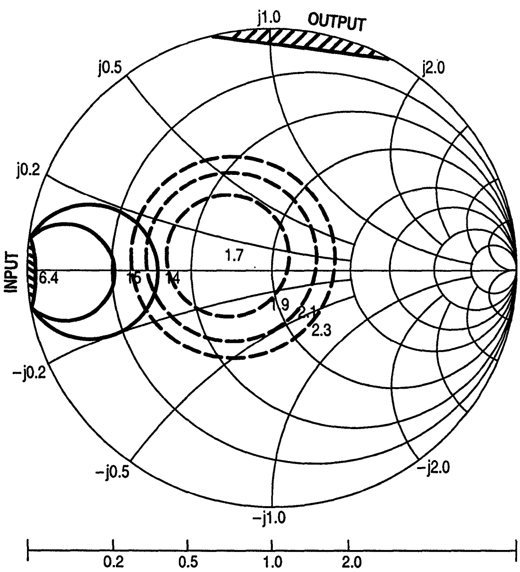
Table 2. MMBR571LT1 Common Emitter S-Parameters



V_{CE} = 5 V
I_C = 10 mA
▧ = Area of Instability

f (GHz)	NF OPT	ΓMS NF OPT	Rn	K
0.5	1.20 dB	0.36 ∠ 104°	7	0.63

Figure 28. MRF5711LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 5 V
I_C = 10 mA
▧ = Area of Instability

f (GHz)	NF OPT	ΓMS NF OPT	Rn	K
1.0	1.70 dB	0.20 ∠ 162°	8	0.94

Figure 29. MRF5711LT1 Constant Gain and noise Figure Contours (f = 1.0 GHz)

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ ϕ	$\|S_{21}\|$	∠ ϕ	$\|S_{12}\|$	∠ ϕ	$\|S_{22}\|$	∠ ϕ
6.0	5.0	200	0.79	−90	10.9	128	0.06	46	0.70	−45
		500	0.72	−144	5.7	96	0.08	28	0.42	−66
		1000	0.69	−177	3.0	75	0.09	28	0.31	−77
		1500	0.66	164	2.0	59	0.10	32	0.34	−89
		2000	0.65	147	1.6	47	0.12	38	0.32	−94
	10	200	0.72	−115	15.2	118	0.05	41	0.55	−66
		500	0.69	−160	6.9	92	0.06	34	0.30	−92
		1000	0.67	174	3.6	74	0.08	42	0.21	−108
		1500	0.64	159	2.4	60	0.10	46	0.23	−114
		2000	0.64	143	1.8	49	0.12	50	0.20	−116
	50	200	0.67	−159	20	102	0.02	48	0.33	−111
		500	0.67	179	8.2	85	0.04	58	0.33	−142
		1000	0.66	174	3.8	72	0.07	65	0.21	−158
		1500	0.63	151	2.7	61	0.10	64	0.22	−158
		2000	0.58	138	2.1	51	0.14	62	0.17	−165
8.0	5.0	200	0.80	−87	11.1	130	0.06	47	0.71	−42
		500	0.72	−141	5.9	97	0.08	30	0.44	−60
		1000	0.70	−177	3.1	75	0.09	28	0.33	−68
		1500	0.66	166	2.1	60	0.10	32	0.35	−80
		2000	0.61	149	1.6	47	0.12	39	0.35	−85
	10	200	0.72	−113	15.6	119	0.05	42	0.56	−61
		500	0.68	−159	7.2	92	0.06	34	0.31	−82
		1000	0.66	175	3.7	74	0.08	41	0.21	−92
		1500	0.64	160	2.5	61	0.09	47	0.23	−101
		2000	0.60	144	2.0	49	0.13	50	0.21	−103
	50	200	0.66	−156	20.9	103	0.02	48	0.31	−101
		500	0.65	−179	8.6	85	0.04	58	0.19	−128
		1000	0.64	164	4.3	72	0.07	65	0.16	−144
		1500	0.61	153	2.9	61	0.10	65	0.17	−142
		2000	0.58	137	2.3	51	0.13	64	0.14	−145

Table 3. MRF5711LT1 Common Emitter S-Parameters

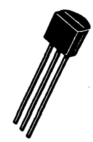
MPS901

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers.

- High Current-Gain — Bandwidth Product — f_T = 4.5 GHz (Typ) @ I_C = 15 mAdc
- High Power Gain — G_{pe} = 12 dB (Typ) @ f = 900 MHz
- Low Noise Figure — NF = 2.4 dB (Typ) @ f = 900 MHz
- Low Feedback Capacitance — C_{cb} = 0.5 pF (Typ) @ V_{cb} = 10 V
- Die Source Same as MRF901

I_C = 30 mA
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON



CASE 29-04, STYLE 2
TO-226AA
(TO-92)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 3.0	mW mW/°C
Operating Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	80	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.5	1.0	pF
Noise Figure (Figure 1) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 900 MHz)	NF	—	2.4	—	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Figure 1) (I_C = 10 mA, V_{CE} = 10 Vdc, f = 900 MHz)	G_{pe}	—	12	—	dB

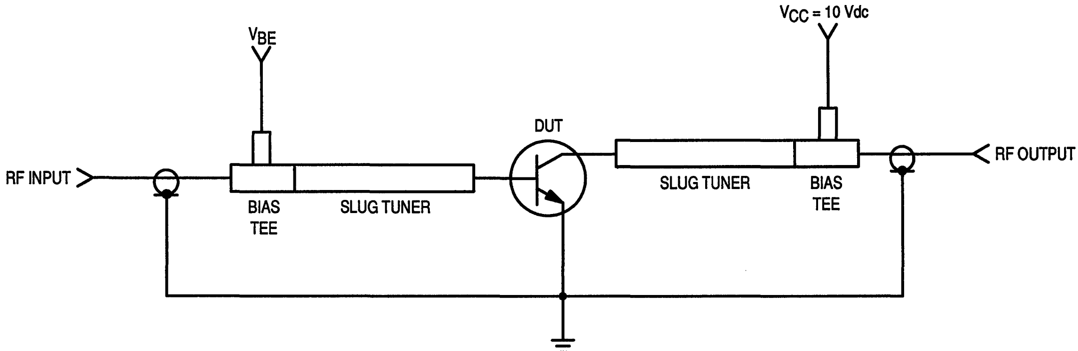


Figure 1. 900 MHz Test Circuit Schematic

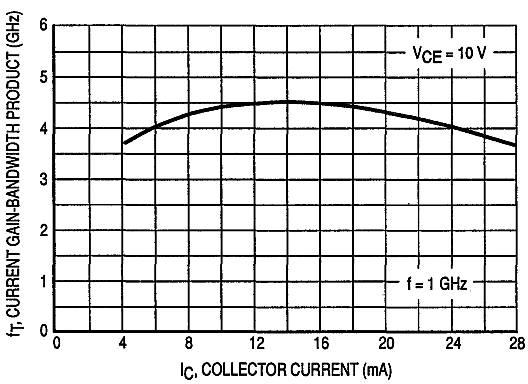


Figure 2. Current Gain-Bandwidth Product versus Collector Current

2

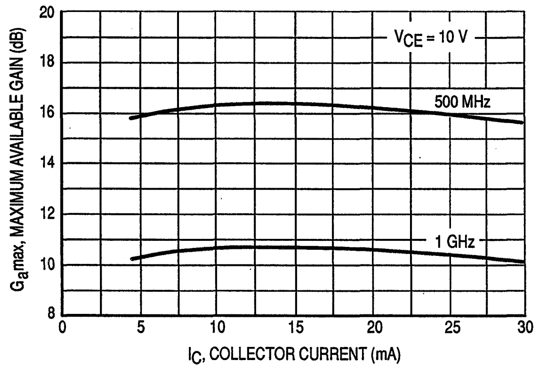


Figure 3. Maximum Available Gain versus Collector Current

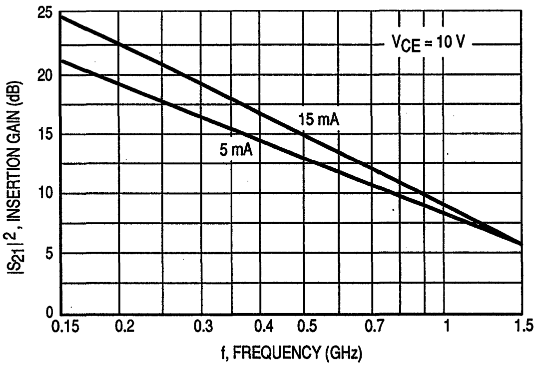


Figure 4. $|S_{21}|^2$ versus Frequency

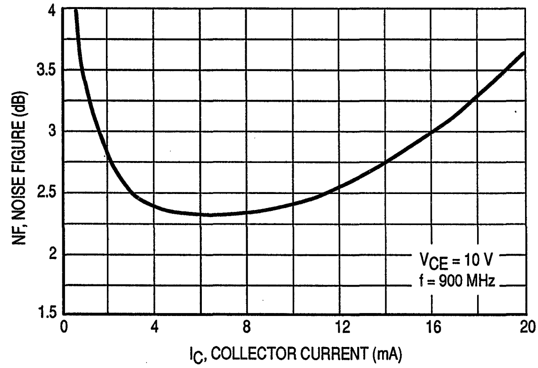


Figure 5. Noise Figure versus Collector Current

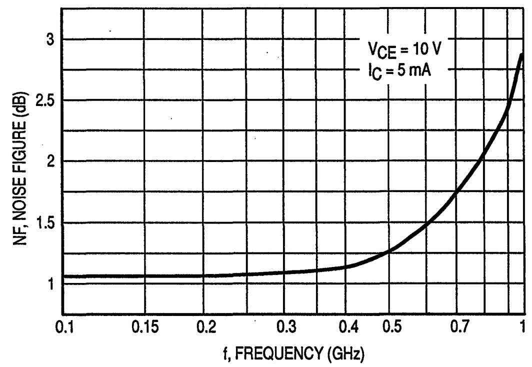


Figure 6. Noise Figure versus Frequency

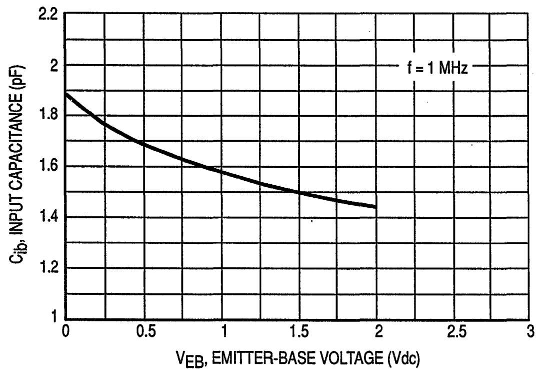


Figure 7. Input Capacitance versus Emitter-Base Voltage

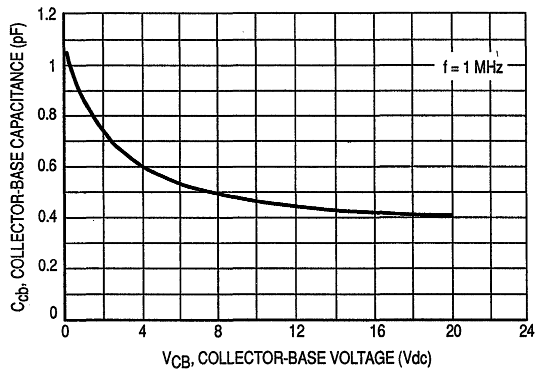


Figure 8. Collector-Base Capacitance versus Collector-Base Voltage

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
5.0	5.0	100	0.76	−35	9.42	142	0.03	67	0.85	−18
		200	0.60	−63	7.98	122	0.05	58	0.70	−26
		500	0.28	−127	4.79	84	0.09	55	0.53	−35
		1000	0.27	148	2.71	50	0.15	51	0.42	−51
		1500	0.43	113	2.02	23	0.21	42	0.28	−79
	10	100	0.57	−51	14.80	131	0.03	65	0.75	−22
		200	0.36	−87	10.80	108	0.04	62	0.60	−26
		500	0.18	−151	5.23	77	0.08	62	0.48	−31
		1000	0.25	136	2.86	47	0.15	55	0.39	−48
		1500	0.42	109	2.12	22	0.22	42	0.25	−75
	15	100	0.42	−67	17.80	123	0.02	66	0.69	−22
		200	0.26	−105	11.50	101	0.04	66	0.56	−23
		500	0.17	−169	5.27	74	0.08	66	0.47	−28
		1000	0.26	131	2.86	46	0.15	57	0.39	−47
		1500	0.43	108	2.12	21	0.22	44	0.25	−73
	20	100	0.33	−82	18.66	117	0.02	67	0.66	−21
		200	0.22	−120	11.54	98	0.03	68	0.55	−21
		500	0.17	−171	5.16	72	0.08	67	0.48	−27
		1000	0.28	129	2.80	45	0.15	58	0.40	−45
		1500	0.45	107	2.07	19	0.22	45	0.27	−71
	25	100	0.28	−103	18.11	113	0.02	68	0.64	−20
		200	0.22	−138	11.03	95	0.03	70	0.55	−19
		500	0.20	169	4.94	71	0.08	68	0.50	−25
		1000	0.32	128	2.68	43	0.15	60	0.42	−44
		1500	0.49	106	1.98	17	0.22	47	0.30	−71
	30	100	0.31	−127	16.10	109	0.02	67	0.64	−16
		200	0.28	−156	9.69	93	0.03	70	0.57	−16
		500	0.28	160	4.32	69	0.07	70	0.53	−25
		1000	0.39	125	2.37	41	0.14	63	0.46	−44
		1500	0.55	104	1.73	15	0.21	51	0.34	−72

Table 1. Common Emitter S-Parameters, V_{CE} = 5.0 V

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
10	5.0	100	0.79	−33	9.36	144	0.03	68	0.88	−15
		200	0.63	−58	7.97	124	0.04	58	0.74	−22
		500	0.28	−117	4.87	86	0.07	57	0.60	−31
		1000	0.23	153	2.80	53	0.13	56	0.50	−46
		1500	0.38	116	2.09	26	0.19	48	0.38	−69
	10	100	0.60	−48	14.87	132	0.02	66	0.79	−18
		200	0.39	−79	11.06	110	0.03	63	0.65	−21
		500	0.16	−135	5.38	79	0.07	64	0.56	−28
		1000	0.20	138	2.97	50	0.13	59	0.47	−44
		1500	0.37	111	2.21	25	0.20	49	0.36	−66
	15	100	0.46	−61	18.20	124	0.02	66	0.74	−18
		200	0.28	−94	11.94	102	0.03	66	0.62	−19
		500	0.14	−154	5.45	76	0.07	67	0.55	−26
		1000	0.22	131	2.97	48	0.13	61	0.48	−42
		1500	0.38	109	2.21	24	0.20	50	0.36	−64
	20	100	0.37	−72	19.38	119	0.02	67	0.71	−17
		200	0.23	−105	11.97	99	0.03	68	0.61	−18
		500	0.14	−172	5.36	74	0.07	69	0.56	−24
		1000	0.23	128	2.91	47	0.13	62	0.48	−41
		1500	0.40	108	2.16	22	0.20	51	0.37	−64
	25	100	0.32	−86	19.40	115	0.02	68	0.70	−16
		200	0.22	−119	11.67	97	0.03	69	0.61	−16
		500	0.19	−176	5.28	74	0.06	70	0.57	−23
		1000	0.26	127	2.82	46	0.13	63	0.50	−41
		1500	0.43	107	2.09	21	0.19	53	0.40	−63
	30	100	0.29	−103	18.29	112	0.02	68	0.70	−14
		200	0.22	−135	10.86	95	0.03	70	0.62	−15
		500	0.20	165	4.82	72	0.06	72	0.59	−22
		1000	0.31	125	2.63	44	0.12	66	0.53	−41
		1500	0.47	106	1.95	19	0.19	55	0.43	−64

Table 2. Common Emitter S-Parameters, V_{CE} = 10 V

MPS911
MMBR911LT1

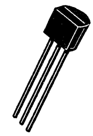
The RF Line
NPN Silicon
High-Frequency Transistors

. . . designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic package, as well as the popular TO-226AA (TO-92) package. This Motorola series of small-signal plastic transistors offers superior quality and performance at low cost.

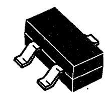
- High Gain-Bandwidth Product
  f_T = 7.0 GHz (Typ) @ 30 mA
- Low Noise Figure
  NF = 1.7 dB (Typ) @ 500 MHz
- High Gain
  G_{NF} = 17 dB (Typ) @ 10 mA/500 MHz
- State-of-the-Art Technology
  Fine Line Geometry
  Ion-Implanted Arsenic Emitters
  Gold Top Metallization and Wires
  Silicon Nitride Passivation

2

**I_C = 60 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTORS
NPN SILICON**



**CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS911**



**CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR911L**

MAXIMUM RATINGS

Rating	Symbol	MPS911	MMBR911LT1	Unit
Collector-Emitter Voltage	V_{CEO}	12		Vdc
Collector-Base Voltage	V_{CBO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	2.0		Vdc
Collector Current — Continuous	I_C	60		mA
Power Dissipation @ T_A = 25°C	P_D	625	200 (Free Air)	mW
Storage Temperature	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBR911LT1 = 7P

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Current Gain-Bandwidth Product (V_{CE} = 10 Vdc, I_C = 30 mAdc, f = 1.0 GHz) MPS911	f_T	—	7.0	—	GHz
MMBR911LT1		—	6.0	—	
FUNCTIONAL TESTS					
Gain @ Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc) MPS911 f = 0.5 GHz	G_{NF}	—	16.5	—	dB
f = 1.0 GHz		—	11	—	
MMBR911LT1 f = 0.5 GHz		—	17	—	
f = 1.0 GHz		—	11	—	
Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc) MPS911 f = 0.5 GHz	NF	—	1.7	—	dB
f = 1.0 GHz		—	2.7	—	
MMBR911LT1 f = 0.5 GHz		—	2.0	—	
f = 1.0 GHz		—	2.9	—	

2

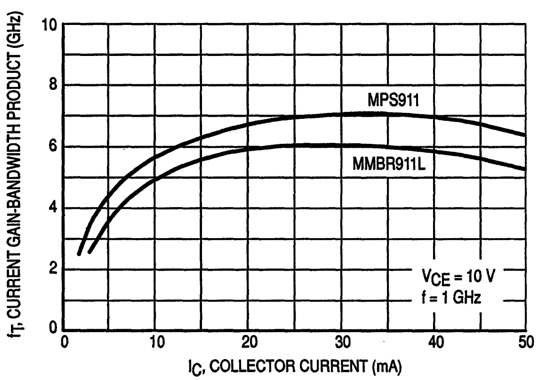


Figure 1. Current Gain-Bandwidth versus Collector Current @ 1.0 GHz

2

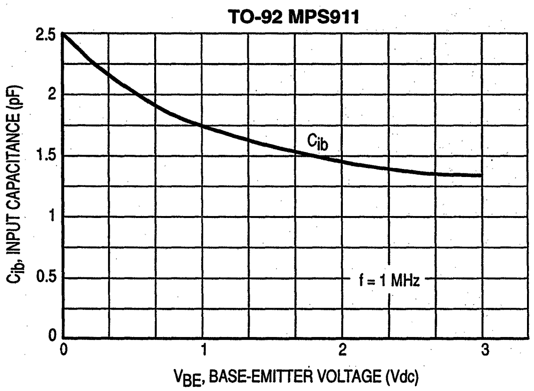


Figure 2. Input Capacitance versus Base-Emitter Voltage

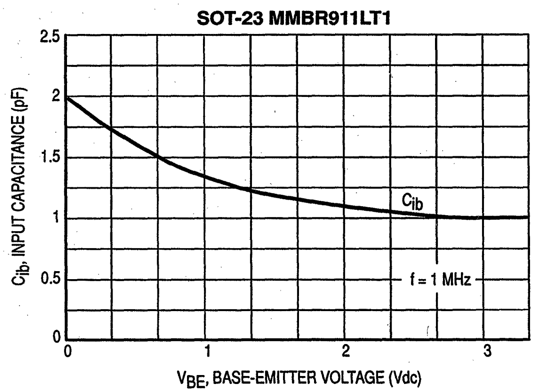


Figure 3. Input Capacitance versus Base-Emitter Voltage

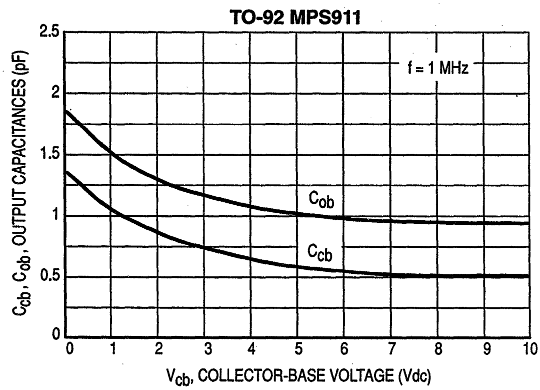


Figure 4. Output Capacitances versus Collector-Base Voltage

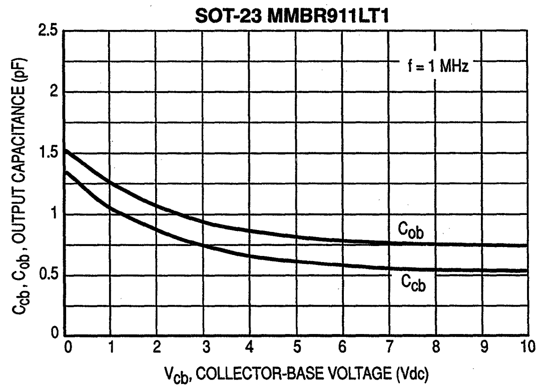


Figure 5. Output Capacitances versus Collector-Base Voltage

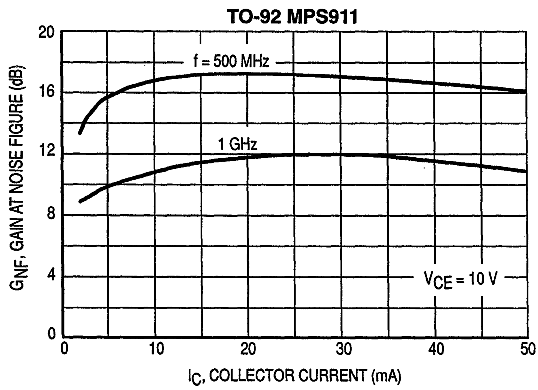


Figure 6. Gain at Noise Figure versus Collector Current

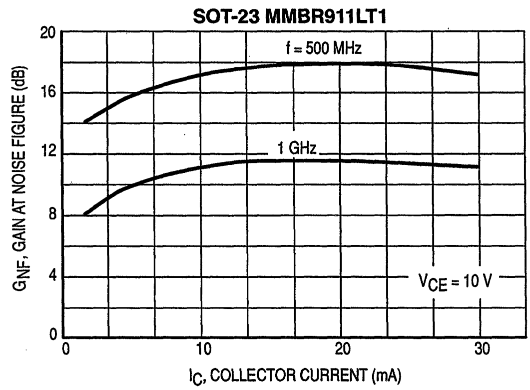


Figure 7. Gain at Noise Figure versus Collector Current

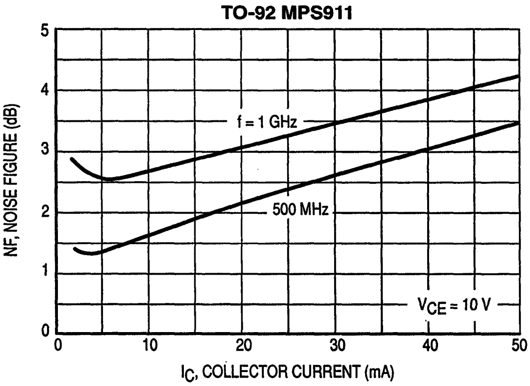


Figure 8. Noise Figure versus Collector Current

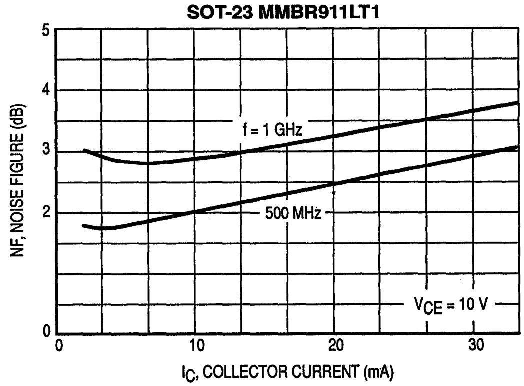


Figure 9. Noise Figure versus Collector Current

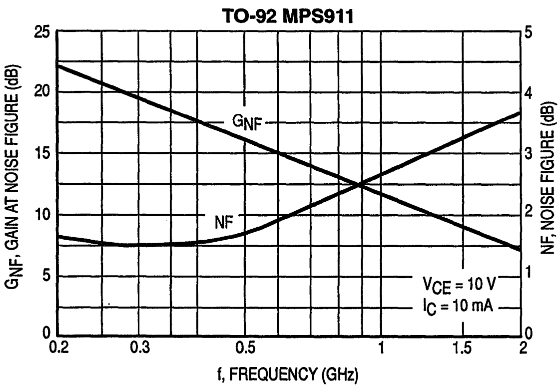


Figure 10. Gain at Noise Figure and Noise Figure versus Frequency

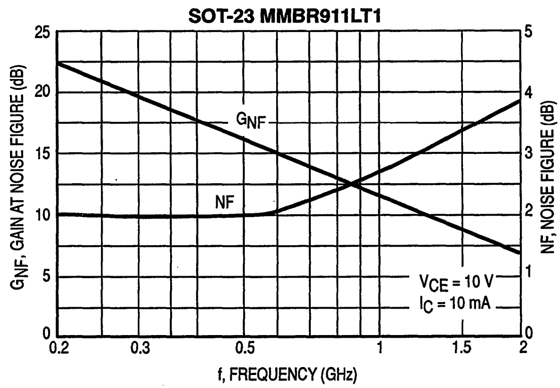


Figure 11. Gain at Noise Figure and Noise Figure versus Frequency

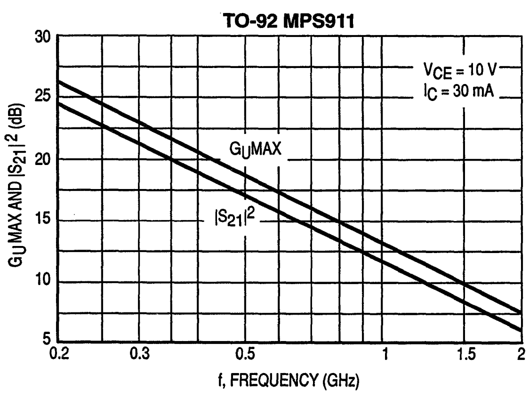


Figure 12. Maximum Unilateral Gain and Insertion Gain versus Frequency

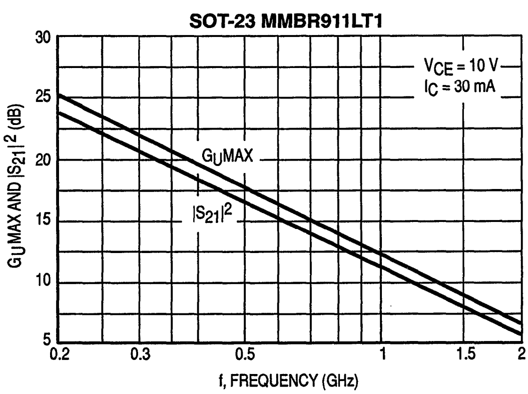


Figure 13. Maximum Unilateral Gain and Insertion Gain versus Frequency

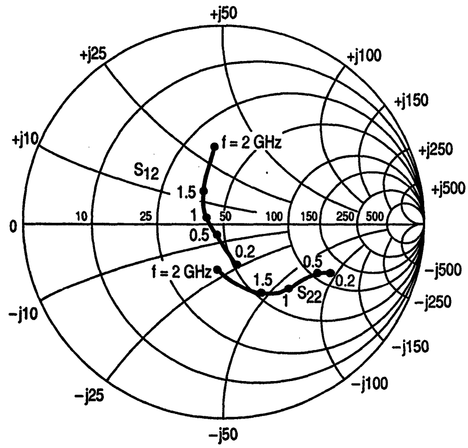


Figure 14. Input and Output Reflection Coefficients versus Frequency
V_{CE} = 10 V, I_C = 30 mA

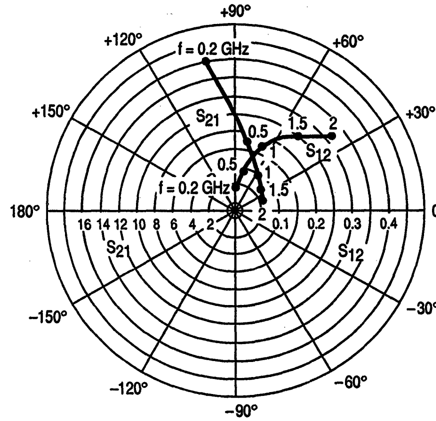


Figure 15. Forward and Reverse Transmission Coefficients versus Frequency
V_{CE} = 10 V, I_C = 30 mA

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11} \rvert$	∠ φ	$\lvert S_{21} \rvert$	∠ φ	$\lvert S_{12} \rvert$	∠ φ	$\lvert S_{22} \rvert$	∠ φ
10	2.0	200	0.78	−46	4.42	134	0.06	69	0.95	−18
		500	0.46	−107	3.35	98	0.10	56	0.78	−30
		1000	0.30	172	2.23	61	0.14	54	0.66	−48
		1500	0.41	118	1.66	34	0.20	51	0.57	−70
		2000	0.60	89	1.43	11	0.29	45	0.46	−107
	5.0	200	0.72	−55	8.75	126	0.05	68	0.87	−23
		500	0.31	−107	5.23	92	0.09	63	0.68	−31
		1000	0.18	178	3.05	61	0.15	60	0.57	−46
		1500	0.27	122	2.22	38	0.22	52	0.50	−66
		2000	0.45	94	1.90	17	0.30	43	0.38	−97
	10	200	0.48	−64	12.79	114	0.04	73	0.74	−24
		500	0.16	−100	6.19	85	0.09	71	0.60	−29
		1000	0.09	165	3.45	59	0.17	63	0.50	−44
		1500	0.22	112	2.50	36	0.25	50	0.41	−65
		2000	0.41	90	2.14	16	0.32	38	0.26	−98
	20	200	0.29	−67	15.30	106	0.04	78	0.65	−23
		500	0.08	−92	6.76	82	0.09	75	0.55	−27
		1000	0.06	144	3.71	58	0.17	64	0.46	−43
		1500	0.20	108	2.65	30	0.25	51	0.37	−63
		2000	0.38	89	2.25	18	0.32	38	0.23	−94
	30	200	0.20	−70	16.04	103	0.04	80	0.61	−22
		500	0.05	−97	6.90	81	0.09	77	0.53	−25
		1000	0.07	138	3.76	58	0.17	66	0.46	−41
		1500	0.20	109	2.68	38	0.25	52	0.37	−61
		2000	0.38	90	2.28	20	0.32	40	0.24	−91
	50	200	0.13	−78	15.26	99	0.04	82	0.62	−18
		500	0.03	−145	6.48	79	0.09	78	0.56	−23
		1000	0.11	126	3.55	56	0.17	67	0.49	−40
		1500	0.24	105	2.56	36	0.25	53	0.39	−62
		2000	0.43	87	2.17	17	0.32	40	0.25	−95

Table 1. Common Emitter S-Parameters

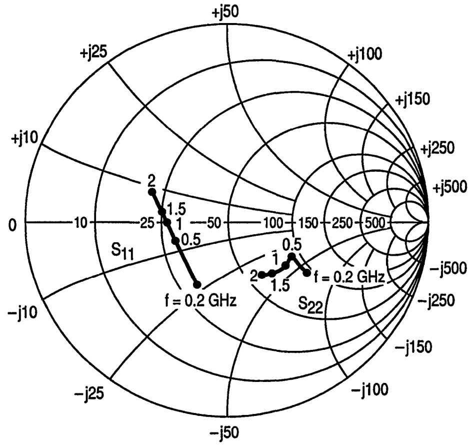


Figure 16. Input and Output Reflection Coefficients versus Frequency
V_{CE} = 10 V, I_C = 30 mA

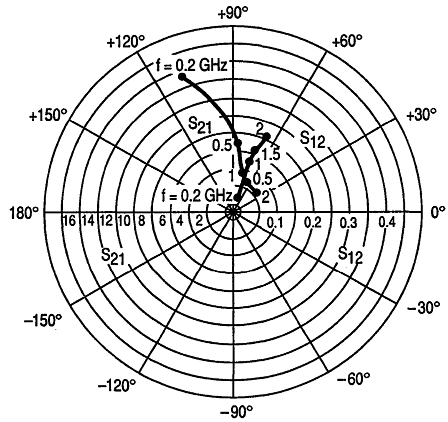


Figure 17. Forward and Reverse Transmission Coefficients versus Frequency
V_{CE} = 10 V, I_C = 30 mA

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
10	2.0	200	0.82	−45	4.14	145	0.06	66	0.88	−16
		500	0.60	−96	3.23	112	0.09	49	0.71	−27
		1000	0.47	−149	2.16	85	0.11	49	0.62	−34
		1500	0.46	−179	1.59	71	0.13	55	0.58	−43
		2000	0.47	162	1.35	57	0.16	62	0.56	−51
	5.0	200	0.66	−63	8.63	134	0.05	64	0.75	−25
		500	0.43	−117	5.29	100	0.07	58	0.55	−31
		1000	0.37	−163	3.05	82	0.11	63	0.48	−36
		1500	0.38	176	2.17	70	0.15	65	0.45	−44
		2000	0.40	160	1.81	57	0.19	65	0.43	−51
	10	200	0.49	−83	12.70	124	0.04	65	0.62	−30
		500	0.33	−134	6.42	94	0.07	66	0.44	−32
		1000	0.32	−171	3.53	80	0.12	70	0.41	−36
		1500	0.35	173	2.46	69	0.16	69	0.38	−45
		2000	0.37	159	2.04	58	0.20	66	0.35	−52
	20	200	0.36	−103	15.25	114	0.03	69	0.52	−32
		500	0.28	−149	6.95	90	0.06	72	0.39	−30
		1000	0.29	−176	3.73	78	0.12	73	0.37	−35
		1500	0.33	172	2.60	68	0.17	71	0.34	−43
		2000	0.36	158	2.14	58	0.21	67	0.32	−52
	30	200	0.32	−114	15.64	109	0.03	71	0.48	−29
		500	0.27	−156	6.92	88	0.06	73	0.38	−27
		1000	0.29	−178	3.71	78	0.12	74	0.37	−33
		1500	0.34	170	2.58	68	0.16	72	0.34	−44
		2000	0.37	156	2.13	57	0.21	68	0.32	−51

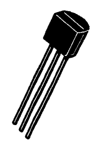
Table 2. Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

The RF Line
NPN Silicon High-Frequency Transistor

MPS3866

I_C = 400 mA
HIGH-FREQUENCY TRANSISTOR
NPN SILICON



CASE 29-04, STYLE 1
TO-226AA
(TO-92)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, R_{BE} = 10 Ω)	$V_{(BR)CER}$	55	—	Vdc
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 µAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, I_B = 0)	I_{CEO}	—	0.02	mAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = −1.5 Vdc (Rev.), T_C = 150°C) (V_{CE} = 55 Vdc, V_{BE} = −1.5 Vdc (Rev.)	I_{CEX}	 — —	 5.0 0.1	mAdc
Emitter Cutoff Current (V_{BE} = 3.5 Vdc, I_C = 0)	I_{EBO}	—	0.1	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 360 mAdc, V_{CE} = 5.0 Vdc) (1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 5.0 10	 — 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	—	1.0	Vdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	500	—	MHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	3.0	pF
FUNCTIONAL TEST				
Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	G_{pe}	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	η	45	—	%

NOTE:
1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

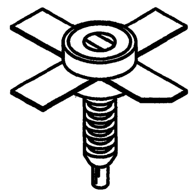
MRA1000-7L

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
  Output Power — 7.0 Watts
  Power Gain — 9.0 dB Min, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

9.0 dB, TO 1000 MHz
7.0 WATTS BROADBAND
UHF POWER TRANSISTOR



CASE 145D, STYLE 1
(.380 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	42 0.25	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70°C$)	$R_{θJC}$	4.0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20$ mA, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 19$ V, $I_E = 0$)	I_{CBO}	—	—	15	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ A, $V_{CE} = 5.0$ V)	h_{FE}	20	—	90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, f = 1.0 MHz)	C_{ob}	—	—	22	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 19$ V, f = 1.0 GHz, $I_C = 1.2$ A)	G_{SS}	9.0	10	—	dB
Load Mismatch ($V_{CE} = 19$ V, $I_C = 1.2$ A, $P_{out} = 7.0$ W, f = 1.0 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive ($V_{CE} = 19$ V, $I_C = 1.2$ A, f = 1.0 GHz) (No degradation)	$P_{in_{over}}$	—	—	3.5	W
Output Power, 1.0 dB Compression Point ($V_{CE} = 19$ V, f = 1.0 GHz, $I_C = 1.2$ A)	$P_{o1\ dB}$	7.0	—	—	W

TYPICAL CHARACTERISTICS

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
19	1200	0.5	0.95	174	1.08	56	0.02	48	0.70	−179
		0.6	0.94	173	1.01	48	0.03	47	0.70	−177
		0.7	092	171	0.97	38	0.03	45	0.71	−176
		0.8	0.90	169	0.97	26	0.03	40	0.72	−175
		0.9	0.87	168	0.99	11	0.03	32	0.76	−174
		1.0	0.83	168	0.99	−9.0	0.03	30	0.82	−174

Table 1. Common Emitter S-Parameters

Freq. (MHz)	Z^*_{OL} (Ohms) Re	Z^*_{OL} (Ohms) Im	Z_{IN} (Ohms) Re	Z_{IN} (Ohms) Im
500	8.69	−0.51	1.30	2.53
600	8.69	−1.14	1.59	3.01
700	8.39	−1.74	2.05	3.88
800	8.01	−2.21	2.67	4.63
900	7.00	−2.74	3.40	5.19
1000	4.95	−2.64	4.61	5.17

V_{CC} = 19 V, P_o = 7.0 W

Table 2. Z_{IN} and Z_{OL}* versus Frequency

2

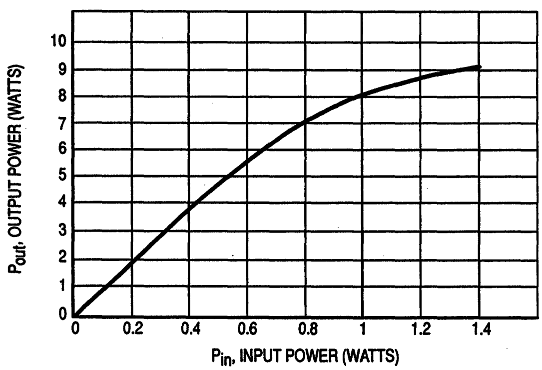
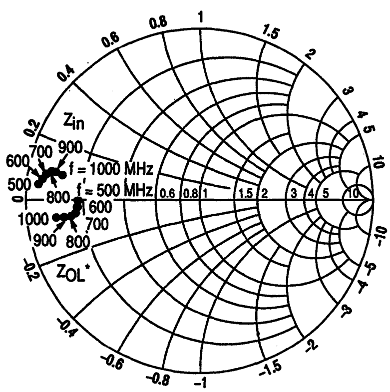
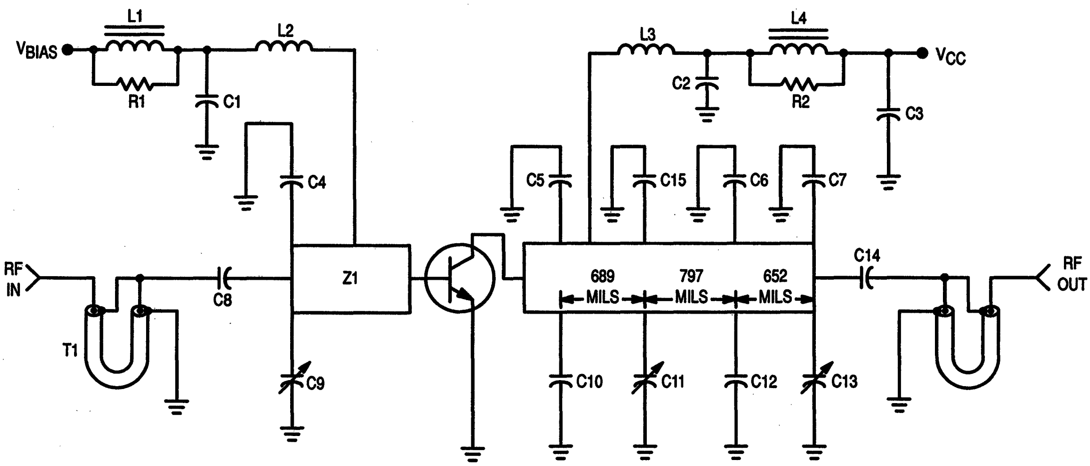


Figure 3. Power Output versus Power Input



V_{CC} = 19 V, P_o = 7.0 W, Z_O = 50 Ohms

Figure 4. Series Equivalent Input/Output Impedance



L1 — 7T, 20 Gauge on 200 Mil Ferrite Torroid
L2 — 7T, 20 Gauge, 100 Mil Dia.
L3 — 5T, 20 Gauge, 100 Mil Dia.
L4 — 8T, 20 Gauge, on 200 Mil Ferrite Torroid
R1, R2 — 15 Ohm, 1/4 Watt
C1, C2 — 500 pF ATC
C3 — 25 µF, Electrolytic
C4 — 3.3 pF ATC
C5 — 5.6 pF ATC
C6 — 1.6 pF ATC
C7 — 1.2 pF ATC
C8 — 33 pF ATC
C9, C13 — 0.3–1.3 pF Johanson
C10 — 6.2 pF ATC
C11 — 1.0–16 pF Johanson
C12 — 3.0 pF ATC
C14 — 33 pF ATC
C15 — 18 pF ATC
T1, T2 — 50 Ohm, ℓ = 2000 Mils
Z1 — 12.5 Ohm, ℓ = 914 Mils, 32 Mil, Teflon (ε_r = 2.55)
Z2 — 12.5 Ohm, ℓ = 2392 Mils, 32 Mil, Teflon (ε_r = 2.55)

Figure 5. 1.0 GHz Test Circuit

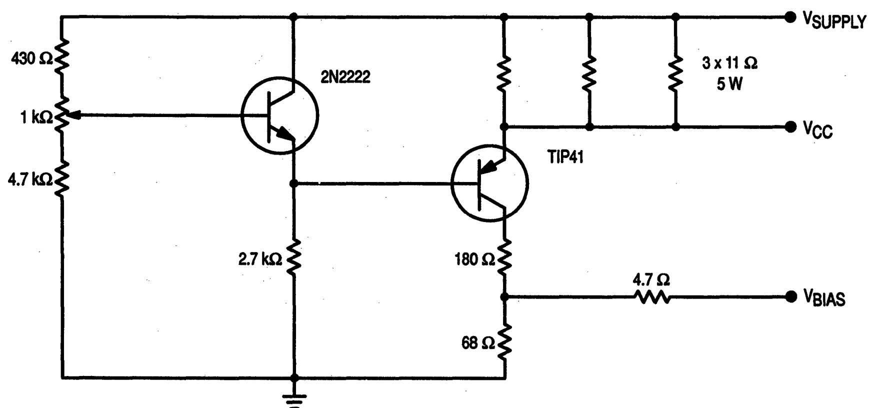
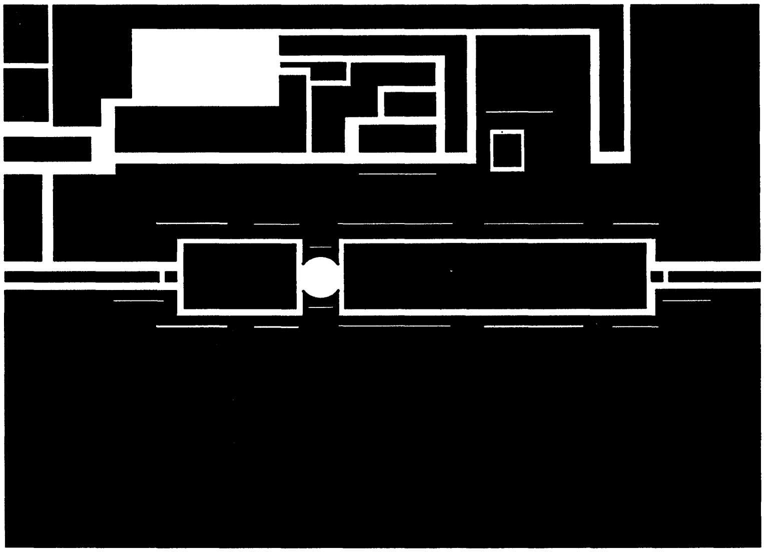


Figure 6. Bias Circuit

2



(Not to Scale)

2

Board Material = 1/32″, Glass Teflon, K = 2.55

Figure 7. Test Circuit Mask

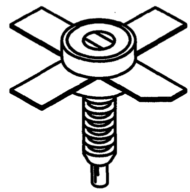
MRA1000-14L

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
  Output Power — 14 Watts
  Power Gain — 8.0 dB, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**8.0 dB, TO 1000 MHz
14 WATTS BROADBAND
UHF POWER TRANSISTOR**



CASE 145D, STYLE 1
(.380 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	83 0.48	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	2.1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mA, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 19 V, I_E = 0)	I_{CBO}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 A, V_{CE} = 5.0 V)	h_{FE}	20	—	90	—

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	40	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 19 V, P_{in} = 1.0 mW, f = 1.0 GHz, I_C = 2.4 A)	G_{SS}	8.0	—	—	dB
Load Mismatch (V_{CE} = 19 V, I_C = 2.4 A, P_{out} = 14 W, f = 1.0 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (V_{CE} = 19 V, I_C = 2.4 A, f = 1.0 GHz) (No degradation)	$P_{in_{over}}$	—	—	7.0	W
Output Power, 1.0 dB Compression Point (V_{CE} = 19 V, f = 1.0 GHz, I_C = 2.4 A)	$P_{o1\ dB}$	14	—	—	W

TYPICAL CHARACTERISTICS

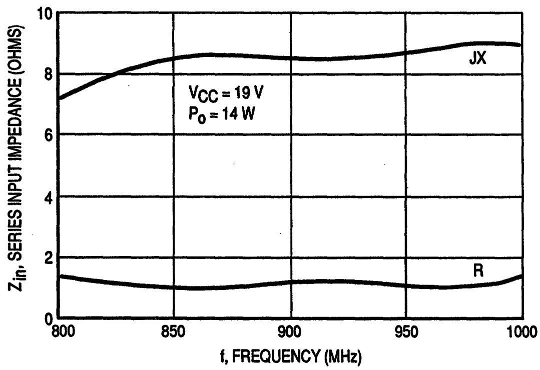


Figure 1. Input Impedance versus Frequency

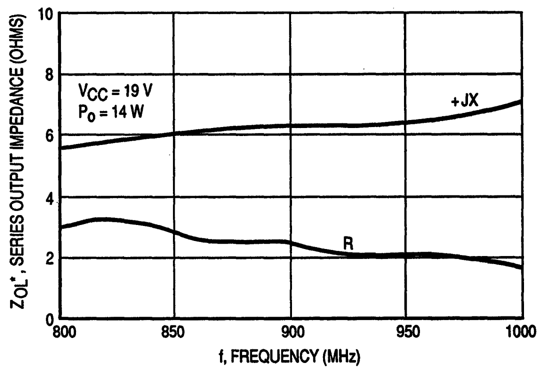


Figure 2. Output Impedance versus Frequency

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
19	2400	0.5	0.98	175	0.56	57	0.02	69	0.84	177
		0.6	0.97	174	0.53	50	0.02	69	0.83	177
		0.7	0.96	173	0.50	41	0.03	66	0.83	176
		0.8	0.96	172	0.52	39	0.03	64	0.83	176
		0.9	0.94	168	0.50	18	0.03	58	0.83	176
		1.0	0.91	165	0.52	1.0	0.03	60	0.85	175

Table 1. Common Emitter S-Parameters

2

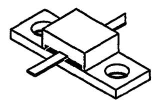
MRA1417-6

The RF Line
Microwave Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.7 GHz Characteristics:
  Output Power — 2.0 to 25 Watts
  Power Gain — 7.0 to 8.0 dB Min
  Collector Efficiency — 40 to 45% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

7.0 to 8.0 dB
1.4 to 1.7 GHz
2.0 TO 25 WATTS BROADBAND
MICROWAVE POWER TRANSISTOR



CASE 394, STYLE 1
(MRA .25)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	8.0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.2 A, V_{CE} = 5.0 V)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	8.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 6.0 W, f = 1.4 & 1.7 GHz)	G_{PB}	7.4	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 6.0 W, f = 1.4 & 1.7 GHz)	η_c	40	—	—	%

TYPICAL CHARACTERISTICS
MRA1417-6 — 6.0 WATTS BROADBAND

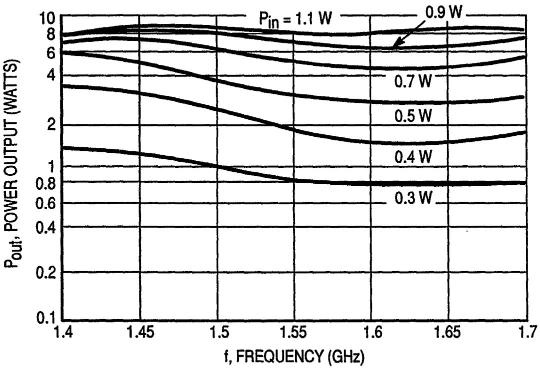


Figure 1. Power Output versus Frequency

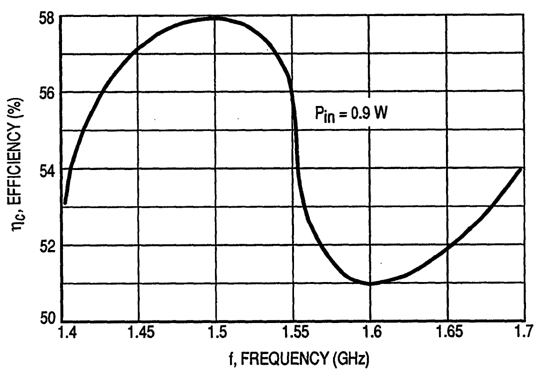


Figure 2. Efficiency versus Frequency

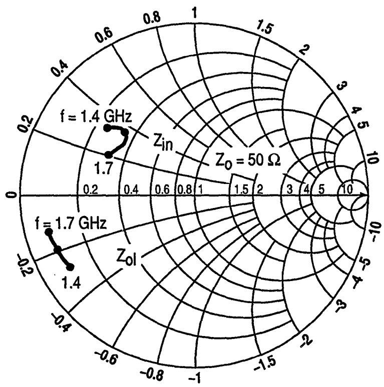


Figure 3. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.

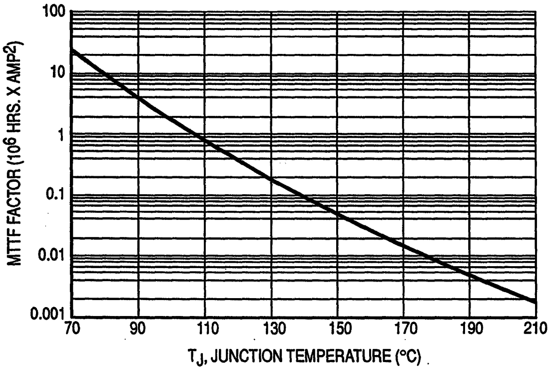
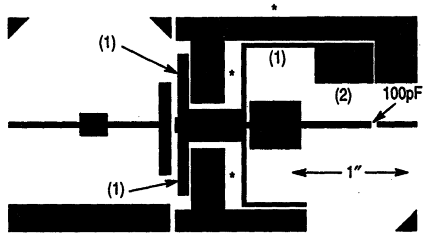


Figure 4. MTTF Factor (Normalized to 1.0 Ampere^2 Continuous Duty)



Board material: 18 mil dielectric thickness teflon fiberglass.
*Ground through to backside ground plane.
(1) Bypass 100 pF chip capacitor.
(2) V_{CC} bypassed by 0.1 μF chip and 5.0 μF electrolytic.

Figure 5. Test Circuit Boards (Not to Scale)

2

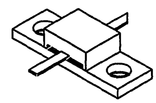
MRAL1720-20

The RF Line
Microwave Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.7 to 2.0 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.0 GHz Characteristics:
  Output Power — 2.0 to 20 Watts
  Power Gain — 6.0 to 7.5 dB Min
  Collector Efficiency — 35 to 40%, Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**6.0 to 7.5 dB
1.7 to 2.0 GHz
2.0 TO 20 WATTS BROADBAND
MICROWAVE POWER TRANSISTOR**



CASE 394, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	8.0	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 160 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.8 A, V_{CE} = 5.0 V)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	(1)	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 22 V, P_{out} = 20 W, f = 1.7 & 2.0 GHz)	G_{PB}	6.0	—	—	dB
Collector Efficiency (V_{CE} = 22 V, P_{out} = 20 W, f = 1.7 & 2.0 GHz)	η_c	40	—	—	%

NOTE:
1. Not measurable because of output matching network.

TYPICAL CHARACTERISTICS

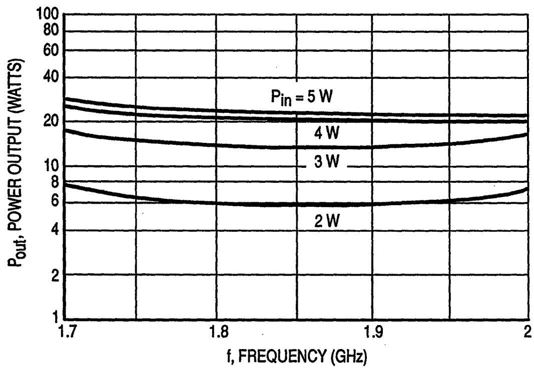


Figure 1. Power Output versus Frequency

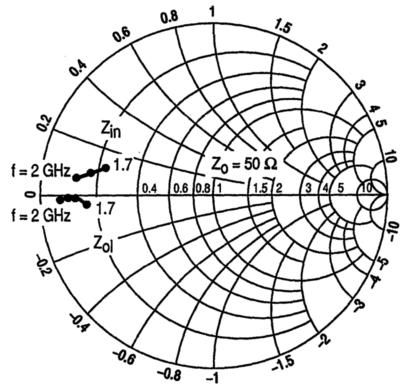


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

2

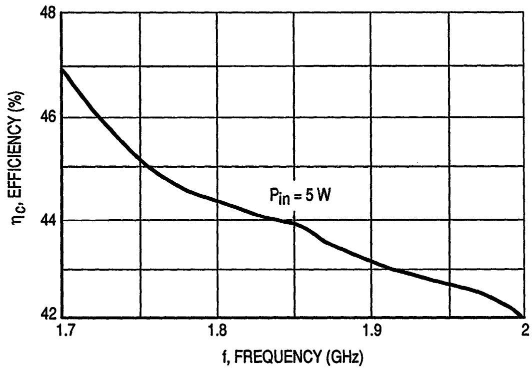


Figure 3. Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.

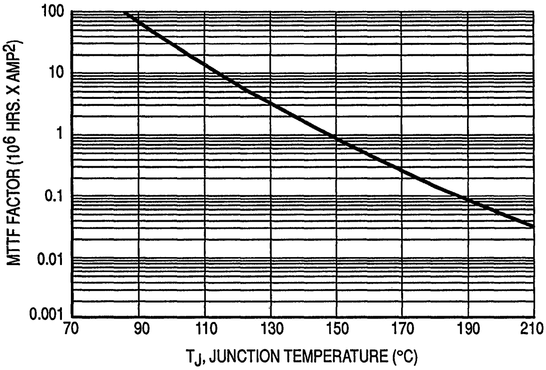
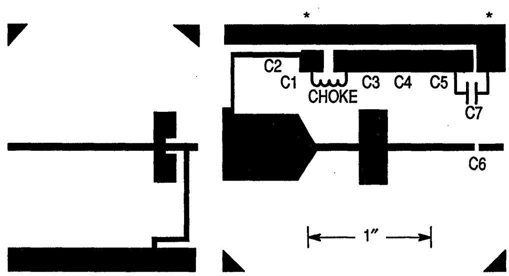


Figure 4. MTTF Factor versus Junction Temperature



*Foil wrap or plate around to ground plane.
(1) Bypass capacitor to ground (100 pF ceramic chip).
(2) Use V_{CC} bypass of 100 pF chip, 0.1 µF chip and 5.0 µF.
Board material 0.020 inch glass teflon ε_r = 2.55.

1) C1, C5 = 0.1 µF chip capacitor
2) C2, C3, C4 = 120 pF
3) C6 = 100 pF (ATC)
4) C7 = 50 µF 50 WV Electrolytic
5) * = 1.0 mil Shim thru ground plane
6) Material = Glass/Teflon
ε_r = 2.55
Thickness = .020 in.
1.0 oz copper

Figure 5. Test Circuit Board Photomaster (Not to Scale)

2

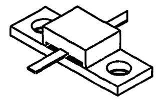
MRAL2023-3
MRAL2023-6

The RF Line
Microwave Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 2.0 – 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
  Output Power — 1.5 to 12 Watts
  Power Gain — 6.8 to 8.0 dB Min
  Collector Efficiency — 35 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

6.8 to 8.0 dB
2.0–2.3 GHz
1.5 TO 12 WATTS BROADBAND
MICROWAVE POWER TRANSISTORS



CASE 394, STYLE 1
(MRA .25)

2

MAXIMUM RATINGS

Rating	Symbol	-3	-6	Unit
Collector-Base Voltage	V_{CES}	42		Vdc
Emitter-Base Voltage	V_{EBO}	3.5		Vdc
Collector Current — Continuous	I_C	0.5	1.25	Adc
Operating Junction Temperature	T_J	200		°C
Storage Temperature Range	T_{stg}	−65 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max		Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	16	8.0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRAL2023-3		42	—	—	
(I_C = 50 mA, V_{BE} = 0)	MRAL2023-6		42	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.4 mA, I_C = 0)	MRAL2023-3		3.5	—	—	
(I_E = 1.0 mA, I_C = 0)	MRAL2023-6		3.5	—	—	
Collector Cutoff Current	MRAL2023-3	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 22 V, I_E = 0)	MRAL2023-6		—	—	1.25	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.2 A, V_{CE} = 5.0 V)	MRAL2023-3		10	—	90	
(I_C = 0.5 A, V_{CE} = 5.0 V)	MRAL2023-6		10	—	90	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRAL2023-3	C_{ob}	—	—	5.0	pF
(V_{CB} = 22 V, I_E = 0, f = 1.0 MHz)	MRAL2023-6		—	—	10.0	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 3.0 W, f = 2.0 & 2.3 GHz)	MRAL2023-3		8.0	—	—	
(V_{CE} = 22 V, P_{out} = 6.0 W, f = 2.0 & 2.3 GHz)	MRAL2023-6		6.8	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 22 V, P_{out} = 3.0 W, f = 2.0 & 2.3 GHz)	MRAL2023-3		40	—	—	
(V_{CE} = 22 V, P_{out} = 6.0 W, f = 2.0 & 2.3 GHz)	MRAL2023-6		40	—	—	

TYPICAL CHARACTERISTICS
MRAL2023-3

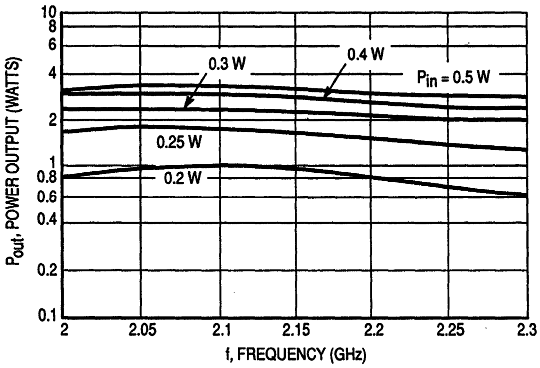


Figure 1. Power Output versus Frequency

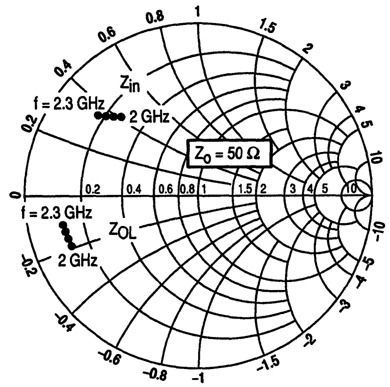


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

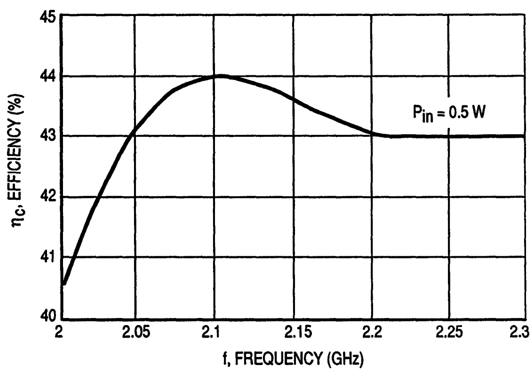


Figure 3. Efficiency versus Frequency

2

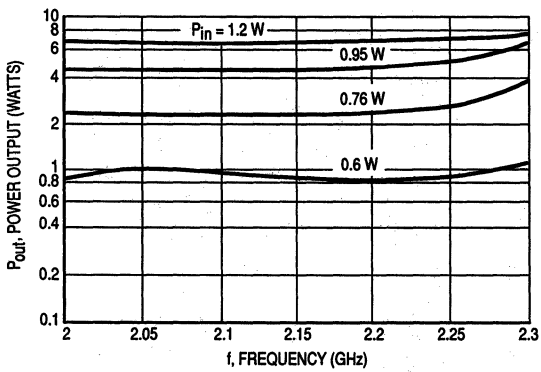


Figure 4. Power Output versus Frequency

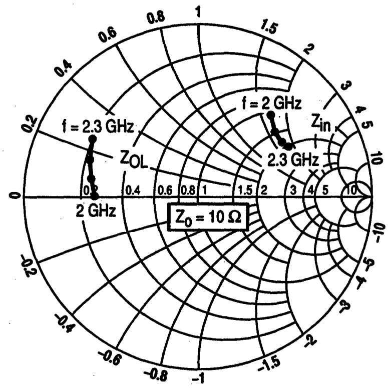


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

2

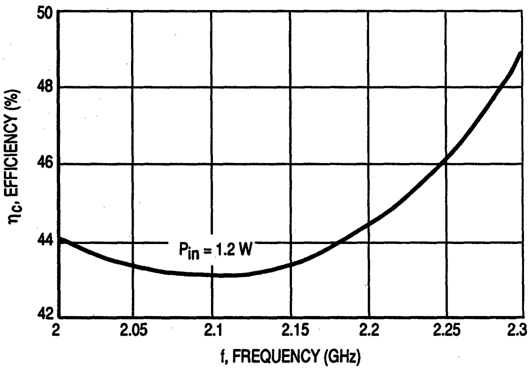


Figure 6. Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.

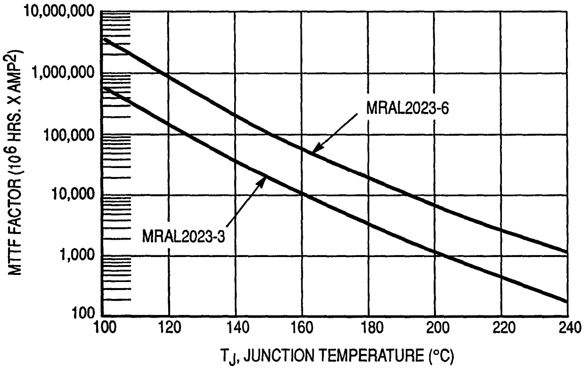


Figure 7. MTTF Factor versus Junction Temperature

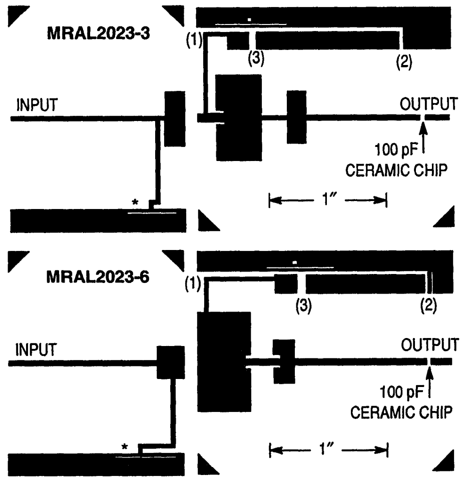


Figure 8. Test Circuit Boards (Not to Scale)

2

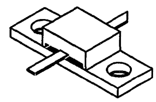
MRAL2023-18

The RF Line
Microwave Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 2.0 – 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
  Output Power — 18 Watts
  Power Gain — 7.0 dB Min
  Collector Efficiency — 35%, Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

7.0 dB
2.0–2.3 GHz
18 WATTS BROADBAND
MICROWAVE POWER TRANSISTOR



CASE 394, STYLE 1
(MRA .25)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 160 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 800 mA, V_{CE} = 5.0 V)	h_{FE}	10	—	100	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 22 V, P_{out} = 18 W, f = 2.0 & 2.3 GHz)	G_{PB}	7.0	—	—	dB
Collector Efficiency (V_{CE} = 22 V, P_{out} = 18 W, f = 2.0 & 2.3 GHz)	η_c	35	—	—	%

TYPICAL CHARACTERISTICS

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

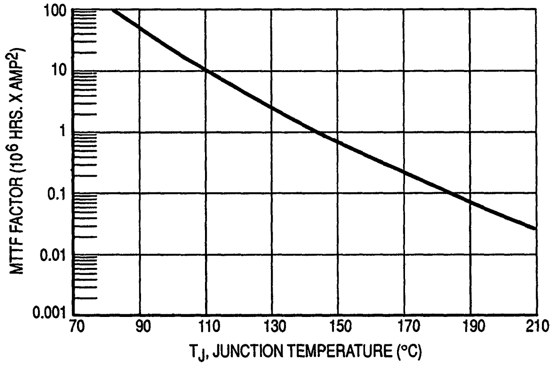


Figure 1. MTTF Factor versus Junction Temperature

Board material — 0.018″ dielectric thickness teflon fiberglass.
* — Ground area to backside of board.
C1, C2, C3 — 100 pF porcelain ceramic chip.
C4 — 0.1 µF ceramic chip.
C5 — 50 µF, 50 V electrolytic.
RFC1 — 5 turns #28 AWG, ~0.125″ dia.

Figure 2. Test Circuit Boards

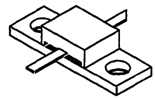
MRAL2327-3
MRAL2327-12

The RF Line
Microwave Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 2.3 – 2.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.7 GHz Characteristics:
  Output Power — 1.3 to 12 Watts
  Power Gain — 5.5 to 6.8 dB Min, Common Base
  Collector Efficiency — 30 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

5.5 to 6.8 dB
2.3–2.7 GHz
1.3 TO 12 WATTS BROADBAND
MICROWAVE POWER TRANSISTORS



CASE 394, STYLE 1
(MRA .25)

2

MAXIMUM RATINGS

Rating	Symbol	Max	Unit
Collector-Base Voltage	V_{CES}	44	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	-3	-12	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	16	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRAL2327-3		42	—	—	
(I_C = 80 mA, V_{BE} = 0)	MRAL2327-12		42	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 1.0 mA, I_E = 0)	MRAL2327-3		38	—	—	
(I_C = 8.0 mA, I_E = 0)	MRAL2327-12		38	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.4 mA, I_E = 0)	MRAL2327-3		3.5	—	—	
(I_E = 2.0 mA, I_E = 0)	MRAL2327-12		3.5	—	—	
Collector Cutoff Current	MRAL2327-3	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 22 V, I_E = 0)	MRAL2327-12		—	—	2.0	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 200 mA, V_{CE} = 5.0 V)	MRAL2327-3		10	—	100	
(I_C = 800 mA, V_{CE} = 5.0 V)	MRAL2327-12		10	—	100	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 3.0 W, f = 2.7 GHz)	MRAL2327-3		6.6	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.7 GHz)	MRAL2327-12		6.8	—	—	
Collector Efficiency		η_C				%
(V_{CE} = 22 V, P_{out} = 3.0 W, f = 2.7 GHz)	MRAL2327-3		35	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.7 GHz)	MRAL2327-12		40	—	—	

TYPICAL CHARACTERISTICS

MRAL2327-3

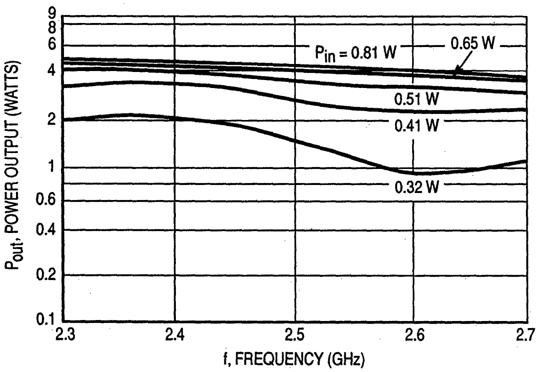


Figure 1. Power Output versus Frequency

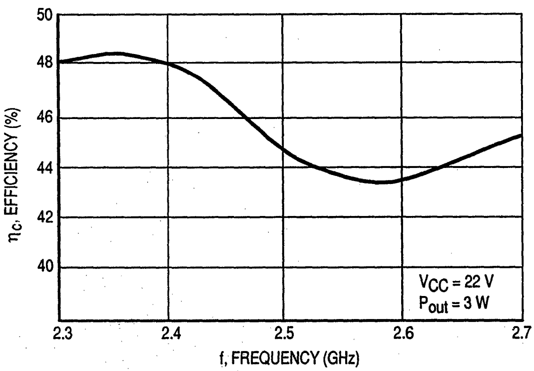


Figure 2. Collector Efficiency versus Frequency

MRAL2327-12

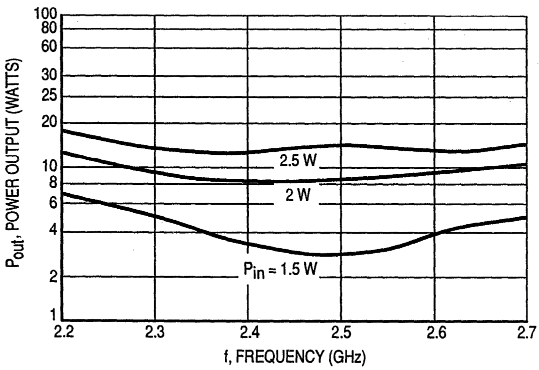


Figure 3. Power Output versus Frequency

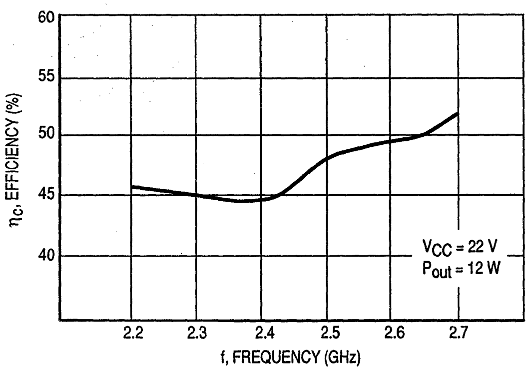
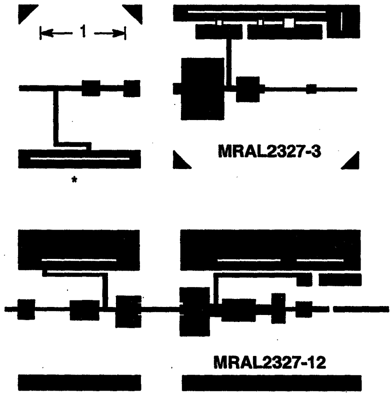


Figure 4. Collector Efficiency versus Frequency

2



Board material — 0.018″ dielectric thickness Teflon fiberglass
* Ground through to back side of board
C1, C3 — 100 pF porcelain ceramic chip
C4 — 0.1 µF ceramic chip
C5 — 50 µF, 50 V electrolytic
RFC1 — 5 turns #22 AWG, ~0.125 dia.

Figure 5. Circuit Boards (Not to Scale)

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular applications.

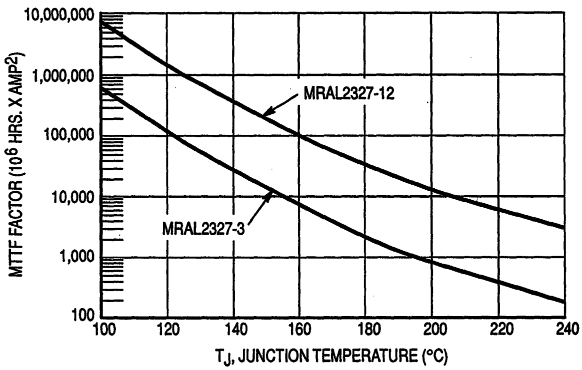


Figure 6. MTTF Factor versus Junction Temperature

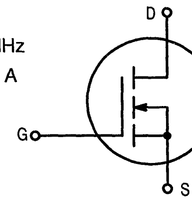
2

MRF134

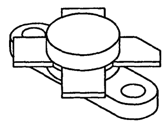
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode

. . . designed for wideband large-signal amplifier and oscillator applications up to 400 MHz range.

- Guaranteed 28 Volt, 150 MHz Performance
  Output Power = 5.0 Watts
  Minimum Gain = 11 dB
  Efficiency — 55% (Typical)
- Small-Signal and Large-Signal Characterization
- Typical Performance at 400 MHz, 28 Vdc, 5.0 W
  Output = 10.6 dB Gain
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 2.0 dB (Typ) at 200 mA, 150 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation



**5.0 W, to 400 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET**



CASE 211-07, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	0.9	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	17.5 0.1	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	°C/W

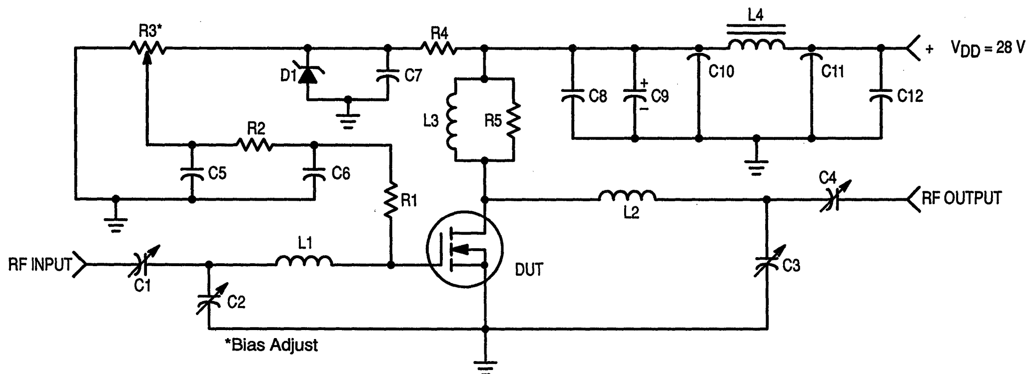
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

2

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (I_D = 10 mA, V_{DS} = 10 V)	$V_{GS(th)}$	1.0	3.5	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 100 mA)	g_{fs}	80	110	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	7.0	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	9.7	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.3	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 28 Vdc, I_D = 200 mA, f = 150 MHz)	NF	—	2.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 5.0 W, I_{DQ} = 50 mA)	G_{ps}				dB
f = 150 MHz (Fig. 1)		11	14	—	
f = 400 MHz (Fig. 14)		—	10.6	—	
Drain Efficiency (Fig. 1) (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 150 MHz, I_{DQ} = 50 mA)	η	50	55	—	%
Electrical Ruggedness (Fig. 1) (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 150 MHz, I_{DQ} = 50 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			



C1, C4 — Arco 406, 15–115 pF
C2 — Arco 403, 3.0–35 pF
C3 — Arco 402, 1.5–20 pF
C5, C6, C7, C8, C12 — 0.1 μF Erie Redcap
C9 — 10 μF, 50 V
C10, C11 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
L1 — 3 Turns, 0.310″ ID, #18 AWG Enamel, 0.2″ Long
L2 — 3-1/2 Turns, 0.310″ ID, #18 AWG Enamel, 0.25″ Long
L3 — 20 Turns, #20 AWG Enamel Wound on R5
L4 — Ferroxcube VK-200 — 19/4B
R1 — 68 Ω, 1.0 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ Beckman Instruments 8108
R4 — 1.8 kΩ, 1/2 W
R5 — 1.0 MΩ, 2.0 W Carbon
Board — G10, 62 mils

Figure 1. 150 MHz Test Circuit

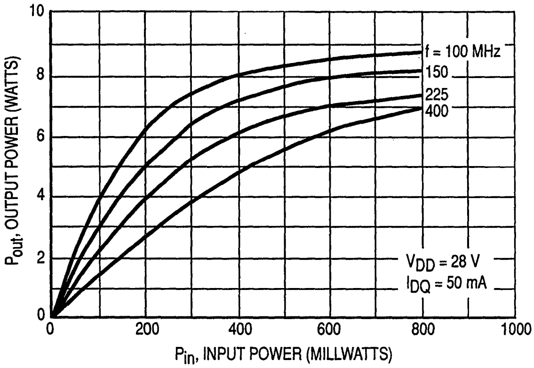


Figure 2. Output Power versus Input Power

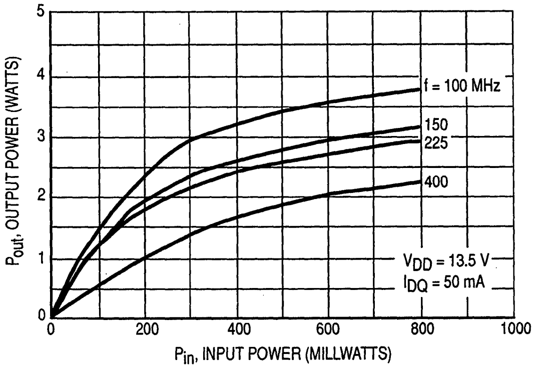


Figure 3. Output Power versus Input Power

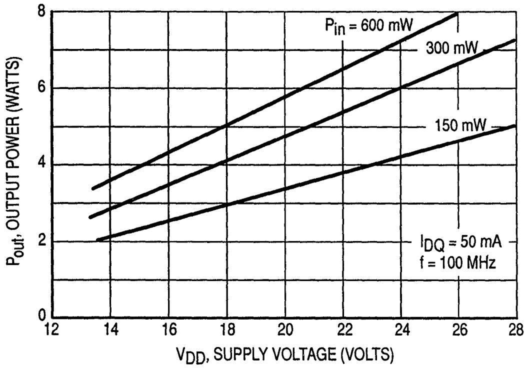


Figure 4. Output Power versus Supply Voltage

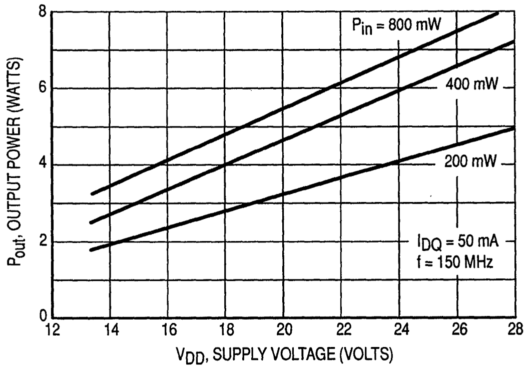


Figure 5. Output Power versus Supply Voltage

2

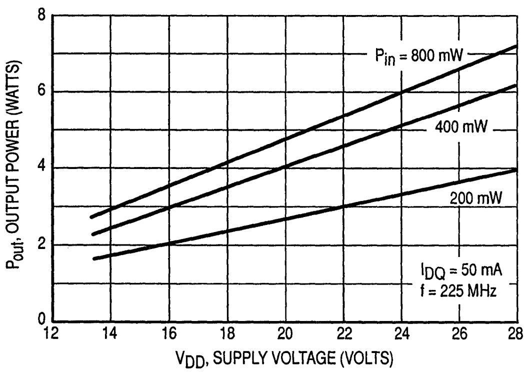


Figure 6. Output Power versus Supply Voltage

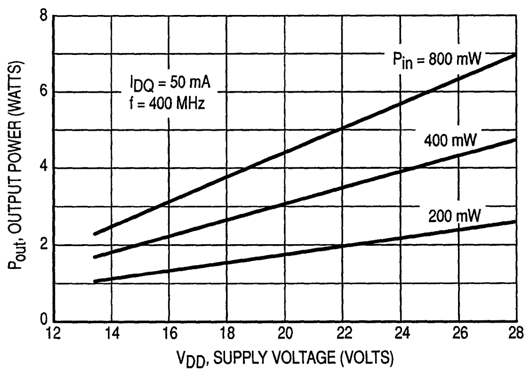


Figure 7. Output Power versus Supply Voltage

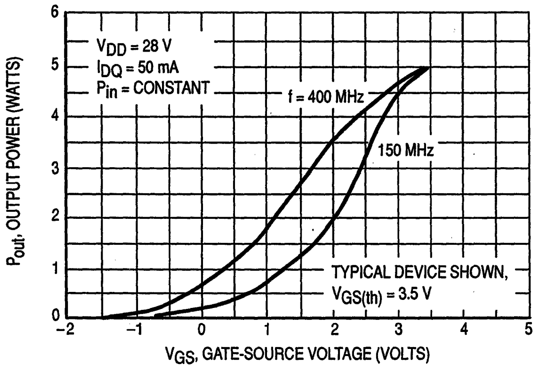


Figure 8. Output Power versus Gate Voltage

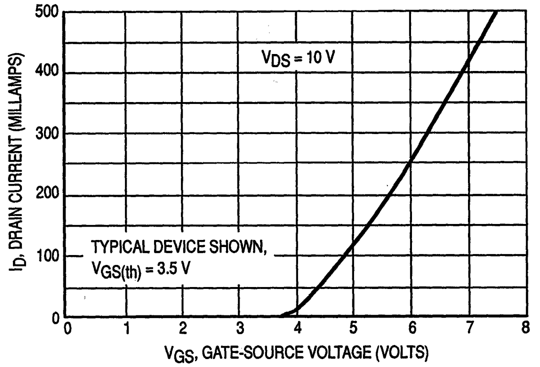


Figure 9. Drain Current versus Gate Voltage (Transfer Characteristics)

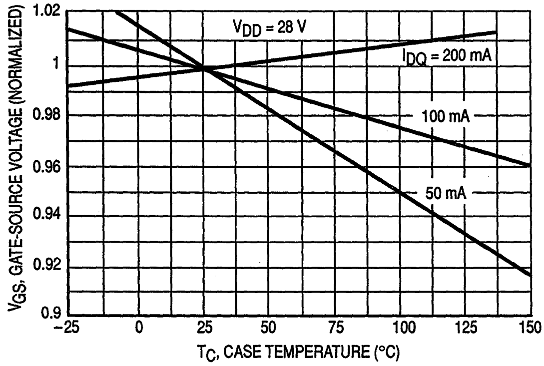


Figure 10. Gate-Source Voltage versus Case Temperature

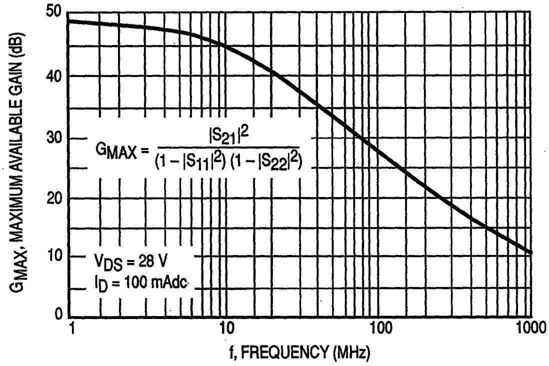


Figure 11. Maximum Available Gain versus Frequency

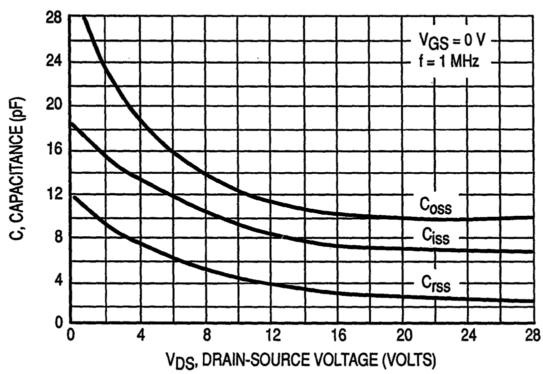


Figure 12. Capacitance versus Voltage

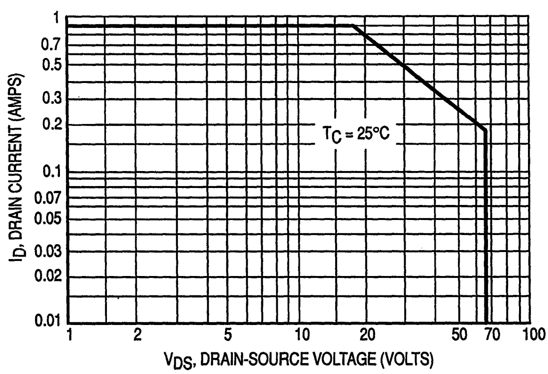
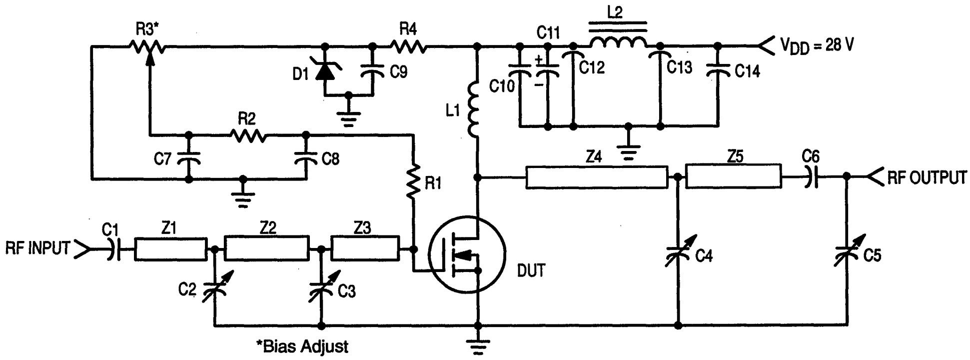
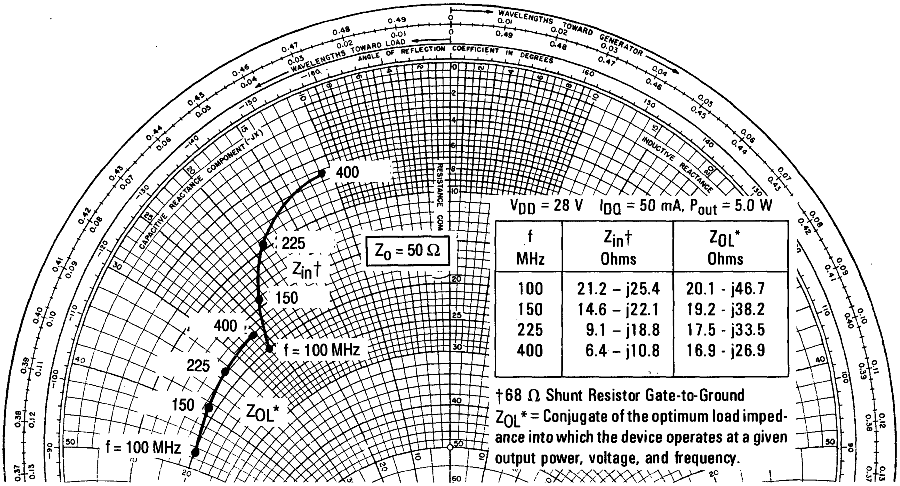


Figure 13. Maximum Rated Forward Biased Safe Operating Area



C1, C6 — 270 pF, ATC 100 mils
C2, C3, C4, C5 — 0–20 pF Johanson
C7, C9, C10, C14 — 0.1 µF Erie Redcap, 50 V
C8 — 0.001 µF
C11 — 10 µF, 50 V
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
L1 — 6 Turns, 1/4″ ID, #20 AWG Enamel
L2 — Ferroxcube VK-200 — 19/4B
R1 — 68 Ω, 1.0 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ Beckman Instruments 8108
R4 — 1.8 kΩ, 1/2 W
Z1 — 1.4″ x 0.166″ Microstrip
Z2 — 1.1″ x 0.166″ Microstrip
Z3 — 0.95″ x 0.166″ Microstrip
Z4 — 2.2″ x 0.166″ Microstrip
Z5 — 0.85″ x 0.166″ Microstrip
Board — Glass Teflon, 62 mils

Figure 14. 400 MHz Test Circuit



f MHz	Z_{in}† Ohms	Z_{OL}* Ohms
100	21.2 – j25.4	20.1 - j46.7
150	14.6 – j22.1	19.2 - j38.2
225	9.1 – j18.8	17.5 - j33.5
400	6.4 – j10.8	16.9 - j26.9

†68 Ω Shunt Resistor Gate-to-Ground
Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 15. Large-Signal Series Equivalent Input/Output Impedances, Z_{in}†, Z_{OL}*

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
1.0	0.989	−1.0	11.27	179	0.0014	89	0.954	−1.0
2.0	0.989	−2.0	11.27	179	0.0028	89	0.954	−2.0
5.0	0.988	−5.0	11.26	176	0.0069	86	0.954	−4.0
10	0.985	−10	11.20	173	0.014	83	0.951	−9.0
20	0.977	−20	10.99	166	0.027	76	0.938	−18
30	0.965	−30	10.66	159	0.039	69	0.918	−26
40	0.950	−39	10.25	153	0.051	63	0.895	−34
50	0.931	−47	9.777	147	0.060	57	0.867	−42
60	0.912	−53	9.359	142	0.069	53	0.846	−49
70	0.892	−58	8.960	138	0.077	49	0.828	−56
80	0.874	−62	8.583	135	0.085	46	0.815	−62
90	0.855	−66	8.190	131	0.091	43	0.801	−68
100	0.833	−70	7.808	128	0.096	40	0.785	−74
110	0.827	−73	7.661	125	0.101	38	0.784	−77
120	0.821	−76	7.515	122	0.107	36	0.784	−82
130	0.814	−79	7.368	119	0.113	34	0.784	−85
140	0.808	−82	7.222	116	0.119	32	0.783	−88
150	0.802	−86	7.075	114	0.125	31	0.783	−90
160	0.788	−89	6.810	112	0.127	30	0.780	−92
170	0.774	−92	6.540	110	0.128	28	0.774	−94
180	0.763	−94	6.220	108	0.130	26	0.762	−98
190	0.751	−97	5.903	106	0.132	24	0.760	−100
200	0.740	−100	5.784	104	0.134	23	0.758	−103
225	0.719	−104	5.334	100	0.136	20	0.757	−107
250	0.704	−108	4.904	97	0.139	19	0.758	−110
275	0.687	−113	4.551	92	0.141	16	0.757	−114
300	0.673	−117	4.219	89	0.141	14	0.750	−117
325	0.668	−120	3.978	86	0.142	12	0.757	−120
350	0.669	−123	3.737	83	0.142	10	0.766	−121
375	0.662	−125	3.519	80	0.143	9.0	0.768	−123
400	0.654	−127	3.325	77	0.142	8.0	0.772	−124
425	0.650	−129	3.170	75	0.140	7.0	0.772	−125
450	0.638	−131	3.048	72	0.141	6.0	0.783	−125
475	0.614	−132	2.898	71	0.136	6.0	0.786	−126
500	0.641	−133	2.833	68	0.136	5.0	0.795	−127
525	0.638	−135	2.709	66	0.135	5.0	0.801	−127
550	0.633	−137	2.574	64	0.133	4.0	0.802	−128
575	0.628	−138	2.481	62	0.131	5.0	0.805	−128
600	0.625	−140	2.408	60	0.129	5.0	0.814	−128

The Power RF characterization data were measured with a 68 ohm resistor shunting the MRF134 input port. (continued)
The scattering parameters were measured on the MRF134 device alone with no external components.

Table 1. Common Source Scattering Parameters
V_{DS} = 28 V, I_D = 100 mA

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
625	0.619	−142	2.334	58	0.128	5.0	0.818	−129
650	0.617	−144	2.259	56	0.125	6.0	0.824	−130
675	0.618	−146	2.192	55	0.123	7.0	0.834	−130
700	0.619	−147	2.124	53	0.122	8.0	0.851	−131
725	0.618	−150	2.061	51	0.120	9.0	0.859	−132
750	0.614	−152	1.983	49	0.118	11	0.857	−133
775	0.609	−154	1.908	48	0.119	13	0.865	−133
800	0.562	−155	1.877	49	0.118	15	0.872	−133
825	0.587	−156	1.869	46	0.119	16	0.869	−134
850	0.593	−158	1.794	44	0.118	18	0.875	−135
875	0.597	−160	1.749	43	0.119	18	0.881	−135
900	0.598	−162	1.700	41	0.118	18	0.889	−136
925	0.592	−164	1.641	40	0.115	18	0.888	−138
950	0.588	−166	1.590	39	0.112	20	0.877	−138
975	0.586	−168	1.572	39	0.108	23	0.864	−137
1000	0.590	−171	1.551	37	0.107	28	0.863	−137

The Power RF characterization data were measured with a 68 ohm resistor shunting the MRF134 input port. The scattering parameters were measurd on the MRF134 device alone with no external components.

Table 1. Common Source Scattering Parameters (continued)
V_{DS} = 28 V, I_D = 100 mA

2

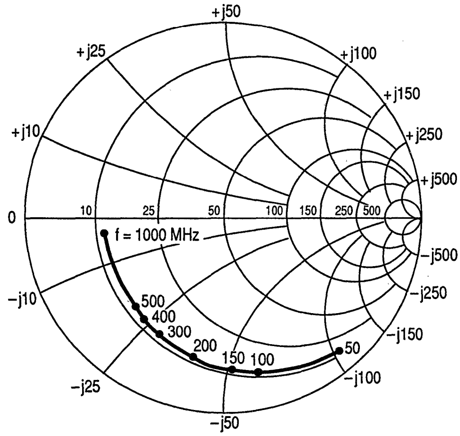


Figure 16. S_{11}, Input Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 100 mA

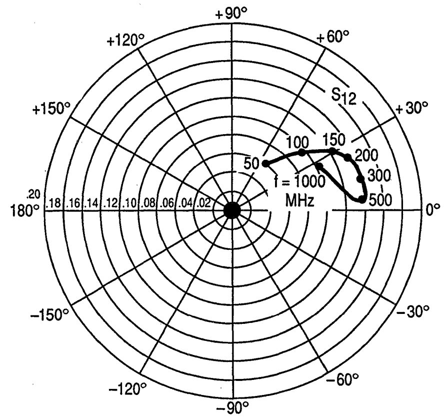


Figure 17. S_{12}, Reverse Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 100 mA

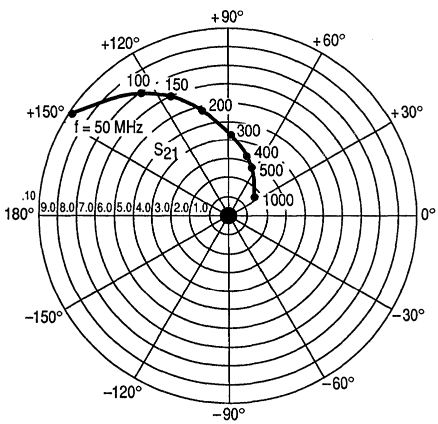


Figure 18. S_{21}, Forward Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 100 mA

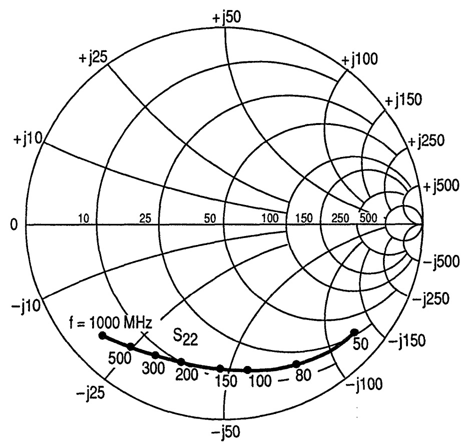


Figure 19. S_{22}, Output Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 100 mA

DESIGN CONSIDERATIONS

The MRF134 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF134 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF134 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF134 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF134. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF134, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. The MRF134 was characterized with a 68-ohm input shunt loading resistor. Two port parameter stability analysis with the MRF134 s-parameters provides a useful-tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

Input resistive loading is not feasible in low noise applications. The MRF134 noise figure data was generated in a circuit with drain loading and a low loss input network.

2

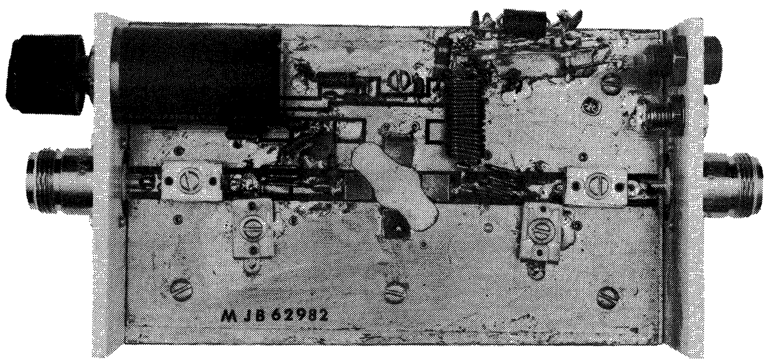


Figure 20. 150 MHz Test Circuit

MRF136
MRF136Y

The RF MOSFET Line
RF Power
Field-Effect Transistors
N-Channel Enhancement-Mode MOSFETs

**15 W, 30 W, to 400 MHz
N-CHANNEL
MOS BROADBAND
RF POWER FETs**

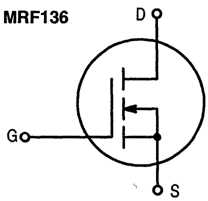
. . . designed for wideband large-signal amplifier and oscillator applications up to 400 MHz range, in either single ended or push-pull configuration.

- Guaranteed 28 Volt, 150 MHz Performance

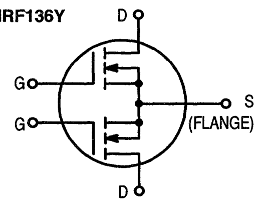
MRF136	MRF136Y
Output Power = 15 Watts	Output Power = 30 Watts
Narrowband Gain = 16 dB (Typ)	Broadband Gain = 14 dB (Typ)
Efficiency = 60% (Typical)	Efficiency = 54% (Typical)

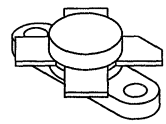
- Small-Signal and Large-Signal Characterization
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Space Saving Package For Push-Pull Circuit Applications — MRF136Y
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques

MRF136

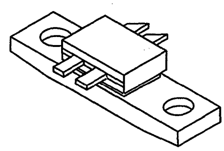


MRF136Y





**CASE 211-07, STYLE 2
MRF136**



**CASE 319B, STYLE 1
MRF136Y**

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		MRF136	MRF136Y	
Drain-Source Voltage	V_{DSS}	65	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	65	Vdc
Gate-Source Voltage	V_{GS}	±40		Vdc
Drain Current — Continuous	I_D	2.5	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	55 0.314	100 0.571	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150		°C
Operating Junction Temperature	T_J	200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max		Unit
		MRF136	MRF136Y	
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	1.75	°C/W

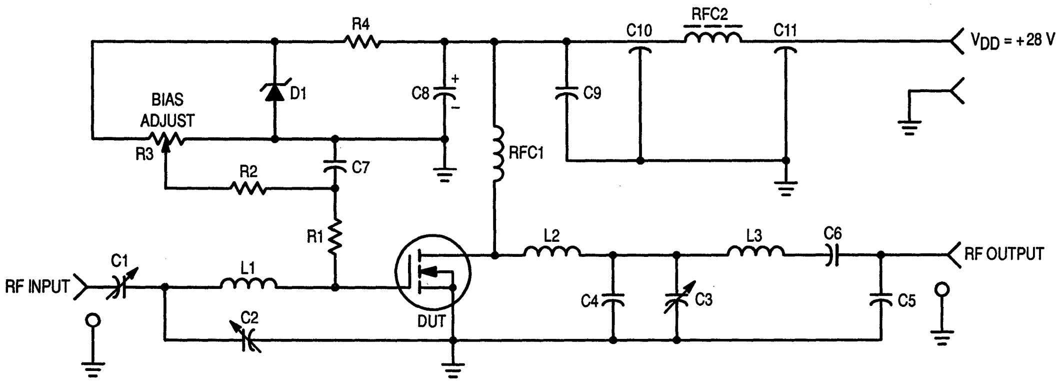
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero-Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc
ON CHARACTERISTICS (1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 250 mA)	g_{fs}	250	400	—	mmhos
DYNAMIC CHARACTERISTICS (1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	24	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	5.5	—	pF
FUNCTIONAL CHARACTERISTICS (2)					
Noise Figure MRF136 (V_{DS} = 28 Vdc, I_D = 500 mA, f = 150 MHz)	NF	—	1.0	—	dB
Common Source Power Gain (Figure 1) MRF136 (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 150 MHz, I_{DQ} = 25 mA)	G_{ps}	13	16	—	dB
Common Source Power Gain (Figure 2) MRF136Y (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (Figure 1) MRF136 (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 150 MHz, I_{DQ} = 25 mA)	η	50	60	—	%
Drain Efficiency (Figure 2) MRF136Y (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 100 mA)	η	50	54	—	%
Electrical Ruggedness (Figure 1) MRF136 (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 150 MHz, I_{DQ} = 25 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
Electrical Ruggedness (Figure 2) MRF136Y (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTES:
1. For MRF136Y, each side measured separately.
2. For MRF136Y measured in push-pull configuration.

2

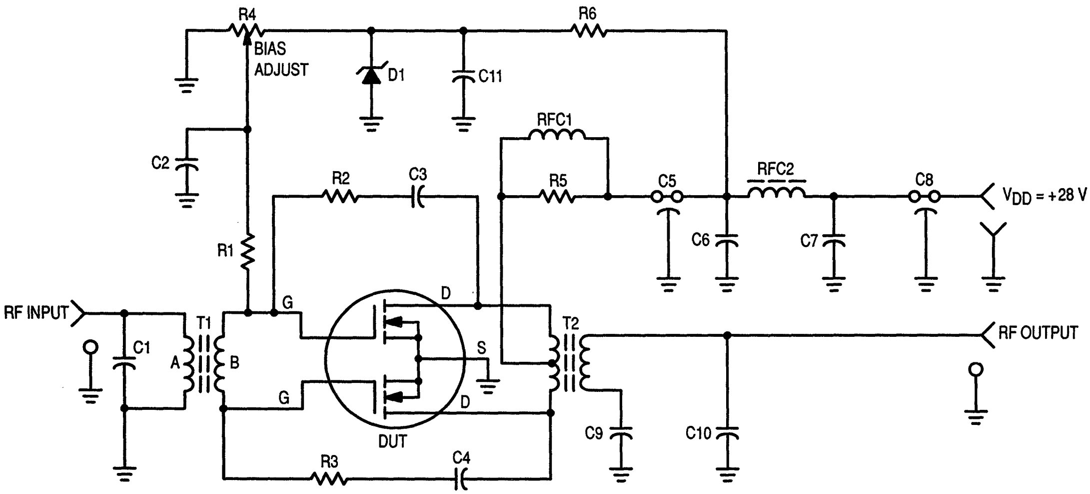


C1, C2 — Arco 406, 15–115 pF or Equivalent
C3 — Arco 404, 8–60 pF or Equivalent
C4 — 43 pF Mini-Unelco or Equivalent
C5 — 24 pF Mini-Unelco or Equivalent
C6 — 680 pF, 100 Mils Chip
C7 — 0.01 µF Ceramic
C8 — 100 µF, 40 V
C9 — 0.1 µF Ceramic
C10, C11 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.29″ ID, #18 AWG, 0.10″ Long
L2 — 2 Turns, 0.23″ ID, #18 AWG, 0.10″ Long
L3 — 2-1/4 Turns, 0.29″ ID, #18 AWG, 0.125″ Long
RFC1 — 20 Turns, 0.30″ ID, #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
R1 — 27 Ω, 1 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, 1/2 W
Board Material — 0.062″ G10, 1 oz. Cu Clad, Double Sided

Figure 1. 150 MHz Test Circuit (MRF136)

2



C1 — 5.0 pF
C2, C3, C4, C6, C7, C9, C11 — 0.1 µF Ceramic
C5, C8 — 680 pF Feedthru
C10 — 15 pF
D1 — 1N4740 Motorola Zener
RFC1 — 17 Turns, #24 AWG Wound on R5
RFC2 — Ferroxcube VK-200-19/4B or Equivalent
R1 — 10 kΩ, 1/4 W
R2, R3 — 560 Ω, 1/2 W
R4 — 10 Turns, 10 kΩ

R5 — 56 kΩ, 1 W
R6 — 1.6 kΩ, 1/4 W
T1 — Primary Winding — 3 Turns #28 Enameled Wire.
— Secondary Winding — 2 Turns #28 Enameled Wire.
Both windings wound through a Fair/Rite Balun 65 core.
Part #2865002402.
T2 — 1:1 Transformer Wound Bifilar — 2 Turns Twisted Pair
#24 Enameled Wire through a Indiana General Balun Q1
core. Part #18006-1-Q1. Primary winding center tapped.
Board Material — 0.062″ G10, 1 oz. Cu Clad, Double Sided

Figure 2. 30–150 MHz Test Circuit (MRF136Y)

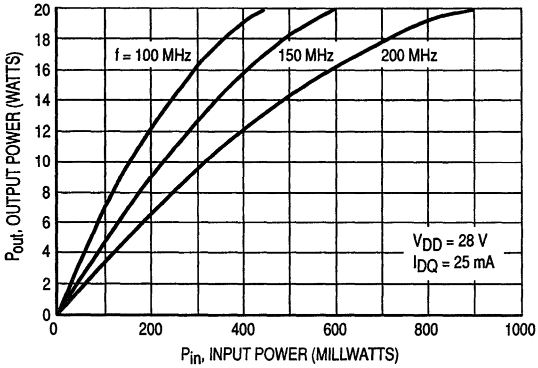


Figure 3. Output Power versus Input Power

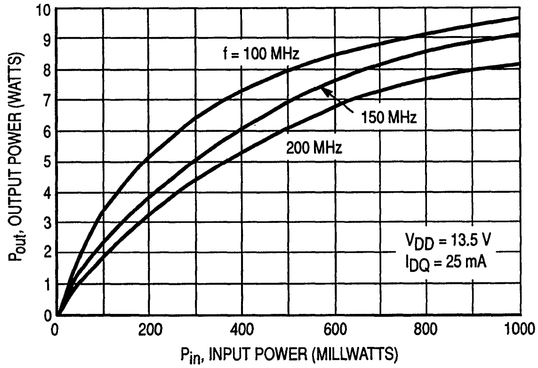


Figure 4. Output Power versus Input Power

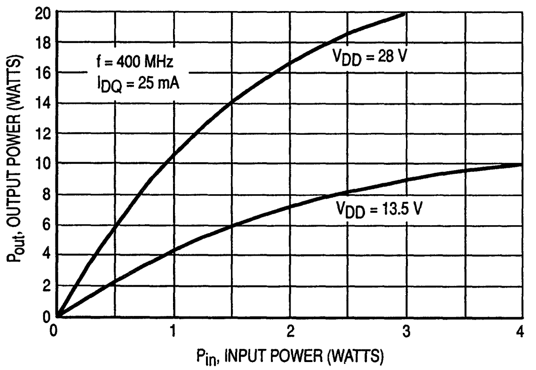


Figure 5. Output Power versus Input Power

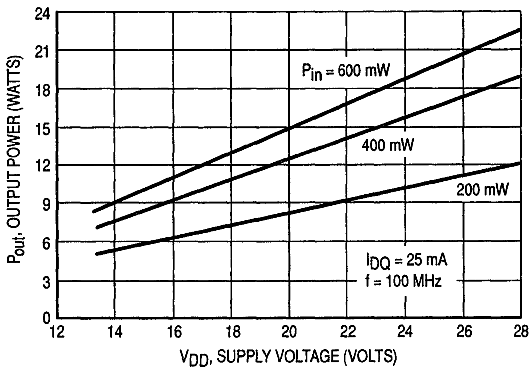


Figure 6. Output Power versus Supply Voltage

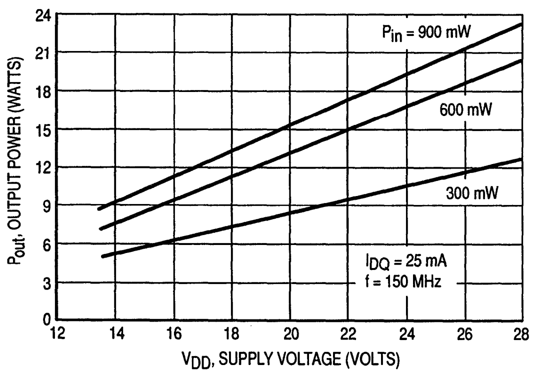


Figure 7. Output Power versus Supply Voltage

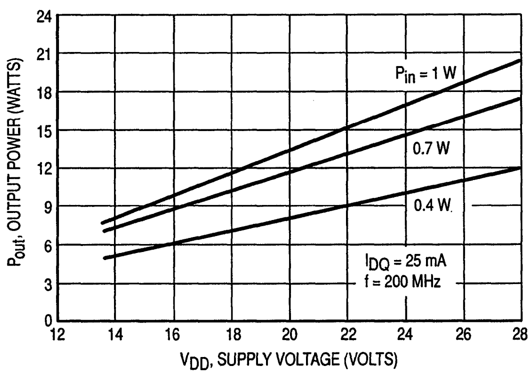


Figure 8. Output Power versus Supply Voltage

2

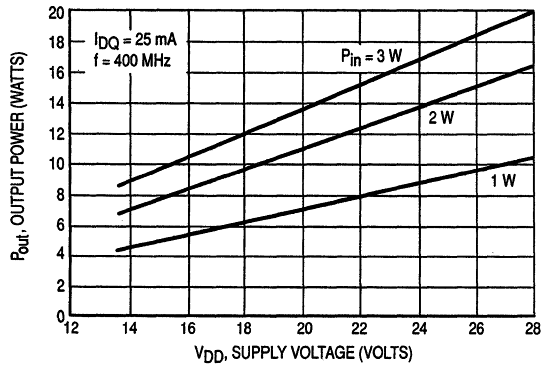


Figure 9. Output Power versus Supply Voltage MRF136

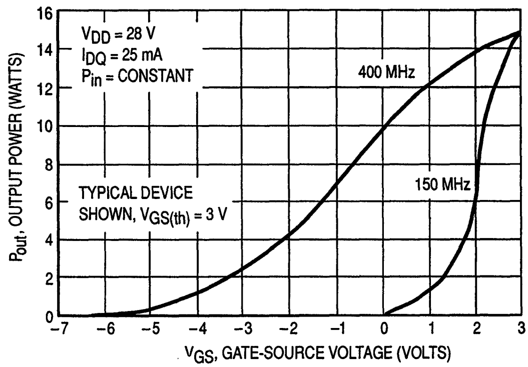


Figure 10. Output Power versus Gate Voltage MRF136

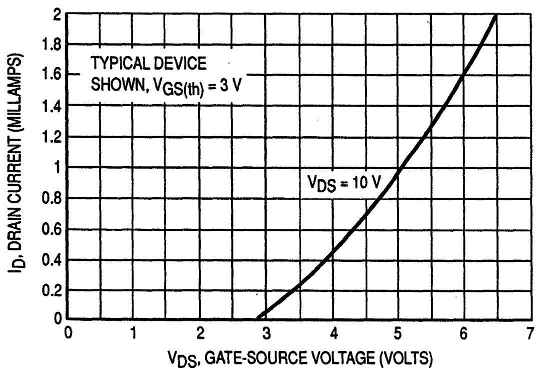


Figure 11. Drain Current versus Gate Voltage (Transfer Characteristics)* MRF136/MRF136Y

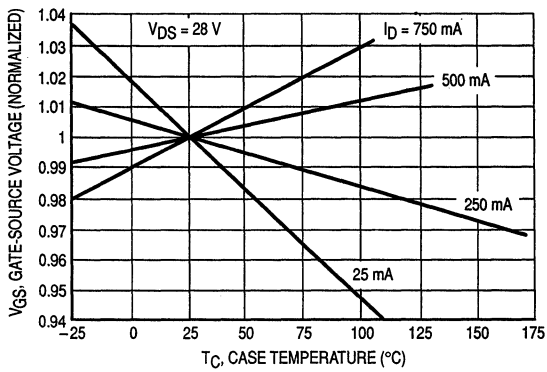


Figure 12. Gate-Source Voltage versus Case Temperature* MRF136/MRF136Y

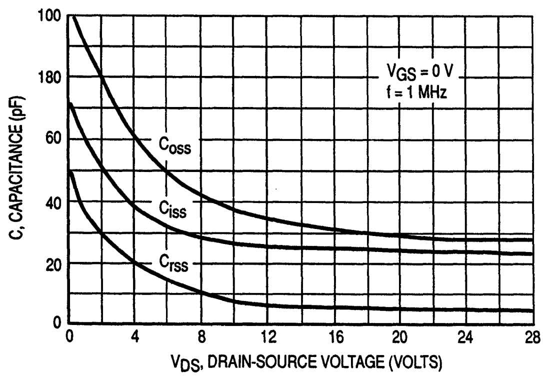


Figure 13. Capacitance versus Drain-Source Voltage* MRF136/MRF136Y

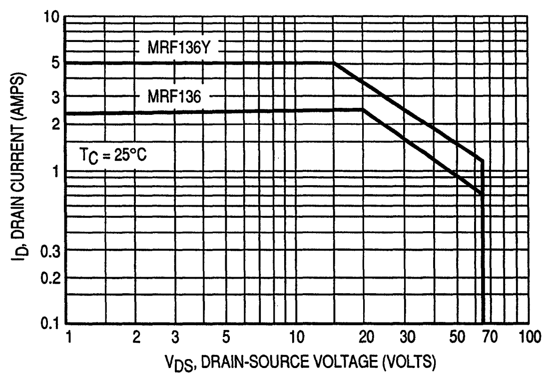


Figure 14. DC Safe Operating Area MRF136/MRF136Y

*Data shown applies to MRF136 and each half of MRF136Y.

MRF136Y
TYPICAL PERFORMANCE IN BROADBAND TEST CIRCUIT
(Refer to Figure 2)

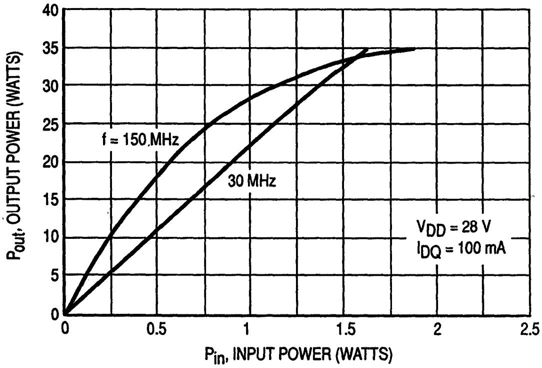


Figure 15. Output Power versus Input Power

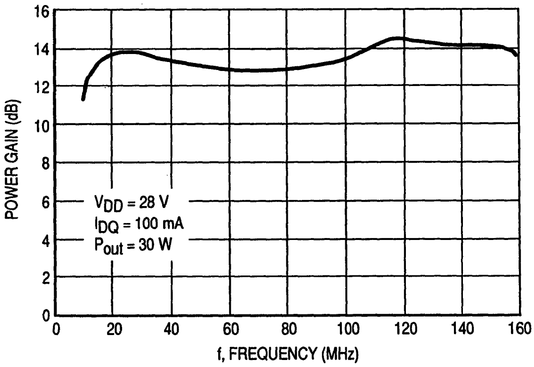


Figure 16. Power Gain versus Frequency

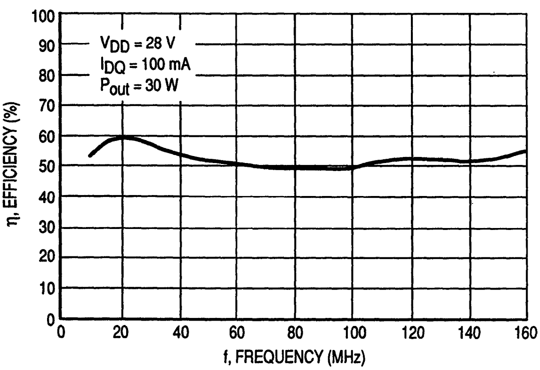


Figure 17. Drain Efficiency versus Frequency

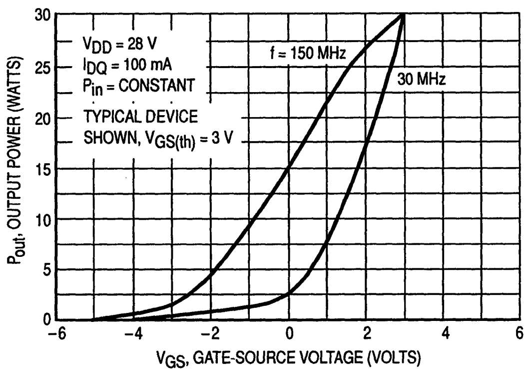


Figure 18. Output Power versus Gate Voltage

TYPICAL 400 MHz PERFORMANCE

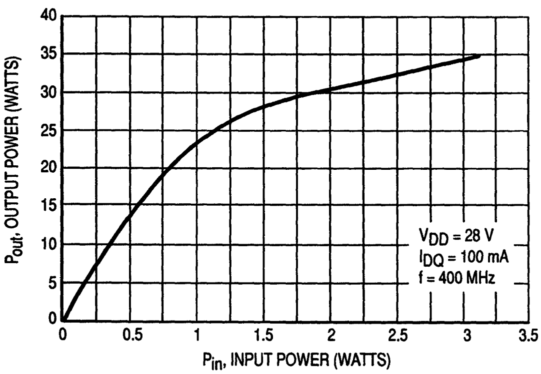


Figure 19. Output Power versus Input Power

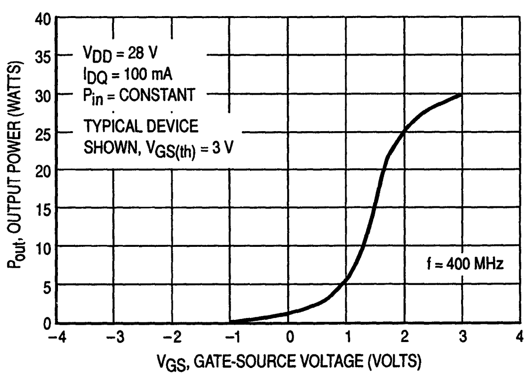
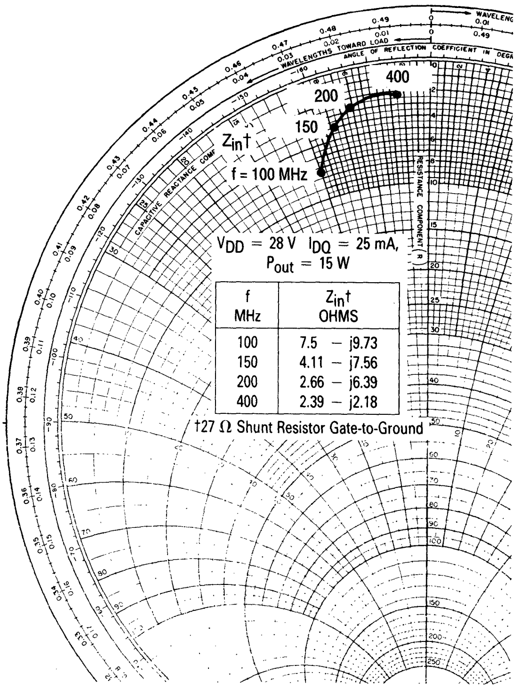


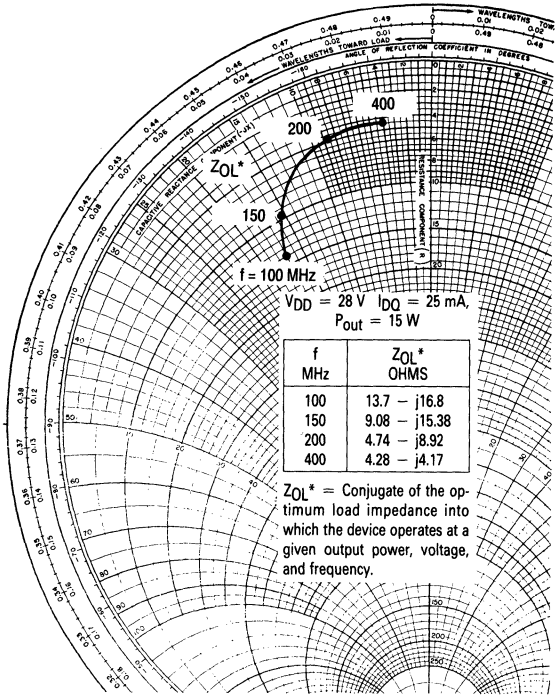
Figure 20. Output Power versus Gate Voltage

2



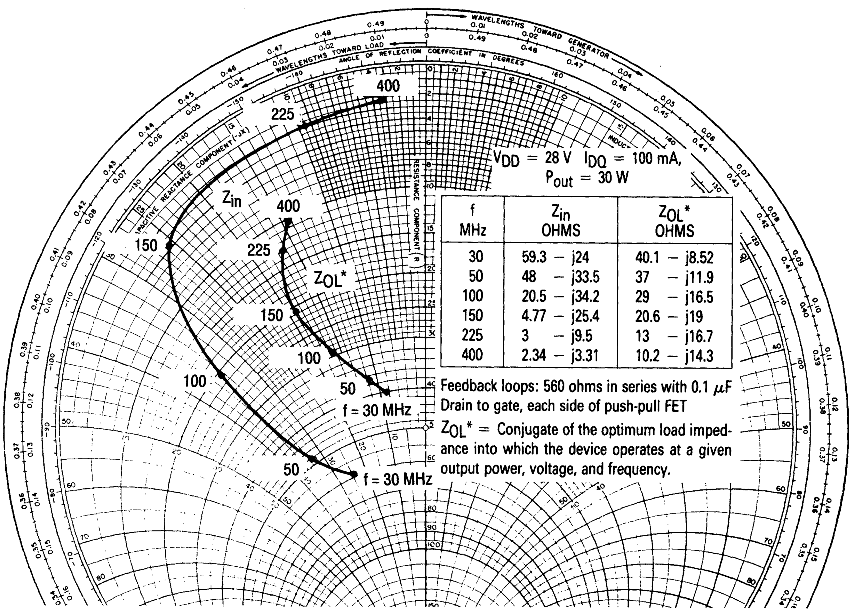
f MHz	Zin† OHMS
100	7.5 – j9.73
150	4.11 – j7.56
200	2.66 – j6.39
400	2.39 – j2.18

Figure 21. Large-Signal Series Equivalent Input Impedance, Z_{in}† MRF136



f MHz	ZOL* OHMS
100	13.7 – j16.8
150	9.08 – j15.38
200	4.74 – j8.92
400	4.28 – j4.17

Figure 22. Large-Signal Series Equivalent Output Impedance, Z_{OL}* MRF136



f MHz	Zin OHMS	ZOL* OHMS
30	59.3 – j24	40.1 – j8.52
50	48 – j33.5	37 – j11.9
100	20.5 – j34.2	29 – j16.5
150	4.77 – j25.4	20.6 – j19
225	3 – j9.5	13 – j16.7
400	2.34 – j3.31	10.2 – j14.3

Figure 23. Input and Outut Impedance MRF136Y

MRF136

f (MHz)	S11		S21		S12		S22	
	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
2.0	0.988	−11	41.19	173	0.006	67	0.729	−12
5.0	0.970	−27	40.07	164	0.014	62	0.720	−31
10	0.923	−52	35.94	149	0.026	54	0.714	−58
20	0.837	−88	27.23	129	0.040	36	0.690	−96
30	0.784	−111	20.75	117	0.046	27	0.684	−118
40	0.751	−125	16.49	108	0.048	22	0.680	−131
50	0.733	−135	13.41	103	0.050	19	0.679	−139
60	0.720	−142	11.43	99	0.050	16	0.678	−145
70	0.709	−147	9.871	96	0.050	14	0.679	−149
80	0.707	−152	8.663	93	0.051	13	0.683	−153
90	0.706	−155	7.784	91	0.051	13	0.682	−155
100	0.708	−157	7.008	88	0.051	13	0.680	−157
110	0.711	−159	6.435	86	0.051	14	0.681	−158
120	0.714	−161	5.899	85	0.051	15	0.682	−159
130	0.717	−163	5.439	82	0.052	16	0.684	−160
140	0.720	−164	5.068	80	0.052	17	0.684	−161
150	0.723	−165	4.709	80	0.052	18	0.686	−161
160	0.727	−166	4.455	78	0.052	18	0.690	−161
170	0.732	−167	4.200	77	0.052	18	0.694	−162
180	0.735	−168	3.967	75	0.052	19	0.699	−162
190	0.738	−169	3.756	74	0.052	19	0.703	−163
200	0.740	−170	3.545	73	0.052	20	0.706	−163
225	0.746	−171	3.140	69	0.053	22	0.717	−163
250	0.742	−172	2.783	67	0.053	25	0.724	−163
275	0.744	−173	2.540	64	0.054	27	0.724	−163
300	0.751	−174	2.323	60	0.055	29	0.736	−163
325	0.757	−175	2.140	58	0.058	32	0.749	−163
350	0.760	−176	1.963	54	0.059	35	0.758	−163
375	0.762	−177	1.838	52	0.062	38	0.768	−163
400	0.774	−179	1.696	50	0.065	41	0.783	−163
425	0.775	−179	1.590	48	0.068	43	0.793	−163
450	0.781	+179	1.493	46	0.071	46	0.805	−163
475	0.787	+177	1.415	43	0.074	47	0.813	−164
500	0.792	+176	1.332	40	0.079	48	0.825	−164
525	0.797	+175	1.259	38	0.083	50	0.831	−164
550	0.801	+175	1.185	37	0.088	51	0.843	−164
575	0.810	+174	1.145	36	0.094	52	0.855	−164
600	0.816	+173	1.091	34	0.101	52	0.869	−165
625	0.818	+171	1.041	32	0.106	53	0.871	−165
650	0.825	+170	0.994	30	0.112	53	0.884	−165
675	0.834	+169	0.962	29	0.119	53	0.890	−165
700	0.837	+168	0.922	27	0.127	53	0.906	−166
725	0.836	+167	0.879	25	0.133	52	0.909	−167
750	0.841	+166	0.838	25	0.140	53	0.917	−167
775	0.844	+165	0.824	24	0.148	52	0.933	−167
800	0.846	+163	0.785	21	0.154	50	0.941	−168

Table 1. Common Source Scattering Parameters
V_{DS} = 28 V, I_D = 0.5 A

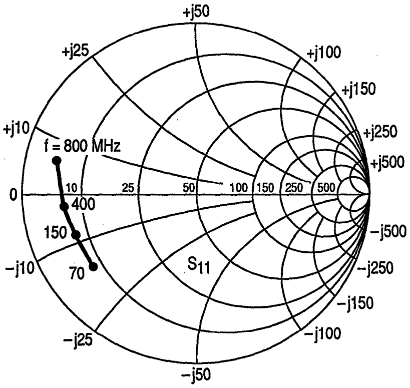


Figure 24. S_{11}, Input Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

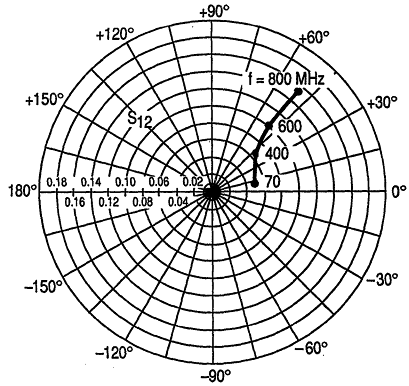


Figure 25. S_{12}, Reverse Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

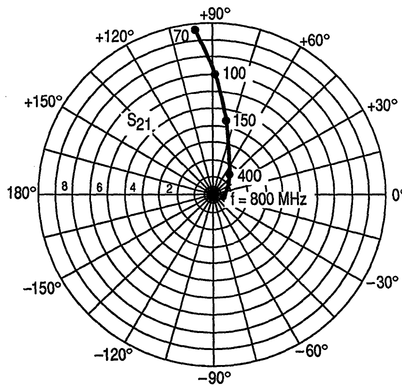


Figure 26. S_{21}, Forward Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

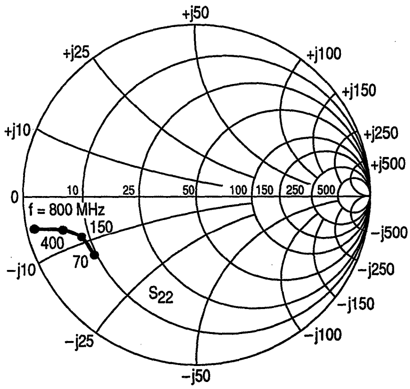


Figure 27. S_{22}, Output Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

2

DESIGN CONSIDERATIONS

The MRF136 and MRF136Y are RF power N-Channel enhancement mode field-effect transistors (FETs) designed especially for HF and VHF power amplifier applications. Motorola RF MOS FETs feature planar design for optimum manufacturability.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF136 and MRF136Y are enhancement mode FETs and, therefore, do not conduct when drain voltage is applied without gate bias. A positive gate voltage causes drain current to flow (see Figure 11). RF power FETs require forward bias for optimum gain and power output. A Class AB condition with quiescent drain current (I_{DQ}) in the 25–100 mA range is sufficient for many applications. For special requirements such as linear amplification, I_{DQ} may have to be adjusted to optimize the critical parameters.

The MOS gate is a dc open circuit. Since the gate bias circuit does not have to deliver any current to the FET, a simple resistive divider arrangement may sometimes suffice for this function. Special applications may require more elaborate gate bias systems.

GAIN CONTROL

Power output of the MRF136 and MRF136Y may be controlled from rated values down to the milliwatt region (>20 dB reduction in power output with constant input power) by varying the dc gate voltage. This feature, not available in bipolar RF power devices, facilitates the incorporation of manual gain control, AGC/ALC and modulation schemes into system designs. A full range of power output control may require dc gate voltage excursions into the negative region.

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar transistors are suitable for MRF136 and MRF136Y. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. Both small signal scattering parameters (MRF136 only) and large signal impedance parameters are provided. Large signal impedances should be used for network designs wherever possible. While the s parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is particularly useful at frequencies outside those presented in the large signal impedance plots.

RF power FETs are triode devices and are therefore not unilateral. This, coupled with the very high gain, yields a device capable of self oscillation. Stability may be achieved using techniques such as drain loading, input shunt resistive loading, or feedback. S parameter stability analysis can provide useful information in the selection of loading and/or feedback to insure stable operation. The MRF136 was characterized with a 27 ohm input shunt loading resistor, while the MRF136Y was characterized with a resistive feedback loop around each of its two active devices.

For further discussion of RF amplifier stability and the use of two port parameters in RF amplifier design, see Motorola Application Note AN215A on page 6-204 in the RF Device Data (DL110 Rev 1).

LOW NOISE OPERATION

Input resistive loading will degrade noise performance, and noise figure may vary significantly with gate driving impedance. A low loss input matching network with its gate impedance optimized for lowest noise is recommended.

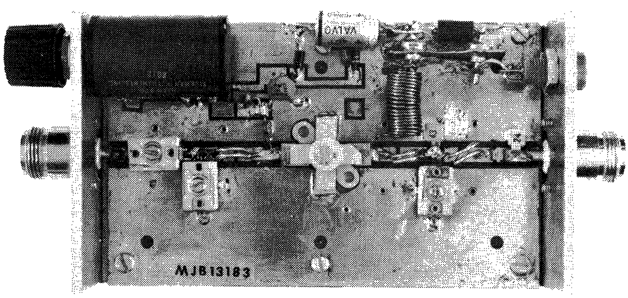
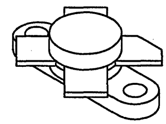


Figure 28. MRF136 Test Circuit

MRF137

30 W, to 400 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET

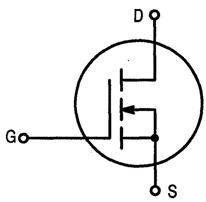


CASE 211-07, STYLE 2

The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode

. . . designed for wideband large-signal output and driver stages up to 400 MHz range.

- Guaranteed 28 Volt, 150 MHz Performance
  Output Power = 30 Watts
  Minimum Gain = 13 dB
  Efficiency — 60% (Typical)
- Small-Signal and Large-Signal Characterization
- Typical Performance at 400 MHz, 28 Vdc, 30 W
  Output = 7.7 dB Gain
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 1.5 dB (Typ) at 1.0 A, 150 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	100 0.571	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

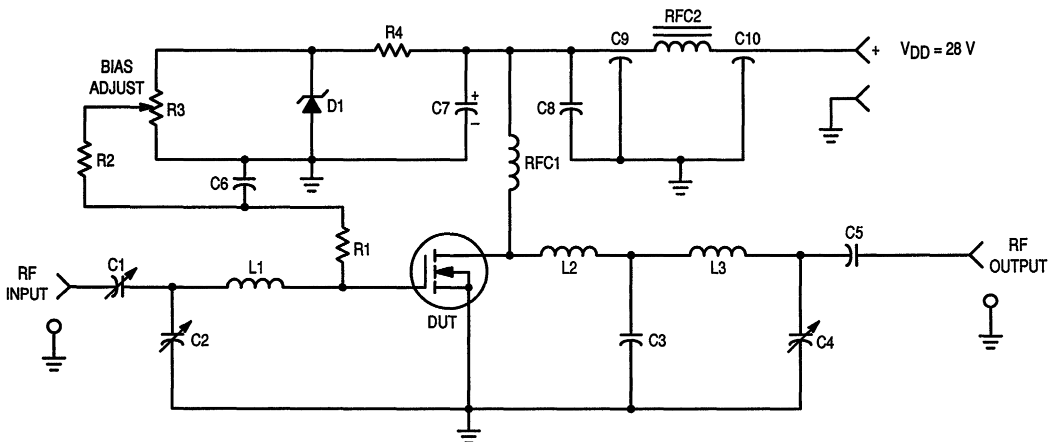
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	4.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 500 mA)	g_{fs}	500	750	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	48	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	54	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	11	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 28 Vdc, I_D = 1.0 A, f = 150 MHz)	NF	—	1.5	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 30 W, I_{DQ} = 25 mA) f = 150 MHz (Figure 1) f = 400 MHz (Figure 14)	G_{ps}	13 —	16 7.7	— —	dB
Drain Efficiency (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 25 mA)	η	50	60	—	%
Electrical Ruggedness (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 25 mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

2



C1 — Arco 403, 3.0–35 pF, or equivalent
C2 — Arco 406, 15–115 pF, or equivalent
C3 — 56 pF Mini-Unelco, or equivalent
C4 — Arco 404, 8.0–60 pF, or equivalent
C5 — 680 pF, 100 Mils Chip
C6 — 0.01 µF, 100 V, Disc Ceramic
C7 — 100 µF, 40 V
C8 — 0.1 µF, 50 V, Disc Ceramic
C9, C10 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.29″ ID, #18 AWG Enamel, Closewound
L2 — 1-1/4 Turns, 0.2″ ID, #18 AWG Enamel, Closewound
L3 — 2 Turns, 0.2″ ID, #18 AWG Enamel, Closewound
RFC1 — 20 Turns, 0.30″ ID, #20 AWG Enamel, Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
R1 — 10 kΩ, 1/2 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, 1/2 W
Board — G10, 62 Mils

Figure 1. 150 MHz Test Circuit

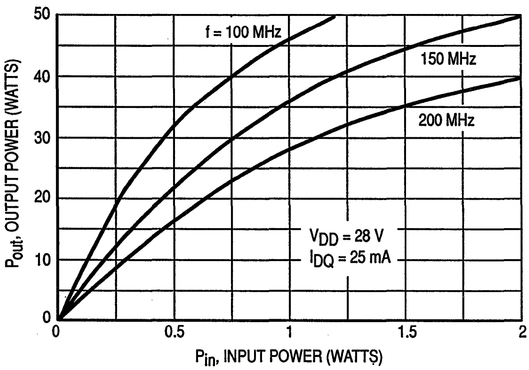


Figure 2. Output Power versus Input Power

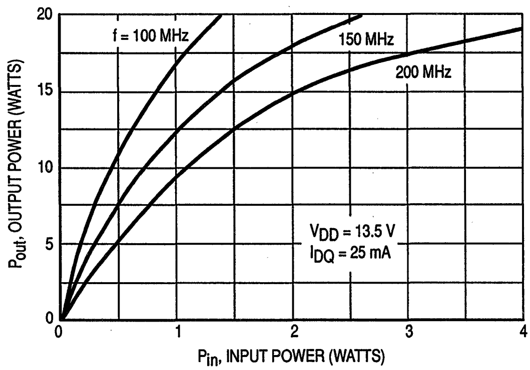


Figure 3. Output Power versus Input Power

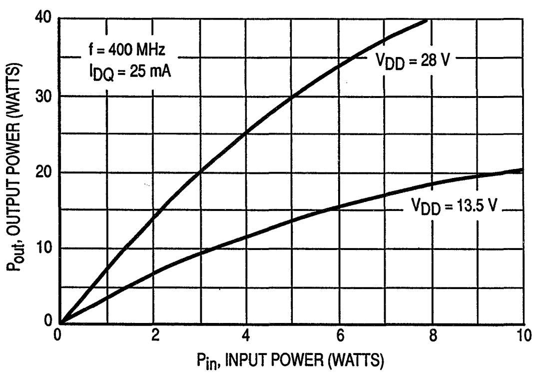


Figure 4. Output Power versus Input Power

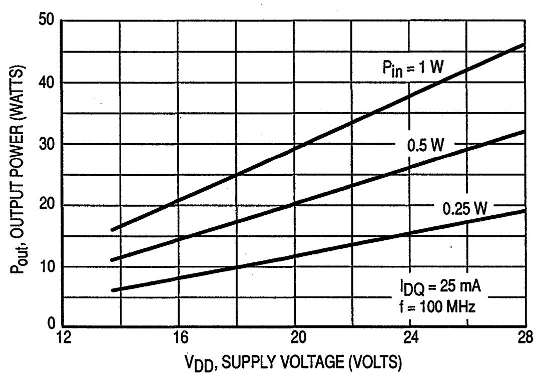


Figure 5. Output Power versus Supply Voltage

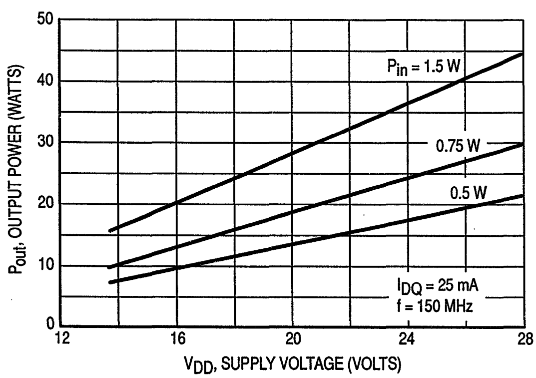


Figure 6. Output Power versus Supply Voltage

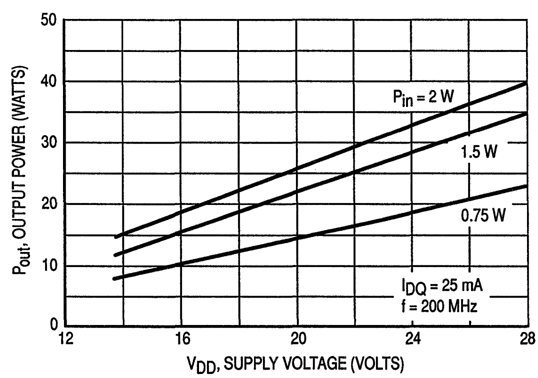


Figure 7. Output Power versus Supply Voltage

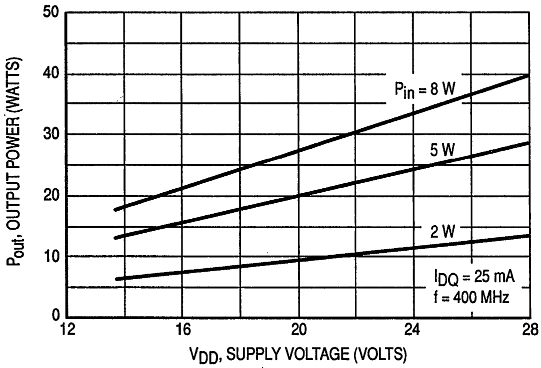


Figure 8. Output Power versus Supply Voltage

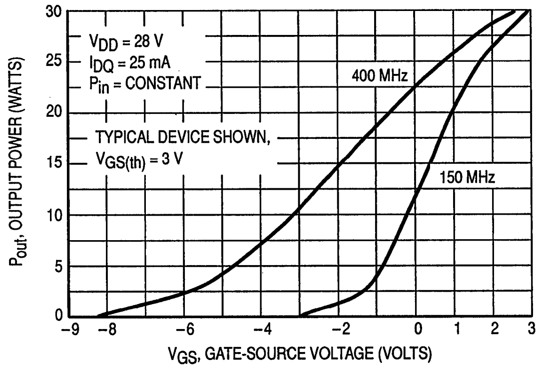


Figure 9. Output Power versus Gate Voltage

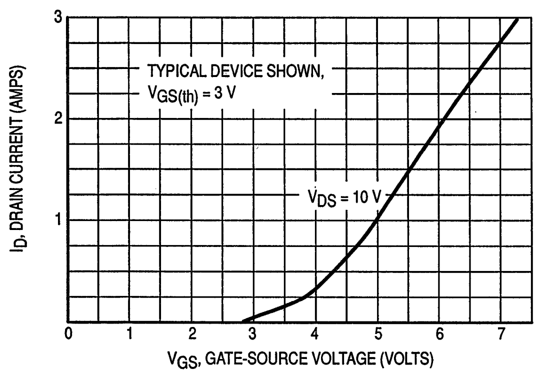


Figure 10. Drain Current versus Gate Voltage (Transfer Characteristics)

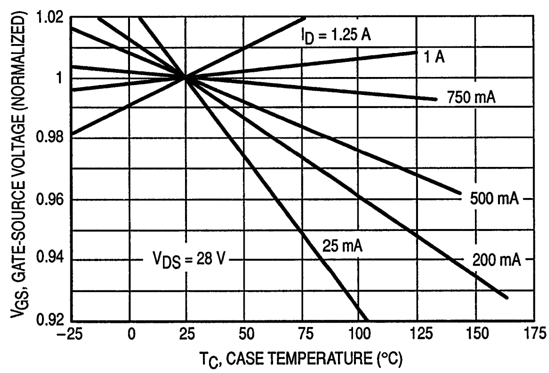


Figure 11. Gate Source Voltage versus Case Temperature

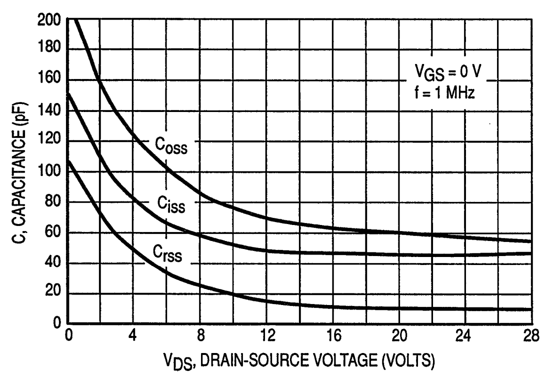


Figure 12. Capacitance versus Drain-Source Voltage

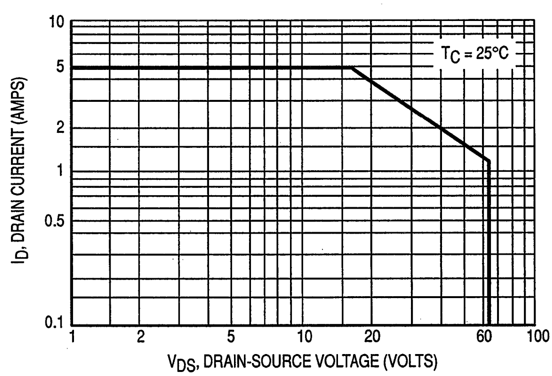
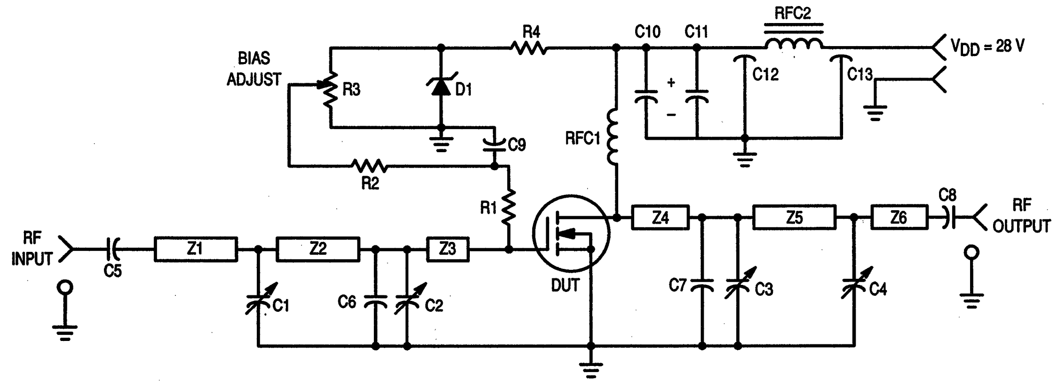


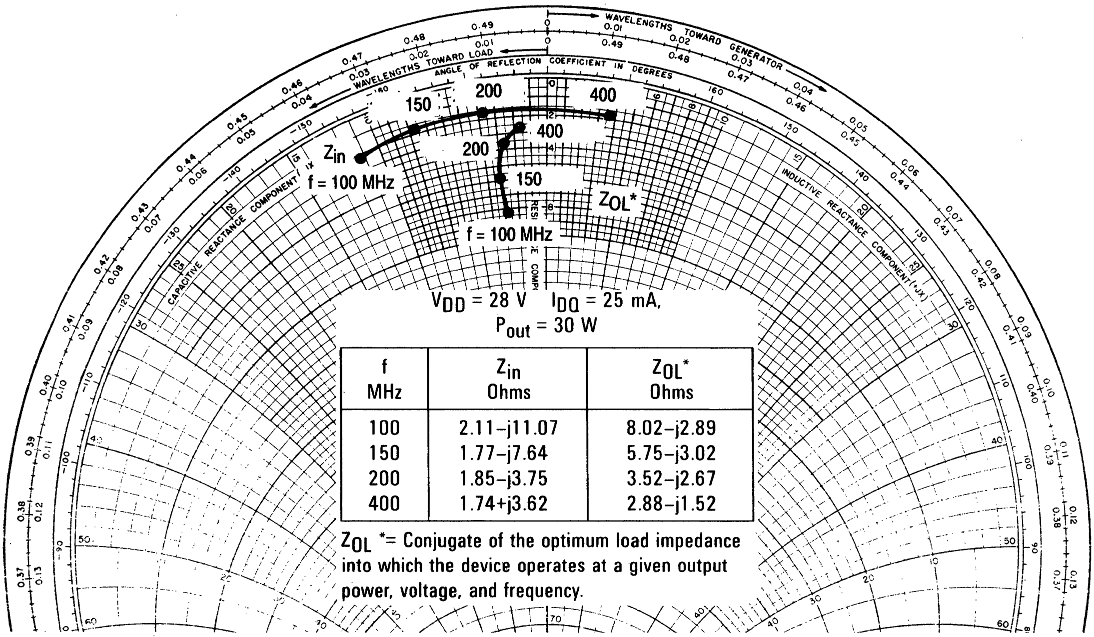
Figure 13. DC Safe Operating Area

2



C1, C2, C3, C4 — 0–20 pF Johanson, or equivalent
C5, C8 — 270 pF, 100 Mil Chip
C6, C7 — 24 pF Mini-Unelco, or equivalent
C9 — 0.01 µF, 100 V, Disc Ceramic
C10 — 100 µF, 40 V
C11 — 0.1 µF, 50 V, Disc Ceramic
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
R1, R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, 1/2 W
Z1 — 2.9″ x 0.166″ Microstrip
Z2, Z4 — 0.35″ x 0.166″ Microstrip
Z3 — 0.40″ x 0.166″ Microstrip
Z5 — 1.05″ x 0.166″ Microstrip
Z6 — 1.9″ x 0.166″ Microstrip
RFC1 — 6 Turns, 0.300″ ID, #20 AWG Enamel, Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
Board — Glass Teflon, 62 Mils

Figure 14. 400 MHz Test Circuit



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	2.11–j11.07	8.02–j2.89
150	1.77–j7.64	5.75–j3.02
200	1.85–j3.75	3.52–j2.67
400	1.74+j3.62	2.88–j1.52

Z_{OL} *= Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 15. Large-Signal Series Equivalent Input and Output Impedance, Z_{in}, Z_{OL}*

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2.0	0.977	−32	59.48	163	0.011	67	0.661	−36
5.0	0.919	−70	48.67	142	0.024	44	0.692	−78
10	0.852	−109	33.50	122	0.032	29	0.747	−117
20	0.817	−140	19.05	106	0.037	16	0.768	−146
30	0.814	−153	13.11	99	0.038	14	0.774	−157
40	0.811	−159	9.88	95	0.038	13	0.782	−162
50	0.812	−164	7.98	92	0.038	12	0.787	−165
60	0.813	−166	6.66	89	0.038	12	0.787	−168
70	0.815	−168	5.708	86	0.038	11	0.787	−169
80	0.816	−170	5.003	84	0.038	11	0.787	−170
90	0.817	−171	4.560	83	0.038	12	0.787	−171
100	0.817	−172	4.170	81	0.039	13	0.787	−172
110	0.818	−173	3.670	80	0.039	13	0.788	−172
120	0.820	−173	3.420	79	0.039	13	0.788	−173
130	0.821	−173	3.170	79	0.039	13	0.788	−173
140	0.822	−174	2.980	78	0.039	13	0.788	−173
150	0.823	−175	2.826	77	0.039	14	0.788	−173
160	0.824	−175	2.650	76	0.039	14	0.790	−174
170	0.825	−176	2.438	75	0.039	14	0.792	−174
180	0.827	−176	2.325	73	0.039	15	0.793	−174
190	0.829	−177	2.175	72	0.039	16	0.796	−174
200	0.831	−177	2.084	71	0.039	16	0.799	−174
225	0.836	−178	1.824	69	0.039	18	0.805	−174
250	0.846	−178	1.621	66	0.039	21	0.816	−174
275	0.853	−179	1.462	64	0.039	23	0.822	−174
300	0.853	−179	1.319	61	0.040	25	0.833	−174
325	0.856	−179	1.194	59	0.040	27	0.828	−174
350	0.857	+179	1.089	56	0.040	30	0.842	−174
375	0.861	+179	1.014	54	0.042	32	0.849	−174
400	0.865	+178	0.927	51	0.043	35	0.856	−174
425	0.875	+178	0.876	49	0.045	37	0.866	−174
450	0.881	+178	0.810	46	0.046	40	0.870	−174
475	0.886	+177	0.755	44	0.046	43	0.875	−174
500	0.887	+177	0.694	41	0.051	43	0.888	−174
525	0.888	+176	0.677	39	0.052	43	0.890	−174
550	0.896	+176	0.625	36	0.055	45	0.898	−174
575	0.907	+175	0.603	34	0.058	45	0.913	−174
600	0.910	+175	0.585	32	0.061	45	0.918	−174
625	0.910	+174	0.563	30	0.065	45	0.945	−174
650	0.920	+174	0.543	28	0.069	46	0.952	−174
675	0.938	+173	0.533	26	0.074	47	0.974	−174
700	0.943	+171	0.515	24	0.078	47	0.958	−176
725	0.934	+170	0.491	22	0.079	46	0.953	−177
750	0.940	+170	0.475	22	0.084	48	0.943	−177
775	0.953	+169	0.477	21	0.090	48	0.957	−177
800	0.959	+168	0.467	17	0.093	48	0.957	−179

Table 1. Common Source Scattering Parameters
50 Ω System
V_{DS} = 28 V, I_D = 0.75 A

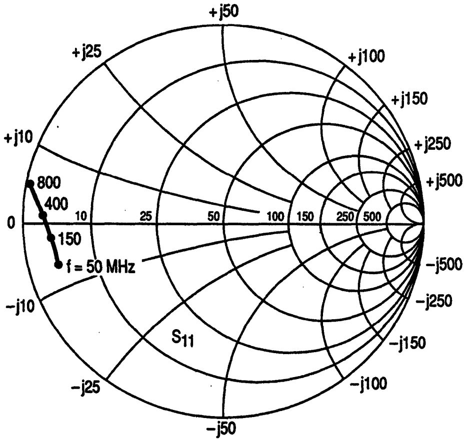


Figure 16. S_{11}, Input Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.75 A

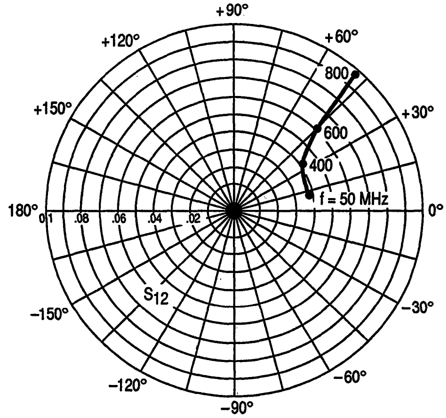


Figure 17. S_{12}, Reverse Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.75 A

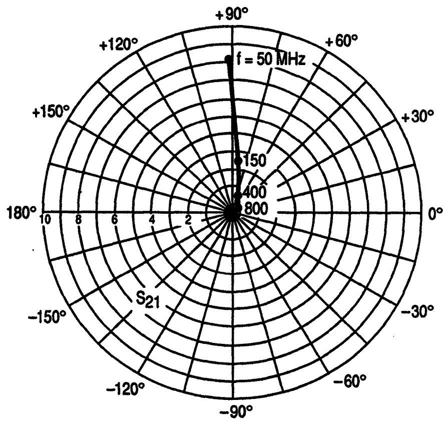


Figure 18. S_{21}, Forward Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.75 A

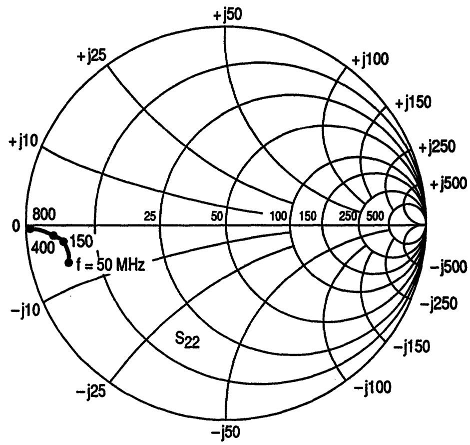


Figure 19. S_{22}, Output Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.75 A

DESIGN CONSIDERATIONS

The MRF137 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF137 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 10 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF137 was characterized at I_{DQ} = 25 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF137 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 9.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF137. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF137, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF137 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

2

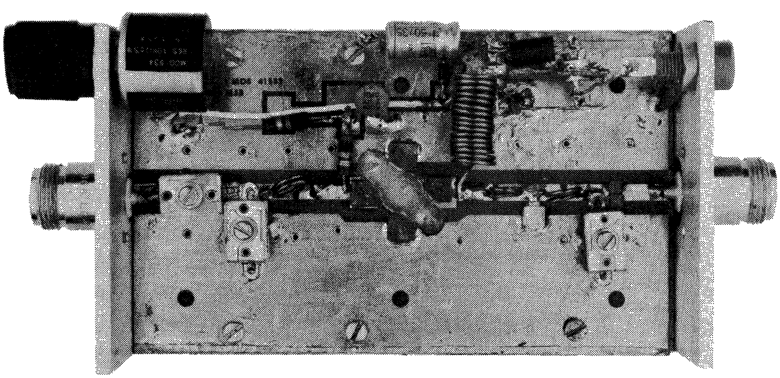


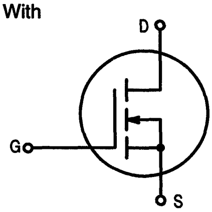
Figure 20. 150 MHz Test Circuit

MRF138

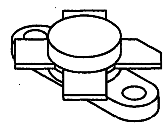
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 175 MHz.

- Superior High Order IMD
- Specified 28 Volts, 30 MHz Characteristics
  Output Power = 30 Watts
  Power Gain = 17 dB (Typ)
  Efficiency = 40% (Typ)
- $IMD_{(d3)}$ (30 W PEP) — −30 dB (Typ)
- $IMD_{(d11)}$ (30 W PEP) — −60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



30 W, 175 MHz
N-CHANNEL MOS
LINEAR RF POWER



CASE 211-07, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	6.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 2.5 A)	$V_{DS(on)}$	—	—	2.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	0.8	1.2	—	mhos

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

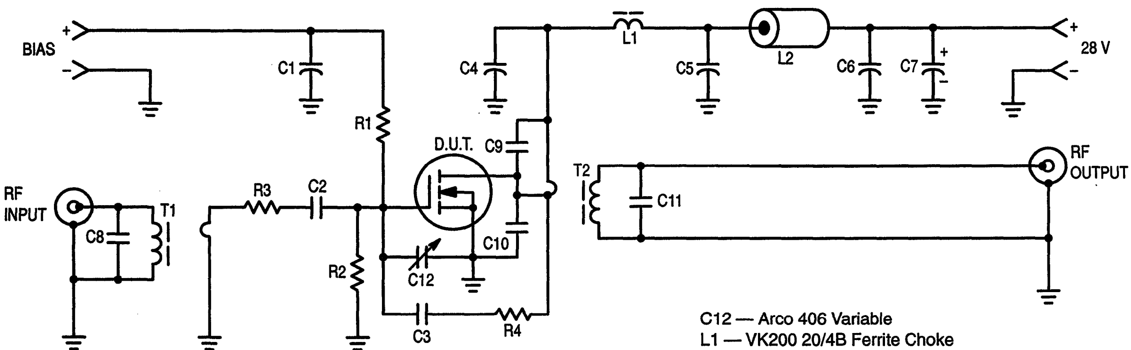
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	55	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	14	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (V_{DD} = 28 V, P_{out} = 30 W (PEP), I_{DQ} = 100 mA) (30 MHz) (Figure 1) / (150 MHz) (Figure 6)	G_{ps}	— —	17 14	— —	dB
Drain Efficiency (Figure 1) (V_{DD} = 28 V, f = 30 MHz, I_{DQ} = 100 mA) (30 W PEP) / (30 W CW)	η	— —	40 50	— —	%
Intermodulation Distortion (Figure 1) (V_{DD} = 28 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	−30 −60	— —	dB
Load Mismatch (Figure 1) (V_{DD} = 28 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 28 V, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 1.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	20 −50 −70	— — —	dB

NOTE:
1. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

2



C12 — Arco 406 Variable
L1 — VK200 20/4B Ferrite Choke or Equivalent (3.0 μH)
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 200 Ω, 1/2 W Carbon
R3 — 2.2 Ω, 1/2 W Carbon
R4 — 330 Ω, 1.0 W Carbon
T1 — 4:1 Impedance Transformer
T2 — 1:4 Impedance Transformer

C1, C2, C3, C4, C5, C6 — 0.1 μF Ceramic Chip or Equivalent
C7 — 10 μF, 100 V Electrolytic
C8 — 10 pF Dipped Mica
C9 — 68 pF Dipped Mica
C10, C11 — 47 pF Dipped Mica

Figure 1. 2.0 to 50 MHz Broadband Test Circuit

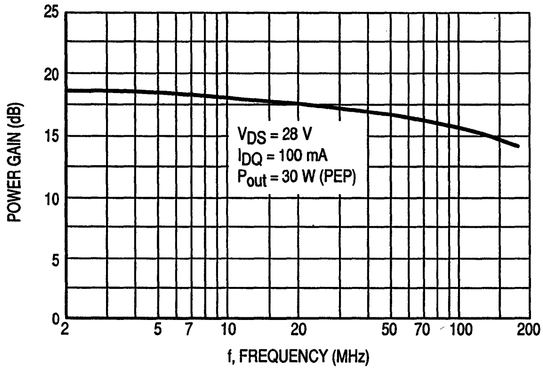


Figure 2. Power Gain versus Frequency

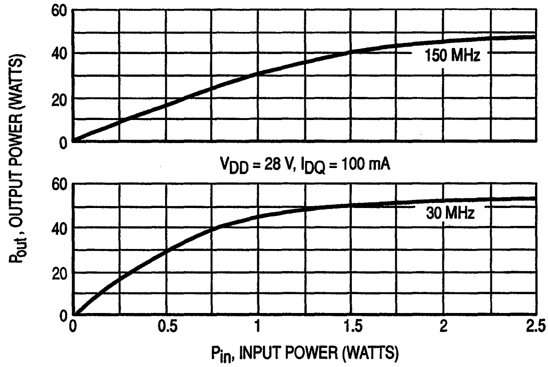


Figure 3. Output Power versus Input Power

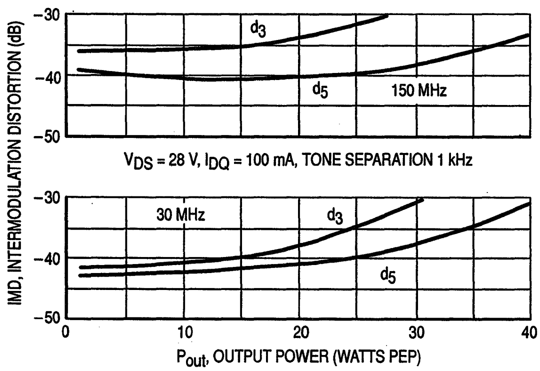


Figure 4. IMD versus P_{out}

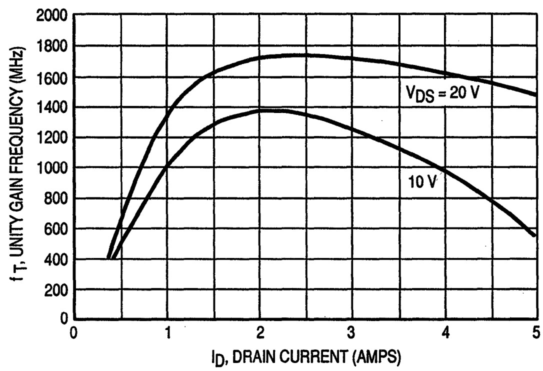
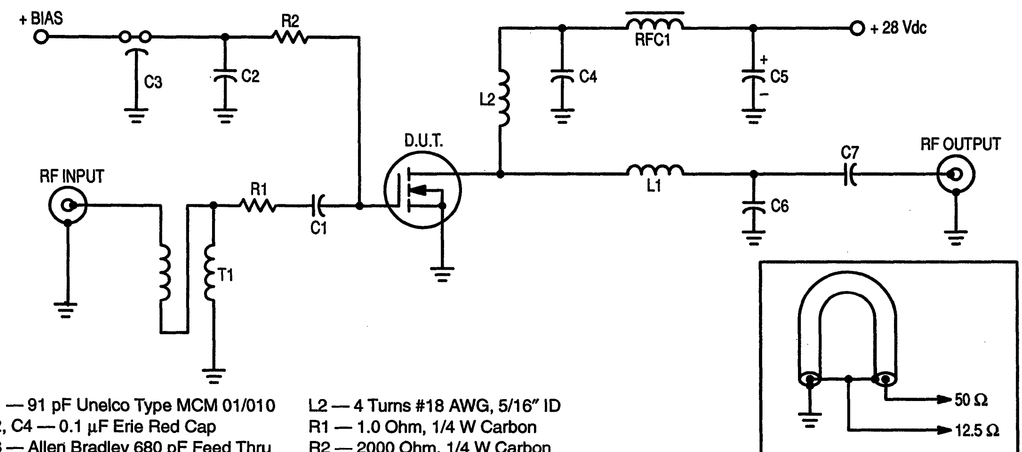


Figure 5. Common Source Unity Current Gain Frequency versus Drain Current

2



T1 — 4:1 Impedance Ratio Transformer, Line Impedance = 25 Ω

C1 — 91 pF Unelco Type MCM 01/010
C2, C4 — 0.1 µF Erie Red Cap
C3 — Allen Bradley 680 pF Feed Thru
C5 — 1.0 µF, 50 Vdc Electrolytic
C6 — Arco 402 Variable
C7 — Arco 404 Variable
L1 — 2 Turns #18 AWG, 5/16″ ID
L2 — 4 Turns #18 AWG, 5/16″ ID
R1 — 1.0 Ohm, 1/4 W Carbon
R2 — 2000 Ohm, 1/4 W Carbon
RFC1 — VK200 21/4B
T1 — 4:1 Transformer, 1.75″ Subminiature Coaxial Cable

Figure 6. 150 MHz Test Circuit

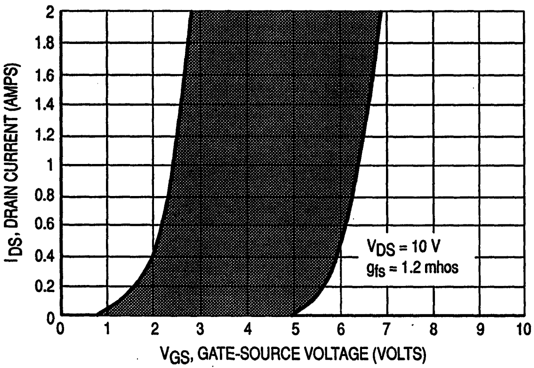


Figure 7. Gate Voltage versus Drain Current

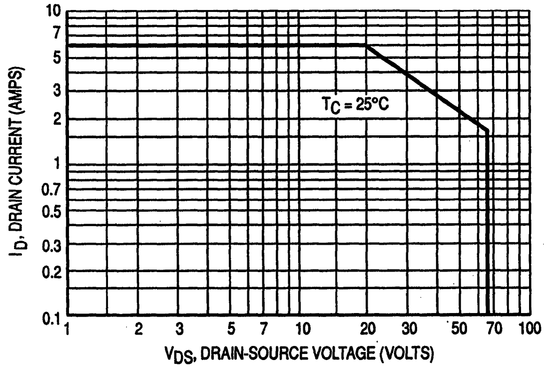
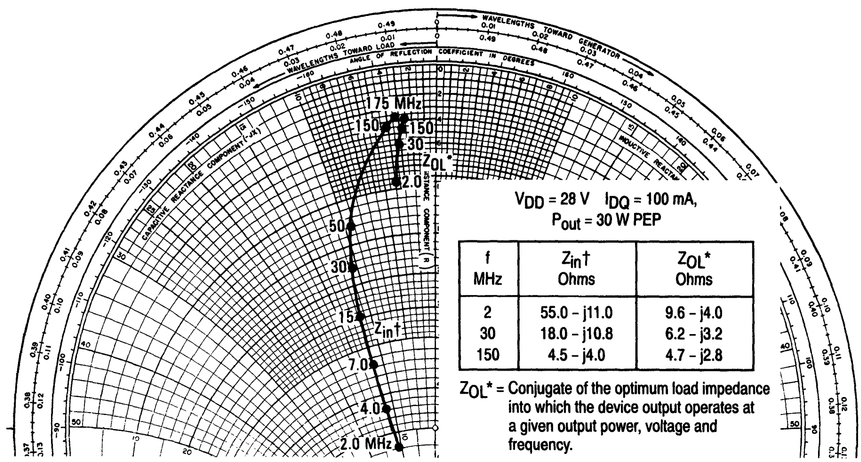


Figure 8. DC Safe Operating Area



V_{DD} = 28 V I_{DQ} = 100 mA,
P_{out} = 30 W PEP

f MHz	Z_{in}† Ohms	Z_{OL}* Ohms
2	55.0 - j11.0	9.6 - j4.0
30	18.0 - j10.8	6.2 - j3.2
150	4.5 - j4.0	4.7 - j2.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

†Gate Shunted By 100 Ω

Figure 9. Large-Signal Series Equivalent Input/Output Impedance, Z_{in}†, Z_{OL}*

2

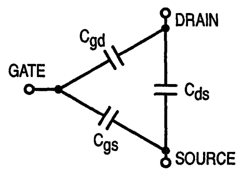
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

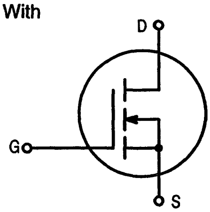
Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF140

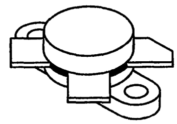
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode

. . . designed primarily for linear large-signal output stages up to 150 MHz frequency range.

- Specified 28 Volts, 30 MHz Characteristics
  Output Power = 150 Watts
  Power Gain = 15 dB (Typ)
  Efficiency = 40% (Typ)
- Superior High Order IMD
- $IMD_{(d3)}$ (150 W PEP) — −30 dB (Typ)
- $IMD_{(d11)}$ (150 W PEP) — −60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



**150 W, to 150 MHz
N-CHANNEL MOS
LINEAR RF POWER
FET**



CASE 211-11, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.7	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

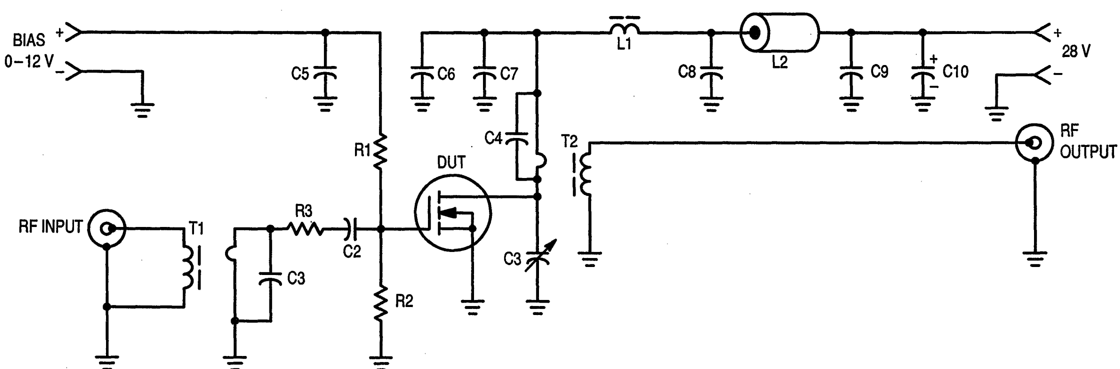
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 Vdc, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 Adc)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	4.0	—	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	450	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	450	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	100	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (30 MHz) (V_{DD} = 28 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA) (150 MHz)	G_{ps}	— —	15 6.0	— —	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_D (Max) = 6.5 A)	η	—	40	—	%
Intermodulation Distortion (1) (V_{DD} = 28 V, P_{out} = 150 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	−30 −60	— —	dB
Load Mismatch (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTE:
1. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1 — 820 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolythic with Short Leads
C3 — Arco 469
C4 — 560 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 μF/100 V Electrolytic
L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 51 Ω/1.0 W Carbon
R3 — 1.0 Ω/1.0 W Carbon
T1 — 16:1 Broadband Transformer
T2 — 1:25 Broadband Transformer

Figure 1. 300 MHz Test Circuit (Class AB)

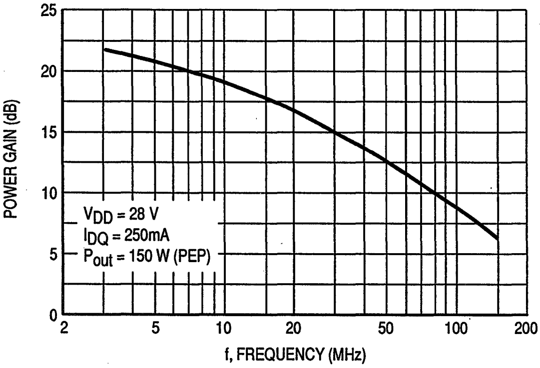


Figure 2. Power Gain versus Frequency

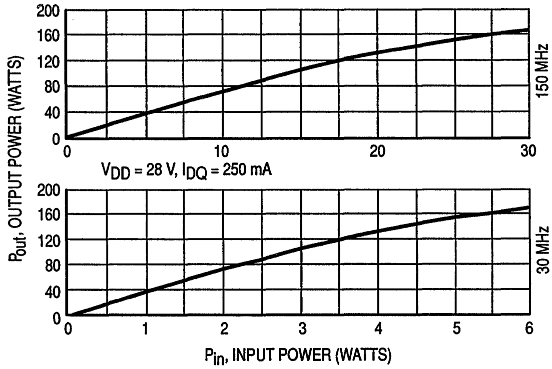


Figure 3. Output Power versus Input Power

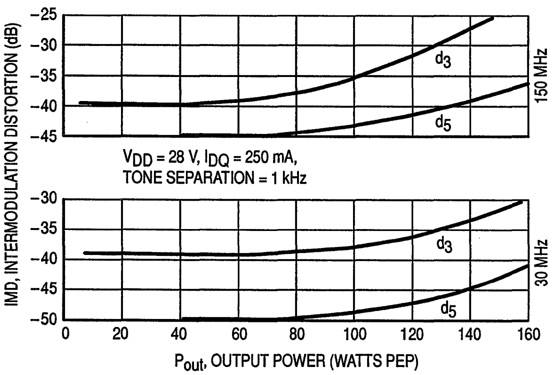


Figure 4. IMD versus P_{out}

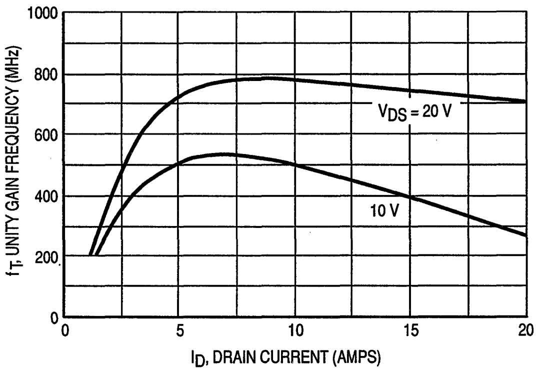


Figure 5. Common Source Unity Gain Frequency versus Drain Current

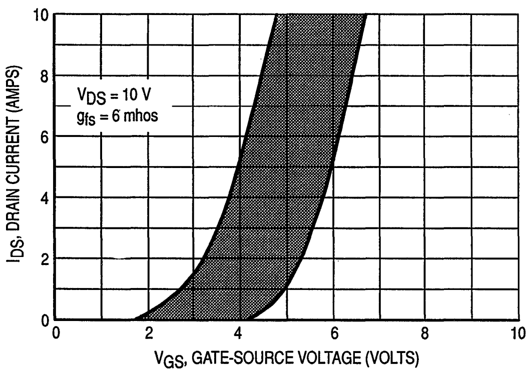
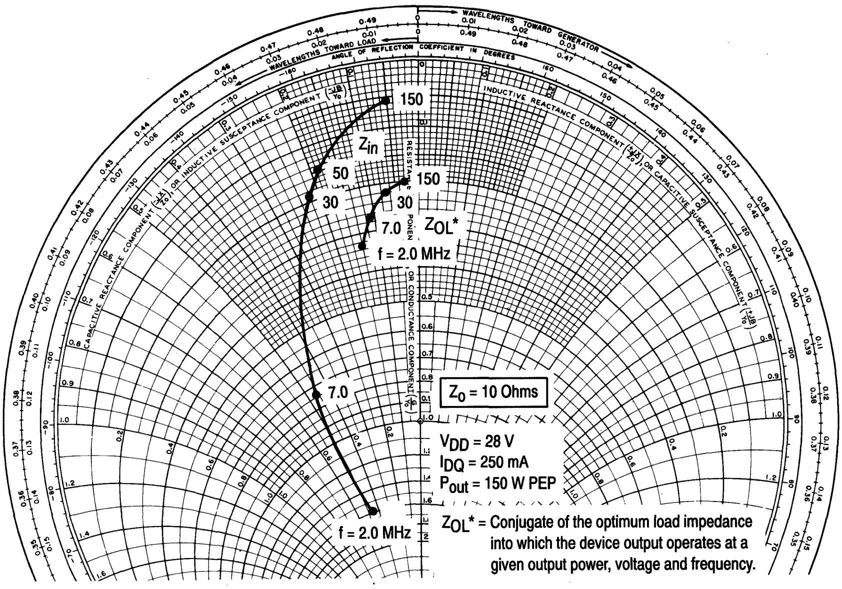


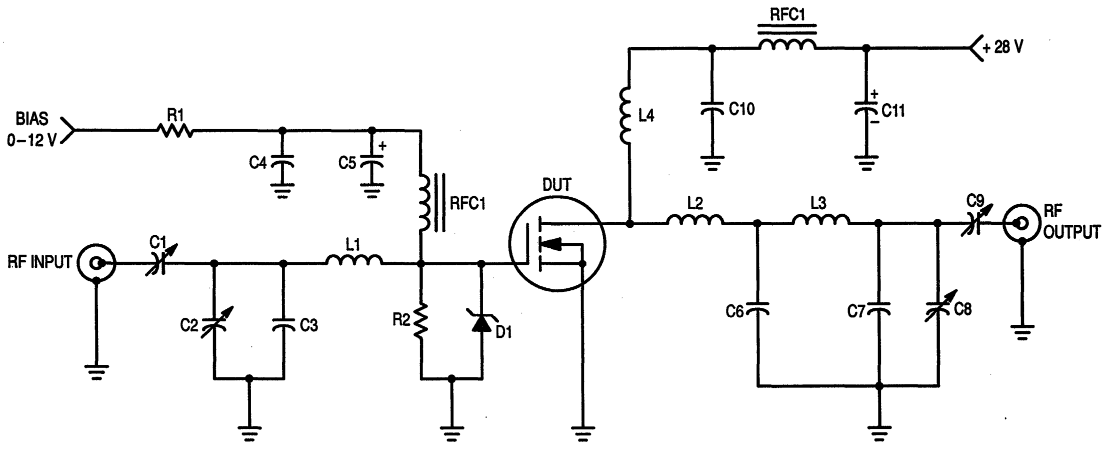
Figure 6. Gate Voltage versus Drain Current

2



NOTE: Gate Shunted by 25 Ohms.

Figure 7. Series Equivalent Impedance



C1, C2, C8 — Arco 463 or equivalent
C3 — 25 pF Unelco
C4 — 0.1 µF Ceramic
C5 — 1.0 µF, 15 WV Tantalum
C6 — 150 pF Unelco J101
C7 — 25 µF Unelco J101
C9 — Arco 262 or equivalent
C10 — 0.05 µF Ceramic
C11 — 15 µF, 35 WV Electrolytic

L1 — 3/4″ #18 AWG into Hairpin
L2 — Printed Line, 0.200″ x 0.500″
L3 — 7/8″ #16 AWG into Hairpin
L4 — 2 Turns #16 AWG, 5/16 ID
RFC1 — 5.6 µH Molded Choke
RFC2 — VK200-4B
R1, R2 — 150 Ω, 1.0 W Carbon

Figure 8. 150 MHz Test Circuit (Class AB)

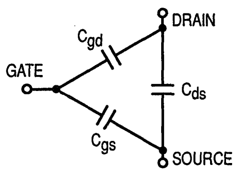
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

2

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

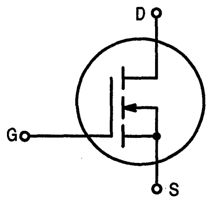
Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF141

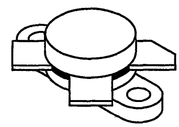
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode MOSFET

. . . designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 30 MHz, 28 V:
  Output Power — 150 W
  Gain — 18 dB (22 dB Typ)
  Efficiency — 40%
- Typical Performance at 175 MHz, 50 V:
  Output Power — 150 W
  Gain — 13 dB
- Low Thermal Resistance
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability



**150 W, 28 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**



CASE 211-11, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

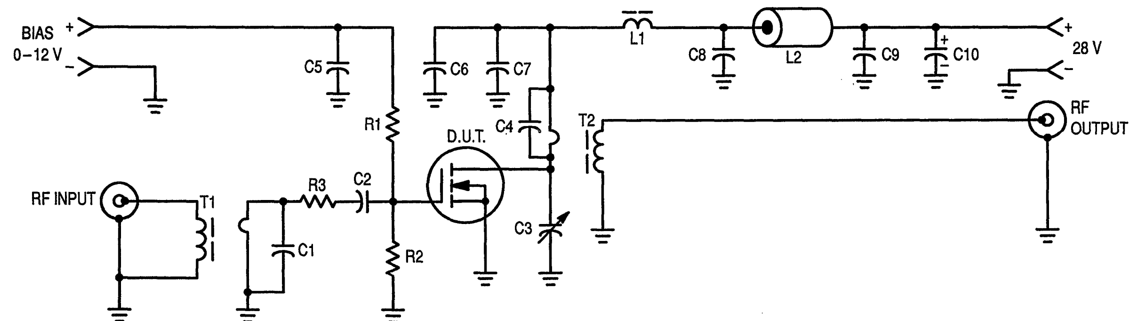
NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS (1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	5.0	7.0	—	mhos
DYNAMIC CHARACTERISTICS (1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	420	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain, f = 30; 30.001 MHz (V_{DD} = 28 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA) f = 175 MHz	G_{ps}	16 —	20 10	— —	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, I_D (Max) = 5.95 A)	η	40	45	—	%
Intermodulation Distortion (1) (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	−30 −60	−28 —	dB
Load Mismatch (V_{DD} = 28 V, P_{out} = 150 W (PEP), f1 = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 28 V, P_{out} = 50 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 4.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	23 −50 −75	— — —	dB

NOTE:
1. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

2



C1 — 820 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolythic with Short Leads
C3 — Arco 469
C4 — 560 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 μF/100 V Electrolytic
L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 51 Ω/1.0 W Carbon
R3 — 1.0 Ω/1.0 W Carbon
T1 — 16:1 Broadband Transformer
T2 — 1:25 Broadband Transformer
Board Material — 0.062″ Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ε_r = 5

Figure 1. 30 MHz Test Circuit

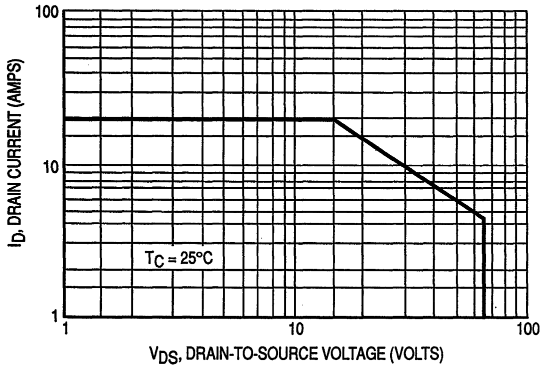


Figure 2. DC Safe Operating Area

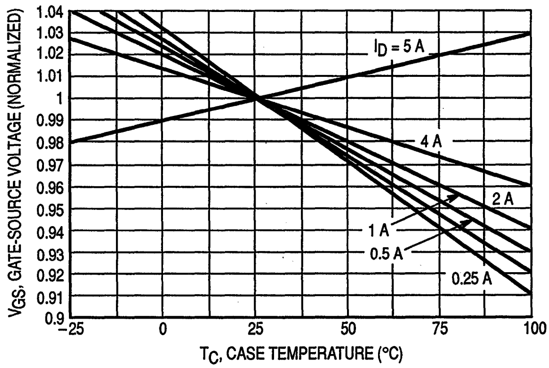


Figure 3. Gate-Source Voltage versus Case Temperature

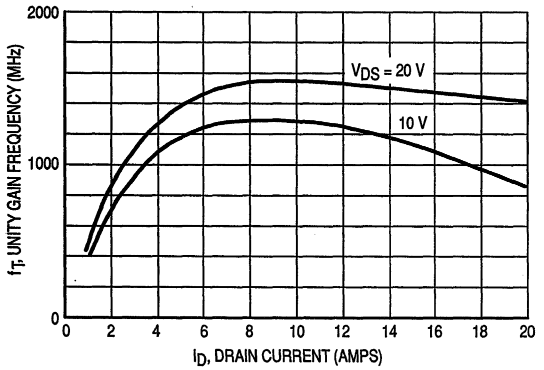


Figure 4. Common Source Unity Gain Frequency versus Drain Current

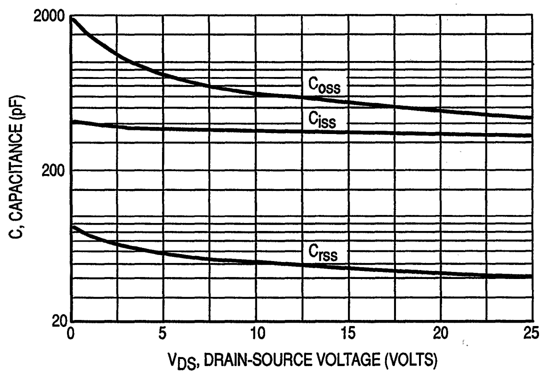


Figure 5. Capacitance versus Drain-Source Voltage

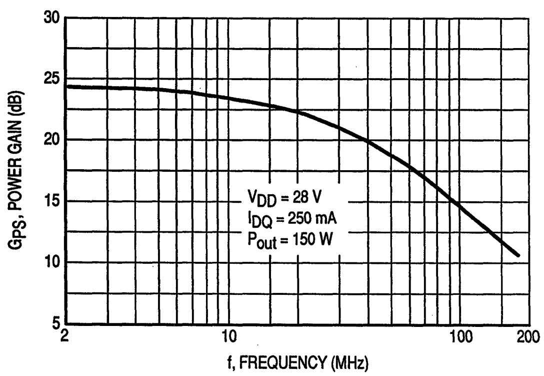


Figure 6. Power Gain versus Frequency

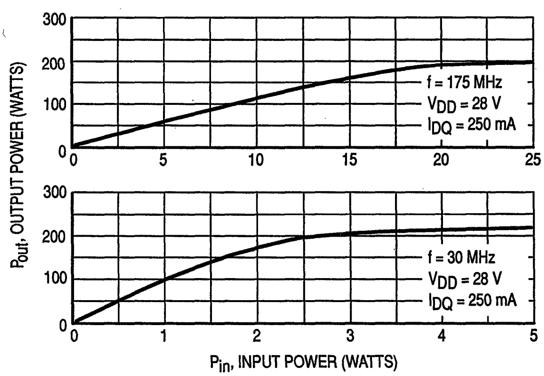


Figure 7. Output Power versus Input Power

TYPICAL CHARACTERISTICS

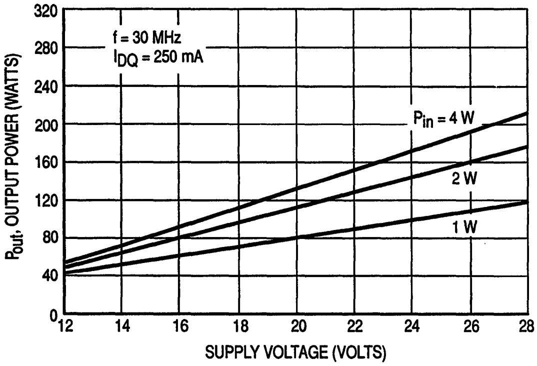


Figure 8. Output Power versus Supply Voltage

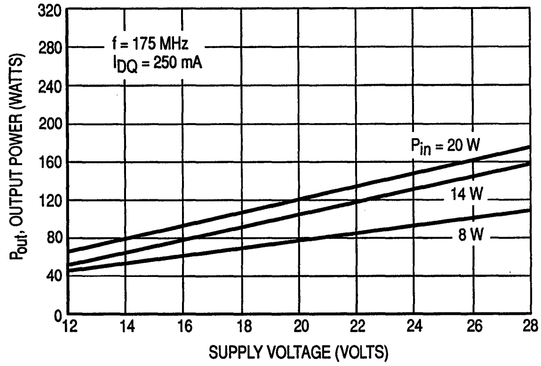


Figure 9. Output Power versus Supply Voltage

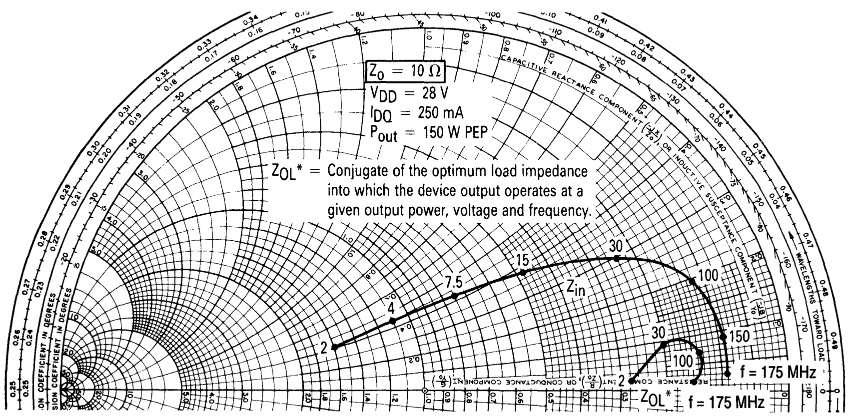


Figure 10. Input and Output Impedances

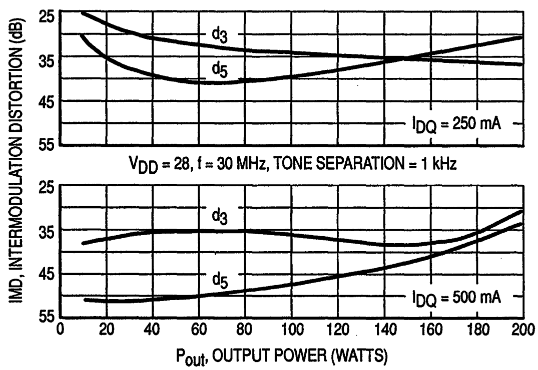


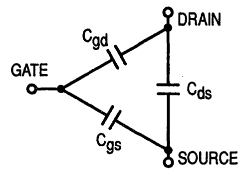
Figure 11. IMD versus P_{out} (PEP)

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} = C_{gs}$$
$$C_{oss} = C_{gd} = C_{ds}$$
$$C_{rss} = C_{gd}$$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 4 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gate of this device is essentially capacitor. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF141 is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF141 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF141 was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

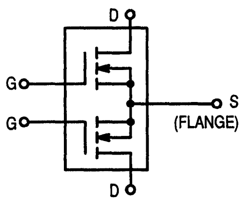
Power output of the MRF141 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

MRF141G

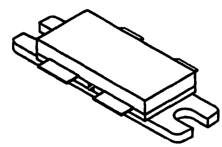
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode MOSFET

. . . designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 175 MHz, 28 V:
  Output Power — 300 W
  Gain — 12 dB (14 dB Typ)
  Efficiency — 50%
- Low Thermal Resistance — 0.35°C/W
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability



**300 W, 28 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**



CASE 375, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	32	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W

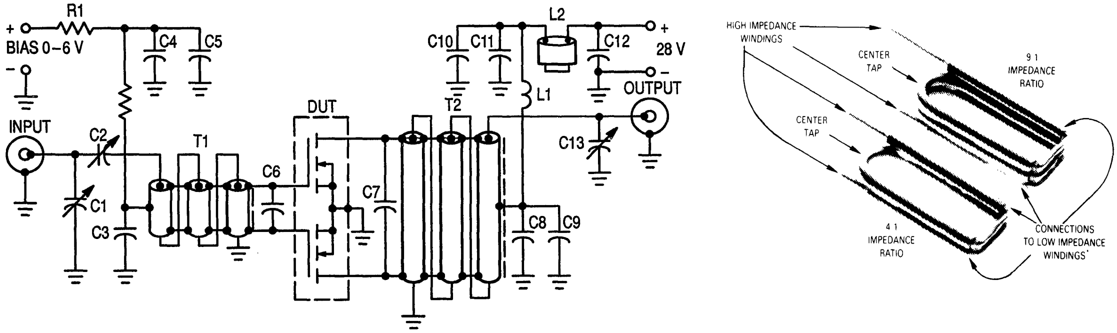
NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS (1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	5.0	7.0	—	mhos
DYNAMIC CHARACTERISTICS (1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	420	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL TESTS (2)					
Common Source Amplifier Power Gain (V_{DD} = 28 V, P_{out} = 300 W, I_{DQ} = 500 mA, f = 175 MHz)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 300 W, f = 175 MHz, I_D (Max) = 21.4 A)	η	45	55	—	%
Load Mismatch (V_{DD} = 28 V, P_{out} = 300 W, I_{DQ} = 500 mA, f = 175 MHz, VSWR 5:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each side measured separately.
2. Measured in push-pull configuration.

2



C1 — Arco 402, 1.5–20 pF
C2 — Arco 406, 15–115 pF
C3, C4, C8, C9, C10 — 1000 pF Chip
C5, C11 — 0.1 µF Chip
C6 — 330 pF Chip
C7 — 200 pF and 180 pF Chips in Parallel
C12 — 0.47 µF Ceramic Chip, Kemet 1215 or Equivalent
C13 — Arco 403, 3.0–35 pF
L1 — 10 Turns AWG #16 Enameled Wire, Close Wound, 1/4″ I.D.
L2 — Ferrite Beads of Suitable Material for 1.5–2.0 µH Total Inductance
R1 — 100 Ohms, 1/2 W
R2 — 1.0 kOhm, 1/2 W

T1 — 9:1 RF Transformer. Can be made of 15–18 Ohms Semirigid Co-Ax, 62–90 Mils O.D.
T2 — 1:9 RF Transformer. Can be made of 15–18 Ohms Semirigid Co-Ax, 70–90 Mils O.D.

Board Material — 0.062″ Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, $\varepsilon_r = 5$

NOTE: For stability, the input transformer T1 must be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

See pictures for construction details.

Unless Otherwise Noted, All Chip Capacitors are ATC Type 100 or Equivalent.

Figure 1. 175 MHz Test Circuit

TYPICAL CHARACTERISTICS

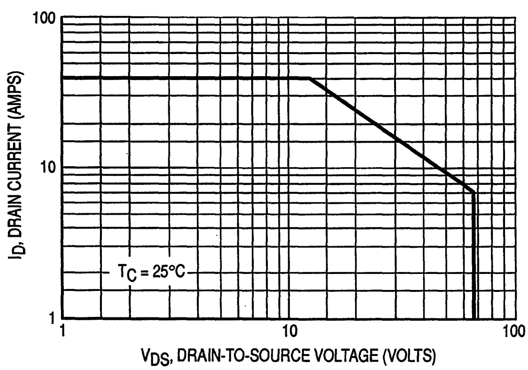


Figure 2. DC Safe Operating Area

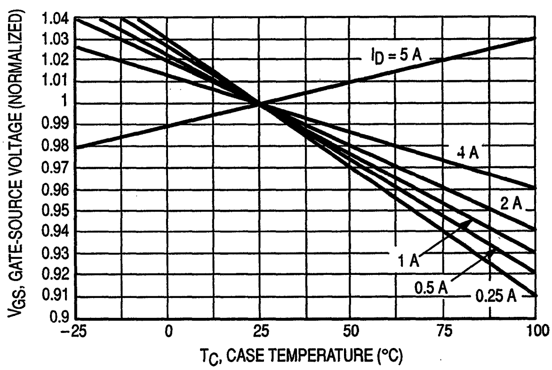
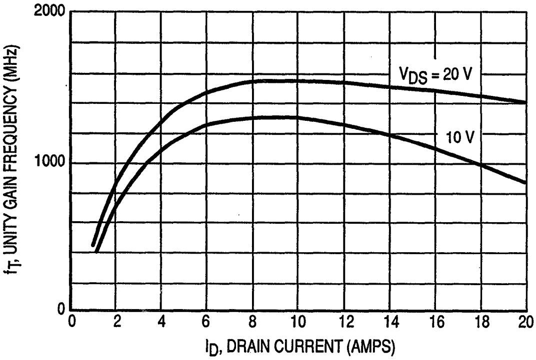
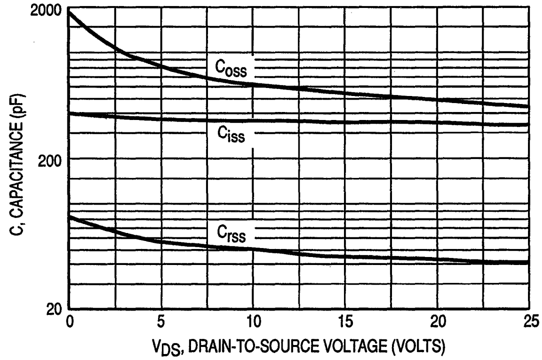


Figure 3. Gate-Source Voltage versus Case Temperature



NOTE: Data shown applies to each half of MRF141G.

Figure 4. Common Source Unity Gain Frequency versus Drain Current



NOTE: Data shown applies to each half of MRF141G.

Figure 5. Capacitance versus Drain-Source Voltage

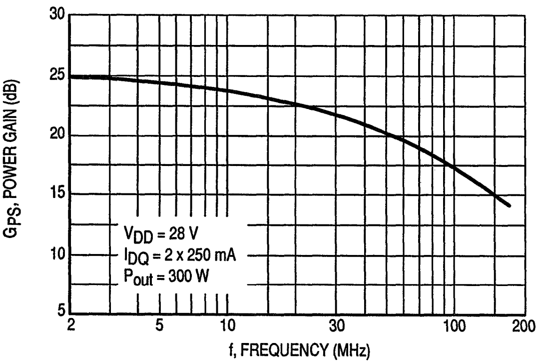


Figure 6. Power Gain versus Frequency

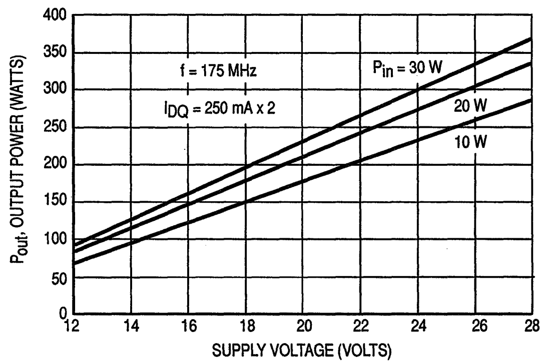
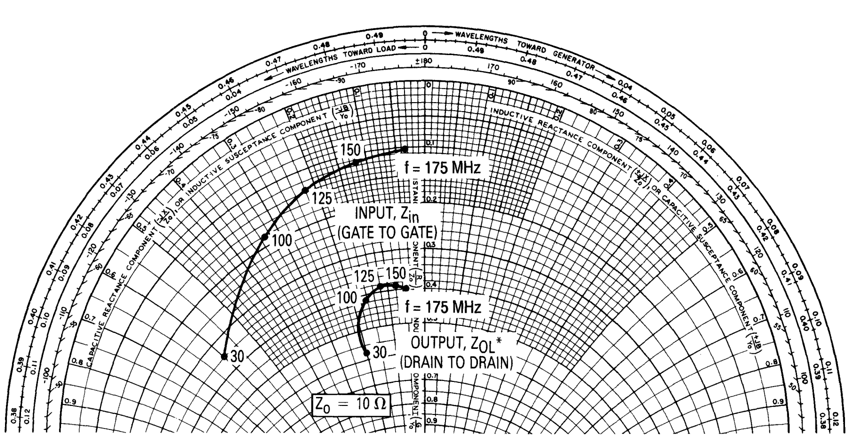


Figure 7. Output Power versus Supply Voltage



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 8. Input and Output Impedances

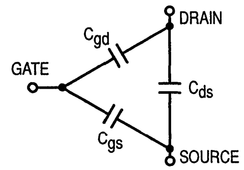
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} = C_{gs}$
$C_{oss} = C_{gd} = C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 4 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gate of this device is essentially capacitor. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF141G is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF141G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF141G was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

Power output of the MRF141G may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

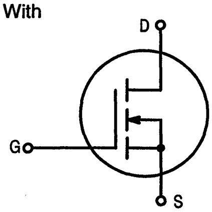
MRF148

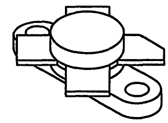
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 175 MHz.

- Superior High Order IMD
- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 30 Watts
  Power Gain = 18 dB (Typ)
  Efficiency = 40% (Typ)
- $IMD_{(d3)}$ (30 W PEP) — –35 dB (Typ)
- $IMD_{(d11)}$ (30 W PEP) — –60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR

30 W, to 175 MHz
N-CHANNEL MOS
LINEAR RF POWER
FET





CASE 211-07, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	120	Vdc
Drain-Gate Voltage	V_{DGO}	120	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	6.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

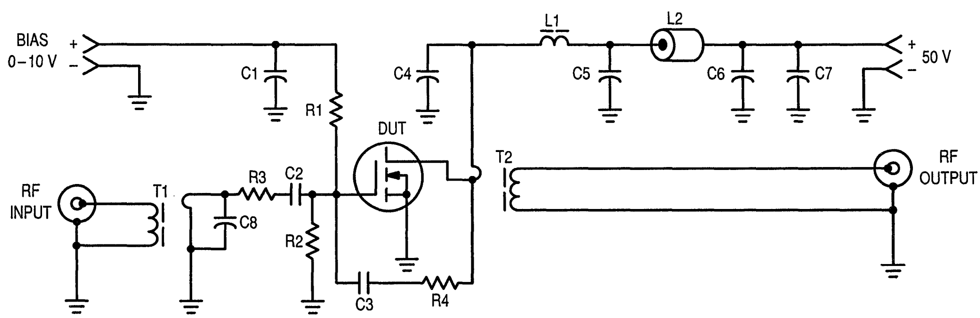
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 2.5 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	0.8	1.2	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	50	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	35	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	8.0	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 30 W (PEP), I_{DQ} = 100 mA) (30 MHz) (175 MHz)	G_{ps}	— —	18 15	— —	dB
Drain Efficiency (V_{DD} = 50 V, f = 30 MHz, I_{DQ} = 100 mA) (30 W PEP) (30 W CW)	η	— —	40 50	— —	%
Intermodulation Distortion (V_{DD} = 50 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	−35 −60	— —	dB
Load Mismatch (V_{DD} = 50 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 50 V, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 1.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	20 −50 −70	— — —	dB

NOTE:
1. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1, C2, C3, C4, C5, C6 — 0.1 μF Ceramic Chip or Equivalent
C7 — 10 μF, 100 V Electrolytic
C8 — 100 pF Dipped Mica
L1 — VK200 20/4B Ferrite Choke or Equivalent (3.0 μH)
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 200 Ω, 1/2 W Carbon
R3 — 4.7 Ω, 1/2 W Carbon
R4 — 470 Ω, 1.0 W Carbon
T1 — 4:1 Impedance Transformer
T2 — 1:2 Impedance Transformer

Figure 1. 2.0 to 50 MHz Broadband Test Circuit

2

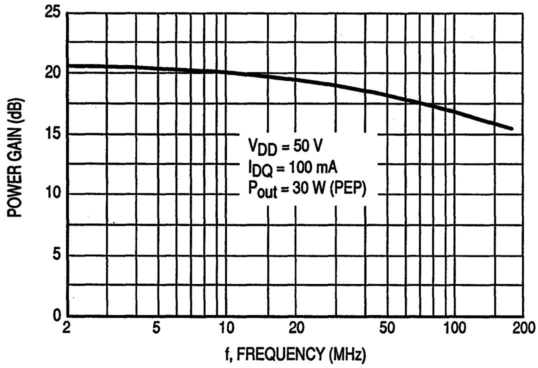


Figure 2. Power Gain versus Frequency

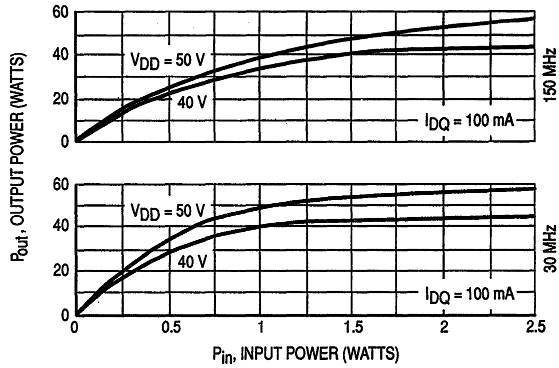


Figure 3. Output Power versus Input Power

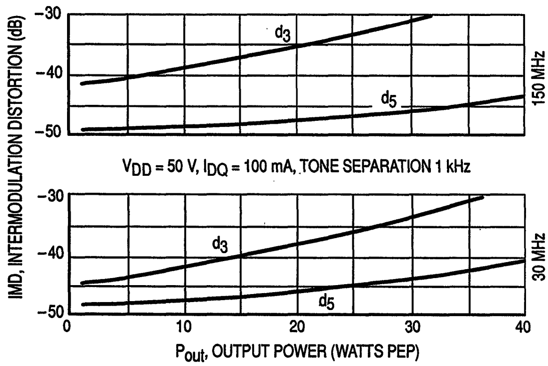


Figure 4. IMD versus P_{out}

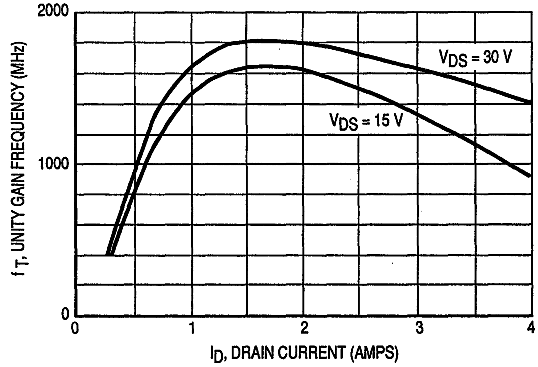
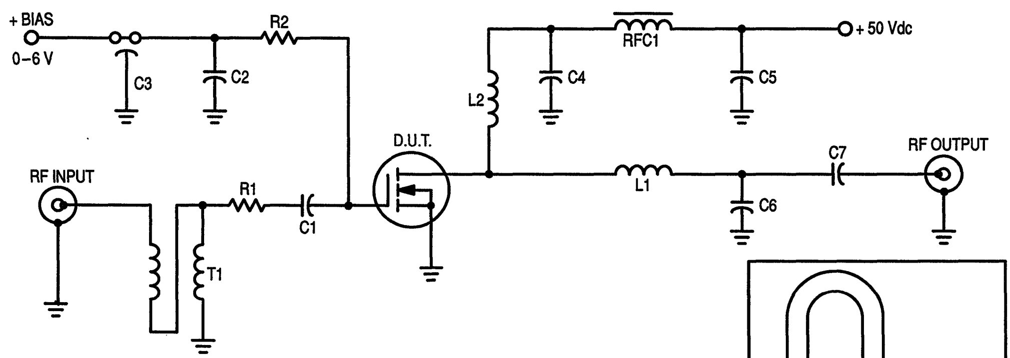
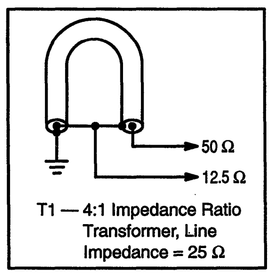


Figure 5. Common Source Unity Gain Frequency versus Drain Current





C1 — 91 pF Unelco Type MCM 01/010
C2, C4 — 0.1 µF Erie Red Cap
C3 — Allen Bradley 680 pF Feed Thru
C5 — 1.0 µF, 50 Vdc Electrolytic
C6 — 15 pF Unelco Type J101
C7 — 24 pF Unelco Type MCM 01/010
L1 — 2 Turns #18 AWG, 5/16″ ID
L2 — 4 Turns #18 AWG, 5/16″ ID
R1 — 1.0 Ohm, 1/4 W Carbon
R2 — 2000 Ohm, 1/4 W Carbon
RFC1 — VK200 21/4B
T1 — 4:1 Transformer, 1.75″ Subminiature Coaxial Cable

Figure 6. 150 MHz Test Circuit

2

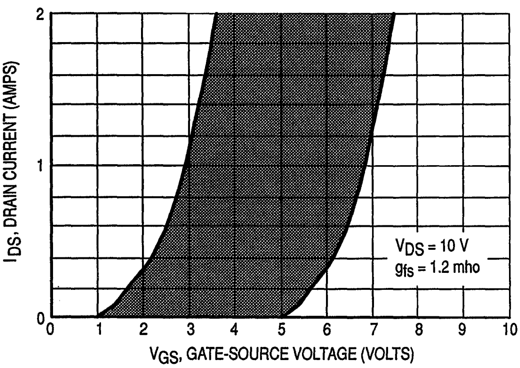


Figure 7. Gate Voltage versus Drain Current

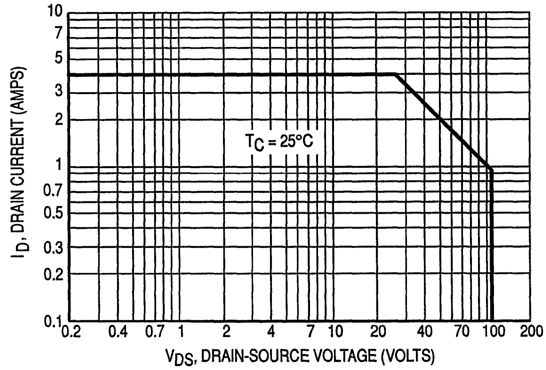
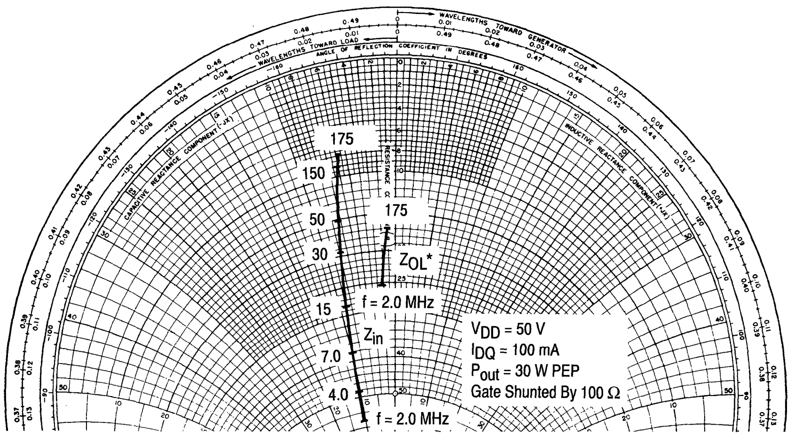


Figure 8. DC Safe Operating Area (SOA)



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 9. Impedance Coordinates — 50 Ohm Characteristic Impedance

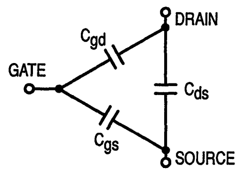
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

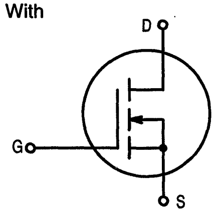
Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF150

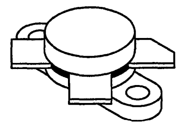
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode

. . . designed primarily for linear large-signal output stages up to 150 MHz frequency range.

- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 150 Watts
  Power Gain = 17 dB (Typ)
  Efficiency = 45% (Typ)
- Superior High Order IMD
- $IMD_{(d3)}$ (150 W PEP) — –32 dB (Typ)
- $IMD_{(d11)}$ (150 W PEP) — –60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



**150 W, to 150 MHz
N-CHANNEL MOS
LINEAR RF POWER
FET**



CASE 211-11, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

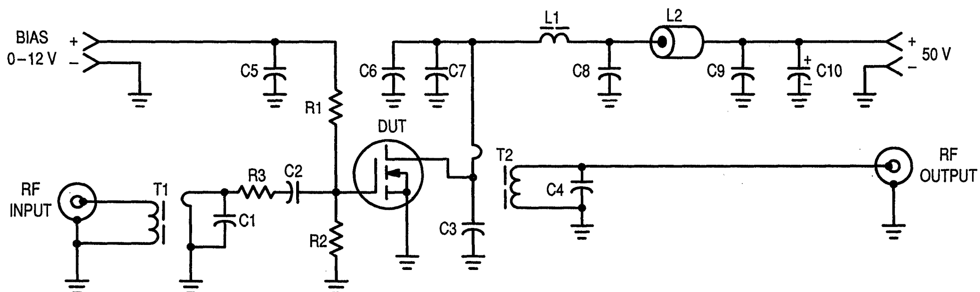
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	4.0	5.0	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	250	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	50	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA) f = 30 MHz f = 150 MHz	G_{ps}	— —	17 8.0	— —	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_D (Max) = 3.75 A)	η	—	45	—	%
Intermodulation Distortion (1) (V_{DD} = 50 V, P_{out} = 150 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	−32 −60	— —	dB
Load Mismatch (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 50 V, P_{out} = 50 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 3.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	20 −50 −75	— — —	dB

NOTE:
1. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1 — 470 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 µF Ceramic Chip or Monolythic with Short Leads
C3 — 200 pF Unencapsulated Mica or Dipped Mica with Short Leads
C4 — 15 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 µF/100 V Electrolytic
L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 µH
L2 — Ferrite Bead(s), 2.0 µH
R1, R2 — 51 Ω/1.0 W Carbon
R3 — 3.3 Ω/1.0 W Carbon (or 2.0 x 6.8 Ω/1/2 W in Parallel
T1 — 9:1 Broadband Transformer
T2 — 1:9 Broadband Transformer

Figure 1. 30 MHz Test Circuit (Class AB)

2

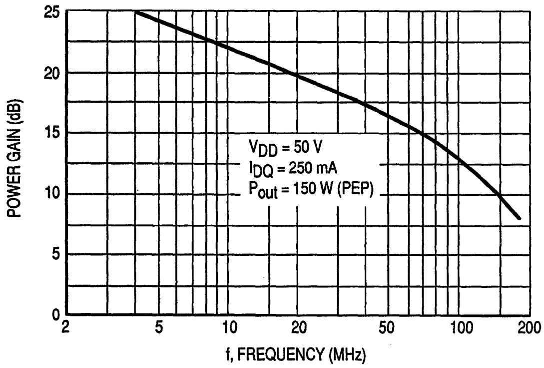


Figure 2. Power Gain versus Frequency

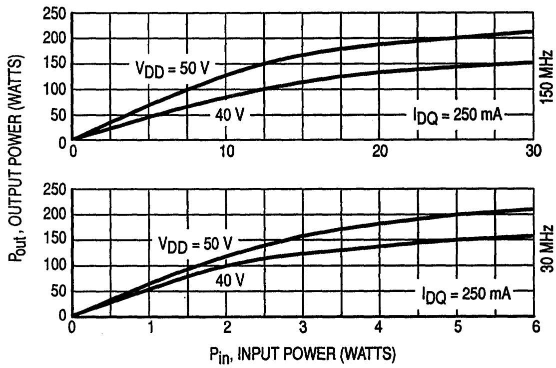


Figure 3. Output Power versus Input Power

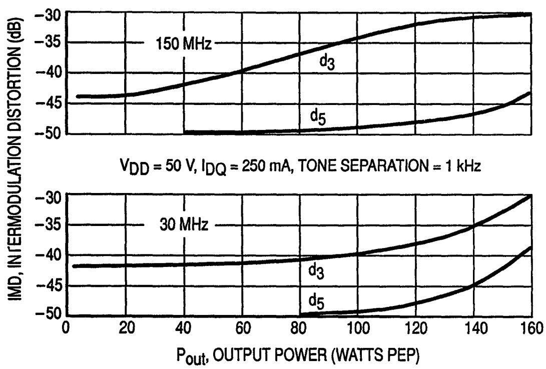


Figure 4. IMD versus P_{out}

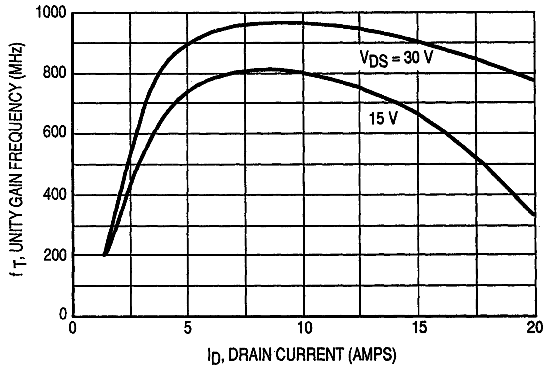


Figure 5. Common Source Unity Gain Frequency versus Drain Current

2

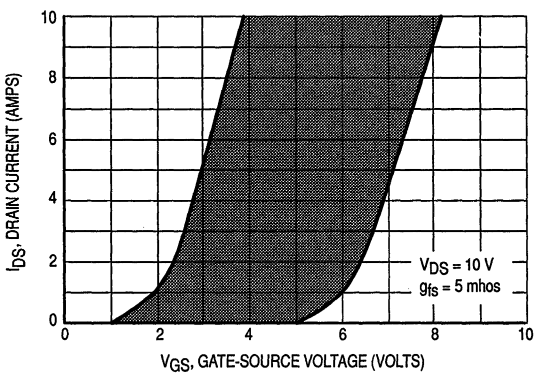
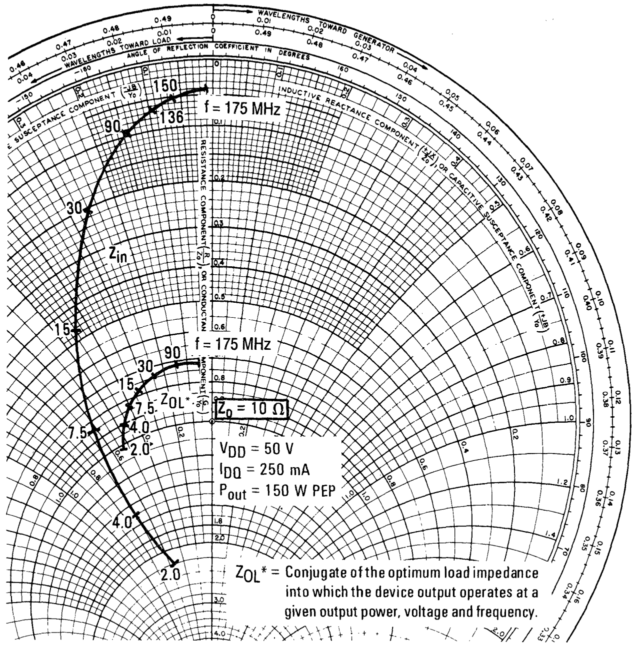
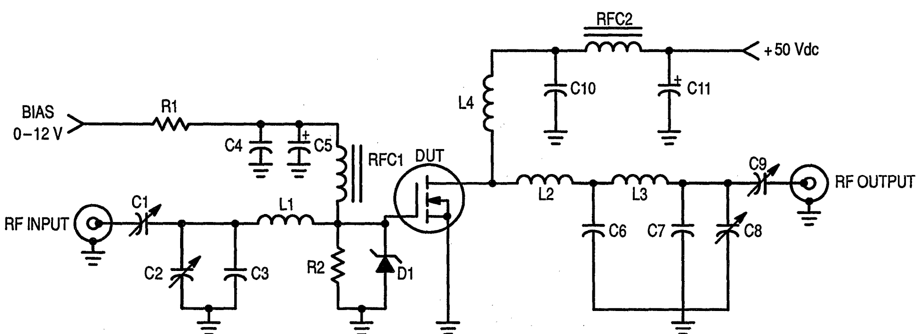


Figure 6. Gate Voltage versus Drain Current



NOTE: Gate Shunted By 25 Ohms.

Figure 7. Series Equivalent Impedance



C1, C2, C8 — Arco 463 or equivalent
C3 — 25 pF Unelco
C4 — 0.1 µF Ceramic
C5 — 1.0 µF, 15 WV Tantalum
C6 — 250 pF Unelco J101
C7 — 25 pF Unelco J101
C9 — Arco 262 or equivalent
C10 — 0.05 µF Ceramic
C11 — 15 µF, 60 WV Electrolytic

D1 — 1N5347 Zener Diode
L1 — 3/4″ #18 AWG into Hairpin
L2 — Printed Line, 0.200″ x 0.500″
L3 — 1″ #16 AWG into Hairpin
L4 — 2 Turns #16 AWG, 5/16 ID
RFC1 — 5.6 µH Choke
RFC2 — VK200-4B
R1, R2 — 150 Ω, 1.0 W Carbon

Figure 8. 150 MHz Test Circuit (Class AB)

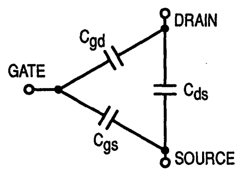
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

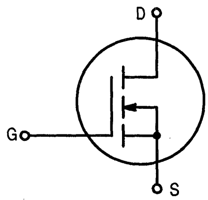
Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF151

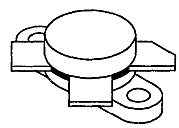
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode MOSFET

. . . designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 30 MHz, 50 V:
  Output Power — 150 W
  Gain — 18 dB (22 dB Typ)
  Efficiency — 40%
- Typical Performance at 175 MHz, 50 V:
  Output Power — 150 W
  Gain — 13 dB
- Low Thermal Resistance
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability



150 W, 50 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET



CASE 211-11, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

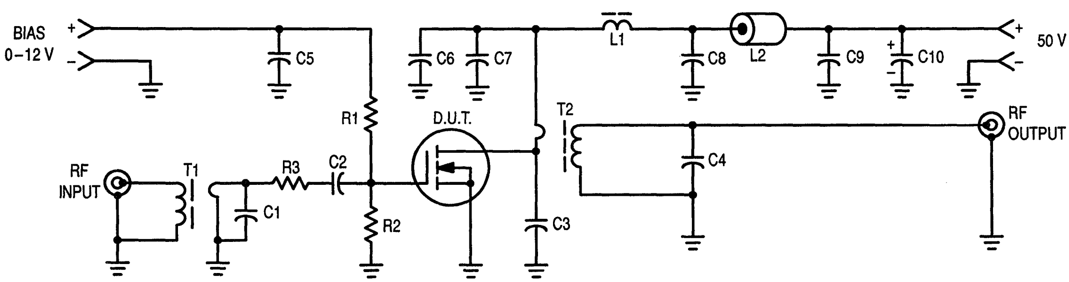
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	5.0	7.0	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	225	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain, f = 30; 30.001 MHz (V_{DD} = 50 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA) f = 175 MHz	G_{ps}	18 —	22 13	— —	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_D (Max) = 3.75 A)	η	40	45	—	%
Intermodulation Distortion (1) (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	−32 −60	−30 —	dB
Load Mismatch (V_{DD} = 50 V, P_{out} = 150 W (PEP), f1 = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 50 V, P_{out} = 50 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 3.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	23 −50 −75	— — —	dB

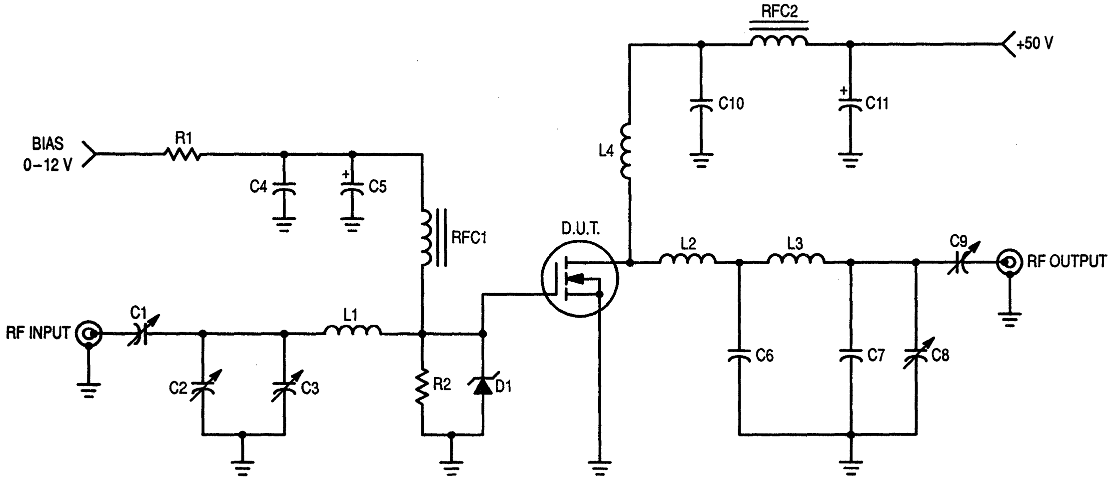
NOTE:
1. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1 — 470 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 µF Ceramic Chip or Monolythic with Short Leads
C3 — 200 pF Unencapsulated Mica or Dipped Mica with Short Leads
C4 — 15 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 µF/100 V Electrolytic
L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 µH
L2 — Ferrite Bead(s), 2.0 µH
R1, R2 — 51 Ω/1.0 W Carbon
R3 — 3.3 Ω/1.0 W Carbon (or 2.0 x 6.8 Ω/1/2 W in Parallel)
T1 — 9:1 Broadband Transformer
T2 — 1:9 Broadband Transformer
Board Material — 0.062″ Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ε_r = 5

Figure 1. 30 MHz Test Circuit

2



C1, C2, C8 — Arco 463 or equivalent	D1 — 1N5347 Zener Diode
C3 — 25 pF Unelco	L1 — 3/4″ #18 AWG into Hairpin
C4 — 0.1 µF Ceramic	L2 — Printed Line, 0.200″ x 0.500″
C5 — 1.0 µF, 15 WV Tantalum	L3 — 1″ #16 AWG into Hairpin
C6 — 250 pF Unelco J101	L4 — 2 Turns #16 AWG, 5/16 ID
C7 — 25 µF Unelco J101	RFC1 — 5.6 µH Choke
C9 — Arco 262 or equivalent	RFC2 — VK200-4B
C10 — 0.05 µF Ceramic	R1, R2 — 150 Ω, 1.0 W Carbon
C11 — 15 µF, 60 WV Electrolytic	Board Material — 0.062″ Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, $\epsilon_r = 5.0$

Figure 2. 175 MHz Test Circuit

2

TYPICAL CHARACTERISTICS

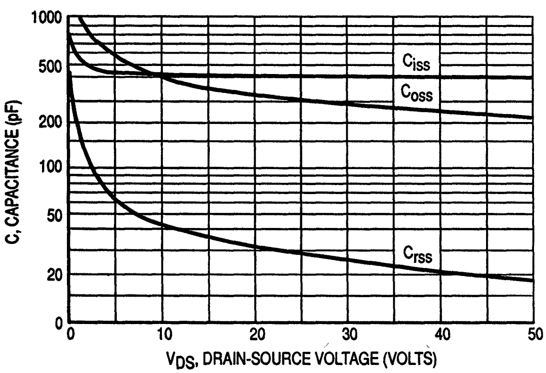


Figure 3. Capacitance versus Drain-Source Voltage

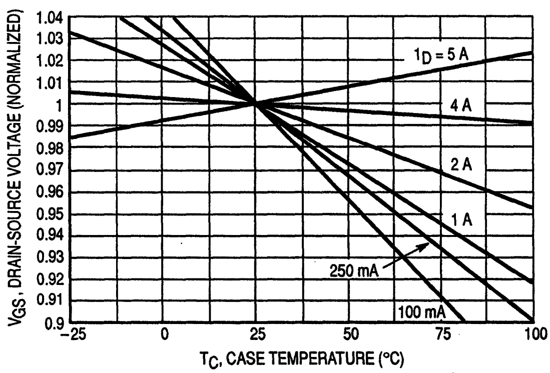


Figure 4. Gate-Source Voltage versus Case Temperature

TYPICAL CHARACTERISTICS

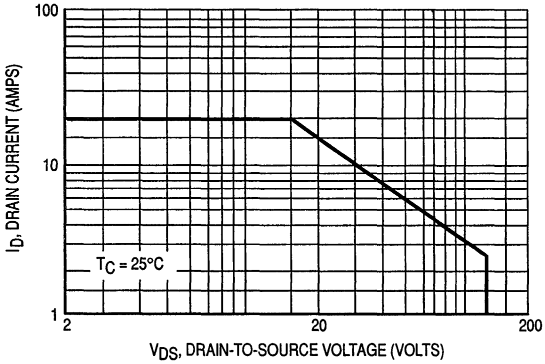


Figure 5. DC Safe Operating Area

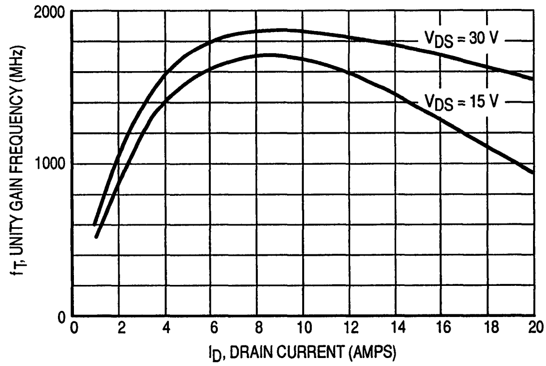


Figure 6. Common Source Unity Gain Frequency versus Drain Current

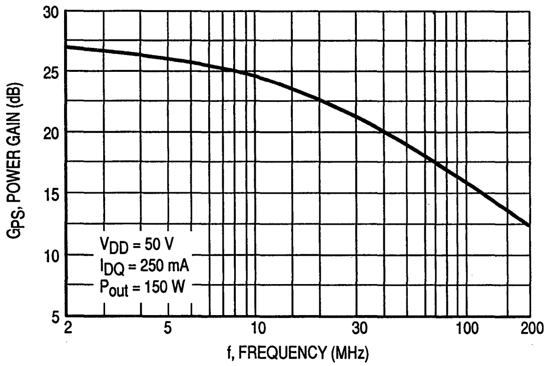


Figure 7. Power Gain versus Frequency

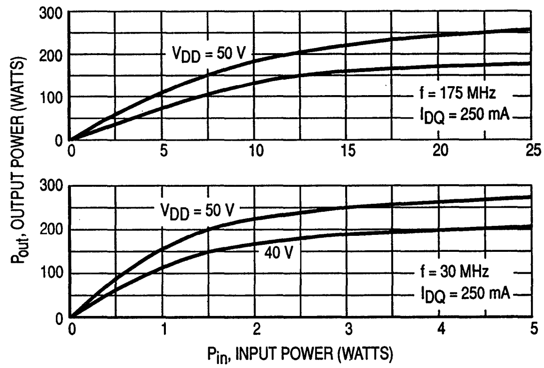


Figure 8. Output Power versus Input Power

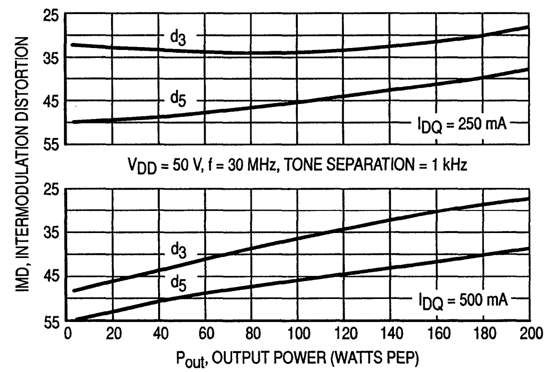


Figure 9. IMD versus P_{out}

2

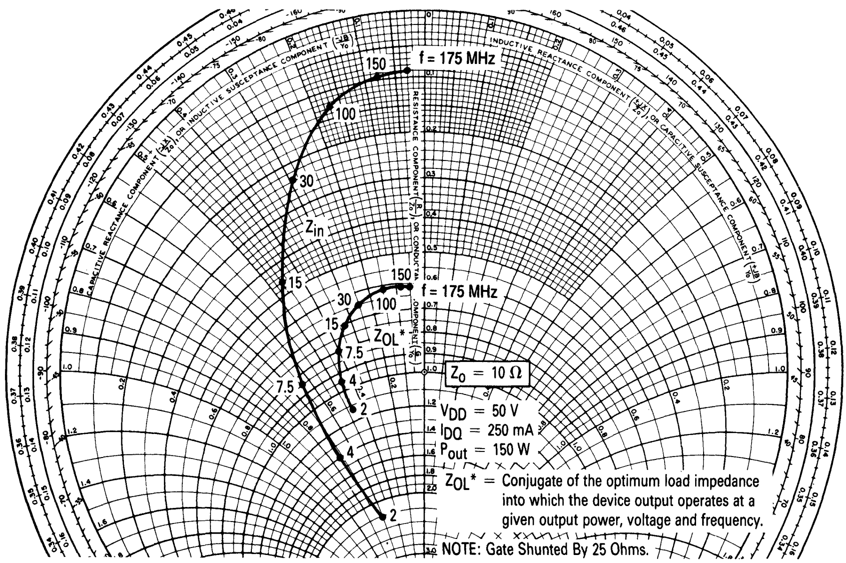


Figure 10. Series Equivalent Impedance

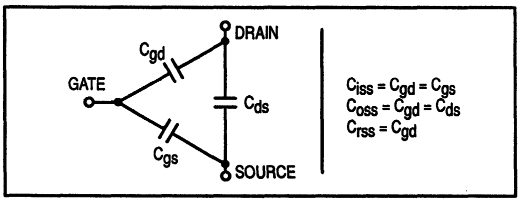
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 6 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gate of this device is essentially capacitor. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF151 is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF151 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF151 was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

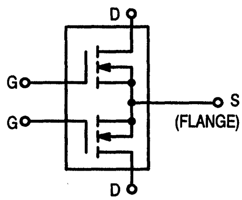
Power output of the MRF151 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

MRF151G

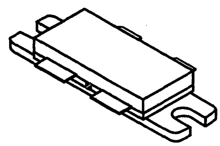
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode MOSFET

. . . designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 175 MHz, 50 V:
  Output Power — 300 W
  Gain — 14 dB (16 dB Typ)
  Efficiency — 50%
- Low Thermal Resistance — 0.35°C/W
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability



**300 W, 50 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**



CASE 375, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	40	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

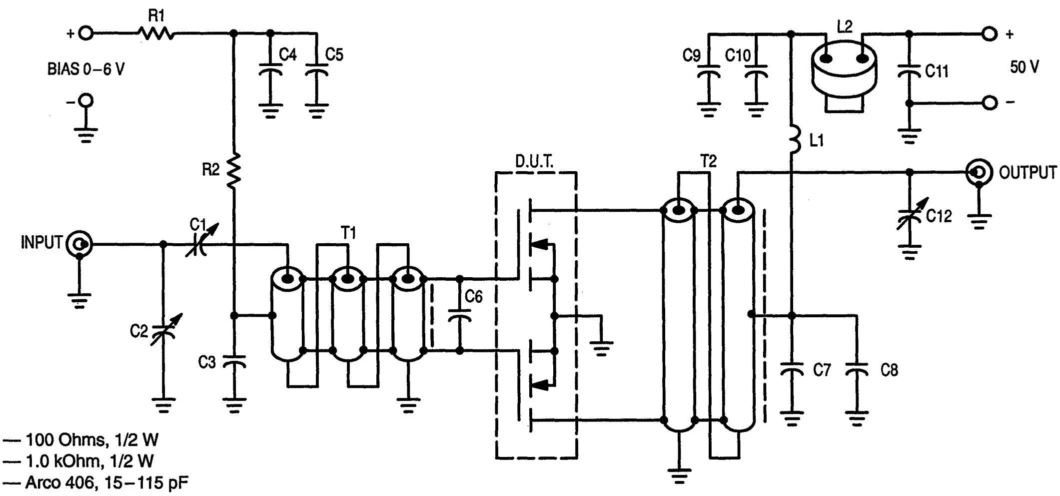
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Each Side)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS (Each Side)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	5.0	7.0	—	mhos
DYNAMIC CHARACTERISTICS (Each Side)					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	225	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 300 W, I_{DQ} = 500 mA, f = 175 MHz)	G_{ps}	14	16	—	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 300 W, f = 175 MHz, I_D (Max) = 11 A)	η	50	55	—	%
Load Mismatch (V_{DD} = 50 V, P_{out} = 300 W, I_{DQ} = 500 mA, VSWR 5:1 at all Phase Angles)	ψ	No Degradation in Output Power			

2



R1 — 100 Ohms, 1/2 W
R2 — 1.0 kOhm, 1/2 W
C1 — Arco 406, 15–115 pF
C2 — Arco 402, 1.5–20 pF
C3, C4, C7, C8, C9 — 1000 pF Chip
C5, C10 — 0.1 μF Chip
C6 — 330 pF Chip
C11 — 0.47 μF Ceramic Chip, Kemet 1215 or Equivalent (100 V)
C12 — Arco 403, 3.0–35 pF
L1 — 10 Turns AWG #16 Enameled Wire, Close Wound, 1/4″ I.D.
L2 — Ferrite Beads of Suitable Material for 1.5–2.0 μH Total Inductance

Unless Otherwise Noted, All Chip Capacitors are ATC Type 100 or Equivalent.

T1 — 9:1 RF Transformer. Can be made of 15–18 Ohms Semirigid Co-Ax, 62–90 Mils O.D.
T2 — 1:4 RF Transformer. Can be made of 15–18 Ohms Semirigid Co-Ax, 70–90 Mils O.D.
Board Material — 0.062″ Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ε_r = 5.0

NOTE: For stability, the input transformer T1 must be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

See Figure 6 for construction details of T1 and T2.

Figure 1. 175 MHz Test Circuit

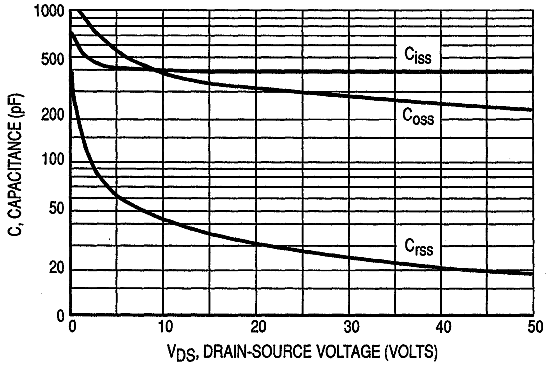


Figure 2. Capacitance versus Drain-Source Voltage*

*Data shown applies to each half of MRF151G.

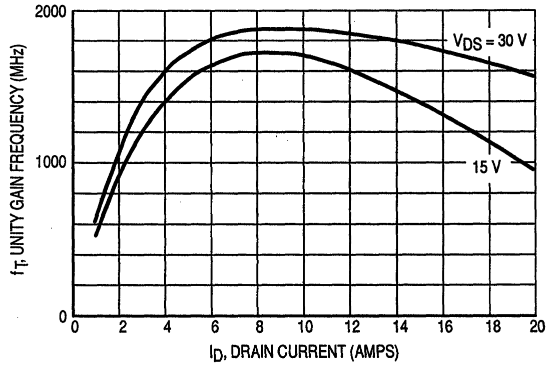


Figure 3. Common Source Unity Gain Frequency versus Drain Current*

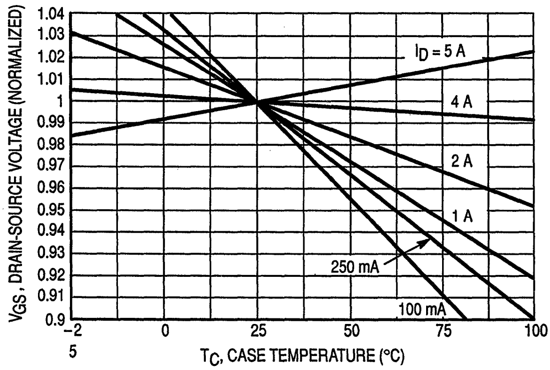


Figure 4. Gate-Source Voltage versus Case Temperature*

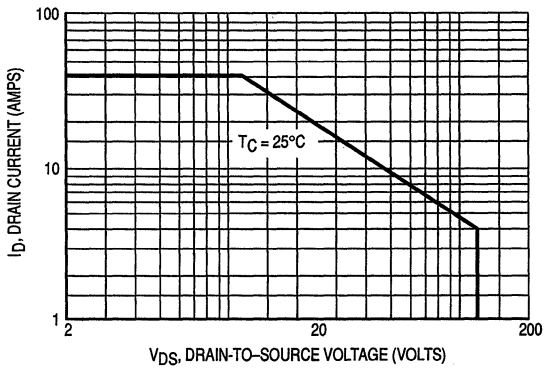


Figure 5. DC Safe Operating Area

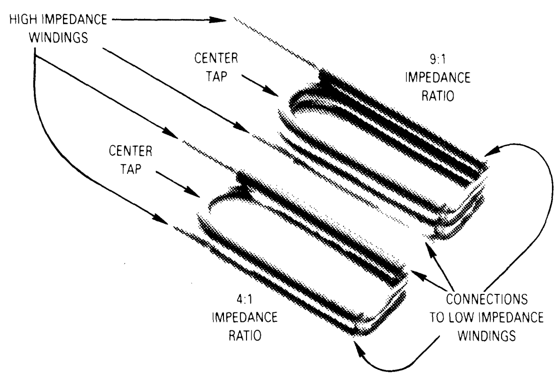


Figure 6. RF Transformer

TYPICAL CHARACTERISTICS

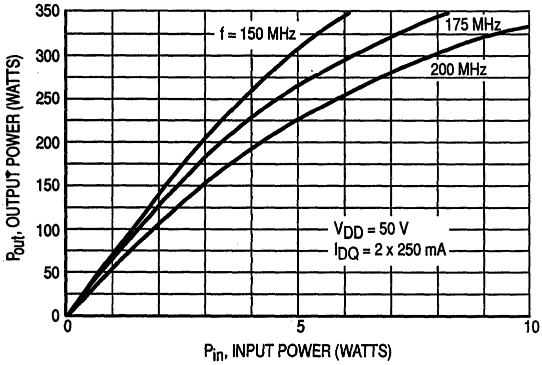


Figure 7. Output Power versus Input Power

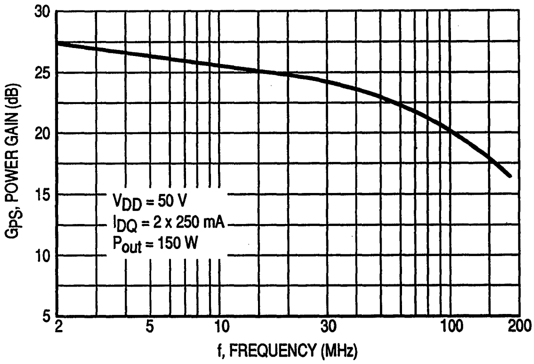
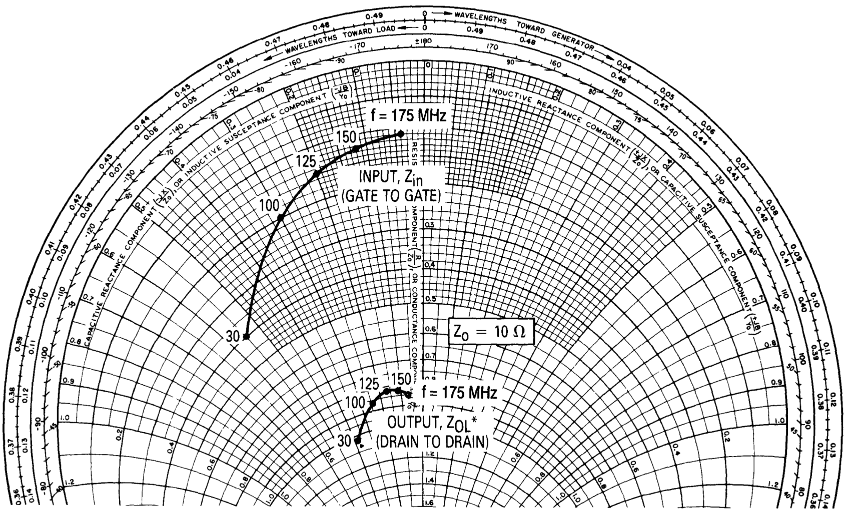


Figure 8. Power Gain versus Frequency

2



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

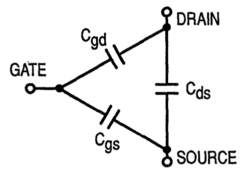
Figure 9. Input and Output Impedance

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} = C_{gs}$
$C_{oss} = C_{gd} = C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF151G is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF151G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF151G was characterized at $I_{DQ} = 250$ mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

Power output of the MRF151G may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

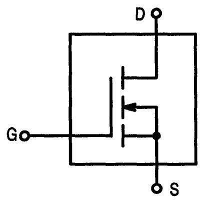
MRF154

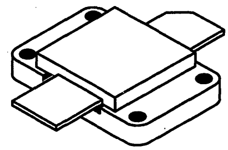
The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode MOSFET

. . . designed primarily for linear large-signal output stages in the 2.0–100 MHz frequency range.

- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 600 Watts
  Power Gain = 17 dB (Typ)
  Efficiency = 45% (Typ)

**600 W, 50 V, 80 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**





**CASE 368, STYLE 2
(HOG PAC)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	60	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1350 7.7	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

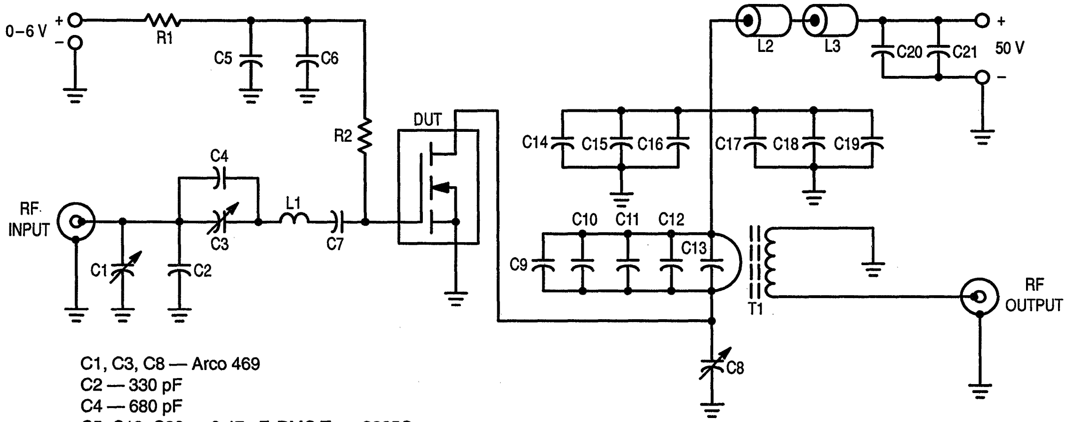
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{θJC}$	0.13	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	20	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	5.0	µAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 40 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 20 A)	g_{fs}	16	20	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	1600	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	1000	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	200	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 600 W, I_{DQ} = 800 mA, f = 30 MHz)	G_{ps}	—	17	—	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 600 W, I_{DQ} = 800 mA, f = 30 MHz)	η	—	45	—	%
Intermodulation Distortion (V_{DD} = 50 V, P_{out} = 600 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 800 mA)	$IMD_{(d3)}$	—	−25	—	dB

2



C1, C3, C8 — Arco 469
C2 — 330 pF
C4 — 680 pF
C5, C19, C20 — 0.47 µF, RMC Type 2225C
C6, C7, C14, C15, C16 — 0.1 µF
C9, C10, C11 — 470 pF
C12 — 1000 pF
C13 — Two Unencapsulated 1000 pF Mica, in Series
C17, C18 — 0.039 µF
C21 — 10 µF/100 V Electrolytic
L1 — 2 Turns #16 AWG, 1/2″ ID, 3/8″ Long
L2, L3 — Ferrite Beads, Fair-Rite Products Corp. #2673000801

R1, R2 — 10 Ohms/2.0 W Carbon
T1 — RF Transformer, 1:25 Impedance Ratio. See Motorola Application Note AN749, Figure 4 for details. Ferrite Material: 2 Each, Fair-Rite Products Corp. #2667540001

All capacitors ATC type 100/200 chips or equivalent unless otherwise noted.

Figure 1. 30 MHz Test Circuit

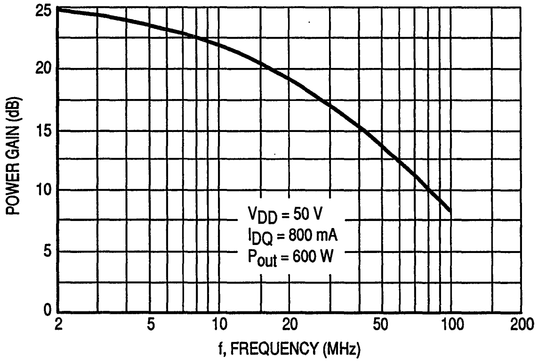


Figure 2. Power Gain versus Frequency

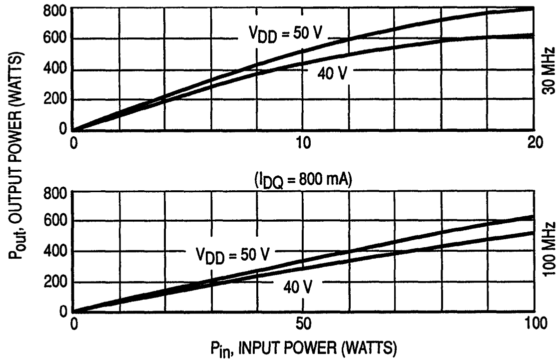


Figure 3. Output Power versus Input Power

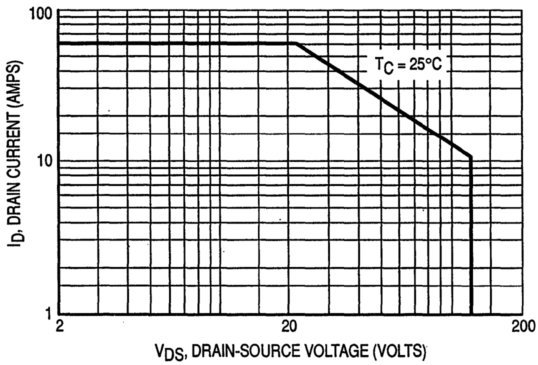


Figure 4. DC Safe Operating Area

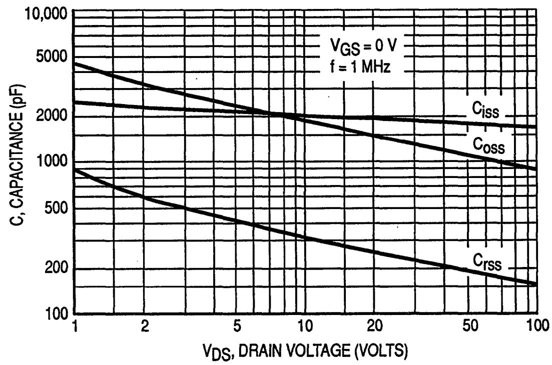


Figure 5. Capacitance versus Drain Voltage

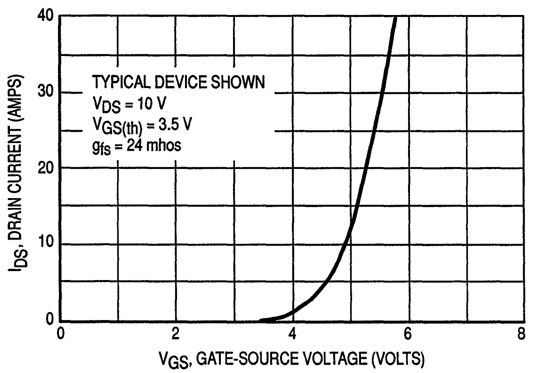


Figure 6. Gate Voltage versus Drain Current

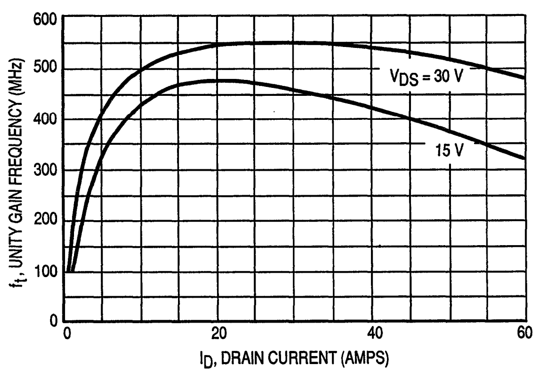


Figure 7. Common Source Unity Gain Frequency versus Drain Current

2

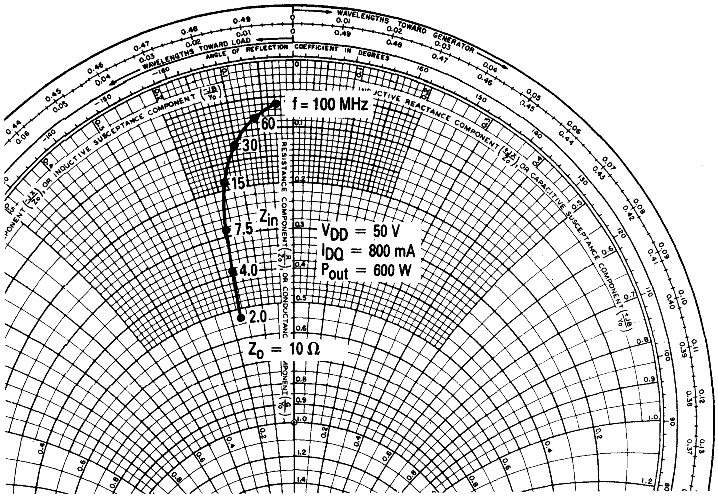
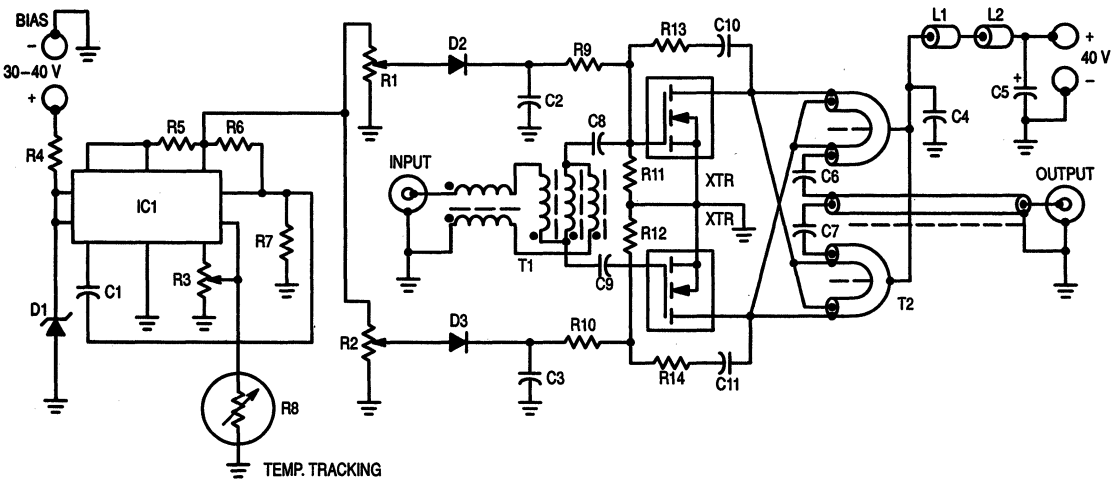


Figure 8. Series Equivalent Impedance



C1 — 1000 pF Ceramic
C2, C3, C4, C8, C9, C10, C11 — 0.1 µF Ceramic
C5 — 10 µF/100 V Electrolytic
C6, C7 — 0.1 µF Ceramic, (ATC 200/823 or Equivalent)
D1 — 28 V Zener, 1N5362 or Equivalent
D3 — 1N4148
IC1 — MC1723
L1, L2 — Fair-Rite Products Corp. Ferrite Beads #2673000801
R1, R2, R3 — 10 k Trimpot
R4 — 1.0 k/1.0 W
R5 — 10 Ohms
R6 — 2.0 k
R7 — 10 k
R8 — Thermistor, 10 k (25°C), 2.5 k (75°C)
R9, R10 — 100 Ohms
R11, R12 — 1.0 k
R13, R14 — 50–100 Ohms, 4.0 x 2.0 W Carbon in Parallel
T1 — 9:1 Transformer, Trifilar and Balun Wound on Separate Fair-Rite Products Corp. Balun Cores #286100012, 5 Turns Each.
T2 — 1:9 Transformer, Balun 50 Ohm CO-AX Cable RG-188, Low Impedance Lines W.L. Gore 16 Ohms CO-AX Type CXN 1837. Each Winding Threaded Through Two Fair-Rite Products Corp. #2661540001 Ferrite Sleeves (6 Each).
XTR — MRF154

Figure 9. 20–80 MHz 1.0 kW Broadband Amplifier

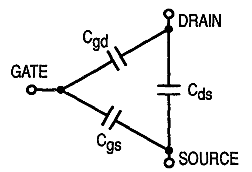
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. ±0.0005″ is considered sufficient for the flange bottom.

The same applies to the heat dissipator in the device mounting area. If copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least 1/4″ thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4-40 mounting screws should be in the area of 4–5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_θ for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF157

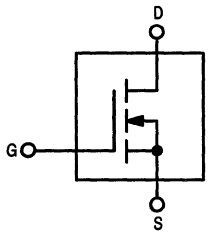
Motorola Preferred Device

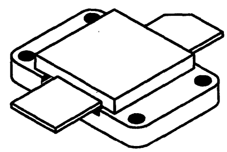
The RF Power MOS Line
Power Field Effect Transistor
N-Channel Enhancement Mode

Designed primarily for linear large-signal output stages to 80 MHz.

- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 600 Watts
  Power Gain = 21 dB (Typ)
  Efficiency = 45% (Typ)

600 W, to 80 MHz
MOS LINEAR
RF POWER FET





CASE 368, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	60	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1350 7.7	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.13	°C/W

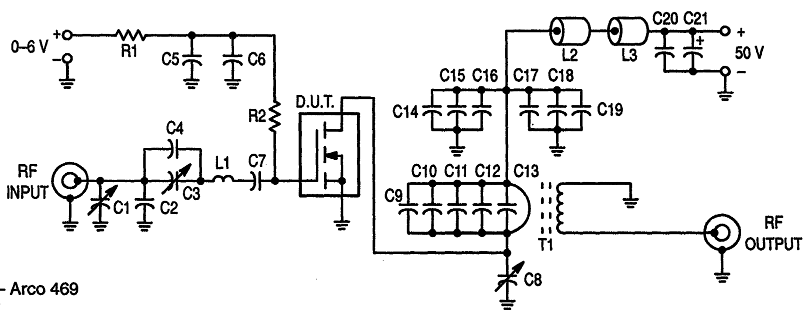
NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	20	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	5.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 40 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 20 A)	g_{fs}	16	24	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	1800	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	750	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	75	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 600 W, I_{DQ} = 800 mA, f = 30 MHz)	G_{ps}	15	21	—	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 600 W, f = 30 MHz, I_{DQ} = 800 mA)	h	40	45	—	%
Intermodulation Distortion (V_{DD} = 50 V, P_{out} = 600 W(PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 800 mA)	$IMD_{(d3)}$	—	−25	—	dB

2



C1, C3, C8 — Arco 469
C2 — 330 pF
C4 — 680 pF
C5, C19, C20 — 0.47 μF, RMC Type 2225C
C6, C7, C14, C15, C16 — 0.1 μF
C9, C10, C11 — 470 pF
C12 — 1000 pF
C13 — Two Unencapsulated 1000 pF Mica, in Series
C17, C18 — 0.039 μF
C21 — 10 μF/100 V Electrolytic
L1 — 2 Turns #16 AWG, 1/2″ ID, 3/8″ Long
L2, L3 — Ferrite Beads, Fair-Rite Products Corp. #2673000801

R1, R2 — 10 Ohms/2W Carbon
T1 — RF Transformer, 1:25 Impedance Ratio. See Motorola Application Note AN749, Figure 4 for details. Ferrite Material: 2 Each, Fair-Rite Products Corp. #2667540001

All capacitors ATC type 100/200 chips or equivalent unless otherwise noted.

Figure 1. 30 MHz Test Circuit

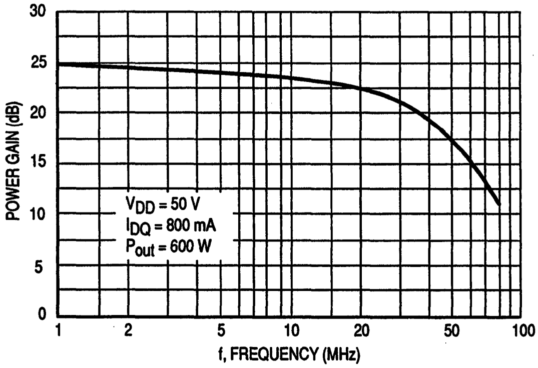


Figure 2. Power Gain versus Frequency

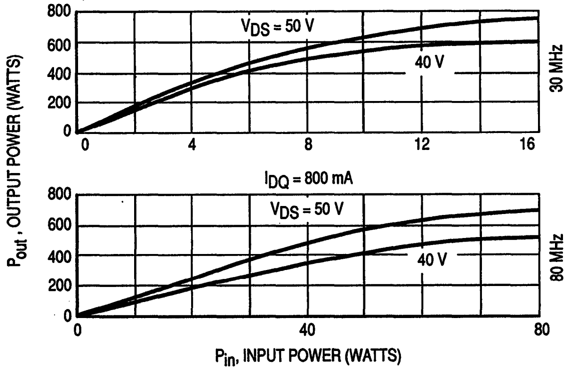


Figure 3. Output Power versus Input Power

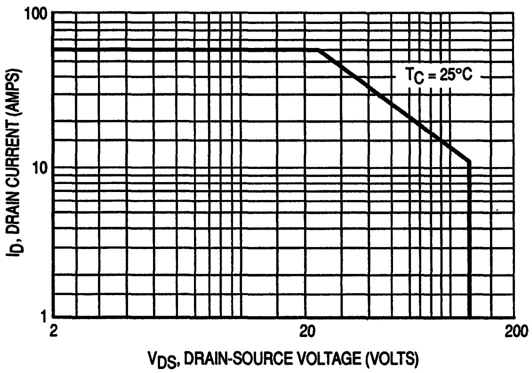


Figure 4. DC Safe Operating Area

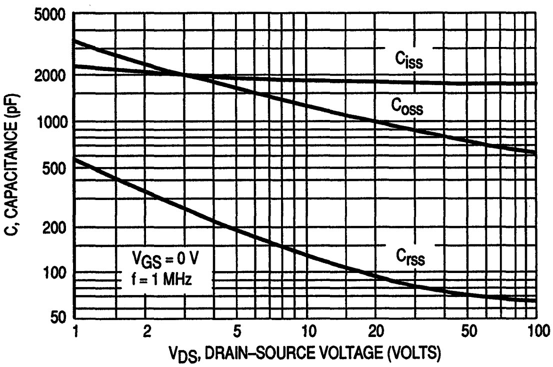


Figure 5. Capacitance versus Drain Voltage

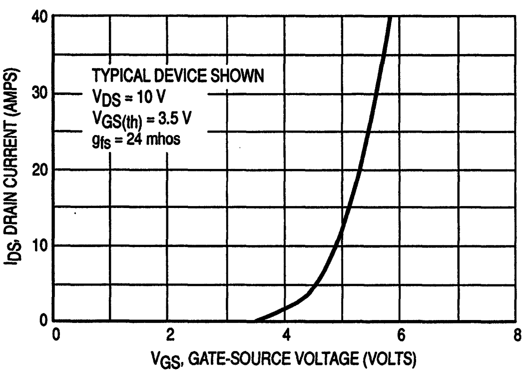


Figure 6. Gate Voltage versus Drain Current

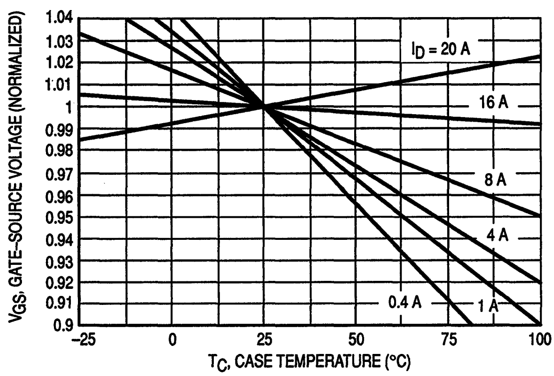


Figure 7. Gate-Source Voltage versus Case Temperature

2

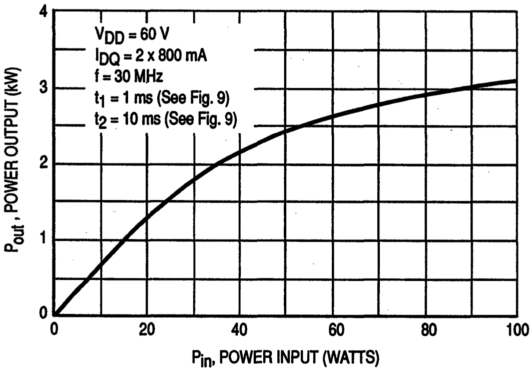


Figure 8. Output Power versus Input Power Under Pulse Conditions (2 x MRF157)

Note: Pulse data for this graph was taken in a push-pull circuit similar to the one shown. However, the output matching network was modified for the higher level of peak power.

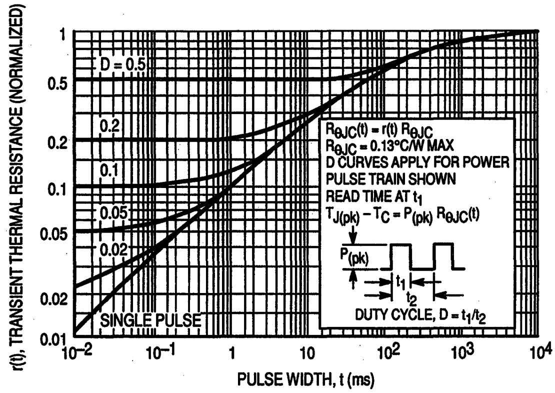
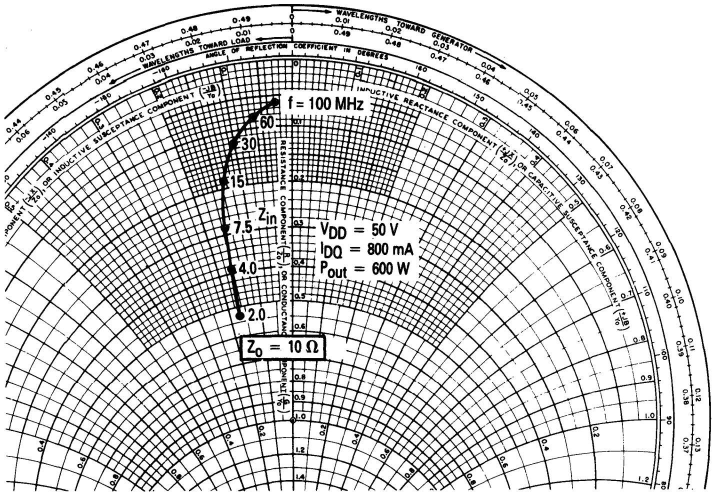
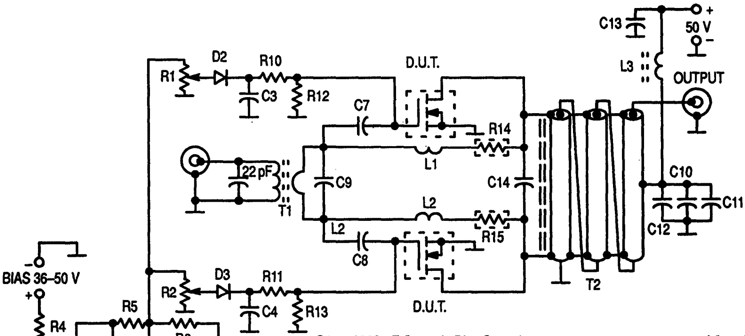


Figure 9. Thermal Response versus Pulse Width



Note: To determine Z_{OL}*, use formula $\frac{(V_{CC} - V_{sat})^2}{2\ P_o} = Z_{OL}^*$

Figure 10. Series Equivalent Impedance



C1 — 1000 pF Ceramic Disc Capacitor
C2, C3, C4 — 0.1 µF Ceramic Disc Capacitor
C5 — 0.01 µF Ceramic Chip Capacitor
C6, C12 — 0.1 µF Ceramic Chip Capacitor
C7, C8 — Two 2200 pF Ceramic Chip Capacitors in Parallel Each
C9 — 820 pF Ceramic Chip Capacitor
C10, C11 — 1000 pF Ceramic Chip Capacitor
C13 — 0.47 µF Ceramic Chip Capacitor or Two Smaller Values in Parallel
C14 — Unencapsulated Mica, 500 V. Two 1000 pF Units in Series, Mounted Under T2
D1 — 1N5357A or Equivalent
D2, D3 — 1N4148 or Equivalent.
IC1 — MC1723 (723) Voltage Regulator
L1, L2 — 15 ηH, Connecting Wires to R14 and R15, 2.5 cm Each #20 AWG
L3 — 10 µH, 10 Turns #12 AWG Enameled Wire on Fair-Rite Products Corp. Ferrite Toroid #5961000401 or Equivalent
R1, R2 — 1.0K Single Turn Trimpots
R3 — 10K Single Turn Trimpot
R4 — 470 Ohms, 2.0 Watts
R5 — 10 Ohms
R6, R12, R13 — 2.0K Ohms
R7 — 10K Ohms
R8 — Exact Value Depends on Thermistor R9 used (Typically 5.0–10K)
R9 — Thermistor, Keystone RL1009-5820-97-D1 or Equivalent
R10, R11 — 100 Ohms, 1.0W Carbon
R14, R15 — EMC Technology Model 5308 or KDI Pyrofilm PPR 870-150-3 Power Resistors, 25 Ohms
T1, T2 — 9:1 and 1:9 Impedance Ratio RF Transformers

Unless otherwise noted, all resistors are 1/2 watt metal film type. All chip capacitors except C13 are ATC type 100/200B or Dielectric Laboratories type C17.

Figure 11. 2.0 to 50 MHz, 1.0 kW Wideband Amplifier

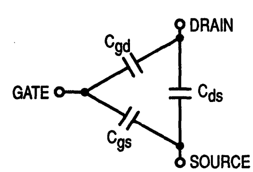
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the TMOS® FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. The addition of an internal zener diode may result in detrimental effects on the reliability of a power MOSFET. If gate protection is required, an external zener diode is recommended.

IMPEDANCE CHARACTERISTICS

Device input and output impedances are normally obtained by measuring their conjugates in an optimized narrow band test circuit. These test circuits are designed and constructed for a number of frequency points depending on the frequency coverage of characterization. For low frequencies the circuits consist of standard LC matching networks including variable capacitors for peak tuning. At increasing power levels the output impedance decreases, resulting in higher RF currents in the matching network. This makes the practicality of output impedance measurements in the manner described questionable at power levels higher than 200–300 W for devices operated at 50 V and 150–200 W for devices operated at 28 V. The physical sizes and values required for the components to withstand the RF currents increase to a point where physical construction of the output matching network gets difficult if not impossible. For this reason the output impedances are not given for high power devices such as the MRF154 and MRF157. However, formulas like $\frac{(V_{DS} - V_{sat})^2}{2P_{out}}$ for a single ended design or $\frac{2((V_{DS} - V_{sat})^2)}{P_{out}}$ for a push-pull design can be used to obtain reasonably close approximations to actual values.

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

If a copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least 1/4″ thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4–40 mounting screws should be in the area of 4–5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_θ for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$R_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF158
MRF158R

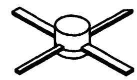
Motorola Preferred Devices

The RF TMOS® Line
Power Field Effect Transistor
N-Channel Enhancement Mode

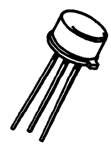
Designed for wideband large-signal amplifier and oscillator applications to 500 MHz.

- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 2.0 Watts
  Minimum Gain = 16 dB
  Efficiency = 55% (Typical)
- Grounded Source Package for High Gain and Excellent Heat Dissipation (MRF158R)
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Excellent Thermal Stability, Ideally Suited for Class A Operation

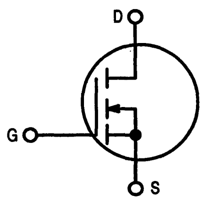
2.0 W, to 500 MHz
TMOS
BROADBAND
RF POWER FET



CASE 305A, STYLE 2



CASE 79-05, STYLE 7



MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Drain-Source Voltage		V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)		V_{DGR}	65	Vdc
Gate-Source Voltage		V_{GS}	±40	Vdc
Drain Current — Continuous		I_D	0.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C		P_D	8.0 45	Watts mW/°C
Storage Temperature Range	MRF158 MRF158R	T_{stg}	−65 to +150 −65 to +200	°C
Operating Junction Temperature		T_J	200	°C

THERMAL CHARACTERISTICS

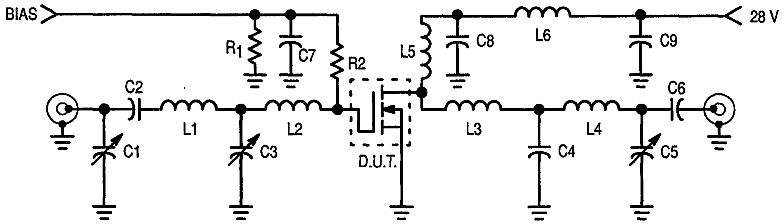
Characteristic		Symbol	Max	Unit
Thermal Resistance, Junction to Case	MRF158 MRF158R	$R_{\theta JC}$	13.2 22	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Preferred devices are Motorola recommended choices for future use and best overall value.

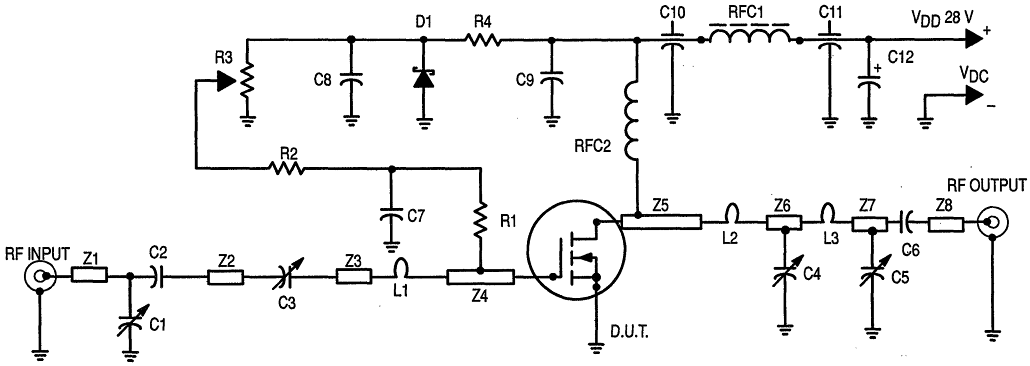
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	0.5	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (I_D = 10 mA, V_{DS} = 10 V)	$V_{GS(th)}$	1.0	4.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 100 mA)	g_{fs}	50	85	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	3.0	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	4.2	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	0.45	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 2.0 W, f = 400 MHz, I_{DQ} = 100 mA)	G_{ps}	16	20	—	dB
Drain Efficiency (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 2.0 W, f = 400 MHz, I_{DQ} = 100 mA)	η	45	55	—	%
Electrical Ruggedness (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 2.0 W, f = 400 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
MRF158 Series Equivalent Input Impedance (V_{DD} = 28 V, P_{out} = 2.0 W, f = 400 MHz, I_{DQ} = 100 mA)	Z_{in}	—	8.8 – j27.37	—	Ohms
Series Equivalent Output Impedance (V_{DD} = 28 V, P_{out} = 2.0 W, f = 400 MHz, I_{DQ} = 100 mA)	Z_{out}	—	16.96 – j62	—	Ohms



C1, C3, C5 — 0.8–10 pF Piston Trimmer Capacitor
C2, C6 — 270 pF Chip Capacitor
C4 — 8.0 pF Mini-Unelco Capacitor
C7, C8 — 0.01 µF Ceramic Capacitor
C9 — 25 µF 50 V Tantalum Capacitor
L1 — Hairpin Inductor #20 W (.300, .320)
L2 — Hairpin Inductor #20 W (.300, .225)
L3 — Two Turns #18 W 1/4″ ID
L4 — Hairpin Inductor #18 W (.300, .420)
L5 — 8 Turns #18 W .380″ ID
L6 — VK200/10/3B Ferroxcube Choke
R1 — 1.0 kΩ 1/4 W Resistor
R2 — 10 kΩ 1/4 W Resistor
Board Material — 0.060″ Teflon Fiberglass $\epsilon_r = 2.55$
Copper Clad both sides 2 oz. copper

Figure 1. 400 MHz Test Circuit, MRF158R



C1, C4, C5 — Johanson Trimmer Capacitor, 2–20 pF
C2, C6 — 270 pF Chip Capacitor
C3 — Arco 404
C7, C8, C9 — 0.1 µF
C10, C11 — 680 pF Feed Through
C12 — 50 µF, 50 V
D1 — 1N5925A Motorola Zener
L1 — #18 AWG, Hairpin 0.825″ long, bend into hairpin (0.245″, 0.330″)
L2 — #18 AWG, Hairpin 0.875″ long, bend into hairpin (0.240″, 0.390″)
L3 — #18 AWG, Hairpin 0.965″ long, bend into hairpin (0.235″, 0.475″)

Board Material — 0.062″, Teflon Fiberglass, 2 oz., Copper clad both sides, $\epsilon_r = 2.55$

R1 — 91 Ω 1/2 Watt
R2 — 10 kΩ 1/2 Watt
R3 — 10 kΩ, 10 Turns Bourns
R4 — 1.8 k 1.4 Watt
RFC1 — Ferroxcube VK200-19/4B
RFC2 — 10 Turns #20 AWG Enameled, 0.250″ ID
Z1 — Microstrip Line 0.150″ wide, 0.420″ long
Z2 — Microstrip Line 0.150″ wide, 0.420″ long
Z3 — Microstrip Line 0.150″ wide, 0.475″ long
Z4 — Microstrip Line 0.150″ wide, 0.825″ long
Z5 — Microstrip Line 0.150″ wide, 0.750″ long
Z6 — Microstrip Line 0.150″ wide, 0.500″ long
Z7 — Microstrip Line 0.150″ wide, 0.500″ long
Z8 — Microstrip Line 0.150″ wide, 0.450″ long

Figure 2. 400 MHz Test Circuit, MRF158

TYPICAL CHARACTERISTICS

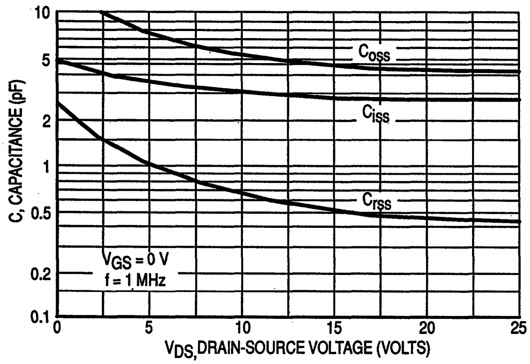


Figure 3. Capacitance versus Drain-Source Voltage

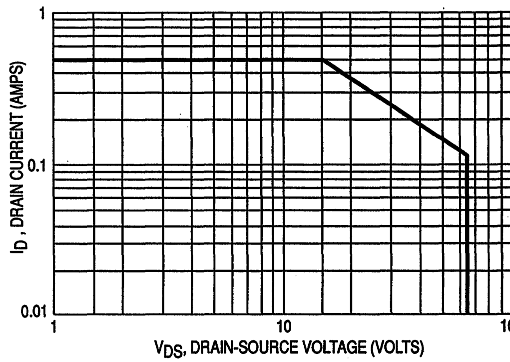


Figure 4. DC Safe Operating Area

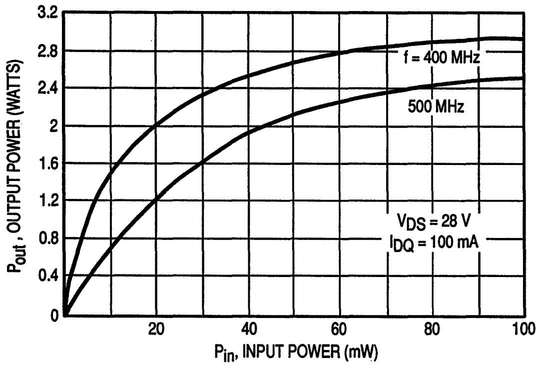


Figure 5. Output Power versus Input Power

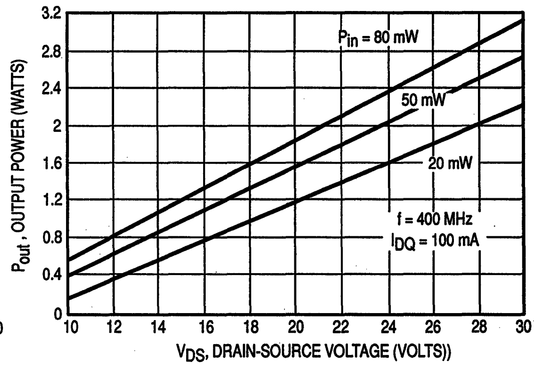
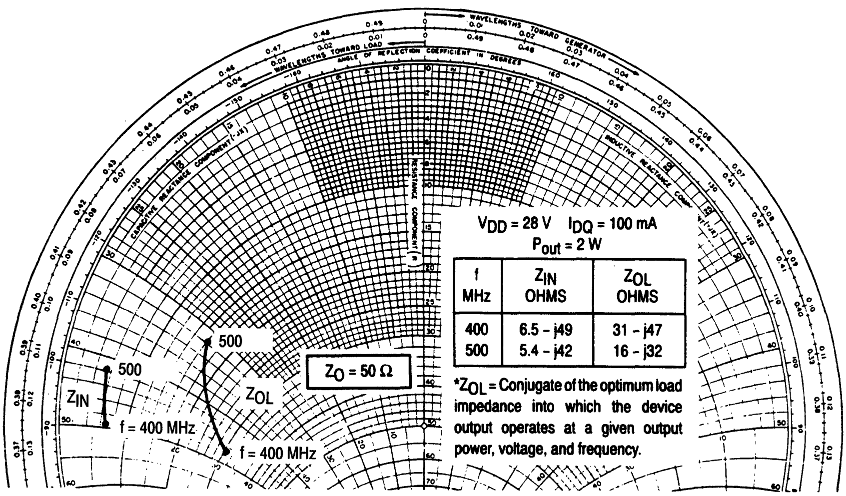


Figure 6. Output Power versus Voltage

MRF158R ONLY



f MHz	Z_{IN} OHMS	Z_{OL} OHMS
400	6.5 – j49	31 – j47
500	5.4 – j42	16 – j32

Figure 7. Series Equivalent Input and Output Impedances

Table 1. Typical Common Emitter S-Parameters (MRF158R)

V_{DS} (Volts)	I_D (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\vert S_{11}\vert$	∠φ	$\vert S_{21}\vert$	∠φ	$\vert S_{12}\vert$	∠φ	$\vert S_{22}\vert$	∠φ
28	100	5	1.00	−3.0	6.47	178	0.003	54	0.95	−3.0
		10	1.00	−3.0	5.95	176	0.003	83	0.95	−2.0
		20	1.00	−5.0	5.87	174	0.006	76	0.95	−4.0
		30	0.99	−8.0	5.86	171	0.009	82	0.95	−6.0
		40	0.99	−10	5.77	168	0.011	81	0.95	−8.0
		50	0.98	−12	5.71	165	0.014	77	0.95	−10
		100	0.95	−24	5.42	153	0.026	68	0.92	−20
		150	0.89	−34	5.07	141	0.034	61	0.89	−28
		200	0.83	−43	4.64	131	0.039	55	0.85	−36
		250	0.78	−51	4.26	121	0.040	51	0.80	−43
		300	0.73	−59	3.87	112	0.039	50	0.77	−48
		350	0.68	−65	3.55	104	0.036	53	0.73	−53
		400	0.64	−71	3.22	97	0.033	63	0.70	−58
		500	0.58	−82	2.77	84	0.037	96	0.64	−69
		600	0.54	−94	2.42	72	0.064	115	0.62	−79
		700	0.54	−107	2.19	63	0.100	117	0.62	−91
		800	0.54	−118	1.99	53	0.147	117	0.64	−101
		900	0.55	−129	1.81	45	0.209	112	0.64	−112
		1000	0.56	−138	1.66	37	0.283	105	0.64	−120

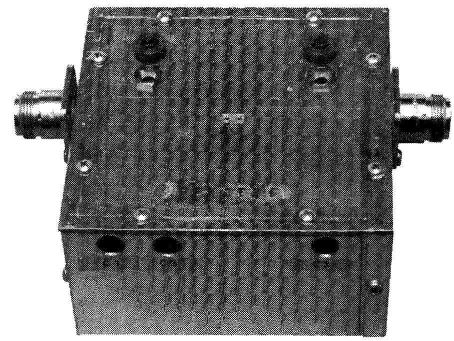


Figure 8. Test Circuit, Top View (MRF158R)

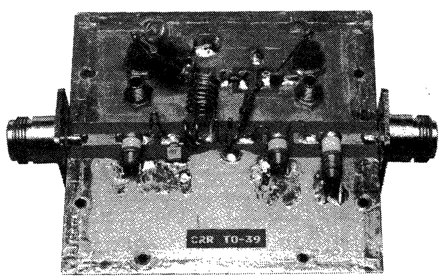


Figure 9. Test Circuit, Bottom View (MRF158R)

Table 2. Typical Common Emitter S-Parameters (MRF158)

V_{DS} (Volts)	I_D (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	∠φ	$\lvert S_{21}\rvert$	∠φ	$\lvert S_{12}\rvert$	∠φ	$\lvert S_{22}\rvert$	∠φ
28	100	5	1.00	−2.0	3.84	−179	0.003	73	0.97	−2.0
		10	1.00	−2.0	3.81	179	0.004	83	0.97	−2.0
		30	1.00	−7.0	3.74	174	0.011	81	0.97	−6.0
		50	1.00	−11	3.72	170	0.018	78	0.96	−9.0
		100	0.98	−21	3.62	159	0.034	70	0.95	−19
		200	0.93	−41	3.28	137	0.061	52	0.90	−35
		300	0.88	−58	2.88	120	0.077	39	0.86	−50
		400	0.83	−75	2.57	104	0.088	27	0.81	−63
		500	0.79	−87	2.24	91	0.090	17	0.78	−74
		600	0.75	−99	1.94	78	0.084	8.0	0.75	−84
		700	0.73	−110	1.72	68	0.077	2.0	0.75	−93
		800	0.72	−120	1.52	58	0.067	−3.0	0.75	−99
		900	0.71	−130	1.35	48	0.055	−6.0	0.74	−108
		1000	0.71	−139	1.18	40	0.043	−4.0	0.73	−114

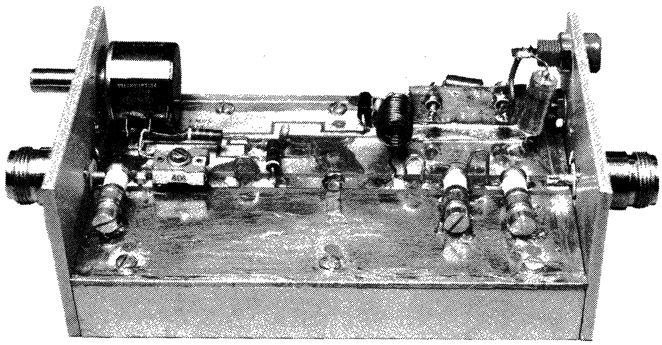
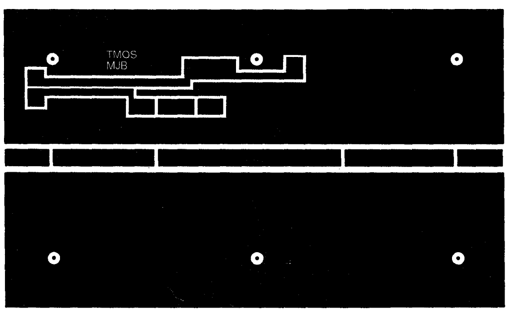


Figure 10. Test Circuit (MRF158)



(Not to Scale)

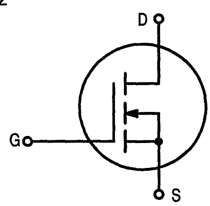
Figure 11. PC Board Photomaster (MRF158)

MRF161

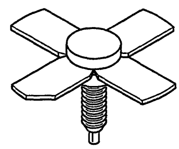
The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

. . . designed for wideband large-signal amplifier and oscillator applications up to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 5.0 Watts
  Minimum Gain = 11 dB
  Efficiency — 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 3.0 dB (Typ) at 100 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



**5.0 W, to 400 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET**



CASE 244, STYLE 3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	0.9	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	17.5 0.1	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

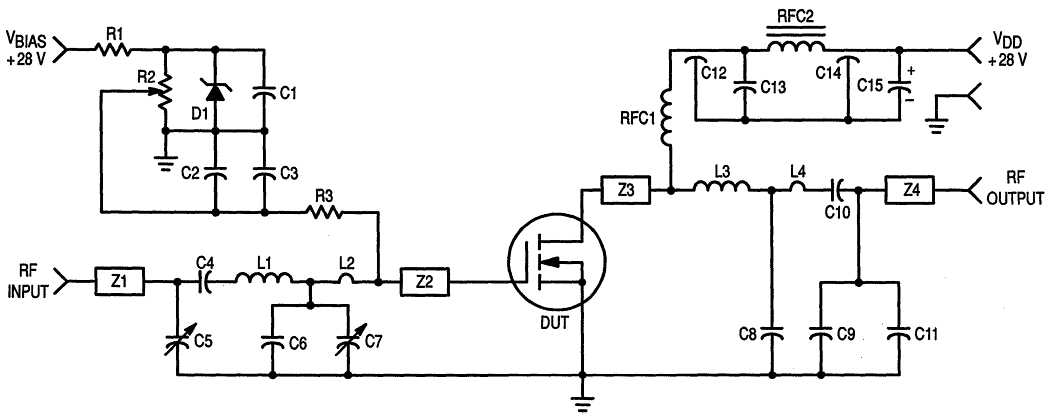
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 100 mA)	g_{fs}	80	110	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	7.0	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	9.7	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.3	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DS} = 28 Vdc, I_D = 100 mA, f = 400 MHz, Z_S = 67.6 + j14.1, Z_L = 14.5 + j25.7)	NF	—	3.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz, I_{DQ} = 50 mA)	G_{ps}	11	13.5	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz, I_{DQ} = 50 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz, I_{DQ} = 50 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			



C1, C2, C13 — 0.1 µF, 50 V Disc Ceramic
C3 — 0.01 µF, 100 V Disc Ceramic
C4, C10 — 220 pF, 100 Mil Chip Cap
C5 — 1.0–10 pF Johanson or Equivalent
C6 — 5.0 pF Mini-Unelco or Equivalent
C7 — 1.0–20 pF Johanson or Equivalent
C8 — 15 pF, 100 Mil ATC Chip Cap or Equivalent
C9, C11 — 2.2, 100 Mil ATC Chip Cap or Equivalent
C12, C14 — 680 pF Feedthru
C15 — 50 µF, 35 V
D1 — 1N5347B Motorola Zener or Equivalent
L1 — 1-3/4 Turns, 0.185″ ID 0.08″ Long #20 AWG Enamel — (25 nH)
L2 — #20 AWG Enamel, Hairpin 0.353″ — (10.5 nH) 0.185″
L3 — 1-3/4 Turns, 0.128″ ID 0.11″ Long #18 AWG Enamel — (15 nH)
L4 — #18 AWG Enamel, Hairpin 0.410″ — (12.5 nH) 0.185″
R1 — 1.6 kΩ, 1/4 W
R2 — 10 Turns 10 kΩ
R3 — 10 k, 1/2 W
RFC1 — 10 Turns, 0.300″ ID #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200
Z1 — 0.82″ x 0.164″ Microstrip — (Z_O = 50 Ω)
Z2, Z3 — 0.60″ x 0.25″ Microstrip
Z4 — 0.76″ x 0.164″ Microstrip — (Z_O = 50 Ω)
Board-Glass Teflon, 62 Mils, ε_r = 2.56

Figure 1. 400 MHz Test Circuit

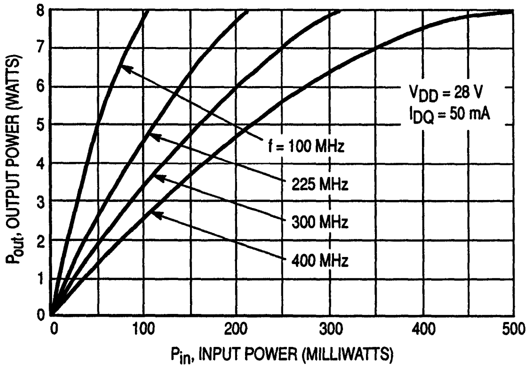


Figure 2. Output Power versus Input Power

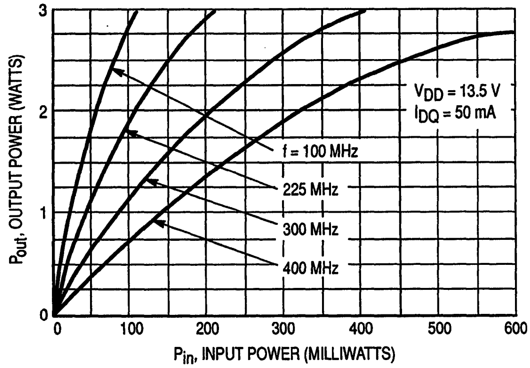


Figure 3. Output Power versus Input Power

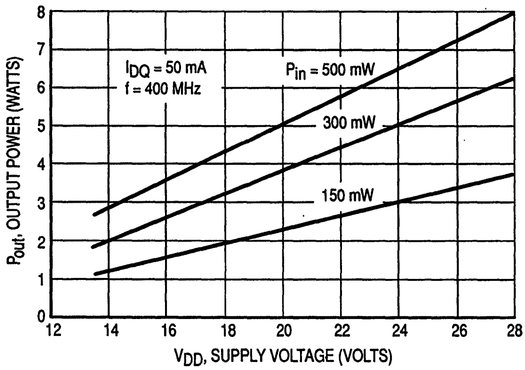


Figure 4. Output Power versus Supply Voltage

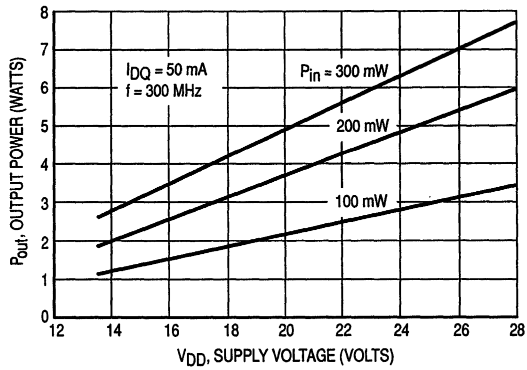


Figure 5. Output Power versus Supply Voltage

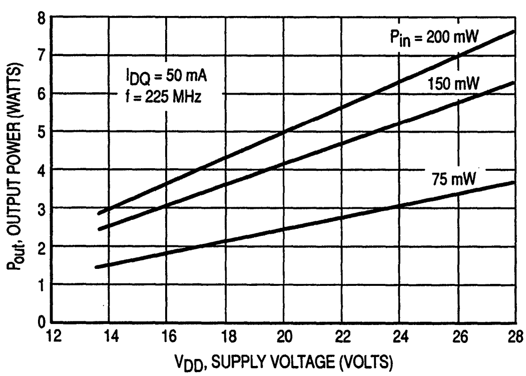


Figure 6. Output Power versus Supply Voltage

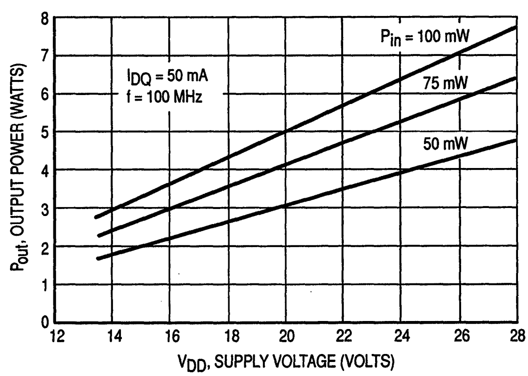


Figure 7. Output Power versus Supply Voltage

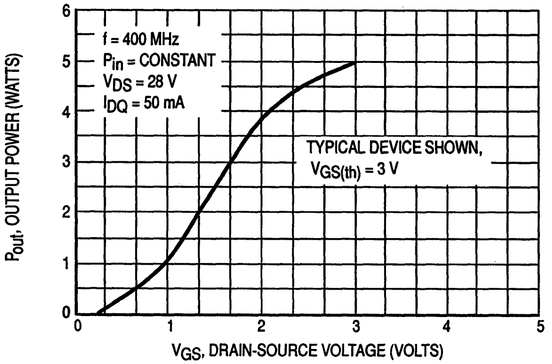


Figure 8. Output Power versus Gate Voltage

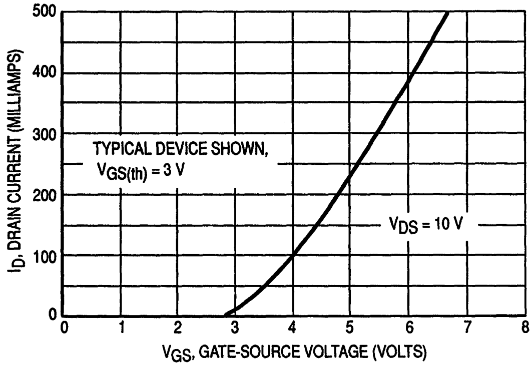


Figure 9. Drain Current versus Gate Voltage (Transfer Characteristics)

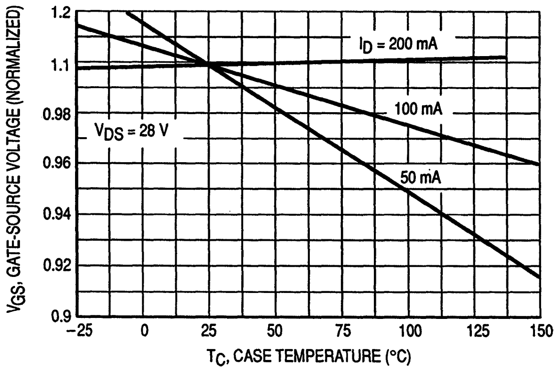


Figure 10. Gate-Source Voltage versus Case Temperature

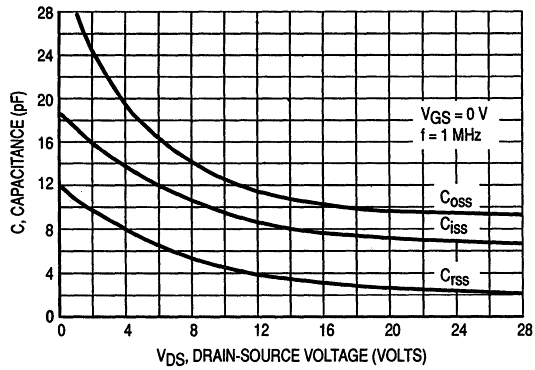


Figure 11. Capacitance versus Voltage

2

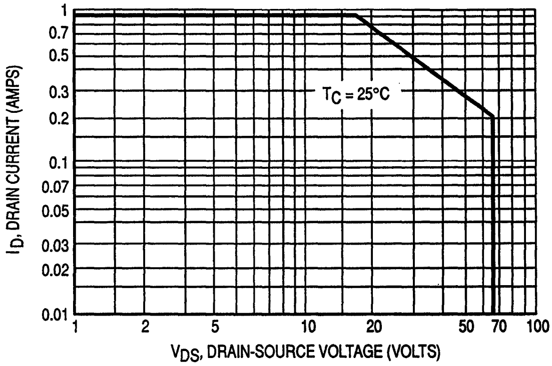
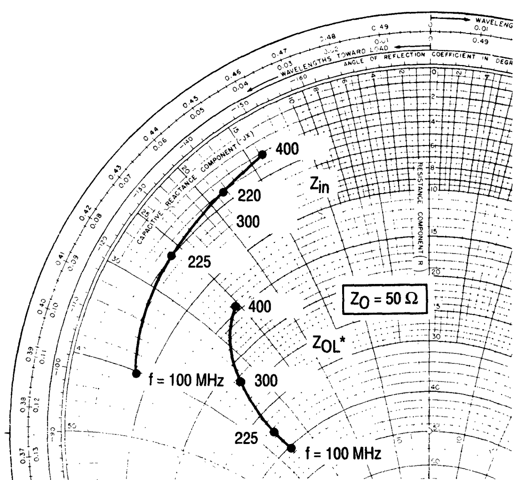


Figure 12. Maximum Rated Forward Biased Safe Operating Area



V_{DD} = 28 V I_{DQ} = 50 mA, P_{out} = 5.0 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	8.00 - j40.5	41.0 - j36.0
225	4.76 - j26.1	34.5 - j36.1
300	4.23 - j18.2	22.1 - j33.4
400	3.34 - j13.7	14.5 - j25.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 13. Large-Signal Series Equivalent Input and Output Impedance, Z_{in}, Z_{OL}*

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2.0	1.000	−1.69	13.64	178	0.002	62	0.947	−1.84
5.0	1.000	−4.63	13.60	176	0.005	69	0.945	−4.00
10	0.997	−8.95	13.70	173	0.010	80	0.941	−7.92
20	0.989	−17.49	13.36	167	0.022	73	0.929	−15.8
30	0.977	−26	13.07	162	0.032	71	0.915	−23
40	0.968	−34	12.76	156	0.042	67	0.902	−30
50	0.949	−42	12.31	151	0.050	61	0.885	−37
60	0.930	−49	11.88	146	0.058	57	0.866	−43
70	0.913	−56	11.45	141	0.066	53	0.846	−49
80	0.897	−62	10.96	137	0.072	50	0.831	−55
90	0.885	−68	10.50	133	0.078	46	0.817	−60
100	0.867	−74	10.00	129	0.081	43	0.800	−65
110	0.853	−78	9.54	125	0.085	40	0.787	−69
120	0.838	−84	8.92	122	0.090	37	0.775	−74
130	0.819	−88	8.75	119	0.093	35	0.762	−78
140	0.812	−92	8.30	116	0.096	31	0.755	−81
150	0.800	−96	7.95	113	0.098	28	0.742	−86
160	0.785	−99	7.54	111	0.100	26	0.735	−89
170	0.775	−103	7.25	109	0.102	24	0.728	−93
180	0.765	−105	6.85	106	0.103	23	0.725	−96
190	0.755	−108	6.60	104	0.104	21	0.720	−98
200	0.740	−111	6.20	100	0.106	18	0.719	−99
225	0.735	−116	5.71	96	0.110	16	0.715	−103
250	0.723	−121	5.17	92	0.112	12	0.708	−107
275	0.720	−124	4.80	89	0.113	10	0.706	−110
300	0.716	−128	4.43	85	0.112	7.0	0.706	−113
325	0.715	−130	4.17	83	0.111	4.0	0.717	−115
350	0.715	−133	3.87	79	0.111	3.0	0.720	−117
375	0.715	−135	3.67	76	0.111	1.0	0.728	−118
400	0.711	−137	3.43	74	0.109	0	0.729	−119
425	0.714	−139	3.25	71	0.104	0	0.738	−120
450	0.717	−140	3.11	69	0.104	−2.0	0.743	−121
475	0.719	−141	2.95	67	0.103	−3.0	0.757	−122
500	0.722	−142	2.81	65	0.102	−4.0	0.770	−122
525	0.723	−144	2.69	62	0.099	−6.0	0.777	−123
550	0.727	−144	2.55	61	0.097	−6.0	0.787	−123
575	0.729	−145	2.46	59	0.097	−7.0	0.802	−124
600	0.733	−146	2.37	57	0.094	−7.0	0.814	−124
625	0.734	−147	2.29	55	0.090	−8.0	0.824	−126
650	0.740	−148	2.19	54	0.087	−8.0	0.830	−127
675	0.749	−149	2.12	53	0.085	−6.0	0.849	−127
700	0.758	−149	2.07	51	0.084	−6.0	0.879	−127
725	0.761	−150	1.99	49	0.082	−5.0	0.886	−127
750	0.763	−151	1.93	48	0.081	−4.0	0.905	−127
775	0.765	−151	1.90	48	0.079	−3.0	0.919	−128
800	0.770	−152	1.83	46	0.076	−1.0	0.921	−128

Table 1. Common Source Scattering Parameters
50 Ohm System
V_{DS} = 28 V, I_D = 250 mA

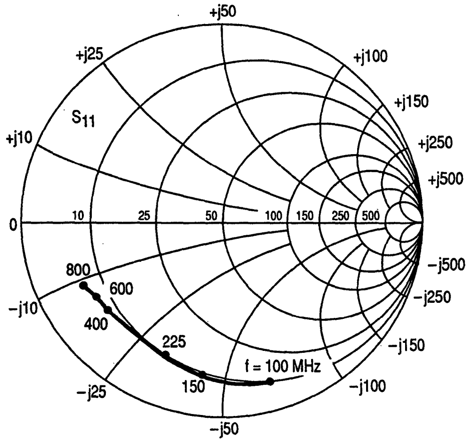


Figure 14. S_{11}, Input Reflection Coefficient versus Frequency
V_{DS} = 28 V, I_D = 250 mA

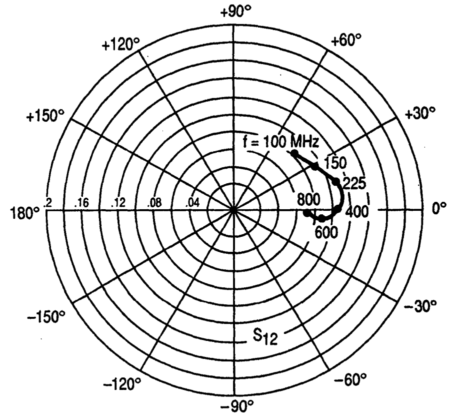


Figure 15. S_{12}, Reverse Transmission Coefficient versus Frequency
V_{DS} = 28 V, I_D = 250 mA

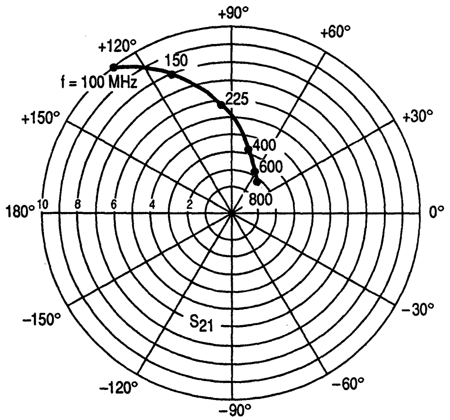


Figure 16. S_{21}, Forward Transmission Coefficient versus Frequency
V_{DS} = 28 V, I_D = 250 mA

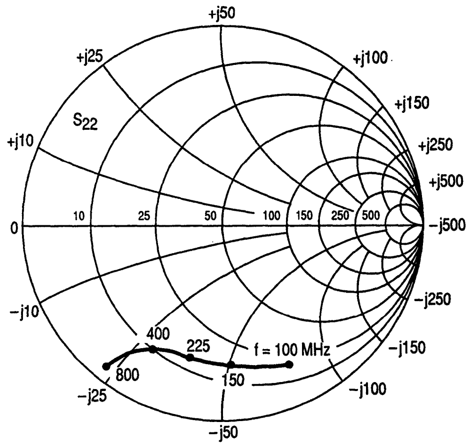


Figure 17. S_{22}, Output Reflection Coefficient versus Frequency
V_{DS} = 28 V, I_D = 250 mA

2

DESIGN CONSIDERATIONS

The MRF161 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF161 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF161 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF161 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for MRF161. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF161, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF161 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

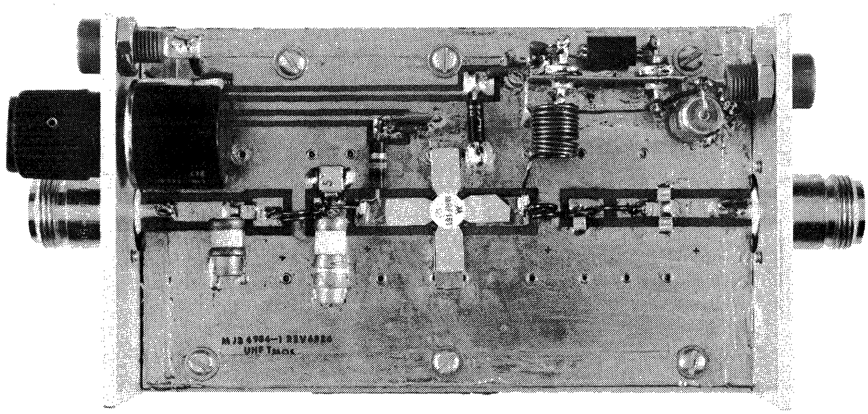


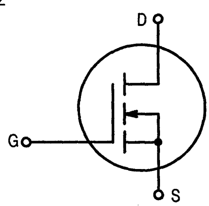
Figure 18. 400 MHz Test Circuit

MRF162

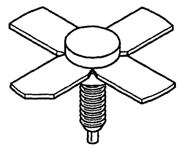
The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

. . . designed for wideband large-signal output and driver applications up to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 15 Watts
  Minimum Gain = 11 dB
  Efficiency — 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 2.0 dB (Typ) at 300 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



**15 W, to 400 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET**



CASE 244, STYLE 3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	2.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.286	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

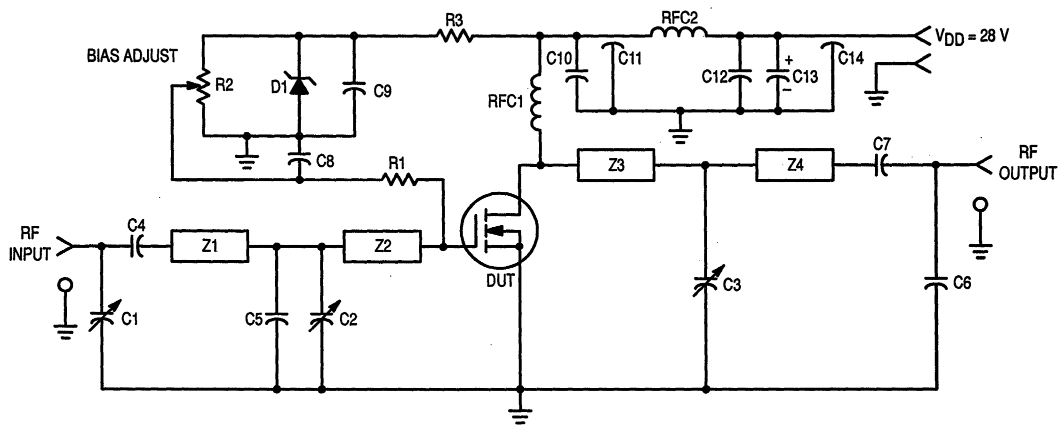
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 250 mA)	g_{fs}	250	400	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	24	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	5.5	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DS} = 28 Vdc, I_D = 300 mA, f = 400 MHz, Z_S = 5.9 + j7.8 Ω, Z_L = 3.78 + j5.75 Ω)	NF	—	2.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 400 MHz, I_{DQ} = 50 mA)	G_{ps}	11	13.6	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 400 MHz, I_{DQ} = 50 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 400 MHz, I_{DQ} = 50 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

2



C1, C2, C3 — 1.0–20 pF Johanson or Equivalent
C4, C7 — 270 pF, 100 Mil Chip Cap
C5 — 18 pF Mini-Unelco or Equivalent
C6 — 12 pF, 100 Mil Chip Cap
C8 — 0.01 μF, 50 V Disc Ceramic
C9, C10, C12 — 0.1 μF, 50 V Disc Ceramic
C11, C14 — 680 pF Feedthru
C13 — 20 μF, 50 V
D1 — 1N5925A Motorola Zener
R1 — 10 kΩ, 1/4 W
R2 — 10 Turns 10 kΩ
R3 — 1.6 kΩ, 1/4 W
RFC1 — 10 Turns, 0.300″ ID #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
Z1 — 1.5″ x 0.250″ Microstrip
Z2 — 0.6″ x 0.250″ Microstrip
Z3 — 1.3″ x 0.250″ Microstrip
Z4 — 0.85″ x 0.250″ Microstrip
Board — Glass Teflon, 62 Mils, ε_r = 2.56

Figure 1. 400 MHz Test Circuit

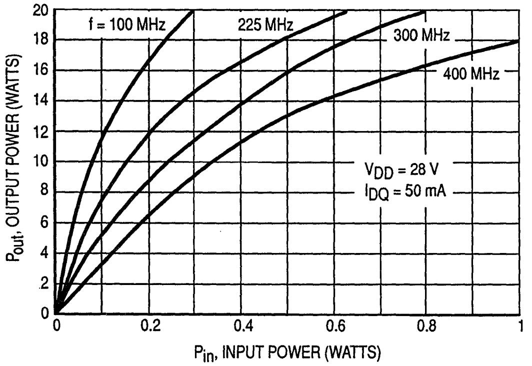


Figure 2. Output Power versus Input Power

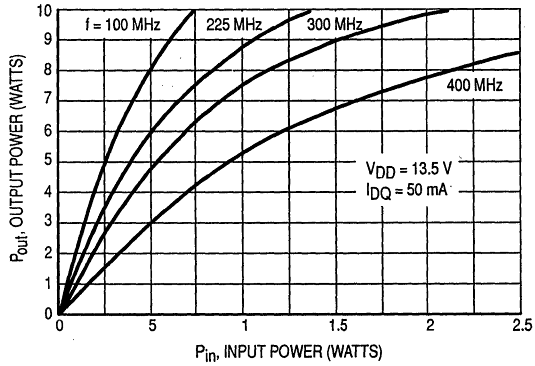


Figure 3. Output Power versus Input Power

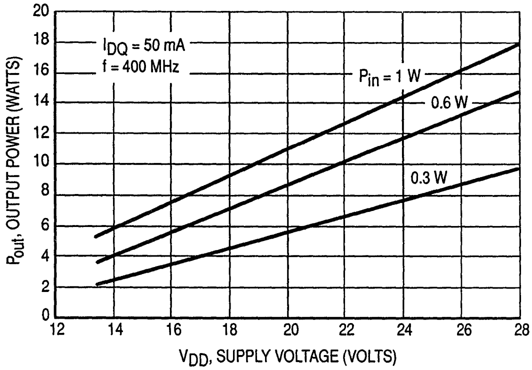


Figure 4. Output Power versus Supply Voltage

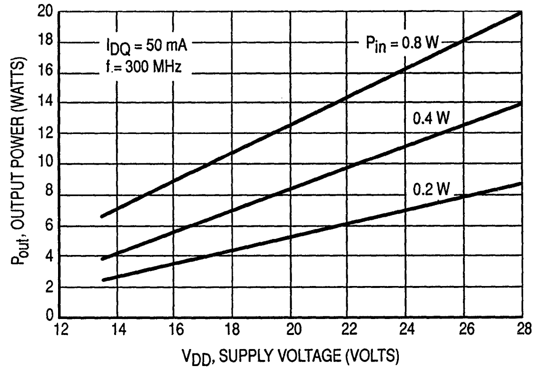


Figure 5. Output Power versus Supply Voltage

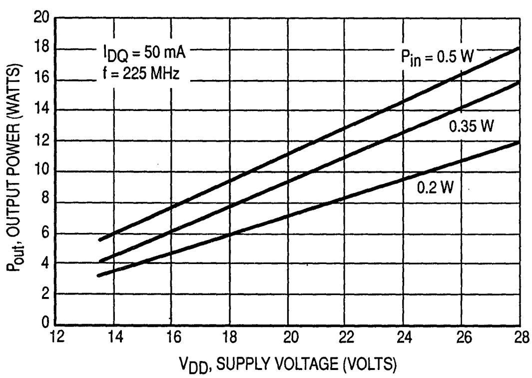


Figure 6. Output Power versus Supply Voltage

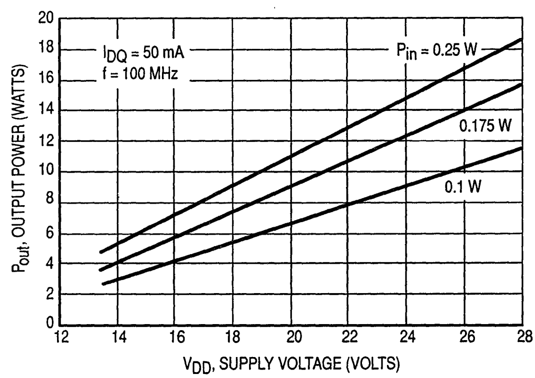


Figure 7. Output Power versus Supply Voltage

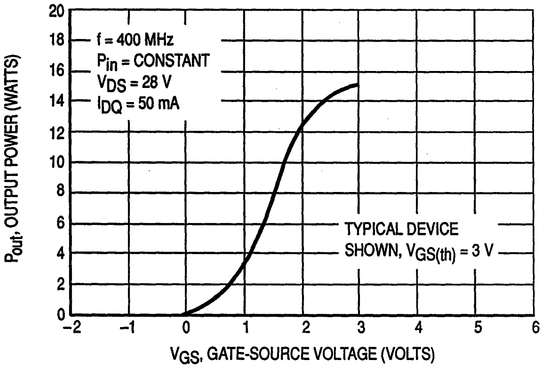


Figure 8. Output Power versus Gate Voltage

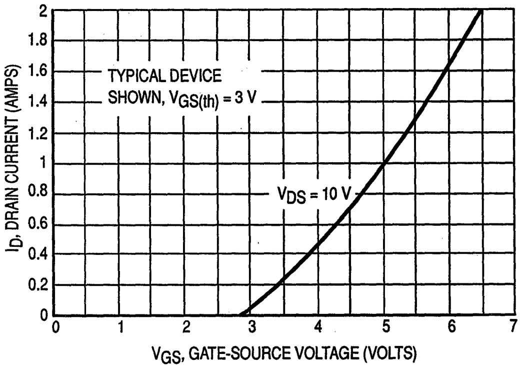


Figure 9. Drain Current versus Gate Voltage (Transfer Characteristics)

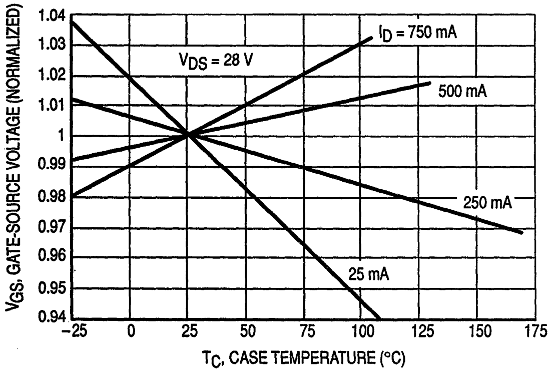


Figure 10. Gate-Source Voltage versus Case Temperature

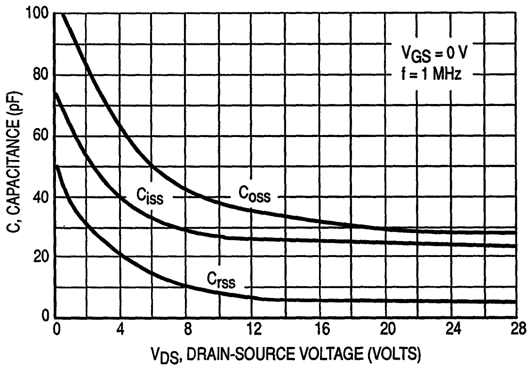


Figure 11. Capacitance versus Drain-Source Voltage

2

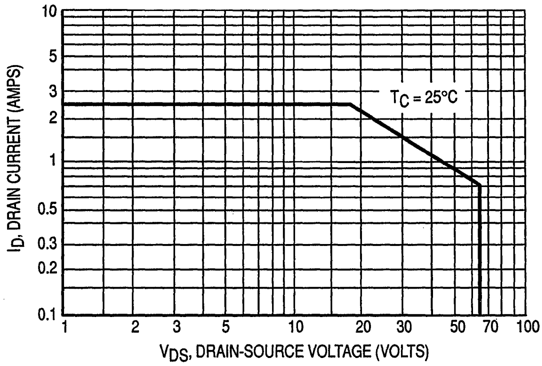


Figure 12. DC Safe Operating Area

2

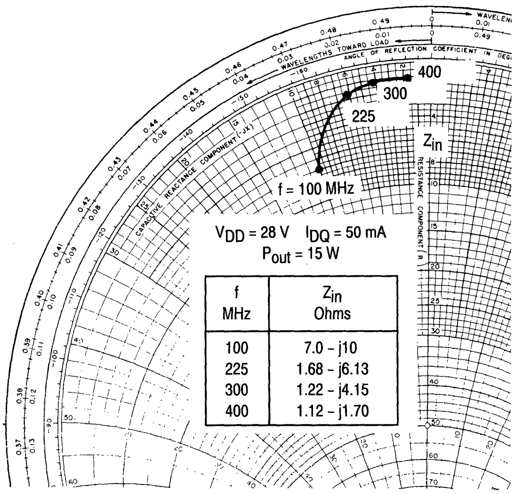


Figure 13. Large-Signal Series Equivalent Input Impedance, Z_{in}

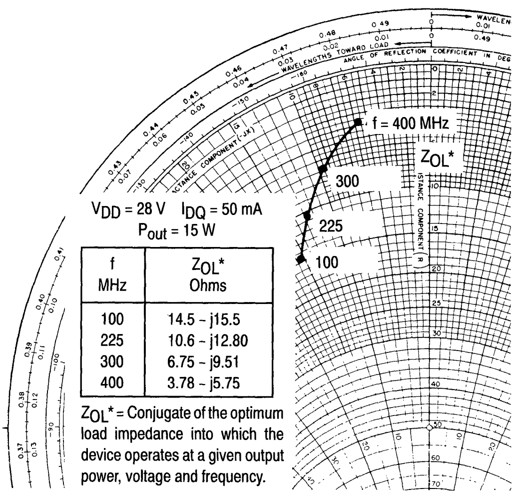


Figure 14. Large-Signal Series Equivalent Output Impedance, Z_{OL}*

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
2.0	0.996	−11	34.29	171	0.007	80	0.730	−12
5.0	0.983	−27	33.00	159	0.016	73	0.729	−30
10	0.943	−51	31.76	147	0.030	60	0.728	−57
20	0.871	−86	24.38	130	0.047	41	0.726	−94
30	0.833	−109	18.82	118	0.054	30	0.727	−116
40	0.811	−123	14.93	110	0.058	23	0.728	−129
50	0.796	−133	12.42	105	0.060	18	0.729	−138
60	0.788	−140	10.45	101	0.061	14	0.729	−143
70	0.782	−145	9.13	97	0.061	11	0.729	−148
80	0.779	−149	8.01	94	0.062	8.9	0.731	−151
90	0.777	−152	7.12	92	0.062	7.1	0.733	−153
100	0.776	−155	6.48	89	0.062	5.3	0.735	−155
110	0.775	−157	5.92	87	0.062	3.9	0.737	−156
120	0.775	−158	5.45	85	0.062	2.4	0.739	−158
130	0.775	−160	5.03	83	0.062	1.5	0.741	−159
140	0.775	−161	4.69	81	0.062	0.4	0.743	−159
150	0.775	−162	4.37	80	0.061	−0.6	0.744	−160
160	0.777	−163	4.10	78	0.062	−1.3	0.746	−161
170	0.777	−163	3.87	77	0.061	−2.2	0.748	−161
180	0.778	−164	3.65	75	0.061	−2.8	0.750	−161
190	0.780	−165	3.46	74	0.061	−3.7	0.753	−162
200	0.781	−165	3.29	72	0.060	−4.2	0.755	−162
225	0.784	−166	2.87	69	0.060	−5.8	0.765	−163
250	0.788	−166	2.57	66	0.059	−7.7	0.770	−163
275	0.790	−167	2.30	64	0.059	−9.0	0.780	−163
300	0.792	−167	2.20	62	0.059	−11	0.795	−163
325	0.794	−168	1.94	57	0.059	−12	0.812	−163
350	0.794	−169	1.78	56	0.058	−15	0.815	−163
375	0.799	−169	1.67	54	0.057	−16	0.826	−163
400	0.805	−169	1.56	51	0.055	−17	0.836	−163
425	0.815	−169	1.45	50	0.054	−17	0.862	−163
450	0.825	−169	1.39	47	0.053	−17	0.860	−162
475	0.834	−170	1.32	45	0.052	−17	0.871	−162
500	0.837	−170	1.23	42	0.051	−16	0.871	−162
525	0.838	−171	1.16	41	0.050	−14	0.872	−162
550	0.843	−171	1.11	39	0.048	−13	0.883	−162
575	0.845	−172	1.07	37	0.048	−12	0.894	−162
600	0.855	−172	1.03	35	0.046	−10	0.901	−163
625	0.856	−173	0.977	33	0.045	−9.0	0.905	−163
650	0.875	−173	0.947	32	0.044	−7.0	0.921	−163
675	0.885	−173	0.914	30	0.044	−5.0	0.938	−163
700	0.888	−174	0.873	27	0.043	−4.0	0.949	−164
725	0.892	−174	0.841	27	0.042	−1.0	0.947	−164
750	0.900	−174	0.821	26	0.043	2.0	0.970	−164
775	0.910	−175	0.814	24	0.044	4.0	0.978	−164
800	0.918	−176	0.775	22	0.045	8.0	0.978	−164

Table 1. Common Source Scattering Parameters 50 Ohm System
V_{DS} = 28 V, I_D = 0.5 A

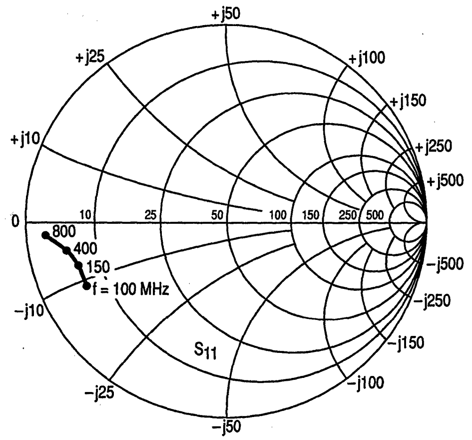


Figure 15. S_{11}, Input Reflection Coefficient versus Frequency
V_{DS} = 28 V, I_D = 0.5 A

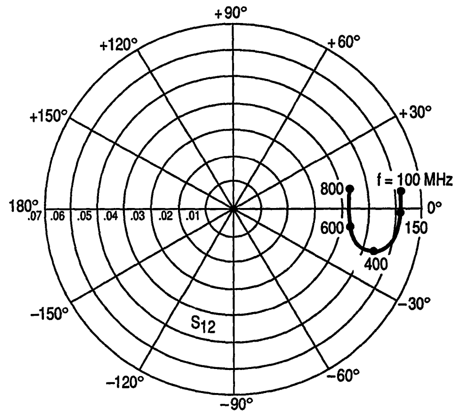


Figure 16. S_{12}, Reverse Transmission Coefficient versus Frequency
V_{DS} = 28 V, I_D = 0.5 A

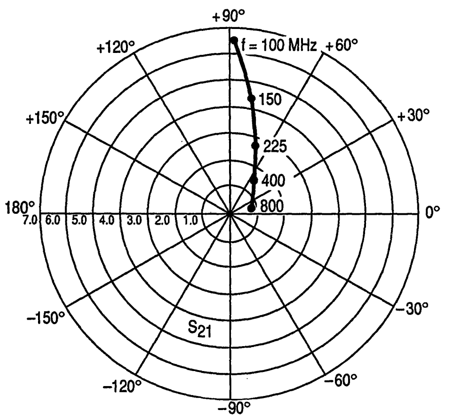


Figure 17. S_{21}, Forward Transmission Coefficient versus Frequency
V_{DS} = 28 V, I_D = 0.5 A

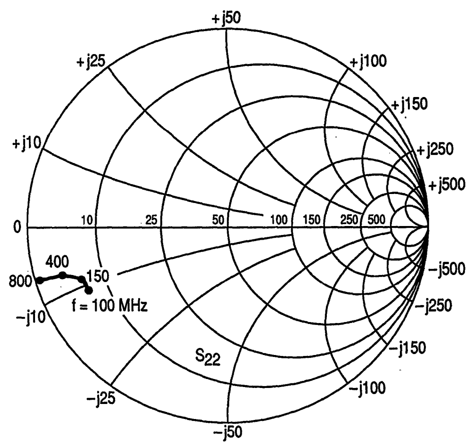


Figure 18. S_{22}, Output Reflection Coefficient versus Frequency
V_{DS} = 28 V, I_D = 0.5 A

2

DESIGN CONSIDERATIONS

The MRF162 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF162 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF162 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

2

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF162 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for MRF162. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF162, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF162 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

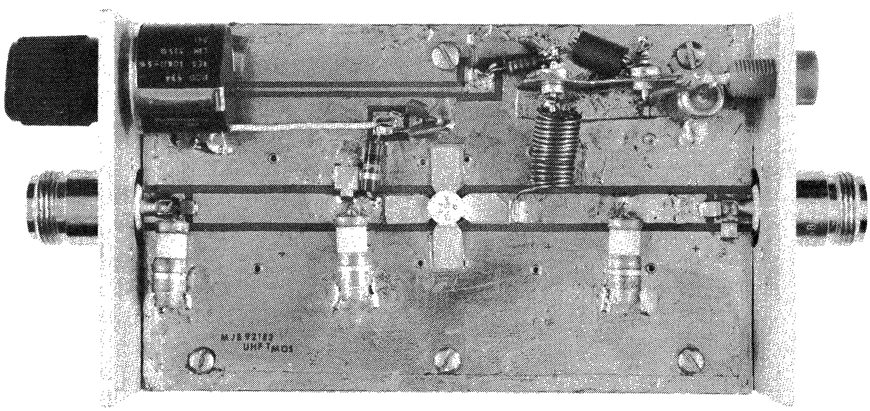


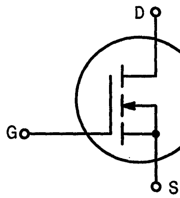
Figure 19. 400 MHz Test Circuit

MRF163

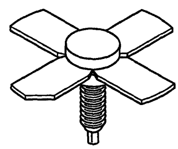
The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

... designed for wideband large-signal output and driver applications up to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 25 Watts
  Minimum Gain = 10 dB
  Efficiency — 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 2.5 dB (Typ) at 500 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



25 W, to 400 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET



CASE 244, STYLE 3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	87.5 0.5	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

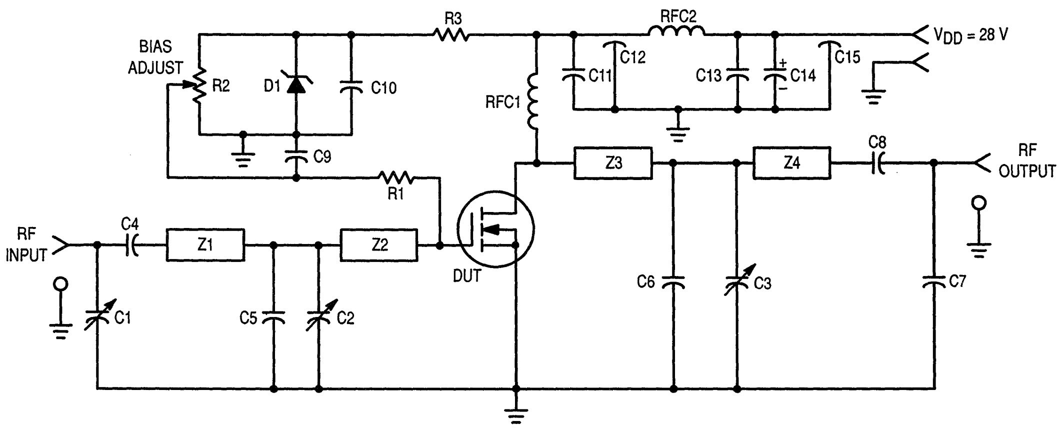
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	4.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 500 mA)	g_{fs}	500	750	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	48	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	54	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	11	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DS} = 28 Vdc, I_D = 500 mA, f = 400 MHz, Z_S = 3.23 + j2.57 Ω, Z_L = 2.11 + j2.97 Ω)	NF	—	2.5	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 25 W, f = 400 MHz, I_{DQ} = 25 mA)	G_{ps}	10	12	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 25 W, f = 400 MHz, I_{DQ} = 25 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 25 W, f = 400 MHz, I_{DQ} = 25 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

2



C1, C2, C3 — 1.0–20 pF Johanson or Equivalent
C4, C8 — 270 pF, 100 Mil Chip Cap
C5, C6 — 18 pF Mini-Unelco or Equivalent
C7 — 12 pF Mini-Unelco or Equivalent
C9 — 0.01 μF, 50 V Disc Ceramic
C10, C11, C13 — 0.1 μF, 50 V Disc Ceramic
C12, C15 — 680 pF Feedthru
C14 — 20 μF, 50 V
D1 — 1N5925A Motorola Zener
R1 — 10 kΩ, 1/4 W
R2 — 10 Turns 10 kΩ
R3 — 1.6 kΩ, 1/4 W
RFC1 — 10 Turns, 0.300″ ID #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
Z1 — 1.350″ x 0.250″ Microstrip
Z2 — 0.600″ x 0.250″ Microstrip
Z3 — 0.710″ x 0.250″ Microstrip
Z4 — 1.300″ x 0.250″ Microstrip
Board — Glass Teflon, 62 Mils, ε_r = 2.56

Figure 1. 400 MHz Test Circuit

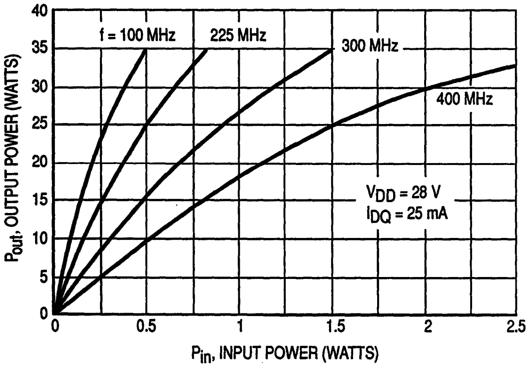


Figure 2. Output Power versus Input Power

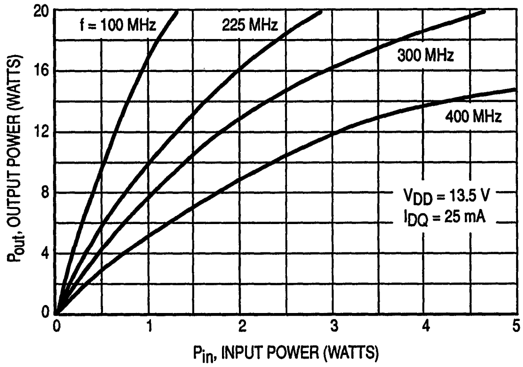


Figure 3. Output Power versus Input Power

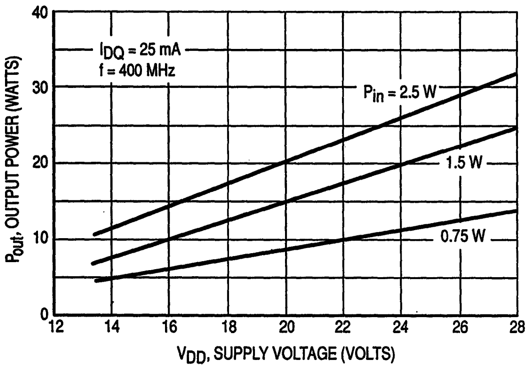


Figure 4. Output Power versus Supply Voltage

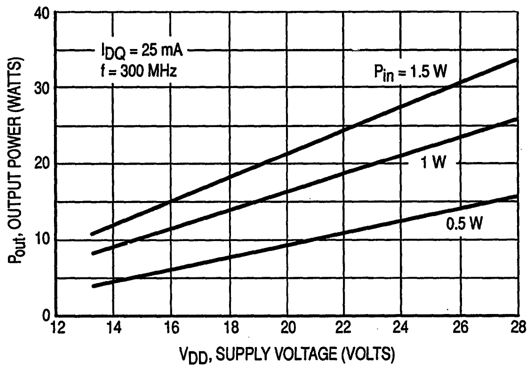


Figure 5. Output Power versus Supply Voltage

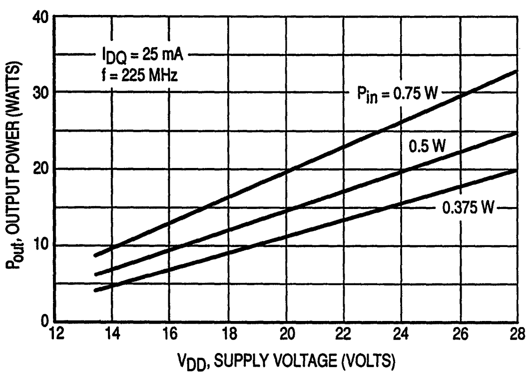


Figure 6. Output Power versus Supply Voltage

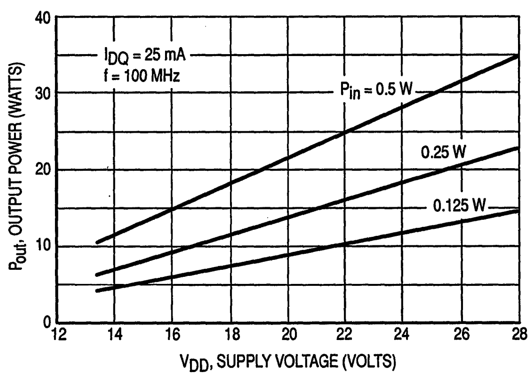


Figure 7. Output Power versus Supply Voltage

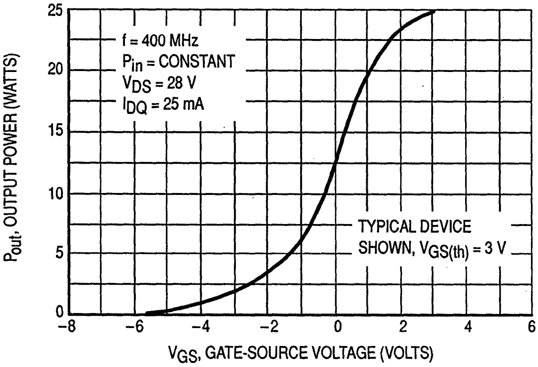


Figure 8. Output Power versus Gate Voltage

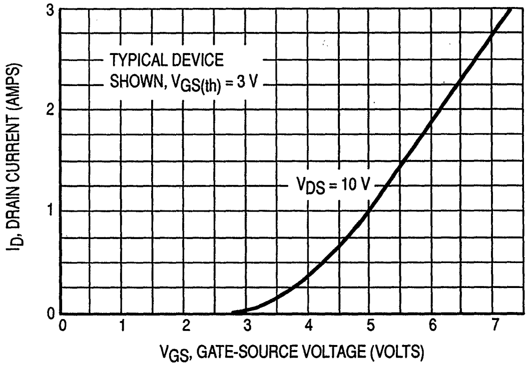


Figure 9. Drain Current versus Gate Voltage (Transfer Characteristics)

2

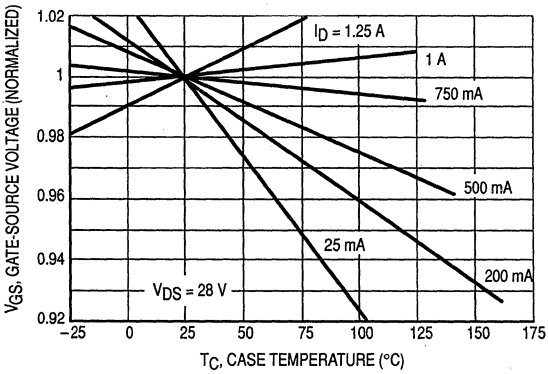


Figure 10. Gate-Source Voltage versus Case Temperature

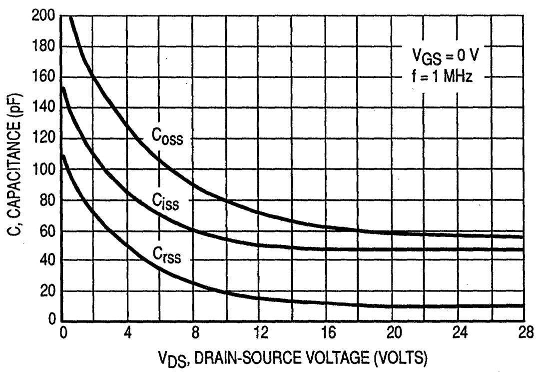


Figure 11. Capacitance versus Drain-Source Voltage

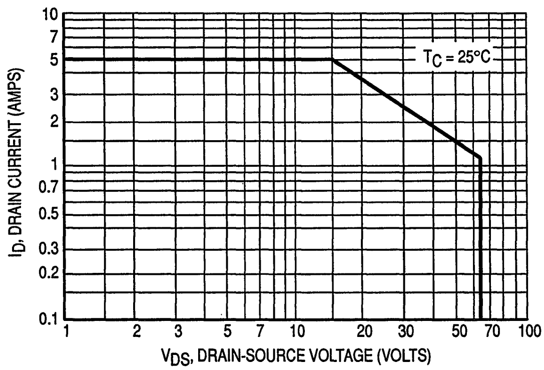
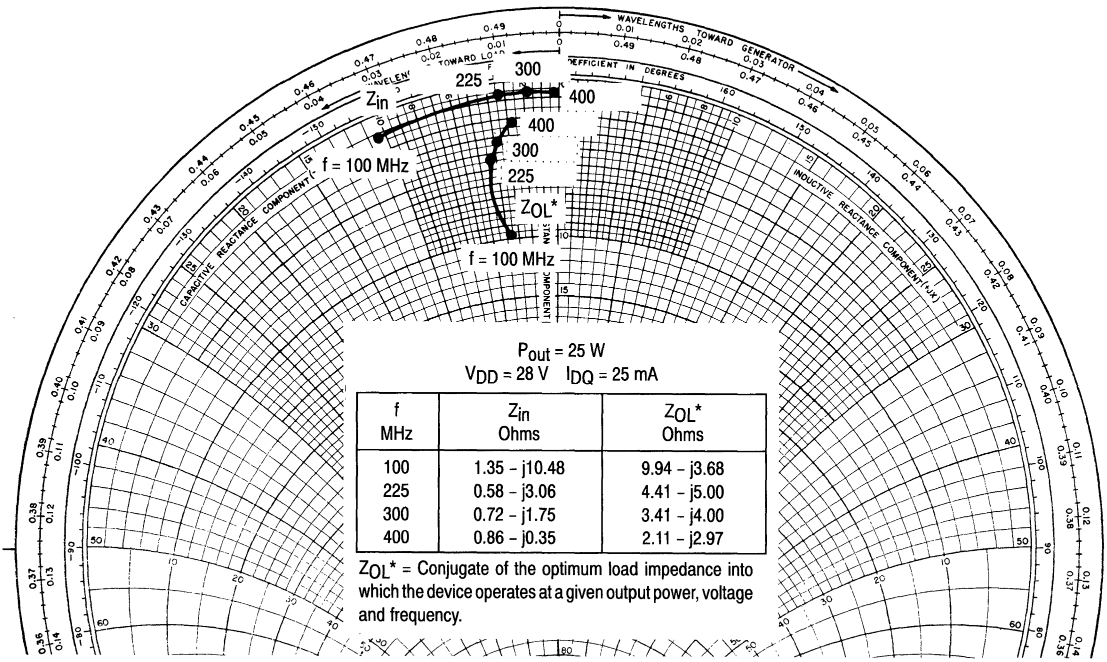


Figure 12. DC Safe Operating Area

2



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	1.35 - j10.48	9.94 - j3.68
225	0.58 - j3.06	4.41 - j5.00
300	0.72 - j1.75	3.41 - j4.00
400	0.86 - j0.35	2.11 - j2.97

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 13. Input and Output Impedance

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2.0	0.985	−30	56.97	166	0.010	63.9	0.611	−36
10	0.875	−105	34.12	125	0.032	30.6	0.736	−116
25	0.841	−145	16.17	104	0.038	9.2	0.798	−152
50	0.833	−162	8.201	92.7	0.038	1.6	0.800	−165
75	0.836	−167	5.496	86.8	0.037	−2.5	0.802	−168
100	0.838	−170	4.121	82.3	0.039	−3.0	0.804	−170
125	0.838	−171	3.255	78.6	0.039	−5.8	0.809	−170
150	0.840	−172	2.718	74.3	0.037	−8.5	0.815	−171
175	0.844	−173	2.326	70.8	0.037	−9.6	0.819	−171
200	0.849	−173	2.027	67.2	0.036	−10.4	0.824	−171
225	0.851	−173	1.782	64.0	0.036	−10.3	0.833	−171
250	0.857	−173	1.593	60.9	0.034	−11.7	0.839	−171
275	0.862	−173	1.438	58.9	0.035	−11.1	0.844	−171
300	0.866	−173	1.319	55.6	0.033	−12.1	0.846	−170
325	0.872	−173	1.209	52.3	0.032	−12.7	0.861	−170
350	0.875	−173	1.110	49.0	0.031	−13.4	0.873	−170
375	0.879	−173	1.030	46.7	0.031	−12.2	0.876	−170
400	0.882	−173	0.966	44.1	0.030	−14.6	0.883	−170
425	0.888	−173	0.904	41.3	0.029	−13.4	0.888	−170
450	0.891	−173	0.836	39.4	0.028	−11.7	0.895	−170
475	0.893	−173	0.792	37.1	0.027	−8.8	0.902	−170
500	0.901	−173	0.748	35.2	0.027	−6.1	0.911	−170
525	0.906	−173	0.715	32.4	0.025	−6.0	0.921	−170
550	0.911	−173	0.679	30.2	0.024	−6.0	0.928	−170
575	0.912	−173	0.637	28.7	0.024	−3.9	0.934	−170
600	0.913	−173	0.605	26.9	0.024	−1.0	0.939	−170
625	0.919	−174	0.579	25.3	0.024	1.0	0.947	−170
650	0.921	−174	0.566	23.0	0.025	10.1	0.961	−170
675	0.927	−174	0.540	22.6	0.025	12.1	0.963	−170
700	0.927	−174	0.510	19.9	0.025	16.5	0.966	−170
725	0.927	−173	0.485	19.5	0.025	23.1	0.967	−170
750	0.933	−174	0.481	17.4	0.026	25.3	0.967	−170
775	0.937	−174	0.453	17.2	0.028	28.0	0.976	−170
800	0.942	−174	0.448	16.8	0.030	33.8	0.976	−170

Table 1. Common Source Scattering Parameters 50 Ohm System
V_{DS} = 28 V, I_D = 0.5 A

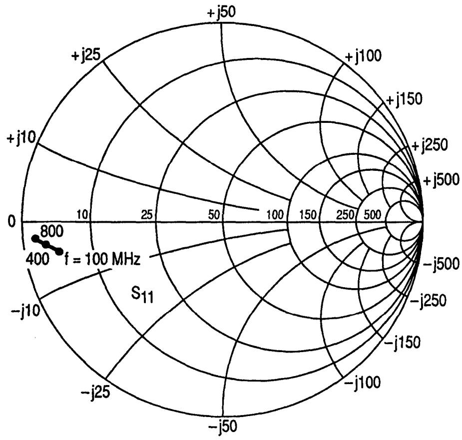


Figure 14. S_{11}, Input Reflection Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

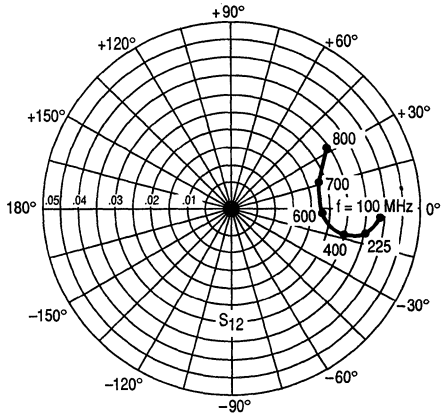


Figure 15. S_{12}, Reverse Transmission Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

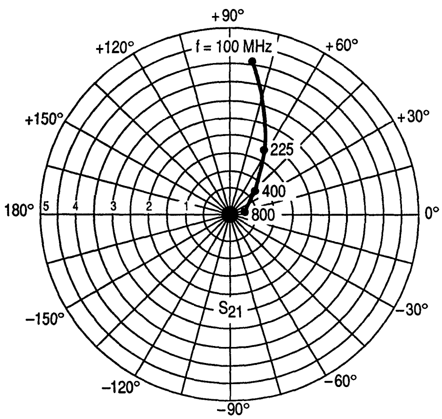


Figure 16. S_{21}, Forward Transmission Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

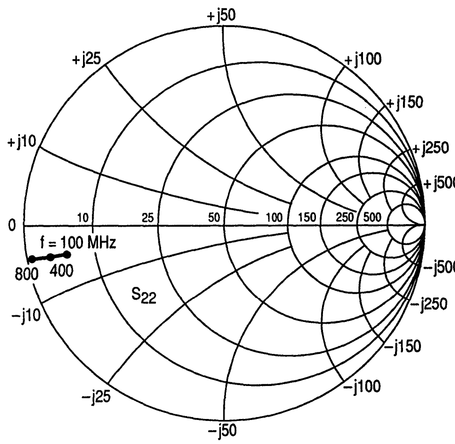


Figure 17. S_{22}, Output Reflection Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

2

DESIGN CONSIDERATIONS

The MRF163 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF163 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF163 was characterized at I_{DQ} = 25 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF163 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for MRF163. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF163, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF163 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

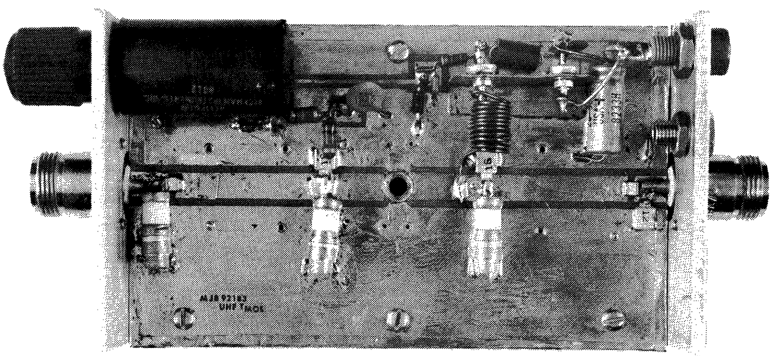


Figure 18. 400 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

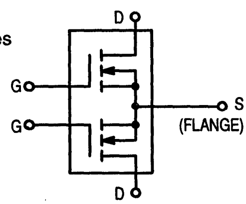
MRF164W

Motorola Preferred Devices

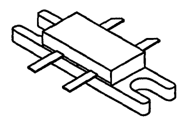
The RF TMOS Line
Power Field Effect Transistor
N-Channel Enhancement Mode

Designed primarily for wideband large-signal output and driver stages to 500 MHz.

- Guaranteed Performance at 400 MHz, 28 Vdc
- Output Power = 20 W
- Minimum Gain = 15 dB
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR



20 W, to 500 MHz
TMOS
BROADBAND
RF POWER FET



CASE 412-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	116 0.67	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

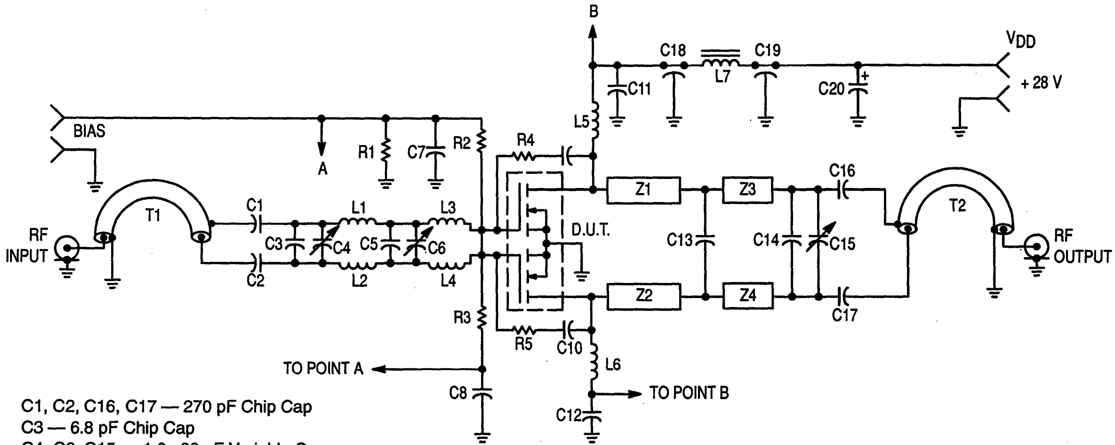
Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

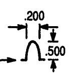
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS (1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	4.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 0.75 A)	g_{fs}	400	500	—	mmhos
DYNAMIC CHARACTERISTICS (1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	18	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	20	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.5	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1) (2)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 20 W, f = 400 MHz, I_{DQ} = 50 mA)	G_{ps}	15	17	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 20 W, f = 400 MHz, I_{DQ} = 50 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 20 W, f = 400 MHz, I_{DQ} = 50 mA, Load VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power Before and After Test			

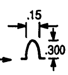
NOTES:
1. Each side of device measured separately.
2. Measured in push-pull configuration.

2



C1, C2, C16, C17 — 270 pF Chip Cap
C3 — 6.8 pF Chip Cap
C4, C6, C15 — 1.0–20 pF Variable Cap
C5 — 18 pF Chip Cap
C7, C8, C11, C12 — 0.1 μF Ceramic Cap
C9, C10 — 0.01 μF Ceramic Cap
C13 — 6.8 pF Chip Cap
C14 — 4.7 pF Chip Cap
C18, C19 — 620 pF feedthru Cap
C20 — 10 μF 50 V Tantalum Cap
L1, L2 — Hairpin Inductor #18 Wire
L3, L4 — Hairpin Inductor #18 Wire
L5, L6 — 10 Turns #18 W .300 ID
L7 — VK-200/19-4B





R1 — 1.0K 1/4 W Resistor
R2, R3 — 10K 1/4 W Resistor
R4, R5 — 470 Ω 1/4 W Resistor
T1, T2 — Balun 2″ 50 Ω Semi Ridgid Coax
Z1, Z2 — Microstrip Element .850 long x .125 W
Z3, Z4 — Microstrip Element .525 long x .125 W
Board Material — Teflon Fiberglass, ε_r = 2.55 Copper Clad, 2 oz. Copper .060″ Dielectric Thickness

Figure 1. 400 MHz Test Circuit

TYPICAL CHARACTERISTICS

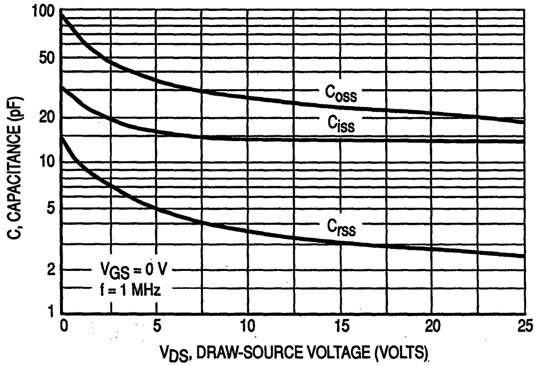


Figure 2. Capacitance versus Voltage

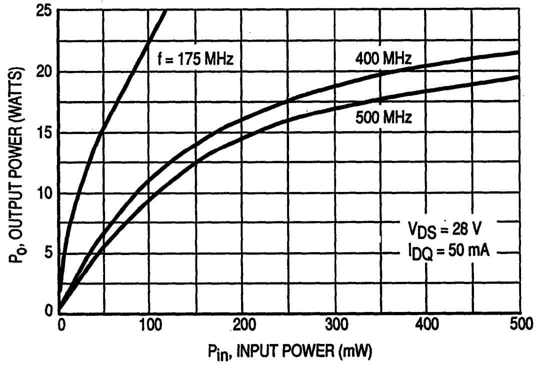


Figure 3. Output Power versus Input Power

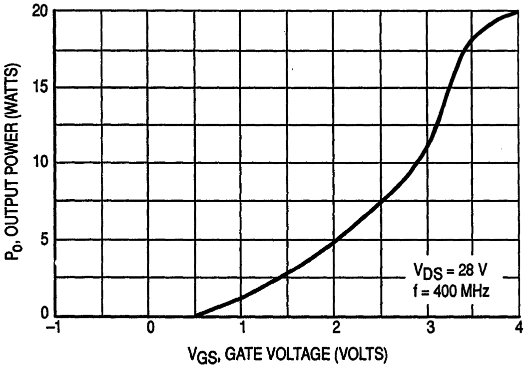


Figure 4. Output Power versus Gate Voltage

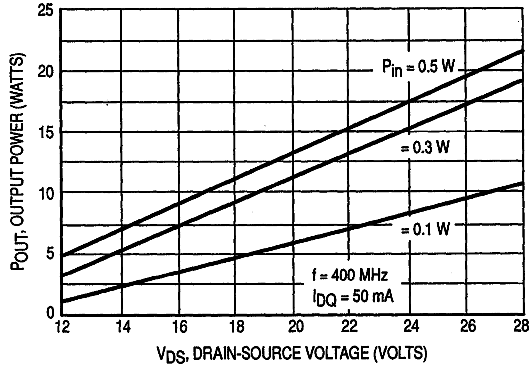
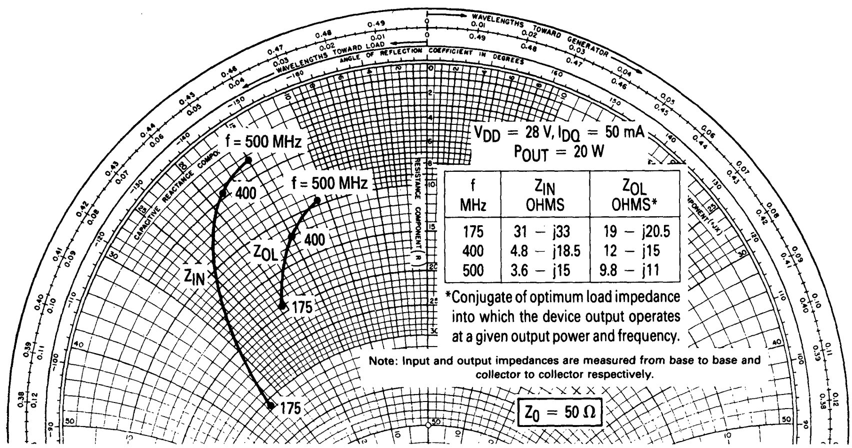


Figure 5. Output Power versus Voltage



f MHz	ZIN OHMS	ZOL OHMS*
175	31 − j33	19 − j20.5
400	4.8 − j18.5	12 − j15
500	3.6 − j15	9.8 − j11

Figure 6. Series Equivalent Input/Output Impedances

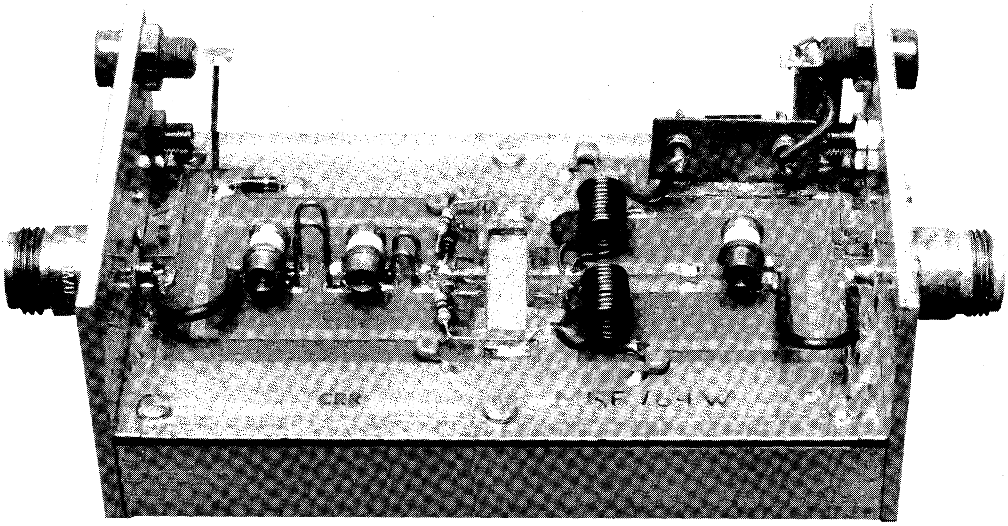
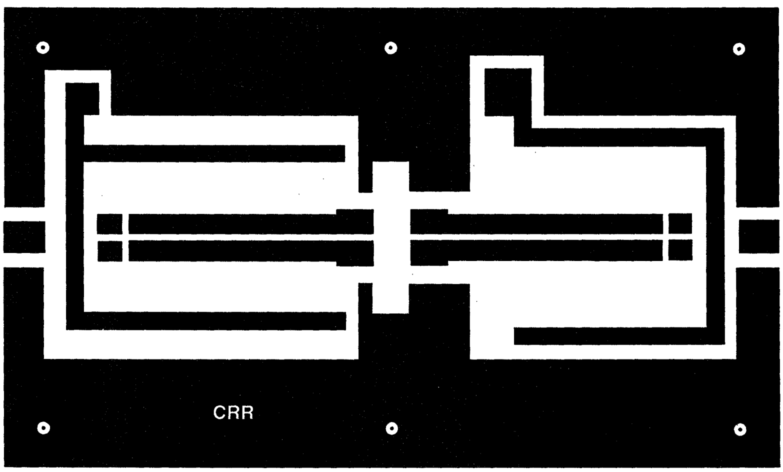


Figure 7. Test Amplifier



SCALE 0.75:1

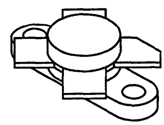
Figure 8. Circuit Board Photomaster

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

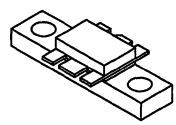
MRF166
MRF166C

The RF MOSFET Line
RF Power
Field Effect Transistors
N-Channel Enhancement Mode MOSFETs

20 W, 500 MHz
MOSFET
BROADBAND
RF POWER FETs



CASE 211-07, STYLE 2

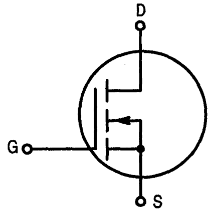


CASE 319, STYLE 3

2

Designed primarily for wideband large-signal output and driver from 30–500 MHz.

- Low C_{rss} — 4.5 pF @ V_{DS} = 28 V
- MRF166C — Typical Performance at 400 MHz, 28 Vdc
  Output Power = 20 W
  Gain = 17 dB
  Efficiency = 55%
- Optional 4-Lead Flange Package (MRF166)
- Replacement for Industry Standards such as MRF136, DV2820, BLF244, SD1902, and ST1001
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- Excellent Thermal Stability, Ideally Suited for Class A Operation



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Adc
Drain Current — Continuous	I_D	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate Above 25°C	P_D	70 0.4	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to 150	°C
Operating Junction Temperature	T_J	200	°C

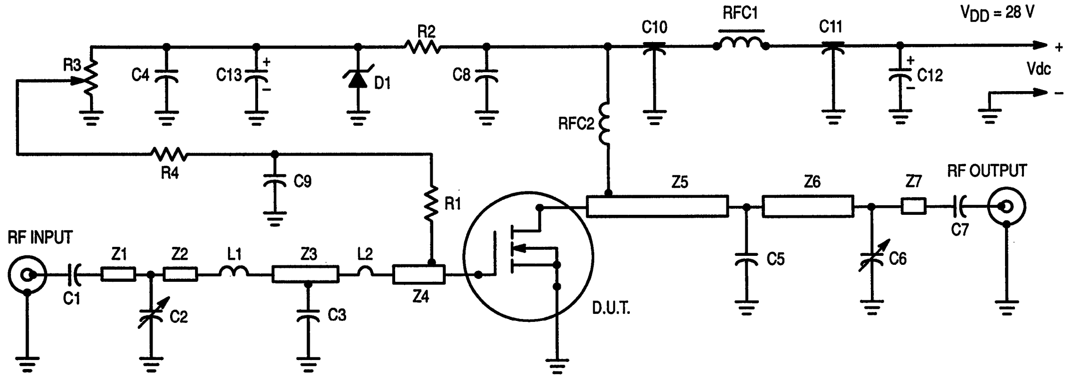
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0 V, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	V
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0 V)	I_{DSS}	—	—	1.0	mA
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0 V)	I_{GSS}	—	—	1.0	µA
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	V
Forward Transconductance (V_{DS} = 10 V, I_D = 1.5 A)	g_{fs}	600	800	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	30	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{oss}	—	35	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{rss}	—	4.5	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DD} = 28 V, f = 30 MHz, I_{DQ} = 50 mA)	NF	—	2.5	—	dB
MRF166C					
Common Source Power Gain (V_{DD} = 28 V, P_{out} = 20 W, f = 400 MHz, I_{DQ} = 100 mA)	G_{ps}	14	17	—	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 20 W, f = 400 MHz, I_{DQ} = 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 28 V, P_{out} = 20 W, f = 400 MHz, I_{DQ} = 100 mA, Load VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			
MRF166					
Common Source Power Gain (V_{DD} = 28 V, P_{out} = 20 W, f = 150 MHz, I_{DQ} = 25 mA)	G_{ps}	15	19	—	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 20 W, f = 150 MHz, I_{DQ} = 25 mA)	η	55	65	—	%
Electrical Ruggedness (V_{DD} = 28 V, P_{out} = 20 W, f = 150 MHz, I_{DQ} = 25 mA, Load VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			
Series Equivalent Input Impedance (V_{DD} = 28 V, P_{out} = 20 W, f = 150 MHz, I_{DQ} = 25 mA)	Z_{in}	—	3.99 – j12.2	—	Ohms
Series Equivalent Output Impedance (V_{DD} = 28 V, P_{out} = 20 W, f = 150 MHz, I_{DQ} = 25 mA)	Z_{out}	—	14.15 – j6.51	—	Ohms

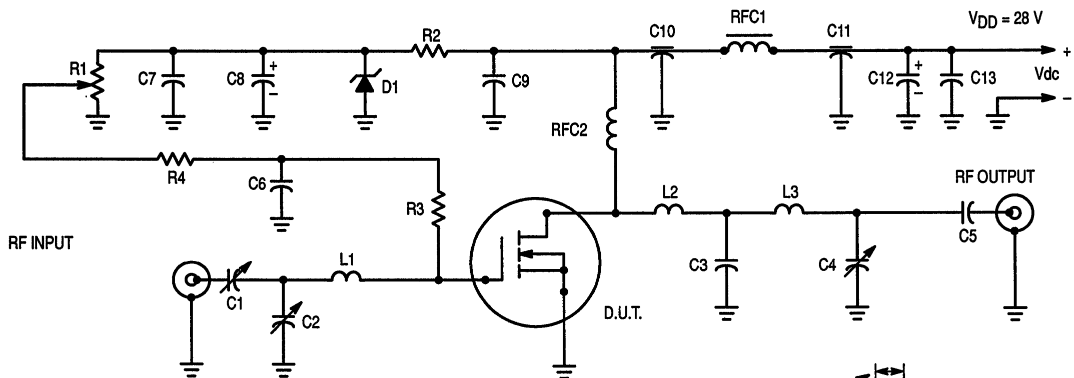


C1, C7 — 270 pF Chip Capacitor
C2, C6 — Johanson Trimmer Capacitor, 2–20 pF
C3 — 21 pF Mini Unelco
C4, C8, C9 — 0.01 µF
C5 — 18 pF Mini Unelco
C10, C11 — 680 pF Feed Through
C12, C13 — 50 µF, 50 V
D1 — 1N5925A Motorola Zener

Board Material — Teflon fiberglass
2 oz. Copper clad both sides, ε_r = 2.55
0.060″ Dielectric Thickness

L1 — #18 AWG, 2 Turns, 0.25″ ID 0.15″ Wide
L2 — #18 AWG Hairpin 0.7″ long, bend into hairpin
RFC1 — Ferroxcube VK200-19/4B
RFC2 — 18 Turns #18 AWG Enameled, 0.3″ ID
R1 — 220 Ω 1/2 Watt
R2 — 1.8 kΩ 1/4 Watt
R3 — 10 kΩ, 10 Turns Bourns
R4 — 10 k 1/4 Watt
Z1 — Microstrip Line 0.150″ wide, 0.420″ long
Z2 — Microstrip Line 0.150″ wide, 0.350″ long
Z3 — Microstrip Line 0.150″ wide, 0.350″ long
Z4 — Microstrip Line 0.150″ wide, 0.450″ long
Z5 — Microstrip Line 0.150″ wide, 1.1″ long
Z6 — Microstrip Line 0.150″ wide, 0.650″ long
Z7 — Microstrip Line 0.150″ wide, 0.200″ long

Figure 1. MRF166C 400 MHz Test Circuit



C1, C2 — 406 ARCO
C3 — 39 pF ATC 100 Mil Chip Cap
C4 — 403 ARCO
C5 — 470 pF ATC 100 Mil Chip Cap
C6, C7, C9, C13 — 0.01 µF
C8, C12 — 50 µF, 50 V
C10, C11 — 680 pF Feed Through
D1 — 1N5925A Motorola Zener

L1 — #20 AWG 2 Turns, 0.235″ ID, 0.10″ OD
L2 — #18 AWG 2 Turns, 0.225″ ID, 0.22″ OD
L3 — #18 AWG 2 Turns, 0.325″ ID, 0.13″ OD
RFC1 — Ferroxcube VK200-19/4B
RFC2 — 18 Turns #18 AWG Enameled, 0.3″ ID
R1 — 10 kΩ, 10 Turn Bourns
R2 — 1.8 kΩ 1/4 Watt
R3 — 120 Ω 1/2 Watt
R4 — 10 kΩ 1/4 Watt
Board Material — 0.062″ G10, 2 oz Cu Clad Double Sided

Figure 2. MRF166 150 MHz Test Circuit

TYPICAL CHARACTERISTICS

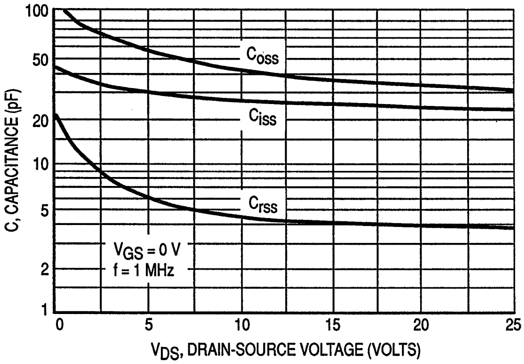


Figure 3. Capacitance versus Drain-Source Voltage

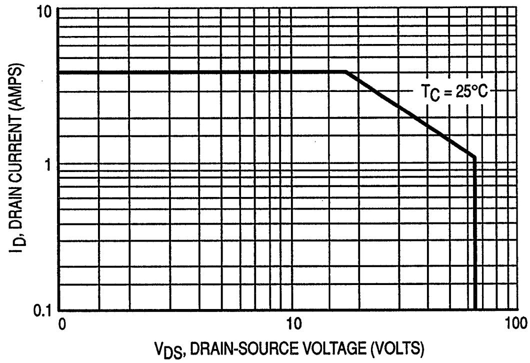


Figure 4. DC Safe Operating Area

MRF166

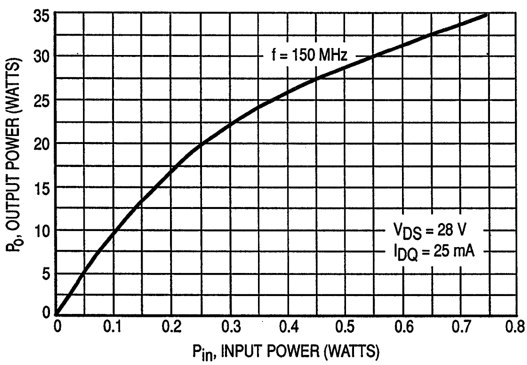


Figure 5. Output Power versus Input Power

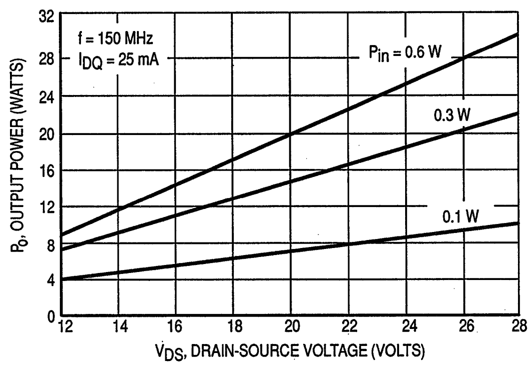


Figure 6. Output Power versus Voltage

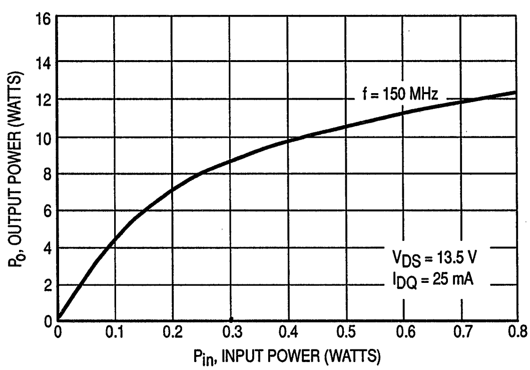


Figure 7. Output Power versus Input Power

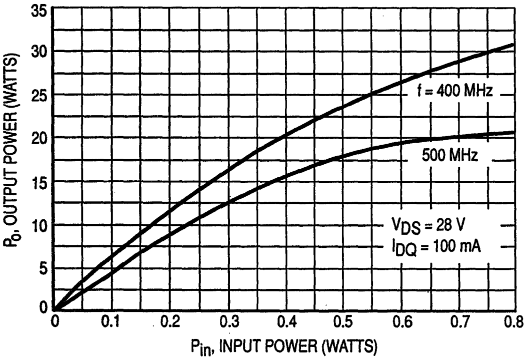


Figure 8. Output Power versus Input Power

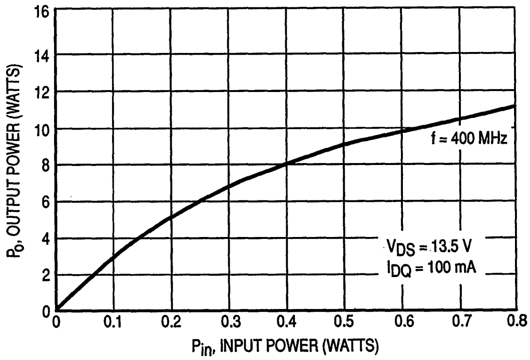


Figure 9. Output Power versus Input Power

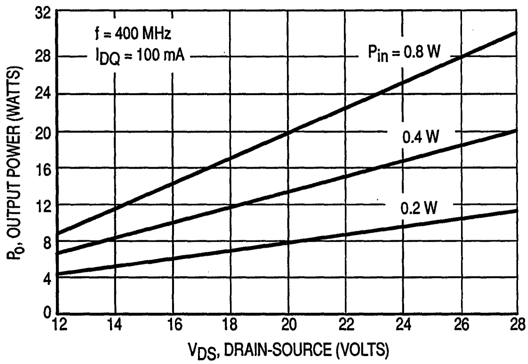
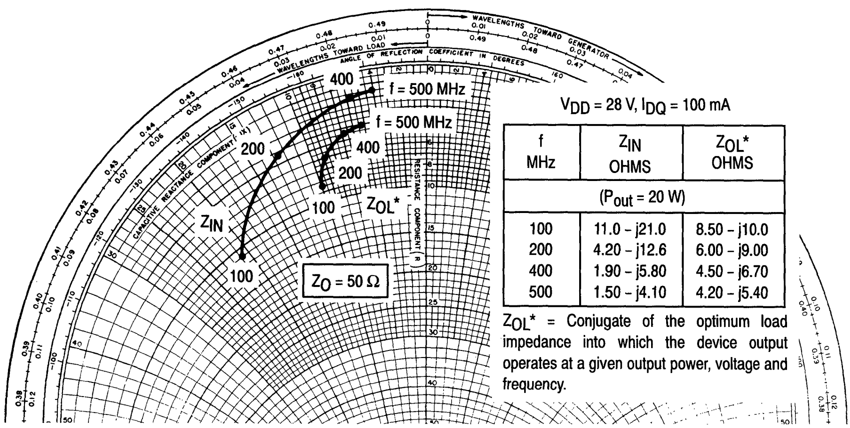


Figure 10. Output Power versus Voltage



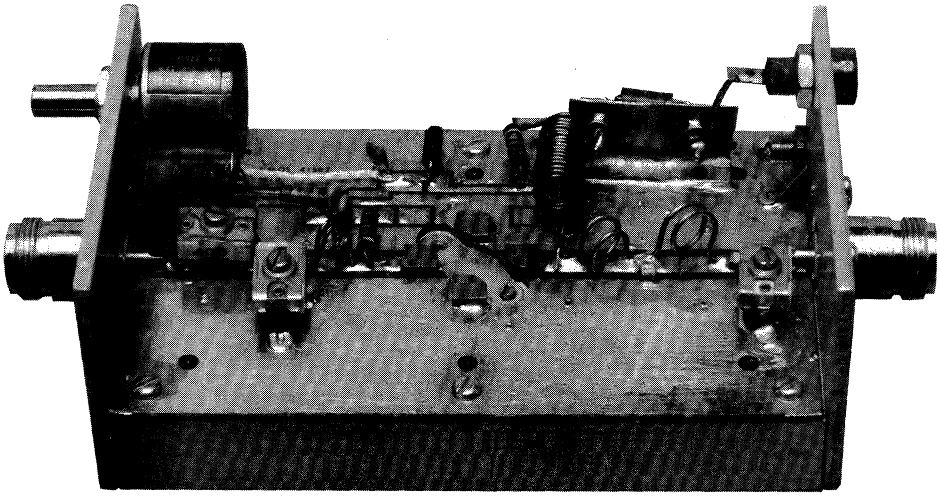
V_{DD} = 28 V, I_{DQ} = 100 mA

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
(P_{out} = 20 W)		
100	11.0 – j21.0	8.50 – j10.0
200	4.20 – j12.6	6.00 – j9.00
400	1.90 – j5.80	4.50 – j6.70
500	1.50 – j4.10	4.20 – j5.40

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

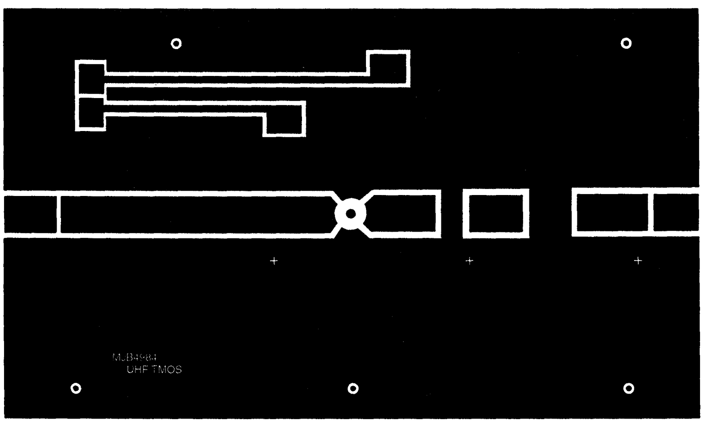
Figure 11. Series Equivalent Input and Output Impedance

2



2

Figure 12. Test Fixture MRF166



(Not to Scale)

Figure 13. Photomaster for MRF166 Test Fixture

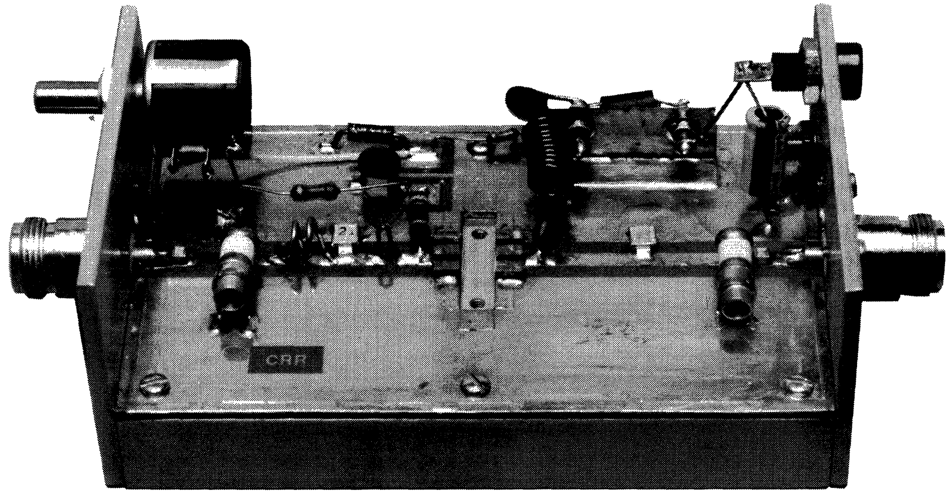
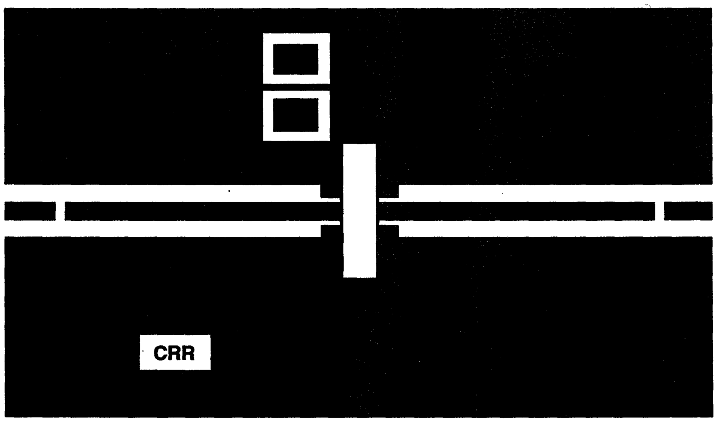


Figure 14. Test Fixture MRF166C



(Not to Scale)

Figure 15. Photomaster for MRF166C Test Fixture

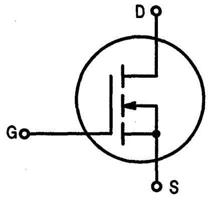
MRF171

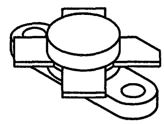
The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

. . . designed primarily for wideband large-signal output and driver stages up to 200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 45 Watts
  Minimum Gain = 12 dB
  Efficiency = 50% (Min)
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Low Noise Figure — 1.5 dB Typ at 1.0 A, 150 MHz

45 W, to 200 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET





CASE 211-07, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	4.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

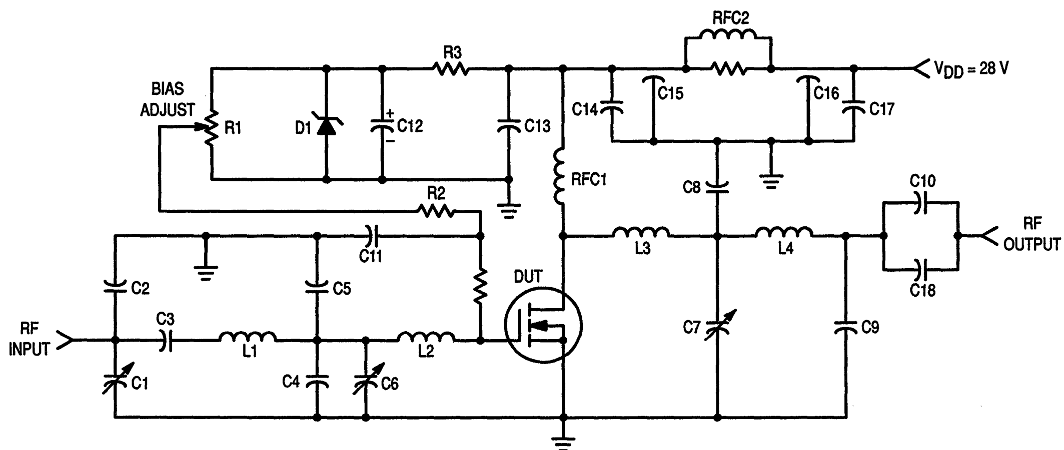
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 1.0 A)	g_{fs}	0.7	1.1	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	55	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	14	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 28 Vdc, I_D = 1.0 A, f = 150 MHz)	NF	—	1.5	—	dB
Common Source Power Gain (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, I_{DQ} = 25 mA)	G_{ps}	12	15	—	dB
Drain Efficiency (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, I_{DQ} = 25 mA)	η	50	60	—	%
Electrical Ruggedness (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, I_{DQ} = 25 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

2



C1, C6, C7 — 1.0–20 pF Johanson
C2, C4, C5, C8 — 63 pF ATC Chip (100 mils)
C3, C10, C18 — 680 pF ATC Chip (100 mils)
C9 — 12 pF ATC Chip (100 mils)
C11, C13, C14, C17 — 0.1 μF Erie Redcap, 50 V
C12 — 25 μF, 50 V
C15, C16 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
L1 — 2 Turns, #18 AWG, 0.3″ ID, 0.3″ Long
L2 — 1-1/4 Turns, #18 AWG, 0.21″ ID
L3 — 1-1/4 Turns, #18 AWG, 0.21″ ID
L4 — 2 Turns, #18 AWG, 0.23″ ID, 0.15″ Long
RFC1 — 20 Turns, #20 AWG Enameled, 0.3″ ID, Close Wound
RFC2 — 15 Turns, #20 AWG Enameled on 2.0 W, 10 Ω Resistor
R1 — 10 kΩ, 10 Turns Helipot 7216-R10K-L.25
R2 — 10 kΩ, 1/4 W
R3 — 1.8 kΩ, 1/2 W
R4 — 47 Ω, 1/2 W

Figure 1. 150 MHz Test Circuit

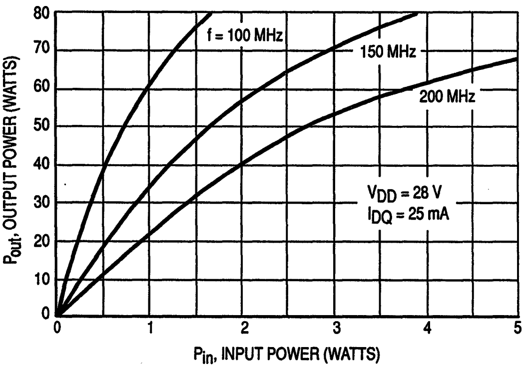


Figure 2. Output Power versus Input Power

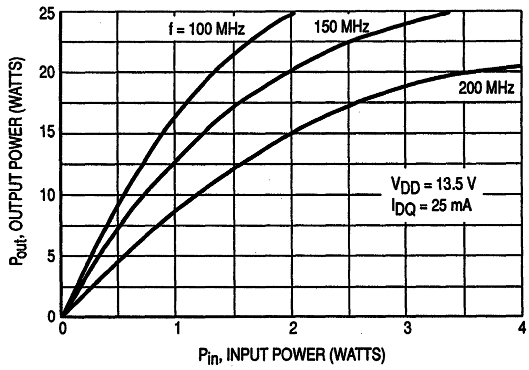


Figure 3. Output Power versus Input Power

2

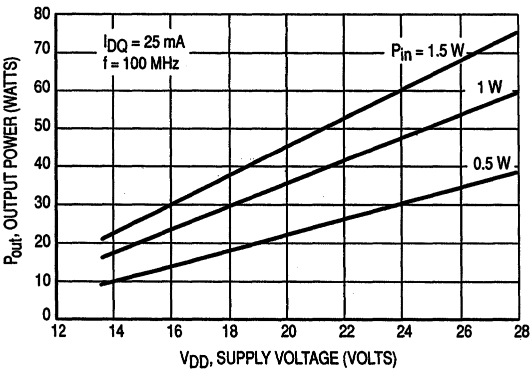


Figure 4. Output Power versus Supply Voltage

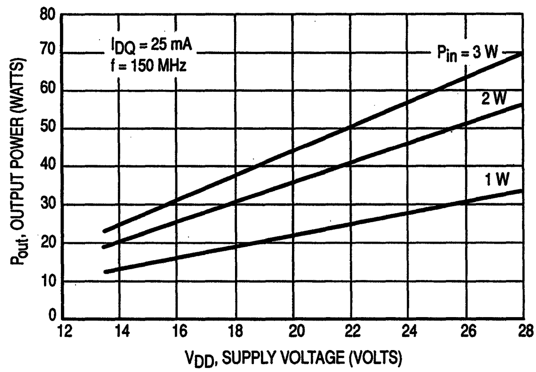


Figure 5. Output Power versus Supply Voltage

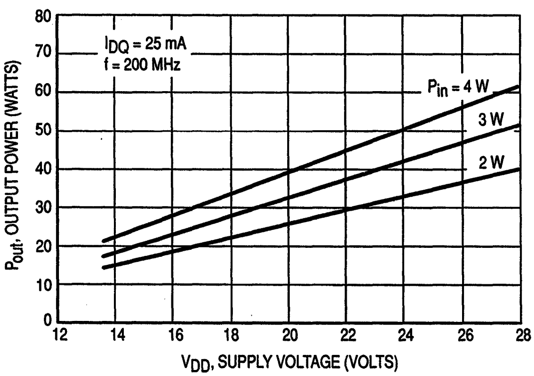


Figure 6. Output Power versus Supply Voltage

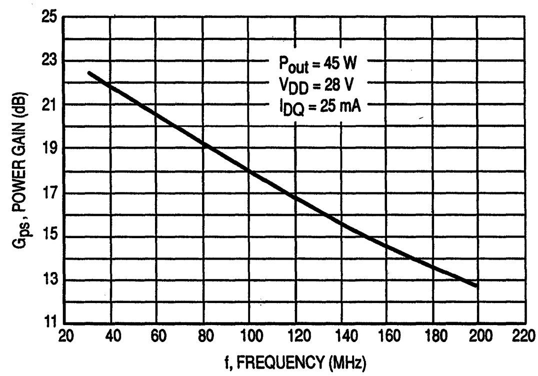


Figure 7. Power Gain versus Frequency

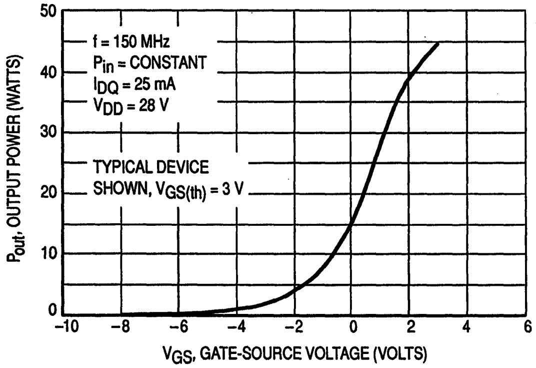


Figure 8. Output Power versus Gate Voltage

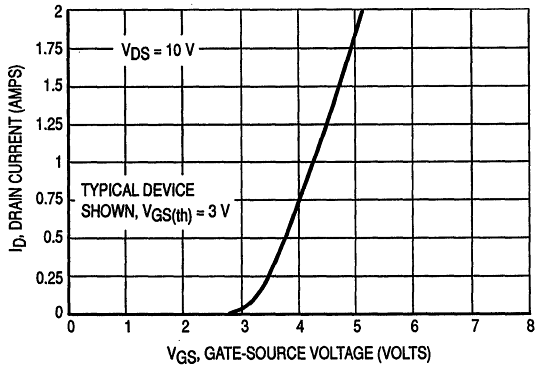


Figure 9. Drain Current versus Gate Voltage (Transfer Characteristics)

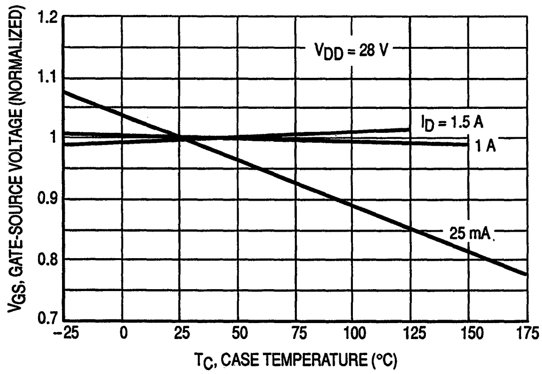


Figure 10. Gate-Source Voltage versus Case Temperature

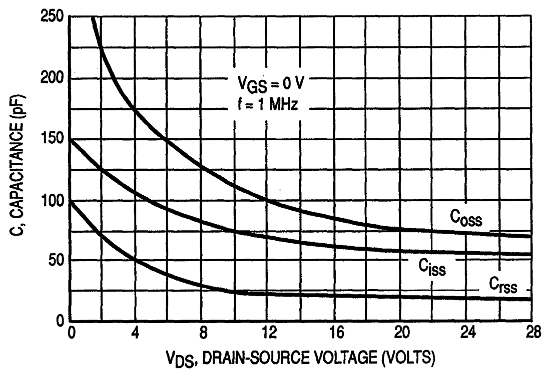


Figure 11. Capacitance versus Drain Voltage

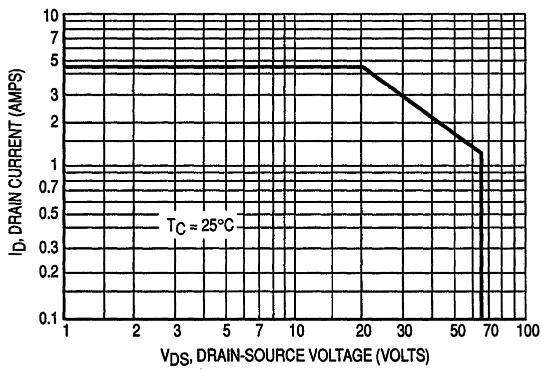


Figure 12. DC Safe Operating Area

2

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
2.0	0.966	−50	72.4	153	0.014	63	0.674	−59
5.0	0.891	−97	50.8	128	0.025	39	0.757	−109
10	0.841	−132	30.1	110	0.030	23	0.801	−141
20	0.821	−155	15.9	99	0.032	14	0.818	−160
30	0.817	−162	10.7	93	0.032	11	0.822	−166
40	0.816	−167	8.06	90	0.032	10	0.823	−169
50	0.816	−169	6.45	88	0.032	11	0.825	−171
60	0.816	−171	5.37	85	0.032	11	0.826	−172
70	0.816	−172	4.60	84	0.032	12	0.828	−173
80	0.816	−172	4.01	82	0.032	13	0.829	−174
90	0.816	−173	3.56	80	0.033	14	0.830	−174
100	0.816	−173	3.15	77	0.034	15	0.832	−174
110	0.816	−173	2.85	76	0.035	16	0.832	−175
120	0.816	−173	2.59	75	0.036	18	0.832	−175
130	0.817	−174	2.40	74	0.036	19	0.832	−175
140	0.817	−174	2.23	72	0.037	20	0.834	−175
150	0.820	−174	2.09	71	0.037	21	0.835	−175
160	0.823	−174	1.97	70	0.037	22	0.836	−175
170	0.825	−175	1.85	69	0.037	23	0.839	−175
180	0.826	−175	1.75	68	0.037	25	0.840	−175
190	0.829	−175	1.66	67	0.037	26	0.843	−175
200	0.832	−175	1.59	66	0.038	27	0.845	−175
250	0.844	−176	1.24	61	0.039	37	0.856	−175
300	0.855	−176	1.02	55	0.042	45	0.867	−174
350	0.862	−177	0.88	51	0.047	53	0.878	−174
400	0.868	−178	0.76	48	0.052	59	0.885	−174
450	0.873	−179	0.67	45	0.059	64	0.897	−174
500	0.907	179	0.63	42	0.067	67	0.892	−175

Table 1. Common Source Scattering Parameters
V_{DS} = 28 V, I_D = 0.5 A

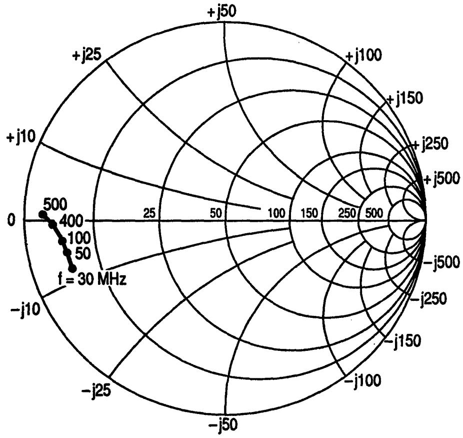


Figure 13. S_{11}, Input Reflection Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

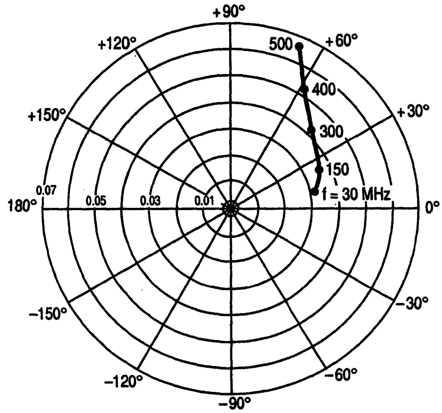


Figure 14. S_{12}, Reverse Transmission Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

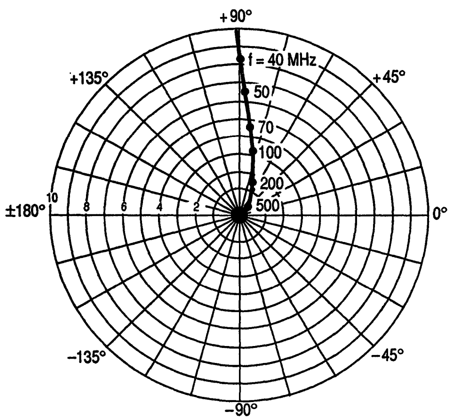


Figure 15. S_{21}, Forward Transmission Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

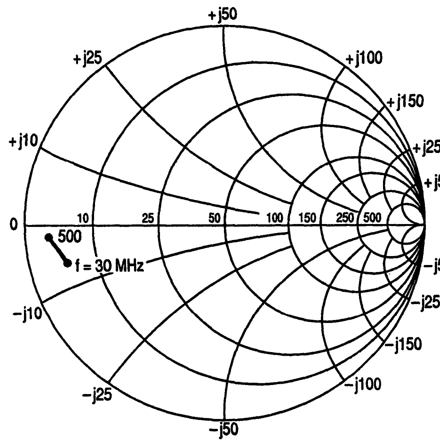
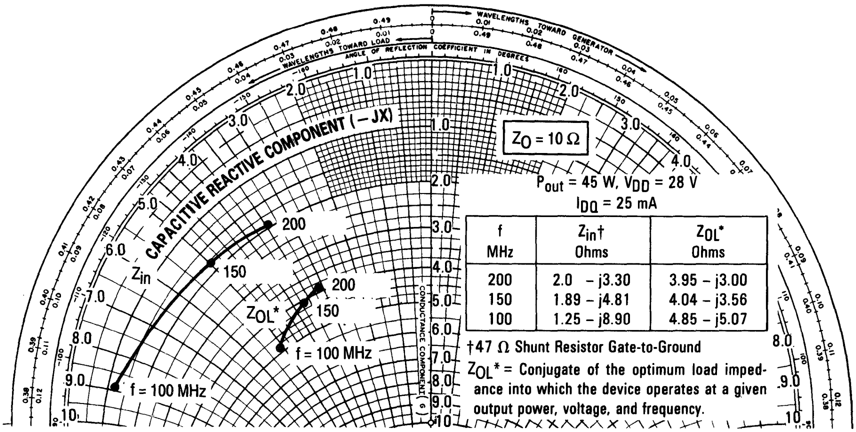


Figure 16. S_{22}, Output Reflection Coefficient versus Frequency V_{DS} = 28 V, I_D = 0.5 A

2



f MHz	Z_{in}† Ohms	Z_{OL}* Ohms
200	2.0 – j3.30	3.95 – j3.00
150	1.89 – j4.81	4.04 – j3.56
100	1.25 – j8.90	4.85 – j5.07

†47 Ω Shunt Resistor Gate-to-Ground

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 17. Large-Signal Series Equivalent Input/Output Impedance

DESIGN CONSIDERATIONS

The MRF171 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF171 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF171 was characterized at I_{DQ} = 25 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF171 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for MRF171. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF171, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF171 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

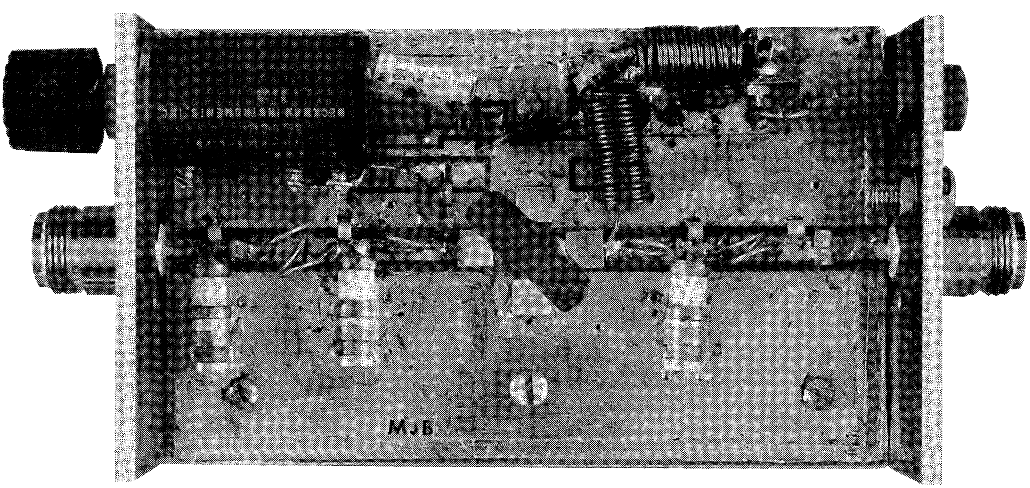


Figure 18. 150 MHz Test Circuit

MRF173*
MRF173CQ

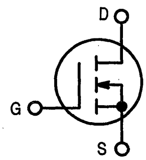
*Motorola Preferred Device

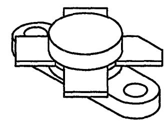
The RF MOSFET Line
RF Power
Field Effect Transistors
N-Channel Enhancement Mode MOSFETs

80 W, 28 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFETs

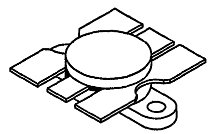
Designed for broadband commercial and military applications up to 200 MHz freqµency range. The high-power, high-gain and broadband performance of these devices make possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 150 MHz, 28 V:
  Output Power = 80 W
  Gain = 11 dB (13 dB Typ)
  Efficiency = 55% Min. (60% Typ)
- Low Thermal Resistance
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability
- Low Noise Figure — 1.5 dB Typ at 2.0 A, 150 MHz
- Excellent Thermal Stability; Suited for Class A Operation





CASE 211-11, STYLE 2
MRF173



CASE 316-01, STYLE 3
MRF173CQ

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	9.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	220 1.26	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Temperature Range	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{DS} = 0 V, V_{GS} = 0 V) I_D = 50 mA	$V_{(BR)DSS}$	65	—	—	V
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0 V)	I_{DSS}	—	—	2.0	mA
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0 V)	I_{GSS}	—	—	1.0	µA
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 50 mA)	$V_{GS(th)}$	1.0	3.0	6.0	V
Drain-Source On-Voltage ($V_{DS(on)}$, V_{GS} = 10 V, I_D = 3.0 A)	$V_{DS(on)}$	—	—	1.4	V
Forward Transconductance (V_{DS} = 10 V, I_D = 2.0 A)	g_{fs}	1.8	2.2	—	mhos

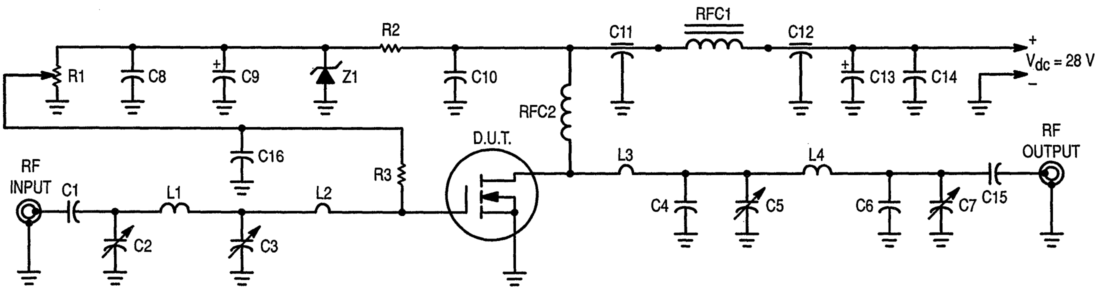
(continued)

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	110	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{oss}	—	105	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{rss}	—	10	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DD} = 28 V, f = 150 MHz, I_{DQ} = 50 mA)	NF	—	1.5	—	dB
Common Source Power Gain (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	G_{ps}	11	13	—	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	η	55	60	—	%
Electrical Ruggedness (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA) Load VSWR 30:1 at all phase angles	ψ	No Degradation in Output Power			
Series Equivalent Input Impedance MRF173 (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	Z_{in}	—	2.99–j4.5	—	Ohms
Series Equivalent Output Impedance MRF173 (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	Z_{out}	—	2.68–j1.3	—	Ohms
Series Equivalent Input Impedance MRF173CQ (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	Z_{in}	—	1.35–j5.15	—	Ohms
Series Equivalent Output Impedance MRF173CQ (V_{DD} = 28 V, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	Z_{out}	—	2.72–j149	—	Ohms



C1, C15 — 470 pF Unelco
C2, C3, C5 — Arco 463, 9–180 pF
C4, C6 — 15 pF Unelco
C7 — Arco 462 5–80 pF
C8, C10, C14, C16 — 0.1 µF
C9, C13 — 50 µF, 50 V Electrolytic
C11, C12 — 680 pF Feed Through
L1 — #16 AWG, 1-1/4 Turns, 0.3″ ID
L2 — #16 AWG Hairpin 1″ long
L3 — #14 AWG Hairpin 0.8″ long
L4 — #14 AWG Hairpin 1.1″ long
RFC1 — Ferroxcube VK200-19/4B
RFC2 — 18 Turns #18 AWG Enameled, 0.3″ ID
R1 — 10 kΩ, 10 Turns Bourns
R2 — 1.8 kΩ, 1/4 Watt
R3 — 10 kΩ, 1/2 Watt
Z1 — 1N5925A Motorola Zener

Figure 1. 150 MHz Test Circuit

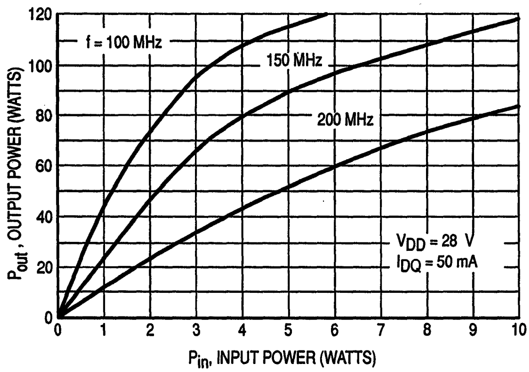


Figure 2. Output Power versus Input Power

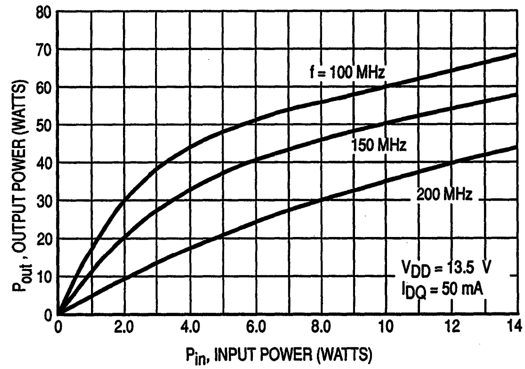


Figure 3. Output Power versus Input Power

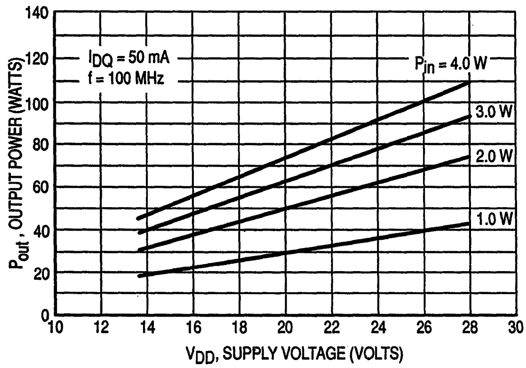


Figure 4. Output Power versus Supply Voltage

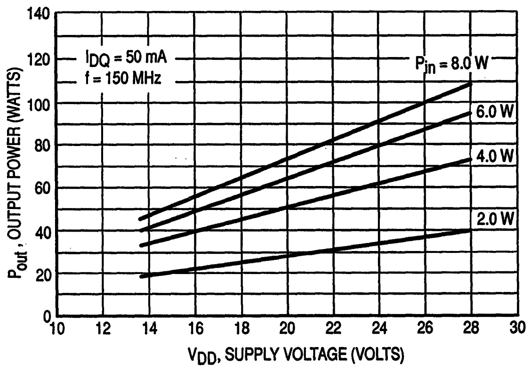


Figure 5. Output Power versus Supply Voltage

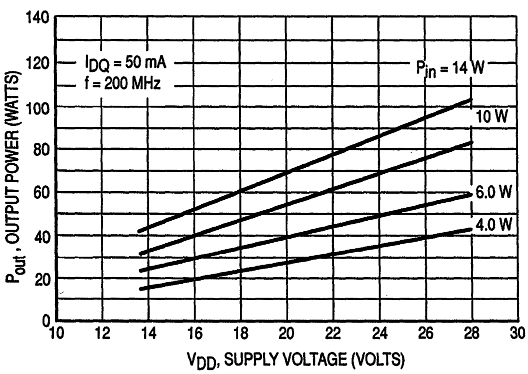


Figure 6. Output Power versus Supply Voltage

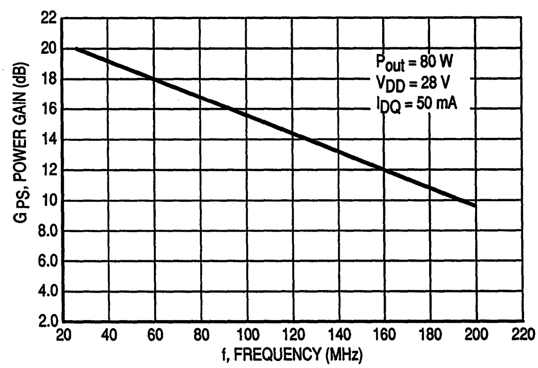


Figure 7. Power Gain versus Frequency

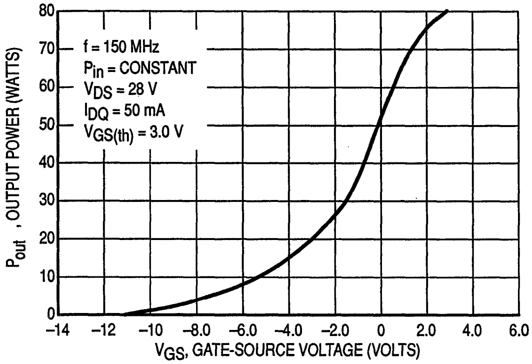


Figure 8. Output Power versus Gate Voltage

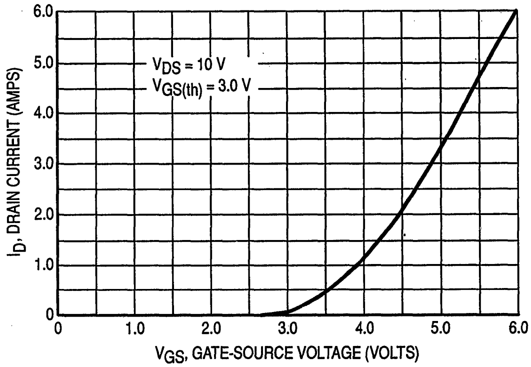


Figure 9. Drain Current versus Gate Voltage

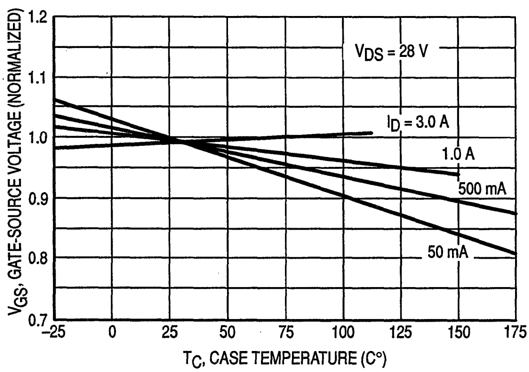


Figure 10. Gate-Source Voltage versus Case Temperature

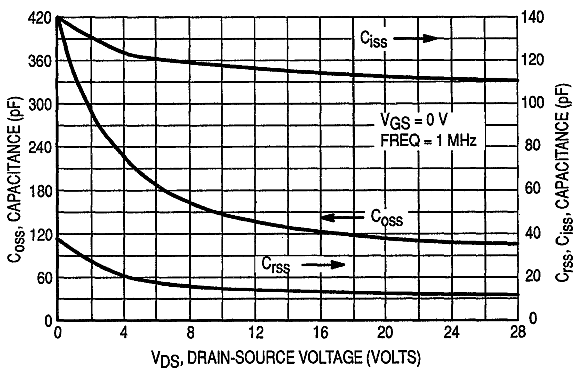


Figure 11. Capacitance versus Drain Voltage

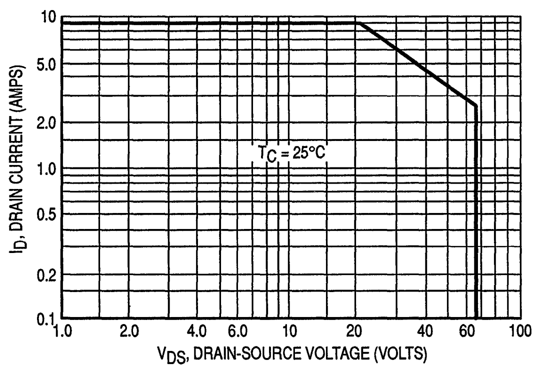


Figure 12. DC Safe Operating Area

DESIGN CONSIDERATIONS

The MRF173/CQ is a RF MOSFET power N-channel enhancement mode field-effect transistor (FET) designed for VHF power amplifier applications. Motorola's RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF173/CQ is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF173/CQ was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF173/CQ may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (see Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF173/CQ. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs helps ease the task of broadband network design. Both small-signal scattering parameters and large-signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

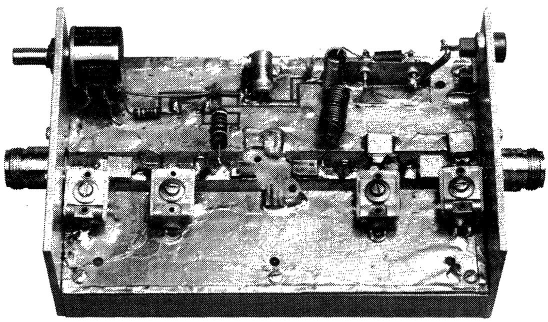


Figure 13. Test Circuit — MRF173

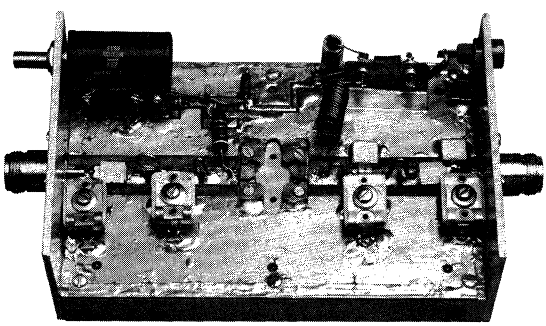


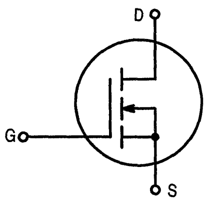
Figure 14. Test Circuit — MRF173CQ

MRF174

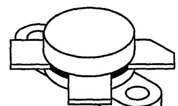
The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

. . . designed primarily for wideband large-signal output and driver stages up to 200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 125 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 50% (Min)
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 3.0 dB Typ at 2.0 A, 150 MHz



**125 W, to 200 MHz
N-CHANNEL MOS
BROADBAND RF POWER
FET**



CASE 211-11, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	13	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

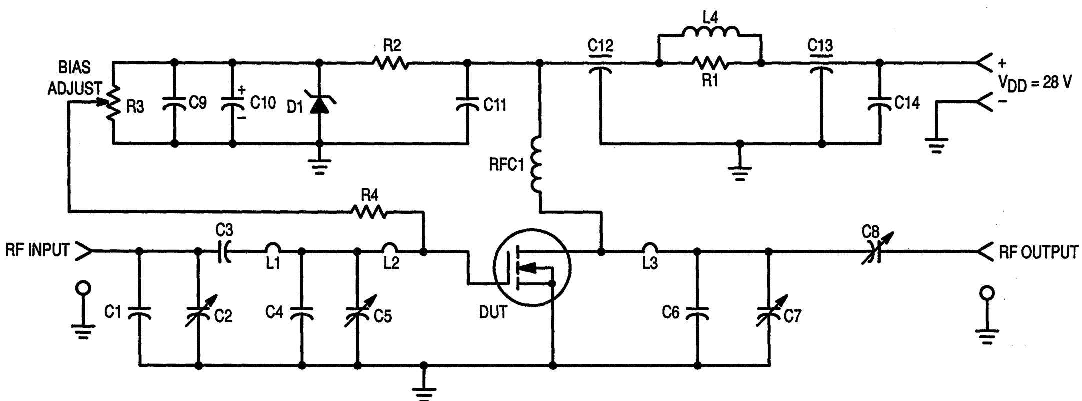
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	10	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 3.0 A)	g_{fs}	1.75	2.5	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	175	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	230	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DD} = 28 Vdc, I_D = 2.0 A, f = 150 MHz)	NF	—	3.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 125 W, f = 150 MHz, I_{DQ} = 100 mA)	G_{ps}	9.0	11.8	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 125 W, f = 150 MHz, I_{DQ} = 100 mA)	η	50	60	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 125 W, f = 150 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

2



C1 — 15 pF Unelco
C2 — Arco 462, 5.0–80 pF
C3 — 100 pF Unelco
C4 — 25 pF Unelco
C6 — 40 pF Unelco
C7 — Arco 461, 2.7–30 pF
C5, C8 — Arco 463, 9.0–180 pF
C9, C11, C14 — 0.1 μF Erie Redcap
C10 — 50 μF, 50 V
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — #16 AWG, 1-1/4 Turns, 0.213″ ID
L2 — #16 AWG, Hairpin 0.25″ 0.062″
L3 — #14 AWG, Hairpin 0.47″ 0.2″
L4 — 10 Turns #16 AWG Enameled Wire on R1
RFC1 — 18 Turns #16 AWG Enameled Wire, 0.3″ ID
R1 — 10 Ω, 2.0 W
R2 — 1.8 kΩ, 1/2 W
R3 — 10 kΩ, 10 Turn Bourns
R4 — 10 kΩ, 1/4 W

Figure 1. 150 MHz Test Circuit

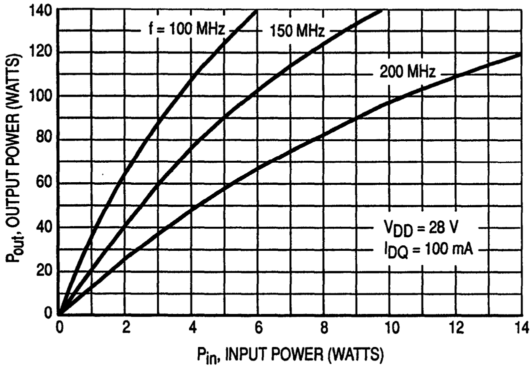


Figure 2. Output Power versus Input Power

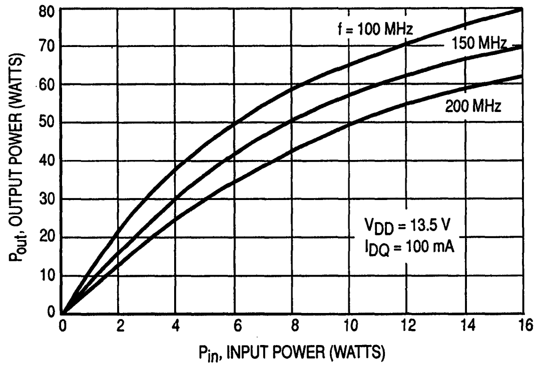


Figure 3. Output Power versus Input Power

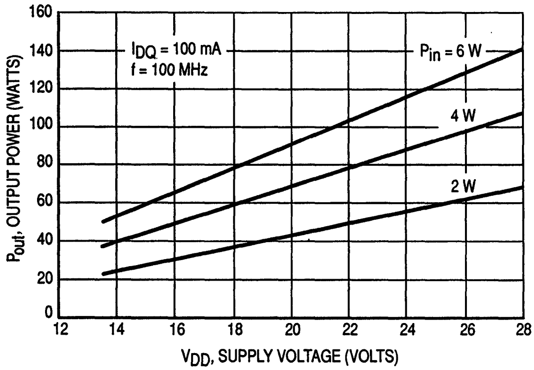


Figure 4. Output Power versus Supply Voltage

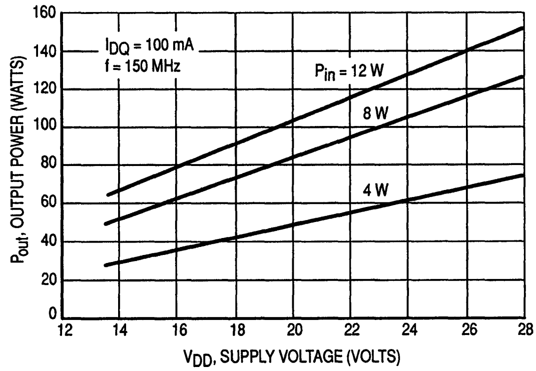


Figure 5. Output Power versus Supply Voltage

2

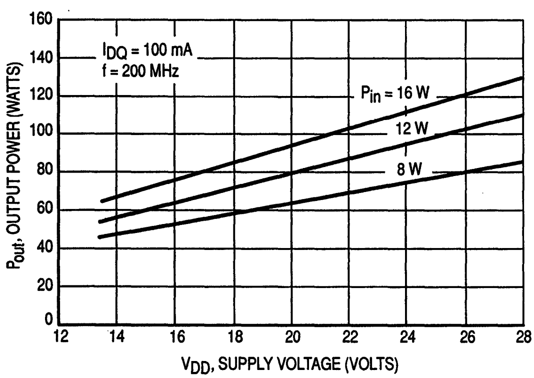


Figure 6. Output Power versus Supply Voltage

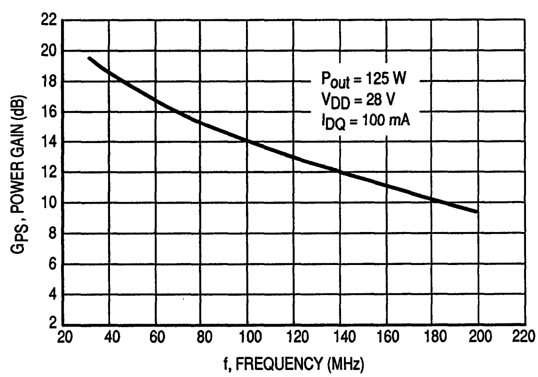


Figure 7. Power Gain versus Frequency

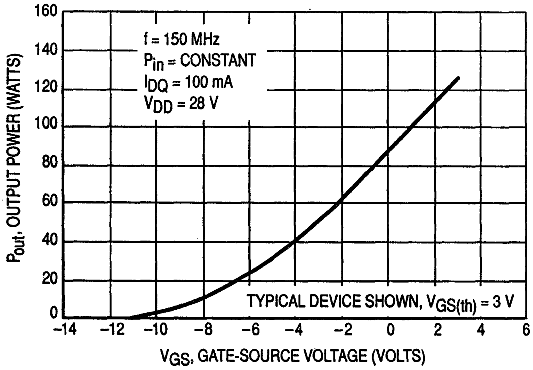


Figure 8. Output Power versus Gate Voltage

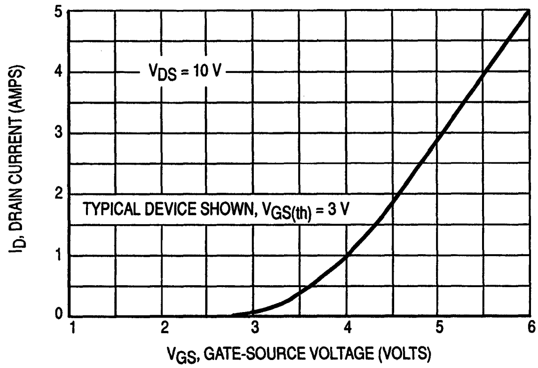


Figure 9. Drain Current versus Gate Voltage (Transfer Characteristics)

2

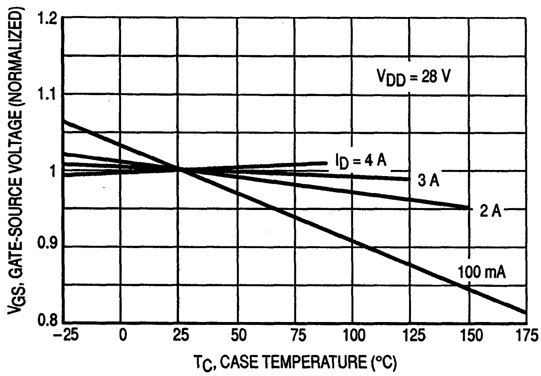


Figure 10. Gate-Source Voltage versus Case Temperature

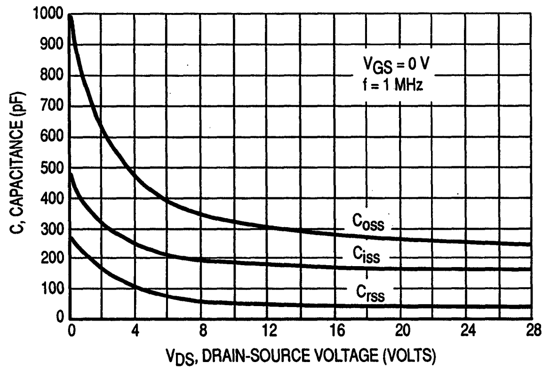


Figure 11. Capacitance versus Drain Voltage

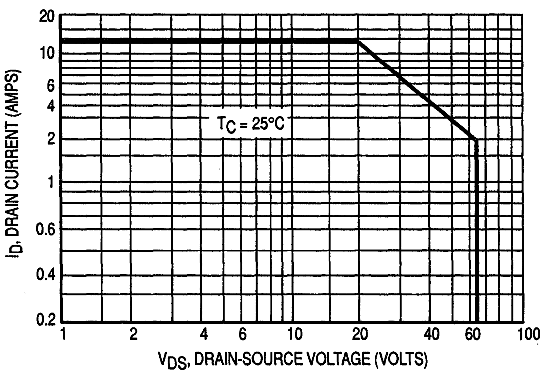


Figure 12. DC Safe Operating Area

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2.0	0.932	−133	74.0	112	0.011	23	0.835	−151
5.0	0.923	−160	31.6	98	0.011	12	0.886	−168
10	0.921	−170	16.0	93	0.011	10	0.896	−174
20	0.921	−175	8.00	88	0.011	12	0.899	−177
30	0.921	−177	5.32	86	0.011	16	0.900	−178
40	0.921	−177	3.98	83	0.012	21	0.901	−178
50	0.922	−178	3.17	81	0.012	26	0.902	−178
60	0.923	−178	2.63	79	0.012	30	0.903	−178
70	0.924	−178	2.24	77	0.013	34	0.904	−178
80	0.925	−178	1.95	75	0.013	39	0.906	−178
90	0.927	−178	1.72	73	0.014	43	0.907	−178
100	0.930	−178	1.50	71	0.016	45	0.910	−178
110	0.930	−178	1.31	70	0.018	46	0.912	−178
120	0.931	−178	1.19	68	0.019	47	0.914	−178
130	0.942	−178	1.10	67	0.019	49	0.919	−178
140	0.936	−178	1.01	66	0.021	50	0.921	−178
150	0.938	−178	0.936	65	0.021	53	0.922	−178
160	0.938	−178	0.879	64	0.022	53	0.923	−178
170	0.940	−178	0.830	63	0.023	54	0.923	−177
180	0.942	−178	0.780	61	0.024	56	0.924	−177
190	0.942	−178	0.737	60	0.026	59	0.928	−177
200	0.952	−178	0.705	59	0.027	58	0.929	−177
210	0.950	−178	0.668	57	0.029	61	0.934	−177
220	0.942	−178	0.626	56	0.030	61	0.933	−177
230	0.943	−178	0.592	56	0.032	62	0.939	−177
240	0.946	−177	0.566	55	0.033	64	0.941	−177
250	0.952	−177	0.545	54	0.035	64	0.943	−177
260	0.958	−177	0.523	53	0.036	65	0.946	−177
270	0.956	−177	0.500	52	0.038	67	0.943	−177
280	0.960	−177	0.481	52	0.039	68	0.946	−177
290	0.956	−178	0.460	51	0.042	68	0.944	−177
300	0.955	−178	0.443	50	0.043	68	0.947	−177

Table 1. Common Source Scattering Parameters
V_{DS} = 28 V, I_D = 3.0 A

2

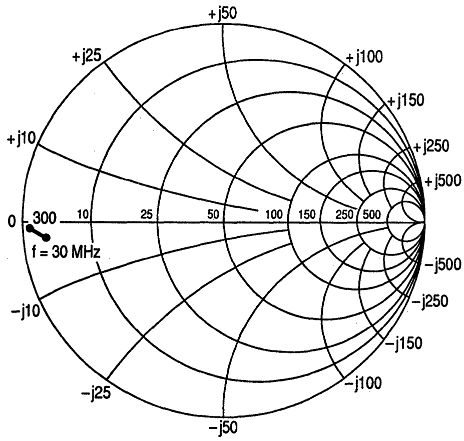


Figure 13. S_{11}, Input Reflection Coefficient versus Frequency V_{DS} = 28 V, I_D = 3.0 A

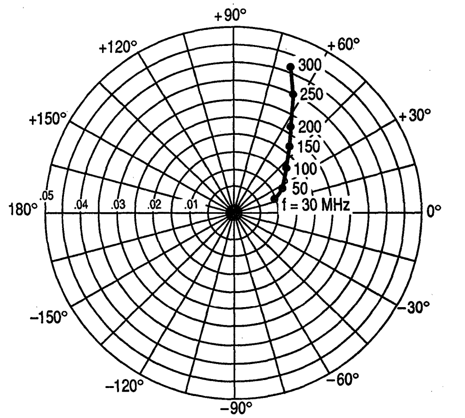


Figure 14. S_{12}, Reverse Transmission Coefficient versus Frequency V_{DS} = 28 V, I_D = 3.0 A

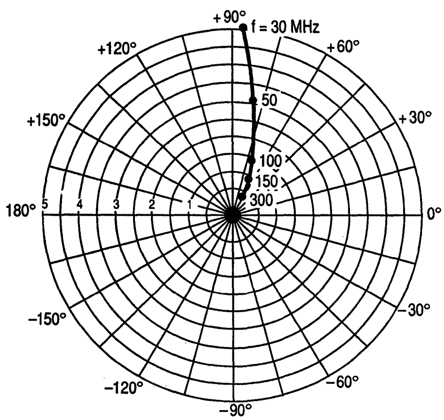


Figure 15. S_{21}, Forward Transmission Coefficient versus Frequency V_{DS} = 28 V, I_D = 3.0 A

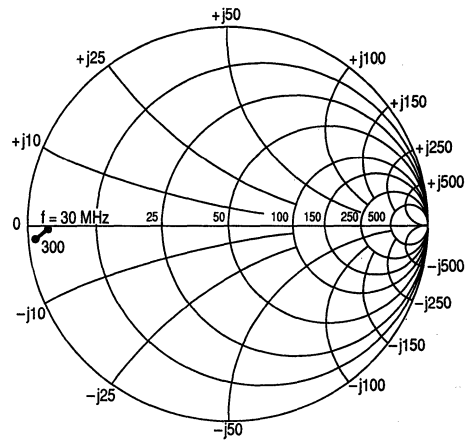
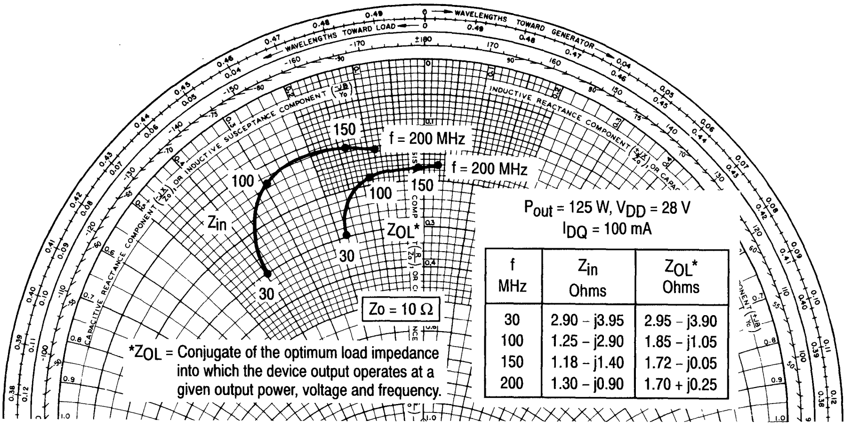


Figure 16. S_{22}, Output Reflection Coefficient versus Frequency V_{DS} = 28 V, I_D = 3.0 A



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
30	2.90 – j3.95	2.95 – j3.90
100	1.25 – j2.90	1.85 – j1.05
150	1.18 – j1.40	1.72 – j0.05
200	1.30 – j0.90	1.70 + j0.25

Figure 17. Series Equivalent Input/Output Impedance, Z_{in}, Z_{OL}*

2

DESIGN CONSIDERATIONS

The MRF174 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF174 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF174 was characterized at I_{DQ} = 100 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF174 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for MRF174. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOSFETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

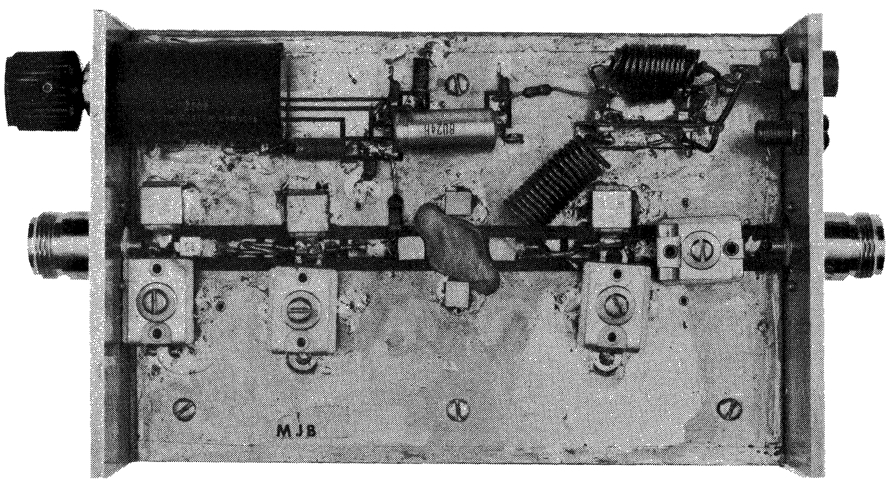


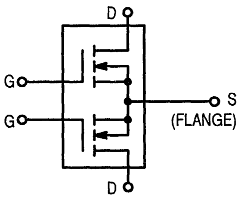
Figure 18. Test Fixture

MRF175GV
MRF175GU

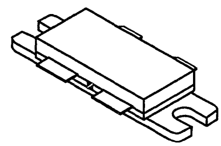
The RF MOSFET Line
RF Power Field-Effect Transistors
N-Channel Enhancement-Mode

. . . designed for broadband commercial and military applications using push pull circuits at frequencies to 500 MHz. The high power, high gain and broadband performance of these devices makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance
  - MRF175GV @ 28 V, 225 MHz (“V” Suffix)
    - Output Power — 200 Watts
    - Power Gain — 14 dB Typ
    - Efficiency — 65% Typ
  - MRF175GU @ 28 V, 400 MHz (“U” Suffix)
    - Output Power — 150 Watts
    - Power Gain — 12 dB Typ
    - Efficiency — 55% Typ
- 100% Ruggedness Tested At Rated Output Power
- Low Thermal Resistance
- Low C_{rss} — 20 pF Typ @ V_{DS} = 28 V



**200/150 WATTS, 28 V, 500 MHz
N-CHANNEL MOS
BROADBAND
RF POWER FETs**



CASE 375, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	26	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	400 2.27	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.44	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.5	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc

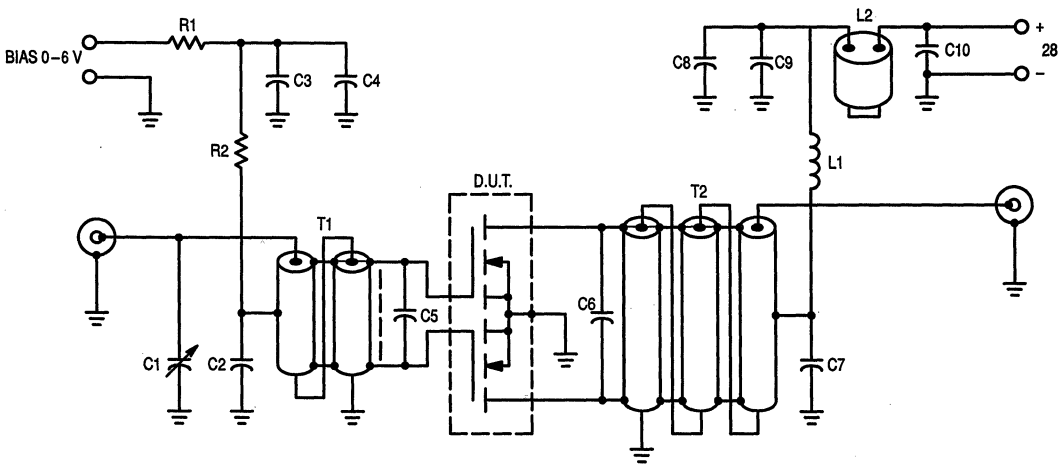
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5.0 A)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	2.0	3.0	—	mhos
DYNAMIC CHARACTERISTICS (1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	180	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	200	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL CHARACTERISTICS — MRF175GV (2) (Figure 1)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2.0 x 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2.0 x 100 mA)	η	55	65	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2.0 x 100 mA, VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each side of device measured separately.
2. Measured in push-pull configuration.

2



C1 — Arco 404, 8.0–60 pF
C2, C3, C7, C8 — 1000 pF Chip
C4, C9 — 0.1 µF Chip
C5 — 180 pF Chip
C6 — 100 pF and 130 pF Chips in Parallel
C10 — 0.47 µF Chip, Kemet 1215 or Equivalent
L1 — 10 Turns AWG #16 Enamel Wire, Close Wound, 1/4″ I.D.
L2 — Ferrite Beads of Suitable Material for 1.5–2.0 µH Total Inductance

Board material — .062″ fiberglass (G10), Two sided, 1 oz. copper, $\varepsilon_r \cong 5$

Unless otherwise noted, all chip capacitors are ATC Type 100 or Equivalent.

R1 — 100 Ohms, 1/2 W
R2 — 1.0 k Ohm, 1/2 W
T1 — 4:1 Impedance Ratio RF Transformer. Can Be Made of 25 Ohm Semirigid Coax, 47–52 Mils O.D.
T2 — 1:9 Impedance Ratio RF Transformer. Can Be Made of 15–18 Ohms Semirigid Coax, 62–90 Mils O.D.

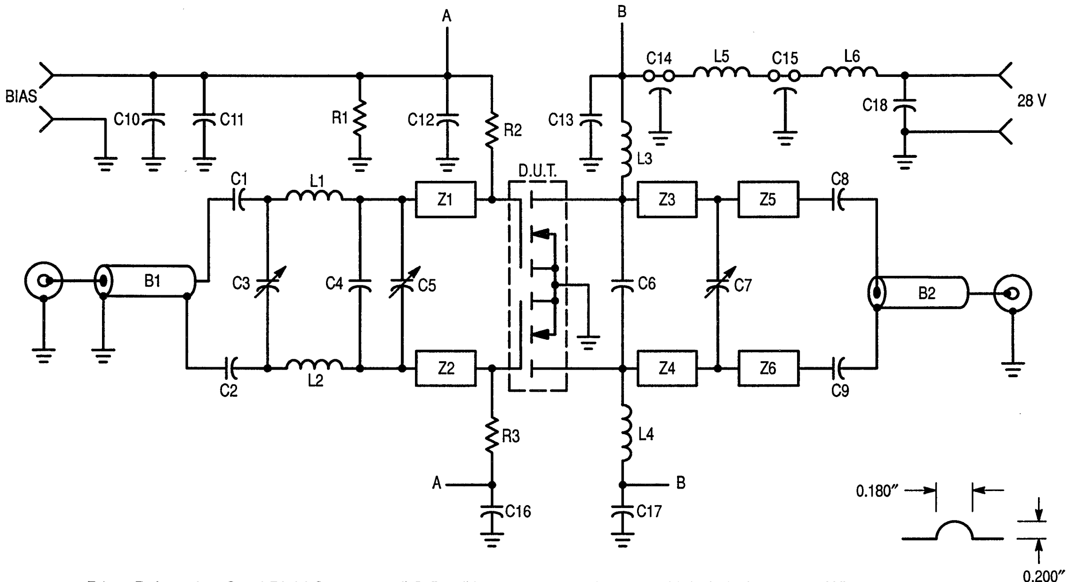
NOTE: For stability, the input transformer T1 should be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

Figure 1. 225 MHz Test Circuit

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS — MRF175GU (1) (Figure 2)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2.0 x 100 mA)	G_{ps}	10	12	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2.0 x 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2.0 x 100 mA, VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTE:
1. Measured in push-pull configuration.



B1 — Balun 50 Ω Semi Rigid Coax 0.086″ O.D. 2″ Long
B2 — Balun 50 Ω Semi Rigid Coax 0.141″ O.D. 2″ Long
C1, C2, C8, C9 — 270 pF ATC Chip Cap
C3, C5, C7 — 1.0–20 pF Trimmer Cap
C4 — 15 pF ATC Chip Cap
C6 — 33 pF ATC Chip Cap
C10, C12, C13, C16, C17 — 0.01 µF Ceramic Cap
C11 — 1.0 µF 50 V Tantalum
C14, C15 — 680 pF Feedthru Cap
C18 — 20 µF 50 V Tantalum

L1, L2 — Hairpin Inductor #18 Wire
L3, L4 — 12 Turns #18 Enameled Wire 0.340″ I.D.
L5 — Ferroxcube VK200 20/4B
L6 — 3 Turns #16 Enameled Wire 0.340″ I.D.
R1 — 1.0 kΩ 1/4 W Resistor
R2, R3 — 10 kΩ 1/4 W Resistor
Z1, Z2 — Microstrip Line 0.400″ x 0.250″
Z3, Z4 — Microstrip Line 0.870″ x 0.250″
Z5, Z6 — Microstrip Line 0.500″ x 0.250″
Board material — 0.060″ Teflon-fiberglass, ε_r = 2.55, copper clad both sides, 2 oz. copper.

Figure 2. 400 MHz Test Circuit

2

TYPICAL CHARACTERISTICS

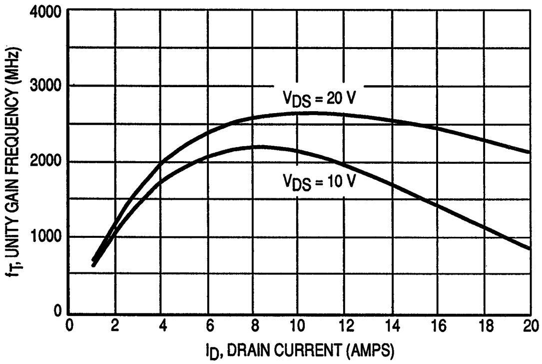


Figure 3. Common Source Unity Current Gain Frequency versus Drain Current

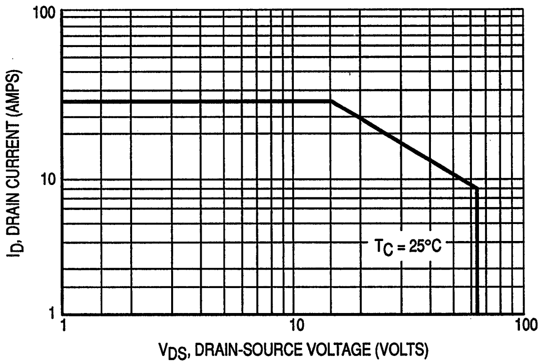


Figure 4. DC Safe Operating Area

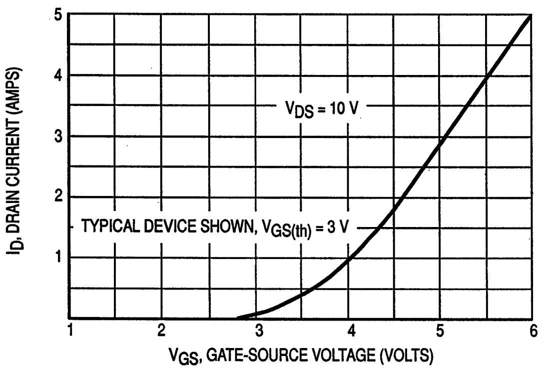


Figure 5. Drain Current versus Gate Voltage (Transfer Characteristics)

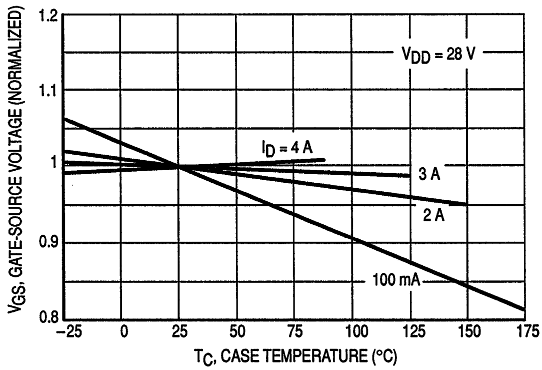


Figure 6. Gate-Source Voltage versus Case Temperature

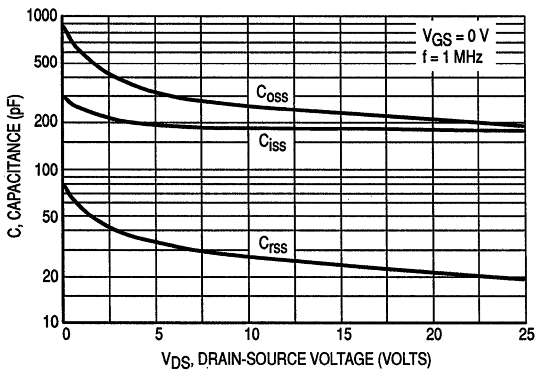


Figure 7. Capacitance versus Drain-Source Voltage*

* Data shown applies to each half of MRF175GV/GU.

TYPICAL CHARACTERISTICS
MRF175GV

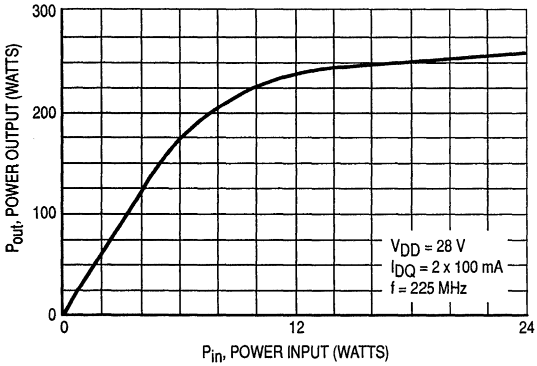


Figure 8. Power Input versus Power Output

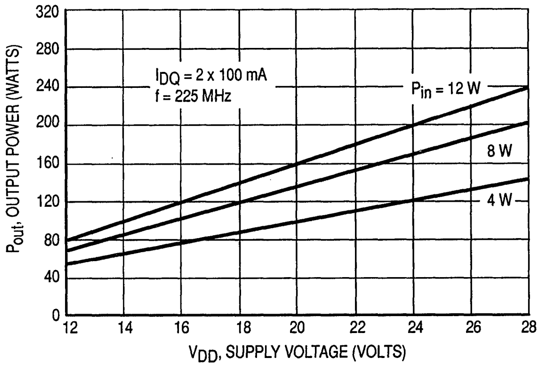


Figure 9. Output Power versus Supply Voltage

MRF175GU

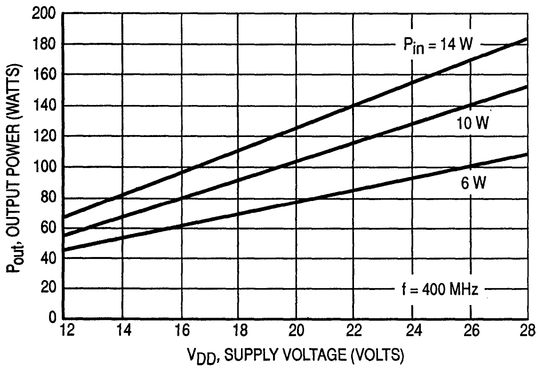


Figure 10. Output Power versus Supply Voltage

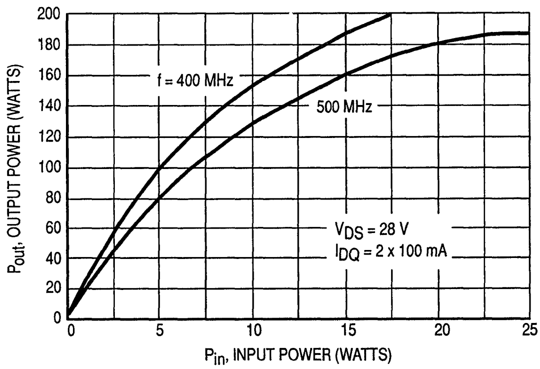


Figure 11. Output Power versus Input Power

MRF175GV

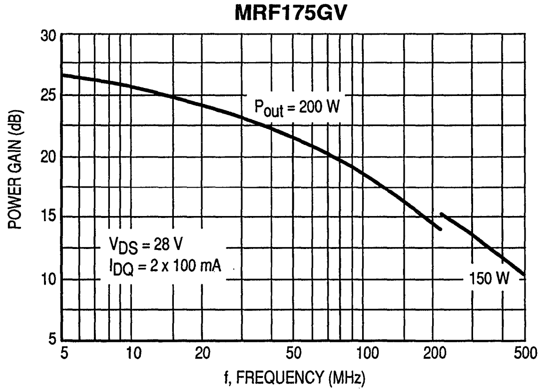
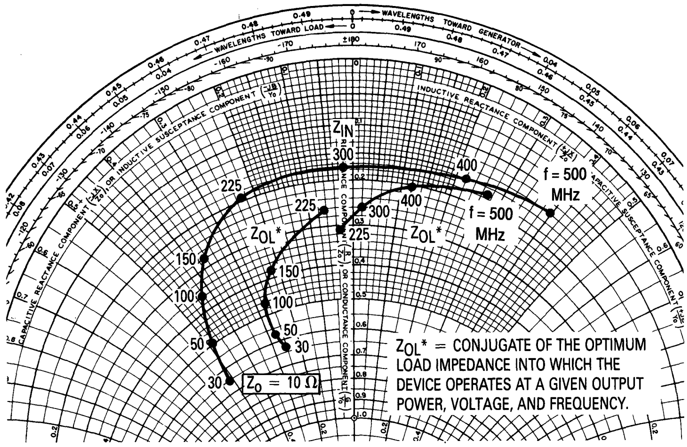


Figure 12. Power Gain versus Frequency

2

INPUT AND OUTPUT IMPEDANCE



V_{DD} = 28 V I_{DQ} = 2 x 100 mA

f MHz	Z_{IN} OHMS	Z_{OL}^* OHMS
(P_{out} = 150 W)		
225	1.95 - j2.30	3.10 - j0.25
300	1.75 - j0.20	2.60 + j0.20
400	1.60 + j2.20	2.00 + j1.20
500	1.35 + j4.00	1.70 + j2.70
(P_{out} = 200 W)		
30	6.50 - j5.10	6.30 - j2.50
50	5.00 - j4.80	5.75 - j2.75
100	3.60 - j4.20	4.60 - j2.65
150	2.80 - j3.60	2.60 - j2.20
225	1.95 - j2.30	2.60 - j0.60

2

NOTE: Input and output impedance values given are measured from gate to gate and drain to drain respectively.

Figure 13. Series Equivalent Input/Output Impedance

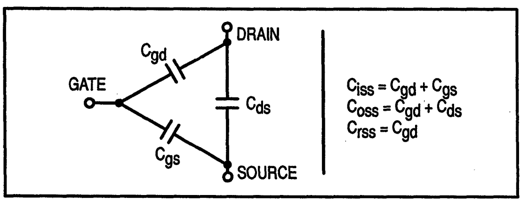
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



The C_{iss} given in the electrical characteristics table was measured using method 2 above. It should be noted that C_{iss}, C_{oss}, C_{rss} are measured at zero drain current and are provided for general information about the device. They are not RF design parameters and no attempt should be made to use them as such.

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain, data presented in Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating (or any of the maximum ratings on the front page). Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of this device are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with grounded equipment.

DESIGN CONSIDERATIONS

The MRF175G is a RF power N-channel enhancement mode field-effect transistor (FETs) designed for HF, VHF and UHF power amplifier applications. Motorola RF MOSFETs feature a vertical structure with a planar design.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF175G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF175G was characterized at I_{DQ} = 100 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

Power output of the MRF176 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

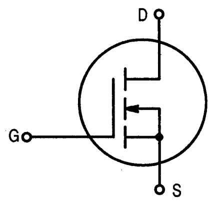
MRF175LV
MRF175LU

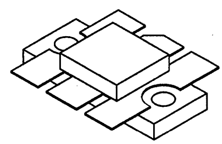
The RF MOSFET Line
RF Power
Field-Effect Transistors
N-Channel Enhancement-Mode

**100 W, 28 V, 400 MHz
N-CHANNEL
BROADBAND
RF POWER FETs**

. . . designed for broadband commercial and military applications using single ended circuits at frequencies to 400 MHz. The high power, high gain and broadband performance of each device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance
  - MRF175LV @ 28 V, 225 MHz ("V" Suffix)
    - Output Power — 100 Watts
    - Power Gain — 14 dB Typ
    - Efficiency — 65% Typ
  - MRF175LU @ 28 V, 400 MHz ("U" Suffix)
    - Output Power — 100 Watts
    - Power Gain — 10 dB Typ
    - Efficiency — 55% Typ
- 100% Ruggedness Tested At Rated Output Power
- Low Thermal Resistance
- Low C_{rss} — 20 pF Typ @ V_{DS} = 28 V





CASE 333, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	13	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

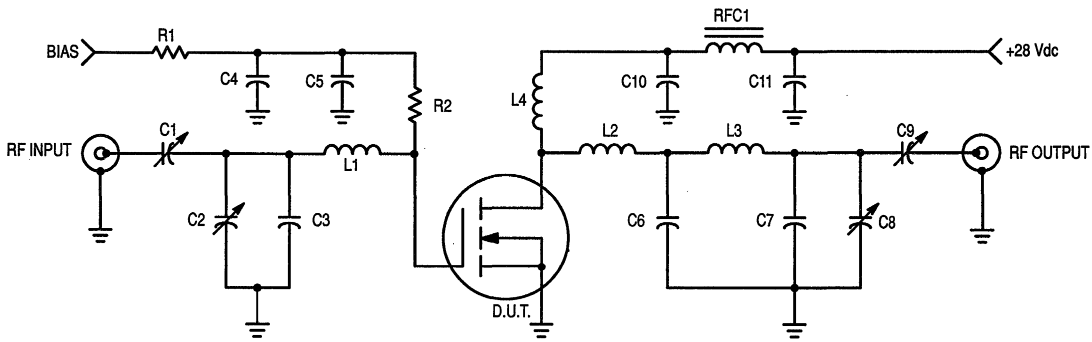
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.5	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

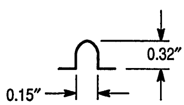
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5.0 A)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	2.0	3.0	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	180	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	200	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL CHARACTERISTICS — MRF175LV (Figure 1)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 225 MHz, I_{DQ} = 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 225 MHz, I_{DQ} = 100 mA)	η	55	65	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 225 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
FUNCTIONAL CHARACTERISTICS — MRF175LU (Figure 2)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 100 mA)	G_{ps}	8.0	10	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

2



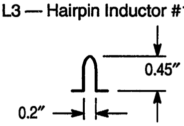
C1, C2, C8 — Arco 463 or Equivalent
C3, C7 — 25 pF Unelco Cap
C4 — 1000 pF Chip Cap
C5 — 0.01 µF Chip Cap
C6 — 250 pF Unelco Cap
C9 — Arco 462 or Equivalent
C10 — 1000 pF ATC Chip Cap
C11 — 10 µF 100 V Electrolytic

L1 — Hairpin Inductor #18 Wire



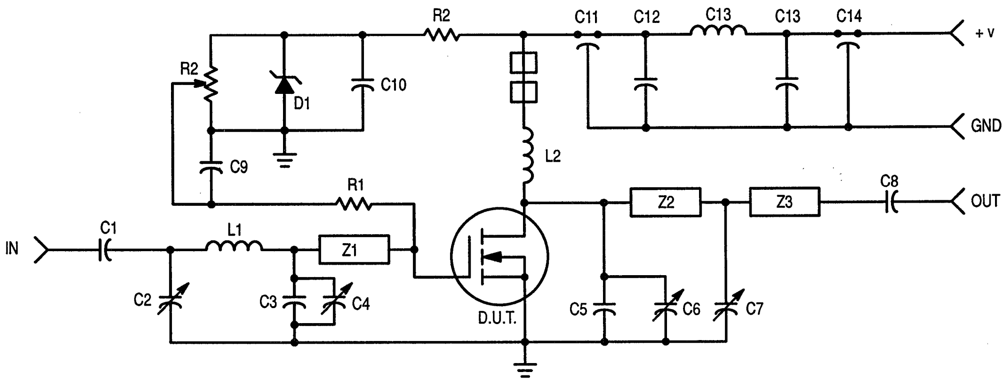
L2 — Stripline Inductor 0.200″ x 0.500″

L3 — Hairpin Inductor #16 Wire



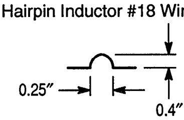
L4 — 2 Turns #16 Wire 5/16″ ID
RFC1 — VK200-4B
R1 — 1.0 k 1/4 W Resistor
R2 — 100 Ω Resistor

Figure 1. 225 MHz Test Circuit



C1, C8 — 270 pF ATC Chip Cap
C2, C4, C6, C7 — 1.0–20 pF Trimmer Cap
C3 — 15 pF Mini Unelco Cap
C5 — 33 pF Mini Unelco Cap
C9, C10, C12 — 0.1 μF Ceramic Cap
C11, C14 — 680 pF Feed Thru Cap
C13 — 50 μF Tantalum Cap

D1 — 1N5352 Zener Diode
L1 — Hairpin Inductor #18 Wire



L2 — 12 Turns #18 Wire 0.450″ ID
L3 — Ferroxcube VK200 20/4B

R1 — 10 k 1/4 W Resistor
R2 — 10 k Variable Resistor
R3 — 1.5 k 1/4 W Resistor
Z1 — Microstrip Line 0.950″ x 0.250″
Z2 — Microstrip Line 1″ x 0.250″
Z3 — Microstrip Line 0.550″ x 0.250″
Board Material — 0.062″ Teflon — fiberglass, ε_r = 2.56, 1 oz. copper clad both sides

Figure 2. 400 MHz Test Circuit

2

TYPICAL CHARACTERISTICS

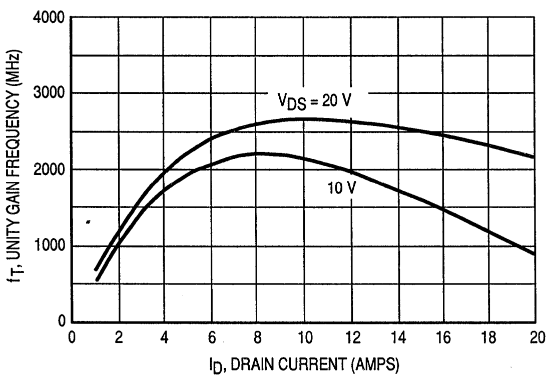


Figure 3. Common Source Unity Current Gain Frequency versus Drain Current

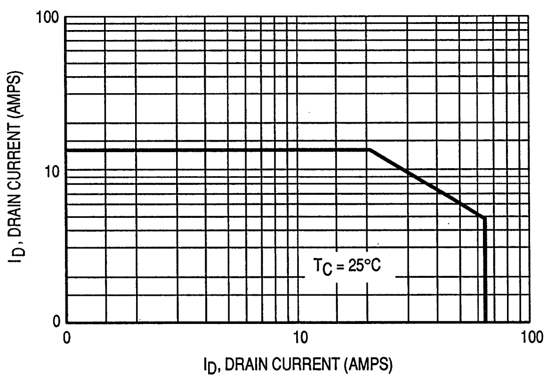


Figure 4. DC Safe Operating Area

TYPICAL CHARACTERISTICS

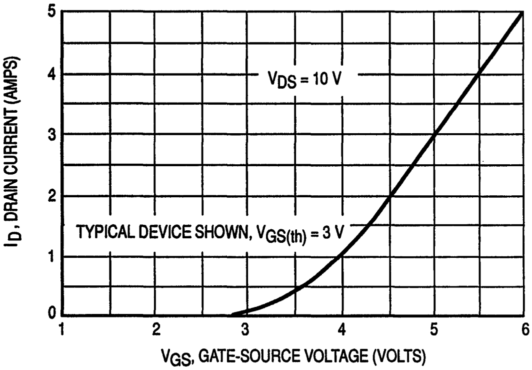


Figure 5. Drain Current versus Gate Voltage (Transfer Characteristics)

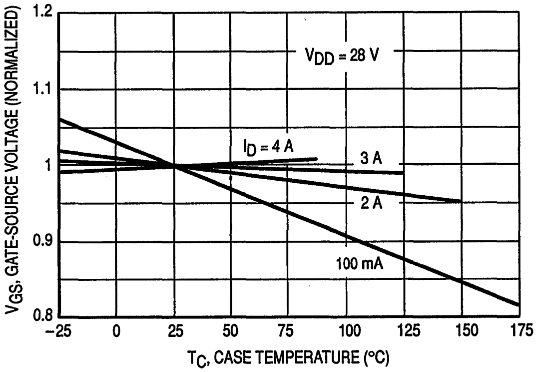


Figure 6. Gate-Source Voltage versus Case Temperature

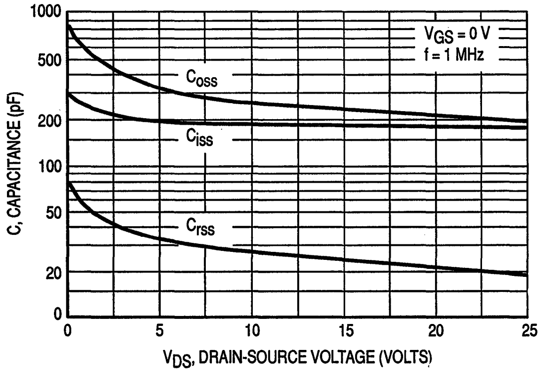


Figure 7. Capacitance versus Drain-Source Voltage

2

TYPICAL CHARACTERISTICS

MRF175LV

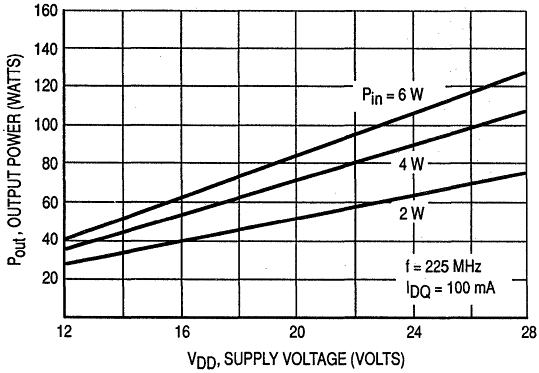


Figure 8. Output Power versus Supply Voltage

MRF175LU

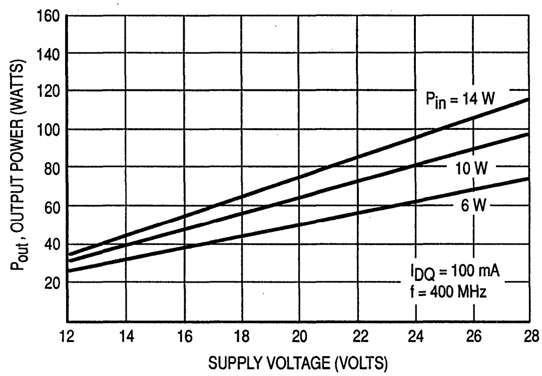


Figure 9. Output Power versus Supply Voltage

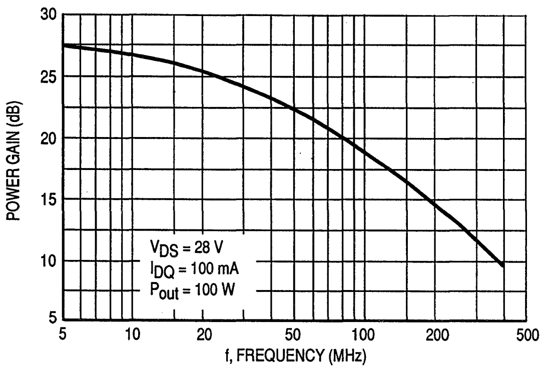


Figure 10. Power Gain versus Frequency

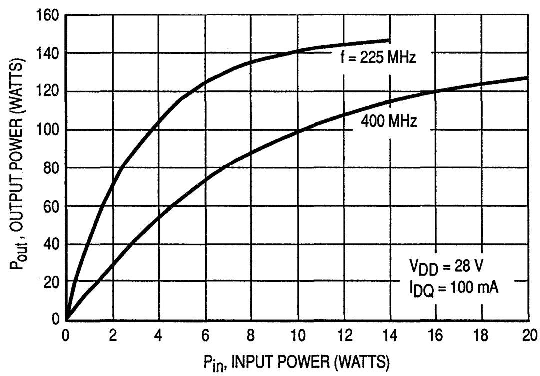
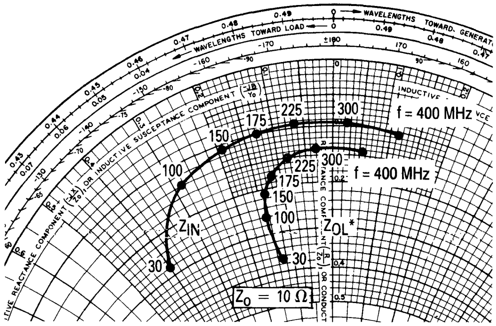


Figure 11. Output Power versus Input Power

INPUT AND OUTPUT IMPEDANCE



V_{DD} = 28 V I_{DQ} = 100 mA
(P_{out} = 100 W)

f MHz	Z_{IN} Ohms	Z_{OL}* Ohms
30	2.80 – j4.00	3.65 – j1.30
100	1.40 – j2.80	2.60 – j1.50
150	1.10 – j1.90	2.10 – j1.40
175	1.00 – j1.25	1.80 – j1.20
225	0.95 – j0.65	1.50 – j0.80
300	0.95 + j0.20	1.35 – j0.30
400	1.05 + j1.15	1.45 + j0.55

Z_{OL}* = CONJUGATE OF THE OPTIMUM LOAD IMPEDANCE INTO WHICH THE DEVICE OPERATES AT A GIVEN OUTPUT POWER, VOLTAGE, AND FREQUENCY.

2

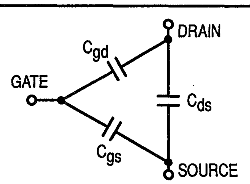
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF175L is a RF power N-channel enhancement mode field-effect transistor (FETs) designed for HF, VHF and UHF power amplifier applications. Motorola FETs feature a vertical structure with a planar design.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF175L is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF175L was characterized at I_{DQ} = 100 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

Power output of the MRF175L may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

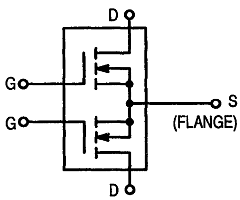
2

MRF176GV
MRF176GU

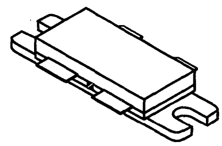
The RF MOSFET Line
RF Power Field-Effect Transistors
N-Channel Enhancement-Mode

. . . designed for broadband commercial and military applications using push pull circuits at frequencies to 500 MHz. The high power, high gain and broadband performance of these devices makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Electrical Performance
  MRF176GV @ 50 V, 225 MHz ("V" Suffix)
  Output Power — 200 Watts
  Power Gain — 17 dB Typ
  Efficiency — 55% Typ
  MRF176GU @ 50 V, 400 MHz ("U" Suffix)
  Output Power — 150 Watts
  Power Gain — 14 dB Typ
  Efficiency — 50% Typ
- 100% Ruggedness Tested At Rated Output Power
- Low Thermal Resistance
- Low C_{rss} — 7.0 pF Typ @ V_{DS} = 50 V



**200/150 W, 50 V, 500 MHz
N-CHANNEL MOS
BROADBAND
RF POWER FETs**



CASE 375, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	400 2.27	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.44	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	2.5	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc

NOTE:
1. Each side of device measured separately.

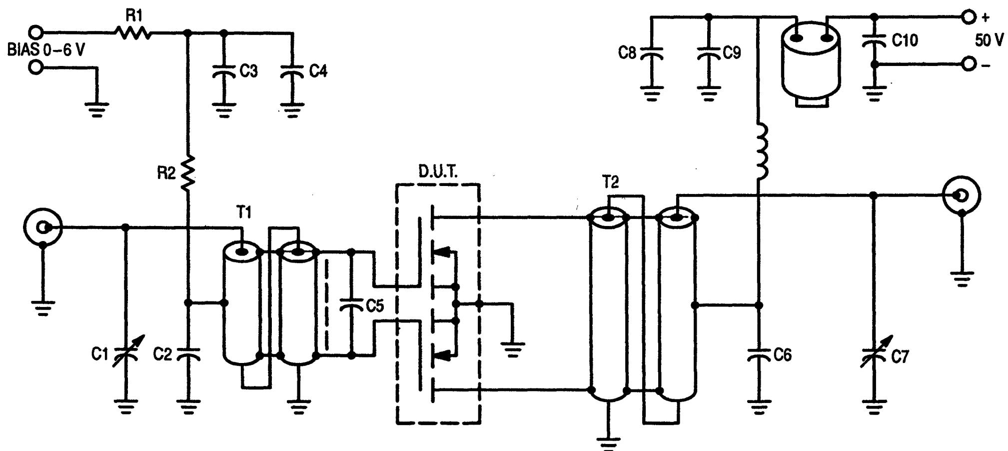
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5.0 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	2.0	3.0	—	mhos
DYNAMIC CHARACTERISTICS (1)					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	180	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	110	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	7.0	—	pF
FUNCTIONAL CHARACTERISTICS — MRF176GV (2) (Figure 1)					
Common Source Power Gain (V_{DD} = 50 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2.0 x 100 mA)	G_{ps}	15	17	—	dB
Drain Efficiency (V_{DD} = 50 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2.0 x 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 50 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2.0 x 100 mA, VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each side of device measured separately.
2. Measured in push-pull configuration.

2



C1 — Arco 404, 8.0–60 pF
C2, C3, C6, C8 — 1000 pF Chip
C4, C9 — 0.1 µF Chip
C5 — 180 pF Chip
C7 — Arco 403, 3.0–35 pF
C10 — 0.47 µF Chip, Kemet 1215 or Equivalent
L1 — 10 Turns AWG #16 Enameled Wire, Close Wound, 1/4″ I.D.

Board material — .062″ fiberglass (G10), Two sided, 1 oz. copper, $\varepsilon_r \cong 5$

Unless otherwise noted, all chip capacitors are ATC Type 100 or Equivalent

L2 — Ferrite Beads of Suitable Material for 1.5–2.0 µH, Total Inductance
R1 — 100 Ohms, 1/2 W
R2 — 1.0 kOhms, 1/2 W
T1 — 4:1 Impedance Ratio RF Transformer. Can Be Made of 25 Ohm Semirigid Co-Ax, 47–62 Mils O.D.
T2 — 1:4 Impedance Ratio RF Transformer. Can Be Made of 25 Ohm Semirigid Co-Ax, 62–90 Mils O.D.

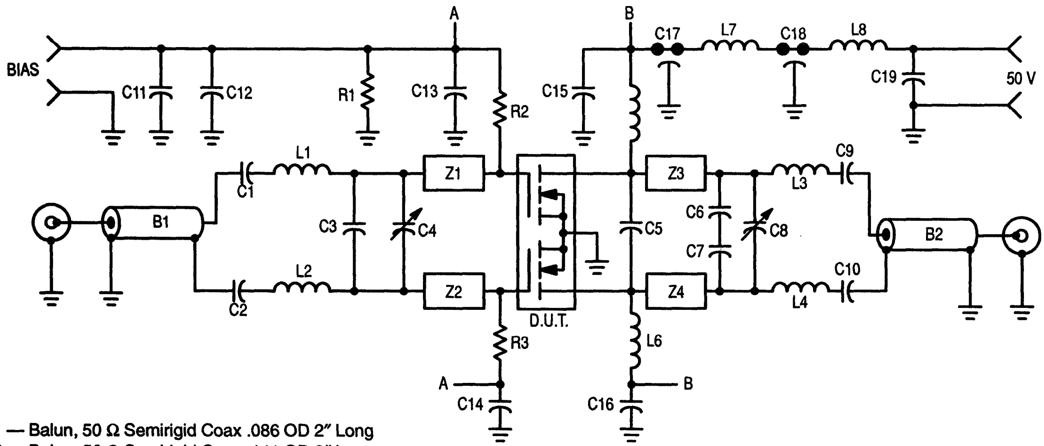
NOTE: For stability, the input transformer T1 should be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

Figure 1. 225 MHz Test Circuit

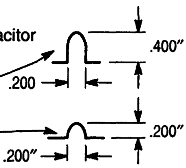
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS — MRF176GU (1) (Figure 2)					
Common Source Power Gain (V_{DD} = 50 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2.0 x 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 50 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2.0 x 100 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 50 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2.0 x 100 mA, VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTE:
1. Measured in push-pull configuration.



B1 — Balun, 50 Ω Semirigid Coax .086 OD 2″ Long
B2 — Balun, 50 Ω Semirigid Coax .141 OD 2″ Long
C1, C2, C9, C10 — 270 pF ATC Chip Capacitor
C3 — 15 pF ATC Chip Cap
C4, C8 — 1.0–20 pF Piston Trimmer Cap
C5 — 27 pF ATC Chip Cap
C6, C7 — 22 pF Mini Unelco Capacitor
C11, C13, C14, C15, C16 — 0.01 µF Ceramic Capacitor
C12 — 1.0 µF 50 V Tantalum Cap
C17, C18 — 680 pF Feedthru Capacitor
C19 — 10 µF 100 V Tantalum Cap
L1, L2 — Hairpin Inductor #18 W
L3, L4 — Hairpin Inductor #18 W



L5, L6 — 13T #18 W .250 ID
L7 — Ferroxcube VK-200 20/4B
L8 — 3T #18 W .340 ID
R1 — 1.0 kΩ 1/4 W Resistor
R2, R3 — 10 kΩ 1/4 W Resistor
Z1, Z2 — Microstrip Line .400L x .250W
Z3, Z4 — Microstrip Line .450L x .250W

Ckt Board Material — .060″ teflon-fiberglass, copper clad both sides, 2 oz. copper, ε_r = 2.55

Figure 2. 400 MHz Test Circuit

TYPICAL CHARACTERISTICS

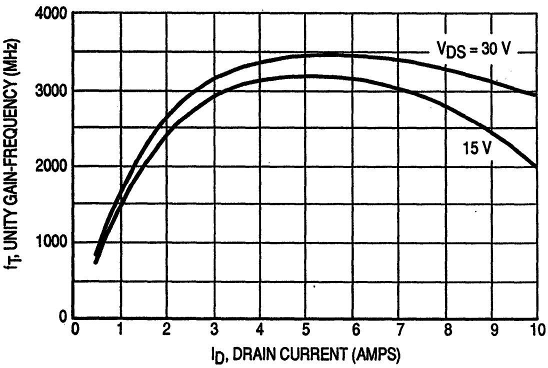


Figure 3. Common Source Unity Current Gain* Gain-Frequency versus Drain Current

* Data shown applies to each half of MRF176GV/GU

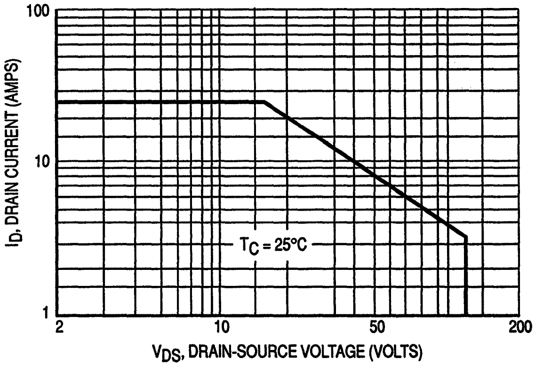
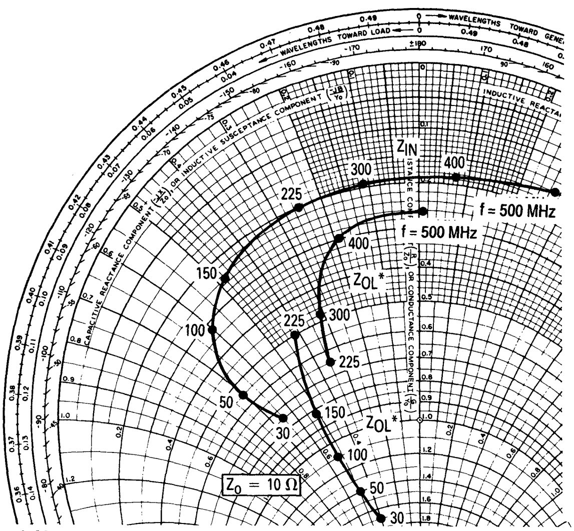


Figure 4. DC Safe Operating Area

2



INPUT AND OUTPUT IMPEDANCE
MRF176GU/GV
V_{DD} = 50 V I_{DQ} = 2 x 100 mA

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
(P_{out} = 150 W)		
225	2.05 - j2.50	6.50 - j3.50
300	2.00 - j1.10	4.80 - j3.10
400	1.85 + j0.75	3.00 - j1.90
500	1.60 + j2.70	2.60 + j0.10
(P_{out} = 200 W)		
30	7.50 - j6.50	17.00 - j4.00
50	5.50 - j7.00	14.00 - j5.00
100	3.20 - j6.00	11.00 - j5.20
150	2.50 - j4.80	8.20 - j5.00
225	2.05 - j2.50	5.00 - j4.20

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

NOTE: Input and output impedance values given are measured from gate to gate and drain to drain respectively.

Figure 5. Series Equivalent Input/Output Impedance

TYPICAL CHARACTERISTICS

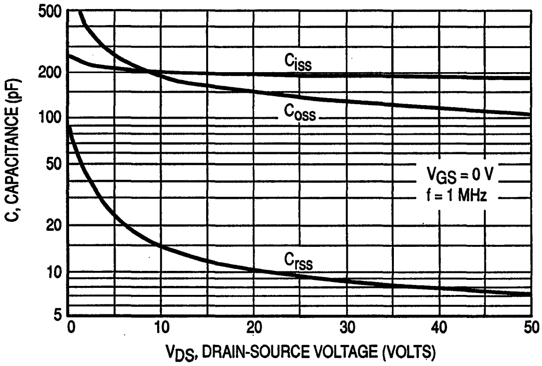


Figure 6. Capacitance versus Drain-Source Voltage*

* Data shown applies to each half of MRF176GV/GU

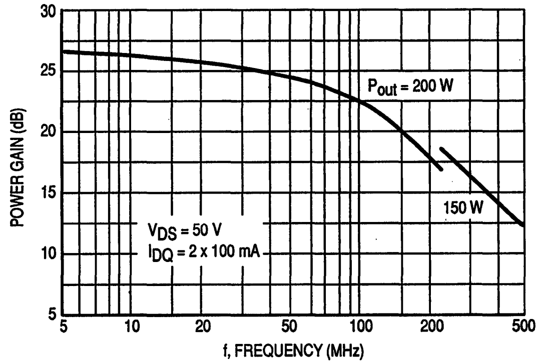


Figure 7. Power Gain versus Frequency

MRF176GV

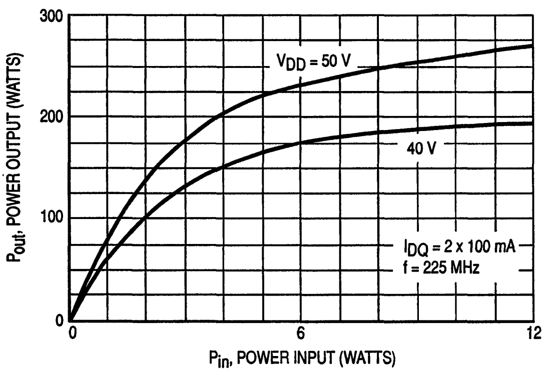


Figure 8. Power Input versus Power Output

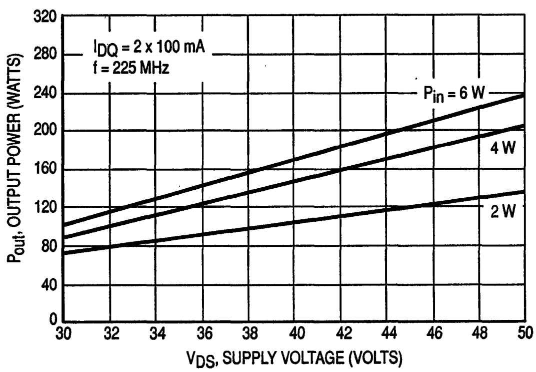


Figure 9. Output Power versus Supply Voltage

2

TYPICAL CHARACTERISTICS
MRF176GU

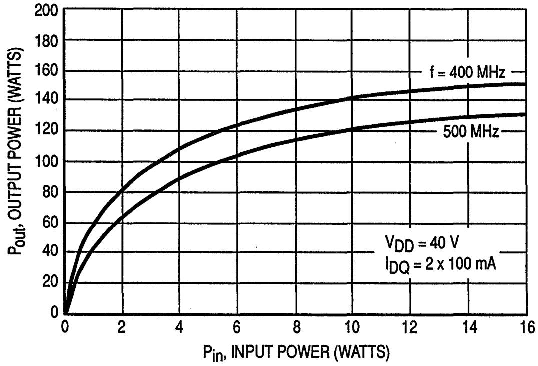


Figure 10. Output Power versus Input Power

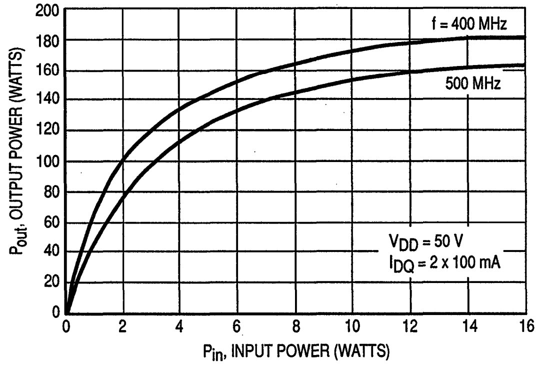


Figure 11. Output Power versus Input Power

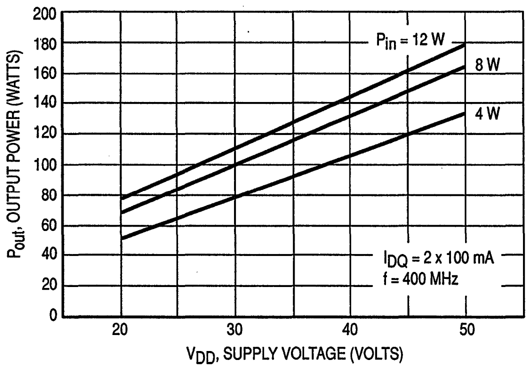


Figure 12. Output Power versus Supply Voltage

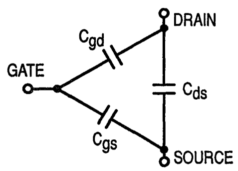
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

The C_{iss} given in the electrical characteristics table was measured using method 2 above. It should be noted that C_{iss}, C_{oss}, C_{rss} are measured at zero drain current and are provided for general information about the device. They are not RF design parameters and no attempt should be made to use them as such.

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain, data presented in Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating (or any of the maximum ratings on the front page). Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of this device are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source. The addition of an internal zener diode may result in detrimental effects on the reliability of a power MOSFET. If gate protection is required, an external zener diode is recommended.

HANDLING CONSIDERATIONS

The gate of the MOSFET, which is electrically isolated from the rest of the die by a very thin layer of SiO_2, may be damaged if the power MOSFET is handled or installed improperly. Exceeding the 40 V maximum gate-to-source voltage rating, $V_{GS(max)}$, can rupture the gate insulation and destroy the FET. RF Power MOSFETs are not nearly as susceptible as CMOS devices to damage due to static discharge because the input capacitances of power MOSFETs are much larger and absorb more energy before being charged to the gate breakdown voltage. However, once breakdown begins, there is enough energy stored in the gate-source capacitance to ensure the complete perforation of the gate oxide. To avoid the possibility of device failure caused by static discharge, precautions similar to those taken with small-signal MOSFET and CMOS devices apply to power MOSFETs.

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with grounded equipment.

The gate of the power MOSFET could still be in danger after the device is placed in the intended circuit. If the gate may see voltage transients which exceed $V_{GS(max)}$, the circuit designer should place a 40 V zener across the gate and source terminals to clamp any potentially destructive spikes. Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

DESIGN CONSIDERATIONS

The MRF176G is a RF power N-channel enhancement mode field-effect transistor (FETs) designed for VHF and

UHF power amplifier applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove MOS power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF176G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF176G was characterized at $I_{DQ} = 100$ mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias sytem.

GAIN CONTROL

Power output of the MRF176 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

2

MRF177
MRF177M*

*Motorola Preferred Device

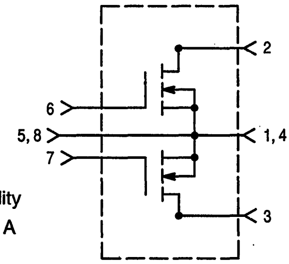
The RF MOSFET Line
RF Power
Field Effect Transistors
N-Channel Enhancement Mode MOSFETs

100 W, 28 V, 400 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFETs

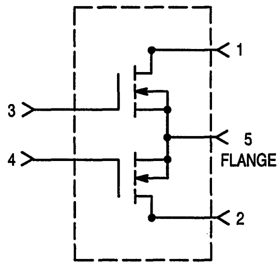
Designed for broadband commercial and military applications up to 400 MHz frequency range. Primarily used as drivers or output amplifiers in push-pull configurations. Can be used in manual gain control, ALC and modulation circuits.

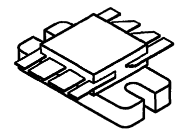
- Typical Performance at 400 MHz, 28 V:
  Output Power — 100 W
  Gain — 12 dB
  Efficiency — 60%
- Low Thermal Resistance
- Low C_{rss} — 10 pF Typ @ V_{DS} = 28 Volts
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability
- Excellent Thermal Stability; Suited for Class A Operation

CASE 744A-01

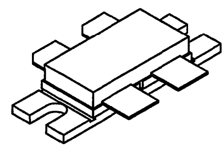


CASE 390B-01





CASE 744A-01, STYLE 2
MRF177



CASE 390B-01, STYLE 1
MRF177M

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Temperature Range	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	0.65	°C/W

NOTE:
1. Total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic (2)	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS (2)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 50 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 3.0 A)	$V_{DS(on)}$	—	—	1.4	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.0 A)	g_{fs}	1.8	2.2	—	mhos
DYNAMIC CHARACTERISTICS (2)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	110	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	105	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	10	—	pF
FUNCTIONAL CHARACTERISTICS (Figures 7 & 8) (4)					
Common Source Power Gain (3) (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 200 mA)	G_{PS}	10	12	—	dB
Drain Efficiency (3) (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 200 mA)	η	55	60	—	%
Electrical Ruggedness (3) (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 200 mA, Load VSWR = 30:1, All Phase Angles At Frequency of Test)	ψ	No Degradation in Output Power Before & After Test			
TYPICAL INPUT/OUTPUT DEVICE IMPEDANCES					
MRF177					
Series Equivalent Input Impedance (V_{DD} = 28 V, I_{DQ} = 200 mA, P_{out} = 100 W, f = 400 MHz)	Z_{in}	—	2.35 + j0.4	—	Ohms
Series Equivalent Output Impedance (V_{DD} = 28 V, I_{DQ} = 200 mA, P_{out} = 100 W, f = 400 MHz)	Z_{out}	—	3.2 – j1.38	—	Ohms
MRF177M					
Series Equivalent Input Impedance (V_{DD} = 28 V, I_{DQ} = 200 mA, P_{out} = 100 W, f = 400 MHz)	Z_{in}	—	2.64 + j1.64	—	Ohms
Series Equivalent Output Impedance (V_{DD} = 28 V, I_{DQ} = 200 mA, P_{out} = 100 W, f = 400 MHz)	Z_{out}	—	3.15 + j0.05	—	Ohms

NOTES:
1. Note each transistor chip measured separately
2. Both transistor chips operating in push-pull amplifier
3. RF functional specification is the same for MRF177 & MRF177M

2

TYPICAL CHARACTERISTICS

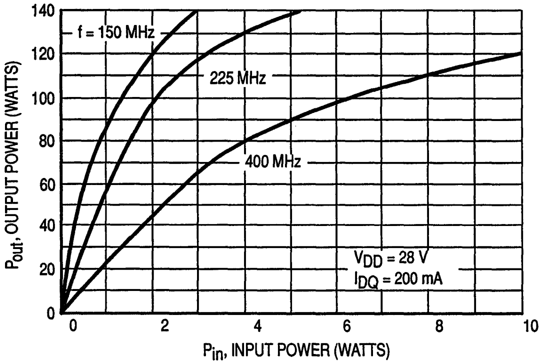


Figure 1. Output Power versus Input Power

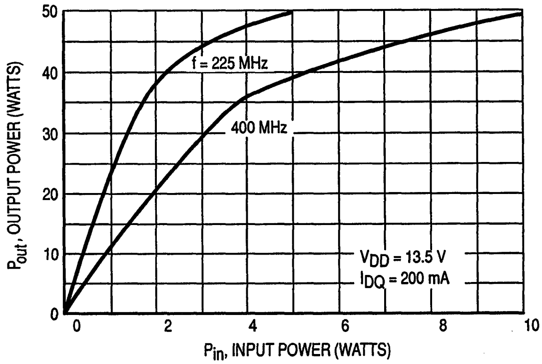


Figure 2. Output Power versus Input Power

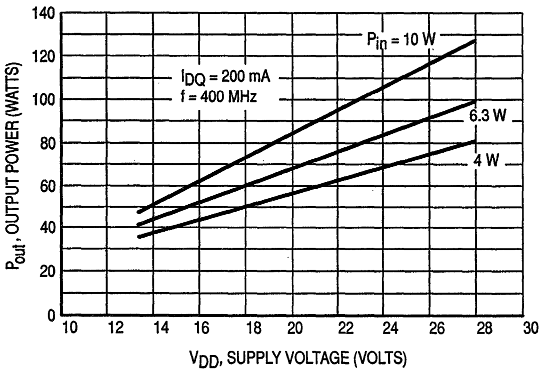


Figure 3. Output Power versus Supply Voltage

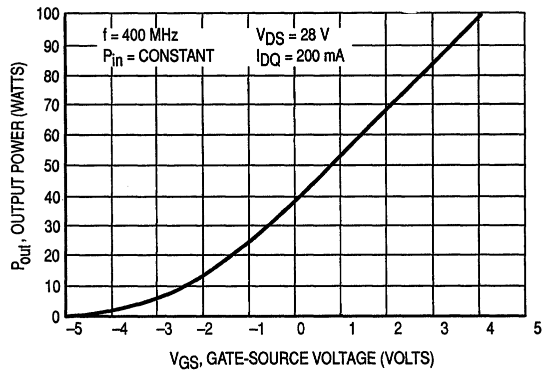


Figure 4. Output Power versus Gate Voltage

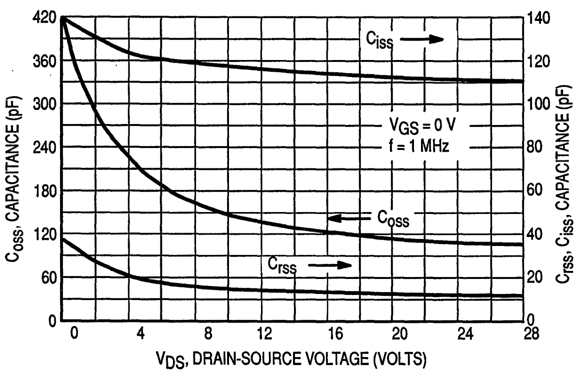


Figure 5. Capacitance versus Drain Voltage

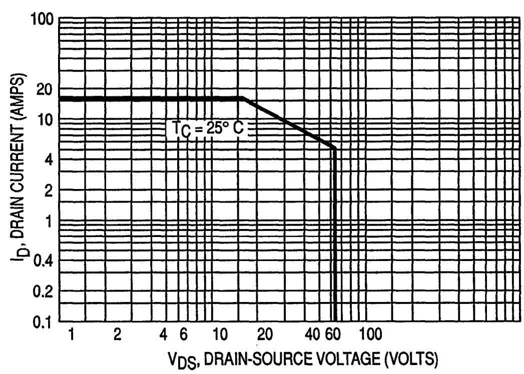
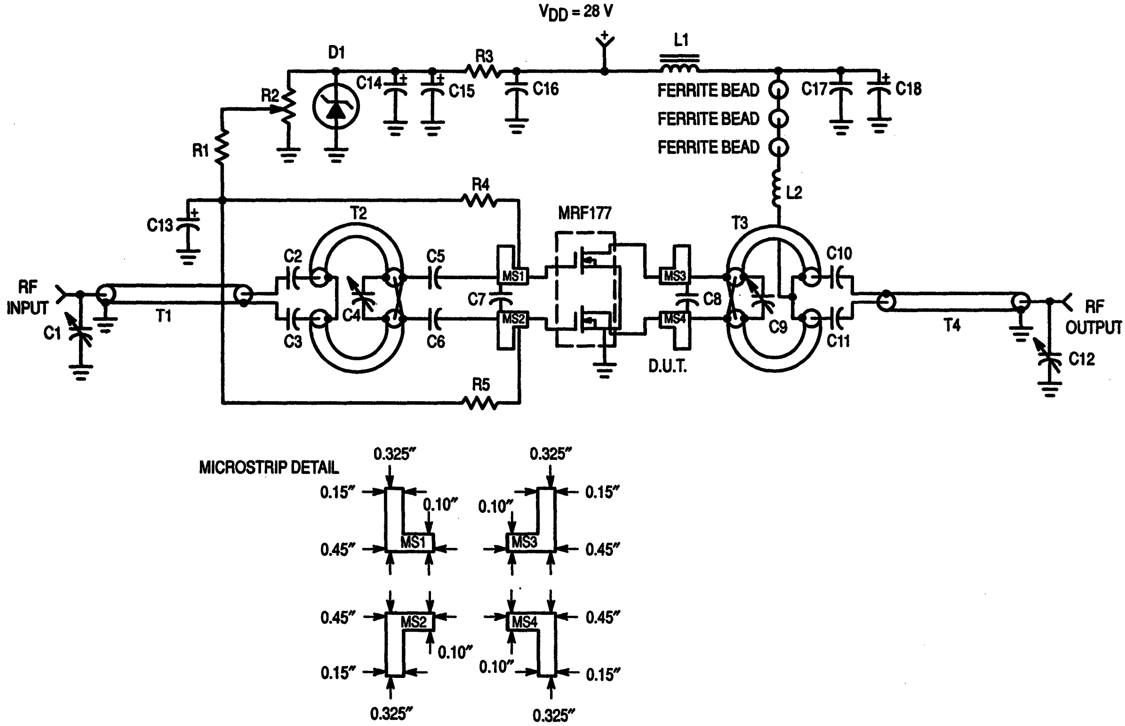


Figure 6. DC Safe Operating Area

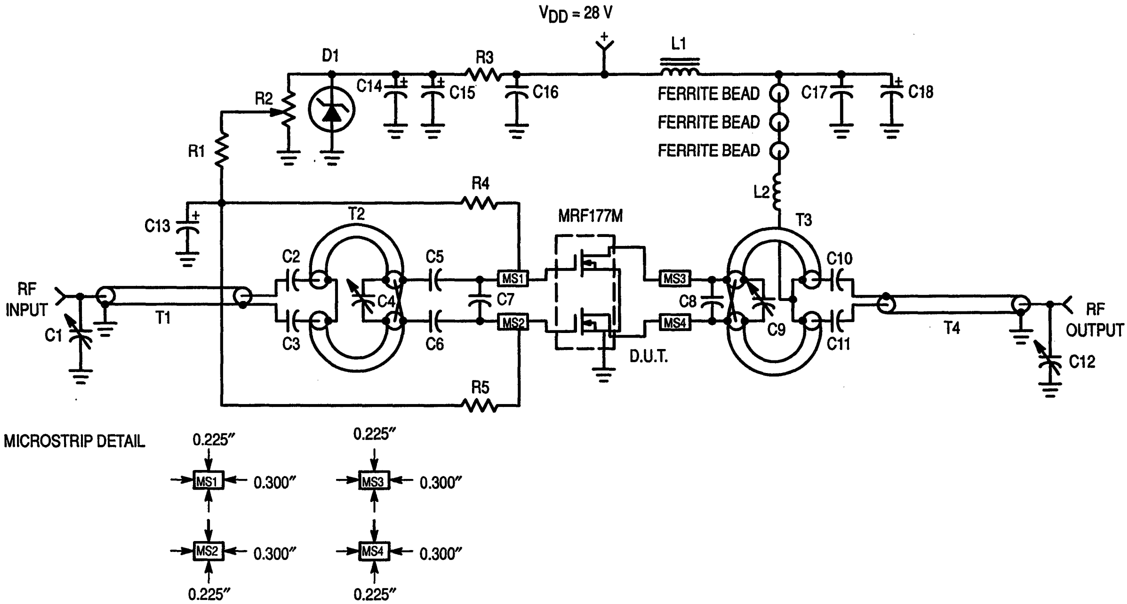
2

2



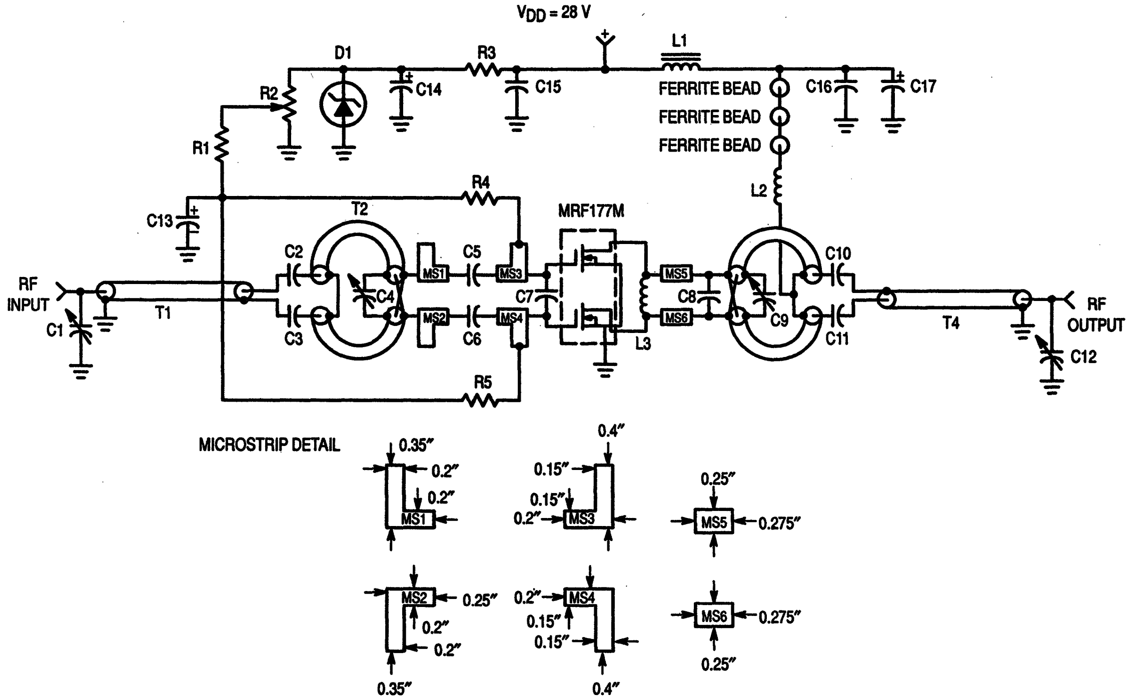
C1, C12	1–10 pF JOHANSON OR EQUIVALENT	D1	1N5347B, 20 Vdc
C2, C3, C5, C6, C10, C11	270 pF ATC 100 MIL CHIP CAP	L1	1-TURN NO. 18, 0.25″, 2-HOLE FERRITE BEAD
C4, C9	1–20 pF	L2	8-1/2 TURNS NO. 18, CLOSE WOUND .375″ DIA.
C7	36 pF CHIP CAP	R1, R4, R5	10 kΩ @ 1/2 W RESISTOR
C8	10 pF CHIP CAP	R2	10 kΩ, 10 TURN RESISTOR
C13, C14	0.1 μFD @ 50 Vdc	R3	2.0 kΩ @ 1/2 W RESISTOR
C15, C18	10 μFD @ 50 Vdc	T1	1-1/2 T, 50 Ω COAX, .034″ DIA. ON DUAL 0.5″ FERRITE CORE
C16	500 pF BUTTON	T2	2.0″ 25 Ω COAX, .075″ DIA.
C17	1000 pF UNCASED MICA	T3	2.1″ 10 Ω COAX, .075″ DIA.
		T4	4.0″ 50 Ω COAX, .0865″ DIA.
		BOARD	.0625″, Cu-Clad, Teflon Fiberglass, $\varepsilon_r = 2.55$

Figure 7. Test Circuit Electrical Schematic — MRF177



C1, C12	1–10 pF JOHANSON OR EQUIVALENT	D1	1N5347B, 20 Vdc MOTOROLA ZENER
C2, C3, C5, C6, C10, C11	270 pF ATC 100 MIL CHIP CAP	L1	1-TURN NO. 18, 0.25″, 2-HOLE FERRITE BEAD
C4, C9	1–20 pF	L2	8-1/2 TURNS NO. 18, CLOSE WOUND .375″ DIA.
C7	36 pF CHIP CAP	R1, R4, R5	10 kΩ @ 1/2 W RESISTOR
C8	10 pF CHIP CAP	R2	10 kΩ, 10 TURN RESISTOR
C13, C14	0.1 μFD @ 50 Vdc	R3	2.0 kΩ @ 1/2 W RESISTOR
C15, C18	10 μFD @ 50 Vdc	T1	1-1/2 T, 50 Ω COAX, .034″ DIA. ON DUAL 0.5″ FERRITE CORE
C16	500 pF BUTTON	T2	2.0″ 25 Ω COAX, .075″ DIA.
C17	1000 pF UNCASED MICA	T3	2.1″ 10 Ω COAX, .075″ DIA.
		T4	4.0″ 50 Ω COAX, .0865″ DIA.
		BOARD	.0625″, Cu-Clad, Teflon Fiberglass, $\varepsilon_r = 2.55$

Figure 8. Test Fixture Electrical Schematic — MRF177M



C1, C12	1–10 pF JOHANSON OR EQUIVALENT	D1	1N5347B, 20 Vdc MOTOROLA ZENER
C2, C3, C5, C6, C10, C11	270 pF ATC 100 MIL CHIP CAP	L1	1-TURN NO. 18, 0.25″, 2-HOLE FERRITE BEAD
C4, C9	1–20 pF	L2	8-1/2 TURNS NO. 18, CLOSE WOUND .375″ DIA.
C7	43 pF CHIP CAP	L3	4-TURNS NO. 22, 1/8″ DIA., 0.25″ LONG
C8	10 pF CHIP CAP	R1, R4, R5	10 kΩ @ 1/2 W RESISTOR
C13, C14	0.1 µFD @ 50 Vdc	R2	10 kΩ, 10 TURN RESISTOR
C15	500 pF BUTTON	R3	2.0 kΩ @ 1/2 W RESISTOR
C16	1000 pF UNCASED MICA	T1	1-1/2 T, 50 Ω COAX, .034″ DIA. ON DUAL 0.5″ FERRITE CORE
C17	10 µFD @ 50 Vdc	T2	2.0″ 25 Ω COAX, .075″ DIA.
		T3	2.1″ 10 Ω COAX, .075″ DIA.
		T4	4.0″ 50 Ω COAX, .0865″ DIA.
		BOARD	.0625″, Cu-Clad, Teflon Fiberglass, $\varepsilon_r = 2.55$

Figure 9. Broadband Amplifier Schematic — MRF177M

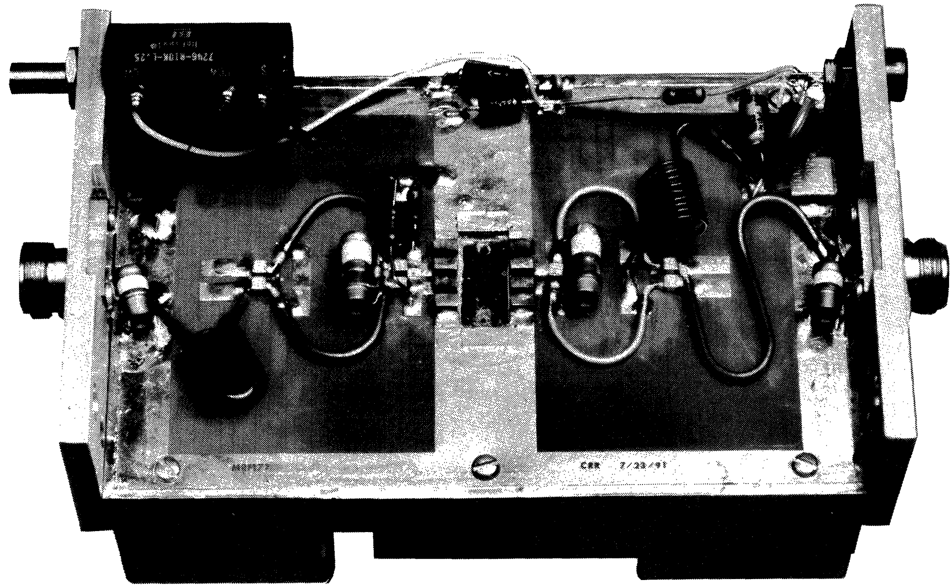
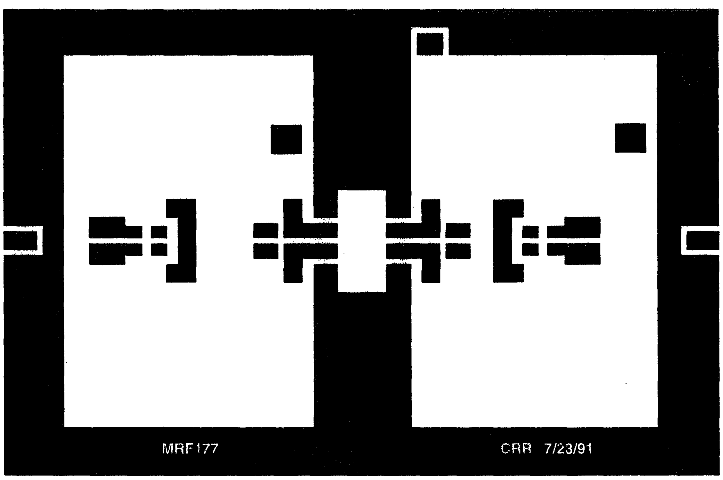


Figure 10. Test Fixture — MRF177



(Not to Scale)

Figure 11. Photomaster for MRF177 Test Fixture

2

2

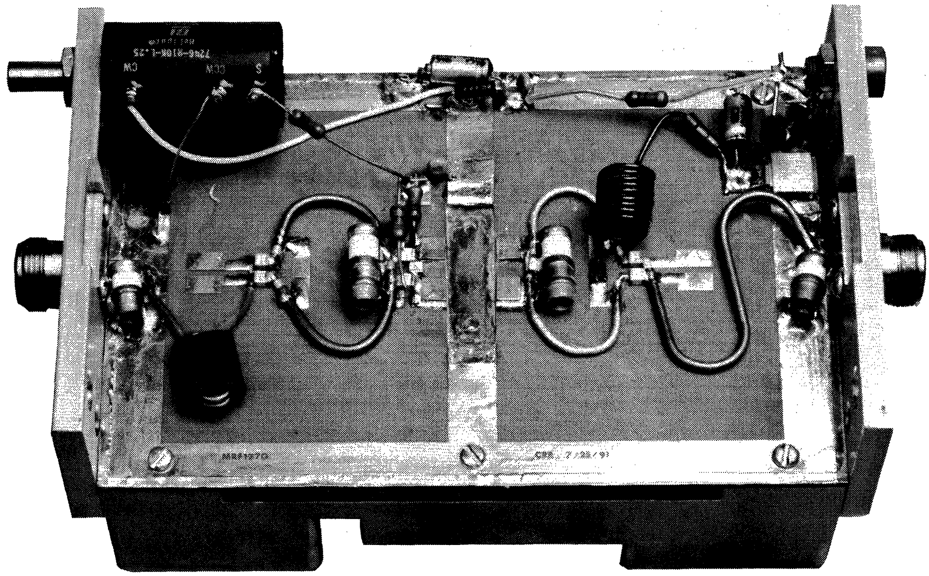
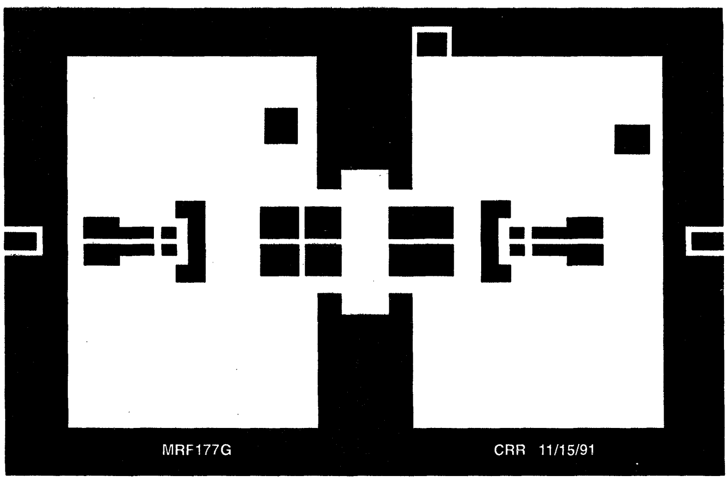


Figure 12. Test Fixture — MRF177M



(Not to Scale)

Figure 13 — Photomaster for MRF177M Test Fixture

Advance Information

The RF MOSFET Line

RF Power Field Effect Transistors

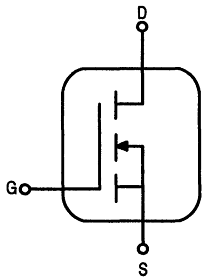
N-Channel Enhancement-Mode Lateral MOSFETs

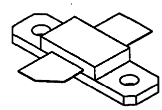
MRF182

Motorola Preferred Device

30 W, 1.0 GHz, 28 VOLTS LATERAL N-CHANNEL BROADBAND RF POWER MOSFET

- High gain, rugged device
- Broadband performance from HF to 1 GHz.
- Bottom side source eliminates DC isolators, reducing common mode inductances.





CASE 360B, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 1 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	µAdc

(continued)

NOTE — CAUTION — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 50 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 1 A)	$V_{DS(on)}$	—	0.34	—	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 3 A)	g_{fs}	—	1.8	—	S
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	53	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	26	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	2.6	—	pF
FUNCTIONAL CHARACTERISTICS					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 30 W, I_{DQ} = 50 mA, f = 1 GHz)	G_{ps}	—	13	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 30 W, I_{DQ} = 50 mA, f = 1 GHz)	η	—	55	—	%
Series Equivalent Input Impedance (V_{DD} = 28 Vdc, P_{out} = 30 W, I_{DQ} = 50 mA, f = 1 GHz)	Z_{in}	—	0.63 + j1.1	—	ohms
Series Equivalent Output Impedance (V_{DD} = 28 Vdc, P_{out} = 30 W, I_{DQ} = 50 mA, f = 1 GHz)	Z_{out}	—	1.70 – j2.3	—	ohms

TYPICAL CHARACTERISTICS

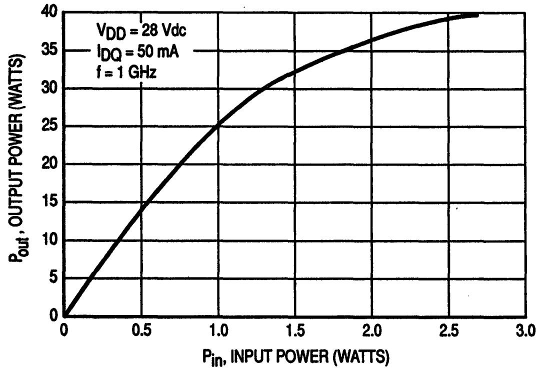


Figure 1. Output Power versus Input Power at 1 GHz

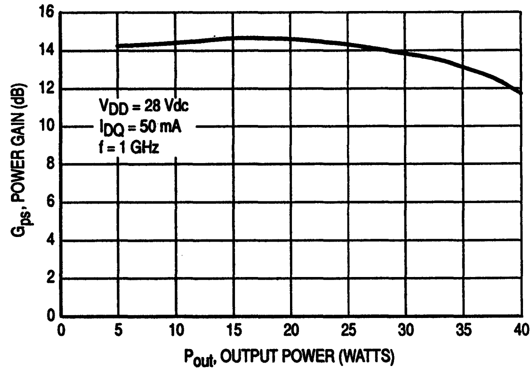


Figure 2. Power Gain versus Output Power at 1 GHz

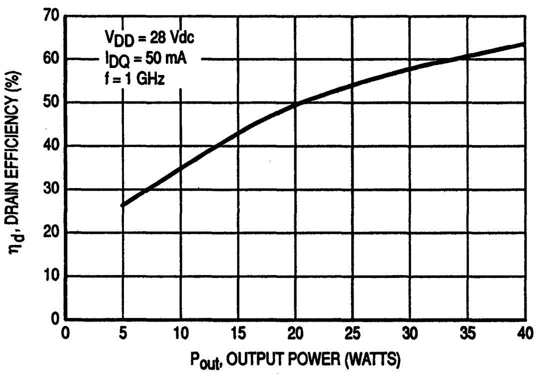


Figure 3. Drain Efficiency versus Output Power at 1 GHz

2

MRF183

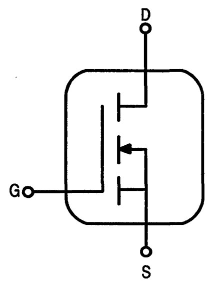
Motorola Preferred Device

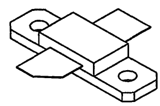
Advance Information

The RF MOSFET Line
RF Power Field Effect Transistors
N-Channel Enhancement-Mode Lateral MOSFETs

45 W, 1.0 GHz, 28 VOLTS
LATERAL N-CHANNEL
BROADBAND RF POWER
MOSFET

- High gain, rugged device
- Broadband performance from HF to 1 GHz.
- Bottom side source eliminates DC isolators, reducing common mode inductances.





CASE 360B, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 1 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	µAdc

(continued)

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 75 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 1 A)	$V_{DS(on)}$	—	0.23	—	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 3 A)	g_{fs}	—	2.6	—	S
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	82	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	38	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	3.8	—	pF
FUNCTIONAL CHARACTERISTICS					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 45 W, I_{DQ} = 75 mA, f = 1 GHz)	G_{ps}	—	12	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 45 W, I_{DQ} = 75 mA, f = 1 GHz)	η	—	55	—	%
Series Equivalent Input Impedance (V_{DD} = 28 Vdc, P_{out} = 45 W, I_{DQ} = 75 mA, f = 1 GHz)	Z_{in}	—	0.65 + j0.24	—	ohms
Series Equivalent Output Impedance (V_{DD} = 28 Vdc, P_{out} = 45 W, I_{DQ} = 75 mA, f = 1 GHz)	Z_{out}	—	1.38 – j1.89	—	ohms

TYPICAL CHARACTERISTICS

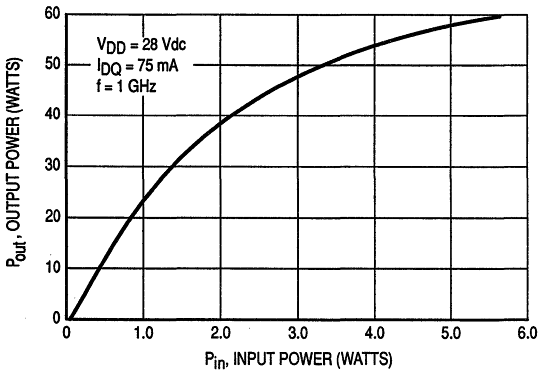


Figure 1. Output Power versus Input Power at 1 GHz

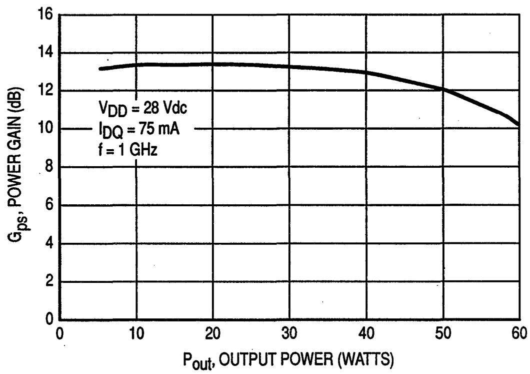


Figure 2. Power Gain versus Output Power at 1 GHz

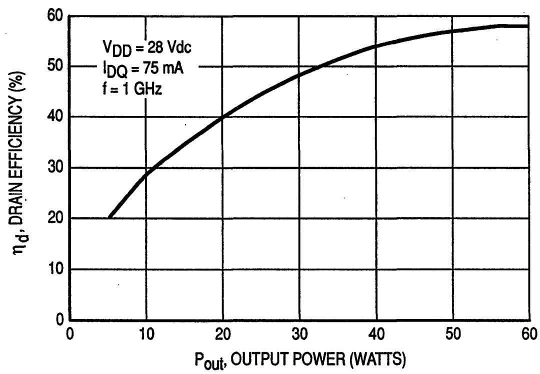


Figure 3. Drain Efficiency versus Output Power at 1 GHz

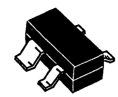
MRF0211LT1

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — f_T = 5.5 GHz (Typ) @ I_C = 40 mAdc
- Low Noise Figure @ f = 1.0 GHz — $NF_{(matched)}$ = 1.8 dB (Typ)
- High Power Gain — G_{pe} (matched) = 13 dB (Typ)
- Surface Mount SOT-143 Offers Improved RF Performance
  Lower Package Parasitics
  Higher Gain
- Higher Voltage Version of MRF5711LT1
- Electrically Similar to NEC NE 02133

**SURFACE MOUNT
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



**CASE 318A, STYLE 1
LOW PROFILE**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.58 4.64	Watts mW/°C
Total Device Dissipation @ T_C = 75°C (1) Derate above 75°C	P_D	0.58 7.73	Watts mW/°C
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	216	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	130	°C/W

DEVICE MARKING

MRF0211LT1 = 15

NOTE:
1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	Figure 1	C_{cb}	—	0.7	1.0	pF
Current Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_C = 40 mA, f = 1.0 GHz)	Figure 7	f_T	—	5.5	—	GHz
FUNCTIONAL TESTS						
Gain at Noise Figure (Tuned) (V_{CE} = 10 Vdc, I_C = 5.0 mAdc)	Figure 4	G_{NFmin}				dB
	f = 0.5 GHz		—	19	—	
	f = 1.0 GHz		—	13	—	
Noise Figure (Tuned) (V_{CE} = 10 Vdc, I_C = 5.0 mAdc)	Figure 4	NF_{min}				dB
	f = 0.5 GHz		—	0.9	—	
	f = 1.0 GHz		—	1.8	—	
	f = 2.0 GHz		—	3.0		
Power Gain in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	Figure 2	G_{NF}	—	9.5	—	dB
Noise Figure in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	Figure 2	NF	—	2.7	3.0	dB
Insertion Gain (V_{CE} = 10 Vdc, I_C = 25 mA, f = 1.0 GHz)		S_{21}^2	11	13.5	—	dB
Maximum Unilateral Gain (V_{CE} = 10 Vdc, I_C = 25 mA, f = 1.0 GHz)		G_{Umax}	—	15.5	—	dB

TYPICAL CHARACTERISTICS

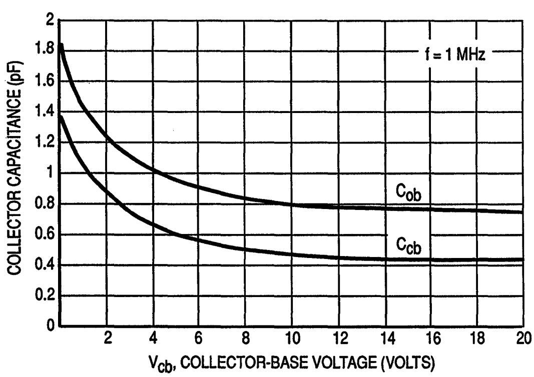


Figure 1. Device Capacitances versus Voltage

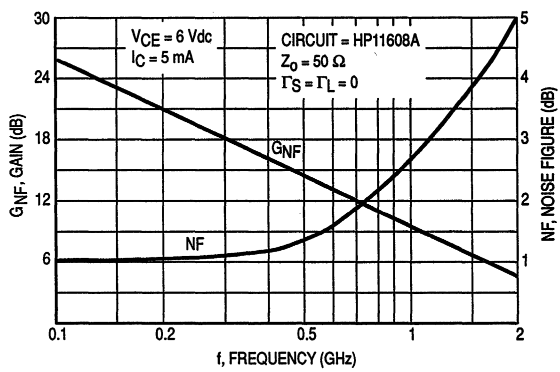


Figure 2. Gain and Noise Figure versus Frequency

2

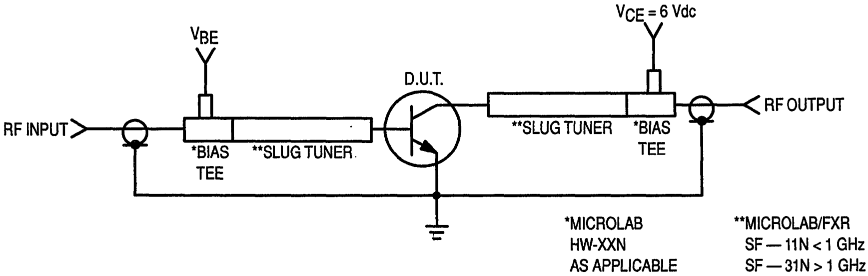


Figure 3. Functional Circuit Schematic

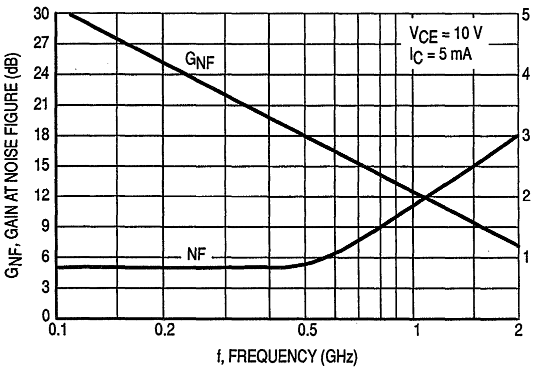


Figure 4. Gain at Noise Figure and Noise Figure versus Frequency

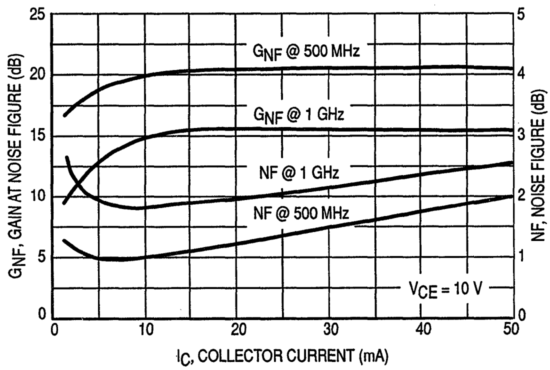


Figure 5. Gain at Noise Figure and Noise Figure versus Collector Current

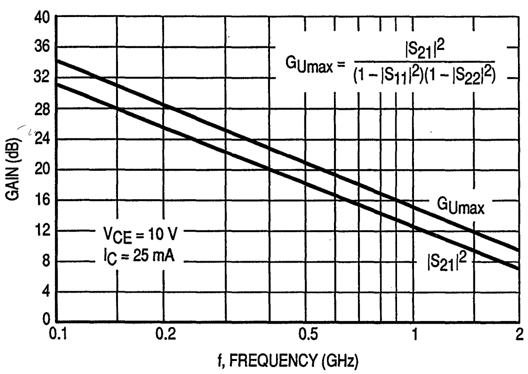


Figure 6. Unilateral-Gain and Insertion Gain versus Frequency

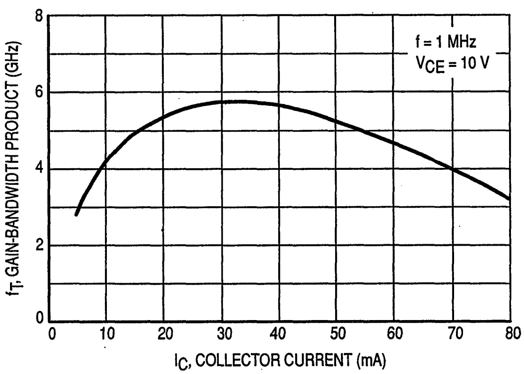


Figure 7. Gain-Bandwidth Product versus Collector Current

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
5.0	5.0	100	0.84	−50	13.2	151	0.04	64	0.90	−22
		200	0.81	−87	10.4	130	0.06	49	0.74	−35
		500	0.74	−139	5.6	100	0.07	32	0.50	−48
		1000	0.68	−175	2.9	77	0.09	32	0.42	−58
		1500	0.66	167	2.0	61	0.09	40	0.44	−67
		2000	0.65	149	1.5	51	0.11	51	0.44	−73
	10	100	0.76	−66	20.6	144	0.03	60	0.83	−32
		200	0.73	−106	14.8	122	0.05	44	0.62	−49
		500	0.69	−153	7.1	96	0.06	37	0.36	−63
		1000	0.65	178	3.7	76	0.08	44	0.28	−71
		1500	0.62	162	2.5	63	0.09	51	0.30	−77
		2000	0.61	145	1.9	54	0.12	59	0.20	−78
	25	100	0.65	−89	28.8	134	0.03	55	0.71	−44
		200	0.67	−126	18.2	114	0.04	45	0.48	−64
		500	0.65	−163	8.3	92	0.05	45	0.27	−80
		1000	0.63	172	4.2	76	0.07	55	0.20	−90
		1500	0.60	158	2.8	64	0.10	60	0.22	−92
		2000	0.59	142	2.2	55	0.13	63	0.20	−90
	50	100	0.62	−110	30.4	126	0.02	51	0.62	−49
		200	0.66	−142	18.0	109	0.03	45	0.41	−65
		500	0.66	−171	7.9	90	0.04	52	0.25	−79
		1000	0.64	168	4.1	75	0.06	62	0.20	−91
		1500	0.62	155	2.7	62	0.10	65	0.20	−93
		2000	0.60	140	2.1	55	0.13	67	0.14	−90
10	5.0	100	0.86	−46	13.2	153	0.03	69	0.92	−18
		200	0.82	−81	10.6	132	0.05	51	0.80	−28
		500	0.72	−134	5.9	102	0.07	36	0.57	−38
		1000	0.65	−171	3.2	78	0.08	38	0.49	−46
		1500	0.63	169	2.1	62	0.08	47	0.52	−55
		2000	0.61	149	1.6	51	0.10	60	0.53	−61
	10	100	0.77	−60	20.7	145	0.03	62	0.85	−26
		200	0.72	−98	15.2	124	0.04	48	0.66	−38
		500	0.65	−147	7.5	97	0.06	42	0.44	−46
		1000	0.59	−177	3.9	77	0.07	48	0.37	−51
		1500	0.58	165	2.6	64	0.09	56	0.39	−59
		2000	0.56	145	2.0	54	0.13	65	0.40	−62
	25	100	0.67	−80	29.4	136	0.02	57	0.75	−35
		200	0.66	−118	19.3	116	0.03	47	0.53	−48
		500	0.63	−158	8.9	94	0.05	47	0.33	−55
		1000	0.61	175	4.6	77	0.07	57	0.26	−60
		1500	0.58	161	3.1	64	0.09	61	0.29	−65
		2000	0.57	144	2.3	55	0.12	66	0.30	−65
	50	100	0.65	−99	32.2	129	0.02	54	0.67	−38
		200	0.65	−135	19.5	110	0.03	44	0.45	−48
		500	0.64	−167	8.5	91	0.04	53	0.31	−51
		1000	0.61	170	4.2	75	0.06	62	0.26	−55
		1500	0.59	157	2.9	63	0.09	58	0.30	−61
		2000	0.58	141	2.3	54	0.11	71	0.31	−63

Table 1. Common Emitter S-Parameters

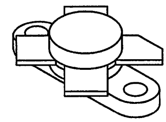
MRF224

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for 12.5 Volt VHF large-signal power amplifier applications required in commercial and industrial equipment operating to VHF frequencies.

- Specified 12.5 Volt, 175 MHz Characteristics —
  Output Power = 40 W
  Power Gain = 4.5 dB Min
  Efficiency = 70% Min

**40 W, 175 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 211-07, STYLE 1

2

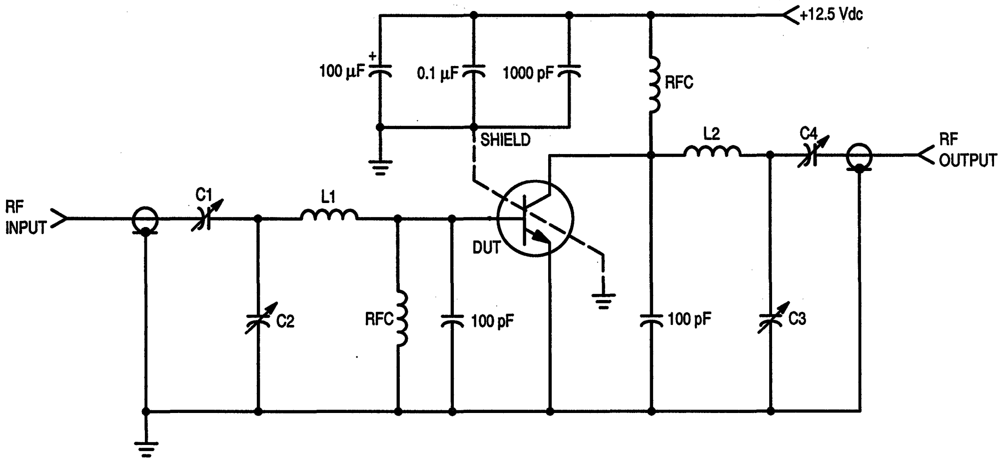
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ T_C = 25°C (2) Derate above 25°C	P_D	80 0.46	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +200	°C
Stud Torque (1)	—	6.5	in. lb.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	—	—	10	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	2.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	—	170	200	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	4.5	—	—	dB
Collector Efficiency (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	70	—	—	%

NOTES:
1. For repeated assembly use 5 in. lb.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.



C1, C2, C3, C4 — 5.0–80 pF ARCO 462
L1 — Straight Wire, #14 AWG, 1-3/8″ Long
L2 — 1 Turn, #14 AWG, 3/8″ ID, Length Plus Leads = 1″
RFC — VK200-20/4B, FERROXCUBE

Figure 1. 175 MHz Test Circuit

2

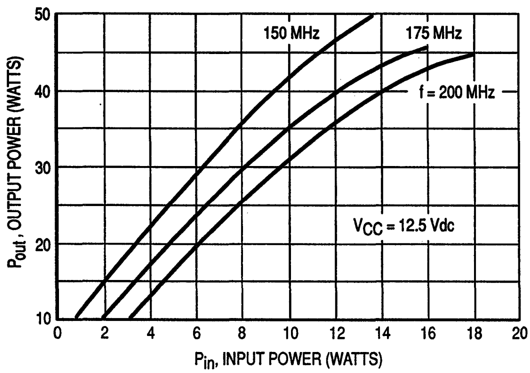


Figure 2. Output Power versus Input Power

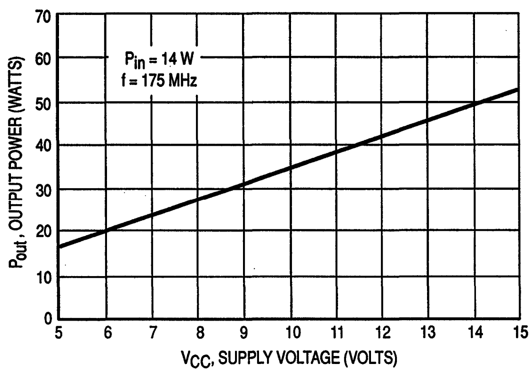
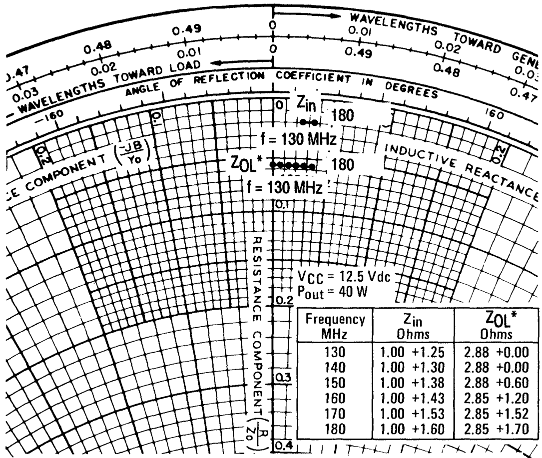


Figure 3. Output Power versus Supply Voltage



Frequency MHz	Z_{in} Ohms	Z_{OL}* Ohms
130	1.00 +1.25	2.88 +0.00
140	1.00 +1.30	2.88 +0.00
150	1.00 +1.38	2.88 +0.60
160	1.00 +1.43	2.85 +1.20
170	1.00 +1.53	2.85 +1.52
180	1.00 +1.60	2.85 +1.70

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 4. Series Equivalent Impedance

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

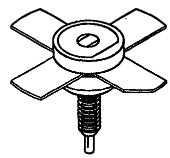
MRF240

The RF Line
NPN Silicon RF Power Transistors

40 W, 145–175 MHz
RF POWER
TRANSISTORS
NPN SILICON

. . . designed for 13.6 volt VHF large-signal class C and class AB linear power amplifier applications in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 13.6 V, 160 MHz Performance:
  Output Power = 40 Watts
  Power Gain = 9.0 dB Min
  Efficiency = 55% Min
- Load Mismatch Capability at Rated Voltage and RF Drive
- Silicon Nitride Passivated
- Low Intermodulation Distortion, d_3 = –30 dB Typ



CASE 145A-09, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	100 0.57	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	90	125	pF

(continued)

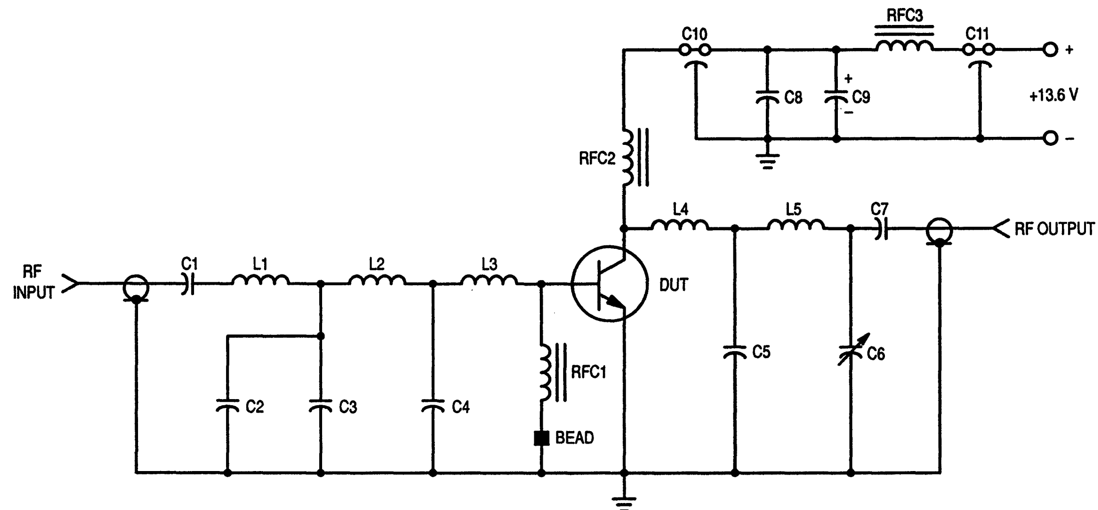
NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 40 W, f = 160 MHz)	G_{PE}	9.0	10	—	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 40 W, f = 160 MHz)	η	55	—	—	%
TYPICAL SSB PERFORMANCE					
Intermodulation Distortion (3) (V_{CC} = 13.6 Vdc, P_{out} = 35 W (PEP), f1 = 146 MHz, f2 = 146.002 MHz, I_{CQ} = 50 mAdc)	IMD (d_3)	—	−30	—	dB

NOTE:
3. To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

2



C1 — 200 pF, 350 Vdc, UNELCO
C2 — 100 pF, 350 Vdc, UNELCO
C3 — 40 pF, 350 Vdc, UNELCO
C4, C5 — 80 pF, 350 Vdc, UNELCO
C6 — 1.0–20 pF, ARCO Trimmer
C7 — 100 pF 350 Vdc, UNELCO
C8 — 0.1 µF ERIE Disc Ceramic
C9 — 1.0 µF TANTALUM
C10, C11 — 680 pF ALLEN BRADLEY Feedthru
RFC1 — 0.15 µH Molded Choke
RFC2 — 10 Turns, #18 AWG on 470 Ohm, 1.0 Watt Resistor
Bead — FERROXCUBE Bead
RFC3 — FERROXCUBE Choke, VK200-4B
L1 — 3.3 x 0.2 cm AIRLINE Inductor
L2 — 1.0 x 0.2 cm AIRLINE Inductor
L3 — 1.2 x 0.6 cm Brass Pad
L4 — 1.2 x 0.6 cm Brass Pad and 2.0 x 0.2 cm AIRLINE Inductor
Board — G10, ε_r = 5, t = 62 mils 2 sided, 2 oz. Clad
Connectors: Type N

Figure 1. 160 MHz Test Circuit Schematic

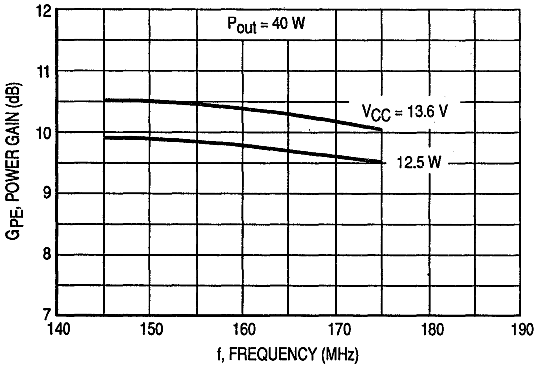


Figure 2. Power Gain versus Frequency

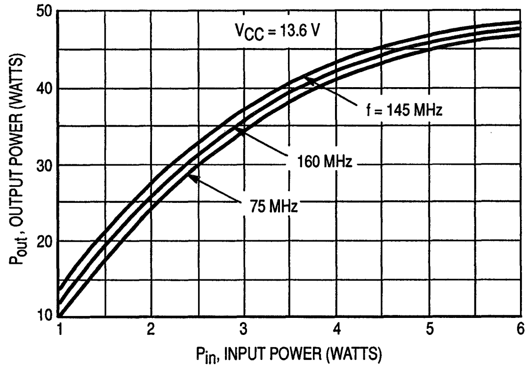


Figure 3. Output Power versus Input Power

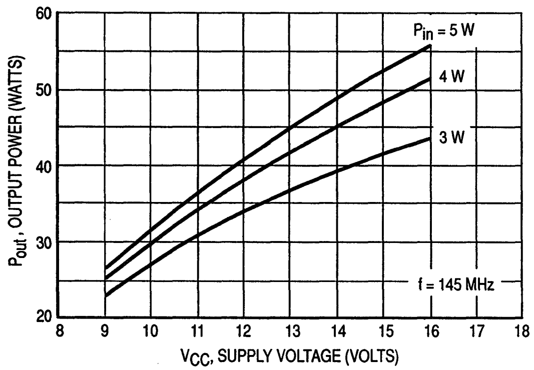


Figure 4. Output Power versus Supply Voltage

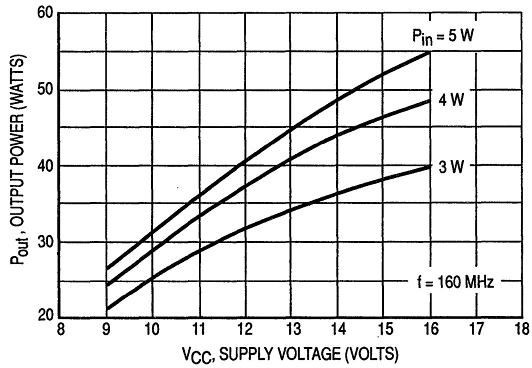


Figure 5. Output Power versus Supply Voltage

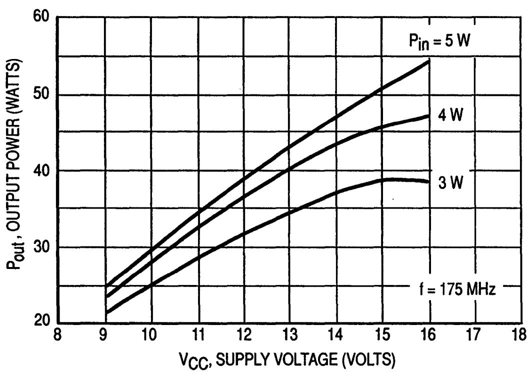


Figure 6. Output Power versus Supply Voltage

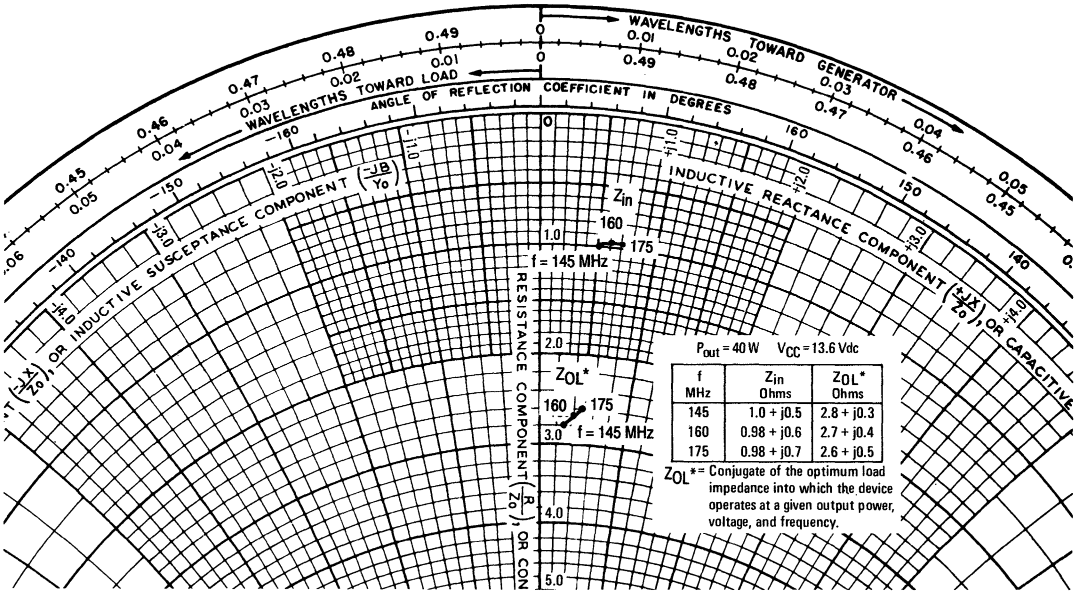


Figure 7. Series Equivalent Input/Output Impedances

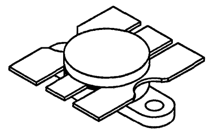
MRF247

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 Volt VHF large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
  Output Power = 75 Watts
  Power Gain = 7.0 dB Min
  Efficiency = 55% Min
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Internal Matching Network Optimized for Minimum Gain Frequency Slope Response Over the Range 136 to 175 MHz
- Load Mismatch Capability at Rated P_{out} and Supply Voltage

**75 W, 175 MHz
CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON**



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak	I_C	20	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc

NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	75	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	235	300	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 75 Watts, f = 175 MHz)	G_{PE}	7.0	8.5	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 75 Watts, f = 175 MHz)	η	55	60	—	%
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 75 Watts, f = 175 MHz, VSWR = 30:1 All Phase Angles)	ψ	No Degradation in Output Power			

2

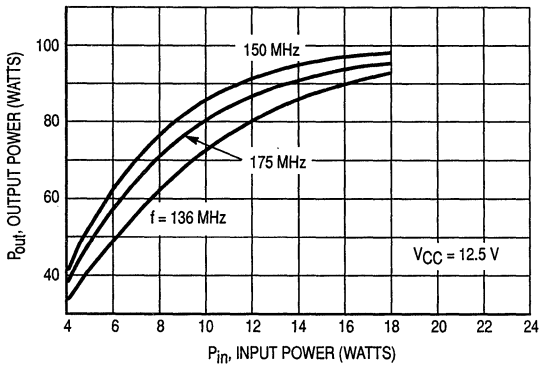


Figure 1. Output Power versus Input Power

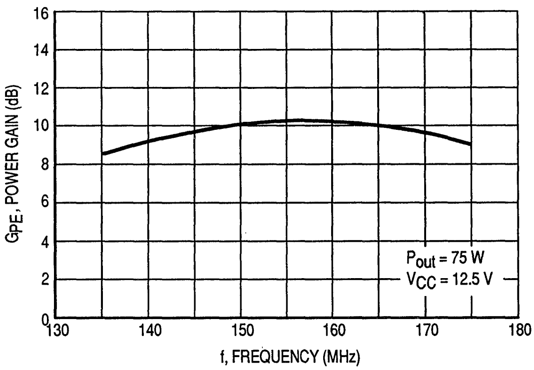


Figure 2. Power Gain versus Frequency

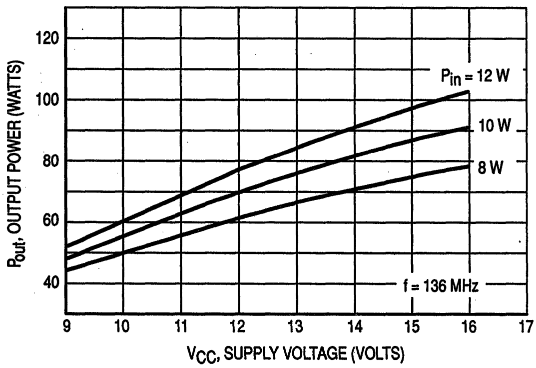


Figure 3. Output Power versus Supply Voltage

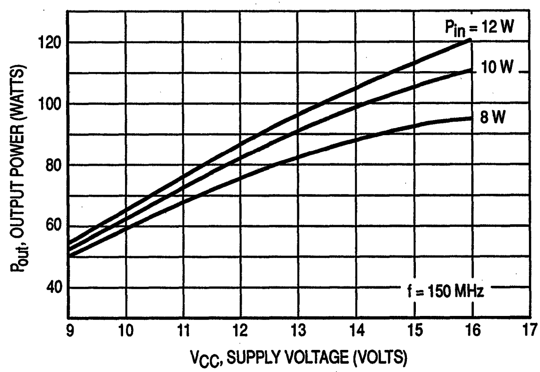


Figure 4. Output Power versus Supply Voltage

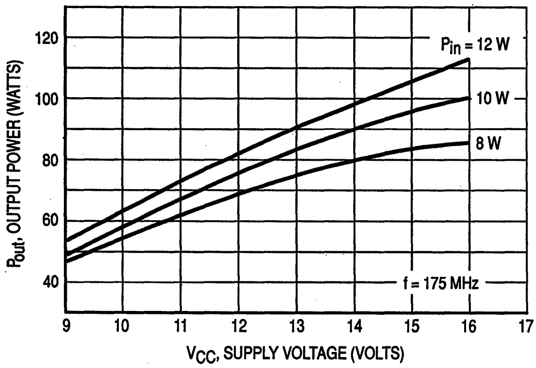
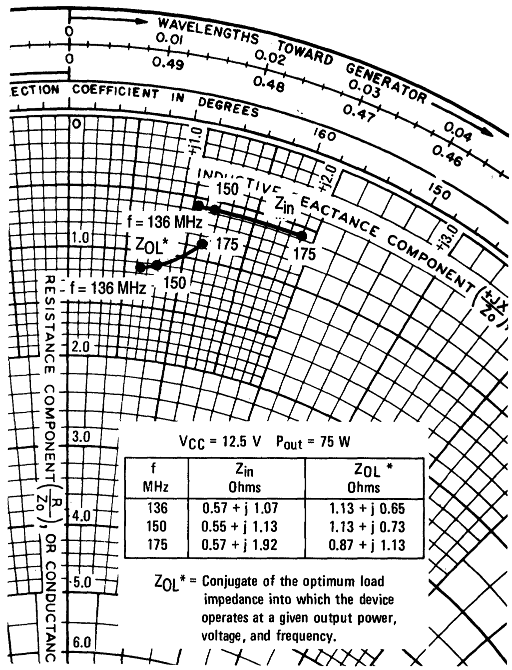


Figure 5. Output Power versus Supply Voltage



f MHz	Zin Ohms	ZOL* Ohms
136	0.57 + j 1.07	1.13 + j 0.65
150	0.55 + j 1.13	1.13 + j 0.73
175	0.57 + j 1.92	0.87 + j 1.13

Figure 6. Series Equivalent Impedances

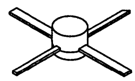
MRF313

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for wideband amplifier, driver or oscillator applications in military, mobile, and aircraft radio.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 1.0 Watt
  Power Gain = 15 dB Min
  Efficiency = 45% Typ
- Emitter Ballast and Low Current Density for Improved MTBF
- Common Emitter for Improved Stability

**1.0 W, 400 MHz
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 305A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	6.1 35	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	28.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, I_B = 0)	I_{CEO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	60	150	—

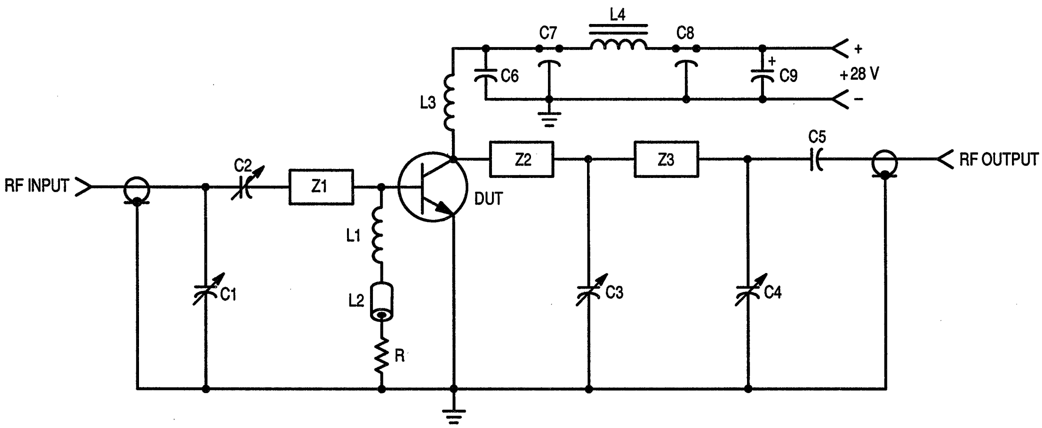
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 100 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	—	2.5	—	GHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.5	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (1) (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	G_{pe}	15	16	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	η	—	45	—	%
Series Equivalent Input Impedance (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	Z_{in}	—	6.4 – j4.8	—	Ohms
Series Equivalent Output Impedance (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	Z_{out}	—	75 – j45	—	Ohms

NOTE:
1. Class C

2



C1, C2, C4 — 1.0–20 pF JOHANSON 9063
C3 — 1.0–10 pF JOHANSON
C5 — 150 pF Chip
C6 — 0.1 µF
C7, C8 — 680 pF Feedthru
C9 — 1.0 µF TANTALUM

L1, L3 — 5 Turns, AWG #20, 1/4″ I.D.
L2 — Ferrite Bead, FERROXCUBE No. 56-590-65/4B
L4 — FERROXCUBE VK200-20/4B
Input/Output Connectors — Type N
Board — Glass Teflon, ε = 2.56, t = 0.062″

R — 4.7 Ohms, 1/4 W
Z1 — 2.0″ x 0.1″ MICROSTRIP LINE
Z2, Z3 — 2.6″ x 0.1″ MICROSTRIP LINE

Figure 1. 400 MHz Power Gain Test Circuit

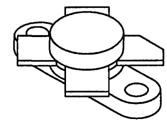
MRF314

The RF Line
NPN Silicon RF Power Transistors

. . . designed primarily for wideband large-signal driver and output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 30 Watts
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

**30 W, 30–200 MHz
RF POWER
TRANSISTORS
NPN SILICON**



CASE 211-07, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	82 0.47	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.13	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

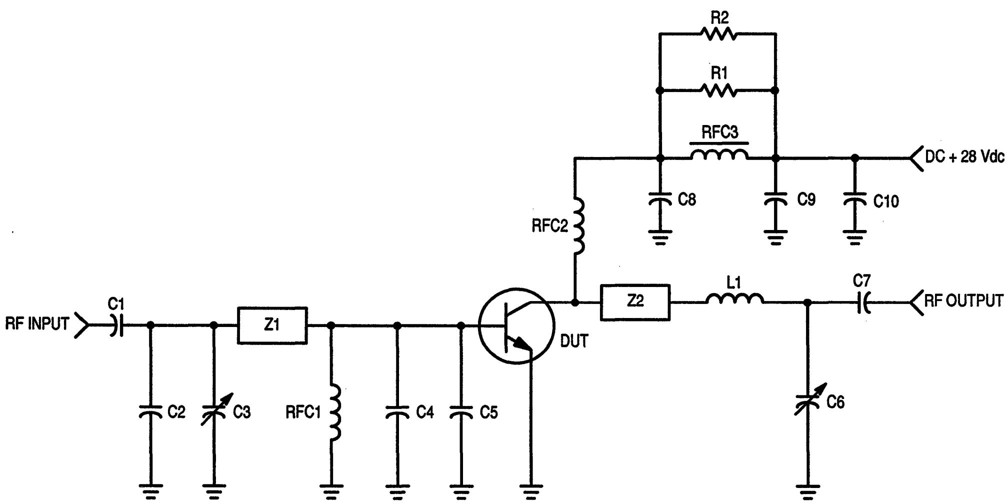
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 30 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—

NOTE:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	30	40	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 150 MHz)	G_{PE}	10	13.5	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 150 MHz)	η	50	—	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Power Output			



C1, C7 — 18 pF, 100 mil ATC
C2 — 68 pF, 100 mil ATC
C3, C6 — Johanson #JMC 5501
C4 — 270 pF, 100 mil ATC
C5 — 240 pF, 100 mil ATC
C8, C9 — 100 pF Underwood
C10 — 1.0 μF Tantalum
L1 — 2 Turns, 2.5″ #20 Wire, ID = 0.275″

R1, R2 — 10 Ω, 1.0 W
RFC1 — 15 μH Molded Coil
RFC2 — 2 Turns, 2.5″ #20 Wire, ID = 0.2″
RFC3 — Ferroxcube VK200-19/4B
Z1 — Microstrip, 0.168″ W x 1.6″ L
Z2 — Microstrip, 0.168″ W x 1.2″ L
Board — Glass Teflon ε_r = 2.55

Figure 1. 150 MHz Test Circuit

2

TYPICAL PERFORMANCE CURVES

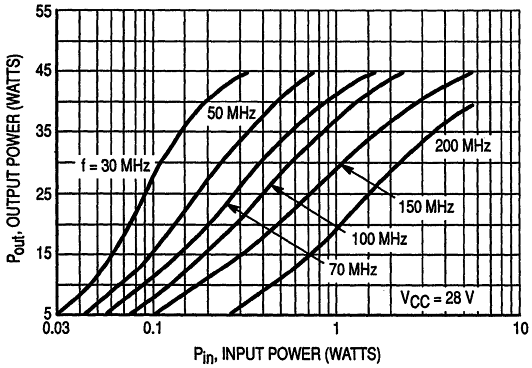


Figure 2. Output Power versus Input Power

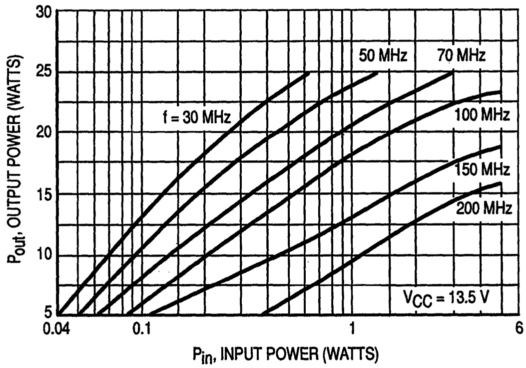


Figure 3. Output Power versus Input Power

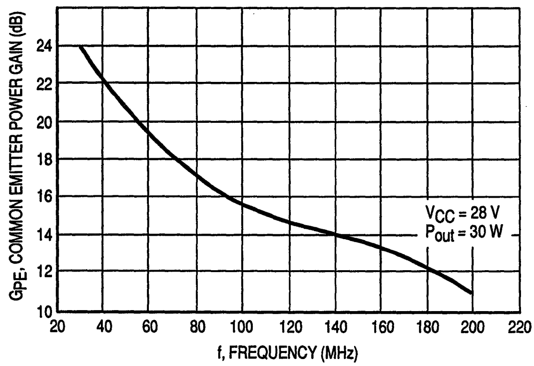


Figure 4. Power Gain versus Frequency

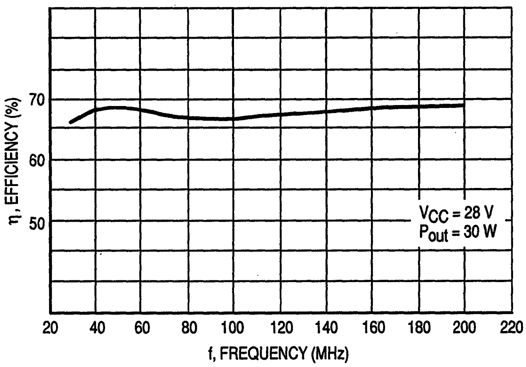
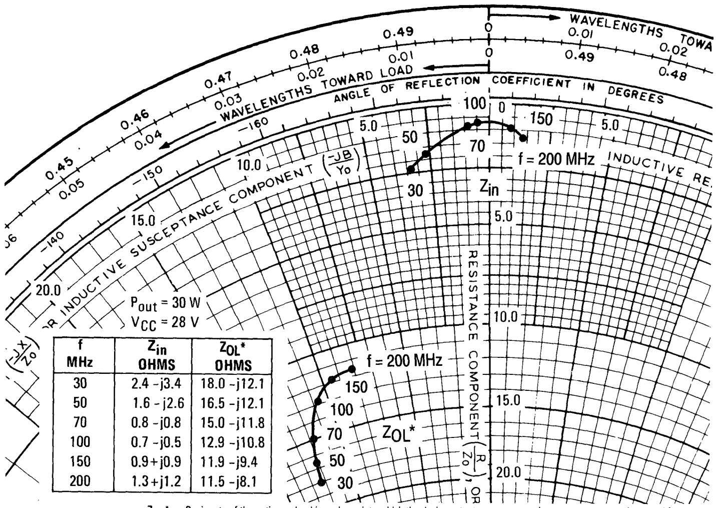


Figure 5. Efficiency versus Frequency

2



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	2.4 -j3.4	18.0 -j12.1
50	1.6 -j2.6	16.5 -j12.1
70	0.8 -j0.8	15.0 -j11.8
100	0.7 -j0.5	12.9 -j10.8
150	0.9+j0.9	11.9 -j9.4
200	1.3+j1.2	11.5 -j8.1

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input/Output Impedance

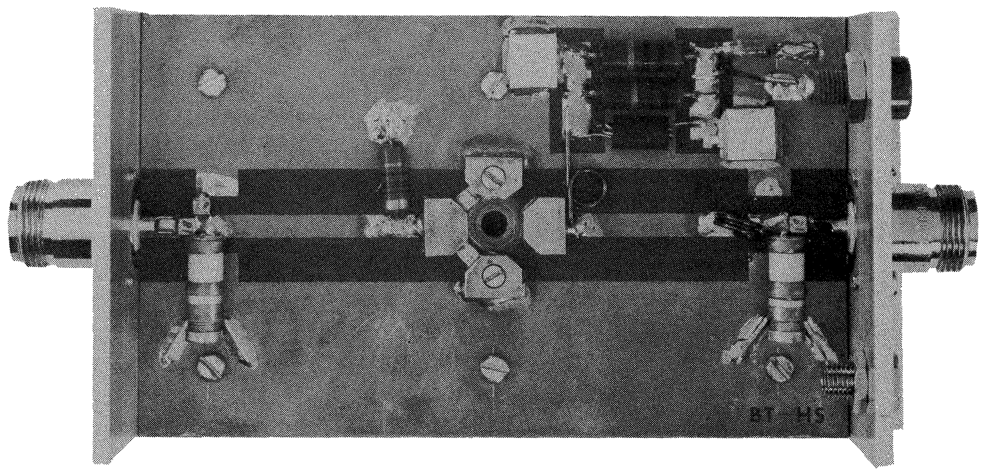


Figure 7. Test Fixture

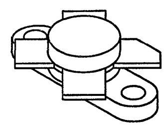
MRF315

The RF Line
NPN Silicon
RF Power Transistors

. . . designed primarily for wideband large-signal output amplifier stages in the 30 to 200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 45 Watts
  Minimum Gain = 9.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

**45 W, 30 to 200 MHz
RF POWER
TRANSISTORS
NPN SILICON**



CASE 211-07, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	110 0.63	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.59	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

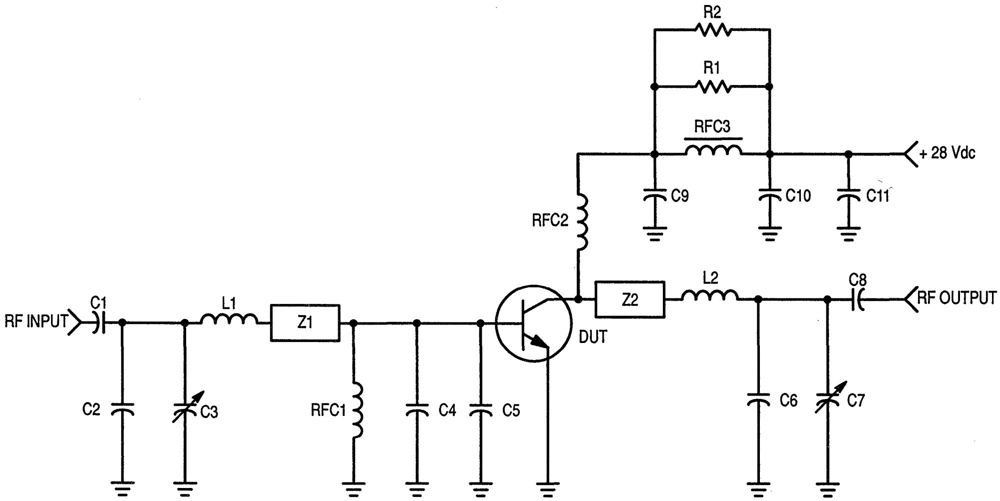
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 4.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—

NOTE:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	45	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 45 W, f = 150 MHz)	G_{PE}	9.0	11	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 45 W, f = 150 MHz)	η	50	—	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, VSWR = 30:1 all phase angles)	—	No Degradation in Power Output			



C1 — 30 pF, 100 mil ATC
C2 — 47 pF, 100 mil ATC
C3, C7 — Johanson #JMC 5501
C4, C5 — 200 pF, 100 mil ATC
C6 — 24 pF, 100 mil ATC
C8 — 27 pF, 100 mil ATC
C9, C10 — 100 pF Underwood
C11 — 1.0 µF Tantalum

L1 — 0.5″ #18 Wire
L2 — 2 Turns, 1.5″ #20 Wire, ID = 0.15″
R1, R2 — 10 Ω, 1.0 W
RFC1 — 15 µH Molded Coil
RFC2 — 2 Turns, 2.5″ #18 Wire, ID = 0.2″
RFC3 — Ferroxcube VK200-19/4B
Z1, Z2 — Microstrip 0.168″ W x 1.25″ L
Board — Glass Teflon $\varepsilon_r \approx 2.55$

Figure 1. 150 MHz Test Circuit

TYPICAL PERFORMANCE CURVES

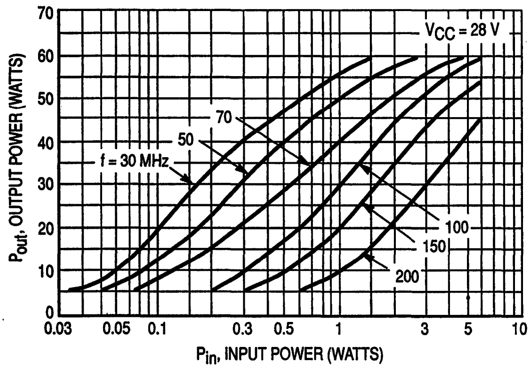


Figure 2. Output Power versus Input Power

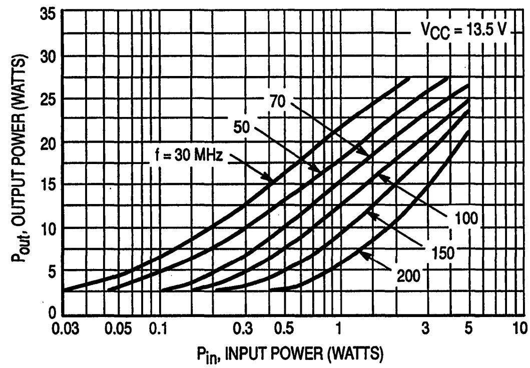


Figure 3. Output Power versus Input Power

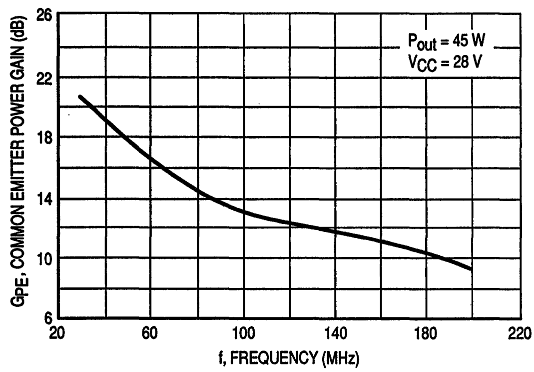


Figure 4. Power Gain versus Frequency

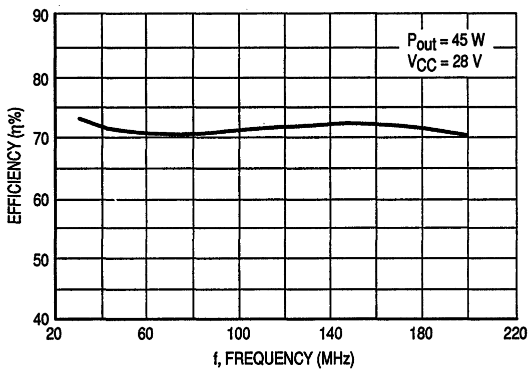
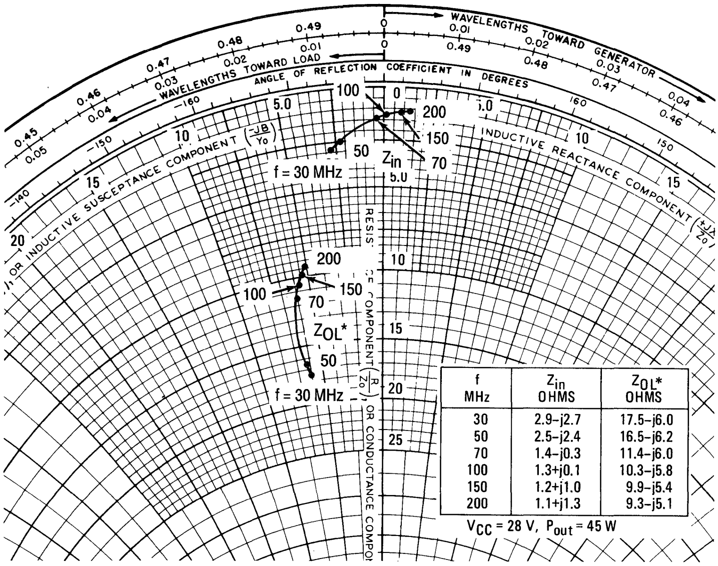


Figure 5. Efficiency versus Frequency



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	2.9–j2.7	17.5–j6.0
50	2.5–j2.4	16.5–j6.2
70	1.4–j0.3	11.4–j6.0
100	1.3+j0.1	10.3–j5.8
150	1.2+j1.0	9.9–j5.4
200	1.1+j1.3	9.3–j5.1

V_{CC} = 28 V, P_{out} = 45 W

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input/Output Impedance

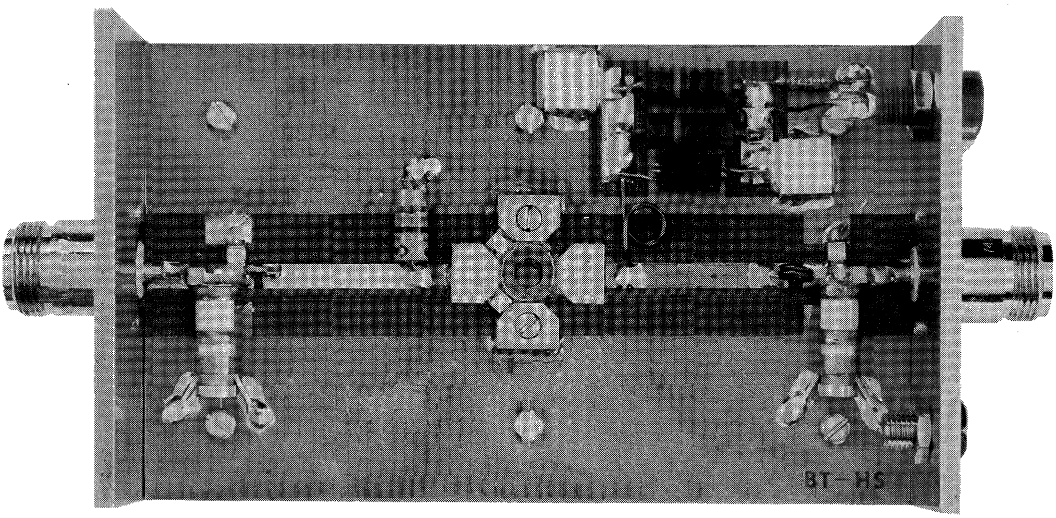


Figure 7. Test Fixture

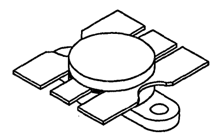
MRF316

The RF Line
NPN Silicon RF Power Transistor

. . . designed primarily for wideband large-signal output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 80 Watts
  Minimum Gain = 10 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

80 W, 3.0–200 MHz
CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR
NPN SILICON



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous Peak	I_C	9.0 13.5	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	220 1.26	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

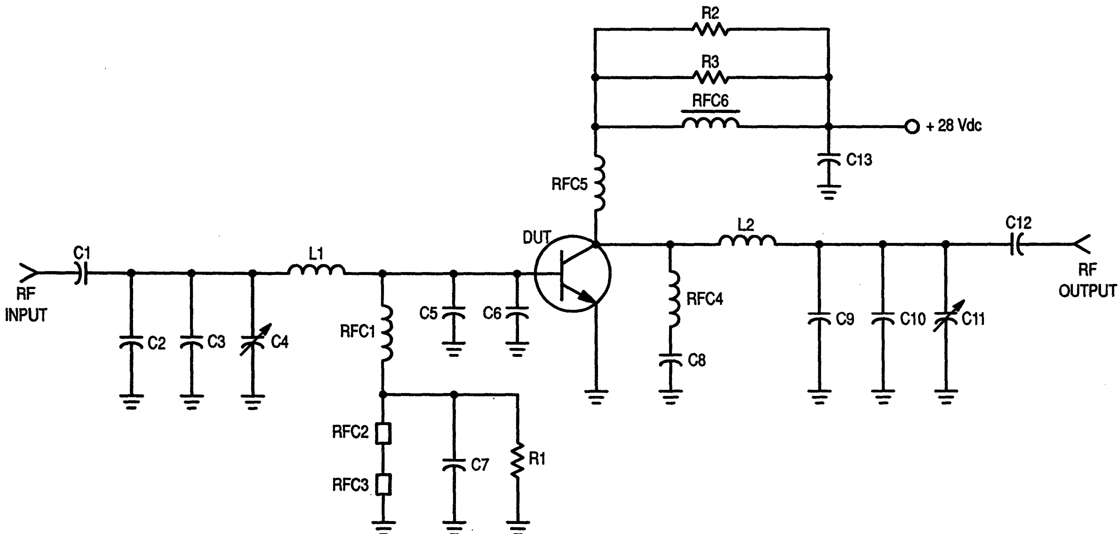
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	130	200	pF

NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
NARROW BAND FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 150 MHz)	G_{PE}	10	13	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 150 MHz)	η	55	—	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 80 W CW, f = 150 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			



C1 — 22 pF 100 mil ATC
C2, C3 — 24 pF 100 mil ATC
C4, C11 — 0.8–20 pF JMC #5501 Johanson
C5 — 200 pF 100 mil ATC
C6 — 240 pF 100 mil ATC
C7 — Dipped Mica 1000 pF
C8 — 0.1 µF Erie Red Cap
C9, C10, C12 — 30 pF 100 mil ATC
C13 — 1.0 µF Tantalum

L1 — 0.8″, #20 Wire
L2 — 1.0″, #20 Wire
RFC1, RFC4 — 0.15 µH Molded Coil
RFC2, RFC3 — Ferroxcube Bead 56-590-65-3B
RFC5 — 2.5″, #20 Wire, 1.5 Turns
RFC6 — Ferroxcube VK200-19/4B
R1 — 10 Ω, 1/2 W
R2, R3 — 10 Ω, 1.0 W

Figure 1. 150 MHz Test Amplifier

TYPICAL PERFORMANCE CURVES

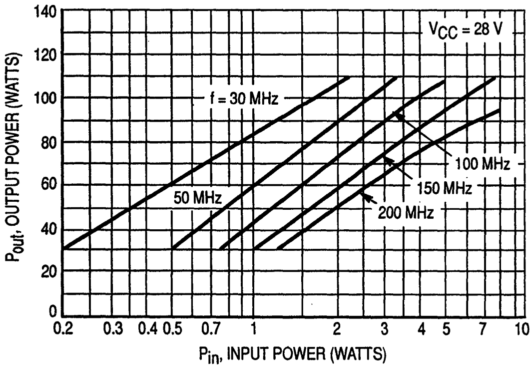


Figure 2. Output Power versus Input Power

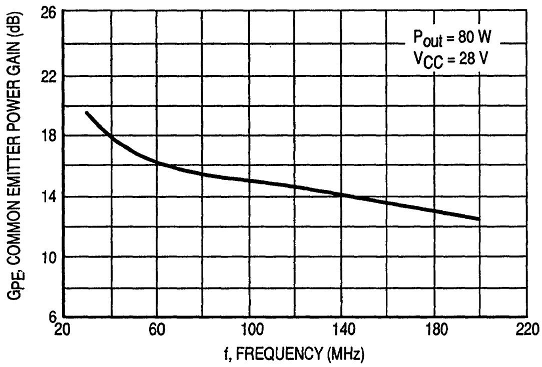


Figure 3. Power Gain versus Frequency

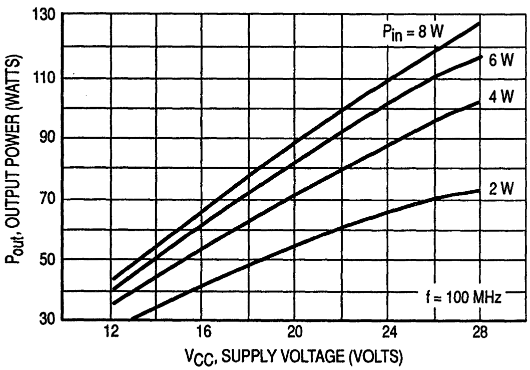


Figure 4. Output Power versus Supply Voltage

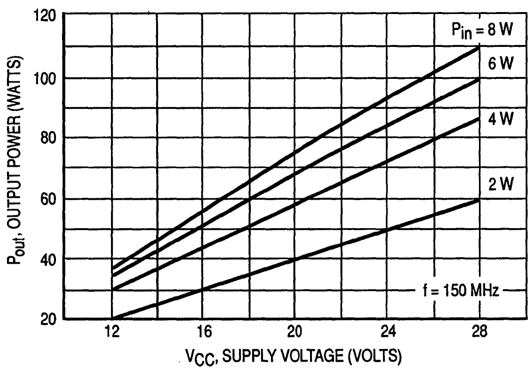


Figure 5. Output Power versus Supply Voltage

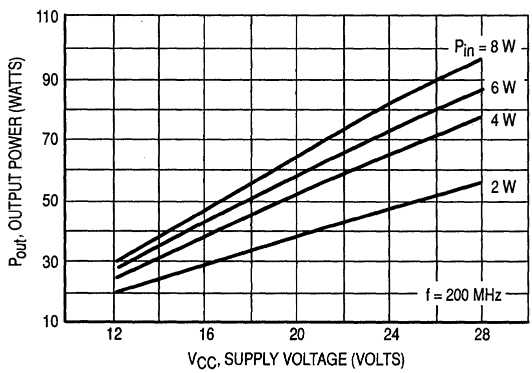
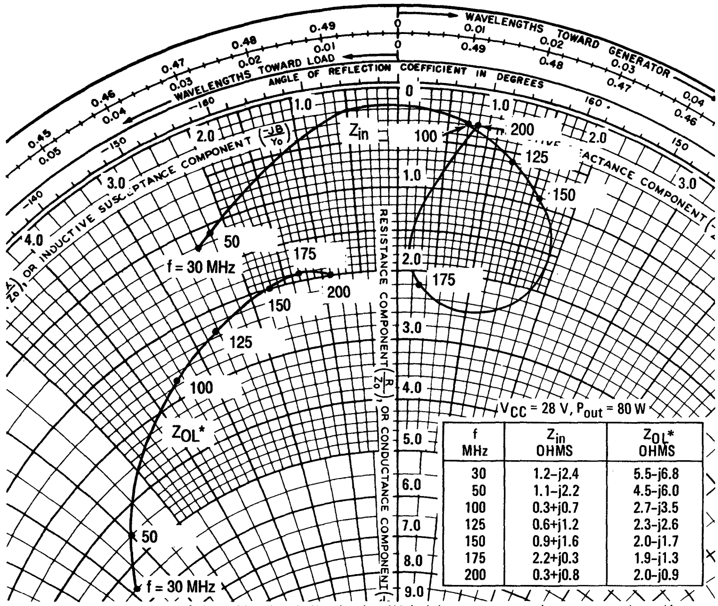


Figure 6. Output Power versus Supply Voltage



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	1.2–j2.4	5.5–j6.8
50	1.1–j2.2	4.5–j6.0
100	0.3+j0.7	2.7–j3.5
125	0.6+j1.2	2.3–j2.6
150	0.9+j1.6	2.0–j1.7
175	2.2+j0.3	1.9–j1.3
200	0.3+j0.8	2.0–j0.9

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 7. Series Equivalent Input-Output Impedance

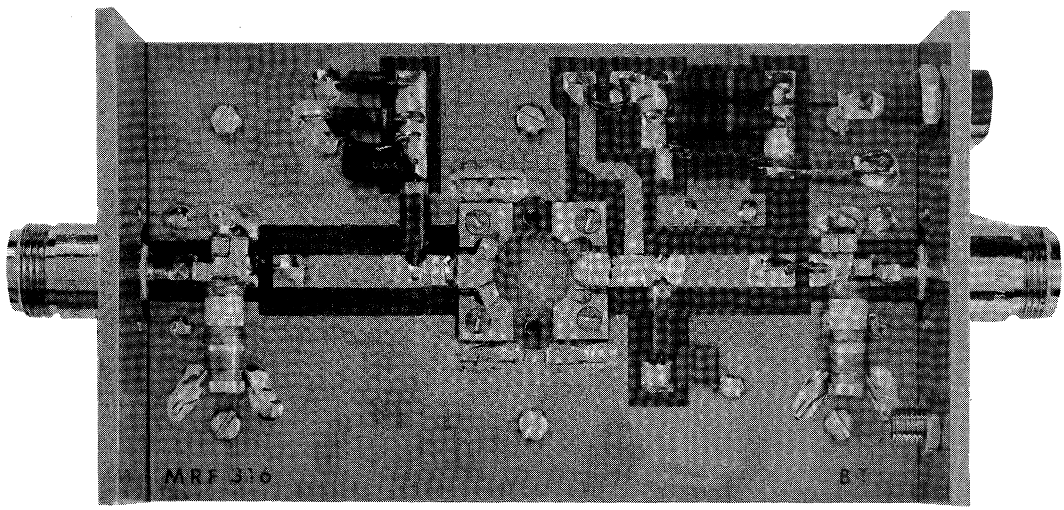


Figure 8. Test Fixture

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

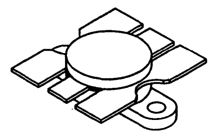
MRF317

The RF Line
NPN Silicon RF Power Transistor

... designed primarily for wideband large-signal output amplifier stages in 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 100 W
  Minimum Gain = 9.0 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- High Output Saturation Power — Ideally Suited for 30 W Carrier/120 W Peak AM Amplifier Service
- Guaranteed Performance in Broadband Test Fixture

100 W, 30–200 MHz CONTROLLED Q BROADBAND RF POWER TRANSISTOR NPN SILICON



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak (10 seconds)	I_C	12 18	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	25	80	—

NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	200	250	pF
FUNCTIONAL TESTS (Figure 2)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 150 MHz, I_C (Max) = 6.5 Adc)	G_{PE}	9.0	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 150 MHz, I_C (Max) = 6.5 Adc)	η	55	60	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W CW, f = 150 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			

2

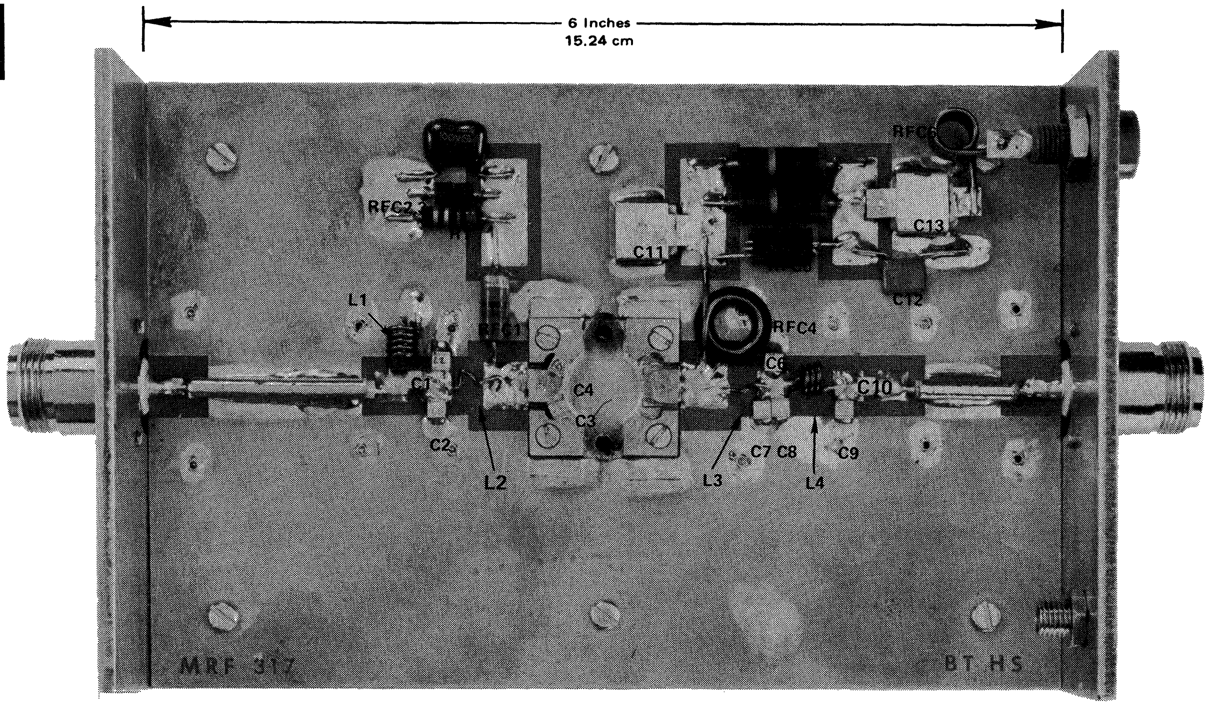
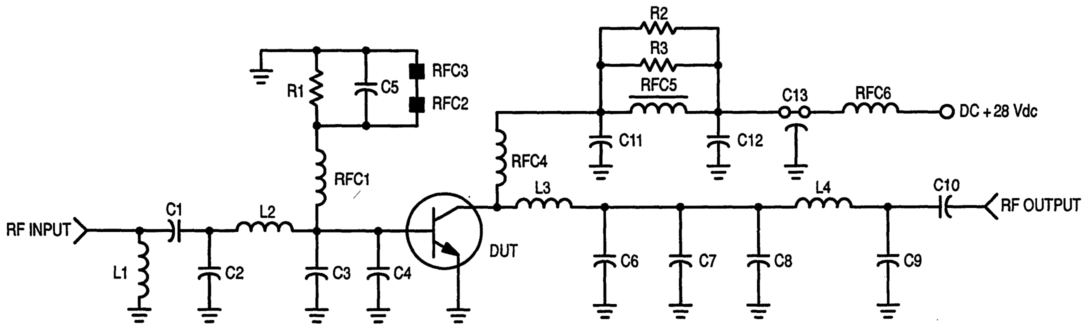


Figure 1. Broadband (110–160 MHz) Test Fixture



C1, C9 — 39 pF, 100 mil ATC
C2 — 120 pF, 100 mil ATC
C3, C4 — 360 pF, 100 mil ATC
C5 — 1000 pF Dipped Mica
C6, C7 — 100 pF, 100 mil ATC*
C8 — 18 pF, 100 mil ATC*
C10 — 43 pF, 100 mil ATC
C11 — 60 pF, Underwood
C12 — 0.1 µF Erie Redcap
C13 — 1000 pF, Underwood J102
L1 — 50 nH
L2 — 6.0 nH
L3 — 8.0 nH
L4 — 32 nH
RFC1 — 0.15 µH Molded Coil
RFC2, RFC3 — Ferroxcube Bead 56-590-65/3B
RFC4 — 1 Turn, #18 Wire, 2.0″ L
RFC5 — Ferroxcube VK200 19/4B
RFC6 — 7 Turns, #18 Wire, 0.3″ ID
R1 — 10 Ω 1/2 W
R2, R3 — 10 Ω 1.0 W
*Combination of C6, C7, C8 equals 220 pF.

Figure 2. 110–160 MHz Broadband Amplifier — Test Fixture Schematic

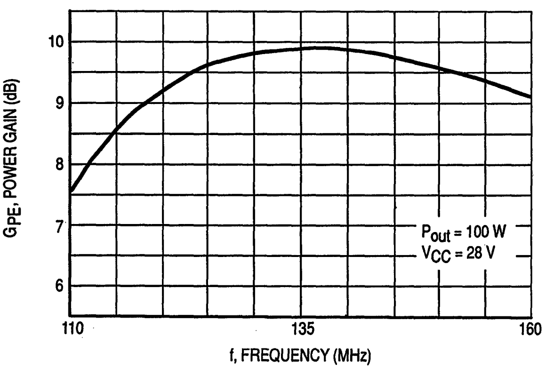


Figure 3. Power Gain versus Frequency Broadband Test Fixture

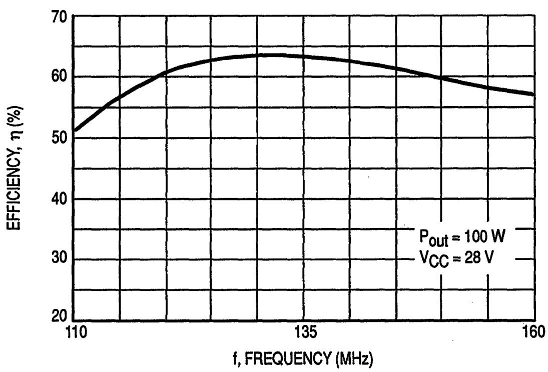


Figure 4. Efficiency versus Frequency Broadband Test Fixture

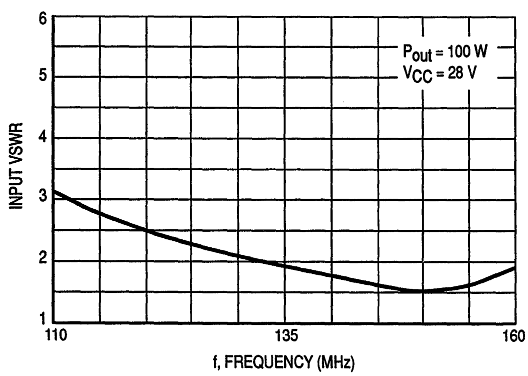


Figure 5. Input VSWR versus Frequency Broadband Test Fixture

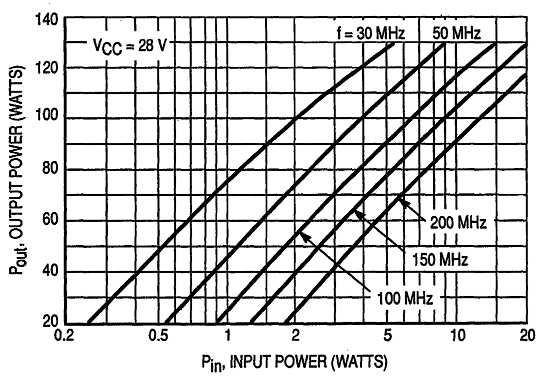


Figure 6. Output Power versus Input Power

TYPICAL PERFORMANCE CURVES

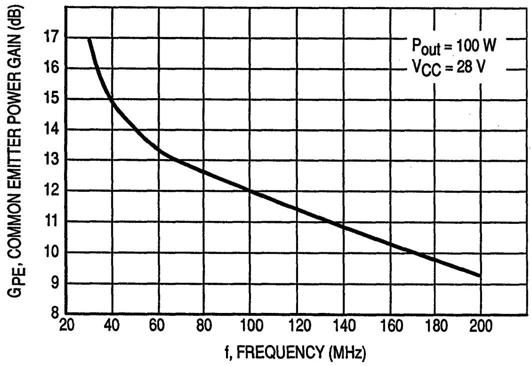


Figure 7. Power Gain versus Frequency

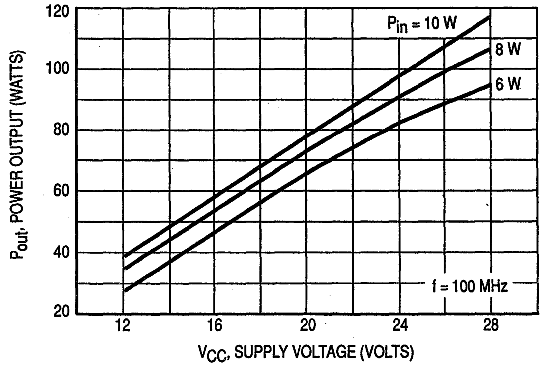


Figure 8. Power Output versus Supply Voltage

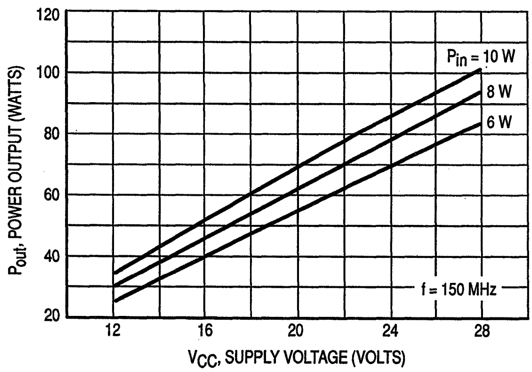


Figure 9. Power Output versus Supply Voltage

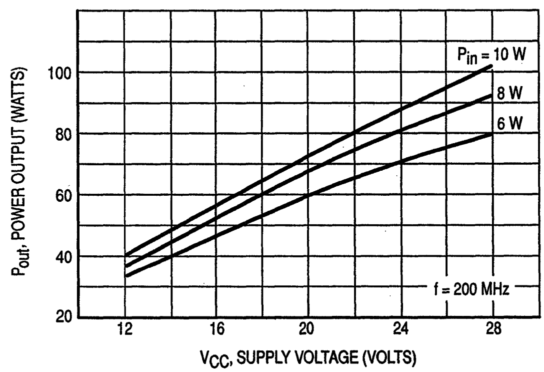
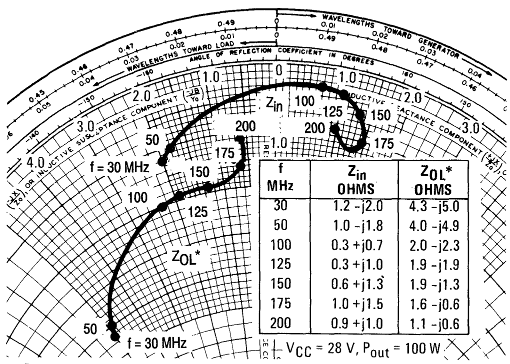


Figure 10. Power Output versus Supply Voltage

2



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	1.2 −j2.0	4.3 −j5.0
50	1.0 −j1.8	4.0 −j4.9
100	0.3 +j0.7	2.0 −j2.3
125	0.3 +j1.0	1.9 −j1.9
150	0.6 +j1.3	1.9 −j1.3
175	1.0 +j1.5	1.6 −j0.6
200	0.9 +j1.0	1.1 −j0.6

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 11. Series Equivalent Input-Output Impedance

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

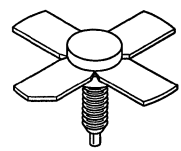
MRF321

The RF Line
NPN Silicon
RF Power Transistor

10 W, 400 MHz
RF POWER
TRANSISTOR
NPN SILICON

... designed primarily for wideband large-signal driver and predriver amplifier stages in 200–500 MHz frequency range.

- Guaranteed Performance at 400 MHz, 28 Vdc
  Output Power = 10 Watts
  Power Gain = 12 dB Min
  Efficiency = 50% Min
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- Computer-Controlled Wirebonding Gives Consistent Input Impedance



CASE 244, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	1.1 1.5	Adc
Total Device Dissipation @ T_A = 25°C (1) Derate above 25°C	P_D	27 160	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

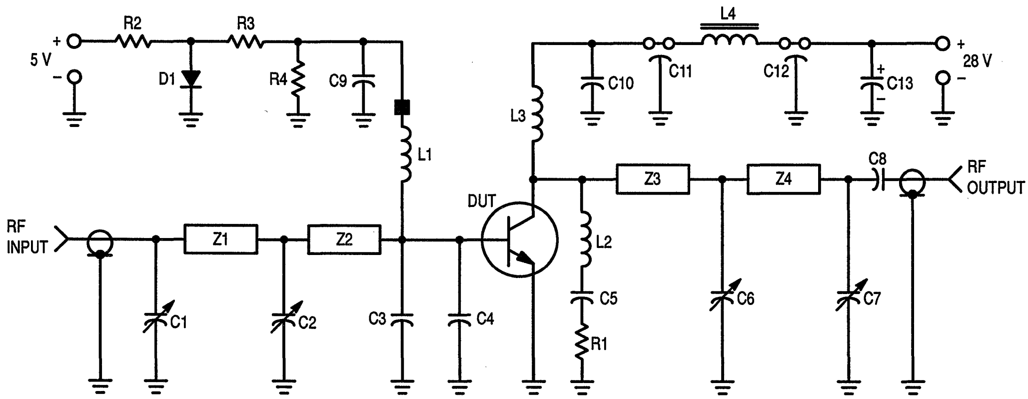
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—

(continued)

NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	10	12	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 400 MHz)	G_{PE}	12	13	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 400 MHz)	η	50	60	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 400 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			



C1, C2, C3 — 1.0–20 pF Johanson Trimmer (JMC 5501)
C3, C4 — 47 pF ATC Chip Capacitor
C5, C10 — 0.1 µF Erie Redcap
C7 — 0.5–10 pF Johanson Trimmer (JMC 5201)
C8 — 0.018 µF Vitramon Chip Capacitor
C9 — 200 pF UNELCO Capacitor
C11, C12 — 680 pF Feedthru
C13 — 1.0 µF, 50 Volt Tantalum Capacitor
D1 — 1N4001
L1 — 0.33 µH Molded Choke with Ferroxcube Bead (Ferroxcube 56-590-65/4B) on Ground End of Coil
L2 — 4 Turns #20 Enamel, 1/8″ ID
L3 — 6 Turns #20 Enamel, 1/4″ ID
L4 — Ferroxcube VK200-19/4B
R1 — 5.1 Ω, 1/4 Watt
R2 — 120 Ω, 1.0 Watt
R3 — 20 Ω, 1/2 Watt
R4 — 47 Ω, 1/2 Watt
Z1 — Microstrip 0.1″ W x 1.35″ L
Z2 — Microstrip 0.1″ W x 0.55″ L
Z3 — Microstrip 0.1″ W x 0.8″ L
Z4 — Microstrip 0.1″ W x 1.75″ L
Board — Glass Teflon, ε_R = 2.56, t = 0.062″
Input/Output Connectors — Type N

Figure 1. 400 MHz Test Circuit Schematic

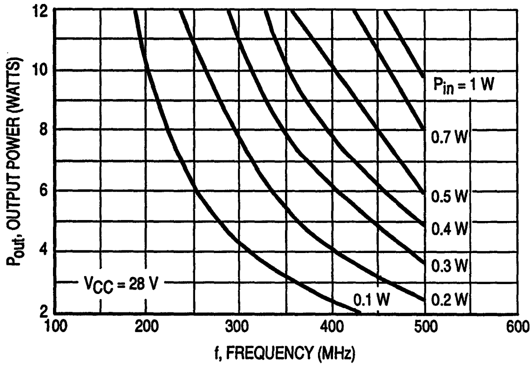


Figure 2. Output Power versus Frequency

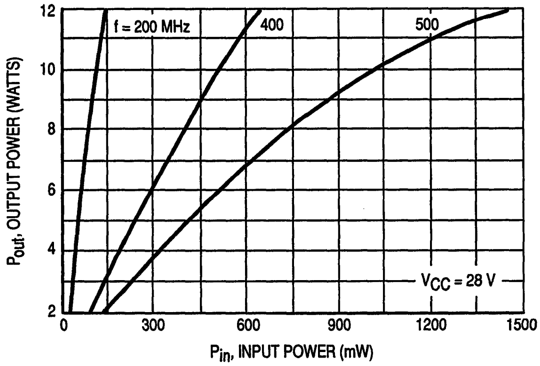


Figure 3. Output Power versus Input Power

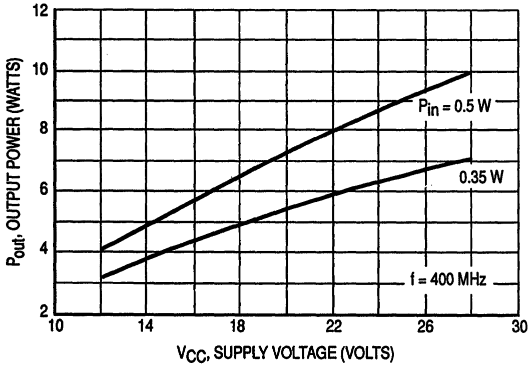


Figure 4. Output Power versus Supply Voltage

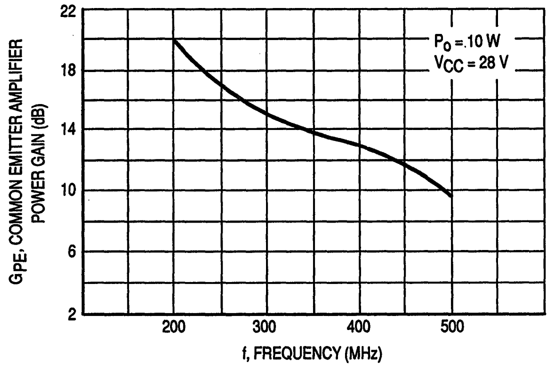
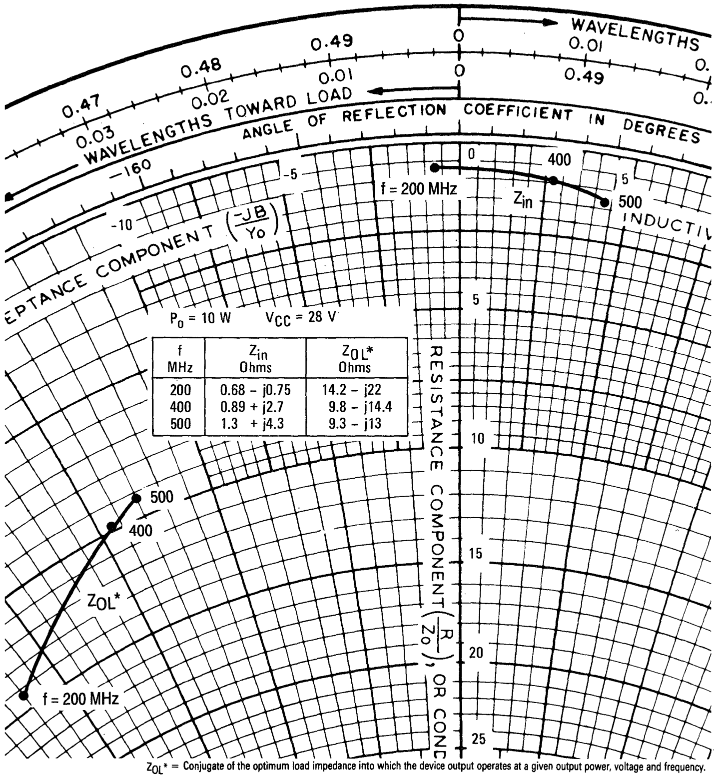


Figure 5. Power Gain versus Frequency

2



P_o = 10 W V_{CC} = 28 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
200	0.68 – j0.75	14.2 – j22
400	0.89 + j2.7	9.8 – j14.4
500	1.3 + j4.3	9.3 – j13

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Impedance

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

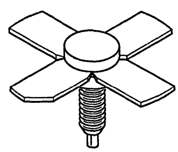
MRF323

The RF Line
NPN Silicon
RF Power Transistor

. . . designed primarily for wideband large-signal driver and predriver amplifier stages in the 200–500 MHz frequency range.

- Guaranteed Performance at 400 MHz, 28 V
  Output Power = 20 Watts
  Power Gain = 10 dB Min
  Efficiency = 50% Min
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- Computer-Controlled Wirebonding Gives Consistent Input Impedance

20 W, 400 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 244, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	2.2 3.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	55 310	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—

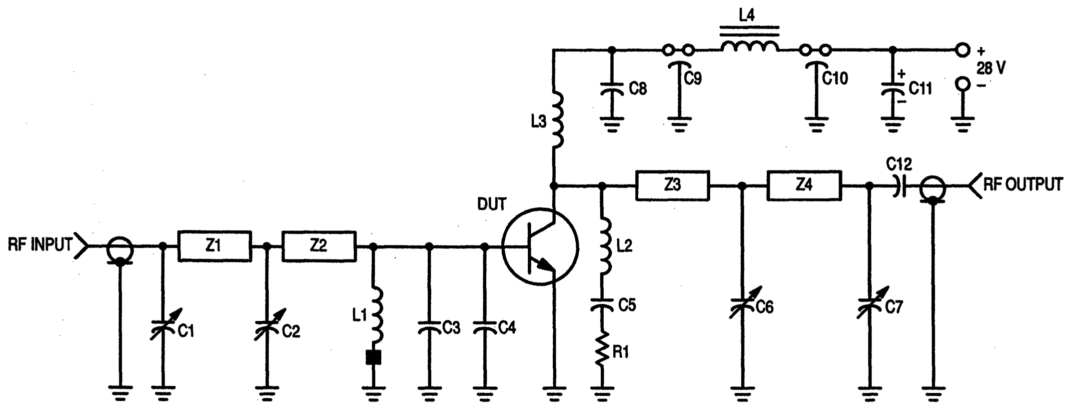
NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	20	24	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 20 W, f = 400 MHz)	G_{PE}	10	11	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 20 W, f = 400 MHz)	η	50	60	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 20 W, f = 400 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			

2



C1, C2, C6 — 1.0–20 pF Johanson Trimmer (JMC 5501)
C3, C4 — 47 pF ATC Chip Capacitor
C5, C8 — 0.1 µF Erie Redcap
C7 — 0.5–10 pF Johanson Trimmer (JMC 5201)
C9, C10 — 680 pF Feedthru
C11 — 1.0 µF 50 Volt Tantalum
C12 — 0.018 µF Vitramon Chip Capacitor
L1 — 0.33 µH Molded Choke with Ferroxcube Bead (Ferroxcube 56-590-65/4B) on Ground End
L2 — 6 Turns #20 Enamel, 1/4″ ID, Closewound
L3 — 4 Turns #20 Enamel, 1/8″ ID, Closewound
L4 — Ferroxcube VK200-19/4B
R1 — 5.1 Ω 1/4 Watt
Z1 — Microstrip 0.1″ W x 1.35″ L
Z2 — Microstrip 0.1″ W x 0.55″ L
Z3 — Microstrip 0.1″ W x 0.8″ L
Z4 — Microstrip 0.1″ W x 1.75″ L
Board — Glass Teflon ε_r = 2.56, t = 0.062″
Input/Output Connectors — Type N

Figure 1. 400 MHz Test Circuit Schematic

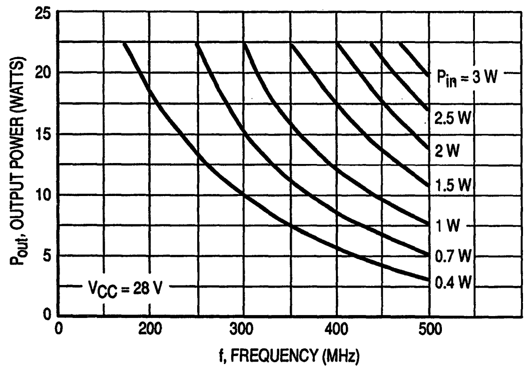


Figure 2. Output Power versus Frequency

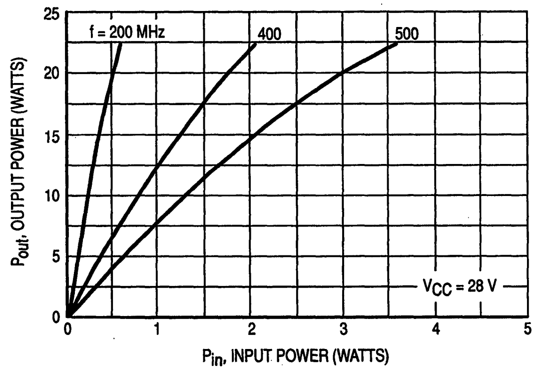


Figure 3. Output Power versus Input Power

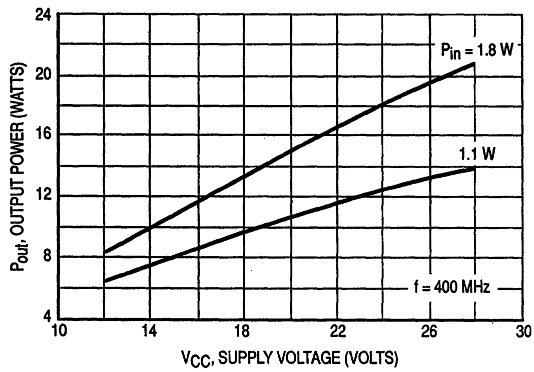


Figure 4. Output Power versus Supply Voltage

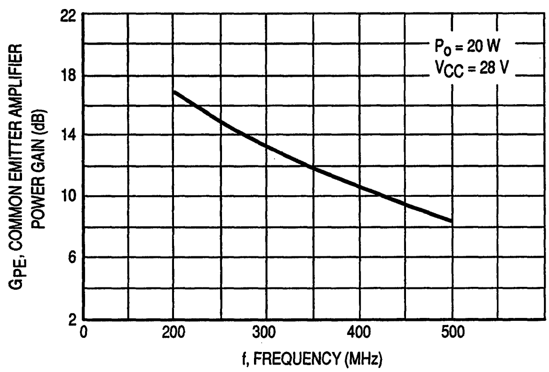
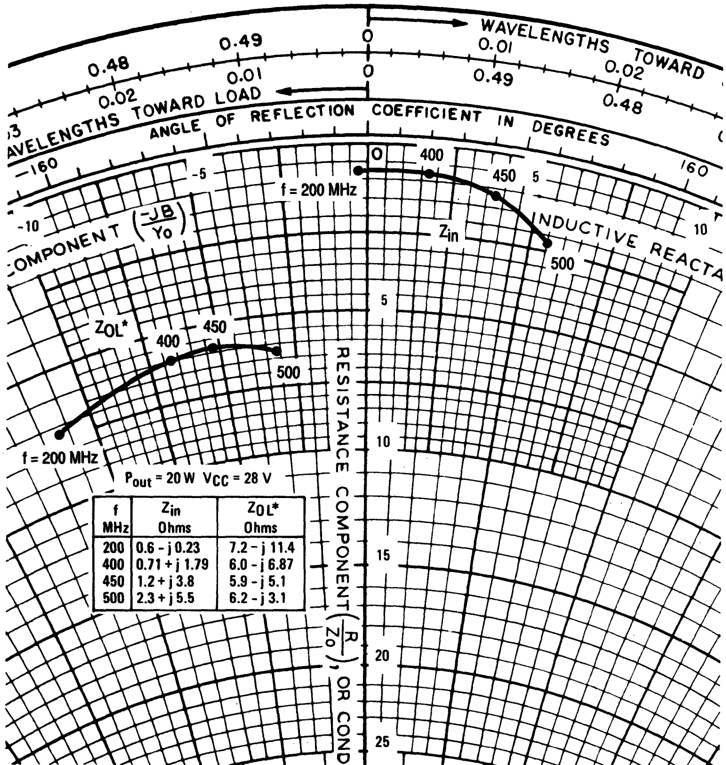


Figure 5. Power Gain versus Frequency

2



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
200	0.6 - j 0.23	7.2 - j 11.4
400	0.71 + j 1.79	6.0 - j 6.87
450	1.2 + j 3.8	5.9 - j 5.1
500	2.3 + j 5.5	6.2 - j 3.1

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Impedance

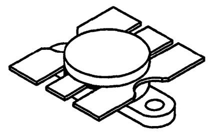
MRF325

The RF Line
NPN Silicon RF Power Transistor

30 W, 225 to 400 MHz
CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR
NPN SILICON

. . . designed primarily for wideband large-signal output and driver amplifier stages in 100 to 500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 30 Watts
  Minimum Gain = 8.5 dB
  Efficiency = 54% (Min)
- Built-In Matching Network for Broadband Operation Using Internal Matching Techniques
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization for High Reliability Applications



CASE 316-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	3.4 4.5	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	82 0.47	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.13	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 30 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—

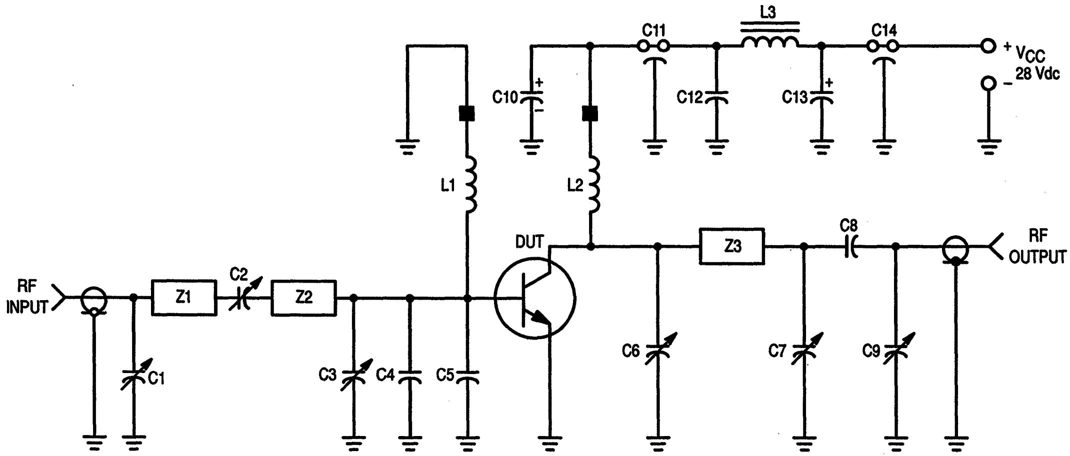
NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	30	40	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 400 MHz)	G_{PE}	8.5	9.5	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 400 MHz)	η	50	60	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 400 MHz, VSWR = 30:1 all angles)	ψ	No Degradation in Output Power			



C1, C9 — 1.0–10 pF Johanson Capacitor (JMC 5201)
C2, C3, C6, C7 — 1.0–20 pF Johanson Capacitor (JMC 5501)
C4, C5 — 36 pF ATC 100-mil Chip Capacitor
C8 — 100 pF UNELCO
C10, C13 — 1.0 µF 50 V Tantalum
C11, C14 — 680 pF Feedthru
C12 — 0.1 µF Erie Redcap
L1 — 8 Turns #26 AWG Enameled, 1/16″ ID Closewound with Ferroxcube Bead (#56-590-65/4B) on Ground End
L2 — 14 Turns, #22 AWG Enameled, Closewound on a 470 Ω, 2.0 Watt Resistor with Ferroxcube Bead (#56-590-65/4B) on Cold End of L2
L3 — Ferroxcube VK200-19/4B Ferrite Choke
Z1 — Microstrip 0.19″ W x 0.88″ L
Z2 — Microstrip 0.28″ W x 1.0″ L
Z3 — Microstrip 0.31″ W x 1.25″ L
Board — Glass Teflon ε_r = 2.56, t = 0.062″
Input/Output Connectors — Type N
DUT Socket Lead Frame Etched from 80-mil-Thick Copper

Figure 1. 400 MHz Test Circuit

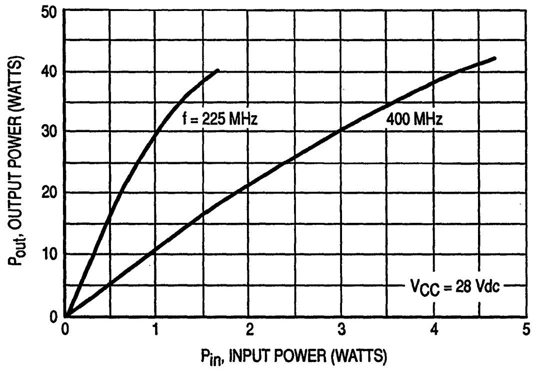


Figure 2. Output Power versus Input Power

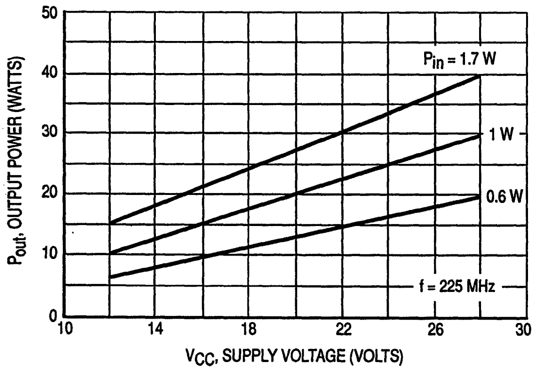


Figure 3. Output Power versus Supply Voltage

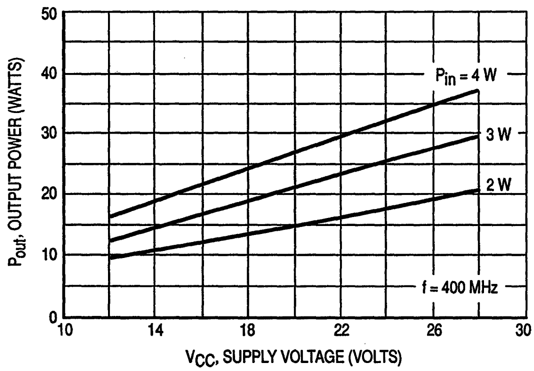
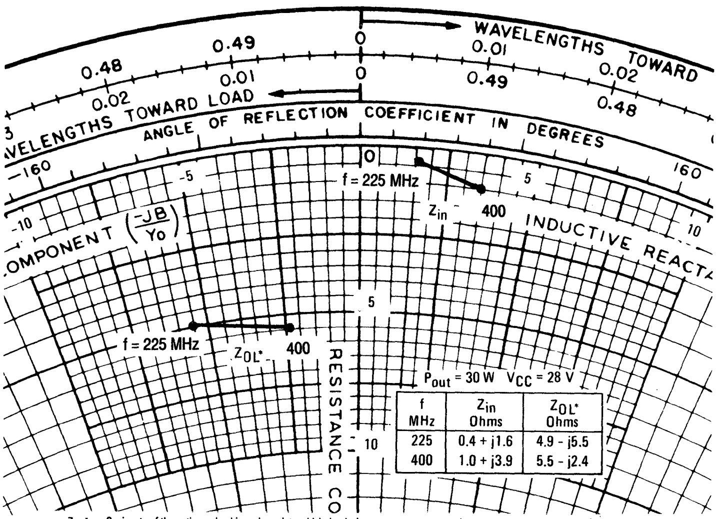


Figure 4. Output Power versus Supply Voltage

2



f MHz	Zin Ohms	ZOL* Ohms
225	0.4 + j1.6	4.9 - j5.5
400	1.0 + j3.9	5.5 - j2.4

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 5. Series Equivalent Impedance

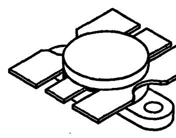
MRF326

The RF Line
NPN Silicon RF Power Transistor

. . . designed primarily for wideband large-signal output amplifier stages in the 100 to 500 MHz frequency range.

- Guaranteed Performance @ 400 MHz, 28 Vdc
  Output Power = 40 Watts
  Minimum Gain = 9.0 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

40 W, 225 to 400 MHz CONTROLLED "Q" BROADBAND RF POWER TRANSISTOR NPN SILICON



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	4.5 6.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	110 0.63	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 4.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	50	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	45	60	pF

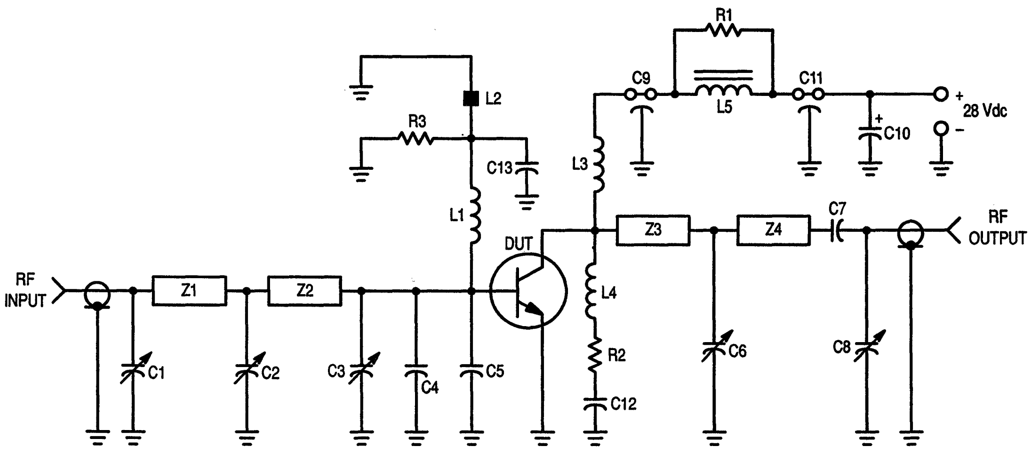
(continued)

NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 40 W, f = 400 MHz, I_C Max = 2.85 Adc)	G_{PE}	9.0	11	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 40 W, f = 400 MHz, I_C Max = 2.85 Adc)	η	50	—	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 40 W CW, f = 400 MHz, VSWR = 30:1 All Phase Angles)	ψ	No Degradation in Output Power			

2



C1 — 1.0–10 pF Johanson, Capacitor (JMC 5201)
C2, C3, C6, C8 — 1.0–20 pF Johanson Capacitor
C4, C5 — 36 pF ATC "B" Style Chip Capacitor
C7, C9, C13 — 100 pF UNELCO Capacitor
C11 — 680 pF Feedthru
C10 — 1.0 μF 50 V Tantalum
C12 — 0.1 μF Erie Redcap
L1 — 8 Turns #26 AWG Enameled, 1/16″ ID Closewound
L2, L5 — Ferroxcube VK200-19/4B Ferrite Choke
L3 — 8 Turns #20 AWG Enameled, 1/4″ ID Closewound
L4 — 4 Turns #26 AWG 0.1″ ID
R1 — 10 Ohm 2.0 W Carbon
R2, R3 — 10 Ohm 1.0 W Carbon
Z1 — Microstrip 0.19″ W x 1.28″ L
Z2 — Microstrip 0.28″ W x 1.0″ L
Z3 — Microstrip 0.31″ W x 1.0″ L
Z4 — Microstrip 0.31″ W x 0.9″ L
Board — Glass Teflon ε_r = 2.56 t = 0.062″
Input/Output Connectors — Type N UG58 A/U

Figure 1. 400 MHz Test Amplifier

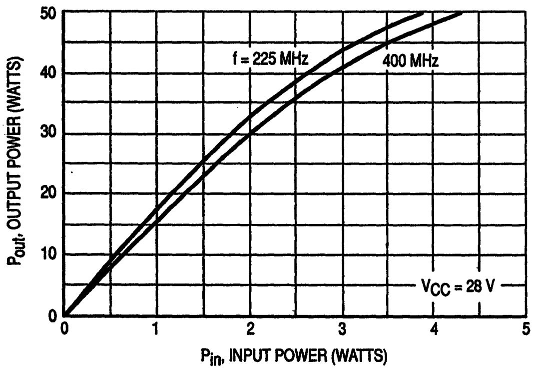


Figure 2. Output Power versus Input Power

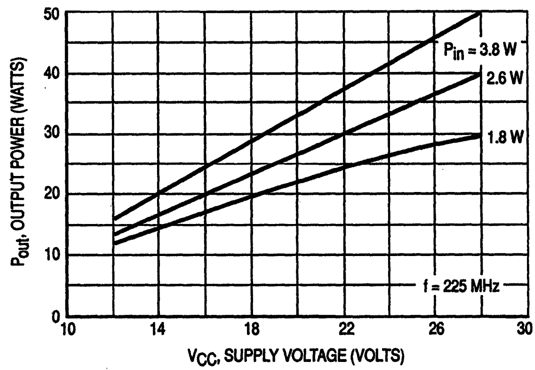


Figure 3. Output Power versus Supply Voltage

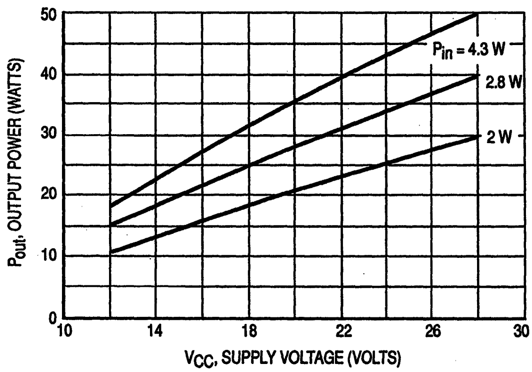
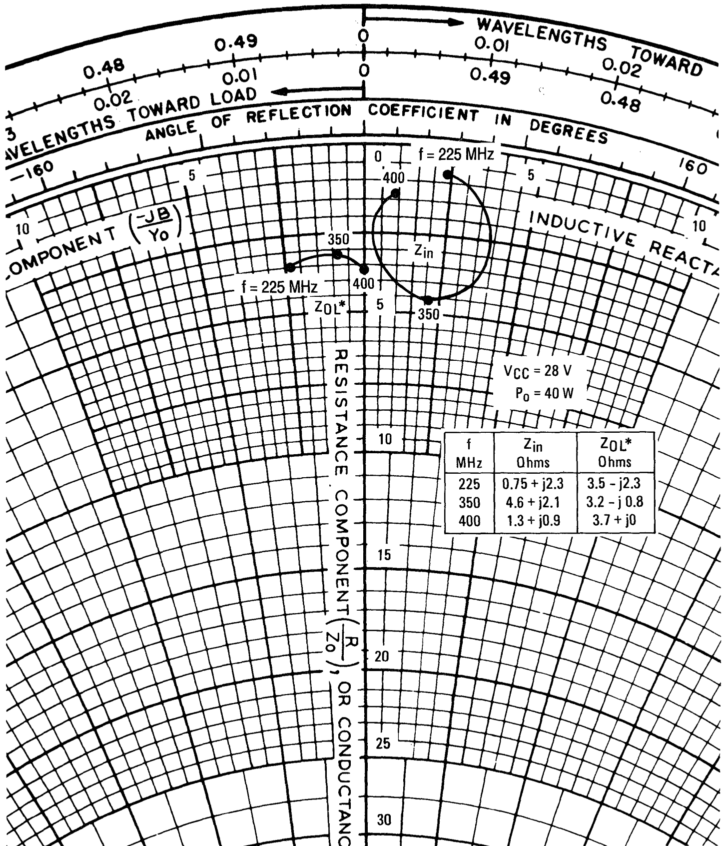


Figure 4. Output Power versus Supply Voltage
f = 400 MHz

2



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
225	0.75 + j2.3	3.5 - j2.3
350	4.6 + j2.1	3.2 - j 0.8
400	1.3 + j0.9	3.7 + j0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 5. Series Equivalent Input-Output Impedance

2

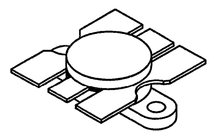
The RF Line
NPN Silicon RF Power Transistor

MRF327

**80 W, 100 to 500 MHz
CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR
NPN SILICON**

. . . designed primarily for wideband large-signal output amplifier stages in the 100 to 500 MHz frequency range.

- Guaranteed Performance @ 400 MHz, 28 Vdc
  Output Power = 80 Watts over 225 to 400 MHz Band
  Minimum Gain = 7.3 dB @ 400 MHz
- Built-In Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications
- Characterized for 100 to 500 MHz



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	9.0 12	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 8.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 80 mAdc, I_C = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	100	145	pF

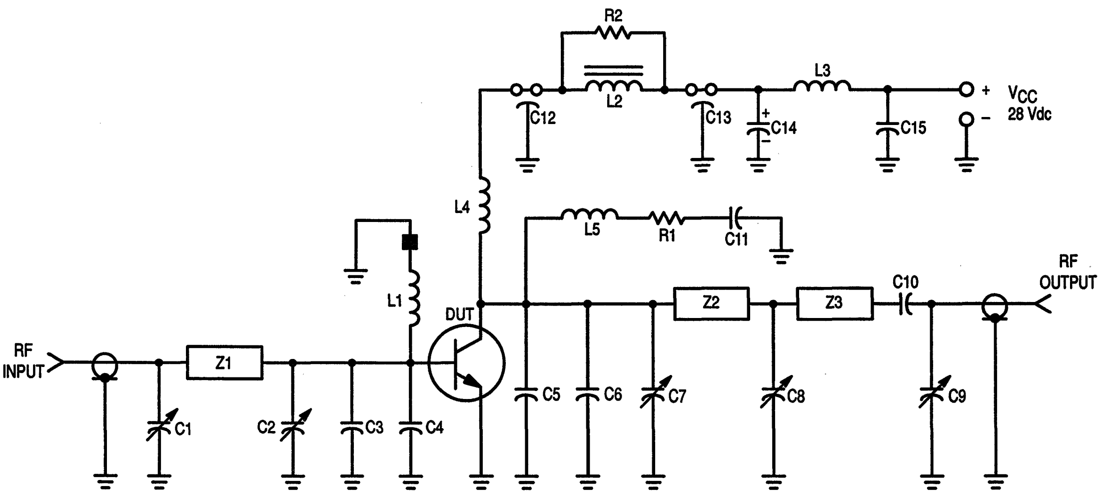
NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 400 MHz)	G_{PE}	7.3	9.0	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 400 MHz)	η	50	60	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 400 MHz, VSWR = 30:1 All Phase Angles)	ψ	No Degradation in Output Power			

2



C1, C2, C7, C8, C9 — 1.0–20 pF Piston Trimmer (Johanson JMC 5501)
C3, C4 — 36 pF ATC 100 mil Chip Capacitor
C5, C6 — 43 pF ATC 100 mil Chip Capacitor
C10 — 100 pF UNELCO
C11, C15 — 0.1 μF Erie Redcap
C12, C13 — 680 pF Feedthru
C14 — 1.0 μF 50 V Tantalum
L1 — 4 Turns #22 AWG Enameled, 3/16″ ID Closewound with Ferroxcube Bead (#56-590-65/4B) on Ground End of Coil
L2 — Ferroxcube VK200-19/4B Ferrite Choke
L3 — 7 Turns #18 AWG, 11/16″ Long, Wound on a 100 kΩ 2.0 Watt Resistor
L4 — 6 Turns #20 AWG Enameled, 3/16″ ID Closewound
L5 — 4 Turns #22 AWG Enameled, 1/8″ ID Closewound
Z1 — Microstrip 0.2″ W x 1.5″ L
Z2 — Microstrip 0.17″ W x 1.16″ L
Z3 — Microstrip 0.17″ W x 0.63″ L
R1, R2 — 10 Ω 2.0 Watt
Board — Glass Teflon ε_r = 2.56, t = 0.062″
Input/Output Connectors Type N
DUT Socket Lead Frame Etched from 80-mil-Thick Copper

Figure 1. 400 MHz Test Circuit

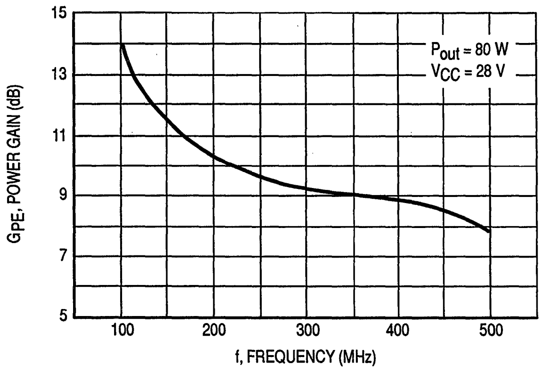


Figure 2. Power Gain versus Frequency

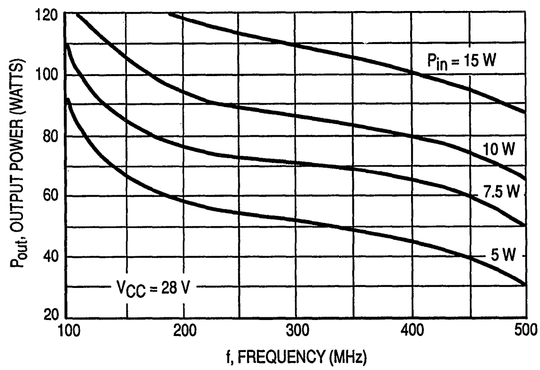


Figure 3. Output Power versus Frequency

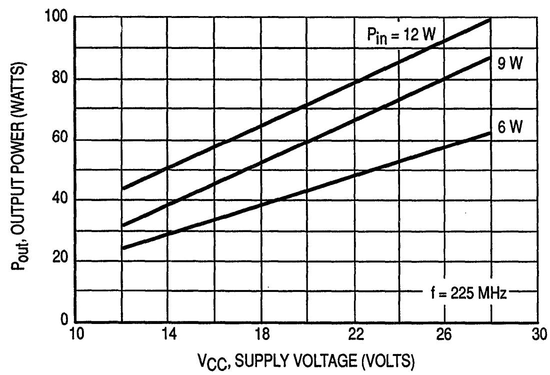


Figure 4. Output Power versus Supply Voltage

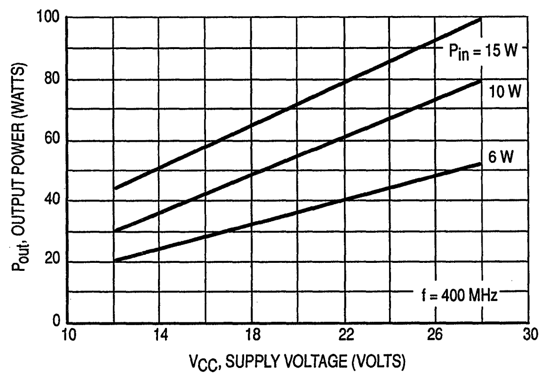


Figure 5. Output Power versus Supply Voltage

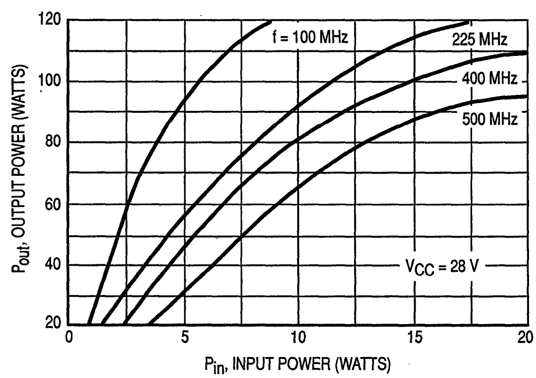
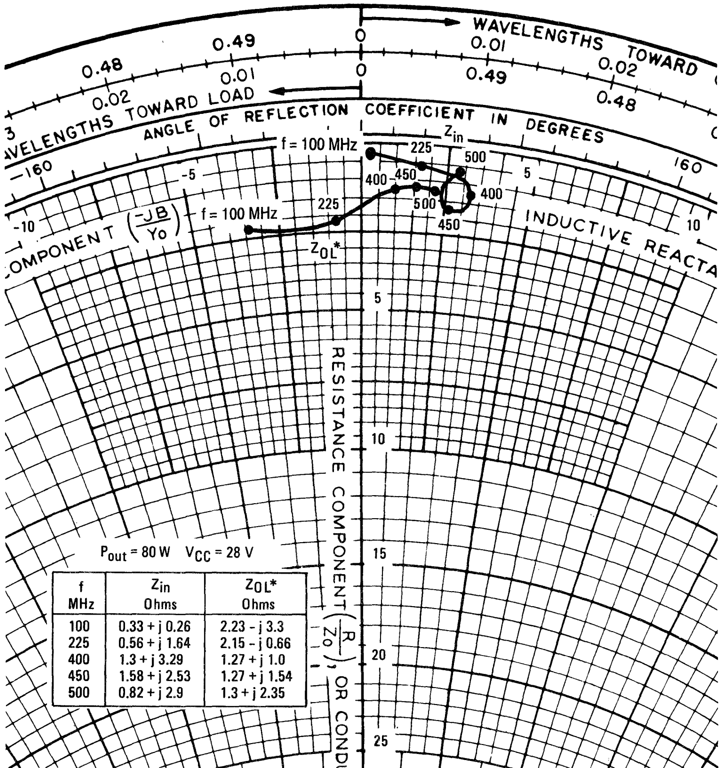


Figure 6. Output Power versus Input Power

2



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	0.33 + j 0.26	2.23 - j 3.3
225	0.56 + j 1.64	2.15 - j 0.66
400	1.3 + j 3.29	1.27 + j 1.0
450	1.58 + j 2.53	1.27 + j 1.54
500	0.82 + j 2.9	1.3 + j 2.35

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 7. Series Equivalent Input-Output Impedance

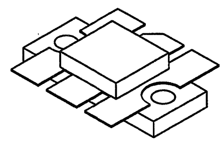
MRF329

The RF Line
NPN Silicon RF Power Transistor

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 100 to 500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 100 Watts
  Minimum Gain = 7.0 dB
  Efficiency = 50% (Min)
- Built-In Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 3:1 VSWR
- Gold Metallization System for High Reliability

100 W, 100 to 500 MHz CONTROLLED "Q" BROADBAND RF POWER TRANSISTOR NPN SILICON



CASE 333, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	9.0 12	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.65	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 8.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc

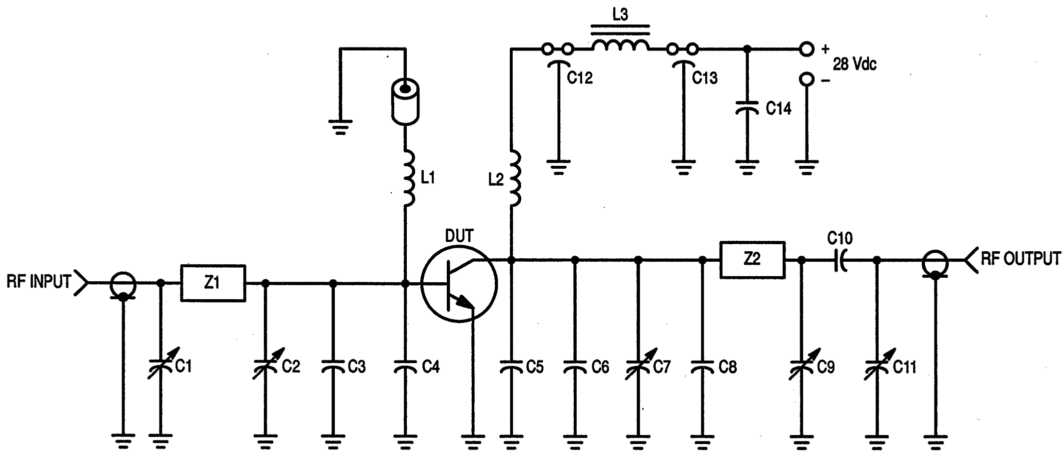
(continued)

NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (continued)					
Collector-Base Breakdown Voltage (I_C = 80 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	95	125	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 400 MHz)	G_{PE}	7.0	9.7	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 400 MHz)	η	50	60	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, VSWR = 3:1 all angles)	ψ	No Degradation in Output Power			

2



C1, C2, C7, C9 — 1.0–20 pF Johanson (JMC 5501)
C3, C4 — 36 pF 100 mil Chip Cap (ATC)
C5, C6 — 50 pF 100 mil Chip Cap (ATC)
C8 — 30 pF 100 mil Chip Cap (ATC)
C10 — 2.0–150 pF 100 mil Chip Caps in Parallel (ATC)
C11 — 1.0–10 pF Johanson (JMC 5201)
C12, C13 — 1000 pF UNELCO Feedthru
C14 — 0.1 µF Erie Redcap

L1 — 0.15 µH Molded Choke with Ferrite Bead (Ferroxcube #56-590-65/4B) on Ground End
L2 — 4 Turns #18 AWG, 1/4″ ID
L3 — Ferroxcube VK200-19/4B
Z1 — Microstrip Line 2300 mils L x 210 mils W
Z2 — Microstrip Line 2300 mils L x 280 mils W
Board — Glass Teflon, t = 0.062″, ε_r = 2.56

Figure 1. 400 MHz Test Circuit

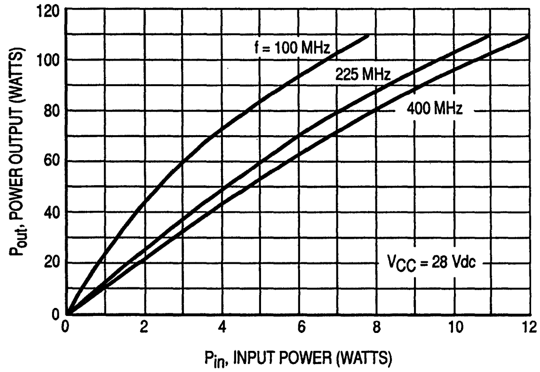


Figure 2. Output Power versus Input Power

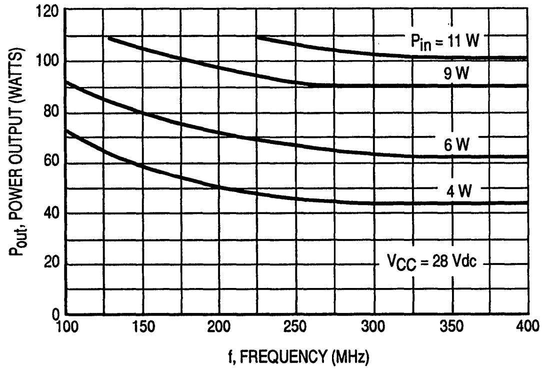


Figure 3. Output Power versus Frequency

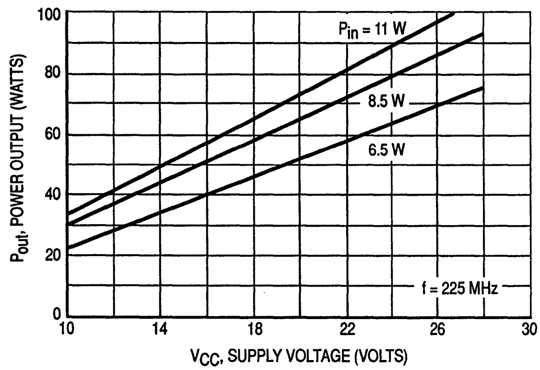


Figure 4. Output Power versus Supply Voltage

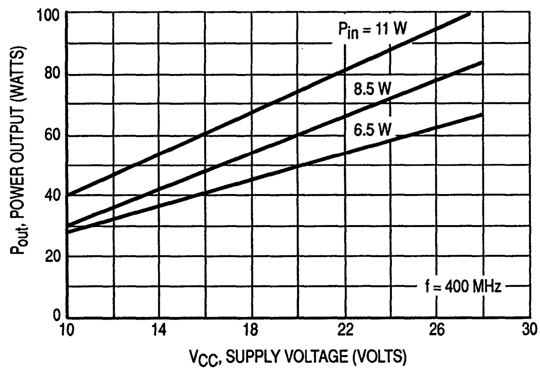


Figure 5. Output Power versus Supply Voltage

2

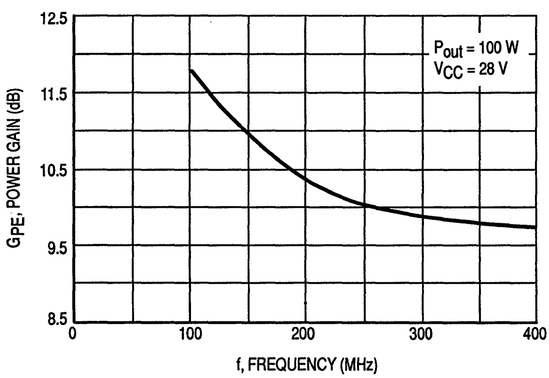
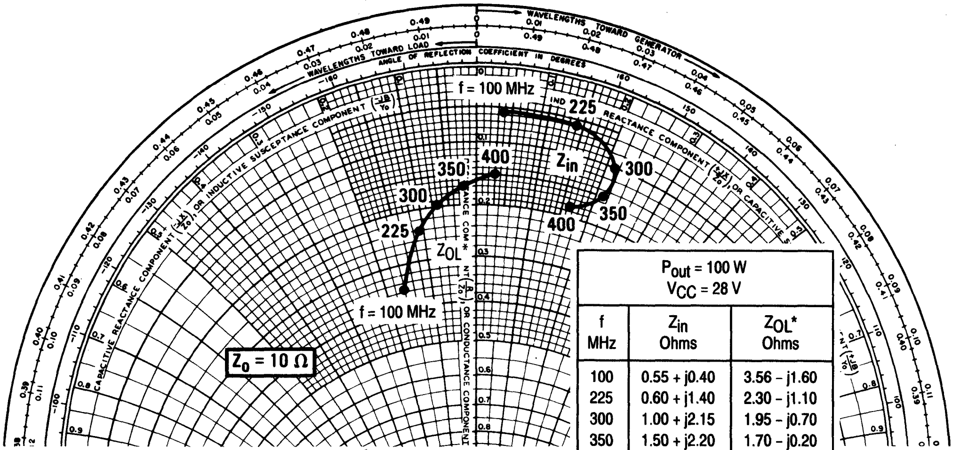


Figure 6. Power Gain versus Frequency



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	0.55 + j0.40	3.56 - j1.60
225	0.60 + j1.40	2.30 - j1.10
300	1.00 + j2.15	1.95 - j0.70
350	1.50 + j2.20	1.70 - j0.20
400	1.85 + j1.70	1.50 + j0.30

P_{out} = 100 W, V_{CC} = 28 V

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 7. Series Equivalent Input/Output Impedance

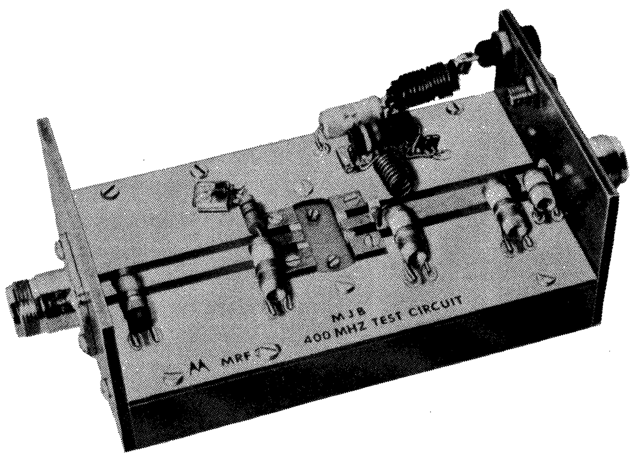


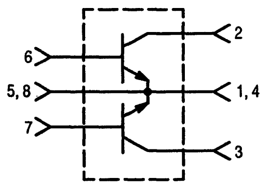
Figure 8. Test Fixture

MRF392

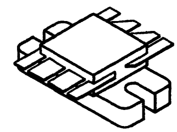
The RF Line
NPN Silicon Push-Pull RF Power Transistor

... designed primarily for wideband large-signal output and driver amplifier stages in the 30 to 500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 125 W
  Typical Gain = 10 dB
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



**125 W, 30 to 500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



CASE 744A, STYLE 1

The MRF392 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

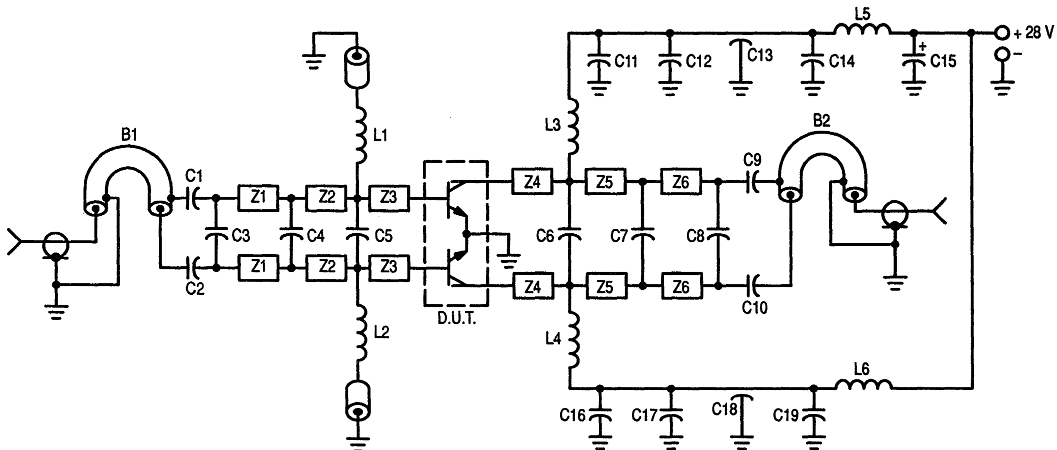
NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TESTS (2) — **See Figure 1**					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	G_{pe}	8.0	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz, VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

2



C1, C2 — 240 pF, 100 Mil Chip Cap (ATC) or Equivalent
C3 — 3.6 pF, 100 Mil Chip Cap (ATC) or Equivalent
C4, C8 — 8.2 pF, 100 Mil Chip Cap (ATC) or Equivalent
C5, C6 — 20 pF, 100 Mil Chip Cap (ATC) or Equivalent
C7 — 18 pF, Mini Unelco or Equivalent
C9, C10 — 270 pF, 100 Mil Chip Cap (ATC) or Equivalent
C11, C12, C16, C17 — 470 pF 100 Mil Chip Cap (ATC) or Equivalent
C13, C18 — 680 pF Feedthru
C14, C19 — 0.1 μF Erie Redcap or Equivalent
C15 — 20 μF, 50 V
L1, L2 — 0.15 μH Molded Choke With Ferrite Bead
L3, L4 — 2-1/2 Turns #20 AWG, 0.200 ID
L5, L6 — 3-1/2 Turns #18 AWG, 0.200 ID

B1 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2″ L
B2 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2″ L
Z1 — Microstrip Line 270 Mil L x 125 Mil W
Z2 — Microstrip Line 375 Mil L x 125 Mil W
Z3 — Microstrip Line 280 Mil L x 125 Mil W
Z4 — Microstrip Line 300 Mil L x 125 Mil W
Z5 — Microstrip Line 350 Mil L x 125 Mil W
Z6 — Microstrip Line 365 Mil L x 125 Mil W
Board Material — 0.0625″ Teflon Fiberglass ε_r = 2.5 ± 0.05 1 oz. Cu. CLAD, Double Sided

Figure 1. 400 MHz Test Fixture

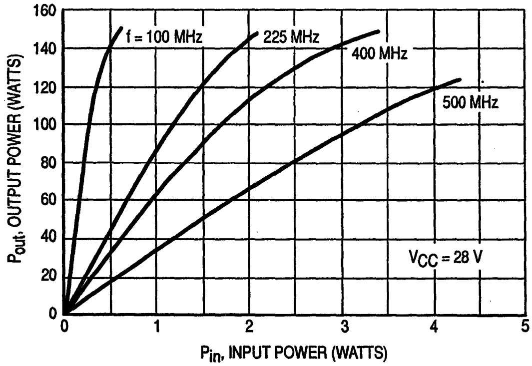


Figure 2. Output Power versus Input Power

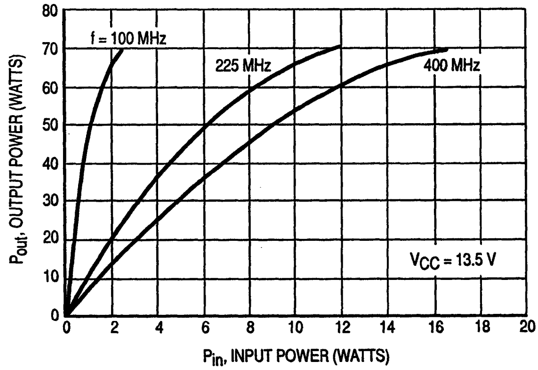


Figure 3. Output Power versus Input Power

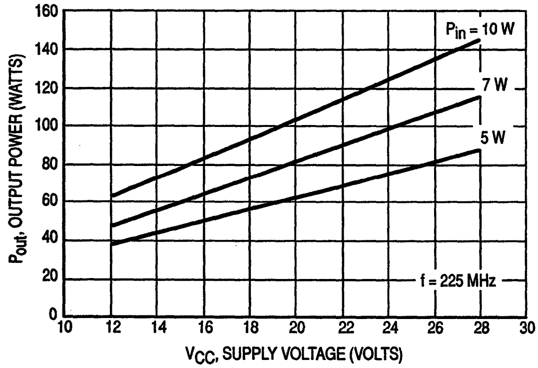


Figure 4. Output Power versus Supply Voltage

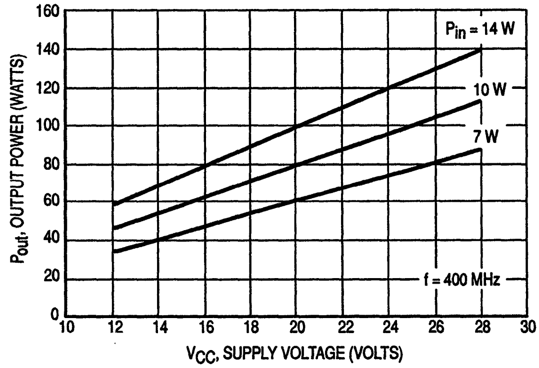
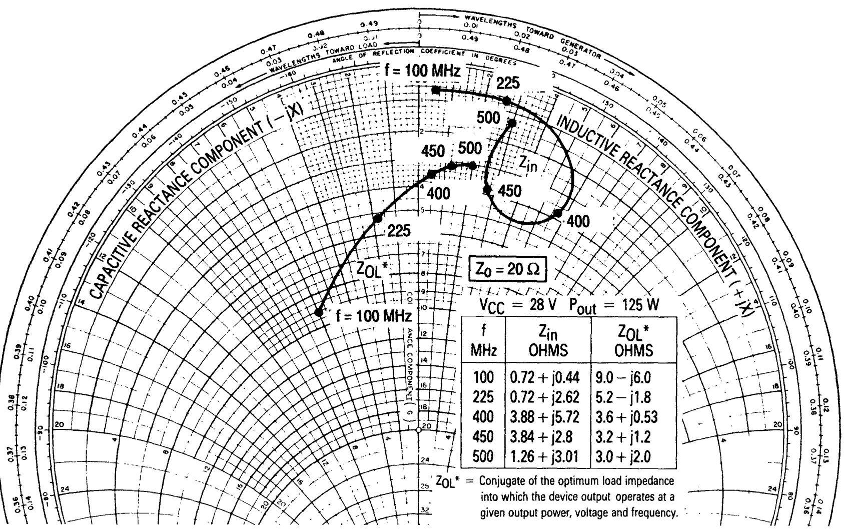


Figure 5. Output Power versus Supply Voltage

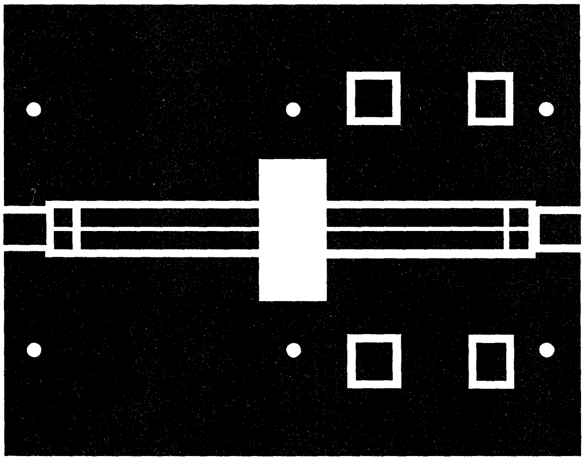


f MHz	Zin OHMS	ZOL* OHMS
100	0.72 + j0.44	9.0 − j6.0
225	0.72 + j2.62	5.2 − j1.8
400	3.88 + j5.72	3.6 + j0.53
450	3.84 + j2.8	3.2 + j1.2
500	1.26 + j3.01	3.0 + j2.0

ZOL* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input/Output Impedance

2



SCALE 0.75:1

Figure 7. Test Circuit Photomaster

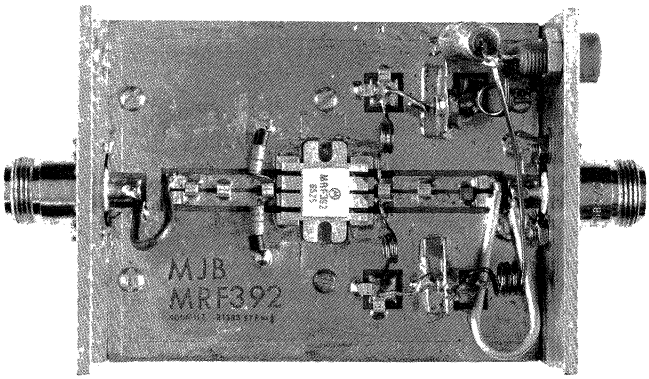


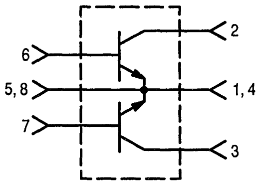
Figure 8. 400 MHz Test Circuit

MRF393

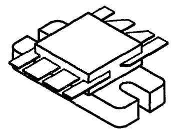
The RF Line
NPN Silicon Push-Pull RF Power Transistor

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 30 to 500 MHz frequency range.

- Specified 28 Volt, 500 MHz Characteristics —
  Output Power = 100 W
  Typical Gain = 9.5 dB (Class AB); 8.5 dB (Class C)
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



**100 W, 30 to 500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



CASE 744A, STYLE 1

2

The MRF393 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

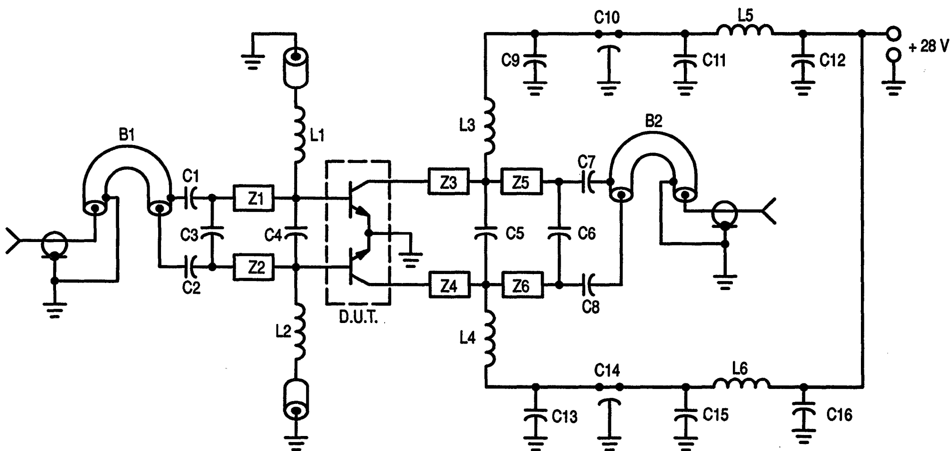
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TESTS (2) — See Figure 1					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	G_{pe}	7.5	8.5	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz, VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.



C1, C2, C7, C8 — 240 pF 100 mil Chip Cap
C3 — 15 pF 100 mil Chip Cap
C4 — 24 pF 100 mil Chip Cap
C5 — 33 pF 100 mil Chip Cap
C6 — 12 pF 100 mil Chip Cap
C9, C13 — 1000 pF 100 mil Chip Cap
C10, C14 — 680 pF Feedthru Cap
C11, C15 — 0.1 µF Ceramic Disc Cap
C12, C16 — 50 µF 50 V

L1, L2 — 0.15 µH Molded Choke with Ferrite Bead
L3, L4 — 2-1/2 Turns #20 AWG 0.200″ ID
L5, L6 — 3-1/2 Turns #18 AWG 0.200″ ID
B1, B2 — Balun 50 Ω Semi Rigid Coax, 86 mil OD, 2″ Long
Z1, Z2 — 850 mil Long x 125 mil W. Microstrip
Z3, Z4 — 200 mil Long x 125 mil W. Microstrip
Z5, Z6 — 800 mil Long x 125 mil W. Microstrip
Board Material — 0.0325″ Teflon-Fiberglass, ε_r = 2.56, 1 oz. Copper Clad both sides.

Figure 1. 500 MHz Test Fixture

CLASS C

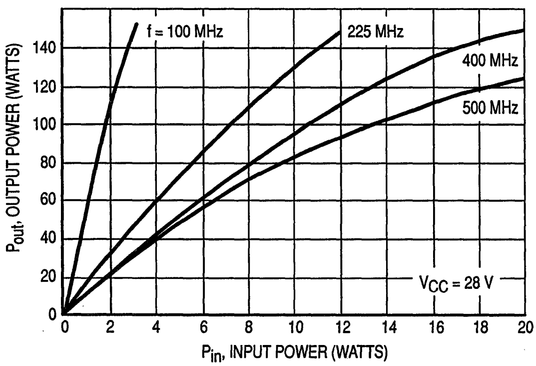


Figure 2. Output Power versus Input Power

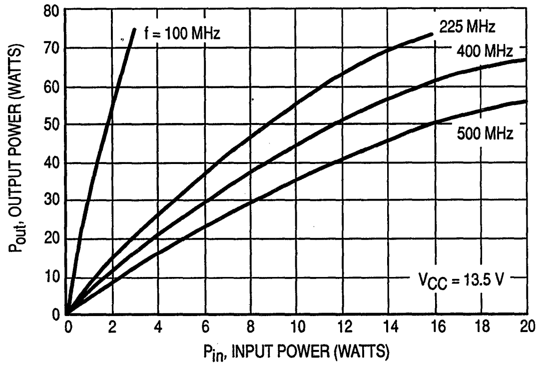


Figure 3. Output Power versus Input Power

CLASS C

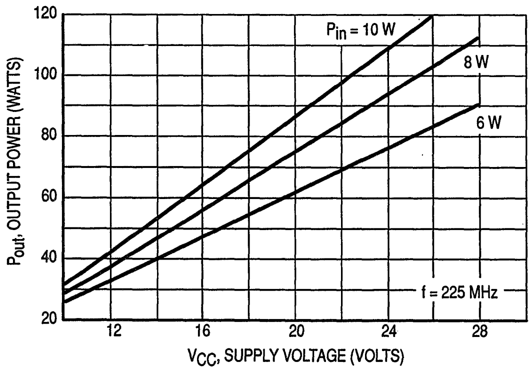


Figure 4. Output Power versus Supply Voltage

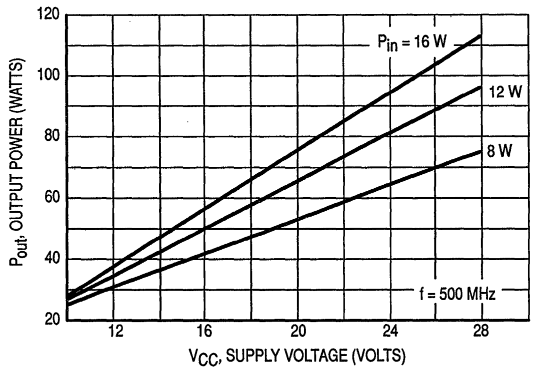


Figure 5. Output Power versus Supply Voltage

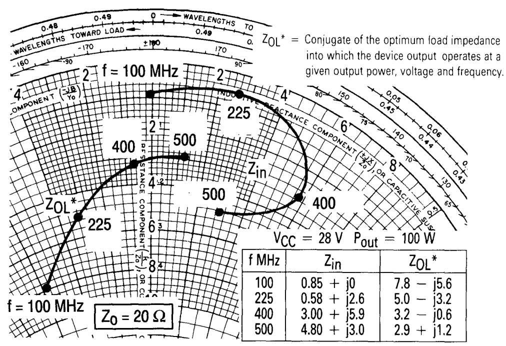


Figure 6. Series Equivalent Input/Output Impedance

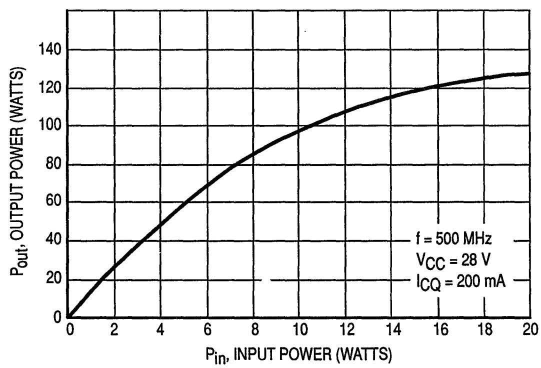


Figure 7. Class AB Output Power versus Input Power

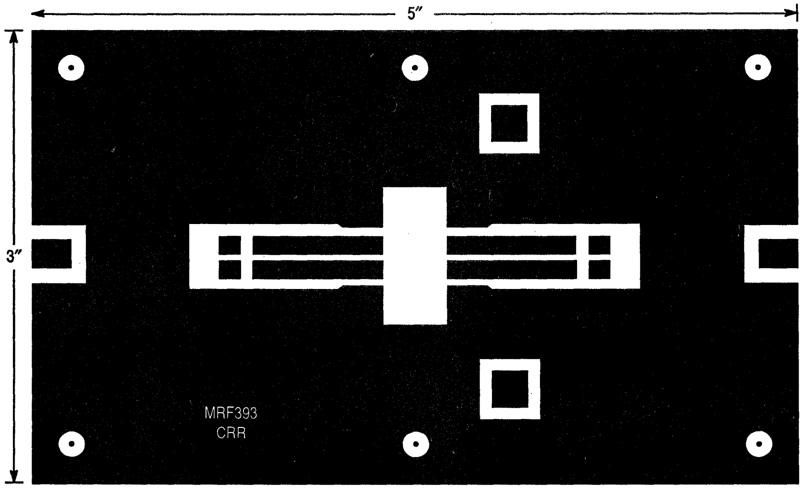


Figure 8. Test Circuit Photomaster

2

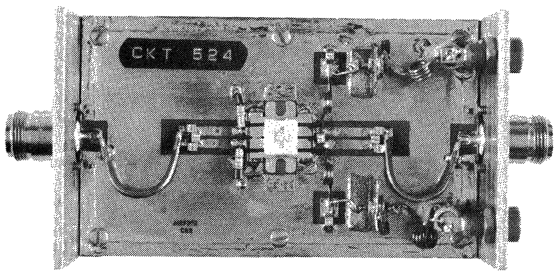


Figure 9. 500 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

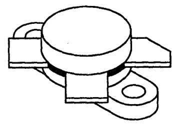
MRF421

The RF Line
NPN Silicon
RF Power Transistor

. . . designed primarily for application as a high-power linear amplifier from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
  Output Power = 100 W (PEP)
  Minimum Gain = 10 dB
  Efficiency = 40%
- Intermodulation Distortion @ 100 W (PEP) —
  IMD = −30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR

100 W (PEP), 30 MHz
RF POWER
TRANSISTORS
NPN SILICON



CASE 211-11, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstand Current — 10 s	—	30	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	290 1.66	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 200 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 16 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	10	mAdc

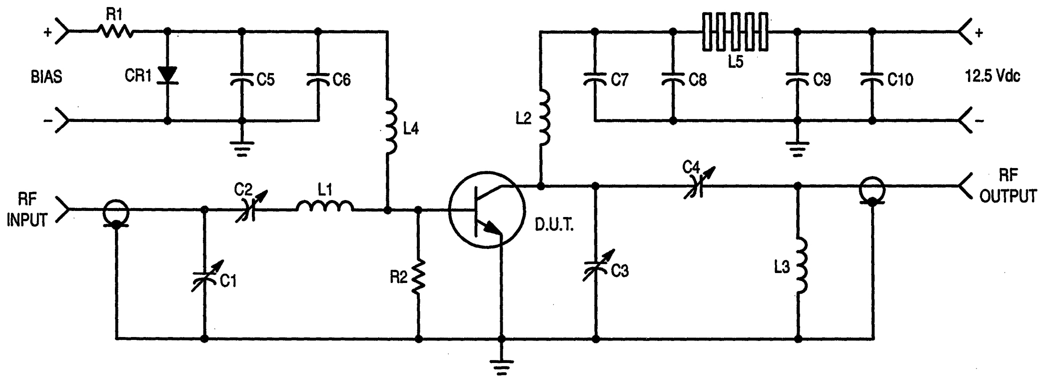
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	550	800	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 100 W, $I_{C(max)}$ = 10 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	G_{PE}	10	12	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 100 W, $I_{C(max)}$ = 10 Adc, I_{CQ} = 150 mA, f = 30, 30.001 MHz)	η	40	—	—	%
Intermodulation Distortion (1) (V_{CE} = 12.5 Vdc, P_{out} = 100 W, I_C = 10 Adc, I_{CQ} = 150 mA, f = 30, 30.001 MHz)	IMD	—	−33	−30	dB

NOTE:
1. To proposed EIA method of measurement. Reference peak envelope power.

2



C1, C2, C4 — 170−780 pF, ARCO 469
C3 — 80−480 pF, ARCO 466
C5, C7, C10 — ERIE 0.1 μF, 100 V
C6 — MALLORY 500 μF @ 15 V Electrolytic
C9 — 100 μF, 15 V Electrolytic
C8 — 1000 pF, 350 V UNDERWOOD
R1 — 10 Ω, 25 Watt Wirewound
R2 — 10 Ω, 1.0 Watt Carbon
CR1 — 1N4997
L1 — 3 Turns, #16 Wire, 5/16″ I.D., 5/16″ Long
L2 — 12 Turns, #16 Enameled Wire Closewound, 1/4″ I.D.
L3 — 1-3/4 Turns, 1/8″ Tubing, 3/8″ I.D., 3/8″ Long
L4 — 10 μH Molded Choke
L5 — 10 Ferrite Beads — FERROXCUBE #56-590-65/3B

Figure 1. 30 MHz Test Circuit Schematic

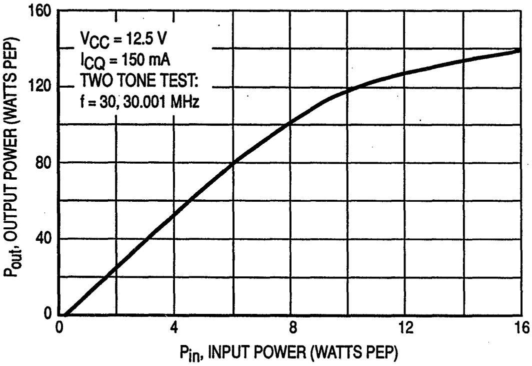


Figure 2. Output Power versus Input Power

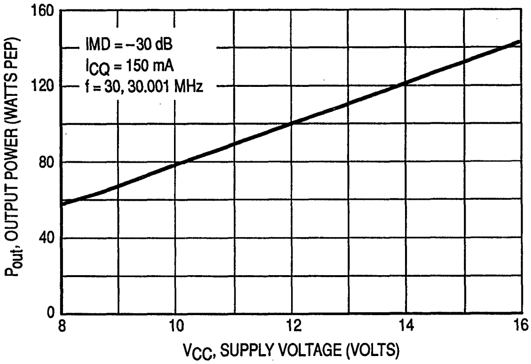


Figure 3. Output Power versus Supply Voltage

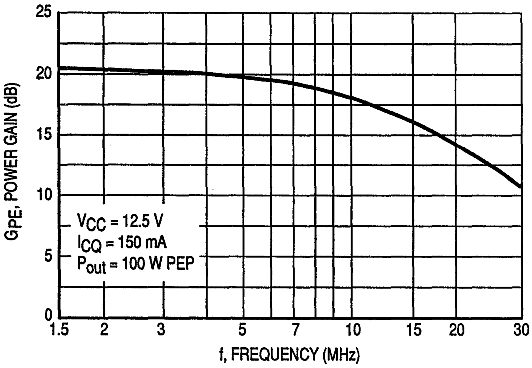


Figure 4. Power Gain versus Frequency

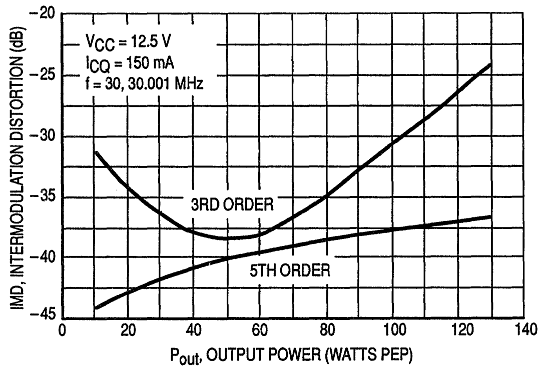
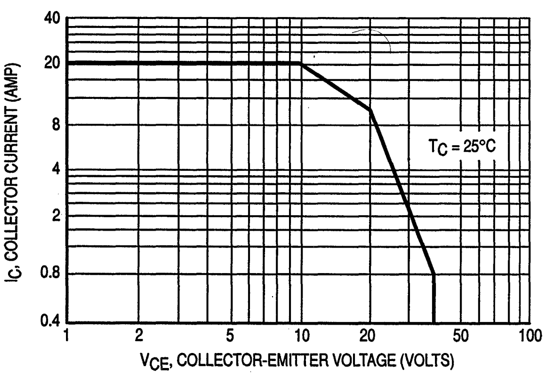
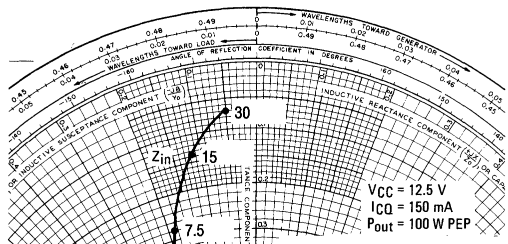


Figure 5. Intermodulation Distortion versus Output Power





FREQUENCY MHz	Z_{in} Ohms
2.0	5.35 - j2.2
7.5	2.8 - j1.9
15	1.39 - j1.1
30	0.7 - j0.5

Figure 6. DC Safe Operating Area

Figure 7. Series Equivalent Impedance

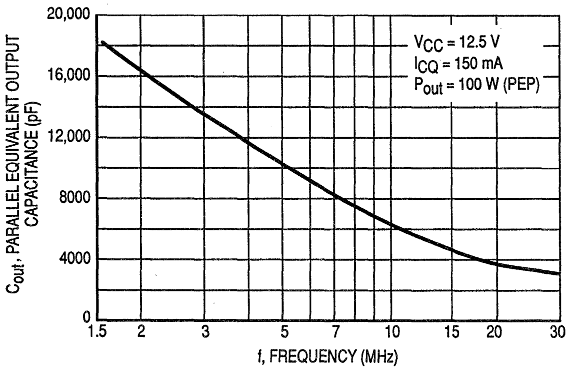


Figure 8. Output Capacitance versus Frequency

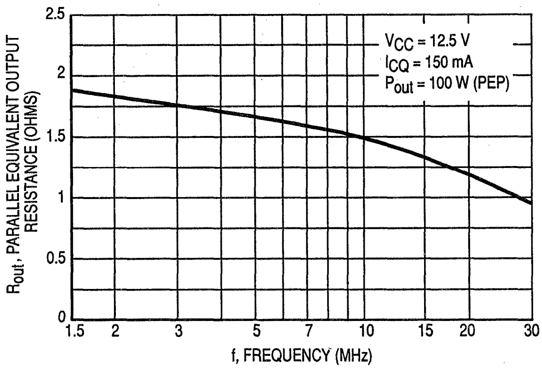


Figure 9. Output Resistance versus Frequency

2

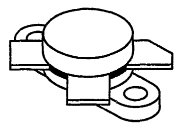
MRF422

The RF Line
NPN Silicon RF Power Transistor

. . . designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz.

- Specified 28 Volt, 30 MHz Characteristics —
  Output Power = 150 W (PEP)
  Minimum Gain = 10 dB
  Efficiency = 40%
- Intermodulation Distortion @ 150 W (PEP) —
  IMD = −30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR

150 W (PEP), 30 MHz
RF POWER
TRANSISTORS
NPN SILICON



CASE 211-11, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	85	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstanding Current — 10 s	—	30	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	290 1.66	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	85	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	85	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	20	mAdc

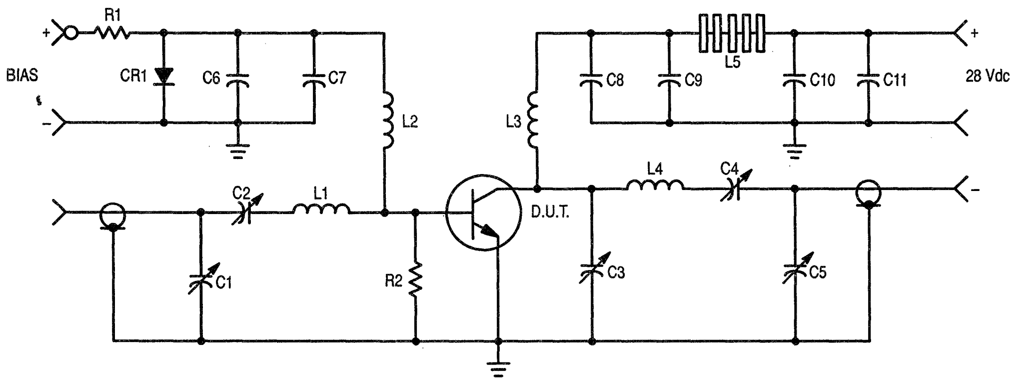
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	420	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 150 W (PEP), $I_{C(max)}$ = 6.7 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	G_{PE}	10	13	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 150 W (PEP), $I_{C(max)}$ = 6.7 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	η	—	45	—	%
Intermodulation Distortion (1) (V_{CE} = 28 Vdc, P_{out} = 150 W (PEP), I_C = 6.7 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	IMD	—	−33	−30	dB
Output Power (V_{CE} = 28 Vdc, f = 30 MHz)	P_{out}	150	—	—	Watts (PEP)

NOTE:
1. To Mil-Std-1311 Version A, Test Method 2204, Two Tone, Reference each Tone.

2



C1, C2, C3, C5 — 170–680 pF, ARCO 469
C4 — 80–480 pF, ARCO 466
C6, C8, C11 — ERIE 0.1 µF, 100 V
C7 — MALLORY 500 µF, 15 V Electrolytic
C9 — UNDERWOOD 1000 pF, 350 V
C10 — 10 µF, 50 V Electrolytic
R1 — 10 Ω, 25 Watt Wire Wound
R2 — 10 Ω, 1.0 Watt Carbon
CR1 — 1N4997

L1 — 3 Turns, #16 Wire, 5/16″ I.D., 5/16″ Long
L2 — 10 µH Molded Choke
L3 — 12 Turns, #16 Enameled Wire, Close Wound, 1/4″ Dia.
L4 — 5 Turns, 1/8″ Copper Tubing
L5 — 10 Ferrite Beads — FERROXCUBE #56-590-65/3B

Figure 1. 30 MHz Test Circuit Schematic

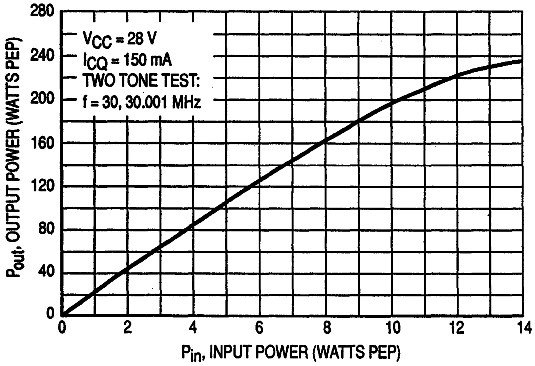


Figure 2. Output Power versus Input Power

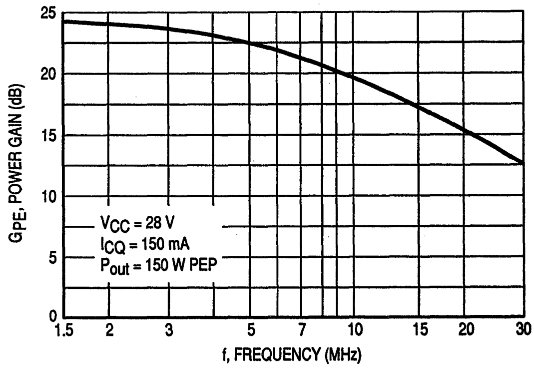


Figure 3. Power Gain versus Frequency

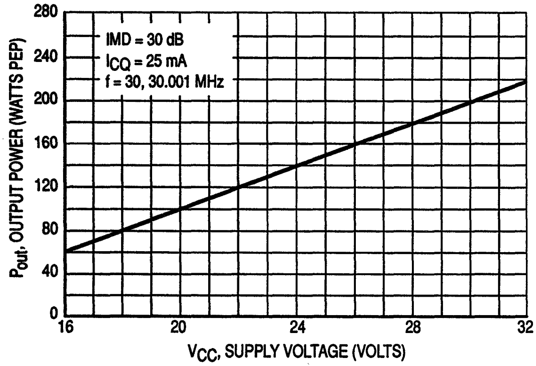


Figure 4. Linear Output Power versus Supply Voltage

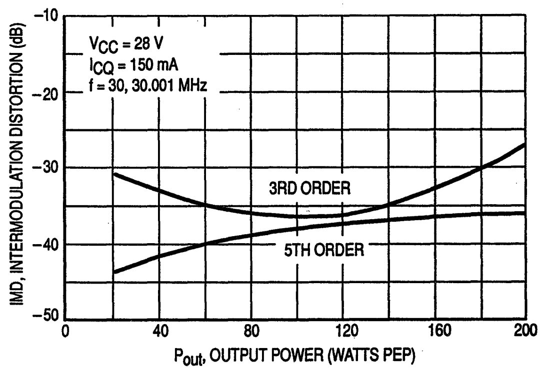


Figure 5. Intermodulation Distortion versus Output Power

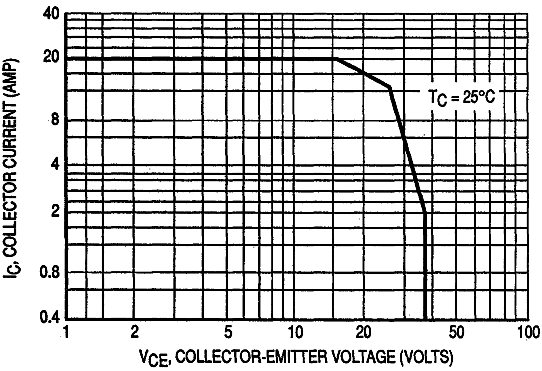
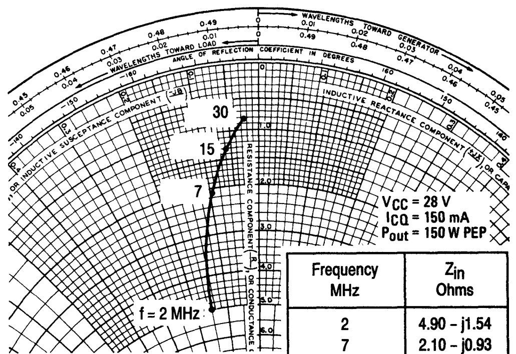


Figure 6. DC Safe Operating Area



Frequency MHz	Zin Ohms
2	4.90 − j1.54
7	2.10 − j0.93
15	1.32 − j0.38
30	0.81 − j0.26

Figure 7. Series Input Impedance

2

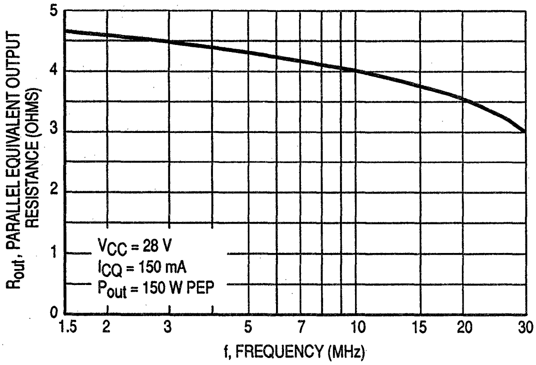


Figure 8. Output Resistance versus Frequency

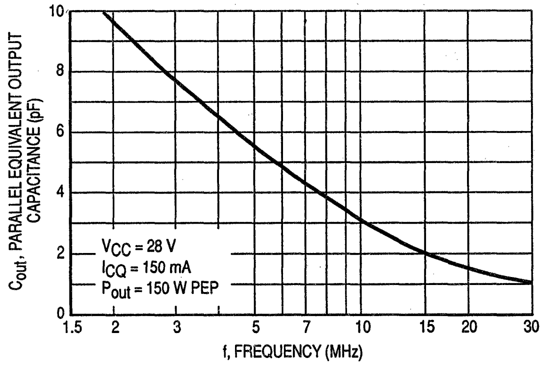


Figure 9. Output Capacitance versus Frequency

2

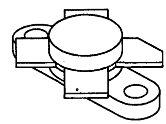
MRF426

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for high gain driver and output linear amplifier stages in 1.5 to 30 MHz HF/SSB equipment.

- Specified 28 Volt, 30 MHz Characteristics —
  Output Power = 25 W (PEP)
  Minimum Gain = 22 dB
  Efficiency = 35%
- Intermodulation Distortion @ 25 W (PEP) —
  IMD = −30 dB (Max)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Class A and AB Characterization
- BLX 13 Equivalent

**25 W (PEP), 30 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 211-07, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	Adc
Withstand Current — 5 s	—	6.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	70 0.4	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc

NOTE:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

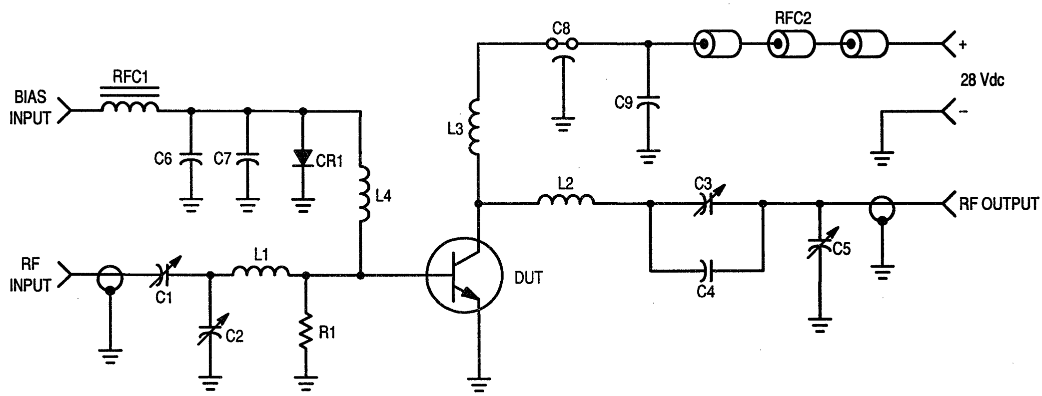
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	35	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	60	80	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Gain (V_{CC} = 28 Vdc, P_{out} = 25 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA)	G_{PE}	22	25	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 25 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA)	η	35	—	—	%
Intermodulation Distortion (2) (V_{CC} = 28 Vdc, P_{out} = 25 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA)	$IMD_{(d3)}$	—	−35	−30	dB
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 25 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (2) and Power Gain (V_{CC} = 28 Vdc, P_{out} = 8.0 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 1.2 Adc)	G_{PE} $IMD_{(d3)}$ $IMD_{(d5)}$	— — —	23.5 −40 −55	— — —	dB

NOTE:
2. To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

2



C1, C2 — ARCO 469, 190−780 pF
C3, C4 — ARCO 464, 25−280 pF
C5 — 120 pF Dipped Mica
C6, C7 — 100 µF, 15 Vdc
C8 — 680 pF F.T. Allen Bradley
C9 — 1.0 µF 35 V Tantalum
CR1 — 1N4997

L1 — 3 Turns #16 0.25″ ID
L2 — 6 Turns #16 0.5″ ID
L3 — 7 Turns #20 0.38″ ID
L4 — 10 µH Molded Choke Delevan
RFC1 — Ferroxcube VK200/20-4B
RFC2 — 3-Ferroxcube 5653065-3B
RF — Input/Output Connectors UG53 A/µ
R1 — 10 Ω 1/2 Watt 10%

Adjust Bias (Base) for I_{CQ} = 20 mA with No RF Applied

Figure 1. 30 MHz Linear Test Circuit

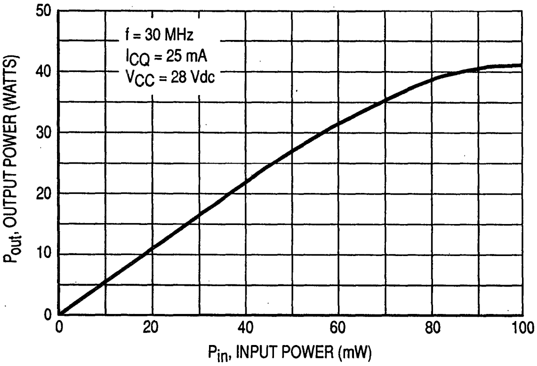


Figure 2. Output Power versus Input Power

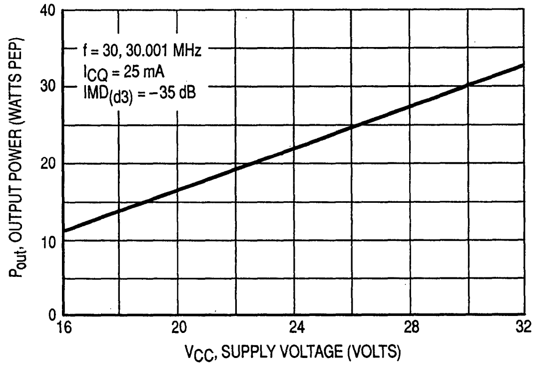


Figure 3. Output Power versus Supply Voltage

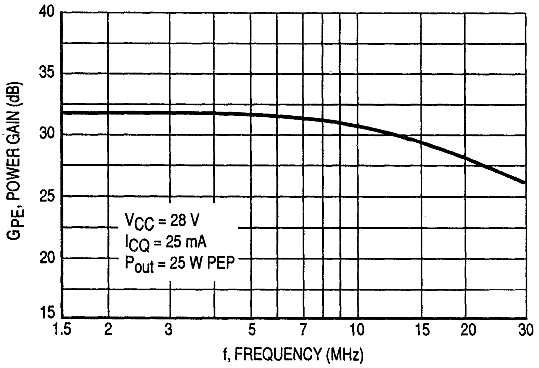


Figure 4. Power Gain versus Frequency

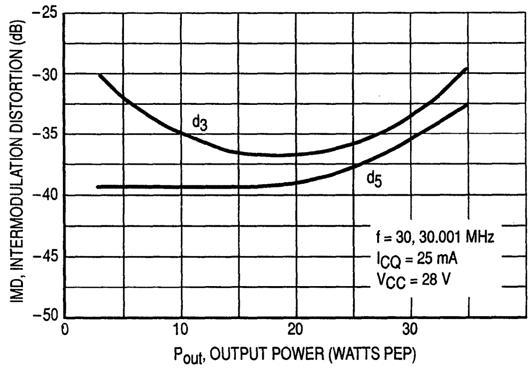


Figure 5. Intermodulation Distortion versus Output Power

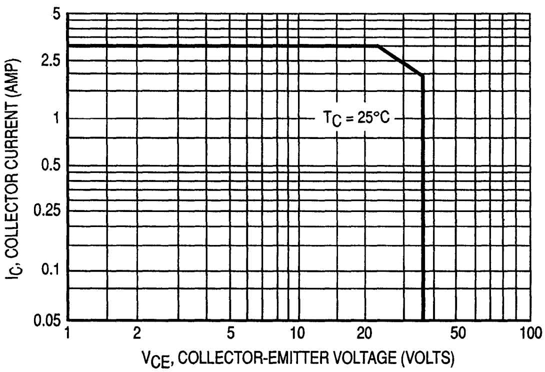


Figure 6. DC Safe Operating Area

2

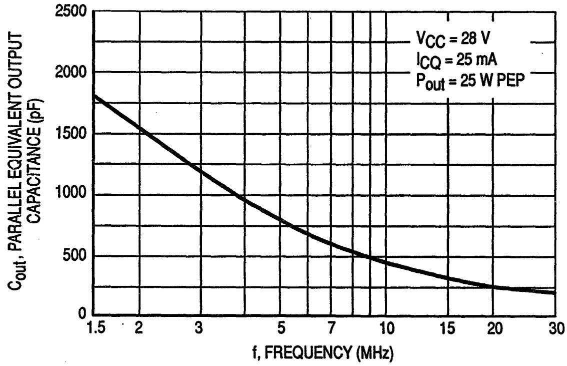


Figure 7. Output Capacitance versus Frequency

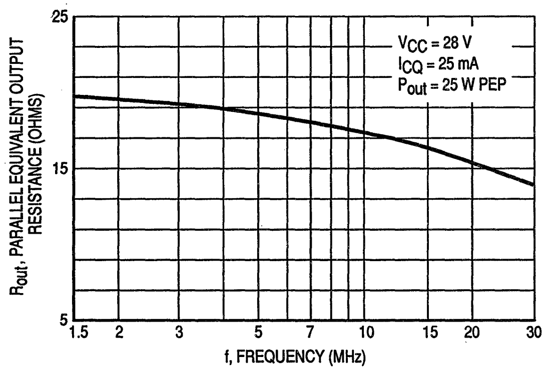


Figure 8. Output Resistance versus Frequency

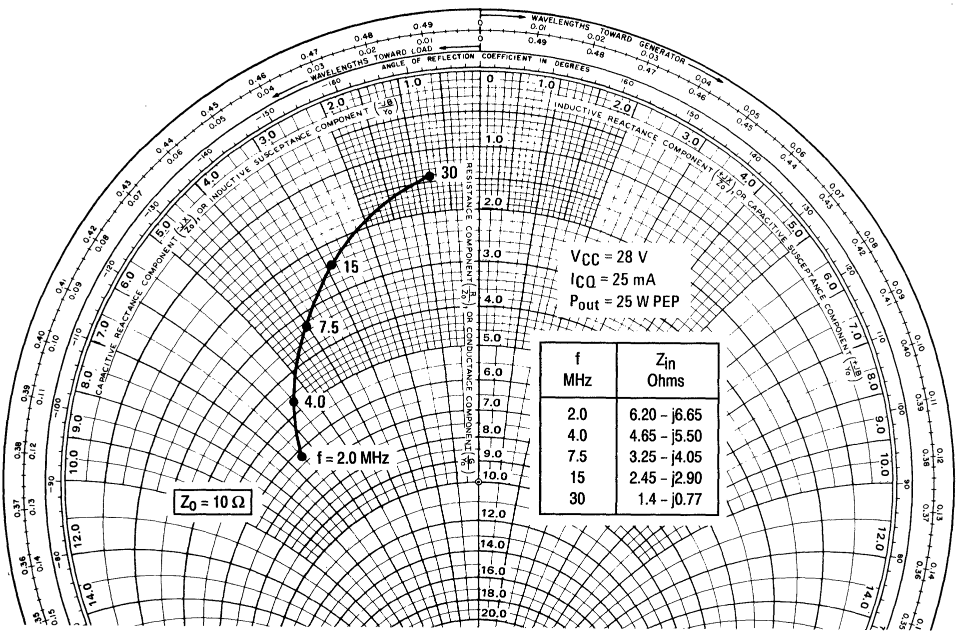


Figure 9. Series Equivalent Input Impedance

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF429

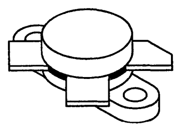
The RF Line

NPN Silicon RF Power Transistor

. . . designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics —
  Output Power = 150 W (PEP)
  Minimum Gain = 13 dB
  Efficiency = 45%
- Intermodulation Distortion @ 150 W (PEP) —
  IMD = −32 dB (Max)
- Diffused Emitter Resistors for Superior Ruggedness
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR @ 150 W CW

150 W (LINEAR), 30 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 211-11, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Withstand Current — 10 s	—	20	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	233 1.33	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	100	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc

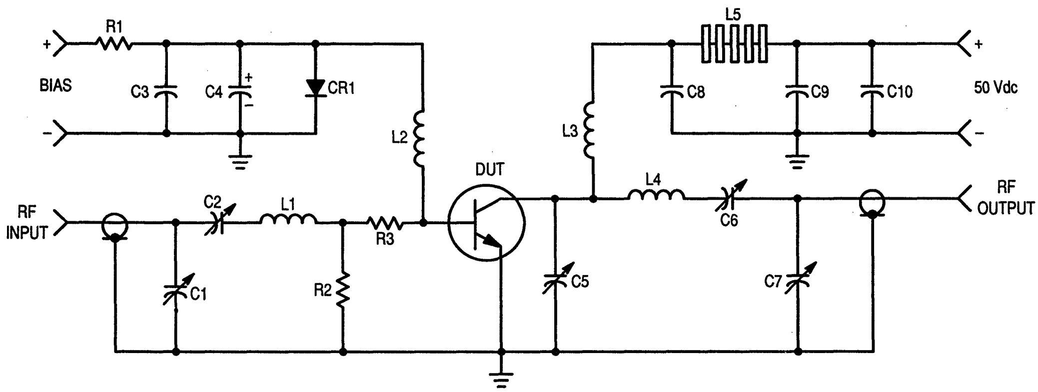
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	220	300	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP), I_C(max) = 3.32 Adc, f = 30; 30.001 MHz)	G_{PE}	13	15	—	dB
Output Power (V_{CE} = 50 Vdc, f = 30; 30.001 MHz)	P_{out}	150	—	—	W (PEP)
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP), I_C(max) = 3.32 Adc, f = 30, 30.001 MHz)	η	45	—	—	%
Intermodulation Distortion (1) (V_{CE} = 50 Vdc, P_{out} = 150 W (PEP), I_C = 3.32 Adc)	IMD	—	−35	−32	dB
Electrical Ruggedness (V_{CC} = 50 Vdc, P_{out} = 150 W CW, f = 30 MHz, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTE:
1. To Mil-Std-1311 Version A, Test Method 2204, Two Tone, Reference each Tone.

2



C1, C2, C7 — 170–780 pF, Arco 469
C3, C8, C9 — 0.1 μF, 100 V Erie
C4 — 500 μF @ 6.0 V
C5 — 9.0–180 pF, Arco 463
C6 — 80–480 pF, Arco 466
C10 — 30 μF, 100 V
R1 — 10 Ω, 10 Watt
R2 — 10 Ω, 1.0 Watt
R3 — 5.0 – 3.3 Ω 1/2 Watt Carbon Resistors in Parallel
CR1 — 1N4997
L1 — 3 Turns, #16 Wire, 5/16″ I.D., 5/16″ Long
L2 — 10 μH Molded Choke
L3 — 12 Turns, #16 Enameled Wire Closewound, 1/4″ I.D.
L4 — 5 Turns, 1/8″ Copper Tubing, 9/16″ I.D., 3/4″ Long
L5 — 10 Ferrite Beads — Ferroxcube #56-590-65/3B

Figure 1. 30 MHz Test Circuit Schematic

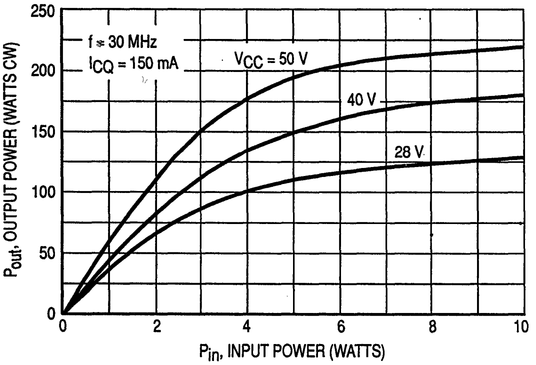


Figure 2. Output Power versus Input Power

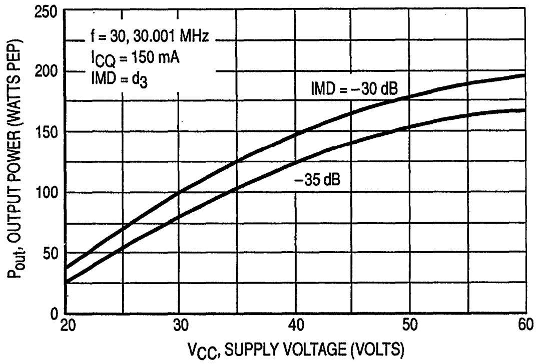


Figure 3. Output Power versus Supply Voltage

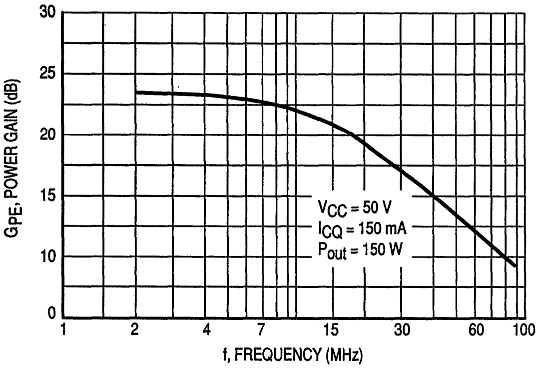


Figure 4. Power Gain versus Frequency

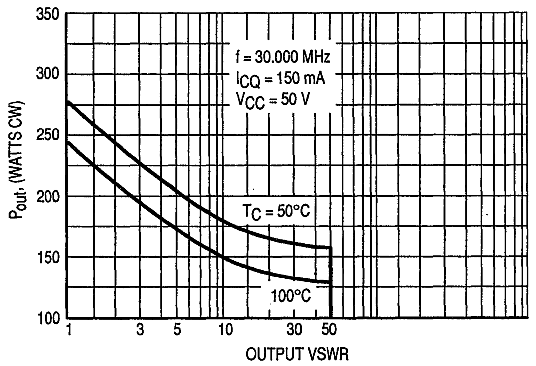


Figure 5. RF Safe Operating Area (SOAR)

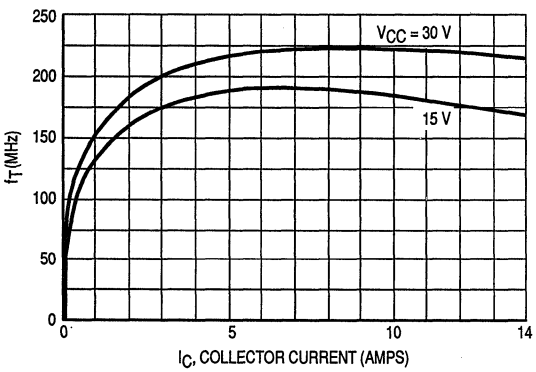


Figure 6. f_T versus Collector Current

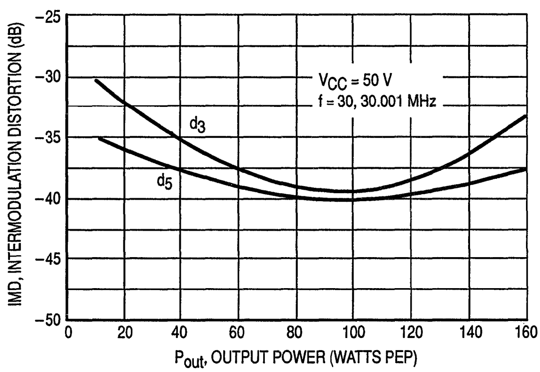


Figure 7. IMD versus P_{out}

2

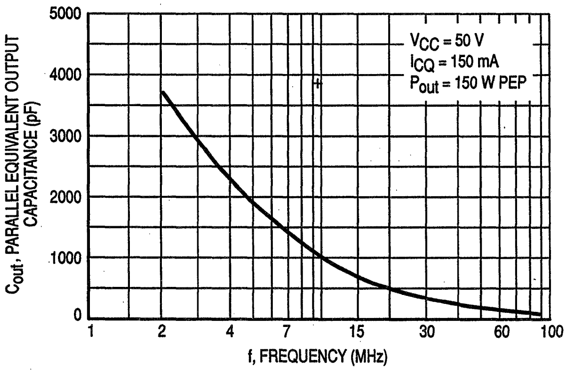


Figure 8. Output Capacitance versus Frequency

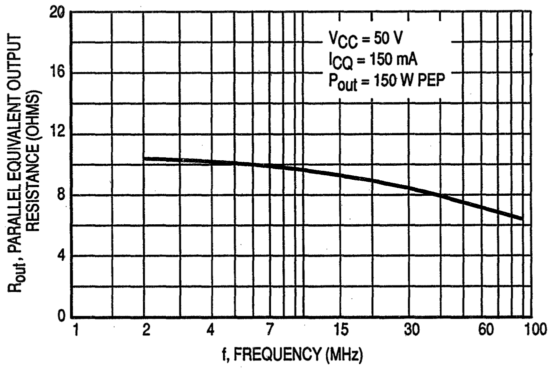
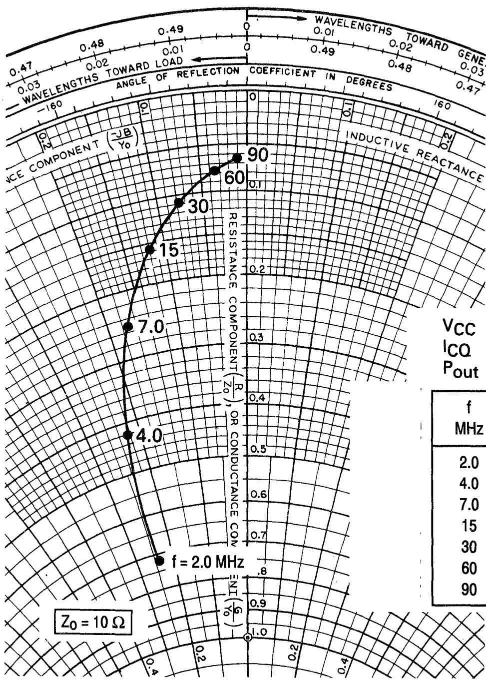


Figure 9. Output Resistance versus Frequency



V_{CC} = 50 V
I_{CQ} = 150 mA
P_{out} = 150 W PEP

f MHz	Z_{in} Ohms
2.0	7.15 - j2.40
4.0	4.20 - j2.25
7.0	2.55 - j1.75
15	1.60 - j1.15
30	1.10 - j0.70
60	0.78 - j0.30
90	0.67 - j0.10

Figure 10. Series Equivalent Impedance

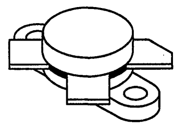
MRF448

The RF Line
NPN Silicon RF Power Transistor

. . . designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics
  Output Power = 250 W
  Minimum Gain = 12 dB
  Efficiency = 45%
- Intermodulation Distortion @ 250 W (PEP) —
  IMD = −30 dB (Max)
- 100% Tested for Load Mismatch at all Phase Angles with 3:1 VSWR

250 W, 30 MHz RF POWER TRANSISTOR NPN SILICON



CASE 211-11, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Withstand Current — 10 s	—	20	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	290 1.67	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	100	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc

NOTE:
1. P_D is a measurement reflecting short term maximum condition. See SOAR curve for operating conditions.

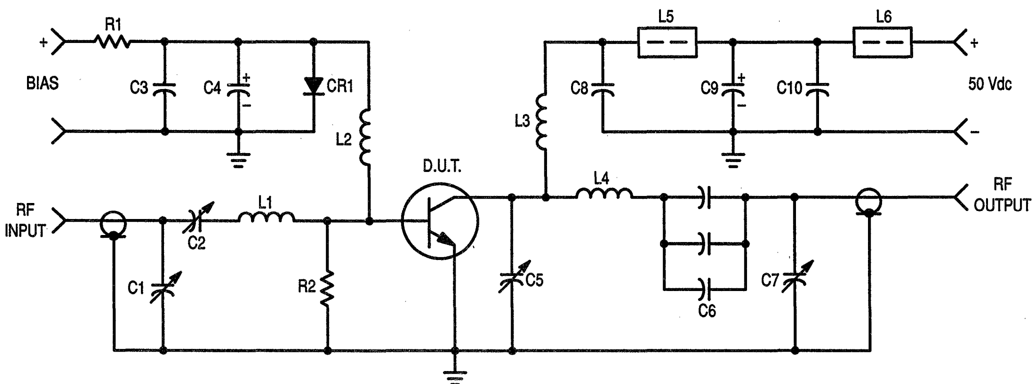
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	350	450	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 250 W CW, f = 30 MHz, I_{CQ} = 250 mA)	G_{PE}	12	14	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 250 W, f = 30 MHz, I_{CQ} = 250 mA)	η	— —	45 65	— —	% (PEP) % (CW)
Intermodulation Distortion (2) (V_{CE} = 50 Vdc, P_{out} = 250 W (PEP), I_{CQ} = 250 mA, f = 30 MHz)	IMD	—	−33	−30	dB
Electrical Ruggedness (V_{CC} = 50 Vdc, P_{out} = 250 W CW, f = 30 MHz, VSWR 3:1 at all Phase Angles)	ψ	No Degradation in Output Power			

NOTE:
2. To Mil-Std-1311 Version A, Test Method 2204, Two Tone, Reference each Tone.

2



C1, C2, C5, C7 — 170–780 pF, Arco 469
C3, C8, C9 — 0.1 µF, 100 V Erie
C4 — 500 µF @ 6.0 V
C6 — 360 pF, 3 x 120 pF 3.0 kV in parallel
C10 — 10 µF, 100 V
R1 — 10 Ω, 10 Watt
R2 — 10 Ω, 1.0 Watt

CR1 — 1N4997 or equivalent
L1 — 3 Turns, #16 Wire, 0.4″ I.D., 0.3″ Long
L2 — 0.8 µH, Ohmite Z-235 or equivalent
L3 — 12 Turns, #16 Enameled Wire Closewound 0.25″ I.D.
L4 — 4 Turns, 1/8″ Copper Tubing, 0.6″ I.D., 1.0″ Long
L5, L6 — 2.0 µH, Fair-Rite 2643021801 Ferrite bead each or equivalent

Figure 1. 30 MHz Test Circuit Schematic

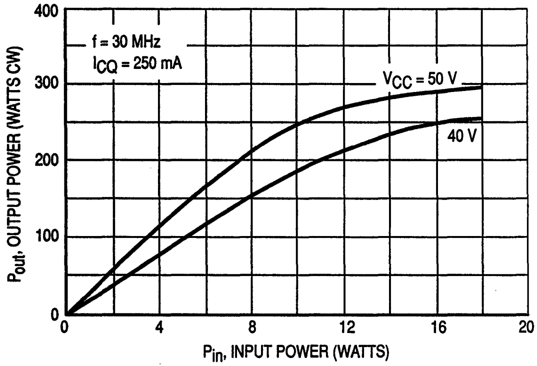


Figure 2. Output Power versus Input Power

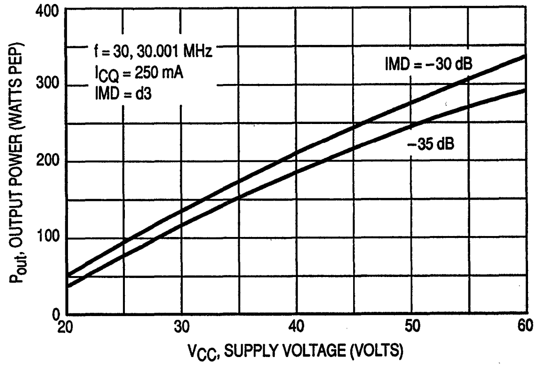


Figure 3. Output Power versus Supply Voltage

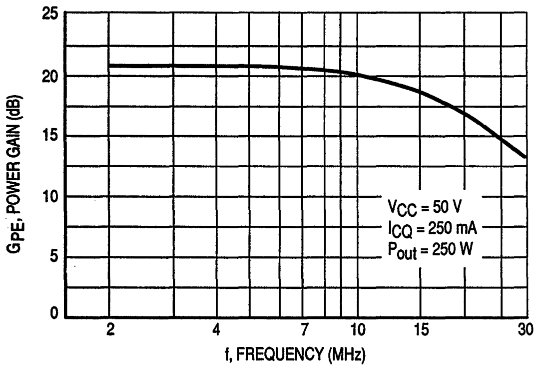


Figure 4. Power Gain versus Frequency

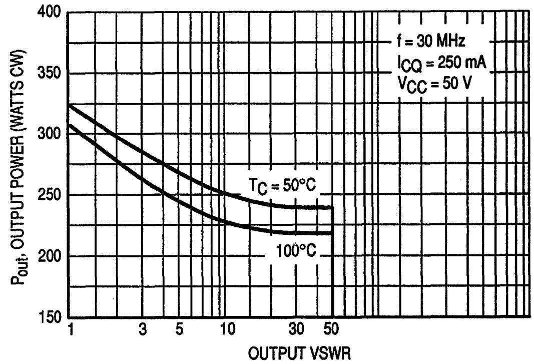


Figure 5. RF SOAR (Class AB)
P_{out} versus Output VSWR

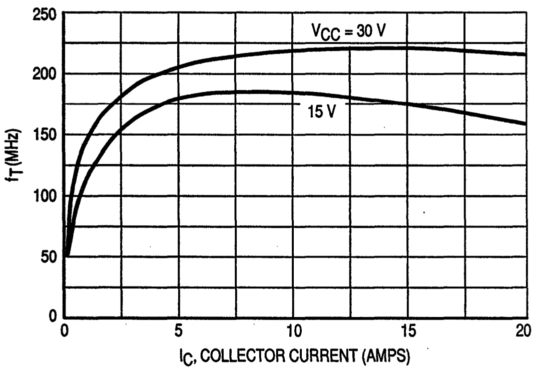


Figure 6. f_T versus Collector Current

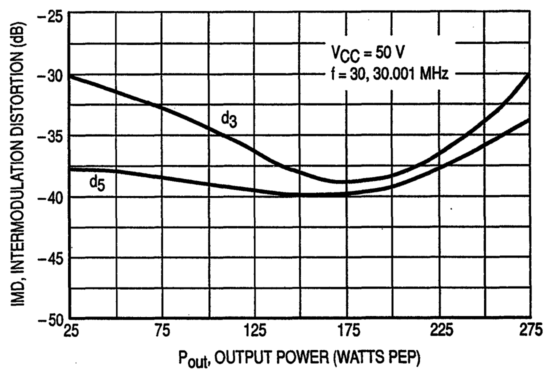


Figure 7. IMD versus P_{out}

2

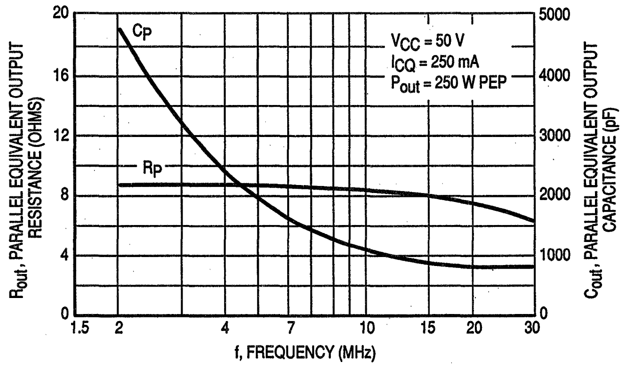
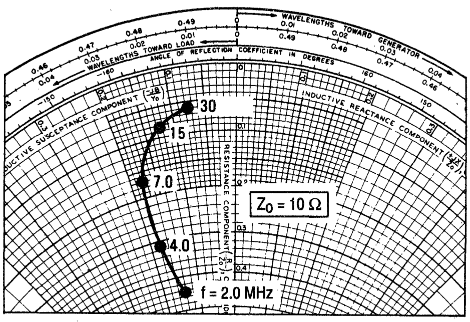


Figure 8. Output Resistance and Capacitance versus Frequency



V_{CC} = 50 V
I_{CQ} = 150 mA
P_{out} = 250 W PEP

f MHz	Z_{in} Ohms
2.0	4.50 - j1.40
4.0	3.10 - j1.80
7.0	1.70 - j1.75
15	0.80 - j1.25
30	0.60 - j0.75

Figure 9. Series Equivalent Impedance

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

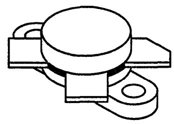
MRF454

The RF Line
NPN Silicon RF Power Transistor

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
  Output Power = 80 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%

80 W, 30 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 211-11, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

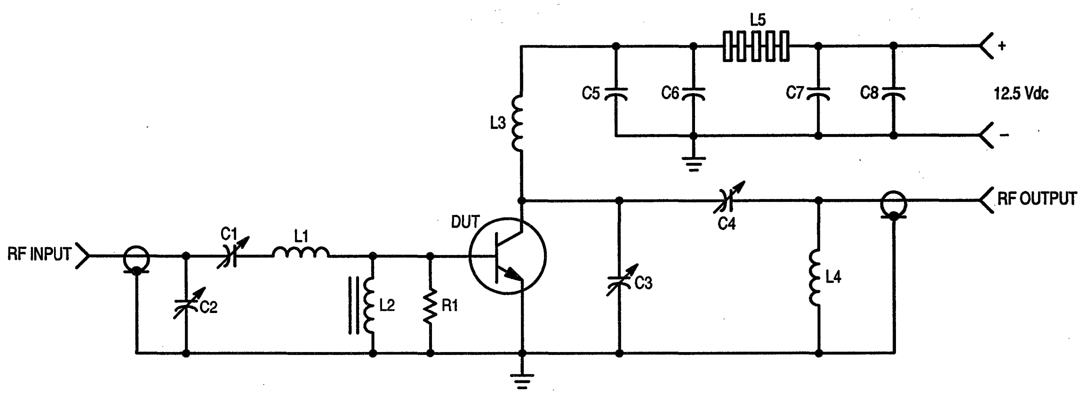
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	250	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	G_{pe}	12	—	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	η	50	—	—	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	Z_{in}	—	.938–j.341	—	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	Z_{out}	—	1.16–j.201	—	Ohms
Parallel Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	—	—	1.06 Ω 1817 pF	—	—
Parallel Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	—	—	1.19 Ω 777 pF	—	—

2



C1, C2, C4 — ARCO 469
C3 — ARCO 466
C5 — 1000 pF, UNELCO
C6, C7 — 0.1 µF Disc Ceramic
C8 — 1000 µF/15 V Electrolytic
R1 — 10 Ohm/1.0 Watt, Carbon

L1 — 3 Turns, #18 AWG, 5/16″ I.D., 5/16″ Long
L2 — VK200-20/4B, FERROXCUBE
L3 — 12 Turns, #18 AWG Enameled Wire, 1/4″ I.D., Close Wound
L4 — 3 Turns 1/8″ O.D. Copper Tubing, 3/8″ I.D., 3/4″ Long
L5 — 7 FERRITE Beads, FERROXCUBE #56-590-65/3B

Figure 1. 30 MHz Test Circuit Schematic

2

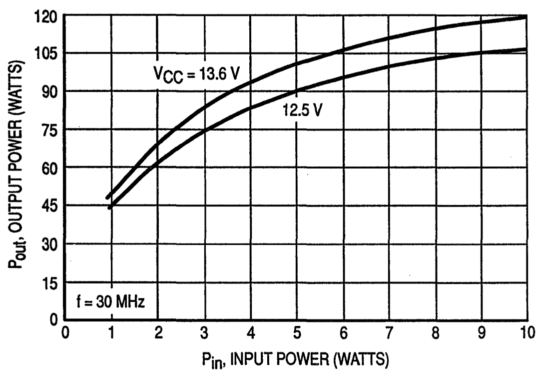


Figure 2. Output Power versus Input Power

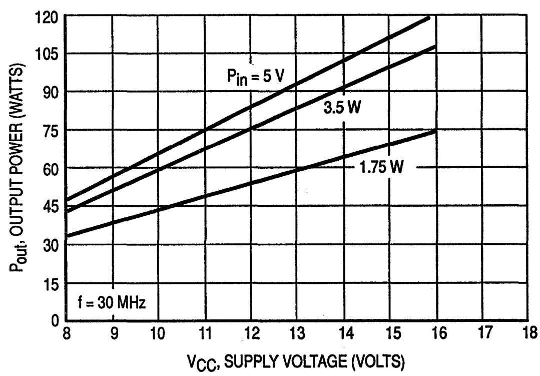


Figure 3. Output Power versus Supply Voltage

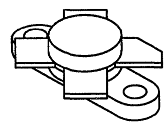
MRF455

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
  Output Power = 60 Watts
  Minimum Gain = 13 dB
  Efficiency = 55%

**60 W, 30 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 211-07, STYLE 1

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Emitter Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

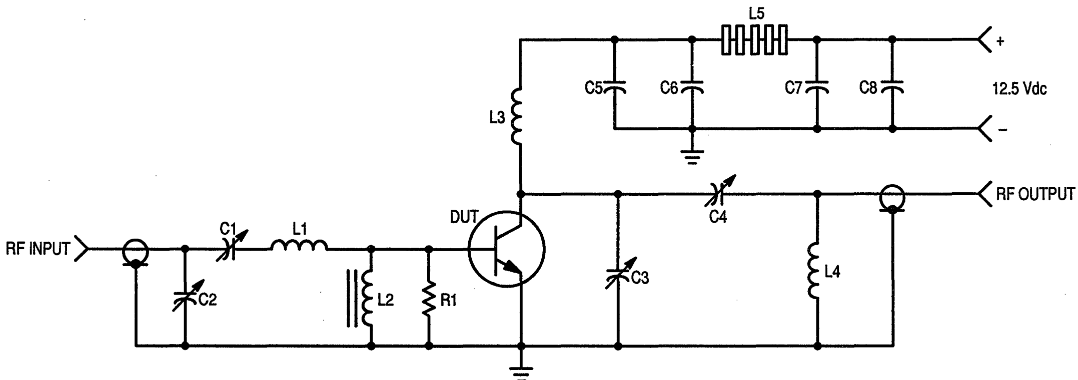
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	250	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	G_{pe}	13	—	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	η	55	—	—	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{in}	—	1.66–j.844	—	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{out}	—	1.73–j.188	—	Ohms
Parallel Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{in}	—	2.09/1030	—	Ω/pF
Parallel Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{out}	—	1.75/330	—	Ω/pF



C1, C2, C4 — ARCO 469
C3 — ARCO 466
C5 — 1000 pF, UNELCO
C6, C7 — 0.1 µF Disc Ceramic
C8 — 1000 µF/15 V Electrolytic
R1 — 10 Ohm/1.0 Watt, Carbon

L1 — 3 Turns, #18 AWG, 5/16″ I.D., 5/16″ Long
L2 — VK200-20/4B, FERROXCUBE
L3 — 12 Turns, #18 AWG Enameled Wire, 1/4″ I.D., Close Wound
L4 — 3 Turns 1/8″ O.D. Copper Tubing, 3/8″ I.D., 3/4″ Long
L5 — 7 FERRITE Beads, FERROXCUBE #56-590-65/3B

Figure 1. 30 MHz Test Circuit Schematic

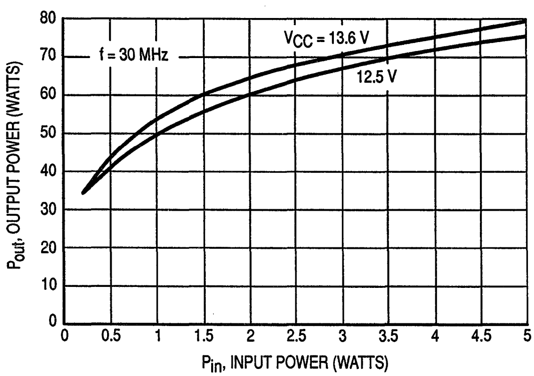


Figure 2. Output Power versus Input Power

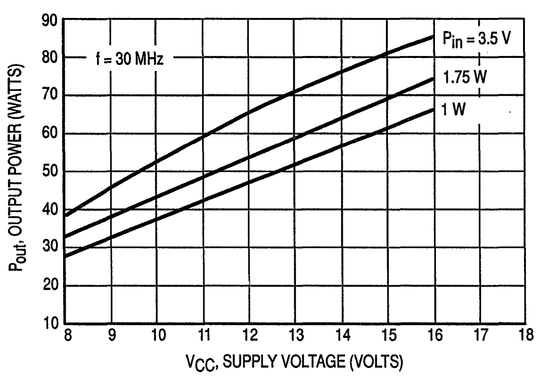


Figure 3. Output Power versus Supply Voltage

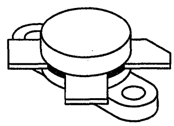
MRF464

The RF Line
NPN Silicon RF Power Transistor

80 W (PEP), 30 MHz
RF POWER
TRANSISTOR
NPN SILICON

. . . designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Specified 28 Volt, 30 MHz Characteristics —
  Output Power = 80 W (PEP)
  Minimum Gain = 15 dB
  Efficiency = 40%
  Intermodulation Distortion = −32 dB (Max)



CASE 211-11, STYLE 1

2

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	250 1.4	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W
Stud Torque (1)	—	8.5	In. Lb.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	—	10	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	—

NOTE:
1. Case 145A-10 — For Repeated Assembly Use 11 In. Lb.

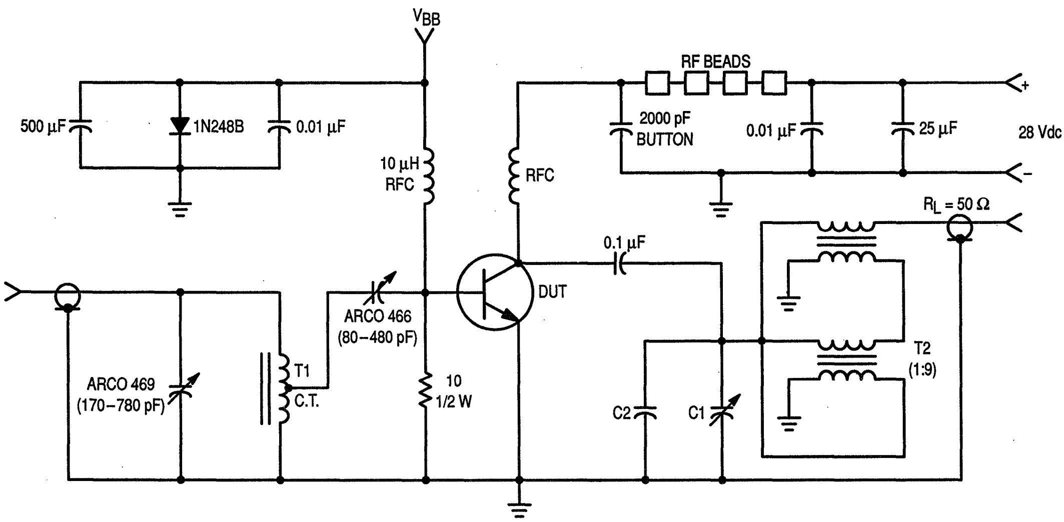
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
DYNAMIC CHARACTERISTICS				
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	200	pF
FUNCTIONAL TESTS				
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 80 W (PEP), I_C = 3.6 Adc (Max), V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	G_{PE}	15	—	dB
Intermodulation Distortion Ratio (Figure 1) (2) (P_{out} = 80 W (PEP), I_C = 3.6 Adc (Max), V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	IMD	—	−32	dB
Collector Efficiency (P_{out} = 80 W (PEP), I_C = 3.6 Adc (Max), V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	η	40	—	%

NOTE:
2. To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

2



RFC — 20 Turns @12 AWG Enameled Wire Close Wound in 2 Layers, 1/4″ I.D.
T1 — 20 Turns #24 AWG Wire Wound on Micro-Metals T37-7 Toroid Core Center Tapped.
T2 — 1:9 XFMR; 6 Turns of 2 Twisted Pairs of #28 AWG Enameled Wire. (8 Crests Per Inch) Bifilar Wound on Each of 2 Separate Balun Cores. (Stackpole #57-1503, No. 14 Material) Interconnected as shown
RF Beads — Ferroxcube #56-590-65/3B

V_{BB} adjusted for I_{CQ} — 40 mAdc (I_{CQ} = Quiescent Collector Current)
C1 — 170−180 pF ARCO 469 or Equivalent
C2 — 330 pF

Figure 1. 30 MHz Test Circuit

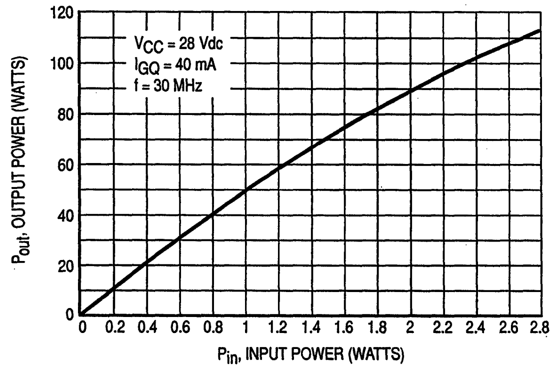


Figure 2. Output Power versus Input Power

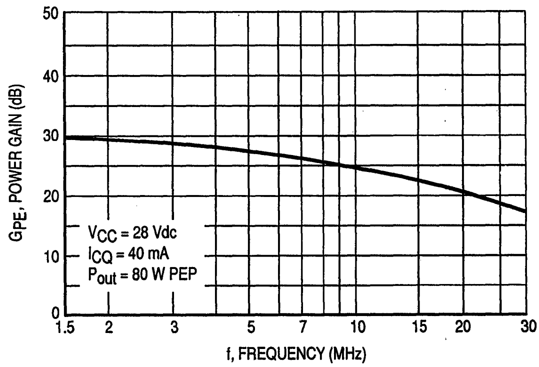


Figure 3. Power Gain versus Frequency

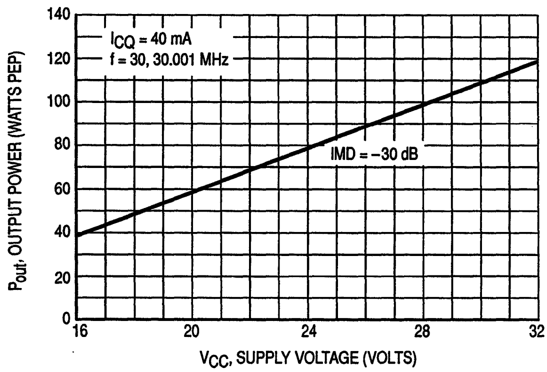


Figure 4. Output Power versus Supply Voltage

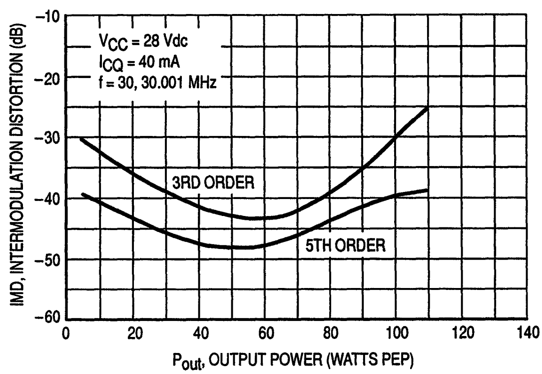


Figure 5. Intermodulation Distortion versus Output Power

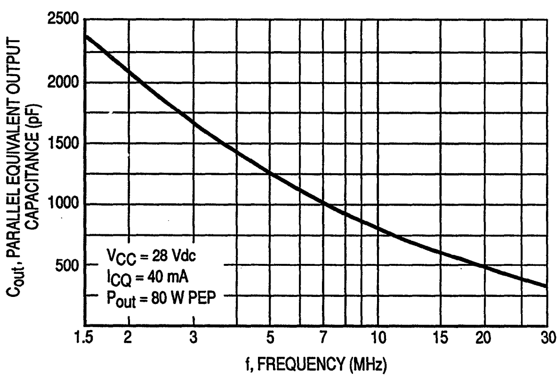


Figure 6. Output Capacitance versus Frequency

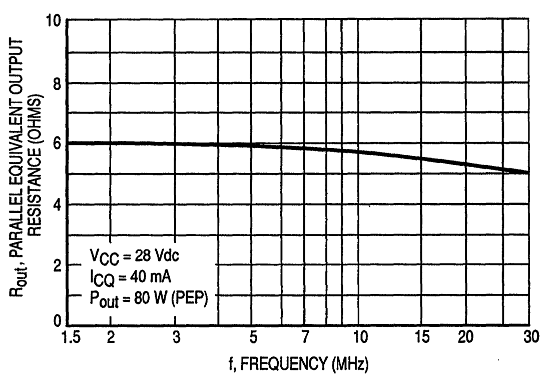


Figure 7. Output Resistance versus Frequency

2

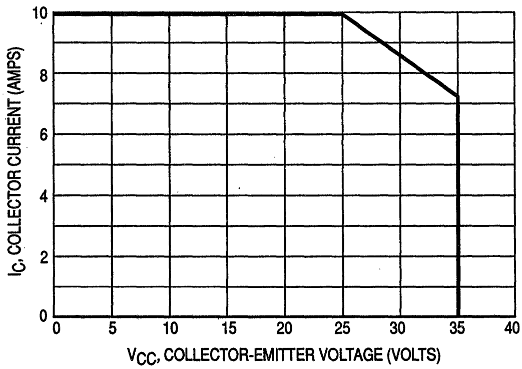
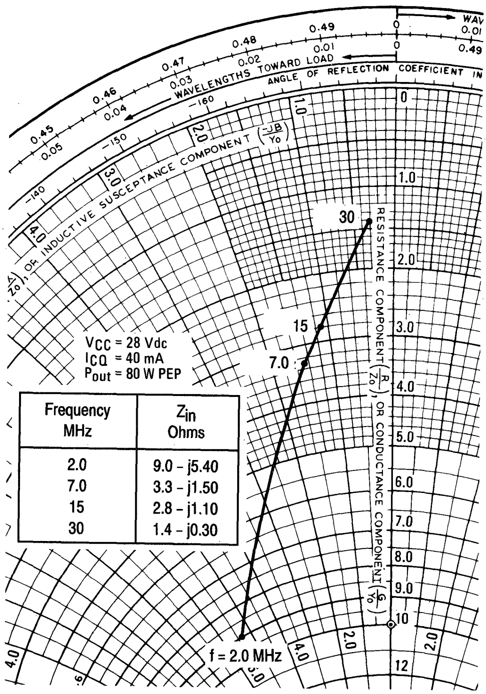


Figure 8. DC Safe Operating Area



Frequency MHz	Z_{in} Ohms
2.0	9.0 – j5.40
7.0	3.3 – j1.50
15	2.8 – j1.10
30	1.4 – j0.30

Figure 9. Series Input Impedance

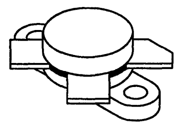
MRF492

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for 12.5 volt low band VHF large-signal power amplifier applications in commercial and industrial FM equipment.

- Specified 12.5 V, 50 MHz Characteristics —
  Output Power = 70 W
  Minimum Gain = 11 dB
  Efficiency = 50%
- Load Mismatch Capability at High Line and RF Overdrive

**70 W, 50 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 211-11, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

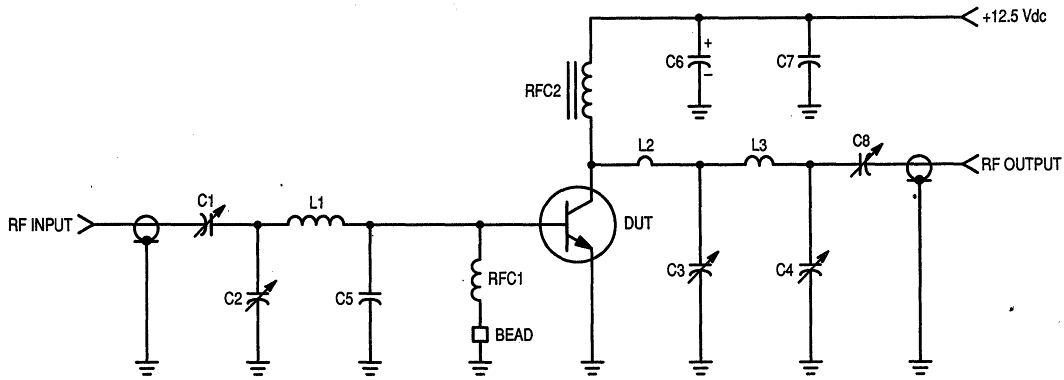
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 13.6 Vdc, V_{BE} = 0)	I_{CES}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	275	450	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 70 W, f = 50 MHz)	G_{PE}	11	13	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 70 W, f = 50 MHz)	η	50	—	—	%

NOTES:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



C1, C8 — 9.0–180 pF, Arco 463
C2, C3, C4 — 80–480 pF, Arco 466
C5 — 1000 pF, 350 V, Unelco
C6 — 10 μF, 25 Vdc
C7 — 0.01 μF, Ceramic
RFC1 — 10 μH Molded Choke
RFC2 — 12 Turns, #16 AWG, Enameled Wire Closewound on a 2.0 W Carbon Resistor
L1 — 2 Turns, #18 AWG Enameled Wire, 0.4″ ID, 0.15″ Long
L2 — Loop, #12 AWG Wire, 0.6″ High, 0.4″ Wide
L3 — 2 Turns, #12 AWG Wire, ID 0.4″, 0.25″ Long
Bead — Ferrite Bead Ferroxcube #56-590-65/3B

Figure 1. 50 MHz Test Circuit

2

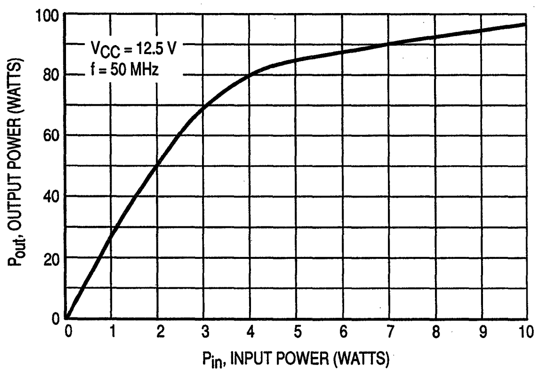


Figure 2. Output Power versus Input Power

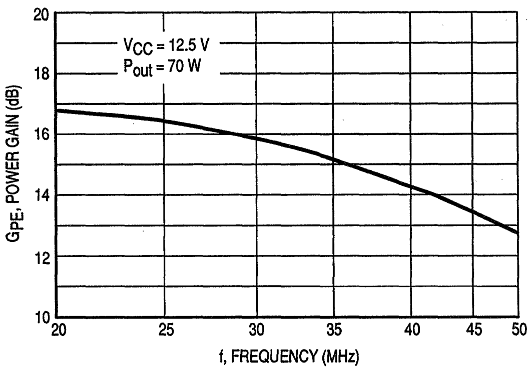


Figure 3. Power Gain versus Frequency

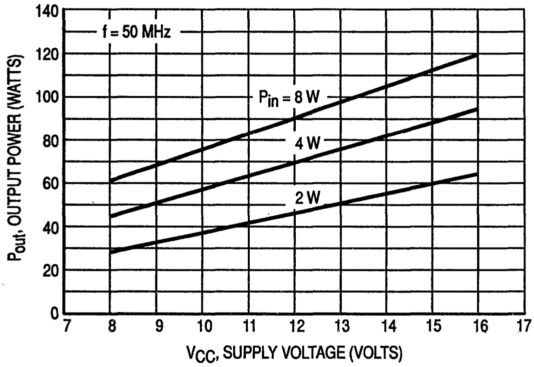
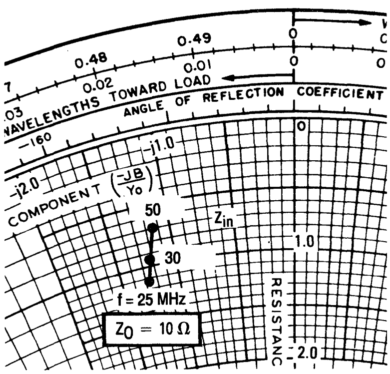


Figure 4. Output Power versus Supply Voltage

2



V_{CC} = 12.5 V, P_{out} = 70 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
25	1.12 - j1.28	0.85 - j1.46
30	0.93 - j1.24	0.76 - j1.3
50	0.7 - j1.17	0.58 - j1.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

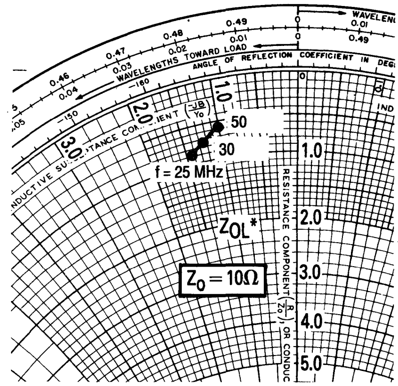


Figure 5. Series Equivalent Input/Output Impedances

MRF553

The RF Line
NPN Silicon
RF Low Power Transistor

... designed primarily for wideband large signal predriver stages in the VHF frequency range.

- Specified @ 12.5 V, 175 MHz Characteristics
  Output Power = 1.5 W
  Minimum Gain = 11.5 dB
  Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

**1.5 W, 175 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON**

CASE 317D, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_C = 75°C (1, 2) Derate above 75°C	P_D	3.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

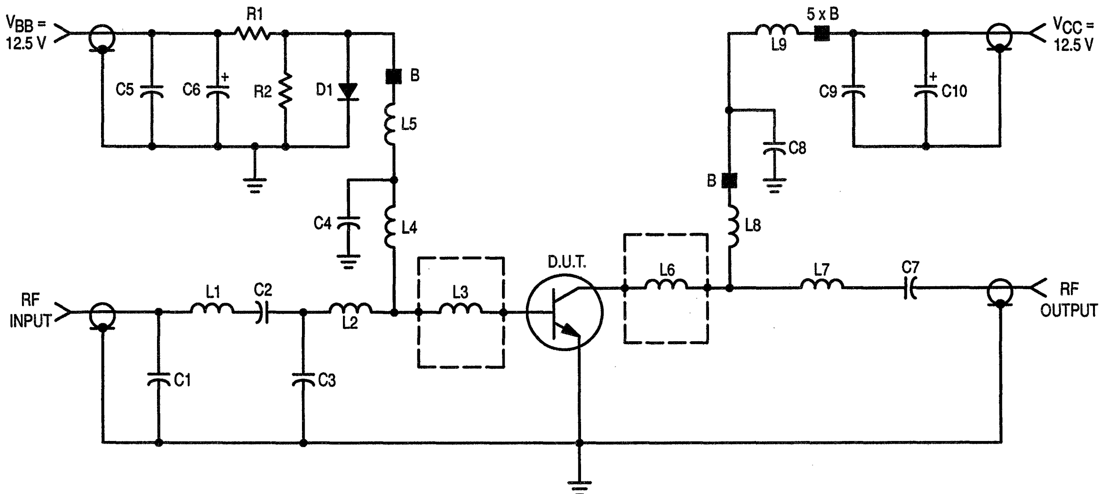
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	—	200	—

NOTES:
1. T_C, Case temperature measured on collector lead immediately adjacent to body of package.
2. The MRF553 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	12	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 175 MHz) Figures 1, 2	G_{pe}	11.5	13	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 175 MHz) Figures 1, 2	η	50	60	—	%
Load Mismatch Stress (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 175 MHz, VSWR ≥ 10:1 All Phase Angles)	ψ	No Degradation in Output Power			—



C1 — 36 pF Mini Underwood
C2 — 47 pF Mini Underwood
C3 — 91 pF Mini Underwood
C4 — 68 pF Mini Underwood
C5, C9 — 1.0 μF Erie Red Cap Capacitor
C6, C10 — 0.1 μF, 35 V Tantulum
C7 — 470 pF Chip Capacitor
C8 — 2200 pF Chip Capacitor
R1 — 4.7 kΩ, 1/4 W
R2 — 100 Ω, 1/4 W
D1 — 1N4148 Diode

L1 — 3 Turns, #18 AWG, 0.210″ ID, 3/16″ Length
L2, L4, L7 — 0.62″, #18 AWG Wire Bent into "V"
L3, L6 — 60 x 125 x 250 Mils Copper Pad on 27 Mils Thick Alumina Substrate
L5 — 12 μH Molded Choke
L8 — 7 Turns, #18 AWG, 0.170″ ID, 7/16″ Length
L9 — 1.0″, #18 AWG Wire with 5 Ferrite Beads
B — Ferrite Bead
Board Material — Glass Teflon, ε_r = 2.56, t = 0.0625″ (See Photomaster, Figure 3)

Figure 1. 140–175 MHz Broadband Circuit Schematic

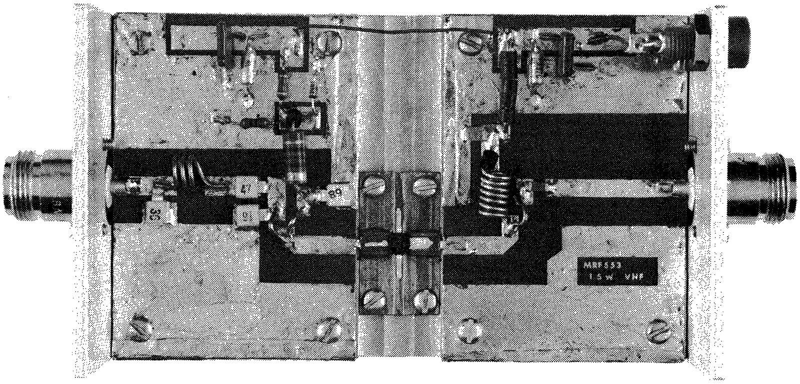
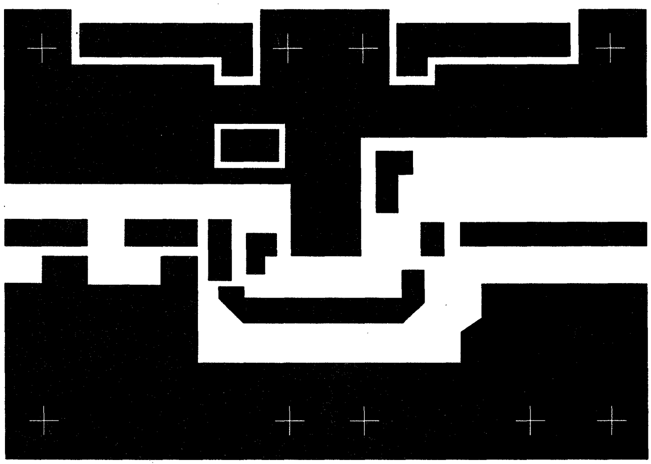


Figure 2. 140–175 MHz Broadband Circuit

2



SCALE 0.75:1

Figure 3. 140–175 MHz Test Circuit Photomaster

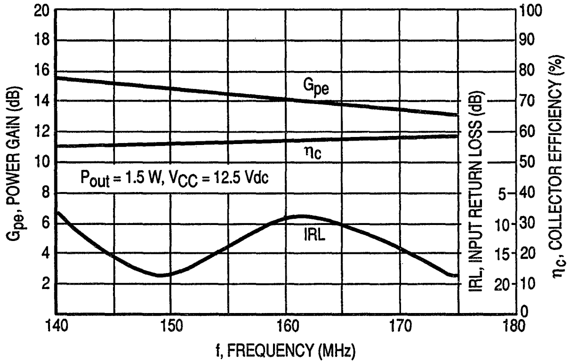


Figure 4. Typical Performance in Broadband Circuit

f Frequency MHz	Z_{in} Ohms						Z_{OL}* Ohms					
	V_{CC} = 7.5 V; P_{in}			V_{CC} = 12.5 V; P_{in}			V_{CC} = 7.5 V; P_{out}			V_{CC} = 12.5 V; P_{out}		
	100 mW	200 mW	300 mW	50 mW	100 mW	150 mW	1.0 W	1.6 W	2.2 W	1.1 W	2.0 W	2.6 W
140	1.65–j3.6	2.0–j2.6	2.3–j1.2	1.7–j4.1	1.8–j3.1	1.9–j2.7	9.9–j11.1	10.6–j5.1	10–j4.9	28.3–j21.5	16–j20.5	16.3–j16.5
175	2.5–j5.6	2.3–j5.9	2.8–j4.0	2.3–j4.6	2.4–j1.2	2.4–j5.7	12.1–j14.9	7.2–j9.8	8.1–j5.4	30.8–j23.3	11.4–j20.9	11.1–j14.3

f Frequency MHz	Z_{in} Ohms						Z_{OL}* Ohms					
	V_{CC} = 7.5 V; P_{in}			V_{CC} = 12.5 V; P_{in}			V_{CC} = 7.5 V; P_{out}			V_{CC} = 12.5 V; P_{out}		
	50 mW	100 mW	200 mW	25 mW	50 mW	100 mW	1.25 W	1.5 W	2.0 W	1.5 W	2.25 W	3.0 W
90	2.5–j9.3	2.5–j6.4	2.5–j4.4	1.6–j10.7	2.5–j7.1	2.2–j1.3	31.8–j9.2	32–j8.9	30.2–j10.7	45.8–j7.2	45.2–j3.9	40–j4.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Table 1. Z_{in} and Z_{OL} versus Collector Voltage, Input Power, and Output Power

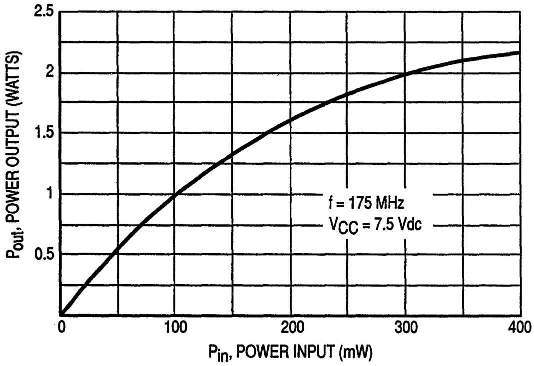


Figure 5. Power Output versus Power Input

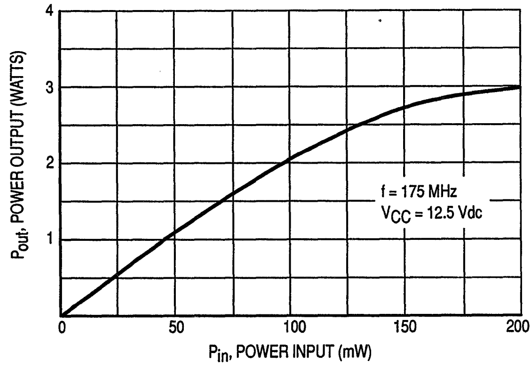


Figure 6. Power Output versus Power Input

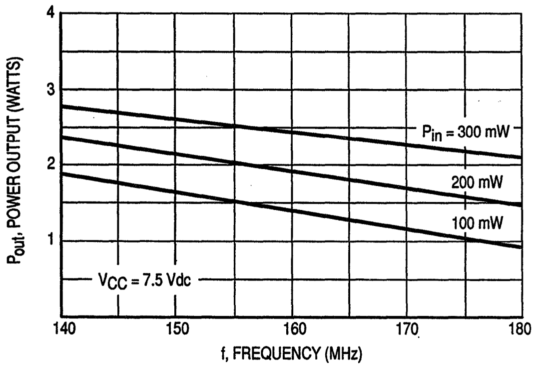


Figure 7. Power Output versus Frequency

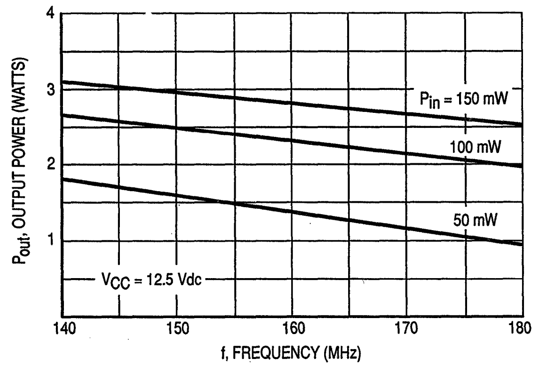


Figure 8. Power Output versus Frequency

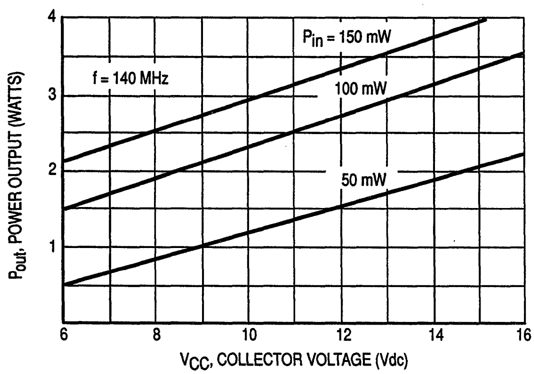


Figure 9. Power Output versus Collector Voltage

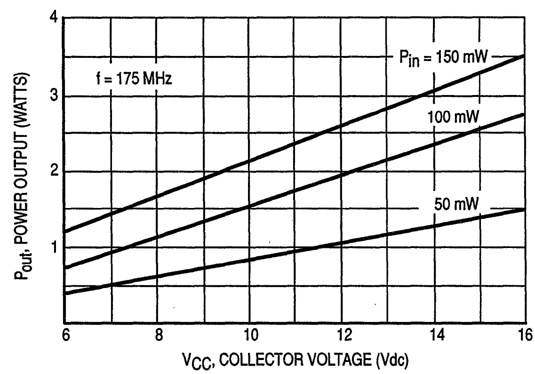


Figure 10. Power Output versus Collector Voltage

2

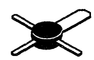
MRF555

The RF Line
NPN Silicon
RF Low Power Transistor

. . . designed primarily for wideband large signal predriver stages in the UHF frequency range.

- Specified @ 12.5 V, 470 MHz Characteristics @ P_{out} = 1.5 W
  Common Emitter Power Gain = 12.5 dB (Typ)
  Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

1.5 W, 470 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON



CASE 317D, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	400	mAdc
Operating Junction Temperature	T_J	150	°C
Total Device Dissipation @ T_C = 75°C (1, 2) Derate above 75°C	P_D	3.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

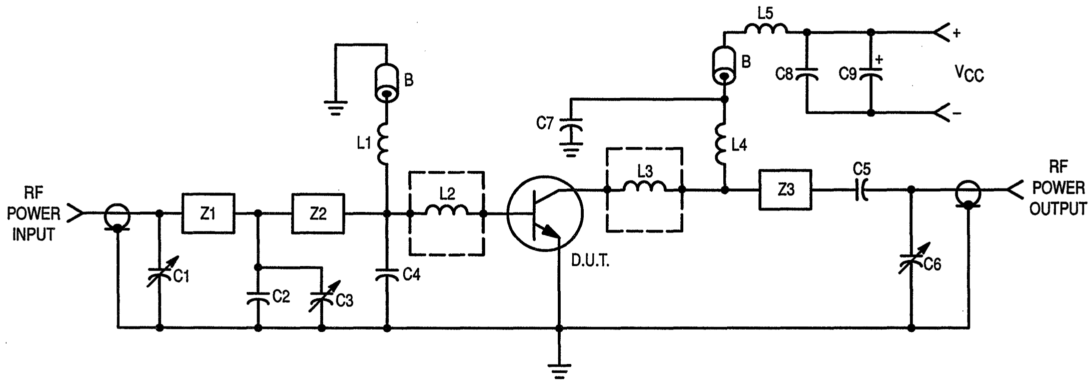
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.5	5.0	pF

(continued)

NOTES:
1. T_C, Case temperature measured on collector lead immediately adjacent to body of package.
2. The MRF555 PowerMacro must be properly mounted for reliable operation. AN938, “Mounting Techniques in PowerMacro Transistor,” discusses methods of mounting and heatsinking.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (f = 470 MHz)					
Common-Emitter Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W)	G_{pe}	11	12.5	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W)	η_c	50	60	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 125 mW, VSWR ≥ 10:1 all phase angles)	ψ	No Degradation in Output Power			



*C1, C3, C6 — 0.8–11 pF Johanson
C2 — 15 pF Clamped Mica, Mini-Underwood
C4 — 36 pF Clamped Mica, Mini-Underwood
C5 — 470 pF Ceramic Chip Capacitor
C7 — 91 pF Clamped Mica, Mini-Underwood
C8 — 68 pF Clamped Mica, Mini-Underwood
C9 — 1.0 µF, 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B

*Fixed tuned for broadband response

L1 — 5 Turns #21 AWG, 5/32″ I.D.
L2, L3 — 60 x 125 x 250 Mils Copper Pad on 27 Mil Thick Alumina Substrate
L4, L5 — 7 Turns #21 AWG 5/32″ I.D.
Z1 — 1.29″ x 0.16″ Microstrip
Z2 — 0.70″ x 0.16″ Microstrip
Z3 — 2.18″ x 0.16″ Microstrip

PCB — 1/16″ Glass Teflon, 1 oz. cu. clad, double sided, ε_r = 2.5
(See Figure 5 — Photomaster)

Figure 1. 400–512 MHz Broadband Circuit

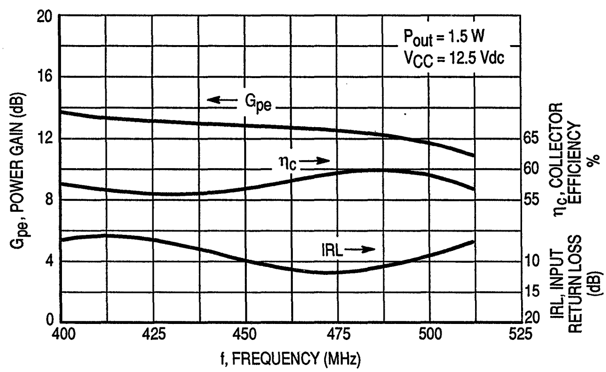


Figure 2. Performance in Broadband Circuit

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 100 mW	P_{in} = 50 mW	P_{out} 400 MHz = 1.5 W P_{out} 450 MHz = 1.35 W P_{out} 512 MHz = 1.05 W	P_{out} 400 MHz = 1.9 W P_{out} 450 MHz = 1.45 W P_{out} 512 MHz = 0.9 W
400	2.9 – j2.7	1.9 – j3.1	18.0 – j13.4	12.2 – j19.7
450	2.2 – j0.8	2.6 – j4.0	21.6 = j9.9	20.2 – j18.6
512	3.5 – j1.2	2.6 – j2.6	20.1 – j1.0	23.4 – j23.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Table 1. Z_{in} and Z_{OL} versus Collector Voltage, Input Power and Output Power

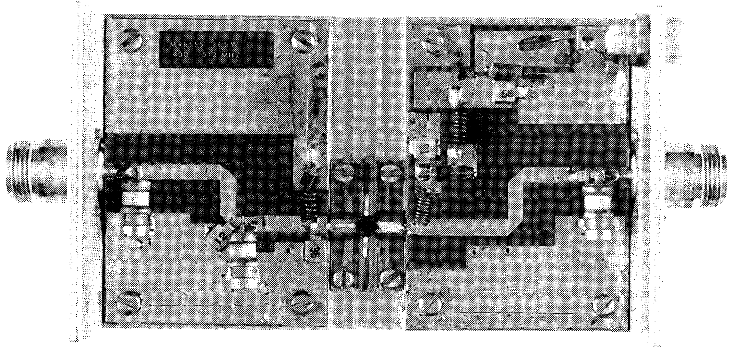
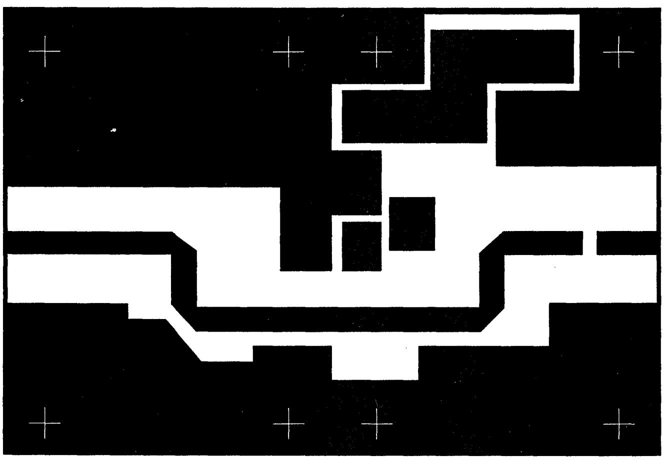


Figure 3. 400–512 MHz Broadband Circuit



SCALE 0.75:1

Figure 4. 400–512 MHz Broadband Circuit Photomaster

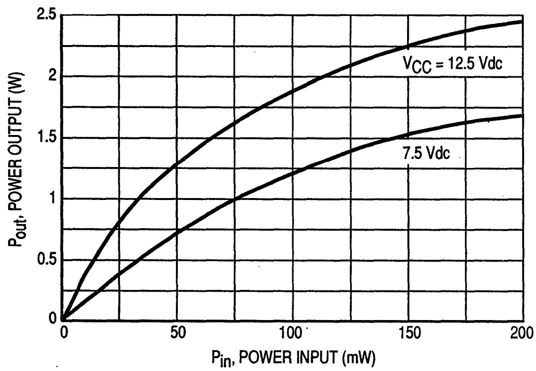


Figure 5. Power Output versus Power Input

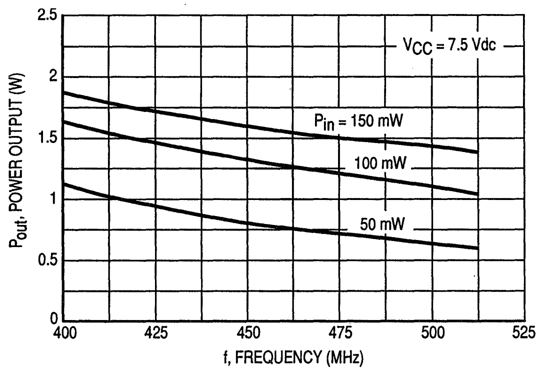


Figure 6. Power Output versus Frequency

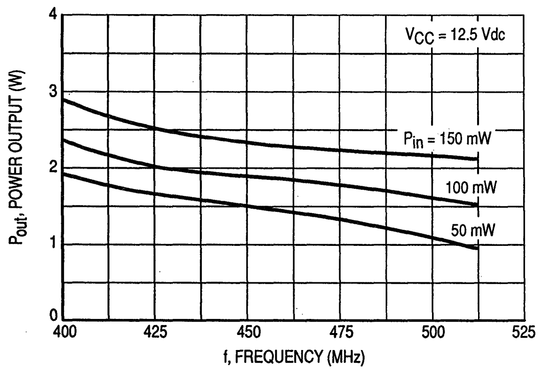


Figure 7. Power Output versus Frequency

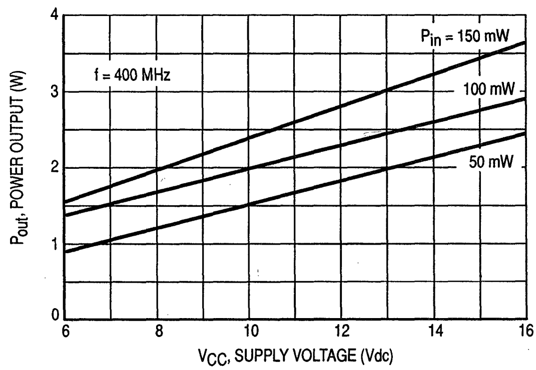


Figure 8. Power Output versus Supply Voltage

2

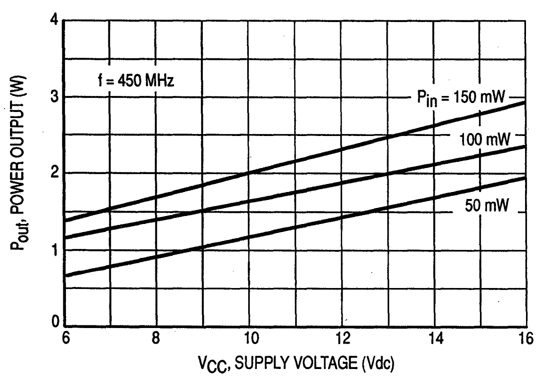


Figure 9. Power Output versus Supply Voltage

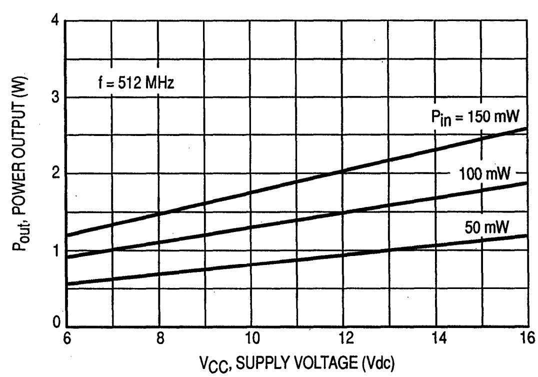


Figure 10. Power Output versus Supply Voltage

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

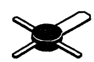
MRF557

The RF Line
NPN Silicon
RF Low Power Transistor

. . . designed primarily for wideband large signal predriver stages in the 800 MHz frequency range.

- Specified @ 12.5 V, 870 MHz Characteristics
  Output Power = 1.5 W
  Minimum Gain = 8.0 dB
  Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

1.5 W, 870 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON



CASE 317D, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_C = 75°C (1, 2) Derate above 75°C	P_D	3.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

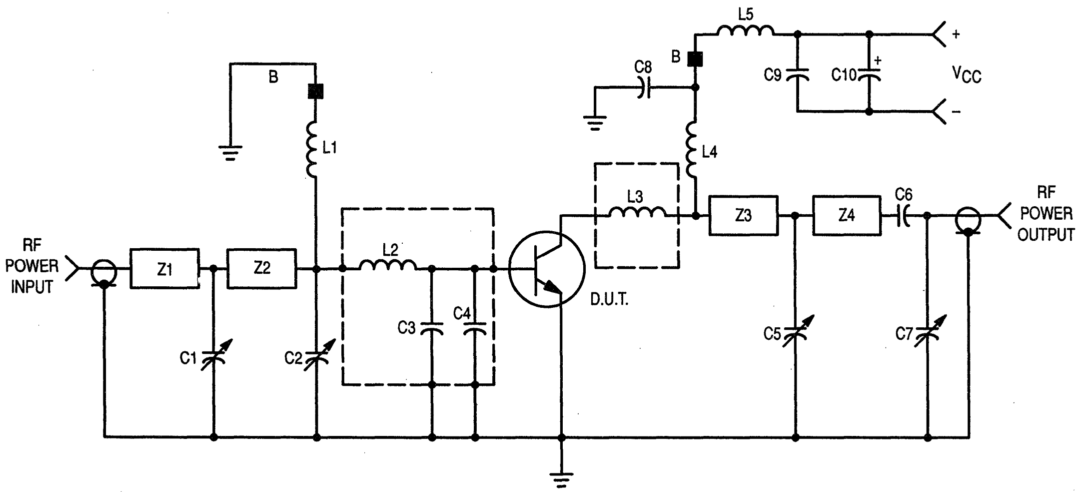
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.5	5.0	pF

NOTES:
1. T_C, Case temperature measured on collector lead immediately adjacent to body of package.
2. The MRF557 PowerMacro must be properly mounted for reliable operation. AN938, “Mounting Techniques in PowerMacro Transistor,” discusses methods of mounting and heatsinking.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 870 MHz)	Figures 1, 2	G_{pe}	8.0	9.0	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 870 MHz)	Figures 1, 2	η_C	55	60	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 225 mW, f = 870 MHz, VSWR ≥ 10:1 all phase angles)	Figures 1, 2	ψ	No Degradation in Output Power			



C1, C2, C5, C7 — 0.8–8.0 pF Johanson Gigatrim*
C3, C4 — 15 pF Clamped Mica, Mini-Underwood
C6 — 27 pF Clamped Mica, Mini-Underwood
C8 — 91 pF Clamped Mica, Mini-Underwood
C9 — 68 pF Clamped Mica, Mini-Underwood
C10 — 1.0 µF, 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B
PCB — 1/16″ Glass Teflon, ε_r = 2.56
(See Photomaster Figure 3)

L1, L4 — 5 Turns #21 AWG, 5/32″ ID
L2, L3 — 60 x 125 x 250 Mils Copper Tab on 27 Mil Thick Alumina Substrate
L5 — 7 Turns #21 AWG, 5/32″ ID
Z1 — 1.65 x 0.163″ Microstrip, Z_o = 50 Ω
Z2 — 0.85 x 0.163″ Microstrip, Z_o = 50 Ω
Z3 — 0.625 x 0.163″ Microstrip, Z_o = 50 Ω
Z4 — 1.35 x 0.163″ Microstrip, Z_o = 50 Ω

*Fixed tuned for broadband response.

Figure 1. 800–880 MHz Broadband Circuit

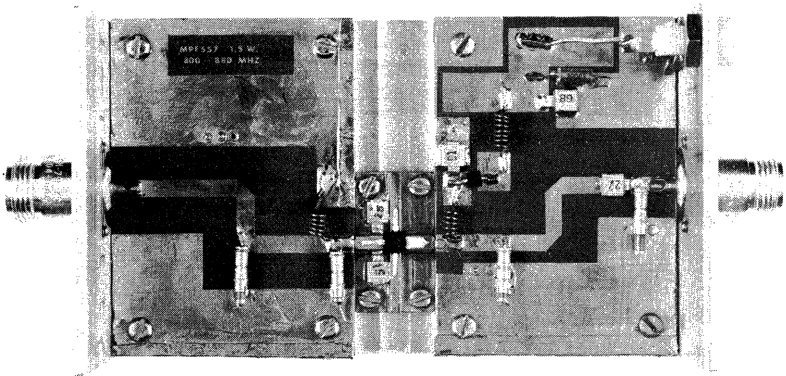
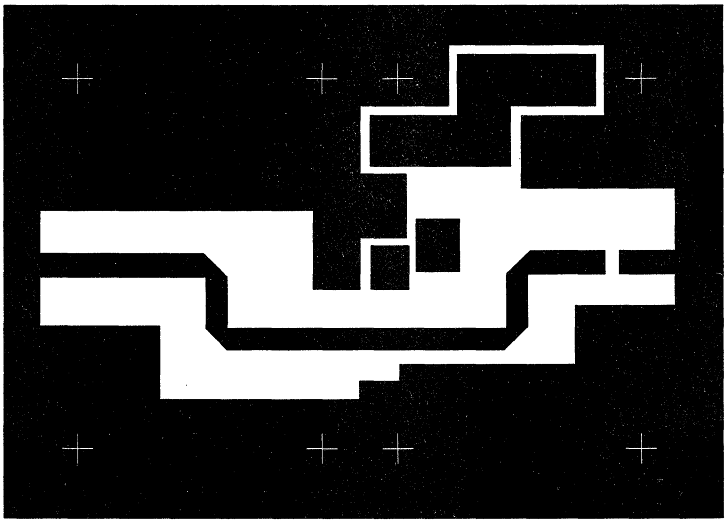


Figure 2. 800−880 MHz Broadband Circuit



SCALE 0.75:1

Figure 3. 800−880 MHz Test Circuit Photomaster

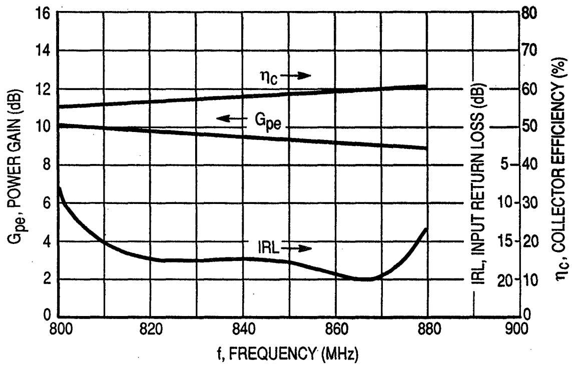


Figure 4. Performance in Broadband Circuit

2

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 300 mW	P_{in} = 200 mW	P_{out} 806 MHz = 1.7 W P_{out} 870 MHz = 1.4 W P_{out} 960 MHz = 1.0 W	P_{out} 806 MHz = 2.1 W P_{out} 870 MHz = 1.8 W P_{out} 960 MHz = 1.1 W
806	2.4 + j3.9	2.4 + j3.1	14.7 – j4.4	13.6 – j12.8
870	2.5 + j4.6	2.7 + j3.7	17.2 – j8.6	16 – j13.2
960	6.1 + j7.4	6.8 + j8.3	40 – j8.3	38 – j10.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Table 1. Z_{in} and Z_{OL} versus Collector Voltage, Input Power and Output Power

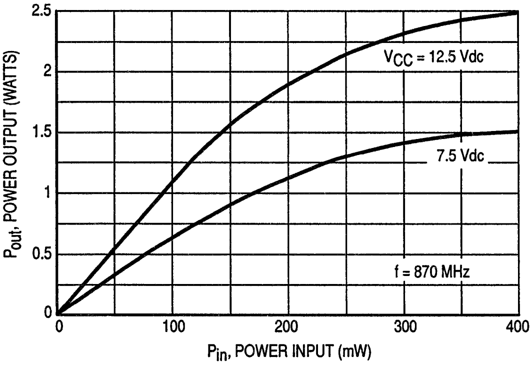


Figure 5. Power Output versus Power Input

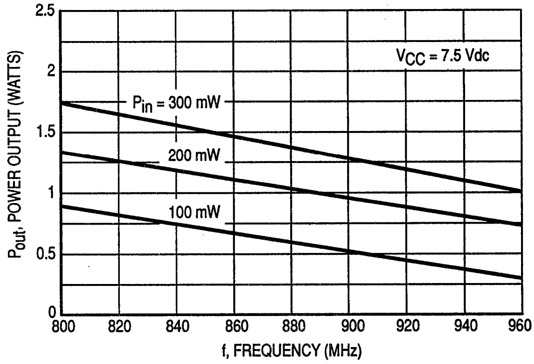


Figure 6. Power Output versus Frequency

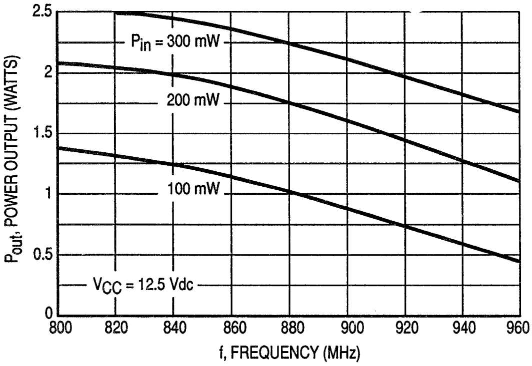


Figure 7. Power Output versus Frequency

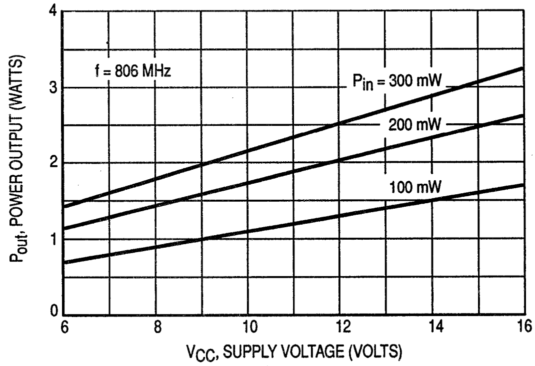


Figure 8. Power Output versus Supply Voltage

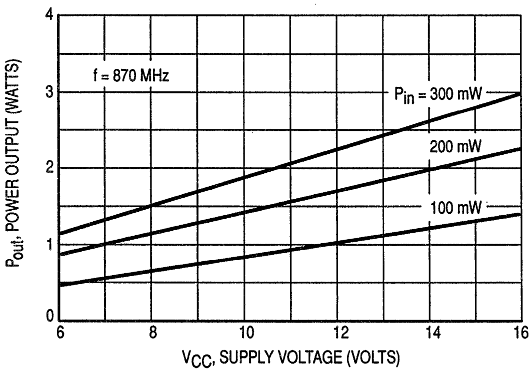


Figure 9. Power Output versus Supply Voltage

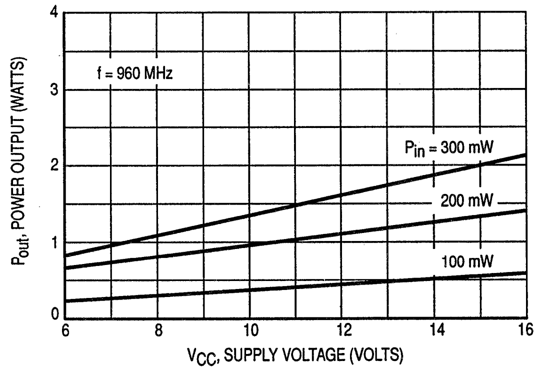


Figure 10. Power Output versus Supply Voltage

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

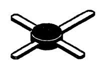
MRF559

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for UHF linear and large-signal amplifier applications.

- Specified 12.5 Volt, 870 MHz Characteristics —
  Output Power = 0.5 Watts
  Minimum Gain = 8.0 dB
  Efficiency 50%
- S Parameter Data From 250 MHz to 1.5 GHz
- 1.0 dB Compression > +20 dBm Typ
- Ideally Suited for Broadband, Class A, Low-Noise Applications
- Recommended As Driver for MHW808

**0.5 W, 870 MHz
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 317, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Device Dissipation @ T_C = 50°C Derate above 50°C	P_D	2.0 20	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 200 MHz)	f_T	—	3000	—	MHz
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	2.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W)	f = 870 MHz f = 512 MHz	G_{PE}	8.0 —	9.5 13	— —	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W)	f = 870 MHz f = 512 MHz	η	50 —	65 60	— —	%
TYPICAL PERFORMANCE @ V_{CC} = 7.5 V						
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W)	f = 870 MHz f = 512 MHz	G_{PE}	— —	6.5 10	— —	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W)	f = 870 MHz f = 512 MHz	η	— —	70 65	— —	%

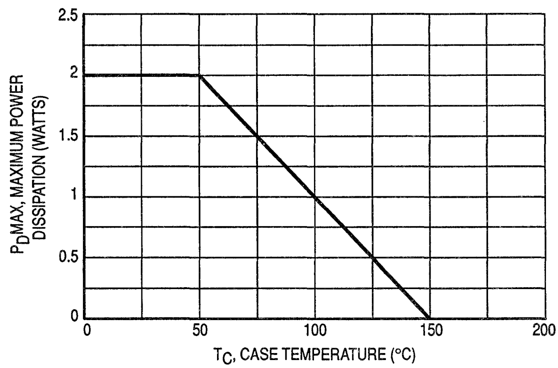
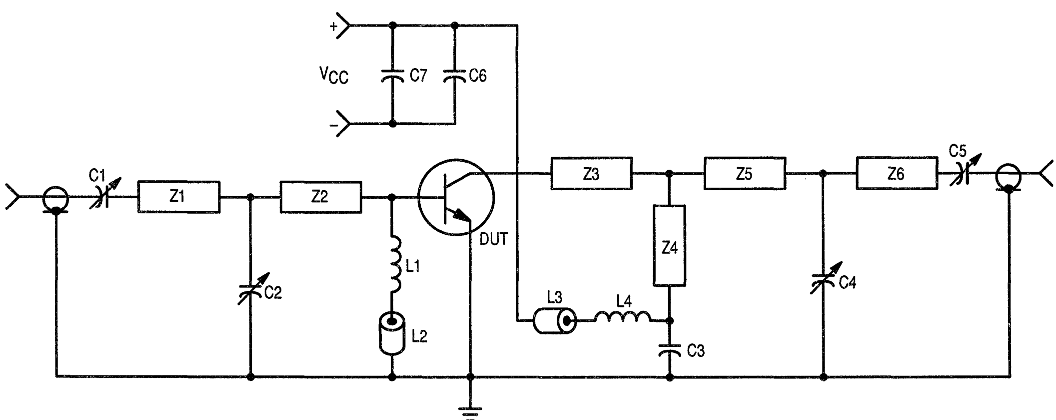


Figure 1. Power Dissipation



C1, C2, C4, C5 — 1.0–10 pF Johanson
C3, C6 — 0.001 μF Chip Capacitor
C7 — 1.0 μF Tantalum
L1, L4 — 4 Turns #26 AWG, 0.3 cm ID, 0.4 cm Long
L2, L3 — Ferrite Bead
Microstrip Elements — ε_r = 2.55

Z1 — 50 Ω 1.5 cm
Z2 — 30 Ω 2.5 cm
Z3 — 50 Ω 2.0 cm
Z4 — 50 Ω 1.2 cm
Z5, Z6 — 50 Ω 1.25 cm

Figure 2. 870 MHz Test Fixture

2

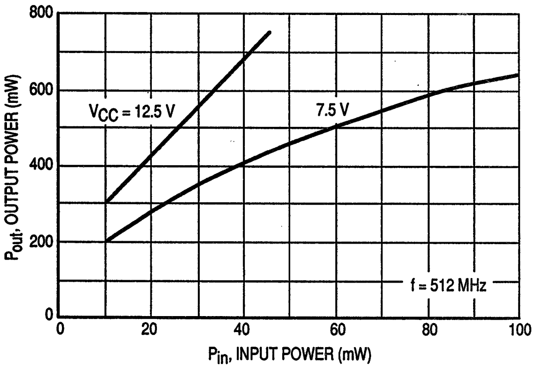


Figure 3. Output Power versus Input Power

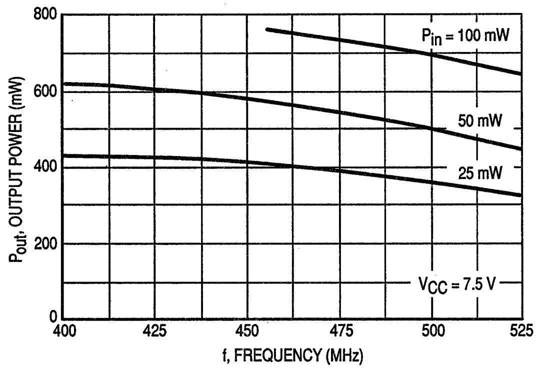


Figure 4. Output Power versus Frequency

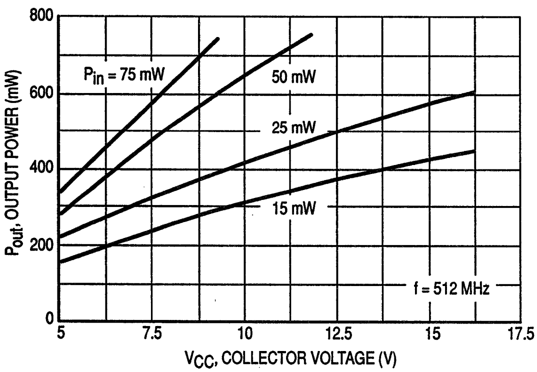


Figure 5. Output Power versus Collector Voltage

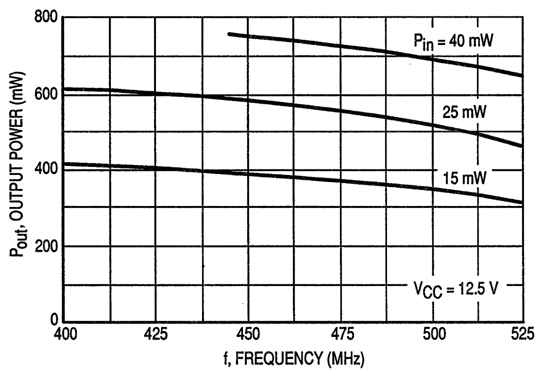


Figure 6. Output Power versus Frequency

2

f Frequency MHz	Z_{in} Ohms			Z_{OL}* Ohms					
	V_{CC} = 7.5–12.5 V			V_{CC} = 7.5 V			V_{CC} = 12.5 V		
	15 mW	25 mW	50 mW	0.25 W	0.5 W	0.75 W	0.25 W	0.5 W	0.75 W
400	4.3 – j13.3	4.9 – j11.0	5.7 – j8.7	31 – j49	44 – j34	42 – j4.9	20 – j68	42 – j60	52 – j54
440	3.9 – j8.8	4.5 – j8.7	5.4 – j6.9	27 – j42	39 – j30	40 – j6.9	19 – j62	37 – j54	49 – j50
480	3.5 – j4.4	4.1 – j6.5	5.0 – j4.3	24 – j36	36 – j25	39 – j9.0	18 – j56	33 – j48	47 – j46
520	3.2 – j2.2	3.8 – j4.3	4.7 – j1.7	22 – j30	34 – j20	37 – j12	17 – j52	31 – j44	47 – j42

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Table 1. Z_{in} and Z_{OL} versus Collector Voltage, Input Power, and Output Power

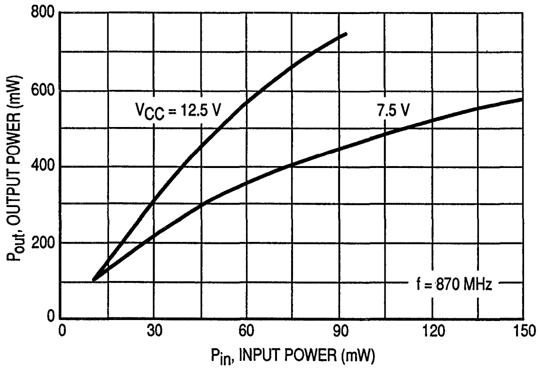


Figure 7. Output Power versus Input Power

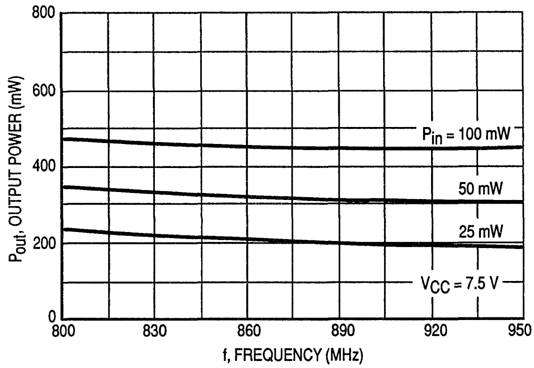


Figure 8. Output Power versus Frequency

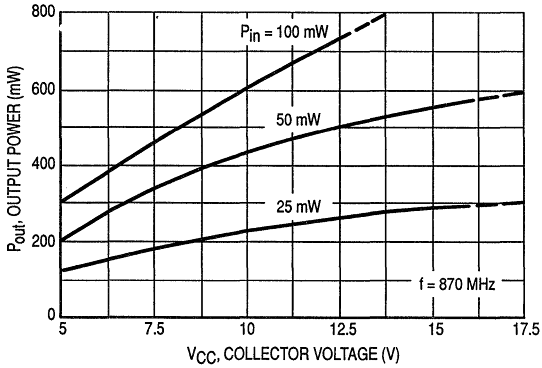


Figure 9. Output Power versus Collector Voltage

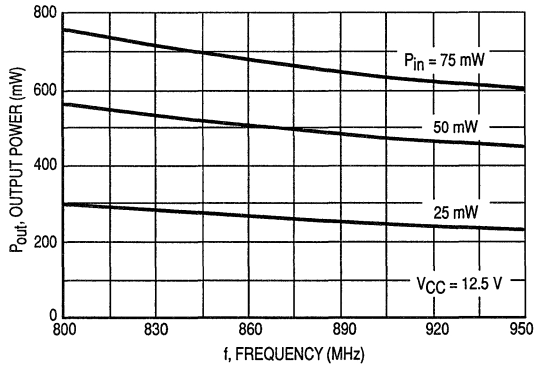
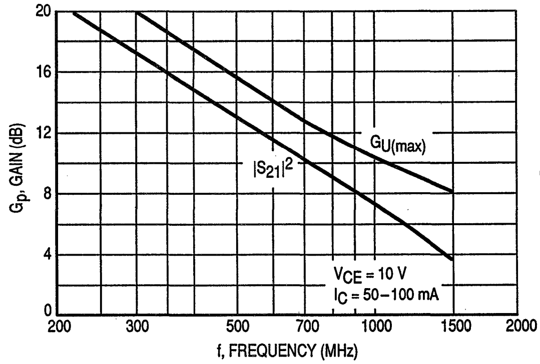


Figure 10. Output Power versus Frequency

f Frequency MHz	Z_{in} Ohms			Z_{OL}* Ohms					
	V_{CC} = 7.5–12.5 V			V_{CC} = 7.5 V			V_{CC} = 12.5 V		
	25 mW	50 mW	100 mW	0.25 W	0.5 W	0.75 W	0.25 W	0.5 W	0.75 W
800	2.9 + j2.2	3.8 + j4.4	4.7 + j6.5	15.0 – j36.8	22.7 – j30.6	27.1 – j22.6	14.6 – j43.6	17.2 – j39.7	23.4 – j37.7
850	3.2 + j3.5	3.8 + j5.2	4.8 + j7.4	15.7 – j35.3	23.9 – j28.7	27.3 – j21.5	16.3 – j40.8	17.8 – j39.5	23.7 – j36.8
900	3.8 + j5.7	4.4 + j7.0	5.4 + j8.7	16.4 – j33.7	25.1 – j27.0	27.5 – j20.5	17.3 – j38.2	18.3 – j39.3	23.9 – j36.0
950	4.1 + j7.4	4.5 + j8.8	5.5 + j10.1	17.0 – j32.2	26.3 – j25.2	27.6 – j19.4	17.2 – j36.1	20.1 – j38.5	24.5 – j35.6

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Table 2. Z_{in} and Z_{OL} versus Collector Voltage, Input Power, and Output Power



$$G_{U(max)} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

Figure 11. Gain versus Frequency

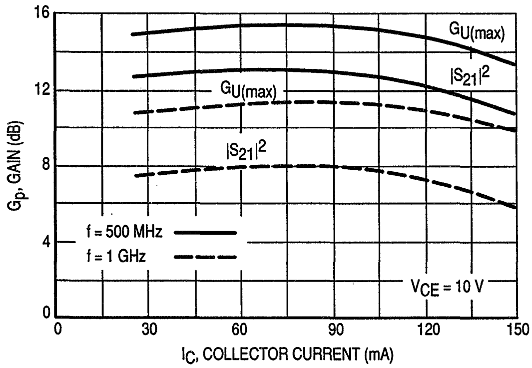


Figure 12. Gain versus Collector Current

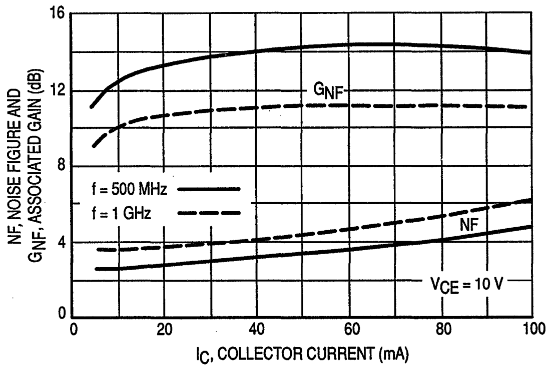


Figure 13. Noise Figure and Associated Gain versus Collector Current

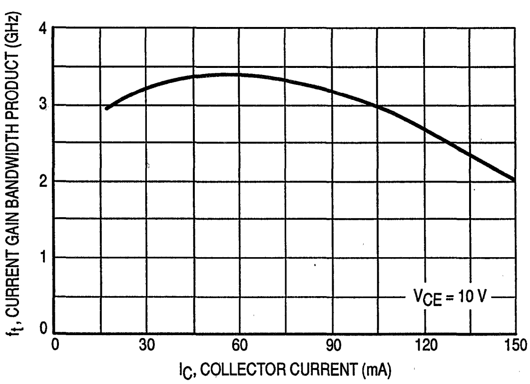


Figure 14. Current Gain Bandwidth Product versus Collector Current

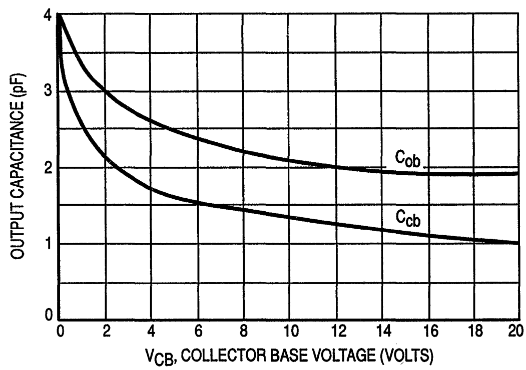


Figure 15. Output Capacitance versus Collector Base Voltage

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
5.0	10	250	0.72	−161	6.20	93	0.057	30	0.30	−91
		500	0.73	179	3.16	76	0.069	43	0.27	−94
		1000	0.76	158	1.62	55	0.105	63	0.27	−119
		1500	0.82	142	1.08	41	0.155	70	0.41	−137
	25	250	0.70	−173	7.17	89	0.045	47	0.26	−123
		500	0.70	172	3.63	75	0.073	60	0.20	−128
		1000	0.74	152	1.90	54	0.134	67	0.21	−157
		1500	0.79	136	1.32	39	0.196	66	0.32	−167
	50	250	0.72	−178	7.63	89	0.038	56	0.27	−139
		500	0.72	170	3.85	77	0.068	67	0.23	−141
		1000	0.75	153	2.01	59	0.129	72	0.23	−162
		1500	0.81	137	1.40	46	0.188	70	0.32	−164
	100	250	0.73	179	7.34	88	0.036	61	0.26	−143
		500	0.74	169	3.70	77	0.067	71	0.22	−144
		1000	0.76	153	1.94	59	0.130	74	0.24	−166
		1500	0.81	138	1.36	46	0.191	71	0.32	−167
	150	250	0.78	176	5.19	92	0.033	64	0.22	−131
		500	0.78	167	2.76	78	0.065	74	0.21	−131
		1000	0.80	151	1.49	58	0.129	77	0.24	−155
		1500	0.85	135	1.05	45	0.191	73	0.35	−161
10	10	250	0.69	−157	7.03	94	0.050	33	0.34	−67
		500	0.70	−178	3.59	77	0.060	46	0.32	−69
		1000	0.74	160	1.84	55	0.094	67	0.29	−94
		1500	0.81	142	1.20	41	0.148	76	0.42	−121
	25	250	0.67	−168	8.30	91	0.039	46	0.24	−93
		500	0.68	176	4.25	77	0.060	60	0.21	−89
		1000	0.72	158	2.19	57	0.109	71	0.19	−114
		1500	0.78	142	1.47	44	0.165	74	0.31	−134
	50	250	0.68	−174	8.88	90	0.035	55	0.21	−110
		500	0.68	172	4.49	77	0.060	67	0.18	−104
		1000	0.72	155	2.31	59	0.113	74	0.17	−128
		1500	0.77	139	1.58	46	0.169	74	0.28	−140
	100	250	0.68	−178	8.49	89	0.030	61	0.19	−104
		500	0.69	170	4.32	76	0.060	71	0.17	−97
		1000	0.72	153	2.25	58	0.120	76	0.17	−123
		1500	0.78	137	1.53	44	0.180	75	0.28	−137
	150	250	0.72	178	6.53	91	0.029	64	0.22	−71
		500	0.73	169	3.37	77	0.056	75	0.24	−75
		1000	0.76	152	1.79	57	0.112	80	0.22	−105
		1500	0.83	137	1.22	43	0.175	79	0.34	−129

Table 3. Common Emitter Scattering Parameters

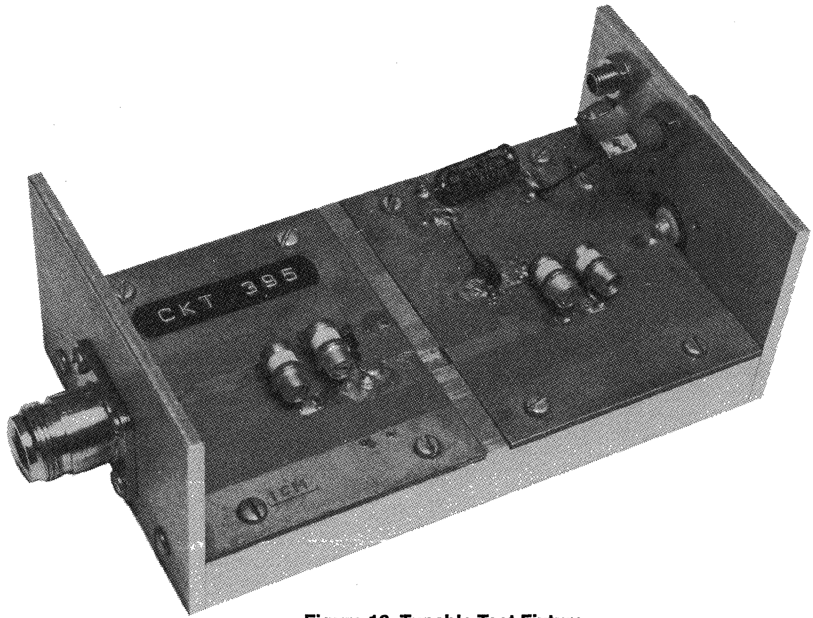


Figure 16. Tunable Test Fixture

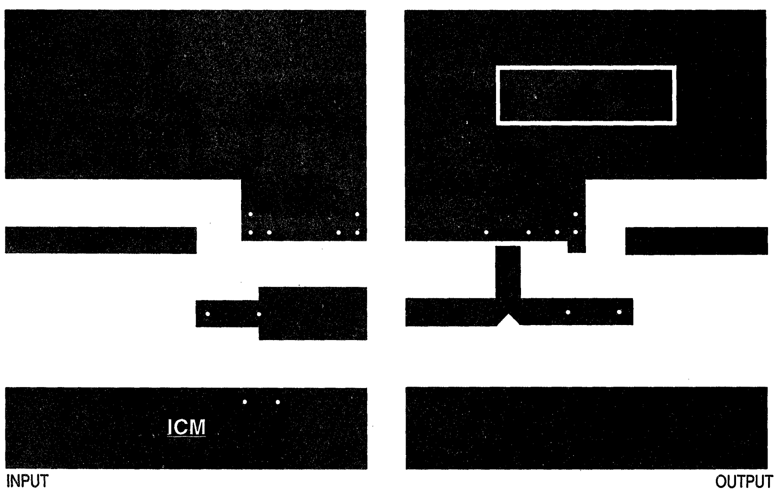


Figure 17. Printed Circuit Board Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

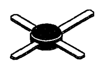
The RF Line
NPN Silicon High-Frequency Transistors

MRF571

. . . designed for low-noise, wide dynamic range front end amplifiers, low-noise VCO's, and microwave power multipliers.

- Low Noise
- High Gain
- Available in Low Cost Plastic, High Reliability Ceramic or Die
- State-of-the-Art Technology
  Fine Line Geometry
  Ion Implanted Arsenic Emitters
  Gold Top Metallization and Wires
  Silicon Nitride Passivation
- Fully Characterized

f_T = 8.0 GHz @ 50 mA
NF = 1.0 dB @ 500 MHz
NF = 1.5 dB @ 1.0 GHz
NF = 2.5 dB @ 2.0 GHz
HIGH-FREQUENCY TRANSISTORS
NPN SILICON



CASE 317, STYLE 2
MACRO-X

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_C = 50°C (1) Derate above 50°C	P_D	1.0 10	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)		$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_B = 0)		$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 8.0 Vdc, I_E = 0)		I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 6.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	0.7	1.0	pF
Current-Gain — Bandwidth Product (V_{CE} = 8.0 Vdc, I_C = 50 mA, f = 1.0 GHz)		f_T	—	8.0	—	GHz
FUNCTIONAL TESTS						
Gain @ Noise Figure (I_C = 10 mAdc, V_{CE} = 6.0 Vdc)	f = 0.5 GHz f = 1.0 GHz	G_{NF}	— 10	16.5 12	— —	dB
Noise Figure (I_C = 10 mAdc, V_{CE} = 6.0 Vdc)	f = 0.5 GHz f = 1.0 GHz f = 2.0 GHz	NF	— — —	1.0 1.5 2.8	— 2.0 —	dB

NOTE:
1. Case temperature measured on collector lead immediately adjacent to body of package.

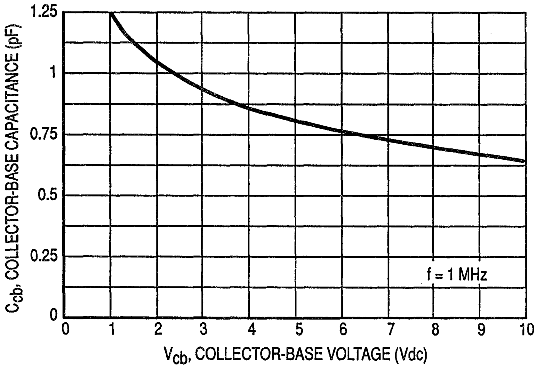


Figure 1. C_{cb}, Collector-Base Capacitance versus Voltage

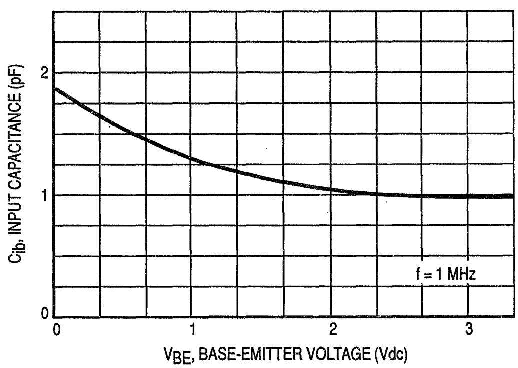


Figure 2. C_{ib}, Input Capacitance versus Emitter Base Voltage

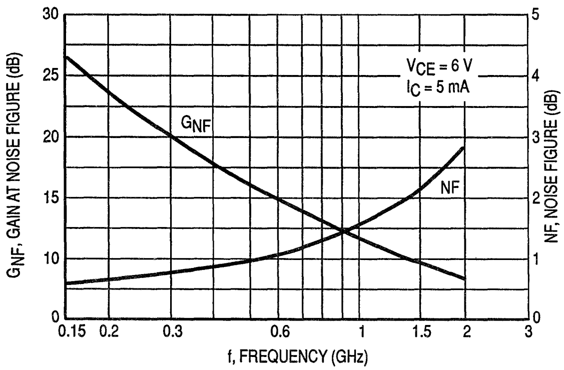


Figure 3. Gain at Noise Figure and Noise Figure versus Frequency

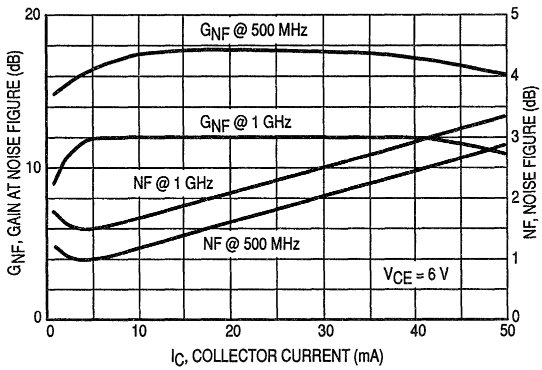


Figure 4. Gain at Noise Figure and Noise Figure versus Collector Current

2

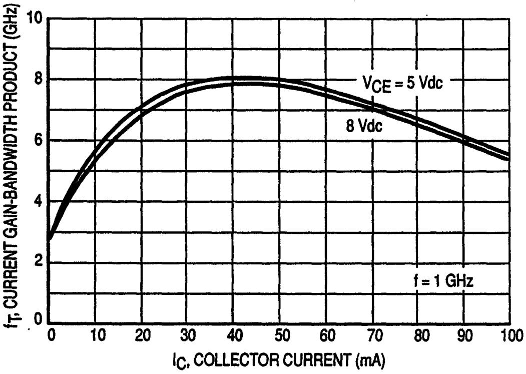


Figure 5. f_T, Current Gain-Bandwidth Product versus Collector Current

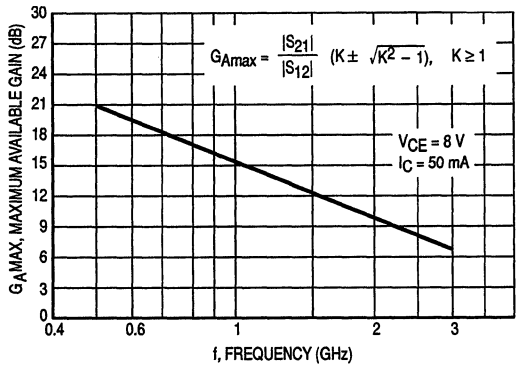


Figure 6. G_{Amax}, Maximum Available Gain versus Frequency

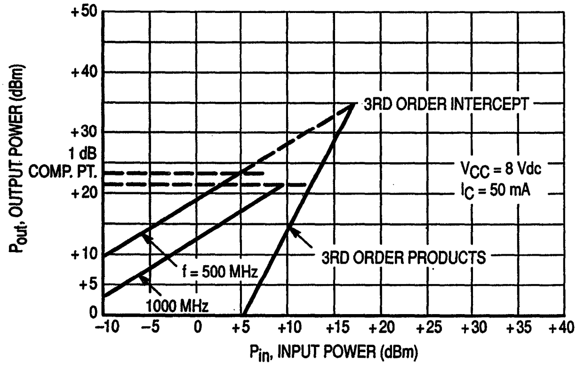


Figure 7. 1.0 dB Compression Point and Third Order Intercept

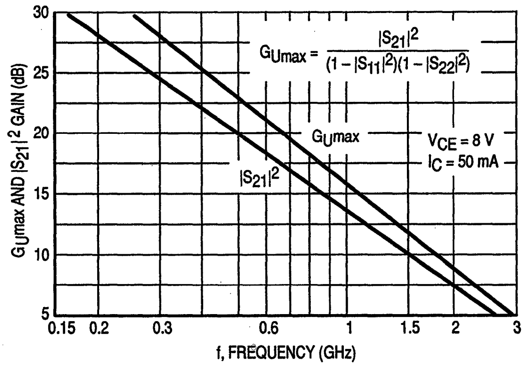


Figure 8. G_{Umax} and $|S_{21}|^2$ versus Frequency

2

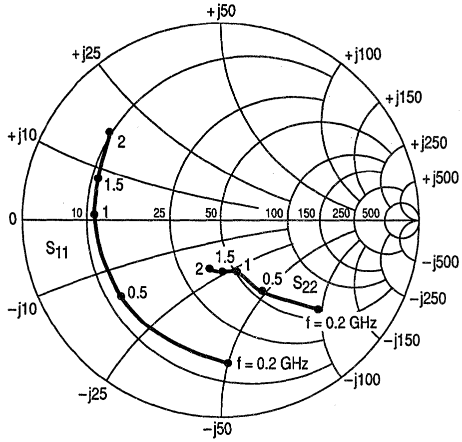


Figure 9. Input/Output Reflection Coefficients versus Frequency (GHz) V_{CE} = 6.0 V, I_C = 5.0 mA

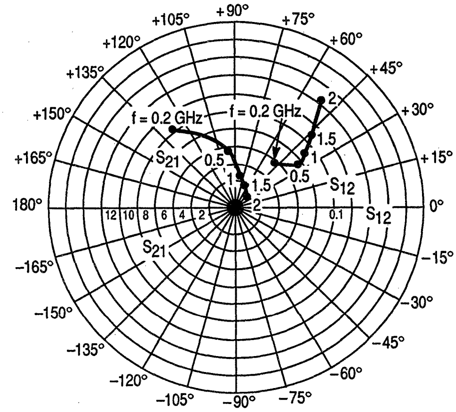
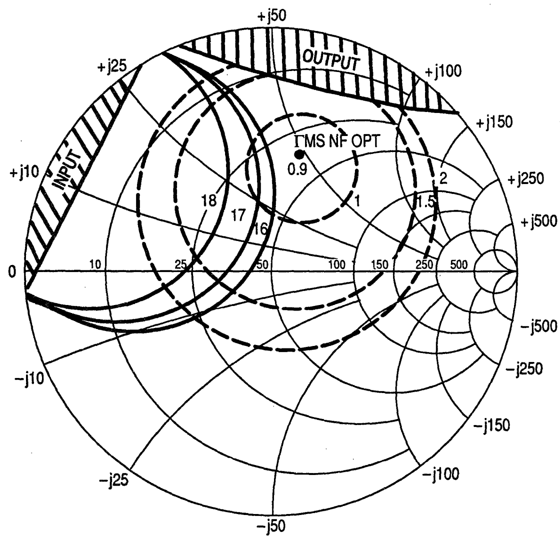


Figure 10. Forward/Reverse Transmission Coefficients versus Frequency (GHz) V_{CE} = 6.0 V, I_C = 5.0 mA

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
6.0	5	200	0.74	−86	10.5	129	0.06	48	0.69	−42
		500	0.62	−143	5.5	97	0.08	33	0.41	−59
		1000	0.61	178	3.0	78	0.09	37	0.28	−69
		1500	0.65	158	2.0	62	0.11	44	0.26	−88
		2000	0.70	140	1.6	51	0.14	51	0.27	−99
	10	200	0.64	−111	15	118	0.04	44	0.53	−59
		500	0.58	−160	6.9	93	0.06	42	0.27	−77
		1000	0.59	168	3.7	77	0.09	52	0.16	−91
		1500	0.63	151	2.5	64	0.12	56	0.16	−113
		2000	0.67	134	2.0	53	0.16	57	0.16	−118
	50	200	0.56	−160	20.4	102	0.02	57	0.27	−98
		500	0.57	176	8.4	86	0.05	67	0.14	−130
		1000	0.60	156	4.4	75	0.09	70	0.11	−164
		1500	0.62	152	2.9	64	0.13	68	0.13	−175
		2000	0.66	127	2.4	53	0.18	62	0.11	−178
8.0	5	200	0.75	−83	10.7	129	0.06	49	0.71	−39
		500	0.62	−140	5.1	98	0.08	34	0.43	−54
		1000	0.60	−179	3.7	78	0.09	38	0.31	−62
		1500	0.64	159	2.1	62	0.10	45	0.29	−80
		2000	0.69	141	1.7	52	0.13	52	0.29	−91
	10	200	0.64	−99	15.1	120	0.05	46	0.54	−60
		500	0.52	−152	7.1	94	0.07	45	0.32	−75
		1000	0.52	170	3.7	76	0.10	54	0.15	−82
		1500	0.52	150	2.5	62	0.13	56	0.16	−108
		2000	0.57	133	2.0	51	0.18	55	0.16	−107
	50	200	0.52	−153	19.6	102	0.03	56	0.28	−92
		500	0.52	178	8.1	86	0.05	67	0.16	−98
		1000	0.56	157	4.1	73	0.10	70	0.06	−130
		1500	0.54	139	2.8	62	0.13	68	0.11	−146
		2000	0.59	126	2.2	52	0.19	63	0.10	−137

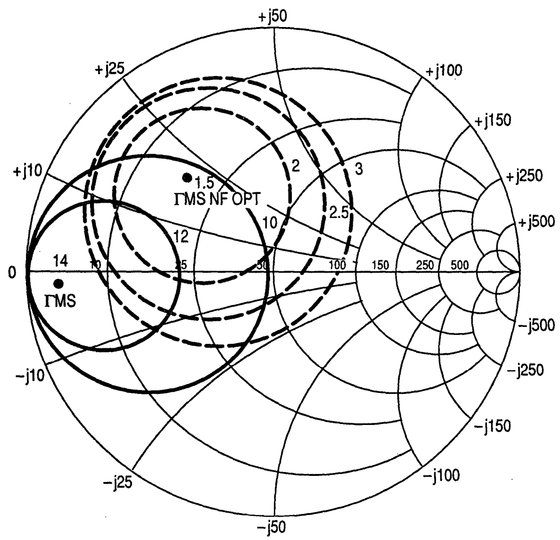
Table 1. Common Emitter S-Parameters



V_{CE} = 6.0 V, I_C = 5.0 mA
f = 500 MHz
▨ — REGION OF INSTABILITY

f (GHz)	NF OPT (dB)	Rn (Ω)	NF50 Ω (dB)
0.5	0.9	9.3	1.3

ΓMS NF OPT	K
0.49 ∠ 74°	0.58

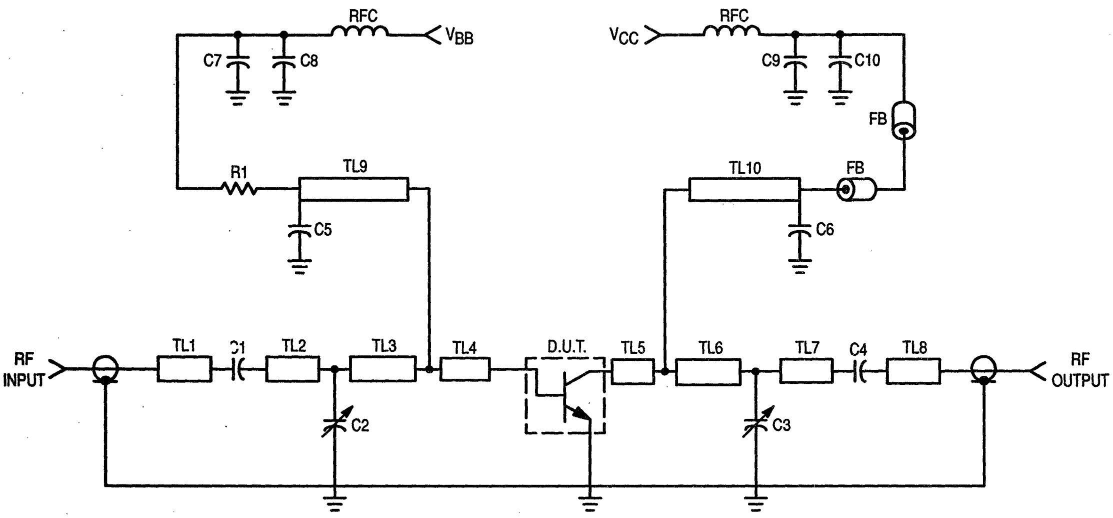


V_{CE} = 6.0 V, I_C = 5.0 mA
f = 1.0 GHz

f (GHz)	NF OPT (dB)	Rn (Ω)	NF50 Ω (dB)	ΓMS NF OPT
1.0	1.5	7.5	2.2	0.48 ∠ 134°

ΓMS	ΓML
0.89 ∠ −179°	0.81 ∠ 66°

Figure 11. Constant Gain and Noise Figure Contours



C1, C4, C5, C6, C8, C9 — 100 pF Chip Capacitor
C2, C3 — 0.8–8.0 pF Johanson Capacitor
C7, C10 — 10 µF Tantalum Capacitor
R1 — 1.0 kOhms Res.
RFC — VK-200, Ferroxcube
FB — Ferrite Bead, Ferroxcube 56-590-65/3B
Board Material — 0.0625″ Glass Teflon, $\varepsilon_r = 2.55$

TL1, TL7, TL8 — Microstrip 0.162″ x 0.600″
TL2 — Microstrip 0.162″ x 1.060″
TL3 — Microstrip 0.162″ x 0.700″
TL4, TL5 — Microstrip 0.162″ x 0.440″
TL6 — Microstrip 0.162″ x 1.140″
TL8, TL9 — Microstrip 0.020″ x 2.130″

Figure 12. Test Circuit Schematic

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF581
MRF581A

The RF Line
NPN Silicon High-Frequency Transistors

. . . designed for high current low power amplifiers up to 1.0 GHz.

- Low Noise (2.0 dB @ 500 MHz)
- Low Intermodulation Distortion
- High Gain
- State-of-the-Art Technology
  - Fine Line Geometry
  - Arsenic Emitters
  - Gold Top Metallization
  - Nichrome Thin-Film Ballasting Resistors
- Excellent Dynamic Range
- Fully Characterized
- High Current-Gain Bandwidth Product (f_τ = 5.0 GHz @ I_C = 75 mA)

I_C = 200 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTORS
NPN SILICON

CASE 317, STYLE 2
MRF581,A

2

MAXIMUM RATINGS

Rating	Symbol	MRF581	MRF581A	Unit
Collector-Emitter Voltage	V_{CEO}	18	15	Vdc
Collector-Base Voltage	V_{CBO}	36	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5		Vdc
Collector Current — Continuous	I_C	200		mAdc
Thermal Resistance θJC (1)	$R_{\theta JC}$	40		°C/W
Thermal Resistance θJC (2)	$R_{\theta JC}$	100		°C/W
Total Device Dissipation @ T_C = 50°C Derate above T_C = 50°C	P_D	2.5 25		Watts mW/°C
Total Device Dissipation @ T_C = 25°C (1) Derate above T_C = 25°C	P_D	1.25 10		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	– 65 to +150		°C

NOTES:
1. Case temperature measured on collector lead immediately adjacent to body of package.
2. Part mounted on 0.062″ G10 board material, collector pad area 110 x 700 mils.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	MRF581 MRF581A	$V_{(BR)CEO}$	18 15	— —	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	MRF581 MRF581A	$V_{(BR)CBO}$	36 30	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Emitter Cutoff Current (V_{EB} = 2.0 Vdc, V_{BE} = 0)		I_{EBO}	—	—	100	µAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	100	µAdc
ON CHARACTERISTICS						
DC Current Gain (1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	MRF581 MRF581A	h_{FE}	50 90	— —	200 250	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	1.4	2.0	pF
Current-Gain Bandwidth Product (2) (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		f_T	—	5.0	—	GHz
FUNCTIONAL TESTS						
Noise Figure (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF581 MRF581A	NF	— —	2.0 1.8	3.0 2.5	dB
Power Gain at Optimum Noise Figure (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF581,A	G_{NF}	13	15.5	—	dB
Maximum Unilateral Gain (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF581,A (2)	$G_{U\,max}$	—	17	—	dB
Intermodulation Distortion (V_{CE} = 10 V, I_C = 75 mA, V_{out} = +50 dBmV)	MRF581,A (3)	IMD(d3)	—	−65	—	dB

NOTES:
1. 300 µs pulse on Tektronix 576 or equivalent.
2. Characterized on HP8542 Automatic Network Analyzer.
3. 2 Tones, f1 = 497 MHz, f2 = 503 MHz, 3rd Order Single Tone reference.

$$G_{Umax} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$$

2

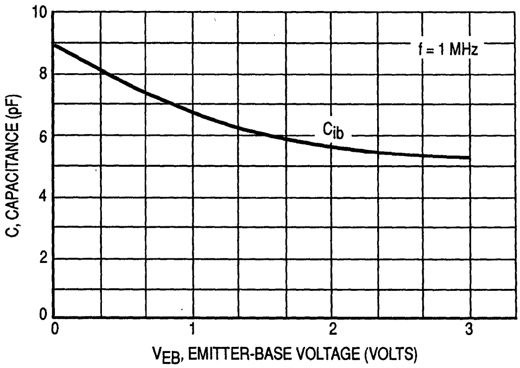


Figure 1. C_{ib} Input Capacitance versus Voltage

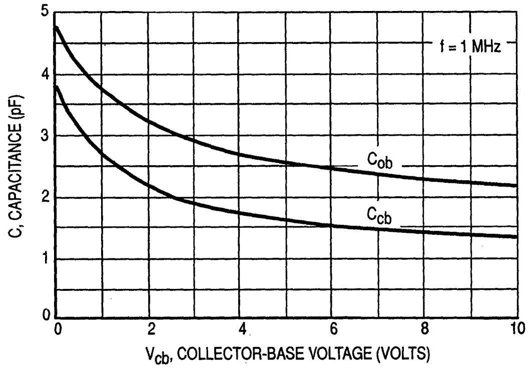


Figure 2. C_{cb}, C_{ob} Collector-Base Capacitance versus Voltage

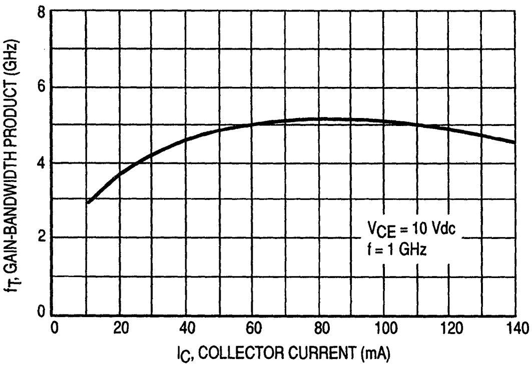


Figure 3. Gain-Bandwidth Product versus Collector Current

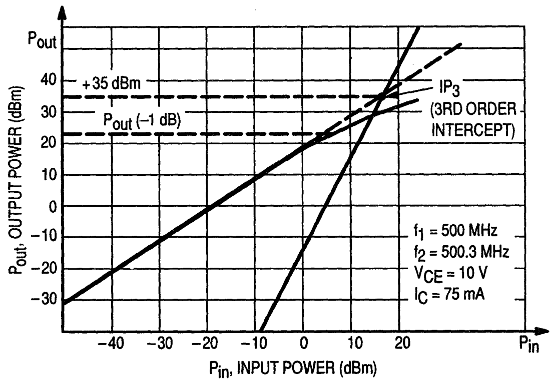


Figure 4. 3rd Order Intercept Point

2

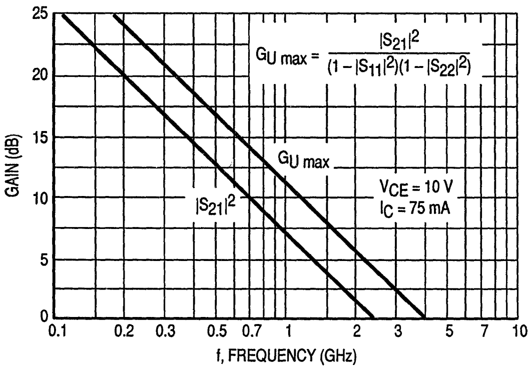


Figure 5. $G_{U\,max}$ — Maximum Unilateral Gain, $|S_{21}|^2$ versus Frequency

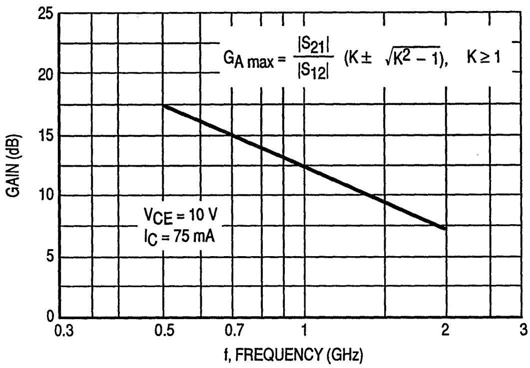


Figure 6. $G_{A\,max}$, Maximum Available Gain versus Frequency

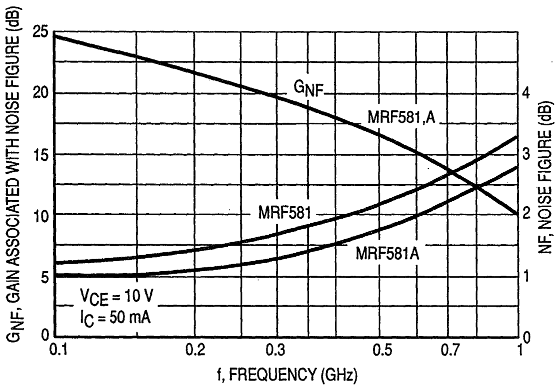


Figure 7. Noise Figure and Gain Associated with Noise Figure versus Frequency

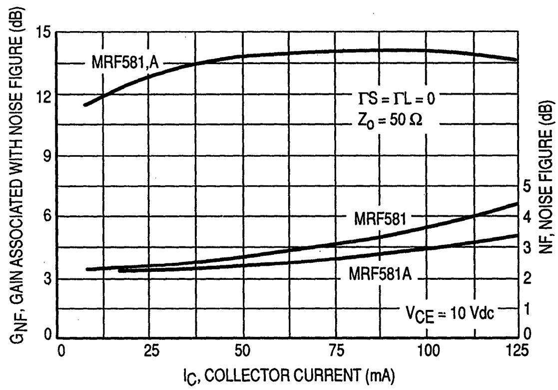


Figure 8. Noise Figure and Gain Associated with Noise Figure versus Collector Current f = 500 MHz

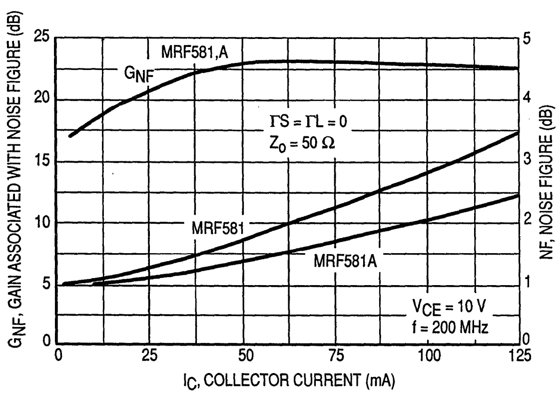


Figure 9. Noise Figure and Gain Associated with Noise Figure versus Collector Current

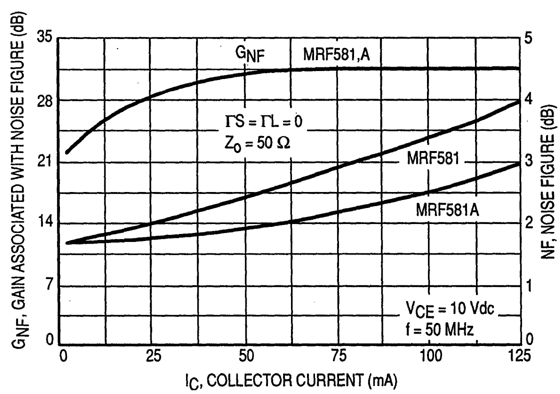


Figure 10. Noise Figure and Gain Associated with Noise Figure versus Collector Current

2

V_{CE} = 10 V I_C = 50 mA

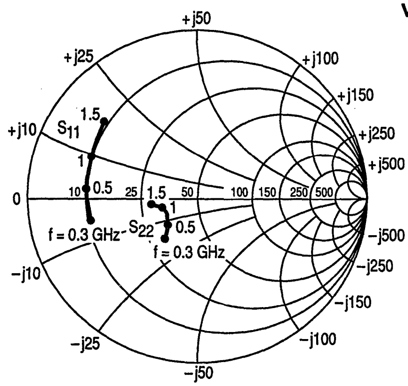


Figure 11. Input/Output Reflection Coefficient versus Frequency

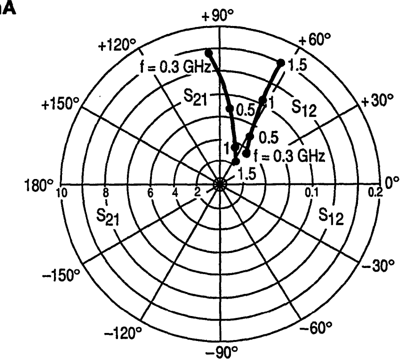
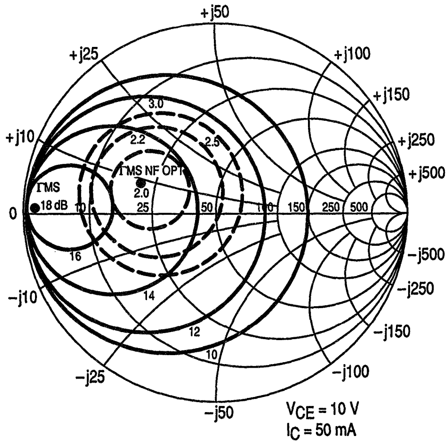


Figure 12. Forward/Reverse Transmission Coefficients versus Frequency

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
5.0	25	300	0.69	−169	6.57	93	0.06	39	0.34	−129
		500	0.72	176	3.95	82	0.07	47	0.29	−142
		1000	0.73	157	2.10	62	0.12	60	0.27	−165
		1500	0.76	139	1.47	50	0.17	61	0.33	−172
	50	300	0.70	−173	7.14	93	0.05	45	0.38	−144
		500	0.72	173	4.27	82	0.07	53	0.34	−157
		1000	0.72	157	2.24	65	0.13	62	0.33	179
		1500	0.76	138	1.61	53	0.18	61	0.37	173
	75	300	0.70	−175	7.26	92	0.05	48	0.40	−148
		500	0.72	172	4.33	82	0.07	55	0.37	−161
		1000	0.72	155	2.28	65	0.13	63	0.30	176
		1500	0.76	138	1.64	53	0.19	61	0.39	170
	100	300	0.70	−176	7.30	92	0.05	48	0.40	−151
		500	0.72	172	4.34	82	0.07	56	0.37	−163
		1000	0.72	155	2.28	65	0.13	63	0.36	175
		1500	0.75	137	1.64	53	0.19	61	0.39	168
10	25	300	0.66	−165	7.58	95	0.05	40	0.29	−106
		500	0.69	178	4.56	82	0.07	48	0.23	−116
		1000	0.70	159	2.39	64	0.11	61	0.19	−141
		1500	0.74	141	1.65	50	0.16	64	0.26	−153
	50	300	0.65	−169	8.25	94	0.05	46	0.30	−126
		500	0.68	175	4.96	82	0.07	54	0.24	−138
		1000	0.69	157	2.60	65	0.12	63	0.22	−164
		1500	0.72	139	1.82	52	0.17	63	0.27	−171
	75	300	0.66	−171	8.49	93	0.05	48	0.30	−132
		500	0.68	175	5.06	82	0.07	55	0.25	−145
		1000	0.69	157	2.64	65	0.12	64	0.23	−170
		1500	0.72	139	1.86	53	0.17	63	0.27	−176
	100	300	0.66	−172	8.46	93	0.05	49	0.30	−134
		500	0.68	174	5.06	82	0.07	56	0.25	−147
		1000	0.68	157	2.64	65	0.12	64	0.23	−172
		1500	0.72	139	1.86	52	0.17	63	0.27	−177
15	25	300	0.65	−163	7.96	95	0.05	40	0.28	−92
		500	0.67	179	4.82	82	0.06	48	0.21	−98
		1000	0.68	160	2.51	63	0.11	62	0.17	−119
		1500	0.72	141	1.73	49	0.16	65	0.24	−137
	50	300	0.64	−167	8.76	94	0.0	46	0.26	−112
		500	0.66	177	5.37	82	0.06	54	0.20	−122
		1000	0.67	159	2.75	65	0.11	64	0.16	−148
		1500	0.71	141	1.91	51	0.16	64	0.22	−157
	75	300	0.64	−168	8.93	93	0.05	47	0.25	−117
		500	0.66	176	5.34	82	0.06	55	0.20	−128
		1000	0.69	158	2.78	65	0.11	65	0.16	−154
		1500	0.70	140	1.93	51	0.16	64	0.22	−162
	100	300	0.64	−169	8.91	93	0.05	48	0.25	−117
		500	0.66	176	5.33	82	0.06	56	0.19	−129
		1000	0.67	158	2.78	64	0.11	65	0.16	−154
		1500	0.70	140	1.93	51	0.16	64	0.21	−160

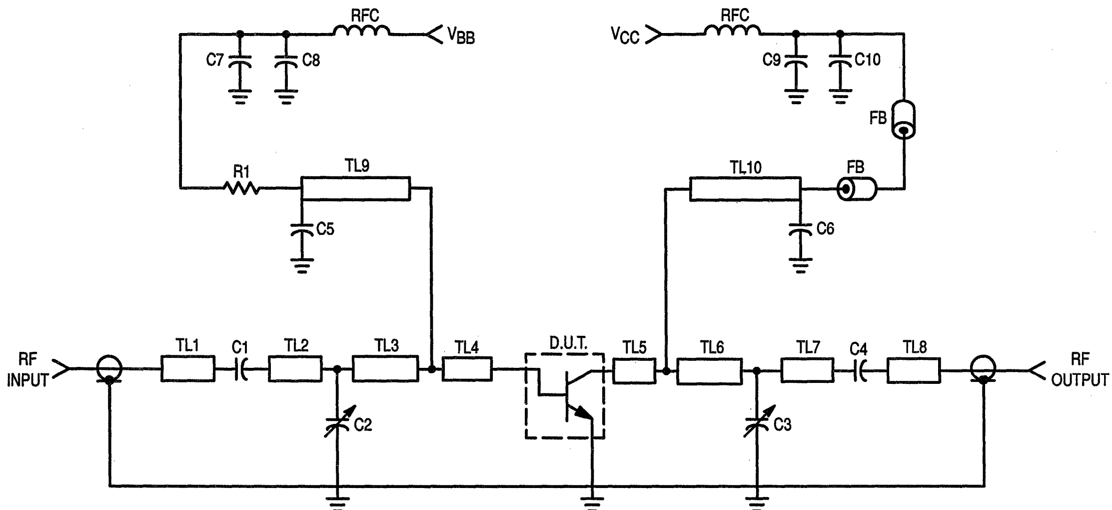
Table 1. MRF581,A Common Emitter S-Parameters



f (MHz)	ΓMS	ΓML	ΓMS NF OPT	G_AMAX (dB)	Rn (Ω)	NF OPT	NF (50 Ω)
500	0.91 ∠ 176°	0.78 ∠ 77°	0.39 ∠ 159°	18	10.5	2.0	2.5

Circuit Per Figure 14

Figure 13. MRF581 Constant Gain Contours Noise Figure Contours



C1, C4, C5, C6, C8, C9 — 1000 pF Chip Capacitor
C2, C3 — 1.0–10 pF Johanson Capacitor
C7, C10 — 10 μF Tantalum Capacitor
R1 — 1.0 kΩ Res.
RFC — VK-200, Ferroxcube
FB — Ferrite Bead, Ferroxcube, 56-590-65/3B
Board Material — 0.0625″ Thick Glass Teflon ε_r = 2.55

TL1, TL7, TL8 — Microstrip 0.162″ x 0.600″
TL2 — Microstrip 0.162″ x 1.000″
TL3 — Microstrip 0.162″ x 0.800″
TL4 — Microstrip 0.162″ x 0.440″
TL5 — Microstrip 0.120″ x 0.440″
TL6 — Microstrip 0.120″ x 1.160″
TL9, TL10 — Microstrip 0.025″ x 4.250″

Figure 14. MRF581 Test Fixture Schematic

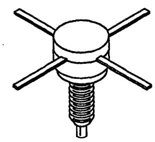
MRF587

The RF Line
NPN Silicon High-Frequency Transistor

NF = 3.0 dB @ 0.5 GHz
HIGH-FREQUENCY TRANSISTOR
NPN SILICON

. . . designed for use in high-gain, low-noise, ultra-linear, tuned and wideband amplifiers. Ideal for use in CATV, MATV, and instrumentation applications.

- Low Noise Figure —
  NF = 3.0 dB (Typ) @ f = 500 MHz, I_C = 90 mA
- High Power Gain —
  $G_{U(max)}$ = 16.5 dB (Typ) @ f = 500 MHz
- Ion Implanted
- All Gold Metal System
- High f_T — 5.5 GHz
- Low Intermodulation Distortion:
  TB_3 = –70 dB
  DIN = 125 dB µV
- Nichrome Emitter Ballast Resistors



CASE 244A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	17	Vdc
Collector-Base Voltage	V_{CBO}	34	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 50°C Derate above T_C = 50°C	P_D	5.0 33	Watts mW/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Junction Temperature	T_J	200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	17	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	34	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 0, I_E = 0.1 mAdc)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	µAdc
ON CHARACTERISTICS					
DC Current Gain (1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	—	200	—

NOTE:
1. 300 µs pulse on Tektronix 576 or equivalent.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (2) (I_C = 90 mAdc, V_{CE} = 15 Vdc, f = 0.5 GHz)	f_T	—	5.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	1.7	2.2	pF
FUNCTIONAL TESTS					
Narrowband — Figure 15 (I_C = 90 mA, V_{CC} = 15 V, f = 0.5 GHz)					dB
Noise Figure	NF	—	3.0	4.0	
Power Gain at Optimum Noise Figure	G_{NF}	11	13	—	
Broadband — Figure 16 (I_C = 90 mA, V_{CC} = 15 V, f = 0.3 GHz)					dB
Noise Figure	NF	—	6.3	—	
Power Gain at Optimum Noise Figure	G_{NF}	—	11	—	
Triple Beat Distortion (I_C = 50 mA, V_{CC} = 15 V, P_{Ref} = 50 dBmV) (I_C = 90 mA, V_{CC} = 15 V, P_{Ref} = 50 dBmV)	TB_3	—	−70	—	dB
DIN 45004 (I_C = 90 mA, V_{CC} = 15 V) (I_C = 90 mA, V_{CC} = 15 V)	DIN	—	125	—	dBμV
Maximum Available Power Gain (3) (I_C = 90 mA, V_{CE} = 15 Vdc, f = 0.5 GHz)	G_{Umax}	—	16.5	—	dB

2

NOTES:
2. Characterized on HP8542 Automatic Network Analyzer

3. $G_{Umax} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

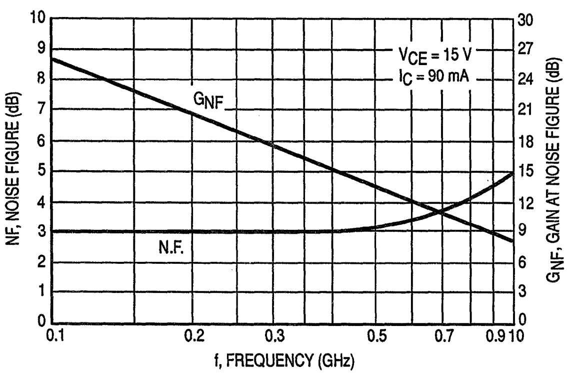


Figure 1. Typical Noise Figure and Associated Gain versus Frequency

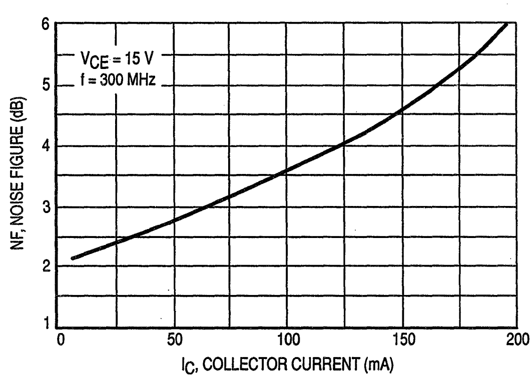


Figure 2. Noise Figure versus Collector Current

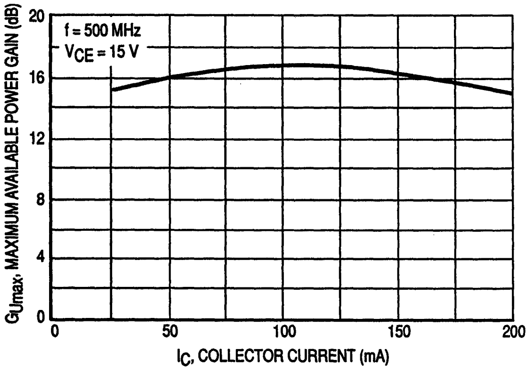


Figure 3. G_{Umax} versus Collector Current

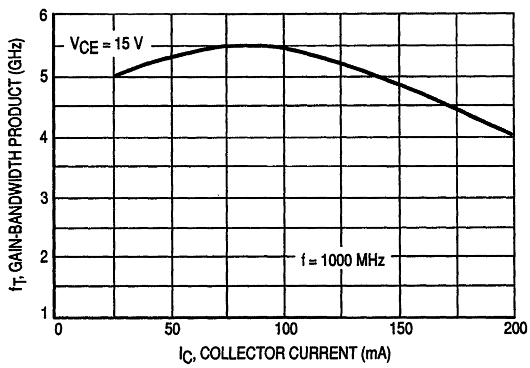


Figure 4. Gain-Bandwidth Product versus Collector Current

TYPICAL PERFORMANCE

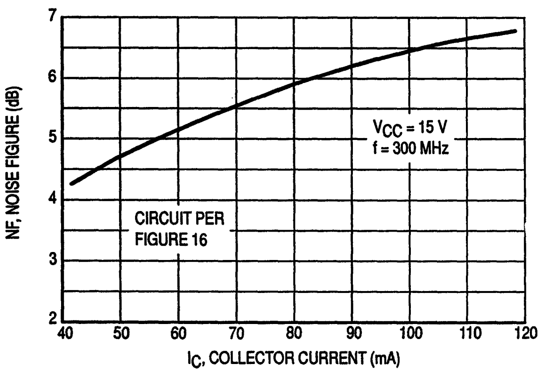


Figure 5. Broadband Noise Figure

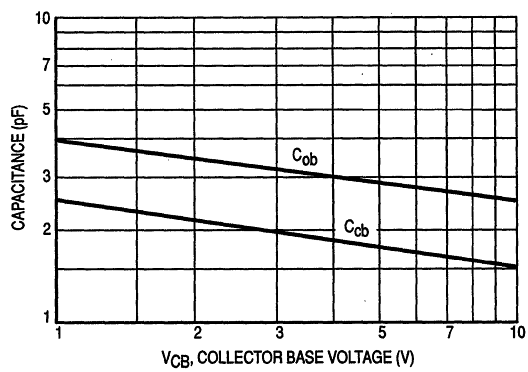


Figure 6. Junction Capacitance versus Voltage

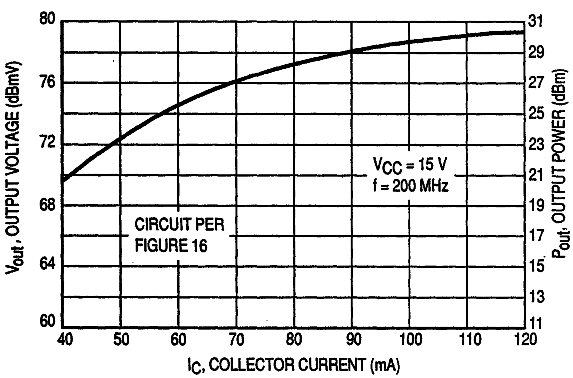


Figure 7. 1.0 dB Compression Point versus Collector Current

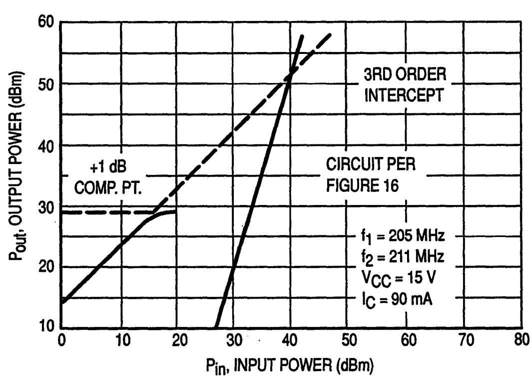


Figure 8. Third Order Intercept Point

2

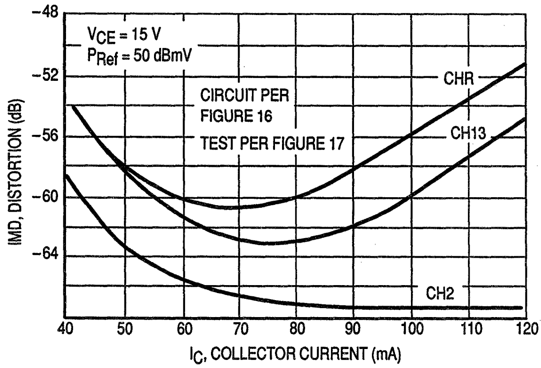


Figure 9. Second Order Distortion versus Collector Current

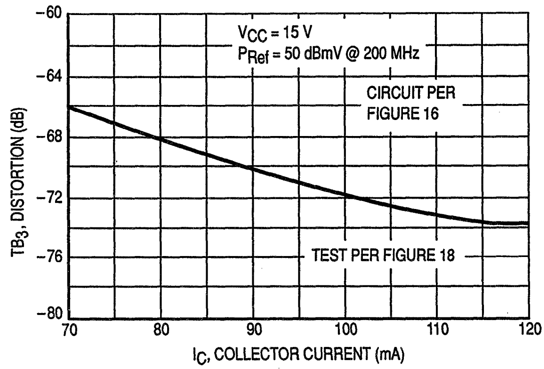


Figure 10. Triple Beat Distortion versus Collector Current

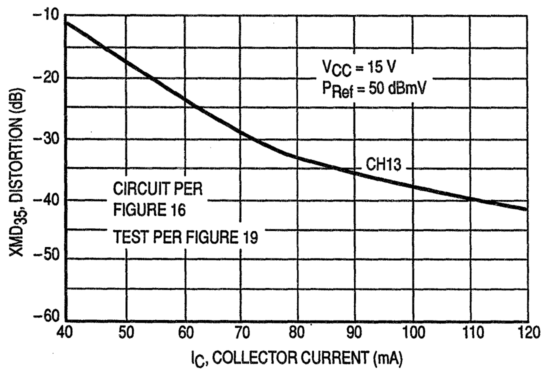


Figure 11. 35-Channel X-Modulation Distortion versus Collector Current

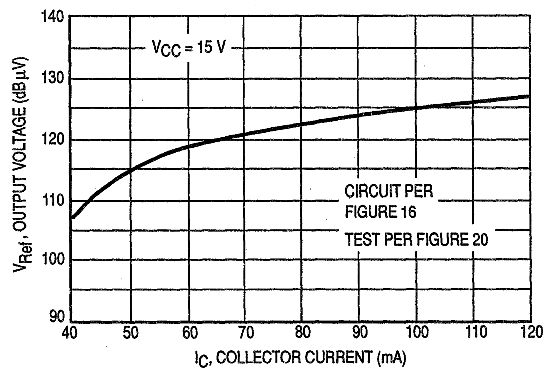


Figure 12. DIN 45004B versus Collector Current

2

V_{CE} = 15 V I_C = 90 mA

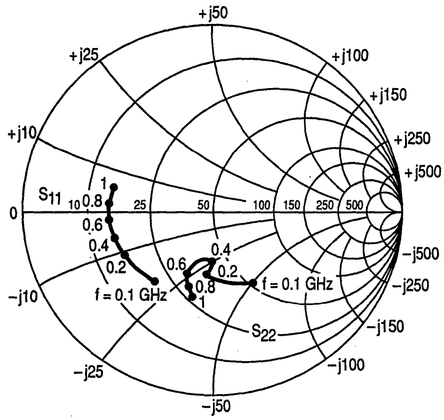


Figure 13. Input/Output Reflection Coefficient versus Frequency (GHz)

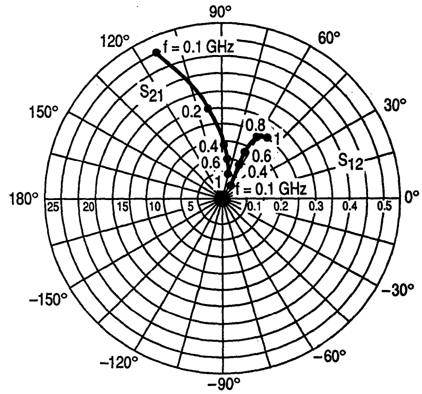


Figure 14. Forward/Reverse Transmission Coefficients versus Frequency (GHz)

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
5.0	30	100	0.56	−131	16.45	113	0.04	45	0.49	−91
		200	0.58	−159	9.42	98	0.06	49	0.38	−116
		400	0.60	−178	5.00	86	0.08	55	0.35	−132
		600	0.64	170	3.61	76	0.11	56	0.38	−138
		800	0.67	162	2.92	67	0.14	55	0.41	−144
		1000	0.70	155	2.55	58	0.17	54	0.44	−152
	60	100	0.53	−141	17.89	110	0.04	50	0.47	−102
		200	0.56	−164	10.05	97	0.05	55	0.39	−126
		400	0.59	178	5.31	85	0.09	60	0.38	−141
		600	0.63	169	3.82	76	0.12	59	0.40	−146
		800	0.66	161	3.09	67	0.15	57	0.44	−153
		1000	0.69	155	2.67	58	0.18	55	0.47	−160
	90	100	0.52	−145	18.26	109	0.04	52	0.47	−106
		200	0.56	−166	10.20	96	0.05	57	0.39	−130
		400	0.59	177	5.38	85	0.09	62	0.39	−144
		600	0.63	168	3.86	76	0.12	60	0.41	−149
		800	0.66	161	3.12	67	0.15	58	0.45	−155
		1000	0.69	155	2.70	58	0.19	55	0.48	−162
10	30	100	0.53	−122	18.36	115	0.04	48	0.50	−75
		200	0.53	−153	10.63	100	0.05	51	0.36	−96
		400	0.55	175	5.71	87	0.08	57	0.33	−112
		600	0.59	173	4.16	78	0.10	58	0.35	−119
		800	0.62	165	3.37	68	0.13	57	0.39	−127
		1000	0.65	158	2.95	59	0.15	55	0.42	−136
	60	100	0.49	−132	20.19	112	0.03	51	0.46	−85
		200	0.51	−158	11.54	99	0.05	57	0.35	−107
		400	0.53	−178	6.12	87	0.08	61	0.33	−123
		600	0.58	171	4.43	78	0.11	60	0.36	−129
		800	0.60	164	3.58	68	0.14	59	0.40	−136
		1000	0.63	157	3.12	60	0.16	57	0.44	−144
	90	100	0.48	−135	20.82	111	0.03	53	0.45	−88
		200	0.50	−160	11.77	98	0.05	59	0.34	−111
		400	0.53	−179	6.22	86	0.08	63	0.33	−126
		600	0.57	171	4.50	78	0.11	62	0.36	−131
		800	0.60	164	3.64	68	0.14	59	0.41	−139
		1000	0.63	157	3.18	60	0.17	57	0.44	−147

(continued)

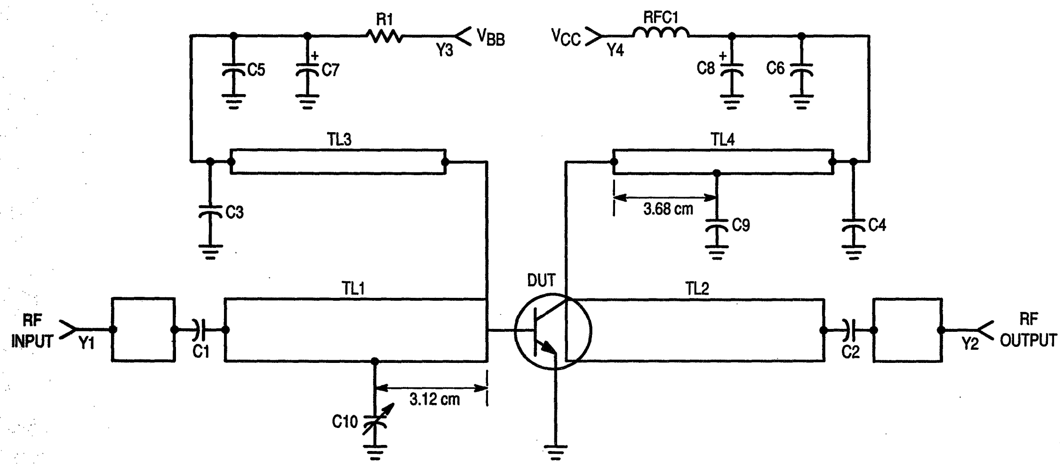
Table 1. Common-Emitter S-Parameters

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
15	30	100	0.49	−112	20.34	118	0.04	54	0.51	−52
		200	0.52	−145	11.51	101	0.05	56	0.36	−77
		400	0.48	−164	6.12	87	0.09	63	0.32	−74
		600	0.52	−174	4.19	75	0.12	62	0.32	−90
		800	0.53	177	3.29	68	0.16	61	0.38	−90
		1000	0.53	168	2.76	61	0.20	56	0.47	−90
	60	100	0.45	−122	22.14	115	0.03	56	0.45	−60
		200	0.49	−150	12.24	99	0.05	60	0.33	−86
		400	0.45	−166	6.45	86	0.09	65	0.30	−83
		600	0.50	−175	4.42	75	0.13	63	0.32	−99
		800	0.51	177	3.47	68	0.16	61	0.38	−98
		1000	0.51	168	2.91	62	0.20	55	0.46	−96
	90	100	0.44	−127	22.76	114	0.03	58	0.43	−62
		200	0.48	−152	12.44	98	0.05	62	0.32	−89
		400	0.44	−167	6.55	85	0.09	66	0.29	−85
		600	0.50	−176	4.47	75	0.13	64	0.32	−102
		800	0.51	176	3.51	69	0.17	61	0.38	−100
		1000	0.51	168	2.95	62	0.20	55	0.46	−98

Table 1. Common-Emitter S-Parameters (continued)

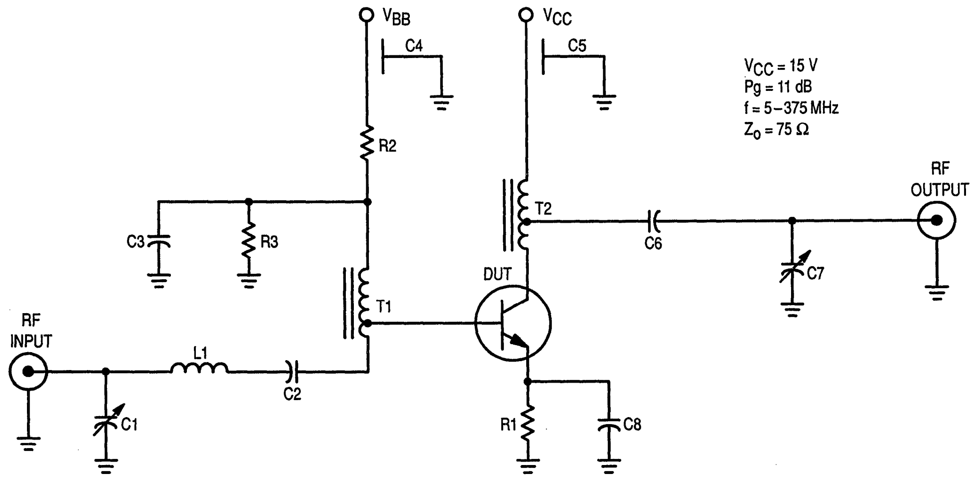
2



C1, C2 — 470 pF Chip (Ceramic)
C3, C4 — 0.018 µF Chip Capacitor
C5, C6 — 0.1 µF Mylar
C7, C8 — 1.0 µF, 25 Vdc Electrolytic
C9 — 91 pF Mini-Unelco (C9 Taped 3.68 cm from Collector Connection on TL4 as shown)
C10 — 35–45 pF Johanson Ceramic Capacitor, JMC 5801 or Equivalent (C10 Taped 3.12 cm from Base Connection on TL1)

R1 — 2.7 kΩ, 1-1/2 W
RFC1 — 0.15 µH Molded Choke
TL1, TL2 — Z_O = 26 Ω, 0.0625 TFG as shown in Photomaster
TL3, TL4 — λ/4 Microstrip, Z_O = 100 Ω
Y1, Y2 — N-Type Connection (Female)
Y3, Y4 — BNC-Type Connector (Female)
Board Material — 0.0625″ Thick Glass Teflon ε_r = 2.5

Figure 15. Narrowband Test Fixture Schematic 500 MHz



C1, C7 — 0.5–10 pF
C2, C6 — 0.001 μF
C3 — 0.01 μF
C4, C5 — 0.01 μF Feedthru
C8 — 12 pF

R1 — 12 Ω 1.0 W (2.0–24 Ω on each emitter port)
R2 — 1.8 k 1/8 W
R3 — 2.2 k 1/8 W
L1 — 1 Turn 0.012 dia #22 AWG
T1(1) — 5 Turns Tapped at 2 Turns, #30 AWG
T2(1) — 8 Turns Tapped at 3 Turns, #30 AWG

(1) Ferroxcube 135 CT050 3D3 Material

Figure 16. Broadband Test Circuit Schematic

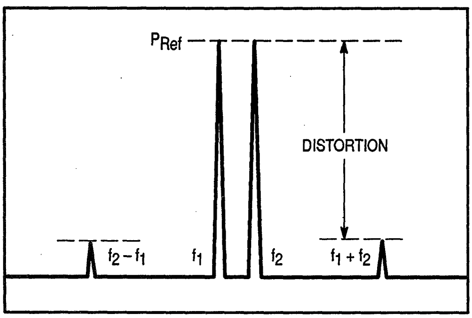


Figure 17. Second Order Distortion Test

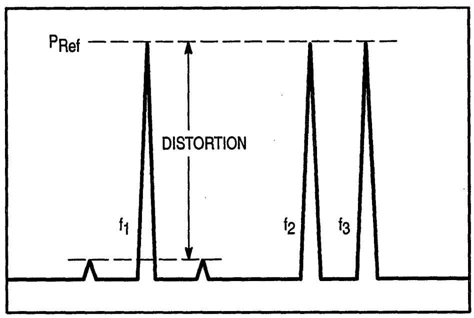


Figure 18. Triple Beat Distortion Test

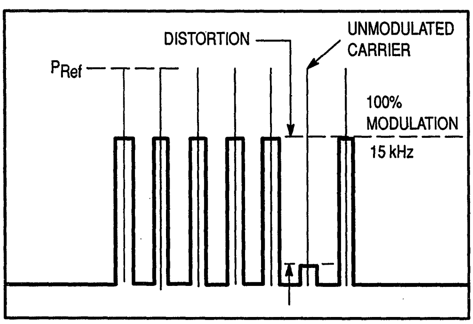


Figure 19. Cross Modulation Distortion Test

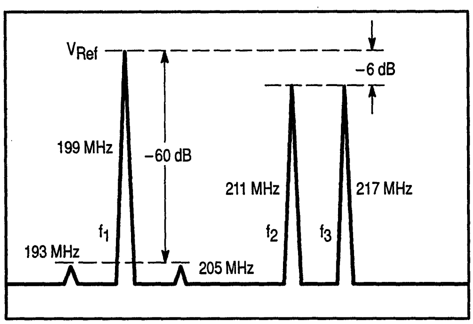


Figure 20. DIN 45004B Intermodulation Test

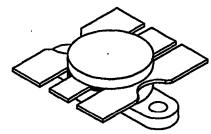
MRF641

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
  Output Power = 15 Watts
  Minimum Gain = 7.8 dB
  Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and Overdrive

**15 W, 470 MHz
CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON**



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	43.7 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W

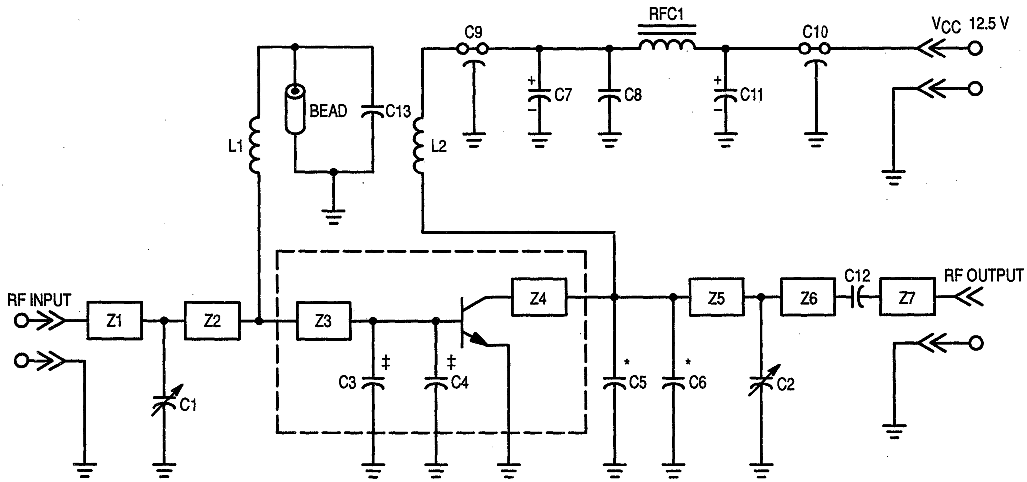
ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$, $T_C = 25°C$)	I_{CES}	—	—	5.0	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	30	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	40	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 470 MHz)	G_{pe}	7.8	8.5	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 470 MHz)	η	55	60	—	%
Output Mismatch Stress (V_{CC} = 16 Vdc, P_{in} = 3.0 W, f = 470 MHz, VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			



PARTS

Z1 — 1.225″ x 0.187″ Microstrip
Z2 — 0.884″ x 0.187″ Microstrip
Z3 — Capacitor Block (Base)
Z4 — Collector Block
Z5 — 1.1″ x 0.187″ Microstrip
Z6 — 0.433″ x 0.187″ Microstrip
Z7 — 0.4″ x 0.187″ Microstrip

Dotted Area — Capacitor Assembly

C1, C2 — 0.8–10 pF Johanson
C3, C4 — 24 pF Chip Caps 100 mils ATC
C5, C6 — 22 pF Chip Caps 100 mils ATC
C12 — 220 pF Chip Cap 100 mils ATC
C7, C11 — 1.0 µF Tantalum 35 Vdc
C9, C10 — 680 pF Feedthrough Allen-Bradley
C13 — 200 pF UNELCO
C8 — 0.1 µF, 50 V Erie Red Cap
RFC1 — VK 200 — 104B Ferrite Choke
L1 — 4 Turns 0.2″ Dia. #16 AWG
L2 — 9 Turns 0.15″ Dia. #16 AWG

Bead — Ferroxcube 56-590-65-35EB

NOTES

*C5, C6, are mounted as close to the capacitor assembly as possible.
‡‡C3, C4 are mounted in the capacitor assembly.
Board — 62.5 mil Glass Teflon, ε_r = 2.55.

Figure 1. Test Circuit Schematic

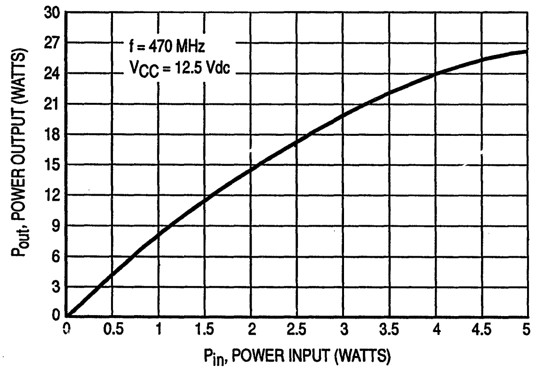


Figure 2. Power Output versus Power Input

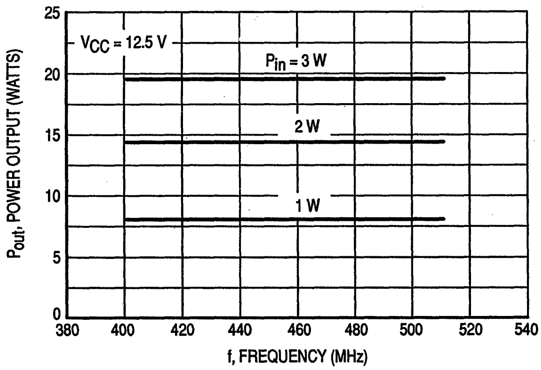


Figure 3. Power Output versus Frequency

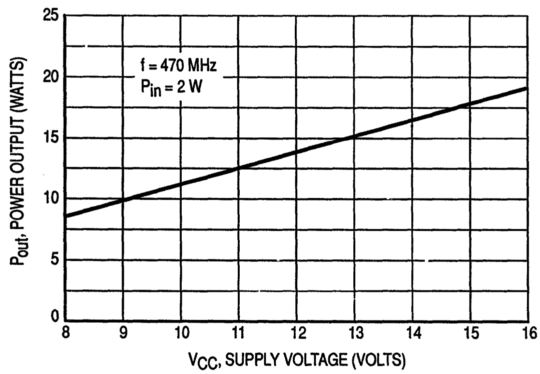


Figure 4. Power Output versus Supply Voltage

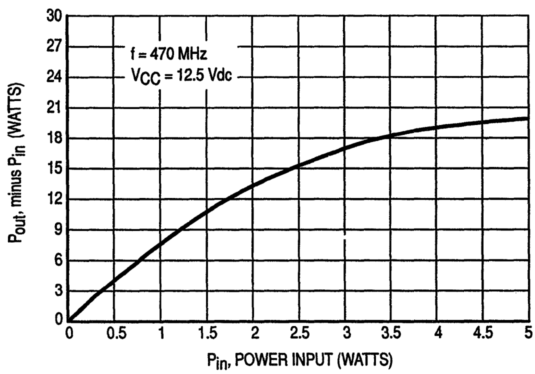
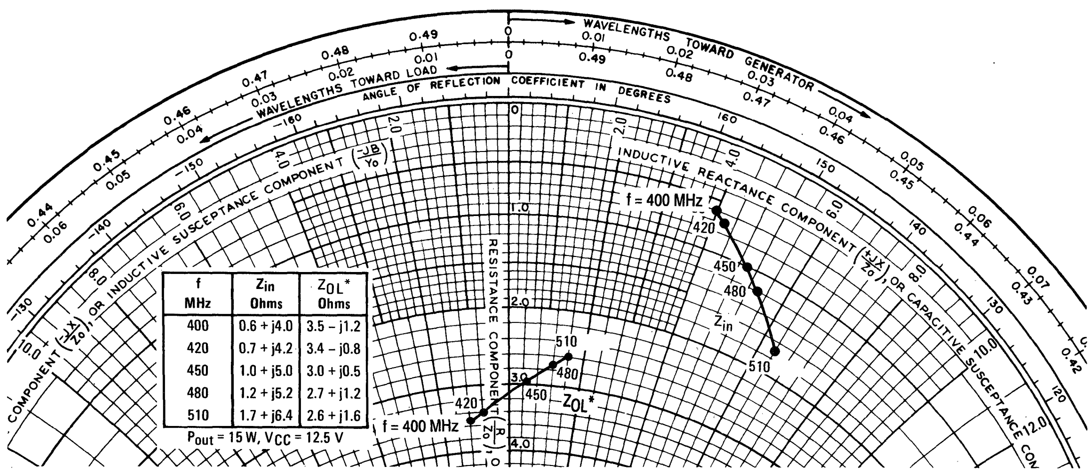


Figure 5. Power Saturation Profile



f MHz	Zin Ohms	ZOL* Ohms
400	0.6 + j4.0	3.5 – j1.2
420	0.7 + j4.2	3.4 – j0.8
450	1.0 + j5.0	3.0 + j0.5
480	1.2 + j5.2	2.7 + j1.2
510	1.7 + j6.4	2.6 + j1.6

P_{out} = 15 W, V_{CC} = 12.5 V

Z_{OL}* = Conjugate of the load impedance into which the device output operates at a given power, η, and frequency.

Figure 6. Series Equivalent Input-Output Impedance

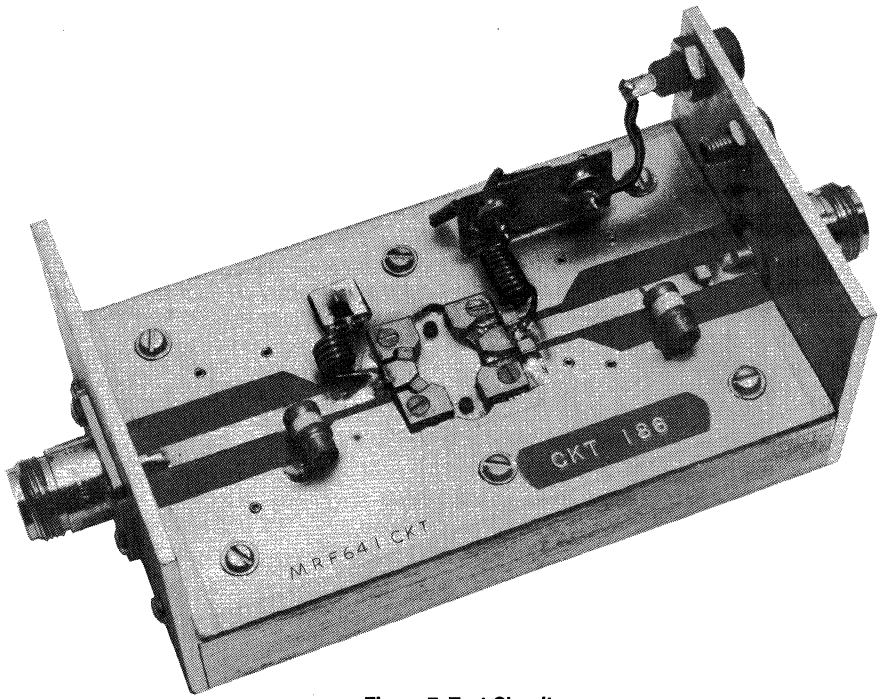


Figure 7. Test Circuit

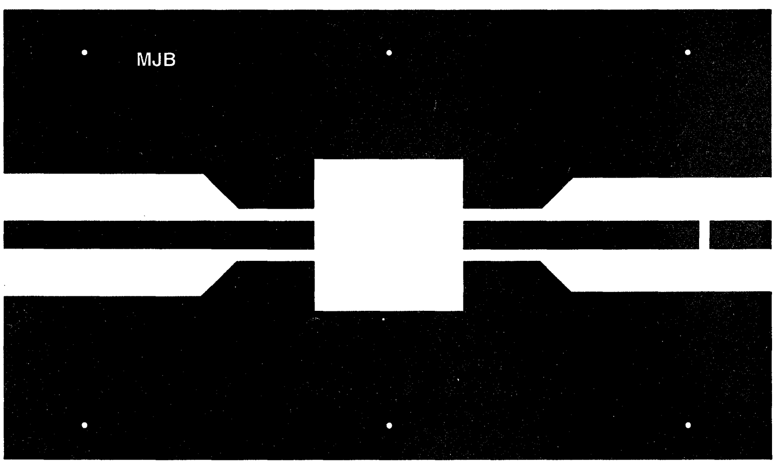


Figure 8. Photomaster

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

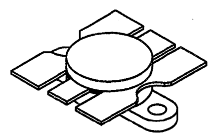
MRF644

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
  Output Power = 25 Watts
  Minimum Gain = 6.2 dB
  Efficiency = 60%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and 50% Overdrive

25 W, 470 MHz CONTROLLED Q RF POWER TRANSISTOR NPN SILICON



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	103 0.59	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc

(continued)

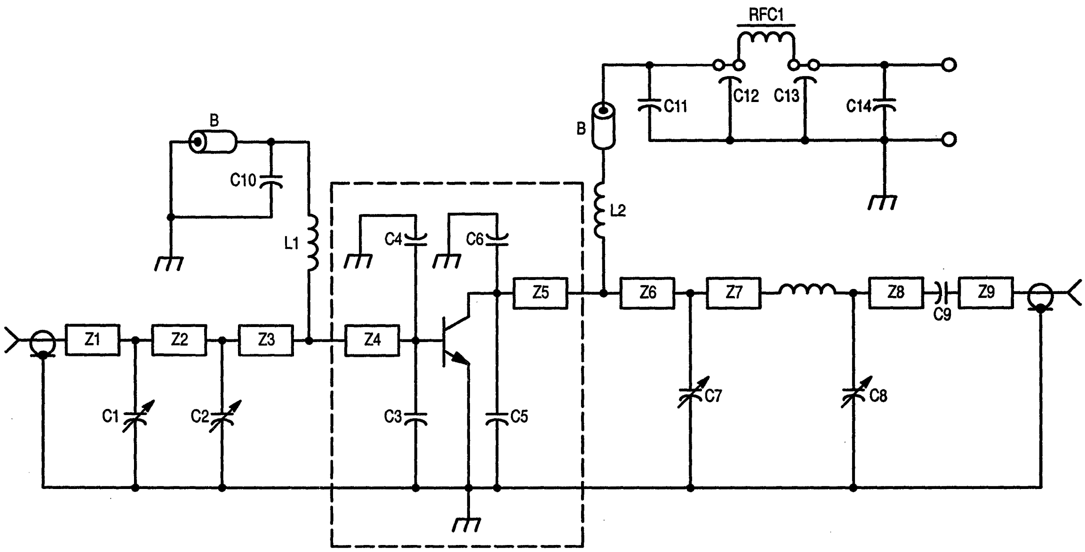
ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	40	70	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	60	85	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 25 W, I_C (MAX) = 3.6 Adc, f = 470 MHz)	G_{pe}	6.2	7.0	—	dB
Input Power (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 470 MHz)	P_{in}	—	5.0	6.0	Watts
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 25 W, I_C (MAX) = 3.6 Adc, f = 470 MHz)	η	55	60	—	%
Output Mismatch Stress (V_{CC} = 16 Vdc, P_{in} = Note 1, f = 470 MHz, VSWR = 20:1, All Phase Angles)	ψ *	No Degradation in Output Power			
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 470 MHz)	Z_{in}	—	1.2 + j3.3	—	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 470 MHz)	Z_{OL}	—	1.9 + j2.1	—	Ohms

NOTES:
1. P_{in} = 150% of Drive Requirement for 25 W Output at 12.5 Vdc.

* ψ = Mismatch stress factor — the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

2



C1, C2, C7, C8 — 1.0–20 pF Johanson Variable
C3 — 27 pF 100 mil ATC
C4 — 30 pF 100 mil ATC
C5, C6 — 33 pF 100 mil ATC
C9 — 250 pF 100 mil ATC
C10 — 100 pF UNELCO
C11, C14 — 1.0 µF 35 V TANTALUM
C12, C13 — 680 pF Feedthrough
L1 — 5″ #22 AWG 0.100″ ID
L2 — 5″ #20 AWG 0.187″ ID
RFC1 — Ferroxcube VK200-20-4B
B — Ferroxcube Bead 56-590-65-3B
Z1 — 0.25″ x 0.20″ Microstrip
Z2 — 1.63″ x 0.20″ Microstrip
Z3 — 0.20″ x 0.20″ Microstrip
Z4, Z5 — 1/2″ #18 AWG bent in a "V" shape 1/8″ Wide
Z6 — 0.20″ x 0.20″ Microstrip
Z7 — 0.70″ x 0.20″ Microstrip
Z8 — 0.33″ x 0.20″ Microstrip
Z9 — 0.50″ x 0.20″ Microstrip
Board — 62.5 mil Glass Teflon, ε_r = 2.55

Figure 1. Test Circuit Schematic

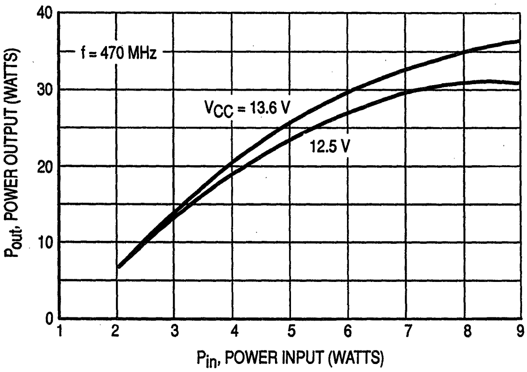


Figure 2. Power Output versus Power Input

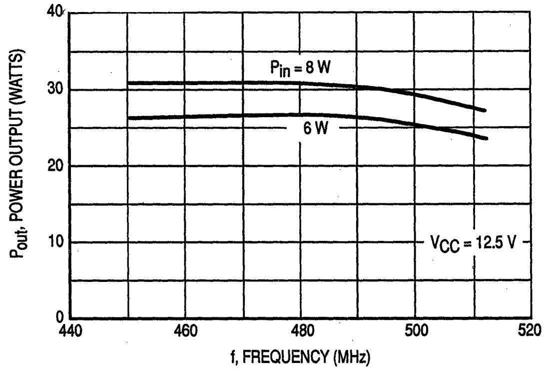


Figure 3. Power Output versus Frequency

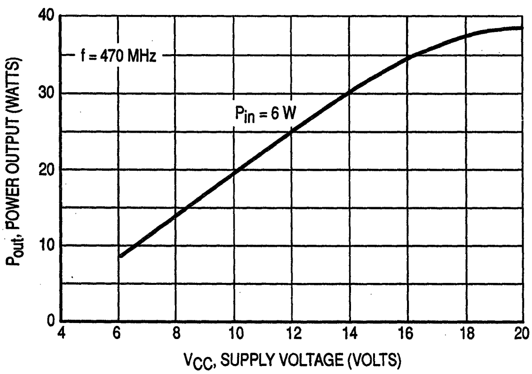


Figure 4. Power Output versus Supply Voltage

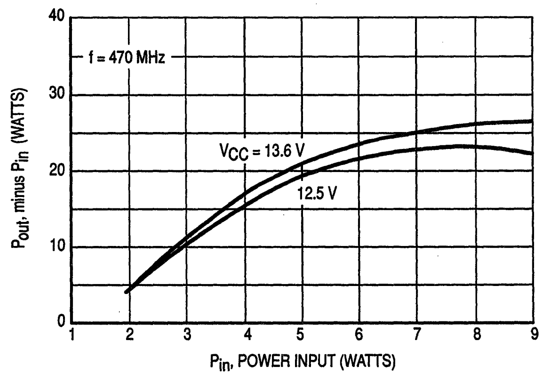
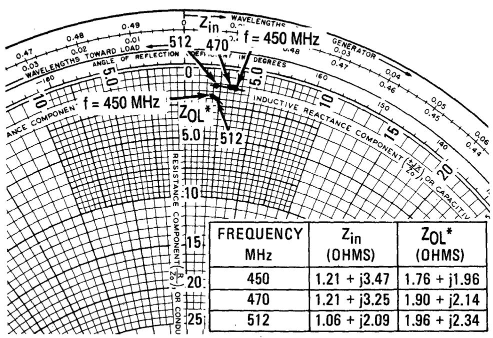


Figure 5. Power Saturation Profile



FREQUENCY MHz	Z_{in} (OHMS)	Z_{OL}* (OHMS)
450	1.21 + j3.47	1.76 + j1.96
470	1.21 + j3.25	1.90 + j2.14
512	1.06 + j2.09	1.96 + j2.34

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input-Output Impedance

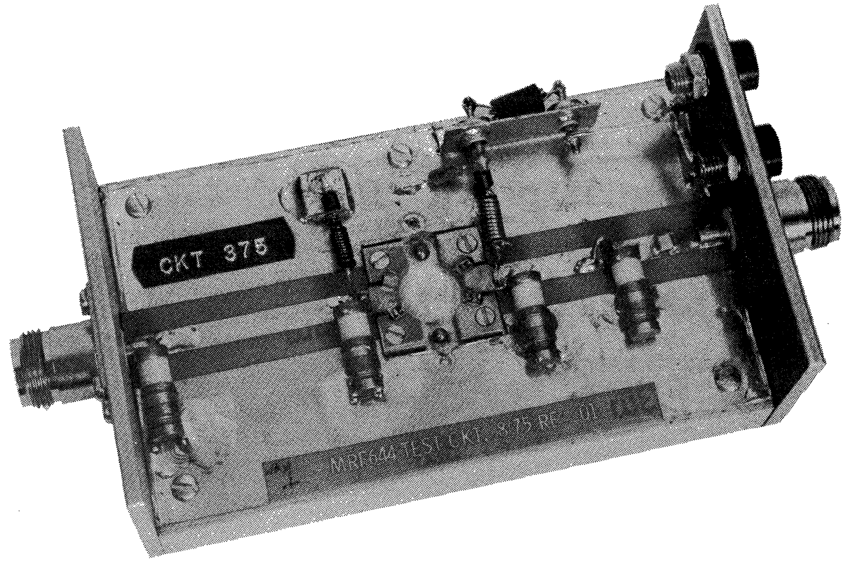


Figure 7. MRF644 Test Fixture

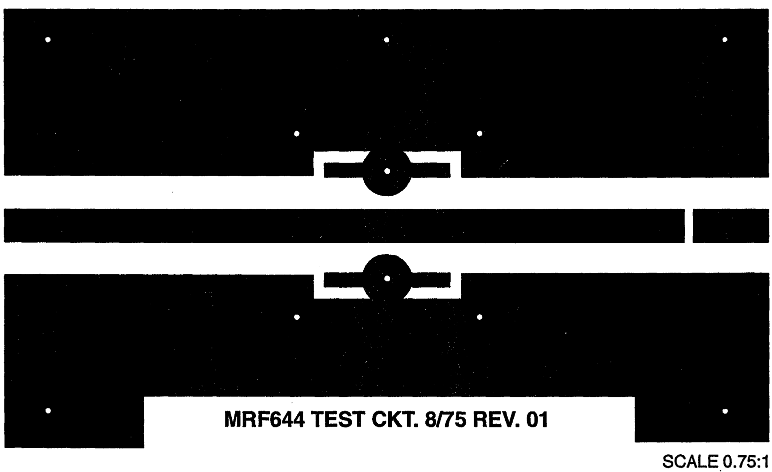


Figure 8. Printed Circuit Board

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

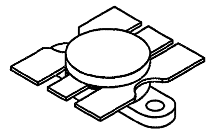
MRF650

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 520 MHz.

- Guaranteed 440, 470, 512 MHz 12.5 Volt Characteristics
  Output Power = 50 Watts
  Minimum Gain = 5.2 dB @ 440, 470 MHz
  Efficiency = 55% @ 440, 470 MHz
  IRL = 10 dB
- Characterized with Series Equivalent Large-Signal Impedance Parameters from 400 to 520 MHz
- Built-In Matching Network for Broadband Operation
- Triple Ion Implanted for More Consistent Characteristics
- Implanted Emitter Ballast Resistors
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 15.5 Vdc, 2.0 dB Overdrive

50 W, 512 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Emitter Voltage	V_{CES}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	12	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	135 0.77	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

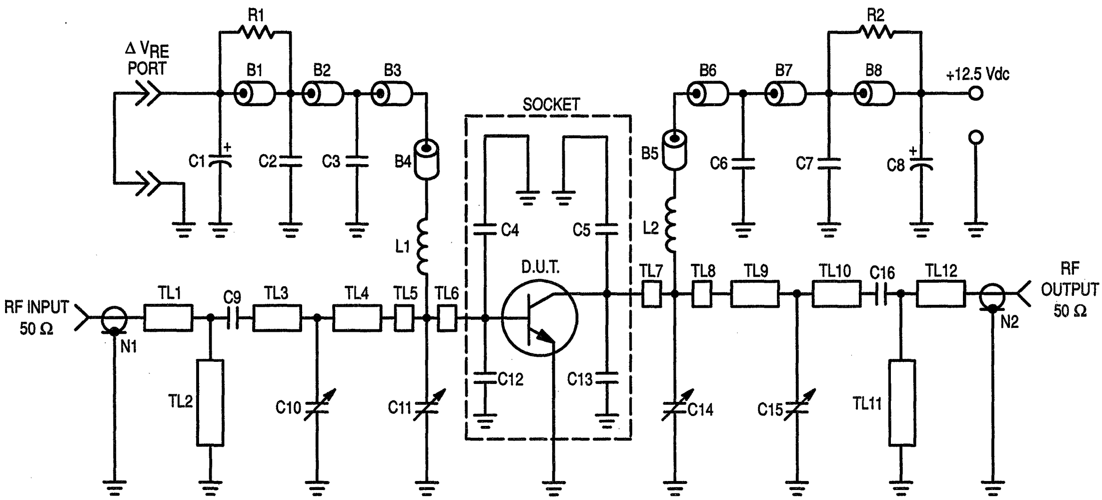
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	70	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	135	170	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (In Motorola Test Fixture. See Figure 1.)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 440, 470 MHz)	G_{pe}	5.2	6.1	—	dB
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 512 MHz)	G_{pe}	5.0	5.9	—	dB
Input Return Loss (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 440, 470, 512 MHz)	IRL	10	15	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 440, 470 MHz)	η	55	65	—	%
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 512 MHz)	—	50	60	—	%
Output Mismatch Stress (V_{CC} = 15.5 V, 2.0 dB Overdrive, f = 470 MHz, VSWR = 20:1, All Phase Angles) (1)	ψ (2)	No Degradation in Output Power			

NOTES:
1. P_{in} = 2.0 dB above drive requirement for 50 W output at 12.5 Vdc.
2. ψ = Mismatch stress factor — the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.



B1, B8 — Ferrite Bead Ferroxcube VK200 20-4B
B2, B3, B4, B5, B6, B7 — Ferrite Bead Ferroxcube #56-590-3B
C1, C8 — 10 µF, 25 V, 25%, Electrolytic, ECS TE-1204
C2, C7 — 1000 pF, Chip Cap, 5%, ATC 100B102JC50
C3, C6 — 91 pF, 5%, Mica, SAHA 3HS0006-91
C4, C5, C12, C13 — 36 pF, 5%, SAHA 3HS0006-36
C9, C16 — 220 pF, Chip Cap, 5%, ATC 100B221JC200
C10, C11, C15 — 0.8–10 pF, Variable, Johanson JMC501 PG26J200
C14 — 1.0–20 pF, Variable, Johanson JMC5501 PG26J200
L1, L2 — 3 Turns, 18 AWG, 0.19″ ID — Total Length 3.5″
N1, N2 — N Coaxial Conn., Omni-Spectra 3052-1648-10
R1, R2 — 10 Ohm, 10%, 1.0 W, Carbon, RCA 831010

TL1, TL12 — Z_o = 50 Ohm
TL2 — See Photomaster
TL3 — See Photomaster
TL4 — See Photomaster
TL5 — See Photomaster
TL6 — See Photomaster
TL7 — See Photomaster
TL8 — See Photomaster
TL9 — See Photomaster
TL10 — See Photomaster
TL11 — See Photomaster

Transmission Line Boards: 1/16″ Glass-Teflon
Keene GX-0600-55-22
2 oz. Cu Clad Both Sides
ε_r = 2.55

Bias Boards: 1/16″ G10 or Equivalent
2 oz. Cu Clad Double Sided

Figure 1. 440 to 512 MHz Broadband Test Circuit Schematic

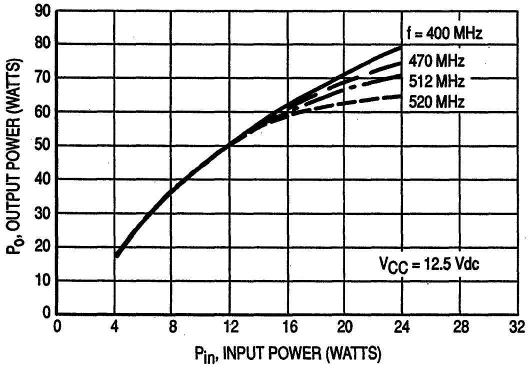


Figure 2. Output Power versus Input Power

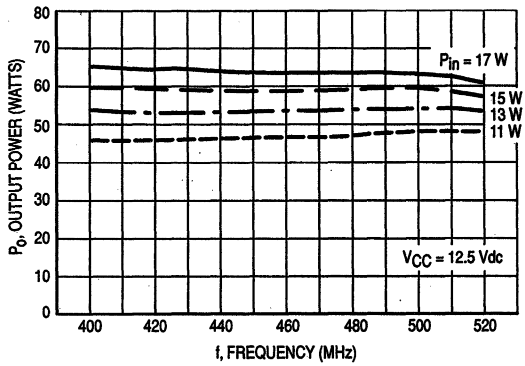


Figure 3. Output Power versus Frequency

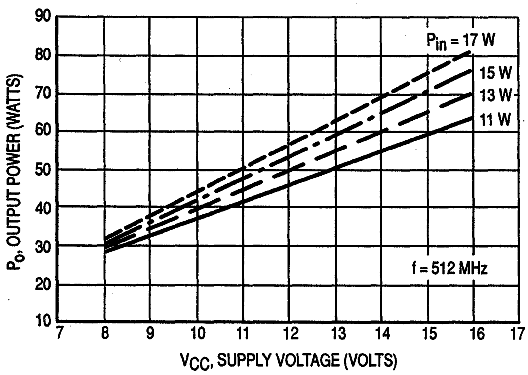


Figure 4. Output Power versus Supply Voltage

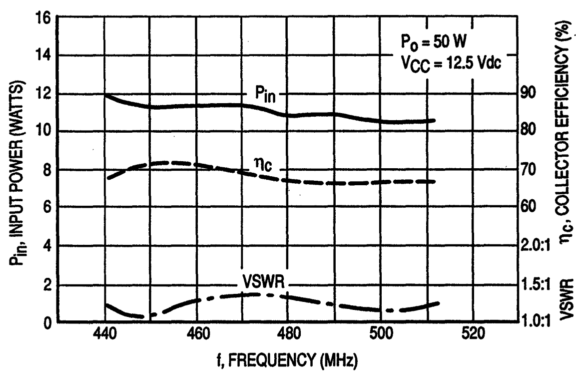
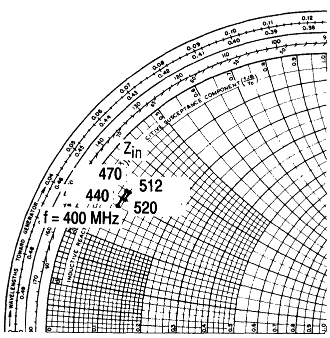


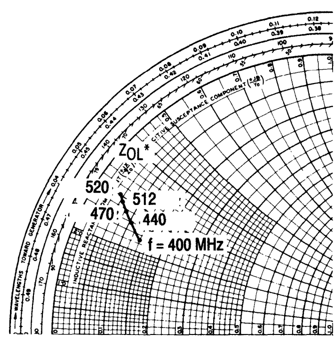
Figure 5. Broadband Performance for P_o = 50 W



P_o = 50 W, V_{CC} = 12.5 Vdc

TUNED FOR MAXIMUM GAIN AT P_o = 50 W

f (MHz)	Z_{in} Ω	Z_{OL}* Ω
400	0.7 + j2.8	1.4 + j2.3
440	0.7 + j3.2	1.1 + j2.6
470	0.8 + j3.3	0.8 + j2.7
512	0.8 + j3.2	0.7 + j2.9
520	0.7 + j3.0	0.6 + j3.0



Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 6. Input and Output Impedance Normalized to 10 Ohms Circuit Tuned for Maximum Gain @ P_o = 50 W

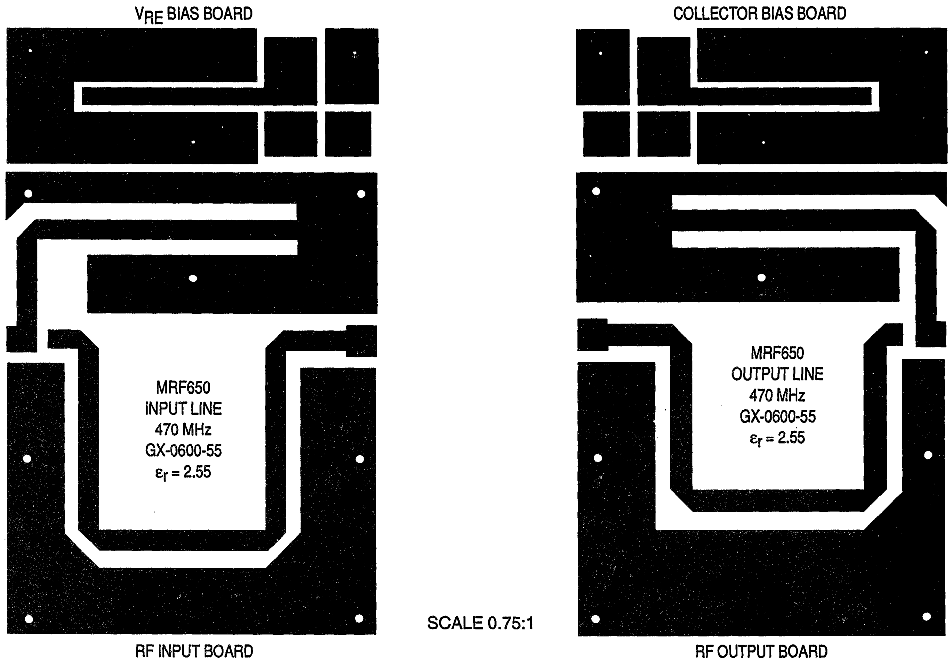


Figure 7. Photomaster for Broadband Test Circuit

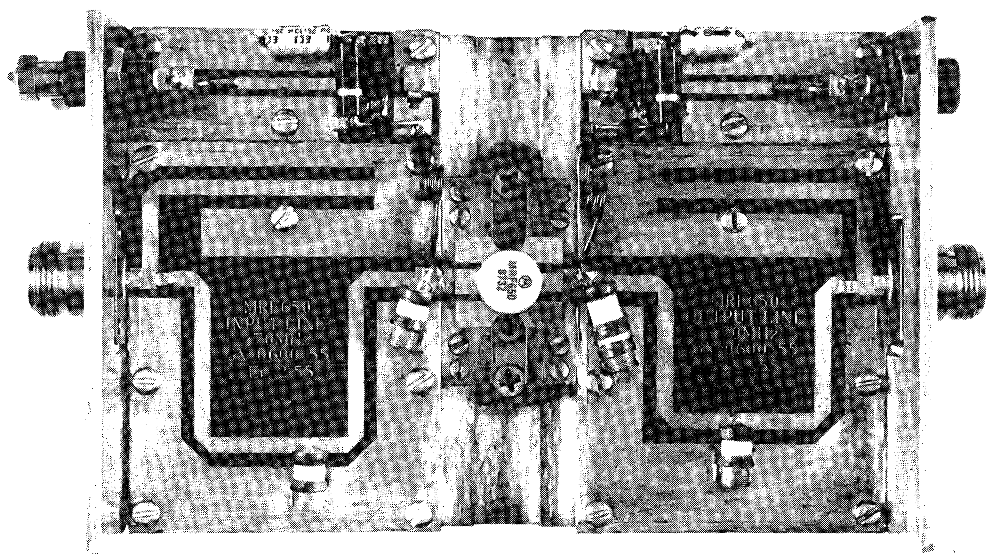
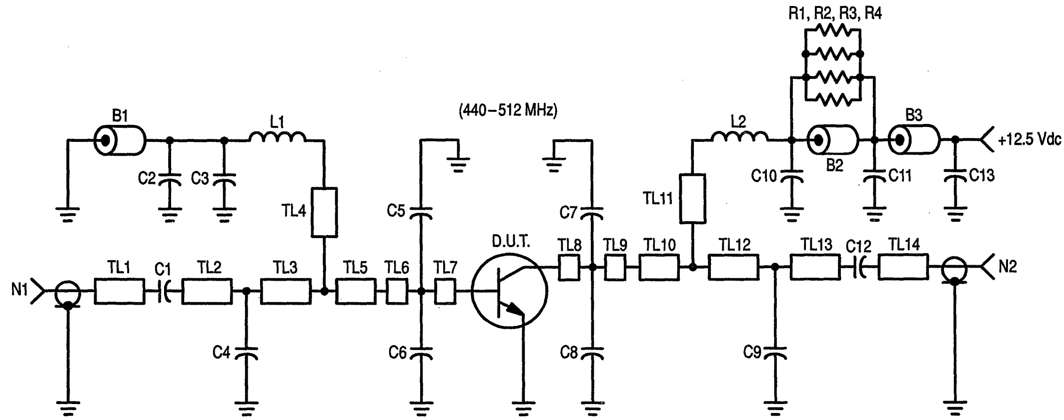


Figure 8. 440–512 MHz Broadband Test Circuit

2



B1, B2 — Ferrite Bead Fair Rite Products Corp.
B3 — Ferrite Bead Fair Rite Products Corp.
C2, C11 — 820 pF, 5%
C3, C10 — 91 pF, 5%, Mica, SAHA 3HS0006-91
C1, C12 — 220 pF, 5%, Murata Erie
C4 — 9.1 pF, 5%, Murata Erie
C5, C6, C7, C8 — 43 pF, 5%, Mica SAHA 3HS0006-43
C9 — 10 pF, 5%, Murata Erie
C13 — 10 µF, Electrolytic, 50 V, Panasonic
L1 — 7 Turns, 24 AWG, ID Dia. 0.116″
L2 — 5 Turns, 18 AWG, ID Dia. 0.165″
N1, N2 — SMA Flange Mount, Omni-Spectra 2052-1618-02

R1, R2, R3, R4 — 39 Ohm 1/8 W 5% Rohm
TL1 — Z_o = 50 Ohm
TL2 — Z_o = 50 Ohm
TL3 — Z_o = 50 Ohm
TL4 — See Photomaster
TL5 — Z_o = 50 Ohm
TL6 — See Photomaster
TL7 — See Photomaster
TL8 — See Photomaster
TL9 — See Photomaster
TL10 — Z_o = 50 Ohm
TL11 — See Photomaster
TL12 — Z_o = 50 Ohm
TL13 — Z_o = 50 Ohm
TL14 — Z_o = 50 Ohm
Board Material: 1/16″ G10, ε_r = 4.5
2 oz. Cu Clad Both Sides

Figure 9. Schematic of Broadband Demonstration Amplifier (3)

PERFORMANCE CHARACTERISTICS OF BROADBAND DEMONSTRATION AMPLIFIER

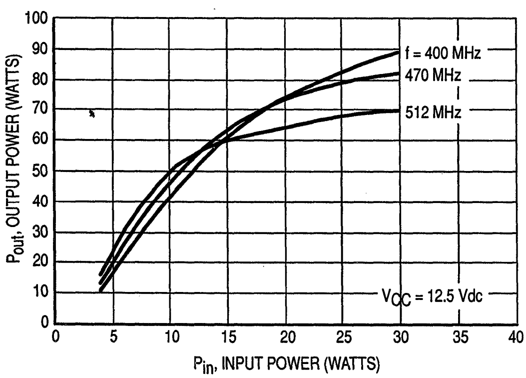


Figure 10. Output Power versus Input Power

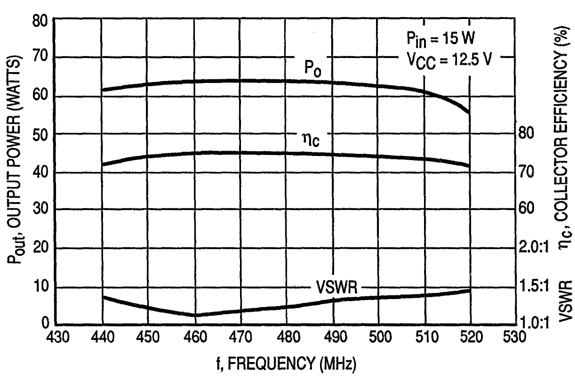


Figure 11. P_o, η_c and VSWR versus Frequency

(3) Detailed design and performance information available from Motorola upon request.

2

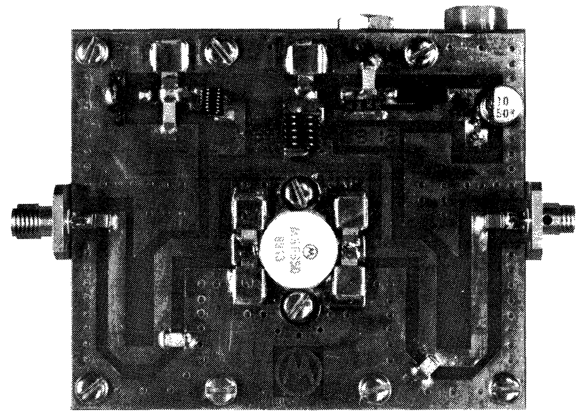
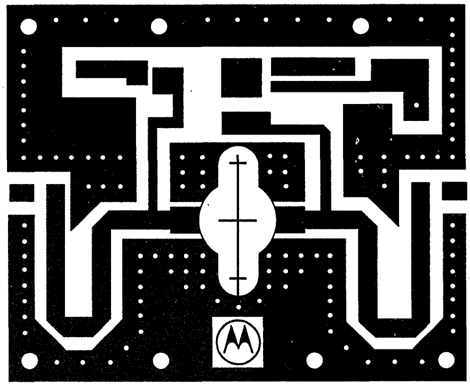


Figure 12. 440–512 MHz Broadband Demonstration Amplifier



SCALE 0.75:1

Figure 13. Photomaster for 440–512 MHz Broadband Demonstration Amplifier

2

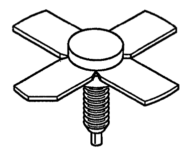
MRF652
MRF652S

The RF Line
NPN Silicon
RF Power Transistors

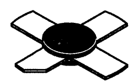
. . . designed for 12.5 Vdc UHF large-signal, amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Guaranteed 12.5 Volt, 512 MHz Characteristics
  - Output Power = 5.0 Watts
  - Minimum Gain = 10 dB
  - Efficiency = 65% (Typ)
- Typical Performance at 870 MHz, 12.5 V, 5.0 W Output = 6.0 dB
- Series Equivalent Large-Signal Characterization
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 30:1 VSWR Load Mismatch at 15.5 V Supply Voltage

5.0 W, 512 MHz
RF POWER
TRANSISTORS
NPN SILICON



CASE 244, STYLE 1
MRF652



CASE 249, STYLE 1
MRF652S

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 143	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7.0	°C/W

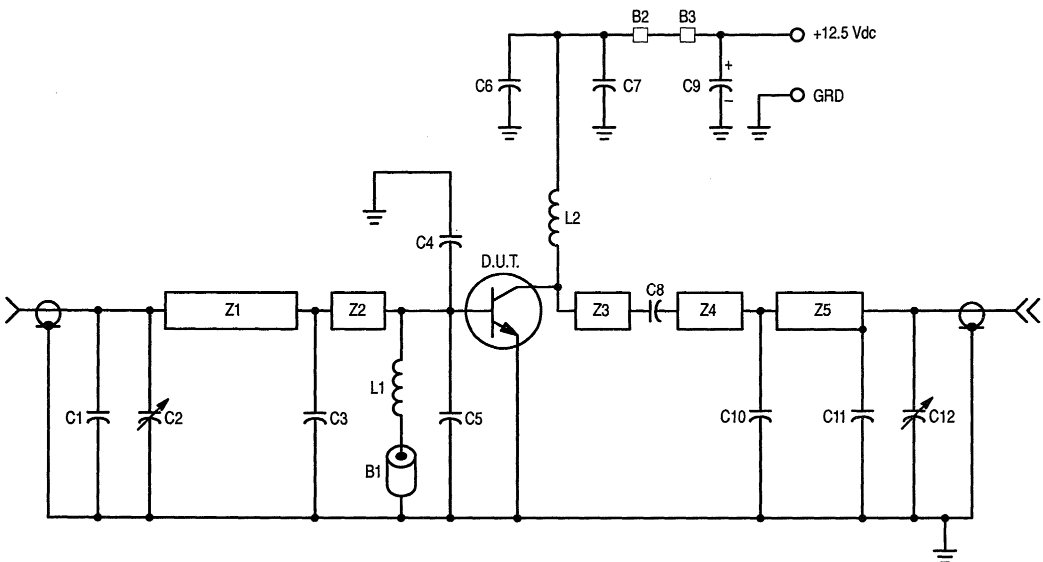
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	150	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	9.5	15	pF
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 5.0 W)	f = 512 MHz f = 870 MHz	G_{pe}	10 —	11 6.0	— —	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 5.0 W, f = 512 MHz)		η	60	65	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 500 mW, f = 512 MHz, VSWR = 30:1, At All Phase Angles)		ψ	No Degradation in Output Power			



B1, B2, B3 — Ferrite Bead
C1 — 7.0 pF Unelco Mica
C2 — 1.0–6.0 pF Johanson Variable 5201
C3 — 15 pF Unelco Mica
C4 — 43 pF Mini-Underwood Mica
C5 — 56 pF Mini-Underwood Mica
C6 — 1000 pF Unelco Mica
C7 — 0.1 μF Ceramic
C8 — 68 pF Mini-Underwood Mica
C9 — 1.0 μF Electrolytic 25 V
C10, C11 — 5.0 pF Unelco Mica
C12 — 1.0–10 pF Johanson Variable 5501
L1, L2 — 6 Turns, 20 AWG Wire 0.125″ ID
Z1, Z2 — 25 Ohm μStripline (See Photo-Mask — Figure 7)
Z3, Z4, Z5 — 50 Ohm μStripline (See Photo-Mask — Figure 7)
Board — 0.032″ Glass-Teflon

Figure 1. 440–512 MHz Broadband Test Circuit

2

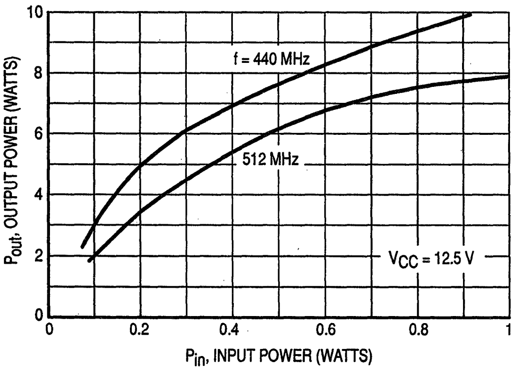


Figure 2. Output Power versus Input Power

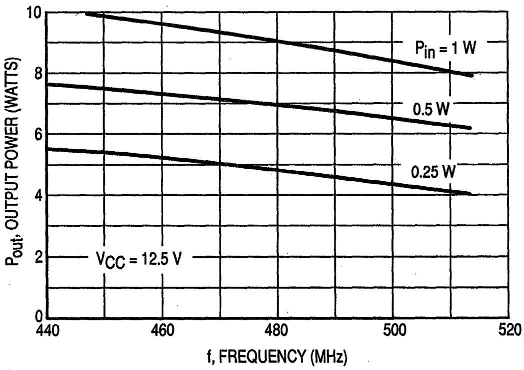


Figure 3. Output Power versus Frequency

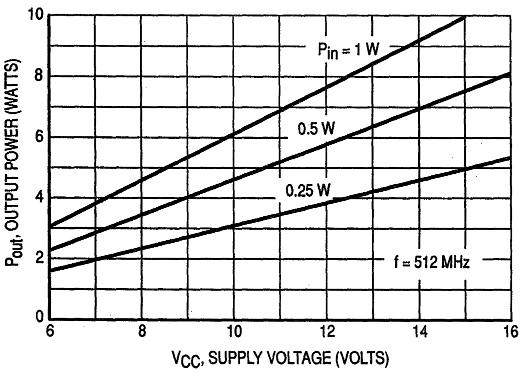


Figure 4. Output Power versus Supply Voltage

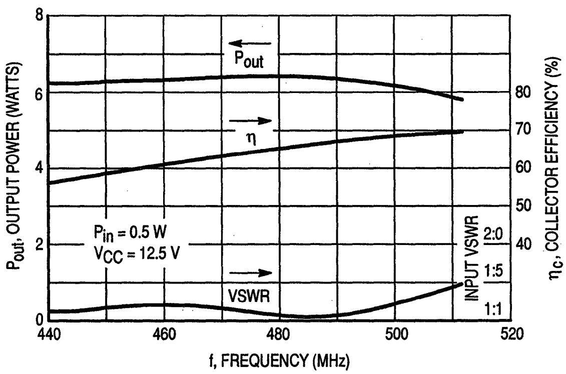
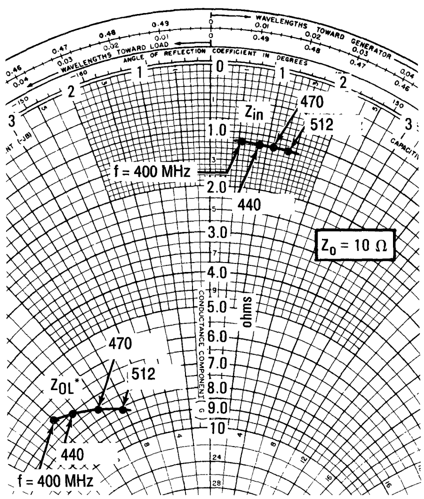


Figure 5. Typical Broadband Circuit Performance

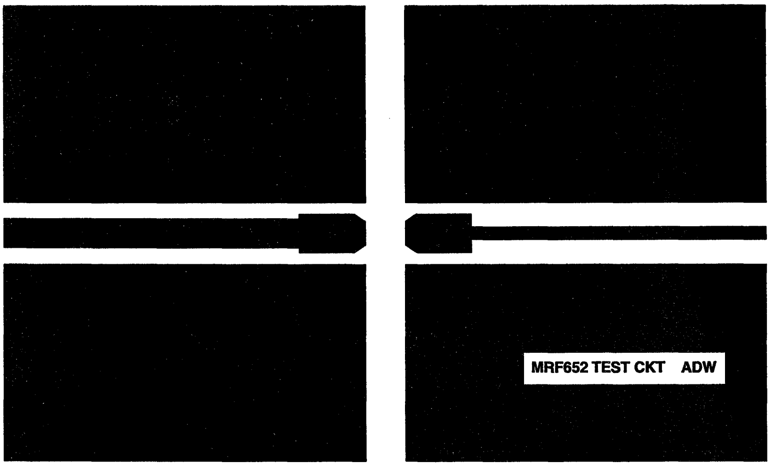


V_{CC} = 12.5 Vdc
P_{out} = 5.0 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	1.18 + j0.54	6.7 – j6.9
440	1.19 + j0.88	7.05 – j6.1
470	1.19 + j1.11	7.6 – j5.1
512	1.19 + j1.35	8.1 – j4.1

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance



SCALE 0.75:1

Figure 7. Photomaster Broadband Test Circuit

2

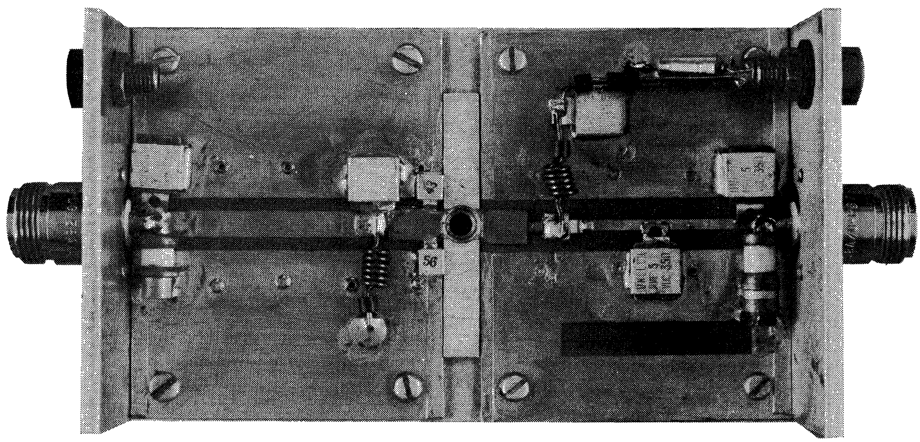


Figure 8. Broadband Test Circuit

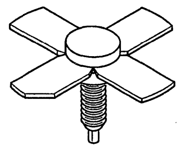
MRF653
MRF653S

The RF Line
NPN Silicon
RF Power Transistors

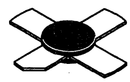
. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 512 MHz Characteristics
  - Output Power = 10 W
  - Gain = 8.0 dB (Typ)
  - Efficiency = 65% (Typ)
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 20:1 VSWR Load Mismatch at 16 V Supply Voltage

**10 W, 512 MHz
RF POWER
TRANSISTORS
NPN SILICON**



**CASE 244
MRF653**



**CASE 249
MRF653S**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Base Voltage	V_{CBO}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.75	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ Adc, $V_{CE} = 5.0$ Vdc)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	—	22	28	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5$ Vdc, $P_{out} = 10$ W, f = 512 MHz)	G_{pe}	7.0	8.0	—	dB
Collector Efficiency ($V_{CC} = 12.5$ Vdc, $P_{out} = 10$ W, f = 512 MHz)	η_c	55	65	—	%
Load Mismatch Stress ($V_{CC} = 16$ Vdc, f = 512 MHz, P_{in} (1) = 2.6 W, VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

NOTE:
1. P_{in} = 2.0 dB over the typical input power required for 10 W output power @ 12.5 Vdc.

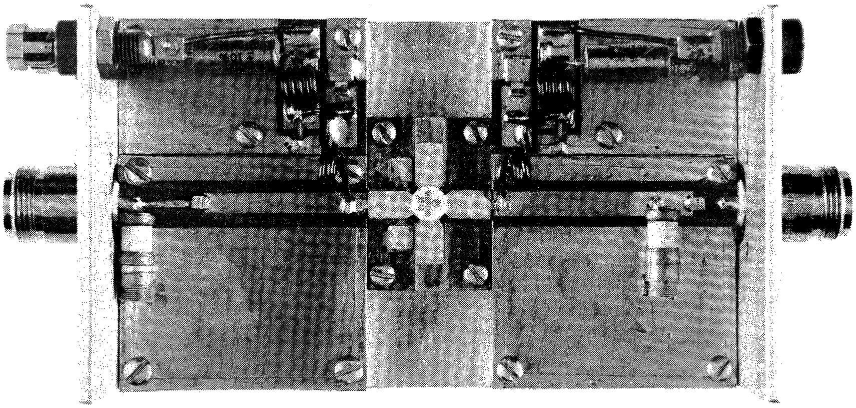
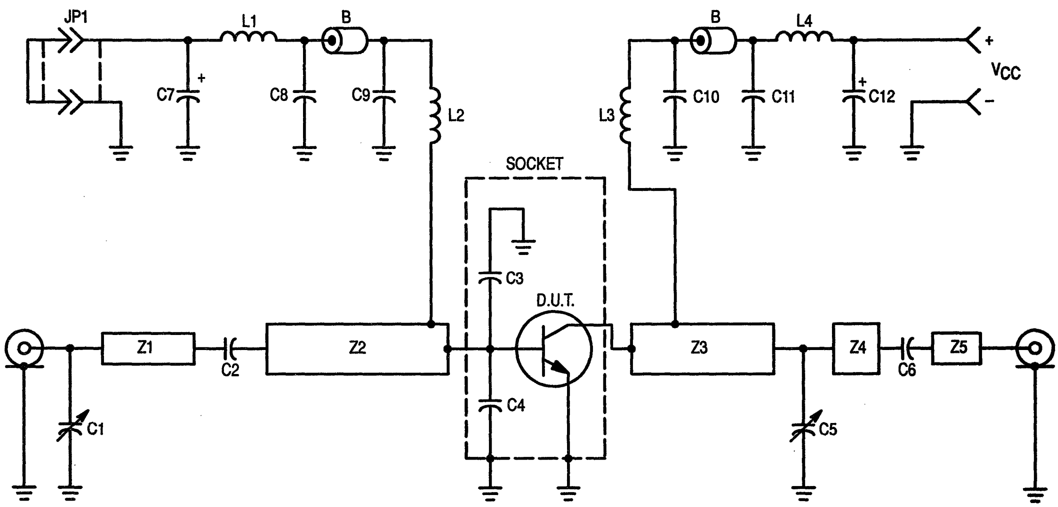


Figure 1. Broadband Test Circuit



C1, C5 — 1.0–20 pF, Johanson
C2, C6 — 330 pF, 100 Mil ATC
C3, C4 — 36 pF, Mini-Unelco
C7, C12 — 10 µF, 35 V, Tantalum
C8, C11 — 0.1 µF, Ceramic
C9, C10 — 91 pF, Mini-Unelco

L1, L4 — 4-1/2 Turns, #18 AWG, 0.16″ ID
L2, L3 — 2 Turns, #18 AWG, 0.16″ ID
B — Ferrite Bead, Ferroxcube 56-590-65-3B
Z1 — 51 x 630 mils
Z2 — 162 x 1300 mils
Z3 — 210 x 1350 mils
Z4 — 210 x 280 mils
Z5 — 51 x 300 mils
Board Material — 0.032″ epoxy glass G10, 1 oz., copper clad, double sided, $\varepsilon_r = 5$
JP1 — Jumper, #14 AWG w/Banana Plugs

Figure 2. Broadband Test Circuit Schematic

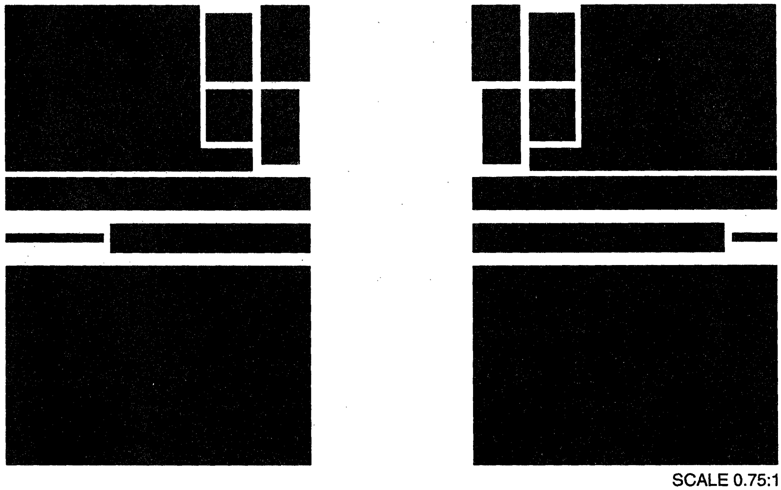


Figure 3. Photomaster

2

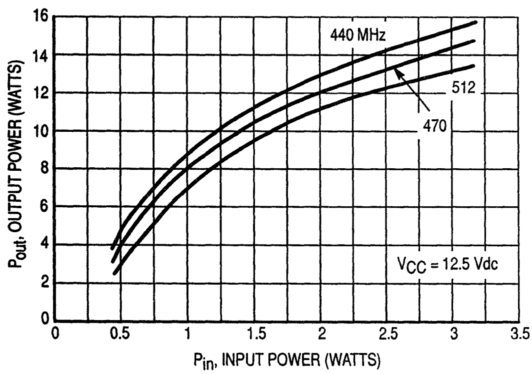


Figure 4. Output Power versus Input Power

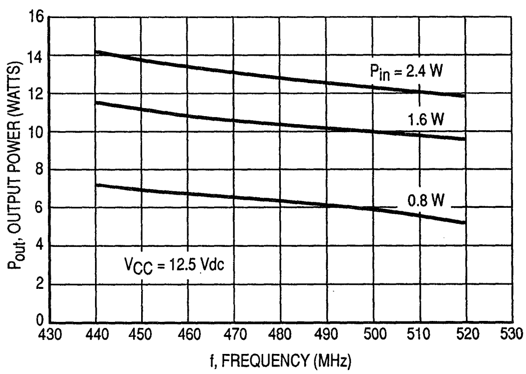


Figure 5. Output Power versus Frequency

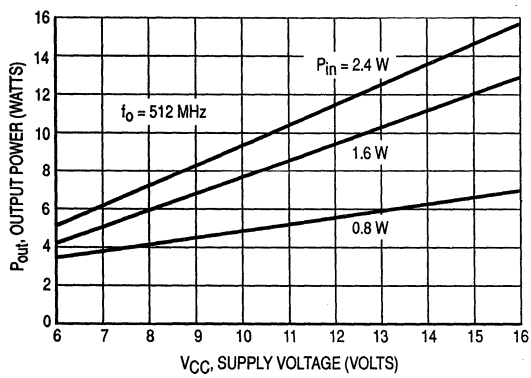


Figure 6. Output Power versus Supply Voltage

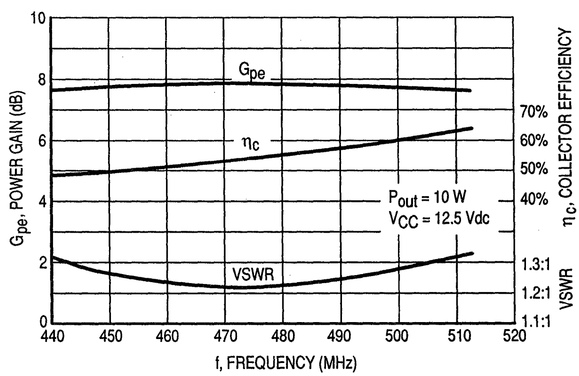
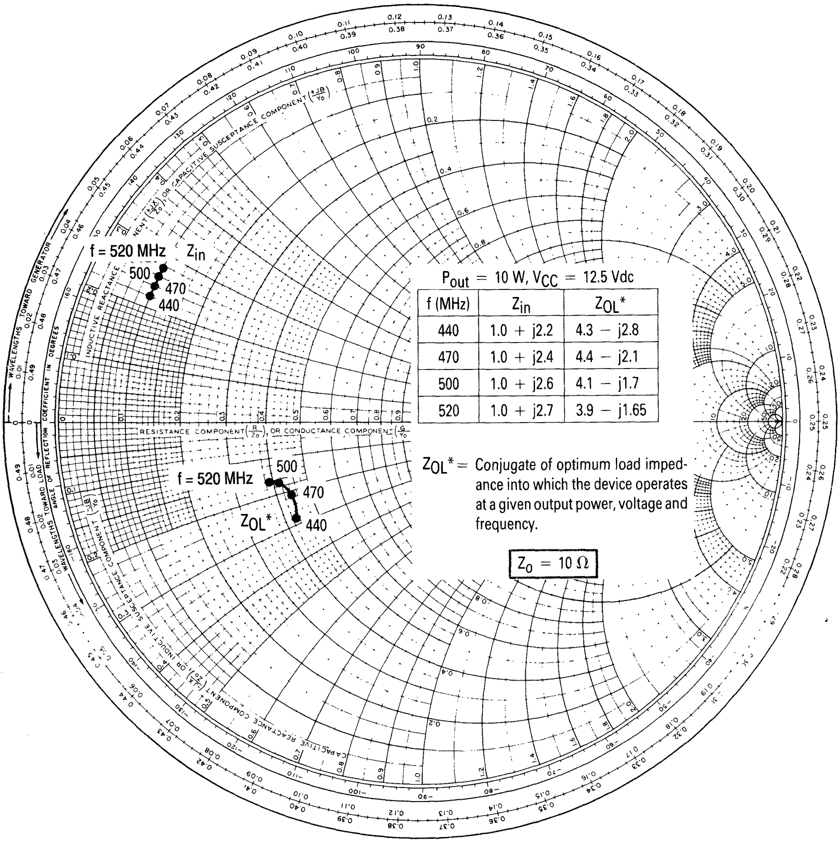


Figure 7. Typical Broadband Circuit Performance



P_{out} = 10 W, V_{CC} = 12.5 Vdc

f (MHz)	Z_{in}	Z_{OL}*
440	1.0 + j2.2	4.3 − j2.8
470	1.0 + j2.4	4.4 − j2.1
500	1.0 + j2.6	4.1 − j1.7
520	1.0 + j2.7	3.9 − j1.65

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 8. Series Equivalent Input and Output Impedance

2

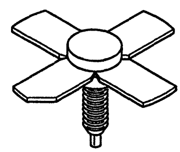
MRF654

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 512 MHz Characteristics
  Output Power = 15 W
  Minimum Gain = 7.8 dB
  Efficiency = 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 20:1 VSWR Load Mismatch at 15.5 V Supply Voltage

15 W, 470 MHz RF POWER TRANSISTOR NPN SILICON



CASE 244, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W

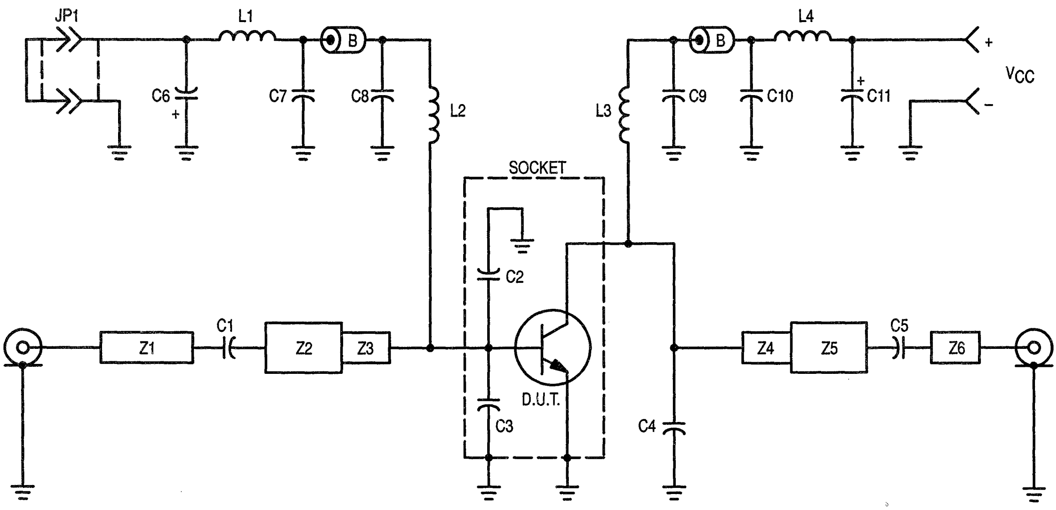
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	2.0	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	31	45	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 512 MHz)	G_{pe}	7.8	8.8	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 512 MHz)	η	55	63	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, f = 512 MHz, P_{in} = 3.0 W, VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			



C1, C5 — 68 pF Mini-Unelco
C2, C3 — 33 pF, Mini-Unelco
C4 — 47 pF, Mini-Unelco
C6, C11 — 10 µF, 25 V Tantalum
C7, C10 — 0.1 µF, Ceramic
C8, C9 — 91 pF, Mini-Unelco
L1, L4 — 4-1/2 Turns, #18 AWG, Enamel Covered, 0.16″ ID
L2, L3 — 2 Turns, #18 AWG Enamel Covered, 0.16″ ID
B — Ferrite Bead, Ferroxcube 56-590-65-3B
Z1 – Z6 — See PCB Artwork
PCB — 1/32″ G-10, ε_r = 4.5 @ UHF
Socket — See Socket Drawings
JP1 — Jumper, #14 AWG w/Banana Plugs

Figure 1. 440–512 MHz Broadband Test Circuit

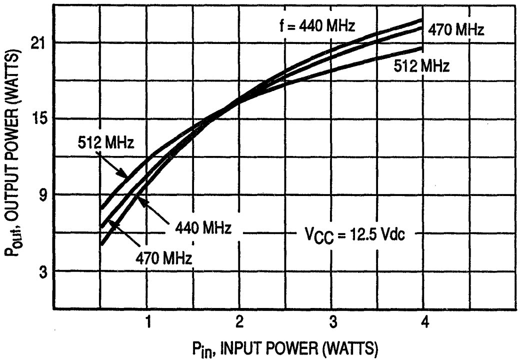


Figure 2. Output Power versus Input Power

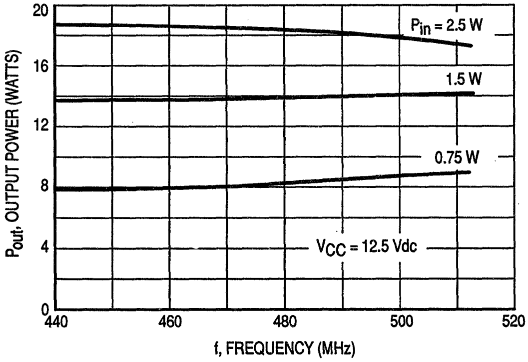


Figure 3. Output Power versus Frequency

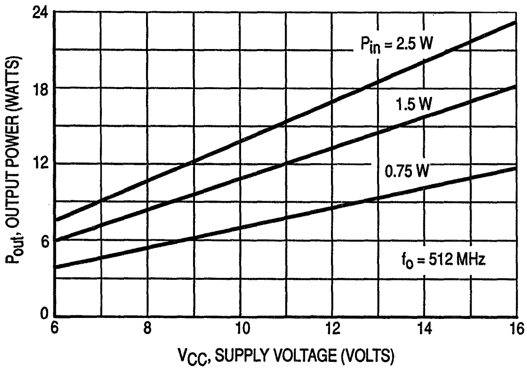


Figure 4. Power Output versus Supply Voltage

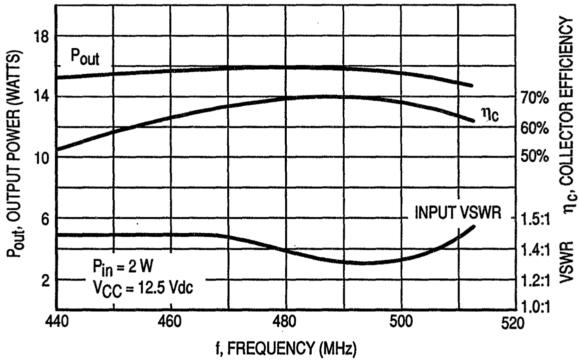
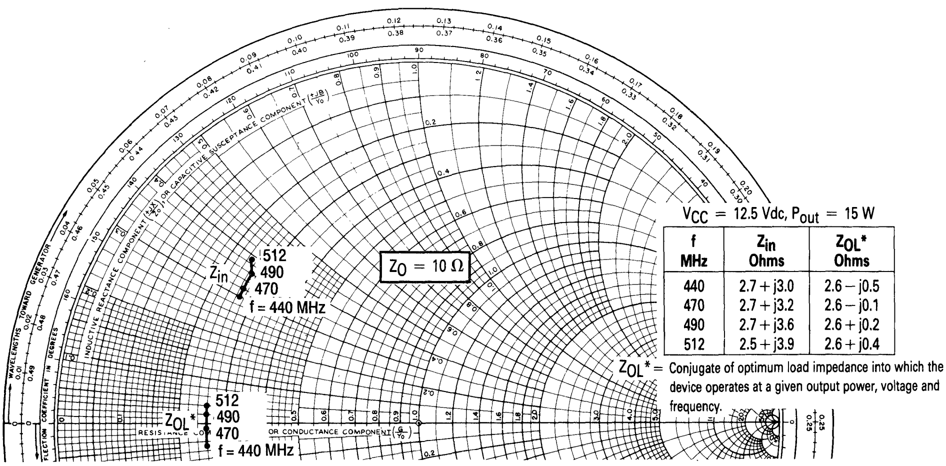


Figure 5. Typical Broadband Circuit Performance



V_{CC} = 12.5 Vdc, P_{out} = 15 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
440	2.7 + j3.0	2.6 − j0.5
470	2.7 + j3.2	2.6 − j0.1
490	2.7 + j3.6	2.6 + j0.2
512	2.5 + j3.9	2.6 + j0.4

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input and Output Impedance

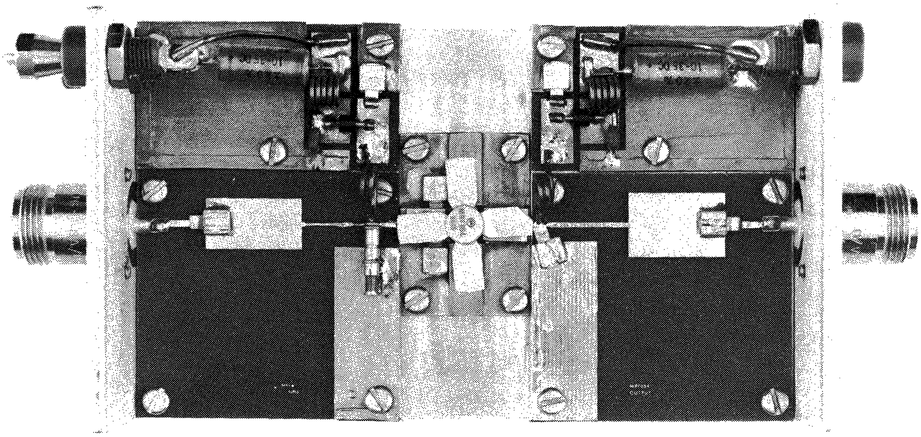


Figure 7. 440–512 MHz Broadband Test Circuit

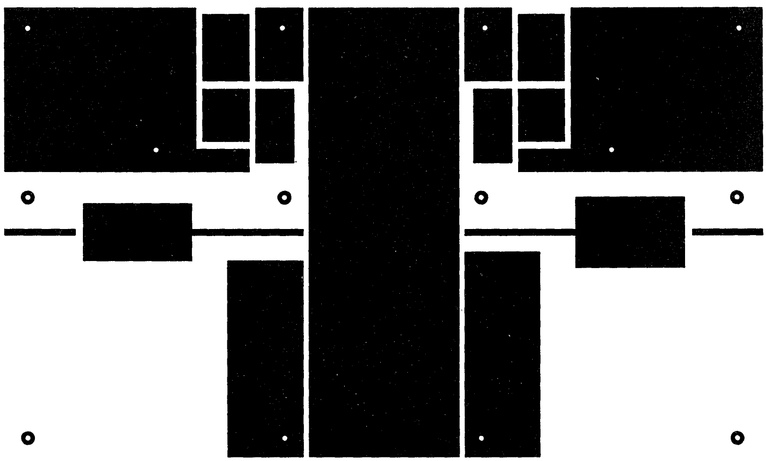


Figure 8. 440–512 MHz PCB Board Layout

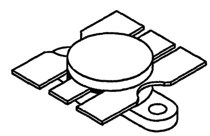
MRF658

The RF Line
NPN Silicon RF Power Transistor

Designed for 12.5 Volt UHF large-signal, common emitter, class-C amplifier applications in industrial and commercial FM equipment operating to 520 MHz.

- Specified 12.5 Volt, 512 MHz Characteristics
  Output Power = 65 Watts
  Minimum Gain = 4.15 dB
  Minimum Efficiency = 50%
- Characterized with Series Equivalent Large-Signal Impedance Parameters from 400 to 520 MHz
- Built-In Matching Network for Broadband Operation
- Triple Ion Implanted for More Consistent Characteristics
- Implanted Emitter Ballast Resistors for Improved Ruggedness
- Silicon Nitride Passivated
- Capable of Surviving Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 15.5 Vdc and 2.0 dB Overdrive

**65 W, 512 MHz
RF POWER TRANSISTOR
NPN SILICON**



CASE 316-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Emitter Voltage	V_{CES}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

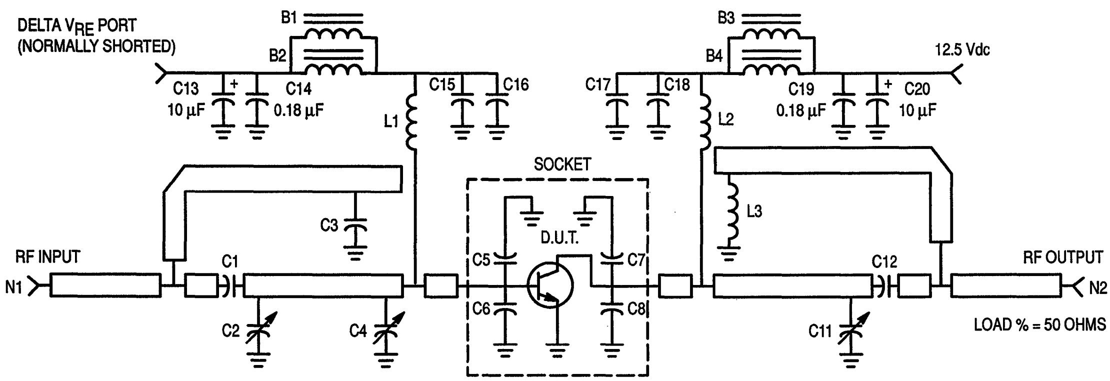
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16.5	29	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	38	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	4.6	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	0.1	10	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	40	85	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	170	220	pF
FUNCTIONAL TESTS (In Motorola Test Fixture. See Figure 1.)					
Output Power (V_{CC} = 12.5 Vdc, P_{in} = 25 W, f = 470 & 512 MHz)	P_{out}	65	—	—	W
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 65 W, f = 470 & 512 MHz)	η	50	60	—	%
Output Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 32 W, f = 512 MHz, VSWR 20:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Return Loss (P_o = 65 W, f = 470 & 512 MHz, V_{CC} = 12.5 V)	IRL	10	15	—	dB



B1–B4 — Long Bead, Fair Rite (2743019446)
C1 — 56 pF, Chip Capacitor, Murata Erie
C2 — 1–20 pF Trimmer, Johanson-JMC 5501 PG26J200
C3 — 39 pF, Chip Capacitor, Murata Erie
C4 — 1–20 pF Trimmer, Johanson-JMC 5501
C5 — 33 pF, Miniature Clamped Mica, SAHA
C6 — 33 pF, Miniature Clamped Mica, SAHA
C7 — 33 pF, Miniature Clamped Mica, SAHA
C8 — 27 pF, Miniature Clamped Mica, SAHA
C11 — 1–20 pF Trimmer, Johanson-JMC 5501 PG26J200
C12 — 110 pF, Chip Capacitor, Murata Erie
C13 — 10 µF, 50 V Electrolytic, Panasonic-ECEV1HV100R
C14 — 0.18 µF Chip Capacitor
C15 — 130 pF, Chip Capacitor, Murata Erie
C16 — 130 pF, Chip Capacitor, Murata Erie
C17 — 130 pF, Chip Capacitor, Murata Erie
C18 — 130 pF, Chip Capacitor, Murata Erie
C19 — 0.18 µF Chip Capacitor
C20 — 10 µF, 50 V Electrolytic, Panasonic-ECEV1HV100R
Board — 1/16″ Glass Teflon, ε_r = 2.55, Keene (GX-0600-55-22)
L1, L2 — 5 Turns, 20 AWG, ID 0.126″
L3 — 2 Turns, 26 AWG, ID 0.073″
N1, N2 — Type N Flange, Omni Spectra (3052-1648-10)

Murata Erie Chip Capacitors —
GRH710COGxxxx100VBE
SAHA Mini Clamped Mica Capacitors — 3HS0006-xx

Figure 1. 512 MHz Test Circuit

2

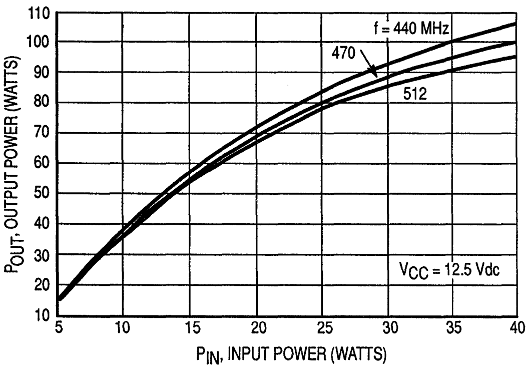


Figure 2. Output Power versus Input Power

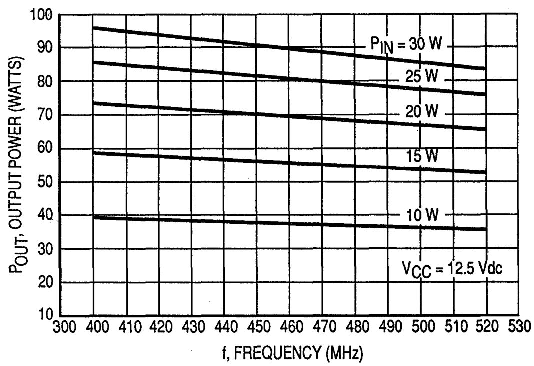


Figure 3. Output Power versus Frequency

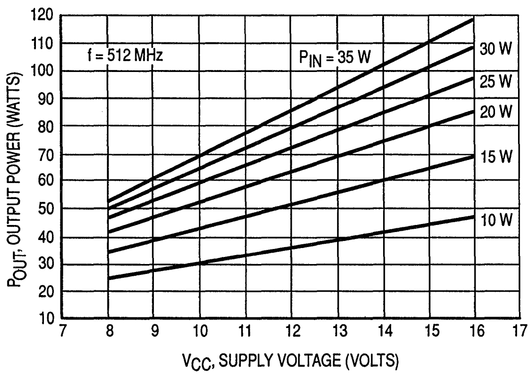
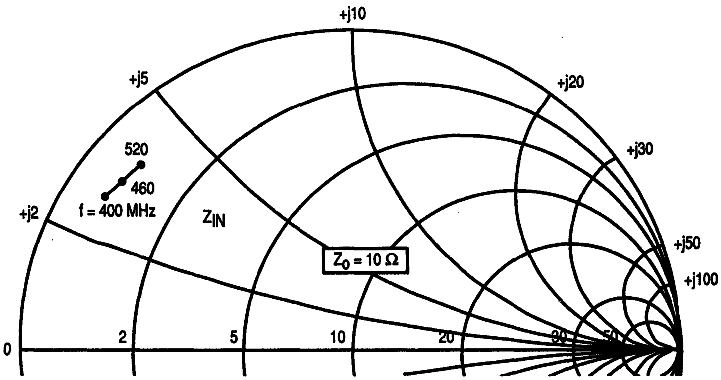


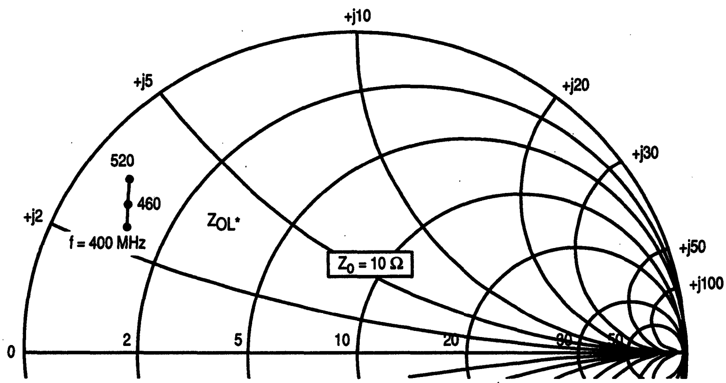
Figure 4. Output Power versus Supply Voltage

2



$V_{CC} = 12.5\ V$ $P_o = 70\ W$

f MHz	ZIN OHMS	Z_{OL}* OHMS
400	0.62 + j2.8	1.20 + j2.5
440	0.72 + j3.1	1.10 + j2.8
480	0.81 + j3.3	0.94 + j3.1
520	0.90 + j3.6	0.80 + j3.4



Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 5. Series Equivalent Input and Output Impedances

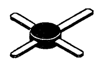
MRF837

The RF Line
NPN Silicon
RF Low Power Transistor

. . . designed primarily for wideband large signal predriver stages in 800 MHz and UHF frequency ranges.

- Specified @ 12.5 V, 870 MHz Characteristics
  Output Power = 750 mW
  Minimum Gain = 8.0 dB
  Efficiency 60% (Typ)
- Low Cost Macro-X Plastic Package
- State-of-the-Art Technology
  Fine Line Geometry
  Gold Top Metal and Wires
  Silicon Nitride Passivated
  Ion Implanted Arsenic Emitters

**750 mW, 870 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON**



**CASE 317, STYLE 2
MACRO-X**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 50°C (1) Derate above 50°C	P_D	2.5 25	Watts mW/°C
Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc

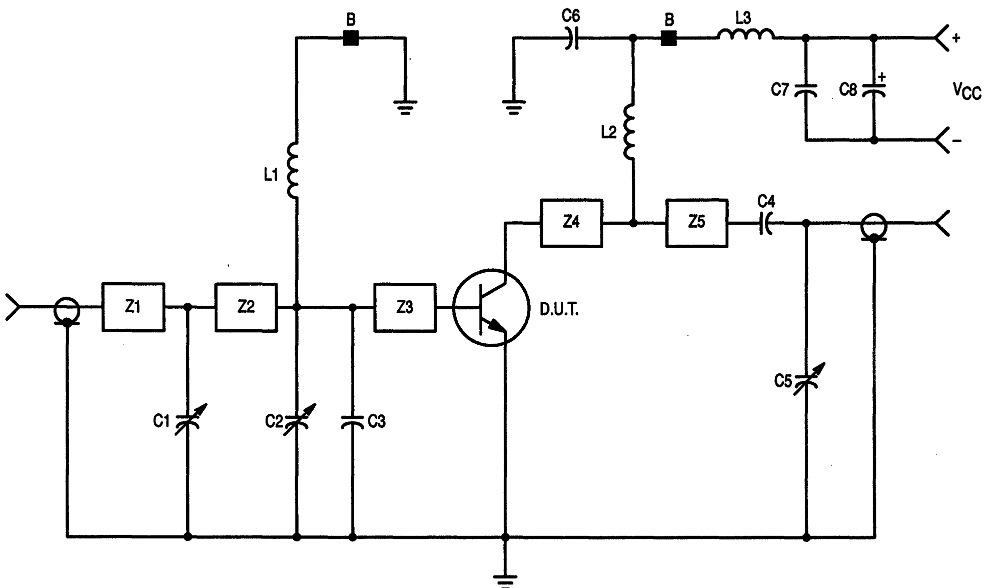
NOTE:
1. Case temperature measured on collector lead immediately adjacent to body of package.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	1.8	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	G_{pe}	8.0	10	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	η	55	60	—	%

2



C1, C2, C5 — 0.8–8.0 pF Johanson Gigatrim
C3 — 5.0 pF Clamped Mica, Mini-Underwood
C6 — 91 pF Clamped Mica, Mini-Underwood
C4 — 470 pF Ceramic Chip Capacitor
C7 — 68 pF Clamped Mica, Mini-Underwood
C8 — 1.0 µF 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B

L1, L2 — 4 Turns, #21 AWG, 5/32″ ID
L3 — 7 Turns, #21 AWG, 5/32″ ID
Z1 — 0.80″ x 0.163″ Microstrip, Z_o = 50 Ω
Z2 — 1.375″ x 0.163″ Microstrip, Z_o = 50 Ω
Z3, Z4 — 0.375″ x 0.163″ Microstrip, Z_o = 50 Ω
Z5 — 1.35″ x 0.163″ Microstrip, Z_o = 50 Ω
PCB — 1/16″ Glass Teflon, $ε_r$ = 2.56

Figure 1. 800–880 MHz Broadband Circuit

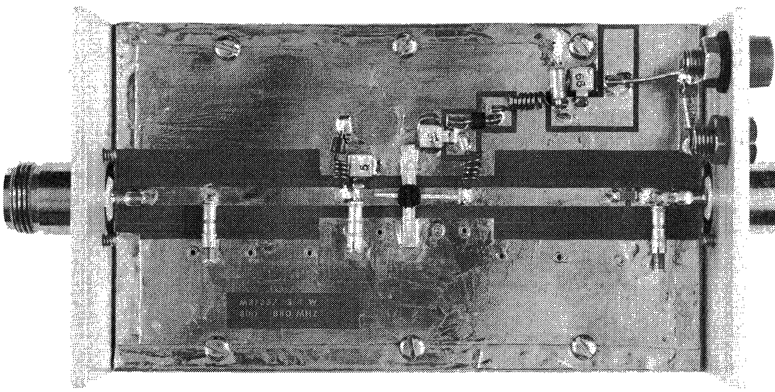
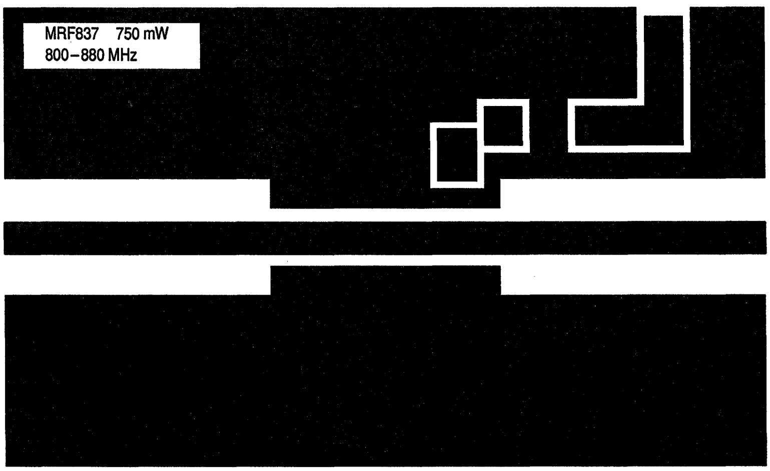


Figure 2. 800−880 Broadband Circuit

2



SCALE 0.75:1

Figure 3. 800−880 MHz Broadband Circuit Photomaster

800/900 MHz BAND DATA

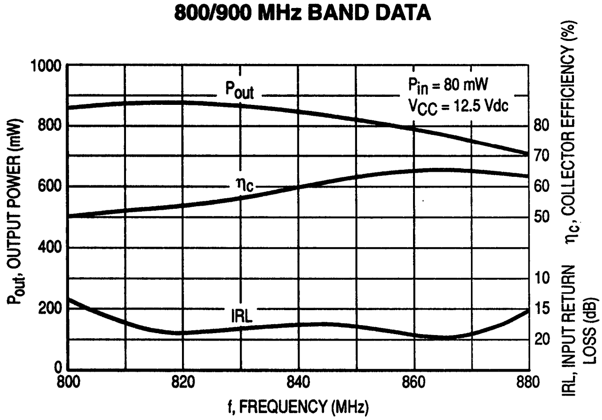


Figure 4. Broadband Performance

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 150 mW	P_{in} = 100 mW	P_{out} 806 MHz = 870 mW P_{out} 870 MHz = 820 mW P_{out} 960 MHz = 700 mW	P_{out} 806 MHz = 1.05 W P_{out} 870 MHz = 950 mW P_{out} 960 MHz = 725 mW
806	6.1 + j3.6	4.3 + j0.6	38.3 – j16.4	23.2 – j31.6
870	5.6 + j5.2	6.5 + j3.6	40.8 – j18.9	41.3 – j18.4
960	6.1 + j6.8	6.4 + j4.5	43.8 – j14.7	41.4 – j19.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Table 1. Z_{in} and Z_{OL} versus Collector Voltage, Input Power and Output Power

800/900 MHz BAND DATA (continued)

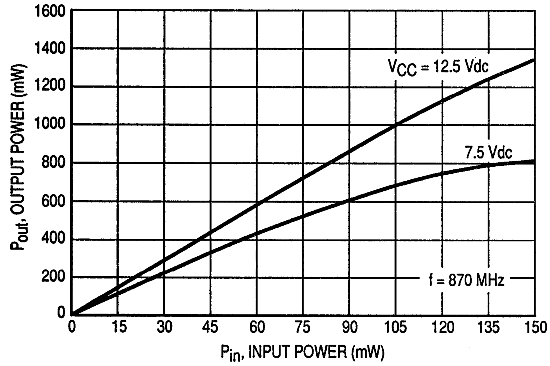


Figure 5. Output Power versus Input Power

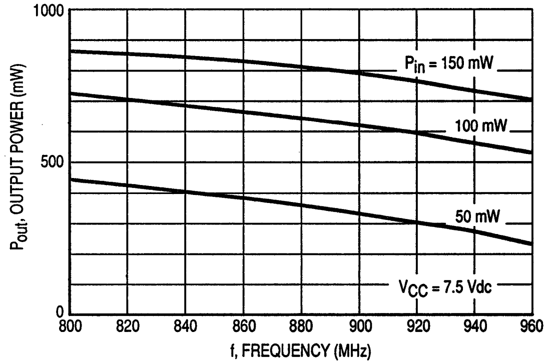


Figure 6. Output Power versus Frequency

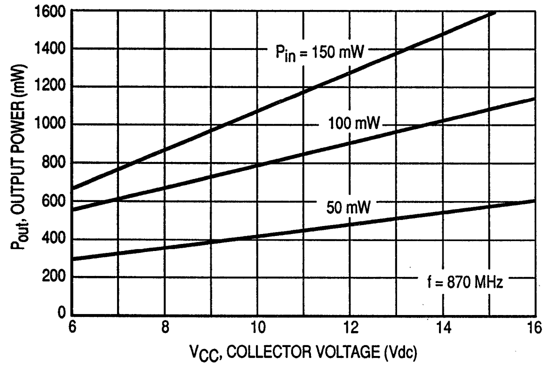


Figure 7. Output Power versus Collector Voltage

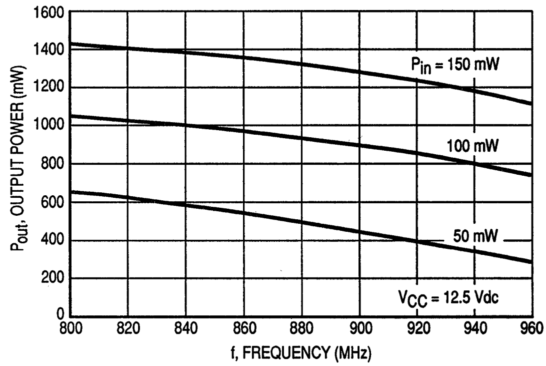


Figure 8. Output Power versus Frequency

2

UHF BAND DATA

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 75 mW	P_{in} = 50 mW	P_{out} 400 MHz = 875 mW P_{out} 450 MHz = 790 mW P_{out} 512 MHz = 675 mW	P_{out} 400 MHz = 1.25 W P_{out} 450 MHz = 1.1 W P_{out} 512 MHz = 775 mW
400	9.6 – j7.5	8.2 – j11.5	37.8 + j12.3	51.8 – j7.2
450	11.3 – j7.5	9.7 – j11	35.8 + j8.6	52.2 – j16.7
512	11.5 – j6.8	12 – j9.2	42.4 + j0.24	43.7 – j5.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Table 2. Z_{in} and Z_{OL} versus Collector Voltage, Input Power, and Output Power

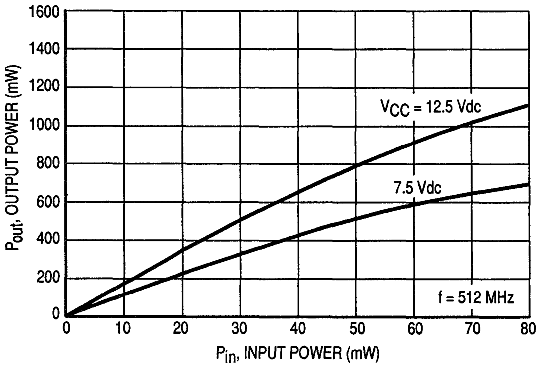


Figure 9. Output Power versus Input Power

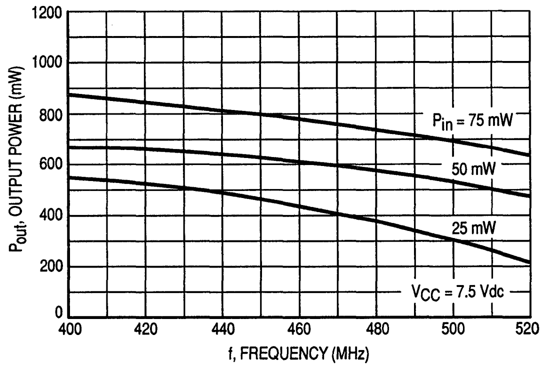


Figure 10. Output Power versus Frequency

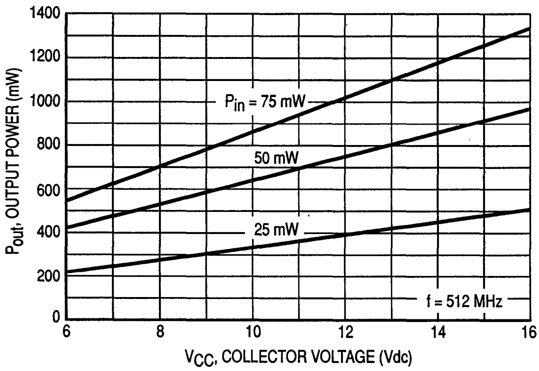


Figure 11. Output Power versus Collector Voltage

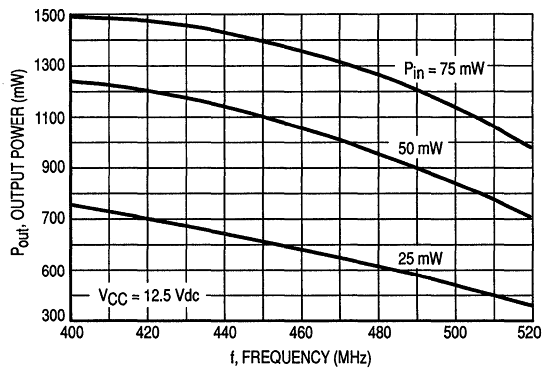


Figure 12. Output Power versus Frequency

2

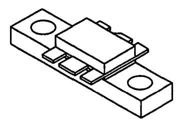
MRF839F

The RF Line
NPN Silicon RF Power Transistors

. . . designed for 12.5 Volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 V, 870 MHz Characteristics
  Output Power = 3.0 Watts
  Power Gain = 8.0 dB Min
  Efficiency = 55% Min
- 100% Tested for Load Mismatch at Rated Input Power and 15.5 V
- Series Equivalent Large-Signal Characterization

3.0 W, 806–960 MHz
RF POWER
TRANSISTORS
COMMON-EMITTER
NPN SILICON



CASE 319, STYLE 2
MRF839F

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.6	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 110°C Derate above 110°C	P_D	10 111	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	90	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	6.5	10	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (P_{out} = 3.0 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PE}	8.0	10	—	dB
Collector Efficiency (P_{out} = 3.0 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η_c	55	63	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 0.5 W, f = 870 MHz, VSWR = 20:1, all phase angles)	ψ	No Degradation in Output Power			

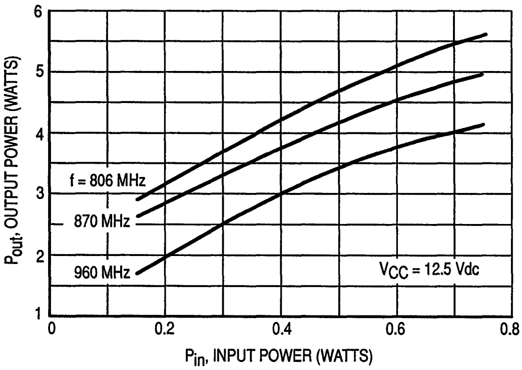


Figure 1. Output Power versus Input Power

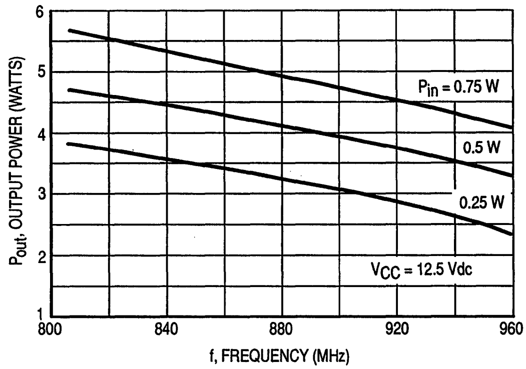


Figure 2. Output Power versus Frequency

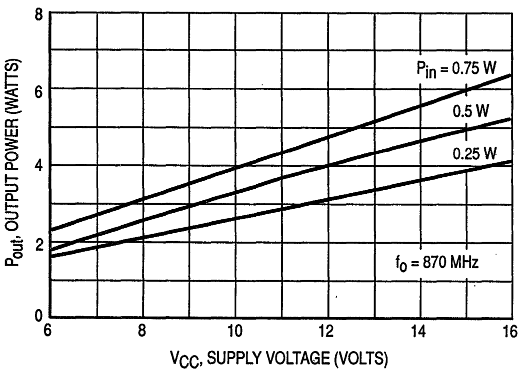


Figure 3. Output Power versus Supply Voltage

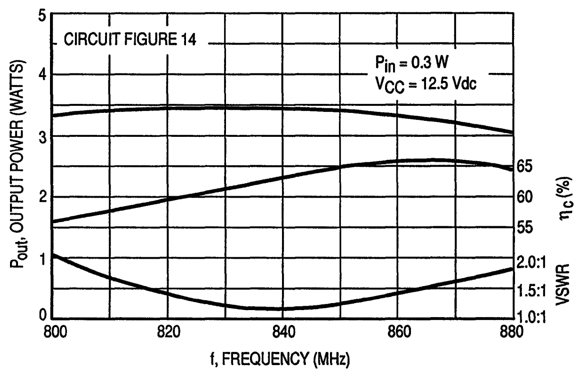
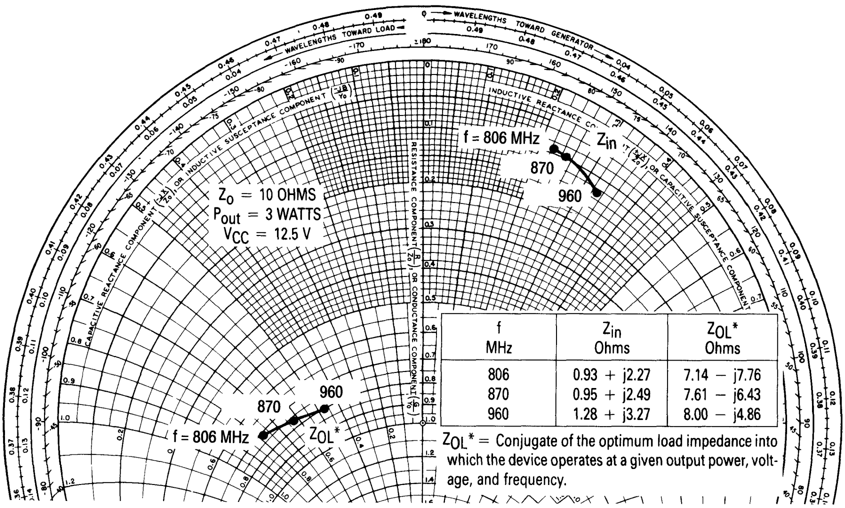


Figure 4. Broadband Performance

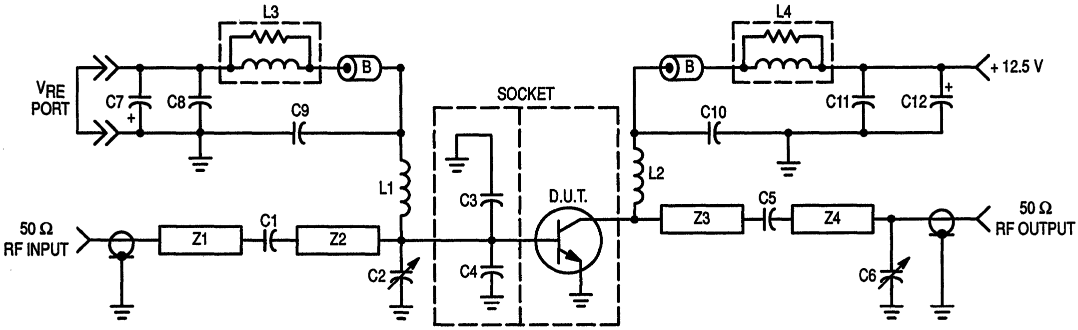


f MHz	Z_{in} Ohms	Z_{OL}* Ohms
806	0.93 + j2.27	7.14 − j7.76
870	0.95 + j2.49	7.61 − j6.43
960	1.28 + j3.27	8.00 − j4.86

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 5. Series Equivalent Input/Output Impedances

2



B — Bead, Ferroxcube #56-590-65/3B
C1 — 47 pF Chip Cap (Murata Erie MA20470B)
C3, C4 — 13 pF Mini-Underwood
C5 — 51 pF Chip Cap (ATC 100B510JC500)
C2, C6 — 0.8–8.0 pF Johanson #7291
C7, C12 — 10 μF, 35 V Electrolytic Capacitor
C8, C11 — 1000 pF Unelco, J101
C9, C10 — 91 pF Mini-Underwood
L1, L2 — 4 Turns, #18 Enameled, 5/32″ ID
L3, L4 — 12 Turns, #22 Enameled over 10 Ohm, 1/2 W Carbon Resistor
Z1, Z4 — 50 Ohm Stripline
Z2 — 32 Ohm Stripline (1/4 λ @ 838 MHz)
Z3 — 16 Ohm Stripline (1/4 λ @ 838 MHz)
Board Material — 0.032″ Glass Teflon, 2 oz. Copper Clad, $\varepsilon_r = 2.55$

Figure 6. 800–880 MHz Broadband Test Circuit

2

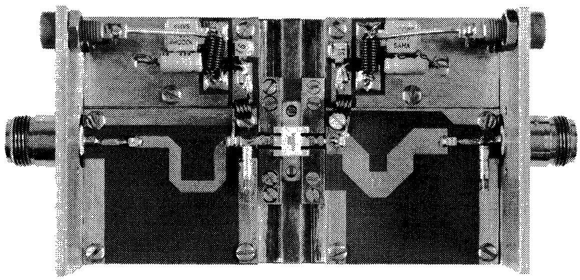
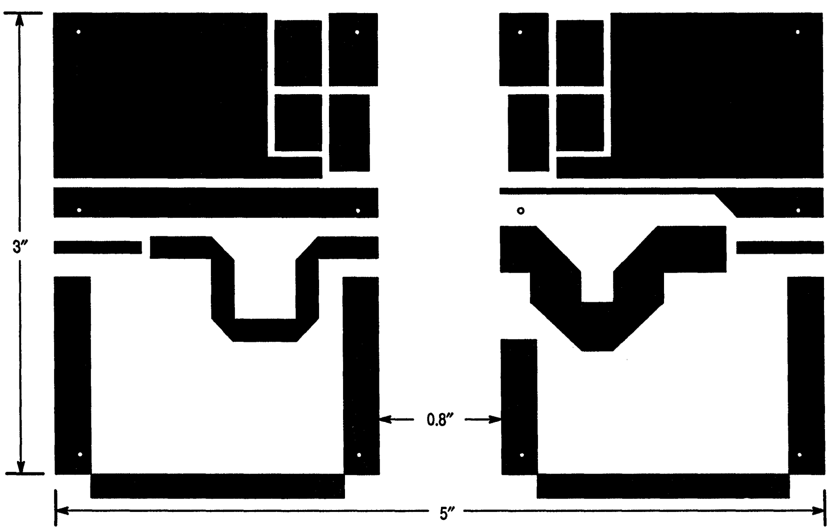


Figure 7. Broadband Test Circuit



SCALE 0.75:1

Figure 8. Photomaster

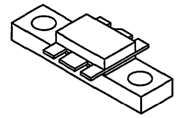
MRF840

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 10 Watts
  Power Gain = 6.0 dB Min
  Efficiency = 50% Min
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ 15.5 Volt Supply and 50% RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**10 W, 870 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 319, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.8	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	40 0.32	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.1	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc

(continued)

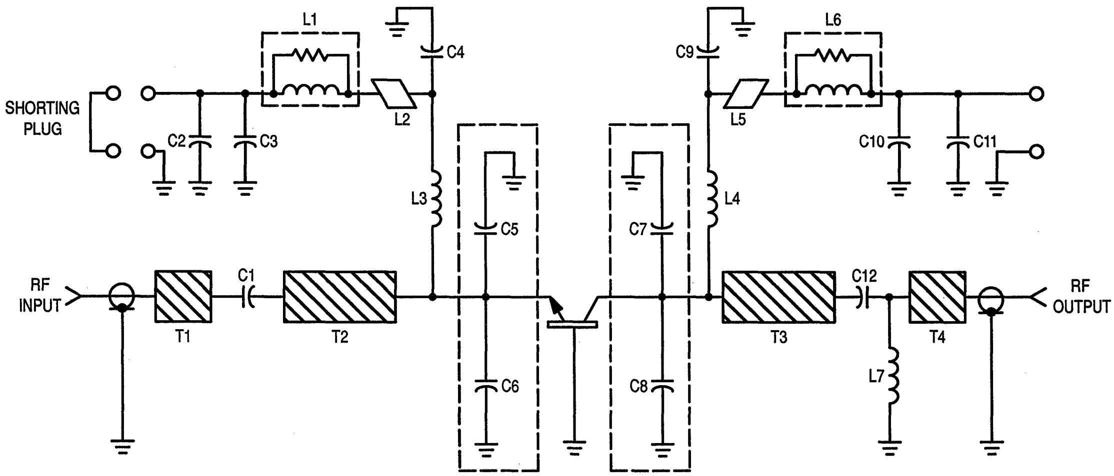
NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	24	35	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (P_{out} = 10 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PE}	6.0	7.0	—	dB
Collector Efficiency (P_{out} = 10 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η	50	55	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 3.0 W, (3) f = 870 MHz, VSWR = 20:1, all phase angles)	—	No Degradation in Output Power			

NOTE:
3. P_{in} = 150% of the typical input power requirement for 10 W output power @ 12.5 Vdc.

2



C1, C12 — 50 pF, 100 Mil Chip Capacitor
C2, C11 — 15 µF, 20 V Tantalum
C3, C10 — 1000 pF, 350 V UNELCO
C4, C9 — 91 pF Mini-Underwood
C5 — 15 pF
C6 — 15 pF
C7 — 15 pF
C8 — 15 pF

L1, L6 — 11 Turns 20 AWG Around 10 Ω 1/2 W Resistor
L2, L5 — Ferrite Bead
L3, L4 — 4 Turn 20 AWG 0.2″ I.D.
T1, T4 — Z_O = 50 Ω
T2 — Z_O = 30 Ω ℓ = λ/4 @ 838 MHz
T3 — Z_O = 13.5 Ω ℓ= λ/4 @ 838 MHz

L7 — 18 AWG Wire Loop

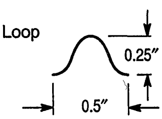


Figure 1. 870 MHz Test Circuit

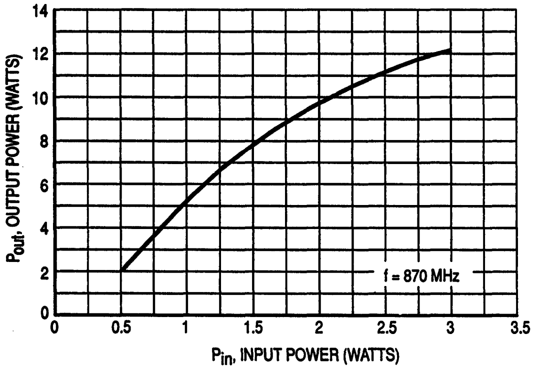


Figure 2. Output Power versus Input Power

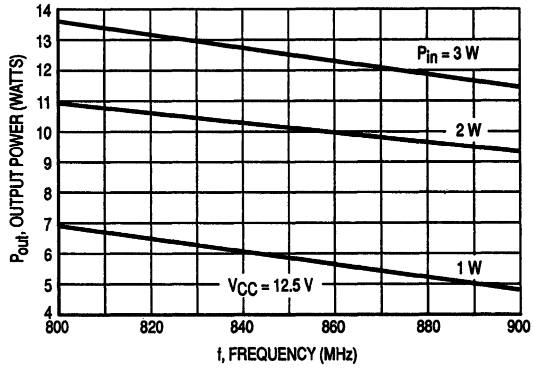


Figure 3. Output Power versus Frequency

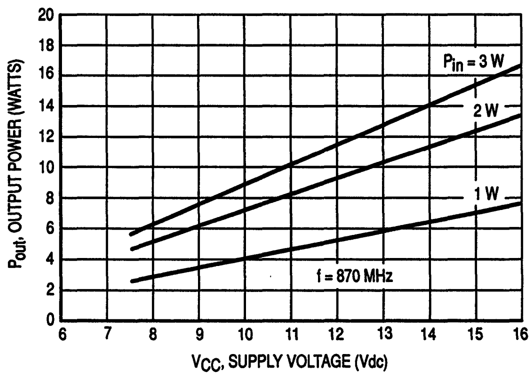
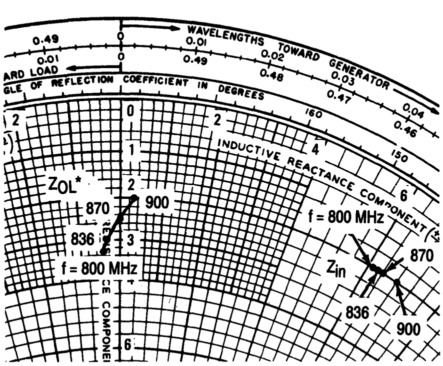


Figure 4. Output Power versus Supply Voltage



P_{out} = 10 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	2.0 + j6.1	3.3 – j0.4
836	2.0 + j6.2	3.0 – j0.3
870	2.0 + j6.4	2.5 + j0.0
900	2.0 + j6.8	2.0 + j0.3

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 5. Series Equivalent Input/Output Impedance

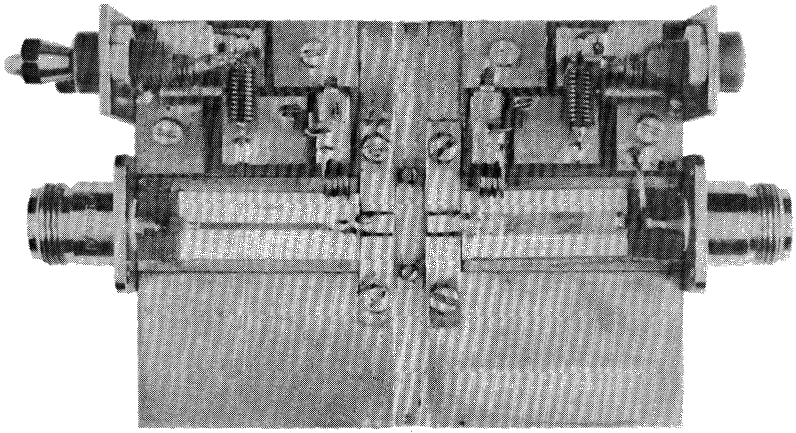


Figure 6. 870 MHz Test Circuit

2

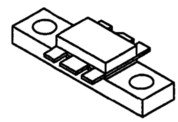
MRF842

The RF Line
NPN Silicon RF Power Transistor

20 W, 870 MHz
RF POWER
TRANSISTOR
NPN SILICON

. . . designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 20 Watts
  Power Gain = 6.0 dB Min
  Efficiency = 50% Min
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- 100% Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ 15.5 Volt Supply and 50% RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated



CASE 319, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.6	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	80 0.64	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc

NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

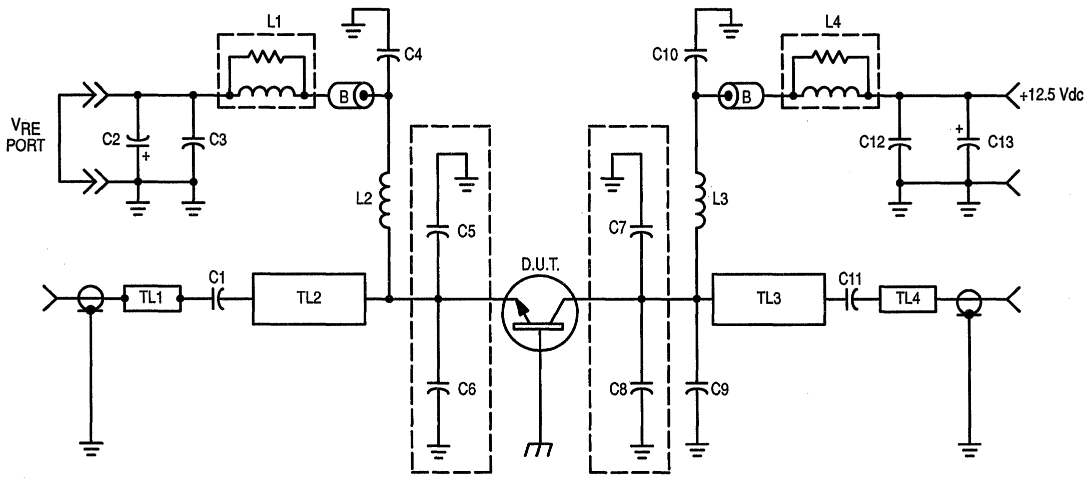
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	45	65	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (P_{out} = 20 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PB}	6.0	7.0	—	dB
Collector Efficiency (P_{out} = 20 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η	50	55	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} (3) = 6.0 W, f = 870 MHz, VSWR = 20:1, all phase angles)	—	No Degradation in Output Power			

NOTE:
3. P_{in} = 150% of the typical input power requirement for 20 W output power @ 12.5 Vdc.

2



B — Ferrite Bead, Ferroxcube 56-590-65-3B
C1, C11 — 51 pF, 100 Mil Chip Capacitor
C2, C13 — 15 µF, 20 WV Tantalum
C3, C12 — 1000 pF Unelco J101
C4, C10 — 91 pF Mini-Underwood
C5 — 15 pF Mini-Underwood
C6 — 12 pF Mini-Underwood
C7, C8 — 21 pF Mini-Underwood
C9 — 11 pF Mini-Underwood

L1, L4 — 11 Turns #20 AWG Over 10 ohm 1/2 W Carbon
L2, L3 — 4 Turns #20 AWG, 200 Mil ID
TL1, TL4 — Micro Strip, Z_o = 50 Ω
TL2 — Micro Strip, Z_o = 38 Ω, λ/4 @ 838 MHz
TL3 — Micro Strip, Z_o = 24 Ω, λ/4 @ 838 MHz
Board — 0.032″ Glass Teflon
2 oz. Cu CLAD, ε_r = 2.55

Figure 1. 870 MHz Test Circuit Schematic

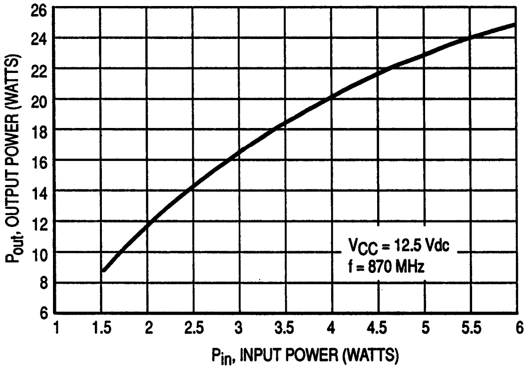


Figure 2. Output Power versus Input Power

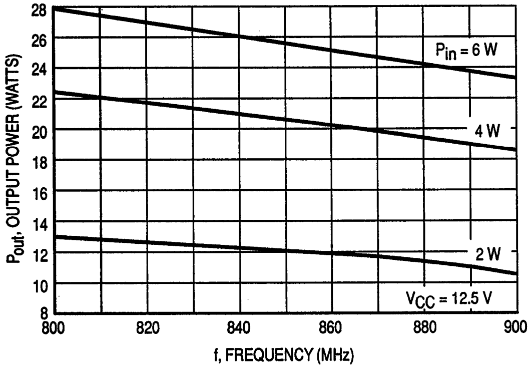


Figure 3. Output Power versus Frequency

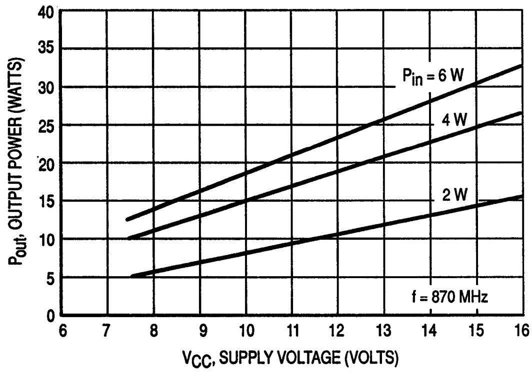
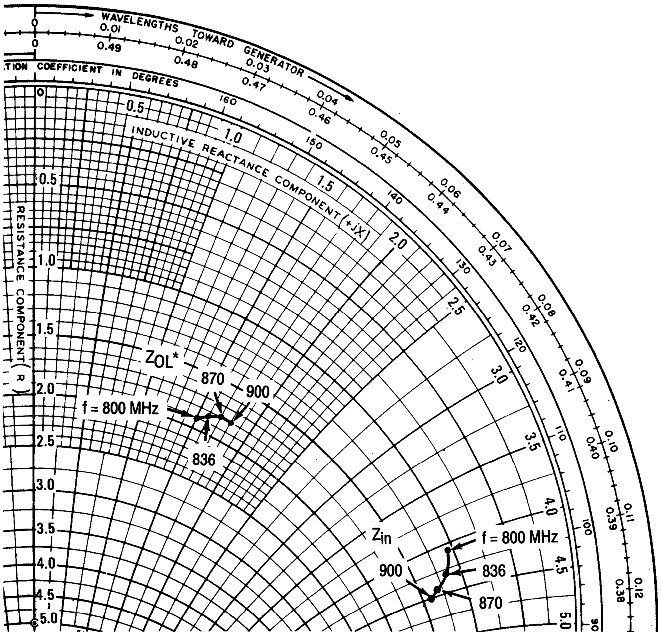


Figure 4. Output Power versus Supply Voltage

2



P_{out} = 20 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	1.1 + j4.1	1.9 + j1.5
836	1.2 + j4.3	1.85 + j1.6
870	1.4 + j4.4	1.8 + j1.7
900	1.6 + j4.5	1.8 + j1.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 5. Series Equivalent Input/Output Impedance

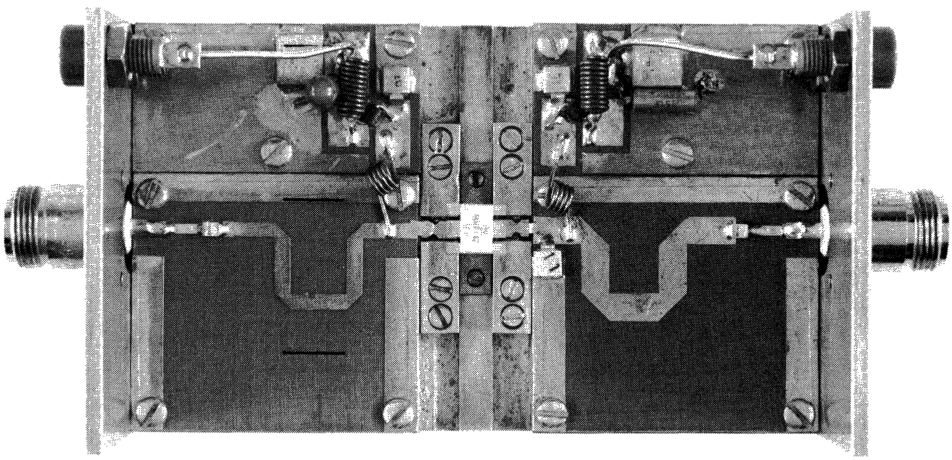


Figure 6. 870 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

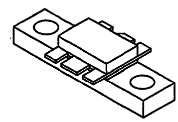
MRF844

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 30 Watts
  Power Gain = 5.2 dB Min
  Efficiency = 50% Min
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ High Line and RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

30 W, 870 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 319, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10.9	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	10	mAdc

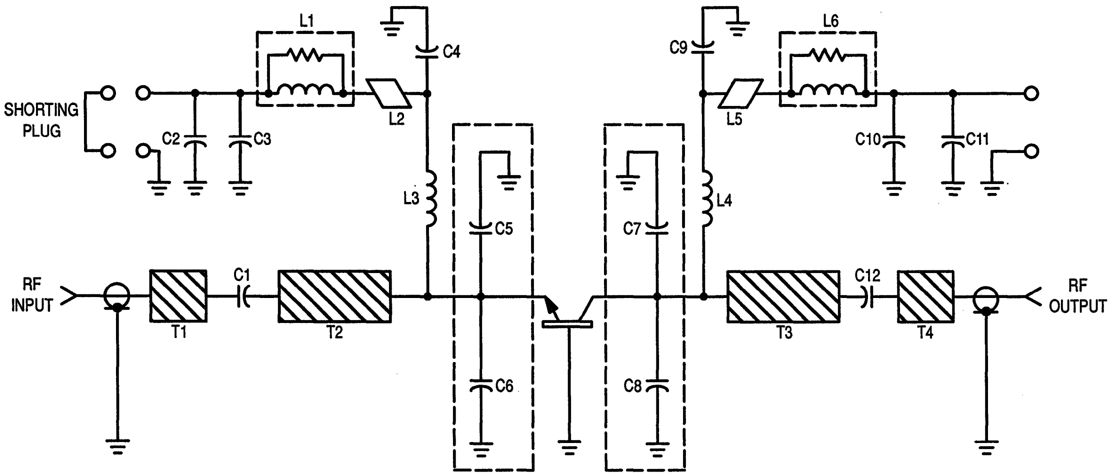
NOTES: (continued)
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	60	90	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (P_{out} = 30 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PB}	5.2	6.0	—	dB
Collector Efficiency (P_{out} = 30 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η	50	55	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 12 W (3), f = 870 MHz, VSWR = 20:1, all phase angles)	—	No Degradation in Output Power			

NOTE:
3. P_{in} = 150% of the typical input power requirement for 30 W output power @ 12.5 Vdc.

2



C1, C12 — 50 pF, 100 Mil Chip Capacitor
C2, C11 — 15 µF, 20 V Tantalum
C3, C10 — 1000 pF, 350 V UNELCO
C4, C9 — 91 pF Mini-Underwood
C5 — 15 pF Mini-Underwood
C6 — 15 pF Mini-Underwood
C7 — 18 pF Mini-Underwood
C8 — 24 pF Mini-Underwood

L1, L6 — 11 Turns 20 AWG Around 10 Ω 1/2 W Resistor
L2, L5 — Ferrite Bead
L3, L4 — 4 Turn 20 AWG 0.2″ I.D.
T1, T4 — Z_O = 50 Ω
T2 — Z_O = 38 Ω $\ell = \lambda/4$ @ 838 MHz
T3 — Z_O = 26 Ω $\ell = \lambda/4$ @ 838 MHz

Figure 1. 870 MHz Test Circuit

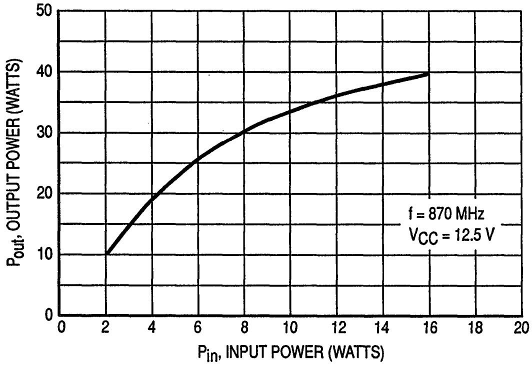


Figure 2. Output Power versus Input Power

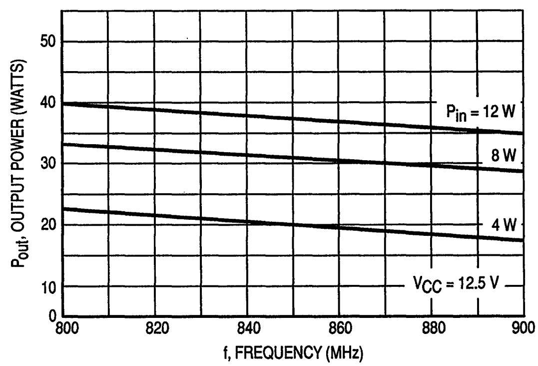


Figure 3. Output Power versus Frequency

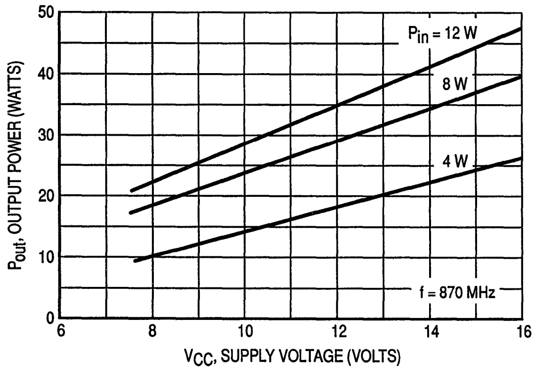
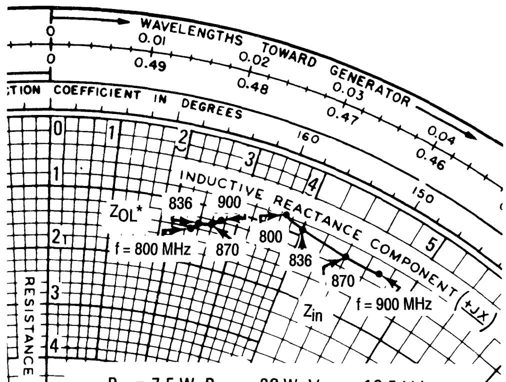


Figure 4. Output Power versus Supply Voltage



P_{in} = 7.5 W, P_{out} = 30 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	0.8 + j3.7	1.4 + j2.3
836	0.9 + j4.0	1.3 + j2.4
870	1.0 + j4.4	1.25 + j2.6
900	1.0 + j4.7	1.2 + j2.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 5. Series Equivalent Input/Output Impedance

2

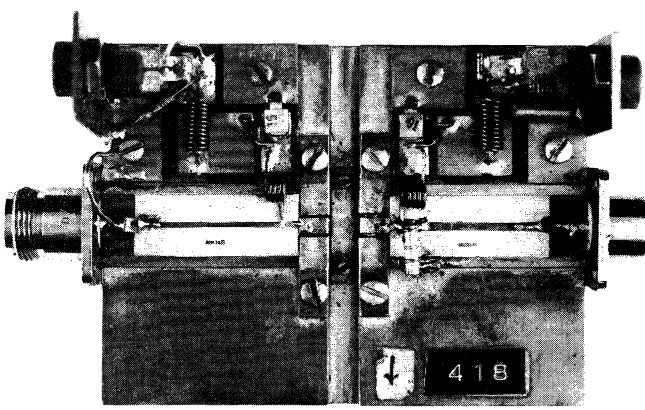


Figure 6. 870 MHz Test Circuit

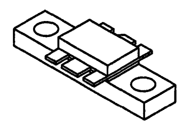
MRF847

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 12.5 volt UHF large-signal, **common-base** amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 45 Watts
  Power Gain = 4.5 dB Min
  Efficiency = 60% Min
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 10:1 VSWR @ High Line and Rated Drive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**45 W, 870 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 319, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Base Voltage	V_{CBO}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	12	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	150 0.85	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	°C/W

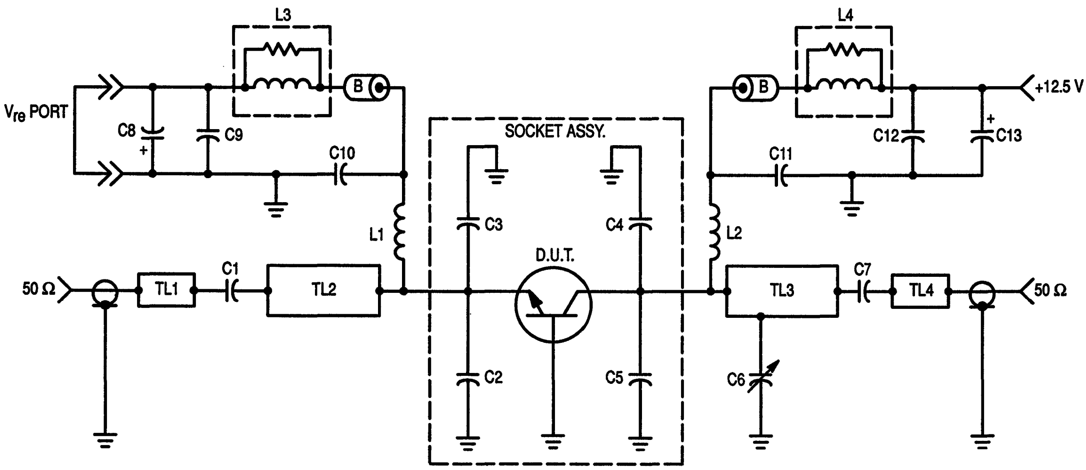
ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	38	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	40	65	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	90	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 45 W, f = 870 MHz)	G_{PB}	4.5	5.5	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 45 W, f = 870 MHz)	η_c	60	68	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 16 W, f = 870 MHz, VSWR = 10:1, All Phase Angles)	ψ	No Degradation in Output Power			



C1 — 51 pF, 100 mil Chip Capacitor
C2 — 12 pF, Mini-Underwood
C3 — 11 pF, Mini-Underwood
C4, C5 — 21 pF, Mini-Underwood
C6 — 0.08–8.0 pF Johansen Gigatrim
C7 — 47 pF, 100 mil Chip Capacitor
C8, C13 — 10 µF, 25 WV Electrolytic Capacitor
C9, C12 — 1000 pF Unelco J101
C10, C11 — 91 pF Mini-Underwood
L1, L2 — 4 Turns #18 Enameled, 200 mil ID
L3, L4 — 12 Turns #22 Enameled, Wound Over 10 Ω Resistor
TL1, TL4 — 50 Ω Microstrip Line
TL2 — Microstrip (Z_o = 38 ohms, λ/4 @ 838 MHz)
TL3 — Microstrip (Z_o = 28 ohms, λ/4 @ 838 MHz)
Board Material — 0.032″ Glass-Teflon, 2 oz. cu. clad, ε_r = 2.56
B — Ferrite Bead, Ferroxcube 56-590-65-3B

Figure 1. 806–870 MHz Broadband Test Circuit

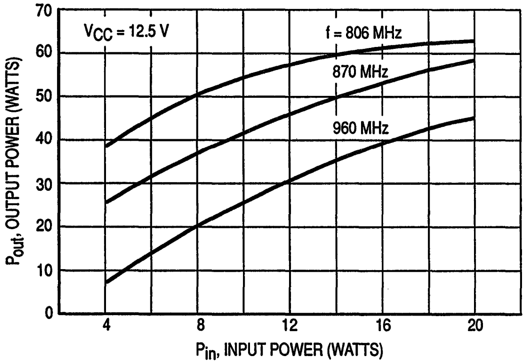


Figure 2. Output Power versus Input Power

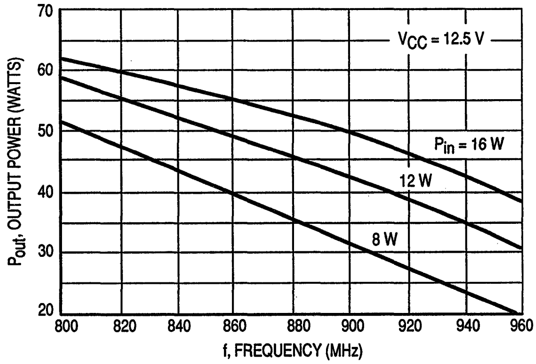


Figure 3. Output Power versus Frequency

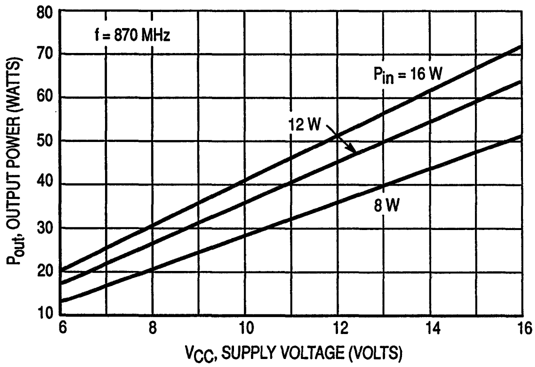
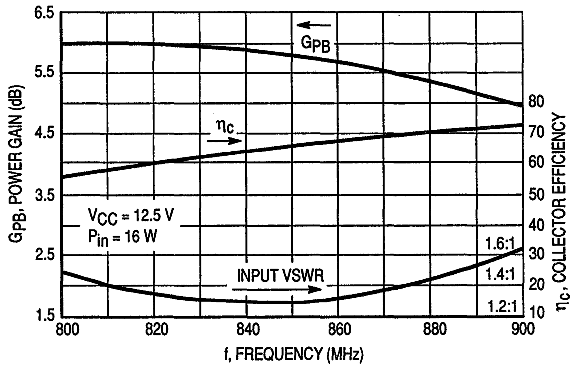
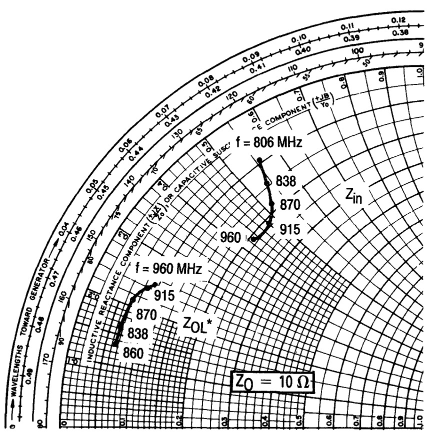


Figure 4. Output Power versus Supply Voltage





V_{CC} = 12.5 Vdc, P_{in} = 16 W, P_{out} = 45 W

f MHz	Z_{in} (Ohms)		f MHz	Z_{OL}* (Ohms)	
806	0.99	+j5.52	806	0.67	+j1.33
838	1.48	+j5.47	838	0.68	+j1.66
870	1.79	+j5.25	870	0.72	+j2.16
915	2.12	+j4.80	915	0.83	+j2.40
960	2.11	+j4.28	960	0.99	+j2.50

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

MRF880

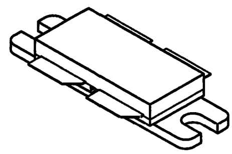
Motorola Preferred Device

The RF Line
NPN Silicon RF Power Transistor

90 W, 900 MHz
RF POWER TRANSISTOR
NPN SILICON

Designed for 26 V UHF large-signal, common emitter, class-AB linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 800–960 MHz.

- Specified 26 V, 900 MHz Characteristics
  Output Power = 90 Watts
  Gain = 8.5 dB Min. @ 900 MHz, class AB
  Efficiency = 35% Min. @ 900 MHz, 90 Watts (PEP)
  Intermodulation Distortion −29 dBc Max. @ 90 Watts (PEP)
- Characterized with Series Equivalent Large-Signal Parameters from 800 to 960 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 5:1 VSWR @ 26 Vdc, and rated output power
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration



CASE 375A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Emitter Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	140 0.80	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	28	33	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	75	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	4.5	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10.0	mAdc

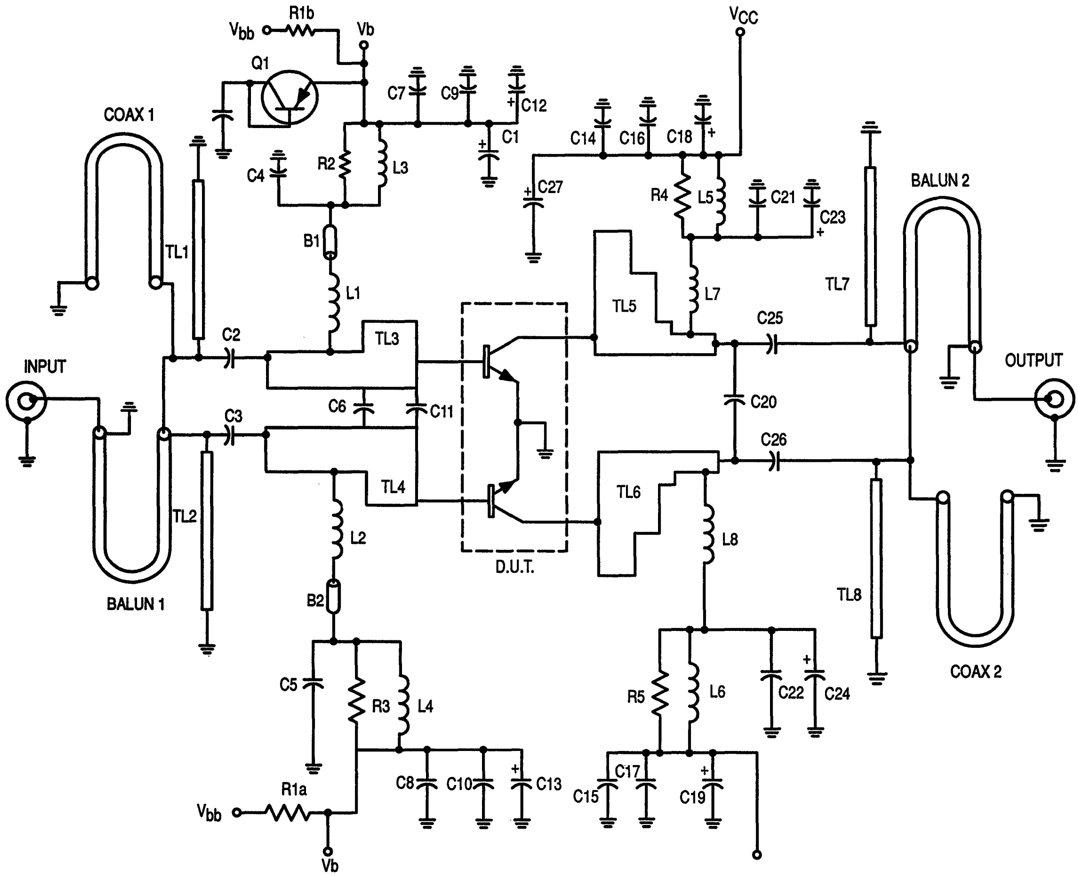
(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	30	60	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz) — for information only. This part is collector matched.	C_{ob}	—	45	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 90 Watts (PEP), I_{CQ} = 250 mA, f_1 = 900 MHz, f_2 = 900.1 MHz)	G_{pe}	8.5	9.5	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 90 Watts (PEP), I_{CQ} = 250 mA, f_1 = 900 MHz, f_2 = 900.1 MHz)	η_C	35	42	—	%
Intermodulation Distortion (V_{CC} = 26 Vdc, P_{out} = 90 Watts (PEP), I_{CQ} = 250 mA, f_1 = 900 MHz, f_2 = 900.1 MHz)	IMD	—	−32	−29	dBc
Output Mismatch Stress (V_{CC} = 26 Vdc, P_{out} = 90 Watts (PEP), I_{CQ} = 250 mA, f_1 = 900 MHz, f_2 = 900.1 MHz Load VSWR = 5:1, All phase angles at frequency of test)	ψ	No Degradation in Output Power Before and After Test			

2



B1, B2 — Ferrite Bead
C1 — 200 μF Cap, 50 Vdc Min
C2, C3, C25, C26 — 43 pF Chip Cap, 100 Mil
C4, C5, C21, C22 — 100 pF Chip Cap, 100 Mil
C6 — 3.3 pF Chip Cap, 100 Mil
C7, C8, C14, C15 — 1000 pF Chip Cap, 100 Mil
C9, C10, C16, C17 — 1800 pF Chip Cap, 100 Mil
C11 — 7.5 pF Chip Cap, 50 Mil
C12, C13, C18, C19, C23, C24 — 10 μF Cap, 50 Vdc
C20 — 1.8 pF Chip Cap
C27 — 500 μF Cap, 50 Vdc Min
L1, L2, L7, L8 — 4T No. 20 AWG, 0.163″ ID CW
L3, L4, L5, L6 — 12T No. 22 AWG, 0.140″ ID CW
Q1 — BD166
R1a, R1b — 56 Ohm, 1 W Resistor
R2, R3, R4, R5 — 4 x 39 Ohm, 1/8 W Chip Resistor
TL1-8 — On PCB Mask
Balun 1,2 Coax 1,2 — 2.20″ 50 Ohm Semi-Rigid Coax, 0.088″ OD
PCB — 0.030″, Teflon®-Fiberglass, $\epsilon_r = 2.55$
Wear Blocks — 0.330″ x 0.170″ x 0.50″ Beryllium Copper

Figure 1. Broadband Test Circuit

2

TYPICAL CHARACTERISTICS

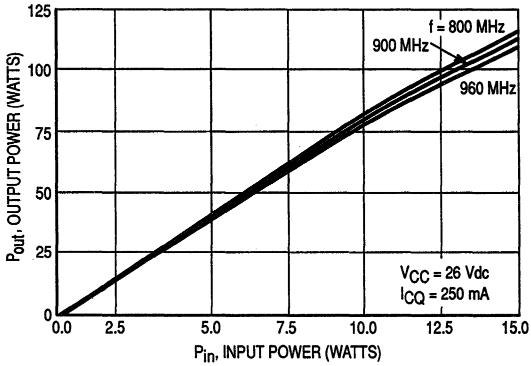


Figure 2. Output Power versus Input Power

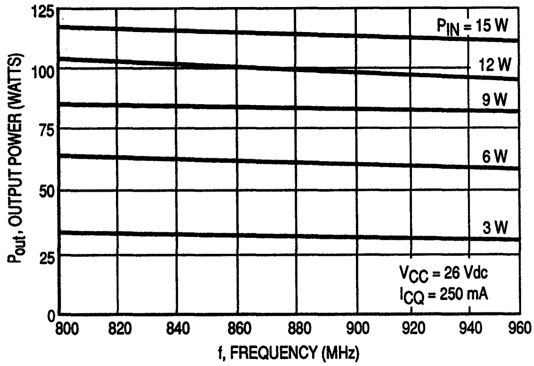


Figure 3. Output Power versus Frequency

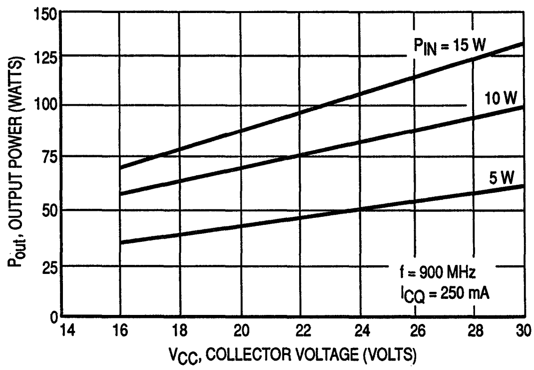


Figure 4. Output Power versus Supply Voltage

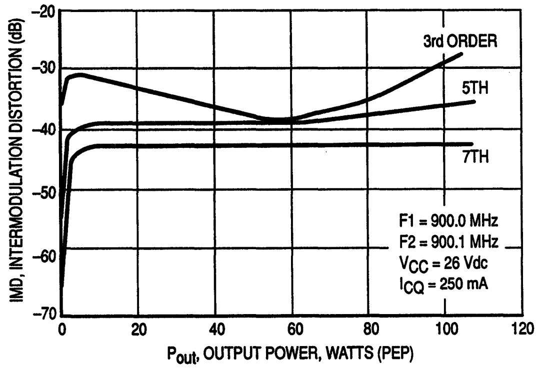
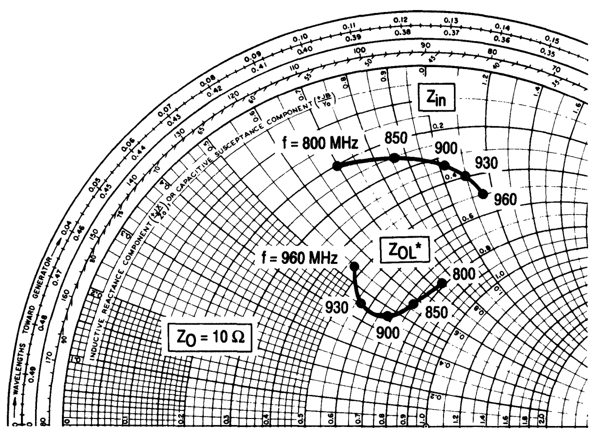


Figure 5. Intermodulation Distortion versus Output Power



P_o = 90 W, V_{CC} = 26 V

f (MHz)	Z_{in} ohms	Z_{OL}* ohms
800	2.00 + j6.90	7.68 + j7.33
850	2.45 + j8.60	7.38 + j5.86
900	3.30 + j10.1	6.93 + j4.53
930	3.90 + j10.9	5.89 + j4.42
960	5.00 + j11.5	4.58 + j5.57

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input/Output Impedances

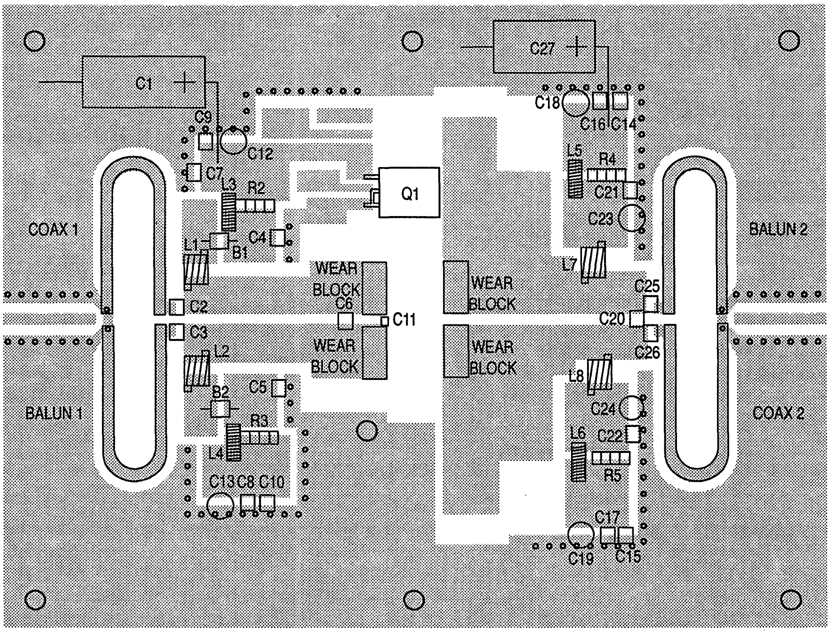
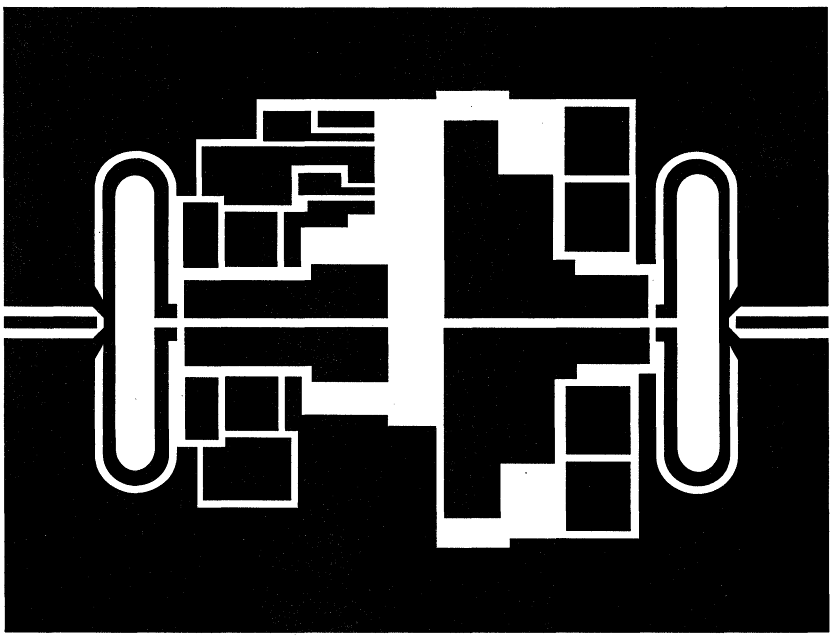


Figure 7. Fixture Component Layout



(Not to Scale)

Figure 8. Photomaster for Test Circuit

2

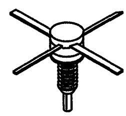
MRF890
MRF890S

The RF Line
NPN Silicon RF Power Transistors

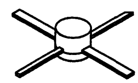
. . . designed for 24 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 804–960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 2.0 Watts
  Power Gain = 9.0 dB Min
  Efficiency = 55% Min
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**2.0 W, 900 MHz
RF POWER
TRANSISTORS
NPN SILICON**



CASE 305, STYLE 1
MRF890



CASE 305A, STYLE 1
MRF890S

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

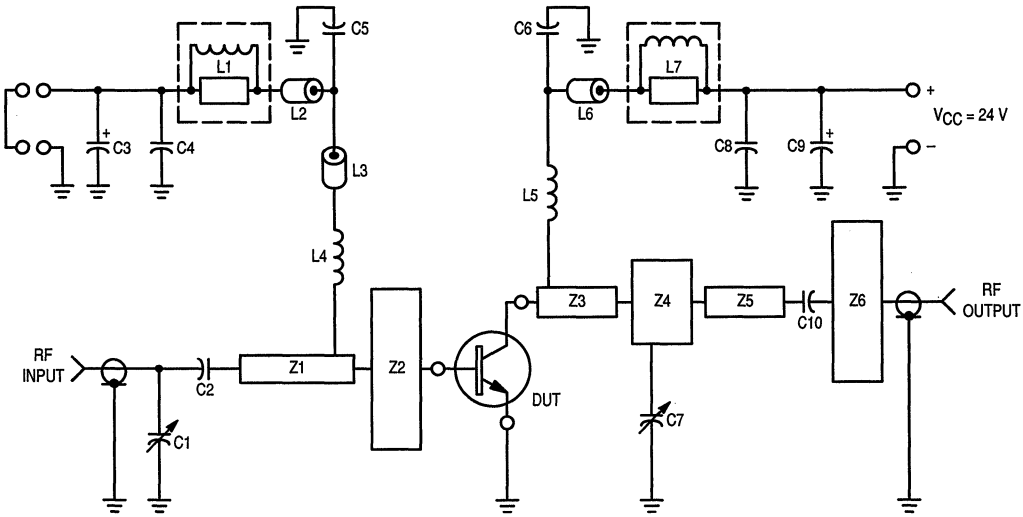
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—

NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (P_{out} = 2.0 W, V_{CC} = 24 Vdc, f = 900 MHz)	G_{PE}	9.0	10.5	—	dB
Collector Efficiency (P_{out} = 2.0 W, V_{CC} = 24 Vdc, f = 900 MHz)	η	55	60	—	%



C1, C7 — Johanson 0.5–4.0 pF Giga-Trim
C2, C5, C6 — 91 pF Mini Underwood Mica
C3, C9 — 1.0 µF Electrolytic
C4, C8 — 250 pF Unelco
C10 — 39 pF Mini Underwood
L1, L7 — 10 Turns Around 10 Ω 1/2 W Resistor
L2, L3, L6 — Ferrite Bead
L4, L5 — 4 Turns 26 AWG 0.1″ ID
Z1, Z2, Z3, Z4, Z5, Z6 — Distributed Microstrip Elements (see photomask)
Board Material — Glass Teflon ε_r = 2.55 t = 0.031″

Figure 1. 850–900 MHz Test Circuit

2

2

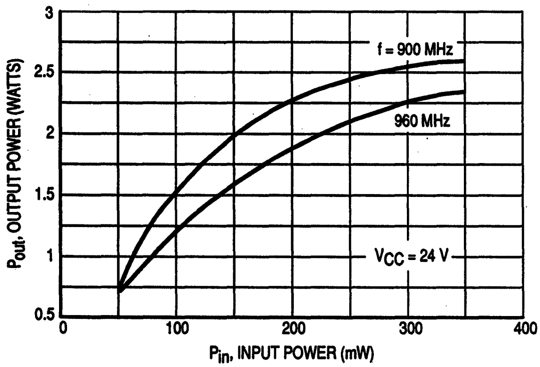


Figure 2. Output Power versus Input Power

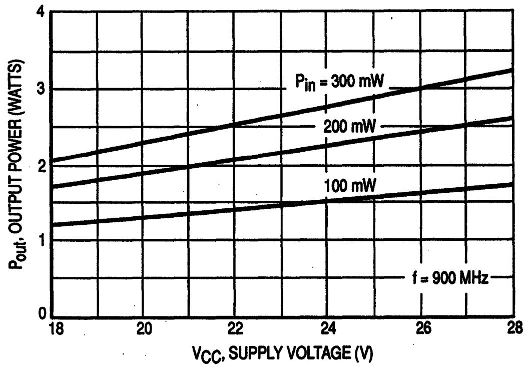


Figure 3. Output Power versus Supply Voltage

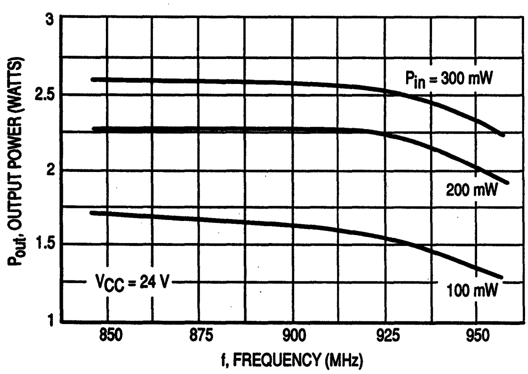


Figure 4. Output Power versus Frequency

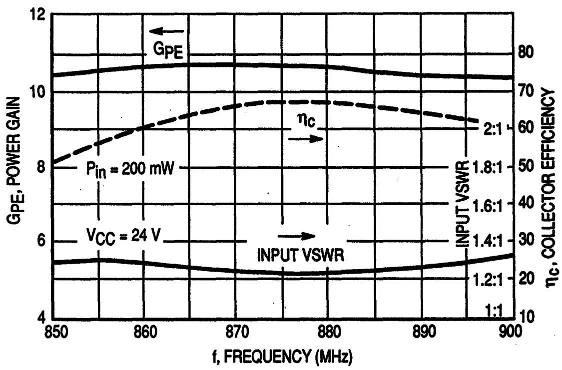
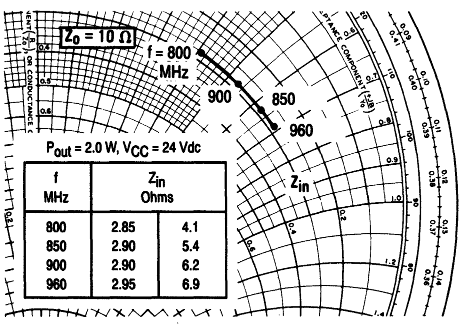


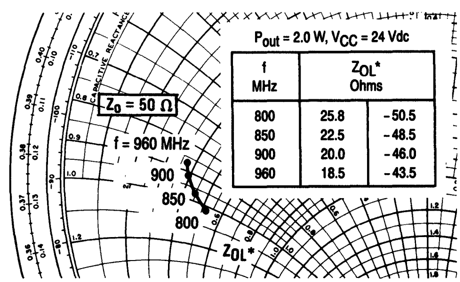
Figure 5. Typical Performance in Broadband Circuit



P_{out} = 2.0 W, V_{CC} = 24 Vdc

f MHz	Z_{in} Ohms	
800	2.85	4.1
850	2.90	5.4
900	2.90	6.2
960	2.95	6.9

Figure 6. Series Equivalent Input Impedance



P_{out} = 2.0 W, V_{CC} = 24 Vdc

f MHz	Z_{OL}* Ohms	
800	25.8	-50.5
850	22.5	-48.5
900	20.0	-46.0
960	18.5	-43.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 7. Series Equivalent Output Impedance

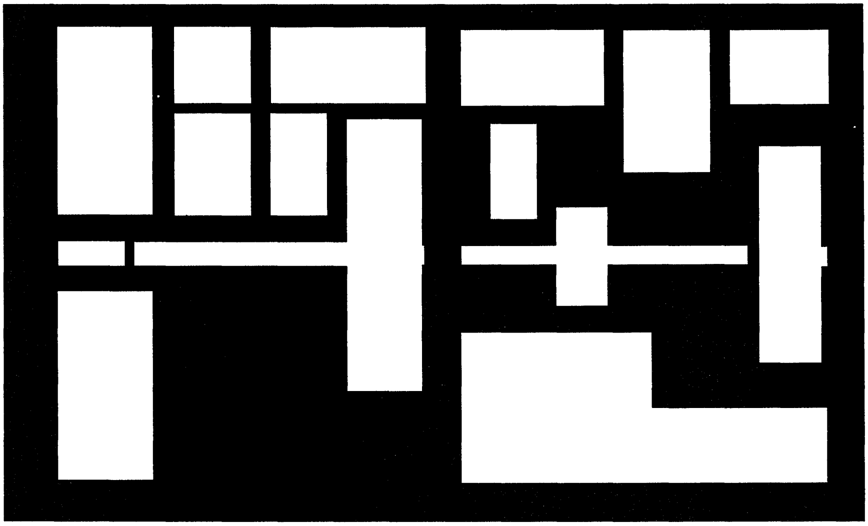

SCALE 0.75:1

Figure 8. Photomaster for Test Fixture

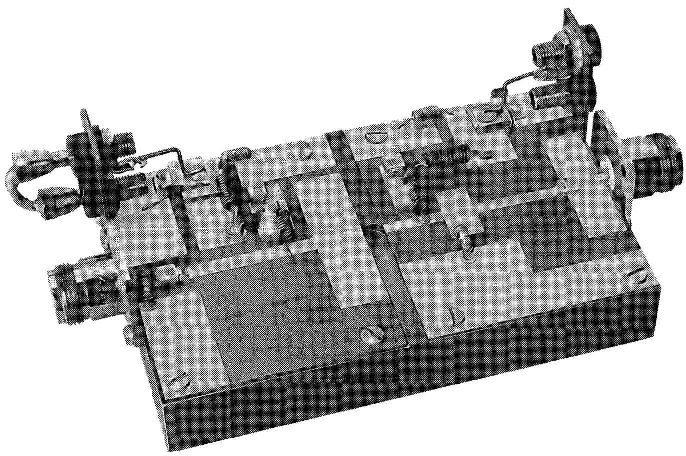


Figure 9. 850–900 MHz Test Circuit

2

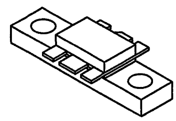
MRF891
MRF891S

The RF Line
NPN Silicon
RF Power Transistors

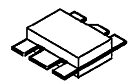
. . . designed for 24 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 800–960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 5.0 Watts
  Power Gain = 9.0 dB Min
  Efficiency = 50% Min
- Series Equivalent Large-Signal Characterization
- Capable of Withstanding 20:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**5.0 W, 900 MHz
RF POWER
TRANSISTORS
NPN SILICON**



**CASE 319, STYLE 2
MRF891**



**CASE 319A, STYLE 2
MRF891S**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.6	Adc
Total Device Dissipation @ $T_A = 50°C$ (1) Derate above 50°C	P_D	18 0.143	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7.0	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

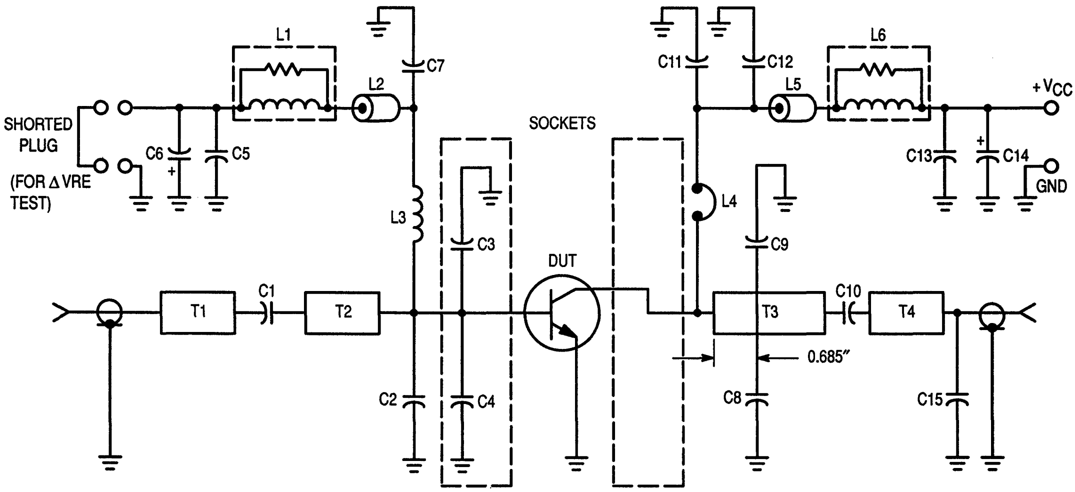
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 0$, $T_C = 25°C$)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 200$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	30	—	150	—

NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	6.5	8.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Broadband) (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 900 MHz)	G_{pe}	9.0	10	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 900 MHz)	η	50	57	—	%
Load Mismatch Stress (V_{CC} = 24 Vdc, P_{in} = 0.63 W, f = 900 MHz, VSWR = 20:1, all phase angles)	ψ	No Degradation in Output Power			



C1 — 39 pF, 100 Mil Chip Capacitor
C2, C8, C15 — 0.8–8.0 pF Johansen Gigatrim
C3, C4 — 12 pF, Mini-Unelco
C5, C13 — 1000 pF, 350 V Unelco
C6, C14 — 10 µF, 25 V Tantalum
C7, C11, C12 — 91 pF, Mini-Unelco
C9 — 5.0 pF, MIni-Unelco
C10 — 47 pF, 100 Mil Chip Capacitor

L1, L6 — 10 Turns #20 AWG Around 10 Ohm 1/2 Watt Resistor
L2, L5 — Ferrite Bead
L3 — 4 Turns #16 AWG Choke
L4 — 0.5″, #18 AWG Wire
T1, T4 — 50 Ohm Microstrip Line
T2 — W = 165 Mils, ℓ = 1946 Mils
T3 — W = 166 Mils, ℓ = 1563 Mils
PC Board — 0.031″ Glass Teflon (ε_r = 2.56)

Figure 1. Broadband Test Fixture

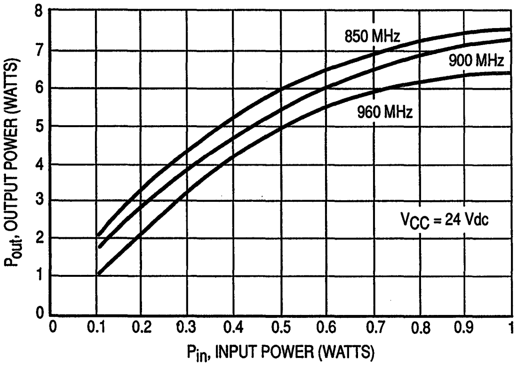


Figure 2. Output Power versus Input Power

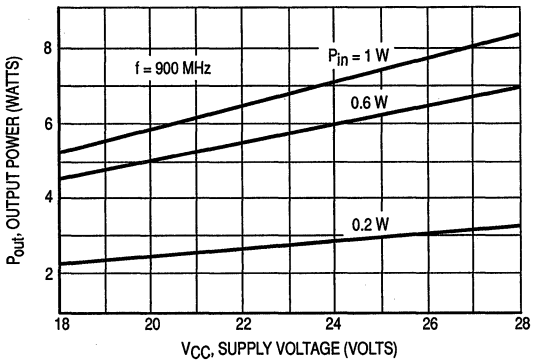


Figure 3. Output Power versus Supply Voltage

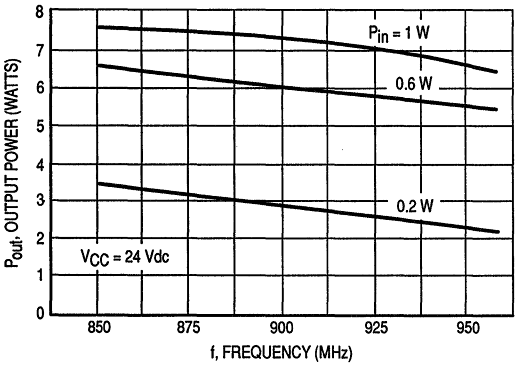


Figure 4. Output Power versus Frequency

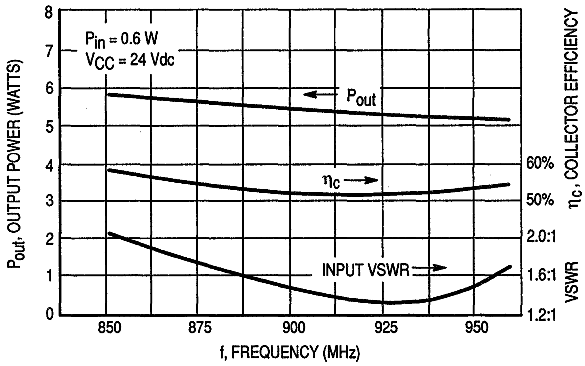


Figure 5. Typical Broadband Circuit Performance

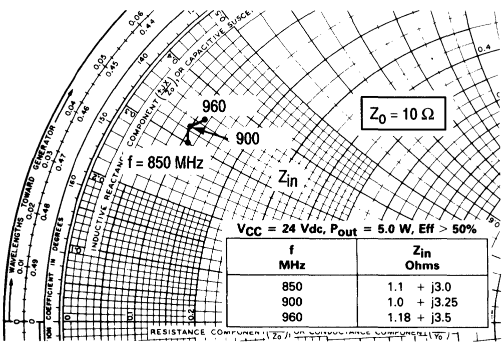


Figure 6. Series Equivalent Input Impedance

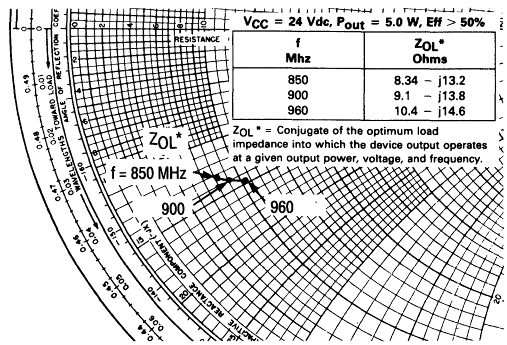


Figure 7. Series Equivalent Output Impedance

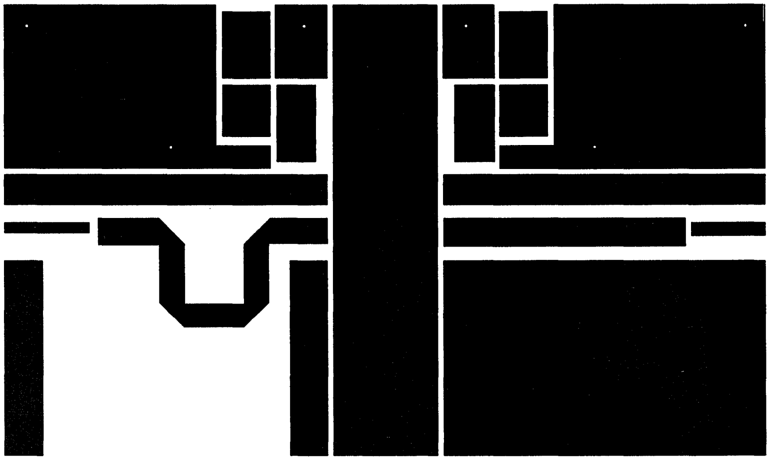


Figure 8. Photomaster for Test Fixture

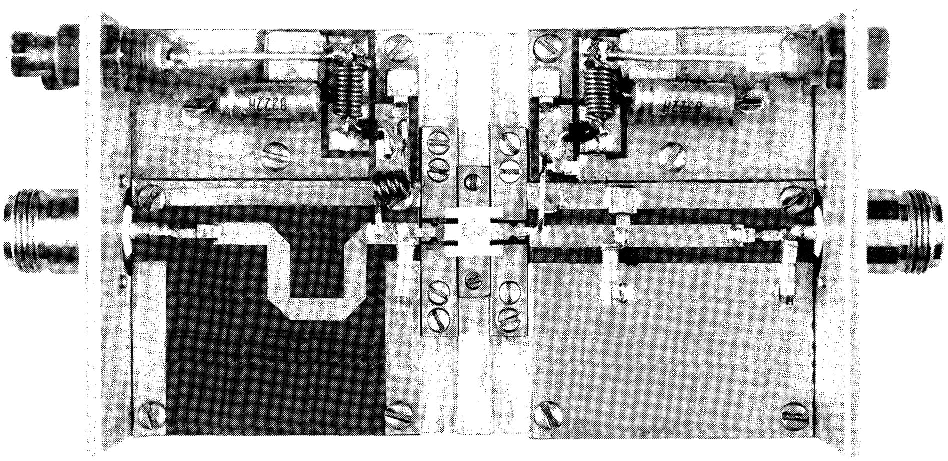


Figure 9. Broadband Test Circuit

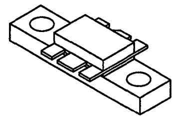
MRF892

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 24 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 804–960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 14 Watts
  Power Minimum = 8.5 dB Min
  Efficiency = 55% Min
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**14 W, 900 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 319, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	50 0.29	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.5	°C/W

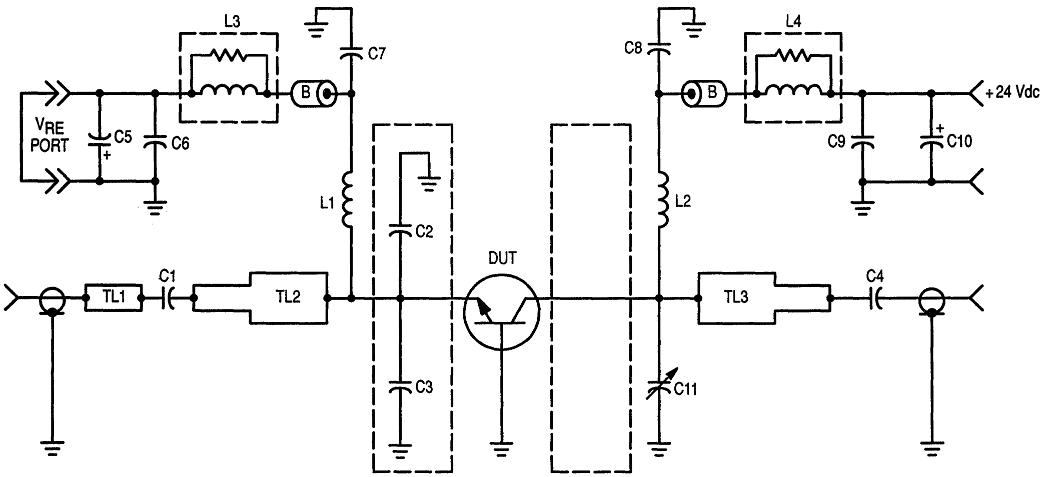
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc

NOTES:
(continued)
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	12.5	—	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (P_{out} = 14 W, V_{CC} = 24 Vdc, f = 900 MHz)	G_{PE}	8.5	9.5	—	dB
Collector Efficiency (P_{out} = 14 W, V_{CC} = 24 Vdc, f = 900 MHz)	η	50	60	—	%



B — Ferrite Bead, Ferroxcube 56-590-65-3B
C1 — 51 pF, 100 Mil Chip Capacitor
C2, C3 — 13 pF Mini-Unelco
C4 — 43 pF, 100 Mil Chip Capacitor
C5, C10 — 10 μF, 35 WV
C6, C9 — 500 pF Unelco J101
C7, C8 — 91 pF Mini-Unelco
C11 — 0.8–8.0 pF Johanson Gigatrim

L1, L2 — 4 Turns #18 Enameled, 5/32″ ID
L3, L4 — 14 Turns #22 Enameled Over 10 Ω Carbon Resistor
TL1 — Micro Strip, 50 Ω
TL2 — Micro Strip, Z_o = 26 Ω, λ/4 @ 875 MHz
TL3 — Micro Strip, Z_o = 14 Ω, λ/4 @ 875 MHz
Board — 0.032″ Glass Teflon
2 oz. Cu CLAD, ε_r = 2.55

Figure 1. 850–900 MHz Broadband Circuit Schematic

2

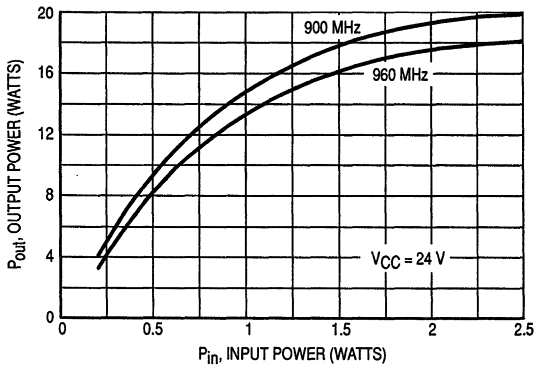


Figure 2. Output Power versus Input Power

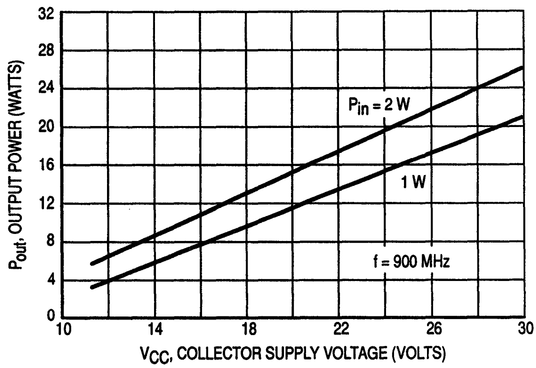


Figure 3. Output Power versus Supply Voltage

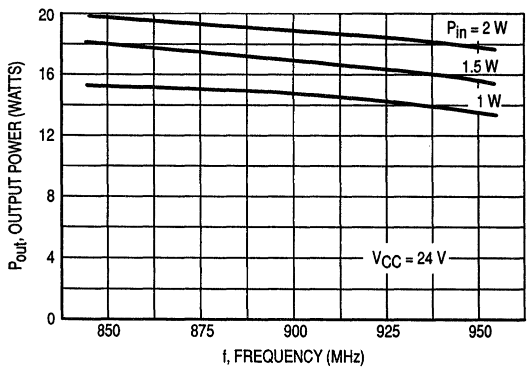


Figure 4. Output Power versus Frequency

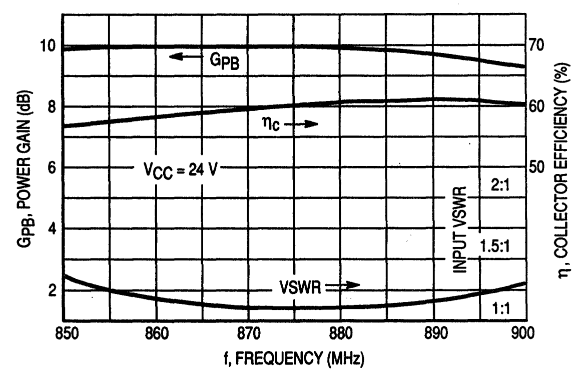
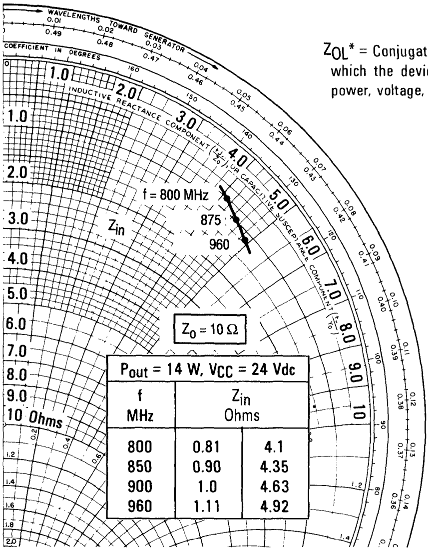


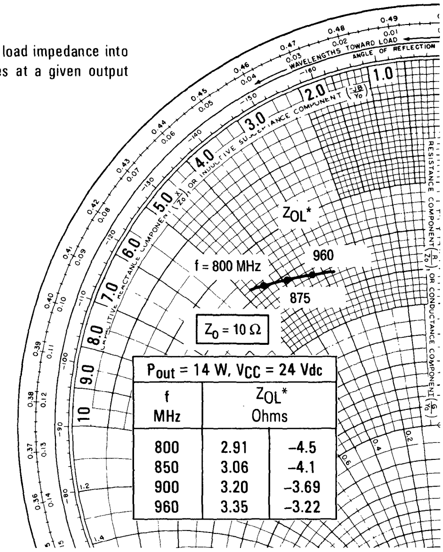
Figure 5. Typical Performance in Broadband Circuit

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.



P_{out} = 14 W, V_{CC} = 24 Vdc		
f MHz	Z_{in} Ohms	
800	0.81	4.1
850	0.90	4.35
900	1.0	4.63
960	1.11	4.92

Figure 6. Series Equivalent Input Impedance



P_{out} = 14 W, V_{CC} = 24 Vdc		
f MHz	Z_{OL}* Ohms	
800	2.91	−4.5
850	3.06	−4.1
900	3.20	−3.69
960	3.35	−3.22

Figure 7. Series Equivalent Output Impedance

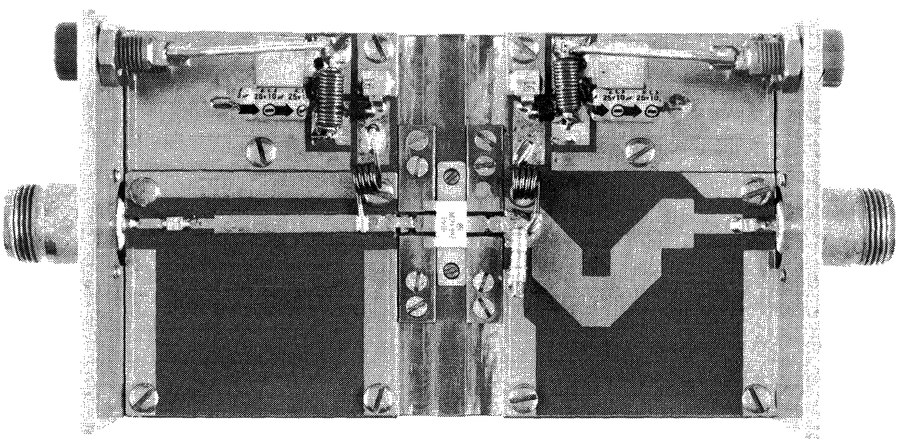


Figure 8. 850−900 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

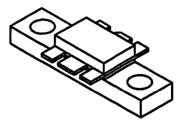
MRF894

The RF Line
NPN Silicon RF Power Transistor

. . . designed for 24 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 804–960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 30 Watts
  Power Gain = 7.0 dB Min
  Efficiency = 55% Min
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

30 W, 900 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 319, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

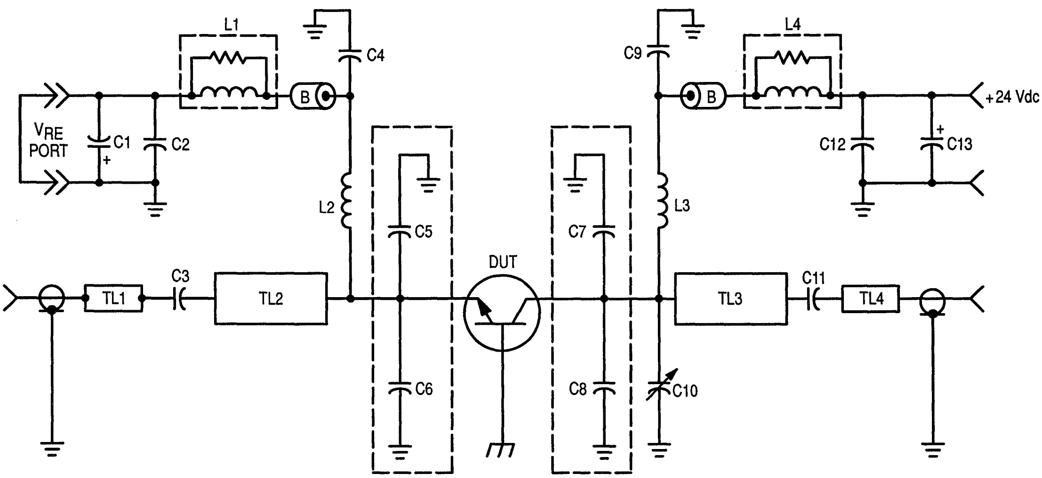
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	10	mAdc

(continued)

NOTES:
1. This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	45	—	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (P_{out} = 30 W, V_{CC} = 24 Vdc, f = 900 MHz)	G_{PE}	7.0	8.5	—	dB
Collector Efficiency (P_{out} = 30 W, V_{CC} = 24 Vdc, f = 900 MHz)	η	55	60	—	%



B — Ferrite Bead, Ferroxcube 56-590-65-3B
C1, C13 — 5.0 µF, 50 Vdc
C2, C12 — 1000 pF Unelco
C3, C11 — 47 pF, 100 Mil Chip Capacitor
C4, C9 — 91 pF, Mini-Underwood
C5, C6 — 12 pF, Mini-Underwood
C7 — 18 pF, Mini-Underwood
C8 — 24 pF, Mini-Underwood
C10 — 0.8–8.0 pF Johanson Gigatrim

L1, L4 — 11 Turns #20 Enameled Over 10 Ω Carbon Resistor
L2, L3 — 4 Turns #20 Enameled, .15″ ID
TL1, TL4 — Micro Strip Line, 50 Ω
TL2 — Micro Strip, Z_o = 30 Ω, λ/4 @ 875 MHz
TL3 — Micro Strip, Z_o = 22 Ω, λ/4 @ 875 MHz
Board — 0.032″ Glass Teflon
2 oz. Cu CLAD, ε_r = 2.55

Figure 1. 850–900 MHz Broadband Circuit Schematic

2

TYPICAL CHARACTERISTICS

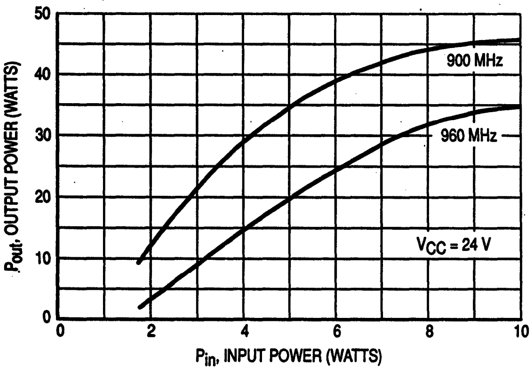


Figure 2. Output Power versus Input Power

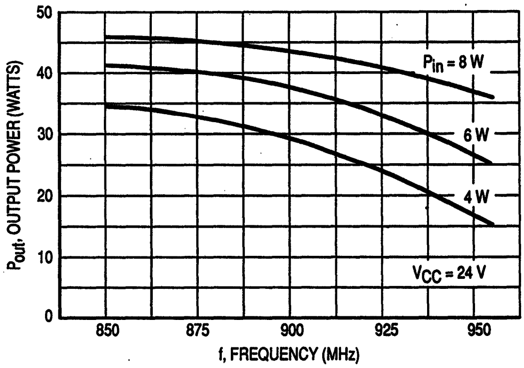


Figure 3. Output Power versus Frequency

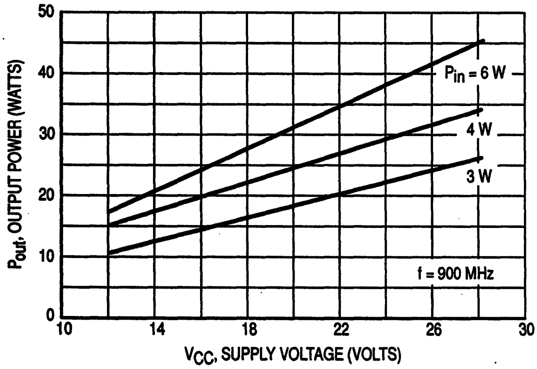


Figure 4. Output Power versus Supply Voltage

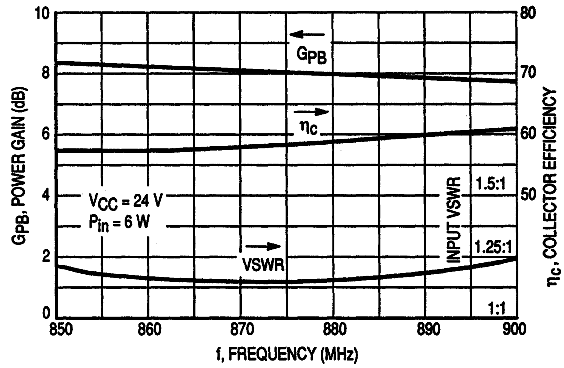
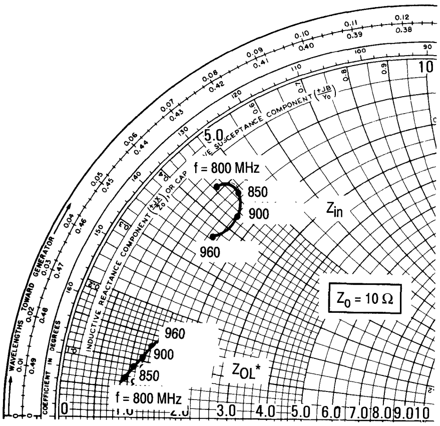


Figure 5. Typical Broadband Circuit Performance



VCC = 24 Vdc, Pout = 30 W

f Frequency MHz	Zin Ohms	ZOL* Ohms
800	0.9 + j4.5	1.0 + j0.7
850	1.3 + j4.7	1.1 + j0.9
900	1.6 + j4.4	1.2 + j1.1
960	1.5 + j3.7	1.2 + j1.3

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Impedance

2

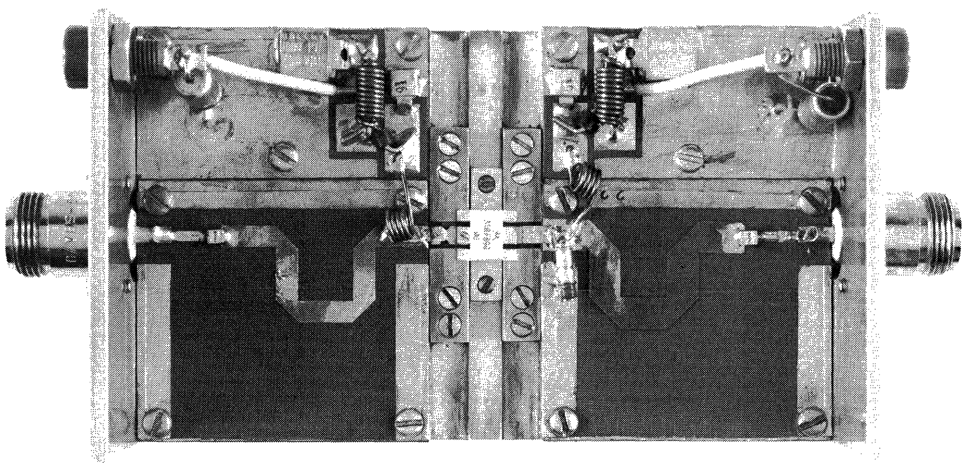


Figure 7. 850–900 MHz Broadband Circuit

MRF896
MRF896S

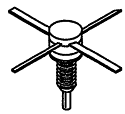
Motorola Preferred Devices

The RF Line
NPN Silicon
RF Power Transistors

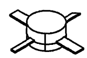
Designed for 24 Volt UHF large-signal, common emitter, Class AB and Class A linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 800–960 MHz.

- Specified 24 Volt, I_{cq} = 8.0 mA (Class AB), 900 MHz Characteristics
  Output Power = 3.0 Watts
  Minimum Gain = 10 dB @ 900 MHz
  Minimum Efficiency = 30% @ 900 MHz, 3.0 Watts
  Maximum Intermodulation Distortion –30 dBc @ 3.0 Watts (PEP)
- Characterized with Series Equivalent Large-Signal Parameters from 800 to 960 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 5:1 VSWR @ 26 Vdc, at rated output power
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration

3.0 W, 900 MHz
RF POWER
TRANSISTORS
NPN SILICON



CASE 305, STYLE 1
MRF896



CASE 305D, STYLE 1
MRF896S

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	0.45	Adc
Total Device Dissipation @ T_C = 50°C Derate Above 50°C	P_D	17 0.143	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise stated)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	37	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	92	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	1.0 nA	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_E = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	60	120	—

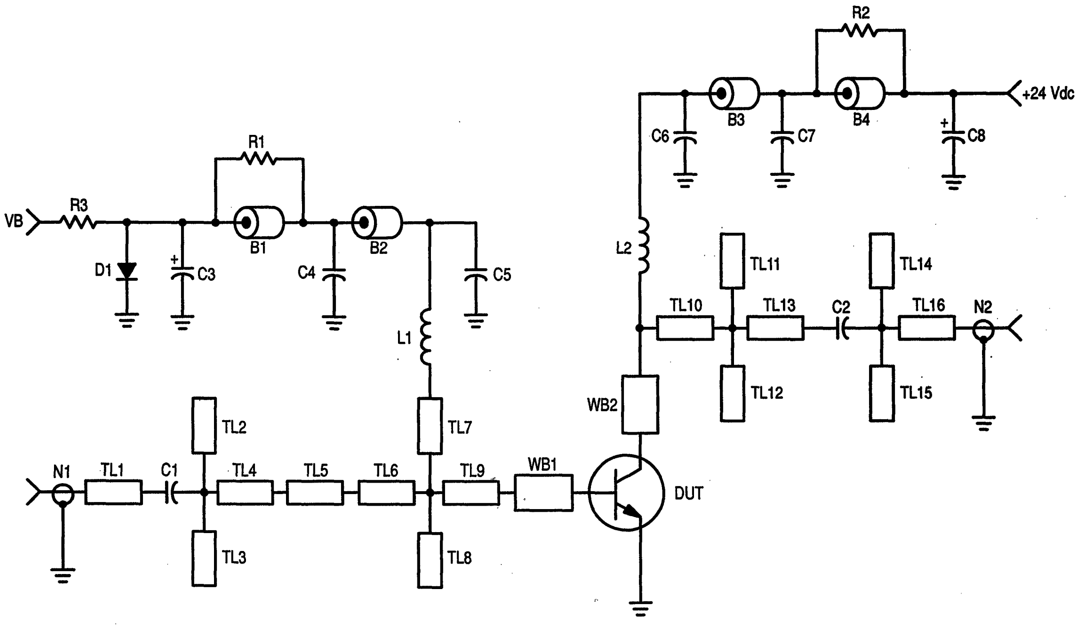
(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise stated)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	2.4	3.3	4.4	pF
FUNCTIONAL TESTS (In Motorola Test Fixture. See Figure 1.)					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 3.0 Watts, I_{cq} = 8.0 mA, f = 900 MHz)	G_{pe}	10	12	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 3.0 Watts, I_{cq} = 8.0 mA, f = 900 MHz)	η_c	30	45	—	%
3rd Order Intermodulation Distortion (V_{CC} = 24 Vdc, P_{out} = 3.0 Watts (PEP), I_{cq} = 8.0 mA, f_1 = 900 MHz, F_2 = 900.1 MHz)	IMD	—	−37	−30	dBc
Output Mismatch Stress (V_{CC} = 26 Vdc, P_{out} = 3.0 Watts, I_{cq} = 8.0 mA, f = 900 MHz, Load VSWR = 5:1, all phase angles)	ψ	No Degradation in Output Power Before and After Test			

2



B1, B4 — Long Bead, Fair Rite (2743019446)
B2, B3 — Short Bead, Fair Rite (2743021446)
C1, C2 — 43 pF, 100 Mil Chip Capacitor, ATC (100B430JCA500X)
C3, C8 — 10 µF, 50 V Electrolytic, Panasonic (ECEV1HV100R)
C4, C7 — 820 pF, Surface Mount, Kemit (C1206N821J1GSC)
C5, C6 — 100 pF Chip Cap, Murata Erie (GRH710COG101J100VBE)
D1 — Diode 1N4001, Motorola
L1, L2 — 7 Turns, 24 AWG, IDIA 0.116″
N1, N2 — Type N Flange, Omni Spectra (3052-1648-10)
R1, R2 — 4 x 39 Ohm, 1/8 W chips in parallel, Rohm (390-J)
R3 — 82 Ohm, 1.0 W
TL1 — Z_o = 50 Ohm
TL2–TL15 — See Photomaster
TL16 — Z_o = 50 Ohm
WB1 — Wear Block .200″ x .005″ BeCu
WB2 — Wear Block .200″ x .060″ x .005″ BeCu
Board — 30 mil Glass Teflon, ε_r = 2.55, Keene (GX-0300-55-22)

Figure 1. 840–960 MHz Broadband Test Circuit

2

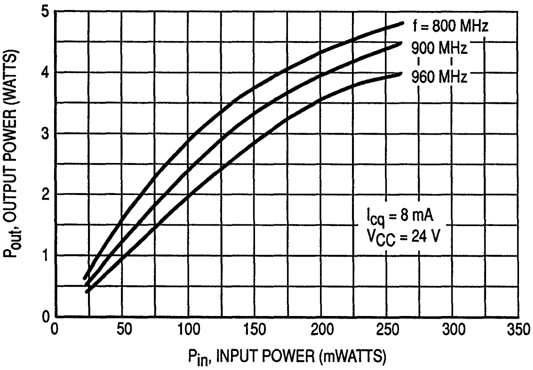


Figure 2. Output Power versus Input Power

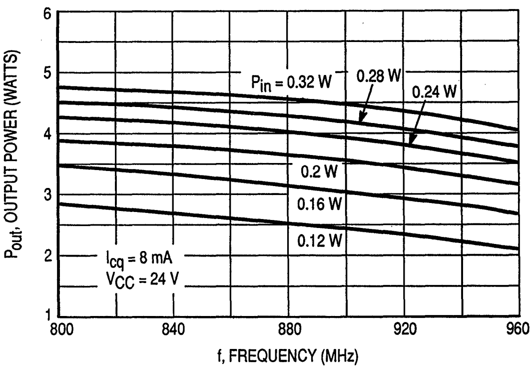


Figure 3. Output Power versus Frequency

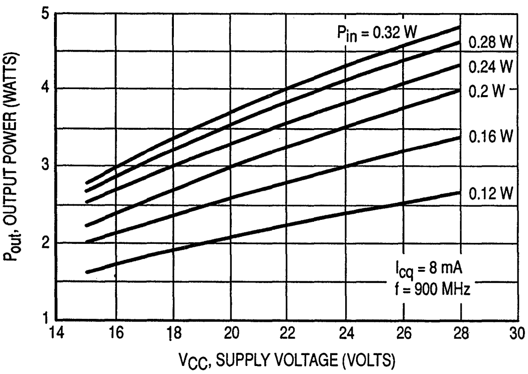


Figure 4. Output Power versus Supply Voltage

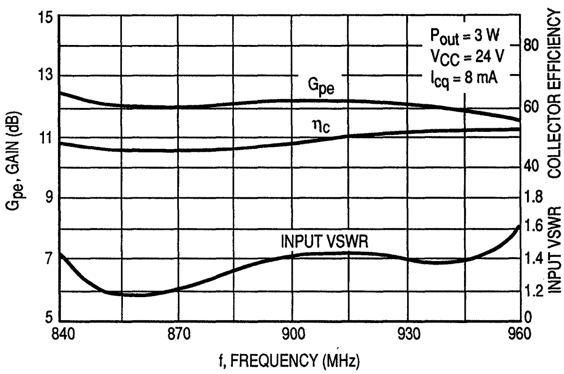


Figure 5. Performance in Broadband Test Fixture

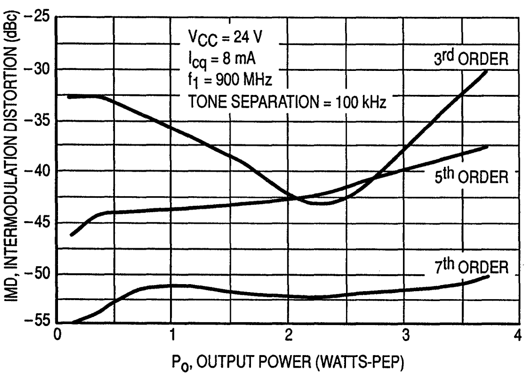


Figure 6. Intermodulation versus Output Power

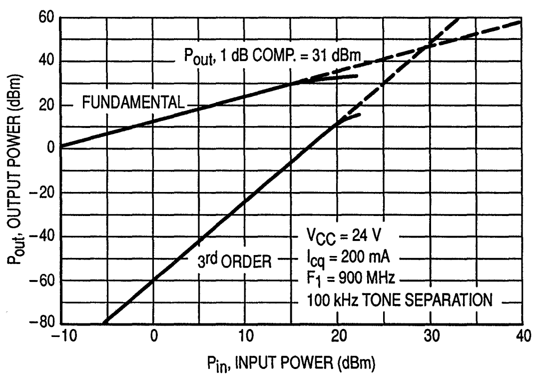
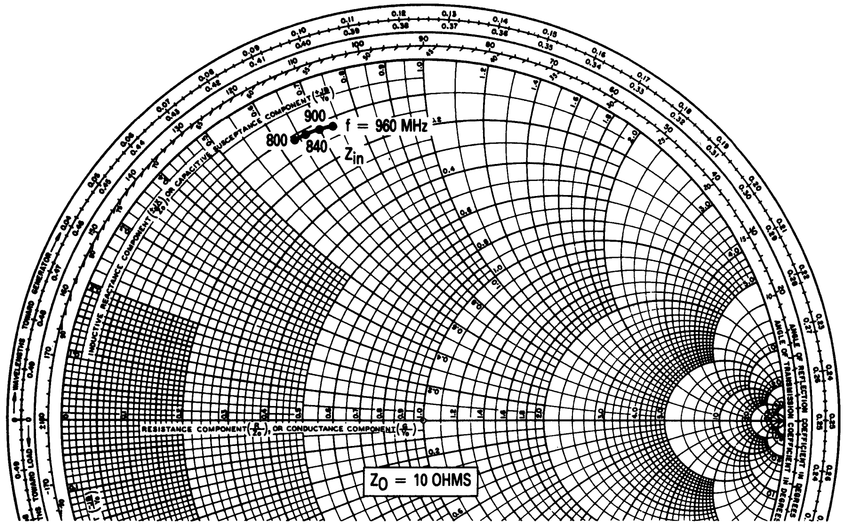
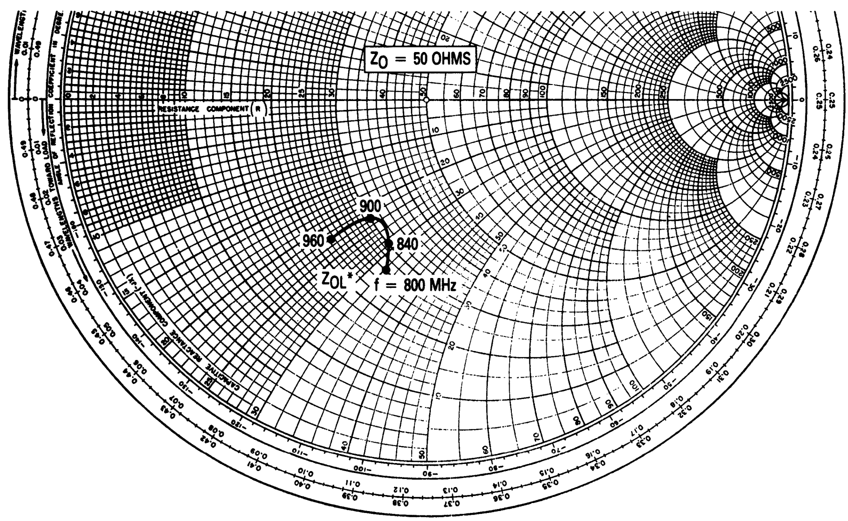


Figure 7. Class A — Third Order Intercept



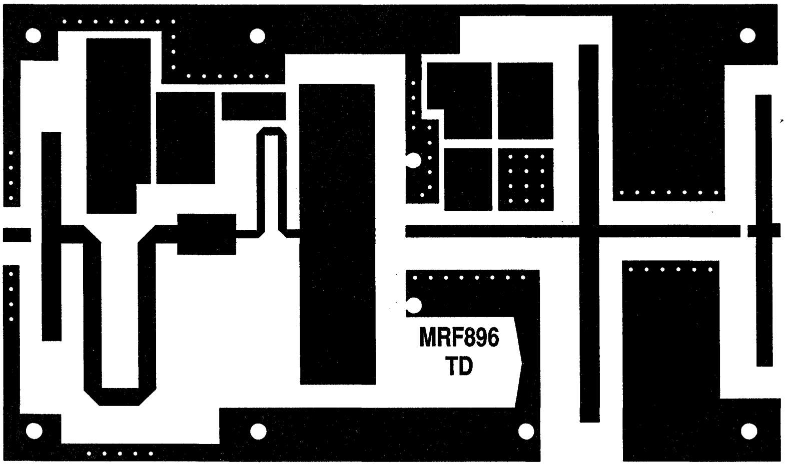
f (MHz)	Z_{in} ohms	Z_{OL} ohms
800	1.1 + j6.4	26.4 − j32.7
840	1.2 + j6.6	30.3 − j28.9
900	1.2 + j7.0	30.1 − j23.4
960	1.3 + j7.3	22.1 − j22.5



Z_{OL}* = CONJUGATE OF OPTIMUM LOAD IMPEDANCE INTO WHICH THE DEVICE OPERATES AT A GIVEN OUTPUT POWER, VOLTAGE AND FREQUENCY.

P_o = 3 W, V_{CC} = 24 V, I_{CQ} = 8 mA

Figure 8. Series Equivalent Input/Output Impedances



SCALE 0.75:1

Figure 9. Photomaster for Broadband Test Circuit

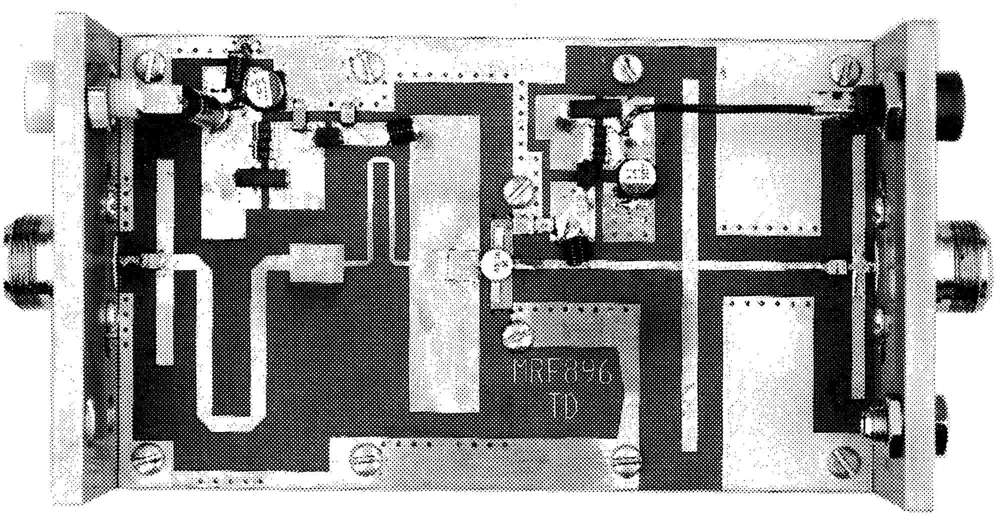


Figure 10. Broadband Test Circuit

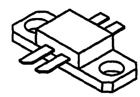
MRF897

The RF Line
NPN Silicon
RF Power Transistor

Designed for 24 Volt UHF large-signal, common emitter, class-AB linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 800–970 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 30 Watts
  Minimum Gain = 10 dB @ 900 MHz, class-AB
  Minimum Efficiency = 30% @ 900 MHz, 30 Watts (PEP)
  Maximum Intermodulation Distortion –30 dBc @ 30 Watts (PEP)
- Characterized with Series Equivalent Large-Signal Parameters from 800 to 960 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 5:1 VSWR @ 26 Vdc, and Rated Output Power
- Gold Metalized, Emitter Ballasted for Long Life and Resistance to Metal-Migration

**30 W, 900 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 395B-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	105 0.60	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	°C/W

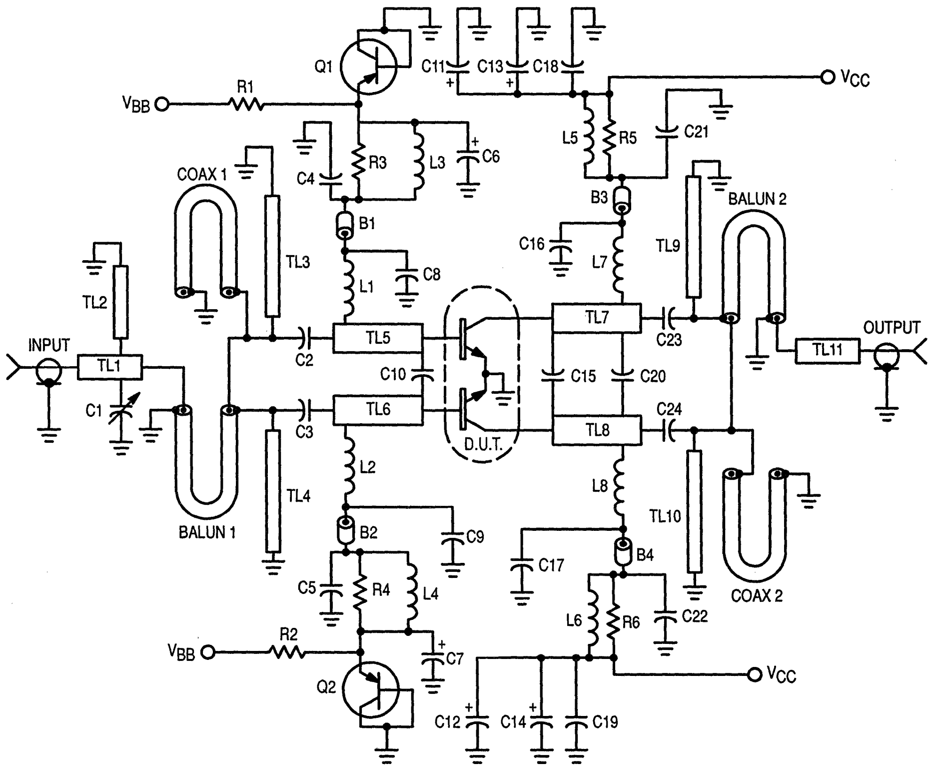
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	33	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	80	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	4.7	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 1.0 Adc, V_{CE} = 5 Vdc)	h_{FE}	30	80	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	14	21	28	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 30 Watts (PEP), I_{cq} = 125 mA, f_1 = 900 MHz, f_2 = 900.1 MHz)	G_{pe}	10.0	12.0	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 30 Watts (PEP), I_{cq} = 125 mA, f_1 = 900 MHz, f_2 = 900.1 MHz)	η	35	38	—	%
Intermodulation Distortion (V_{CC} = 24 Vdc, P_{out} = 30 Watts (PEP), I_{cq} = 125 mA, f_1 = 900 MHz, f_2 = 900.1 MHz)	IMD	—	–37	–30	dBc
Output Mismatch Stress (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{cq} = 125 mA, f_1 = 900 MHz, f_2 = 900.1 MHz, Load VSWR = 5:1 (all phase angles))	ψ	No Degradation in Output Power Before and After Test			



B1, B2, B3, B4 — Ferrite Bead, Fair Rite #2743019447
C1 — 0.8–8.0 pF Trimmer Capacitor, Johanson
C2, C3, C23, C24 — 43 pF, 100 mil, ATC Chip Capacitor
C4, C5, C18, C19, C21, C22 — 820 pF, 100 mil, Chip Capacitor, Kemet
C6, C7, C11, C12 — 10 µF, Lytic Capacitor, Panasonic
C8, C9, C16, C17 — 100 pF, 100 mil, Chip Capacitor, Murata Erie
C10 — 13 pF, 50 mil, ATC Chip Capacitor
C13, C14 — 250 µF Lytic Capacitor, Mallory
C15 — 1.1 pF, 50 mil, ATC Chip Capacitor
C20 — 6.8 pF, 100 mil, ATC Chip Capacitor
L1, L2, L3, L4, L5, L6 — 5 Turns 20 AWG, IDIA 0.126″ choke

N1, N2 — Type N Flange Mount, Omni Spectra 3052-1648-10
Q1 — Bias Transistor BD136 PNP
R1, R12 — 39 Ohm, 2.0 W
R3, R4, R5, R6 — 4.0 x 39 Ohm, 1/8 W, Chips in Parallel, Rohm 390-J
TL1–TL11 — See Photomaster
Balun1, Balun2, Coax 1, Coax 2 — 2.20″ 50 Ohm, 0.088″ o.d. semi-rigid coax, Micro Coax UT-85-M17
Board — 1/32″ Glass Teflon, Arlon GX-0300-55-22, ε_r = 2.55

Figure 1. MRF897 Broadband Test Circuit

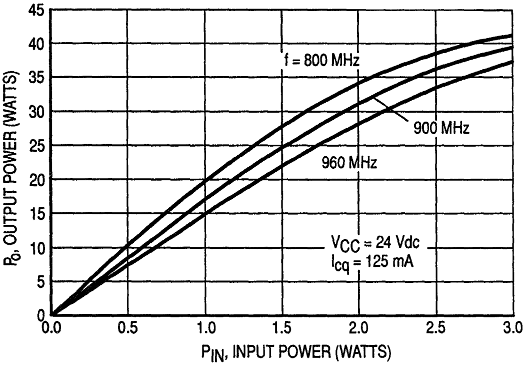


Figure 2. Output Power versus Input Power

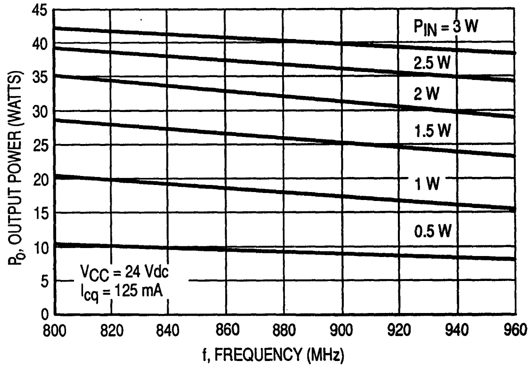


Figure 3. Output Power versus Frequency

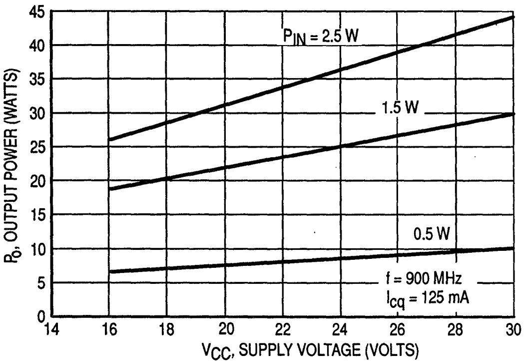


Figure 4. Output Power versus Supply Voltage

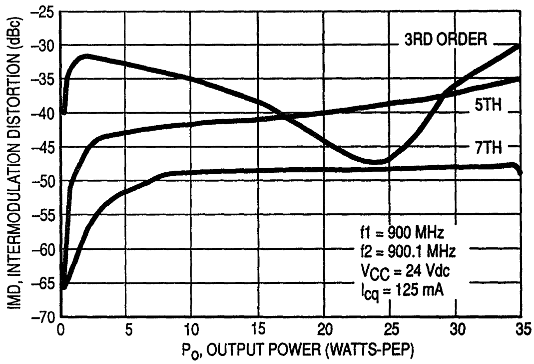


Figure 5. Intermodulation versus Output Power

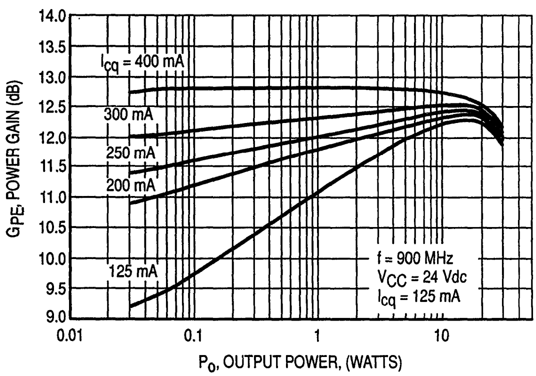


Figure 6. Power Gain versus Output Power

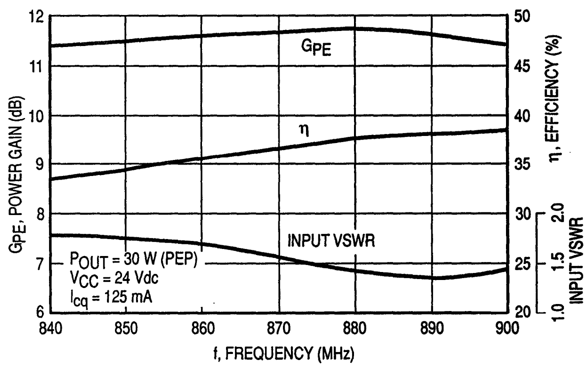


Figure 7. Broadband Test Fixture Performance

f (MHz)	Z_{in} ohms	Z^*_{OL} ohms
800	1.0 + j10.3	5.9 – j0.4
850	1.5 + j10.5	5.7 + j2.6
900	1.8 + j11.0	5.9 + j3.4
960	2.2 + j11.4	6.2 + j4.4

Z^*_{OL} = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

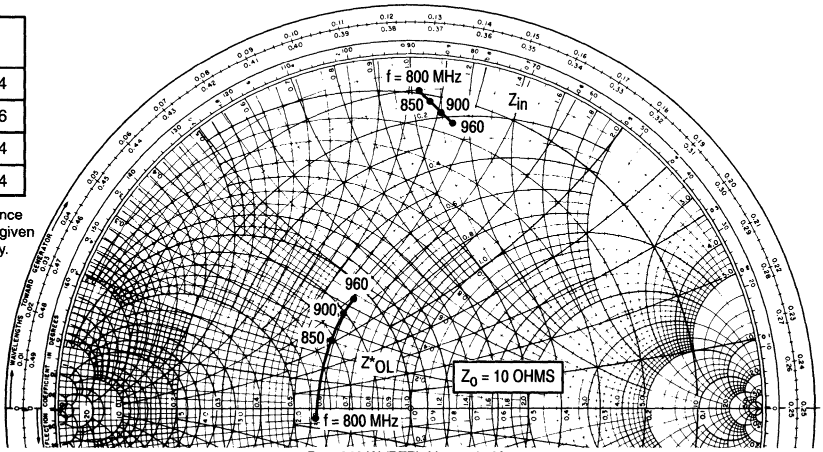


Figure 8. Series Equivalent Input/Output Impedances

2

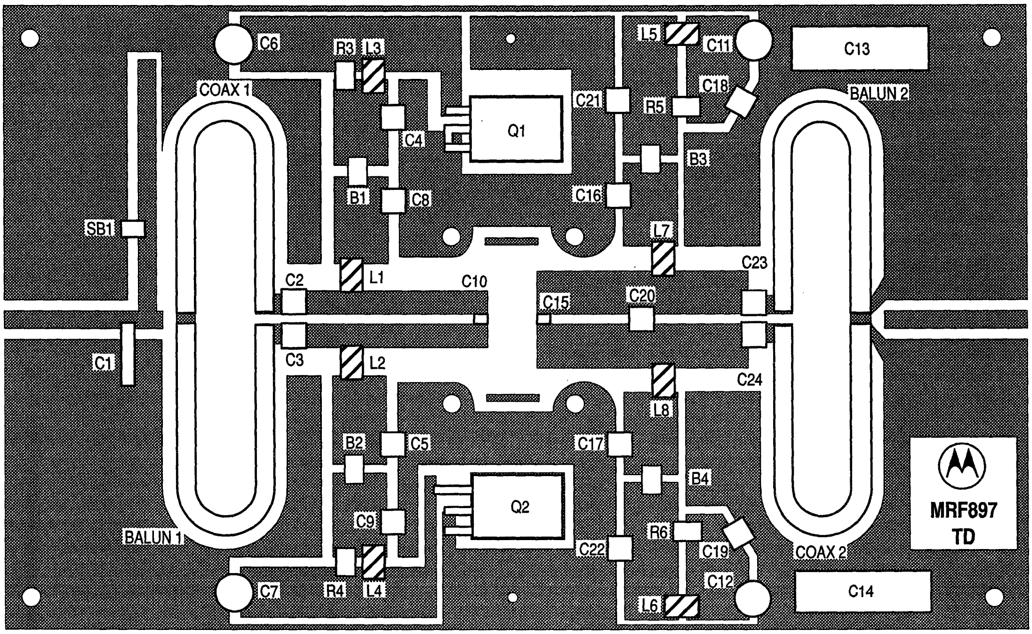
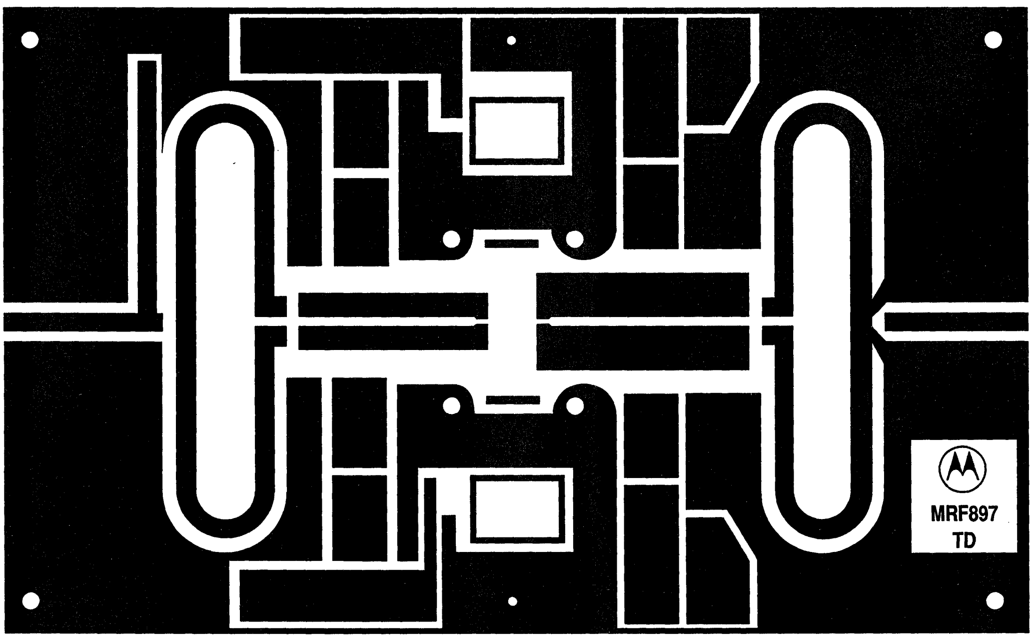


Figure 9. MRF897 Broadband Test Fixture



(Not to Scale)

Figure 10. Photomaster for MRF897 Test Fixture

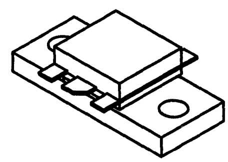
MRF898

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for 24 Volt UHF large-signal, common base amplifier applications in industrial and commercial FM equipment operating in the range of 850–960 MHz.

- Motorola Advanced Amplifier Concept Package
- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 60 Watts
  Power Gain = 7.0 dB Min
  Efficiency = 60% Min
- Double Input/Output Matched for Wideband Performance and Simplified External Matching
- Series Equivalent Large-Signal Characterization
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**60 W, 850–960 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 333A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	10	mAdc

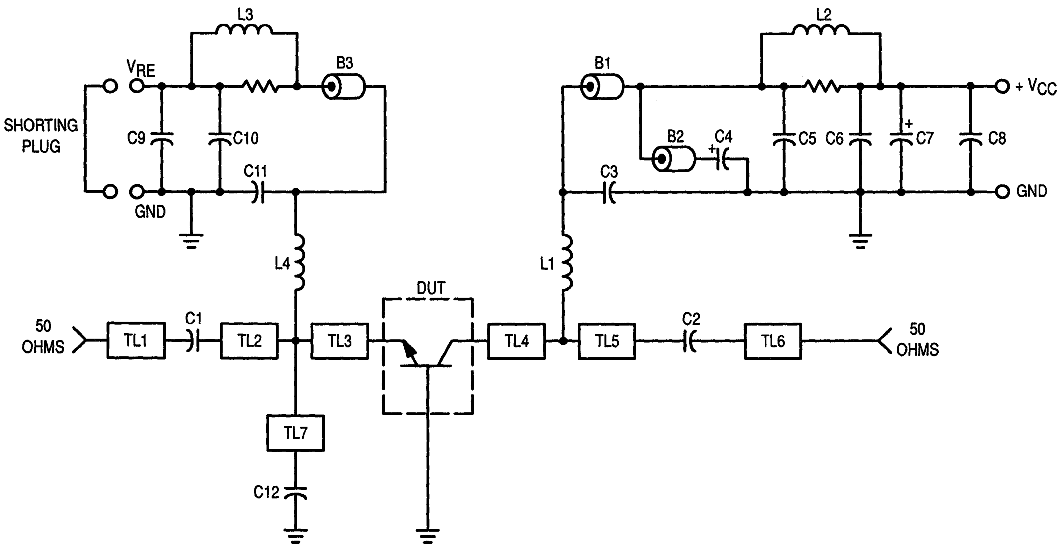
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	50	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (1) (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	60	—	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 60 W, f = 900 MHz)	G_{pb}	7.0	7.9	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 60 W, f = 900 MHz)	η	60	65	—	%
Output Mismatch Stress (V_{CC} = 24 Vdc, P_{out} = 60 W, f = 900 MHz, VSWR = 5:1, all phase angles)	ψ	No Degradation in Output Power			

NOTE:
1. Value of "C_{ob}" is that of die only. It is not measurable in MRF898 because of internal matching network.

2



B1, B2, B3 — Bead, Ferroxcube 56-390-65/3B
C1, C2, C12 — 39 pF, 100 Mil Chip Capacitor
C3, C11 — 91 pF, Mini Underwood or Equivalent
C4, C7, C9 — 10 μF, 35 V Electrolytic
C5 — 4000 pF, 1.0 kV Ceramic
C6, C10 — 1000 pF, 350 V Unelco or Equivalent
C8 — 47 pF, 100 Mil Chip Capacitor
L1, L4 — 4 Turns #18 AWG Choke
L2 — 11 Turns #20 AWG Choke on 10 Ohm, 1.0 Watt Resistor
L3 — 3 Turns #18 AWG Choke on 10 Ohm, 1.0 Watt Resistor

TL1, TL6 — 50 Ohm Microstrip
TL2 — 400 x 950 Mils
TL3, TL4 — 140 x 200 Mils
TL5 — 320 x 690 Mils
TL7 — 260 x 230 Mils
Board — 3M Epsilam-10, 50 Mil
Bias Boards — 1/32″ G10 or Equivalent

Figure 1. 850–960 MHz Broadband Test Circuit

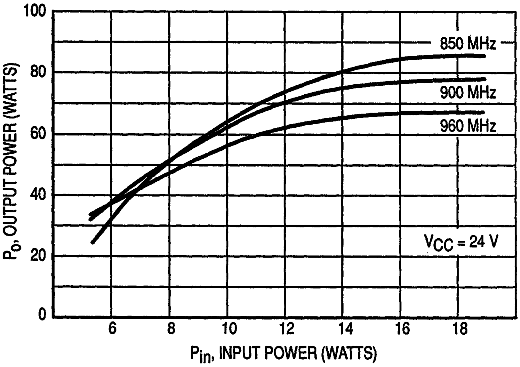


Figure 2. Output Power versus Input Power

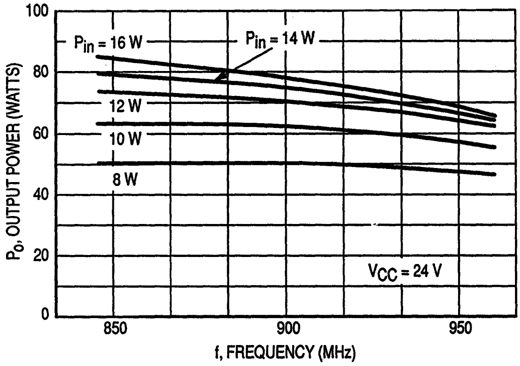


Figure 3. Output Power versus Frequency

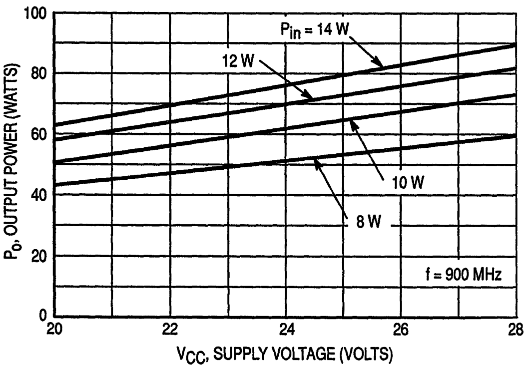


Figure 4. Output Power versus Supply Voltage

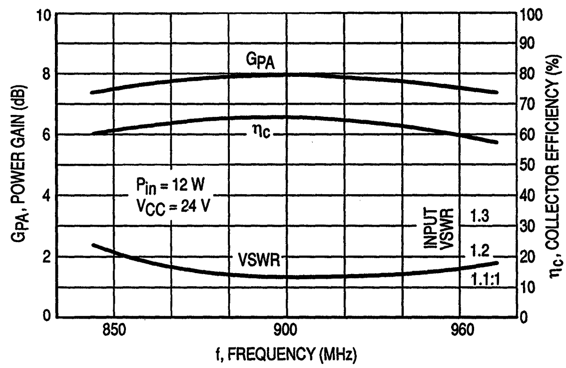
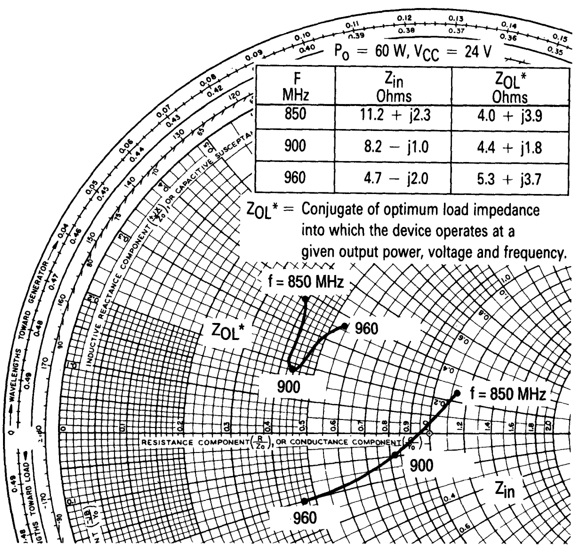


Figure 5. Typical Broadband Circuit Performance



F MHz	Zin Ohms	ZOL* Ohms
850	11.2 + j2.3	4.0 + j3.9
900	8.2 − j1.0	4.4 + j1.8
960	4.7 − j2.0	5.3 + j3.7

Figure 6. Input/Output Impedance versus Frequency

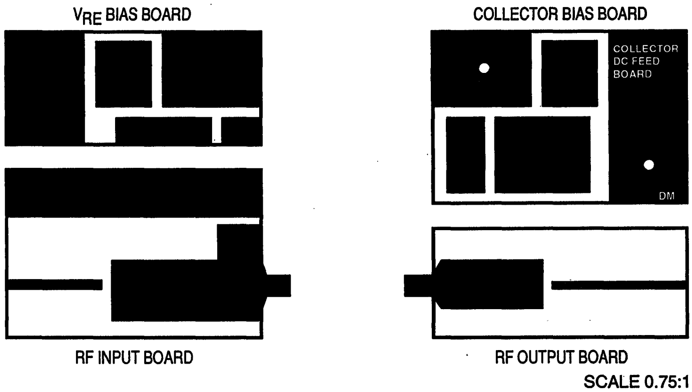


Figure 7. Photomaster

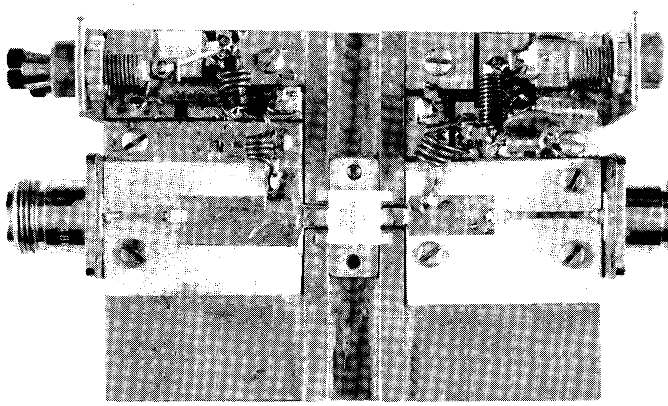


Figure 8. 850–960 MHz Broadband Test Circuit

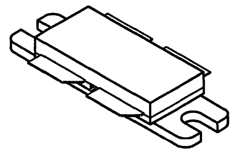
MRF899

The RF Line
NPN Silicon RF Power Transistor

Designed for 26 Volt UHF large-signal, common emitter, Class AB linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 800–960 MHz.

- Specified 26 Volt, 900 MHz Characteristics
  Output Power = 150 Watts (PEP)
  Minimum Gain = 8.0 dB @ 900 MHz, Class AB
  Minimum Efficiency = 35% @ 900 MHz, 150 Watts (PEP)
  Maximum Intermodulation Distortion –28 dBc @ 150 Watts (PEP)
- Characterized with Series Equivalent Large-Signal Parameters from 800 to 960 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 5:1 VSWR @ 26 Vdc, and Rated Output Power
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration

**150 W, 900 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 375A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Emitter Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	25	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	230 1.33	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

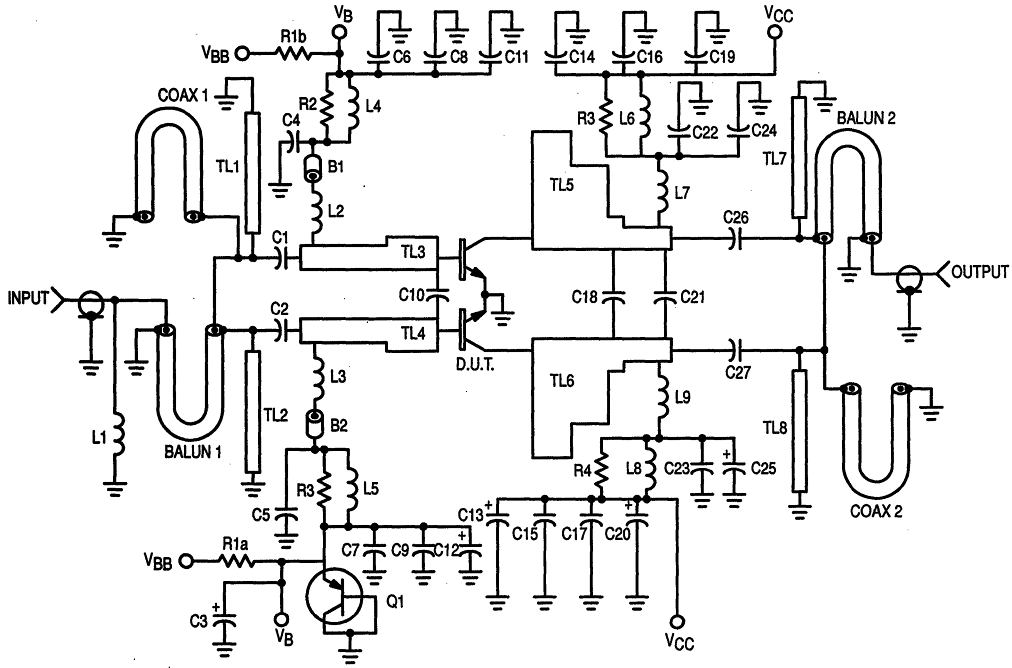
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	28	37	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	85	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	4.9	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	30	75	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1.0 MHz) (1)	C_{ob}	—	75	—	pF

NOTE:
1. For information only. This part is collector matched.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Common-Emitter Amplifier Power Gain V_{CC} = 26 Vdc, P_{out} = 150 Watts (PEP), I_{cq} = 300 mA, f_1 = 900 MHz, f_2 = 900.1 MHz	G_{pe}	8.0	9.0	—	dB
Collector Efficiency V_{CC} = 26 Vdc, P_{out} = 150 Watts (PEP), I_{cq} = 300 mA, f_1 = 900 MHz, f_2 = 900.1 MHz	η	30	40	—	%
3rd Order Intermodulation Distortion V_{CC} = 26 Vdc, P_{out} = 150 Watts (PEP), I_{cq} = 300 mA, f_1 = 900 MHz, f_2 = 900.1 MHz	IMD	—	−32	−28	dBc
Output Mismatch Stress V_{CC} = 26 Vdc, P_{out} = 150 Watts (PEP), I_{cq} = 300 mA, f_1 = 900 MHz, f_2 = 900.1 MHz, VSWR = 5:1 (all phase angles)	ψ	No Degradation in Output Power Before and After Test			



B1, B2 — Ferrite Bead, Ferroxcube #56-590-65-3B
C1, C2, C26, C27 — 43 pF, B Case, ATC Chip Capacitor
C3 — 200 µF Lytic Capacitor
C4, C5, C22, C23 — 100 pF, B Case, ATC Chip Capacitor
C6, C7, C14, C15 — 1000 pF, B Case, ATC Chip Capacitor
C10 — 9.1 pF, A Case, ATC Chip Capacitor
C13 — 500 µF Electrolytic Capacitor
C18 — 3.9 pF, B Case, ATC Chip Capacitor
C21 — 0.8 pF, B Case, ATC Chip Capacitor
C8, C9, C16, C17 — CDR32BP182AJWS, 1800 pF, AVX Chip Capacitor
C11, C12, C19, C20, C24, C25 — 10 µF, Electrolytic Capacitor Panasonic
L1 — 5 Turns 24 AWG IDIA 0.059″ Choke, 19.8 nH
L2, L3, L7, L9 — 4 Turns 20 AWG IDIA 0.163″ Choke
L4, L5, L6, L8 — 12 Turns 22 AWG IDIA 0.140″ Choke, on 10–20 Ω Resistor
N1, N2 — Type N Flange Mount, Omni Spectra
Q1 — Bias Transistor BD136 PNP
R2, R3, R4, R5 — 4.0 x 39 Ohm 1/8 W Chips in Parallel
R1a, R1b — 56 Ohm 1.0 W
TL1–TL8 — See Photomaster
Balun1, Balun2, Coax 1, Coax 2 — 2.20″ 50 Ohm 0.088″ o.d. semi-rigid coax
Board — 1/32″ Glass Teflon, ε_r = 2.55″ Arlon (GX-0300-55-22)

Figure 1. 900 MHz Power Gain Test Circuit

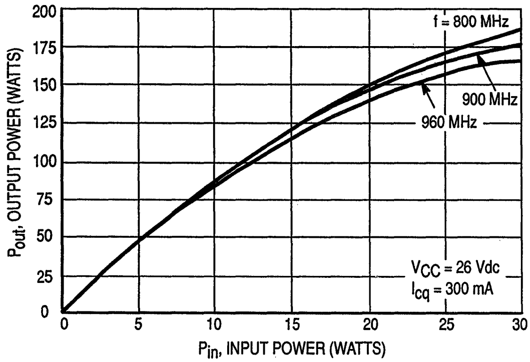


Figure 2. Output Power versus Input Power

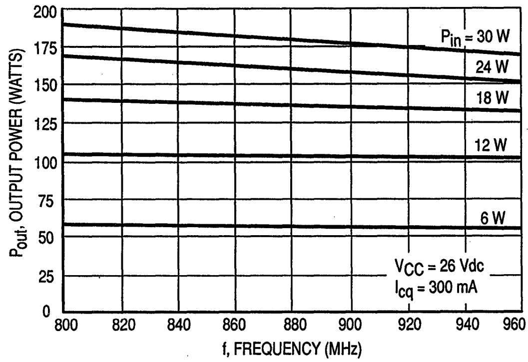


Figure 3. Output Power versus Frequency

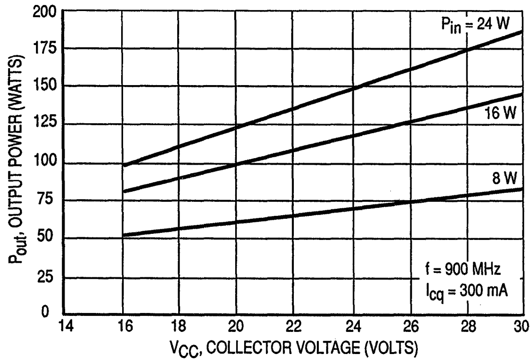


Figure 4. Output Power versus Supply Voltage

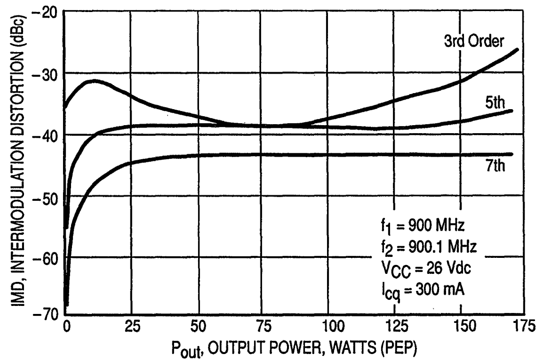


Figure 5. Intermodulation versus Output Power

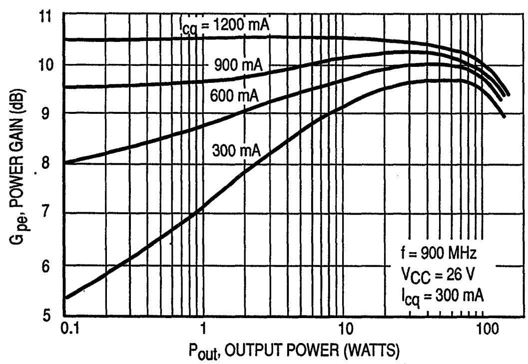


Figure 6. Power Gain versus Output Power

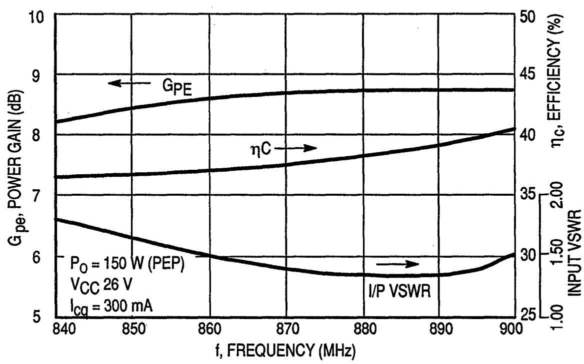
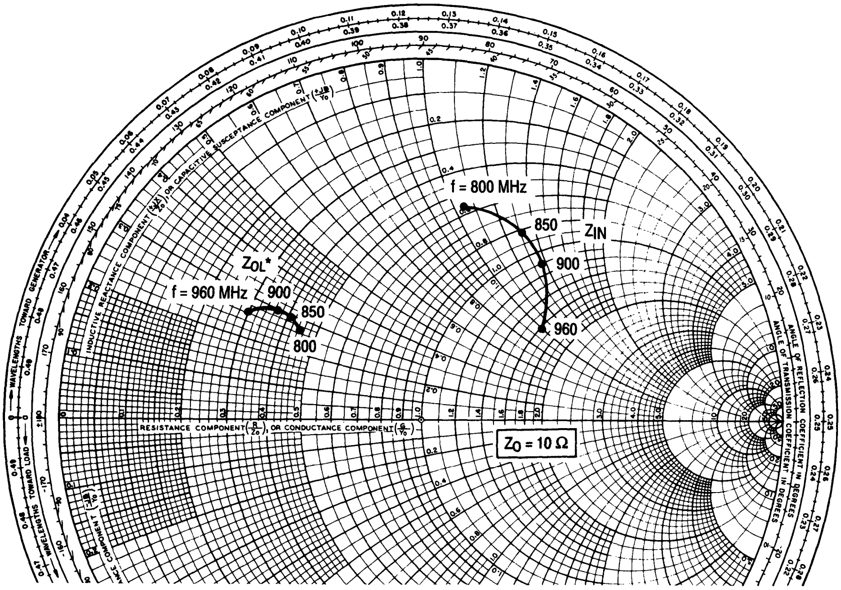


Figure 7. Broadband Test Fixture Performance



f MHz	Z_{IN} OHMS	Z_{OL}^* OHMS
800	5.51 + j10.6	4.52 + j2.64
850	8.17 + j13.2	4.21 + j2.98
900	11.2 + j13.8	3.68 + j2.97
960	16.8 + j10.1	2.98 + j2.71

Z_{OL}^* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 8. Input and Output Impedances with Circuit Tuned for Maximum Gain @ P_O = 150 W (PEP), V_{CC} = 26 V

2

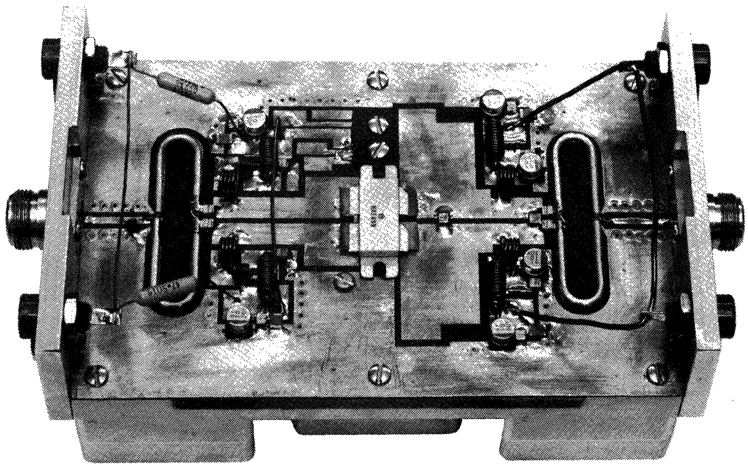
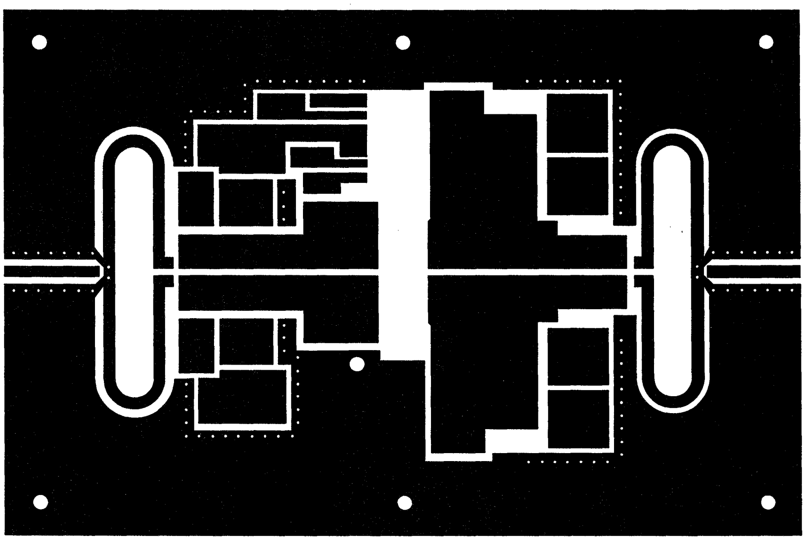


Figure 9. Photo of 900 MHz Test Circuit

2



(Not to Scale)

Figure 10. MRF899 Test Circuit Photomaster

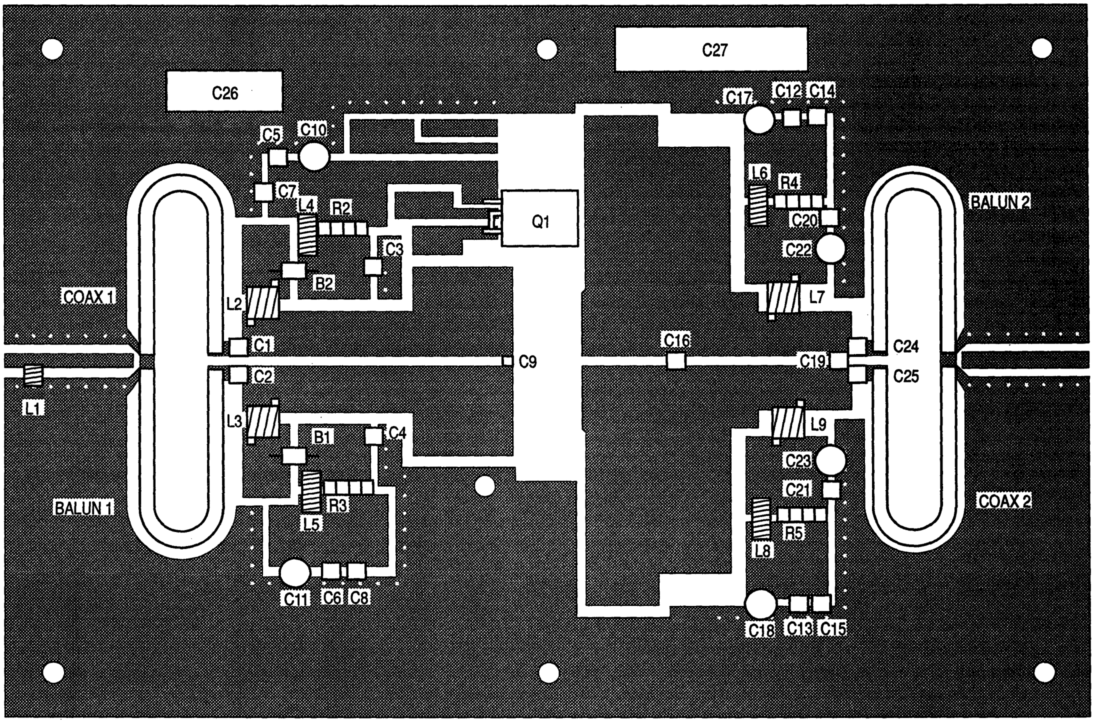


Figure 11. MRF899 Test Fixture Component Layout

2

MRF901

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers. Also usable in applications requiring fast switching times.

- High Current-Gain — Bandwidth Product — f_T = 4.5 GHz (Typ) @ I_C = 15 mAdc
- Low Noise Figure @ f = 1.0 GHz — NF = 2.0 dB (Typ) and 2.5 dB (Max)
- High Power Gain — G_{pe} = 10 dB (Min) @ f = 1.0 GHz
- Third Order Intercept = +23 dBm (Typ)

**2.5 dB @ 1.0 GHz
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**

CASE 317, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.375 3.3	Watt mW/°C
Storage Temperature Range	T_{stg}	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	300	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	80	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.4	1.0	pF
Noise Figure (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	NF	—	2.0	2.5	dB
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 6.0 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	G_{pe}	10	12	—	dB
Third Order Intercept (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 0.9 GHz)	—	—	+23	—	dBm

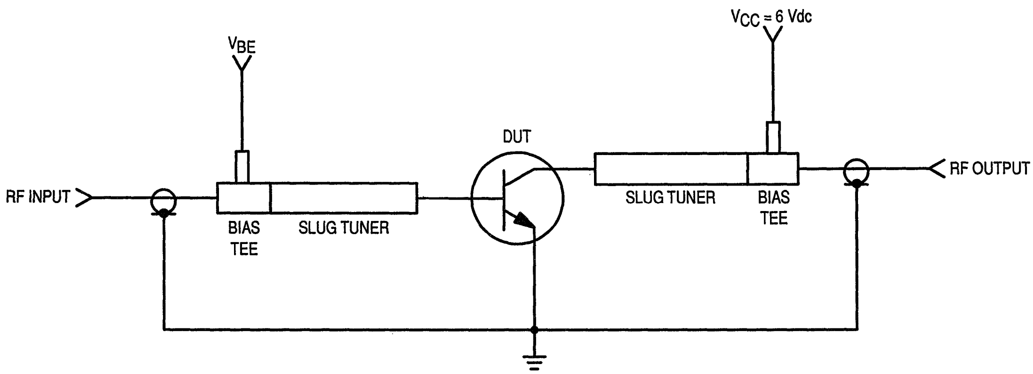


Figure 1. 1.0 GHz Test Circuit Schematic

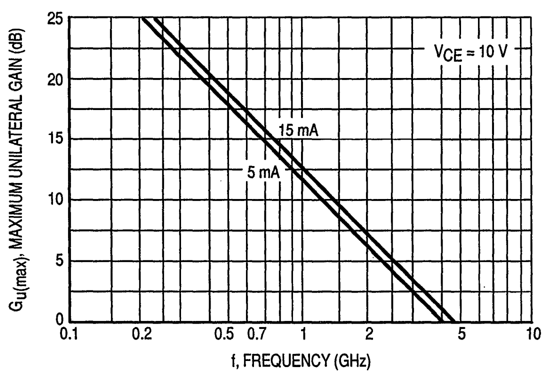


Figure 2. Maximum Unilateral Gain versus Frequency

2

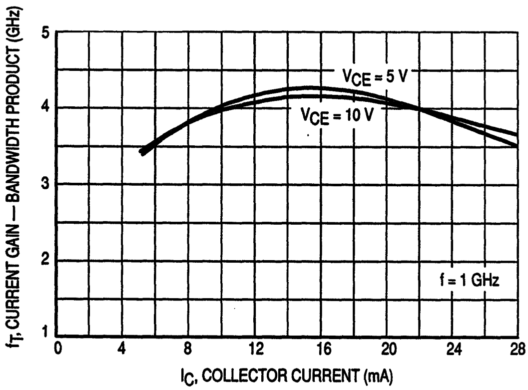


Figure 3. Current Gain — Bandwidth Product versus Collector Current

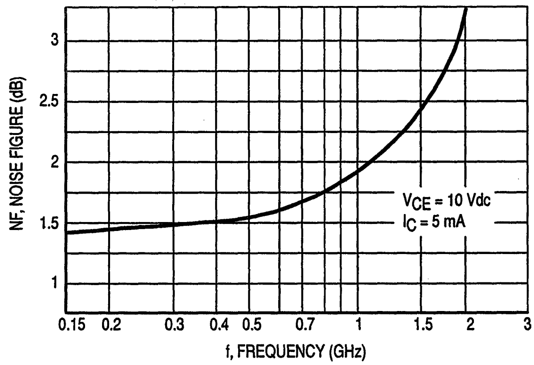


Figure 4. Noise Figure versus Frequency

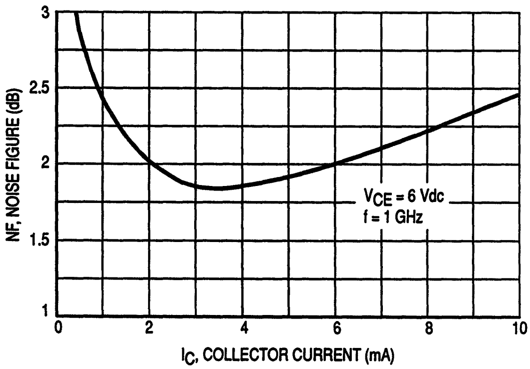


Figure 5. Noise Figure versus Collector Current

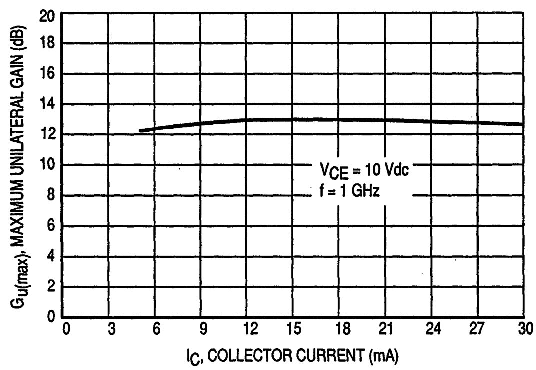


Figure 6. Maximum Unilateral Gain versus Collector Current

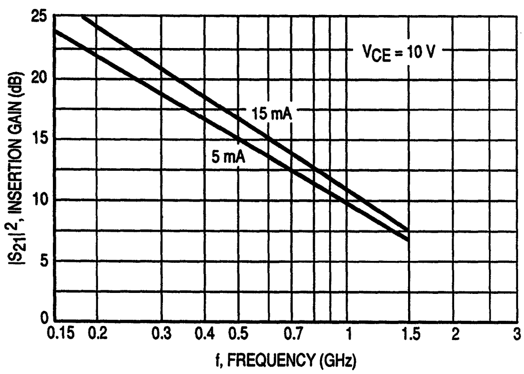


Figure 7. $|S_{21}|^2$ versus Frequency

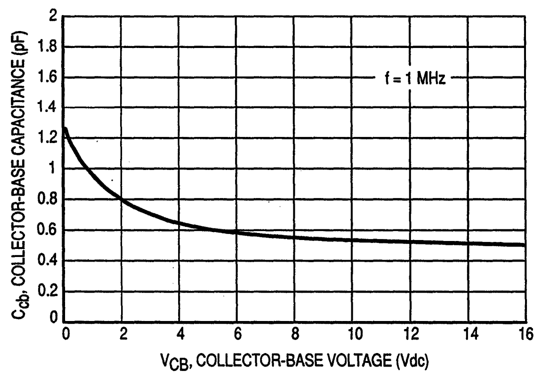


Figure 8. Collector-Base Capacitance versus Collector-Base Voltage

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
5.0	5.0	100	0.71	−38	11.30	153	0.03	68	0.92	−17
		200	0.62	−75	9.48	133	0.05	55	0.76	−29
		500	0.54	−141	5.40	100	0.07	43	0.48	−44
		1000	0.53	178	2.93	76	0.09	48	0.40	−56
		2000	0.59	130	1.51	48	0.16	62	0.35	−85
	10	100	0.57	−58	16.95	145	0.03	63	0.85	−23
		200	0.51	−103	12.61	123	0.04	53	0.64	−35
		500	0.52	−161	6.24	93	0.06	50	0.38	−45
		1000	0.52	166	3.24	73	0.09	61	0.33	−54
		2000	0.59	125	1.66	47	0.17	67	0.29	−84
	15	100	0.48	−75	20.08	139	0.02	61	0.80	−27
		200	0.47	−121	13.89	117	0.04	53	0.57	−38
		500	0.53	−170	6.44	91	0.05	56	0.34	−44
		1000	0.53	162	3.33	72	0.09	66	0.31	−52
		2000	0.60	123	1.70	46	0.18	68	0.28	−82
	20	100	0.44	−88	21.62	136	0.02	60	0.76	−28
		200	0.47	−132	14.33	114	0.03	54	0.53	−38
		500	0.53	−175	6.45	89	0.05	60	0.32	−41
		1000	0.53	159	3.31	70	0.09	68	0.31	−50
		2000	0.61	122	1.69	45	0.18	70	0.28	−80
	30	100	0.43	−112	21.45	130	0.02	58	0.72	−28
		200	0.50	−148	13.38	109	0.03	57	0.51	−33
		500	0.57	178	5.82	86	0.05	65	0.35	−34
		1000	0.57	156	2.99	68	0.08	73	0.35	−46
		2000	0.65	121	1.50	42	0.18	74	0.33	−78

Table 1. Common Emitter S-Parameters, V_{CE} = 5.0 V

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
10	5.0	100	0.73	−35	11.32	154	0.03	69	0.93	−14
		200	0.63	−69	9.69	135	0.05	57	0.79	−25
		500	0.53	−135	5.65	101	0.07	43	0.54	−38
		1000	0.51	−177	3.11	77	0.08	50	0.47	−48
		2000	0.57	132	1.58	48	0.14	66	0.41	−75
	10	100	0.59	−52	17.06	147	0.02	64	0.87	−19
		200	0.52	−95	13.06	125	0.04	54	0.69	−30
		500	0.49	−156	6.58	95	0.05	51	0.45	−37
		1000	0.50	170	3.44	74	0.08	62	0.41	−45
		2000	0.57	126	1.75	47	0.16	70	0.36	−72
	15	100	0.51	−66	20.36	141	0.02	63	0.83	−22
		200	0.47	−112	14.48	119	0.03	54	0.63	−31
		500	0.50	−166	6.81	92	0.05	57	0.41	−35
		1000	0.50	164	3.54	72	0.08	67	0.39	−43
		2000	0.58	124	1.78	46	0.16	72	0.35	−70
	20	100	0.47	−78	22.08	138	0.02	61	0.80	−23
		200	0.46	−123	15.07	116	0.03	55	0.60	−30
		500	0.50	−171	6.84	90	0.05	60	0.40	−32
		1000	0.51	162	3.51	71	0.08	69	0.39	−41
		2000	0.59	123	1.77	45	0.17	73	0.35	−68
	30	100	0.44	−98	22.70	133	0.02	59	0.76	−23
		200	0.47	−139	14.47	111	0.03	55	0.57	−27
		500	0.53	−177	6.33	87	0.04	65	0.43	−28
		1000	0.54	158	3.26	69	0.07	74	0.43	−39
		2000	0.62	122	1.61	42	0.16	77	0.39	−68

Table 2. Common Emitter S-Parameters, V_{CE} = 10 V

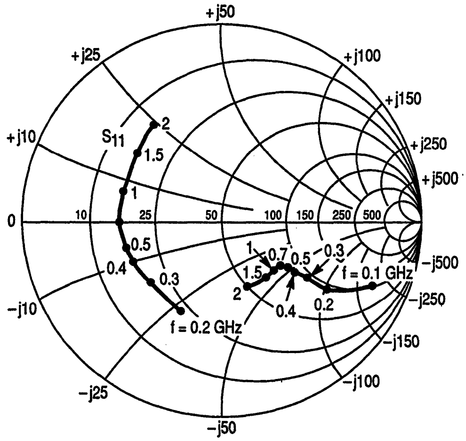


Figure 9. Input and Output Reflection Coefficients versus Frequency (V_{CE} = 10 V, I_C = 15 mA)

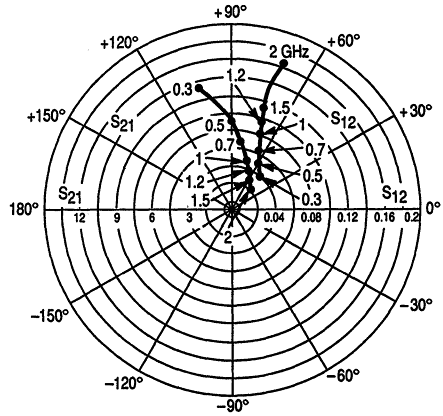


Figure 10. Forward/Reverse Transmission Coefficients versus Frequency (V_{CE} = 10 V, I_C = 15 mA)

2

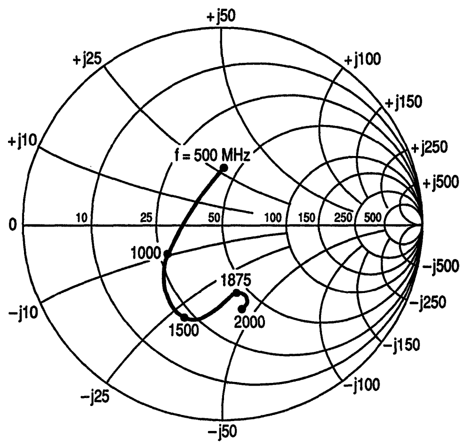
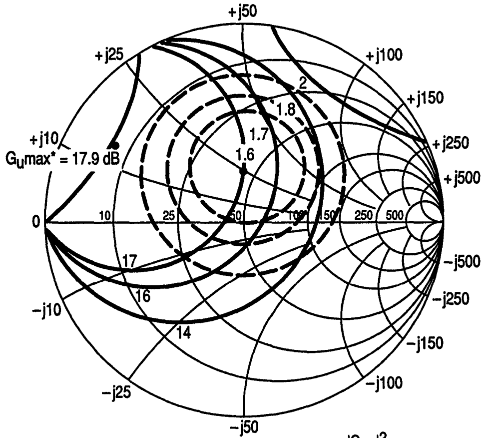
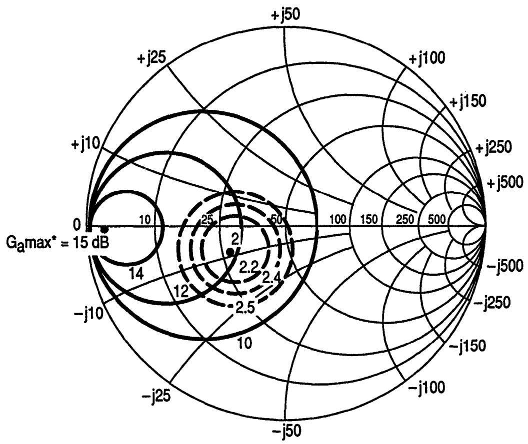


Figure 11. Source Impedance (Γms) for Optimum Noise Figure versus Frequency (V_{CE} = 10 V, I_C = 5.0 mA)



*MAXIMUM UNILATERAL GAIN, $G_u max = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$ (K < 1)

Figure 12. Constant Gain and Noise Figure Contours (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 500 MHz)



*MAXIMUM AVAILABLE GAIN, $G_a max = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1})$ (K > 1)

Figure 13. Constant Gain and Noise Figure Contours (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)

2

MRF941
MMBR941LT1
MMBR941BLT1
MRF9411LT1
MRF9411BLT1

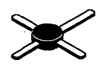
The RF Line

NPN Silicon Low Noise, High-Frequency Transistors

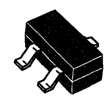
. . . designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 9 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal

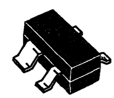
**I_C = 50 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTORS**



CASE 317, STYLE 2
MACRO-X
MRF941



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR941LT1, MMBR941BLT1



CASE 318A, STYLE 1
SOT-143
LOW PROFILE
MRF9411LT1, MRF9411BLT1

2

MAXIMUM RATINGS

Rating	Symbol	MRF941	MMBR941LT1	MRF9411LT1	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	1.5	1.5	Vdc
Power Dissipation (1) T_C = 50°C	P_D	0.4	0.33	0.33	Watts
Collector Current — Continuous (2)	I_C	50	50	50	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	°C
Storage Temperature	T_{stg}	–65 to +150	–65 to +150	–65 to +150	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	250	300	300	°C/W

DEVICE MARKING

MMBR941LT1 = 7Y	MMBR941BLT1 = 7N
MRF9411LT1 = 10	MRF9411BLT1 = 18

NOTES:
1. To calculate the junction temperature use $T_J = P_D \times R_{\theta JA} + T_{CASE}$. Case temperature measured on collector lead immediately adjacent to body of package.
2. I_C — Continuous (MTBF ≈ 10 years).

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	23	—	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS (3)					
DC Current Gain	h_{FE}				—
(V_{CE} = 6.0 V, I_C = 5.0 mA) (MRF941, MMBR941LT1, MRF9411LT1)		50	—	200	
(MRF941B, MMBR941BLT1, MRF9411BLT1)		100	—	200	
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.35	—	pF
Current Gain — Bandwidth Product (V_{CE} = 6.0 V, I_C = 15 mA, f = 1.0 GHz)	f_T	—	8.0	—	GHz

NOTE:
3. Pulse width ≤ 300 μs, duty cycle ≤ 2% pulsed.

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF941			MRF9411LT1			MMBR941LT1			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain	$\|S_{21}\|^2$										dB
(V_{CE} = 6.0 V, I_C = 15 mA, f = 1.0 GHz)		—	16	—	—	16	—	—	14	—	
(V_{CE} = 6.0 V, I_C = 15 mA, f = 2.0 GHz)		—	10	—	—	10	—	—	8.0	—	
Maximum Unilateral Gain (1)	$G_{U\,max}$										dB
(V_{CE} = 6.0 V, I_C = 15 mA, f = 1.0 GHz)		—	18	—	—	18	—	—	16	—	
(V_{CE} = 6.0 V, I_C = 15 mA, f = 2.0 GHz)		—	12	—	—	12	—	—	10	—	
Noise Figure — Minimum	NF_{MIN}										dB
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)		—	1.3	—	—	1.3	—	—	1.3	—	
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 2.0 GHz)		—	2.1	—	—	2.1	—	—	2.1	—	
Associated Gain at Minimum NF	G_{NF}										dB
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)		—	15	—	—	15	—	—	14	—	
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 2.0 GHz)		—	9.5	—	—	9.5	—	—	8.5	—	
Noise Figure — 50 ohm Source (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)	$NF_{50\,\Omega}$	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE:
1. Maximum Unilateral Gain is $GU_{max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

TYPICAL CHARACTERISTICS

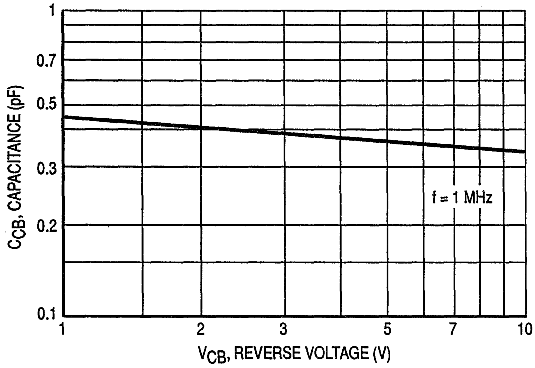


Figure 1. Collector-Base Capacitance versus Voltage

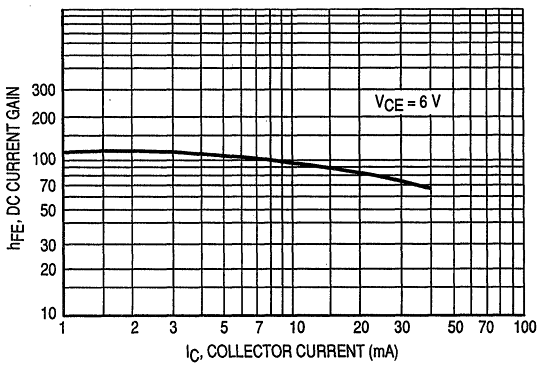


Figure 2. DC Current Gain versus Collector Current

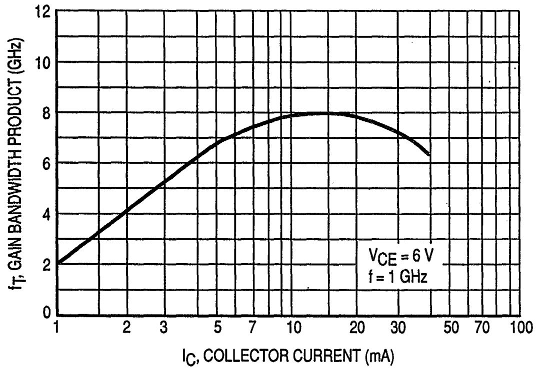


Figure 3. Gain Bandwidth Product versus Collector Current

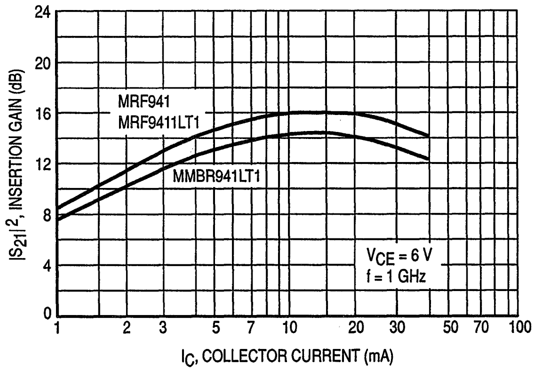


Figure 4. Insertion Gain versus Collector Current

FORWARD INSERTION GAIN AND MAXIMUM UNILATERAL GAIN versus FREQUENCY

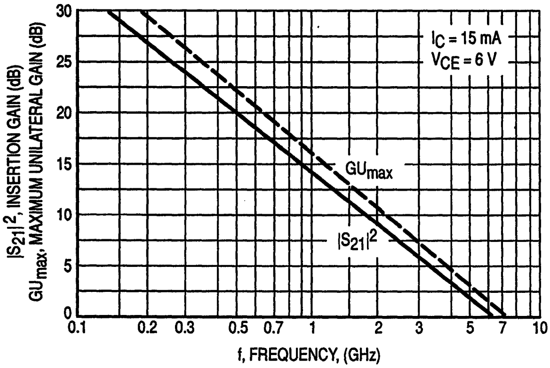


Figure 5. MMBR941LT1

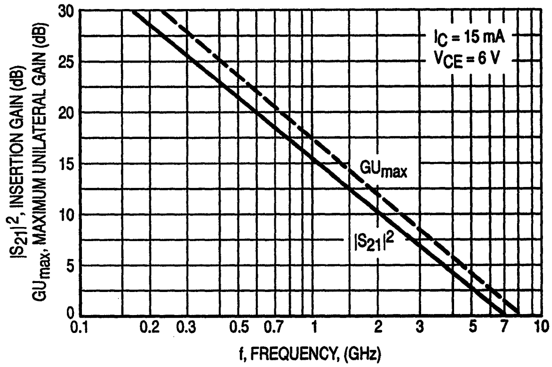


Figure 6. MRF941, MRF9411LT1

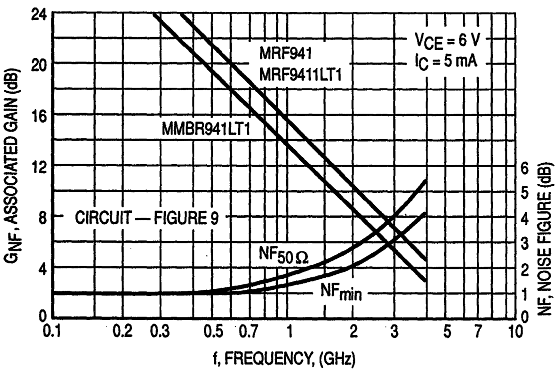


Figure 7. Noise Figure and Associated Gain versus Frequency

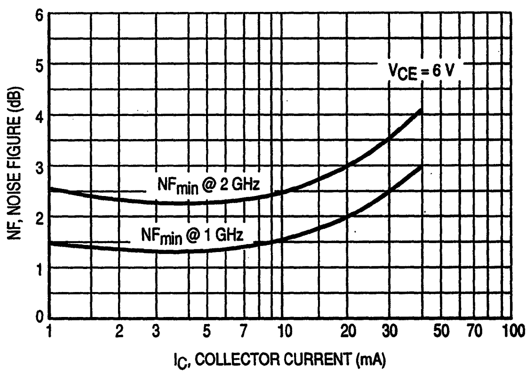


Figure 8. Noise Figure versus Collector Current

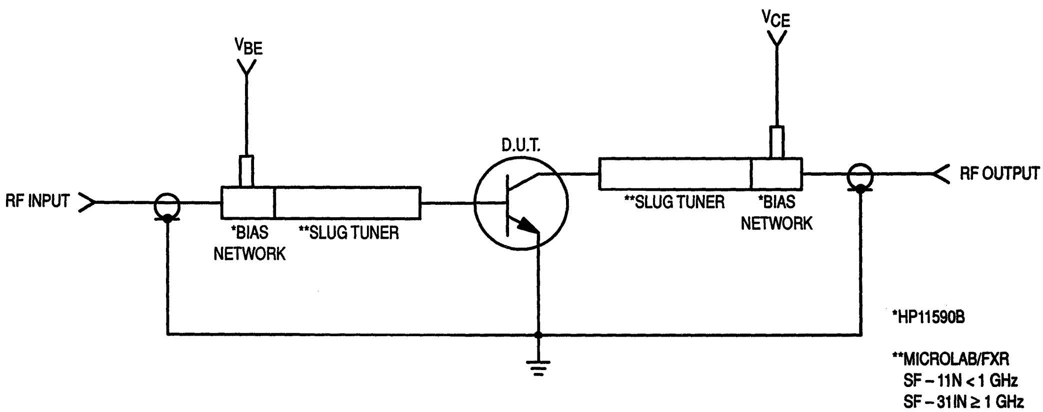


Figure 9. Functional Circuit Schematic

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
6.0	5.0	100	0.82	−24	14.5	162	0.02	81	0.96	−11
		200	0.77	−47	13.2	147	0.03	68	0.89	−21
		400	0.62	−84	10.3	124	0.04	53	0.73	−33
		600	0.54	−110	8.1	108	0.06	49	0.63	−39
		800	0.46	−131	6.4	98	0.06	49	0.58	−44
		1000	0.42	−148	5.3	90	0.07	52	0.55	−46
		1500	0.36	177	3.6	74	0.09	56	0.51	−53
		2000	0.34	145	2.7	61	0.11	59	0.50	−61
		2500	0.36	118	2.2	51	0.14	60	0.49	−69
		3000	0.42	90	1.9	44	0.16	56	0.46	−75
		3500	0.51	77	1.7	35	0.22	53	0.41	−90
		4000	0.58	58	1.6	28	0.23	47	0.37	−100
		5000	0.72	44	1.5	9.0	0.26	33	0.39	−151
		6000	0.86	35	1.4	−14	0.30	24	0.55	167
	10	100	0.67	−37	24.4	154	0.02	88	0.91	−17
		200	0.48	−67	20	135	0.02	55	0.79	−29
		400	0.45	−111	13.4	112	0.03	56	0.59	−37
		600	0.40	−136	9.8	99	0.04	57	0.50	−41
		800	0.44	−155	7.5	90	0.06	61	0.47	−43
		1000	0.35	−170	6.1	84	0.06	62	0.45	−44
		1500	0.31	159	4.1	70	0.08	66	0.45	−50
		2000	0.32	130	3.1	59	0.11	66	0.44	−58
		2500	0.34	107	2.4	50	0.15	65	0.44	−66
		3000	0.41	82	2.1	43	0.17	59	0.41	−71
		3500	0.49	72	1.9	35	0.21	54	0.36	−85
		4000	0.55	54	1.7	27	0.23	46	0.33	−93
		5000	0.68	42	1.6	10	0.27	32	0.32	−144
		6000	0.82	34	1.5	−12	0.30	23	0.48	−169
	15	100	0.57	−47	30.1	149	0.02	63	0.87	−20
		200	0.48	−83	23.2	128	0.02	64	0.72	−31
		400	0.40	−126	14.4	107	0.03	65	0.52	−37
		600	0.36	−150	10.2	95	0.04	65	0.46	−39
		800	0.34	−167	7.8	87	0.05	66	0.43	−42
		1000	0.33	180	6.3	81	0.06	67	0.42	−42
		1500	0.27	151	4.2	69	0.08	72	0.43	−49
		2000	0.32	124	3.1	59	0.12	69	0.42	−56
		2500	0.34	103	2.5	49	0.15	67	0.42	−64
		3000	0.41	80	2.1	42	0.17	59	0.40	−69
		3500	0.49	70	1.9	34	0.20	54	0.35	−84
		4000	0.55	52	1.7	27	0.28	47	0.32	−90
		5000	0.68	41	1.7	9.0	0.26	33	0.31	−143
		6000	0.82	33	1.5	−13	0.29	23	0.46	169
	30	100	0.41	−74	37.8	139	0.01	69	0.79	−24
		200	0.37	−116	25.8	118	0.01	65	0.62	−32
		400	0.37	−152	14.7	100	0.02	72	0.47	−32
		600	0.36	−170	10.1	90	0.03	70	0.43	−33
		800	0.35	176	7.7	83	0.04	71	0.42	−36
		1000	0.35	167	6.1	78	0.06	75	0.42	−38
		1500	0.34	142	4.1	65	0.08	72	0.44	−44
		2000	0.36	118	3.1	55	0.11	71	0.43	−53
		2500	0.38	100	2.4	46	0.14	68	0.44	−62
		3000	0.45	77	2.1	40	0.17	61	0.42	−68
		3500	0.53	68	1.8	32	0.21	58	0.37	−82
		4000	0.59	51	1.6	25	0.24	48	0.34	−92
		5000	0.72	40	1.5	7.0	0.26	34	0.33	−143
		6000	0.85	31	1.4	−15	0.30	24	0.48	171

Table 1. MRF941 Common Emitter S-Parameters

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
1.0	0.5	100	0.97	−11	1.78	170	0.03	83	0.99	−4.7
		200	0.96	−22	1.74	161	0.06	76	0.99	−9.1
		500	0.90	−53	1.60	133	0.13	56	0.93	−21
		900	0.75	−89	1.37	105	0.18	37	0.83	−33
		1000	0.72	−98	1.32	100	0.18	33	0.82	−36
		1500	0.63	−132	1.07	74	0.19	20	0.75	−47
		2000	0.57	−163	0.89	55	0.16	15	0.72	−57
		3000	0.55	144	0.67	30	0.15	40	0.71	−76
	1.0	100	0.95	−13	3.37	169	0.03	81	0.99	−6.2
		200	0.93	−27	3.27	158	0.06	73	0.98	−12
		500	0.81	−62	2.85	128	0.12	52	0.86	−26
		900	0.63	−101	2.21	101	0.15	37	0.73	−38
		1000	0.60	−110	2.08	96	0.15	34	0.71	−40
		1500	0.51	−144	1.59	73	0.16	27	0.64	−49
		2000	0.46	−173	1.28	56	0.16	29	0.61	−58
		3000	0.46	138	0.95	30	0.19	44	0.60	−75
6.0	5.0	100	0.82	−25	14.6	159	0.02	77	0.94	−13
		200	0.75	−47	12.6	142	0.04	68	0.85	−22
		400	0.55	−79	9.2	120	0.05	61	0.69	−31
		600	0.42	−98	6.9	106	0.07	60	0.60	−32
		800	0.33	−114	5.3	97	0.08	61	0.56	−33
		1000	0.28	−129	4.5	90	0.09	62	0.52	−33
		1500	0.25	−155	3.1	77	0.13	67	0.51	−37
		2000	0.16	176	2.4	66	0.16	68	0.51	−36
		2500	0.21	151	2.0	57	0.20	69	0.48	−40
		3000	0.18	122	1.7	50	0.23	68	0.48	−44
		3500	0.30	108	1.5	42	0.27	66	0.45	−46
		4000	0.29	91	1.4	37	0.32	64	0.42	−53
	10	100	0.67	−37	23.5	149	0.02	74	0.88	−18
		200	0.54	−64	18.1	129	0.03	68	0.73	−28
		400	0.37	−96	11.3	108	0.05	67	0.56	−31
		600	0.26	−114	8.0	98	0.06	67	0.50	−30
		800	0.21	−130	6.0	91	0.08	70	0.47	−30
		1000	0.18	−147	5.1	85	0.09	70	0.45	−30
		1500	0.18	−167	3.4	74	0.13	72	0.46	−34
		2000	0.11	159	2.6	64	0.17	71	0.46	−34
		2500	0.17	140	2.2	56	0.21	69	0.44	−38
		3000	0.15	107	1.8	59	0.25	67	0.45	−41
		3500	0.27	100	1.7	42	0.28	65	0.42	−42
		4000	0.26	85	1.5	37	0.33	61	0.39	−49
	15	100	0.56	−46	28.6	143	0.02	73	0.83	−22
		200	0.43	−75	20.2	122	0.03	67	0.65	−30
		400	0.29	−107	11.8	104	0.04	70	0.50	−30
		600	0.22	−125	8.2	95	0.06	74	0.46	−28
		800	0.18	−141	6.2	88	0.08	74	0.45	−27
		1000	0.16	−158	5.1	83	0.09	74	0.43	−28
		1500	0.17	−174	3.4	72	0.13	73	0.44	−32
		2000	0.11	150	2.6	63	0.17	72	0.45	−33
		2500	0.17	138	2.2	55	0.21	70	0.43	−37
		3000	0.15	102	1.9	49	0.25	67	0.44	−39
		3500	0.28	98	1.7	42	0.29	65	0.40	−41
		4000	0.25	82	1.5	37	0.32	61	0.38	−47

(continued)

Table 2. MMBR941LT1 Common Emitter S-Parameters

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
6.0	20	100	0.49	−52	31.5	139	0.01	70	0.79	−23
		200	0.36	−84	21.1	118	0.02	69	0.60	−29
		400	0.25	−115	12.1	101	0.04	73	0.48	−29
		600	0.20	−134	8.3	93	0.06	74	0.45	−26
		800	0.16	−150	6.2	87	0.07	75	0.44	−26
		1000	0.15	−166	5.1	82	0.09	75	0.42	−26
		1500	0.16	−176	3.5	75	0.14	74	0.44	−31
		2000	0.12	144	2.6	63	0.17	73	0.45	−32
		2500	0.17	133	2.2	55	0.22	70	0.43	−36
		3000	0.16	101	1.9	49	0.25	68	0.44	−39
		3500	0.28	98	1.6	41	0.29	65	0.41	−40
		4000	0.26	82	1.5	36	0.33	61	0.39	−47
	30	100	0.41	−65	34.3	134	0.01	70	0.74	−25
		200	0.30	−99	21.6	113	0.02	70	0.56	−28
		400	0.23	−131	11.9	98	0.04	76	0.47	−25
		600	0.20	−147	8.1	91	0.06	76	0.45	−24
		800	0.18	−163	6.1	84	0.07	78	0.44	−23
		1000	0.17	−177	5.0	80	0.09	78	0.43	−24
		1500	0.18	174	3.4	70	0.13	76	0.45	−30
		2000	0.14	141	2.5	61	0.17	74	0.47	−31
		2500	0.20	131	2.1	54	0.21	71	0.45	−36
		3000	0.18	104	1.8	47	0.25	69	0.46	−39
		3500	0.31	100	1.6	40	0.29	65	0.42	−42
		4000	0.29	84	1.5	35	0.33	62	0.40	−48

Table 2. MMBR941LT1 Common Emitter S-Parameters (continued)

2

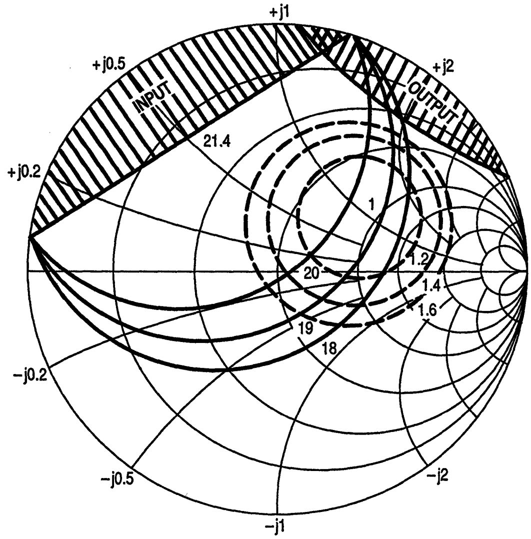
VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
1.0	0.5	100	0.97	−10	1.78	171	0.03	83	100	−4.7
		200	0.97	−20	1.75	163	0.05	77	100	−9.2
		500	0.93	−49	1.62	137	0.12	57	0.94	−21
		900	0.81	−84	1.43	110	0.18	36	0.86	−35
		1000	0.79	−92	1.38	104	0.19	32	0.84	−38
		1500	0.72	−125	1.12	78	0.20	14	0.77	−50
		2000	0.68	−152	0.92	57	0.20	1	0.74	−61
		3000	0.66	169	0.68	27	0.16	−11	0.73	−82
	1.0	100	0.95	−13	3.37	170	0.03	82	0.99	−6.2
		200	0.94	−25	3.30	161	0.05	74	0.98	−12
		500	0.88	−59	2.96	133	0.16	53	0.89	−27
		1000	0.70	−107	2.26	101	0.16	29	0.74	−44
		1500	0.64	−139	1.72	78	0.17	15	0.66	−55
		2000	0.61	−165	1.36	59	0.17	6.7	0.62	−65
		3000	0.61	160	0.97	32	0.14	3.0	0.61	−84

(continued)

Table 3. MRF9411LT1 Common Emitter S-Parameters

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
6.0	5.0	100	0.73	−24	14	164	0.02	92	0.96	−11
		200	0.74	−47	12.9	150	0.03	65	0.90	−20
		400	0.66	−83	10.4	129	0.05	56	0.75	−32
		600	0.62	−108	8.4	115	0.06	45	0.65	−40
		800	0.56	−127	6.7	105	0.07	46	0.60	−43
		1000	0.54	−141	5.6	96	0.07	51	0.57	−46
		1500	0.46	−166	3.9	82	0.08	55	0.52	−50
		2000	0.43	172	2.9	70	0.09	56	0.50	−54
		2500	0.41	151	2.3	62	0.11	61	0.48	−60
		3000	0.44	128	1.9	55	0.14	62	0.49	−65
		3500	0.49	117	1.6	47	0.15	61	0.46	−74
		4000	0.57	101	1.4	42	0.16	62	0.47	−81
		5000	0.60	92	1.2	32	0.21	60	0.46	−105
		6000	0.58	88	1.0	20	0.25	61	0.51	−137
	10	100	0.64	−39	23.6	157	0.01	59	0.91	−16
		200	0.60	−71	20	139	0.02	70	0.80	−27
		400	0.54	−112	13.9	117	0.03	57	0.61	−39
		600	0.52	−135	10.3	104	0.04	50	0.51	−43
		800	0.49	−151	8.0	96	0.05	54	0.46	−44
		1000	0.47	−161	6.5	89	0.06	60	0.46	−46
		1500	0.41	177	4.4	77	0.08	62	0.44	−47
		2000	0.40	158	3.2	67	0.09	65	0.43	−52
		2500	0.39	139	2.6	60	0.11	68	0.41	−56
		3000	0.44	118	2.1	53	0.13	69	0.43	−62
		3500	0.49	110	1.8	47	0.15	67	0.39	−72
		4000	0.54	96	1.6	42	0.18	65	0.41	−78
		5000	0.63	88	1.3	32	0.23	61	0.40	−101
		6000	0.58	86	1.1	20	0.26	62	0.44	−136
	15	100	0.56	−51	29.5	152	0.01	78	0.87	−20
		200	0.53	−88	23.5	131	0.02	63	0.73	−31
		400	0.51	−128	15.1	111	0.03	63	0.54	−40
		600	0.49	−148	11.8	99	0.04	56	0.46	−42
		800	0.48	−161	8.3	92	0.04	59	0.42	−41
		1000	0.46	−170	6.7	86	0.05	59	0.41	−44
		1500	0.41	−171	4.4	75	0.07	70	0.42	−45
		2000	0.40	152	3.3	66	0.09	71	0.41	−50
		2500	0.39	135	2.6	59	0.11	71	0.41	−55
		3000	0.45	116	2.2	53	0.14	73	0.42	−61
		3500	0.50	108	1.9	46	0.17	70	0.39	−70
		4000	0.55	94	1.6	41	0.19	67	0.41	−76
		5000	0.61	87	1.3	32	0.22	62	0.34	−114
		6000	0.58	85	1.1	21	0.27	63	0.43	−135
	30	100	0.45	−82	36.3	142	0.01	62	0.79	−23
		200	0.48	−121	25.5	121	0.01	48	0.62	−31
		400	0.49	−152	14.6	103	0.02	58	0.47	−33
		600	0.50	−166	10.2	93	0.03	60	0.44	−34
		800	0.49	−175	7.7	87	0.04	65	0.42	−34
		1000	0.48	177	6.1	81	0.05	76	0.43	−37
		1500	0.45	162	4.1	71	0.07	75	0.45	−39
		2000	0.45	145	3.0	62	0.09	78	0.44	−46
		2500	0.44	130	2.4	56	0.11	79	0.44	−53
		3000	0.50	113	1.9	50	0.13	79	0.45	−58
		3500	0.55	105	1.6	43	0.15	75	0.44	−70
		4000	0.61	92	1.5	39	0.19	73	0.45	−76
		5000	0.65	84	1.2	30	0.24	68	0.43	−100
		6000	0.61	82	1.0	19	0.28	64	0.48	−135

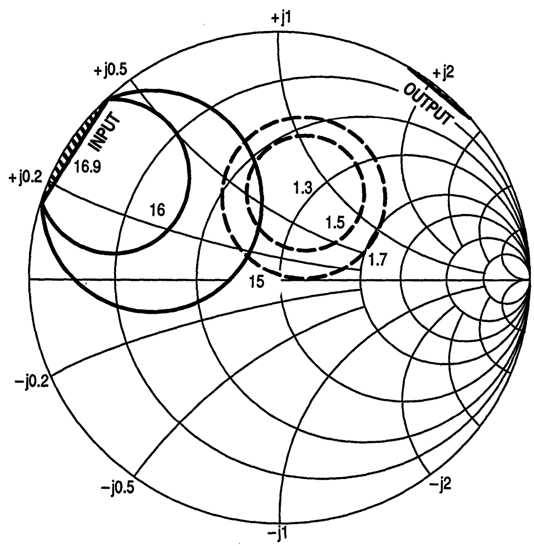
Table 3. MRF9411LT1 Common Emitter S-Parameters (continued)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.0	0.42 ∠ 32°	18	0.71

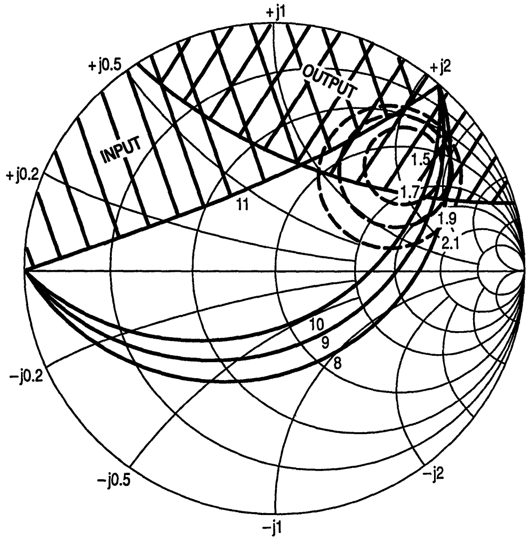
Figure 10. MRF941 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.30	0.38 ∠ 72°	16	0.98

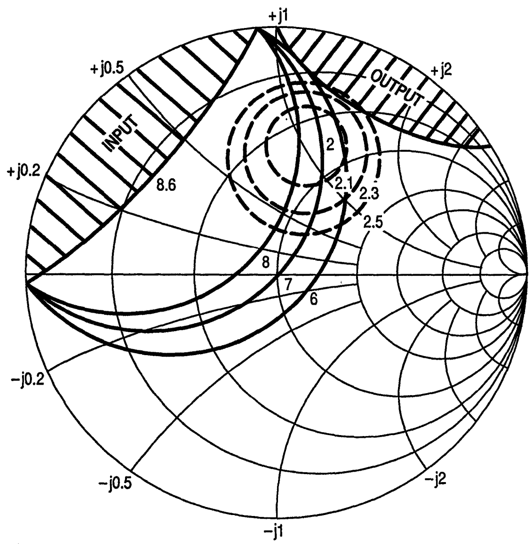
Figure 11. MRF941 Constant Gain and Noise Figure Contours (f = 1.0 GHz)



V_{CE} = 1.0 V
I_C = 0.5 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.54	0.71 ∠ 39°	38	0.28

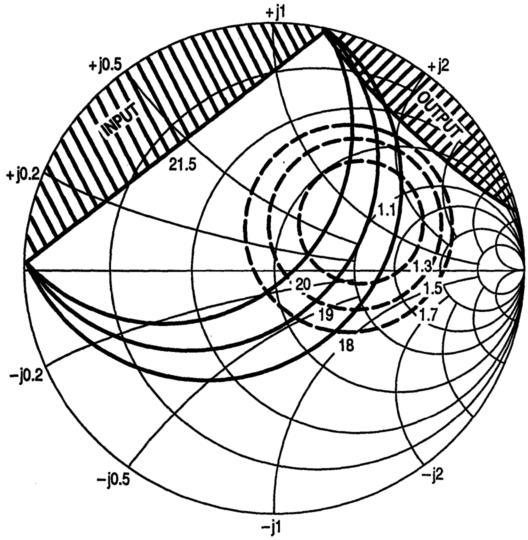
Figure 12. MMBR941LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 1.0 V
I_C = 0.5 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.95	0.55 ∠ 76°	28	0.51

Figure 13. MMBR941LT1 Constant Gain and Noise Figure Contours (f = 1.0 GHz)

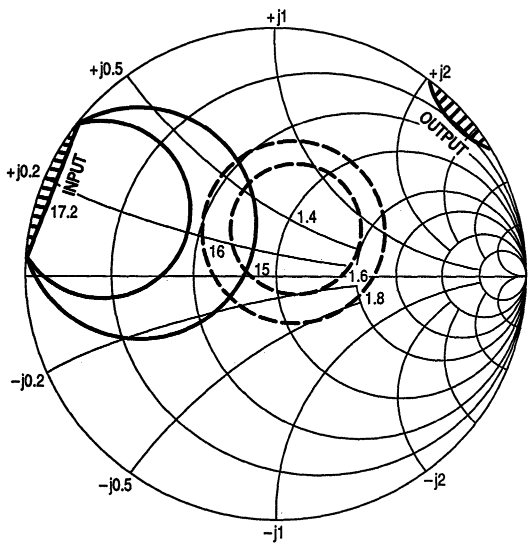


V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.10	0.43 ∠ 30°	18	0.67

2

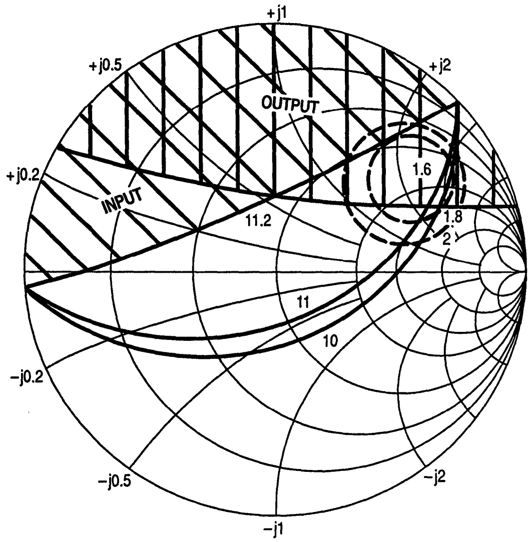
Figure 14. MMBR941LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.40	0.22 ∠ 64°	13	0.96

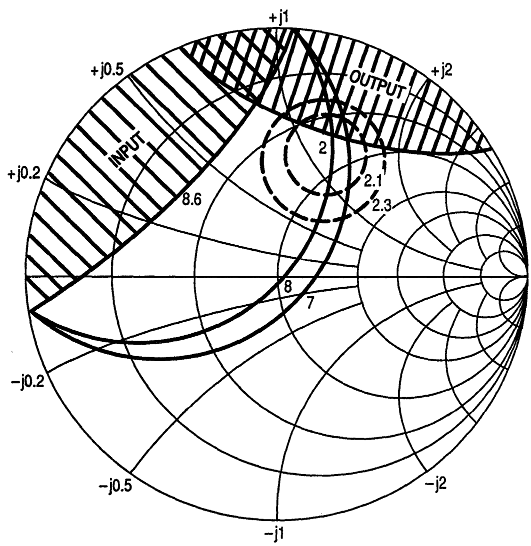
Figure 15. MMBR941LT1 Constant Gain and Noise Figure Contours (f = 1.0 GHz)



V_{CE} = 1.0 V
I_C = 0.5 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.60	0.70 ∠ 35°	40	0.22

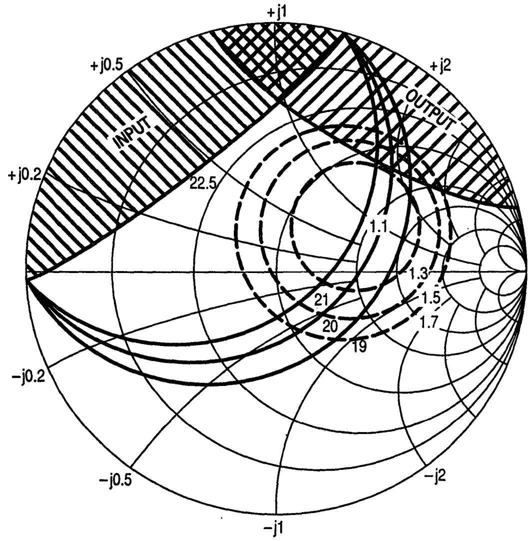
Figure 16. MRF9411LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 1.0 V
I_C = 0.5 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.95	0.55 ∠ 69°	30	0.39

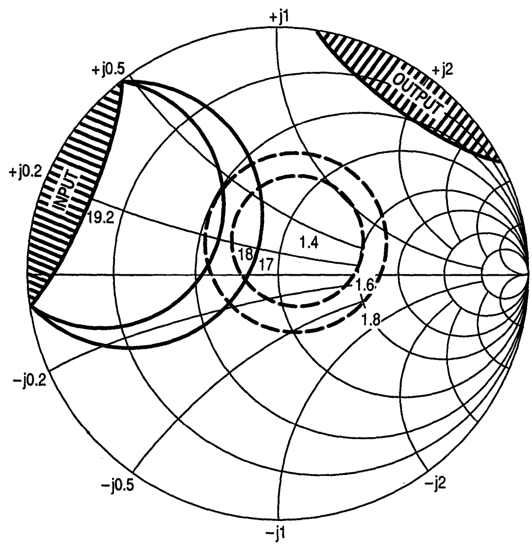
Figure 17. MRF9411LT1 Constant Gain and Noise Figure Contours (f = 1.0 GHz)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.10	0.40 ∠ 28°	17	0.43

Figure 18. MRF9411LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.40	0.17 ∠ 60°	13	0.74

Figure 19. MRF9411LT1 Constant Gain and Noise Figure Contours (f = 1.0 GHz)

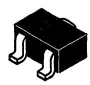
MRF947T1
MRF947BT1

The RF Line
NPN Silicon RF Power Transistor

Designed for use in high gain, low noise small-signal amplifiers. This transistor features excellent broadband linearity, in an ultra-small surface mount package suitable for automated assembly.

- Fully Implanted Base and Emitter Structure
- 9 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal

I_C = 50 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTOR



CASE 419, STYLE 3

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Power Dissipation(1) T_A = 25°C	P_D	175	mW
Collector Current — Continuous(2)	I_C	50	mA
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	714	°C/W

DEVICE MARKING

MRF947T1 = A	MRF947BT1 = H

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	23	—	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	—	—	0.1	µAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	µAdc

(continued)

NOTES:
1. To calculate the junction temperature use $T_J = P_D \times R_{\theta JA} + T_{AMBIENT}$.
2. I_C — Continuous (MTBF ≈ 10 years)
3. Pulse width ≤ 300 µs, duty cycle ≤ 2% pulsed.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (3)					
DC Current Gain (V_{CE} = 6.0 V, I_C = 5.0 mA)	h_{FE1}	50	—	200	—
DC Current Gain (V_{CE} = 1.0 V, I_C = 500 μA)	h_{FE2}	50	—	—	—
(V_{CE} = 6.0 V, I_C = 5.0 mA) MRF947BT1	h_{FE3}	100	—	200	
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	0.35	—	pF
Current Gain — Bandwidth Product (V_{CE} = 6.0 V, I_C = 15 mA, f = 1.0 GHz)	f_T	—	8.0	—	GHz

NOTE:
3. Pulse width ≤ 300 μs, duty cycle ≤ 2% pulsed.

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	Min	Typ	Max	Unit
Insertion Gain (V_{CE} = 6.0 V, I_C = 15 mA, f = 1.0 GHz)	$\|S_{21}\|^2$	—	14	—	dB
(V_{CE} = 6.0 V, I_C = 15 mA, f = 1.5 GHz)		—	10.8	—	
Maximum Unilateral Gain(1) (V_{CE} = 6.0 V, I_C = 15 mA, f = 1.0 GHz)	$G_{U\ max}$	—	14.8	—	dB
(V_{CE} = 6.0 V, I_C = 15 mA, f = 1.5 GHz)		—	11.6	—	
Noise Figure (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)	NF_{opt}	—	1.8	—	dB
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.5 GHz)		—	2.1	—	
Associated Gain at Minimum (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)	G_{NF}	—	14	—	dB
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.5 GHz)		—	10.5	—	
Noise Figure (V_{CE} = 6.0 V, I_C = 5 mA, f = 1.0 GHz)	$NF_{50\Omega}$	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $G_{U\ max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

V_{CE} (Vdc)	I_C (mA)	f (MHz)	NF_{min} (dB)	Γ_o (MAG, ANGLE)	r_N
6	5	1000	1.8	0.33 ∠ 77	0.28
		1500	2.1	0.26 ∠ 141	0.3

Table 1. Typical Noise Parameters

2

TYPICAL CHARACTERISTICS

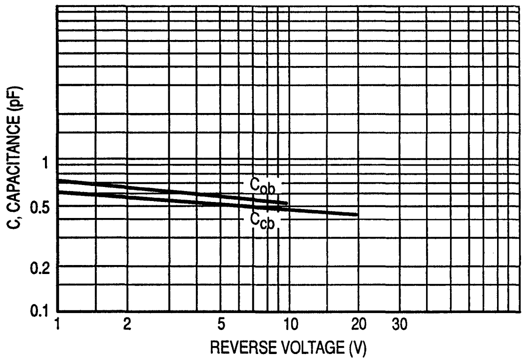


Figure 1. Capacitance versus Voltage

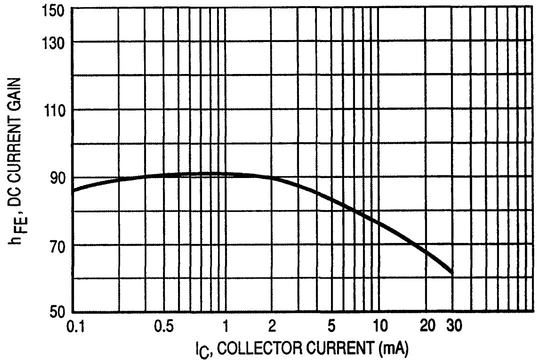


Figure 2. DC Current Gain versus Collector Current

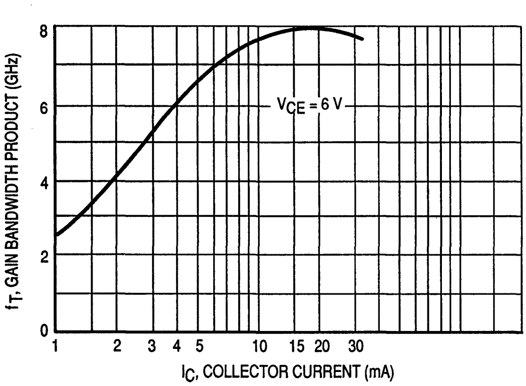


Figure 3. Gain-Bandwidth Product versus Collector Current

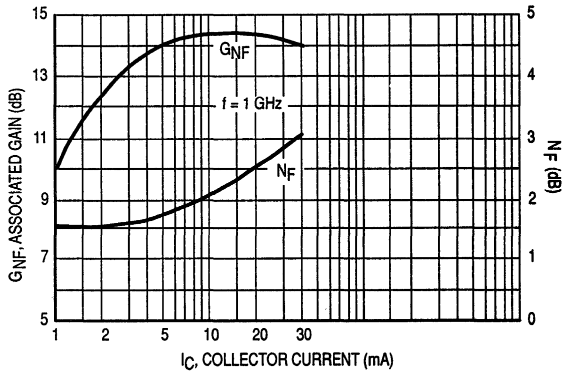


Figure 4. Associated Gain and Noise Figure versus Collector Current

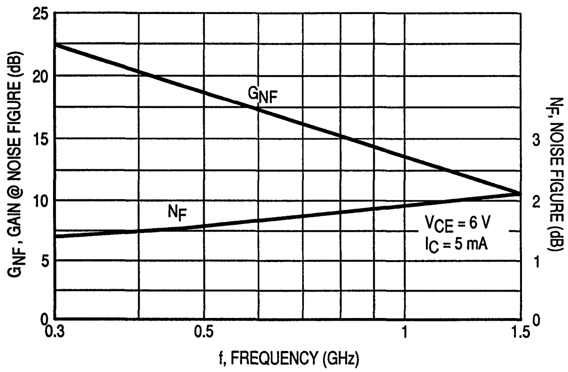


Figure 5. Noise Figure and Associated Gain versus Frequency

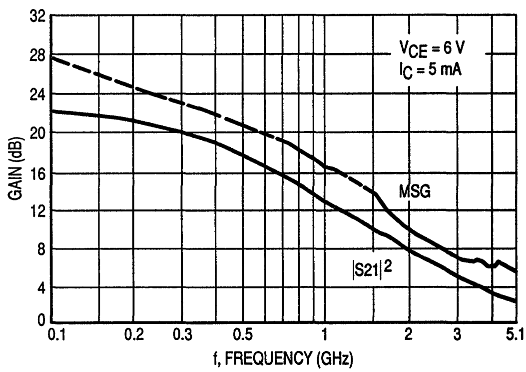


Figure 6. Forward Insertion Gain and Maximum Stable Power Gain versus Frequency

V_{CE} = 6 V
I_C = 5 mA

f (GHz)	NF OPT	Γ_o	R_N	K
1.0	1.8 dB	0.33 ∠ 77°	14	0.89

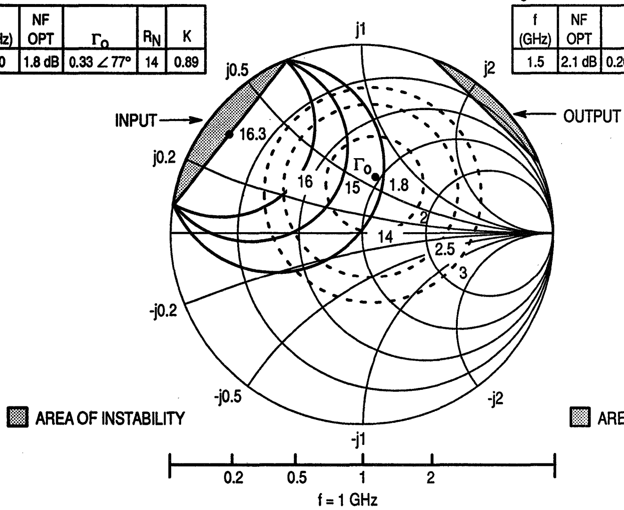


Figure 7. Constant Gain and Noise Figure Contours

V_{CE} = 6 V
I_C = 5 mA

f (GHz)	NF OPT	Γ_o	R_N	K
1.5	2.1 dB	0.26 ∠ 141°	15	0.96

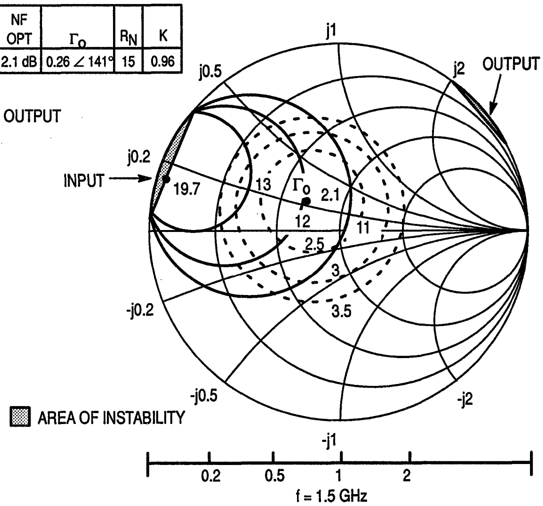


Figure 8. Constant Gain and Noise Figure Contours

V_{CE} = 1 V
I_C = 0.5 mA

f (GHz)	NF OPT	ΓMS NF OPT	Rn	K
1.0	1.95 dB	0.59 ∠ 72°	30	0.50

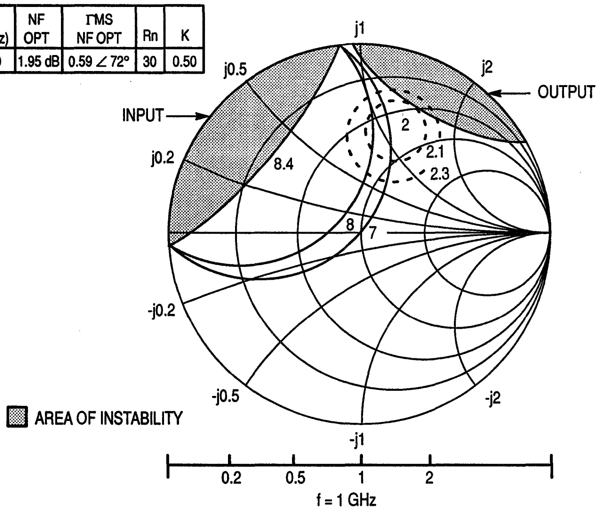


Figure 9. Constant Gain and Noise Figure Contours

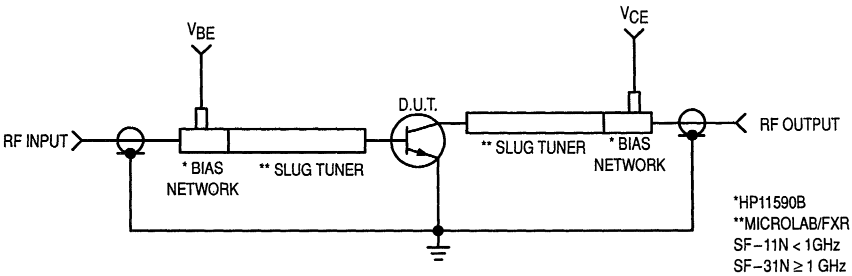


Figure 10. Functional Circuit Schematic

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} Mag	S_{11} ∠ϕ	S_{21} Mag	S_{21} ∠ϕ	S_{12} Mag	S_{12} ∠ϕ	S_{22} Mag	S_{22} ∠ϕ
1.0	0.5	100	0.966	−11.46	1.776	170.10	0.031	82.57	0.998	−4.70
		200	0.956	−23.02	1.735	160.72	0.061	75.42	0.991	−9.25
		500	0.892	−54.71	1.587	132.34	0.135	54.85	0.923	−21.14
		900	0.749	−91.29	1.355	104.19	0.185	35.43	0.827	−33.53
		1000	0.720	−100.07	1.300	98.21	0.190	31.61	0.808	−35.99
		1500	0.637	−134.17	1.057	72.77	0.196	18.05	0.743	−47.18
		2000	0.587	−163.82	0.883	53.17	0.176	12.30	0.708	−58.12
		3000	0.572	149.42	0.672	27.46	0.149	33.04	0.680	−81.83
	1.0	100	0.941	−14.07	3.391	168.35	0.031	81	0.991	−6.46
		200	0.921	−28.11	3.285	157.61	0.060	73	0.974	−12.40
		500	0.806	−64.76	2.844	127.72	0.123	51.40	0.852	−26.69
		900	0.638	−103.89	2.196	100.55	0.158	35.25	0.717	−38.67
		1500	0.533	−145.86	1.580	72.45	0.168	25.20	0.619	−50.31
		2000	0.495	−173.94	1.281	54.58	0.164	25.37	0.581	−59.87
		3000	0.494	143.54	0.956	28.72	0.187	39.10	0.554	−81.37
2.0	0.5	100	0.979	−9.26	1.827	172.62	0.030	84.74	0.996	−4.04
		200	0.960	−18.37	1.909	164.83	0.060	79.81	0.991	−8.55
		500	0.920	−42.91	1.652	143.57	0.132	64.52	0.940	−18.86
		1000	0.749	−77.43	1.451	116.35	0.196	46.87	0.842	−32.38
		1500	0.674	−104.70	1.190	93.78	0.214	35.67	0.774	−39.43
		2000	0.548	−128.41	1.077	79.19	0.189	33.18	0.692	−43.43
		3000	0.480	−177.94	0.808	60.10	0.153	55.32	0.625	−52.49
	2.0	100	0.907	−16.39	6.640	167.45	0.029	80.99	0.977	−8.61
		200	0.846	−31.62	6.419	155.54	0.054	72.92	0.944	−16.93
		500	0.711	−67.85	4.874	128.23	0.104	57.29	0.770	−31.67
		1000	0.495	−106.45	3.178	102.77	0.138	49.89	0.603	−41.27
		1500	0.405	−131.24	2.358	86.49	0.157	52.19	0.542	−44.76
		2000	0.314	−154.66	1.910	75.22	0.173	58.26	0.490	−43.65
		3000	0.296	157.52	1.394	59.09	0.228	67.66	0.454	−47.05
	5.0	100	0.780	−27.85	14.100	158.94	0.027	77.86	0.932	−15.42
		200	0.676	−51.21	12.219	141.68	0.046	66.87	0.831	−27.35
		500	0.470	−94.63	7.373	112.66	0.078	58.67	0.568	−39.84
		1000	0.327	−131.66	4.148	92.48	0.114	62.28	0.436	−42.57
		1500	0.271	−152.62	2.921	80.85	0.151	66.45	0.413	−44.18
		2000	0.218	−177.42	2.295	71.76	0.188	69.38	0.394	−40.58
		3000	0.237	138.31	1.661	58.25	0.265	70.37	0.372	−42.71

(continued)

Table 2. Common Emitter S-Parameters

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
2.0	10	100	0.608	−43.09	21.812	149.09	0.022	71.64	0.859	−22.70
		200	0.488	−73.47	16.618	128.80	0.038	64.60	0.689	−35.49
		500	0.330	−118.69	8.427	103.30	0.065	66.23	0.438	−41.16
		1000	0.262	−152.10	4.484	87.25	0.109	70.70	0.354	−40.02
		1500	0.227	−168.95	3.114	77.14	0.155	72.85	0.358	−41.98
		2000	0.197	166.15	2.423	69.47	0.198	73.10	0.355	−37.94
		3000	0.233	128.04	1.755	57.14	0.281	71.04	0.338	−40.40
	30	100	0.353	−99.56	25.543	130.99	0.018	69.51	0.653	−28.97
		200	0.353	−134.75	15.823	111.86	0.026	68.27	0.484	−33.62
		500	0.346	−163.46	6.979	93.31	0.054	75.98	0.367	−28.62
		1000	0.337	177.40	3.637	80.00	0.103	78.84	0.351	−30.05
		1500	0.324	165.83	2.518	71.06	0.150	79.14	0.372	−35.60
		2000	0.319	148.22	1.975	62.92	0.197	78.29	0.378	−34.91
		3000	0.374	122.07	1.441	50.52	0.290	74.82	0.363	−41.67
6.0	0.5	100	0.978	−8.66	1.791	173.27	0.024	85.89	0.995	−3.57
		200	0.964	−16.94	1.889	166.10	0.049	79.87	0.994	−7.32
		500	0.932	−40.03	1.643	146.36	0.110	66.84	0.953	−16.19
		1000	0.765	−72.66	1.473	120.56	0.165	50.45	0.869	−28.01
		1500	0.688	−99.80	1.206	98.40	0.184	39.36	0.812	−34.63
		2000	0.554	−123.40	1.099	83.59	0.162	38.05	0.735	−38.23
		3000	0.463	−174.05	0.823	63.88	0.136	63.33	0.671	−46.47
	2.0	100	0.918	−14.76	6.614	168.34	0.023	83.55	0.983	−7.19
		200	0.862	−28.56	6.456	157.28	0.045	75.14	0.956	−14.02
		500	0.729	−62.16	5.010	131.12	0.089	60.10	0.809	−26.64
		1000	0.504	−98.85	3.344	105.76	0.121	53.16	0.654	−35.06
		1500	0.397	−123.02	2.485	89.51	0.137	55.48	0.599	−38.01
		2000	0.295	−145.96	2.013	78.14	0.152	61.91	0.553	−37.03
		3000	0.257	161.75	1.452	61.78	0.202	72.72	0.523	−40.30
	5.0	100	0.806	−24.38	14.025	160.52	0.022	78.28	0.947	−12.67
		200	0.704	−45.03	12.425	144.30	0.040	70.14	0.861	−22.52
		500	0.487	−85.18	7.751	115.51	0.068	61.61	0.627	−32.81
		1000	0.316	−120.17	4.399	95.11	0.101	64.59	0.505	−34.64
		1500	0.245	−140.68	3.112	83.14	0.134	69.35	0.488	−36.12
		2000	0.177	−166.20	2.447	74.39	0.167	72.13	0.473	−33.43
		3000	0.185	139.55	1.743	60.74	0.237	74.04	0.457	−35.82
	10	100	0.657	−36.69	22.098	151.43	0.019	74.63	0.888	−18.25
		200	0.526	−63.52	17.304	131.70	0.033	67.90	0.741	−28.80
		500	0.328	−104.79	9.028	105.89	0.056	66.80	0.509	−32.64
		1000	0.228	−138.09	4.844	89.49	0.096	72.77	0.438	−31.28
		1500	0.184	−156.11	3.359	79.89	0.138	75.02	0.440	−33.55
		2000	0.140	175.01	2.591	72.03	0.175	76.11	0.441	−30.73
		3000	0.172	126.26	1.852	59.99	0.249	74.64	0.430	−33.31
	20	100	0.492	−53.13	28.934	141.62	0.017	72.00	0.808	−22.96
		200	0.372	−85.00	19.971	121.25	0.028	69.78	0.630	−30.71
		500	0.249	−126.97	9.335	99.50	0.053	73.73	0.454	−28.28
		1000	0.201	−156.11	4.878	86.00	0.094	77.63	0.418	−26.90
		1500	0.174	−171.44	3.358	77.41	0.138	78.54	0.432	−30.20
		2000	0.149	160.61	2.580	70.07	0.177	78.20	0.444	−28.32
		3000	0.193	120.90	1.852	58.27	0.253	75.92	0.435	−31.73

Table 2. Common Emitter S-Parameters (continued)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

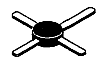
MRF951
MMBR951LT1
MMBR951ALT1
MRF9511LT1

The RF Line
NPN Silicon Low Noise, High-Frequency Transistors

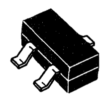
. . . designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 18 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal

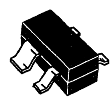
I_C = 100 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTORS



CASE 317, STYLE 2
MACRO-X
MRF951



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR951LT1, MMBR951ALT1



CASE 318A, STYLE 1
SOT-143
LOW PROFILE
MRF9511LT1

2

MAXIMUM RATINGS

Rating	Symbol	MRF951	MMBR951LT1	MRF9511LT1	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	1.5	1.5	Vdc
Power Dissipation (1) T_C = 50°C	P_D	0.475	0.3	0.3	Watts
Collector Current — Continuous (2)	I_C	100	100	100	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	°C
Storage Temperature	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	210	260	260	°C/W

DEVICE MARKING

MRF9511LT1 = 11	MMBR951ALT1 = AAG	MMBR951LT1 = 7Z

NOTES:
1. To calculate the junction temperature use $T_J = (P_D \times R_{\theta JA}) + T_{CASE}$. Case temperature measured on collector lead immediately adjacent to body of package.
2. I_C — Continuous (MTBF ≈ 10 years).

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS (3)					
DC Current Gain	h_{FE}				—
(V_{CE} = 6.0 V, I_C = 5.0 mA)		50	—	200	
(V_{CE} = 6.0 V, I_C = 5.0 mA) MMBR951ALT1		75	—	150	
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.45	1.0	pF
Current Gain — Bandwidth Product (V_{CE} = 8.0 V, I_C = 30 mA, f = 1.0 GHz)	f_T	—	8.0	—	GHz

NOTE:
3. Pulse width ≤ 300 μs, duty cycle ≤ 2% pulsed.

2

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF951			MRF9511LT1			MMBR951LT1			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain	$\|S_{21}\|^2$										dB
(V_{CE} = 8.0 V, I_C = 30 mA, f = 1.0 GHz)		—	14.5	—	—	14.5	—	—	12.5	—	
(V_{CE} = 8.0 V, I_C = 30 mA, f = 2.0 GHz)		—	9.5	—	—	9.0	—	—	7.0	—	
Maximum Unilateral Gain (1)	$G_{U\,max}$										dB
(V_{CE} = 8.0 V, I_C = 30 mA, f = 1.0 GHz)		—	17	—	—	17	—	—	14	—	
(V_{CE} = 8.0 V, I_C = 30 mA, f = 2.0 GHz)		—	11	—	—	10.5	—	—	8.0	—	
Noise Figure — Minimum	NF_{MIN}										dB
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)		—	1.3	—	—	1.3	—	—	1.3	—	
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 2.0 GHz)		—	2.1	—	—	2.1	—	—	2.1	—	
Associated Gain at Minimum NF	G_{NF}										dB
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)		—	14	—	—	14	—	—	13	—	
(V_{CE} = 6.0 V, I_C = 5.0 mA, f = 2.0 GHz)		—	9.0	—	—	9.0	—	—	7.5	—	
Noise Figure — 50 ohm Source (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)	$NF_{50\,\Omega}$	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE:
1. Maximum Unilateral Gain is $GU_{max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

TYPICAL CHARACTERISTICS

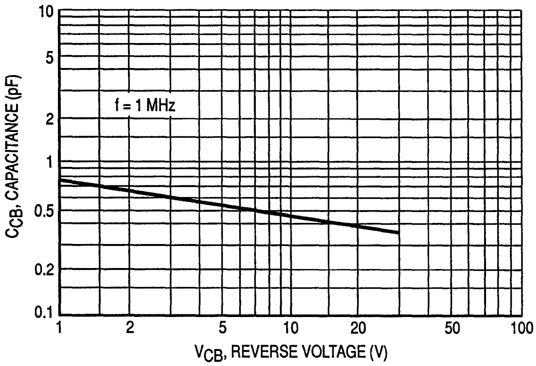


Figure 1. Collector-Base Capacitance versus Voltage

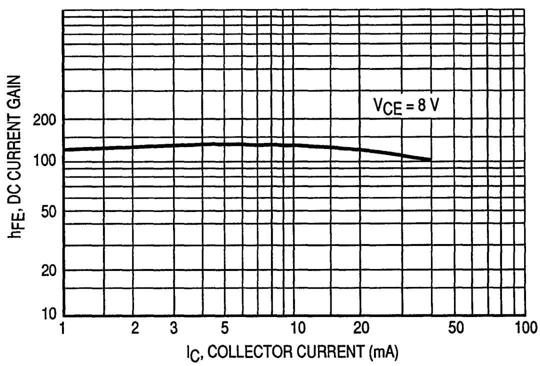


Figure 2. DC Current Gain versus Collector Current

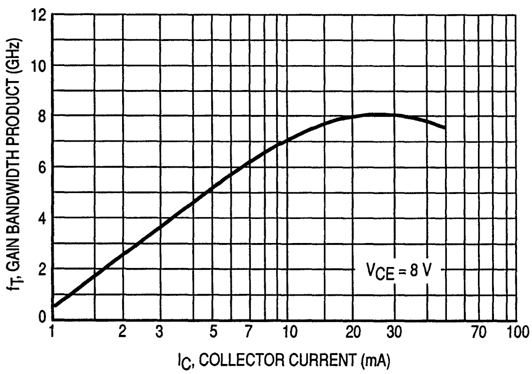


Figure 3. Gain Bandwidth Product versus Collector Current

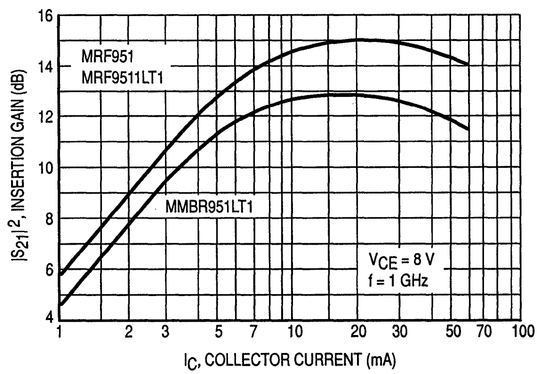


Figure 4. Insertion Gain versus Collector Current

TYPICAL FORWARD INSERTION GAIN AND MAXIMUM UNILATERAL GAIN versus FREQUENCY

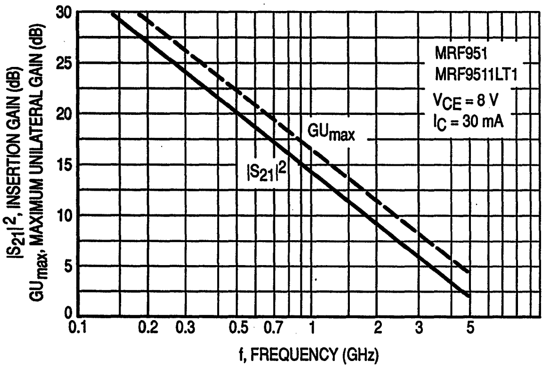


Figure 5. MRF951, MRF9511L

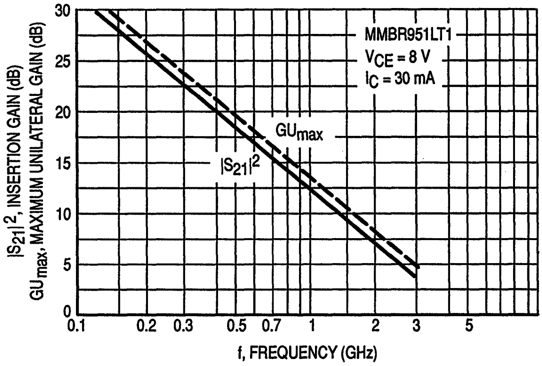


Figure 6. MMBR951L

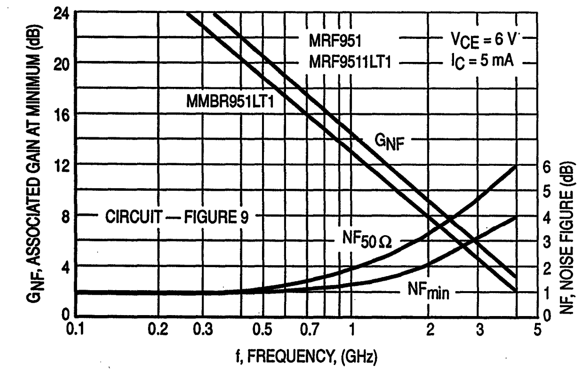


Figure 7. Typical Noise Figure and Associated Gain versus Frequency

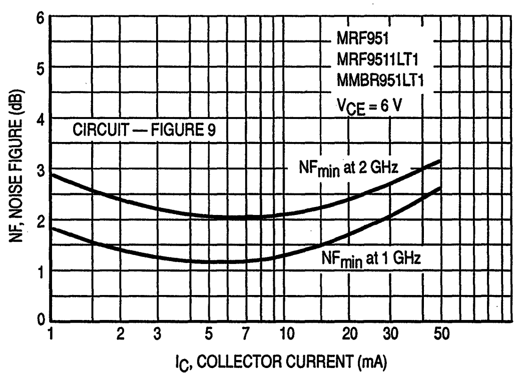


Figure 8. Typical Noise Figure versus Collector Current

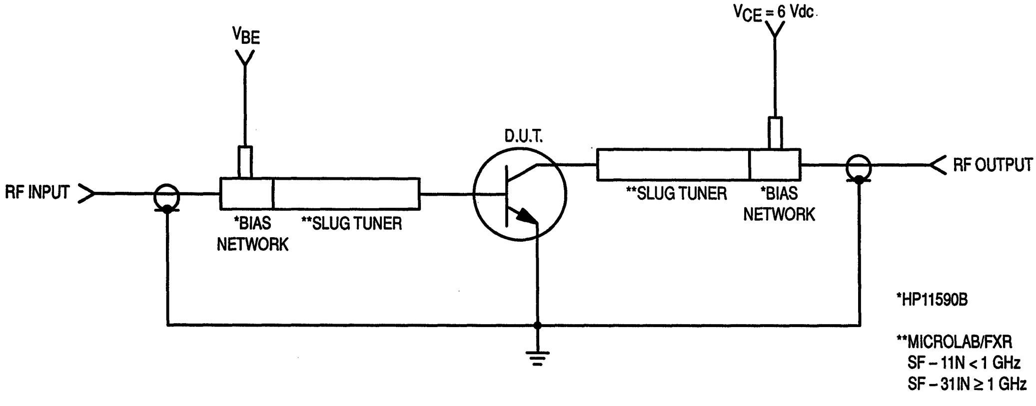


Figure 9. Functional Circuit Schematic

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
6.0	5.0	100	0.81	−36	13.89	156	0.03	72	0.94	−17
		500	0.58	−122	7.23	105	0.07	42	0.55	−46
		1000	0.53	−165	4.06	78	0.08	41	0.42	−57
		1500	0.54	172	2.78	61	0.10	44	0.40	−67
		2000	0.55	155	2.13	46	0.12	47	0.40	−79
		2500	0.56	140	1.74	32	0.15	48	0.41	−92
		3000	0.59	127	1.46	21	0.18	47	0.43	−105
		3500	0.61	115	1.28	9.0	0.22	44	0.45	−119
		4000	0.62	104	1.13	−1.0	0.26	40	0.48	−132
	10	100	0.67	−41	22.99	147	0.02	67	0.86	−26
		500	0.50	−85	8.94	97	0.05	49	0.41	−53
		1000	0.48	−34	4.75	75	0.08	54	0.31	−61
		1500	0.49	163	3.26	60	0.11	55	0.29	−71
		2000	0.51	148	2.47	46	0.14	53	0.30	−83
		2500	0.52	135	2.03	34	0.17	50	0.31	−97
		3000	0.55	123	1.72	22	0.20	46	0.34	−109
		3500	0.56	112	1.50	11	0.24	41	0.36	−122
		4000	0.59	101	1.33	1.0	0.28	37	0.39	−135
	20	100	0.52	−77	32.50	137	0.02	62	0.75	−34
		500	0.46	−96	10.00	92	0.05	60	0.30	−56
		1000	0.47	172	5.20	73	0.08	63	0.24	−63
		1500	0.48	156	3.50	59	0.11	61	0.24	−74
		2000	0.49	143	2.70	46	0.15	57	0.24	−86
		2500	0.51	131	2.20	34	0.18	52	0.26	−100
		3000	0.53	121	1.90	23	0.22	47	0.29	−112
		3500	0.55	110	1.60	13	0.25	41	0.31	−125
		4000	0.57	100	1.40	3.0	0.28	35	0.34	−137
	30	100	0.45	−95	36.80	132	0.02	64	0.68	−38
		500	0.46	−170	10.20	89	0.04	65	0.27	−55
		1000	0.47	169	5.30	72	0.08	66	0.22	−62
		1500	0.48	154	3.60	58	0.11	63	0.22	−73
		2000	0.50	142	2.80	45	0.15	58	0.23	−86
		2500	0.51	132	2.30	36	0.18	54	0.25	−97
		3000	0.53	119	1.90	23	0.22	47	0.28	−113
		3500	0.55	109	1.60	12	0.25	41	0.30	−125
		4000	0.57	99	1.50	2.0	0.29	35	0.33	−137
	60	100	0.41	−129	38.90	123	0.01	63	0.58	−40
		500	0.49	−35	9.70	86	0.04	71	0.26	−44
		1000	0.50	164	4.90	70	0.07	71	0.24	−53
		1500	0.52	151	3.30	56	0.11	67	0.24	−66
		2000	0.53	140	2.50	43	0.15	61	0.26	−79
		2500	0.55	128	2.10	31	0.18	56	0.28	−94
		3000	0.57	118	1.70	21	0.21	50	0.31	−108
		3500	0.59	108	1.50	10	0.25	44	0.33	−121
		4000	0.61	98	1.30	0	0.29	38	0.36	−134

(continued)

Table 1. MRF951 Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
8.0	5.0	100	0.82	−34	13.71	157	0.03	74	0.94	−16
		500	0.59	−119	7.35	106	0.07	42	0.57	−44
		1000	0.52	−162	4.14	78	0.08	41	0.44	−54
		1500	0.52	174	2.86	61	0.10	46	0.41	−65
		2000	0.54	156	2.19	46	0.12	48	0.41	−76
		2500	0.55	141	1.78	32	0.15	50	0.42	−90
		3000	0.58	128	1.49	21	0.18	48	0.45	−103
		3500	0.59	116	1.31	9.0	0.22	45	0.47	−116
		4000	0.62	104	1.15	−1.0	0.26	41	0.50	−129
	10	100	0.68	−50	23.16	148	0.02	67	0.86	−24
		500	0.49	−142	9.19	98	0.05	50	0.43	−49
		1000	0.47	−177	4.87	75	0.07	54	0.33	−56
		1500	0.48	164	3.33	60	0.10	56	0.32	−66
		2000	0.50	149	2.56	46	0.13	54	0.32	−77
		2500	0.51	136	2.08	34	0.16	52	0.34	−91
		3000	0.54	124	1.76	23	0.20	48	0.36	−103
		3500	0.55	113	1.54	11	0.23	43	0.38	−117
		4000	0.58	103	1.36	1.0	0.27	39	0.41	−129
	20	100	0.53	−73	32.78	138	0.02	65	0.76	−32
		500	0.45	−160	10.25	92	0.04	60	0.33	−50
		1000	0.45	174	5.33	73	0.07	62	0.27	−57
		1500	0.46	161	3.96	62	0.10	61	0.26	−65
		2000	0.48	144	2.74	46	0.14	57	0.27	−79
		2500	0.50	132	2.24	34	0.17	54	0.29	−93
		3000	0.52	121	1.90	23	0.21	48	0.31	−106
		3500	0.54	111	1.66	12	0.24	42	0.33	−118
		4000	0.56	101	1.48	3.0	0.28	37	0.36	−131
	30	100	0.45	−90	37.27	132	0.01	62	0.70	−36
		500	0.45	−102	10.50	90	0.04	65	0.30	−48
		1000	0.45	170	5.41	72	0.07	66	0.25	−55
		1500	0.47	155	3.66	58	0.11	64	0.25	−66
		2000	0.48	142	2.81	46	0.14	59	0.26	−78
		2500	0.50	131	2.27	34	0.18	55	0.27	−92
		3000	0.52	120	1.93	23	0.21	49	0.30	−105
		3500	0.54	110	1.69	12	0.25	43	0.32	−118
		4000	0.56	100	1.50	2.0	0.28	38	0.35	−131
	60	100	0.42	−124	38.02	124	0.01	63	0.60	−35
		500	0.49	−106	9.54	87	0.04	70	0.31	−38
		1000	0.50	165	4.92	70	0.07	71	0.29	−47
		1500	0.51	152	3.36	57	0.10	68	0.29	−60
		2000	0.52	140	2.55	44	0.14	62	0.30	−74
		2500	0.54	129	2.08	32	0.17	58	0.32	−88
		3000	0.56	118	1.76	21	0.21	52	0.34	−102
		3500	0.58	108	1.53	10	0.24	46	0.37	−116
		4000	0.61	98	1.35	0	0.28	40	0.39	−129

Table 1. MRF951 Common Emitter S-Parameters (continued)

V_{CE} (Volts)	I_C (mA)	f (MHz)	S11 |S11|	S11 ∠ φ	S21 |S21|	S21 ∠ φ	S12 |S12|	S12 ∠ φ	S22 |S22|	S22 ∠ φ
6.0	5.0	100	0.82	−36.6	14.0	153	0.04	44.7	0.88	−18.2
		500	0.50	−119	6.6	104	0.07	48.2	0.52	−40
		1000	0.39	−162	3.5	81	0.11	55	0.43	−43
		2000	0.32	150	1.9	57	0.21	66	0.42	−50
		3000	0.36	110	1.4	40	0.31	66	0.40	−67
	10	100	0.66	−54	22.6	142	0.03	60	0.78	−29
		500	0.38	−138	7.8	96	0.07	55	0.40	−42
		1000	0.32	−176	4.0	78	0.13	71	0.34	−47
		2000	0.26	142	2.2	57	0.22	70	0.36	−46
		3000	0.31	105	1.6	41	0.32	64	0.33	−62
	20	100	0.49	−76	30	131	0.01	85	0.67	−37
		500	0.32	−153	8.3	92	0.08	76	0.34	−39
		1000	0.29	175	4.3	77	0.11	67	0.29	−44
		2000	0.24	137	2.3	57	0.24	71	0.32	−48
		3000	0.28	102	1.6	42	0.34	63	0.29	−60
	30	100	0.40	−94	33	125	0.03	87	0.58	−42
		500	0.30	−162	8.4	90	0.07	84	0.31	−35
		1000	0.29	170	4.3	76	0.12	80	0.27	−39
		2000	0.24	134	2.3	56	0.23	71	0.33	−48
		3000	0.30	101	1.6	41	0.35	66	0.30	−60
	60	100	0.38	−126	31	116	0.03	74	0.49	−37
		500	0.37	−176	7.3	77.6	0.05	84	0.34	−26
		1000	0.36	163	3.7	73.4	0.12	84	0.34	−37
		2000	0.33	130	2.0	52	0.22	78	0.37	−48
		3000	0.38	98	1.4	37	0.34	69	0.34	−62
8.0	5.0	100	0.83	−35	13.9	154	0.04	92	0.90	−19
		500	0.51	−117	6.7	104	0.08	51	0.55	−38
		1000	0.38	−160	3.6	82	0.10	72	0.44	−42
		2000	0.31	151	1.9	58	0.20	73	0.46	−47
		3000	0.35	110	1.4	41	0.32	71	0.43	−63
	10	100	0.67	−52	23	143	0.02	96	0.81	−28
		500	0.37	−135	7.9	97	0.07	64	0.43	−38
		1000	0.30	−173	4.1	80	0.11	78	0.37	−41
		2000	0.25	143	2.2	57	0.21	74	0.38	−47
		3000	0.30	105	1.6	42	0.31	67	0.34	−60
	20	100	0.51	−72	30	131	0.02	68	0.68	−35
		500	0.31	−150	8.5	92	0.07	75	0.36	−36
		1000	0.28	177	4.3	77	0.13	76	0.32	−39
		2000	0.23	138	2.3	57	0.22	72	0.35	−45
		3000	0.27	103	1.6	42	0.31	64	0.31	−58
	30	100	0.42	−87	33	125	0.02	71	0.61	−38
		500	0.31	−159	8.6	90	0.07	71	0.33	−33
		1000	0.27	172	4.4	76	0.11	74	0.32	−39
		2000	0.23	135	2.3	57	0.22	73	0.34	−42
		3000	0.28	102	1.6	41	0.31	65	0.33	−55
	60	100	0.39	−119	32	117	0.02	31	0.52	−31
		500	0.36	−174	7.4	87	0.06	84	0.37	−25
		1000	0.35	164	3.8	74	0.11	78	0.35	−33
		2000	0.32	131	2.0	53	0.22	81	0.42	−41
		3000	0.37	100	1.4	38	0.33	70	0.40	−62

Table 2. MMBR951LT1 Common Emitter S-Parameters

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠ φ	|S21|	∠ φ	|S12|	∠ φ	|S22|	∠ φ
6.0	5.0	100	0.81	−48	13.69	152	0.04	66	0.88	−22
		500	0.67	−122	7.58	92	0.07	41	0.57	−50
		1000	0.61	−157	4.65	76	0.09	40	0.45	−62
		1500	0.57	86	2.87	70	0.10	44	0.42	−71
		2000	0.54	156	2.14	60	0.12	52	0.42	−75
		2500	0.55	121	1.72	51	0.14	57	0.40	−86
		3000	0.57	121	1.48	44	0.17	59	0.39	−97
		3500	0.65	110	1.28	38	0.21	60	0.37	−112
		4000	0.67	100	1.14	33	0.24	54	0.38	−130
	10	100	0.71	−56	24.07	149	0.03	66	0.86	−28
		500	0.60	−143	9.47	101	0.05	46	0.41	−62
		1000	0.56	−176	4.97	81	0.07	51	0.30	−73
		1500	0.53	167	3.35	69	0.10	57	0.31	−78
		2000	0.50	148	2.54	60	0.13	63	0.30	−78
		2500	0.52	132	2.02	52	0.16	63	0.29	−89
		3000	0.54	116	1.75	45	0.19	61	0.29	−78
		3500	0.60	106	1.53	39	0.22	60	0.26	−115
		4000	0.64	97	1.35	34	0.26	57	0.28	−133
	20	100	0.59	−80	33.51	138	0.02	61	0.75	−38
		500	0.56	−159	10.39	95	0.04	54	0.31	−69
		1000	0.54	175	5.36	79	0.07	62	0.23	−79
		1500	0.51	161	3.58	68	0.10	66	0.25	−82
		2000	0.49	142	2.75	60	0.13	68	0.25	−80
		2500	0.52	128	2.18	52	0.16	66	0.23	−91
		3000	0.53	112	1.88	45	0.20	63	0.23	−99
		3500	0.60	103	1.65	39	0.24	62	0.21	−117
		4000	0.63	95	1.46	34	0.27	57	0.22	−137
	30	100	0.54	−97	37.48	133	0.02	57	0.67	−43
		500	0.56	−166	10.60	93	0.04	59	0.27	−70
		1000	0.54	171	5.45	78	0.07	68	0.21	−80
		1500	0.51	158	3.62	67	0.10	69	0.24	−81
		2000	0.50	140	2.73	60	0.13	70	0.23	−79
		2500	0.52	126	2.19	51	0.17	68	0.23	−90
		3000	0.53	111	1.89	45	0.20	64	0.23	−97
		3500	0.60	102	1.65	38	0.24	62	0.20	−115
		4000	0.63	94	1.47	33	0.27	58	0.22	−136
	60	100	0.54	−128	36.66	123	0.01	57	0.56	−43
		500	0.60	−177	8.97	89	0.03	67	0.27	−50
		1000	0.59	166	4.62	75	0.06	73	0.25	−59
		1500	0.56	153	3.05	64	0.09	75	0.29	−68
		2000	0.55	136	2.29	56	0.13	76	0.30	−71
		2500	0.57	125	1.85	48	0.16	74	0.29	−83
		3000	0.59	110	1.59	42	0.20	69	0.30	−92
		3500	0.65	102	1.41	36	0.23	67	0.27	−108
		4000	0.69	93	1.22	31	0.27	62	0.29	−130

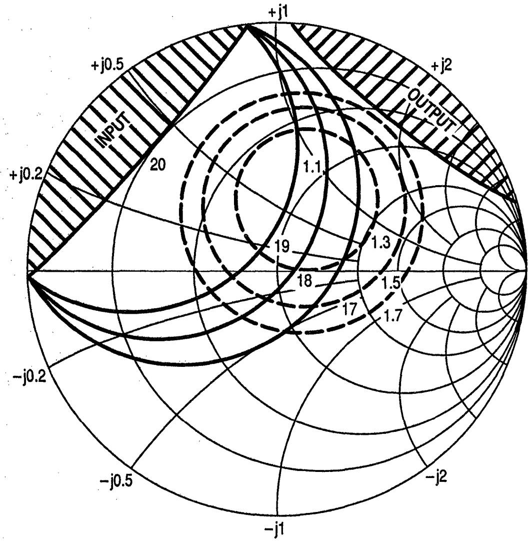
(continued)

Table 3. MRF9511LT1 Common Emitter S-Parameters

2

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	∠ φ	$|S_{21}|$	∠ φ	$|S_{12}|$	∠ φ	$|S_{22}|$	∠ φ
8.0	5.0	100	0.84	−36	14.65	158	0.03	72	0.94	−18
		500	0.68	−120	7.79	110	0.07	42	0.58	−48
		1000	0.60	−161	4.32	86	0.08	41	0.44	−60
		1500	0.56	88	2.95	71	0.10	45	0.44	−68
		2000	0.53	157	2.19	60	0.11	53	0.44	−71
		2500	0.55	140	1.76	51	0.14	58	0.42	−82
		3000	0.56	122	1.50	44	0.17	60	0.42	−92
		3500	0.63	112	1.33	39	0.18	62	0.38	−107
		4000	0.68	105	1.18	33	0.21	63	0.36	−125
	10	100	0.73	−53	24.04	150	0.02	68	0.87	−26
		500	0.60	−140	9.68	101	0.05	46	0.43	−58
		1000	0.55	−174	5.10	82	0.07	52	0.32	−66
		1500	0.52	169	3.42	69	0.09	58	0.33	−72
		2000	0.49	149	2.59	61	0.12	63	0.33	−73
		2500	0.51	133	2.06	52	0.15	63	0.32	−83
		3000	0.53	116	1.78	45	0.19	63	0.32	−91
		3500	0.64	109	1.60	38	0.20	62	0.28	−108
		4000	0.67	101	1.39	34	0.23	60	0.29	−131
	20	100	0.61	−76	33.76	139	0.02	60	0.76	−36
		500	0.56	−157	10.72	96	0.04	54	0.32	−63
		1000	0.53	176	5.53	79	0.07	62	0.29	−70
		1500	0.50	162	3.69	68	0.10	66	0.27	−75
		2000	0.48	143	2.79	60	0.13	68	0.27	−74
		2500	0.51	129	2.22	52	0.16	68	0.26	−84
		3000	0.52	112	1.92	46	0.19	65	0.26	−91
		3500	0.59	104	1.75	40	0.21	64	0.24	−109
		4000	0.63	98	1.54	35	0.24	59	0.25	−131
	30	100	0.57	−89	37.35	134	0.02	58	0.71	−40
		500	0.55	−163	10.82	94	0.04	57	0.29	−63
		1000	0.53	128	5.54	78	0.07	65	0.24	−69
		1500	0.50	159	3.69	67	0.10	69	0.26	−73
		2000	0.49	141	2.77	59	0.13	70	0.27	−71
		2500	0.51	127	2.23	51	0.16	69	0.26	−82
		3000	0.52	112	1.93	45	0.19	66	0.26	−89
		3500	0.61	106	1.68	40	0.21	64	0.21	−110
		4000	0.66	97	1.51	34	0.24	60	0.23	−130
	60	100	0.55	−122	34.92	126	0.01	52	0.59	−37
		500	0.59	−175	8.71	91	0.03	65	0.33	−42
		1000	0.58	167	4.52	76	0.06	73	0.30	−53
		1500	0.55	154	3.04	65	0.09	75	0.34	−62
		2000	0.54	138	2.28	56	0.12	77	0.35	−66
		2500	0.57	125	1.82	48	0.16	76	0.34	−78
		3000	0.59	110	1.56	42	0.19	72	0.35	−88
		3500	0.66	104	1.28	36	0.22	70	0.32	−105
		4000	0.70	95	1.14	32	0.26	66	0.32	−132

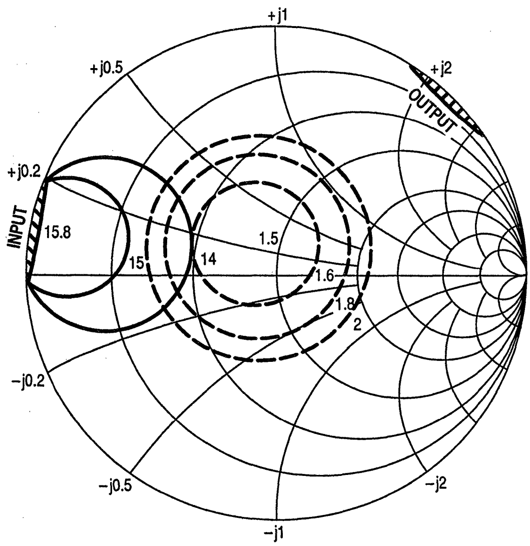
Table 3. MRF9511LT1 Common Emitter S-Parameters (continued)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.13	0.35 ∠ 68°	9	0.68

Figure 10. MMBR951LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)

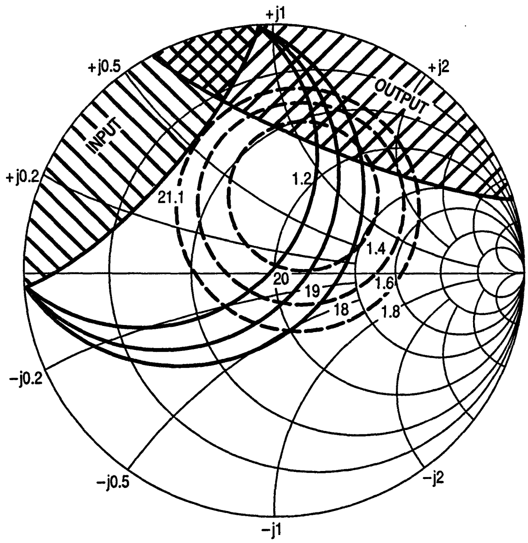


V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.45	0.16 ∠ 124°	8	0.97

Figure 11. MMBR951LT1 Constant Gain and Noise Figure Contours (f = 1.0 GHz)

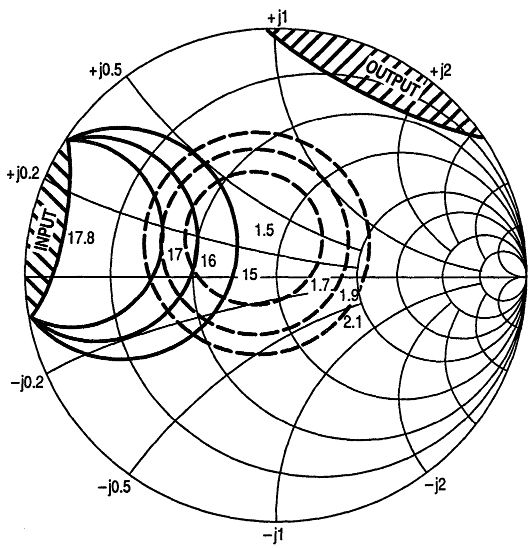
2



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
0.5	1.20	0.37 ∠ 69°	10	0.42

Figure 12. MRF9511LT1 Constant Gain and Noise Figure Contours (f = 0.5 GHz)



V_{CE} = 6.0 V
I_C = 5.0 mA
▧ — AREA OF INSTABILITY

f (GHz)	NF OPT (dB)	ΓMS NF OPT	Rn	K
1.0	1.50	0.19 ∠ 120°	9	0.74

Figure 13. MRF9511LT1 Constant Gain and Noise Figure Contours (f = 1.0 GHz)

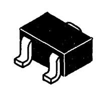
MRF957T1

The RF Line
NPN Silicon Low Noise, High-Frequency Transistor

I_C = 100 mA
LOW NOISE
HIGH-FREQUENCY
TRANSISTOR

Designed for use in high gain, low noise small-signal amplifiers. This transistor features excellent broadband linearity and is offered in an ultra-small surface mount package suitable for automated assembly.

- Fully Implanted Base and Emitter Structure
- 18 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal



CASE 419, STYLE 3

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Power Dissipation (1)	P_D	175	mW
Collector Current — Continuous (2)	I_C	100	mA
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	714	°C/W

DEVICE MARKING

MRF957T1 = B

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS (3)					
DC Current Gain (V_{CE} = 6.0 V, I_C = 5.0 mA)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.45	—	pF
Current Gain — Bandwidth Product (V_{CE} = 8.0 V, I_C = 30 mA, f = 1.0 GHz)	f_T	—	8.0	—	GHz

NOTES:
1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. To calculate the junction temperature use $T_J = P_D \times R_{\theta JC} + T_{CASE}$.
2. I_C — Continuous (MTBF ≈ 10 years)
3. Pulse width ≤ 300 μs, duty cycle ≤ 2% pulsed.

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	Min	Typ	Max	Unit
Insertion Gain (V_{CE} = 5.0 V, I_C = 30 mA, f = 1.0 GHz) (V_{CE} = 5.0 V, I_C = 30 mA, f = 1.5 GHz)	$\|S_{21}\|^2$	 — —	 13.3 10.1	 — —	dB
Maximum Unilateral Gain (1) (V_{CE} = 5.0 V, I_C = 30 mA, f = 1.0 GHz) (V_{CE} = 5.0 V, I_C = 30 mA, f = 1.5 GHz)	$G_{U\,max}$	 — —	 14 10.8	 — —	dB
Noise Figure (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz) (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.5 GHz)	NF_{opt}	 — —	 1.7 2.0	 — —	dB
Associated Gain at Minimum (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz) (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.5 GHz)	G_{NF}	 — —	 11.8 9.0	 — —	dB
Noise Figure (V_{CE} = 6.0 V, I_C = 5.0 mA, f = 1.0 GHz)	$NF_{50\Omega}$	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $G_{U\,max} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

V_{CE} (Vdc)	I_C (mA)	f (MHz)	NF_{min} (dB)	Γ_o (MAG, ANG)	r_N (ohms)
6.0	5.0	1000 1500	1.7 2.0	0.27 ∠ 97 0.21 ∠ 54	0.2 0.28

Table 1. Typical Noise Parameters

2

TYPICAL CHARACTERISTICS

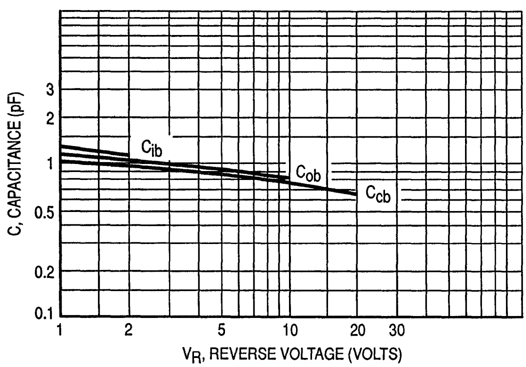


Figure 1. Capacitance versus Voltage

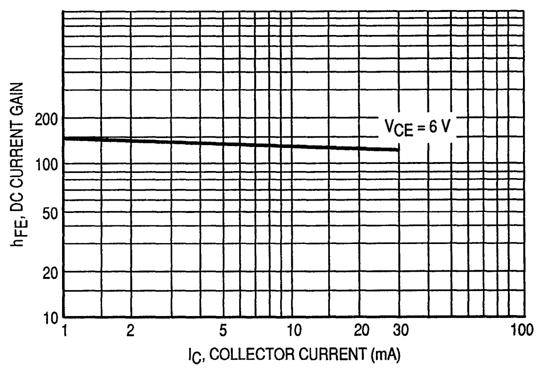


Figure 2. DC Current Gain versus Collector Current

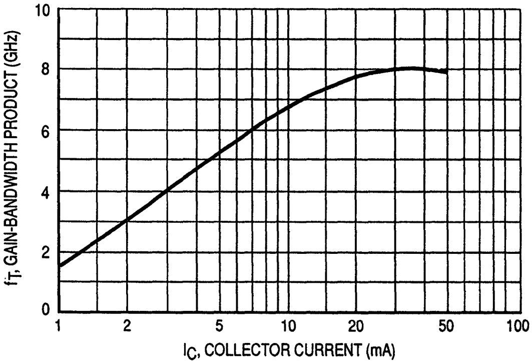


Figure 3. Gain-Bandwidth Product versus Collector Current

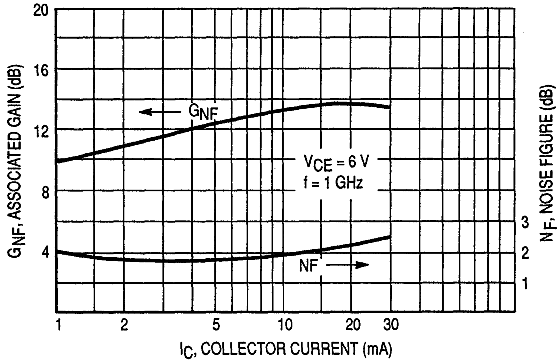


Figure 4. Associated Gain versus Collector Current

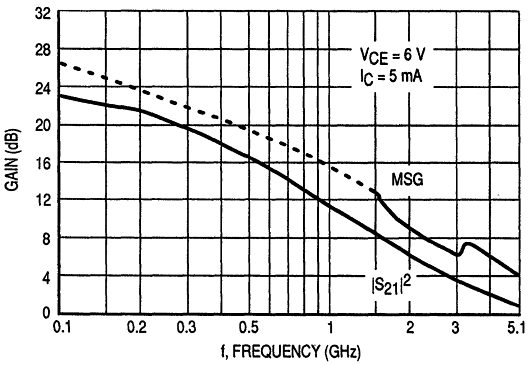


Figure 5. Insertion Gain and Maximum Stable Power Gain versus Frequency

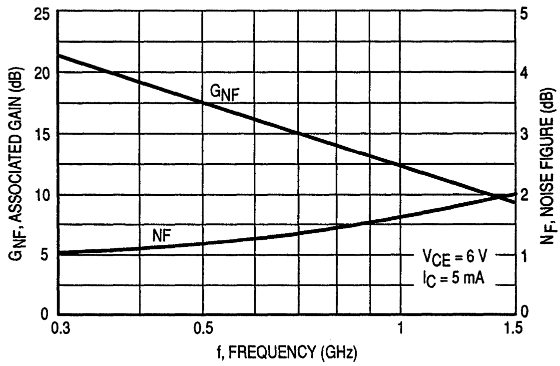


Figure 6. Noise Figure and Associated Gain versus Frequency

V_{CE} = 6.0 V I_C = 5.0 mA

f (GHz)	NF OPT	Γ_o	R_N	K
1.0	1.7 dB	0.27 ∠ 97°	10	0.91

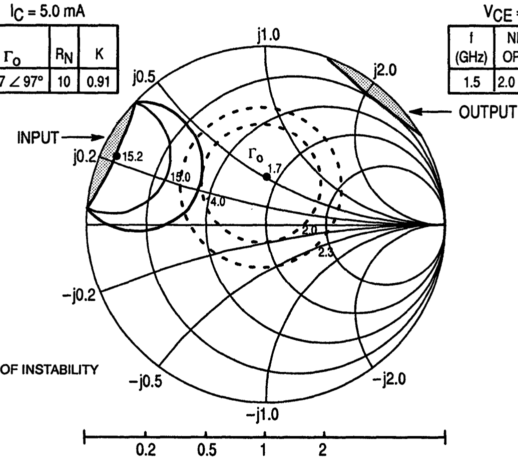


Figure 7. Constant Gain and Noise Figure Contours f = 1.0 GHz

V_{CE} = 6.0 V I_C = 5.0 mA

f (GHz)	NF OPT	Γ_o	R_N	K
1.5	2.0 dB	0.21 ∠ 54°	14	1.02

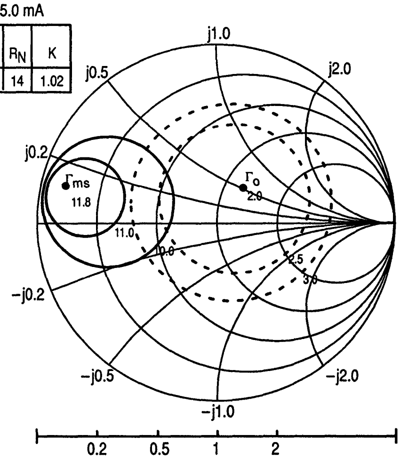


Figure 8. Constant Gain and Noise Figure Contours f = 1.5 GHz

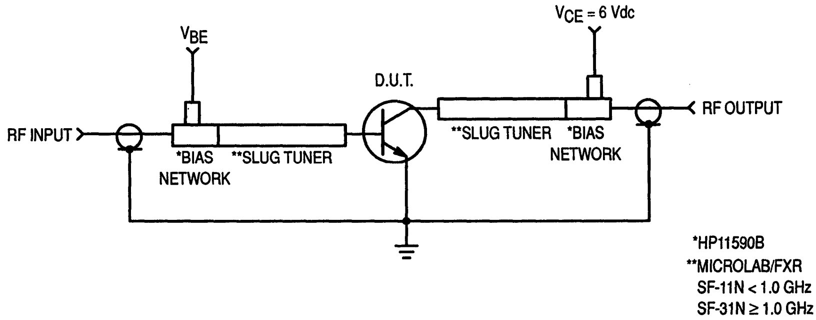


Figure 9. Functional Circuit Schematic

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
2.0	1.0	100	0.959	−19.22	3.518	166.25	0.044	78.43	0.986	−8.12
		200	0.922	−38.32	3.482	153.75	0.079	69.06	0.948	−15.98
		500	0.825	−81.94	2.614	122.98	0.146	44.99	0.803	−30.02
		1000	0.690	−125.83	1.737	93.40	0.167	30.15	0.662	−41.41
		2000	0.600	−174.02	1.079	63.65	0.131	44.93	0.576	−51.42
		3000	0.640	147.15	0.791	50.62	0.196	80.39	0.517	−64.42
	2.0	100	0.922	−24.97	6.598	162.54	0.042	75.55	0.967	−12.35
		200	0.862	−48.55	6.177	147.47	0.075	64.60	0.893	−23.28
		500	0.713	−96.45	4.140	116.09	0.123	43.92	0.671	−38.55
		1000	0.586	−137.24	2.483	90.37	0.140	38.71	0.524	−46.93
		2000	0.506	179.54	1.462	64.47	0.158	57.00	0.456	−51.97
		3000	0.546	144.80	1.079	49.98	0.232	74.13	0.416	−61.22
	5.0	100	0.815	−39.45	14.163	153.09	0.038	70.19	0.895	−22.63
		200	0.708	−71.89	11.635	133.50	0.061	58.57	0.739	−38.46
		500	0.541	−121.43	6.284	104.78	0.090	49.12	0.454	−52.31
		1000	0.461	−155.05	3.428	85.44	0.123	54.90	0.337	−56.38
		2000	0.406	169.75	1.921	65.04	0.198	65.80	0.304	−54.16
		3000	0.438	139.42	1.424	51.41	0.282	69.61	0.276	−57.77
	10	100	0.667	−57.75	22.121	142.36	0.032	64.38	0.788	−34.26
		200	0.559	−95.89	15.709	121.54	0.048	57.27	0.574	−52.06
		500	0.447	−140.52	7.417	98.06	0.075	58.00	0.317	−63.32
		1000	0.405	−166.70	3.921	82.59	0.123	66.07	0.235	−65.49
		2000	0.360	162.90	2.155	65.25	0.222	69.45	0.220	−57.93
		3000	0.390	134.95	1.597	52.60	0.311	68.14	0.196	−57.79
	30	100	0.435	−99.80	31.662	125.82	0.023	62.49	0.570	−51.69
		200	0.421	−135.04	18.696	108.07	0.034	64.74	0.360	−68.74
		500	0.398	−162.97	8.025	91.81	0.069	71.43	0.192	−75.85
		1000	0.382	−179.33	4.163	79.67	0.127	74.17	0.151	−77.73
		2000	0.347	155.68	2.269	64.55	0.240	72.04	0.155	−63.30
		3000	0.379	130.21	1.686	52.60	0.336	67.80	0.132	−60.40
	60	100	0.442	−131.87	26.755	118.52	0.021	62.60	0.422	−56.23
		200	0.483	−155.78	15.086	103.17	0.032	66.87	0.261	−70.51
		500	0.484	−173.89	6.390	88.79	0.067	74.30	0.154	−73.64
		1000	0.472	172.69	3.317	76.81	0.127	76.73	0.140	−74.96
		2000	0.452	149.80	1.834	60.68	0.243	72.97	0.155	−66.57
		3000	0.496	126.23	1.393	48.59	0.345	68.81	0.131	−71.10

(continued)

Table 2. Typical Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	∠ϕ	$\lvert S_{21}\rvert$	∠ϕ	$\lvert S_{12}\rvert$	∠ϕ	$\lvert S_{22}\rvert$	∠ϕ
5.0	1.0	100	0.965	−17.73	3.508	167.36	0.035	78.18	0.990	−6.80
		200	0.931	−35.39	3.495	155.78	0.065	71.66	0.958	−13.35
		500	0.835	−77.08	2.680	126.50	0.122	48.12	0.839	−25.23
		1000	0.694	−120.78	1.820	97.22	0.143	33.67	0.713	−35.51
		2000	0.583	−170.80	1.133	67.35	0.115	50.88	0.629	−44.48
		3000	0.615	148.45	0.813	53.19	0.182	85.71	0.565	−55.47
	2.0	100	0.932	−22.38	6.532	164.05	0.034	77.81	0.975	−9.92
		200	0.875	−44.00	6.217	150.00	0.061	67.15	0.914	−18.98
		500	0.726	−89.77	4.314	119.58	0.106	47.42	0.724	−31.79
		1000	0.582	−131.10	2.638	93.76	0.122	41.23	0.586	−39.20
		2000	0.483	−176.30	1.544	67.35	0.140	60.85	0.521	−43.55
		3000	0.515	146.92	1.117	52.27	0.208	78.88	0.479	−51.26
	5.0	100	0.836	−34.35	14.112	155.49	0.031	71.72	0.920	−18.06
		200	0.731	−63.59	11.971	137.05	0.052	61.40	0.785	−31.06
		500	0.539	−112.00	6.737	107.93	0.080	51.32	0.522	−41.63
		1000	0.438	−147.18	3.710	88.06	0.110	57.59	0.408	−43.94
		2000	0.364	175.10	2.050	67.58	0.175	68.31	0.383	−42.49
		3000	0.392	142.26	1.501	53.59	0.251	73.36	0.357	−45.46
	10	100	0.704	−49.02	22.526	145.79	0.027	67.46	0.831	−27.03
		200	0.577	−83.93	16.647	125.23	0.042	59.78	0.634	−41.45
		500	0.421	−129.59	8.120	100.71	0.069	60.52	0.385	−47.31
		1000	0.361	−158.62	4.290	84.82	0.109	67.54	0.305	−46.57
		2000	0.307	168.57	2.330	67.52	0.196	71.46	0.305	−42.00
		3000	0.332	137.50	1.706	54.85	0.277	71.05	0.288	−42.21
	20	100	0.559	−66.34	30.018	136.00	0.023	64.88	0.720	−35.45
		200	0.453	−103.91	19.598	116.12	0.036	61.80	0.501	−48.64
		500	0.358	−143.87	8.835	96.19	0.064	68.23	0.298	−49.15
		1000	0.324	−167.05	4.595	83.08	0.112	72.95	0.247	−47.12
		2000	0.278	163.88	2.462	67.27	0.208	72.96	0.263	−41.09
		3000	0.306	133.94	1.809	55.45	0.291	70.31	0.249	−39.38
	30	100	0.492	−73.65	32.055	131.68	0.022	64.17	0.669	−37.70
		200	0.412	−110.53	20.121	113.25	0.033	64.60	0.459	−49.28
		500	0.345	−147.89	8.900	94.88	0.062	69.52	0.278	−48.58
		1000	0.319	−169.39	4.646	82.13	0.113	74.20	0.234	−46.64
		2000	0.277	162.38	2.492	67.55	0.210	73.10	0.255	−40.63
		3000	0.305	133.57	1.821	55.24	0.295	70.42	0.239	−38.73

Table 2. Typical Common Emitter S-Parameters (continued)

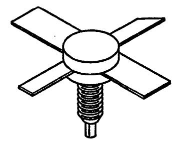
MRF1000MA
MRF1000MB

The RF Line
Microwave Pulse Power Transistors

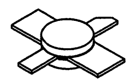
0.7 W, 960–1215 MHz
CLASS A/AB
MICROWAVE POWER
TRANSISTORS
NPN SILICON

. . . designed for Class A and AB common emitter amplifier applications in the low-power stages of IFF, DME, TACAN, radar transmitters, and CW systems.

- Guaranteed Performance @ 1090 MHz, 18 Vdc — Class A
  Output Power = 0.2 Watt
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation



CASE 332-04, STYLE 2
MRF1000MA



CASE 332A, STYLE 2
MRF1000MB

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—

NOTES:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Power Gain — Class A (V_{CE} = 18 Vdc, I_C = 100 mAdc, f = 1090 MHz, P_{out} = 200 mW)	G_{PE}	10	12	—	dB
Common-Emitter Power Gain — Class AB (V_{CE} = 18 Vdc, I_{CQ} = 10 mAdc, f = 1090 MHz, P_{out} = 0.7 W)	G_{PE}	—	10.7	—	dB
Load Mismatch — Class A (V_{CE} = 18 Vdc, I_C = 100 mAdc, f = 1090 MHz, P_{out} = 200 mW, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

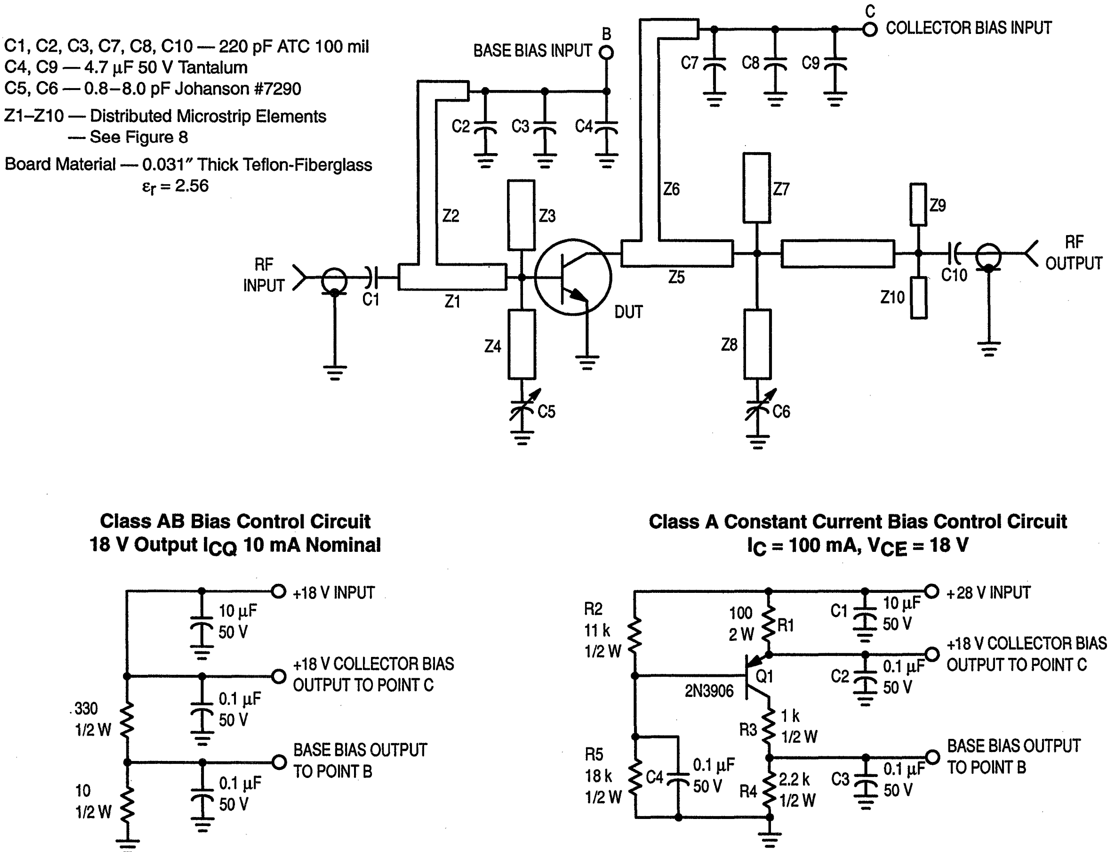


Figure 1. 1090 MHz Test Circuit

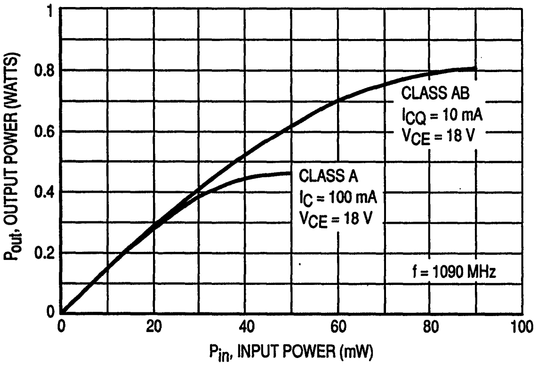


Figure 2. Output Power versus Input Power

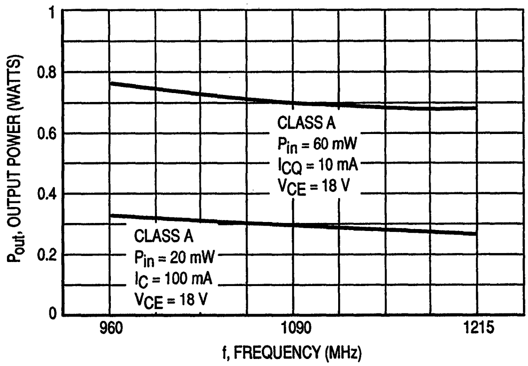


Figure 3. Output Power versus Frequency

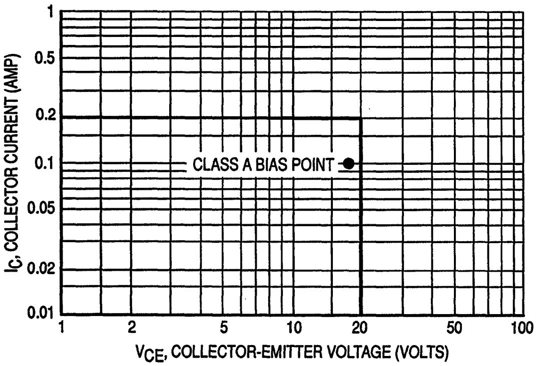


Figure 4. DC Safe Operating Area

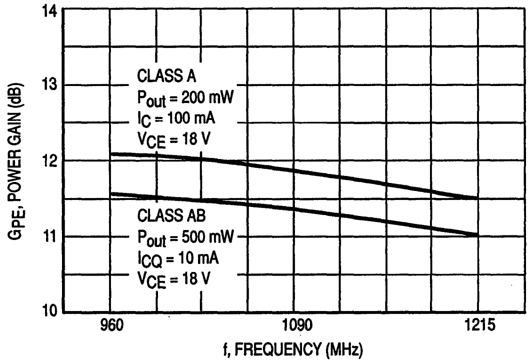
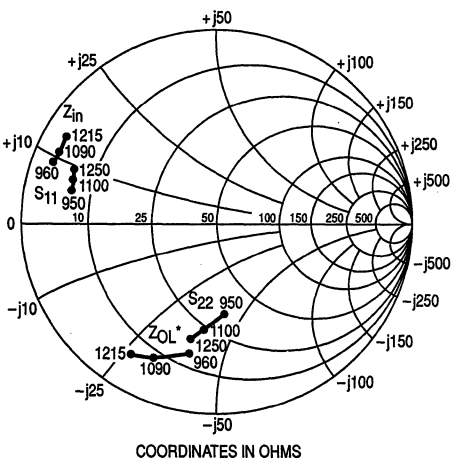


Figure 5. Power Gain versus Frequency



SERIES EQUIVALENT IMPEDANCES
P_{out} = 0.5 W, V_{CE} = 18 Vdc,
I_{CQ} = 10 mAdc, Class AB

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	3.0 + j9.0	16 − j40
1090	3.2 + j10	8.5 − j31
1215	2.8 + j12	7.0 − j26

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

S-PARAMETERS — V_{CE} = 18 Vdc, I_C = 100 mAdc, Class A

f	S_{11}		S_{21}		S_{12}		S_{22}	
(MHz)	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
950	0.77	166	2.42	40	0.016	42	0.48	−87
1000	0.78	165	2.36	38	0.016	48	0.50	−90
1050	0.77	163	2.31	33	0.016	46	0.51	−94
1100	0.77	162	2.31	28	0.016	46	0.54	−97
1150	0.78	161	2.20	23	0.015	46	0.57	−100
1200	0.78	159	2.20	19	0.016	47	0.59	−103
1250	0.78	158	2.12	12	0.016	42	0.61	−106

Figure 6. Common-Emitter S-Parameters and Series Equivalent Input/Output Impedances

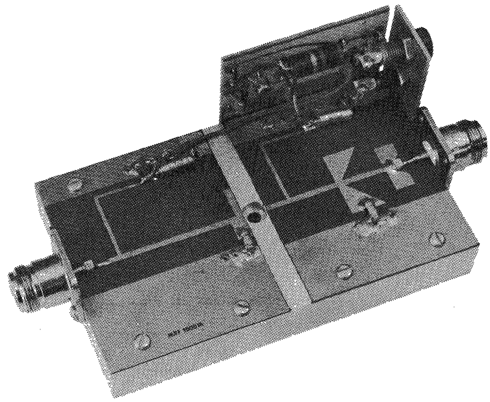


Figure 7. 1090 MHz Test Amplifier

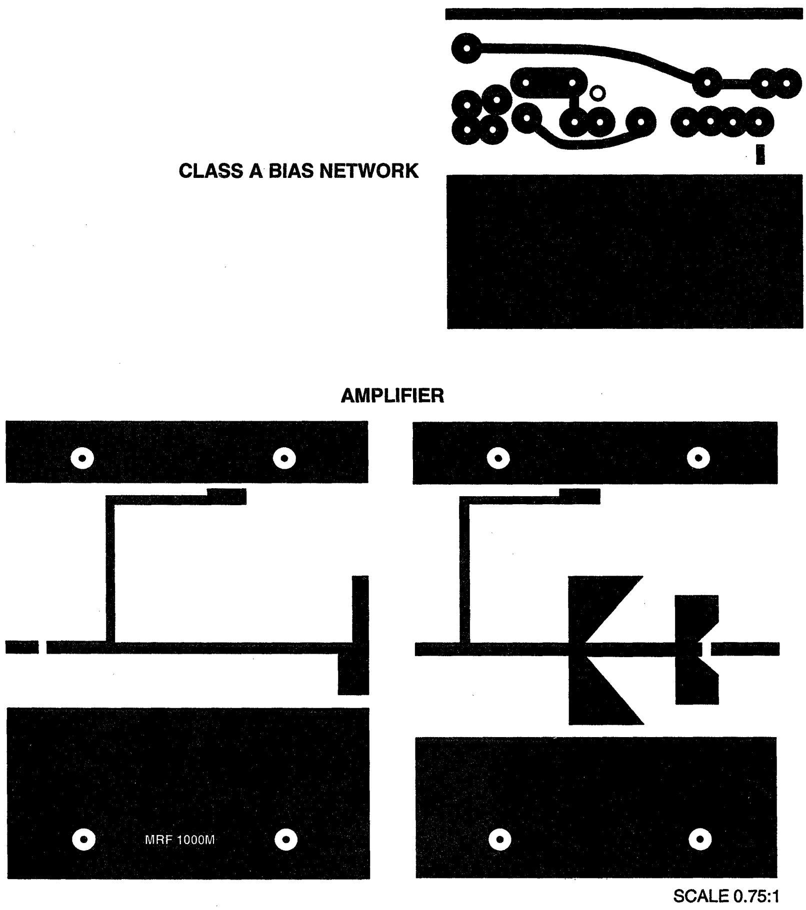


Figure 8. Printed Circuit Board Layout — 1090 MHz Test circuit

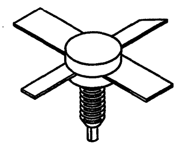
The RF Line
Microwave Pulse Power Transistors

MRF1002MA
MRF1002MB

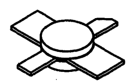
2.0 W (PEAK), 960–1215 MHz
MICROWAVE POWER
TRANSISTORS
NPN SILICON

. . . designed for Class B and C common base amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 35 Vdc
  Output Power = 2.0 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation



CASE 332-04, STYLE 1
MRF1002MA



CASE 332A, STYLE 1
MRF1002MB

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—

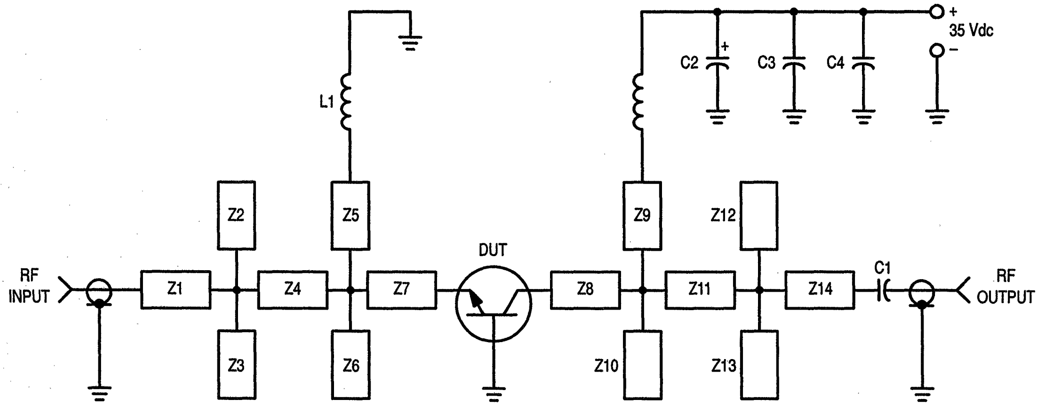
NOTES:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 35 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.5	5.0	pF
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 35 Vdc, P_{out} = 2.0 W pk, f = 1090 MHz)	G_{PB}	10	12	—	dB
Collector Efficiency (V_{CC} = 35 Vdc, P_{out} = 2.0 W pk, f = 1090 MHz)	η	40	45	—	dB
Load Mismatch (V_{CC} = 35 Vdc, P_{out} = 2.0 W, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

2



C1, C3 — 220 pF Chip Capacitor, 100 mil ATC
C2 — 20 µF/50 Vdc Electrolytic
C4 — 0.1 µF Erie Redcap
L1, L2 — 2 Turns #18 AWG, 1/8″ ID
Z1–Z14 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.031″ Thick Teflon-Fiberglass, ε_r = 2.56

Figure 1. 1090 MHz Test Circuit

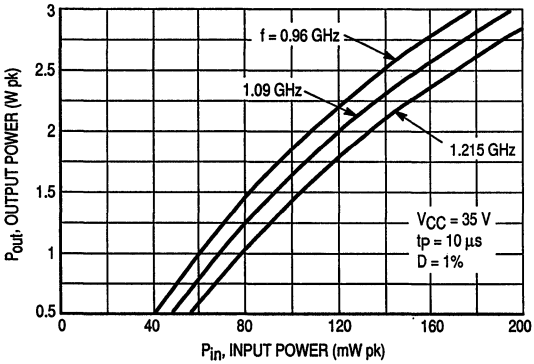


Figure 2. Output Power versus Input Power

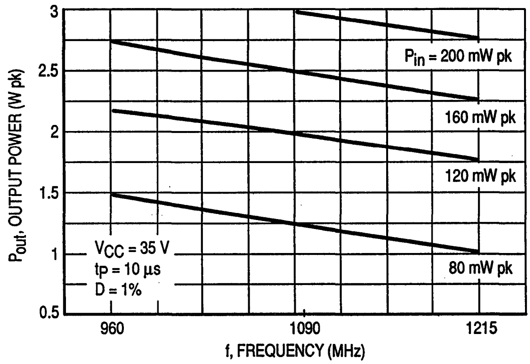


Figure 3. Output Power versus Frequency

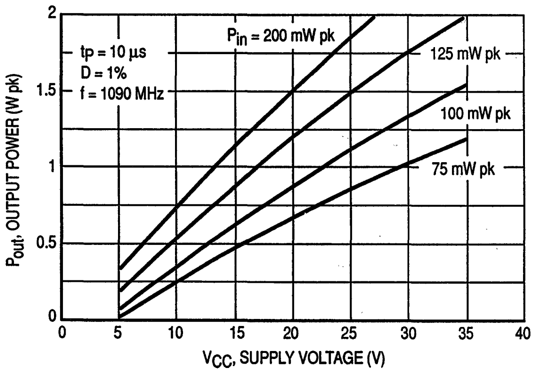


Figure 4. Output Power versus Supply Voltage

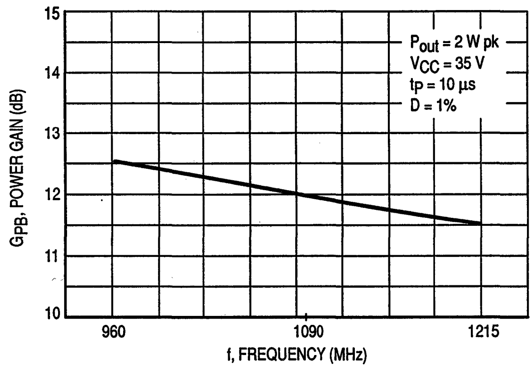
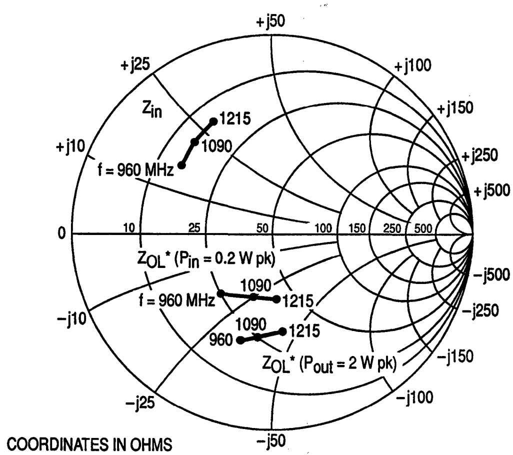


Figure 5. Power Gain versus Frequency



V_{CC} = 35 Vdc,
tp = 10 µs, D = 1.0%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms P_{out} = 2.0 W pk	Z_{OL}* Ohms P_{in} = 0.2 W pk
960	15.5 + j16.5	20 + j32.5	25 + j21
1090	15 + j20	25 + j34	31 + j26
1215	14 + j27	33.5 + j42.5	37 + j32.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

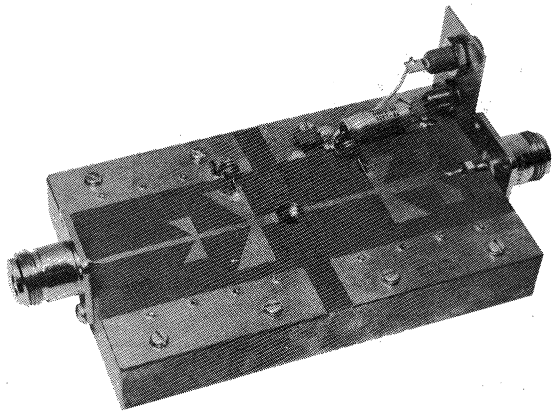


Figure 7. 1090 MHz Test Amplifier

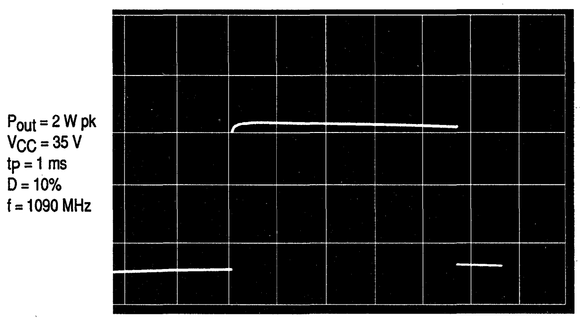


Figure 8. Typical Long Pulse Performance

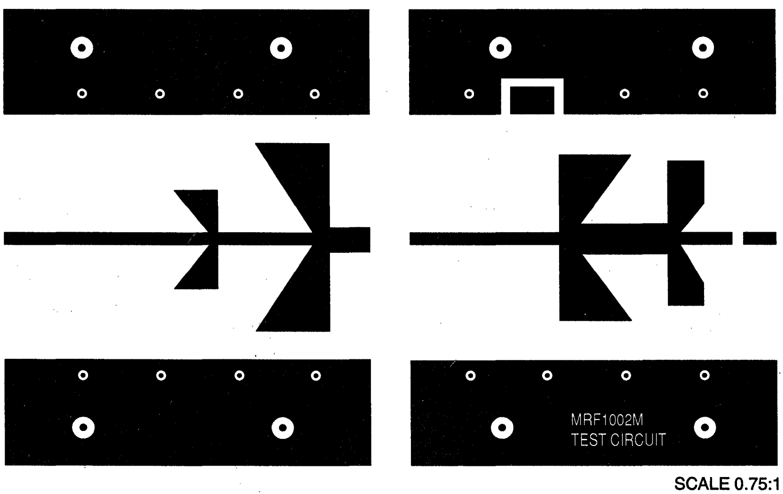


Figure 9. Printed Circuit Board Layout — 1090 MHz Test circuit

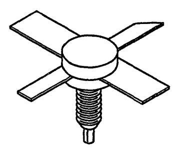
MRF1004MA
MRF1004MB

The RF Line
Microwave Pulse Power Transistors

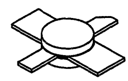
. . . designed for Class B and C common base amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 35 Vdc
  Output Power = 4.0 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**4.0 W, 960–1215 MHz
MICROWAVE POWER
TRANSISTORS
NPN SILICON**



**CASE 332-04, STYLE 1
MRF1004MA**



**CASE 332A, STYLE 1
MRF1004MB**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 75 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—

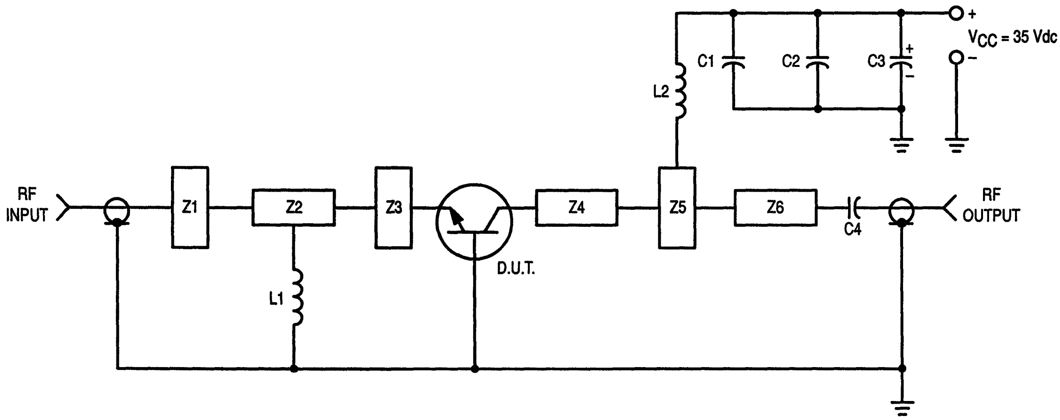
(continued)

NOTES:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 35 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.3	5.0	pF
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 35 Vdc, P_{out} = 4.0 W pk, f = 1090 MHz)	G_{PB}	10	11	—	dB
Collector Efficiency (V_{CC} = 35 Vdc, P_{out} = 4.0 W pk, f = 1090 MHz)	η	40	45	—	dB
Load Mismatch (V_{CC} = 35 Vdc, P_{out} = 4.0 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

2



C1 — 0.1 µF
C2, C4 — 220 pF Chip Capacitor
C3 — 20 µF, 50 V Electrolytic
L1, L2 — 3 Turns #18 AWG, 1/8″ ID
Z1–Z6 Distributed Microstrip Elements — See Figure 9
Board Material — 0.031″ Thick Glass Teflon

Figure 1. 1090 MHz Test Circuit

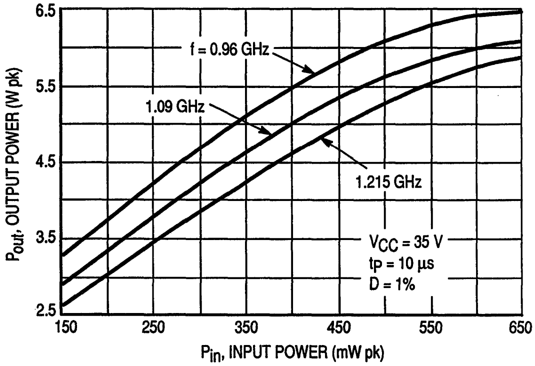


Figure 2. Output Power versus Input Power

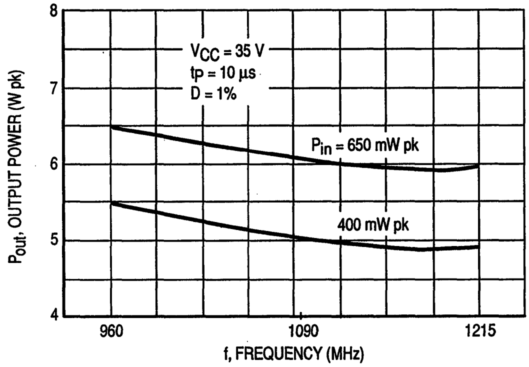


Figure 3. Output Power versus Frequency

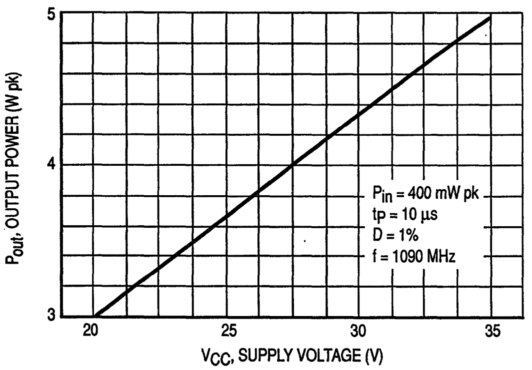


Figure 4. Output Power versus Supply Voltage

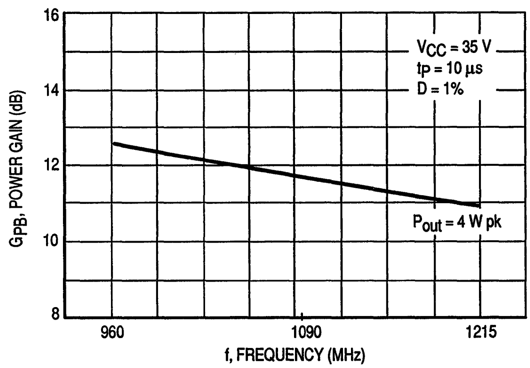
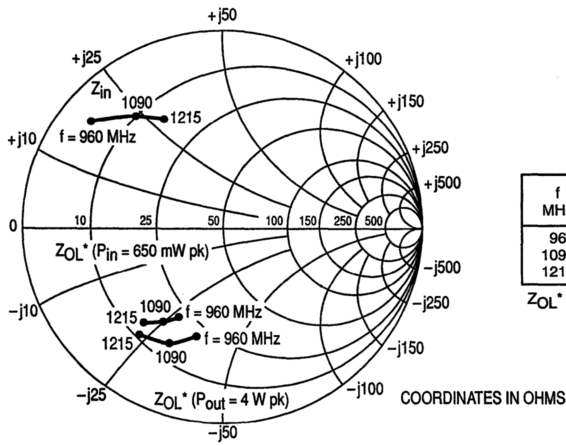


Figure 5. Power Gain versus Frequency



f MHz	Z_{in} Ohms	Z_{OL}* (P_{in} = 400 mW pk) Ohms	Z_{OL}* (P_{out} = 4.0 W pk) Ohms
960	5.0 + j17.5	23.5 – j26	22.5 – j36
1090	10 + j23	18.5 – j25	15 – j32.5
1215	16 + j29.5	15.5 – j23.5	11 – j23

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

2

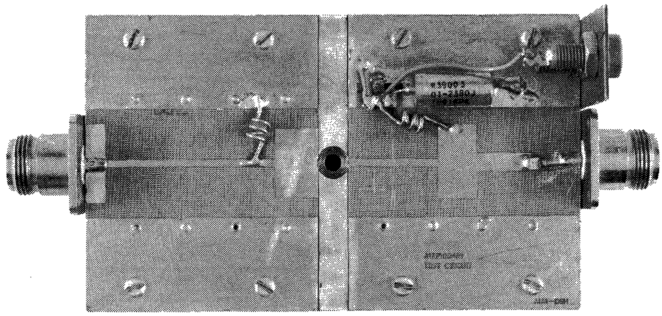


Figure 7. 1090 MHz Test Amplifier

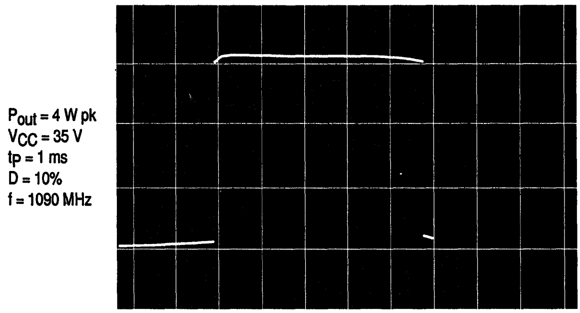
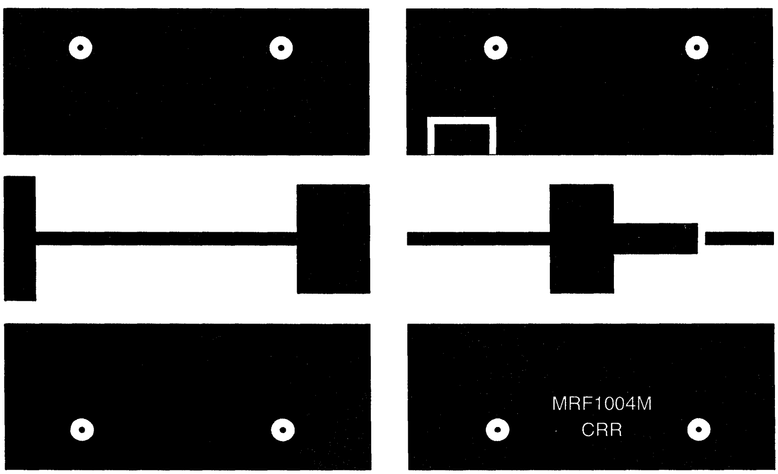


Figure 8. Typical Long Pulse Performance



SCALE 0.75:1

Figure 9. Printed Circuit Board Layout — 1090 MHz Test circuit

2

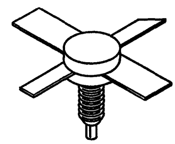
MRF1015MA
MRF1015MB

The RF Line
Microwave Pulse Power Transistors

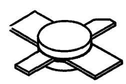
. . . designed for Class B and C common base amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 15 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**15 W (PEAK), 960–1215 MHz
MICROWAVE POWER
TRANSISTORS
NPN SILICON**



**CASE 332-04, STYLE 1
MRF1015MA**



**CASE 332A, STYLE 1
MRF1015MB**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	17.5 100	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	10	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

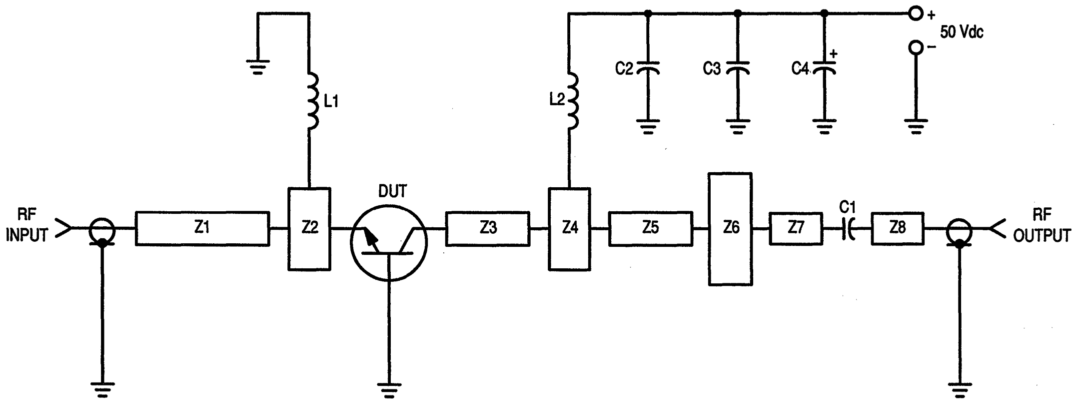
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	100	—

(continued)

NOTES:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	5.0	7.5	pF
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 15 W Peak, f = 1090 MHz)	G_{PB}	10	12.5	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 15 W Peak, f = 1090 MHz)	η	30	35	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 15 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — 0.1 µF
C4 — 47 µF/75 V Electrolytic Capacitor
L1, L2 — 3 Turns #18 AWG, 1/8″ ID
Z1–Z8 — Microstrip, See Photomaster, Figure 8
Board Material — 0.032″ Glass Teflon
ε_r = 2.5

Figure 1. 1090 MHz Test Circuit

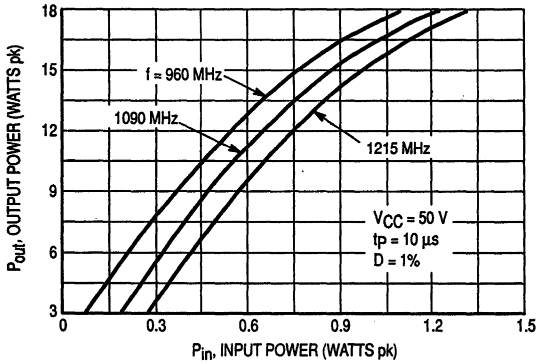


Figure 2. Output Power versus Input Power

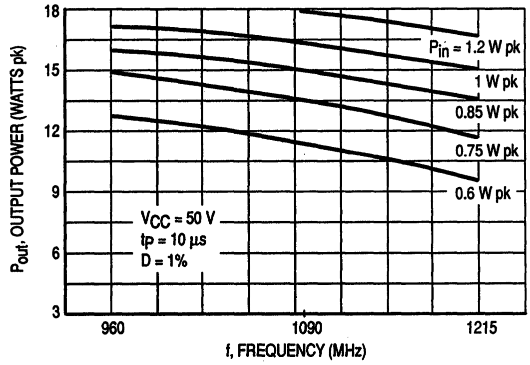


Figure 3. Output Power versus Frequency

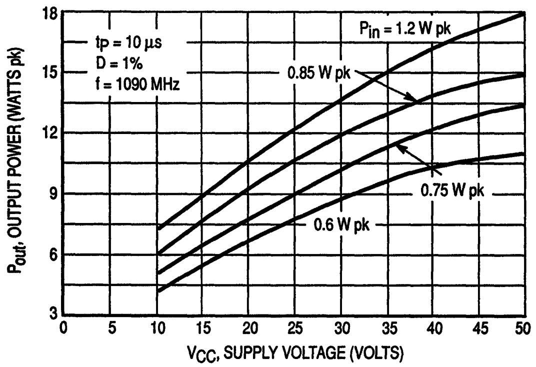


Figure 4. Output Power versus Supply Voltage

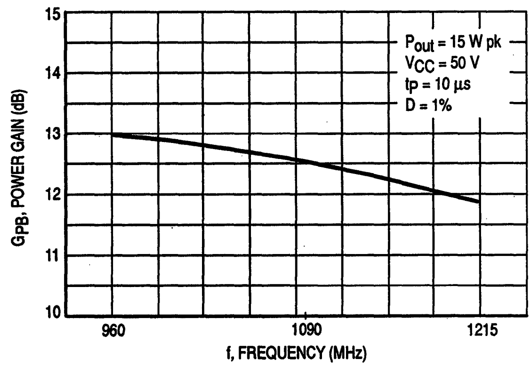
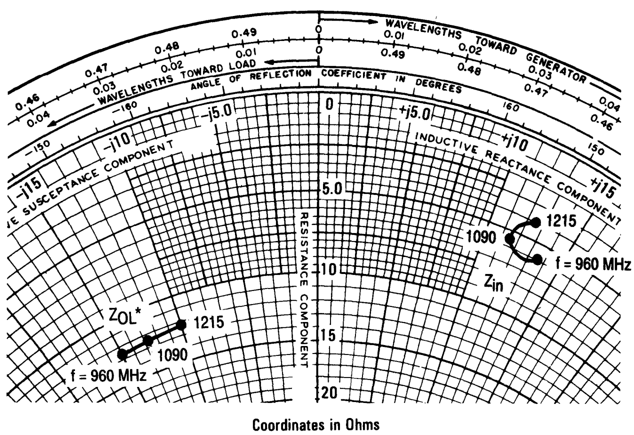


Figure 5. Power Gain versus Frequency



P_{out} = 15 W pk V_{CC} = 50 V
t_p = 10 μs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	5.9 + j13.6	12.5 – j15
1090	5.5 + j11.5	12.4 – j12.8
1215	4.0 + j12.5	12.1 – j10

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

2

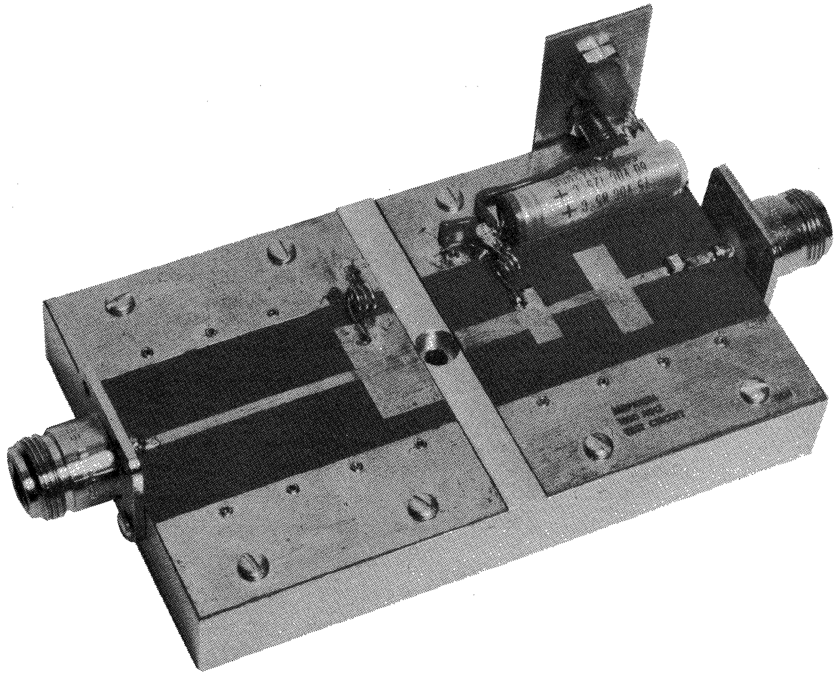


Figure 7. 1090 MHz Test Amplifier

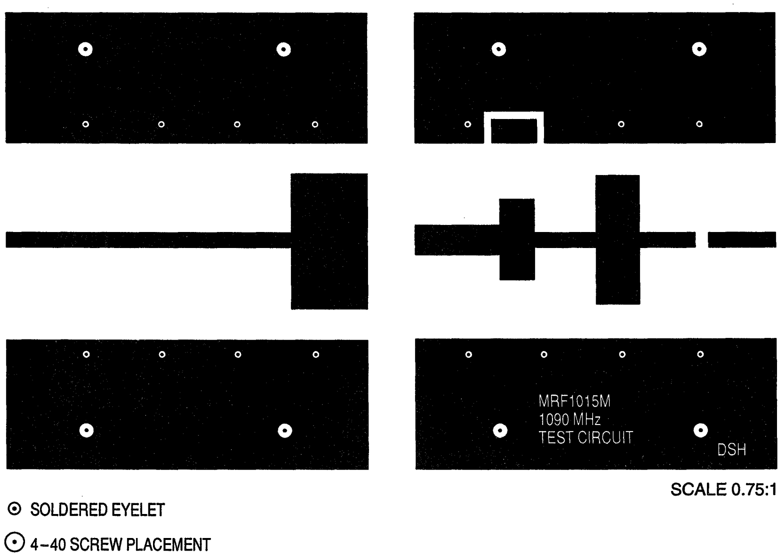


Figure 8. Printed Circuit Board Layout — 1090 MHz Test circuit

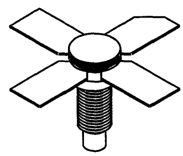
MRF1029

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1.0 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 1.5 Watts
  Power Gain — 8.0 dB Min, Class AB
- Gold Metallization for Improved Reliability

**1.5 W, TO 1.0 GHz
LINEAR
UHF POWER TRANSISTOR
NPN SILICON**



**.280 SOE
CASE 244C, STYLE 1**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	14.5 0.084	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70°C$)	$R_{\theta JC}$	12	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ V, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250$ mA, $V_{CE} = 5.0$ V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, f = 1.0 MHz)	C_{ob}	—	—	4.75	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 25$ V, $P_{out} = 1.5$ W, f = 900 MHz, $I_C = 0.2$ A)	G_{PE}	8.0	9.3	—	dB
Load Mismatch ($V_{CE} = 25$ V, $I_C = 0.2$ A, $P_{out} = 1.5$ W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

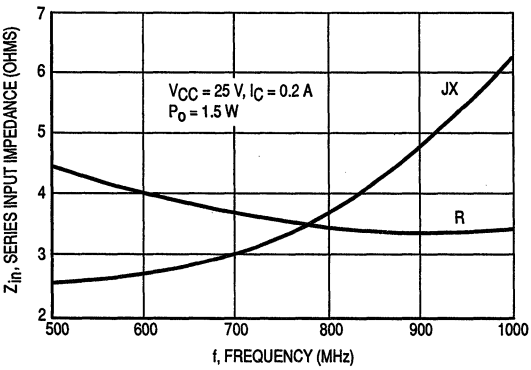


Figure 1. Input Impedance versus Frequency

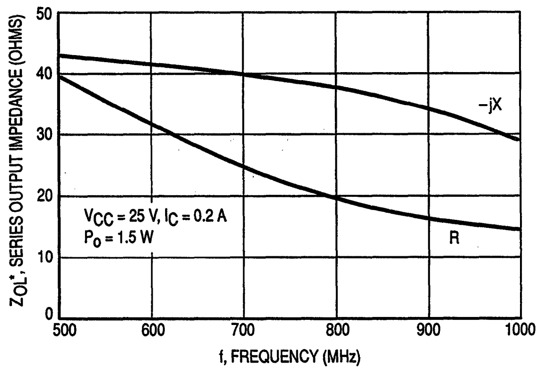


Figure 2. Output Impedance versus Frequency

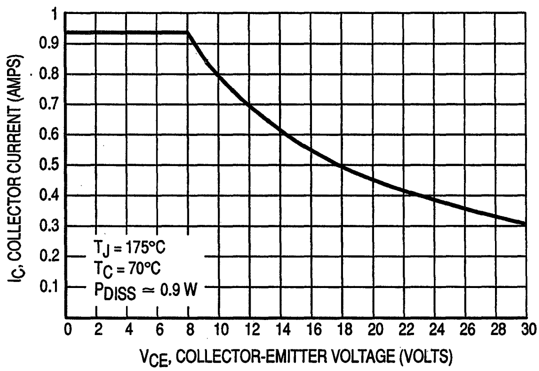


Figure 3. RF Safe Operating Area

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ ϕ	Mag	∠ ϕ	Mag	∠ ϕ	Mag	∠ ϕ
25	200	0.40	0.86	178	10.43	74	0.04	35	0.43	−143
		0.45	0.86	177	9.7	80	0.04	32	0.41	−149
		0.50	0.86	175	9.03	78	0.04	35	0.41	−151
		0.55	0.86	174	8.11	76	0.05	37	0.42	−150
		0.60	0.86	172	7.46	72	0.05	38	0.43	−149
		0.65	0.86	171	6.9	71	0.05	41	0.43	−151
		0.70	0.86	170	6.04	69	0.05	41	0.43	−150
		0.75	0.85	168	5.71	66	0.05	43	0.45	−149
		0.80	0.85	167	5.16	64	0.05	46	0.45	−150
		0.85	0.85	165	4.48	61	0.06	47	0.46	−149
		0.90	0.85	164	4.36	59	0.06	49	0.47	−148
		0.95	0.85	162	3.64	56	0.06	51	0.47	−149
		1.00	0.84	160	3.48	54	0.06	51	0.48	−148

Table 1. Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

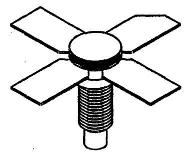
MRF1030

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1.0 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 3.0 Watts
  Power Gain — 7.5 dB Min, Class AB
- Gold Metallization for Improved Reliability

3.0 W, TO 1.0 GHz
LINEAR
UHF POWER TRANSISTOR
NPN SILICON



CASE 244C, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	29 0.167	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70°C$)	$R_{\theta JC}$	6.0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 15$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 15$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 15$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ V, $I_E = 0$)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500$ mA, $V_{CE} = 5.0$ V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, f = 1.0 MHz)	C_{ob}	—	—	9.8	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 25$ V, $P_{out} = 3.0$ W, f = 900 MHz, $I_C = 0.4$ A)	G_{PE}	7.5	8.5	—	dB
Load Mismatch ($V_{CE} = 25$ V, $I_C = 0.4$ A, $P_{out} = 3.0$ W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

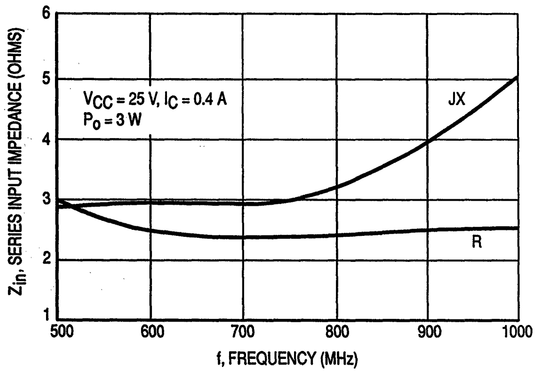


Figure 1. Input Impedance versus Frequency

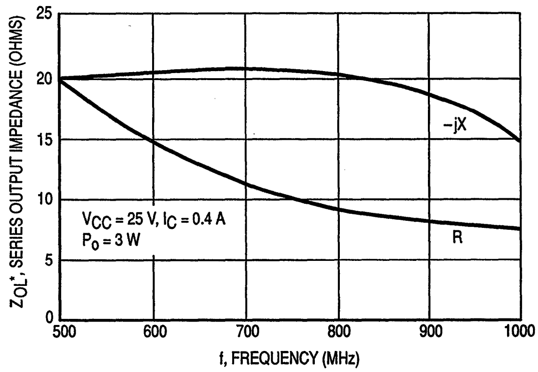


Figure 2. Output Impedance versus Frequency

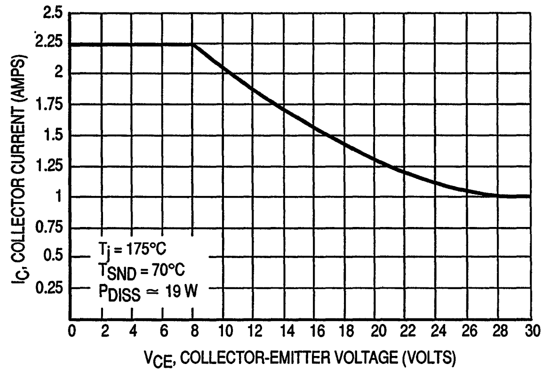


Figure 3. RF Safe Operating Area

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
25	400	0.40	0.92	178	2.05	73	0.03	48	0.62	−171
		0.45	0.92	177	1.9	81	0.03	46	0.63	−169
		0.50	0.92	176	1.75	80	0.03	48	0.63	−170
		0.55	0.92	175	1.57	79	0.04	51	0.63	−170
		0.60	0.92	175	1.47	75	0.04	53	0.63	−169
		0.65	0.92	174	1.38	74	0.04	57	0.64	−170
		0.70	0.92	173	1.25	72	0.04	57	0.64	−170
		0.75	0.92	172	1.2	70	0.05	59	0.64	−169
		0.80	0.92	172	1.13	68	0.05	62	0.64	−170
		0.85	0.91	171	1.05	66	0.05	63	0.64	−169
		0.90	0.91	170	1.04	64	0.06	64	0.64	−169
		0.95	0.91	169	0.96	64	0.06	67	0.65	−169
		1.00	0.91	168	0.95	61	0.06	66	0.65	−169

Table 1. Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

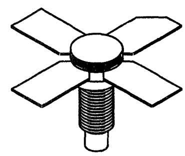
MRF1031

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1.0 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 4.5 Watts
  Power Gain — 7.0 dB Min, Class AB
- Gold Metallization for Improved Reliability

4.5 W, TO 1.0 GHz
LINEAR
UHF POWER TRANSISTOR
NPN SILICON



CASE 244C, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.286	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	3.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0)	I_{CBO}	—	—	2.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	14	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 4.5 W, f = 900 MHz, I_C = 0.6 A)	G_{PE}	7.0	8.0	—	dB
Load Mismatch (V_{CE} = 25 V, I_C = 0.6 A, P_{out} = 4.5 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

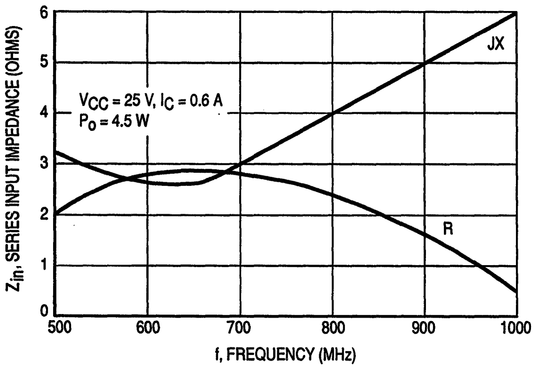


Figure 1. Input Impedance versus Frequency

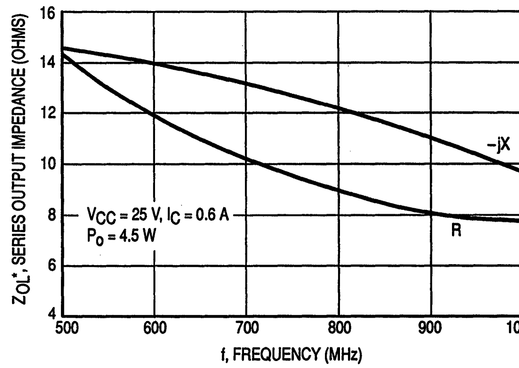


Figure 2. Output Impedance versus Frequency

2

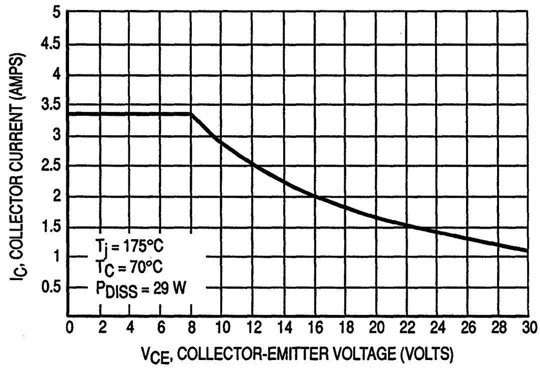


Figure 3. RF Safe Operating Area

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
25	500	0.40	0.95	178	1.54	81	0.02	62	0.67	–171
		0.45	0.96	178	1.35	79	0.03	62	0.68	–170
		0.50	0.95	177	1.24	77	0.03	64	0.69	–170
		0.55	0.95	177	1.12	75	0.03	67	0.69	–170
		0.60	0.96	176	1.04	72	0.03	68	0.69	–169
		0.65	0.95	176	0.97	72	0.04	72	0.7	–170
		0.70	0.95	175	0.88	69	0.04	72	0.7	–170
		0.75	0.95	175	0.84	68	0.04	74	0.7	–169
		0.80	0.95	174	0.79	66	0.04	77	0.71	–170
		0.85	0.95	174	0.73	64	0.05	78	0.71	–170
		0.90	0.95	173	0.72	62	0.05	77	0.72	–169
		0.95	0.95	172	0.67	62	0.05	81	0.72	–170
		1.00	0.95	172	0.65	59	0.05	79	0.72	–169

Table 1. Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

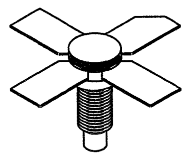
MRF1032

The RF Line
UHF Power Transistor

. . . designed primarily for large-signal output and driver amplifier stages to 1.0 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 6.0 Watts
  Power Gain — 6.5 dB Min, Class AB
- Gold Metallization for Improved Reliability

6.0 W, TO 1.0 GHz
LINEAR
UHF POWER TRANSISTOR
NPN SILICON



CASE 244C, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.286	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	3.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	19.5	pF
FUNCTIONAL TESTS					
Common Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 6.0 W, f = 900 MHz, I_C = 0.85 A)	G_{PE}	6.5	7.5	—	dB
Load Mismatch (V_{CE} = 25 V, P_{out} = 6.0 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
25	850	0.4	0.97	178	1.01	82	0.03	85	0.74	179
		0.5	0.96	177	0.99	74	0.03	69	0.78	−179
		0.6	0.96	176	0.84	77	0.03	73	0.78	−179
		0.7	0.97	175	0.68	75	0.04	76	0.77	−177
		0.8	0.96	174	0.62	69	0.05	77	0.78	178
		0.9	0.96	173	0.60	67	0.05	78	0.78	−178
		1.0	0.96	172	0.54	66	0.06	77	0.78	−177

Table 1. Common Emitter S-Parameters

2

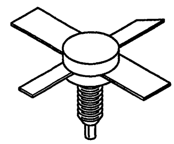
MRF1035MA
MRF1035MB

The RF Line
Microwave Pulse Power Transistors

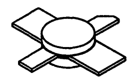
. . . designed for Class B and C common base amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 35 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**35 W (PEAK), 960–1215 MHz
MICROWAVE POWER
TRANSISTORS
NPN SILICON**



**CASE 332-04, STYLE 1
MRF1035MA**



**CASE 332A, STYLE 1
MRF1035MB**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	35 200	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	100	—

NOTES:

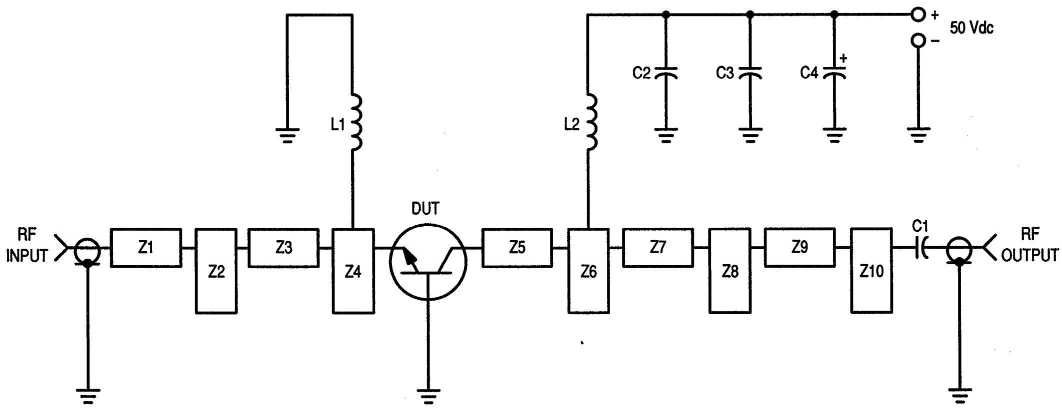
(continued)

1. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	10	15	pF
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 35 W Peak, f = 1090 MHz)	G_{PB}	10	12.4	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 35 W Peak, f = 1090 MHz)	η	30	34	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 35 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

2



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — 0.1 µF
C4 — 10 µF/75 V Electrolytic
L1, L2 — 3 Turns #18 AWG, 1/8″ ID
Z1–Z10 — Microstrip, See Photomaster
Board Material — 0.031″ Glass Teflon
ε_r = 2.5

Figure 1. 1090 MHz Test Circuit

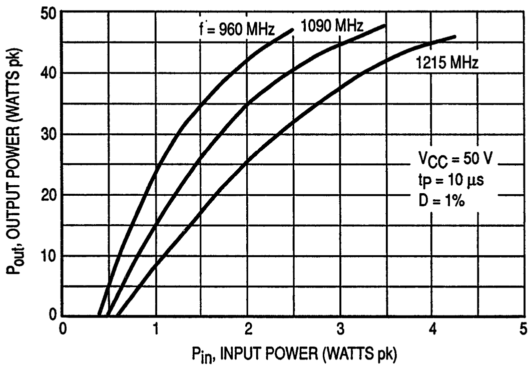


Figure 2. Output Power versus Input Power

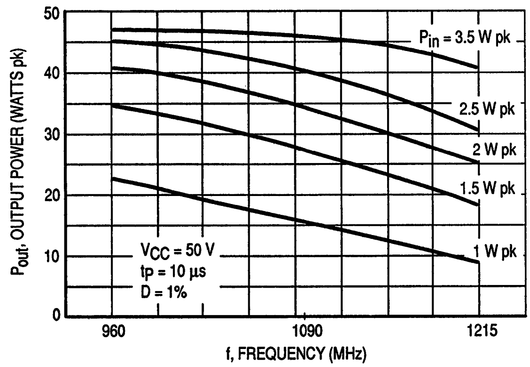


Figure 3. Output Power versus Frequency

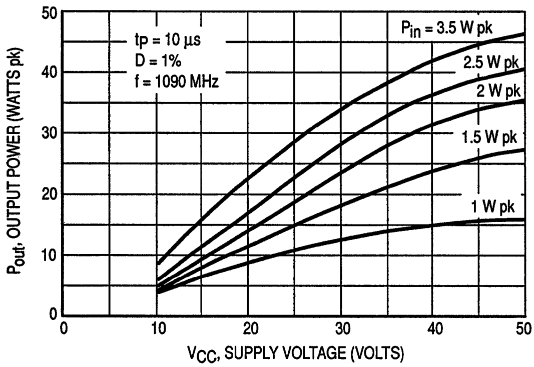


Figure 4. Output Power versus Supply Voltage

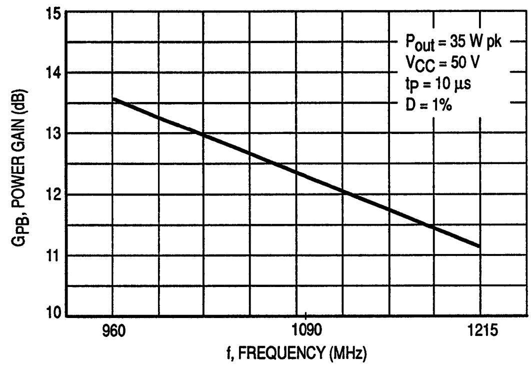
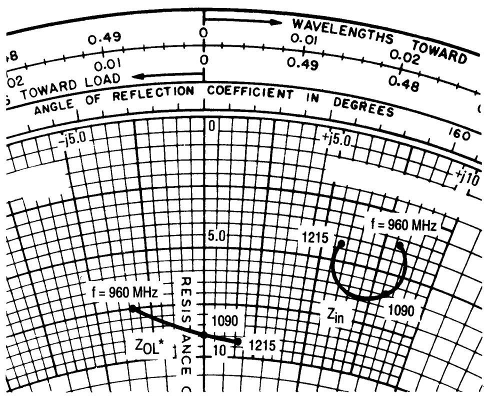


Figure 5. Power Gain versus Frequency

2



P_{out} = 35 W pk V_{CC} = 50 V
t_p = 10 µs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	3.8 + j8.2	7.5 – j3.3
1090	6.0 + j8.2	9.0 + j0
1215	4.2 + j5.7	9.1 + j1.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

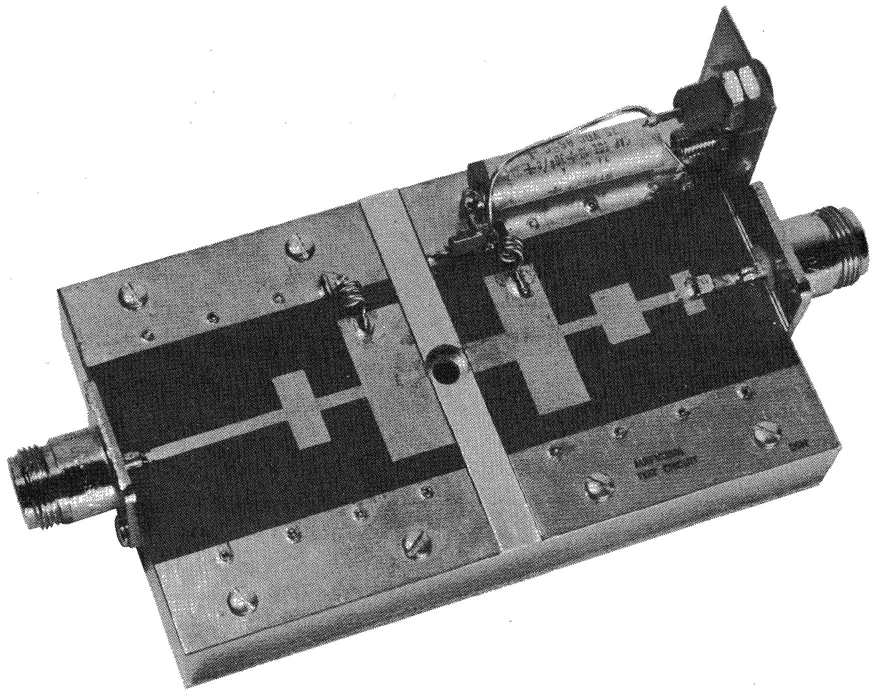


Figure 7. 1090 MHz Test Amplifier

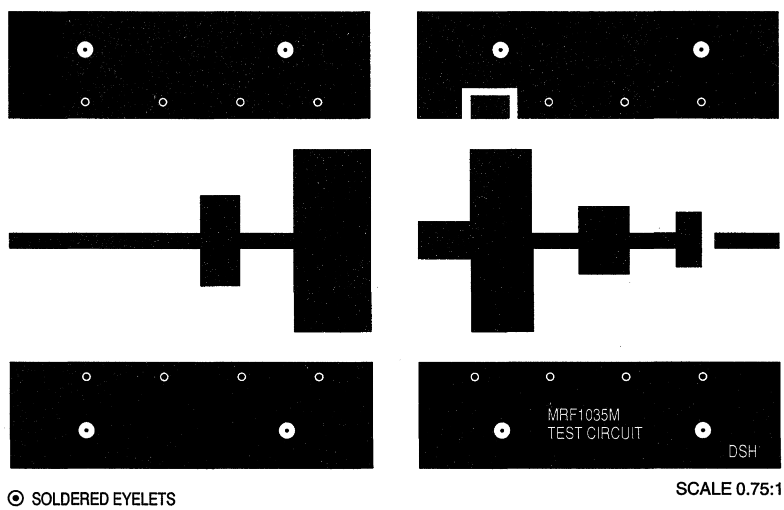


Figure 8. Printed Circuit Board Layout — 1090 MHz Test circuit

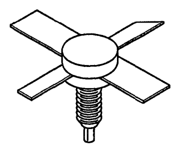
MRF1090MA
MRF1090MB

The RF Line
Microwave Pulse Power Transistors

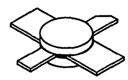
. . . designed for Class B and C common base amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 90 Watts Peak
  Minimum Gain = 8.4 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**90 W PEAK, 960–1215 MHz
MICROWAVE POWER
TRANSISTORS
NPN SILICON**



**CASE 332-04, STYLE 1
MRF1090MA**



**CASE 332A, STYLE 1
MRF1090MB**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1)	I_C	6.0	Adc
Total Device Dissipation @ T_C = 25°C (1) (2) Derate above 25°C	P_D	290 1.66	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

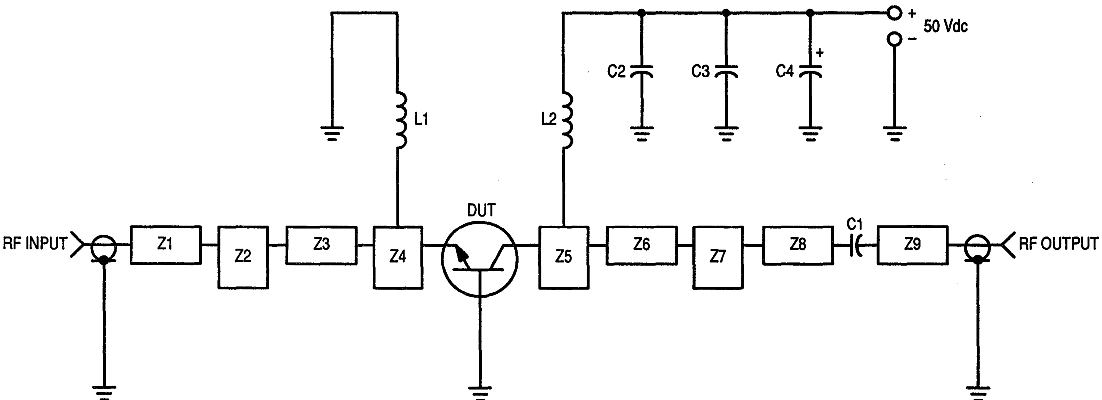
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (4) (I_C = 2.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—

(continued)

NOTES:
1. Pulse Width = 10 μs, Duty Cycle = 1%.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.
4. 80 μs Pulse on Tektronix 576 or equivalent.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	12	16	pF
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 90 W pk, f = 1090 MHz)	G_{PB}	8.4	10.8	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 90 W pk, f = 1090 MHz)	η	35	40	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 90 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			



C1, C2 — 220 pF Chip Capacitor, 100-mil ATC
C3 — 0.1 μF
C4 — 47 μF/75 V
L1, L2 — 3 Turns #18 AWG, 1/8″ ID
Z1–Z9 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.031″ Thick Glass Teflon, ε_r = 2.5

Figure 1. 1090 MHz Test Circuit

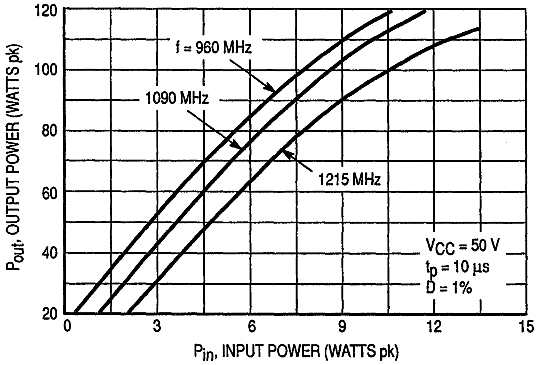


Figure 2. Output Power versus Input Power

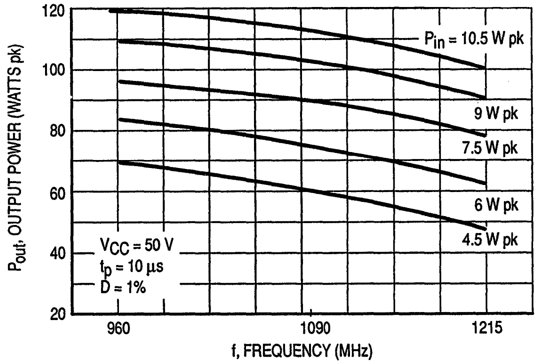


Figure 3. Output Power versus Frequency

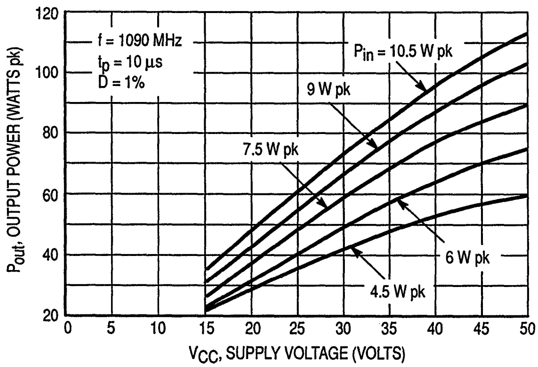


Figure 4. Output Power versus Supply Voltage

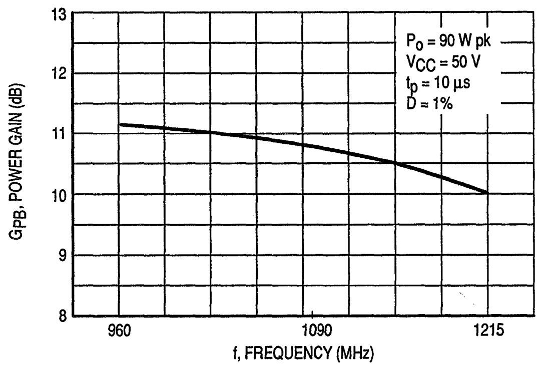
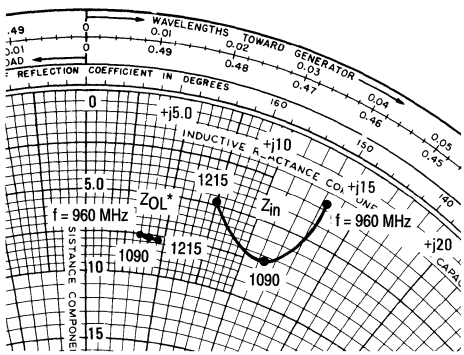


Figure 5. Power Gain versus Frequency



Coordinates in Ohms

P_{out} = 90 W pk V_{CC} = 50 V
t_p = 10 µs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	2.8 + j13.2	7.6 + j3.5
1090	7.4 + j11.4	7.6 + j4.0
1215	4.7 + j7.5	7.7 + j4.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

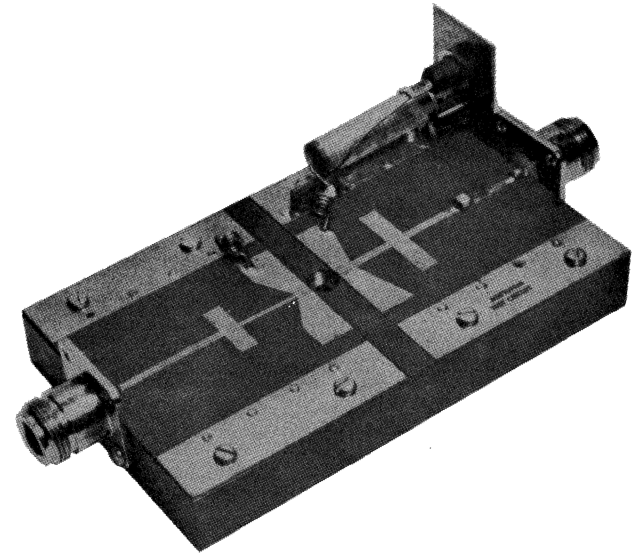


Figure 7. 1090 MHz Test Amplifier

P_O = 90 W pk
V_{CC} = 50 V
t_p = 10 µs
D = 1%
f = 1090 MHz

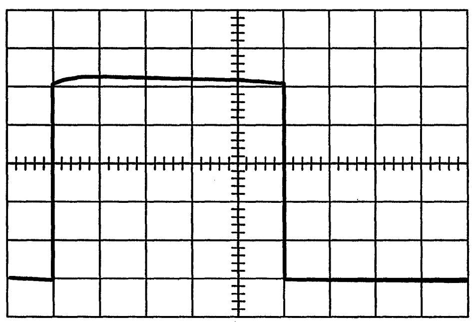


Figure 8. Typical Pulse Performance

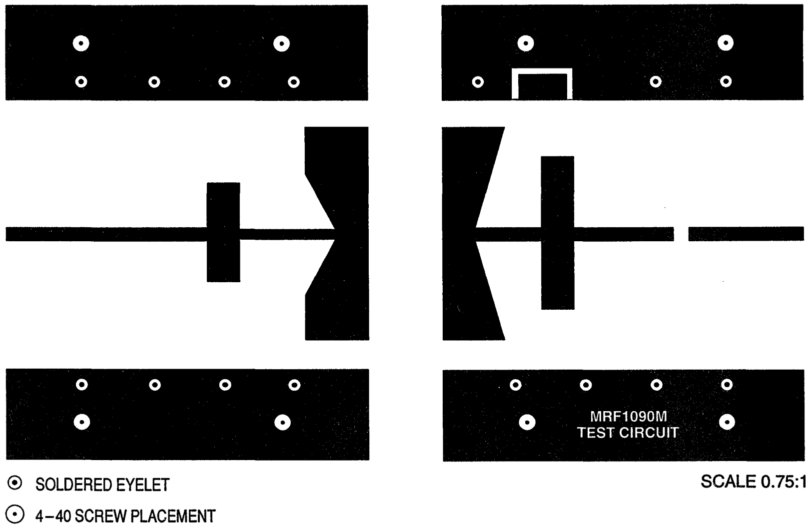


Figure 9. Printed Circuit Board Layout — 1090 MHz Test circuit

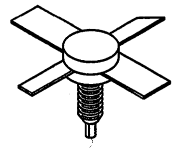
MRF1150MA
MRF1150MB

The RF Line
Microwave Pulse Power Transistors

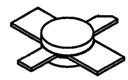
. . . designed for Class B and C common base amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 150 Watts Peak
  Minimum Gain = 7.8 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**150 W PEAK, 960–1215 MHz
MICROWAVE POWER
TRANSISTORS
NPN SILICON**



**CASE 332-04, STYLE 1
MRF1150MA**



**CASE 332A, STYLE 1
MRF1150MB**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak (1)	I_C	12	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) (2) Derate above 25°C	P_D	583 3.33	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.3	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

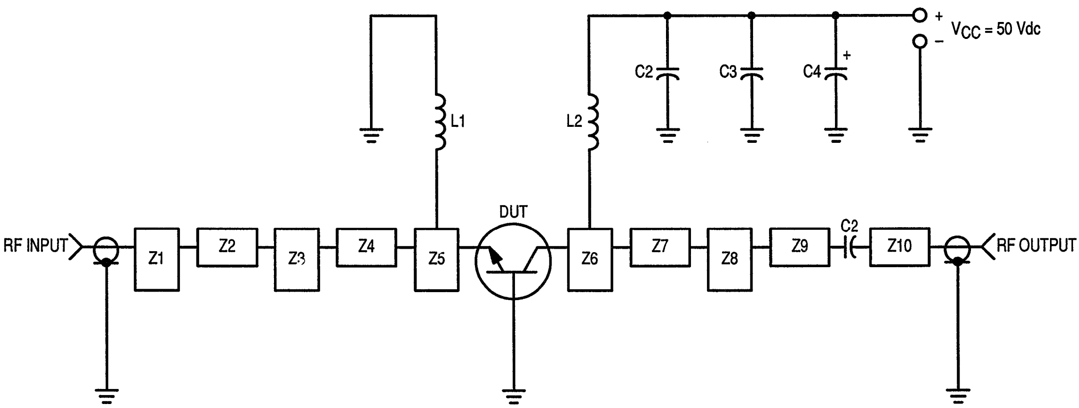
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (4) ($I_C = 5.0$ Adc, $V_{CE} = 5.0$ Vdc)	h_{FE}	10	30	—	—

(continued)

NOTES:
1. Pulse Width = 10 μs, Duty Cycle = 1%.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.
4. 80 μs Pulse on Tektronix 576 or equivalent.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	25	32	pF
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz)	G_{PB}	7.8	9.8	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz)	η	35	40	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			



C1, C2 — 220 pF Chip Capacitor, 100-mil ATC
C3 — 0.1 µF/100 V
C4 — 47 µF/75 V Electrolytic
L1, L2 — 3 Turns #18 AWG, 1/8″ ID
Z1–Z10 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.031″ Thick Teflon-Fiberglass, ε_r = 2.5

Figure 1. 1090 MHz Test Circuit

2

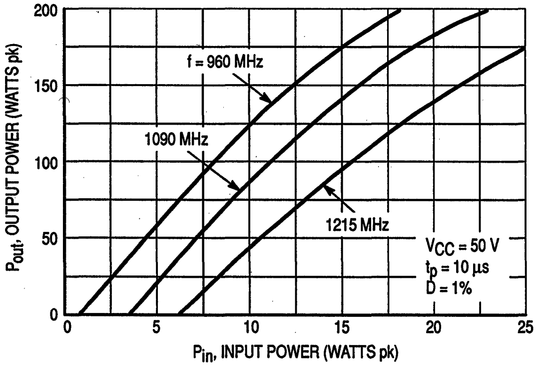


Figure 2. Output Power versus Input Power

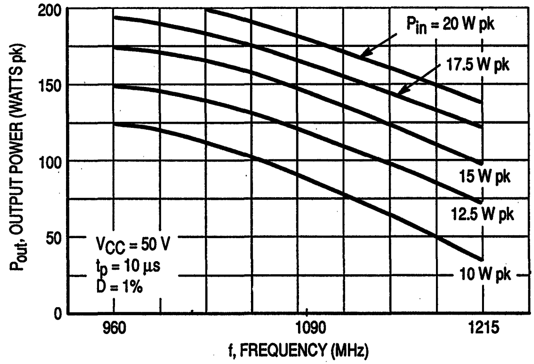


Figure 3. Output Power versus Frequency

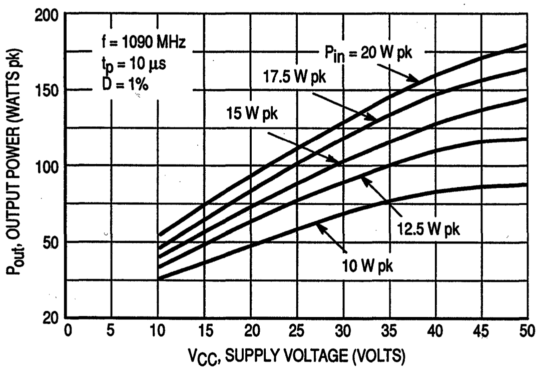


Figure 4. Output Power versus Supply Voltage

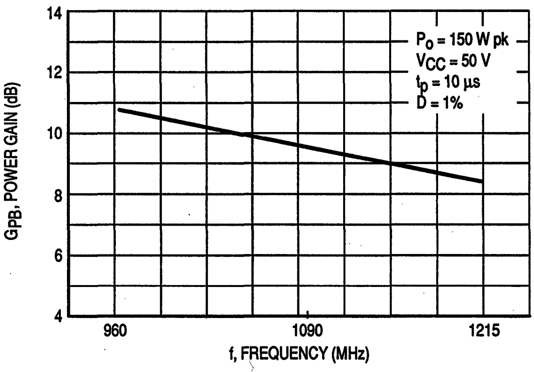
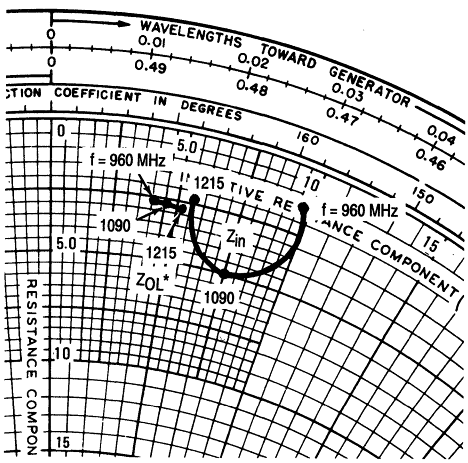


Figure 5. Power Gain versus Frequency



P_{out} = 150 W pk V_{CC} = 50 V
t_p = 10 µs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	1.5 + j9.6	2.6 + j4.1
1090	5.0 + j7.5	2.7 + j4.6
1215	2.4 + j5.6	2.8 + j5.3

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

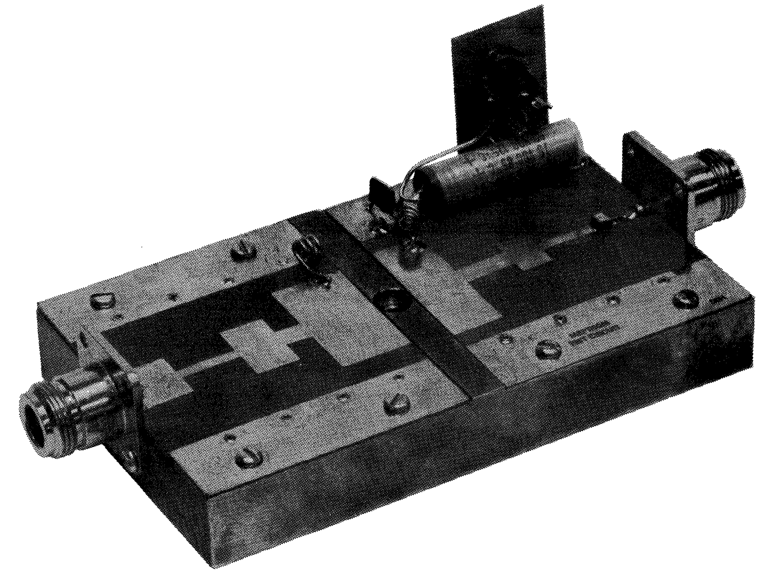


Figure 7. 1090 MHz Test Amplifier

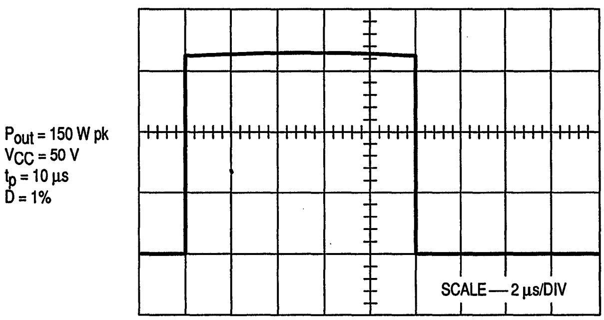


Figure 8. Typical Pulse Performance

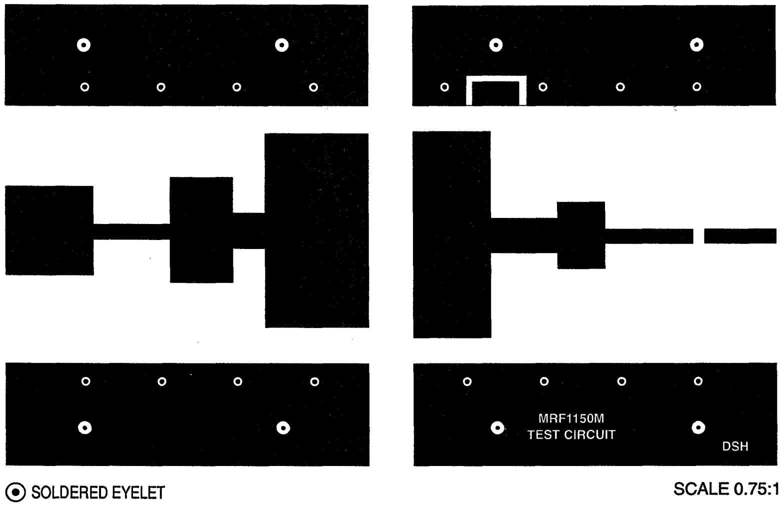


Figure 9. Printed Circuit Board Layout — 1090 MHz Test circuit

2

The RF Line
Microwave Pulse Power Transistor

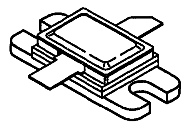
Designed for 1025-1150 MHz pulse common base amplifier applications such as TACAN and DME.

- Guaranteed Performance @ 1090 MHz
  Output Power = 375 Watts Peak
  Gain = 6.7 dB Min 7.5 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 3:1 VSWR
- Hermetically Sealed Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching
- Characterized using 10 μs, 1% Duty Pulse Format

MRF1375

Motorola Preferred Device

**375 W (PEAK), 1025–1150 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 355G, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	70	Vdc
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak (1)	I_C	29	Adc
Total Device Dissipation @ T_C = 25°C (1) (2) Derate above 25°C	P_D	1458 8.33	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +200	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

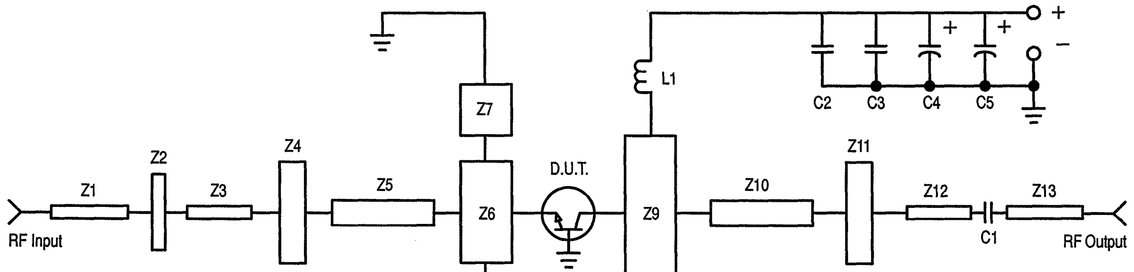
Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3) (4)	$R_{\theta JC}$	0.12	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.
4. Pulse Width = 10 μs, Duty Cycle = 1%

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	—	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 375 W Peak, f = 1090 MHz)	G_{PB}	6.7	7.5	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 375 W Peak, f = 1090 MHz)	η_c	40	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 375 W Peak, f = 1090 MHz, Load VSWR = 3:1 All Phase Angles)	Ψ	No Degradation in Output Power			



C1, C2 82 pF ATC Chip
C3 .1 µF 50 V
C4 10 µF 100 V, Electrolytic
C5 1000 µF 50 V, Electrolytic
L1 3 Turns # 18AWG, 1/8″ ID, 0.18″ Long
Z1-Z13 Microstrip, See Details

Board Material — Teflon® Glass Laminate, Dielectric Thickness 0.020″, ϵ_r = 2.55, 2 oz. Copper

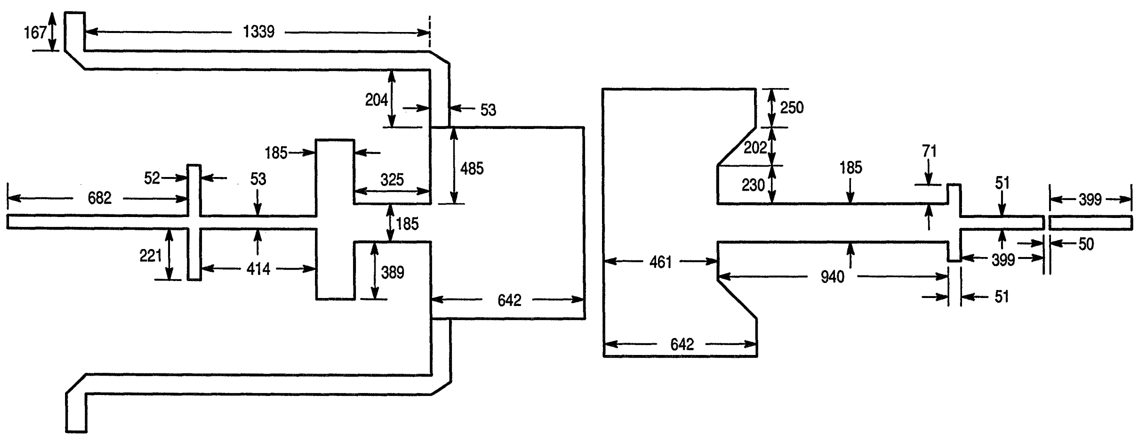


Figure 1. Test Circuit

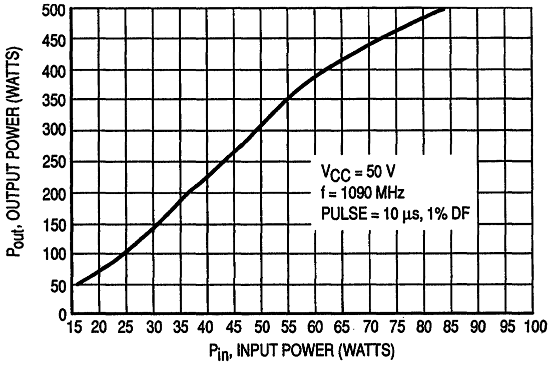


Figure 2. Output Power versus Input Power

2

P_{out} = 375 W, V_{CC} = 50 V
T_p = 10 μs, DF = 1%

Freq MHz	Z_{in} Ohms	Z_{OL}* Ohms (1)
1025	2.4 + j1.7	1.1 + j1.3
1050	2.1 + j1.2	1.1 + j1.4
1090	1.8 + j1.1	1.1 + j1.3
1125	1.6 + j1.1	1.3 + j1.3
1150	1.4 + j1.0	1.2 + j1.6

(1) Z_{OL}* is the conjugate of the optimum load impedance into which the device operates at a given output power voltage and frequency.

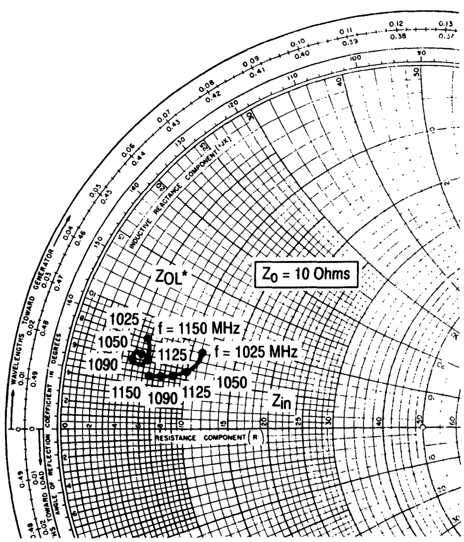


Figure 3. Series Equivalent Input/Output Impedances

MRF1500

Motorola Preferred Device

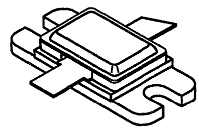
The RF Line
Microwave Pulse Power Transistor

Designed for 1025–1150 MHz pulse common base amplifier applications such as DME.

- Guaranteed Performance @ 1090 MHz
  Output Power = 500 Watts Peak
  Gain = 5.2 dB Min
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching
- Characterized with 10 μs, 1.0% Duty Cycle Pulses

**500 W (PEAK), 1025–1150 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**

2



CASE 355E, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	35	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	1750 10	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

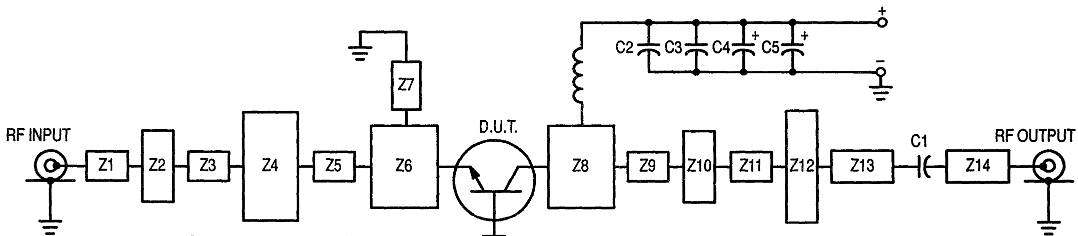
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.1	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques. (Worst case θ_{JC} value measured @32 μs, 2.0%)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	40	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	40	—	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 500 W Peak, f = 1090 MHz)	G_{PB}	5.2	—	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 500 W Peak, f = 1090 MHz)	η	37	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 500 W Peak, f = 1090 MHz, Load VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			



C1 — 82 pF 100 mil Chip Capacitor
C2 — 82 pF 100 mill Chip Capacitor
C3 — 0.1 μF
C4 — 10 μF 100 V, Electrolytic
C5 — 1000 μF 60 V, Electrolytic

L1 — 3 Turns, #18 AWG, 1/8″ ID, 0.18 Long
Z1–Z14 — Microstrip, See Details Below
Board Material — Teflon-Glass Laminate,
Dielectric Thickness = .020″,
ϵ_r = 2.55, 2 oz. Copper

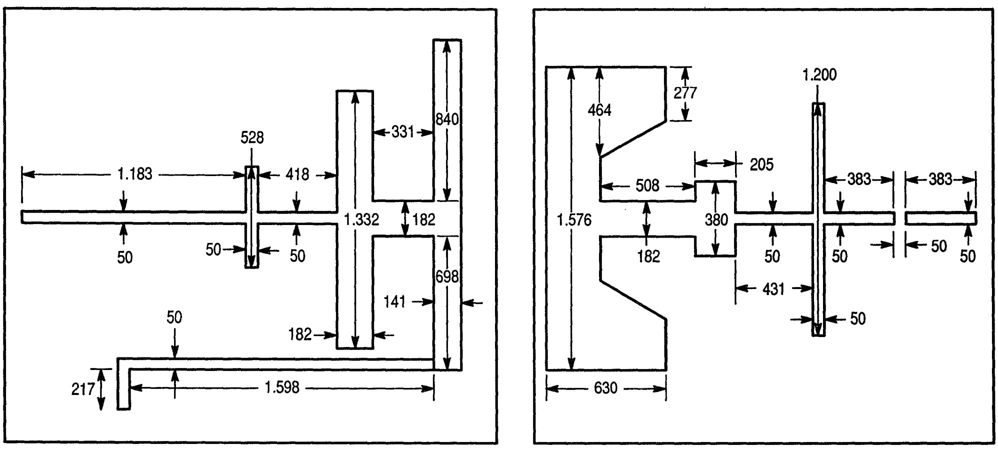


Figure 1. Test Circuit

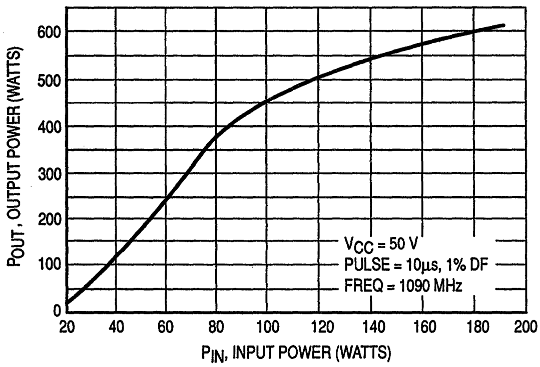
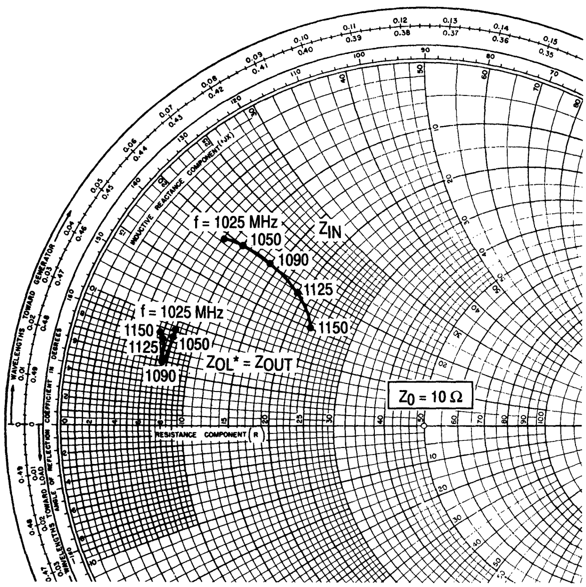


Figure 2. Output Power versus Input Power



f MHz	Z_{IN} OHMS	Z_{OL}*
1025	1.6 + j3.9	1.6 + j1.7
1050	2.0 + j4.0	1.6 + j1.6
1090	2.8 + j4.0	1.5 + j1.1
1125	3.9 + j3.8	1.5 + j1.4
1150	4.6 + j3.0	1.4 + j1.6

Z_{OL}* is the conjugate of the optimum load impedance into which the device operates at a given output power voltage and frequency.

Figure 3. Series Equivalent Input/Output Impedances

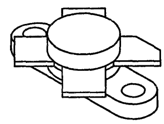
MRF1946
MRF1946A

The RF Line
NPN Silicon Power Transistors

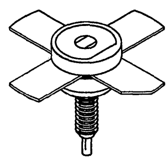
. . . designed for 12.5 volt large-signal power amplifiers in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 12.5 V, 175 MHz Performance
  Output Power = 30 Watts
  Power Gain = 10 dB
  Efficiency = 60%
- Diffused Emitter Resistor Ballasting
- Characterized to 220 MHz
- Load Mismatch at High Line and Overdrive Conditions

**30 W, 136–220 MHz
RF POWER
TRANSISTORS
NPN SILICON**



CASE 211-07, STYLE 1
MRF1946



CASE 145A-09, STYLE 1
MRF1946A

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	100 0.57	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

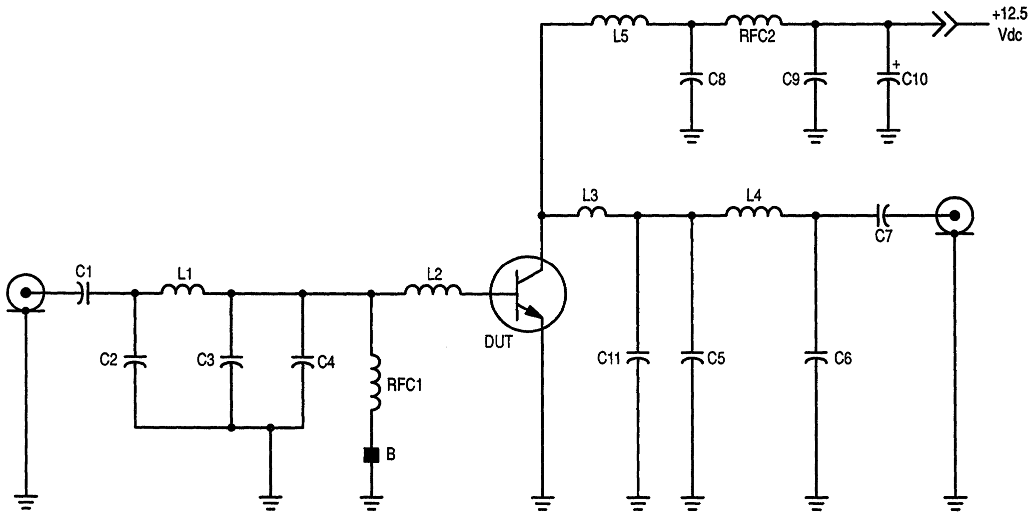
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	40	75	150	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	100	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 175 MHz)	G_{pe}	10	11	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 175 MHz)	η	60	70	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 2.0 dB Overdrive, Load VSWR = 30:1)	ψ	No Degradation in Power Output			

2



C1 — 56 pF Mini-Unelco, 3HS0006-56
C2 — 47 pF Mini-Unelco, 3HS0006-47
C3, C4 — 180 pF Chip Cap, ATC 100B181JC500
C5 — 150 pF Unelco, J101-150
C6 — 39 pF Mini-Unelco, 3HS0006-39
C7, C8 — 1000 pF Chip Cap, ATC 100B102JC50
C9 — 0.1 µF Ceramic Capacitor
C10 — 10 µF, 25 V Electrolytic Capacitor
C11 — 56 pF Mini-Unelco, 3HS0006-56

L1 — 2 Turns #18 AWG, 0.125″ ID
L2, L3 — Circuit Board and Mounting Pad Inductance
L4 — 3 Turns #18 AWG, 0.125″ ID
L5 — 6 Turns #16 Enameled, 0.250″ ID
RFC1 — 0.15 µH Molded Choke w/Ferrite Bead
RFC2 — Ferrite Choke, Fair Rite VK200-4B
Board Material — 1/32, Glass Teflon, 1 oz. Cu Plating
Bead — Ferroxcube

Figure 1. Broadband Test Circuit Schematic

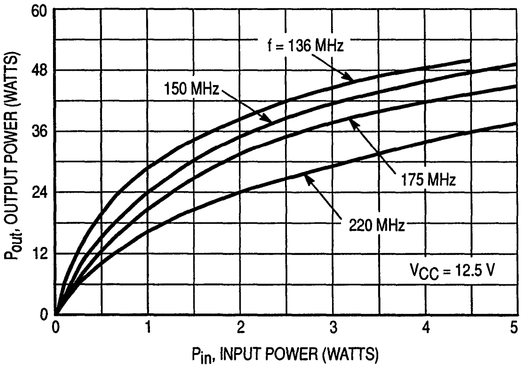


Figure 2. Output Power versus Input Power

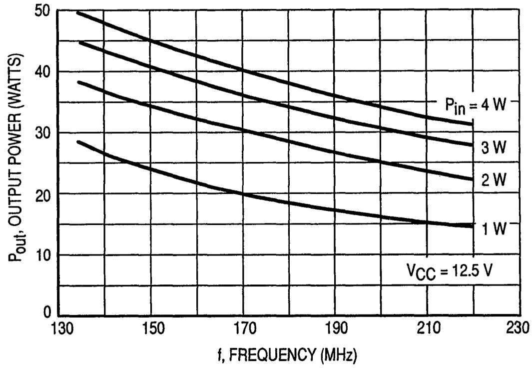


Figure 3. Output Power versus Frequency

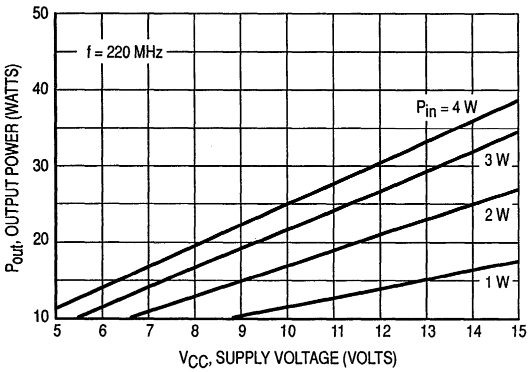


Figure 4. Output Power versus Supply Voltage

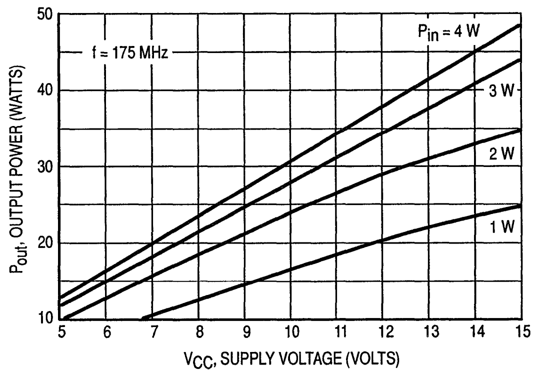


Figure 5. Output Power versus Supply Voltage

2

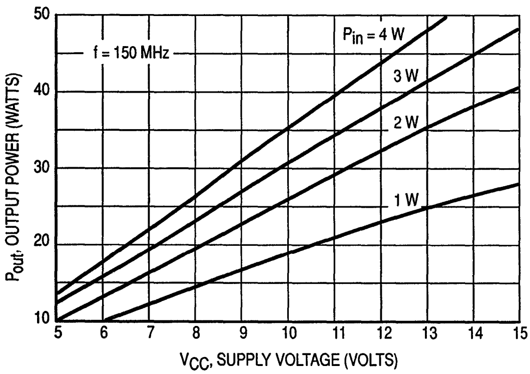


Figure 6. Output Power versus Supply Voltage

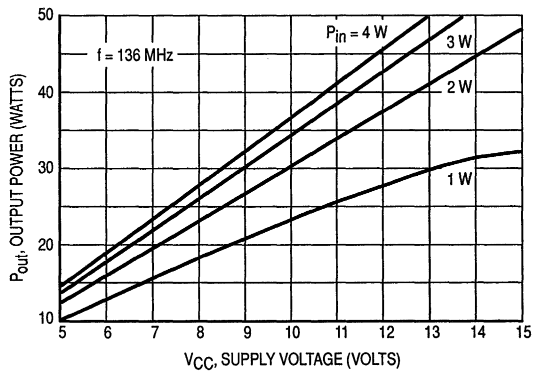


Figure 7. Output Power versus Supply Voltage

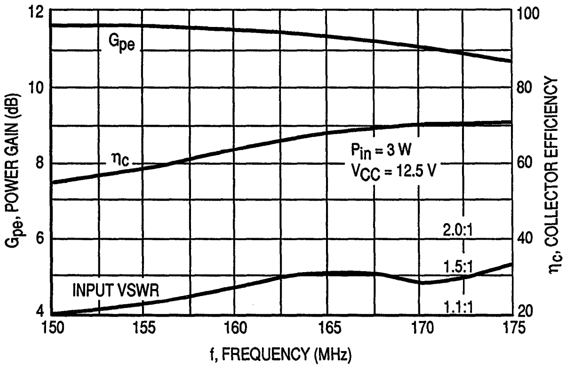
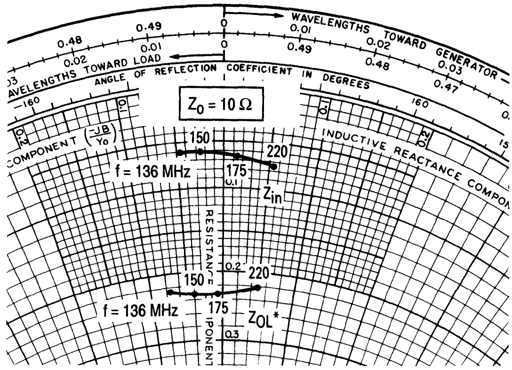


Figure 8. Typical Performance in a Broadband Circuit



V_{CC} = 12.5 Vdc, P_{out} = 30 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	0.60 – j0.48	2.22 – j0.74
150	0.63 – j0.26	2.30 – j0.40
175	0.62 + j0.13	2.35 – j0.04
220	0.73 + j0.57	2.20 + j0.43

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 9. Series Equivalent Input and Output Impedance

2

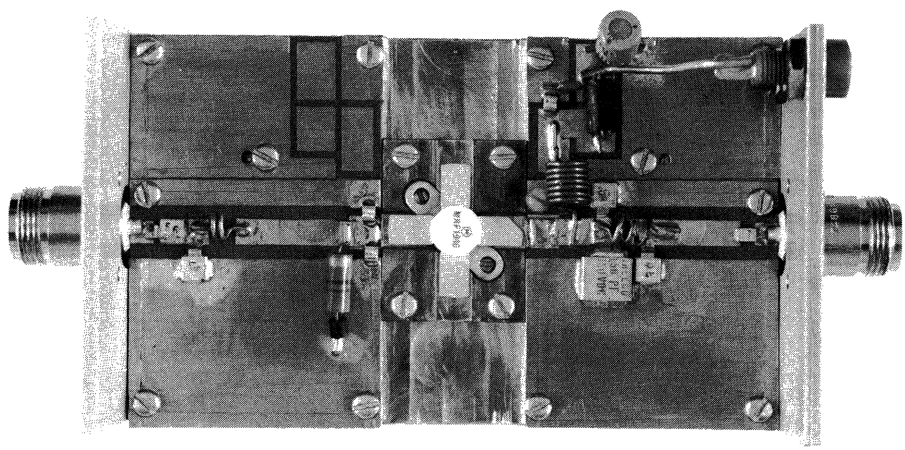


Figure 10. Broadband Test Circuit

MRF2000-5L

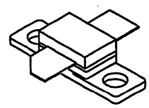
Motorola Preferred Device

The RF Line
Microwave Linear Power Transistor

Designed primarily for wideband, large signal output and driver amplifier stages in the 1.0 to 2.0 GHz frequency range.

- Designed for Class A or AB, Common Emitter Power Amplifiers
- Specified 20 Volt, 2.0 GHz Characteristic Power Gain — 7.0 dB Min @ 5.0 W P_{out}
- Built In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**7.0–8.0 dB GAIN
USABLE 1.0–2.0 GHz
5.0 WATTS
MICROWAVE
LINEAR POWER TRANSISTOR**



CASE 360A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case, DC	$R_{\theta JC}$ (DC)	12	°C/W
Thermal Resistance, Junction to Case, RF	$R_{\theta JC}$ (RF)	10	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_C = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ohms)	$V_{(BR)CER}$	35	—	—	Vdc
Collector Cutoff Current (V_{CE} = 20 V, I_E = 0)	I_{CBO}	—	—	1.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 A, V_{CE} = 5.0 V)	h_{FE}	20	35	100	—

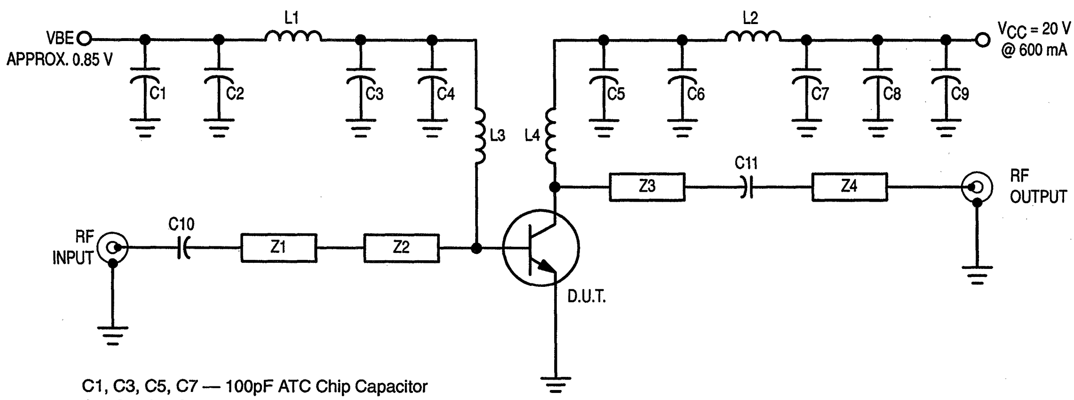
(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 5.0 W, f = 2.0 GHz, I_C = 600 mA)	G_{PE1}	7.0	—	—	dB
Collector Efficiency (V_{CE} = 20 V, P_{out} = 5.0 W, f = 2.0 GHz, I_C = 600 mA)	η_c	39	—	—	%
Typical Class AB Performance					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 6.0 W, f = 2.0 GHz, I_{CQ} = 100 mA)	G_{PE2}	—	5.0	—	dB
Collector Efficiency (V_{CE} = 20 V, P_o = 6.0 W, f = 2.0 GHz, I_{CQ} = 100 mA)	η_c	—	48	—	%
Common-Emitter Amplifier Power Gain (V_{CE} = 24 V, P_{out} = 8.0 W, f = 2.0 GHz, I_{CQ} = 100 mA)	G_{PE3}	—	6.5	—	dB
Collector Efficiency (V_{CE} = 24 V, P_o = 8.0 W, f = 2 .0 GHz, I_{CQ} = 100 mA)	η_c	—	50	—	%

2



C1, C3, C5, C7 — 100pF ATC Chip Capacitor
C2, C4, C6, C8 — 0.1 µF Chip Capacitor
C9 — 50 µF Electrolytic Capacitor
C10, C11 — 28 pF ATC Chip Capacitor
L1, L2, L3 — 3 Turns, 0.125″ Dia., 18 AWG
L4 — Loop, 18 AWG
Z1, Z4 — 50r Line
Z2 — 0.55″ wide x 0.4″ Long Microstrip
Z3 — 0.4″ wide x 1.125″ Long Microstrip
PC Board — 0.018″ Teflon® Fiberglass, Cu Clad ϵ_r = 2.55

Figure 1. 2.0 GHz Test Circuit

TYPICAL CHARACTERISTICS

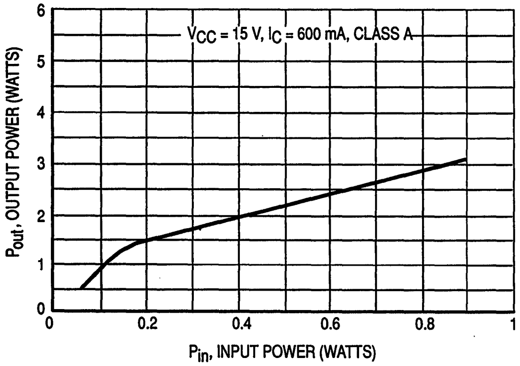


Figure 2. Output Power versus Input Power

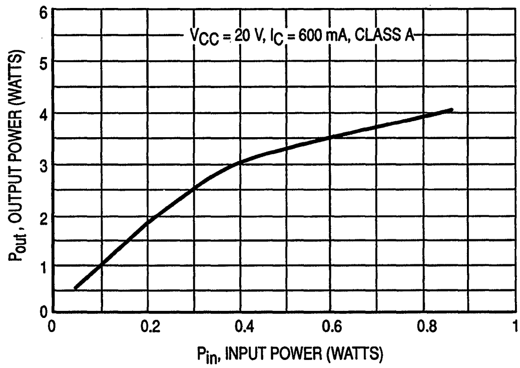


Figure 3. Output Power versus Input Power

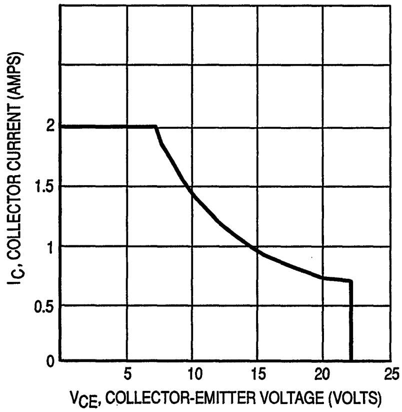
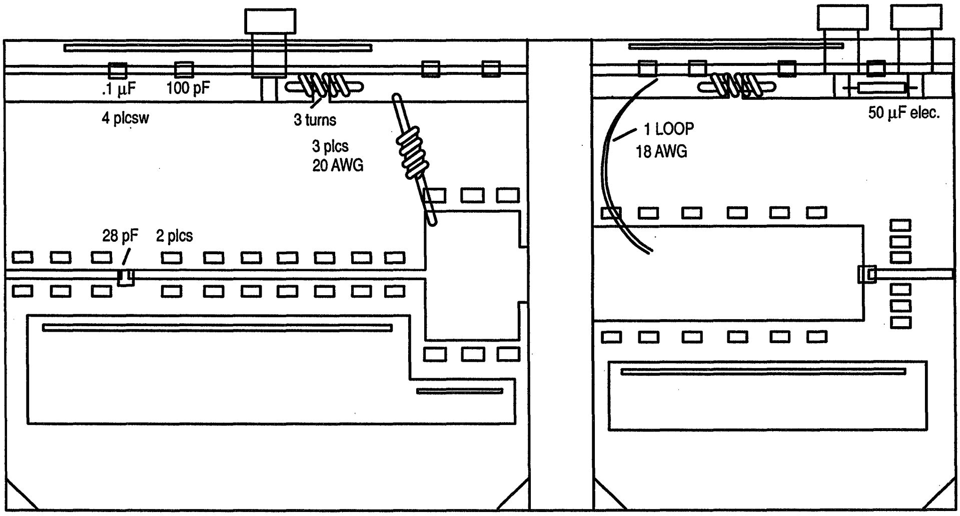


Figure 4. DC Safe Operating Area

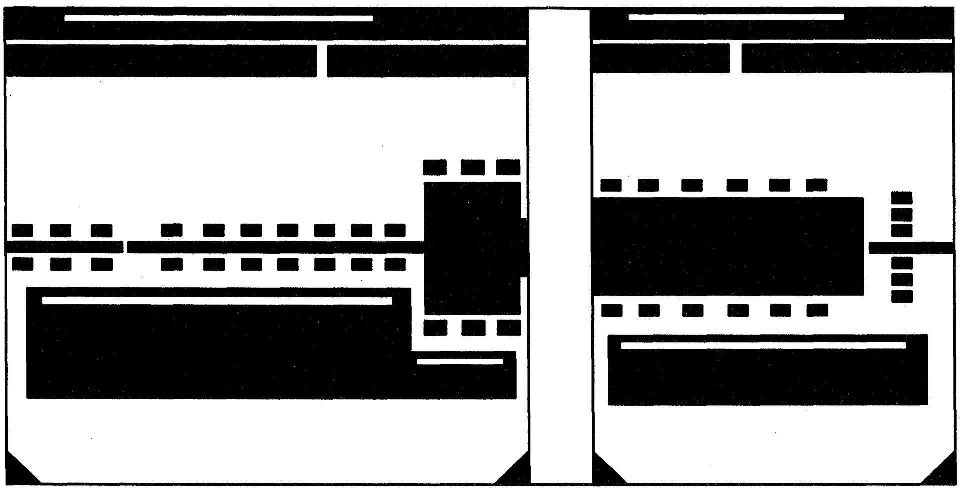
V_{CE} (Vdc)	I_C (mA)	f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
20	500	500	0.94	174	1.95	− 17	0.02	− 63	0.57	− 170
		600	0.94	172	1.65	− 40	0.02	− 78	0.59	− 170
		700	0.94	171	1.44	− 62	0.02	− 93	0.61	− 170
		800	0.93	170	1.28	− 84	0.02	− 107	0.63	− 170
		900	0.92	169	1.16	− 107	0.02	− 121	0.65	− 169
		1000	0.92	169	1.06	− 129	0.02	− 138	0.67	− 169
		1100	0.91	169	0.99	− 152	0.02	− 155	0.70	− 169
		1200	0.90	169	0.93	− 175	0.02	− 172	0.73	− 169
		1300	0.89	169	0.88	161	0.02	171	0.75	− 169
		1400	0.88	169	0.84	137	0.02	154	0.76	− 170
		1500	0.88	170	0.81	113	0.02	141	0.80	− 170
		1600	0.87	171	0.77	88	0.01	130	0.81	− 171
		1700	0.87	172	0.73	62	0.01	120	0.83	− 173
		1800	0.81	172	0.69	34	0.01	123	0.83	− 174
		1900	0.89	173	0.64	8	0.01	125	0.83	− 176
		2000	0.90	173	0.58	− 18	0.01	127	0.83	− 177
		2100	0.92	173	0.52	− 46	0.01	122	0.82	− 178
		2200	0.93	172	0.48	− 73	0.02	110	0.81	− 179
		2300	0.94	170	0.42	− 99	0.02	95	0.80	− 179
		2400	0.95	167	0.37	− 126	0.02	82	0.80	− 180
		2500	0.95	165	0.32	− 153	0.03	67	0.81	− 180

Table 1. Common Emitter S-Parameters



NOTE: MATERIAL IS TEFLON FIBERGLASS, 20 MIL THICK, Cu CLAD 2 SIDES

Figure 5. Test Circuit Board — Component Placement



(Not to Scale)

Figure 6. Test Circuit Photomaster

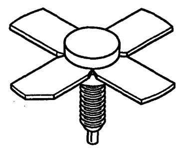
MRF2628

The RF Line
NPN Silicon
RF Power Transistor

. . . designed for 12.5 volt VHF large-signal power amplifiers in commercial and industrial FM equipment.

- Compact .280 Stud Package
- Specified 12.5 V, 175 MHz Performance
  Output Power = 15 Watts
  Power Gain = 12 dB Min
  Efficiency = 60% Min
- Characterized to 220 MHz
- Load Mismatch Capability at High Line and Overdrive

**15 W 136–220 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 244, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	40 0.23	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W

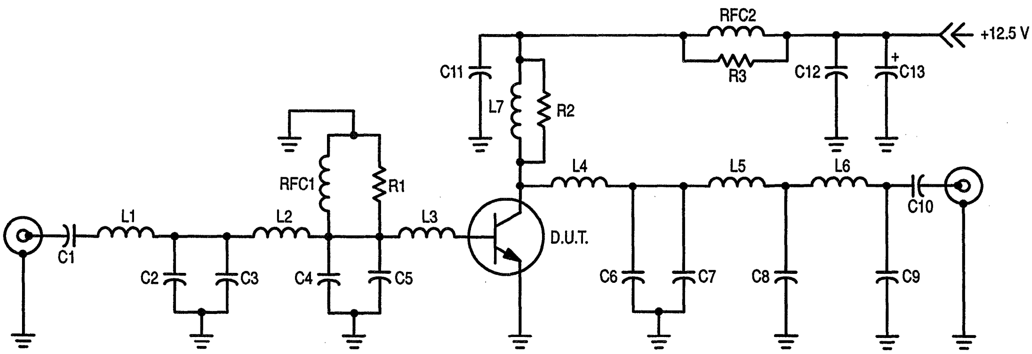
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	33	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 175 MHz)	G_{pe}	12	13	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 175 MHz)	η	60	68	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 2.0 dB Overdrive, Load VSWR = 30:1)	ψ	No Degradation in Output Power			



C1, C10, C11 — 1000 pF Ceramic Chip Capacitor
C2 — 27 pF Mini Unelco Capacitor
C3 — 33 pF Mini Unelco Capacitor
C4, C5 — 270 pF Unelco J101 Capacitor
C6, C9 — 18 pF Mini Unelco Capacitor
C7 — 91 pF Mini Unelco Capacitor
C8 — 68 pF Mini Unelco Capacitor
C12 — 0.1 µF Monolythic Capacitor
C13 — 100 µF, 15 V Electrolytic
L1 — 3 Turns #18 AWG, 3/16″ ID
L2 — 1-1/8″ #18 AWG into 1/2″ High Loop
L3 — Copper Pad, 0.200 x 0.400 x 0.060
L4 — 1/4″ #18 AWG into 1/8″ High Loop
L5 — 3 Turns #24 AWG Enameled, 3/32″ ID
L6 — 6 Turns #24 AWG Enameled, 3/32″ ID
L7 — 1-3/4″ #16 AWG into 3/4″ High Loop
R1 — 12 Ω, 1/2 W Carbon
R2 — 100 Ω, 1.0 W Carbon
R3 — 10 Ω, 1.0 W Carbon
RFC1 — 0.15 µH Molded Choke
RFC2 — Ferroxcube Choke, VK200-4B

Figure 1. Broadband Circuit

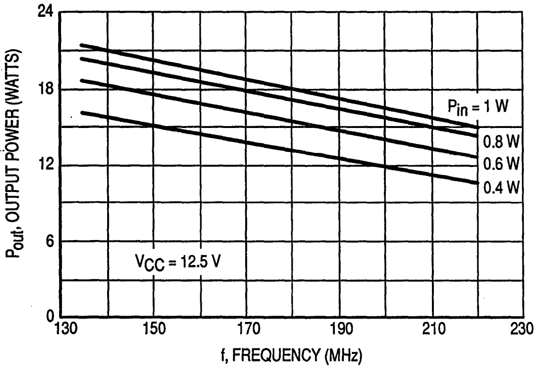


Figure 2. Output Power versus Frequency

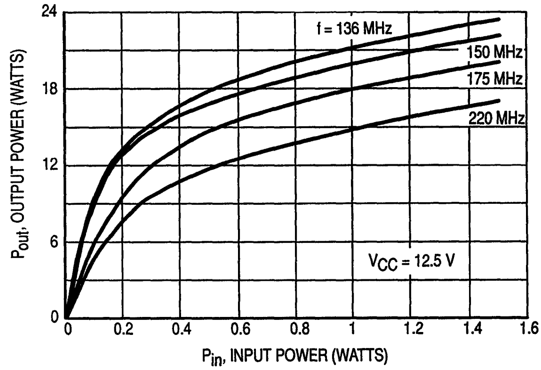


Figure 3. Output Power versus Input Power

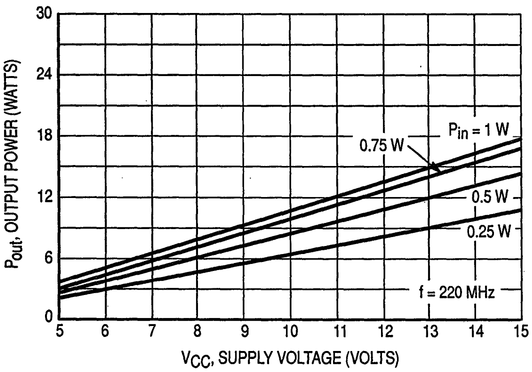


Figure 4. Output Power versus Supply Voltage

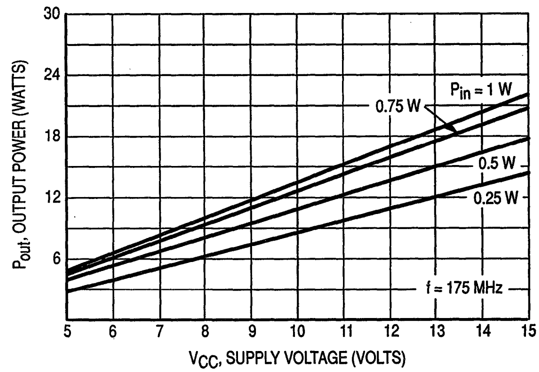


Figure 5. Output Power versus Supply Voltage

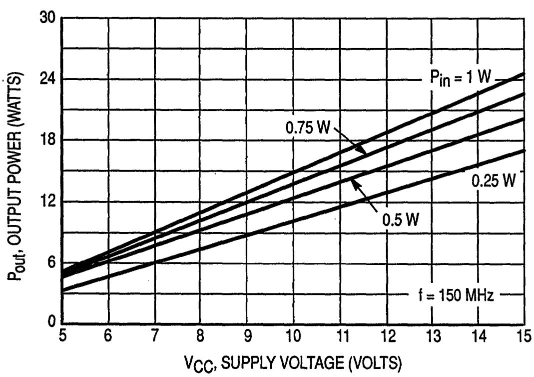


Figure 6. Output Power versus Supply Voltage

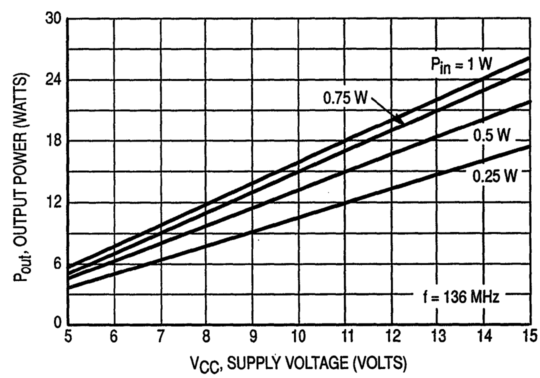


Figure 7. Output Power versus Supply Voltage

2

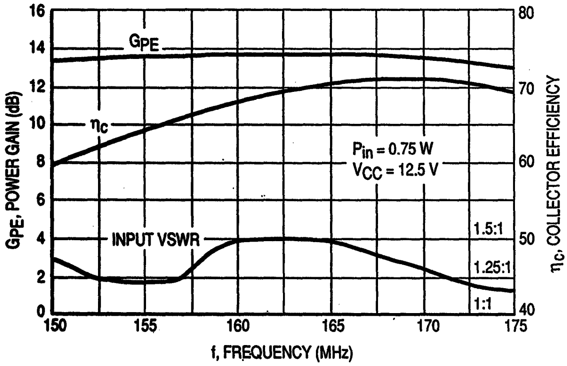
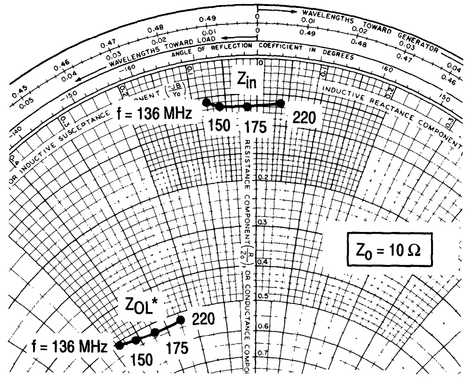


Figure 8. Typical Performance in a Broadband Circuit



V_{CC} = 12.5 V
P_{out} = 15 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	0.59 - j0.80	5.07 - j4.76
150	0.68 - j0.61	5.23 - j4.14
175	0.69 - j0.17	5.26 - j3.46
220	0.62 + j0.39	5.25 - j2.46

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 9. Series Equivalent Impedance

2

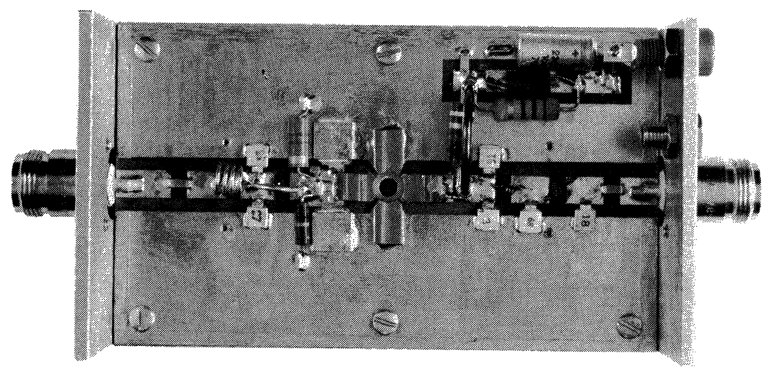


Figure 10. Broadband Test Circuit

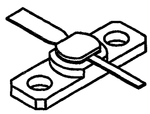
MRF3094
MRF3095
MRF3096

The RF Line
Microwave Linear Power Transistors

. . . designed for Class A, common emitter linear power amplifiers.

- Specified 20 Volt, 1.6 GHz Characteristics
  Output Power — 0.5, 0.8, 1.6 Watts
  Gain — 9.0–12 dB
- Low Parasitic Microwave Stripline Package
- Gold Metallization Diffused Emitter Ballast Resistors

9.0–12 dB
1.55–1.65 GHz
0.5–1.6 WATTS
MICROWAVE LINEAR
POWER TRANSISTORS



CASE 328F, STYLE 1

MAXIMUM RATINGS

Rating		Symbol	Limit	Unit
Collector Base Voltage		V_{CES}	50	Vdc
Emitter Base Voltage		V_{EBO}	3.5	Vdc
Collector Emitter Voltage		V_{CEO}	22	Vdc
Collector Current	MRF3094, 3095 MRF3096	I_C	0.4 0.8	Adc
Operating Junction Temperature		T_J	200	°C
Storage Temperature		T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
		MRF3094	MRF3095	MRF3096	
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	35	22	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mA) (I_C = 20 mA)	 MRF3094, MRF3095 MRF3096	$V_{(BR)CES}$	50	—	—	Vdc
Emitter Base Breakdown Voltage (I_E = 0.25 mA) (I_E = 0.5 mA)	 MRF3094, MRF3095 MRF3096	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Base Breakdown Voltage (I_C = 1.0 mA) (I_C = 2.0 mA)	 MRF3094, MRF3095 MRF3096	$V_{(BR)CBO}$	45	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA) (I_C = 20 mA)	 MRF3094, MRF3095 MRF3096	$V_{(BR)CEO}$	22	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V)	 MRF3094, MRF3095 MRF3096	I_{CBO}	 — —	 — —	 0.25 0.5	mAdc
ON CHARACTERISTICS						
DC Current Gain (V_{CE} = 5.0 V, I_C = 100 mA) (V_{CE} = 5.0 V, I_C = 200 mA)	 MRF3094, MRF3095 MRF3096	h_{fe}	20	35	120	—
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, f = 1.0 MHz)	 MRF3094, MRF3095 MRF3096	C_{ob}	 — —	 — —	 3.5 5.5	pF
Functional Tests (V_{CE} = 20 V, I_C = 120 mA, P_o = 0.5 W, f = 1.6 GHz) (V_{CE} = 20 V, I_C = 120 mA, P_o = 0.8 W, f = 1.6 GHz) (V_{CE} = 20 V, I_C = 240 mA, P_o = 1.6 W, f = 1.6 GHz)	 MRF3094 MRF3095 MRF3096	G_{PE}	 10.5 9.0 9.0	 11.5 10 9.5	 — — —	dB
Output Load Mismatch (V_{CE} = 20 V, I_C = 120 mA, P_o = 0.5 W, f = 1.6 GHz, Load VSWR = ∞:1) (V_{CE} = 20 V, I_C = 120 mA, P_o = 0.8 W, f = 1.6 GHz, Load VSWR = ∞:1) (V_{CE} = 20 V, I_C = 240 mA, P_o = 1.6 W, f = 1.6 GHz, Load VSWR = ∞:1)	 MRF3094 MRF3095 MRF3096	ψ	No degradation in output power			
Gain Linearity (V_{CE} = 20 V, I_C = 120 mA, f = 1.6 GHz, P_{o1} = 0.5 W, P_{o2} = 0.5 mW) (V_{CE} = 20 V, I_C = 120 mA, f = 1.6 GHz, P_{o1} = 0.8 W, P_{o2} = 0.8 mW) (V_{CE} = 20 V, I_C = 120 mA, f = 1.6 GHz, P_{o1} = 1.6 W, P_{o2} = 1.6 mW)	 MRF3094 MRF3095 MRF3096	L_G	 — — —	 — — —	 −0.2 to +1.0 −0.2 to +1.0 −0.2 to +1.0	dB

TYPICAL CHARACTERISTICS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
20	100	500	0.77	−177.9	6.16	83.7	0.36	31.9	0.32	−57.1
		600	0.78	176.7	5.20	77.2	0.38	32.2	0.30	−60.3
		700	0.78	171.8	4.48	71.1	0.40	33.4	0.29	−62.6
		800	0.78	167.4	3.90	66.3	0.41	35.0	0.29	−67.3
		900	0.79	163.3	3.46	61.2	0.42	36.6	0.28	−70.8
		1000	0.79	159.3	3.11	56.4	0.46	38.1	0.29	−74.5
		1100	0.80	155.7	2.81	52.0	0.48	39.2	0.29	−79.3
		1200	0.80	152.4	2.60	47.5	0.50	40.1	0.29	−83.3
		1300	0.80	149.3	2.40	43.5	0.53	40.7	0.30	−88.3
		1400	0.80	147.1	2.18	40.6	0.57	42.2	0.30	−93.3
		1500	0.81	143.6	2.06	34.3	0.59	41.0	0.30	−97.7
		1600	0.81	140.8	1.92	30.8	0.62	41.9	0.30	−103.4
		1700	0.82	137.9	1.81	27.9	0.66	42.5	0.31	−107.6
		1800	0.82	135.2	1.67	22.7	0.68	41.9	0.32	−112.7
		1900	0.83	132.7	1.61	19.4	0.71	41.9	0.33	−117.8
		2000	0.83	130.2	1.52	16.3	0.75	41.8	0.34	−121.3

Table 1. MRF3094 Common Emitter S-Parameters

MRF3094

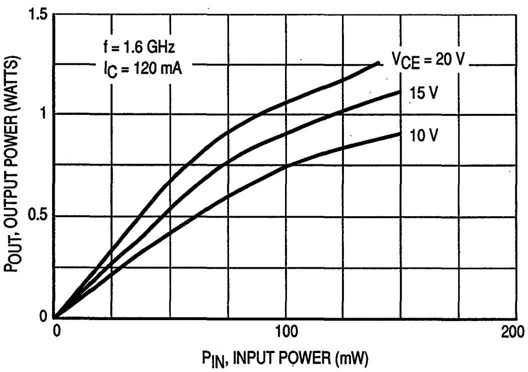


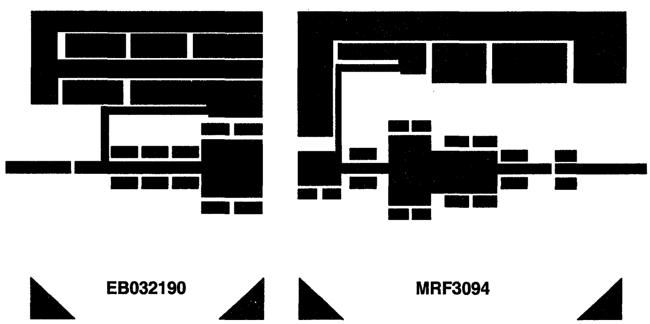
Figure 1. Output Power versus Input Power

f GHz	Z_{IN} Ohms		Z_{OL}* Ohms	
	R	jx	R	jx
1.55	5.9	11.9	10.2	0.23
1.60	5.8	11.3	11.3	−2.4
1.65	5.6	10.6	12.4	−6.0

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and power.

Figure 2. Series Equivalent Input and Output Impedance

2



(Not to Scale)

NOTE: Material is Teflon Fiberglass, 18 mils thick, Cu clad 2 sides

Figure 3. Photomaster of Test Circuit

TYPICAL CHARACTERISTICS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
20	120	500	0.83	−177.4	4.90	71.1	0.29	21.7	0.36	−81.6
		600	0.83	179.6	4.08	64.4	0.30	22.1	0.37	−87.2
		700	0.83	176.9	3.48	59.3	0.31	23.6	0.39	−92.3
		800	0.83	175.0	3.20	52.8	0.34	23.2	0.42	−96.4
		900	0.82	171.6	2.70	48.6	0.33	25.0	0.43	−103.2
		1000	0.82	169.5	2.49	42.3	0.36	24.9	0.46	−107.6
		1100	0.83	167.4	2.26	37.0	0.38	25.2	0.48	−112.5
		1200	0.80	164.3	2.10	29.4	0.39	22.1	0.51	−117.7
		1300	0.81	162.2	1.87	27.9	0.41	25.9	0.54	−121.6
		1400	0.81	160.1	1.77	21.7	0.44	24.4	0.57	−125.3
		1500	0.80	157.8	1.63	15.2	0.45	22.4	0.58	−129.3
		1600	0.80	155.2	1.46	11.1	0.46	22.6	0.61	−131.7
		1700	0.80	152.3	1.42	9.6	0.48	23.9	0.66	−133.9
		1800	0.78	148.5	1.36	2.5	0.53	21.6	0.66	−136.6
		1900	0.77	144.5	1.25	−3.1	0.54	19.7	0.66	−139.3
		2000	0.78	141.0	1.17	−5.6	0.58	20.3	0.67	−141.9

Table 2. MRF3095 Common Emitter S-Parameters

MRF3095

2

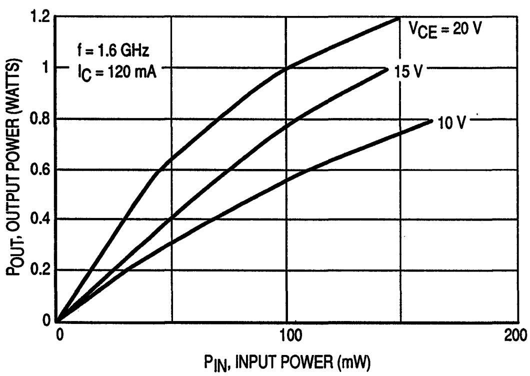
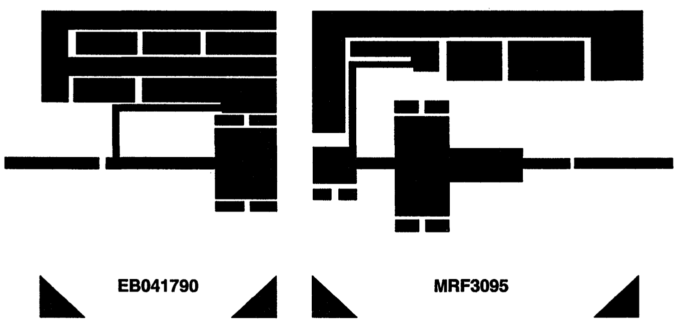


Figure 4. Output Power versus Input Power

f GHz	Z_{IN} Ohms		Z_{OL}* Ohms	
	R	jx	R	jx
1.55	5.2	10.6	8.6	−22.4
1.60	4.9	9.9	9.6	−25.4
1.65	4.8	9.3	10.3	−27.8

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and power.

Figure 5. Series Equivalent Input and Output Impedance



(Not to Scale)

NOTE: Material is Teflon Fiberglass, 18 mils thick, Cu clad 2 sides

Figure 6. Photomaster of Test Circuit

TYPICAL CHARACTERISTICS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
20	230	500	0.87	174.6	3.66	65.2	0.31	17.2	0.34	−133.0
		600	0.88	171.1	3.01	57.8	0.32	18.9	0.36	−137.4
		700	0.88	167.9	2.56	50.9	0.33	20.5	0.39	−140.0
		800	0.88	165.2	2.21	44.9	0.36	21.9	0.41	−143.0
		900	0.88	161.8	1.92	37.8	0.37	23.6	0.44	−145.8
		1000	0.88	158.9	1.72	32.7	0.39	24.7	0.48	−149.2
		1100	0.88	156.0	1.54	26.3	0.40	25.8	0.50	−152.4
		1200	0.88	153.2	1.39	20.5	0.42	25.7	0.53	−156.2
		1300	0.88	150.6	1.28	15.2	0.44	26.5	0.56	−158.6
		1400	0.88	147.9	1.15	10.3	0.50	27.2	0.58	−162.9
		1500	0.88	146.2	1.06	4.8	0.50	26.6	0.60	−166.1
		1600	0.88	143.2	0.98	−1.0	0.52	26.4	0.64	−170.4
		1700	0.89	140.9	0.90	−4.2	0.54	27.3	0.65	−173.3
		1800	0.88	138.5	0.84	−10.5	0.58	25.4	0.67	−175.9
		1900	0.88	136.0	0.79	−15.2	0.59	24.2	0.67	179.1
		2000	0.88	133.6	0.73	−16.6	0.64	26.2	0.69	178.6

Table 3. MRF3096 Common Emitter S-Parameters

MRF3096

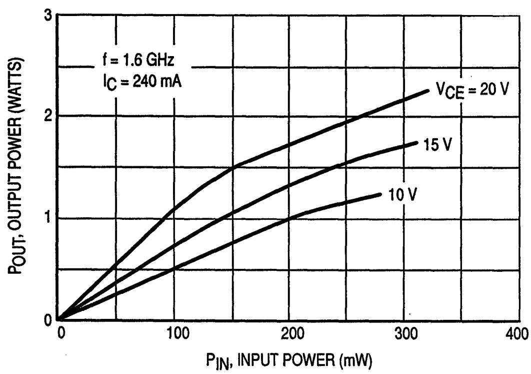
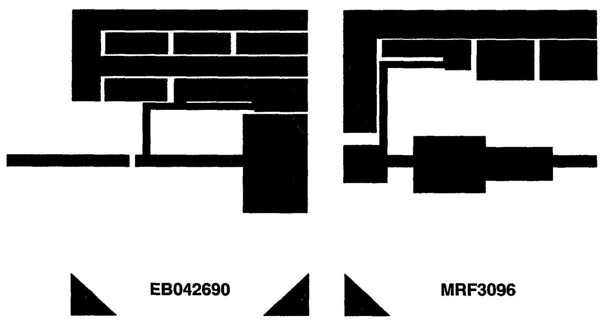


Figure 7. Output Power versus Input Power

f GHz	Z_{IN} Ohms		Z_{OL}* Ohms	
	R	jx	R	jx
1.55	2.9	6.1	8.2	−12.0
1.60	3.0	5.2	8.5	−12.8
1.65	2.7	4.6	8.9	−14.3

Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and power.

Figure 8. Series Equivalent Input and Output Impedance



(Not to Scale)

NOTE: Material is Teflon Fiberglass, 18 mils thick, Cu clad 2 sides

Figure 9. Photomaster of Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF3104
MRF3105
MRF3106

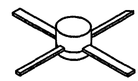
8.0–12 dB GAIN
1.55–1.65 GHz
MICROWAVE LINEAR
POWER TRANSISTORS

The RF Line
Microwave Linear Power Transistors

- Designed for Class A, Common Emitter Linear Power Amplifiers.
- Specified 20 Volt, 1.6 GHz Characteristics:

	MRF3104	MRF3105	MRF3106
Output Power	0.5 W	0.8 W	1.6 W
Power Gain	10.5 dB	9 dB	8 dB

- Low Parasitic Microwave Stripline Package
- Gold Metalization for Improved Reliability
- Diffused Ballast Resistors



CASE 305A, STYLE 1
(.204″ PILL)

2

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Emitter Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current MRF3104, MRF3105 MRF3106	I_C	0.4 0.8	Adc
Operating Junction Temperature	T_j	200	°C
Storage Temperature	T_{stg}	−65 to +125	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case, DC MRF3104 MRF3105 MRF3106	$R_{\theta JC}$ (DC)	40 35 22	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	BV_{CEO}	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	BV_{CES}	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	BV_{CBO}	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	BV_{EBO}	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0) MRF3104, MRF3105 MRF3106	I_{CBO}	— —	— —	0.25 0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (V_{CE} = 5.0 V, I_C = 100 mA)	h_{FE}	20	35	120	—

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	MRF3104 MRF3105 MRF3106	C_{OB}	— — —	— — —	1.5 3.5 5.5	pF
FUNCTIONAL TESTS						
Common Emitter Amplifier Gain (V_{CE} = 20 V, I_C = 120 mA, P_{out} = 0.5 W, f = 1.6 GHz) (V_{CE} = 20 V, I_C = 120 mA, P_{out} = 0.8 W, f = 1.6 GHz) (V_{CE} = 20 V, I_C = 240 mA, P_{out} = 1.6 W, f = 1.6 GHz)	 MRF3104 MRF3105 MRF3106	Gpe	 10.5 9.0 8.0	 11.5 10.0 9.0	 — — —	dB
Output Load Mismatch (V_{CE} = 20 V, I_C = 120 mA, P_{out} = 0.5 W, f = 1.6 GHz) (V_{CE} = 20 V, I_C = 120 mA, P_{out} = 0.8 W, f = 1.6 GHz) (V_{CE} = 20 V, I_C = 240 mA, P_{out} = 1.6 W, f = 1.6 GHz)	 MRF3104 MRF3105 MRF3106	No Degradation in Output Power				 — — —
Gain Linearity (V_{CE} = 20 V, I_C = 120 mA, f = 1.6 GHz, P_{o1} = 0.5 W, P_{o2} = 0.5 mW) (V_{CE} = 20 V, I_C = 120 mA, f = 1.6 GHz, P_{o1} = 0.8 W, P_{o2} = 0.5 mW) (V_{CE} = 20 V, I_C = 240 mA, f = 1.6 GHz, P_{o1} = 1.6 W, P_{o2} = 0.5 mW)	 MRF3104 MRF3105 MRF3106	L_G	 — — —	 — — —	 –0.2 to 1.0 –0.2 to 1.0 –0.2 to 1.0	dB

2

TYPICAL CHARACTERISTICS

MRF3104

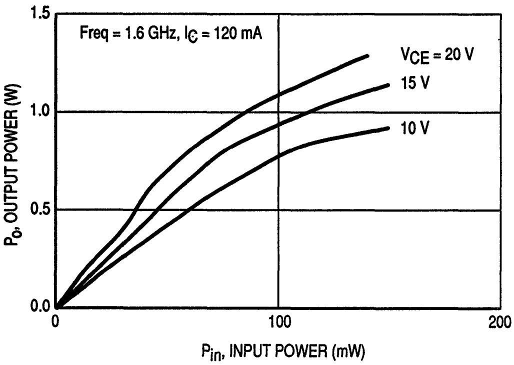


Figure 1. Output Power versus Input Power

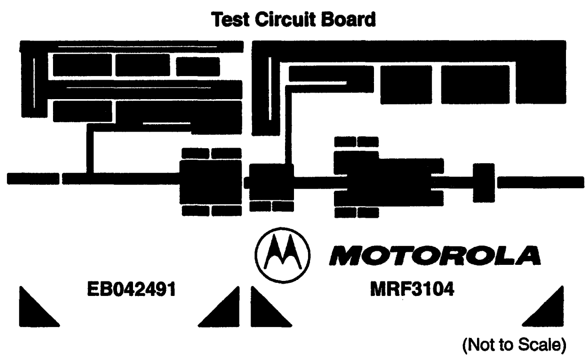


Figure 2. Photomaster for Test Circuit

V_{CE} (V)	I_C (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	Deg	Mag	Deg	Mag	Deg	Mag	Deg
20	120	1550	0.75	123	1.97	21	0.08	44	0.31	–113
		1575	0.76	123	1.93	20	0.09	44	0.32	–115
		1600	0.76	122	1.91	19	0.09	43	0.32	–116
		1625	0.76	122	1.80	18	0.09	42	0.32	–117
		1650	0.76	121	1.85	17	0.09	42	0.33	–119

Table 1. Common Emitter S-Parameters

TYPICAL CHARACTERISTICS — continued

MRF3105

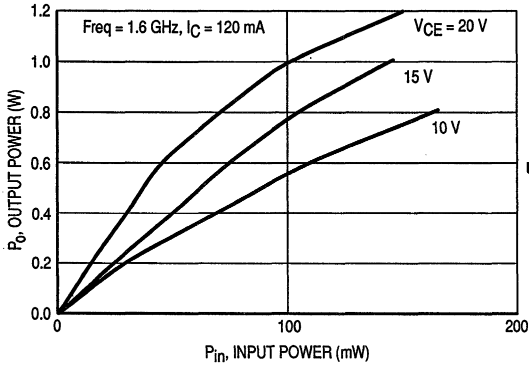


Figure 3. Output Power versus Input Power

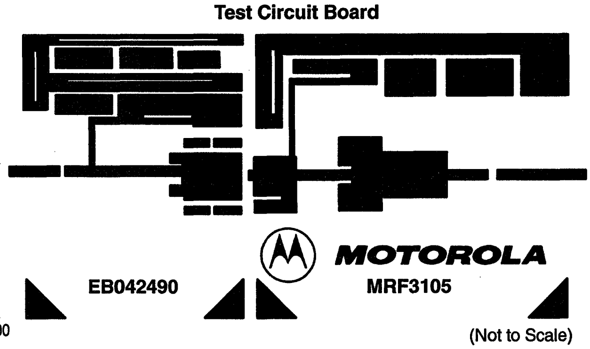


Figure 4. Photomaster for Test Circuit

V_{CE} (V)	I_C (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	Deg	Mag	Deg	Mag	Deg	Mag	Deg
20	120	1550	0.75	139	1.49	19	0.09	44	0.42	–124
		1575	0.75	138	1.46	18	0.10	43	0.42	–126
		1600	0.75	137	1.44	17	0.10	43	0.43	–127
		1625	0.75	137	1.42	15	0.10	43	0.43	–129
		1650	0.75	136	1.39	14	0.10	42	0.44	–130

Table 2. Common Emitter S-Parameters

MRF3106

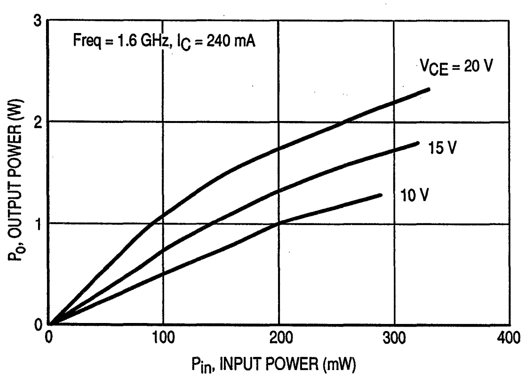


Figure 5. Output Power versus Input Power

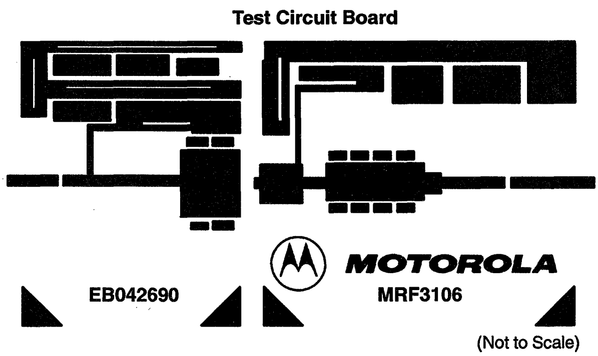


Figure 6. Photomaster for Test Circuit

V_{CE} (V)	I_C (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	Deg	Mag	Deg	Mag	Deg	Mag	Deg
20	240	1550	0.97	145	0.78	11	0.20	–130	0.56	169
		1575	0.97	143	0.78	10	0.17	–104	0.56	168
		1600	0.96	142	0.77	9	0.16	–104	0.56	166
		1625	0.96	140	0.76	8	0.14	–104	0.56	165
		1650	0.95	139	0.75	7	0.12	–104	0.56	164

Table 3. Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

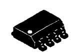
MRF3866

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for amplifier and oscillator applications in industrial equipment construted with surface mount components.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

SURFACE MOUNT RF TRANSISTOR NPN SILICON



CASE 751, STYLE 1 (SO-8)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	55	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current — Continuous	I_C	0.4	A
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Storage Temperature	T_{stg}	150	°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0$ mA, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	55	—	—	V
Collector-Base Sustaining Voltage ($I_E = 5.0$ mA)	$V_{CEO(sus)}$	30	—	—	V
Collector-Base Breakdown Voltage ($I_C = 0.1$ mA)	$V_{(BR)CBO}$	55	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA)	$V_{(BR)EBO}$	3.5	—	—	V
Collector Cutoff Current ($V_{CE} = 28$ V)	I_{CEO}	—	—	20	µA
Collector Cutoff Current ($V_{CE} = 55$ V, $V_{BE} = -1.5$ V Reverse)	I_{CEX}	—	—	100	µA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.36$ A, $V_{CE} = 5.0$ V) ($I_C = 0.05$ A, $V_{CE} = 5.0$ V)	h_{FE}	 5.0 10	 — —	 — 200	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mA, $I_B = 20$ mA)	$V_{CE(sat)}$	—	—	1.0	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mA, $V_{CE} = 15$ V, f = 200 MHz)	f_T	500	800	—	MHz
Output Capacitance ($V_{CB} = 30$ V, f = 1.0 MHz)	C_{obo}	—	—	3.0	pF

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			S_{11}	∠ϕ	S_{21}	∠ϕ	S_{12}	∠ϕ	S_{22}	∠ϕ
15	50	100	0.67	−166	13.75	92	0.016	44	0.32	−27
		200	0.69	−176	6.93	81	0.024	53	0.30	−24
		300	0.70	177	4.57	73	0.032	57	0.32	−31
		400	0.71	172	3.38	67	0.042	59	0.34	−37
		500	0.72	168	2.66	61	0.049	59	0.37	−45
		600	0.72	164	2.17	54	0.056	61	0.40	−53
		700	0.72	160	1.85	49	0.061	63	0.43	−60
		800	0.72	155	1.61	44	0.068	65	0.47	−66
		900	0.71	151	1.40	39	0.075	64	0.50	−73
		1000	0.70	146	1.25	34	0.084	68	0.53	−79

Table 1. Common Emitter S-Parameters

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

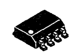
MRF4427

The RF Line
NPN Silicon
RF Low Power Transistor

. . . designed for amplifier, frequency multiplier, or oscillator applications in industrial equipment constructed with surface mount components. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Low Voltage Version of MRF3866
- Tape and Reel Packaging Options Available

**1.0 W, 175 MHz
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



**CASE 751, STYLE 1
SORF
(SO-8)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.5 12.5	Watts mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

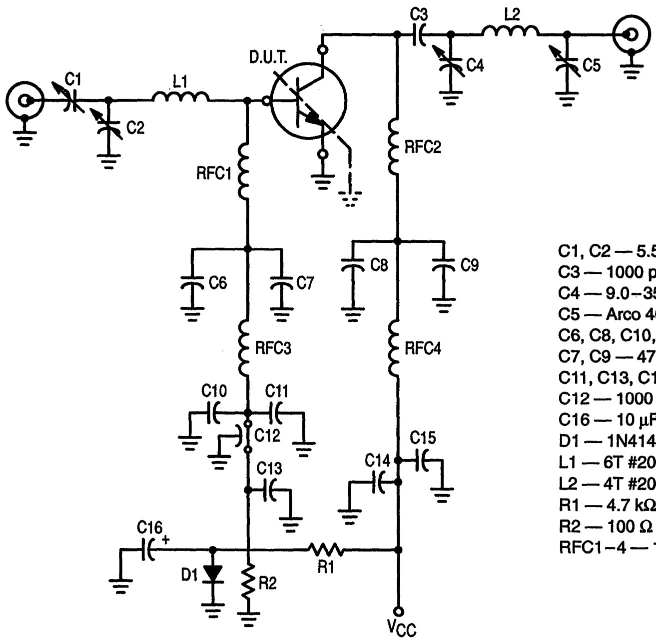
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	—	—	20	μAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		10	50	200	
(I_C = 360 mAdc, V_{CE} = 5.0 Vdc)		5.0	—	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	—	60	—	mVdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 12 Vdc, f = 200 MHz)	f_T	—	1600	—	MHz
Output Capacitance (V_{CB} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	3.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (P_{in} = 15 mW, V_{CC} = 12 Vdc, f = 175 MHz)	G_{pe}	—	18	—	dB
Collector Efficiency (Figure 1) (P_{out} = 1.0 W, V_{CC} = 12 Vdc, f = 175 MHz)	η	—	60	—	%
Insertion Gain (V_{CE} = 12 Vdc, I_C = 50 mA, f = 200 MHz)	$\|S_{21}\|^2$	14	16.4	—	dB

2



C1, C2 — 5.5–18 pF Erie ceramic trimmer
C3 — 1000 pF ATC 100 mil chip cap.
C4 — 9.0–35 pF Erie ceramic trimmer
C5 — Arco 405 mica trimmer
C6, C8, C10, C14 — 0.1 µF Erie blue cap.
C7, C9 — 470 pF ATC 100 mil chip cap.
C11, C13, C15 — 1.0 µF Erie blue cap, non-polar
C12 — 1000 pF feedthru
C16 — 10 µF, 25 V tantalum
D1 — 1N4148 or 1N914
L1 — 6T #20 AWG on #2 drill bit
L2 — 4T #20 AWG on #4 drill bit
R1 — 4.7 kΩ 1/8 watt carbon
R2 — 100 Ω 1/8 watt carbon
RFC1–4 — 10 µH molded choke

Figure 1. 175 MHz RF Amplifier Circuit for Functional Tests

TYPICAL CHARACTERISTICS

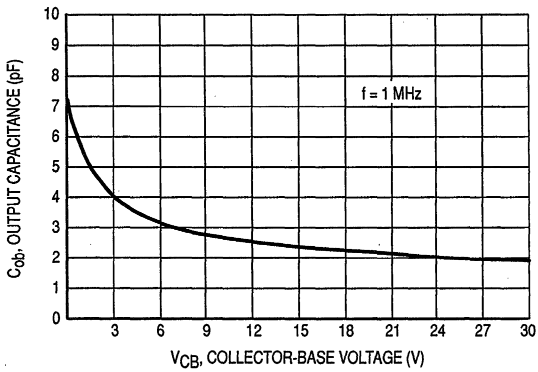


Figure 2. Collector-Base Capacitance versus Voltage

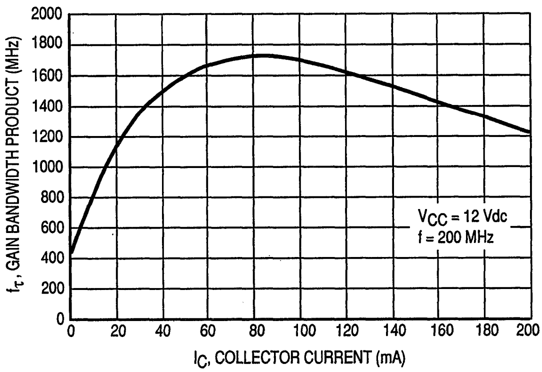


Figure 3. Gain Bandwidth Product versus Collector Current

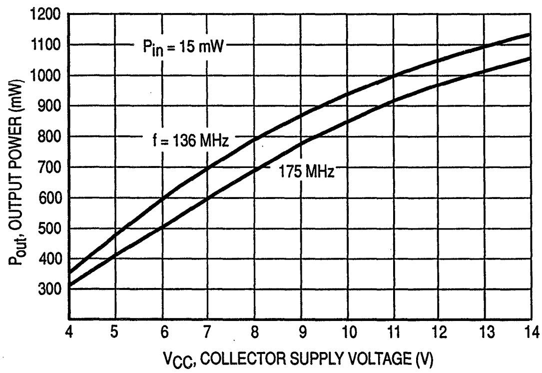


Figure 4. Output Power versus Voltage

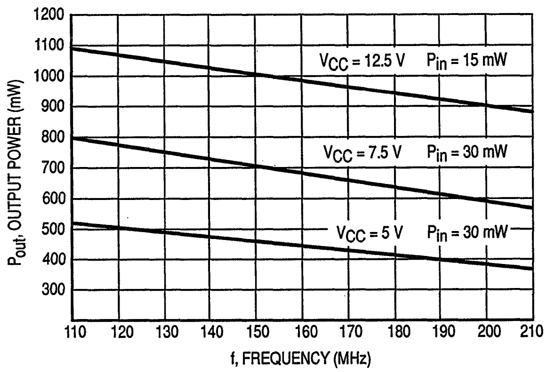


Figure 5. Output Power versus Frequency

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
5.0	5.0	50	0.82	−104	10.3	125	0.05	38	0.68	−34
		100	0.83	−141	6.1	103	0.06	26	0.51	−40
		200	0.81	−165	3.2	85	0.07	21	0.44	−46
		500	0.80	169	1.3	57	0.07	32	0.49	−73
		750	0.79	156	0.8	42	0.08	49	0.58	−94
		1000	0.76	144	0.6	30	0.11	61	0.65	−114
	25	50	0.77	−151	19	107	0.02	36	0.35	−75
		100	0.79	−168	9.9	94	0.03	37	0.21	−87
		200	0.79	−180	5.0	82	0.04	49	0.16	−97
		500	0.78	163	2.0	61	0.07	62	0.22	−106
		750	0.77	152	1.3	48	0.10	66	0.31	−115
		1000	0.74	141	0.9	36	0.13	66	0.37	−127
	50	50	0.77	−163	21.1	103	0.02	37	0.29	−98
		100	0.79	−174	10.7	92	0.02	50	0.19	−119
		200	0.79	177	5.4	82	0.03	62	0.16	−134
		500	0.78	162	2.2	62	0.07	67	0.20	−131
		750	0.77	151	1.4	50	0.10	69	0.26	−130
		1000	0.74	140	1.1	38	0.13	67	0.32	−139
12	5.0	50	0.83	−97	11	129	0.04	46	0.75	−26
		100	0.82	−135	6.8	107	0.05	29	0.61	−29
		200	0.81	−162	3.6	88	0.05	24	0.54	−34
		500	0.79	171	1.4	60	0.06	37	0.47	−57
		750	0.78	157	0.9	44	0.07	55	0.64	−76
		1000	0.75	145	0.7	32	0.09	68	0.70	−95
	25	50	0.73	−143	22.1	111	0.02	38	0.43	−52
		100	0.76	−164	11.7	96	0.02	39	0.29	−52
		200	0.77	−177	6.0	84	0.03	48	0.22	−53
		500	0.76	165	2.4	63	0.06	64	0.27	−69
		750	0.75	154	1.6	49	0.08	67	0.35	−84
		1000	0.72	143	1.1	38	0.11	69	0.42	−98
	50	50	0.73	−156	25.5	106	0.02	41	0.32	−67
		100	0.75	−171	13.1	94	0.02	49	0.20	−69
		200	0.76	59	6.6	83	0.03	60	0.15	−71
		500	0.75	164	2.6	64	0.06	69	0.20	−81
		750	0.74	153	1.7	51	0.09	70	0.27	−92
		1000	0.71	142	1.2	38	0.12	70	0.34	−104

Table 1. Common Emitter S-Parameters

Freq. (MHz)	P_{in} (mW)	P_{out} (mW)	V_{CC} (Volts)	Z_{in} (Ohms)	Z_{OL}* (Ohms)
136	15	—	12.5	6.2 − j11.6	—
175	15	—	12.5	4.6 − j10.4	—
136	—	1000	12.5	—	47.7 + j41.7
175	—	1000	12.5	—	47.4 − j34.4
136	30	—	7.5	5.65 − j12.6	—
175	30	—	7.5	6.25 − j12.2	—
136	—	650	7.5	—	27.6 − j32.4
175	—	650	7.5	—	27.9 − j27.6
136	30	—	5.0	6.1 − j13.3	—
175	30	—	5.0	5.9 − j12.22	—
136	—	450	5.0	—	24.8 − j22.8
175	—	450	5.0	—	28.3 − j29.3

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a gain output power, voltage and frequency.

Table 2. Series Input/Output Impedances

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF5003

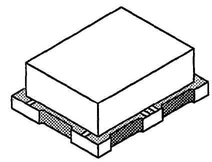
Motorola Preferred Device

The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

3.0 W, 7.5 V, 512 MHz
N-CHANNEL
BROADBAND
RF POWER FET

The MRF5003 is designed for broadband commercial and industrial applications at frequencies to 520 MHz. The high gain and broadband performance of this device makes it ideal for large-signal, common source amplifier applications in 7.5 Volt and 12.5 Volt mobile, portable, and base station FM equipment.

- Guaranteed Performance at 512 MHz, 7.5 Volts
  - Output Power = 3.0 Watts
  - Power Gain = 9.5 dB
  - Efficiency = 45%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- S-Parameter Characterization at High Bias Levels
- Excellent Thermal Stability
- All Gold Metal for Ultra Reliability
- Capable of Handling 20:1 VSWR, @ 15.5 Vdc, 512 MHz, 2.0 dB Overdrive
- Suitable for 12.5 Volt Applications
- True Surface Mount Package
- Available in Tape and Reel



CASE 430, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	36	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 Meg Ohm)	V_{DGR}	36	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current — Continuous	I_D	1.7	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	12.5 0.07	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	14	°C/W

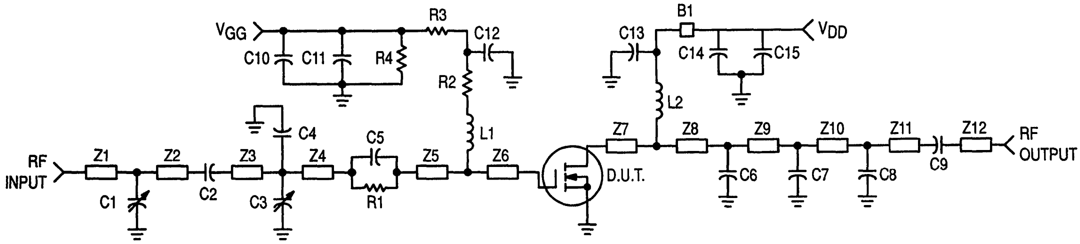
NOTE — <u>**CAUTION**</u> — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 2.5 mAdc)	$V_{(BR)DSS}$	36	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	1.0	µAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 5.0 mAdc)	$V_{GS(th)}$	1.25	2.25	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 0.5 Adc)	$V_{DS(on)}$	—	—	0.375	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 0.5 Adc)	g_{fs}	0.6	—	—	mho
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	16.5	—	pF
Output Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	37	—	pF
Reverse Transfer Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	3.5	4.4	5.4	pF
FUNCTIONAL TESTS (In Motorola Test Fixture)					
Common-Source Amplifier Power Gain (V_{DD} = 7.5 Vdc, P_{out} = 3.0 W, I_{DQ} = 50 mA) f = 512 MHz	G_{ps}	9.5	10.5	—	dB
f = 175 MHz		—	15	—	
Drain Efficiency (V_{DD} = 7.5 Vdc, P_{out} = 3.0 W, I_{DQ} = 50 mA) f = 512 MHz	h	45	50	—	%
f = 175 MHz		—	55	—	

2



C1, C3, C7, C8	0 to 20 pF Johanson	Z1	0.350″ x 0.08″ Microstrip
C2, C9	56 pF, 100 mil Chip	Z2	0.190″ x 0.08″ Microstrip
C4	10 pF, 100 mil Chip	Z3	0.800″ x 0.08″ Microstrip
C5	47 pF, Miniature Clamped Mica Capacitor	Z4	0.380″ x 0.08″ Microstrip
C6	22 pF, 100 mil Chip	Z5	0.150″ x 0.08″ Microstrip
C10, C15	10 µF, 50 V, Electrolytic	Z6	0.285″ x 0.08″ Microstrip
C11, C14	0.1 µF, Capacitor	Z7	0.340″ x 0.08″ Microstrip
C12	1000 pF, 100 mil Chip	Z8	0.070″ x 0.08″ Microstrip
C13	160 pF, 100 mil Chip	Z9	0.280″ x 0.08″ Microstrip
R1	35 Ω, 1/4 W Carbon	Z10	0.840″ x 0.08″ Microstrip
R2	30 Ω, 0.1 W Chip	Z11	0.180″ x 0.08″ Microstrip
R3	1.0 kΩ, 0.1 W Chip	Z12	0.600″ x 0.08″ Microstrip
R4	1.0 MΩ, 1/4 W Carbon	L1	7 Turns, 0.076″ ID, #24 AWG Enamel
B1	Fair Rite Products Short Ferrite Bead (2743021446)	L2	5 Turns, 0.126″ ID, #20 AWG Enamel
Board — Glass Teflon®, 31 mils		Input/Output Connectors — Type N	

Note: Plated ceramic part locators (0.1″ x 0.15″) soldered onto Z6 and Z7.

Figure 1. 512 MHz Narrowband Test Circuit

2

TYPICAL CHARACTERISTICS

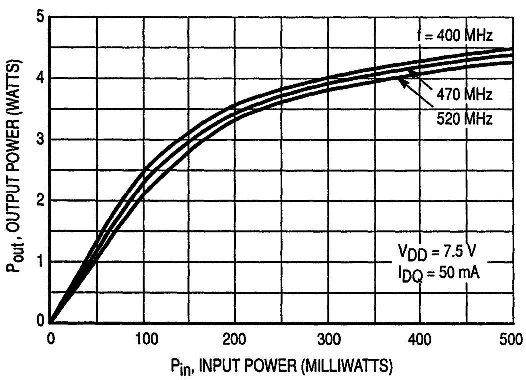


Figure 2. Output Power versus Input Power

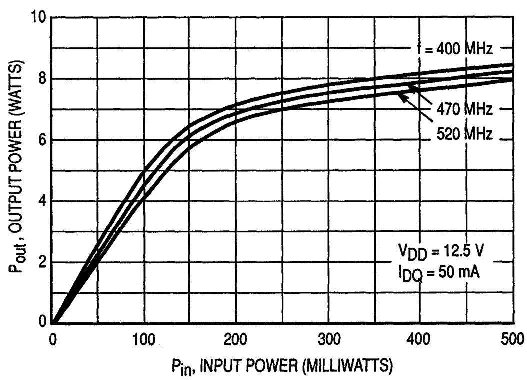


Figure 3. Output Power versus Input Power

TYPICAL CHARACTERISTICS

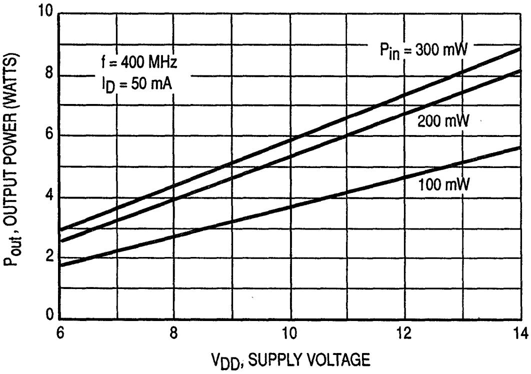


Figure 4. Output Power versus Supply Voltage

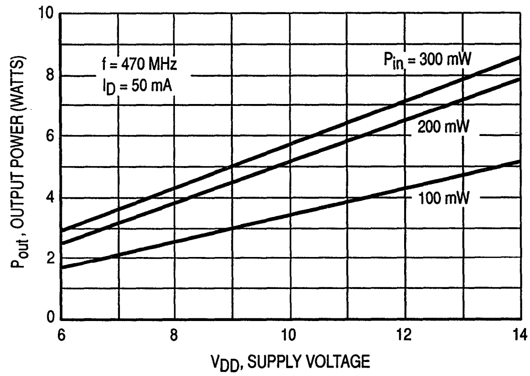


Figure 5. Output Power versus Supply Voltage

2

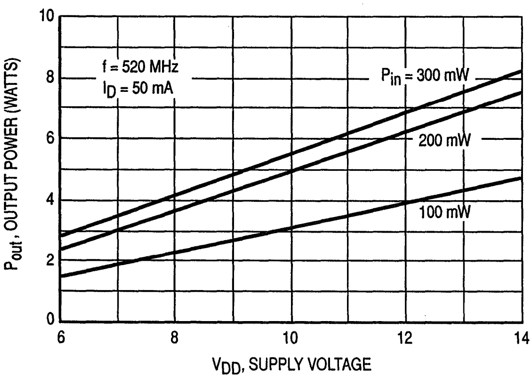


Figure 6. Output Power versus Supply Voltage

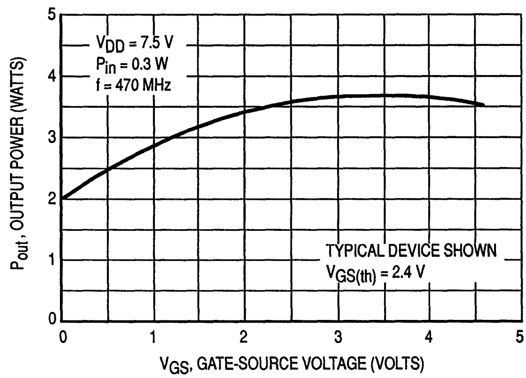


Figure 7. Output Power versus Gate Voltage

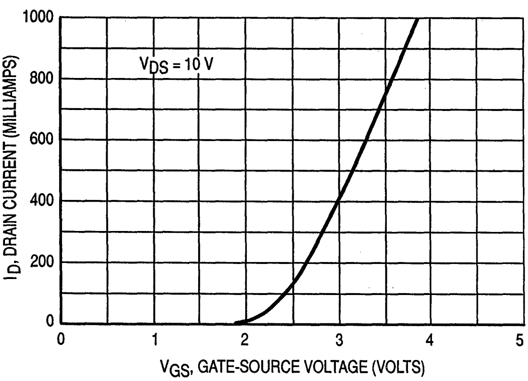


Figure 8. Drain Current versus Gate Voltage (Typical Device Shown)

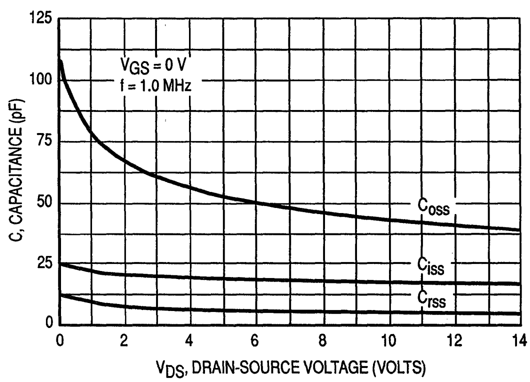


Figure 9. Capacitance versus Voltage

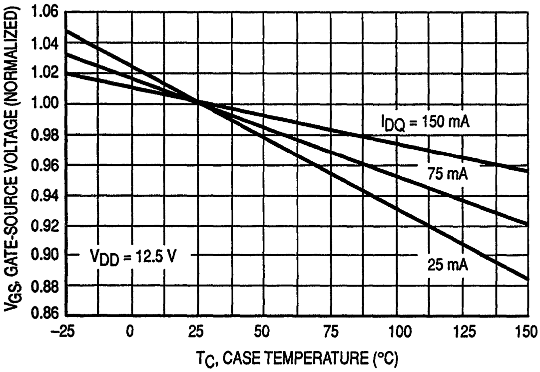


Figure 10. Gate-Source Voltage versus Case Temperature

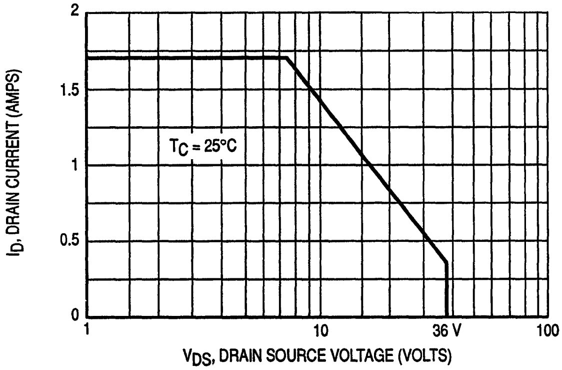
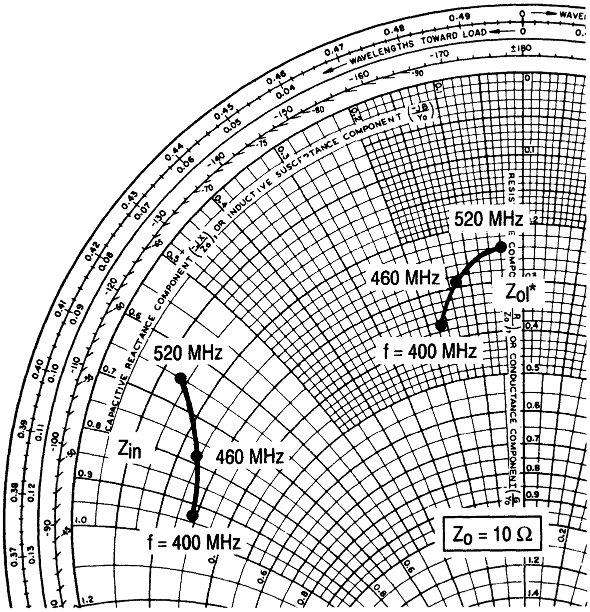


Figure 11. Maximum Rated Forward Biased Safe Operating Area



V_{DD} = 7.5 V I_{DQ} = 50 mA P_{out} = 3.0 W

f MHz	Z_{in} Ω	Z_{ol}* Ω
400	2.8 – j9.2	3.6 – j1.7
430	2.7 – j8.5	3.3 – j1.5
460	2.5 – j7.8	2.7 – j1.1
490	2.0 – j7.2	2.5 – j0.8
520	1.3 – j6.5	2.4 – j0.5

Z_{in} = Conjugate of source impedance with parallel 35 Ω resistor and 47 pF capacitor in series with gate

Z_{ol}* = Conjugate of the load impedance at given output power, voltage, frequency, and η_D > 50%

Note: Z_{ol}* was chosen based on tradeoffs between gain, drain efficiency, and device stability.

Figure 12. Series Equivalent Input and Output Impedance

Table 1. Common Source Scattering Parameters (V_{DS} = 10 V)

I_D = 50 mA

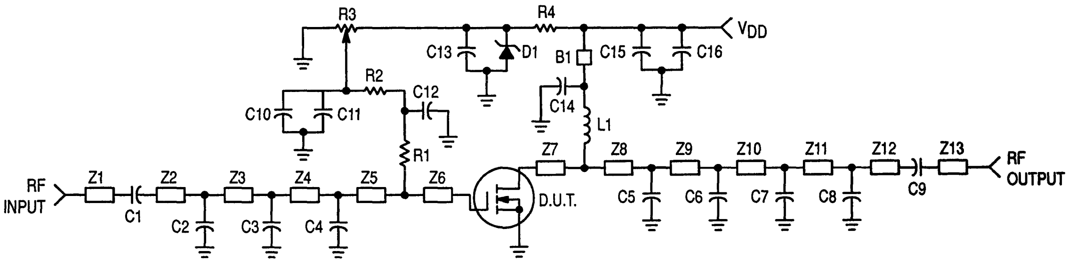
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
50	0.69	−90	10.8	117	0.07	29	0.74	−119
100	0.58	−120	6.0	96	0.08	10	0.78	−146
200	0.58	−139	3.0	75	0.08	−7	0.81	−161
300	0.64	−147	1.9	61	0.07	−16	0.84	−166
400	0.70	−152	1.3	50	0.06	−21	0.86	−169
500	0.75	−157	0.99	41	0.05	−24	0.88	−172
700	0.82	−165	0.61	28	0.03	−15	0.92	−176
850	0.86	−171	0.45	21	0.02	13	0.94	−179
1000	0.89	−176	0.34	16	0.02	47	0.95	178

I_D = 500 mA

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
50	0.76	−124	15.0	109	0.04	23	0.76	−151
100	0.72	−150	7.9	94	0.04	12	0.81	−165
200	0.72	−163	4.0	80	0.04	6	0.83	−172
300	0.73	−168	2.6	71	0.04	5	0.84	−175
400	0.75	−171	1.9	62	0.04	7	0.85	−176
500	0.77	−173	1.5	55	0.03	12	0.86	−178
700	0.81	−177	0.97	42	0.03	29	0.89	−180
850	0.84	−180	0.75	35	0.03	44	0.90	178
1000	0.86	177	0.60	29	0.04	55	0.92	176

I_D = 1.0 A

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
50	0.80	−125	14.6	110	0.04	23	0.75	−155
100	0.76	−150	7.8	95	0.04	10	0.81	−167
200	0.76	−164	3.9	81	0.04	1	0.83	−173
300	0.77	−169	2.6	71	0.04	−3	0.84	−175
400	0.79	−172	1.9	63	0.03	−5	0.85	−176
500	0.80	−174	1.4	56	0.03	−5	0.86	−177
700	0.83	−178	0.95	43	0.03	−1	0.88	−179
850	0.85	179	0.73	35	0.02	9	0.90	179
1000	0.87	177	0.58	28	0.02	22	0.91	178



C1, C9	100 pF 100 mil Chip
C2	16 pF, 100 mil Chip
C3	24 pF, 100 mil Chip
C4	68 pF, 100 mil Chip
C5	51 pF, 100 mil Chip
C6	39 pF, 100 mil Chip
C7	6.2 pF, 100 mil Chip
C8	9.1 pF, 100 mil Chip
C10, C15	39000 pF, 100 mil Chip
C11, C16	10 µF, 50 V Electrolytic
C12	10000 pF, 100 mil Chip
B1	Fair Rite Products Short Ferrite Bead (2743021446)
C13	0.1 µF, 100 mil Chip
C14	160 pF, 100 mil Chip
R1	43 Ω, 0.1 W Chip Resistor
R2	1000 Ω, 0.1 W Chip Resistor
R3	10 kΩ Potentiometer
R4	3000 Ω, 0.1 W Chip Resistor
L1	5 Turns, 0.126″ ID, #20 AWG Enamel
Z1 to Z13	See Photomaster
D1	1N4734 Motorola Zener

Board — G10, 1/32″

Input/Output Connectors — SMA

Figure 13. Schematic of Broadband Demonstration Amplifier

PERFORMANCE CHARACTERISTICS OF BROADBAND DEMONSTRATION AMPLIFIER

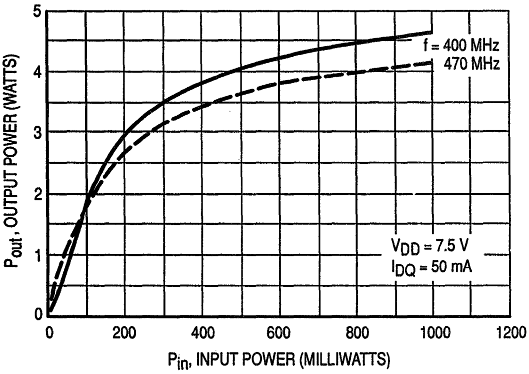


Figure 14. Output Power versus Input Power

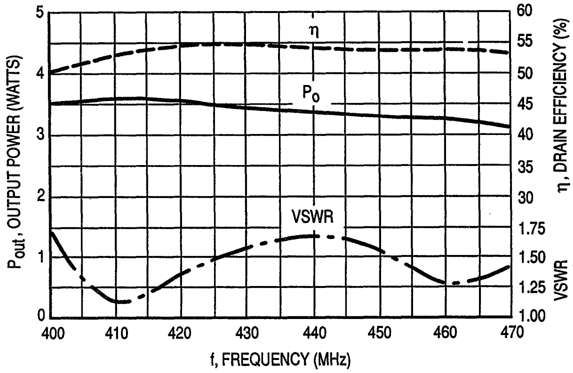


Figure 15. Output Power, Drain Efficiency and VSWR versus Frequency

2

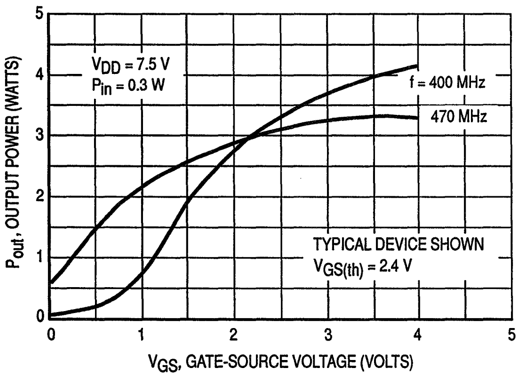
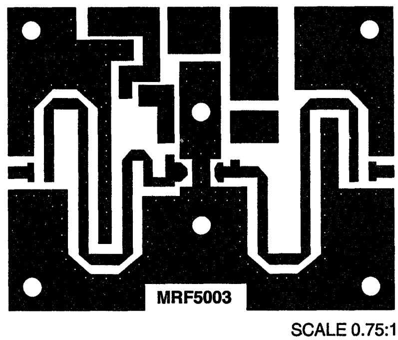


Figure 16. Output Power versus Gate Voltage



SCALE 0.75:1

Figure 17. Photomaster for 400–470 MHz Broadband Demonstration Amplifier

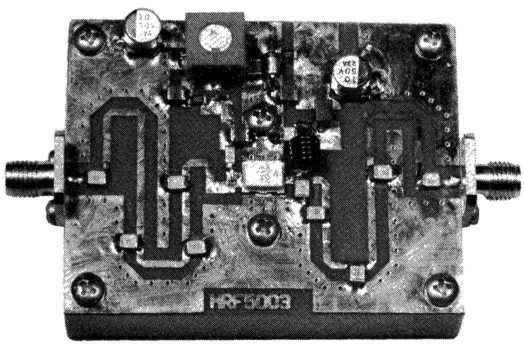


Figure 18. 512 MHz Broadband Test Circuit

DESIGN CONSIDERATIONS

The MRF5003 is a common-source, RF power, N-Channel enhancement mode, Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET). Motorola RF MOSFETs feature a vertical structure with a planar design. Motorola Application Note AN211A, "FETs in Theory and Practice", is suggested reading for those not familiar with the construction and characteristics of FETs.

This surface mount packaged device was designed primarily for VHF and UHF power amplifier applications. Manufacturability is improved by utilizing the tape and reel capability for fully automated pick and placement of parts.

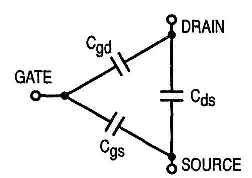
The major advantages of RF power MOSFETs include high gain, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage.

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between all three terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}). These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate.

In the latter case, the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

DRAIN CHARACTERISTICS

One critical figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $R_{DS(on)}$, occurs in the linear region of the output characteristic and is specified at a specific gate-source voltage and drain current. The drain-source voltage under these conditions is termed $V_{DS(on)}$. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient at high temperatures because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of $10^9\ \Omega$ — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage to the gate greater than the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended with appropriate RF decoupling.

Using a resistor to keep the gate-to-source impedance low also helps dampen transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

DC BIAS

Since the MRF5003 is an enhancement mode FET, drain current flows only when the gate is at a higher potential than the source. See Figure 8 for a typical plot of drain current versus gate voltage. RF power FETs operate optimally with a quiescent drain current (I_{DQ}), whose value is application dependent. The MRF5003 was characterized at $I_{DQ} = 50$ mA, which is the suggested value of bias current for typical applications. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF5003 may be controlled from its rated value down to zero (negative gain) with a low power dc control signal, thus facilitating applications such as manual gain control, ALC/AGC and modulation systems. Figure 16 is an example of output power variation with gate-source bias voltage. This characteristic is very dependent on frequency and load line.

MOUNTING

The specified maximum thermal resistance of 14°C/W assumes a majority of the 0.100″ x 0.200″ source contact on the back side of the package is in good contact with an appropriate heat sink. In the test fixture shown in Figure 1, the device is clamped directly to a copper pedestal. In the demonstration amplifier, the device was mounted on top of the G10 circuit board and heat removal was accomplished through several solder filled plated through holes. As with all RF power devices, the goal of the thermal design should be to minimize the temperature at the back side of the package.

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar transistors are suitable for the MRF5003. For examples see Motorola Application Note AN721, "Impedance Matching Networks Applied to RF Power Transistors". Both small-signal S-parameters and large-signal impedances are provided. While the S-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF power MOSFETs.

Since RF power MOSFETs are triode devices, they are not unilateral. This coupled with the very high gain of the MRF5003 yield a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Different stabilizing techniques were applied to the test fixture and demonstration amplifiers. The RF test fixture implements a parallel resistor and capacitor in series with the gate while the demonstration amplifier utilizes a 43 Ω shunt resistor from gate to ground. Both circuits have a load line selected for a higher efficiency, lower gain, and more stable operating region.

Two port stability analysis with the MRF5003 S-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A, "RF Small-Signal Design Using Two-Port Parameters", for a discussion of two port network theory and stability.

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

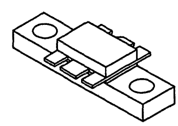
Advance Information

The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

MRF5015

Motorola Preferred Device

15 W, 512 MHz, 12.5 VOLTS
N-CHANNEL BROADBAND
RF POWER FET



CASE 319, STYLE 3

Designed for broadband commercial and industrial applications at frequencies to 520 MHz. The high gain and broadband performance of this device makes it ideal for large-signal, common source amplifier applications in 12.5 volt mobile, and base station FM equipment.

- Guaranteed Performance at 512 MHz, 12.5 Volts
  Output Power — 15 Watts
  Power Gain — 10 dB Min
  Efficiency — 50% Min
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- S-Parameter Characterization at High Bias Levels
- Excellent Thermal Stability
- All Gold Metal for Ultra Reliability
- Capable of Handling 20:1 VSWR, @ 15.5 Vdc, 512 MHz, 2 dB Overdrive

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Drain-Source Voltage	V_{DSS}	36	Vdc
Drain-Gate Voltage (RGS = 1 MΩ)	V_{DGR}	36	Vdc
Gate-Source Voltage	V_{GS}	± 20	Vdc
Drain Current — Continuous	I_D	6	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.29	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5 mAdc)	$V_{(BR)DSS}$	36	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	—	—	5	mAdc
Gate-Source Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	2	μAdc

(continued)

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

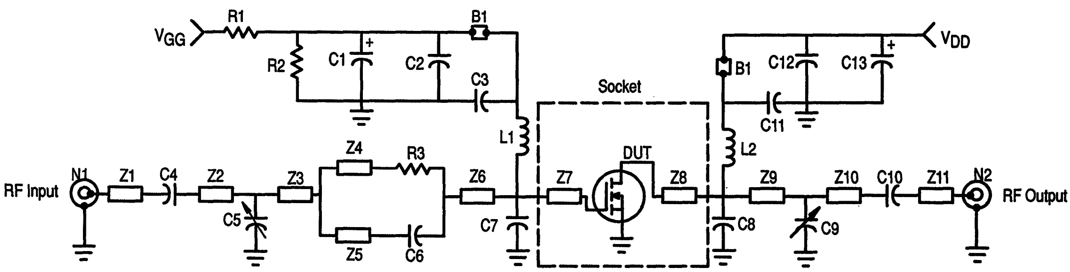
Preferred devices are Motorola recommended choices for future use and best overall value.

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

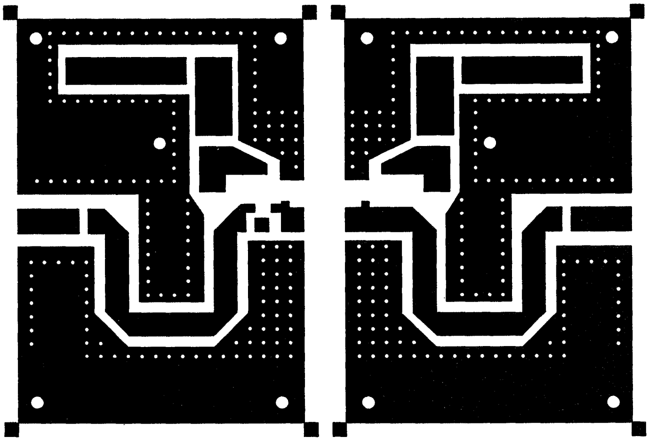
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 10 mAdc)	$V_{GS(th)}$	1.25	2.3	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1 Adc)	$V_{DS(on)}$	—	—	0.375	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 1 Adc)	g_{fs}	1.2	—	—	S
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	33	—	pF
Output Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	74	—	pF
Reverse Transfer Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1 MHz)	C_{rss}	7	8.8	10.8	pF
FUNCTIONAL TESTS (In Motorola Test Fixture)					
Common-Source Amplifier Power Gain (V_{DD} = 12.5 Vdc, P_{out} = 15 W, I_{DQ} = 100 mA) f = 512 MHz f = 175 MHz	G_{ps}	10 —	11.5 15	— —	dB
Drain Efficiency (V_{DD} = 12.5 Vdc, P_{out} = 15 W, I_{DQ} = 100 mA) f = 512 MHz f = 175 MHz	η	50 —	55 55	— —	%
Load Mismatch (V_{DD} = 15.5 Vdc, 2 dB Overdrive, f = 512 MHz, Load VSWR = 20:1, All Phase Angles at Frequency of Test)	ψ	No Degradation in Output Power			

2



B1, B2	Ferrite Bead, Fair Rite Products	R3	160 Ω, 0.1 W Chip
C1, C13	10 µF, 50 V, Electrolytic	Z1, Z11	Transmission Line*
C2, C12	0.1 µF, Chip Capacitor	Z2	Transmission Line*
C3, C4, C10, C11	120 pF, Chip Capacitor	Z3	Transmission Line*
C5, C9	0 to 20 pF, Trimmer Capacitor	Z4	Transmission Line*
C6	36 pF, Chip Capacitor	Z5	Transmission Line*
C7	43 pF, Chip Capacitor	Z6	Transmission Line*
C8	30 pF, Chip Capacitor	Z7, Z8	Transmission Line+
L1, L2	7 Turns, 24 AWG 0.116″ ID	Z9	Transmission Line*
N1, N2	Type N Flange Mount	Z10	Transmission Line*
R1	1 kΩ, 1/4 W, Carbon	Board	Glass Teflon® 0.060″
R2	470 kΩ, 1/4 W, Carbon		+ Part of Capacitor Mount Socket
			*See Photomaster

Figure 1. 512 MHz Narrowband Test Circuit Electrical Schematic



SCALE 0.75:1

Figure 2. Photomaster for 512 MHz Narrowband Test Fixture

2

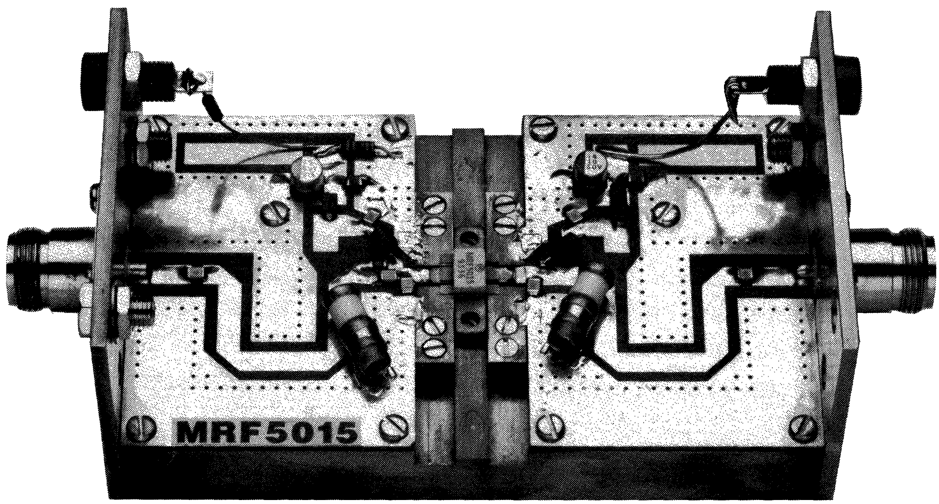


Figure 3. Test Fixture

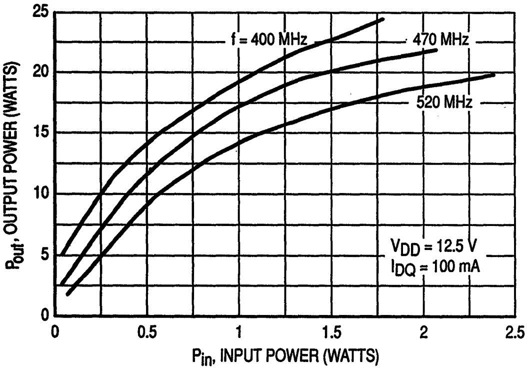


Figure 4. Output Power versus Input Power

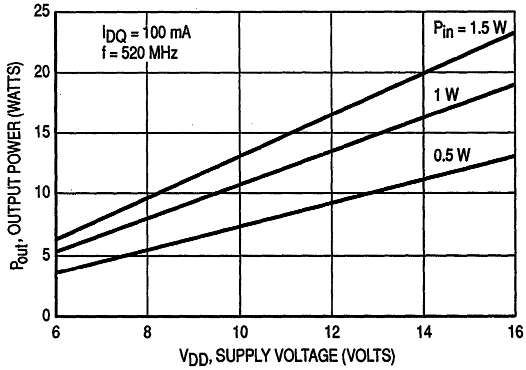


Figure 5. Output Power versus Supply Voltage

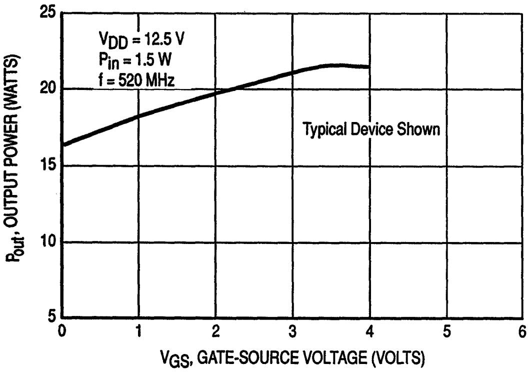


Figure 6. Output Power versus Gate Voltage

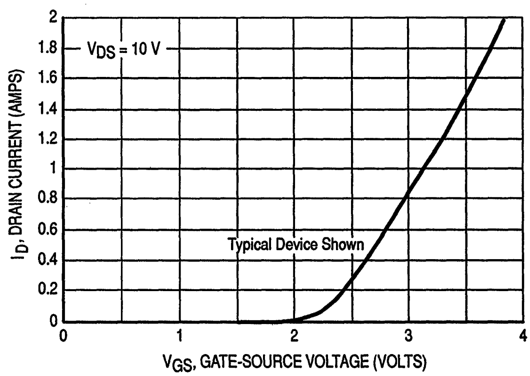


Figure 7. Drain Current versus Gate Voltage

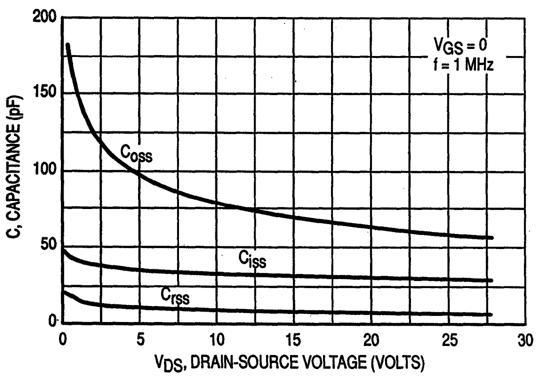


Figure 8. Capacitance versus Voltage

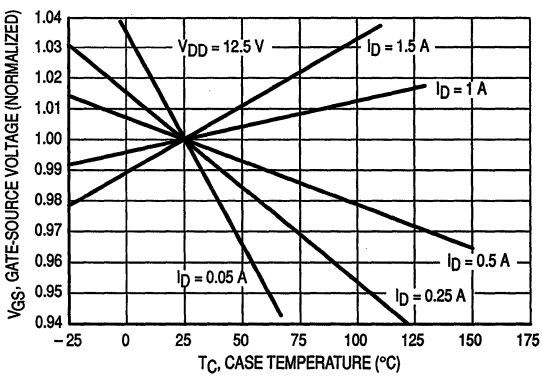


Figure 9. Gate-Source Voltage versus Case Temperature

TYPICAL CHARACTERISTICS

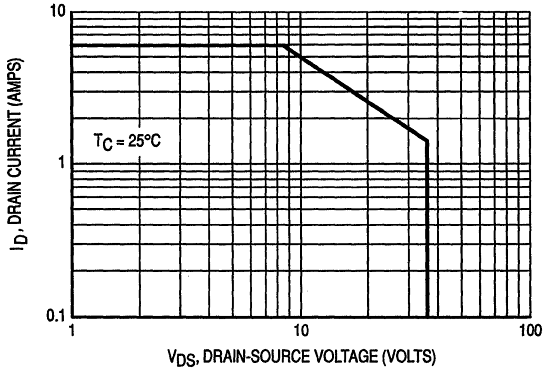
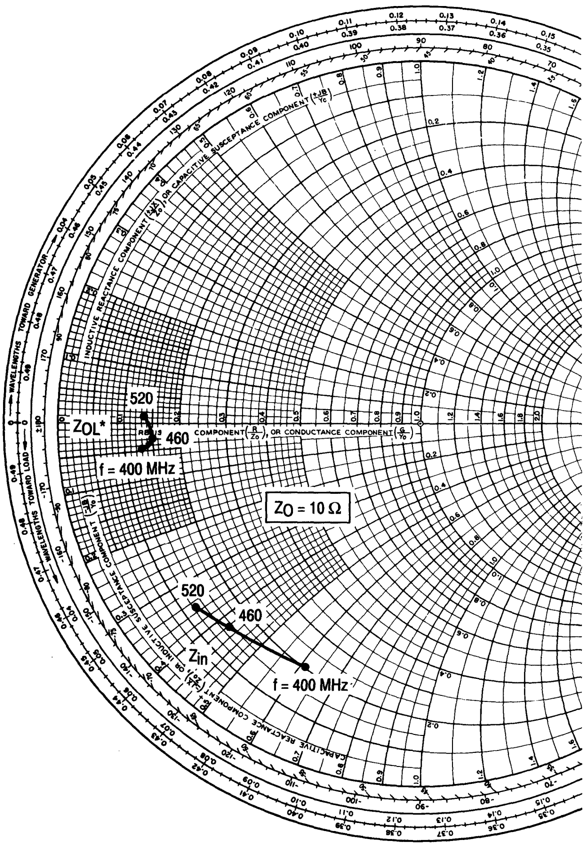


Figure 10. DC Safe Operating Area



V_{DD} = 12.5 V, I_{DQ} = 100 mA, P_{out} = 15 W

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
400	2.0 – j6.1	1.3 – j0.4
420	1.8 – j5.3	1.4 – j0.4
440	1.6 – j4.7	1.5 – j0.4
460	1.5 – j4.2	1.5 – j0.3
480	1.4 – j3.8	1.5 – j0.2
500	1.3 – j3.6	1.4 – j0.1
520	1.2 – j3.5	1.3 + j0.1

Z_{in} = Conjugate of source impedance with parallel 160 Ω resistor and 36 pF capacitor in series with gate.

Z_{OL}* = Conjugate of the load impedance at given output power, voltage and frequency that produces maximum gain.

Figure 11. Series Equivalent Input and Output Impedance

Table 1. Common Source Scattering Parameters (V_{DS} = 12.5 V)

I_D = 50 mA

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
50	0.63	-123	8	100	0.063	11	0.79	-149
100	0.62	-142	4	82	0.063	- 6	0.82	-162
200	0.70	-152	1.8	61	0.056	- 23	0.86	-169
300	0.78	-157	1.1	47	0.046	- 35	0.90	-171
400	0.84	-162	0.70	36	0.037	- 42	0.93	-174
500	0.88	-165	0.49	28	0.029	- 46	0.94	-175
700	0.93	-171	0.28	17	0.016	- 45	0.97	-179
850	0.95	-175	0.20	13	0.010	- 31	0.97	179
1000	0.96	-178	0.15	10	0.007	11	0.98	178

I_D = 100 mA

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
50	0.67	-136	9.1	99	0.047	10	0.82	-158
100	0.66	-153	4.6	84	0.048	-3	0.85	-168
200	0.71	-160	2.2	66	0.043	-17	0.87	-172
300	0.77	-163	1.3	54	0.037	- 26	0.90	-174
400	0.82	-165	0.89	44	0.031	- 32	0.92	-175
500	0.86	-168	0.64	36	0.025	- 35	0.94	-177
700	0.91	-173	0.37	25	0.015	- 30	0.96	-179
850	0.93	-176	0.27	20	0.010	-11	0.97	179
1000	0.95	-179	0.20	16	0.009	25	0.98	177

I_D = 500 mA

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
50	0.81	-150	11.1	98	0.027	11	0.85	-168
100	0.81	-164	5.6	86	0.027	2	0.87	-174
200	0.82	-170	2.7	73	0.025	- 5	0.88	-176
300	0.84	-173	1.7	63	0.023	- 9	0.89	-177
400	0.86	-174	1.2	55	0.020	- 9	0.91	-178
500	0.88	-175	0.92	47	0.018	- 7	0.92	-179
700	0.91	-178	0.57	35	0.013	7	0.94	180
850	0.93	180	0.43	29	0.013	26	0.95	178
1000	0.94	178	0.33	23	0.014	44	0.96	177

I_D = 2.5 A

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
50	0.86	-144	10.1	101	0.022	15	0.85	-171
100	0.85	-161	5.2	88	0.022	5	0.87	-175
200	0.86	-170	2.5	74	0.021	-1	0.89	-177
300	0.87	-173	1.6	64	0.019	- 4	0.90	-178
400	0.89	-175	1.1	55	0.017	- 2	0.91	-178
500	0.91	-176	0.84	48	0.015	2	0.93	-179
700	0.93	-179	0.52	37	0.013	22	0.95	179
850	0.94	179	0.39	30	0.014	39	0.96	178
1000	0.95	177	0.30	26	0.016	52	0.96	176

DESIGN CONSIDERATIONS

The MRF5015 is a common-source, RF power, N-Channel enhancement mode, Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET). Motorola RF MOSFETs feature a vertical structure with a planar design. Motorola Application Note AN211A, "FETs in Theory and Practice," is suggested reading for those not familiar with the construction and characteristics of FETs.

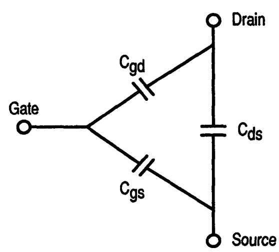
This device was designed primarily for 12.5 volt VHF and UHF power amplifier applications. The major advantages of RF power MOSFETs include high gain, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage.

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between all three terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}). These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate.

In the latter case, the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

DRAIN CHARACTERISTICS

One critical figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $R_{ds(on)}$, occurs in the linear region of the output characteristic and is specified at a specific gate-source voltage and drain current. The drain-source voltage under these conditions is termed $V_{ds(on)}$. For MOSFETs, $V_{ds(on)}$ has a positive temperature coefficient at high temperatures because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high, on the order of $10^9\ \Omega$, resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage to the gate greater than the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating – Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination – The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating must be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection – These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended with appropriate RF decoupling networks.

Using a resistor to keep the gate-to-source impedance low also helps dampen transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

DC BIAS

Since the MRF5015 is an enhancement mode FET, drain current flows only when the gate is at a higher potential than the source. See Figure 7 for a typical plot of drain current versus gate voltage. RF power FETs operate optimally with a quiescent drain current (I_{DQ}), whose value is application dependent. The MRF5015 was characterized at I_{DQ} = 100 mA, which is the suggested value of bias current for typical applications. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws essentially no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF5015 may be controlled to some degree with a low power dc control signal applied to the gate, thus facilitating applications such as manual gain control, ALC/AGC and modulation systems. Figure 6 is an example of output power variation with gate-source bias voltage with P_{in} held constant. This characteristic is very dependent on frequency and load line.

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar transistors are suitable for the MRF5015. For examples see Motorola Application Note AN721, "Impedance Matching Networks Applied to RF Power Transistors." Both small-signal S-parameters and large-signal impedances are provided. While the S-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF power MOSFETs.

Since RF power MOSFETs are triode devices, they are not unilateral. This coupled with the very high gain of MRF5015 yield a device quite capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Different stabilizing techniques may be required depending on the desired gain and bandwidth of the application. The RF test fixture implements a parallel resistor and capacitor in series with the gate to improve stability and input impedance Q.

Two port stability analysis with the MRF5015 S-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A, "RF Small-Signal Design Using Two-Port Parameters," for a discussion of two port network theory and stability.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Advance Information

The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode

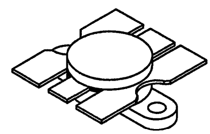
MRF5035

Motorola Preferred Device

35 W, 12.5 VOLTS, 512 MHz
N-CHANNEL BROADBAND
RF POWER FET

Designed for broadband commercial and industrial applications at frequencies to 520 MHz. The high gain and broadband performance of this device makes it ideal for large-signal, common source amplifier applications in 12.5 volt mobile, and base station FM equipment.

- Guaranteed Performance at 512 MHz, 12.5 Volt
  Output Power — 35 Watts
  Power Gain — 6.5 dB Min
  Efficiency — 50% Min
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- S-Parameter Characterization at High Bias Levels
- Excellent Thermal Stability
- All Gold Metal for Ultra Reliability
- Capable of Handling 20:1 Load VSWR, @ 15.5 Volt, 512 MHz, 2 dB Overdrive



CASE 316, STYLE 3

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	36	Vdc
Drain-Gate Voltage (RGS = 1 MΩ)	V_{DGR}	36	Vdc
Gate-Source Voltage	V_{GS}	± 20	Vdc
Drain Current — Continuous	I_D	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	97 0.56	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.8	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 20 mAdc)	$V_{(BR)DSS}$	36	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	—	—	5	mAdc
Gate-Source Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	5	µAdc

(continued)

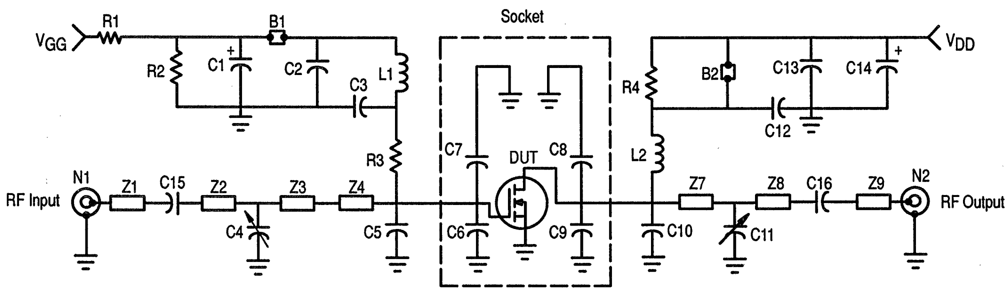
NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

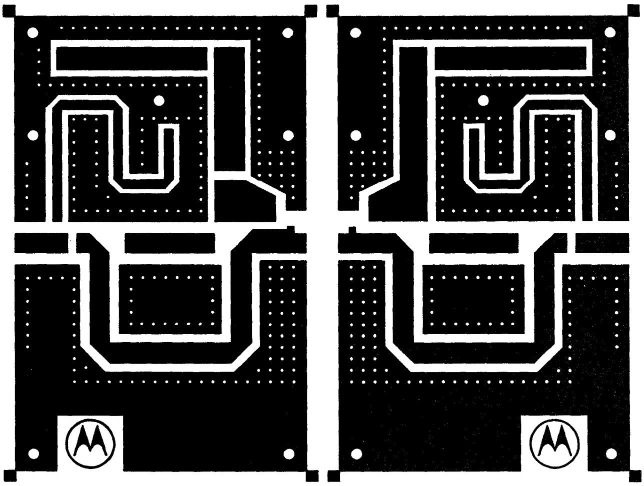
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 25 mAdc)	$V_{GS(th)}$	1.25	2.3	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3 Adc)	$V_{DS(on)}$	—	—	0.422	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 3 Adc)	g_{fs}	3.2	—	—	S
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	88	—	pF
Output Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	197	—	pF
Reverse Transfer Capacitance (V_{DS} = 12.5 Vdc, V_{GS} = 0, f = 1 MHz)	C_{rss}	18	24	29	pF
FUNCTIONAL TESTS (In Motorola Test Fixture)					
Common-Source Amplifier Power Gain (V_{DD} = 12.5 Vdc, P_{out} = 35 W, I_{DQ} = 400 mA)	G_{ps}				dB
f = 512 MHz		6.5	7.5	—	
f = 175 MHz		—	12	—	
Drain Efficiency (V_{DD} = 12.5 Vdc, P_{out} = 35 W, I_{DQ} = 400 mA)	η				%
f = 512 MHz		50	55	—	
f = 175 MHz		—	55	—	
Load Mismatch (V_{DD} = 15.5 Vdc, 2 dB Overdrive, f = 512 MHz, Load VSWR = 20:1, All Phase Angles at Frequency of Test)	ψ	No Degradation in Output Power			



Components List

B1, B2	Short Ferrite Bead, Fair Rite Products
C1, C14	10 µF, 50 V, Electrolytic
C2	1500 pF, Chip Capacitor
C3	140 pF, Chip Capacitor
C4, C11	0-10pF, Trimmer Capacitor
C5	30 pF, Chip Capacitor
C6, C7	43 pF, Chip Capacitor
C8, C9	36 pF, Chip Capacitor
C10	3.6 pF, Chip Capacitor
C12, C15, C16	120 pF, Chip Capacitor
C13	0.1 µF, Chip Capacitor
L1	5 Turns, 18 AWG, 0.116″ ID
L2	8 Turns, 20 AWG, 0.125″ ID
N1, N2	Type N Flange Mount
R1	1 kΩ, 1/4 W, Carbon
R2	1 MΩ, 1/4 W, Carbon
R3	100 Ω, 1/4 W, Carbon
R4	110 Ω, 1/4 W, Carbon
Z1, Z9	Transmission Line*
Z2	Transmission Line*
Z3	Transmission Line*
Z4	Transmission Line*
Z7	Transmission Line*
Z8	Transmission Line*
Board	Glass Teflon® 0.060″
	*See Photomaster for Dimensions

Figure 1. 512 MHz Narrowband Test Circuit Electrical Schematic



SCALE 0.75:1

Figure 2. Photomaster for 512 MHz Narrowband Test Fixture

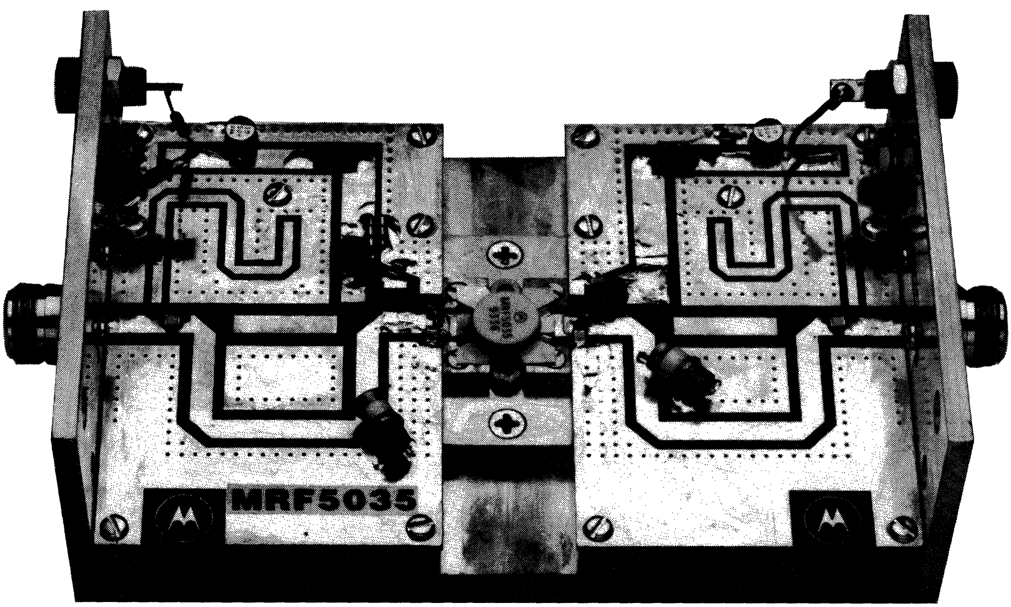


Figure 3. Test Fixture

TYPICAL CHARACTERISTICS

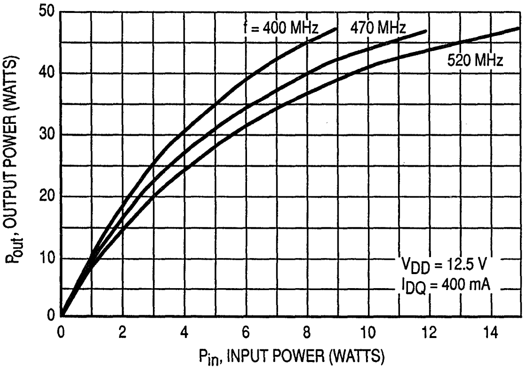


Figure 4. Output Power versus Input Power

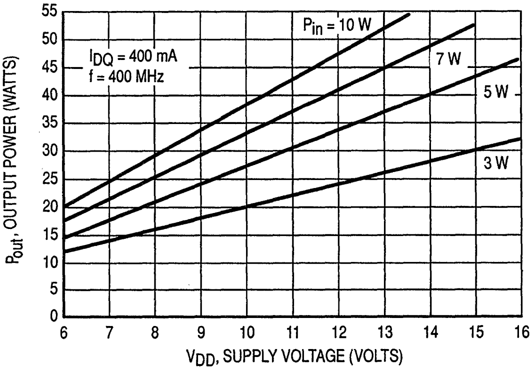


Figure 5. Output Power versus Supply Voltage

2

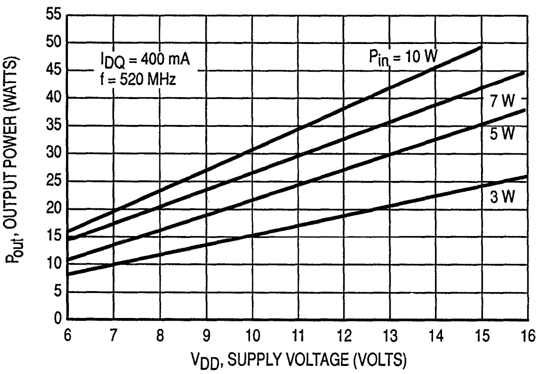


Figure 6. Output Power versus Supply Voltage

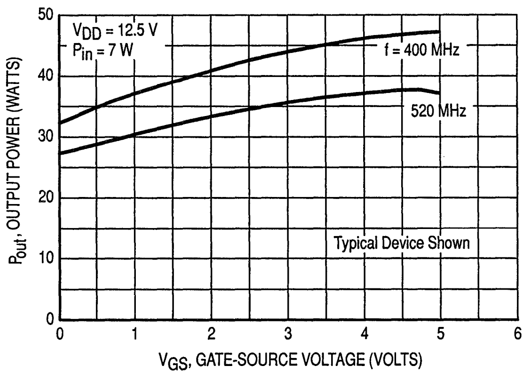


Figure 7. Output Power versus Gate Voltage

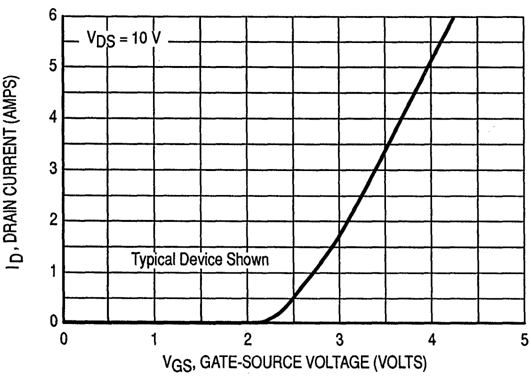


Figure 8. Drain Current versus Gate Voltage

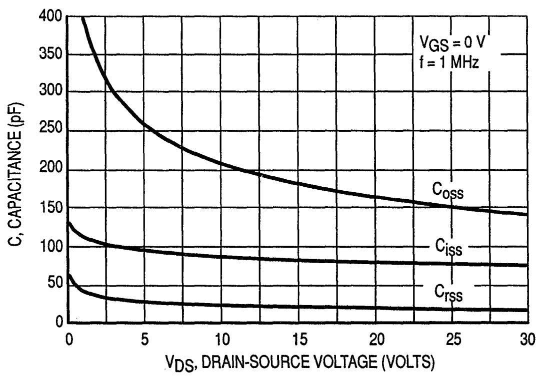


Figure 9. Capacitance versus Voltage

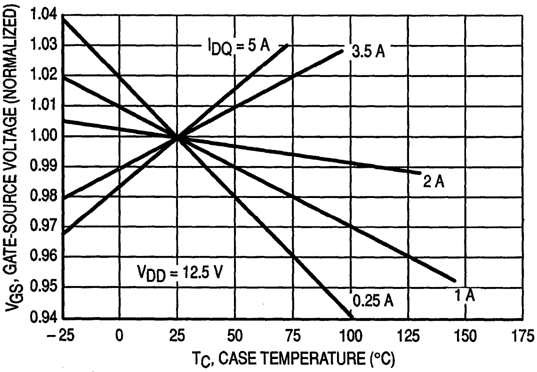


Figure 10. Gate-Source Voltage versus Case Temperature

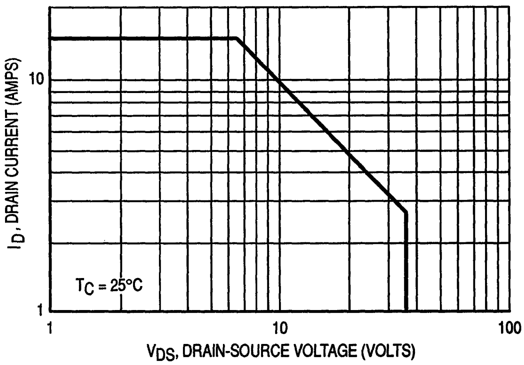
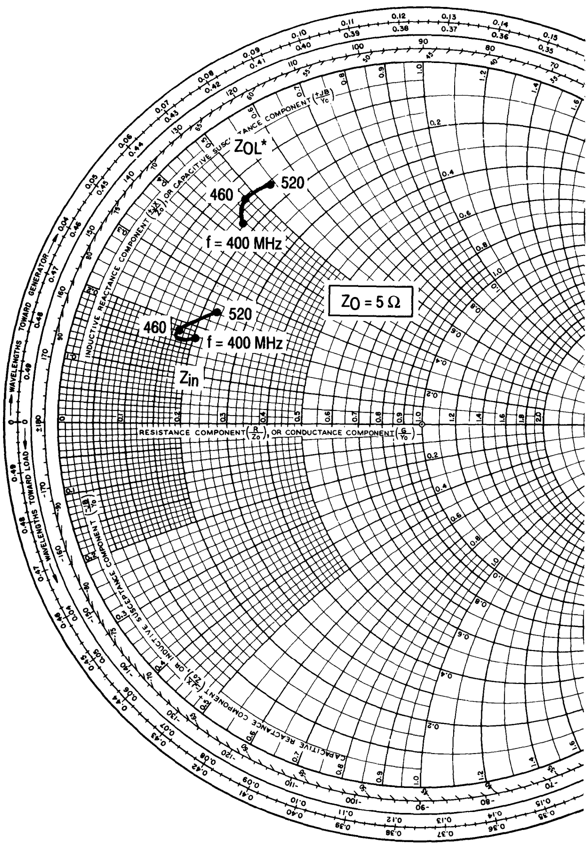


Figure 11. DC Safe Operating Area



V_{DD} = 12.5 V, I_{DQ} = 400 mA, P_{in} = 7.8 W, Tune for Maximum Output Power

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
400	1.0 + j0.89	0.87 + j2.1
420	0.90 + j0.83	0.79 + j2.2
440	0.83 + j0.81	0.73 + j2.3
460	0.82 + j0.83	0.71 + j2.4
480	0.87 + j0.90	0.71 + j2.5
500	0.97 + j1.0	0.74 + j2.6
520	1.1 + j1.2	0.80 + j2.7

Z_{in} = Conjugate of source impedance.

Z_{OL}* = Conjugate of the load impedance at given input power, voltage and frequency that produces maximum output power.

Figure 12. Series Equivalent Input and Output Impedance

2

Table 1. Common Source Scattering Parameters (V_{DS} = 12.5 V)

I_D = 100 mA

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\lvert S_{11}\rvert$	∠ φ	$\lvert S_{21}\rvert$	∠ φ	$\lvert S_{12}\rvert$	∠ φ	$\lvert S_{22}\rvert$	∠ φ
25	0.74	-153	6.9	94	0.039	6	0.87	-169
50	0.74	-164	3.4	82	0.039	- 5	0.89	-174
100	0.77	-168	1.6	67	0.036	-16	0.90	-176
150	0.81	-170	1	56	0.032	- 25	0.92	-178
200	0.85	-171	0.69	46	0.028	- 31	0.93	-179
300	0.90	-174	0.38	32	0.019	- 36	0.96	179
400	0.93	-178	0.24	22	0.013	- 30	0.97	177
450	0.94	-179	0.20	19	0.010	- 22	0.97	175
500	0.95	179	0.17	16	0.008	- 8	0.98	174
600	0.96	176	0.12	13	0.008	27	0.98	172

I_D = 400 mA

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\lvert S_{11}\rvert$	∠ φ	$\lvert S_{21}\rvert$	∠ φ	$\lvert S_{12}\rvert$	∠ φ	$\lvert S_{22}\rvert$	∠ φ
25	0.88	-163	7.8	94	0.018	7	0.93	-175
50	0.88	-172	3.9	87	0.018	3	0.93	-178
100	0.88	-176	1.9	77	0.018	-1	0.94	-180
150	0.89	-178	1.3	70	0.017	- 2	0.94	179
200	0.89	-179	0.91	63	0.016	-1	0.94	178
300	0.91	180	0.57	51	0.014	3	0.95	177
400	0.92	178	0.39	41	0.012	14	0.96	175
450	0.93	177	0.33	37	0.012	22	0.96	174
500	0.94	176	0.29	33	0.012	29	0.97	173
600	0.95	174	0.22	27	0.014	42	0.97	171

2

I_D = 1 A

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\lvert S_{11}\rvert$	∠ φ	$\lvert S_{21}\rvert$	∠ φ	$\lvert S_{12}\rvert$	∠ φ	$\lvert S_{22}\rvert$	∠ φ
25	0.92	-165	7.8	95	0.013	9	0.94	-177
50	0.91	-173	3.9	88	0.013	6	0.95	-179
100	0.92	-177	1.9	81	0.013	7	0.95	179
150	0.92	-179	1.3	75	0.013	9	0.95	179
200	0.92	180	0.95	69	0.012	12	0.95	178
300	0.93	178	0.61	59	0.012	21	0.96	176
400	0.94	176	0.43	50	0.013	32	0.96	174
450	0.94	175	0.38	46	0.013	37	0.97	174
500	0.94	174	0.33	43	0.014	42	0.97	173
600	0.95	173	0.26	36	0.016	49	0.97	171

I_D = 5 A

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\lvert S_{11}\rvert$	∠ φ	$\lvert S_{21}\rvert$	∠ φ	$\lvert S_{12}\rvert$	∠ φ	$\lvert S_{22}\rvert$	∠ φ
25	0.94	-164	7.2	95	0.010	10	0.95	-178
50	0.94	-172	3.6	89	0.010	9	0.95	-180
100	0.94	-177	1.8	81	0.010	11	0.96	179
150	0.94	-179	1.2	76	0.011	16	0.96	178
200	0.94	179	0.89	70	0.011	21	0.96	177
300	0.95	177	0.57	61	0.011	31	0.96	176
400	0.95	176	0.42	52	0.013	41	0.97	174
450	0.95	175	0.36	48	0.013	45	0.97	173
500	0.96	174	0.32	45	0.014	48	0.97	172
600	0.96	172	0.26	39	0.017	54	0.97	171

DESIGN CONSIDERATIONS

The MRF5035 is a common-source, RF power, N-Channel enhancement mode, Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET). Motorola RF MOSFETs feature a vertical structure with a planar design. Motorola Application Note AN211A, "FETs in Theory and Practice," is suggested reading for those not familiar with the construction and characteristics of FETs.

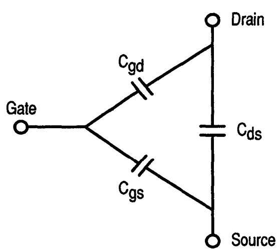
This device was designed primarily for 12.5 volt VHF and UHF Land Mobile FM power amplifier applications. The major advantages of RF power MOSFETs include high gain, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage.

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between all three terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}). These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate.

In the latter case, the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

DRAIN CHARACTERISTICS

One critical figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $R_{ds(on)}$, occurs in the linear region of the output characteristic and is specified at a specific gate-source voltage and drain current. The drain-source voltage under these conditions is termed $V_{ds(on)}$. For MOSFETs, $V_{ds(on)}$ has a positive temperature coefficient at high temperatures because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high, on the order of $10^9\ \Omega$, resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage to the gate greater than the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating – Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination – The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating must be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection – These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended with appropriate RF decoupling networks.

Using a resistor to keep the gate-to-source impedance low also helps dampen transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

DC BIAS

Since the MRF5035 is an enhancement mode FET, drain current flows only when the gate is at a higher potential than the source. See Figure 8 for a typical plot of drain current versus gate voltage. RF power FETs operate optimally with a quiescent drain current (I_{DQ}), whose value is application dependent. The MRF5035 was characterized at I_{DQ} = 400 mA, which is the suggested value of bias current for typical applications. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws essentially no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF5035 may be controlled to some degree with a low power dc control signal applied to the gate, thus facilitating applications such as manual gain control, ALC/AGC and modulation systems. Figure 7 is an example of output power variation with gate-source bias voltage with P_{in} held constant. This characteristic is very dependent on frequency and load line.

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar transistors are suitable for the MRF5035. For examples see Motorola Application Note AN721, "Impedance Matching Networks Applied to RF Power Transistors." Both small-signal S-parameters and large-signal impedances are provided. While the S-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF power MOSFETs.

Since RF power MOSFETs are triode devices, they are not unilateral. This coupled with the high gain of the MRF5035 yield a device quite capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Different stabilizing techniques may be required depending on the desired gain and bandwidth of the application. The RF test fixture implements a resistor in shunt with the gate to improve stability. Two port stability analysis with the MRF5035 S-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A, "RF Small-Signal Design Using Two-Port Parameters," for a discussion of two port network theory and stability.

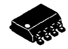
MRF5583

The RF Line
PNP Silicon High-Frequency Transistor

. . . designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

**I_C = –500 mA
SURFACE MOUNT
HIGH-FREQUENCY
TRANSISTOR
PNP SILICON**



**CASE 751, STYLE 1
(SO-8)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–30	V
Collector-Base Voltage	V_{CBO}	–30	V
Emitter-Base Voltage	V_{EBO}	–3.0	V
Collector Current — Continuous	I_C	–500	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = –10 mA)	$V_{(BR)CEO}$	–30	—	—	V
Collector-Base Breakdown Voltage (I_C = –10 μA)	$V_{(BR)CBO}$	–30	—	—	V
Emitter-Base Breakdown Voltage (I_E = –100 μA)	$V_{(BR)EBO}$	–3	—	—	V
Collector Cutoff Current (V_{CB} = –20 V)	I_{CBO}	—	—	–1.0	μA
Emitter Cutoff Current (V_{EB} = –2.0 V)	I_{EBO}	—	—	–0.5	μA
ON CHARACTERISTICS					
DC Current Gain (I_C = –40 mA, V_{CE} = –2.0 V) (I_C = –100 mA, V_{CE} = –2.0 V) (I_C = –300 mA, V_{CE} = –5.0 V)	h_{FE}	20 25 15	— — —	— 100 —	—
Collector-Emitter Saturation Voltage (I_C = –100 mA, I_B = –10 mA)	$V_{CE(sat)}$	—	—	0.8	V
Base-Emitter On Voltage (I_C = –100 mA, V_{CE} = –2.0 V)	$V_{BE(on)}$	—	—	1.8	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = –35 mA, V_{CE} = –15 V, f = 100 MHz)	f_T	—	2100	—	MHz
Insertion Gain (V_{CE} = –15 V, I_C = –35 mA, f = 250 MHz)	$\|S_{21}\|^2$	12.5	15.5	—	dB

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
–15	–35	10	0.47	–57	64.7	155	0.01	60	0.83	–26
		30	0.59	–116	42.2	126	0.02	44	0.56	–58
		50	0.63	–140	28.8	113	0.02	39	0.39	–74
		70	0.64	–151	21.4	105	0.02	42	0.30	–82
		100	0.65	–161	15.4	97	0.02	45	0.24	–80
		300	0.67	179	5.23	79	0.05	58	0.13	–109
		500	0.67	168	3.11	66	0.07	60	0.20	–114
		700	0.67	160	2.24	57	0.09	60	0.24	–116
		1000	0.66	146	1.54	44	0.13	60	0.30	–123

Table 1. Common Emitter S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

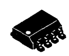
MRF5812

The RF Line
NPN Silicon
RF Low Power Transistor

. . . designed for high current, low power amplifiers up to 2.0 GHz.

- High Current-Gain — Bandwidth Product —
  f_T = 5.5 GHz (Typ) @ I_C = 75 mA
- Low Noise — 2.0 dB (Typ) @ 500 MHz
- Low Intermodulation Distortion
- High Gain — 15.5 dB (Typ) @ 500 MHz
- Low Cost SORF Plastic Surface Mount Package
- State-of-the-Art Technology
  Fine Line Geometry
  Gold Top Metal and Wires
  Silicon Nitride Passivated
  Ion Implanted Arsenic Emitters
- Die Same as MRF581,A

I_C = 200 mA
SURFACE MOUNT
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON



CASE 751, STYLE 1
SORF
(SO-8)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 110°C (1) Derate above 110°C	P_D	1.0 25	Watts mW/°C
Total Device Dissipation @ T_A = 25°C Derate above 25°C (2)	P_D	1.0 8.0	Watts mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	85	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CBO}	—	—	0.1	mAdc

(continued)

NOTE:
1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.
2. Free air.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	1.2	2.0	pF
Current-Gain — Bandwidth Product (1) (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	—	5.5	—	GHz
FUNCTIONAL TESTS					
Noise Figure (Minimum) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) Figure 4	NF_{MIN}	—	2.0	—	dB
Noise Figure (50 Ohm Insertion) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) Figure 5	$NF_{50\ \Omega}$	—	2.5	3.0	dB
Power Gain Associated with Noise Figure (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) Figure 5	$\lvert S_{21}\rvert^2$	13	15.5	—	dB
Maximum Unilateral Gain (1) (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	G_{Umax}	—	17	—	dB
Intermodulation Distortion (2) Figure 1 (V_{CE} = 10 Vdc, I_C = 75 mAdc, V_{out} = +50 dBmV)	IMD(d3)	—	−65	—	dB

NOTES:
1. Characterized on HP8542 Automatic Network Analyzer. $G_{Umax} = \frac{\lvert S_{21}\rvert^2}{(1-\lvert S_{11}\rvert^2)(1-\lvert S_{22}\rvert^2)}$
2. 2 Tones, f1 = 497 MHz, f2 = 503 MHz, 3rd Order Single Tone Reference.

2

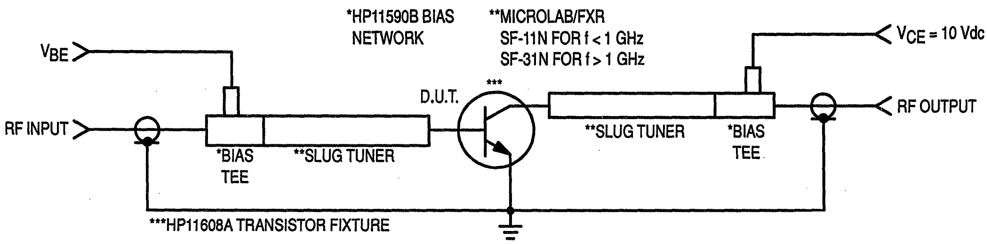


Figure 1. Functional Circuit Schematic

TYPICAL CHARACTERISTICS

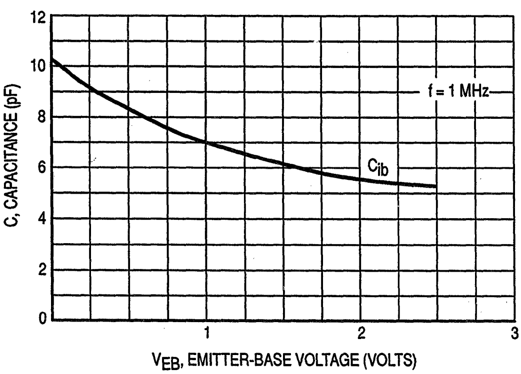


Figure 2. C_{ib} Input Capacitance versus Voltage

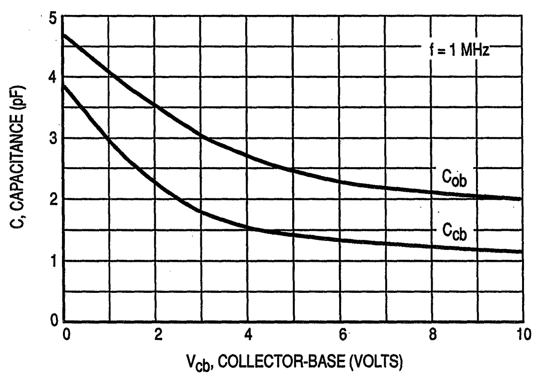


Figure 3. C_{cb}, C_{ob} Collector-Base Capacitance versus Voltage

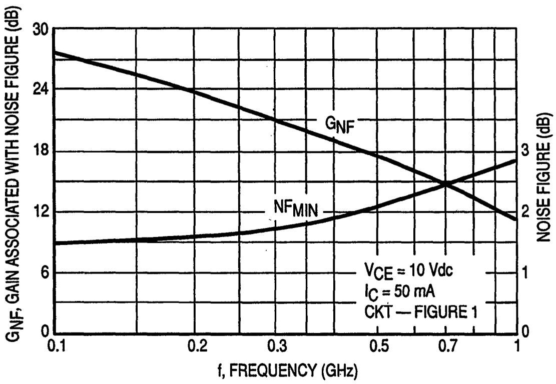


Figure 4. Noise Figure and Gain Associated with Noise Figure versus Frequency

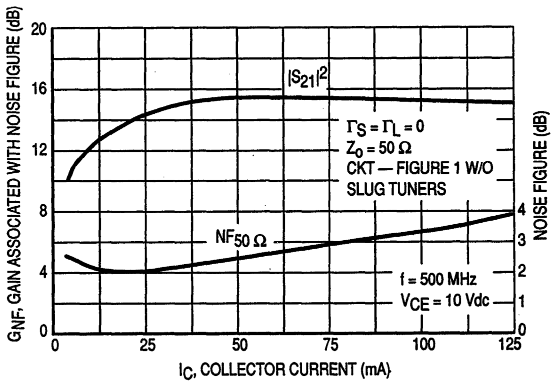


Figure 5. Noise Figure and Gain Associated with Noise Figure versus Collector Current

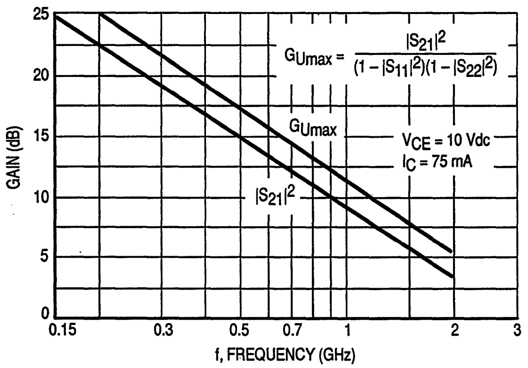


Figure 6. G_{Umax} — Maximum Unilateral Gain, $|S_{21}|^2$ versus Frequency

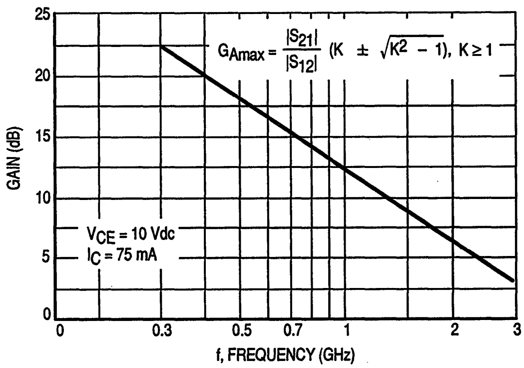


Figure 7. G_{Amax}, Maximum Available Gain versus Frequency

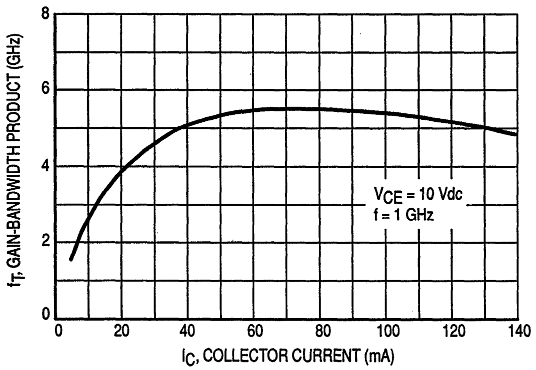


Figure 8. Gain-Bandwidth Product versus Collector Current

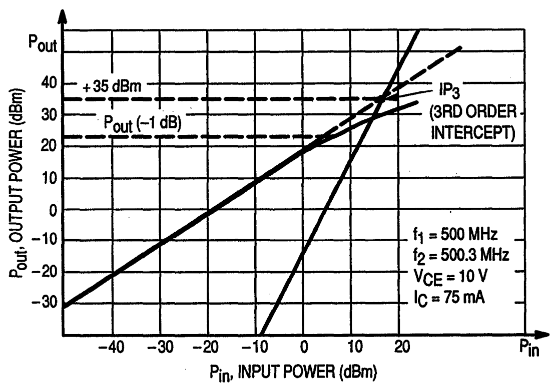


Figure 9. 3rd Order Intercept Point and 1.0 dB Compression Point

2

2

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	25	100	0.66	−123	18.3	118	0.04	43	0.53	−79
		300	0.66	−167	7.0	92	0.06	44	0.31	−120
		500	0.65	178	4.3	81	0.08	52	0.28	−133
		1000	0.62	154	2.2	63	0.13	61	0.28	−141
		2000	0.57	109	1.3	39	0.28	57	0.31	−148
		3000	0.55	68	1.0	23	0.41	41	0.34	−164
	50	100	0.64	−133	20.2	114	0.04	44	0.51	−93
		300	0.65	−171	7.6	91	0.06	50	0.34	−137
		500	0.65	175	4.6	81	0.08	56	0.31	−148
		1000	0.61	152	2.3	63	0.13	63	0.28	−149
		2000	0.56	109	1.3	39	0.28	57	0.30	−150
		3000	0.52	70	1.0	23	0.41	39	0.29	−169
	75	100	0.64	−137	20.8	113	0.04	44	0.50	−99
		300	0.66	−173	7.7	91	0.06	52	0.35	−142
		500	0.64	174	4.7	82	0.08	59	0.32	−154
		1000	0.61	151	2.4	65	0.14	64	0.30	−164
		2000	0.54	107	1.4	42	0.30	55	0.27	−167
		3000	0.52	69	1.1	24	0.42	37	0.25	−172
	100	100	0.64	−140	20.8	112	0.03	44	0.50	−103
		300	0.65	−174	7.6	90	0.06	53	0.36	−145
		500	0.64	173	4.7	81	0.08	60	0.33	−156
		1000	0.61	151	2.4	65	0.15	64	0.31	−166
		2000	0.54	107	1.4	42	0.30	54	0.27	−169
		3000	0.52	65	1.1	24	0.42	37	0.25	−174
10	25	100	0.65	−112	20.2	121	0.04	46	0.56	−62
		300	0.63	−162	8.0	93	0.05	46	0.29	−93
		500	0.62	−178	5.0	82	0.07	52	0.25	−102
		1000	0.60	157	2.5	63	0.11	63	0.26	−112
		2000	0.55	112	1.4	39	0.25	61	0.35	−125
		3000	0.55	69	1.0	23	0.39	47	0.40	−145
	50	100	0.63	−122	22.9	117	0.03	46	0.50	−74
		300	0.62	−167	8.8	92	0.05	51	0.28	−112
		500	0.60	178	5.3	82	0.07	58	0.24	−122
		1000	0.58	154	2.7	64	0.12	65	0.23	−129
		2000	0.51	111	1.5	40	0.26	59	0.28	−132
		3000	0.50	70	1.2	24	0.39	44	0.34	−144
	75	100	0.63	−126	23.8	116	0.03	45	0.49	−80
		300	0.63	−168	9.0	92	0.05	51	0.28	−120
		500	0.62	177	5.5	82	0.07	58	0.24	−130
		1000	0.58	154	2.8	65	0.12	65	0.23	−137
		2000	0.52	111	1.5	41	0.26	58	0.27	−135
		3000	0.50	70	1.2	24	0.39	42	0.32	−145
	100	100	0.62	−128	23.8	114	0.03	46	0.46	−82
		300	0.62	−169	8.9	91	0.05	54	0.26	−120
		500	0.60	176	5.4	81	0.07	61	0.23	−130
		1000	0.57	152	2.8	64	0.12	66	0.21	−136
		2000	0.51	109	1.5	40	0.27	59	0.26	−134
		3000	0.50	68	1.2	24	0.39	43	0.32	−145
15	25	100	0.66	−106	21	123	0.03	47	0.57	−54
		300	0.63	−159	8.5	94	0.05	46	0.30	−77
		500	0.61	−177	5.2	82	0.06	52	0.26	−84
		1000	0.58	156	2.6	62	0.11	64	0.28	−96
		2000	0.54	110	1.4	36	0.23	63	0.39	−115
		3000	0.56	68	1.0	22	0.37	49	0.46	−137
	50	100	0.62	−114	24	119	0.03	46	0.51	−64
		300	0.60	−163	9.2	93	0.05	51	0.26	−92
		500	0.58	−179	5.7	81	0.07	58	0.22	−100
		1000	0.56	154	2.9	63	0.12	66	0.23	−109
		2000	0.52	109	1.5	39	0.25	60	0.32	−118
		3000	0.52	67	1.1	22	0.37	46	0.39	−137
	75	100	0.62	−118	24.6	117	0.03	46	0.48	−67
		300	0.59	−165	9.4	92	0.05	53	0.24	−96
		500	0.58	179	5.7	81	0.07	60	0.21	−104
		1000	0.56	154	2.9	63	0.12	66	0.22	−111
		2000	0.50	109	1.5	38	0.25	60	0.31	−118
		3000	0.52	67	1.1	22	0.37	46	0.38	−136
	100	100	0.62	−121	24.8	116	0.03	46	0.46	−68
		300	0.60	−165	9.3	91	0.05	53	0.23	−96
		500	0.58	179	5.7	81	0.07	61	0.20	−102
		1000	0.56	155	2.9	63	0.12	65	0.22	−109
		2000	0.50	111	1.5	39	0.25	62	0.32	−117
		3000	0.50	68	1.1	23	0.37	47	0.39	−136

Table 1. Common Emitter S-Parameters

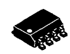
MRF5943

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

**I_C = 400 mA
SURFACE MOUNT
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



**CASE 751, STYLE 1
(SO-8)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	400	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mA)	$V_{(BR)CEO}$	30	—	—	V
Collector-Base Breakdown Voltage (I_C = 100 µA)	$V_{(BR)CBO}$	40	—	—	V
Emitter-Base Breakdown Voltage (I_E = 100 µA)	$V_{(BR)EBO}$	3.5	—	—	V
Collector Cutoff Current (V_{CE} = 20 V)	I_{CEO}	—	—	50	µA
Collector Cutoff Current (V_{CB} = 15 V)	I_{CBO}	—	—	10	µA
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 15 V)	h_{FE}	25	—	300	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$	—	—	0.2	V
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{BE(sat)}$	—	—	1.0	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 35 mA, V_{CE} = 15 V, f = 100 MHz)	f_T	—	1550	—	MHz
Insertion Gain (V_{CE} = 15 V, I_C = 35 mA, f = 250 MHz)	$|S_{21}|^2$	12	15	—	dB

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
15	35	10	0.37	−63	53.7	157	0.01	59	0.91	−18
		30	0.52	−120	36.5	128	0.01	48	0.64	−38
		50	0.58	−142	25.4	113	0.02	45	0.47	−44
		70	0.59	−154	19	105	0.02	46	0.38	−44
		100	0.60	−162	13.6	97	0.02	49	0.32	−43
		300	0.64	178	4.6	77	0.05	59	0.28	−49
		500	0.65	168	2.8	64	0.07	60	0.32	−62
		700	0.65	159	2.0	53	0.09	63	0.38	−76
		1000	0.64	144	1.4	38	0.13	63	0.46	−93

Table 1. Common Emitter S-Parameters

2

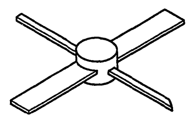
MRF6401

The RF Line
NPN Silicon RF Power Transistor

0.5 W, 1–2 GHz
RF LINEAR
POWER TRANSISTOR

The MRF6401 is designed for Class A common emitter, linear power amplifiers in the 1–2 GHz frequency range. It has been specifically designed for use in Personal Communications Network (PCN) base station and INMARSAT Standard M applications. The studless package version offers a good possibility for surface mounting.

- Specified 20 Volts, 1.66 GHz Characteristics:
  Output Power — 0.5 Watts
  Gain — 10 dB Min
  Class A Operation
- Specified 20 Volts, 1.88 GHz Characteristics:
  Output Power — 0.5 Watts
  Gain — 9 dB Min
  Class A Operation



CASE 305C, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.8 0.033	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	30	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, R_B = 75 Ω)	$V_{(BR)CER}$	28	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mAdc)	$V_{(BR)CBO}$	45	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	120	—

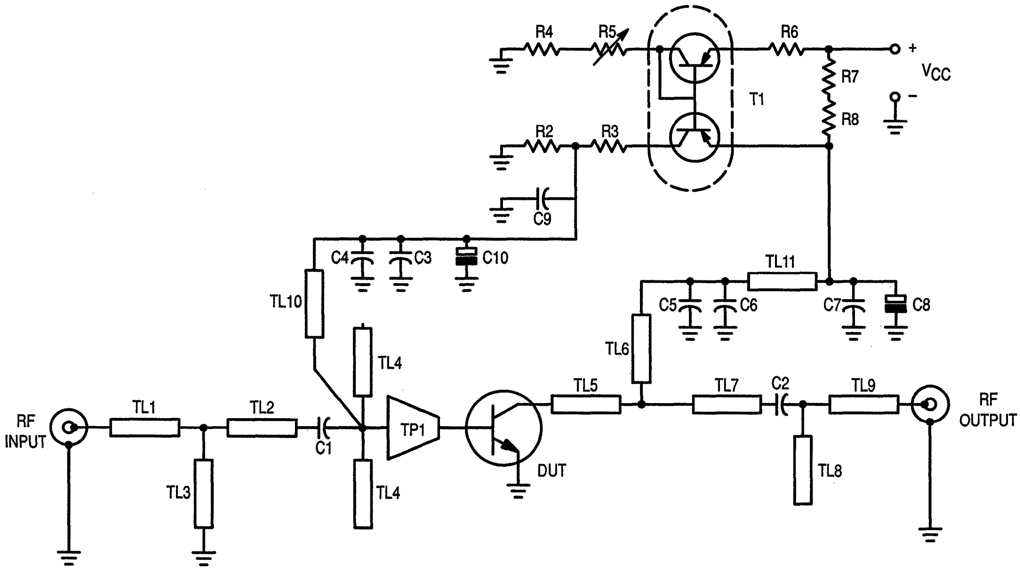
NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	1.4	—	pF
FUNCTIONAL TESTS (V_{CC} = 20 V, I_{CQ} = 80 mA)					
Common-Emitter Amplifier Power Gain	G_p				dB
(f = 1660 MHz, P_{out} = 0.5 W)		10	11	—	
(f = 1880 MHz, P_{out} = 0.5 W)		9	10	—	
Load Mismatch (f = 1660 MHz, f = 1880 MHz, P_{out} = 0.5 W, Load VSWR = 20:1, all phase angles at frequency of test)	ψ	No Degradiation in Output Power			
Intermodulation Distortion	IMD				dBc
(P_{out} = 0.5 W PEP, f1 = 1659.2 MHz, f2 = 1660 MHz)		−30	−35	—	
(P_{out} = 0.5 W PEP, f1 = 1879.2 MHz, f2 = 1880 MHz)		−30	−35	—	

2



C1	1.5 pF, ATC Chip Capacitor 100A	R2	470 Ω, Chip Resistor 0805
C2	3.9 pF, ATC Chip Capacitor 100A	R3	4.7 kΩ, Chip Resistor 0805
C3	56 pF, ATC Chip Capacitor 100A	R4	8.2 kΩ, Chip Resistor 0805
C4, C6, C7, C9	15 nF, Chip Capacitor 0805	R5	5 kΩ, SMD Potentiometer
C5	47 pF, ATC Chip Capacitor 100A	R6	680 Ω, Chip Resistor 0805
C8	4.7 µF, 35 V, Capacitor	R7, R8	7.5 Ω, Chip Resistor 0805
C10	10 µF, 16 V, Capacitor	T1	Transistor, BCV62
C11	100 pF, ATC Chip Capacitor 100A		
TL1 to TL11	µStrip Lines; See Photomaster		
TP1	µStrip Taper; See Photomaster		

Figure 1. 1600–2000 MHz Broadband Application Amplifier Schematic

TYPICAL CHARACTERISTICS

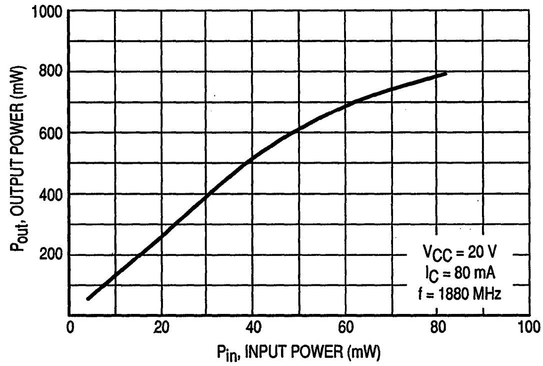


Figure 2. Output Power versus Input Power

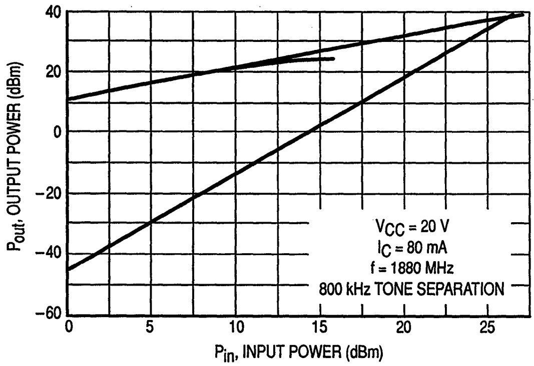


Figure 3. Third Order Intercept

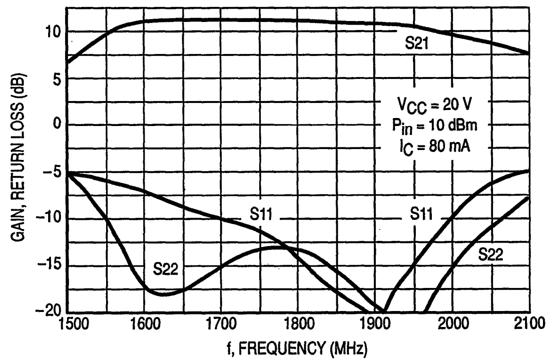


Figure 4. Performance in Broadband Test Fixture

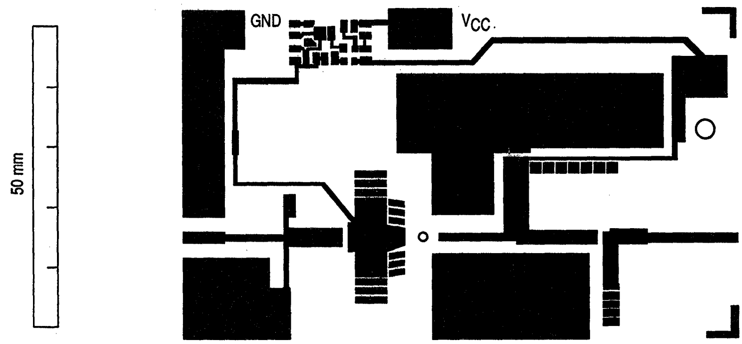
Table 1. Common Emitter S-Parameters

V_{CC} = 20 V, I_C = 80 mA

POLAR S-PARAMETERS IN 50 Ω SYSTEM								
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠Ø	$\|S_{21}\|$	∠Ø	$\|S_{12}\|$	∠Ø	$\|S_{22}\|$	∠Ø
100	0.626	−118	28.4	127	0.0186	45	0.649	−40
200	0.718	−149	17.1	106	0.0230	35	0.434	−49
400	0.754	−171	9.10	88	0.0271	35	0.303	−53
600	0.761	179	6.15	77	0.0312	38	0.272	−56
800	0.762	171	4.65	68	0.0359	42	0.266	−62
1000	0.763	165	3.73	60	0.0409	44	0.271	−68
1200	0.758	159	3.13	52	0.0469	44	0.286	−75
1400	0.753	155	2.60	44	0.0490	46	0.291	−87
1600	0.765	150	2.30	39	0.0574	50	0.288	−93
1800	0.769	144	2.06	32	0.0665	49	0.303	−97
1900	0.768	142	1.98	29	0.0714	48	0.312	−100
2000	0.767	139	1.88	25	0.0756	48	0.322	−103

V_{CC} = 20 V, I_C = 50 mA

POLAR S-PARAMETERS IN 50 Ω SYSTEM								
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠Ø	$\|S_{21}\|$	∠Ø	$\|S_{12}\|$	∠Ø	$\|S_{22}\|$	∠Ø
100	0.618	−113	26.2	130	0.0195	45	0.678	−36
200	0.713	−145	16.2	108	0.0251	34	0.465	−47
400	0.758	−168	8.78	89.2	0.0288	32	0.331	−51
600	0.763	180	5.94	78	0.0323	35	0.297	−55
800	0.761	169	4.49	68	0.0363	39	0.290	−61
1000	0.764	166	3.61	60	0.0415	41	0.294	−68
1200	0.758	160	3.02	52	0.0467	42	0.310	−75
1400	0.757	155	2.52	44.5	0.0486	45	0.313	−87
1600	0.768	150	2.22	39	0.0566	48	0.311	−92
1800	0.772	145	2	32	0.0655	48	0.328	−97
1900	0.770	142	1.91	28	0.0705	47	0.335	−101
2000	0.772	140	1.81	25	0.0745	47	0.345	−104



TEFLON® GLASS 0.508 mm 2 sides 35 µm Cu

SCALE 0.75:1

Figure 5. PC Board Photomaster

2

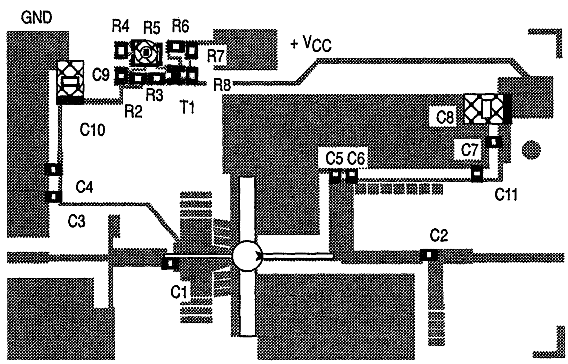


Figure 6. Test Circuit Components View

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

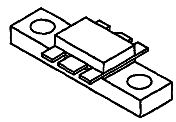
MRF6402

The RF Line
NPN Silicon RF Power Transistor

The MRF6402 is designed for 1.8 GHz Personal Communications Network (PCN) base stations applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. For ease of design, this transistor has an internally matched input.

- To be used in Class AB for PCN and Cellular Radio Applications
- Specified 26 V, 1.88 GHz Characteristics
  Output Power — 4.5 Watts
  Gain — 10 dB Typ
  Efficiency — 45% Typ

4.5 W, 1.88 GHz
RF POWER TRANSISTOR
NPN SILICON



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	0.7	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	15 0.2	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

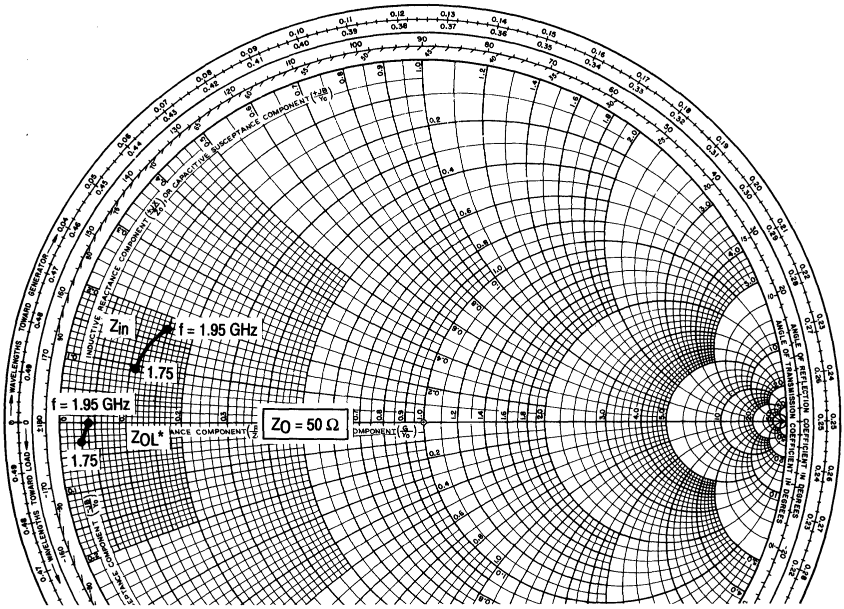
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mAdc)	$V_{(BR)CBO}$	40	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	5	mA

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 Adc, V_{CE} = 20 Vdc)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	6	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 4 W, I_{CQ} = 40 mA, f = 1.88 GHz)	G_p	9	10	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 4 W, f = 1.88 GHz)	η	40	43	—	%
Load Mismatch (V_{CC} = 26 V, P_{out} = 4.5 W, I_{CQ} = 40 mA, f = 1.88 GHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	Ψ	No Degradation in Output Power			



f (GHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
1.75	5.9 + j9.2	2.8 + j2.7
1.80	6.2 + j9.6	2.9 + j2.3
1.84	6.5 + j10	2.9 + j1.8
1.90	6.8 + j9.1	2.9 + j1.4
1.95	7.3 + j8.1	3.1 + j0.9

Z_{OL}*: Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Input and Output Impedances with Circuit Tuned for Maximum Gain @ V_{CE} = 26 V, I_{CQ} = 40 mA, P_{out} = 4.5 W

TYPICAL CHARACTERISTICS

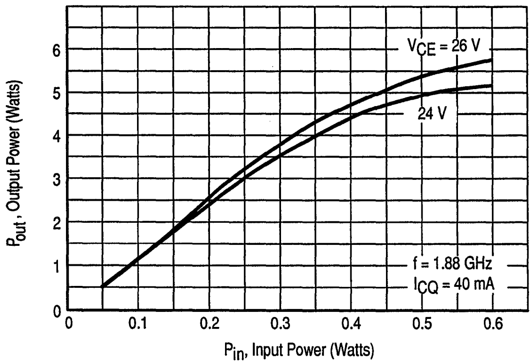


Figure 2. Typical Output Power versus Input Power

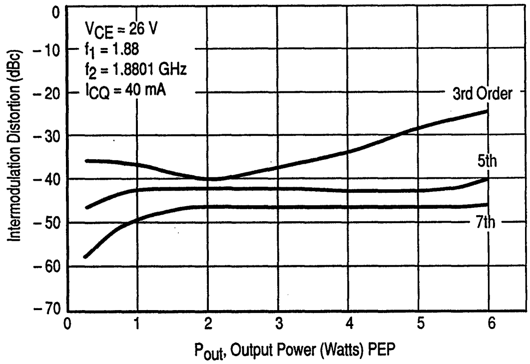
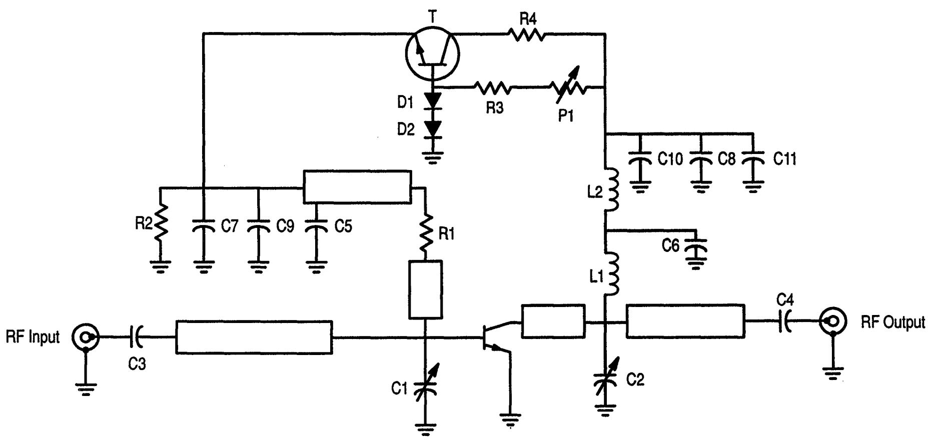


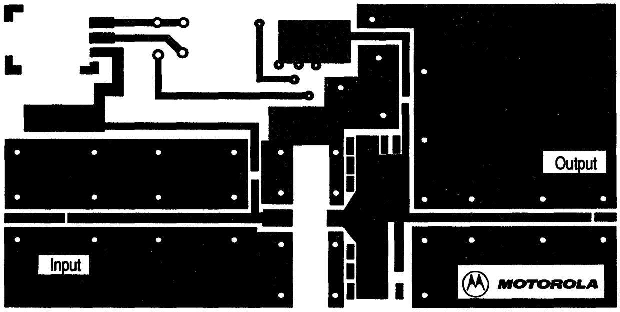
Figure 3. IMD versus Output Power

2



C1, C2	1 to 5 pF, Trimmer Capacitor, Johanson	L1	2 Turns, Wire 0.5 mm, ID 2 mm
C3, C4	100A, 68 pF, Chip Capacitor, ATC	L2	Ferrite Bead, SMD Fair-Rite
C5, C6	100A, 82 pF, Chip Capacitor, ATC	P1	10 kΩ, Trimmer
C7, C8	15 nF, Chip Capacitor, 0805	R1	2.2 Ω, Chip Resistor, 0805
C9, C10	330 pF, Chip Capacitor, 0805	R2	56 Ω, Chip Resistor, 1206
C11	4.7 µF, 35 V, Capacitor	R3	1.2 kΩ, 1/4 W, 5%, Resistor
D1, D2	Diode, 1N4148	R4	100 Ω, 3 W, Power Resistor
		T	Transistor, BD135

Figure 4. 1.80−1.88 GHz Test Circuit Electrical Schematic



Teflon Glass® 0.5 mm — Double Side 35 μm Cu.

SCALE 0.75:1

Figure 5. Photomaster

2

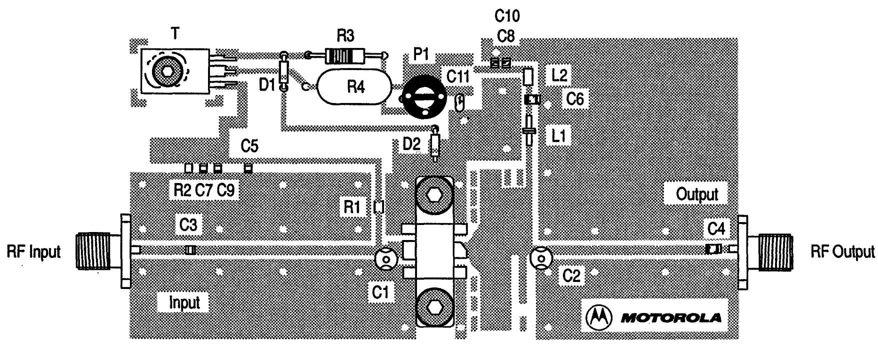


Figure 6. Test Circuit Components View and Parts List

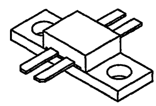
MRF6403

The RF Line
NPN Silicon RF Power Transistor

**25 W, 1.88 GHz
RF POWER TRANSISTOR
NPN SILICON**

The MRF6403 is designed for 1.8 GHz Personal Communications Network (PCN) base station applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- To be used in Class AB for PCN and Cellular Radio
- Specified 26 Volts, 1.88 GHz Characteristics
  Output Power — 25 Watts
  Gain — 6.5 dB Typ
  Efficiency — 43% Typ



CASE 395, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	70 0.4	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

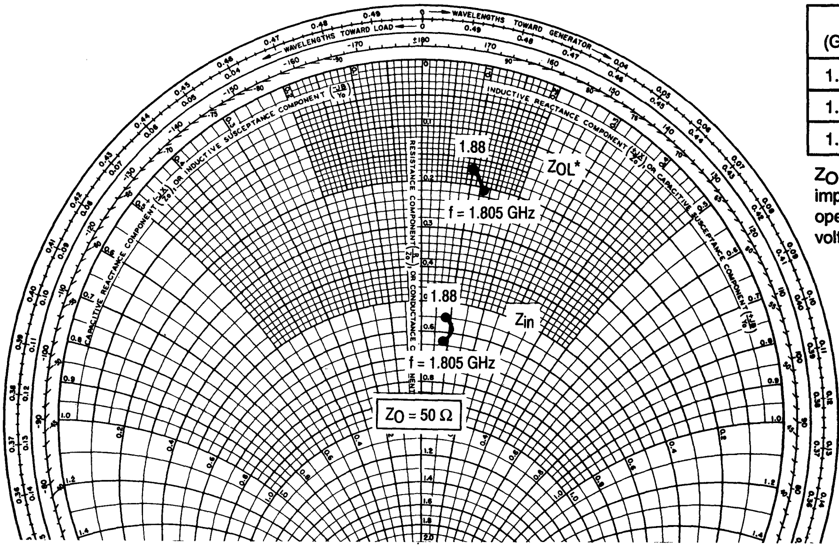
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mAdc)	$V_{(BR)CBO}$	45	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	5	mA

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.2 Adc, V_{CE} = 20 Vdc)	h_{FE}	30	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (each side) (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	15	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 25 W, I_{CQ} = 200 mA, f = 1.88 GHz)	G_p	—	6.5	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 25 W, f = 1.88 GHz)	η	38	43	—	%



f (GHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
1.805	33.7 + j5.6	9.8 + j7.7
1.845	31.5 + j5.4	9.3 + j7
1.880	29.5 + j5.1	8.9 + j6.4

Z_{OL}*: conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Series Equivalent Input and Output Impedances

TYPICAL CHARACTERISTICS

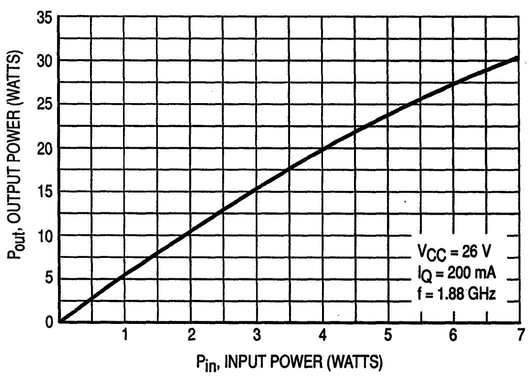
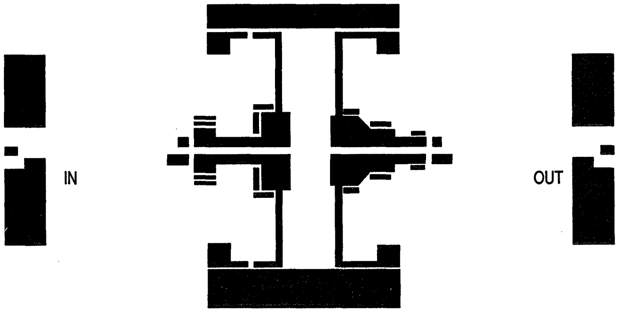


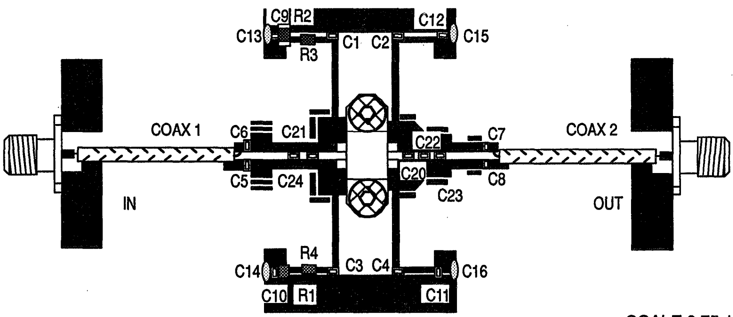
Figure 2. Output Power versus Input Power



TEFLON® GLASS 0.5 mm — DOUBLE SIDE 35 µm Cu.

SCALE 0.75:1

Figure 3. Photomaster



SCALE 0.75:1

Figure 4. Components View

C1 to C8	68 pF, ATC Chip Capacitor 100A
C9 to C12	330 pF, Chip Capacitor 0805
C13 to C16	4.7 µF, 35 V, Capacitor
C20	1.3 pF, ATC Chip Capacitor 100A
C21 to C23	1 pF, ATC Chip Capacitor 100A
C24	0.5 pF, ATC Chip Capacitor 100A
R1, R2	56 Ω, Chip Resistor 1206
R3, R4	2.2 Ω, Chip Resistor 0805
Coax 1, Coax 2	50 Ω Coaxial, l = 27 mm

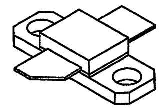
MRF6404

The RF Line
NPN Silicon
RF Power Transistor

The MRF6404 is designed for 1.8 GHz Personal Communications Network (PCN) base station applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- To be used in Class AB for PCN and Cellular Radio
- Specified 26 V, 1.88 GHz Characteristics
  Output Power — 30 Watts
  Gain — 9 dB Typ
  Efficiency — 43% Typ

30 W, 1.88 GHz
RF POWER TRANSISTOR
NPN SILICON



CASE 395C, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	125 0.71	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	1.4	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

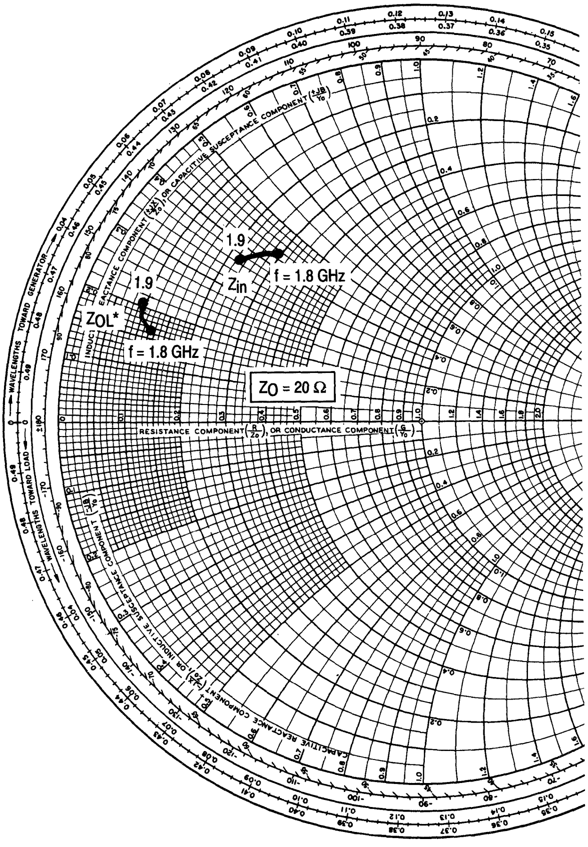
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	25	28	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ mAdc)	$V_{(BR)EBO}$	4	5	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mAdc)	$V_{(BR)CES}$	60	68	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ V, $V_{BE} = 0$)	I_{CES}	—	—	10	mA

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	30	50	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	38	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 30 W, I_{CQ} = 150 mA, f = 1.88 GHz)	G_p	—	9	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 30 W, f = 1.88 GHz)	η	—	43	—	%
Load Mismatch (V_{CC} = 26 V, P_{out} = 30 W, I_{CQ} = 150 mA, f = 1.88 GHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	Ψ	No Degradation in Output Power			



f (GHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
1.8	6.5 + j8.5	3 + j3
1.85	5.6 + j8	2.6 + j3.3
1.9	5.2 + j7.3	2.3 + j3.7

Z_{OL}*: Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Input and Output Impedances with Circuit Tuned for Maximum Gain @ V_{CC} = 26 V, I_{CQ} = 0.15 A, P_{out} = 30 W

2

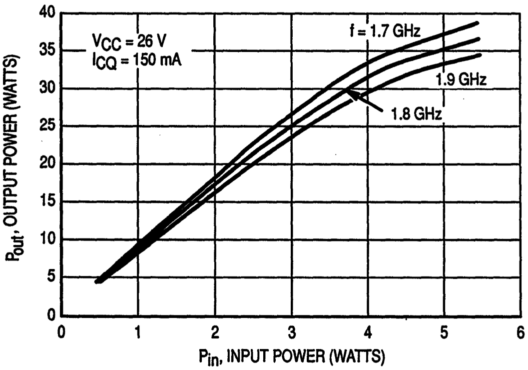


Figure 2. Output Power versus Input Power

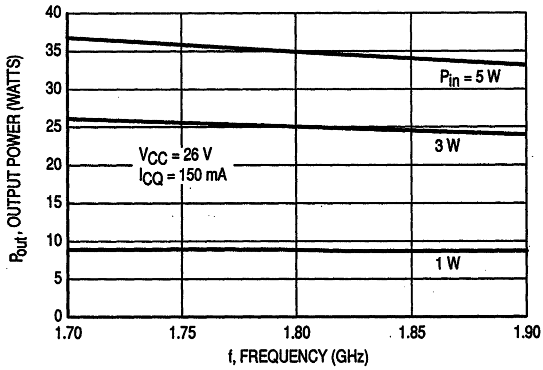


Figure 3. Output Power versus Frequency

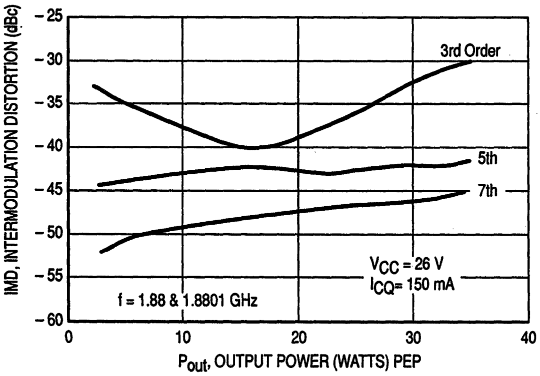


Figure 4. Intermodulation versus Output Power

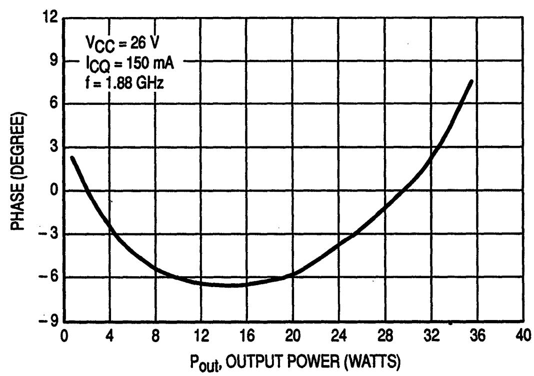
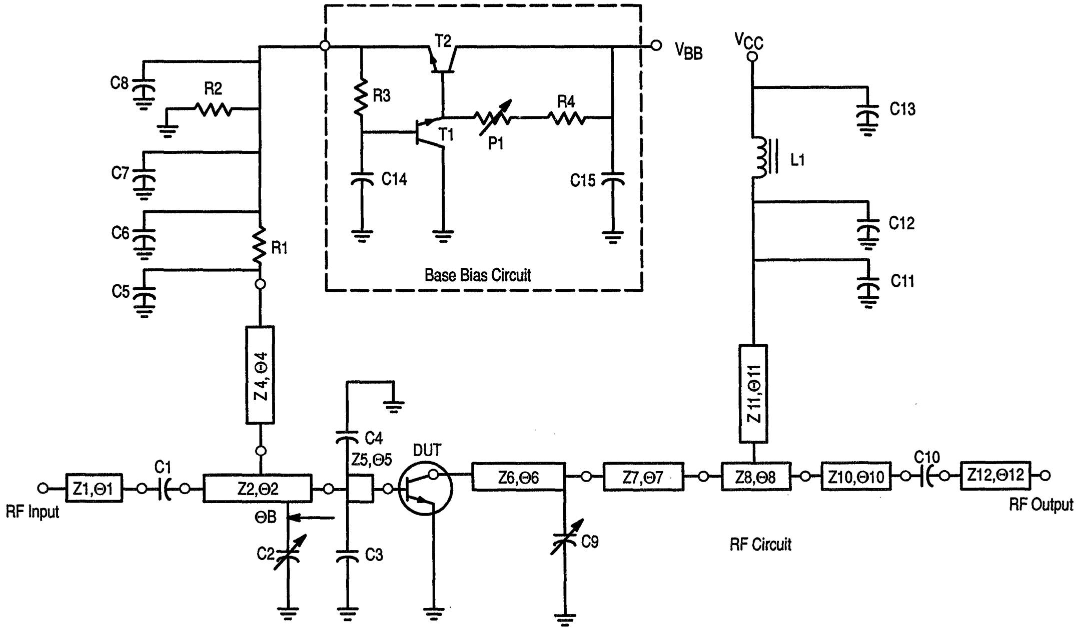


Figure 5. AM/PM Conversion

2



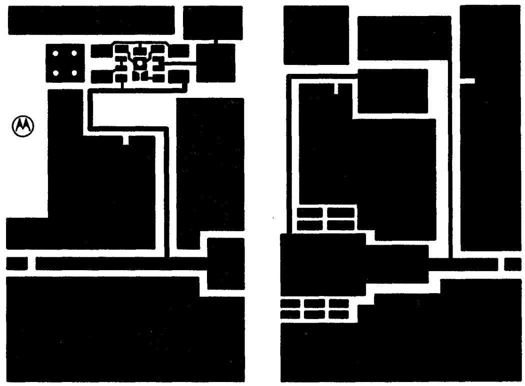
2

C1, C5, C10, C11	68 pF, Chip Capacitor, ATC 100A
C2, C9	Trimmer Capacitor, Gigatrim
C3, C4	1.3 pF, Chip Capacitor, ATC 100A
C6, C12	330 pF, Chip Capacitor, Vitramon
C7, C14, C15	15 nF, Chip Capacitor, Vitramon
C8	10 µF, 63 V, Electrolytic Capacitor
C13	4.7 µF, 63 V, Electrolytic Capacitor
L1	Ferrite Bead SMD Fair-Rite
P1	1 KΩ, Trimmer
R1	2.2 Ω, Chip Resistor, 0805
R2	56 Ω, Chip Resistor, 1206
R3	47 Ω, Chip Resistor, 0805
R4	330 Ω, Chip Resistor, 0805
T1,T2	Motorola MJD 31C
Board	ε_r = 2.55, H = 0.508 mm, T = 0.035 mm

All Electrical Lengths Are Referenced from λg @ F = 1.9 GHz

Z1 : 50 Ω	Θ1 : 10°
Z2 : 50 Ω	Θ2 : 74.5° ΘB : 16.5°
Z4 : 74 Ω	Θ4 : 68°
Z5 : 12.8 Ω	Θ5 : 21°
Z6 : 10.4 Ω	Θ6 : 49.5°
Z7 : 18 Ω	Θ7 : 36.5°
Z8 : 45 Ω	Θ8 : 20°
Z10 : 50 Ω	Θ10 : 10°
Z11 : 74 Ω	Θ11 : 74.5°
Z12 : 50 Ω	Θ12 : 10°

Figure 6. 1.8–1.88 GHz Test Circuit Electrical Schematic



(Not to Scale)

Teflon® Glass 0.5 mm – Double Side 35 µm Cu.

Figure 8. Photomaster

2

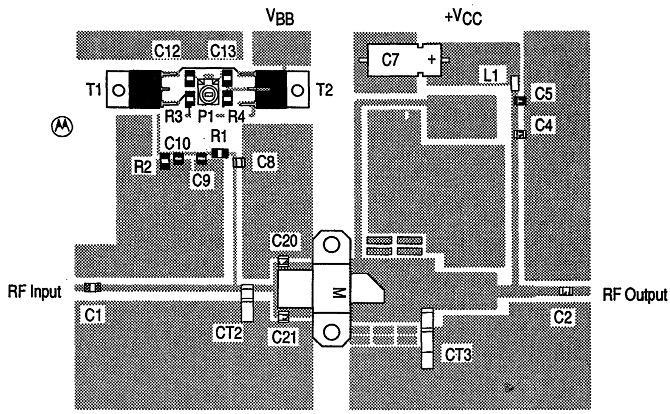


Figure 9. Components Layout

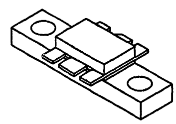
MRF6406

The RF Line
NPN Silicon RF Power Transistor

The MRF6406 is designed for 1.88 GHz Personal Communications Network (PCN) base station applications. For ease of design, this transistor has an internally matched input.

- Specified 26 V, 1.88 GHz Characteristics
  Output Power — 12 Watts
  Gain — 7.5 dB Typ @ 1.88 GHz, Class AB
  Efficiency — 43% Typ @ 1.88 GHz, 12 Watts
- Characterized with Series Equivalent Large-Signal Parameters from 1.75–1.9 GHz
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**12 W, 1.88 GHz
RF POWER TRANSISTOR
NPN SILICON**



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	38 0.26	Watts W/°C
Quiescent Current (without RF drive)	I_{CQ}	400	mAdc
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	4.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

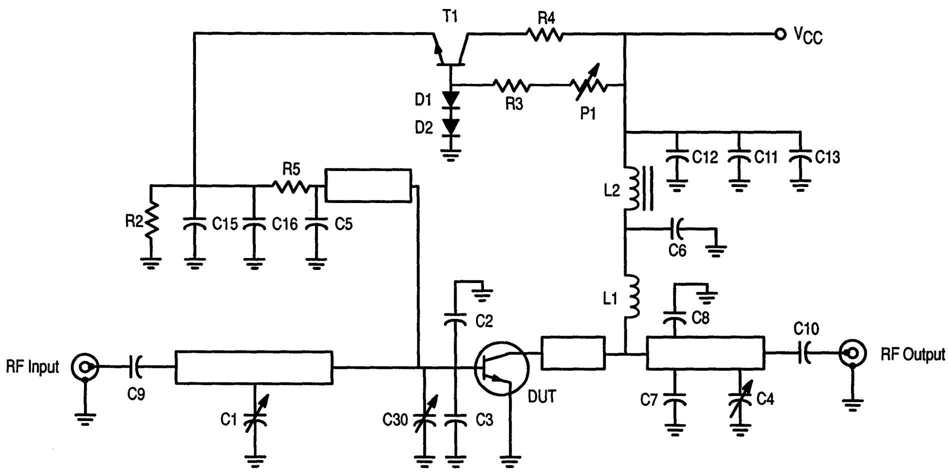
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 5 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Collector-Emitter Leakage Current (V_{CE} = 26 Vdc, R_{BE} = 75 Ω)	I_{CER}	—	—	5	mAdc

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

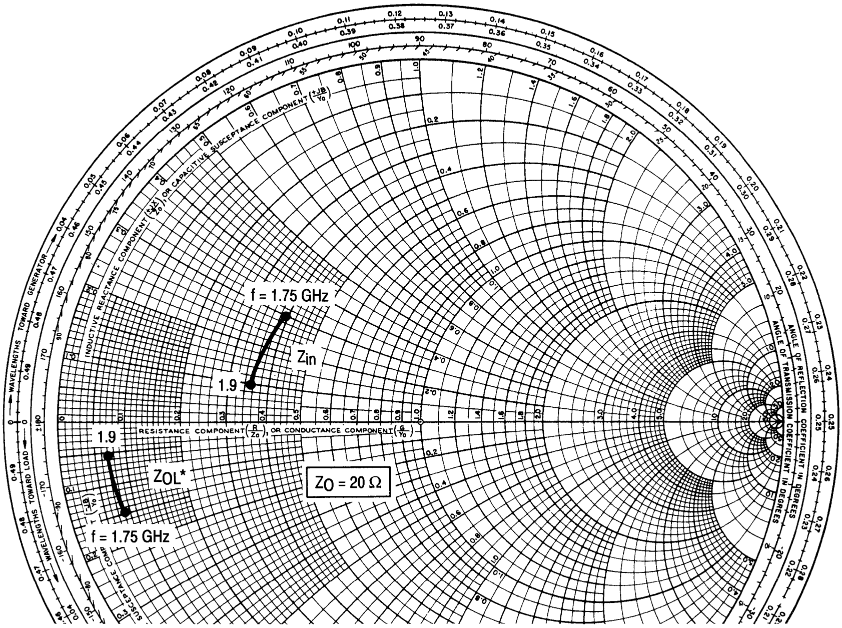
ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 200 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	17	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 Vdc, P_{out} = 12 W, I_{CQ} = 100 mA, f = 1.88 GHz)	G_{pe}	—	7.5	—	dB
Collector Efficiency (V_{CE} = 26 Vdc, P_{out} = 12 W, I_{CQ} = 100 mA, f = 1.88 GHz)	η	38	43	—	%
Load Mismatch (V_{CE} = 26 Vdc, P_{out} = 12 W, I_{CQ} = 100 mA, f = 1.88 GHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	Ψ	No Degradation in Output Power			



C1	0.5 pF, Chip Capacitor, ATC 100A	D1, D2	Diode, 1N4148
C2, C3	1.2 pF, Chip Capacitor, ATC 100A	L1	2 Turns, Wire Dia. 0.5 mm, ID 2 mm
C4, C30	1.5/5 pF, Trimmer Capacitor, Johanson	L2	Ferrite Bead, SMD Fair Rite
C5, C6	68 pF, Chip Capacitor, ATC 100A	P1	10 kΩ, Trimmer Resistor
C7, C8	0.1 pF, Chip Capacitor, ATC 100A	R2	56 Ω, Chip Resistor, 1206
C9, C10	82 pF, Chip Capacitor, ATC 100A	R3	1.2 kΩ, 1/4 W, 5%, Resistor
C11, C15	15 nF, Chip Capacitor, 0805	R4	100 Ω, 3 W, Resistor
C12, C16	330 pF, Chip Capacitor, 0805	R5	2.2 Ω, Chip Resistor, 1206
C13	4.7 µF, 35 V, Capacitor	T1	Transistor, BD135

Figure 1. 1.80–1.88 GHz Test Circuit Electrical Schematic



f (GHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
1.75	8.3 + j6.8	1.9 – j2.8
1.80	7.7 + j3.4	1.75 – j2
1.90	7.5 + j2.1	1.7 – j1.3

Z_{OL}*: Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 2. Input and Output Impedances with Circuit Tuned for Maximum Gain @ V_{CC} = 26 V, I_{CQ} = 100 mA, P_{out} = 12 W

2

TYPICAL CHARACTERISTICS

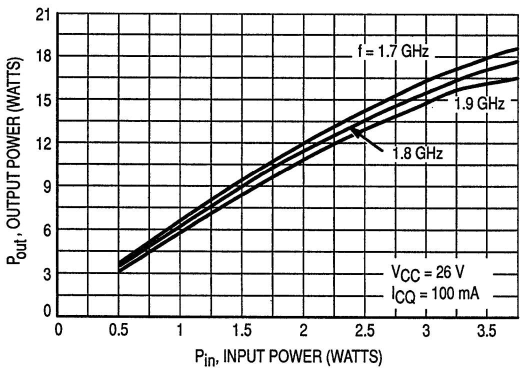


Figure 3. Output Power versus Input Power

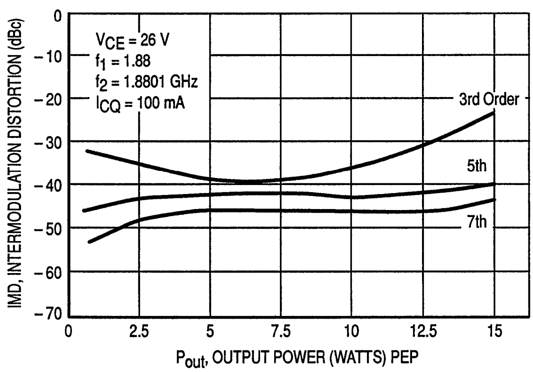


Figure 4. IMD versus Output Power

TYPICAL CHARACTERISTICS

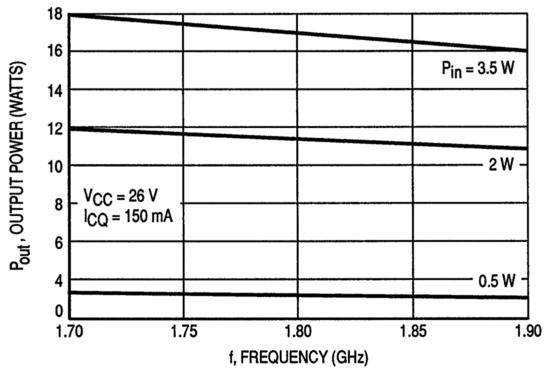
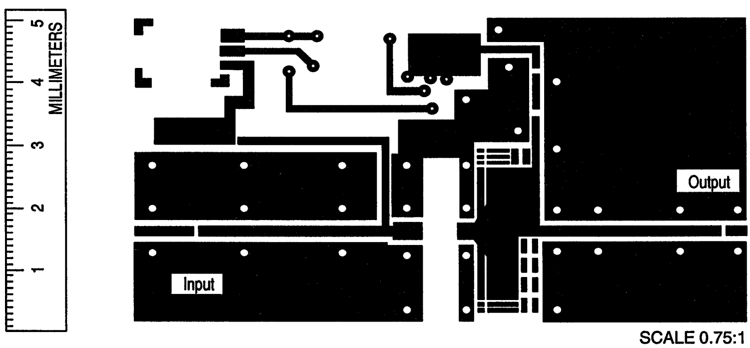


Figure 5. Output Power versus Frequency



Teflon® Glass 0.5 mm — Double Side 35 µm Cu.

Figure 6. Photomaster

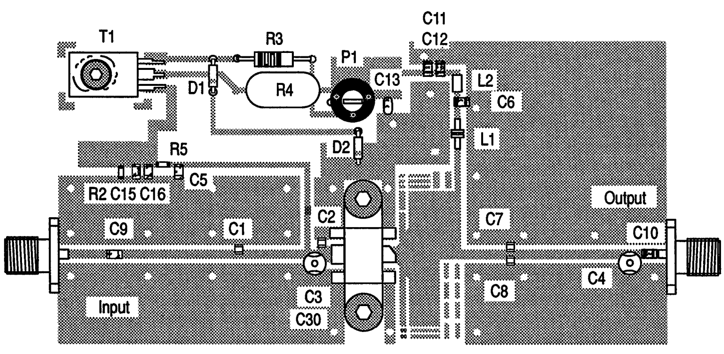


Figure 7. Components Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

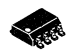
MRF8372

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for wideband large signal predriver stages in 800 MHz and UHF frequency ranges.

- Specified @ 12.5 V, 870 MHz Characteristics
  Output Power = 750 mW
  Common Emitter Power Gain = 10 dB (Typ)
  Efficiency 60% (Typ)
- Low Cost SORF Plastic Surface Mounted Package
- State-of-the-Art Technology
  Fine Line Geometry
  Gold Top Metal and Wires
  Silicon Nitride Passivated
  Ion Implanted Arsenic Emitters

750 mW, 870 MHz
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON



CASE 751, STYLE 1
SORF
(SO-8)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 90°C (1) Derate above 90°C	P_D	1.0 17	Watts mW/°C
Total Device Dissipation @ T_A = 25°C (2) Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	85	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

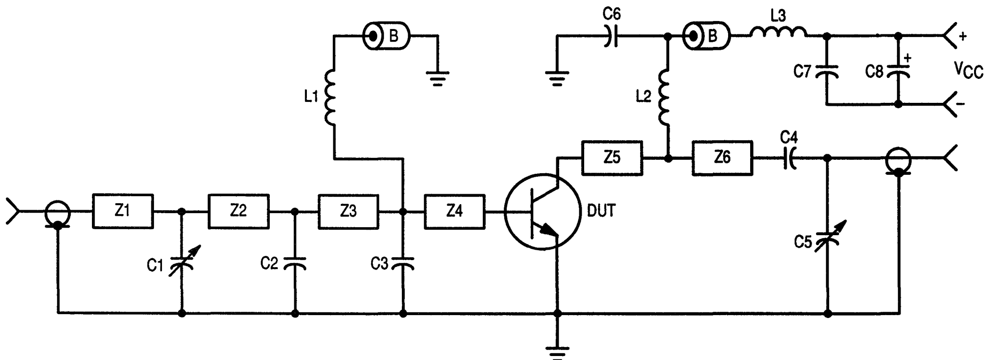
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc

(continued)

NOTE:
1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.
2. Free air.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	1.8	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain Figures 1, 3 (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	G_{pe}	8.0	10	—	dB
Collector Efficiency Figures 1, 3 (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	η	55	60	—	%



C1, C5 — 0.8–8.0 pF Johanson Gigatrim
C2, C3 — 10 pF Ceramic Chip Capacitor
C6 — 91 pF Clamped Mica, Mini-Underwood
C4 — 47 pF Ceramic Chip Capacitor
C7 — 91 pF Clamped Mica, Mini-Underwood
C8 — 1.0 µF 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B

L1, L2 — 4 Turns, #21 AWG, 5/32″ ID
L3 — 7 Turns, #21 AWG, 5/32″ ID
Z1, Z2 — 1″ x 0.078″ Microstrip, Z_o = 50 Ohms
Z3 — 0.25″ x 0.078″ Microstrip, Z_o = 50 Ohms
Z4 — 0.15″ x 0.078″ Microstrip, Z_o = 50 Ohms
Z5 — 0.30″ x 0.078″ Microstrip, Z_o = 50 Ohms
Z6 — 1.63″ x 0.078″ Microstrip, Z_o = 50 Ohms
PCB — 1/32″ Glass Teflon, ε_r = 2.56

Figure 1. 800–900 MHz Broadband Circuit

800/900 MHz BAND DATA

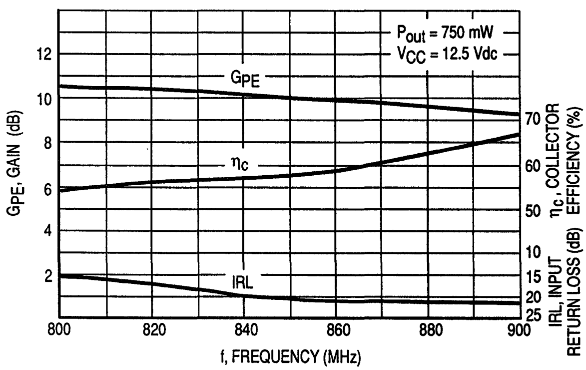


Figure 2. Typical Broadband Performance

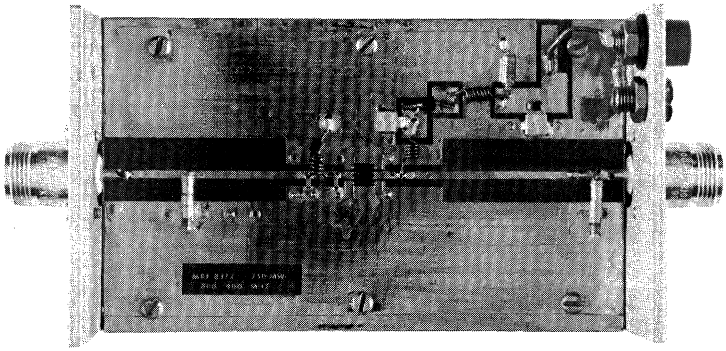
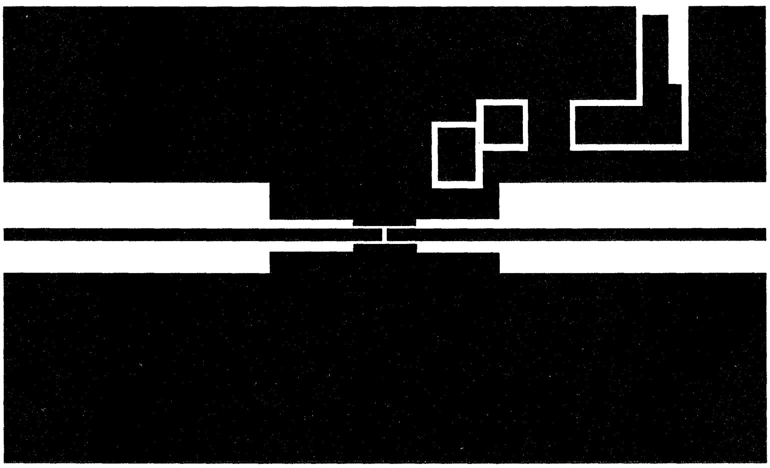


Figure 3. 800−900 Broadband Circuit



SCALE 0.75:1

Figure 4. 800−900 MHz Broadband Circuit Photomaster

2

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 150 mW	P_{in} = 100 mW	P_{out} = 806 MHz = 820 mW P_{out} = 870 MHz = 635 mW P_{out} = 960 MHz = 530 mW	P_{out} = 806 MHz = 1.05 mW P_{out} = 870 MHz = 855 mW P_{out} = 960 MHz = 580 mW
806	8.0 + j1.9	4.0 + j1.2	24.7 − j19.2	20.9 − j31.0
870	5.2 + j3.5	6.0 + j1.9	36.9 − j20.5	32.1 − j26.6
960	6.8 + j4.0	6.1 + j2.5	39.3 − j18.5	36.3 − j25.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Table 1. Series Equivalent Input/Output Impedance

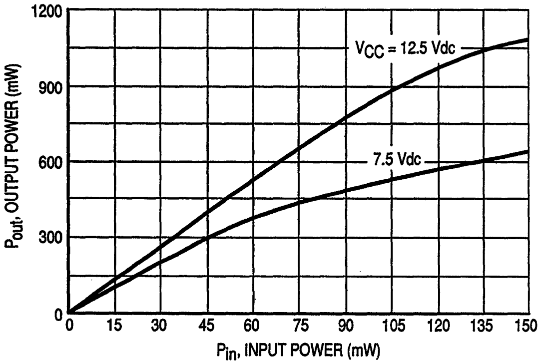


Figure 6. Output Power versus Input Power
f = 870 MHz

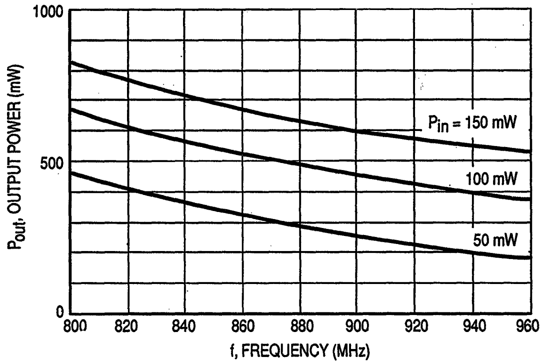


Figure 7. Output Power versus Frequency
V_{CC} = 7.5 Vdc

2

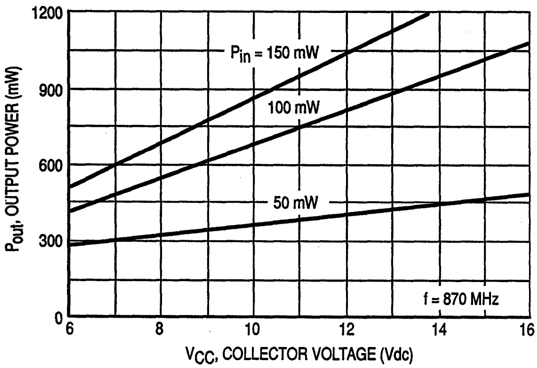


Figure 8. Output Power versus Collector Voltage

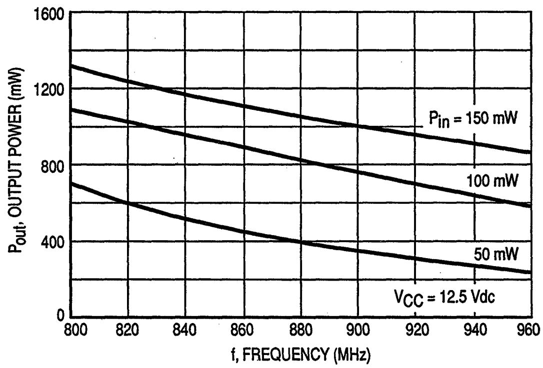


Figure 9. Output Power versus Frequency

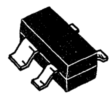
MRF9331LT1

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in low power amplifiers to 1.0 GHz. Ideal for pagers and other battery operated systems where low power consumption is critical.

- Low Power Consumption Characterized for I_E = 0.1 to 1.0 mA
- High Current-Gain — Bandwidth Product —
  f_T = 5.0 GHz (Typ) @ I_C = 1.0 mAdc
- Low Noise Figure and High Power Gain @ f = 1.0 GHz —
  NF(matched) = 2.5 dB (Typ)
  GNF(matched) = 12.5 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
  Lower Package Parasitics
  High Gain

I_C = 1.0 mA
SURFACE MOUNTED HIGH-FREQUENCY TRANSISTOR NPN SILICON



CASE 318A, STYLE 1
SOT-143
LOW PROFILE

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	8.0	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	2.0	mAdc
Total Device Dissipation @ T_C = 100°C Derate above 100°C	P_D	50 1.0	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W

DEVICE MARKING

MRF9331LT1 = 05

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	8.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Leakage Current (V_{EB} = 2.0 Vdc, I_C = 0)	I_{EBO}	—	—	0.1	mAdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = 0.5 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	30	80	200	—
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)	Figure 2	f_T	3.5	5.0	—	GHz
Collector-Base Capacitance (V_{CB} = 1.0 Vdc, I_E = 0, f = 1.0 MHz)	Figure 1	C_{cb}	—	0.21	0.3	pF
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure (V_{CE} = 1.0 Vdc, I_C = 0.5 mA, f = 1.0 GHz)	Figures 3, 5	G_{NFmin}	—	12.5	—	dB
Noise Figure (V_{CE} = 1.0 Vdc, I_C = 0.5 mA, f = 1.0 GHz)	Figures 3, 5	NF_{min}	—	2.5	—	dB

2

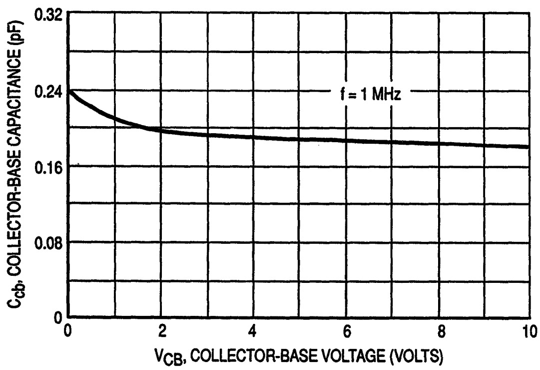


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

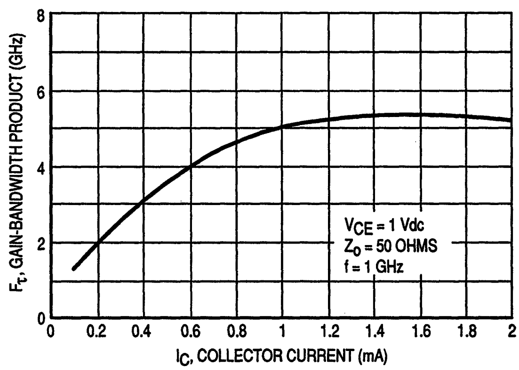


Figure 2. Current Gain-Bandwidth Product versus Collector Current

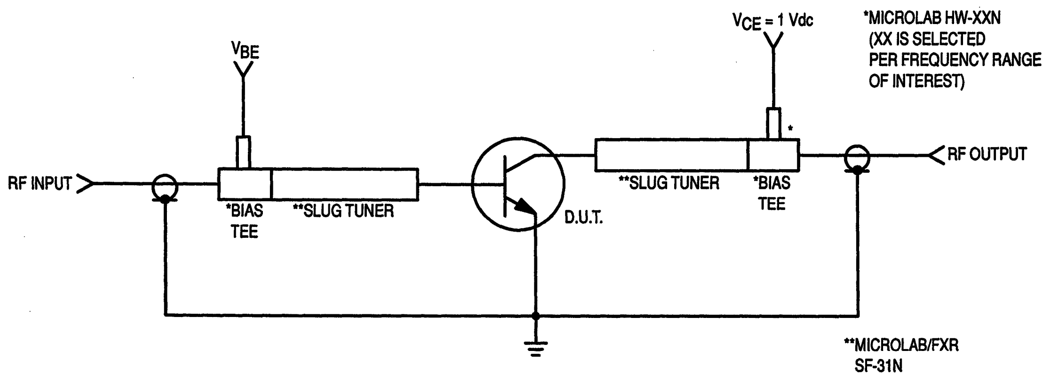


Figure 3. Functional Circuit Schematic

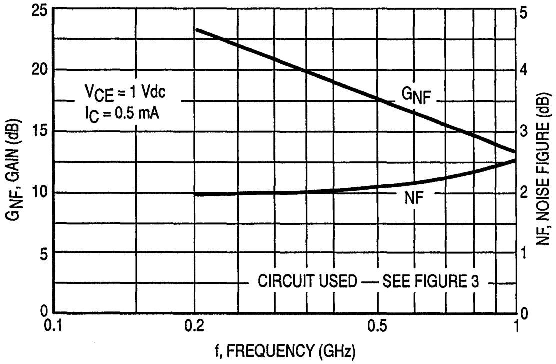


Figure 4. Gain and Noise Figure versus Frequency

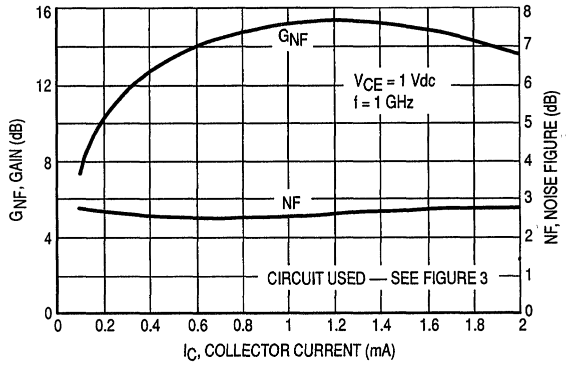


Figure 5. Gain and Noise Figure versus Collector Current

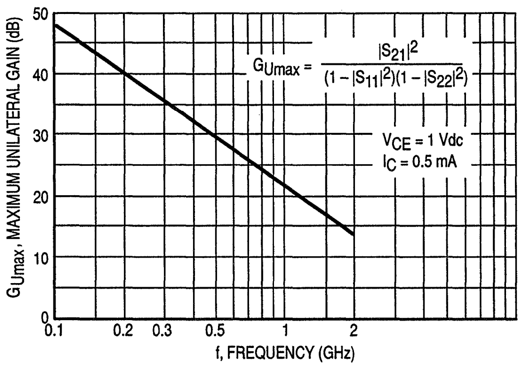


Figure 6. Maximum Unilateral Gain versus Frequency

2

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
1.0	0.1	100	0.99	−1.0	0.35	174	0.01	87	1.0	−1.0
		200	1.0	−3.0	0.35	171	0.03	86	1.0	−4.0
		500	0.97	−9.0	0.34	156	0.07	81	1.0	−9.0
		1000	0.98	−19	0.38	134	0.13	72	1.0	−21
		2000	0.98	−36	0.45	103	0.22	59	1.0	−38
	0.25	100	0.99	−1.0	0.77	175	0.01	86	1.0	−1.0
		200	1.0	−4.0	0.77	173	0.03	86	1.0	−4.0
		500	0.96	−11	0.73	160	0.06	79	0.99	−11
		1000	0.96	−23	0.75	140	0.13	70	0.98	−23
		2000	0.94	−42	0.77	110	0.21	56	0.93	−42
	0.5	100	0.99	−2.0	1.43	174	0.01	86	1.0	−1.0
		200	0.99	−5.0	1.42	172	0.03	84	1.0	−5.0
		500	0.95	−13	1.33	158	0.06	77	0.99	−12
		1000	0.92	−28	1.30	137	0.13	67	0.95	−25
		2000	0.83	−51	1.20	107	0.19	54	0.91	−43

(continued)

Table 1. Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
1.0	1.0	100	0.97	−3.0	2.68	173	0.01	85	1.0	−2.0
		200	0.97	−8.0	2.68	169	0.03	83	1.0	−6.0
		500	0.91	−19	2.42	152	0.06	74	0.96	−15
		1000	0.82	−37	2.22	128	0.11	62	0.89	−29
		2000	0.63	−59	1.74	97	0.17	53	0.80	−46
	2.0	100	0.93	−6.0	4.55	169	0.01	84	0.99	−4.0
		200	0.92	−13	4.3	163	0.03	81	0.98	−9.0
		500	0.81	−29	3.8	142	0.06	69	0.91	−19
		1000	0.62	−52	3.1	115	0.10	59	0.81	−31
		2000	0.40	−66	2.0	85	0.14	55	0.75	−44
3.0	0.1	100	0.99	−1.0	0.34	175	0.01	88	1.0	−1.0
		200	1.0	−3.0	0.34	172	0.03	86	1.0	−3.0
		500	0.99	−8.0	0.32	157	0.06	81	1.0	−9.0
		1000	0.99	−18	0.36	137	0.11	73	1.0	−20
		2000	1.0	−34	0.43	107	0.20	61	1.0	−37
	0.25	100	0.99	−1.0	0.76	175	0.01	86	1.0	−1.0
		200	1.0	−4.0	0.76	173	0.03	86	1.0	−4.0
		500	0.98	−10	0.72	161	0.06	80	1.0	−10
		1000	0.98	−21	0.75	143	0.11	72	0.99	−22
		2000	0.97	−40	0.75	113	0.19	59	0.98	−39
	0.5	100	0.99	−2.0	1.4	175	0.01	86	1.0	−1.0
		200	0.99	−5.0	1.42	172	0.03	84	1.0	−4.0
		500	0.96	−12	1.3	159	0.06	78	0.99	−11
		1000	0.93	−25	1.3	141	0.11	68	0.96	−23
		2000	0.87	−47	1.2	111	0.18	57	0.93	−41
	1.0	100	0.97	−3.0	2.67	174	0.01	85	1.0	−2.0
		200	0.98	−7.0	2.67	170	0.02	84	1.0	−6.0
		500	0.93	−17	2.42	154	0.06	76	0.97	−14
		1000	0.84	−34	2.29	133	0.10	65	0.91	−26
		2000	0.67	−55	1.82	101	0.16	56	0.85	−43
	2.0	100	0.95	−5.0	4.64	172	0.01	85	1.0	−3.0
		200	0.94	−10	4.62	166	0.02	81	0.99	−8.0
		500	0.85	−25	4.0	147	0.05	72	0.94	−17
		1000	0.69	−44	3.4	122	0.09	63	0.84	−29
		2000	0.48	−61	2.3	91	0.13	57	0.78	−42
5.0	0.1	100	1.0	0	0.36	175	0.01	85	1.0	−1.0
		200	1.0	−3.0	0.34	172	0.02	87	1.0	−3.0
		500	0.99	−8.0	0.32	158	0.06	82	1.0	−9.0
		1000	1.0	−17	0.36	138	0.11	74	1.0	−19
		2000	0.94	−35	0.42	108	0.20	63	1.0	−36
	0.25	100	1.0	−1.0	0.76	176	0.01	86	1.0	−1.0
		200	1.0	−3.0	0.76	174	0.02	86	1.0	−4.0
		500	0.97	−9.0	0.71	161	0.06	80	1.0	−10
		1000	0.97	−20	0.74	143	0.11	73	0.99	−21
		2000	0.97	−38	0.75	115	0.18	61	0.99	−38
	0.5	100	0.99	−1.0	1.4	175	0.01	86	1.0	−1.0
		200	1.0	−5.0	1.41	173	0.02	85	1.0	−4.0
		500	0.98	−12	1.3	159	0.06	79	0.99	−11
		1000	0.93	−25	1.3	141	0.10	70	0.97	−23
		2000	0.87	−45	1.2	111	0.17	58	0.94	−40
	1.0	100	0.98	−3.0	2.7	174	0.01	86	1.0	−2.0
		200	0.98	−7.0	2.7	170	0.02	84	1.0	−5.0
		500	0.93	−17	2.42	155	0.05	76	0.97	−13
		1000	0.85	−33	2.3	134	0.09	66	0.92	−26
		2000	0.67	−55	2.0	103	0.15	57	0.85	−42
	2.0	100	0.95	−4.0	4.6	172	0.01	86	1.0	−3.0
		200	0.94	−10	4.6	166	0.02	83	1.0	−7.0
		500	0.86	−24	3.9	148	0.05	73	0.94	−16
		1000	0.70	−43	3.4	123	0.09	64	0.86	−28
		2000	0.50	−60	2.3	92	0.13	59	0.80	−40

Table 1. Common Emitter S-Parameters (continued)

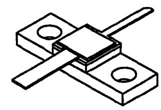
MRF10005

The RF Line
Microwave Power Transistor

. . . designed for CW and long pulsed common base amplifier applications, such as JTIDS and Mode S, in the 0.96 to 1.215 GHz frequency range at high overall duty cycles.

- Guaranteed Performance @ 1.215 GHz, 28 Vdc
  Output Power = 5.0 Watts CW
  Minimum Gain = 8.5 dB, 10.3 dB (Typ)
- RF Performance Curves given for 28 Vdc and 36 Vdc Operation
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**5.0 W, 960–1215 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 336E, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	55	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous (1)	I_C	1.25	mAdc
Total Device Dissipation @ T_A = 25°C (1) Derate above 25°C	P_D	25 143	Watt mW/°C
Storage Temperature Range	T_{stg}	–65 to +200	°C
Junction Temperature	T_J	200	°C

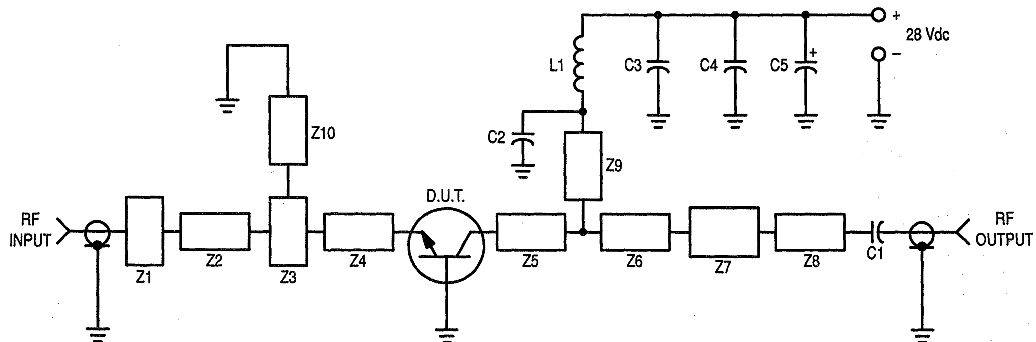
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7.0	°C/W

NOTES:
1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
2. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	7.0	10	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 1215 MHz)	G_{PB}	8.5	10.3	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 1215 MHz)	η	45	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 1215 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			



C1, C2, C3 — 220 pF 100 mil Chip Capacitor
C4 — 0.1 µF
C5 — 47 µF/50 V Electrolytic
L1 — 3 turn #18 AWG, 1/8″ ID, 0.18″ Long

Z1–Z10 — Microstrip, see details below
Board Material — 0.030″ Glass Teflon, 2.0 oz. Copper, ε_r = 2.55

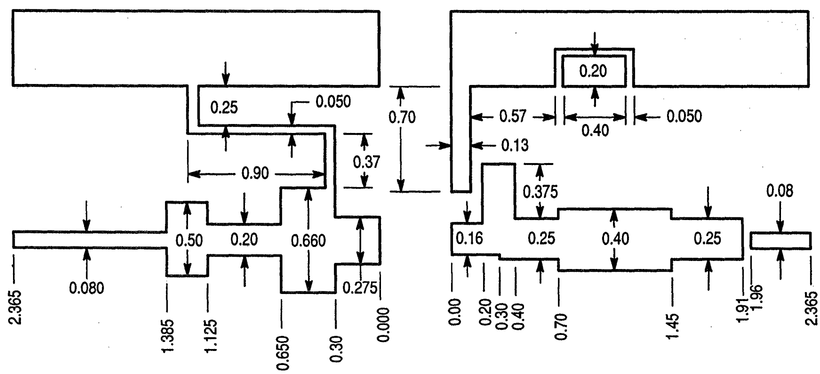


Figure 1. Test Circuit

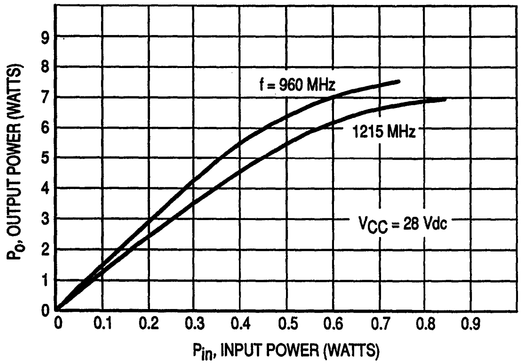


Figure 2. Output Power versus Input Power

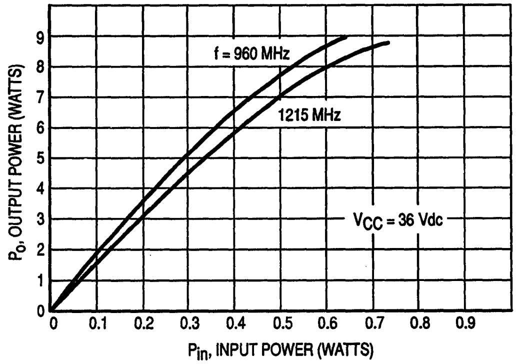
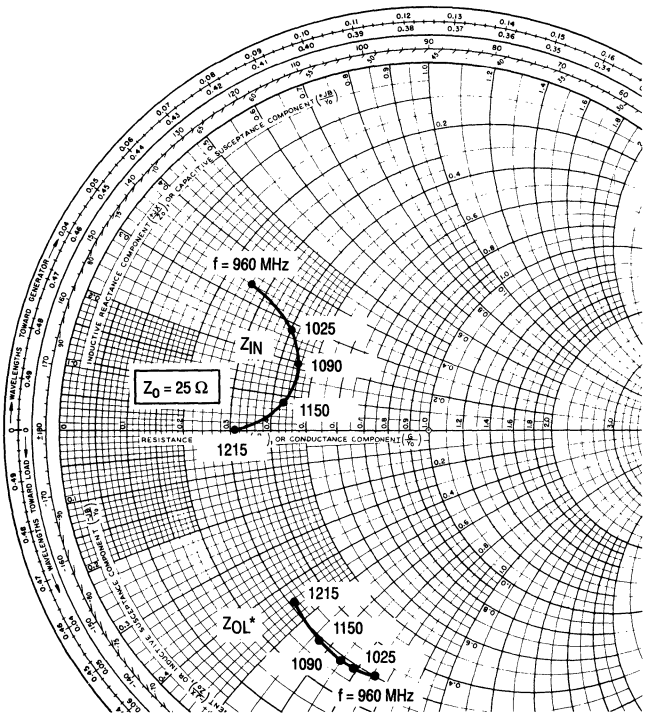


Figure 3. Output Power versus Input Power



P_{OUT} = 5 W V_{CC} = 28 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
960	6.5 + j8.5	7.4 – j18.9
1025	10.0 + j7.0	7.2 – j17.4
1090	11.2 + j4.9	7.1 – j16.3
1150	10.8 + j2.0	7.15 – j14.3
1215	7.8 + j0.0	7.8 – j11.2

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 4. Series Equivalent Input/Output Impedances

2

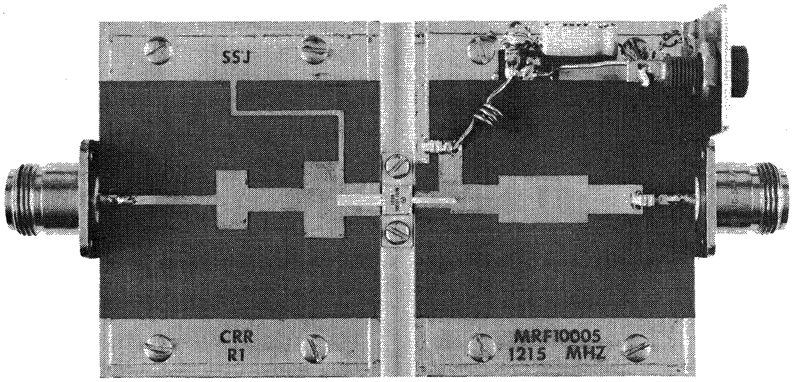


Figure 5. Test Amplifier

2

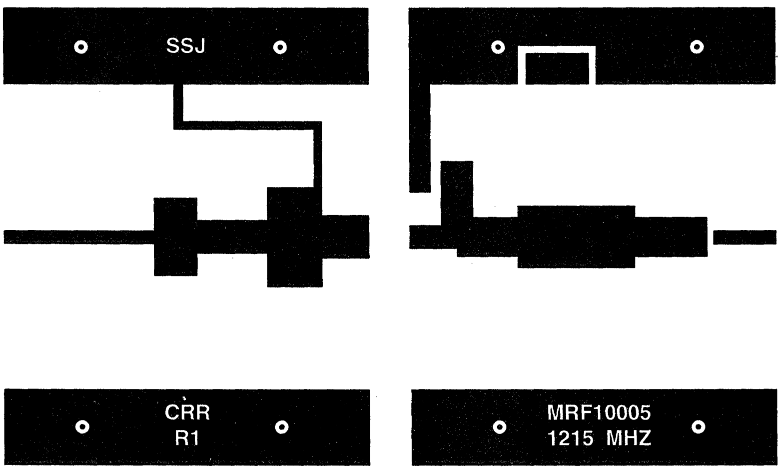


Figure 6. Printed Circuit Board Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

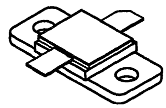
MRF10031

The RF Line
Microwave Long Pulse Power Transistor

30 W (PEAK)
960–1215 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON

Designed for 960–1215 MHz long or short pulse common base amplifier applications such as JTIDS and Mode-S transmitters.

- Guaranteed Performance @ 960 MHz, 36 Vdc
  Output Power = 30 Watts Peak
  Minimum Gain = 9.0 dB Min (9.5 dB Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation



CASE 376B, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	55	Vdc
Collector-Base Voltage (1)	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous (1)	I_C	3.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1), (2) Derate above 25°C	P_D	110 0.625	Watts mW/°C
Storage Temperature Range	T_{stg}	– 65 to + 200	°C
Junction Temperature	T_J	200	°C

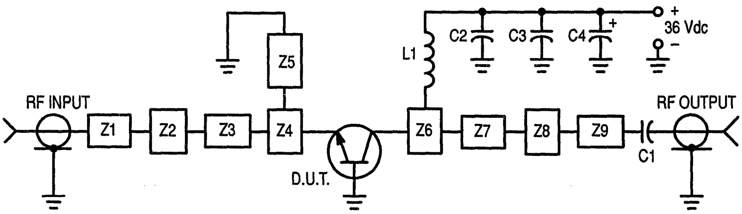
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	1.6	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques. (Worst case θ_{JC} value measured @ 23% duty cycle)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 36 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
FUNCTIONAL TESTS (10 μs Pulses @ 50% duty cycle for 3.5 ms; overall duty cycle – 25%)					
Common-Base Amplifier Power Gain (V_{CC} = 36 Vdc, P_{out} = 30 W Peak, f = 960 MHz)	G_{PB}	9.0	9.5	—	dB
Collector Efficiency (V_{CC} = 36 Vdc, P_{out} = 30 W Peak, f = 960 MHz)	η	40	45	—	%
Load Mismatch (V_{CC} = 36 Vdc, P_{out} = 30 W Peak, f = 960 MHz, VSWR = 10:1.All Phase Angles)	ψ	No Degradation in Output Power			



C1 — 75 pF 100 Mil Chip Capacitor
C2 — 39 pF 100 Mil Chip Capacitor
C3 — 0.1 μF
C4 — 1000 μF, 50 Vdc, Electrolytic
L1 — 3 Turns #18 AWG, 1/8″ ID, 0.18 Long

Z1–Z9 — Microstrip, See Details
Board Material — Teflon, Glass Laminate
Dielectric Thickness = 0.030″
ε_r = 2.55, 2 Oz. Copper

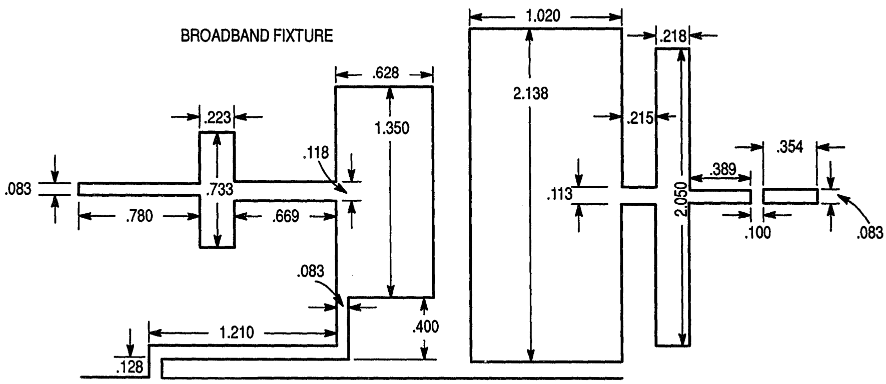


Figure 1. Test Circuit

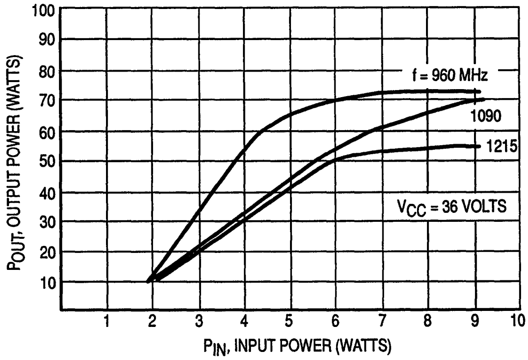
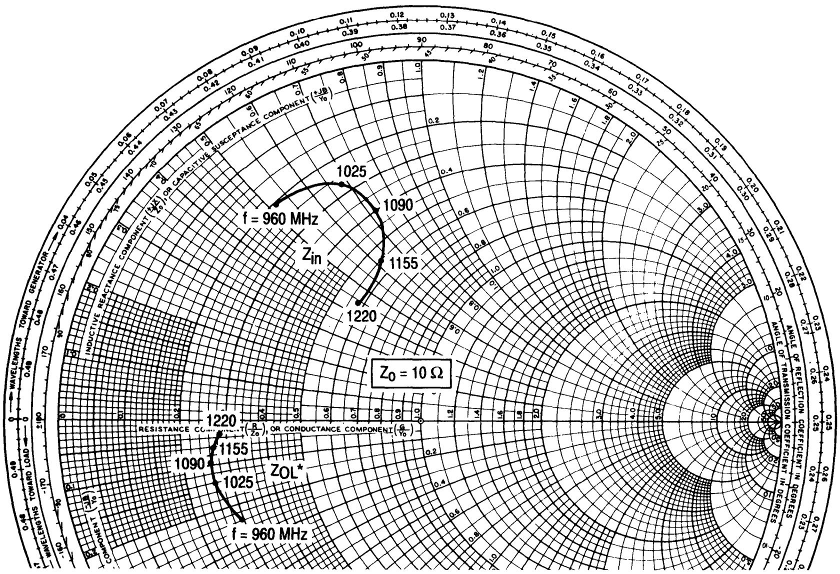


Figure 2. Output Power versus Input Power



P_{out} = 30 W Pk V_{CC} = 36 V

f MHz	Zin Ohms	Z_{OL}* Ohms
960	2.05 + j5.2	2.9 – j2.35
1025	2.67 + j6.34	2.55 – j1.3
1090	4.0 + j7.1	2.52 – j0.9
1155	5.5 + j6.2	2.6 – j0.6
1220	5.7 + j4.3	2.8 – j0.3

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 3. Series Equivalent Input/Output Impedances

2

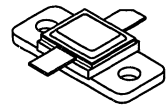
MRF10070

The RF Line
Microwave Pulse Power Transistor

Designed for 1025–1150 MHz pulse common base amplifier applications such as TCAS, TACAN and Mode-S transmitters.

- Guaranteed Performance @ 1090 MHz
  Output Power = 70 Watts Peak
  Gain = 9.0 dB Min
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Characterized with 10 μs, 10% Duty Cycle Pulses
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input and Output Matching
- Hermetically Sealed Package
- Recommended Driver for MRF10500 Transistor or a Pair of MRF10350 Transistors

70 W (PEAK)
1025 –1150 MHz
MICROWAVE POWER TRANSISTOR
NPN SILICON



CASE 376C, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	8.8	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	438 2.5	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to + 200	°C
Junction Temperature	T_J	200	°C

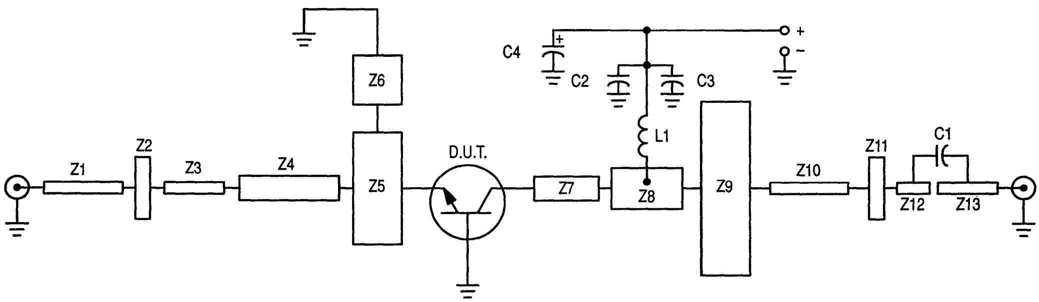
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.4	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques. (Worst case θ_{JC} value measured @ 10 μs, 10%.)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 70 W Peak, f = 1090 MHz)	G_{PB}	9.0	10	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 70 W Peak, f = 1090 MHz)	η	40	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 70 W Peak, f = 1090 MHz, Load VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power Before or After Test			



C1 — 82 pF 100 mil Chip Capacitor
C2 — 82 pF 100 mil Chip Capacitor
C3 — 0.1 µF
C4 — 100 µF/100 Vdc Electrolytic
L1 — 3 turns #18 AWG, 1/8″ ID, 0.18″ Long

Z1 – Z13 — Microstrip, see details below
Board Material — 0.030″ Glass Teflon®; 2 oz.
Cu clad; both sides; ϵ_r = 2.55

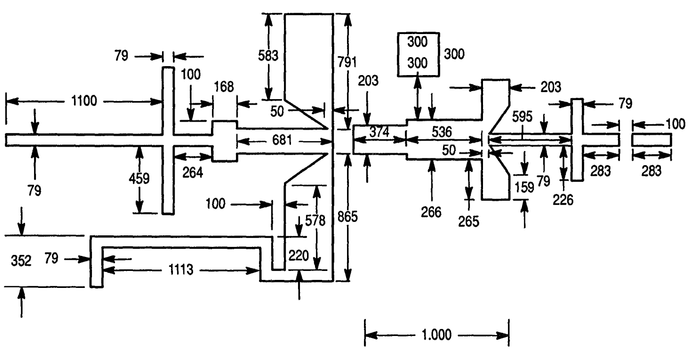


Figure 1. Test Circuit

2

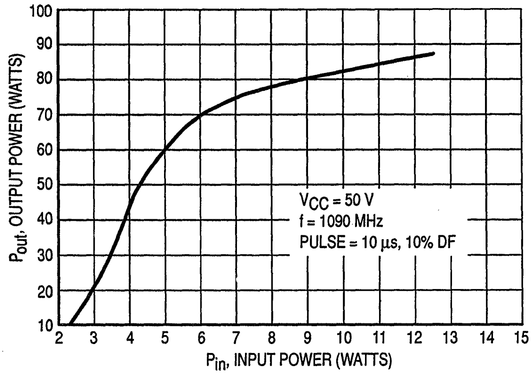
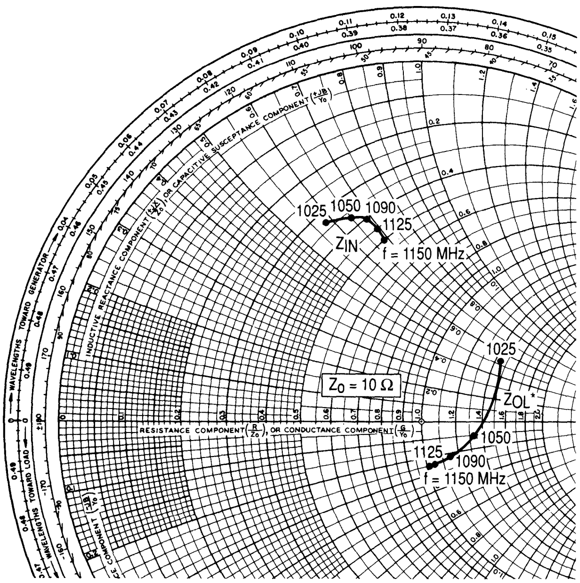


Figure 2. Output Power versus Input Power



P_{out} = 70 W Pk V_{CC} = 50 V

f MHz	ZIN OHMS	Z_{OL}* (Z_{OUT}) OHMS
1025	3.3 + j5.8	14.3 + j5.6
1050	3.6 + j6.5	13.3 – j1.0
1090	4.0 + j6.9	11.3 – j2.1
1125	4.5 + j6.9	10.4 – j2.5
1150	5.0 + j6.9	10.2 – j2.6

Z_{OL}* is the conjugate of the optimum load impedance into which the device operates at a given output power voltage and frequency.

Figure 3. Series Equivalent Input/Output Impedances

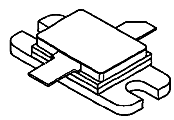
MRF10120

The RF Line
Microwave Long Pulse Power Transistor

. . . designed for 960–1215 MHz long pulse common base amplifier applications such as JTIDS and Mode S transmitters.

- Guaranteed Performance @ 1.215 GHz, 36 Vdc
  Output Power = 120 Watts Peak
  Gain = 8.0 dB Min., 9.2 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 3:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input and Output Matching for Broadband Operation

**120 W (PEAK), 960–1215 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 355C, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	55	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	380 2.17	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +200	°C
Junction Temperature	T_J	200	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.46	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

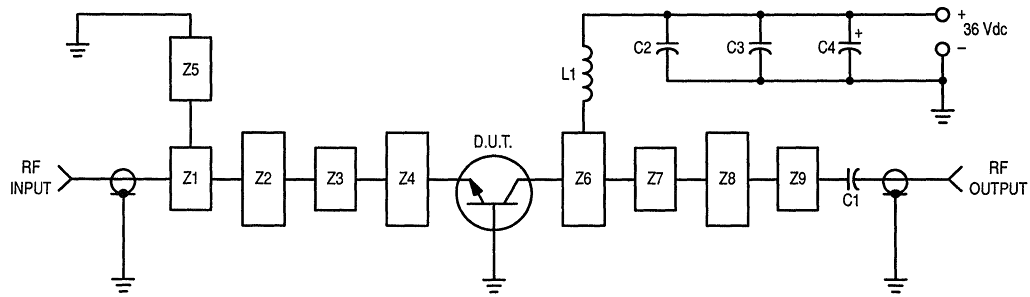
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 36 Vdc, I_E = 0)	I_{CBO}	—	—	25	mAdc

(continued)

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the device is operated as RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
FUNCTIONAL TESTS (7.0 μs Pulses @ 54% duty cycle for 3.4 ms; then off for 4.5 ms; overall duty cycle = 23%)					
Common-Base Amplifier Power Gain (V_{CC} = 36 Vdc, P_{out} = 120 W Peak, f = 1215 MHz)	G_{PB}	8.0	9.2	—	dB
Collector Efficiency (V_{CC} = 36 Vdc, P_{out} = 120 W Peak, f = 1215 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 36 Vdc, P_{out} = 120 W Peak, f = 1215 MHz, VSWR = 3:1 All Phase Angles)	ψ	No Degradation in Output Power			



C1 — 270 pF 100 Mil Chip Capacitor
C2 — 220 pF 100 Mil Chip Capacitor
C3 — 0.1 μF
C4 — 47 μF 50 V Electrolytic
L1 — 3 Turns #18 AWG, 1/8″ ID, 0.18 Long

Z1–Z9 — Microstrip, See Details
Board Material — Teflon®/Glass Laminate, Dielectric Thickness = 0.030″, ε_r = 2.55, 2 Oz. Copper

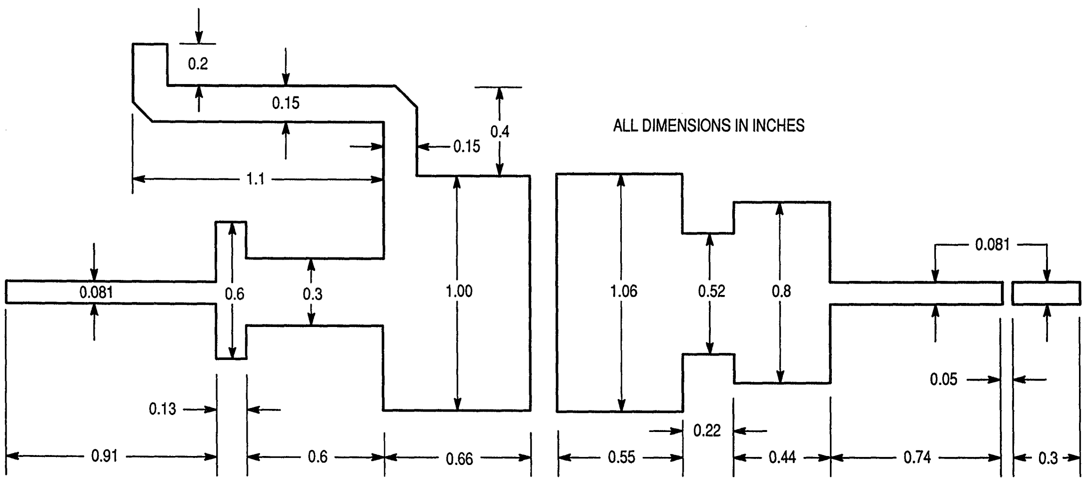


Figure 1. Test Circuit

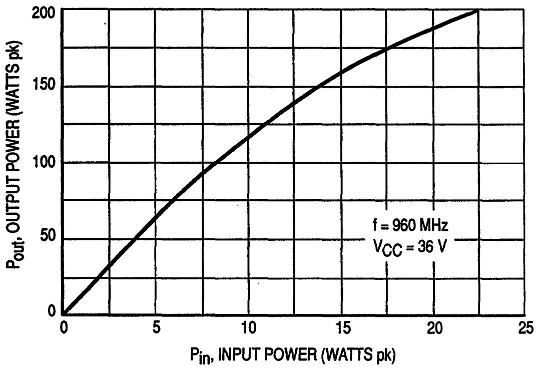


Figure 2. Output Power versus Input Power

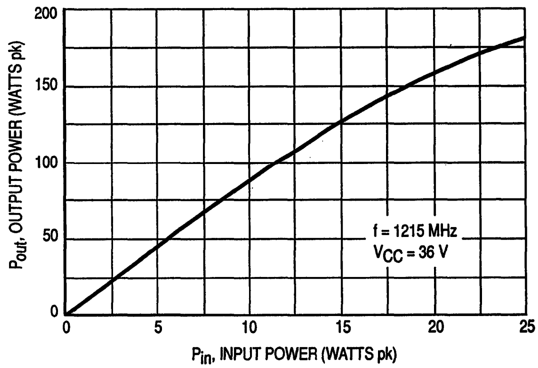
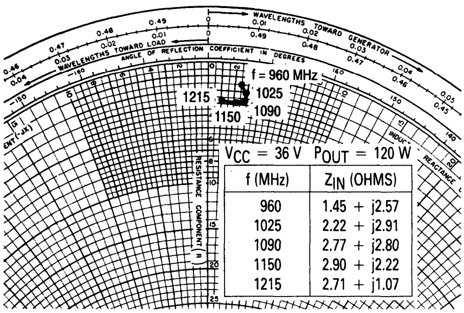
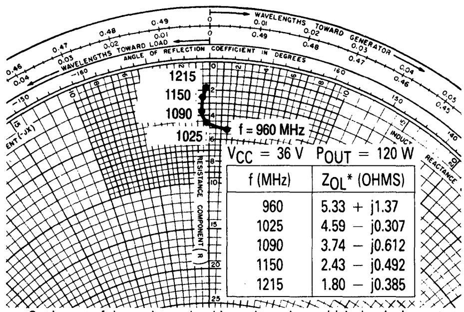


Figure 3. Output Power versus Input Power



f (MHz)	Z_{IN} (OHMS)
960	1.45 + j2.57
1025	2.22 + j2.91
1090	2.77 + j2.80
1150	2.90 + j2.22
1215	2.71 + j1.07

Figure 4. Series Equivalent Input Impedances



f (MHz)	Z_{OL}* (OHMS)
960	5.33 + j1.37
1025	4.59 − j0.307
1090	3.74 − j0.612
1150	2.43 − j0.492
1215	1.80 − j0.385

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 5. Series Equivalent Output Impedance

2

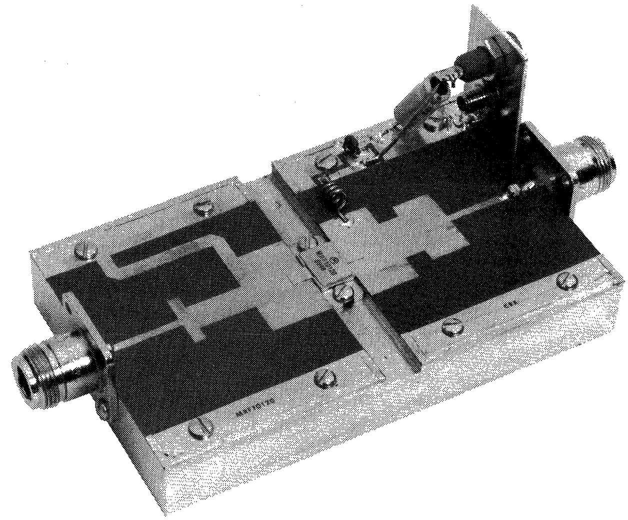


Figure 6. Test Amplifier

2

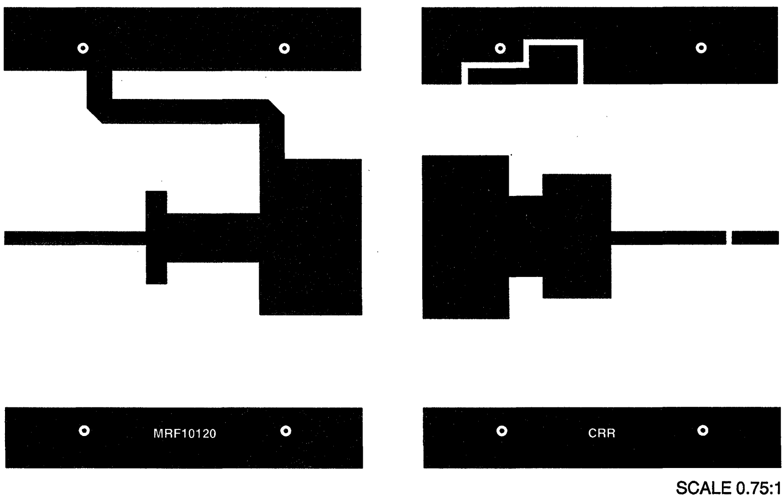


Figure 7. Printed Circuit Board Layout

MRF10150

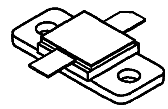
The RF Line

Microwave Pulse Power Transistor

. . . designed for 1025–1150 MHz pulse common base amplifier applications such as TCAS, TACAN and Mode-S transmitters.

- Guaranteed Performance @ 1090 MHz
  Output Power = 150 Watts Peak
  Gain = 9.5 dB Min, 10.0 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input and Output Matching
- Characterized with 10 µs, 10% Duty Cycle Pulses
- Recommended Driver for a Pair of MRF10500 Transistors

**150 W (PEAK)
1025–1150 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 376B, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	14	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	700 4.0	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +200	°C
Junction Temperature	T_J	200	°C

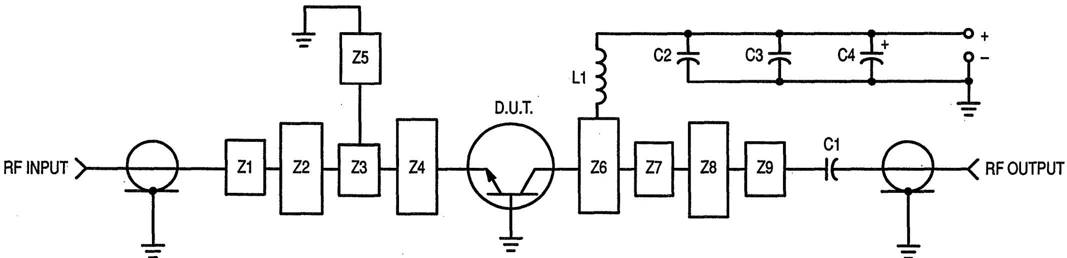
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.25	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques. (Worst case θ_{JC} value measured @ 10 µs, 10%.)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 36 Vdc, I_E = 0)	I_{CBO}	—	—	25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 150 W Peak, f = 1090 MHz)	G_{PB}	9.5	10	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W Peak, f = 1090 MHz)	η	40	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 150 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			



C1 — 82 pF 100 Mil Chip Capacitor
C2 — 39 pF 100 Mil Chip Capacitor
C3 — 0.1 µF
C4 — 100 µF, 100 Vdc, Electrolytic
L1 — 3 Turns #18 AWG, 1/8″ ID, 0.18 Long

Z1–Z9 — Microstrip, See Details
Board Material — Teflon Glass Laminate
Dielectric Thickness = 0.030″
ε_r = 2.55, 2 Oz. Copper

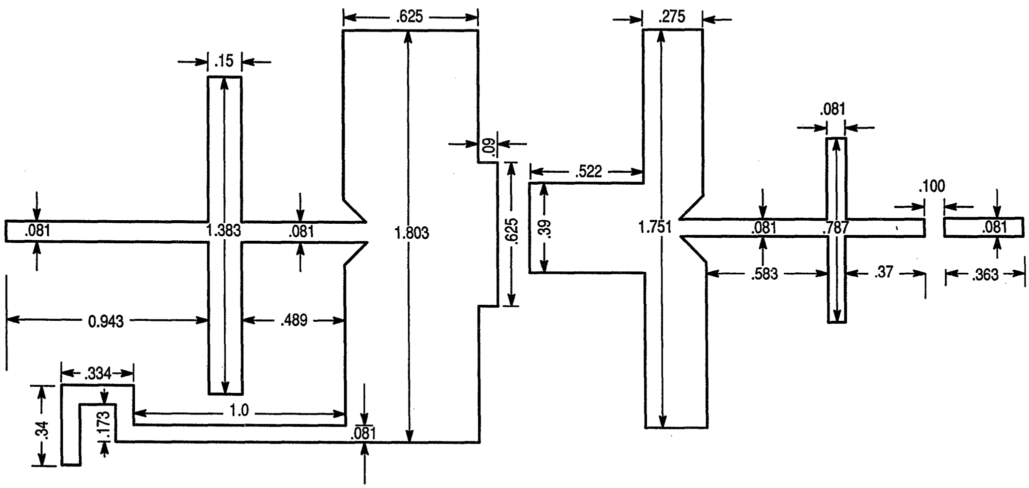


Figure 1. Test Circuit

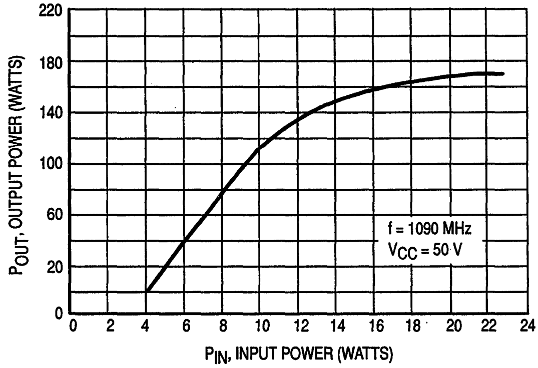
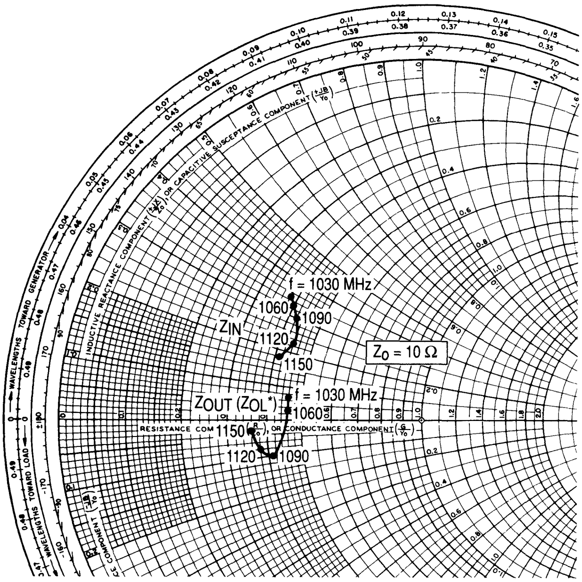


Figure 2. Output Power versus Input Power



P_{OUT} = 150 W Pk V_{CC} = 50 V

f MHz	ZIN OHMS	Z_{OL}* (Z_{OUT}) OHMS
1030	3.8 + j3.5	4.6 + j0.7
1060	4.0 + j3.3	4.6 + j0.3
1090	4.2 + j3.0	4.1 – j1.0
1120	4.4 + j2.3	3.8 – j0.8
1150	4.1 + j1.8	3.6 – j0.3

Z_{OL}* is the conjugate of the optimum load impedance into which the device operates at a given output power voltage and frequency.

Figure 3. Series Equivalent Input/Output Impedances

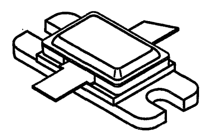
MRF10350

The RF Line
Microwave Pulse Power Transistor

. . . designed for 1025–1150 MHz pulse common base amplifier applications such as TCAS, TACAN and Mode-S transmitters.

- Guaranteed Performance @ 1090 MHz
  Output Power = 350 Watts Peak
  Gain = 8.5 dB Min, 9.0 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input and Output Matching
- Characterized using Mode-S Pulse Format

**350 W (PEAK)
1025–1150 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 355E, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	31	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	1590 9.1	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

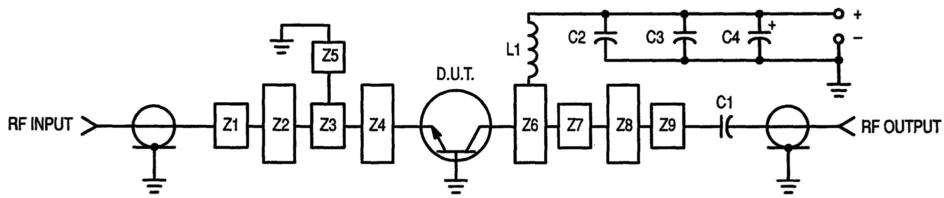
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.11	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques. (Worst Case θ_{JC} measured using Mode-S pulse train, 128 µs burst 0.5 µs on, 0.5 µs off repeating at 6.4 ms interval.)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 36 Vdc, I_E = 0)	I_{CBO}	—	—	25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 350 W Peak, f = 1090 MHz)	G_{PB}	8.5	9.0	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 350 W Peak, f = 1090 MHz)	η	40	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 350 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

2



C1 — 75 pF 100 Mil Chip Capacitor
C2 — 39 pF 100 Mil Chip Capacitor
C3 — 0.1 μF
C4 — 100 μF, 100 Vdc, Electrolytic
L1 — 3 Turns #18 AWG, 1/8″ ID, 0.18 Long

Z1–Z9 — Microstrip, See Details
Board Material — Teflon, Glass Laminate
Dielectric Thickness = 0.030″
ε_r = 2.55, 2 Oz. Copper

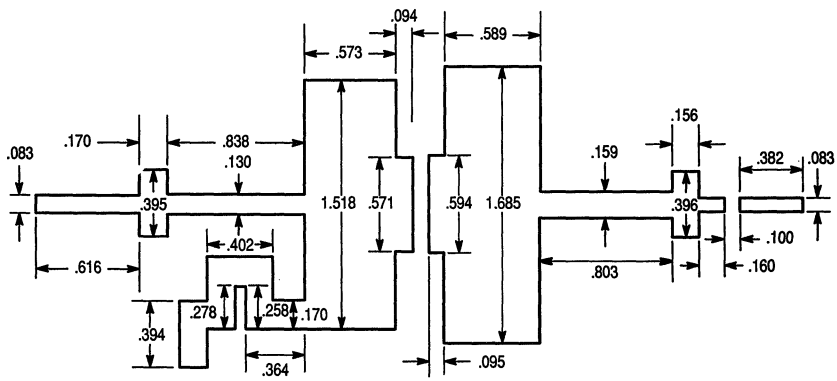
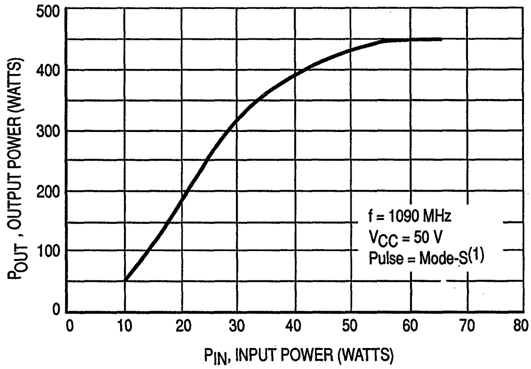
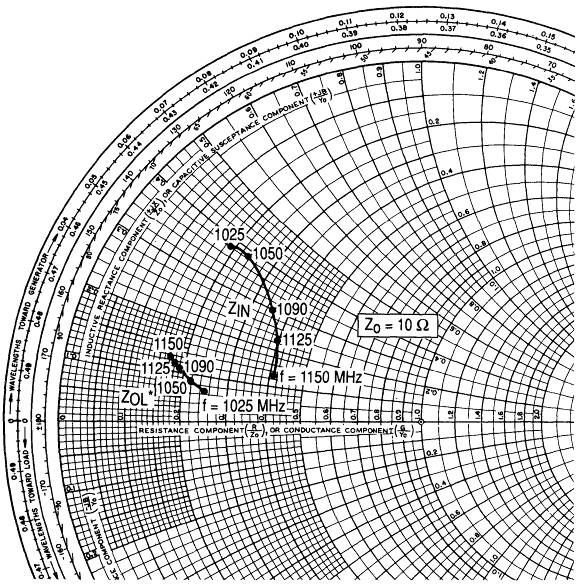


Figure 1. Test Circuit



(1) 128 µs burst 0.5 µs on, 0.5 µs off repeating at 6.4 ms interval.

Figure 2. Output Power versus Input Power



P_{OUT} = 350 W Pk V_{CC} = 50 V

f MHz	ZIN OHMS	Z_{OL}* (1) OHMS
1025	1.92 + j3.80	2.52 + j0.70
1050	2.44 + j3.92	2.18 + j0.85
1090	3.55 + j3.02	1.94 + j1.13
1125	4.11 + j2.27	1.80 + j1.22
1150	4.13 + j1.35	1.71 + j1.31

Z_{OL}* is the conjugate of the optimum load impedance into which the device operates at a given output power voltage and frequency.

Figure 3. Series Equivalent Input/Output Impedances

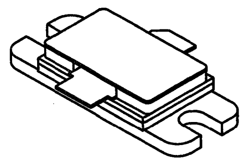
MRF10500

The RF Line
Microwave Pulse Power Transistor

. . . designed for 1025–1150 MHz pulse common base amplifier applications such as TCAS, TACAN and Mode-S transmitters.

- Guaranteed Performance @ 1090 MHz
  Output Power = 500 Watts Peak
  Gain = 8.5 dB Min, 9.0 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input and Output Matching
- Characterized with 10 µs, 1% Duty Cycle Pulses

**500 W (PEAK)
1025–1150 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 355D, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	29	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	1460 8.3	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +200	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

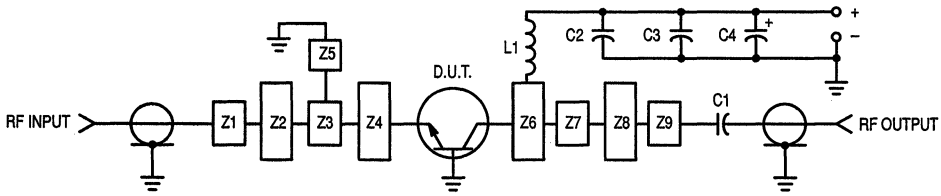
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.12	°C/W

NOTES:
1. Under pulse RF operating conditions.
2. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
3. Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques. (Worst case θ_{JC} value measured @ 32 µs, 2%.)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 60 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 36 Vdc, I_E = 0)	I_{CBO}	—	—	25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 500 W Peak, f = 1090 MHz)	G_{PB}	8.5	9.0	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 500 W Peak, f = 1090 MHz)	η	40	45	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 500 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

2



C1 — 82 pF 100 Mil Chip Capacitor
C2 — 39 pF 100 Mil Chip Capacitor
C3 — 0.1 μF
C4 — 100 μF, 100 Vdc, Electrolytic
L1 — 3 Turns #18 AWG, 1/8″ ID, 0.18 Long

Z1–Z9 — Microstrip, See Details
Board Material — Teflon, Glass Laminate
Dielectric Thickness = 0.030″
ε_r = 2.55, 2 Oz. Copper

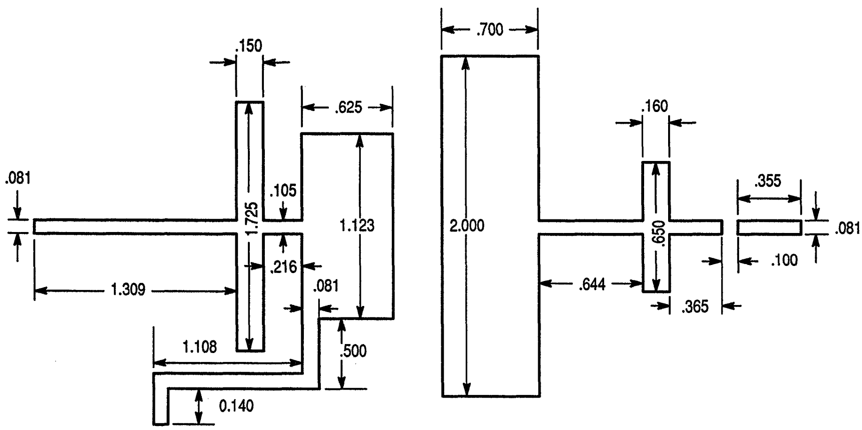


Figure 1. Test Circuit

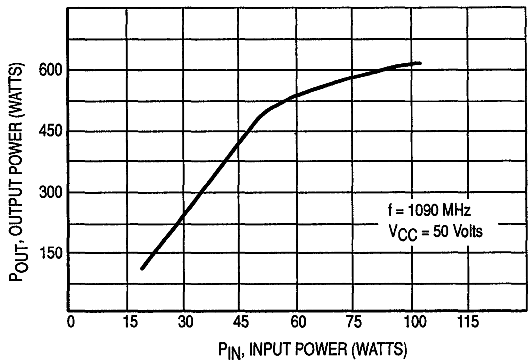
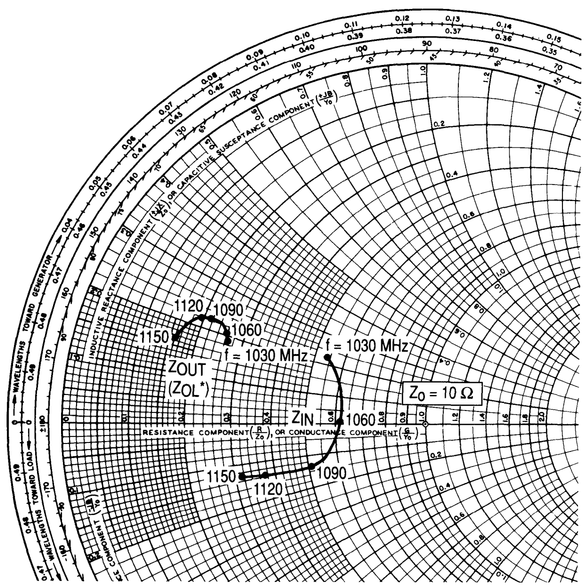


Figure 2. Output Power versus Input Power

2



P_{OUT} = 500 W Pk V_{CC} = 50 V

f MHz	ZIN OHMS	Z_{OL}* (Z_{OUT}) OHMS
1030	5.3 + j2.25	2.6 + j1.89
1060	6.2 + j0.2	2.56 + j2.0
1090	5.2 – j1.4	2.12 + j2.2
1120	3.7 – j1.35	1.9 + j2.15
1150	3.15 – j1.3	1.6 + j1.62

Z_{OL}* is the conjugate of the optimum load impedance into which the device operates at a given output power voltage and frequency.

Figure 3. Series Equivalent Input/Output Impedances

Advance Information

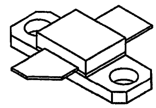
The RF Line

NPN Silicon RF Power Transistor

MRF15030

Motorola Preferred Device

**30 W, 1.5 GHz
RF POWER TRANSISTOR
NPN SILICON**



CASE 395C, STYLE 1

Designed for 26 volts microwave large-signal, common emitter, class A and class AB linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 1400–1600 MHz.

- Specified 26 Volts, 1490 MHz, Class AB Characteristics:
  Output Power — 30 Watts
  Gain — 9 dB Min @ 30 Watts (PEP)
  Efficiency — 30% Min @ 30 Watts (PEP)
  Intermodulation Distortion — –30 dBc Max @ 30 Watts (PEP)
- Third Order Intercept Point — 53.5 dBm Typ @ 1490 MHz, V_{CE} = 24 Vdc, I_C = 2.5 Adc
- Characterized with Series Equivalent Large-Signal Parameters from 1400–1600 MHz
- Characterized with Small Signal S-Parameters from 1000–2000 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 3:1 Load VSWR @ 28 Vdc, at Rated Output Power
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Emitter Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	125 0.71	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.40	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	29	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	64	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, R_{BE} = 100 Ω)	$V_{(BR)CER}$	30	52	—	Vdc

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS — continued					
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	5	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	35	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	30	38	50	pF
FUNCTIONAL TESTS (Figure 12)					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 30 W (PEP), I_{CQ} = 125 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	G_{pe}	9.0	9.6	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 30 W (PEP), I_{CQ} = 125 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	η	30	34	—	%
Intermodulation Distortion (V_{CC} = 26 Vdc, P_{out} = 30 W (PEP), I_{CQ} = 125 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	IMD	—	– 34	– 30	dBc
Input Return Loss (V_{CC} = 26 Vdc, P_{out} = 30 W (PEP), I_{CQ} = 125 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	IRL	12	15	—	dB
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 30 W (PEP), I_{CQ} = 125 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

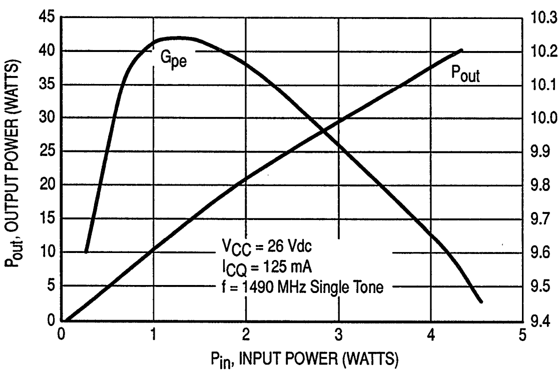


Figure 1. Output Power & Power Gain versus Input Power

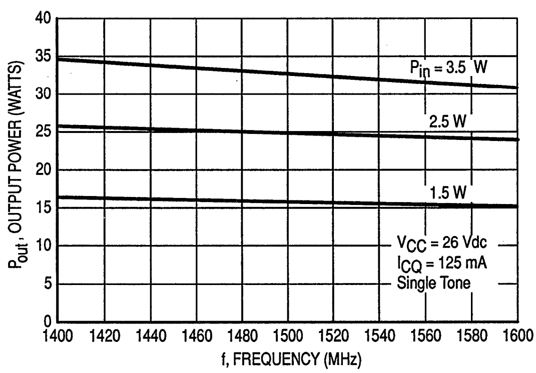


Figure 2. Output Power versus Frequency

TYPICAL CHARACTERISTICS

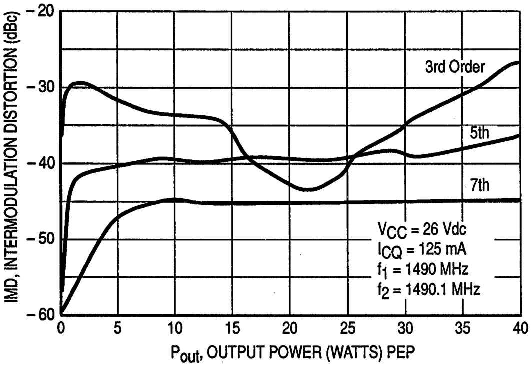


Figure 3. Intermodulation Distortion versus Output Power

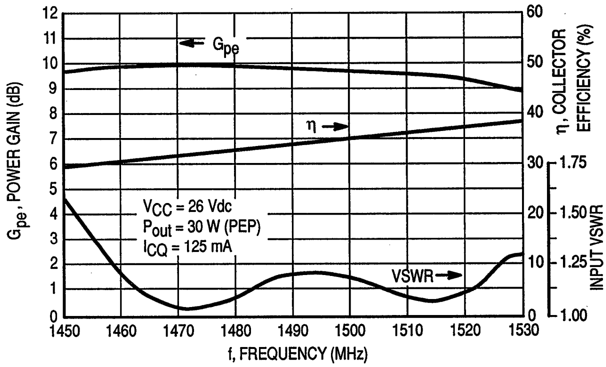


Figure 4. Performance in Broadband Circuit

2

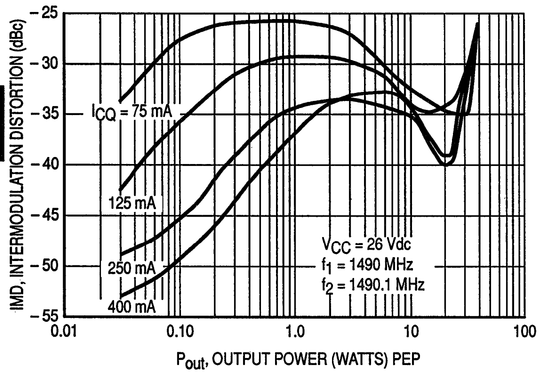


Figure 5. Intermodulation Distortion versus Output Power

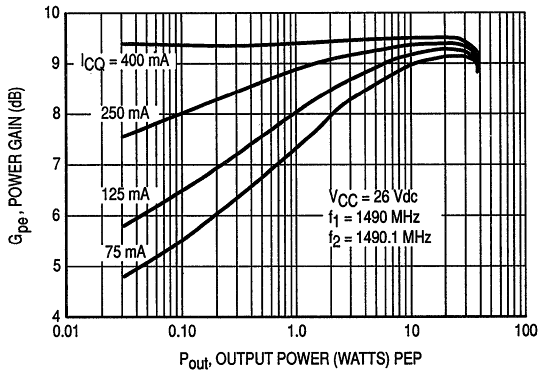


Figure 6. Power Gain versus Output Power

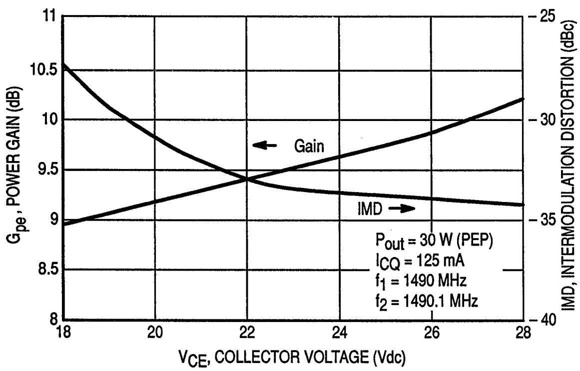


Figure 7. Power Gain and Intermodulation Distortion versus Collector Voltage

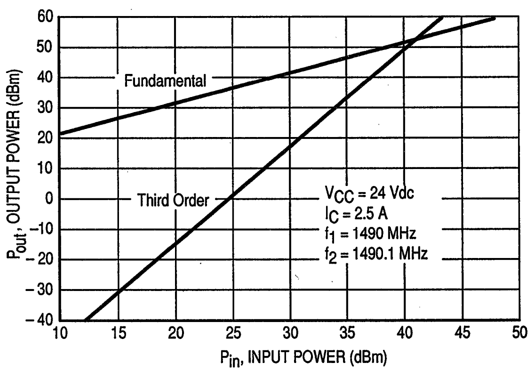


Figure 8. Class A Third Order Intercept Point

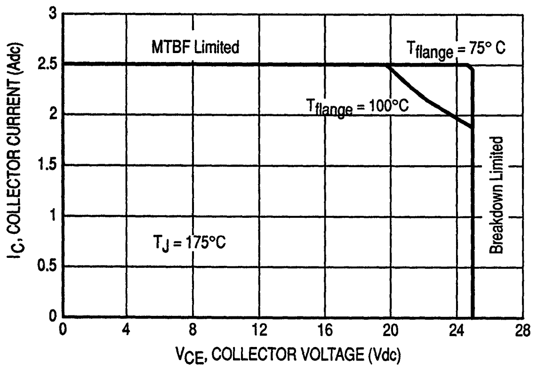


Figure 9. DC Safe Operating Area

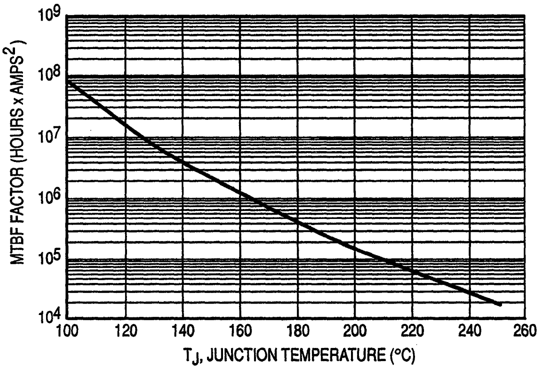
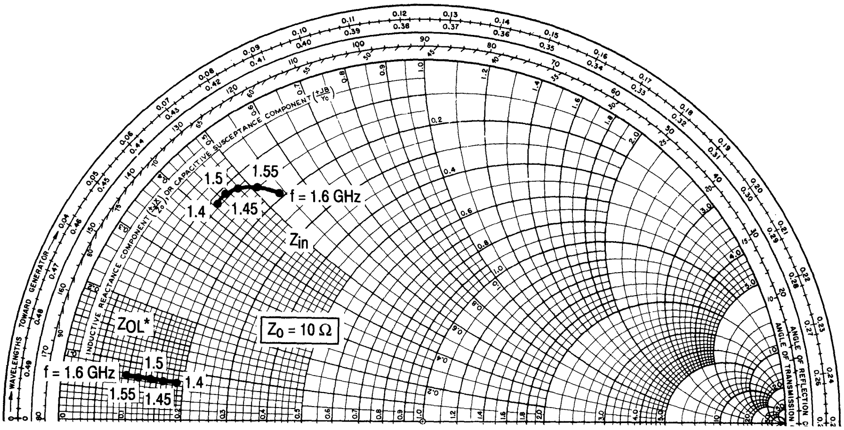


Figure 10. MTBF Factor versus Junction Temperature

The above graph displays calculated MTBF in hours x ampere^2 emitter current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTBF Factor by I_C^2 for MTBF in a particular application.

2



f (GHz)	Z_{in} (Ω)	Z^*_{OL} (Ω)
1.40	1.15 + j4.25	1.87 + j0.78
1.45	1.15 + j4.55	1.67 + j0.78
1.50	1.20 + j4.80	1.47 + j0.78
1.55	1.45 + j5.15	1.27 + j0.78
1.60	1.89 + j5.25	1.00 + j0.78

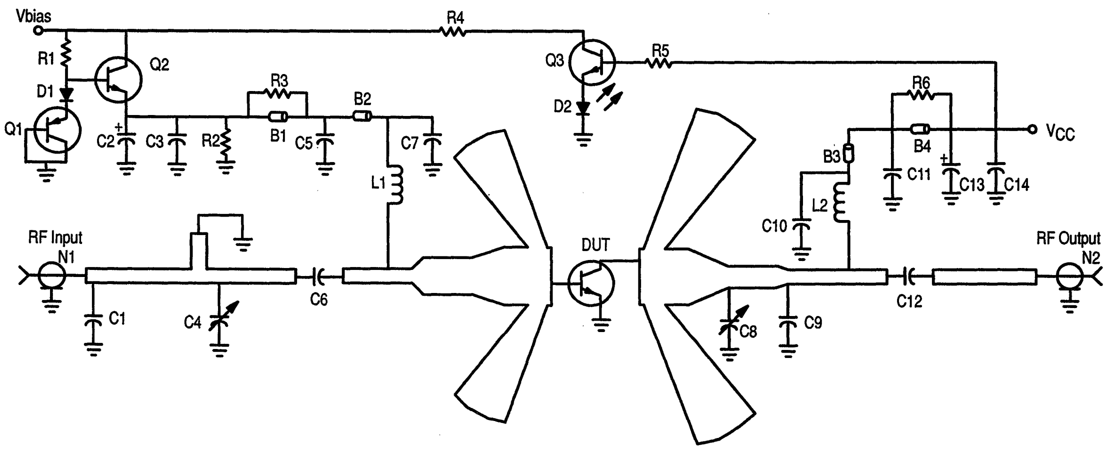
Z^*_{OL} = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 11. Input and Output Impedances with Circuit Tuned for Maximum Gain @ P_{out} = 30 Watts (PEP), V_{CC} = 26 Volts, I_{CQ} = 125 mA, and Driven by Two Equal Amplitude Tones with Separation of 100 KHz

Table 1. Small Signal S Parameters at V_{CE} = 24 Vdc, I_C = 2.5 Adc

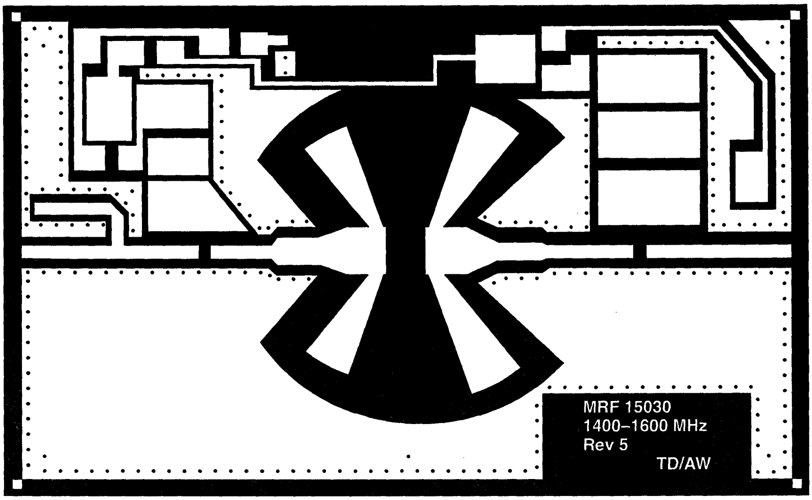
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\lvert S_{11}\rvert$	∠ φ	$\lvert S_{21}\rvert$	∠ φ	$\lvert S_{12}\rvert$	∠ φ	$\lvert S_{22}\rvert$	∠ φ
1000	0.983	173	0.366	49	0.006	36	0.890	178
1050	0.984	172	0.367	46	0.007	33	0.893	178
1100	0.978	172	0.367	43	0.007	33	0.888	178
1150	0.975	171	0.373	40	0.007	30	0.885	178
1200	0.975	171	0.382	36	0.008	31	0.886	177
1250	0.969	170	0.391	33	0.007	27	0.881	177
1300	0.963	169	0.408	29	0.008	21	0.879	177
1350	0.955	169	0.428	25	0.009	20	0.879	177
1400	0.945	168	0.452	20	0.008	7	0.873	177
1450	0.933	167	0.487	13	0.009	1	0.875	178
1500	0.915	166	0.525	6	0.009	- 8	0.875	178
1550	0.889	166	0.572	- 3	0.009	-18	0.877	178
1600	0.856	166	0.618	-16	0.009	- 35	0.887	178
1650	0.833	168	0.654	- 30	0.010	- 54	0.901	178
1700	0.820	171	0.654	- 48	0.010	- 86	0.918	178
1750	0.839	174	0.600	- 66	0.010	-120	0.930	177
1800	0.872	175	0.517	- 81	0.010	-152	0.932	176
1850	0.909	176	0.435	- 94	0.010	-176	0.925	174
1900	0.937	175	0.357	-104	0.011	159	0.924	173
1950	0.957	174	0.296	-112	0.012	148	0.917	173
2000	0.970	173	0.247	-119	0.012	136	0.915	173

2



B1, B4	Long Bead, Fair Rite	D1	Surface Mount Diode, Motorola
B2, B3	Short Bead, Fair Rite	D2	Light Emitting Diode, Industrial Devices
C1	0.3 pF, B Case Chip Capacitor, ATC	L1, L2	3 Turn, 20 AWG, 0.126″ ID Choke
C2	220 μF, Electrolytic Capacitor, Mallory	N1, N2	Type N Flange Mount RF Connector, Omni Spectra
C3, C14	0.1 μF, Chip Capacitor, Kemit	Q1	Transistor PNP Motorola (BD136)
C4, C8	0.8 to 8 pF, Variable Capacitor, Johanson	Q2, Q3	Surface Mount Transistor, NPN, Motorola (MJD47)
C5, C11	1800 pF, Chip Capacitor, Kemit	R1	2 x 330 Ω, 1/8 Watt Chip Resistors in Parallel, Rohm
C6, C12	18 pF, B Case Chip Capacitor, ATC	R2	100 Ω, 1/8 Watt, Chip Resistor, Rohm
C7, C10	51 pF, Chip Capacitor, Murata Erie	R3, R6	4 x 38 Ω, 1/8 Watt, Chip Resistors in Parallel, Rohm
C9	1.7 pF, B Case Chip Capacitor, ATC	R4	39 Ω, 1/8 Watt, Chip Resistor, Rohm
C13	470 μF, Electrolytic Capacitor, Mallory	R5	22 KΩ, 1/8 Watt, Chip Resistor, Rohm
		Board	Glass Teflon®, Arlon GX-0300-55-22, ε_r = 2.55

Figure 12. Class AB Broadband Test Fixture Electrical Schematic



SCALE 0.75:1

Figure 13. Photomaster for Broadband Class AB Test Fixture

2

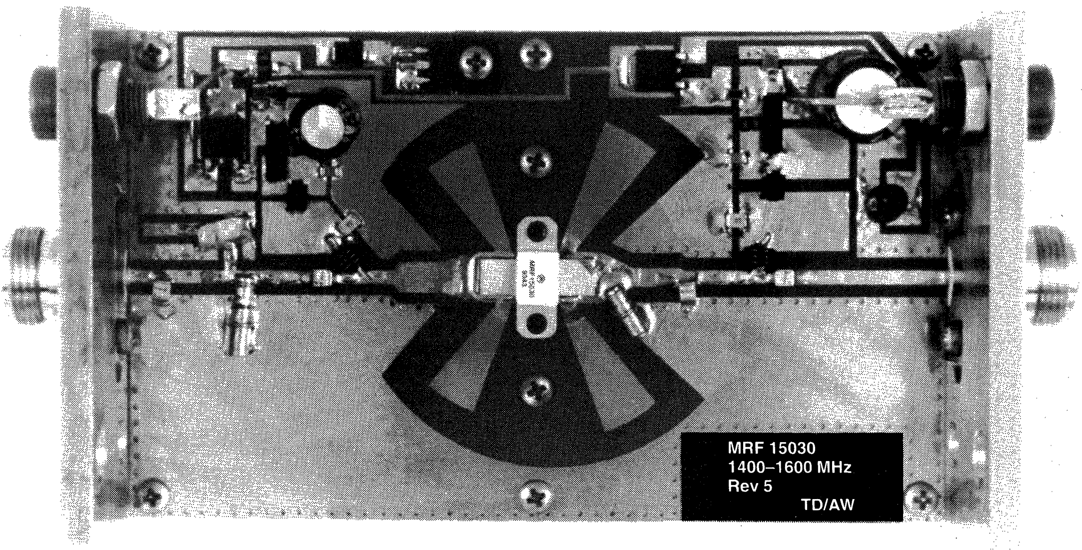
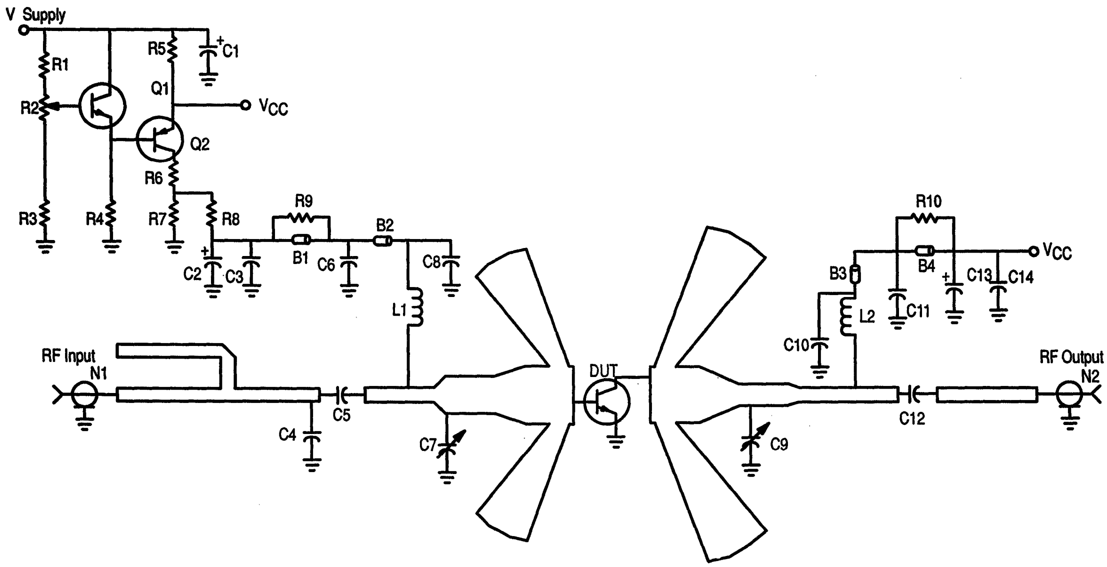
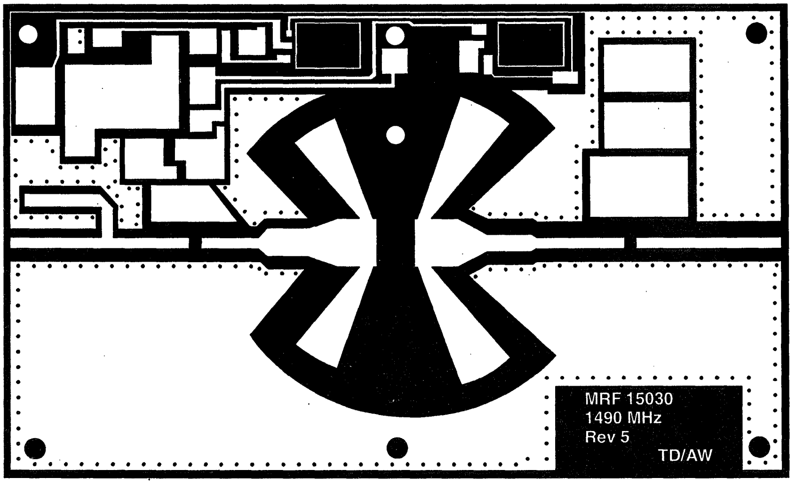


Figure 14. Broadband Class AB Test Fixture



B1, B4	Long Bead, Fair Rite	Q1	Transistor NPN Motorola (BD135)
B2, B3	Short Bead, Fair Rite	Q2	Transistor PNP Motorola (BD136)
C1, C2	100 µF, Electrolytic Capacitor, Mallory	R1	250 Ω, 1/8 Watt, Chip Resistor Rohm
C3, C14	0.1 µF, Chip Capacitor, Kemit	R2	500 Ω, 1/4 Watt Potentiometer, State of the Art
C4	1.3 pF, B Case Chip Capacitor, ATC	R3	4.7 KΩ, 1/8 Watt, Chip Resistor, Rohm
C5, C12	18 pF, B Case Chip Capacitor, ATC	R4	2 x 4.7 KΩ, 1/8 Watt, Chip Resistors in Parallel, Rohm
C6, C11	1800 pF, Chip Capacitor, Kemit	R5	1.0 Ω, 10 Watt, Resistor, Dale
C7, C9	0.8 to 8 pF, Variable Capacitor, Johanson	R6	38 Ω, 1.0 Watt, Resistor
C8, C10	51 pF, Chip Capacitor, Murata Erie	R7	75 Ω, 1/8 Watt, Chip Resistor, Rohm
C13	470 µF, Electrolytic Capacitor, Mallory	R8	2 x 10 Ω, 1/8 Watt, Chip Resistors in Parallel, Rohm
L1, L2	3 Turn, 20 AWG, 0.126″ ID Choke	R9, R10	4 x 38 Ω, 1/8 Watt, Chip Resistors in Parallel, Rohm
N1, N2	Type N Flange Mount RF Connector, Omni Spectra	Board	Glass Teflon®, Arlon GX-0300-55-22, $\varepsilon_r = 2.55$

Figure 15. Class A Test Fixture Electrical Schematic



SCALE 0.75:1

Figure 16. Photomaster for Class A Test Fixture

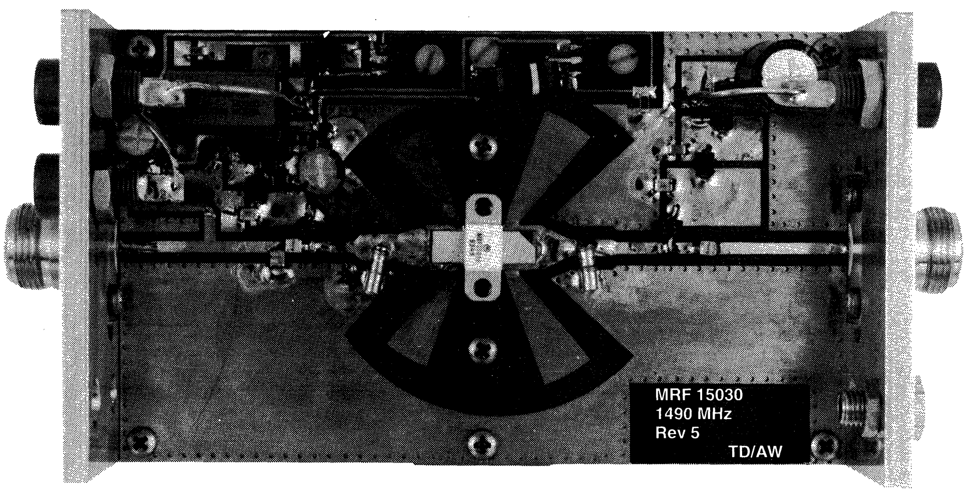


Figure 17. Class A Test Fixture

Advance Information

The RF Line
NPN Silicon RF Power Transistor

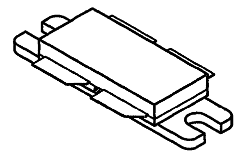
MRF15090

Motorola Preferred Device

**90 W, 1.5 GHz
RF POWER TRANSISTOR
NPN SILICON**

Designed for 26 volts microwave large-signal, common emitter, class A and class AB linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 1400–1600 MHz.

- Specified 26 Volts, 1490 MHz, Class AB Characteristics
  Output Power — 90 Watts (PEP)
  Gain — 7.5 dB Min @ 90 Watts (PEP)
  Collector Efficiency — 30% Min @ 90 Watts (PEP)
  Intermodulation Distortion — –28 dBc Max @ 90 Watts (PEP)
- Third Order Intercept Point — 56.5 dBm Typ @ 1490 MHz, V_{CE} = 24 Vdc, I_C = 5 Adc
- Characterized with Series Equivalent Large-Signal Parameters from 1400–1600 MHz
- Characterized with Small-Signal S-Parameters from 1000–2000 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at All Phase Angles with 3:1 Load VSWR @ 28 Vdc, and Rated Output Power
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration



CASE 375A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Emitter Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous @ $T_{J(max)}$ = 150°C	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.70	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	28	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	65	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, R_{BE} = 100 Ω)	$V_{(BR)CER}$	30	—	—	Vdc

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS — continued					
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	4.8	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	40	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1 MHz) – For Information Only. This Part Is Collector Matched.	C_{ob}	—	52	—	pF
FUNCTIONAL TESTS (Figure 12)					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 90 W (PEP), I_{CQ} = 250 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	G_{pe}	7.5	8.3	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 90 W (PEP), I_{CQ} = 250 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	η	30	36	—	%
Intermodulation Distortion (V_{CC} = 26 Vdc, P_{out} = 90 W (PEP), I_{CQ} = 250 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	IMD	—	–32	–28	dBc
Input Return Loss (V_{CC} = 26 Vdc, P_{out} = 90 W (PEP), I_{CQ} = 250 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz)	IRL	12	15	—	dB
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 90 W (PEP), I_{CQ} = 250 mA, f_1 = 1490 MHz, f_2 = 1490.1 MHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

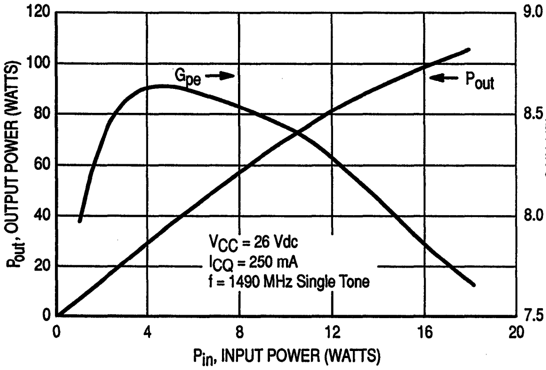


Figure 1. Output Power & Power Gain versus Input Power

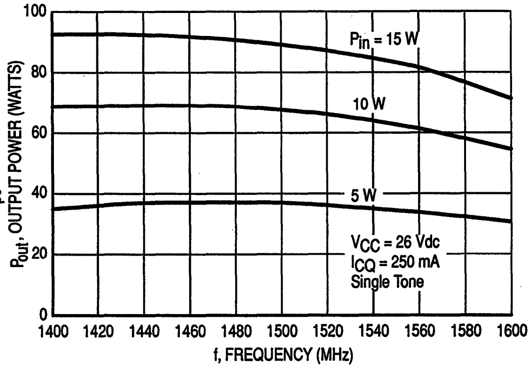


Figure 2. Output Power versus Frequency

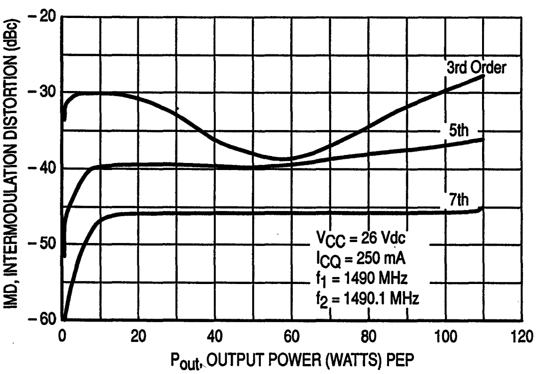


Figure 3. Intermodulation Distortion versus Output Power

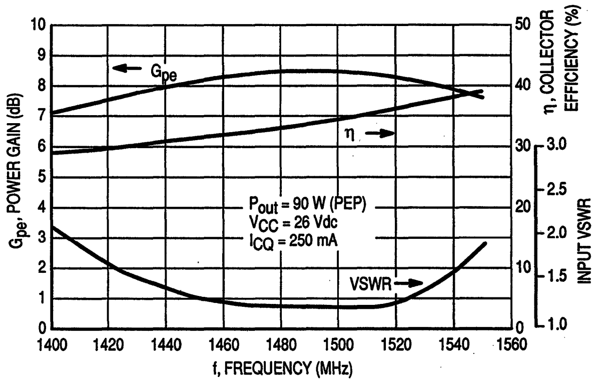


Figure 4. Performance in Broadband Circuit

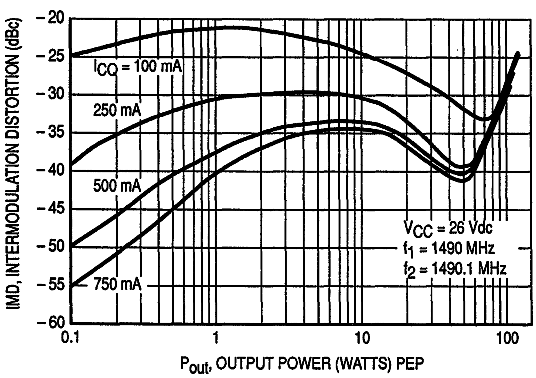


Figure 5. Intermodulation Distortion versus Output Power

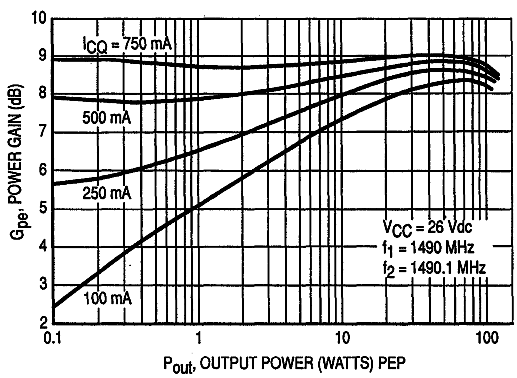


Figure 6. Power Gain versus Output Power

TYPICAL CHARACTERISTICS

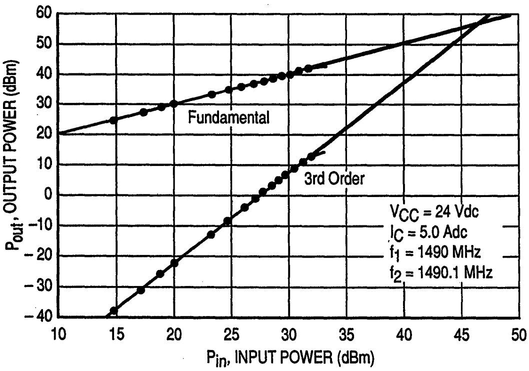


Figure 7. Class A Third Order Intercept Point

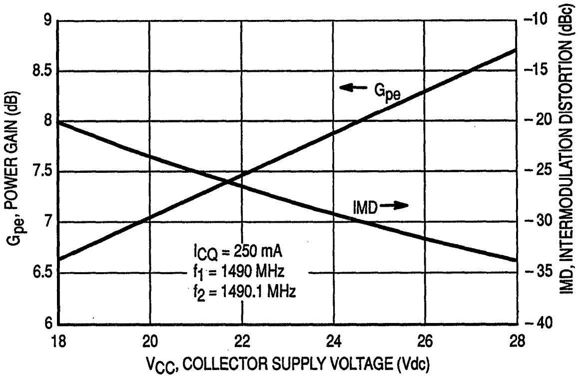


Figure 8. Power Gain and Intermodulation Distortion versus Supply Voltage

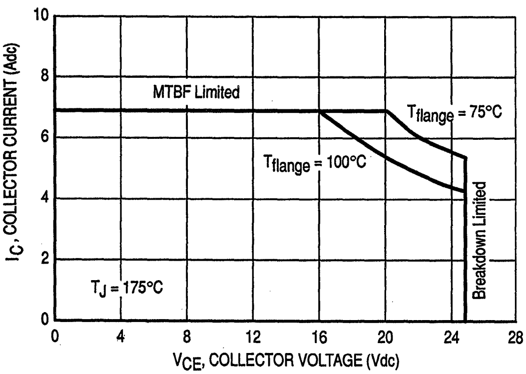


Figure 9. DC Safe Operating Area

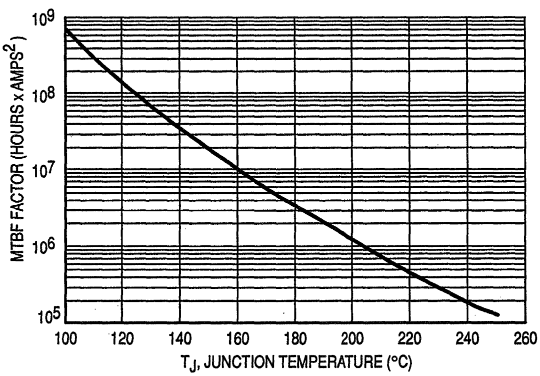
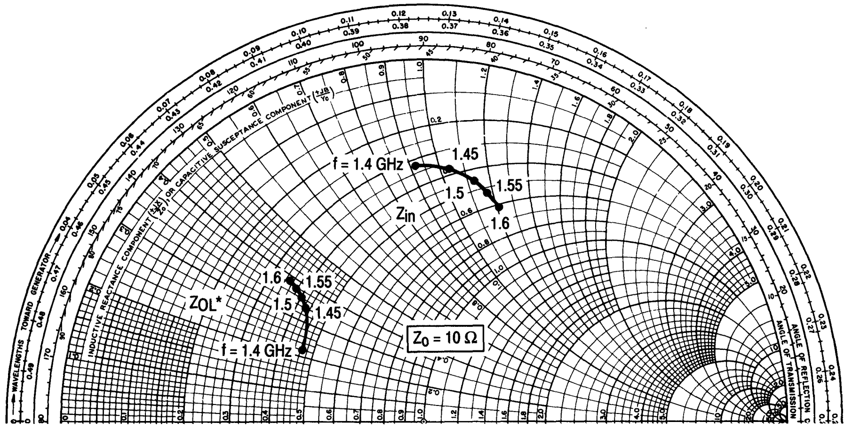


Figure 10. MTBF Factor versus Junction Temperature

The graph above displays calculated MTBF in hours x ampere^2 emitter current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTBF Factor by $I_C{}^2$ for MTBF in a particular application.



f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
1400	3.28 + j9.07	4.62 + j2.23
1450	3.85 + j10.4	4.35 + j3.41
1500	4.55 + j11.4	4.08 + j3.60
1550	5.45 + j11.9	3.80 + j3.78
1600	6.20 + j12.2	3.55 + j3.84

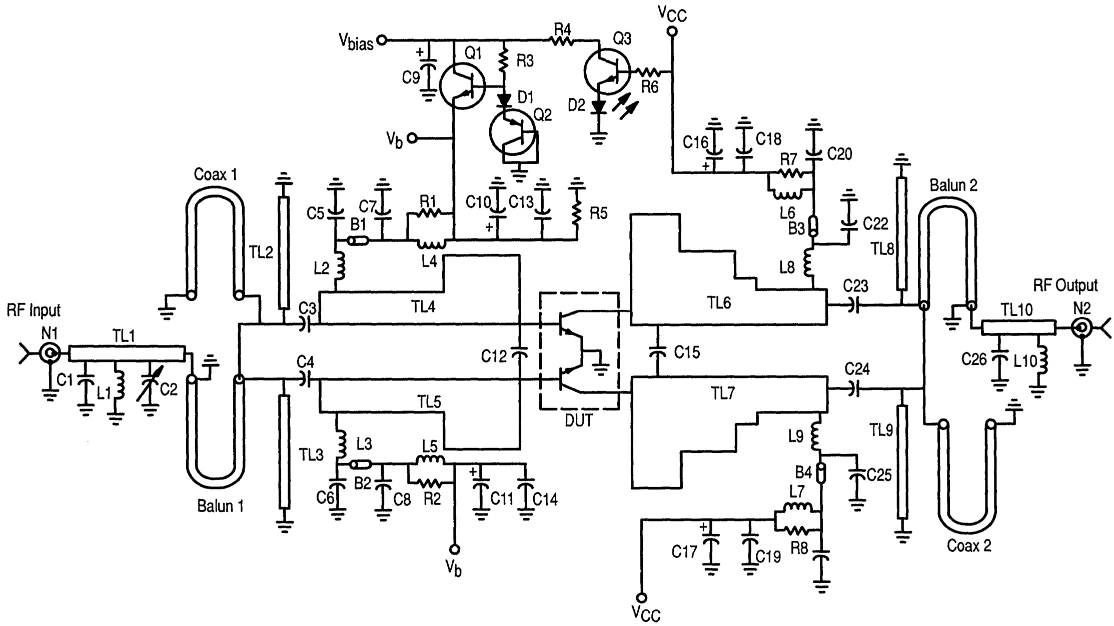
Z_{in} = Input impedance is a balanced base to base measurement.

Z_{OL}* = Conjugate of optimum load impedance collector to collector into which the device operates at a given output power, bias current, voltage and frequency.

Figure 11. Input and Output Impedances with Circuit Tuned for Maximum Gain @ P_{out} = 90 Watts (PEP), V_{CC} = 26 Volts, I_{CQ} = 250 mA, and Driven by Two Equal Amplitude Tones with Separation of 100 KHz

Table 1. Common Emitter S-Parameters (for One Side of Push-Pull MRF15090) at V_{CE} = 24 Vdc, I_C = 2.5 Adc

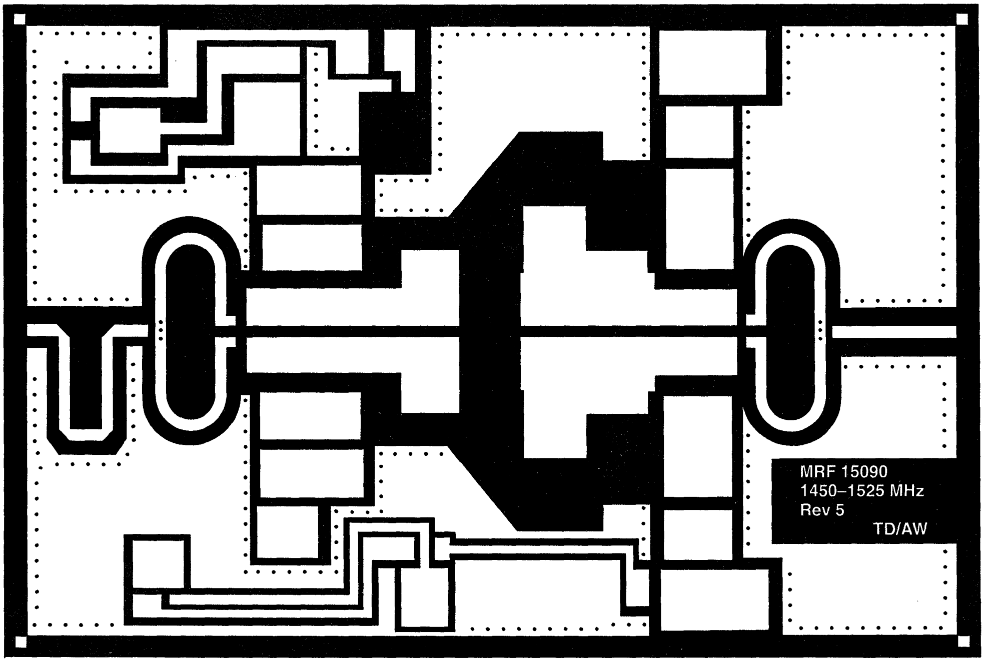
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
1000	0.999	172	0.164	108	0.006	72	0.957	173
1050	0.999	171	0.179	103	0.007	69	0.956	172
1100	0.994	170	0.196	97	0.007	66	0.948	172
1150	0.992	170	0.216	92	0.008	63	0.940	171
1200	0.994	169	0.241	86	0.008	62	0.935	171
1250	0.986	168	0.269	80	0.009	57	0.924	170
1300	0.982	167	0.306	73	0.010	51	0.915	170
1350	0.973	166	0.351	66	0.011	45	0.905	170
1400	0.957	164	0.408	56	0.012	33	0.888	170
1450	0.938	163	0.483	44	0.013	22	0.876	170
1500	0.903	162	0.571	29	0.014	7	0.859	171
1550	0.857	163	0.651	10	0.014	−13	0.855	173
1600	0.821	165	0.673	−14	0.013	−40	0.877	174
1650	0.837	169	0.623	−37	0.011	−67	0.902	174
1700	0.872	170	0.529	−56	0.009	−104	0.922	173
1750	0.901	170	0.437	−70	0.008	−138	0.931	172
1800	0.920	170	0.363	−81	0.007	−165	0.932	171
1850	0.940	169	0.309	−90	0.008	173	0.930	170
1900	0.954	169	0.265	−98	0.008	150	0.932	169
1950	0.965	168	0.232	−104	0.009	139	0.930	169
2000	0.971	167	0.205	−110	0.010	132	0.929	168



B1, B2, B3, B4	Ferrite Bead, Ferroxcube	L1	1 Turn, 24 AWG, 0.042″ ID Choke
C1	2.7 pF, B Case Chip Capacitor, ATC	L2, L3, L8, L9	3 Turn, 20 AWG, 0.126″ ID Choke
C2	0.6–4.0 pF, Variable Capacitor, Johanson	L4, L5, L6, L7	12 Turns, 22 AWG, 0.140″ ID Choke
C3, C4, C23, C24	18 pF, B Case Chip Capacitor, ATC	L10	3 Turns, 24 AWG, 0.046″ ID Choke
C5, C6, C22, C25	51 pF, Chip Capacitor, Murata Erie	N1, N2	Type N Flange Mount RF Connector, Omni Spectra
C7, C8, C20, C21	1800 pF, Chip Capacitor, Kemit	Q1, Q3	Transistor, NPN, Motorola (MJD47)
C9, C10, C11	100 μF, Electrolytic Capacitor, Mallory	Q2	Transistor PNP Motorola (BD136)
C12	5.1 pF, A Case Chip Capacitor, ATC	R1, R2, R7, R8	10 Ω, 1/2 W, Resistor
C13, C14, C18, C19	0.1 μF, Chip Capacitor, Kemit	R3	150 Ω, 1/2 W, Resistor
C15	1.1 pF, B Case Chip Capacitor, ATC	R4	2 x 66 Ω, 1/8 W, Chip Resistors in Parallel, Rohm
C16, C17	470 μF, Electrolytic Capacitor, Mallory	R5	93 Ω, 1/8 W, Chip Resistor, Rohm
C26	0.3 pF, B Case Chip Capacitor, ATC	R6	22 KΩ, 1/8 W, Chip Resistor, Rohm
D1	Diode, Motorola (MUR5120T3)	TL1 to TL10	See Photomaster
D2	Light Emitting Diode, Industrial Devices	Board	Glass Teflon®, Arlon GX-0300-55-22, ε_r = 2.55

Figure 12. Class AB Test Fixture Electrical Schematic

2



SCALE 0.75:1

Figure 13. Photomaster for Class AB Broadband Test Fixture

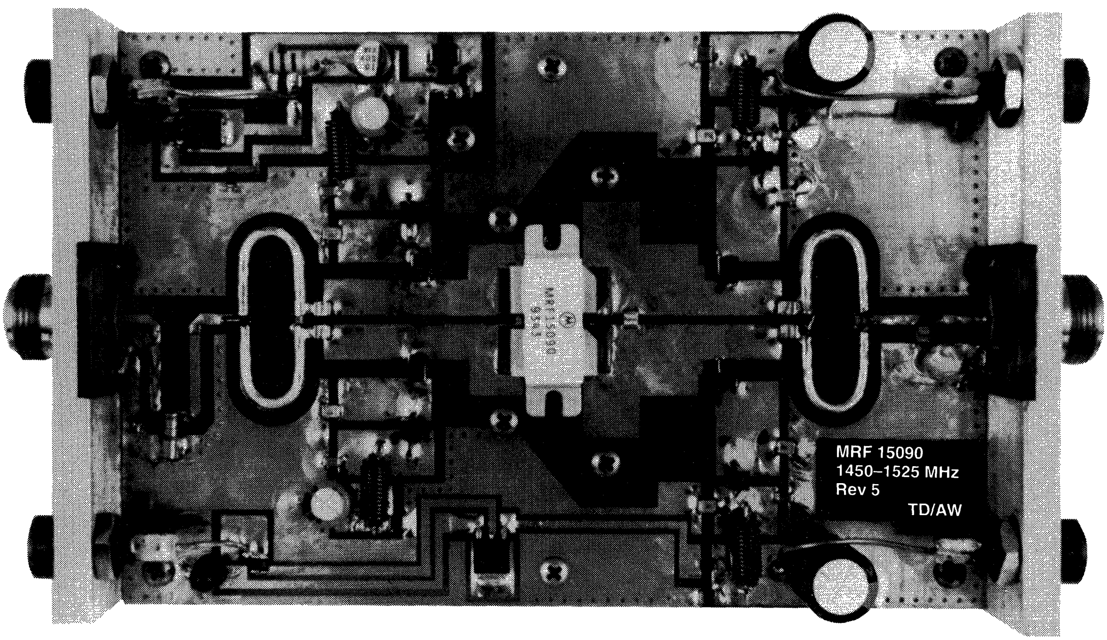
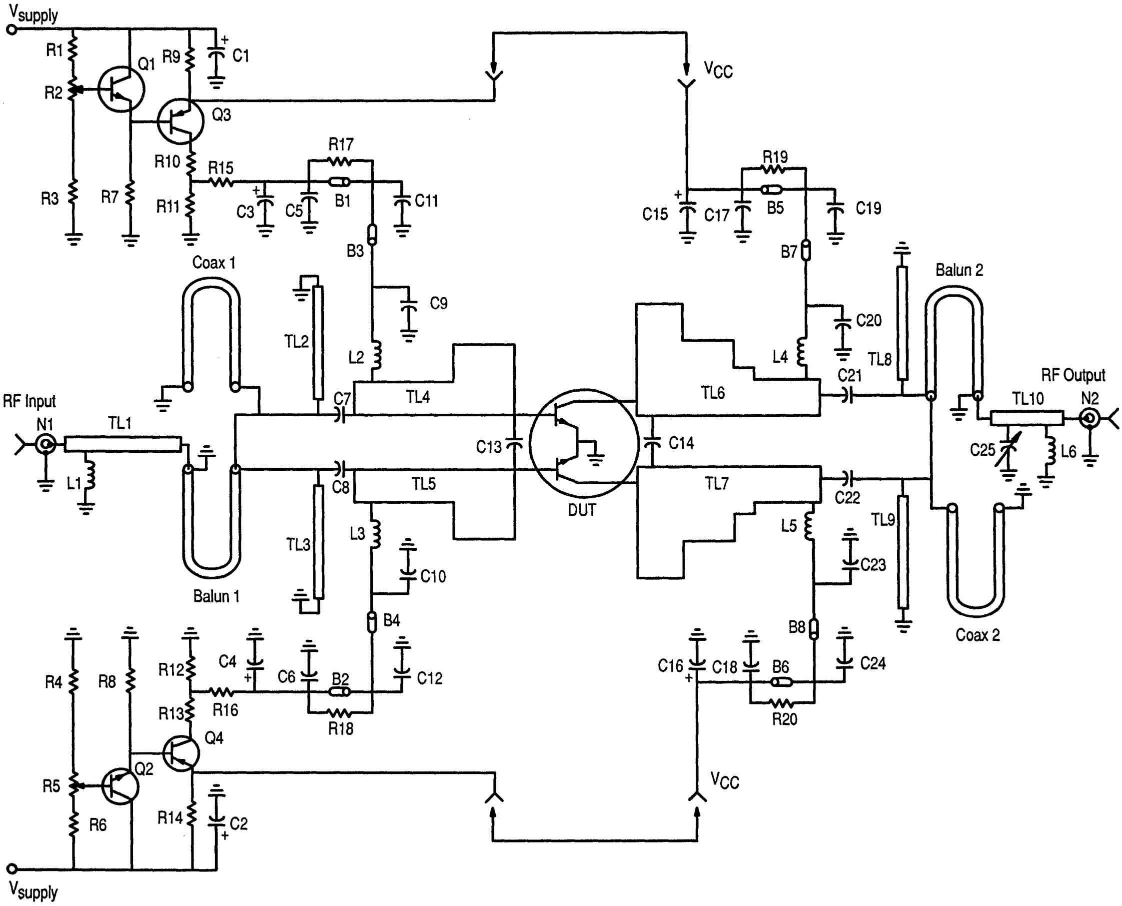


Figure 14. Broadband Test Fixture

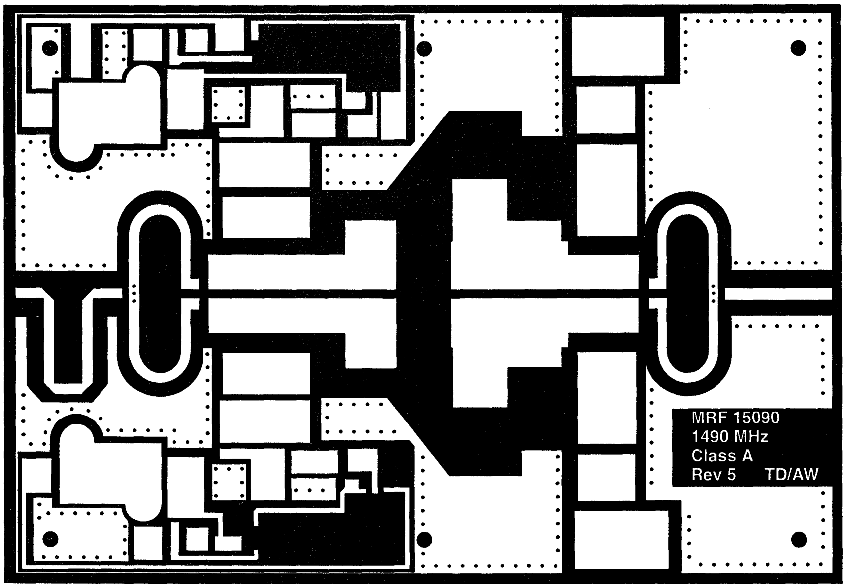


B1, B2, B5, B6	Long Bead, Fair Rite	N1, N2	Type N Flange Mount RF Connector, Omni Spectra
B3, B4, B7, B8	Short Bead, Fair Rite	Q1, Q2	Transistor NPN Motorola (BD135)
C1, C2, C3, C4	100 μF, Electrolytic Capacitor, Mallory	Q3, Q4	Transistor PNP Motorola (BD136)
C5, C6, C17, C18	0.1 μF, Chip Capacitor, Kemit	R1, R6	250 Ω, 1/8 W, Chip Resistor, Rohm
C7, C8, C21, C22	18 pF, B Case Chip Capacitor, ATC	R2, R5	500 Ω, 1/4 W, Potentiometer, State of the Art
C9, C10, C20, C23	51 pF, Chip Capacitor, Murata Erie	R3, R4	4.7 Ω, 1/8 W, Chip Resistor, Rohm
C11, C12, C19, C24	1800 pF, Chip Capacitor, Kemit	R7, R8	2 x 4.7 KΩ, 1/8 W, Chip Resistors
C13	4.3 pF, B Case Chip Capacitor, ATC		in Parallel, Rohm
C14	2.0 pF, B Case Chip Capacitor, ATC	R9, R14	1.0 Ω, 10 W, Resistor, Dale
C15, C16	470 μF, Electrolytic Capacitor, Mallory	R10, R13	38 Ω, 1 W, Resistor
C25	0.6–4 pF Variable Capacitor, Johanson	R11, R12	75 Ω, 1/8 W, Chip Resistor, Rohm
L1	3 Turns, 24 AWG, 0.046″ ID Choke	R15, R16	2 x 10 Ω, 1/8 W, Chip Resistors in Parallel, Rohm
L2, L3, L4, L5	3 Turns, 20 AWG, 0.126″ ID Choke	R17, R18, R19, R20	4 x 38 Ω, 1/8 W, Chip Resistors in Parallel, Rohm
L6	2 Turns, 24 AWG, 0.042″ ID Choke	Board	Glass Teflon®, Arlon GX-0300-55-22, $\varepsilon_r = 2.55$

Figure 15. Class A Test Fixture Electrical Schematic

2

2



SCALE 0.75:1

Figure 16. Photomaster for Class A Test Fixture

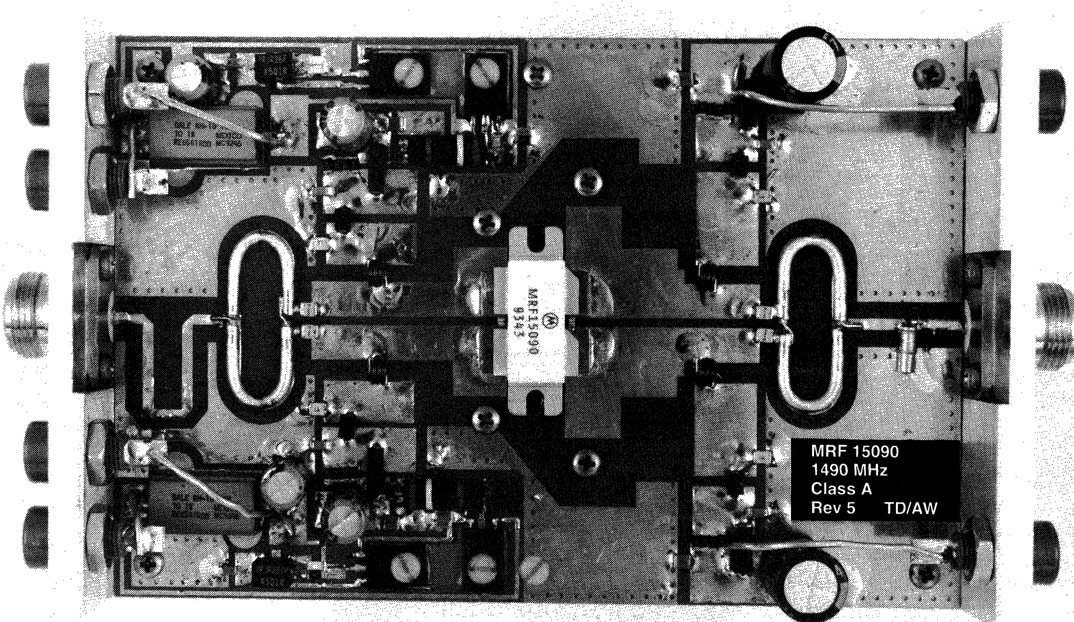


Figure 17. Class A Test Fixture

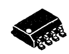
MRFQ17

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

**I_C = 300 mA
SOURCE MOUNT
HIGH-FREQUENCY
TRANSISTOR
NPN SILICON**



**CASE 751, STYLE 1
(SO-8)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	V
Collector-Base Voltage	V_{CBO}	40	V
Emitter-Base Voltage	V_{EBO}	2.0	V
Collector Current — Continuous	I_C	300	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	25	—	—	V
Collector-Base Breakdown Voltage (I_C = 100 µA)	$V_{(BR)CBO}$	40	—	—	V
Emitter-Base Breakdown Voltage (I_E = 100 µA)	$V_{(BR)EBO}$	2.0	—	—	V
Collector Cutoff Current (V_{CB} = 20 V)	I_{CBO}	—	—	1.0	µA
Emitter Cutoff Current (V_{EB} = 1.0 V)	I_{CEO}	—	—	1.0	µA

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5.0 V) (I_C = 150 mA, V_{CE} = 5.0 V)	h_{FE}	 25 25	 — —	 200 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$	—	—	0.5	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 12.5 V, f = 500 MHz)	f_T	—	2250	—	MHz
Insertion Gain (V_{CE} = 12.5 V, I_C = 50 mA, f = 500 MHz)	$\|S_{21}\|^2$	10	12.2	—	dB

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠ϕ	$\|S_{21}\|$	∠ϕ	$\|S_{12}\|$	∠ϕ	$\|S_{22}\|$	∠ϕ
12.5	50	10	0.32	−72	38.2	165	0.005	47	0.97	−13
		20	0.36	−103	37.8	151	0.007	48	0.88	−23
		50	0.60	−139	33.0	124	0.013	40	0.62	−42
		75	0.66	−152	25.0	112	0.014	36	0.49	−47
		100	0.69	−159	19.6	105	0.016	38	0.43	−49
		200	0.72	−174	10.3	91	0.021	47	0.32	−51
		500	0.72	168	4.10	68	0.040	65	0.37	−70
		750	0.70	157	2.80	57	0.059	72	0.43	−83
		1000	0.69	146	2.10	45	0.081	76	0.47	−95

Table 1. Common Emitter S-Parameters

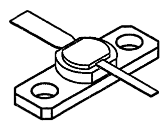
MRW2001
MRW2003
MRW2005
MRW2010

The RF Line
Microwave Power Transistors

. . . designed primarily for large-signal output and driver amplifier stages in the 1.0 to 2.3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 28 Volt, 2.0 GHz Characteristics:
  Output Power — 1.0 to 20 Watts
  Power Gain — 5.2 to 9.0 dB, Min
  Collector Efficiency — 40%, Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

5.2–9.0 dB
1.0–2.3 GHz
1.0–20 WATTS
MICROWAVE
POWER TRANSISTORS



CASE 328A, STYLE 1
(GP-13)

2

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector-Base Voltage		V_{CES}	50	Vdc
Emitter-Base Voltage		V_{EBO}	3.5	Vdc
Collector Current — Continuous		I_C		Adc
	MRW2001		0.25	
	MRW2003		0.5	
	MRW2005		1.0	
	MRW2010		2.0	
Operating Junction Temperature		T_J	200	°C
Storage Temperature Range		T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic		Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case		$R_{\theta JC}$		°C/W
	MRW2001		25	
	MRW2003		15	
	MRW2005		8.5	
	MRW2010		6.0	

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRW2001		50	—	—	
(I_C = 20 mA, V_{BE} = 0)	MRW2003		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	MRW2005		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	MRW2010		50	—	—	

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (continued)						
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.2 mA, I_C = 0)	MRW2001		3.5	—	—	
(I_E = 0.25 mA, I_C = 0)	MRW2003		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	MRW2005		3.5	—	—	
(I_E = 1.0 mA, I_C = 0)	MRW2010		3.5	—	—	
Collector Cutoff Current	MRW2001	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	MRW2003		—	—	0.5	
	MRW2005		—	—	0.5	
	MRW2010		—	—	0.5	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5.0 V)	MRW2001		10	—	120	
(I_C = 100 mA, V_{CE} = 5.0 V)	MRW2003		10	—	100	
(I_C = 200 mA, V_{CE} = 5.0 V)	MRW2005		10	—	100	
(I_C = 400 mA, V_{CE} = 5.0 V)	MRW2010		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRW2001	C_{ob}	—	—	4.0	pF
(V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	MRW2003		—	—	5.0	
	MRW2005		—	—	7.0	
	MRW2010		—	—	12	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 1.0 W, f = 2.0 GHz)	MRW2001		9.0	—	—	
(V_{CE} = 28 V, P_{out} = 10 W, f = 2.0 GHz)	MRW2010		7.0	—	—	
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 3.0 W, f = 2.0 GHz)	MRW2003		8.0	—	—	
(V_{CE} = 28 V, P_{out} = 5.0 W, f = 2.0 GHz)	MRW2005		8.0	—	—	
Collector Efficiency		η	40	—	—	%
(V_{CE} = 28 V, P_{out} = 1.0 W, f = 2.0 GHz)	MRW2001					
(V_{CE} = 28 V, P_{out} = 3.0 W, f = 2.0 GHz)	MRW2003					
(V_{CE} = 28 V, P_{out} = 5.0 W, f = 2.0 GHz)	MRW2005					
(V_{CE} = 28 V, P_{out} = 10 W, f = 2.0 GHz)	MRW2010					
Load Mismatch		ψ	No Degradation in Output Power			
(V_{CE} = 28 V, f = 2.0 GHz, Load VSWR = ∞:1, All Phase Angles)						
P_{out} = 1.0 W	MRW2001					
P_{out} = 3.0 W	MRW2003					
P_{out} = 5.0 W	MRW2005					
P_{out} = 10 W	MRW2010					
Saturated Output Power						W
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2001	P_{sat1}	—	1.0	—	
(V_{CE} = 28 V, f = 1.5 GHz)		P_{sat2}	—	1.2	—	
(V_{CE} = 28 V, f = 1.0 GHz)		P_{sat3}	—	1.3	—	
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2003		—	3.0	—	
(V_{CE} = 28 V, f = 1.5 GHz)			—	3.7	—	
(V_{CE} = 28 V, f = 1.0 GHz)			—	4.0	—	
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2005		—	5.0	—	
(V_{CE} = 28 V, f = 1.5 GHz)			—	6.5	—	
(V_{CE} = 28 V, f = 1.0 GHz)			—	7.5	—	
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2010		—	10	—	
(V_{CE} = 28 V, f = 1.5 GHz)			—	13	—	
(V_{CE} = 28 V, f = 1.0 GHz)			—	15	—	

TYPICAL CHARACTERISTICS

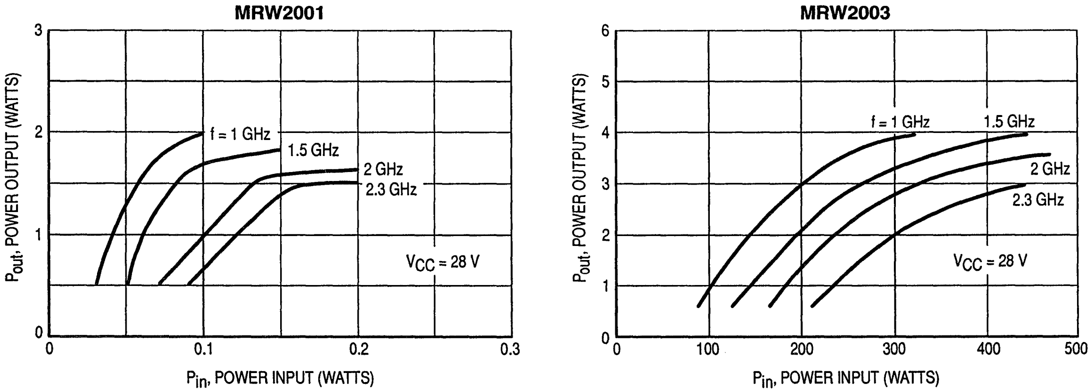


Figure 1. Output Power versus Input Power

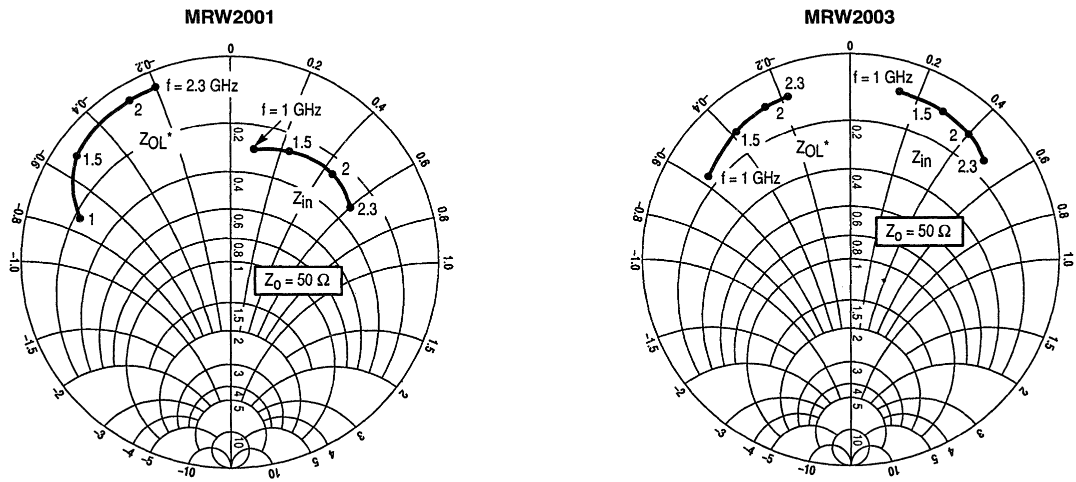


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

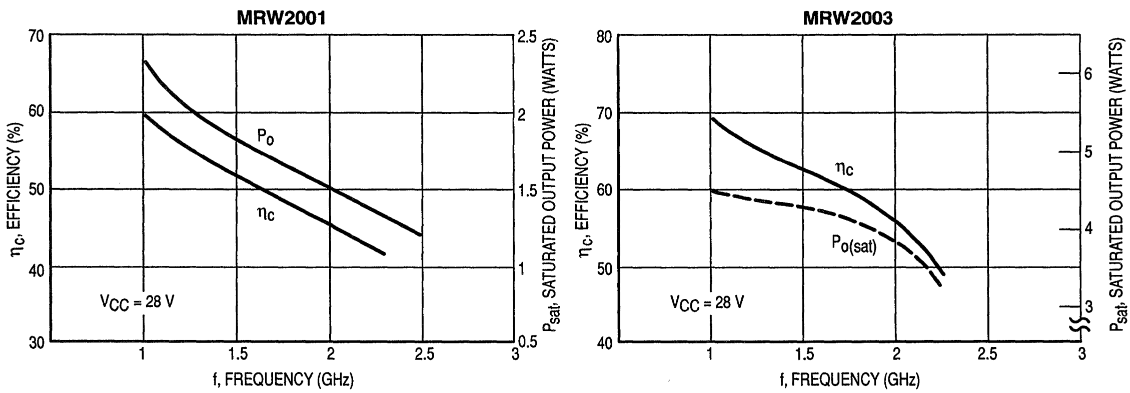


Figure 3. Power Output and Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS

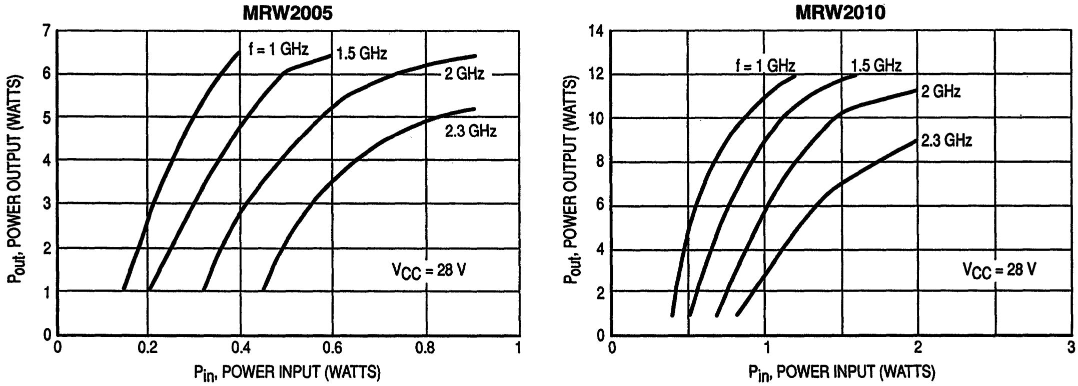


Figure 4. Output Power versus Input Power

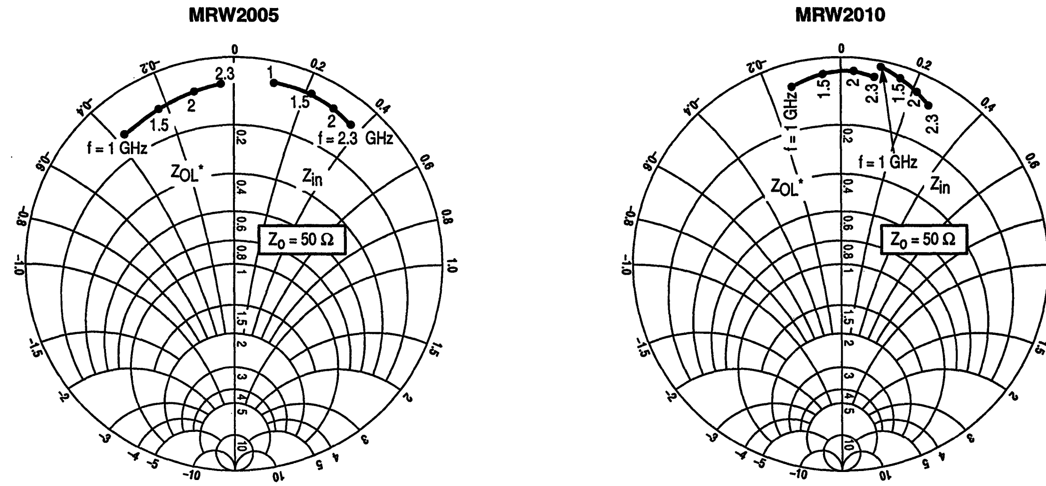


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

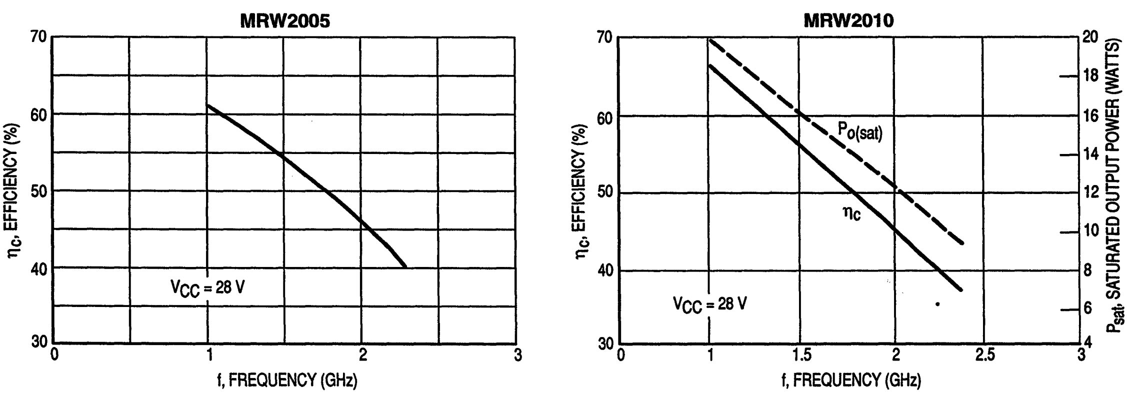


Figure 6. Power Output and Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere² emitter current for each of the "Super 2.0 GHz" devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included on the graph.

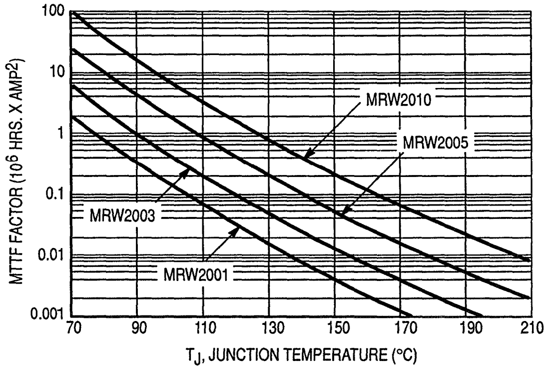


Figure 7. MTTF Factor

2

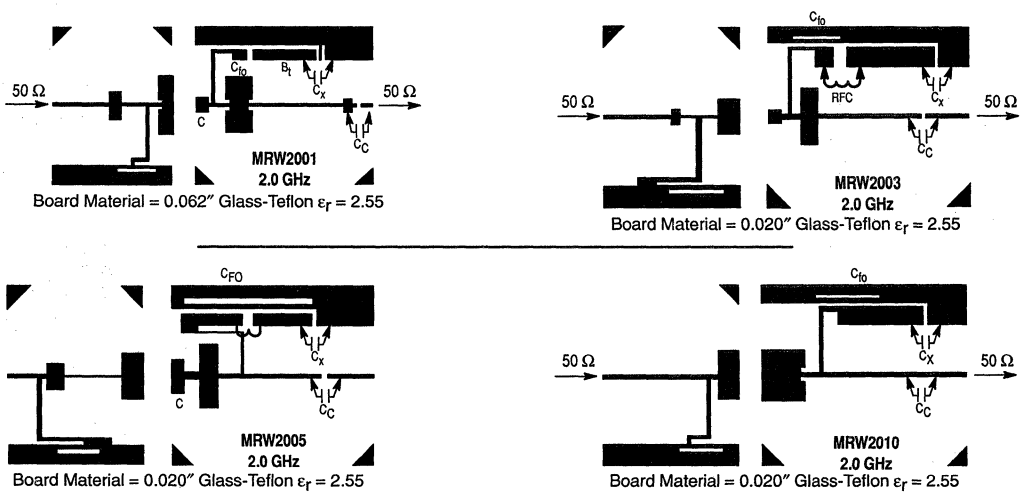


Figure 8. PC Board Layouts

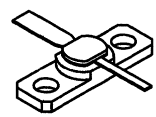
MRW3001
MRW3003
MRW3005

The RF Line
Microwave Power Transistors

. . . designed primarily for large-signal output and driver amplifier stages in the 1.5 to 3.0 GHz frequency range.

- Designed for Class B or C, Common Base Linear Power Amplifiers
- Specified 28 Volt, 3.0 GHz Characteristics:
  Output Power — 1.0 to 5.0 Watts
  Power Gain — 5.0 to 7.0 dB Min
  Collector Efficiency — 30% Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

5.0–7.0 dB
1.5–3.0 GHz
1.0–5.0 WATTS
MICROWAVE
POWER TRANSISTORS



CASE 328F, STYLE 2
(GP-13)
MRW3001, 3003, 3005

2

MAXIMUM RATINGS

Rating	Symbol	3001	3003	3005	Unit
Collector-Base Voltage	V_{CBO}	45			Vdc
Emitter-Base Voltage	V_{EBO}	3.5			Vdc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	35	17	8.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRW3001		50	—	—	
(I_C = 30 mA, V_{BE} = 0)	MRW3003		50	—	—	
(I_C = 50 mA, V_{BE} = 0)	MRW3005		50	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 1.0 mA, I_E = 0)	MRW3001		45	—	—	
(I_C = 3.0 mA, I_E = 0)	MRW3003		45	—	—	
(I_C = 5.0 mA, I_E = 0)	MRW3005		45	—	—	
Emitter-Base Breakdown Voltage (I_E = 1.0 mA, I_C = 0)		$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	MRW3001	I_{CBO}	—	—	0.5	mAdc
	MRW3003		—	—	0.75	
	MRW3005		—	—	1.25	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5.0 V)	MRW3001		10	—	120	
(I_C = 300 mA, V_{CE} = 5.0 V)	MRW3003		10	—	120	
(I_C = 500 mA, V_{CE} = 5.0 V)	MRW3005		10	—	120	

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	MRW3001	C_{ob}	—	3.5	4.0	pF
	MRW3003		—	5.7	7.0	
	MRW3005		—	8.4	10	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 1.0 W, f = 3.0 GHz)	MRW3001		7.0	—	—	
(V_{CE} = 28 V, P_{out} = 3.0 W, f = 3.0 GHz)	MRW3003		6.0	—	—	
(V_{CE} = 28 V, P_{out} = 5.0 W, f = 3.0 GHz)	MRW3005		5.0	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 1.0 W, f = 3.0 GHz)	MRW3001		30	—	—	
(V_{CE} = 28 V, P_{out} = 3.0 W, f = 3.0 GHz)	MRW3003		30	—	—	
(V_{CE} = 28 V, P_{out} = 5.0 W, f = 3.0 GHz)	MRW3005		30	—	—	
Load Mismatch (V_{CE} = 28 V, f = 3.0 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
P_{out} = 1.0 W	MRW3001					
P_{out} = 3.0 W	MRW3003					
P_{out} = 5.0 W	MRW3005					

MRW3001
TYPICAL CHARACTERISTICS

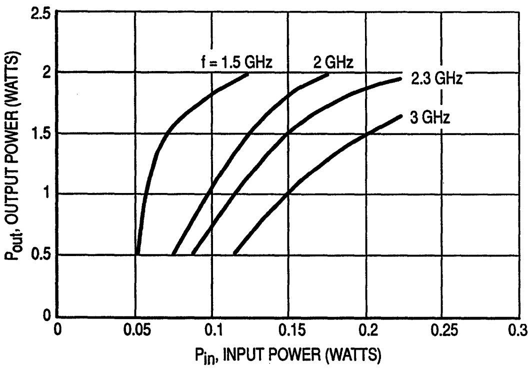


Figure 1. Output Power versus Input Power

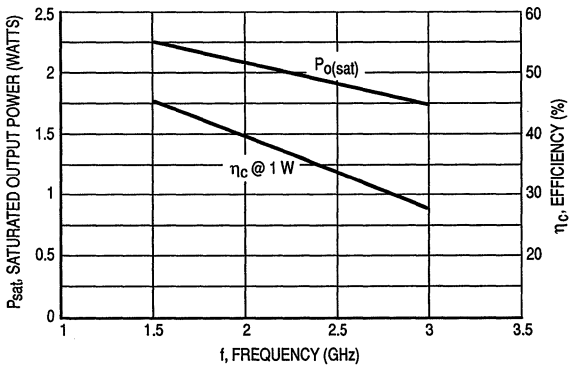


Figure 2. P_{sat} and η versus Frequency

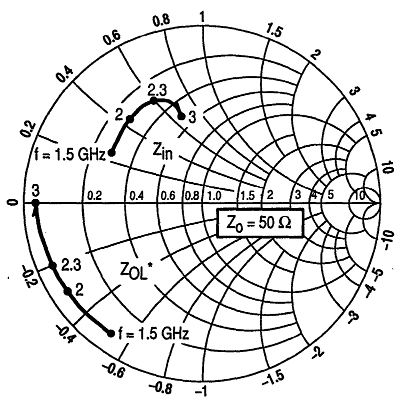
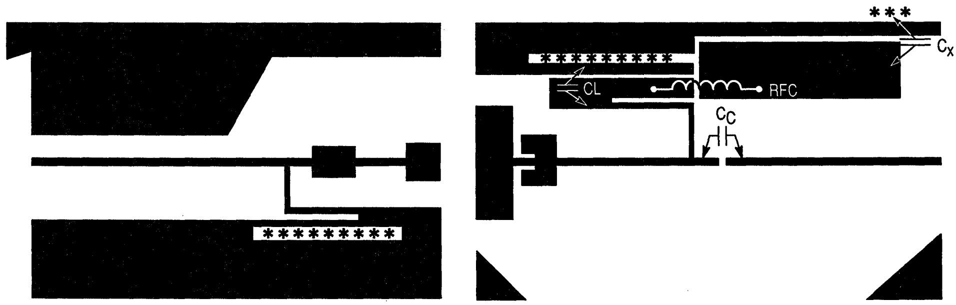


Figure 3. Series Equivalent Input/Output Impedance



Board material ≅ 0.018″ dielectric thickness Glass teflon (ε_r = 2.55).
* = Foil wrap asterisked edge to ground plane.
C_C = 100 pF chip.
C_X = 100 pF chip capacitor and 10 µF electrolytic.
C_L = 100 pF chip capacitor. The capacitor position can be tuned.
RFC = 8 turns #28 AWG, 0.010 dia.

Figure 4. MRW3001 PC Board Layout, f = 3.0 GHz

2

MRW3003
TYPICAL CHARACTERISTICS

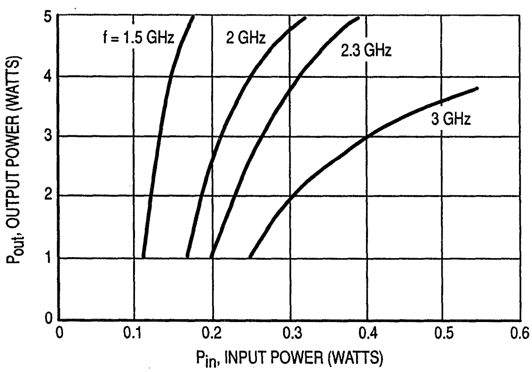


Figure 5. Output Power versus Input Power

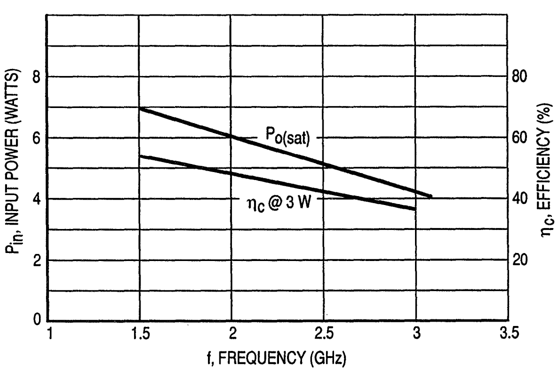


Figure 6. P_{sat} and η versus Frequency

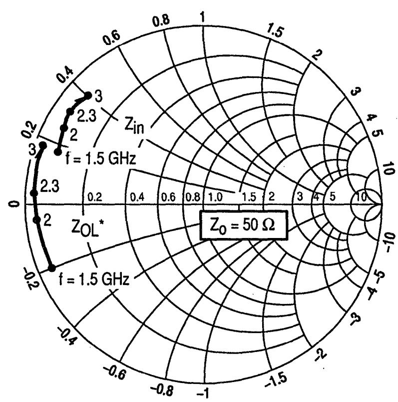
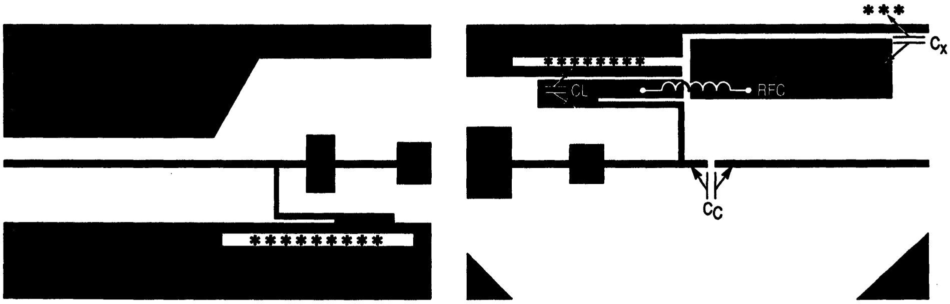


Figure 7. Series Equivalent Input/Output Impedance



Board material ≅ 0.018″ dielectric thickness Glass teflon (ε_r = 2.55).
* = Foil wrap asterisked edge to ground plane.
C_C = 100 pF chip.
C_X = 100 pF chip capacitor and 10 µF electrolytic.
C_L = 100 pF chip capacitor. The capacitor position can be tuned.
RFC = 8 turns #28 AWG, 0.010 dia.

1″

(Not to Scale)

Figure 8. MRW3003 PC Board Layout, f = 3.0 GHz

MRW3005
TYPICAL CHARACTERISTICS

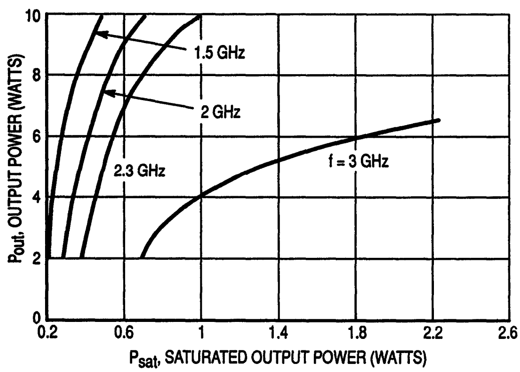


Figure 9. Output Power versus Input Power

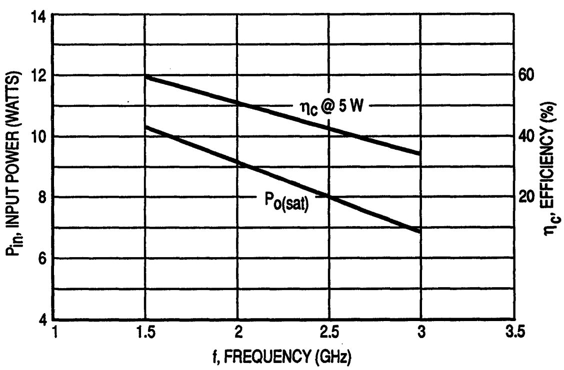


Figure 10. P_{sat} and η versus Frequency

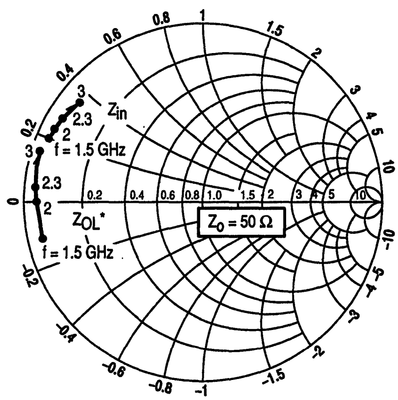
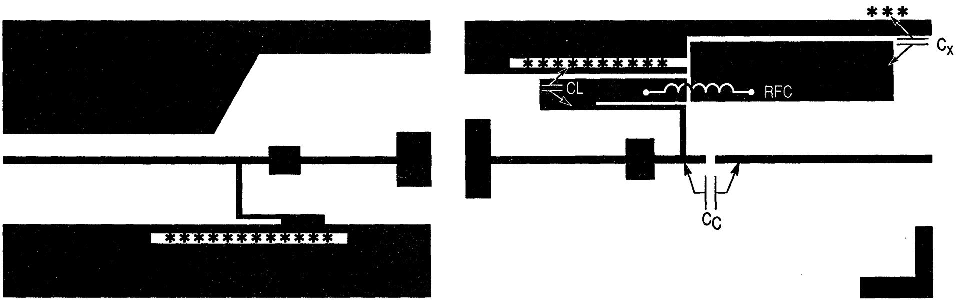


Figure 11. Series Equivalent Input/Output Impedance

2



Board material ≅ 0.018″ dielectric thickness Glass teflon (ε_r = 2.55).
* = Foil wrap asterisked edge to ground plane.
C_C = 100 pF chip.
C_X = 100 pF chip capacitor and 10 µF electrolytic.
C_L = 100 pF chip capacitor. The capacitor position can be tuned.
RFC = 8 turns #28 AWG, 0.010 dia.

Figure 12. MRW3005 PC Board Layout, f = 3.0 GHz

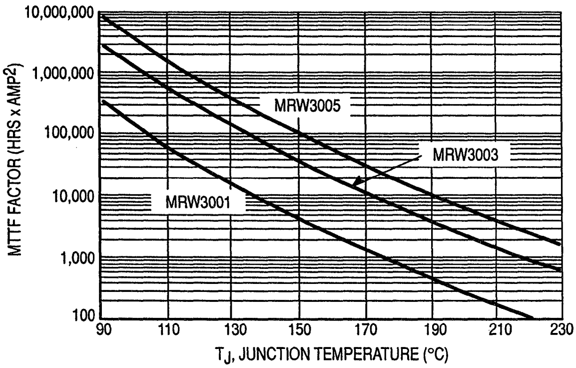


Figure 13. MTTF Factor versus Junction Temperature

MTTF Factor
(Normalized to 1.0 ampere^2 Continuous Duty)

The graph shown displays MTTF in hours x ampere^2 emitter current for each of the 3.0 GHz devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. **CAUTION** — A calculation is required to obtain actual metal life. Sample MTTF calculations based on operating conditions are shown below.

Junction Temperature — °C

To calculate metal lifetime under any set of conditions, obtain actual data or estimate from typical performance curves. Solve for T_J (°C):

$$(1)\ T_J = \theta_{JF}\left(\frac{P_{out} \times 100}{\eta_C\ \%} + P_{in} - P_{out}\right) + T_{FLANGE}$$

Enter graph of MTF factor versus T_J. Obtain MTF factor. Calculate metal life by:

$$(2)\ \text{Metal Life in Hours} = \frac{\text{MTF Factor}}{I_C{}^2\ \text{(Amps)}}$$

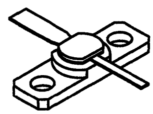
MRW52602

The RF Line
Microwave Linear Power Transistor

. . . designed primarily for large-signal output and driver amplifier stages in the 1.0 to 2.0 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2.0 GHz Characteristics:
  Output Power — 3.0 Watts
  Power Gain — 5.0 to 6.0 dB
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

3.0 W, 6.0 dB
1.0–2.0 GHz
MICROWAVE LINEAR
POWER TRANSISTOR



CASE 328F, STYLE 1
(GP-13)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	8.5	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	10	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	7.0	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 3.0 W, f = 2.0 GHz, I_E = 440 mA)	G_{PE}	6.0	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 440 mA, P_{out} = 3.0 W, f = 2.0 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)	f_τ	—	2.7	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 440 mA, f = 2.0 GHz, P_{o1} = 3.0 W, P_{o2} = 3.0 mW)	L_G	— —	— —	−0.2 +1.0	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 440 mA, P_o (PEP) = 3.0 W, Tones at 2.0 GHz and 2.005 GHz)	IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

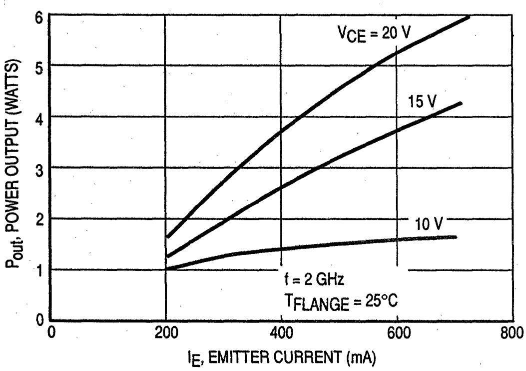


Figure 1. 1.0 dB Compression Point versus Emitter Current

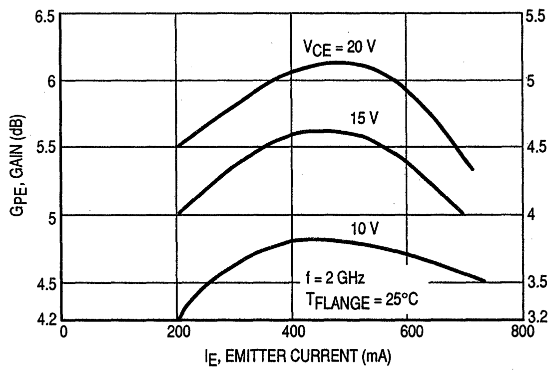


Figure 2. Gain versus Emitter Current

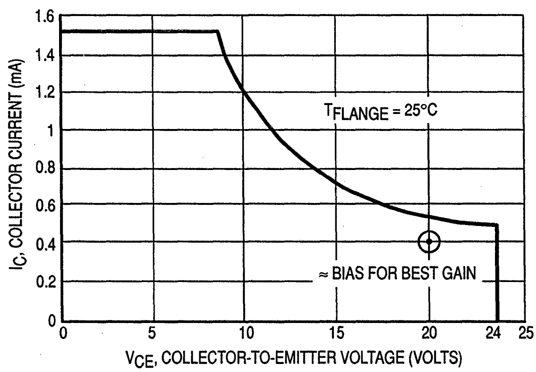


Figure 3. Safe Operating Area

VCE (Volts)	IC (mA)	f (GHz)	S11		S21		S12		S22	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
20	440	0.5	0.94	170	2.57	64	0.03	24	0.49	−173
		1.0	0.92	156	1.23	35	0.04	30	0.55	−179
		1.3	0.92	148	0.93	18	0.05	30	0.60	177
		1.5	0.91	144	0.78	8.0	0.05	28	0.62	172
		1.7	0.92	139	0.68	0	0.06	27	0.66	168
		2.0	0.92	131	0.57	−12	0.07	24	0.68	163
		2.5	0.91	120	0.43	−35	0.08	14	0.75	150
		3.0	0.93	108	0.36	−49	0.10	7.0	0.79	138

Table 1. Common Emitter S-Parameters

2

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by $I_C{}^2$ for MTTF in a particular application.

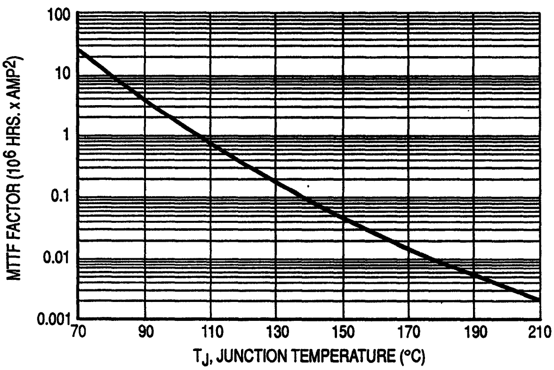


Figure 4. MTTF Factor versus Junction Temperature

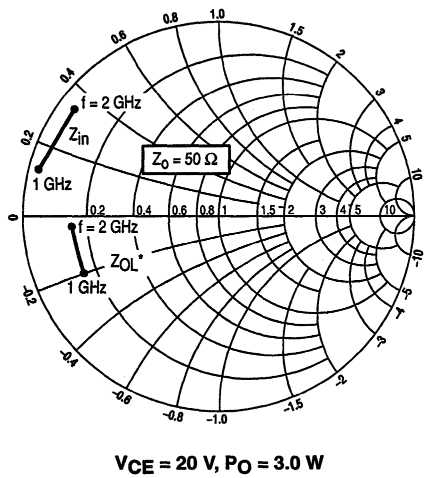


Figure 5. Series Equivalent Input/Output Impedance

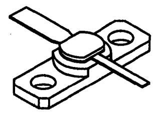
MRW52604

The RF Line
Microwave Linear Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.0 to 2.0 GHz frequency range.

- Designed for Class A, or AB Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2.0 GHz Characteristics:
  Output Power — 6.0 Watts
  Power Gain — 4.8 dB, Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**6.0 W, 4.8 dB
1.0–2.0 GHz
MICROWAVE LINEAR
POWER TRANSISTOR**



**CASE 328F, STYLE 1
(GP-13)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	6.0	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	9.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 4.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 400 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	12	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 6.0 W, f = 2.0 GHz, I_E = 880 mA)	G_{PE}	4.8	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 880 mA, P_{out} = 6.0 W, f = 2.0 GHz, Load VSWR = 3:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)	f_τ	—	2.7	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 880 mA, f = 2.0 GHz, P_{o1} = 6.0 W, P_{o2} = 6.0 mW)	L_G	— —	— —	−0.2 +1.0	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 880 mA, P_o (PEP) = 6.0 W, Tones at 1.0 GHz and 1.005 GHz)	IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

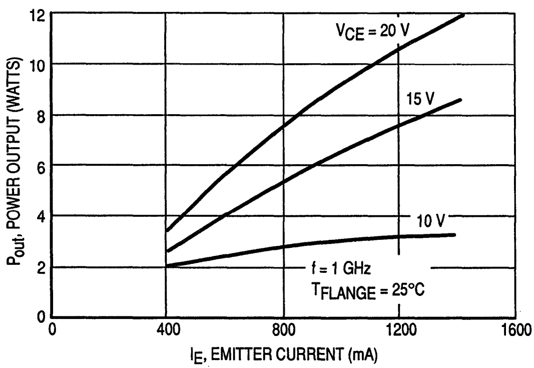


Figure 1. 1.0 dB Compression Point versus Emitter Current

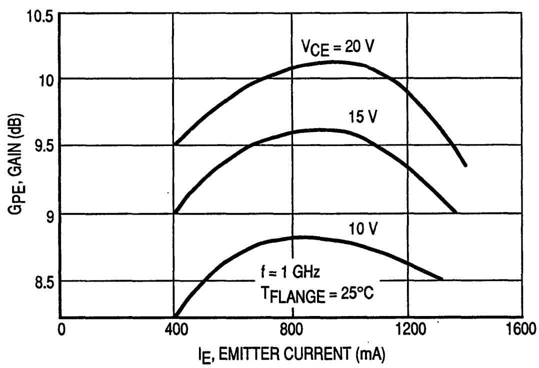


Figure 2. Gain versus Emitter Current

2

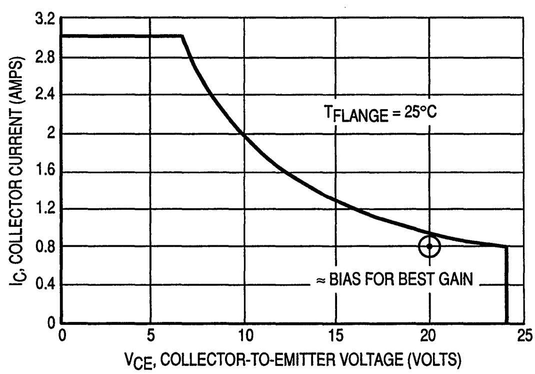


Figure 3. DC Safe Operating Area

Large Signal Impedance Data

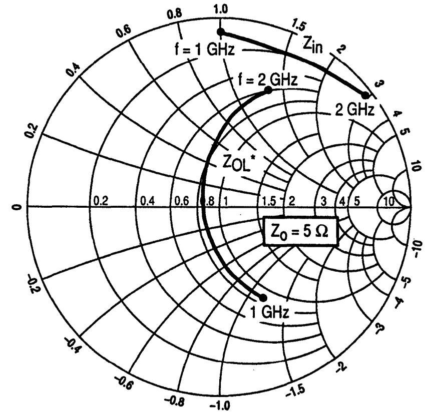


Figure 4. Series Equivalent Input/Output Impedance

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by $I_C{}^2$ for MTTF in a particular application.

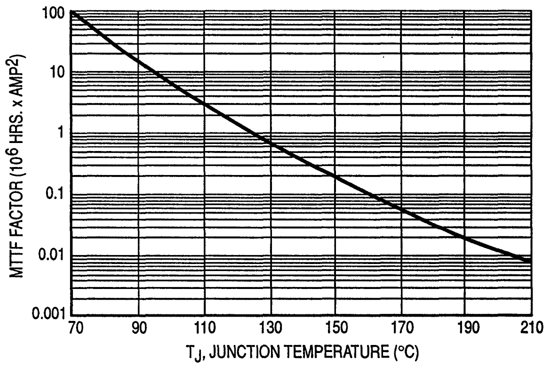


Figure 5. MTTF Factor versus Junction Temperature

2

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
20	600	0.5	0.96	170	1.45	66	0.02	33	0.73	175
		1.0	0.95	158	0.71	40	0.04	41	0.75	167
		1.3	0.95	151	0.56	26	0.04	39	0.77	163
		1.5	0.94	147	0.47	18	0.05	37	0.77	158
		1.7	0.95	143	0.42	11	0.05	37	0.79	155
		2.0	0.96	136	0.35	0	0.06	34	0.79	150
		2.5	0.95	127	0.28	−17	0.08	25	0.83	140
		3.0	0.98	118	0.24	−27	0.09	19	0.85	131

Table 1. Common Emitter S-Parameters

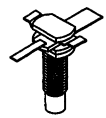
MRW53502

The RF Line
Microwave Linear Power Transistor

. . . designed primarily for large-signal output and driver amplifier stages in the 1.0 to 3.0 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2.0 GHz Characteristics:
  Output Power — 1.6 Watts
  Power Gain — 7.0 to 8.0 dB
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

7.0–8.0 dB
1.0–3.0 GHz
1.6 WATTS
MICROWAVE LINEAR
POWER TRANSISTOR



CASE 401, STYLE 1
(GP-14)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	17	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	5.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.6 W, f = 2.0 GHz, I_E = 230 mA)	G_{PE}	7.0	—	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 1.6 W, f = 2.0 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)	f_τ	—	3.0	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 230 mA, f = 2.0 GHz, P_{o1} = 1.6 W, P_{o2} = 1.6 mW)	L_G	— —	— —	−0.2 +1.0	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 230 mA, P_o (PEP) = 1.6 W, Tones at 2.0 GHz and 2.005 GHz)	IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

2

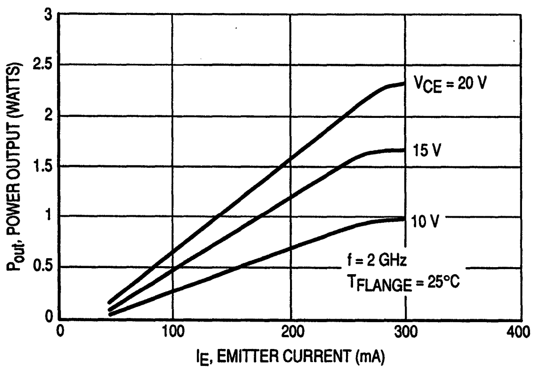


Figure 1. 1.0 dB Compression Point versus Emitter Current

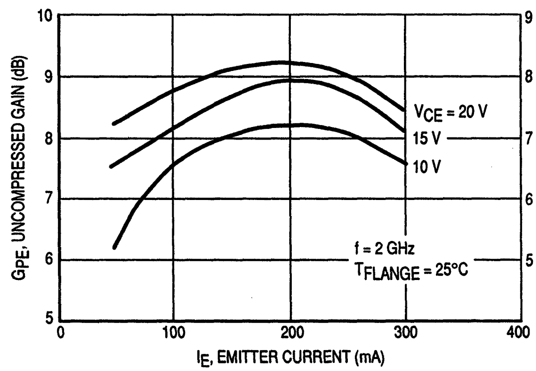


Figure 2. Gain versus Emitter Current

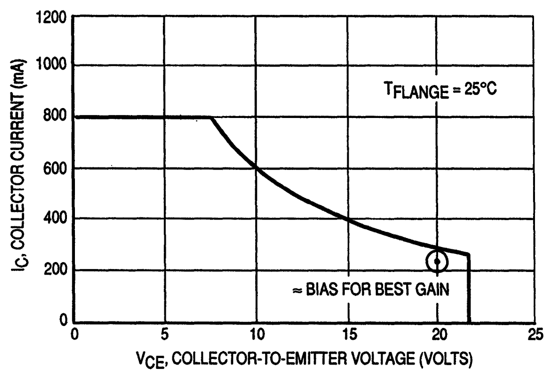


Figure 3. DC Safe Operating Area

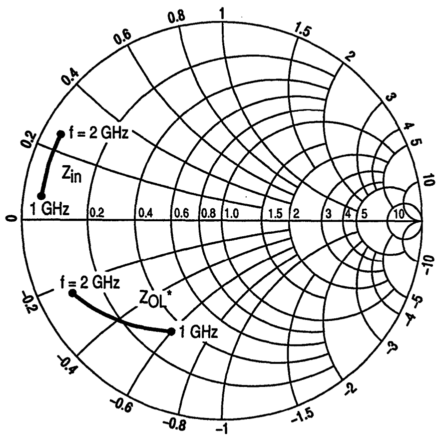


Figure 4. Series Equivalent Input/Output Impedance

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by $I_C{}^2$ for MTTF in a particular application.

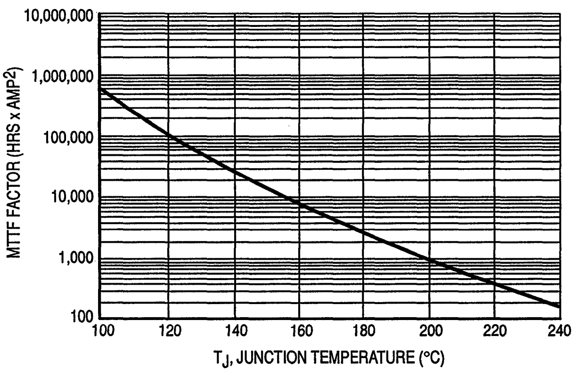


Figure 5. MTTF Factor versus Junction Temperature

2

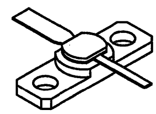
MRW53601

The RF Line
Microwave Linear Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.0 to 3.0 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 3.0 GHz Characteristics:
  Output Power — 0.8 Watts
  Power Gain — 7.5 to 8.5 dB, Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**7.5–8.5 dB
1.0–3.0 GHz
0.8 WATT
MICROWAVE LINEAR
POWER TRANSISTOR**



**CASE 328F, STYLE 1
(GP-13)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	31	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	35	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	3.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.8 W, f = 3.0 GHz)	G_{PE}	8.5	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 120 mA, P_{out} = 0.8 W, f = 3.0 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 120 mA)	f_τ	—	3.0	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 120 mA, f = 3.0 GHz, P_{o1} = 0.8 W, P_{o2} = 0.8 mW)	L_G	— —	— —	−0.2 +1.0	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 120 mA, P_o (PEP) = 0.8 W, Tones at 3.0 GHz and 3.005 GHz)	IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

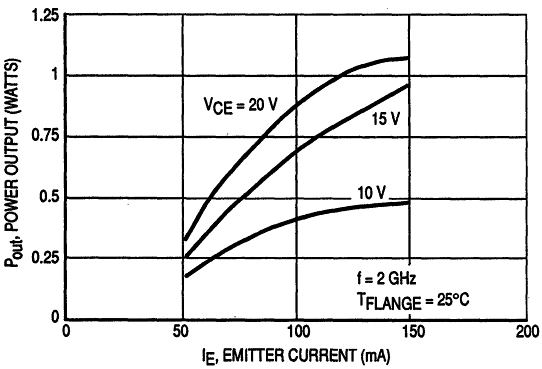


Figure 1. 1.0 dB Compression Point versus Emitter Current

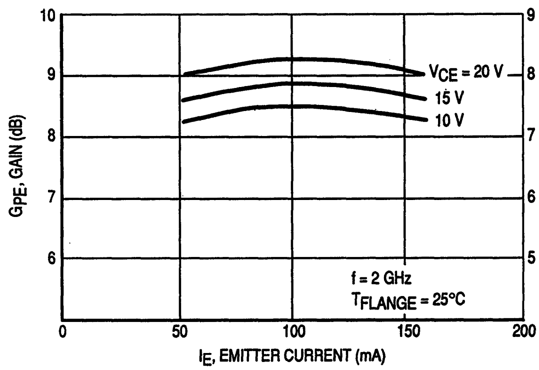


Figure 2. Gain versus Emitter Current

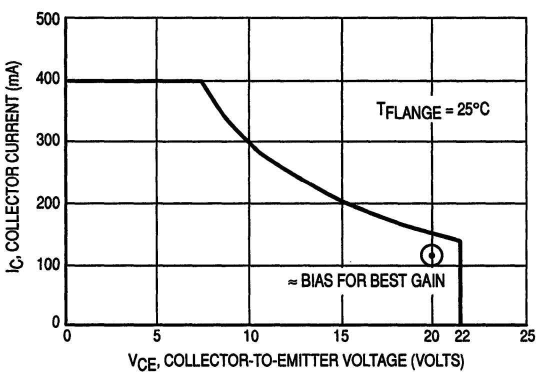


Figure 3. DC Safe Operating Area

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ ϕ	Mag	∠ ϕ	Mag	∠ ϕ	Mag	∠ ϕ
20	120	0.5	0.83	−177	4.91	71	0.03	22	0.36	-82
		1.0	0.82	170	2.48	42	0.04	25	0.46	−108
		1.3	0.81	162	1.87	28	0.04	26	0.54	−122
		1.6	0.80	155	1.45	11	0.05	23	0.62	−132
		2.0	0.78	141	1.17	−6.0	0.06	20	0.67	−142
		2.3	0.83	132	1.02	−20	0.07	15	0.69	−151
		2.5	0.84	130	0.91	−29	0.07	11	0.72	−158
		2.7	0.79	125	0.85	−35	0.08	10	0.76	−160
		3.0	0.64	110	0.79	−43	0.10	6.0	0.80	−168
		3.3	0.61	82	0.77	−57	0.12	−2.0	0.79	−174

Table 1. Common Emitter S-Parameters

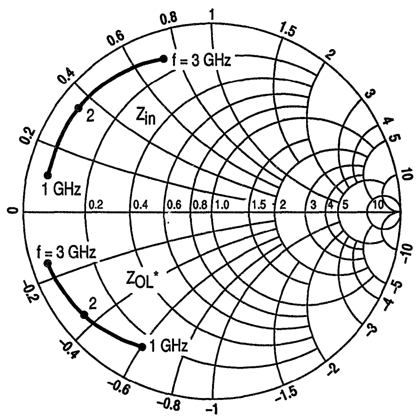


Figure 4. Series Equivalent Input/Output Impedance Conditions: V_{CE} = 20 V, I_E = 120 mA, T_{FLANGE} = 25°C

2

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

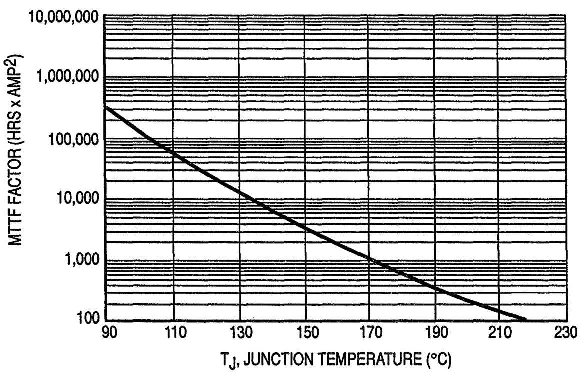


Figure 5. MTTF Factor versus Junction Temperature

MRW54001
MRW54601

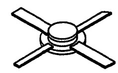
The RF Line

Microwave Linear Power Transistors

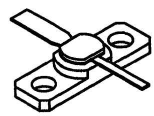
. . . designed primarily for large-signal output and driver amplifier stages in the 1.0 to 4.0 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2.0 GHz Characteristics:
  Output Power — 0.5 Watt
  Power Gain — 10 to 11 dB
- 100% Tested for Load Mismatch at All Phase Angles with ∞:1 VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**10–11 dB
1.0–4.0 GHz
0.5 WATT
MICROWAVE LINEAR
POWER TRANSISTORS**



CASE 400, STYLE 1
(TW200)
MRW54001



CASE 328F, STYLE 1
(GP-13)
MRW54601

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	3.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.5 W, f = 2.0 GHz, I_E = 120 mA)	MRW54001	G_{PE}	10	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.5 W, f = 2.0 GHz, I_E = 120 mA)	MRW54601	G_{PE}	11	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 120 mA, P_{out} = 0.5 W, f = 2.0 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 120 mA)		f_τ	4.0	4.5	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 120 mA, f = 2.0 GHz, P_{o1} = 0.5 W, P_{o2} = 0.5 mW)		L_G	— —	— —	−0.2 +1.0	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 120 mA, P_o (PEP) = 0.5 W, Tones at 2.0 GHz and 2.005 GHz)		IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

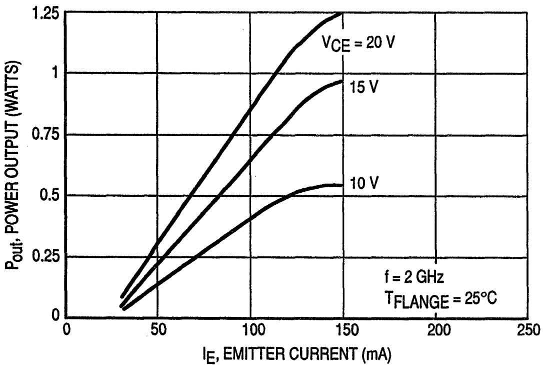


Figure 1. 1.0 dB Compression Point versus Emitter Current

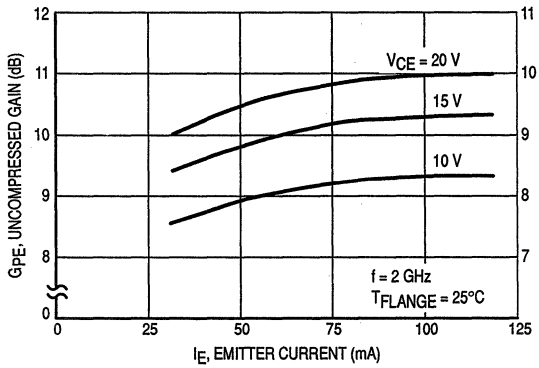


Figure 2. Gain versus Emitter Current

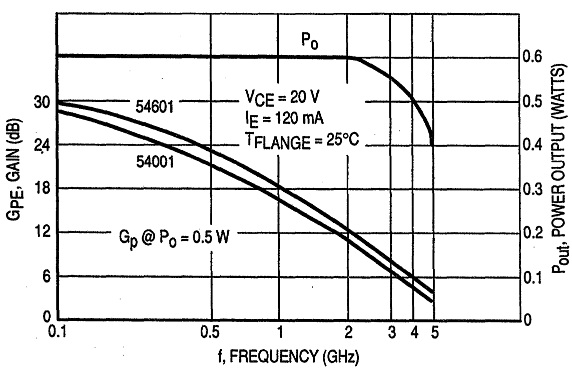


Figure 3. Gain and 1.0 dB Compressed Power versus Frequency

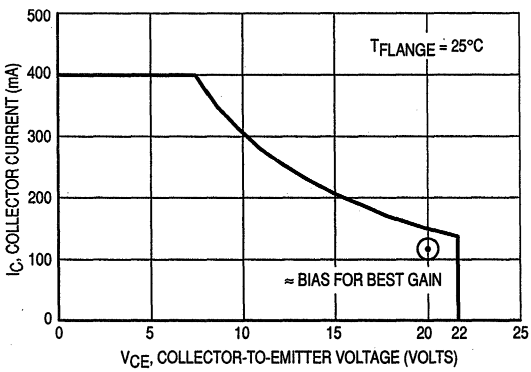


Figure 4. DC Safe Operating Area

VCE (Volts)	IC (mA)	f (GHz)	S11		S21		S12		S22	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
20	100	0.5	0.76	−177	6.65	74	0.03	20	0.43	−73
		1.0	0.76	159	3.24	39	0.03	24	0.50	−104
		1.3	0.76	148	2.46	21	0.04	25	0.56	−120
		1.5	0.75	141	2.07	9.0	0.04	24	0.60	−130
		1.7	0.76	134	1.80	−1.0	0.05	24	0.64	−140
		2.0	0.76	124	1.51	−14	0.06	22	0.68	−152
		2.3	0.74	113	1.27	−33	0.06	13	0.74	−167
		2.5	0.73	106	1.15	−43	0.07	9.0	0.76	−173
		2.7	0.72	98	1.06	−52	0.07	5.0	0.77	179
		32	0.69	85	0.95	−67	0.08	−4.0	0.82	170
		3.3	0.64	71	0.86	−81	0.09	−14	0.85	161
		3.5	0.61	60	0.81	−94	0.10	−22	0.87	155
		3.7	0.57	47	0.77	−103	0.10	−30	0.80	149
		4.0	0.51	24	0.70	−119	0.11	−44	0.92	141

Table 1. MRW54001 Common Emitter S-Parameters

VCE (Volts)	IC (mA)	f (GHz)	S11		S21		S12		S22	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
20	100	0.5	0.77	−178	6.17	84	0.04	32	0.32	−57
		1.0	0.79	159	3.11	56	0.05	38	0.28	−75
		1.3	0.80	149	2.40	44	0.05	41	0.29	−88
		1.5	0.81	144	2.06	34	0.06	41	0.30	−98
		1.7	0.82	138	1.81	28	0.06	43	0.32	−108
		2.0	0.83	130	1.52	16	0.08	42	0.35	−121
		2.3	0.85	127	1.29	7.0	0.09	41	0.39	−135
		2.5	0.86	123	1.17	−1.0	0.10	39	0.41	−142
		2.7	0.87	119	1.06	−5.0	0.10	39	0.43	−150
		3.0	0.89	113	0.96	−16	0.12	35	0.48	−162
		3.3	0.89	105	0.83	−25	0.13	31	0.53	−172
		3.5	0.91	102	0.76	−31	0.14	27	0.57	−178
		3.7	0.93	98	0.70	−35	0.15	25	0.59	176
		4.0	0.89	90	0.62	−44	0.17	19	0.66	166

Table 2. MRW54601 Common Emitter S-Parameters

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by $I_C{}^2$ for MTTF in a particular application.

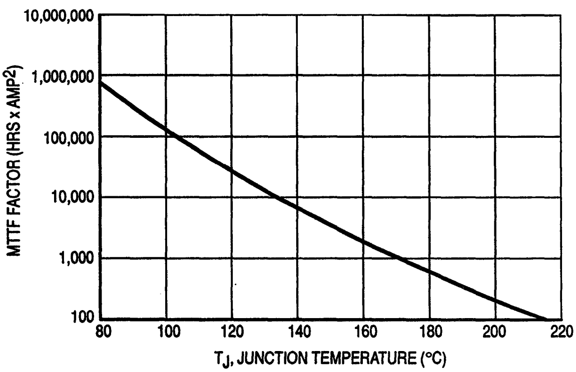


Figure 5. MTTF Factor versus Junction Temperature

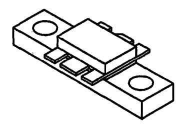
TP3005

The RF Line
UHF Power Transistor

The TP3005 is designed for 960 MHz base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 4.0 Watts
  Minimum Gain = 8.5 dB
  Class AB
  I_Q = 60 mA

**4.0 W, 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	7.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

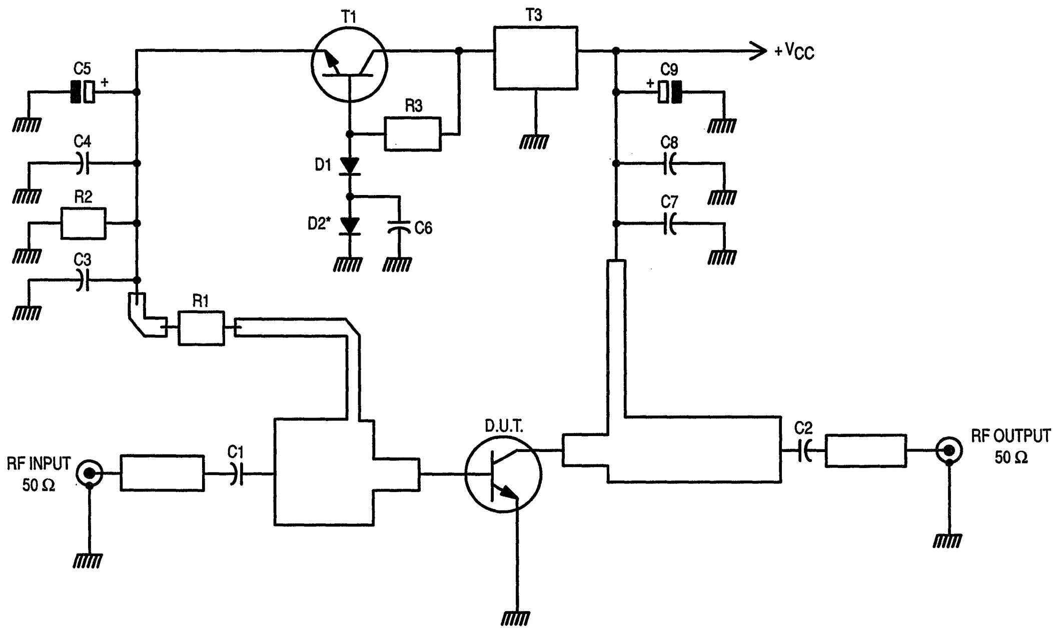
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 3.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 15 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	3.0	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	7.5	—	12.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 4.0 W, I_{CQ} = 60 mA, f = 960 MHz)	G_p	8.5	9.5	—	dB
Load Mismatch (V_{CC} = 26 V, P_{out} = 4.0 W, I_{CQ} = 60 mA, Load VSWR = 5:1, at all phase angles)	ψ	No Degradation in Output Power Before and After Test			
Collector Efficiency (V_{CC} = 26 V, P_{out} = 4.0 W, f = 960 MHz)	η_c	50	55	—	%
Power Saturation P_{in} = 1.0 W	P_{sat}	7.0	—	—	W



*Contact with RF Transistor
C1 — Capacitor Chip 0805 22 pF 5%
C2, C3, C6, C8 — Capacitor Chip 0805 330 pF 5%
C4, C7 — Capacitor Chip 0805 15 nF 5%
C5, C9 — Capacitor Chip 0805 6.0, 8.0 nF 35 V
D1, D2 — SMD Diode

R1 — Chip Resistor 2.2 Ω 1206 5%
R2 — Chip Resistor 51 Ω 0805 5%
R3 — Chip Resistor 470 Ω 0805 5% to be adjusted for I_Q = 60 mA
T1 — SMD Transistor BCX54 or Similar
T3 — Voltage Regulator 7805
Board Material — 0.8 mm, Epoxy Glass, Cu Clad, 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

2

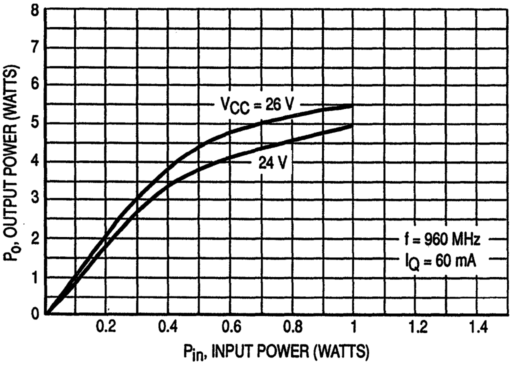


Figure 2. Output Power versus Input Power

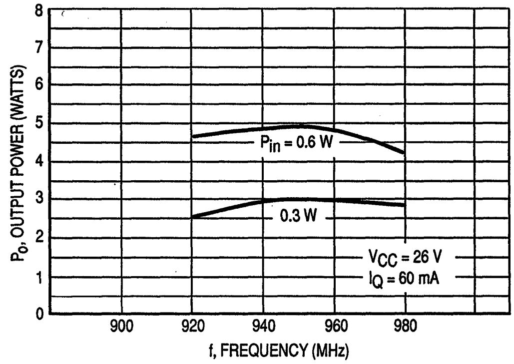


Figure 3. Output Power versus Frequency

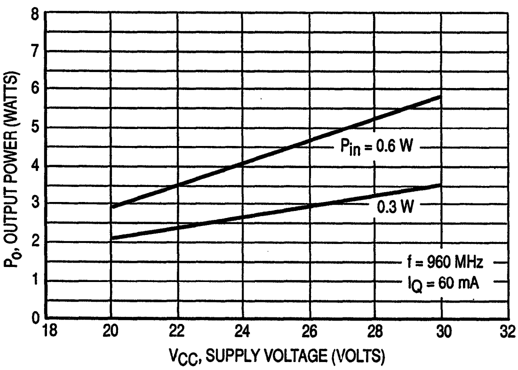


Figure 4. Output Power versus Supply Voltage

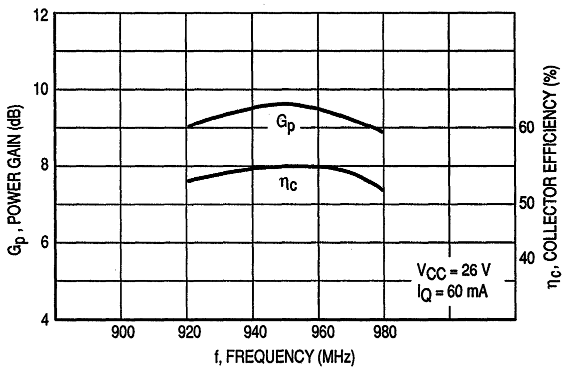
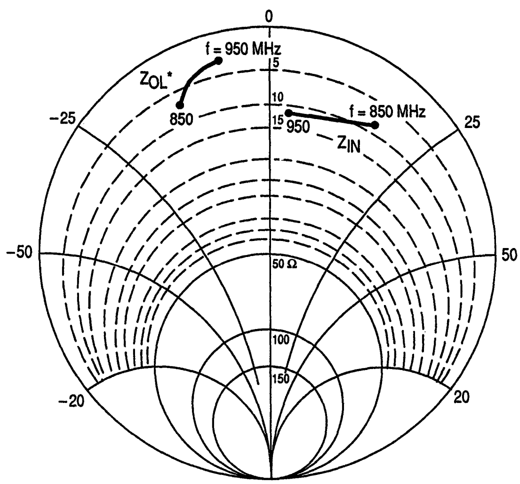


Figure 5. Typical Broadband Circuit Performance



P_{out} = 4.0 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	8.1 + j17	6.7 – j11
900	9.1 + j12.7	4.0 – j10
950	13.9 + j4.4	3.2 – j6.1

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

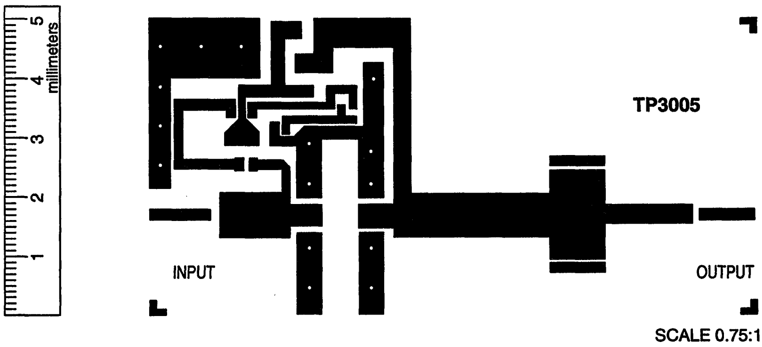


Figure 7. Test Circuit — Photomaster

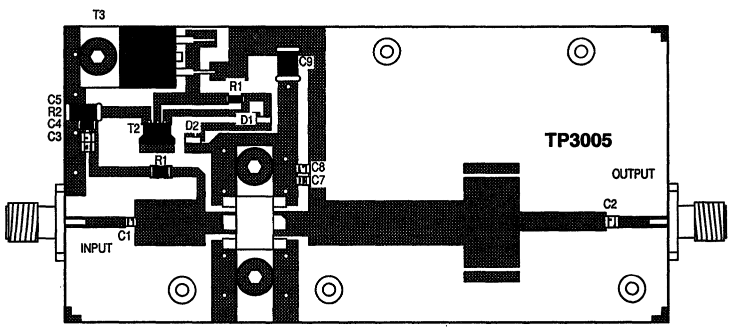


Figure 8. Test Circuit — Component Locations

2

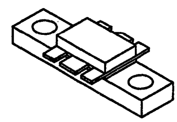
TP3006

The RF Line
NPN Silicon
RF Power Transistor

5 W, 870–960 MHz
RF POWER TRANSISTOR
NPN SILICON

The TP3006 is designed for cellular radio base station amplifiers up to 960 MHz. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. The TP3006 also features input and output matching networks and high impedances. It can easily operate in a full 870–960 MHz bandwidth in a simple circuit.

- Class AB Operation
- Specified 26 Volts, 960 MHz Characteristics
  Output Power — 5 Watts
  Gain — 9 dB min
  Efficiency — 45% min



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	45	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	2	Adc
Storage Temperature Range	T_{stg}	– 40 to +100	°C
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.14	Watts W/°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

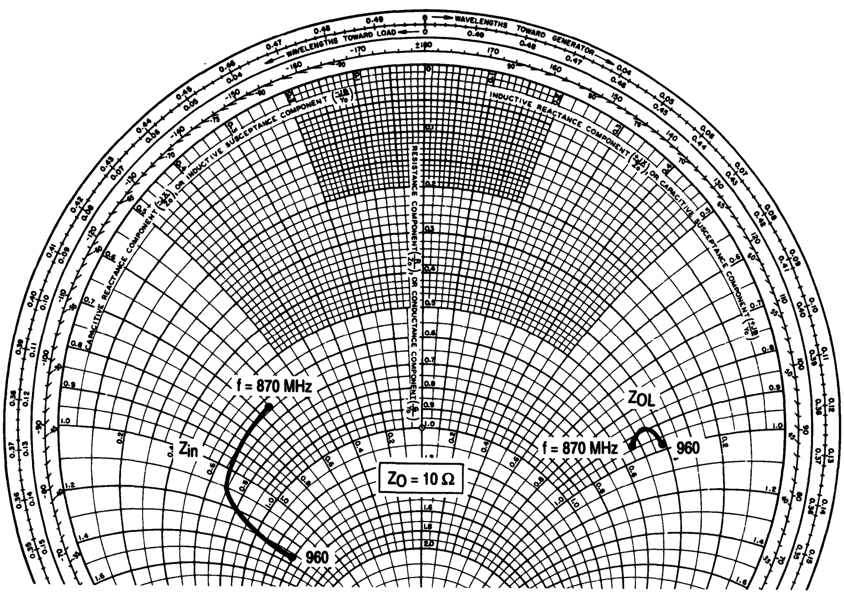
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 4 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 15 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	4	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—

NOTE:
1. Thermal resistance is determined under specified RF operating condition at temperature test point (see drawing of the package).

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

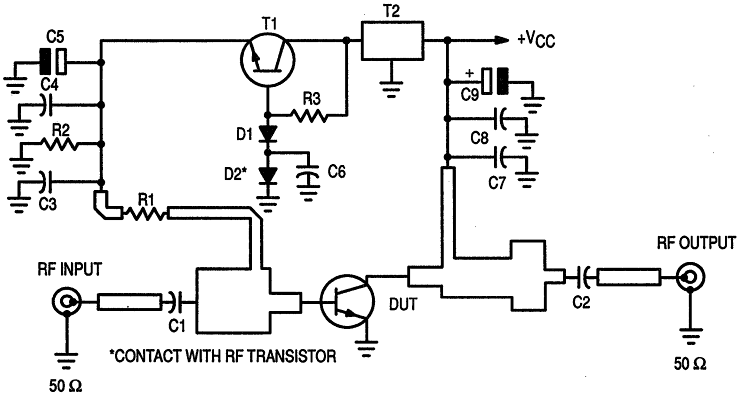
Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	8.5	—	pF
FUNCTIONAL TESTS IN CW					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 5 W, I_{CQ} = 50 mA, f = 960 MHz)	G_p	9	10.5	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 5 W, I_Q = 50 mA, f = 960 MHz)	h	45	50	—	%
Input Overdrive (no degradation in P_{out}) (V_{CC} = 26 V, I_Q = 50 mA, f = 960 MHz)	P_{in}	3	—	—	dB
FUNCTIONAL TESTS IN 2 TONES					
3rd Order Intermodulation (V_{CC} = 26 V, P_{peak}= 5 W, I_{CQ} = 50 mA, f = 900 MHz)	IMD3	—	– 46	—	dB
5th Order Intermodulation (V_{CC} = 26 V, P_{peak}= 5 W, I_{CQ} = 50 mA, f = 900 MHz)	IMD5	—	– 46	—	dB



P_{out} = 5 W (CW), V_{CE} = 26 V, I_{CQ} = 50 mA

f (MHz)	Z_{in} (Ω)	Z_{OL} (Ω)
870	6.26 - j6.40	5.22 + j9.47
900	7.40 - j12.3	4.17+ j9.02
960	14.8 - j12.9	4.21 + j9.91

Figure 1. Series Equivalent Input and Output Impedances



C1	22 pF, 5%, Chip Capacitor 0805	R1	2.2 Ω, 5%, Chip Resistor 1206
C2,C3	330 pF, Chip Capacitor 0805	R2	51 Ω, 5%, Chip Resistor 0805
C4,C7	15 nF, 5%, Chip Capacitor 0805	R3	470 Ω, 5%, Chip Resistor 0805 to be adjusted for I_Q = 50 mA
C5,C9	6.8 F, 35 V, Chip Capacitor 0805	T1	SMD Transistor, BCX54 or Similar
C6,C8	330 pF, Chip Capacitor 0805	T2	Voltage Regulator 7805
D1,D2	SMD Diode		

Figure 2. 960 MHz Electrical Schematic

2

TYPICAL CHARACTERITICS
CW – WIDEBAND

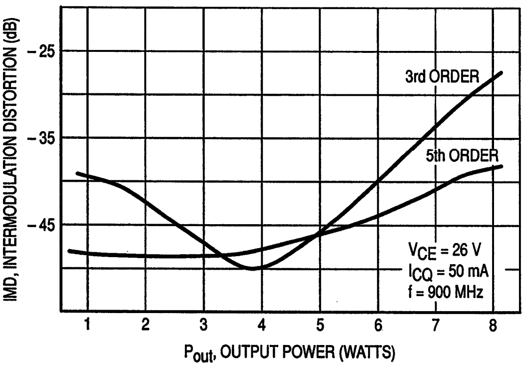


Figure 3. Intermodulation versus Output Power

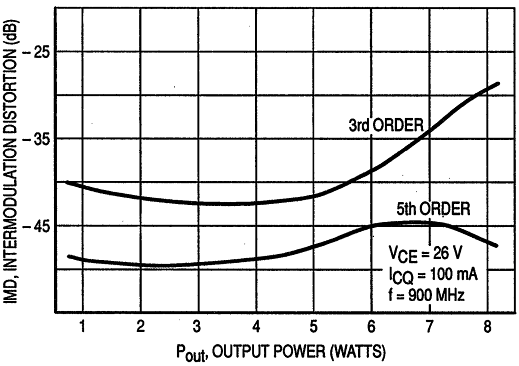
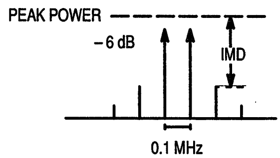


Figure 4. Intermodulation versus Output Power



TYPICAL CHARACTERITICS
CW – WIDEBAND

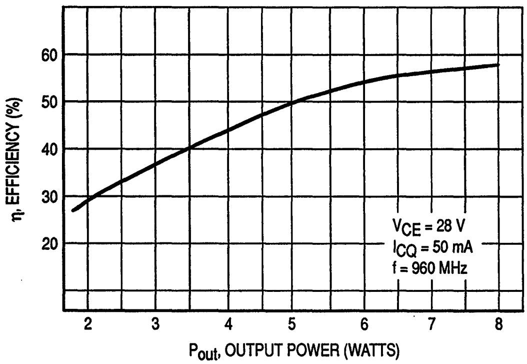


Figure 5. Collector Efficiency versus Output Power

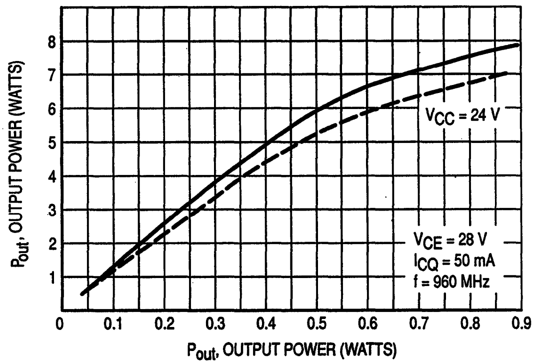


Figure 6. Output Power versus Input Power

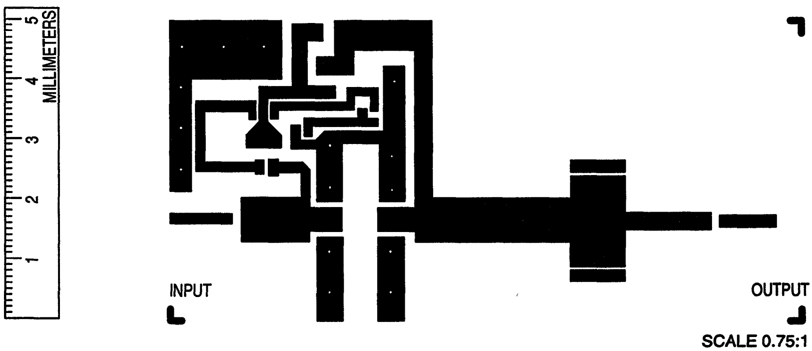
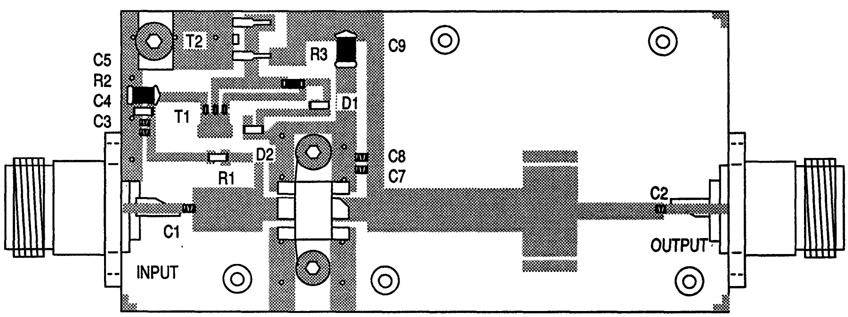


Figure 7. Photomaster



EPOXY GLASS 0.8 mm GI 180 PERSTORP DOUBLE SIDE 35 μm Cu.

Figure 8. 960 MHz Test Circuit Components View

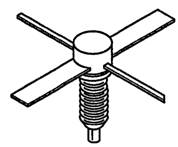
TP3007S

The RF Line
NPN Silicon
RF Power Transistor

The TP3007S is designed for 24 volts common emitter base station amplifiers, operating up to 1 GHz bandwidth. It has been specifically designed for use in analog and digital Global System Mobile (GSM) systems. The studless package offers a possibility for surface mounting.

- Specified 24 Volts, 960 MHz Characteristics
  Output Power — 2 Watts
  Gain — 9 dB min
  Efficiency — 50% min, 2 Watts
- Characterized with Series Equivalent Large-Signal Parameters from 920–960 MHz
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Class AB Operation

**2 W, 960 MHz
RF POWER TRANSISTOR
NPN SILICON**



**SOE200 STUDLESS
CASE 305B, STYLE 1**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	45	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	1	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	8.3 0.048	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) (Studless)	$R_{\theta JC}$	21	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5$ mAdc, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc

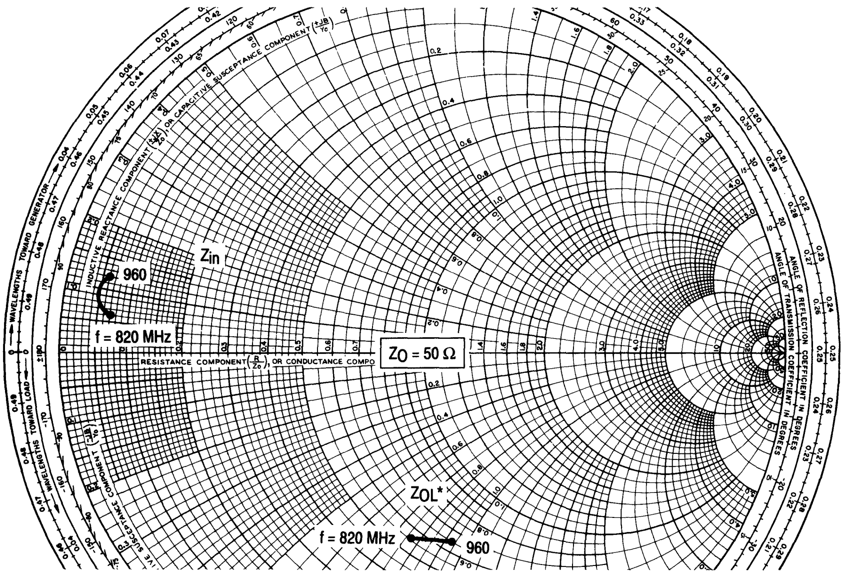
NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 0.1 Adc, V_{CE} = 5 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	2	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 2 W, I_{CQ} = 30 mA, f = 960 MHz)	G_p	9	10	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 2 W, I_{CQ} = 30 mA, f = 960 MHz)	h	50	56	—	%
Output Mismatch Stress (V_{CC} = 24 Vdc, P_{out} = 2 W, I_{CQ} = 30 mA, f = 960 MHz, Load VSWR = 10:1, all phase angles at frequency of test)	Ψ	No Degradation in Output Power			

2

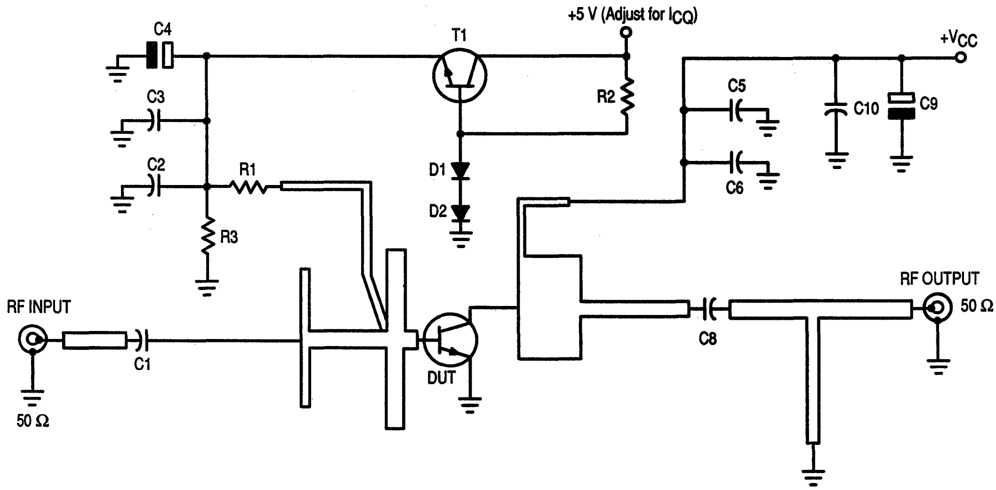


Output Impedances with circuit tuned for maximum gain
@ V_{CC} = 24 V, P_{out} = 2 W

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
820	4 + j3.8	29 – j41
860	3.4 + j4.4	30 – j43
900	3.1 + j5.1	31 – j44
960	3.5 + j5.5	35 – j45

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Series Equivalent Input and Output Impedances



C1	3.9 pF, ATC Chip Capacitor 100A	C10	15 nF, Chip Capacitor
C2,C6	100 pF, ATC Chip Capacitor 100A	D1,D2	Diode, BAS16
C3,C5	15 nF, Chip Capacitor 0805	R1	2.2 Ω, Chip Resistor 1206
C4	10 μF, 16 V, Capacitor	R2	1.2 kΩ, Chip Resistor 1206
C7	15 nF, Chip Capacitor 0805	R3	68 Ω, Chip Resistor 1206
C8	47 pF, Chip Capacitor 100A	T1	Transistor, MJD31C
C9	4.7 μF, 50 V, Capacitor		

Figure 2. 960 MHz Electrical Schematic

TYPICAL CHARACTERISTICS

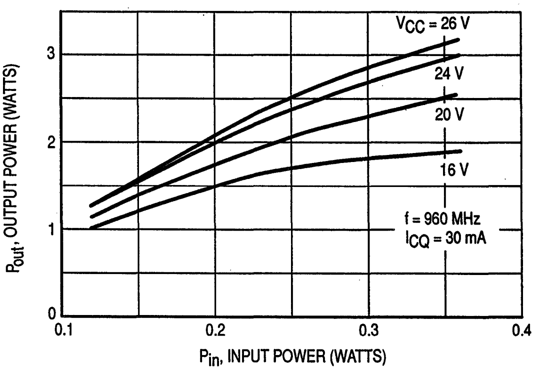


Figure 3. Output Power versus Input Power

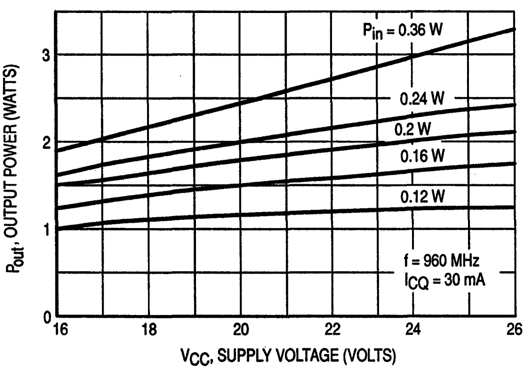


Figure 4. Output Power versus Supply Voltage

TYPICAL CHARACTERISTICS

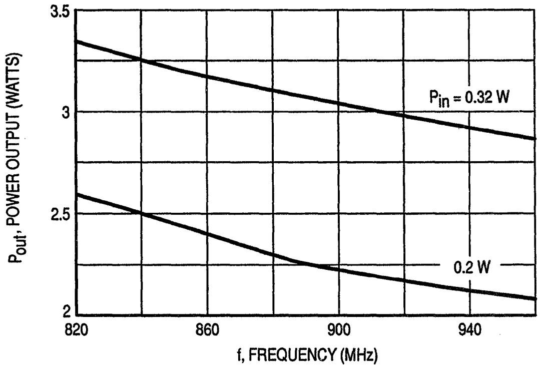
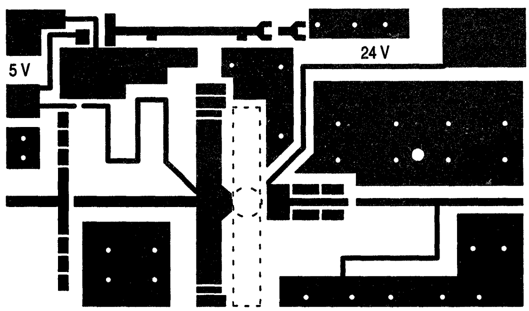


Figure 5. Output Power versus Frequency



SCALE 0.75:1

TEFLON® GLASS 0.508 mm 2 SIDES 35 μm Cu

Figure 6. PC Board Photomaster

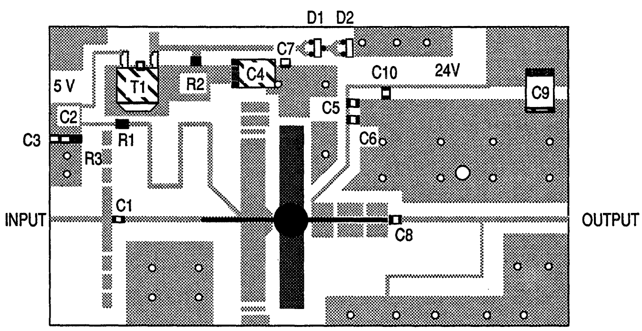


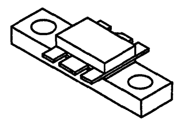
Figure 7. 960 MHz Test Circuit Components View

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP3008

4 W, 960 MHz
RF POWER TRANSISTOR
NPN SILICON



CASE 319, STYLE 2

The RF Line
RF Power Transistor

The TP3008 is designed for 960 MHz cellular radio base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 24 Volts, 960 MHz Characteristics
  Output Power — 4 Watts
  Gain — 11.5 dB min
  Efficiency — 45% min
- Class AB Operation

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	1	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	35 0.2	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	°C/W

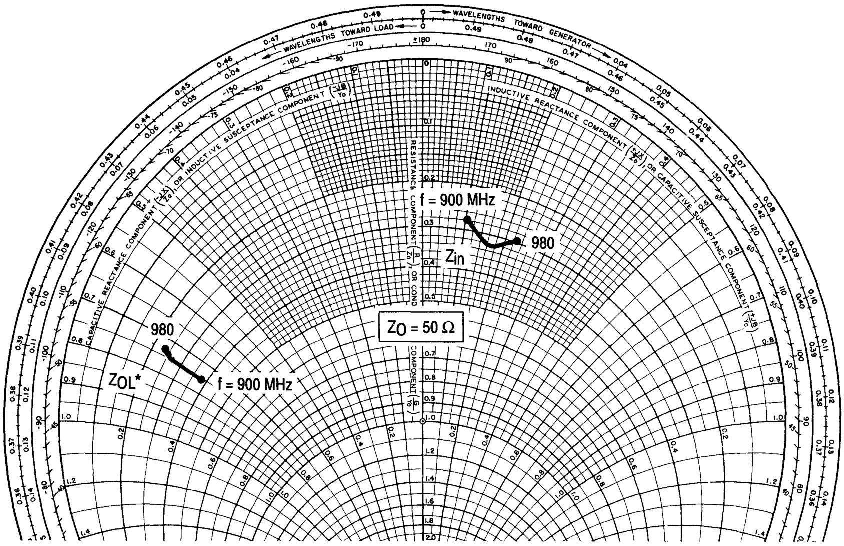
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 3 mAdc)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	2	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.2 Adc, V_{CE} = 5 Vdc)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CE} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	6	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (V_{CC} = 24 V, f = 960 MHz)					
Common-Emitter Amplifier Gain (P_{out} = 4 W, I_{CQ} = 50 mA)	G_p	11.5	—	—	dB
Collector Efficiency (P_{out} = 4 W, I_{CQ} = 50 mA)	h	45	50	—	%
Load Mismatch (P_{out} = 4 W, I_{CQ} = 50 mA, Load VSWR = 5:1, all phase angles at frequency of test)	Ψ	No Degradation in Output Power			

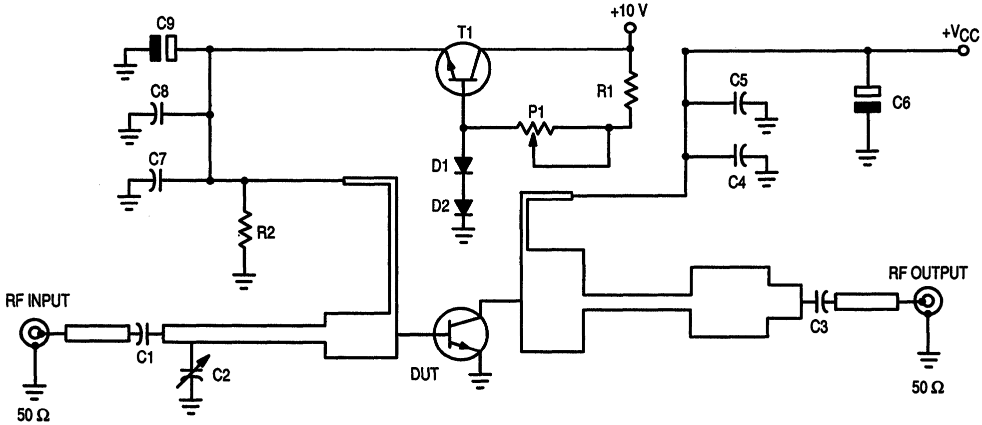


Output impedance with circuit tuned for maximum gain
@ P_{out} = 4 W, V_{CE} = 24 V

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
900	6 + j5	7.6 – j15
935	6.2 + j4.7	5.5 – j13.5
960	6.8 + j3.6	5.5 – j13.5
980	7.2 + j2	5.3 – j13.5

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Series Equivalent Input and Output Impedance



2

Components List

C1,C3	100 pF, ATC Chip Capacitor 100A	D1,D2	Diode, BAS16
C2	1 to 5 pF, Trimmer Capacitor	P1	1 kΩ, Trimmer
C4,C7	330 pF, Chip Capacitor 0805	R1	1 kΩ, Resistor
C5,C8	10 nF, Chip Capacitor 0805	R2	56 Ω, 0805 Resistor
C6	15 µF, 63 V, Capacitor	T1	Transistor, NPN Type, MJD31C
C9	100 µF, 16 V, Capacitor		

Figure 2. 960 MHz Electrical Schematic

TYPICAL CHARACTERISTICS

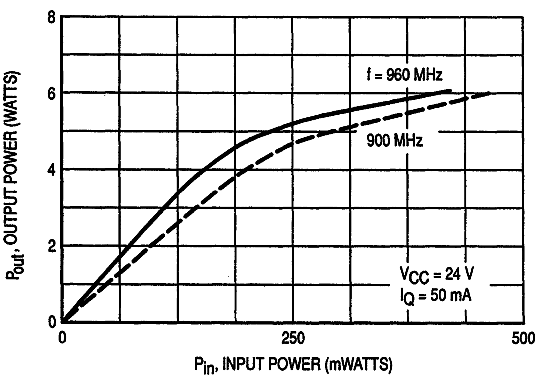


Figure 3. Output Power versus Input Power

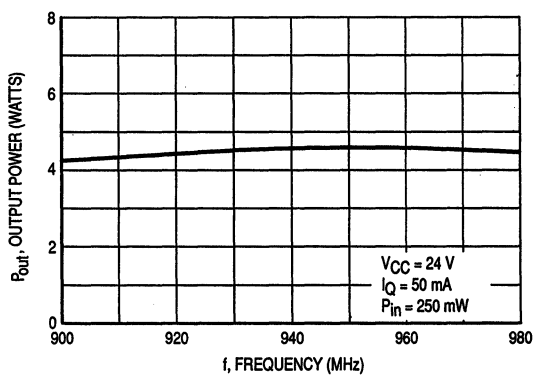


Figure 4. Output Power versus Frequency

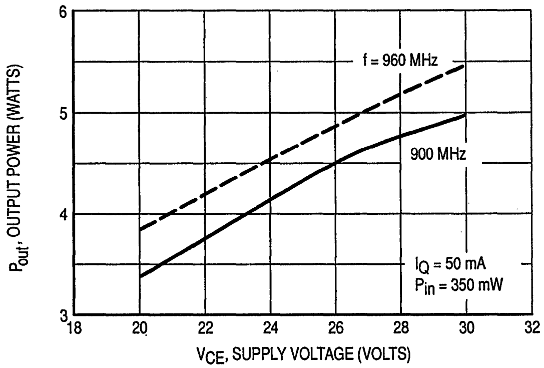


Figure 5. Output Power versus Supply Voltage

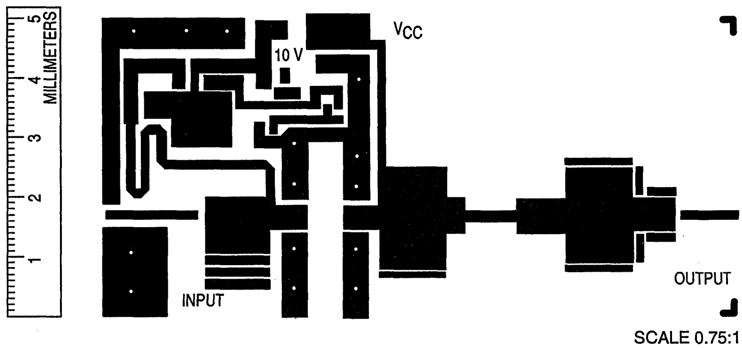
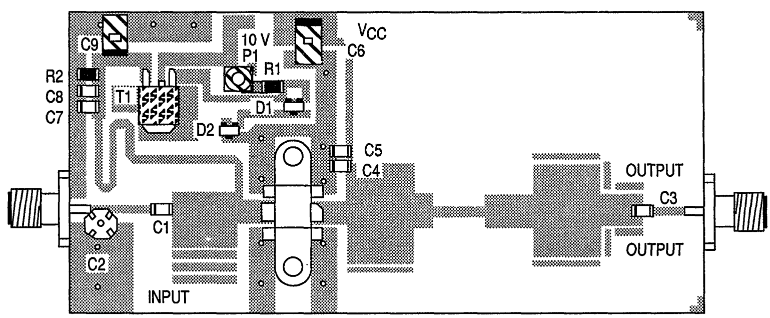


Figure 6. Photomaster



TEFLON® GLASS 1/50 INCH ε_r = 2.55

Figure 7. 960 MHz Test Circuit Components View

2

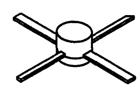
TP3019S

The RF Line
UHF Power Transistor

2.0 W, 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON

The TP3019S is designed for 24 V common emitter base station amplifiers. Operating in the 820–960 MHz bandwidth, the device has been specifically designed for use in analog and digital (GSM) systems.

- Specified 24 Volts, 960 MHz Characteristics
  Output Power = 2.0 Watts
  Minimum Gain = 9.0 dB
  Class AB
  I_Q = 20 mA



CASE 305A, STYLE 1
TP3019S

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	12.5 0.15	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	14	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

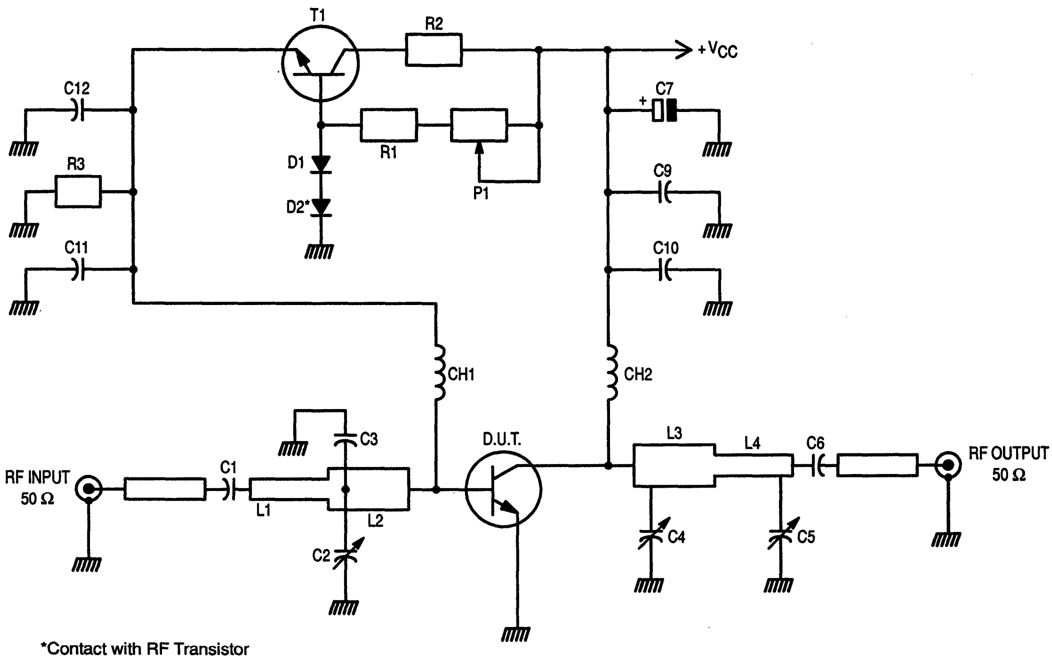
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mA, I_B = 0)	$V_{(BR)CER}$	28	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 1.0 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 5.0 mAdc)	$V_{(BR)CBO}$	50	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 20 V)	I_{CES}	—	—	2.0	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	15	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 25 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	4.0	pF

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 V, P_{out} = 2.0 W, I_{CQ} = 20 mA, f = 960 MHz)	G_p	9.0	—	—	dB
Load Mismatch (V_{CC} = 24 V, P_{out} = 2.0 W, I_{CQ} = 20 mA, Load VSWR = 20:1, at all phase angles)	ψ	No Degradation in Output Power Before and After Test			
Collector Efficiency (V_{CC} = 24 V, P_{out} = 2.0 W, f = 960 MHz)	η_c	50	55	—	%



*Contact with RF Transistor

C1, C6, C10, C11 — Capacitor Chip 0805 330 pF 5%
C2, C4, C5 — Trimmer Capacitor 0.5–4.0 pF
C3 — Capacitor Chip 0805 3.9 pF 5%
C7 — Capacitor Chip 0805 6.0, 8.0 µF 35 V
C9, C12 — Capacitor Chip 0805 15 nF 5%
CH1 — Microstrip Line 80 Ω L = 23 mm
CH2 — 3 Turns Wire 8/10 ID 4 mm
D1, D2 — Diode 1N4148
L1 — Microstrip Line 50 Ω L = 12 mm
L2 — Microstrip Line 25 Ω L = 6 mm
L3 — Microstrip Line 25 Ω L = 6 mm
L4 — Microstrip Line 50 Ω L = 28 mm
P1 — Trimmer 5.0 kΩ
R1 — Resistor 1.0 kΩ 5%
R2 — Resistor 100 Ω 2.0 W
R3 — Chip Resistor 75 Ω 0805 5%
T1 — Transistor BD135 or Similar
Board Material — 1/50″, Teflon Glass, Cu Clad 2 Sides, 35 µm Thick

Figure 1. 960 MHz Test Circuit

2

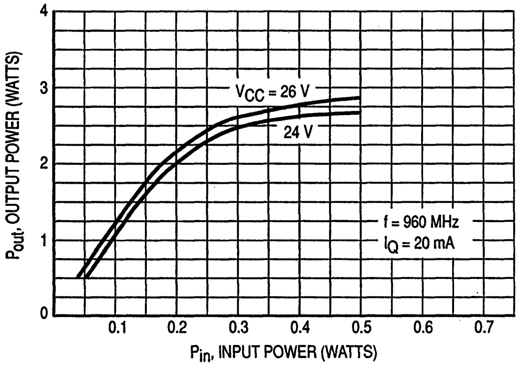
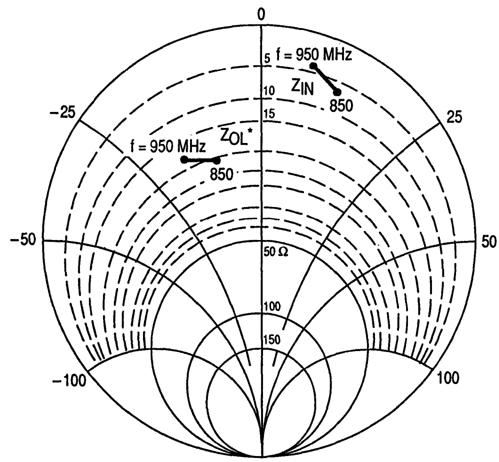


Figure 2. Output Power versus Input Power

2



P_{out} = 2.0 W V_{CE} = 24 V

f MHz	Z_{IN} OHMS	Z_{OL}^* OHMS
850	5.8 + j9.8	21.3 – j10
900	5.4 + j9	21 – j11
950	4.8 + j7.9	20 – j14

Z_{OL}^* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 3. Series Equivalent Input/Output Impedances

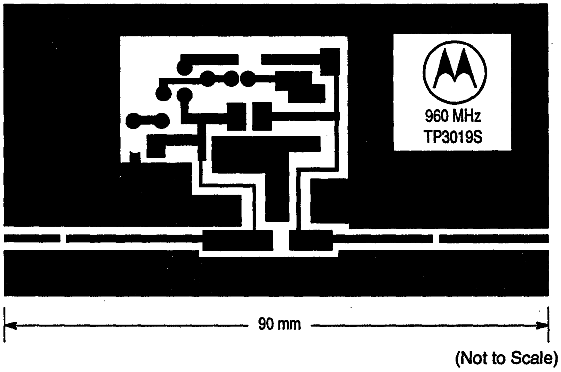


Figure 4. Test Circuit — Photomaster

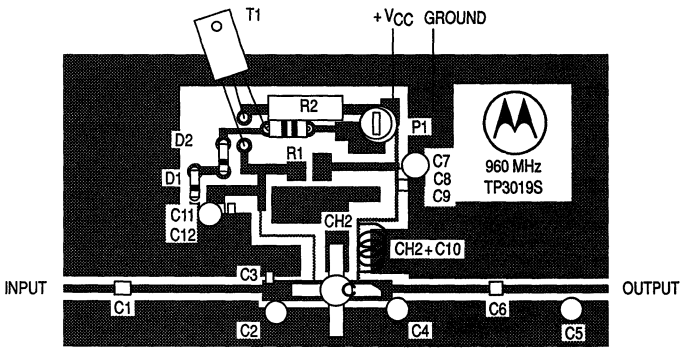


Figure 5. Test Circuit — Component Locations

2

TP3020A

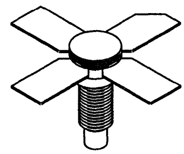
Advance Information

The RF Line
UHF Power Transistor

**2.2 W, 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**

The TP3020A is designed for use in the 900 MHz mobile radio band. Its high gain and ability to operate Class A makes it an ideal choice as a driver operating Class A, Class B or Class C.

- 960 MHz
- 2.2 W — P_{out}
- 26 V — V_{CC}
- High Gain — 9.0 dB, Class A



**CASE 244-04, STYLE 1
(.280 SOE)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.75 0.05	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	20	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CB} = 24 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 V, P_{out} = 2.2 W, f = 960 MHz, I_Q = 200 mA)	G_{PE}	9.1	—	—	dB

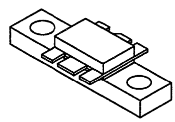
TP3021

The RF Line
UHF Power Transistor

The TP3021 is designed for 24 V common emitter base station amplifiers. Operating in the 820–960 MHz bandwidth, it has been specifically designed for use in analog and digital (GSM) systems as a medium power output device.

- Specified 24 Volts, 960 MHz Characteristics
  Output Power = 10 Watts
  Minimum Gain = 10 dB
  Class AB
  I_Q = 60 mA

10 W, 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	35 0.35	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	5.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

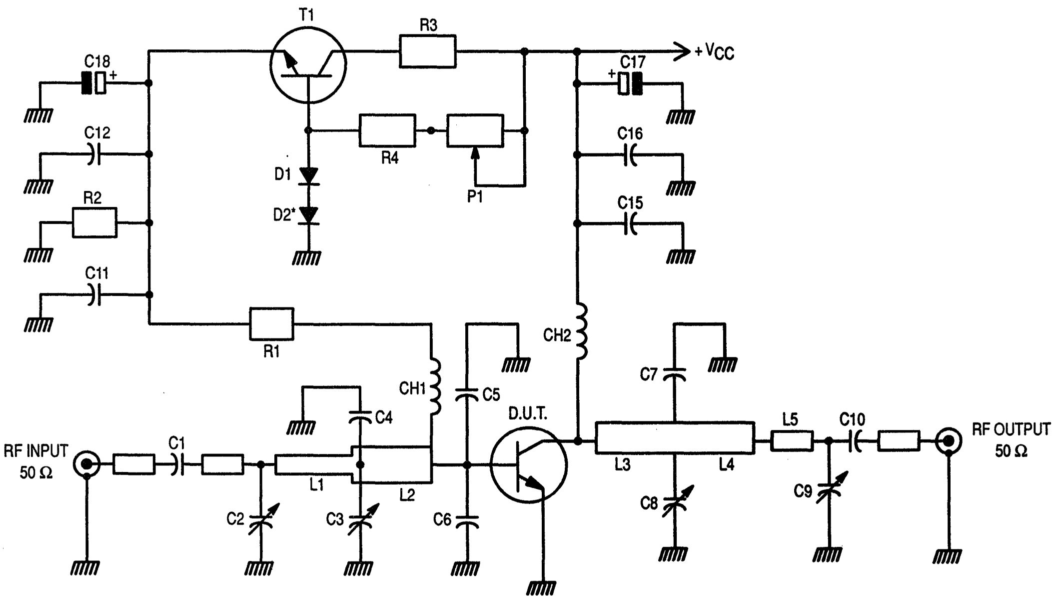
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—

(continued)

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1.0 MHz)	C_{ob}	15	—	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 V, P_{out} = 10 W, I_{CQ} = 60 mA, f = 960 MHz)	G_p	10	—	—	dB
Load Mismatch (V_{CC} = 26 V, P_{out} = 10 W, I_{CQ} = 60 mA, Load VSWR = 20:1, at all phase angles)	ψ	No Degradation in Output Power Before and After Test			
Collector Efficiency (V_{CC} = 24 V, P_{out} = 10 W, f = 960 MHz)	η_c	50	55	—	%



*D2 is in Physical Contact with RF Transistor
C1, C10, C11, C15 — Capacitor Chip 0805 330 pF 5%
C2, C4, C8, C9 — Trimmer Capacitor 0.5–4.0 pF
C4 — Capacitor Chip 0805 3.9 pF 5%
C5, C6 — Capacitor Chip 15 pF HQ
C7 — Chip Resistor 0805 8.2 pF
C12, C16 — Capacitor Chip 0805 15 nF 5%
C17, C18 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
CH1 — Microstrip Line 80 Ω L = 40 mm
CH2 — Microstrip Line 80 Ω L = 23 mm
D1, D2 — Diode 1N4148

L1 — Microstrip Line 50 Ω L = 20 mm
L2 — Microstrip Line 25 Ω L = 13 mm
L3 — Microstrip Line 25 Ω L = 10 mm
L4 — Microstrip Line 50 Ω L = 5 mm
L5 — Microstrip Line 50 Ω L = 7 mm
P1 — Trimmer 5.0 kΩ
R1 — Chip Resistor 2.2 Ω 1206 5%
R2 — Chip Resistor 75 Ω 0805 5%
R3 — Resistor 100 Ω 2.0 W
R4 — Resistor 1.0 kΩ 5%
T1 — Transistor BD135 or Similar
Board Material — 1/50″, Teflon Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

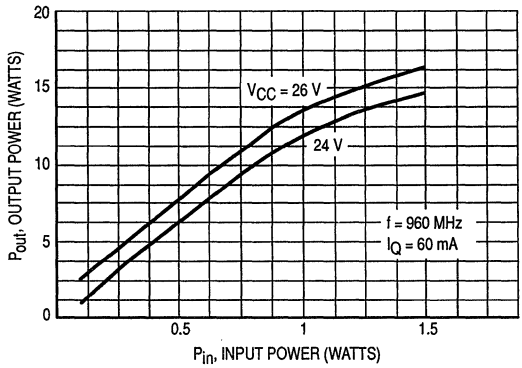
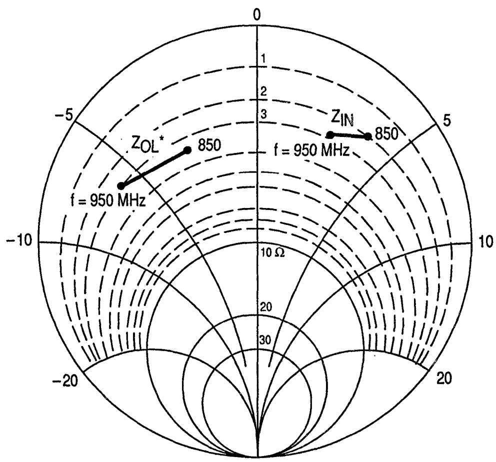


Figure 2. Output Power versus Input Power



P_{out} = 10 W V_{CE} = 24 V

f MHz	Z_{IN} OHMS	Z_{OL}^* OHMS
850	2.4 + j3.5	3.4 – j3.2
900	2.6 + j3.4	3.1 – j4.4
950	2.8 + j3.4	2.7 – j6.2

Z_{OL}^* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 3. Series Equivalent Input/Output Impedances

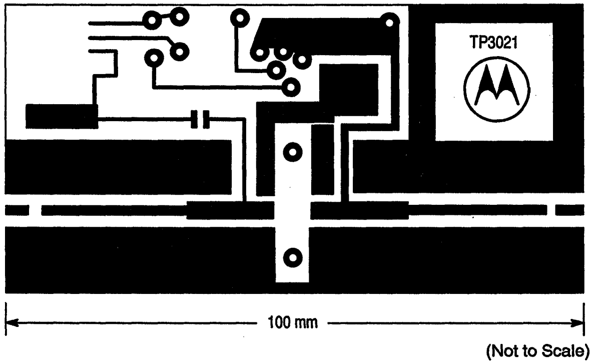


Figure 4. Test Circuit — Photomaster

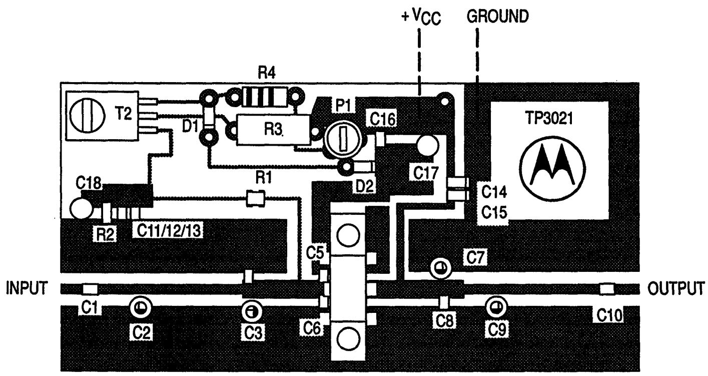


Figure 5. Test Circuit — Component Locations

2

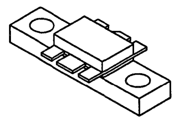
TP3022B

The RF Line
UHF Power Transistor

The TP3022B is designed for common-emitter operation in the 900 MHz mobile radio band. Use of gold metallization and silicon diffused ballast resistors results in a medium power output/driver transistor with state-of-the-art ruggedness and reliability.

- Specified 26 Volts, 960 MHz Characteristics:
  Output Power = 15 Watts
  Minimum Gain = 8.5 dB
  I_Q = 50 mA
- Class AB Operation

**15 W, 960 MHz
NPN SILICON
UHF POWER
TRANSISTOR**



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	29 0.167	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	6.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ohms)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ohms)	I_{CER}	—	—	5.0	mA
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Emitter-Base Leakage (V_{BE} = 2.5 V)	I_{EBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 10 V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	17	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 V, P_{out} = 15 W, f = 960 MHz, I_Q = 50 mA)	G_{PE}	8.5	—	—	dB
Collector Efficiency (V_{CE} = 26 V, P_{out} = 15 W, f = 960 MHz, I_Q = 50 mA)	η_c	45	—	—	%

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

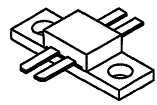
TP3024B

The RF Line
UHF Linear Power Transistor

The TP3024B is a balanced transistor designed specifically for use in cellular radio systems. This device permits the design of a Class AB push-pull, high gain, broadband amplifier having a high degree of linearity without the need for complicated biasing circuitry.

- Specified 26 Volts, 960 MHz Characteristics:
  Output Power = 35.5 W
  Minimum Gain = 7.5 dB
  I_{Qtotal} = 150 mA
- Push-Pull Configuration

**35.5 W, 960 MHz
UHF LINEAR POWER
TRANSISTOR**



CASE 395, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) (T_C = 75°C)	$R_{\theta JC}$	3.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ohms)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ohms)	I_{CER}	—	—	5.0	mA
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Emitter-Base Leakage (V_{BE} = 2.5 V)	I_{EBO}	—	—	1.0	mA
ON CHARACTERISTICS (2)					
DC Current Gain (I_C = 500 mA, V_{CE} = 10 V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS (1)					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	17	25	pF
FUNCTIONAL TESTS (3)					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 V, P_{out} = 35.5 W, f = 960 MHz, I_{Qtotal} = 150 mA)	G_{PE}	7.5	—	—	dB
Collector Efficiency (V_{CE} = 26 V, P_{out} = 35.5 W, f = 960 MHz, I_{Qtotal} = 150 mA)	η_c	45	—	—	%

NOTE:
1. Thermal resistance is determined under specified RF operating condition.
2. Each transistor chip measured separately.
3. Both transistor chips operating in push-pull amplifier.

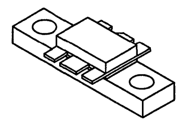
TP3032

The RF Line
NPN Silicon
RF Power Transistor

21 W, 960 MHz
RF POWER TRANSISTOR
NPN SILICON

The TP3032 is designed for 26 volts, common emitter, 960 MHz base station amplifiers, for use in analog and digital systems.

- Specified 26 Volts, 960 MHz Characteristics
  Output Power — 21 Watts
  Gain — 7.5 dB min
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Class AB Operation



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	52.5 0.3	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	3.3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

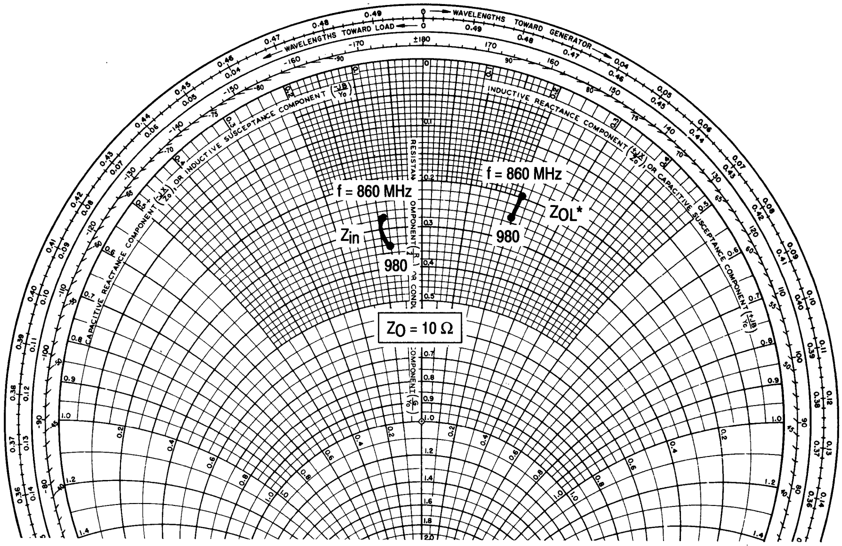
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 30 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	8	mA
ON CHARACTERISTICS					
DC Current Gain (I_C =1 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	80	—

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	30	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain (V_{CC} = 26 V, P_{out} = 21 W, I_{CQ} = 100 mA, f = 960 MHz)	G_p	7.5	8.5	—	dB
Load Mismatch (V_{CC} = 26 V, P_{out} = 21 W, I_{CQ} = 100 mA, Load VSWR = 5:1, at All Phase Angles at Frequency of Test)	ψ	No Degradation in Output Power			
Collector Efficiency (V_{CC} = 26 V, P_{out} = 21 W, f = 960 MHz)	η	50	55	—	%
Over Drive (V_{CC} = 26 V, P_{in} = 6 W, f = 960 MHz)	OD	No Degradation in Output Power			

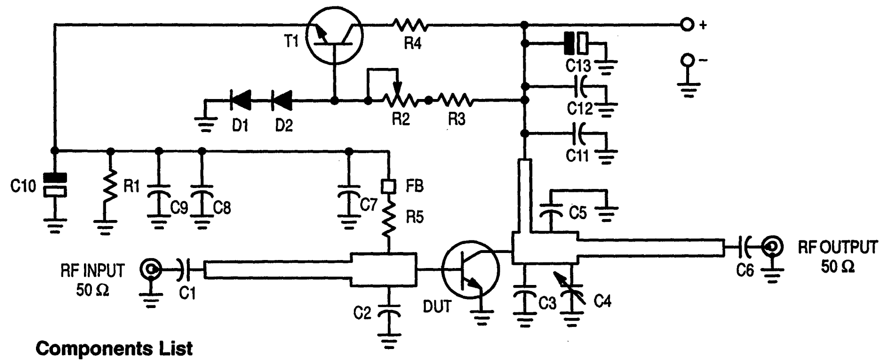


V_{CE} = 26 V P_{out} = 21 W

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
860	2.9 - j0.4	2 + j2.2
880	2.9 - j0.9	2.1 + j2.2
900	2.9 - j1.45	2.25 + j2.5
935	3.2 - j0.95	2.4 + j2.3
960	3.25 - j1.5	2.5 + j2
980	3.55 - j1.1	2.6 + j2.15

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Series Equivalent Input and Output Impedances



Components List

C1	300 pF, ATC Chip Capacitor 100B	D1,D2	Diode, 1N4148
C2	12 pF, ATC Chip Capacitor 100A	FB	Ferrite Bead
C3	10 pF, ATC Chip Capacitor 100A	R1	75 Ω, Chip Resistor 1206
C4	1−4.5 pF, Johanson Capacitor 9410-0	R2	10 kΩ, Trimmer Resistor
C5	6.8 pF, ATC Chip Capacitor 100A	R3	1 kΩ, 1/2 W, Resistor
C6	82 pF, ATC Chip Capacitor 100B	R4	82 Ω, 3 W, Resistor
C7,C8,C11	330 pF, Chip Capacitor	R5	1 Ω, 1/4 W, Resistor
C9,C12	15 nF, Chip Capacitor	T1	Transistor, BD135
C10,C13	6.8 µF, 35 V, Tantalum Capacitor		

Figure 2. 960 MHz Test Circuit Schematic

TYPICAL CHARACTERISTICS

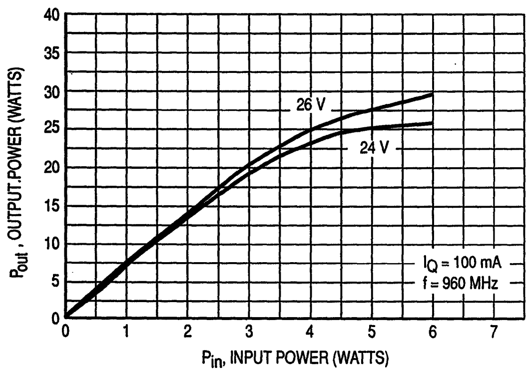


Figure 3. Output Power versus Input Power

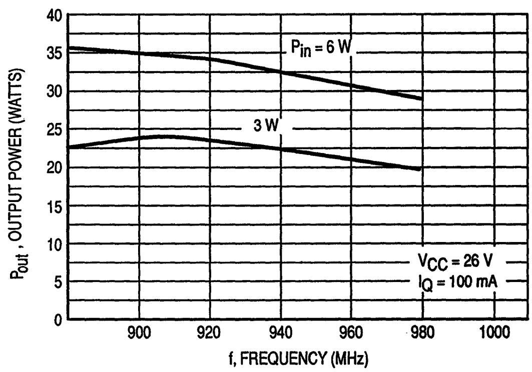


Figure 4. Output Power versus Frequency

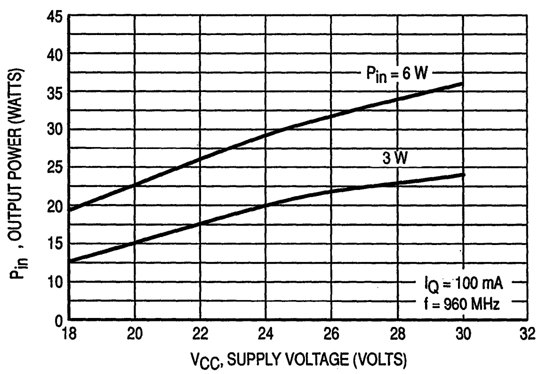
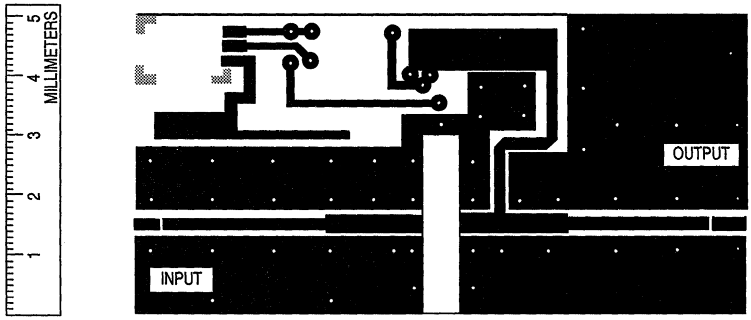


Figure 5. Output Power versus Supply Voltage



SCALE 0.75:1

TEFLON® GLASS 0.5 mm - DOUBLE SIDE 35 μm CU.

Figure 6. Photomaster

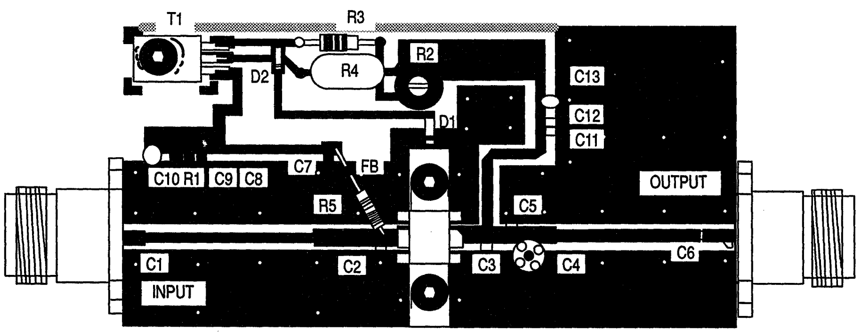


Figure 7. Test Circuit Components View

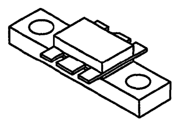
TP3034

The RF Line
NPN Silicon RF Power Transistor

**35 W, 960 MHz
RF POWER TRANSISTOR
NPN SILICON**

The TP3034 is designed for 960 MHz cellular radio base stations in both analog and digital applications. It incoporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 24 Volts, 960 MHz Characteristics
  - Output power — 35 Watts
  - Gain — 7 dB Min
  - Efficiency — 50% Min
- Class AB Operation



CASE 319, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	76 0.43	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

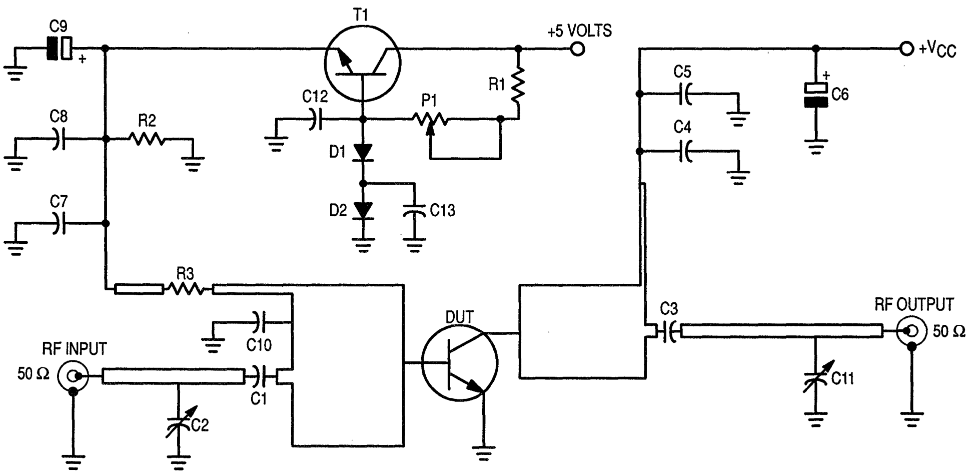
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, I_C = 1 A, R_{BE} = 75 Ω)	I_{CER}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	40	—	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain (P_{out} = 35 W, I_{CQ} = 60 mA, V_{CC} = 24 V, f = 960 MHz)	G_{p1}	7	8	—	dB
Collector Efficiency (P_{out} = 35 W, V_{CC} = 24 V, f = 960 MHz)	η_{c1}	50	55	—	%
Load Mismatch (P_{out} = 35 W, I_{CQ} = 60 mA, V_{CC} = 24 V, f = 960 MHz, Load VSWR = 20:1, All Phase Angles at frequency of test)	ψ	—	No Degradation in Output Power		
Input Return Loss (P_{out} = 35 W, I_{CQ} = 60 mA, V_{CC} = 24 V, f = 960 MHz)	IRL	12	—	—	dB
Common-Emitter Amplifier Gain (P_{out} = 15 W, I_{CQ} = 100 mA, V_{CC} = 25 V, f = 960 MHz)	G_{p2}	8	—	—	dB
Collector Efficiency (P_{out} = 15 W, I_{CQ} = 100 mA, V_{CC} = 25 V, f = 960 MHz)	η_{c2}	40	—	—	%



C1, C3	100 pF, ATC Chip Capacitor 100A	D1, D2	Diode, Type BAS16
C2, C11	0.5–20 pF, Trimmer Capacitor	P1	1 kΩ, Trimmer
C4, C7	330 pF, Chip Capacitor 0805	R1	1 kΩ, Resistor 0805
C5, C6, C12, C13	10 nF, Chip Capacitor 0805	R2	56 Ω, Resistor 0805
C6	4.7 µF, 50 Volts, Capacitor	R3	2.2 Ω, Resistor 0805
C9	10 µF, 16 Volts, Capacitor	T1	Transistor, NPN Type MJD31C
C10	5.6 pF, ATC Chip Capacitor 100A		

Figure 1. 960 MHz Electrical Schematic

TYPICAL CHARACTERISTICS

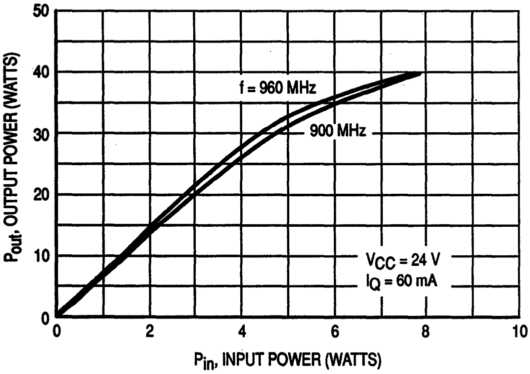


Figure 2. Output Power versus Input Power

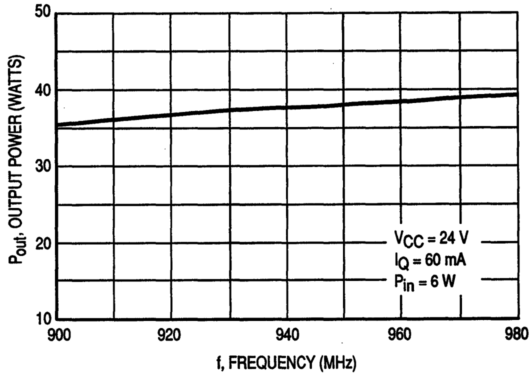


Figure 3. Output Power versus Frequency

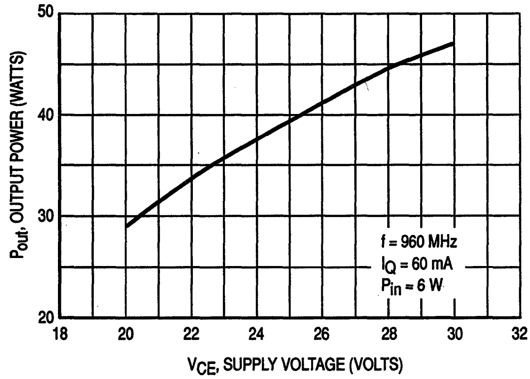
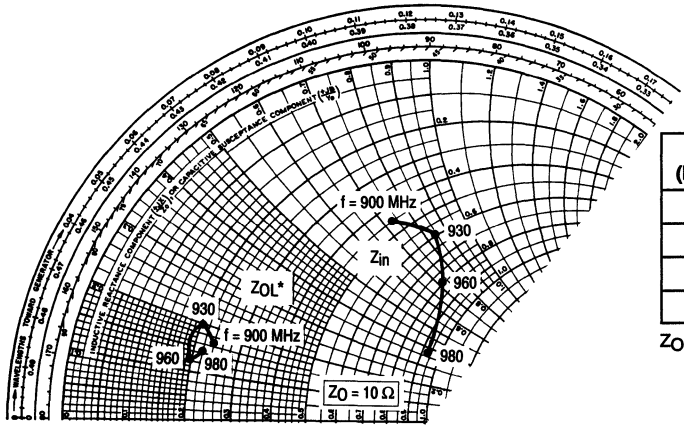


Figure 4. Output Power versus Supply Voltage

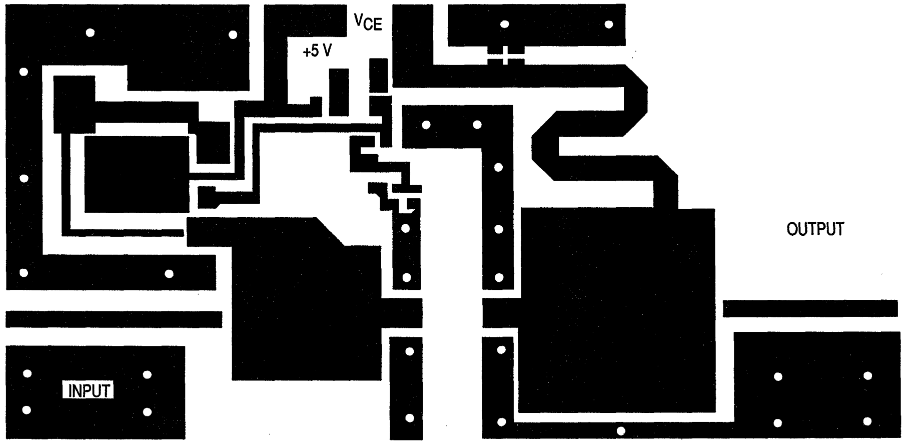


$V_{CE} = 24$ V $\quad P_{out} = 35$ W

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
900	4.5 + j7.4	2.4 + j1.7
930	5.8 + j8.4	2 + j2
960	7.9 + j7.2	2 + j1.3
980	9.4 + j3.8	2.2 + j1.5

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 5. Series Equivalent Input and Output Impedances



(Not to Scale)

TEFLON® GLASS 1/50 INCH - DOUBLE SIDE 35 μ Cu. ε_r = 2.55

Figure 6. Photomaster

2

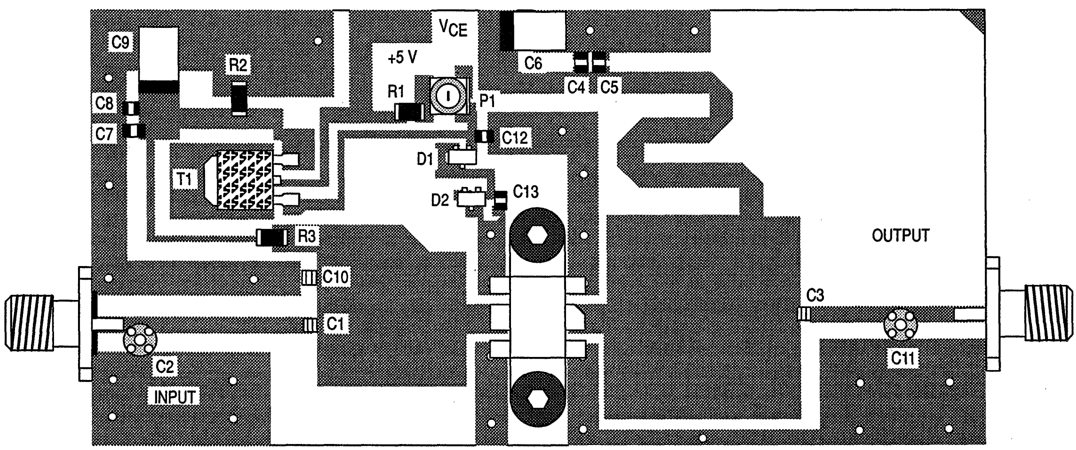


Figure 7. Test Circuit Components View

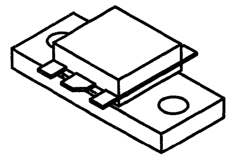
The RF Line
UHF Power Transistor

TP3061

**45 W, 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**

The TP3061 is designed for 960 MHz mobile base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. Including double input and output matching networks, the TP3060 features high impedances and is easy to match.

- Motorola Advanced Amplifier Concept Package
- Oxynitride Passivation
- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 45 Watts
  Minimum Gain = 8.0 dB
  Efficiency = 50%



CASE 333A, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{θJC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 6.0 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 60 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

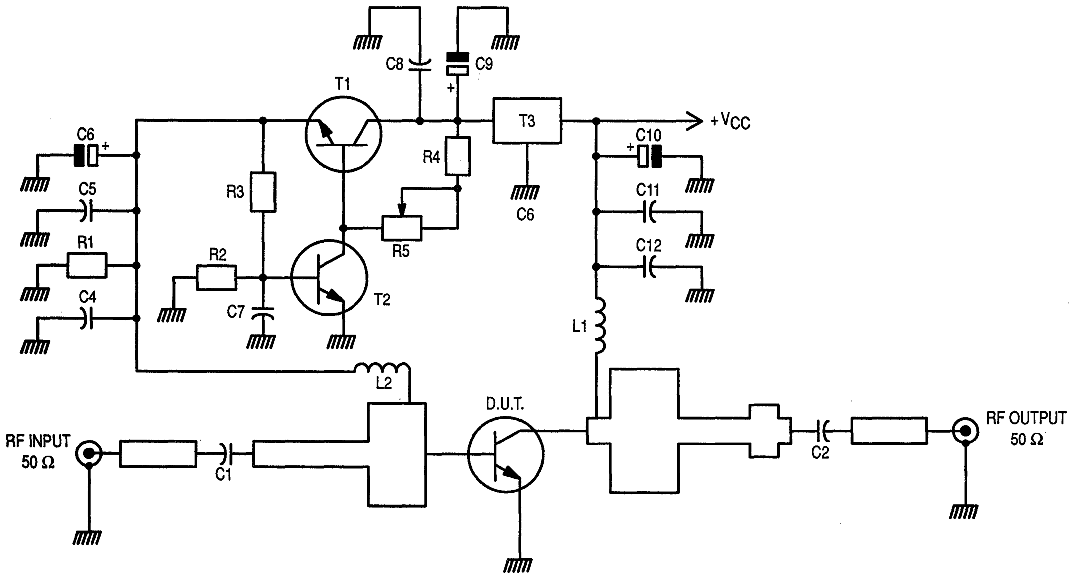
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (2) (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	45	60	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 45 W, I_{CQ} = 200 mA, f = 960 MHz)	G_p	8.0	8.8	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 45 W, f = 960 MHz)	η	50	53	—	%
Load Mismatch (V_{CC} = 26 V, P_{out} = 45 W, I_{CQ} = 200 mA, Load VSWR = 5:1, at all phase angles)	ψ	No Degradation in Output Power Before and After Test			
Overdrive (V_{CC} = 26 V, P_{in} = 15 W, f = 960 MHz)	OD	No Degradation in Output Power			

NOTE:
2. Value of "C_{ob}" is that of die only. It is not measurable in TP3061 because of internal matching network.

2



C1, C4, C7, C12 — Capacitor Chip 0805 330 pF 5%
C2 — Capacitor Chip 82 pF ATC
C5, C11, C8 — Capacitor Chip 0805 15 nF 5%
C6, C9, C10 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
L1, L2 — 1.5 Turns #18 AWG Choke
R1 — Chip Resistor 47 Ω 1206 5%
R2 — Chip Resistor 270 Ω 0805 5%
R3 — Chip Resistor 47 Ω 0805 5%
R4 — Chip Resistor 100 Ω 0805 5%
R5 — Trimmer 1.0 kΩ
T1 — SMD Transistor MJD31C or Similar
T2 — SMD Transistor
T3 — Voltage Regulator 7805
Board Material — 1/50″, Teflon Glass, ε_r = 2.5, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

TYPICAL CHARACTERISTICS

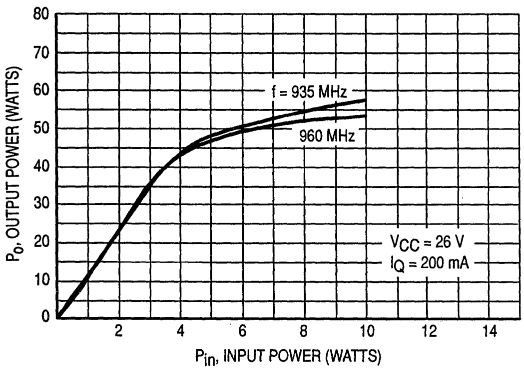


Figure 2. Output Power versus Input Power

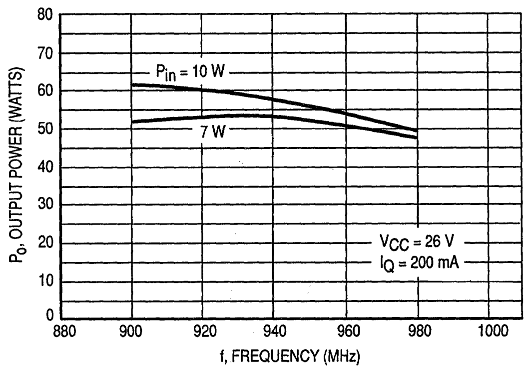


Figure 3. Output Power versus Frequency

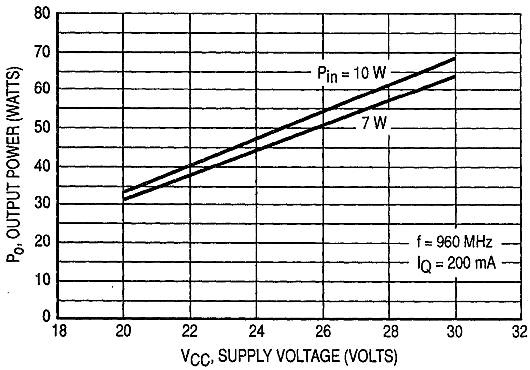


Figure 4. Power Output versus Supply Voltage

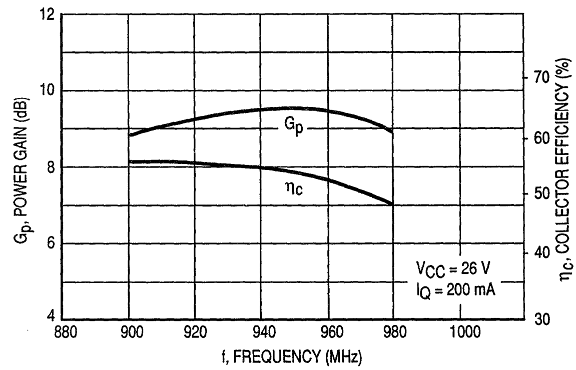
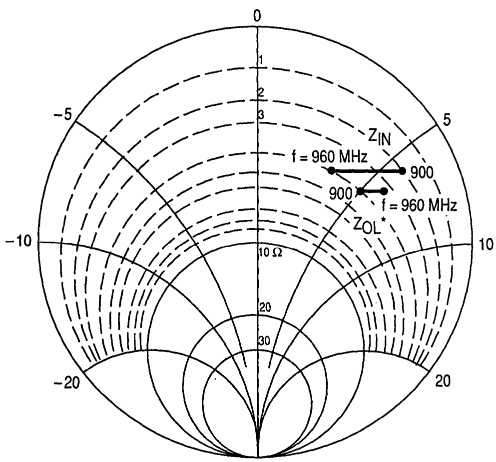


Figure 5. Typical Broadband Circuit Performance



P_{out} = 45 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	—	—
900	2.8 + j6	4.1 + j5
950	3.95 + j3.55	3.7 + j5.2

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

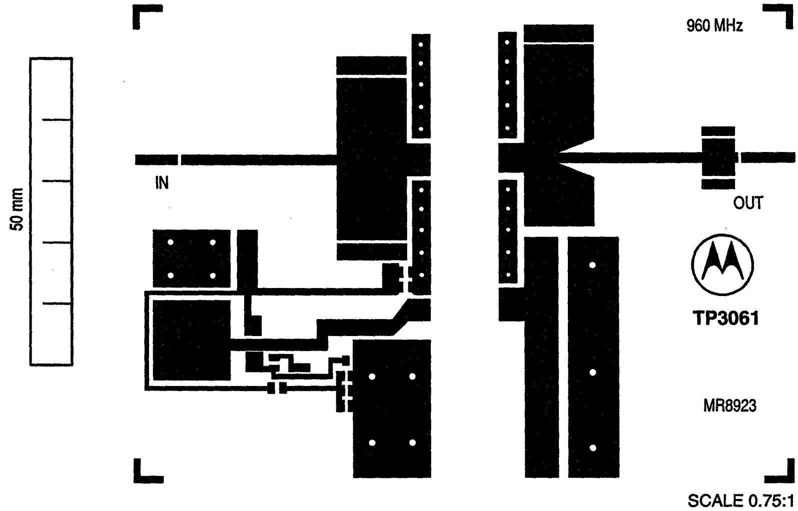


Figure 7. Test Circuit — Photomaster

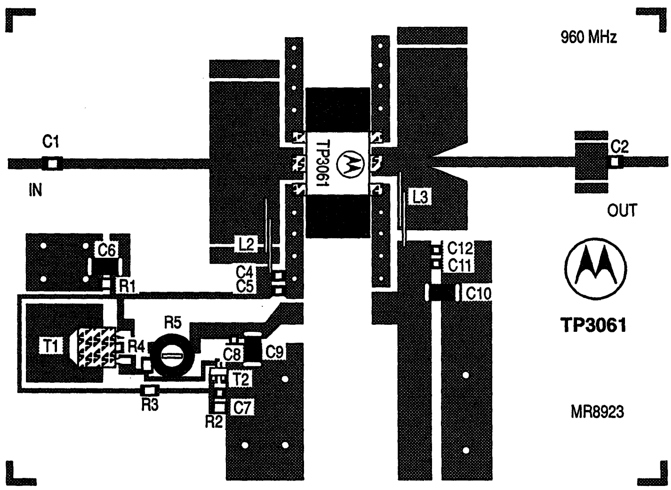


Figure 8. Test Circuit — Component Locations

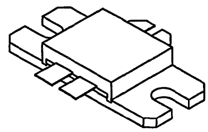
TP3062

The RF Line
UHF Power Transistor

The TP3062 is designed for 960 MHz mobile base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. Including double input and output matching networks, the TP3062 features high impedances. It can easily operate in a full 860 MHz to 960 MHz bandwidth in a single circuit and without any tuning.

- Motorola Advanced Amplifier Concept Package
- To Be Used Class AB for FM, GSM, Digital
- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 60 Watts
  Minimum Gain = 7.5 dB
  Efficiency = 50%

**60 W, 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**



CASE 398, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	145 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 15 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

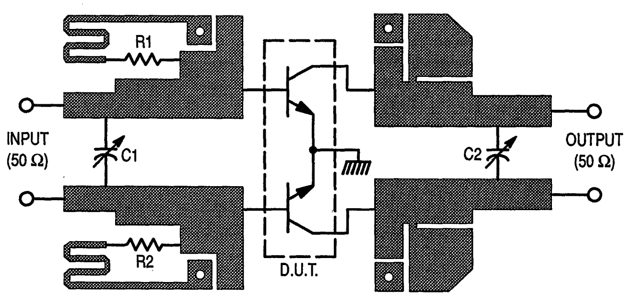
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (2) (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	30	35	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 200 mA, f = 960 MHz)	G_p	7.5	8.0	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 60 W, f = 960 MHz)	η	48	50	—	%
Load Mismatch (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 200 mA, Load VSWR = 5:1, at all phase angles)	ψ	No Degradation in Output Power Before and After Test			

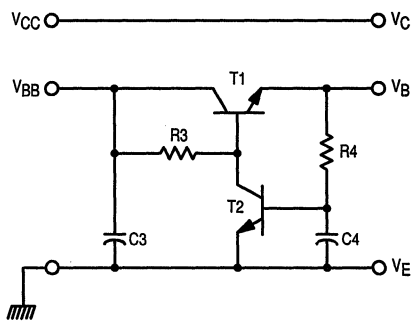
NOTE:
2. Value of "C_{ob}" is that of die only. It is not measurable in TP3062 because of internal matching network.

2



Bias is adjusted by varying V_{BB}
C1, C2 — Adjustable Capacitor 1.0–4.0 pF
C2, C4 — Capacitor Chip 15 nF 5%
R1 — Chip Resistor 22 Ω 0805 5%
R2 — Chip Resistor 22 Ω 0805 5%

Figure 1. 960 MHz Test Circuit



R3 — Chip Resistor 330 Ω 0805 5%
R4 — Chip Resistor 51 Ω 0805 5%
T1 — Transistor Type BD135
T2 — Transistor Type BD135
Board Material — 1/50″, Teflon Glass, ε_r = 2.5, Cu Clad 2 Sides, 35 µm Thick

Figure 2. Bias Current

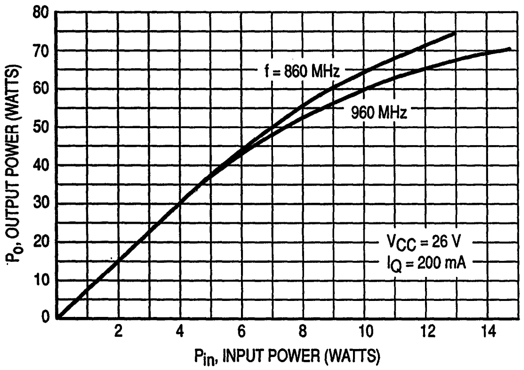


Figure 3. Output Power versus Input Power

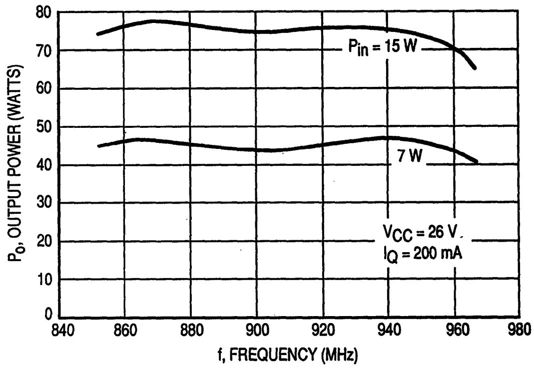


Figure 4. Output Power versus Frequency

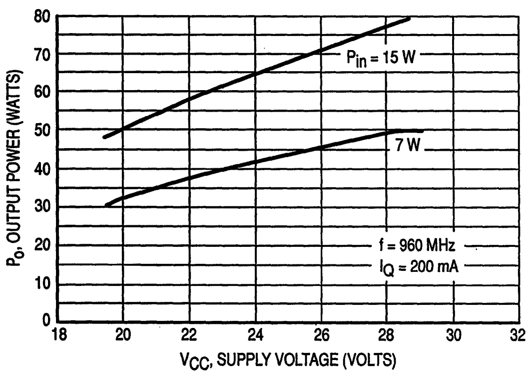


Figure 5. Power Output versus Supply Voltage

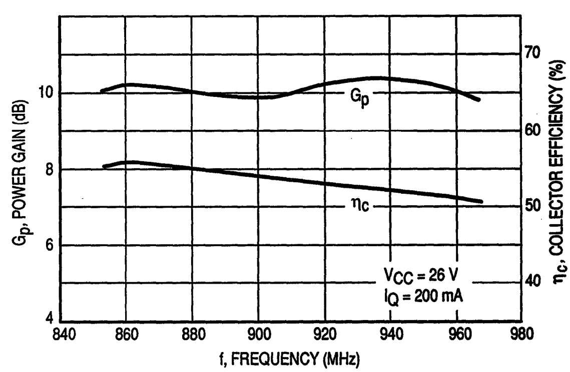
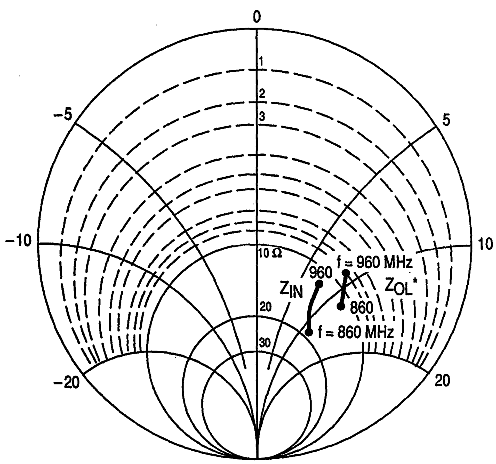


Figure 6. Typical Broadband Circuit Performance

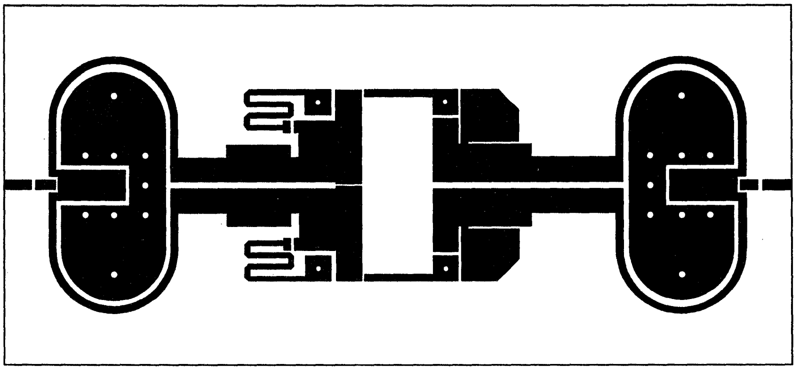


P_{out} = 60 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
860	17.3 + j10.4	11.5 + j11.5
910	15.0 + j9.50	10.2 + j10.2
960	12.7 + j8.10	8.70 + j8.90

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 7. Series Equivalent Input/Output Impedances



SCALE 0.75:1

Figure 8. Test Circuit — Photomaster

2

Figure 9. Printed Circuit Board for Bias Current

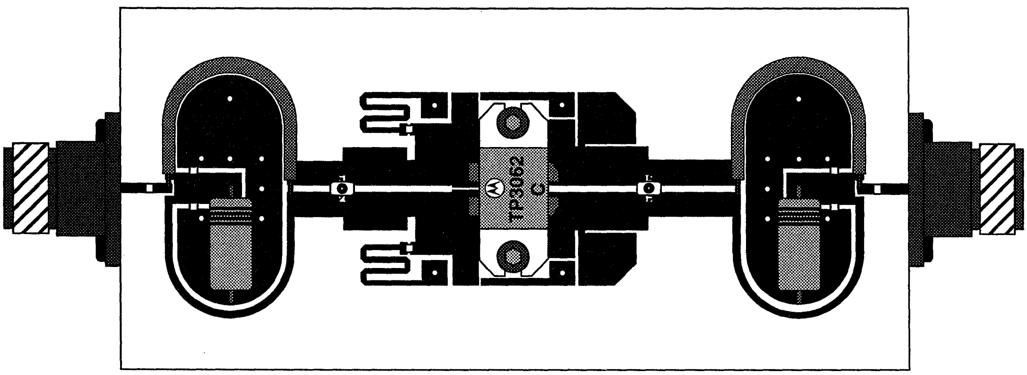


Figure 10. Test Circuit — Component Locations

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

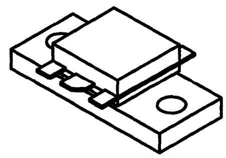
TP3064

The RF Line
RF Power Transistor

The TP3064 is designed for 960 MHz mobile base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. The TP3064 also features input and output matching networks and high impedances.

- Oxynitride Passivation
- Specified 26 Volts, 960 MHz Characteristics
  Output Power — 50 Watts
  Gain — 7.5 dB min
  Efficiency — 50% typ
- Class AB Operation

50 W, 960 MHz
RF POWER TRANSISTOR
NPN SILICON



CASE 333A, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	145 0.8	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

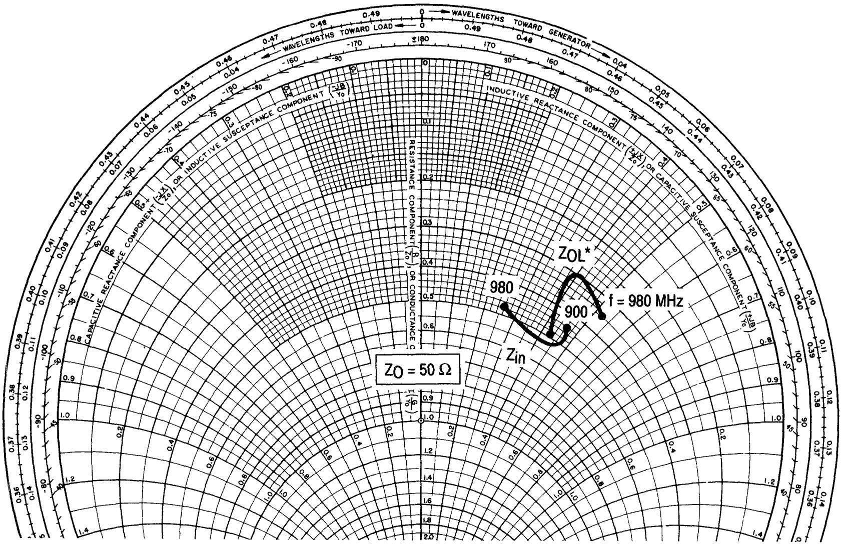
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter Base Breakdown Voltage (I_E = 15 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS (V_{CB} = 26 V, f = 1 MHz)					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	60	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain (P_{out} = 50 W, I_{CQ} = 200 mA, V_{CC} = 26 V, f = 960 MHz)	G_{pa}	7.5	8.5	—	dB
Collector Efficiency (P_{out} = 50 W, V_{CC} = 26 V, f = 960 MHz)	η	48	50	—	%
Load Mismatch (P_{out} = 50 W, I_{CQ} = 200 mA, V_{CC} = 26 V, Load VSWR = 5:1, all phase angles at frequency of test)	ψ	No Degradation in Output Power			

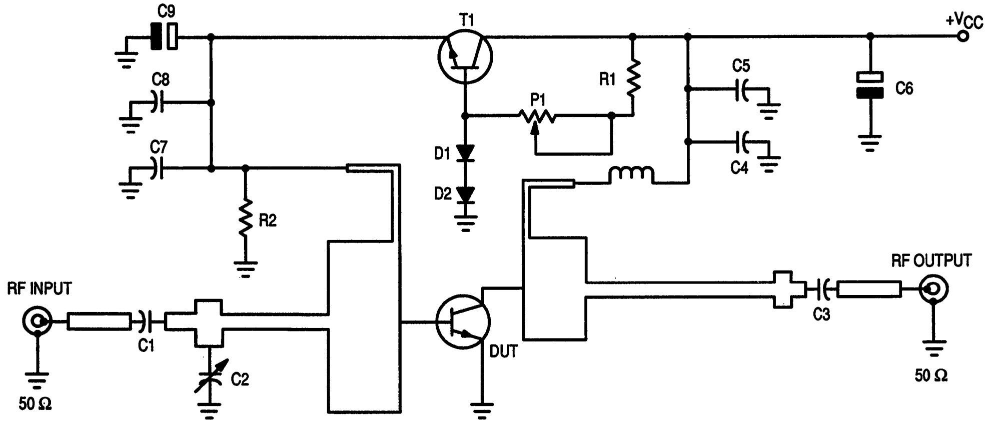


Output impedance with circuit tuned for maximum gain
@ P_{out} = 50 W, V_{CE} = 26 V

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
900	4.4 + j4.6	5 + j4.4
935	5.1 + j4.8	3 + j4.1
960	5.4 + j3.6	3.1 + j4.6
980	4.7 + j2.5	3.5 + j5

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Series Equivalent Input and Output Impedances



C1,C3	100 pF, ATC Chip Capacitor 100A	L1	1.5 Turns, 18 AWG Choke
C4,C7	330 pF, Chip Capacitor 0805	P1	1 kΩ, Trimmer
C5,C6	10 nF, Chip Capacitor 0805	R1	1 kΩ, Resistor
C6	15 µF, 63 V, Capacitor	R2	56 Ω, Resistor 0805
C9	100 µF, 16 V, Capacitor	T1	Transistor, NPN Type, BD135
D1,D2	Diode, 1N4007		

Figure 2. 960 MHz Test Circuit Schematic

TYPICAL CHARACTERISTICS

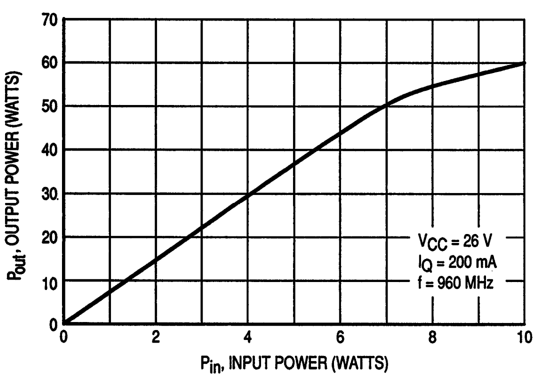


Figure 3. Output Power versus Input Power

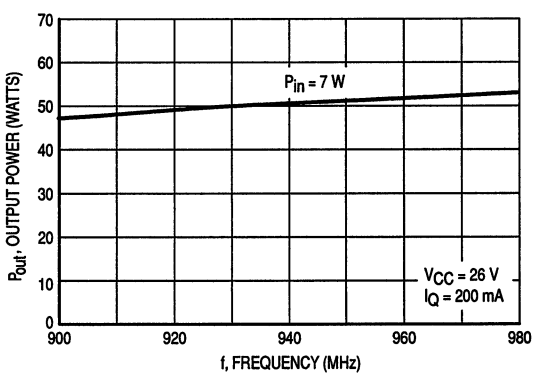


Figure 4. Output Power versus Frequency

TYPICAL CHARACTERISTICS

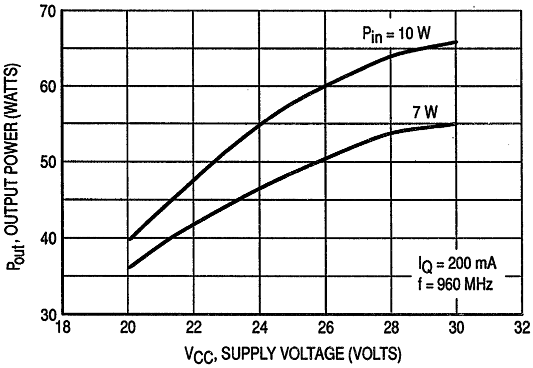


Figure 5. Output Power versus Supply Voltage

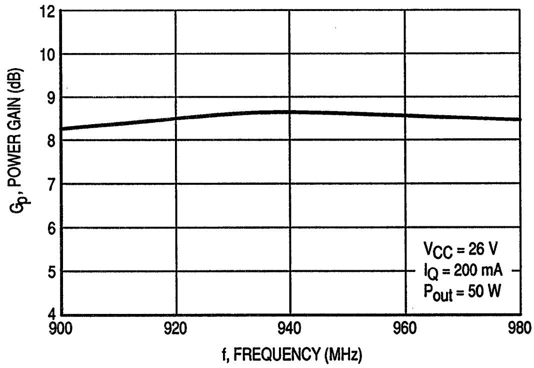


Figure 6. Broadband Amplifier

2

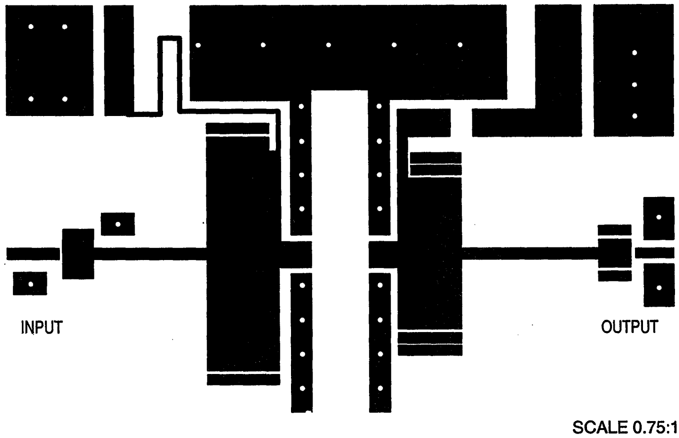


Figure 7. Photomaster

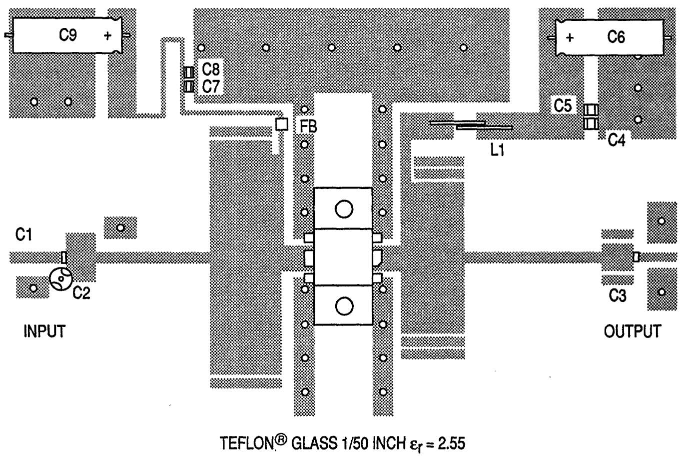


Figure 8. 960 MHz Test Circuit Components View

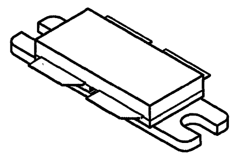
TP3069

The RF Line
RF Power Transistor

**100 W, 960 MHz
RF POWER TRANSISTOR
NPN SILICON**

The TP3069 is designed for cellular radio base station amplifiers up to 960 MHz. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. The TP3069 also features input and output matching networks and high impedances. It can easily operate in a full 935–960 MHz bandwidth in a simple circuit.

- Class AB Operation
- Specified 26 Volts, 960 MHz Characteristics
  Output Power — 100 Watts
  Gain — 7.5 dB min



CASE 375A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	20	Adc
Storage Temperature Range	T_{stg}	– 40 to +100	°C
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	245 1.4	Watts W/°C
Quiescent Current	I_{CQ}	2 x 500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

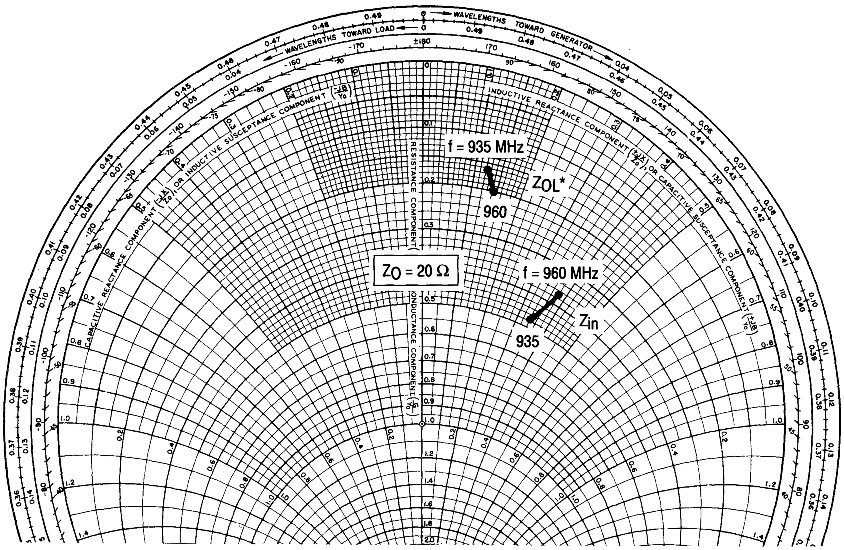
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA)	$V_{(BR)CEO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mAdc)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 35 mAdc)	$V_{(BR)CBO}$	65	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 28 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 2 Adc, V_{CE} = 10 V)	h_{FE}	30	—	120	—
DYNAMIC CHARACTERISTICS (V_{CB} = 28 V, I_E = 0, f = 1 MHz)					
Output Capacitance (each side) (2)	C_{ob}	—	75	—	pF

NOTES:
1. Thermal resistance is determined under specified RF operating condition.
2. Value of "C_{ob}" is that of die only. It is not measurable in TP3069 because of internal matching network.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (V_{CC} = 26 V, f = 960 MHz)					
Common-Emitter Amplifier Gain (P_{out} = 100 W, I_{CQ} = 2 x 100 mA)	G_p	7.5	8.8	—	dB
Collector Efficiency (P_{out} = 100 W)	η	45	50	—	%
Over Drive 2 dB Input Power Overdrive	OD	No Degradation in Output Power			
3rd Order Intermodulation (P_{out} = 100 W PEP, I_{CQ} = 2 x 50 mA, Δf = 400 KHz)	IMD3	—	– 32	—	dB

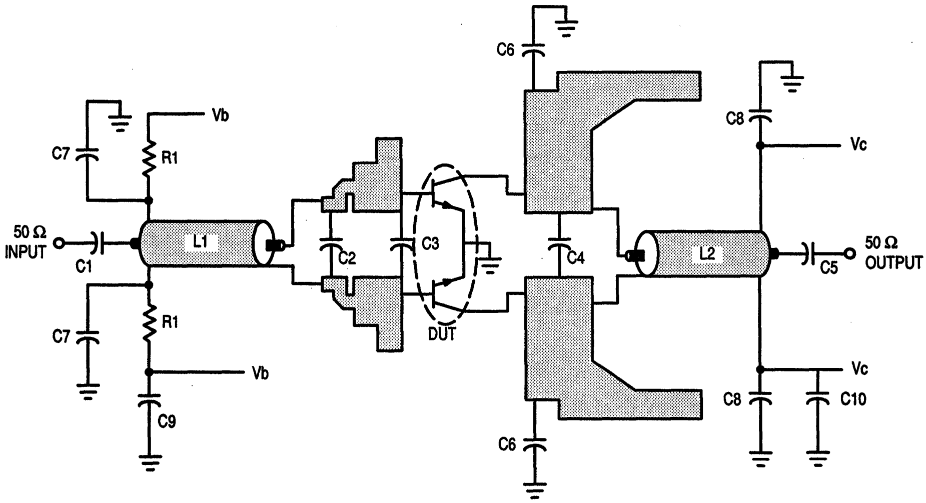


V_{CE} = 26 V P_{out} = 100 W

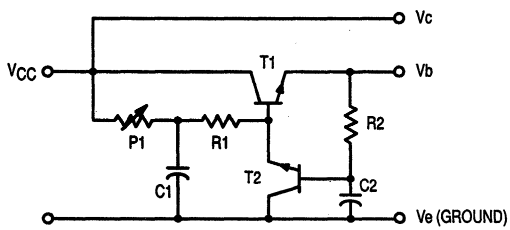
f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
935	9.5 + j7	3.4 + j2.7
960	8.8 + j7.5	3.8 + j2.8

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Figure 1. Series Equivalent Input and Output Impedances



C1	10 pF, ATC Chip Capacitor 100A	C8	1 μF, Vitramon
C2	2.2 pF, ATC Chip Capacitor 100A	C9	1 μF, 16 V, Tantalum
C3	12 pF, ATC Chip Capacitor 100A	C10	4.7 μF, 35 V, Tantalum
C4	10 pF, ATC Chip Capacitor 175B	L1	25 Ω/41 mm (Teflon)
C5	47 pF, ATC Chip Capacitor 100A	L2	25 Ω/41 mm (Teflon)
C6	5.6 pF, ATC Chip Capacitor 175B	R1	0.5 Ω, Resistor 0805 (2 x 1 Ω)
C7	1000 pF, Vitramon		



C1	15 nF
C2	15 nF
P1	2.2 kΩ
R1	3.3 kΩ
R2	51 Ω
T1	BD135
T2	BD135

Figure 2. 960 MHz Test Circuit and Its Bias Circuit

2

TYPICAL CHARACTERISTICS

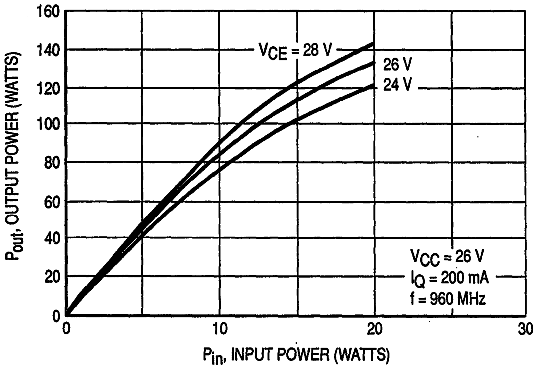


Figure 3. Output Power versus Input Power

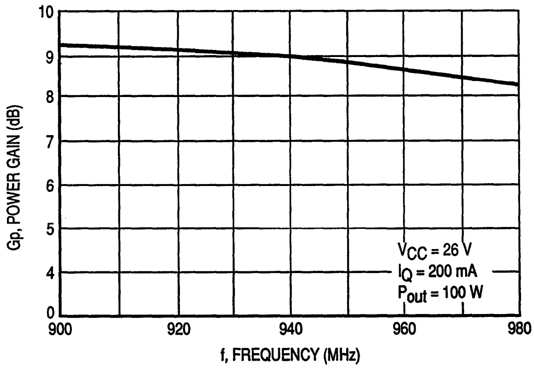


Figure 4. Power Gain versus Frequency

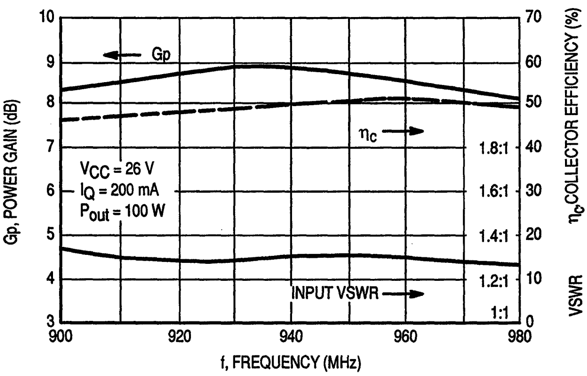


Figure 5. Broadband Amplifier

2

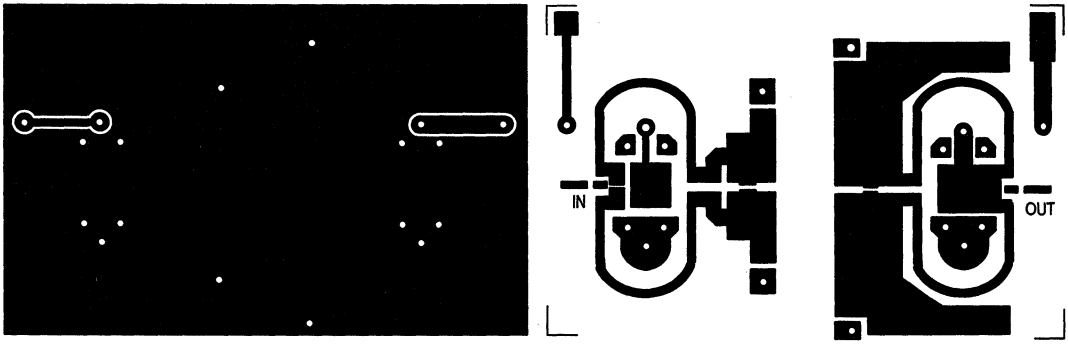


Figure 6. Photomaster (1/50″ Teflon® Glass, ε_r = 2.55) Scale 0.75:1

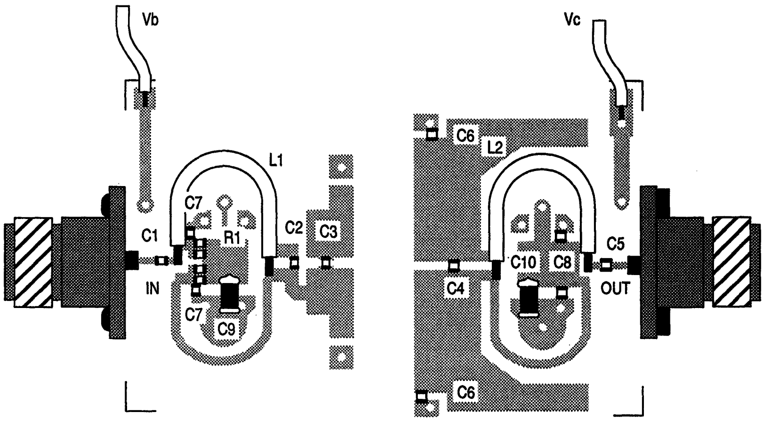


Figure 7. 960 MHz Test Circuit: Printed Circuit Board (PCB) + Components Location (Scale 0.75:1)

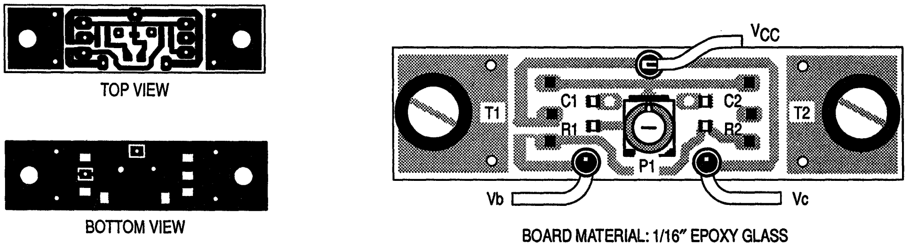


Figure 8. Bias Printed Circuit Board (PCB) (Scale 0.75:1) & Components Location (Not to Scale)

2

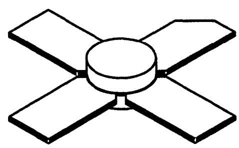
TP5002S

The RF Line
UHF Linear Power Transistor

The TP5002S is an NPN gold metallized transistor using diffused ballast resistors for reliability and ruggedness. The TP5002S was specifically designed as a low power driver with high gain and can be operated in Class A, B or C.

- 380–512 MHz
- 1.5 W — P_{out}
- 24 V — V_{CC}
- High Gain — 13 dB Min, Class A @ 470 MHz

**1.5 W, 380 to 512 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON**



**CASE 249-05, STYLE 1
(.280 SOE S)
TP5002S**

2

MAXIMUM RATINGS

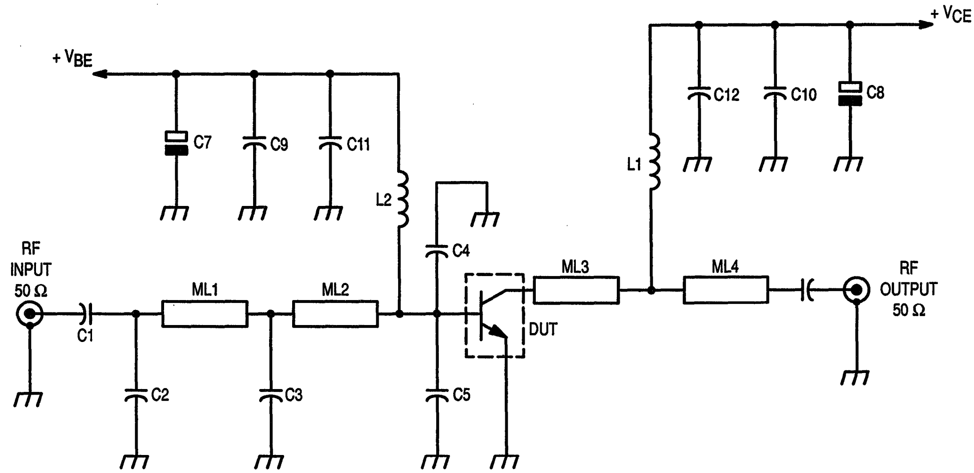
Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	7.0 0.045	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	21	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 2.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 24 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	4.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 23 V, P_{out} = 1.5 W, f = 470 MHz, I_C = 200 mA)	G_{PE}	13	—	—	dB
Saturated Output Power (V_{CE} = 23 V, f = 470 MHz, I_C = 200 mA)	P_{sat}	—	2.2	—	W



C1, C6 — 220 pF 0805 681C Sprague
C2 — 8.2 pF ATC100A8R2DP50
C3 — 10 pF ATC100A100DP50
C4, C5 — 27 pF ATC100A8R2DP50
C7 — 10 μF 35 V
C8 — 100 μF 63 V
C9, C10 — 1.0 nF 0805 681C Sprague
C11, C12 — 220 pF 0805 681C Sprague

L1 — Hairpin wire 1.1 mm L = 33 mm
L2 — 4 turns, ID 2.5 mm, 0.5 mm wire
ML1 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 6% λg at 470 MHz
ML2 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 3% λg at 470 MHz
ML3 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 5% λg at 470 MHz
ML4 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 3% λg at 470 MHz
Board Material: 1/16 In. Teflon Glass, ε_r = 2.55, h = 1.59 mm

Figure 1. 400–500 MHz Broadband Amplifier

FREQUENCY (MHz)	400	410	420	430	440	450	460	470	480	490	500
RE(Zin)Ω	2.5	2.5	2.5	2.3	2.4	2.3	2.2	2.2	2.1	2.1	2.0
IM(Zin)Ω	2.0	2.2	2.7	3.2	3.5	3.8	3.9	4.0	4.2	4.9	5.0
RE(Zload)Ω	33.4	35.5	36.5	37.0	38.4	39.5	40.4	41.4	42.4	43.4	44.4
IM(Zload)Ω	48.3	48.9	49.4	49.9	50.8	50.9	51.3	51.7	52.2	52.6	53.0

Table 1. Impedance Data
V_{CC} = 23 Volts
I_C = 200 mA
P_{out} = 1.5 Watts

TYPICAL CHARACTERISTICS

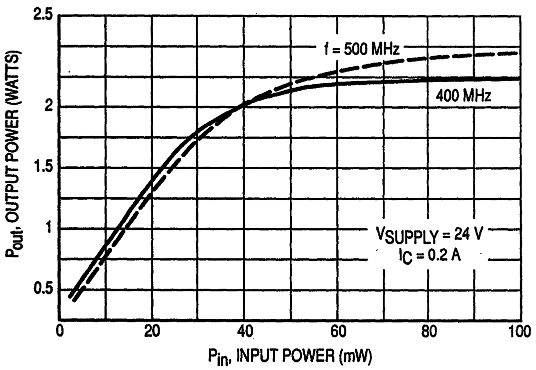


Figure 2. Output Power versus Input Power

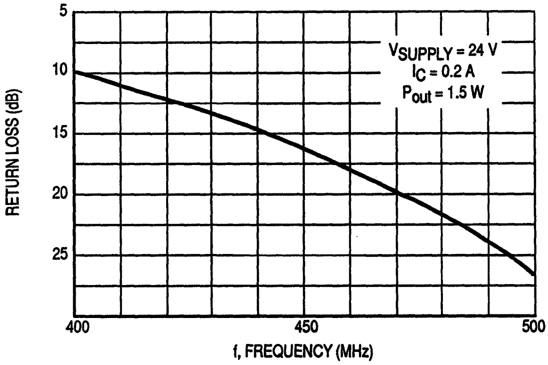


Figure 3. Return Loss versus Frequency

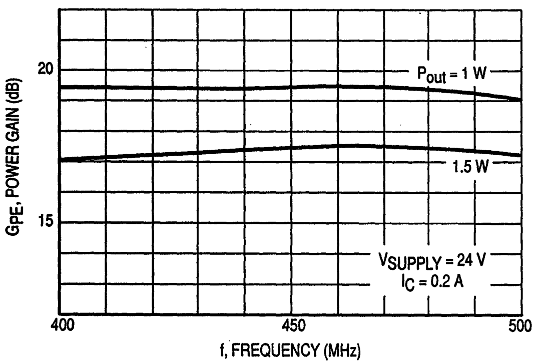


Figure 4. Power Gain versus Frequency

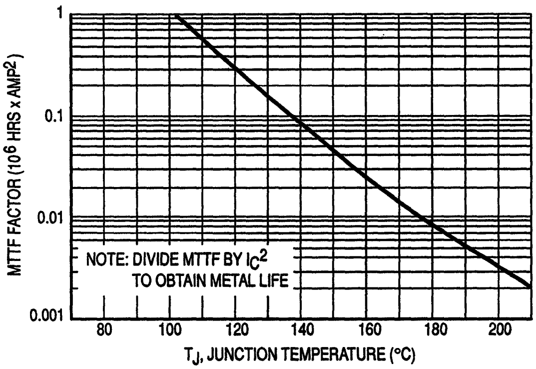
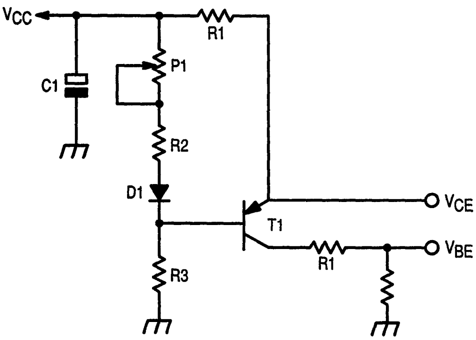


Figure 5. MTTF Factor versus Junction Temperature



C1 — 100 µF 63 V
D1 — 1N4148
P1 — 1.0 kΩ
R1 — 10 Ω 1/2 W
R2 — 180 Ω 1/4 W
R3 — 10 kΩ 1/4 W
R4 — 50 Ω 1/4 W
R5 — 100 Ω 1/4 W
T1 — BD136

Figure 6. Class A Bias Circuit

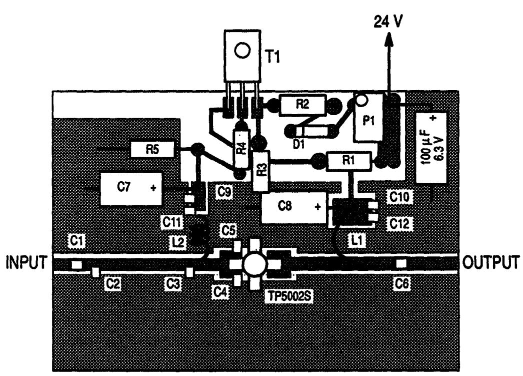


Figure 7. Component Layout

2

TP5015

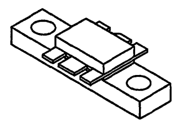
Advance Information

The RF Line
UHF Linear Power Transistor

. . . designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 380 to 512 MHz frequency range, i.e., cellular radio base stations.

- 380–512 MHz
- 15 W — P_{out}
- 24 V — V_{CC}
- High Gain — 11 dB Min, Class AB
- Gold Metallization for Reliability

15 W, 380–512 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON



CASE 319, STYLE 2
(EB)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 70°C$ Derate above 70°C	P_D	18 0.143	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70°C$)	$R_{\theta JC}$	7.0	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 26$ V, $R_{BE} = 75\ \Omega$)	I_{CER}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100$ mA, $V_{CE} = 10$ V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, f = 1.0 MHz)	C_{ob}	—	16	24	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 24$ V, $P_{out} = 15$ W, f = 470 MHz, $I_Q = 50$ mA)	G_{PE}	11	—	—	dB
Collector Efficiency ($V_{CE} = 24$ V, $P_{out} = 15$ W, f = 470 MHz, $I_Q = 50$ mA)	η_c	50	60	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP5051

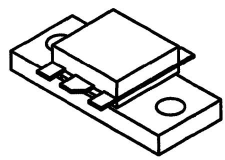
Motorola Preferred Device

The RF Line
NPN Silicon
RF Power Transistor

50/60 W, 470 MHz
RF POWER TRANSISTOR
NPN SILICON

The TP5051 is designed for 470 MHz cellular radio base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 470 MHz Characteristics
  - Output Power — 50 Watts @ 24 Volts, 60 Watts @ 26 Volts
  - Gain — 9 dB min
  - Efficiency — 60% min
  - Class AB or C Operation



CASE 333A, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	145 0.8	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case at 70°C Case (1)	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 15 mAdc)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	80	—

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

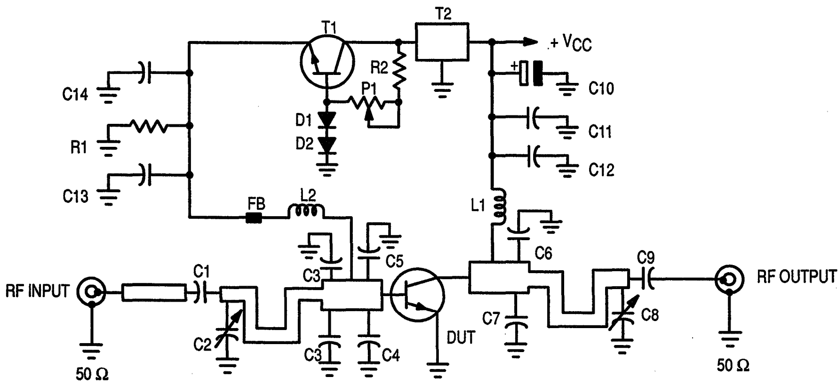
(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1 MHz)	C_{ob}	—	60	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 V, P_{out} = 50 W, I_{CQ} = 150 mA, f = 470 MHz)	G_{p1}	9	10	—	dB
Collector Efficiency (V_{CC} = 24 V, P_{out} = 50 W, f = 470 MHz)	$\eta 1$	60	65	—	%
Load Mismatch (V_{CC} = 24 V, P_{out} = 50 W, I_{CQ} = 150 mA Load VSWR = 5:1, all phase angles at frequency of test)	$\psi 1$	No Degradation in Output Power			
Overdrive (V_{CC} = 24 V, P_{in} = 12 W, f = 470 MHz)	OD	No Degradation in Output Power			
Power Saturation (V_{CC} = 24 V, f = 470 MHz)	P_{sat}	65	—	—	W
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 150 mA, f = 470 MHz)	G_{p2}	9	10	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 60 W, f = 470 MHz)	$\eta 2$	60	65	—	%
Load Mismatch (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 150 mA Load VSWR = 5:1, all phase angles at frequency of test)	$\psi 2$	No Degradation in Output Power			

2

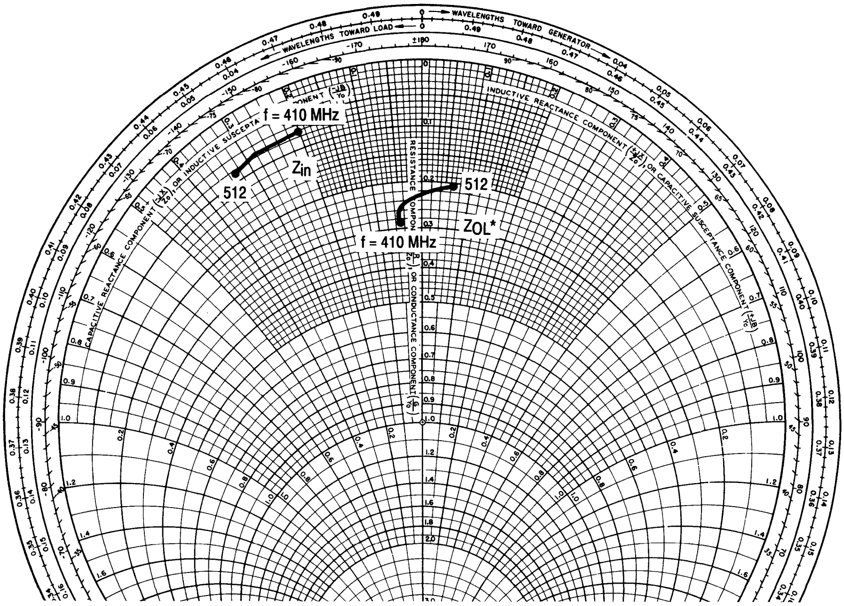


EPOXY GLASS 1/16 INCH ∈r = 4.5

Components List

C1,C9,	330 pF, 5%, Chip Capacitor 0805	D1,D2	Diode, 1N4148
C2,C8	AIRTRONIC Trimmer Capacitor 5400	FB	Ferrite Board
C3	10 pF, ATC Chip Capacitor	L1,L2	6 Turns, #18 AWG ϕ 4 mm Choke
C3′	12 pF, ATC Chip Capacitor	P1	1 kΩ, Trimmer
C4,C5	22 pF, ATC Chip Capacitor	R1	56 Ω, 5%, Chip Resistor 1205
C6	15 pF, ATC Chip Capacitor	R2	470 Ω, 5%, Chip Resistor 0805
C7	18 pF, ATC Chip Capacitor	T1	SMD Transistor, MJD31C or Similiar
C10	47 µF, 63 V, Electrolytic Capacitor	T2	Voltage Regulator 7805
C11,C14	15 nF, Chip Capacitor 0805		
C12,C13	330 pF, 5%, Chip Capacitor 0805		

Figure 1. 470 MHz Electrical Schematic



P_{out} = 50 W, V_{CE} = 24 V

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
512	1 – j3.2	2 – j0.7
490	0.97 – j2.8	2.2 – j0.5
470	0.9 – j2.7	2.4 + j0.13
450	0.85 – j2.5	2.6 + j0.9
410	0.8 – j2.1	3 + j0.5

Figure 2. Series Equivalent Input and Output Impedances

2

TYPICAL CHARACTERISTICS

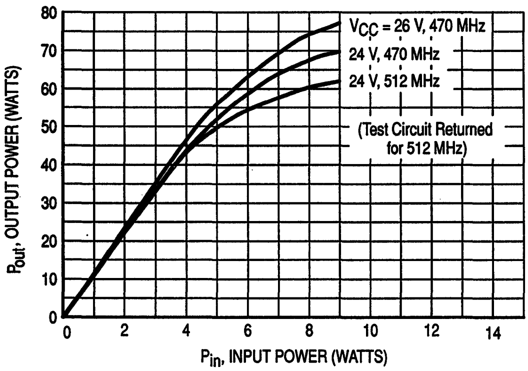


Figure 3. Output Power versus Input Power

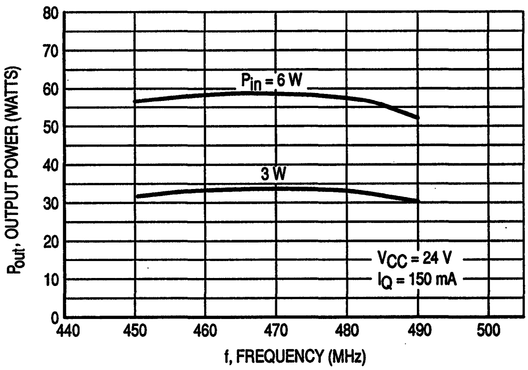


Figure 4. Output Power versus Frequency

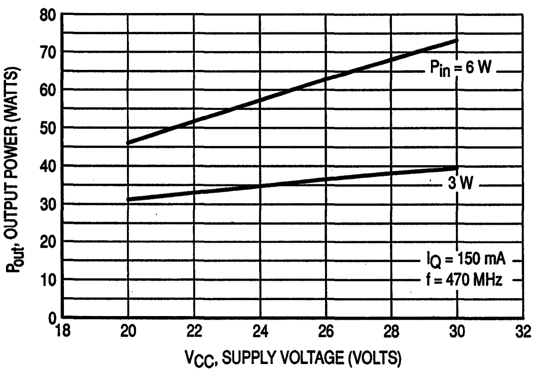


Figure 5. Output Power versus Supply Voltage

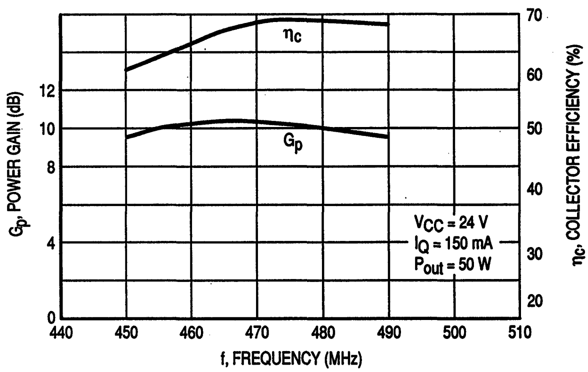


Figure 6. Power Gain, Collector Efficiency versus Frequency

2

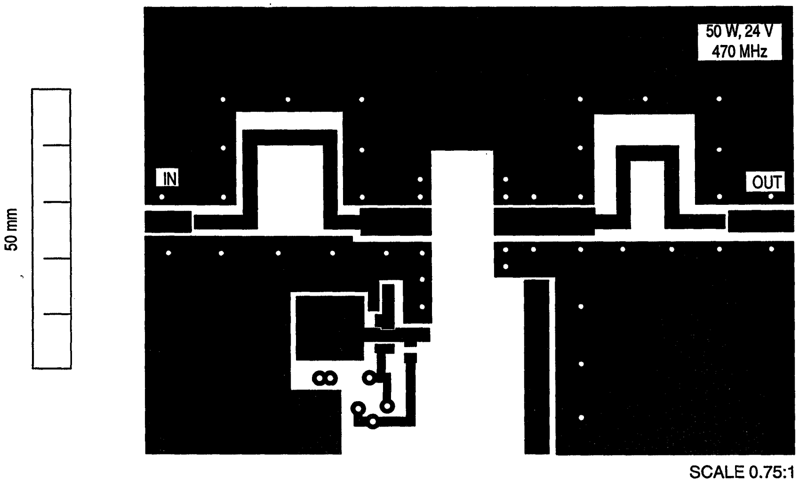
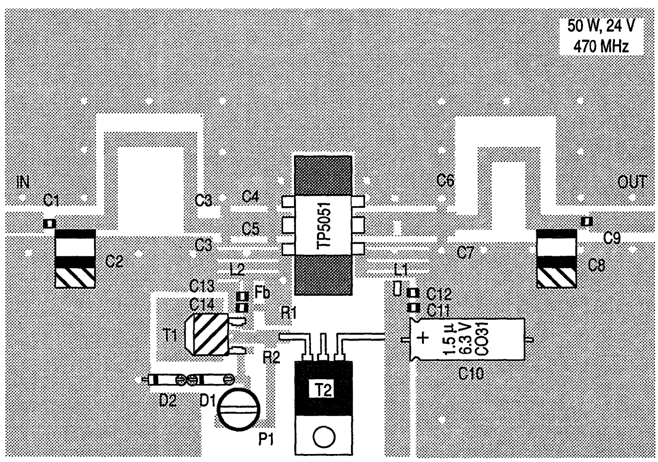


Figure 7. Photomaster



EPOXY GLASS 1/16 INCH $\varepsilon_r = 4.5$

Figure 8. 470 MHz Test Circuit Components View

TP62601

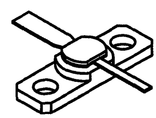
The RF Line
Microwave Power Oscillator Transistor

. . . designed for use as power oscillators at frequencies to 3.0 GHz with typical output power of over 1.0 watt.

- Operation to 3.0 GHz
- High Output Power (1.2 W Typ @ 2.5 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistors
- Common Collector Configuration
- Formerly named TRW62601

2

MICROWAVE POWER OSCILLATOR TRANSISTOR



CASE 328A-03, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.125	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	20	—	120	—

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	5.0	pF
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 2.0 GHz, I_E = 220 mA)	P_{out}	1.25	—	—	W
Load Mismatch (V_{CE} = 20 V, I_E = 220 mA, P_{out} = 1.25 W, f = 2.0 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 220 mA)	f_τ	—	2.7	—	GHz

TYPICAL CHARACTERISTICS

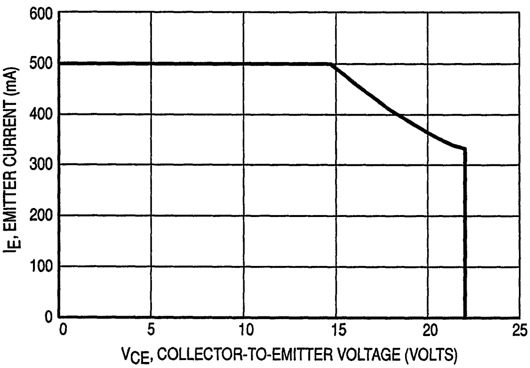


Figure 1. DC Safe Operating Area

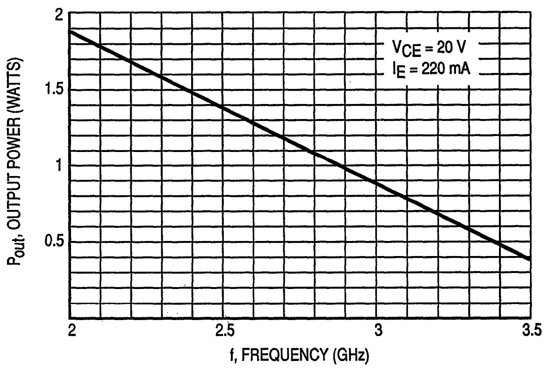


Figure 2. Output Power versus Frequency

C1 — 220 pF (chip)
C2 — 220 pF (chip) + 10 nF
C3 — 220 pF (chip) + 10 nF + 10 μF
C4 — 0.6–4.5 pF (Frequency tuning)
L — adjust to obtain the maximum output power
θ — 0.115 λg for f_o = 2.3 GHz
θ — 0.06 λg for f_o = 3.0 GHz

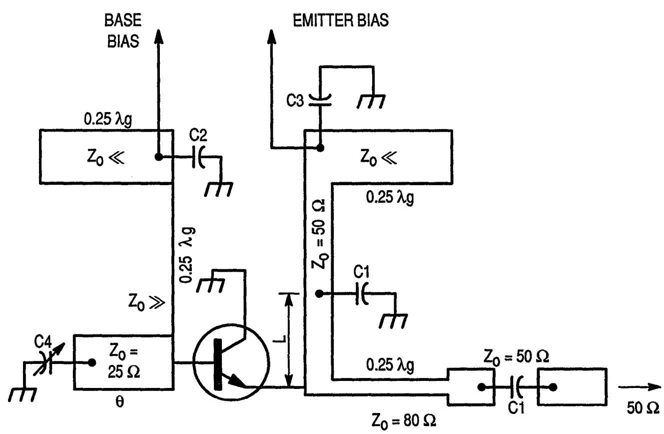


Figure 3. Test Circuit

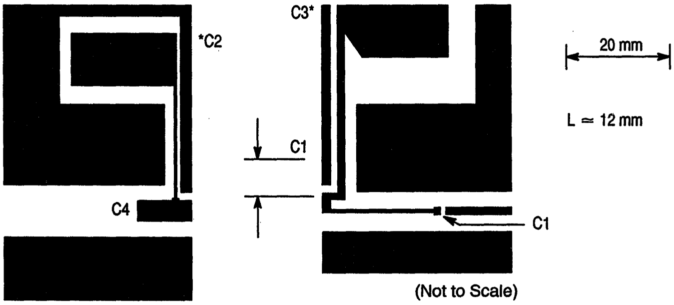
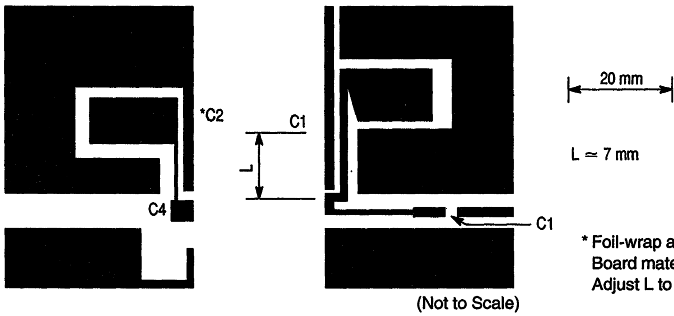


Figure 4. PC Board Layout for f_o = 2.3 GHz (BW = 500 MHz)



* Foil-wrap asterisked edge to ground plane.
Board material: –0.020″ Glass teflon (ε_r = 2.55)
Adjust L to obtain the maximum output power

Figure 5. PC Board Layout for f_o = 3.0 GHz (BW = 500 MHz)

TYPICAL CHARACTERISTICS

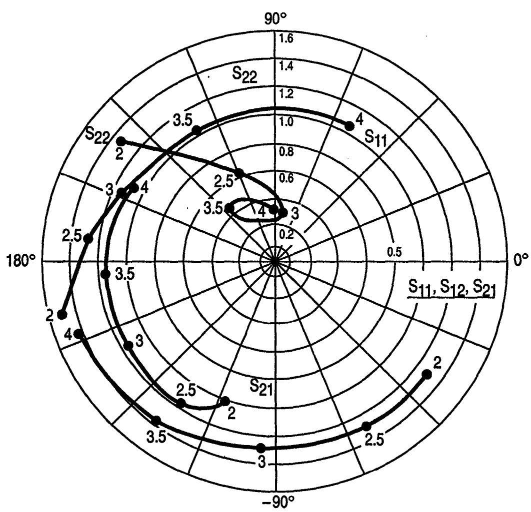


Figure 6. Small Signal S-Parameters (V_{CE} = 20 V, I_E = 220 mA)

2

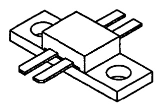
TPV595A

The RF Line
UHF Linear Power Transistor

. . . designed for driver and output stages in band IV and V TV transposers and transmitter amplifiers. The TPV595A uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 14 W — P_{ref} @ −47 dB IMD
- 25 V — V_{CC}
- High Gain — 9.0 dB Typ, Class A, f = 860 MHz
- Push-Pull Package

**25 V, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR**



CASE 395, STYLE 1
(BMA2)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ T_C = 70°C Derate above 70°C	P_D	50 0.4	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 51 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 25 V, I_C = 2.0 x 900 mA)	G_{SSE}	8.5	—	—	dB
Load Mismatch (V_{CC} = 25 V, P_{out} = 15 W, I_{CQ} = 2.0 x 900 mA, f = 470 MHz, 2 Tones, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (no degradation) (f_o = 470 MHz, V_{CE} = 25 V, 2 Tones, I_{CQ} = 2.0 x 900 mA)	$P_{in_{over}}$	15	—	—	W
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_{CQ} = 2.0 x 900 mA, P_{ref} = 14 W, Vision Carrier = –8.0 dB, Sound Carrier = –7.0 dB, Sideband Signal = –16 dB, Specification TV05001)	IMD_1	—	—	–47	dB
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 25 V, I_{CQ} = 2.0 x 900 mA, P_{ref} = 14 W, Vision Carrier = –8.0 dB, Sound Carrier = –10 dB, Sideband Signal = –16 dB)	IMD_2	—	—	–50	dB

2

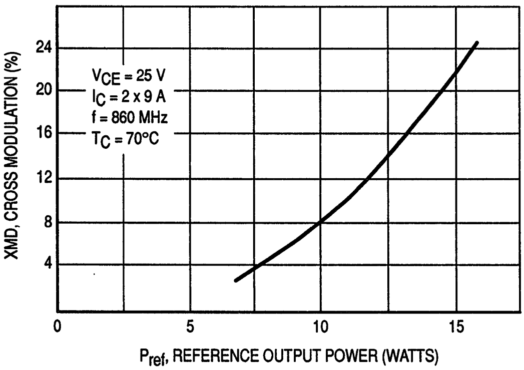


Figure 1. Cross-mod* versus Output Power

*Cross-mod: Δ% sound (–7.0 dB)
— vision O → PEAK

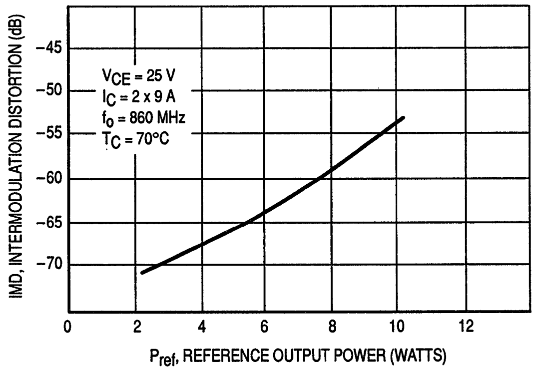


Figure 2. IMD* versus Output Power

*IMD: 3 tones –7.0 dB, –8.0 dB, –16 dB

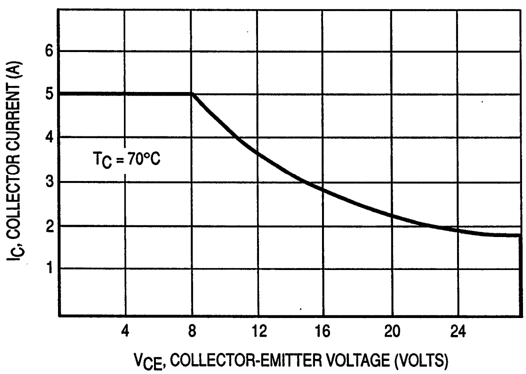


Figure 3. DC Safe Operating Area

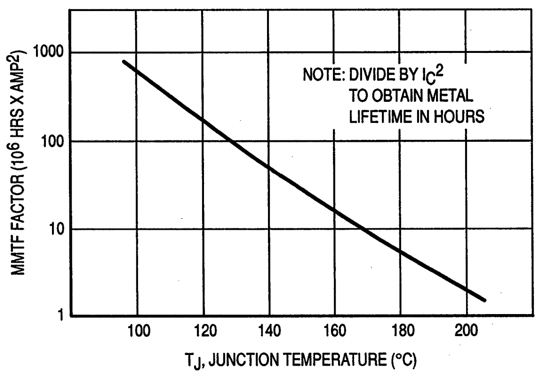


Figure 4. MTTF versus Junction Temperature

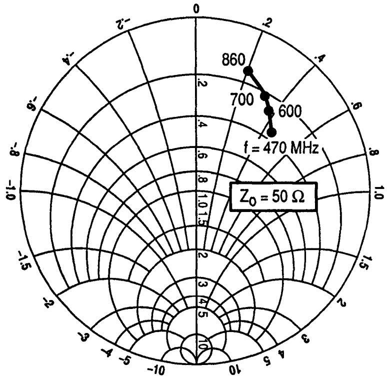


Figure 5. Z Load For Best IMD (8.0 W) and Cross-Modulation (12 W) Collector-to-Collector

$V_{CE} = 25\ V$
$I_C = 2 \times 0.9\ A$

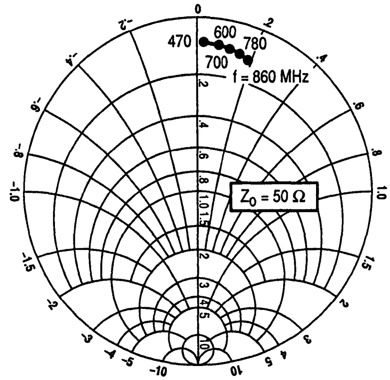
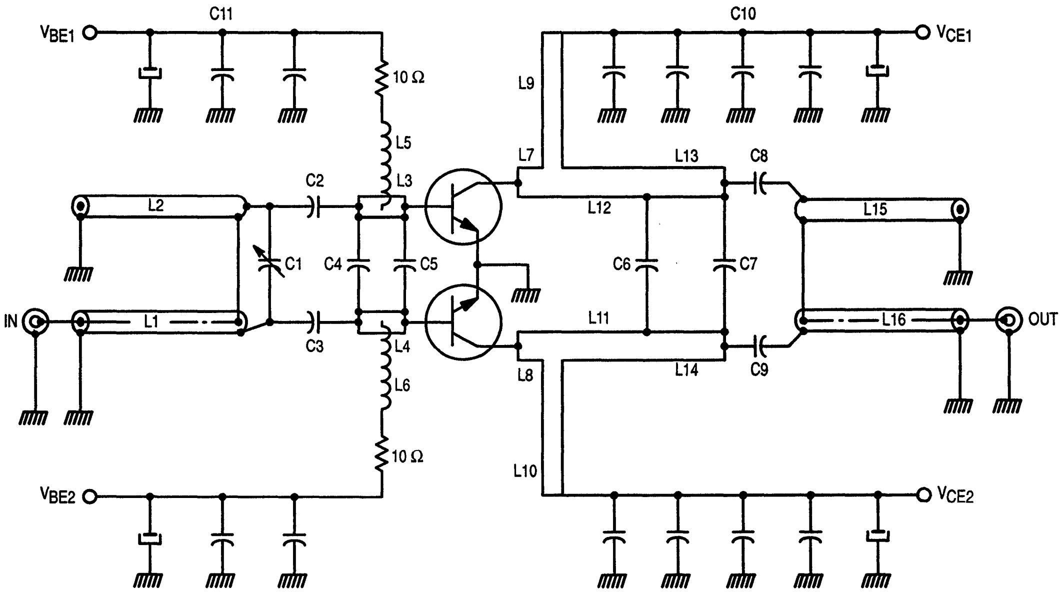


Figure 6. Z_{in} For Best Input VSWR Base-to-Base

2



C1 — 0.5–4.5 pF Gigatrim Trimmer
C2, C3 — 27 pF ATC 100 A
C4 — 6.8 pF ATC 100 A
C5 — 18 pF ATC 100 A
C6 — 3.3 pF ATC 100 A
C7 — 4.7 pF ATC 100 A
C8, C9 — 27 pF ATC 100 A
C10 — +330 pF ATC 100 B
+ 1.0 nF + 10 nF + 47 µF
C11 — 1.0 nF + 10 nF + 10 µF

L1, L2, L15, L16 — 60 mm of 50 Ω, 2.2 mm semi rigid coax
L3, L4 — 50 Ω line, 5.5% λg at 860 MHz
L5, L6 — 3 turns ID 2 mm
L7, L8 — 50 Ω line, 1.5% λg at 860 MHz
L9, L10 — 50 Ω line, 4.9% λg at 860 MHz
L11, L12 — 50 Ω line, 2% λg at 860 MHz
L13, L14 — 50 Ω line, 1.5% λg at 860 MHz

Figure 7. 470–860 MHz Broadband Amplifier

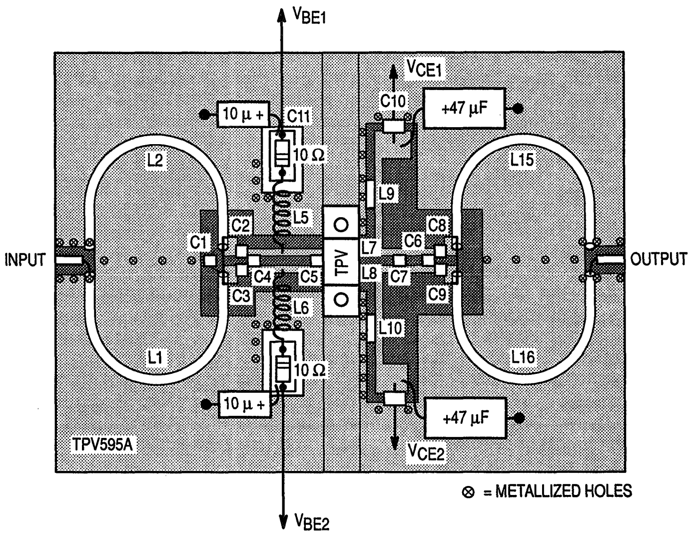
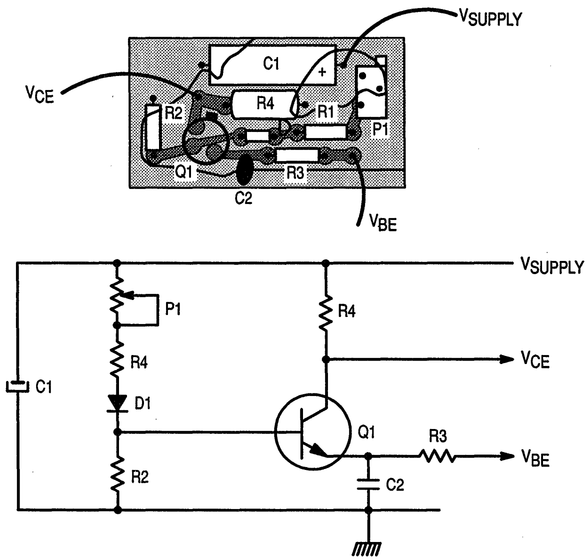


Figure 8. 470–860 MHz Broadband Amplifier



C1 — 100 mF	P1 — 1.0 kΩ	R2 — 5.6 kΩ
C2 — 10 nF	Q1 — 2N2904	R3 — 100 Ω
D1 — 1N4148	R1 — 150 Ω	R4 — 2.7 Ω 2.0 Ω

Figure 9. Bias Circuit

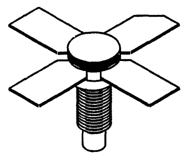
TPV596A

The RF Line
UHF Linear Power Transistor

... designed for very high output 1.5 V MATV amplifiers up to 860 MHz and 500 mW Band V TV transposer stages. Gold metallization and diffused emitter ballast resistors are used to enhanced reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 0.5 W — P_{ref} @ −58 dB IMD
- High Gain — 12 dB Typ, Class A, f = 860 MHz
- Gold Metallization for Reliability

**0.5 W, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR**



**CASE 244-04, STYLE 1
(.280 SOE)**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.7	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.75 0.05	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	20	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 4.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Emitter-Base Leakage Current (V_{EB} = 2.0 V)	I_{EBO}	—	—	0.25	mA
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	5.0	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.5 W, f = 860 MHz, I_E = 0.22 A)	G_{PE}	11.5	12	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 1.0 W, I_E = 0.22 A, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 20 V, I_E = 0.22 A, P_{ref} = 1.0 W, Vision Carrier = −8.0 dB, Sound Carrier = −7.0 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−50	dB
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 20 V, I_E = 0.22 A, P_{ref} = 0.5 W, Vision Carrier = −8.0 dB, Sound Carrier = −10 dB, Sideband Signal = −16 dB)	IMD_2	—	−60	−58	dB

TYPICAL CHARACTERISTICS

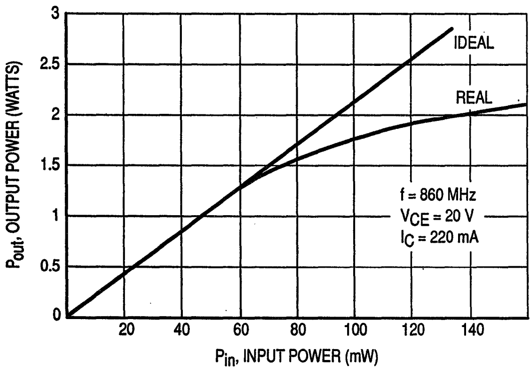


Figure 1. Power Output versus Power Input

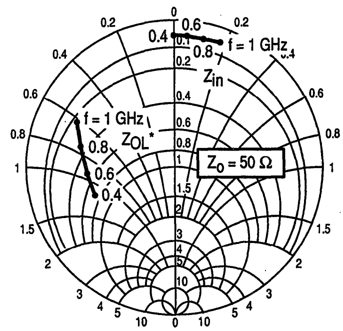


Figure 2. Large Signal Impedances
V_{CE} = 20 V — I_C = 220 mA

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

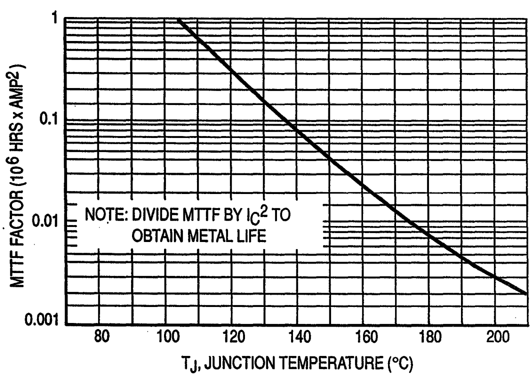


Figure 3. MTTF Factor versus Junction Temperature

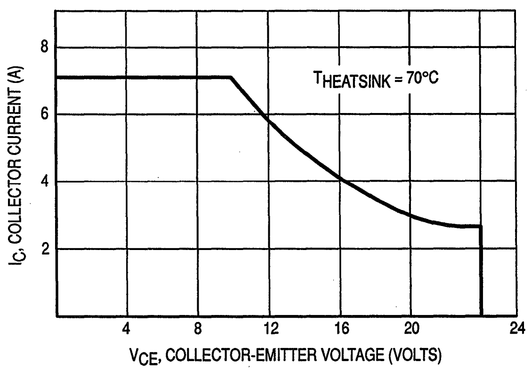


Figure 4. DC Safe Operating Area

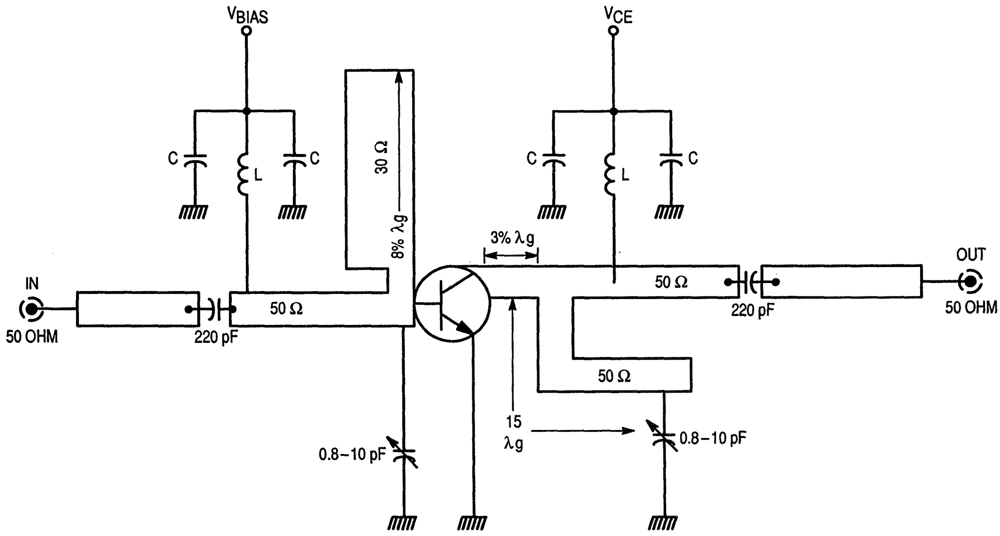


Figure 5. 860 MHz Test Circuit

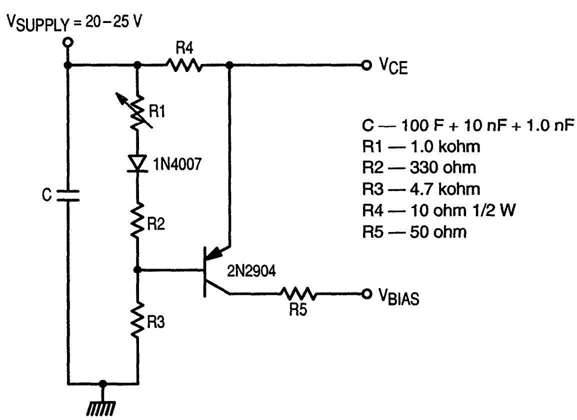


Figure 6. Class A Bias Circuit

2

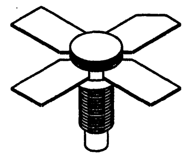
TPV597

The RF Line
UHF Linear Power Transistor

. . . designed for 1.0 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 1.0 W — P_{ref} @ –58 dB IMD
- 20 V — V_{CC}
- High Gain — 11 dB Typ, Class A @ f = 860 MHz
- Gold Metallization for Reliability

1.0 W, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



CASE 244-04, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	19 0.11	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9.0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2.0 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 4.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Emitter-Base Leakage Current (V_{EB} = 2.0 V)	I_{EBO}	—	—	0.5	mA
Collector-Emitter Breakdown Voltage (I_C = 40 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0)	I_{CBO}	—	—	1.2	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5.0 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	7.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.0 W, f = 860 MHz, I_E = 0.44 A)	G_{PE}	10.5	11	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 2.0 W, I_E = 0.44 A, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (continued)					
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 20 V, I_E = 0.44 A, P_{ref} = 1.0 W, Vision Carrier = −8.0 dB, Sound Carrier = −7.0 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	−60	−58	dB
Cutoff Frequency (V_{CE} = 20 V, I_E = 0.44 A)	f_τ	2.2	2.5	—	GHz
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 20 V, I_E = 0.44 A, P_{ref} = 2.0 W, Vision Carrier = −8.0 dB, Sound Carrier = −10 dB, Sideband Signal = −16 dB)	IMD_2	—	—	−51	dB

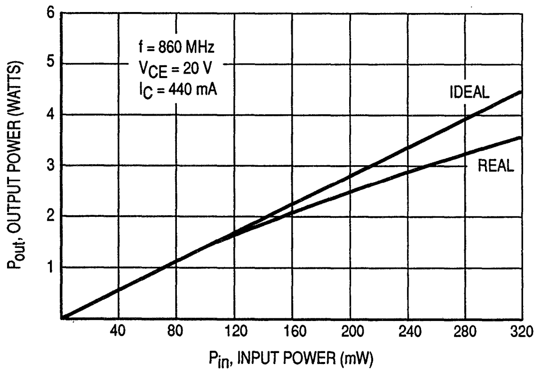


Figure 1. Power Output versus Power Input

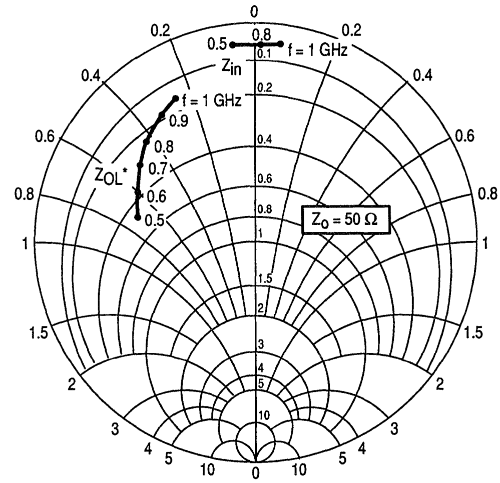


Figure 2. Large Signal Impedances
V_{CE} = 20 V — I_C = 440 mA

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

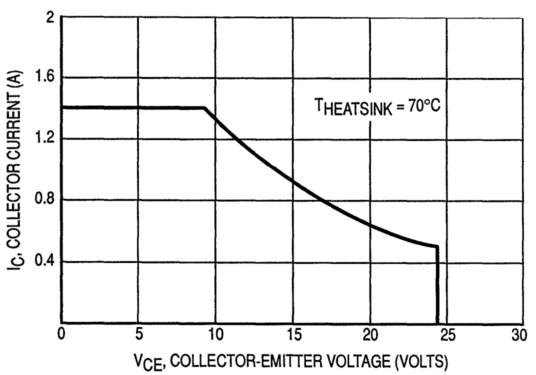


Figure 3. Safe Operating Area

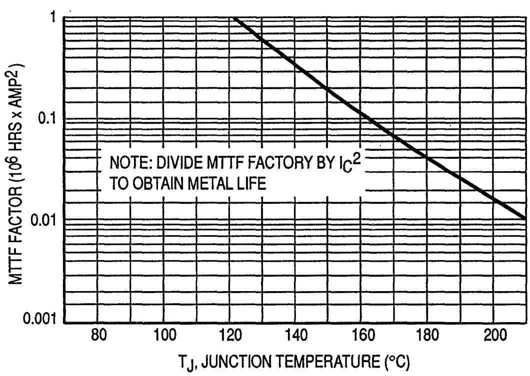
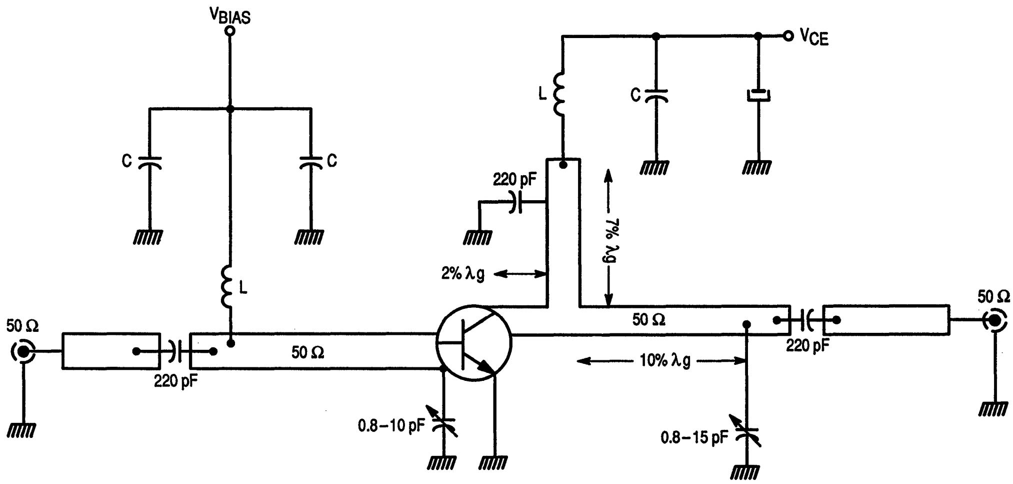


Figure 4. MTTF Factor versus Junction Temperature

2



L = 6 turns ID = 1 mm Wire diameter = 0.6 mm
The lengths are given for f = 860 MHz

Figure 5. 860 MHz Test Circuit

2

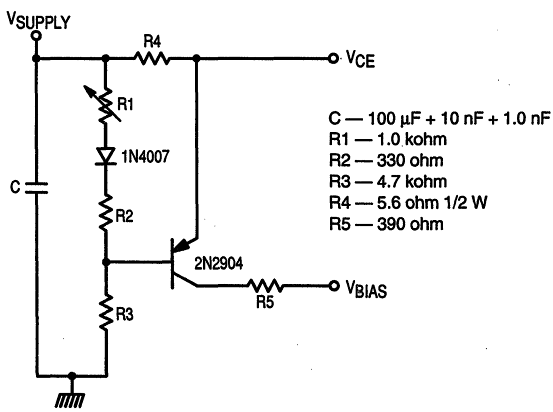


Figure 6. Class A Bias Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Advance Information

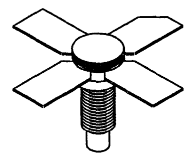
The RF Line
UHF Linear Power Transistor

TPV598

4.0 W, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR

. . . designed for 4.0 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 4.0 W — P_{ref} @ −60 dB IMD
- 25 V — V_{CC}
- High Gain — 7.0 dB Min, Class A @ f = 860 MHz
- Gold Metallization for Reliability



CASE 244-04, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

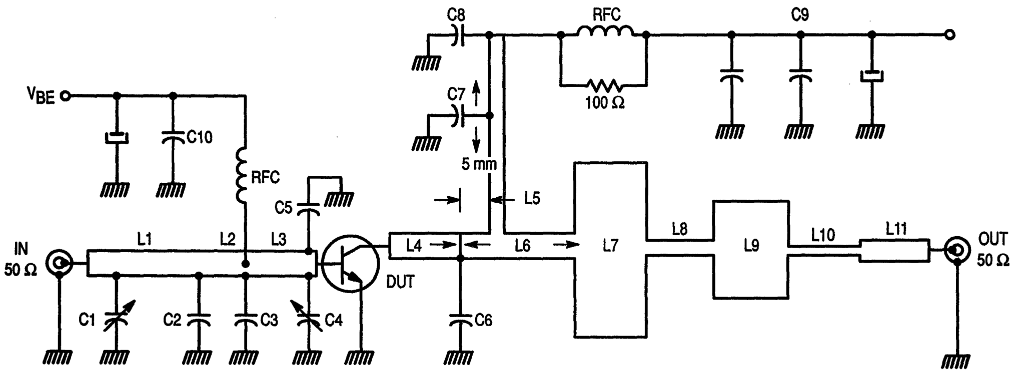
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	6.2	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.4 Typ	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, I_B = 0)	$V_{(BR)CEO}$	27	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Emitter Leakage Current (V_{CE} = 20 V)	I_{CEO}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 25 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 4.0 W, f = 860 MHz, I_C = 850 mA)	G_{PE}	7.0	—	—	dB
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_E = 850 mA, P_{ref} = 4.0 W, Vision Carrier = −8.0 dB, Sound Carrier = −7.0 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−58	dB
Cutoff Frequency (V_{CE} = 25 V, I_C = 850 mA)	f_τ	—	2.0	—	GHz

This document contains information on a new product. Specifications and information herein are subject to change without notice.



C1 — Variable 0.5–4.7 pF Airtronic
C2, C3 — ATC 4.7 pF
C4 — ATC 10 pF + Variable 0.5–4.7 pF Airtronic
C5 — ATC 10 pF + ATC 5.6 pF
C6 — ATC 18 pF + 0.5–4.7 pF Variable Airtronic
C7 — 470 pF Chip Capacitor
C8 — 1.0 nF + 10 nF Decoupling
C9 — 1.0 nF + 10 nF + 0.1 μF + 10 μF
C10 — 10 nF + 1.0 μF + 10 μF
RFC = 8 turns, ID 2.5 mm, Wire = 0.5 mm

L1 — 50 Ω line 6.2% λg at 860 MHz
L2 — 50 Ω line 4.2% λg at 760 MHz
L3 — 50 Ω line 4.9% λg at 860 MHz
L4 — 20 Ω line 6.5% λg at 860 MHz
L5 — 50 Ω line 5% λg at 860 MHz
L6 — 20 Ω line 9.5% λg at 860 MHz
L7 — 4.0 Ω line 8% λg at 860 MHz
L8 — 55 Ω line 7.5% λg at 860 MHz
L9 — 7.5 Ω line 8% λg at 860 MHz
L10 — 100 Ω line 8% λg at 860 MHz
L11 — 20 Ω line 8% λg at 860 MHz

Figure 1. Broadband Test Circuit

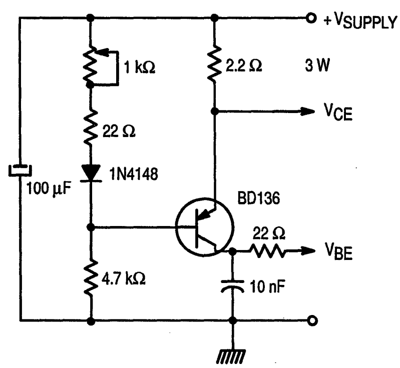


Figure 2. Class A Bias Circuit

2

TPV695A

Advance Information

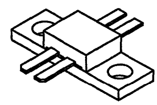
The RF Line

UHF Linear Power Transistor

. . . designed for driver and output stages in band IV and V TV transposers and transmitter amplifiers. The TPV695A uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 14 W — P_{ref} @ –47 dB IMD
- 25 V — V_{CC}
- High Gain — 10 dB Min, Class A, f = 860 MHz
- Gold Metallization for Reliability
- Push-Pull Package

**25 V, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR**



**CASE 395B-01, STYLE 1
BMA2**

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.4	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–50 to +200	°C
Operating Case Temperature Range	T_C	–15 to +70	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 19 V, I_E = 0)	I_{CBO}	—	—	15	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 A, V_{CE} = 10 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	18	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 14 W, f = 860 MHz, I_C = 2.0 x 900 mA)	G_{PE}	10	—	—	dB
Overdrive (no degradation) (f = 470 MHz, V_{CE} = 25 V, I_C = 2.0 x 900 mA)	$P_{in_{over}}$	12.5	—	—	W
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_E = 2.0 x 900 mA, P_{ref} = 14 W, Vision Carrier = –7.0 dB, Sound Carrier = –8.0 dB, Sideband Signal = –16 dB, Specification TV05001)	IMD_1	—	–48	–47	dB

This document contains information on a new product. Specifications and information herein are subject to change without notice.

TPV5055B

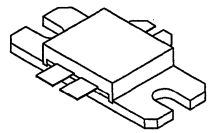
The RF Line
UHF Linear Power Transistor

. . . designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 50 W — P_{out}, Class AB
- 28 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability

50 V, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON



CASE 398, STYLE 1
(BMA-4)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 A, V_{CE} = 10 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	38	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W, f = 860 MHz, I_{CQ} = 2.0 x 200 mA)	G_{PE}	7.0	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 50 W, f = 860 MHz, I_{CQ} = 2.0 x 200 mA)	η	45	50	—	%
Output Power, 1.0 dB Compression Point (V_{CE} = 28 V, f = 860 MHz, I_{CQ} = 2.0 x 200 mA, P_{ref} = 12.5 W)	$P_{o1\ dB}$	50	—	—	W

TYPICAL BROADBAND RESULTS
V_{CC} = 28 V I_{CQ} = 2 x 200 mA
f = 470–860 MHz

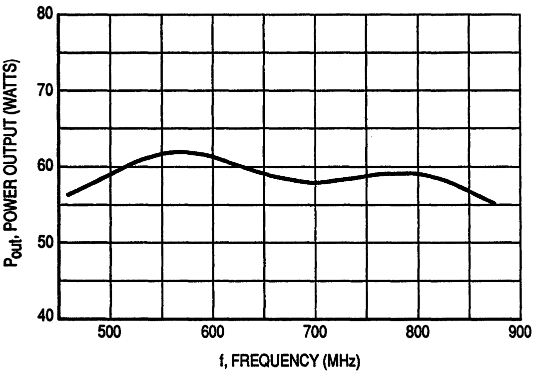


Figure 1. Power Output at 1.0 dB Compression versus Frequency

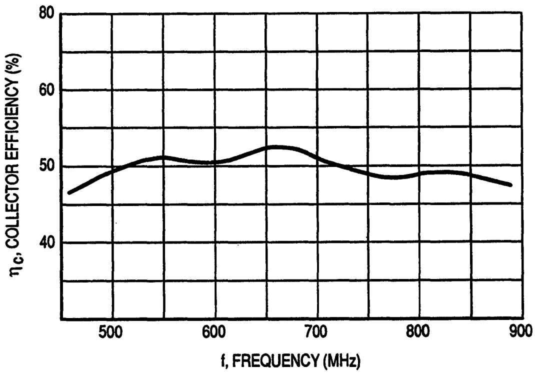


Figure 2. Collector Efficiency versus Frequency

TYPICAL CHARACTERISTICS

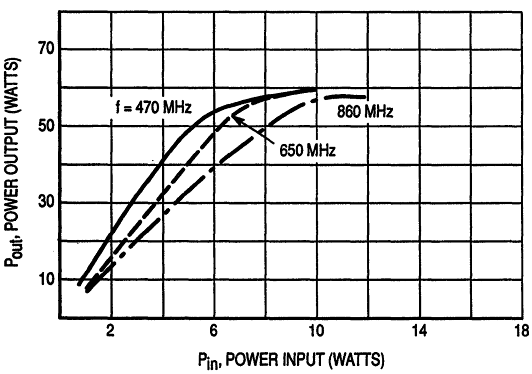
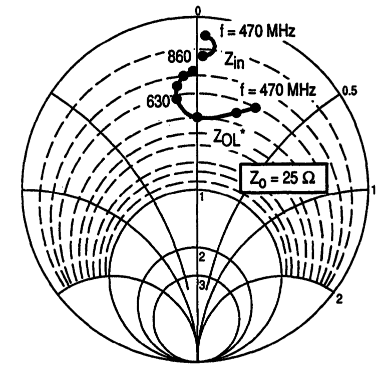


Figure 3. Power Output versus Power Input



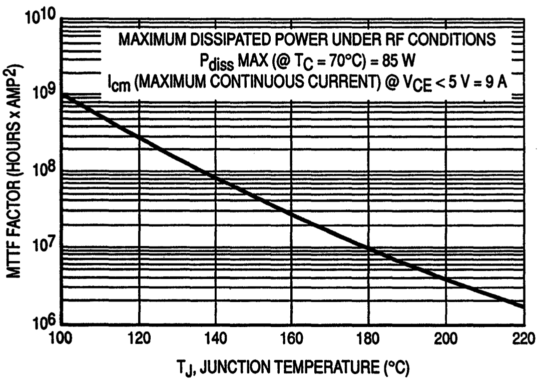


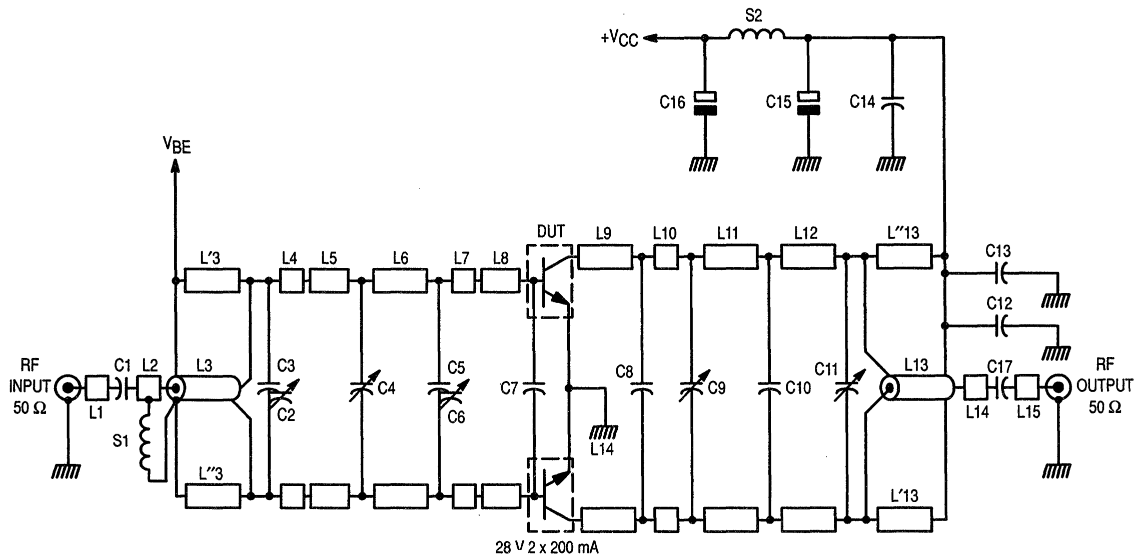
Figure 4. MTTF Factor versus Junction Temperature (MTTF — Hrs. x A^2 — Divide by I_C^2 to obtain MTTF in hours)

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
470	1.5 + j0.65	7.8 + j5.3
520		9 + j4.5
565	1.9 + j1	10 + j2.5
590		10 + j0
630	2.5 + j1	7.8 – j2
680		6 – j1.7
765	2.9 + j0.8	5 – j1
860	3 + j0.5	4.5 – j0.5

P_{out} = @ 1.0 dB Compression
V_{CC} = 28 V, I_{CQ} = 2.0 x 200 mA

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 5. Z_{IN} and Z_{OL}* versus Frequency (Each Side)



C1 — Chip Capacitor 100 pF ATC 100A101JP50
C2 — Trimmer Capacitor 0.5/4.0 pF Ref. 37275 TEKELEC
C3 — Chip Capacitor 1.3 pF ATC 100A1R3BP50
C4 — Trimmer Capacitor 1.0–4.0 pF GKU 4RO
C5 — Chip Capacitor 5.6 pF ATC 100A5R6CP50
C6 — Trimmer Capacitor 0.5/4.0 pF Ref. 37275 TEKELEC
C7 — Chip Capacitor 18 pF ATC 100A180DP50
C8 — Chip Capacitor 6.8 pF ATC 100A6R8CP50
C9 — Trimmer Capacitor 0.5/4.0 pF Ref. 37275 TEKELEC
C10 — 6 mm Coaxial Line 50 Ω Dia.070
C11 — Trimmer Capacitor 0.5/4.0 pF Ref. 37275 TEKELEC
C12 — Chip Capacitor 100 pF ATC 100A101JP50
C13 — Chip Capacitor 100 pF ATC 100A101JP50
C14 — Chip Capacitor 1.0 nF
C15 — Chip Tantalum Capacitor 6.8 µF 35 V
C16 — Capacitor 100 µF 40 V
C17 — Chip Capacitor 100 pF ATC 100A101JP50

L1 — 50 Ω Printed Line
L2 — 50 Ω Printed Line
L3 — Coaxial Cable 50 Ω 85 mils L = 75 mm
L′3 — 70 Ω Printed Line; Length 75 mm
L4 — 25 Ω Printed Line; Length 2 mm
L5 — 35 Ω Printed Line; Length 22 mm
L6 — 35 Ω Printed Line; Length 12 mm
L7 — 35 Ω Printed Line; Length 2 mm
L8 — 25 Ω Printed Line; Length 8 mm
L9 — 25 Ω Printed Line; Length 16 mm
L10 — 25 Ω Printed Line; Length 7 mm
L11 — 35 Ω Printed Line; Length 15 mm
L12 — 35 Ω Printed Line; Length 15 mm
L13 — Coaxial Cable 50 Ω 85 mils L = 75 mm
L′13 — 70 Ω Printed Line; Length 75 mm
L″13 — 70 Ω Printed Line; Length 75 mm
L14 — 40 Ω Printed Line; Length 7 mm
S1 — 4 Turns Wire 0.8 mm ID 3 mm
S2 — 4 Turns Wire 0.8 mm ID 3 mm
RF Substrate, Teflon Glass 1/50 inch 35 µ
Note: L3 & L13 soldered on 70 W printed line L′3/L′13

Figure 6. 470–860 MHz Test Circuit, Class AB

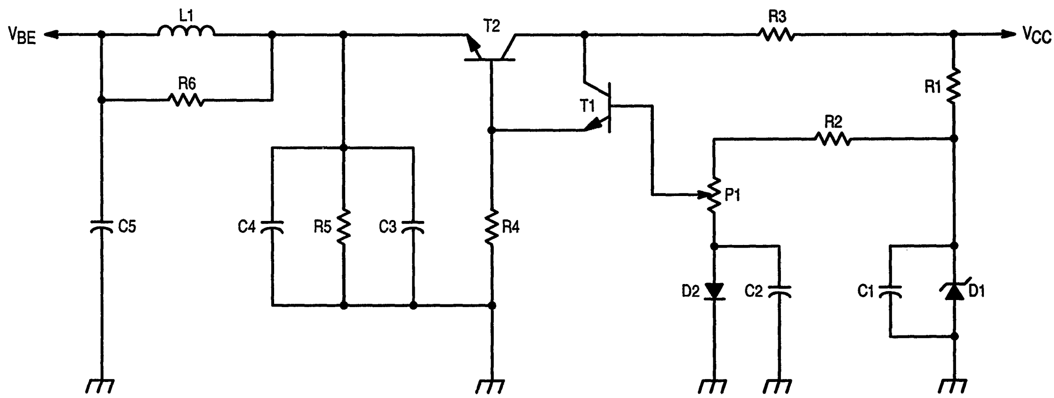
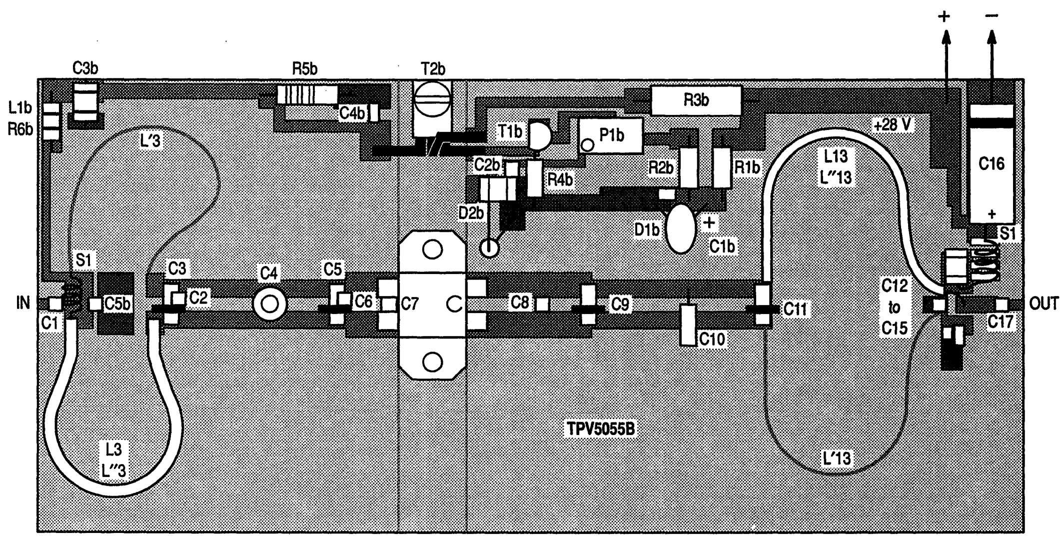


Figure 7. Bias Circuit, Class AB



C1b — 22 µF 35 V Tantalum Capacitor
C2b — 6.8 µF 35 V Tantalum Capacitor + 1.0 nF Chip Capacitor
C3b — 6.8 µF 35 V Tantalum Capacitor
C4b — 1.0 nF Chip Capacitor
C5b — 100 pF ATC 100A101JP50
D1b — Zener Diode 9.1 V
D2b — Diode 1N4007 (fixed in the heatsink next to the RF Transistor Flange)
L1b — 10 Turns Wire Ø 30/100 around R6
P1b — 500 Ω Trimmer
R1b — 2.2 kΩ 1/4 W
R2b — 1.5 kΩ 1/4 W
R3b — 15 Ω 3.0 W SFERNICE
R4b — 1.0 kΩ 1/4 W
R5b — 47 Ω 1/2 W
R6b — 150 Ω 1/4 W
T1b — Transistor BC337
T2b — Transistor BD135 fixed on the heatsink

Figure 8. PC Board Layout

TPV6030

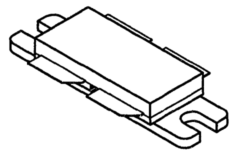
The RF Line
NPN Silicon RF Power Transistor

The TPV6030 is designed for driver stages in band IV and V TV transmitter amplifiers. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

Including double input and output matching networks, the TPV6030 features high impedances. It can easily operate in a full 470 MHz to 860 MHz bandwidth in a single and simple circuit.

- To be used class A for TV band IV and V.
- Specified 25 Volts, 860 MHz Characteristics
  Output Power = 20 Watts @ −51 dB (3 tones)
  Output Power = 35 Watts @ 1 dB Comp. (CW)

**35 W, 470–860 MHz
NPN SILICON
RF POWER TRANSISTOR**



CASE 375A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T = 25°C Derate above 25°C	P_D	160 0.9	W W/°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	1.1	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 35 mA, R_{be} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 35 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 30 V, R_{be} = 75 Ω)	I_{CER}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 2 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (each side) (2) (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	45	—	pF

(continued)

NOTES:
1. Thermal resistance is determined under specified RF operating condition.
2. Value of "C_{ob}" is that of die only. It is not measurable in TPV6030 because of internal matching network.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, I_C = 4.5 A, f = 860 MHz)	G_p	9.5	10.5	—	dB
Intermodulation (−8 dB/−7 dB/−16 dB) (3) (V_{CE} = 25 V, P_{out} = 20 W ref, I_C = 4.5 A, f = 860 MHz)	IMD	—	−52	−51	dB
Output Power @ 1 dB Compression (V_{CE} = 25 V, I_C = 4.5 A, f = 860 MHz)	P_{out}	35	40	—	W

NOTE:
3. Vision Carrier, Sound Carrier and Sideband Signal respectively.

2

V_{CE} = 25 V, I_C = 4.5 A

f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠Ø	$\|S_{21}\|$	∠Ø	$\|S_{12}\|$	∠Ø	$\|S_{22}\|$	∠Ø
460	.98	175	1.04	98	.012	50	.73	168
560	.97	172	1.17	83	.015	39	.66	170
660	.94	170	1.46	60	.020	23	.59	176
760	.88	168	1.77	35	.026	−4	.59	−168
860	.81	171	1.70	−7	.027	−42	.77	−163

Table 1. Common Emitter S-Parameters

TPV7025

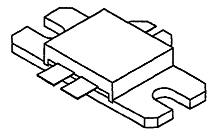
The RF Line
UHF Linear Power Transistor

. . . designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 25 W — P_{ref} @ −45 dB IMD
- 25 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability

25 W, 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



CASE 398, STYLE 1
(BMA-4)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C
Operating Case Temperature	T_C	70	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Breakdown Voltage (I_C = 120 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 1.0 A, V_{CE} = 20 V)	h_{FE}	10	—	60	—
DYNAMIC CHARACTERISTICS (1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	C_{ob}	64	—	80	pF

NOTE:
1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 25 W, f = 860 MHz, I_{CQ} = 3.2 A)	G_{PE}	9.0	—	10.5	dB
Load Mismatch (V_{CE} = 25 V, P_{out} = 24 W, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (f = 470 MHz, 2 tones, V_{CE} = 25 V, I_C = 3.2 A) (No Degradation)	$P_{in_{over}}$	24	—	—	W
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_E = 3.2 A, P_{ref} = 25 W, Vision Carrier = −8.0 dB, Sound Carrier = −7.0 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−45	dB
Cross Modulation Distortion (P_{ref} = 25 W, f = 860 MHz, Δ% Sound = (−7.0 dB), Vision 0 – Peak)	X_{MOD}	—	—	20	%

NOTE:
2. Both transistor chips operating in push-pull amplifier.

2

TYPICAL CHARACTERISTICS

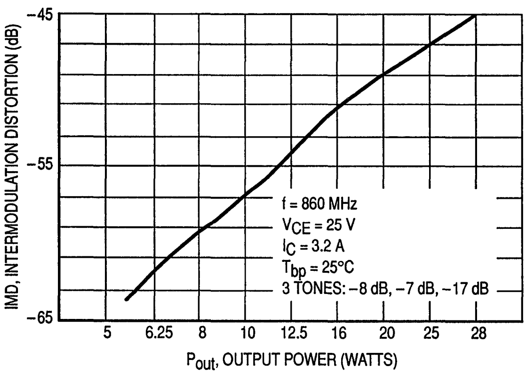


Figure 1. IMD versus Output Power

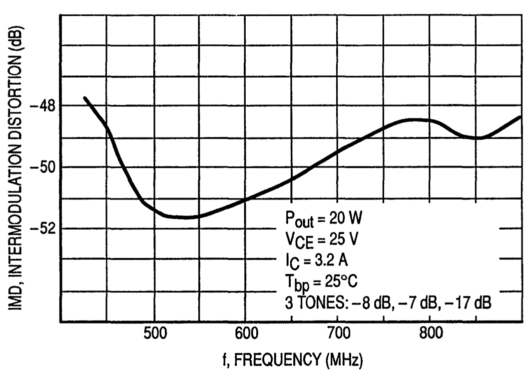
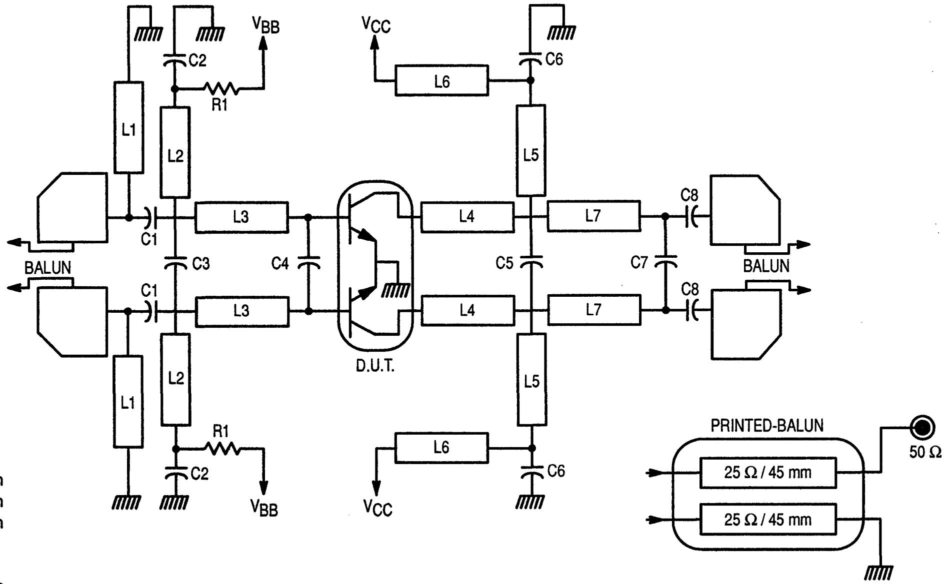


Figure 2. IMD versus Frequency

2



C1 — 15 pF
C2 — 180 pF
C3 — 10 pF
C4 — 15 pF
C5 — 15 pF
C6 — 180 pF
C7 — 4.7 pF
C8 — 100 pF
L1 — 90 / 16 mm
L2 — 90 / 16 mm
L3 — 35 / 10 mm
L4 — 25 / 7 mm
L5 — 70 / 6 mm
L6 — 70 / 26 mm
L7 — 60 / 16 mm
R1 — 3.3 Ω
Board Material: Teflon Glass Substrate .020 In.

Figure 3. 470–860 MHz Broadband Test Circuit

V_{CE} (Volts)	I_C (A)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ φ	Mag	∠ φ	Mag	∠ φ	Mag	∠ φ
25	2 x 1.8	0.44	1.0	178	1.25	80	0.02	29	0.89	156
		0.46	1.0	176	1.25	84	0.02	31	0.78	151
		0.48	1.0	174	1.30	81	0.02	30	0.70	148
		0.50	0.99	173	1.39	75	0.02	29	0.65	145
		0.52	0.98	171	1.42	70	0.03	26	0.59	142
		0.54	0.97	173	1.52	65	0.03	17	0.53	140
		0.56	0.97	171	1.67	67	0.03	12	0.46	139
		0.58	0.94	169	1.77	49	0.03	8.0	0.39	138
		0.60	0.92	164	1.93	40	0.04	0	0.31	142
		0.62	0.89	163	2.05	30	0.04	−9.0	0.23	157
		0.64	0.86	163	2.19	18	0.05	−19	0.21	−173
		0.66	0.82	164	2.29	4.0	0.05	−30	0.30	−150
		0.68	0.79	166	2.29	−11	0.05	−42	0.43	−147
		0.70	0.79	169	2.16	−26	0.05	−55	0.57	−150
		0.72	0.79	171	1.99	−40	0.05	−66	0.68	−155
		0.74	0.82	172	1.80	−52	0.05	−76	0.77	−161
		0.76	0.84	172	1.59	−63	0.04	−87	0.83	−168
		0.78	0.86	172	1.38	−74	0.04	−96	0.86	−173
		0.80	0.88	171	1.23	−82	0.03	−102	0.88	−178
		0.82	0.89	170	1.10	−88	0.03	−106	0.88	178
		0.84	0.90	170	0.99	−94	0.03	−110	0.89	175
		0.86	0.90	169	0.89	−100	0.03	−115	0.88	172
		0.88	0.90	168	0.80	−107	0.03	−119	0.87	170

Table 1. Common Emitter S-Parameters

TPV8100B

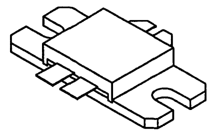
The RF Line
NPN Silicon RF Power Transistor

The TPV8100B is designed for output stages in band IV and V TV transmitter amplifiers. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

Including double input and output matching networks, the TPV8100B features high impedances. It can easily operate in a full 470 MHz to 860 MHz bandwidth in a single and simple circuit.

- To be used class AB for TV band IV and V.
- Specified 28 Volts, 860 MHz Characteristics
  Output Power = 125 Watts (peak sync.)
  Output Power = 100 Watts (CW)
  Minimum Gain = 8.5 dB
- Specified 32 Volts, 860 MHz Characteristics
  Output Power = 150 Watts (peak sync.)

**150 W, 470–860 MHz
NPN SILICON
RF POWER TRANSISTOR**



CASE 398, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	12	Adc
Total Device Dissipation @ 25°C Case Derate above 25°C	P_D	215 1.25	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{be} = 75 Ω)	$V_{(BR)CER}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 20 mAdc)	$V_{(BR)CBO}$	65	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 28 V, R_{be} = 75 Ω)	I_{CER}	—	—	10	mA

NOTE:
1. Thermal resistance is determined under specified RF operating condition.

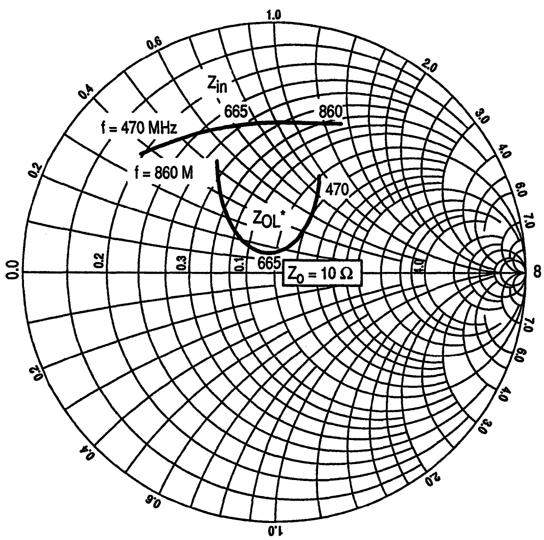
(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2 Adc, V_{CE} = 10 Vdc)	h_{FE}	30	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (each side) (2) (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	44	—	pF
FUNCTIONAL TESTS IN CW (SOUND)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 V, P_{out} = 100 W, I_{CQ} = 2 x 50 mA, f = 860 MHz)	G_p	8.5	9.5	—	dB
Collector Efficiency (V_{CC} = 28 V, P_{out} = 100 W, I_Q = 2 x 50 mA, f = 860 MHz)	η	55	58	—	%
Output Power @ 1 dB Compression (P_{ref} = 25 W) (V_{CC} = 28 V, I_{CQ} = 2 x 50 mA, f = 860 MHz)	P_{out}	100	110	—	W
FUNCTIONAL TESTS IN VIDEO (STANDARD BLACK LEVEL)					
Peak Output Power (synch.) (V_{CC} = 28 V, I_{CQ} = 2 x 50 mA, f = 860 MHz)	P_{out}	125	135	—	W
Peak Output Power (synch.) (V_{CC} = 32 V, I_{CQ} = 2 x 25 mA, f = 860 MHz)	P_{out}	150	160	—	W
Recommended Quiescent Current	I_{CQ}	—	—	2 x 0.3	A

NOTE:
2. Value of "C_{ob}" is that of die only. It is not measurable in TPV8100B because of internal matching network.

2

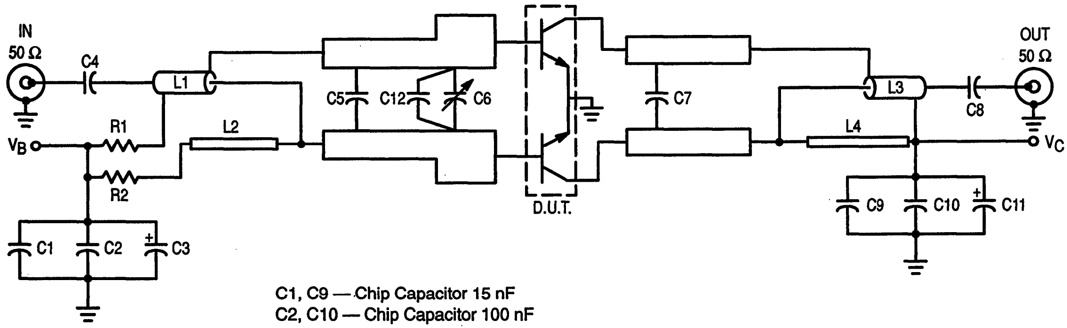


f (MHz)	Z_{in} (Ohms)	Z_{OL}* (Ohms)
470	1.95 + j3.67	10.0 + j9.50
665	3.65 + j6.82	9.23 + j1.30
860	6.66 + j13.8	4.45 + j5.22

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current and frequency.

Input and Output impedances with circuit tuned for maximum linearity @ V_{CC} = 28 V / I_{CQ} = 2 x 50 mA / P_{out} = 100 W

Figure 1. Series Equivalent Input/Output Impedances



C1, C9 — Chip Capacitor 15 nF
C2, C10 — Chip Capacitor 100 nF
C3, C11 — Chip Capacitor 100 µF/40 V
C4 — Chip Capacitor 15 pF ATC 100A
C5 — Chip Capacitor 5.6 pF ATC 100A
C6 — Trimmer Capacitor 1–4 pF
C7 — Chip Capacitor 12 pF ATC 100B
C8 — Chip Capacitor 15 pF ATC 100A
C12 — Chip Capacitor 12 pF ATC 100A
L1, L3 — Coaxial Wire 25 Ω/85 Mils/40 mm
L2, L4 — Printed Board Inductance
R1, R2 — Chip Resistor 1 Ω 0805 5%

Figure 2. Test Circuit

2

TYPICAL CHARACTERISTICS

CW — WIDEBAND

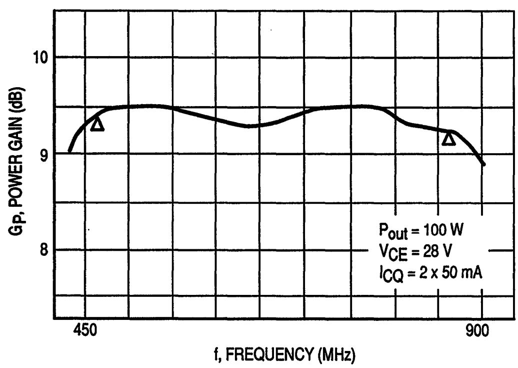


Figure 3. Power Gain versus Frequency

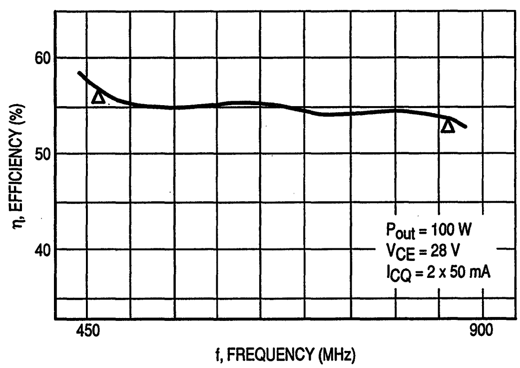
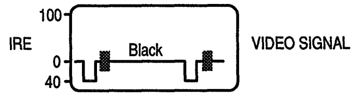


Figure 4. Collector Efficiency versus Frequency

TYPICAL VIDEO CHARACTERISTICS @ f = 800 MHz
V_{CE} = 28 V



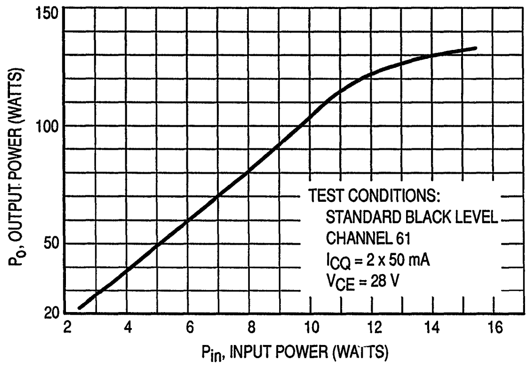


Figure 5. Peak Output Power versus Peak Input Power

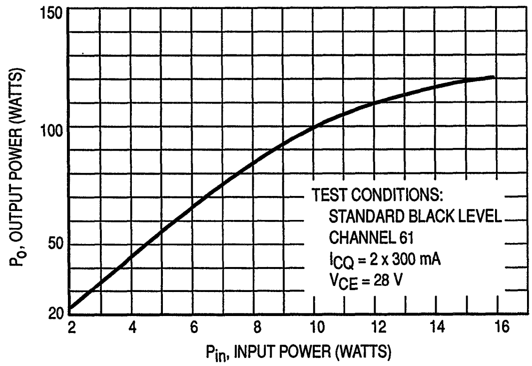


Figure 6. Peak Output Power versus Peak Input Power

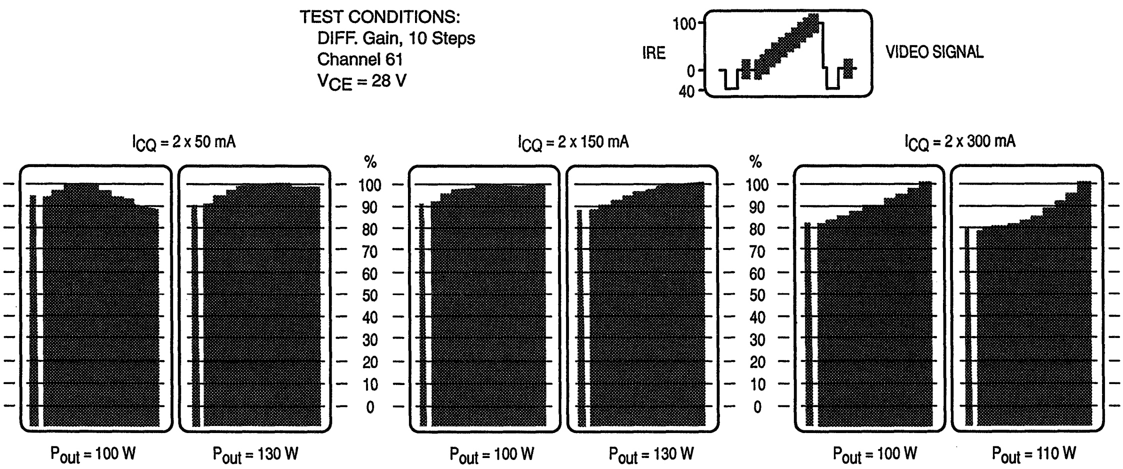
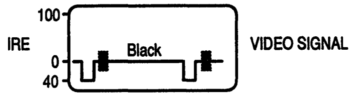


Figure 7. Gain versus Output Power

TYPICAL VIDEO CHARACTERISTICS @ f = 800 MHz
V_{CE} = 32 V



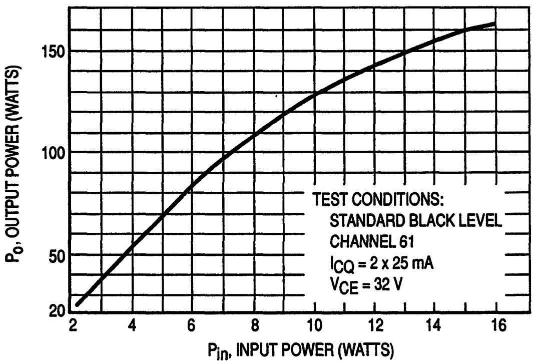


Figure 8. Peak Output Power versus Peak Input Power

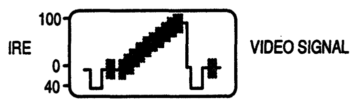
V_{CE} = 32 V, I_{CQ} = 2 x 25 mA

Pout	Gain
25 W	10.6 dB
50 W	11.1 dB
100 W	11.3 dB
120 W	11.1 dB
130 W	11.0 dB
140 W	10.7 dB
150 W	10.5 dB
160 W	10.2 dB

(see curve on left)

2

TEST CONDITIONS:
DIFF. Gain, 10 Steps
Channel 61
V_{CE} = 32 V
I_{CQ} = 2 x 25 mA



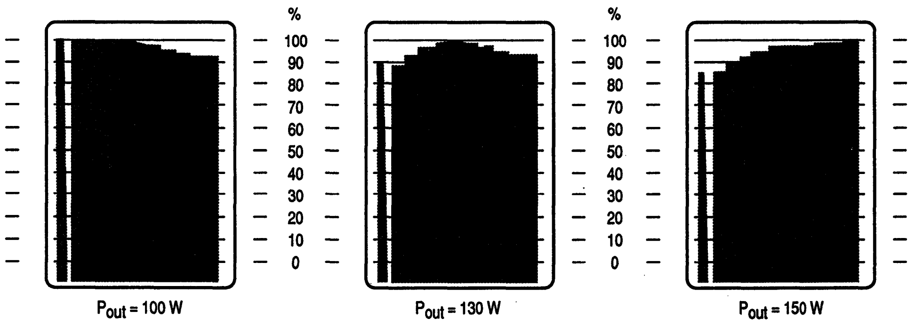


Figure 9. Differential Gain

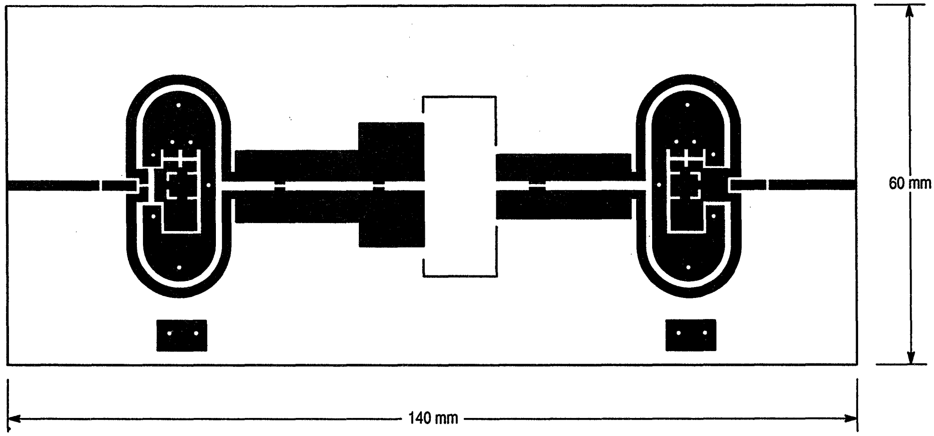


Figure 10. Photomaster
(Teflon® Glass 1/50 in., ϵ_r = 2.43)

2

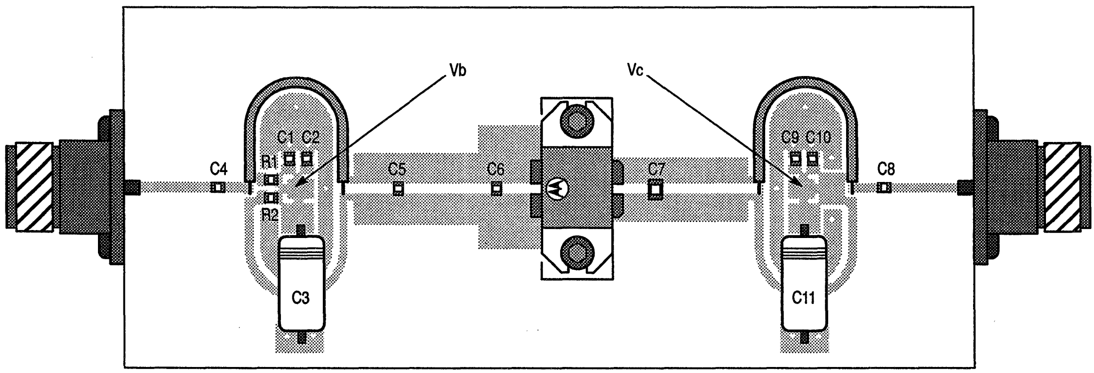


Figure 11. Components View

The RF Line
NPN Silicon RF Power Transistor

TPV8200B

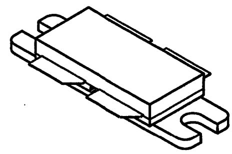
Motorola Preferred Device

**190 W, 470–860 MHz
RF POWER TRANSISTOR
NPN SILICON**

The TPV8200B is designed for output stages in band IV and V TV transmitter amplifiers. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

Including input and output matching networks, the TPV8200B features high impedances. It can operate over the 470 MHz to 860 MHz bandwidth using a single fixed tuned circuit.

- To be used class AB for TV band IV and V.
- Specified 28 Volts, 860 MHz Characteristics
  - Output Power = 190 Watts (peak sync.)
  - Output Power = 150 Watts (CW)
  - Gain = 8 dB Min



CASE 375A, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	20	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	250 1.43	Watts W/°C
Quiescent Current (without RF drive)	I_{CQ}	2 x 500	mAdc
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	35	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	80	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	5	—	Vdc
Collector-Emitter Leakage Current (V_{CE} = 28 Vdc, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mAdc

NOTE:
1. Thermal resistance is determined under specific RF condition.

(continued)

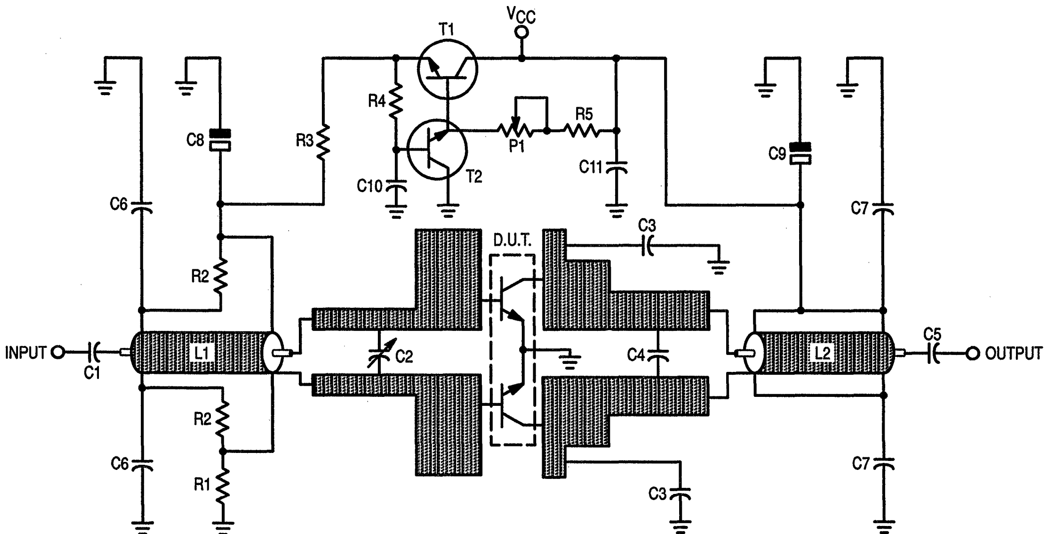
Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_{CE} = 2 Adc, V_{CE} = 10 Vdc)	h_{FE}	30	75	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (each side) (2) (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	76	—	pF
FUNCTIONAL TESTS IN CW					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 Vdc, P_{out} = 150 W, I_{CQ} = 2 x 75 mA, f = 860 MHz)	G_{pe}	8	9.5	—	dB
Collector Efficiency (V_{CE} = 28 Vdc, P_{out} = 150 W, I_{CQ} = 2 x 75 mA, f = 860 MHz)	η	45	53	—	%
Output Power @ 1 dB Compression (P_{ref} = 40 W) (V_{CE} = 28 Vdc, I_{CQ} = 2 x 75 mA, f = 860 MHz)	P_{out}	150	165	—	W
Input overdrive: no degradation (V_{CE} = 28 Vdc, I_{CQ} = 2 x 75 mA, f = 860 MHz)	P_{in}	30	—	—	W
Output Mismatch Stress: (V_{CE} = 28 Vdc, P_{out} = 120 W, I_{CQ} = 2 x 75 mA, f = 860 MHz, Load VSWR = 3:1, all phase angles at frequency of test)	ψ	No Degradation in Output Power Before or After Test			
FUNCTIONAL TESTS IN VIDEO (Standard Black Level)					
Peak Output Power @ 1 dB Compression (V_{CE} = 28 Vdc, I_{CQ} = 2 x 75 mA, f = 860 MHz)	P_{out}	190	210	—	W

NOTE:
2. Value of "C_{ob}" is that of die only. It is not measurable in TPV8200B because of internal matching network.

2



C1 — Chip Capacitor 47 pF ATC 100A
C2 — Chip Capacitor 12 pF ATC 100B
+ Trimmer Capacitor 0.5–4 pF
C3 — Chip Capacitor 8.2 pF ATC 100B
C4 — Chip Capacitor 12 pF ATC 100B
C5 — Chip Capacitor 100 pF ATC 100A
C6 — Chip Capacitor 2 x 1000 pF Vitramon
C7 — Chip Capacitor 2 x 0.1 µF Vitramon
C8 — Capacitor 220 µF/16 V
C9 — Capacitor 100 µF/40 V
C10 — Chip Capacitor 100 pF Vitramon
C11 — Chip Capacitor 15 nF Vitramon
L1 — Coaxial 25 Ω/length = 41 mm
L2 — Coaxial 25 Ω/length = 41 mm
R1 — Chip Resistor 47 Ω
R2 — 2 x 1 Ω (0.5 Ω)
R3 — Resistor 0.8 Ω
R4 — Resistor 47 Ω
R5 — Resistor 1.2 kΩ
P1 — Trimmer Resistor 5 kΩ
T1 — Transistor BD 135
T2 — Transistor BD 135
PC Board: 1/50″ Glass Teflon® ϵ_r = 2.55

Figure 1. 860 MHz Test Circuit

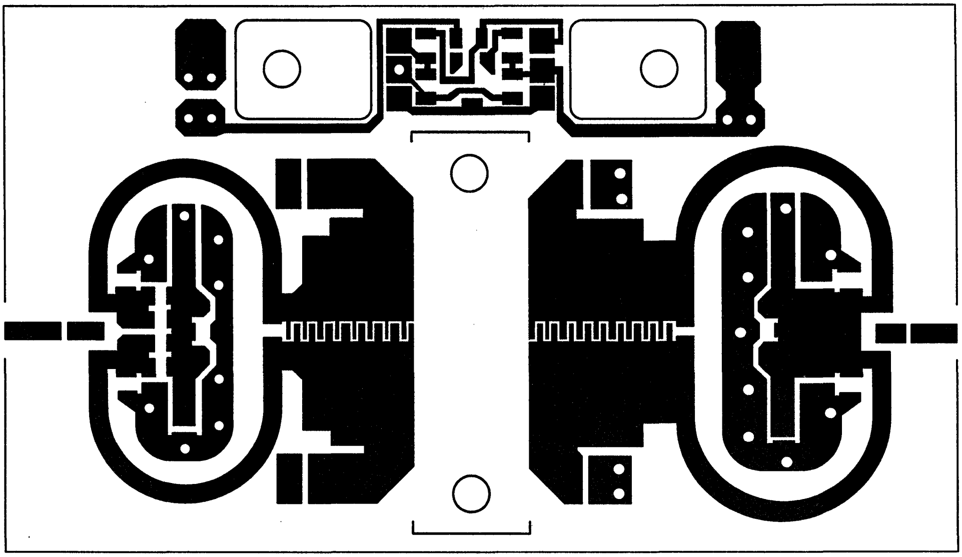


Figure 2. Photomaster

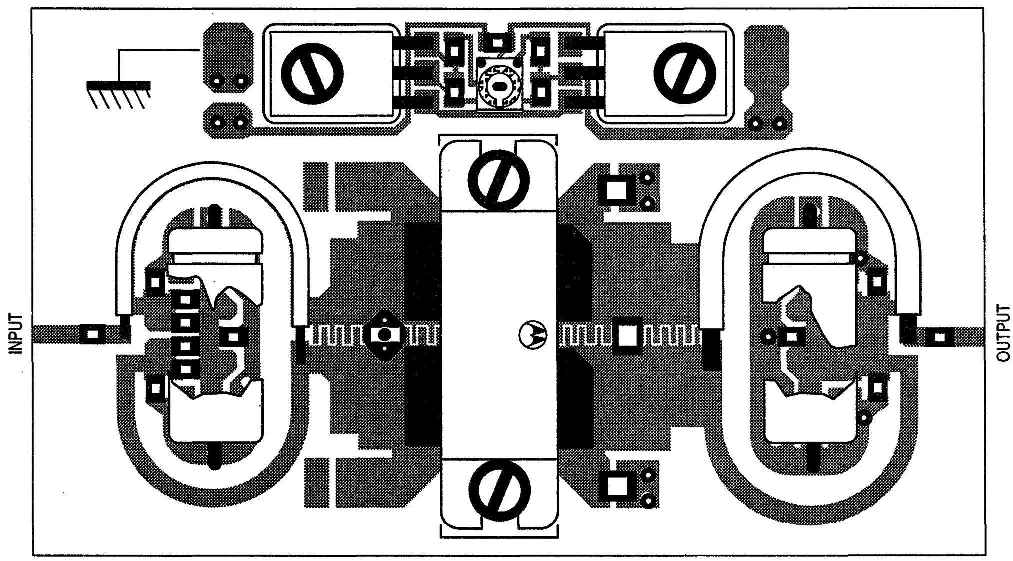


Figure 3. Components View

CAUTION

The TPV8200B is a high power transistor and thermal adaptation is very important for good RF performance (see mechanical drawing for mounting recommendations).

Maximum Ratings (see page 2-841) are given to avoid destruction of the transistor; another limitation is MMMTBF and the user must first determine the minimum wanted life-time in order to choose the right way of use for the device (see MMMTBF curves), especially in case of CW application.

TYPICAL CHARACTERISTICS

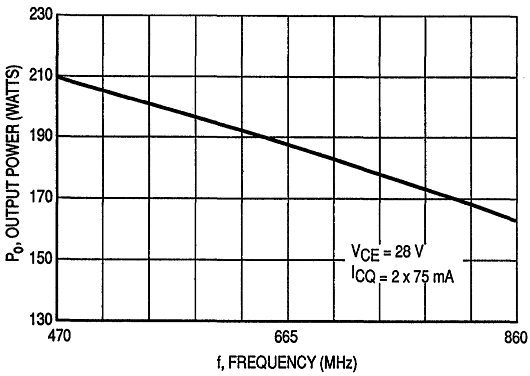


Figure 4. Output Power @ 1 dB Comp. versus Frequency

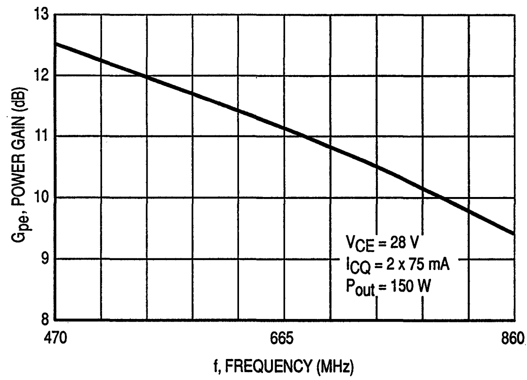


Figure 5. Power Gain versus Frequency

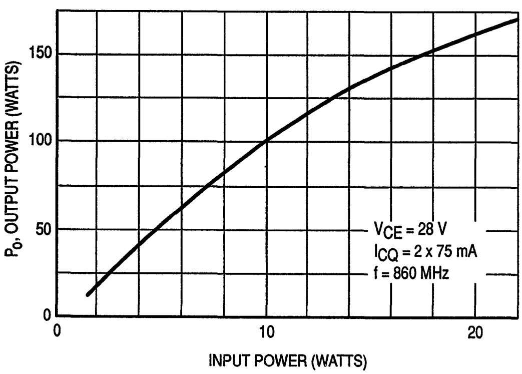


Figure 6. Output Power versus Input Power

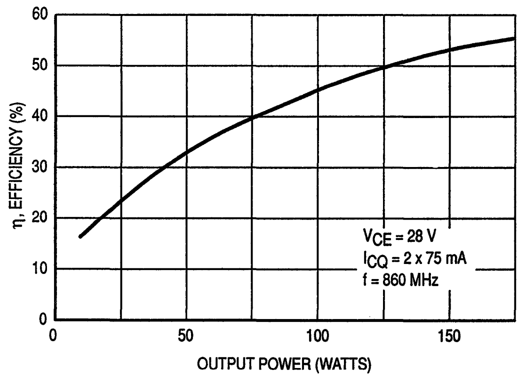


Figure 7. Collector Efficiency versus Output Power

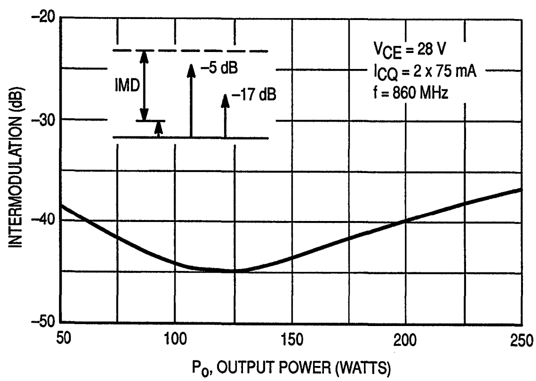


Figure 8. Intermodulation versus Peak Power
(Side Band)

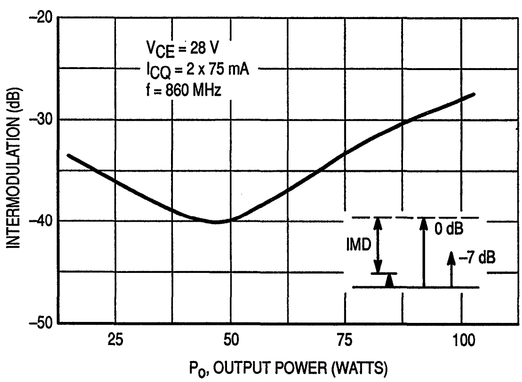


Figure 9. Intermodulation versus Peak Power
(Dual Sound)

TYPICAL VIDEO CHARACTERISTICS @ f = 860 MHz
V_{CE} = 28 V

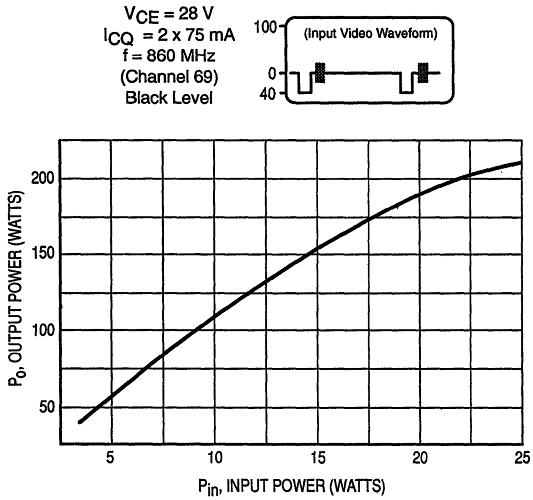


Figure 10. Peak Output Power versus Peak Input Power

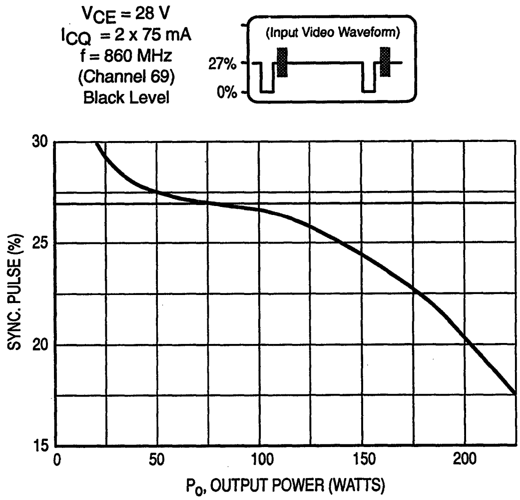


Figure 11. Sync. Pulse versus Peak Output Power

2

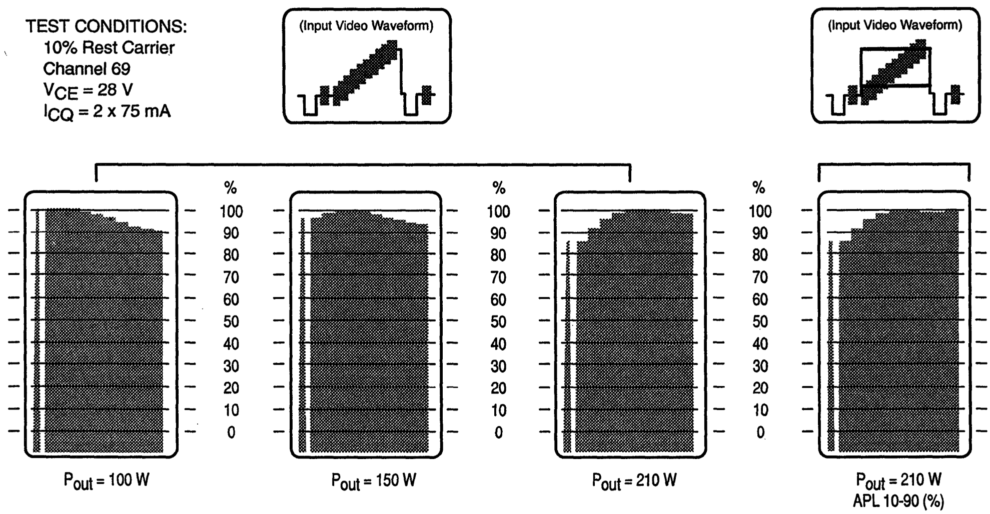
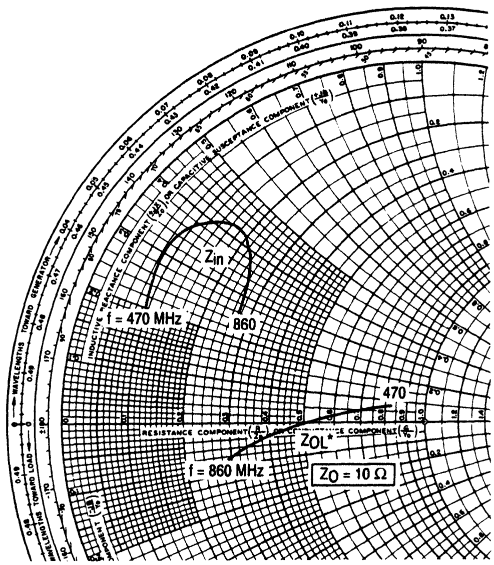


Figure 12. Gain versus Output Power



f (MHz)	Z_{IN} (Ohms)	Z_{OL}* (Ohms)
470	0.80 + j2.11	7.93 + j0.94
567	0.85 + j3.15	5.94 + j0.30
665	1.56 + j4.20	4.55 – j0.02
762	2.64 + j3.36	3.70 – j0.52
860	2.72 + j2.24	2.91 – j0.92

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage, current, and frequency.

Base-base & collector-collector Impedances with
Circuit Tuned for Maximum Gain @ V_{CE} = 28 V / I_{CQ} = 2 x 75 mA / P_{out} = 150 W

Figure 13. Series Equivalent Input/Output Impedances

RELIABILITY DEPENDENCE ON THERMAL CONSIDERATIONS

MMMTBF: Metal Migration Mean Time Before Failure.

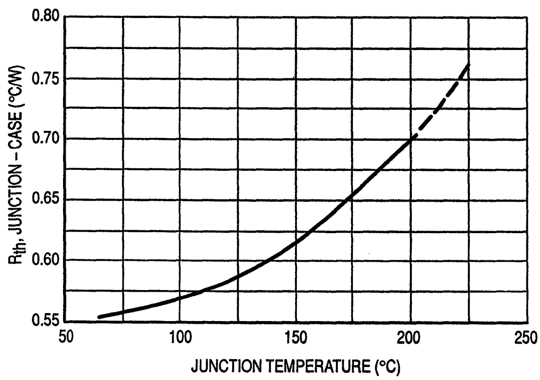


Figure 14. Thermal Resistance versus Junction Temperature

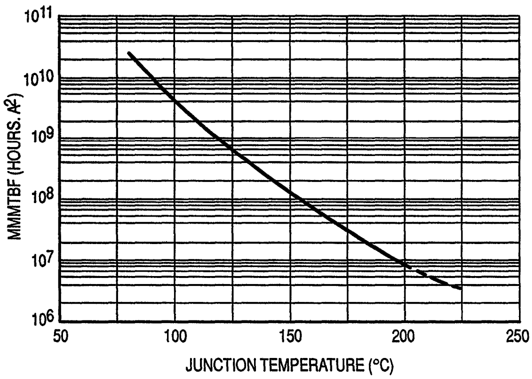


Figure 15. MMMTBF versus Junction Temperature

TYPICAL CONDITIONS (120 W CW):

P_{out} = 120 W
P_{in} = 15 W
V_{CE} = 28 V
η = 45%
I_{CQ} = 9.5 A
R_{TH} = 0.7°C/W
T_{max} = 70°C

⇒ P_{diss} = 161 W
T_{jct} = 183°C
J = (5.64) 10^4 A/cm^2

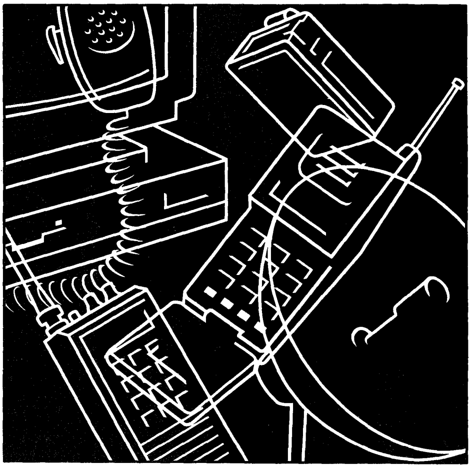
⇒ **MTBF = 26 YEARS**

TYPICAL CONDITIONS (210 W VIDEO):

P_{out} = 70 W
P_{in} = 7.8 W
V_{CE} = 28 V
η = 38%
I_{CQ} = 6.6 A
R_{TH} = 0.7°C/W
T_{max} = 70°C

⇒ P_{diss} = 123 W
T_{jct} = 156°C
J = (3.92) 10^4 A/cm^2

⇒ **MTBF = 252 YEARS**



Amplifier Data Sheets

3

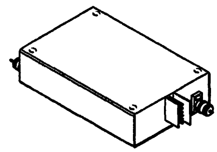
ATV6031

The RF Line
Linear Power Amplifier

. . . a solid state Class A amplifier specifically designed for TV transposers and transmitters. This amplifier incorporates microstrip technology and discrete linear push-pull transistors with gold metallization and diffused emitter ballast resistors to enhance ruggedness and reliability.

- 470–860 MHz
- 20 W — P_{out}
- 26.5 V — V_{CC}
- 10.5 dB Min. Gain, Class A

**20 W, 470–860 MHz
LINEAR
POWER SUPPLY**



CASE 389B, STYLE 1
(ATV)

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector Voltage Supply	V_{CC}	27	Vdc
Supply Current	I_{CC}	4	Adc
Source and Load VSWR (50 Ω REF.)	$VSWR_{S, L}$	1.2	
Operating Temperature Range (Note 1)	T_C	−20 to +70	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 50°C, 50 Ω system, V_{CC} = 26.5 V unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Bandwidth	BW	470	—	860	MHz
Power Gain (P_{out} = 20 W, CW)	G_p	10.5	—	—	dB
Power Output @ 1 dB Gain Compression	$P_{out(1\ dB)}$	25	28	—	W
Supply Current (P_{out} = 20 W)	I_{CC}	—	—	3.8	A
Input Return Loss (P_{out} = 20 W)	IRL	15	—	—	dB
Load Mismatch (P_{out} = 20 W, CW, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No degradation in power output			
Gain Ripple (P_{out} = 20 W, CW, BW = 470 to 860 MHz)	G_r	—	±0.5	±1	dB
Intermodulation Distortion — 3 tones (f = 860 MHz, V_{CE} = 25.5 V, P_{ref} = 20 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−50	dB
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 25.5 V, P_{ref} = 20 W, Vision Carrier = −8 dB, Sound Carrier = 10 dB, Sideband Signal = −16 dB)	IMD_2	—	—	−53	dB

NOTE: 1. Case Temperature is measured at base plate — on RF transistor flange.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

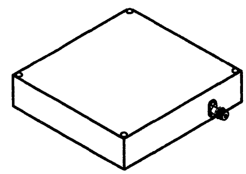
ATV6060

The RF Line
Broadband Linear Power Amplifier

60 W, 470–860 MHz
CLASS A
RF POWER AMPLIFIER

The ATV6060 is a solid state class A amplifier and is specifically designed for TV transposers and transmitters. This amplifier incorporates microstrip technology and reliable MOTOROLA push-pull transistors.

- Specified 25.5 Volts, 470–860 MHz Characteristics
  Output Power = 40 Watts @ –50 dB IMD (3 tones)
  Output Power = 60 Watts @ 1 dB Comp. (CW)
  Gain = 9 dB Min (Small Signal)
- Will Withstand Infinite Load VSWR
- High Performance, Gold Metallized Die for Ultra Reliable Performance



CASE 389U, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	26.5	Vdc
Storage Temperature Range	T_{stg}	–40 to +100	°C
Maximum Operating Temperature (1)	T_{op}	–20 to +70	°C

NOMINAL OPERATION CONDITION (T_C = 60°C)

Supply Current (V_{CC} = 25.5 V)	I_{sup}	9.2	A

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted, Z_{in}, Z_{out} = 50 Ω)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain (Small Signal)	G_p	9	—	—	dB
Gain Ripple (Small Signal)	G_{rple}	—	—	+1.0	dB
Output Power @ 1.0 dB Compression	P_{1dB}	60	—	—	W
Load Mismatch (P_{out} = 60 W, V_{CC} = 25.5 V, f = 860 MHz, Load VSWR = ∞:1, all phase angles at frequency of test)	ψ	No degradation in output power before or after test			
Intermodulation (–8 dB/–7 dB/–16 dB, P_{ref} = 40 W)	IMD_1	—	—	–50	dB
Intermodulation (–8 dB/–10 dB/–16 dB, P_{ref} = 40 W)	IMD_2	—	—	–53	dB
Input Return Loss	IRL	—	—	–15	dB
Output Return Loss	ORL	—	—	–15	dB

NOTE: 1. Temperature is measured at temperature test point (on the flange of the transistor).

TYPICAL CHARACTERISTICS

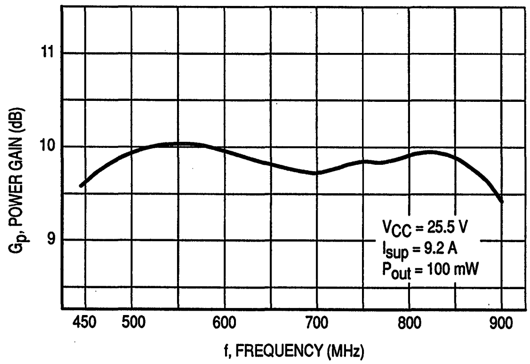


Figure 1. Power Gain versus Frequency

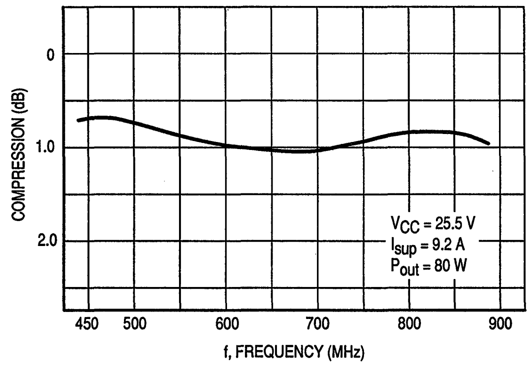


Figure 2. Gain Compression versus Frequency

3

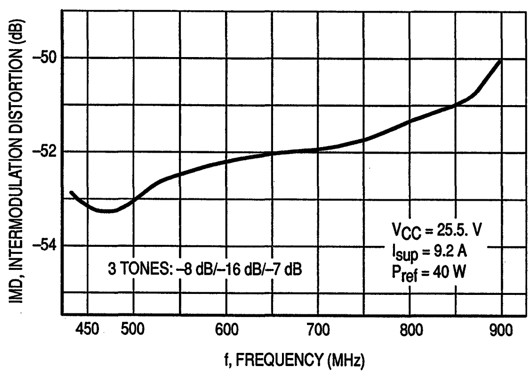


Figure 3. Intermodulation versus Frequency

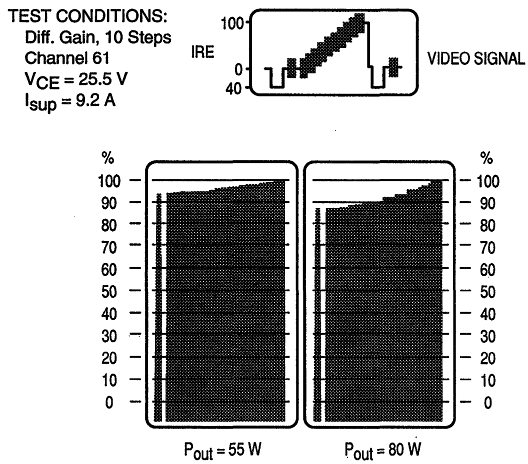


Figure 4. Gain versus Output Power

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

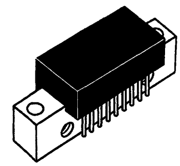
CA901
CA901A

The RF Line
VHF/UHF CATV Amplifiers

. . . designed for broadband applications requiring low-distortion amplification. Specifically intended for CATV/MATV market requirements. These amplifiers feature ion-implanted arsenic emitter transistors and an all gold metal system.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 40 to 860 MHz
  Power Gain — 17 dB Typ @ f = 40 MHz
  Noise Figure — 6.5 dB Typ @ f = 500 MHz
  120 dBμV DIN45004B @ 860 MHz
- All Gold Metallization for Improved Reliability
- Superior Gain, Return Loss and DC Current Stability with Temperature

17 dB
40–860 MHz
VHF/UHF
CATV/MATV
AMPLIFIERS



CASE 714P, STYLE 2
(CA)

3

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+14	dBm
Supply Voltage	V_{CC}	26	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	860	MHz
Power Gain (f = 40 MHz)	P_G	16.5	17	17.5	dB
Slope (40–860 MHz)	S	0.2	0.8	1.5	dB
Gain Flatness	—	—	—	±0.3	dB
Input/Output Return Loss f = 40–100 MHz f = 100–800 MHz f = 800–860 MHz	IRL/ORL	20 15 10/15	— 17 12/18	— — —	dB
Second Order Intermodulation Distortion CA901 (V_{out} = +50 dBmV per ch.) CA901A	IMD_2	— —	— —	–60 –64	dB
DIN45004B (See Figure 1) f = 40–400 MHz f = 400–860 MHz	DIN	121 120	— —	— —	dBμV
Noise Figure f = 500 MHz f = 860 MHz	NF	— —	6.5 7.0	7.5 8.0	dB
Supply Current	I_{DC}	—	235	255	mA

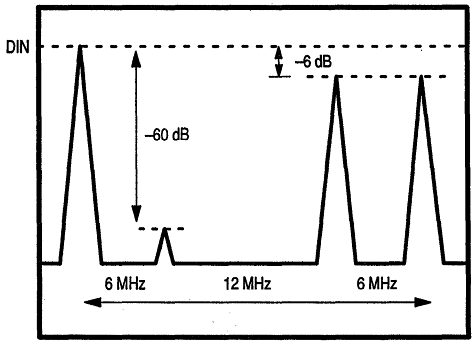


Figure 1. DIN45004B Test

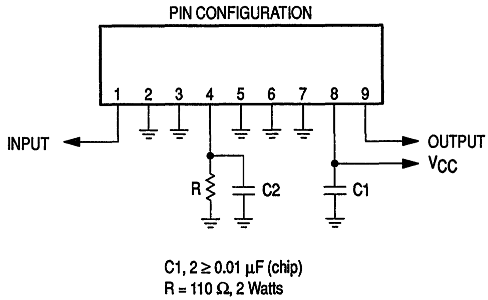


Figure 2. External Connections

3

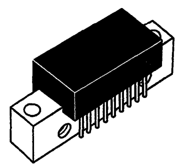
CA902
CA902A

The RF Line
VHF/UHF CATV Amplifiers

. . . designed for broadband applications requiring low-distortion and high output capability. Specifically intended for CATV/MATV market requirements. These amplifiers feature ion-implanted arsenic emitter transistors and an all gold metal system.

- Specified Characteristics at T_C = 25°C; V_{CC} = 28 V
  Frequency Range — 40 to 860 MHz
  Power Gain — 17 dB Typ @ f = 40 MHz
  Noise Figure — 7.0 dB Typ @ f = 500 MHz
  123 dBµV DIN45004B @ 860 MHz
- All Gold Metallization for Improved Reliability
- Superior Gain, Return Loss and DC Current Stability with Temperature

**17 dB
40–860 MHz
VHF/UHF
CATV/MATV
AMPLIFIERS**



**CASE 714P, STYLES 2, 3
(CA)**

3

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	30	V
RF Input Power Per Tone	P_{in}	+17	dBm
Storage Temperature	T_{stg}	– 40 to +125	°C
Operating Case Temperature Range	T_C	– 20 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, 75 Ohm System)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current	I_{DC}	—	400	450	mA
Power Gain (f = 40 MHz)	PG	16.5	17	17.5	dB
Bandwidth	BW	40	—	860	MHz
Slope (40–860 MHz)	S	0.2	0.8	1.4	dB
Gain Flatness	FL	—	—	± 0.5	dB
Input/Output Return Loss f = 40 – 100 MHz f = 100 – 800 MHz f = 800 – 860 MHz	IRL/ORL	20 15 10	— 17 12	— — —	dB
Second Order Intermodulation Distortion (V_o = + 50 dBmV/ch.) CA902 CA902A	IMD_2	— —	— —	–63 –67	dB
DIN45004B (See Figure 1) f = 40 – 400 MHz f = 400 – 860 MHz	DIN	124 123	— —	— —	dBµV
Noise Figure f = 500 MHz f = 860 MHz	NF	— —	7.0 8.0	8.5 9.5	dB

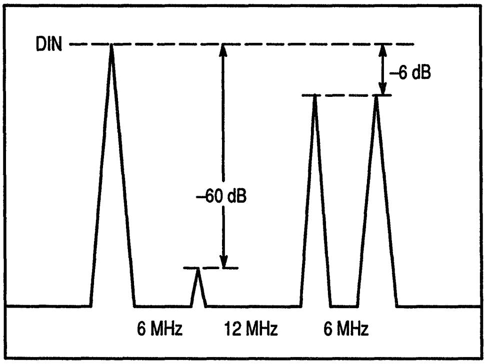


Figure 1. DIN45004B Test

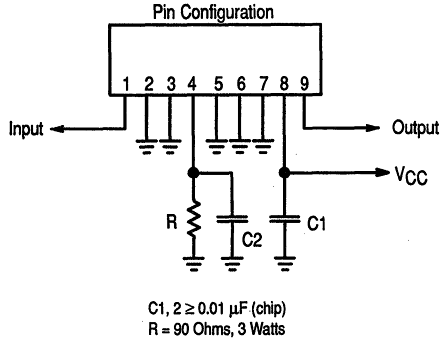


Figure 2. External Connections
Case 714P-01, Style 2

3

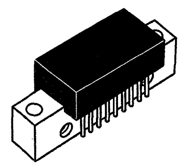
CA912

The RF Line
VHF/UHF CATV Amplifier

. . . designed for broadband applications requiring low-distortion and high output capability. Specifically intended for CATV/MATV market requirements. These amplifiers feature ion-implanted arsenic emitter transistors and an all gold metal system.

- Specified Characteristics at T_C = 25°C; V_{CC} = 15 V
  Frequency Range — 40 to 860 MHz
  Power Gain — 17 dB Typ @ f = 40 MHz
  Noise Figure — 7.0 dB Typ @ f = 500 MHz
  123 dBμV DIN45004B @ 860 MHz
- All Gold Metallization for Improved Reliability
- Superior Gain, Return Loss and DC Current Stability with Temperature

**17 dB
40–860 MHz
VHF/UHF
CATV/MATV
AMPLIFIER**



CASE 714P, STYLES 2, 3

3

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	18	V
RF Input Power Per Tone	P_{in}	+17	dBm
Storage Temperature	T_{stg}	– 40 to +100	°C
Operating Case Temperature Range	T_C	– 20 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 15 V, 75 Ohm System)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current	I_{DC}	640	700	760	mA
Power Gain (f = 40 MHz)	PG	16.5	17	17.5	dB
Bandwidth	BW	40	—	860	MHz
Slope (40–860 MHz)	S	0.2	0.8	1.5	dB
Gain Flatness	FL	—	—	± 0.5	dB
Input/Output Return Loss f = 40 – 100 MHz f = 100 – 800 MHz f = 800 – 860 MHz	IRL/ORL	20 15 10	— 17 12	— — —	dB
Second Order Intermodulation Distortion (V_o = + 50 dBmV/ch.)	IMD_2	—	—	–63	dB
DIN45004B (See Figure 1) f = 40 – 400 MHz f = 400 – 860 MHz	DIN	124 123	— —	— —	dBμV
Noise Figure f = 500 MHz f = 860 MHz	NF	— —	7.0 8.0	8.5 9.5	dB

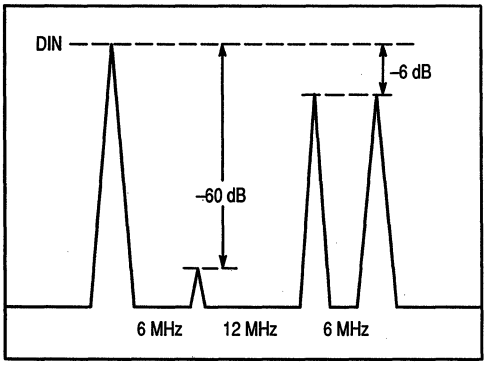


Figure 1. DIN45004B Test

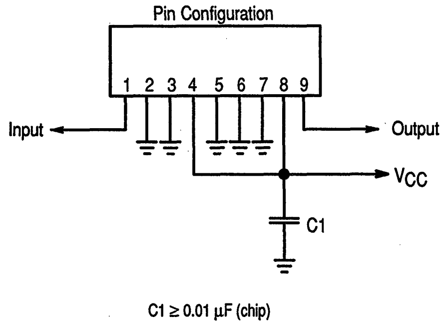


Figure 2. External Connections
Case 714P-01, Style 3

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

CA922
CA922A

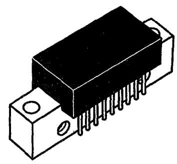
Motorola Preferred Devices

The RF Line
VHF/UHF CATV Amplifiers

17 dB
40–860 MHz
VHF/UHF
CATV/MATV
AMPLIFIERS

Designed for broadband applications requiring low-distortion and high output capability. Specifically intended for CATV/MATV market requirements. These amplifiers feature ion-implanted arsenic emitter transistors and an all gold metal system.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C
  Frequency Range — 40 to 860 MHz
  Power Gain — 17 dB Typ @ f = 40 MHz
  Noise Figure — 7.0 dB Typ @ f = 500 Mhz
  123 dBµV DIN45004B @ 860 MHz
- All Gold Metalization for Improved Reliability
- Superior Gain, Return Loss and DC Current Stability with Temperature
- Improved 2nd Order IMD Available (CA922A)



CASE 714P, STYLE 2

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	26	V
RF Input Power Per Tone	P_{in}	+16	dBm
Storage Temperature	T_{stg}	– 40 to +100	°C
Operating Case Temperature Range	T_C	– 20 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 75 Ohm System)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current	Idc	—	400	440	mA
Power Gain (f = 40 MHz)	PG	16.5	17	17.5	dB
Bandwidth	BW	40	—	860	MHz
Slope (40 - 860 MHz)	S	0.2	0.8	1.5	dB
Gain Flatness	FL	—	—	± .5	dB
Input/Output Return Loss f = 40–100 MHz f = 100–800 MHz f = 800–860 MHz	IRL/ORL	20 15 10/13	— 17 12/15	— — —	dB
Second Order Intermodulation Distortion CA922 (V_O = +50 dBmV/ch.) CA922A	IMD_2	— —	— —	– 63 – 67	dB dB
DIN45004B (See Figure 1) f = 40–400 MHz f = 400–860 MHz	DIN	124 123	— —	— —	dBµV
Noise Figure f = 500 MHz f = 860 MHz	NF	— —	7.0 8.0	8.5 9.5	dB

Preferred devices are Motorola recommended choices for future use and best overall value.

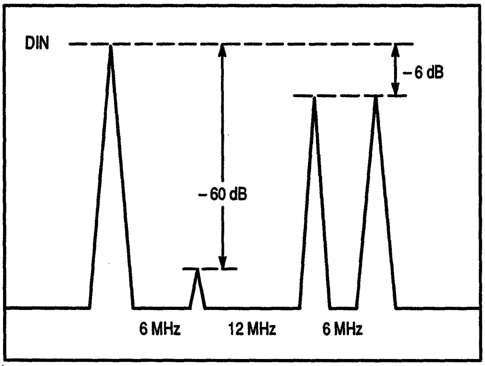


Figure 1. DIN45004B Test

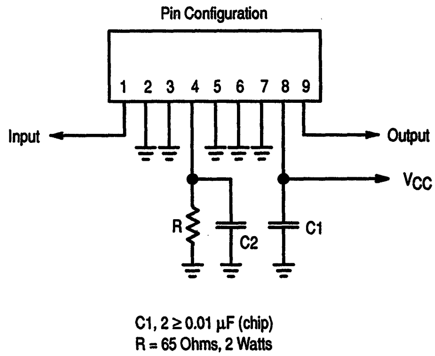


Figure 2. External Connections

3

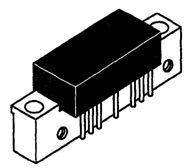
CA2810C

The RF Line
Wideband Linear Amplifier

. . . designed for amplifier applications in 50 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
- Frequency Range — 10 to 450 MHz
  Output Power — 1 W Typ @ 1 dB Compression, f = 200 MHz
  Power Gain — 34 dB Typ @ f = 50 MHz
  PEP — 400 mW Typ @ –32 dB IMD
  Noise Figure — 5 dB Max @ f = 300 MHz
- All Gold Metallization for Improved Reliability

**34 dB
10–450 MHz
800 mWATT
WIDEBAND
LINEAR AMPLIFIER**



**CASE 714F, STYLE 1
[CA (POS. SUPPLY)]**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	28	Vdc
RF Power Input	P_{in}	+5	dBm
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	10	—	450	MHz
Gain Flatness (f = 10–450 MHz)	F_L	—	—	±1.5	dB
Power Gain (f = 50 MHz)	P_G	33	34	35	dB
Noise Figure, Boradband (f = 300 MHz)	NF	—	—	5	dB
Power Output — 1 dB Compression (f = 200 MHz)	$P_{o1\ dB}$	800	1000	—	mW
Third Order Intercept (See Figure 10, f_1 = 300 MHz)	ITO	—	43	—	dBm
Input/Output VSWR (f = 10–450 MHz)	VSWR	—	—	2:1	—
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 10–300 MHz)	d_{so}	—	−55	−45	dB
Reverse Isolation (f = 10–450 MHz)	—	—	40	—	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) (f = 10–450 MHz @ –32 dB IMD)	PEP	—	400	—	mW
Supply Current	I_{CC}	270	310	330	mA

3

TYPICAL CHARACTERISTICS

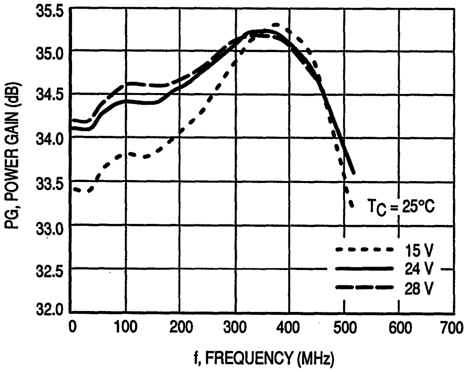


Figure 1. Power Gain versus Voltage

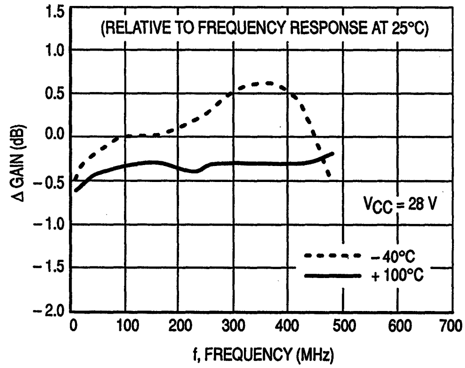


Figure 2. Relative Power Gain versus Temperature

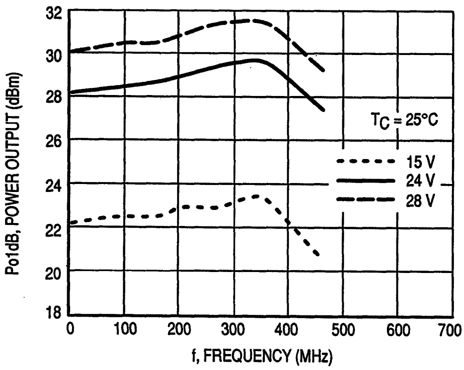


Figure 3. 1 dB Compression versus Voltage

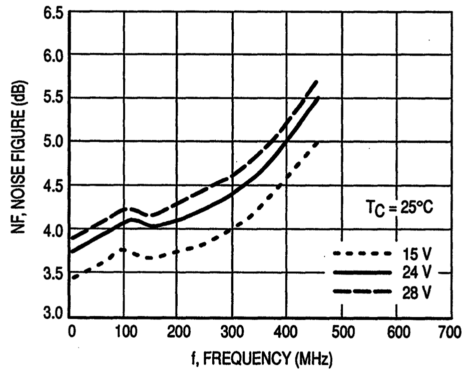


Figure 4. Noise Figure versus Voltage

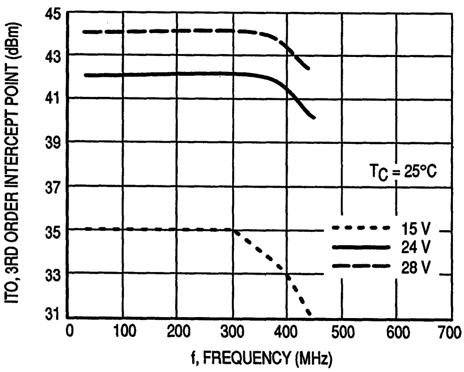


Figure 5. Third Order Intercept versus Voltage

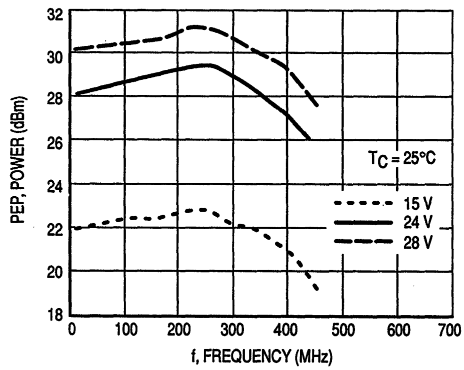


Figure 6. Peak Envelope Power versus Voltage

3

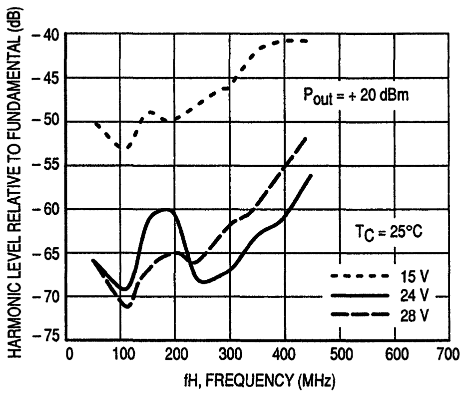


Figure 7. Second Harmonic Distortion versus Voltage

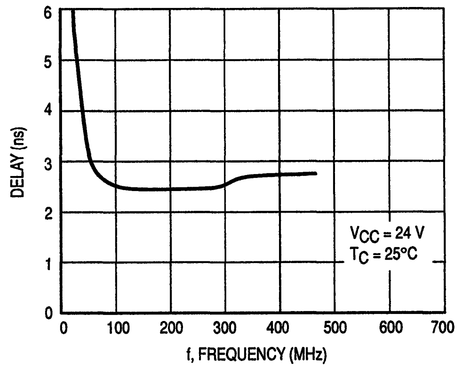


Figure 8. Group Delay versus Frequency

Biased at 24 Volts **T = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
10	−13.8	3.5	34.2	−145	−46	−131	−13.5	8.2
50	−16.0	−3.0	34.2	150	−47	−172	−18.5	4.6
100	−14.4	−14	34.4	88	−48	102	−14.5	−9.2
200	−13.2	−50	34.6	2	−42	35	−13.2	−80
300	−13.9	−79	35.0	−80	−46	65	−16.7	−49
400	−14.1	−115	35.0	−80	−48	−44	−14.2	11
450	−16.2	−122	34.6	120	−53	−82	−13.8	−46

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

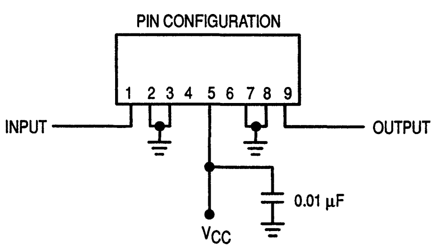
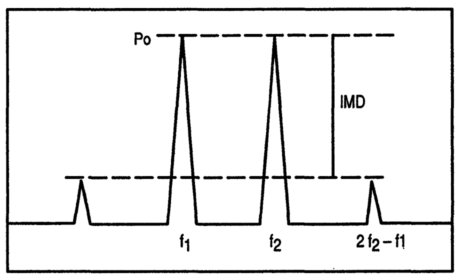


Figure 9. External Connections



ITO = Po + IMD / 2 @ IMD > 60 dB
PEP = 4 x Po @ IMD = − 32 dB

Figure 10. Intermodulation Test

3

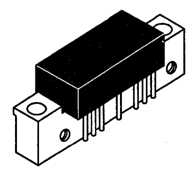
CA2818C

The RF Line
Wideband Linear Amplifier

... designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 0.35 to 400 MHz
  Output Power — 1000 mW Typ @ 1 dB Compression, f = 200 MHz
  Power Gain — 18.5 dB Typ @ f = 50 MHz
  PEP — 1000 mW Typ @ −32 dB IMD, f = 200 MHz
  Noise Figure — 5 dB Typ @ f = 200 MHz
  ITO — 47 dBm Typ @ f = 150 MHz
- All Gold Metallization for Improved Reliability
- Unconditional Stability Under All Load Conditions

**18.5 dB
10–400 MHz
1000 mWATT
WIDEBAND
LINEAR AMPLIFIER**



**CASE 714F, STYLE 1
[CA (POS. SUPPLY)]**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	28	Vdc
RF Power Input	P_{in}	+14	dBm
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

3

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	0.35	—	400	MHz
Gain Flatness (f = 0.35–400 MHz)	F_L	—	±0.5	±1	dB
Power Gain (f = 50 MHz)	P_G	17.75	18.5	19.25	dB
Noise Figure, Broadband (f = 200 MHz)	NF	—	5	6	dB
Power Output — 1 dB Compression (f = 200 MHz)	$P_{o\ 1dB}$	800	1000	—	mW
Third Order Intercept (See Figure 10, f_1 = 200 MHz)	ITO	43	45	—	dBm
Input/Output VSWR (f = 0.35–400 MHz)	VSWR	—	1.7:1	2:1	—
Second Harmonic Distortion (P_o = 100 mW) f_{2H} = 0.35–200 MHz f_{2H} = 200–400 MHz	d_{so}	— —	−65 —	−60 −50	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) f = 0.35–200 MHz @ −32 dB IMD f = 200–400 MHz @ −32 dB IMD	PEP	600	800	—	mW
Supply Current	I_{CC}	190	205	220	mA

TYPICAL CHARACTERISTICS

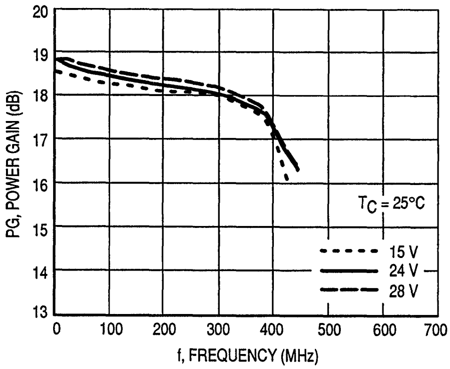


Figure 1. Power Gain versus Voltage

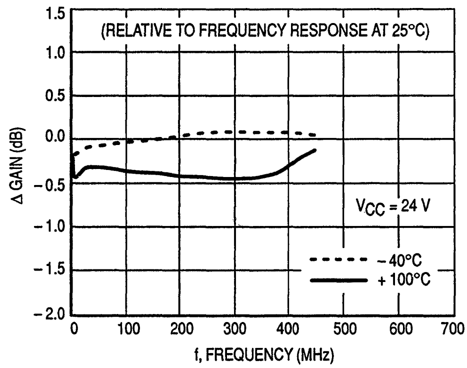


Figure 2. Relative Power Gain versus Temperature

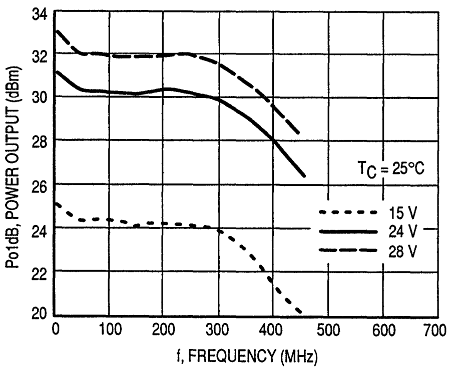


Figure 3. 1 dB Compression versus Voltage

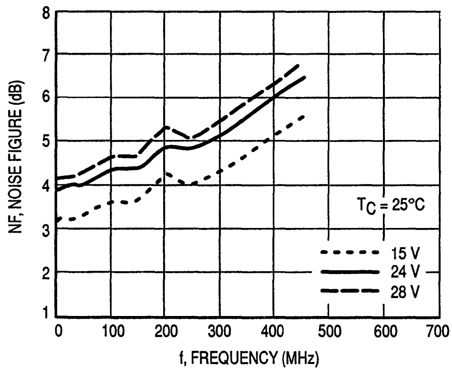


Figure 4. Noise Figure versus Voltage

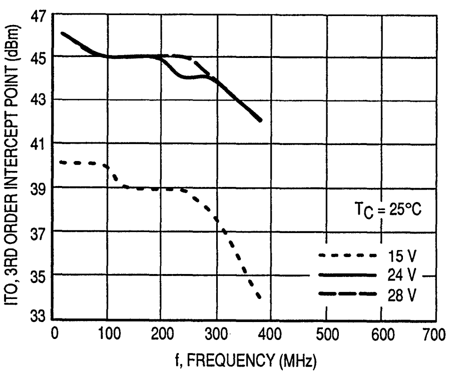


Figure 5. Third Order Intercept versus Voltage

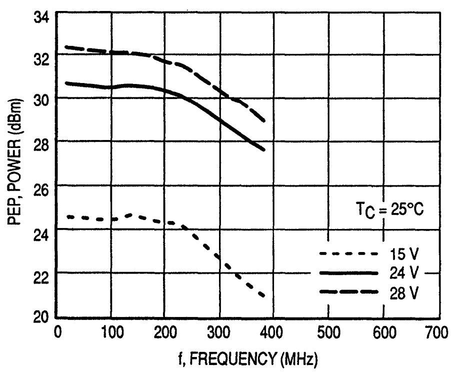


Figure 6. Peak Envelope Power versus Voltage

3

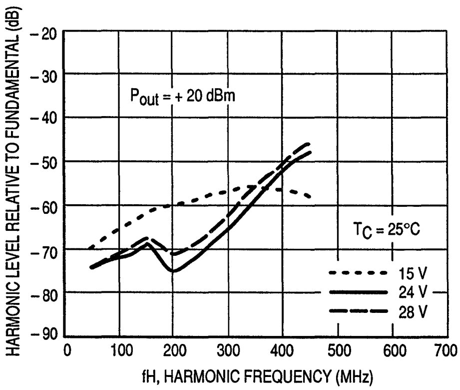


Figure 7. Second Harmonic Distortion versus Voltage

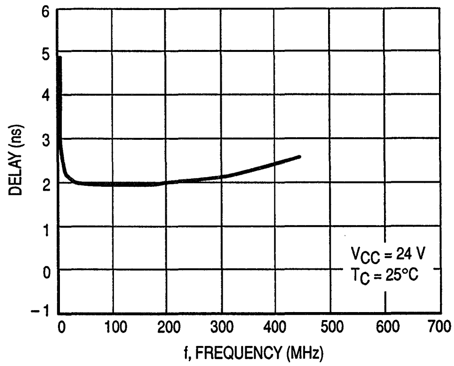


Figure 8. Group Delay versus Frequency

Biased at 24 Volts **T = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.35	−17.0	18.7	18.4	7.4	−24.1	−169	−16.4	11.1
1	−17.3	10.7	18.6	3.4	−24.0	−175	−16.7	6.5
50	−16.3	−7.6	18.7	−38.8	−23.9	145	−17.0	−38.8
100	−15.6	−15.1	18.5	−70.1	−24.1	117	−18.4	−65.9
200	−14.0	−47.3	18.3	−149	−24.8	47.9	−20.6	−101
300	−14.1	−85	18.1	135	−25.3	−15	−16.6	−142
400	−18.0	−137	17.4	58	−25.9	−84.3	−14.2	134

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

3

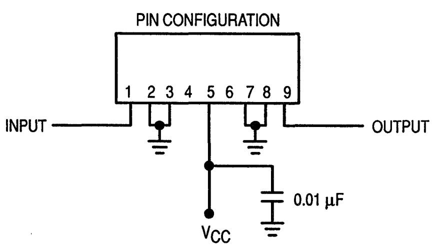
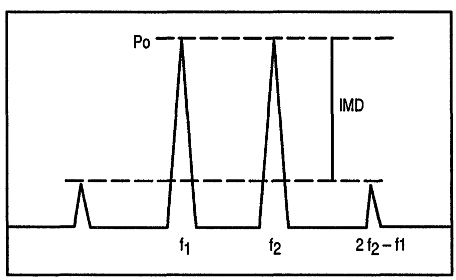


Figure 9. Functional Schematic



ITO = Po + IMD / 2 @ IMD > 60 dB
PEP = 4 x Po @ IMD = − 32 dB

Figure 10. Intermodulation Test

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

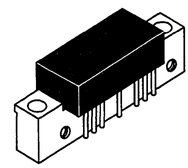
CA2830C
CA2833C

The RF Line
Wideband Linear Amplifiers

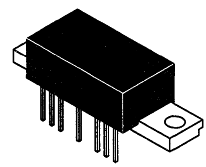
. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 5 to 200 MHz
  Output Power — 800 mW Typ @ 1 dB Compression, f = 200 MHz
  Power Gain — 34.5 dB Typ @ f = 100 MHz
  PEP — 800 mW Typ @ −32 dB IMD
  Noise Figure — 4.7 dB Typ @ f = 200 MHz
  ITO — 46 dBm @ f = 200 MHz
- All Gold Metallization for Improved Reliability
- Unconditional Stability Under All Load Conditions

34.5 dB
5–200 MHz
800 mWATT
WIDEBAND
LINEAR AMPLIFIERS



CASE 714F, STYLE 1
(CA)
CA2830C



CASE 714G, STYLE 1
[CA, LOW PROFILE]
CA2833C

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	28	Vdc
RF Power Input	P_{in}	+5	dBm
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	5	—	200	MHz
Gain Flatness (f = 5−200 MHz)	—	—	±0.5	±1	dB
Power Gain (f = 100 MHz)	P_G	33.5	34.5	35.5	dB
Noise Figure, Broadband (f = 200 MHz)	NF	—	4.7	5.5	dB
Power Output — 1 dB Compression (f = 5−200 MHz)	$P_{o\ 1dB}$	630	800	—	mW
Power Output — 1 dB Compression (f = 5−200 MHz, V_{CC} = 28 V)	$P_{o\ 1dB}$	1000	1260	—	mW
Third Order Intercept (See Figure 10, f_1 = 200 MHz)	ITO	44	46	—	dBm
Input/Output VSWR (f = 5−200 MHz)	VSWR	—	1.5:1	2:1	—
Second Harmonic Distortion (Tone at 100 mW, f_{2H} = 150 MHz)	d_{so}	—	−60	−50	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) (f = 5−200 MHz @ −32 dB IMD)	PEP	600	800	—	mW
Supply Current	I_{CC}	270	300	330	mA

3

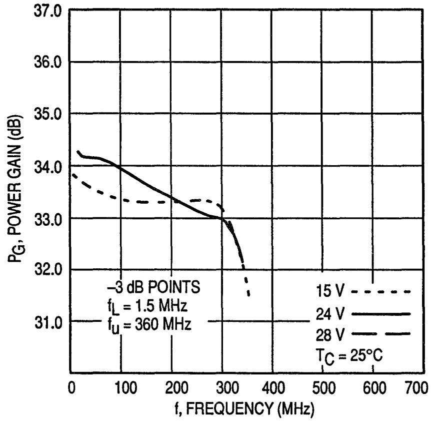


Figure 1. Power Gain versus Frequency

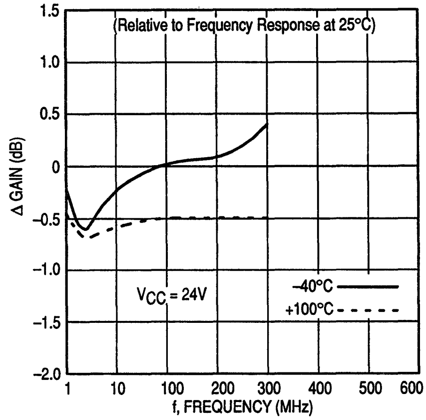


Figure 2. Relative Power Gain versus Temperature

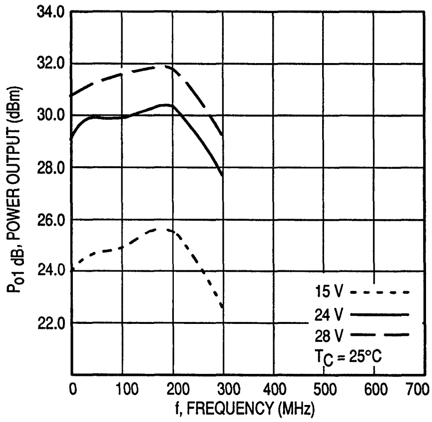


Figure 3. 1 dB Gain Compression versus Voltage

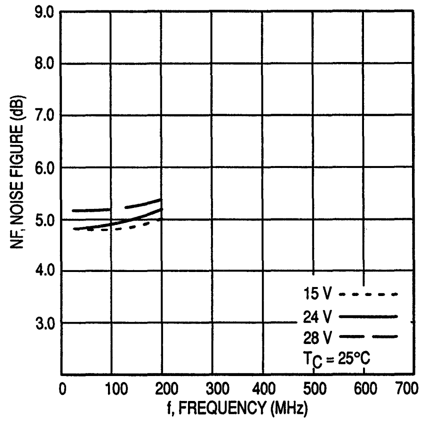


Figure 4. Noise Figure versus Voltage

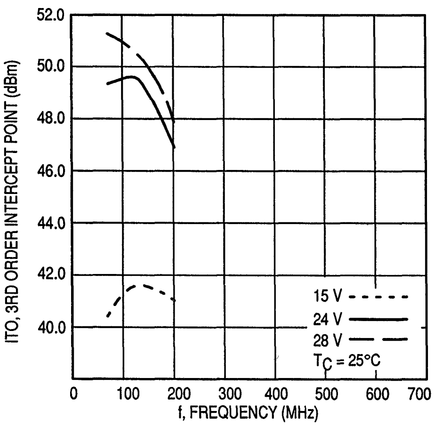


Figure 5. Third Order Intercept versus Voltage

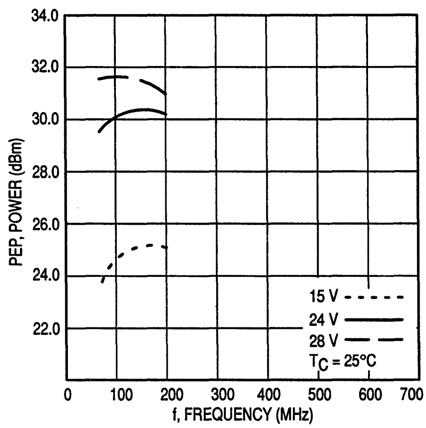


Figure 6. Peak Envelope Power versus Voltage

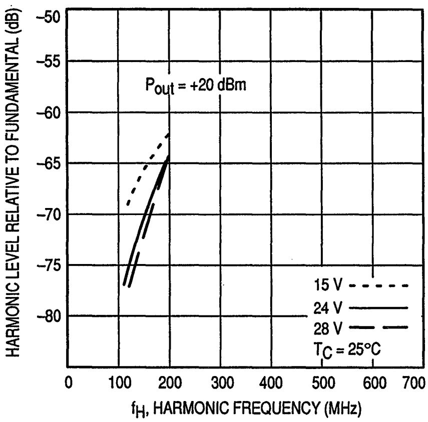


Figure 7. Second Harmonic Distortion versus Voltage

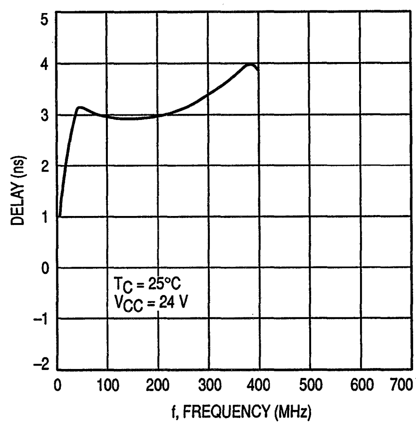


Figure 8. Group Delay versus Frequency

Biased at 24 Volts **T = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
5	-18.3	66.2	34.6	15.2	-47.0	17.7	-9.8	87.4
10	-19.3	45.5	34.6	-0.6	-47.0	2.3	-14.5	76.8
50	-15.6	35.0	34.2	-56.7	-47.5	-30.3	-12.6	45.0
100	-13.2	34.4	33.9	-114	-47.9	-62.9	-10.8	10.7
200	-11.1	30.1	33.5	134	-48.3	-128	-14.9	-42.6

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

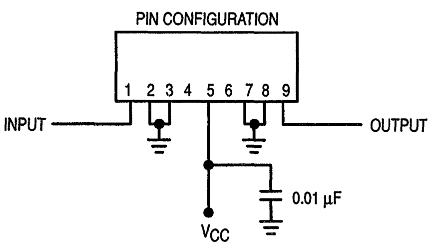
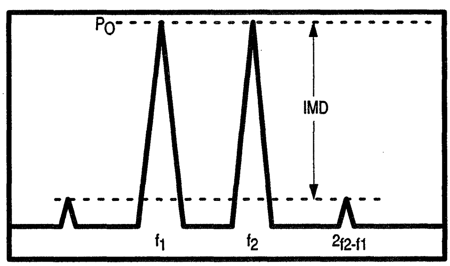


Figure 9. External Connections



$ITO = P_O + \frac{IMD}{2}$ @ IMD > 60dB

PEP = 4X P_O @ IMD = –32dB

Figure 10. Intermodulation Test

3

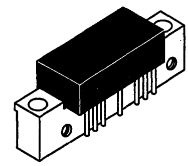
CA2832C

The RF Line
Wideband Linear Amplifier

... designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 28 V, T_C = 25°C:
  Frequency Range — 1 to 200 MHz
  Output Power — 1580 mW Typ @ 1 dB Compression, f = 200 MHz
  Power Gain — 35.5 dB Typ @ f = 100 MHz
  PEP — 900 mW Typ @ −32 dB IMD
  Noise Figure — 5 dB Typ @ f = 200 MHz
  ITO — 47 dBm @ f = 200 MHz
- All Gold Metallization for Improved Reliability
- Unconditional Stability Under All Load Conditions

**35.5 dB
1–200 MHz
1.6 WATT
WIDEBAND
LINEAR AMPLIFIER**



**CASE 714F, STYLE 1
[CA (POS. SUPPLY)]**

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	30	Vdc
RF Power Input	P_{in}	+5	dBm
Operating Case Temperature Range	T_C	−20 to +90	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	1	—	200	MHz
Gain Flatness (f = 1–200 MHz)	—	—	±0.5	±1	dB
Power Gain (f = 100 MHz)	P_G	34	35.5	37	dB
Noise Figure, Broadband (f = 200 MHz)	NF	—	5	6	dB
Power Output — 1 dB Compression (f = 1–200 MHz)	$P_{o\ 1dB}$	1260	1580	—	mW
Power Output — 1 dB Compression (f = 150 MHz)	$P_{o\ 1dB}$	—	2000	—	mW
Third Order Intercept (See Figure 10, f_1 = 200 MHz)	ITO	45	47	—	dBm
Input/Output VSWR (f = 1–200 MHz)	VSWR	—	1.5:1	2:1	—
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 150 MHz)	d_{so}	—	−70	−60	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) (f = 1–200 MHz @ −32 dB IMD)	PEP	—	900	—	mW
Supply Current	I_{CC}	400	435	470	mA

TYPICAL CHARACTERISTICS

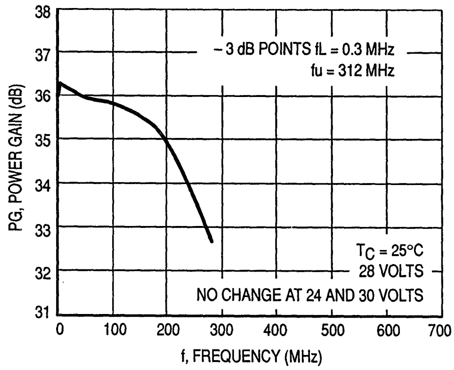


Figure 1. Power Gain versus Voltage

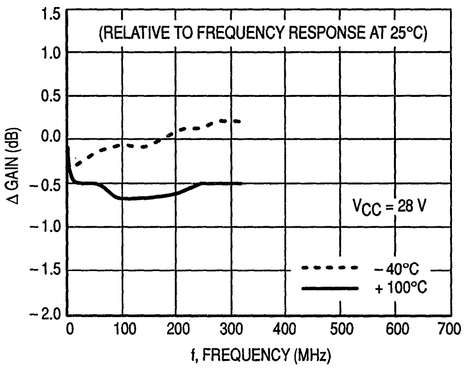


Figure 2. Relative Power Gain versus Temperature

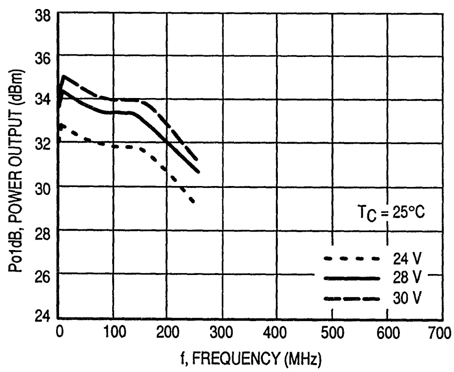


Figure 3. 1 dB Compression versus Voltage

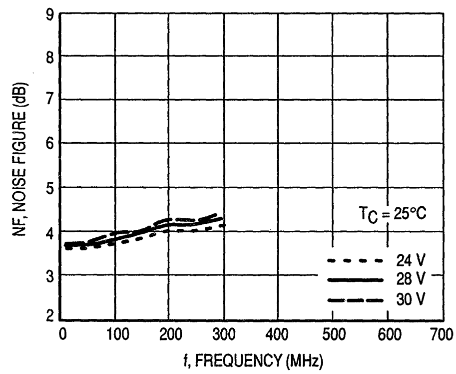


Figure 4. Noise Figure versus Voltage

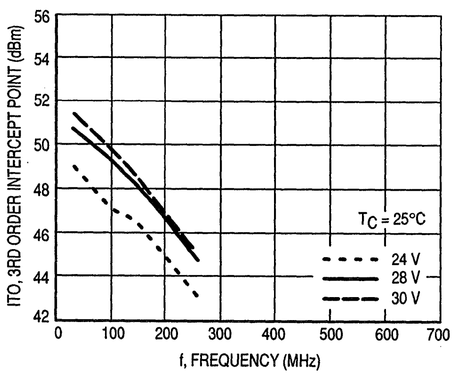


Figure 5. Third Order Intercept versus Voltage

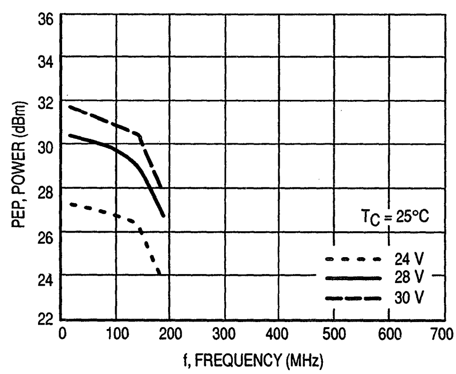


Figure 6. Peak Envelope Power versus Voltage

3

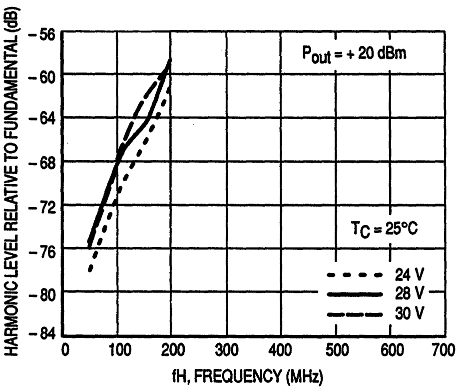


Figure 7. Second Harmonic Distortion versus Voltage

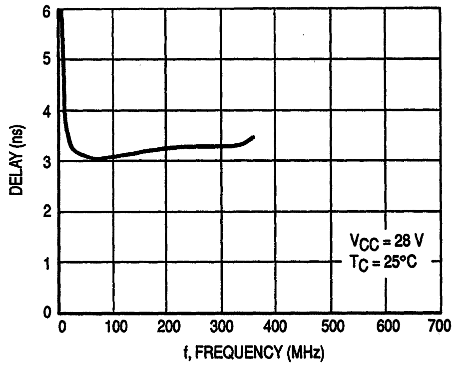


Figure 8. Group Delay versus Frequency

Biased at 28 Volts **T_C = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1	−16.7	64	36.0	23.3	−42	−5.2	−12.9	73
10	−21.5	21	36.2	−8.4	−47	−1.4	−21.9	28
50	−18.5	6.8	35.9	−56	−44	2.8	−17.9	−10
100	−16.9	−1.8	35.7	−103	−46	−68	−15.7	−48
200	−12.9	−18	34.7	145	−49	−98	−14.9	115

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

3

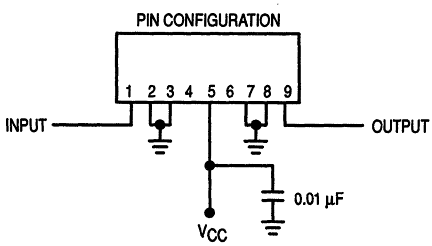
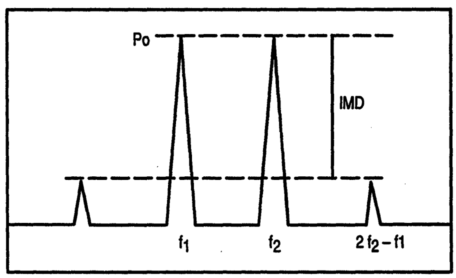


Figure 9. External Connections



ITO = Po + IMD / 2 @ IMD > 60 dB
PEP = 4 x Po @ IMD = − 32 dB

Figure 10. Intermodulation Test

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

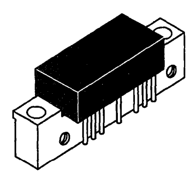
CA2842C

The RF Line
Wideband Linear Amplifier

... designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 10–400 MHz
  Output Power — 1580 mW Typ @ 1 dB Compression, f = 200 MHz, V_{CC} = 28 V
  Power Gain — 22 dB Typ @ f = 100 MHz
  PEP — 650 mW Min @ −32 dB IMD
  Noise Figure — 4 dB Typ @ f = 100 MHz
  ITO — 46 dBm @ f = 300 MHz
- All Gold Metallization for Improved Reliability
- Unconditional Stability Under All Load Conditions

22 dB
10–400 MHz
1.2 WATTS
WIDEBAND
LINEAR AMPLIFIER



CASE 714F, STYLE 1
[CA (POS. SUPPLY)]

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	28	Vdc
RF Power Input	P_{in}	+14	dBm
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	10	—	400	MHz
Gain Flatness (f = 10–400 MHz)	—	—	±0.5	±1	dB
Power Gain (f = 100 MHz)	P_G	21	22	23	dB
Noise Figure, Broadband (f = 100 MHz)	NF	—	4	5	dB
Power Output — 1 dB Compression (f = 10–200 MHz, V_{CC} = 28 V)	$P_{o1\ dB}$	1260	1580	—	mW
Power Output — 1 dB Compression (f = 200–400 MHz, V_{CC} = 28 V)	$P_{o1\ dB}$	630	—	—	mW
Third Order Intercept (See Figure 10, f_1 = 10–400 MHz, See Fig. 10)	ITO	42	44	—	dBm
Input/Output VSWR (f = 10–400 MHz)	VSWR	—	1.3:1	1.5:1	—
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 300 MHz)	d_{so}	—	—	−50	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) (f = 200 MHz @ −32 dB IMD)	PEP	650	1000	—	mW
Supply Current	I_{CC}	200	230	250	mA

TYPICAL CHARACTERISTICS

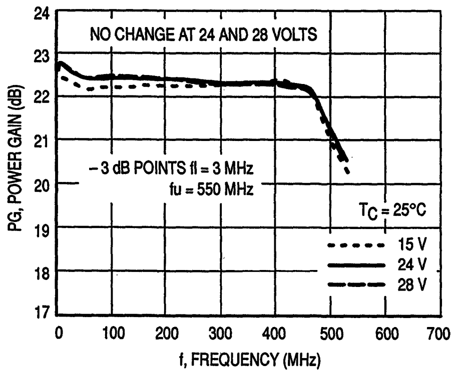


Figure 1. Power Gain versus Voltage

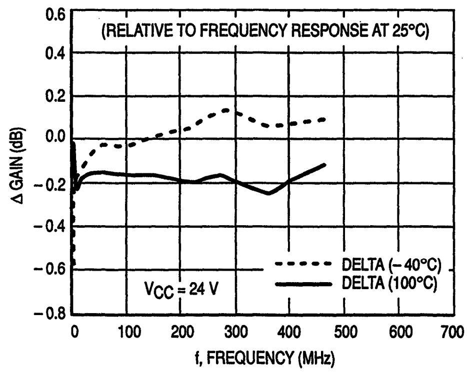


Figure 2. Relative Power Gain versus Temperature

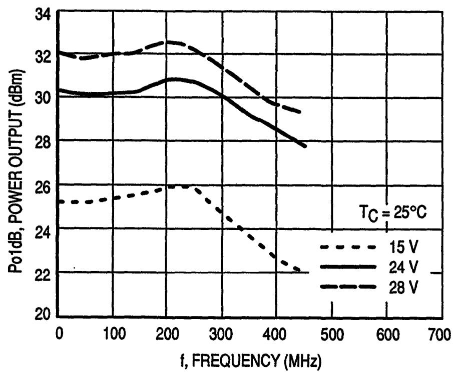


Figure 3. 1 dB Compression versus Voltage

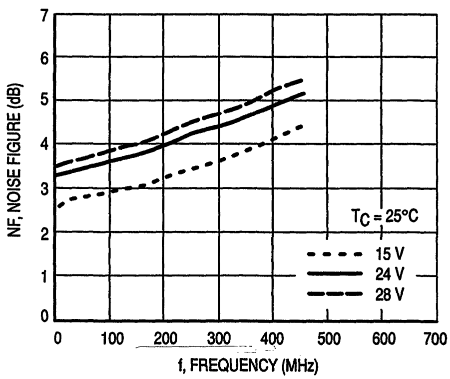


Figure 4. Noise Figure versus Voltage

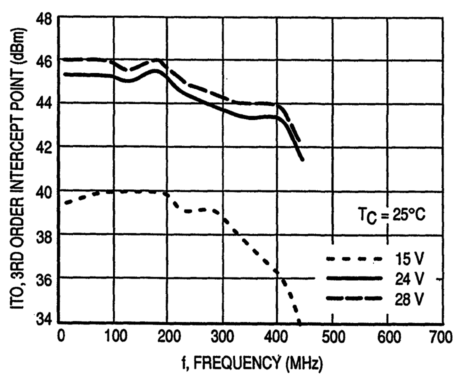


Figure 5. Third Order Intercept versus Voltage

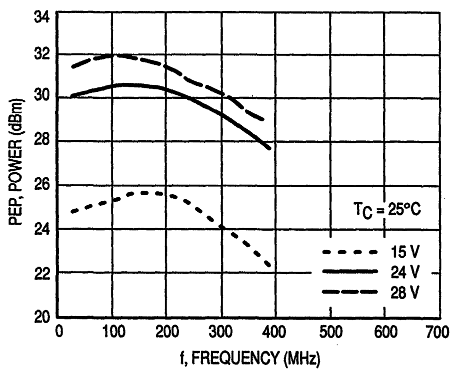


Figure 6. Peak Envelope Power versus Voltage

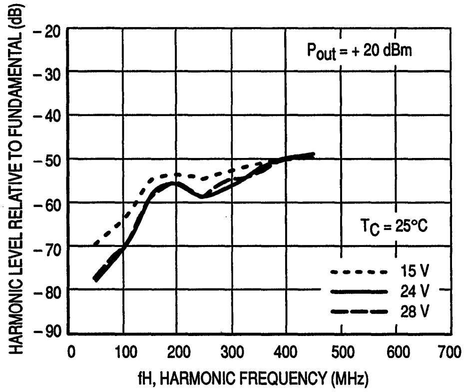


Figure 7. Second Harmonic Distortion versus Voltage

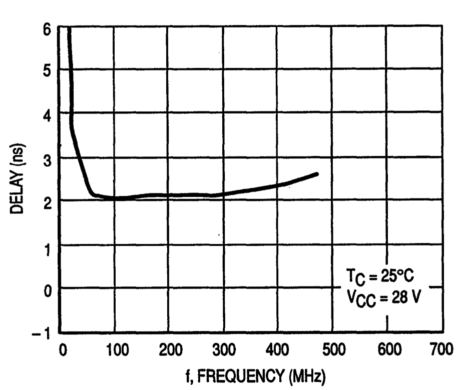


Figure 8. Group Delay versus Frequency

Biased at 24 Volts **T_C = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
10	−15.8	62	22.8	−168	−27	15	−20.2	29
50	−26.5	20	22.5	146	−27	−25	−24	15
100	−25.5	25	22.5	111	−27.5	−56	−22.5	−16
200	−20.5	−7	22.5	26	−27.9	−117	−18.1	−73
300	−17.2	−48	22.5	−51	−28.5	−170	−16.5	−125
400	−18.8	−129	22.4	−126	−28.3	114	−22.5	156

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

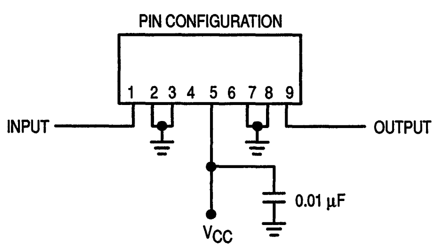
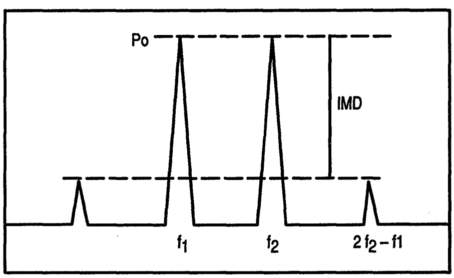


Figure 9. External Connections



ITO = Po + IMD / 2 @ IMD > 60 dB
PEP = 4 x Po @ IMD = − 32 dB

Figure 10. Intermodulation Test

3

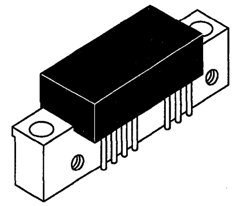
CA2850CR
CA2851CR

The RF Line
Wideband Linear Amplifiers

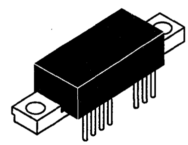
. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = −19 V, T_C = 25°C:
  Frequency Range — 40 to 100 MHz
  Output Power — 320 mW Typ @ 1 dB Compression, f = 100 MHz,
  Power Gain — 17.5 dB Typ @ f = 100 MHz
  PEP — 300 mW Typ @ −32 dB IMD
  Noise Figure — 4.5 dB Typ @ f = 70 MHz
- All Gold Metallization for Improved Reliability
- Lower Power Consumption — I_{CC} = 125 mA Typ @ V_{CC} = −19 V

**17.5 dB
40–100 MHz
320 mWATT
WIDEBAND
LINEAR AMPLIFIERS**



**CASE 714H, STYLE 1
(CA)
CA2850CR**



**CASE 714L, STYLE 1
(CA, LOW PROFILE)
CA2851CR**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	−28	Vdc
RF Power Input	P_{in}	+14	dBm
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 19 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	100	MHz
Gain Flatness (f = 40–100 MHz)	—	—	±0.1	±0.2	dB
Power Gain (f = 100 MHz)	P_G	17	17.5	18	dB
Noise Figure, Broadband (f = 70 MHz)	NF	—	4.5	5	dB
Power Output — 1 dB Compression (f = 40–100 MHz)	$P_{o\ 1dB}$	250	320	—	mW
Third Order Intercept (See Figure 9, f_1 = 70 MHz)	ITO	37	40	—	dBm
Input/Output VSWR (f = 40–100 MHz)	VSWR	—	1.2:1	1.3:1	—
Second Harmonic Distortion (Tone at 250 mW, f_{2H} = 100 MHz)	d_{so}	—	−40	—	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 9) (f = 40–100 MHz @ −32 dB IMD)	PEP	250	300	—	mW
Supply Current	I_{CC}	110	125	140	mA

TYPICAL CHARACTERISTICS

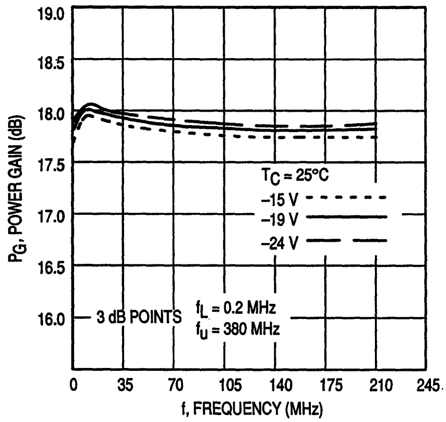


Figure 1. Power Gain versus Frequency

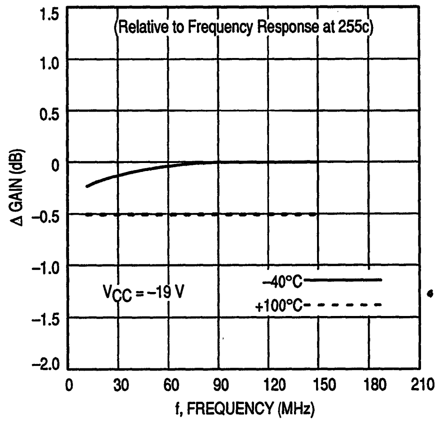


Figure 2. Relative Power Gain versus Temperature

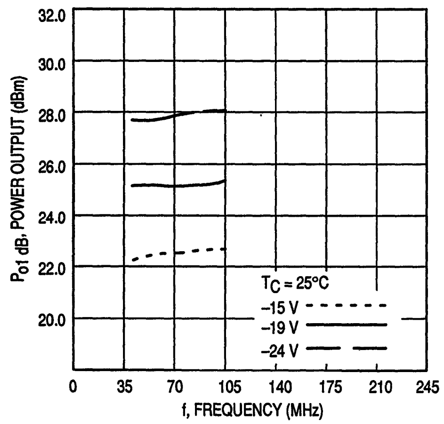


Figure 3. 1 dB Gain Compression versus Voltage

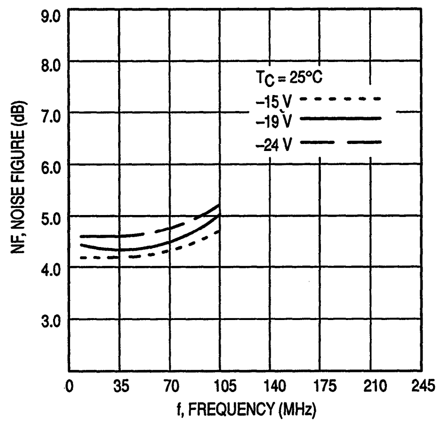


Figure 4. Noise Figure versus Voltage

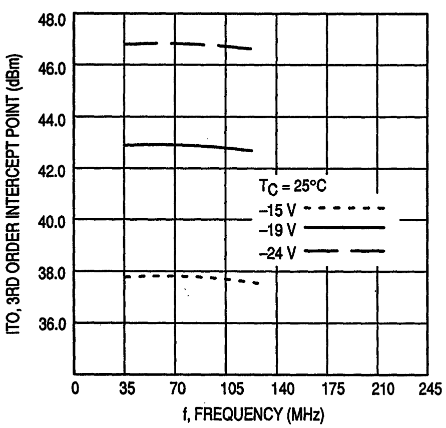


Figure 5. Third Order Intercept versus Voltage

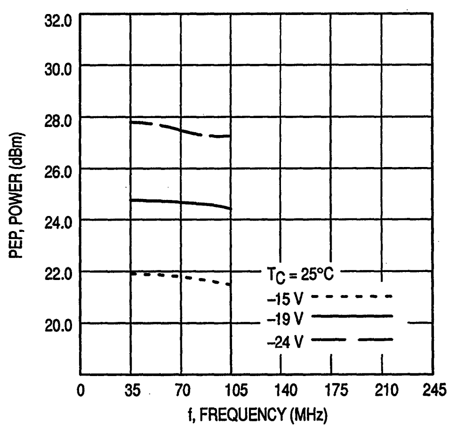


Figure 6. Peak Envelope Power versus Voltage

3

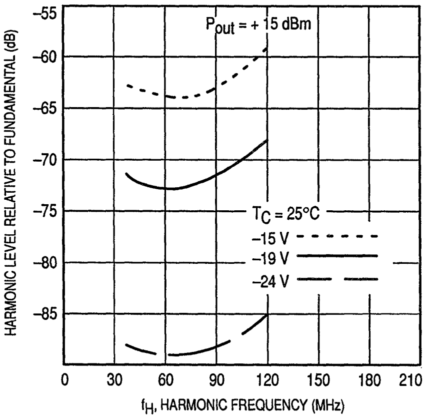


Figure 7. Second Harmonic Distortion versus Voltage

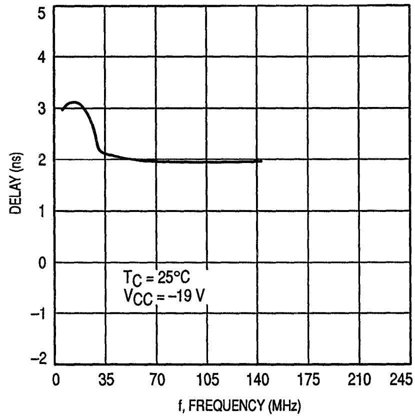


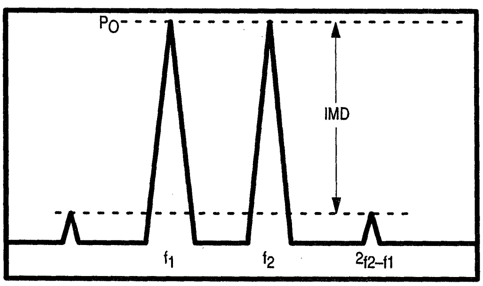
Figure 8. Group Delay versus Frequency

Biased at – 19 Volts **T = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
40	-33.7	-16.0	17.6	-28.2	-23.7	161	-23.6	4.2
50	-35.8	-8.8	17.6	-35.0	-23.8	158	-24.1	3.2
70	-38.9	+16.8	17.6	-49.1	-23.8	149	-25.5	-7.5
90	-38.0	53.2	17.6	-63.3	-23.8	141	-27.0	-24.8
100	-36.9	63.5	17.6	-70.2	-23.9	136	-27.4	-31.5

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters



$$ITO = P_O + \frac{IMD}{2} \text{ @ IMD > 60dB}$$

$$PEP = 4X\ P_O \text{ @ IMD = –32dB}$$

Figure 9. Intermodulation Test

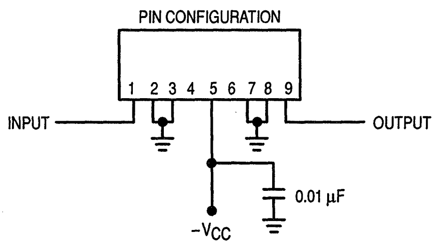


Figure 10. External Connections

3

CA2870C

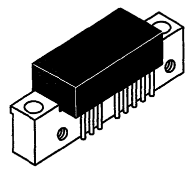
The RF Line
Wideband Linear Amplifier

34 dB
10–450 MHz
800 mWATT
WIDEBAND
LINEAR AMPLIFIER

. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

Two V+ inputs, one for the preamplifier and one for the final stage, provide a convenient means of RF leveling by variation of the final stage V+ voltage. Although the uncorrected flatness of this module is superb (±0.5 dB typical), the leveling provisions provide convenient means of correcting for the frequency response of succeeding stages and injection of AM modulation.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 10–450 MHz
  Output Power — 1 W Typ @ 1 dB Compression, f = 200 MHz
  Power Gain — 34 dB Typ @ f = 100 MHz
  PEP — 400 mW Typ @ –32 dB IMD
  Noise Figure — 5 dB Max @ f = 300 MHz
- All Gold Metallization for Improved Reliability
- Amplitude Leveling Provision



CASE 714M, STYLE 1
(CA)

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	28	Vdc
RF Power Input	P_{in}	+5	dBm
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	10	—	450	MHz
Gain Flatness (f = 10–450 MHz)	—	—	—	±1.5	dB
Power Gain (f = 100 MHz)	P_G	33	34	35	dB
Noise Figure, Broadban (f = 300 MHz)	NF	—	—	5	dB
Power Output — 1 dB Compression (f = 200 MHz)	$P_{o\ 1dB}$	800	1000	—	mW
Third Order Intercept (See Figure 10, f_1 = 300 MHz)	ITO	—	43	—	dBm
Input/Output VSWR (f = 10–450 MHz)	VSWR	—	—	2:1	—
Second Harmonic Distortion (P_O = 100 mW, f_{2H} = 300 MHz)	d_{so}	—	–55	–45	dB
Reverse Isolation (f = 10–450 MHz)	—	—	40	—	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) (f = 10–450 MHz @ –32 dB IMD)	PEP	—	400	—	mW
Supply Current	I_{CC}	270	310	330	mA

TYPICAL CHARACTERISTICS

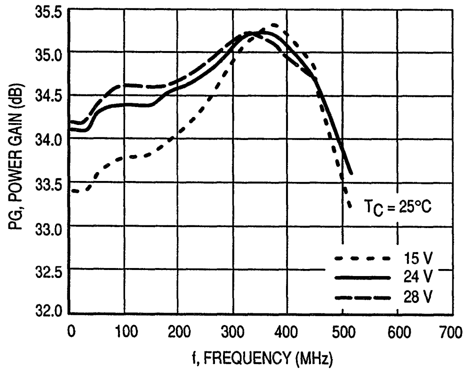


Figure 1. Power Gain versus Voltage

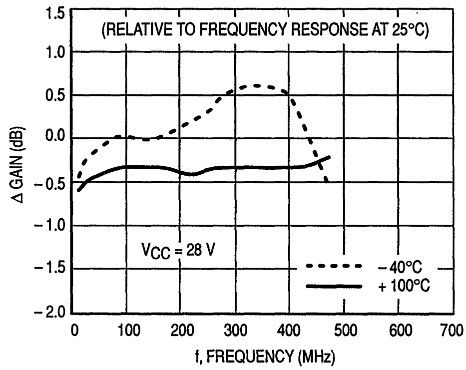


Figure 2. Relative Power Gain versus Temperature

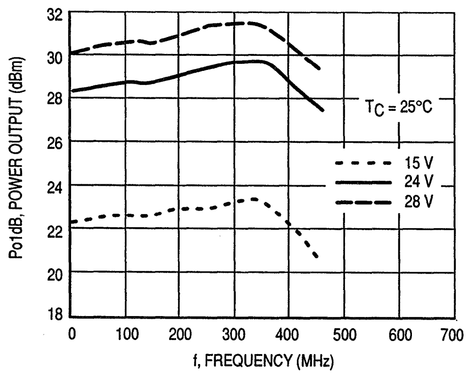


Figure 3. 1 dB Compression versus Voltage

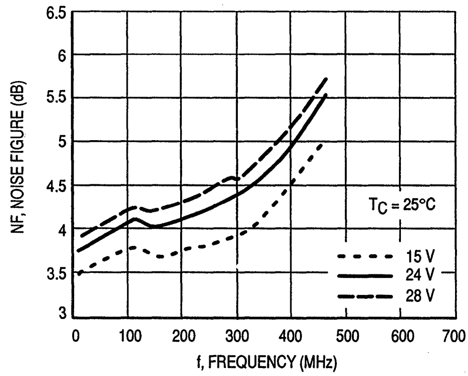


Figure 4. Noise Figure versus Voltage

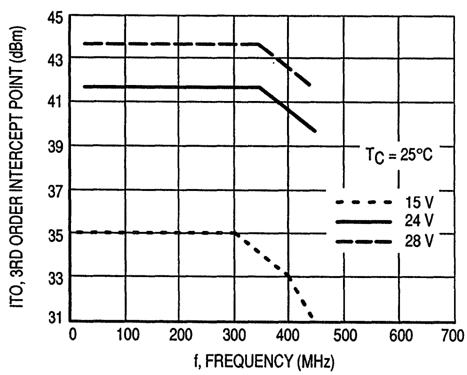


Figure 5. Third Order Intercept versus Voltage

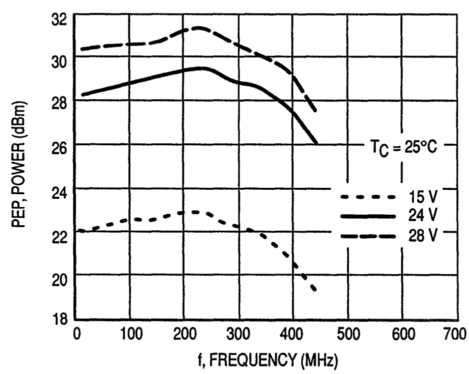


Figure 6. Peak Envelope Power versus Voltage

3

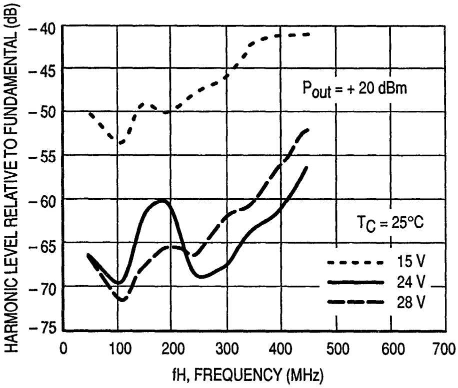


Figure 7. Second Harmonic Distortion versus Voltage

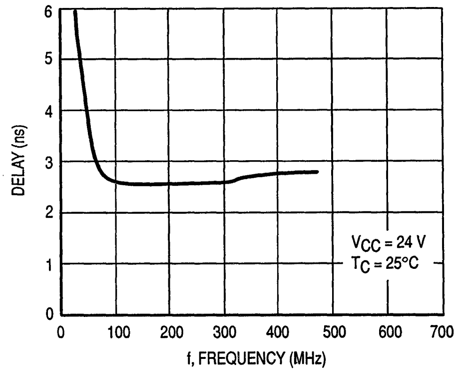


Figure 8. Group Delay versus Frequency

Biased at 24 Volts **T_C = 25°C Zo = 50Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
10	−13.8	3.5	34.2	−145	−46	−131	−13.5	8.2
50	−16.0	−3.0	34.2	150	−47	−172	−18.5	4.6
100	−14.4	−14	34.4	88	−48	102	−14.5	−9.2
200	−13.2	−50	34.6	2	−42	35	−13.2	−80
300	−13.9	−79	35.0	−80	−46	65	−16.7	−49
400	−14.1	−115	35.0	−80	−48	−44	−14.2	11
450	−16.2	−122	34.6	120	−53	−82	−13.8	−46

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

3

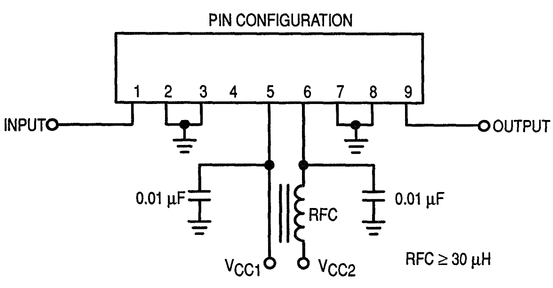
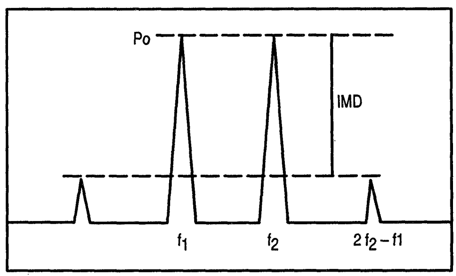


Figure 9. External Connections



ITO = Po + IMD / 2 @ IMD > 60 dB
PEP = 4 x Po @ IMD = − 32 dB

Figure 10. Intermodulation Test

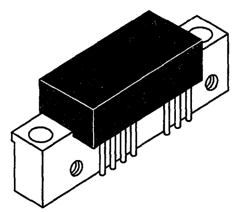
CA2875CR

The RF Line
Wideband Linear Amplifier

. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = –19 V, T_C = 25°C:
  Frequency Range — 40 to 100 MHz
  Output Power — 400 mW Typ @ 1 dB Compression, f = 100 MHz
  Power Gain — 17.5 dB Typ @ f = 100 MHz
  PEP — 300 mW Typ @ –32 dB IMD
  Noise Figure — 4.5 dB Typ @ f = 70 MHz
  ITO — 43 dBm @ f = 70 MHz
- All Gold Metallization for Improved Reliability
- Specified for 75 Ohm Systems

**17.5 dB
40–100 MHz
400 mWATT
WIDEBAND
LINEAR AMPLIFIER**



**CASE 714H, STYLE 1
(CA)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	–28	Vdc
RF Power Input	P_{in}	+14	dBm
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

3

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = –19 V, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	100	MHz
Gain Flatness (f = 40–100 MHz)	—	—	±0.1	±0.2	dB
Power Gain (f = 100 MHz)	P_G	17	17.5	18	dB
Noise Figure, Broadband (f = 70 MHz)	NF	—	4.5	5	dB
Power Output — 1 dB Compression (f = 40–100 MHz)	$P_{o\ 1dB}$	315	400	—	mW
Third Order Intercept (See Figure 10, f_1 = 70 MHz)	ITO	42	43	—	dBm
Input/Output VSWR (f = 40–100 MHz)	VSWR	—	—	1.1:1	—
Second Harmonic Distortion (Tone at 250 mW, f_{2H} = 100 MHz)	d_{so}	—	–40	—	dB
Peak Envelope Power (Two Tone Distortion Test — See Figure 10) (f = 40–100 MHz @ –32 dB IMD)	PEP	250	300	—	mW
Supply Current	I_{CC}	140	155	170	mA

TYPICAL CHARACTERISTICS

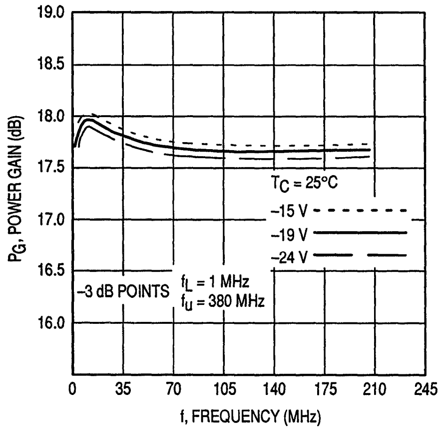


Figure 1. Power Gain versus Frequency

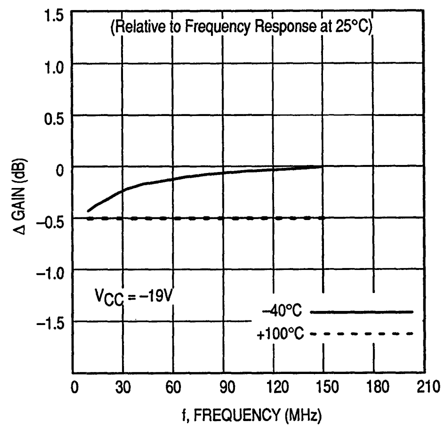


Figure 2. Relative Power Gain versus Temperature

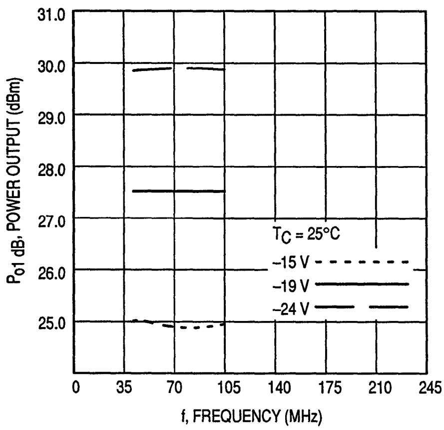


Figure 3. 1 dB Gain Compression versus Voltage

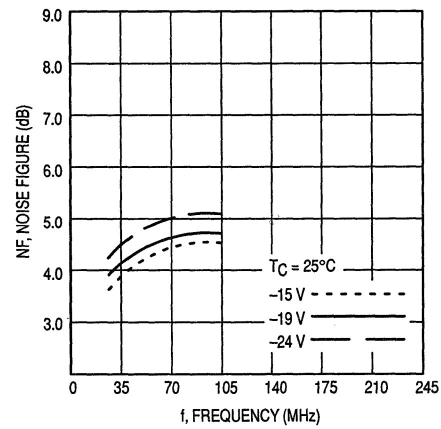


Figure 4. Noise Figure versus Voltage

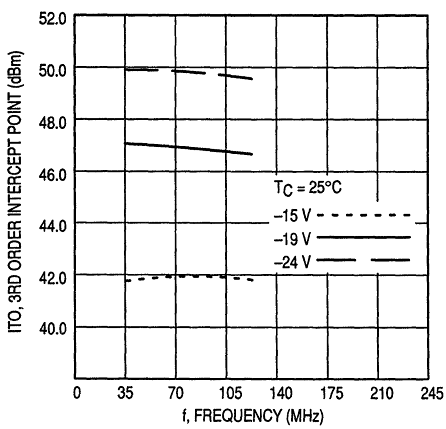


Figure 5. Third Order Intercept versus Voltage

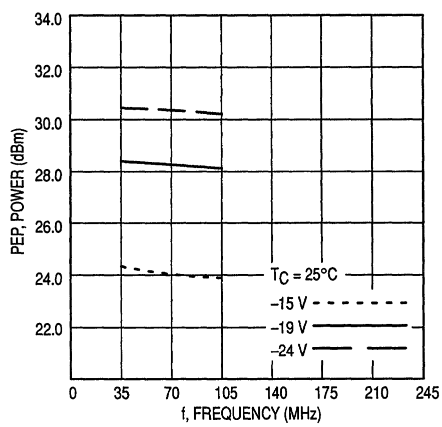


Figure 6. Peak Envelope Power versus Voltage

3

3

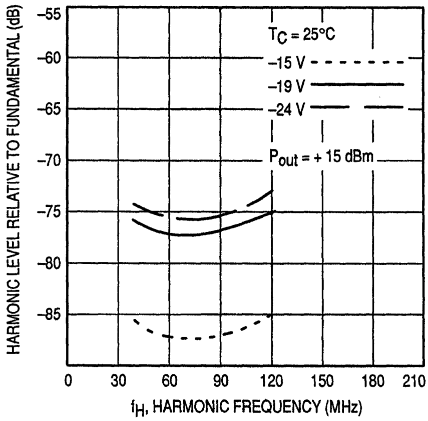


Figure 7. Second Harmonic Distortion versus Voltage

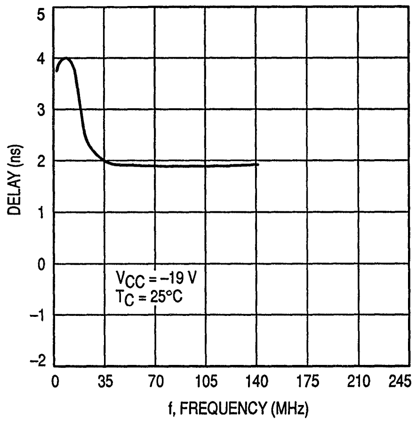


Figure 8. Group Delay versus Frequency

Biased at –19 Volts **T = 25°C Zo = 75Ω**

Frequency (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
40	-32.1	14.8	17.6	-27.4	-24.2	161	-40.5	-31.1
50	-32.7	2.0	17.6	-34.3	-24.3	156	-39.4	-38.1
70	-33.4	-16.0	17.6	-48.1	-24.3	147	-36.0	-57.2
90	-32.8	-27.0	17.5	-60.9	-24.4	138	-32.4	-76.7
100	-32.6	-34.0	17.5	-68.0	-24.5	133	-30.3	-87.7

Magnitude in dB, Phase Angle in degrees.

Table 1. S-Parameters

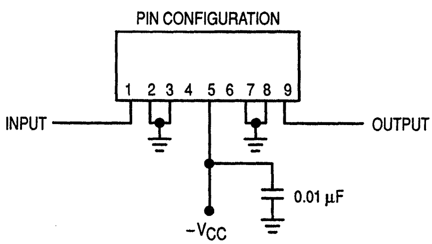
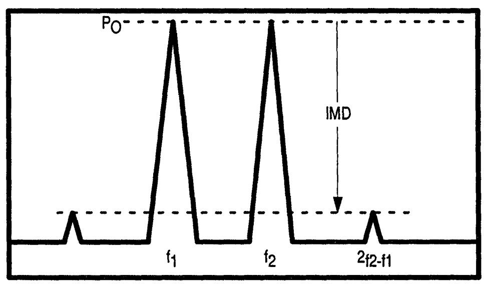


Figure 9. External Connections



$ITO = P_O + \frac{IMD}{2}$ @ IMD > 60dB

PEP = 4X P_O @ IMD = –32dB

Figure 10. Intermodulation Test

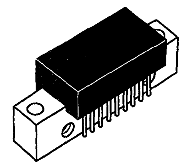
CA4800C,CS
CA4812C,CS
CA4815C,CS

The RF Line
Wideband Linear Amplifiers

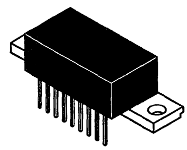
. . . designed for amplifier applications in 50 ohm systems requiring wide bandwidth, low noise and low-distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 10 to 1000 MHz
  Output Power — 400 mW Typ @ 1 dB Compression, f = 900 MHz
  Power Gain — 17.5 dB Typ @ 1000 MHz
  Noise Figure — 6.5 dB Typ @ f = 500 MHz
  ITO — 38 dBm Typ @ 1000 MHz
- All Gold Metallization for Improved Reliability
- CA4812C is Optimized for 12 V Operation
- CA4815C is Optimized for 15 V Operation

17 dB
10–1000 MHz
400 mW
WIDEBAND
LINEAR AMPLIFIERS



CASE 714P, STYLES 2, 3
CA4800C, CA4812C, CA4815C



CASE 714T, STYLES 1, 2
CA4800CS, CA4812CS, CA4815CS

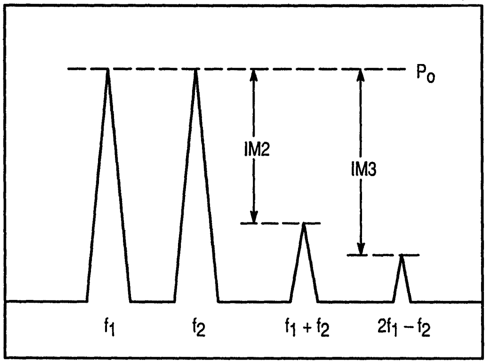
3

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating		Symbol	Value	Unit
Supply Voltage	CA4800C,CS CA4815C,CS CA4812C,CS	V_{CC}	28 18 14	V
RF Input Power		P_{in}	+14	dBm
Storage Temperature		T_{stg}	−40 to +100	°C
Operating Case Temperature Range		T_C	−20 to +100	°C

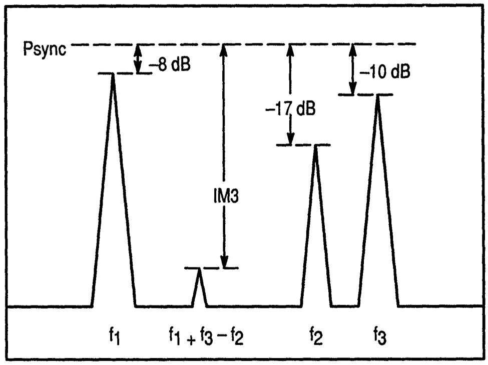
ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ohm System)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current CA4800C,CS CA4812C,CS; CA4815C,CS	I_{DC}	— —	220 380	240 400	mA
Power Gain (f = 1000 MHz)	PG	16.5	17.5	18.5	dB
Bandwidth (3 dB Down at 10 MHz)	BW	10	—	1000	MHz
Gain Flatness (f = 40–1000 MHz)	FL	—	1	2	dB
Power Output — 1 dB Compression (f = 900 MHz)	$P_{o\ 1dB}$	300	400	—	mW
Input/Output VSWR f = 40–900 MHz f = 900–1000 MHz	VSWR	— —	— —	2:1 2.6:1	—
Noise Figure, Broadband f = 500 MHz f = 1000 MHz	NF	— —	6.5 7.5	8 9	dB
Third Order Intercept (f_1 = 10–1000 MHz, See Figure 1)	ITO	37	38	—	dBm
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 1000 MHz)	dso	—	−50	−40	dB
Second Order Intermodulation Distortion (P_o = 2.75 dBm, f_1 = 373 MHz, f_2 = 450 MHz, See Figure 1)	IM2	—	—	−60	dB
Intermodulation Distortion, 3 Tone (f = 860 MHz, P_{sync} = 200 mW, See Figure 2)	IM3	—	−60	—	dB



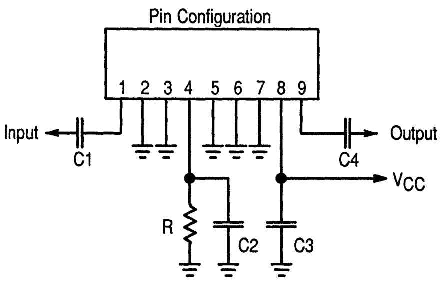
ITO = P_0 + IM3 / 2 @ IM3 > 60 dB

Figure 1. 2-Tone Intermodulation Test A



f_1 = Video
f_2 = Sideband
f_3 = Sound

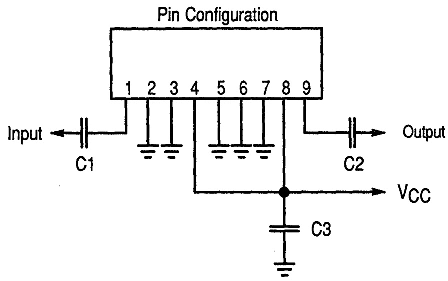
Figure 2. 3-Tone TV Intermodulation Test



C1,2,3,4 ≥ 0.01 µF (chip)
R = 200 Ohms, 1 Watt

CA4800C (Case 714P-02, Style 2)
CA4800CS (Case 714T-02, Style 1)

Figure 3. External Connections



C1,2,3 ≥ 0.01 µF (chip)

CA4812C, CA4815C (Case 714P-02, Style 3)
CA4812CS, CA4815CS (Case 714T-02, Style 2)

Figure 4. External Connections

3

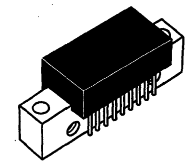
CA4900,S
CA4912,S
CA4915,S

The RF Line
Wideband Linear Amplifiers

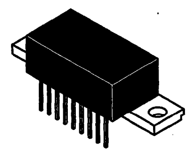
. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low-distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 10 to 1200 MHz
  Output Power — 400 mW Typ @ 1 dB Compression, f = 900 MHz
  Power Gain — 17.5 dB Typ @ f = 1000 MHz
  Noise Figure — 6.5 dB Typ @ f = 500 MHz
  ITO — 38 dBm Typ @ 1000 MHz
- All Gold Metallization for Improved Reliability
- CA4912 is Optimized for 12 V Operation
- CA4915 is Optimized for 15 V Operation

**17 dB
10–1200 MHz
400 mW
WIDEBAND
LINEAR AMPLIFIERS**



**CASE 714P, STYLES 2, 3
CA4900, CA4912, CA4915**



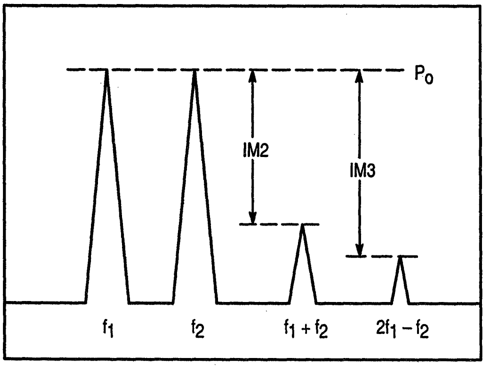
**CASE 714T, STYLES 1, 2
CA4900S, CA4912S, CA4915S**

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating		Symbol	Value	Unit
Supply Voltage	CA4900,S CA4915,S CA4912,S	V_{CC}	28 18 14	V
RF Input Power		P_{in}	+13	dBm
Storage Temperature		T_{stg}	−40 to +100	°C
Operating Case Temperature Range		T_C	−20 to +100	°C

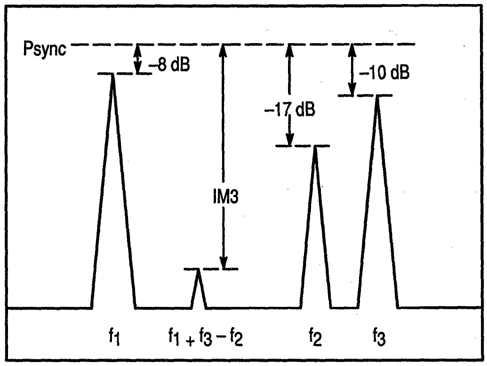
ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 24 V, 50 Ohm System)

Characteristic		Symbol	Min	Typ	Max	Unit
Supply Current	CA4900,S CA4912,S, CA4915,S	I_{DC}	200 360	220 380	240 400	mA
Power Gain (f = 1000 MHz)		PG	16.5	17.5	18.5	dB
Bandwidth (3 dB down at 10 MHz)		BW	10	—	1200	MHz
Gain Flatness (f = 40–1200 MHz)		FL	—	1	2	dB
Power Output — 1 dB Compression (f = 900 MHz)		$P_{o\ 1dB}$	300	400	—	mW
Input/Output VSWR f = 40–900 MHz f = 900–1200 MHz		VSWR	— —	— 2.6:1	2:1 —	—
Noise Figure, Broadband f = 500 MHz f = 1200 MHz		NF	— —	6.5 7.5	8 9	dB
Third Order Intercept (f_1 = 10–1000 MHz, See Figure 1)		ITO	37	38	—	dBm
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 1200 MHz)		dso	—	−50	−40	dB
Second Order Intermodulation Distortion (P_o = 2.75 dBm, f_1 = 373 MHz, f_2 = 450 MHz, See Figure 1)		IM2	—	−64	−60	dB
Intermodulation Distortion, 3 Tone (f = 860 MHz, P_{sync} = 200 mW, See Figure 2)		IM3	—	−60	—	dB



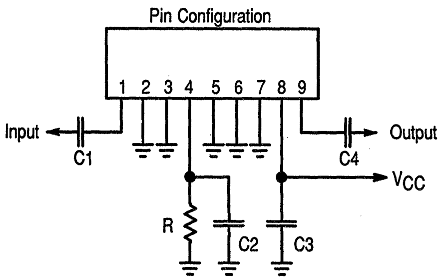
$ITO = P_O + IM3 / 2$ @ $IM3 > 60$ dB

Figure 1. 2-Tone Intermodulation Test A



f_1 = Video
f_2 = Sideband
f_3 = Sound

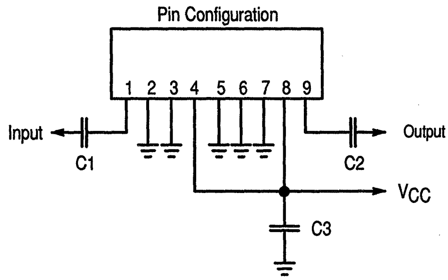
Figure 2. 3-Tone TV Intermodulation Test



C1,2,3,4 ≥ 0.01 µF (chip)
R = 200 Ohms, 1 Watt

CA4900 (Case 714P-02, Style 2)
CA4900S (Case 714T-02, Style 1)

Figure 3. External Connections



C1,2,3, ≥ 0.01 µF (chip)

CA4912, CA4915 (Case 714P-02, Style 3)
CA4912S, CA4915S (Case 714T-02, Style 2)

Figure 4. External Connections

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

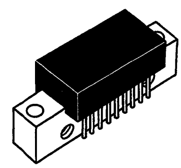
CA5800C
CA5800CS

The RF Line
Wideband Linear Amplifiers

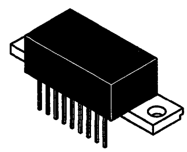
15 dB
10–1000 MHz
1 WATT
WIDEBAND
LINEAR AMPLIFIERS

. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 28 V, T_C = 25°C:
  Frequency Range — 10 to 1000 MHz
  Output Power — 1 W Typ @ 1 dB Compression, f = 900 MHz
  Power Gain — 15.5 Typ @ f = 1000 MHz
  Noise Figure — 7.5 dB Typ @ f = 500 MHz
  ITO — 40.5 dBm @ f = 1000 MHz
- All Gold Metallization for Improved Reliability
- Optimized for 28 V Operation



CASE 714P, STYLE 2
(CA)
CA5800C



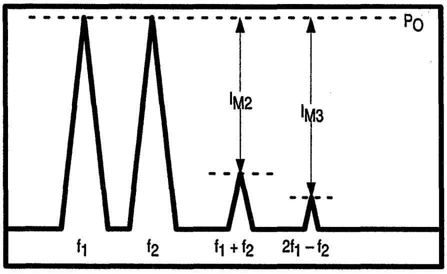
CASE 714T, STYLE 6
CA5800CS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	32	Vdc
RF Power Input	P_{in}	+18	dBm
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

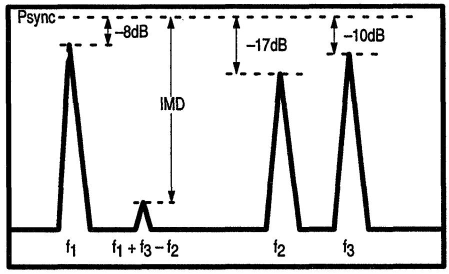
ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range (3 dB Down at 10 MHz)	BW	10	—	1000	MHz
Gain Flatness (f = 40–1000 MHz)	—	—	1	2	dB
Power Gain (f = 1000 MHz)	P_G	14.5	15.5	—	dB
Noise Figure, Broadband f = 500 MHz f = 1000 MHz	NF	— —	7.5 8.5	8.5 9.5	dB
Power Output — 1 dB Compression (f = 900 MHz)	$P_{o\ 1dB}$	800	1000	—	mW
Third Order Intercept (See Figure 1, f_1 = 10–1000 MHz)	ITO	—	40.5	—	dBm
Input/Output VSWR f = 40–900 MHz f = 900–1000 MHz	VSWR	— —	— —	2:1 2.6:1	—
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 1000 MHz)	d_{so}	—	–55	–45	dB
Supply Current	I_{CC}	360	400	440	mA
Intermodulation Distortion, 3 Tone (Vision Carrier = –8 dB, Sound Carrier = –10 dB, Sideband Signal = –17 dB. See Figure 2. f = 860 MHz, P_{sync} = 200 mW)	IMD	—	–58	—	dB
Second Order IMD (P_t = 2.75 dBm, f_1 = 373 MHz, f_2 = 450 MHz, See Figure 1)	IM2		–65	–60	dB



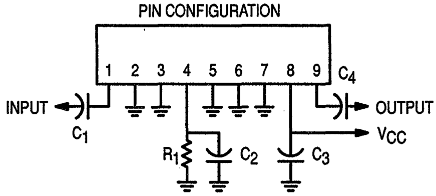
$ITO = P_O + \frac{IM3}{2}$ @ IM3 > 60 dB

Figure 1. 2-Tone Intermodulation, Test B



f1: video
f2: sideband
f3: sound

Figure 2. 3-Tone TV Intermodulation Test



$C_{1,\,2,\,3,\,4} \geq 0.01\ \mu F$ (Chip)
R1 = 90 OHMS, 3 WATTS

CA5800C (Case 714P-02, Style 2)
CA5800CS (Case 714T-02, Style 1)

Figure 3. External Connections

CA5801
CA5801S

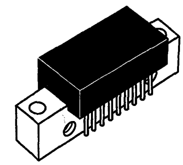
Motorola Preferred Devices

The RF Line
Wideband Linear Amplifiers

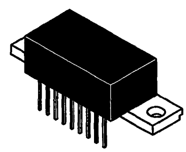
Designed for amplifier applications in 50 ohm systems requiring wide bandwidth, low noise and low-distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 28 V, T_C = 25°C
  Frequency Range — 50 to 1000 MHz
  Output Power — 1 W Typ @ 1 dB Compression, f = 900 MHz
  Power Gain — 17.5 dB Typ @ f = 1000 MHz
  Noise Figure — 7.5 dB Typ @ f = 500 MHz
  ITO — 41.5 dBm Typ @ 1000 MHz
- All Gold Metalization for Improved Reliability
- Optimized for 28 V Operation

**1 W, 17 dB
50–1000 MHz
WIDEBAND
LINEAR AMPLIFIERS**



CASE 714P, STYLE 2
CA5801



CASE 714T, STYLE 1
CA5801S

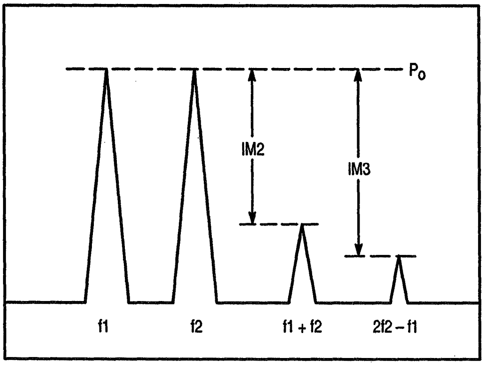
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	32	V
RF Input Power	P_{in}	+20	dBm
Storage Temperature	T_{stg}	– 40 to +100	°C
Operating Case Temperature Range	T_C	– 20 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, 50 Ohm System)

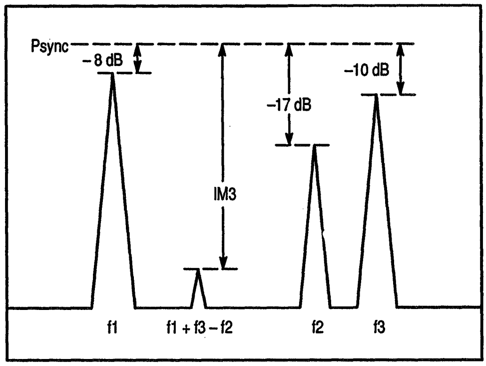
Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current	Idc	—	400	440	mA
Power Gain f = 1000 MHz	PG	16.5	17.5	—	dB
Bandwidth	BW	50	—	1000	MHz
Gain Flatness (f = 50–1000 MHz)	FL	—	1	2	dB
Power Output – 1 dB Compression (f = 900 MHz)	P_o 1 dB	800	1000	—	mW
Input/Output VSWR (f = 50–900 MHz) (f = 900–1000 MHz)	VSWR	— —	— —	2:1 2.6:1	—
Noise Figure, Broadband f = 500 MHz f = 1000 MHz	NF	— —	7.5 8.5	8.5 9.5	dB
Third Order Intercept (f1 = 10–1000 MHz, See Figure 1)	ITO	—	41.5	—	dBm
Second Harmonic Distortion (P_o = 100 mW, f2H = 1000 MHz)	dso	—	– 55	– 45	dB
Second Order Intermodulation Distortion (P_o = 2.75 dBm, f1 = 373 MHz, f2 = 450 MHz, See Figure 1)	IM2	—	– 65	– 60	dB
Intermodulation Distortion, 3 Tone (f = 860 MHz, Psync = 200 mW, See Figure 2)	IM3	—	– 60	—	dB

Preferred devices are Motorola recommended choices for future use and best overall value.



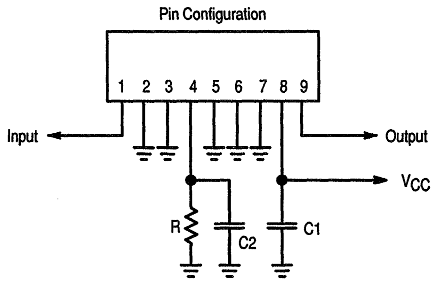
ITO = P_O + IM3/2 @ IM3 > 60 DB

Figure 1. 2-Tone Intermodulation Test



f1 = Video
f2 = Sideband
f3 = Sound

Figure 2. 3-Tone TV Intermodulation Test



C1, C2 ≥ 0.01 μF (chip)
R = 90 Ohms, 3 Watts

Figure 3. External Connections

3

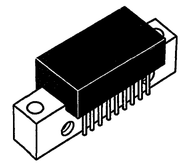
CA5815C
CA5815CS

The RF Line
Wideband Linear Amplifiers

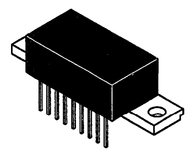
**15 dB
10–1000 MHz
1 WATT
WIDEBAND
LINEAR AMPLIFIERS**

. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 15 V, T_C = 25°C:
  Frequency Range — 10 to 1000 MHz
  Output Power — 1 W Typ @ 1 dB Compression, f = 900 MHz
  Power Gain — 15.5 Typ @ f = 1000 MHz
  PEP — 1 W Typ @ –32 dB IMD
  Noise Figure — 7.5 dB Typ @ f = 500 MHz
  ITO — 40.5 dBm @ f = 1000 MHz
- All Gold Metallization for Improved Reliability
- Optimized for 15 Volt Operation



**CASE 714P
(CA)
CA5815C**



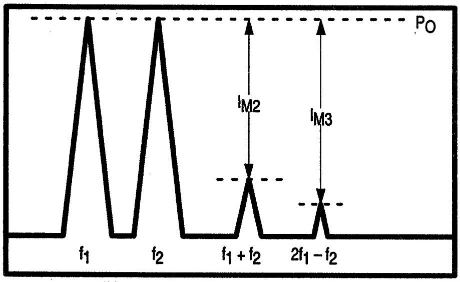
**CASE 714T
(SIP)
CA5815CS**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	18	Vdc
RF Power Input	P_{in}	+18	dBm
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

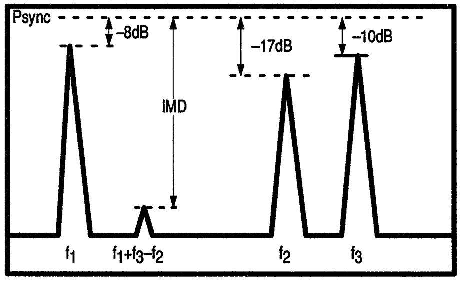
ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 15 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range (3 dB Down at 10 MHz)	BW	10	—	1000	MHz
Gain Flatness (f = 40–1000 MHz)	—	—	1	2	dB
Power Gain (f = 1000 MHz)	P_G	14.5	15.5	—	dB
Noise Figure, Broadband f = 500 MHz f = 1000 MHz	NF	— —	7.5 8.5	8.5 9.5	dB
Power Output — 1 dB Compression (f = 900 MHz)	$P_{o\ 1dB}$	800	1000	—	mW
Third Order Intercept (See Figure 1, f = 10–1000 MHz)	ITO	—	40.5	—	dBm
Input/Output VSWR f = 40–900 MHz f = 900–1000 MHz	VSWR	— —	— —	2:1 2.6:1	—
Second Harmonic Distrotion (P_o = 100 mW, f_{2H} = 1000 MHz)	d_{so}	—	–55	–45	dB
Supply Current	I_{CC}	—	700	760	mA
Intermodulation Distortion, 3 Tone (Vision Carrier = –8 dB, Sound Carrier = –10 dB, Sideband Signal = –17 dB. See Figure 2. f = 860 MHz, P_{sync} = 200 mW)	IMD	—	–58	—	dB
Second Order IMD (P_o = 2.75 dBm, f_1 = 373 MHz, f_2 = 450 MHz, See Figure 1.)	IM2	—	–65	–60	dB



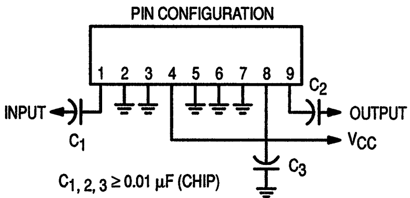
$ITO = P_O + \frac{IM_3}{2}$ @ $IM_3 < 60$ dB

Figure 1. 2-Tone Intermodulation, Test B



f1: video
f2: sideband
f3: sound

Figure 2. 3-Tone TV Intermodulation Test



CA5815C (Case 714P-02, Style 3)
CA5815CS (Case 714-02, Style 2)

Figure 3. External Connections

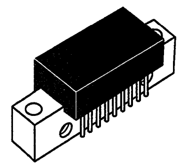
CA5900
CA5900S

The RF Line
Wideband Linear Amplifiers

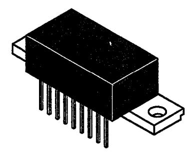
15 dB
10–1200 MHz
1 WATT
WIDEBAND
LINEAR AMPLIFIERS

. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 28 V, T_C = 25°C:
  - Frequency Range — 10 to 1200 MHz
  - Output Power — 1.0 W Typ @ 1 dB Compression, f = 900 MHz
  - Power Gain — 15.5 dB Typ @ f = 1000 MHz
  - PEP — 800 mW Typ @ –32 dB IMD
  - Noise Figure — 7.5 dB Typ @ f = 500 MHz
  - ITO — 40.5 dBm Typ @ f = 1000 MHz
- All Gold Metallization for Improved Reliability
- Optimized for 28 Volt Operation



CASE 714P
(CA)
CA5900



CASE 714T
CA5900S

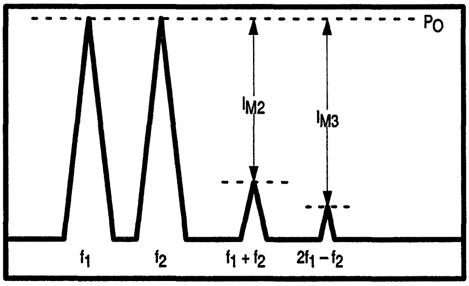
3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	32	Vdc
RF Power Input	P_{in}	+20	dBm
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

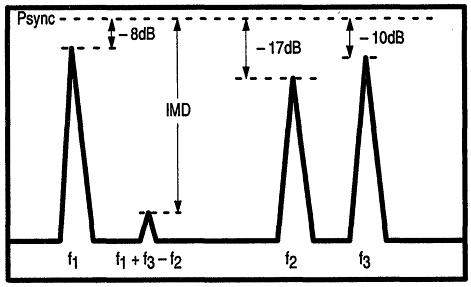
ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current	I_{CC}	—	400	440	mA
Frequency Range (3 dB Down at 10 MHz)	BW	10	—	1200	MHz
Gain Flatness (f = 40–1200 MHz)	—	—	1	2	dB
Power Gain (f = 1000 MHz)	P_G	14.5	15.5	—	dB
Noise Figure, Broadband f = 500 MHz f = 1200 MHz	NF	— —	7.5 8.5	8.5 9.5	dB
Power Output — 1.0 dB Compression (f = 900 MHz)	$P_{o\ 1dB}$	800	1000	—	mW
Third Order Intercept (See Figure 1, f_1 = 10–1200 MHz)	ITO	—	40.5	—	dBm
Input/Output VSWR f = 40–900 MHz f = 900–1200 MHz	VSWR	— —	— 2.6:1	2:1 —	—
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 1200 MHz)	d_{so}	—	–50	–45	dB
Intermodulation Distortion, 3 Tone (Vision Carrier = –8.0 dB, Sound Carrier = –10 dB, Sideband Signal = –17 dB. See Figure 2, f = 860 MHz, P_{sync} = 200 mW)	IMD	—	–58	—	dB
Second Order Intermodulation Distortion (P_o = 2.75 dBm, f_1 = 373 MHz, f_2 = 450 MHz, See Figure 1)	IM2	—	–65	–60	dB



$$ITO = P_O + \frac{IM3}{2} \ @ \ IM3 > 60dB$$

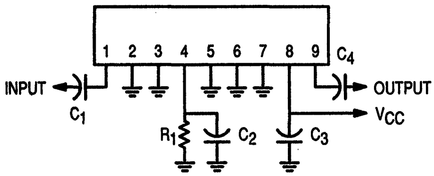
Figure 1. 2-Tone Intermodulation, Test A



f1: video
f2: sideband
f3: sound

Figure 2. 3-Tone TV Intermodulation Test

PIN CONFIGURATION



$C_{1, 2, 3, 4} \geq 0.01$ µF (CHIP)
R_1 = 90 OHMS, 3 WATTS

CA5900 (Case 714P-02, Style 2)
CA5900S (Case 714T-02, Style 1)

Figure 3. External Connections

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

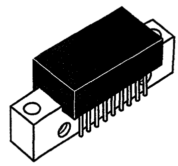
CA5915
CA5915S

The RF Line
Wideband Linear Amplifiers

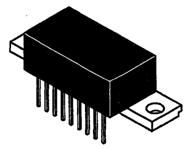
. . . designed for amplifier applications in 50 to 100 ohm systems requiring wide bandwidth, low noise and low distortion. This hybrid provides excellent gain stability with temperature and linear amplification as a result of the push-pull circuit design.

- Specified Characteristics at V_{CC} = 15 V, T_C = 25°C:
  Frequency Range — 10 to 1200 MHz
  Output Power — 1.0 W Typ @ 1 dB Compression, f = 900 MHz
  Power Gain — 15.5 dB Typ @ f = 1000 MHz
  Noise Figure — 7.5 dB Typ @ f = 500 MHz
  ITO — 40.5 dBm Typ @ f = 1000 MHz
- All Gold Metallization for Improved Reliability
- Optimized for 15 Volt Operation
- CA5915 is Optimized for 15 V Operation

15 dB
10–1200 MHz
1.0 WATT
WIDEBAND
LINEAR AMPLIFIERS



CASE 714P, STYLE 3
(CA)
CA5915



CASE 714T, STYLE 2
CA5915S

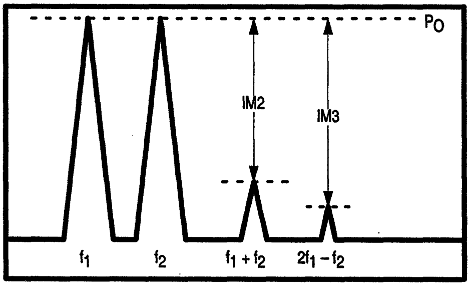
3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	18	Vdc
RF Power Input	P_{in}	+20	dBm
Operating Case Temperature Range	T_C	–40 to +100	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C

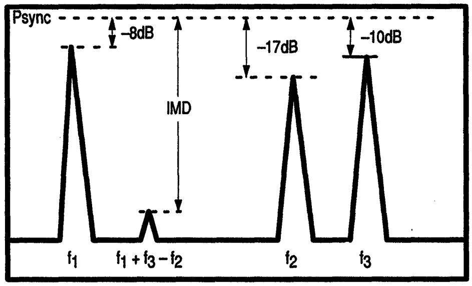
ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 15 V, 50 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current	I_{CC}	—	700	760	mA
Frequency Range (3 dB Down at 10 MHz)	BW	10	—	1200	MHz
Gain Flatness (f = 40–1200 MHz)	—	—	1	2	dB
Power Gain (f = 1000 MHz)	P_G	14.5	15.5	—	dB
Noise Figure, Broadband f = 500 MHz f = 1200 MHz	NF	— —	7.5 8.5	8.5 9.5	dB
Power Output — 1.0 dB Compression (f = 900 MHz)	$P_{o\ 1dB}$	800	1000	—	mW
Third Order Intercept (See Figure 1, f_1 = 10–1200 MHz)	ITO	—	40.5	—	dBm
Input/Output VSWR f = 40–900 MHz f = 900–1200 MHz	VSWR	— —	— 2.6:1	2:1 —	—
Second Harmonic Distortion (P_o = 100 mW, f_{2H} = 1200 MHz)	d_{so}	—	–50	–45	dB
Intermodulation Distortion, 3 Tone (Vision Carrier = –8.0 dB, Sound Carrier = –10 dB, Sideband Signal = –17 dB. See Figure 2, f = 860 MHz, P_{sync} = 200 mW)	IMD	—	–60	—	dB
Second Order Intermodulation Distortion (P_o = 2.75 dBm, f_1 = 373 MHz, f_2 = 450 MHz, See Figure 1)	IM2	—	–65	–60	dB



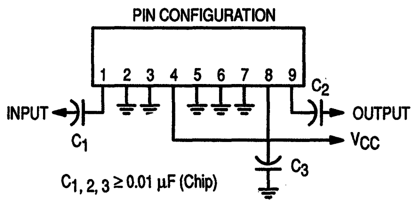
$ITO = P_O + \frac{IM3}{2}$ @ IM3 > 60dB

Figure 1. 2-Tone Intermodulation, Test A



f1: video
f2: sideband
f3: sound

Figure 2. 3-Tone TV Intermodulation Test



CA5915 (Case 714P-02, Style 3)
CA5915S (Case 714T-02, Style 2)

Figure 3. External Connections

CA97901

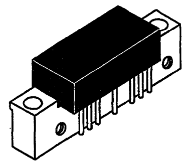
The RF Line
36-Channel (450 MHz) CATV Hi-Slope Input/Output Trunk Amplifier

. . . allows increased trunk length. Effectively reduces trunk distortion. 5.0 dB less output noise at low end.

Designed for broadband applications requiring low-distortion amplification. Specifically intended for CATV market requirements. These amplifiers feature ion-implanted arsenic emitter transistors and an all gold metallization system. The input amplifier is tuned for minimum noise figure while the output amplifier is tuned for minimum distortion.

- Specified Characteristics at V_{CC} = 24 V, T_C = 25°C:
  Frequency Range — 40 to 450 MHz
  Power Gain— 15.6 dB Typ @ f = 50 MHz
  — 20.7 dB Typ @ f = 450 MHz
  Noise Figure — 5.7 dB Typ @ f = 450 MHz
  CTB — –66 dB @ V_{out} = 46 dBmV
- All Gold Metallization System for Improved Reliability

15–20 dB
40–450 MHz
36-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER



CASE 714F, STYLE 1
[CA (POS. SUPPLY)]

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	69	dBmV
DC Supply Voltage	V_{CC}	28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–55 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 V, T_C = 25°C, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	450	MHz
Power Gain — 50 MHz — 450 MHz	G_P	14.8 20.2	15.6 20.7	16.4 21.2	dB
Gain Slope	S	4.7	5.1	5.5	dB
Gain Flatness (Note 1)	—	—	—	±0.2	dB
Return Loss — Input/Output (f = 40 MHz) (f = 50–80 MHz) (f = 80–160 MHz) (f = 160–450 MHz)	IRL/ORL	22 20 19 18	26 24 22 20	— — — —	dB
Composite Second Order Distortion (V_{out} = +46 dBmV per ch., Ch. H20, 36-CH Flat) (Note 2)	CSO	—	–68	–65	dB
Cross Modulation Distortion (V_{out} = +46 dBmV per ch., Ch. 2, 36-CH Flat) (Note 2)	XMD	—	–66	–65	dB
Composite Triple Beat (V_{out} = +46 dBmV per ch., Ch. H20, 36-CH Flat) (Note 2)	CTB	—	–66	–65	dB
Noise Figure (f = 50 MHz) (f = 450 MHz)	NF	— —	4.6 5.5	6.0 6.8	dB
DC Current	I_{DC}	—	220	240	mA

NOTE 1 and NOTE 2 — See Next Page.

NOTES:

1. Flatness calculated is based upon the following gain curve:

$$G_f = G_{50} + \Delta G [\propto (f-50) + \beta (f-50)^2 + \gamma (f-50)^3]$$

where: G_{50} = Gain at 50 MHz
G_f = Gain at frequency f MHz
ΔG = Gain slope between 50 MHz and 450 MHz
$\alpha = 3.132^* 10^{-3}$
$\beta = 1.993^* 10^{-6}$
$\gamma = -8.934^* 10^{-9}$

2. The following Channels are turned on for the CTB, XMOD and CSO measurement:

Channel #	Frequency (MHz)	Channel #	Frequency (MHz)	Channel #	Frequency (MHz)
1	55.25	13	235.25	25	325.25
2	61.25	14	247.25	26	337.25
3	133.25	15	253.25	27	349.25
4	139.25	16	259.25	28	361.25
5	145.25	17	265.25	29	367.25
6	151.25	18	271.25	30	373.25
7	163.25	19	283.25	31	385.25
8	175.25	20	289.25	32	391.25
9	187.25	21	295.25	33	409.25
10	205.25	22	301.25	34	415.25
11	217.25	23	313.25	35	421.25
12	229.25	24	319.25	36	433.25

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

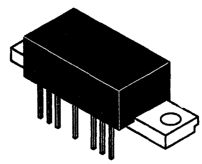
CR2424A
CR2424R
CR2425A

2.5 ns
130 MHz
VIDEO DRIVER
HYBRID
AMPLIFIERS

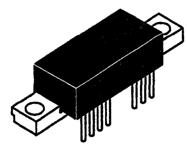
The RF Line
Video Driver Hybrid Amplifiers

. . . designed specifically for use as the video channel final stage in high resolution monitors.

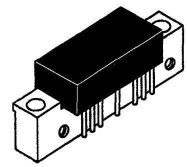
- Typical 10–90% Transition Times are 2.5 ns
- 130 MHz Minimum Bandwidth at 40 V_{p-p} Output
- Low Power Consumption
- Excellent Grey-Scale Linearity
- Unconditional Stability
- Gold Metallization System for the Ultimate in Reliability
- Reverse Polarity Version CR2424R (Negative Supply) for Grid Drive Application



CASE 714G, STYLE 1
(CA LP)
CR2424A



CASE 714L, STYLE 1
(CA LP, NEG SUPPLY)
CR2424R



CASE 714F, STYLE 1
(CA)
CR2425A

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	70	Vdc
Case Operating Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 60 V, T_C = 25°C, C_{Load} = 8.5 pF, 40 V Peak-to-Peak output swing with 30 Vdc offset; R_1 = 215 ohms, C_1 = 90 pF typ.)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current (With Input Open Circuited)	I_{CC}	39.5	43.5	47.5	mA
Input DC Voltage (With Input Open Circuited)	V_{inDC}	1.15	1.4	1.65	V
Output DC Voltage (With Input Open Circuited)	V_{outDC}	26	30	34	V
Voltage Gain (1) (2)	A_V	—	12.4	—	V/V
Transient Response (2) — Rise Time (10% to 90%)	t_r	—	2.5	2.9	ns
— Overshoot	$V_{os,r}$	—	8.0	15	%
— Fall Time (10% to 90%)	t_f	—	2.5	2.9	ns
— Overshoot	$V_{os,f}$	—	6.0	10	%
Operating Supply Current (V_{out} = 40 V Peak-to-Peak, 50 MHz Square Wave with 30 V offset) (3)	I_{CC}, max	—	—	100	mA
Linearity Error (V_{out} = +5.0 V to +55 V)	—	—	—	5.0	%

NOTES:
1. $A_V = V_{out}/V_S$
2. Input Signal is nominally a 62.5 KHz square wave of 3.25 V peak-to-peak with 1.4 Vdc offset. Input t_r, t_f < 1.0 ns.
3. Output is not short circuit protected.

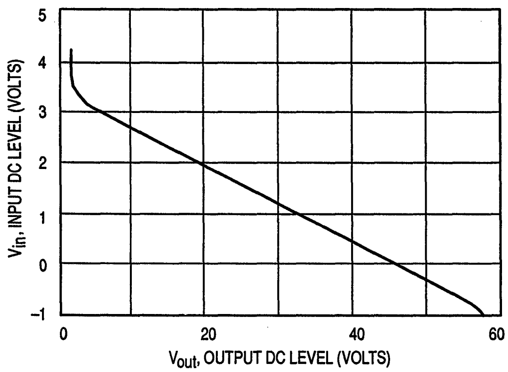


Figure 1. Voltage Ratio at RF Input Port

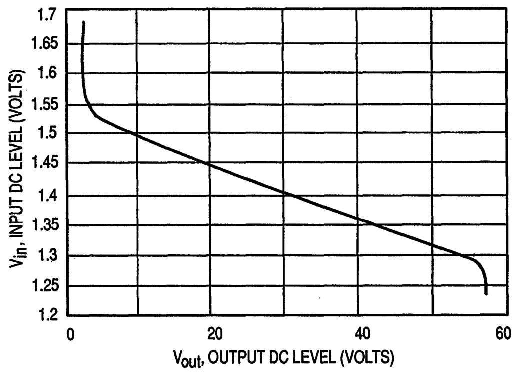


Figure 2. Voltage Ratio at Port 1

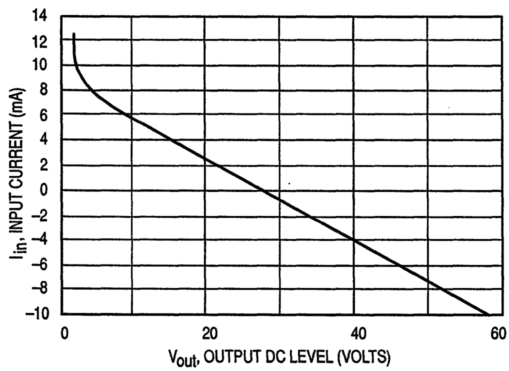


Figure 3. Output Voltage versus Input Current

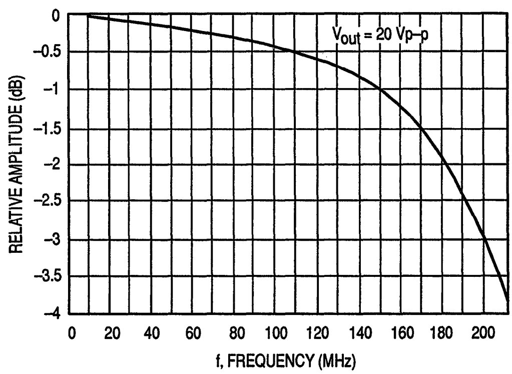


Figure 4. Frequency Response

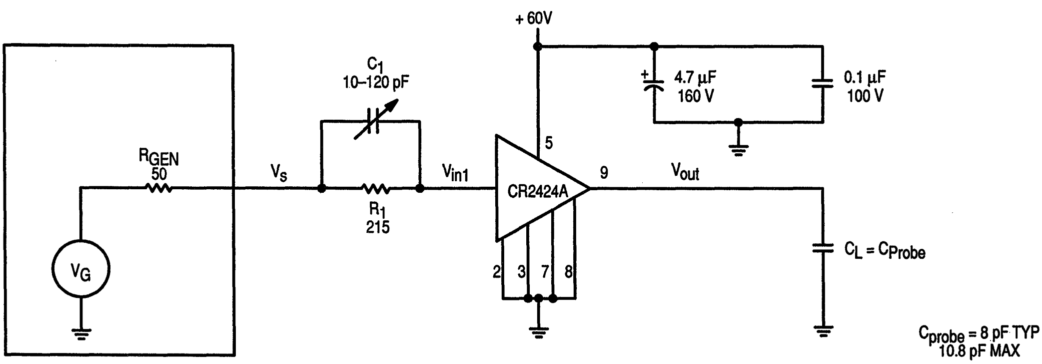


Figure 5. CRT Driver Test Circuit

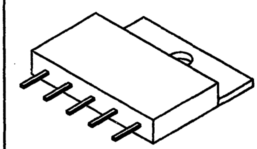
CR2428

The RF Line
Video Driver Hybrid Amplifier

The CR2428 is designed specifically for use as the video channel final stage in high resolution monitors.

- Typical 10–90% Transitions Times are 2.5 ns
- 130 MHz Minimum Bandwidth at 40 Vp-p Output
- Up to 50 Vp-p Output Swing with 60 V Supply Voltage
- Low Power Consumption
- Excellent Grey-Scale Linearity
- Unconditional Stability
- Gold Metallization System for the Ultimate in Reliability

**2.5 ns
130 MHz
VIDEO DRIVER
HYBRID
AMPLIFIER**



**CASE 431A, STYLE 1
(CR LP)**

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	70	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 60 V, C_{LOAD} = 8.5 pF, 40 V peak-to-peak output swing with 30 Vdc offset; R_1 = 215 Ω, C_1 = 90 pF typ)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current (With Input Open Circuited)	I_{CC}	39.5	43.5	47.5	mA
Input DC Voltage (With Input Open Circuited)	V_{inDC}	1.15	1.4	1.65	V
Output DC Voltage (With Input Open Circuited)	V_{outDC}	26	30	34	V
Voltage Gain (1) (2)	A_V	11.2	12.4	13.2	V/V
Transient Response (2) — Rise Time (10% to 90%) — Overshoot — Fall Time (90% to 10%) — Overshoot	 t_r $V_{os,r}$ t_f $V_{os,f}$	 — — — —	 2.5 8.0 2.5 6.0	 2.9 15 2.9 10	 ns % ns %
Operating Supply Current (V_{out} = 40 V Peak-to-Peak, 50 MHz Square Wave with 30 V offset) (3)	I_{CC}	—	100	—	mA
Linearity Error (V_{out} = +5.0 V to +55 V)	—	—	—	5.0	%

NOTES:
1. $A_V = V_{out}/V_S$
2. Input Signal is nominally a 62.5 kHz square wave of 3.25 V peak-to-peak with 1.4 Vdc offset. Input t_r, t_f < 1.0 ns.
3. Output is not short circuit protected.

TYPICAL CHARACTERISTICS

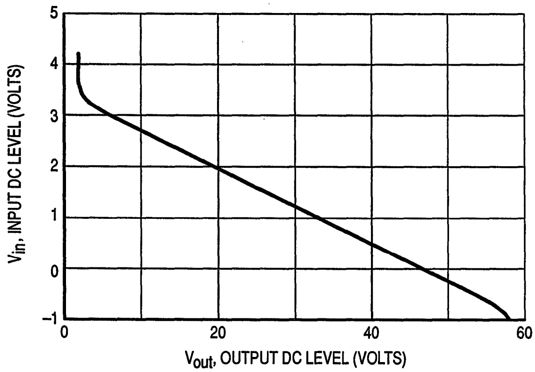


Figure 1. Voltage Ratio at RF Input Port

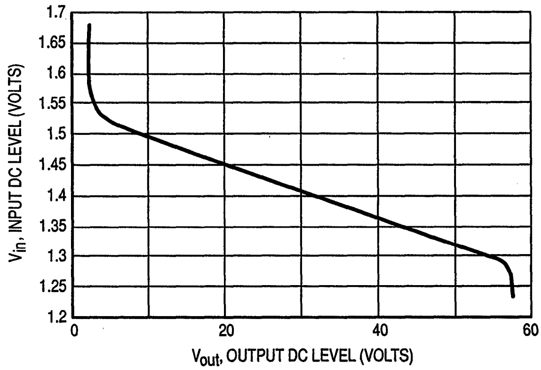


Figure 2. Voltage Ratio at Port 1

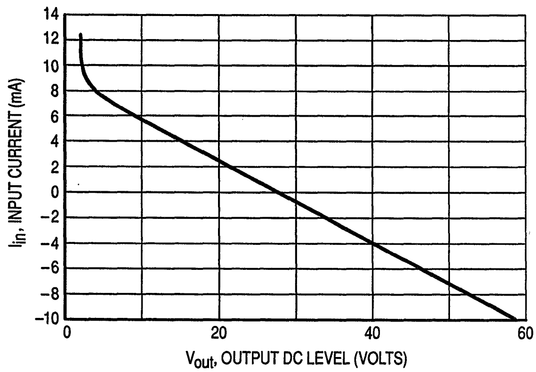


Figure 3. Output Voltage versus Input Current

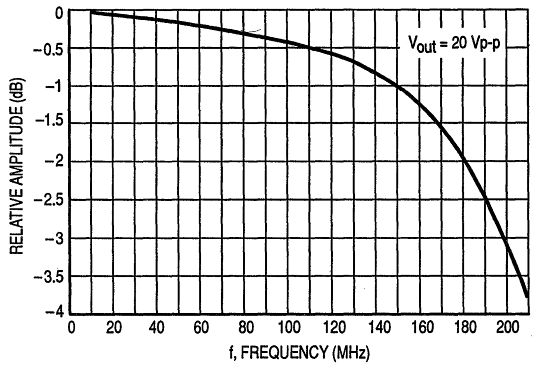


Figure 4. Frequency Response

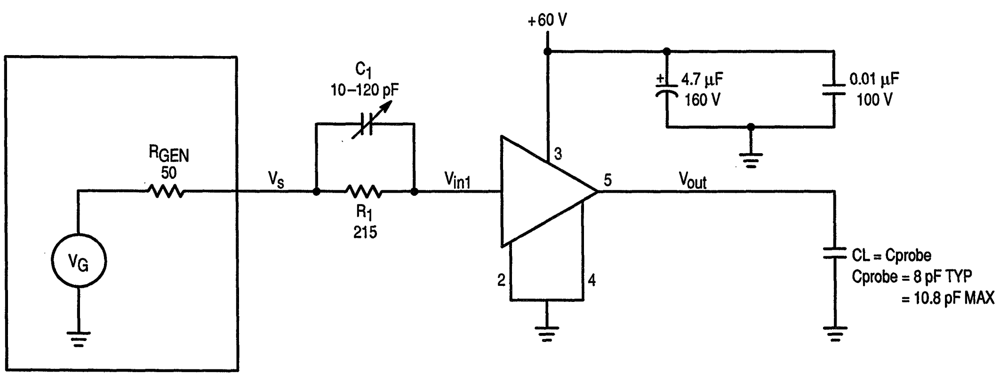


Figure 5. CRT Driver Test Circuit

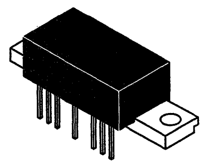
3

CR3424A
CR3424R
CR3425A

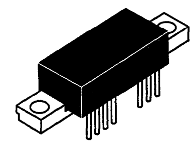
The RF Line
Video Driver Hybrid Amplifiers

- Designed Specifically for use as the Video Channel Final Stage in High Resolution Monitors
- Low Power Consumption
- Typical 10–90% Transitions Times are 2.7 ns
- 115 MHz Minimum Bandwidth at 40 V_{p-p} Output Swing
- Excellent Grey-Scale Linearity
- Unconditional Stability
- Gold Metallization System for the Ultimate in Reliability
- 80 Volt Supply Operation Provides Large DC Offset Range and Large Output Swing Capability for Color Applications
- Reverse Polarity Version CR3424R (Negative Supply) for Grid Drive Application

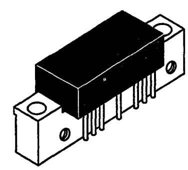
**2.7 ns
115 MHz
VIDEO DRIVER
HYBRID
AMPLIFIERS**



**CASE 714G, STYLE 1
(CA LP)
CR3424A**



**CASE 714L, STYLE 1
(CA LP, NEGATIVE SUPPLY)
CR3424R**



**CASE 714F, STYLE 1
(CA)
CR3425A**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	90	Vdc
Case Operating Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 80 Vdc, T_C = 25°C, C_{Load} = 10 pF, R_1 = 287 ohms, C_1 = 60 pF Typ., V_{out} = 40 V Peak-to-Peak with 40 Vdc offset). See Figure 4 for test circuit.

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current (With Input Open Circuited)	I_{CC}	41	45	49	mA
DC Input Voltage (With Input Open Circuited)	V_{inDC}	1.3	1.55	1.8	Vdc
DC Output Voltage (With Input Open Circuited)	V_{outDC}	36	40	44	Vdc
Voltage Gain (1) (2)	A_V	—	12.7	—	V/V
Transient Response (2) — Rise Time (10% to 90%)	t_r	—	2.7	3.1	ns
— Overshoot	$V_{os,r}$	—	—	10	%
— Fall Time (90% to 10%)	t_f	—	2.7	3.1	ns
— Overshoot	$V_{os,f}$	—	—	10	%
Bandwidth (−3.0 dB Point)		115	—	—	MHz
Operating Supply Current (V_{out} = 40 V Peak-to-Peak, 50 MHz Square Wave with 40 V offset) (3)	I_{CC}, max	—	—	100	mA
Linearity Error (V_{out} = +5.0 V to +55 V)	—	—	—	5.0	%

NOTES:
1. $A_V = V_{out}/V_s$
2. Signal source output signal (V_s in Figure 1) is nominally a 62.5 KHz square wave of 3.25 V peak-to-peak with 1.4 Vdc offset
3. Output is not short circuit protected

TYPICAL CHARACTERISTICS

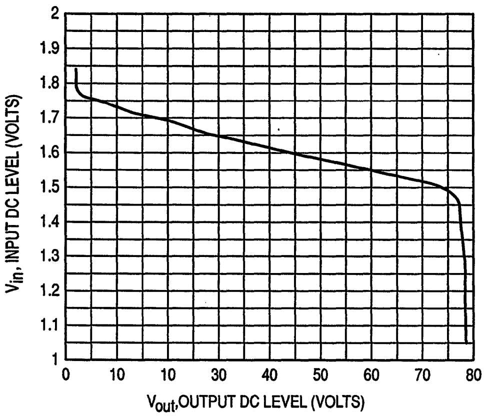


Figure 1. V_{in} versus V_{out}

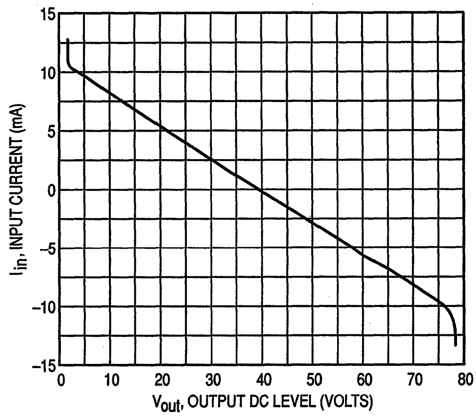


Figure 2. I_{in} versus V_{out}

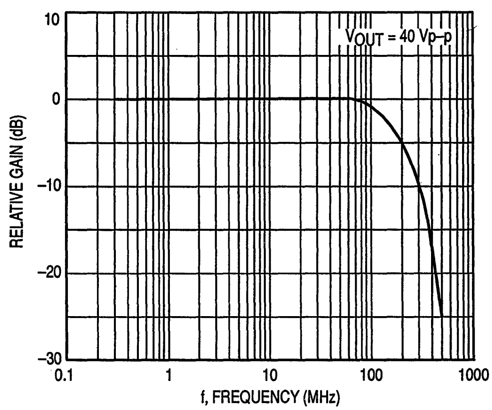


Figure 3. Frequency Response

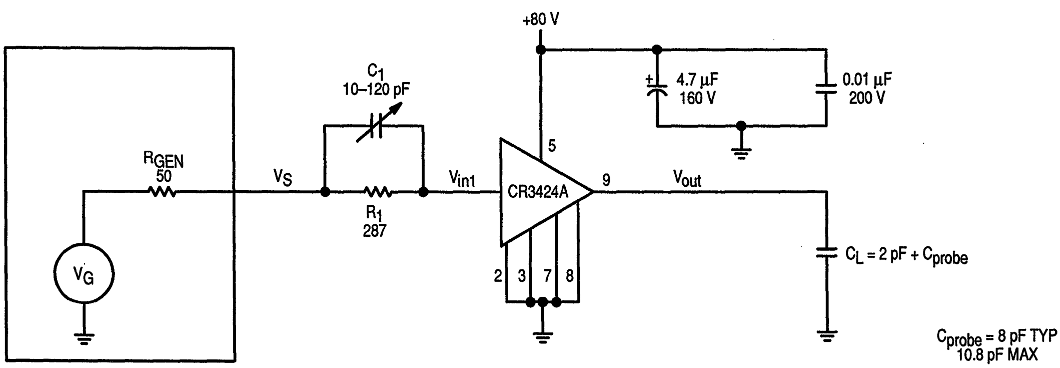


Figure 4. Hybrid Amplifier Test Circuit

3

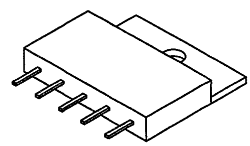
CR3428

The RF Line
Video Driver Hybrid Amplifier

The CR3428 is designed specifically for use as the video channel final stage in high resolution monitors.

- 80 V Supply Operation Provide Large DC Offset Range for Color Applications
- Typical 10–90% Transitions Times are 2.7 ns
- 115 MHz Minimum Bandwidth at 40 Vp-p Output
- Up to 70 Vp-p Output Swing with 80 V Supply Voltage
- Low Power Consumption
- Excellent Grey-Scale Linearity
- Unconditional Stability
- Gold Metallization System for the Ultimate in Reliability

**2.7 ns
115 MHz
VIDEO DRIVER
HYBRID
AMPLIFIER**



CASE 431A, STYLE 1
(CR LP)

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	90	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 80 V, C_{LOAD} = 10 pF, 40 V peak-to-peak output swing with 40 Vdc offset; R_1 = 287 Ω, C_1 = 60 pF typ)

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Current (With Input Open Circuited)	I_{CC}	41	45	49	mA
Input DC Voltage (With Input Open Circuited)	V_{inDC}	1.3	1.55	1.8	V
Output DC Voltage (With Input Open Circuited)	V_{outDC}	36	40	44	V
Voltage Gain (1) (2)	A_V	11.5	12.7	13.5	V/V
Transient Response (2) — Rise Time (10% to 90%) — Overshoot — Fall Time (90% to 10%) — Overshoot	 t_r $V_{os,r}$ t_f $V_{os,f}$	 — — — —	 2.7 — 2.7 —	 3.1 10 3.1 10	 ns % ns %
Operating Supply Current (V_{out} = 40 V Peak-to-Peak, 50 MHz Square Wave with 30 V offset) (3)	I_{CC}	—	100	—	mA
Linearity Error (V_{out} = +5.0 V to +55 V)	—	—	—	5.0	%

NOTES:
1. $A_V = V_{out}/V_s$
2. Input Signal is nominally a 62.5 kHz square wave of 3.25 V peak-to-peak with 1.4 Vdc offset. Input t_r, t_f < 1.0 ns.
3. Output is not short circuit protected.

TYPICAL CHARACTERISTICS

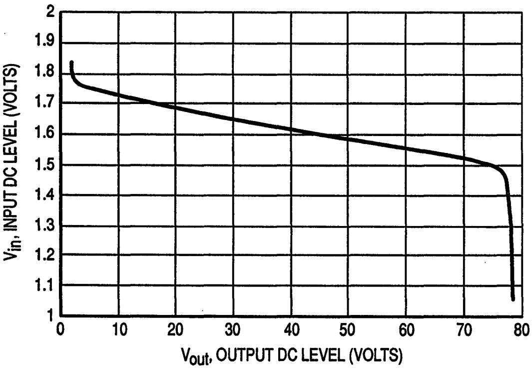


Figure 1. V_{in} versus V_{out}

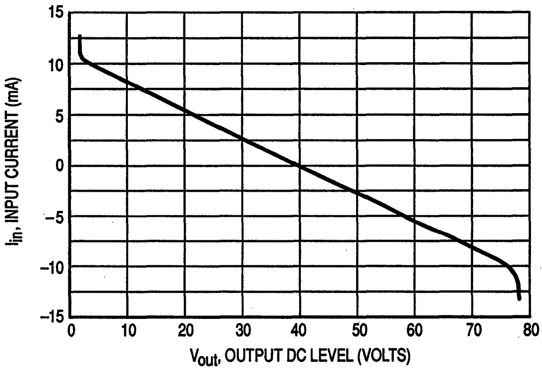


Figure 2. I_{in} versus V_{out}

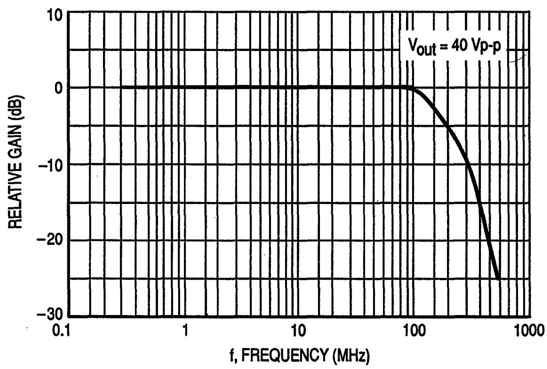


Figure 3. Frequency Response

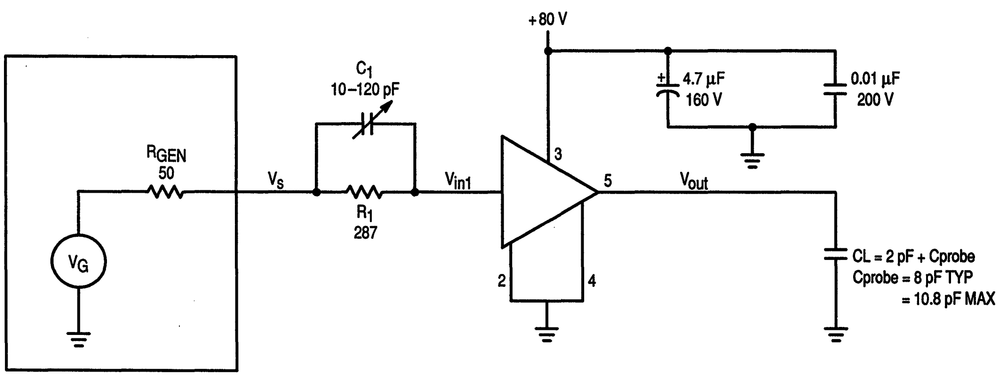


Figure 4. Hybrid Amplifier Test Circuit

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

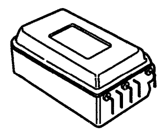
MFF124B

The RF Line
450 MHz CATV Feedforward Amplifier

. . . designed for broadband applications requiring low-distortion amplification. Specifically intended for CATV market requirements. Two hybrid amplifiers along with couplers and delay lines are packaged together to provide extremely low distortion products at conventional CATV amplifier output levels.

- Specifically Designed to Provide Improved Performance in 450 MHz CATV Applications
- Distortion Components Reduced more than 20 dB from Conventional CATV Hybrid Amplifiers
- Specified for 60-Channel Performance
- Fully Shielded Metal Package

24 dB
40–450 MHz
60-CHANNEL
CATV
FEEDFORWARD
AMPLIFIER



CASE 825A, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

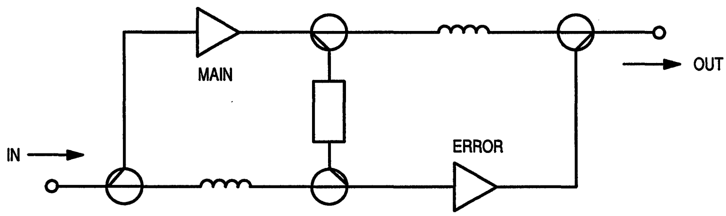
ELECTRICAL CHARACTERISTICS (V_{CC} = 24 V, T_C = 50°C, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	550	MHz
Power Gain — 50 MHz	G_P	23.4	24	24.6	dB
Slope	S	+0.2	—	+1.4	dB
Gain Flatness	—	—	—	±0.2	dB
Return Loss — Input (f = 40–450 MHz)	IRL	18	—	—	dB
Return Loss — Output (f = 40–450 MHz)	ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +50 dBmV per ch., ch. A, H2, H22)	IMD	—	—	−80	dB
Cross Modulation Distortion (V_{out} = 46 dBmV per ch., ch. 2, 60-channels) (V_{out} = 46 dBmV per ch., ch. 2, ---, H22)	XMD_{60}	 — —	 −80 —	 — −75	dB
Composite Triple Beat (V_{out} = 46 dBmV per ch., ch. 2, 60-channels) (V_{out} = 46 dBmV per ch., ch. 2, ---, H22)	CTB	 — —	 −85 —	 — −79	dB
Noise Figure (f = 50 MHz) (f = 450 MHz)	NF	— —	— —	9 10	dB
DC Current	I_{DC}	—	660	725	mA

PERFORMANCE DERATE versus TEMPERATURE (TYP)

Symbol	Characteristics	Test Conditions	–20 +80°C	–20 +100°C
G	Gain	50 MHz	±0.5 dB	±0.6 dB

CIRCUITRY BLOCK DIAGRAM



PERFORMANCE MEASUREMENT
Motorola test fixture: P/N MFF124BTF is necessary for accurate measurement.

3

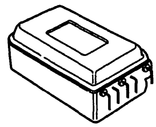
MFF224B

The RF Line
550 MHz CATV Feedforward Amplifier

24 dB
40–550 MHz
77-CHANNEL
CATV
FEEDFORWARD
AMPLIFIER

... designed for broadband applications requiring low-distortion amplification. Specifically intended for CATV market requirements. Two hybrid amplifiers along with couplers and delay lines are packaged together to provide extremely low distortion products at conventional CATV amplifier output levels.

- Specifically Designed to Provide Improved Performance in 550 MHz CATV Applications
- Distortion Components Reduced more than 20 dB from Conventional CATV Hybrid Amplifiers
- Specified for 77-Channel Performance
- Fully Shielded Metal Package



CASE 825A, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

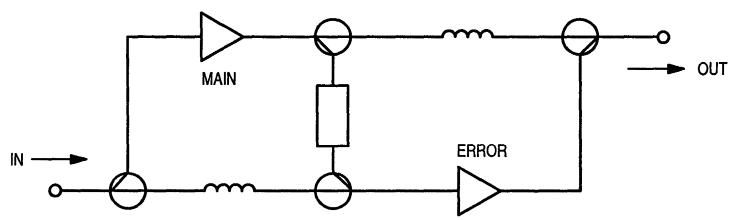
ELECTRICAL CHARACTERISTICS (V_{CC} = 24 V, T_C = 50°C, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	550	MHz
Power Gain — 50 MHz	G_P	23.4	24	24.6	dB
Slope	S	+0.2	—	+1.8	dB
Gain Flatness	—	—	—	±0.25	dB
Return Loss — Input (f = 40–550 MHz)	IRL	18	—	—	dB
Return Loss — Output (f = 40–550 MHz)	ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +50 dBmV per ch., ch. A, H2, H22)	IMD	—	—	-80	dB
Cross Modulation Distortion (V_{out} = 44 dBmV per ch., ch. 2, 77-channels) (V_{out} = 44 dBmV per ch., ch. 2, ---, H39)	XMD_{77}	 — —	 −80 —	 — −70	dB
Composite Triple Beat (V_{out} = 44 dBmV per ch., ch. 2, 77-channels) (V_{out} = 44 dBmV per ch., ch. 2, ---, H39)	CTB	 — —	 −85 —	 — −75	dB
Noise Figure (f = 50 MHz) (f = 550 MHz)	NF	— —	— —	9 11	dB
DC Current	I_{DC}	—	660	725	mA

PERFORMANCE DERATE versus TEMPERATURE (TYP)

Symbol	Characteristics	Test Conditions	–20 +80°C	–20 +100°C
G	Gain	50 MHz	±0.5 dB	±0.6 dB

CIRCUITRY BLOCK DIAGRAM



PERFORMANCE MEASUREMENT
Motorola test fixture: P/N MFF124BTF is necessary for accurate measurement.

3

MFF324B

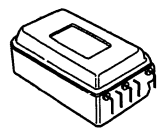
Motorola Preferred Device

The RF Line
600 MHz CATV Feedforward Amplifier

Designed for broadband applications requiring low-distortion amplification. Specifically intended for CATV market requirements. Two hybrid amplifiers along with couplers and delay lines are packaged together to provide extremely low distortion products at conventional CATV amplifier output levels.

- Specifically Designed to Provide Improved Performance in 600 MHz CATV Applications
- Distortion Components Reduced more than 20 dB from Conventional CATV Hybrid Amplifiers
- Specified for 85-Channel Performance
- Fully Shielded Metal Package

24 dB
40–600 MHz
85-CHANNEL
CATV
FEEDFORWARD
AMPLIFIER



CASE 825A, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	28	V
RF Input Power	P_{in}	+55	dBmV
Storage Temperature Range	T_{stg}	−40 to +100	°C
Operating Case Temperature Range	T_C	−20 to +100	°C

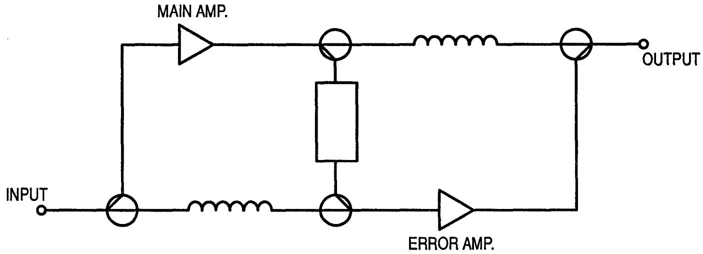
ELECTRICAL CHARACTERISTICS (T_C = 50°C, V_{CC} = 24 V, 75 Ω System)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	600	MHz
Power Gain — 50 MHz	G_p	23.4	24	24.6	dB
Slope	S	+0.4	—	+2.0	dB
Gain Flatness	—	—	—	±0.25	dB
Return Loss — Input	IRL	18	—	—	dB
Return Loss — Output	ORL	18	—	—	dB
Cross Modulation Distortion (V_{out} = +44 dBmV per ch., ch. 2, ---, H47)	XMD_{85}	—	—	−68	dB
Composite Triple Beat (V_{out} = +44 dBmV per ch., ch. 2, ---, H47)	CTB_{85}	—	—	−73	dB
Noise Figure (f = 50 MHz) (f = 600 MHz)	NF	— —	— —	9.0 12.5	dB
DC Current	I_{DC}	—	660	725	mA

PERFORMANCE DERATE versus TEMPERATURE (TYP)

Symbol	Characteristics	Test Conditions	−20 + 80°C	−20 + 100°C
ΔG_p	Change in Gain w/Temp.	50 MHz	±0.5 dB	±0.6 dB

Preferred devices are Motorola recommended choices for future use and best overall value.



PERFORMANCE MEASUREMENT

Motorola test fixture: P/N MFF124BTF is necessary for accurate measurement.

Figure 1. Block Diagram of Circuit

3

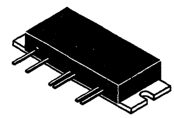
MHW105

The RF Line
VHF Power Amplifier

The MHW105 is designed specifically for portable radio applications. The MHW105 is capable of 5.0 watts power output, operates from a 7.5 volt supply and requires only 1.0 mW of RF input power.

- Specified 7.5 Volt Characteristics:
  RF Input Power — 1.0 mW (0 dBm)
  RF Output Power — 5.0 W
  Minimum Gain — 37 dB
  Harmonics — −40 dBc Max @ 2 f_0
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability

**5.0 W
68 to 88 MHz
VHF POWER
AMPLIFIER**



CASE 301K, STYLE 3

3

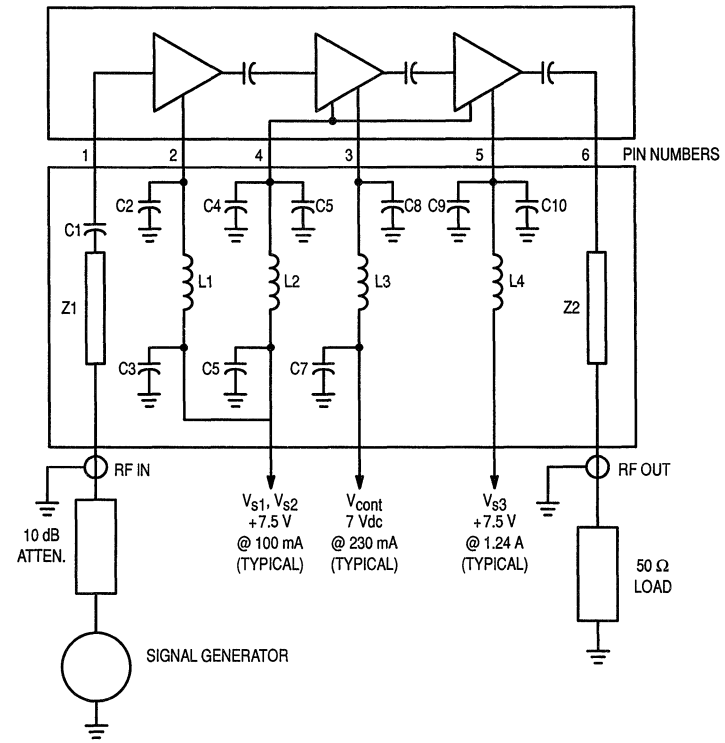
MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{S3}	9.0	Vdc
DC Control & Bias Voltage	$V_{S1,2}$	9.0	Vdc
DC Control Voltage	V_{cont}	9.0	Vdc
RF Input Power	P_{in}	5.0	mW
RF Output Power (V_{cont} = 9.0 Vdc)	P_{out}	7.0	W
Operating Case Temperature Range	T_C	−30 to +100	°C
Storage Temperature Range	T_{stg}	−30 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 Vdc; $V_{cont} \le$ 7.0 Vdc; T_C = +25°C, 50 Ω system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Frequency Range	BW	68	88	MHz
Power Gain (P_{out} = 5.0 W) (1)	G_P	37	—	dB
Control Voltage (P_{in} = 1.0 mW; P_{out} = 5.0 W) (1)	V_{cont}	—	7.0	Vdc
Efficiency (P_{out} = 5.0 W) (1)	η	40	—	%
Harmonics (P_{out} = 5.0 W) (1) 2 f_0, 3 f_0	—	—	−40	dBc
Input VSWR (P_{out} = 5.0 W) (1)	$VSWR_{in}$	—	2.0:1	—
Load Mismatch ($V_{S1} = V_{S2} = V_{S3}$ = 9.0 Vdc; Load VSWR = 20:1; P_{out} = 5.0 W) (1)	ψ	No Degradation in Power Output Before and After Test		
Stability (P_{in} = 1.0 to 3.0 mW; $V_{S1} = V_{S2} = V_{S3}$ = 6.0 to 9.0 Vdc; P_{out} = 1.0 W to 5.0 W; Load VSWR = 8:1, All Phase Angles) (1)	—	All Spurious Outputs More Than 60 dB Below Desired Signal		
Quiescent Current ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 Vdc; V_{cont} = 7.0 Vdc; P_{in} = 0)	I_Q	—	200	mA

NOTE:
1. Adjust V_{cont} for specified P_{out}



C1, C2, C3, C4, C6, C7, C8, C9 — 18,000 pF CHIP
C5, C10 — 3.3 μF TANTALUM CHIP
L1, L2, L3, L4 — 0.2 μH
Z1, Z2 — 50 Ω MICROSTRIP LINE

Figure 1. VHF Power Module Test Circuit Diagram

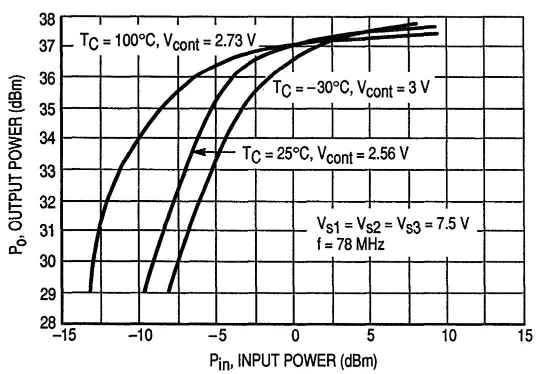


Figure 2. Output Power versus Input Power

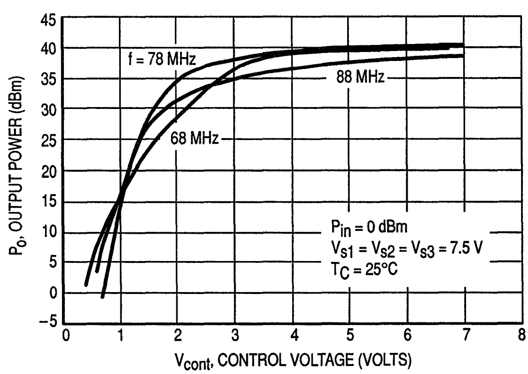


Figure 3. Output Power versus Control Voltage

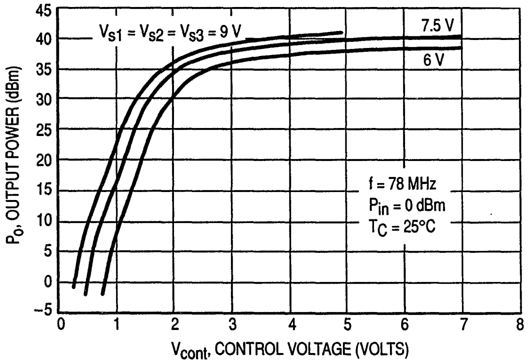


Figure 4. Output Power versus Control Voltage

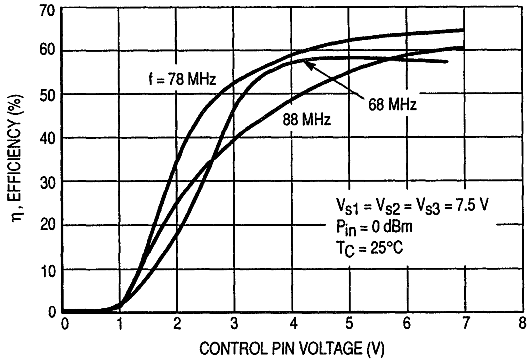


Figure 5. Efficiency versus Control Voltage

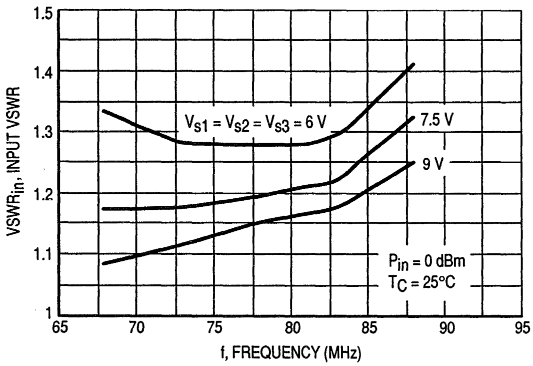


Figure 6. Input VSWR versus Frequency

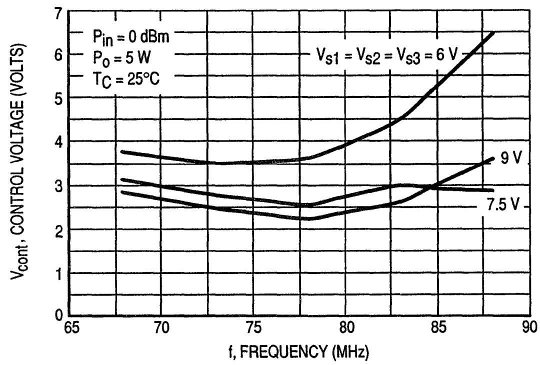


Figure 7. Control Voltage versus Frequency

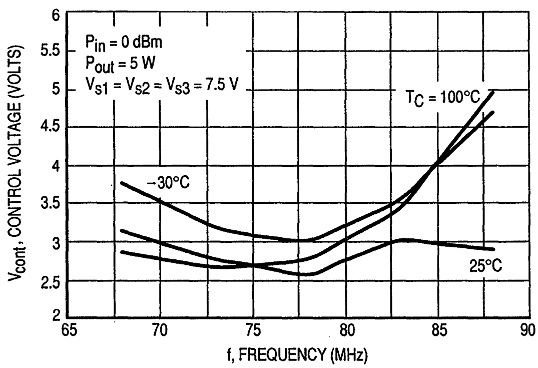


Figure 8. Control Voltage versus Frequency

3

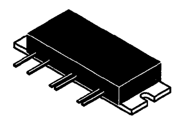
MHW607-1
MHW607-2
MHW607-3
MHW607-4

The RF Line
VHF Power Amplifiers

. . . designed for 7.5 volt VHF power amplifier applications in industrial and commercial equipment primarily hand portable radios.

- MHW607-1: 136–150 MHz
- MHW607-2: 146–174 MHz
- MHW607-3: 174–195 MHz
- MHW607-4: 184–210 MHz
- Specified 7.5 Volt Characteristics:
  - — RF Input Power = 1.0 mW (0 dBm)
  - — RF Output Power = 7.0 Watts (MHW607-1,-2); 6.5 W (MHW607-3,-4)
  - — Minimum Gain ($V_{Control}$ = 7.0 V) = 38.5 dB
  - — Harmonics = −40 dBc Max @ 2.0 f_o
- 50 Ω Input/Output Impedance
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability

7.0 W — 136 to 210 MHz
6.5 W — 174 to 210 MHz
VHF POWER AMPLIFIERS



CASE 301K, STYLE 3

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage (Pins 2, 4, 5)	$V_{s1,2,3}$	9.0	Vdc
DC Control Voltage (Pin 3)	V_{Cont}	9.0	Vdc
RF Input Power	P_{in}	5.0	mW
RF Output Power ($V_{S1} = V_{S2} = V_{S3}$ = 9.0 V)	P_{out}	10	W
Operating Case Temperature Range	T_C	−30 to +100	°C
Storage Temperature Range	T_{stg}	−30 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 Vdc, (Pins 2, 4, 5), T_C = 25°C, 50 Ω System)

Characteristic	Symbol	Min	Max	Unit
Frequency Range MHW607-1 MHW607-2 MHW607-3 MHW607-4	—	136 146 174 184	150 174 195 210	MHz
Control Voltage (P_{out} = 7.0 W, P_{in} = 1.0 MW)(1)	V_{Cont}	0	7.0	Vdc
Quiescent Current ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 Vdc, V_{Cont} = 7.0 Vdc)	$I_{s1(q)} + I_{s2(q)}$	—	160	mA
Power Gain (P_{out} = 7.0 W, V_{Cont} = 7.0 Vdc)	G_p	38.5	—	dB
Efficiency (P_{out} = 7.0 W, P_{in} = 1.0 mW)(1)	η	40	—	%
Harmonics (P_{out} = 7.0 W)(1) 2 f_o (P_{in} = 1.0 mW) 3 f_o	—	—	−40 −45	dBc
Input VSWR (P_{out} = 7.0 W, P_{in} = 1.0 mW), 50 Ω Ref. (1)	—	—	2.0:1	—
Load Mismatch ($V_{S1} = V_{S2} = V_{S3}$ = 9.0 Vdc) VSWR = 20:1, P_{out} = 8 W, P_{in} = 5.0 mW)(1)		No Degradation in Power Output		
Stability (P_{in} = 1.0–30 mW, $V_{S1} = V_{S2} = V_{S3}$ = 6.0–9.0 Vdc) P_{out} between 1.0 W and 10 W (1) Load VSWR = 8:1		All spurious outputs more than 60 dB below desired signal		
Control Current ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 V, P_{in} = 0 dBm, V_{Cont} Set for P_o = 7.0 W)		—	325	mA

(1) Adjust V_{Cont} for specified P_{out}.

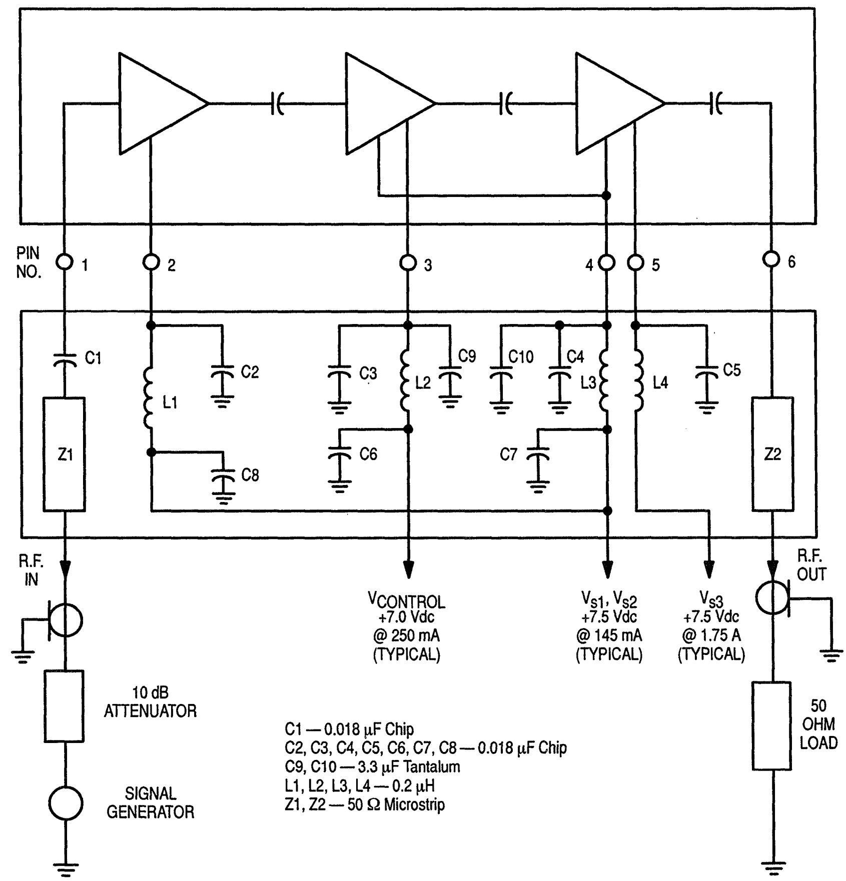


Figure 1. Power Module Test System Block Diagram

TYPICAL CHARACTERISTICS

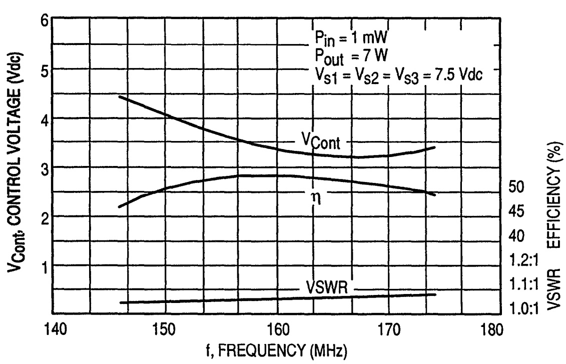


Figure 2. Control Voltage, Efficiency and VSWR versus Frequency

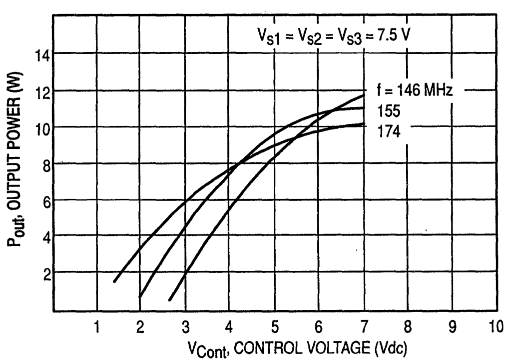


Figure 3. Output Power versus Control Voltage

TYPICAL CHARACTERISTICS

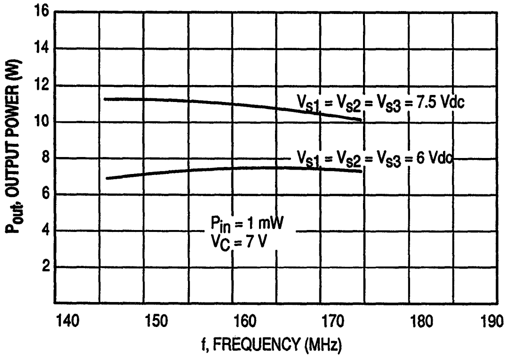


Figure 4. Output Power versus Frequency

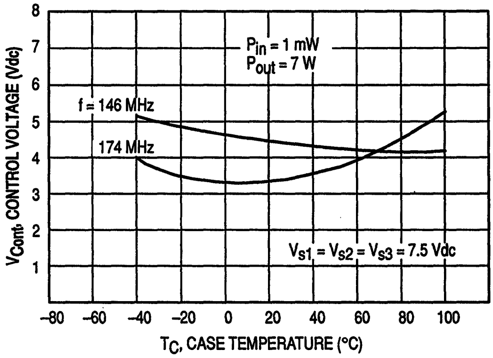


Figure 5. Control Voltage versus Case Temperature

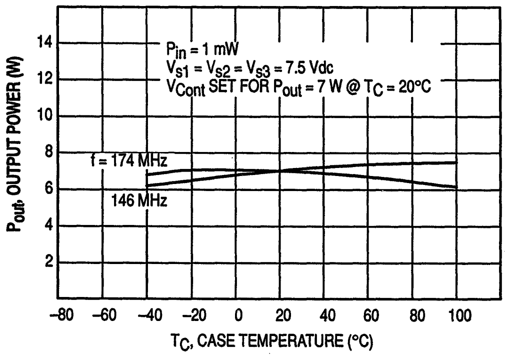


Figure 6. Output Power versus Case Temperature

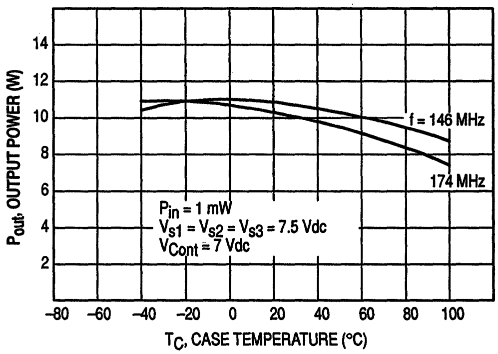


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

3

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = 7.5$ Vdc (Pins 2, 4, 5) and P_{out} equal to 7.0 watts. With these conditions, maximum current density on any device is 1.5×10^5 A/cm^2 and maximum die temperature with 100°C case operating temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the limits of published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output should be limited to 7.0 watts. The preferred method of power output control is to fix $V_{S1} = V_{S2} = V_{S3} = 7.5$ Vdc (Pins 2, 4, 5), P_{in} (Pin 1) at 1.0 mW, and vary V_{Cont} (Pin 3) voltage.

DECOUPLING

Due to the high gain of the three stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3, 4 and 5 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5.0 MHz through 174 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

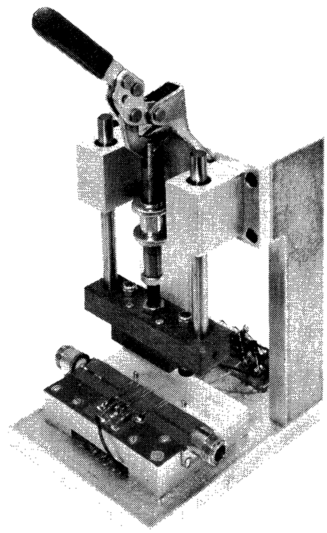
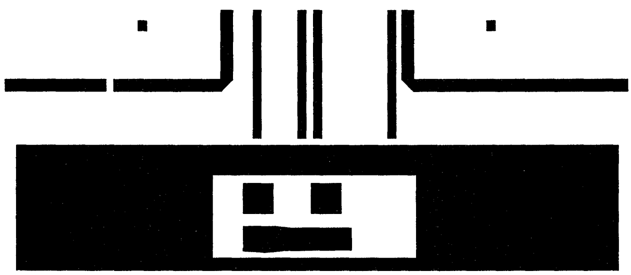


Figure 8. Test Fixture Assembly

LOAD MISMATCH

During final test, each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3}$ equal to 9.0 Vdc, VSWR equal to 20:1, and output power equal to 8.0 watts.

3



SCALE 0.75:1

Figure 9. Photomaster For Test Fixture

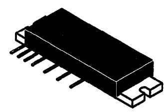
MHW704

The RF Line
UHF Power Amplifier

Designed for 6.0 V UHF power amplifier applications in industrial and commercial equipment, primarily hand portable radios.

- Specified 6.0 Volt Characteristics:
  RF Input Power — 1.0 mW (0 dBm)
  RF Output Power — 3.0 W
  Minimum Gain ($V_{Control}$ = 6.0 V) = 34.8 dB
  Harmonics — −40 dBc Max @ 2 f_o
- 50 Ω Input/Output Impedances
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability

**3.0 W
440 to 470 MHz
UHH POWER
AMPLIFIER**



CASE 301J, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage (Pins 2, 4, 5, 6)	$V_{s1,2,3,4}$	7.5	Vdc
DC Control Voltage (Pin 3)	V_{cont}	6.0	Vdc
RF Input Power	P_{in}	3.0	mW
RF Output Power ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 7.5 Vdc)	P_{out}	4.5	W
Operating Case Temperature Range	T_C	−25 to +100	°C
Storage Temperature Range	T_{stg}	−25 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 6.0 Vdc (Pins 2, 4, 5, 6); T_C = +25°C, 50 ohm system)

Characteristic	Symbol	Min	Max	Unit
Frequency Range	BW	440	470	MHz
Power Gain (P_{out} = 3.0 W; V_{cont} = 6.0 V)	G_p	34.8	—	dB
Control Voltage (P_{in} = 1.0 mW; P_{out} = 3.0 W) (1)	V_{cont}	—	6.0	Vdc
Efficiency (P_{in} = 1.0 mW; P_{out} = 3.0 W) (1)	η	38	—	%
Harmonics (P_{out} = 3.0 W; P_{in} = 1.0 mW) (1) 2 f_o	—	—	−40	dBc
Input VSWR (P_{out} = 3.0 W; P_{in} = 1.0 mW) (1)	$VSWR_{in}$	—	2.0:1	—
Load Mismatch ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 7.5 Vdc; Load VSWR = 10:1, All Phase Angles At Frequency of Test; P_{out} = 4.0 W; P_{in} = 3.0 mW) (1)	ψ	No Degradiation in Power Output		
Stability (P_{in} = 1.0 to 3.0 mW; $V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 5.0 to 7.5 Vdc; P_{out} = 100 mW to 4.0 W; Load VSWR = 8:1, All Phase Angles At Frequency of Test) (1)	—	All Spurious Outputs More Than 60 dB Below Desired Signal		
Control Current (P_{out} = 3.0 W; P_{in} = 1.0 mW) (1)	I_{cont}	—	80	mA
Quiescent Current (P_{in} = 0 mW; V_{cont} = 0 Vdc)	I_Q	—	150	mA
Leakage Current ($V_{s1} = V_{s2} = V_{cont}$ = 0 Vdc; $V_{s3} = V_{s4}$ = 7.5 Vdc; P_{in} = 0 mW)	I_L	—	0.2	mA

(1) Adjust V_{Cont} for specified P_{out}.

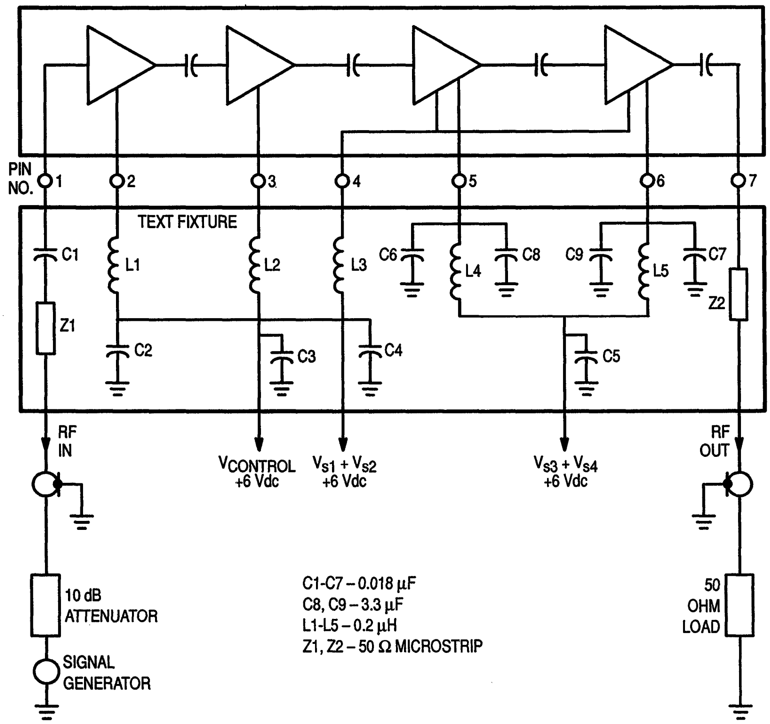


Figure 1. UHF Power Amplifier Test System Diagram

3

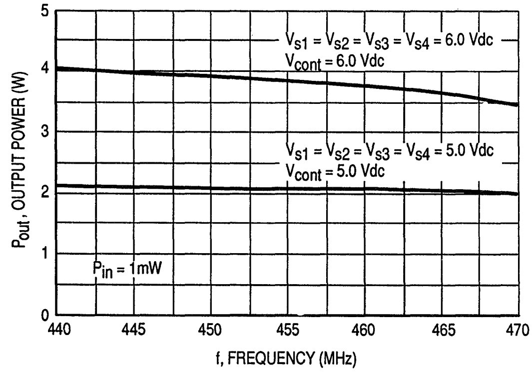


Figure 2. Output Power versus Frequency

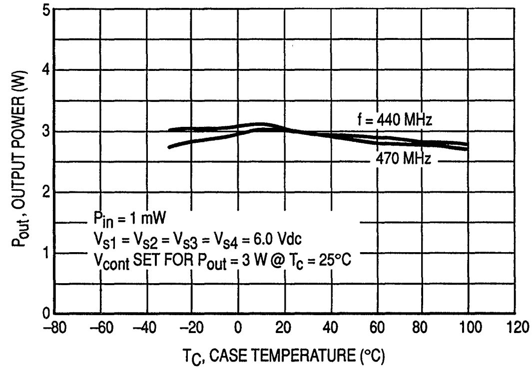


Figure 3. Output Power versus Case Temperature

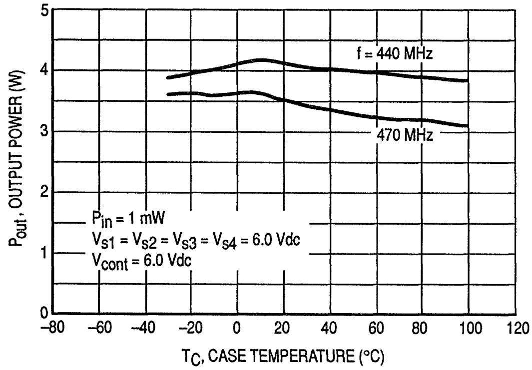


Figure 4. Output Power versus Case Temperature at Maximum Control Voltage

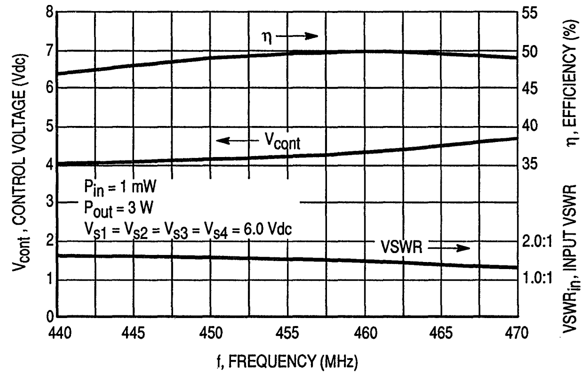


Figure 5. Control Voltage, Efficiency and VSWR versus Frequency

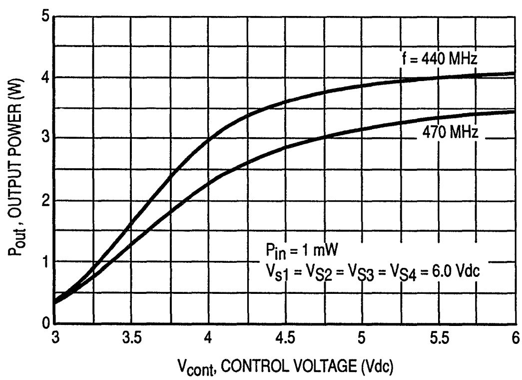


Figure 6. Output Power versus Control Voltage

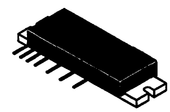
MHW707-1
MHW707-2
MHW707-3
MHW707-4

The RF Line
UHF Power Amplifiers

. . . designed for 7.5 Volt UHF power amplifier applications in industrial and commercial equipment primarily hand portable radios.

- MHW707-1, f = 403–440 MHz
- MHW707-2, f = 440–470 MHz
- MHW707-3, f = 470–500 MHz
- MHW707-4, f = 490–512 MHz
- Specified 7.5 Volt Characteristics:
  RF Input Power = 1.0 mW (0 dBm)
  RF Output Power = 7.0 Watts (2)
  Minimum Gain ($V_{Control}$ = 7.0 V) = 38.5 dB (2)
  Harmonics = –40 dBc Max @ 2 f_o
- 50 Ω Input/Output Impedance
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability

7.0 W, 403 to 500 MHz
6.5 W, 490 to 512 MHz
UHF POWER AMPLIFIERS



CASE 301J, STYLE 1

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage (Pins 2,4,5,6)	$V_{s1,2,3,4}$	9.0	Vdc
DC Control Voltage (Pin 3)	V_{Cont}	7.0	Vdc
RF Input Power	P_{in}	3.0	mW
RF Output Power ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 9.0 Vdc)	P_{out}	9.0	W
Operating Case Temperature Range	T_C	–30 to +80	°C
Storage Temperature Range	T_{stg}	–30 to +80	°C

ELECTRICAL CHARACTERISTICS $V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 7.5 Vdc, (Pins 2,4,5,6), T_C = 25°C, 50 Ω System

Characteristic		Symbol	Min	Max	Unit
Frequency Range	MHW707-1 MHW707-2 MHW707-3 MHW707-4	—	403 440 470 490	440 470 500 512	MHz
Control Voltage (P_{out} = 7.0 W, P_{in} = 1.0 MW)(1)		V_{Cont}	0	7.0	Vdc
Quiescent Current ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 7.5 Vdc, P_{in} = 0 mW, V_{Cont} = 0 Vdc)			—	150	mA
Power Gain (P_{out} = 7.0 W, V_{Cont} = 7.0 Vdc) (2)		G_p	38.5	—	dB
Efficiency (P_{out} = 7.0 W, P_{in} = 1.0 mW) (1) (2)		η	40	—	%
Harmonics (P_{out} = 7.0 W) (1) (2) 2 f_o (P_{in} = 1.0 mW)		—	—	–40	dBc
Input VSWR (P_{out} = 7.0 W, P_{in} = 1.0 mW), 50 Ω Ref. (1) (2)		—	—	2.0:1	—
Control Current ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 7.5 Vdc, P_{in} = 1.0 mW) (1)		—	—	95	mA
Load Mismatch ($V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 9.0 Vdc) VSWR = 10:1, P_{out} = 9.0 W, P_{in} = 3.0 mW(1)			No Degradation in Power Output		
Stability (P_{in} = 1.0–3.0 mW, $V_{s1} = V_{s2} = V_{s3} = V_{s4}$ = 6.0–9.0 Vdc) P_{out} between 1.0 W and 9.0 W (1) Load VSWR = 8:1, All Phase Angles			All spurious outputs more than 60 dB below desired signal		

NOTES:
1. Adjust V_{Cont} for specified P_{out}.
2. MHW707-4 Specifications: P_{out} = 7.0 W @ 490 MHz
P_{out} = 6.5 W @ 512 MHz

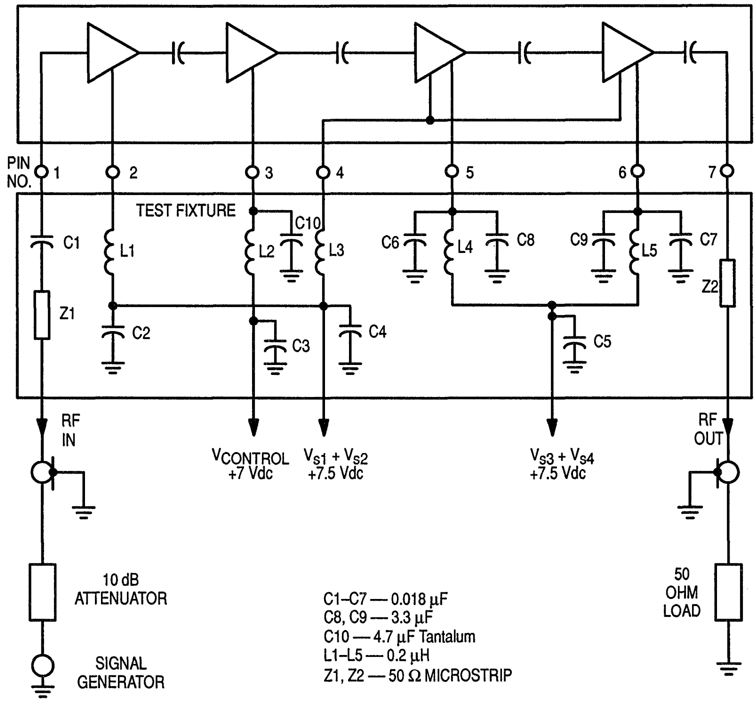


Figure 1. Power Module Test System Block Diagram

3

TYPICAL CHARACTERISTICS (MHW707-1)

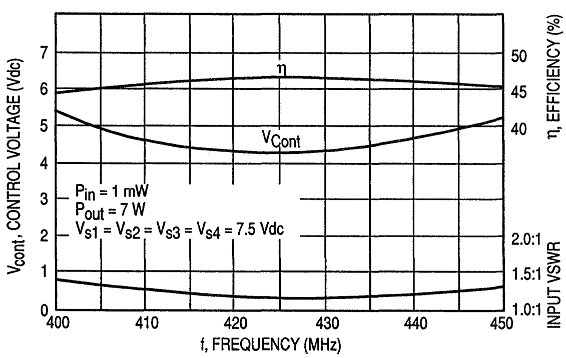


Figure 2. Control Voltage, Efficiency and VSWR versus Frequency

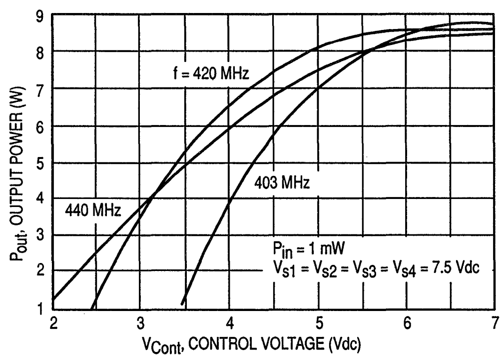


Figure 3. Output Power versus Control Voltage

TYPICAL CHARACTERISTICS
(MHW707-1)

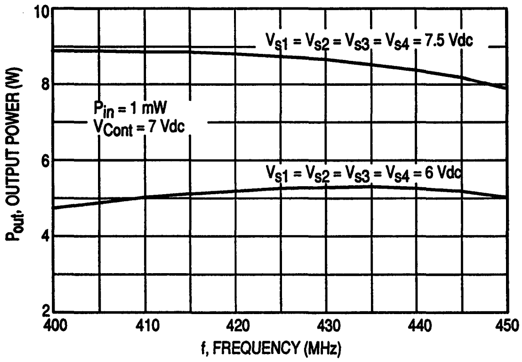


Figure 4. Output Power versus Frequency

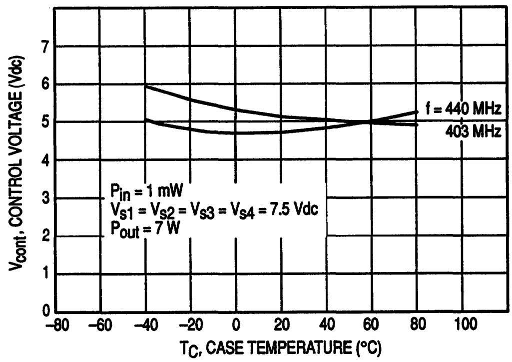


Figure 5. Control Voltage versus Case Temperature

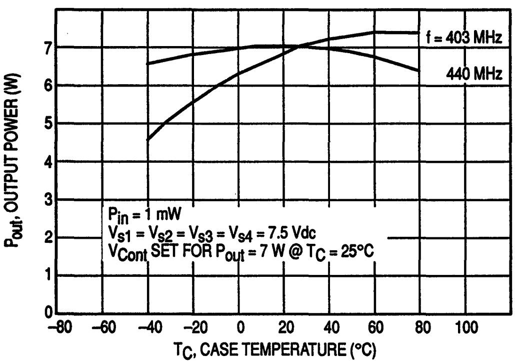


Figure 6. Output Power versus Case Temperature

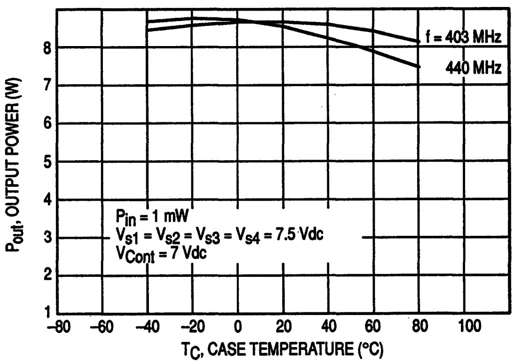


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

TYPICAL CHARACTERISTICS
(MHW707-2)

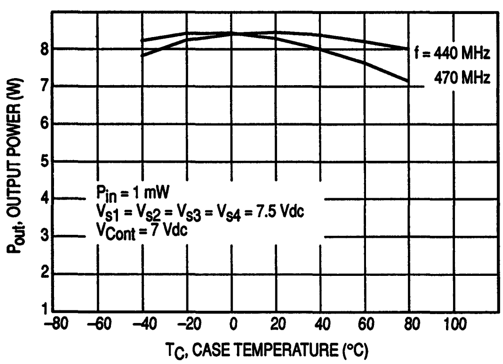


Figure 8. Output Power versus Case Temperature at Maximum Control Voltage

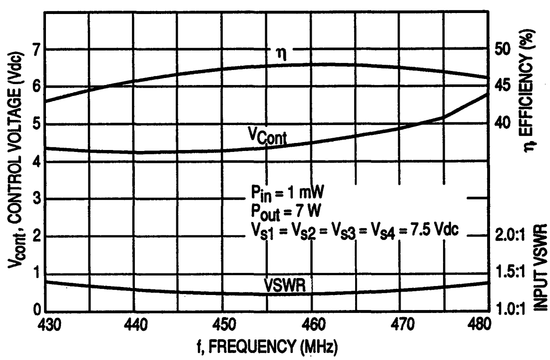


Figure 9. Control Voltage Efficiency and VSWR versus Frequency

3

TYPICAL CHARACTERISTICS
(MHW707-2)

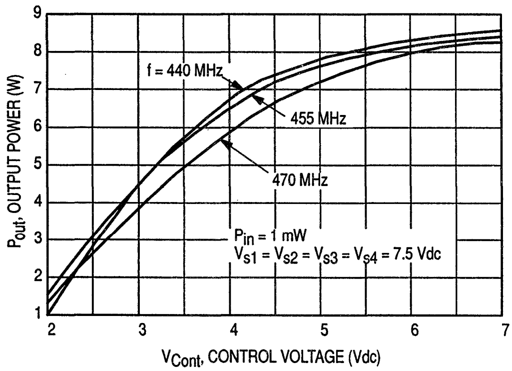


Figure 10. Output Power versus Control Voltage

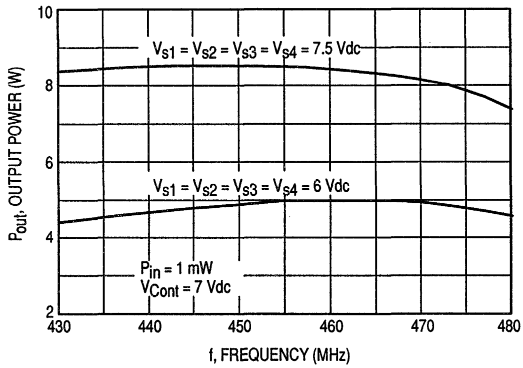


Figure 11. Output Power versus Frequency

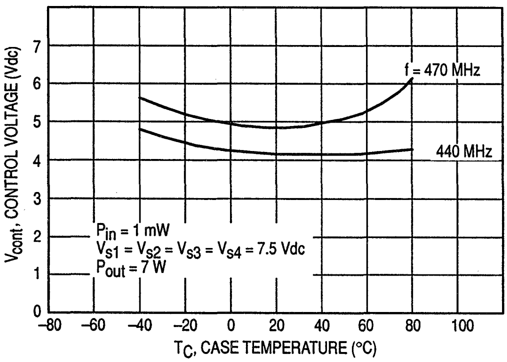


Figure 12. Control Voltage versus Case Temperature

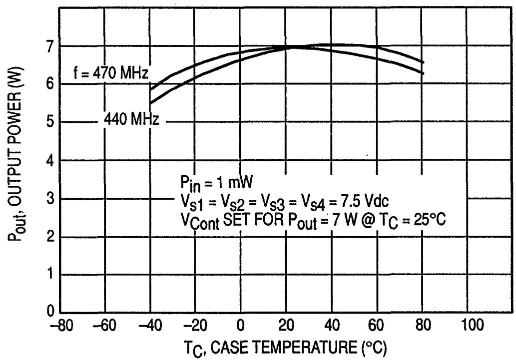


Figure 13. Output Power versus Case Temperature

3

TYPICAL CHARACTERISTICS (MHW707-3)

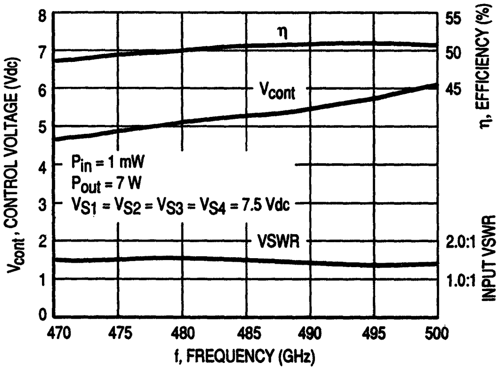


Figure 14. Control Voltage, Efficiency and VSWR versus Frequency

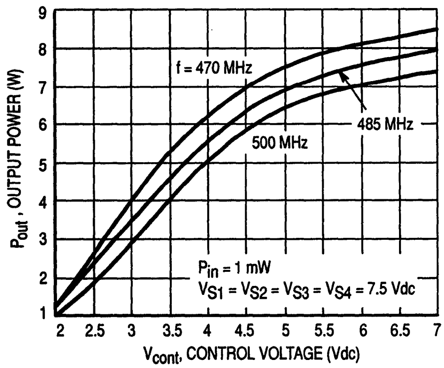


Figure 15. Output Power versus Control Voltage

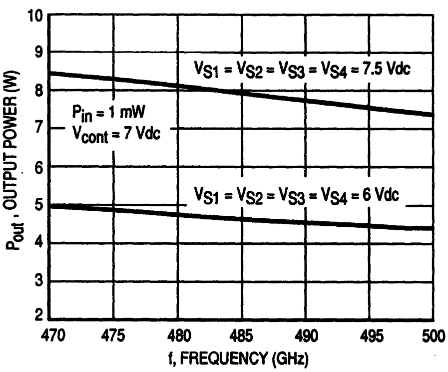


Figure 16. Output Power versus Frequency

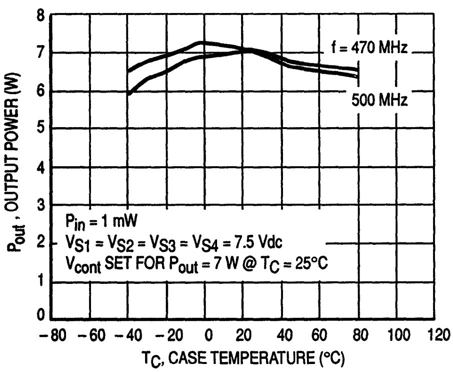


Figure 17. Output Power versus Case Temperature

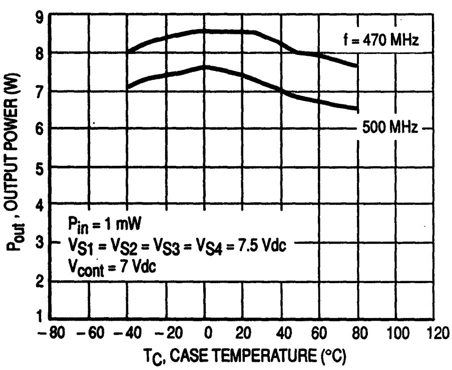


Figure 18. Output Power versus Case Temperature at Maximum Control Voltage

TYPICAL CHARACTERISTICS
(MHW707-4)

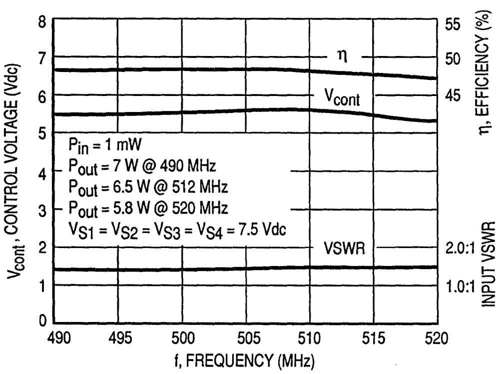


Figure 19. Control Voltage, Efficiency and VSWR versus Frequency

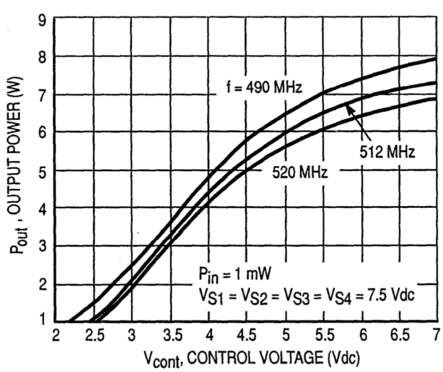


Figure 20. Output Power versus Control Voltage

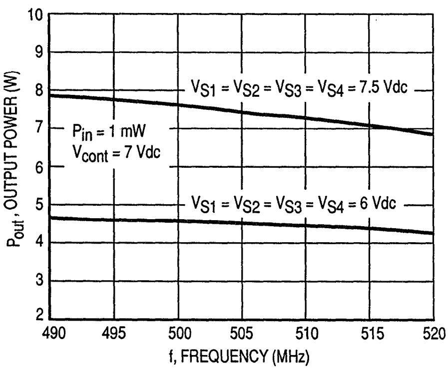


Figure 21. Output Power versus Frequency

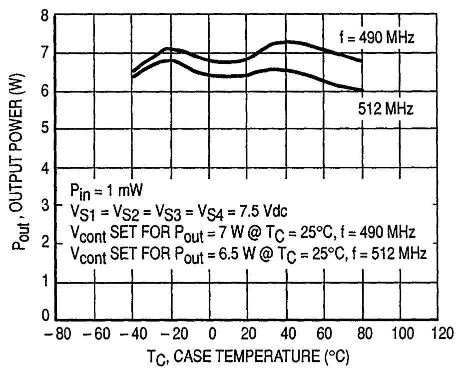


Figure 22. Output Power versus Case Temperature

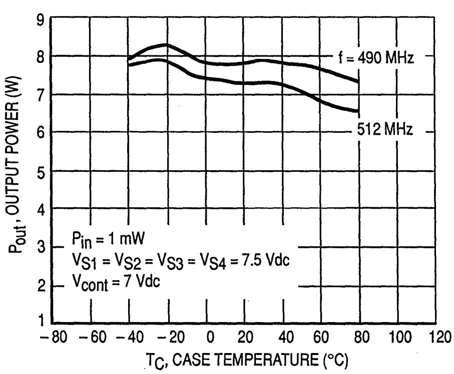


Figure 23. Output Power versus Case Temperature at Maximum Control Voltage

3

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = V_{S4} = 7.5$ Vdc (Pins 2, 4, 5, 6) and P_{out} equal to 7.0 watts (6.5 W for MHW707-4). With these conditions, maximum current density on any device is 1.5×10^5 A/cm^2. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the limits of published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output should be limited to 7.0 watts. The preferred method of power output control is to fix $V_{S1} = V_{S2} = V_{S3} = V_{S4} = 7.5$ Vdc (Pins 2, 4, 5, 6), P_{in} (Pin 1) at 1.0 mW, and vary V_{cont} (Pin 3) voltage.

DECOUPLING

Due to the high gain of the four stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3, 5 and 6 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5.0 MHz through 940 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

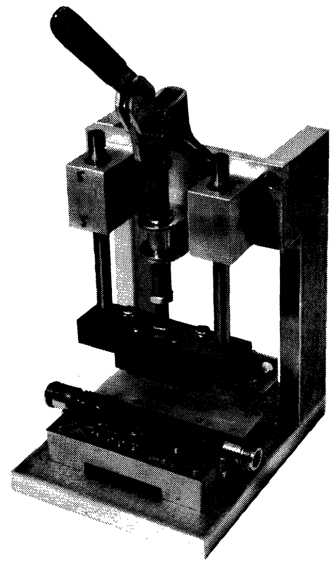


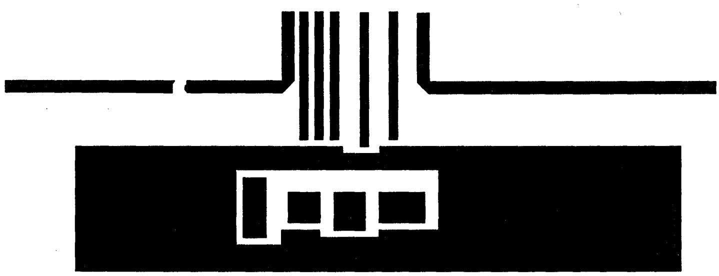
Figure 24. Test Fixture Assembly

LOAD MISMATCH

During final test, each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ equal to 9.0 Vdc, VSWR equal top 10:1, and output power equal to 9.0 watts.

3

INPUT



OUTPUT

SCALE 0.75:1

Figure 25. Photomaster For Test Fixture

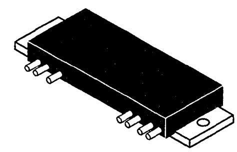
MHW720A1
MHW720A2
MHW720A3

The RF Line
UHF Power Amplifiers

. . . capable of wide power range control as encountered in UHF cellular telephone applications.

- MHW720A1 400–440 MHz
- MHW720A2 440–470 MHz
- MHW720A3 450–458 MHz
- Specified 12.5 Volt, UHF Characteristics —
  Output Power = 20 Watts
  Minimum Gain = 21 dB
  Harmonics = –40 dB (Max)
- 50 Ω Input/Output Impedance
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability
- MHW720A3 Specifically Designed for C-NETZ Mobile Applications
- MHW720A3 Guaranteed for Dynamic Range and Extreme Condition Performances

20 W, 400 to 70 MHz
RF POWER
AMPLIFIERS



CASE 700, STYLE 2

3

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating		Symbol	Value	Unit
DC Supply Voltages		V_{S1}, V_{S2}	15.5	Vdc
RF Input Power		P_{in}	250	mW
RF Output Power (@ V_{S1} = V_{S2} = 12.5 V)		P_{out}	25	W
Operating Case Temperature Range		T_C	−30 to +100	°C
Storage Temperature Range	MHW720A1, MHW720A2 MHW720A3	T_{stg}	−40 to +100 −30 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{S1} and V_{S2} set at 12.5 Vdc, T_C = 25°C, 50 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
Frequency Range	MHW720A1 MHW720A2 MHW720A3	—	400 440 450	440 470 458	MHz
Input Power (P_{out} = 20 W)		P_{in}	—	150	mW
Power Gain (P_{out} = 20 W)		G_p	21	—	dB
Efficiency (P_{out} = 20 W)	MHW720A1, MHW720A2 MHW720A3	η	35 37	— —	%
Harmonics (P_{out} = 20 W, Reference)		—	—	–40	dB
Input Impedance (P_{out} = 20 W, 50 Ω Reference)		Z_{in}	—	2:1	VSWR
Gain Degradation (1) (P_{out} = 20 W, Reference Gain @ T_C = + 25°C)	T_C = –30°C T_C = +80°C	—	— —	–0.7 –0.7	dB
Load Mismatch (VSWR = 30:1, V_{S1} = V_{S2} = 15.5 Vdc, P_{out} = 30 W)		—	No degradation in P_{out}		
Stability (P_{in} = 0 to 250 mW, V_{S1} = V_{S2} = 10 to 15.5 Vdc) MHW720A1, MHW720A2 1. Load VSWR = 4:1, 50 Ω Reference 2. Source VSWR = 2:1, 50 Ω Refernece		—	All spurious outputs more than 60 dB below desired signal		
Stability (P_{in} = 0 to 250 mW, V_{S1} = V_{S2} = 7.5–15.5 Vdc) MHW720A3 1. Load VSWR = 6:1, 50 Ω Reference 2. Source VSWR = 3:1, 50 Ω Reference		—	All spurious outputs more than 60 dB below desired signal		
Quiescent Current (I_{S1} No RF Drive Applied)	MHW720A1, MHW720A2 MHW720A3	$I_{S1 (q)}$	— —	200 75	mA

NOTE:
1. See Figure 5, Input Power versus Case Temperature

APPLICATIONS INFORMATION

Nominal Operation

All electrical specifications are based on the nominal conditions of V_{S1} (Pin 5) and V_{S2} (Pin 3) equal to 12.5 Vdc and with output power equaling 20 watts. With these conditions, maximum current density on any device is 1.5 x 10^5 A/ cm^2 and maximum die temperature with 100° base plate temperature is 165°. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the limits of published specifications is not recommended unless prior communications regarding intended use has been made with the factory representative.

Gain Control

This module is designed for wide range P_{out} level control. The recommended method of power output control, as shown in Figure 3, is to fix V_{S1} and V_{S2} at 12.5 Vdc and vary the input RF drive level at Pin 7.

In all applications, the module output power should be limited to 20 watts.

Decoupling

Due to the high gain of the three stages and the module size limitation, the external decoupling network requires careful consideration. Both Pins 3 and 5 are internally bypassed with a 0.018 µF chip capacitor effective for frequencies from 5 through 470 MHz. For bypassing frequencies below 5 MHz, networks equivalent to that shown in the test fixture schematic are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR less than 4:1.

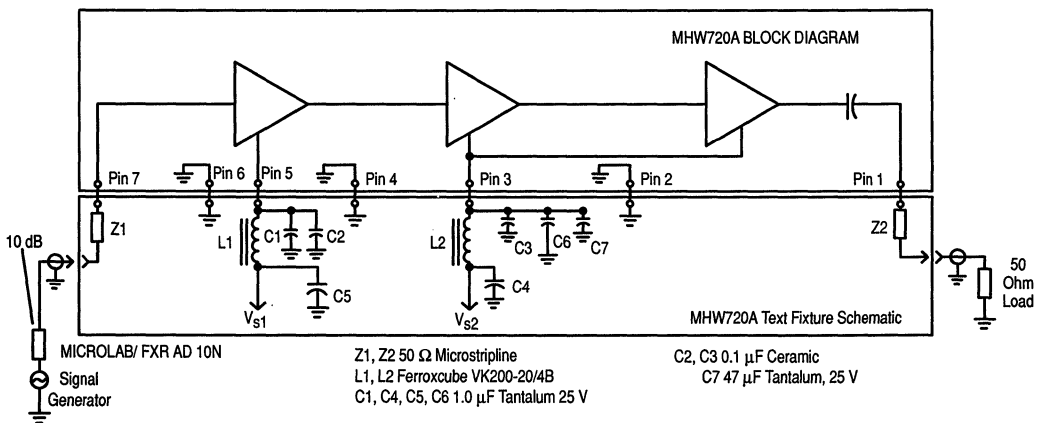
Load Mismatch

During final test, each module is load mismatch tested in a fixture having the identical decoupling network described in Figure 1. Electrical conditions are V_{S1} and V_{S2} equal 15.5 V, load VSWR infinite, and output power equal to 30 watts.

Mounting Considerations

To insure optimum heat transfer from the flange to heatsink, use standard 6–32 mounting screws and an adequate quantity of silicon thermal compound (e.g., Dow Corning 340). With both mounting screws finger tight, alternately torque down the screws to 4–6 inch pounds. The heatsink mounting surface directly beneath the module flange should be flat to within 0.005 inch to prevent fracturing of ceramic substrate material. For more information on module mounting, see EB-107.

3



NOTE: No Internal D.C. blocking on input pin.

Figure 1. UHF Power Amplifier Test Setup

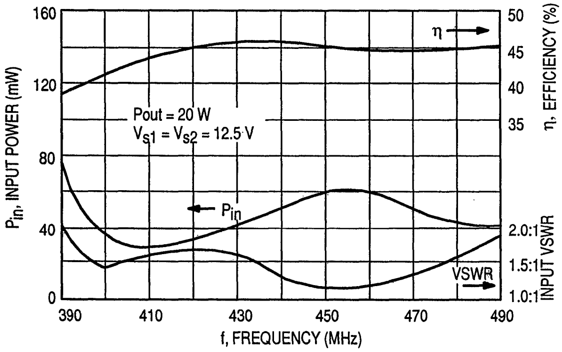


Figure 2. Input Power, Efficiency, and VSWR versus Frequency

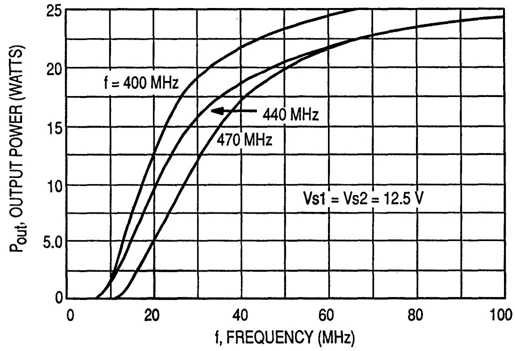


Figure 3. Output Power versus Input Power

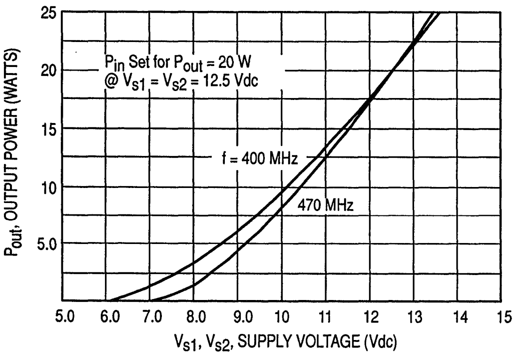


Figure 4. Output Power versus Voltage

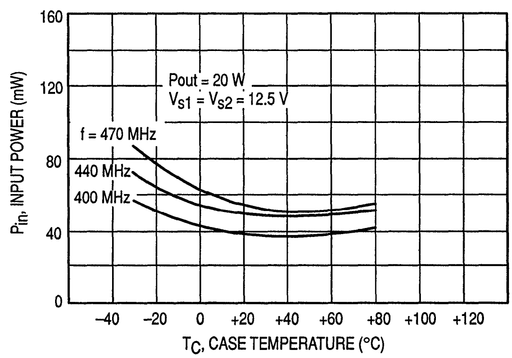


Figure 5. Input Power versus Case Temperature

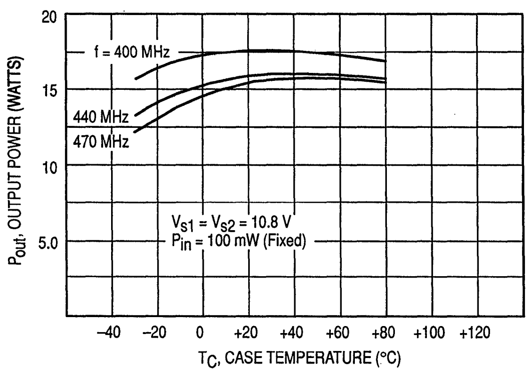


Figure 6. Output Power versus Case Temperature @ 10.8 V Supply

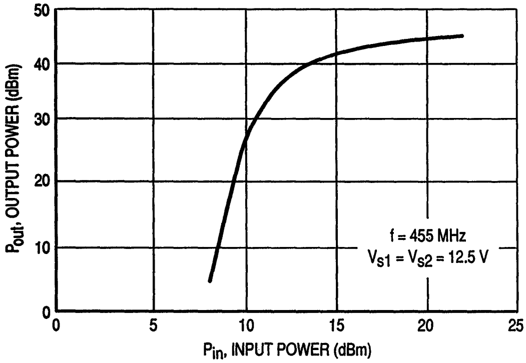


Figure 7. Output Power versus Input Power

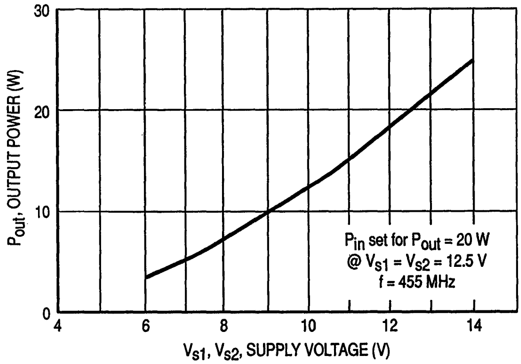


Figure 8. Output Power versus Voltage

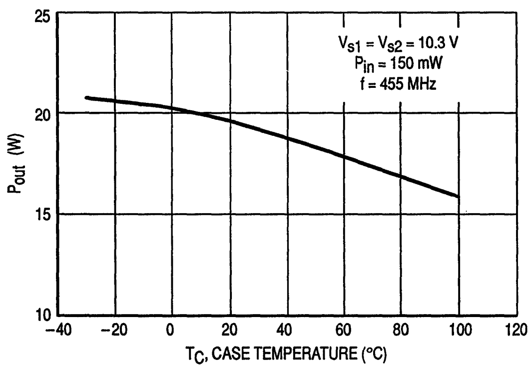


Figure 9. Output Power versus Case Temperature @ 10.3 V Supply

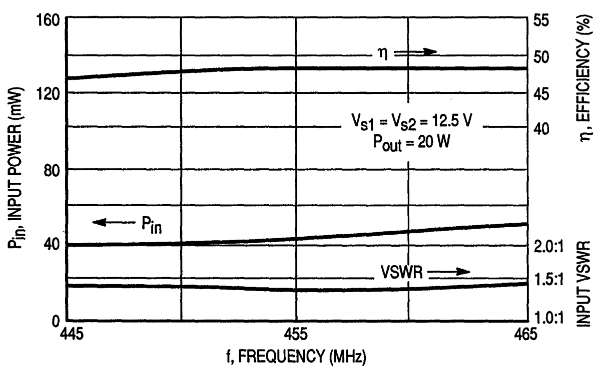


Figure 10. Input Power, Efficiency & VSWR versus Frequency

3

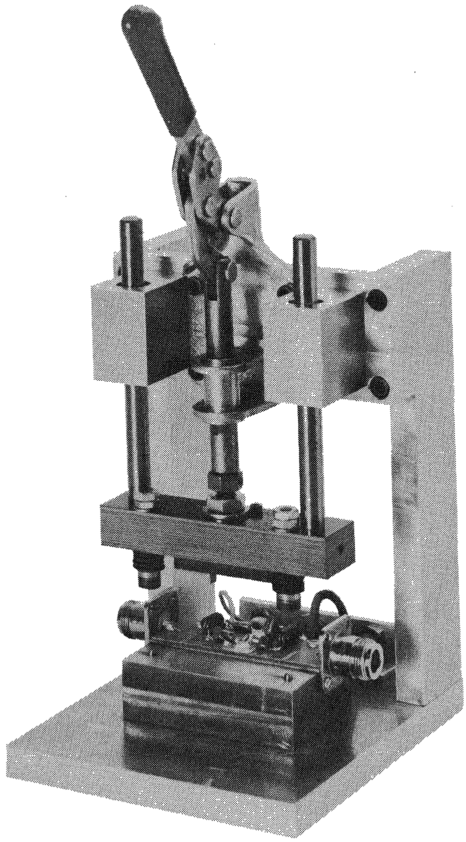
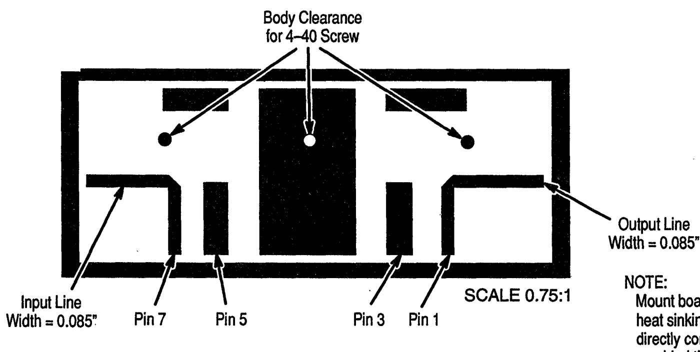


Figure 11. Test Fixture Assembly



Teflon Glass Board
t = 0.031"
ε_r = 2.56

NOTE:
Mount board and module on 1/2" thick aluminum block for heat sinking and electrical ground. Pins 2, 4 and 6 are not directly connected to ground in this test fixture. Ground is provided through module heat sink.

Figure 12. UHF Power Amplifier Test Fixture Printed Circuit Board

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

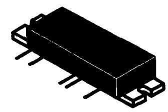
MHW803-1
MHW803-2
MHW803-3

The RF Line
UHF Power Amplifiers

. . . capable of wide power range control as encountered in portable cellular radio applications (30 dB typical).

- MHW803-1 820–850 MHz
- MHW803-2 806–870 MHz
- MHW803-3 870–905 MHz
- Specified 7.5 Volt Characteristics
  RF Input Power = 1 mW (0 dBm)
  RF Output Power = 2 Watts
  Minimum Gain ($V_{Control}$ = 4 V) = 33 dB
  Harmonics = −45 dBc Max @ 2 f_o
- 50 Ω Input/Output Impedance
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability

2 W, 806 to 905 MHz
UHF POWER
AMPLIFIERS



CASE 301E, STYLE 1

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage (Pins 2,3,4)	$V_{s1,2,3}$	10	Vdc
DC Control Voltage (Pin 1)	V_{Cont}	4	Vdc
RF Input Power	P_{in}	3	mW
RF Output Power (V_{s1} = V_{s2} = V_{s3} = 10 V)	P_{out}	3	W
Operating Case Temperature Range	T_C	−30 to +100	°C
Storage Temperature Range	T_{stg}	−30 to +100	°C

ELECTRICAL CHARACTERISTICS V_{s1} = V_{s2} = V_{s3} = 7.5 Vdc, (Pins 2,3,4), T_C = 25°C, 50 Ω System

Characteristic	Symbol	Min	Max	Unit
Frequency Range MHW803-1 MHW803-2 MHW803-3	—	820 806 870	850 870 905	MHz
Control Voltage (P_{out} = 2 W, P_{in} = 1 mW) (1)	V_{Cont}	0	4	Vdc
Quiescent Current (V_{s1}, Pin 2 = 7.5 Vdc) (2)	$I_{s1(q)}$	—	65	mA
Power Gain (P_{out} = 2 W, V_{Cont} = 4 Vdc)	G_p	33	—	dB
Efficiency (P_{out} = 2 W, P_{in} = 1 mW) (1)	η	37	—	%
Harmonics (P_{out} = 2 W) (1) 2 f_o (P_{in} = 1 mW) 3 f_o	—	—	−45 −55	dBc
Input VSWR (P_{out} = 2 W, P_{in} = 1 mW), 50 Ω Ref. (1)	—	—	2.0:1	—
Noise power 30 kHz Bandwidth, 45 MHz above fo (P_{out} = 2 W (1) T_C = +25°C (P_{in} = 1 mW) T_C = +100°C	— —	— —	−85 −82	dBm dBm
Load Mismatch (V_{s1} = V_{s2} = V_{s3} = 10 Vdc) VSWR = 10:1, P_{out} = 3 W, P_{in} = 3 mW (1)		No Degradation in Power Output		
Stability (P_{in} = 0.5–2 mW, V_{s1} = V_{s2} = V_{s3} = 6–9 Vdc) P_{out} between 0 mW and 2 W (1) Load VSWR = 6:1, Source VSWR = 3:1)		All spurious outputs more than 60 dB below desired signal		

NOTES:
1. Adjust V_{cont} for specified P_{out}.
2. V_{Cont} = 0 Vdc.

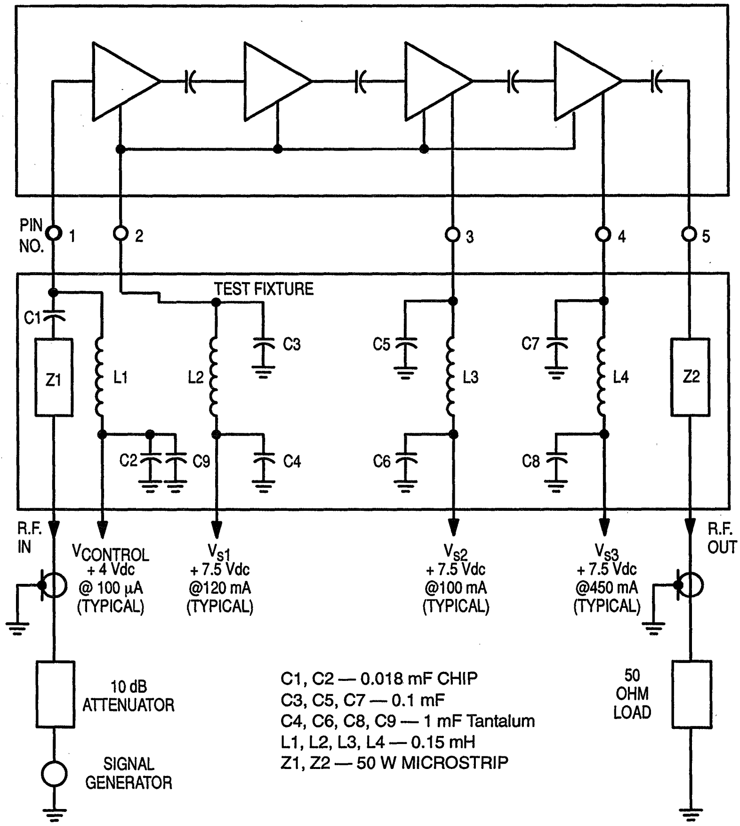


Figure 1. Power Module Test System Block Diagram

TYPICAL CHARACTERISTICS
(MHW803-1,-2)

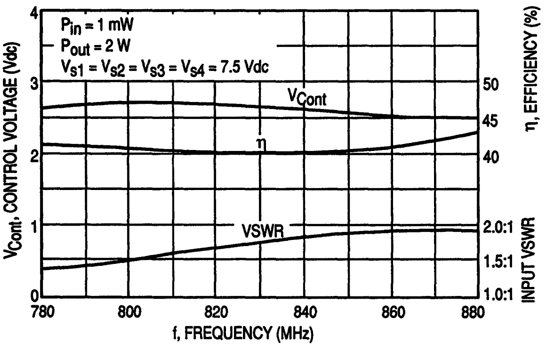


Figure 2. Control Voltage, Efficiency and VSWR versus Frequency

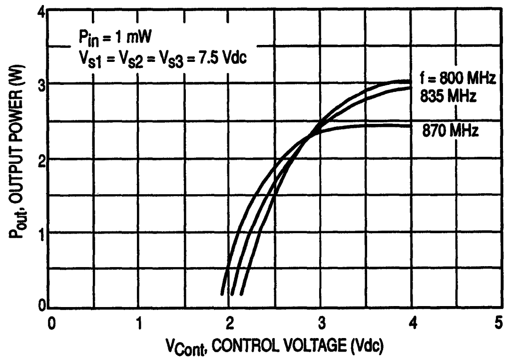


Figure 3. Output Power versus Control Voltage

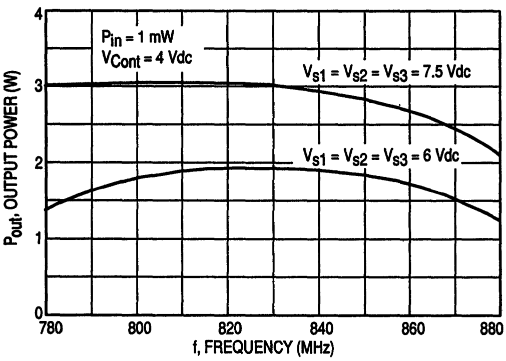


Figure 4. Output Power versus Frequency

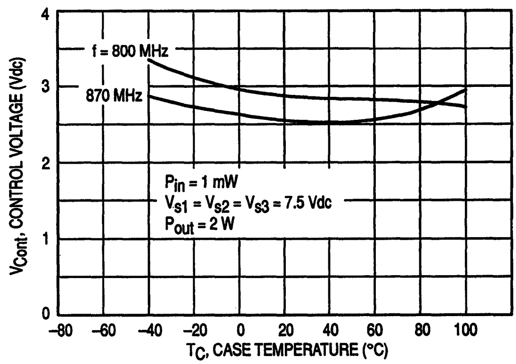


Figure 5. Control Voltage versus Case Temperature

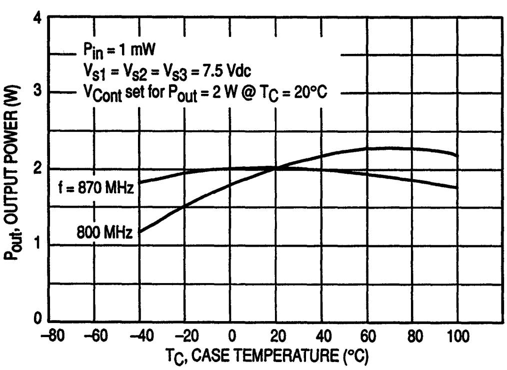


Figure 6. Output Power versus Case Temperature

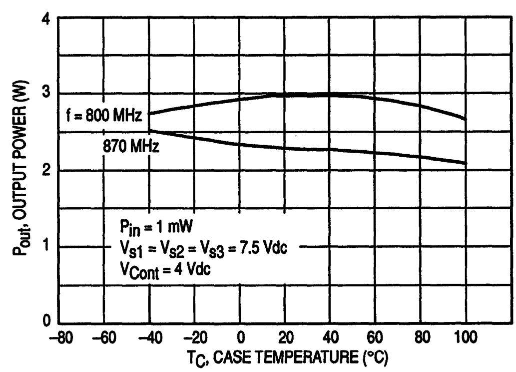


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

3

TYPICAL CHARACTERISTICS
(MHW803-3)

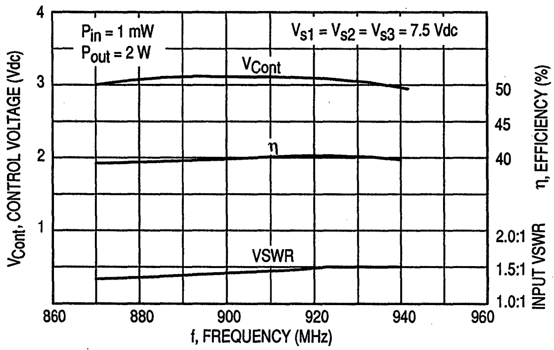


Figure 8. Control Voltage, Efficiency and VSWR versus Frequency

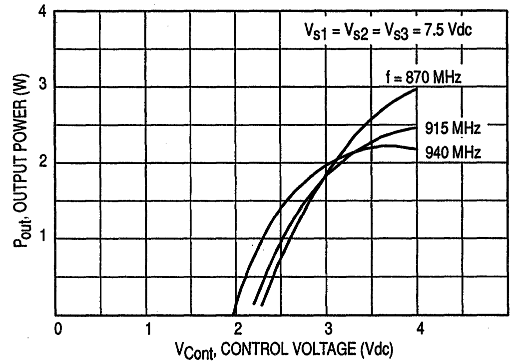


Figure 9. Output Power versus Control Voltage

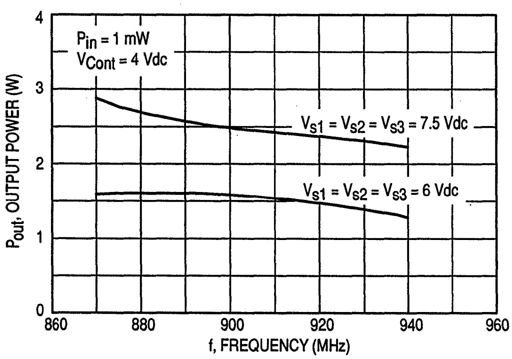


Figure 10. Output Power versus Frequency

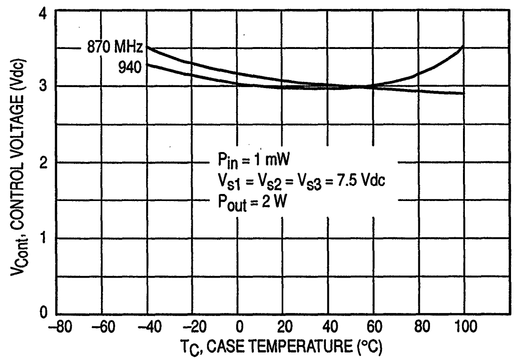


Figure 11. Control Voltage versus Case Temperature

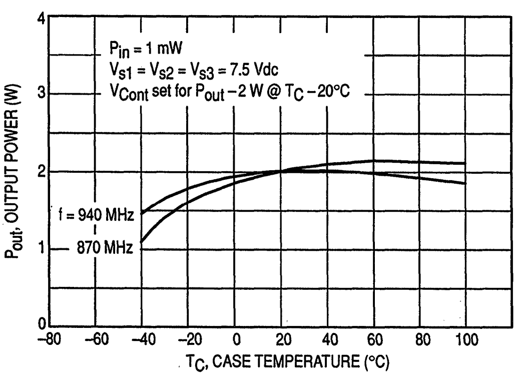


Figure 12. Output Power versus Case Temperature

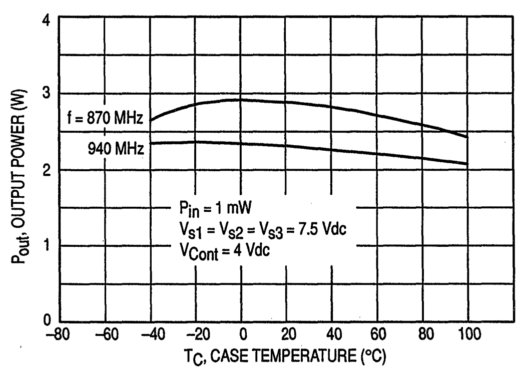


Figure 13. Output Power versus Case Temperature at Maximum Control Voltage

3

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = 7.5$ Vdc (Pins 2, 3, 4) and P_{out} equal to 2 watts. With these conditions, maximum current density on any device is 1.5×10^5 A/cm^2 and maximum die temperature with 100°C case operating temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the limits of published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output should be limited to 2 watts. The preferred method of power output control is to fix $V_{S1} = V_{S2} = V_{S3}$ = 7.5 Vdc (Pins 2, 3, 4), P_{in} (Pin 1) at 1 mW, and vary V_{Cont} (Pin 1) voltage.

DECOUPLING

Due to the high gain of the three stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3 and 4 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5 MHz through 905 MHz. For bypassing frequencies below 5 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

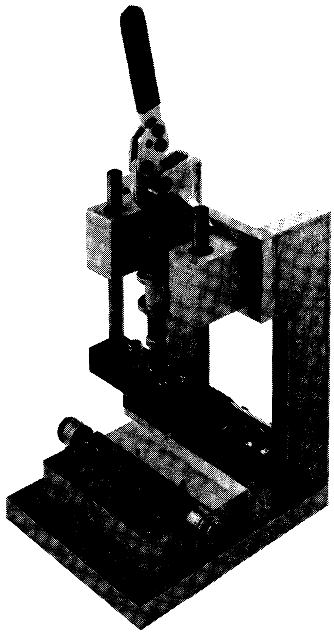


Figure 14. Test Fixture Assembly

LOAD MISMATCH

During final test, each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3}$ equal to 10 Vdc, VSWR equal to 10:1, and output power equal to 3 watts.

3

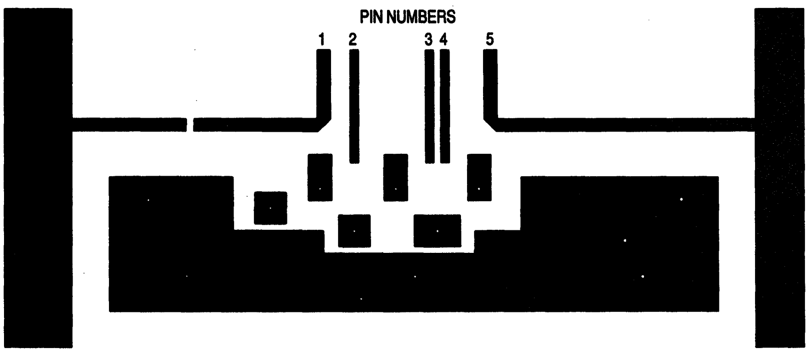


Figure 15. Photomaster For Test Fixture

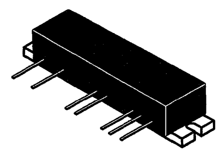
MHW804-1
MHW804-2

The RF Line
UHF Power Amplifiers

4.0 WATTS
800 to 940 MHz
RF POWER
AMPLIFIERS

. . . designed specifically for portable radio applications. The MHW804 Series is capable of wide power range control, operates from a 7.5 volt supply and requires only 1.0 mW of RF input power.

- MHW804-1 — 800 to 870 MHz
  MHW804-2 — 896 to 940 MHz
- Specified 7.5 Volt Characteristics:
  RF Input Power — 1.0 mW (0 dBm)
  RF Output Power — 4.0 W
  Minimum Gain — 36 dB
  Harmonics — –45 dBc Max @ 2.0 f_o
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness



CASE 301F, STYLE 1

3

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage	V_S	10	Vdc
DC Control Voltage	V_{cont}	4.0	Vdc
RF Input Power	P_{in}	5.0	mW
RF Output Power	P_{out}	6.0	W
Operating Case Temperature Range	T_C	– 30 to +100	°C
Storage Temperature Range	T_{stg}	– 30 to +100	°C

ELECTRICAL CHARACTERISTICS (T_C = + 25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Frequency Range MHW804-1 MHW804-2	BW	800 896	870 940	MHz
Power Gain ($V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5}$ = 7.5 V; V_{cont} = 3.75 V)	G_p	36	—	dB
Control Voltage (P_{in} = 0 dBm, P_{out} = 4.0 W, $V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5}$ = 7.5 V, Adjust V_{cont} for specified P_{out})	V_{cont}	—	3.75	Vdc
Efficiency (Same condition as for V_{cont})	η	32	—	%
Current Drain (Same conditions as for V_{cont}) IS1 + IS4 (Pins 2, 5) IS2 + IS3 + IS5 (Pins 3, 4, 6) $I_{control}$ (Pin 1)	I_D	— — —	210 1430 0.2	mA
Input VSWR (Same conditions as for V_{cont})	$VSWR_{in}$	—	2.0:1	—
Harmonic Content (Same conditions as for V_{cont}) 2.0 f_o 3.0 f_o	—	— —	– 45 – 50	dBc
Leakage Current — $I_{S2} + I_{S3} + I_{S5}$ ($V_{S2} = V_{S3} = V_{S5}$ = 7.5 V; $V_{S1} = V_{S4}$ = 0 V V_{cont} = 0 V; P_{in} = 0 mW)	I_L	—	0.3	mA
Standby Current — $I_{S1} + I_{S4}$ ($V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5}$ = 7.5 V V_{cont} = 4.0 V; P_{in} = 0 mW)	I_S	—	220	mA
Load Mismatch Stress ($V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5}$ = 9.0 V; P_{in} = 2.0 mW; P_{out} = 6.0 W; Load VSWR = 20:1, All Phase Angles. Adjust V_{cont} for Specified P_{out})	ψ	No Degradation in Output Power		
Stability ($V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5}$ = 6.0 to 9.0 V; P_{IN} = – 1.0 dBm to + 3.0 dBm; P_{out} = 1.0 W to 4.0 W; Load VSWR = 6:1, All Phase Angles; Adjust V_{cont} for Specified P_{out})	—	All Spurious Outputs More Than 60 dB Below Desired Signal		

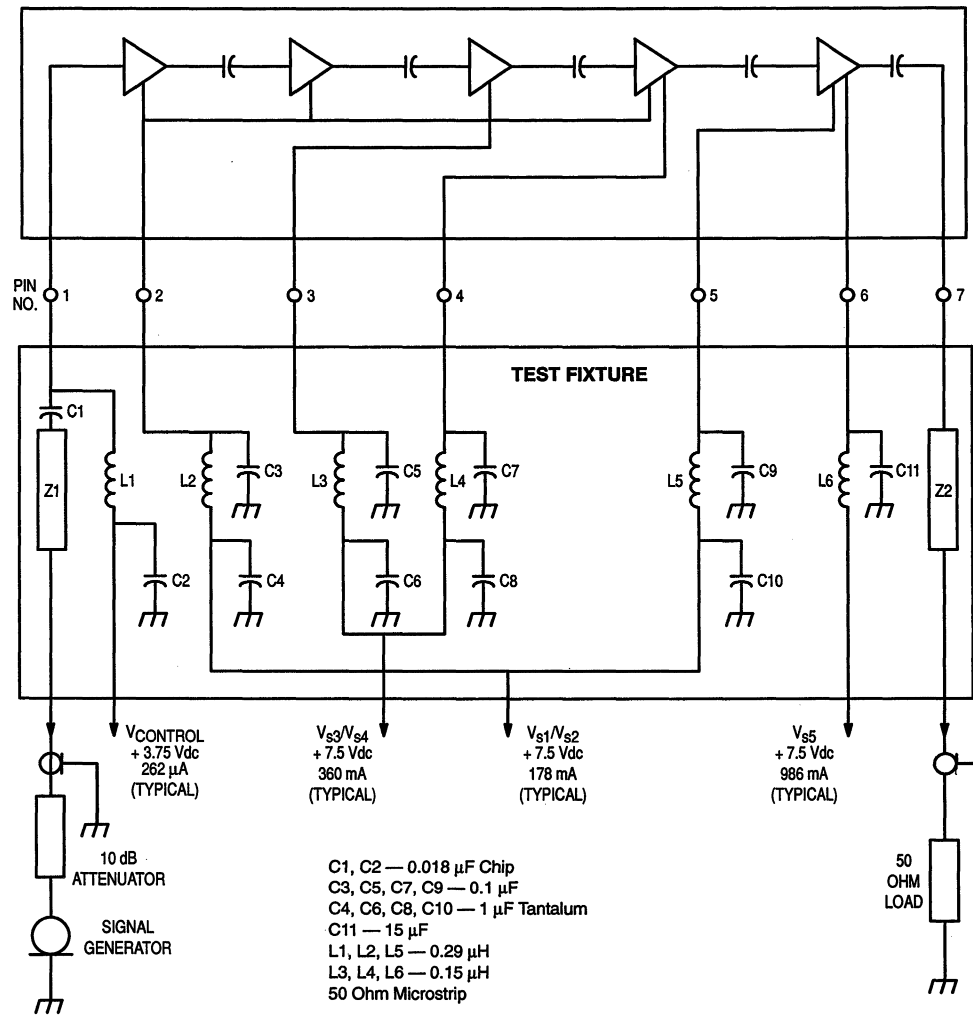


Figure 1. Power Module Test System Block Diagram

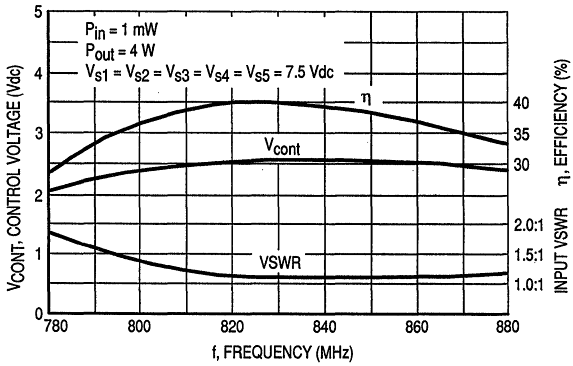


Figure 2. Control Voltage, Efficiency and VSWR versus Frequency

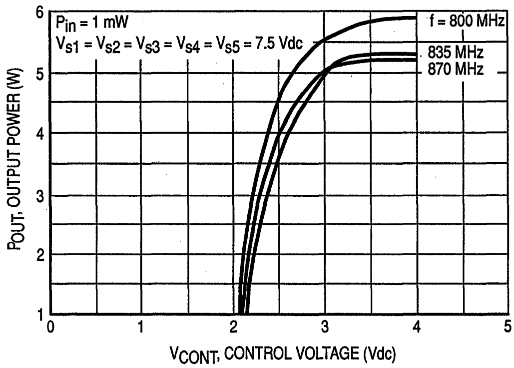


Figure 3. Output Power versus Control Voltage

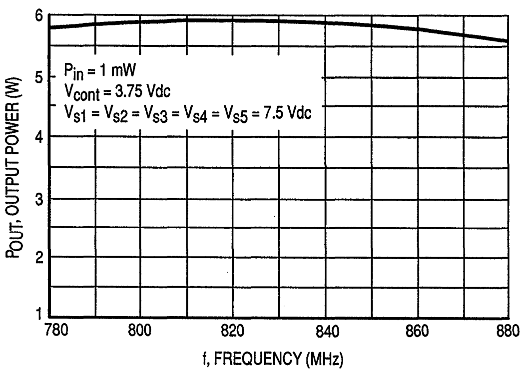


Figure 4. Output Power versus Frequency

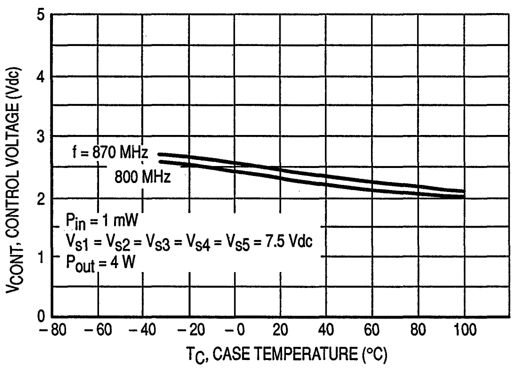


Figure 5. Control Voltage Case Temperature

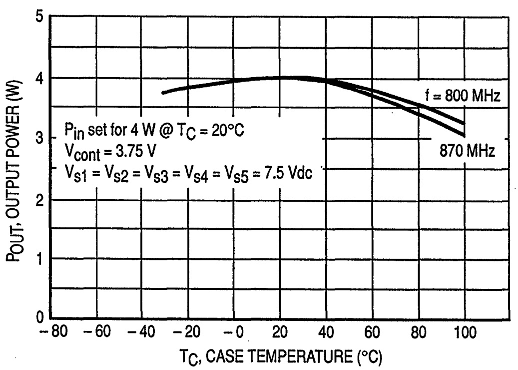


Figure 6. Output Power versus Case Temperature

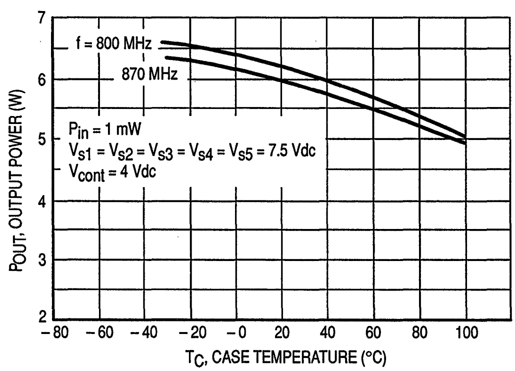


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5} = 7.5$ Vdc (Pins 2, 3, 4, 5, 6) and P_{out} equal to 4.0 watts. With these conditions, maximum current density on any device is 1.5×10^5 A/cm^2 and maximum die temperature with 100°C case operating temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the limits of published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output should be limited to 4.0 watts. The preferred method of power output control is to fix $V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5} = 7.5$ Vdc (Pins 2, 3, 4, 5, 6), P_{in} (Pin 1) at 1.0 mW, and vary V_{cont} (Pin 1) voltage.

DECOUPLING

Due to the high gain of the three stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3, 4, and 6 are internally bypassed with a 0.018 μF chip capacitor which is effective for frequencies from 5.0 MHz through 925 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

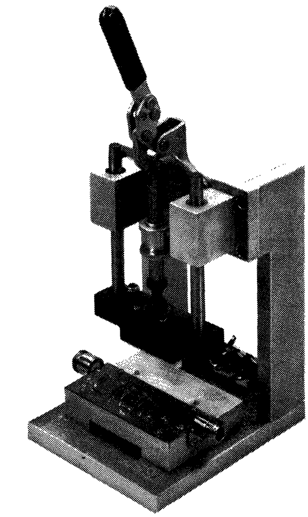
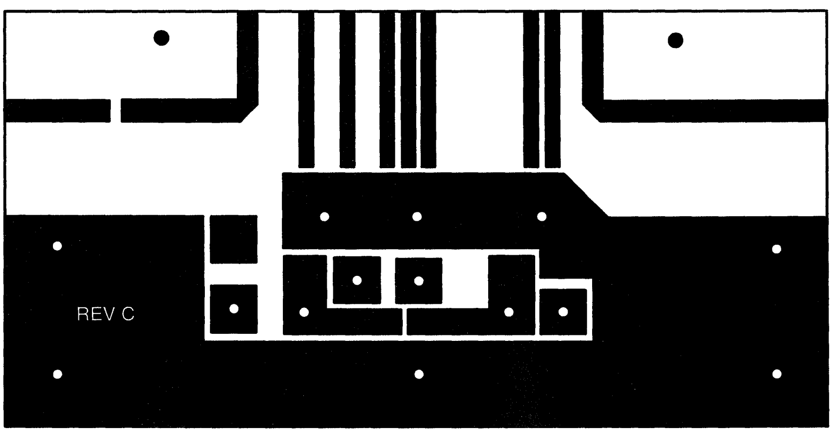


Figure 8. Test Fixture Assembly

LOAD MISMATCH

During final test, each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3} = V_{S4} = V_{S5}$ equal to 9.0 V, VSWR equal to 20:1, and output power equal to 6.0 watts.

3



(Not to Scale)

Figure 9. Photomaster For Test Fixture

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

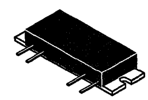
MHW806A1
MHW806A2
MHW806A3
MHW806A4

The RF Line
UHF Power Amplifiers

. . . designed for 12.5 Volt UHF power amplifier applications in industrial and commercial FM equipment operating from 806 to 950 MHz.

- MHW806A1 820–850 MHz
  MHW806A2 806–870 MHz
  MHW806A3 890–915 MHz
  MHW806A4 870–950 MHz
- Specified 12.5 Volt, UHF Characteristics
  Output Power = 6 Watts
  Minimum Gain = 23 dB (MHW806A1,2)
  = 21.7 dB (MHW806A3,4)
  Harmonics = −42 dBc Max ($2f_o$)
  = −60 dBc Max ($3f_o$ and higher)
- 50 Ω Input/Output Impedances
- Guaranteed Stability and Ruggedness
- Features Three Common-Emitter Gain Stages
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability
- Gold-Metallized and Silicon Nitride-Passivated Transistor Chips
- Controllable, Stable Performance Over More Than 35 dB Range in Output Power

6 W, 806–950 MHz
HIGH GAIN RF POWER
AMPLIFIERS



CASE 301H, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltages	V_{s1}	16	Vdc
RF Input Power	P_{in}	18	mW
RF Output Power	P_{out}	7.5	W
Storage Temperature Range	T_{stg}	–30 to +100	°C
Operating Case Temperature Range	T_C	–30 to +100	°C
DC Control Voltage	V_{Cont}	12.5	Vdc

ELECTRICAL CHARACTERISTICS (Flange Temperature = 25°C, 50 Ω system, and V_{s1} = 12.5 V unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range	MHW806A1 MHW806A2 MHW806A3 MHW806A4	BW	820 806 890 870	— — — —	850 870 915 950	MHz
Power Gain (V_{Cont} = 12.5 Vdc, P_{out} = 6 W)	MHW806A1,2 MHW806A3,4	G_p	23 21.7	24 22.7	— —	dB
Efficiency (1) (P_{out} = 6 W)		η	30	35	—	%
Harmonic Output (1) (P_{out} = 6 W Reference)	$2f_o$ $3f_o$ and Higher	—	— —	— —	−42 −60	dBc
Input VSWR (1) (P_{out} = 6 W, 50 Ω Reference, Reflected Signal Filtered to Eliminate Harmonic Content)		—	—	—	2:1	—

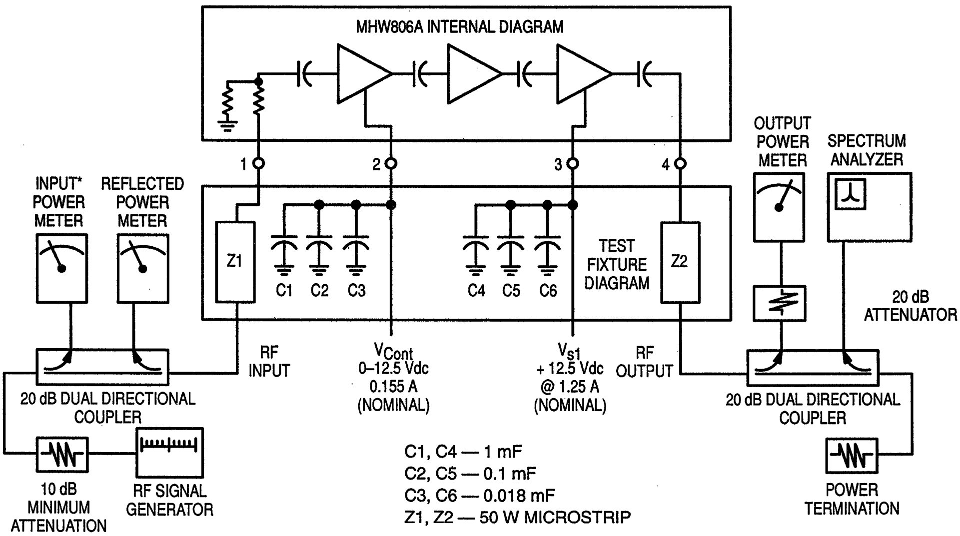
NOTE:
1. P_{in} = 30 mW (MHW806A1,2) or P_{in} = 40 mW (MHW806A3,4), adjust V_{Cont} for specified P_{out}.

(continued)

ELECTRICAL CHARACTERISTICS — continued
(Flange Temperature = 25°C, 50 Ω system, and V_{S1} = 12.5 V unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Degradation (−30 to +80°C) (1) (Reference P_{out} = 6 W @ T_C = 25°C)	—	—	—	1.7	dB
Load Mismatch Stress (1) (V_{S1} = 16 Vdc, P_{out} = 7.5 W, VSWR = 30:1, all phase angles)	—	No degradation in Power Output			
Stability (P_{in} = 0 to 30 mW, [MHW806A1,2] or 0 to 40 mW [MHW806A3,4], V_{S1} = 10 to 16 Vdc, V_{Cont} = 0 to 12.5 Vdc, Load VSWR = 4:1, P_{out} Max = 7.5 W) (2)		All spurious outputs ⩾ 70 dB below desired output signal level			
Quiescent Current @ V_{S1} = 12.5 V, V_{Cont} = 0 V (I_{Cont} with no RF drive applied)	$I_{s1(q)}$	—	—	1	mA
Control Voltage — P_{in} = 30 mW (MHW806A1,2), P_{in} = 40 mW (MHW806A3,4), P_{out} = 6 W, VCont = 12.5 V	V_{Cont}	0	9	12.5	Vdc
Control Current — P_{in} = 30 mW (MHW806A1,2), P_{in} = 40 mW (MHW806A3,4), P_{out} = 6 W, VCont = 12.5 V	I_{Cont}	0	155	225	mA

NOTES:
1. P_{in} = 30 mW (MHW806A1,2) or P_{in} = 40 mW (MHW806A3,4) adjust V_{Cont} for specified P_{out}.
2. Combination of P_{in}, V_{S1}, and V_{Cont} can not exceed max P_{out} = 7.5 W.



*Module input power is forward power as sampled by the directional coupler and read on the input power meter.

Figure 1. UHF Power Amplifier Test System Diagram

3

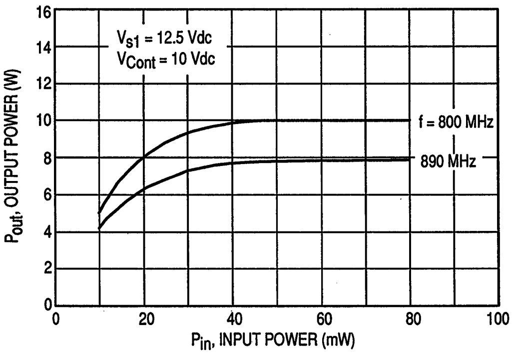


Figure 2. Output Power versus Input Power

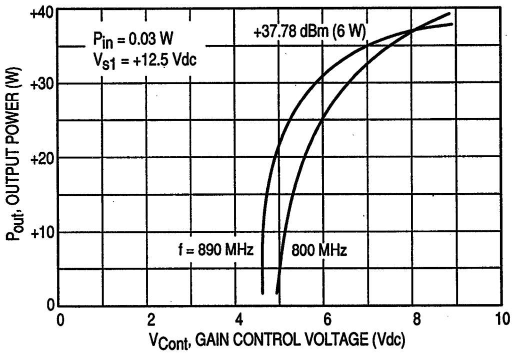


Figure 3. Output Power versus Gain Control Voltage

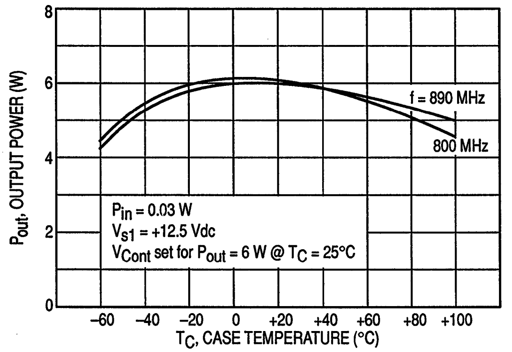


Figure 4. Output Power versus Case Temperature

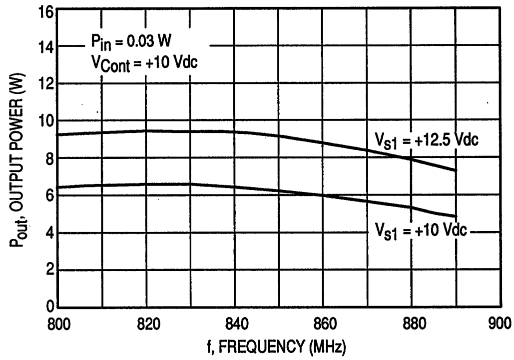


Figure 5. Output Power versus Frequency

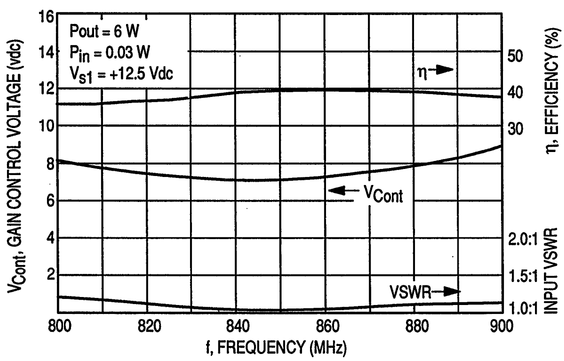


Figure 6. Gain Control Voltage Input VSWR, Efficiency versus Frequency

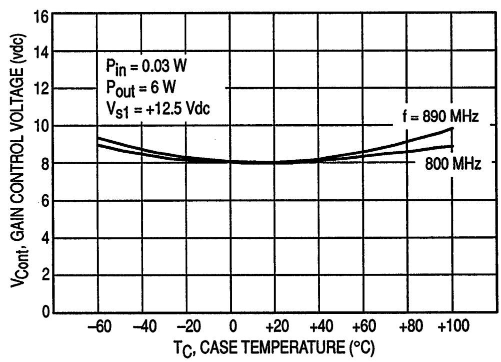


Figure 7. Gain Control Voltage versus Case Temperature

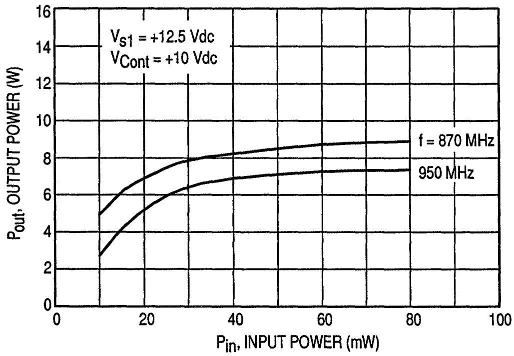


Figure 8. Output Power versus Input Power

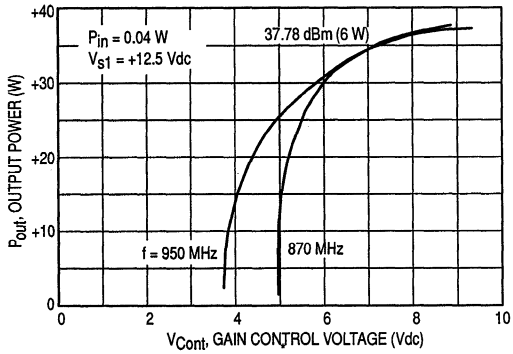


Figure 9. Output Power versus Gain Control Voltage

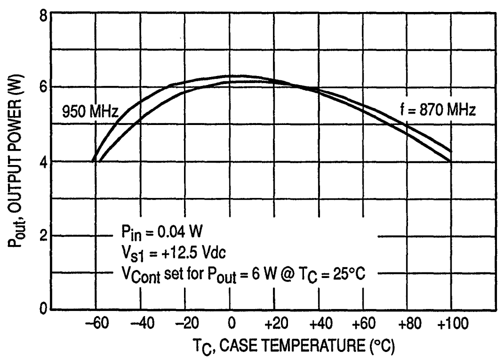


Figure 10. Output Power versus Case Temperature

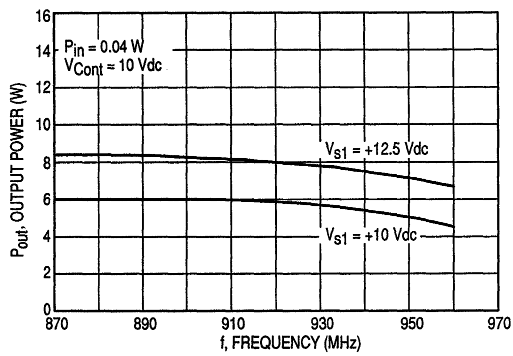


Figure 11. Output Power versus Frequency

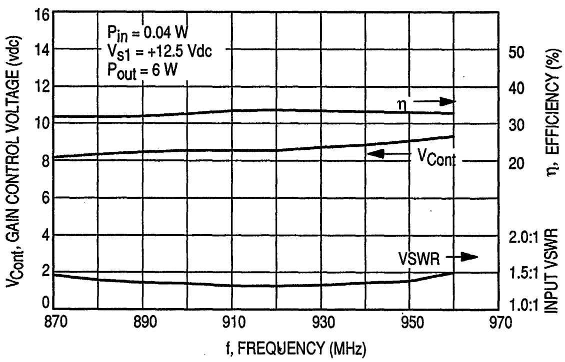


Figure 12. Gain Control Voltage, Input VSWR, Efficiency versus Frequency

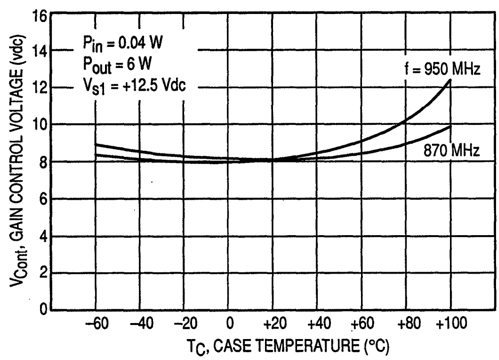


Figure 13. Gain control Voltage versus Case Temperature

3

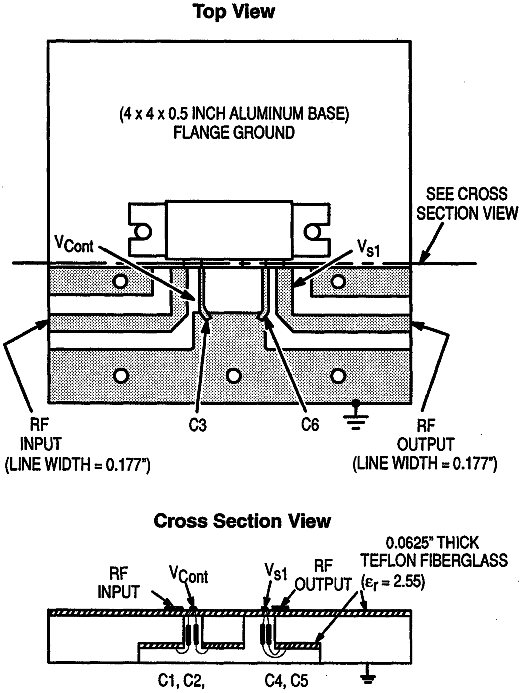
APPLICATIONS INFORMATION

Nominal Operation

All electrical specifications are based on the following nominal conditions: (P_{out} = 6W, V_{S1} = 12.5 Vdc). This module is designed to have excess gain margin with ruggedness, but operation outside the limits of the published specifications is not recommended unless prior communications regarding the intended use have been made with the factory representative.

Gain Control

In general, the module output power should be limited to 7.5 watts. The preferred method of power output control is to fix V_{S1} at 12.5 volts, set RF drive level and vary the control voltage from 0 to 12.5 Volts. As designed, the module exhibits a gain control range greater than 35 dB using the method described above.



Bring capacitor leads through fiberglass board and solder to V_{S1} and V_{Cont} lines as close to module as possible.

Figure 15. Test Fixture Construction

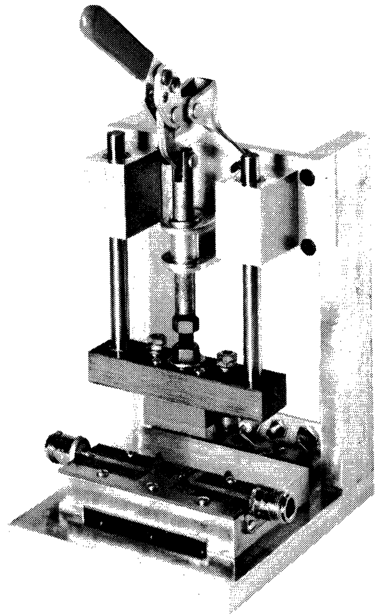


Figure 14. Test Fixture Assembly

Decoupling

Due to the high gain of each of the three stages and the module size limitation, external decoupling networks require careful consideration. Both Pins 2 and 3 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5 MHz through 960 MHz. For bypassing frequencies below 5 MHz, networks equivalent to that shown in the test fixture schematic are recommended. Inadequate decoupling will result in spurious outputs at specific operating frequencies and phase angles of input and output VSWR.

Load Mismatch Stress

During final test, each module is load mismatch stress tested in a fixture having the identical decoupling network described in Figure 1. Electrical conditions are V_{S1} equal to 16 volts, load VSWR 30:1 and output power equal to 7.5 watts.

Mounting Considerations

To insure optimum heat transfer from the flange to heatsink, use standard 6–32 mounting screws and an adequate quantity of silicone thermal compound (e.g., Dow Corning 340). With both mounting screws finger tight, alternately torque down the screws to 4–6 inch pounds. The heatsink mounting surface directly beneath the module flange should be flat to within 0.0015 inch. For more information on module mounting, see EB-107.

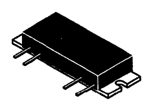
MHW812A3

The RF Line
UHF Power Amplifier

... designed for 13 Volt UHF power amplifier applications in industrial and commercial FM equipment operating from 890 to 915 MHz.

- Specified 13 Volt, UHF Characteristics
  Output Power = 12 Watts
  Minimum Gain = 20.8 dB
  Harmonics = −42 dBc Max ($2f_o$)
  −60 dBc Max ($3f_o$ and Higher)
- 50 Ω Input/Output Impedances
- Guaranteed Stability and Ruggedness
- Features Three Common-Emitter Gain Stages
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability
- Gold-Metallized and Silicon Nitride-Passivated Transistor Chips
- Controllable, Stable Performance Over More Than 35 dB Range in Output Power

**12 W, 890–915 MHz
HIGH GAIN RF POWER
AMPLIFIERS**



CASE 301H, STYLE 2

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltages	V_{S1}	16	Vdc
RF Input Power	P_{in}	200	mW
RF Output Power	P_{out}	15	W
Storage Temperature Range	T_{stg}	−30 to +100	°C
Operating Case Temperature Range	T_C	−30 to +100	°C
DC Control Voltage	V_{Cont}	12.5	Vdc

ELECTRICAL CHARACTERISTICS (Flange Temperature = 25°C, 50 Ω system, and V_{S1} = 13 V unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	890	—	915	MHz
Power Gain (V_{Cont} = 12.5 Vdc, P_{out} = 12 W)	G_p	20.8	21.5	—	dB
Efficiency (1) (P_{out} = 12 W)	η	40	45	—	%
Harmonic Output (1) (P_{out} = 12 W Reference) $2f_o$ / $3f_o$ and Higher	—	— / —	— / —	−42 / −60	dBc
Input VSWR (1) (P_{out} = 12 W, 50 Ω Reference, Reflected Signal Filtered to Eliminate Harmonic Content)	$VSWR_{in}$	—	—	2:1	—

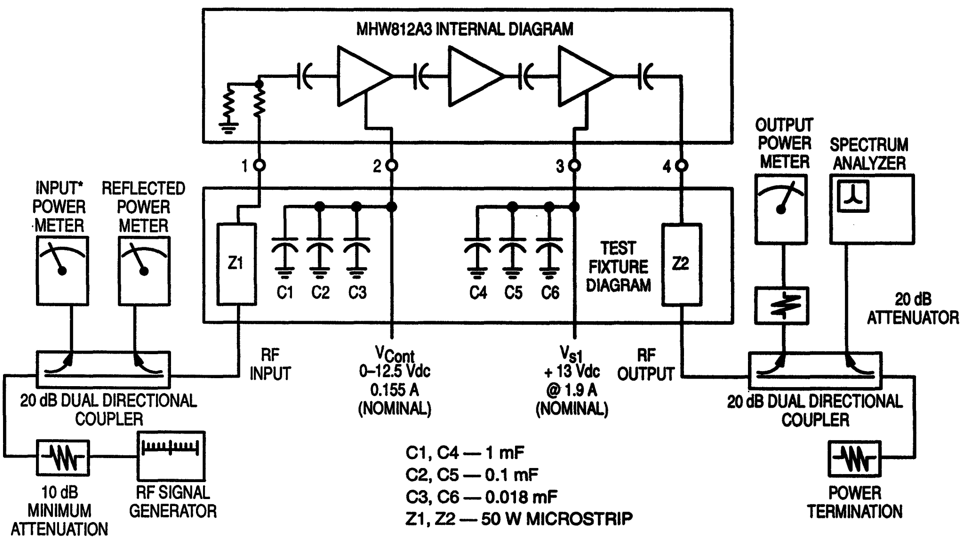
NOTE:
1. P_{in} = 100 mW; adjust V_{Cont} for specified P_{out}.

(continued)

ELECTRICAL CHARACTERISTICS — continued
(Flange Temperature = 25°C, 50 Ω system, and V_{S1} = 13 V unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Degradation (−30 to +80°C) (1) (Reference P_{out} = 12 W @ T_C = 25°C)	—	—	—	1.7	dB
Load Mismatch Stress (1) (V_{S1} = 16 Vdc, P_{out} = 13 W, VSWR = 30:1, all phase angles)	ψ	No degradation in Power Output			
Stability (P_{in} = 0 to 200 mW, V_{S1} = 10 to 16 Vdc, V_{Cont} = 0 to 12.5 Vdc, Load VSWR = 4:1, P_{out} Max = 13 W) (2)		All spurious outputs ≥ 70 dB below desired output signal level			
Quiescent Current @ V_{Cont} = 12.5 V (I_{Cont} with no RF drive applied)	I_{Cont}	—	—	225	mA
Control Voltage — P_{in} = 100 mW, P_{out} = 12 W	V_{Cont}	0	9	12.5	Vdc
Control Current — P_{in} = 100 mW, V Cont = 12.5 V	I_{Cont}	0	155	225	mA

NOTES:
1. P_{in} = 100 mW; adjust V_{Cont} for specified P_{out}.
2. Combination of P_{in}, V_{S1} and V_{Cont} can not exceed max P_{out} = 15 W.



*Module input power is forward power as sampled by the directional coupler and read on the input power meter.

Figure 1. UHF Power Amplifier Test System Diagram

TYPICAL CHARACTERISTICS

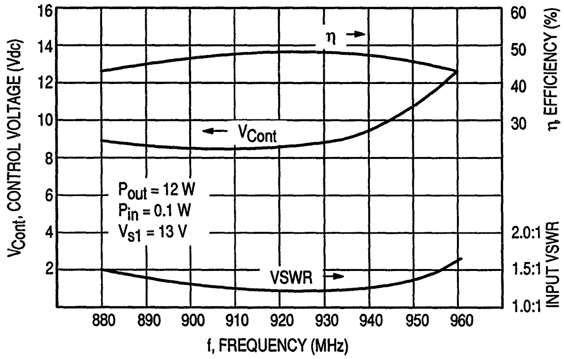


Figure 2. Control Voltage, Efficiency and VSWR versus Frequency

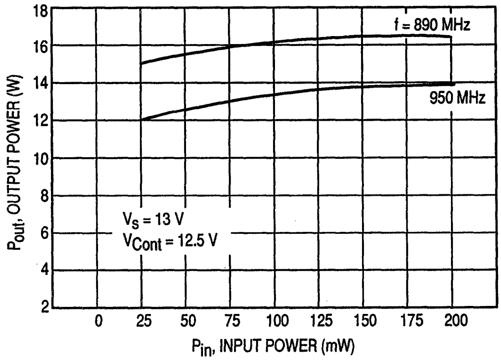


Figure 3. Output Power versus Input Power

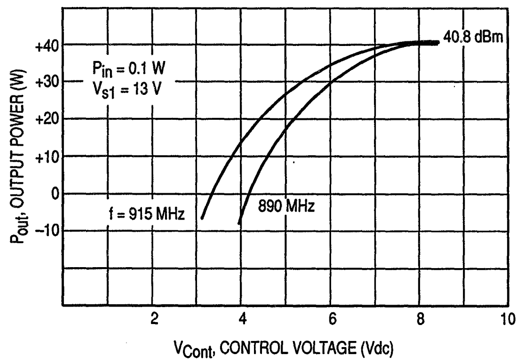


Figure 4. Output Power versus Control Voltage

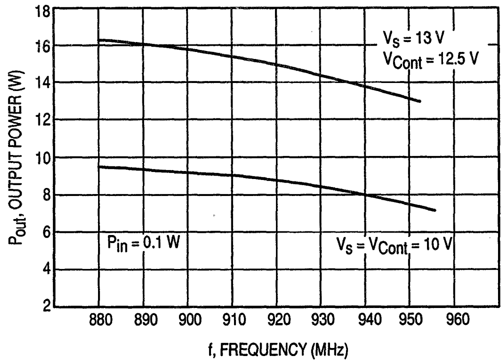


Figure 5. Output Power versus Frequency

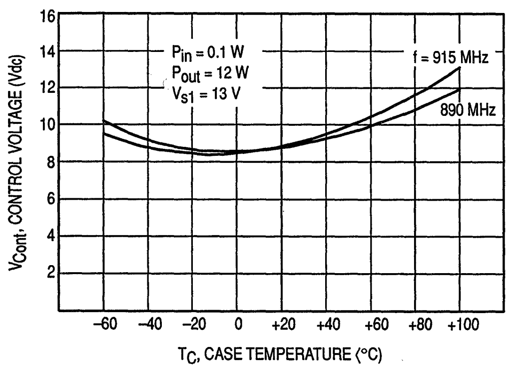


Figure 6. Control Voltage versus Case Temperature

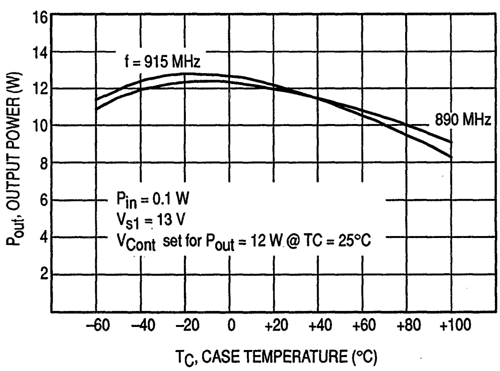


Figure 7. Output Power versus Case Temperature

APPLICATIONS INFORMATION

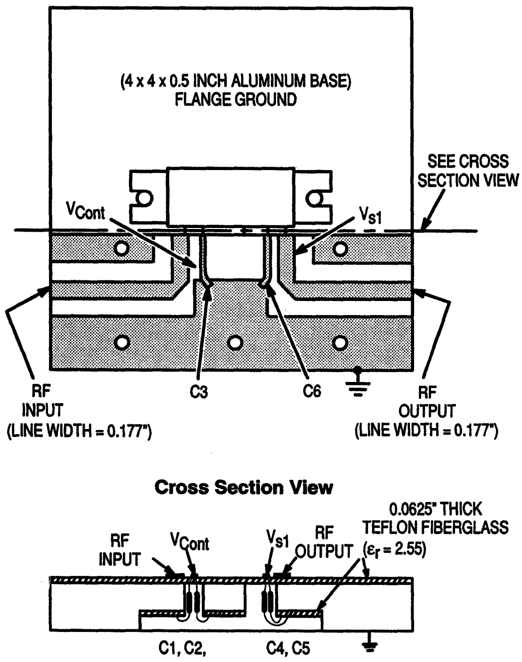
Nominal Operation

All electrical specifications are based on the following nominal conditions: (P_{out} = 12 W, V_{S1} = 13 Vdc). This module is designed to have excess gain margin with ruggedness, but operation outside the limits of the published specifications is not recommended unless prior communications regarding the intended use have been made with a factory representative.

Gain Control

In general, the module output power should be limited to 13 watts. The preferred method of power output control is to fix V_{S1} at 13 volts, set RF drive level and vary the control voltage from 0 to 12.5 Volts. As designed, the module exhibits a gain control range greater than 35 dB using the method described above.

Top View



Bring capacitor leads through fiberglass board and solder to V_{S1} and V_{Cont} lines as close to module as possible.

Figure 9. Test Fixture Construction

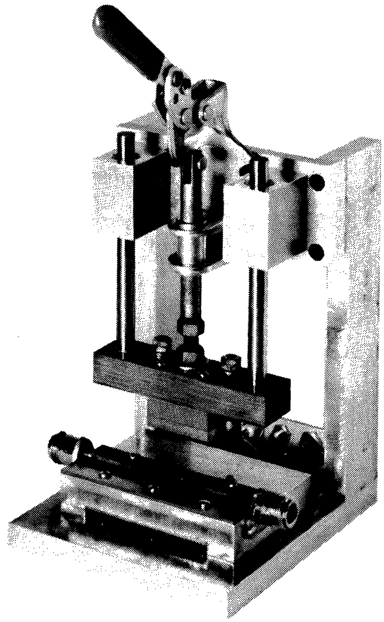


Figure 8. Test Fixture Assembly

Decoupling

Due to the high gain of each of the three stages and the module size limitation, external decoupling networks require careful consideration. Both Pins 2 and 3 are internally bypassed with a 0.018 μF chip capacitor which is effective for frequencies from 5 MHz through 960 MHz. For bypassing frequencies below 5 MHz, networks equivalent to that shown in the test fixture schematic are recommended. Inadequate decoupling will result in spurious outputs at specific operating frequencies and phase angles of input and output VSWR.

Load Mismatch Stress

During final test, each module is load mismatch stress tested in a fixture having the identical decoupling network described in Figure 1. Electrical conditions are V_{S1} equal to 16 volts, load VSWR 30:1 and output power equal to 13 watts.

Mounting Considerations

To insure optimum heat transfer from the flange to heatsink, use standard 6–32 mounting screws and an adequate quantity of silicone thermal compound (e.g., Dow Corning 340). With both mounting screws finger tight, alternately torque down the screws to 4–6 inch pounds. The heatsink mounting surface directly beneath the module flange should be flat to within 0.0015 inch. For more information on module mounting, see EB-107.

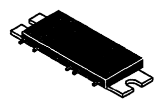
MHW851-1
MHW851-2
MHW851-3
MHW851-4

The RF Line
UHF Power Amplifiers

. . . capable of wide power range control as encountered in portable cellular radio applications (30 dB typical).

- High Efficiency
- MHW851-1: f = 820–850 MHz
- MHW851-2: f = 870–905 MHz
- MHW851-3: f = 890–915 MHz
- MHW851-4: f = 915–925 MHz
- Specified 6.0 Volt Characteristics
  RF Input Power = 1.0 mW (0 dBm)
  RF Output Power = 1.6 Watts (MHW851-1,-2,-4)
  = 2.0 Watts (MHW851-3)
  Minimum Gain ($V_{Control}$ = 3.5 V) = 32 dB (MHW851-1,-2,-4)
  ($V_{Control}$ = 3.5 V) = 33 dB (MHW851-3)
  Harmonics = –45 dBc Max @ 2.0 f_o
- 50 Ω Input/Output Impedance
- Guaranteed Stability and Ruggedness
- Epoxy Glass PCB Construction Gives Consistent Performance and Reliability

**1.6 W, 820–925 MHz
RF POWER
AMPLIFIERS**



CASE 301N, STYLE 1

3

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage (Pins 2, 3, 4)	$V_{S1,2,3}$	7.5	Vdc
DC Control Voltage (Pin 1)	V_{Cont}	4.0	Vdc
RF Input Power	P_{in}	3.0	mW
RF Output Power ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 V)	P_{out}	3.0	W
Operating Case Temperature Range	T_C	–30 to +100	°C
Storage Temperature Range	T_{stg}	–30 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{S1} = V_{S2} = V_{S3}$ = 6.0 Vdc, (Pins 2, 3, 4), T_C = 25°C, 50 Ω System)

Characteristic		Symbol	Min	Max	Unit
Frequency Range	MHW851-1 MHW851-2 MHW851-3 MHW851-4	BW	820 870 890 915	850 905 915 925	MHz
Control Voltage (P_{out} = 1.6 W, P_{in} = 1.0 mW) (1)(3)		V_{Cont}	0	3.5	Vdc
Quiescent Current (V_{S1}, Pin 2 = 6.0 Vdc) (2)		$I_{S1(q)}$	—	65	mA
Power Gain (P_{out} = 1.6 W, V_{Cont} = 3.5 Vdc) (3) (P_{out} = 2.0 W, V_{Cont} = 3.5 Vdc)	MHW851-1,-2,-4 MHW851-3	G_p	32 33	—	dB
Efficiency (P_{out} = 1.6 W, P_{in} = 1.0 mW) (1) (3)		η	45	—	%

NOTES:
1. Adjust V_{cont} for specified P_{out}.
2. V_{Cont} = 0 Vdc.
3. P_{out} = 2.0 watts for MHW851-3 only.

(continued)

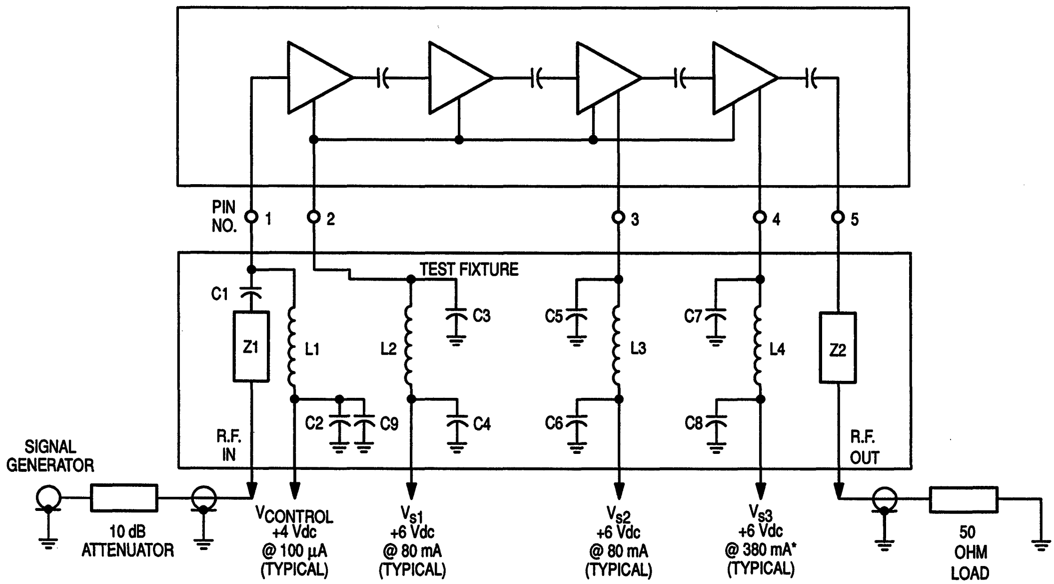
3

ELECTRICAL CHARACTERISTICS ($V_{S1} = V_{S2} = V_{S3}$ = 6.0 Vdc, (Pins 2, 3, 4), T_C = 25°C, 50 Ω System)

Characteristic	Symbol	Min	Max	Unit
Harmonics (P_{out} = 1.6 W) (1)(3) 2.0 f_o (P_{out} = 1.0 mW) 3.0 f_o	—	—	–45 –55	dBc
Input VSWR (P_{out} = 1.6 W, V_{Cont} = 3.5 V) (3)(4)	$VSWR_{in}$	—	2.0:1	—
Noise Power 30 kHz Bandwidth, 45 MHz, above f_o (P_{out} = 1.6 W) (1)(3) T_C = +25°C (P_{in} = 1.0 mW) T_C = +100°C	—	 — —	 –85 –82	dBm
Load Mismatch ($V_{S1} = V_{S2} = V_{S3}$ = 7.5 Vdc) VSWR = 10:1, P_{out} = 3.0 W, P_{in} = 3.0 mW) (1)	ψ	No Degradation in Power Output		
Stability (P_{in} = 0.5–2.0 mW, $V_{S1} = V_{S2} = V_{S3}$ = 4.8–7.5 Vdc P_{out} between 0 mW and 1.6 W (1)(3) Load VSWR = 6:1, Source VSWR = 3:1)		All spurious outputs more than 60 dB below desired signal		

NOTES:

1. Adjust V_{Cont} for specified P_{out}.
2. V_{Cont} = 0 Vdc.
3. P_{out} = 2.0 watts for MHW851-3 only.
4. Adjust P_{in} for specified P_{out}.



C1, C2 — 0.018 mF CHIP
C3, C5, C7 — 0.1 mF
C4, C6, C8, C9 — 1 mF TANTALUM
L1, L2, L3, L4 — 0.15 mH
Z1, Z2 — 50 W MICROSTRIP

*480 mA for MHW851–3

Figure 1. Power Module Test System Block Diagram

TYPICAL CHARACTERISTICS

MHW851-1 and MHW851-2

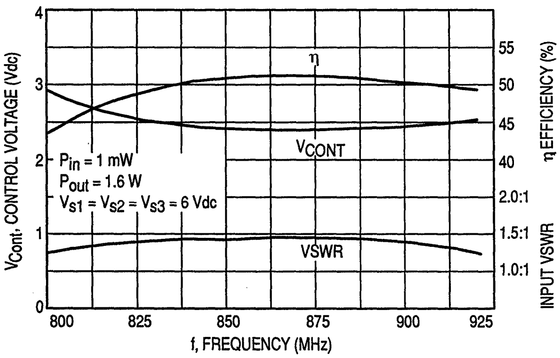


Figure 2. Control Voltage, Efficiency and Input VSWR versus Frequency

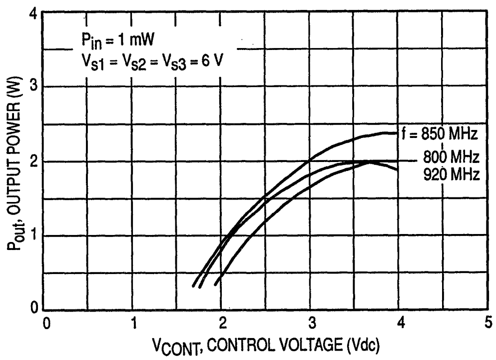


Figure 3. Output Power versus Control Voltage

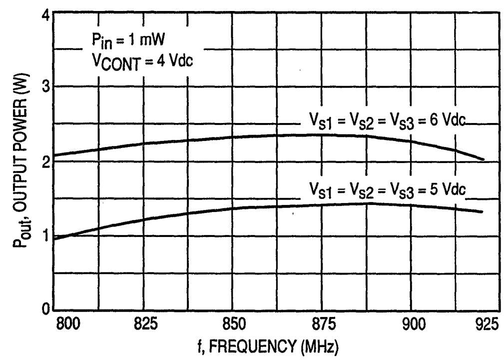


Figure 4. Output Power versus Frequency

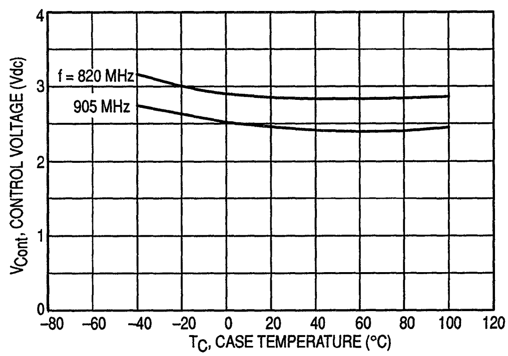


Figure 5. Control Voltage versus Case Temperature

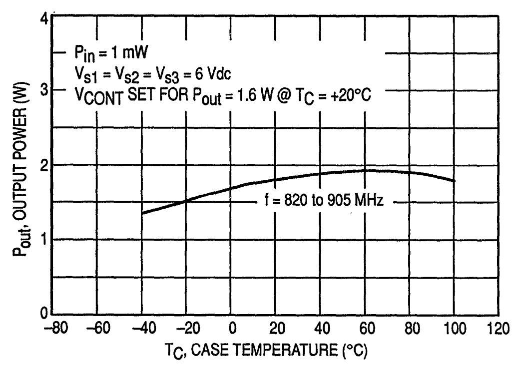


Figure 6. Output Power versus Case Temperature

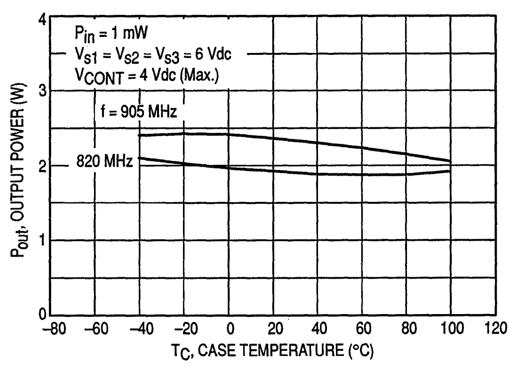


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

3

TYPICAL CHARACTERISTICS (continued)

MHW851-3 and MHW851-4

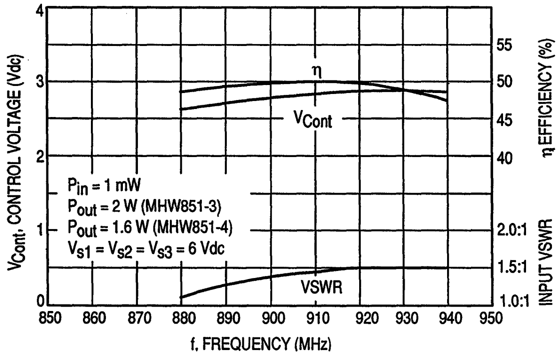


Figure 8. Control Voltage, Efficiency and VSWR versus Frequency

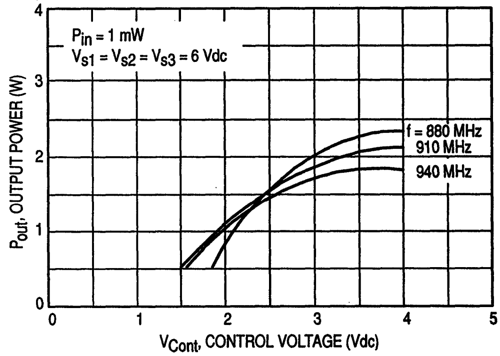


Figure 9. Output Power versus Control Voltage

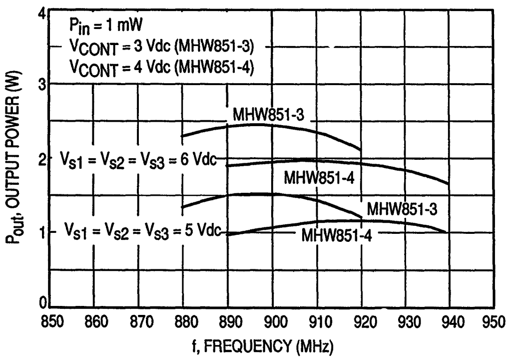


Figure 10. Output Power versus Frequency

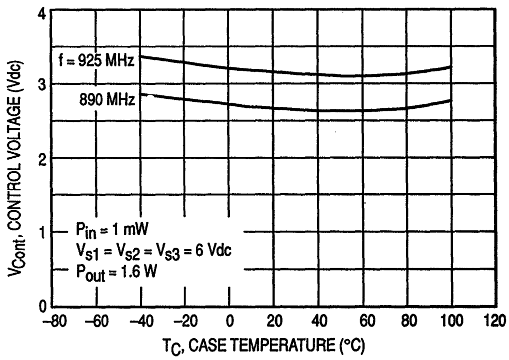


Figure 11. Control Voltage versus Case Temperature

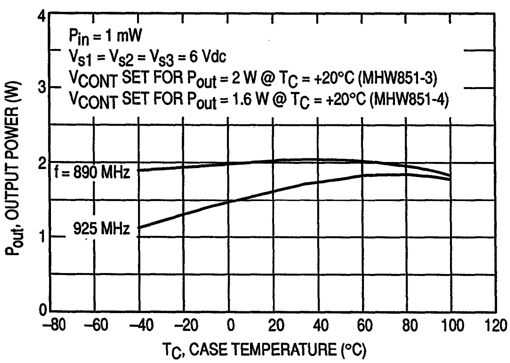


Figure 12. Output Power versus Case Temperature

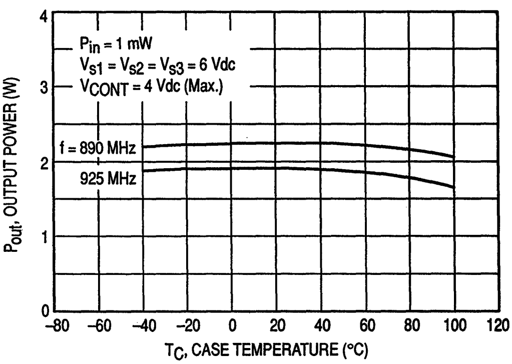


Figure 13. Output Power versus Case Temperature at Maximum Control Voltage

3

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = 6.0$ Vdc (Pins 2, 3, 4). With these conditions, maximum current density on any device is 1.5×10^5 A/cm^2 and maximum die temperature with 100°C case operating temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the limits of published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output should be limited to specified value. The preferred method of power output control is to fix $V_{S1} = V_{S2} = V_{S3} = 6.0$ Vdc (Pins 2, 3, 4), P_{in} (Pin 1) at 1 mW, and vary V_{Cont} (Pin 1) voltage.

DECOUPLING

Due to the high gain of the three stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3 and 4 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5 MHz through 940 MHz. For bypassing frequencies below 5 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

Remember that the modules are NOT hermetic. Do not immerse a module in a flux cleaning solution or other liquids under any circumstances.

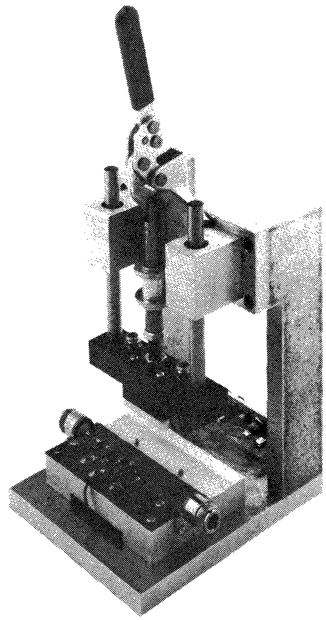
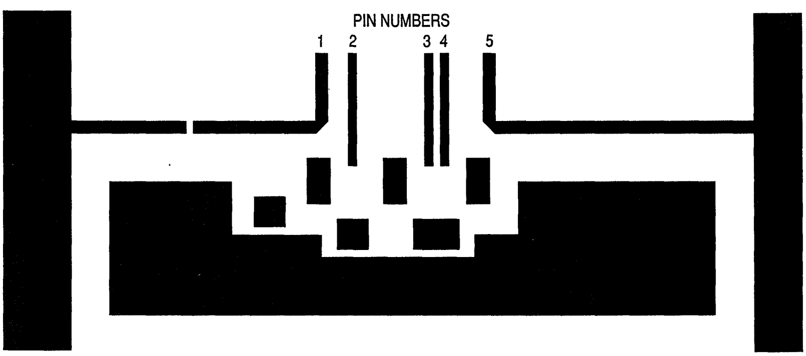


Figure 14. Test Fixture Assembly

LOAD MISMATCH

During final test, each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3}$ equal to 7.5 Vdc, VSWR equal to 10:1, and output power equal to 3 watts.

3



(Not to Scale)

Figure 15. Photomaster For Test Fixture

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

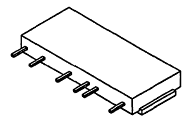
MHW903
MHW953
MHW954

The RF Line
UHF Power Amplifiers

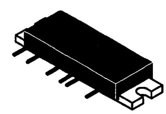
. . . designed specifically for the Pan European digital 2.0 watt, GSM hand-held radio. The MHW903, MHW953 and MHW954 are capable of wide power range control, operate from a 7.2 volt supply and require 1.0 mW (MHW903/953) or 100 mW (MHW954) of RF input power.

- Specified 7.2 Volt Characteristics:
  RF Input Power — 1.0 mW (0 dBm) MHW903/953; 100 mW (20 dBm) MHW954
  RF Output Power — 3.5 W
  Minimum Gain — 35.4 dB (MHW903/953) or 15.4 dB (MHW954)
  Harmonics — −35 dBc Max @ 2.0 f_o (MHW930/953) or
  −30 dBc Max @ 2.0 f_o (MHW954)
- New Biasing and Control Techniques Providing Dynamic Range and Control Circuit Bandwidth Ideal for GSM
- Low Control Current
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness

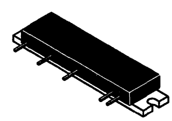
3.5 W
890 to 915 MHz
RF POWER
AMPLIFIERS



CASE 413A, STYLE 1
(MHW903)



CASE 301V, STYLE 1
(MHW953)



CASE 301Y, STYLE 1
(MHW954)

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{S1}, V_{S2}, V_{S3}	9.0	Vdc
DC Bias Voltage (MHW903/953) (MHW954)	V_b	5.25 4.75	Vdc
DC Control Voltage (MHW903/953 only)	V_{cont}	3.0	Vdc
RF Input Power (MHW903/953) (MHW954)	P_{in}	2.0 400	mW
RF Output Power (V_S = 9.0 Vdc)	P_{out}	4.5	W
Operating Case Temperature Range Storage Temperature Range	T_C T_{stg}	−30 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{S1} = V_{S2} = V_{S3}$ = 7.2 Vdc; V_b = 5.0 Vdc for MHW903/953)
($V_{S1} = V_{S2}$ = 7.2 Vdc; V_b = 4.5 Vdc for MHW954)
(T_C = 25°C; 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Frequency Range	BW	890	915	MHz
Power Gain (P_{out} = 3.5 mW) MHW903/953 (1) MHW954 (2)	G_P	35.4 15.4	— —	dB
Control Current (P_{out} = 3.5 W; P_{in} = 1.0 mW) MHW903/953 only (1)	I_{cont}	—	1.0	mA
Supply Current (P_{out} = 3.5 W; P_{in} = 1.0 mW) MHW903/953 only (1)	I_b	—	85	mA
Leakage Current (P_{in} = 0 mW; $V_{cont} = V_b$ = 0 Vdc; $V_{S1} = V_{S2} = V_{S3}$ = 9.0 Vdc for MHW903/953. P_{in} = 0 mW; V_b = 0 Vdc; $V_{S1} = V_{S2}$ = 9.0 Vdc for MHW954)	I_L	 — —	 1.0 200	 mA µA
Input VSWR (P_{out} = 3.5 W; P_{in} = 1.0 mW) MHW903/953 (1) (P_{out} = 3.5 W) MHW954 (2)	$VSWR_{in}$	—	2.0:1	—

NOTES:
1. Adjust V_{cont} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms
2. Adjust P_{in} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms

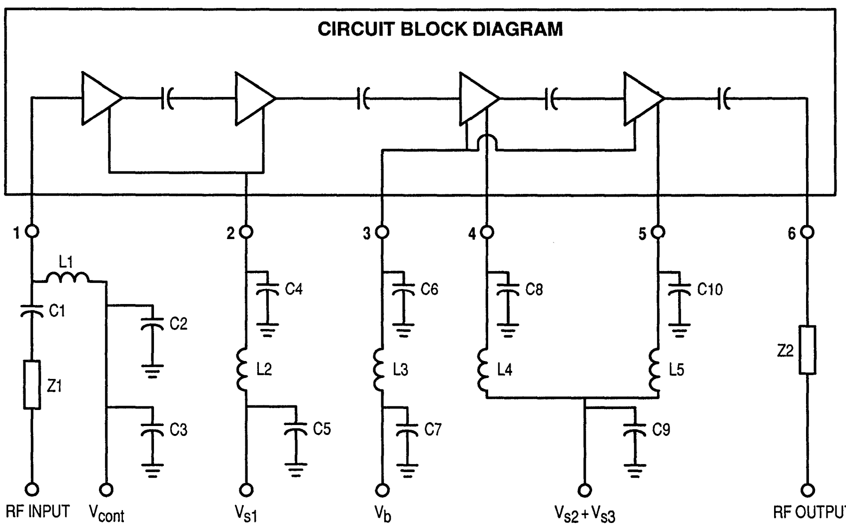
(continued)

ELECTRICAL CHARACTERISTICS — continued ($V_{S1} = V_{S2} = V_{S3}$ = 7.2 Vdc; V_b = 5.0 Vdc for MHW903/953)
($V_{S1} = V_{S2}$ = 7.2 Vdc; V_b = 4.5 Vdc for MHW954)
(T_C = 25°C; 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Efficiency (P_{out} = 3.5 W; P_{in} = 1.0 mW) MHW903/953 (1) (P_{out} = 3.5 W) MHW954 (2)	η	40	—	%
Harmonics (P_{out} = 3.5 W; P_{in} = 1.0 mW) MHW903/953 (1) 2.0 f_o 3.0 f_o (P_{out} = 3.5 W) MHW954 (2) 2.0 f_o 3.0 f_o	—	— — — —	−35 −45 −30 −40	dBc
Noise Power (In 30 kHz Bandwidth, 20 MHz above f_o) (T_C = 25°C−100°C) (P_{out} = 0.3−3.5 W; $V_{S1} = V_{S2} = V_{S3}$ = 6.25−9.0 Vdc, P_{in} = 1.0 mW) MHW903/953 (1) (P_{out} = 0.3−3.5 W; $V_{S1} = V_{S2}$ = 6.25−9.0 Vdc) MHW954 (2)	—	— —	−65 −75	dBm
Output Power, Low Voltage (P_{in} = 1.0 mW; $V_{S1} = V_{S2} = V_{S3}$ = 6.25 Vdc; V_{cont} = 3.0 Vdc) MHW903/953 (P_{in} = 100 mW; $V_{S1} = V_{S2}$ = 6.25 Vdc) MHW954	P_{o1}	2.0 2.3	— —	W
Isolation (P_{in} = 1.0 mW; V_{cont} = 0 Vdc; $V_{S1} = V_b$ = 0−5 Vdc) MHW903/953 only (1)	—	—	−36	dBm
3.0 dB V_{cont} Bandwidth (P_{in} = 1.0 mW; P_{out} = 0.03−3.5 W) MHW903/953 only (1)	—	1.0	—	MHz
% AM In Output (P_{out} = 0.035−3.5 W; 135 kHz, 1% AM on Input) MHW954 only (2)	—	—	6	%
Load Mismatch Stress (P_{in} = 2.0 mW; P_{out} = 3.5 W; $V_{S1} = V_{S2} = V_{S3}$ = 9.0 Vdc) MHW903/953 (1) (P_{out} = 3.5 W; V_b = 4.75 Vdc; $V_{S1} = V_{S2}$ = 9.0 Vdc) MHW954 (2) (Load VSWR = 10:1, All Phase Angles at Frequency of Test)	ψ	No degradation in output power before and after test		
Stability (P_{in} = 0.5 to 2.0 mW; P_{out} = 0.03−3.5 W; $V_{S1} = V_{S2} = V_{S3}$ = 6.0 to 9.0 Vdc) MHW903/953 (1) (P_{out} = 0.03−3.5 W; $V_{S1} = V_{S2}$ = 6.0 to 9.0 Vdc) MHW954 (2) (Load VSWR = 6:1, Source VSWR = 3:1, All Phase Angles at Frequency of Test)	—	All spurious outputs more than 60 dB below desired signal		

NOTES:
1. Adjust V_{cont} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms
2. Adjust P_{in} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms

3



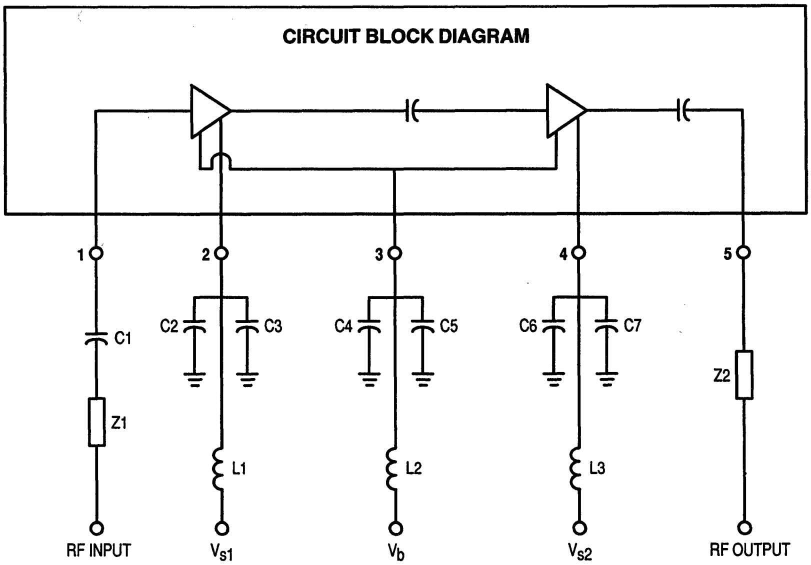
PIN DESIGNATIONS:

Pin 1 — RF Input Power @ 0 dBm and Control Voltage @ 0−3.0 Vdc
Pin 2 — First and Second Stage Collector Supply Voltage @ 7.2 Vdc
Pin 3 — Trickle Base Bias Voltage @ 5.0 Vdc
Pin 4 — Third Stage Collector Supply Voltage @ 7.2 Vdc
Pin 5 — Fourth Stage Collector Supply Voltage @ 7.2 Vdc
Pin 6 — RF Output Power @ 3.5 W

ELEMENT VALUES:

C1=C2= 0.018 μF
C4=C6=C8=C10= 0.1 μF
C3=C5=C7=C9 = 1.0 μF Tant.
L1−L3 = 0.29 μH Choke
L4, L5 = 0.15 μH Choke
Z1, Z2 = 50 Ohm Microstrip

Figure 1. Test Circuit Diagram — MHW903/953



PIN DESIGNATIONS:

Pin 1 — RF Input Power @ 20 dBm Max Adjust for Output Power
Pin 2 — First Stage Collector Voltage @ 7.2 Vdc
Pin 3 — Trickle Bias Voltage @ 4.5 Vdc
Pin 4 — Third Stage Collector Supply @ 7.2 Vdc
Pin 5 — RF Output Power @ 3.5 W Nominal

ELEMENT VALUES:

C1=C2=C4=C6= 0.018 μF
C3=C5=C7= 2.2 μF
L1, L2 = 0.29 μH
L3 = 0.2 μH
Z1, Z2 = 50 Ohm Microstrip

Figure 2. Test Circuit Diagram — MHW954

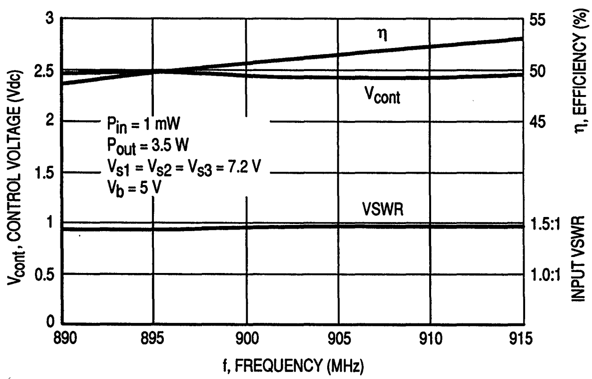


Figure 3. Control Voltage, Efficiency and Input VSWR versus Frequency

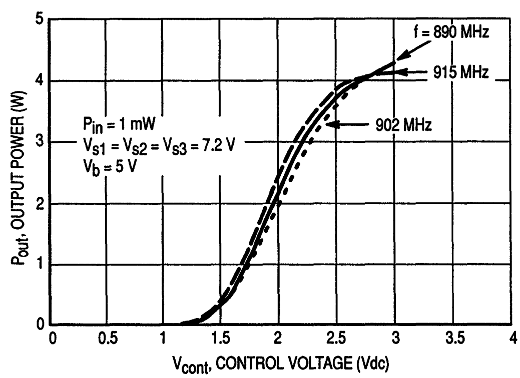


Figure 4. Output Power versus Control Voltage

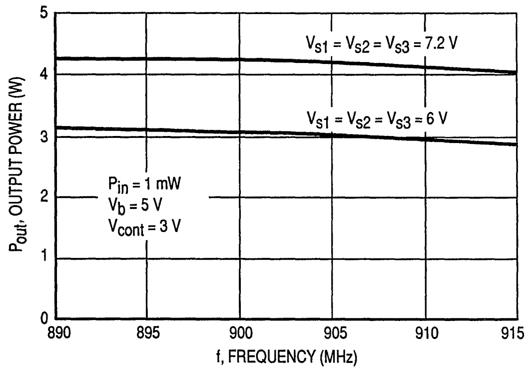


Figure 5. Output Power versus Frequency

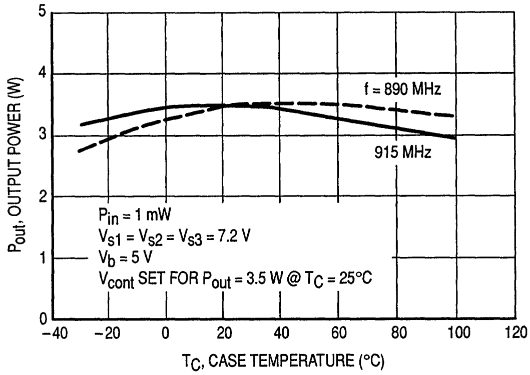


Figure 6. Output Power versus Case Temperature

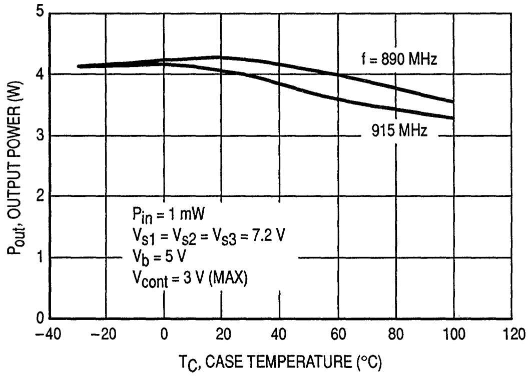


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

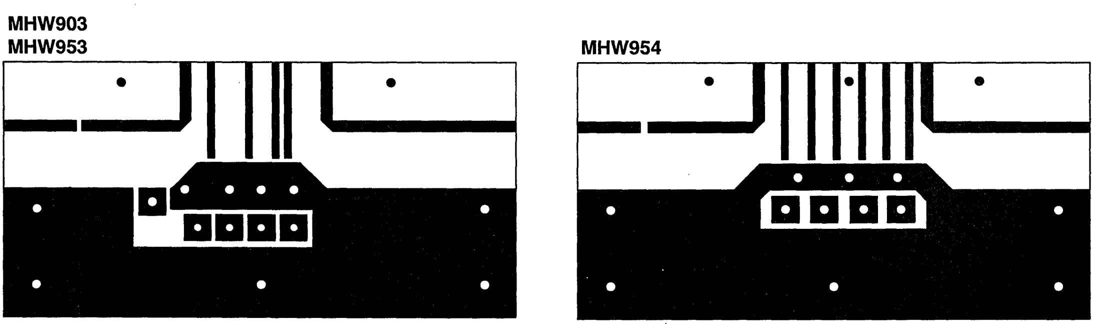


Figure 8. Photomasters for Test Fixture

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = 7.2$ Vdc (Pins 2, 4, 5) and $V_b = 5.0$ Vdc (Pin 3) for MHW903/953. Nominal conditions are $V_{S1} = V_{S2} = 7.2$ Vdc (Pins 2 and 4) and $V_b = 4.5$ Vdc (Pin 3) for MHW954. With these conditions, maximum current density on any device is 1.5×10^5 A/cm^2 and maximum die temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output power should be limited to specified value. The preferred method of power control for the MHW903/953 is to fix $V_{S1} = V_{S2} = V_{S3} = 7.2$ Vdc, $V_b = 5.0$ Vdc, P_{in} (Pin 1) at 1.0 mW, and vary V_{cont} (Pin 1) voltage. For the MHW954, fix $V_{S1} = V_{S2} = 7.2$ Vdc and $V_b = 4.5$ Vdc; then vary P_{in} (Pin 1) to control P_{out} (Pin 5).

DECOUPLING

Due to the high gain of the four stages and the module size limitation, external decoupling networks require careful consideration, Pins 2, 3, 4 and 5 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5.0 MHz through 940 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

3

MOUNTING CONSIDERATIONS

For the MHW903 Series module, mounting is generally accomplished by soldering the flange to a suitable heat sink. This can be done with a low temperature solder such as 52% In, 48% Sn and type "R" Flux which liquifies below 150°C. Under no circumstances should the MHW903 Series modules be heated to a temperature greater than ≈165°C. Internal construction of the module has been achieved using 36% Tin, 62% lead, 2% silver solder which liquifies at 179–180°C.

The modules are NOT hermetic. Do not immerse a module in a flux cleaning solution or other liquids under any circumstances.

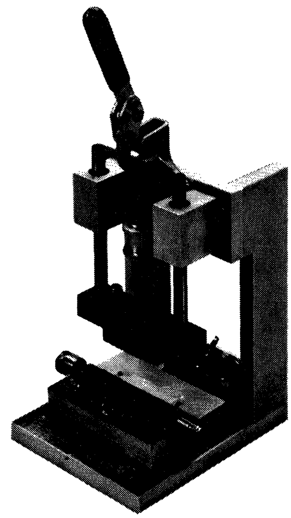


Figure 9. Test Fixture Assembly

LOAD MISMATCH

During final test each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3} = 9.0$ Vdc (Pins 2, 4, 5), and $V_b = 5.0$ Vdc (Pin 3), $P_{in} = 2.0$ mW (12.5% duty cycle, 4.6 ms period), VSWR equal to 10:1, and output power equal to 4.5 watts.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MHW909

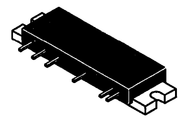
Advance Information

The RF Line
UHF Power Amplifier

. . . designed specifically for the Pan European digital 5.0 watt, GSM handheld radio. The MHW909 is capable of wide power range control, operates from a 7.2 volt supply and requires 100 mW of RF input power.

- Specified 7.2 Volt Characteristics:
  RF Input Power — 100 mW (20 dBm)
  RF Output Power — 9.0 W
  Minimum Gain — 19.5 dB
  Harmonics — −35 dBc Max @ 2.0 f_o
- New Biasing and Control Techniques Providing Dynamic Range and Control Circuit Bandwidth Ideal for GSM
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness

9.0 W
890 to 915 MHz
RF POWER
AMPLIFIER



CASE 301T, STYLE 1

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage	V_S	9.0	Vdc
DC Bias Voltage	V_B	4.75	Vdc
RF Input Power	P_{in}	400	mW
RF Output Power (V_S = 9.0 Vdc)	P_{out}	10	W
Operating Case Temperature Range	T_C	−30 to +100	°C
Storage Temperature Range	T_{stg}	−30 to +100	°C

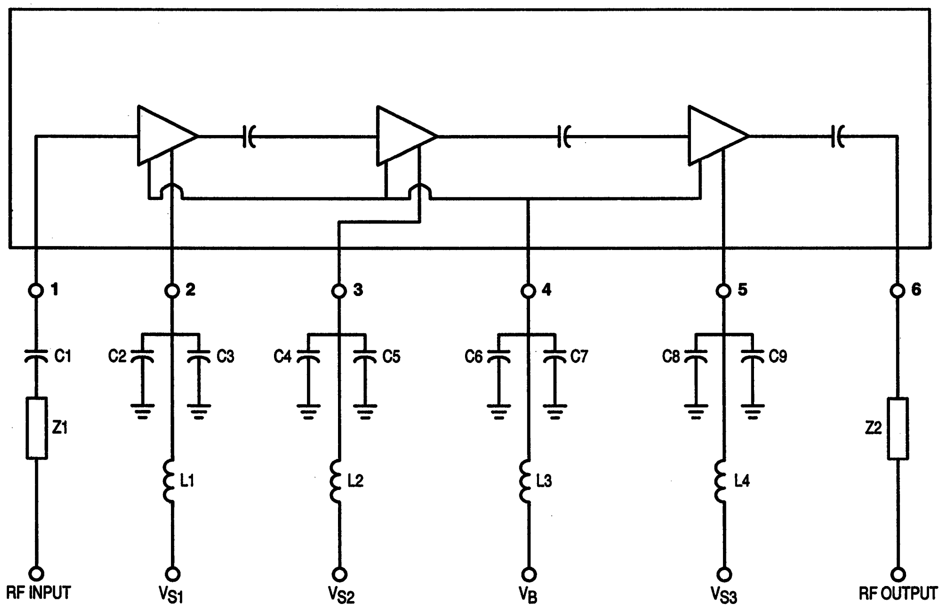
ELECTRICAL CHARACTERISTICS (V_{S1} = V_{S2} = V_{S3} = 7.2 Vdc; V_B = 4.5 Vdc, T_C = +25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Frequency Range	BW	890	915	MHz
Power Gain (P_{OUT} = 9.0 W) (1)	G_p	19.5	—	dB
Leakage Current (P_{in} = 0 mW, V_B = 0 Vdc, V_{S1} = V_{S2} = V_{S3} = 9.0 Vdc)	I_L	—	5.0	mA
Efficiency (P_{out} = 9.0 W) (1)	η	30	—	%
Input VSWR (P_{out} = 9.0 W) (1)	$VSWR_{in}$	—	2.0:1	—
Harmonics (P_{out} = 9.0 W) (1) 2.0 f_o 3.0 f_o to 5.0 f_o		—	−35 −40	dBc
Noise Power (In 30 kHz Bandwidth, 935 to 960 MHz frequency range; (P_{out} = 0.03 to 9.0 W; V_{S1} = V_{S2} = V_{S3} = 6.25 to 9.0 Vdc) (1)		—	−75	dBm
Linearity — % AM in Output (P_{out} = 0.2 to 9.0 W; 135 kHz 1% AM in Input) (1)	—	—	6.0	%
Output Power, Low Voltage (P_{IN} = 100 mW; V_{S1} = V_{S2} = V_{S3} = 6.25 Vdc)	P_{OUT2}	6.8	—	W
Load Mismatch Stress (V_{S1} = V_{S2} = V_{S3} = 9.0 Vdc; V_B = 4.75 Vdc; P_{OUT} = 10 W; Load VSWR = 10:1, All Phase Angles at Frequency of Test) (1)	ψ	No Degradation In Output Power Before/After Test		
Stability (V_{S1} = V_{S2} = V_{S3} = 6.0 to 9.0 Vdc; P_{OUT} = 0.03 to 9.0 W; Load VSWR = 6:1, Source VSWR = 3:1, All Phase Angles at Frequency of Test) (1)	—	All Spurious Outputs More Than 60 dB Below Desired Signal		

NOTE:
1. Adjust P_{IN} for Specified P_{OUT}; Duty Cycle = 12.5%, Period = 4.6 msec

This document contains information on a new product. Specifications and information herein are subject to change without notice.

3



Pin Designations:

Pin 1 — RF Input Power @ 20 dBm Max Adjust for Output Power
Pin 2 — First Stage Collector Voltage @ 7.2 Vdc
Pin 3 — Second Stage Collector Voltage @ 7.2 Vdc
Pin 4 — Trickle Bias Voltage @ 4.5 Vdc
Pin 5 — Third Stage Collector Supply @ 7.2 Vdc
Pin 7 — RF Output Power @ 9.0 W Nominal

Element Values:

C1 = C2 = C4 = C6 = C8 = 0.018 µF
C3 = C5 = C7 = C9 = 2.2 µF
L1–L3 = 0.29 µH
L4 = 0.2 µH
Z1, Z2 = 50 Ohm Microstrip

Figure 1. Test Circuit Diagram

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

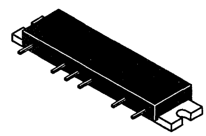
MHW912

The RF Line
UHF Power Amplifier

. . . designed specifically for the Pan European digital 8.0 watt, GSM mobile radio. Other applications exist in standard analog cellular radios. The MHW912 is capable of wide power range control, operates from a 12.5 volt supply and requires only 1.0 mW of RF input power.

- Specified 12.5 Volt Characteristics:
  - RF Input Power — 1.0 mW (0 dBm)
  - RF Output Power — 12.5 W
  - Minimum Gain — 41 dB
  - Harmonics — –30 dBc Max @ 2.0 f_o
- New Biasing and Control Techniques Providing Dynamic Range and Control Circuit Bandwidth Ideal for GSM
- Low Control Current
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness

12.5 W
884 to 915 MHz
RF POWER
AMPLIFIER



CASE 301R, STYLE 1

3

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage	$V_{S1,\,b}$	8.5	Vdc
DC Supply Voltage — With RF Applied/Without RF Applied	$V_{S2,\,3}$	15.6/30	Vdc
DC Control Voltage	V_{cont}	4.0	Vdc
RF Input Power	P_{in}	3.0	mW
RF Output Power (V_S = 15.6 Vdc)	P_{out}	14	W
Operating Case Temperature Range	T_C	– 30 to +100	°C
Storage Temperature Range	T_{stg}	– 30 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{S2} = V_{S3}$ = 12.5 Vdc; $V_{S1} = V_b$ = 8.0 Vdc; T_C = +25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Frequency Range	BW	884	915	MHz
Output Power (P_{in} = 1.0 mW; V_{cont} = 3.0 Vdc)	P_{out1}	12.5	—	W
Output Power, Reduced Voltage (P_{in} = 1.0 mW; V_{cont} = 3.0 Vdc; $V_{S1} = V_b$ = 8.0 V; $V_{S2} = V_{S3}$ = 10.8 Vdc)	P_{out2}	8.5	—	W
Control Current (P_{out} = 12.5 W; P_{in} = 1.0 mW) (1)	I_{cont}	—	1.0	mA
Current Consumption in 8.0 V Pins (P_{out} = 12.5 W; P_{in} = 1.0 mW)	$I_{S1} + I_b$	—	220	mA
Leakage Current (P_{in} = 0 mW; V_{cont} = 0; $V_{S1} = V_b$ = 0)	I_L	—	1.0	mA
Efficiency (P_{out} = 12.5 W; P_{in} = 1.0 mW) (1) f = 890–915 MHz f = 884–890 MHz	η	35 33	— —	%
Input VSWR (P_{out} = 0.03 to 12.5 W; P_{in} = 1.0 mW) (1)	$VSWR_{in}$	—	2.0:1	—
Harmonics (P_{out} = 12.5 W; P_{in} = 1.0 mW) (1) 2 f_o 3 f_o	—	— —	– 30 – 40	dBc
Noise Power (In 30 kHz Bandwidth, 20 MHz Above f_o; P_{out} = 12.5 W; P_{in} = 1.0 mW) (1)	—	—	– 70	dBm

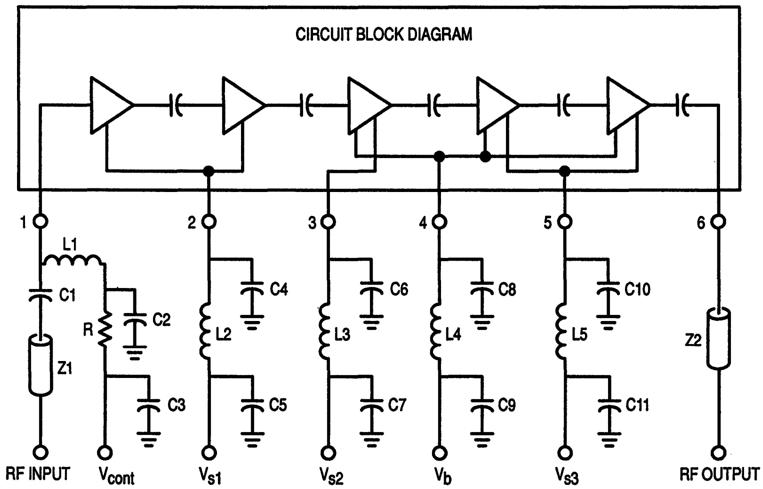
NOTE:
1. Adjust V_{cont} for specified P_{out}; Duty Cycle = 12.5%, Period = 4.6 ms.

ELECTRICAL CHARACTERISTICS — continued

($V_{S2} = V_{S3} = 12.5$ Vdc; $V_{S1} = V_b = 8.0$ Vdc; $T_C = +25°C$, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Isolation ($P_{in} = 1.0$ mW; $V_{cont} = 0$ Vdc; $V_{S1} = V_b = 0$ to 8.0 V)	—	—	−36	dBm
3.0 dB V_{cont} Bandwidth ($P_{in} = 1.0$ mW; $P_{out} = 0.03$ to 12.5 W) (1)	—	1.0	—	MHz
Load Mismatch Stress ($V_S = 15.6$ Vdc; $P_{in} = 3.0$ mW; $P_{out} = 14$ W; Load VSWR = 10:1, All Phase Angles at Frequency of Test) (1)	ψ	No degradation in output power before and after test		
Stability ($V_{S2} = V_{S3} = 10.8$ to 15.6 Vdc; $P_{in} = 0.5$ to 3.0 mW; $P_{out} = 12$ mW to 12.5 W; Load VSWR = 6:1, All Phase Angles; Source VSWR = 3:1, All Phase Angles at Frequency of Test) (1)	—	All spurious outputs more than 60 dB below desired signal		

NOTE:
1. Adjust V_{cont} for specified P_{out}; Duty Cycle = 12.5%, Period = 4.6 ms.



PIN DESIGNATIONS:

PIN 1 — RF INPUT POWER @ 0 dBm AND CONTROL VOLTAGE @ 0–3 Vdc
PIN 2 — FIRST & SECOND STAGE COLLECTOR SUPPLY VOLTAGE @ 8 Vdc
PIN 3 — THIRD STAGE COLLECTOR VOLTAGE @ 12.5 Vdc
PIN 4 — TRICKLE BIAS VOLTAGE @ 8 Vdc
PIN 5 — FOURTH & FIFTH STAGE COLLECTOR SUPPLY VOLTAGE @ 12.5 Vdc
PIN 6 — RF OUTPUT POWER @ 12.5 W

ELEMENT VALUES:

C1 = C2= C4 = C6 = C8 = C10 = 0.018 μF
C3 = C5 = C7 = C9 = C11 = 1 μF
L1–L4 = 0.29 μH
L5 = 0.2 μH
R = 20 OHMS
Z1, Z2 = 50 OHM MICROSTRIP

Figure 1. UHF Power Module Test Circuit Diagram

TYPICAL CHARACTERISTICS

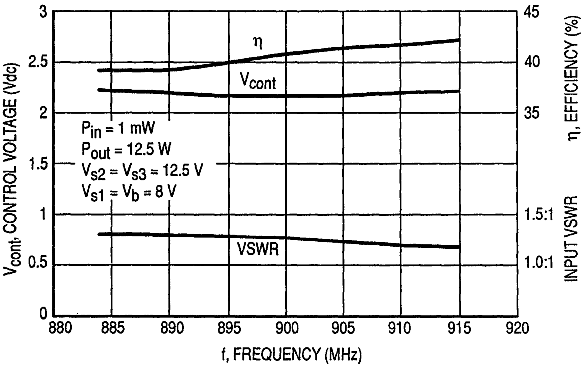


Figure 2. Control Voltage, Efficiency and Input VSWR versus Frequency

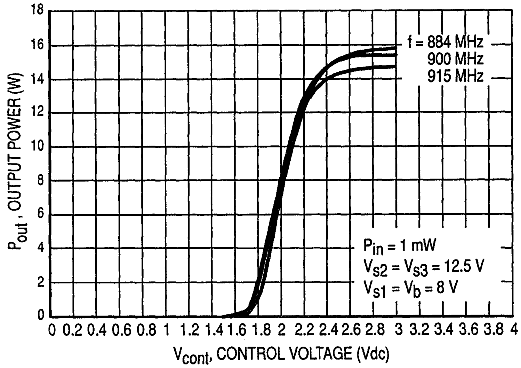


Figure 3. Output Power versus Control Voltage

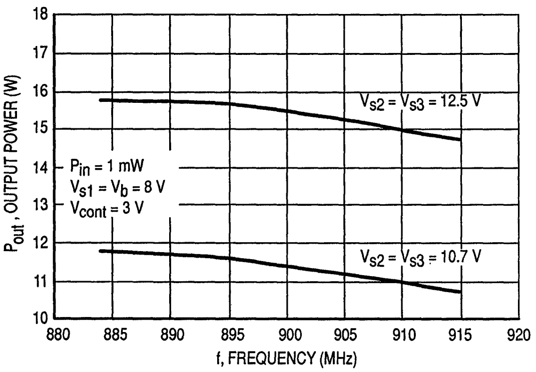


Figure 4. Output Power versus Frequency

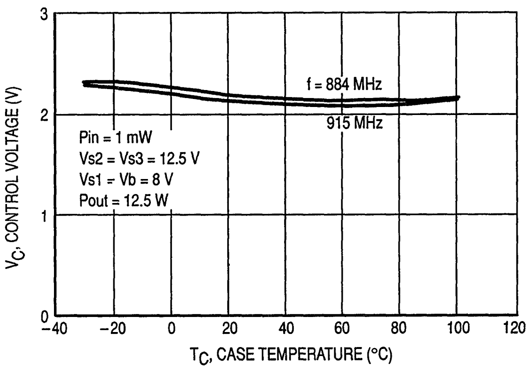


Figure 5. Control Voltage versus Case Temperature

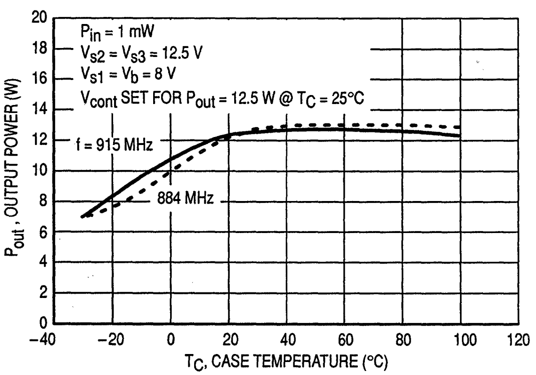


Figure 6. Output Power versus Case Temperature

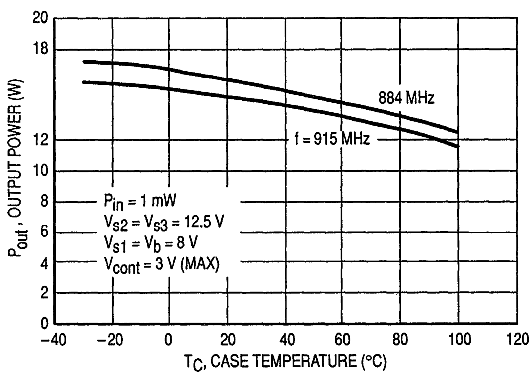


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_b = V_{S1} = 8.0$ Vdc (Pins 2, 4), and $V_{S2} = V_{S3} = 12.5$ Vdc (Pins 3, 5). With these conditions, maximum current density on any device is 1.5 x 10^5 A/cm^2 and maximum die temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output power should be limited to specified value. The preferred method of power control is to fix $V_b = V_{S1} = 8.0$ Vdc (Pins 2, 4), $V_{S2} = V_{S3} = 12.5$ Vdc (Pins 3, 5), Pin (Pin 1) at 1.0 mW, and vary V_{cont} (Pin 1) voltage.

DECOUPLING

Due to the high gain of the five stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3, 4, and 5 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5.0 MHz through 940 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

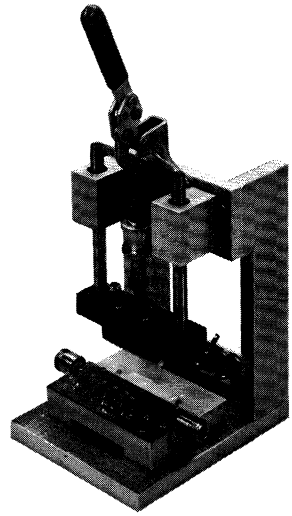
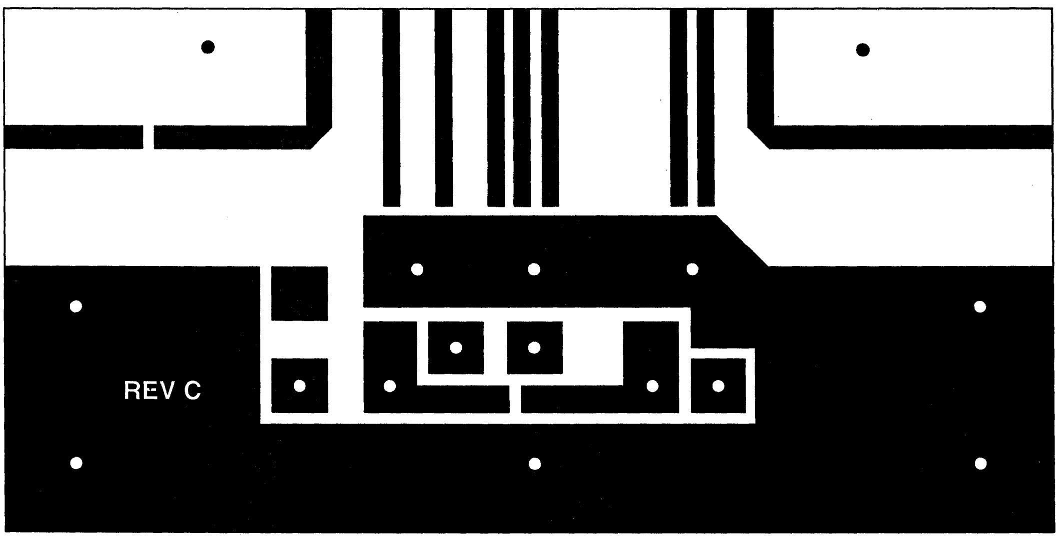


Figure 8. Test Fixture Assembly

LOAD MISMATCH

During final test, each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_b = V_{S1} = 8.0$ V (Pins 2, 4), and $V_{S2} = V_{S3} = 15.6$ Vdc (Pins 3, 5), $P_{in} = 3.0$ mW, VSWR equal to 10:1, and output power equal to 15 watts.

3



SCALE 0.75:1

Figure 9. Photomaster for Test Fixture

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

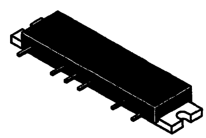
MHW914
MHW915

The RF Line
UHF Power Amplifiers

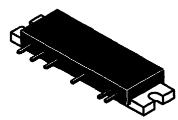
. . . designed specifically for the Pan European digital 8.0 watt, GSM mobile radio. The MHW914 and MHW915 are capable of wide power range control, operate from a 12.5 volt supply and require only 1 mW (MHW914) or 100 mW (MHW915) of RF input power.

- Specified 12.5 Volt Characteristics:
  RF Input Power — 1.0 mW (0 dBm) MHW914 or 100 mW (20 dBm) MHW915
  RF Output Power — 14 W
  Minimum Gain — 41.5 dB (MHW914) or 21.5 dB (MHW915)
  Harmonics — −30 dBc Max @ 2.0 f_o
- New Biasing and Control Techniques Providing Dynamic Range and Control Circuit Bandwidth Ideal for GSM
- Low Control Current
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness

14 W
890 to 915 MHz
RF POWER
AMPLIFIERS



CASE 301R, STYLE 1
(MHW914)



CASE 301T, STYLE 1
(MHW915)

MAXIMUM RATINGS (Flange Temperature = 25°C)

Rating	Symbol	MHW914	MHW915	Unit
DC Supply Voltage	V_{s1}	8.5	15.6	Vdc
DC Supply Voltage	V_b	8.5	5.25	Vdc
DC Supply Voltage	$V_{s2,3}$	15.6	15.6	Vdc
DC Control Voltage	V_{cont}	4.0	—	Vdc
RF Input Power	P_{in}	3.0	400	mW
RF Output Power	P_{out}	15		W
Operating Case Temperature Range Storage Temperature Range	T_C T_{stg}	−30 to +100		°C

ELECTRICAL CHARACTERISTICS MHW914 — $V_{s2} = V_{s3}$ = 12.5 Vdc; $V_{s1} = V_b$ = 8.0 Vdc; MHW915 — $V_{s1} = V_{s2} = V_{s3}$ = 12.5 Vdc; V_b = 5.0 Vdc (T_C = 25°C, 50 ohm system, unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
Frequency Range		BW	890	915	MHz
Power Gain (P_{out} = 14 W)	MHW914 (1) MHW915 (2)	G_P	41.5 21.5	— —	dB
Control Current (P_{out} = 14 W; P_{in} = 1.0 mW)	MHW914 only (1)	I_{cont}	—	1.0	mA
Supply Current (P_{out} = 14 W; P_{in} = 1.0 mW)	MHW914 only (1)	$I_{s1} + I_b$	—	220	mA
Leakage Current (P_{in} = 0 mW; $V_{cont.} = V_{s1} = V_b$ = 0 Vdc; $V_{s2} = V_{s3}$ = 15.6 V for MHW914 • $V_{s1} = V_{s2} = V_{s3}$ = 15.6 V; V_b = 0 Vdc; P_{in} = 0 mW for MHW915		I_L	—	1.0	mA
Efficiency (P_{out} = 14 W, P_{in} = 1.0 mW) MHW914 (1) (P_{out} = 14 W) MHW915 (2)		η	35 35	— —	%
Input VSWR (P_{out} = 14 W, P_{in} = 1.0 mW) MHW914 (1) (P_{out} = 14 W) MHW915 (2)		$VSWR_{in}$	— —	2.0:1 2.0:1	—
Harmonics (P_{out} = 14 W, P_{in} = 1.0 mW) MHW914 (1) (P_{out} = 14 W) MHW915 (2)	2.0 f_o 3.0 f_o to 5.0 f_o 2.0 f_o 3.0 f_o to 5.0 f_o	—	— — — —	−30 −40 −30 −35	dBc

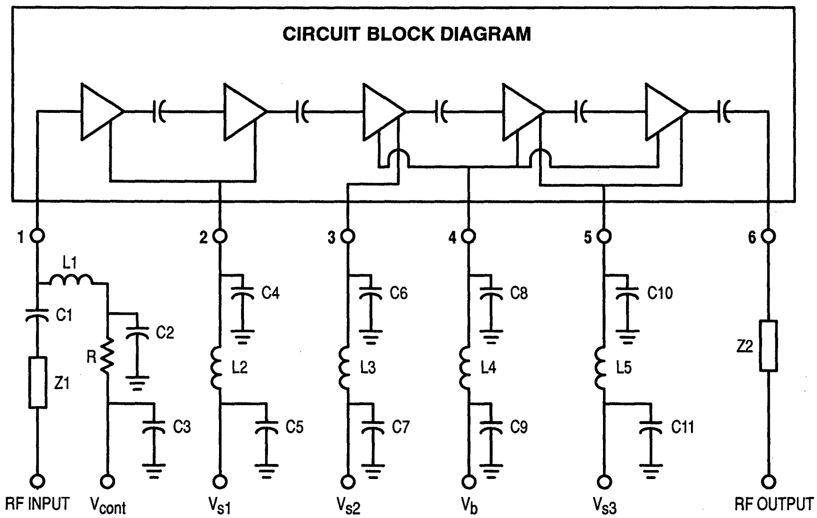
NOTES:
1. Adjust V_{cont} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms
2. Adjust P_{in} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms

(continued)

ELECTRICAL CHARACTERISTICS — continued MHW914 — $V_{S2} = V_{S3}$ = 12.5 Vdc; $V_{S1} = V_b$ = 8.0 Vdc;
MHW915 — $V_{S1} = V_{S2} = V_{S3}$ = 12.5 Vdc; V_b = 5.0 Vdc (T_C = 25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Noise Power (In 30 kHz Bandwidth, 20 MHz above f_o) (P_{out} = 0.03 to 14 W, $V_{S2} = V_{S3}$ = 10.8 to 15.6 Vdc, P_{in} = 1.0 mW) MHW914 (1) (P_{out} = 0.03 to 14 W, $V_{S1} = V_{S2} = V_{S3}$ = 10.8 to 15.6 Vdc) MHW915 (2)	—	 — —	 −70 −70	dBm
3.0 dB V_{cont} Bandwidth (P_{in} = 1.0 mW, P_{out} = 0.03 to 14 W) MHW914 only	—	1.0	—	MHz
Output Power Reduced Voltage (P_{in} = 1.0 mW; $V_{S2} = V_{S3}$ = 10.8 Vdc) MHW914 (P_{in} = 100 mW; $V_{S1} = V_{S2} = V_{S3}$ = 10.8 Vdc) MHW915	P_{OUT2}	10	—	W
Linearity — % AM in Output (P_{out} = 0.02 to 14 W; 135 kHz, 1% AM on Input) MHW915 only (2)	—	—	6.0	%
Load Mismatch Stress ($V_{S2} = V_{S3}$ = 15.6 Vdc, P_{in} = 3.0 mW, P_{out} = 15 W) MHW914 (1) ($V_{S1} = V_{S2} = V_{S3}$ = 15.6 Vdc, P_{out} = 15 W) MHW915 (2) (Load VSWR = 10:1, All Phase Angles at Frequency of Test)	ψ	No degradation in output power before and after test		
Stability ($V_{S2} = V_{S3}$ = 10.8 to 15.6 Vdc; P_{in} = 0.5 to 3.0 mW; P_{out} = 0 mW to 14 W) MHW914 (1) ($V_{S1} = V_{S2} = V_{S3}$ = 10.8 to 15.6 Vdc, P_{out} = 0.03 to 14 W) MHW915 (2) (Load VSWR = 6:1, Source VSWR = 3:1, All Phase Angles at Frequency of Test)	—	All spurious outputs more than 60 dB below desired signal		

NOTES:
1. Adjust V_{cont} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms
2. Adjust P_{in} for specified P_{out}; duty cycle = 12.5%, period = 4.6 ms



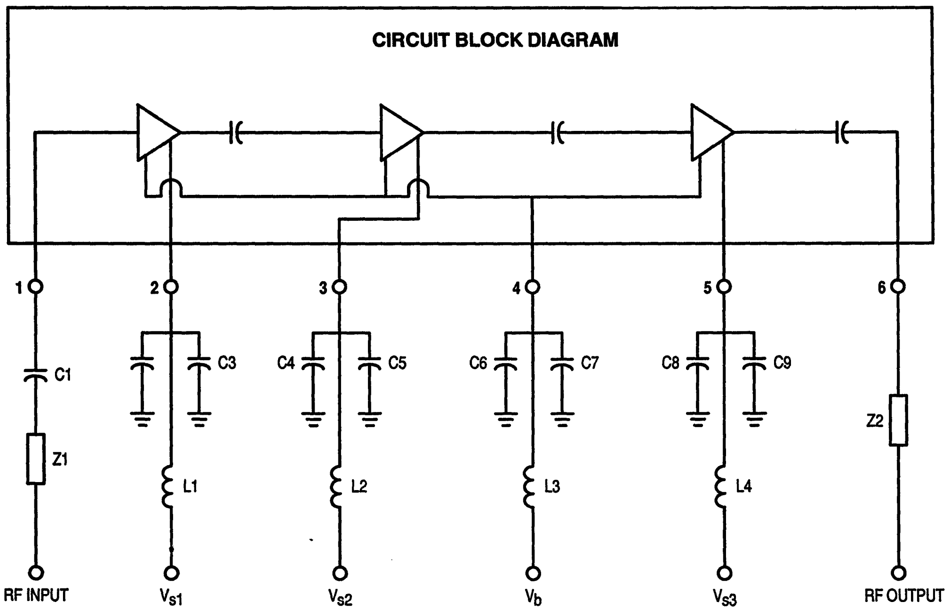
PIN DESIGNATIONS:

Pin 1 — RF Input Power @ 0 dBm and Control Voltage @ 0–3.0 Vdc
Pin 2 — First and Second Stage Collector Supply Voltage @ 8.0 Vdc
Pin 3 — Third Stage Collector Voltage @ 12.5 Vdc
Pin 4 — Trickle Bias Voltage @ 8.0 Vdc
Pin 5 — Fourth and Fifth Stage Collector Supply Voltage @ 12.5 Vdc
Pin 6 — RF Output Power @ 14 W

ELEMENT VALUES:

C1=C4=C6=C8=C10 = 0.018 µF
C2=0.1 µF
C3=C5=C7=C9=C11 = 1.0 µF
L1−L4 = 0.29 µH
L5 = 0.2 µH
R = 20 Ohms
Z1, Z2 = 50 Ohm Microstrip

Figure 1. Test Circuit Diagram — MHW914



PIN DESIGNATIONS:

Pin 1 — RF Input Power @ 20 dBm Max Adjust for Output Power
Pin 2 — First Stage Collector Voltage @ 12.5 Vdc
Pin 3 — Second Stage Collector Voltage @ 12.5 Vdc
Pin 4 — Trickle Bias Voltage @ 5.0 Vdc
Pin 5 — Third Stage Collector Supply @ 12.5 Vdc
Pin 6 — RF Output Power @ 14 W Nominal

ELEMENT VALUES:

C1=C2=C4=C6=C8 = 0.018 µF
C3=C5=C7=C9 = 2.2 µF
L1 – L3 = 0.29 µH
L4 = 0.2 µH
Z1, Z2 = 50 Ohm Microstrip

Figure 2. Test Circuit Diagram — MHW915

3

TYPICAL CHARACTERISTICS
(MHW914)

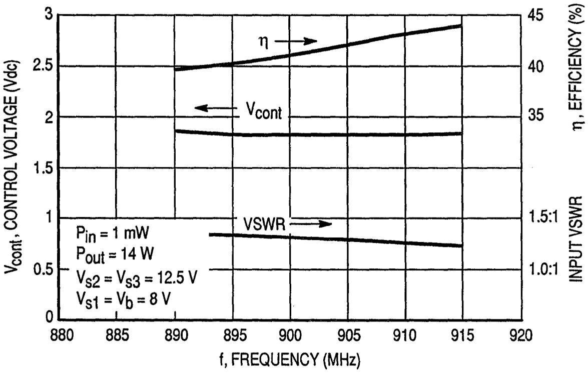


Figure 3. Control Voltage, Efficiency and Input VSWR versus Frequency

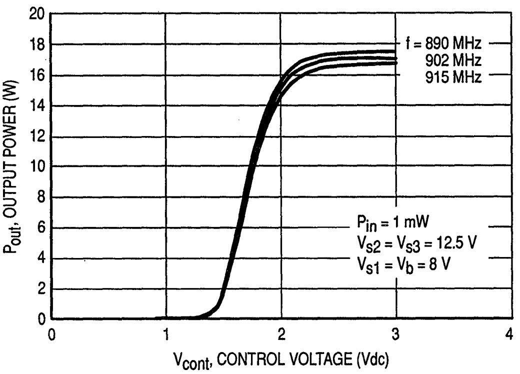


Figure 4. Output Power versus Control Voltage

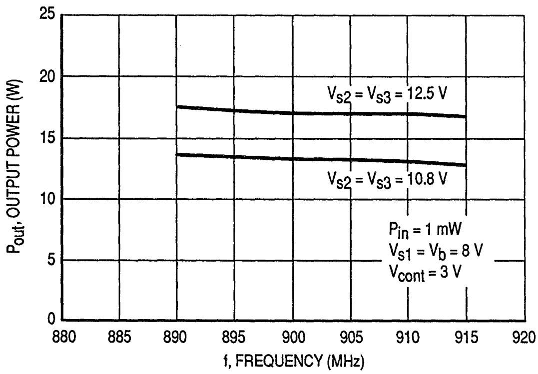


Figure 5. Output Power versus Frequency

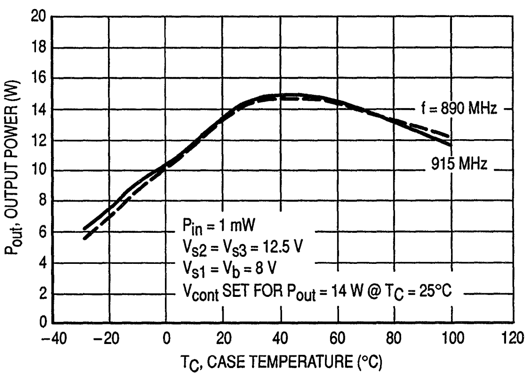


Figure 6. Output Power versus Case Temperature

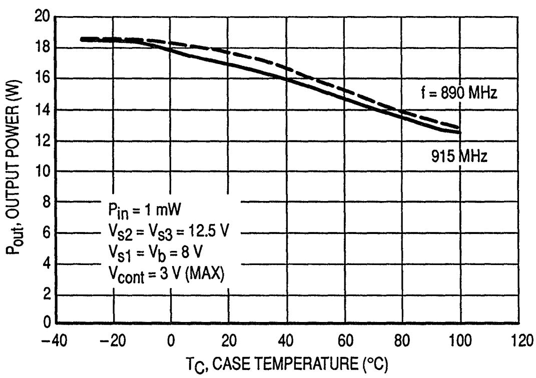


Figure 7. Output Power versus Case Temperature at Maximum Control Voltage

3

TYPICAL CHARACTERISTICS
(MHW915)

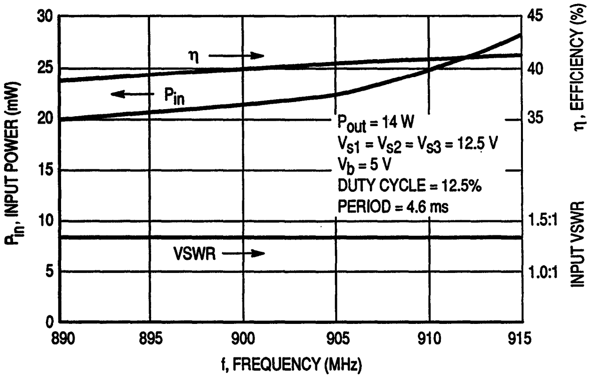


Figure 8. Input Power, Efficiency and Input VSWR versus Frequency

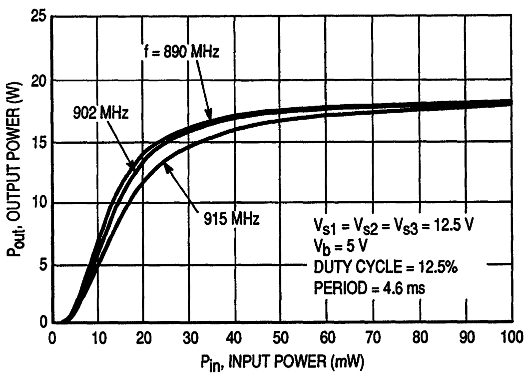


Figure 9. Output Power versus Input Power

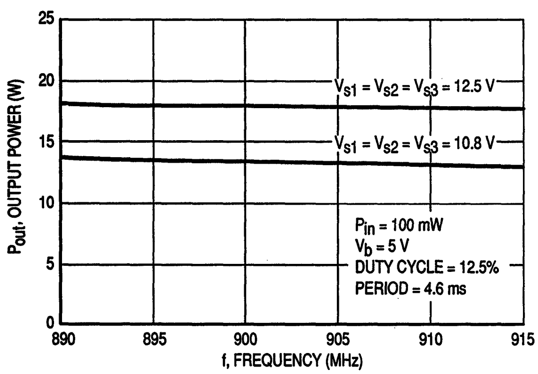


Figure 10. Output Power versus Frequency

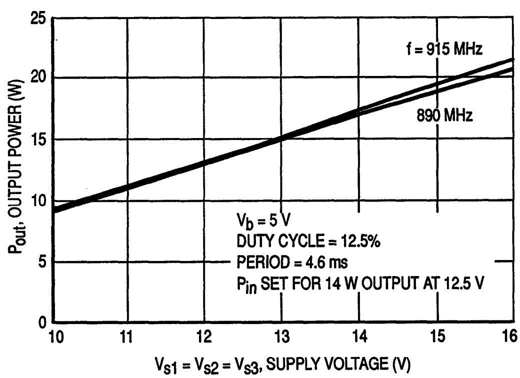


Figure 11. Output Power versus Supply Voltage

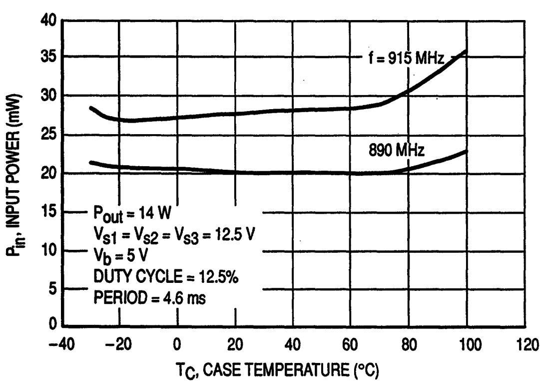


Figure 12. Input Power versus Case Temperature for P_{out} = 14 W

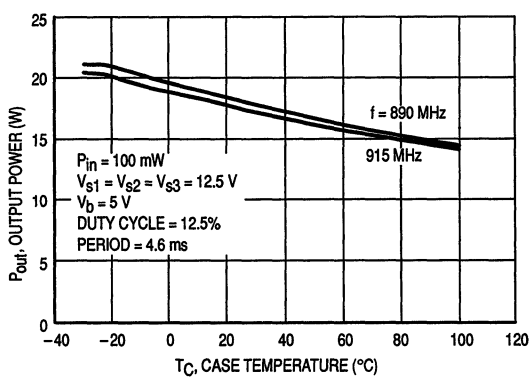


Figure 13. Output Power versus Case Temperature for Maximum Input Power

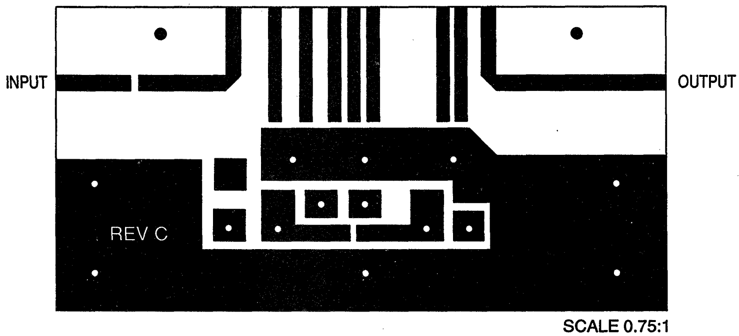


Figure 14. Photomaster for Test Fixture — MHW914

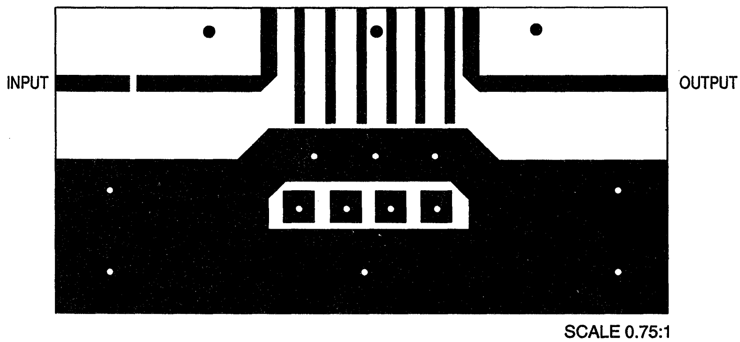


Figure 15. Photomaster for Test Fixture — MHW915

APPLICATIONS INFORMATION

NOMINAL OPERATION

For the MHW914, all electrical specifications are based on the nominal conditions of $V_b = V_{s1} = 8.0$ Vdc (Pins 2, 4), and $V_{s2} = V_{s3} = 12.5$ Vdc (Pins 3, 5). For the MHW915 the nominal conditions are $V_{s1} = V_{s2} = V_{s3} = 12.5$ Vdc (Pins 2, 3, 5) and $V_b = 5.0$ Vdc (Pin 4). With these conditions, maximum current density on any device is 1.5 x 10^5 A/cm^2 and maximum die temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output power should be limited to specified value. The preferred method of power control for the MHW914 is to fix $V_b = V_{s1} = 8.0$ Vdc, $V_{s2} = V_{s3} = 12.5$ Vdc, P_{in} (Pin 1) at 1.0 mW, and vary V_{cont} (Pin 1) voltage. The preferred method for the MHW915 is to fix all voltages at nominal and vary P_{out} (Pin 6) by changing P_{in} (Pin 1) from 0 to 100 mW.

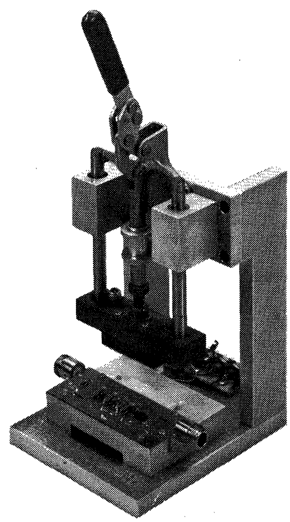


Figure 16. Test Fixture Assembly

DECOULPING

Due to the high gain of the five stages and the module size limitation, external decoupling networks require careful consideration, Pins 2, 3, 4 and 5 are internally bypassed with a 0.018 μF chip capacitor which is effective for frequencies from 5.0 MHz through 940 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 and Figure 2 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

LOAD MISMATCH

During final test each module is load mismatch tested in a fixture having the identical decoupling networks described in Figures 1 and 2 for the MHW914 and MHW915 respectively. Electrical conditions are $V_b = V_{s1} = 8.0$ V (Pins 2, 4) and $V_{s2} = V_{s3} = 15.6$ Vdc (Pins 3, 5) for the MHW914 and $V_{s1} = V_{s2} = V_{s3} = 15.6$ Vdc (Pins 2, 3, 5) and $V_b = 5.0$ Vdc (Pin 4) for the MHW915. $P_{out} = 15$ W, $P_{in} = 3.0$ mW, load VSWR equals 10:1 at all phase angles for both modules.

3

MHW927A*
MHW927B

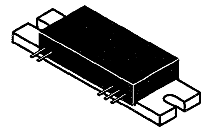
*Motorola Preferred Device

The RF Line
UHF Linear Power Amplifiers

Designed specifically for the United States digital 3.0 W, mobile radio. The MHW927A/B are capable of wide power range control, operate from a 12.5 V supply and require 1.0 mW of RF input power.

- MHW927A Operates from a 9.5 Volt Bias Supply (V_B)
  MHW927B Operates from a 8.0 Volt Bias Supply (V_B)
- Specified 12.5 Volt Characteristics for MHW927A/B:
  RF Input Power — 1.0 mW (0 dBm) Max
  RF Output Power — 6.0 W
  Power Gain — 40 dB Typ
  Harmonics — –30 dBc Max @ 2 f_0
- Linearity (IMD) — –29 dBc Max for 3rd Order; –34 dBc Max for 5th Order
- New Biasing and Control Techniques Providing Dynamic Range and Control Circuit Bandwidth Ideal for USDC
- 50 Ω Input/Output Impedances
- Guaranteed Stability and Ruggedness

**6.0 W
824 to 849 MHz
RF LINEAR
POWER AMPLIFIERS**



CASE 301AA, STYLE 1

3

MAXIMUM RATINGS (Recommended Values for Safe Operation — Not Guaranteed Performance)

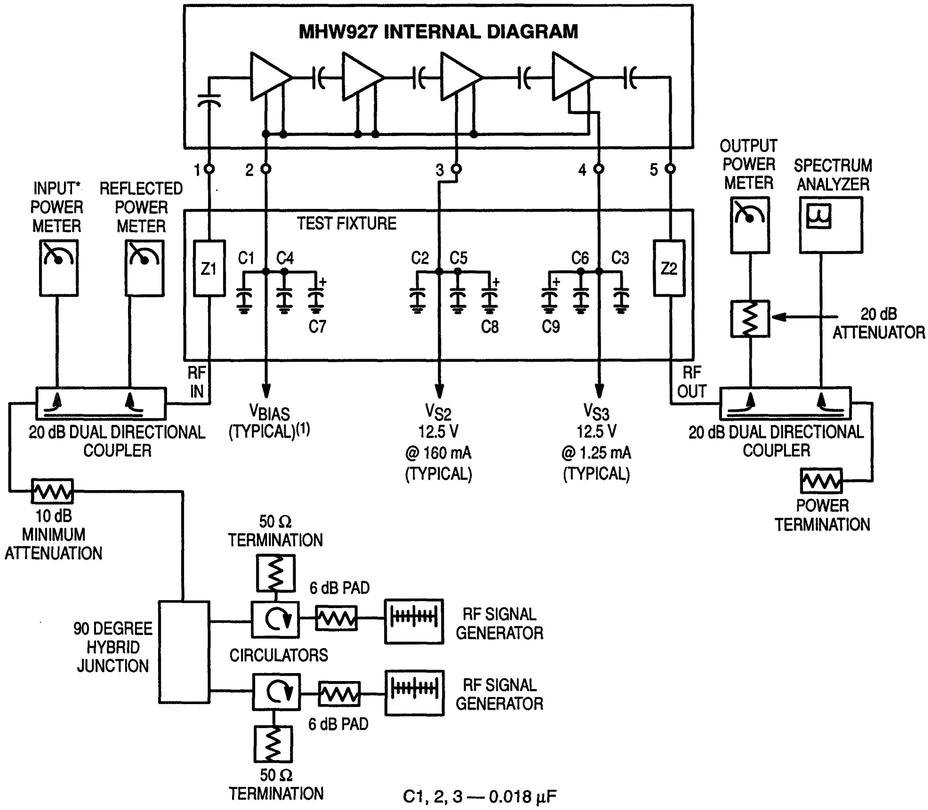
Rating		Symbol	Value	Unit
DC Supply Voltage		V_{S2}, V_{S3}	16.5	Vdc
DC Bias Voltage		V_B	10	Vdc
RF Input Power	MHW927A, B	P_{in}	3.0	mW
RF Output Power		P_{out}	13	W
Operating Case Temperature Range		T_C	–30 to +100	°C
Storage Temperature Range		T_{stg}	–30 to +100	°C

ELECTRICAL CHARACTERISTICS ($V_{S2} = V_{S3}$ = 12.5 Vdc; V_B = 9.5 Vdc (MHW927A); V_B = 8.0 Vdc (MHW927B); $P_{in} \le$ 1.0 mW (MHW927A/B); T_C = +25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	824	—	849	MHz
Input Power (P_{out} = 6.0 W) (1)	P_{in}	—	—	1.0	mW
Efficiency (P_{out} = 6.0 W) (1)	η_1	28	30	—	%
Efficiency, Two Tone (P_{out} (Avg.) = 6.0 W; f_1 & f_2 10 kHz apart) (1)	η_2	28	30	—	%
Input VSWR (P_{out} = 6.0 W) (1)	$VSWR_{in}$	—	—	2.5:1	—
Harmonics (P_{out} = 6.0 W) (1) 2 f_0 3 f_0	—	— —	— —	–30 –45	dBc
Noise Power (In 30 kHz Bandwidth, 45 MHz Above f_0; T_C = +25°C to T_C = +100°C; P_{out} = 6.0 W) (1)	—	—	—	–82	dBm
Linearity (P_{out} (Avg.) = 6.0 W; f_1 & f_2 are 10 kHz apart) (1) 3rd Order IMD 5th Order IMD	—	— —	–31 –36	–29 –34	dBc
Load Mismatch Stress ($V_{S2} = V_{S3}$ = 16 Vdc; P_{out} = 12.5 W; Pulsed at 50% Duty Cycle; Load VSWR = 20:1, All Phase Angles At Frequency of Test) (1)	ψ	No Degradation In Output Power Between Before and After Test			
Stability ($V_{S2} = V_{S3}$ = 10 to 16 Vdc; P_{out} = 0.012 to 12 W; Load VSWR = 4:1, All Phase Angles At Frequency of Test) (1)	—	All Spurious Outputs More Than 70 dB Below Desired Signal			

NOTE:
1. Adjust P_{in} for Specified P_{out}.

Preferred devices are Motorola recommended choices for future use and best overall value.



C1, 2, 3 — 0.018 µF
C4, 5, 6 — 0.1 µF
C7, 8, 9 — 1.0 µF (tant.)
Z1, Z2 — 50 Ω MICROSTRIP

(1) V_{BIAS} = 9.5 V @ 140 mA (MHW927A) or 8.0 V @ 140 mA (MHW927B)

*Module input power is forward power as sampled by the directional coupler and read on the input power meter.

Figure 1. MHW927A/B Test Circuit Diagram

3

TYPICAL CHARACTERISTICS

(MHW927A)

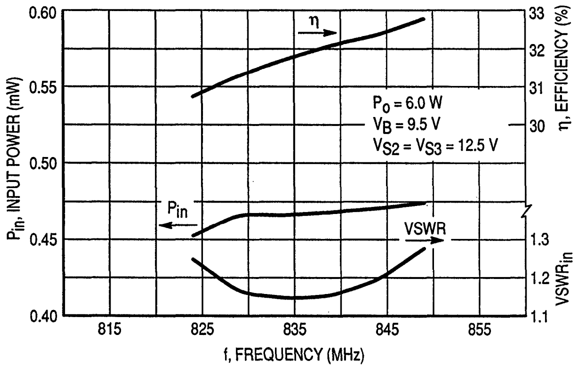


Figure 2. Input Power, Efficiency and VSWR versus Frequency

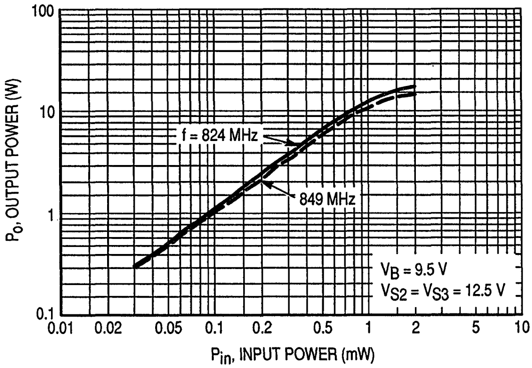


Figure 3. Output Power versus Input Power

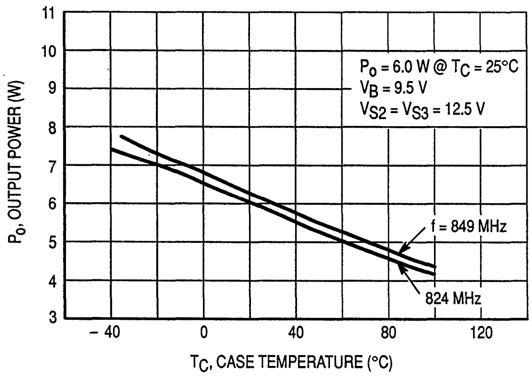


Figure 4. Output Power versus Case Temperature

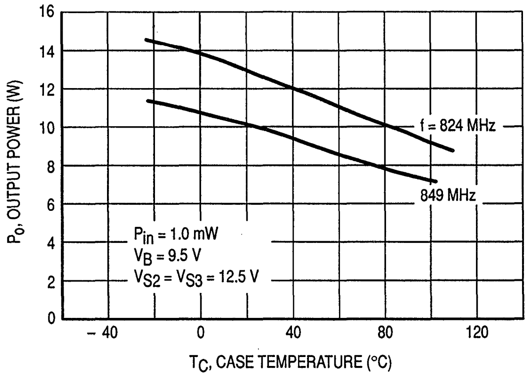


Figure 5. Output Power versus Case Temperature at Maximum Input Power

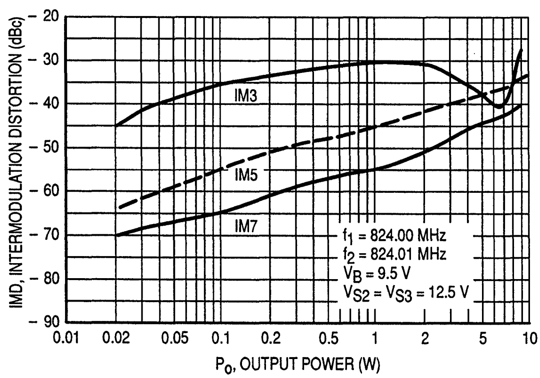


Figure 6. Intermodulation versus Output Power

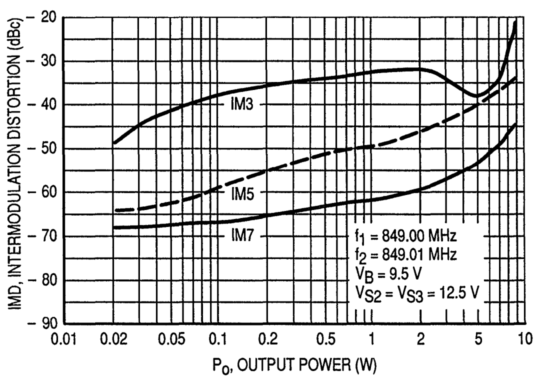


Figure 7. Intermodulation versus Output Power

TYPICAL CHARACTERISTICS

(MHW927B)

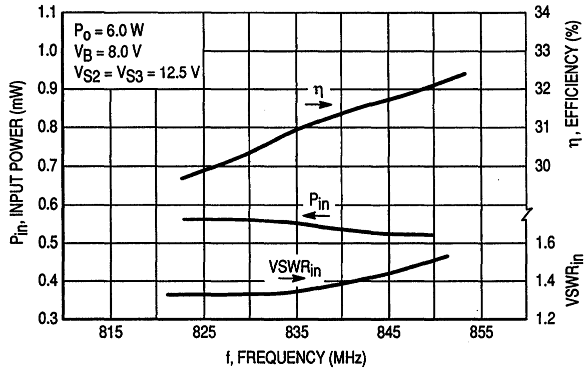


Figure 8. Input Power, Efficiency and VSWR versus Frequency

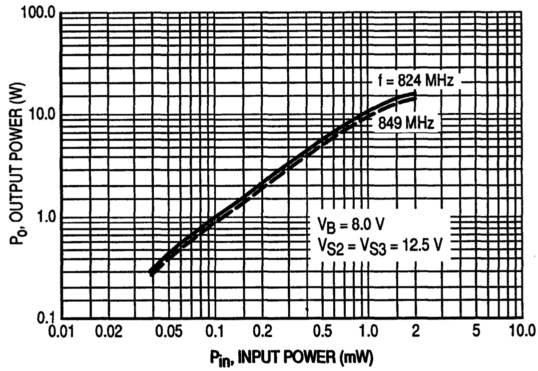


Figure 9. Output Power versus Input Power

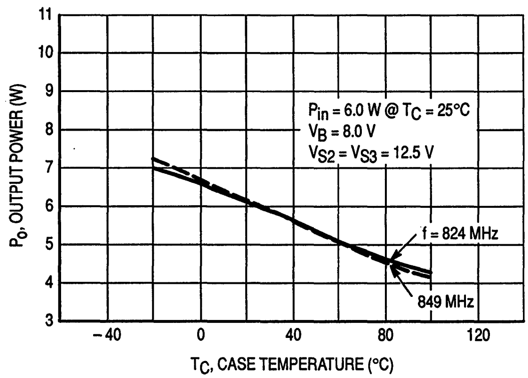


Figure 10. Output Power versus Case Temperature

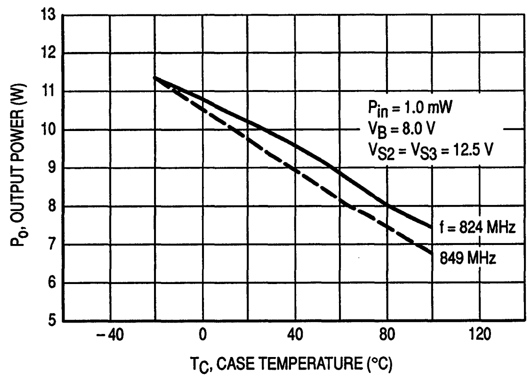


Figure 11. Output Power versus Case Temperature at Maximum Input Power

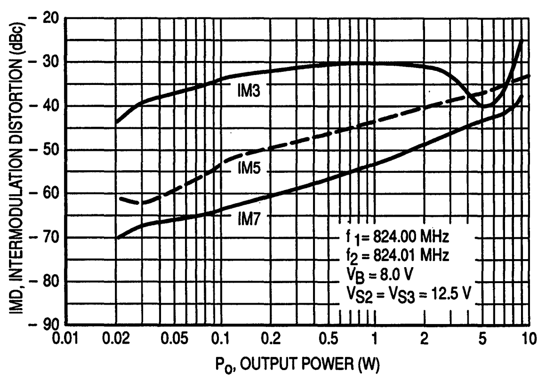


Figure 12. Intermodulation versus Output Power

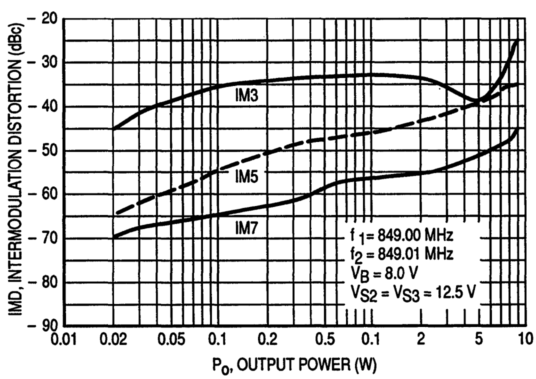


Figure 13. Intermodulation versus Output Power

3

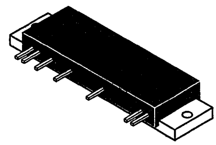
MHW932

The RF Line
UHF Power Amplifier

. . . designed specifically for the Pan European digital 20 watt, GSM mobile radio. The MHW932 is capable of wide power range control, operates from a 12.5 volt supply and requires 100 mW of RF input power.

- Specified 12.5 Volt Characteristics:
  RF Input Power — 100 mW (20 dBm)
  RF Output Power — 32 W
  Minimum Gain — 25 dB
  Harmonics — −35 dBc Max @ 2.0 f_o
- New Biasing and Control Techniques Providing Dynamic Range and Control Circuit Bandwidth Ideal for GSM
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness

**32 W
890 to 915 MHz
RF POWER
AMPLIFIER**



CASE 301S, STYLE 1

MAXIMUM RATINGS (Flange Temperature = 25°C)

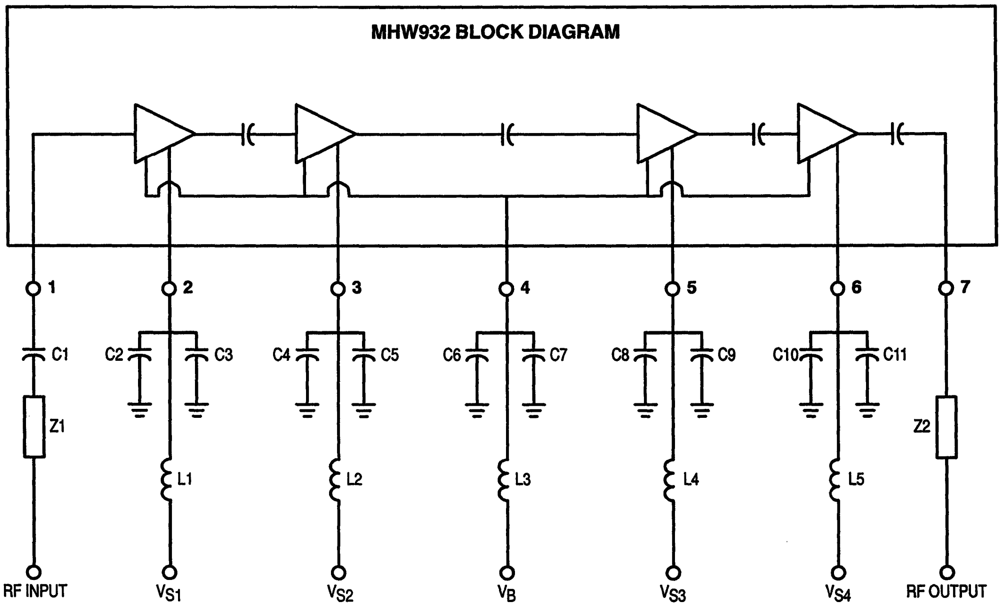
Rating	Symbol	Value	Unit
DC Supply Voltage	V_S	15.6	Vdc
DC Bias Voltage	V_B	5.25	Vdc
RF Input Power	P_{in}	400	mW
RF Output Power	P_{out}	40	W
Operating Case Temperature Range	T_C	−30 to +100	°C
Storage Temperature Range	T_{stg}	−30 to +100	°C

ELECTRICAL CHARACTERISTICS
($V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 12.5 Vdc; V_B = 5.0 Vdc, T_C = +25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Frequency Range	BW	890	915	MHz
Power Gain (P_{out} = 32 W) (1)	G_p	25	—	dB
Leakage Current (P_{in} = 0 mW, V_B = 0 Vdc, $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 15.6 Vdc)	I_L	—	10	mA
Efficiency (P_{out} = 32 W) (1)	η	23	—	%
Input VSWR (P_{out} = 32 W) (1)	$VSWR_{in}$	—	2.0:1	—
Harmonics (P_{out} = 32 W) (1) 2.0 f_o 3.0 f_o to 5.0 f_o		—	−35 −45	dBc
Noise Power (In 30 kHz Bandwidth, 935 to 960 MHz frequency range; (P_{out} = 0.03 to 32 W; $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 10.8 to 15.6 Vdc) (1)		—	−65	dBm
Linearity — % AM in Output (P_{out} = 0.02 to 32 W; 135 kHz, 1% AM in Input)	—	—	6.0	%
Output Power, Low Voltage (P_{IN} = 100 mW; $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 10.8 Vdc)	P_{out2}	24	—	W
Load Mismatch Stress ($V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 15.6 Vdc; P_{OUT} = 40 W; Load VSWR = 10:1, All Phase Angles at Frequency of Test) (1)	ψ	No Degradation In Output Power Before and After Test		
Stability ($V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 10.8 to 15.6 Vdc; P_{OUT} = 0.03 to 32 W; Load VSWR = 6:1, Source VSWR = 3:1, All Phase Angles at Frequency of Test) (1)	—	All Spurious Outputs More Than 60 dB Below Desired Signal		

NOTE:
1. Adjust P_{IN} for Specified P_{OUT}; Duty Cycle = 12.5%, Period = 4.6 msec

3



Pin Designations:

Pin 1 — RF Input Power @ 20 dBm Max Adjust for Output Power
Pin 2 — First Stage Collector Voltage @ 12.5 Vdc
Pin 3 — Second Stage Collector Voltage @ 12.5 Vdc
Pin 4 — Trickle Bias Voltage @ 5.0 Vdc
Pin 5 — Third Stage Collector Supply @ 12.5 Vdc
Pin 6 — Fourth Stage Collector Supply @ 12.5 Vdc
Pin 7 — RF Output Power @ 32 W Nominal

Element Values:

C1 = C2 = C4 = C6 = C8 = C10 = 0.018 µF
C3 = C5 = C7 = C9 = C11 = 2.2 µF
L1 – L3 = 0.29 µH
L4 = 0.2 µH
L5 — VR200, Up to 10 A Max IS4
Z1, Z2 = 50 Ohm Microstrip

Figure 1. Test Circuit Diagram

3

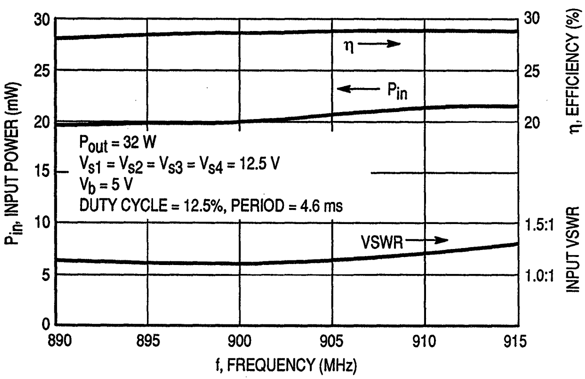


Figure 2. Input Power, Efficiency and Input VSWR versus Frequency

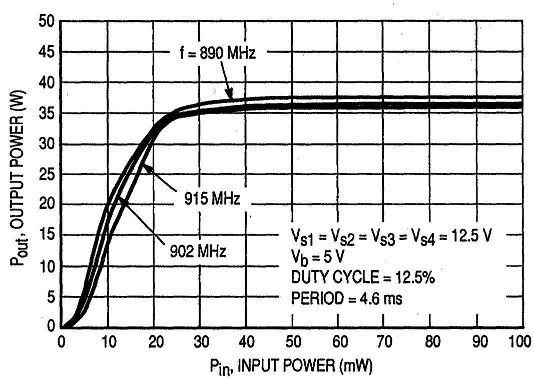


Figure 3. Output Power versus Input Power

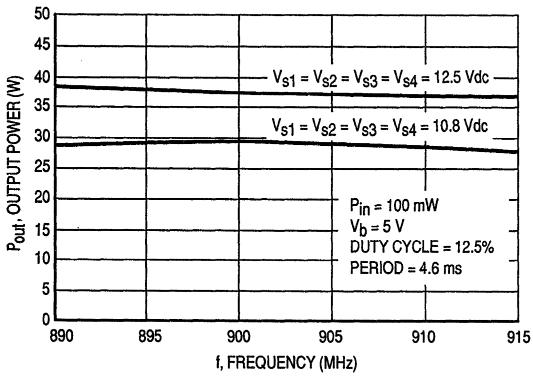


Figure 4. Output Power versus Frequency

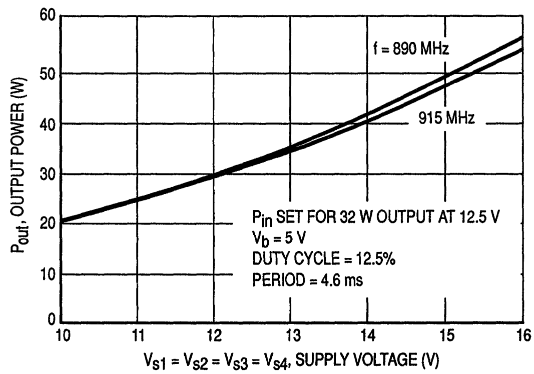


Figure 5. Output Power versus Supply Voltage

3

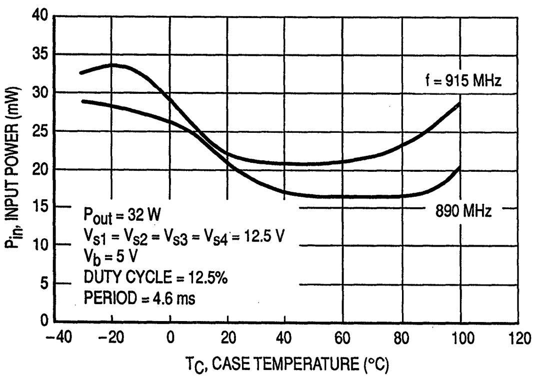


Figure 6. Input Power versus Case Temperature

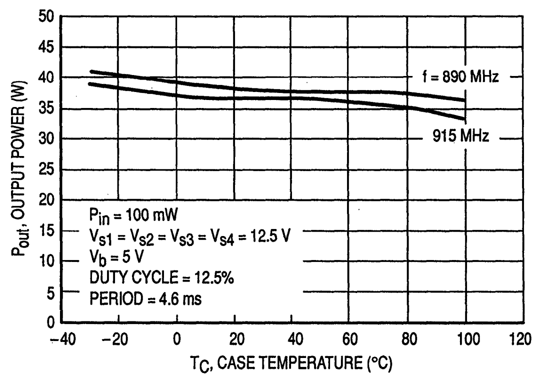


Figure 7. Output Power versus Case Temperature for Maximum Input Power

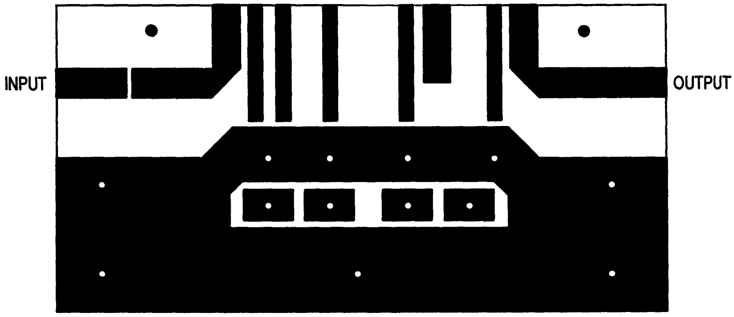


Figure 8. Photomaster for Test Fixture

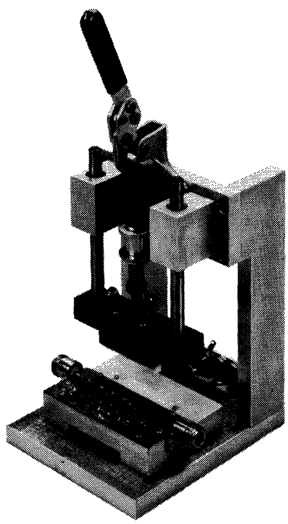


Figure 9. Test Fixture Assembly

3

APPLICATIONS INFORMATION

NOMINAL OPERATION

All electrical specifications are based on the nominal conditions of $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 12.5 Vdc (Pins 2, 3, 5, 6), and V_b = 5.0 Vdc (Pin 4). With these conditions, maximum current density on any device is 1.5 x 10^5 A/cm^2 and maximum die temperature is 165°C. While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the published specifications is not recommended unless prior communications regarding intended use have been made with the factory representative.

GAIN CONTROL

The module output power should be limited to specified value. The preferred method of power control is to fix $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 12.5 Vdc (Pins 2, 3, 5, 6), V_b = 5.0 Vdc (Pin 4), and vary P_{in} (Pin 1) from 0 to 100 mW.

DECOUPLING

Due to the high gain of the four stages and the module size limitation, external decoupling networks require careful consideration. Pins 2, 3, 4, 5, and 6 are internally bypassed with a 0.018 µF chip capacitor which is effective for frequencies from 5.0 MHz through 940 MHz. For bypassing frequencies below 5.0 MHz, networks equivalent to that shown in Figure 1 are recommended. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

LOAD MISMATCH

During final test each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{S1} = V_{S2} = V_{S3} = V_{S4}$ = 15.6 Vdc (Pins 2, 3, 5, 6), and V_b = 5.0 Vdc (Pin 4), VSWR equal to 10:1, and output power equal to 40 watts.

3

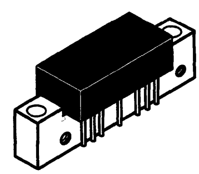
MHW1134
MHW1224
MHW1244

The RF Line
Low Distortion Wideband Amplifiers

. . . designed specifically for broadband applications requiring low distortion characteristics. Specified for use as return amplifiers for mid-split and high-split 2-way cable TV systems. Features all gold metallization system.

- Guaranteed Broadband Power Gain @ f = 5.0–200 MHz
- Guaranteed Broadband Noise Figure @ f = 5.0–175 MHz
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- All Ion-Implanted Arsenic Emitter Transistor Chips with 7.0 GHz f_T's
- Circuit Design Optimized for Good RF Stability Under High VSWR Load Conditions
- Transformers Designed to Insure Good Low Frequency Gain Stability versus Temperature

13.0 dB
18.5 dB
22.0 dB
24.0 dB
5.0–200 MHz
CATV HIGH-SPLIT
REVERSE AMPLIFIERS



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+65	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system)

Characteristic	Symbol	MHW1134	MHW1224	MHW1244	Units
Power Gain @ 10 MHz	G_P	13.0 ± 0.5	22.0 ± 0.5	24.0 ± 0.5	dB
Frequency Range (Response/Return Loss) Note 1	BW	5.0–200			MHz
Cable Slope Equivalent (5.0–200 MHz)	S	–0.2 Min/+0.8 Max			dB
Gain Flatness (5.0–200 MHz)	F	±0.2 Max			dB
Input/Output Return Loss (5.0–200 MHz) Note 1	IRL/ORL	18.0 Min			dB
Cross Modulation Distortion @ +50 dBmV per ch.					
12-Channel FLAT (5.0–120 MHz)	XM_{12}	–70 Typ	–67 Typ	–66 Typ	dB
22-Channel FLAT (5.0–175 MHz) (2) (3)	XM_{22}	–65 Max	–62 Max	–61 Max	dB
26-Channel FLAT (5.0–200 MHz)	XM_{26}	–65 Typ	–62 Typ	–61 Typ	dB

(continued)

NOTES:

1. Response and return loss characteristics are tested and guaranteed for the full 5.0–200 MHz frequency range.
2. Motorola 100% distortion and noise figure testing is performed over the 5.0–175 MHz frequency range. Cross modulation and composite triple beat testing are with 22-channel loading; Video carriers used are:

T7–T13	7.0–43.0 MHz	7-Channels
2–6	55.25–83.25 MHz	5-Channels
A–7	121.25–175.25 MHz	10-Channels

3. Video carriers used for 12-Channel typical performances are T7–6; For 26-Channel typical performance, Channels 8, 9, 10 and 11 are added to the 22-Channel carriers listed above.

ELECTRICAL CHARACTERISTICS — continued (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system)

Characteristic	Symbol	MHW1134	MHW1224	MHW1244	Units
Composite Triple Beat Distortion @ +50 dBmV per ch. 22-Channel FLAT (5.0–175 MHz) Notes 2 and 3 26-Channel FLAT (5.0–200 MHz)	CTB_{22} CTB_{26}	–73 Max –71 Typ	–69 Max –68.5 Typ	–68 Max –67.5 Typ	dB dB
Individual Triple Beat Distortion @ +50 dBmV per ch. Mid-Split (5.0–120 MHz) T11, T12 and CH2 @ 123.25 MHz High-Split (5.0–175 MHz) T13, CH2 and CH5 @ 175.5 MHz	TB_3 TB_3	–90 Typ –87 Typ	–88 Typ –85 Typ	–87 Typ –84 Typ	dB dB
Second Order Distortion @ +50 dBmV per ch. High-Split (5.0–175 MHz) CH2, CHA @ 176.5 MHz	IMD	–72 Max	–72 Max	–72 Max	dB
Noise Figure High-Split (5.0–175 MHz) Note 2	NF	7.0 Max	5.5 Max	5.0 Max	dB
DC Current	I_{DC}	210 Typ/240 Max			mAdc

NOTES:

1. Response and return loss characteristics are tested and guaranteed for the full 5.0–200 MHz frequency range.
2. Motorola 100% distortion and noise figure testing is performed over the 5.0–175 MHz frequency range. Cross modulation and composite triple beat testing are with 22-channel loading; Video carriers used are:

T7–T13	7.0–43.0 MHz	7-Channels
2–6	55.25–83.25 MHz	5-Channels
A–7	121.25–175.25 MHz	10-Channels

3. Video carriers used for 12-Channel typical performances are T7–6; For 26-Channel typical performance, Channels 8, 9, 10 and 11 are added to the 22-Channel carriers listed above.

3

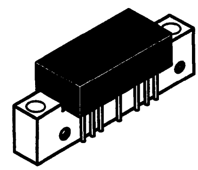
MHW5122A

The RF Line
450 MHz CATV Amplifier

. . . designed for broadband applications requiring low distortion characteristics. Specified for use as a CATV trunk-line amplifier. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T, and an all gold metallization system.

- Specified for 53- and 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 12.5 dB (Typ)
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 12.5 dB (Typ)
- Broadband Noise Figure — @ f = 450 MHz
  NF = 7.0 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature

**12.5 dB GAIN
450 MHz
60-CHANNEL
CATV TRUNK AMPLIFIER**



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	450	MHz
Power Gain — 50 MHz	G_p	12	12.5	13	dB
Slope	S	+0.2	+0.7	+1.5	dB
Gain Flatness (Peak To Valley)	—	—	0.2	0.4	dB
Return Loss — Input/Output 40–450 MHz (Z_o = 75 Ohms)	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +46 dBmV per ch., Ch 2, M6, M15) (V_{out} = +46 dBmV per ch., Ch 2, M13, M22)	IMD	 — —	 −78 —	 — −72	dB
Cross Modulation Distortion 53-Channel FLAT (V_{out} = +46 dBmV per ch.) 60-Channel FLAT	XMD_{53} XMD_{60}	— —	−63 −63	— −61	dB
Composite Triple Beat 53-Channel FLAT (V_{out} = +46 dBmV per ch.) 60-Channel FLAT	CTB_{53} CTB_{60}	— —	−63 −61	— −58	dB
DIN (European Applications Only)* 300 MHz — (CH V + Q – P @ W) 400 MHz — (CH M8 + M15 – M9 @ M14) 450 MHz — (CH M20 + M23 – M22 @ M21)	 DIN1 DIN2 DIN3	 — — —	 125 124 123	 — — —	dBμV**
Noise Figure (f = 450 MHz)	NF	—	7.0	8.0	dB
DC Current	I_{DC}	—	200	240	mA

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)** (Typ)	DIN Beat Level dB Relative to Ref. Ch.
P	253.25	+59	≤−60
Q	259.25	+59	
V	289.25	+65	
W (Ref.)	295.25	+65	
M8	361.25	+58	≤−60
M9	367.25	+58	
M14 (Ref.)	397.25	+64	
M15	403.25	+64	
M20	433.25	+63	≤−60
M21 (Ref.)	439.25	+63	
M22	445.25	+57	
M23	451.25	+57	

** DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

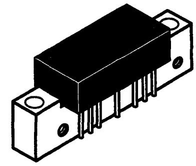
MHW5142A

The RF Line
450 MHz CATV Amplifier

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 14 dB (Typ) @ 50 MHz
  14.5 dB (Min) @ 450 MHz
- Broadband Noise Figure @ 450 MHz
  NF = 7.0 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

14 dB GAIN
450 MHz
60-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain — 50 MHz		G_p	13.5	14	14.5	dB
Power Gain — 450 MHz		G_p	14.0	—	15.5	dB
Slope		S	0.2	—	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M6, M15)			—	−78	—	
(V_{out} = +46 dBmV per ch., Ch2, M13, M22)			—	—	−74	
Cross Modulation Distortion						dB
(V_{out} = +46 dBmV per ch.)	53-Channel FLAT	XMD_{53}	—	−63	—	
	60-Channel FLAT	XMD_{60}	—	−63	−62	
Composite Triple Beat						dB
(V_{out} = +46 dBmV per ch.)	53-Channel FLAT	CTB_{53}	—	−63	—	
	60-Channel FLAT	CTB_{60}	—	−62	−61	
DIN (European Applications Only)*						dBµV**
300 MHz — (CH V + Q – P @ W)		DIN1	—	127	—	
400 MHz — (CH M8 + M15 – M9 @ M14)		DIN2	—	126	—	
450 MHz — (CH M20 + M23 – M22 @ M21)		DIN3	—	125	—	
Noise Figure (f = 450 MHz)		NF	—	6.0	7.0	dB
DC Current		I_{DC}	—	210	240	mA

3

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Ouput Level (dBmV)**(Typ)		DIN Beat Level dB Relative to Ref. Ch.
		MHW5181A	MHW5182A	
P	253.25	+59	+61	≤−60
Q	259.25	+59	+61	
V	289.25	+65	+67	
W (Ref.)	295.25	+65	+67	
M8	361.25	+58	+60	≤−60
M9	367.25	+58	+60	
M14 (Ref.)	397.25	+64	+66	
M15	403.25	+64	+66	
M20	433.25	+63	+65	≤−60
M21 (Ref.)	439.25	+63	+65	
M22	445.25	+57	+59	
M23	451.25	+57	+59	

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

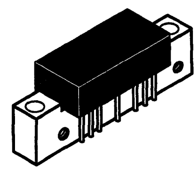
MHW5172A

The RF Line
450 MHz CATV Amplifier

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 53- and 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 17.4 dB (Typ)
- Broadband Noise Figure
  NF = 7.0 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

17 dB GAIN
450 MHz
60-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain — 50 MHz		G_p	16.8	17.4	17.8	dB
Power Gain — 450 MHz		G_p	17.4	18.4	19.0	dB
Slope		S	0.3	0.5	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +50 dBmV per ch., Ch 2, M6, M15)			—	–78	—	
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	—	–74	
Cross Modulation Distortion	53-Channel FLAT	XMD_{53}	—	–65	—	dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	XMD_{60}	—	–64	–62	
Composite Triple Beat	53-Channel FLAT	CTB_{53}	—	–63	—	dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CTB_{60}	—	–61	–60	
DIN (European Applications Only)*						dBμV**
300 MHz — (CH V + Q – P @ W)		DIN1	—	127	—	
400 MHz — (CH M8 + M15 – M9 @ M14)		DIN2	—	126	—	
450 MHz — (CH M20 + M23 – M22 @ M21)		DIN3	—	125	—	
Noise Figure (f = 450 MHz)		NF	—	6.0	7.0	dB
DC Current		I_{DC}	—	210	240	mA

3

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)**(Typ)	DIN Beat Level dB Relative to Ref. Ch.
P	253.25	+61	≤−60
Q	259.25	+61	
V	289.25	+67	
W (Ref.)	295.25	+67	
M8	361.25	+60	≤−60
M9	367.25	+60	
M14 (Ref.)	397.25	+66	
M15	403.25	+66	
M20	433.25	+65	≤−60
M21 (Ref.)	439.25	+65	
M22	445.25	+59	
M23	451.25	+59	

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

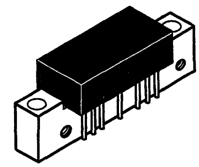
MHW5182A

The RF Line
450 MHz CATV Amplifier

18 dB GAIN
450 MHz
60-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 53- and 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 18.2 dB (Typ) @ 50 MHz
  19.0 dB (Typ) @ 450 MHz
- Broadband Noise Figure
  NF = 6.5 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain — 50 MHz		G_p	17.8	18.2	18.8	dB
Power Gain — 450 MHz		G_p	18.5	19	20	dB
Slope		S	0.3	—	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M6, M15)			—	−85	—	
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	−80	−72	
Cross Modulation Distortion (V_{out} = +46 dBmV per ch.)	53-Channel FLAT	XMD_{53}	—	−62	—	dB
	60-Channel FLAT	XMD_{60}	—	−61	−59	
Composite Triple Beat (V_{out} = +46 dBmV per ch.)	53-Channel FLAT	CTB_{53}	—	−64	—	dB
	60-Channel FLAT	CTB_{60}	—	−62	−61	
DIN (European Applications Only)*						dBμV**
300 MHz — (CH V + Q – P @ W)		DIN1	—	126	—	
400 MHz— (CH M8 + M15 – M9 @ M14)		DIN2	—	126	—	
450 MHz — (CH M20 + M23 – M22 @ M21)		DIN3	—	125	—	
Noise Figure (f = 450 MHz)		NF	—	5.5	6.5	dB
DC Current		I_{DC}	—	210	240	mA

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)**(Typ)	DIN Beat Level dB Relative to Ref. Ch.
P	253.25	+60	≤−60
Q	259.25	+60	
V	289.25	+66	
W (Ref.)	295.25	+66	
M8	361.25	+60	≤−60
M9	367.25	+60	
M14 (Ref.)	397.25	+66	
M15	403.25	+66	
M20	433.25	+65	≤−60
M21 (Ref.)	439.25	+65	
M22	445.25	+59	
M23	451.25	+59	

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

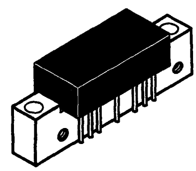
MHW5183
MHW6183

The RF Line
60-Channel (450 MHz) & 77-Channel (550 MHz) CATV Low Noise Amplifiers

. . .designed specifically for up to 550 MHz CATV systems as input amplifiers in trunk and line extender applications. Both amplifiers feature ion-implanted, arsenic emitter transistors with 8.0 GHz f_T and an all gold metallization system.

- Specified for 60/77-Channel Performance
- Broadband Power Gain — @ f = 40 – 550 MHz
  G_P = 18.5 dB Typ @ 50 MHz
  19.1 dB Typ @ 450 MHz
  19.5 dB Typ @ 550 MHz
- Broadband Noise Figure
  NF = 4.5 dB Typ — MHW5183
  5.0 dB Typ — MHW6183
- Superior Gain, Return Loss and DC Current Stability with Temperature

18 dB GAIN
450/550 MHz
60/77 CHANNEL
LOW NOISE
CATV AMPLIFIERS



CASE 714, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	+28	Vdc
RF Input Voltage (Single Tone)	V_{IN}	+70	dBmV
Operating Case Temperature Range	T_C	−30 to +100	°C
Storage Temperature Range	T_{stg}	−30 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 ohm system, unless otherwise noted)

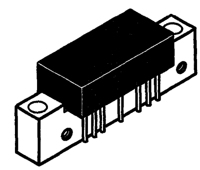
Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range	MHW5183 MHW6183	BW	40 40	— —	450 550	MHz
Power Gain	50 MHz 450 MHz 550 MHz	G_P	18 18.7 19	18.5 19.1 19.5	19 20.2 20.5	dB
Slope	MHW5183 MHW6183	S	0.3 0.5	0.7 1.0	1.8 2.0	dB
Gain Flatness (Peak To Valley)	MHW5183 MHW6183	—	— —	0.3 0.4	0.4 0.5	dB
Input/Output Return Loss	MHW5183 MHW6183	IRL/ORL	18	—	—	dB
Composite Second Order	MHW5183; V_{OUT} = +46 dBmV/ch MHW6183; V_{OUT} = +44 dBmV/ch	CSO_{60} CSO_{77}	— —	−65 −60	−62 −58	dB
Cross Modulation Distortion (V_{out} = +46 dBmV/ch, 60-Channel FLAT) (V_{out} = +44 dBmV/ch, 77-Channel FLAT)	 MHW5183 MHW6183	 XMD_{60} XMD_{77}	 — —	 −59 −60	 −57 −58	dBc
Composite Triple Beat (V_{out} = +46 dBmV/ch, 60-Channel FLAT) (V_{out} = +44 dBmV/ch, 77-Channel FLAT)	 MHW5183 MHW6183	 CTB_{60} CTB_{77}	 — —	 −62 −60	 −58 −58	dBc
Noise Figure	f = 50 MHz MHW5183 f = 450 MHz MHW6183 f = 550 MHz	NF	— — —	3.6 4.5 5.0	4.0 5.0 5.5	dB
DC Current		I_{DC}	—	245	265	mA

MHW5185B
MHW6185B
MHW6185-6

Motorola Preferred Devices

The RF Line
High Output Doubler 450/550/600 MHz CATV Amplifier Modules

**18 dB GAIN
450/550/600 MHz
60/77/87-CHANNEL
CATV AMPLIFIERS**



CASE 714, STYLE 1

The MHW5185B, MHW6185B, and MHW6185-6 are designed specifically for 450/550/600 MHz CATV applications. Features ion-implanted arsenic emitter transistors and an all gold metallization system.

- 5th Generation Die Technology
- Specified for 60/77/87-Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 18.5 dB Typ @ 50 MHz
  19.2 dB Typ @ 450 MHz
  19.5 dB Typ @ 550 MHz
  19.8 dB Typ @ 600 MHz
- Broadband Noise Figure
  NF = 4.5 dB Typ @ 50 MHz
  = 6.5 dB Typ @ 600 MHz
- Improvement in Distortion Over Conventional Hybrids
- Allows Higher Output Level Operation

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +125	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic			Symbol	Min	Typ	Max	Unit
Frequency Range		MHW5185B	BW	40	—	450	MHz
		MHW6185B		40	—	550	
		MHW6185-6		40	—	600	
Power Gain	50 MHz	All	G_p	18	18.5	19	dB
	450 MHz	MHW5185B		18.5	19.2	20	
	550 MHz	MHW6185B		18.8	19.5	20.5	
	600 MHz	MHW6185-6		19	19.8	21	
Slope	40–450 MHz	MHW5185B	S	0.3	—	1.8	dB
	40–550 MHz	MHW6185B		0.3	—	2.0	
	40–600 MHz	MHW6185-6		0.5	—	2.5	
Gain Flatness (Peak To Valley)		MHW5185B	—	—	—	0.4	dB
		MHW6185B		—	—	0.5	
		MHW6185-6		—	—	0.6	
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	MHW5185B	IRL/ORL	18	—	—	dB
	40–550 MHz	MHW6185B		18	—	—	
	40–600 MHz	MHW6185-6		18	—	—	
Composite Second Order			$CSO_{60/77/87}$				dB
60 ch, (V_{out} = +46 dBmV)		MHW5185B		—	−70	−67	
77 ch, (V_{out} = +44 dBmV)		MHW6185B		—	−68	−65	
87 ch, (V_{out} = +44 dBmV)		MHW6185-6		—	−60	−60	

(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Cross Modulation Distortion		$XMD_{60/77/87}$				dB
(60 ch, V_{out} = +46 dBmV @ Fm = 55 MHz)	MHW5185B		—	−70	−67	
(77 ch, V_{out} = +44 dBmV @ Fm = 55 MHz)	MHW6185B		—	−78	−68	
(87 ch, V_{out} = +44 dBmV @ Fm = 55 MHz)	MHW6185-6		—	−70	−66	
Signal-to-Triple Beat Noise		$CTB_{60/77/87}$				dB
(60 ch, V_{out} = +46 dBmV)	MHW5185B		—	−68	−67	
(77 ch, V_{out} = +44 dBmV)	MHW6185B		—	−66	−65	
(87 ch, V_{out} = +44 dBmV)	MHW6185-6		—	−62	−62	
Noise Figure 450 MHz	MHW5185B	NF	—	5.5	7.0	dB
550 MHz	MHW6185B		—	6.0	7.5	
600 MHz	MHW6185-6		—	6.5	8.0	
DC Current (V_{DC} = 24 Vdc, T_C = 30°C)		I_{DC}	380	415	440	mA

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

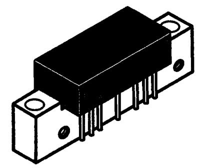
MHW5205

The RF Line
High Output Doubler 450 MHz CATV Amplifier

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 6.0 to 8.0 GHz f_T and an all gold metallization system.

- 24 V Supply Voltage
- 4th Generation Die Technology
- Specified for 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 20 dB (Typ) @ 50 MHz
  22 dB (Typ) @ 450 MHz
- Broadband Noise Figure
  NF = 6.5 dB (Typ)
- Improvement in Distortion Over Conventional Hybrids
- Allows Higher Output Level Operation

**20 dB GAIN
450 MHz
60-CHANNEL
CATV AMPLIFIER**



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_A = +25°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain	50 MHz 450 MHz	G_p	20 21	20.5 21.7	21 23	dB
Slope		S	0.5	—	2.5	dB
Gain Flatness (Peak to Valley)		—	—	—	0.5	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Composite Second Order — Intermodulation Distortion (V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CSO_{60}	—	−63	−58	dB
Cross Modulation Distortion (V_{out} = +46 dBmV per ch.)	60-Channel FLAT	XMD_{60}	—	−67	−64	dB
Composite Triple Beat (V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CTB_{60}	—	−65	−64	dB
Noise Figure	50 MHz 450 MHz	NF	— —	4.5 5.5	5.0 6.5	dB
DC Current (V_{DC} = 24 ±0.5 Vdc, T_C = 30°C)		I_{DC}	—	415	440	mA

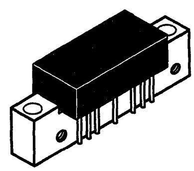
MHW5222A

The RF Line
450 MHz CATV Amplifier

. . . designed for broadband applications requiring low distortion characteristics. Specifically intended for CATV market requirements. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T, and an all gold metallization system.

- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 22 dB (Typ)
- Broadband Noise Figure — @ f = 40–450 MHz
  NF = 4.5 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

**22 dB GAIN
450 MHz
60-CHANNEL
CATV TRUNK AMPLIFIER**



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain — 50 MHz		G_p	21.4	22	22.6	dB
Power Gain — 450 MHz		G_p	22.0	22.9	23.5	dB
Slope		S	0.2	0.5	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +46 dBmV, Ch 2, M6, M15) (V_{out} = +44 dBmV, Ch 2, M13, M22)		IMD	 — —	 −80 −78	 — −72	dB
Cross Modulation Distortion (V_{out} = +46 dBmV)	53-Channel FLAT 60-Channel FLAT	XMD_{53} XMD_{60}	—	−60 −60	— −59	dB
Composite Triple Beat (V_{out} = +46 dBmV)	53-Channel FLAT 60-Channel FLAT	CTB_{53} CTB_{60}	— —	−63 −61	— −60	dB
DIN (European Applications Only) 300 MHz — (CH V + Q − P @ W) 400 MHz — (CH M8 + M15 − M9 @ M14) 450 MHz — (CH M20 + M23 − M22 @ M21)		 DIN1 DIN2 DIN3	 — — —	 125.5 125 124	 — — —	dBμV
Noise Figure (f = 450 MHz)		NF	—	4.5	5.0	dB
DC Current		I_{DC}	—	210	240	mA

3

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)**(Typ)	DIN Beat Level dB Relative to Ref. Ch.
P	253.25	+59.5	
Q	259.25	+59.5	≤−60
V	289.25	+65.5	
W (Ref.)	295.25	+65.5	
M8	361.25	+59	
M9	367.25	+59	≤−60
M14 (Ref.)	397.25	+65	
M15	403.25	+65	
M20	433.25	+64	
M21 (Ref.)	439.25	+64	≤−60
M22	445.25	+58	
M23	451.25	+58	

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

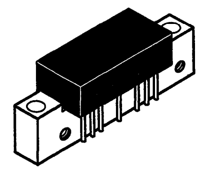
MHW5225

The RF Line
High Output Doubler 450 MHz CATV Amplifier

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 6.0 to 8.0 GHz f_T and an all gold metallization system.

- 24 V Supply Voltage
- 4th Generation Die Technology
- Specified for 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 22 dB (Typ) @ 50 MHz
  23 dB (Typ) @ 450 MHz
- Broadband Noise Figure
  NF = 4.5 dB (Typ)
- Improvement in Distortion Over Conventional Hybrids
- Allows Higher Output Level Operation

**22 dB GAIN
450 MHz
60-CHANNEL
CATV AMPLIFIER**



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_A = + 25°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain	50 MHz 450 MHz	G_p	21.4 22.3	22.0 23.0	22.6 23.7	dB
Slope		S	0.3	1.0	1.8	dB
Gain Flatness (Peak To Valley)		—	—	0.25	0.5	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +46 dBmV per ch., Ch 2, M13, M22)		IMD	—	−74	−69	dB
Cross Modulation Distortion (V_{out} = +46 dBmV per ch.)	60-Channel FLAT	XMD_{60}	—	−67	−60	dB
Composite Triple Beat (V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CTB_{60}	—	−65	−62	dB
Noise Figure	450 MHz	NF	—	4.5	6.0	dB
DC Current		I_{DC}	—	415	440	mA

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

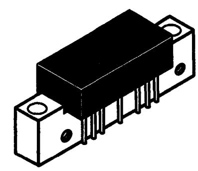
MHW5272A

The RF Line
450 MHz CATV Amplifier

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 53- and 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 27 dB (Typ)
- Broadband Noise Figure
  NF = 5.0 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

27 dB GAIN
450 MHz
60-CHANNEL
CATV LINE EXTENDER
AMPLIFIER



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range	BW	40	—	450	MHz
Power Gain — 50 MHz	G_p	26.2	27	27.8	dB
Power Gain — 450 MHz	G_p	27.0	28.0	29.0	dB
Slope	S	0	+1.0	+2.5	dB
Gain Flatness (Peak To Valley)	—	—	0.4	0.6	dB
Return Loss — Input/Output 40–450 MHz (Z_o = 75 Ohms)	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +46 dBmV per ch., Ch 2, M 6, M15) (V_{out} = +46 dBmV per ch., Ch 2, M13, M22)	IMD	 — —	 –78 –76	 — –68	dB
Cross Modulation Distortion 53-Channel FLAT (V_{out} = +46 dBmV) 60-Channel FLAT	XMD_{53} XMD_{60}	—	–63 –63	— –60	dB
Composite Triple Beat 53-Channel FLAT (V_{out} = +46 dBmV) 60-Channel FLAT	CTB_{53} CTB_{60}	— —	–63 –61	— –59	dB
DIN (European Applications Only) 300 MHz — (CH V + Q – P @ W) 400 MHz — (CH M8 + M15 – M9 @ M14) 450 MHz — (CH M20 + M23 – M22 @ M21)	 DIN1 DIN2 DIN3	 — — —	 126 125 124	 — — —	dBμV
Noise Figure (f = 450 MHz)	NF	—	5.0	6.0	dB
DC Current	I_{DC}	—	310	340	mA

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)**(Typ)	DIN Beat Level dB Relative to Ref. Ch.
P	253.25	+60	≤−60
Q	259.25	+60	
V	289.25	+66	
W (Ref.)	295.25	+66	
M8	361.25	+59	≤−60
M9	367.25	+59	
M14 (Ref.)	397.25	+65	
M15	403.25	+65	
M20	433.25	+64	≤−60
M21 (Ref.)	439.25	+64	
M22	445.25	+58	
M23	451.25	+58	

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

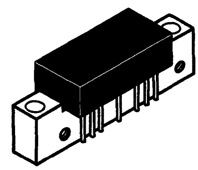
3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MHW5342A

The RF Line
450 MHz CATV Amplifier

34 dB GAIN
450 MHz
60-CHANNEL
CATV LINE EXTENDER
AMPLIFIER



CASE 714, STYLE 1

. . . designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 53- and 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 34.5 dB Typ @ 50 MHz
  35.5 dB Typ @ 450 MHz
- Broadband Noise Figure
  NF = 5.0 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain — 50 MHz		G_p	33.5	34.5	35.5	dB
Power Gain — 450 MHz		G_p	34.5	35.5	37	dB
Slope		S	0	+1.0	+2.5	dB
Gain Flatness (Peak To Valley)		—	—	0.3	0.6	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M6, M15)			—	–78	—	
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	–74	–68	
Cross Modulation Distortion	53-Channel FLAT	XMD_{53}	—	–63	—	dB
(V_{out} = +46 dBmV)	60-Channel FLAT	XMD_{60}		–63	–59	
Composite Triple Beat	53-Channel FLAT	CTB_{53}	—	–63	—	dB
(V_{out} = +46 dBmV)	60-Channel FLAT	CTB_{60}	—	–62	–59	
DIN (European Applications Only)						dBμV
300 MHz — (CH V + Q – P @ W)		DIN1	—	126	—	
400 MHz — (CH M8 + M15 – M9 @ M14)		DIN2	—	125	—	
450 MHz — (CH M20 + M23 – M22 @ M21)		DIN3	—	124	—	
Noise Figure (f = 450 MHz)		NF	—	5.0	5.5	dB
DC Current		I_{DC}	—	310	340	mA

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)**(Typ)	DIN Beat Level dB Relative to Ref. Ch.
P Q V W (Ref.)	253.25 259.25 289.25 295.25	+60 +60 +66 +66	≤−60
M8 M9 M14 (Ref.) M15	361.25 367.25 397.25 403.25	+59 +59 +65 +65	≤−60
M20 M21 (Ref.) M22 M23	433.25 439.25 445.25 451.25	+64 +64 +58 +58	≤−60

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

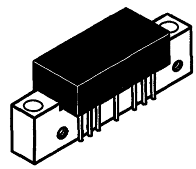
MHW5382A

The RF Line
450 MHz CATV AMPLIFIER

... designed specifically for 450 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 53- and 60-Channel Performance
- Broadband Power Gain — @ f = 40–450 MHz
  G_p = 38 dB (Typ)
- Broadband Noise Figure
  NF = 4.0 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

**38 dB GAIN
450 MHz
60-CHANNEL
CATV LINE EXTENDER
AMPLIFIER**



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

3

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	450	MHz
Power Gain — 50 MHz		G_p	37	38	39.5	dB
Power Gain — 450 MHz		G_p	38	39	40	dB
Slope		S	0	+1.0	+2.5	dB
Gain Flatness (Peak To Valley)		—	—	0.3	0.6	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–450 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M6, M15)			—	−78	—	
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	−72	−64	
Cross Modulation Distortion (V_{out} = +46 dBmV)	53-Channel FLAT	XMD_{53}	—	−63	—	dB
	60-Channel FLAT	XMD_{60}		−61	−59	
Composite Triple Beat (V_{out} = +46 dBmV)	53-Channel FLAT	CTB_{53}	—	−63	—	dB
	60-Channel FLAT	CTB_{60}	—	−60	−59	
DIN (European Applications Only)						dBμV
300 MHz — (CH V + Q – P @ W)		DIN1	—	125	—	
400 MHz— (CH M8 + M15 – M9 @ M14)		DIN2	—	124	—	
450 MHz — (CH M20 + M23 – M22 @ M21)		DIN3	—	123	—	
Noise Figure (f = 450 MHz)		NF	—	4.0	5.0	dB
DC Current		I_{DC}	—	310	340	mA

***DIN (European Applications Only)**

NCTA Channel Designation	Frequency (MHz)	DIN Output Level (dBmV)**(Typ)	DIN Beat Level dB Relative to Ref. Ch.
P	253.25	+59	≤−60
Q	259.25	+59	
V	289.25	+65	
W (Ref.)	295.25	+65	
M8	361.25	+58	≤−60
M9	367.25	+58	
M14 (Ref.)	397.25	+64	
M15	403.25	+64	
M20	433.25	+57	≤−60
M21 (Ref.)	439.25	+57	
M22	445.25	+63	
M23	451.25	+63	

**DIN (dBμV) = Reference Channel Level (dBmV) +60 dB

3

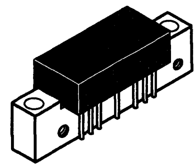
MHW6122

The RF Line
550 MHz CATV AMPLIFIER

. . . designed specifically for 550 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 77-Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 12.5 dB (Typ) @ 50 MHz
  13 dB (Min) @ 550 MHz
- Broadband Noise Figure @ 550 MHz
  NF = 8.5 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

**12 dB GAIN
550 MHz
77-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER**



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain — 50 MHz		G_p	12	12.5	13	dB
Power Gain — 550 MHz		G_p	12.5	—	—	dB
Slope		S	0.2	—	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–550 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV, Ch 2, M13, M22)			—	—	−72	
(V_{out} = +44 dBmV, Ch 2, M30, M39)			—	—	−72	
Cross Modulation Distortion						dB
(V_{out} = +46 dBmV)	60-Channel FLAT	XMD_{60}	—	−63	—	
(V_{out} = +44 dBmV)	77-Channel FLAT	XMD_{77}	—	−65	−62	
Composite Triple Beat						dB
(V_{out} = +46 dBmV)	60-Channel FLAT	CTB_{60}	—	−62	—	
(V_{out} = +44 dBmV)	77-Channel FLAT	CTB_{77}	—	−58	−56	
Noise Figure (f = 550 MHz)		NF	—	7.0	8.5	dB
DC Current		I_{DC}	—	210	240	mA

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

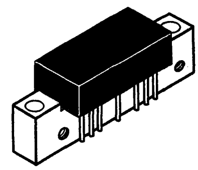
MHW6142

The RF Line
550 MHZ CATV Amplifier

. . . designed specifically for 550 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 77 Channel Performance
- Broadband Power Gain — @ f = 40−550 MHz
  G_p = 14 dB (Typ) @ 50 MHz
  14.5 dB (Min) @ 550 MHz
- Broadband Noise Figure
  NF = 7.5 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

14 dB GAIN
550 MHz
77-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain — 50 MHz		G_p	13.5	14	14.5	dB
Power Gain — 550 MHz		G_p	14.5	—	—	dB
Slope		S	0.2	—	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.5	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40−550 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	−78	—	
(V_{out} = +44 dBmV per ch., Ch 2, M30, M39)			—	−75	−72	
Cross Modulation Distortion						dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	XMD_{60}	—	−64	—	
(V_{out} = +44 dBmV per ch.)	77-Channel FLAT	XMD_{77}	—	−65	−62	
Composite Triple Beat						dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CTB_{60}	—	−62	—	
(V_{out} = +44 dBmV per ch.)	77-Channel FLAT	CTB_{77}	—	−65	−59	
Noise Figure (f = 550 MHz)		NF	—	6.5	7.5	dB
DC Current		I_{DC}	—	210	240	mA

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MHW6172

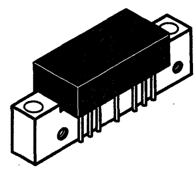
The RF Line

77-Channel (550 MHz) CATV Input/Output Trunk Amplifier

. . . designed specifically for 550 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7 GHz f_T and an all gold metallization system.

- Specified for 77-Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 17.2 dB (Typ)
- Broadband Noise Figure — @ f = 550 MHz
  NF = 6 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7 GHz Ion-Implanted Transistors

17 dB GAIN
550 MHz
77-CHANNEL
CATV AMPLIFIER



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain	50 MHz	G_p	16.8	17.2	17.8	dB
Slope		S	0	+0.5	+1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–550 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	−80	—	
(V_{out} = +44 dBmV per ch., Ch 2, M30, M39)			—	−78	−70	
Cross Modulation Distortion						dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	XMD_{60}	—	−63	—	
(V_{out} = +44 dBmV per ch.)	77-Channel FLAT	XMD_{77}	—	−65	−62	
Composite Triple Beat Noise						dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CTB_{60}	—	−62	—	
(V_{out} = +44 dBmV per ch.)	77-Channel FLAT	CTB_{77}	—	−60	−59	
Noise Figure	450 MHz	NF	—	5.5	—	dB
	550 MHz		—	6	7	
DC Current		I_{DC}	—	210	240	mA

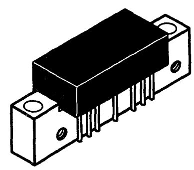
MHW6182

The RF Line
550 MHz CATV Amplifier

. . . designed specifically for 550 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 77 Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 18.2 dB (Typ) @ 50 MHz
  18.8 dB (Min) @ 550 MHz
- Broadband Noise Figure @ 550 MHz
  NF = 7.0 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

**18 dB GAIN
550 MHz
77-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER**



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+70	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain — 50 MHz		G_p	17.7	18.2	18.7	dB
Power Gain — 550 MHz		G_p	18.8	19.2	20	dB
Slope		S	0.5	—	2.0	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.5	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–550 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion (V_{out} = +46 dBmV per ch., Ch 2, M13, M22) (V_{out} = +44 dBmV per ch., Ch 2, M30, M39)		IMD	 — —	 −85 −80	 — −72	dB
Cross Modulation Distortion (V_{out} = +46 dBmV per ch.) (V_{out} = +44 dBmV per ch.)	 60-Channel FLAT 77-Channel FLAT	 XMD_{60} XMD_{77}	 — —	 −61 −64	 — −62	dB
Composite Triple Beat (V_{out} = +46 dBmV per ch.) (V_{out} = +44 dBmV per ch.)	 60-Channel FLAT 77-Channel FLAT	 CTB_{60} CTB_{77}	 — —	 −62 −60	 — −58	dB
Noise Figure (f = 550 MHz)		NF	—	—	7.0	dB
DC Current		I_{DC}	—	210	240	mA

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

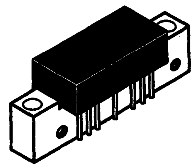
MHW6222

The RF Line
550 MHz CATV AMPLIFIER

. . . designed specifically for 550 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7.0 GHz f_T and an all gold metallization system.

- Specified for 77-Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 22 dB (Typ) @ 50 MHz
  22 dB (Min) @ 550 MHz
- Broadband Noise Figure @ 550 MHz
  NF = 6.0 dB (Max)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7.0 GHz Ion-Implanted Transistors

22 dB GAIN
550 MHz
77-CHANNEL
CATV INPUT/OUTPUT
TRUNK AMPLIFIER



CASE 714, STYLE 1

3

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+60	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

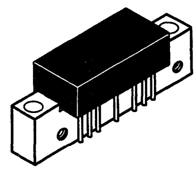
Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain — 50 MHz		G_p	21.4	22	22.6	dB
Power Gain — 550 MHz		G_p	22	—	—	dB
Slope		S	0.2	—	1.5	dB
Gain Flatness (Peak To Valley)		—	—	0.2	0.4	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–550 MHz	IRL/ORL	18	—	—	dB
Second Order Intermodulation Distortion		IMD				dB
(V_{out} = +46 dBmV per ch., Ch 2, M13, M22)			—	−80	—	
(V_{out} = +46 dBmV per ch., Ch 2, M30, M39)			—	−72	−66	
Cross Modulation Distortion						dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	XMD_{60}	—	−60	—	
(V_{out} = +44 dBmV per ch.)	77-Channel FLAT	XMD_{77}	—	−60	−57	
Composite Triple Beat						dB
(V_{out} = +46 dBmV per ch.)	60-Channel FLAT	CTB_{60}	—	−61	—	
(V_{out} = +44 dBmV per ch.)	77-Channel FLAT	CTB_{77}	—	−59	−57	
Noise Figure (f = 550 MHz)		NF	—	5.0	6.0	dB
DC Current		I_{DC}	—	210	240	mA

MHW6272

The RF Line
77-Channel (550 MHz) CATV Line Extender Amplifier

**27 dB GAIN
550 MHz
77-CHANNEL
CATV AMPLIFIER**

- Specified for 60- and 77-Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 27 dB (Typ)
- Broadband Noise Figure
  NF = 6 dB (Typ) @ 550 MHz
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7 GHz f_T Ion-Implanted Transistors



CASE 714, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain	50 MHz 550 MHz	G_p	26.2 27	27 —	27.8 29.2	dB
Slope		S	0	1	2	dB
Gain Flatness (Peak To Valley)		—	—	0.4	0.8	dB
Return Loss — Input/Output (Z_O = 75 Ohms)	40–450 MHz 450–550 MHz	IRL/ORL	18 16	— —	— —	dB
Second Order Intermodulation Distortion (V_{out} = +48 dBmV per ch., Ch 2, 13, R) (V_{out} = +46 dBmV per ch., Ch 2, M6, M15) (V_{out} = +46 dBmV per ch., Ch 2, M13, M22) (V_{out} = +44 dBmV per ch., Ch 2, M30, M39)		IMD	 — — — —	 –80 –78 –76 –69	 — — — –64	dB
Cross Modulation Distortion @ Ch 2 (V_{out} = +46 dBmV per ch.) (V_{out} = +44 dBmV per ch.)	 53-Channel FLAT 60-Channel FLAT 70-Channel FLAT 77-Channel FLAT	 XMD_{53} XMD_{60} XMD_{70} XMD_{77}	 — — — —	 –63 –62 –61 –59	 — — — –57	dB
Composite Triple Beat (V_{out} = +46 dBmV per ch.) (V_{out} = +44 dBmV per ch.)	 53-Channel FLAT 60-Channel FLAT 70-Channel FLAT 77-Channel FLAT	 TB_{53} TB_{60} TB_{70} TB_{77}	 — — — —	 –63 –62 –61 –59	 — — — –57	dB
Noise Figure	550 MHz	NF	—	6.0	6.5	dB
DC Current		I_{DC}	—	310	340	mA

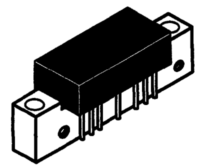
MHW6342

The RF Line
77-Channel (550 MHz) CATV Amplifier

. . . designed specifically for 550 MHz CATV applications. Features ion-implanted arsenic emitter transistors with 7 GHz f_T and an all gold metallization system.

- Specified for 77-Channel Performance
- Broadband Power Gain — @ f = 40–550 MHz
  G_p = 34.5 dB (Typ) @ 50 MHz
  35 dB (Min) @ 550 MHz
- Broadband Noise Figure @ 550 MHz
  NF = 5.5 dB (Typ)
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization
- 7 GHz Ion-Implanted Transistors

**34 dB GAIN
550 MHz
77-CHANNEL
CATV AMPLIFIER**



CASE 714, STYLE 1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
RF Voltage Input (Single Tone)	V_{in}	+55	dBmV
DC Supply Voltage	V_{CC}	+28	Vdc
Operating Case Temperature Range	T_C	–20 to +100	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc, T_C = +30°C, 75 Ω system unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Frequency Range		BW	40	—	550	MHz
Power Gain	50 MHz	G_p	33.5	34.5	35.5	dB
Power Gain	550 MHz	G_p	35	—	—	dB
Slope		S	0	1	2	dB
Gain Flatness (Peak To Valley)		—	—	0.4	0.8	dB
Return Loss — Input/Output (Z_o = 75 Ohms)	40–550 MHz 450–550 MHz	IRL/ORL	18 16	— —	— —	dB
Second Order Intermodulation Distortion (V_{out} = +46 dBmV per ch., Ch 2, M13, M22) (V_{out} = +44 dBmV per ch., Ch 2, M30, M39)		IMD	 — —	 –75 –70	 — –64	dB
Cross Modulation Distortion (V_{out} = +46 dBmV per ch.) (V_{out} = +44 dBmV per ch.)	 60-Channel FLAT 77-Channel FLAT	 XMD_{60} XMD_{77}	 — —	 –61 –59	 — –57	dB
Composite Triple Beat (V_{out} = +46 dBmV per ch.) (V_{out} = +44 dBmV per ch.)	 60-Channel FLAT 77-Channel FLAT	 CTB_{60} CTB_{77}	 — —	 –60 –58	 — –57	dB
Noise Figure	550 MHz	NF	—	5.5	6.5	dB
DC Current		I_{DC}	—	310	340	mA

MHW7182
MHW8182
MHW9182

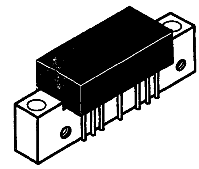
Motorola Preferred Devices

The RF Line
110-Channel (750 MHz), 128-Channel (860 MHz) & 152-Channel (1000 MHz) CATV Amplifiers

18 dB GAIN
750/860/1000 MHz
110/128/152 CHANNEL
CATV AMPLIFIERS

The MHW7182, MHW8182, and MHW9182 are designed specifically for up to 1000 MHz CATV systems as output amplifiers in trunk and line extender applications. These amplifiers feature ion-implanted, arsenic emitter transistors and an all gold metallization system.

- Specified for 110/128/152-Channel Performance
- Broadband Power Gain — @ f = 40–1000 MHz
  G_p = 18.2 dB Min @ 750, 860 & 1000 MHz
- Broadband Noise Figure
  NF = 5.5 dB Typ — MHW7182
  6.0 dB Typ — MHW8182
  6.5 dB Typ — MHW9182
- Superior Gain, Return Loss and DC Current Stability with Temperature
- All Gold Metallization



CASE 714, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{CC}	+28	Vdc
RF Input Voltage (Single Tone)	V_{in}	+70	dBmV
Operating Case Temperature Range	T_C	−20 to +100	°C
Storage Temperature Range	T_{stg}	−40 to +125	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 24 Vdc; T_C = +30°C, 75 ohm system, unless otherwise noted)

Characteristic			Symbol	Min	Typ	Max	Unit
Frequency Range		MHW7182 MHW8182 MHW9182	BW	40 40 40	— — —	750 860 1000	MHz
Power Gain	50 MHz 750 MHz 860 MHz 1000 MHz	All MHW7182 MHW8182 MHW9182	G_p	17.6 18.2 18.2 18.2	18.2 18.9 19.0 19.2	18.8 20.5 20.5 20.7	dB
Slope		MHW7182, MHW8182, MHW9182	S	0	1.0	2.5	—
Gain Flatness (Peak To Valley)		 MHW7182, MHW8182 MHW9182	G_f	— —	0.4 0.4	0.6 0.8	—
Input/Output Return Loss @ f = 40 MHz		MHW7182, MHW8182, MHW9182	IRL/ORL	20	24	—	dB
Derate Return Loss @ f > 40 MHz (Ref = 20 dB @ 40 MHz)		MHW7182 MHW8182 MHW9182	RLD	— — —	— — —	0.007 0.008 0.009	dB/MHz
Composite Second Order (V_{out} = +40 dBmV/ch; 110 Channels) (V_{out} = +38 dBmV/ch; 128 Channels) (V_{out} = +38 dBmV/ch; 152 Channels)		 MHW7182 MHW8182 MHW9182	 CSO_{110} CSO_{128} CSO_{152}	 — — —	 −67 −67 −67	 −62 −60 −59	dB

(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (V_{CC} = 24 Vdc; T_C = +30°C, 75 ohm system, unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Cross Modulation Distortion						dBc
(V_{out} = +40 dBmV/ch, 110-Channel @ Fm = 55.25 MHz)	MHW7182	XMD_{110}	—	−68	−64	
(V_{out} = +38 dBmV/ch, 128-Channel @ Fm = 55.25 MHz)	MHW8182	XMD_{128}	—	−68	−60	
(V_{out} = +38 dBmV/ch, 152-Channel @ Fm = 55.25 MHz)	MHW9182	XMD_{152}	—	−68	−59	
Composite Triple Beat						dBc
(V_{out} = +40 dBmV/ch, 110-Channels, Worst Case)	MHW7182	CTB_{110}	—	−64	−62	
(V_{out} = +38 dBmV/ch, 128-Channels, Worst Case)	MHW8182	CTB_{128}	—	−62	−60	
(V_{out} = +38 dBmV/ch, 152-Channels, Worst Case)	MHW9182	CTB_{152}	—	−61	−59	
Noise Figure f = 50 MHz		NF	—	3.6	5.0	dB
f = 750 MHz	MHW7182		—	5.5	6.5	
f = 860 MHz	MHW8182		—	6.0	7.0	
f = 1000 MHz	MHW9182		—	6.5	8.0	
DC Current		I_{DC}	180	210	240	mA

MHW9002-1
MHW9002-2
MHW9002-3
MHW9002-4

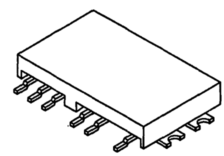
Motorola Preferred Devices

The RF Line
UHF GaAs FET Power Amplifiers

Designed for use in a wide variety of telecommunications equipment, including portable cellular applications, satellite cellular applications, gateways and satellite stations. All MHW9002 Series modules are capable of wide power range control (30 dB typical), operate from a 5.8 volt supply and require only 5 mW of RF input power.

- High Efficiency
- Specified 5.8 Volt Characteristics:
  RF Input Power — 5.0 mW (7 dBm)
  RF Output Power — 1.41 W (31.5 dBm)
  Minimum Gain — 24.5 dB
  Minimum Efficiency – 55%
  Harmonics — –30 dBc Max @ 2 f_o
- 50 Ohm Input/Output Impedances
- Guaranteed Stability and Ruggedness
- Epoxy Glass Substrate Eliminates Possibility of Substrate Fracture

**31.5 dBm
824 to 925 MHz
HIGH EFFICIENCY
RF POWER
AMPLIFIERS**



CASE 420A, STYLE 1

3

MAXIMUM RATINGS (Range Temperature = 25°C)

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{DD2}	10	Vdc
DC Bias Voltage	$V_{GG1,2}$	–6	Vdc
DC Control Voltage	V_{DD1}	10	Vdc
RF Input Power	P_{in}	15	dBm
RF Output Power (V_S = 9 Vdc)	P_{out}	33	dBm
Operating Case Temperature Range	T_C	–30 to +100	°C
Storage Temperature Range	T_{stg}	–30 to +100	°C

ELECTRICAL CHARACTERISTICS (V_{DD1} ≤ 5.8 Vdc, V_{DD2} = 5.8 Vdc, V_{GG1} = V_{GG2} = –4.0 Vdc, P_{out} = 31.5 dBm for MHW9002-1, -2, -4; V_{DD1} ≤ 6.0 Vdc, V_{DD2} = 6.0 Vdc, V_{GG1} = V_{GG2} = –4.0 Vdc, P_{out} = 32 dBm for MHW9002-3; P_{in} = 7 dBm; T_C = +25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency Range MHW9002-1 MHW9002-2 MHW9002-3 MHW9002-4	BW	824 870 890 898		849 905 915 925	MHz
Output Power, Low Voltage (T_C = –30 to +80°C, V_{DD1} = V_{DD2} = 5.0 Vdc)	P_{out1}	29.3	30	—	dBm
Output Power, Zero Control Voltage (V_{DD1} = 0 Vdc; P_{in} = 7 dBm)	P_{out2}	—	—	6	dBm
Gate Current (1)	I_{GG}	—	—	5	mA
Efficiency (1)	η	55	60		%
Input VSWR (1)	$VSWR_{in}$		—	3.0:1	—
Harmonics (1) 2f_o to 4f_o				–30	dBc

NOTE:
1. Adjust V_{DD1} for Specified P_{out}, V_{DD1} = 5.8 Vdc Max for MHW9002-1, -2, & -4. V_{DD1} = 6.0 Vdc Max for MHW9002-3.

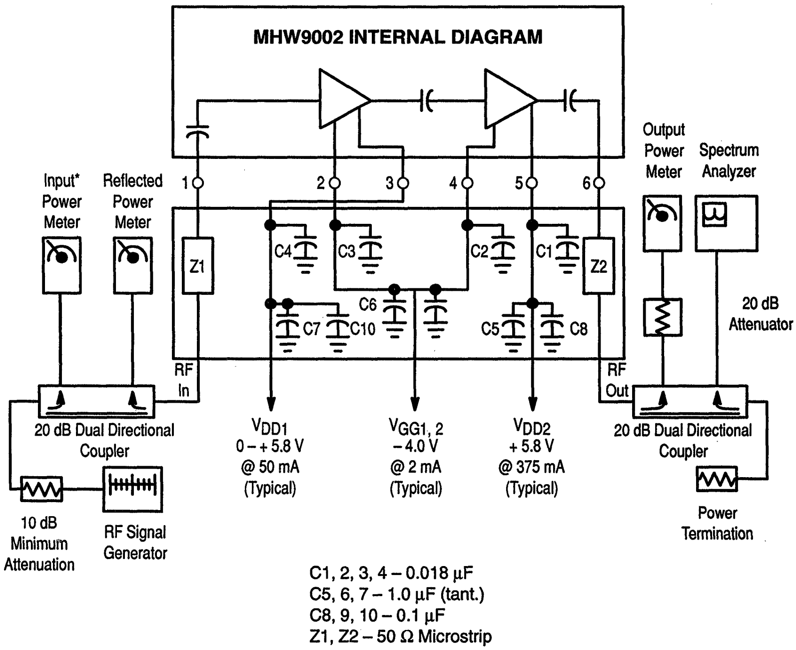
(continued)

Preferred devices are Motorola recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS — continued (V_{DD1} ≤ 5.8 Vdc, V_{DD2} = 5.8 Vdc, V_{GG1} = V_{GG2} = −4.0 Vdc, P_{out} = 31.5 dBm for MHW9002-1, -2, -4; V_{DD1} ≤ 6.0 Vdc, V_{DD2} = 6.0 Vdc, V_{GG1} = V_{GG2} = −4.0 Vdc, P_{out} = 32 dBm for MHW9002-3; P_{in} = 7 dBm; T_C = +25°C, 50 ohm system, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Power (In 20 kHz Bandwidth, 45 MHz Above f_o, V_{DD2} = 5 to 7 Vdc, V_{DD1} = 0 to 5.8 Vdc)	P_{N1}	—	—	−95	dBm
Noise Power (In 20 kHz Bandwidth, 45 MHz Above f_o, V_{DD2} = 5 to 7 Vdc, V_{DD1} = 0 to 5.8 Vdc, T_C = −30°C to T_C = +80°C)	P_{N2}	—	—	−92	dBm
Stability (V_{DD1} = 0 to 7 Vdc, P_{in} = 4 to 10 dBm, V_{DD2} = 4.5 to 8 Vdc, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	—	All Spurious Outputs more than 60 dB Below Desired Signal			
Load Mismatch Stress (V_{DD2} = 8 Vdc, P_{out} = 31.5 dB Load VSWR = 20:1, All Phase Angles at Frequency of Test) (2)	ψ	No Degradation in Output Power Before and After Test			

NOTE:
2. Adjust V_{DD1} for Specified P_{out}, V_{DD1} = 8.0 Vdc Max for MHW9002-1, -2, -3, & -4.



*Module input power is forward power as sampled by the directional coupler and read on the input power meter.

Figure 1. UHF Power Module Test Circuit Diagram

TYPICAL CHARACTERISTICS

MHW9002-1

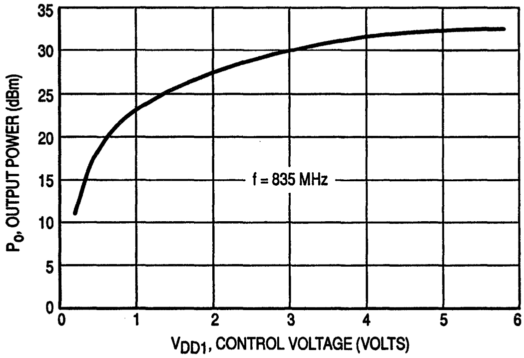


Figure 2. Output Power versus Control Voltage

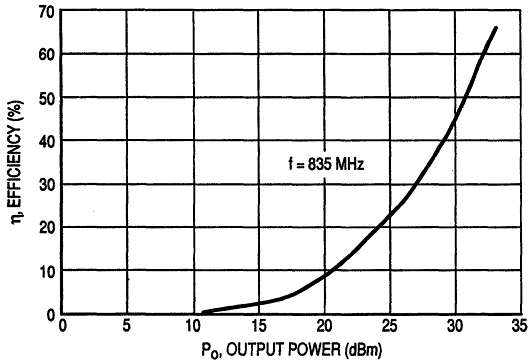


Figure 3. Efficiency versus Output Power

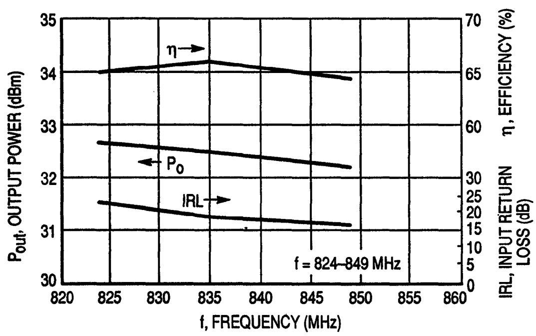


Figure 4. Output Power, Efficiency, Input Return Loss versus Frequency

MHW9002-2

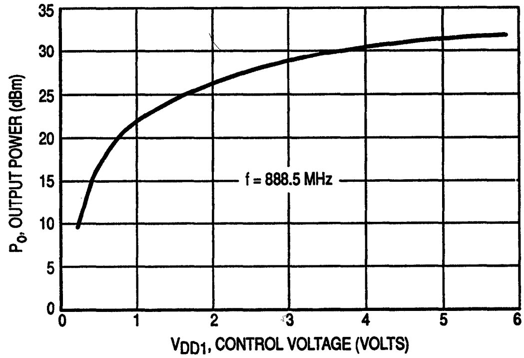


Figure 5. Output Power versus Control Voltage

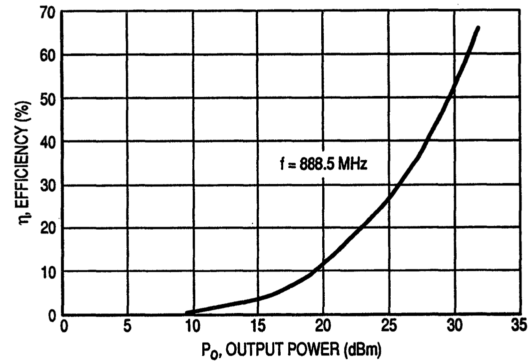


Figure 6. Efficiency versus Output Power

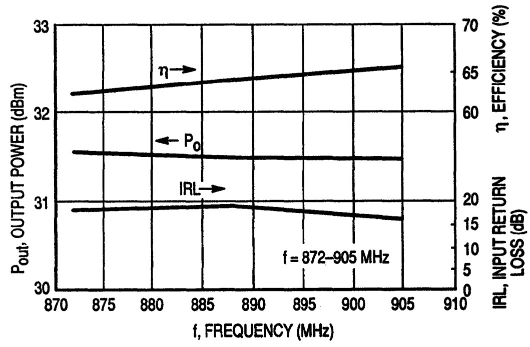


Figure 7. Output Power, Efficiency, Input Return Loss versus Frequency

3

TYPICAL CHARACTERISTICS

MHW9002-3

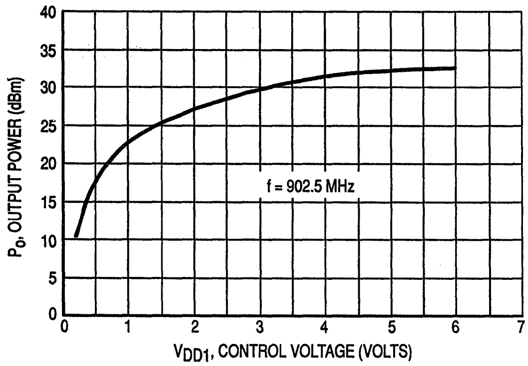


Figure 8. Output Power versus Control Voltage

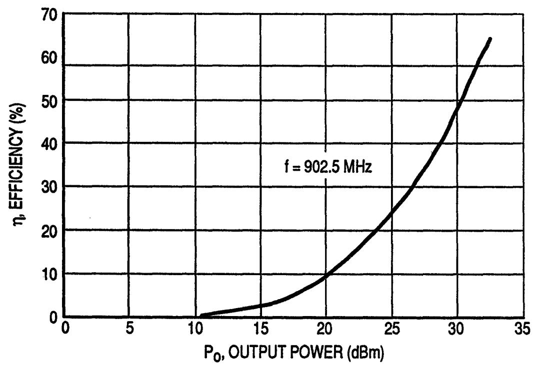


Figure 9. Efficiency versus Output Power

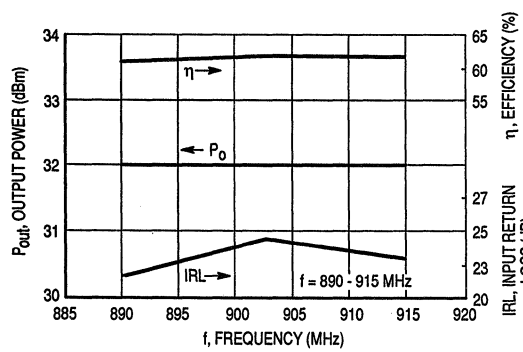


Figure 10. Output Power, Efficiency, Input Return Loss versus Frequency

MHW9002-4

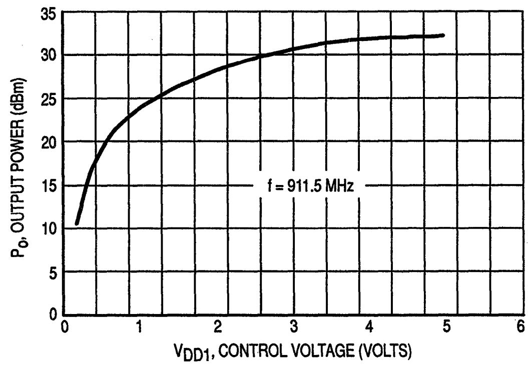


Figure 11. Output Power versus Control Voltage

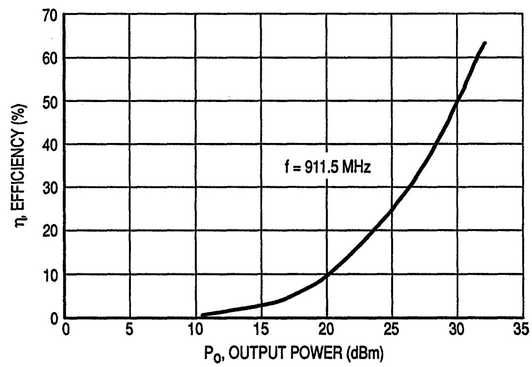


Figure 12. Efficiency versus Output Power

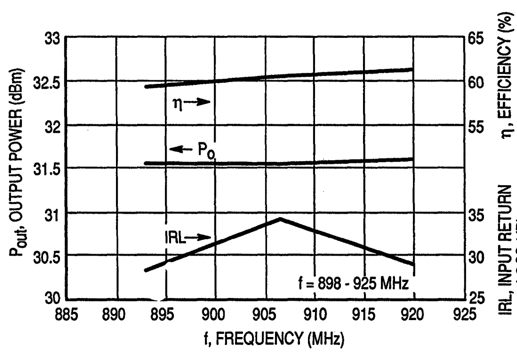


Figure 13. Output Power, Efficiency, Input Return Loss versus Frequency

3

APPLICATIONS INFORMATION

Mounting Considerations

For the MHW9002 Series module, mounting is done by soldering the four "feet" to a suitable heatsink. This can be done with a low temperature solder such as 52% In, 48% Sn and type "R" flux which liquifies below 150°C. Under no circumstances should the MHW9002 Series modules be heated to a temperature greater than 165°C (temperature of the flange proper). Internal construction of the module has been achieved using 36% tin, 62% lead, and 2% silver solder which liquifies at about 180°C. Also, remember that the modules are NOT hermetic.

Nominal Operation

All electrical specifications are based on the nominal conditions of $V_{DD1} \leq 5.8$ Vdc, $V_{DD2} = 5.8$ Vdc, $V_{GG1,2} = -4$ Vdc, and P_{out} equal to 31.5 dBm ($V_{DD2} = 6.0$ Vdc, $V_{DD1} \leq 6.0$ Vdc, $V_{GG1,2} = -4$ Vdc and P_{out} equal to 32.0 dBm for the MHW9002-3). While the modules are designed to have excess gain margin with ruggedness, operation of these units outside the published specifications is not recommended unless prior communications regarding intended use have been made with a factory representative.

Gain Control

The module output power should be limited to specified value. The preferred method of power control is to fix $V_{DD2} = 5.8$ Vdc (Pin 5) (6.0 Vdc for the MHW9002-3) and $V_{GG1,2} = -4$ Vdc (Pins 2, 4), P_{in} (Pin 1) at 5 mW, and vary V_{DD1} (Pin 3) voltage.

Decoupling

External decoupling networks are recommended to ensure stable operation of the device. Pins 2, 3, 4, and 5 are internally bypassed with a 1000 pF chip capacitor. Additional external decoupling is recommended as shown in Figure 1. Inadequate decoupling will result in spurious outputs at certain operating frequencies and certain phase angles of input and output VSWR.

Handling Considerations

GaAs FETs are more sensitive to electrostatic discharge (ESD) than Si bipolar transistors. Therefore, steps should be taken in handling GaAs products to prevent damage. The use of ground straps, grounded breakers and test equipment is strongly recommended.

Soldering Leads

Be sure the soldering iron is grounded. Temperature of the iron should not exceed 350°C. Apply heat to a lead to be soldered for not more than 5 seconds.

Load Mismatch

During final test each module is load mismatch tested in a fixture having the identical decoupling networks described in Figure 1. Electrical conditions are $V_{DD2} = 8.0$ Vdc and $V_{GG1,2} = -4$ Vdc, P_{in} at 5 mW, and V_{DD1} set for 31.5 dBm output power (32.0 dBm for the MHW9002-3), and VSWR equal to 20:1.

Biasing and Use Considerations

In all cases, RF input power should not be applied until the bias voltages have been applied, and RF input power should be turned off prior to removing the bias voltages. Bias application should be timed such that gate voltage ($V_{GG1,2}$) is always applied before the drain voltages (V_{DD}), and, when returning to the standby mode, gate voltage should only be removed once the drain voltages have been removed.

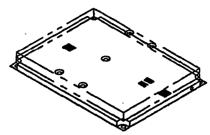
MRFA2600

The RF Line
Broadband RF Array for TV Transmitter

25 W, 470–860 MHz
CLASS A
RF POWER AMPLIFIER

The MRFA2600 is a solid state class A amplifier and is specifically designed for TV transposers and transmitters. This amplifier incorporates microstrip technology and reliable Motorola push-pull transistors.

- Specified 26.5 Volts, 470–860 MHz Characteristics
  Output Power — 25 Watts Min @ 1 dB Comp. (CW)
  Gain — 10.5 dB Min (Small Signal)
- Suitable for 28 Volts Application
- 50 Ω Input and Output Impedance



CASE 429A, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	29	Vdc
Current	I_{max}	4	Adc
Storage Temperature Range	T_{stg}	–40 to +100	°C
Operating Temperature (1)	T_{op}	–20 to +70	°C

NOMINAL OPERATION CONDITION

Supply	Transposer Application	V_{CC} = 26.5 V	I_{sup} = 3.8 A
	Transmitter Application	V_{CC} = 28 V	I_{sup} = 3.6 A

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 26.5 V, I_{sup} = 3.8 A, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Instantaneous Bandwidth	BW	470	860	MHz
Power Gain (small signal)	G_p	10.5	—	dB
Gain Ripple (small signal)	G_{rple}	—	±1	dB
Output Power @ 1 dB Compression	P_{out}	25	—	W
Mismatch Tolerance (P_{out} = 25 W)	VSWR	20:1	—	—
Intermodulation (–8 dB/–16 dB/–10 dB, P_{ref} = 20 W)	IMD	—	–53	dB
Intermodulation (–8 dB/–16 dB/–7 dB, P_{ref} = 20 W)	IMD	—	–50	dB
Input Return Loss	IRL	—	–15	dB

NOTE:
1. Temperature is measured at temperature test point (on the flange of the transistor).

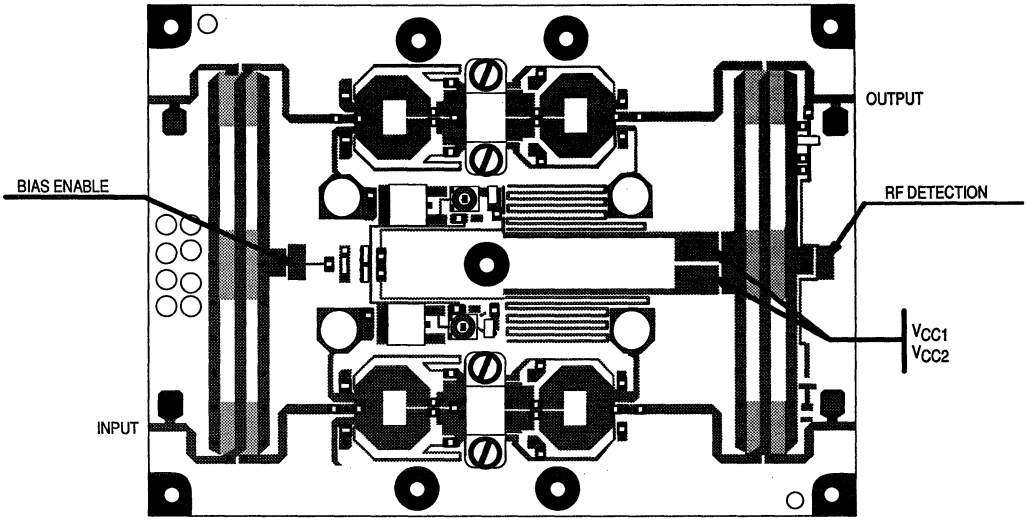
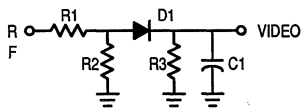


Figure 1. Test Circuit Components View

RF DETECTION

V_D = 1 V @ 25 W
on infinite load

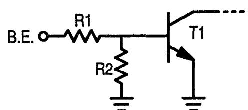
R1 .... 22 kΩ
R2 .... 680 Ω
R3 .... 2.2 kΩ
C1 .... 22 pF
D1 .... MMBD701



BIAS ENABLE

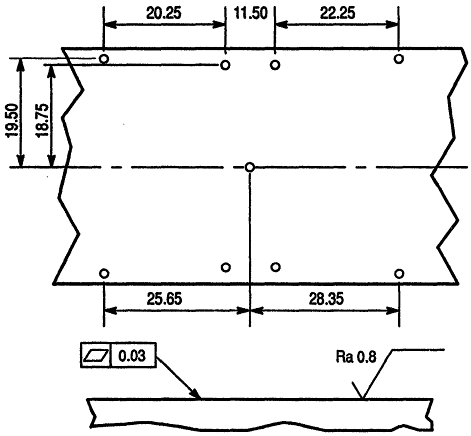
If B.E. = "1" (TTL signal)
bias circuit is off

R1 .... 4.7 kΩ
R2 .... 4.7 kΩ
T1 .... BCX20



MOUNTING RECOMMENDATIONS

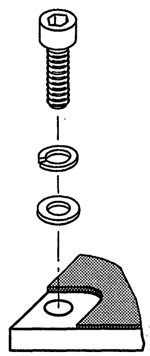
HEATSINK TOOLING



o 9 Fixing holes M3
Minimum useful depth: — Copper/Aluminum: 6 mm

THERMAL COMPOUND

- Paste with silicones: SICERONT KF Ref. 1201 Recommended.
- Thickness: Optimum between 0.06 mm and 0.15 mm, on the whole back surface of the amplifier.
  (Typical volume: 700 mm 3 for 0.1 mm thickness)
  (Equivalent weight: 1.5g for 2.2 density paste).



SCREWS

- Socket head cap screws: CHC M3 x 10 for Copper/Aluminum Heatsink.
- Material: Nickel plated steel.

WASHERS

- Split lock washers WZ Ø3 + Flat washers ZU Ø3.
- Split lock washers WZ Ø3 + Flat washers ZU Ø3.

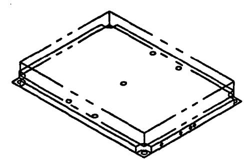
MRFA2602

The RF Line
Broadband RF Power Amplifier for TV Transmitter

60 W, 470–860 MHz
CLASS A
RF POWER AMPLIFIER

The MRFA2602 is a solid state class A amplifier and is specifically designed for TV transposers and transmitters. This amplifier incorporates microstrip technology and reliable Motorola push-pull transistors.

- Specified 25.5 Volts, 470–860 MHz Characteristics
  Output Power — 40 Watts @ –50 dB (3 Tones)
  Output Power — 60 Watts Min @ 1 dB Comp. (CW)
  Gain — 9 dB Min (Small Signal)



CASE 429C, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	26.5	Vdc
Input Power	P_{in}	15	W
Storage Temperature Range	T_{stg}	–40 to +100	°C
Operating Temperature (1)	T_{op}	–20 to +70	°C

NOMINAL OPERATION CONDITION (T_C = 60°C)

Supply	V_{CC} = 25.5 V	I_{sup} = 9.2 A

ELECTRICAL CHARACTERISTICS (T_C = 25°C, Nominal Supply, 470–860 MHz Bandwidth, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain (small signal)	G_p	9	—	—	dB
Gain Ripple (small signal)	G_{rple}	—	—	±1	dB
Output Power @ 1 dB Compression	P_{out}	60	—	—	W
Mismatch Tolerance (P_{out} = 60 W)	VSWR	20:1	—	—	—
Intermodulation (–8 dB/–7 dB/–16 dB, P_{ref} = 40 W)	IMD1	—	—	–50	dB
Intermodulation (–8 dB/–10 dB/–16 dB, P_{ref} = 40 W)	IMD2	—	—	–53	dB
Input Return Loss/Output Return Loss	IRL/ORL	—	—	–15	dB

NOTE:
1. Temperature is measured at temperature test point (on the flange of the transistor).

3

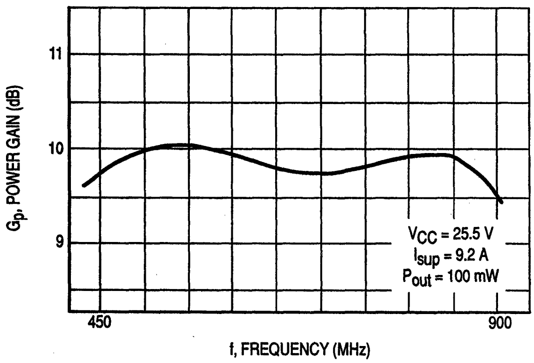


Figure 1. Power Gain versus Frequency

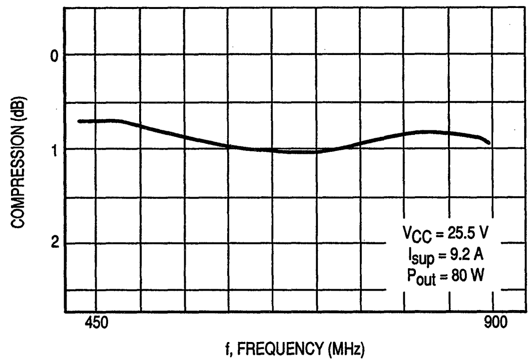


Figure 2. Gain Compression versus Frequency

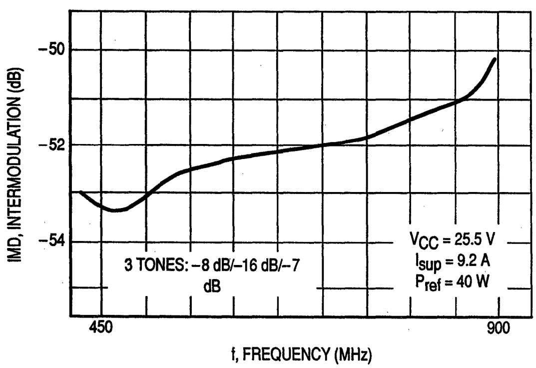


Figure 3. Intermodulation versus Frequency

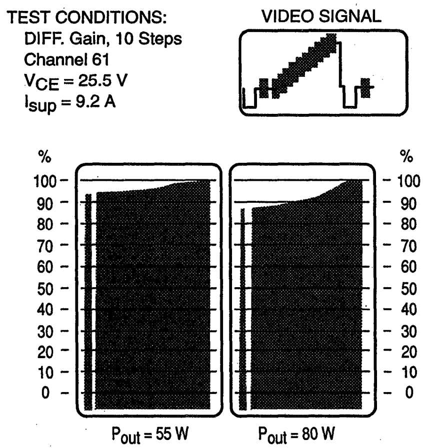
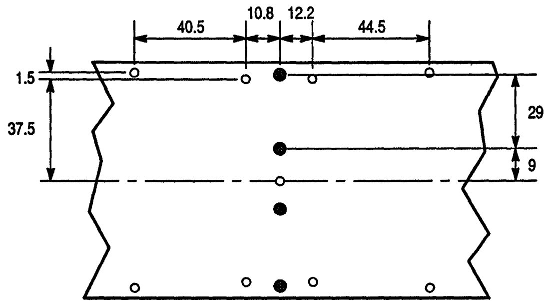


Figure 4. Differential Gain

MOUNTING RECOMMENDATIONS

HEATSINK TOOLING



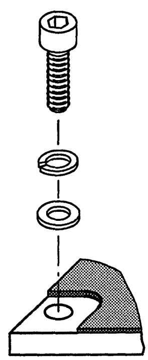
○ 9 Fixing holes M3
Minimum useful depth: — Iron: 4 mm
— Copper/Aluminum: 6 mm

● 4 Cavities Ø5
Minimum depth: 1 mm

3

THERMAL COMPOUND

- Paste with silicones: SICERONT KF Ref. 1201 Recommended.
- Thickness: Optimum between 0.06 mm and 0.15 mm, on the whole back surface of the amplifier.
  (Typical volume: 680 mm 3 for 0.1 mm thickness)
  (Equivalent weight: 1.5g for 2.2 density paste)



SCREWS

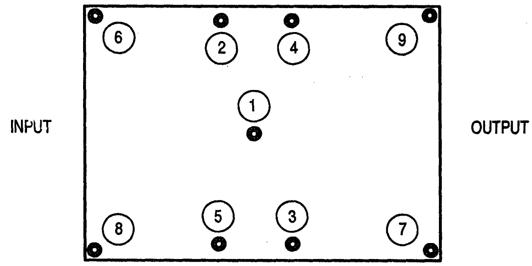
- Socket head cap screws: — CHC M3 x 8 for Iron Heatsink.
  — CHC M3 x 10 for Copper/Aluminum Heatsink.
- Material: Nickel plated steel.

WASHERS

- Split lock washers WZ Ø3 + Flat washers ZU Ø3.

MOUNTING RECOMMENDATIONS (continued)

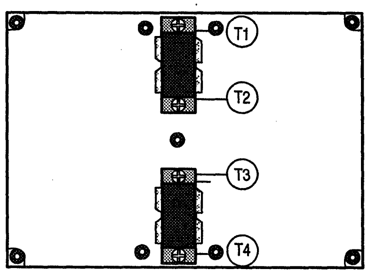
TIGHTENING ORDER



Recommended Torque: 12 Kg.cm (10.5 in. lbs.)

MOUNTING VERIFICATION

Supply the amplifier (25.5 Vdc) without RF signal, and measure temperature on points 1, 2, 3, and 4.



Characteristic	Typ	Max	Unit
T1, T2, T3, T4	—	70	°C
Δ(T1, T2), Δ(T3, T4)	3	5	°C

3

CLEANING

RF Transistors are not hermetic, so DO NOT clean the amplifier in a solvent bath.
Local cleaning is recommended.

The MRFIC Line
900 MHz Downconverter (LNA/Mixer)

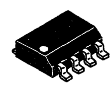
MRFIC2001

Motorola Preferred Device

900 MHz DOWNCONVERTER LNA/MIXER SILICON MONOLITHIC INTEGRATED CIRCUIT

The MRFIC2001 is an integrated downconverter designed for receivers operating in the 800 MHz to 1.0 GHz frequency range. The design utilizes Motorola's advanced MOSAIC 3 silicon bipolar RF process to yield superior performance in a cost effective monolithic device. Applications for the MRFIC2001 include CT-1 and CT-2 cordless telephones, remote controls, video and audio short range links, low cost cellular radios, and ISM band receivers. A power down control is provided to minimize current drain with minimum recovery/turn-on time.

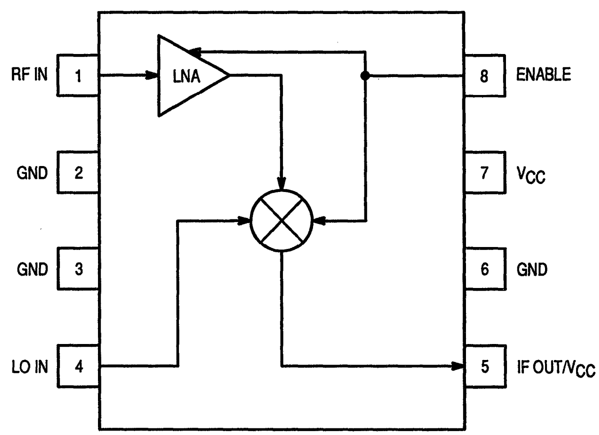
- Conversion Gain = 23 dB (Typ)
- Supply Current = 4.7 mA (Typ)
- Power Down Supply Current = 2.0 µA (Max)
- Low LO Drive = –10 dBm (Typ)
- LO Impedance Insensitive to Power Down
- No Image Filtering Required
- No Matching Required for RF IN Port
- All Ports are Single Ended
- Available in Tape and Reel



CASE 751 (SO-8)

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	5.5	Vdc
Control Voltage	ENABLE	5.0	Vdc
Input Power, RF and LO Ports	P_{RF}, P_{LO}	+10	dBm
Operating Ambient Temperature	T_A	– 35 to + 85	°C
Storage Temperature	T_{stg}	– 65 to +150	°C



Pin Connections and Functional Block Diagram

Preferred devices are Motorola recommended choices for future use and best overall value.

RECOMMENDED OPERATING RANGES

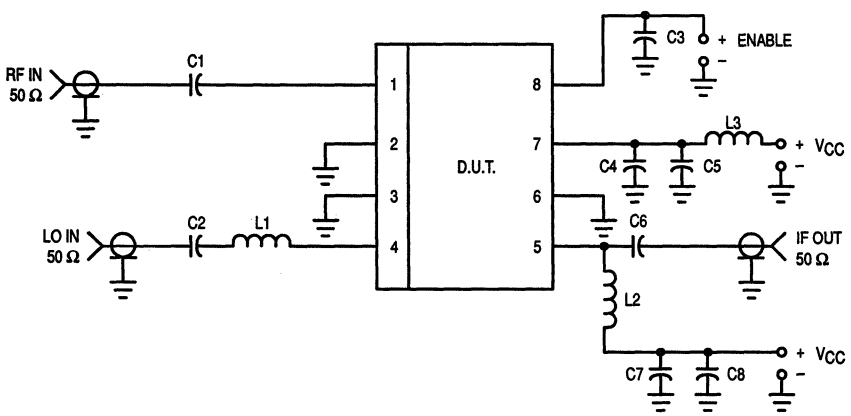
Parameter	Symbol	Value	Unit
Supply Voltage Range	V_{CC}	2.7 to 5.0	Vdc
Control Voltage Range	ENABLE	0 to 5.0	Vdc
RF Port Frequency Range	f_{RF}	500 to 1000	MHz
IF Port Frequency Range	f_{IF}	0 (dc) to 250	MHz

ELECTRICAL CHARACTERISTICS (V_{CC}, ENABLE = 3.0 V, T_A = 25°C, RF @ 900 MHz, LO @ 1.0 GHz, P_{LO} = –7.0 dBm, IF @ 100 MHz unless otherwise noted)

Characteristic (1)	Min	Typ	Max	Unit
Supply Current: On-Mode	—	4.7	5.5	mA
Supply Current: Off-Mode (ENABLE < 1.0 Volts)	—	0.1	2.0	µA
ENABLE Response Time	—	1.0	—	µs
Conversion Gain	20	23	26	dB
Input Return Loss (RF IN Port)	—	13	—	dB
Single Sideband Noise Figure	—	5.5	—	dB
Input 3rd Order Intercept Point	– 26	– 22.5	—	dBm
Output Power at 1.0 dB Gain Compression	—	–10	—	dBm
LO – RF Isolation (1.0 GHz)	—	37	—	dB
LO – IF Isolation (1.0 GHz)	—	33	—	dB
RF – IF Isolation (900 MHz)	—	4.0	—	dB
RF – LO Isolation (900 MHz)	—	19	—	dB

NOTE:
1. All Electrical Characteristics measured in test circuit schematic shown in Figure 1 below:

3



C1, C2, C4, C7 — 100 pF Chip Capacitor
C3, C5, C8 — 1000 pF Chip Capacitor
C6 — 6.8 pF Chip Capacitor
L1 — 8.2 nH Chip Inductor
L2 — 270 nH Chip Inductor

L3 — 150 nH Chip Inductor
RF Connectors — SMA Type
Board Material — 0.025″ Thick Duroid,
0.062″ Copper Clad, 0.5 oz. Copper, ϵ_r = 10.2

Figure 1. Test Circuit Configuration

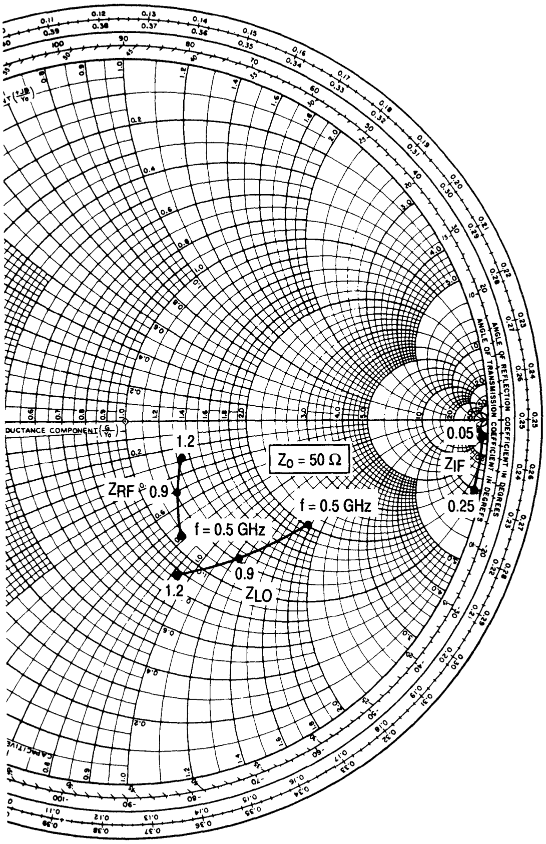


Figure 2. Port Impedances versus Frequency (GHz)

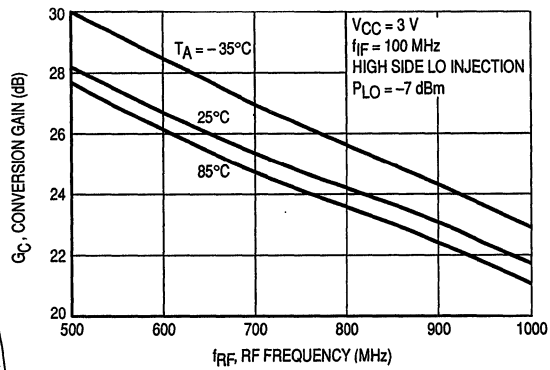


Figure 3. Conversion Gain versus RF Frequency

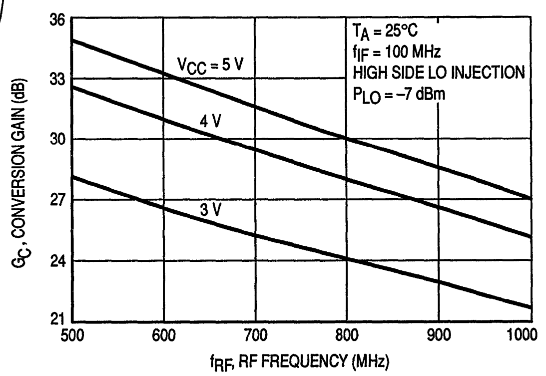


Figure 4. Conversion Gain versus RF Frequency

V_{CC} (Volts)	f (MHz)	Γ_{IF}		Γ_{RF}		Γ_{LO}	
		Mag	∠ϕ Degrees	Mag	∠ϕ Degrees	Mag	∠ϕ Degrees
3.0	50	0.998	– 2.5	—	—	—	—
	100	0.996	– 4.9	—	—	—	—
	150	0.993	– 7.2	—	—	—	—
	200	0.990	–10	—	—	—	—
	250	0.987	–12	—	—	—	—
	500	—	—	0.36	–70	0.58	– 31
	600	—	—	0.32	–70	0.55	– 36
	700	—	—	0.29	– 69	0.53	– 42
	800	—	—	0.26	– 68	0.51	– 48
	900	—	—	0.23	– 63	0.50	– 54
	1000	—	—	0.20	– 58	0.49	– 61
	1100	—	—	0.18	– 51	0.47	– 68
	1200	—	—	0.17	– 44	0.45	– 76

Table 1. Port Reflection Coefficients
(ENABLE = 3.0 V, Z_O = 50 Ω, T_A = 25°C)

TYPICAL CHARACTERISTICS

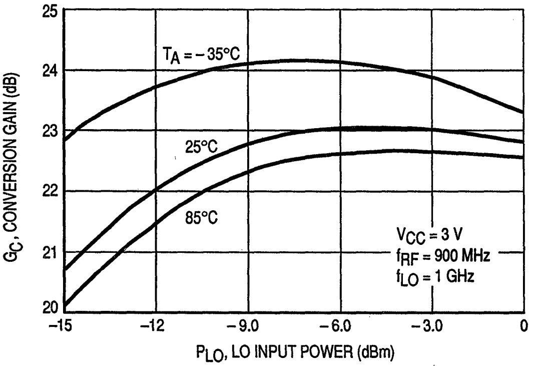


Figure 5. Conversion Gain versus LO Input Power

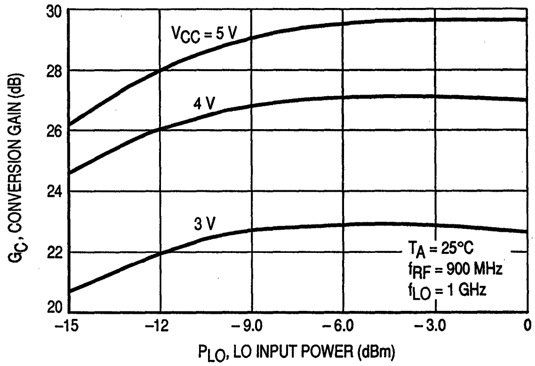


Figure 6. Conversion Gain versus LO Input Power

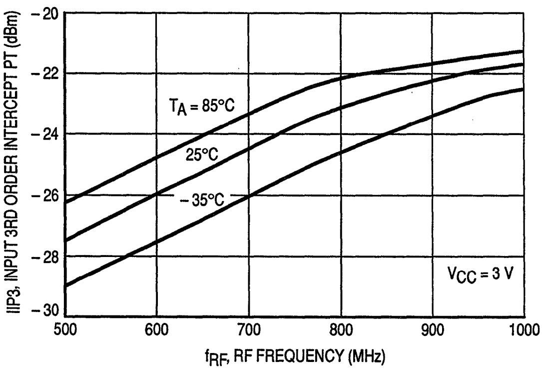


Figure 7. Input Third Order Intercept Point versus RF Frequency

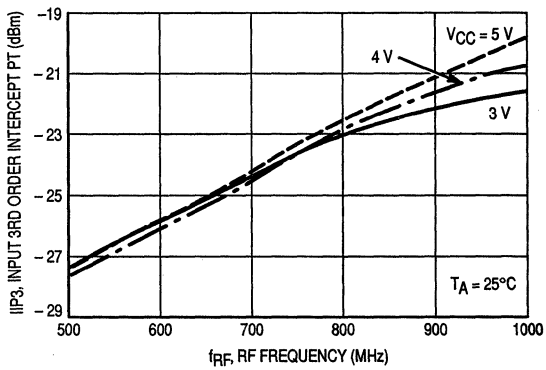


Figure 8. Input Third Order Intercept Point versus RF Frequency

3

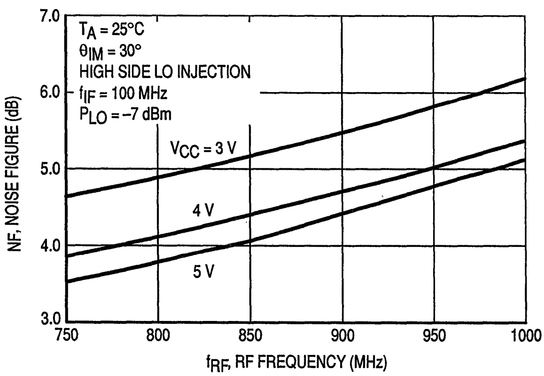


Figure 9. Noise Figure versus RF Frequency

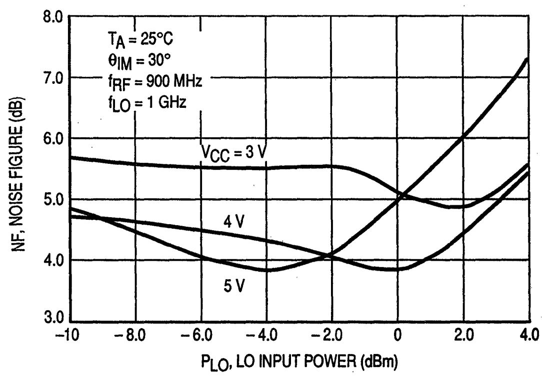


Figure 10. Noise Figure versus LO Input Power

TYPICAL CHARACTERISTICS

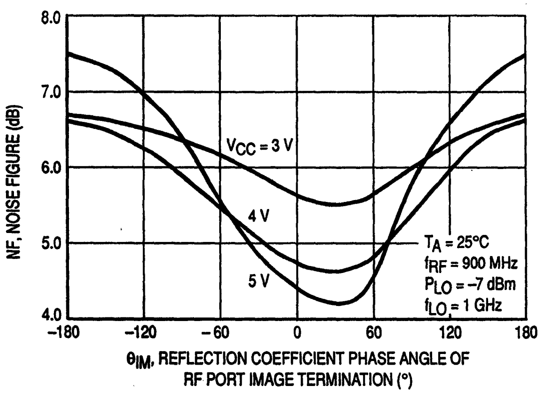


Figure 11. Noise Figure versus Reflection Coefficient Phase Angle of RF Port Image Termination

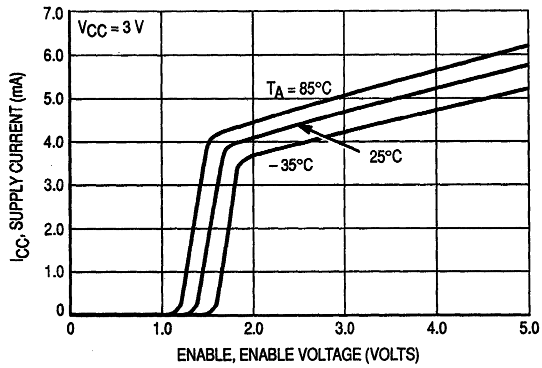


Figure 12. Supply Current versus Enable Voltage

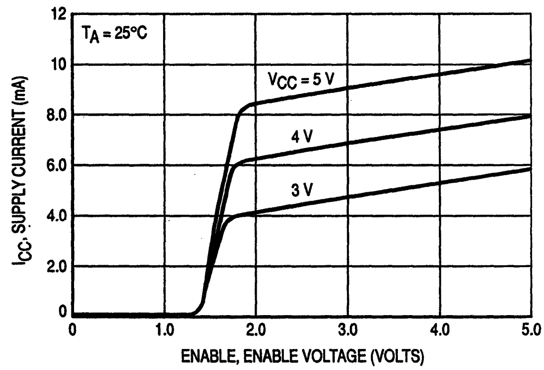


Figure 13. Supply Current versus Enable Voltage

APPLICATIONS INFORMATION

Design Philosophy

The MRFIC2001 was designed for low cost, small size, and ease of use. This is accomplished by minimizing the number of necessary external components.

The most significant external component eliminated was an image filter between the LNA and mixer. It was found the ensuing image noise entering the mixer from the LNA could be minimized by optimizing the LNA input termination at the image frequency. Also, a double-balanced mixer was used to reject the IF noise from the LNA. This results in excellent LO and spurious rejection.

To eliminate the need for external baluns or decoupling elements, the unused LO and RF ports of the mixer are decoupled internally. Only one of the IF outputs is used, eliminating the need for an external balun on the IF port as well. Also, the LNA input is matched to 50 ohms internally. External matching is required for the LO and IF ports.

To minimize current drain in various TDD/TDMA systems, the MRFIC2001 has a TTL/CMOS compatible enable pin.

Theory of Operation

Optimizing the LNA input termination to minimize image noise is quite simple. The optimum LNA input (RF IN pin) termination is $1\angle 30°$ at the image frequency (regardless of what the image frequency is). A reflection coefficient magnitude close to 1 is automatically obtained from a front-end filter, since the image frequency would be in the stop-band. The 30° phase angle can be obtained by rotating the phase angle of the front-end filter with a series 50 ohm transmission line. The dependance of single-sideband noise figure on the image phase angle is shown in Figure 11. As the plot indicates, there is a little over 1.0 dB of variation across all possible phase angles for a 3.0 V supply. Therefore, setting the phase angle is not critical. At higher supply voltages setting the phase angle is more critical (and more rewarding).

Matching the LO port to 50 ohms can be done several ways. The recommended approach is a series inductor as close to the IC as possible. The inductor value is small enough (~8–15 nH depending on LO frequency) to be printed on the board. A DC block is required and should not be placed between the inductor and IC since this will prevent the inductor from being close enough to the IC to provide a good match.

The IF port is an open collector resulting in a very high output impedance. For optimum linearity (IP3), the IF port should be loaded with a 1000 ohm load-line. Since the output requires a bias inductor and blocking capacitor, the IF filter impedance can be transformed to 1000 ohms with these two elements. If a low output VSWR is desired (to reduce IF filter ripple), a 2.0–4.0 K ohm resistor can be placed in parallel with the bias inductor. This will reduce the conversion gain by 1.0–2.0 dB.

The RF port is nearly 55 ohms resistive in series with a small amount of capacitive reactance, which results in a 12–13 dB return loss. If a higher return loss is desired, a 3.0–4.0 nH series inductor printed on the board as close to the IC as possible will improve it to over 20 dB. A DC block is also required.

Supply decoupling must be done as close to the IC as possible. A 1000 pF capacitor is recommended. An additional 100 pF capacitor and an RF choke are recommended to keep the LO signal off the supply line.

Enabling/Disabling the MRFIC2001 can be done with its TTL/CMOS compatible Enable pin. The trip point is between 1.0 and 2.0 volts.

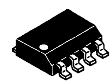
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

The MRFIC Line
900 MHz Transmit Mixer

MRFIC2002

Motorola Preferred Device

900 MHz TX-MIXER
SILICON MONOLITHIC
INTEGRATED CIRCUIT



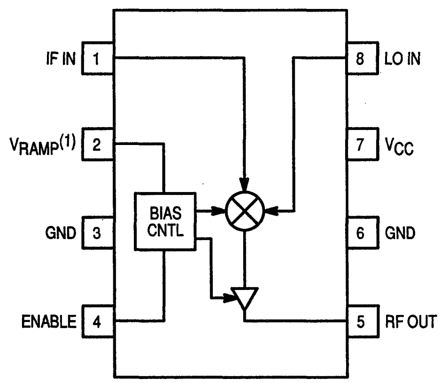
CASE 751
(SO-8)

The MRFIC2002 is a double-balanced, active mixer designed for transmitters operating in the 800 MHz to 1.0 GHz frequency range. The design utilizes Motorola's advanced MOSAIC 3 silicon bipolar RF process to yield superior performance in a cost effective monolithic device. Applications for the MRFIC2002 include CT1 and CT2 cordless telephones, GSM, remote controls, video and audio short range links, low cost cellular radios, and ISM band transmitters. A power down control is provided to minimize current drain with minimum recovery/turn-on time.

- Conversion Gain = 10 dB (Typ)
- Supply Current = 5.5 mA (Typ)
- Power Down Supply Current = 2.0 µA (Max)
- LO-RF Isolation = 25 dB (Typ)
- Low LO Drive Required = –10 dBm (Typ)
- LO Impedance Insensitive to Power Down
- No Matching Required for RF OUT Port
- All Ports are Single Ended
- Available in Tape and Reel

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	5.5	Vdc
Control Voltages	ENABLE, V_{RAMP}	5.0	Vdc
Input Power, LO and IF Ports	P_{LO}, P_{IF}	+10	dBm
Operating Ambient Temperature	T_A	–35 to +85	°C
Storage Temperature	T_{stg}	–65 to +150	°C



(1) For CT2 applications, apply ramp voltage provided in MRFIC2004. For non-CT2, leave open circuited.

Pin Connections and Functional Block Diagram

Preferred devices are Motorola recommended choices for future use and best overall value.

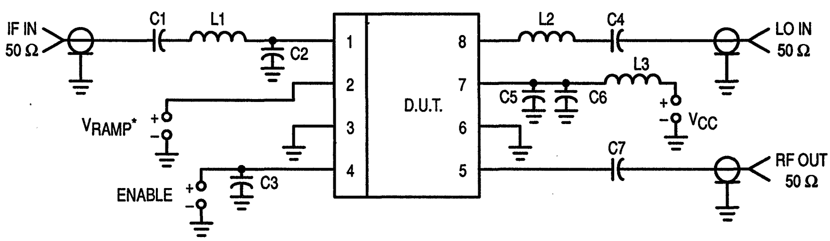
RECOMMENDED OPERATING RANGES

Parameter	Symbol	Value	Unit
Supply Voltage Range	V_{CC}	2.7 to 5.0	Vdc
Control Voltage Ranges	ENABLE, V_{RAMP}	0 to 5.0	Vdc
RF Port Frequency Range	f_{RF}	500 to 1000	MHz
IF Port Frequency Range	f_{IF}	0 (dc) to 250	MHz

ELECTRICAL CHARACTERISTICS (V_{CC}, Enable = 3.0 V and V_{Ramp}(1) Open Circuited, P_{LO} = –7.0 dBm, IF @ 100 MHz, LO @ 1.0 GHz, RF @ 900 MHz, T_A = 25°C unless otherwise noted)

Characteristic (2)	Min	Typ	Max	Unit
Supply Current: On-Mode Supply Current: Off-Mode (Enable < 1.0 V)	— —	5.5 0.1	7.0 2.0	mA μA
Enable Response Time	—	1.0	—	μs
Conversion Gain	8.0	10	12	dB
Single Sideband Noise Figure	—	10	—	dB
Output Power at 1.0 dB Gain Compression	—	–18	—	dBm
Output Power at Saturation	–16	–14	—	dBm
LO-RF Isolation (1.0 GHz)	—	25	—	dB
LO-IF Isolation (1.0 GHz)	—	65	—	dB
IF-RF Isolation (100 MHz)	—	18	—	dB
IF-LO Isolation (100 MHz)	—	50	—	dB

NOTES:
1. For CT2 applications, apply ramp voltage provided in MRFIC2004. For non-CT2, leave open circuited.
2. All Electrical Characteristics are measured in test circuit schematic as shown in Figure 1.



C1, C3, C6 — 1000 pF Chip Capacitor
C2 — 6.8 pF Chip Capacitor
C4 — 3.9 pF Chip Capacitor
C5 — 100 pF Chip Capacitor
C7 — 5.6 pF Chip Capacitor
L1 — 270 nH Chip Inductor
L2 — 10 nH Chip Inductor
L3 — 390 nH Chip Inductor
RF Connectors — SMA Type
Board Material — 0.025″ Thick Duroid, 0.062″ Copper Clad, 0.5 oz. Copper, ϵ_r = 10.2

Figure 1. Test Circuit Configuration

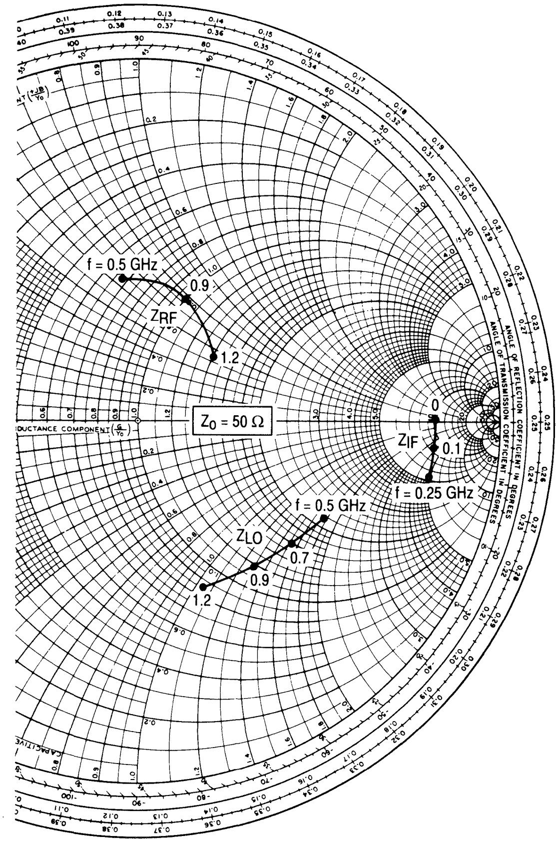


Figure 2. Port Impedances versus Frequency

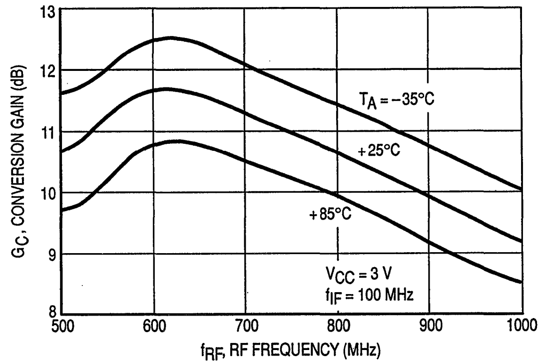


Figure 3. Gain versus RF Frequency

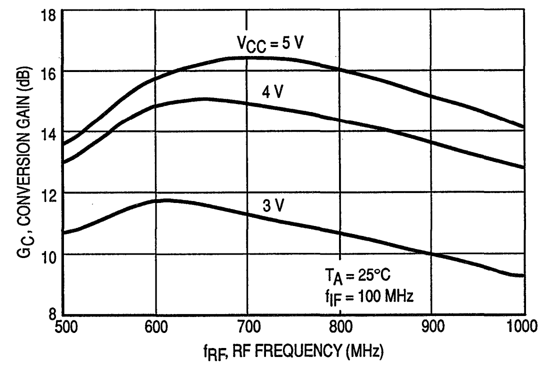


Figure 4. Gain versus RF Frequency

V_{CC} (Volts)	f (MHz)	Γ_{IF}		Γ_{RF}		Γ_{LO}	
		Mag	∠φ Degrees	Mag	∠φ Degrees	Mag	∠φ Degrees
3.0	50	0.83	–2.4	—	—	—	—
	100	0.82	–4.7	—	—	—	—
	150	0.82	–7.1	—	—	—	—
	200	0.81	–9.6	—	—	—	—
	250	0.81	–11.7	—	—	—	—
	500	—	—	0.42	100	0.57	–29
	600	—	—	0.41	94	0.55	–35
	700	—	—	0.40	88	0.54	–41
	800	—	—	0.39	80	0.52	–48
	900	—	—	0.36	71	0.51	–54
	1000	—	—	0.33	63	0.50	–60
	1100	—	—	0.31	55	0.49	–65
	1200	—	—	0.28	45	0.49	–70

Table 1. Deembedded Port Reflection Coefficients
(Enable = 3.0 V, Z_O = 50 Ω, T_A = 25°C)

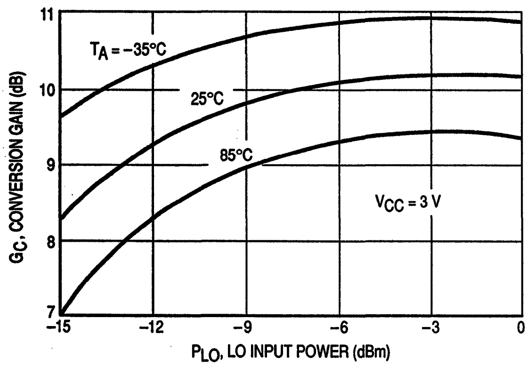


Figure 5. Gain versus LO Input Power

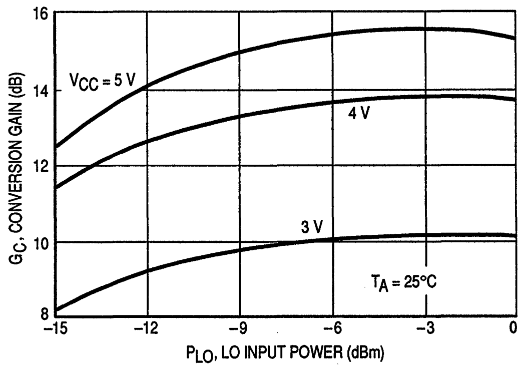


Figure 6. Gain versus LO Input Power

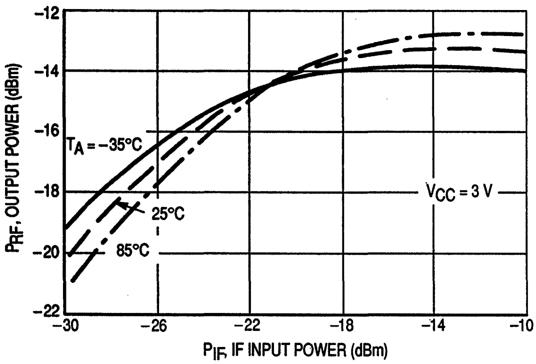


Figure 7. Output Power versus IF Input Power

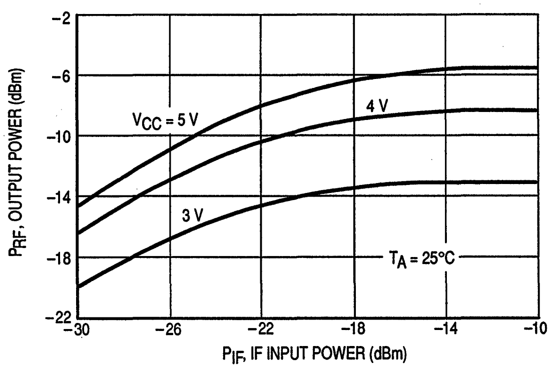


Figure 8. Output Power versus IF Input Power

3

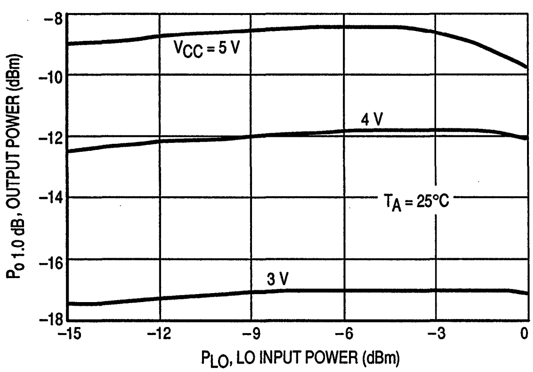


Figure 9. Output Power at 1.0 dB Gain Compression versus LO Input Power

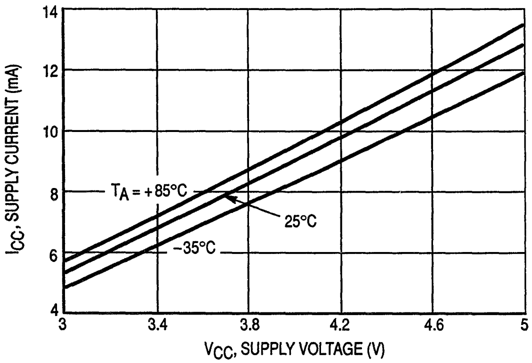


Figure 10. I_{CC} versus V_{CC}

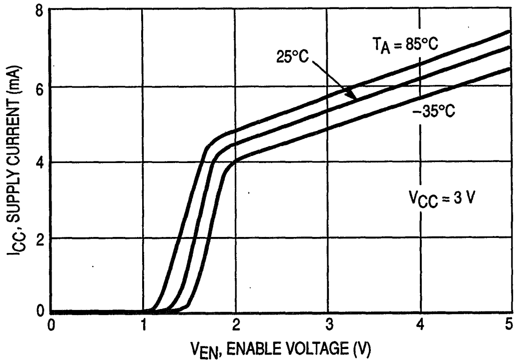


Figure 11. I_{CC} versus Enable Voltage

APPLICATIONS INFORMATION

Design Philosophy

The MRFIC2002 was designed to have excellent LO and spurious rejection. This is accomplished by using a double-balanced configuration and using a symmetrical die layout.

To eliminate the need for external baluns or decoupling elements, the unused LO and IF ports are decoupled internally. Only one of the RF outputs is used, eliminating the need for an external balun on the RF port as well. Also, the RF port is buffered to provide a 50 ohm output impedance. External matching is required for the LO and IF ports.

To minimize current drain in various TDD/TDMA systems, two methods of enabling/disabling the MRFIC2002 are provided: one that is TTL/CMOS compatible and one that is triggered from a ramp, such as the one provided in the MRFIC2004. The former method must be used if a ramp is not available. The latter method is more desirable since the MRFIC2002 can remain off during guard times and while in idle mode.

Theory of Operation

Matching the LO port to 50 ohms can be done several ways. The recommended approach is a series inductor as close to the IC as possible. The inductor value is small enough (~8–15 nH depending on LO frequency) to be printed on the board. A DC block is required and should not be placed between the inductor and IC since this will prevent the inductor from being placed close enough to the IC to provide a good match.

The IF port is approximately 500 ohms resistive in parallel with 1.3 pF of capacitance. If 50 ohms is the desired IF port impedance, a shunt capacitor followed by a series inductor will provide the transformation. A DC block is required and can be placed on either side of the matching network.

The RF port is nearly 50 ohms resistive in series with a small amount of inductive reactance, which results in an 8–11 dB return loss. However, a series 5.6 pF capacitor placed as close to the IC as possible will typically provide greater than a 15 dB return loss. The series capacitor also serves as a DC block which is required.

Supply decoupling must be done as close to the IC as possible. A 1000 pF capacitor is recommended. An additional 100 pF capacitor and an RF choke are recommended to keep the RF and LO signals off the supply line.

For systems that use a ramp, like the one provided in the MRFIC2004, enabling/disabling can be done by applying the ramp voltage to the V_{RAMP} pin which trips the IC between 0.6 and 1.0 volts. The Enable pin must either be tied high or to the inverse of the receiver enable control line, $\overline{RXEN}$. An inverter is provided in the MRFIC2004 to invert RXEN.

For systems that do not use a ramp, the V_{RAMP} pin can be left open circuited and enabling/disabling the MRFIC2002 can be done with its TTL/CMOS compatible Enable pin. The trip point is between 1.0 and 2.0 volts.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRFIC2003

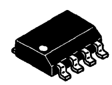
Motorola Preferred Device

The MRFIC Line
900 MHz GaAs Antenna Switch

The MRFIC2003 is an integrated GaAs SPDT Antenna Switch designed for transceivers operating in the 800 MHz to 1.0 GHz frequency range. The design utilizes Motorola's CS-1 advanced GaAs RF process to yield superior performance in a cost effective monolithic device. Applications for the MRFIC2003 include CT-2 and the ISM band cordless telephones.

- Surface Mount SO-8 Package
- Low Power Consumption
- 50 mW Power Handling Capability
- Single Source Low Operating Supply Voltage (2.8 – 6.0 Volts)
- Low Cost
- Available in Rape and Reel

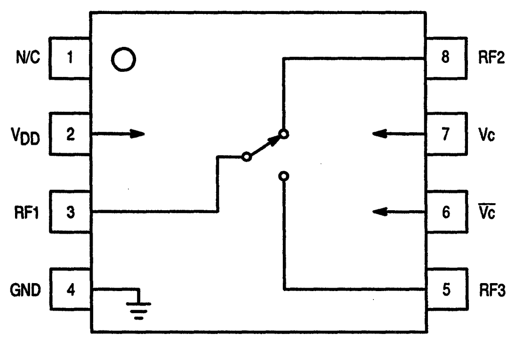
900 MHz GaAs ANTENNA SWITCH GaAs MONOLITHIC INTEGRATED CIRCUIT



CASE 751
(SO-8)

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Operating Voltages, Supply and Control	V_{DD}, Vc, $\overline{Vc}$	6.5	Vdc
Supply Current	I_D	100	µA
Input Power, All Ports (V_{DD} = 3.0 V)	RF1, RF2, RF3	25	dBm
Operating Ambient Temperature	T_A	– 35 to + 85	°C
Storage Temperature	T_{stg}	– 65 to +150	°C



Pin Connections and Functional Block Diagram

Preferred devices are Motorola recommended choices for future use and best overall value.

RECOMMENDED OPERATING RANGES

Parameter	Symbol	Value	Unit
Nominal Impedance	Z_O	50	Ω
Supply Voltage Range	V_{DD}	2.8 to 6.0	Vdc
Control Voltage Range, High	Vc, $\overline{Vc}$	2.8 to 6.0	Vdc
Control Voltage Range, Low	Vc, $\overline{Vc}$	0 to 0.2	Vdc
Frequency Range	f	100–1000	MHz

ELECTRICAL CHARACTERISTICS (V_{DD} = 3.0 V, T_A = 25°C, f = 900 MHz, P_{in} = 50 mW (17 dBm) unless otherwise noted)

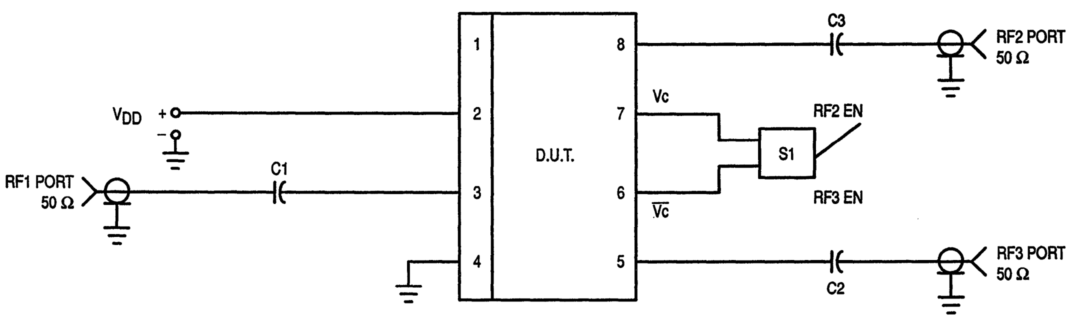
Characteristic (1)	Min	Typ	Max	Unit
RF1 to RF2 on:				
RF1 SWR	—	1.1:1	1.4:1	
RF2 VSWR	—	1.2:1	1.4:1	
Insertion Loss (RF1/RF2)	—	0.8	1.0	dB
Isolation	19	23	—	dB
RF1 to RF3 on:				
RF1 SWR	—	1.1:1	1.4:1	
RF3 SWR	—	1.1:1	1.4:1	
Insertion Loss (RF1/RF3)	—	0.5	0.8	dB
Isolation	17	20	—	dB
Input Power @ 1.0 dB Compression	—	21	—	dBm

NOTE:
1. All Electrical Characteristics measured in test circuit schematic shown in Figure 1 below.

Vc	$\overline{Vc}$	RF1 – RF2	RF1 – RF3
V_{DD}	0 Volts	Isolation	Insertion Loss
0 Volts	V_{DD}	Insertion Loss	Isolation

Table 1. Logic Table

3



C1, C2, C3 — 100 pF 50 mil Chip Capacitor
S1 — DPDT Switch with Aluminum Switch Bracket
RF Connectors SMA Type
Board Material — 0.025″ Thick Duriod, 0.5 oz. Copper, ϵ_r = 10.2

Figure 1. Test Circuit Configuration

TYPICAL CHARACTERISTICS

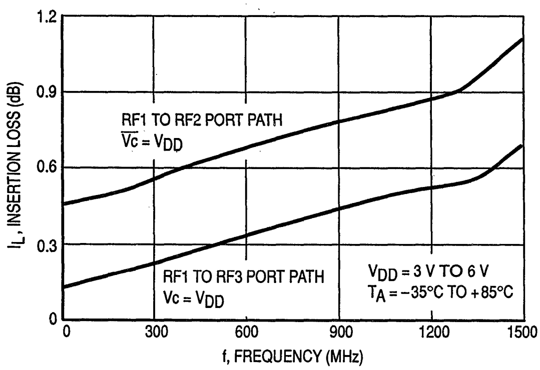


Figure 2. Insertion Loss versus Frequency

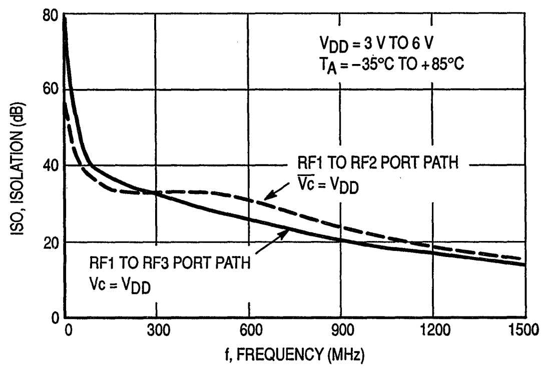


Figure 3. Isolation versus Frequency

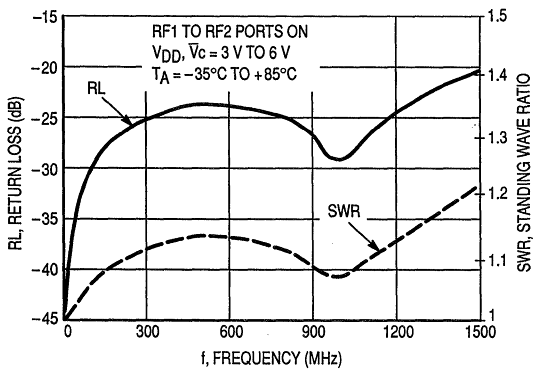


Figure 4. RF1 Port Return Loss and SWR versus Frequency

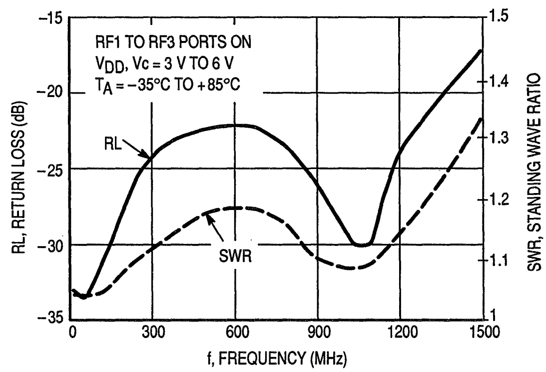


Figure 5. RF1 Port Return Loss and SWR versus Frequency

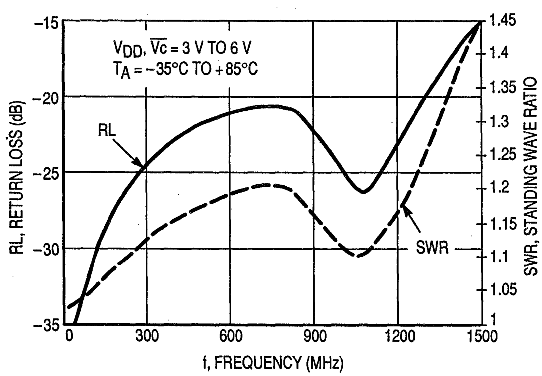


Figure 6. RF2 Port Return Loss and SWR versus Frequency

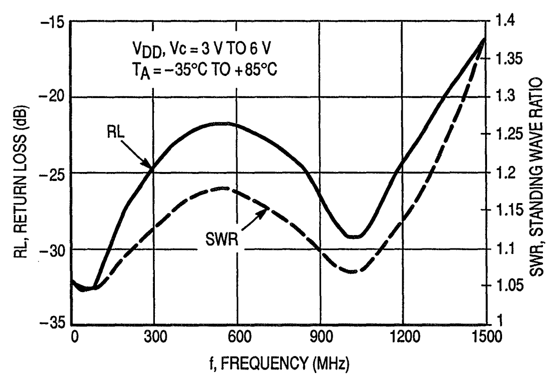


Figure 7. RF3 Port Return Loss and SWR versus Frequency

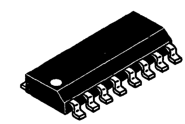
3

MRFIC2004

Motorola Preferred Device

The MRFIC Line
900 MHz Driver and Ramp

900 MHz DRIVER
& RAMP
SILICON MONOLITHIC
INTEGRATED CIRCUIT



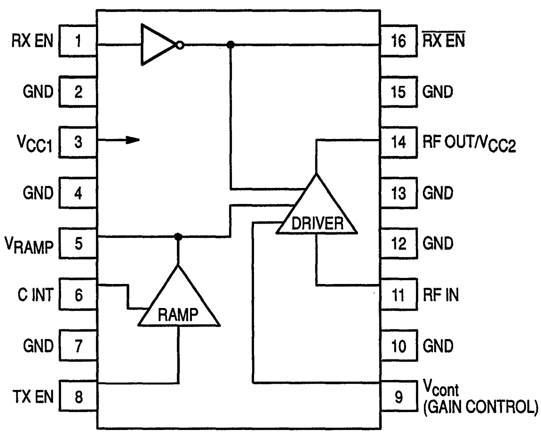
CASE 751B
(SO-16)

The MRFIC2004 is an integrated Driver and Ramp designed for transmitters operating in the 800 MHz to 1.0 GHz frequency range. The Ramp is an integrator which can be used for burst control for TDD/TDMA systems. The Driver uses a cascode configuration for high gain and reverse isolation. A power down control is provided to minimize current drain with minimum recovery/turn-on time. Also, an on-board inverter is included to provide complementary control for an antenna switch, such as the MRFIC2003. The design utilizes Motorola's advanced MOSAIC 3 silicon bipolar RF process to yield superior performance in a cost effective monolithic device. Applications for the MRFIC2004 include CT1 and CT2 cordless telephones, GSM, remote controls, video and audio short range links, low cost cellular radios, and ISM band transmitters.

- Small Signal Gain = 21.5 dB (Typ)
- Small Signal Gain Control = 34 dB (Typ)
- $P_{o\ 1.0\ dB}$ = −1.0 dBm (Typ)
- On Board Ramp for Burst Control
- Power Down Supply Current = 0.7 mA (Typ)
- Low Operating Supply Voltage (2.7 to 4.0 Volts)
- Input/Output VSWR Insensitive to Gain Control
- Available in Tape and Reel

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Supply Voltages	V_{CC1} V_{CC2}	4.5 6.0	Vdc
Control Voltages	RXEN, TXEN, V_{cont}	6.0	Vdc
Input Power, RF IN Port	P_{RF}	+10	dBm
Operating Ambient Temperature	T_A	−35 to +85	°C
Storage Temperature	T_{stg}	−65 to +150	°C



Pin Connections and Functional Block Diagram

Preferred devices are Motorola recommended choices for future use and best overall value.

RECOMMENDED OPERATING RANGES

Parameter	Symbol	Value	Unit
Supply Voltage Ranges	V_{CC1}, V_{CC2}	2.7 to 4.0	Vdc
Control Voltage Ranges	TX EN, RX EN, V_{cont}	0 to V_{CC1}	Vdc
Frequency Range	f	800 to 1000	MHz

ELECTRICAL CHARACTERISTICS (V_{CC1}, V_{CC2} = 3.0 V, C_{INT} = 2.0 nF, T_A = 25°C, f = 900 MHz, V_{CONT} = 1.3 V)

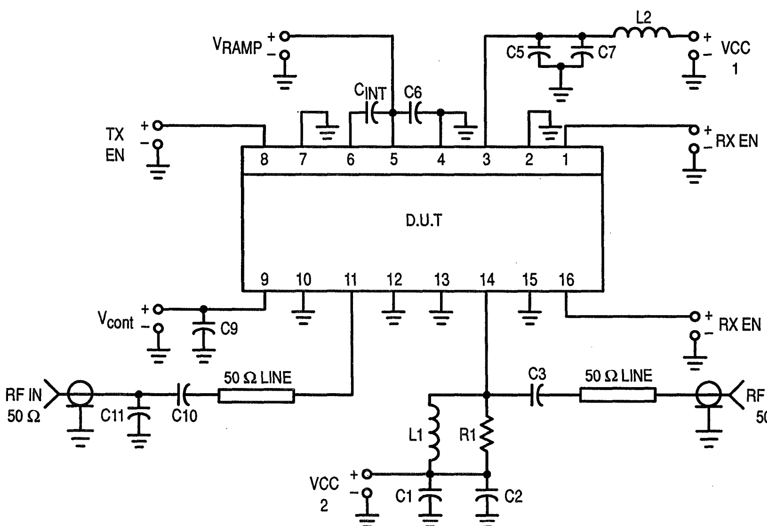
Characteristics (1)	Min	Typ	Max	Unit
Supply Current, TX EN High, RX EN Low	—	11	13	mA
Supply Current, TX EN Low, RX EN High	—	0.7	1.5	mA
Driver Characteristics (1)				
Gain (Small Signal)	19	21.5	24	dB
Gain Control (Small Signal)	—	34	—	dB
Power Out @ 1.0 dB Gain Compression	−4.0	−1.0	—	dBm
Third Order Intercept Point (out)	—	+7.5	—	dBm
Reverse Isolation	—	32	—	dB
Ramp Characteristics (1)				
Ramp Up Delay Time Rise Time Total Time	— — —	4.0 18 22	— — —	µs
Ramp Down Delay Time Fall Time Total Time	— — —	4.0 18 22	— — —	µs

LOGIC LEVELS (V_{CC1} = 2.7 to 4.0 V, T_A = 25°C)

RX EN & TX EN Input Voltage	Min	Typ	Max	Unit
High Low	$V_{CC1} - 0.8$ —	— —	— 0.8	V
$\overline{RX\ EN}$ Output Voltage				
High Low	$V_{CC1} - 0.2$ —	— —	— 0.2	V

NOTE:

1. All electrical characteristics measured in test circuit schematic shown in Figure 1 below.



C1, C7, C9 — 1000 pF Chip Capacitor
C2, C5, C6, C10 — 100 pF Chip Capacitor
C3 — 1.6 pF Chip Capacitor
C_{INT} — 2000 pF Chip Capacitor
C11 — 6.2 pF Chip Capacitor
L1 — 4.7 nH Chip Inductor
L2 — 150 nH Chip Inductor
R1 — 330 Ω Chip Resistor
RF Connectors — SMA Type
Board Material — 0.025″ Thick Duroid, 0.062″ Copper Clad, 0.5 oz. Copper, ϵ_r = 10.2

Figure 1. Typical Biasing Configuration

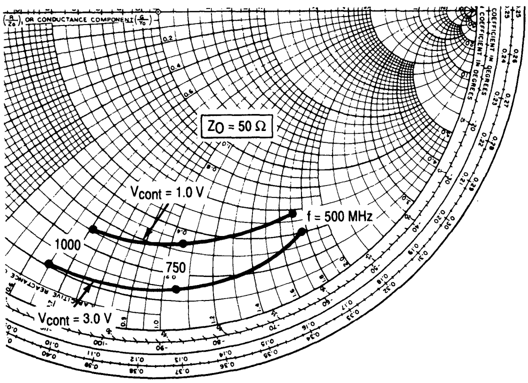


Figure 2. S_{11} versus Frequency versus V_{cont}

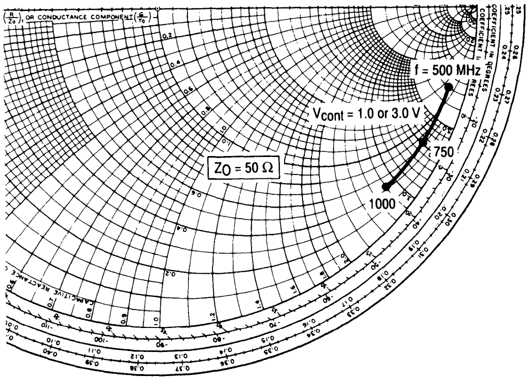


Figure 3. S_{22} versus Frequency

3

V_{cont}	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
		$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
1.0	100	0.85	−11.3	10.48	171.5	0.0002	142.7	0.99	−2.9
	300	0.83	−32.8	10.33	156.3	0.0020	129.0	0.99	−7.3
	500	0.79	−56.9	10.15	140.5	0.0030	130.6	0.98	−15.9
	550	0.79	−62.5	10.04	135.9	0.0030	132.6	0.98	−17.9
	600	0.78	−68.5	9.85	130.2	0.0040	133.3	0.98	−20.0
	650	0.77	−74	9.47	126.9	0.0040	135.9	0.98	−22.3
	700	0.76	−79	9.23	123.6	0.0050	137.2	0.98	−24.7
	750	0.76	−84.4	9.02	119.4	0.0050	138.1	0.97	−27.0
	800	0.75	−89.6	8.69	113.8	0.0060	139.7	0.97	−29.3
	850	0.74	−94.5	8.33	110.8	0.0070	140.3	0.97	−31.4
	900	0.73	−99.1	8.13	108.9	0.0080	141.2	0.96	−33.2
	950	0.73	−102	7.98	105.4	0.0090	138.3	0.96	−36.3
	1000	0.72	−106.9	7.70	101.0	0.0100	133.7	0.95	−38.4
1.9	100	0.85	−11.3	0.53	−173.5	0.0002	104.3	0.99	−2.9
	300	0.86	−33.5	0.69	−169.7	0.0009	118.7	0.98	−8.7
	500	0.87	−59.3	0.89	−179.5	0.0010	134.3	0.98	−15.5
	550	0.87	−65.7	0.96	175.1	0.0020	136.3	0.98	−17.5
	600	0.88	−73.1	1.02	169.9	0.0020	138.9	0.97	−19.6
	650	0.88	−78.7	1.04	167.3	0.0020	142.6	0.97	−21.8
	700	0.88	−84.7	1.07	165.0	0.0030	147.8	0.97	−24.1
	750	0.89	−90.7	1.14	161.5	0.0030	153.4	0.96	−26.4
	800	0.89	−98.2	1.17	155.8	0.0040	161.0	0.96	−28.8
	850	0.88	−104.6	1.22	151.2	0.0050	161.8	0.96	−30.7
	900	0.87	−110.1	1.24	144.6	0.0060	162.7	0.95	32.8
	950	0.86	−114.6	1.26	139.9	0.0070	160.3	0.95	−35.1
	1000	0.85	−118.8	1.27	134.1	0.0080	158.2	0.94	−37.2
3.0	100	0.85	−10.9	0.003	−85.9	0.0001	115.0	0.99	−2.8
	300	0.86	−31.9	0.014	−78.8	0.0006	121.0	0.99	−8.5
	500	0.87	−56.9	0.032	−61.1	0.0010	128.0	0.98	−15.1
	550	0.88	−62.4	0.038	−65.8	0.0010	136.2	0.98	−17.0
	600	0.89	−69.4	0.048	−68.3	0.0010	140.0	0.98	−19.2
	650	0.90	−75.1	0.058	−75.1	0.0020	145.1	0.98	−21.3
	700	0.90	−81.3	0.069	−82.4	0.0020	150.8	0.97	−23.6
	750	0.91	−87.3	0.081	−89.4	0.0020	156.8	0.97	−25.8
	800	0.91	−93.8	0.092	−113.4	0.0030	160.3	0.97	−28.1
	850	0.92	−100.7	0.092	−121.8	0.0040	163.3	0.96	−30.1
	900	0.91	−106.8	0.089	−128.2	0.0050	163.3	0.96	−32.3
	950	0.90	−111.4	0.083	−137.1	0.0060	155.2	0.95	−34.5
	1000	0.89	−115.2	0.077	−151.9	0.0060	150.0	0.95	−36.6

Table 1. Small Signal Deembedded S Parameters

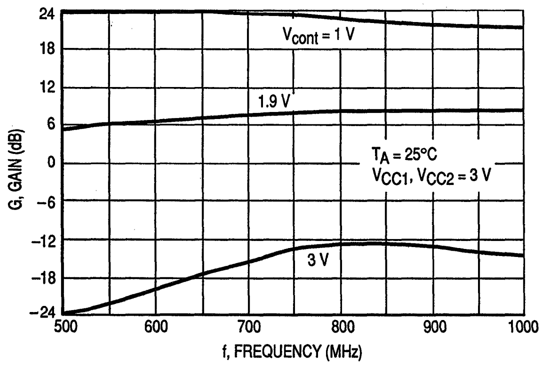


Figure 4. Small Signal Gain versus Frequency

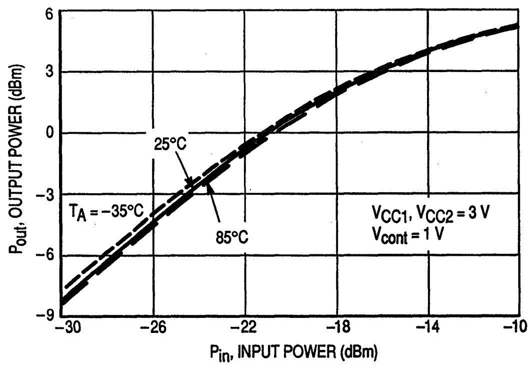


Figure 5. Output Power versus Input Power

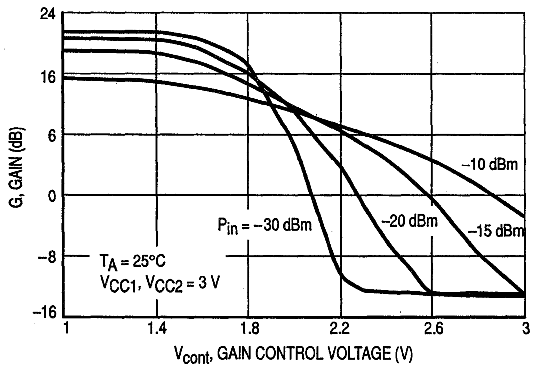


Figure 6. Driver Gain versus Gain Control Voltage

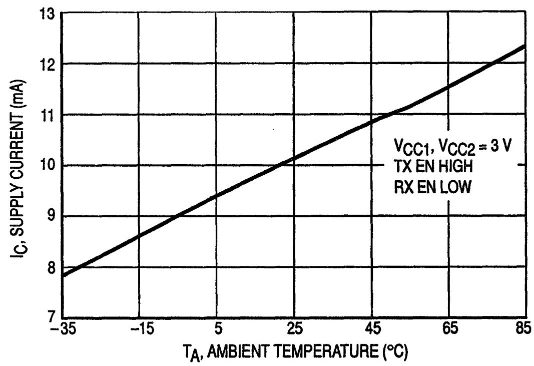


Figure 7. Supply Current versus Ambient Temperature

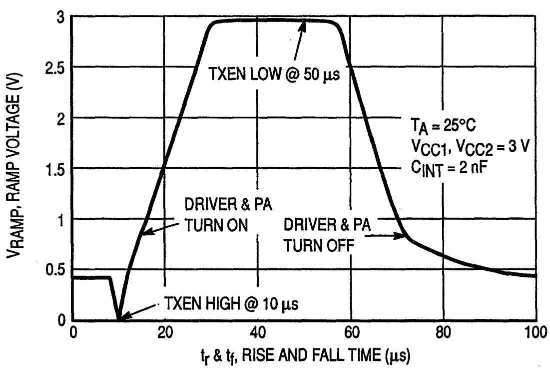


Figure 8. Ramp Voltage versus Rise & Fall Time

APPLICATIONS INFORMATION

Design Philosophy

The MRFIC2004 was designed as a support IC for a CT2 chip-set. The other chips making up the chip-set are the MRFIC2001 downconverter, the MRFIC2002 transmit mixer, the MRFIC2003 antenna switch and the MRFIC2006 PA. A complete CT2 front-end solution requires a ramp for burst control, an inverter for complementary antenna switch control and gain control (or an attenuator) for the transmitter low power mode. In order to keep the other chips in the chip-set relatively general purpose, yet provide the system designer with an easily controlled solution, these functions were combined with a driver amplifier into one IC, the MRFIC2004.

Theory of Operation

The driver is a cascode design that exits the IC open-collector. Impedance matching must be done externally. Since the output requires a bias inductor and DC blocking capacitor, the output can be matched with these two elements. To keep the driver unconditionally stable, it is recommended that a 300–400 ohm resistor be placed in parallel with the bias inductor as close to the IC as possible. Since the output impedance of the driver by itself is very high, the resistor sets the output impedance. The input can be matched with a series inductor followed by a shunt capacitor. Alternatively, a series transmission line followed by a shunt capacitor can be used. A DC block is also required on the input.

Gain control is provided to meet the CT2 low power mode requirement. The CT2 Common Air Interface specification requires the transmitter to be capable of dropping the output power by 16 ± 4.0 dB. Although the driver has 34 dB of small signal gain control, it can be reduced by adding a resistor in series with the gain control pin. The value of the resistor depends on the logic levels being used and the amount of gain compression after the driver. Also, the amount of gain control is a function of the driver input power level. The input power should be kept less than –10 dBm to allow for sufficient gain control to achieve the low power mode. The gain control can also be used for PA output power trimming. However, this is not an efficient method.

The ramp is an integrator which is used to slow down the driver and PA turn-on and turn-off times to reduce AM splatter. By applying a pulse waveform to the input, a linear ramp waveform is created at the output which is then applied to the current mirrors of the driver and PA. An external integrating capacitor is used so that the rise/fall time can be programmed externally. A minimum value of 2.0–2.4 nF is needed to meet the CT2 Common Air Interface splatter specification. For non-TDD/TDMA systems the ramp reverts to an enable/disable function.

The inverter is CMOS/TTL compatible and was included to provide complementary control for an antenna switch such as the MRFIC2003. By applying the receiver enable control line, RXEN, to the inverter the inverse $\overline{\text{RXEN}}$ will be created. RXEN and $\overline{\text{RXEN}}$ can then be used to control the MRFIC2003 antenna switch.

MRFIC2006

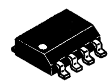
Motorola Preferred Device

The MRFIC Line
900 MHz 2 Stage PA

The MRFIC2006 is an Integrated PA designed for linear operation in the 800 MHz to 1.0 GHz frequency range. The design utilizes Motorola's advanced MOSAIC 3 silicon bipolar RF process to yield superior performance in a cost effective monolithic device. Applications for the MRFIC2006 include CT-1 and CT-2 cordless telephones, remote controls, video and audio short range links, low cost cellular radios, and ISM band transmitters.

- 50 Ω Input and Output Impedance
- Typical Gain = 23 dB @ 900 MHz
- Bias Current Externally Adjustable
- Bias Pin can be used to Ramp or Disable
- Class A or AB Linear Operation
- Unconditionally Stable
- SO-8 Leaded Plastic Package
- Available in Tape and Reel

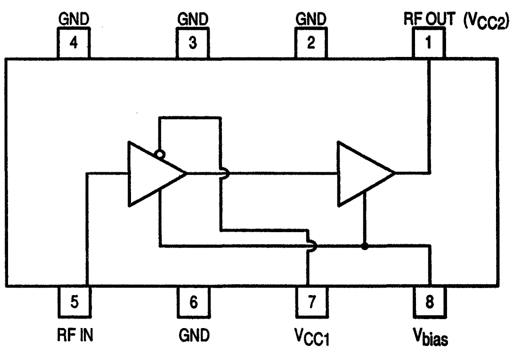
900 MHz 2 STAGE PA
SILICON MONOLITHIC
INTEGRATED CIRCUIT



CASE 751
(SO-8)

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C, Z_0 = 50 Ω unless otherwise noted)

Rating	Symbol	Value	Unit
Supply Voltages	V_{CC1}, V_{CC2}	5.0	Vdc
Bias Voltage	V_{bias}	6.0	Vdc
RF Output Power (V_{CC2} ≤ 4.0 V)	P_{out}	+21	dBm
RF Output Power (V_{CC2} > 4.0 V)	P_{out}	+13	dBm
RF Input Power	P_{in}	+10	dBm
Operating Ambient Temperature	T_A	– 35 to + 85	°C
Storage and Junction Temperature	T_{stg}	– 65 to +150	°C
Thermal Resistance, Junction to Case	$R_{θJC}$	63	°C/W



Pin Connections and Functional Block Diagram

Preferred devices are Motorola recommended choices for future use and best overall value.

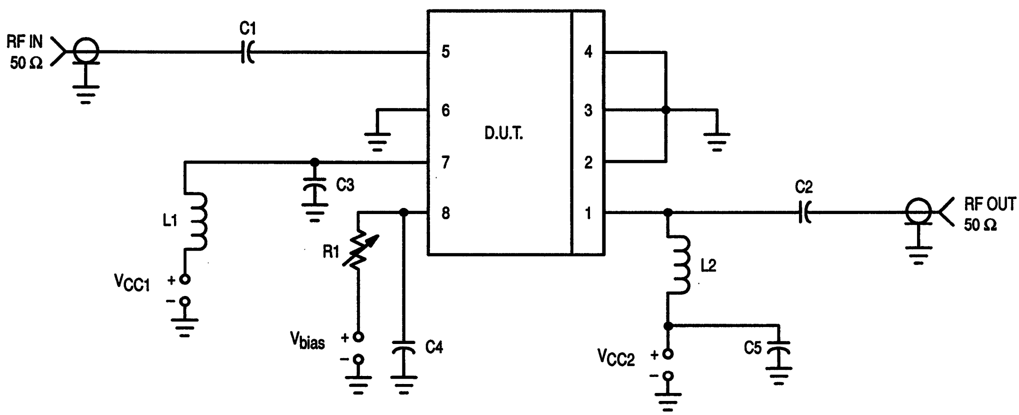
RECOMMENDED OPERATING RANGES

Parameter	Symbol	Value	Unit
Supply Voltage Ranges	V_{CC1}, V_{CC2}	1.8 to 4.0	Vdc
Bias Voltage Range	V_{bias}	0 to 5.0	Vdc
RF Frequency Range	f	500 to 1000	MHz

ELECTRICAL CHARACTERISTICS (V_{CC1}, V_{CC2}, V_{bias} = 3.0 V, T_A = 25°C, f = 900 MHz, Z_o = 50 Ω unless otherwise noted)

Characteristics (1)	Min	Typ	Max	Unit
Supply Current — Total I_{CC1} I_{CC2} I Bias	— — — —	46 14 29 3.0	55 — — —	mA mA mA mA
Small Signal Gain	19	23	26	dB
Input Return Loss, RF IN Port	—	15	—	dB
Output Return Loss, RF OUT Port	—	15	—	dB
Reverse Isolation	—	35	—	dB
Output Power at 1.0 dB Gain Compression	+12	+15.5	—	dBm
3rd Order Intercept Point (Out)	—	+ 25	—	dBm
5th Order Intercept Point (Out)	—	+ 21	—	dBm

NOTE:
1. All electrical characteristics measured in test circuit schematic shown in Figure 1 below.



C1, C2 — 100 pF Chip Capacitor
C3, C5 — 1.0 nF Chip Capacitor
C4 — 10 nF Chip Capacitor
L1 — 150 nH Chip Inductor
L2 — 10 nH Chip Inductor

R1 — Resistor Optional
RF Connectors — SMA Type
Board Material — 0.025″ Thick Duroid, 0.062″
Copper Clad 0.5 oz. Copper, ϵ_r = 10.2

Figure 1. Typical Biasing Configuration

3

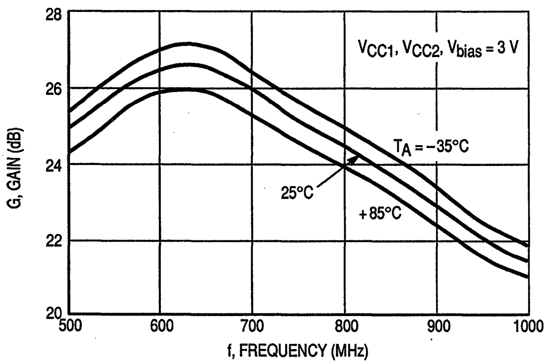


Figure 2. Gain versus Frequency

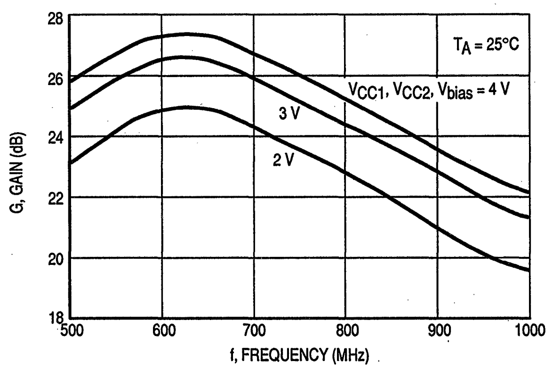


Figure 3. Gain versus Frequency

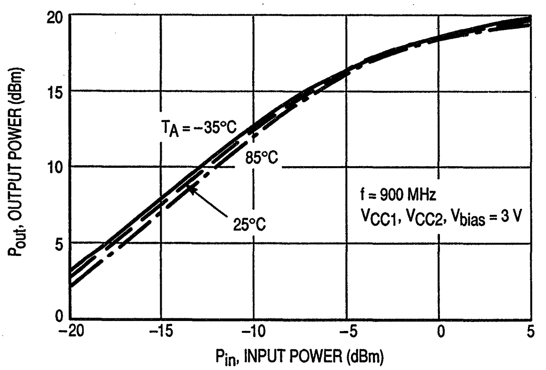


Figure 4. Output Power versus Input Power

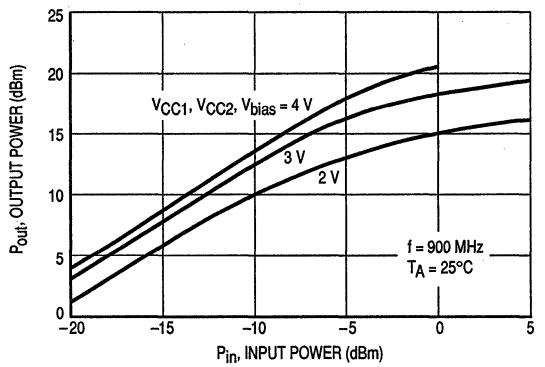


Figure 5. Output Power versus Input Power

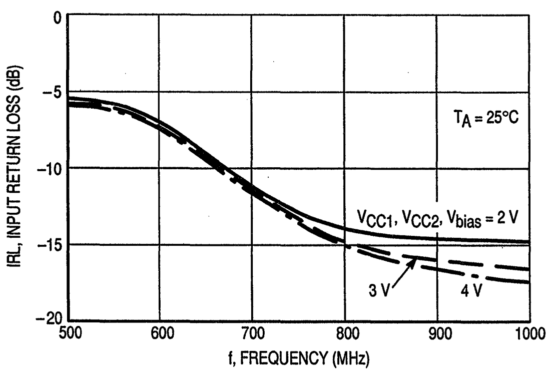


Figure 6. Input Return Loss versus Frequency

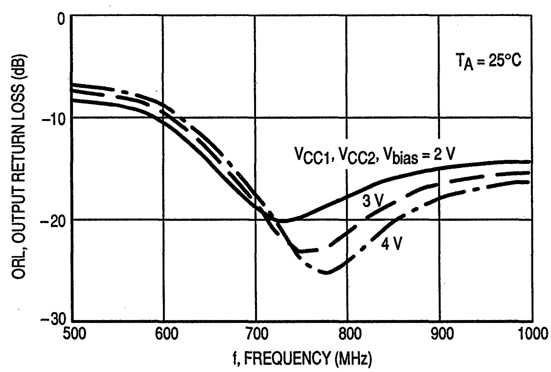


Figure 7. Output Return Loss versus Frequency

3

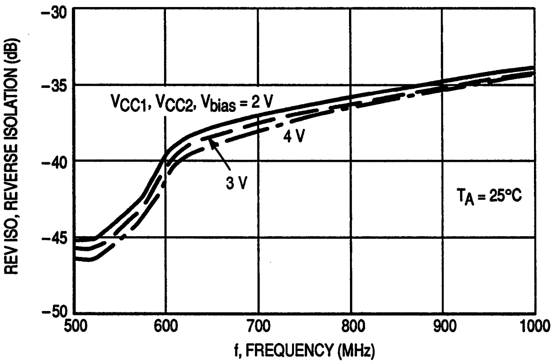


Figure 8. Reverse Isolation versus Frequency

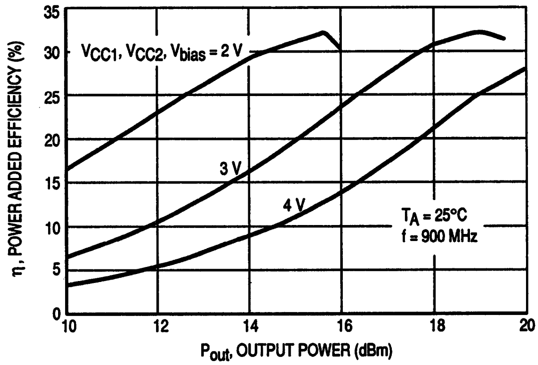


Figure 9. Power Added Efficiency versus Output Power

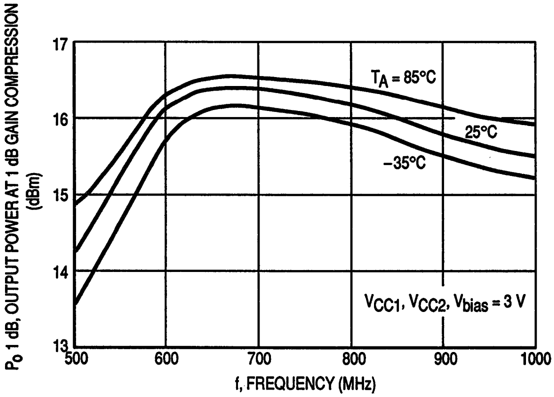


Figure 10. Output Power at 1 dB Gain Compression versus Frequency

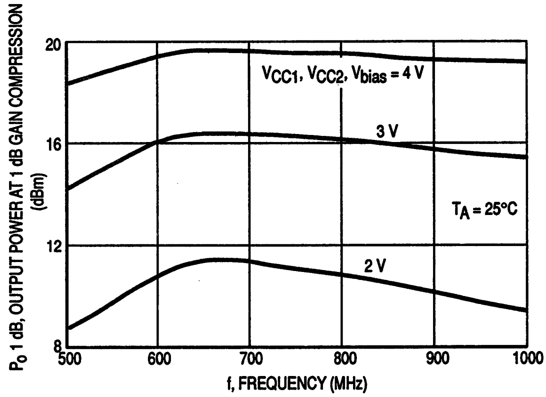


Figure 11. Output Power at 1 dB Gain Compression versus Frequency

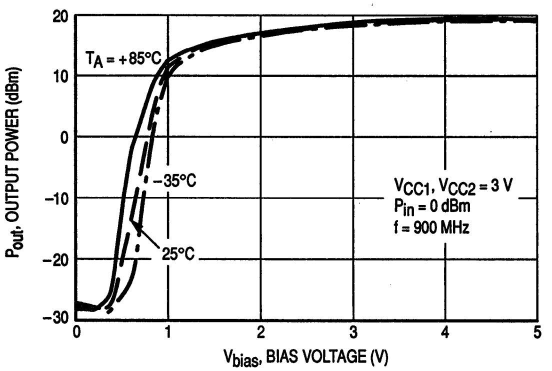


Figure 12. Output Power versus Bias Voltage

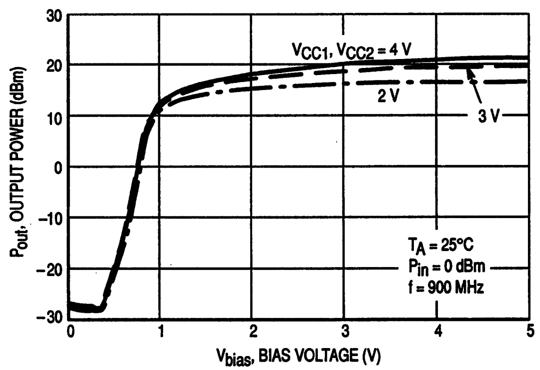


Figure 13. Output Power versus Bias Voltage

3

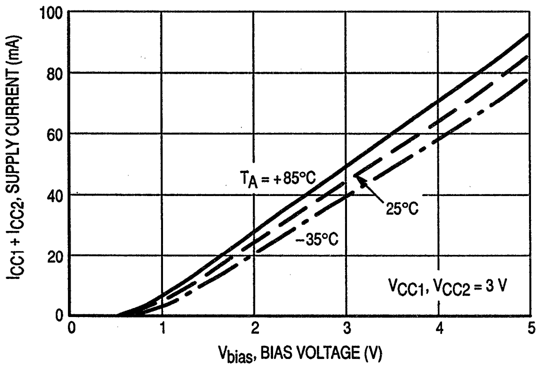


Figure 14. Supply Current versus Bias Voltage

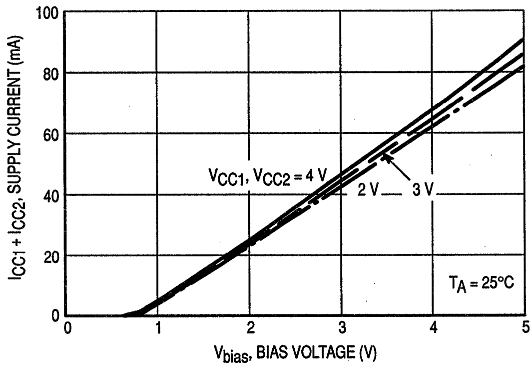


Figure 15. Supply Current versus Bias Voltage

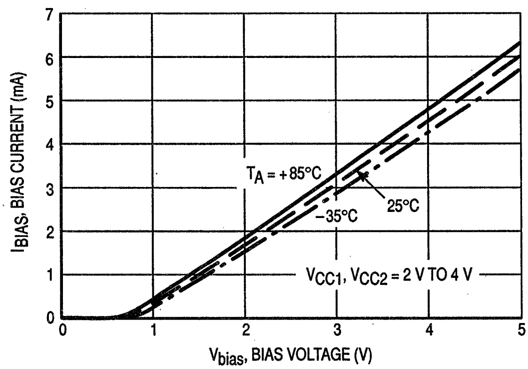


Figure 16. Bias Current versus Bias Voltage

3

APPLICATIONS INFORMATION

Design Philosophy

The MRFIC2006 was designed for low cost and flexibility. Low cost was achieved by minimizing external components and using an SOIC package. Flexibility was achieved by allowing the bias current to be externally adjustable resulting in a broad range of output power capability. The bias pin can be ramped to reduce AM splatter in TDD/TDMA systems and can be used to trim the RF output power.

Theory of Operation

The input port is internally matched to 50 ohms. Return loss is typically 15–16 dB in the 800–1000 MHz range. The output port is nearly 50 ohms but is an open collector and therefore requires an external bias inductor. Using an RF choke will result in a 11–12 dB output return loss. However, a 10 nH inductor will improve it to 15–20 dB. A 10 nH inductor is small enough in value to be printed on the board. DC blocks are required on the input and output. Values of 100 pF are recommended.

Supply decoupling must be done as close to the IC as possible. A 1000 pF capacitor is recommended. A series RF choke is recommended to keep the RF signal off the supply line. A 10 nF decoupling capacitor is recommended on the V_{bias} line but does not need to be very close to the IC.

The V_{bias} pin can be used several ways. Tying it directly to V_{CC} will maximize the bias current which will maximize linearity. Adding a series resistor will reduce the bias current which will improve efficiency. Figure 9 shows the efficiency versus output power with V_{bias} tied to V_{CC}. The series resistor will cause these curves to shift to the left. The RF output power can be trimmed by using a variable resistor. The V_{bias} pin can also be used to power down the IC or, in the case of TDD/TDMA systems, to ramp the IC. By applying a linear ramp voltage, such as the one provided by the MRFIC2004, it has been demonstrated to meet the CT2 Common Air Interface splatter specifications.

The MRFIC2006 is internally temperature compensated. For input powers of −5.0 to 0 dBm the output power temperature variation is typically less than 0.2 dB from −35 to +85°C.

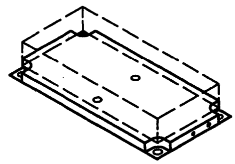
RFA8090B

The RF Line
Broadband RF Array for TV Transmitter

**140 W, 470–860 MHz
CLASS AB
RF POWER AMPLIFIER**

The RFA8090B is a solid state class AB amplifier and is specifically designed for TV transposers and transmitters. This amplifier incorporates microstrip technology and reliable Motorola push-pull transistors.

- Specified 28 Volts, 470–860 MHz Characteristics
  Output Power — 95 Watts (CW)
  Output Power — 140 Watts (peak)
  Gain — 8 dB min (@ 95 Watts)
- 50 Ω Input and Output Impedance



CASE 429E, STYLE 1

3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	32	Vdc
Quiescent Current	I_{CQ}	2 x 300	mAdc
Input Power	P_{in}	20	Watts
Storage Temperature Range	T_{stg}	–40 to +100	°C
Operating Temperature (1)	T_{op}	–20 to +70	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, I_{CQ} = 200 mA, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Instantaneous Bandwidth	BW	470	860	MHz

FUNCTIONAL TESTS IN CW (SOUND) (T_C = 25°C, V_{CC} = 28 V, I_{CQ} = 200 mA, unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Power Gain (P_{out} = 95 W)	G_p	8	—	dB
Gain Ripple (P_{out} = 95 W)	G_{rple}	—	±0.7	dB
Output Power @ 1 dB Compression	P_{out}	95	—	Watts
Mismatch Tolerance (P_{out} = 95 W)	VSWR	3:1	—	—
Efficiency (P_{out} = 95 W)	η	50	—	%

FUNCTIONAL TESTS IN VIDEO (standard black level)

Characteristic	Symbol	Min	Typ	Max	Unit
Peak Output Power (synch.) (V_{CC} = 28 Vdc, I_{CQ} = 200 mA, f = 860 MHz)	P_{out}	120	—	—	Watts
Peak Output Power (synch.) (V_{CC} = 32 Vdc, I_{CQ} = 100 mA, f = 860 MHz)	P_{out}	140	—	—	Watts

NOTE:
1. Temperature is measured at temperature test point (on the flange of the transistor).

TYPICAL CHARACTERISTICS

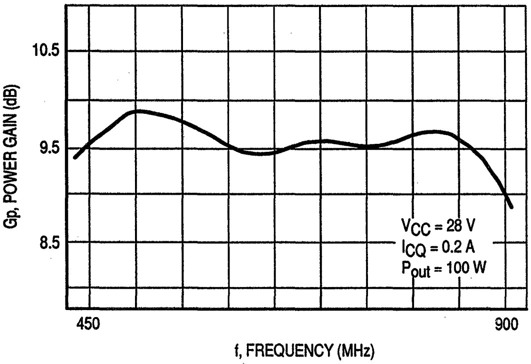


Figure 1. Power Gain versus Frequency

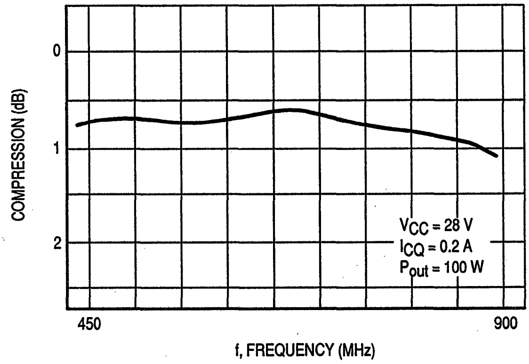


Figure 2. Gain Compression versus Frequency

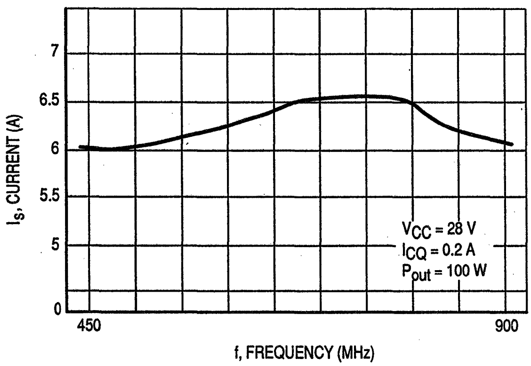


Figure 3. Supply Current versus Frequency

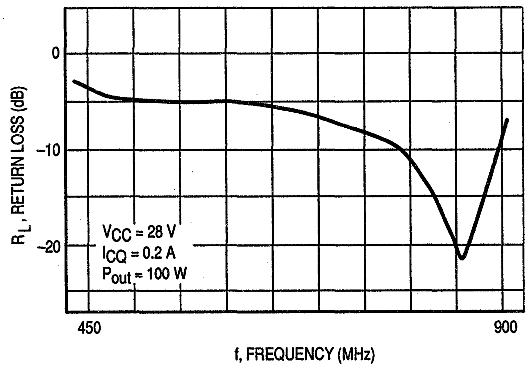


Figure 4. Input Return Loss versus Frequency

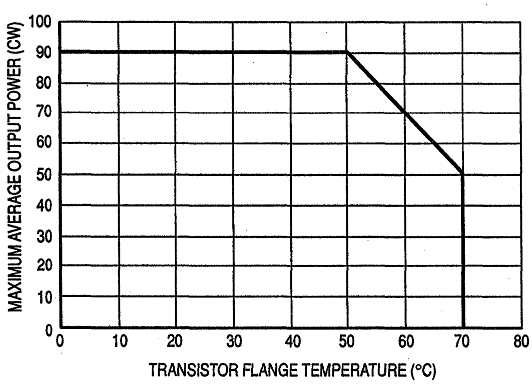


Figure 5. Maximum Average Output Power versus Temperature

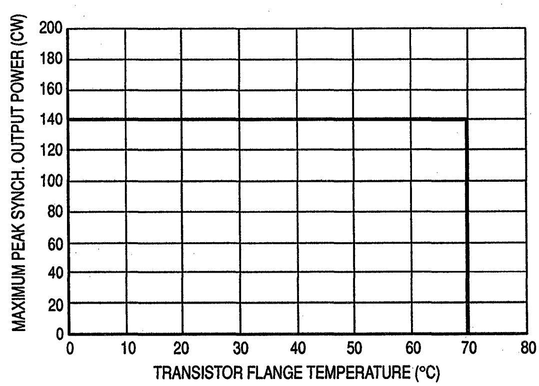


Figure 6. Maximum Peak Synch. Output Power (B/G Standard) versus Temperature

3

TYPICAL VIDEO CHARACTERISTICS

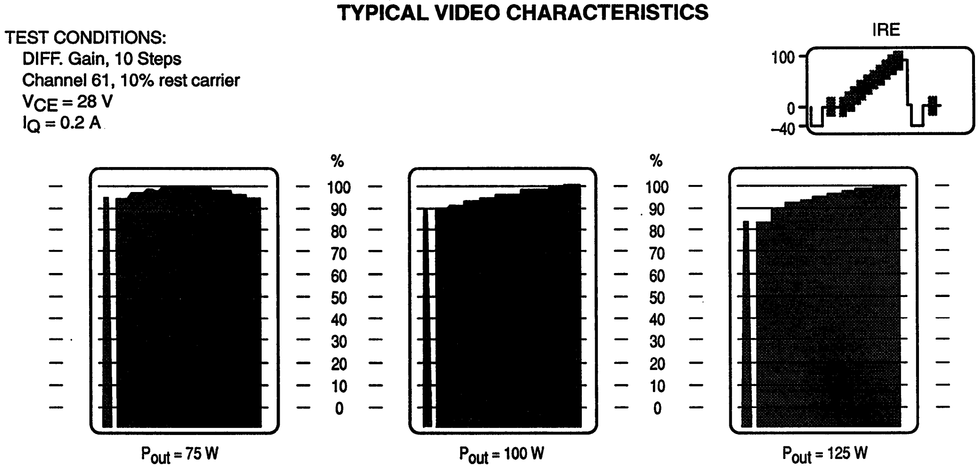
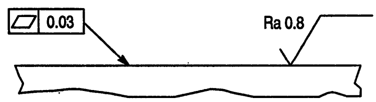


Figure 7. Differential Gain

MOUNTING RECOMMENDATIONS

HEATSINK TOOLING

- Planarity: Better than 0.03 mm
- Roughness: Typical value 0.8
- 6 fixing holes M3



THERMAL COMPOUND

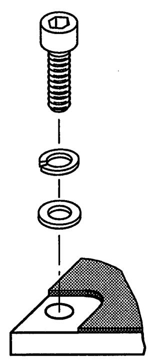
- Paste with silicones: SICERONT KF Ref. 1201 Recommended.
- Thickness: Optimum between 0.06 mm and 0.15 mm, on the whole back surface of the amplifier.
  (Typical volume: 215 mm 3 for 0.1 mm thickness)
  (Equivalent weight: 0.5g for 2.2 density paste).

SCREWS

- Socket head cap screws: CHC M3 x 10 for Copper/Aluminum Heatsink.
- Material: Nickel plated steel.

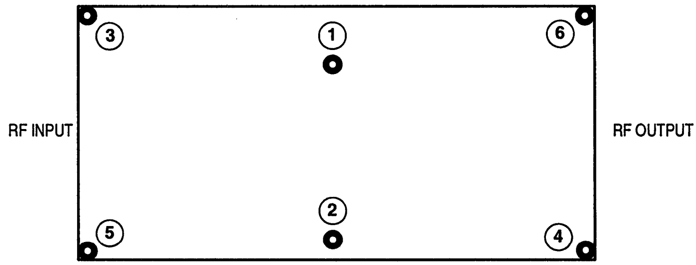
WASHERS

- Split lock washers WZ Ø3 + Flat washers ZU Ø3.



MOUNTING RECOMMENDATIONS (continued)

TIGHTENING ORDER



RECOMMENDED TORQUE: 12 Kg.cm (10.5 in. lbs)

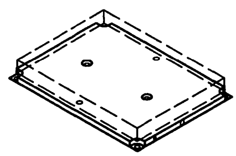
CLEANING

Some components of the RFA8090B are not qualified for every kind of cleaning solvent; do not clean the amplifier in a solvent bath. Local cleaning is recommended.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

RFA8180B

180 W C.W. (28 V)
270 W P. SYNC. (32 V)
470–860 MHz
RF POWER AMPLIFIER



CASE 429, STYLE 1

The RF Line
Broadband RF Array for TV Transmitter

The RFA8180B is a solid state class AB amplifier and is specifically designed for TV transposers and transmitters. This amplifier incorporates microstrip technology and reliable Motorola push-pull transistors.

- Specified 28 Volts, 470–860 MHz Characteristics
  Output Power — 180 Watts (CW)
  Gain — 8 dB Min (@ 180 W)
- 50 Ω Input and Output Impedance

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	32	Vdc
Quiescent Current	I_{CQ}	2 [2 x 300]	mAdc
Input Power	P_{in}	35	W
Storage Temperature Range	T_{stg}	–40 to +100	°C
Operating Temperature (1)	T_{op}	–20 to +70	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C, V_{CC} = 28 V, I_{CQ} = 2 x 200 mA, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Bandwidth	BW	470	—	860	MHz
Input Return Loss	IRL	—	—	–15	dB

FUNCTIONAL TESTS IN CW (SOUND) (T_C = 25°C, V_{CC} = 28 V, I_{CQ} = 2 x 200 mA, f = 470–860 MHz, unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain (P_{out} = 180 W)	G_p	8	—	—	dB
Gain Ripple (P_{out} = 180 W)	G_{rple}	—	—	±1	dB
Output Power @ 1 dB Compression	P_{out}	180	—	—	W
Mismatch Tolerance (P_{out} = 180 W)	VSWR	3:1	—	—	—
Efficiency (P_{out} = 180 W)	η	48	51	—	%

FUNCTIONAL TESTS IN VIDEO (standard black level)

Characteristic	Symbol	Min	Typ	Max	Unit
Peak Output Power (synch.) (V_{CC} = 28 Vdc)	P_{out1}	230	—	—	W
Peak Output Power (synch.) (V_{CC} = 32 Vdc)	P_{out2}	270	—	—	W

NOTE:
1. Temperature is measured at temperature test point (on the flange of the transistor).

3

TYPICAL CHARACTERISTICS
CW — WIDEBAND

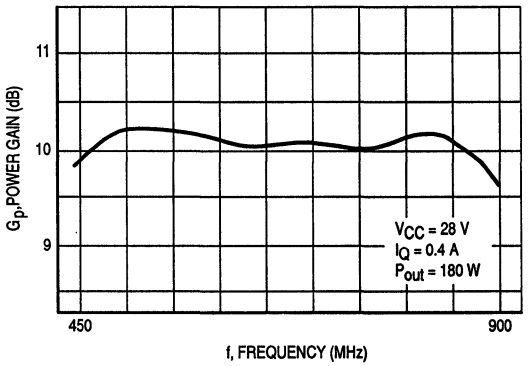


Figure 1. Power Gain versus Frequency

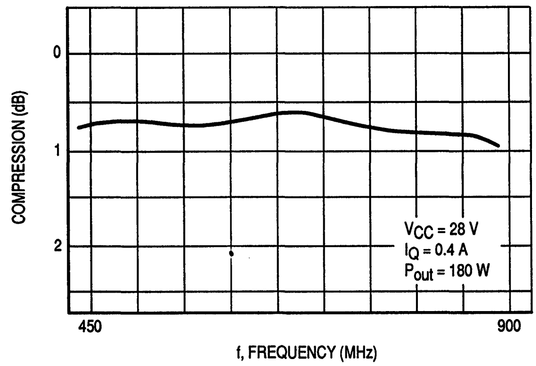


Figure 2. Gain Compression versus Frequency

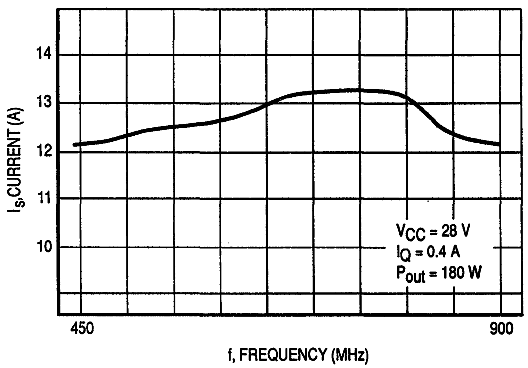


Figure 3. Supply Current versus Frequency

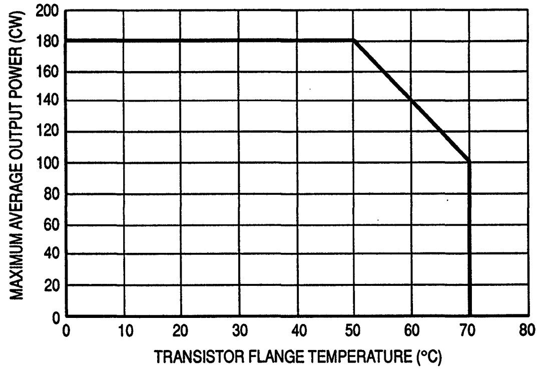


Figure 4. Maximum Average Output Power versus Temperature

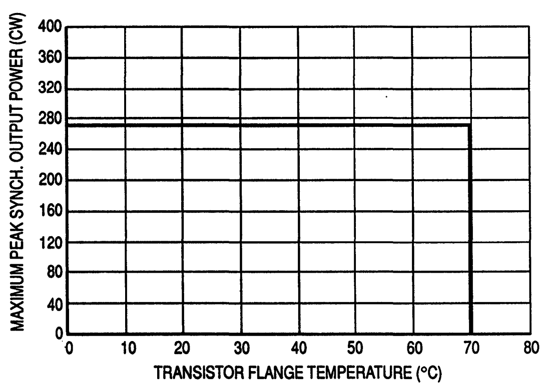
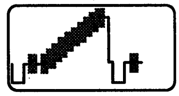


Figure 5. Maximum Peak Synch. Output Power (B/G Standard) versus Temperature

TYPICAL VIDEO CHARACTERISTICS @ f = 860 MHz

TEST CONDITIONS:
DIFF. Gain, 10 Steps
Channel 61
V_{CE} = 28 V
I_Q = 0.4 A



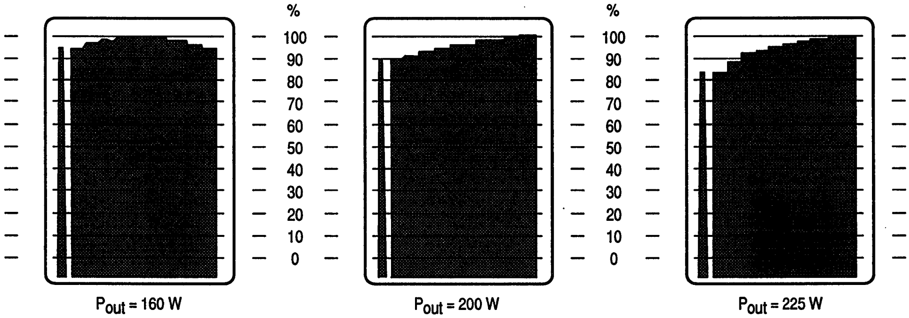


Figure 6. Differential Gain

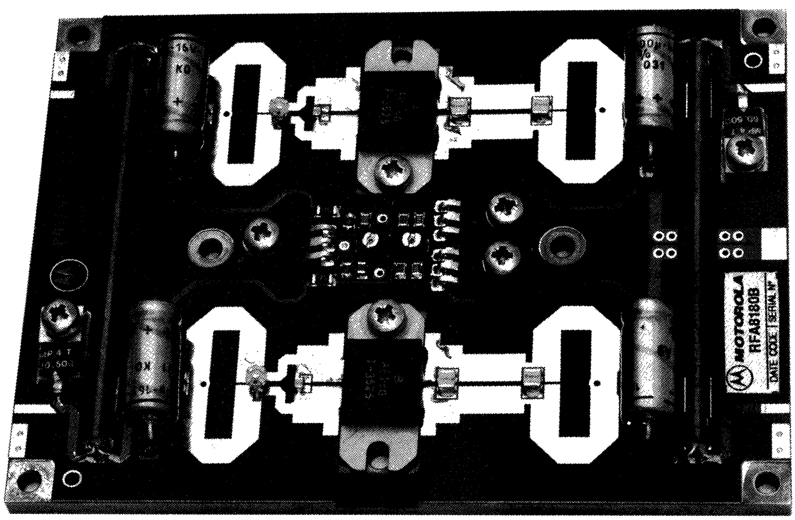
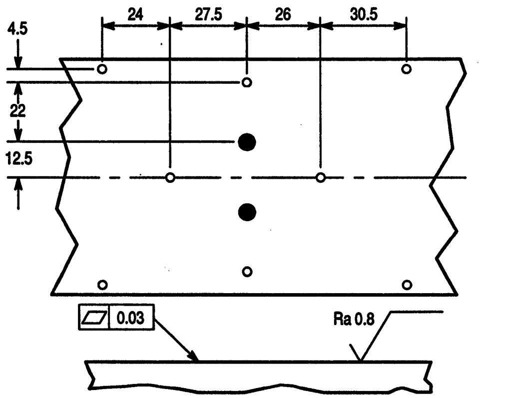


Figure 7. RFA8180B Amplifier

APPLICATIONS INFORMATION

HEATSINK TOOLING



○ 8 Fixing holes M3
Minimum useful depth: 6 mm

● 2 Cavities Ø5
Minimum depth: 1 mm

MOUNTING RECOMMENDATIONS

3

THERMAL COMPOUND

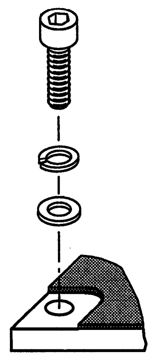
- Paste with silicones: SICERONT KF Ref. 1201 Recommended.
- Thickness: Optimum between 0.06 mm and 0.15 mm, on the whole back surface of the amplifier.
  (Typical volume: 700 mm 3 for 0.1 mm thickness)
  (Equivalent weight: 1.5g for 2.2 density paste).

SCREWS

- Socket head cap screws: CHC M3 x 10 for Copper/Aluminum Heatsink.
- Material: Nickel plated steel.

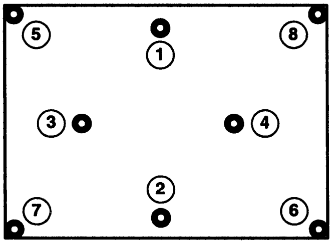
WASHERS

- Split lock washers WZ Ø3 + Flat washers ZU Ø3.



MOUNTING RECOMMENDATIONS (continued)

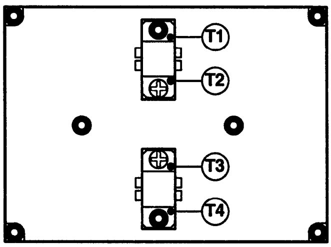
TIGHTENING ORDER



Recommended Torque: 12 Kg.cm (10.5 in.lbs)

MOUNTING VERIFICATION

Make the amplifier work at nominal RF conditions, and measure temperature on points 1, 2, 3, and 4.

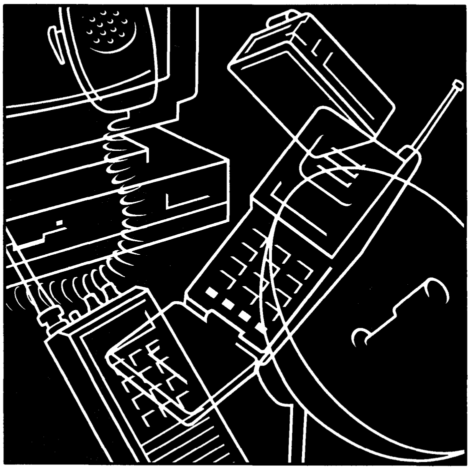


Characteristic	Typ	Max	Unit
T1, T2, T3, T4	—	70	°C
Δ(T1, T2), Δ(T3, T4)	3	5	°C

3

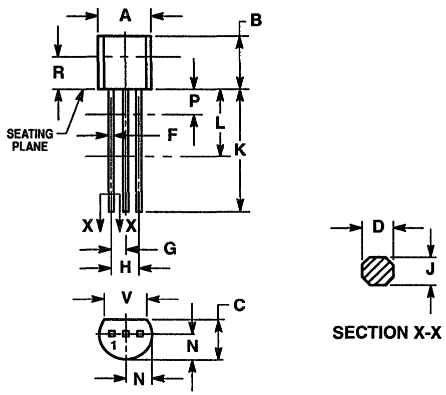
CLEANING

Some components of the RFA8180B amplifier are not qualified for every kind of cleaning solvent; do not clean the amplifier in a solvent bath. Local cleaning is recommended.



Case Dimensions

4



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIM R IS UNCONTROLLED.
4. DIM F APPLIES BETWEEN P AND L. DIM D AND J APPLIES BETWEEN L AND K MINIMUM. LEAD DIM IS UNCONTROLLED IN P AND BEYOND DIM K MINIMUM.

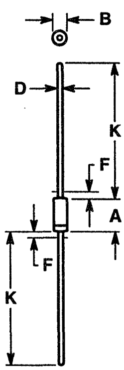
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.022	0.41	0.55
F	0.016	0.019	0.41	0.48
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	—	12.70	—
L	0.250	—	6.35	—
N	0.080	0.105	2.04	2.66
P	—	0.100	—	2.54
R	0.115	—	2.93	—
V	0.135	—	3.43	—

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

STYLE 15:
PIN 1. ANODE 1
2. CATHODE
3. ANODE 2

CASE 29-04



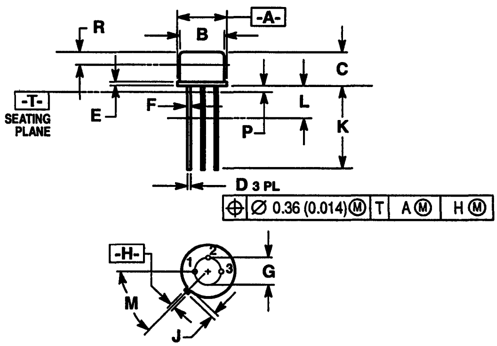
NOTES:
1. PACKAGE CONTOUR OPTIONAL WITHIN DIA B AND LENGTH A. HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT SHALL NOT BE SUBJECT TO THE MIN LIMIT OF DIA B.
2. LEAD DIA NOT CONTROLLED IN ZONES F, TO ALLOW FOR FLASH, LEAD FINISH BUILDUP, AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	5.84	7.62	0.230	0.300
B	2.16	2.72	0.085	0.107
D	0.46	0.56	0.018	0.022
F	—	1.27	—	0.050
K	25.40	38.10	1.000	1.500

All JEDEC dimensions and notes apply

CASE 51-02

4



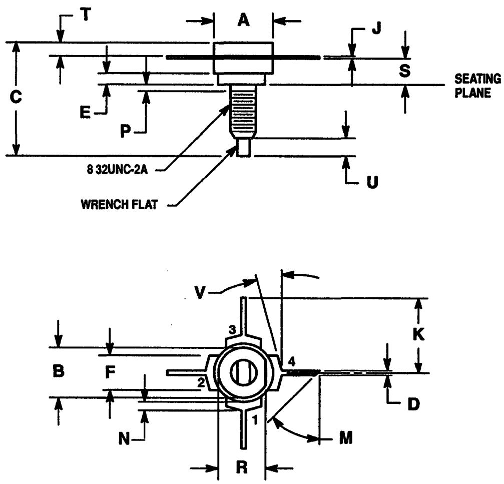
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y.145M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.355	0.366	9.02	9.29
B	0.315	0.335	8.01	8.50
C	0.165	0.180	4.20	4.57
D	0.017	0.021	0.44	0.53
E	0.017	0.035	0.44	0.88
F	0.016	0.019	0.41	0.48
G	0.200 BSC		5.08 BSC	
H	0.028	0.034	0.72	0.86
J	0.029	0.040	0.74	1.01
K	0.500	0.750	12.70	19.05
L	0.250	—	6.35	—
M	45° BSC		45° BSC	
P	—	0.050	—	1.27
R	0.100	—	2.54	—

STYLE 5:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

STYLE 7:
PIN 1. DRAIN
2. GATE
3. SOURCE

CASE 79-05



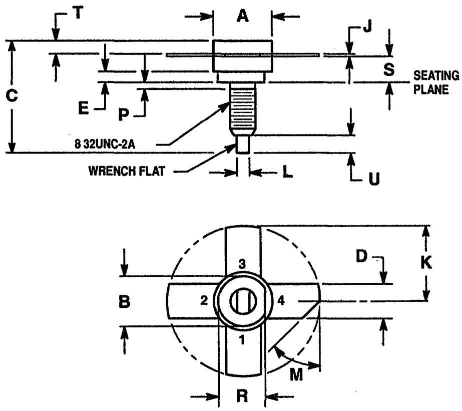
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.370	0.385	9.40	9.78
B	0.320	0.330	8.13	8.38
C	0.670	0.790	17.02	20.07
D	0.025	0.035	0.64	0.89
E	0.070	—	1.78	—
F	0.215	0.235	5.64	5.97
J	0.003	0.007	0.08	0.18
K	0.490	—	12.45	—
M	45° NOM		45° NOM	
N	0.050	0.060	1.27	1.52
P	—	0.050	—	1.27
R	0.299	0.307	7.59	7.80
S	0.158	0.178	4.01	4.52
T	0.083	0.100	2.11	2.54
U	0.098	0.132	2.49	3.35
V	10°	20°	10°	20°

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 144B-05

4

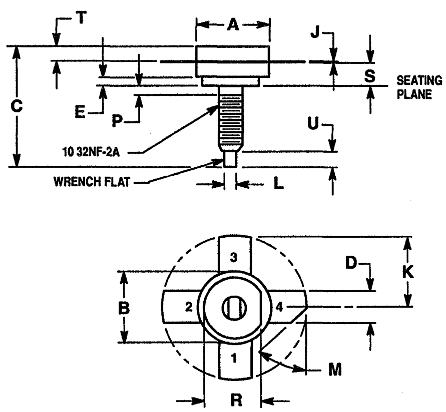


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.370	0.385	9.40	9.78
B	0.320	0.330	8.13	8.38
C	0.670	0.790	17.02	20.07
D	0.215	0.235	5.46	5.97
E	0.070	—	1.78	—
J	0.003	0.007	0.08	0.18
K	0.490	—	12.45	—
L	0.055	0.070	1.40	1.78
M	45° NOM		45° NOM	
P	—	0.050	—	1.27
R	0.299	0.307	7.59	7.80
S	0.158	0.178	4.01	4.52
T	0.083	0.100	2.11	2.54
U	0.098	0.132	2.49	3.35

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145A-09



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

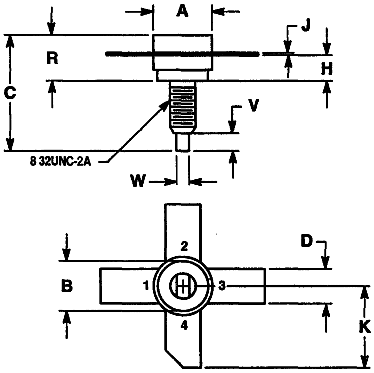
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.490	0.510	12.45	12.95
B	0.415	0.425	10.54	10.80
C	0.775	0.895	19.68	22.73
D	0.215	0.235	5.46	5.97
E	0.072	—	1.83	—
J	0.003	0.007	0.08	0.18
K	0.490	—	12.45	—
L	0.065	0.075	1.65	1.90
M	45° NOM		45° NOM	
P	—	0.050	—	1.27
R	0.383	0.396	9.73	10.06
S	0.151	0.177	3.84	4.50
T	0.083	0.100	2.11	2.54
U	0.098	0.132	2.49	3.35

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145A-10

4

CASE DIMENSIONS (continued)

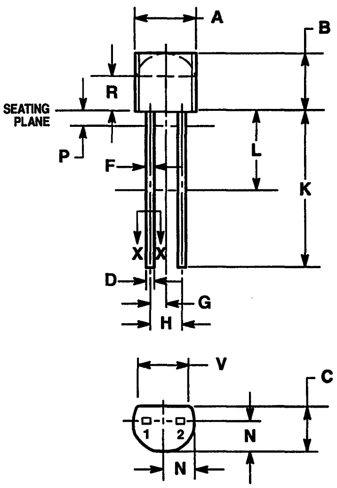


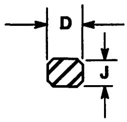
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.365	0.385	9.28	9.77
B	0.320	0.330	8.13	8.38
C	0.700	0.778	17.78	19.76
D	0.220	0.230	5.59	5.84
H	0.160	0.170	4.07	4.31
J	0.003	0.006	0.08	0.15
K	0.490	0.520	12.45	13.20
R	0.248	0.275	6.30	7.23
V	0.100	0.130	2.54	3.30
W	0.055	0.065	1.40	1.65

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145D-02





SECTION X-X

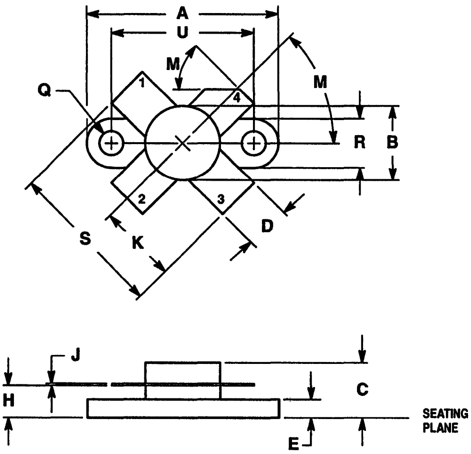
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND ZONE R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSIONS D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIM K MINIMUM.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.175	0.205	4.45	5.21
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.022	0.41	0.56
F	0.016	0.019	0.407	0.482
G	0.050 BSC		1.27 BSC	
H	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.500	—	12.70	—
L	0.250	—	6.35	—
N	0.080	0.105	2.03	2.66
P	—	0.050	—	1.27
R	0.115	—	2.93	—
V	0.135	—	3.43	—

STYLE 1:
PIN 1. ANODE
2. CATHODE

CASE 182-02

4



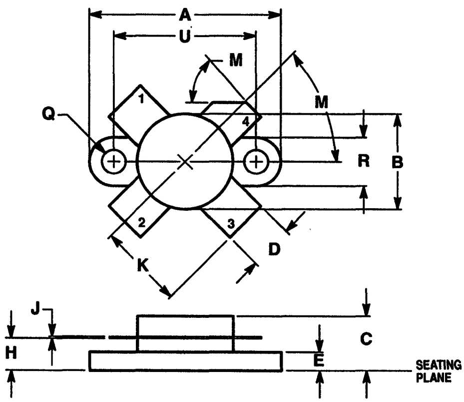
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.960	0.990	24.39	25.14
B	0.370	0.390	9.40	9.90
C	0.229	0.281	5.82	7.13
D	0.215	0.235	5.47	5.96
E	0.085	0.105	2.16	2.66
H	0.150	0.180	3.81	4.57
J	0.004	0.006	0.11	0.15
K	0.395	0.405	10.04	10.28
M	40°	50°	40°	50°
Q	0.113	0.130	2.88	3.30
R	0.245	0.255	6.23	6.47
S	0.790	0.810	20.07	20.57
U	0.720	0.730	18.29	18.54

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. SOURCE
2. GATE
2. SOURCE
2. DRAIN

CASE 211-07



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.960	0.990	24.39	25.14
B	0.465	0.510	11.82	12.95
C	0.229	0.275	5.82	6.98
D	0.216	0.235	5.49	5.96
E	0.084	0.110	2.14	2.79
H	0.144	0.178	3.66	4.52
J	0.003	0.007	0.08	0.17
K	0.435	—	11.05	—
M	45° NOM		45° NOM	
Q	0.115	0.130	2.93	3.30
R	0.246	0.255	6.25	6.47
U	0.720	0.730	18.29	18.54

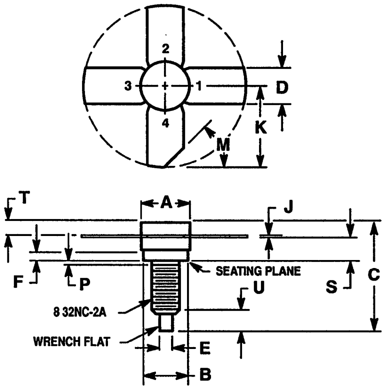
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

CASE 211-11

4

CASE DIMENSIONS (continued)

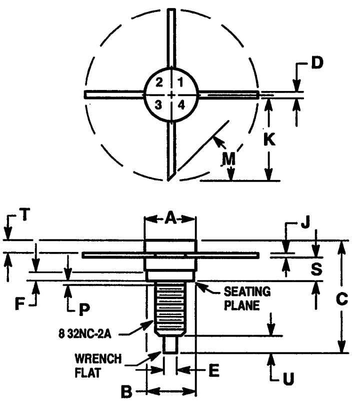


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

CASE 244-04



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	15.24	16.51	0.600	0.650
D	0.66	0.86	0.026	0.034
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.10	0.15	0.004	0.006
K	11.17	—	0.440	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	2.74	3.35	0.108	0.132
T	1.40	1.78	0.055	0.070
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

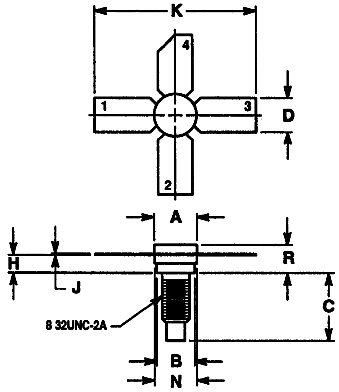
STYLE 2:
PIN 1. COMMON
2. OUTPUT
3. COMMON
4. INPUT

STYLE 3:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

CASE 244A-01

4

CASE DIMENSIONS (continued)

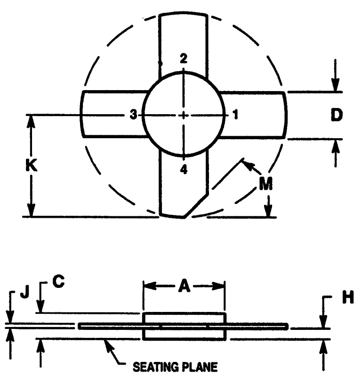


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.271	0.281	6.88	7.14
B	0.245	0.255	6.22	6.48
C	0.435	0.465	11.05	11.81
D	0.220	0.230	5.59	5.84
H	0.113	0.123	2.87	3.12
J	0.004	0.006	0.10	0.15
K	1.000	1.060	25.40	26.92
N	0.273	0.283	6.93	7.19
R	0.175	0.197	4.45	5.00

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 244C-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. SEATING PLANE = GROUND AND IS CONNECTED TO PIN 1 AND 3.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.278	0.286	7.06	7.26
C	0.112	0.136	2.84	3.45
D	0.215	0.235	5.46	5.97
H	0.055	0.065	1.40	1.65
J	0.003	0.007	0.08	0.18
K	0.435	—	11.05	—
M	45° REF		45° REF	

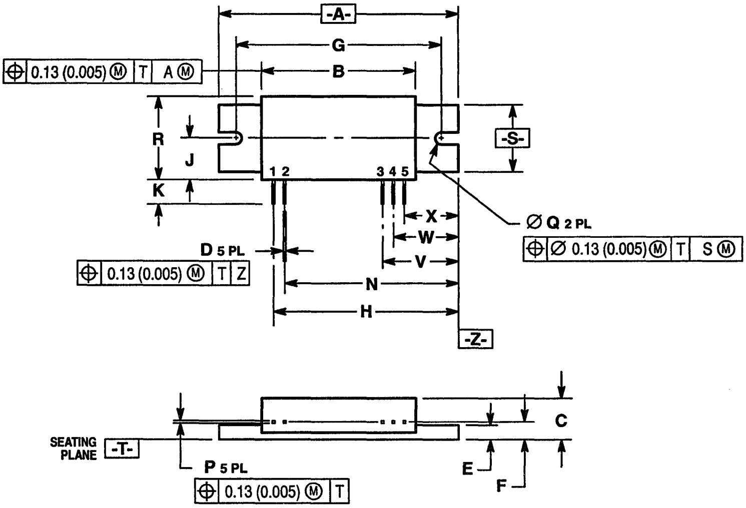
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 249-05

4

CASE DIMENSIONS (continued)

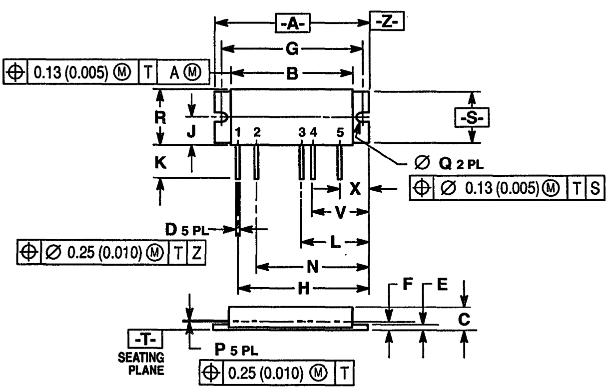


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	2.190	2.210	55.63	56.13
B	1.395	1.415	35.44	35.94
C	0.355	0.380	9.02	9.65
D	0.018	0.022	0.46	0.55
E	0.120	0.135	3.05	3.42
F	0.164 BSC		4.16 BSC	
G	1.900 BSC		48.26 BSC	
H	1.700 BSC		43.18 BSC	
J	0.345	0.385	8.77	9.77
K	0.225	—	5.72	—
N	1.600 BSC		40.64 BSC	
P	0.008	0.012	0.21	0.30
Q	0.150	0.160	3.81	4.06
R	0.690	0.770	17.53	19.55
S	0.595	0.615	15.12	15.62
V	0.700 BSC		17.78 BSC	
W	0.600 BSC		15.24 BSC	
X	0.500 BSC		12.70 BSC	

STYLE 1:
PIN 1. RF INPUT
2. V_{BIAS} (8.0 V)
3. V_{CC2} (12.5 V)
4. V_{CC3} (12.5 V)
5. RF OUTPUT

CASE 301AA-01



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

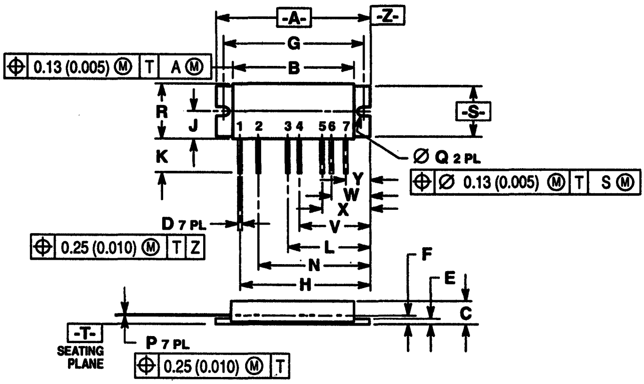
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.760	1.780	44.71	45.21
B	1.370	1.390	34.80	35.30
C	0.245	0.265	6.23	6.73
D	0.018	0.022	0.46	0.55
E	0.080	0.100	2.04	2.54
F	0.130 BSC		3.30 BSC	
G	1.650 BSC		41.91 BSC	
H	1.485 BSC		37.72 BSC	
J	0.267	0.278	6.79	7.06
K	0.230	0.300	5.85	7.62
L	0.785 BSC		19.94 BSC	
N	1.285 BSC		32.64 BSC	
P	0.008	0.012	0.21	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.09
S	0.445	0.465	11.31	11.81
V	0.685 BSC		17.40 BSC	
X	0.385 BSC		9.78 BSC	

STYLE 1:
PIN 1. RF INPUT/V CONT
2. VS1
3. VS2
4. VS3
5. RF OUTPUT
CASE: GROUND

CASE 301E-04

4

CASE DIMENSIONS (continued)

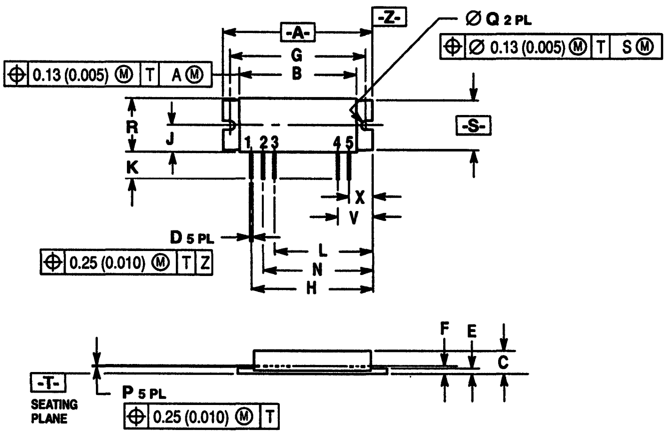


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	2.380	2.395	60.46	60.83
B	1.970	1.990	50.04	50.54
C	0.250	0.265	6.35	6.73
D	0.018	0.022	0.46	0.55
E	0.085	0.100	2.16	2.54
F	0.132 BSC		3.35 BSC	
G	2.260 BSC		57.40 BSC	
H	2. 042 BSC		51.87 BSC	
J	0.267	0.278	6.78	7.06
K	0.230	0.300	5.85	7.62
L	1.242 BSC		31.55 BSC	
N	1.742 BSC		44.25 BSC	
P	0.008	0.012	0.21	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.09
S	0.445	0.465	11.31	11.81
V	1.142 BSC		29.01 BSC	
W	0.542 BSC		13.77 BSC	
X	0.642 BSC		16.31 BSC	
Y	0.342 BSC		8.69 BSC	

STYLE 1:
PIN 1. RF INPUT/V CONT
2. VS1
3. VS2
4. VS3
5. VS4
6. VS5
7. RF OUTPUT
CASE: GROUND

CASE 301F-03



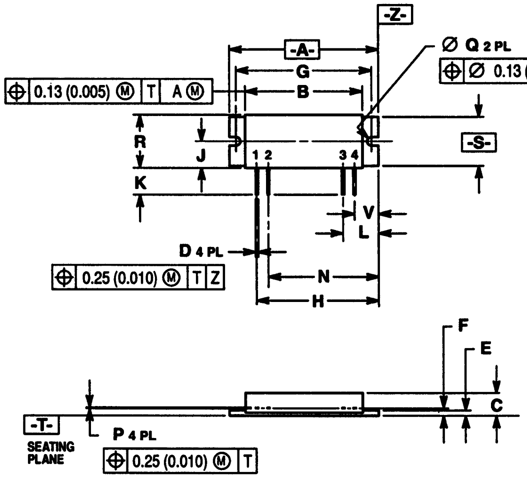
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	2.190	2.210	55.63	56.13
B	1.395	1.415	35.44	35.94
C	0.350	0.376	8.89	9.55
D	0.018	0.022	0.46	0.55
E	0.120	0.135	3.05	3.42
F	0.160 BSC		4.06 BSC	
G	1.900 BSC		48.26 BSC	
H	1.600 BSC		40.64 BSC	
J	0.345	0.385	8.77	9.77
K	0.225	—	5.72	—
L	1.400 BSC		35.56 BSC	
N	1.500 BSC		38.10 BSC	
P	0.008	0.012	0.21	0.30
Q	0.150	0.160	3.81	4.06
R	0.690	0.770	17.53	19.55
S	0.595	0.610	15.12	15.49
V	0.700 BSC		17.78 BSC	
X	0.500 BSC		12.70 BSC	

STYLE 1:
PIN 1. RF INPUT
2. +DC
3. +DC
4. +DC
5. RF OUTPUT
CASE: GROUND

CASE 301G-03

CASE DIMENSIONS (continued)

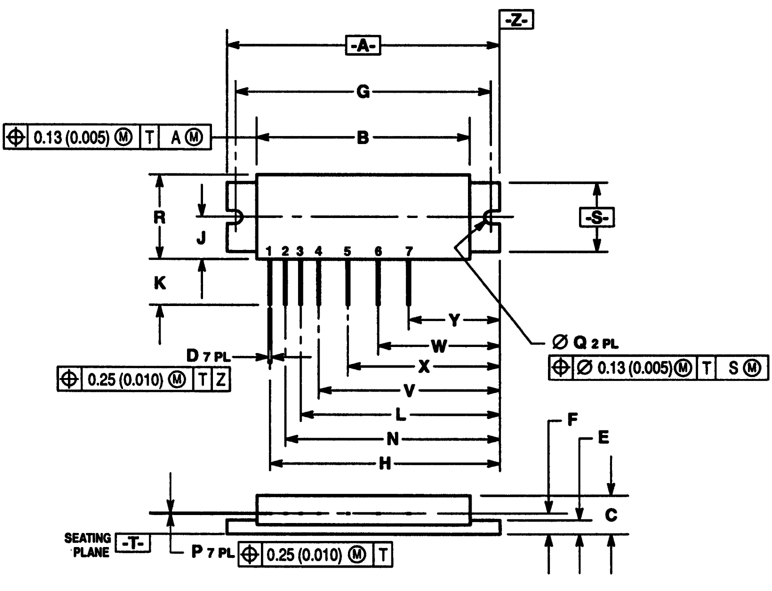


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.890	1.910	48.01	48.51
B	1.170	1.190	29.72	30.22
C	0.350	0.376	8.89	9.55
D	0.018	0.022	0.46	0.55
E	0.120	0.135	3.05	3.42
F	0.160 BSC		4.06 BSC	
G	1.600 BSC		40.64 BSC	
H	1.400 BSC		35.56 BSC	
J	0.345	0.385	8.77	9.77
K	0.225	—	5.72	—
L	0.700 BSC		17.78 BSC	
N	1.300 BSC		33.02 BSC	
P	0.008	0.012	0.21	0.30
Q	0.150	0.160	3.81	4.06
R	0.685	0.770	17.40	19.55
S	0.595	0.610	15.12	15.49
V	0.500 BSC		12.70 BSC	

STYLE 2:
PIN 1. RF INPUT
2. +DC (CONTROL)
3. +DC (SUPPLY)
4. RF OUTPUT
CASE: GROUND

CASE 301H-03



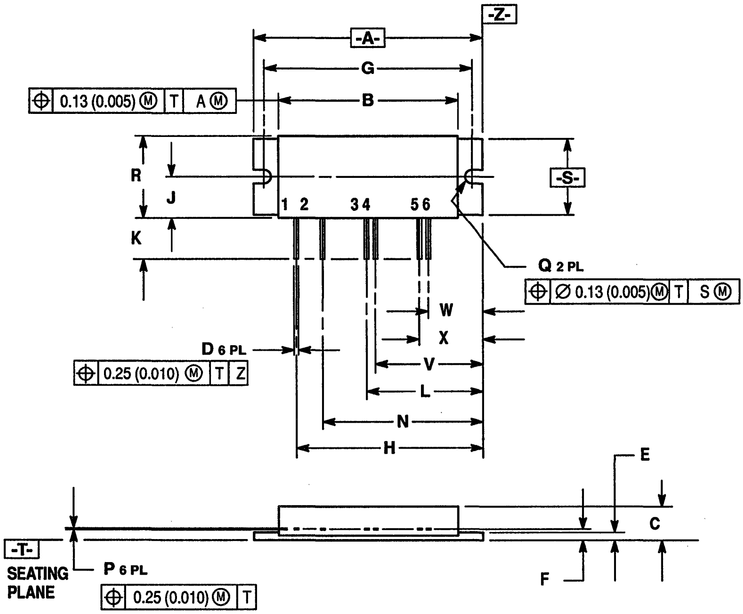
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.765	1.780	44.84	45.21
B	1.370	1.390	34.80	35.30
C	0.250	0.265	6.35	6.73
D	0.018	0.022	0.46	0.55
E	0.085	0.100	2.16	2.54
F	0.132 BSC		3.35 BSC	
G	1.654 BSC		42.02 BSC	
H	1.487 BSC		37.77 BSC	
J	0.267	0.278	6.79	7.06
K	0.150	0.450	3.81	11.43
L	1.287 BSC		32.69 BSC	
N	1.387 BSC		35.23 BSC	
P	0.008	0.012	0.21	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.09
S	0.445	0.465	11.31	11.81
V	1.187 BSC		30.15 BSC	
W	0.787 BSC		19.99 BSC	
X	0.987 BSC		25.07 BSC	
Y	0.587 BSC		14.91 BSC	

STYLE 1:
PIN 1. RF INPUT
2. VSI
3. VCONT
4. VS2
5. VS3
6. VS4
7. RF OUTPUT
CASE: GROUND

CASE 301J-02

CASE DIMENSIONS (continued)

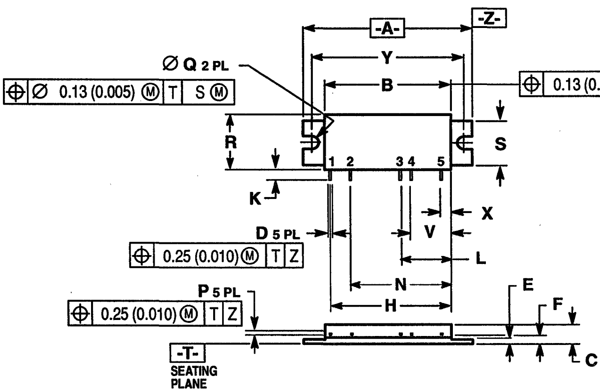


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.770	1.785	44.96	45.34
B	1.370	1.390	34.80	35.31
C	0.250	0.265	6.35	6.73
D	0.018	0.022	0.46	0.55
E	0.085	0.100	2.16	2.54
F	0.132 BSC		3.35 BSC	
G	1.655 BSC		42.04 BSC	
H	1.490 BSC		37.85 BSC	
J	0.267	0.278	6.78	7.06
K	0.230	0.300	5.85	7.62
L	0.990 BSC		25.15 BSC	
N	1.290 BSC		32.77 BSC	
P	0.008	0.012	0.21	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.09
S	0.445	0.465	11.31	11.81
V	0.890 BSC		22.61 BSC	
W	0.285 BSC		7.24 BSC	
X	0.390 BSC		9.91 BSC	

STYLE 3:
PIN 1. RF INPUT
2. VS1
3. VCONT
4. VS2
5. VS3
6. RF OUTPUT
CASE: GROUND

CASE 301K-02



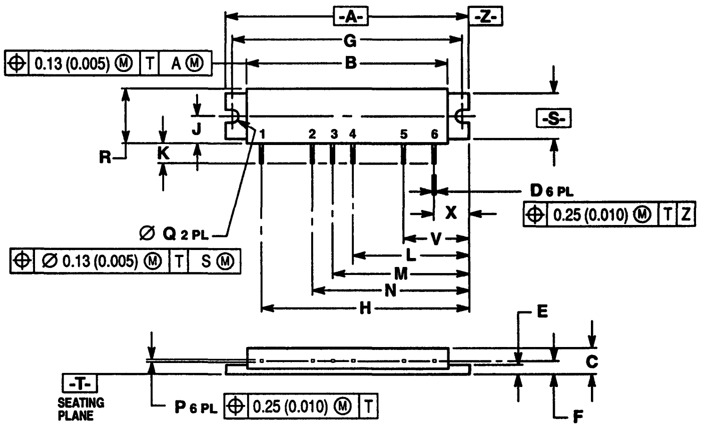
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION F TO CENTER OF LEADS.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	42.80	43.05	1.685	1.695
B	32.01	32.38	1.260	1.275
C	4.45	4.75	0.175	0.187
D	0.46	0.55	0.018	0.022
E	1.02	1.14	0.040	0.045
F	1.96	2.41	0.077	0.095
H	30.61 BSC		1.205 BSC	
K	2.54	—	0.100	—
L	12.83 BSC		0.505 BSC	
N	25.53 BSC		1.005 BSC	
P	0.21	0.30	0.008	0.012
Q	3.05	3.30	0.120	0.130
R	13.85	14.22	0.545	0.560
S	11.43	11.68	0.450	0.460
V	10.29 BSC		0.405 BSC	
X	2.67 BSC		0.105 BSC	
Y	38.99 BSC		1.535 BSC	

STYLE 1:
PIN 1. RF INPUT/V CONT
2. VS1
3. VS2
4. VS3
5. RF OUTPUT
CASE: GROUND

CASE 301N-02

CASE DIMENSIONS (continued)

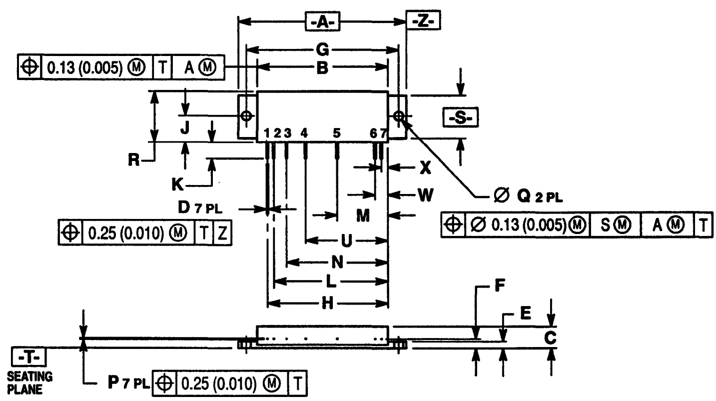


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	2.380	2.395	60.46	60.83
B	1.970	1.990	50.04	50.54
C	0.250	0.265	6.35	6.73
D	0.018	0.022	0.46	0.55
E	0.085	0.100	2.16	2.54
F	0.132 BSC		3.35 BSC	
G	2.260 BSC		57.40 BSC	
H	2.042 BSC		51.87 BSC	
J	0.267	0.278	6.78	7.06
K	0.177	0.217	4.49	5.51
L	1.142 BSC		29.01 BSC	
M	1.342 BSC		34.09 BSC	
N	1.542 BSC		39.17 BSC	
P	0.008	0.012	0.21	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.09
S	0.445	0.465	11.31	11.81
V	0.642 BSC		16.31 BSC	
X	0.342 BSC		8.69 BSC	

STYLE 1:
PIN 1. RF INPUT/VCONT
2. VS1
3. VS2
4. Vb
5. VS3
6. RF OUTPUT

CASE 301R-01



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

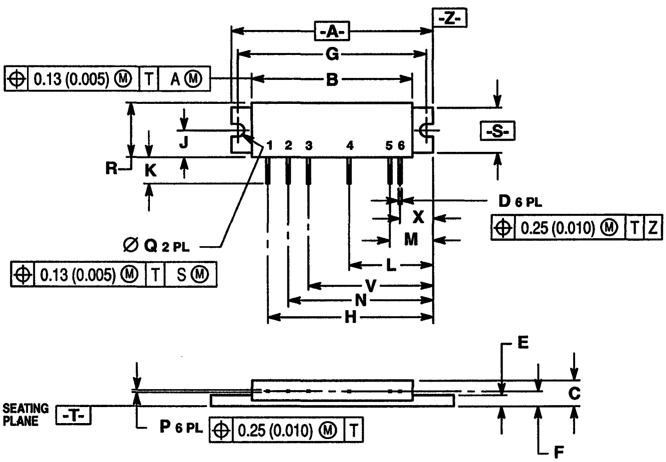
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	2.640	2.660	67.06	67.56
B	2.040	2.085	51.82	52.95
C	0.335	0.360	8.51	9.14
D	0.018	0.022	0.46	0.56
E	0.100	0.115	2.54	2.92
F	0.147 BSC		3.73 BSC	
G	2.405 BSC		61.09 BSC	
H	1.900 BSC		48.26 BSC	
J	0.400	0.440	10.16	11.18
K	0.177	0.217	4.50	5.51
L	1.800 BSC		45.72 BSC	
M	0.800 BSC		20.32 BSC	
N	1.600 BSC		40.64 BSC	
P	0.008	0.012	0.21	0.30
Q	0.136	0.146	3.45	3.71
R	0.800	0.820	20.32	20.83
S	0.670	0.690	17.02	17.53
U	1.300 BSC		33.02 BSC	
W	0.200 BSC		5.08 BSC	
X	0.100 BSC		2.54 BSC	

STYLE 1:
PIN 1. RF INPUT
2. DC TERMINAL, Vs1
3. DC TERMINAL, Vs2
4. DC TERMINAL, Vb
5. DC TERMINAL, Vs3
6. DC TERMINAL, Vs4
7. RF OUTPUT

CASE 301S-02

4

CASE DIMENSIONS (continued)

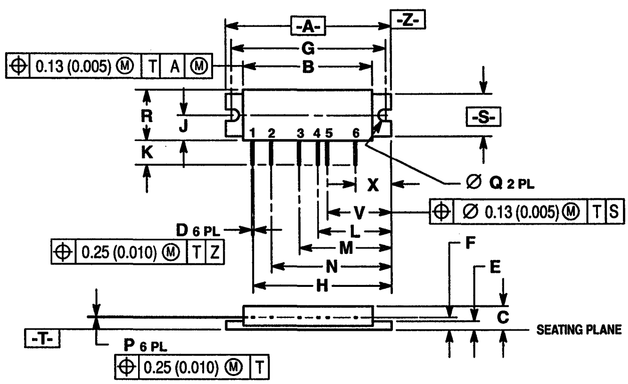


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.970	1.990	50.04	50.55
B	1.570	1.590	39.88	40.39
C	0.245	0.265	6.23	6.73
D	0.018	0.022	0.46	0.56
E	0.100	0.115	2.54	2.92
F	0.147 BSC		3.73 BSC	
G	1.860 BSC		47.24 BSC	
H	1.625 BSC		41.28 BSC	
J	0.267	0.278	6.78	7.06
K	0.177	0.217	4.50	5.51
L	0.825 BSC		20.96 BSC	
M	0.425 BSC		10.80 BSC	
N	1.425 BSC		36.20 BSC	
P	0.008	0.012	0.20	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.10
S	0.445	0.465	11.30	11.81
V	1.225 BSC		31.12 BSC	
X	0.325 BSC		8.26 BSC	

STYLE 1:
PIN 1. RF INPUT
2. DC TERMINAL, Vs1
3. DC TERMINAL, Vs2
4. DC TERMINAL, Vb
5. DC TERMINAL, Vs3
6. RF OUTPUT

CASE 301T-02



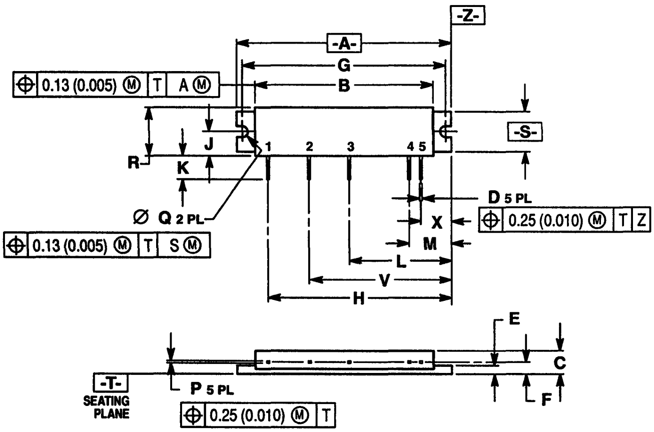
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.760	1.780	44.71	45.21
B	1.370	1.390	34.80	35.30
C	0.245	0.265	6.23	6.73
D	0.018	0.022	0.46	0.55
E	0.080	0.100	2.04	2.54
F	0.130 BSC		3.30 BSC	
G	1.650 BSC		41.91 BSC	
H	1.485 BSC		37.72 BSC	
J	0.267	0.278	6.79	7.06
K	0.177	0.217	4.50	5.51
L	0.785 BSC		19.94 BSC	
M	0.985 BSC		25.02 BSC	
N	1.285 BSC		32.64 BSC	
P	0.008	0.012	0.21	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.09
S	0.445	0.465	11.31	11.81
V	0.685 BSC		17.40 BSC	
X	0.385 BSC		9.78 BSC	

STYLE 1:
PIN 1. RF INPUT/V CONT
2. VS1
3. Vb
4. VS2
5. VS3
6. RF OUTPUT
CASE: GROUND

CASE 301V-02

CASE DIMENSIONS (continued)

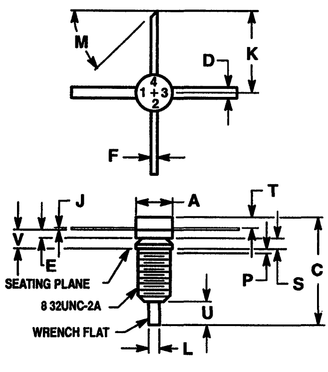


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION F TO CENTER OF LEADS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.970	1.990	50.04	50.55
B	1.570	1.590	39.88	40.39
C	0.245	0.265	6.23	6.73
D	0.018	0.022	0.46	0.56
E	0.100	0.115	2.54	2.92
F	0.147 BSC		3.73 BSC	
G	1.860 BSC		47.24 BSC	
H	1.625 BSC		41.28 BSC	
J	0.267	0.278	6.78	7.06
K	0.177	0.217	4.50	5.51
L	0.825 BSC		20.96 BSC	
M	0.425 BSC		10.80 BSC	
P	0.008	0.012	0.20	0.30
Q	0.120	0.130	3.05	3.30
R	0.535	0.555	13.59	14.10
S	0.445	0.465	11.30	11.81
V	1.225 BSC		31.12 BSC	
X	0.325 BSC		8.26 BSC	

STYLE 1:
PIN 1. RF INPUT
2. DC TERMINAL, Vs1
3. DC TERMINAL, Vb
4. DC TERMINAL, Vs2
5. RF OUTPUT

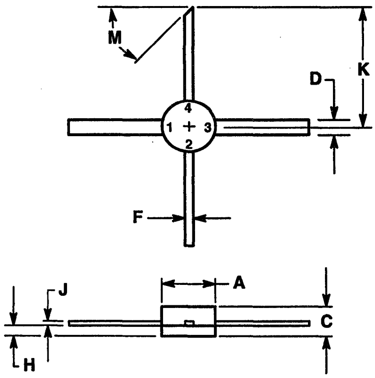
CASE 301Y-02



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.200	0.220	5.08	5.59
C	0.550	0.640	13.97	16.26
D	0.055	0.065	1.40	1.65
E	0.040	0.050	1.02	1.27
F	0.025	0.035	0.64	0.89
J	0.003	0.007	0.08	0.18
K	0.435	—	11.05	—
L	0.055	0.065	1.40	1.65
M	45° NOM		45° NOM	
P	—	0.050	—	1.27
S	0.055	0.065	1.40	1.65
T	0.055	0.070	1.40	1.78
U	0.110	0.150	2.79	3.81
V	0.095	0.115	2.41	2.92

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 305-01



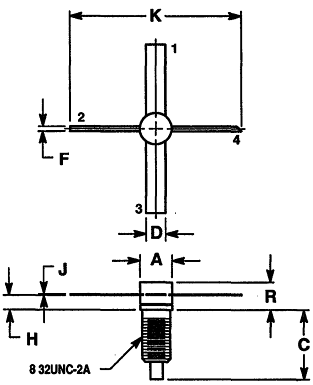
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.200	0.220	5.08	5.59
C	0.095	0.130	2.41	3.30
D	0.055	0.065	1.40	1.65
F	0.025	0.035	0.64	0.89
H	0.040	0.050	1.02	1.27
J	0.003	0.007	0.08	0.18
K	0.435	—	11.05	—
M	45° REF		45° REF	

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

CASE 305A-01



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

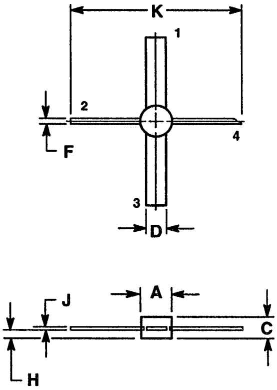
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.200	0.210	5.08	5.33
C	0.425	0.465	10.80	11.81
D	0.120	0.130	3.05	3.30
F	0.025	0.035	0.64	0.88
H	0.092	0.108	2.34	2.74
J	0.004	0.006	0.11	0.15
K	0.970	1.030	26.64	26.16
R	—	0.180	—	4.57

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 305B-02

4

CASE DIMENSIONS (continued)

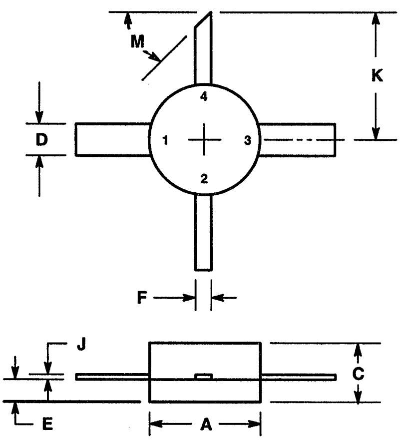


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.200	0.210	5.08	5.33
C	—	0.125	—	3.17
D	0.120	0.130	3.05	3.30
F	0.025	0.035	0.64	0.88
H	0.035	0.045	0.88	1.14
J	0.004	0.006	0.11	0.15
K	0.970	1.030	24.64	26.16

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 305C-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMERNSION: INCH.

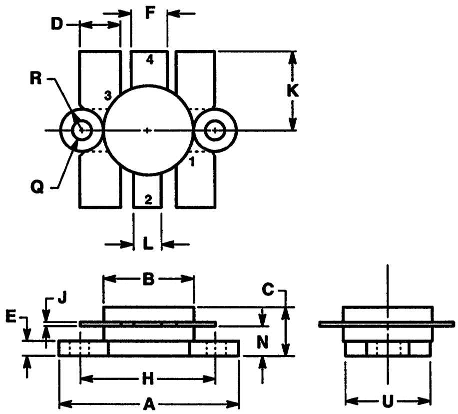
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.200	0.220	5.08	5.59
C	0.095	0.130	2.41	3.30
D	0.055	0.065	1.40	1.65
E	0.040	0.050	1.02	1.27
F	0.025	0.035	0.64	0.89
J	0.003	0.007	0.08	0.18
K	0.235	0.265	5.97	6.73
M	45° NOM		45° NOM	

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 305D-01

4

CASE DIMENSIONS (continued)



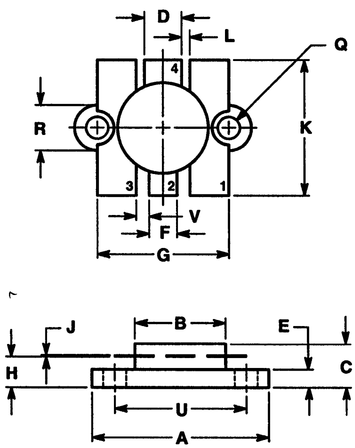
NOTES:
1. FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

STYLE 3:
PIN 1. SOURCE
2. DRAIN
3. SOURCE
4. GATE

CASE 316-01



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

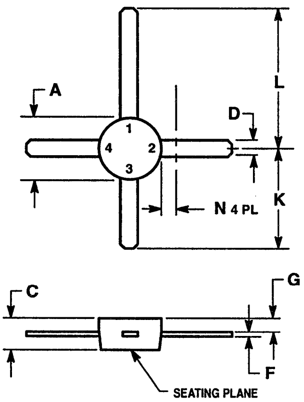
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.970	0.980	24.64	24.89
B	0.495	0.505	12.58	12.82
C	—	0.300	—	7.62
D	0.200	0.210	5.08	5.33
E	0.095	0.105	2.42	2.66
F	0.150	0.160	3.81	4.06
G	0.720	0.730	18.29	18.54
H	0.160	0.180	4.07	4.57
J	0.004	0.006	0.11	0.15
K	0.750	—	19.05	—
L	0.040	0.080	1.02	1.27
Q	0.115	0.130	2.93	3.30
R	0.245	0.255	6.23	6.47
U	0.720	0.730	18.29	18.54
V	0.065	0.075	1.66	1.90

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

CASE 316A-01

4

CASE DIMENSIONS (continued)



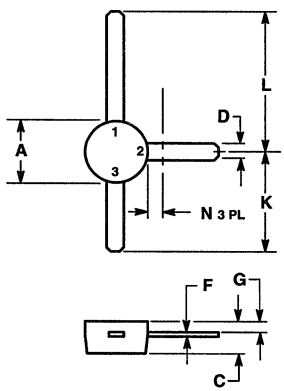
NOTES:
1. DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

STYLE 3:
PIN 1. OUTPUT
2. GROUND
3. INPUT
4. GROUND

CASE 317-01

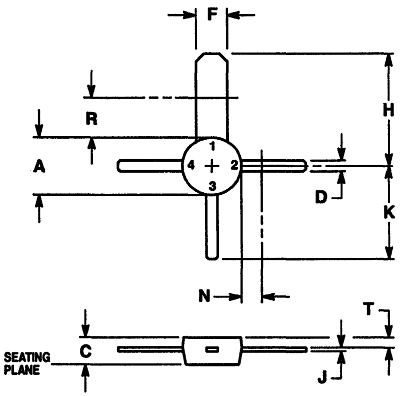


NOTES:
1. DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 317A-01



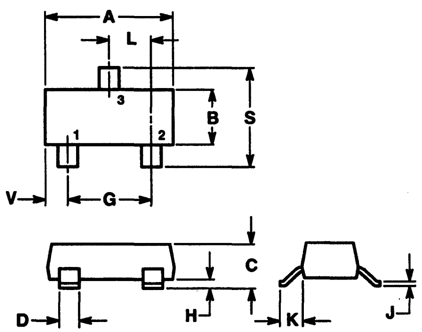
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. LEAD DIMENSIONS UNCONTROLLED WITHIN DIMENSION N AND R.

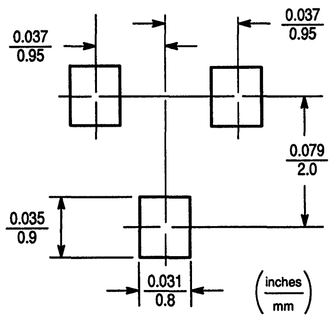
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
C	0.075	0.100	1.91	2.54
D	0.033	0.039	0.84	0.99
F	0.097	0.104	2.46	2.64
H	0.348	0.383	8.84	9.72
J	0.008	0.012	0.21	0.30
K	0.285	0.320	7.24	8.12
N	—	0.065	—	1.65
R	—	0.128	—	3.25
T	0.025	0.040	0.64	1.01

STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

CASE 317D-02

4





SOT-23 FOOTPRINT

STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

STYLE 8:
PIN 1. ANODE
2. NO CONNECTION
3. CATHODE

STYLE 9:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 11:
PIN 1. ANODE
2. CATHODE
3. CATHODE-ANODE

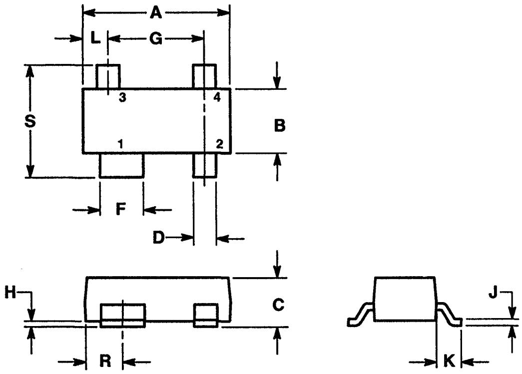
STYLE 19:
PIN 1. CATHODE
2. ANODE
3. CATHODE-ANODE

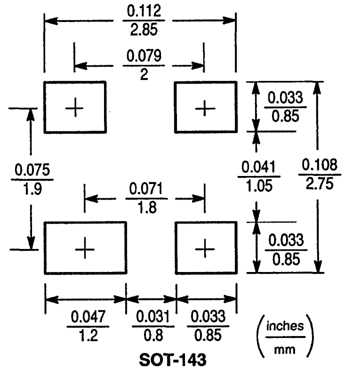
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0350	0.0440	0.89	1.11
D	0.0150	0.0200	0.37	0.50
G	0.0701	0.0807	1.78	2.04
H	0.0005	0.0040	0.013	0.100
J	0.0034	0.0070	0.085	0.177
K	0.0180	0.0236	0.45	0.60
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.0984	2.10	2.50
V	0.0177	0.0236	0.45	0.60

CASE 318-07

CASE DIMENSIONS (continued)





SOT-143 FOOTPRINT

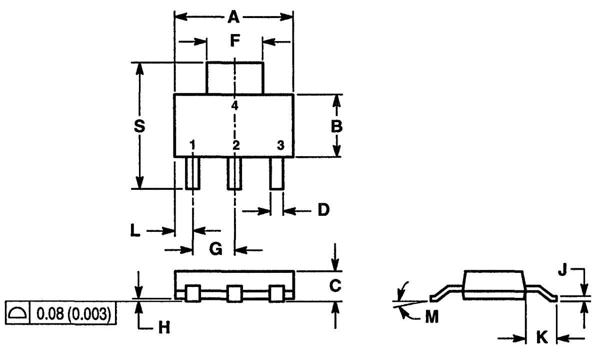
STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. EMITTER
4. BASE

STYLE 4:
PIN 1. OUTPUT
2. GROUND
3. GROUND
4. INPUT

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.04	0.110	0.120
B	1.20	1.39	0.047	0.055
C	0.84	1.14	0.033	0.045
D	0.39	0.50	0.015	0.020
F	0.79	0.93	0.031	0.037
G	1.78	2.03	0.070	0.080
H	0.013	0.10	0.0005	0.004
J	0.08	0.15	0.003	0.006
K	0.46	0.60	0.018	0.024
L	0.445	0.60	0.0175	0.024
R	0.72	0.83	0.028	0.033
S	2.11	2.48	0.083	0.098

CASE 318A-05



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

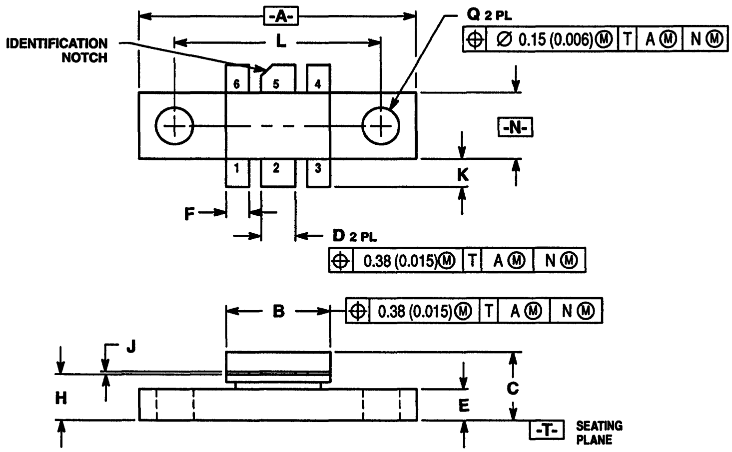
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.249	0.263	6.30	6.70
B	0.130	0.145	3.30	3.70
C	0.060	0.068	1.50	1.75
D	0.024	0.035	0.60	0.89
F	0.115	0.126	2.90	3.20
G	0.087	0.094	2.20	2.40
H	0.0008	0.0040	0.020	0.100
J	0.009	0.014	0.24	0.35
K	0.060	0.078	1.50	2.00
L	0.033	0.041	0.85	1.05
M	0°	10°	0°	10°
S	0.264	0.287	6.70	7.30

STYLE 2:
PIN 1. ANODE
2. CATHODE
3. NC
4. CATHODE

CASE 318E-04

4

CASE DIMENSIONS (continued)



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

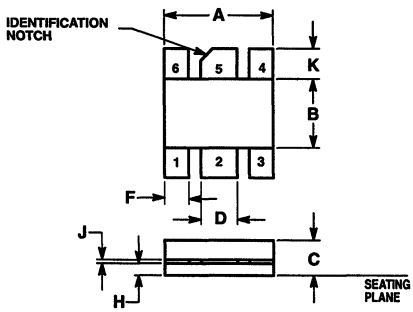
DIM	INCHES MIN	INCHES MAX	MILLIMETER MIN	MILLIMETER MAX
A	0.965	0.985	24.52	25.01
B	0.355	0.375	9.02	9.52
C	0.230	0.260	5.85	6.60
D	0.115	0.125	2.93	3.17
E	0.102	0.114	2.59	2.90
F	0.075	0.085	1.91	2.15
H	0.160	0.170	4.07	4.31
J	0.004	0.006	0.11	0.15
K	0.090	0.110	2.29	2.79
L	0.725 BSC		18.42 BSC	
N	0.225	0.241	5.72	6.12
Q	0.125	0.135	3.18	3.42

STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

STYLE 2:
PIN 1. EMITTER (COMMON)
2. BASE (INPUT)
3. EMITTER (COMMON)
4. EMITTER (COMMON)
5. COLLECTOR (OUTPUT)
6. EMITTER (COMMON)

STYLE 3:
PIN 1. SOURCE (COMMON)
2. GATE (INPUT)
3. SOURCE (COMMON)
4. SOURCE (COMMON)
5. DRAIN (OUTPUT)
6. SOURCE (COMMON)

CASE 319-07



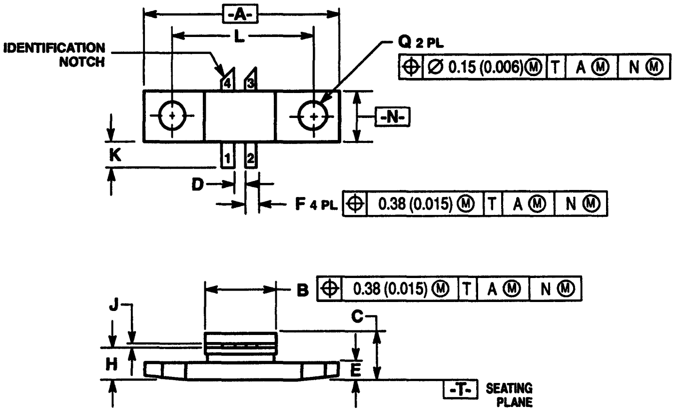
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.355	0.365	9.02	9.27
B	0.225	0.235	5.72	5.96
C	0.110	0.125	2.80	3.17
D	0.115	0.125	2.93	3.17
F	0.075	0.085	1.91	2.15
H	0.035	0.045	0.89	1.14
J	0.004	0.006	0.11	0.15
K	0.090	0.110	2.29	2.79

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. EMITTER
5. COLLECTOR
6. EMITTER

CASE 319A-02

CASE DIMENSIONS (continued)

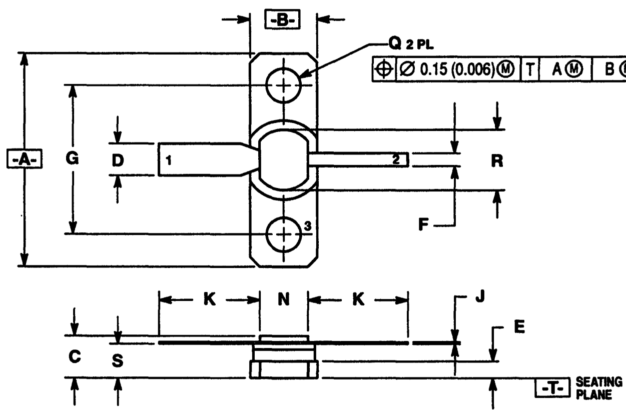


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	0.985	24.51	25.02
B	0.355	0.375	9.02	9.52
C	0.230	0.260	5.84	6.60
D	0.055	0.065	1.40	1.65
E	0.102	0.114	2.59	2.90
F	0.055	0.065	1.40	1.65
H	0.160	0.170	4.06	4.31
J	0.004	0.006	0.10	0.15
K	0.120	0.140	3.05	3.55
L	0.725 BSC		18.42 BSC	
N	0.225	0.241	5.72	6.12
Q	0.125	0.135	3.18	3.42

STYLE 1:
PIN 1. GATE (INPUT)
2. GATE (INPUT)
3. DRAIN (OUTPUT)
4. DRAIN (OUTPUT)
SOURCE IS FLANGE

CASE 319B-02

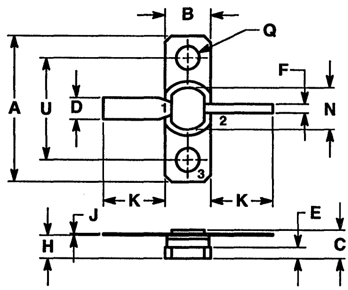


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M. 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.795	0.805	20.20	20.45
B	0.245	0.255	6.23	6.47
C	0.145	0.170	3.69	4.31
D	0.115	0.125	2.93	3.17
E	0.055	0.065	1.40	1.65
F	0.045	0.055	1.15	1.39
G	0.562 BSC		14.27 BSC	
J	0.003	0.006	0.08	0.15
K	0.260	0.375	6.60	9.52
N	0.175	0.185	4.45	4.69
Q	0.120	0.135	3.05	3.42
R	0.225	0.235	5.72	5.97
S	0.120	0.130	3.05	3.30

CASE 328A-03

4



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

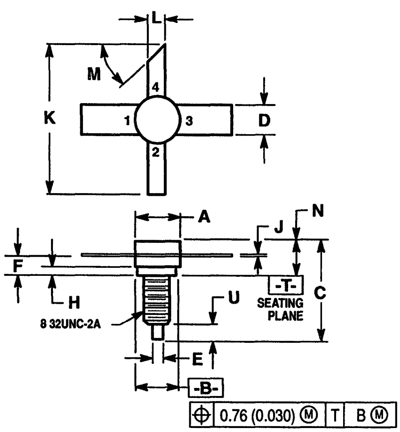
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.790	0.810	20.07	20.57
B	0.240	0.260	6.10	6.60
C	0.144	0.170	3.66	4.31
D	0.115	0.125	2.93	3.17
E	0.055	0.065	1.40	1.65
F	0.045	0.055	1.15	1.39
H	0.115	0.135	2.93	3.42
J	0.003	0.006	0.08	0.15
K	0.225	0.275	5.72	6.98
N	0.220	0.240	5.59	6.09
Q	0.125	0.135	3.18	3.42
U	0.552	0.572	14.03	14.52

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

STYLE 2:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 3:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

CASE 328F-01



NOTES:
1. DIMENSION K APPLIES TWO PLACES.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1973.

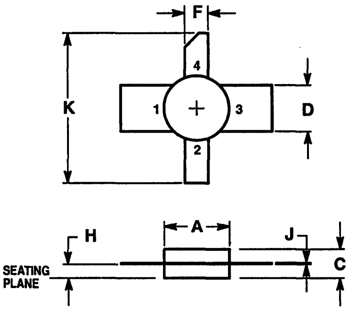
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 332-04

CASE DIMENSIONS (continued)



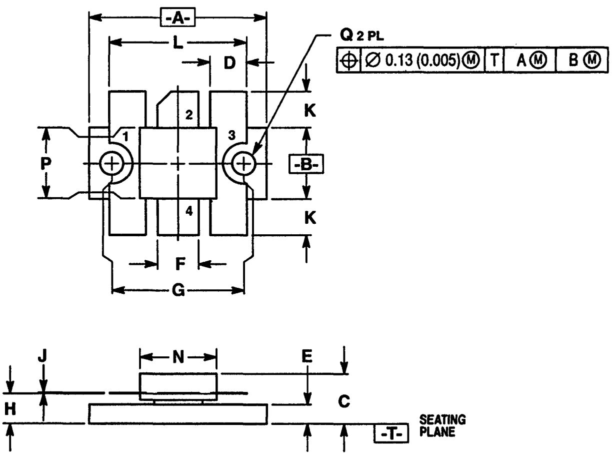
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.270	0.290	6.86	7.36
C	0.115	0.135	2.93	3.42
D	0.195	0.205	4.96	5.20
F	0.095	0.105	2.42	2.66
H	0.050	0.070	1.27	1.77
J	0.003	0.007	0.08	0.17
K	0.600	—	15.24	—

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 332A-03



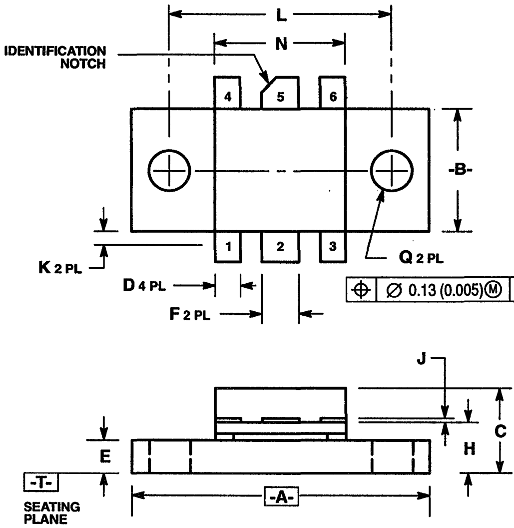
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	0.985	24.51	25.02
B	0.390	0.410	9.91	10.41
C	0.250	0.290	6.73	7.36
D	0.190	0.210	4.83	5.33
E	0.095	0.115	2.42	2.92
F	0.215	0.235	5.47	5.96
G	0.725 BSC		18.42 BSC	
H	0.155	0.175	3.94	4.44
J	0.004	0.006	0.10	0.15
K	0.195	0.205	4.95	5.21
L	0.740	0.770	18.80	19.55
N	0.415	0.425	10.54	10.80
P	0.390	0.400	9.91	10.16
Q	0.120	0.135	3.05	3.42

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

CASE 333-04

CASE DIMENSIONS (continued)



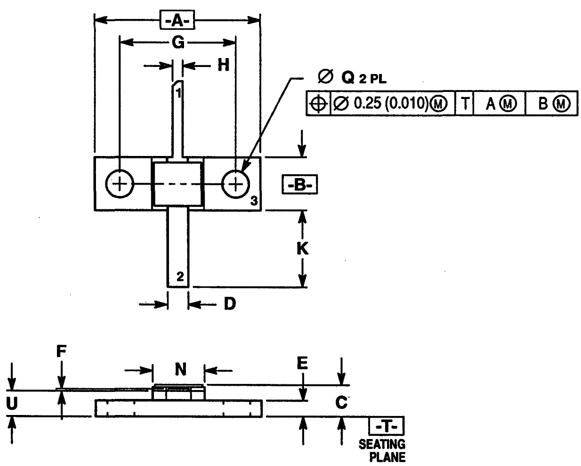
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	0.985	24.52	25.01
B	0.390	0.410	9.91	10.41
C	0.250	0.290	6.35	7.36
D	0.075	0.090	1.91	2.28
E	0.095	0.115	2.42	2.92
F	0.110	0.130	2.80	3.30
H	0.155	0.175	3.94	4.44
J	0.004	0.006	0.11	0.15
K	0.090	0.116	2.29	2.94
L	0.725 BSC		18.41 BSC	
N	0.415	0.435	10.55	11.04
Q	0.120	0.135	3.05	3.42

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. BASE
5. COLLECTOR
6. BASE

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. EMITTER
5. COLLECTOR
6. EMITTER

CASE 333A-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

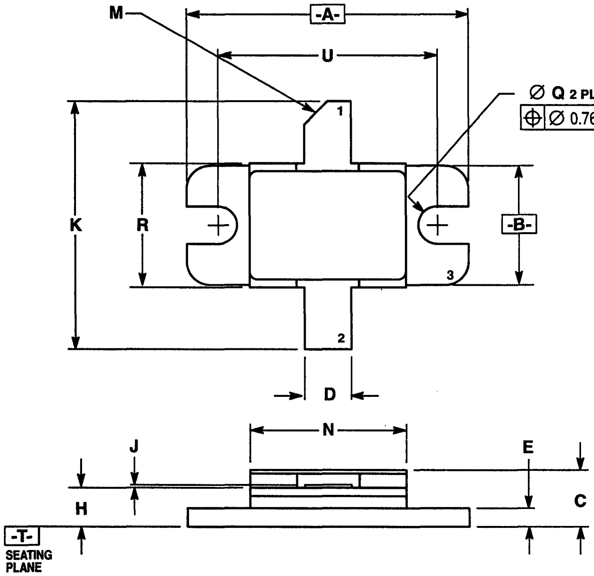
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	20.07	20.57	0.790	0.810
B	6.43	6.78	0.253	0.267
C	3.66	4.06	0.144	0.160
D	2.37	2.71	0.093	0.107
E	1.88	2.03	0.074	0.080
F	0.06	0.15	0.002	0.006
G	14.22 BSC		0.560 BSC	
H	1.10	1.44	0.043	0.057
K	8.79	10.10	0.346	0.394
N	6.18	6.52	0.243	0.257
Q	3.18	3.42	0.125	0.135
U	2.98	3.25	0.117	0.128

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 336E-02

4

CASE DIMENSIONS (continued)

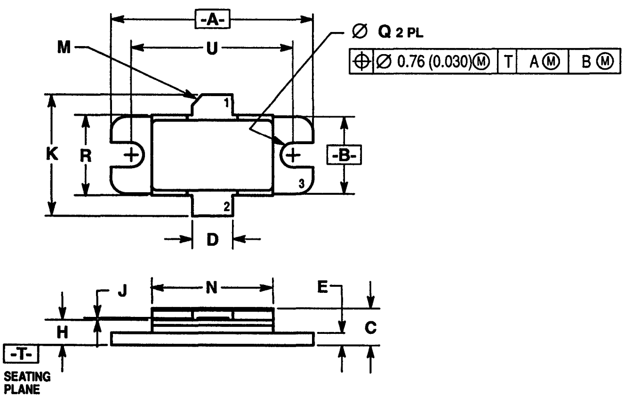


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.890	0.910	22.61	23.11
B	0.375	0.395	9.53	10.03
C	0.150	0.165	3.81	4.19
D	0.145	0.155	3.69	3.93
E	0.055	0.065	1.40	1.65
H	0.120	0.130	3.05	3.30
J	0.003	0.006	0.08	0.15
K	0.770	0.830	19.56	21.08
M	45° REF		45° REF	
N	0.490	0.510	12.45	12.95
Q	0.115	0.125	2.93	3.17
R	0.395	0.405	10.04	10.28
U	0.700 BSC		17.78 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 355C-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

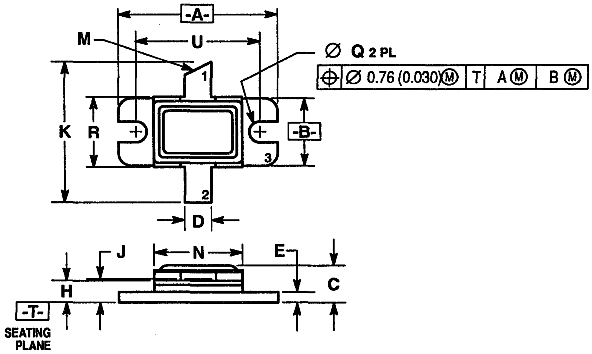
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.990	1.010	25.15	25.65
B	0.375	0.395	9.53	10.03
C	0.150	0.165	3.81	4.19
D	0.195	0.205	4.95	5.21
E	0.055	0.065	1.40	1.65
H	0.120	0.130	3.05	3.30
J	0.003	0.006	0.08	0.15
K	0.570	0.630	14.48	16.00
M	45° REF		45° REF	
N	0.590	0.610	14.99	15.49
Q	0.115	0.125	2.92	3.18
R	0.395	0.405	10.03	10.29
U	0.800 BSC		20.32 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 355D-02

4

CASE DIMENSIONS (continued)



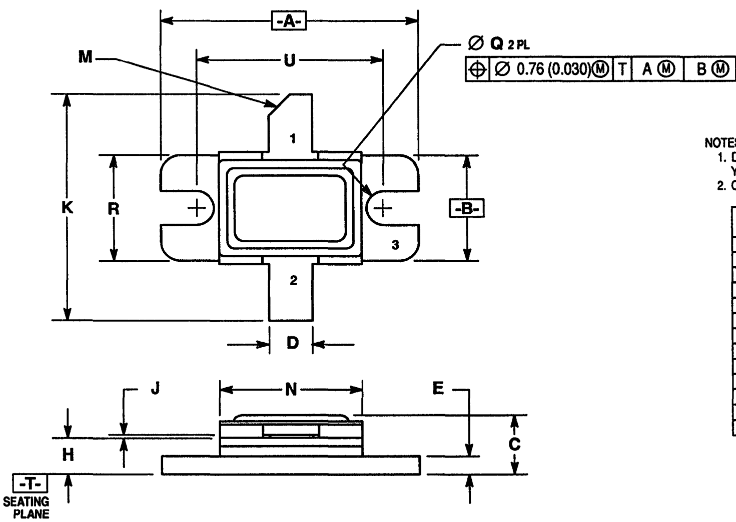
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.890	0.910	22.61	23.11
B	0.375	0.395	9.53	10.03
C	0.190	0.210	4.83	5.33
D	0.145	0.155	3.69	3.93
E	0.055	0.065	1.40	1.65
H	0.120	0.130	3.05	3.30
J	0.003	0.006	0.08	0.15
K	0.770	0.830	19.56	21.08
M	45° REF		45° REF	
N	0.490	0.510	12.45	12.95
Q	0.115	0.125	2.93	3.17
R	0.395	0.405	10.04	10.28
U	0.700 BSC		17.78 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 355E-01

4



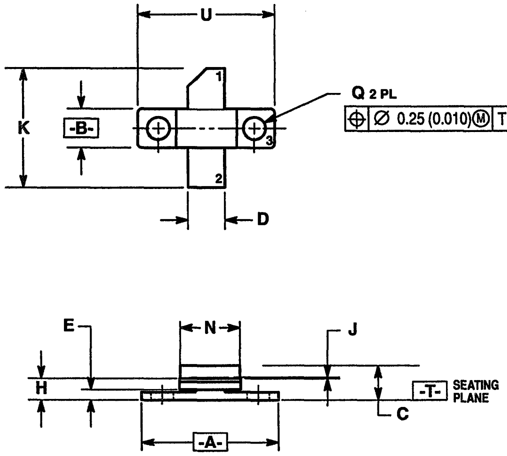
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.890	0.910	22.61	23.11
B	0.375	0.395	9.53	10.03
C	0.190	0.210	4.83	5.33
D	0.145	0.155	3.69	3.93
E	0.055	0.065	1.40	1.65
H	0.120	0.130	3.05	3.30
J	0.003	0.006	0.08	0.15
K	0.770	0.830	19.56	21.08
M	45° REF		45° REF	
N	0.490	0.510	12.45	12.95
Q	0.115	0.125	2.93	3.17
R	0.395	0.405	10.04	10.28
U	0.650 BSC		16.51 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 355G-01

CASE DIMENSIONS (continued)

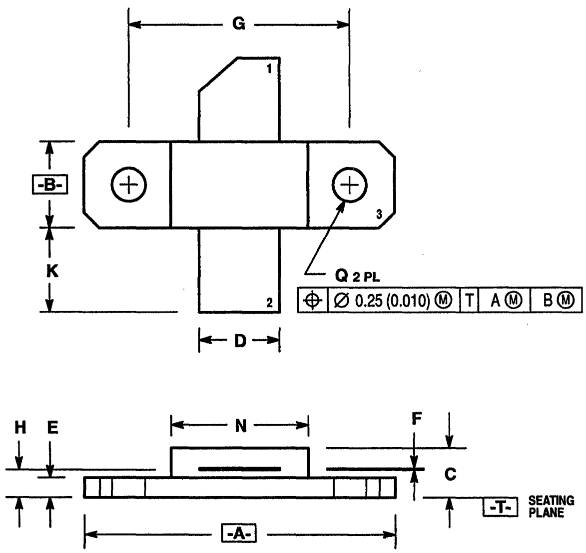


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.795	0.805	20.19	20.45
B	0.225	0.235	5.71	5.97
C	0.184	0.216	4.67	5.49
D	0.210	0.220	5.33	5.59
E	0.055	0.065	1.40	1.65
H	0.115	0.135	2.92	3.43
J	0.004	0.006	0.10	0.15
K	0.670	0.730	17.02	18.54
N	0.345	0.355	8.76	9.02
Q	0.125	0.135	3.18	3.43
U	0.560 BSC		14.22 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 360A-01



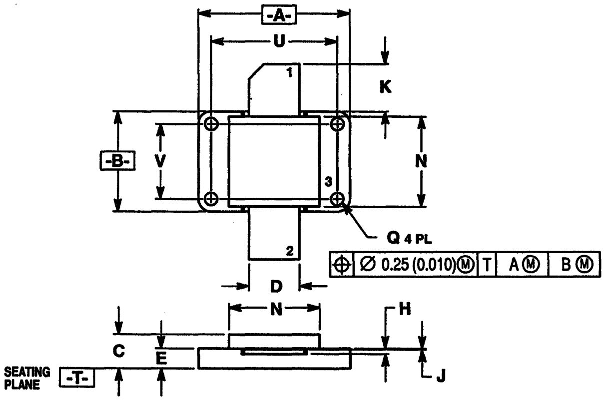
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.790	0.810	20.07	20.57
B	0.220	0.240	5.59	6.09
C	0.125	0.175	3.18	4.45
D	0.205	0.225	5.21	5.71
E	0.050	0.070	1.27	1.77
F	0.004	0.006	0.11	0.15
G	0.562 BSC		14.27 BSC	
H	0.070	0.090	1.78	2.29
K	0.215	0.255	5.47	6.47
N	0.350	0.370	8.89	9.39
Q	0.120	0.140	3.05	3.55

STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

CASE 360B-01

4



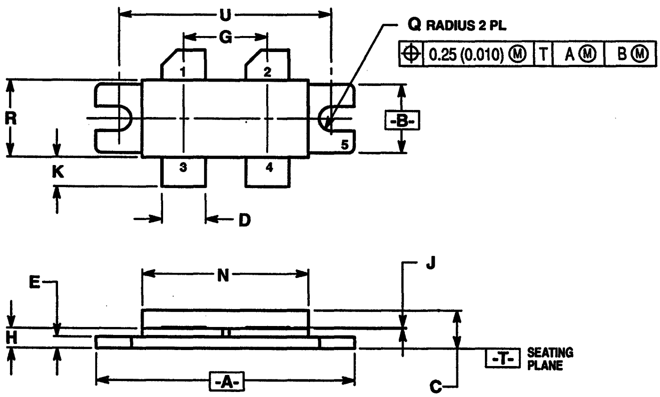
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.490	1.510	37.85	38.35
B	0.990	1.010	25.15	25.65
C	0.330	0.350	8.38	8.89
D	0.490	0.510	12.45	12.95
E	0.195	0.205	4.95	5.21
H	0.045	0.055	1.14	1.39
J	0.004	0.006	0.10	0.15
K	0.425	0.500	10.80	12.70
N	0.890	0.910	22.87	23.11
Q	0.120	0.130	3.05	3.30
U	1.250 BSC		31.75 BSC	
V	0.750 BSC		19.05 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

STYLE 2:
PIN 1. DRAIN
2. GATE
3. SOURCE

CASE 368-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

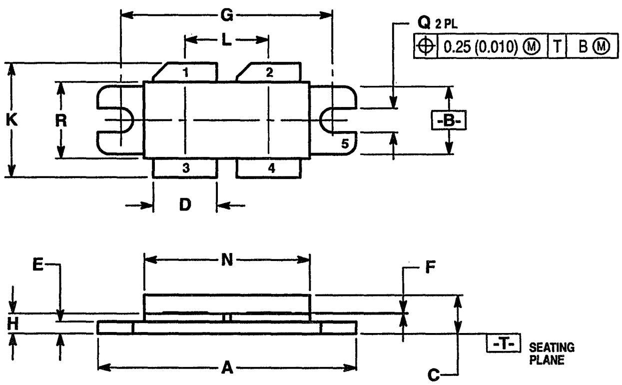
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.330	1.350	33.79	34.29
B	0.370	0.410	9.40	10.41
C	0.190	0.230	4.83	5.84
D	0.215	0.235	5.47	5.96
E	0.050	0.070	1.27	1.77
G	0.430	0.440	10.92	11.18
H	0.102	0.112	2.59	2.84
J	0.004	0.006	0.11	0.15
K	0.185	0.215	4.83	5.33
N	0.845	0.875	21.46	22.23
Q	0.053	0.074	1.35	1.87
R	0.390	0.410	9.91	10.41
U	1.100 BSC		27.94 BSC	

STYLE 2:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

CASE 375-03

4

CASE DIMENSIONS (continued)

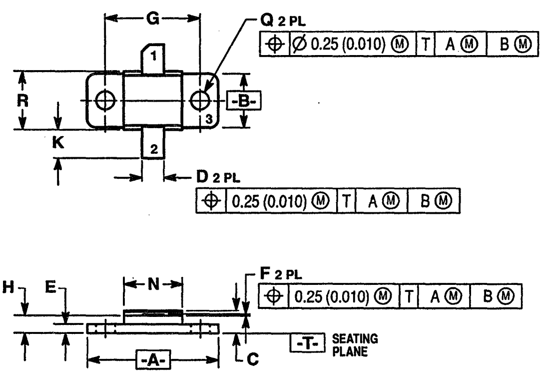


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.330	1.350	33.79	34.29
B	0.375	0.395	9.52	10.03
C	0.180	0.205	4.57	5.21
D	0.320	0.340	8.13	8.64
E	0.060	0.070	1.52	1.77
F	0.004	0.006	0.11	0.15
G	1.100 BSC		27.94 BSC	
H	0.082	0.097	2.08	2.46
K	0.580	0.620	14.73	15.75
L	0.435 BSC		11.05 BSC	
N	0.845	0.875	21.46	22.23
Q	0.118	0.130	3.00	3.30
R	0.390	0.410	9.91	10.41

STYLE 1:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER

CASE 375A-01



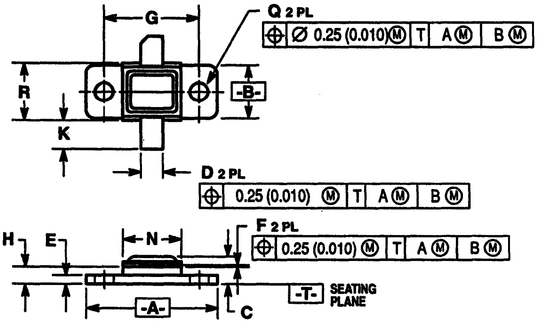
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.890	0.910	22.61	23.11
B	0.370	0.400	9.40	10.16
C	0.145	0.160	3.69	4.06
D	0.140	0.160	3.56	4.06
E	0.055	0.065	1.40	1.65
F	0.003	0.006	0.08	0.15
G	0.650 BSC		16.51 BSC	
H	0.110	0.130	2.80	3.30
K	0.180	0.220	4.57	5.59
N	0.390	0.410	9.91	10.41
Q	0.115	0.135	2.93	3.42
R	0.390	0.410	9.91	10.41

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 376B-02

CASE DIMENSIONS (continued)

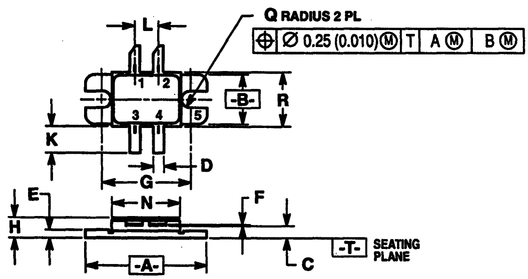


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.890	0.910	22.61	23.11
B	0.370	0.400	9.40	10.16
C	0.190	0.210	4.83	5.33
D	0.140	0.160	3.56	4.06
E	0.055	0.065	1.40	1.65
F	0.003	0.006	0.08	0.15
G	0.650 BSC		16.51 BSC	
H	0.110	0.130	2.80	3.30
K	0.180	0.220	4.57	5.59
N	0.390	0.410	9.91	10.41
Q	0.115	0.135	2.93	3.42
R	0.390	0.410	9.91	10.41

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 376C-01



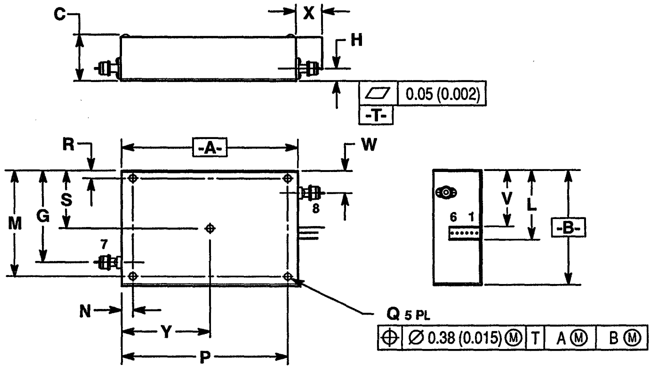
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.890	0.910	22.61	23.11
B	0.370	0.400	9.40	10.16
C	0.105	0.135	2.67	3.42
D	0.065	0.085	1.66	2.15
E	0.055	0.065	1.40	1.65
F	0.003	0.006	0.08	0.15
G	0.650 BSC		16.51 BSC	
H	0.150	0.175	3.81	4.44
K	0.190	0.210	4.83	5.33
L	0.155	0.190	3.94	4.82
N	0.490	0.510	12.45	12.95
Q	0.060	0.070	1.53	1.77
R	0.390	0.410	9.91	10.41

STYLE 1:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER

CASE 382-01

CASE DIMENSIONS (continued)

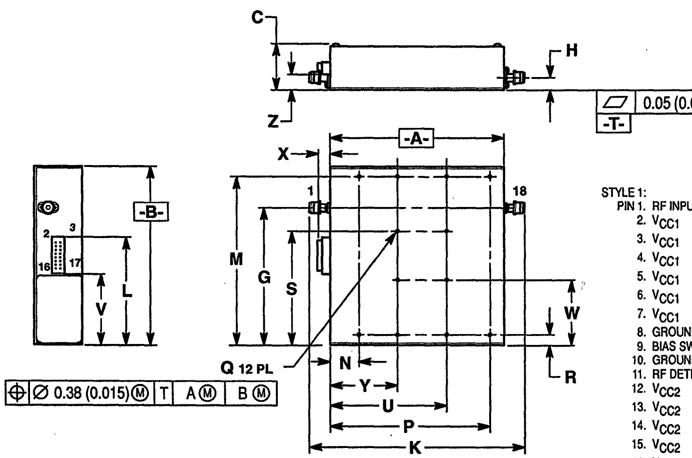


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	133.7	134.2	5.26	5.28
B	—	86.0	—	3.38
C	—	36.2	—	1.42
G	68.1	68.3	2.68	2.70
H	9.1	9.7	0.36	0.38
L	51.2	51.5	2.02	2.03
M	79.6 BSC		3.13 BSC	
N	8.5 BSC		0.33 BSC	
P	125.5 BSC		4.94 BSC	
Q	4.4	4.6	0.17	0.18
R	6.2 BSC		0.24 BSC	
S	35.2 BSC		1.38 BSC	
V	42.1	42.6	1.66	1.68
W	17.5	17.9	0.69	0.70
X	—	13.5	—	0.53
Y	67.0 BSC		2.64 BSC	

STYLE 1:
PIN 1. +V SUPPLY 26.5V
2. DO NOT USE
3. GROUND
4. TEST POINT (Ic1)
5. TEST POINT (Ic2)
6. OPTION
7. RF INPUT
8. RF OUTPUT

CASE 389B-02



STYLE 1:
PIN 1. RF INPUT
2. V_{CC1}
3. V_{CC1}
4. V_{CC1}
5. V_{CC1}
6. V_{CC1}
7. V_{CC1}
8. GROUND
9. BIAS SWITCH (OPTIONAL)
10. GROUND
11. RF DETECTOR (OPTIONAL)
12. V_{CC2}
13. V_{CC2}
14. V_{CC2}
15. V_{CC2}
16. V_{CC2}
17. V_{CC2}
18. RF OUTPUT

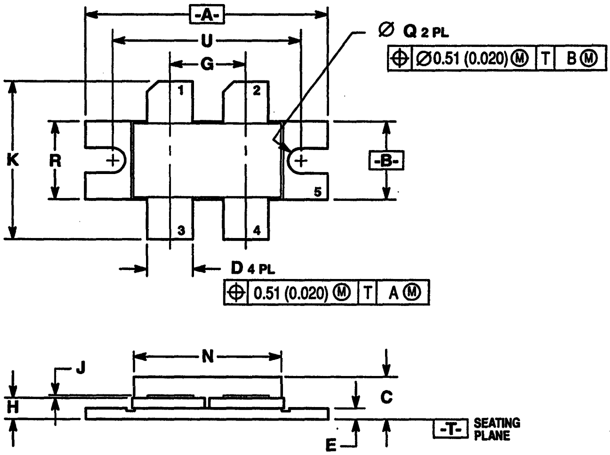
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	133.7	134.2	5.26	5.28
B	—	139.5	—	5.49
C	—	36.20	—	1.42
G	107.1	107.7	4.22	4.24
H	9.20	9.60	0.36	0.38
K	—	155.0	—	6.10
L	83.8	84.2	3.30	3.31
M	132.0 BSC		5.20 BSC	
N	13.40 BSC		0.53 BSC	
P	120.6 BSC		4.75 BSC	
Q	4.40	4.60	0.17	0.18
R	7.0 BSC		0.28 BSC	
S	89.1 BSC		3.51 BSC	
U	78.6 BSC		3.09 BSC	
V	54.6	55.4	2.15	2.18
W	49.9 BSC		1.96 BSC	
X	—	6.0	—	0.24
Y	52.2 BSC		2.06 BSC	
Z	8.0	9.5	0.31	0.37

CASE 389U-01

4

CASE DIMENSIONS (continued)

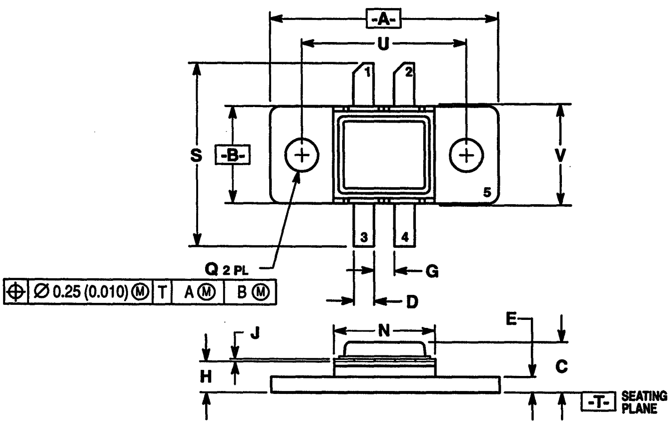


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.190	1.210	30.23	30.73
B	0.375	0.400	9.53	10.16
C	0.190	0.230	4.83	5.84
D	0.215	0.235	5.46	5.96
E	0.050	0.070	1.27	1.77
G	0.385 BSC		9.78 BSC	
H	0.090	0.115	2.29	2.92
J	0.002	0.005	0.06	0.12
K	0.535	0.565	13.59	14.35
N	0.750	0.780	19.05	19.81
Q	0.106	0.148	2.70	3.75
R	0.375	0.395	9.53	10.03
U	0.935 BSC		23.75 BSC	

STYLE 1:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

CASE 390B-01



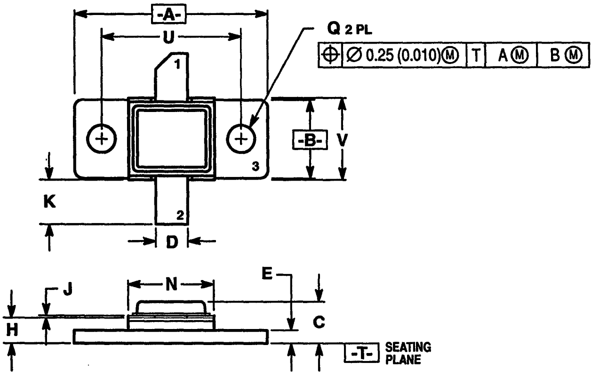
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.895	0.905	22.73	22.99
B	0.380	0.390	9.65	9.91
C	0.172	0.208	4.37	5.28
D	0.075	0.085	1.91	2.16
E	0.055	0.065	1.40	1.65
G	0.075	0.085	1.91	2.16
H	0.115	0.125	2.92	3.18
J	0.003	0.006	0.08	0.15
N	0.393	0.403	9.98	10.24
Q	0.123	0.133	3.13	3.38
S	0.705	0.745	17.91	18.92
U	0.650 BSC		16.51 BSC	
V	0.393	0.403	9.98	10.24

STYLE 1:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER

CASE 391-03

CASE DIMENSIONS (continued)

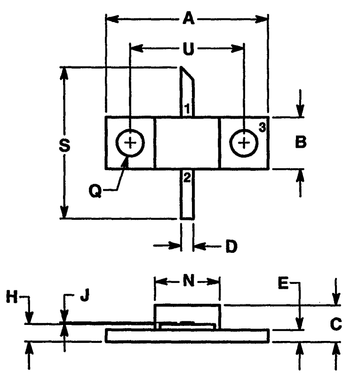


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	22.73	22.99	0.895	0.905
B	9.65	9.91	0.380	0.390
C	4.32	5.33	0.170	0.210
D	3.68	3.94	0.145	0.155
E	1.40	1.65	0.055	0.065
H	2.79	3.30	0.110	0.130
J	0.08	0.12	0.003	0.005
K	4.70	5.59	0.185	0.220
N	10.03	10.29	0.395	0.405
Q	3.12	3.38	0.123	0.133
U	16.51 BSC		0.650 BSC	
V	10.03	10.29	0.395	0.405

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 392-03

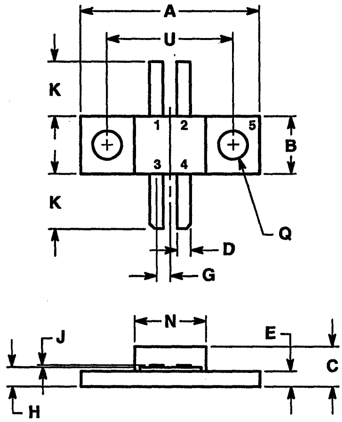


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.795	0.805	20.19	20.45
B	0.255	0.265	6.48	6.73
C	0.156	0.176	3.96	4.47
D	0.055	0.065	1.40	1.65
E	0.057	0.063	1.45	1.60
H	0.081	0.089	1.98	2.34
J	0.002	0.006	0.05	0.15
N	0.316	0.326	8.03	8.28
Q	0.125	0.135	3.18	3.43
S	0.620	0.680	15.75	17.27
U	0.552	0.572	14.02	14.53

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

CASE 394-03

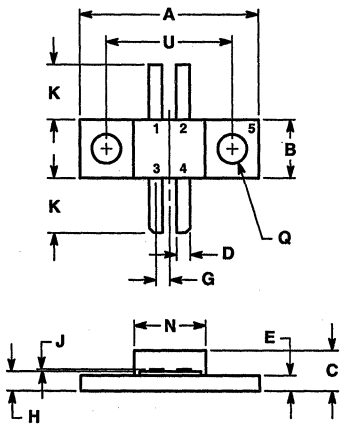


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.795	0.805	20.19	20.45
B	0.255	0.265	6.48	6.73
C	0.161	0.189	4.09	4.80
D	0.055	0.065	1.40	1.65
E	0.055	0.065	1.40	1.65
G	0.055	0.065	1.40	1.65
H	0.075	0.095	1.90	2.41
J	0.003	0.006	0.08	0.15
K	0.170	0.220	4.32	5.59
N	0.260	0.266	6.60	6.76
Q	0.125	0.135	3.18	3.42
U	0.552	0.572	14.03	14.52

STYLE 1:
PIN 1. BASE
2. BASE
3. COLLECTOR
4. COLLECTOR
5. EMITTER

CASE 395-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

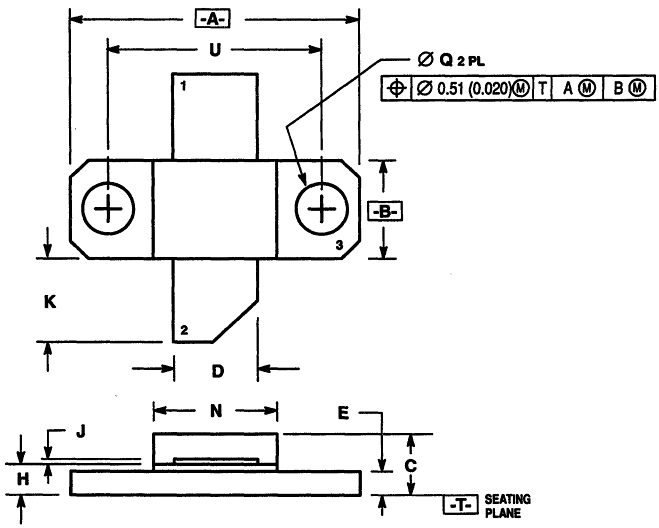
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.795	0.805	20.19	20.45
B	0.255	0.265	6.48	6.73
C	0.161	0.189	4.09	4.80
D	0.055	0.065	1.40	1.65
E	0.055	0.065	1.40	1.65
G	0.055	0.065	1.40	1.65
H	0.075	0.095	1.90	2.41
J	0.003	0.006	0.08	0.15
K	0.170	0.220	4.32	5.59
N	0.260	0.266	6.60	6.76
Q	0.125	0.135	3.18	3.42
U	0.552	0.572	14.03	14.52

STYLE 1:
PIN 1. BASE
2. BASE
3. COLLECTOR
4. COLLECTOR
5. EMITTER

CASE 395B-01

4

CASE DIMENSIONS (continued)

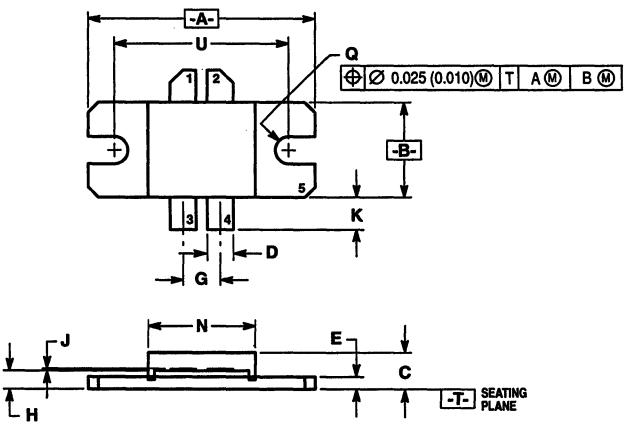


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.739	0.750	18.77	19.05
B	0.240	0.260	6.10	6.60
C	0.165	0.198	4.19	5.03
D	0.215	0.225	5.46	5.72
E	0.055	0.070	1.40	1.78
H	0.079	0.091	2.01	2.31
J	0.004	0.006	0.10	0.15
K	0.210	0.240	5.33	6.10
N	0.315	0.330	8.00	8.38
Q	0.125	0.135	3.18	3.42
U	0.560 BSC		14.23 BSC	

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

CASE 395C-01



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

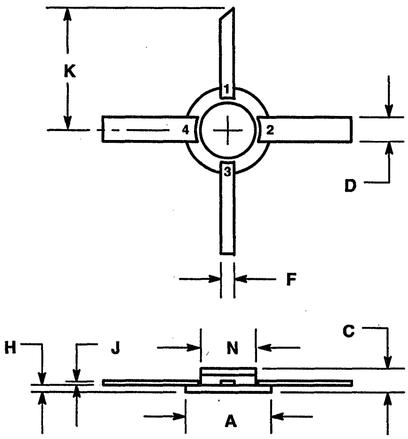
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.094	1.110	27.79	28.19
B	0.457	0.465	11.61	11.81
C	0.172	0.182	4.37	4.62
D	0.121	0.131	3.08	3.32
E	0.055	0.065	1.40	1.65
G	0.177	0.185	4.50	4.69
H	0.081	0.091	2.06	2.31
J	0.002	0.004	0.06	0.10
K	0.142	0.163	3.60	4.14
N	0.510	0.520	12.95	13.21
Q	0.125	0.135	3.18	3.42
U	0.844 BSC		21.44 BSC	

STYLE 1:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER

CASE 398-02

4

CASE DIMENSIONS (continued)

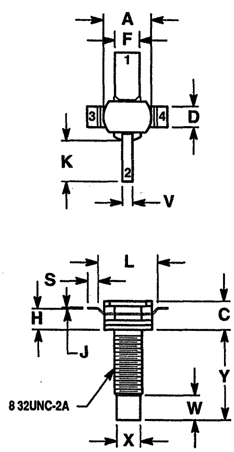


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.203	0.207	5.16	5.25
C	0.049	0.065	1.25	1.65
D	0.055	0.065	1.40	1.65
F	0.025	0.035	0.64	0.88
H	0.017	0.023	0.44	0.58
J	0.002	0.004	0.06	0.10
K	0.280	0.320	7.12	8.12
N	0.123	0.133	3.13	3.37

STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

CASE 400-01



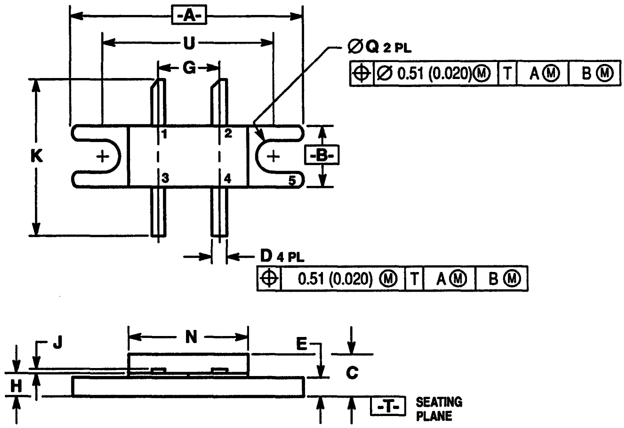
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.225	0.240	5.72	6.09
C	—	0.175	—	4.44
D	0.095	0.105	2.42	2.66
F	0.115	0.125	2.93	3.17
H	0.115	0.135	2.93	3.42
J	0.003	0.007	0.08	0.17
K	0.200	—	5.08	—
L	0.280	0.300	7.12	7.62
S	0.050	—	1.27	—
V	0.045	0.055	1.15	1.39
W	0.115	0.145	2.92	3.68
X	0.110	0.120	2.80	3.04
Y	0.420	0.460	10.67	11.68

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. EMITTER

CASE 401-02

CASE DIMENSIONS (continued)

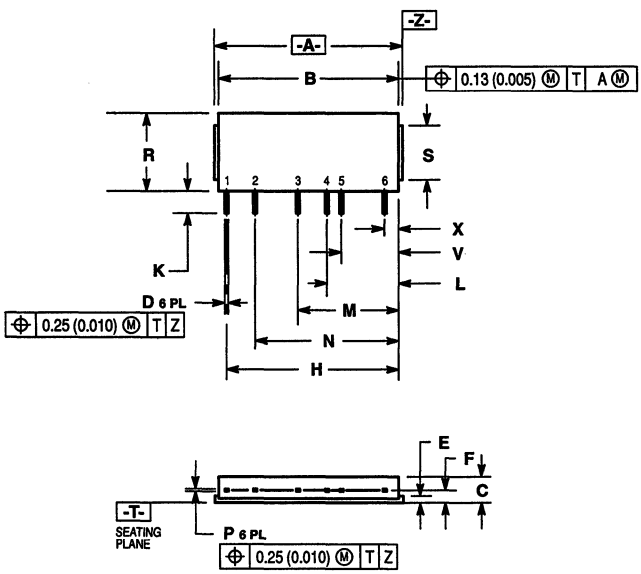


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.965	0.985	24.52	25.01
B	0.245	0.265	6.23	6.73
C	0.165	0.185	4.20	4.69
D	0.050	0.070	1.27	1.77
E	0.070	0.080	1.78	2.03
G	0.254 BSC		6.45 BSC	
H	0.095	0.105	2.42	2.66
J	0.003	0.006	0.08	0.15
K	0.625	0.675	15.88	17.14
N	0.495	0.520	12.58	13.20
Q	0.120	0.140	3.05	3.55
U	0.725 BSC		18.42 BSC	

STYLE 1:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

CASE 412-01



NOTES:
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
4. CONTROLLING DIMENSION: INCH.
5. DIMENSION F TO CENTER OF LEADS.

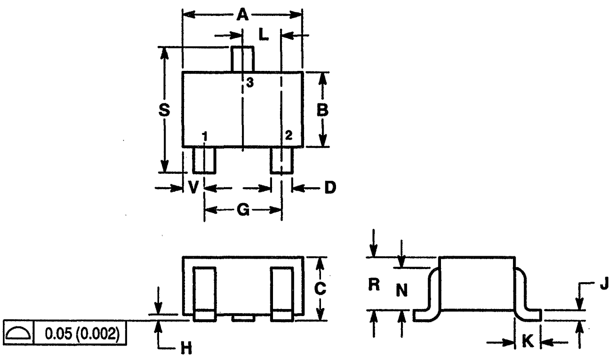
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.290	1.305	32.77	33.14
B	1.260	1.275	32.01	32.38
C	0.175	0.180	4.45	4.57
D	0.018	0.022	0.46	0.55
E	0.040	0.045	1.02	1.14
F	0.077	0.095	1.96	2.41
H	1.205 BSC		30.61 BSC	
K	0.100	—	2.54	—
L	0.505 BSC		12.83 BSC	
M	0.705 BSC		17.91 BSC	
N	1.005 BSC		25.53 BSC	
P	0.008	0.012	0.21	0.30
R	0.545	0.560	13.85	14.22
S	0.375	0.390	9.53	9.90
V	0.405 BSC		10.29 BSC	
X	0.105 BSC		2.67 BSC	

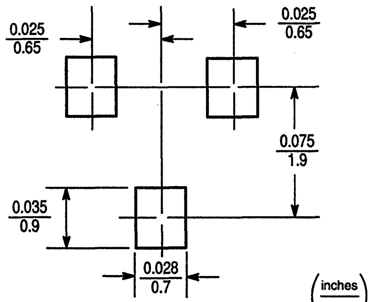
STYLE 1:
PIN 1. RF INPUT/V CONT
2. DC TERMINAL, VS1
3. DC TERMINAL, VB
4. DC TERMINAL, VS2
5. DC TERMINAL, VS3
6. RF OUTPUT
CASE: GROUND

CASE 413A-01

4

CASE DIMENSIONS (continued)





SC-70/SOT-323
FOOTPRINT

STYLE 3:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

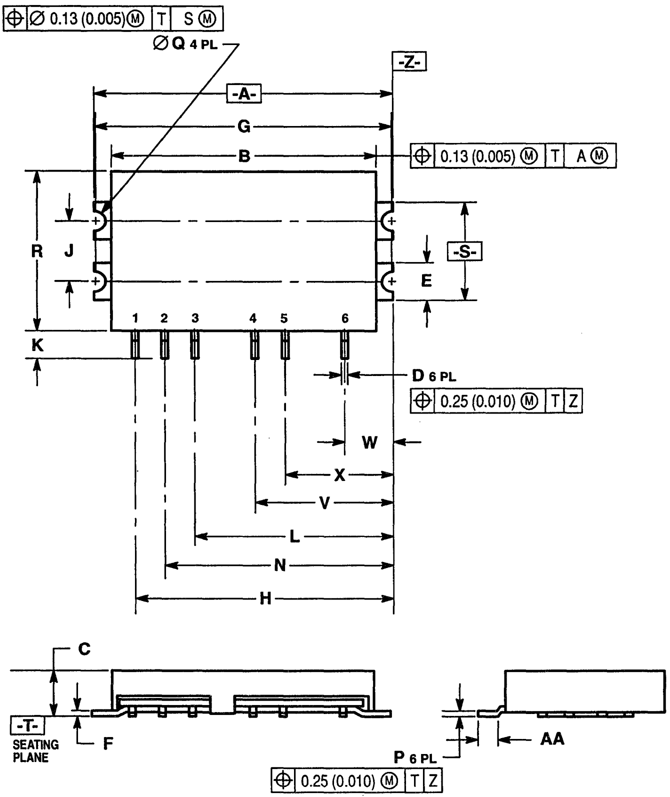
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.035	0.049	0.90	1.25
D	0.012	0.016	0.30	0.40
G	0.047	0.055	1.20	1.40
H	0.000	0.004	0.00	0.10
J	0.004	0.010	0.10	0.25
K	0.017 REF		0.425 REF	
L	0.026 BSC		0.65 BSC	
N	0.028 REF		0.70 REF	
R	0.031	0.039	0.80	1.00
S	0.079	0.087	2.00	2.20
V	0.012	0.016	0.30	0.40

CASE 419-02

4

CASE DIMENSIONS (continued)



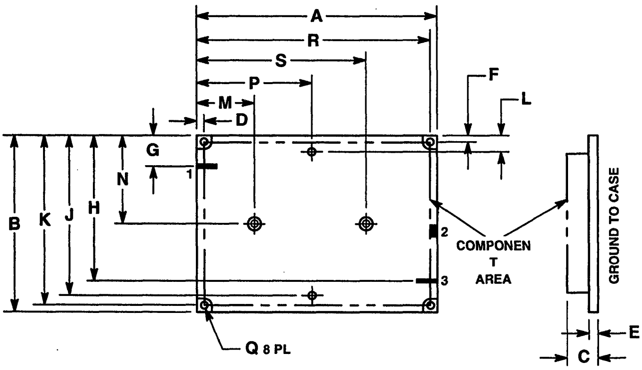
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.74	25.00	0.974	0.984
B	21.80	22.20	0.858	0.874
C	3.64	4.00	0.143	0.157
D	0.46	0.55	0.018	0.022
E	2.80	3.20	0.110	0.126
F	0.17	0.43	0.007	0.017
G	24.50 BSC		0.965 BSC	
H	21.50 BSC		0.846 BSC	
J	5.00 BSC		0.197 BSC	
K	2.20	2.48	0.087	0.097
L	16.50 BSC		0.650 BSC	
N	19.00 BSC		0.748 BSC	
P	0.21	0.30	0.008	0.12
Q	1.37	1.63	0.054	0.064
R	13.17	13.43	0.519	0.529
S	7.80	8.20	0.307	0.323
V	11.50 BSC		0.453 BSC	
W	4.00 BSC		0.157 BSC	
X	9.00 BSC		0.354 BSC	
AA	1.37	1.63	0.054	0.064

STYLE 1:
PIN 1. P IN
2. VGG1
3. VDD1
4. VGG2
5. VDD2
6. P OUT

CASE 420A-01

CASE DIMENSIONS (continued)

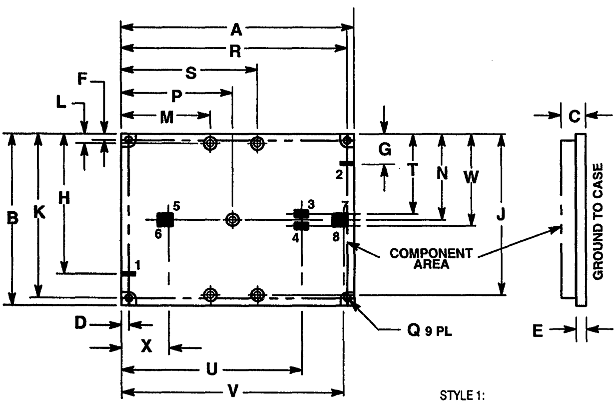


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	114.88	115.12	4.523	4.532
B	84.88	85.12	3.342	3.351
C	—	15.00	—	0.591
D	3.40	3.60	0.134	0.142
E	4.50	4.90	0.177	0.193
F	3.40	3.60	0.134	0.142
G	14.60	15.40	0.575	0.606
H	69.60	70.40	2.740	2.772
J	76.90	77.10	3.205	3.035
K	81.40	81.60	3.205	3.213
L	7.90	8.10	0.311	0.319
M	27.40	27.60	1.079	1.087
N	42.40	42.60	1.669	1.677
P	54.90	55.10	2.161	2.169
Q	3.10	3.40	0.122	0.134
R	111.40	111.60	4.386	4.394
S	80.90	81.10	3.185	3.193

STYLE 1:
PIN 1. RF INPUT
2. DC VOLTAGE
3. RF OUTPUT
GROUND TO PLANE

CASE 429-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

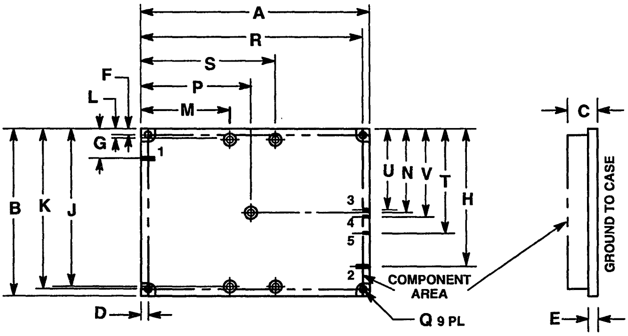
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	4.523	4.532	114.88	115.12
B	3.342	3.351	84.88	85.12
C	—	0.472	—	12.0
D	0.134	0.142	3.4	3.6
E	0.177	0.193	4.5	4.9
F	0.134	0.142	3.4	3.6
G	0.575	0.606	14.6	15.4
H	2.740	2.772	69.6	70.4
J	3.146	3.154	79.9	80.1
K	3.205	3.213	81.4	81.6
L	0.193	0.201	4.9	5.1
M	1.728	1.736	43.9	44.1
N	1.669	1.677	42.4	42.6
P	2.154	2.161	54.7	54.9
Q	0.122	0.134	3.1	3.4
R	4.386	4.394	111.4	111.6
S	2.634	2.642	66.9	67.1
T	1.539	1.571	39.1	39.9
U	3.492	3.524	88.7	89.5
V	4.311	4.343	109.5	110.3
W	1.776	1.807	45.1	45.9
X	0.906	0.937	23.0	23.8

STYLE 1:
PIN 1. RF INPUT
2. RF OUTPUT
3. $+V_{CC}1$ – (GROUND TO CASE)
4. $+V_{CC}2$ – (GROUND TO CASE)
5. BIAS REMOTE
6. GROUND (BIAS REMOTE ONLY)
7. RF DETECTION
8. GROUND (RF DETECTION ONLY)

CASE 429A-01

4

CASE DIMENSIONS (continued)

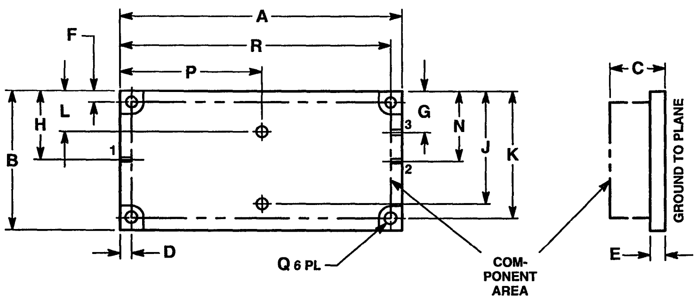


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	4.523	4.532	114.88	115.12
B	3.342	3.351	84.88	85.12
C	—	0.669	—	17.0
D	0.134	0.142	3.4	3.6
E	0.177	0.193	4.5	4.9
F	0.134	0.142	3.4	3.6
G	0.575	0.606	14.6	15.4
H	2.740	2.772	69.6	70.4
J	3.146	3.154	79.9	80.1
K	3.205	3.213	81.4	81.6
L	0.193	0.201	4.9	5.1
M	1.728	1.736	43.9	44.1
N	1.669	1.677	42.4	42.6
P	2.155	2.163	54.73	54.93
Q	0.122	0.134	3.1	3.4
R	4.386	4.394	111.4	111.6
S	2.634	2.642	66.9	67.1
T	2.106	2.138	53.5	54.3
U	1.602	1.634	40.7	41.5
V	1.713	1.744	43.5	44.3

STYLE 1:
PIN 1. RF INPUT
2. RF OUTPUT
3. $+V_{CC}1$
4. $+V_{CC}2$
5. RF DETECTION GROUND TO CASE

CASE 429C-01



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

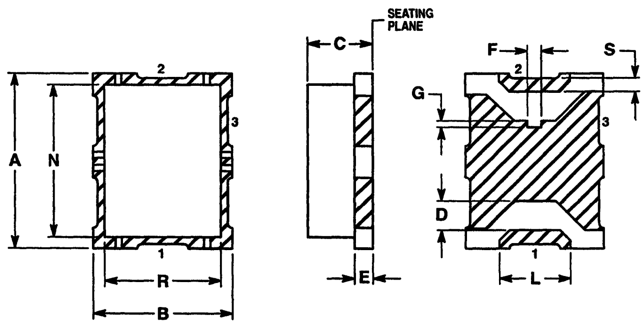
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	3.342	3.351	84.88	85.12
B	1.669	1.678	42.38	42.62
C	—	0.669	—	17.00
D	0.124	0.132	3.15	3.35
E	0.177	0.193	4.50	4.90
F	0.124	0.132	3.15	3.35
G	0.476	0.508	12.10	12.90
H	0.909	0.941	23.10	23.90
J	1.354	1.362	34.40	34.60
K	1.541	1.549	39.15	39.35
L	0.488	0.496	12.40	12.60
N	0.909	0.941	23.10	23.90
P	1.569	1.577	39.85	40.05
Q	0.122	0.134	3.10	3.40
R	3.215	3.222	81.65	81.85

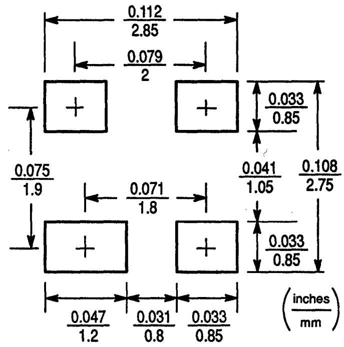
STYLE 1:
PIN 1. RF INPUT
2. RF OUTPUT
3. $+V_{CC}$
GROUND TO CASE

CASE 429E-01

4

CASE DIMENSIONS (continued)





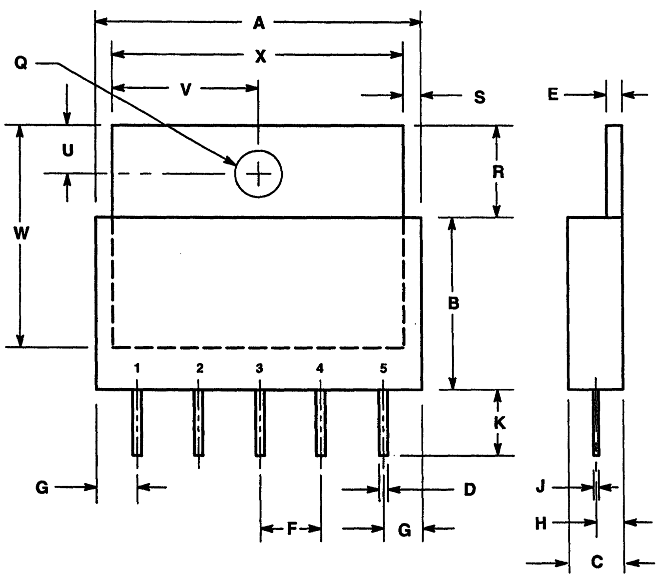
SOT-143 FOOTPRINT

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.260	0.270	6.60	6.86
B	0.200	0.210	5.08	5.33
C	0.090	0.104	2.29	2.64
D	0.040	0.050	1.02	1.27
E	0.022	0.028	0.56	0.71
F	0.015	0.025	0.38	0.64
G	0.005	0.015	0.13	0.38
L	0.100	0.110	2.54	2.79
N	0.226	0.236	5.74	5.99
R	0.166	0.176	4.22	4.47
S	0.025	0.035	0.64	0.89

CASE 430-01



NOTES:

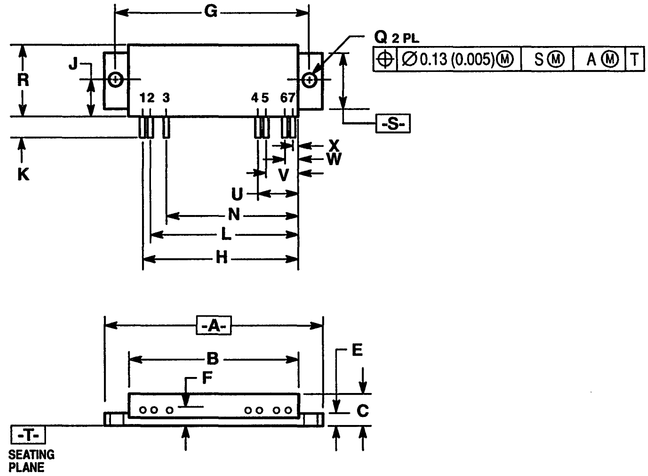
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
4. CONTROLLING DIMENSION: INCH

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.055	1.065	26.80	27.05
B	0.550	0.565	13.97	14.35
C	0.175	0.185	4.45	4.70
D	0.020	—	0.51	—
E	0.045	0.055	1.14	1.40
F	0.195	0.205	4.95	5.21
G	0.125	0.135	3.18	3.43
H	0.080	0.090	2.03	2.29
J	0.010	—	0.25	—
K	0.215	0.225	5.46	5.72
Q	0.145	0.155	3.68	3.94
R	0.300	0.320	7.62	8.13
S	0.045	0.055	1.14	1.40
U	0.155	0.165	3.94	4.19
V	0.470	0.480	11.94	12.19
W	0.730	0.740	18.54	18.80
X	0.945	0.955	24.00	24.26

STYLE 1:
PIN 6. V_{in}
7. GROUND
8. $+V_{CC}$
9. GROUND
10. Vout

CASE 431A-02

CASE DIMENSIONS (continued)



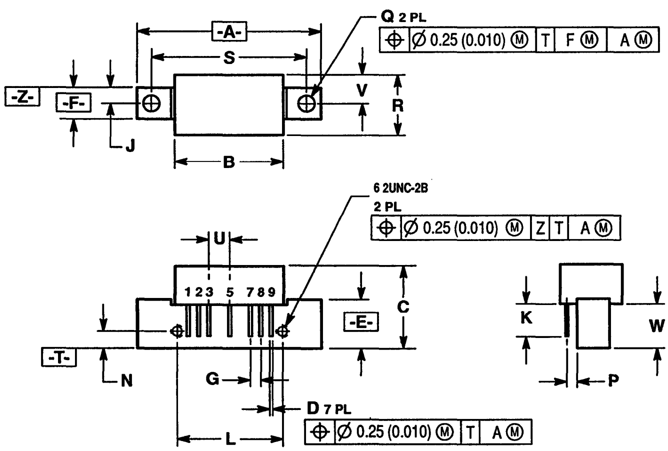
NOTES:
1. CONTROLLING DIMINSION: INCH.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	2.640	2.660	67.06	67.56
B	2.040	2.085	51.82	52.95
C	0.335	0.360	8.51	9.14
E	0.100	0.115	2.54	2.92
F	0.085	0.115	2.16	2.92
G	2.405 BSC		61.09 BSC	
H	1.885	1.915	47.88	48.64
J	0.400	0.440	10.16	11.18
K	0.230	0.300	5.85	7.62
L	1.785	1.815	45.34	46.10
N	1.585	1.615	40.26	41.02
Q	0.136	0.146	3.46	3.70
R	0.800	0.820	20.32	20.82
S	0.670	0.690	17.02	17.52
U	0.485	0.515	12.32	13.08
V	0.385	0.415	9.78	10.54
W	0.185	0.215	4.70	5.46
X	0.085	0.115	2.16	2.92

STYLE 1:
PIN 1. RF OUTPUT
2. GROUND
3. D.C. TERMINAL
4. GROUND
5. D.C. GAIN
6. GROUND
7. RF INPUT

STYLE 2:
PIN 1. RF OUTPUT
2. GROUND
3. Vs 2
4. GROUND
5. Vs 1
6. GROUND
7. RF INPUT

CASE 700-04



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

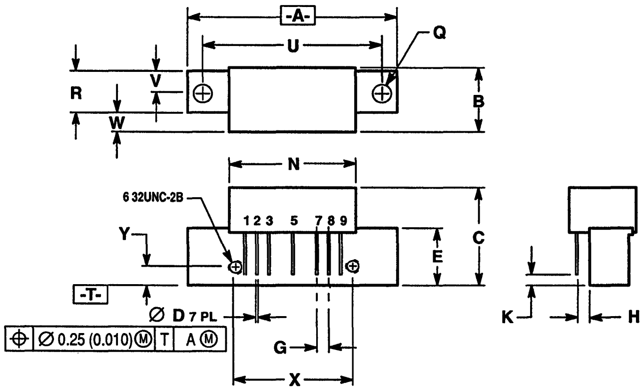
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	—	1.775	—	45.08
B	—	1.085	—	27.56
C	—	0.840	—	21.34
D	0.018	0.022	0.46	0.56
E	0.465	0.510	11.81	12.95
F	0.300	0.325	7.62	8.25
G	0.100 BSC		2.54 BSC	
J	0.156 BSC		3.96 BSC	
K	0.315	0.355	8.00	8.50
L	1.00 BSC		25.40 BSC	
N	0.165 BSC		4.19 BSC	
P	0.100 BSC		2.54 BSC	
Q	0.148	0.168	3.76	4.27
R	—	0.595	—	15.11
S	1.500 BSC		38.10 BSC	
U	0.200 BSC		5.08 BSC	
V	0.280 BSC		7.11 BSC	
W	0.435	0.450	11.05	11.43

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. DELETED
5. VDC
6. DELETED
7. GROUND
8. GROUND
9. RF OUTPUT

CASE 714-06

4

CASE DIMENSIONS (continued)



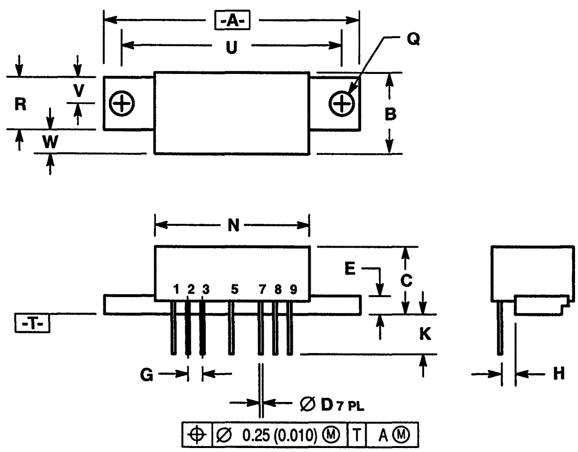
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	—	1.775	—	45.09
B	—	0.585	—	14.85
C	—	0.870	—	22.09
D	0.019	0.022	0.49	0.55
E	0.490	0.510	12.45	12.95
G	0.100 BSC		2.54 BSC	
H	0.100 BSC		2.54 BSC	
K	0.070	0.110	1.78	2.79
N	1.040	1.060	26.42	26.92
Q	0.148	0.210	3.76	5.33
R	0.305	0.325	7.75	8.25
U	1.490	1.510	37.85	38.35
V	0.152	0.163	3.87	4.14
W	0.165	0.175	4.20	4.44
X	0.990	1.010	25.15	25.65
Y	0.160	0.170	4.07	4.31

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
5. + V_{CC}
7. GROUND
8. GROUND
9. RF OUTPUT

CASE 714F-02



NOTES:

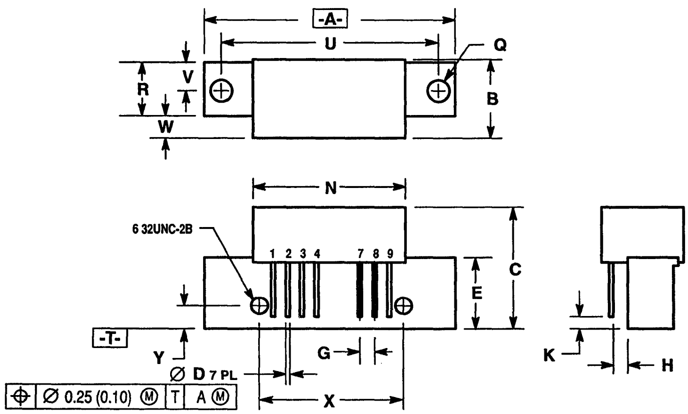
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	—	1.775	—	45.09
B	0.550	0.570	13.97	14.47
C	0.430	0.470	10.93	11.93
D	0.017	0.020	0.44	0.50
E	0.120	0.130	3.05	3.30
G	0.100 BSC		2.54 BSC	
H	0.100 BSC		2.54 BSC	
K	0.255	0.305	6.48	7.74
N	1.040	1.060	26.42	26.92
Q	0.150	0.160	3.81	4.06
R	0.310	0.320	7.88	8.12
U	1.490	1.510	37.85	38.35
V	0.155	0.160	3.94	4.06
W	0.160	0.180	4.07	4.57

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
5. +VCC
7. GROUND
8. GROUND
9. RF OUTPUT

CASE 714G-02

CASE DIMENSIONS (continued)

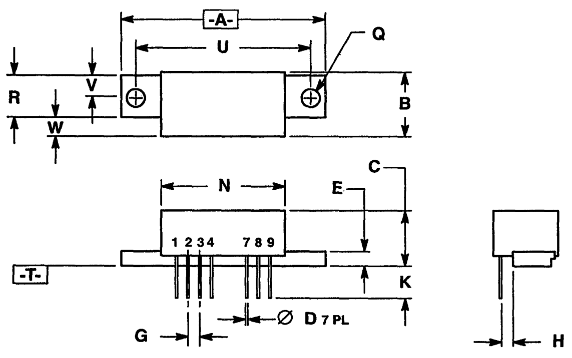


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	—	1.775	—	45.09
B	—	0.585	—	14.85
C	—	0.870	—	22.09
D	0.019	0.022	0.49	0.55
E	0.490	0.510	12.45	12.95
G	0.100 BSC		2.54 BSC	
H	0.100 BSC		2.54 BSC	
K	0.070	0.110	1.78	2.79
N	1.040	1.060	26.42	26.92
Q	0.148	0.210	3.76	5.33
R	0.305	0.325	7.75	8.25
U	1.490	1.510	37.85	38.35
V	0.152	0.163	3.87	4.14
W	0.165	0.175	4.20	4.44
X	0.990	1.010	25.15	25.65
Y	0.160	0.170	4.07	4.31

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. $-V_{CC}$
7. GROUND
8. GROUND
9. RF OUTPUT

CASE 714H-02



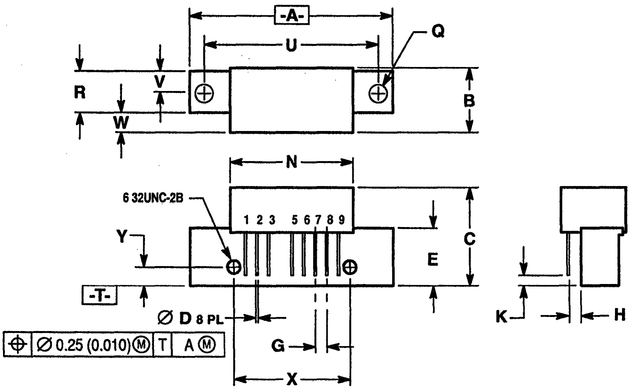
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	—	1.755	—	45.09
B	0.550	0.570	13.97	14.47
C	0.430	0.470	10.93	11.93
D	0.017	0.020	0.44	0.50
E	0.205	0.130	3.05	3.30
G	0.100		2.54 BSC	
H	0.100		2.54 BSC	
K	0.255	0.305	6.48	7.74
N	1.040	1.060	26.42	26.92
Q	0.150	0.160	3.81	4.06
R	0.310	0.320	7.88	8.12
U	1.490	1.510	37.85	38.35
V	0.155	0.160	3.94	4.06
W	0.160	0.180	4.07	4.57

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. $-V_{CC}$
7. GROUND
8. GROUND
9. RF OUTPUT

CASE 714L-02

4



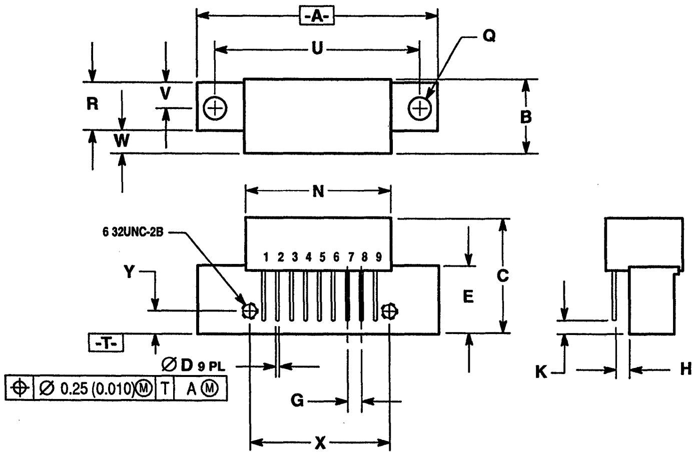
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	—	1.755	—	44.09
B	—	0.585	—	14.85
C	—	0.870	—	22.09
D	0.019	0.022	0.49	0.55
E	0.490	0.510	12.45	12.95
G	0.100 BSC		2.54 BSC	
H	0.100 BSC		2.54 BSC	
K	0.070	0.110	1.78	2.79
N	1.040	1.060	26.42	26.92
Q	0.148	0.210	3.76	5.33
R	0.305	0.325	7.75	8.25
U	1.490	1.510	37.85	38.35
V	0.152	0.163	3.87	4.14
W	0.165	0.175	4.20	4.44
X	0.990	1.010	25.15	25.65
Y	0.160	0.170	4.07	4.31

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
5. V_{CC} 1
6. V_{CC} 2
7. GROUND
8. GROUND
9. RF OUTPUT

STYLE 2:
PIN 1. RF INPUT
2. GROUND
3. GROUND
5. V_{CC} 1
6. V_{CC} 2
7. GROUND
8. GROUND
9. RF OUTPUT, V_{CC} 3

CASE 714M-02



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH.

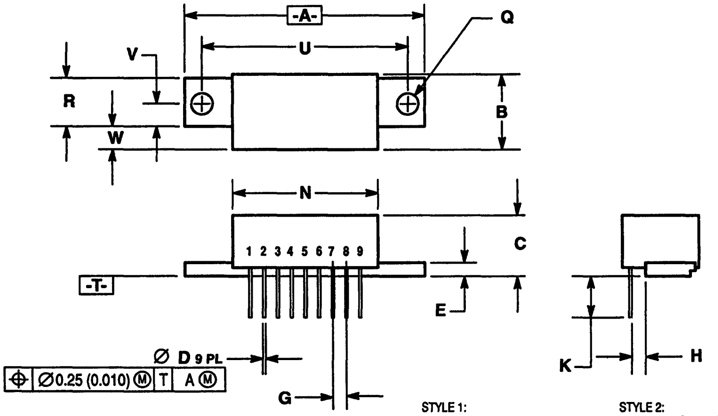
DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	—	1.755	—	44.57
B	—	0.585	—	14.85
C	—	0.870	—	22.09
D	0.019	0.022	0.49	0.55
E	0.490	0.510	12.45	12.95
G	0.100 BSC		2.54 BSC	
H	0.100 BSC		2.54 BSC	
K	0.070	0.110	1.78	2.79
N	1.040	1.060	26.42	26.92
Q	0.148	0.210	3.76	5.33
R	0.305	0.325	7.75	8.25
U	1.490	1.510	37.85	38.35
V	0.152	0.163	3.87	4.14
W	0.165	0.175	4.20	4.44
X	0.990	1.010	25.15	25.65
Y	0.160	0.170	4.07	4.31

STYLE 2:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. RESISTOR-GROUND
5. GROUND
6. GROUND
7. GROUND
8. V_{CC} 1
9. RF OUTPUT

STYLE 3:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. V_{CC} 1
5. GROUND
6. GROUND
7. GROUND
8. V_{CC} 2
9. RF OUTPUT

CASE 714P-02

CASE DIMENSIONS (continued)



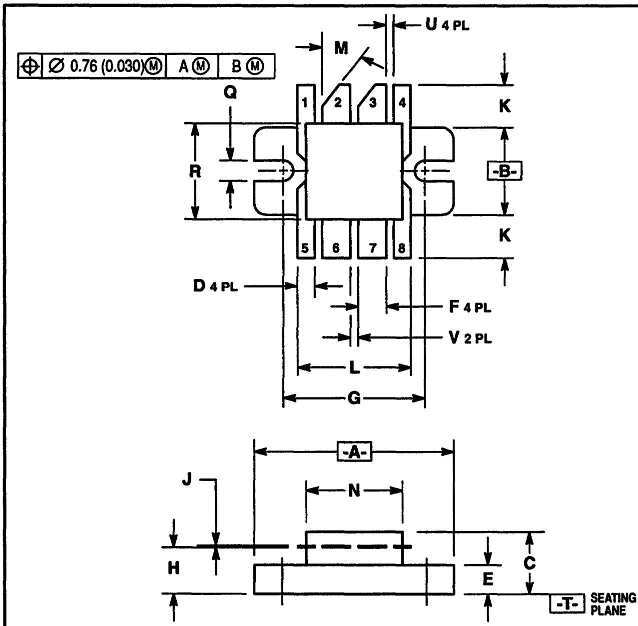
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMERNSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	—	1.775	—	45.09
B	0.550	0.570	13.97	14.27
C	0.430	0.470	10.93	11.93
D	0.017	0.020	0.44	0.50
E	0.120	0.130	3.05	3.30
G	0.100 BSC		2.54 BSC	
H	0.100 BSC		2.54 BSC	
K	0.255	0.305	6.48	7.74
N	1.040	1.060	26.42	26.92
Q	0.150	0.160	3.81	4.06
R	0.310	0.320	7.88	8.12
U	1.490	1.510	37.85	38.35
V	0.155	0.160	3.94	4.06
W	0.160	0.180	4.07	4.57

STYLE 1:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. RESISTOR-GROUND
5. GROUND
6. GROUND
7. GROUND
8. V_{CC} 1
9. RF OUTPUT

STYLE 2:
PIN 1. RF INPUT
2. GROUND
3. GROUND
4. V_{CC} 1
5. GROUND
6. GROUND
7. GROUND
8. V_{CC} 2
9. RF OUTPUT

CASE 714T-02



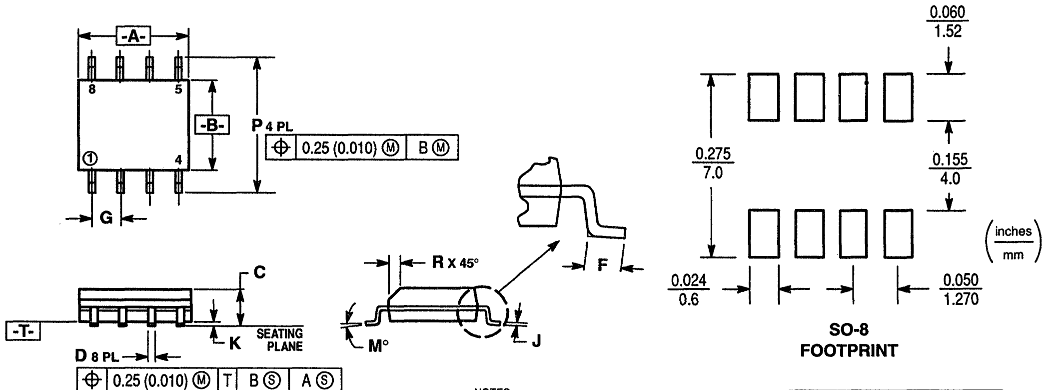
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.60	23.11	0.890	0.910
B	9.52	10.03	0.375	0.395
C	6.65	7.16	0.262	0.282
D	1.60	1.95	0.063	0.077
E	2.94	3.40	0.116	0.134
F	2.87	3.22	0.113	0.127
G	16.51 BSC		0.650 BSC	
H	4.01	4.36	0.158	0.172
J	0.07	0.15	0.003	0.006
K	4.34	4.90	0.171	0.193
L	12.44	12.95	0.490	0.510
M	45° NOM		45° NOM	
N	10.51	11.02	0.414	0.434
Q	3.04	3.35	0.120	0.132
R	9.90	10.41	0.390	0.410
U	1.02	1.27	0.040	0.050
V	0.64	0.89	0.025	0.035

STYLE 1:
PIN 1. EMITTER (COMMON)
2. COLLECTOR
3. COLLECTOR
4. EMITTER (COMMON)
5. EMITTER (COMMON)
6. BASE
7. BASE
8. EMITTER (COMMON)

CASE 744A-01

4

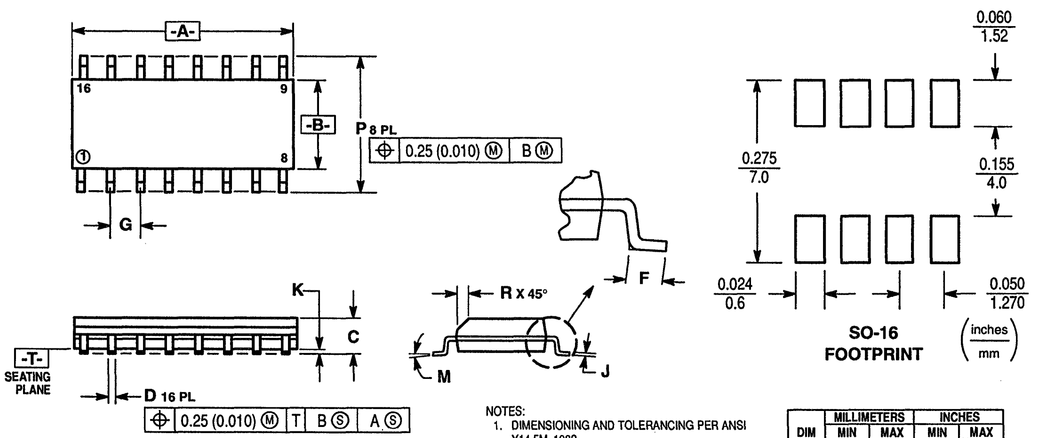


STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIM: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.18	0.25	0.007	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

CASE 751-04

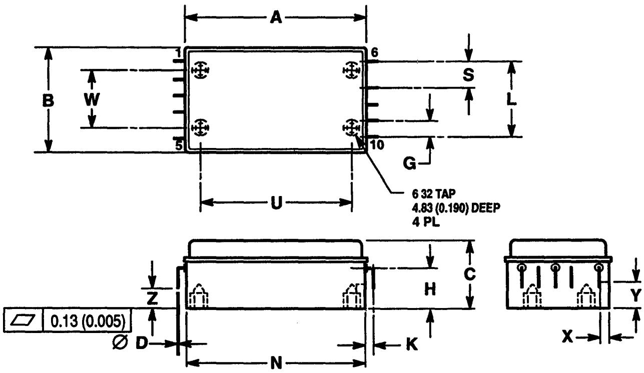


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

CASE 751B-05

CASE DIMENSIONS (continued)

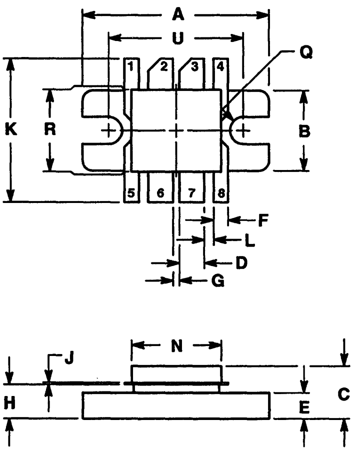


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	2.107	2.150	53.52	54.61
B	1.225	1.250	31.12	31.75
C	0.805	0.845	20.45	21.46
D	0.018	0.022	0.46	0.56
G	0.190	0.210	4.83	5.33
H	0.490	0.510	12.45	12.95
K	0.100	0.120	2.54	3.05
L	0.910	0.930	23.12	23.62
N	2.053	2.083	52.15	52.90
S	0.310	0.330	7.87	8.38
U	1.785	1.815	45.34	46.10
W	0.690	0.710	17.53	18.03
X	0.090	0.110	2.29	2.79
Y	0.290	0.310	7.37	7.87
Z	0.230	0.270	5.84	6.86

STYLE 1:
PIN 1. 24 V
2. GROUND
3. INPUT
4. GROUND
5. TEST
6. TEST
7. GROUND
8. OUTPUT
9. GROUND
10. 24 V

CASE 825A-02



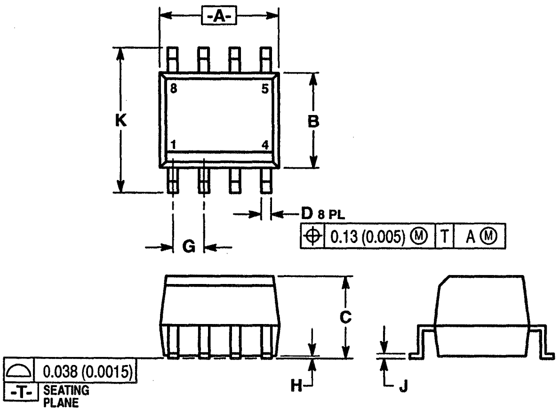
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

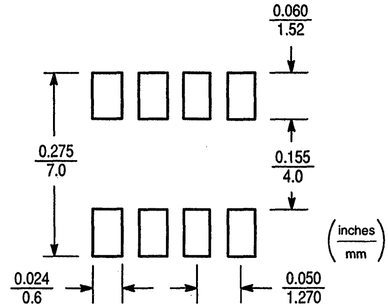
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.892	0.908	22.66	23.06
B	0.378	0.394	9.61	10.00
C	0.246	0.266	6.25	6.75
D	0.110	0.130	2.80	3.30
E	0.115	0.135	2.93	3.42
F	0.060	0.080	1.53	2.03
G	0.020	0.040	0.51	1.01
H	0.157	0.173	3.99	4.39
J	0.004	0.006	0.11	0.15
K	0.624	0.768	15.85	19.50
L	0.035	0.055	0.89	1.39
N	0.423	0.443	10.75	11.25
Q	0.120	0.140	3.05	3.55
R	0.384	0.404	9.76	10.26
U	0.640	0.660	16.26	16.76

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

CASE 827-01

CASE DIMENSIONS (continued)





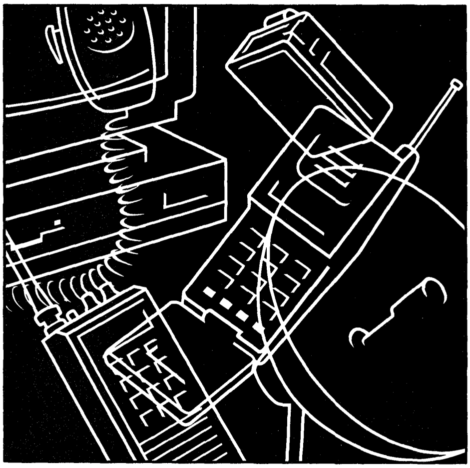
SO-8 FOOTPRINT

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.182	0.202	4.63	5.13
B	0.144	0.164	3.66	4.16
C	0.123	0.143	3.13	3.63
D	0.011	0.021	0.28	0.53
G	0.050 BSC		1.27 BSC	
H	0.003	0.008	0.08	0.20
J	0.006	0.010	0.16	0.25
K	0.224	0.244	5.69	6.19

CASE 846-01

4



Cross Reference and Sales Offices

5

Index and Cross Reference

The Index and Cross Reference provides a listing of Motorola's closest replacement devices to industry standard devices. It is Motorola's intent to provide suitable replacement devices and to encourage the device user to investigate these alternatives.

Several guidelines are used to determine Motorola's closest replacement devices. For low power devices, guidelines are based on dc voltage ratings, cutoff frequency, current rating, junction capacitance, and noise figure. The high power guidelines are dc voltage ratings, output power, gain, frequency of operation and output capacitance.

New chip technologies and packaging requirements are constantly evolving to meet the explosive demands of the Communications market. Motorola's portfolio of RF devices reflects this growth and the changes in the Communications market.

Industry Part Number	Motorola Closest Replacement	Page No.
2N1491	MRF5812	2-647
2N2857	MMBR5179LT1	2-52
2N2876	MRF134	2-101
2N3296	MRF134	2-101
2N3375	MRF134	2-101
2N3478	MMBR5179LT1	2-52
2N3600	MMBR5179LT1	2-52
2N3632	MRF134	2-101
2N3733	MRF134	2-101
2N3818	MRF134	2-101
2N3839	MMBR5179LT1	2-52
2N3866	MRF3866	2-613
2N3866A	MRF3866	2-613
2N3880	MMBR5031LT1	2-51
2N3924	MRF5003	2-619
2N3925	MRF5003	2-619
2N3927	MRF2628	2-601
2N3948	MRF4427	2-615
2N3959	MRF9011LT1	2-42
2N3960	MRF9011LT1	2-42
2N3961	MRF134	2-101
2N4012	MRF134	2-101
2N4040	MRF321	2-311
2N4072	MRF5003	2-619
2N4073	MRF4427	2-615
2N4130	MRF464	2-367
2N4427	MRF4427	2-615
2N4428	MRF3866	2-613
2N4932	MRF2628	2-601
2N4957	MMBR4957LT1	2-49
2N4958	MMBR4957LT1	2-49
2N4959	MMBR4957LT1	2-49
2N5016	MRF323	2-315
2N5031	MMBR5031LT1	2-51
2N5032	MMBR5031LT1	2-51
2N5070	MRF426	2-351
2N5109	MRF5943	2-651
2N5179	MMBR5179LT1	2-52
2N5180	MMBR5179LT1	2-52
2N5421	MRF4427	2-615
2N5424	MRF2628	2-601
2N5583	MRF5583	2-645
2N5589	MRF5003	2-619
2N5590	MRF2628	2-601
2N5591	MRF1946/A	2-593
2N5636	MRF321	2-311
2N5637	MRF323	2-315
2N5641	MRF134	2-101
2N5642	MRF166C	2-215
2N5643	MRF137	2-120
2N5644	MRF5003	2-619
2N5645	MRF652	2-428
2N5646	MRF653	2-432
2N5688	MRF2628	2-601
2N5689	MRF2628	2-601
2N5690	MRF1946/A	2-593
2N5697	MRF5003	2-619
2N5698	MRF5003	2-619
2N5699	MRF652	2-428
2N5710	MRF4427	2-615
2N5711	MRF134	2-101
2N5713	MRF137	2-120
2N5774	MRF321	2-311
2N5775	MRF325	2-319
2N5829	MMBR4957LT1	2-49
2N5835	MRF9011LT1	2-42
2N5836	MRF951	2-533
2N5837	MRF951	2-533
2N5841	MRF571	2-395
2N5842	MRF571	2-395
2N5847	MRF2628	2-601
2N5848	MRF1946/A	2-593
2N5862	MRF316	2-303
2N5914	MRF5003	2-619
2N5915	MRF653	2-432
2N5918	MRF321	2-311
2N5919A	MRF323	2-315
2N5941	MRF138	2-128
2N5942	MRF464	2-367
2N5943	MRF5943	2-651

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
2N5944	MRF5003	2-619
2N5945	MRF652	2-428
2N5946	MRF653	2-432
2N5947	MRF587	2-407
2N5992	MRF2628	2-601
2N5993	MRF1946/A	2-593
2N5994	MRF315	2-299
2N5995	MRF2628	2-601
2N5996	MRF1946/A	2-593
2N6080	MRF5003	2-619
2N6081	MRF2628	2-601
2N6082	MRF1946/A	2-593
2N6083	MRF1946/A	2-593
2N6084	MRF1946/A	2-593
2N6093	MRF464	2-367
2N6104	MRF325	2-319
2N6105	MRF325	2-319
2N6136	MRF644	2-418
2N6166	MRF173	2-230
2N6197	MRF134	2-101
2N6199	MRF137	2-120
2N6200	MRF137	2-120
2N6201	MRF317	2-307
2N6203	MRF321	2-311
2N6204	MRF323	2-315
2N6205	MRF325	2-319
2N6206	MRF891	2-476
2N6207	MRF892	2-480
2N6255	MRF5003	2-619
2N6256	MRF559	2-388
2N6366	MRF5003	2-619
2N6368	MRF455	2-365
2N6439	2N6439	2-2
2N6455	MRF1946/A	2-593
2N6457	MRF492	2-371
2N6460	MRF492	2-371
2N6603	MRF901	2-508
2N6604	MMBR911LT1	2-72
2N6985	2N6985	2-7
2N6986	2N6986	2-11
2SA1161	MMBR536LT1	2-53
2SA1223	MMBR536LT1	2-53
2SA1228	MMBR536LT1	2-53
2SA1230	MMBR536LT1	2-53
2SA1245	MMBR4957LT1	2-49
2SA711	MRF9011LT1	2-42
2SA800	MMBR536LT1	2-53
2SC1043	MRF587	2-407
2SC1081	MRF654	2-436
2SC1090-1	MMBR911LT1	2-72
2SC1119	MRF901	2-508
2SC1251	MRF587	2-407
2SC1252	MRF5812	2-647
2SC1253	MRF5812	2-647
2SC1256	MRF5003	2-619
2SC1257	MRF2628	2-601
2SC1258	MRF2628	2-601
2SC1259	MRF1946/A	2-593
2SC1260	MMBR5179LT1	2-52
2SC1268	MRF571	2-395
2SC1275	MMBR5179LT1	2-52
2SC1297	MRF137	2-120
2SC1298	MRF315	2-299
2SC1336	MRF571	2-395
2SC1365	MRF5812	2-647
2SC1366	MRF5812	2-647
2SC1424	MRF571	2-395
2SC1426	BFR96	2-22
2SC1560	MRF571	2-395
2SC1592	MRF587	2-407
2SC1593	MRF587	2-407
2SC1594	MRF587	2-407
2SC1600	MRF5812	2-647
2SC1605A	MRF2628	2-601
2SC1606	MRF5003	2-619
2SC1689	MRF315	2-299
2SC1729	MRF2628	2-601
2SC1763	MRF464	2-367
2SC1764	MRF464	2-367
2SC1804	MRF321	2-311
2SC1805	MRF323	2-315
2SC1808	MRF652	2-428
2SC1946	MRF1946/A	2-593
2SC1946A	MRF1946/A	2-593
2SC1947	MRF5003	2-619
2SC1949	MRF951	2-533
2SC1955	MRF5003	2-619
2SC1966	MRF652	2-428
2SC1967	MRF653	2-432
2SC1968A	MRF641	2-414
2SC1970	MRF553	2-374
2SC1988	MRF571	2-395
2SC2025	BFR96	2-22
2SC2026	MPS911	2-72
2SC2040	MRF587	2-407
2SC2065	MRF587	2-407
2SC2081	MRF5003	2-619
2SC2082	MRF653	2-432
2SC2083	MRF654	2-436
2SC2100	MRF492	2-371
2SC2101	MRF2628	2-601
2SC2102	MRF2628	2-601
2SC2103A	MRF1946/A	2-593
2SC2104	MRF652	2-428
2SC2105	MRF653	2-432
2SC2106	MRF654	2-436
2SC2131	MRF5003	2-619
2SC2148	MMBR911LT1	2-72
2SC2149	MRF571	2-395
2SC2174	MRF571	2-395
2SC2181	MRF224	2-283
2SC2217	MRF571	2-395
2SC2218	MRF571	2-395
2SC2222	MRF653	2-432
2SC2280	MRF5003	2-619
2SC2281	MRF653	2-432
2SC2282	MRF2628	2-601
2SC2290	MRF454	2-363
2SC2350	MRF571	2-395
2SC2351	MMBR571LT1	2-58

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
2SC2367	MRF571	2-395
2SC2369	MRF0211LT1	2-279
2SC2420	MRF1946/A	2-593
2SC2498	MPS911	2-72
2SC2499	MPS901	2-68
2SC2508	MRF1946/A	2-593
2SC2510	MRF422	2-347
2SC2570	MPS571	2-58
2SC2586	MRF5003	2-619
2SC2627	MRF5003	2-619
2SC2628	MRF2628	2-601
2SC2629	MRF1946/A	2-593
2SC2630	MRF247	2-290
2SC2642	MRF641	2-414
2SC2643	MRF644	2-418
2SC2652	MRF448	2-359
2SC2694	MRF247	2-290
2SC2753	MPS571	2-58
2SC2759	MMBR911LT1	2-72
2SC2782	MRF247	2-290
2SC2876	MRF571	2-395
2SC2879	MRF421	2-343
2SC2886	MRF321	2-311
2SC2887	MRF321	2-311
2SC2888	MRF314	2-295
2SC2889	MRF315	2-299
2SC2890	MRF316	2-303
2SC2891	MRF317	2-307
2SC2893	MRF321	2-311
2SC2894	MRF323	2-315
2SC2895	MRF325	2-319
2SC2896	2N6439	2-2
2SC2897	MRF327	2-327
2SC2915	MRF658	2-440
2SC2917	MRF247	2-290
2SC2931	MRF557	2-383
2SC2932	MRF840	2-453
2SC2933	MRF842	2-457
2SC2952	MRF5812	2-647
2SC2953	MRF587	2-407
2SC2954	BFR96	2-22
2SC3011	MMBR901LT1	2-42
2SC3019	MRF559	2-388
2SC3020	MRF652	2-428
2SC3021	MRF653	2-432
2SC3022	MRF644	2-418
2SC3099	MMBR901LT1	2-42
2SC3101	MRF5003	2-619
2SC3102	MRF658	2-440
2SC3105	MRF844	2-461
2SC3120	MMBR911LT1	2-72
2SC3139	MRF890	2-472
2SC3147	MRF247	2-290
2SC319	MRF4427	2-615
2SC3268	MRF5711LT1	2-58
2SC3282	MRF842	2-457
2SC3283	MRF844	2-461
2SC3301	MRF5711LT1	2-58
2SC3302	MRF571	2-395
2SC3355	MPS571	2-58

Industry Part Number	Motorola Closest Replacement	Page No.
2SC3356	MMBR571LT1	2-58
2SC3358	MRF571	2-395
2SC3429	MMBR571LT1	2-58
2SC3445	MMBR571LT1	2-58
2SC3484	MRF571	2-395
2SC3582	MPS571	2-58
2SC3583	MMBR571LT1	2-58
2SC3604	MRF571	2-395
2SC3660A	TPV8200B	2-841
2SC4093	MRF9411LT1	2-514
2SC4226	MRF957T1	2-544
2SC4228	MRF947T1	2-527
2SC4321	MRF947T1	2-527
2SC4394	MRF957T1	2-544
2SC567	MMBR5179LT1	2-52
2SC568	MMBR5179LT1	2-52
2SC573	MRF2628	2-601
2SC585	MRF134	2-101
2SC600	MRF134	2-101
2SC635	MRF134	2-101
2SC636	MRF134	2-101
2SC638	MRF2628	2-601
2SC651	MRF3866	2-613
2SC652	MRF3866	2-613
2SC730	MRF4427	2-615
2SC821	MRF4427	2-615
2SC822	MRF4427	2-615
2SC823	MRF5943	2-651
2SC824	MRF5943	2-651
2SC831	MRF321	2-311
2SC852	MRF5943	2-651
2SC890	MRF5003	2-619
2SC891	MRF652	2-428
2SC892	MRF653	2-432
2SC988	MRF571	2-395
2SC988A	MRF571	2-395
2SC990	MRF323	2-315
2SC994	MRF4427	2-615
2SC998	MRF5003	2-619
AT0017	MRF9011LT1	2-42
AT0017A	MRF9011LT1	2-42
AT004	MRF9011LT1	2-42
AT0045	MRF9011LT1	2-42
AT1425	BFR90	2-15
AT1825	MMBR911LT1	2-72
AT1845	MRF901	2-508
AT1845A	MRF901	2-508
AT25	MRF901	2-508
AT25A	MRF901	2-508
AT25B	MRF901	2-508
AT2625	MRF901	2-508
AT2645	MRF901	2-508
AT2645A	MRF901	2-508
AT2715	MRF951	2-533
AT50	BFR90	2-15
AT51	BFR90	2-15
AT52	BFR90	2-15
ATV6030	ATV6031	3-2
ATV6031	ATV6031	3-2
ATV6060	ATV6060	3-3

5

Industry Part Number	Motorola Closest Replacement	Page No.
ATV7060	ATV6060	3-3
BF100-35	MRF174	2-235
BF14-35	MRF136	2-110
BF25-35	MRF137	2-120
BF430	MRF5711LT1	2-58
BF431	MRF9011LT1	2-42
BF432	MRF9331LT1	2-677
BF433	MRF5812	2-647
BF50-35	MRF173	2-230
BF679	MMBR536LT1	2-53
BF7-35	MRF134	2-101
BF751	MPS911	2-72
BFG134	MRF581	2-401
BFG195	MRF571	2-395
BFG197/X	MRF5711LT1	2-58
BFG25A/X	MRF9331LT1	2-677
BFG33	MRF9411LT1	2-514
BFG33H	MRF9411LT1	2-514
BFG34	MRF557	2-383
BFG520/X	MRF9411LT1	2-514
BFG540/X	MRF9511LT1	2-533
BFG65	MRF941	2-514
BFG67	MRF9411LT1	2-514
BFG67/X	MRF9411LT1	2-514
BFG90A	MRF901	2-508
BFG91A	MRF0211LT1	2-279
BFG92A/X	MRF9011LT1	2-42
BFG93A/X	MRF5211LT1	2-34
BFG96	MRF581	2-401
BFG97	MRF5812	2-647
BFP10	MRF571	2-395
BFP520	MRF951	2-533
BFP90A	MRF571	2-395
BFP91A	MRF0211LT1	2-279
BFP96	MRF581	2-401
BFQ163	MRF5812	2-647
BFQ17	MRFQ17	2-721
BFQ18A	MRF5812	2-647
BFQ19	BFR96	2-22
BFQ22	MRF9011LT1	2-42
BFQ22S	MRF571	2-395
BFQ23	MMBR536LT1	2-53
BFQ24	MMBR536LT1	2-53
BFQ32M	MMBR521LT1	2-34
BFQ34	MRF587	2-407
BFQ34T	MRF5812	2-647
BFQ43	MRF5003	2-619
BFQ43S	MRF5003	2-619
BFQ51	MMBR536LT1	2-53
BFQ63	MRF571	2-395
BFQ66	MRF571	2-395
BFQ67	MMBR951LT1	2-533
BFQ67W	MRF947T1	2-527
BFQ85	MRF571	2-395
BFR134	MRF5812	2-647
BFR38	MMBR4957LT1	2-49
BFR49	MRF901	2-508
BFR520	MMBR941LT1	2-514
BFR53	MMBR920LT1	2-47
BFR540	MMBR951LT1	2-533

Industry Part Number	Motorola Closest Replacement	Page No.
BFR541	MRF951	2-533
BFR63	MRF587	2-407
BFR64	MRF587	2-407
BFR65	MRF587	2-407
BFR90	BFR90	2-15
BFR90A	BFR90	2-15
BFR91	MMBR911LT1	2-72
BFR91A	MRF571	2-395
BFR92	BFR92ALT1	2-18
BFR92A	BFR92ALT1	2-18
BFR93	BFR93ALT1	2-20
BFR93A	BFR93ALT1	2-20
BFR93ALT1	BFR93ALT1	2-20
BFR94	MRF587	2-407
BFR95	MMBR536LT1	2-53
BFR96	BFR96	2-22
BFR96S	MRF581A	2-401
BFR99	MMBR4957LT1	2-49
BFS17	BFS17LT1	2-26
BFS17LT1	BFS17LT1	2-26
BFS17S	BFS17LT1	2-26
BFS520	MRF947T1	2-527
BFS540	MRF957T1	2-544
BFT24	MMBR931LT1	2-48
BFT25A	MMBR931LT1	2-48
BFT50	MRF9011LT1	2-42
BFT92	MMBR536LT1	2-53
BFT95	MMBR536LT1	2-53
BFT96	MMBR536LT1	2-53
BFW93	MRF571	2-395
BFW94	MRF559	2-388
BGD102	MHW5185B	3-150
BGD104	MHW5205	3-152
BGD106	MHW5225	3-155
BGD502	MHW6185B	3-150
BGX885	CA901	3-5
BGY110A	MHW851-1	3-107
BGY110B	MHW851-2	3-107
BGY110D	MHW803-1	3-89
BGY110E	MHW803-3	3-89
BGY110F	MHW803-3	3-89
BGY112B	MHW607-1	3-70
BGY112C	MHW607-2	3-70
BGY113A	MHW707-1	3-77
BGY113B	MHW707-2	3-77
BGY114C	MHW909	3-117
BGY115A	MHW9002-1	3-171
BGY115B	MHW9002-2	3-171
BGY115C	MHW9002-3	3-171
BGY200	MHW903	3-112
BGY201	MHW914	3-123
BGY49A	MHW720A1	3-84
BGY49B	MHW720A2	3-84
BGY50	MHW5122A	3-141
BGY51	MHW5122A	3-141
BGY52	MHW5172A	3-145
BGY53	MHW5172A	3-145
BGY54	MHW5172A	3-145
BGY55	MHW5172A	3-145
BGY56	MHW5222A	3-153

Industry Part Number	Motorola Closest Replacement	Page No.
BGY57	MHW5222A	3-153
BGY580	MHW6122	3-162
BGY581	MHW6122	3-162
BGY582	MHW6142	3-163
BGY583	MHW6142	3-163
BGY584	MHW6172	3-164
BGY584A	MHW6182	3-165
BGY585	MHW6172	3-164
BGY585A	MHW6182	3-165
BGY586	MHW6222	3-166
BGY587	MHW6222	3-166
BGY587B	MHW6272	3-167
BGY588	MHW6342	3-168
BGY58A	MHW5342A	3-158
BGY59	MHW5382A	3-160
BGY61	MHW1134	3-139
BGY67	MHW1224	3-139
BGY67A	MHW1244	3-139
BGY70	MHW5122A	3-141
BGY71	MHW5122A	3-141
BGY78	MHW5342A	3-158
BGY80	MHW5122A	3-141
BGY81	MHW5122A	3-141
BGY82	MHW5142A	3-143
BGY83	MHW5142A	3-143
BGY84	MHW5172A	3-145
BGY84A	MHW5182A	3-147
BGY85	MHW5172A	3-145
BGY85A	MHW5182A	3-147
BGY86	MHW5222A	3-153
BGY87	MHW5222A	3-153
BGY87B	MHW5272A	3-156
BGY88	MHW5342A	3-158
BGY89	MHW5382A	3-160
BGY90A	MHW806A2	3-98
BGY90B	MHW806A4	3-98
BGY92C	MHW812A3	3-103
BGY95A	MHW803-1	3-89
BGY95B	MHW803-3	3-89
BLF145	MRF138	2-128
BLF147	MRF141	2-138
BLF175	MRF148	2-148
BLF177	MRF151	2-158
BLF241	MRF158R	2-181
BLF242	MRF134	2-101
BLF244	MRF136	2-110
BLF245	MRF137	2-120
BLF245B	MRF136Y	2-110
BLF246	MRF173	2-230
BLF246B	MRF177	2-265
BLF248	MRF141G	2-143
BLF277	MRF151	2-158
BLF278	MRF151G	2-164
BLF346	MRF173	2-230
BLF348	MRF175GV	2-243
BLF368	MRF175GV	2-243
BLF378	MRF151G	2-164
BLF521	MRF158	2-181
BLF544	MRF166C	2-215
BLF544B	MRF164W	2-211

Industry Part Number	Motorola Closest Replacement	Page No.
BLF548	MRF175GU	2-243
BLT90	MRF557	2-383
BLT90SL	MRF557	2-383
BLU10/12	MRF653	2-432
BLU15/12	MRF654	2-436
BLU20/12	MRF644	2-418
BLU53	MRF392	2-335
BLU60/12	MRF658	2-440
BLU97	MRF653	2-432
BLU98	MRF581	2-401
BLU99	MRF652	2-428
BLV10	MRF2628	2-601
BLV103	MRF891	2-476
BLV12	MRF1946/A	2-593
BLV13	MRF1946/A	2-593
BLV193	MRF842	2-457
BLV194	MRF842	2-457
BLV20	MRF134	2-101
BLV21	MRF314	2-295
BLV57	TPV695A	2-825
BLV59	TPV5055B	2-826
BLV75/12	MRF247	2-290
BLV80/28	MRF316	2-303
BLV90	MRF557	2-383
BLV90/SL	MRF557	2-383
BLV91	MRF840	2-453
BLV92	MRF840	2-453
BLV93	MRF840	2-453
BLV94	MRF842	2-457
BLV945A	MRF897	2-493
BLV948	MRF899	2-502
BLV95	MRF844	2-461
BLV96	MRF847	2-464
BLV97	MRF894	2-484
BLV98	MRF892	2-480
BLV99	MRF894	2-484
BLW29	MRF2628	2-601
BLW30	MRF1946/A	2-593
BLW31	MRF1946/A	2-593
BLW32	TPV596A	2-817
BLW33	TPV597	2-820
BLW40	MRF240	2-286
BLW50F	MRF464	2-367
BLW60	MRF1946/A	2-593
BLW60C	MRF1946/A	2-593
BLW76	MRF464	2-367
BLW77	MRF422	2-347
BLW78	MRF464	2-367
BLW79	MRF5003	2-619
BLW80	MRF652	2-428
BLW81	MRF653	2-432
BLW82	MRF644	2-418
BLW83	MRF426	2-351
BLW84	MRF314	2-295
BLW85	MRF224	2-283
BLW86	MRF315	2-299
BLW87	MRF1946/A	2-593
BLW91	MRF321	2-311
BLW91/SL	MRF321	2-311
BLW95	MRF429	2-355

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
BLW96	MRF448	2-359
BLW97	MRF422	2-347
BLW98	TPV598	2-823
BLW99	MRF421	2-343
BLX13	MRF426	2-351
BLX13C	MRF426	2-351
BLX14	MRF464	2-367
BLX39	MRF315	2-299
BLX65	MRF5003	2-619
BLX65ES	MRF5003	2-619
BLX66	MRF5003	2-619
BLX67	MRF653	2-432
BLX68	MRF653	2-432
BLX69A	MRF654	2-436
BLX91	MRF313	2-293
BLX91A	MRF313	2-293
BLX93	MRF321	2-311
BLX93A	MRF321	2-311
BLX94A	MRF325	2-319
BLX94C	MRF323	2-315
BLX95	MRF325	2-319
BLX96	TPV596A	2-817
BLX97	TPV597	2-820
BLX98	TPV598	2-823
BLY53A	MRF653	2-432
BLY58	MRF2628	2-601
BLY59	MRF134	2-101
BLY60	MRF134	2-101
BLY87A	MRF2628	2-601
BLY87C	MRF2628	2-601
BLY88A	MRF2628	2-601
BLY88C	MRF2628	2-601
BLY88C/01	MRF2628	2-601
BLY89A	MRF1946/A	2-593
BLY89C	MRF1946/A	2-593
BLY91A	MRF134	2-101
BLY91C	MRF134	2-101
BLY93A	MRF314	2-295
BLY93C	MRF314	2-295
BLY94	MRF315	2-299
BM100-28	MRF317	2-307
BM45-12	MRF247	2-290
BM70-12	MRF247	2-290
BM80-12	MRF247	2-290
BRF521	MRF941	2-514
CA100	MHW5172A	3-145
CA200	MHW5172A	3-145
CA2100	MHW5172A	3-145
CA2101	MHW5172A	3-145
CA2200	MHW5172A	3-145
CA2201	MHW5172A	3-145
CA2300	MHW5222A	3-153
CA2301	MHW5222A	3-153
CA2422	MHW1224	3-139
CA2600	MHW5342A	3-158
CA2700	MHW5382A	3-160
CA2800	CA2818C	3-16
CA2810	CA2810C	3-13
CA2810B	CA2810C	3-13
CA2810C	CA2810C	3-13
CA2810CH	CA2810C	3-13
CA2810H	CA2810C	3-13
CA2813	CA2810C	3-13
CA2813B	CA2810C	3-13
CA2813C	CA2810C	3-13
CA2813CH	CA2810C	3-13
CA2818	CA2818C	3-16
CA2818B	CA2818C	3-16
CA2818C	CA2818C	3-16
CA2818H	CA2818C	3-16
CA2828CH	CA2818C	3-16
CA2830	CA2830C	3-19
CA2830B	CA2830C	3-19
CA2830C	CA2830C	3-19
CA2830H	CA2830C	3-19
CA2832	CA2832C	3-22
CA2832B	CA2832C	3-22
CA2832C	CA2832C	3-22
CA2832H	CA2832C	3-22
CA2833	CA2833C	3-19
CA2833C	CA2833C	3-19
CA2840	CA2842C	3-25
CA2840H	CA2842C	3-25
CA2842	CA2842C	3-25
CA2842B	CA2842C	3-25
CA2842C	CA2842C	3-25
CA2842H	CA2842C	3-25
CA2846	CA2842C	3-25
CA2850	MHW5182A	3-147
CA2850CR	CA2850CR	3-28
CA2850R	CA2850CR	3-28
CA2850RH	CA2850CR	3-28
CA2851CR	CA2851CR	3-28
CA2851R	CA2851CR	3-28
CA2870	CA2870C	3-31
CA2870B	MHW5342A	3-158
CA2870C	CA2870C	3-31
CA2870H	CA2870C	3-31
CA2875CR	CA2875CR	3-34
CA2875R	CA2875CR	3-34
CA2875RH	CA2875CR	3-34
CA2880R	CA2875CR	3-34
CA2885	MHW5185B	3-150
CA2888	CA2832C	3-22
CA2888H	CA2832C	3-22
CA2889	CA2832C	3-22
CA2889H	CA2832C	3-22
CA2890	CA2870C	3-31
CA2890B	CA2870C	3-31
CA2890H	CA2870C	3-31
CA3100	MHW5172A	3-145
CA3101	MHW5172A	3-145
CA3170	MHW5172A	3-145
CA3180	MHW5142A	3-143
CA3200	MHW5172A	3-145
CA3201	MHW5172A	3-145
CA3220	MHW5182A	3-147
CA3270	MHW5172A	3-145
CA3280	MHW5142A	3-143
CA3300	MHW5222A	3-153

Industry Part Number	Motorola Closest Replacement	Page No.
CA3301	MHW5222A	3-153
CA3600	MHW5342A	3-158
CA3700	MHW5382A	3-160
CA4101	MHW5172A	3-145
CA4170	MHW5172A	3-145
CA4180	MHW5142A	3-143
CA4201	MHW5172A	3-145
CA4220	MHW5182A	3-147
CA4270	MHW5172A	3-145
CA4280	MHW5142A	3-143
CA4300	MHW5222A	3-153
CA4301	MHW5222A	3-153
CA4411	MHW1134	3-139
CA4412	MHW1134	3-139
CA4422	MHW1224	3-139
CA4424	MHW1244	3-139
CA4600	MHW5342A	3-158
CA4700	MHW5342A	3-158
CA4800	CA4800C	3-37
CA4800C	CA4800C	3-37
CA4800CS	CA4800CS	3-37
CA4800H	CA4800CS	3-37
CA4812	CA4812C	3-37
CA4812C	CA4812C	3-37
CA4812CS	CA4812CS	3-37
CA4812H	CA4812CS	3-37
CA4815	CA4815C	3-37
CA4815C	CA4815C	3-37
CA4815CS	CA4815CS	3-37
CA4815H	CA4815CS	3-37
CA4900	CA4900	3-39
CA4900S	CA4900S	3-39
CA4912	CA4912	3-39
CA4912S	CA4912S	3-39
CA4915	CA4915	3-39
CA4915S	CA4915S	3-39
CA5001	MHW5182A	3-147
CA5101	MHW5182A	3-147
CA5170	MHW5172A	3-145
CA5180	MHW5142A	3-143
CA5201	MHW5182A	3-147
CA5270	MHW5172A	3-145
CA5280	MHW5142A	3-143
CA5300	MHW5222A	3-153
CA5301	MHW5222A	3-153
CA5501	MHW5185B	3-150
CA5520	MHW5185B	3-150
CA5600	MHW5342A	3-158
CA5700	MHW5382A	3-160
CA5800	CA5800C	3-41
CA5800C	CA5800C	3-41
CA5800CS	CA5800CS	3-41
CA5800H	CA5800CS	3-41
CA5801	CA5801	3-43
CA5801S	CA5801S	3-43
CA5815	CA5815C	3-45
CA5815C	CA5815C	3-45
CA5815CS	CA5815CS	3-45
CA5815H	CA5815CS	3-45
CA5900	CA5900	3-47

Industry Part Number	Motorola Closest Replacement	Page No.
CA5900S	CA5900S	3-47
CA5915	CA5915	3-49
CA5915S	CA5915S	3-49
CA601B/U	MHW5342A	3-158
CA6101	MHW6182	3-165
CA6201	MHW6182	3-165
CA6220	MHW6182	3-165
CA636	MHW5342A	3-158
CA6501	MHW6185B	3-150
CA6520	MHW6185B	3-150
CA900	CA901	3-5
CA901	CA901	3-5
CA901A	CA901A	3-5
CA902	CA902	3-7
CA902A	CA902A	3-7
CA912	CA912	3-9
CA922	CA922	3-11
CA922A	CA922A	3-11
CA97901	CA97901	3-51
CAB914	CA901	3-5
CAR2424H	CR2424A	3-53
CF4-28	MRF161	2-187
CG125	MRF901	2-508
CG125A	MRF901	2-508
CG125B	MRF571	2-395
CG125C	MRF571	2-395
CG125D	MMBR911LT1	2-72
CG125L	MMBR911LT1	2-72
CG127	MRF571	2-395
CG127A	MRF571	2-395
CG127B	MRF571	2-395
CR2424	CR2424A	3-53
CR2424A	CR2424A	3-53
CR2424H	CR2424A	3-53
CR2424R	CR2424R	3-53
CR2425	CR2425A	3-53
CR2425A	CR2425A	3-53
CR2425R	CR2424R	3-53
CR2428	CR2428	3-55
CR3424	CR3424A	3-57
CR3424A	CR3424A	3-57
CR3424H	CR3424A	3-57
CR3424R	CR3424R	3-57
CR3425	CR3425A	3-57
CR3425A	CR3425A	3-57
CR3425R	CR3424R	3-57
CR3428	CR3428	3-59
DME10	MRF1015MA	2-561
DME120L	MRF1150MA	2-582
DME150	MRF10150	2-695
DME2	MRF1002MA	2-553
DME25	MRF1035MA	2-573
DME250	MRF10350	2-698
DME30L	MRF1035MA	2-573
DME375	MRF10350	2-698
DME375A	MRF10350	2-698
DME50	MRF1090MA	2-577
DME75	MRF1090MB	2-577
DMEG250	MRF10350	2-698
DMEG70	MRF1090MA	2-577

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
DU2812OU	MRF174	2-235
DU2820S	MRF166	2-215
DU2840S	MRF171	2-222
FF124	MFF124B	3-61
FF124B	MFF124B	3-61
FF224	MFF224B	3-63
FF224B	MFF224B	3-63
H100-28	MRF422	2-347
H100-50	MRF429	2-355
H175-50	MRF429	2-355
H50-28	MRF464	2-367
HMIL-100-28	MRF422	2-347
HMIL-150-50	MRF429	2-355
HXTR2102	MMBR911LT1	2-72
HXTR6104	MRF901	2-508
HXTR6105	MRF901	2-508
IMD2001	MRW2001	2-723
IMD2003	MRW2003	2-723
IMD2005	MRW2005	2-723
IMD2010	MRW2010	2-723
IMD604HA	MRW2001	2-723
IMD604HB	MRW2003	2-723
IMD604HC	MRW2005	2-723
J01006	MRF317	2-307
J02000	MRF325	2-319
J02005	MRF325	2-319
J02007A	2N6439	2-2
J02009	MRF325	2-319
J02014	MRF326	2-323
J02015A	2N6439	2-2
J02016	MRF327	2-327
J03012	MRF641	2-414
J03015	MRF641	2-414
J03025	MRF644	2-418
J03028	MRF644	2-418
J03037	MRF658	2-440
J03055	MRF658	2-440
J03060	MRF658	2-440
J03401	MRF840	2-453
J03402	MRF842	2-457
J03403	MRF844	2-461
J03404	MRF844	2-461
J03405	MRF847	2-464
J03406	MRF847	2-464
J03501	MRF892	2-480
J03502	MRF894	2-484
J04020	MRF247	2-290
J04028	MRF247	2-290
J04030	MRF247	2-290
J04036	MRF1946	2-593
J04040	MRF247	2-290
J04045	MRF1946/MRF247	2-593/2-290
J04070	MRF247	2-290
J04075	MRF247	2-290
J04080	MRF247	2-290
LF40100M	MRF177M	2-265
LF4030C	MRF182	2-273
LMIL1	MRF890	2-472
LP1001	LP1001	2-27
LP1001A	LP1001A	2-27

Industry Part Number	Motorola Closest Replacement	Page No.
LP1983	LP1983	2-30
LT1001A	MRF5812	2-647
LT2001	MRF581	2-401
LT3005	MRF581	2-401
LT3014	MRF581	2-401
LT3046	MRF5812	2-647
LT3047	MRF9011LT1	2-42
LT3072	MRF9011LT1	2-42
LT3203	MRF581	2-401
LT3204	MRF581	2-401
LT3700	MRF901	2-508
LT3703	MRF901	2-508
LT3704	MRF901	2-508
LT3746	MRF5812	2-647
LT3772	MRF9011LT1	2-42
LT4403	BFR96	2-22
LT4404	MRF951	2-533
LT4485	MRF951	2-533
LT4700	MRF901	2-508
LT4703	MMBR911LT1	2-72
LT4704	MRF571	2-395
LT4746	BFR96	2-22
LT4772	MRF571	2-395
LT5217	MRF521	2-34
LT5239	MRF521	2-34
M57729/L	MHW720A1	3-84
M57729H	MHW720A2	3-84
M57734	MHW720A2	3-84
M57739	MHW806A2	3-98
M57739A	MHW806A2	3-98
M57744	MHW812A3	3-103
M57765	MHW804-1	3-94
M57768	MHW812A3	3-103
M57769	MHW806A4	3-98
M57773	MHW803-1	3-89
M57783H	MHW607-2	3-70
M57783L	MHW607-1	3-70
M57785H	MHW607-2	3-70
M57785L	MHW607-1	3-70
M57785M	MHW607-2	3-70
M57786M	MHW707-2	3-77
M57789	MHW812A3	3-103
M57794	MHW806A3	3-98
M57795	MHW803-2	3-89
M57799M	MHW707-2	3-77
M67729H	MHW720A2	3-84
M67729L	MHW720A1	3-84
M67743	MHW105	3-67
M67748H	MHW607-2	3-70
M67748L	MHW607-1	3-70
M67749H	MHW707-2	3-77
M67749L	MHW707-1	3-77
M67749SH	MHW707-4	3-77
M67749UH	MHW707-3	3-77
M67766	MHW927A	3-130
M67768	MHW932	3-134
M67769	MHW909	3-117
M67770	MHW912	3-119
M67771	MHW953	3-112
M67779L	MHW806A1	3-98

5

Industry Part Number	Motorola Closest Replacement	Page No.
M67779M	MHW806A4	3-98
M67780L	MHW851-1	3-107
M67780M	MHW851-2	3-107
MC5381	MHW5182A	3-147
MC5382	MHW5182A	3-147
MC5383	MHW5272A	3-156
MC5384	MHW5182A	3-147
MC5385	MHW5182A	3-147
MC5386	MHW5342A	3-158
MC5387	MHW6182	3-165
MC5388	MHW6182	3-165
MC5389	MHW5342A	3-158
MC5813	MHW1134	3-139
MC5814	MHW5222A	3-153
MC5815	MHW5222A	3-153
MC5816	MHW6222	3-166
MC5817	MHW6222	3-166
MC5819	MHW6182	3-165
MC5820	MHW6182	3-165
MC5821	MHW5342A	3-158
MC5822	MHW1224	3-139
MC5824	MHW1244	3-139
MFF124	MFF124B	3-61
MFF124B	MFF124B	3-61
MFF224	MFF224B	3-63
MFF224B	MFF224B	3-63
MFF324	MFF324B	3-65
MFF324B	MFF324B	3-65
MHW105	MHW105	3-67
MHW1121	MHW5122A	3-141
MHW1122	MHW5122A	3-141
MHW1134	MHW1134	3-139
MHW1222	MHW5222A	3-153
MHW1224	MHW1224	3-139
MHW1244	MHW1244	3-139
MHW1341	MHW5342A	3-158
MHW1342	MHW5342A	3-158
MHW2172	MHW5172A	3-145
MHW3171	MHW5172A	3-145
MHW3172	MHW5172A	3-145
MHW3181	MHW5182A	3-147
MHW3182	MHW5182A	3-147
MHW3222	MHW5222A	3-153
MHW3272A	MHW5272A	3-156
MHW3342	MHW5342A	3-158
MHW3382A	MHW5382A	3-160
MHW4524F	MFF124B	3-61
MHW5122A	MHW5122A	3-141
MHW5141A	MHW5142A	3-143
MHW5142	MHW5142A	3-143
MHW5142A	MHW5142A	3-143
MHW5162A	MHW5172A	3-145
MHW5171	MHW5172A	3-145
MHW5171A	MHW5172A	3-145
MHW5172	MHW5172A	3-145
MHW5172A	MHW5172A	3-145
MHW5181	MHW5182A	3-147
MHW5181A	MHW5182A	3-147
MHW5182	MHW5182A	3-147
MHW5182A	MHW5182A	3-147

Industry Part Number	Motorola Closest Replacement	Page No.
MHW5182R	MHW5182R	—
MHW5183	MHW5183	3-149
MHW5185	MHW5185B	3-150
MHW5185B	MHW5185B	3-150
MHW5205	MHW5205	3-152
MHW5222	MHW5222A	3-153
MHW5222A	MHW5222A	3-153
MHW5225	MHW5225	3-155
MHW5272A	MHW5272A	3-156
MHW5332	MHW5342A	3-158
MHW5332A	MHW5342A	3-158
MHW5341	MHW5342A	3-158
MHW5342	MHW5342A	3-158
MHW5342A	MHW5342A	3-158
MHW5382	MHW5382A	3-160
MHW5382A	MHW5382A	3-160
MHW580	MHW5342A	3-158
MHW594	MHW5172A	3-145
MHW595	MHW5172A	3-145
MHW607-1	MHW607-1	3-70
MHW607-2	MHW607-2	3-70
MHW607-3	MHW607-3	3-70
MHW607-4	MHW607-4	3-70
MHW6122	MHW6122	3-162
MHW6141	MHW6142	3-163
MHW6142	MHW6142	3-163
MHW6171	MHW6172	3-164
MHW6172	MHW6172	3-164
MHW6181	MHW6182	3-165
MHW6182	MHW6182	3-165
MHW6183	MHW6183	3-149
MHW6185	MHW6185B	3-150
MHW6185-6	MHW6185-6	3-150
MHW6185B	MHW6185B	3-150
MHW6222	MHW6222	3-166
MHW6272	MHW6272	3-167
MHW6342	MHW6342	3-168
MHW6342F	MHW5342A	3-158
MHW703	MHW704	3-74
MHW704	MHW704	3-74
MHW707-1	MHW707-1	3-77
MHW707-2	MHW707-2	3-77
MHW707-3	MHW707-3	3-77
MHW707-4	MHW707-4	3-77
MHW7182	MHW7182	3-169
MHW720-1	MHW720A1	3-84
MHW720-2	MHW720A2	3-84
MHW720A1	MHW720A1	3-84
MHW720A2	MHW720A2	3-84
MHW720A3	MHW720A3	3-84
MHW721A2	MHW720A3	3-84
MHW801-1	MHW851-1	3-107
MHW801-2	MHW851-2	3-107
MHW801-3	MHW851-3	3-107
MHW801-4	MHW851-4	3-107
MHW802-1	MHW803-1	3-89
MHW802-2	MHW803-3	3-89
MHW803-1	MHW803-1	3-89
MHW803-2	MHW803-2	3-89
MHW803-3	MHW803-3	3-89

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
MHW804-1	MHW804-1	3-94
MHW804-2	MHW804-2	3-94
MHW806-1	MHW806A1	3-98
MHW806-2	MHW806A2	3-98
MHW806-3	MHW806A3	3-98
MHW806-4	MHW806A4	3-98
MHW806A1	MHW806A1	3-98
MHW806A2	MHW806A2	3-98
MHW806A3	MHW806A3	3-98
MHW806A4	MHW806A4	3-98
MHW808-1	MHW806A1	3-98
MHW808-2	MHW806A2	3-98
MHW808-3	MHW806A3	3-98
MHW808-4	MHW806A4	3-98
MHW812-3	MHW812A3	3-103
MHW812A3	MHW812A3	3-103
MHW8182	MHW8182	3-169
MHW851-1	MHW851-1	3-107
MHW851-2	MHW851-2	3-107
MHW851-3	MHW851-3	3-107
MHW851-4	MHW851-4	3-107
MHW9002-1	MHW9002-1	3-171
MHW9002-2	MHW9002-2	3-171
MHW9002-3	MHW9002-3	3-171
MHW9002-4	MHW9002-4	3-171
MHW903	MHW903	3-112
MHW909	MHW909	3-117
MHW912	MHW912	3-119
MHW914	MHW914	3-123
MHW915	MHW915	3-123
MHW9182	MHW9182	3-169
MHW927A	MHW927A	3-130
MHW927B	MHW927B	3-130
MHW932	MHW932	3-134
MHW953	MHW953	3-112
MHW954	MHW954	3-112
MKB12040WS	MRF1035MA	2-573
MKB12100WS	MRF1090MA	2-577
MKB12140W	MRF1090MA	2-577
MM1500	MRF5812	2-647
MM1500A	MRF5812	2-647
MM1501A	MRF5812	2-647
MM1550	MRF321	2-311
MM1551	MRF323	2-315
MM1557	MRF134	2-101
MM1559	MRF137	2-120
MM1601	MRF5003	2-619
MM1602	MRF2628	2-601
MM1603	MRF1946/A	2-593
MM1605	MRF571	2-395
MM1606	MRF571	2-395
MM1607	MRF571	2-395
MM1608	MRF5003	2-619
MM1612	MRF5003	2-619
MM1632	MRF138	2-128
MM1633	MRF464	2-367
MM1660	MRF5003	2-619
MM1661	MRF652	2-428
MM1662	MRF653	2-432
MM1665	MRF644	2-418

Industry Part Number	Motorola Closest Replacement	Page No.
MM1666	MRF1946/A	2-593
MM1667	MRF1946/A	2-593
MM1668	MRF1946/A	2-593
MM1669	MRF1946/A	2-593
MM1680	MRF5003	2-619
MM1681	MRF2628	2-601
MM1713	MRF559	2-388
MM1943	MRF559	2-388
MM1945	MRF559	2-388
MM4018	MRF5583	2-645
MM4049	MMBR536LT1	2-53
MM439	MMBR4957LT1	2-49
MM4500	MRF5583	2-645
MM5177	MRF325	2-319
MM8000	MRF5943	2-651
MM8001	MRF5943	2-651
MM8003	MRF587	2-407
MM8006	MMBR5031LT1	2-51
MM8007	MMBR5031LT1	2-51
MM8008	MRF5812	2-647
MM8010	MRF5812	2-647
MM8011	MRF5812	2-647
MM8012	MRF587	2-407
MM8020	MRF951	2-533
MM8021	MRF951	2-533
MM8023	MRF5943	2-651
MMBR2060	BFS17LT1	2-26
MMBR2060L	BFS17LT1	2-26
MMBR2857	MMBR5179LT1	2-52
MMBR2857L	MMBR5179LT1	2-52
MMBR4957	MMBR4957LT1	2-49
MMBR4957L	MMBR4957LT1	2-49
MMBR4957LT1	MMBR4957LT1	2-49
MMBR5031	MMBR5031LT1	2-51
MMBR5031L	MMBR5031LT1	2-51
MMBR5031LT1	MMBR5031LT1	2-51
MMBR5179	MMBR5179LT1	2-52
MMBR5179L	MMBR5179LT1	2-52
MMBR5179LT1	MMBR5179LT1	2-52
MMBR521L	MMBR521LT1	2-34
MMBR521LT1	MMBR521LT1	2-34
MMBR536	MMBR536LT1	2-53
MMBR536L	MMBR536LT1	2-53
MMBR536LT1	MMBR536LT1	2-53
MMBR571	MMBR571LT1	2-58
MMBR571L	MMBR571LT1	2-58
MMBR571LT1	MMBR571LT1	2-58
MMBR901	MMBR901LT1	2-42
MMBR901L	MMBR901LT1	2-42
MMBR901LT1	MMBR901LT1	2-42
MMBR911	MMBR911LT1	2-72
MMBR911L	MMBR911LT1	2-72
MMBR911LT1	MMBR911LT1	2-72
MMBR920	MMBR920LT1	2-47
MMBR920L	MMBR920LT1	2-47
MMBR920LT1	MMBR920LT1	2-47
MMBR930	MMBR911LT1	2-72
MMBR930L	MMBR911LT1	2-72
MMBR931	MMBR931LT1	2-48
MMBR931L	MMBR931LT1	2-48

5

Industry Part Number	Motorola Closest Replacement	Page No.
MMBR931LT1	MMBR931LT1	2-48
MMBR941	MMBR941LT1	2-514
MMBR941BLT1	MMBR941BLT1	2-514
MMBR941L	MMBR941LT1	2-514
MMBR941LT1	MMBR941LT1	2-514
MMBR951	MMBR951LT1	2-533
MMBR951ALT1	MMBR951ALT1	2-533
MMBR951L	MMBR951LT1	2-533
MMBR951LT1	MMBR951LT1	2-533
MO1011B150Y	MRF1150MA	2-582
MO1011B250Y	MRF10350	2-698
MPS1983	MPS901	2-68
MPS3866	MPS3866	2-78
MPS536	MPS536	2-53
MPS571	MPS571	2-58
MPS901	MPS901	2-68
MPS911	MPS911	2-72
MR1011B150Y	MRF1150MA	2-582
MR1011B300Y	MRF10350	2-698
MRA0204-30V	MRF325	2-319
MRA0204-60	2N6439	2-2
MRA0204-60V	2N6439	2-2
MRA0204-70	MRF327	2-327
MRA1000-14L	MRA1000-14L	2-84
MRA1000-7L	MRA1000-7L	2-80
MRA1214-55H	MRF10120	2-691
MRA1417-6	MRA1417-6	2-86
MRA2000-5L	MRF2000-5L	2-597
MRAL1720-20	MRAL1720-20	2-89
MRAL2023-18	MRAL2023-18	2-96
MRAL2023-3	MRAL2023-3	2-92
MRAL2023-6	MRAL2023-6	2-92
MRAL2327-1.3	MRAL2023-3	2-92
MRAL2327-3	MRAL2327-3	2-98
MRAL2327-12	MRAL2327-12	2-98
MRB12175YR	MRF1150MA	2-582
MRB12350YR	MRF10350	2-698
MRF0211	MRF0211LT1	2-279
MRF0211L	MRF0211LT1	2-279
MRF0211LT1	MRF0211LT1	2-279
MRF10005	MRF10005	2-681
MRF1000MA	MRF1000MA	2-549
MRF1000MB	MRF1000MB	2-549
MRF1000MC	MRF1000MA	2-549
MRF1001A	MRF5812	2-647
MRF1002MA	MRF1002MA	2-553
MRF1002MB	MRF1002MB	2-553
MRF1002MC	MRF1002MA	2-553
MRF10030	MRF10031	2-685
MRF10031	MRF10031	2-685
MRF1004MA	MRF1004MA	2-557
MRF1004MB	MRF1004MB	2-557
MRF1004MC	MRF1004MA	2-557
MRF10070	MRF10070	2-688
MRF10120	MRF10120	2-691
MRF10150	MRF10150	2-695
MRF1015MA	MRF1015MA	2-561
MRF1015MB	MRF1015MB	2-561
MRF1015MC	MRF1015MA	2-561
MRF1029	MRF1029	2-565

Industry Part Number	Motorola Closest Replacement	Page No.
MRF1030	MRF1030	2-567
MRF1031	MRF1031	2-569
MRF1032	MRF1032	2-571
MRF10350	MRF10350	2-698
MRF1035MA	MRF1035MA	2-573
MRF1035MB	MRF1035MB	2-573
MRF1035MC	MRF1035MA	2-573
MRF10500	MRF10500	2-701
MRF1090MA	MRF1090MA	2-577
MRF1090MB	MRF1090MB	2-577
MRF1090MC	MRF1090MA	2-577
MRF1150M	MRF10150	2-695
MRF1150MA	MRF1150MA	2-582
MRF1150MB	MRF1150MB	2-582
MRF1150MC	MRF1150MA	2-582
MRF1250M	MRF10350	2-698
MRF1325M	MRF10350	2-698
MRF134	MRF134	2-101
MRF136	MRF136	2-110
MRF136Y	MRF136Y	2-110
MRF137	MRF137	2-120
MRF1375	MRF1375	2-587
MRF138	MRF138	2-128
MRF140	MRF140	2-133
MRF141	MRF141	2-138
MRF141G	MRF141G	2-143
MRF148	MRF148	2-148
MRF150	MRF150	2-153
MRF1500	MRF1500	2-590
MRF15030	MRF15030	2-704
MRF15090	MRF15090	2-712
MRF151	MRF151	2-158
MRF151G	MRF151G	2-164
MRF153	MRF157	2-175
MRF154	MRF154	2-169
MRF157	MRF157	2-175
MRF158	MRF158	2-181
MRF158R	MRF158R	2-181
MRF161	MRF161	2-187
MRF162	MRF162	2-195
MRF163	MRF163	2-203
MRF164W	MRF164W	2-211
MRF166	MRF166	2-215
MRF166C	MRF166C	2-215
MRF171	MRF171	2-222
MRF172	MRF172	2-230
MRF173	MRF173	2-230
MRF173CQ	MRF173CQ	2-230
MRF174	MRF174	2-235
MRF175GU	MRF175GU	2-243
MRF175GV	MRF175GV	2-243
MRF175LU	MRF175LU	2-250
MRF175LV	MRF175LV	2-250
MRF176GU	MRF176GU	2-257
MRF176GV	MRF176GV	2-257
MRF177	MRF177	2-265
MRF177M	MRF177M	2-265
MRF182	MRF182	2-273
MRF183	MRF183	2-276
MRF1946	MRF1946	2-593

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
MRF1946A	MRF1946A	2-593
MRF2000-5L	MRF2000-5L	2-597
MRF2001	MRW2001	2-723
MRF2003	MRW2003	2-723
MRF2003B	MRW2003	2-723
MRF2003M	MRAL2023-3	2-92
MRF2005	MRW2005	2-723
MRF2005B	MRW2005	2-723
MRF2005M	MRAL2023-6	2-92
MRF201	MRF5003	2-619
MRF2010	MRW2010	2-723
MRF2010B	MRW2010	2-723
MRF2016M	MRAL2023-18	2-96
MRF203	MRF247	2-290
MRF212	MRF2628	2-601
MRF216	MRF247	2-290
MRF221	MRF5015	2-629
MRF222	MRF1946/A	2-593
MRF223	MRF1946/A	2-593
MRF224	MRF224	2-283
MRF226	MRF5015	2-629
MRF227	MRF5003	2-619
MRF229	MRF5003	2-619
MRF231	MRF5003	2-619
MRF232	MRF2628	2-601
MRF233	MRF2628	2-601
MRF234	MRF1946/A	2-593
MRF2369	MRF0211LT1	2-279
MRF237	MRF5003	2-619
MRF238	MRF1946/A	2-593
MRF239	MRF1946/A	2-593
MRF240	MRF240	2-286
MRF240A	MRF1946	2-593
MRF243	MRF247	2-290
MRF245	MRF247	2-290
MRF247	MRF247	2-290
MRF248	MRF247	2-290
MRF2628	MRF2628	2-601
MRF3001	MRW3001	2-728
MRF3001F	MRW3001	2-728
MRF3003	MRW3003	2-728
MRF3003F	MRW3003	2-728
MRF3005	MRW3005	2-728
MRF3005F	MRW3005	2-728
MRF305	MRF325	2-319
MRF306	2N6439	2-2
MRF309	2N6439	2-2
MRF3094	MRF3094	2-605
MRF3095	MRF3095	2-605
MRF3096	MRF3096	2-605
MRF3104	MRF3104	2-610
MRF3105	MRF3105	2-610
MRF3106	MRF3106	2-610
MRF313	MRF313	2-293
MRF313A	MRF313	2-293
MRF314	MRF314	2-295
MRF314A	MRF314	2-295
MRF315	MRF315	2-299
MRF315A	MRF315	2-299
MRF316	MRF316	2-303

Industry Part Number	Motorola Closest Replacement	Page No.
MRF317	MRF317	2-307
MRF321	MRF321	2-311
MRF323	MRF323	2-315
MRF325	MRF325	2-319
MRF326	MRF326	2-323
MRF327	MRF327	2-327
MRF329	MRF329	2-331
MRF331	MRF321	2-311
MRF338	MRF393	2-339
MRF3866	MRF3866	2-613
MRF390	MRF177	2-265
MRF392	MRF392	2-335
MRF393	MRF393	2-339
MRF401	MRF426	2-351
MRF402	MRF4427	2-615
MRF4070	MRF247	2-290
MRF412	MRF492	2-371
MRF412A	MRF492	2-371
MRF415	MRF5003	2-619
MRF417	MRF455	2-365
MRF418	MRF455	2-365
MRF420	MRF454	2-363
MRF421	MRF421	2-343
MRF422	MRF422	2-347
MRF422A	MRF422	2-347
MRF426	MRF426	2-351
MRF426A	MRF426	2-351
MRF427	MRF138	2-128
MRF427A	MRF138	2-128
MRF428	MRF429	2-355
MRF428A	MRF429	2-355
MRF429	MRF429	2-355
MRF430	MRF157	2-175
MRF433	MRF2628	2-601
MRF435	MRF422	2-347
MRF4427	MRF4427	2-615
MRF448	MRF448	2-359
MRF449	MRF1946/A	2-593
MRF449A	MRF1946/A	2-593
MRF450	MRF455	2-365
MRF450A	MRF455	2-365
MRF451	MRF455	2-365
MRF452	MRF455	2-365
MRF453	MRF455	2-365
MRF453A	MRF455	2-365
MRF454	MRF454	2-363
MRF454A	MRF454	2-363
MRF455	MRF455	2-365
MRF455A	MRF455	2-365
MRF458	MRF454	2-363
MRF458A	MRF454	2-363
MRF460	MRF455	2-365
MRF464	MRF464	2-367
MRF464A	MRF464	2-367
MRF466	MRF138	2-128
MRF492	MRF492	2-371
MRF492A	MRF492	2-371
MRF5003	MRF5003	2-619
MRF501	MMBR5179LT1	2-52
MRF5015	MRF5015	2-629

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
MRF502	MMBR5179LT1	2-52
MRF5035	MRF5035	2-637
MRF504	MRF587	2-407
MRF511	MRF587	2-407
MRF515	MRF559	2-388
MRF5176	MRF323	2-315
MRF5177	MRF325	2-319
MRF5177A	MRF325	2-319
MRF5178	2N6439	2-2
MRF521	MRF521	2-34
MRF5211	MRF5211LT1	2-34
MRF5211L	MRF5211LT1	2-34
MRF5211LT1	MRF5211LT1	2-34
MRF522	MRF521	2-34
MRF524	MRF521	2-34
MRF525	MRF5003	2-619
MRF526	MRF5812	2-647
MRF534	MPS536	2-53
MRF536	MPS536	2-53
MRF553	MRF553	2-374
MRF555	MRF555	2-379
MRF557	MRF557	2-383
MRF5583	MRF5583	2-645
MRF559	MRF559	2-388
MRF571	MRF571	2-395
MRF5711	MRF5711LT1	2-58
MRF5711L	MRF5711LT1	2-58
MRF5711LT1	MRF5711LT1	2-58
MRF572	MRF571	2-395
MRF580	MRF581	2-401
MRF580A	MRF581A	2-401
MRF581	MRF581	2-401
MRF5812	MRF5812	2-647
MRF581A	MRF581A	2-401
MRF586	MRF5812	2-647
MRF587	MRF587	2-407
MRF5943	MRF5943	2-651
MRF601	MRF559	2-388
MRF602	MRF644	2-418
MRF603	MRF2628	2-601
MRF604	MRF4427	2-615
MRF605	2N6439	2-2
MRF616	MRF652S	2-428
MRF618	MRF641	2-414
MRF619	MRF644	2-418
MRF620	MRF644	2-418
MRF628	MRF559	2-388
MRF629	MRF5003	2-619
MRF630	MRF5003	2-619
MRF6401	MRF6401	2-653
MRF6402	MRF6402	2-657
MRF6403	MRF6403	2-661
MRF6404	MRF6404	2-664
MRF6406	MRF6406	2-669
MRF641	MRF641	2-414
MRF644	MRF644	2-418
MRF646	MRF650	2-422
MRF648	MRF650	2-422
MRF650	MRF650	2-422
MRF652	MRF652	2-428

Industry Part Number	Motorola Closest Replacement	Page No.
MRF652S	MRF652S	2-428
MRF653	MRF653	2-432
MRF653S	MRF653S	2-432
MRF654	MRF654	2-436
MRF658	MRF658	2-440
MRF750	MRF557	2-383
MRF752	MRF5003	2-619
MRF816	MRF837	2-444
MRF837	MRF837	2-444
MRF8372	MRF8372	2-673
MRF838	MRF557	2-383
MRF838A	MRF557	2-383
MRF839	MRF840	2-453
MRF839F	MRF839F	2-450
MRF840	MRF840	2-453
MRF842	MRF842	2-457
MRF843	MRF842	2-457
MRF843F	MRF842	2-457
MRF844	MRF844	2-461
MRF846	MRF847	2-464
MRF847	MRF847	2-464
MRF870	MRF840	2-453
MRF870A	MRF840	2-453
MRF880	MRF880	2-467
MRF890	MRF890	2-472
MRF890S	MRF890S	2-472
MRF891	MRF891	2-476
MRF891S	MRF891S	2-476
MRF892	MRF892	2-480
MRF894	MRF894	2-484
MRF896	MRF896	2-488
MRF896S	MRF896S	2-488
MRF897	MRF897	2-493
MRF898	MRF898	2-498
MRF899	MRF899	2-502
MRF901	MRF901	2-508
MRF9011	MRF9011LT1	2-42
MRF9011L	MRF9011LT1	2-42
MRF9011LT1	MRF9011LT1	2-42
MRF902	MRF901	2-508
MRF904	MRF9011LT1	2-42
MRF905	MRF5812	2-647
MRF911	MRF571	2-395
MRF912	MMBR911LT1	2-72
MRF914	MRF571	2-395
MRF931	MRF9331LT1	2-677
MRF9331	MRF9331LT1	2-677
MRF9331L	MRF9331LT1	2-677
MRF9331LT1	MRF9331LT1	2-677
MRF941	MRF941	2-514
MRF9411	MRF9411LT1	2-514
MRF9411BLT1	MRF9411BLT1	2-514
MRF9411L	MRF9411LT1	2-514
MRF9411LT1	MRF9411LT1	2-514
MRF942	MRF941	2-514
MRF947	MRF947T1	2-527
MRF947B	MRF947BT1	2-527
MRF947BT1	MRF947BT1	2-527
MRF947T1	MRF947T1	2-527
MRF951	MRF951	2-533

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
MRF9511	MRF9511LT1	2-533
MRF9511L	MRF9511LT1	2-533
MRF9511LT1	MRF9511LT1	2-533
MRF952	MRF951	2-533
MRF957	MRF957T1	2-544
MRF957T1	MRF957T1	2-544
MRF961	MRF951	2-533
MRF962	MRF951	2-533
MRF965	BFR96	2-22
MRFA2600	MRFA2600	3-176
MRFA2602	MRFA2602	3-179
MRFIC2001	MRFIC2001	3-183
MRFIC2002	MRFIC2002	3-189
MRFIC2003	MRFIC2003	3-194
MRFIC2004	MRFIC2004	3-197
MRFIC2006	MRFIC2006	3-202
MRFQ17	MRFQ17	2-721
MRFQ19	BFR96	2-22
MRT0105-75	MRF393	2-339
MRT0105-75V	MRF393	2-339
MRT0204-110V	MRF392	2-335
MRT0204-125	MRF392	2-335
MRW2001	MRW2001	2-723
MRW2001F	MRW2001	2-723
MRW2003	MRW2003	2-723
MRW2003F	MRW2003	2-723
MRW2005	MRW2005	2-723
MRW2005F	MRW2005	2-723
MRW2010	MRW2010	2-723
MRW2010F	MRW2010	2-723
MRW3001	MRW3001	2-728
MRW3001F	MRW3001	2-728
MRW3003	MRW3003	2-728
MRW3003F	MRW3003	2-728
MRW3005	MRW3005	2-728
MRW3005F	MRW3005	2-728
MRW52102	MRW52602	2-733
MRW52104	MRW52604	2-736
MRW52202	MRW52602	2-733
MRW52204	MRW52604	2-736
MRW52402	MRW52602	2-733
MRW52502	MRW52602	2-733
MRW52602	MRW52602	2-733
MRW52604	MRW52604	2-736
MRW53101	MRW53601	2-742
MRW53201	MRW53601	2-742
MRW53401	MRW53601	2-742
MRW53402	MRW53502	2-739
MRW53502	MRW53502	2-739
MRW53601	MRW53601	2-742
MRW54001	MRW54001	2-745
MRW54601	MRW54601	2-745
MSC1000M	MRF1000MA	2-549
MSC1002M	MRF1002MA	2-553
MSC1004M	MRF1004MA	2-557
MSC1015M	MRF1015MA	2-561
MSC1035M	MRF1035MA	2-573
MSC1075M	MRF1090MA	2-577
MSC1090M	MRF1090MA	2-577
MSC1175M	MRF10150	2-695

Industry Part Number	Motorola Closest Replacement	Page No.
MSC1250M	MRF10350	2-698
MSC1325M	MRF10350	2-698
MSC2001	MRW2001	2-723
MSC2003	MRW2003	2-723
MSC2005	MRW2005	2-723
MSC2010	MRW2010	2-723
MSC8020M	MRAL2023-18	2-96
MSC82001	MRW2001	2-723
MSC82003	MRW2003	2-723
MSC82005	MRW2005	2-723
MSC82005M	MRAL2023-6	2-92
MSC82010	MRW2010	2-723
MSC82201	MRW2001	2-723
MSC82203	MRW2003	2-723
MSC82304M	MRAL2023-6	2-92
MSC82313M	MRAL2023-18	2-96
MWA5121	MHW5172A	3-145
MX20-1	MHW720A1	3-84
MX20-2	MHW720A2	3-84
MXR100	MRF5812	2-647
MXR3866	MRF3866	2-613
MXR5583	MRF5583	2-645
MXR571	MRF5711LT1	2-58
MXR5943	MRF5943	2-651
MXR911	MMBR911LT1	2-72
NE020320-12	MRF5003	2-619
NE020320-28	MRF321	2-311
NE020620-07	MRF653	2-432
NE021020-12	MRF653	2-432
NE021020-28	MRF321	2-311
NE02107	MRF571	2-395
NE02132	MPS571	2-58
NE02133	MMBR571LT1	2-58
NE02137	MRF0211LT1	2-279
NE022025-12	MRF2628	2-601
NE022025-28	MRF314	2-295
NE022526-12	MRF1946/A	2-593
NE024027-28	MRF315	2-299
NE028029-12	MRF247	2-290
NE028029-28	MRF316	2-303
NE050214-12	MRF5003	2-619
NE050320-12	MRF5003	2-619
NE051020-28	MRF321	2-311
NE051025-12	MRF653	2-432
NE051525-12	MRF654	2-436
NE052025-28	MRF323	2-315
NE080420-12	MRF840	2-453
NE21935	MRF571	2-395
NE21937	MRF571	2-395
NE22120	MRF587	2-407
NE24615	MRF5812	2-647
NE24620	MRF587	2-407
NE32702	MMBR911LT1	2-72
NE32707	MMBR911LT1	2-72
NE41603	MRF951	2-533
NE41607	MRF951	2-533
NE41610	BFR96	2-22
NE41612	BFR96	2-22
NE41615	BFR96	2-22
NE41620	MRF587	2-407

5

Industry Part Number	Motorola Closest Replacement	Page No.
NE41635	MRF951	2-533
NE57510	MRF5812	2-647
NE57520	MRF587	2-407
NE57803	MRF941	2-514
NE57807	MRF941	2-514
NE59312	MMBR536LT1	2-53
NE59335	MRF5812	2-647
NE59503	MRF581	2-401
NE64310	MRF5812	2-647
NE64320	MRF587	2-407
NE68132	MPS571	2-58
NE68133	MMBR571LT1	2-58
NE68137	MRF571	2-395
NE73412	MRF571	2-395
NE73432	MMBR911LT1	2-72
NE73433	MMBR911LT1	2-72
NE73435	MMBR911LT1	2-72
NE73437	MMBR911LT1	2-72
NE74014	MRF5812	2-647
NE74020	MRF587	2-407
NE74113	MRF5812	2-647
NE74114	MRF5812	2-647
NE77320	MRF587	2-407
NE85632	MPS571	2-58
NE85633	MMBR571LT1	2-58
NE85637	MRF571	2-395
NE88912	MMBR536LT1	2-53
NE88933	MMBR536LT1	2-53
NEL080120-24	MRF890	2-472
NEM020C29-28	MRF317	2-307
NEM050C29-28	MRF327	2-327
NEM054029-28	MRF325	2-319
NEM056029-12	MRF658	2-440
NEM056029-28	2N6439	2-2
NEM080481E-12	MRF839F	2-450
NEM081081B-12	MRF840	2-453
NEM081081E-12	MRF842	2-457
NEM082081B-12	MRF842	2-457
NEM084081B-12	MRF844	2-461
NEM085081B-12	MRF847	2-464
NEM090701-7	MRF840	2-453
NEM092081B-28	MRF892	2-480
NEM094081B-28	MRF894	2-484
NEM2305B-20	MRAL2023-6	2-92
ON4184	MPS901	2-68
PEE0015U	MRF323	2-315
PEE0020U	MRF323	2-315
PEE0035U	MRF325	2-319
PH0105-100	MRF393	2-339
PH0412H	MRF321	2-311
PH0425H	MRF325	2-319
PH0450D	2N6439	2-2
PH0450H	2N6439	2-2
PH0506H	MRF321	2-311
PH0512H	MRF321	2-311
PH0525H	MRF325	2-319
PH0550H	2N6439	2-2
PH1100C	MRF1150MA	2-582
PH1100H	MRF1150MA	2-582
PH1110C	MRF1015MA	2-561
PH1150C	MRF1090MA	2-577
PH1175	MRF1150MA	2-582
PH2003C	MRAL2023-3	2-92
PH2005C	MRAL2023-6	2-92
PH2020C	MRAL2023-18	2-96
PH8193	MRF5812	2-647
PHA3317-1	MHW5172A	3-145
PHA3317-2	MHW5172A	3-145
PHA3318-1	MHW5182A	3-147
PHA3318-2	MHW5182A	3-147
PHA3334-2	MHW5272A	3-156
PHA4517-1	MHW5172A	3-145
PHA4517-2	MHW5172A	3-145
PHA4518-1	MHW5182A	3-147
PHA4518-2	MHW5182A	3-147
PHA4534	MHW5342A	3-158
PHA5018-1	MHW6182	3-165
PHA5018-2	MHW6182	3-165
PHA5034	MHW5342A	3-158
PKB20010U	MRW2010	2-723
PME04030U	MRF325	2-319
PT3501	MRF4427	2-615
PT3503	MRF5003	2-619
PT3535	MRF4427	2-615
PT3536	MRF553	2-374
PT3537	MRF5003	2-619
PT3570	MRF587	2-407
PT3571	MRF5943	2-651
PT3571A	MRF5943	2-651
PT3690	MRF134	2-101
PT4537	MRF5003	2-619
PT4555	MRF1946/A	2-593
PT4570	MRF587	2-407
PT4572A	MRF587	2-407
PT4574	MRF587	2-407
PT4579	MRF5812	2-647
PT4599G	MRF5812	2-647
PT4617	MRF587	2-407
PT5695	MRF2628	2-601
PT5701	MRF4427	2-615
PT5740	MRF2628	2-601
PT5741	MRF1946/A	2-593
PT5788	MRF464	2-367
PT6665A	MRF464	2-367
PT8549	MRF5003	2-619
PT8554A	MRF492	2-371
PT8717	MRF5003	2-619
PT8769	MRF2628	2-601
PT8809	MRF5003	2-619
PT8809A	MRF5003	2-619
PT8809S	MRF652S	2-428
PT8810	MRF652	2-428
PT8811	MRF653	2-432
PT8811A	MRF653	2-432
PT8825	MRF644	2-418
PT8837	MRF2628	2-601
PT8838	MRF1946/A	2-593
PT8851A	MRF2628	2-601
PT8852	MRF1946/A	2-593
PT8852A	MRF1946/A	2-593

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
PT8854	MRF492	2-371
PT8854A	MRF492	2-371
PT8860	MRF4427	2-615
PT8861A	MRF5003	2-619
PT8863	MRF1946/A	2-593
PT8863A	MRF1946/A	2-593
PT8864	MRF224	2-283
PT8864A	MRF1946/A	2-593
PT8865	MRF492	2-371
PT8865A	MRF492	2-371
PT8866	MRF5003	2-619
PT8870A	MRF2628	2-601
PT8871	MRF652S	2-428
PT8871A	MRF5003	2-619
PT8873A	MRF2628	2-601
PT8874	MRF224	2-283
PT8874A	MRF1946/A	2-593
PT8877	MRF5003	2-619
PT8881	MRF652S	2-428
PT8881A	MRF5003	2-619
PT8889	MRF5812	2-647
PT9073B	MRF321	2-311
PT9701B	MRF321	2-311
PT9702	MRF323	2-315
PT9702B	MRF323	2-315
PT9703	MRF321	2-311
PT9703B	MRF321	2-311
PT9704	MRF325	2-319
PT9704A	MRF325	2-319
PT9704B	MRF163	2-203
PT9730	MRF161	2-187
PT9731	MRF314	2-295
PT9732	MRF321	2-311
PT9734	MRF323	2-315
PT9776	MRF492	2-371
PT9776A	MRF492	2-371
PT9780	MRF422	2-347
PT9780A	MRF422	2-347
PT9782	MRF317	2-307
PT9782A	MRF317	2-307
PT9783	MRF464	2-367
PT9783A	MRF464	2-367
PT9784	MRF454	2-363
PT9784A	MRF454	2-363
PT9785	MRF421	2-343
PT9788	MRF426	2-351
PT9788A	MRF426	2-351
PT9790	MRF429	2-355
PT9795	MRF1946/A	2-593
PT9795A	MRF2628	2-601
PT9796	MRF1946/A	2-593
PT9796A	MRF1946/A	2-593
PT9798	MRF429	2-355
PT9847	MRF421	2-343
PTE801	MRF890	2-472
RF1004	MRF1946/A	2-593
RF1023	MRF321	2-311
RF1023R	MRF321	2-311
RF1029	MRF1029	2-565
RF1030	MRF1030	2-567

Industry Part Number	Motorola Closest Replacement	Page No.
RF1031	MRF1031	2-569
RF1032	MRF1032	2-571
RF105	MRF421	2-343
RF110	MRF421	2-343
RF14	MRF455	2-365
RF15	MRF455	2-365
RF16	MRF455	2-365
RF2081	MRF247	2-290
RF2092	MRF455	2-365
RF2123	MRF1946/A	2-593
RF2127	MRF247	2-290
RF2135	MRF1946/A	2-593
RF2143	MRF454	2-363
RF2144	MRF224	2-283
RF23	MRF224	2-283
RF25	MRF455	2-365
RF3094	MRF3094	2-605
RF3095	MRF3095	2-605
RF3096	MRF3096	2-605
RF3104	MRF3104	2-610
RF3105	MRF3105	2-610
RF3106	MRF3106	2-610
RF35	MRF455	2-365
RF45	MRF455	2-365
RF46	MRF1946/A	2-593
RF48	MRF1946/A	2-593
RF49	MRF1946/A	2-593
RF85	MRF454	2-363
RFA6031	MRFA2600	3-176
RFA6060	MRFA2602	3-179
RFA8090B	RFA8090B	3-207
RFA8180B	RFA8180B	3-211
S-AU11	MHW806A3	3-98
S-AU16H	MHW707-2	3-77
S-AU27L	MHW720A1	3-84
S-AU27M	MHW720A2	3-84
S-AU31	MHW806A3	3-98
S-AU9	MHW812A3	3-103
S-AV16H	MHW607-2	3-70
S-AV16L	MHW607-1	3-70
S-AV16VH	MHW607-2	3-70
SD1005	MRF587	2-407
SD1006	MRF5943	2-651
SD1007-1	MRF587	2-407
SD1012	MRF5003	2-619
SD1013	MRF134	2-101
SD1014-2	MRF2628	2-601
SD1015	MRF314	2-295
SD1018	MRF1946/A	2-593
SD1018-15	MRF224	2-283
SD1018-6	MRF224	2-283
SD1019	MRF316	2-303
SD102-6	MRF313	2-293
SD102-7	MRF313	2-293
SD1021	MRF2628	2-601
SD1022	MRF1946/A	2-593
SD1074	MRF455	2-365
SD1076	MRF454	2-363
SD1078	MRF464	2-367
SD1080-4	MRF4427	2-615

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
SD1080-7	MRF557	2-383
SD1087	MRF641	2-414
SD1088	MRF644	2-418
SD1095	MRF840	2-453
SD1096	MRF842	2-457
SD1098	MRF844	2-461
SD1099	MRF847	2-464
SD1124	MRF247	2-290
SD1127	MRF5003	2-619
SD1131	MRF5003	2-619
SD1132-5	MRF557	2-383
SD1133	MRF2628	2-601
SD1133-1	MRF2628	2-601
SD1134	MRF5003	2-619
SD1134-1	MRF5003	2-619
SD1135	MRF652	2-428
SD1135-3	MRF652S	2-428
SD1136	MRF653	2-432
SD1143	MRF2628	2-601
SD1146	MRF2628	2-601
SD1148	MRF321	2-311
SD1149	MRF323	2-315
SD1150	MRF652	2-428
SD1150-3	MRF652S	2-428
SD1168	MRF1946/A	2-593
SD1174	MRF5003	2-619
SD1177	MRF5003	2-619
SD1200	MRF3866	2-613
SD1212-2	MRF5003	2-619
SD1214-12	MRF2628	2-601
SD1216	MRF1946/A	2-593
SD1218	MRF1946/A	2-593
SD1220	MRF134	2-101
SD1220-1	MRF134	2-101
SD1224-10	MRF138	2-128
SD1224-2	MRF315	2-299
SD1224-4	MRF138	2-128
SD1229-1	MRF1946/A	2-593
SD1229-7	MRF1946/A	2-593
SD1242-5	MRF134	2-101
SD1245	MRF321	2-311
SD1256	MRF5003	2-619
SD1272	MRF1946/A	2-593
SD1272-2	MRF1946/A	2-593
SD1273	MRF240	2-286
SD1274	MRF1946/A	2-593
SD1274-1	MRF1946/A	2-593
SD1275	MRF240	2-286
SD1275-1	MRF224	2-283
SD1278	MRF240	2-286
SD1288	MRF455	2-365
SD1289	MRF455	2-365
SD1295	MRF421	2-343
SD1299	MRF326	2-323
SD1308	MRF5812	2-647
SD1309	MMBR5179LT1	2-52
SD1315	MRF587	2-407
SD1316	MRF5812	2-647
SD1317	MRF587	2-407
SD1330	MRF571	2-395

Industry Part Number	Motorola Closest Replacement	Page No.
SD1331	MRF571	2-395
SD1332	MRF901	2-508
SD1333	MRF951	2-533
SD1334	MRF581	2-401
SD1347-7	MRF4427	2-615
SD1375	MMBR4957LT1	2-49
SD1398	TP3006	2-752
SD1400-2	MRF892	2-480
SD1400-3	MRF892	2-480
SD1401	MRF894	2-484
SD1402	MRF559	2-388
SD1403	MRF429	2-355
SD1405	MRF454	2-363
SD1407	MRF422	2-347
SD1407-8	MRF317	2-307
SD1409	MRF840	2-453
SD1410	MRF840	2-453
SD1410-1	MRF842	2-457
SD1410-3	MRF840	2-453
SD1411	MRF448	2-359
SD1412	MRF842	2-457
SD1412-3	MRF842	2-457
SD1414	MRF847	2-464
SD1415	MRF247	2-290
SD1416	MRF247	2-290
SD1418	MRF842	2-457
SD1420	TP3020A	2-768
SD1420-1	MRF890S	2-472
SD1421	MRF844	2-461
SD1422	MRF644	2-418
SD1423	TP3022B	2-773
SD1424	TP3024B	2-774
SD1426	MRF898	2-498
SD1427	MRF247	2-290
SD1428	MRF247	2-290
SD1429	MRF641	2-414
SD1429-3	MRF641	2-414
SD1430	MRF1946/A	2-593
SD1433	MRF653	2-432
SD1438	MRF316	2-303
SD1438-2	MRF317	2-307
SD1439	TPV596A	2-817
SD1444	MRF5003	2-619
SD1446	MRF492	2-371
SD1448	TPV598	2-823
SD1449	TPV597	2-820
SD1450	MRF422	2-347
SD1451	MRF455	2-365
SD1451-1	MRF455	2-365
SD1452	MRF454	2-363
SD1461	MRF313	2-293
SD1462	MRF327	2-327
SD1463	MRF392	2-335
SD1464	MRF393	2-339
SD1466	MRF326	2-323
SD1467	MRF326	2-323
SD1468	MRF327	2-327
SD1469	MRF329	2-331
SD1470	MRF329	2-331
SD1475	MRF321	2-311

5

Index and Cross Reference (continued)

Industry Part Number	Motorola Closest Replacement	Page No.
SD1484-10	MRF4427	2-615
SD1487	MRF421	2-343
SD1490	TPV7025	2-832
SD1492	TPV8200B	2-841
SD1495	MRF894	2-484
SD1495-3	MRF894	2-484
SD1496	MRF898	2-498
SD1496-3	MRF898	2-498
SD1499	MRF393	2-339
SD1499-1	MRF658	2-440
SD1512	MRF10005	2-681
SD1513	MRF10031	2-685
SD1514	MRF10150	2-695
SD1520	MRF1000MA	2-549
SD1520-3	MRF1000MB	2-549
SD1522	MRF1000MA	2-549
SD1522-3	MRF1002MB	2-553
SD1522-4	MRF1002MA	2-553
SD1524	MRF1004MA	2-557
SD1524-1	MRF1004MB	2-557
SD1528	MRF1035MA	2-573
SD1528-6	MRF1035MB	2-573
SD1530	MRF1035MA	2-573
SD1530-1	MRF1035MB	2-573
SD1532	MRF1090MA	2-577
SD1534	MRF1090MA	2-577
SD1534-1	MRF1090MB	2-577
SD1536	MRF1090MA	2-577
SD1536-3	MRF1090MB	2-577
SD1538	MRF1150MA	2-582
SD1538-2	MRF10150	2-695
SD1538-8	MRF10150	2-695
SD1540	MRF10350	2-698
SD1540-8	MRF10350	2-698
SD1541	MRF10500	2-701
SD1541-1	MRF10500	2-701
SD1541-9	MRF10500	2-701
SD1542	MRF10500	2-701
SD1546-1	MRF1090MB	2-577
SD1554	MRF10070	2-688
SD1555	MRF10070	2-688
SD1556	MRF10350	2-698
SD1557	MRF10350	2-698
SD1650	TP3061	2-783
SD1658	TP3062	2-787
SD1680	TP3069	2-796
SD1724-1	MRF464	2-367
SD1726	MRF429	2-355
SD1727	MRF429	2-355
SD1728	MRF448	2-359
SD1729	MRF422	2-347
SD1730	MRF422	2-347
SD1731	MRF448	2-359
SD1732	TPV595A	2-813
SD1847	TP62601	2-810
SD1900	MRF134	2-101
SD1900-1	MRF161	2-187
SD1902	MRF136	2-110
SD1902-1	MRF162	2-195
SD1904	MRF137	2-120

Industry Part Number	Motorola Closest Replacement	Page No.
SD1904-1	MRF163	2-203
SD1905	MRF171	2-222
SD1906-1	MRF173	2-230
SD1907	MRF173	2-230
SD1908-1	MRF174	2-235
SD1912	MRF141	2-138
SD1912-2	MRF141G	2-143
SD1918	MRF148	2-148
SD1920	MRF151	2-158
SD1920-2	MRF151G	2-164
SD4011	TPV598	2-823
SD4590	MRF899	2-502
ST1001	MRF166	2-215
ST1002	MRF171	2-222
ST1004	MRF173CQ	2-230
ST1005	MRF173	2-230
ST1006	MRF175LV	2-250
ST1007	MRF164W	2-211
ST1010	MRF174	2-235
ST1011	MRF174	2-235
ST1014	MRF166C	2-215
ST1015	MRF177M	2-265
ST1016	MRF136Y	2-110
ST1019	MRF177	2-265
ST1020	MRF175GU	2-243
ST1027	MRF141G	2-143
ST1028	MRF141G	2-143
STM915-12	MHW912	3-119
TAN15	MRF1015MA	2-561
TAN150H	MRF1150MA	2-582
TAN250A	MRF10350	2-698
TAN75	MRF1090MA	2-577
TCC0105-100	MRF393	2-339
TCC0204-125	MRF392	2-335
TCC1720-20	MRAL1720-20	2-89
TCC2023-16	MRAL2023-18	2-96
TCC2023-6	MRAL2023-6	2-92
TCC20L08	MRF3095	2-605
TCC20L15	MRF3096	2-605
TCC2100	MRF3094	2-605
TCC2223-18	MRAL2023-18	2-96
TCC2223-3	MRAL2023-3	2-92
TCC3000	MRW3001	2-728
TCC3001	MRW3001	2-728
TCC3003	MRW3003	2-728
TCC3005	MRW3005	2-728
TCC598	TPV598	2-823
TDS570	TPV595A	2-813
TDS595	TPV595A	2-813
TP1940	MRF151G	2-164
TP2031	MRF5003	2-619
TP2033	MRF1946/A	2-593
TP2034	MRF1946/A	2-593
TP2034F	MRF224	2-283
TP2037	MRF1946/A	2-593
TP212	MRF5003	2-619
TP2180	MRF247	2-290
TP2300	MRF5003	2-619
TP2304	MRF1946/A	2-593
TP2314	MRF5003	2-619

5

Industry Part Number	Motorola Closest Replacement	Page No.
TP2317	MRF1946/A	2-593
TP2325	MRF1946/A	2-593
TP2330	MRF1946/A	2-593
TP2330F	MRF1946/A	2-593
TP2335	MRF1946/A	2-593
TP2370	MRF247	2-290
TP2502	MRF652S	2-428
TP2503	MRF652	2-428
TP2505	MRF652	2-428
TP2505S	MRF652	2-428
TP2510	MRF653	2-432
TP2511	MRF653	2-432
TP2520	MRF644	2-418
TP254	MRF652	2-428
TP3004	TP3006	2-752
TP3005	TP3005	2-748
TP3006	TP3006	2-752
TP3007S	TP3007S	2-756
TP3008	TP3008	2-760
TP3009	MRF557	2-383
TP3009S	MRF557	2-383
TP301	MRF557	2-383
TP3010	MRF557	2-383
TP3010S	MRF557	2-383
TP3011	MRF840	2-453
TP3011S	MRF840	2-453
TP3012	MRF842	2-457
TP3013	MRF840	2-453
TP3015	MRF842	2-457
TP3019S	TP3019S	2-764
TP301S	MRF557	2-383
TP302	MRF840	2-453
TP3020A	TP3020A	2-768
TP3021	TP3021	2-769
TP3022A	TP3022B	2-773
TP3022B	TP3022B	2-773
TP3023	TP3005	2-748
TP3024A	TP3024B	2-774
TP3024B	TP3024B	2-774
TP302S	MRF840	2-453
TP303	MRF840	2-453
TP3032	TP3032	2-775
TP3034	TP3034	2-779
TP303S	MRF840	2-453
TP3040	TP3061	2-783
TP3060	TP3061	2-783
TP3061	TP3061	2-783
TP3062	TP3062	2-787
TP3064	TP3064	2-791
TP3069	TP3069	2-796
TP3093	MRF5812	2-647
TP312	BFR96	2-22
TP3401	MRF587	2-407
TP3401S	MRF581	2-401
TP393	MMBR911LT1	2-72
TP394	MRF5812	2-647
TP4001	MRF6401	2-653
TP4001S	MRF6401	2-653
TP4004	MRF6402	2-657
TP4012	MRF6406	2-669

Industry Part Number	Motorola Closest Replacement	Page No.
TP4025	MRF6403	2-661
TP4035	MRF6404	2-664
TP491	MMBR911LT1	2-72
TP5002S	TP5002S	2-801
TP5015	TP5015	2-804
TP5050	TP5051	2-805
TP5051	TP5051	2-805
TP62601	TP62601	2-810
TP8828	MRF2628	2-601
TP9390	MRF151G	2-164
TPA0102-130	MRF392	2-335
TPR10	MRF1015MB	2-561
TPR150	MRF1150MB	2-582
TPR50	MRF1090MB	2-577
TPV1325B	MRF151G	2-164
TPV3250B	MRF151G	2-164
TPV5055B	TPV5055B	2-826
TPV595A	TPV595A	2-813
TPV596	TPV596A	2-817
TPV596A	TPV596A	2-817
TPV597	TPV597	2-820
TPV598	TPV598	2-823
TPV6030	TPV6030	2-830
TPV6080B	TPV8200B	2-841
TPV657	TPV595A	2-813
TPV695A	TPV695A	2-825
TPV695B	TPV5055B	2-826
TPV698	TPV598	2-823
TPV7025	TPV7025	2-832
TPV8100B	TPV8100B	2-835
TPV8200B	TPV8200B	2-841
TRF559	MRF559	2-388
TRW2001	MRW2001	2-723
TRW2003	MRW2003	2-723
TRW2005	MRW2005	2-723
TRW2010	MRW2010	2-723
TRW3001	MRW3001	2-728
TRW3003	MRW3003	2-728
TRW3005	MRW3005	2-728
TRW52102	MRW52602	2-733
TRW52104	MRW52604	2-736
TRW52202	MRW52602	2-733
TRW52402	MRW52602	2-733
TRW52502	MRW52602	2-733
TRW52602	MRW52602	2-733
TRW52604	MRW52604	2-736
TRW53101	MRW53601	2-742
TRW53201	MRW53601	2-742
TRW53401	MRW53601	2-742
TRW53502	MRW53502	2-739
TRW53601	MRW53601	2-742
TRW54001	MRW54001	2-745
TRW54402	MRW53502	2-739
TRW54601	MRW54601	2-745
TRW62601	TP62601	2-810
UF2801KI	MRF158R	2-181
UF28100V	MRF177	2-265
UF2815B	MRF166C	2-215
UF2820P	MRF136Y	2-110

5

Index and Cross Reference (continued)

5

MOTOROLA DISTRIBUTOR AND WORLDWIDE SALES OFFICES

AUTHORIZED NORTH AMERICAN DISTRIBUTORS

UNITED STATES

ALABAMA

Huntsville
Arrow/Schweber Electronics . (205)837-6955
Future Electronics .... (205)830-2322
Hamilton Hallmark .... (205)837-8700
Newark .... (205)837-9091
Time Electronics .... (205)721-1133

Arizona

Phoenix
Future Electronics .... (602)968-7140
Hamilton Hallmark .... (602)437-1200
Newark Electronics .... (602)864-9905
Wyle Laboratories .... (602)437-2088

Tempe
Arrow/Schweber Electronics . (602)431-0030
Time Electronics .... (602)967-2000

CALIFORNIA

Agoura Hills
Time Electronics Corporate .. (818)707-2890

Belmont
Richardson Electronics .... (415)592-9225

Calabassas
Arrow/Schweber Electronics . (818)880-9686
Wyle Laboratories .... (818)880-9000

Chatsworth
Future Electronics .... (818)772-6240
Time Electronics .... (818)998-7200

Costa Mesa
Hamilton Hallmark .... (714)641-4100

Culver City
Hamilton Hallmark .... (213)558-2000

Irvine
Arrow/Schweber Electronics (714)587-0404
Future Electronics .... (714)250-4141
Wyle Laboratories Corporate . (714)753-9953
Wyle Laboratories .... (714)863-9953

Mountain View
Richardson Electronics .... (415)960-6900

Orange
Newark .... (714)634-8224

Rocklin
Hamilton Hallmark .... (916)624-9781

Sacramento
Newark .... (916)721-1633
Wyle Laboratories .... (916)638-5282

San Diego
Arrow/Schweber Electronics (619)565-4800
Future Electronics .... (619)625-2800
Hamilton Hallmark .... (619)571-7540
Newark .... (619)569-9877
Wyle Laboratories .... (619)565-9171

San Francisco
Newark .... (415)571-5300

San Jose
Arrow/Schweber Electronics . (408)441-9700
Arrow/Schweber Electronics . (408)428-6400
Future Electronics .... (408)434-1122

Santa Clara
Wyle Laboratories .... (408)727-2500

Sunnyvale
Hamilton Hallmark .... (408)743-3300
Time Electronics .... (408)734-9888

Torrance
Time Electronics .... (310)320-0880

Tustin
Time Electronics .... (714)669-0100

West Hills
Newark .... (818)888-3718

Woodland Hills
Hamilton Hallmark .... (818)594-0404
Richardson Electronics .... (615)594-5600

COLORADO

Lakewood
Future Electronics .... (303)232-2008

Colorado Springs
Newark .... (719)592-9494

Denver
Newark .... (303)757-3351

Englewood
Arrow/Schweber Electronics . (303)799-0258
Hamilton Hallmark .... (303)790-1662
Time Electronics .... (303)721-8882

Thornton
Wyle Laboratories .... (303)457-9953

CONNECTICUT

Chesire
Future Electronics .... (203)250-0083
Hamilton Hallmark .... (203)271-2844

Southbury
Time Electronics .... (203)271-3200

Wallingfort
Arrow/Schweber Electronics . (203)265-7741

Windsor
Newark .... (203)683-8860

FLORIDA

Altamonte Springs
Future Electronics .... (407)767-8414

Clearwater
Future Electronics .... (813)530-1222

Deerfield Beach
Arrow/Schweber Electronics . (305)429-8200

Ft. Lauderdale
Future Electronics .... (305)351-0660
Hamilton Hallmark .... (305)767-6377
Time Electronics .... (305)484-1778

Lake Mary
Arrow/Schweber Electronics . (407)333-9300

Largo/Tampa/St. Petersburg
Hamilton Hallmark .... (813)541-7440
Newark .... (813)287-1578
Time Electronics .... (407)841-6565

Orlando
Newark .... (407)896-8350
Time Electronics .... (407)841-6565

Plantation
Newark .... (305)424-4400

Winter Park
Richardson Electronics .... (407)644-1453
Hamilton Hallmark .... (407)657-3800

GEORGIA

Atlanta
Time Electronics .... (404)351-3545

Duluth
Arrow/Schweber Electronics . (404)497-1300
Hamilton Hallmark .... (404)623-5475

Norcross
Future Electronics .... (404)441-7676
Newark .... (404)448-1300
Time Electronics .... (404)368-0969

ILLINOIS

Bensenville
Hamilton Hallmark .... (708)860-7780

Chicago
Newark Electronics Corp. .. (312)784-5100

Hoffman Estates
Future Electronics .... (708)882-1255

Itasca
Arrow/Schweber Electronics (708)250-0500

LaFox
Richardson Electronics .... (708)208-2401

Schaumburg
Newark .... (708)310-8980
Time Electronics .... (708)303-3000

INDIANA

Indianapolis
Arrow/Schweber Electronics . (317)299-2071
Hamilton Hallmark .... (317)872-8875
Newark .... (317)259-0085
Time Electronics .... (708)303-3000

Ft. Wayne
Newark .... (219)484-0766

IOWA

Cedar Rapids
Newark .... (319)393-3800
Time Electronics .... (314)391-6444

KANSAS

Lenexa
Arrow/Schweber Electronics . (913)541-9542
Hamilton Hallmark .... (913)888-4747

Overland Park
Future Electronics .... (913)649-1531
Newark .... (913)677-0727
Time Electronics .... (314)391-6444

MARYLAND

Beltsville
Newark .... (301)604-1700

Columbia
Arrow/Schweber Electronics . (301)596-7800
Future Electronics .... (410)290-0600
Hamilton Hallmark .... (410)988-9800
Time Electronics .... (301)964-3090

MASSACHUSETTS

Boston
Arrow/Schweber Electronics . (508)658-0900

Bolton
Future Corporate .... (508)779-3000

Burlington
Wyle Laboratories .... (617)272-7300

Methuen
Newark .... (508)683-0913

Norwell
Richardson Electronics .... (617)871-5162

Peabody
Time Electronics .... (508)532-9900
Hamiltion Hallmark .... (508)532-3701

MICHIGAN

Detroit
Newark .... (313)967-0600

Grand Rapids
Future Electronics .... (616)698-6800

Livonia
Arrow/Schweber Electronics . (313)462-2290
Future Electronics .... (313)261-5270
Hamilton Hallmark .... (313)416-5800
Time Electronics .... (614)794-3301

MINNESOTA

Eden Prairie
Arrow/Schweber Electronics . (612)941-5280
Future Electronics .... (612)944-2200
Hamilton Hallmark .... (612)881-2600
Time Electronics .... (612)943-2433

Minneapolis
Newark .... (612)331-6350

MISSOURI

Earth City
Hamilton Hallmark .... (314)291-5350

5

UNITED STATES – continued

MISSOURI – continued

St. Louis
Arrow/Schweber Electronics . (314)567-6888
Future Electronics .... (314)469-6805
Newark .... (314)298-2505
Time Electronics .... (314)391-6444

NEW JERSEY

Cherry Hill
Hamilton Hallmark .... (609)424-0100
Fairfield
Newark .... (201)882-0300
Marlton
Arrow/Schweber Electronics . (609)596-8000
Future Electronics .... (609)596-4080
Pinebrook
Arrow/Schweber Electronics . (201)227-7880
Parsippany
Future Electronics .... (201)299-0400
Hamilton Hallmark .... (201)515-1641
Wayne
Time Electronics .... (201)785-8250

NEW MEXICO

Albuquerque
Alliance Electronics .... (505)292-3360
Hamilton Hallmark .... (505)828-0360
Newark .... (505)828-1878

NEW YORK

Commack
Newark .... (516)499-1216
Fairport
Hamilton Hallmark Electronics(716)425-3300
Hauppauge
Arrow/Schweber Electronics . (516)231-1000
Future Electronics .... (516)234-4000
Konkoma
Hamilton Hallmark .... (516)737-0600
Pittsford
Newark .... (716)381-4244
Rochester
Arrow/Schweber Electronics . (716)427-0300
Future Electronics .... (716)272-1120
Hamilton Hallmark .... (716)292-0730
Richardson Electronics ..... (716)264-1100
Time Electronics .... (315)432-0355
Rockville Centre
Richardson Electronics .... (516)872-4400
Syracuse
Future Electronics .... (315)451-2371
Time Electronics .... (315)432-0355

NORTH CAROLINA

Charlotte
Future Electronics .... (704)455-9030
Richardson Electronics .... (704)548-9042
Greensboro
Newark .... (919)292-7240
Raleigh
Arrow/Schweber Electronics . (919)876-3132
Future Electronics .... (919)790-7111
Hamilton Hallmark .... (919)872-0712
Time Electronics .... (919)693-5166

OHIO

Centerville
Arrow/Schweber Electronics . (513)435-5563
Cleveland
Newark .... (216)391-9330
Time Electronics .... (614)794-3301
Columbus
Newark .... (614)431-0809
Time Electronics .... (614)794-3301
Dayton
Future Electronics .... (513)439-5700
Newark .... (513)294-8980
Time Electronics .... (614)794-3301
Mayfield Heights
Future Electronics .... (216)449-6996
Solon
Arrow/Schweber Electronics . (216)248-3990
Hamilton Hallmark .... (216)498-1100
Worthington
Hamilton Hallmark .... (614)888-3313

OKLAHOMA

Tulsa
Hamilton Hallmark .... (918)254-6110
Newark .... (918)252-5070

OREGON

Beaverton
Arrow/Almac Electronics Corp. (503)629-8090
Future Electronics .... (503)645-9454
Wyle Laboratories .... (503)643-7900
Hamilton Hallmark .... (503)526-6200
Portland
Newark .... (503)297-1984
Time Electronics .... (503)626-2979

PENNSYLVANIA

King of Prussia
Newark .... (215)265-0933
Montgomeryville
Richardson Electronics .... (215)628-0805
Philadelphia
Time Electronics .... (609)596-6700
Pittsburgh
Arrow/Schweber Electronics . (412)963-6807
Newark .... (412)788-4790
Time Electronics .... (614)794-3301

TENNESSEE

Franklin
Richardson Electronics .... (615)791-4900
Knoxville
Newark .... (615)588-6493

TEXAS

Austin
Arrow/Schweber Electronics . (512)835-4180
Future Electronics .... (512)502-0991
Hamilton Hallmark .... (512)258-8848
Newark .... (512)338-0287
Time Electronics .... (512)346-7346
Wyle Laboratories .... (512)345-8853
Carollton
Arrow/Schweber Electronics . (214)380-6464
Dallas
Future Electronics .... (214)437-2437
Hamilton Hallmark .... (214)553-4300
Richardson Electronics .... (214)239-3680
Time Electronics .... (214)644-4644
Wyle Laboratories .... (214)235-9953
Ft. Worth
Allied Electronics .... (817)336-5401
Houston
Arrow/Schweber Electronics . (713)530-4700
Future Electronics .... (713)785-1155
Hamilton Hallmark .... (713)781-6100
Newark .... (713)270-4800
Time Electronics .... (713)530-0800
Wyle Laboratories .... (713)879-9953
Richardson
Newark .... (214)235-1998

UTAH

Salt Lake City
Arrow/Schweber Electronics . (801)973-6913
Future Electronics .... (801)467-4448
Hamilton Hallmark .... (801)266-2022
Newark .... (801)261-5660
West Valley City
Time Electronics .... (801)973-8494
Wyle Laboratories .... (801)974-9953

WASHINGTON

Bellevue
Almac Electronics Corp. ... (206)643-9992
Newark .... (206)641-9800
Richardson Electronics .... (206)646-7224
Bothell
Future Electronics .... (206)489-3400
Redmond
Hamilton Hallmark .... (206)881-6697
Time Electronics .... (206)820-1525
Wyle Laboratories .... (206)881-1150
Spokane
Arrow/Almac Electronics Corp. (509)924-9500

WISCONSIN

Brookfield
Arrow/Schweber Electronics . (414)792-0150
Future Electronics .... (414)879-0244
Milwaukee
Time Electronics .... (708)303-3000
New Berlin
Hamilton Hallmark .... (414)797-7844
Wauwatosa
Newark .... (414)453-9100

CANADA

ALBERTA

Calgary
Electro Sonic Inc. .... (403)255-9550
Future Electronics .... (403)250-5550
Hamilton Hallmark .... (800)663-5500
Edmonton
Future Electronics .... (403)438-2858
Hamilton Hallmark .... (800)663-5500

BRITISH COLUMBIA

Vancouver
Arrow Electronics .... (604)421-2333
Electro Sonic Inc. .... (604)273-2911
Future Electronics .... (604)294-1166
Hamilton Hallmark .... (604)420-4101
Newark .... (800)463-9275

MANITOBA

Winnipeg
Electro Sonic Inc. .... (204)783-3105
Future Electronics .... (204)944-1446
Hamilton Hallmark .... (800)663-5500

ONTARIO

Ottawa
Arrow Electronics .... (613)226-6903
Electro Sonic Inc. .... (613)728-8333
Future Electronics .... (613)820-8313
Hamilton/Avnet Electronics .. (613)226-1700
Toronto
Arrow Electronics .... (416)670-7769
Electro Sonic Inc. .... (416)494-1666
Future Electronics .... (416)612-9200
Hamilton Hallmark .... (905)564-6060
Newark .... (800)463-9275
Richardson Electronics .... (800)348-5530

QUEBEC

Montreal
Arrow Electronics .... (514)421-7411
Future Electronics .... (514)694-7710
Hamilton Hallmark .... (514)335-1000
Newark .... (800)463-9275
Richardson Electronics .... (800)348-5530
Quebec City
Future Electronics .... (418)877-6666

SALES OFFICES

UNITED STATES

ALABAMA, Huntsville	(205)464-6800
ARIZONA, Tempe	(602)897-5056
CALIFORNIA, Agoura Hills	(818)706-1929
CALIFORNIA, Los Angeles	(310)417-8848
CALIFORNIA, Irvine	(714)753-7360
CALIFORNIA, Roseville	(916)922-7152
CALIFORNIA, San Diego	(619)541-2163
CALIFORNIA, Sunnyvale	(408)749-0510
COLORADO, Colorado Springs	(719)599-7497
COLORADO, Denver	(303)337-3434
CONNECTICUT, Wallingford	(203)949-4100
FLORIDA, Maitland	(407)628-2636
FLORIDA, Pompano Beach/ Ft. Lauderdale	(305)351-6040
FLORIDA, Clearwater	(813)538-7750
GEORGIA, Atlanta	(404)729-7100
IDAHO, Boise	(208)323-9413
ILLINOIS, Chicago/ Hoffman Estates	(708)419-2500
INDIANA, Fort Wayne	(219)436-5818
INDIANA, Indianapolis	(317)571-0400
INDIANA, Kokomo	(317)455-5100
IOWA, Cedar Rapids	(319)378-0383
KANSAS, Kansas City/ Mission	(913)451-8555
MARYLAND, Columbia	(410)381-1570
MASSACHUSETTS, Marlborough	(508)481-8100
MASSACHUSETTS, Woburn	(617)932-9700
MICHIGAN, Detroit	(313)347-6800
MINNESOTA, Minnetonka	(612)932-1500
MISSOURI, St. Louis	(314)275-7380
NEW JERSEY, Fairfield	(201)808-2400
NEW YORK, Fairport	(716)425-4000
NEW YORK, Hauppauge	(516)361-7000
NEW YORK, Poughkeepsie/ Fishkill	(914)896-0511
NORTH CAROLINA, Raleigh	(919)870-4355
OHIO, Cleveland	(216)349-3100
OHIO, Columbus/ Worthington	(614)431-8492
OHIO, Dayton	(513)495-6800
OKLAHOMA, Tulsa	(800)544-9496
OREGON, Portland	(503)641-3681
PENNSYLVANIA, Colmar	(215)997-1020
Philadelphia/Horsham	(215)957-4100
TENNESSEE, Knoxville	(615)690-5593
TEXAS, Austin	(512)873-2000
TEXAS, Houston	(800)343-2692
TEXAS, Plano	(214)516-5100
VIRGINIA, Richmond	(804)285-2100
WASHINGTON, Bellevue	(206)454-4160
Seattle Access	(206)622-9960
WISCONSIN, Milwaukee/ Brookfield	(414)792-0122

Field Applications Engineering Available Through All Sales Offices

CANADA

BRITISH COLUMBIA, Vancouver	(604)293-7650
ONTARIO, Toronto	(416)497-8181
ONTARIO, Ottawa	(613)226-3491
QUEBEC, Montreal	(514)333-3300

INTERNATIONAL

AUSTRALIA, Melbourne	(61-3)887-0711
AUSTRALIA, Sydney	61(2)906-3855
BRAZIL, Sao Paulo	55(11)815-4200
CHINA, Beijing	86-505-2180
FINLAND, Helsinki	358-0-351 61191
car phone	358(49)211501
FRANCE, Paris/Vanves	33(1)40 955 900
GERMANY, Langenhagen/ Hannover	49(511)789911
GERMANY, Munich	49 89 92103-0
GERMANY, Nurenberg	49 911 64-3044
GERMANY, Sindelfingen	49 7031 69 910
GERMANY, Wiesbaden	49 611 761921
HONG KONG, Kwai Fong	852-489-1111
Tai Po	852-6668333
INDIA, Bangalore	(91-812)627094
ISRAEL, Tel Aviv	972(3)753-8222
ITALY, Milan	39(2)82201
JAPAN, Atsugi	81-462-23-0761
JAPAN, Gotanda	81-3-5487-8448
JAPAN, Kumagaya	81-485-26-2600
JAPAN, Kyushu	81-92-771-4212
JAPAN, Nagoya	81-52-232-1621
JAPAN, Osaka	81-06-305-1801
JAPAN, Sendai	81-22-268-4333
JAPAN, Tachikawa	81(0425)23-6700
JAPAN, Takamatsu	81-878-37-9972
JAPAN, Tokyo	(03)587-8311
JAPAN, Yokohama	81-45-472-2751
KOREA, Pusan	82(51)4635-035
KOREA, Seoul	82(2)554-5118
MALAYSIA, Penang	60(4)374514
MEXICO, Mexico City	52(5)282-0230
MEXICO, Guadalajara	52(36)21-8977
Marketing	52(36)21-2023
Customer Service	52(36)669-9160
NETHERLANDS, Best	(31)4998 612 11
PUERTO RICO, San Juan	(809)793-2170
SINGAPORE	(65)2945438
SPAIN, Madrid	34(1)457-8204
or	34(1)457-8254
SWEDEN, Solna	46(8)734-8800
SWITZERLAND, Geneva	41(22)799 11 11
SWITZERLAND, Zurich	41(1)730-4074
TAIWAN, Taipei	886(2)717-7089
THAILAND, Bangkok	66(2)254-4910
UNITED KINGDOM, Aylesbury	44(296)395-252

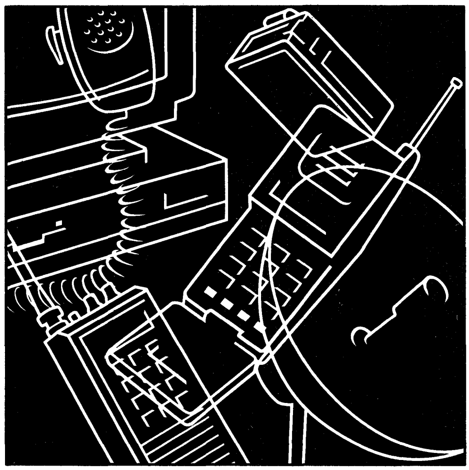
FULL LINE REPRESENTATIVES

CALIFORNIA, Loomis Galena Technology Group	(916)652-0268
COLORADO, Grand Junction Cheryl Lee Whitely	(303)243-9658
KANSAS, Wichita Melinda Shores/ Kelly Greiving	(316)838-0190
NEVADA, Reno Galena Tech. Group	(702)746-0642
NEW MEXICO, Albuquerque S&S Technologies, Inc.	(505)298-7177
UTAH, Salt Lake City Utah Comp. Sales, Inc.	(801)561-5099
WASHINGTON, Spokane Doug Kenley	(509)924-2322
ARGENTINA, Buenos Aires Argonics, S.A.	(541)343-1787

HYBRID/MCM COMPONENT SUPPLIERS

Chip Supply	(407)298-7100
Elmo Semiconductor	(818)768-7400
Minco Technology Labs Inc.	(512)834-2022
Semi Dice Inc.	(310)594-4631

5



2PHX11136Q-16 Printed in USA 5/94 BANTA CO. MOTO 38 15,000 RF YBACAA

MOTOROLA

Literature Distribution Centers:

USA: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.

EUROPE: Motorola Ltd.; European Literature Centre; 88 Tanners Drive, Blakelands, Milton Keynes, MK14 5BP, England.

JAPAN: Nippon Motorola Ltd.; 4-32-1, Nishi-Gotanda, Shinagawa-ku, Tokyo 141 Japan.

ASIA-PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Center, No. 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.

DL110/D