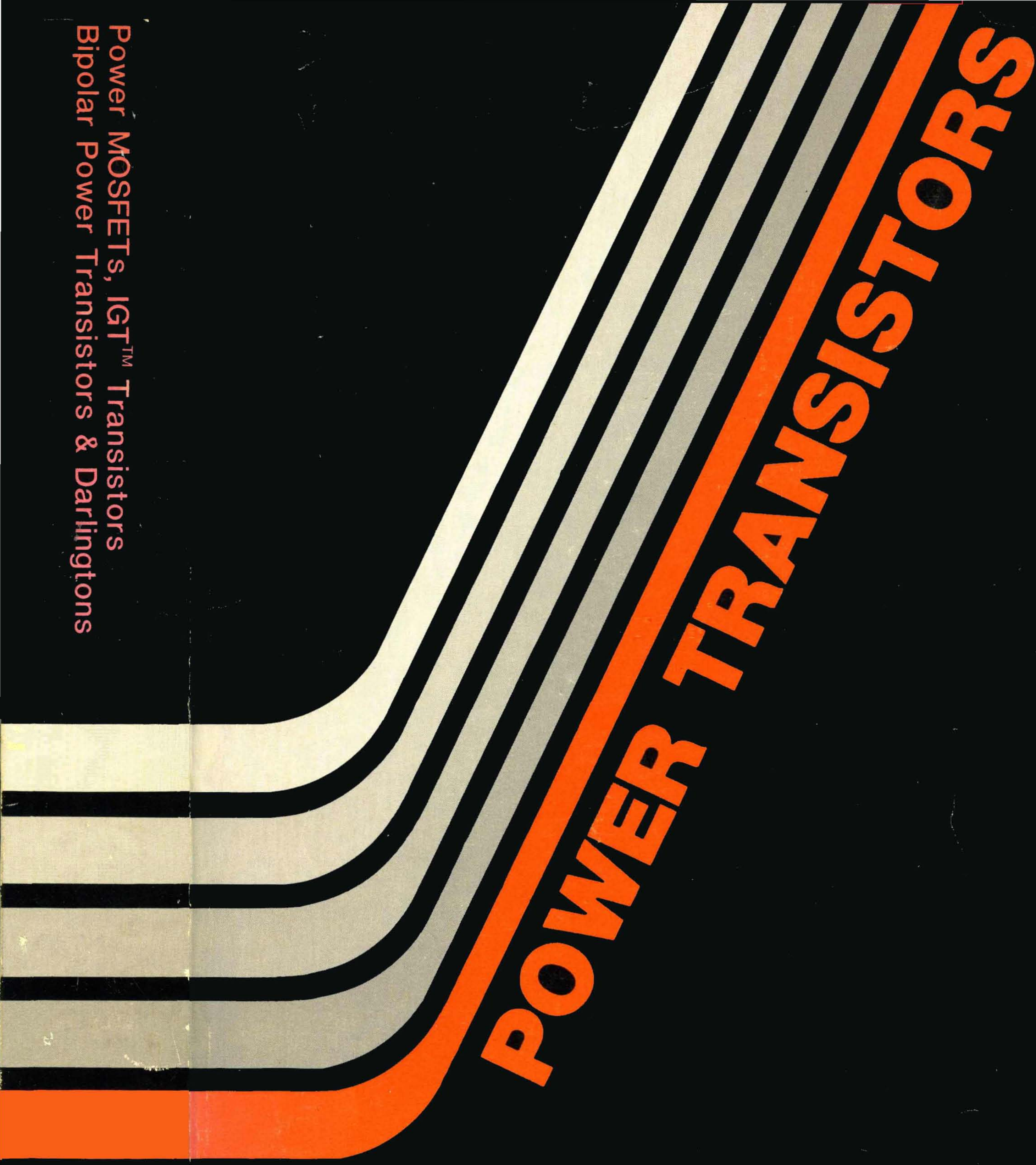
400.8 8/85
Supersedes 400.8 8/84



POWER TRANSISTORS

Power MOSFETs, IGT™ Transistors
Bipolar Power Transistors & Darlingtons

1st. Edition

Electronics Data Library – Semiconductors

POWER TRANSISTORS

POWER MOSFETs
IGT™ TRANSISTORS
POWER BIPOLAR TRANSISTORS
POWER DARLINGTONS

Power Electronics Semiconductor Department

General Electric Company
Electronics Park
Syracuse, New York 13221

SEMICONDUCTOR

INTRODUCTION

The Power Electronics Semiconductor Department of the General Electric Company acknowledges the efforts of all contributing authors and editors of all editions of the General Electric Power Transistor Manual.

The circuit diagrams included in this manual are intended merely for illustration of typical semiconductor applications and are not intended as constructional information. Although reasonable care has been taken in their preparation to assure their technical correctness, in the absence of an express written agreement to the contrary, no responsibility is assumed by the General Electric Company for any consequences of their use.

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GE BIPOLAR POWER TRANSISTORS

1. POWER TRANSISTOR TERMS, SYMBOLS & DEFINITIONS

2. RATINGS AND CHARACTERISTICS

3. QUALITY AND RELIABILITY OF TRANSISTORS

GE
POWER MOSFET
&
IGT™ TRANSISTOR
PRODUCT MATRIX &
SELECTOR GUIDE

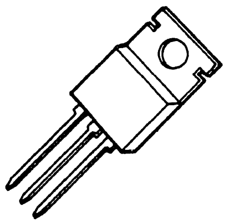
HOW TO SPECIFY GE POWER MOS DEVICES USING THIS MANUAL

Step 1: First, turn to the Product Matrix (next page). Look up the basic parameters of the device you want: its voltage, current, RDS_{on} and package. The Product Matrix will supply the GE product number to look for in the following Selector Guide tables. (How GE numbers its Power MOS devices is also explained in this section.)

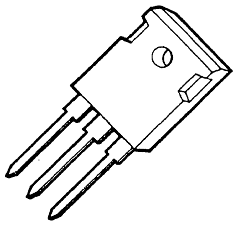
Step 2: Now go to the Selector Guide Tables that immediately follow the Product Matrix. The Selector Guide tables are arranged by package in ascending voltage. This will supply additional data about the device and the page number for the corresponding spec sheet.

Step 3: Turn to the spec sheet; it's in the section that begins on Page 125. Here you will find complete performance and rating information.

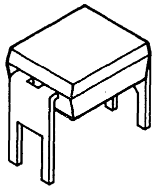
TO-220



TO-247



4 PIN DIP



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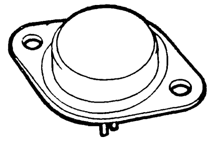
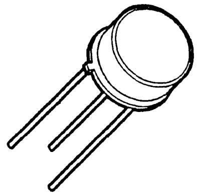


TO-39



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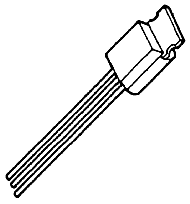
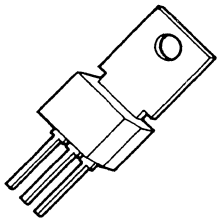
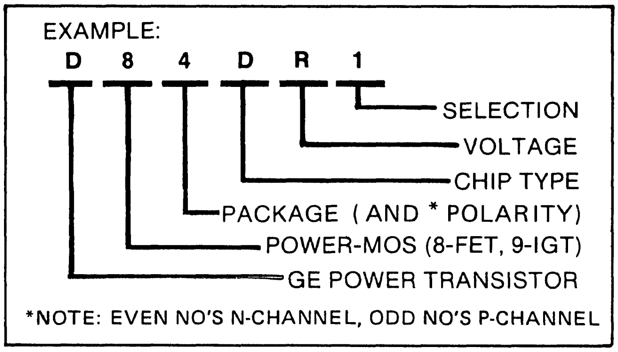


TO-202



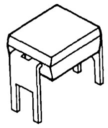
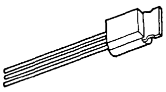
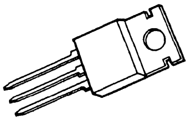
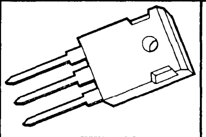
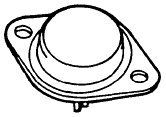
GE POWER-MOS NUMBERING SYSTEM



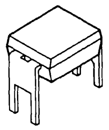
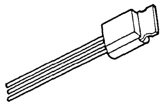
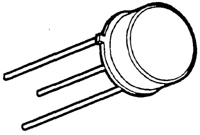
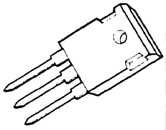
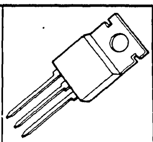
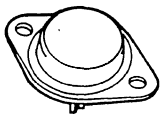
EXAMPLE:
D 8 4 D R 1
SELECTION
VOLTAGE
CHIP TYPE
PACKAGE (AND * POLARITY)
POWER-MOS (8-FET, 9-IGT)
GE POWER TRANSISTOR

*NOTE: EVEN NO'S N-CHANNEL, ODD NO'S P-CHANNEL

GE POWER-MOSFET PRODUCT MATRIX

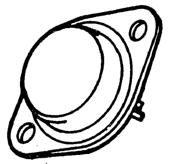
PACKAGE TYPE MAX. RATINGS N-CHANNEL						
BV_{DSS}	I_D	4 Pin DIP	TO-237	TO-220	TO-247	TO-204
450-500 R1 450V R2 500V	13A				D88FR1,2 .4Ω	D86FR1,2 .4Ω
	8A			D84ER1,2 .85Ω		D86ER1,2 .85Ω
	4.5A			D84DR1,2 1.5Ω		D86DR1,2 1.5Ω
	2.5A			D84CR1,2 3.0Ω		
350-400 Q1 350V Q2 400V	15A				D88FQ1,2 .3Ω	D86FQ1,2 .3Ω
	10A			D84EQ1,2 .55Ω		D86EQ1,2 .55Ω
	5.5A			D84DQ1,2 1.0Ω		D86DQ1,2 1.0Ω
	3.0A			D84CQ1,2 1.8Ω		
	1.5A			D84BQ1,2 3.6Ω		
	0.5A	D82CQ1,2 1.8Ω				
120-220 M1 120V M2 150V N1 180V N2 200V	30A				D88FM2 N2 .085Ω	D86FM2 N2 .085Ω
	18A			D84EM2 N2 .18Ω		D86EM2 N2 .18Ω
	9A			D84DM2 N2 .4Ω		D86DM2 N2 .4Ω
	5A			D84CM2 N2 .8Ω		
	2.5A			D84BM2 N2 1.5Ω		
	1.0A	D82CM2 N2 .8Ω				
	.8A	D82BM2 N2 1.5Ω				
	.4A	D82AM2 N2 5.0Ω	D80AM2 N2 5.0Ω			
50-100 K1 50V K2 60V L1 80V L2 100V	40A				D88FK2 L2 .055Ω	D86FK2 L2 .055Ω
	27A			D84EK2 L2 .085Ω		D86EK2 L2 .085Ω
	14A			D84DK2 L2 .18Ω		D86DK2 L2 .18Ω
	8A			D84DK2 L2 .3Ω		
	4.0A			D84BK2 L2 .6Ω		
	1.3A	D82CK2 L2 .3Ω				
	1A	D82BK2 L2 .6Ω				
	.5A	D82AK2 L2 2.4Ω	D80AK2 L2 2.4Ω			
	.3A					

GE INDUSTRY STANDARD POWER MOSFETs

PACKAGE TYPE MAX. RATINGS N-CHANNEL							
BV$_{DSS}$	I$_D$	4 Pin DIP	TO-237	TO-39	TO-247	TO-220	TO-204
450-500	13A				IRFP450 0.4Ω		IRF450 .4Ω1
	8A					IRF840 .85Ω	IRF440 .85Ω
	4.5A					IRF830 1.5Ω	IRF430 1.5Ω
	2.5A			IRFF430 1.5Ω		IRF820 3.0Ω	
350-400	15A				IRFP350 0.3Ω		IRF350 .3Ω
	10A					IRF740 .55Ω	IRF340 Ω
	5.5A					IRF730 1.0Ω	IRF330 1.0Ω
	3.0A			IRFF330 1.0Ω		IRF720 1.8Ω	
	1.5A			IRFF320 1.8Ω		IRF710 3.6Ω	
150-200	30A				IRFP250 0.085Ω		IRF250 .085Ω
	18A					IRF640 .18Ω	IRF240 .18Ω
	9A					IRF630 .4Ω	IRF230 .4Ω
	5A			IRFF230 .40Ω		IRF620 .8Ω	
	2.5A			IRFF220 .8Ω		IRF610 1.5Ω	
	.6A	IRFD210 1.5Ω		IRFF210 1.5Ω			
30-100 IVN D 40V E 60V F 80V H 100V VN	40A				IRFP150 0.055Ω		IRF150 .055Ω
	27A					IRF540 .085Ω	IRF140 .085Ω
	14A					IRF530 .18Ω	IRF130 .18Ω
	8A			IRFF130 .18Ω		IRF520 .3Ω	
	4A			IRFF120 .3Ω		IRF510 .6Ω	
	1.3A	IRFD120 .3Ω		IRFF110 .6Ω			
30,35 30V	1A	IRFD110 .6Ω		VN30ABA,AK* †			
10,66,67 60V	.5A	IRFD1Z0 2.4Ω	VN10KMA 5.0Ω	VN67ABA,AK* †			
89 80V	.7A		IVN5000AN() 2.5Ω	VN89ABA* †			
90,98,99 90V	—			VN90,98,ABA,AK*†			

*I$_D$ NOT APPLICABLE

† AVAILABLE IN TO-202 PACKAGE (**AFA** SUFFIX DESIGNATION)

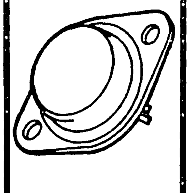


CASE STYLE
TO-204

GE POWER MOSFET SELECTOR GUIDE

V_{DS} (Volts)	I_D (Amps) 25°C	I_D (Amps) 100°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
60	12.0	8.0	0.25	800	48	75	IRF 133	127
60	12.0	8.0	0.25	800	25	75	2N6755	—
60	14.0	9.0	0.18	800	56	75	D86DK2	125
60	14.0	9.0	0.18	800	56	75	IRF 131	125
60	24.0	15.0	0.11	1600	96	125	IRF 143	131
60	27.0	17.0	0.085	1600	108	125	D86EK2	129
60	27.0	17.0	0.085	1600	108	125	IRF 141	129
60	31.0	20.0	0.08	3000	60	150	2N6763	—
60	33.0	20.0	0.08	3000	132	150	IRF 153	135
60	40.0	25.0	0.055	3000	160	150	D86FK2	133
60	40.0	25.0	0.055	3000	160	150	IRF 151	133
100	12.0	8.0	0.25	800	48	75	IRF 132	127
100	14.0	9.0	0.18	800	56	75	D86DL2	125
100	14.0	9.0	0.18	800	56	75	IRF 130	125
100	14.0	9.0	0.18	800	30	75	2N6756	—
100	24.0	15.0	0.11	1600	96	125	IRF 142	131
100	27.0	17.0	0.085	1600	108	125	IRF 140	129
100	27.0	17.0	0.085	1600	108	125	D86EL2	129
100	33.0	20.0	0.08	3000	132	150	IRF 152	135
100	38.0	24.0	0.055	3000	70	150	2N6764	—
100	40.0	25.0	0.055	3000	160	150	IRF 150	133
100	40.0	25.0	0.055	3000	160	150	D86FL2	133
150	8.0	5.0	0.60	800	32	75	IRF 233	139
150	8.0	5.0	0.60	800	12	75	2N6757	—
150	9.0	6.0	0.40	800	36	75	D86DM2	137
150	9.0	6.0	0.40	800	36	75	IRF 231	137
150	16.0	10.0	0.22	1600	64	125	IRF 243	143
150	18.0	11.0	0.18	1600	72	125	D86EM2	141
150	18.0	11.0	0.18	1600	72	125	IRF 241	141
150	25.0	16.0	0.12	3000	100	150	IRF 253	147
150	25.0	16.0	0.12	3000	50	150	2N6765	—
150	30.0	19.0	0.085	3000	120	150	D86FM2	145
150	30.0	19.0	0.085	3000	120	150	IRF 251	145
200	8.0	5.0	0.60	800	32	75	IRF 232	139
200	9.0	6.0	0.40	800	15	75	2N6758	—
200	9.0	6.0	0.40	800	36	75	D86DN2	137
200	9.0	6.0	0.40	800	36	75	IRF 230	137
200	16.0	10.0	0.22	1600	64	125	IRF 242	143
200	18.0	11.0	0.18	1600	72	125	D86EN2	141
200	18.0	11.0	0.18	1600	72	125	IRF 240	141
200	25.0	16.0	0.12	3000	100	150	IRF 252	147
200	30.0	19.0	0.085	3000	60	150	2N6766	—
200	30.0	19.0	0.085	3000	120	150	D86FN2	145
200	30.0	19.0	0.085	3000	120	150	IRF 250	145
350	4.5	3.0	1.5	800	18	75	IRF 333	151
350	4.5	3.0	1.5	800	7	75	2N6759	—
350	5.5	3.5	1.0	800	22	75	D86DQ1	149
350	5.5	3.5	1.0	800	22	75	IRF 331	149
350	8.0	5.0	0.80	1600	32	125	IRF 343	155
350	10.0	6.0	0.55	1600	40	125	D86EQ1	153

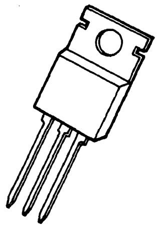
Electrical characteristics @ 25° C unless otherwise specified.


CASE STYLE
TO-204

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	100°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
350	10.0	6.0	0.55	1600	40	125	IRF 341	153
350	12.0	7.75	0.40	3000	20	150	2N6767	—
350	13.0	8.0	0.40	3000	52	150	IRF 353	159
350	15.0	9.0	0.30	3000	60	150	D86FQ1	157
350	15.0	9.0	0.30	3000	60	150	IRF 351	157
400	4.5	3.0	1.5	800	18	75	IRF 332	151
400	5.5	3.5	1.0	800	22	75	D86DQ2	149
400	5.5	3.5	1.0	800	22	75	IRF 330	149
400	5.5	3.5	1.0	800	8	75	2N6760	—
400	8.0	5.0	0.80	1600	32	125	IRF 342	155
400	10.0	6.0	0.55	1600	40	125	D86EQ2	153
400	10.0	6.0	0.55	1600	40	125	IRF 340	153
400	13.0	8.0	0.40	3000	52	150	IRF 352	159
400	14.0	9.0	0.30	3000	25	150	2N6768	—
400	15.0	9.0	0.30	3000	60	150	D86FQ2	157
400	15.0	9.0	0.30	3000	60	150	IRF 350	157
450	4.0	2.5	2.0	800	16	75	IRF 433	163
450	4.0	2.5	2.0	800	6	75	2N6761	—
450	4.5	3.0	1.5	800	18	75	D86DR1	161
450	4.5	3.0	1.5	800	18	75	IRF 431	161
450	7.0	4.0	1.1	1600	28	125	IRF 443	167
450	8.0	5.0	0.85	1600	32	125	D86ER1	165
450	8.0	5.0	0.85	1600	32	125	IRF 441	165
450	11.0	7.0	0.50	3000	20	150	2N6769	—
450	12.0	7.0	0.50	3000	48	150	IRF 453	171
450	13.0	8.0	0.40	3000	52	150	D86FR1	169
450	13.0	8.0	0.40	3000	52	150	IRF 451	169
500	4.0	2.5	2.0	800	16	75	IRF 432	163
500	4.5	3.0	1.5	800	18	75	D86DR2	161
500	4.5	3.0	1.5	800	18	75	IRF 430	161
500	4.5	3.0	1.5	800	7	75	2N6762	—
500	7.0	4.0	1.1	1600	28	125	IRF 442	167
500	8.0	5.0	0.85	1600	32	125	D86ER2	165
500	8.0	5.0	0.85	1600	32	125	IRF 440	165
500	12.0	7.0	0.50	3000	48	150	IRF 452	171
500	12.0	7.75	0.40	3000	25	150	2N6770	—
500	13.0	8.0	0.40	3000	62	150	D86FR2	169
500	13.0	8.0	0.40	3000	52	150	IRF 450	169

Electrical characteristics @ 25°C unless otherwise specified.

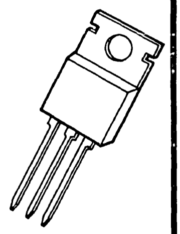


CASE STYLE
TO-220

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	100°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
60	3.5	2.0	0.80	150	14	20	IRF 513	175
60	4.0	2.5	0.60	150	16	20	D84BK2	173
60	4.0	2.5	0.60	150	16	20	IRF 511	173
60	7.0	4.0	0.40	400	28	40	IRF 523	179
60	8.0	5.0	0.30	400	32	40	D84CK2	177
60	8.0	5.0	0.30	400	32	40	IRF 521	177
60	12.0	8.0	0.25	800	48	75	IRF 533	183
60	14.0	9.0	0.18	800	56	75	D84DK2	181
60	14.0	9.0	0.18	800	56	75	IRF 531	181
60	24.0	15.0	0.11	1600	96	125	IRF 543	187
60	27.0	17.0	0.085	1600	108	125	D84EK2	185
60	27.0	17.0	0.085	1600	108	125	IRF 541	185
100	3.5	2.0	0.80	150	14	20	IRF 512	175
100	4.0	2.5	0.60	150	16	20	D84BL2	173
100	4.0	2.5	0.60	150	16	20	IRF 510	173
100	7.0	4.0	0.40	400	28	40	IRF 522	179
100	8.0	5.0	0.30	400	32	40	D84CL2	177
100	8.0	5.0	0.30	400	32	40	IRF 520	177
100	12.0	8.0	0.25	800	48	75	IRF 532	183
100	14.0	9.0	0.18	800	56	75	D84DL2	181
100	14.0	9.0	0.18	800	56	75	IRF 530	181
100	24.0	15.0	0.11	1600	96	125	IRF 542	187
100	27.0	17.0	0.085	1600	108	125	D84EL2	185
100	27.0	17.0	0.085	1600	108	125	IRF 540	185
150	2.0	1.25	2.4	150	8	20	IRF 613	191
150	2.5	1.5	1.5	150	10	20	D84BM2	189
150	2.5	1.5	1.5	150	10	20	IRF 611	189
150	4.0	2.5	1.2	400	16	40	IRF 623	195
150	5.0	3.0	0.80	400	20	40	D84CM2	193
150	5.0	3.0	0.80	400	20	40	IRF 621	193
150	8.0	5.0	0.60	800	32	75	IRF 633	199
150	9.0	6.0	0.40	800	36	75	D84DM2	197
150	9.0	6.0	0.40	800	36	75	IRF 631	197
150	16.0	10.0	0.22	1600	64	125	IRF 643	203
150	18.0	11.0	0.18	1600	72	125	D84EM2	201
150	18.0	11.0	0.18	1600	72	125	IRF 641	201
200	2.0	1.25	2.4	150	8	20	IRF 612	191
200	2.5	1.5	1.5	150	10	20	D84BN2	189
200	2.5	1.5	1.5	150	10	20	IRF 610	189
200	4.0	2.5	1.2	400	16	40	IRF 622	195
200	5.0	3.0	0.80	400	20	40	D84CN2	193
200	5.0	3.0	0.80	400	20	40	IRF 620	193
200	8.0	5.0	0.60	800	32	75	IRF 632	199
200	9.0	6.0	0.40	800	36	75	D84DN2	197
200	9.0	6.0	0.40	800	36	75	IRF 630	197
200	16.0	10.0	0.22	1600	64	125	IRF 642	203
200	18.0	11.0	0.18	1600	72	125	D84EN2	201
200	18.0	11.0	0.18	1600	72	125	IRF 640	201

Electrical characteristics @ 25° C unless otherwise specified.

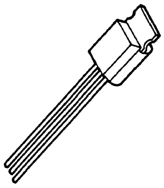


CASE STYLE
TO-220

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps)		R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
	25°C	100°C						
350	1.3	0.8	5.0	150	5	20	IRF 713	207
350	1.5	1.0	3.6	150	6	20	D84BQ1	205
350	1.5	1.0	3.6	150	6	20	IRF 711	205
350	2.5	1.5	2.5	400	10	40	IRF 723	211
350	3.0	2.0	1.8	400	12	40	D84CQ1	209
350	3.0	2.0	1.8	400	12	40	IRF 721	209
350	4.5	3.0	1.5	800	18	75	IRF 733	215
350	5.5	3.5	1.0	800	22	75	D84DQ1	213
350	5.5	3.5	1.0	800	22	75	IRF 731	213
350	8.0	5.0	0.80	1600	32	125	IRF 743	219
350	10.0	6.0	0.55	1600	40	125	D84EQ1	217
350	10.0	6.0	0.55	1600	40	125	IRF 741	217
400	1.3	0.8	5.0	150	5	20	IRF 712	207
400	1.5	1.0	3.6	150	6	20	D84BQ2	205
400	1.5	1.0	3.6	150	6	20	IRF 710	205
400	2.5	1.5	2.5	400	10	40	IRF 722	211
400	3.0	2.0	1.8	400	12	40	D84CQ2	209
400	3.0	2.0	1.8	400	12	40	IRF 720	209
400	4.5	3.0	1.5	800	18	75	IRF 732	215
400	5.5	3.5	1.0	800	22	75	D84DQ2	213
400	5.5	3.5	1.0	800	22	75	IRF 730	213
400	8.0	5.0	0.80	1600	32	125	IRF 742	219
400	10.0	6.0	0.55	1600	40	125	D84EQ2	217
400	10.0	6.0	0.55	1600	40	125	IRF 740	217
450	2.0	1.0	4.0	400	8	40	IRF 823	223
450	2.5	1.5	3.0	400	10	40	D84CR1	221
450	2.5	1.5	3.0	400	10	40	IRF 821	221
450	4.0	2.5	2.0	800	16	75	IRF 833	227
450	4.5	3.0	1.5	800	18	75	D84DR1	225
450	4.5	3.0	1.5	800	18	75	IRF 831	225
450	7.0	4.0	1.1	1600	28	125	IRF 843	231
450	8.0	5.0	0.85	1600	32	125	D84ER1	229
450	8.0	5.0	0.85	1600	32	125	IRF 841	229
500	2.0	1.0	4.0	400	8	40	IRF 822	223
500	2.5	1.5	3.0	400	10	40	D84CR2	221
500	2.5	1.5	3.0	400	10	40	IRF 820	222
500	4.0	2.5	2.0	800	16	75	IRF 832	227
500	4.5	3.0	1.5	800	18	75	D84DR2	225
500	4.5	3.0	1.5	800	18	75	IRF 830	225
500	7.0	4.0	1.1	1600	28	125	IRF 842	231
500	8.0	5.0	0.85	1600	32	125	D84ER2	229
500	8.0	5.0	0.85	1600	32	125	IRF 840	229

Electrical characteristics @ 25°C unless otherwise specified.

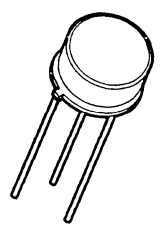


CASE STYLE
TO-237

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
40	0.70	2.5	50	2.0	2.0	IVN5000AND	321
40	0.70	2.5	50	2.0	2.0	IVN5001AND	321
60	0.50	2.4	70	2.0	1.8	D80AK2	317
60	0.70	2.5	50	2.0	2.0	IVN5000ANE	321
60	0.70	2.5	50	2.0	2.0	IVN5001ANE	321
60	0.75	5.0	65	1.0	1.0	VN10KMA	325
80	0.70	2.5	50	2.0	2.0	IVN5000ANF	321
80	0.70	2.5	50	2.0	2.0	IVN5001ANF	321
100	0.50	2.4	70	2.0	1.8	D80AL2	317
100	0.70	2.5	50	2.0	2.0	IVN5000ANH	321
100	0.70	2.5	50	2.0	2.0	IVN5001ANH	321
150	0.30	5.6	70	1.2	1.8	D80AM2	319
200	0.30	5.6	70	1.2	1.8	D80AN2	319

Electrical characteristics @ 25°C unless otherwise specified.

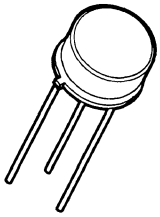


CASE STYLE
TO-39

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
35	1.2	5.00	50	3	6.25	VN30ABA	327
35	1.2	4.50	50	3	6.25	VN35ABA	327
35	1.2	2.50	50	3	6.25	VN35AK	329
40	1.2	2.50	50	3	6.25	IVN5000/1TND	323
60	1.2	2.50	50	3	6.25	IVN5000/1TNE	323
60	1.2	3.00	50	3	6.25	VN66AK	329
60	1.2	5.10	50	3	6.25	VN67ABA	327
60	1.2	3.50	50	3	6.25	VN67AK	329
60	1.2	3.00	50	3	6.25	2N6660	335
60	3.0	0.80	200	12	15.00	IRFF 113	259
60	3.5	0.60	200	14	15.00	IRFF 111	257
60	5.0	0.40	400	20	20.00	IRFF 123	263
60	6.0	0.30	400	24	20.00	IRFF 121	261
60	7.0	0.25	800	28	25.00	IRFF 133	267
60	8.0	0.18	800	32	25.00	IRFF 131	265
80	1.2	2.50	50	3	6.25	IVN5000/1TNF	323
80	1.2	5.10	50	3	6.25	VN89ABA	327
90	1.2	6.00	50	3	6.25	VN90ABA	327
90	1.2	4.00	50	3	6.25	VN98AK	329
90	1.2	4.00	50	3	6.25	2N6661	335
90	1.2	4.50	50	3	6.25	VN99AK	329
100	1.2	2.50	50	3	6.25	IVN5000/1TNH	323
100	3.0	0.80	200	12	15.00	IRFF 112	259
100	3.5	0.60	200	14	15.00	IRFF 110	257
100	5.0	0.40	400	20	20.00	IRFF 122	263
100	6.0	0.30	400	24	20.00	IRFF 120	261
100	7.0	0.25	800	28	25.00	IRFF 132	267
100	8.0	0.18	800	32	25.00	IRFF 130	265
150	1.8	2.40	200	—	15.00	IRFF 213	271
150	2.2	1.50	200	—	15.00	IRFF 211	269
150	3.0	1.20	400	—	20.00	IRFF 223	275
150	3.5	0.80	400	—	20.00	IRFF 221	273
150	4.5	0.60	800	—	25.00	IRFF 233	279
150	5.5	0.40	800	—	25.00	IRFF 231	277
200	1.8	2.40	200	—	15.00	IRFF 212	271
200	2.2	1.50	200	—	15.00	IRFF 210	269
200	3.0	1.20	400	—	20.00	IRFF 222	275

Electrical characteristics @ 25°C unless otherwise specified.

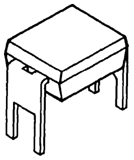


CASE STYLE
TO-39

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
200	3.50	0.8	400	—	20	IRFF 220	273
200	4.50	0.6	800	—	25	IRFF 232	279
200	5.50	0.4	800	—	25	IRFF 230	277
350	1.15	5.0	200	—	15	IRFF 313	283
350	1.35	3.6	200	—	15	IRFF 311	281
350	2.00	2.5	400	—	20	IRFF 323	287
350	2.50	1.8	400	—	20	IRFF 321	285
350	3.00	1.5	800	—	25	IRFF 333	291
350	3.50	1.0	800	—	25	IRFF 331	289
400	1.15	5.0	200	—	15	IRFF 312	283
400	1.35	3.6	200	—	15	IRFF 310	281
400	2.00	2.5	400	—	20	IRFF 322	287
400	2.50	1.8	400	—	20	IRFF 320	285
400	3.00	1.5	800	—	25	IRFF 332	291
400	3.50	1.0	800	—	25	IRFF 330	289
450	1.40	4.0	400	—	20	IRFF 423	295
450	1.60	3.0	400	—	20	IRFF 421	293
450	2.25	2.0	800	—	25	IRFF 433	299
450	2.75	1.5	800	—	25	IRFF 431	297
500	1.40	4.0	400	—	20	IRFF 422	295
500	1.60	3.0	400	—	20	IRFF 420	293
500	2.25	2.0	800	—	25	IRFF 432	299
500	2.75	1.5	800	—	25	IRFF 430	297

Electrical characteristics @ 25°C unless otherwise specified.

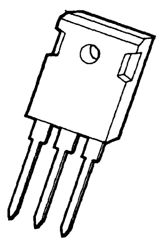


CASE STYLE
4 PIN DIP

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
60	0.40	3.20	70	1.5	1.0	IRFD1Z3	243
60	0.50	2.40	70	2.0	1.0	IRFD1Z1	241
60	0.50	2.40	70	2.0	1.0	D82AK2	241
60	0.80	0.80	200	3.0	1.0	IRFD113	235
60	1.00	0.60	200	4.0	1.0	D82BK2	233
60	1.00	0.60	200	4.0	1.0	IRFD111	233
60	1.10	0.40	400	4.4	1.0	IRFD123	239
60	1.30	0.30	400	5.2	1.0	D82CK2	237
60	1.30	0.30	400	5.2	1.0	IRFD121	237
100	0.40	3.20	70	1.5	1.0	IRFD1Z2	243
100	0.50	2.40	70	2.0	1.0	IRFD1Z0	241
100	0.50	2.40	70	2.0	1.0	D82AL2	241
100	0.80	0.80	200	3.0	1.0	IRFD112	235
100	1.00	0.60	200	4.0	1.0	D82BL2	233
100	1.00	0.60	200	4.0	1.0	IRFD110	233
100	1.10	0.40	400	4.4	1.0	IRFD122	239
100	1.30	0.30	400	5.2	1.0	D82CL2	237
100	1.30	0.30	400	5.2	1.0	IRFD120	237
150	0.60	1.50	200	2.5	1.0	IRFD211	245
150	0.45	2.40	200	1.8	1.0	IRFD213	247
150	0.30	5.60	70	1.2	1.0	D82AM2	253
150	0.30	5.60	70	1.2	1.0	IRFD2Z1	253
150	0.60	1.50	200	2.5	1.0	D82BM2	245
150	0.80	0.80	400	3.2	1.0	D82CM2	249
150	0.80	0.80	400	3.2	1.0	IRFD221	249
150	0.70	1.20	600	5.6	1.0	IRFD223	251
200	0.45	2.40	200	1.8	1.0	IRFD212	247
200	0.30	5.60	70	1.2	1.0	D82AN2	253
200	0.30	5.60	70	1.2	1.0	IRFD2Z0	253
200	0.60	1.50	200	2.5	1.0	D82BN2	245
200	0.60	1.50	200	2.5	1.0	IRFD210	245
200	0.70	1.2	600	5.6	1.0	IRFD222	251
200	0.80	0.80	400	3.2	1.0	D82CN2	249
200	0.80	0.80	400	3.2	1.0	IRFD220	249
350	0.40	2.50	400	1.6	1.0	IRFD323	—
350	0.50	1.80	400	2.0	1.0	IRFD321	255
350	0.50	1.80	400	2.0	1.0	D82CQ1	255
400	0.40	2.50	400	1.6	1.0	IRFD322	—
400	0.50	1.80	400	2.0	1.0	D82CQ2	255
400	0.50	1.80	400	2.0	1.0	IRFD320	255

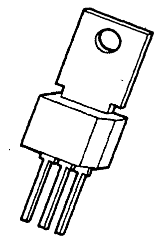
Electrical characteristics @ 25° C unless otherwise specified.


CASE STYLE
TO-247

GE Power MOSFET Selector Guide (Cont.)

V_{DS} (Volts)	I_D (Amps) 25°C	100°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
60	33.0	20.0	0.08	3000	132	150	IRFP153	303
60	40.0	25.0	0.055	3000	160	150	IRFP151	301
60	40.0	25.0	0.055	3000	160	150	D88FK2	301
100	33.0	20.0	0.08	3000	132	150	IRFP152	303
100	40.0	25.0	0.055	3000	160	150	D88FL2	301
100	40.0	25.0	0.055	3000	160	150	IRFP150	301
150	25.0	16.0	0.12	3000	100	150	IRF253	307
150	30.0	19.0	0.085	3000	120	150	D88FM2	305
150	30.0	19.0	0.085	3000	120	150	IRFP251	305
200	25.0	16.0	0.12	3000	100	150	IRFP252	307
200	30.0	19.0	0.085	3000	120	150	IRFP250	305
200	30.0	19.0	0.085	3000	120	150	D88FN2	305
350	13.0	8.0	0.4	3000	52	150	IRFP353	311
350	15.0	9.0	0.3	3000	60	150	D88FQ1	309
350	15.0	9.0	0.3	3000	60	150	IRFP351	309
400	13.0	8.0	0.4	3000	52	150	IRFP352	311
400	15.0	9.0	0.3	3000	60	150	IRFP350	309
400	15.0	9.0	0.3	3000	60	150	D88FQ2	309
450	12.0	7.0	0.5	3000	48	150	IRFP453	315
450	13.0	8.0	0.4	3000	52	150	IRFP451	313
450	13.0	8.0	0.4	3000	52	150	D88FR1	313
500	12.0	7.0	0.5	3000	48	150	IRFP452	315
500	13.0	8.0	0.4	3000	52	150	D88FR2	313
500	13.0	8.0	0.4	3000	52	150	IRFP450	313

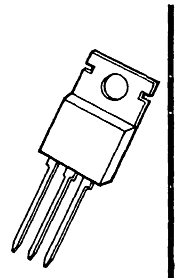
Electrical characteristics @ 25° C unless otherwise specified.


CASE STYLE
TO-202

V_{DS} (Volts)	I_D (Amps) 25°C	100°C	R_{DS} (ON) (Ohms)	C_{ISS} (pF)	I_{DM} (Amps)	P_D (Watts)	GE Type Number	Page
40	1.2	6.5	5.0	50	3	12	VN40AFA	331
40	1.2	3.0	3.0	50	3	12	VN46AFA	333
60	1.2	3.0	3.0	50	3	12	VN66AFA	333
60	1.2	5.5	3.5	50	3	12	VN67AFA	331
80	1.2	4.0	4.0	50	3	12	VN88AFA	333
80	1.2	6.4	4.5	50	3	12	VN89AFA	331

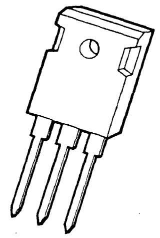
Electrical characteristics @ 25° C unless otherwise specified.

GENERAL ELECTRIC
INSULATED GATE TRANSISTORS



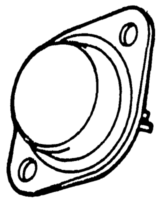
CASE STYLE
TO-220

V_{CES} Volts	I_C (Amps) 25°C	100°C	V_{SAT} Volts	t_{off} μs	P_D Watts	Type	Page
400	18	10	2.5	4.5	75	IGT4D10	337
400	18	10	2.5	0.8	75	IGT4D11	341
500	18	10	2.5	4.5	75	IGT4E10	337
500	18	10	2.5	0.8	75	IGT4E11	341



CASE STYLE
TO-247

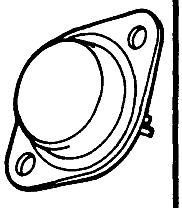
V_{CES} Volts	I_C (Amps) 25°C	90°C	V_{SAT} Volts	t_{off} μs	P_D Watts	Type	Page
400	32	22	2.2	4.5	125	IGT8D20	361
400	32	20	2.5	0.8	125	IGT8D21	365
500	32	22	2.2	4.5	125	IGT8E20	361
500	32	20	2.5	0.8	125	IGT8E21	365



CASE STYLE
TO-204

V_{CES} Volts	I_C (Amps) 25°C	100°C	V_{SAT} Volts	t_{off} μs	P_D Watts	Type	Page
400	18	10	2.5	4.5	75	IGT6D10	345
400	18	10	2.5	0.8	75	IGT6D11	349
400	32	22	2.2	4.5	125	IGT6D20	353
400	32	20	2.5	0.8	125	IGT6D21	357
500	18	10	2.5	4.5	75	IGT6E10	345
500	18	10	2.5	0.8	75	IGT6E11	349
500	32	22	2.2	4.5	125	IGT6E20	353
500	32	20	2.5	0.8	125	IGT6E21	357

POWER MOSFET CROSS REFERENCE



CASE STYLE
TO-204

GENERAL JEDEC TYPES

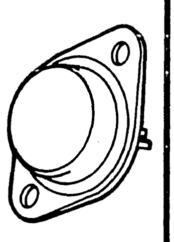
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	GE Direct Replacement	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
2N6755	60	12.0	0.25	TO-204AA	2N6755	60	12.0	0.25	TO-204AA
2N6756	100	14.0	0.18	TO-204AA	2N6756	100	14.0	0.18	TO-204AA
2N6757	150	8.0	0.60	TO-204AA	2N6757	150	8.0	0.60	TO-204AA
2N6758	200	9.0	0.40	TO-204AA	2N6758	200	9.0	0.40	TO-204AA
2N6759	350	4.5	1.5	TO-204AA	2N6759	350	4.5	1.5	TO-204AA
2N6760	400	5.5	1.0	TO-204AA	2N6760	400	5.5	1.0	TO-204AA
2N6761	450	4.0	2.0	TO-204AA	2N6761	450	4.0	2.0	TO-204AA
2N6762	500	4.5	1.5	TO-204AA	2N6762	500	4.5	1.5	TO-204AA
2N6763	60	31.0	0.080	TO-204AE	2N6763	60	31.0	0.080	TO-204AE
2N6764	100	38.0	0.055	TO-204AE	2N6764	100	38.0	0.055	TO-204AE
2N6765	150	25.0	0.12	TO-204AE	2N6765	150	25.0	0.12	TO-204AE
2N6766	200	30.0	0.085	TO-204AE	2N6766	200	30.0	0.085	TO-204AE
2N6767	350	12.0	0.40	TO-204AA	2N6767	350	12.0	0.40	TO-204AA
2N6768	400	14.0	0.30	TO-204AA	2N6768	400	14.0	0.30	TO-204AA
2N6769	450	11.0	0.50	TO-204AA	2N6769	450	11.0	0.50	TO-204AA
2N6770	500	12.0	0.40	TO-204AA	2N6770	500	12.0	0.40	TO-204AA

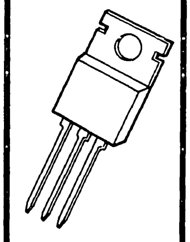
INTERNATIONAL RECTIFIER

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	GE Direct Replacement	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
IRF130	100	14.0	0.18	TO-204AA	IRF130	100	14.0	0.18	TO-204AA
IRF131	60	14.0	0.18	TO-204AA	IRF131	60	14.0	0.18	TO-204AA
IRF132	100	12.0	0.25	TO-204AA	IRF132	100	12.0	0.25	TO-204AA
IRF133	60	12.0	0.25	TO-204AA	IRF133	60	12.0	0.25	TO-204AA
IRF140	100	27.0	0.085	TO-204AE	IRF140	100	27.0	0.085	TO-204AE
IRF141	60	27.0	0.085	TO-204AE	IRF141	60	27.0	0.085	TO-204AE
IRF142	100	24.0	0.11	TO-204AE	IRF142	100	24.0	0.11	TO-204AE
IRF143	60	24.0	0.11	TO-204AE	IRF143	60	24.0	0.11	TO-204AE
IRF150	100	40.0	0.055	TO-204AE	IRF150	100	40.0	0.055	TO-204AE
IRF151	60	40.0	0.055	TO-204AE	IRF151	60	40.0	0.055	TO-204AE
IRF152	100	33.0	0.080	TO-204AE	IRF152	100	33.0	0.080	TO-204AE
IRF153	60	33.0	0.080	TO-204AE	IRF153	60	33.0	0.080	TO-204AE
IRF230	200	9.0	0.40	TO-204AA	IRF230	200	9.0	0.40	TO-204AA
IRF231	150	9.0	0.40	TO-204AA	IRF231	150	9.0	0.40	TO-204AA
IRF232	200	8.0	0.60	TO-204AA	IRF232	200	8.0	0.60	TO-204AA
IRF233	150	8.0	0.60	TO-204AA	IRF233	150	8.0	0.60	TO-204AA
IRF240	200	18.0	0.18	TO-204AE	IRF240	200	18.0	0.18	TO-204AE
IRF241	150	18.0	0.18	TO-204AE	IRF241	150	18.0	0.18	TO-204AE
IRF242	200	16.0	0.22	TO-204AE	IRF242	200	16.0	0.22	TO-204AE
IRF243	150	16.0	0.22	TO-204AE	IRF243	150	16.0	0.22	TO-204AE
IRF250	200	30.0	0.085	TO-204AE	IRF250	200	30.0	0.085	TO-204AE
IRF251	150	30.0	0.085	TO-204AE	IRF251	150	30.0	0.085	TO-204AE
IRF252	200	25.0	0.12	TO-204AE	IRF252	200	25.0	0.12	TO-204AE
IRF253	150	25.0	0.12	TO-204AE	IRF253	150	25.0	0.12	TO-204AE
IRF330	400	5.5	1.0	TO-204AA	IRF330	400	5.5	1.0	TO-204AA
IRF331	350	5.5	1.0	TO-204AA	IRF331	350	5.5	1.0	TO-204AA
IRF332	400	4.5	1.5	TO-204AA	IRF332	400	4.5	1.5	TO-204AA
IRF333	350	4.5	1.5	TO-204AA	IRF333	350	4.5	1.5	TO-204AA

Power MOSFET
Cross-Reference (Cont.)

International Rectifier (Cont.)

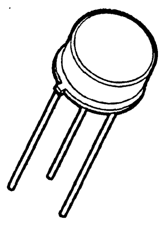

CASE STYLE
TO-204

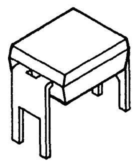

CASE STYLE
TO-220

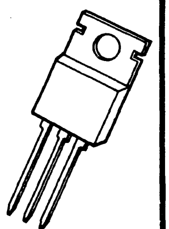
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	GE Direct Replacement	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
IRF340	400	10.0	0.55	TO-204AA	IRF340	400	10.0	0.55	TO-204AA
IRF341	350	10.0	0.55	TO-204AA	IRF341	350	10.0	0.55	TO-204AA
IRF342	400	8.0	0.80	TO-204AA	IRF342	400	8.0	0.80	TO-204AA
IRF343	350	8.0	0.80	TO-204AA	IRF343	350	8.0	0.80	TO-204AA
IRF350	400	15.0	0.30	TO-204AA	IRF350	400	15.0	0.30	TO-204AA
IRF351	350	15.0	0.30	TO-204AA	IRF351	350	15.0	0.30	TO-204AA
IRF352	400	13.0	0.40	TO-204AA	IRF352	400	13.0	0.40	TO-204AA
IRF353	350	13.0	0.40	TO-204AA	IRF353	350	13.0	0.40	TO-204AA
IRF430	500	4.5	1.5	TO-204AA	IRF430	500	4.5	1.5	TO-204AA
IRF431	450	4.5	1.5	TO-204AA	IRF431	450	4.5	1.5	TO-204AA
IRF432	500	4.0	2.0	TO-204AA	IRF432	500	4.0	2.0	TO-204AA
IRF433	450	4.0	2.0	TO-204AA	IRF433	450	4.0	2.0	TO-204AA
IRF440	500	8.0	0.85	TO-204AA	IRF440	500	8.0	0.85	TO-204AA
IRF441	450	8.0	0.85	TO-204AA	IRF441	450	8.0	0.85	TO-204AA
IRF442	500	7.0	1.1	TO-204AA	IRF442	500	7.0	1.1	TO-204AA
IRF443	450	7.0	1.1	TO-204AA	IRF443	450	7.0	1.1	TO-204AA
IRF450	500	13.0	0.40	TO-204AA	IRF450	500	13.0	0.40	TO-204AA
IRF451	450	13.0	0.40	TO-204AA	IRF451	450	13.0	0.40	TO-204AA
IRF452	500	12.0	0.50	TO-204AA	IRF452	500	12.0	0.50	TO-204AA
IRF453	450	12.0	0.50	TO-204AA	IRF453	450	12.0	0.50	TO-204AA
IRF510	100	4.0	0.60	TO-220AB	IRF510	100	4.0	0.60	TO-220AB
IRF511	60	4.0	0.60	TO-220AB	IRF511	60	4.0	0.60	TO-220AB
IRF512	100	3.5	0.80	TO-220AB	IRF512	100	3.5	0.80	TO-220AB
IRF513	60	3.5	0.80	TO-220AB	IRF513	60	3.5	0.80	TO-220AB
IRF520	100	8.0	0.30	TO-220AB	IRF520	100	8.0	0.30	TO-220AB
IRF521	60	8.0	0.30	TO-220AB	IRF521	60	8.0	0.30	TO-220AB
IRF522	100	7.0	0.40	TO-220AB	IRF522	100	7.0	0.40	TO-220AB
IRF523	60	7.0	0.40	TO-220AB	IRF523	60	7.0	0.40	TO-220AB
IRF530	100	14.0	0.18	TO-220AB	IRF530	100	14.0	0.18	TO-220AB
IRF531	60	14.0	0.18	TO-220AB	IRF531	60	14.0	0.18	TO-220AB
IRF532	100	12.0	0.25	TO-220AB	IRF532	100	12.0	0.25	TO-220AB
IRF533	60	12.0	0.25	TO-220AB	IRF533	60	12.0	0.25	TO-220AB
IRF540	100	27.0	0.085	TO-220AB	IRF540	100	27.0	0.085	TO-220AB
IRF541	60	27.0	0.085	TO-220AB	IRF541	60	27.0	0.085	TO-220AB
IRF542	100	24.0	0.11	TO-220AB	IRF542	100	24.0	0.11	TO-220AB
IRF543	60	24.0	0.11	TO-220AB	IRF543	60	24.0	0.11	TO-220AB
IRF610	200	2.5	1.5	TO-220AB	IRF610	200	2.5	1.5	TO-220AB
IRF611	150	2.5	1.5	TO-220AB	IRF611	150	2.5	1.5	TO-220AB
IRF612	200	2.0	2.4	TO-220AB	IRF612	200	2.0	2.4	TO-220AB
IRF613	150	2.0	2.4	TO-220AB	IRF613	150	2.0	2.4	TO-220AB
IRF620	200	5.0	0.80	TO-220AB	IRF620	200	5.0	0.80	TO-220AB
IRF621	150	5.0	0.80	TO-220AB	IRF621	150	5.0	0.80	TO-220AB
IRF622	200	4.0	1.2	TO-220AB	IRF622	200	4.0	1.2	TO-220AB
IRF623	150	4.0	1.2	TO-220AB	IRF623	150	4.0	1.2	TO-220AB
IRF630	200	9.0	0.40	TO-220AB	IRF630	200	9.0	0.40	TO-220AB
IRF631	150	9.0	0.40	TO-220AB	IRF631	150	9.0	0.40	TO-220AB
IRF632	200	8.0	0.60	TO-220AB	IRF632	200	8.0	0.60	TO-220AB
IRF633	150	8.0	0.60	TO-220AB	IRF633	150	8.0	0.60	TO-220AB
IRF640	200	18.0	0.18	TO-220AB	IRF640	200	18.0	0.18	TO-220AB
IRF641	150	18.0	0.18	TO-220AB	IRF641	150	18.0	0.18	TO-220AB
IRF642	200	16.0	0.22	TO-220AB	IRF642	200	16.0	0.22	TO-220AB
IRF643	150	16.0	0.22	TO-220AB	IRF643	150	16.0	0.22	TO-220AB

Power MOSFET Cross-Reference (Cont.)

International Rectifier (Cont.)


CASE STYLE
TO-39

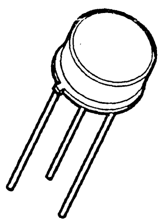

CASE STYLE
4 PIN DIP


CASE STYLE
TO-220

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	GE Direct Replacement	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
IRF710	400	1.5	3.6	TO-220AB	IRF710	400	1.5	3.6	TO-220AB
IRF711	350	1.5	3.6	TO-220AB	IRF711	350	1.5	3.6	TO-220AB
IRF712	400	1.3	5.0	TO-220AB	IRF712	400	1.3	5.0	TO-220AB
IRF713	350	1.3	5.0	TO-220AB	IRF713	350	1.3	5.0	TO-220AB
IRF720	400	3.0	1.8	TO-220AB	IRF720	400	3.0	1.8	TO-220AB
IRF721	350	3.0	1.8	TO-220AB	IRF721	350	3.0	1.8	TO-220AB
IRF722	400	2.5	2.5	TO-220AB	IRF722	400	2.5	2.5	TO-220AB
IRF723	350	2.5	2.5	TO-220AB	IRF723	350	2.5	2.5	TO-220AB
IRF730	400	5.5	1.0	TO-220AB	IRF730	400	5.5	1.0	TO-220AB
IRF731	350	5.5	1.0	TO-220AB	IRF731	350	5.5	1.0	TO-220AB
IRF732	400	4.5	1.5	TO-220AB	IRF732	400	4.5	1.5	TO-220AB
IRF733	350	4.5	1.5	TO-220AB	IRF733	350	4.5	1.5	TO-220AB
IRF740	400	10.0	0.55	TO-220AB	IRF740	400	10.0	0.55	TO-220AB
IRF741	350	10.0	0.55	TO-220AB	IRF741	350	10.0	0.55	TO-220AB
IRF742	400	8.0	0.80	TO-220AB	IRF742	400	8.0	0.80	TO-220AB
IRF743	350	8.0	0.80	TO-220AB	IRF743	350	8.0	0.80	TO-220AB
IRF820	500	2.5	3.0	TO-220AB	IRF820	500	2.5	3.0	TO-220AB
IRF821	450	2.5	3.0	TO-220AB	IRF821	450	2.5	3.0	TO-220AB
IRF822	500	2.0	4.0	TO-220AB	IRF822	500	2.0	4.0	TO-220AB
IRF823	450	2.0	4.0	TO-220AB	IRF823	450	2.0	4.0	TO-220AB
IRF830	500	4.5	1.5	TO-220AB	IRF830	500	4.5	1.5	TO-220AB
IRF831	450	4.5	1.5	TO-220AB	IRF831	450	4.5	1.5	TO-220AB
IRF832	500	4.0	2.0	TO-220AB	IRF832	500	4.0	2.0	TO-220AB
IRF833	450	4.0	2.0	TO-220AB	IRF833	450	4.0	2.0	TO-220AB
IRF840	500	8.0	0.85	TO-220AB	IRF840	500	8.0	0.85	TO-220AB
IRF841	450	8.0	0.85	TO-220AB	IRF841	450	8.0	0.85	TO-220AB
IRF842	500	7.0	1.1	TO-220AB	IRF842	500	7.0	1.1	TO-220AB
IRF843	450	7.0	1.1	TO-220AB	IRF843	450	7.0	1.1	TO-220AB
IRFD1Z0	100	0.50	2.4	4 PIN DIP	IRFDIZ0	100	0.50	2.4	4 PIN DIP
IRFD1Z1	60	0.50	2.4	4 PIN DIP	IRFDIZ1	60	0.50	2.4	4 PIN DIP
IRFD1Z2	100	0.40	3.2	4 PIN DIP	IRFDIZ2	100	0.40	3.2	4 PIN DIP
IRFD1Z3	60	0.40	3.2	4 PIN DIP	IRFDIZ3	60	0.40	3.2	4 PIN DIP
IRFD110	100	1.0	0.60	4 PIN DIP	IRFD110	100	1.0	0.60	4 PIN DIP
IRFD111	60	1.0	0.60	4 PIN DIP	IRFD111	60	1.0	0.60	4 PIN DIP
IRFD112	100	0.80	0.80	4 PIN DIP	IRFD112	100	0.80	0.80	4 PIN DIP
IRFD113	60	0.80	0.80	4 PIN DIP	IRFD113	60	0.80	0.80	4 PIN DIP
IRFD120	100	1.3	0.30	4 PIN DIP	IRFD120	100	1.3	0.30	4 PIN DIP
IRFD123	60	1.1	0.40	4 PIN DIP	IRFD123	60	1.1	0.40	4 PIN DIP
IRFD210	200	0.60	1.5	4 PIN DIP	IRFD210	200	0.60	1.5	4 PIN DIP
IRFD213	150	0.45	2.5	4 PIN DIP	IRFD213	150	0.45	2.5	4 PIN DIP
IRFF110	100	3.5	0.60	TO-39	IRFF110	100	3.5	0.60	TO-39
IRFF111	60	3.5	0.60	TO-39	IRFF111	60	3.5	0.60	TO-39
IRFF112	100	3.0	0.80	TO-39	IRFF111	60	3.5	0.80	TO-39
IRFF113	60	3.0	0.80	TO-39	IRFF113	60	3.0	0.80	TO-39

Power MOSFET Cross-Reference (Cont.)

International Rectifier (Cont.)

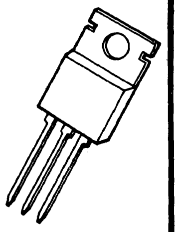


CASE STYLE
TO-39

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS (ON)}$ (Ohms)	Case Style	GE Direct Replacement	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS (ON)}$ (Ohms)	Case Style
IRFF120	100	6.0	0.30	TO-39	IRFF120	100	6.0	0.30	TO-39
IRFF121	60	6.0	0.30	TO-39	IRFF121	60	6.0	0.30	TO-39
IRFF122	100	5.0	0.40	TO-39	IRFF122	100	5.0	0.40	TO-39
IRFF123	60	5.0	0.40	TO-39	IRFF120	60	5.0	0.40	TO-39
IRFF130	100	8.0	0.18	TO-39	IRFF130	100	8.0	0.18	TO-39
IRFF131	60	8.0	0.18	TO-39	IRFF131	60	8.0	0.18	TO-39
IRFF132	100	7.0	0.25	TO-39	IRFF132	100	7.0	0.25	TO-39
IRFF133	60	7.0	0.25	TO-39	IRFF133	60	7.0	0.25	TO-39
IRFF210	200	2.2	1.5	TO-39	IRFF210	200	2.2	1.5	TO-39
IRFF211	150	2.2	1.5	TO-39	IRFF211	150	2.2	1.5	TO-39
IRFF212	200	1.8	2.4	TO-39	IRFF212	200	1.8	2.4	TO-39
IRFF213	150	1.8	2.4	TO-39	IRFF213	150	1.8	2.4	TO-39
IRFF220	200	3.5	0.80	TO-39	IRFF220	200	3.5	0.80	TO-39
IRFF221	150	3.5	0.80	TO-39	IRFF221	150	3.5	0.80	TO-39
IRFF222	200	3.0	1.2	TO-39	IRFF222	200	3.0	1.2	TO-39
IRFF223	150	3.0	1.2	TO-39	IRFF223	150	3.0	1.2	TO-39
IRFF230	200	5.5	0.40	TO-39	IRFF230	200	5.5	0.40	TO-39
IRFF231	150	5.5	0.40	TO-39	IRFF231	150	5.5	0.40	TO-39
IRFF232	200	4.5	0.60	TO-39	IRFF232	200	4.5	0.60	TO-39
IRFF233	150	4.5	0.60	TO-39	IRFF233	150	4.5	0.60	TO-39
IRFF310	200	1.35	3.6	TO-39	IRFF310	200	1.35	3.6	TO-39
IRFF311	150	1.35	3.6	TO-39	IRFF311	150	1.35	3.6	TO-39
IRFF312	200	1.15	5.0	TO-39	IRFF312	200	1.15	5.0	TO-39
IRFF313	150	1.15	5.0	TO-39	IRFF313	150	1.15	5.0	TO-39
IRFF320	400	2.5	1.8	TO-39	IRFF320	400	2.5	1.8	TO-39
IRFF321	350	2.5	1.8	TO-39	IRFF321	350	2.5	1.8	TO-39
IRFF322	400	2.0	2.5	TO-39	IRFF322	400	2.0	2.5	TO-39
IRFF323	350	2.0	2.5	TO-39	IRFF323	350	2.0	2.5	TO-39
IRFF330	400	3.5	1.0	TO-39	IRFF330	400	3.5	1.0	TO-39
IRFF331	350	3.5	1.0	TO-39	IRFF331	350	3.5	1.0	TO-39
IRFF332	400	3.0	1.5	TO-39	IRFF332	400	3.0	1.5	TO-39
IRFF333	350	3.0	1.5	TO-39	IRFF333	350	3.0	1.5	TO-39
IRFF420	500	1.6	3.0	TO-39	IRFF420	500	1.6	3.0	TO-39
IRFF421	450	1.6	3.0	TO-39	IRFF421	450	1.6	3.0	TO-39
IRFF422	500	1.4	4.0	TO-39	IRFF422	500	1.4	4.0	TO-39
IRFF423	450	1.4	4.0	TO-39	IRFF423	450	1.4	4.0	TO-39
IRFF430	500	2.75	1.5	TO-39	IRFF430	500	2.75	1.5	TO-39
IRFF431	450	2.75	1.5	TO-39	IRFF431	450	2.75	1.5	TO-39
IRFF432	500	2.25	2.0	TO-39	IRFF432	500	2.25	2.0	TO-39
IRFF433	450	2.25	2.0	TO-39	IRFF433	450	2.25	2.0	TO-39

Power MOSFET Cross-Reference (Cont.)

MOTOROLA

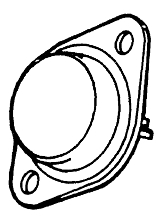


CASE STYLE
TO-220

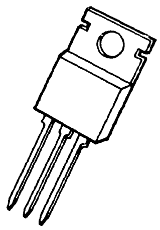
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
MTP2N50	500	2.0	4.0	TO-220	IRF822	500	2.0	4.0	TO-220AB
MTP2N45	450	2.0	4.0	TO-220	IRF823	450	2.0	4.0	TO-220AB
MTP2N40	400	2.0	3.3	TO-220	IRF722	400	2.5	2.5	TO-220AB
MTP2N35	350	2.0	3.3	TO-220	IRF723	350	2.5	2.5	TO-220AB
MTP2N20	200	2.0	2.2	TO-220	IRF612	200	2.0	2.4	TO-220AB
MTP2N18	180	2.0	2.2	TO-220	IRF612	200	2.0	2.4	TO-220AB
MTP3N40	400	3.0	3.3	TO-220	IRF722	400	2.5	2.5	TO-220AB
MTP3N35	350	3.0	3.3	TO-220	IRF723	350	2.5	2.5	TO-220AB
MTP3N15	150	3.0	1.5	TO-220	D84BM2	150	2.5	1.5	TO-220AB
MTP3N12	120	3.0	1.5	TO-220	D84BM2	150	2.5	1.5	TO-220AB
MTP4N50	500	4.0	2.0	TO-220	IRF832	500	4.0	2.0	TO-220AB
MTP4N45	450	4.0	2.0	TO-220	IRF833	450	4.0	2.0	TO-220AB
MTP5N40	400	5.0	1.5	TO-220	IRF732	400	4.5	1.5	TO-220AB
MTP5N35	350	5.0	1.5	TO-220	IRF733	350	4.5	1.5	TO-220AB
MTP5N20	200	5.0	1.0	TO-220	D84CN2	200	5.0	0.80	TO-220AB
MTP5N18	180	5.0	1.0	TO-220	D84CN2	200	5.0	0.80	TO-220AB
MTP5N06	60	5.0	0.60	TO-220	D84BK2	60	4.0	0.60	TO-220AB
MTP5N05	50	5.0	0.60	TO-220	D84BK2	60	4.0	0.60	TO-220AB
MTP7N20	200	7.0	0.65	TO-220	IRF632	200	8.0	0.60	TO-220AB
MTP7N18	180	7.0	0.65	TO-220	IRF632	200	8.0	0.60	TO-220AB
MTP7N15	150	7.0	0.70	TO-220	IRF633	150	8.0	0.60	TO-220AB
MTP7N12	120	7.0	0.70	TO-220	IRF633	150	8.0	0.60	TO-220AB
MTP8N20	200	8.0	0.50	TO-220	IRF632	200	8.0	0.60	TO-220AB
MTP8N18	180	8.0	0.50	TO-220	IRF632	200	8.0	0.60	TO-220AB
MTP8N15	150	8.0	0.40	TO-220	IRF633	150	8.0	0.60	TO-220AB
MTP8M12	120	8.0	0.40	TO-220	IRF633	150	8.0	0.60	TO-220AB
MTP8N10	100	8.0	0.40	TO-220	D84CL2	100	8.0	0.30	TO-220AB
MTP8N08	80	8.0	0.50	TO-220	D84CL2	100	8.0	0.30	TO-220AB
MTP10N15	150	10.0	0.30	TO-220	D84DM2	150	9.0	0.40	TO-220AB
MTP10N12	120	10.0	0.30	TO-220	D84DM2	150	9.0	0.40	TO-220AB
MTP10N10	100	10.0	0.33	TO-220	D84CL2	100	8.0	0.30	TO-220AB
MTP10N08	80	10.0	0.33	TO-220	D84CL2	100	8.0	0.30	TO-220AB
MTP10N06	60	10.0	0.28	TO-220	D84CK2	60	8.0	0.30	TO-220AB
MTP10N05	50	10.0	0.28	TO-220	D84CK2	60	8.0	0.30	TO-220AB
MTP12N10	100	12.0	0.18	TO-220	IRF532	100	12.0	0.25	TO-220AB
MTP12N08	80	12.0	0.18	TO-220	IRF532	100	12.0	0.25	TO-220AB
MTP12N06	60	12.0	0.20	TO-220	IRF533	60	12.0	0.25	TO-220AB
MTP12N05	50	12.0	0.20	TO-220	IRF533	60	12.0	0.25	TO-220AB
MTP15N06	60	15.0	0.16	TO-220	D84DK2	60	14.0	0.18	TO-220AB
MTP15N05	50	15.0	0.16	TO-220	D84DK2	60	14.0	0.18	TO-220AB

Power MOSFET Cross-Reference (Cont.)

Motorola (Cont.)



CASE STYLE TO-204

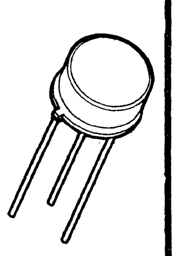


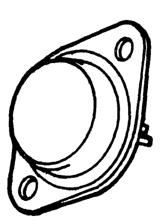
CASE STYLE TO-220

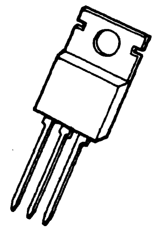
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\ (ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\ (ON)}$ (Ohms)	Case Style
MTM2N50	500	2.0	4.0	TO-204	IRF822	500	2.0	4.0	TO-220AB
MTM2N45	450	2.0	4.0	TO-204	IRF823	450	2.0	4.0	TO-220AB
MTM3N40	400	3.0	3.3	TO-204	IRF722	400	2.5	2.5	TO-220AB
MTM3N35	350	3.0	3.3	TO-204	IRF723	350	2.5	2.5	TO-220AB
MTM4N50	500	4.0	2.0	TO-204	IRF432	500	4.0	2.0	TO-204AA
MTM4N45	450	4.0	2.0	TO-204	IRF433	450	4.0	2.0	TO-204AA
MTM5N40	400	5.0	1.5	TO-204	IRF332	400	4.5	1.5	TO-204AA
MTM5N35	350	5.0	1.5	TO-204	IRF333	350	4.5	1.5	TO-204AA
MTM5N20	200	5.0	1.0	TO-204	D84CN2	200	5.0	0.80	TO-220AB
MTM5N18	180	5.0	1.0	TO-204	D84CN2	200	5.0	0.80	TO-220AB
MTM7N50	500	7.0	1.2	TO-204	IRF442	500	7.0	1.1	TO-204AA
MTM7N45	450	7.0	1.2	TO-204	IRF443	450	7.0	1.1	TO-204AA
MTM7N20	200	7.0	0.65	TO-204	IRF232	200	8.0	0.60	TO-204AA
MTM7N18	180	7.0	0.65	TO-204	IRF232	200	8.0	0.60	TO-204AA
MTM7N15	150	7.0	0.70	TO-204	IRF233	150	8.0	0.60	TO-204AA
MTM7N12	120	7.0	0.70	TO-204	IRF233	150	8.0	0.60	TO-204AA
MTM8N40	400	8.0	0.80	TO-204	IRF342	400	8.0	0.80	TO-204AA
MTM8N35	350	8.0	0.80	TO-204	IRF343	350	8.0	0.80	TO-204AA
MTM8N20	200	8.0	0.40	TO-204	IRF232	200	8.0	0.60	TO-204AA
MTM8N18	180	8.0	0.40	TO-204	IRF232	200	8.0	0.60	TO-204AA
MTM8N15	150	8.0	0.50	TO-204	IRF233	150	8.0	0.60	TO-204AA
MTM8N12	120	8.0	0.50	TO-204	IRF233	150	8.0	0.60	TO-204AA
MTM8N10	100	8.0	0.50	TO-204	IRF132	100	12.0	0.25	TO-204AA
MTM8N08	80	8.0	0.50	TO-204	IRF132	100	12.0	0.25	TO-204AA
MTM10N15	150	10.0	0.30	TO-204	D86DM2	100	9.0	0.40	TO-204AA
MTM10M12	120	10.0	0.30	TO-204	D86DM2	100	9.0	0.40	TO-204AA
MTM10N10	100	10.0	0.33	TO-204	IRF132	100	12.0	0.25	TO-204AA
MTM10N08	80	10.0	0.33	TO-204	IRF132	100	12.0	0.25	TO-204AA
MTM10N06	60	10.0	0.28	TO-204	IRF133	60	12.0	0.25	TO-204AA
MTM10N05	50	10.0	0.28	TO-204	IRF133	60	12.0	0.25	TO-204AA
MTM12N20	200	12.0	0.35	TO-204	D86DN2	200	9.0	0.40	TO-204AA
MTM12N18	180	12.0	0.35	TO-204	D86DN2	200	9.0	0.40	TO-204AA
MTM12N15	150	12.0	0.26	TO-204	D86DM2	150	9.0	0.40	TO-204AA
MTM12N12	120	12.0	0.26	TO-204	D86DM2	150	9.0	0.40	TO-204AA
MTM12N10	100	12.0	0.18	TO-204	IRF132	100	12.0	0.25	TO-204AA
MTM12N08	80	12.0	0.18	TO-204	IRF132	100	12.0	0.25	TO-204AA
MTM12N06	60	12.0	0.20	TO-204	IRF133	60	12.0	0.25	TO-204AA
MTM12N05	50	12.0	0.20	TO-204	IRF133	60	12.0	0.25	TO-204AA

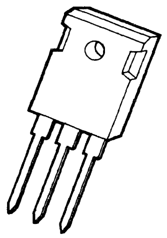
Power MOSFET Cross-Reference (Cont.)

Motorola (Cont.)


CASE STYLE
TO-39


CASE STYLE
TO-204

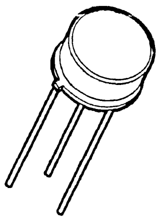

CASE STYLE
TO-220

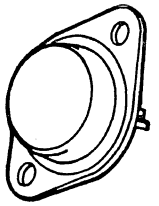

CASE STYLE
TO-247

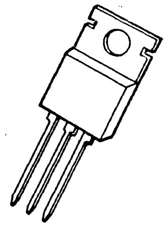
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\ (ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\ (ON)}$ (Ohms)	Case Style
MTM15N50	500	15.0	0.50	TO-204	D86FR2	500	13.0	0.40	TO-204AA
MTM15N45	450	15.0	0.50	TO-204	D86FR1	450	13.0	0.40	TO-204AA
MTM15N40	400	15.0	0.40	TO-204	D86FQ2	400	15.0	0.30	TO-204AA
MTM15N35	350	15.0	0.40	TO-204	D86FQ1	350	15.0	0.30	TO-204AA
MTM15N20	200	15.0	0.16	TO-204	IRF242	200	16.0	0.22	TO-204AE
MTM15N18	180	15.0	0.16	TO-204	IRF242	200	16.0	0.22	TO-204AE
MTM15N15	150	15.0	0.22	TO-204	IRF243	150	16.0	0.22	TO-204AE
MTM15N12	120	15.0	0.22	TO-204	IRF243	150	16.0	0.22	TO-204AE
MTM15N06	60	15.0	0.16	TO-204	D86DK2	60	14.0	0.18	TO-220AA
MTM15N05	50	15.0	0.16	TO-204	D86DK2	60	14.0	0.18	TO-220AA
MTM20N14	150	20.0	0.12	TO-204	D86EM2	150	18.0	0.18	TO-204AE
MTM20N12	120	20.0	0.12	TO-204	D86EM2	150	18.0	0.18	TO-204AE
MTM20N10	100	20.0	0.15	TO-204	IRF142	100	24.0	0.11	TO-204AE
MTM20N08	80	20.0	0.15	TO-204	IRF142	100	24.0	0.11	TO-204AE
MTM25N10	100	25.0	0.070	TO-204	IRF142	100	24.0	0.11	TO-204AE
MTM25N08	80	25.0	0.070	TO-204	IRF142	100	24.0	0.11	TO-204AE
MTM25N06	60	25.0	0.080	TO-204	IRF143	60	24.0	0.11	TO-204AE
MTM25N05	50	25.0	0.080	TO-204	IRF143	60	24.0	0.11	TO-204AE
MTM35N06	60	35.0	0.055	TO-204	IRF153	60	33.0	0.080	TO-204AE
MTM35N05	50	35.0	0.055	TO-204	IRF153	60	33.0	0.080	TO-204AE
MTH7N50	500	7.0	0.80	TO-218	D88FR2	500	13.0	0.40	TO-247
MTH7N45	450	7.0	0.80	TO-218	D88FR2	500	13.0	0.50	TO-247
MTH8N40	400	8.0	0.55	TO-218	D88FQ2	400	15.0	0.40	TO-247
MTH8N35	350	8.0	0.55	TO-218	D88FQ2	400	15.0	0.40	TO-247
MTH15N20	200	15.0	0.16	TO-218	D88FN2	200	30.0	0.085	TO-247
MTH15M18	180	15.0	0.16	TO-218	D88FN2	200	30.0	0.085	TO-247
MTH15N15	150	15.0	0.25	TO-218	D88FM2	150	30.0	0.085	TO-247
MTH15N12	120	15.0	0.25	TO-218	D88FM2	150	30.0	0.085	TO-247
MTH20N15	150	20.0	0.12	TO-218	D88FM2	150	30.0	0.085	TO-247
MTH20N12	120	20.0	0.12	TO-218	D88FM2	150	30.0	0.085	TO-247
MTH25N10	100	25.0	0.070	TO-218	D88FL2	100	40.0	0.055	TO-247
MTH25N08	80	25.0	0.070	TO-218	D88FL2	100	40.0	0.055	TO-247
MTH35N06	60	35.0	0.055	TO-218	D88FK2	60	40.0	0.055	TO-247
MTH35N05	50	35.0	0.055	TO-218	D88FK2	50	40.0	0.055	TO-247
MFE990	90	2.0	2.0	TO-39	IRF112	100	3.0	0.80	TO-39
MFE960	60	2.0	1.7	TO-39	IRF113	60	3.0	0.80	TO-39
MFE930	35	2.0	1.4	TO-39	IRF113	60	3.0	0.80	TO-39
MFE910	60	0.5	5.0	TO-39	IRF113	60	3.0	0.80	TO-39

Power MOSFET Cross-Reference (Cont.)

R.C.A.


CASE STYLE TO-39

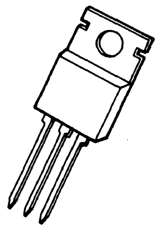

CASE STYLE TO-204


CASE STYLE TO-220

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
RFL1N20	200	1.0	3.0	TO-39	IRFF212	200	1.8	2.4	TO-39
RFL1N18	180	1.0	3.0	TO-39	IRFF212	200	1.8	2.4	TO-39
RFL1N15	150	1.0	2.0	TO-39	IRFF211	150	2.2	1.5	TO-39
RFL1N12	120	1.0	2.0	TO-39	IRFF213	150	1.8	2.4	TO-39
RFL1N10	100	1.0	1.25	TO-39	IRFF112	100	3.0	0.80	TO-39
RFL1N08	80	1.0	1.25	TO-39	IRFF112	100	3.0	0.80	TO-39
RFL2N06	60	2.0	0.80	TO-39	IRFF113	60	3.0	0.80	TO-39
RFL2N05	50	2.0	0.80	TO-39	IRFF113	60	3.0	0.80	TO-39
RFL4N15	150	4.0	0.30	TO-39	IRFF233	150	4.5	0.60	TO-39
RFL4N12	120	4.0	0.30	TO-39	IRFF233	150	4.5	0.60	TO-39
RFK10N50	500	10.0	0.85	TO-204	D86ER2	500	8.0	0.85	TO-204AA
RFK10N45	450	10.0	0.85	TO-204	D86ER1	450	8.0	0.85	TO-204AA
RFK25N20	200	25.0	0.15	TO-204	IRF252	200	25.0	0.12	TO-204AE
RFK25N18	180	25.0	0.15	TO-204	IRF252	200	25.0	0.12	TO-204AE
RFK30N15	150	30.0	0.085	TO-204	D86FM2	150	30.0	0.085	TO-204AE
RFK30N12	120	30.0	0.085	TO-204	D86FM2	150	30.0	0.085	TO-204AE
RFK35N10	100	35.0	0.060	TO-204	IRF152	100	33.0	0.080	TO-204AE
RFK35N08	80	35.0	0.060	TO-204	IRF152	100	33.0	0.080	TO-204AE
RFK45N06	60	45.0	0.040	TO-204	D86FK2	60	40.0	0.055	TO-204AE
RFK45N05	50	45.0	0.040	TO-204	D86FK2	60	40.0	0.055	TO-204AE
RFM3N50	500	3.0	3.0	TO-204	D84CR2	500	2.5	3.0	TO-220AB
RFM3N45	450	3.0	3.0	TO-204	D84CR1	450	2.5	3.0	TO-220AB
RFM8N20	200	8.0	0.50	TO-204	IRF232	200	8.0	0.60	TO-204AA
RFM8N18	180	8.0	0.50	TO-204	IRF232	200	8.0	0.60	TO-204AA
RFM10N50	500	10.0	0.85	TO-204	D86ER2	500	8.0	0.85	TO-204AA
RFM10N45	450	10.0	0.85	TO-204	D86ER1	450	8.0	0.85	TO-204AA
RFM10N15	150	10.0	0.30	TO-204	D86DM2	150	9.0	0.40	TO-204AA
RFM10N12	120	10.0	0.30	TO-204	D86DM2	150	9.0	0.40	TO-204AA
RFM12N40	400	12.0	0.50	TO-204	IRF352	400	13.0	0.40	TO-204AA
RFM12N35	350	12.0	0.50	TO-204	IRF353	350	13.0	0.40	TO-204AA
RFM12N20	200	12.0	0.25	TO-204	D86DN2	200	9.0	0.40	TO-204AA
RFM12N18	180	12.0	0.25	TO-204	D86DN2	200	9.0	0.40	TO-204AA
RFM12N10	100	12.0	0.20	TO-204	D86DL2	100	14.0	0.18	TO-204AA
RFM12N08	80	12.0	0.20	TO-204	D86DL2	100	14.0	0.18	TO-204AA
RFM15N15	150	15.0	0.15	TO-204	IRF243	150	16.0	0.22	TO-204AE
RFM15N12	120	15.0	0.15	TO-204	IRF243	150	16.0	0.22	TO-204AE
RFM15N06	60	15.0	0.15	TO-204	D86DK2	60	14.0	0.18	TO-204AA
RFM15N05	50	15.0	0.15	TO-204	D86DK2	60	14.0	0.18	TO-204AA
RFM18N10	100	18.0	0.12	TO-204	D86DL2	100	14.0	0.18	TO-204AA
RFM18N08	80	18.0	0.12	TO-204	D86DL2	100	14.0	0.18	TO-204AA

Power MOSFET Cross Reference (Cont.)

R.C.A. (Cont.)

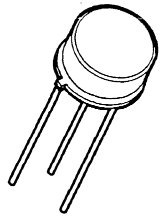


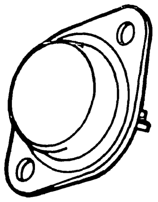
CASE STYLE
TO-220

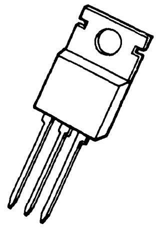
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
RFP2N20	200	2.0	3.0	TO-220	IRF612	200	2.0	2.4	TO-220AB
RFP2N18	180	2.0	3.0	TO-220	IRF612	200	2.0	2.4	TO-220AB
RFP2N15	150	2.0	2.0	TO-220	IRF613	150	2.0	2.4	TO-220AB
RFP2N12	120	2.0	2.0	TO-220	IRF613	150	2.0	2.4	TO-220AB
RFP2N10	100	2.0	1.25	TO-220	IRF512	100	3.5	0.80	TO-220AB
RFP2N08	80	2.0	1.25	TO-220	IRF512	100	3.5	0.80	TO-220AB
RFP3N50	500	3.0	3.0	TO-220	D85CR2	500	2.5	3.0	TO-220AB
RFP3N45	450	3.0	3.0	TO-220	D84CR1	450	2.5	3.0	TO-220AB
RFP4N06	60	4.0	0.80	TO-220	D84BK2	60	4.0	0.60	TO-220AB
RFP4N05	50	4.0	0.80	TO-220	D84BK2	60	4.0	0.60	TO-220AB
RFP8N20	200	8.0	0.50	TO-220	IRF632	200	8.0	0.60	TO-220AB
RFP8N18	180	8.0	0.50	TO-220	IRF632	200	8.0	0.60	TO-220AB
RFP10N15	150	10.0	0.30	TO-220	D84DM2	150	9.0	0.40	TO-220AB
RFP10N12	120	10.0	0.30	TO-220	D84DM2	150	9.0	0.40	TO-220AB
RFP12N20	200	12.0	0.25	TO-220	D84DN2	200	9.0	0.40	TO-220AB
RFP12N18	180	12.0	0.25	TO-220	D84DN2	200	9.0	0.40	TO-220AB
RFP12N10	100	12.0	0.20	TO-220	IRF532	100	12.0	0.25	TO-220AB
RFP12N08	80	12.0	0.20	TO-220	IRF532	100	12.0	0.25	TO-220AB
RFP15N15	150	15.0	0.15	TO-220	IRF643	150	16.0	0.22	TO-220AB
RFP15N12	120	15.0	0.15	TO-220	IRF643	150	16.0	0.22	TO-220AB
RFP15N06	60	15.0	0.15	TO-220	D84DK2	60	14.0	0.18	TO-220AB
RFP15N05	50	15.0	0.15	TO-220	D84DK2	60	14.0	0.18	TO-220AB
RFP18N10	100	18.0	0.15	TO-220	D84DL2	100	14.0	0.18	TO-220AB
RFP18N08	80	18.0	0.12	TO-220	D84DL2	100	14.0	0.18	TO-220AB

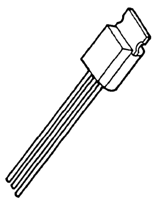
Power MOSFET Cross-Reference (Cont.)

SIEMENS


CASE STYLE TO-39

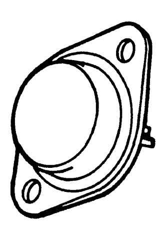

CASE STYLE TO-204

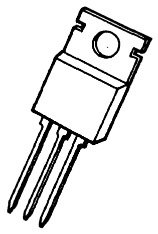

CASE STYLE TO-220


CASE STYLE TO-237

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
BSS89	200	0.30	6.0	TO-92	D80AN2	200	0.3	5.6	TO-237
BSS93	200	0.50	6.0	TO-39	IRFF212	200	1.8	2.4	TO-39
BSS100	100	0.23	6.0	TO-92	D80AL2	100	0.5	2.4	TO-237
BSS101	200	0.16	12.0	TO-92	D80AN2	200	0.3	5.6	TO-237
BUZ10	50	12.0	0.10	TO-220	IRFF533	60	12.0	0.25	TO-220AB
BUZ10A	50	12.0	0.12	TO-220	IRF533	60	12.0	0.25	TO-220AB
BUZ10B	50	12.0	0.25	TO-220	IRF533	60	12.0	0.25	TO-220AB
BUZ11	50	30.0	0.040	TO-220	D84EK2	60	27.0	0.085	TO-220AB
BUZ11A	50	25.0	0.060	TO-220	IRF543	60	24.0	0.11	TO-220AB
BUZ14	50	39.0	0.040	TO-204	D86FL2	60	40.0	0.055	TO-204AE
BUZ14A	50	33.0	0.055	TO-204	IRF153	60	33.0	0.080	TO-204AE
BUZ14B	50	28.0	0.080	TO-204	D86EK2	60	27.0	0.085	TO-204AE
BUZ14C	50	14.0	0.18	TO-204	D86DK2	60	14.0	0.18	TO-204AA
BUZ14D	50	12.0	0.25	TO-204	IRF133	60	12.0	0.25	TO-204AA
BUZ15	50	45.0	0.030	TO-204	D86FK2	60	40.0	0.055	TO-204AE
BUZ20	100	12.0	0.20	TO-220	IRF532	100	12.0	0.25	TO-220AB
BUZ20A	100	12.0	0.25	TO-220	IRF532	100	12.0	0.25	TO-220AB
BUZ20B	100	8.0	0.30	TO-220	D84CL2	100	8.0	0.30	TO-220AB
BUZ21	100	19.0	0.10	TO-220	D84DL2	100	14.0	0.18	TO-220AB
BUZ23	100	10.0	0.20	TO-204	IRF132	100	12.0	0.25	TO-204AA
BUZ23A	100	14.0	0.18	TO-204	D86DL2	100	14.0	0.18	TO-204AA
BUZ23B	100	33.0	0.080	TO-204	IRF152	100	33.0	0.080	TO-204AE
BUZ24	100	32.0	0.060	TO-204	IRF152	100	33.0	0.080	TO-204AE
BUZ24B	100	28.0	0.080	TO-204	D86EL2	100	27.0	0.085	TO-204AE
BUZ25	100	19.0	0.10	TO-204	D86DL2	100	14.0	0.18	TO-204AA
BUZ30	200	6.5	0.75	TO-220	D84CN2	200	5.0	0.80	TO-220AB
BUZ31	200	12.5	0.20	TO-220	D84DN2	200	9.0	0.40	TO-220AB
BUZ32	200	9.5	0.40	TO-220	D84DN2	200	9.0	0.40	TO-220AB
BUZ32A	150	9.5	0.40	TO-220	D84DM2	150	9.0	0.40	TO-220AB
BUZ32B	200	7.5	0.60	TO-220	IRF632	200	8.0	0.60	TO-220AB
BUZ32C	150	7.5	0.60	TO-220	IRF633	150	8.0	0.60	TO-220AB
BUZ33	200	7.2	0.75	TO-204	IRF232	200	8.0	0.60	TO-204AA
BUZ33A	200	7.5	0.60	TO-204	IRF232	200	8.0	0.60	TO-204AA
BUZ33B	150	7.5	0.60	TO-204	IRF233	150	8.0	0.60	TO-204AA
BUZ34	200	14.0	0.20	TO-204	IRF242	200	16.0	0.22	TO-204AE
BUZ35	200	9.9	0.40	TO-204	D86DN2	200	9.0	0.40	TO-204AA
BUZ35A	150	9.9	0.40	TO-204	D86DM2	150	9.0	0.40	TO-204AA
BUZ36	200	22.0	0.12	TO-204	D86EN2	200	18.0	0.18	TO-204AE
BUZ41A	500	4.5	1.5	TO-220	D84DR2	500	4.5	1.5	TO-220AB
BUZ41B	450	4.5	1.5	TO-220	D85DR1	450	4.5	1.5	TO-220AB
BUZ42	500	4.0	2.0	TO-220	IRF832	500	4.0	2.0	TO-220AB

Power MOSFET Cross-Reference (Cont.)


CASE STYLE
TO-204

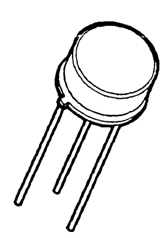

CASE STYLE
TO-220

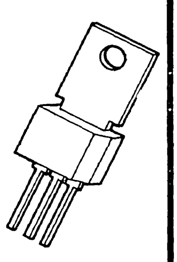
Siemens (Cont.)

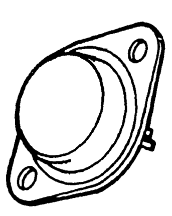
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
BUZ42A	450	4.0	2.0	TO-220	IRF833	450	4.0	2.0	TO-220AB
BUZ42B	500	2.5	3.0	TO-220	D84CR2	500	2.5	3.0	TO-220AB
BUZ42C	450	2.5	3.0	TO-220	D84CR1	450	2.5	4.0	TO-220AB
BUZ42D	500	2.0	4.0	TO-220	IRF822	500	2.0	4.0	TO-220AB
BUZ44A	500	4.8	1.5	TO-204	D86DR2	500	4.5	1.5	TO-204AA
BUZ44B	450	4.8	1.5	TO-204	D86DR1	450	4.5	1.5	TO-204AA
BUZ45	500	9.6	1.6	TO-204	D86ER2	500	8.0	0.85	TO-204AA
BUZ45A	500	8.3	0.80	TO-204	D86ER2	500	8.0	0.85	TO-204AA
BUZ45B	500	10.0	0.50	TO-204	D86ER2	500	8.0	0.85	TO-204AA
BUZ45C	450	10.0	0.50	TO-204	D86ER1	450	8.0	0.85	TO-204AA
BUZ46	500	4.2	2.0	TO-204	IRF432	500	4.0	2.0	TO-204AA
BUZ46A	450	4.2	2.0	TO-204	IRF433	450	4.0	2.0	TO-204AA
BUZ46B	500	2.4	3.0	TO-204	D84CR1	500	2.5	3.0	TO-220AB
BUZ60	400	5.5	1.0	TO-220	D84DQ2	400	5.5	1.0	TO-220AB
BUZ60A	350	5.5	1.0	TO-220	D84DQ1	350	5.5	1.0	TO-220AB
BUZ60B	400	4.5	1.5	TO-220	IRF732	500	4.5	1.5	TO-220AB
BUZ60C	350	4.5	1.5	TO-220	IRF733	350	4.5	1.5	TO-220AB
BUZ60D	400	3.0	1.8	TO-220	D84CQ2	400	3.0	1.8	TO-220AB
BUZ63	400	5.9	1.0	TO-204	D86DQ2	400	5.5	1.0	TO-204AA
BUZ63A	350	5.9	1.0	TO-204	D86DQ1	350	5.5	1.0	TO-204AA
BUZ63B	400	4.5	1.5	TO-204	IRF332	400	4.5	1.5	TO-204AA
BUZ63C	350	4.5	1.5	TO-204	IRF333	350	4.5	1.5	TO-204AA
BUZ63D	400	3.0	1.8	TO-204	D84DQ2	400	3.0	1.8	TO-220AB
BUZ64	400	10.0	0.40	TO-204	D86EQ2	400	10.0	0.55	TO-204AA
BUZ64A	350	10.0	0.40	TO-204	D86EQ1	350	10.0	0.55	TO-204AA
BUZ71	50	12.0	0.10	TO-220	IRF533	60	12.0	0.25	TO-220AB
BUZ71A	50	12.0	0.12	TO-220	IRF533	60	12.0	0.25	TO-220AB
BUZ72A	100	9.0	0.25	TO-220	D84CL2	100	8.0	0.30	TO-220AB
BUZ73A	200	5.8	0.60	TO-220	D84CN2	200	5.0	0.80	TO-220AB
BUZ74	500	2.4	3.0	TO-220	D84CR2	500	2.5	3.0	TO-220AB
BUZ74A	500	2.0	4.0	TO-220	IRF822	500	2.0	4.0	TO-220AB
BUZ76	400	3.0	1.8	TO-220	D84CQ2	400	3.0	1.8	TO-220AB
BUZ76A	400	2.6	2.5	TO-220	IRF722	400	2.5	2.5	TO-220AB

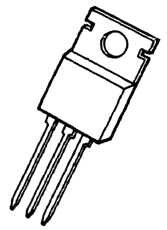
Power MOSFET Cross-Reference (Cont.)

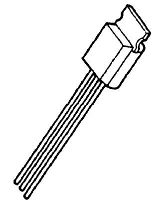
SUPERTEX INC.


CASE STYLE TO-39


CASE STYLE TO-202

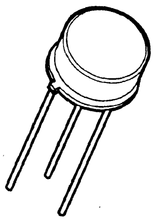

CASE STYLE TO-204


CASE STYLE TO-220

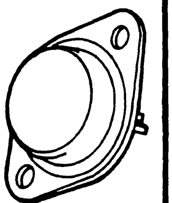

CASE STYLE TO-237

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
VN0104N2	40	4.0	4.0	TO-39	IRFF111	60	3.5	0.60	TO-39
VN0104N3	40	4.0	4.0	TO-92	VN10KMA	60	0.75	5.0	TO-237
VN0104N4	40	4.0	4.0	TO-202	VN40AFA	40	1.3	5.0	TO-202
VN0104N5	40	4.0	4.0	TO-220	D84BK2	60	4.0	0.60	TO-220AB
VN0106N2	60	4.0	4.0	TO-39	IRFF111	60	3.5	0.60	TO-39
VN0106N3	60	4.0	4.0	TO-92	VN10KMA	60	0.75	5.0	TO-237
VN0106N4	60	4.0	4.0	TO-202	VN67AFA	60	1.6	3.5	TO-202
VN0106N5	60	4.0	4.0	TO-220	D84BK2	60	4.0	0.60	TO-220AB
VN0109N2	90	4.0	4.0	TO-39	IRFF110	100	3.5	0.60	TO-39
VN0109N3	90	4.0	4.0	TO-92	D80AL2	100	0.50	2.4	TO-237
VN0109N4	90	4.0	4.0	TO-202	IRFF112	80	1.5	4.0	TO-202
VN0109N5	90	4.0	4.0	TO-220					
VN0110N2	100	3.0	8.0	TO-39	IRFF112	100	3.0	0.80	TO-39
VN0110N3	100	3.0	8.0	TO-92	D80AL2	100	0.50	2.4	TO-237
VN0110N5	100	3.0	8.0	TO-220	IRF512	100	3.5	0.80	TO-220AB
VN0114N2	140	3.0	8.0	TO-39	IRFF223	150	3.0	1.2	TO-39
VN0114N3	140	3.0	8.0	TO-92	D80AM2	150	0.30	5.6	TO-237
VN0114N5	140	3.0	8.0	TO-220	D84BM2	150	2.5	1.5	TO-220AB
VN0116N2	160	2.0	16.0	TO-39	IRFF211	150	2.2	1.5	TO-39
VN0116N3	160	2.0	16.0	TO-92	D80AM2	150	0.30	5.6	TO-237
VN0116N5	160	2.0	16.0	TO-220	IRF613	150	2.0	2.4	TO-220AB
VN0120N2	200	2.0	16.0	TO-39	IRFF210	200	2.2	1.5	TO-39
VN0120N3	200	2.0	16.0	TO-92	D80AN2	200	0.30	5.6	TO-237
VN0120N5	200	2.0	16.0	TO-220	IRF612	200	2.0	2.4	TO-220AB
VN0204N2	40	10.0	2.0	TO-39	IRFF131	60	8.0	0.18	TO-39
VN0204N5	40	10.0	2.0	TO-220	D84CK2	60	8.0	0.30	TO-220AB
VN0206N2	60	10.0	2.0	TO-39	IRFF131	60	8.0	0.18	TO-39
VN0206N5	60	10.0	2.0	TO-220	D84CK2	60	8.0	0.30	TO-220AB
VN0210N2	100	10.0	2.0	TO-39	IRFF130	100	8.0	0.18	TO-39
VN0210N5	100	10.0	2.0	TO-220	D84CL2	100	8.0	0.30	TO-220AB
VN0215N2	150	8.0	4.0	TO-39	IRFF231	150	5.5	0.40	TO-39
VN0215N5	150	8.0	4.0	TO-220	IRF633	150	8.0	0.60	TO-220AB
VN0220N2	200	6.0	8.0	TO-39	IRFF230	200	5.5	0.40	TO-39
VN0220N5	200	6.0	8.0	TO-220	D84CN2	200	5.0	0.80	TO-220AB
VN0330N1	300	12.0	3.0	TO-204	IRF353	350	13.0	0.40	TO-204AA
VN0330N2	300	12.0	3.0	TO-39	IRFF331	350	3.5	1.0	TO-39
VN0330N5	300	12.0	3.0	TO-220	D84EQ1	350	10.0	0.55	TO-220AB
VN0335N1	350	12.0	3.0	TO-204	IRF353	350	13.0	0.40	TO-204AA
VN0335N2	350	12.0	3.0	TO-39	IRFF331	350	3.5	1.0	TO-39
VN0335N5	350	12.0	3.0	TO-220	D84EQ1	350	10.0	0.55	TO-220AB
VN0340N1	400	12.0	3.0	TO-204	IRF352	400	13.0	0.40	TO-204AA
VN0340N2	400	12.0	3.0	TO-39	IRFF330	400	3.5	1.0	TO-39
VN0340N5	400	12.0	3.0	TO-220	D84EQ2	400	10.0	0.55	TO-220AB
VN0345N1	450	12.0	3.0	TO-204	IRF453	450	12.0	0.50	TO-204AA
VN0345N2	450	12.0	3.0	TO-39	IRFF431	450	2.75	1.5	TO-39
VN0345N5	450	12.0	3.0	TO-220	D84ER1	450	8.0	0.85	TO-220AB
VN0350N1	500	8.0	6.0	TO-204	D86ER2	500	8.0	0.85	TO-204AA
VN0350N2	500	8.0	6.0	TO-39	IRFF430	500	2.75	1.5	TO-39
VN0350N5	500	8.0	6.0	TO-220	D84ER2	500	8.0	0.85	TO-220AB

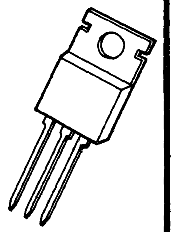
Power MOSFET Cross-Reference (Cont.)



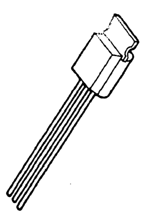
CASE STYLE TO-39



CASE STYLE TO-204



CASE STYLE TO-220



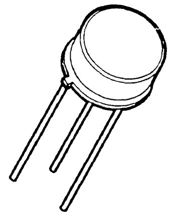
CASE STYLE TO-237

Supertex Inc. (Cont.)

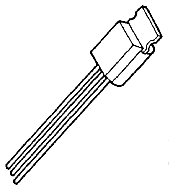
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
VN0430N1	300	40.0	0.75	TO-204	D86FQ1	350	15.0	0.30	TO-204AA
VN0435N1	350	40.0	0.75	TO-204	D86FQ1	350	15.0	0.30	TO-204AA
VN0440N1	400	40.0	0.75	TO-204	D86FQ2	400	15.0	0.30	TO-204AA
VN0445N1	450	40.0	0.75	TO-204	D86FR1	450	13.0	0.40	TO-204AA
VN0450N1	500	24.0	1.5	TO-204	D86FR2	500	13.0	0.40	TO-204AA
VN0530N2	300	0.20	50.0	TO-39	IRFF313	350	1.15	5.0	TO-39
VN0530N3	300	0.20	50.0	TO-92	D80AN2	200	0.30	5.6	TO-237
VN0535N2	350	0.20	50.0	TO-39	IRFF313	350	1.15	5.0	TO-39
VN0535N3	350	0.20	50.0	TO-92	D80AN2	200	0.30	5.6	TO-237
VN0540N2	400	0.20	50.0	TO-39	IRFF312	400	1.15	5.0	TO-39
VN0540N3	400	0.20	50.0	TO-92	D80AN2	200	0.30	5.6	TO-237
VN0545N2	450	0.20	50.0	TO-39	IRFF423	450	1.4	4.0	TO-39
VN0545N3	450	0.20	50.0	TO-92	D80AN2	200	0.30	5.6	TO-237
VN1106N1	60	16.0	1.0	TO-204	D86DK2	60	14.0	0.18	TO-204AA
VN1106N2	60	16.0	1.0	TO-39	IRFF131	60	8.0	0.18	TO-39
VN1106N5	60	16.0	1.0	TO-220	D84DK2	60	14.0	0.18	TO-220AB
VN1110N1	100	16.0	1.0	TO-204	D86DL2	100	14.0	0.18	TO-204AA
VN1110N2	100	16.0	1.0	TO-39	IRFF130	100	8.0	0.18	TO-39
VN1110N5	100	16.0	1.0	TO-220	D84DL2	100	14.0	0.18	TO-220AB
VN1156N1	150	12.0	2.0	TO-204	D86DM2	150	9.0	0.40	TO-204AA
VN1156N2	150	12.0	2.0	TO-39	IRFF231	150	5.5	0.40	TO-39
VN1156N5	150	12.0	2.0	TO-220	D84DM2	150	9.0	0.40	TO-220AB
VN1120N1	200	8.0	4.0	TO-204	IRF232	200	8.0	0.60	TO-204AA
VN1120N2	200	8.0	4.0	TO-39	IRFF230	200	5.5	0.40	TO-39
VN1120N5	200	8.0	4.0	TO-220	IRF632	200	8.0	0.60	TO-220AB
VN1204N1	40	24.0	0.40	TO-204	IRF143	60	24.0	0.11	TO-204AE
VN1204N2	40	24.0	0.40	TO-39	IRFF131	60	8.0	0.18	TO-39
VN1204N5	40	24.0	0.40	TO-220	IRF543	60	24.0	0.11	TO-220AB
VN1206N1	60	24.0	0.40	TO-204	IRF143	60	24.0	0.11	TO-204AE
VN1206N2	60	24.0	0.40	TO-39	IRFF131	60	8.0	0.18	TO-39
VN1206N5	60	24.0	0.40	TO-220	IRF543	60	24.0	0.11	TO-220AB
VN1210N1	100	24.0	0.40	TO-204	IRF142	100	24.0	0.11	TO-204AE
VN1210N2	100	24.0	0.40	TO-39	IRFF130	100	8.0	0.18	TO-39
VN1210N5	100	24.0	0.40	TO-220	IRF542	100	24.0	0.11	TO-220AB
VN1215N1	150	20.0	0.75	TO-204	D86EM2	150	18.0	0.18	TO-204AE
VN1215N2	150	20.0	0.75	TO-39	IRFF231	150	5.5	0.40	TO-39
VN1215N5	150	20.0	0.75	TO-220	D84EM2	150	18.0	0.18	TO-220AB
VN1216N1	160	16.0	2.0	TO-204	IRF243	150	16.0	0.22	TO-204AE
VN1216N2	160	16.0	2.0	TO-39	IRFF231	150	5.5	0.40	TO-39
VN1216N5	160	16.0	2.0	TO-220	IRF643	150	16.0	0.22	TO-220AB
VN1220N1	200	16.0	2.0	TO-204	IRF242	200	16.0	0.22	TO-204AE
VN1220N2	200	16.0	2.0	TO-39	IRFF230	200	5.5	0.40	TO-39
VN1220N5	200	16.0	2.0	TO-220	IRF642	200	16.0	0.22	TO-220AB

Power MOSFET Cross-Reference (Cont.)

Supertex Inc. (Cont.)



CASE STYLE
TO-39



CASE STYLE
TO-237

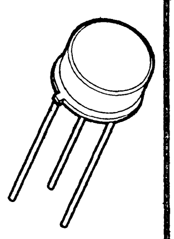
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
VN1304N2	40	2.0	10.0	TO-39	IRFF113	60	3.0	0.6	TO-39
VN1304N3	40	2.0	10.0	TO-92	VN10KMA	60	0.75	5.0	TO-237
VN1306N2	60	2.0	10.0	TO-39	IRFF113	60	3.0	0.6	TO-39
VN1306N3	60	2.0	10.0	TO-92	VN10KMA	60	0.75	5.0	TO-237
VN1310N2	100	2.0	10.0	TO-39	IRFF112	100	3.0	0.6	TO-39
VN1310N3	100	2.0	10.0	TO-92	D80AL2	100	0.50	2.4	TO-237
VN1315N2	150	1.5	20.0	TO-39	IRFF213	150	1.8	2.4	TO-39
VN1315N3	150	1.5	20.0	TO-92	D80AM2	150	0.30	5.6	TO-237
VN1320N2	200	1.0	40.0	TO-39	IRFF212	200	1.8	2.4	TO-39
VN1320N3	200	1.0	40.0	TO-92	D80AN2	200	0.30	5.6	TO-237

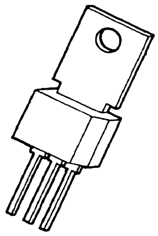
SPI

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
SD1102BD	250	0.25	10.0	TO-92	D80AN2	200	0.30	5.6	TO-237
SD1106AD	60	0.25	5.0	TO-237	D80AK2	60	0.50	2.4	TO-237
SD1107BD	100	2.0	4.0	TO-92	D80AL2	100	0.50	2.4	TO-237
SD1112BD	200	0.5	7.0	TO-92	D80AN2	200	0.30	5.6	TO-237
SD1113BD	200	0.5	10.0	TO-92	D80AN2	200	0.30	5.6	TO-237
SD1117BD	60	2.0	2.5	TO-92	VN10KMA	60	0.75	5.0	TO-237
SD1122BD	200	0.5	10.0	TO-92	D80AN2	200	0.30	5.6	TO-237
SD1124BD	60	1.0	5.0	TO-92	VN10KMA	60	0.75	5.0	TO-237
SD1202BD	200	0.04	250	TO-92	D80AN2	200	0.30	5.6	TO-237

Power MOSFET Cross-Reference (Cont.)

SILICONIX


CASE STYLE TO-39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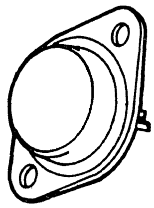
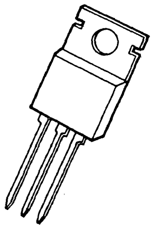
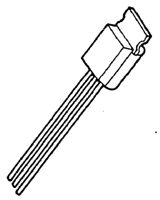

CASE STYLE TO-204

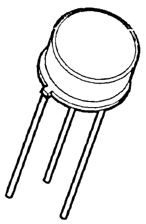

CASE STYLE TO-220

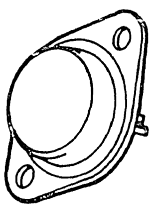

CASE STYLE TO-237

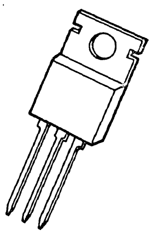
Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
VN10KE	60	0.2	5.0	TO-52	IRFF113	60	3.0	0.8	TO-39
VN10KM	60	0.75	5.0	TO-237	VN10KMA	60	0.75	5.0	TO-237
VN10LE	60	0.3	5.0	TO-52	D80AK2	60	3.0	0.8	TO-39
VN10LM	60	0.3	5.0	TO-237	D80AK2	60	0.5	2.4	TO-237
VN35AA	35	2.0	2.5	TO-204	IRF513	60	3.5	0.8	TO-220AB
VN35AB	35	1.2	2.5	TO-39	VN35ABA	35	1.2	2.5	TO-39
VN40AD	40	1.5	5.0	TO-220	IRF513	60	3.5	0.8	TO-220AB
VN40AF	40	1.3	5.0	TO-202	VN40AFA	40	1.3	5.0	TO-202
VN46AD	40	1.9	3.0	TO-220	IRF513	60	3.5	0.8	TO-220AB
VN46F	40	1.6	3.0	TO-202	VN46AFA	40	1.6	3.0	TO-202
VN64GA	60	10.0	0.4	TO-204	IRF133	60	12.0	0.25	TO-204AA
VN66AD	60	1.9	3.0	TO-220	IRF513	60	3.5	0.8	TO-220AB
VN66AF	60	1.7	3.0	TO-202	VN66AFA	60	1.7	3.0	TO-202
VN67AA	60	2.0	3.5	TO-220	IRF513	60	3.5	0.8	TO-220AB
VN67AB	60	1.0	3.5	TO-39	VN67ABA	60	1.0	3.5	TO-39
VN67AD	60	1.8	3.5	TO-220	IRF513	60	3.5	0.8	TO-220AB
VN67AF	60	1.6	3.5	TO-202	VN67AFA	60	1.6	3.5	TO-202
VN80AF	80	1.3	5.0	TO-202	VN80AFA	80	1.3	5.0	TO-202
VN88AD	80	1.7	4.0	TO-220	D84BL2	100	4.0	0.6	TO-220AB
VN88AF	80	1.5	4.0	TO-202	VN88AFA	80	1.5	4.0	TO-202
VN89AD	80	1.6	4.5	TO-220	IRF512	100	3.5	0.8	TO-220AB
VN90AA	90	1.7	5.0	TO-204	IRF512	100	3.5	0.8	TO-220AB
VN90AB	90	0.8	5.0	TO-39	VN90ABA	100	1.0	5.0	TO-39
VN99AA	90	1.8	4.5	TO-204	IRF512	100	3.5	0.8	TO-220AB
VN99AB	90	0.9	4.5	TO-39	VN90ABA	100	1.0	5.0	TO-39
VN0300D	30	2.5	1.2	TO-220	IRF513	60	3.5	0.8	TO-220AB
VN0300M	30	0.7	1.2	TO-237	D80AK2	60	0.5	2.4	TO-237
VN0400A	40	18.0	0.12	TO-204	D86DK2	60	14.0	0.18	TO-204AA
VN0400D	40	18.0	0.12	TO-220	D84DK2	60	14.0	0.18	TO-220AB
VN0401A	40	16.0	0.15	TO-204	D86DK2	60	14.0	0.18	TO-204AA
VN0401D	40	16.0	0.15	TO-220	D84DK2	60	14.0	0.18	TO-220AB
VN0600A	60	18.0	0.12	TO-204	D86DK2	60	14.0	0.18	TO-204AA
VN0600D	60	18.0	0.12	TO-220	D84DK2	60	14.0	0.18	TO-220AB
VN0601A	60	16.0	0.15	TO-204	D86DK2	60	14.0	0.18	TO-204AA
VN0601D	60	16.0	0.15	TO-220	D84DK2	60	14.0	0.18	TO-220AB
VN0606M	60	0.4	3.0	TO-237	D80AK2	60	0.5	2.4	TO-237
VN0610L	60	0.2	5.0	TO-92	D80AK2	60	0.5	2.4	TO-237
VN0800A	80	14.0	0.18	TO-204	D86DL2	100	14.0	0.18	TO-204AA
VN0800D	80	14.0	0.18	TO-204	D84DL2	100	14.0	0.18	TO-220AB
VN0801A	80	12.0	0.25	TO-204	D86DL2	100	14.0	0.18	TO-204AA

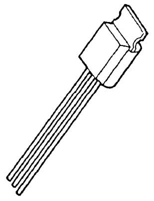
Power MOSFET Cross-Reference (Cont.)

Siliconix (Cont.)


CASE STYLE
TO-39

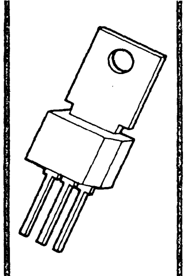

CASE STYLE
TO-204

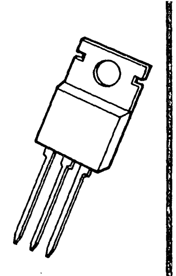

CASE STYLE
TO-220


CASE STYLE
TO-237

Competitive Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style	Nearest GE Equivalent Part Number	V_{DS} (Volts)	I_D (Amps) @ 25°C	$R_{DS\,(ON)}$ (Ohms)	Case Style
VN0801D	80	12.0	0.25	TO-220	D84DL2	100	14.0	0.18	TO-220AB
VN0808M	80	0.35	4.0	TO-237	D80AL2	100	0.5	2.4	TO-237
VN1000A	100	14.0	0.18	TO-204	D86DL2	100	14.0	0.18	TO-204AA
VN1000D	100	14.0	0.18	TO-220	D84DL2	100	14.0	0.18	TO-220AB
VN1001A	100	12.0	0.25	TO-204	IRF132	100	12.0	0.25	TO-204AA
VN1001D	120	12.0	0.25	TO-220	IRF532	100	12.0	0.25	TO-220AB
VN1200A	120	14.0	0.18	TO-204	D86DM2	150	9.0	0.4	TO-204AA
VN1200D	120	14.0	0.18	TO-220	D84DM2	150	9.0	0.4	TO-220AB
VN1201A	120	12.0	0.25	TO-204	D86DM2	150	9.0	0.4	TO-204AA
VN1201D	120	12.0	0.25	TO-220	D84DM2	150	9.0	0.4	TO-220AB
VN1206B	120	0.80	6.0	TO-39	IRF213	150	1.8	2.4	TO-39
VN1206D	120	1.4	6.0	TO-220	IRF611	150	2.5	1.5	TO-220AB
VN1206L	120	0.21	6.0	TO-92	D08AM2	150	0.3	5.6	TO-237
VN1206M	120	0.3	6.0	TO-237	D80AM2	150	0.3	5.6	TO-237
VN1210L	120	0.16	10.0	TO-92	D80AM2	150	0.3	5.6	TO-237
VN1210M	120	0.25	10.0	TO-237	D80AM2	150	0.3	5.6	TO-237
VN1706B	170	0.80	6.0	TO-39	IRFF212	200	1.8	2.4	TO-39
VN1706D	170	1.4	6.0	TO-220	D84BN2	200	2.5	1.5	TO-220AB
VN1706L	170	0.21	6.0	TO-92	D80AN2	200	0.3	5.6	TO-237
VN1706M	170	0.30	6.0	TO-237	D80AN2	200	0.3	5.6	TO-237
VN1710L	170	0.16	10.0	TO-92	D80AN2	200	0.3	5.6	TO-237
VN1710M	170	0.25	10.0	TO-237	D80AN2	200	0.3	5.6	TO-237
VN2222L	60	0.15	7.5	TO-92	D80AK2	60	0.5	2.4	TO-237
VN2222KM	60	0.25	7.5	TO-237	D80AK2	60	0.5	2.4	TO-237
VN2222LM	60	0.25	7.6	TO-237	D80AK2	60	0.5	2.4	TO-237
VN2406B	240	0.80	6.0	TO-39	IRFF313	350	1.15	5.0	TO-39
VN2406D	240	1.4	6.0	TO-220	IRF713	350	1.3	5.0	TO-220AB
VN2406L	240	0.21	6.0	TO-92	D80AN2	200	0.3	5.6	TO-237
VN2406M	240	0.30	6.0	TO-237	D80AN2	200	0.3	5.6	TO-237
VN2410L	240	0.16	10.0	TO-92	D80AN2	200	0.3	5.6	TO-237
VN2410M	240	0.25	10.0	TO-237	D80AN2	200	0.3	5.6	TO-237
VN3500A	350	6.0	1.0	TO-204	D86DQ1	350	5.5	1.0	TO-204AA
VN3500D	350	6.0	1.0	TO-220	D84DQ1	350	5.5	1.0	TO-220AB
VN3501A	350	5.0	1.5	TO-204	IRF333	350	4.5	1.5	TO-204AA
VN3501D	350	5.0	1.5	TO-220	IRF733	350	4.5	1.5	TO-220AB
VN4000A	400	6.0	1.0	TO-204	D86DQ2	400	5.5	1.0	TO-204AA
VN4000D	400	6.0	1.0	TO-220	D84DQ2	400	5.5	1.0	TO-220AB
VN4001A	400	5.0	1.5	TO-204	IRF332	400	4.5	1.5	TO-204AA
VN4001D	400	5.0	1.5	TO-220	IRF732	400	4.5	1.5	TO-220AB
VN4501A	450	4.5	1.5	TO-204	D86DR1	450	4.5	1.5	TO-204AA
VN4501D	450	4.5	1.5	TO-220	D84DR1	450	4.5	1.5	TO-220AB
VN4502A	450	4.0	2.0	TO-204	IRF433	450	4.0	2.0	TO-204AA
VN4502D	450	4.0	2.0	TO-220	IRF833	450	4.0	2.0	TO-220AB
VN5001A	500	4.5	1.5	TO-204	D86DR2	500	4.5	1.5	TO-204AA
VN5001D	500	4.5	1.5	TO-220	D86DR2	500	4.5	1.5	TO-220AB
VN5002A	500	4.0	2.0	TO-204	IRF432	500	4.0	2.0	TO-204AA
VN5002D	500	4.0	2.0	TO-220	IRF832	500	4.0	2.0	TO-220AB
VNL001A	350	8.0	1.0	TO-204	IRF343	350	8.0	0.8	TO-204AA
VNM001A	400	8.0	1.0	TO-204	IRF342	400	8.0	0.8	TO-204AA
VNN003A	450	6.5	1.5	TO-204	IRF443	450	7.0	1.1	TO-204AA

GE
BIPOLAR POWER
TRANSISTOR
SELECTOR GUIDE

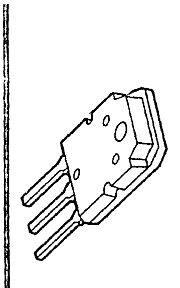

CASE STYLE
TO-202


CASE STYLE
TO-220

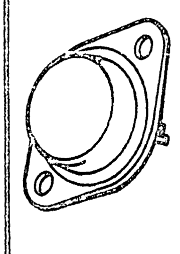
POWER TRANSISTORS
COMPLEMENTARY PAIRS

I_C CONT. (A)	GE Device		V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
	NPN	PNP		h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
1.0A	D40D1	D41D1	30	50	150	0.1A	2.0V	0.5	500mA	50mA	6.25	TO-202	375
	D40D2	D41D2	30	120	360	0.1A	2.0V	0.5	500mA	50mA	6.25	TO-202	375
	D40D4	D41D4	45	50	150	0.1A	2.0V	0.5	500mA	50mA	6.25	TO-202	375
	D40D5	D41D5	45	120	360	0.1A	2.0V	0.5	500mA	50mA	6.25	TO-202	375
	D40D7	D41D7	60	50	150	0.1A	2.0V	0.5	500mA	50mA	6.25	TO-202	375
	D40D8	D41D8	60	120	360	0.1A	2.0V	0.5	500mA	50mA	6.25	TO-202	375
2.0A	D40E1	D41E1	30	50	—	0.1A	2.0V	1.0	1.0A	0.1A	8.0	TO-202	383
	D40E5	D41E5	60	50	—	0.1A	2.0V	1.0	1.0A	0.1A	8.0	TO-202	383
	D40E7	D41E7	80	50	—	0.1A	2.0V	1.0	1.0A	0.1A	8.0	TO-202	383
3.0A	D42C1	D43C1	30	25	—	200mA	1V	0.5	1A	100mA	12.5	TO-202	399
	D42C2	D43C2	30	100	220	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C3	D43C3	30	40	120	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C4	D43C4	45	25	—	200mA	1V	0.5	1A	100mA	12.5	TO-202	399
	D42C5	D43C5	45	100	220	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C6	D43C6	45	40	120	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C7	D43C7	60	25	—	200mA	1V	0.5	1A	100mA	12.5	TO-202	399
	D42C8	D43C8	60	100	220	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C9	D43C9	60	40	120	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C10	D43C10	80	25	—	200mA	1V	0.5	1A	100mA	12.5	TO-202	399
	D42C11	D43C11	80	100	220	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
	D42C12	D43C12	80	40	120	200mA	1V	0.5	1A	50mA	12.5	TO-202	399
4.0A	D44C1	D45C1	30	25	—	200mA	1V	0.5	1A	100mA	30.0	TO-220AB	407
	D44C2	D45C2	30	100	220	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C3	D45C3	30	40	120	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C4	D45C4	45	25	—	200mA	1V	0.5	1A	100mA	30.0	TO-220AB	407
	D44C5	D45C5	45	100	220	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C6	D45C6	45	40	120	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C7	D45C7	60	25	—	200mA	1V	0.5	1A	100mA	30.0	TO-220AB	407
	D44C8	D45C8	60	100	220	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C9	D45C9	60	40	120	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C10	D45C10	80	25	—	200mA	1V	0.5	1A	100mA	30.0	TO-220AB	407
	D44C11	D45C11	80	100	220	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
	D44C12	D45C12	80	40	120	200mA	1V	0.5	1A	50mA	30.0	TO-220AB	407
8.0A	D44VM1	D45VM1	30	40	—	4A	1V	0.4	4A	0.2A	50.0	TO-220AB	469
	D44VM4	D45VM4	45	40	—	4A	1V	0.4	4A	0.2A	50.0	TO-220AB	469
	D44VM7	D45VM7	60	40	—	4A	1V	0.4	4A	0.2A	50.0	TO-220AB	469
	D44VM10	D45VM10	80	40	—	4A	1V	0.4	4A	0.2A	50.0	TO-220AB	469
10.0A	D44H1	D45H1	30	40	—	4A	1V	1.0	8A	0.8A	50.0	TO-220AB	431
	D44H2	D45H2	30	40	—	4A	1V	1.0	8A	0.4A	50.0	TO-220AB	431
	D44H4	D45H4	45	20	—	4A	1V	1.0	8A	0.8A	50.0	TO-220AB	431
	D44H5	D45H5	45	40	—	4A	1V	1.0	8A	0.4A	50.0	TO-220AB	431
	D44H7	D45H7	60	20	—	4A	1V	1.0	8A	0.8A	50.0	TO-220AB	431
	D44H8	D45H8	60	40	—	4A	1V	1.0	8A	0.4A	50.0	TO-220AB	431
	D44H10	D45H10	80	20	—	4A	1V	1.0	8A	0.8A	50.0	TO-220AB	431
	D44H11	D45H11	80	40	—	4A	1V	1.0	8A	0.4A	50.0	TO-220AB	431
15.0A	D44VH1	D45VH1	30	20	—	4A	1V	0.4	8A	0.4A	83.0	TO-220AB	457
	D44VH4	D45VH4	45	20	—	4A	1V	0.4	8A	0.4A	83.0	TO-220AB	457
	D44VH7	D45VH7	60	20	—	4A	1V	0.4	8A	0.4A	83.0	TO-220AB	457
	D44VH10	D45VH10	80	20	—	4A	1V	0.4	8A	0.4A	83.0	TO-220AB	457

GENERAL PURPOSE POWER TRANSISTORS/DARLINGTONS



CASE STYLE
TO-247S



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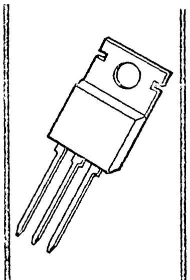
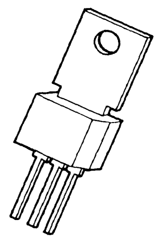
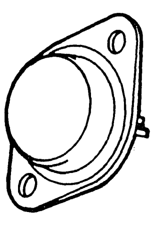


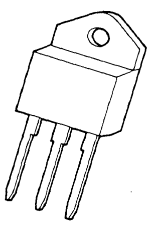
CASE STYLE
TO-220

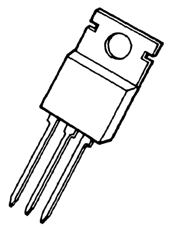
I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
1	TIP30	PNP	40	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	775
1	TIP29	NPN	40	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	771
1	TIP30A	PNP	60	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	775
1	TIP29A	NPN	60	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	771
1	TIP30B	PNP	80	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	775
1	TIP29B	NPN	80	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	771
1	TIP30C	PNP	100	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	775
1	TIP29C	NPN	100	15	75	1.0	4.0	0.7	1	0.125	30	TO-220AB	771
3	TIP31	NPN	40	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	779
3	TIP32	PNP	40	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	783
3	TIP31A	NPN	60	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	779
3	TIP32A	PNP	60	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	783
3	TIP31B	NPN	80	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	779
3	TIP32B	PNP	80	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	783
3	TIP31C	NPN	100	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	779
3	TIP32C	PNP	100	10	50	3.0	4.0	1.2	3	0.375	40	TO-220AB	783
5	TIP120	NPND	60	1000	—	3.0	3.0	2.0	3	0.012	65	TO-220AB	759
5	TIP125	PNPD	60	1000	—	3.0	3.0	2.0	3	0.012	65	TO-220AB	765
5	TIP126	PNPD	80	1000	—	3.0	3.0	2.0	3	0.012	65	TO-220AB	765
5	TIP121	NPND	80	1000	—	3.0	3.0	2.0	3	0.012	65	TO-220AB	759
5	TIP127	PNPD	100	1000	—	3.0	3.0	2.0	3	0.012	65	TO-220AB	765
5	TIP122	NPND	100	1000	—	3.0	3.0	2.0	3	0.012	65	TO-220AB	759
6	TIP41	NPN	40	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	787
6	TIP42	PNP	40	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	791
6	TIP41A	NPN	60	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	787
6	TIP42A	PNP	60	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	791
6	TIP41B	NPN	80	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	787
6	TIP42B	PNP	80	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	791
6	TIP41C	NPN	100	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	787
6	TIP42C	PNP	100	15	75	3.0	4.0	1.5	6	0.600	65	TO-220AB	791
7	2N6292	NPN	70	30	150	2.0	4.0	1.0	2	0.200	40	TO-220AB	811
10	GE3055P	NPN	80	20	100	4.0	4.0	1.1	4	0.400	70	TO-247S	693
15	2N3055	NPN	60	20	70	4.0	4.0	1.1	4	0.400	115	TO-204	795
15	2N6487	NPN	60	20	150	5.0	4.0	1.3	5	0.500	75	TO-220AB	815
15	2N6547	NPN	400	12	60	5.0	2.0	1.5	10	2.0	175	TO-204	819
16	2N3773	NPN	140	15	60	8.0	4.0	1.4	8	0.800	150	TO-204	807
20	2N3772	NPN	60	15	60	10.0	4.0	1.4	10	1.0	150	TO-204	803
30	2N3771	NPN	40	15	60	15.0	4.0	2.0	15	1.5	150	TO-204	799

HIGH VOLTAGE POWER TRANSISTORS

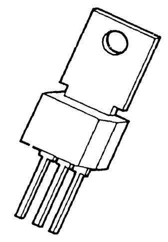

CASE STYLE TO-202


CASE STYLE TO-204

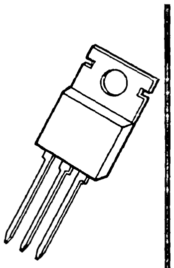

CASE STYLE TO-218


CASE STYLE TO-220

I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
0.1	D40V1	NPN	250	30	90	0.02	10.0	1.0	0.020	0.002	9.0	TO-202	395
0.1	D40V2	NPN	250	60	180	0.02	10.0	1.0	0.020	0.002	9.0	TO-202	395
0.1	D40V3	NPN	300	30	90	0.02	10.0	1.0	0.020	0.002	9.0	TO-202	395
0.1	D40V4	NPN	300	60	180	0.02	10.0	1.0	0.020	0.002	9.0	TO-202	395
0.1	D40V5	NPN	350	30	90	0.02	10.0	1.0	0.020	0.002	9.0	TO-202	395
0.1	D40V6	NPN	350	60	180	0.02	10.0	1.0	0.020	0.002	9.0	TO-202	395
2.0	D44T1	NPN	250	30	—	0.50	10.0	1.0	0.5	0.050	31.2	TO-220AB	443
2.0	D44T2	NPN	250	75	175	0.50	10.0	1.0	0.5	0.050	31.2	TO-220AB	443
2.0	D44T3	NPN	300	30	—	0.50	10.0	1.0	0.5	0.050	31.2	TO-220AB	443
2.0	D44T4	NPN	300	75	175	0.50	10.0	1.0	0.5	0.050	31.2	TO-220AB	443
2.0	D44TD3	NPN	300	5	—	2.0	3.0	1.0	2.0	0.400	50.0	TO-220AB	447
2.0	D44TD4	NPN	350	5	—	2.0	3.0	1.0	2.0	0.400	50.0	TO-220AB	447
2.0	D44TD5	NPN	400	5	—	2.0	3.0	1.0	2.0	0.400	50.0	TO-220AB	447
4.0	D44Q1	NPN	125	20	—	2.0	10.0	1.0	2.0	0.200	31.2	TO-220AB	439
4.0	D44Q3	NPN	175	20	—	2.0	10.0	1.0	2.0	0.200	31.2	TO-220AB	439
4.0	D44Q5	NPN	225	20	—	2.0	10.0	1.0	2.0	0.200	31.2	TO-220AB	439
4.0	MJE13004	NPN	300	10	60	1.0	5.0	0.5	1.0	0.2	75.0	TO-220AB	715
4.0	MJE13005	NPN	400	10	60	1.0	5.0	0.5	1.0	0.2	75.0	TO-220AB	719
4.0	GE13070P	NPN	400	8	—	3.0	5.0	1.0	3.0	0.6	100.0	TO-218	681
4.0	MJE13070	NPN	400	8	—	3.0	5.0	1.0	3.0	0.6	80.0	TO-220AB	747
4.0	MJE13071	NPN	450	8	—	3.0	5.0	1.0	3.0	0.6	80.0	TO-220AB	747
4.0	GE13071P	NPN	450	8	—	3.0	5.0	1.0	3.0	0.6	100.0	TO-218	681
8.0	MJE13006	NPN	300	8	60	2.0	5.0	1.0	2.0	0.4	80.0	TO-220	723
8.0	GE13080T	NPN	400	8	—	5.0	3.0	1.0	5.0	1.0	90.0	TO-220AB	685
8.0	MJE13007	NPN	400	8	60	2.0	5.0	1.0	2.0	0.4	80.0	TO-220	729
8.0	GE13080P	NPN	400	8	—	5.0	3.0	1.0	5.0	1.0	110.0	TO-218	683
8.0	GE13081T	NPN	450	8	—	5.0	3.0	1.0	5.0	1.0	90.0	TO-220AB	685
8.0	GE13081P	NPN	450	8	—	5.0	3.0	1.0	5.0	1.0	110.0	TO-218	683
12.0	MJE13008	NPN	300	8	40	5.0	5.0	1.0	5.0	1.0	100.0	TO-220AB	735
12.0	MJE13009	NPN	400	8	40	5.0	5.0	1.0	5.0	1.0	100.0	TO-220AB	741
12.0	D44TQ1	NPN	400	8	40	5.0	5.0	1.0	5.0	1.0	100.0	TO-220AB	453
12.0	D46TQ1	NPN	400	8	40	5.0	5.0	1.0	5.0	1.0	110.0	TO-218	481
12.0	D44TQ2	NPN	450	8	40	5.0	5.0	1.0	5.0	1.0	100.0	TO-220AB	453
12.0	D46TQ2	NPN	450	8	40	5.0	5.0	1.0	5.0	1.0	110.0	TO-218	481
15.0	D64VS3	NPN	300	10	—	10.0	2.0	1.0	15.0	2.5	195.0	TO-204	523
15.0	2N6676	NPN	300	8	—	15.0	3.0	1.5	15.0	3.0	175.0	TO-204	823
15.0	2N6677	NPN	350	8	—	15.0	3.0	1.5	15.0	3.0	175.0	TO-204	823
15.0	D64VS4	NPN	350	10	—	10.0	2.0	1.0	15.0	2.5	195.0	TO-204	523
15.0	D64VS5	NPN	400	10	—	10.0	2.0	1.0	15.0	2.5	195.0	TO-204	523
15.0	2N6678	NPN	400	8	—	15.0	3.0	1.5	15.0	3.0	175.0	TO-204	823
15.0	MJH13090	NPN	400	8	—	10.0	3.0	1.0	10.0	2.0	125.0	TO-218	753
15.0	MJH13091	NPN	450	8	—	10.0	3.0	1.0	10.0	2.0	125.0	TO-218	753
20.0	GE13100P	NPN	400	8	40	15.0	3.0	1.0	15.0	3.0	125.0	TO-218	691
20.0	GE13101P	NPN	450	8	40	15.0	3.0	1.0	15.0	3.0	125.0	TO-218	691



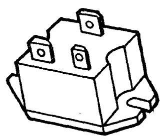
CASE STYLE
TO-202



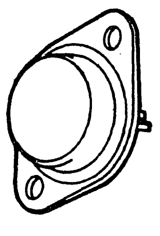
CASE STYLE
TO-220

VERY HIGH GAIN COMPLEMENTARY POWER DARLINGTON TRANSISTORS

I_C CONT. (A)	GE Device		V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
	NPN	PNP		h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
0.5A	D40C1	—	30	10K	60K	200mA	5V	1.5	500mA	0.5mA	6.25	TO-202	371
0.5A	D40C4	—	40	10K	60K	200mA	5V	1.5	500mA	0.5mA	6.25	TO-202	371
0.5A	D40C7	—	50	10K	60K	200mA	5V	1.5	500mA	0.5mA	6.25	TO-202	371
2.0A	D40K1	D41K1	30	10K	—	200mA	5V	1.5	1.5A	3.0mA	10.0	TO-202	391
	D40K2	D41K2	50	10K	—	200mA	5V	1.5	1.5A	3.0mA	10.0	TO-202	391
	D40K3	D41K3	30	10K	—	200mA	5V	1.5	1.0A	2.0mA	10.0	TO-202	391
	D40K4	D41K4	50	10K	—	200mA	5V	1.5	1.0A	2.0mA	10.0	TO-202	391
6.0A	D44D1	D45D1	40	2K	—	1A	2V	1.5	3A	3.0mA	30.0	TO-220AB	415
	D44D2	D45D2	40	2K	—	1A	2V	1.5	3A	3.0mA	30.0	TO-220AB	415
	D44D3	D45D3	60	2K	—	1A	2V	1.5	3A	3.0mA	30.0	TO-220AB	415
	D44D4	D45D4	60	2K	—	1A	2V	1.5	3A	3.0mA	30.0	TO-220AB	415
	D44D5	D45D5	80	2K	—	1A	2V	1.5	3A	3.0mA	30.0	TO-220AB	415
	D44D6	D45D6	80	2K	—	1A	2V	1.5	3A	3.0mA	30.0	TO-220AB	415
10.0A	D44E1	D45E1	40	1K	—	5A	5V	1.5	5A	10.0mA	50.0	TO-220AB	423
	D44E2	D45E2	60	1K	—	5A	5V	1.5	5A	10.0mA	50.0	TO-220AB	423
	D44E3	D45E3	80	1K	—	5A	5V	1.5	5A	10.0mA	50.0	TO-220AB	423



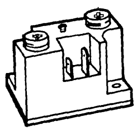
CASE STYLE
D-66



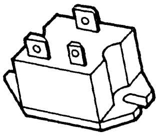
CASE STYLE
TO-204

HIGH VOLTAGE POWER DARLINGTON TRANSISTORS

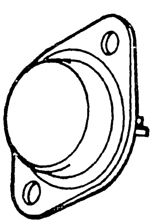
I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
10	GE10002	NPND	350	30	300	5	5	2.9	10	1.0	150.0	TO-204	667
10	GE10006	NPND	350	30	300	5	5	2.9	10	1.0	150.0	TO-204	667
10	GE10007	NPND	400	30	300	5	5	2.9	10	1.0	150.0	TO-204	667
10	GE10003	NPND	400	30	300	5	5	2.9	10	1.0	150.0	TO-204	667
10	GE6251	NPND	400	60	—	3	5	2.0	5	0.5	125.0	TO-204	709
10	GE6252	NPND	450	60	—	3	5	2.0	5	0.5	125.0	TO-204	709
10	GE6253	NPND	500	60	—	3	5	2.0	5	0.5	125.0	TO-204	709
20	GE5060	NPND	350	40	—	15	5	2.0	20	2.0	125.0	TO-204	697
20	GE5062	NPND	450	40	—	15	5	2.0	20	2.0	125.0	TO-204	697
20	GE6060	NPND	350	30	—	15	5	2.0	20	2.0	125.0	TO-204	703
20	GE10004	NPND	350	40	400	10	5	3.0	20	1.0	175.0	TO-204	667
20	GE10000	NPND	350	40	400	10	5	3.0	20	1.0	175.0	TO-204	667
20	D66DS5	NPND	400	40	—	20	5	2.5	20	2.0	62.5	D66	529
20	GE5061	NPND	400	40	—	15	5	2.0	20	2.0	125.0	TO-204	697
20	GE6061	NPND	400	30	—	15	5	2.0	20	2.0	125.0	TO-204	703
20	D64ES5	NPND	400	40	—	20	5	2.0	20	2.0	125.0	TO-204	507
20	GE10005	NPND	400	40	400	10	5	3.0	20	1.0	175.0	TO-204	667
20	GE10001	NPND	400	40	400	10	5	3.0	20	1.0	175.0	TO-204	667
20	D64DS5	NPND	400	40	—	20	5	2.5	20	2.0	125.0	TO-204	507
20	D66ES5	NPND	400	40	—	20	5	2.5	20	2.0	62.5	D66	529
20	GE10008	NPND	450	30	300	10	5	3.5	20	2.0	175.0	TO-204	667
20	D66DS6	NPND	450	40	—	20	5	2.5	20	2.0	62.5	D66	529
20	D64DS7	NPND	500	40	—	20	5	2.5	20	2.0	125.0	TO-204	507
20	D66ES6	NPND	450	40	—	20	5	2.5	20	2.0	62.5	D66	529
20	GE6062	NPND	450	30	—	15	5	2.0	20	2.0	125.0	TO-204	703
20	D64DS6	NPND	450	40	—	20	5	2.5	20	2.0	125.0	TO-204	507
20	D64ES6	NPND	450	40	—	20	5	2.5	20	2.0	125.0	TO-204	507
20	D66ES7	NPND	500	40	—	20	5	2.5	20	2.0	62.5	D66	529
20	GE10009	NPND	500	30	300	10	5	3.5	20	2.0	175.0	TO-204	667
20	D64ES7	NPND	500	40	—	20	5	2.5	20	2.0	125.0	TO-204	507
20	D66DS7	NPND	500	40	—	20	5	2.5	20	2.0	62.5	D66	529
40	GE10022	NPND	350	50	—	10	5	2.2	20	1.0	250.0	TO-204	673
40	GE10023	NPND	400	50	—	10	5	2.2	20	1.0	250.0	TO-204	673
50	D66DV5	NPND	400	50	—	50	5	2.0	50	4.0	125.0	D66	537
50	D64EV6	NPND	450	50	—	50	5	2.0	50	4.0	180.0	TO-204	515
50	D66GV5	NPND	400	50	—	50	5	2.0	50	4.0	125.0	D66	549
50	D64EV7	NPND	500	50	—	50	5	2.0	50	4.0	180.0	TO-204	515
50	D64DV5	NPND	400	50	—	50	5	2.0	50	4.0	180.0	TO-204	515
50	D64EV5	NPND	400	50	—	50	5	2.0	50	4.0	180.0	TO-204	515
50	D66EV5	NPND	400	50	—	50	5	2.0	50	4.0	125.0	D66	537
50	GE10015	NPND	400	25	—	20	5	2.0	20	1.0	250.0	TO-204	673
50	D66DV6	NPND	450	50	—	50	5	2.0	50	4.0	125.0	D66	537
50	D66EV6	NPND	450	50	—	50	5	2.0	50	4.0	125.0	D66	537
50	D64DV6	NPND	450	50	—	50	5	2.0	50	4.0	180.0	TO-204	515
50	D66GV6	NPND	450	50	—	50	5	2.0	50	4.0	125.0	D66	549
50	D66GV7	NPND	500	50	—	50	5	2.0	50	4.0	125.0	D66	549
50	GE10016	NPND	500	25	—	20	5	2.2	20	1.0	250.0	TO-204	673
50	D66EV7	NPND	500	50	—	50	5	2.0	50	4.0	125.0	D66	537
50	D66DV7	NPND	500	50	—	50	5	2.0	50	4.0	125.0	D66	537
50	D64DV7	NPND	500	50	—	50	5	2.0	50	4.0	180.0	TO-204	515
50	D66EW1	NPND	600	25	—	50	5	2.5	50	4.0	167.0	D66	545
50	D66DW1	NPND	600	25	—	50	5	2.5	50	4.0	167.0	D66	545
50	D66DW2	NPND	650	25	—	50	5	2.5	50	4.0	156.0	D66	545
50	D66EW2	NPND	650	25	—	50	5	2.5	50	4.0	167.0	D66	545
50	D66EW3	NPND	700	25	—	50	5	2.5	50	4.0	167.0	D66	545



CASE STYLE
D-67



CASE STYLE
D-66

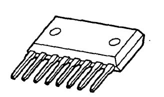


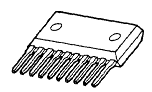
CASE STYLE
TO-204

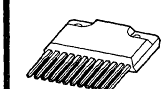
HIGH VOLTAGE
Power Darlington Transistors (Cont.)

I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE}				$V_{CE(SAT)}$					
				Min. -	Max.	@ I_C	@ V_{CE}	Max. (V)	@ I_C	I_B			
50	D66DW3	NPND	700	25	—	50	5	2.5	50	4.0	167.0	D66	545
60	GE10020	NPND	200	75	—	15	5	2.2	30	1.2	250.0	TO-204	673
60	GE10021	NPND	250	75	—	15	5	2.2	30	1.2	250.0	TO-204	673
100	D67DE5	NPND	400	50	—	100	5	2.0	100	8.0	312.5	D67	553
100	D67FP5	NPND	400	50	—	100	5	2.0	100	8.0	312.5	D67	559
100	D67DE6	NPND	450	50	—	100	5	2.0	100	8.0	312.5	D67	553
100	D67FP6	NPND	450	50	—	100	5	2.0	100	8.0	312.5	D67	559
100	D67DE7	NPND	500	50	—	100	5	2.0	100	8.0	312.5	D67	553
100	D67FP7	NPND	500	50	—	100	5	2.0	100	8.0	312.5	D67	559

POWER TRANSISTOR/ DARLINGTON ARRAYS — SINGLE INLINE PACKAGE


CASE STYLE
SIP 8 PIN


CASE STYLE
SIP 10 PIN


CASE STYLE
SIP 12 PIN

I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Array Config.	Page
				h_{FE}				$V_{CE(SAT)}$						
				Min. -	Max.	@ I_C	@ V_{CE}	Max. (V)	@ I_C	I_B				
2	D74FI2D	NPND	60	2K	—	1.0	2.0	1.5	1.0	0.001	3	SIP 8PIN	Fig. 3	625
2	D76FI2D	NPND	60	2K	—	1.0	2.0	1.5	1.0	0.001	4	SIP 10PIN	Fig. 6	641
2	D76FY2D	NPN/PNPD	80	2K	—	1.0	1.0	1.5	1.0	0.001	4	SIP 10PIN	Fig. 5	649
2	D74FY2D	NPND	80	2K	—	1.0	2.0	1.5	1.0	0.001	3	SIP 8PIN	Fig. 1	629
2	D76FY2T	NPN	80	500	—	0.4	1.0	0.5	0.3	0.001	4	SIP 10PIN	Fig. 7	651
2	D75FY2D	PNPD	80	2K	—	1.0	2.0	1.5	1.0	0.001	3	SIP 8PIN	Fig. 2	633
3	D76FI3T	NPN	60	500	—	0.4	1.0	1.0	2.0	0.050	4	SIP 10PIN	Fig. 7	643
3	D78A3D1	NPND	100	2K	12K	1.5	2.0	1.5	1.5	0.003	5	SIP 12PIN	Fig. 8	657
3	D78A3D2	NPND	100	2K	12K	1.5	2.0	1.5	1.5	0003	5	SIP 12PIN	Fig. 9	661
3	D76A3D	NPND	100	2K	12K	1.5	2.0	1.5	1.5	0.003	4	SIP 10PIN	Fig. 4	637
4	D76FI4D	NPND	60	2K	15K	1.0	2.0	1.5	3.0	0.010	4	SIP 10PIN	Fig. 6	645
4	D74FI4D	NPND	60	2K	15K	1.0	2.0	1.5	3.0	0.010	3	SIP 8PIN	Fig. 3	627
4	D78FY4D	NPN/PNPD	80	2K	—	1.0	2.0	1.5	3.0	0.006	5	SIP 12PIN	Fig. 10	665
4	D74FY4D	NPND	80	2K	—	1.0	2.0	1.5	3.0	0.006	3	SIP 8PIN	Fig. 1	631
4	D75FY4D	PNPD	80	2K	—	1.0	2.0	1.5	3.0	0.006	3	SIP 8PIN	Fig. 2	635
4	D76FY4D	NPN/PNPD	80	2K	—	1.0	2.0	1.5	3.0	0.006	4	SIP 10PIN	Fig. 5	655
5	D76A5D	NPND	100	1K	—	0.5	3.0	2.0	3.0	0.012	4	SIP 10PIN	Fig. 4	639
5	D74A5D	NPND	100	1K	—	0.5	3.0	2.0	3.0	0.012	3	SIP 8PIN	Fig. 1	623

8-PIN ARRAY CONFIGURATIONS

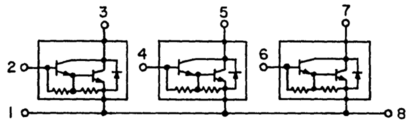


FIG. 1

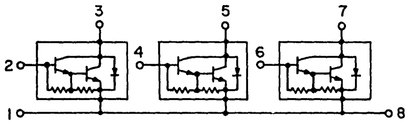


FIG. 2

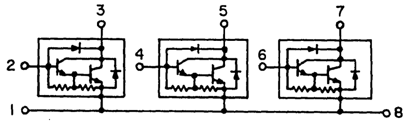


FIG. 3

10-PIN ARRAY CONFIGURATIONS

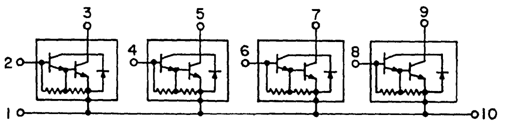


FIG. 4

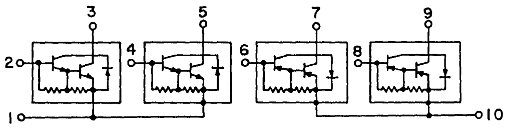


FIG. 5

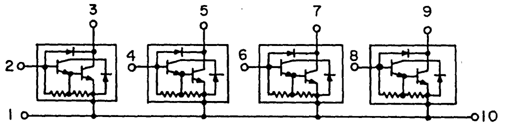


FIG.6

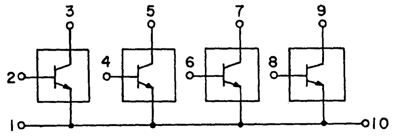


FIG. 7

12-PIN ARRAY CONFIGURATIONS

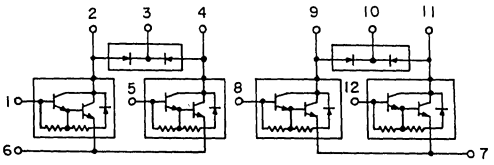


FIG. 8

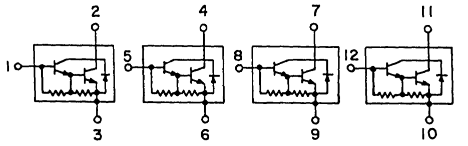


FIG. 9

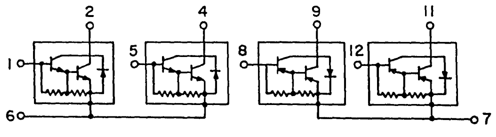
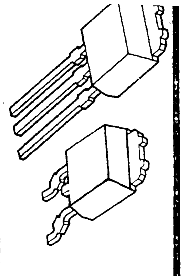
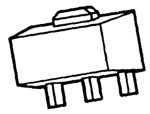


FIG. 10

POWER TRANSISTORS/ DARLINGTONS — SURFACE MOUNTED DEVICES



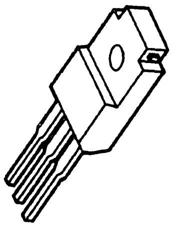
CASE STYLE
D-PAK



CASE STYLE
SOT-89

I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
0.05	D71G.05T1	PNP	150	70	240	0.010	5	0.8	0.01	0.001	0.5	SOT-89	583
0.05	D70G.05T1	NPN	150	70	240	0.010	5	0.5	0.01	0.001	0.5	SOT-89	567
0.8	D71Y.8T1	PNP	30	100	320	0.1	1	0.7	0.5	0.02	0.5	SOT-89	587
0.8	D70Y.8T1	NPN	30	100	320	0.1	1	0.5	0.5	0.02	0.5	SOT-89	571
1.5	D71Y1.5T1	PNP	30	100	320	0.5	2	2.0	1.5	0.03	0.5	SOT-89	591
1.5	D70Y1.5T1	NPN	30	100	320	0.5	2	2.0	1.5	0.03	0.5	SOT-89	575
1.5	D72Y1.5D1	NPND	30	4000	—	0.15	2	1.5	1.0	0.001	10.0	D-PAK	607
2.0	D71F2T1	PNP	50	70	240	0.5	2	0.5	1.0	0.05	0.5	SOT-89	579
2.0	D70F2T1	NPN	50	70	240	0.5	2	0.5	1.0	0.05	0.5	SOT-89	563
3.0	D72K3D1	NPND	40	2000	—	1.0	2	1.4	2.0	0.004	10.0	D-PAK	603
3.0	D73K3D1	PNPD	40	2000	—	1.0	2	1.5	2.0	0.004	10.0	D-PAK	619
4.0	D72FY4D1	NPND	80	2000	—	1.0	2	1.5	3.0	0.006	10.0	D-PAK	599
4.0	D73FY4D1	PNPD	80	2000	—	1.0	2	1.5	3.0	0.006	10.0	D-PAK	615
5.0	D72F5T1	NPN	50	70	240	1.0	1	0.4	3.0	0.015	20.0	D-PAK	595
5.0	D73F5T1	PNP	50	70	240	1.0	1	0.4	3.0	0.015	20.0	D-PAK	611

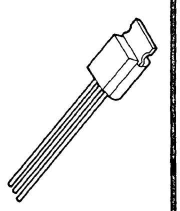
POWER DARLINGTONS — ISOLATED TO-220 PACKAGE



CASE STYLE
TO-220IS

I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
7	D54FY7D	NPND	80	2K	15K	3	3	1.5	3.0	0.006	30	TO-220IS	491
7	D55FY7D	PNPD	80	2K	15K	3	3	1.5	3.0	0.006	30	TO-220IS	503
7	D54A7D	NPND	100	2K	15K	3	3	1.5	3.0	0.006	30	TO-220IS	483
7	D55A7D	PNPD	100	2K	15K	3	3	1.5	3.0	0.006	30	TO-220IS	499
6	D54H6D	NPND	250	2K	—	2	2	2.0	4.0	0.040	25	TO-220IS	495
6	D54D6D	NPND	400	600	—	2	2	2.0	4.0	0.040	25	TO-220IS	487

POWER TRANSISTORS/DARLINGTONS — TO-237 PACKAGE



CASE STYLE
TO-237

I_C CONT. (A)	GE Device	Type	V_{CEO} Volts	Electrical Characteristics (@ Ta = 25°C)							P_D T_C = 25°C Max. (W)	Package Outline	Page
				h_{FE} Min. -	Max.	@ I_C	@ V_{CE}	$V_{CE(SAT)}$ Max. (V)	@ I_C	I_B			
2	92GU01	NPN	30	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	829
2	2N6714	NPN	30	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	829
2	2N6726	PNP	30	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	835
2	92GU51	PNP	30	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	835
2	92GU01A	NPN	40	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	829
2	92GU51A	PNP	40	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	835
2	2N6715	NPN	40	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	829
2	2N6727	PNP	40	60	—	0.100	1.0	0.5	1.0	0.100	1.2	TO-237	835
2	2N6724	NPND	40	25000	—	0.100	5.0	1.5	1.0	0.002	1.0	TO-237	833
2	92GU45	NPND	40	25000	—	0.100	5.0	1.5	1.0	0.002	1.0	TO-237	833
2	92GU45A	NPND	50	25000	—	0.100	5.0	1.5	1.0	0.002	1.0	TO-237	833
2	2N6725	NPND	50	25000	—	0.100	5.0	1.5	1.0	0.002	1.0	TO-237	833
2	92GU05	NPN	60	20	—	0.500	1.0	0.35	0.25	0.025	1.2	TO-237	831
2	2N6728	PNP	60	50	—	0.250	1.0	0.5	0.25	0.010	1.2	TO-237	837
2	2N6716	NPN	60	50	—	0.250	1.0	0.5	0.25	0.010	1.2	TO-237	831
2	92GU55	PNP	60	20	—	0.500	1.0	0.5	0.15	0.050	1.2	TO-237	837
2	2N6717	NPN	80	50	—	0.250	1.0	0.5	0.25	0.010	1.2	TO-237	831
2	92GU06	NPN	80	20	—	0.500	1.0	0.35	0.25	0.025	1.2	TO-237	831
2	2N6729	PNP	80	50	—	0.250	1.0	0.5	0.25	0.010	1.2	TO-237	837
2	92GU56	PNP	80	20	—	0.500	1.0	0.5	0.50	0.050	1.2	TO-237	837

GENERAL ELECTRIC
BIPOLAR POWER TRANSISTOR
PART NUMBERING KEY 1

(Applies to SOT-89, D-Pak, TO-220IS, & SIP-packaged devices)

D OO XX OO X O X O

STANDARD TRANSISTOR = D: SPECIAL =X

PACKAGE CODE (SEE TABLE 1)
EVEN = NPN; ODD = PNP

VOLTAGE CODE (SEE TABLE 2)

CURRENT RATING

CONFIGURATION (T = TRANSISTOR; D = DARLINGTON)

OTHER DEVICE SPECIFICATION

OTHER DEVICE SPECIFICATION

OTHER DEVICE SPECIFICATION

Example: **D 72 FY 4 D 2**

STANDARD TRANSISTOR

D-PAK PACKAGE, NPN (SEE TABLE 1)

80-VOLT DEVICE (SEE TABLE 2)

4-AMP DEVICE

DARLINGTON

LEAD-FORMED VERSION, WIDE h_{FE}

Table 1

Package Code NPN	PNP	Package
54	55	TO-220IS
70	71	SOT-89
72	73	D-PAK
74	75	SIP 8-PIN
76	77	SIP 10-PIN
78	79	SIP 12-PIN

Table 2

VOLT. CODE	VOLT. RATING	VOLT. CODE	VOLT. RATING	VOLT. CODE	VOLT. RATING
I	10	FK	90	EF	550
Q	15	A	100	M	600
J	20	G	150	S	700
U	25	B	200	N	800
Y	30	BF	250	T	900
K	40	C	300	P	1000
F	50	CF	350	PA	1100
FI	60	D	400	PB	1200
FJ	70	DF	450		
FY	80	E	500		

GENERAL ELECTRIC
BIPOLAR POWER TRANSISTOR
PART NUMBERING KEY 2

(Applies to TO-202, TO-220AB, TO-218, TO-204, D66 & D67-packaged devices)

D OO XXX OOO

STANDARD TRANSISTOR = D; SPECIAL = X

PACKAGE CODE (SEE TABLE 3)
EVEN = NPN; ODD = PNP

DEVICE TYPE

TYPE NUMBER

Example 1: **D 44 TD 3**

STANDARD TRANSISTOR

TO-220AB PACKAGE, NPN (SEE TABLE 3)

DEVICE TYPE

TYPE NUMBER

Example 2: **D 64 VS 5**

STANDARD TRANSISTOR

TO-204 PACKAGE, NPN (SEE TABLE 3)

DEVICE TYPE

TYPE NUMBER

Table 3

Package Code NPN	Package Code PNP	Package
40 42	41 43	TO-202
44	45	TO-220AB
46	47	TO-218
64	65	TO-204 (TO-3)
66		D66 MODULE
67		D67 MODULE

GENERAL ELECTRIC
SURFACE-MOUNT POWER TRANSISTOR
DEVICE MARKING KEY

(Applies to D-Pak-packaged devices)

Part Number Suffix	Lead Configuration	h_{FE} Range
1	Standard leads	Wide h_{FE} (70-240)
2	Lead-formed version	Wide h_{FE} (70-240)
3	Standard leads	Low h_{FE} (70-140)
4	Lead-formed version	Low h_{FE} (70-140)
5	Standard leads	High h_{FE} (140-240)
6	Lead-formed version	High h_{FE} (140-240)

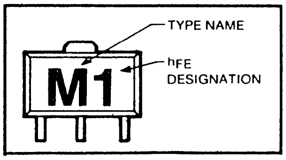
Example: D 73 K 3 D 2

STANDARD TRANSISTOR
D-PAK PACKAGE, PNP
40-VOLT DEVICE
3-AMP DEVICE
DARLINGTON
LEAD-FORMED VERSION, WIDE h_{FE}

GENERAL ELECTRIC SURFACE-MOUNT POWER TRANSISTOR DEVICE MARKING KEY

(Applies to SOT-89-packaged device)

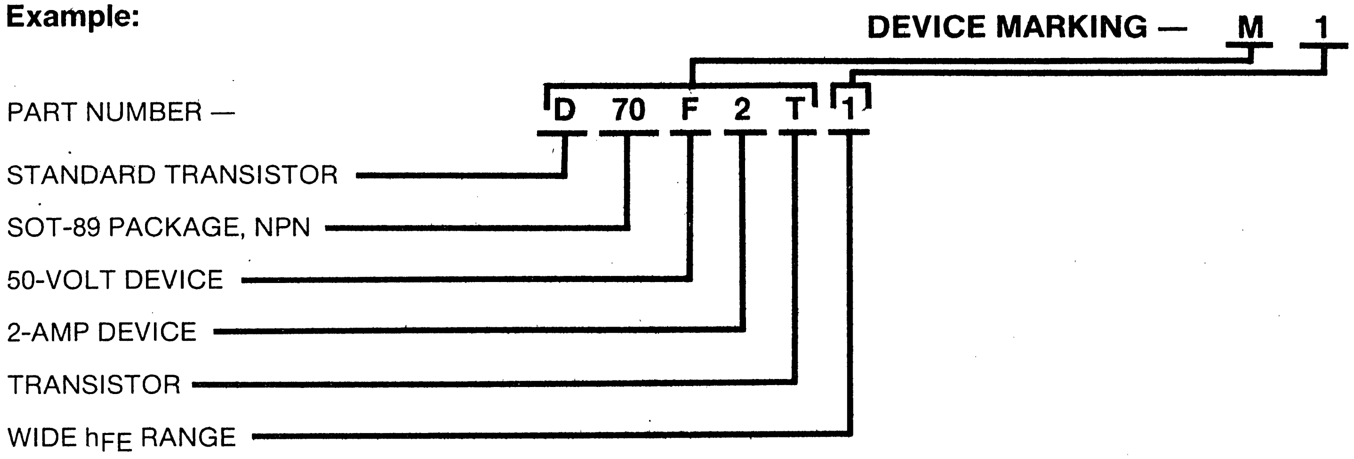
MARKING SYSTEM



Device Marking* Prefix	Part Number
B	D71G.05T
H	D71Y1.5T
R	D71Y.8T
N	D71F2T
M	D70F2T
A	D70G.05T
G	D70Y1.5T
P	D70Y.8T

Device Marking Suffix	h_{FE} Range
1	Wide h_{FE} (70-240)
3	Low h_{FE} (70-140)
5	High h_{FE} (120-240)

Example:



*UNDERLINED DEVICE MARKING INDICATES PNP VERSION

POWER TRANSISTOR INDEX

Power Transistor Index (Cont.)

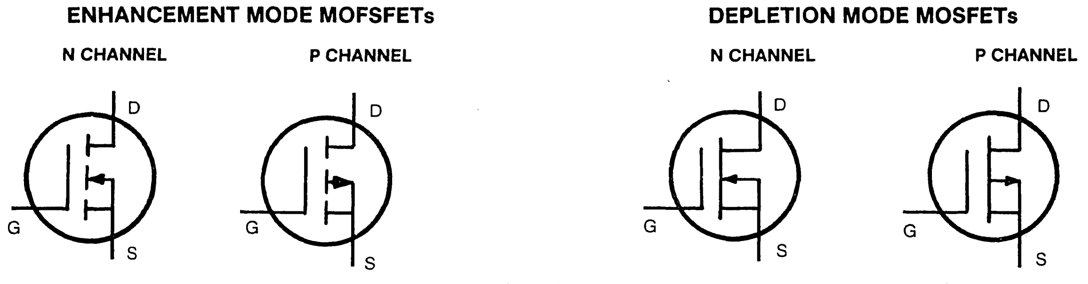
CHAPTER 1

POWER TRANSISTOR TERMS, SYMBOLS AND DEFINITIONS

1.1 MOS-GATED TRANSISTORS

1.1.1 GENERAL TERMS AND DEFINITIONS

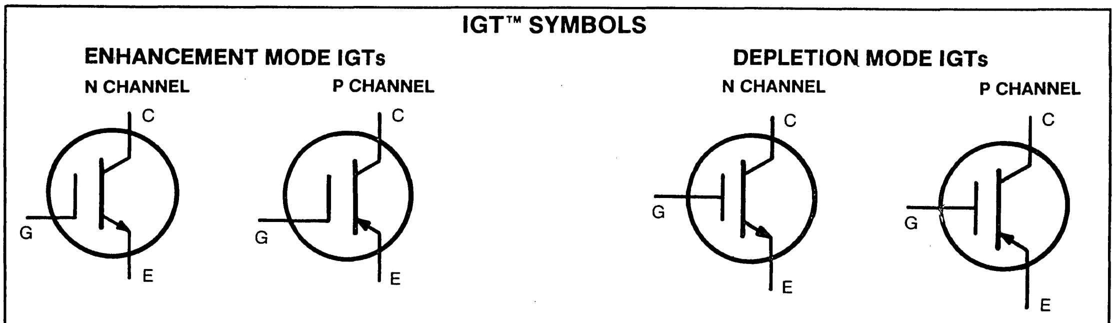
SYMBOL	TERM	DEFINITION
Channel		A thin semiconductor layer, between the source and drain regions in which current flow is controlled by the gate potential.
Collector (C, c)		A region which provides a source of minority carriers for the purpose of modulating a normally high resistivity region of opposite polarity adjacent to the collector.
Drain (D, d)		A region which collects majority carriers introduced by the source and passed through the channel area. The drain is adjacent to the channel area of opposite carrier polarity.
Emitter (E, e)		A region in which majority carriers may flow. The emitter provides a source of carriers which may pass through the channel when inverted by a gate potential.
Gate (G, g)		A region which can be forward or reverse biased relative to the source area, and by effect of electric field can invert a channel area to control current flow between two other device terminals, the source and drain.
Source (S, s)		A region in which majority carriers may flow. The source is adjacent to the channel area of opposite carrier polarity.
Junction-Gate-Field Effect-Transistor (J-FET)		A field-effect transistor whose gate regions form bipolar junctions with the channel.
Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET)		An insulating gate field effect transistor having an oxide insulating layer between the gate electrode and the channel. The gate is metal or other conductive material.



NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.

SYMBOL	TERM	DEFINITION
Depletion Mode FET		A field effect transitor having a conducting channel established under zero bias gate conditions. Both J-FETs and MOSFETs may be constructed to operate in this way.
Enhancement Mode FET		A field effect transistor having blocking characteristics (cut-off) under zero bias gate conditions. Only insulated gate enhancement mode devices are available commercially.
Double Diffused MOS (DMOS)		A process whereby a double diffusion of p and n type materials into the top of an epitaxial layer forms channel and source (emitter) regions with a planar structure having superior voltage breakdown and on resistance characteristics to earlier V groove type structures.
Insulated Gate Transistor (IGT)		A MOS gated device having a conductivity modulated drain region by injection of minority carriers from an opposite polarity semiconducting region adjacent to the drain and opposite from the channel region. The terminals are designated Gate, Emitter and Collector.

IGT™ SYMBOLS



NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.

1.1.2 LETTER SYMBOLS, TERMS & DEFINITIONS — MOSFETs

SYMBOL	TERM	DEFINITION
C_{ds}	Drain-source capacitance	The capacitance between the drain and source terminals with the gate terminal connected to the guard terminal of a three-terminal bridge.
C_{dg}	Drain-gate capacitance	The capacitance between the drain and gate terminals with the source connected to the guard terminal of a three-terminal bridge.
C_{gs}	Gate-source capacitance	The capacitance between the gate and source terminals with the drain terminal connected to the guard terminal of a three-terminal bridge.
C_{iss}	Short-circuit input capacitance, common source	The capacitance between the input terminals (gate and source) with the drain short-circuited to the source for alternating current.
C_{oss}	Short-circuit output capacitance, common source	The capacitance between the output terminals (drain and source) with the drain short-circuited to the source for alternating current.

SYMBOL	TERM	DEFINITION
C_{rss}	Short-circuit reverse transfer capacitance, common-source	The capacitance between the output and input (drain and gate) terminals with the source short-circuited to the gate for alternating current.
di/dt_{rr}	Reverse recovery rate of change of current	The rate of change of reverse recovery current, when the internal parasitic diode is recovering from forward conduction to the reverse blocking state, measured at the first zero crossing on the current wareform.
$g_{\_s}$	Common-source small signal,	The real part of the corresponding admittance. See y_{fs}, y_{is}, y_{os}, y_{rs}. Symbols in the form of g_{xx} and $y_{xx(real)}$ are equivalent.
g_{fs}	(forward transfer,	
g_{is}	input,	
g_{os}	output,	
g_{rs}	reverse transfer conductance)	
I_D	Drain current, dc	The direct current into the drain terminal.
$I_{D(on)}$	On-state drain current	The direct current into the drain terminal with a specified forward gate-source voltage and drain to source voltage applied to bias the device to the on-state.
I_{DSS}	Zero-gate-voltage drain current	The direct current into the drain terminal when the gate-source voltage is zero.
I_G	Gate current, dc	The direct current into the gate terminal.
I_{GSS}	Gate current, drain short-circuited to source	The direct current into the gate terminal of a MOSFET when the gate terminal is biased with respect to the source terminal and the drain terminal is short-circuited to the source terminal.
I_S	Source current, dc	The direct current into the source terminal.
P_T	Total nonreactive power input to all terminals	The sum of the products of the dc input currents and voltages.
p_T	Nonreactive power input, instantaneous total to all terminals	The sum of the products of the instantaneous input currents and voltages.
$r_{ds(on)}$	Small-signal drain-source on-state resistance	The small-signal resistance between drain and source terminals with a specified gate-source voltage and drain-source voltage applied to bias the device to the on-state.
$r_{DS(on)}$	Static drain-source on-state resistance	The dc resistance between drain and source terminals with a specified gate-source voltage and drain-source voltage applied to bias the device to the on-state.
$R_{\theta JA}$	Thermal resistance, junction-to-ambient	The thermal resistance (steady state) from the semiconductor junction(s) to the ambient.
$R_{\theta JC}$	Thermal resistance, junction-to-case	The thermal resistance (steady state) from the semiconductor junction(s) to a stated location on the case.
T_A	Ambient temperature or free-air temperature	The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.

SYMBOL	TERM	DEFINITION
t_{fv}	Voltage fall time	The time interval during which the drain voltage changes from 90% to 10% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_{off}	Turn-off time	See current turn-off time ($t_{off(i)}$).
$t_{off(i)}$	Current turn-off time	The sum of the current turn-off delay time and current fall time, i.e.: $t_{d(off)i} + t_{fi}$
$t_{off(v)}$	Voltage turn-off time	The sum of the voltage turn-off delay time and voltage rise time, i.e.: $t_{d(off)v} + t_{rv}$.
t_{on}	Turn-on time	See current turn-on time ($t_{on(i)}$).
$t_{on(i)}$	Current turn-on time	The sum of the current turn-on delay time and current rise time, i.e.: $t_{d(on)i} + t_{ri}$
$t_{on(v)}$	Voltage turn-on time	The sum of the voltage turn-on delay time and voltage fall time, i.e.: $t_{d(on)v} + t_{fv}$
t_p	Pulse duration (formerly pulse time)	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform.
	NOTE: The two reference points are usually 90% of the steady-state amplitude existing before the leading edge. If the reference points are 50% points, the symbol t_w and the term "average pulse duration" should be used.	
t_r	Rise time	See current rise time (t_{ri}).
t_{ri}	Current rise time	The time interval during which the drain current changes from 10% to 90% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{rv}	Voltage rise time	The time interval during which the drain voltage changes from 10% to 90% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_{ti}	Current tail time	The time interval during current fall time during which the drain current changes from 10% to 2% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_w	Average pulse duration, (formerly pulse average time)	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform, with both reference points being 50% of the steady-state amplitude of the waveform existing after the leading edge, measured with respect to the steady-state amplitude existing before the leading edge.
T_C	Case temperature	The temperature measured at a specified location on the case of a device.
T_J	Channel temperature	The temperature of the channel of a field-effect transistor.
T_{stg}	Storage temperature	The temperature at which the device may be stored (with no power applied).

SYMBOL	TERM	DEFINITION
t_c	turn-off cross-over time (for reserve symbol, see t_{xo})	The time interval during which drain voltage rises from 10% of its peak off-state value and drain current falls 10% of its peak on-state value, in both cases ignoring spikes that are not charge-carrier induced.
$t_{d(off)}$	Turn-off delay time	See current turn-off delay time ($t_{(off)i}$).
$t_{(off)i}$	Current turn-off delay time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the drain current waveform falls to 90% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
$t_{(off)v}$	Voltage turn-off delay time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the drain voltage waveform rises to 10% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
$t_{d(on)}$	Turn-on delay time	See current turn-on delay time ($t_{(on)i}$).
$t_{(on)i}$	Current turn-on delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the drain current waveform rises to 10% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
$t_{(on)v}$	Voltage turn-on delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the drain voltage waveform falls to 90% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
t_f	Fall time	See current fall time (t_{fi}).
t_{fi}	Current fall time	The time interval during which the drain current changes from 90% to 10% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{rr}	Reverse recovery time	The time interval when the internal parasitic diode is recovering from foward conduction to the reverse blocking state, from the first zero crossing on the current wareform, to the time when the reverse current (in diode terms) is reduced from its peak value $I_{RM(REC)}$ to: 1) its first interception with the zero-current axis or, 2) a specified low value $I_{R(REC)}$ or, 3) when the extrapolated reverse current reaches zero.

SYMBOL	TERM	DEFINITION
$V_{(BR)DSR}$	Drain-source breakdown voltage, resistance between gate and source	The breakdown voltage between the drain terminal and the source terminal when the gate terminal is returned to the source terminal through a specified resistance.
$V_{(BR)DSS}$	Drain-source breakdown voltage, gate short-circuited to source	The breakdown voltage between the drain terminal and the source terminal when the gate terminal is short-circuited to the source terminal.
$V_{(BR)DSV}$	Drain-source breakdown voltage, voltage between gate and source	The breakdown voltage between the drain terminal and the source terminal when the gate terminal is returned to the source terminal through a specified voltage.
$V_{(BR)DSX}$	Drain-source breakdown voltage, circuit between gate and source	The breakdown voltage between the drain terminal and the source terminal when the gate terminal is returned to the source terminal through a specified circuit.
$V_{(BR)GSS}$	Gate-source breakdown voltage, drain short-circuited to source	The breakdown voltage between gate and source terminals with the drain terminal short-circuited to the source terminal.
V_{DD}	Supply voltage, dc (drain)	The dc supply voltage applied to a circuit connected to the drain terminal.
V_{GG}	Supply voltage, dc (gate)	The dc supply voltage applied to a circuit connected to the gate terminal.
V_{SS}	Supply voltage, dc (source)	The dc supply voltage applied to a circuit connected to the source terminal.
V_{DG}	Voltage, dc (drain-to-gate)	The dc voltage between the drain terminal and the gate terminal (stated in terms of the polarity at the drain terminal).
V_{DS}	Voltage, dc (drain-to-source)	The dc voltage between the drain terminal and the source terminal (stated in terms of the polarity at the drain terminal).
V_{GD}	Voltage, dc (gate-to-drain)	The dc voltage between the gate terminal and the drain terminal (stated in terms of the polarity at the gate terminal).
V_{GS}	Voltage, dc (gate-to-source)	The dc voltage between the gate terminal and the source terminal (stated in terms of the polarity at the gate terminal).
V_{SD}	Voltage, dc (source-to-drain)	The dc voltage between the source terminal and the drain terminal (stated in terms of the polarity at the source terminal).
V_{SG}	Voltage, dc (source-to-gate)	The dc voltage between the source terminal and the gate terminal (stated in terms of the polarity at the source terminal).
$V_{DS(on)}$	Drain-source on-state voltage	The voltage between the drain and source terminals with a specified forward gate-source voltage applied to bias the device to the on-state.
$V_{GS(th)}$	Gate-source threshold voltage	The gate-source voltage at which the magnitude of the drain current reaches a specified low value, usually $250\mu A$.
W_{DSR}	Drain to source withstand avalanche energy	The ability to withstand non-repetitive drain to source avalanche energy with the gate connected to the source through a specified resistance.
y_{fs}	common-source small-signal short-circuit forward transfer admittance	The ratio of RMS drain current to RMS gate-source voltage with the drain terminal ac short-circuited to the terminal.

SYMBOL	TERM	DEFINITION
y_{is}	common-source small-signal short-circuit input admittance	The ratio of RMS gate current to RMS gate-source voltage with the drain terminal ac short-circuited to the source terminal.
y_{os}	common-source small-signal short-circuit output admittance	The ratio of RMS drain current to RMS drain-source voltage with the gate terminal ac short-circuited to the source terminal.
y_{rs}	common-source small-signal short-circuit reverse transfer admittance	The ratio of RMS gate current to RMS drain-source voltage with the gate terminal ac short-circuited to the source terminal.

1.1.3 LETTER SYMBOLS, TERMS & DEFINITIONS - IGT™ TRANSISTORS

SYMBOL	TERM	DEFINITION
C_{ce}	Collector-emitter capacitance	The capacitance between the collector and emitter terminals with the gate terminal connected to the guard terminal of a three-terminal bridge.
C_{cg}	Collector-gate capacitance	The capacitance between the collector and gate terminals with the emitter connected to the guard terminal of a three-terminal bridge.
C_{ge}	Gate-emitter capacitance	The capacitance between the gate and emitter terminals with the collector terminal connected to the guard terminal of a three-terminal bridge.
C_{ies}	Short-circuit input capacitance, common emitter	The capacitance between the input terminals (gate and emitter) with the collector short-circuited to the emitter for alternating current.
C_{oes}	Short-circuit output capacitance, common emitter	The capacitance between the output terminals (collector and emitter) with the collector short-circuited to the emitter for alternating current.
C_{res}	Short-circuit reverse transfer capacitance common-emitter	The capacitance between the collector and gate terminals with the emitter connected to the guard terminal of a three-terminal bridge.
$g_{\_e}$ g_{fe} g_{ie} g_{oe} g_{re}	Common-emitter small signal (forward transfer, input, output, reverse transfer conductance)	The real part of the corresponding admittance. See y_{fe}, y_{ie}, y_{oe}, y_{re}. Symbols in the form of g_{xx} and $y_{xx(real)}$ are equivalent.
I_C	Collector current, dc	The direct current into the collector terminal.
$I_{C(on)}$	On-state collector current	The direct current into the collector terminal with a specified forward gate-emitter voltage applied to bias the device to the on-state.
I_{CES}	Zero-gate-voltage collector current	The direct current into the collector terminal when the gate-emitter voltage is zero.
I_G	Gate current, dc	The direct current into the gate terminal.
I_{GES}	Reverse gate current, collector short-circuited to emitter	The direct current into the gate terminal of an IGT when the gate terminal is biased with respect to the emitter terminal and the collector terminal is short-circuited to the emitter terminal.
I_E	Emitter current, dc	The direct current into the emitter terminal.

SYMBOL	TERM	DEFINITION
P_T	Total nonreactive power to all terminals	The sum of the products of the dc input currents and voltages.
p_T	Nonreactive power input, instantaneous total, to all terminals	The sum of the products of the instantaneous input currents and voltages.
$r_{ce(on)}$	Small-signal collector-emitter on-state resistance	The small-signal resistance between collector and emitter terminals with a specified gate-emitter voltage applied to bias the device to the on-state.
$r_{CE(on)}$	Static collector-emitter on-state resistance	The dc resistance between collector and emitter terminals with a specified gate-emitter voltage applied to bias the device to the on-state.
$R_{\theta JA}$	Thermal resistance, junction-to-ambient	The thermal resistance (steady state) from the semiconductor junction(s) to the ambient.
$R_{\theta JC}$	Thermal resistance, junction-to-case	The thermal resistance (steady state) from the semiconductor junction(s) to a stated location on the case.
T_A	Ambient temperature or free-air temperature	The air temperature measured below a device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.
t_{fv}	Voltage fall time	The time interval during which the drain voltage changes from 90% to 10% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_{off}	Turn-off time	See current turn-off time ($t_{off(i)}$).
$t_{off(i)}$	Current turn-off time	The sum of the current turn-off delay time and current fall time, i.e.: $t_{d(off)i} = t_{fi}$
$t_{off(v)}$	Voltage turn-off time	The sum of the voltage turn-off delay time and voltage rise time, i.e.: $t_{d(off)v} = t_{rv}$
t_{on}	Turn-on time	See current turn-on time ($t_{on(i)}$).
$t_{on(i)}$	Current turn-on time	The sum of the current turn-on delay time and current rise time, i.e.: $t_{d(on)i} = t_{ri}$
$t_{on(v)}$	Voltage turn-on time	The sum of the voltage turn-on delay time and voltage fall time, i.e.: $t_{d(on)v} = t_{fv}$
t_p	Pulse duration (formerly pulse time)	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform.

NOTE: The two reference points are usually 90% of the stead-state amplitude existing before the leading edge. If the reference points are 50% points, the symbol t_w and the term "average pulse duration" should be used.

$t_{d(off)}$	Turn-off delay time	See current turn-off delay time ($t_{(off)i}$).

SYMBOL	TERM	DEFINITION
$t_{(off)i}$	Current turn-off delay time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% to its peak amplitude and the collector current waveform falls to 90% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
$t_{(off)v}$	Voltage turn-off delay time	The time interval during which an input pulse that is switching the transistor from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector voltage waveform rises to 10% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
$t_{d(on)}$	Turn-on delay time	See current turn-on delay time ($t_{(on)i}$).
$t_{(on)i}$	Current turn-on delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector current waveform rises to 10% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
$t_{(on)v}$	Voltage turn-on delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector voltage waveform falls to 90% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
t_f	Fall time	See current fall time (t_{fi}).
t_{fi}	Current fall time	The time interval during which the collector current changes from 90% to 10% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
$t_{f(eq)}$	Equivalent (current) fall time	The time interval which is defined by the following equation, where t_o is the time defined by the end of the $t_{d(off)i}$ interval, and I is the current before turn-off is initiated: $t_{f(eq)} = \frac{2}{I} \int_{t_o}^{\infty} i(t)dt$
t_r	Rise time	See current rise time (t_{ri}).
t_{ri}	Current rise time	The time interval during which the drain current changes from 10% to 90% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{rv}	Voltage rise time	The time interval during which the drain voltage changes from 10% to 90% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_{ti}	Current tail time	The time interval during current fall time during which the drain current changes from 10% to 2% of its peak on-state value, ignoring spikes that are not charge-carrier induced.

SYMBOL	TERM	DEFINITION
t_w	Average pulse duration, (formerly pulse average time)	The time interval between a reference point on the leading edge of a pulse waveform and a reference point on the trailing edge of the same waveform, with both reference points being 50% of the steady-state amplitude of the waveform existing after the leading edge, measured with respect to the steady-state amplitude existing before the leading edge.
T_C	Case temperature	The temperature measured at a specified location on the case of a device.
T_J	Channel temperature	The temperature of the channel of an IGT™ transistor.
T_{stg}	Storage temperature	The temperature at which the device may be stored (with no power applied).
t_c	Turn-off cross-over time (for reserve symbol, see t_{xo})	The time interval during which collector voltage rises from 10% of its peak off-state value and collector current falls 10% of its peak on-state value, in both cases ignoring spikes that are not charge-carrier induced.
$V_{(BR)CER}$	Collector-emitter breakdown voltage, resistance between gate and emitter	The breakdown voltage between the collector terminal and the emitter terminal when the gate terminal is returned to the emitter terminal through a specified resistance.
$V_{(BR)CES}$	Collector-emitter breakdown voltage, gate short-circuited to emitter	The breakdown voltage between the collector terminal and the emitter terminal when the gate terminal is short-circuited to the emitter terminal.
$V_{(BR)CEV}$	Collector-emitter breakdown voltage, voltage between gate and emitter	The breakdown voltage between the collector terminal and the emitter terminal when the gate terminal is returned to the emitter terminal through a specified voltage.
$V_{(BR)CEX}$	Collector-emitter breakdown voltage, circuit between gate and emitter	The breakdown voltage between the collector terminal and the emitter terminal when the gate terminal is returned to the emitter terminal through a specified circuit.
$V_{(BR)GES}$	Gate-emitter breakdown voltage, collector short-circuited to emitter	The breakdown voltage between gate and emitter terminals with the collector terminal short-circuited to the emitter terminal.
V_{CC}	Supply voltage, dc (collector)	The dc supply voltage applied to a circuit connected to the collector terminal.
V_{GG}	Supply voltage, dc (gate)	The dc supply voltage applied to a circuit connected to the gate terminal.
V_{EE}	Supply voltage, dc (emitter)	The dc supply voltage applied to a circuit connected to the emitter terminal.
V_{CG}	Voltage, dc (collector-to-gate)	The dc voltage between the collector terminal and the gate terminal (stated in terms of the polarity at the collector terminal).
V_{CE}	Voltage, dc (collector-to-emitter)	The dc voltage between the collector terminal and the emitter terminal (stated in terms of the polarity at the collector terminal).
V_{GC}	Voltage, dc (gate-to-collector)	The dc voltage between the gate terminal and the collector terminal (stated in terms of the polarity at the gate terminal).

SYMBOL	TERM	DEFINITION
V_{GE}	Voltage, dc (gate-to-emitter)	The dc voltage between the gate terminal and the emitter terminal (stated in terms of the polarity at the gate terminal).
V_{EC}	Voltage, dc (emitter-to-collector)	The dc voltage between the emitter terminal and the collector terminal (stated in terms of the polarity at the emitter terminal).
V_{EG}	Voltage, dc (emitter-to-gate)	The dc voltage between the emitter terminal and the gate terminal (stated in terms of the polarity at the emitter terminal).
$V_{CE(on)}$	collector-emitter on-state voltage	The voltage between the collector and emitter terminals with a specified forward gate-emitter voltage applied to bias the device to the on-state.
$V_{GE(th)}$	Gate-emitter threshold voltage	The gate-emitter voltage at which the magnitude of the collector current reaches a specified low value, usually $250\mu A$.
W_f	Fall time energy loss	The energy dissipated during the fall time interval with a clamped inductive load.
y_{fe}	common-emitter small-signal short-circuit forward transfer admittance	The ratio of RMS collector current to RMS gate-emitter voltage with the collector terminal ac short-circuited to the emitter terminal.
y_{ie}	common-emitter small-signal short-circuit input admittance	The ratio of RMS gate current to RMS gate-emitter voltage with the collector terminal ac short-circuited to the emitter terminal.
y_{oe}	common-emitter small-signal short-circuit output admittance	The ratio of RMS collector current to RMS collector-emitter voltage with the gate terminal ac short-circuited to the emitter terminal.
y_{re}	common-emitter small-signal short-circuit reverse transfer admittance	The ratio of RMS gate current to RMS collector-emitter voltage with the gate terminal ac short-circuited to the emitter terminal.

1.2 JUNCTION TRANSISTORS, MULTIJUNCTION TYPES

1.2.1 GENERAL TERMS AND DEFINITIONS

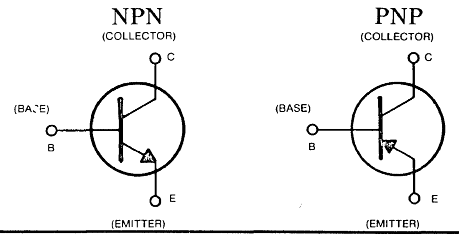
SYMBOL	TERM	DEFINITION
Base, (B,b)		A region that lies between an emitter and collector of a transistor and into which minority carriers are injected.[3]
Collector, (C,c)		A region through which a primary flow of charge carriers leaves the base.[3]
Emitter, (E,e)		A region from which charge carriers that are minority charges in the base are injected into the base.[3]
Junction, collector		A junction normally biased in the reversed direction, the current through which can be controlled by the introduction of minority carriers into the base.[3]
Junction, emitter		A junction normally biased in the forward direction to inject minority carriers into the base.[3]

NOTE: References to base, collector, and emitter symbolism (B,b; C,c; E,e) refer to the device terminals connected to those regions.

SYMBOL	TERM	DEFINITION
Saturation		A base-current and a collector current condition resulting in a forward-biased collector junction.
Transistor, junction multijunction type		A transistor having a base and two or more junctions.

Graphic symbols for triode transistors.[1]

NOTE: In the graphic symbols, the envelope is optional if no element is connected to the envelope.



SYMBOL	TERM	DEFINITION
C_{cb} or $C_{cb(dir)}$	Interterminal capacitance, collector-to-base	The direct interterminal capacitance between the collector terminal and the base terminal, with the collector-base junction reverse-biased, and with the emitter terminal open-circuited to dc, but ac-connected to the guard terminal of a three-terminal bridge.
C_{ce} or $C_{ce(dir)}$	Interterminal capacitance, collector-to-emitter	The direct interterminal capacitance between the collector terminal and the emitter terminal, with the collector-emitter junction reversed biased, and with the base terminal open-circuited to dc, but ac-connected to the guard terminal of a three-terminal bridge.
C_{eb} or $C_{eb(dir)}$	Interterminal capacitance, emitter-to-base	The direct interterminal capacitance between the emitter terminal and the base terminal, with the emitter-base junction reversed biased, and with the collector terminal open-circuited to dc, but ac-connected to the guard terminal of a three-terminal bridge.

NOTE: This capacitance includes the interelement capacitance plus capacitance to the shield where the shield is connected to one of the terminals under measurement.

SYMBOL	TERM	DEFINITION
C_{ibo}	Open-circuit input capacitance, common-base	The capacitance measured across the input terminals (emitter and base) with the collector open-circuited for ac.[4]
C_{ieo}	Open-circuit input capacitance, common-emitter	The capacitance measured across the input terminals (base and emitter) with the collector open-circuited for ac.[4]
C_{ibs}	Short-circuit input capacitance, common-base	The capacitance measured across the input terminals (emitter and base) with the collector short-circuited to the base terminal for ac.[4]
C_{ies}	Short-circuit input capacitance, common-emitter	The capacitance measured across the input terminals (base and emitter) with the collector short-circuited to the emitter terminal for ac.[4]
C_{obo}	Open-circuit output capacitance, common-base	The capacitance measured across the output terminals (collector and base) with the input open-circuited for ac.[4]
C_{oeo}	Open-circuit output capacitance, common-emitter	The capacitance measured across the output terminals (collector and emitter) with the input open-circuited for ac.[4]
C_{obs}	Short-circuit output capacitance, common-base	The capacitance measured across the output terminals (collector and base) with the emitter terminal short-circuited to the base terminal for ac.[4]

SYMBOL	TERM	DEFINITION
C_{oes}	Short-circuit output capacitance, common-emitter	The capacitance measured across the output terminals (collector and emitter) with the base terminal short-circuited to the emitter terminal for ac.[4]
C_{rbs}	Short-circuit reverse transfer capacitance, common-base	The capacitance measured from the output terminal to the input terminal with the base terminal and case (if lead is provided) connected to the guard terminal of a three-terminal bridge and with the device biased in the active region.
C_{rcs}	Short-circuit reverse transfer capacitance, common-collector	The capacitance measured from the output terminal to the input terminal with the collector terminal and case (if lead is provided) connected to the guard terminal of a three-terminal bridge and with the device biased in the active region.
C_{res}	Short-circuit reverse transfer capacitance, common-emitter	The capacitance measured from the output terminal to the input terminal with the emitter terminal and case (if lead is provided) connected to the guard terminal of a three-terminal bridge and with the device biased in the active region.
C_{tc}	Depletion-layer capacitance, collector	The part of the capacitance across the collector-base junction that is associated with its depletion layer.
C_{te}	Depletion-layer capacitance, emitter	The part of the capacitance across the emitter-base junction that is associated with its depletion layer.
	NOTE: This capacitance is a function of the total potential difference across the depletion layer.[2]	
f_1	Frequency of unity current transfer ratio	The frequency at which the modulus of the common-emitter small-signal short-circuit forward current transfer ratio [h_{fe}] has decreased to unity.[2]
	NOTE: This frequency must be determined by direct measurement, not by extrapolation. See f_T.	
f_{hf}	Small-signal short-circuit forward current transfer ratio cutoff frequency,	The lowest frequency at which the magnitude of the small-signal short-circuit forward current transfer ratio is 0.707 of its value at a specified low frequency (usually 1 kHz or less).[4]
f_{hfb}	common-base	
f_{hfc}	common-collector	
f_{hfe}	common-emitter	
f_{max}	Maximum frequency of oscillation	The maximum frequency at which a transistor can be made to oscillate under specified conditions.[2]
	NOTE: This approximates the frequency at which the maximum available power gain has decreased to unity.	
$f_{s\_}$	Frequency of unity forward transmission coefficient;	The frequency at which the modulus of the forward transmission coefficient [s_{21}] has decreased to unity.
f_{sb}	common-base	
f_{sc}	common-collector	
f_{se}	common-emitter	

SYMBOL	TERM	DEFINITION
f_T	Transistion frequency, or frequency at which small-signal forward current transfer ratio (common-emitter) extrapolates to unity	The product of the modulus (magnitude) of the common-emitter small-signal short-circuit forward current transfer ratio [h_{fe}] and the frequency of measurement when this frequency is sufficiently high so that the modulus of h_{fe} is decreasing with a slope of approximately 6 dB per octave. (Also see f_1)
$g_{M\_}$	Static transconductance,	The ratio of the dc output current to the dc input voltage.[5]
g_{MB}	common-base	
g_{MC}	common-collector	
g_{ME}	common-emitter	
$*g_{m\_}$	Small-signal transconductance,	The ratio of the ac output current to the ac input volatge with the output short-circuited to ac.[5]
g_{mb}	common-base	
g_{mc}	common-collector	
g_{me}	common-emitter	
	*Use preferred parameters y_{fb}, y_{fc}, y_{fe}.	
$G_{P\_}$	Large-signal insertion power gain,	The ratio, usually expressed in dB, of (1) the signal power delivered to the load after insertion of a transducer between the source and the load to (2) the signal power that was delivered to the load when the load was connected directly to the source, under large signal conditions.
G_{PB}	common-base	
G_{PC}	common-collector	
G_{PE}	common-emitter	
$G_{p\_}$	Small-signal insertion power gain,	The ratio, usually expressed in dB, of (1) the signal power delivered to the load after insertion of a transducer between the source and the load to (2) the signal power that was delivered to the load when the load was connected directly to the source, under large signal conditions.
G_{pb}	common-base	
G_{pc}	common-collector	
G_{pe}	common-emitter	
$G_{T\_}$	Large-signal transducer power gain,	The ratio, usually expressed in dB, of the signal power delivered to the load to the maximum signal power available from the source, under large-signal conditions.
G_{TB}	common-base	
G_{TC}	common-collector	
G_{TE}	common-emitter	
$G_{t\_}$	Small-signal transducer power gain,	The ratio, usually expressed in dB, of the signal power delivered to the load to the maximum signal power available from the source, under small-signal conditions.
G_{tb}	common-base	
G_{tc}	common-collector	
G_{te}	common-emitter	
$h_{F\_}$	Static forward current transfer ratio	The ratio of dc output current to the dc input current.
h_{FB}	common-base	
h_{FC}	common-collector	
h_{FE}	common-emitter	
$h_{f\_}$	Small-signal short-circuit forward current transfer ratio,	The ratio of ac output current to the the small-signal ac input current with the output short-circuited to ac.[5]

SYMBOL	TERM	DEFINITION
h_{fb}	common-base	
h_{fc}	common-collector	
h_{fe}	common-emitter	
$h_{I\_}$	Static input resistance,	The ratio of dc input voltage to the dc input current.
h_{IB}	common-base	
h_{IC}	common-collector	
h_{IE}	common-emitter	
$h_{i\_}$	Small-signal short-circuit input impedance,	The ratio of the small-signal ac input short-circuit voltage to the ac input current with the output short-circuited to ac.[5]
h_{ib}	common-base	
h_{ic}	common-collector	
h_{ie}	common-emitter	
$h_{ie(imag)}$ or $Im(h_{ie})$	Imaginary part of the small-signal short-circuit input impedance, common-emitter	The ratio of the out-of-phase (imaginary) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal short-circuited to the emitter terminal for ac.
$h_{ie(real)}$ or $Re(h_{ie})$	Real part of the small-signal short-circuit input impedance, common-emitter	The ratio of the in-phase (real) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal short-circuited to the emitter terminal for ac.
$h_{o\_}$	Small-signal open-circuit output admittance,	The ratio of the ac output current to the small-signal ac output voltage applied to the output terminal with the input open-circuited to ac.[5]
h_{ob}	common-base	
h_{oc}	common-collector	
h_{oe}	common-emitter	
$h_{oe(imag)}$ or $Im(h_{oe})$	Imaginary part of the small-signal open-circuit output admittance, common-emitter	The ratio of the ac collector current to the out-of-phase (imaginary) component of the small-signal collector-emitter voltage with the base terminal open-circuited to ac.
$h_{oe(real)}$ or $Re(h_{oe})$	Real part of the small-signal open-circuit output admittance, common-emitter	The ratio of the ac collector current to the in-phase (real) component of the small-signal collector-emitter voltage with the base terminal open-circuited to ac.
$h_{r\_}$	Small-signal open-circuit reverse voltage transfer ratio	The ratio of the ac input voltage to the small-signal ac output voltage with the input open-circuited to ac.[5]
h_{rb}	common-base	
h_{rc}	common-collector	
h_{re}	common-emitter	
I_B	Current, dc (base)	The value of the dc current into the base terminal.
I_C	Current, dc (collector)	The value of the dc current into the collector terminal.
I_E	Current, dc (emitter)	The value of the dc current into the emitter terminal.
I_b	Current, RMS value of alternating current, base	The root-means-square value of alternating current into the base terminal.
I_c	Current, RMS value of alternating current, collector	The root-means-square value of alternating current into the collector terminal.

SYMBOL	TERM	DEFINITION
I_e	Current, RMS value of alternating current emitter	The root-means-square value of alternating current into the emitter terminal.
i_B	Current, instantaneous total value, base	The instantaneous total value of alternating current into the base terminal.
i_C	Current, instantaneous total value, collector	The instantaneous total value of alternating current into the collector terminal.
i_E	Current, instantaneous total value, emitter	The instantaneous total value of alternating current into the emitter terminal.
I_{BEV}	Base cutoff current	The current into the base terminal when it is biased in the reverse direction with respect to the emitter terminal and there is a specified voltage between the collector and emitter terminals.
I_{CBO}	Collector cutoff current, emitter open	The current into the collector terminal when it is biased in the reverse direction with respect to the base terminal and the emitter terminal is open-circuited.[4]
I_{CEO}	Collector cutoff current, base open	The current into the collector terminal when it is biased in the reverse direction* with respect to the emitter terminal and the base terminal is open-circuited.
I_{CER}	Collector cutoff current, resistance between base and emitter	The current into the collector terminal when it is biased in the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified resistance.
I_{CES}	Collector cutoff current, base short-circuit to emitter	The current into the collector terminal when it is biased in the reverse direction* with respect to the emitter terminal and the base terminal is short-circuited to the emitter terminal
I_{CEV}	Collector cutoff current, voltage between base and emitter	The current into the collector terminal when it is biased in the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified voltage.
I_{CEX}	Collector cutoff current, circuit between base and emitter	The current into the collector terminal when it is biased in the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified voltage[4].

**For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for NPN transistors or negative for PNP transistors with respect to the emitter terminal.*

I_{EBO}	Emitter cutoff current, collector open	The current into the emitter terminal when it is biased in the reverse direction with respect to the base terminal and the collector terminal is open-circuited.[4]
$I_{EC(ofs)}$	Emitter-collector offset current	The external short-circuit current between the emitter and collector when the base-collector diode is reverse biased.
I_{ECS}	Emitter cutoff current, base short-circuited to collector	The current into the emitter terminal when it is biased in the reverse direction** with respect to the collector terminal and the base terminal is short-circuited to the collector terminal.[4]

***For this parameter, the emitter terminal is considered to be biased in the reverse direction when it is made positive for NPN transistors or negative for PNP transistors with respect to the collector terminal.*

SYMBOL	TERM	DEFINITION
$\mathrm{Im}(h_{ie})$	See preferred symbol $h_{ie(imag)}$.	
$\mathrm{Im}(h_{oe})$	See preferred symbol $h_{oe(imag)}$.	
$\mathrm{Im}(y_{ie})$	See preferred symbol $y_{ie\ (imag)}$.	
$\mathrm{Im}(y_{oe})$	See preferred symbol $y_{oe(imag)}$.	
P_{BE}	Power input, dc to the base, common-emitter	The product of the dc input current and voltage with the common emitter circuit configuration.
P_{CB}	Power input, dc to the collector, common-base	The product of the dc input current and voltage with the common base circuit configuration.
P_{CE}	Power input, dc to the collector, common-emitter	The product of the dc input current and voltage with the common emitter circuit configuration.
P_{EB}	Power input, dc to the emitter, common-base	The product of the dc input current and voltage with the common base circuit configuration.
p_{BE}	Power input, dc; instantaneous total to the base, common-emitter	The product of the instantaneous input current and voltage with the common emitter circuit configuration.
p_{CB}	Power input, dc; instantaneous to the collector, common-base	The product of the instantaneous input current and voltage with the common base circuit configuration.
p_{CE}	Power input, dc; instantaneous total to the collector, common-emitter	The product of the instantaneous current and voltage with the common emitter circuit configuration.
p_{EB}	Power input, dc; instantaneous total to the emitter, common-base	The product of the instantaneous input current and voltage with the common base circuit configuration.
P_{IB}	Large-signal input power, common base	The product of the large-signal ac input current and voltage with the common base circuit configuration.
P_{IC}	Large-signal input power, common collector	The product of the large-signal ac input current and voltage with the common collector circuit configuration.
P_{IE}	Large-signal input power, common emitter	The product of the large-signal ac input current and voltage with the common emitter circuit configuration.
P_{ib}	Small-signal input power, common emitter	The product of the small-signal ac input current and voltage with the common base circuit configuration.
P_{ic}	Small-signal input power, common collector	The product of the small-signal ac input current and voltage with the common collector circuit configuration.
P_{ie}	Small-signal input power, common emitter	The product of the small-signal ac input current and voltage with the common emitter circuit configuration.
P_{OB}	Large-signal output power, common base	The product of the large-signal ac output current and voltage with the common base circuit configuration.
P_{OC}	Large-signal output power, common collector	The product of the large-signal ac output current and voltage with the common collector circuit configuration.
P_{OE}	Large-signal output power, common emitter	The product of the large-signal ac output current and voltage with the common emitter circuit configuration.

SYMBOL	TERM	DEFINITION
P_{ob}	Small-signal output power, common base	The product of the small-signal ac output current and voltage with the common base circuit configuration.
P_{oc}	Small-signal output power, common collector	The product of the small-signal ac output current and voltage with the common collector circuit configuration.
P_{oe}	Small-signal output power, common emitter	The product of the small-signal ac output current and voltage with the common emitter circuit configuration.
P_T	Total nonreactive power input, instantaneous total, to all terminals	The sum of the products of the dc input currents and voltages, i.e.: $V_{BE} \cdot I_B + V_{CE} \cdot I_C$ or $V_{BE} \cdot I_E + V_{CB} \cdot I_C$
p_T	Nonreactive power input instantaneous total, to all terminals	The sum of the products of the instantaneous input currents and voltages.
$r_b'C_c$	Collector-base time constant	The product of the intrinsic base resistance and collector capacitance under specified small-signal conditions.
$r_{CE(sat)}$	Saturation resistance, collector-to-emitter	The resistance between the collector and emitter terminals for the saturation conditions specified.[4]
$Re(h_{ie})$	See preferred symbol $h_{ie(real)}$.	
$Re(h_{oe})$	See preferred symbol $h_{oe(real)}$.	
$Re(y_{ie})$	See preferred symbol $y_{ie(real)}$.	
$Re(y_{oe})$	See preferred symbol $y_{oe(real)}$.	
$s_{f\_}$ or $s_{21\_}$	Forward transmission coefficient,	The complex ratio of the voltage at the output port to the voltage incident on the input port under small-signal conditions, the output port terminating impedance and the impedance of the source of the incident voltage being equal and purely resistive.
s_{fb},s_{21b}	common-base	
s_{fc},s_{21c}	common-collector	
s_{fe},s_{21e}	common-emitter	
$s_{i\_}$ or s_{11}	Input reflection coefficient,	The complex ratio of the voltage reflected from the input port to the voltage incident on the output port under small-signal conditions, the output-port terminating impedance and the impedance of the source of the incident voltage being equal and purely resistive.
s_{ib},s_{11b}	common-base	
s_{ic},s_{11c}	common-collector	
s_{ie},s_{11e}	common-emitter	
$s_{o\_}$ or $s_{22\_}$	Output reflection coefficient,	The complex ratio of the voltage reflected from the output port to the voltage incident on the output port under small-signal conditions, the input-port terminating impedance and the impedance of the source of the incident voltage being equal and purely resistive.
s_{ob},s_{22b}	common-base	
s_{oc},s_{22c}	common-collector	
s_{oe},s_{22e}	common-emitter	
$s_{r\_}$ or $s_{12\_}$	Reverse transmission coefficient,	The complex ratio of the voltage at the input port to the voltage incident on the output port under small-signal conditions, the input-port terminating impedance and the impedance of the source of the incident voltage being equal and purely resistive.
s_{rb},s_{12b}	common-base	
s_{rc},s_{12c}	common-collector	
s_{re},s_{12e}	common-emitter	

SYMBOL	TERM	DEFINITION
t_c	Turn-off crossover time (for reserve symbol, see t_{xo})	The time interval during which collector voltage rises from 10% of its peak off-state value and collector current falls to 10% of its peak on-state value, in both cases ignoring spikes that are not charge-carrier induced.
t_d	Delay time	See current delay time (t_{di}).
t_{di}	Current delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector current waveform rises to 10% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.
t_{dv}	Voltage delay time	The time interval during which an input pulse that is switching the transistor from a nonconducting to a conducting state rises from 10% of its peak amplitude and the collector voltage waveform falls to 90% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
t_f	Fall time	See current fall time (t_{fi}).
t_{fi}	Current fall time	The time interval during which the collector current changes from 90% to 10% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{fv}	Voltage fall time	The time interval during which the collector voltage changes from 90% to 10% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_{off}	Turn-off time	See current turn-off time $t_{off(i)}$.
$t_{off(i)}$	Current turn-off time	The sum of current storage time and current fall time, i.e.: $t_{si} + t_{fi}$.
$t_{off(v)}$	Voltage turn-off time	The sum of voltage storage time and voltage rise time, i.e.: $t_{sv} + t_{rv}$.
t_{on}	Turn-on time	See current turn-on time $t_{on(i)}$.
$t_{on(i)}$	Current turn-on time	The sum of current delay time and current fall time, i.e.: $t_{di} + t_{ri}$.
$t_{on(v)}$	Voltage turn-on time	The sum of voltage delay time and voltage rise time, i.e.: $t_{dv} + t_{fv}$.
t_r	Rise time	See current rise time t_{ri}.
t_{ri}	Current rise time	The time interval during which the collector current changes from 10% to 90% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{rv}	Voltage rise time	The time interval during which the collector voltage changes from 10% to 90% of its peak off-state value, ignoring spikes that are not charge-carrier induced.
t_s	Storage time	See current storage time t_{si}.
t_{si}	Current storage time	The time interval during which an input pulse that is switching from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector current waveform falls to 90% of its on-state amplitude, ignoring spikes that are not charge-carrier induced.

SYMBOL	TERM	DEFINITION
t_{sv}	Voltage storage time	The time interval during which an input pulse that is switching from a conducting to a nonconducting state falls from 90% of its peak amplitude and the collector voltage waveform rises to 10% of its off-state amplitude, ignoring spikes that are not charge-carrier induced.
t_{ti}	Current tail time	The time interval following current fall time during which the collector current changes from 10% to 2% of its peak on-state value, ignoring spikes that are not charge-carrier induced.
t_{xo}	Turn-off crossover time	For definition, see t_c (t_{xo} is a reserve symbol to be used if t_c will cause confusion).

NOTE: As names of time intervals for characterizing switching transistors, the terms "fall time" and "rise time" always refer to the change that is taking place in the magnitude of the output current even though measurements may be made using voltage waveforms. In a purely resistive circuit, the (current) rise time may be considered equal and coincident to the voltage fall time; and the (current) fall time may be considered equal and coincident to the voltage rise time. The delay times for current and voltage will be equal and coincident, as will the storage times. When significant amounts of inductance are present in a circuit, these equalities and coincidences no longer exist, and the use of the unmodified terms "delay time," "fall time," "rise time," and "storage time" must be avoided.

SYMBOL	TERM	DEFINITION
V_{BB}	Supply voltage, dc (base)	The dc supply voltage applied to a circuit connected to the base terminal.
V_{CC}	Supply voltage, dc (collector)	The dc supply voltage applied to a circuit connected to the collector terminal.
V_{EE}	Supply voltage, dc, (emitter)	The dc supply voltage applied to a circuit connected to the emitter terminal.
V_{BC}	Voltage, dc, base-to-collector	The dc voltage between the base terminal and the collector terminal (stated in terms of the polarity at the base terminal).
V_{BE}	Voltage, dc, base-to-emitter	The dc voltage between the base terminal and the emitter terminal (stated in terms of the polarity at the emitter terminal).
V_{CB}	Voltage, dc, collector-to base	The dc voltage between the collector terminal and the base terminal (stated in terms of the polarity at the base terminal).
V_{CE}	Voltage, dc, collector-emitter	The dc voltage between the collector terminal and the emitter terminal (stated in terms of the polarity at the emitter terminal).
V_{EB}	Voltage, dc, emitter-to-base	The dc voltage between the emitter terminal and the base terminal (stated in terms of the polarity at the base terminal).
V_{EC}	Voltage, dc, emitter-to-collector	The dc voltage between the emitter terminal and the collector terminal (stated in terms of the polarity at the collector terminal).
v_{bc}	Voltage, instantaneous value of alternating component, base-to-collector	The instantaneous value of ac voltage between the base terminal and collector terminal.

SYMBOL	TERM	DEFINITION
v_{be}	Voltage, instantaneous value of alternating component, base-to-emitter	The instantaneous value of ac voltage between the base terminal and emitter terminal.
v_{cb}	Voltage, instantaneous value of alternating component, collector-to-base	The instantaneous value of ac voltage between the collector terminal and base terminal.
v_{ce}	Voltage, instantaneous value of alternating component, collector-to-emitter	The instantaneous value of ac voltage between the collector terminal and emitter terminal.
v_{eb}	Voltage, instantaneous value of alternating component, emitter-to-base	The instantaneous value of ac voltage between the emitter terminal and base terminal.
v_{ec}	Voltage, instantaneous value of alternating component, emitter-to-collector	The instantaneous value of ac voltage between the emitter terminal and collector terminal.
$V_{BE(sat)}$	Saturation voltage, base-to-emitter	The voltage between the base and emitter terminals for specified base-current and collector-current conditions which are intended to ensure that the collector junction is forward biased.
$V_{(BR)CBO}$, formerly BV_{CBO}	Breakdown voltage, collector-to-base, emitter open	The breakdown voltage between the collector terminal and the base terminal when the collector terminal is biased in the reverse direction with respect to the base terminal and the emitter terminal is open-circuited.[4]
$V_{(BR)CEO}$, formerly BV_{CEO}	Breakdown voltage, collector-to-emitter, base open	The breakdown voltage between the collector terminal and the emitter terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is open-circuited.
$V_{(BR)CER}$, formerly BV_{CER}	Breakdown voltage, collector-to-emitter, resistance between base and emitter	The breakdown voltage between the collector terminal and the emitter terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified resistance.
$V_{(BR)CES}$, formerly BV_{CES}	Breakdown voltage, collector-to-emitter, base short-circuited to emitter	The breakdown voltage between the collector terminal and the emitter base terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is short-circuited to the emitter terminal.
$V_{(BR)CEV}$, formerly BV_{CEV}	Breakdown voltage, collector-to-emitter, voltage between base and emitter	The breakdown voltage between the collector terminal and the emitter voltage terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified voltage.
$V_{(BR)CEX}$, formerly BV_{CEX}	Breakdown voltage, collector-to-emitter, circuit between base and emitter	The breakdown voltage between the collector terminal and the emitter circuit terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified circuit.[4]

SYMBOL	TERM	DEFINITION
$V_{(BR)EBO}$, formerly BV_{EBO}	Breakdown voltage, emitter-to-base, collector open	The breakdown voltage between the emitter terminal and the base terminal when the emitter terminal is biased in the reverse direction with respect to the base terminal and the emitter terminal is open-circuited.[4]
$V_{(BR)ECO}$, formerly BV_{ECO}	Breakdown voltage, emitter-to-collector, base open	The breakdown voltage between the emitter terminal and the collector terminal when the emitter terminal is biased in the reverse direction** with respect to the collector terminal and the base terminal is open-circuited.

**For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for NPN transistors or negative for PNP transistors with respect to the emitter terminal.*

***For these parameters, the collector terminal is considered to be biased in the reverse direction when it is made positive for NPN transistors or negative for PNP transistors with respect to the base terminal.*

$V_{CB(fl)}$	Open-circuit voltage (floating potential), collector-to-base	The open-circuit voltage (floating potential) between the collector terminal and the base terminal when the emitter terminal is biased in the reverse direction with respect to the base terminal.[4]
$V_{CE(fl)}$	Open-circuit voltage (floating potential), collector-to-emitter	The open-circuit voltage (floating potential) between the collector terminal and the emitter terminal when the base terminal is biased in the reverse direction with respect to the emitter terminal.[4]
$V_{EB(fl)}$	Open-circuit voltage (floating potential) emitter-to-base	The open-circuit voltage (floating potential) between the emitter terminal and the base terminal when the collector terminal is biased in the reverse direction with respect to the base terminal.[4]
$V_{EC(fl)}$	Open-circuit voltage (floating potential) emitter-to-collector	The open-circuit voltage (floating potential) between the emitter terminal and the collector terminal when the base terminal is biased in the reverse direction with respect to the collector terminal.[4]
V_{CBO}	Collector-to-base voltage emitter open	The voltage between the collector terminal and the base terminal when the emitter terminal is open circuited.
$V_{CE(ofs)}$	Collector-to-emitter offset voltage	The open-circuit voltage between the collector terminal and the emitter terminal when the base-emitter diode is forward-biased.
$V_{CE(sat)}$	Saturation voltage, collector-to-emitter	The voltage between the collector and emitter terminals under conditions of base current or base-emitter voltage beyond which the collector current remains essentially constant as the base current or voltage is increased.

NOTE: This is the voltage between the collector and emitter terminals when both the base-emitter and base-collector junctions are forward-biased.

V_{CEO}	Collector-to-emitter voltage, base open	The voltage between the collector terminal and the emitter terminal when the base terminal is open-circuited.
V_{CER}	Collector-to-emitter voltage, resistance between base and emitter	The voltage between the collector and the emitter terminal when the base terminal is returned to the emitter terminal through a specified resistance.

SYMBOL	TERM	DEFINITION
V_{CES}	Collector-to-emitter voltage, base short-circuited to emitter	The voltage between the collector terminal and the emitter terminal when the base terminal is short-circuited to the emitter terminal.
V_{CEV}	Collector-to-emitter voltage, voltage between base and emitter	The voltage between the collector terminal and the emitter terminal when the base terminal is returned to the terminal through a specified voltage.
V_{CEX}	Collector-to-emitter voltage, circuit between base and emitter	The voltage between the collector terminal and the emitter terminal when the base terminal is returned to the emitter terminal through a specified circuit.
$V_{CEO(sus)}$	Sustaining voltage, collector-to-emitter with base open	The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current and the base terminal is open-circuited.
$V_{CER(sus)}$	Sustaining voltage, collector-to-emitter with resistance between base and emitter	The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current and the base terminal is returned to the emitter terminal through a specified resistance.
$V_{CES(sus)}$	Sustaining voltage, collector-to-emitter with base short-circuited to emitter	The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current and the base terminal is short-circuited to the emitter terminal.
$V_{CEV(sus)}$	Sustaining voltage, collector-to-emitter with voltage between base and emitter	The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current and the base terminal is returned to the emitter terminal through a specified voltage.
$V_{CEX(sus)}$	Sustaining voltage, collector-to-emitter with circuit between base and emitter	The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current and the base terminal is returned to the emitter terminal through a specified circuit.
	NOTE: This would be the transient voltage between the collector and emitter terminals during switching with an inductive load from a forward-biased base-emitter to an external condition described by the third subscript letter.	
V_{EBO}	Emitter-to-base voltage, collector open	The voltage between the emitter terminal and the base terminal when the collector terminal is open-circuited.
$V_{EC(ofs)}$	Emitter-to-collector offset voltage	The open-circuit voltage between the emitter terminal and the collector terminal when the base-collector diode is forward-biased.
V_{RT}	Reach-through voltage	The value of reverse collector-to-base voltage voltage at which the space charge region of the collector-base junction extends to the space charge region of the emitter-base junction.[4]
$y_{f\_}$	Small-signal short-circuit forward transfer admittance,	The ratio of rms output current to rms input voltage with the output short-circuited to ac.

SYMBOL	TERM	DEFINITION
y_{fb}	common-base	
y_{fc}	common-collector	
y_{fe}	common-emitter	
$y_{i.}$	Small-signal short-circuit input admittance,	The ratio of rms input current to rms input voltage with the output short-circuited to ac.
y_{ib}	common-base	
y_{ic}	common-collector	
y_{ie}	common-emitter	
$y_{ie(imag)}$ or $Im(y_{ie})$	Imaginary part of the small-signal short-circuit input admittance, common-emitter	The ratio of rms current to the rms out-of-phase (imaginary) component of the input voltage with the output short-circuited to ac.
$y_{ie(real)}$ or $Re(y_{ie})$	Real part of the small-signal short-circuit input admittance, common-emitter	The ratio of rms input current to the rms in-phase (real) component of the input voltage with output short-circuited to ac.
$y_{o\_}$	Small-signal open-circuit output admittance,	The ratio of rms output current to rms output voltage with the input short-circuited to ac.
y_{ob}	common-base	
y_{oc}	common-collector	
y_{oe}	common-emitter	
$y_{oe(imag)}$ or $Im(y_{oe})$	Imaginary part of the small-signal short-circuit output admittance, common-emitter	The ratio of rms current to the rms out-of-phase (imaginary) component of the output voltage with the input short-circuited to ac.
$y_{oe(real)}$ or $Re(y_{oe})$	Real part of the small-signal short-circuit output admittance, common-emitter	The ratio of rms output current to the rms in-phase (real) component of the output voltage with input short-circuited to ac.
$y_{r\_}$	Small-signal short-circuit reverse transfer admittance,	The ratio of rms input current to rms output voltage with the input short-circuited to ac.
y_{rb}	common-base	
y_{rc}	common-collector	
y_{re}	common-emitter	

REFERENCES

1. ANSI - Y 32-2 or EIA Standard 315 -- 1975; Graphic Symbols for Electrical and Electronic Diagrams.
2. IEC Publication 147.0 - International Electronic Commission.
3. IEEE Standard 100 - 1972; IEEE Standard Dictionary of Electrical and Electronic Terms (ANSI C42.100, 1972).
4. IEEE Standard 255.
5. MIL-Specification — 19500, Semiconductor Device General Specification.

CHAPTER 2
RATINGS AND CHARACTERISTICS

The proper application of power semiconductors requires an understanding of their absolute maximum ratings and electrical characteristics, information which is presented within the device data sheet. Good design practice employs data sheet limit values and not data gleaned from samples.

A rating is a value that establishes either a limiting capability or a limiting condition (either maxima or minima) for a device. It is determined for specific values of environment and operation. Operation in excess of a rating may result in irreversible degradation or device failure. Parameters which fall into this category include breakdown voltages, currents, power dissipation, temperature, isolation voltage, and mounting torque. Many ratings are specified at a case temperature of 25° C. This is incompatible with typical applications, since both the junction and case temperatures will normally run hotter than the ambient temperature due to power dissipated within the device. However, it is a convenient way to specify devices, since a very short pulse (10-100 μs) with a low duty cycle (1 to 5%) can be applied to the device without raising either the junction or case temperatures significantly above the ambient temperature. Therefore, the easily measured case temperature closely approximates the junction temperature.

A characteristic is an inherent and measurable property of a device, expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form. Devices can have static (dc) and dynamic (ac or pulsed) characteristics usually specified by minimum, typical and maximum values. These characteristics are strongly influenced by test conditions.

2.1 POWER DISSIPATION AND THERMAL RATINGS

Successful application of power semiconductor devices requires close attention to power dissipation and thermal ratings. The probability of semiconductor device failure is directly proportional to junction temperature. Thus, derating junction temperature below device data sheet maximum is an often used design technique to enhance reliability.

2.1.1 POWER DISSIPATION vs. TEMPERATURE

The maximum power dissipation in Watts is specified at a case temperature of 25° C. If the case temperature is higher than +25° C, then the derating curve shown in Figure 2.1 must be used. The total power dissipation, or losses, dissipated in a semiconductor device consist of off-state, conduction and switching losses. For three-terminal devices, i.e., transistors, drive power dissipation may also need to be considered.

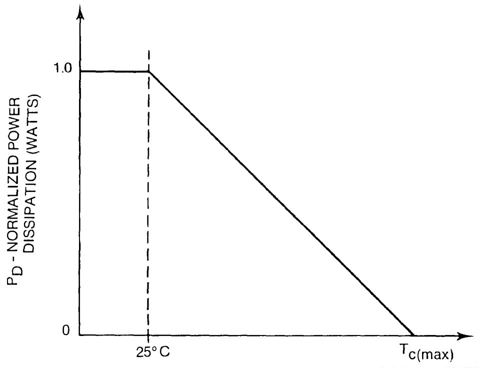


FIGURE 2.1. ALLOWABLE POWER DISSIPATION vs. TEMPERATURE

2.1.2 THERMAL RESISTANCE

Temperature calculations are simplified by using thermal resistance concepts. The flow of heat through a thermal path as a result of power dissipation is analogous to the flow of current through a conductive path as a result of a voltage source. Hence, knowing the power being dissipated in a device, and the ambient temperature, the resulting junction temperature can be calculated using the total thermal resistance and the following equation:

$$T_J = T_A + P_T R_{\theta T}$$

where:

$R_{\theta T}$ = total thermal resistance (°C/W)
P_T = total power dissipation (Watts)
T_J, T_A = junction and ambient temperatures respectively (°C)

The total thermal resistance is given by:

$$R_{\theta T} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA}$$

where:

$R_{\theta JC}$ = junction-to-case thermal resistance specified on the device data sheet (°C/W)

$R_{\theta CS}$ = case-to-sink thermal resistance (°C/W)

$R_{\theta SA}$ = sink-to-ambient thermal resistance (°C/W)

The thermal resistance ($R_{\theta JC}$) is specified for a semiconductor mounted in a particular package type. $R_{\theta JC}$ is always a maximum value, with a safety margin included to allow for production variations from lot to lot.

In some applications, the interface case-to-sink thermal resistance ($R_{\theta CS}$) may be significant and attention to mounting torques, heat sink surfaces and possible use of thermal compounds is important.

2.1.3 TRANSIENT THERMAL RESPONSE

For single or constant duty cycle and frequency power pulses, using the steady-state thermal resistance will give conservative junction temperatures. In addition, using the average value of power dissipation will underestimate the junction temperature. The solution is use of the normalized transient thermal impedance curves (Figure 2.2) and average power dissipation to calculate the maximum average junction temperature.

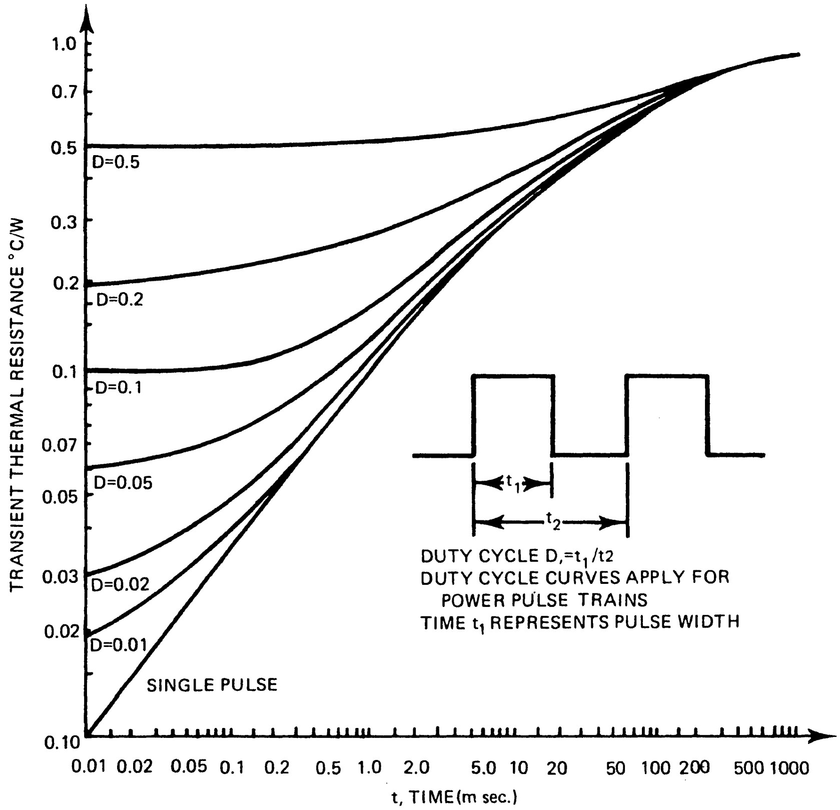


FIGURE 2.2. TRANSIENT THERMAL RESPONSE

2.1.4 USE OF THERMAL COMPOUNDS AND INSULATORS

Use of thermal compounds when mounting devices to heat sinks is highly recommended to prevent hot spots due to voids between the package and the heat sink surface. GE No. 6644 or Dow No. 4 are recommended.

In those instances where the package must be isolated from the heat sink, insulating washers with thermal compound applied on both sides of the interface are recommended. If the manufacturing environment precludes the use of thermal compounds, there are greaseless washers, such as Chotherm No. 1674 and SILPADS No. 400.

For proper mounting and thermal considerations of plastic encapsulated devices, refer to General Electric Application Note No. 200.55 which is available upon request.

2.1.5 SURFACE FINISH

It is recommended that heat sink surfaces be flat within ± 1.5 mils/inch (0.015 mm/cm) over the mounting area and have a surface finish of < 64 micro inches (1.62 microns).

2.2 DIODES

The PN junction rectifier, or diode, may be considered as a two terminal electronic switch, whose conduction state (open or closed) depends on the polarity of an externally applied bias voltage. When the anode (P-side) is biased positively with respect to the cathode (N-side), the device behaves as a closed switch and current flows freely from anode to cathode; conversely, when a positive voltage is applied to the cathode with respect to the anode, the device behaves as an open switch and current flow is inhibited as long as the applied voltage is beneath a critical and specified threshold level (V_{RRM}). Should the applied reverse voltage exceed this V_{RRM} threshold, a condition known as reverse avalanche sets in, characterized by an abrupt increase in reverse current as shown in Figure 2.3. Figure 2.3 illustrates the voltage-current relationships of a PN junction diode where each of the three distinct operating modes is defined.

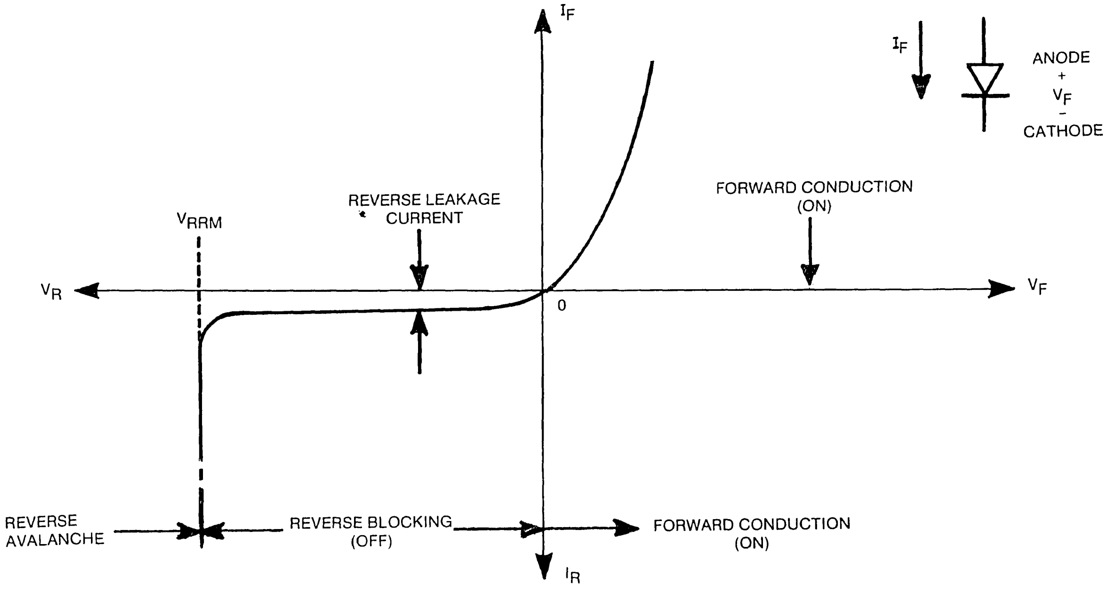


FIGURE 2.3. DIODE SYMBOL AND OUTPUT CHARACTERISTICS

For clarity, the reverse leakage current has been exaggerated in Figure 2.3. Diode forward current is many orders of magnitude greater than reverse leakage current. Also, note that significant forward current does not flow until the approximate 0.7 volt threshold is exceeded.

Diode characteristics are usually specified at 25°C. Forward voltage decreases as a function of temperature with the value dependent on current. A typical value equals -2.5mV per °C. Reverse saturation current approximately doubles for every 10°C rise in temperature.

2.2.1 DIODE CAPACITANCES

Referring to Figure 2.3, while in the steady state the rectifier must operate in one of three modes; forward conduction, reverse blocking or reverse avalanche. During transition intervals, however, when operation transfers from one mode to another, or where sudden changes in operating point occur within a given mode, transient effects come into play. In the reverse blocking mode, for example, the stored charge in the depletion region gives rise to a capacitive effect at the junction. This capacitance is called the transition or space charge capacitance, its boundaries (or "plates") represented by the edges of the depletion layer. As for any capacitance, its value C_T is dependent on the plate area A, on the distance between the two plates W_D and on the dielectric constant of the material ϵ.

$$C_T = \epsilon \cdot A/W_D \text{ where } W_D \cong V^{1/n},\ 1/3<n<1/2 \text{ and } V = \text{Applied Voltage}$$

Thus, the magnitude of the transition capacitance is directly proportional to junction area and inversely proportional to applied voltage. Should the reverse voltage applied to the junction suddenly change, the transition capacitance will change and a current must flow transiently to establish a new equilibrium.

In the forward biased mode, yet another capacitive effect manifests itself, with a much greater impact on transient behavior than the transition capacitance. The doping levels associated with the P and N layers of a practical PN junction are by no means identical. One area is heavily doped (low resistivity), whereas the other is lightly doped (high resistivity). This is necessary to create a diode with a low forward voltage drop and a high reverse voltage capability.

If the P-region is heavily doped, it becomes the emitter and holes are injected into the N-region under forward bias. When these holes enter the N-region, they become minority carriers and diffuse away from the junction to eventually recombine with electrons. As a result, the hole density tails off exponentially with distance from the junction. The rate of change of this charge with applied voltage is called the diffusion or storage capacitance. It is directly proportional to the mean lifetime of holes in the N-region and inversely proportional to the dynamic resistance of the forward biased diode. Thus,

$$C_D = \frac{\tau_p}{\gamma}$$

where C_D = diffusion capacitance
τ_p = mean hole lifetime
γ = dynamic resistance

The resulting time constant γC_D limits the performance of the diode, especially at high frequencies.

2.2.2 REVERSE RECOVERY TIME

When reverse voltage is applied to a diode that has been conducting in the forward direction, reversion to the blocking mode is not immediate, and for a brief interval a high amplitude reverse current flows. This results from the applied reverse bias voltage sweeping minority carriers stored in the diffusion capacitance back across the junction into the P-region. Some, of course, recombine with electrons en route.

The time required to remove this stored charge and allow the diode to regain its high reverse blocking resistance is called *reverse recovery time*. Reverse recovery time is not only related to the time constant τ_p, but is also a function of the external circuit which determines the negative di/dt through the diode. During the reverse recovery interval between the time the current crosses zero and reaches its peak value, the junction remains forward biased as shown diagrammatically in Figure 2.4.

With the reversal of the recovery current toward zero, transients are induced across any inductances in the path of the current. Depending on the circuit parameters, the amount of charge stored in the diode and on its commutation behavior ("soft" or "snappy" see Figure 2.5), these commutation transients may be of low amplitude and relatively harmless for a soft recovery, or of high amplitude and potentially destructive in the event of "snappy" recovery. R-C snubber networks may be required to protect the diode and other circuit components from over voltage and to control electromagnetic interference (EMI).

A slow tail off of reverse current reduces the peak transients; however, there may be an undersirable high peak energy dissipation in the diode, as the device assumes reverse voltage simultaneously with the flow of significant reverse current for a finite period of time. This can be particularly troublesome in high frequency applications.

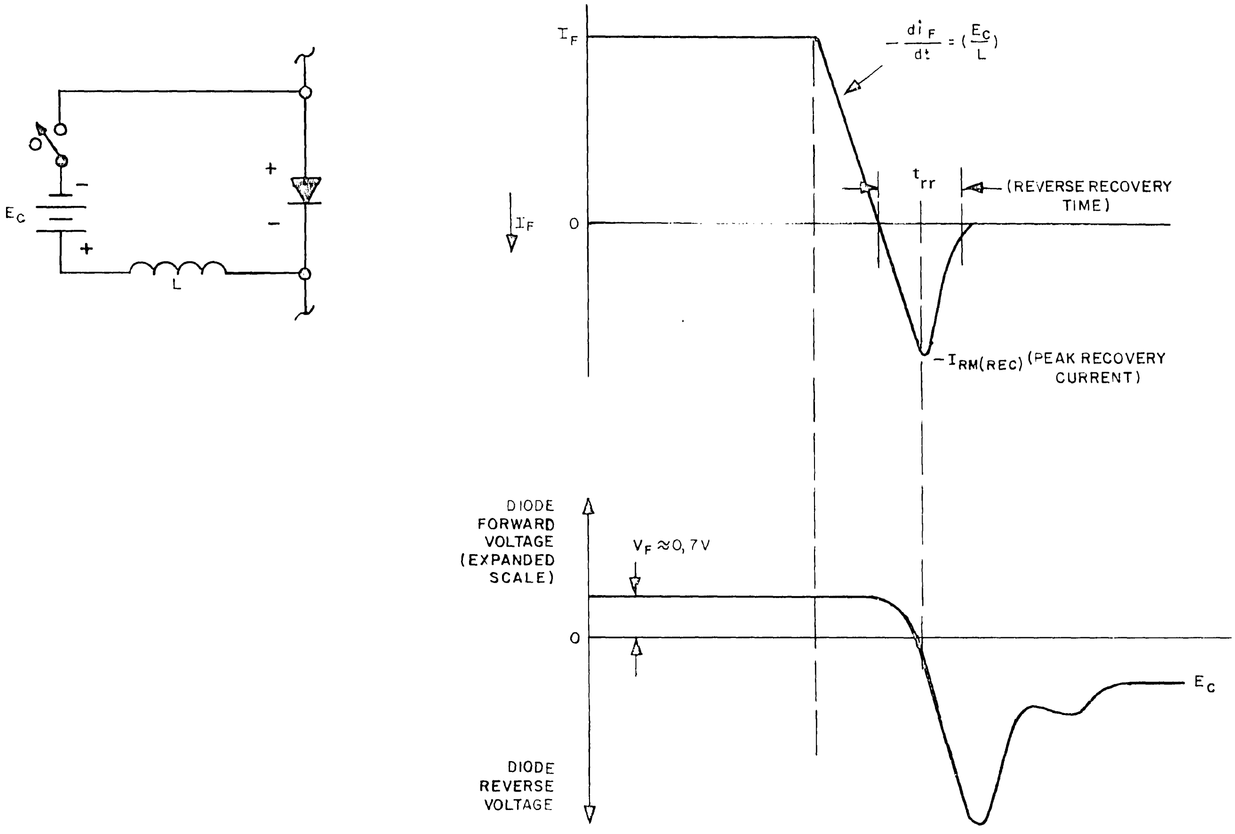


FIGURE 2.4 PN DIODE COMMUTATION

The relative snappiness of a diode may be established quantitatively by assigning a time to each of the two segments of the total reverse recovery current waveshape (t_a and t_b) and then comparing these two times, as shown in Figure 2.5. The ratio t_b/t_a is called the "S" factor.

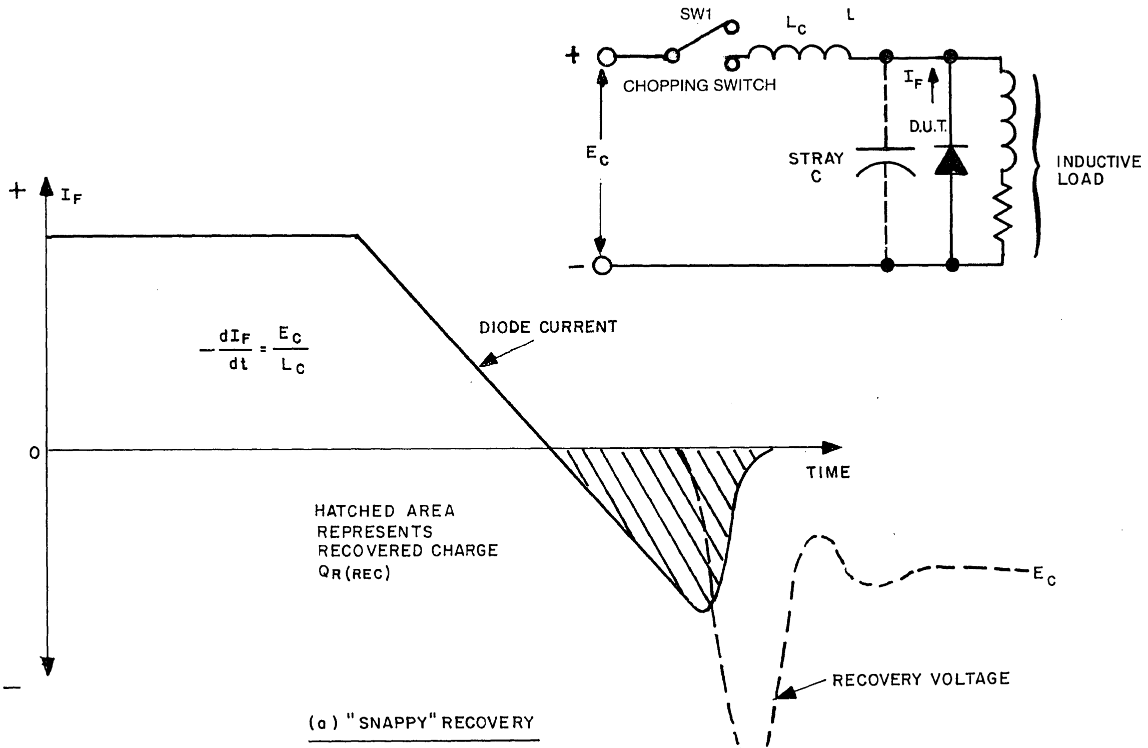
The steeper the final slope, the smaller the S-number becomes, and the snappier the diode. Knowing the S factor provides an indication of the likelihood of excessive voltage transients (small S factor), or inordinate power dissipation (high S factor) during the recovery phase. For fast diodes, experience shows an S factor in the region of unity ($t_A = t_B$) represents a reasonable compromise between these contradictory phenomena.

2.2.3 FORWARD RECOVERY TIME

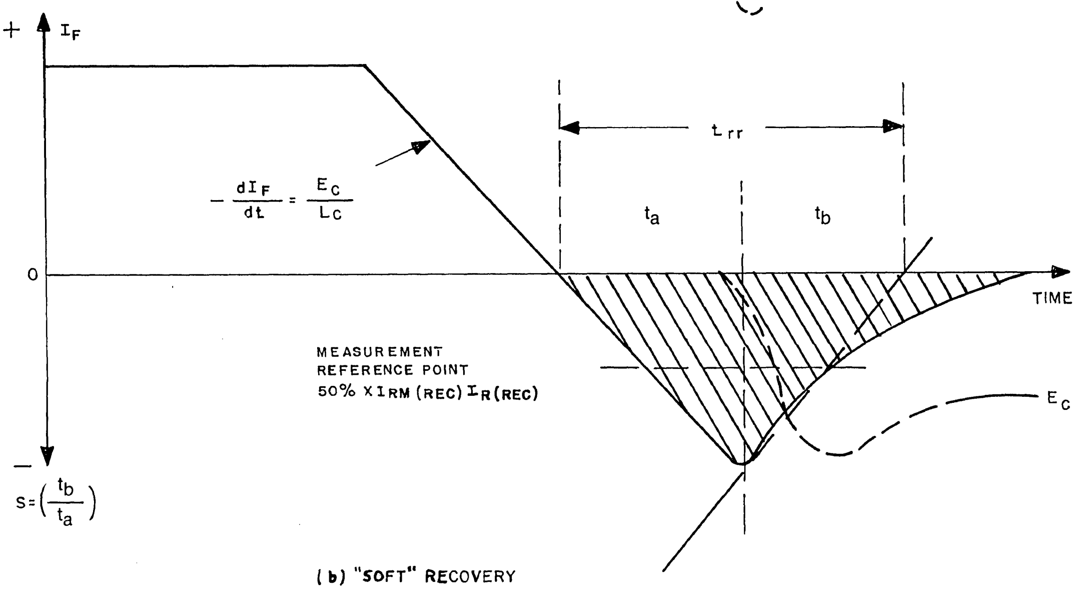
When the non-conducting diode is suddenly forward biased from a state of rest by application of a circuit dependent forward current, there is an accompanying transient *forward recovery voltage.* Under certain circumstances this overshoot voltage can significantly influence circuit behavior, so an understanding of its origins and likely magnitude is an indispensable prerequisite for reliable circuit design.

Referring to Figure 2.6, note that the forward current slope di_F/dt is determined by the external circuit, not by the diode, and that this slope may be either linear or exponential. In the latter case, di_F/dt is defined by the linear ramp through the single time constant point (63%) of the exponential.

As can be seen, the transient voltage developed across the diode rises to a maximum value V_{FP}, thereafter declining asymptotically towards a steady state value. Forward recovery time is defined as the interval between the onset of conduction and that point in time where forward voltage has decayed to an arbitrary reference level. Traditionally, the reference level for small signal switching diodes is $1.2V_F$, where V_F is the steady state forward drop at the test current level. For power diodes, however, it is common practice to use 2 volts as the reference point, to facilitate testing.



(a) "SNAPPY" RECOVERY

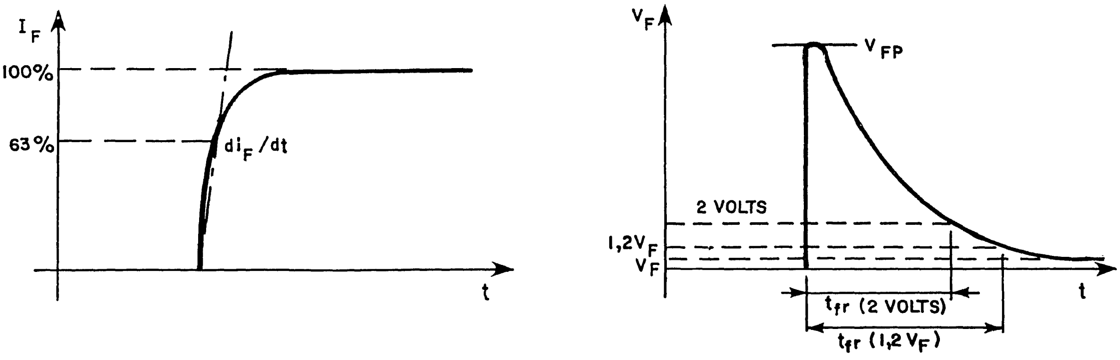


(b) "SOFT" RECOVERY

FIGURE 2.5. SNAPPY AND SOFT DIODE RECOVERY

Theoretically, the forward recovery may be considered as the cumulative effect of three separate phenomena; namely, the capacitance, ohmic resistance and apparent inductance of the junction at the moment conduction is initiated. The capacitive mechanism, relatively insignificant at nominal current levels, is related to the injection of minority carriers into the previously carrier-free junction zone at the instant of turn-on. It is characterized by an *increasing* voltage with time, this voltage tending toward the steady state level without overshoot.

The more significant ohmic resistance mechanism is related to the dramatic increase in minority carriers within the junction region as the device turns on. Initially the resistance is relatively high resulting in a high forward voltage drop; however, as the concentration of minority carriers spread (conductivity modulation effect), the ohmic resistance and consequently the forward voltage drop decreases as a function of time. In standard rectifiers, the ohmic-related overshoot can attain 15-20 volts peak, whereas the effect is much less pronounced in high speed diodes, due to their relatively narrow junction regions. As a corollary, such fast diodes also have commensurately lower forward recovery times.



VOLTAGE RESPONSE OF A RECTIFIER DIODE SUBJECTED TO AN EXPONENTIAL CURRENT RAMP di_F/dt.

A SURGE VOLTAGE APPEARS OF PEAK AMPLITUDE V_{FP} WITH A "TURN-ON TIME" OF t_{fr} DEFINED AS THE LENGTH OF TIME THE VOLTAGE IS ABOVE A DEFINED LEVEL EITHER $1.2V_F$ OR 2 VOLTS.

FIGURE 2.6. FORWARD RECOVERY TIME

The third mechanism contributing to the turn-on overshoot voltage magnitude is the apparent inductance of the semiconductor chip, which can be in the order of 150 nH for a 12 amp 1200 volt diode. It should be emphasized that this inductance is that of the chip itself, and is not associated with stray inductance due to packaging considerations or ohmic contacts to the chip. Since inductive voltage is generated by rate of change of current, the inductive component of the forward recovery is present only during the forward current rise time phase, and is directly proportional to di_F/dt. Thus, for the 12A diode already cited, the inductive overshoot would be about 15 volts at a di_F/dt of 100 amps per microsecond, but would be only 1.5 volts at 10 amps per microsecond. As is the case for the resistive component of overshoot voltage, inductive overshoot is less pronounced in fast diodes than in standard types, for the same reasons. A summary of facts associated with the forward voltage recovery is given as follows:

- Total overshoot is the sum of the individual contributions, principally the resistive and inductive components at normal current levels.
- This overshoot has a positive temperature coefficient, its amplitude increasing by about 50% for a 100°C rise in junction temperature.
- The forward recovery time t_{fr} is virtually independent of the rate of rise of current di_F/dt.
- The overshoot voltage varies only slightly with the amplitude of forward current, at least over the normal operating current range of the diode.
- The phenomenon is unaffected by prior reverse biasing.
- The additional power losses due to forward recovery can be neglected in the majority of applications, since the energy associated with each pulse is low.
- In all cases where the effects of forward recovery must be minimized, specification of a *fast reverse recovery* rectifier will usually suffice.

2.2.4 CONTROL OF MINORITY CARRIER LIFETIME BY GOLD OR PLATINUM DIFFUSION, OR BY ELECTRON IRRADIATION

Gold diffusion is a process whereby controlled amounts of gold atoms are introduced into the crystal lattice. These gold atoms provide additional recombination sites which reduces the reverse recovery time. Gold doping, while enabling a significant reduction in reverse recovery time, causes reverse leakage currents to rise and forward drop to increase compared to non-gold diffused devices, so it is generally not used to fabricate conventional rectifiers for low frequency operation. Similar results are obtained when platinum is substituted for gold.

In recent years, a third technique, electron irradiation, has been used as a non-diffusion related method of minority carrier lifetime control. Here, the silicon crystal is bombarded with high energy radiation that induces dislocations in the orderly structure of the crystal lattice. These dislocations, like gold or platinum atoms, serve as supplementary recombination sites, thereby again reducing reverse recovery time. From a manufacturing viewpoint, electron irradiation offers several advantages over gold or platinum diffusion, most notably lower reverse leakage; however, electron irradiation suffers from the disadvantage of presenting reverse recovery characteristics that are "snappy". Its effects can be annulled or reduced by subsequent annealing at high temperature.

2.2.5 EPITAXIAL GROWTH OF SILICON

Epitaxy is a sophisticated process in which the silicon crystaline structure may be extended (thickened) by growing additional material onto an existing substrate. The nature of the grown layer (N or P) may be adjusted during the growing process. After growth of the first layer, a second layer of different concentration may be added, or alternatively PN junctions can be generated by changing doping sources.

In diodes, epitaxy may be used to fabricate PNN$^+$ structures, where the high resistivity N region reduces the electric field magnitude that could otherwise produce premature breakdown (avalanche) and the low resistivity, highly doped N$^+$ layer provides an abundant supply of carriers to conduct forward current with minimum forward voltage drop.

2.3 BIPOLAR TRANSISTORS

The bipolar junction transistor (BJT) is a three terminal current controlled device. A current through the base-to-emitter junction produces an amplified current flow from collector and emitter. The magnitude of the collector current is equal to the base current multiplied by the gain of the transistor. The emitter current equals the base current, plus the collector current. Figure 2.7 illustrates the common emitter voltage-current relationships of NPN and PNP bipolar junction transistors, with three distinct operating modes defined.

In region A (the linear region) the collector current is approximately constant for a given base current and is essentially a linear function of base current. In region B (the quasi-saturation region) for a fixed base current, the collector current and hence the gain decreases as the collector-emitter voltage is reduced. This phenomenon is due to an effective widening of the base region with voltage and is more pronounced in high-voltage devices. In region C (the saturation region) both the collector-base and the base-emitter junctions are forward biased and the collector current becomes essentially independent of base current. The ratio of V_{CEsat}/I_C in the saturation region defines the saturation resistance.

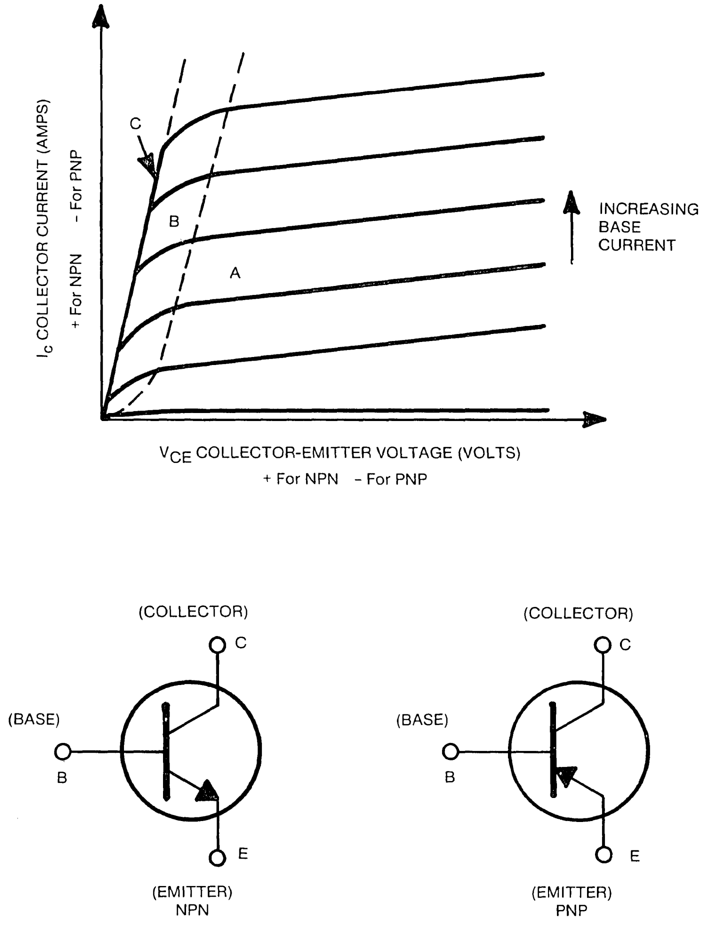


FIGURE 2.7 BIPOLAR JUNCTION TRANSISTOR SYMBOLS AND OUTPUT CHARACTERISTICS

2.3.1 VOLTAGE RATINGS

As indicated earlier, voltage ratings are the absolute maximum values that the device can be subjected to without danger of degradation or failure. Even though the devices have specified values on voltage ratings, conditions must be defined to qualify the rating. The voltage ratings and their significance are given in the following paragraphs.

V_{EBO} — A rating specified at low values of I_{EB} which is intended to prevent the base-to-emitter diode from avalanching. If the diode avalances repetitively, degradation of low current h_{FE} may result. If this junction is used as a zener diode, it must be rated for maximum current and power dissipation.

V_{CEV} — A conditional rating specified with a negative voltage applied between base and emitter. The negative voltage must be defined and the corresponding value of I_{CEV} is usually at low values of current. This parameter becomes important when using load line shaping and can extend the device's operating collector to emitter voltage beyond its sustaining voltage rating.

V_{CEO} — A rating specified with the base open. Because of the device's current gain, V_{CEO} is always lower than V_{CEV}. The permissible value of V_{CEO} will depend upon the magnitude of the collector current. At large currents, after breakdown, the voltage drops to a lower sustaining voltage, V_{CEOsus}; consequently, this determines the lowest value of rated collector-emitter voltages with an open base. This latter condition is taken into account when specifying the device's safe-operating-area and it is recommended that the designer use this information when determining acceptable collector to emitter voltage stress levels.

2.3.2 CURRENT RATINGS

The current ratings of a device are specified as continuous (dc) or peak (pulsed). Current ratings are functions of chip size, junction temperature, bonding wire sizes, and the electrical-to-mechanical interface (type of package).

Continous Current Ratings. The base, emitter and collector continuous current ratings are specified at $T_C = 25°C$ on the data sheet. However, all current ratings are valid up to $T_{J(MAX)}$. The emitter current rating is the maximum permissible device current, since $I_E = I_B + I_C$.

Peak Current Ratings. Peak current ratings are limited by the chip, bonding wire size, and number of wires and are determined by fusing current at $T_{J(MAX)}$. Occasionally, peak currents are specified as a function of the maximum pulse width and duty cycle to prevent fusing of the bonding wires within the package.

2.3.3 CUT-OFF CURRENTS

These current values should be maximum permissible values with circuit conditions and junction temperatures carefully defined. The usual rule-of-thumb for I_{CBO} is to double the 25°C value of leakage current for each 10°C increase in junction temperature. However, this may be misleading, since there is usually a surface leakage component within the device which is relatively independent of operating temperature. Therefore, the high temperature value at $T_{J(MAX)}$ may be only three to 10 times the 25°C value.

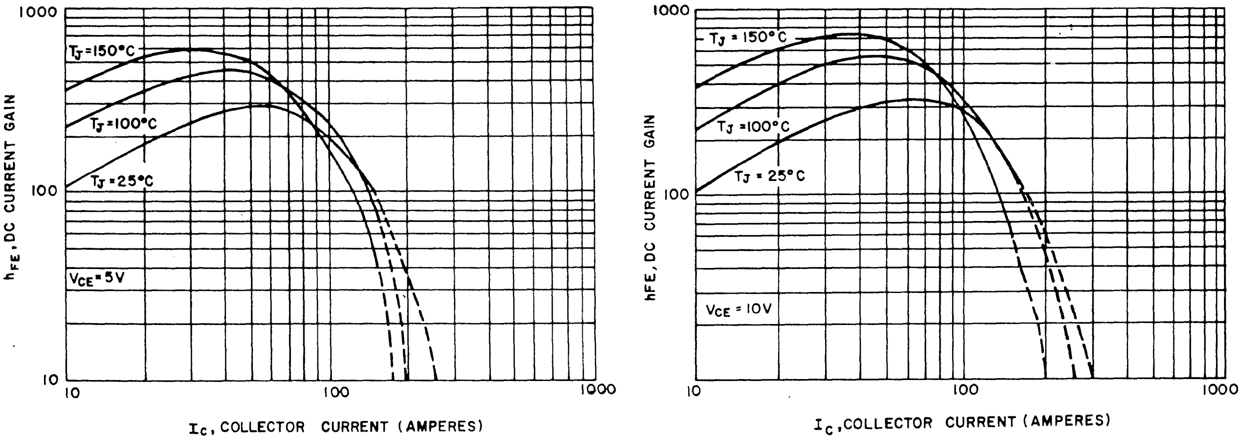
2.3.4 DC CURRENT GAIN

Minimum, typical, and/or maximum values are specified at one or more values of collector current and at a specified collector-to-emitter voltage. The gain is less at low voltages and will increase with increasing values of V_{CE}. Figure 2.8 shows typical gain as a function of I_C and T_J of the General Electric D67DE power Darlington transistor at $V_{CE} = 5$ volts and 10 volts.

Figure 2.8 also provides several other items of interest to the designer. These include:

1) Gain hold-up defined as the Δh_{FE} as a function of collector current. Note that it would be inappropriate to rate the device for 150 amperes continuous current since both the gain and gain hold-up is low at that level.
2) Change of h_{FE} as a function of junction temperature. Note in the example that for $I_C = 100$ amperes and a temperature change from $T_J = 25°C$ to $150°C$ h_{FE} varies from 180 to 240 for $V_{CE} = 5$ volts whereas the spread is considerably narrower (290 to 310) for $V_{CE} = 10$ volts.

The fact that high gain is available at rated current generally means that low values of $V_{CE(SAT)}$ are obtainable with reasonable values of forced beta ($\beta_F = I_C/I_B$), and consequently that turn-on times can be optimized in high speed switching applications.



(a) DC CURRENT GAIN (V_{CE} = 5V)

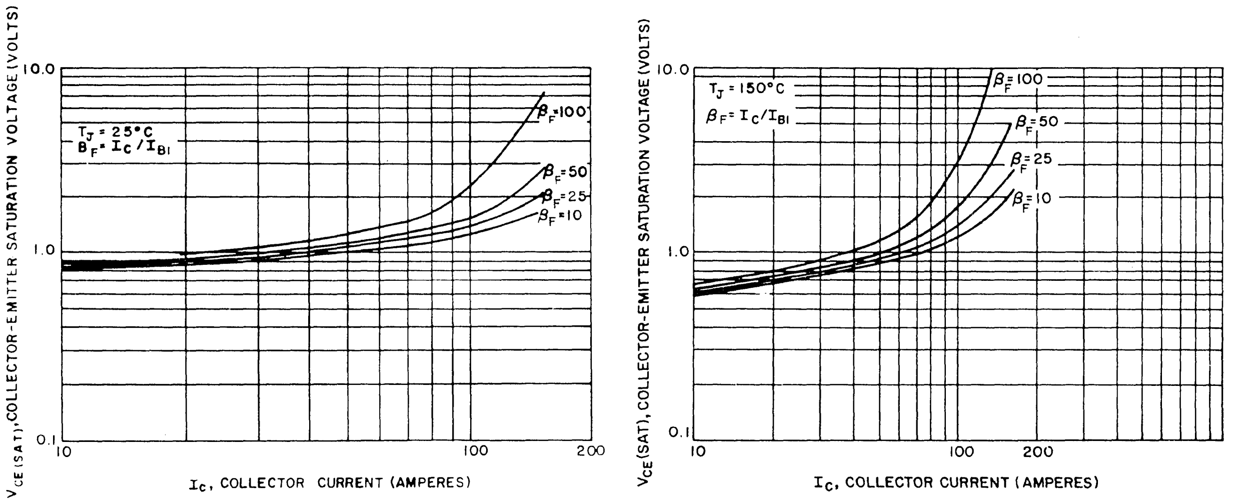
(b) DC CURRENT GAIN (V_{CE} = 10V)

FIGURE 2.8 GAIN VERSUS V_{CE}

2.3.5 SATURATION VOLTAGES

The saturation voltages must be specified as a function of base current, collector current and temperature. Drive conditions determine the limits on minimum values. When the forced beta ($\beta_F = I_C/I_B$) is high, saturation voltages are high and vice versa. Gain hold-up is important if saturation voltages and consequential conductor losses are kept low over the current range of interest.

Figure 2.9 shows typical values of $V_{CE(SAT)}$ as a function of I_C and β_F for junction temperatures of 25°C and 150°C for the General Electric D67DE Darlington transistor. Note that for T_J = 150°C and I_C = 100 amperes, $V_{CE(SAT)}$ varies from 3 volts down to approximately 1.2 volts as β_F is varied from 100 to 10.

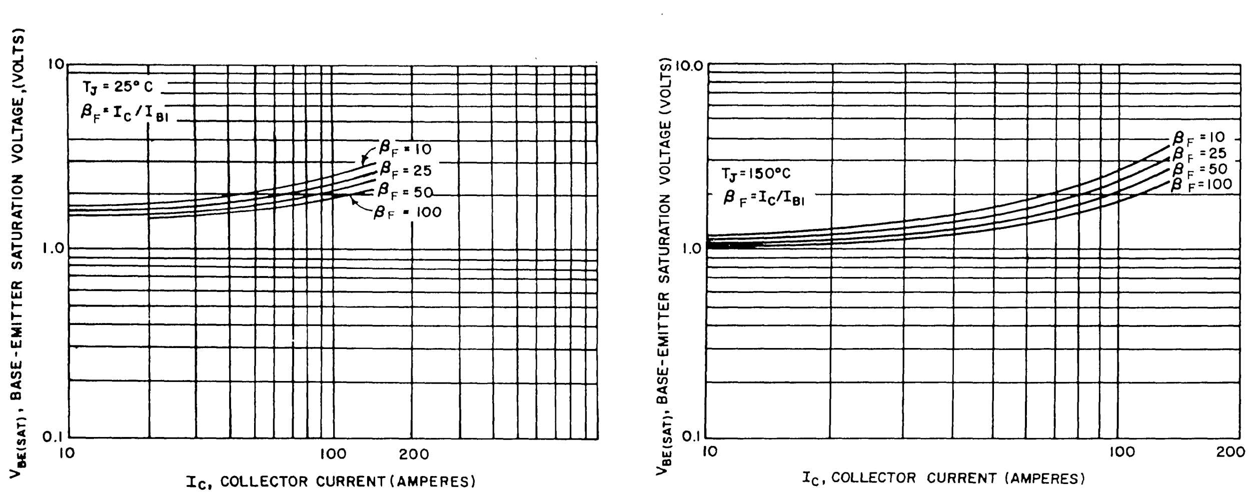


(a) $V_{CE(SAT)}$ VERSUS I_C, T_J = 25°C

(b) $V_{CE(SAT)}$ VERSUS I_C, T_J = 150°C

FIGURE 2.9. $V_{CE(SAT)}$ VERSUS β_F AND TEMPERATURE

The $V_{BE(SAT)}$ versus I_C curves shown in Figure 2.10 provide information about the transconductance (i.e., $g_m = I_C/V_{BE}$ with V_{CE} constant) of the device. Transconductance is useful to equalize current sharing in parallel operation of transistors. For single transistor applications these curves are useful in determining the required clamping diode characteristic when using a Baker clamp for anti-saturation applications. In hard saturation applications, $V_{BE(SAT)}$ maximum values enable optimization of the driver circuit.



(a) $V_{BE(SAT)}$ versus I_C, $T_J = 25°C$

(b) $V_{BE(SAT)}$ versus I_C, $T_J = 150°C$

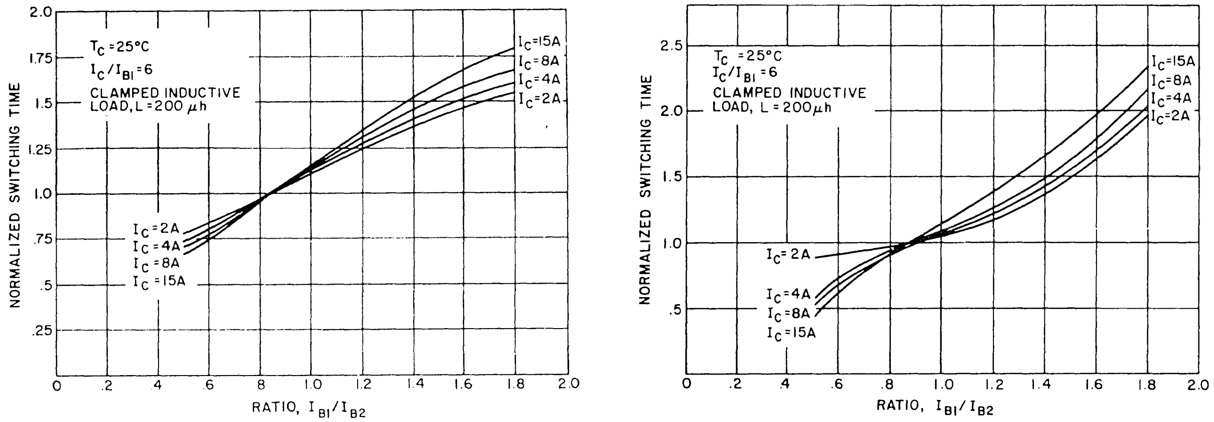
FIGURE 2.10. $V_{BE(SAT)}$ VERSUS I_C AND TEMPERATURE

2.3.6 SWITCHING CHARACTERISTICS

The switching times (t_{ON}, t_s and t_f) of a device can be heavily influenced by the drive conditions.

- Turn-on time can be decreased by increasing base drive for a fixed value of collector current (low β_F);
- Both storage time and fall time can be reduced by providing negative base current during turn-off and use of anti-saturation circuitry.

Consequently, it is important to define the drive conditions when specifying switching times. For the General Electric D64VS power transistor, Figure 2.11 illustrates the effects on inductive switching times using negative base drive (I_{B2}). These times can be decreased even further by use of anti-saturation techniques.



(a) STORAGE TIME VARIATION WITH I_{B2}

(b) FALL TIME VARIATION WITH I_{B2}

FIGURE 2.11. EFFECT OF REVERSE DRIVE ON t_s, t_f

2.3.7 FORWARD BIAS SAFE OPERATING AREA (FBSOA)

Depending on the transistor design, current in the collector region generally tends to concentrate under the emitter periphery at turn-on. This reduces the total conducting area to a fraction of the total emitter area, as shown in Figure 2.12. When switching into a clamped inductive load (Figure 2.13), I_C must rise to the full value of I_L before the rectifier can turn-off, releasing the clamp. Consequently, the collector-emitter voltage equals V_{CC} plus the forward voltage of the diode during this time period.

Therefore, during the current rise time (t_r) the transistor sees simultaneously high voltage (V_{CE}), high current, and reduced active conducting area. Similar conditions can also exist under fault conditions of the circuit. Depending on the rise time of the transistor or the duration of the fault condition, this can cause excessive localized heating that can lead to thermal instability followed by thermal runaway and second breakdown.

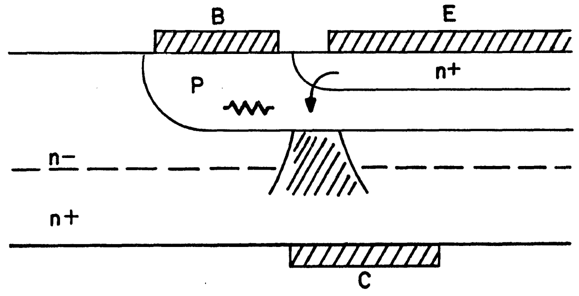


FIGURE 2.12. CURRENT CONSTRICTION

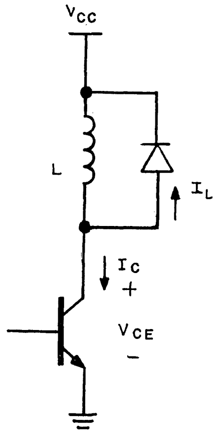


FIGURE 2.13. CLAMPED INDUCTIVE LOAD

An important item of information for the power circuit designer is the locus of I_C - V_{CE}, which marks the boundary between stable and unstable operation, and defines the Forward Bias Safe Operating Area (FBSOA). A typical FBSOA curve is shown in Figure 2.14. Note the limits of collector current and collector voltage.

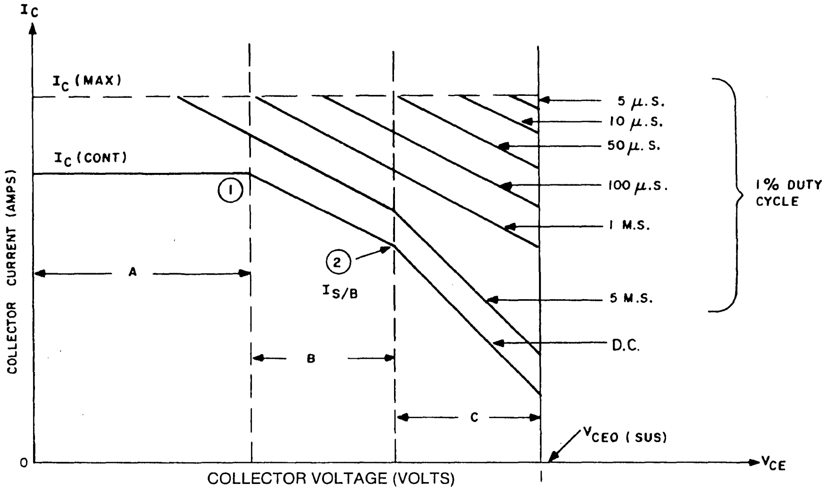


FIGURE 2.14. FBSOA

Collector current is permissible on a continuous basis in Regions A through C up to a maximum of $I_{C(cont)}$ in Region A. Above the defined continuous current limits, the current may be applied on a pulsed basis up to the limit defined by $I_{C(max)}$. Operation above $I_{C(max)}$ may result in melting or lifting of the bonding wires or internal damage to the chip. Point (1) and the upper DC boundary of Region B represent the maximum dc power of the device at 25°C case temperature in order to maintain the junction temperature at a temperature less than or equal to $T_{J(max)}$. In Region C, the second breakdown limit is defined by the onset of $I_{S/B}$ (Point 2). Currents greater than the maximum limits defined for dc and pulsed duty (1%) may cause irreparable damage to the transistor as a result of localized heating.

Since energy (that is, a power-time product) destroys the power transistor, high peak powers above the average power rating are permissible as long as the average power is less than that required to reach the maximum junction temperature of the device. It must be emphasized that under pulsed operation the junction must be allowed to cool, such that a temperature build-up does not occur within the device. Note that pulse ratings are specified with a 1% duty cycle for convenience; however, again duty cycles greater than 1% are permissible as long as the maximum junction temperature of the device is not exceeded.

2.3.8 REVERSE BIAS SAFE OPERATING AREA (RBSOA)

In inductive switching, transistors are susceptible to second breakdown during turn-off. However, the mechanisms that induce this type of breakdown are quite different from those of forward bias second breakdown. The values of collector current and voltage at which second breakdown occur are found to vary with the values of the reverse base drive. This is illustrated in Figure 2.15 for a 10A high voltage transistor. (The data was provided by the National Bureau of Standards.)

The degree of this dependence varies with the type of emitter geometry and vertical structure of a transistor.

For high current inductive switching and with either no reverse bias or weak reverse base drive during turn-off, the second breakdown usually coincides with the breakdown sustaining voltage of the transistor. In an inductive circuit, the energy that the transistor has to sustain following avalanche breakdown can be very large. It can cause the local temperature to exceed the intrinsic temperature of silicon, resulting in thermal instability and second breakdown by formation of mesoplasmas.

Where a strong reverse base drive is present, second breakdown is initiated by a different mechanism. Reverse base drive produces a strong localization of emitter current that can be an order of magnitude higher than that in the forward biased case. It can create a high electric field at the N-N$^+$ junction which triggers avalanche injection. This lateral electrical instability leads to the formation of filamentary current and results in nucleation and, finally, melt-through. In either the weak or the strong reverse base drive case, second breakdown is electric field-initiated and thermally terminated. On the other hand, forward bias second breakdown is usually thermally initiated, as well as thermally terminated.

It is interesting to note that when the reverse base current is increased to the point where it is equal to the collector current, the emitter is effectively disconnected and the threshold for reverse bias second breakdown is substantially increased. This is clearly shown in Figure 2.15. In this situation, a high "pinched in" current density cannot exist (because $I_E = 0$) and, therefore, there is no observable reverse bias second breakdown.

If an inductive load is used without a clamp and sufficient energy exists to avalanche the transistor during turn-off, an $E_{S/B}$ rating ($LI^2/2$) is applicable. At turn-off, the collector-emitter voltage flies up due to inductive (di/dt) kick causing the transistor to avalanche. The maximum energy the transistor can sustain is determined by increasing the inductor current prior to turn off until a subsequent device failure results. With increased reverse base drive, current crowding decreases the transistor $E_{S/B}$ capability.

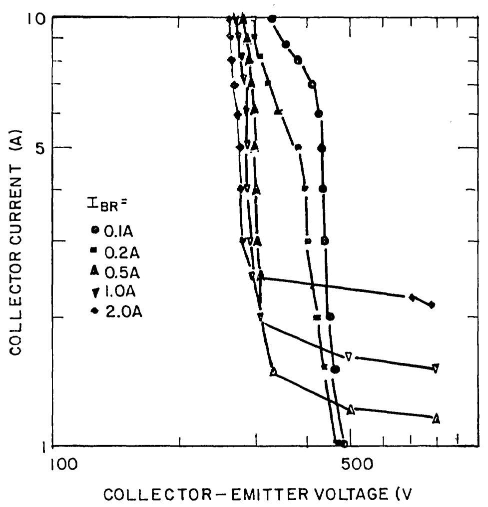


FIGURE 2.15. THE VALUES OF COLLECTOR CURRENT AND VOLTAGE AT WHICH SECOND BREAKDOWN OCCURS FOR DIFFERENT VALUES OF REVERSE BASE CURRENT. ONE DEVICE WAS USED FOR ALL THE MEASUREMENTS.

Most practical applications employ clamped loads. A typical clamped Reverse Bias Safe Operating Area (RBSOA) curve is shown in Figure 2.16. The RBSOA curve represents the allowable worst-case turn-off load lines. RBSOA applies whenever reverse base current flows during turn-off, even when the reverse base current is generated by a base emitter resistor with no external reverse voltage source. RBSOA is essentially independent of temperature.

As indicated earlier, RBSOA performance varies considerably with reverse bias. Increasing levels of reverse bias decrease turn-off switching times and hence turn-off switching losses but also increases turn-off current crowding. These two phenomenom work against each other in relation to RBSOA performance. Hence, device design will determine whether RBSOA performance improves or degrades with increasing reverse bias.

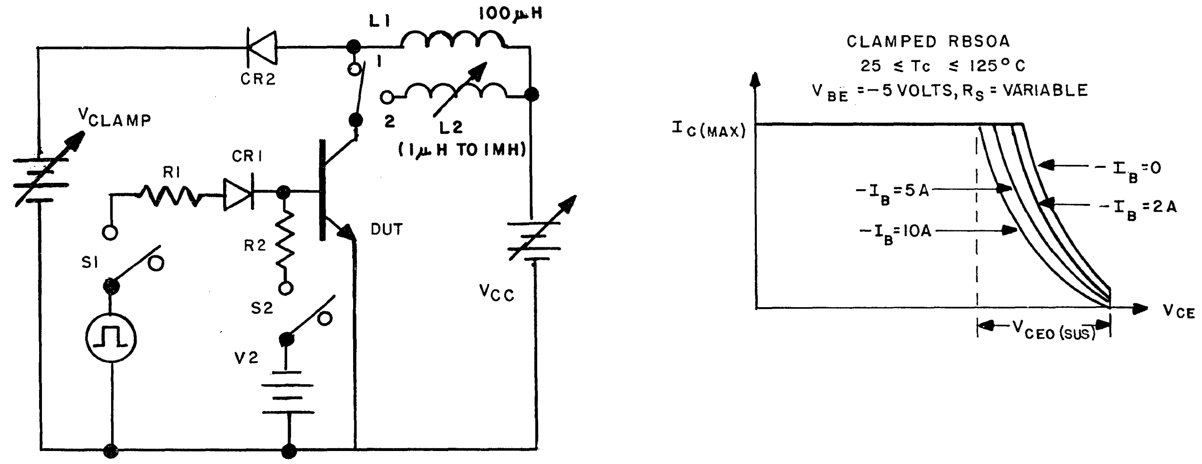


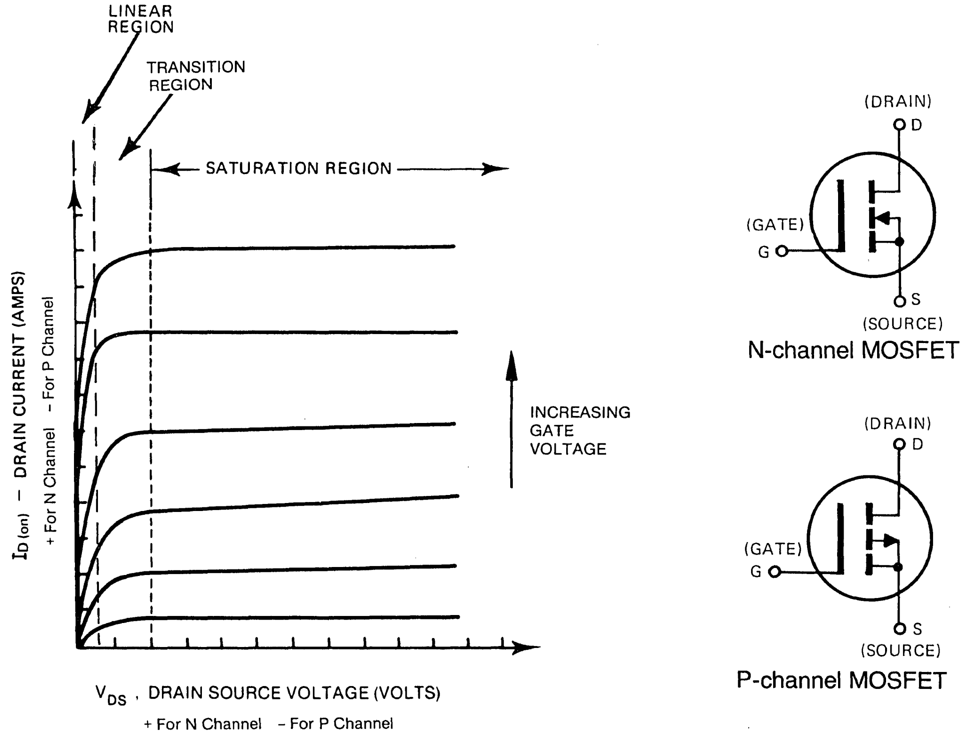
FIGURE 2.16. RBSOA TEST CIRCUIT

2.4 MOSFET TRANSISTORS

The MOSFET transistor is a three-terminal voltage controlled device. The drain-to-source current of the MOSFET is controlled by a voltage applied between the gate and source.

The current gain of the device is extremely high (typically greater than 10^9), since the gate current consists only of current required to charge the gate input capacitance and some small leakage through the gate oxide. Since current gain is extremely high and the drain current is controlled by the voltage applied between gate and source, it is more appropriate to specify transconductance ($\Delta I_D / \Delta V_{GS}$) when using MOSFETs.

Figure 2.17 illustrates the common source voltage-current relationships of n and p-channel MOSFETs. In the linear, or ohmic, region the slope represents the MOSFET on-resistance. In the transition region dynamic resistance of the device is changing as channel pinch-off begins to occur. In the saturation, or active, region the MOSFET characteristic is nearly flat due to pinch-off occurring in the channel. In this region the MOSFET makes an effective constant current source.



N-channel MOSFET

P-channel MOSFET

FIGURE 2.17. MOSFET TRANSISTOR SYMBOLS AND OUTPUT CHARACTERISTICS

2.4.1 POWER MOSFET STRUCTURE

A double diffusion (DMOS) of P and N material into the top epitaxial layer of the substrate creates its channel and source regions. See Figure 2.18. A thin oxide then covers them and polysilicon is deposited. This polysilicon layer acts as the gate, providing the means for creating an electric field to invert the channel region. All the source cells are then connected together with a single layer of metallization to form the source terminal, and the back of the wafer is metallized to form the drain terminal.

An enhancement mode N channel MOSFET is turned on when the voltage applied to the gate creates an electric field in the P-channel region. This field converts the channel from P-material to N-material, permitting current to flow from the drain terminal vertically through the chip then horizontally through the channel into the source region.

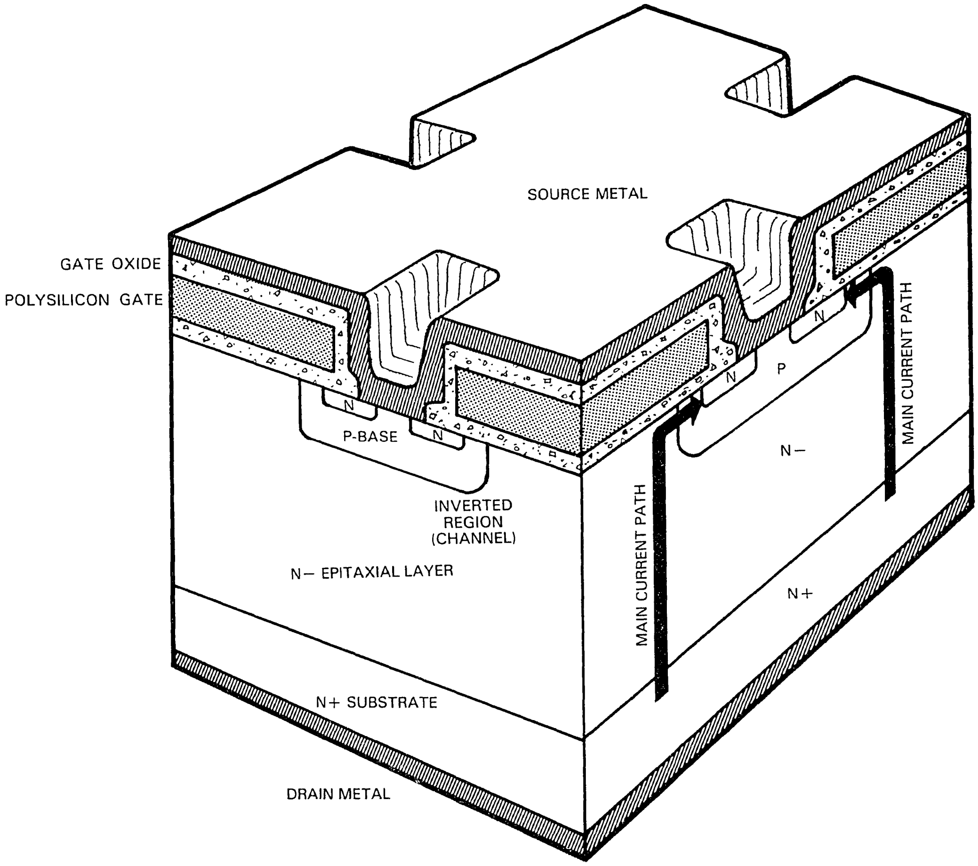


FIGURE 2.18. POWER MOSFET STRUCTURE

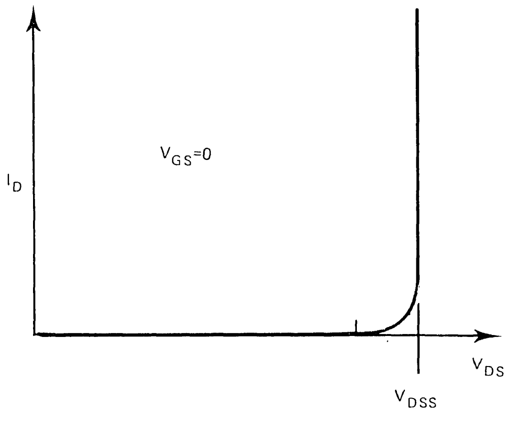


FIGURE 2.19. BLOCKING CHARACTERISTIC

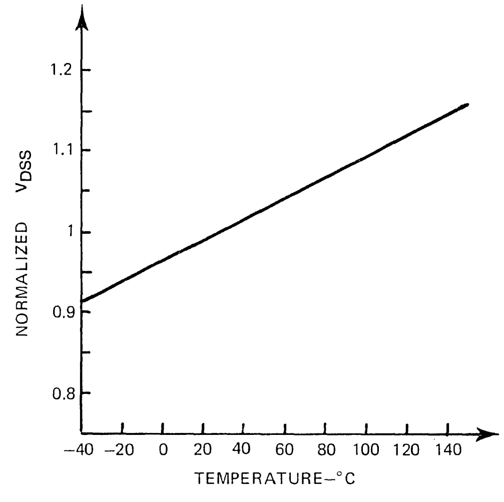


FIGURE 2.20. DRAIN-SOURCE BREAKDOWN VOLTAGE VARIATION WITH TEMPERATURE

2.4.2 BLOCKING CHARACTERISTICS

BV_{DSS} is the maximum drain-to-source voltage at a specified junction temperature (usually $T_J = 25°C$) that can be safely blocked without avalanching the device. This is illustrated in Figure 2.19. V_{DGR} is the maximum allowable drain-to-gate voltage that can be safely applied at a specified T_J and gate-to-source resistance (R_{gs}).

The temperature coefficient of V_{DS} shows a strong temperature dependence, increasing as much as 16% between +25°C and +150°C, but decreasing as much as 8% between +25°C and −40°C. See Figure 2.20. The temperature coefficient is approximately 0.12%/°C.

BV_{DSS} is the maximum drain-to-source voltage at a specified drain current (I_D) with no gate-to-source signal applied.

2.4.3 TRANSCONDUCTANCE (g_{fs})

Transconductance is defined as the ratio of the change of drain-to-source current brought about by a change in gate voltage. That is:

$$g_{fs} = \frac{\Delta I_{DS}}{\Delta V_{GS}}$$

$$V_{DS} = \text{constant}$$

Transconductance is temperature dependent and the effect can best be seen in Figure 2.21. The temperature coefficient of g_{fs} is approximately 0.2%/°C.

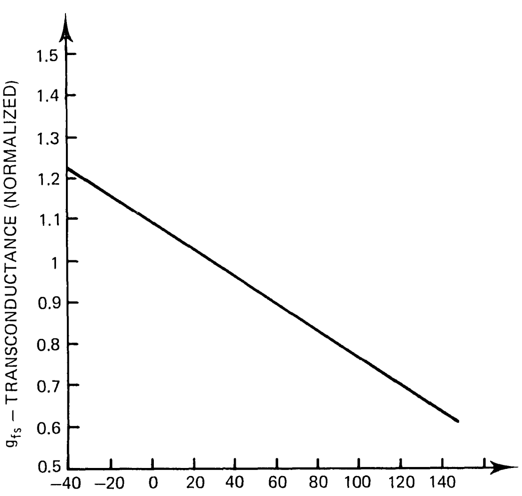


FIGURE 2.21. TYPICAL TRANSCONDUCTANCE vs. TEMPERATURE

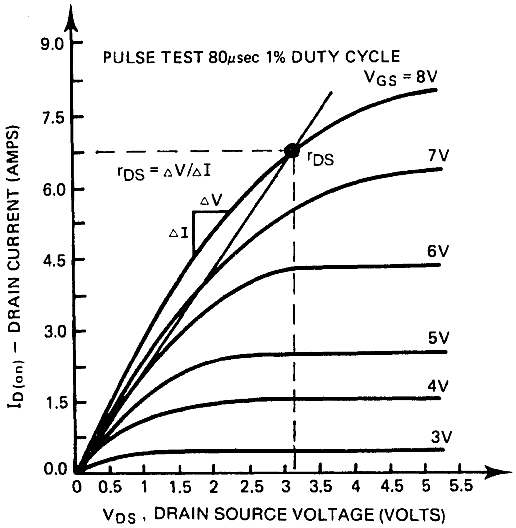


FIGURE 2.22. OUTPUT CHARACTERISTICS OF MOSFET (AT LOWER V_{DS})

2.4.4 ON RESISTANCE ($r_{DS(ON)}$)

The static drain-source resistance r_{DS} is equal to V_{DS}/I_D at each point (r_{DS} is the small signal on resistance $\Delta V_{DS}/\Delta I_{DS}$ at each point). This is illustrated in Figure 2.22.

The "on" resistance of a MOSFET consists of two components, the channel "on" resistance and the bulk resistance of the device. The "on" resistance of low voltage devices (<100v) consists primarily of the channel resistance, whereas the "on" resistance of higher voltage devices is dominated by the resistance of the epi layer. That is,

$$r_{DS(ON)} = R_{ch} + R_D$$

R_{ch} = channel resistance

R_D = extended drain resistance (epi layer)

In addition, channel resistance is controlled by the gate voltage and can be decreased by increasing V_{GS} for a fixed value of drain current. However, the maximum value of V_{GS} must not be exceeded. Figure 2.23 shows typical normalized "on"resistance. The temperature coefficient of $r_{DS(ON)}$ is positive and results in increased power losses at higher junction temperature (see Figure 2.24).

The temperature coefficient of $r_{DS(ON)}$ ranges from +0.2% to +0.7%/°C depending on voltage (higher voltage devices have higher temperature coefficients). The difference is caused by the competing effects of the positive temperature coefficient of the silicon versus the negative temperature coefficient of the gate-to-source threhold voltage $V_{GS(th)}$. Initially, the temperature coefficient of $V_{GS(th)}$ dominates, but as V_{DS} is increased (with increased epi thickness and resistivity), the temperature coefficient of the silicon becomes the dominating influence due to the epi resistance and approaches +0.6 to +0.7%/C.

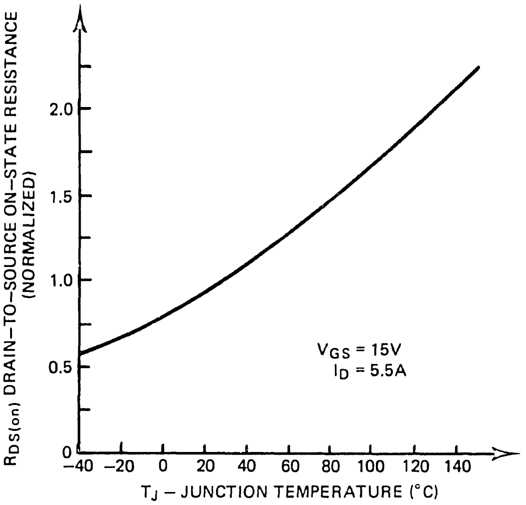


FIGURE 2.23 NORMALIZED TYPICAL ON-RESISTANCE

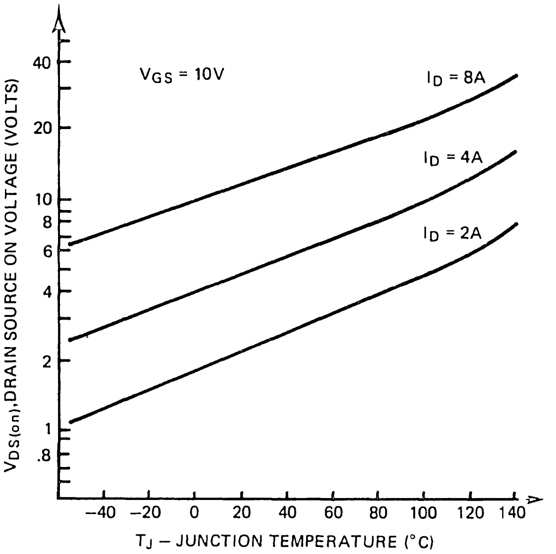


FIGURE 2.24. ON VOLTAGE vs TEMPERATURE

2.4.5 BREAKDOWN VOLTAGE VERSUS $r_{DS(ON)}$

When the drain-to-source breakdown voltage of a MOSFET is increased, the "on" resistance for a fixed chip size and process will increase exponentially by a factor of 2.3 to 2.7. If the breakdown voltage of a 100-volt device with an $r_{DS(ON)}$ of one ohm is increased to 200 Volts, and the $r_{DS(ON)}$ of one ohm must remain constant, the area must be increased five-fold. See Figure 2.25. That is, for a fixed chip size, the conduction losses increase as the breakdown voltage is increased.

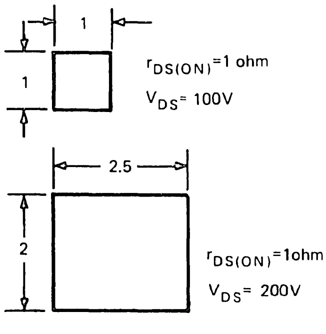


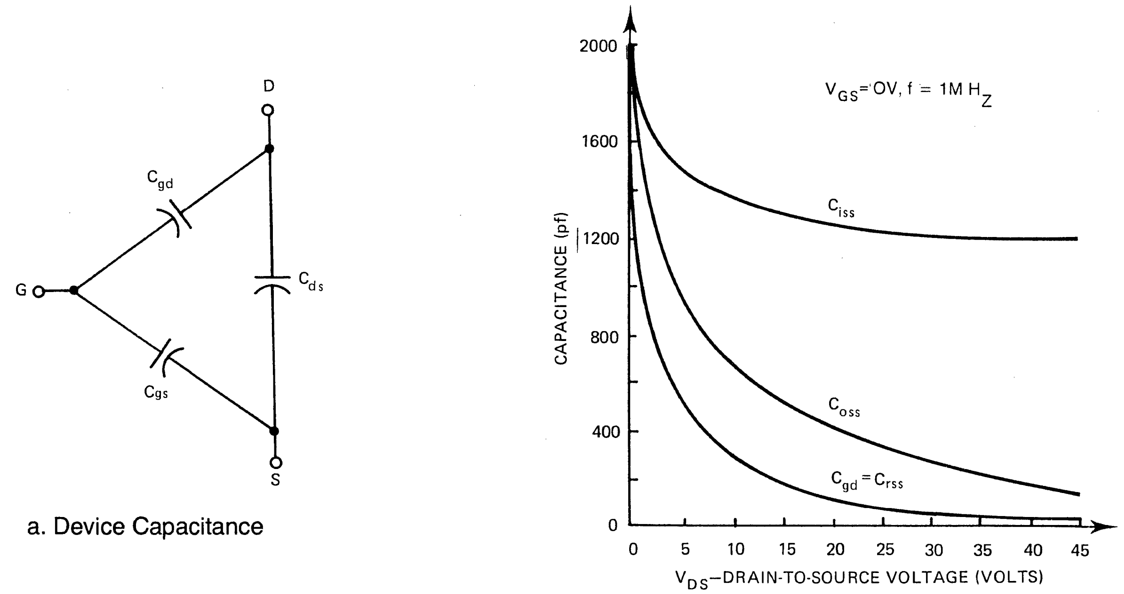
FIGURE 2.25. 100 VOLT CHIP SIZE vs 200 VOLT CHIP SIZE WITH CONSTANT $R_{DS(ON)}$

2.4.6 INPUT AND OUTPUT CAPACITANCE

Capacitances of the MOSFET vary with voltage. The gate structure has capacitance to the source (C_{gs}) and to the drain (C_{dg}). The inherent reverse biased PN junction adds capacitance between the drain and source (C_{ds}). This is illustrated in Figure 2.26.

The data sheet specifies C_{iss}, C_{oss}, and C_{rss}. The relationship to C_{gs}, C_{ds}, and C_{gd} are defined below.

$$C_{iss} = C_{gd}\ \mathrm{II}C_{gs}$$
$$C_{oss} = C_{ds}\ \mathrm{II}C_{gd}$$
$$C_{rss} = C_{gd}$$



a. Device Capacitance

b. Typical Data Sheet Values of Capacitance

FIGURE 2.26. TYPICAL CAPACITANCE VS. DRAIN-TO-SOURCE VOLTAGE

2.4.7 GATE CHARGE

The gate input capacitance is a nonlinear function of drain to source voltage. Therefore, switching time and drive power calculations are based on the average input capacitance. Precise values are obtained from the gate charge as a function of V_{GS}. If the gate is driven from a current source and the current is integrated, the charge in the gate is obtained (see Figure 2.27).

If gate capacitance is examined as a function of gate voltage, there are three areas with distinctly different capacitances (see Figure 2.28). Between t_0 and t_1, the device is practically off and the linearity of the slope indicates constant capacitance. At time t_1, the drain-to-source voltage (V_{DS}) begins to decrease until time t_2. The slope of V_{DS} changes dramatically indicating a large increase in capacitance, a result of the Miller effect. At time t_3, the device is on. Between t_2 and t_3, the slope of V_{GS} changes, due to the increase in C_{gs} as V_{DS} decreases. The energy to turn the device on is:

$$W = ½ \bullet V_{GS}\, Q_G \text{ (Watt-Sec)}$$

The power consumed is

$$P = Q_G \bullet V_{GS} \bullet f$$

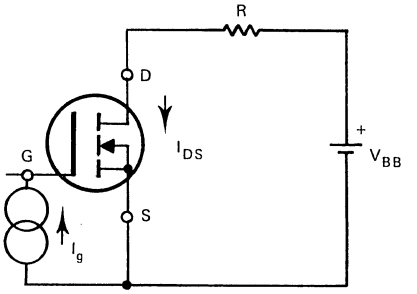


FIGURE 2.27. CIRCUIT FOR GATE CHARGE MEASUREMENTS

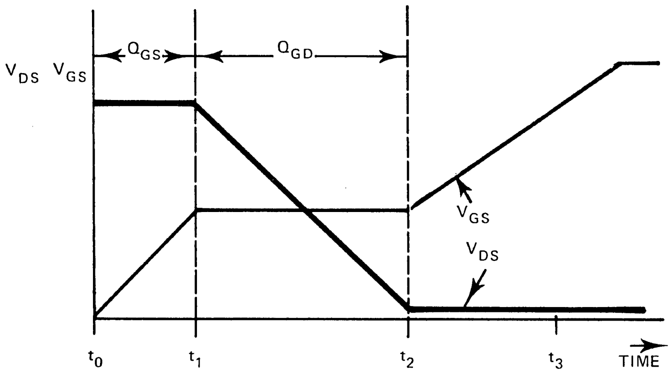


FIGURE 2.28. DYNAMIC GATE CHARACTERISTICS

2.4.8 SWITCHING CHARACTERISTICS

The MOSFET inherently has very fast switching speeds. Switching speed is primarily limited to the time it takes to charge the gate input capacitance (C_{iss}). If it were possible to charge the gate instantaneously, the switching time would consist only of the time it takes for the carriers to travel from source to drain (typically pico-seconds).

In addition to the pulse source impedance and input capacitance, other limiting factors at high switching speeds are parasitic inductances in the wiring and connections to the package. Switching times for a MOSFET device change very little as a function of temperature. A simple test circuit (Figure 2.29) can be used to evaluate switching times. It consists of a pulse generator with known rise and fall times and known source impedance.

In most cases, switching speeds will be limited by the pulse generator source impedance, peak current capability, and the parasitic inductances of the external package connections. Even the shortest connection will make an undesirable contribution to switching time. The delay at turn-on is due to the time required for the gate voltage to rise from zero volts to $V_{gs(th)}$. Once $V_{gs(th)}$ is exceeded, the device will begin to conduct current. The delay at turn-off is due to the over-drive of the gate to maintain minimum $r_{DS(ON)}$ (i.e., ON-voltage) while the device is conducting. V_{GS} must decrease significantly before $r_{DS(ON)}$ or V_{DS} begins to rise. Switching waveforms of the input voltage and the output voltage are shown in Figure 2.30. Note that these are idealized waveforms and actual waveforms may be rounded or will have overshoot.

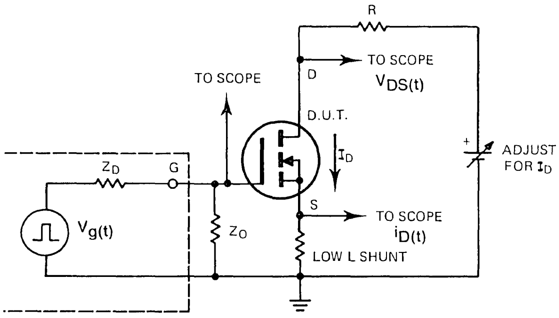


FIGURE 2.29. SWITCHING TIME TEST CIRCUIT

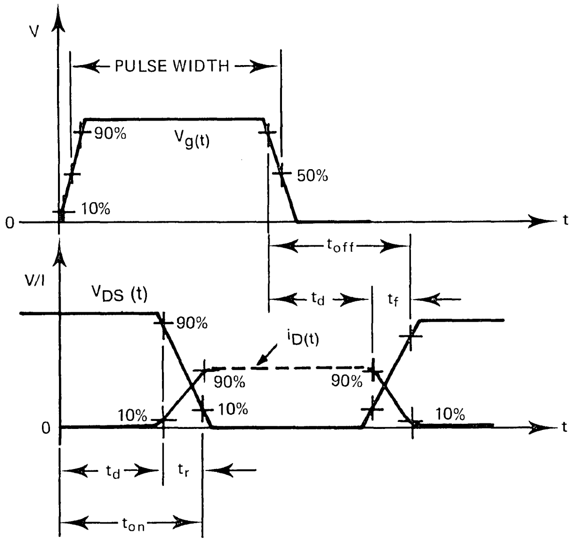


FIGURE 2.30. SWITCHING WAVEFORMS OF INPUT AND OUTPUT VOLTAGE

2.4.9 RATED CONTINUOUS CURRENT AND PEAK CURRENT

The rated drain current (I_D) is the maximum dc current a device can conduct without derating.

I_{DM} — the rated pulsed drain current — is the maximum value of peak current the device can conduct at a specified pulse width without derating. It is a function of pulse width, duty cycle, junction temperature, and repetition rate. The maximum peak current may be limited by the diameter of the bonding wire, the mounting pad area, or by the pellet surface metallization.

In a bipolar transistor, the rapidly decreasing h_{FE} at high currents generally discourages operation in excess of peak current ratings. In a MOSFET, the gain is not significantly reduced at high currents, but $r_{DS(ON)}$ may increase if the gate-to-source voltage is not sufficiently high.

2.4.10 RUGGEDNESS

The ruggedness issue associated with Power MOSFETs is a result of the presence of a parasitic bipolar transistor intrinsic in the structure of a vertical DMOS processed device. Figure 2.31 shows the equivalent circuit of this parasitic element. This transistor has its base-emitter junction shorted by the source metallization, but the effectiveness of the short is dependent on design and process control. If carriers generated by high electric fields in the drain region are allowed to cross the base region into the emitter region to cause bipolar transistor action, the characteristic V_{CER} breakdown shown in Figure 2.32 is observed. The locus of this breakdown is very much lower in voltage than the V_{CBO} (BV_{DSS}) characteristic which would be observed if the transistor were completely suppressed. Additionally, this locus shows a negative resistance characteristic as bipolar transistor gain increases with increasing current. If the transistor is allowed to become active, the classic failure mechanism of the second breakdown can occur, with current hogging taking place on both a macroscopic (amongst cells) and microscopic (within cells) level. This causes local heating, thereby increasing bipolar gain, further constricting current and eventually leading to failure.

The equivalent circuit of an NPN bipolar transistor in parallel with a MOSFET serves to explain the ruggedness phenomenon from a circuit standpoint. The effectiveness of the base shorting resistor in preventing transistor action determines the activity of the transistor when stressed by high voltages, or by high displacement currents through the depletion region capacitance.

The transistor can be stressed in any or all of three ways. 1) High dv/dt impressed on the equivalent collector can cause large displacement currents through the equivalent base shorting resistor which can cause the transistor to turn on with predictable disastrous results if circuit conditions allow. 2) If the equivalent diode (transistor collector-base junction) is caused to conduct in the forward direction, minority carriers left in the equivalent base region during diode recovery can cause transistor action, again with destructive results if external circuit conditions allow. 3) Finally, minority carriers crossing the base-emitter junction, generated as a result of avalanche conditions in the drain region, can initiate transistor action, again resulting in failure of the device given sufficient external circuit energy.

Effective suppression of the parasitic bipolar transistor by design and strict process control is essential to producing Power MOSFETs with the capability of operating under adverse stress conditions.

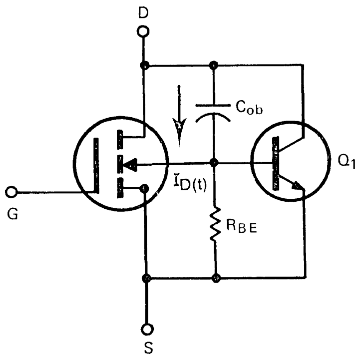
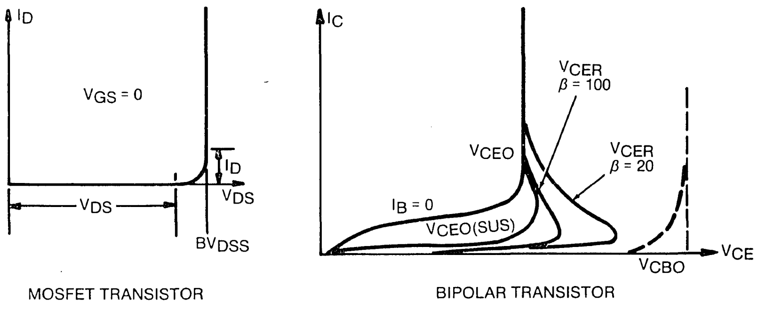


FIGURE 2.31. PARASITIC BIPOLAR CONTAINED IN MOSFET STRUCTURE



MOSFET TRANSISTOR

BIPOLAR TRANSISTOR

FIGURE 2.32. MOSFET/TRANSISTOR BREAKDOWN

While the stress condition caused by avalanche breakdown is to be avoided on a repetitive basis, this stress can be realized even in properly designed circuits when fault conditions arise. The Unclamped Inductive Switching (UIS) test, performed using the circuit shown in Figures 2.33A and 2.33B, which stresses devices in the avalanche mode, has been instituted as a process control in the GE Power MOSFET product line. The UIS test is an easily performed and repeatable test, and devices shown to be rugged in avalanche breakdown also exhibit excellent characteristics in dv/dt and diode recovery ruggedness. The converse, however, is not necessarily true — Power MOSFETs showing good diode performance do not necessarily perform well in dv/dt capability or UIS.

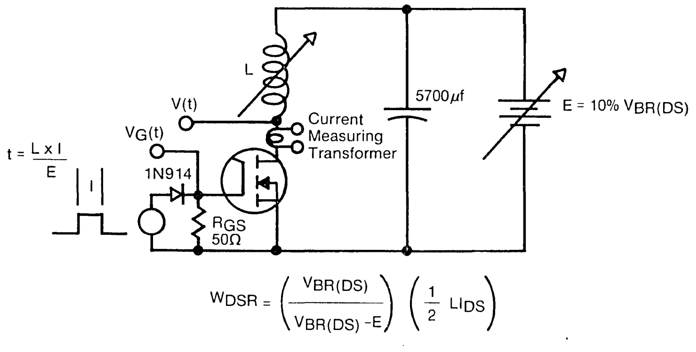


FIGURE 2.33A AVALANCHE ENERGY TEST CIRCUIT

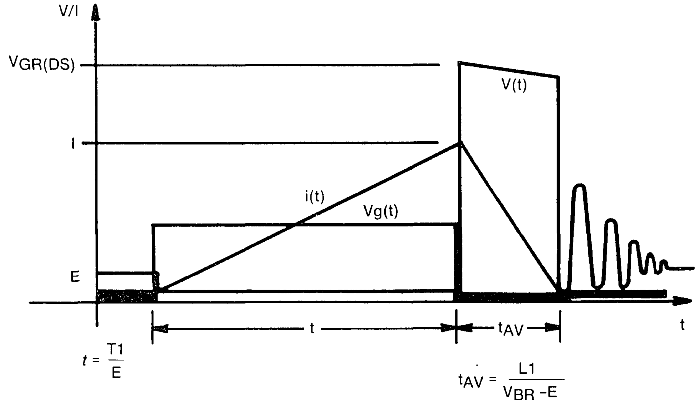


FIGURE 2.33B AVALANCHE ENERGY TEST WAVEFORMS

2.4.11 THE PARASITIC DIODE

It has been shown in the previous discussion on ruggedness that the base-to-emitter junction of the parasitic NPN transistor is practically a short circuit. Therefore, Figure 2.34 becomes the new equivalent circuit, that is, a MOSFET in parallel with a diode.

If the drain-to-source is reverse biased, the diode will conduct. The forward current and reverse voltage ratings of the diode are the same as the current and voltage ratings of the MOSFET. It may be used in inductive circuits as a free-wheeling diode or as a clamp.

The internal diode is characterized for forward voltage drop and reverse recovery parameters like a discrete diode.

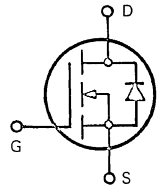


FIGURE 2.34. MOSFET WITH INTERNAL DIODE

2.4.12 FORWARD BIAS SAFE OPERATING AREA (FBSOA)

To achieve reliable operation for a power semiconductor, the FBSOA of the device must not be exceeded. Data provided for this curve is at a case temperature of 25° C or at a specified junction temperature. This is shown in Figure 2.35. The limits of the FBSOA curve are established by peak current, power dissipation at $T_{J(MAX)}$ and breakdown voltage.

2.4.13 SWITCHING SAFE OPERATING AREA

GE MOSFETs are rugged devices. The area that the load line can safely traverse is rectangular, limited by the rated drain current (I_{DM}), drain-to-source voltage (V_{DSS}), and maximum permissible power dissipation within the device.

The Switching Safe Operating Area, illustrated in Figure 2.36, is applicable to both turn-on and turn-off.

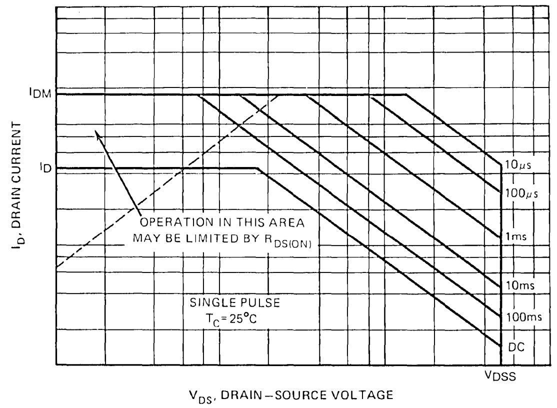


FIGURE 2.35. MAXIMUM SAFE OPERATING AREA

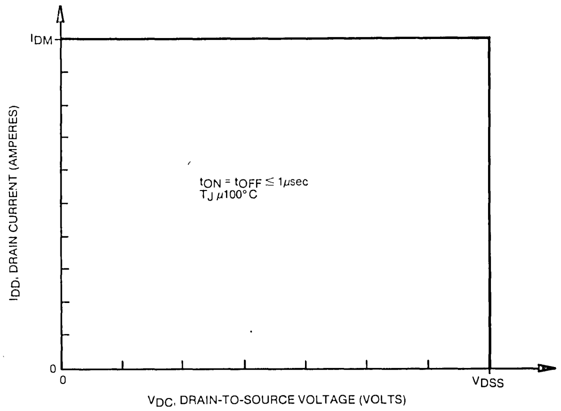


FIGURE 2.36 MAXIMUM RATED CLAMPED SAFE OPERATING AREA

2.4.14 HANDLING CONSIDERATIONS

MOS integrated circuits are extremely sensitive to electrostatic discharge (ESD) or any other voltage transient with sufficient energy content to break down the gate dielectric and do permanent damage.

Power MOSFET and IGT™ transistor input capacitances are much higher than MOS IC's (many thousands of cells in parallel), therefore more energy is required to charge the capacitance. This makes the device somewhat less sensitive than integrated circuits. However, proper precautions must be taken in handling, packaging, and installation of devices.

There is always the threat of a latent ESD failure! A latent failure can be defined as a time-dependent malfunction that occurs under use conditions as a result of earlier exposure to electrostatic discharge that did not result in an immediately detectable problem.

When devices arrive at their destination, it is recommended that they be left in the antistatic package until used. They should be stored in conductive containers and only unpackaged on a static safe work station by persons familiar with the ESD problem. Operator recommendations include use of: (1) static wrist straps, (2) static controlled floor mats, (3) static controlled work surfaces, and (4) grounded soldering tips. All ground connections should contain a 1 Megohm safety resistor-to-ground to protect personnel. Devices should not be picked up by their terminals, and when inserted into electrical test equipment, voltages should only be applied after all terminals are connected to the electrical circuit.

2.5 INSULATED GATE BIPOLAR TRANSISTORS

The IGT™ transistor is a three terminal device with the voltage controlled input of the MOSFET. The output characteristic of the IGT™ transistor is similar to that of the MOSFET, except that there is an approximate 1.0 volt offset in collector emitter voltage before significant collector current flows. The effective on-resistance in the saturation region is much lower for the IGT™ transistor than the MOSFET. Understanding the IGT™ transistor output characteristic is aided by the equivalent circuits shown in Figure 2.37.

When a gate-to-emitter voltage greater than the threshold voltage [$V_{GE(th)}$] is applied to the device with the collector positive with respect to the emitter, collector current flows. Current gain of the device (I_C / I_G) is extremely high and is typically greater than 10^9, since the gate current consists only of current required to charge the effective input capacitance of the device and some small leakage through the gate oxide.

Since collector current is a function of gate-to-emitter voltage, it is more appropriate to specify transconductance ($\Delta I_C / \Delta V_{GE}$) when using IGT™ transistors.

Figure 2.38 illustrates the common emitter voltage-current relationships of n and p-channel IGT™ transistors. Note that the definition of the linear and saturation regions is the same as the bipolar case.

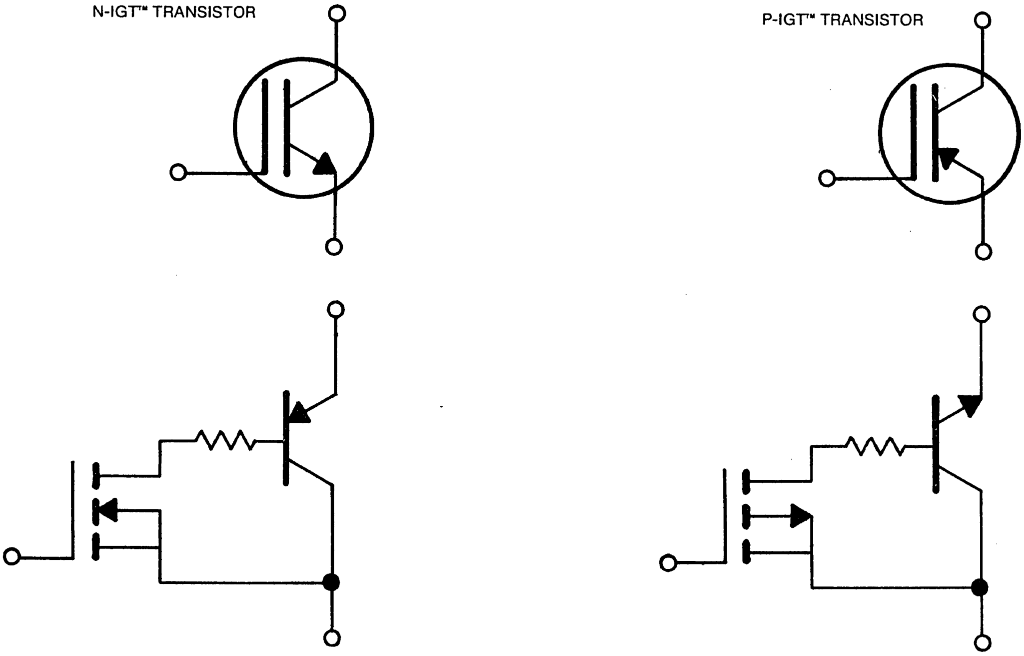


FIGURE 2.37 IGT™ TRANSISTOR EQUIVALENT CIRCUITS

2.5.1 IGT™ TRANSISTOR STRUCTURE

The IGT™ transistor is fabricated by starting with a heavily boron doped (P+) substrate and epitaxially growing a high resistivity phosphorous doped (N-type) drift region. See Figure 2.39. The gate and emitter structure is then formed in the epitaxial layer by using a high resolution, N-channel, DMOS process. Since the IGT™ transistor contains a parasitic pnpn thyristor structure, a P+ diffusion has been added to the basic power MOSFET structure in the middle of each cell. This layer reduces the current gain of the upper NPN transistor and prevents latch up of the parasitic thyristor. Without this feature, the IGT™ transistor would latch up at high current levels causing loss of gate control. In the GE IGT™ transistor, the P+ region is introduced without additional processing in order to obtain high yields and minimize wafer processing cost. The use of a separate P-base region allows independent control over the gate turn-on threshold voltage. In these devices, the blocking voltage capability is controlled by the thickness and resistivity of the N-drift region. This region has been optimized to simultaneously keep the forward drop as low as possible.

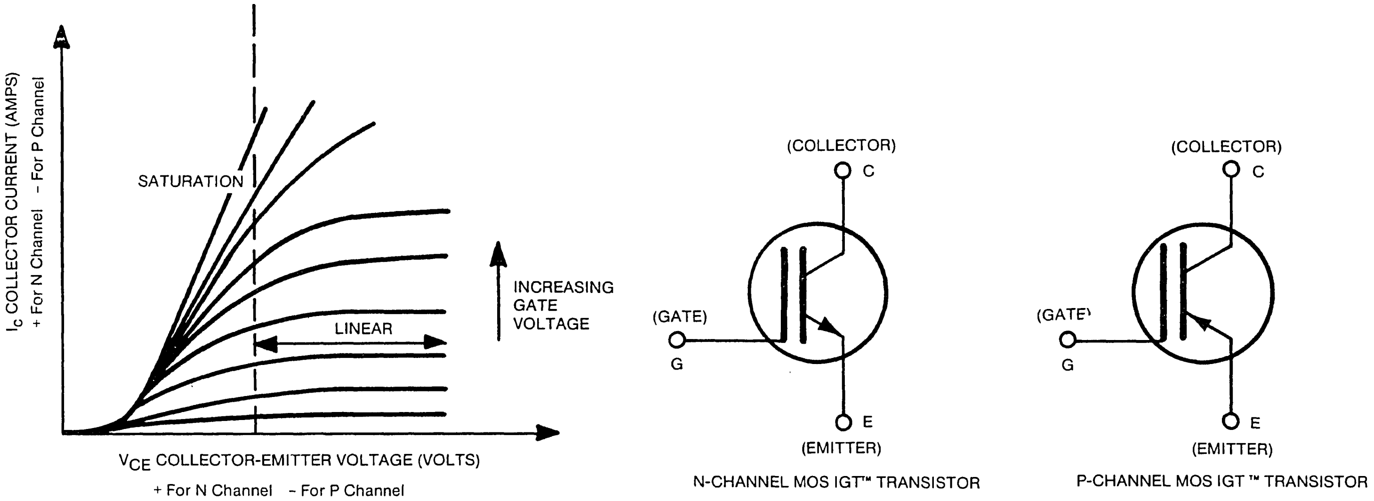


FIGURE 2.38 IGT™ TRANSISTOR SYMBOLS AND OUTPUT CHARACTERISTIC.

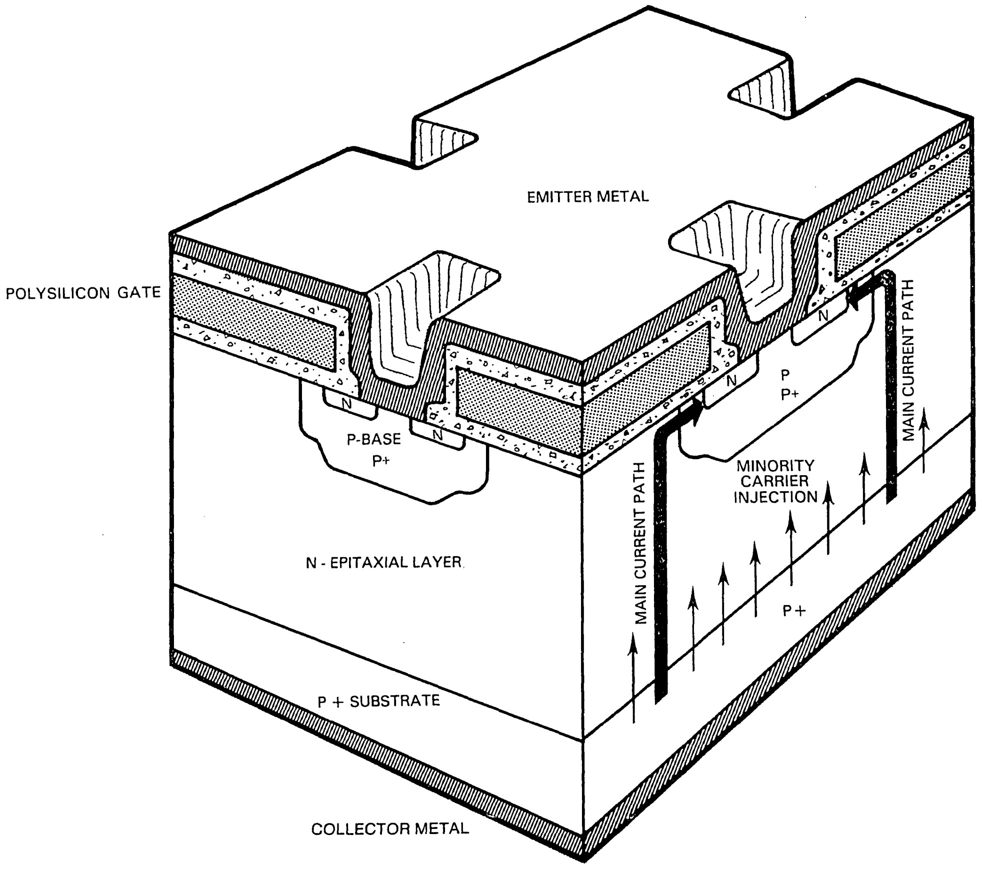


FIGURE 2.39 IGT™ TRANSISTOR STRUCTURE

2.5.2 BLOCKING CHARACTERISTICS

The IGT™ transistor has blocking characteristics similar to the Power MOSFET. That is V_{CER} is the maximum allowable voltage at a specified junction temperature (usually $T_J = 25°C$) that can be applied between the collector and emitter terminals with a specified gate-to-emitter resistance (see Figure 2.40).

The temperature coefficient of V_{CER} shows a strong temperature dependence, increasing as much as 15% between 25°C and +150°C, but decreasing as much as 8% between 25°C and -40°C (see Figure 2.41). The temperature coefficient is approximately 0.12%/°C.

V_{CGR} is the maximum allowable collector-to-gate voltage that can be safely applied at a specified T_J and gate-to-emitter resistor (R_{GE}).

V_{ECR} is the maximum emitter-to-collector voltage that can be applied in the reverse direction at the onset of avalanche at a fixed collector current with the gate-to-emitter resistance specified at a minimum value. Increasing the magnitude of V_{CE} beyond this value will eventually lead to device destruction.

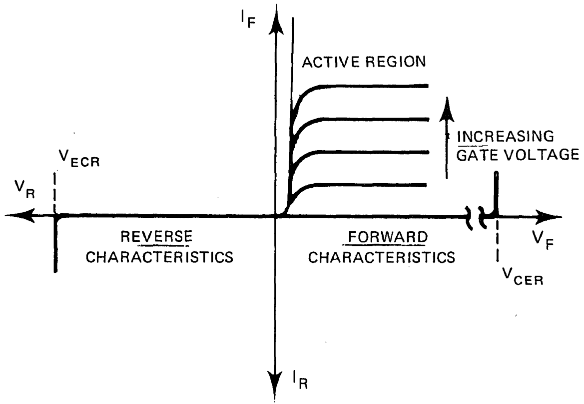


FIGURE 2.40 COLLECTOR CHARACTERISTICS

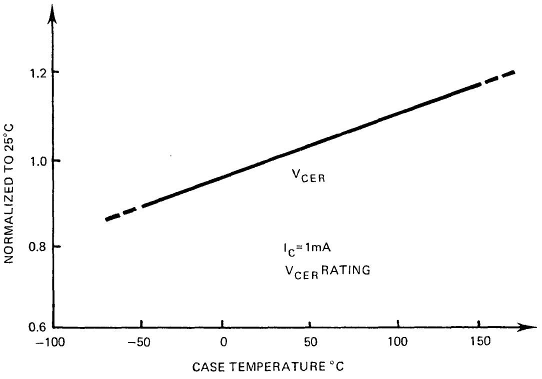


FIGURE 2.41 NORMALIZED COLLECTOR-EMITTER BREAKDOWN VOLTAGE VARIATION WITH TEMPERATURE

Although the IGT™ transistor inherently provides reverse blocking, special junction passivation techniques are required to provide low leakage. Devices without this extra processing are not characterized for reverse blocking.

2.5.3 GATE-TO-EMITTER THRESHOLD VOLTAGE

If the gate-to-emitter voltage is increased from zero volts, the collector current does not increase significantly until the gate-to-emitter threshold voltage (2-5V) has been exceeded. Gate-to-emitter threshold voltage is specified at different current levels, depending on device current rating. Gate-to-emitter threshold voltage changes with temperature. The temperature effect is shown in Figure 2.42 and $V_{GS(th)}$ has a coefficient of -6 mV/°C.

2.5.4 TRANSCONDUCTANCE (g_{fs})

Transconductance is defined as the ratio of change of collector-to-emitter current brought about by a change in gate voltage. That is:

$$g_{fs} = \frac{\Delta I_{CE}}{\Delta V_{GE}} \qquad V_{CE} = \text{constant}$$

Transconductance is temperature dependent, and the effect can best be seen in Figure 2.43. The temperature coefficient of g_{fs} is approximately -0.3%/°C.

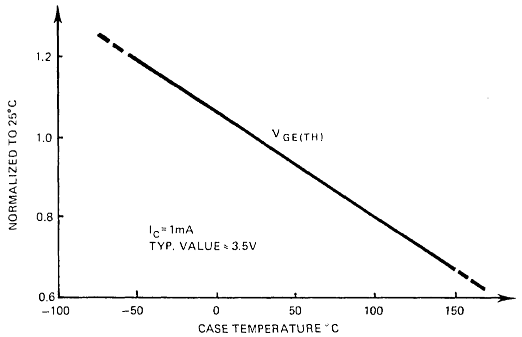


FIGURE 2.42. NORMALIZED GATE-TO-EMITTER THRESHOLD VOLTAGE VARIATION WITH TEMPERATURE

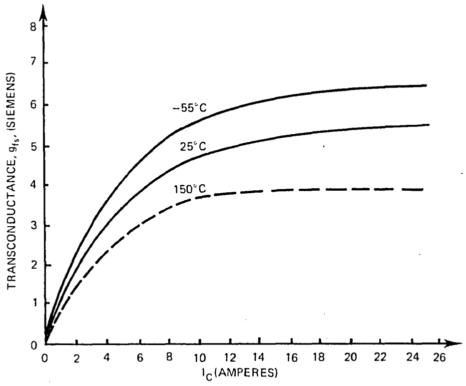


FIGURE 2.43. NORMALIZED TRANSCONDUCTANCE VS. COLLECTOR CURRENT.

2.5.5 ON-STATE VOLTAGE [$V_{CE(SAT)}$]

The on-state voltage characteristics of the IGT™ transistor are similar to a bipolar transistor. That is, $V_{CE(SAT)}$ decreases with increasing gate-to-emitter voltage and has a temperature coefficient that varies as a function of collector current. This is shown in Figure 2.44 for a 10 amp device. It is observed that for collector currents from 0.5 Amps to 7 Amps the temperature coefficient of voltage [$\Delta V_{CE(SAT)}$] varies from -0.5 mV/°C to a zero temperature coefficient at 7 Amps. For currents greater than 7 Amps, the temperature coefficient is positive. At 9 Amps, the temperature coefficient is approximately +0.75 mV/°C.

2.5.6 GATE-TO-EMITTER DRIVE

The input characteristics of the IGT™ transistor are similar to a Power MOSFET. That is, it has a gate-to-emitter threshold voltage and a capacitive input impedance. In order to turn the device "on," the input capacitance must be charged up to a value greater than $V_{GE(th)}$ before collector current can begin to flow. Typical $V_{GE(th)}$ is shown as a function of temperature in Figure 2.45.

In order to turn the IGT™ off, a resistor connected between gate and emitter is all that is required. This resistor provides a path for the gate-to-emitter input capacitance to discharge. It must be emphasized that R_{GE} has a lower limit that cannot be reduced, and the value is indicated on individual device data sheets. The IGT™ transistor has a maximum controllable collector current that is dependent on the gate-to-emitter dv/dt. That is, the higher the gate-to-emitter turn-off dv/dt, the lower the controllable collector current.

2.5.7 SWITCHING PROPERTIES

The IGT™ transistor is designed such that the turn-on and turn-off times of the device can be controlled by the gate-to-emitter source impedance. Its equivalent input capacitance is lower than a Power MOSFET with a comparable current and voltage rating. The device is turned on by applying a positive voltage between the gate and emitter terminals. When V_{GE} is greater than $V_{GE(th)}$, collector current flows. In switching applications where $V_{GE} >> V_{GE(th)}$, the device saturates.

The IGT™ transistor is similar to a Power MOSFET during turn-on and similar to Power Bipolars during turn-off. However, during turn-off, it exhibits a fall time that consists of two distinct time intervals — designated hereafter as t_{f1} and t_{f2}. Typical switching waveforms for a resistive load are shown in Figure 2.46 using two types of IGT™ transistors. The two time intervals are very distinct for the slow device. The turn-off delay is caused by the discharge time constant of the effective gate-to-emitter capacitance and R_{GE}.

The IGT™ transistor has a positive temperature coefficient associated with its fall time. It is approximately 0.27%/°C. The rise time of the IGT™ transistor is relatively constant over temperature and is similar to a Power MOSFET.

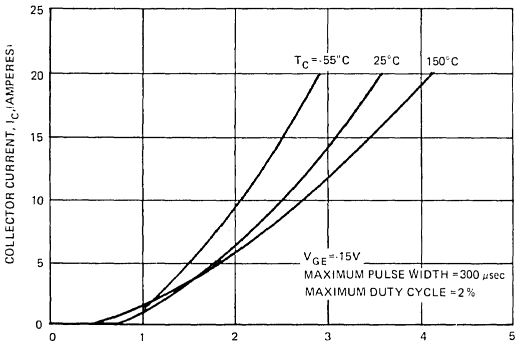


FIGURE 2.44. TYPICAL $V_{CE(SAT)}$ VS. I_{CE} AND T_J FOR A 10 AMP DEVICE

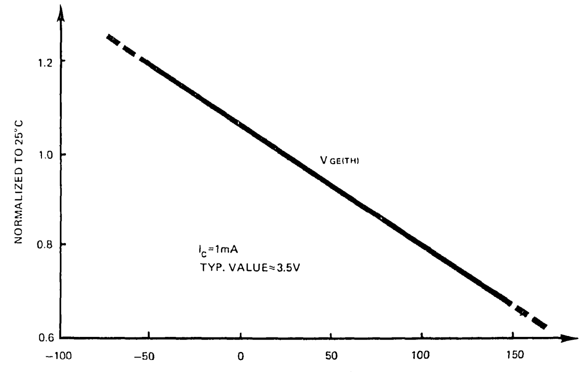
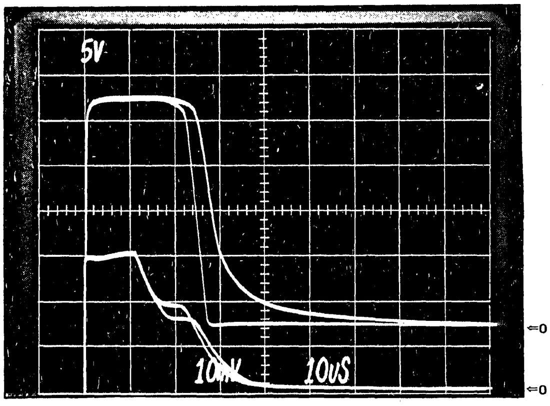


FIGURE 2.45. NORMALIZED $V_{GE(th)}$ VS. TEMPERATURE

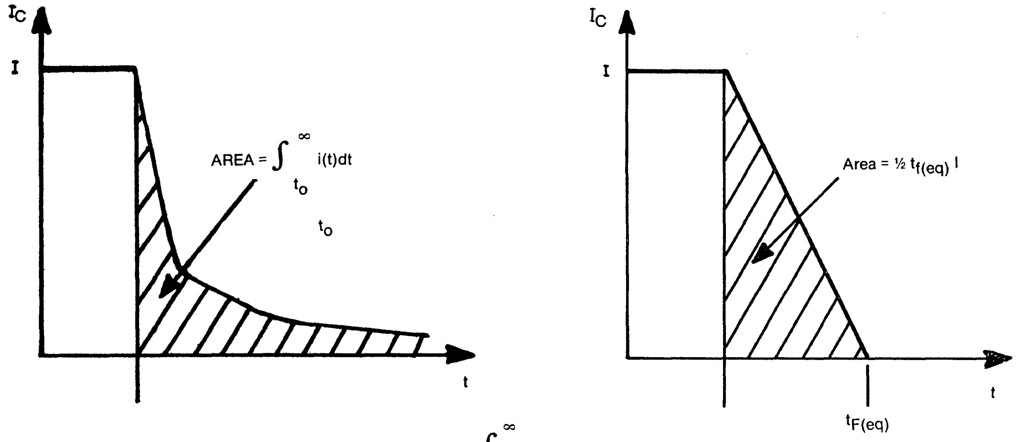


TOP (I_C) VERT= 2A/cm BOTTOM (V_{GE}) VERT= 5V/cm

FIGURE 2.46. RESISTIVE LOAD SWITCHING

2.5.8 EQUIVALENT FALL TIME

The two distinct fall time intervals make it difficult to estimate power loss given the traditional 10-90% fall time. The equivalent fall time, $t_{f(eq)}$, is the calculated linear fall time that yields the same area under the current curve as the actual turn-off curve, see Figure 2.47. For inductive switching, turn-off losses can be estimated using $\frac{1}{2} V_{CE} I_C f\, t_{f(eq)}$).



$$1/2\, t_F = \int_{t_o}^{\infty} i(t)dt$$

$$\boxed{t_F = \frac{2}{I} \int_{t_o}^{\infty} i(t)dt}$$

FIGURE 2.47. EQUIVALENT FALL TIME

2.5.9 CONTROLLING CURRENT FALL TIME

The current fall time of the IGT™ transistor can be controlled by use of external circuitry. t_{f1} is directly controlled by the value of R_{GE} (Figure 2.48). This dependence is shown in Figures 2.49 and 2.50. t_{f2} is not controllable and is an inherent characteristic of the type of IGT™ transistor that is selected. The control feature of t_{f1} by a resistor (R_{GE}) can be an advantage. For example, in case of an inductive load, the fall time can be slowed to the extent that snubberless operation is possible. Figures 2.49 and 2.50 are idealized representations of the two phases of the device turn-off. That is, a slow device can be used for dc and low frequency applications with minimal gate turn-off current or a fast device can be used with a nearly linear turn-off characteristic. [Figure 2.50]. For higher frequency operation, a fast device with R_{GE} = 1 p.u. will minimize switching losses due to t_{f1} and t_{f2} per Figure 2.50.

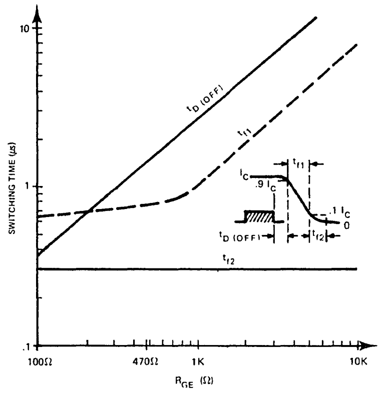


FIGURE 2.48. SWITCHING TIME VS. R_{GE}

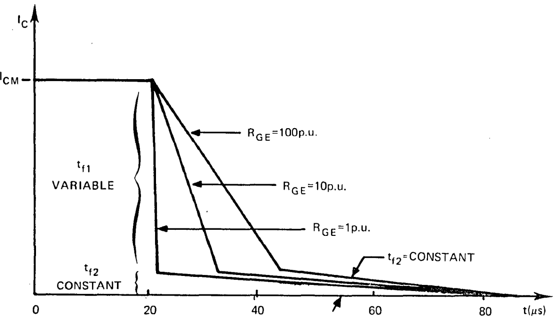


FIGURE 2.49. FALL TIME CONTROL FOR A SLOW DEVICE

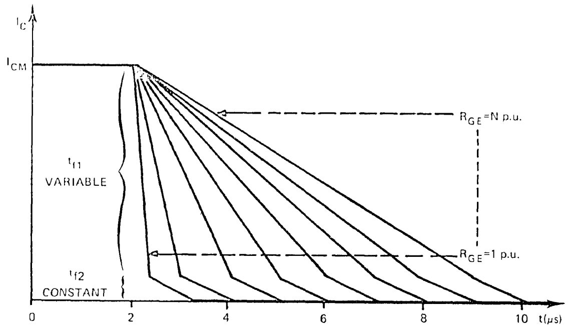


FIGURE 2.50. FALL TIME CONTROL FOR A FAST DEVICE

2.5.10 FORWARD BIAS SAFE OPERATING AREA (FBSOA)

A typical Forward Biased Safe Operating Area curve is shown in Figure 2.51. The IGT™ transistor can conduct peak currents beyond the controllable current limit of the device. The device is derated linearly due to thermal limitations and has a peak pulse current rating limited by power dissipation and wire bond capability. There is no second breakdown current derating for the IGT™ transistor.

2.5.11 TURN-OFF SAFE OPERATING AREA

The IGT™ transistor does not require a negative turn-off bias for high speed switching. The current fall time is determined by the value of R_{GE}. Therefore, the devices have been characterized as a function of R_{GE} for a resistive, as well as an inductive load. A typical clamped SOA for an inductive load is shown in Figure 2.52. The area that the turn-off load line can safely traverse is rectangular-limited by the collector current, collector-emitter voltage (V_{CE}), and maximum permissible power dissipation within the device.

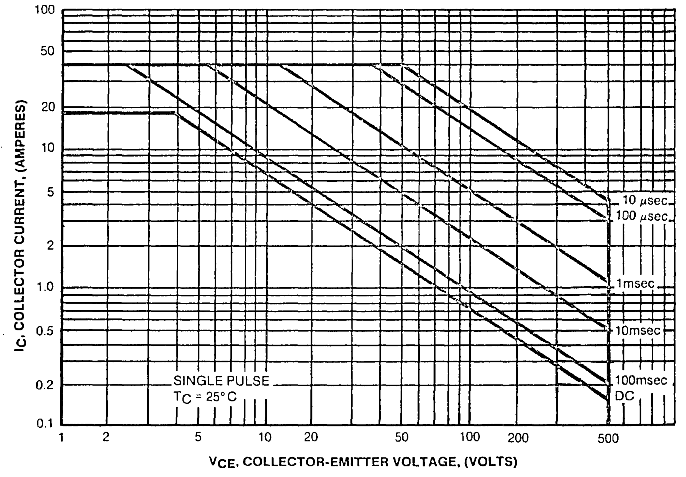


FIGURE 2.51. FORWARD BIAS SAFE OPERATING AREA AND TURN-ON

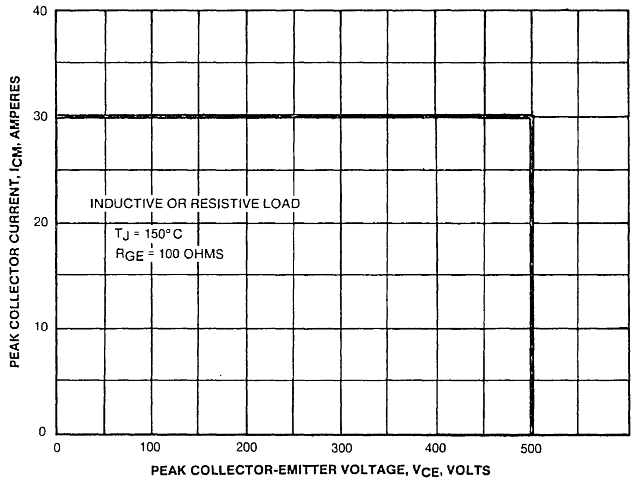


FIGURE 2.52. TURN-OFF SAFE OPERATING AREA

2.5.12 HANDLING CONSIDERATIONS

MOS integrated circuits are extremely sensitive to electrostatic discharge (ESD) or any other voltage transient with sufficient energy content to break down the gate dielectric and do permanent damage.

Power MOSFET and IGT™ transistor input capacitances are much higher than MOS IC's (many thousands of cells in parallel), therefore more energy is required to charge the capacitance. This makes the device somewhat less sensitive than integrated circuits. However, proper precautions must be taken in handling, packaging, and installation of devices.

There is always the threat of a latent ESD failure! A latent failure can be defined as a time-dependent malfunction that occurs under use conditions as a result of earlier exposure to electrostatic discharge that did not result in an immediately detectable problem.

When devices arrive at their destination, it is recommended that they be left in the antistatic package until used. They should be stored in conductive containers and only unpackaged on a static safe work station by persons familiar with the ESD problem. Operator recommendations include use of: (1) static wrist straps, (2) static controlled floor mats, (3) static controlled work surfaces, and (4) grounded soldering tips. All ground connections should contain a 1 Megohm safety resistor-to-ground to protect personnel. Devices should not be picked up by their terminals, and when inserted into electrical test equipment, voltages should only be applied after all terminals are connected to the electrical circuit.

CHAPTER 3
QUALITY AND RELIABILITY OF TRANSISTORS

The increased need for electronic component quality and reliability has zoomed dramatically in recent years. One of the primary reasons for this sudden change has been the rapid growth of complex industrial and consumer electronic systems that require the use of large numbers of devices per system. This requires the defective levels of incoming components be extremely low in order to successfully manufacture these systems at minimum costs. This has resulted in the recent trend to measure component defective levels in Parts Per Million (PPM) instead of the previous parts per hundred or percent. This quality measurement is 10,000 times more sensitive than the previous measurement.

In addition, these systems are required to perform satisfactorily over long periods of time such as for 10 to 20 years. This means that accelerated reliability assessment techniques must be used to develop models for predicting long life performance of these components. The accelerated component assessment must be made long before the devices can be evaluated under application conditions. This is needed since testing at use conditions would require stressing a large number of devices for years in order to prove that devices were reliable. In the meantime, the devices and the systems would be obsolete. Accelerated testing techniques are also needed to give a rapid evaluation of component product designs and design improvements to minimize costs.

A new method of predicting the reliability or product life of semiconductors under field conditions is described. This includes the use of accelerated test results to obtain the quantitative multipliers for derating semiconductor junction temperature, voltage and measurement conditions. The failure rate based on these multipliers is used with the negative exponential distribution to predict the probability of survival (P_S) or reliability. The expression one minus P_S gives the probability of failure. The result of this method was confirmed with the accelerated testing of over 5,000 diodes and three years of field operation of over 770,000 diodes[1].

The purpose of this chapter is to discuss some of the latest techniques used in the manufacture and assessment of semiconductors to meet the new quality and reliability requirements. Results from the accelerated testing of our signal and power bipolar transistors, Power-MOS transistors and our Insulated Gate Transistors (IGT's) will be discussed.

3.1 QUALITY

Product quality can be defined as a result of the successful development, design, manufacture and shipment of a product that meets customer expectations. It is recognized that this cycle from concept to customer acceptance can only be accomplished with quality conscious personnel who are trained, motivated and dedicated to excellence. To aid in achieving this product quality, a world class Computer Aided Manufacturing (CAM) facility was developed and is operating in Syracuse, New York. This incorporates the latest in cleanroom technology, automated process equipment and state-of-the-art integrated circuit processing environments to give consistent quality and reliability in our products.

This Computer Aided Manufacturing (CAM) is supported by the latest Computer Aided Design (CAD) techniques which includes device and package simulation. This system has taken years off the product development cycle which enables us to tighten design specifications and produce higher quality products.

Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) are enhanced with a wide range of quality and reliability assurance activities. The latest quality assurance techniques are being implemented on a worldwide basis. For example, manufacturing personnel are being trained in the use of statistical process control. Control charts are being used at critical manufacturing steps.

These control charts are used to graphically display the results of process measurements and identify variations that are due to assignable causes. Corrective actions are taken to remove the assignable causes. The results from these charts show when the assignable cause variations are removed and the measurement data variations return to random or chance variation. This assures that the product is made under a uniform manufacturing process which is necessary to meet the low outgoing defective levels in Parts Per Million (PPM).

The outgoing inspection gate is used to assure that only lots of devices that pass the inspection criteria are shipped to customers. A random sample from each lot is submitted to inspection. The inspection criteria includes a section for electrical parameters and another section on visual/mechanical parameters. If the sample passes inspection, the lot is accepted for shipment. If the sample fails, the lot is returned for 100% screening to remove the defectives. A defective is defined as any device that does not conform to a specification in some respect. The rescreened lot is again submitted to outgoing inspection. The defective level in the accepted lots is summarized monthly and included in the *GE Quarterly Quality Report.*

A worldwide quality organization is set up to meet the requirements of MIL Q 9858A for the signal and power products on the MIL-S-19500 Qualified Products List (QPL). The quality system and product lines on the QPL are audited periodically by the Defense Electronics Supply Center, Dayton, Ohio to assure compliance to MIL-S-19500. In addition, regular contributions are being made to IEC Technical Committee TC47-Semiconductors, for the new International Electrotechnical Commission Quality System (IECQ) on Semiconductors.

The quality System used to manufacture these devices includes documented procedures that are described under the concept of "Total Quality Control".

3.2 RELIABILITY

In order to demonstrate the reliable performance of transistors, a number reliability evaluation stress programs have been conducted. These programs were designed to evaluate and demonstrate device properites such as chip surface stability, sealed junction integrity, thermally matched package materials, and long life stability. The devices used in the testing programs were random samples from several production lots taken from different product lines, and they received no special preconditioning or stress screening. They were submitted to accelerated levels of environmental, thermal, and power stresses which usually exceeded the normal MIL-STD levels. The results of these statistically significant programs have established the capability of the General Electric transistors to operate under the extreme range of environmental conditions required in demanding consumer and industrial applications[2].

This chapter summarizes the results of accelerated testing of transistors, and includes a discussion of reliability prediction. Calculations of expected reliability under normal application conditions are shown. An Arrhenius model of response to stress shows the gain in reliability that can be expected by derating to operating levels below device ratings. This chapter also discusses the probability of survival and failure of a device or system when using a given MTBF and the negative exponential failure distribution.

Evaluating the reliability of discrete semiconductor devices was accelerated a number of years ago with the Minuteman and other government-sponsored reliability improvement programs. This discussion will focus on some important accelerated testing techniques and analytical methods that have been developed and show how they are used to obtain reliability prediction models. These techniques can also be used to determine effective stress screens to remove the early failures, especially for critical and costly applications. These early failures are normally due to random manufacturing defects that usually occur in a small fraction of the device population. These early failures usually cannot be detected with only conventional electrical measurements.

3.2.1 GENERAL APPROACH TO ACCELERATED TESTING

The accelerated tests have been evaluated on a number of reliability improvement programs. The chief advantage of these tests is that they allow one to estimate, in a short period of time, the probability of successful operation of electronic components in long-life systems. The test results are used 1) to evaluate early designs of new products and process changes, 2) to maintain process controls during the manufacture of the devices, and 3) to predict reliability, failure rate, and mean time-to-failure over the useful life of devices in applications.

The usual failure pattern that can be anticipated for electronic components is shown in Figure 3.1. This pattern includes the early failure period followed by the useful life (constant failure rate) period, and finally the wear-out period which has not been established for well designed semiconductors. Failures that occur during the early failure period are usually due to random manufacturing defects. A constant failure rate estimate after the early failure period is quite conservative, since well designed semiconductors under test and in most applications have a slightly decreasing failure rate.

The two types of accelerated tests to be discussed are the step-stress and the constant stress-in-time tests shown in Figure 3.2. The step-stress test is usually used to explore the device capability in the stress domain. A sample size of about 20 is sufficient for this evaluation. The devices are subjected to a stress for 72 to 100 hours, measured, and then subjected to a higher stress level for the same time increment, and then measured. This sequence is continued until about half of the total sample has failed. The stress level reached can be defined as the threshold of stress at which devices fail in a short period of time, such as less than 100 hours. Stress levels below this threshold can be used for the constant stress-in-time tests. The failures generated on these tests are usually valid candidates for failure analysis and failure mechanism studies. The effectiveness of this type of testing can be greatly improved by using control devices which are not stressed, but are measured at each readout point. These readouts provide data for the effective assessment of device response to stress and afford an estimate of the precision of measurements. Furthermore, the control devices are excellent candidates for analysis so that comparisons can be made with failed devices to determine valid failure mechanisms. The step-stress is an excellent method for maintaining process control during the device manufacture and for a quick comparison of new process changes to determine any adverse side effects. The step-stress results are not generally used in determining failure-in-time patterns because of the cumulative effect of the several levels of stress on the device performance. However, failure-in-time patterns can be obtained from the constant stress-in-time tests.

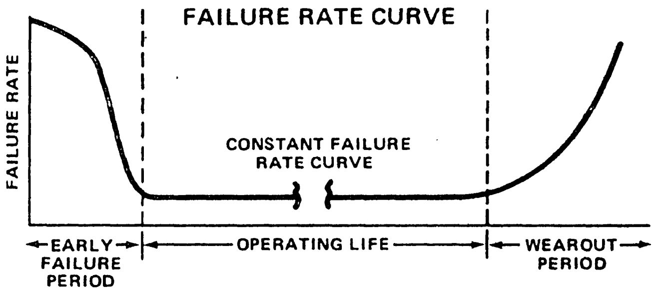


FIGURE 3.1. ELECTRONIC COMPONENT FAILURE PATTERN

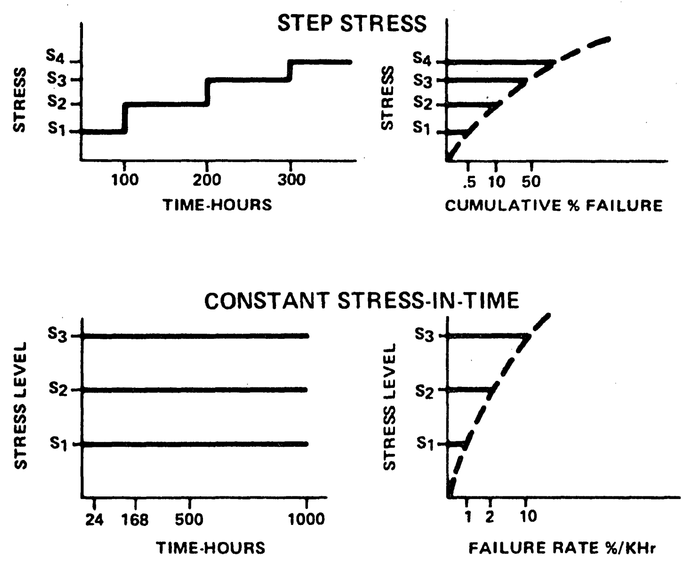


FIGURE 3.2. ACCELERATED TESTING

The objective of the constant stress-in-time tests is to determine the relationship of time, generally at three levels of stress, on the device performance. Sample sizes of from 20 to 100 or more devices are usually used on these tests. Each group of samples is subjected to each of the three levels of stress for a duration of at least 1000 hours. Failure rates of about 0.5% to 10% per 1000 hours are usually obtained during this test. The test results from the three stress levels S_1, S_2 and S_3 can be used to verify the reliability prediction model for the type of devices under test.

The predominant failure mechanisms found in semiconductor devices are related to temperature and often fit the Arrhenius Model of response. The model is generally described by the equation:

$$\lambda = e^{A - B/T}$$

$$= A' e^{-E/(kT)}$$

λ failure rate.
T absolute temperature (°Kelvin).
A, B empirically derived constants from life test data.
A' $\exp(A)$.
k Boltzman's constant, 8.62×10^{-5}eV/K.
E activation energy, empirically derived from: $E \cong -kB$. The slope B is negative.

The activation energy (E) can be obtained from the empirically derived Arrrhenius Model equation. For example, from Figure 3.7.

$$E = -k\,B$$

$$E = -(8.62 \times 10^{-5})\,(-7289) = 0.63\text{eV}$$

The slope (B) can also be obtained graphically from two coordinate points (λ_1, T_1), (λ_2, T_2).

$$B = \frac{\ln \lambda_1 - \ln \lambda_2}{\frac{1}{T_1} - \frac{1}{T_2}}$$

Since measurement readouts are usually made at 0, 24, 168, 500 and 1000 hours during the constant stress-in-time tests, a failure-in-time analysis can be made on a Weibull graph at shown in Figure 3.3. This graph shows whether an increasing, a constant, or a decreasing failure rate is obtained. As seen in the graph of Figure 3.3, a β of less than one was obtained, demonstrating that these devices had a decreasing failure rate.

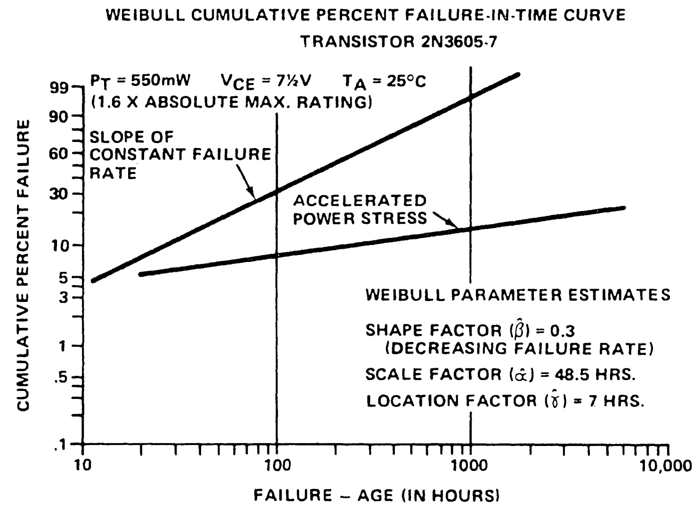


FIGURE 3.3. WEIBULL CUMULATIVE PERCENT FAILURE-IN-TIME

In general the Weibull reliability function has been used effectively in evaluating the reliability of semiconductors[3]. This function can be expressed as:

$$P_s = e^{\frac{-(t-\gamma)^{\beta}}{\alpha}} \quad \text{where}$$

P_s is the probability of survival or reliability:
γ is the location parameter.
α is the scale parameter.
β is the shape parameter which is a measure of the rate of failure.
t is the operating time.

The above parameters are usually determined graphically when specific test results are plotted on a special Weibull graph. The most interesting parameter is beta (β). When beta is greater than one the failure rate increases with time and if it is less than one the failure rate decreases with time. When beta is equal to one the failure rate is constant and the function reduces to the negative exponential case. Also in this case γ is zero since failures can start at time zero. This can be expressed as:

$$P_s = e^{\frac{-t}{\alpha}} = e^{\frac{-t}{MTBF}}$$

Where α is a constant equal to the Mean Time Between Failure (MTBF).

If beta is greater than one this indicates the occurrence of an increasing failure rate. This is usually not desirable from a reliability standpoint; for example, in the operation of an equipment. Also, it indicates that a test or stress is destructive which identifies the need to lower the stress test level or to redesign the component tested.

It is also to be noted that when beta is less than one for a given stress the stress can be used as an effective screen to remove early failures. Once the early failures are removed it is desirable to move into the constant failure rate region where only infrequent random type of failures occur. This was demonstrated on several life tests on the signal diode[4]. Also a constant failure rate normally occurs under derated operating conditions in practical applications. This assures that the negative exponential reliability function can be used with confidence in predicting the device reliability.

3.2.2 RELIABILITY PREDICTION FROM ACCELERATED TESTS TO APPLICATION

The General Electric semiconductor signal diode with a Meta-Bond® construction was chosen as a model for this analysis. This device was selected since it had been evaluated under extensive testing conditions as well as under three years of monitored operation in the field[1]. Acceleration multipliers that quantitatively give the stress relations between different levels of junction temperature, voltage and measurement under accelerated test and application conditions are used. These multipliers enable the prediction of reliability at the application conditions.

- Application Conditions:

Type of Device: Similar to 1N4148
No. of Devices in the System: 770,679
Reverse Voltage: 30 Volts
Peak Current: $I_F = 0.5$ Ampere; 50% Duty Cycle
Ambient Temperature: 55°C
Junction Temperature: Average 70°C
Peak 80°C
Environment: Ground Fixed
Reliability Objective: Zero Functional Failures Per Year

- Accelerated Life Test Results:

Conditions: $T_A = 25°C$, $f = 60$ Hz
$I_O = 225mA$, $V_R = 70V_{PK}$
$t = 1{,}000$ Hours
Failure Criteria: I_R @ 40V = 500nA (Max)
$\Delta V_F > + 15MV$ @ I_F 65mA
LTPD = 3%
Failures/Samples Tested: 1/5,381
Best Estimate Failure Rate: 0.03%/K Hrs.

- Acceleration Multipliers

To determine acceleration multipliers between the accelerated test and application conditions, reference is made to the above operating life test data.[2]

Voltage Multiplier (M_V):

From Figure 7 of GE Publication "Reliability Evaluation and Prediction for Discrete Semiconductors", *IEEE Transactions on Reliability*

t_1 at V_R of 30V and T_J of 65°C = 5000 Hours
t_2 at V_R of 70V and T_J of 65°C = 1220 Hours

$$M_V = \frac{5000}{1220} = 4.098$$

Measurement Multiplier (M_M):

From Figure 8 of GE Publication "Reliability Evaluation and Prediction for Discrete Semiconductors", *IEEE Transactions on Reliability*

I_R at V_R of 40V = 70nA
I_R at V_R of 30V = 45nA

$$M_M = \frac{70}{45} = 1.56$$

Temperature Multiplier (M_T):

From the above life test data there was one specification limit failure; however, there were zero non-functional failures in 5,381,000 device operating hours. This give a best estimate failure rate of 0.013%/KHRS at $T_J = 170°C$. Using this as a starting point and the same slope of the graph in Figure 4 of GE Publication[2] the following is obtained for non-functional failures:

$$\lambda = e^{15.197 - \frac{8656}{TJ+273}}$$

$\therefore \lambda_1 = 0.013\%/KHRS$ at $T_J = 170°C$
$\lambda_2 = 0.000043657\%/KHRS$ at $T_J = 70°C$

$$M_T = \frac{\lambda_1}{\lambda_2} = 297.777$$

The total multiplier (M) is

$$M = M_V \times M_M \times M_T$$
$$M = (4.098)(1.56)(297.777) = 1903.82$$

Failure Rate at Application Conditions:

$$\lambda_3 = \frac{0.013}{1903.82} = 0.000006828\%/KHRS$$

$$MTFB = \frac{1}{\lambda_3} = 1.464477 \times 10^{10} \text{ hours}$$

- Reliability = Probability of Survival (P_S) for the negative exponential reliability function.

$$P_S = e^{-t/MTBF}$$

where t = operating time in hours.

MTBF = Mean Time Between Failure

The Probability of Failure (P_F):

$$P_F = 1 - P_S$$

Results from the above equations:

Period in Year	P_S	P_F
1.5	99.9999103%	0.0000897%
15.0	99.999103%	0.000897%

The expected failures = $(0.897 \times 10^{-6})(770{,}679) = 0.69$ Failures

- Results: This method predicted that there would be 0.69 failures out of 770,679 devices or 0.0000897% failures in an average operating time of 1.5 years. The actual field results showed that there were no failures out of 770,679 devices operating in the field during this period. This demonstrates that the method is quite accurate in predicting the failure rate under application conditions.

- Conclusions:

1. The use of the negative exponential distribution for the probability of survival and one minus this for the probability of failure was very accurate in predicting less than one failure out of 770,000 diodes during a 3-year operating period in the field. No failures actually occurred.

2. Quantitative acceleration multiplying factors for voltage, junction temperature and measurement levels can be used to realistically predict low percent failures in years of operation in applications.

3. The determination and use of these multipliers enables realistic and timely reliability predictions on new products with a minimum accelerated testing time and cost.

4. The Weibull reliability model provides an excellent method of evaluating the effectiveness of a burn-in screen for removing early failures.

5. The use of these analysis techniques will accelerate the successful application of complex electronic systems that use large numbers of semiconductor devices.

The general approach using accelerated testing results to predict the reliability of semiconductors was described in the previous Sections 3.2.1 and 3.2.2. The validity of this prediction technique was demonstrated on an extensive reliability evaluation program on signal diodes. This type of device was chosen since accelerated test results were available as well as three years of field operation data. As seen in the previous section, the prediction technique was very accurate. Therefore, these accelerated testing and analysis techniques were extended to bipolar power transistors and the reliability prediction model is shown in Figure 3.7. These accelerated testing techniques have also been extended to Power-MOSFETs and Power-MOS Insulated Gate Transistors. The results of these tests are shown in the subsequent sections.

3.2.3. PLASTIC ENCAPSULATED POWER TRANSISTORS

GE is a leader in the development and production of power semiconductors. This leadership was first established in metal package type devices and in recent years has extended into the field of plastic encapsulated power devices. The growth of the plastic power transistors is following a similar reliability improvement pattern as that of the signal transistors. Presented are the reliability test results based on thousands of unit hours and cycles of power transistor test data, which demonstrate the structural, thermal and chemical stability of these devices. This information demonstrates the capability of these transistors to operate successfully under the wide range of environmental, electrical and thermal stress levels required in the consumer and industrial applications.

The plastic power packages used with the two types of power transistors are:
— JEDEC TO-202 — 15 watt dissipation,
— JEDEC TO-220 — 60 watt dissipation.

The transistor is shown in Figure 3.4. Both plastic package structures are basically the same and share the following construction features:
— excellent free air power dissipation capability.
— copper heat sink tabs and leads for high heat dissipation and conduction of current in small size packages.

The Power Darlington transistors, model D66DV and D67DE, are shown in Figure 3.5 and 3.6. These devices range from 75 to 150 amperes peak and up to 500 volts. They also feature a single chip design with low thermal resistance and a high isolation voltage. Reliability test results are shown in Figure 3.10.

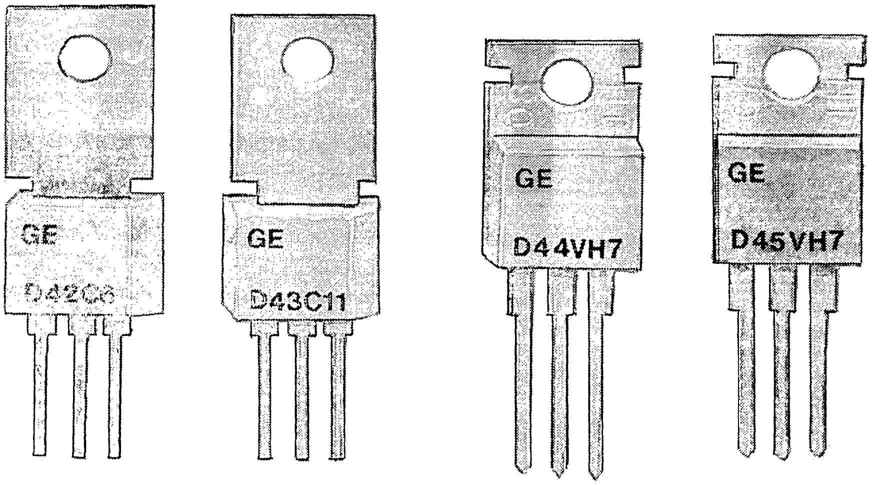


FIGURE 3.4. PLASTIC ENCAPSULATED POWER TRANSISTORS

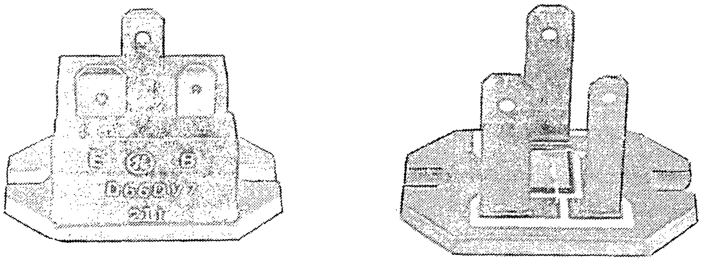


FIGURE 3.5. 75 AMP PEAK POWER DARLINGTON

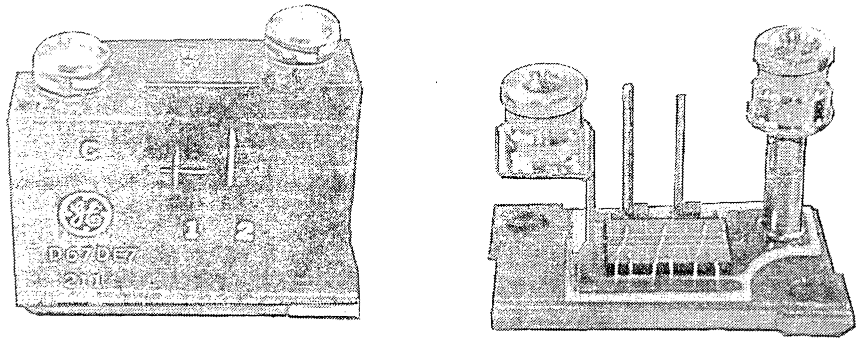


FIGURE 3.6. 150 AMP PEAK POWER DARLINGTON

3.2.3.1 Reliability Prediction of Power Transistors

The predominant failure mechanisms found in plastic encapsulated power transistors during operation are related to temperature and fit the Arrhenius Model of response as shown in Figure 3.7. The model is generally described by the equation:

$$\lambda = e^{A+B/T}$$
$$= A'e^{-E/(kT)}$$

λ failure rate.
T absolute temperature (°Kelvin)
A, B empirically derived constants from life test data.
A' $\exp(A)$.
k Boltzman's constant, 8.62×10^{-5} eV/K.
E activation energy, empirically derived from: $E = -kB$. The slope B is negative.

For example, the Arrhenius Model derived empirically for the power transistors of Figure 3.7 results in:

$$\lambda = e^{15.6 - \frac{7289}{T_J + 273}}$$

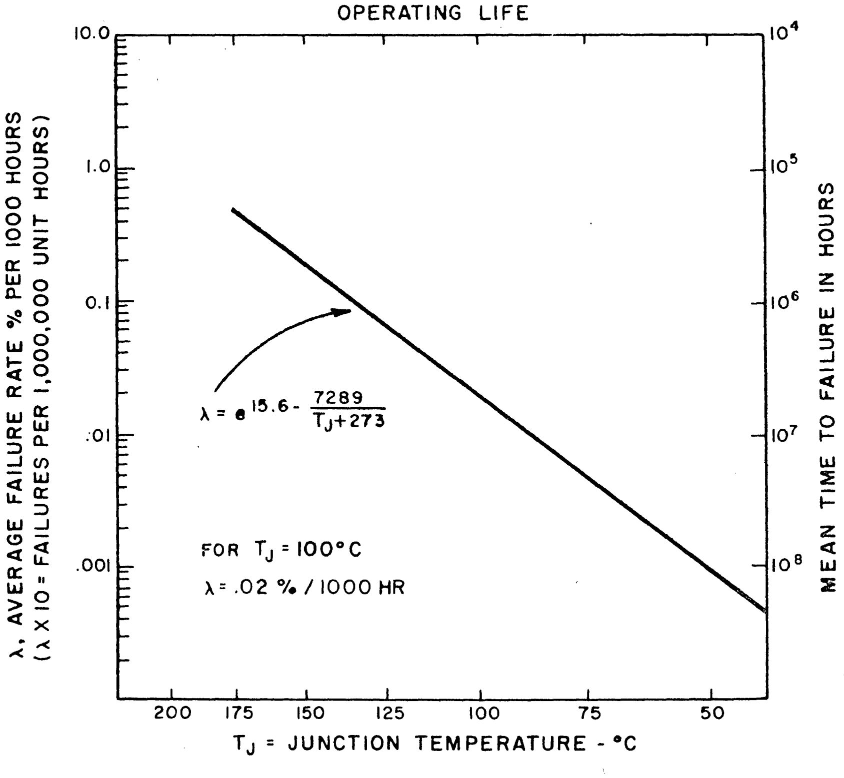
Since:

$$B = -7289K$$
$$E = -k(-7289) = 0.63\text{eV}$$

The activation energy associated with the Arrhenius Model can be used to determine the effect of a higher to a lower operating junction temperature of devices under test. The model can be used to predict the reliability of semiconductors under application conditions.

When the logarithm of λ is plotted against a linear reciprocal scale of T, the constants A and B represent the intercept and slope respectively of the resultant straight line plot, as shown in Figure 3.7

ARRHENIUS MODEL - PLASTIC ENCAPSULATED POWER TRANSISTOR



FAILURE CRITERIA: $I_{CBO} > 2 \times$ SPEC. LIMITS, $\Delta h_{FE} > \pm 30\%$

FIGURE 3.7. RELIABILITY PREDICTION MODEL - PLASTIC ENCAPSULATED POWER TRANSISTORS

3.2.3.2 Power Transistor Thermal Characteristics

In power transistor applications it is often desirable to determine the expected reliability of a device operating in free air with or without a heat dissipator attached. In either case it is necessary to determine the average operating junction temperature which can be used with the Arrhenius graph of Figure 3.7 to find the expected level of reliability.

For the free air dissipation case, the operating junction temperature is found using the same relationship.

$$T_J = P_D(R_{\Theta JA}) + T_A$$

For the case involving a heat dissipator, the relationship for finding the operating junction temperature is:

$$T_J = P_D(R_{\Theta JC} + R_{\Theta SA}) + T_A$$

where $R_{\theta JC}$ and $R_{\theta SA}$ are the thermal resistances of the device junction to case, and the heat dissipator to ambient, respectively and where T_J is the junction temperature; P_D is the power dissipation in the transistor and T_A is the ambient temperature.

NOTE: DURING LIFE TESTS THE TAB TEMPERATURE REFERENCE POINT INDICATED BELOW (Figure 3.8) IS USED FOR MONITORING AND CONTROLLING THE TEMPERATURE OF THE DEVICE.

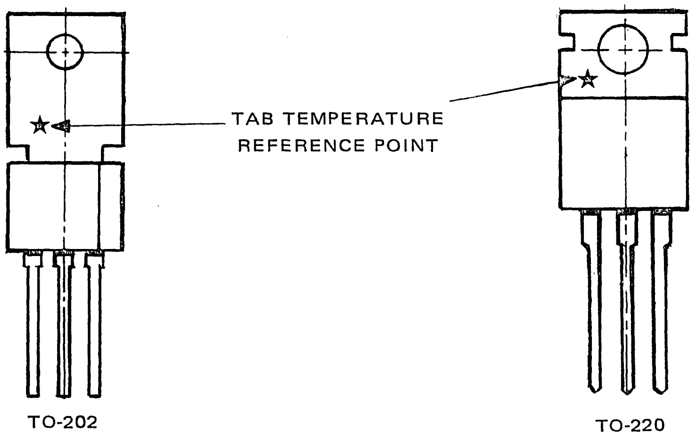


FIGURE 3.8. TAB TEMPERATURE REFERENCE POINT

General Electric publishes thermal resistance values, junction to ambient ($R_{\Theta JA}$) and junction to case ($R_{\Theta JC}$), for its plastic encapsulated power transistors. When a heat dissipator is employed, the user can calculate or measure its thermal resistance ($R_{\Theta SA}$) unless it is a commercially available dissipator with specified thermal resistance. It is assumed that thermal grease is used at the interface between the power transistor and attached heat dissipators so that the interface thermal resistance can be neglected. If an electrical insulator is used between the power transistor and heat dissipator, the thermal resistance of the insulator must be included in the value of $R_{\Theta SA}$.

Using the Arrhenius Model, a calculation of the expected reliability can be made by considering the GE D44C power transistor attached to a heat dissipator having a thermal resistance ($R_{\Theta SA}$) of 8°C/W. An example of such a dissipator could be a painted aluminum fin with dimensions of 2-1/2″ x 2-1/2″ x 1/32″.

Thus, the operating junction temperature us:

$$T_J = 5(4.2 + 8) + 25 = 86^\circ C$$

where T_A is 25°C, P_D is 5 watts, $R_{\Theta JC}$ and $R_{\Theta SA}$ are 4.2 and 8°C/watt respectively.

The use of the curve or the model equation in Figure 3.7 yields a reliability prediction for this application of .015% per thousand hours at a junction temperature of 86°C.

3.2.3.3 Power Transistor System Reliability

The electronic equipment designer is often required to predict the life of the equipment in field applications and to relate the equipment requirements and environments to the component level to be used. An example of this is shown for a plastic encapsulated power transistor in a typical application:

Number of Devices/System: 5
V_{CEO}: 50% to 70% of rating
Average Junction Temperature (T_J): 87°C
Environment: Normal Consumer or Industrial Application within Device Ratings.
Operating Time: 6,000 Hours/Year
Reliability Objective: $\leq$ 0.3% System Failures/Year

The system reliability objective of 0.3% per year for 6,000 hours is equivalent to a λ of 0.05%/K hours. this would give a Mean Time Between Failure (MTBF) of:

$$\text{MTBF} = \frac{1}{\lambda} = \frac{1}{.05\%/\text{KHrs}} = 2 \times 10^6 \text{ hours}$$

The probability of survival (P_S) of the electronic system for a negative exponential failure distribution and a constant failure rate would be:

$$P_S = e^{\frac{-t}{\text{MTBF}}}$$

where t = operating time.

Also, the probability of failure is:

$$P_F = 1 - P_S$$

The following results are obtained:

Period	Probability of Survival (P_S)	Probability of Failure (P_F)
1 Year	99.7%	0.3%
2 Years	99.4%	0.6%
3 Years	99.1%	0.9%
5 Years	98.5%	1.5%

In order to realize the above system reliability (0.05%/K hours), the reliability of each device must not exceed a failure rate of 0.05/5 devices or 0.01%/K hours at T_J = 87°C.

Reference is made to Figure 3.7 to determine the multiplier for temperature (M_T) when derating from the accelerated test condition of T_J = 150°C to the application condition of T_J = 87°C.

$$\lambda = e^{15.6 - \frac{7289}{T_J + 273}}$$

$$\lambda_1 = 0.196\%/\text{K Hrs. at } T_J = 150°\text{C}$$

$$\lambda_2 = .0096\%/\text{K Hrs. at } T_J = 87°\text{C}$$

The multiplier for temperature derating (M_T) is

$$M_T = \frac{\lambda_1}{\lambda_2} = 20.4$$

Failure Rate at Accelerated Test Conditions (T_J = 150°C)

$$\lambda = (20.4)\,(0.01) = 0.204\%/\text{K Hrs.}$$

Reliability Demonstration:

V_{CEO} = 70% of Rating
T_J = 150°C
t = 1000 hours
n = 350 devices
c = 0 failures
λ = 0.2%/K Hrs. at 50% confidence level.

A review of the power life test results from Figure 3.9 shows that the above reliability demonstration was successful for 361,000 device hours which exceeds the 350,000 hours required. This assures that these power transistors would meet the system reliability objective of 0.3% system failures per year.

STRESS	STRESS CONDITION	NUMBER OF LOTS	TOTAL DEVICES	DEVICE HOURS	NUMBER OF CATASTROPHIC FAILURES	FAILURE RATE* BEST ESTIMATE % PER 1000 HOURS
Power Life	P_T = 19 to 32W T_J = 150°C	15	367	361,000	0	0.2
High Temperature Reverse Bias (HTRB)	V_{CB} = 80% Rated Voltage T_A = 150°C	2	75	54,200	0	—
Back Bias Life with Humidity (Wet HTRB)	V_{CB} = 80% Rated Voltage T_A = 85°C R_H = 85% t = 1,000 HRS.	1	50	50,000	0	—
Humidity Life	T_A = 85°C RH = 85% t = 1000 HRS. (min)	24	595	595,000	0	0.11
Storage Life	T_A = 150°C t = 1000 HRS (min)	24	595	595,000	0	0.11
				DEVICE CYCLES		% PER CYCLES
Temperature Cycling	-55 to 150°C 15 Cycles	26	629	9,435	0	0.007
Temperature Cycling	-55°C to +150°C 1,000 Cycles	1	76	76,000	0	0.0009
Power Cycling	ΔT_J = 130°C, 10,000 Cycles	3	78	795,600	0	0.00009

*Failure Definition — Opens or Shorts

FIGURE 3.9. RELIABILITY OF POWER TRANSISTORS

STRESS	STRESS CONDITION	TOTAL DEVICES	DEVICE HOURS	NUMBER OF CATASTROPHIC* FAILURES
High Temperature Reverse Bias (HTRB)	$V_{CB} = 700V$ $T_A = 150°C$ t = 1000 HRS	46	46,000	0
Storage Life	$T_A = 150°C$ t = 1000 HRS	52	52,000	0
Humidity Life	$T_A = 40°C$ RH = 90-95% t = 240 HRS	52	12,480	0
			DEVICE CYCLES	
Temperature Cycling	-40 to 125°C 20 Cycles	52	1,040	0
Power Cycling	$\Delta T_J = 115°C$ 5,000 Cycles	12	60,000	0

*Failure Definition — Opens or Shorts

FIGURE 3.10. RELIABILITY OF POWER DARLINGTONS

3.2.3.4 Power MOSFETs

General Electric has incorporated its wide experience gained in the manufacture of bipolar signal and power transistors with the latest MOS technology to manufacture a broad line of Power MOS Field Effect Transistors. The latest Computer Aided Manufacturing (CAM) and Computer Aided Design (CAD) techniques are being utilized to manufacture consistently high quality and high reliability types of devices. The computer system, **PRO**cess **M**anagement and **I**nformation **S**ystem (PROMIS) is utilized to store all in-process data at key steps in the wafer fabrication area. All outgoing lots are given a quality acceptance test. The reliability of the finished products is assured by an on-going four-step reliability program. This program includes (1) wafer lot acceptance, (2) finished product acceptance, (3) product qualification and requalification and (4) reliability modeling. In addition, the product is subjected to stress-in-time monitoring tests as shown in Figure 3.11.

3.2.3.5 Power MOS Insulated Gate Transistor (IGT)

General Electric has developed a new type of MOS turn on/off power switching device called the Insulated Gate Transistor (IGT). This combines the prime advantages of Power MOSFETs and bipolar transistors. This results in a device that has the high input impedance of MOSFETs and the low on-state conduction losses found in bipolar power transistors. These types of devices are manufactured under the same high technology conditions as described earlier for Power MOSFETs. These IGT's are being evaluated under similar accelerated reliability tests as described in the earlier sections of this chapter. An extensive reliability program has been designed and initiated that uses a multi-level matrix of tests. These are to be used to quantitatively obtain stress multipliers for voltage (M_V) and temperature (M_T) as described earlier. These multipliers will be used to predict the long term reliability of the IGT's. An example of a portion of this matrix is shown in Figure 3.12.

STRESS	DEVICE* TYPE	NO. OF DEVICES	NO. OF** FAILURES	ACTUAL DEVICE HRS @ 150°C	EQUIVALENT DEVICE HRS. @ 90°C $E_A = 1.0\text{eV}$	RANDOM FAILURE RATE %/K HRS. 60% UCL
High Temperature Reverse Bias V_{DS} = 80% Max Rating V_{GS} = 0V (G = Shorted) T_J = 150°C t = 1240 Hours	D84CQ2	39	0	$4.84\text{x}10^4$	$4.5\text{x}10^6$	0.022
same as above	D84DQ2	40	0	$4.96\text{x}10^4$	$4.6\text{x}10^6$	0.018
same as above	D84ER1	40	1	$4.96\text{x}10^4$	$4.6\text{x}10^6$	0.070
Humidity Life 85°C, 85% RH V_{DS} = 10V V_{GS} = 0V (G = S)	D84CG2	20	0	10^4	—	—
same as above	D84DQ2	20	0	10^4	—	—
same as above	D84ER1	20	0	10^4	—	—
				DEVICE CYCLES		
Thermal Shock -55 TO 150°C t_{SOAK} = 15 Minutes MIL-STD-202F Method 107D n = 50 Cycles	D84CQ2	50	0	2500	—	—
same as above	D84DQ2	50	0	2500	—	—
same as above	D84ER1	50	0	2500	—	—

* TO-220 Package

** Non Functional Failures

FIGURE 3.11. RELIABILITY OF POWER MOSFETs

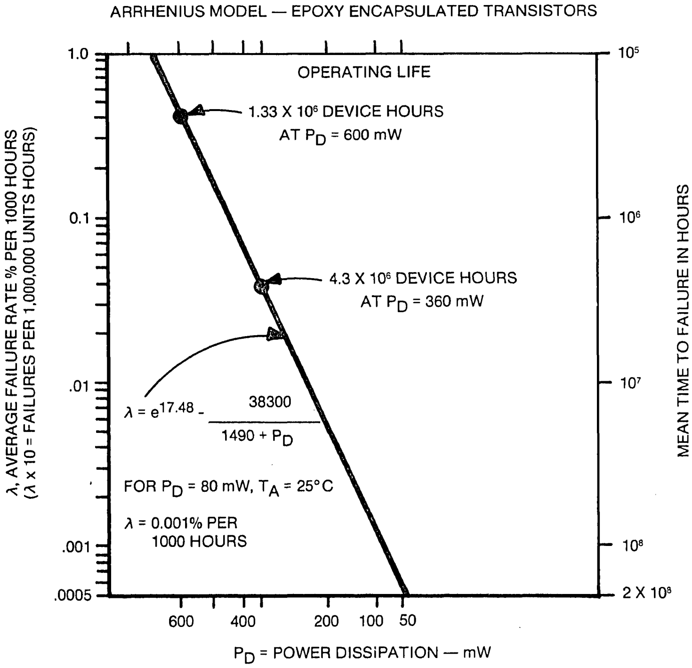
STRESS	DEVICE TYPE	NO. OF DEVICES	NO. OF* FAILURES	DEVICE HOURS
High Temperature Bias (Collector +), HTB(C+) V_{CE} = 100V T_J = 100°C	N-IGT MOX PKG.	20	0	10,000
V_{CE} = 200V T_J = 100°C	N-IGT MOX PKG.	20	1	10,000
V_{CE} = 100V T_J = 150°C	N-IGT MOX PKG.	20	0	10,000
Humidity Life 85°C, 85% RH	N-IGT MOX PKG.	158	1	79,000
Temperature Cycle -40 to 150°C 100 Cycles	N-IGT MOX PKG	80	0	

*Non Functional Failures

FIGURE 3.12. RELIABILITY OF N-TYPE INSULATED GATE TRANSISTORS (IGT's)

3.2.4 PLASTIC ENCAPSULATED SIGNAL TRANSISTORS

Another example of how accelerated-testing techniques are used is the assessment of the reliability of plastic encapsulated signal transistors. A number of in-depth reliability evaluation stress programs have been conducted over the years. The emphasis in the design of the programs was to evaluate and demonstrate device properties such as chip surface stability. The devices were randomly sampled from several production lots taken from different product lines and the devices received no special preconditioning or stress screening. These devices were usually subjected to three constant stress-in-time tests described earlier. General Electric epoxy encapsulated signal transistors were evaluated under these tests. A straight line Arrhenius graph and equation shown in Figure 3.13 was obtained from accelerated operating life test data on non-stress screened devices.



FAILURE CRITERIA: $I_{CBO} > 1\mu A$, $\Delta h_{FE} > \pm 30\%$
$\Delta V_{CE(sat)} > \pm 25\%$, $\Delta V_{BE(sat)} > 100$ mV

FIGURE 3.13. RELIABILITY PREDICTION MODEL - EPOXY ENCAPSULATES SIGNAL TRANSISTORS

Consider the requirement of determining the reliability of an epoxy encapsulated signal transistor such as the 2N6000 to 2N6017 family. The applied operating conditions of the transistor are such that the average power dissipation (P_D) is a maximum of 80 mW and the ambient temperature (T_A) is 25°C. The anticipated failure rate (λ) can be directly calculated for these conditions in the model equation shown in Figure 3.13.

$$\begin{aligned} \lambda &= \exp\,[17.48 - 38\,300/(1490 + 80)] \text{ per 1000 hours} \\ &= 0.0010\% \text{ per 1000 hours} \end{aligned} \tag{1}$$

for the case where T_A is greater than 25°C, such as 55°C, and P_D = 80 mW, the following relationship can be used:

$$T_J = P_D\,(R_{\theta JA}) + T_A. \tag{2}$$

T_J junction temperature
P_D power dissipation in the transistor
T_A ambient temperature
$R_{\theta JA}$ thermal resistance, junction to ambient.

For the case where $R_{\theta JA} = 0.2$°C/mW, (2) becomes:

$$T_J = [80 \times 0.2 + 55]°\mathrm{C} = 71°\mathrm{C}.$$

The equivalent power dissipation at $T_A = 25°C$ is found by using (2) again. Thus,

$$T_J = 71°C = P_D \times 0.2°C/mW + 25°C$$

$$P_D = 230\ mW.$$

λ is found by substituting this equivalent power dissipation into the model equation of Figure 3.13.

$$\lambda = \exp\,[71.48 - 38\,300/(1490 + 230)]\ \%\ \text{per 1000 hours}$$

$$= 0.0083\%\ \text{per 1000 hours.}$$

3.3 RELATIVE HUMIDITY

The operating environment of a semiconductor can have an important effect on reliability that can often be greatly diminished by the use of proper packaging. The effects of high relative humidity on plastic encapsulated devices have been studied extensively in the industry.

The degradation rate of semiconductor devices by humidity depends in almost all cases on the extent of formation of a continuous liquid film on the semiconductor surface or on the metal parts and contacts associated with the device. The amount of surface water adsorption determines 1) surface ion mobility and 2) the rate of ion transfer under the influence of electric fields or by liquid diffusion with concentration gradients.

The effect of temperature on water-film activated processes is complex. Temperature increases ion mobility and the degree of ionization of water in a manner analogous to its effect on electron and hole carriers in a semiconductor. This results in higher conductivities for equal densities of surface adsorbed films. However, temperature also determines a more critical parameter, the effective relative humidity, RH, of the ambient vapor in equilibrium with the adsorbed film. As shown in Table 3.2, the RH is the water vapor pressure divided by the theoretical saturated vapor pressure at the temperature, $P_{V(SAT)}$. The latter is very close to an Arrhenius type of increasing function (see Table 3.2) so that the effective RH decreases rapidly as the temperature increases. The degree of surface water adsorption is determined by this relative humidity, not by the absolute value of the water vapor pressure existing at any time in the air space above a semiconductor or in the pores and interface spacings in the plastic encapsulating the semiconductor.

Normally, degradation processes are measurable between 10^3 to 10^4 hours at RH values exceeding 30% to 50%. Thus when a semiconductor is powered during a humidity exposure or life test, the heat dissipation at the most critical junction areas or resistive contacts results in water desorption and in drying of parts most susceptible to degradation. This occurs even in a plastic encapsulated device where the plastic has a higher solubility for water at increased temperature. Water from the warmest active device surface will transfer to the gas phase or dissolve into the plastic bulk and might even condense out on cooler parts of a package enclosure. In Table 3.1, a constant humidity of 95% RH at 40°C, or 52.56 torr vapor pressure ambient surrounds a device permeable to water vapor. Power dissipation results in increasing the dryness as surface temperatures increase near the junction of the semiconductor. Then outward diffusion of water molecules will proceed as air pockets within the plastic, building up higher vapor pressures than in the external ambients. Thus, for example, the relative humidity near the junction of the semiconductor is 12.1% instead of 95% when the device is operating at a power level which raises the junction temperature to 85°C as shown in Table 3.1. This physical analysis helps to explain why well designed plastic encapsulated devices in nonhermetic packages have performed extremely well for years under a range of humidity and temperature environments.

Temperature outside the package = 40°C
Relative humidity outside the package = 95%

Device Junction Temperature (°)	Relative Humidity Near Junction (%)
40	95 (Reference)
50	56.8
55	44.5
65	28.0
75	18.2
85	12.1
100	6.92
125	3.02
150	1.47

TABLE 3.1: RELATIVE HUMIDITY NEAR SEMICONDUCTOR JUNCTION OF PLASTIC ENCAPSULATED DEVICES UNDER OPERATING POWER

$$RH = \frac{\text{Pressure of Water Vapor Present}}{\text{Pressure of Saturated Water Vapor at Same Temperature}}$$

$$= P_{RFF}/P_V(\text{sat}) = 52.56/P_V(\text{sat})$$

P_{RFF} = 95% x 55.3 = 52.56 torr in the device and in the ambient (T_A = 40°C, 95% RH) surrounding the device. P_V(sat) saturated vapor pressure at the specified temperature.

Vapor Temperature (°C)	Saturated Vapor Pressure of H_2O In torr $P_{v(sat)}$
40	55.3
50	92.5
55	118.0
65	187.5
75	289.1
85	433.6
100	760.0 (1 atm.)
125	1740.9
150	3570.5

TABLE 3.2. PRESSURE OF AQUEOUS VAPOR OVER WATER

3.4 STRESS SCREENING: "GE-XTRA, EXTRA RELIABILITY ASSURANCE PROGRAM"

Failure mechanism studies of field failures suggest that other types of failures occur which are not readily predicted by the Arrhenius Model. A program[4] was initiated to develop a practical, economical stress screen to remove the small percentage of infant mortality failures from devices to be used for "Hi Rel" automotive applications. These were usually bond-related or semiconductor chip type failures. These manufacturing type defects are random and usually involve less than one percent of the population of devices that have passed a series of the regular electrical parameter screens. This new screen was first developed for improving the reliability of plastic encapsulated signal and power transistors for the automotive industry.

The following accelerated stress screen was developed and evaluated:

- Discrete Devices
- Electrical Classification
- 20 Temperature Cycles -55 to 150°C
- 12-Minute Soak At Temperature Extremes
- 3-Minute Dwell at $T_A = 25°C$
- Special Electrical Screen at $T_A = 25°C$.

The special electrical screen included the measurement of low voltage parameters such as h_{FE} followed by leakage currents, breakdown voltages and a repeat of h_{FE}.

An evaluation of thousands of devices subjected to this screen showed that the fallout of potential device failures from the screen ranged from one to three percent of the population. A shape factor of $\beta = 0.16$ for the Weibull Model of response was obtained, indicating a decreasing device failure pattern as the number of temperature cycles was increased. The effectiveness of the screen was demonstrated out to 800 temperature cycles.

Failure mechanism studies were performed on devices removed by this screen. The three most common bond related failure modes detected by this stress screen occur when the lead breaks at the bond heel, the lead separates from the metallization on the chip, and the lead separates from the header post. Another bond related failure mode occurs when bonds are misplaced on the metallization. This results predominantly in emitter-base shorts and less frequently in collector-base shorts. The stress screen also detects devices with defects such as cracks in the chip and wire dress shorts.

Analysis of results of this study on stress screen effectiveness showed it was:

- Effective, efficient and economical in reducing automotive assembly-line fallout to 120 parts per million or less.
- Very effective in reducing field failures during warranty and longer periods.

Over 1.2 million plastic encapsulated bipolar signal transistors have been subjected to this temperature cycle screen. The average bond-related fallout from this stress screen was 1.7 percent.

An analysis was made of field application returns of bipolar transistors. These devices had been returned for failure analysis and the resulting study showed that the primary failure modes were due to chip cracks, oxide defects, and opens. These were the same types of failure modes found in the devices that were screened out in the temperature cycle screen. Therefore, there is a very high probability that they would have been removed by the temperature cycle stress screen previously described. This stress screen is included in the *"GE-XTRA - Extra Reliability Assurance Program"* which follows.

POWER TRANSISTORS AND SWITCHES

(Also Applies to Signal Transistors)

GE-XTRA

EXTRA RELIABILITY ASSURANCE PROGRAM

GE-XTRA IS GENERAL ELECTRIC'S ANSWER TO TRANSISTOR CUSTOMERS WHO ASK:

What can I do to —

- Reduce early failures?
- Lower warranty costs?
- Eliminate the need for incoming inspection?
- Improve the availability of products?
- Improve my productivity and product flow by reducing line fallout/rework?
- Reduce my costs by achieving low PPM or AQL levels?
- Increase reliability?

IN ORDER TO ANSWER THESE QUESTIONS, GE-XTRA FEATURES:

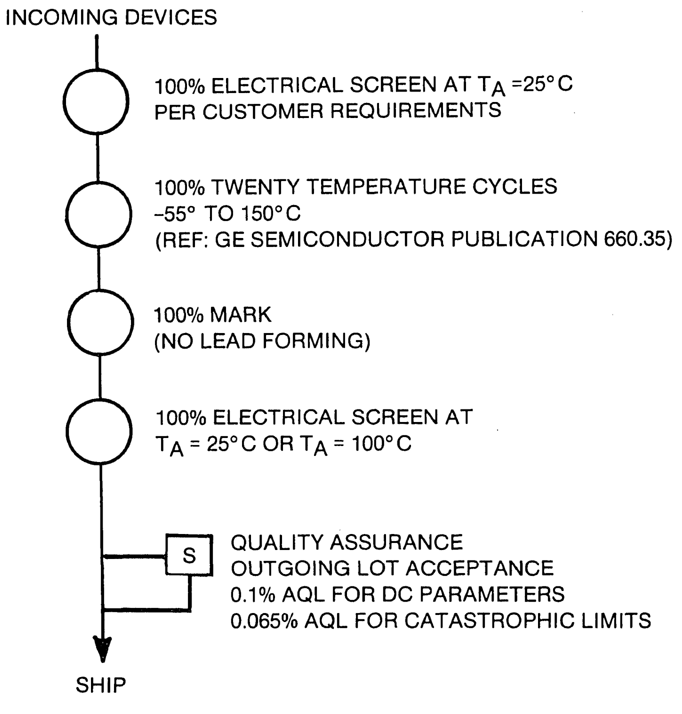
- 100% temperature cycle stressing from -55 to +150°C for 20 cycles!
- A second 100% electrical screen test *after* temperature cycle stressing!
- Electrical screen tests engineered for removal of infant mortality failure modes!
- Optional 100% elevated temperature electrical screening!

THE GE-XTRA PROGRAM PROVIDES:

- Assured Quality levels of:
  0.10% AQL for dc device parameters
  0.065% AQL for device catastrophic limits
- Low additional cost!

The following flow chart illustrates the process flexibility which can be tailored to individual applications. Note that marking is performed *before* the second 100% electrical screen in order to prevent any inadvertent product mixing during the mark operation.

Also note the reference to the General Electric Publication No. 660.35. *"Transistor High-Reliability Program"* for a detailed description of the effectiveness of this screen.



In addition to these techniques for improving the reliability of power transistors, efforts continue to improve the dynamic capabilities of these devices. An example of this is described in "Relating Power Transistor Failure Modes to Post-Failure Characteristics."[5] This study included the failure of power transistors under controlled circuit overload conditions, followed by failure analysis of the results. This information is directly applicable to the design engineer interested in preventing circuit-induced type faults in applications.

3.5 TOTAL QUALITY CONTROL

The Quality System being used in the manufacture of signal and power transistors is an example of the General Electric concept of Total Quality Control[6]. This concept provides, through established and documented procedures, a system that assures that the quality needs are incorporated in the product planning, design, manufacturing and final test phases of the products. The Total Quality Control Concept for these products includes the inspection of incoming materials, chemicals, solvents, gases and process controls used in the manufacture of these transistors.

Three basic types of instructions are used to control processes. These are Engineering, Manufacturing and Quality Control Instructions. The Engineering Instruction defines the important variables of the process and the applied limits to control them. In order to implement the Engineering Instructions, a more specific document, the Manufacturing Instruction, is generated. The Quality Control Instructions are written for Quality Control personnel to perform the necessary inspections and tests. These instructions and procedures are implemented to assure that reliability is built into these devices. The flow charts in Figures 3.14, 3.15 and 3.16 are examples of the major process steps and the extensive inspections that each device receives during the fabrication and test cycle.

In addition to these inspections, reliability monitoring tests are conducted by Quality Control. The devices used in these tests are randomly selected from production and do not receive any special preconditioning or stress screening. This data is used to determine and control the quality of the manufacturing line. The tests include temperature cycling and life tests. Life test data are collected on the basis of 1,000 hour tests of continuous operating life, high temperature storage life and humidity life tests. Information from these tests is used to measure product line reliability.

As a complement to the regular monitoring tests several extensive accelerated reliability evaluation programs have been performed. These programs are statistically designed to incorporate balance, random sampling and replication in the devices tested so that product unformity, reproducibility and long life stability can be demonstrated. The accelerated test results are used to develop reliability models which establish the expected device reliability at application levels based on performance under extreme ranges of environmental, mechanical, thermal and operating power levels.

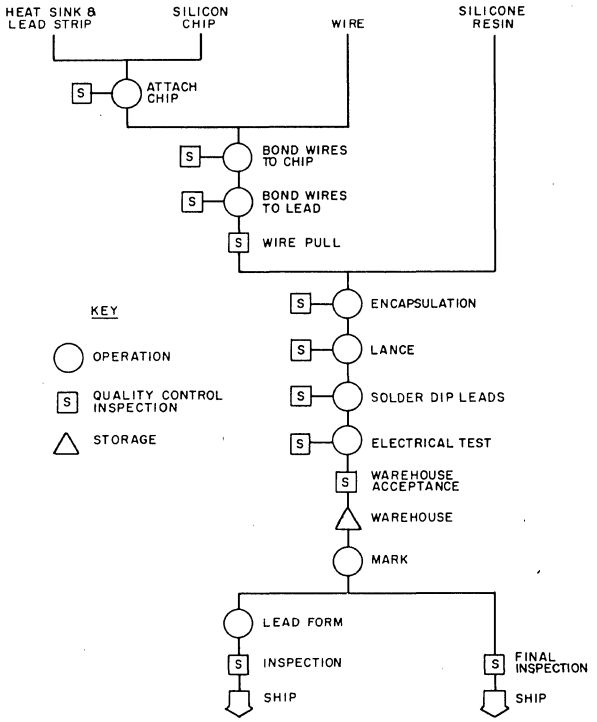


FIGURE 3.14. TRANSISTOR ASSEMBLY (JEDEC TO-202)

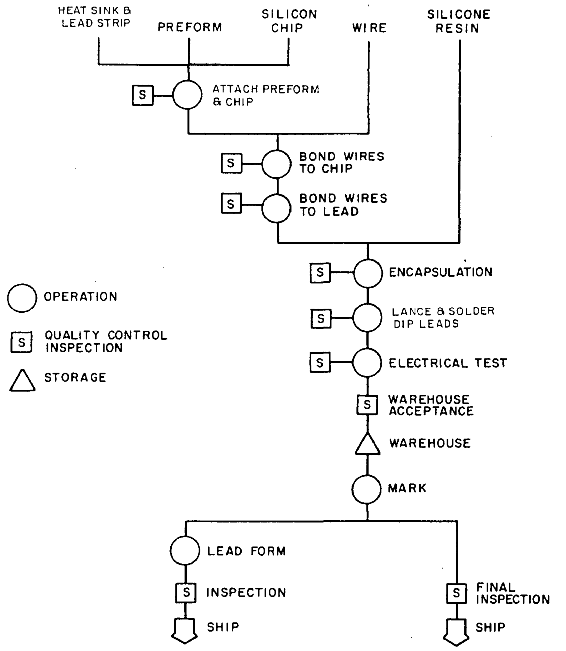


FIGURE 3.15. TRANSISTOR ASSEMBLY (JEDEC TO-220)

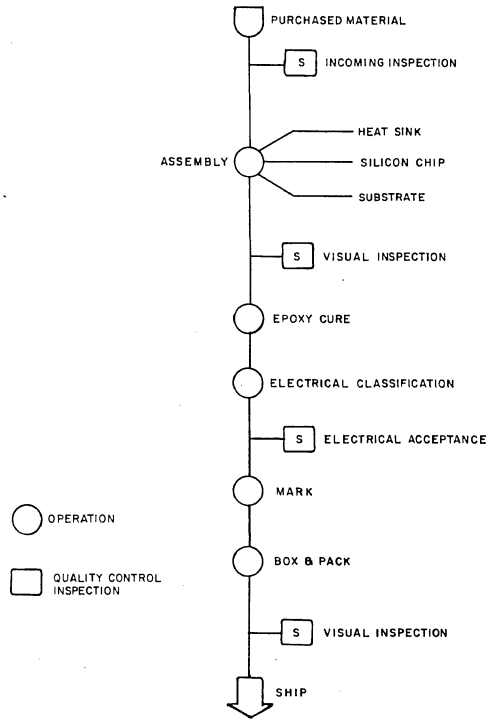


FIGURE 3.16. POWER DARLINGTON ASSEMBLY

3.6 GENERAL CONCLUSIONS

The recent industry trend to improve quality and reliability of electronic components is continually being reviewed. The general approach taken by General Electric Power Electronics Semiconductor Department (PESD) to meet the new quality levels in the PPM range and long life requirements of 10 to 20 years is described. The major conclusions of this approach include:

- The general quality and reliability of PESD semiconductors are being enhanced by investment in the latest Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) equipment including the latest in clean room facilities.
- Quality Control activities are being enhanced with new quality awareness and motivation programs, training and implementation of the latest statistical process control techniques.
- The new Outgoing PPM Program was initiated in October 1982 and the results are reported in the *GE Quarterly Quality Reports*. This program has shown an overall improvement of 84% on the combined electrical and visual/mechanical parameters of products being supplied.
- A new method of predicting the reliability of product life of semiconductors under field use conditions is described. This method was confirmed with accelerated tests and actual field results for 3 years.
- The general approach for obtaining reliability prediction models is given along with models for bipolar signal and power transistors. Programs are underway to determine these models for the latest Insulated Gate Transistors (IGT's).
- The technique is shown on how these reliability models are used to determine the acceleration multipliers for multi-levels of stress voltage (M_V) and temperature (M_T).
- The general approach is given on how to start with a system reliability objective and determine the accelerated test conditions to demonstrate that the components have the necessary reliability. This is a timely and cost effective strategy for achieving this objective.
- Reliability performance data are shown for bipolar signal and power transistors, Power MOS transistors and Insulated Gate Transistors (IGT's).
- The low relative humidity that occurs in a plastic package when the semiconductor is operating and dissipating power is described. This gives reasons why plastic encapsulated devices have a long life performance.
- The effectiveness of the use of a temperature cycle stress screen for bipolar transistors is discussed in the *"GE-XTRA Program"*.
- The overall concept of "Total Quality Control" is used to define procedures in the quality and reliability system.
- The above concepts are being implemented to achieve the excellence required in electronic components to meet the very low defective levels in PPM and long life performance.

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GE
POWER MOSFET
SPECIFICATIONS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF130,131
D86DL2,K2

14.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.18 Ω

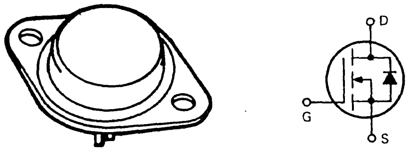
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

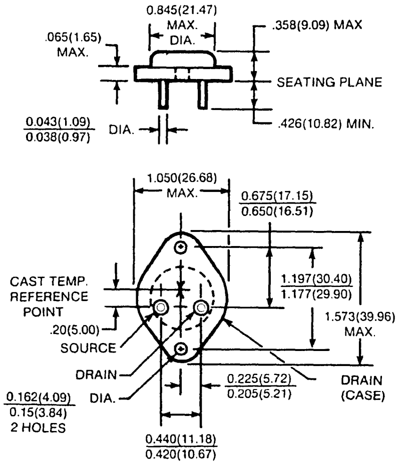
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF130/D86DL2	IRF131/D86DK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C	I_D	14	14	A
Pulsed Drain Current(1)	I_{DM}	56	56	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF130/D86DL2 IRF131/D86DK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	14	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)		$R_{DS(ON)}$	—	0.15	0.18	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)		g_{fs}	3.2	4.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	240	500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	150	pF

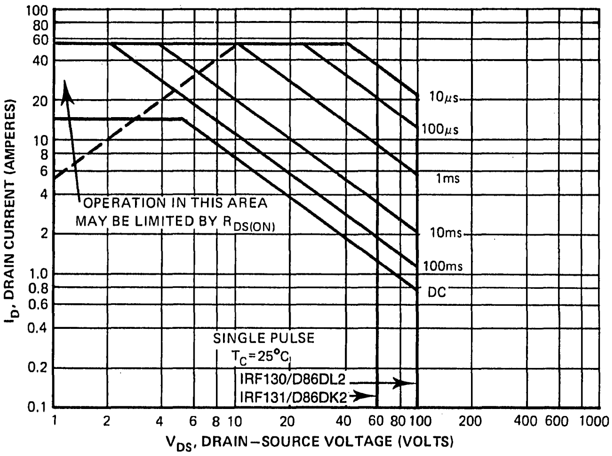
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	55	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

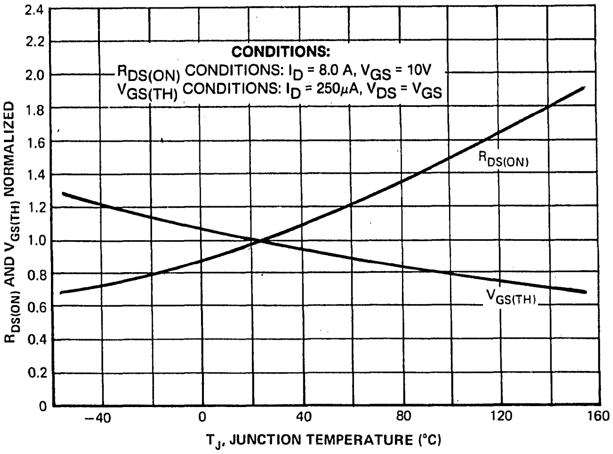
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	14	A
Pulsed Source Current	I_{SM}	—	—	56	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 14A)	V_{SD}	—	1.0	2.5	Volts
Reverse Recovery Time (I_S = 14A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	210 1.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF132,133

12.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.25\ \Omega$

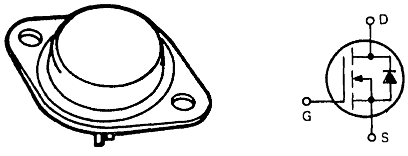
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

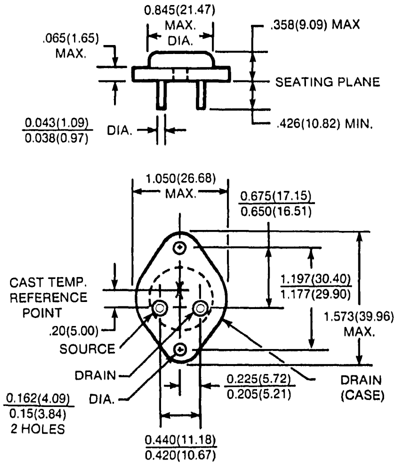
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF132	IRF133	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	100	60	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	12 8	12 8	A A
Pulsed Drain Current$^{(1)}$	I_{DM}	48	48	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF132 IRF133	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	12	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)		$R_{DS(ON)}$	—	0.18	0.25	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)		g_{fs}	3.2	4.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	240	500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	150	pF

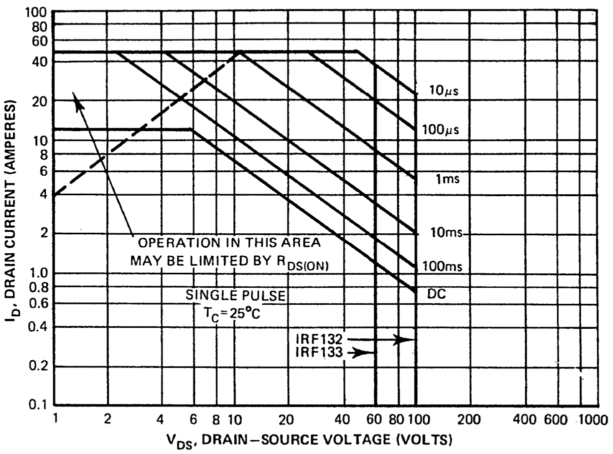
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	55	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

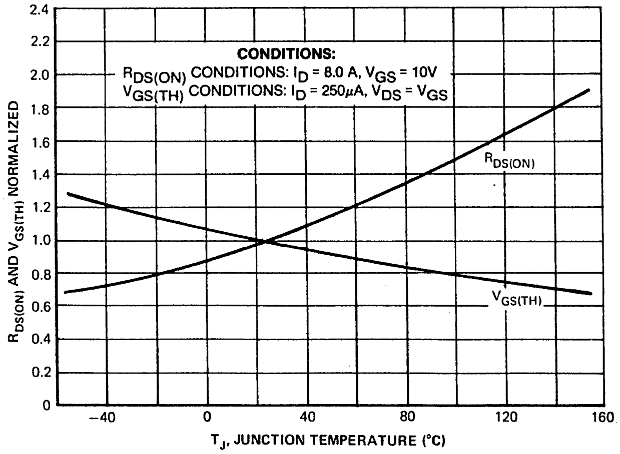
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	12	A
Pulsed Source Current		I_{SM}	—	—	48	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 12A)		V_{SD}	—	1.0	2.3	Volts
Reverse Recovery Time (I_S = 14A, dI_S/dt = 100A/μsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	210 1.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF140,141
D86EL2,K2

27 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.085 Ω

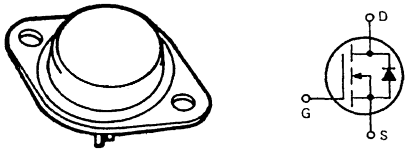
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

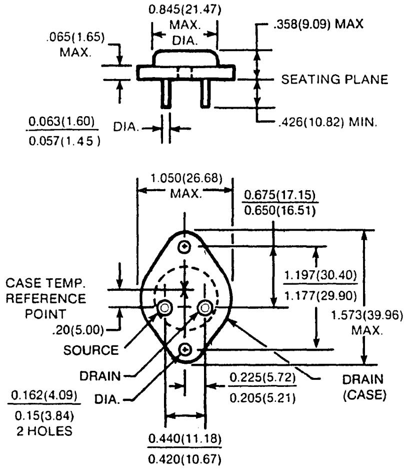
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF140/D86EL2	IRF141/D86EK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	27 17	27 17	A A
Pulsed Drain Current(1)	I_{DM}	108	108	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA) IRF140/D86EL2 IRF141/D86EK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA) T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	27	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 15A)	$R_{DS(ON)}$	—	0.073	0.085	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 15A)	g_{fs}	5.4	7.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	550	800	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	300	pF

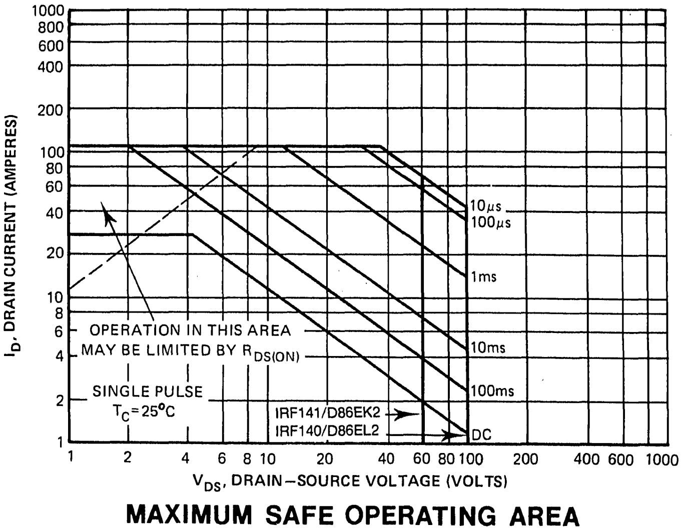
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 15A, V_{GS} = 15V	t_r	—	115	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

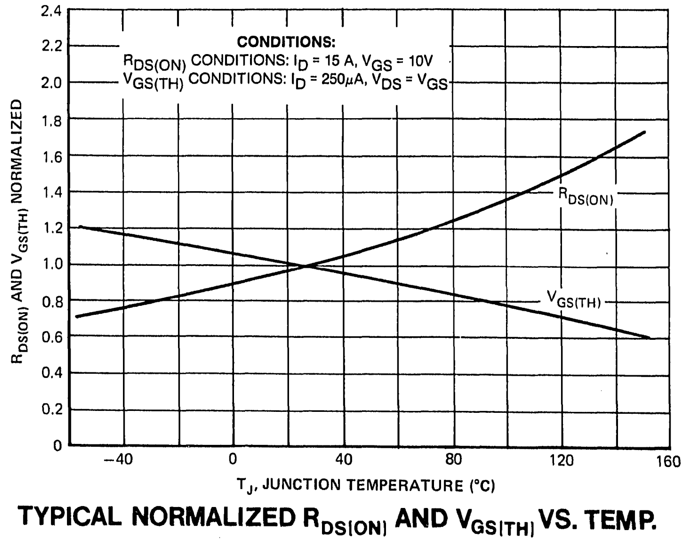
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	27	A
Pulsed Source Current	I_{SM}	—	—	108	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 27A)	V_{SD}	—	1.2	2.5	Volts
Reverse Recovery Time (I_S = 27A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	250 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF142,143

24 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.11\ \Omega$

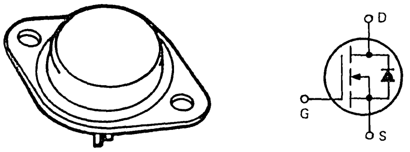
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

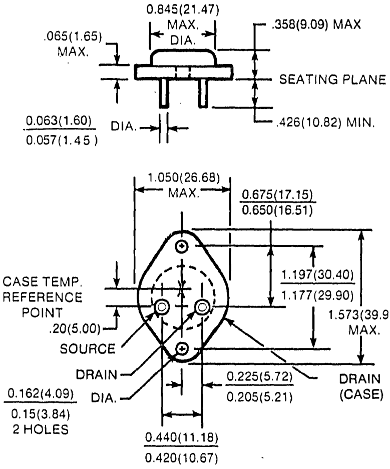
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF142	IRF143	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	100	60	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	24 15	24 15	A A
Pulsed Drain Current(1)	I_{DM}	96	96	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF142 IRF143	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	24	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 15A)		$R_{DS(ON)}$	—	0.09	0.11	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 15A)		g_{fs}	5.4	7.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	550	800	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	300	pF

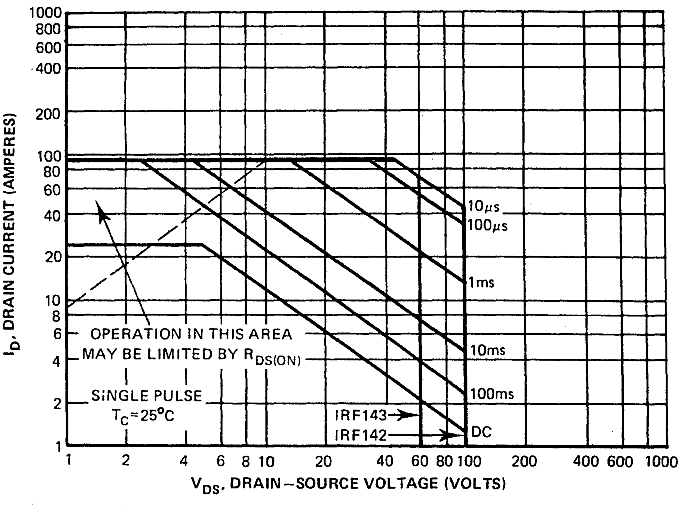
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 15A, V_{GS} = 15V	t_r	—	115	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

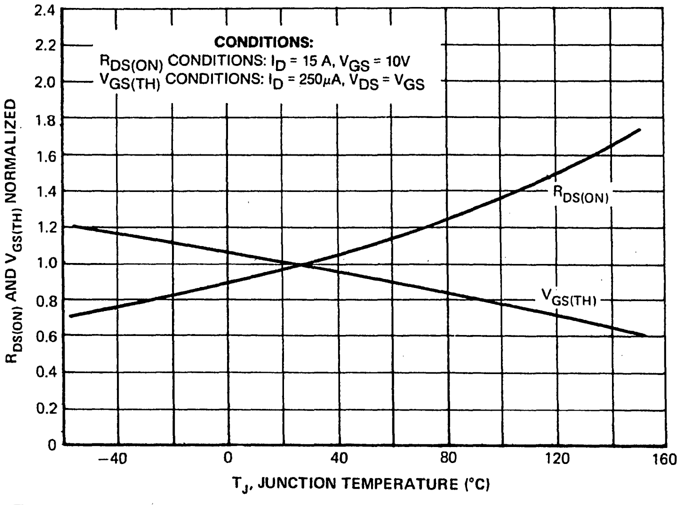
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	24	A
Pulsed Source Current	I_{SM}	—	—	96	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 24A)	V_{SD}	—	1.1	2.3	Volts
Reverse Recovery Time (I_S = 27A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	250 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF150,151
D86FL2,K2

40 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.055\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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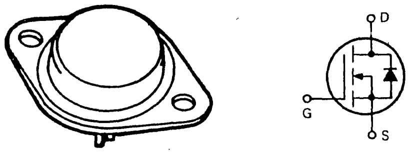
Features

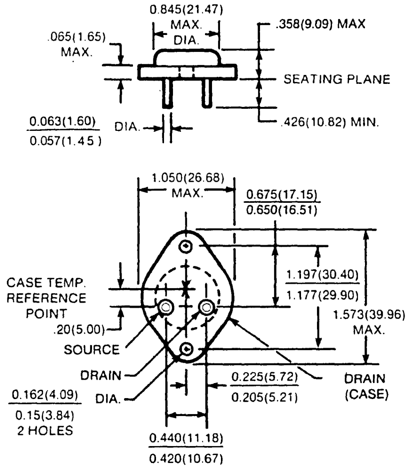
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF150/D86FL2	IRF151/D86FK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	100	60	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	40 25	40 25	A A
Pulsed Drain Current(1)	I_{DM}	160	160	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF150/D86FL2 ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRF151/D86FK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)	$I_{D(ON)}$	40	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 20A$)	$R_{DS(ON)}$	—	0.050	0.055	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 20A$)	g_{fs}	8.1	10	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	2800	3000	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	1000	1500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	225	500	pF

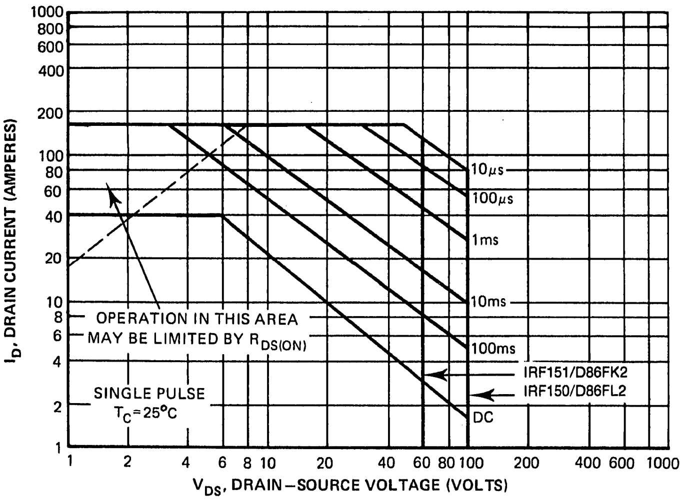
switching characteristics*

Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	25	—	ns
Rise Time	$I_D = 20A$, $V_{GS} = 15V$	t_r	—	145	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	95	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	75	—	ns

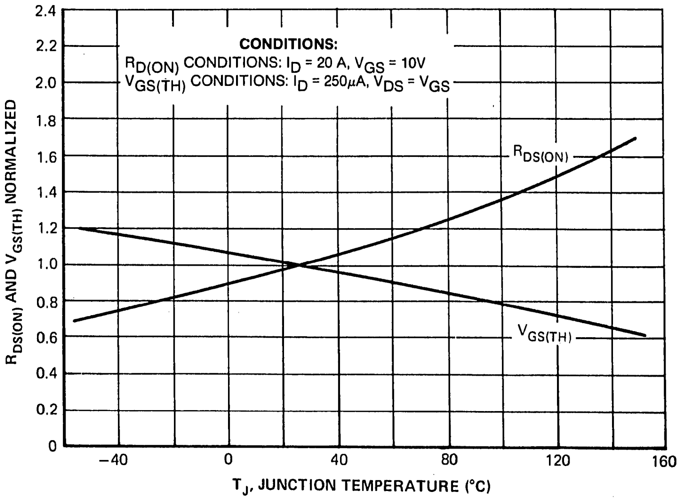
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	40	A
Pulsed Source Current	I_{SM}	—	—	160	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 40A$)	V_{SD}	—	1.3	2.5	Volts
Reverse Recovery Time ($I_S = 40A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	300 2.8	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRF152,153

33 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.08 Ω

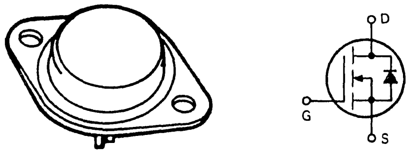
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

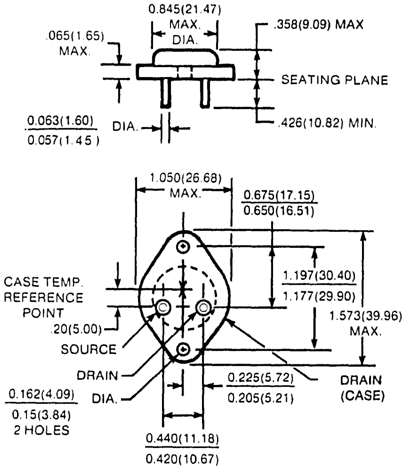
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF152	IRF153	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	33 20	33 20	A A
Pulsed Drain Current(1)	I_{DM}	132	132	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRF152 IRF153	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	33	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 20A$)		$R_{DS(ON)}$	—	0.06	0.08	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 20A$)		g_{fs}	8.1	10	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	2800	3000	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	1000	1500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	225	500	pF

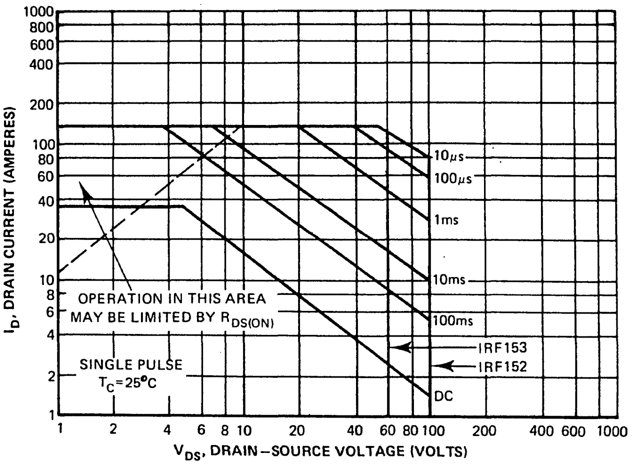
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	25	—	ns
Rise Time	$I_D = 20A$, $V_{GS} = 15V$	t_r	—	145	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	95	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	75	—	ns

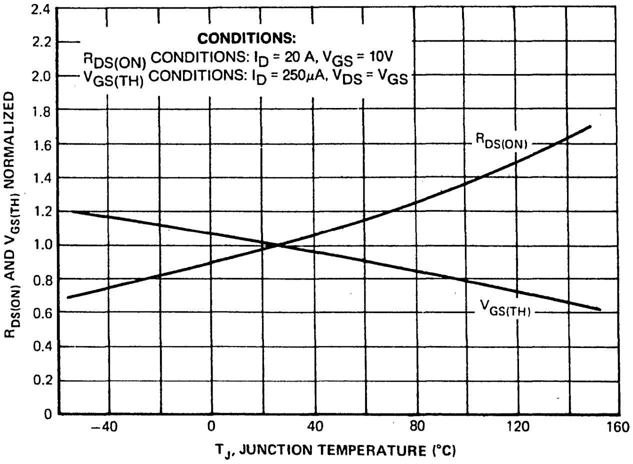
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	33	A
Pulsed Source Current	I_{SM}	—	—	132	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 33A$)	V_{SD}	—	1.2	2.3	Volts
Reverse Recovery Time ($I_S = 40A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	300 2.8	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF230,231
D86DN2,M2

9.0 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.4\ \Omega$

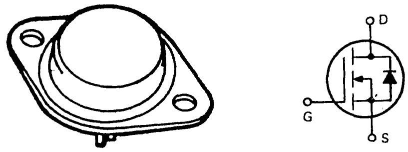
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

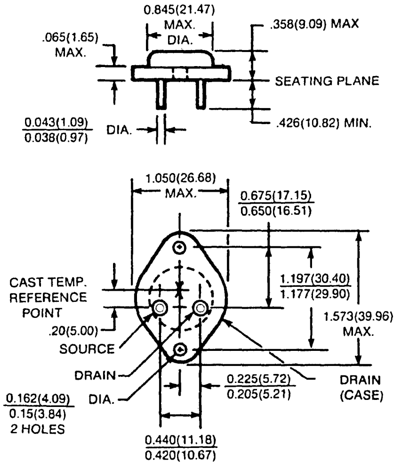
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF230/D86DN2	IRF231/D86DM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	9.0 6.0	9.0 6.0	A A
Pulsed Drain Current[1]	I_{DM}	36	36	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF230/D86DN2 (V_{GS} = 0V, I_D = 250 μA) IRF231/D86EM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25° C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	9.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5.0A)	$R_{DS(ON)}$	—	0.34	0.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5.0A)	g_{fs}	2.4	3.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	150	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	30	150	pF

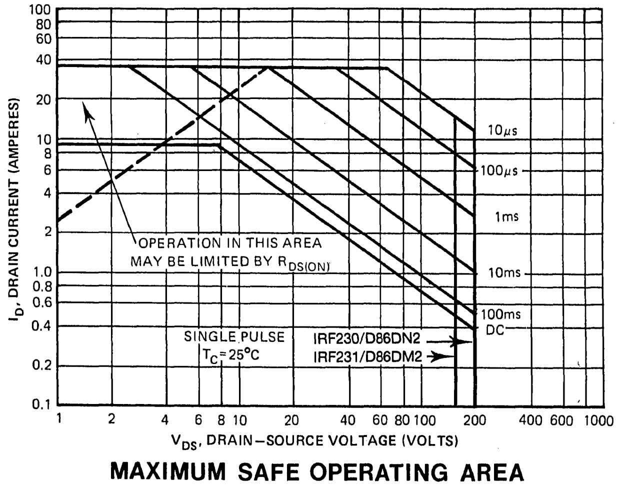
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 5.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

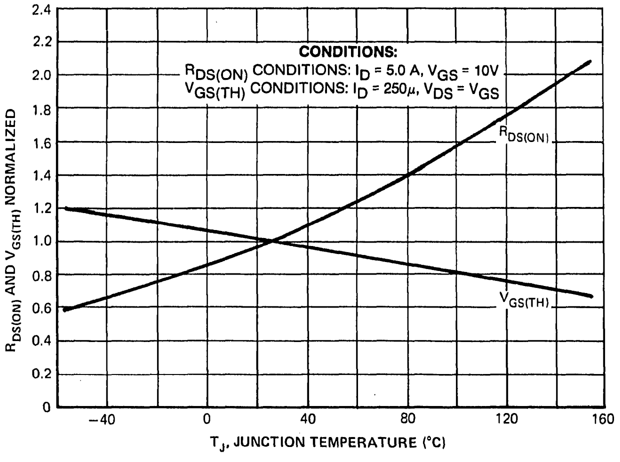
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	9.0	A
Pulsed Source Current	I_{SM}	—	—	36.0	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 18A)	V_{SD}	—	1.0	2.0	Volts
Reverse Recovery Time (I_S = 9.0A, dI_S/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	300 2.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF232,233

8.0 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.6\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

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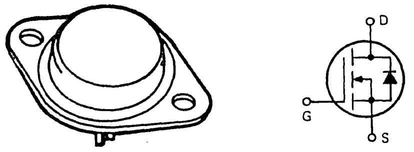
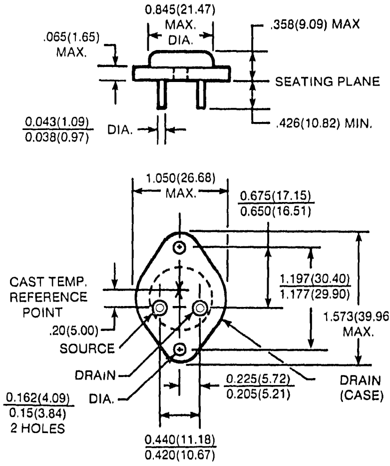
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF232	IRF233	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	8.0 5.0	8.0 5.0	A A
Pulsed Drain Current[1]	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

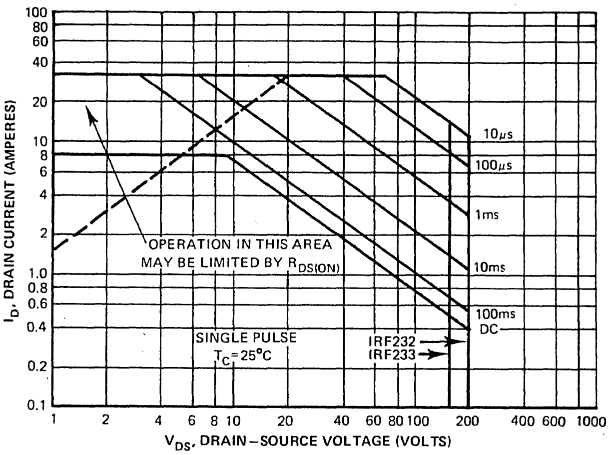
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

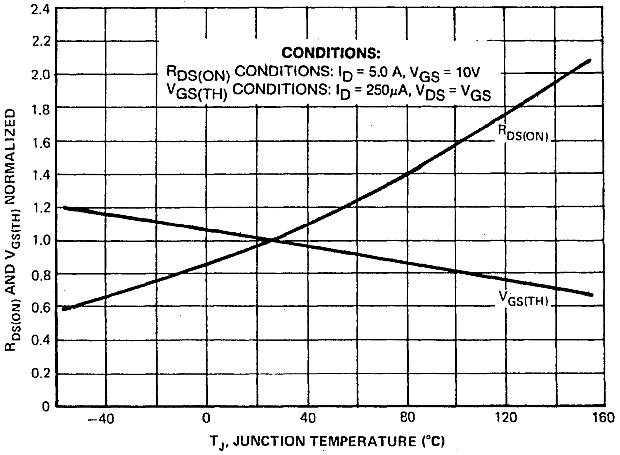
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF232 IRF233	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	8.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5.0A)		$R_{DS(ON)}$	—	0.4	0.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5.0A)		g_{fs}	2.4	3.0	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	150	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	30	150	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 5.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	8.0	A
Pulsed Source Current		I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8.0A)		V_{SD}	—	1.0	1.8	Volts
Reverse Recovery Time (I_S = 9.0A, dI_S/dt = 100A/μsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	300 2.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF240,241
D86EN2,M2

18 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.18 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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Features

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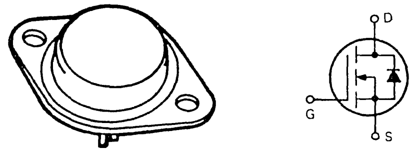
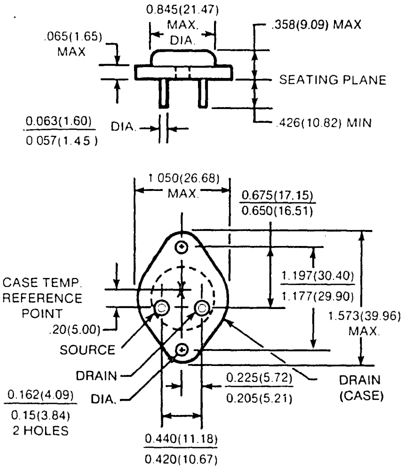
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF240/D86EN2	IRF241/D86EM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	18 11	18 11	A A
Pulsed Drain Current(1)	I_{DM}	72	72	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF240/D86EN2 (V_{GS} = 0V, I_D = 250 μA) IRF241/D86EM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	18	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 10A)	$R_{DS(ON)}$	—	0.14	0.18	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 10A)	g_{fs}	4.8	6.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	310	750	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	65	300	pF

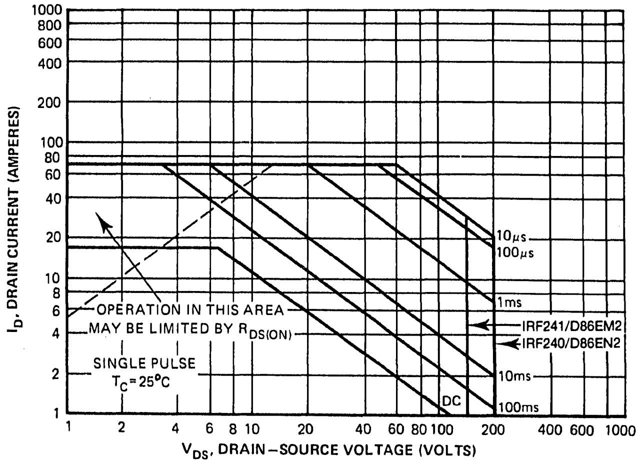
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 10A, V_{GS} = 15V	t_r	—	40	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

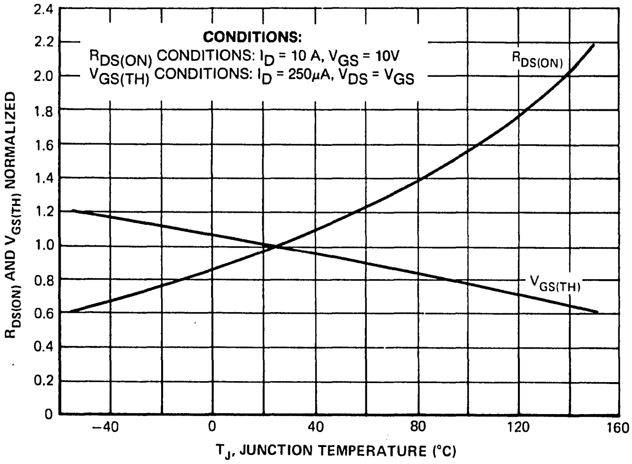
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	18	A
Pulsed Source Current	I_{SM}	—	—	72	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 18A)	V_{SD}	—	1.0	2.0	Volts
Reverse Recovery Time (I_S = 18A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	330 3.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF242,243

16 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.22 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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Features

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- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
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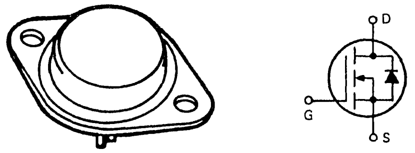
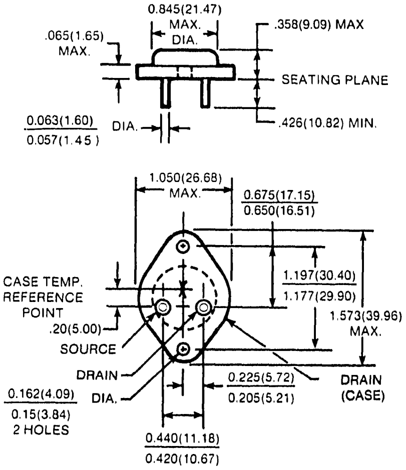
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF242	IRF243	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	16 10	16 10	A A
Pulsed Drain Current⁽¹⁾	I_{DM}	64	64	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF242 IRF243	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	16	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 10A)		$R_{DS(ON)}$	—	0.18	0.22	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 10A)		g_{fs}	4.8	6.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	310	750	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	65	300	pF

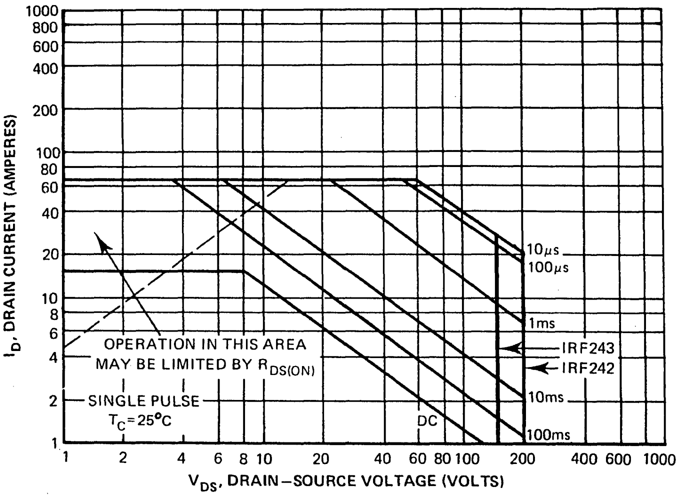
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 10A, V_{GS} = 15V	t_r	—	40	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

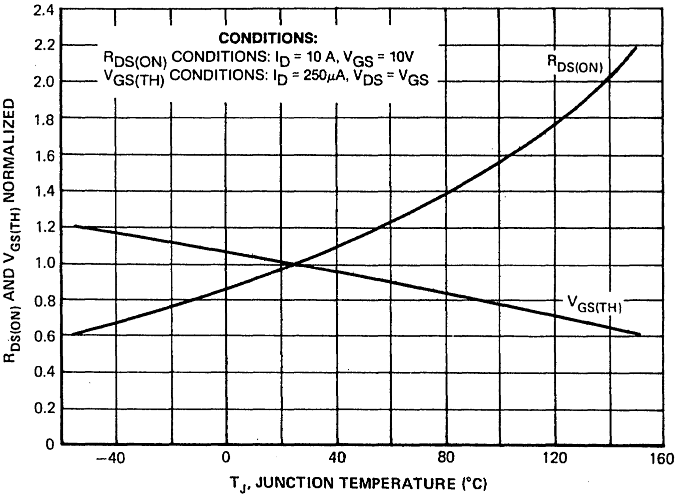
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	16	A
Pulsed Source Current	I_{SM}	—	—	64	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 16A)	V_{SD}	—	1.0	1.9	Volts
Reverse Recovery Time (I_S = 18A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	330 3.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF250,251
D86FN2,M2

30 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.085\ \Omega$

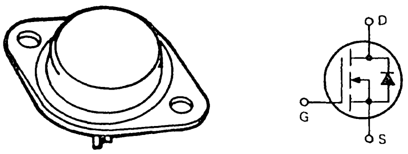
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

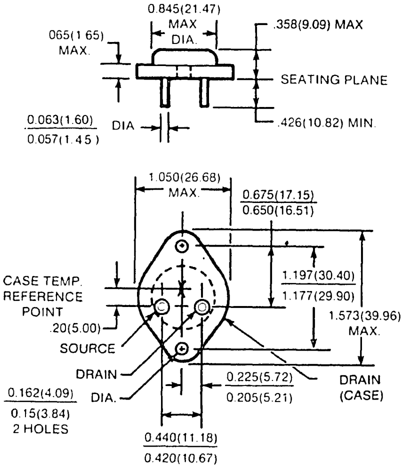
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF250/D86FN2	IRF251/D86FM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	30 19	30 19	A A
Pulsed Drain Current(1)	I_{DM}	120	120	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF250/D86FN2 IRF251/D86FM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	30	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 16A)		$R_{DS(ON)}$	—	0.075	0.085	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 16A)		g_{fs}	7.2	10	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	520	1200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	500	pF

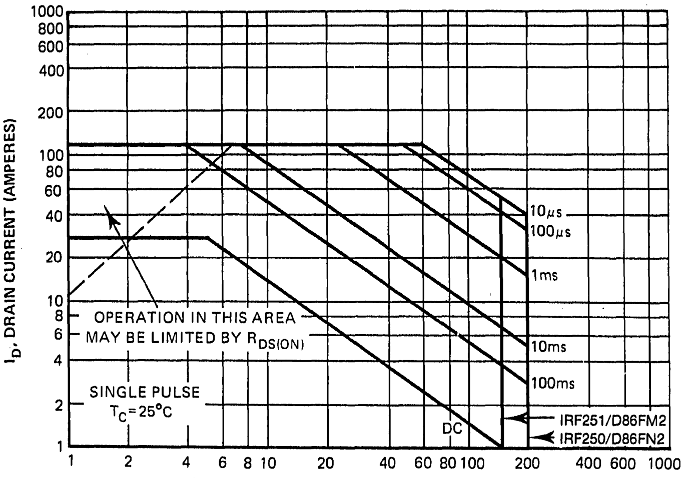
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 16A, V_{GS} = 15V	t_r	—	75	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	90	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	65	—	ns

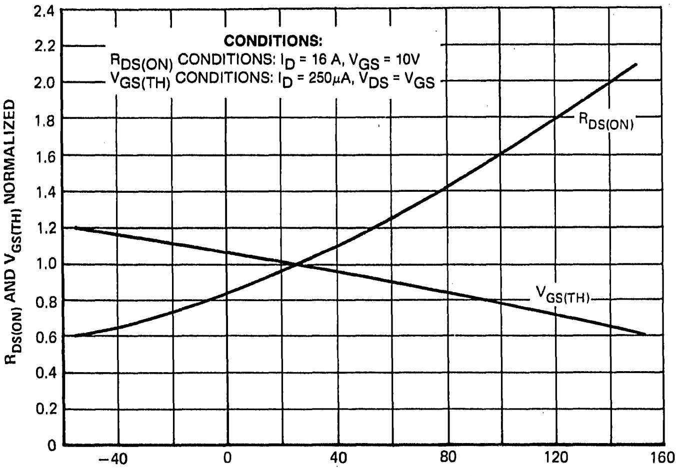
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	30	A
Pulsed Source Current	I_{SM}	—	—	120	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 30A)	V_{SD}	—	1.3	2.0	Volts
Reverse Recovery Time (I_S = 30A, dI_s/dt = 100A/μs, T_C = 125°C)	t_{rr} Q_{RR}	— —	345 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

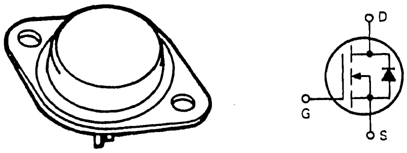
IRF252,253

25 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.12 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

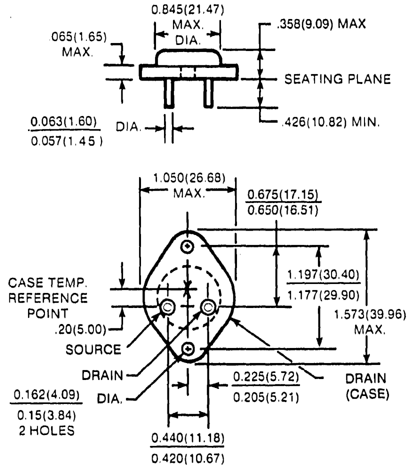
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

N-CHANNEL



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF252	IRF253	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	25 16	25 16	A A
Pulsed Drain Current(1)	I_{DM}	100	100	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

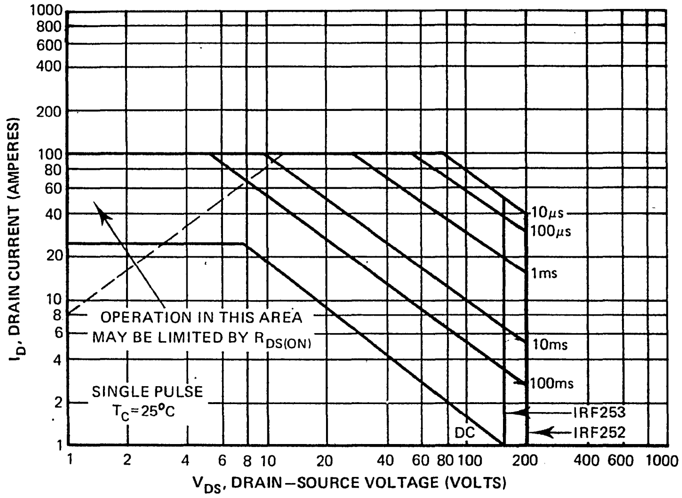
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

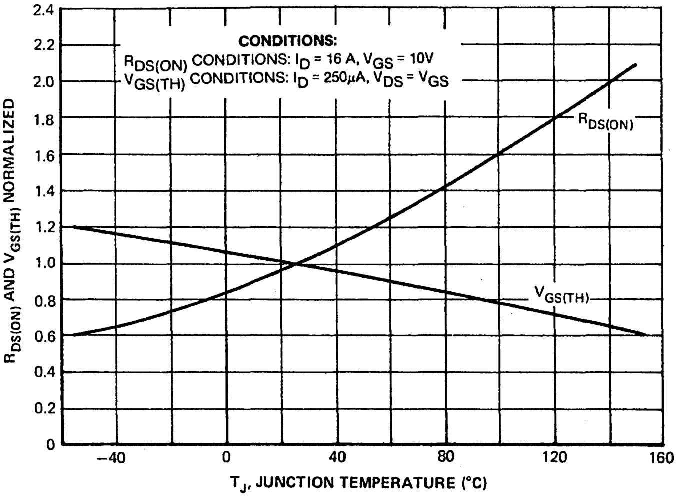
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF252 IRF253	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	25	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 16A)		$R_{DS(ON)}$	—	0.10	0.12	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 16A)		g_{fs}	7.2	10	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	520	1200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	500	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 16A, V_{GS} = 15V	t_r	—	75	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	90	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	65	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	25	A
Pulsed Source Current		I_{SM}	—	—	100	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 25A)		V_{SD}	—	1.2	1.8	Volts
Reverse Recovery Time (I_S = 30A, dI_S/dt = 100A/μs, T_C = 125° C)		t_{rr} Q_{RR}	— —	345 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF330,331
D86DQ2,Q1

5.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 1.0\ \Omega$

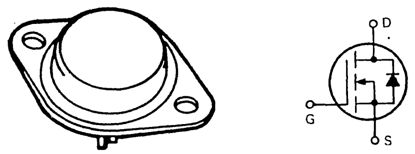
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

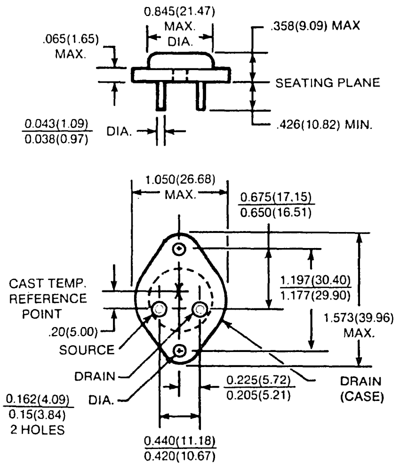
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF330/D86DQ2	IRF331/D86DQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	5.5 3.5	5.5 3.5	A A
Pulsed Drain Current[1]	I_{DM}	22	22	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

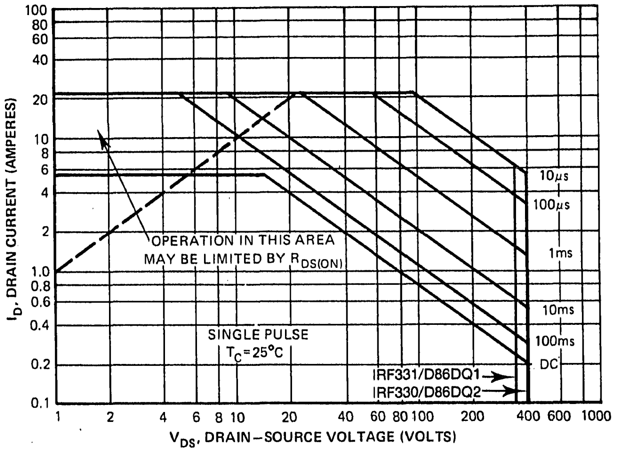
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

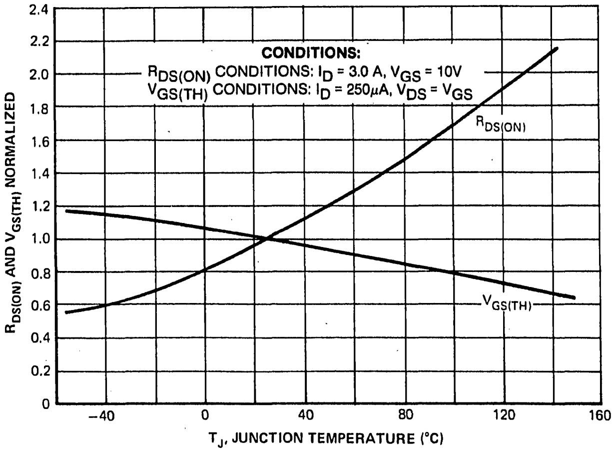
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF330/D86DQ2 IRF331/D86DQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	5.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 3A)		$R_{DS(ON)}$	—	0.8	1.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 3A)		g_{fs}	2.1	2.5	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	100	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 3A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	5.5	A
Pulsed Source Current		I_{SM}	—	—	22	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 5.5A)		V_{SD}	—	1.0	1.6	Volts
Reverse Recovery Time (I_S = 5.5A, dI_s/dt = 100A/μs, T_C = 125° C)		t_{rr} Q_{RR}	— —	360 4.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF332,333

4.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 1.5\ \Omega$

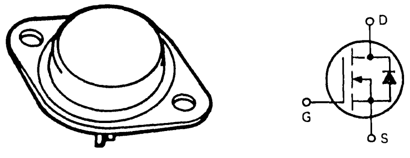
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

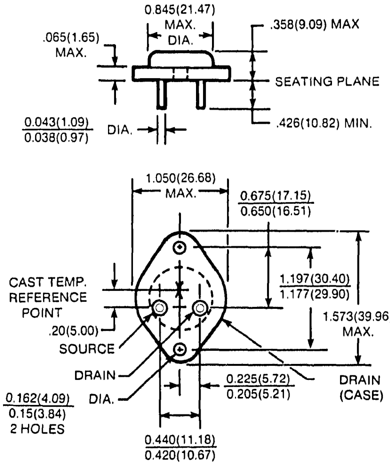
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF332	IRF333	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	4.5 3.0	4.5 3.0	A A
Pulsed Drain Current(1)	I_{DM}	18	18	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA) IRF332	BV_{DSS}	400	—	—	Volts
IRF333		350	—	—	
Zero Gate Voltage Drain Current	I_{DSS}				
(V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C)		—	—	250	μA
(V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		—	—	1000	
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	4.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 3.0A)	$R_{DS(ON)}$	—	1.2	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 3.0A)	g_{fs}	2.1	2.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	100	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

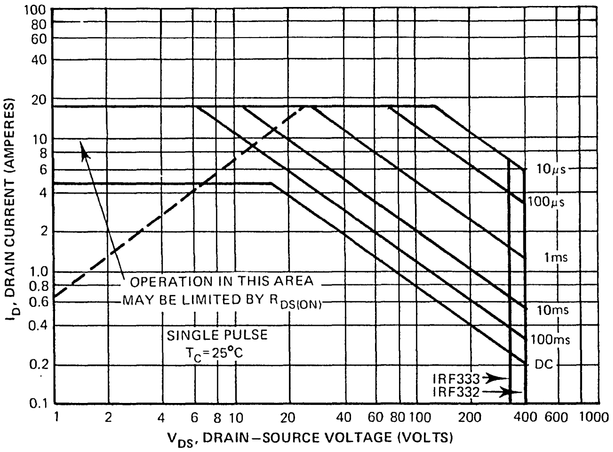
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 3A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

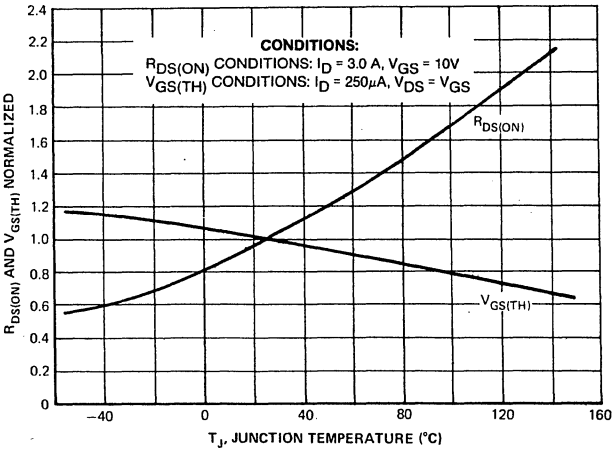
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	4.5	A
Pulsed Source Current	I_{SM}	—	—	18	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 4.5A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 5.5A, dI_S/dt = 100A/μs, T_C = 125° C)	t_{rr} Q_{RR}	— —	360 4.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF340,341
D86EQ2,Q1

10 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.55 Ω

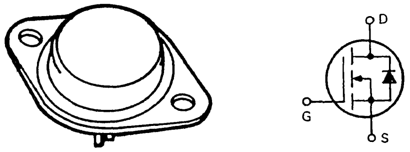
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

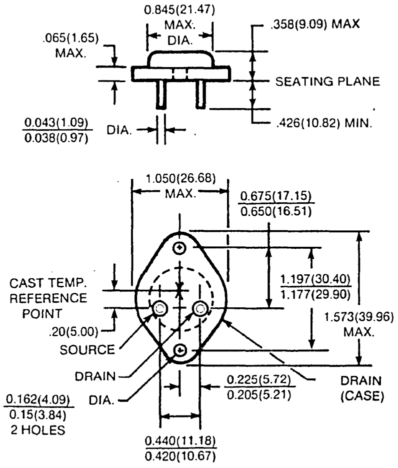
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF340/D86EQ2	IRF341/D86EQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	10 6	10 6	A A
Pulsed Drain Current[(1)]	I_{DM}	40	40	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	125 1.0	125 1.0	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF340/D86EQ2 IRF341/D86EQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	10	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5A)		$R_{DS(ON)}$	—	0.48	0.55	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5A)		g_{fs}	3.2	4.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	210	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	37	150	pF

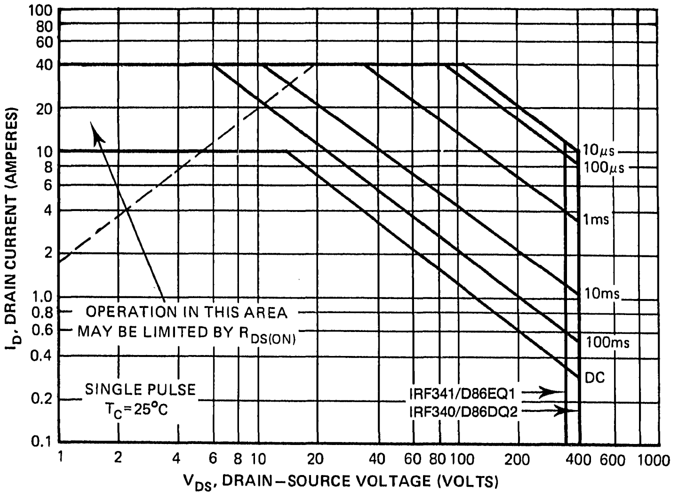
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 5A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	70	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

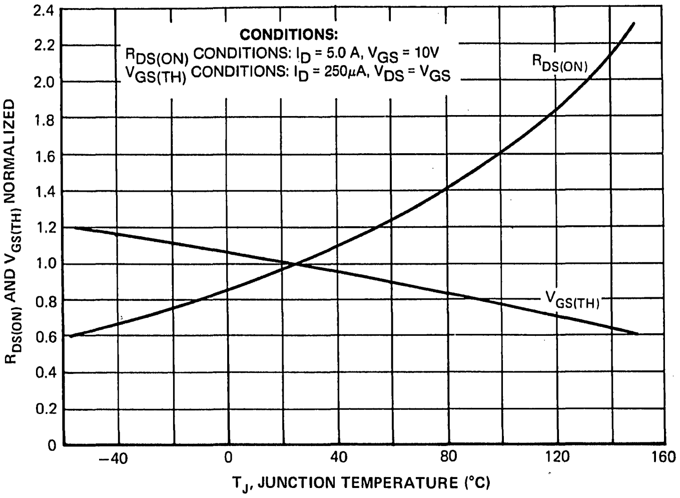
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	10	A
Pulsed Source Current	I_{SM}	—	—	40	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 10A)	V_{SD}	—	0.9	2.0	Volts
Reverse Recovery Time (I_S = 10A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	420 5.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF342,343

8 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.80 Ω

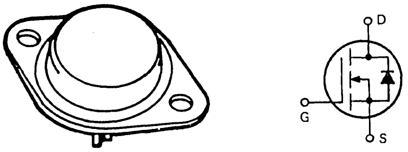
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

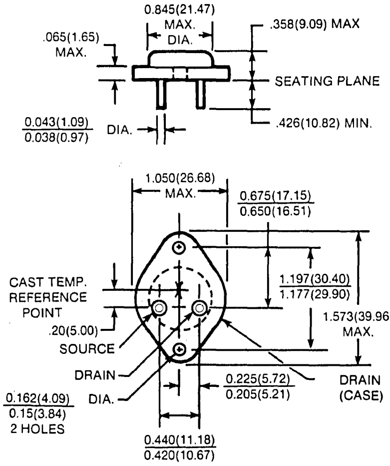
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF342	IRF343	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	8 5	8 5	A A
Pulsed Drain Current[1]	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF342 IRF343	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5A)		$R_{DS(ON)}$	—	0.70	0.80	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5A)		g_{fs}	3.2	4.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	210	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	37	150	pF

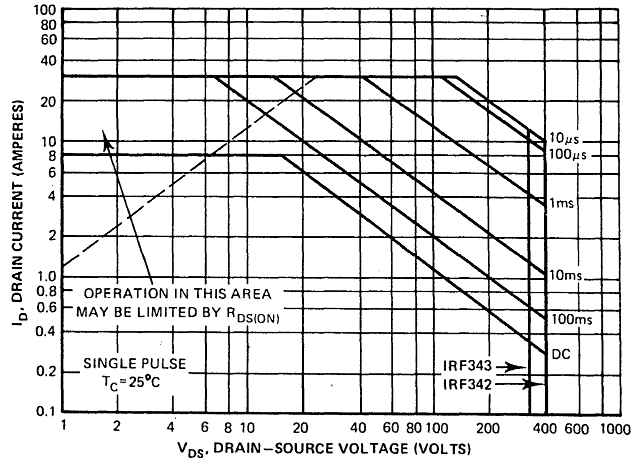
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 5, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	70	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

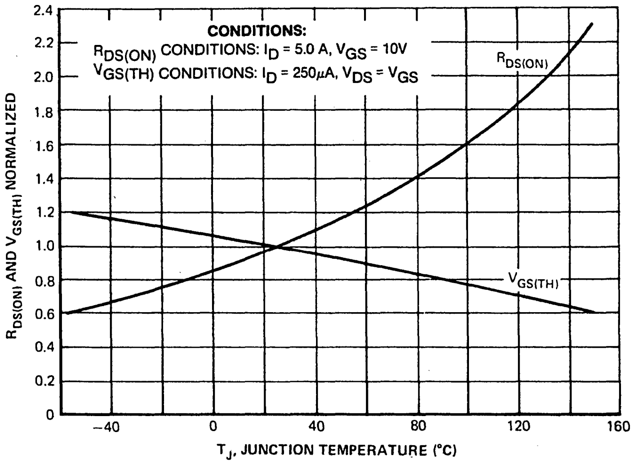
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	8	A
Pulsed Source Current	I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 8A)	V_{SD}	—	0.8	1.9	Volts
Reverse Recovery Time (I_S = 10A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	420 5.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF350,351
D86FQ2,Q1

15 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 0.3\ \Omega$

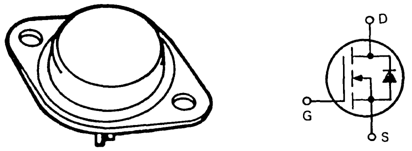
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

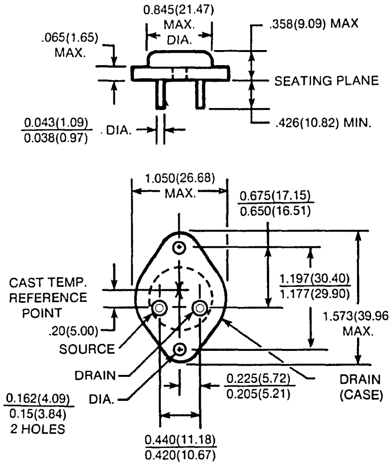
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF350/D86FQ2	IRF351/D86FQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	15 9	15 9	A A
Pulsed Drain Current(1)	I_{DM}	60	60	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25° C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF350/D86FQ2 (V_{GS} = 0V, I_D = 250 µA) IRF351/D86FQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	µA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 µA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	15	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)	$R_{DS(ON)}$	—	0.26	0.30	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)	g_{fs}	5.6	8.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	300	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	60	200	pF

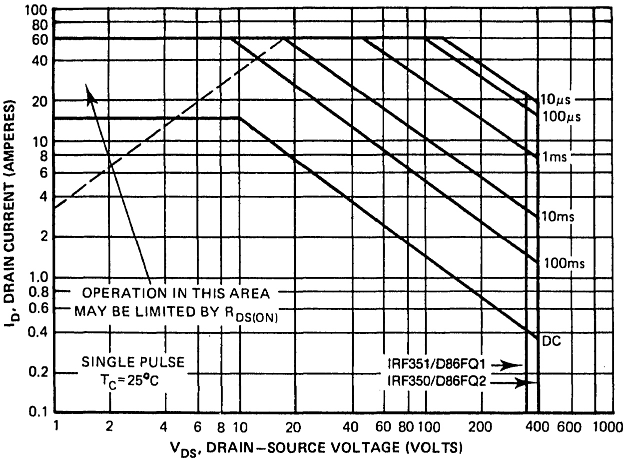
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	110	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	70	—	ns

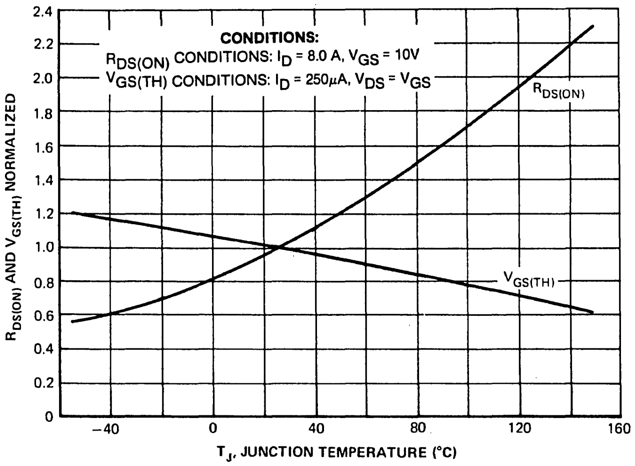
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	15	A
Pulsed Source Current	I_{SM}	—	—	60	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 15A)	V_{SD}	—	1.0	1.6	Volts
Reverse Recovery Time (I_S = 15A, dI_S/dt = 100A/µsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	500 6.5	— —	ns µC

*Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRF352,353

13 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.4 Ω

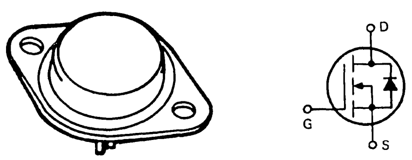
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

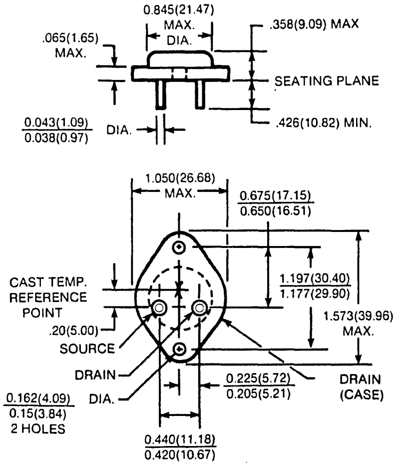
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF352	IRF353	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	13 8	13 8	A A
Pulsed Drain Current(1)	I_{DM}	52	52	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF352 IRF353	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	13	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)		$R_{DS(ON)}$	—	0.35	0.40	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)		g_{fs}	5.6	8.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	300	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	60	200	pF

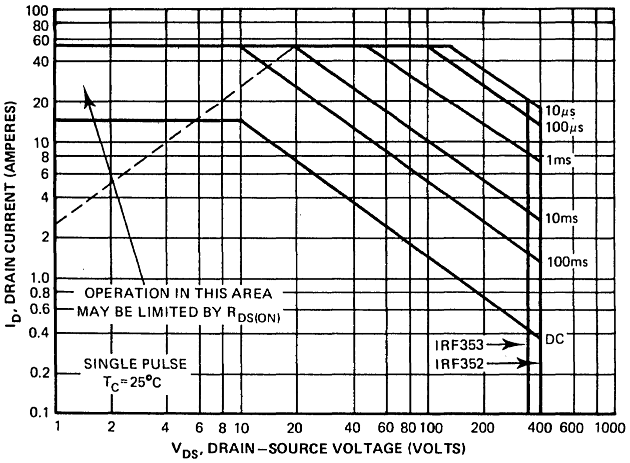
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	110	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	70	—	ns

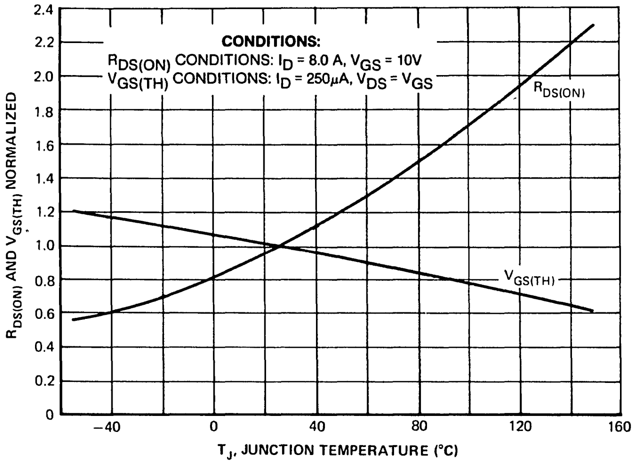
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	13	A
Pulsed Source Current	I_{SM}	—	—	52	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 13A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 15A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	500 6.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF430,431
D86DR2,R1

4.5 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 1.5\ \Omega$

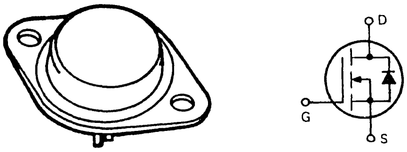
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

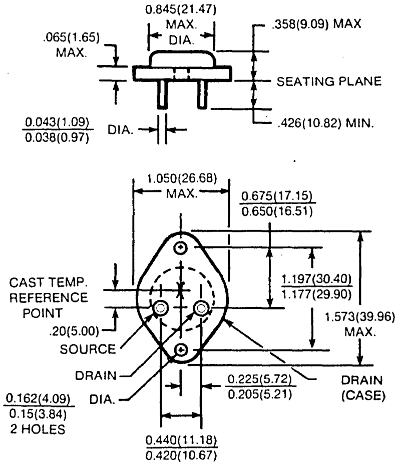
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF430/D86DR2	IRF431/D86DR1	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	4.5 3.0	4.5 3.0	A A
Pulsed Drain Current(1)	I_{DM}	18	18	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF430/D86DR2 IRF431/D86DR1	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	4.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.5A)		$R_{DS(ON)}$	—	1.3	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.5A)		g_{fs}	1.75	2.2	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	90	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	60	pF

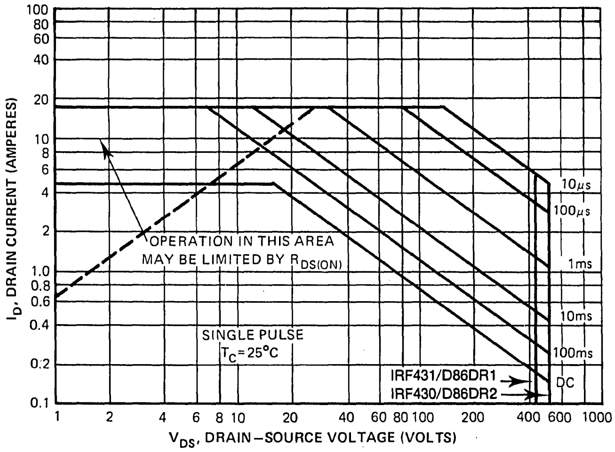
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	40	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

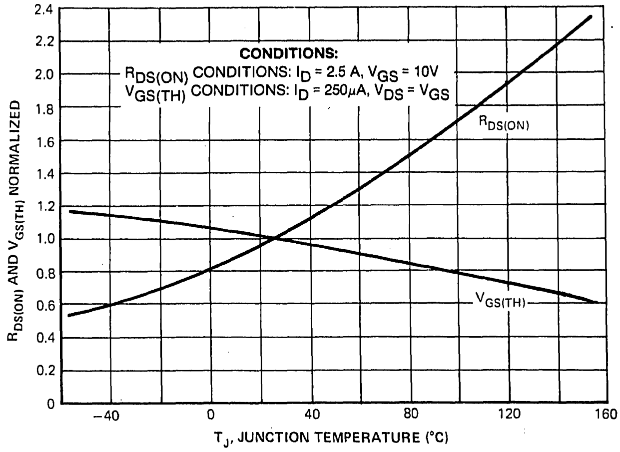
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	4.5	A
Pulsed Source Current	I_{SM}	—	—	18	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 4.5A)	V_{SD}	—	1.0	1.4	Volts
Reverse Recovery Time (I_S = 4.5A, dI_S/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	460 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF432,433

4.0 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 2.0 Ω

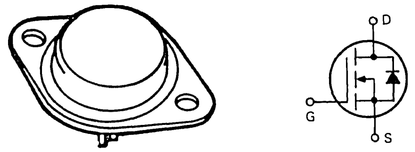
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

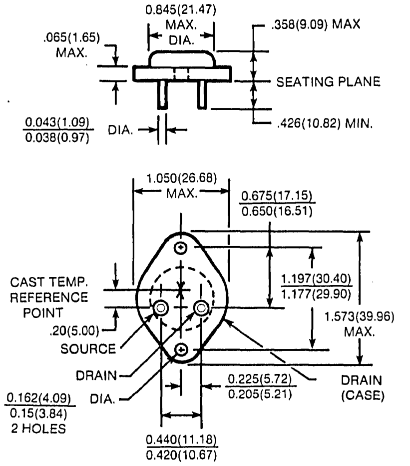
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF432	IRF433	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	4.0 2.5	4.0 2.5	A A
Pulsed Drain Current⁽¹⁾	I_{DM}	16	16	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF432 IRF433	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	4.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.5A)		$R_{DS(ON)}$	—	1.5	2.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.5A)		g_{fs}	1.75	2.2	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	90	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	60	pF

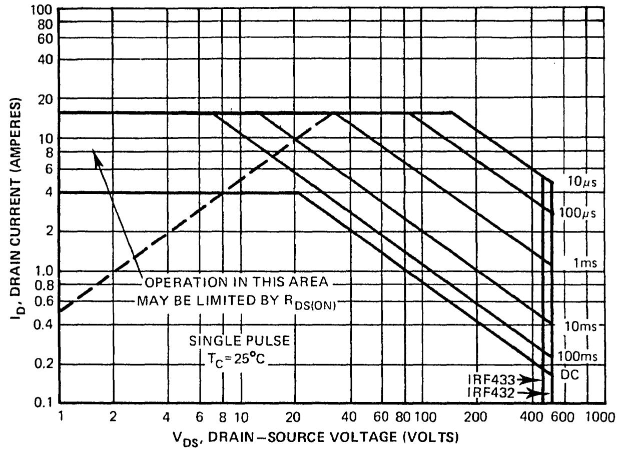
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	40	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

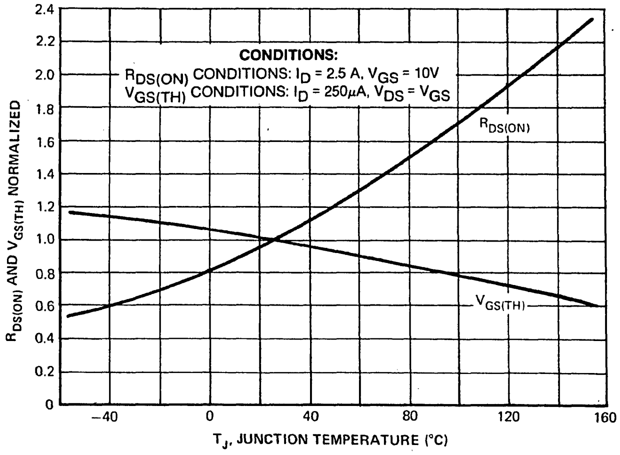
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	4.0	A
Pulsed Source Current	I_{SM}	—	—	16	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4.0A)	V_{SD}	—	1.0	1.3	Volts
Reverse Recovery Time (I_S = 4.5A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	460 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF440,441
D86ER2,R1

8 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 0.85\ \Omega$

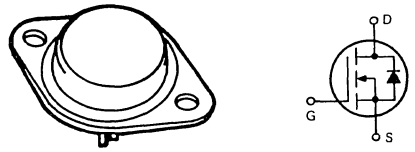
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

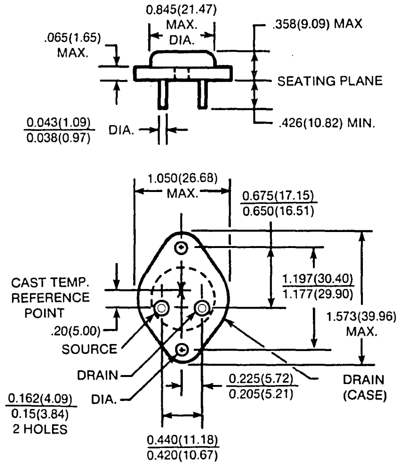
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF440/D86ER2	IRF441/D86ER1	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	8 5	8 5	A A
Pulsed Drain Current(1)	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF440/D86ER2 IRF441/D86ER1	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4A)		$R_{DS(ON)}$	—	0.75	0.85	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4A)		g_{fs}	2.8	3.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	190	350	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	28	150	pF

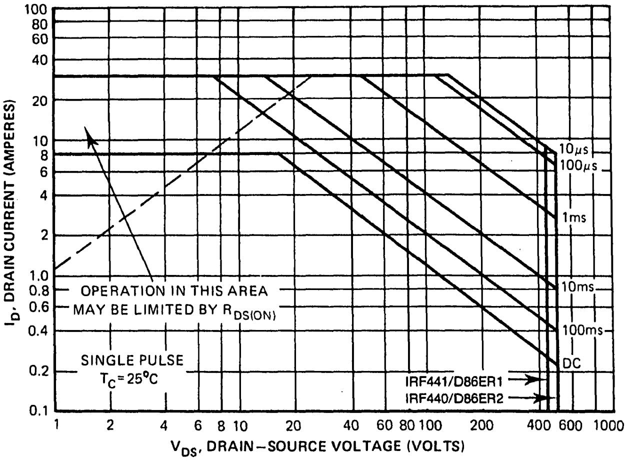
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 4A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

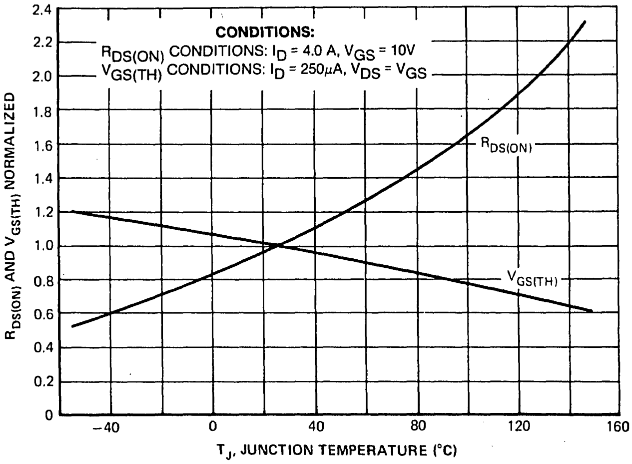
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	8	A
Pulsed Source Current		I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8A)		V_{SD}	—	0.9	2.0	Volts
Reverse Recovery Time (I_S = 8A, dI_s/dt = 100A/μsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	520 6.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF442,443

7 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 1.1\ \Omega$

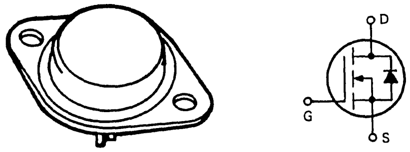
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

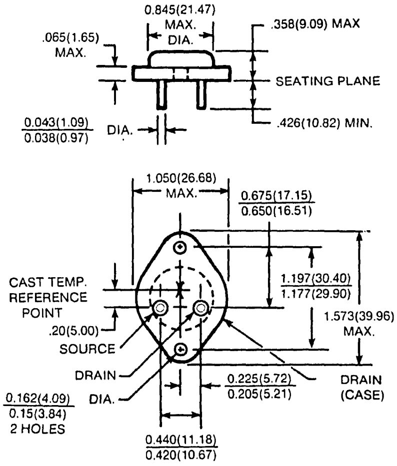
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF442	IRF443	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	7 4	7 4	A A
Pulsed Drain Current(1)	I_{DM}	28	28	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

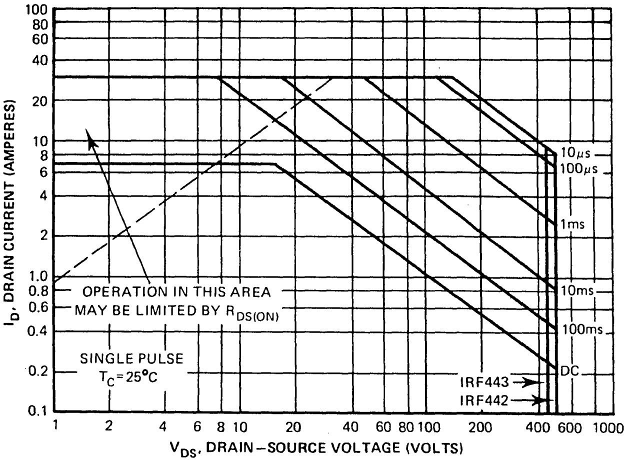
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

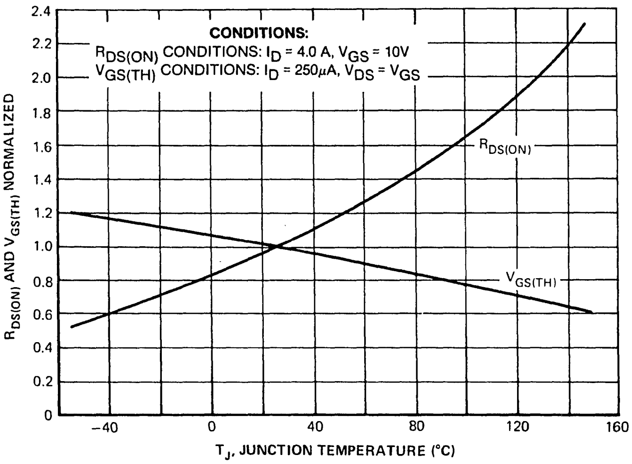
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF442 IRF443	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	7	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4A)		$R_{DS(ON)}$	—	1.0	1.1	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4A)		g_{fs}	2.8	3.5	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	190	350	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	28	150	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 4A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	7	A
Pulsed Source Current		I_{SM}	—	—	28	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 7A)		V_{SD}	—	0.8	1.9	Volts
Reverse Recovery Time (I_S = 8A, dI_S/dt = 100A/μsec, T_C = 125° C)		t_{rr} Q_{RR}	— —	520 6.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF450,451
D86FR2,R1

13 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 0.4 Ω

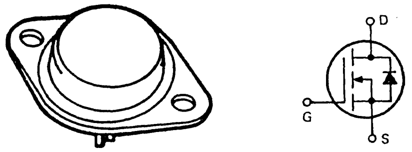
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

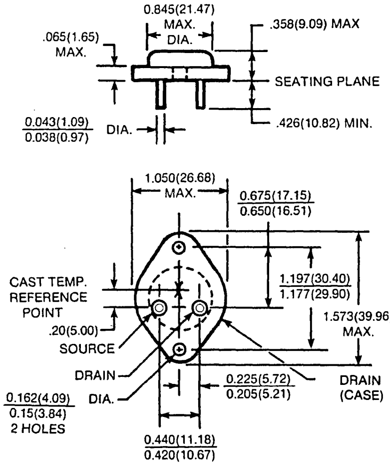
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF450/D86FR2	IRF451/D86FR1	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	13 8	13 8	A A
Pulsed Drain Current⁽¹⁾	I_{DM}	52	52	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRF450/D86FR2 IRF451/D86FR1	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	13	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 7A$)		$R_{DS(ON)}$	—	0.3	0.4	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 7A$)		g_{fs}	4.8	7.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	2800	3000	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	330	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	200	pF

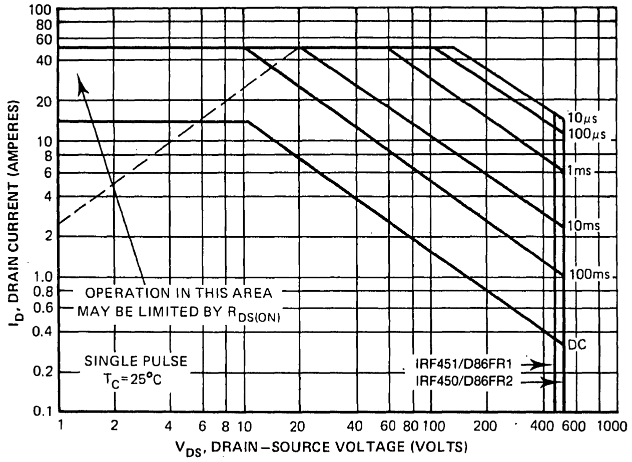
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	$V_{DS} = 225V$	$t_{d(on)}$	—	25	—	ns
Rise Time	$I_D = 7A$, $V_{GS} = 15V$	t_r	—	20	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	120	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	65	—	ns

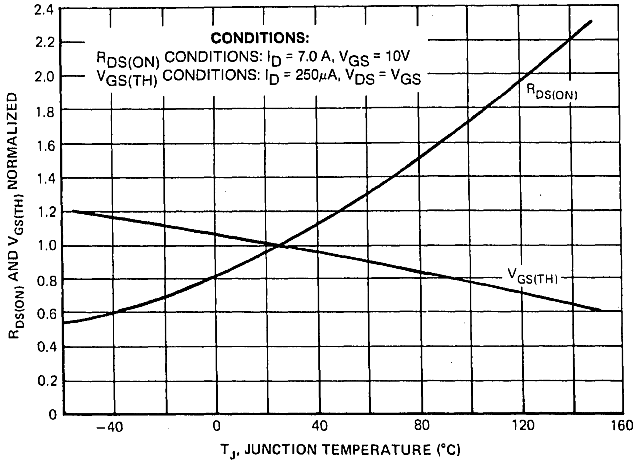
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	13	A
Pulsed Source Current	I_{SM}	—	—	52	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 13A$)	V_{SD}	—	0.9	1.4	Volts
Reverse Recovery Time ($I_S = 13A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	590 7.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF452,453

12 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 0.5\ \Omega$

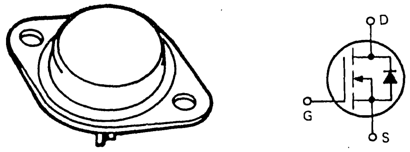
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

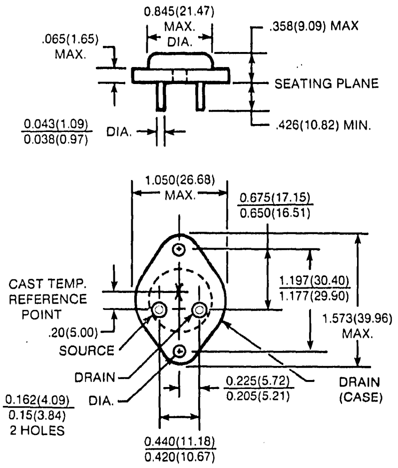
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF452	IRF453	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	12 7	12 7	A A
Pulsed Drain Current⁽¹⁾	I_{DM}	48	48	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	30	30	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRF452 IRF453	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	12	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 7A$)		$R_{DS(ON)}$	—	0.4	0.5	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 7A$)		g_{fs}	4.8	7.0	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	2800	3000	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	330	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	200	pF

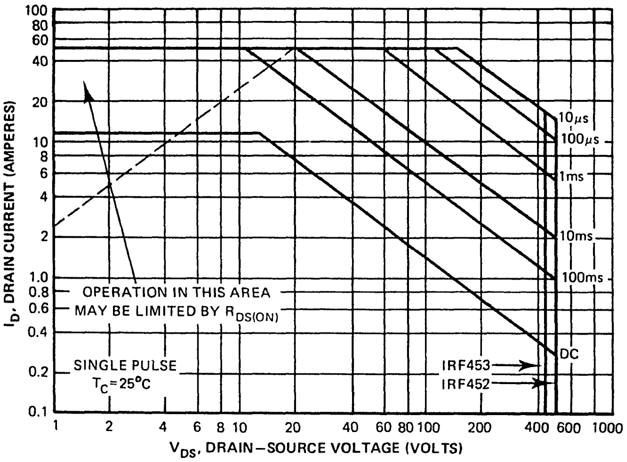
switching characteristics*

Turn-on Delay Time	$V_{DS} = 225V$	$t_{d(on)}$	—	25	—	ns
Rise Time	$I_D = 7A$, $V_{GS} = 15V$	t_r	—	20	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	120	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	65	—	ns

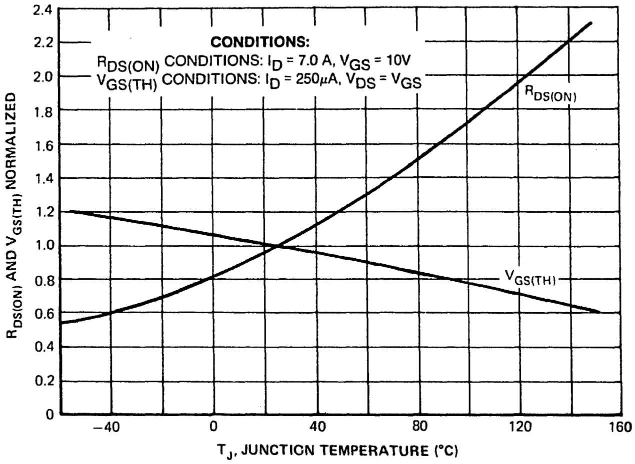
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	12	A
Pulsed Source Current	I_{SM}	—	—	48	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 12A$)	V_{SD}	—	0.9	1.3	Volts
Reverse Recovery Time ($I_S = 13A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	590 7.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF510,511
D84BL2,K2

4.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.6\ \Omega$

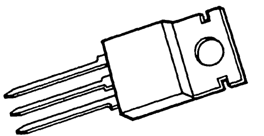
The IRF510, 511 Series is an N-Channel Enhancement-mode Power MOSFET utilizing GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

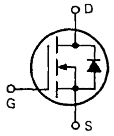
The IRF510, 511 design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

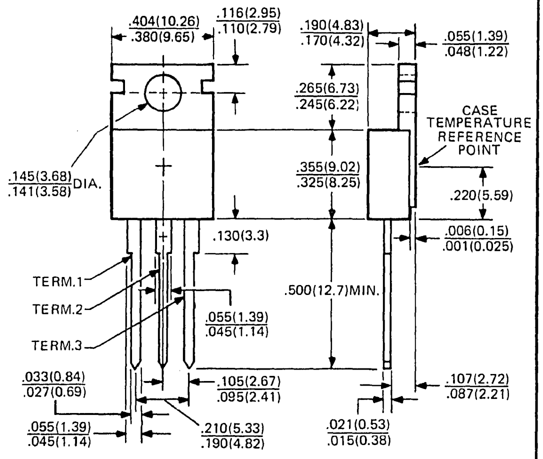
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF510/D84BL2	IRF511/D84BK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	100	60	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	4.0 2.5	4.0 2.5	A A
Pulsed Drain Current(1)	I_{DM}	16	16	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

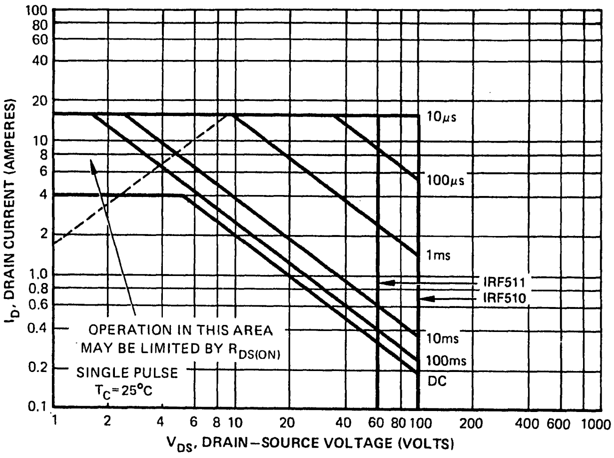
Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	6.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

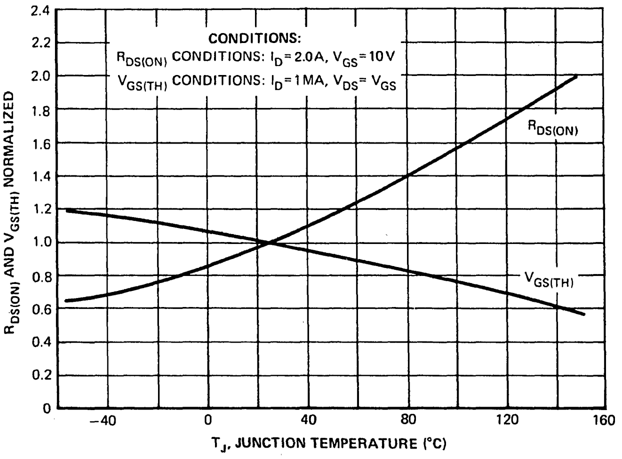
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA) IRF510/D84BL2 IRF511/D84BK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA
on characteristics*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 mA) T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$V_{DS(ON)}$	4.0	—	—	Volts
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2A)	$R_{DS(ON)}$	—	—	0.6	Ohms
Forward Transconductance (I_D = 2A)	g_{fs}	.8	1.1	—	mhos
dynamic characteristics					
Input Capacitance — V_{GS} = 0V	C_{iss}	—	145	200	pF
Output Capacitance — V_{DS} = 25V	C_{oss}	—	65	100	pF
Reverse Transfer Capacitance — f = 1 MHz	C_{rss}	—	20	25	pF
switching characteristics*					
Turn-on Delay Time — V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time — I_D = 1.5A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time — R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time — ($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns
source-drain diode ratings and characteristics*					
Continuous Source Current	I_S	—	—	4.0	A
Pulsed Source Current	I_{SM}	—	—	16	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4A)	V_{SD}	—	1.3	2.5	Volts
Reverse Recovery Time (I_S = 4A, di_S/dt = 100A/μs, V_{DS} = 40V max., T_C = 125°C)	t_{rr} Q_{RR}	— —	100 .3	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF512,513

3.5 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.8 Ω

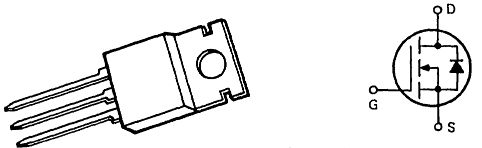
The IRF512, 513 Series is an N-Channel Enhancement-mode Power MOSFET utilizing GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

The IRF512, 513 design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

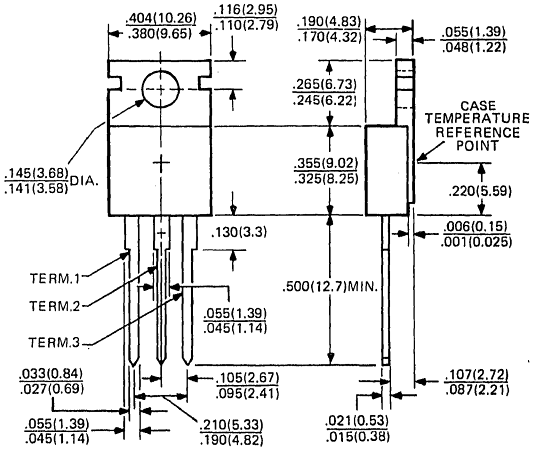
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF512	IRF513	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	3.5 2.0	3.5 2.0	A A
Pulsed Drain Current(1)	I_{DM}	14	14	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	6.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF512 (V_{GS} = 0V, I_D = 250 μA) IRF513	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 mA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$V_{DS(ON)}$	3.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2A)	$R_{DS(ON)}$	—	0.6	0.8	Ohms
Forward Transconductance (I_D = 1.5A)	g_{fs}	.8	1.1	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	145	200	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	65	100	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	20	25	pF

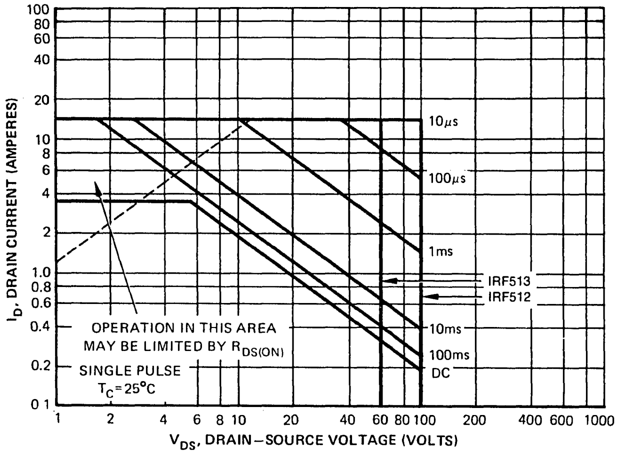
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

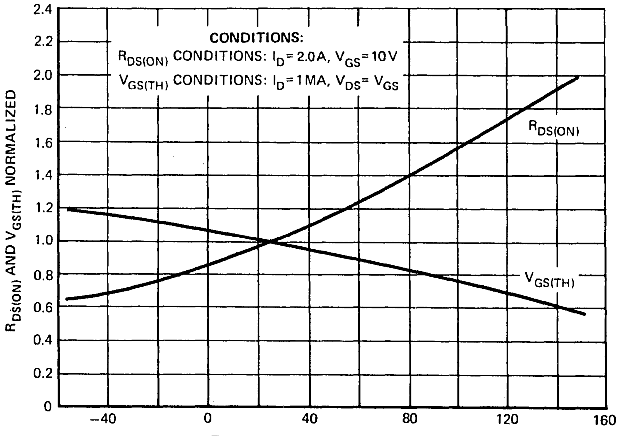
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	3.5	A
Pulsed Source Current	I_{SM}	—	—	14	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 3.5A)	V_{SD}	—	1.1	2.0	Volts
Reverse Recovery Time (I_S = 4A, di_S/dt = 100A/μs, V_{DS} = 40V max., T_C = 125°C)	t_{rr} Q_{RR}	— —	100 .3	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF520,521
D84CL2,K2

8 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.3 Ω

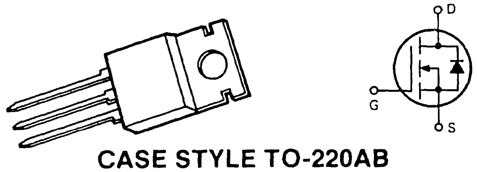
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

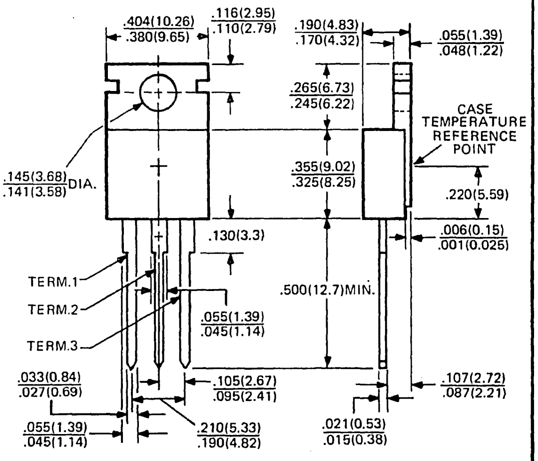
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF520/D84CL2	IRF521/D84CK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	8 5	8 5	A A
Pulsed Drain Current(1)	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	40 0.32	40 0.32	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 µA)	IRF520/D84CL2 IRF521/D84CK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	µA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 µA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	8.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4A)		$R_{DS(ON)}$	—	0.23	0.3	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4A)		g_{fs}	1.2	2.2	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	410	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	160	400	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	40	100	pF

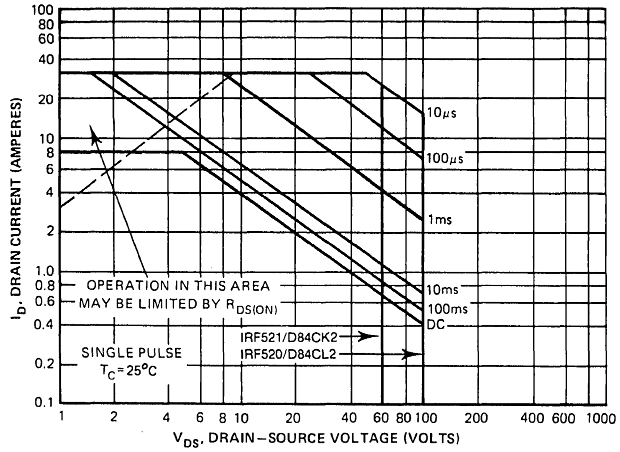
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 4A, V_{GS} = 15V	t_r	—	30	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

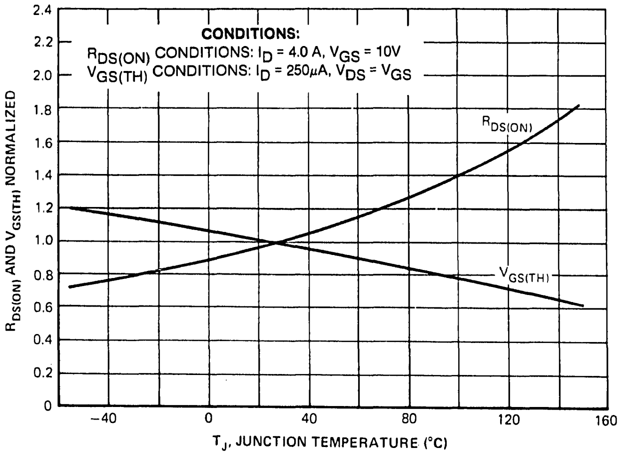
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	8	A
Pulsed Source Current		I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8A)		V_{SD}	—	1.0	2.5	Volts
Reverse Recovery Time (I_S = 8A, dI_S/dt = 100A/µsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	100 0.9	— —	ns µC

*Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRF522,523

7 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.4 Ω

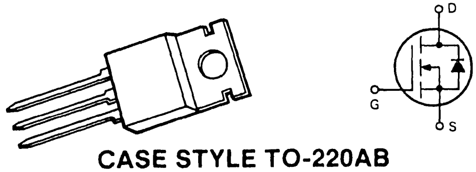
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

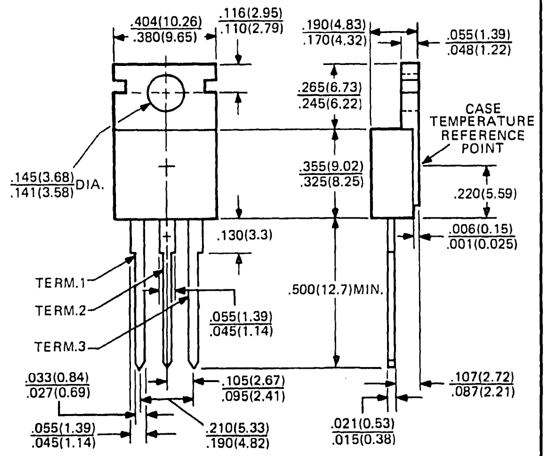
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF522	IRF523	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	7 4	7 4	A A
Pulsed Drain Current(1)	I_{DM}	28	28	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	40 0.32	40 0.32	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF522 IRF523	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	7.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4A)		$R_{DS(ON)}$	—	0.3	0.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4A)		g_{fs}	1.2	2.2	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	410	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	160	400	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	40	100	pF

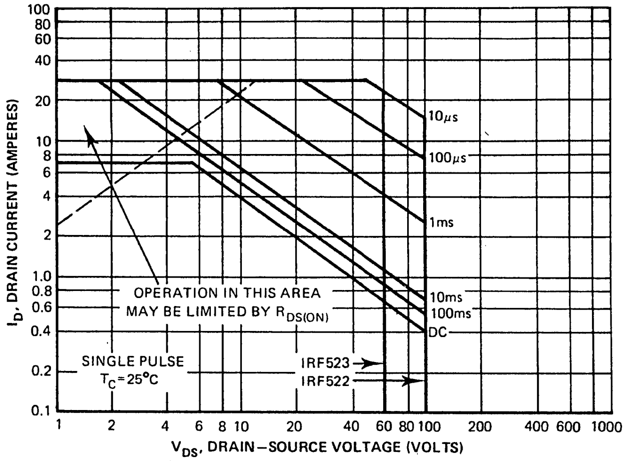
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 4.0A, V_{GS} = 15V	t_r	—	30	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

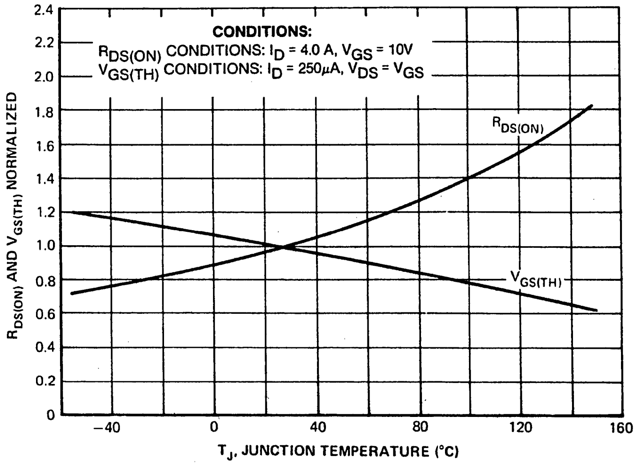
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	7	A
Pulsed Source Current	I_{SM}	—	—	28	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 7A)	V_{SD}	—	1.0	2.3	Volts
Reverse Recovery Time (I_S = 8A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	100 0.9	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRF530,531
D84DL2,K2

14.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.18 Ω

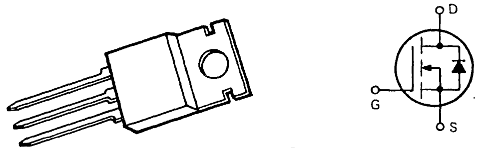
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

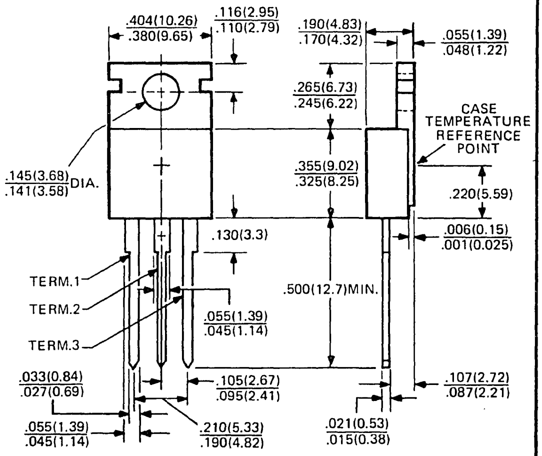
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF530/D84DL2	IRF531/D84DK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	14 9	14 9	A A
Pulsed Drain Current(1)	I_{DM}	56	56	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF530/D84DL2 IRF531/D84DK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	14.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)		$R_{DS(ON)}$	—	0.15	0.18	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)		g_{fs}	3.2	4.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	240	500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	150	pF

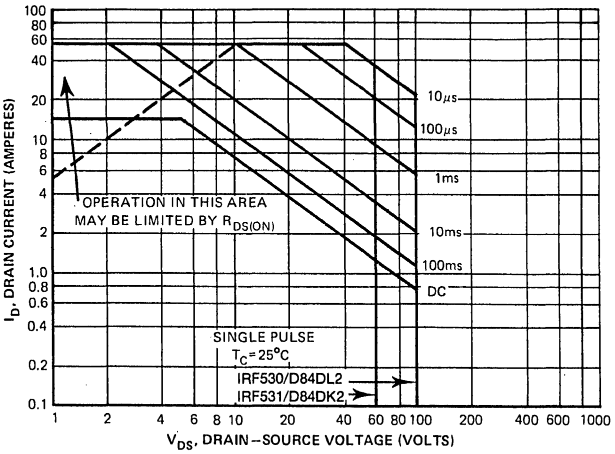
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	55	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

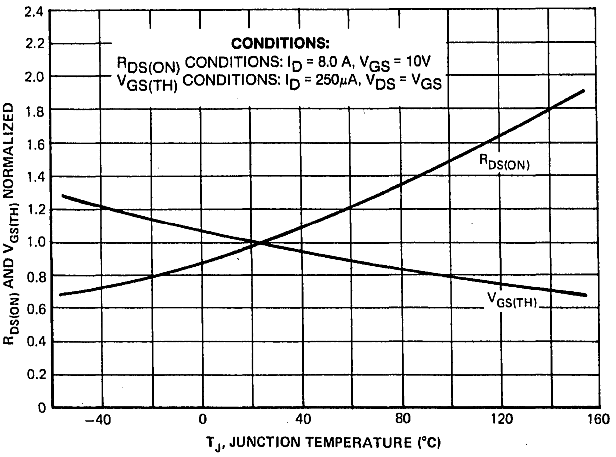
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	14	A
Pulsed Source Current	I_{SM}	—	—	56	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 14A)	V_{SD}	—	1.0	2.5	Volts
Reverse Recovery Time (I_S = 14A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	210 1.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF532,533

12.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.25\ \Omega$

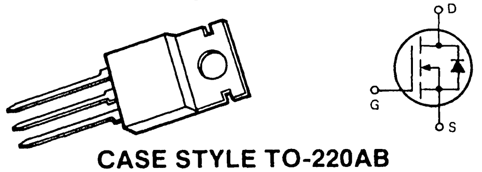
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

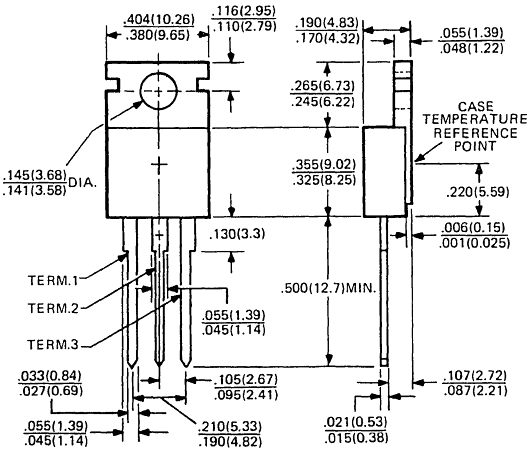
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF532	IRF533	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	12 8	12 8	A A
Pulsed Drain Current(1)	I_{DM}	48	48	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

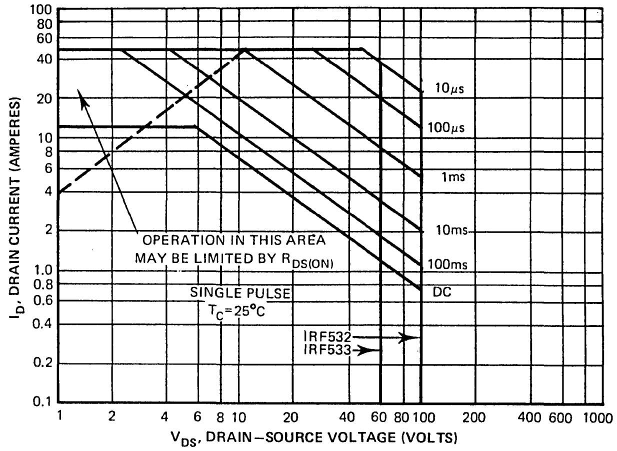
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

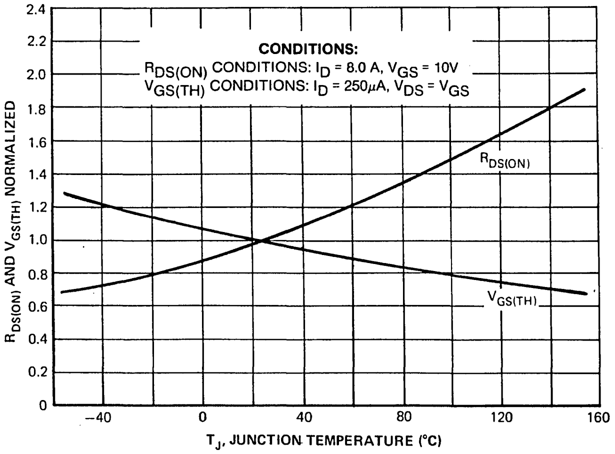
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Drain-Source Breakdown Voltage IRF532 (V_{GS} = 0V, I_D = 250 μA) IRF533	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA
on characteristics*					
Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	12	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)	$R_{DS(ON)}$	—	0.18	0.25	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)	g_{fs}	3.2	4.0	—	mhos
dynamic characteristics					
Input Capacitance — V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance — V_{DS} = 25V	C_{oss}	—	240	500	pF
Reverse Transfer Capacitance — f = 1 MHz	C_{rss}	—	55	150	pF
switching characteristics*					
Turn-on Delay Time — V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time — I_D = 8A, V_{GS} = 15V	t_r	—	55	—	ns
Turn-off Delay Time — R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time — ($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns
source-drain diode ratings and characteristics*					
Continuous Source Current	I_S	—	—	12	A
Pulsed Source Current	I_{SM}	—	—	48	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 12A)	V_{SD}	—	1.0	2.3	Volts
Reverse Recovery Time (I_S = 14A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	210 1.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF540,541
D84EL2,K2

27 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.085 Ω

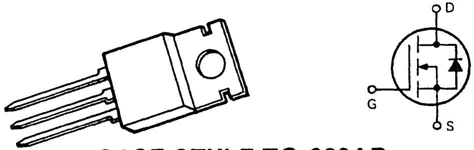
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

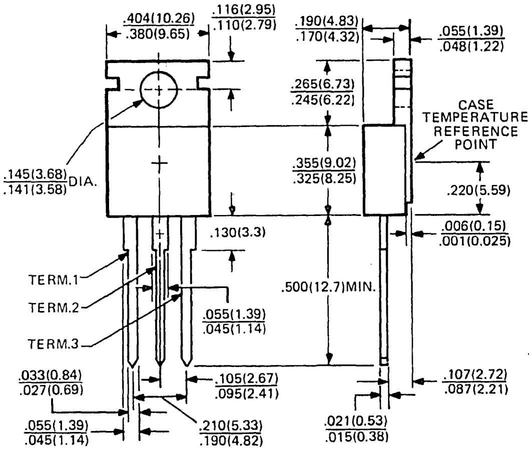
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF540/D84EL2	IRF541/D84EK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	27 17	27 17	A A
Pulsed Drain Current(1)	I_{DM}	108	108	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA) IRF540/D84EL2	BV_{DSS}	100	—	—	Volts
IRF541/D84EK2		60	—	—	
Zero Gate Voltage Drain Current	I_{DSS}				
(V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C)		—	—	250	μA
(V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		—	—	1000	
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA) T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	27	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 15A)	$R_{DS(ON)}$	—	0.073	0.085	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 15A)	g_{fs}	5.4	7.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	550	800	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	300	pF

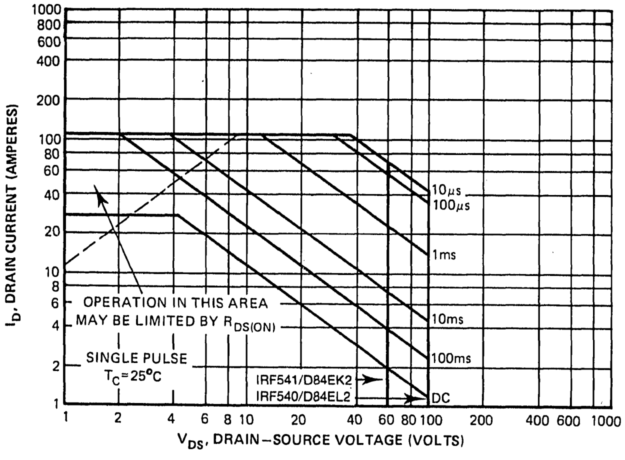
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 15A, V_{GS} = 15V	t_r	—	115	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

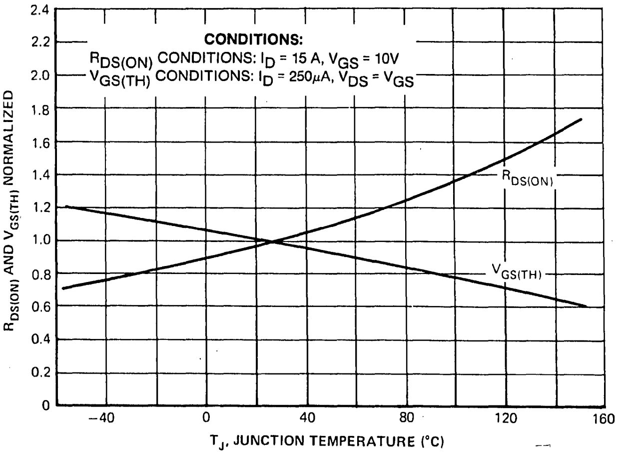
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	27	A
Pulsed Source Current	I_{SM}	—	—	108	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 27A)	V_{SD}	—	1.2	2.5	Volts
Reverse Recovery Time (I_S = 27A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	250 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF542,543

24 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.11 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

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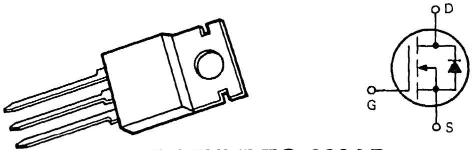
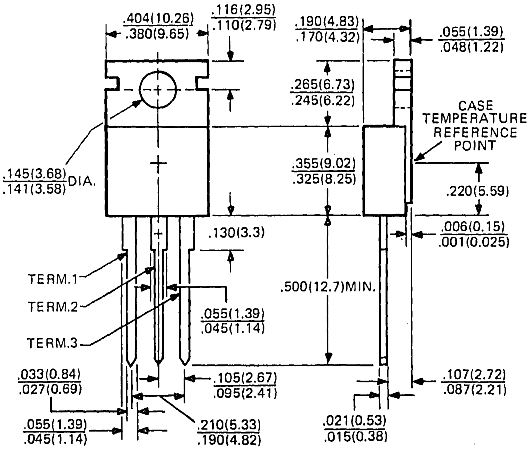
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF542	IRF543	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	24 15	24 15	A A
Pulsed Drain Current(1)	I_{DM}	96	96	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRF542 IRF543	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	24	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 15A$)		$R_{DS(ON)}$	—	0.09	0.11	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 15A$)		g_{fs}	5.4	7.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	1400	1600	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	550	800	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	300	pF

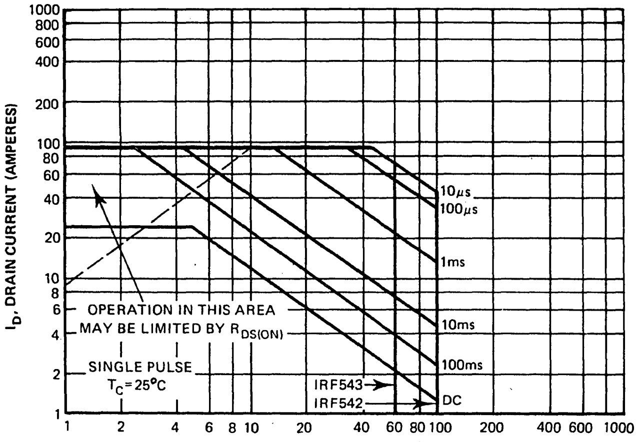
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	20	—	ns
Rise Time	$I_D = 15A$, $V_{GS} = 15V$	t_r	—	115	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	30	—	ns

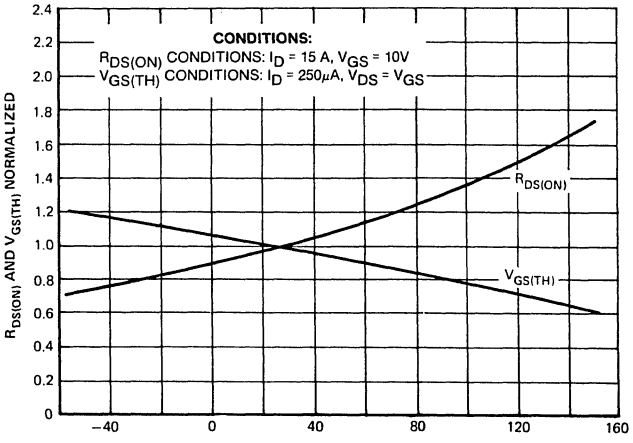
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	24	A
Pulsed Source Current	I_{SM}	—	—	96	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 24A$)	V_{SD}	—	1.1	2.3	Volts
Reverse Recovery Time ($I_S = 27A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	250 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF610,611
D84BN2,M2

2.5 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 1.5 Ω

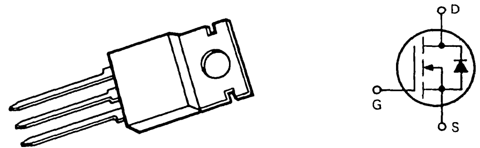
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

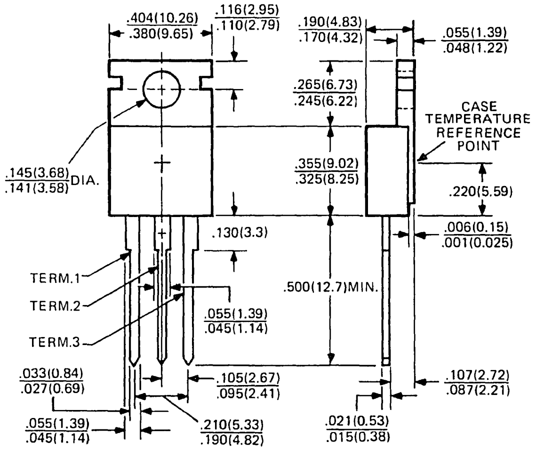
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF610/D84BN2	IRF611/D84BM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	2.5 1.5	2.5 1.5	A A
Pulsed Drain Current(1)	I_{DM}	10	10	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	6.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF610/D84BN2	BV_{DSS}	200	—	—	Volts
($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRF611/D84BM2		150	—	—	
Zero Gate Voltage Drain Current	I_{DSS}				
(V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$)		—	—	250	µA
(V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		—	—	1000	
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)	$I_{D(ON)}$	2.5	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.25A$)	$R_{DS(ON)}$	—	1.28	1.5	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 1.25A$)	g_{fs}	0.72	0.75	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	120	150	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	40	80	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	10	25	pF

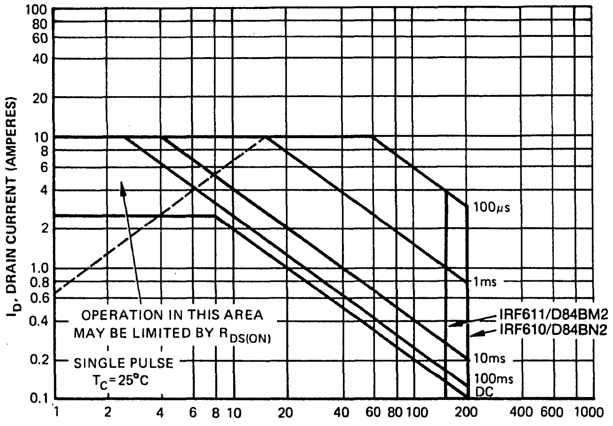
switching characteristics*

Turn-on Delay Time	$V_{DS} = 90V$	$t_{d(on)}$	—	5	—	ns
Rise Time	$I_D = 1.25A$, $V_{GS} = 15V$	t_r	—	15	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	10	—	ns

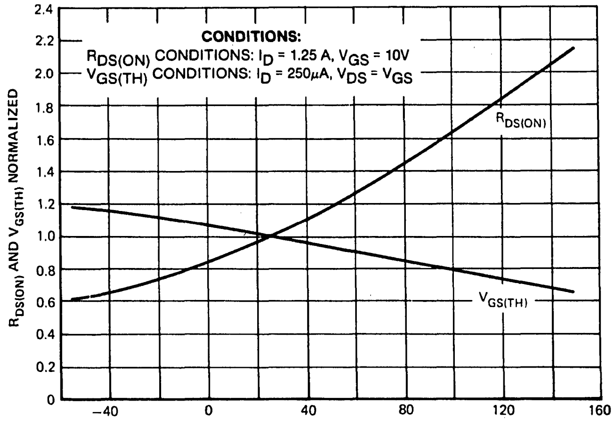
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.5	A
Pulsed Source Current	I_{SM}	—	—	10	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 2.5A$)	V_{SD}	—	0.9	2.0	Volts
Reverse Recovery Time	t_{rr}	—	150	—	ns
($I_S = 2.5A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	Q_{RR}	—	0.9	—	µC

*Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF612,613

2.0 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 2.4\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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Features

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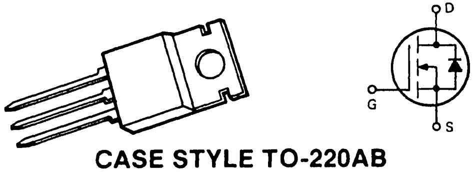
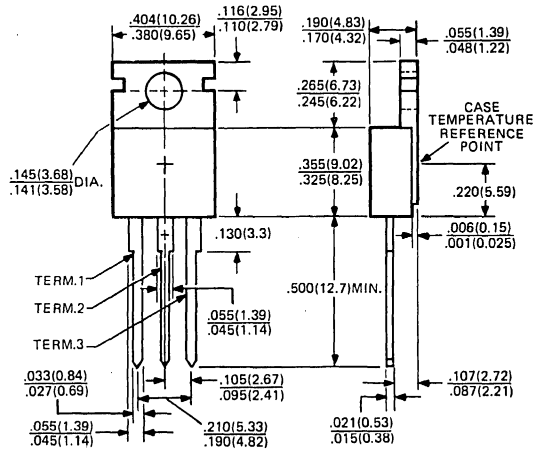
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF612	IRF613	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	2.0 1.25	2.0 1.25	A A
Pulsed Drain Current(1)	I_{DM}	8	8	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	6.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF612 (V_{GS} = 0V, I_D = 250 μA) IRF613	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	2.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.25A)	$R_{DS(ON)}$	—	1.5	2.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.25A)	g_{fs}	0.72	0.75	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	120	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	40	80	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	10	25	pF

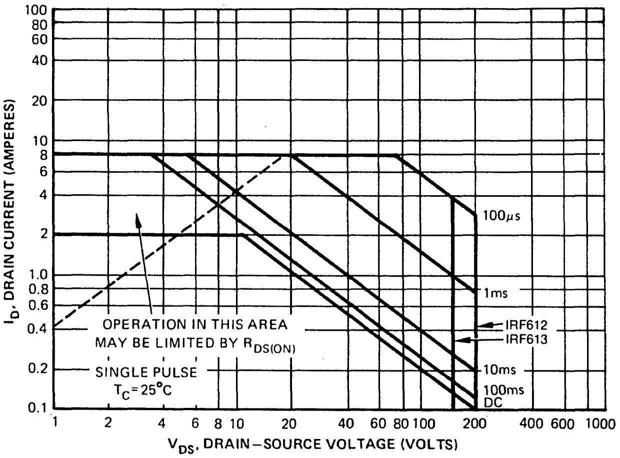
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	5	—	ns
Rise Time	I_D = 1.25A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

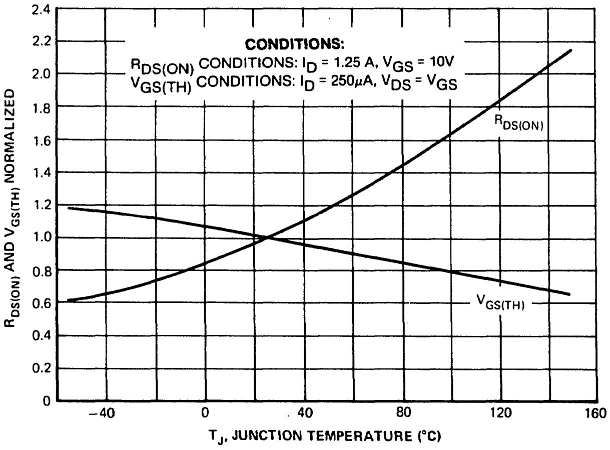
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.0	A
Pulsed Source Current	I_{SM}	—	—	8.0	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.0A)	V_{SD}	—	0.8	1.8	Volts
Reverse Recovery Time (I_S = 2.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	150 0.9	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF620,621
D84CN2,M2

5 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.8\ \Omega$

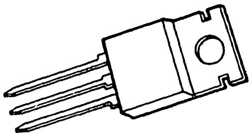
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

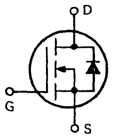
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

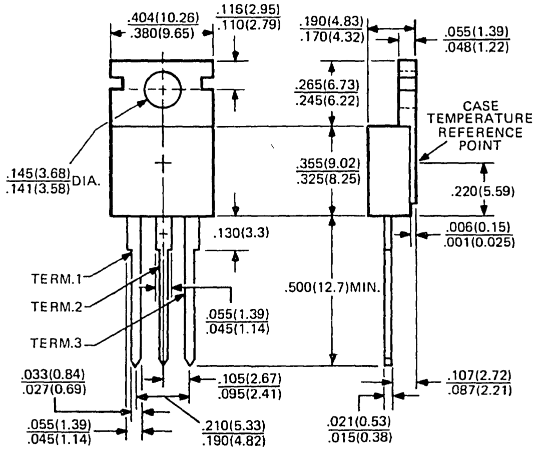
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF620/D86CN2	IRF621/D84CM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	5 3	5 3	A A
Pulsed Drain Current(1)	I_{DM}	20	20	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	40 3.2	40 3.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF620/D84CN2 (V_{GS} = 0V, I_D = 250 μA) IRF621/D84DM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	5.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.5A)	$R_{DS(ON)}$	—	0.6	0.8	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.5A)	g_{fs}	1.2	1.8	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	80	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

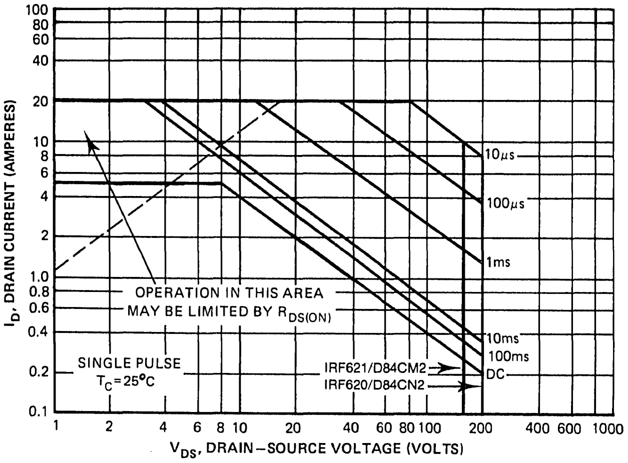
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

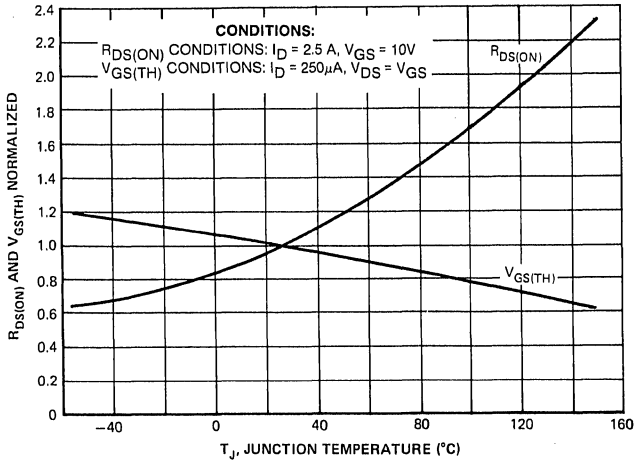
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	5	A
Pulsed Source Current	I_{SM}	—	—	20	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 5A)	V_{SD}	—	1.0	1.8	Volts
Reverse Recovery Time (I_S = 5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	270 1.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF622,623

4 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 1.2 Ω

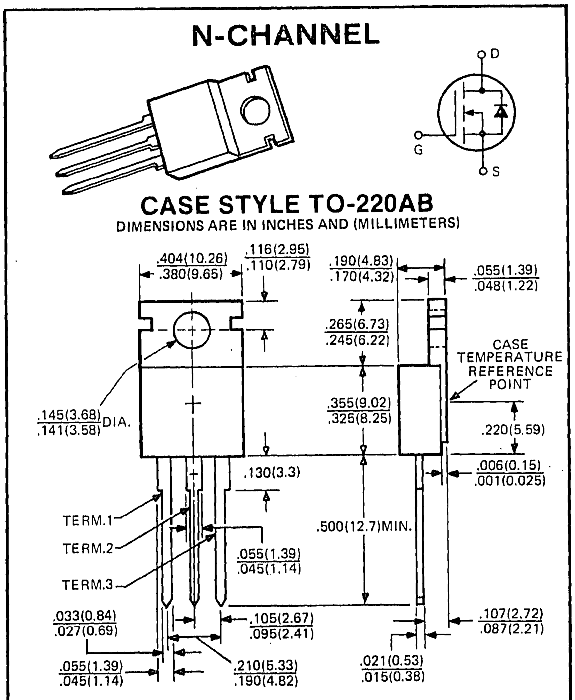
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF622	IRF623	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	4.0 2.5	4.0 2.5	A A
Pulsed Drain Current(1)	I_{DM}	16	16	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	40 0.32	40 0.32	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF622 IRF623	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	4.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.5A)		$R_{DS(ON)}$	—	0.8	1.2	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.5A)		g_{fs}	1.2	1.8	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	80	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

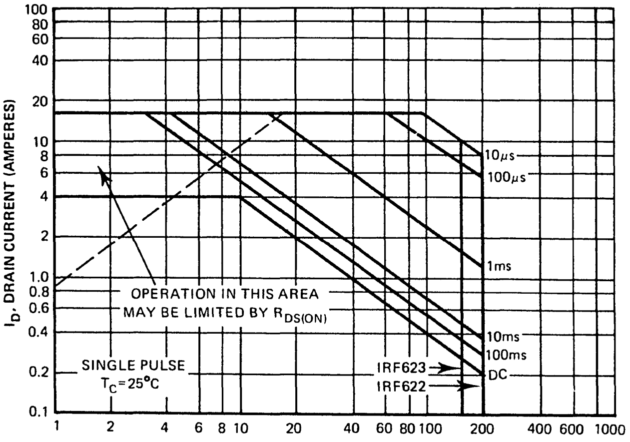
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

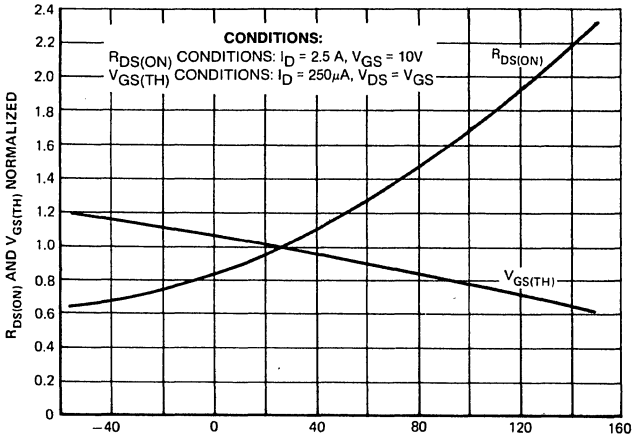
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	4	A
Pulsed Source Current	I_{SM}	—	—	16	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4A)	V_{SD}	—	1.0	1.4	Volts
Reverse Recovery Time (I_S = 5A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	270 1.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF630,631
D84DN2,M2

9.0 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.4\ \Omega$

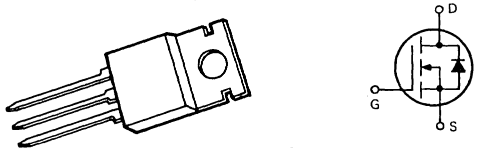
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

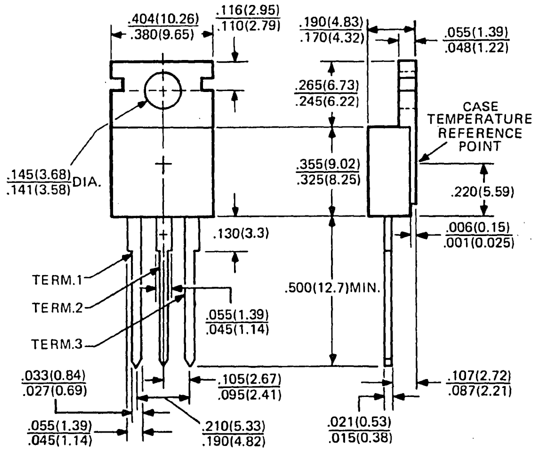
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF630/D84DN2	IRF631/D84DM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	9.0 6.0	9.0 6.0	A A
Pulsed Drain Current(1)	I_{DM}	36	36	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF630/D84DN2 (V_{GS} = 0V, I_D = 250 μA) IRF631/D84DM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	9.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5.0A)	$R_{DS(ON)}$	—	0.34	0.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5.0A)	g_{fs}	2.4	3.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	150	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	30	150	pF

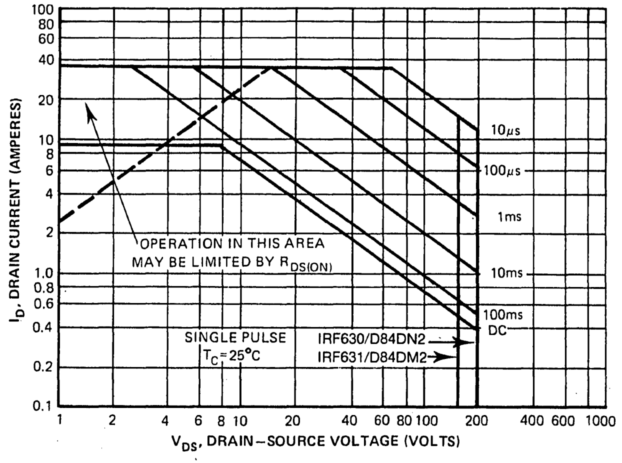
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 5.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

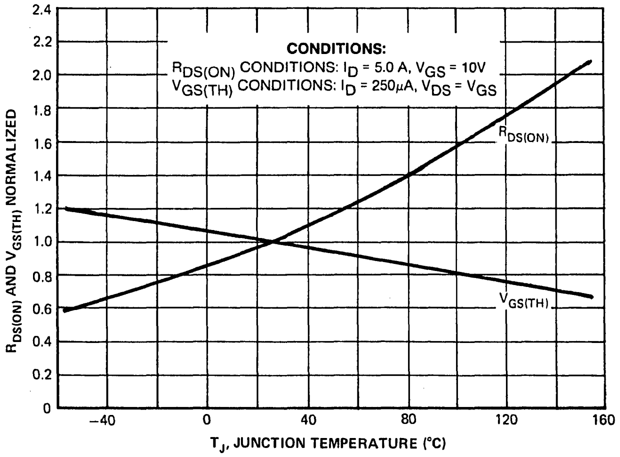
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	9.0	A
Pulsed Source Current	I_{SM}	—	—	36.0	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 9.0A)	V_{SD}	—	1.0	2.0	Volts
Reverse Recovery Time (I_S = 9.0A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	300 2.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF632,633

8.0 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.6 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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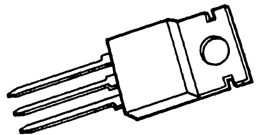
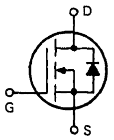
Features

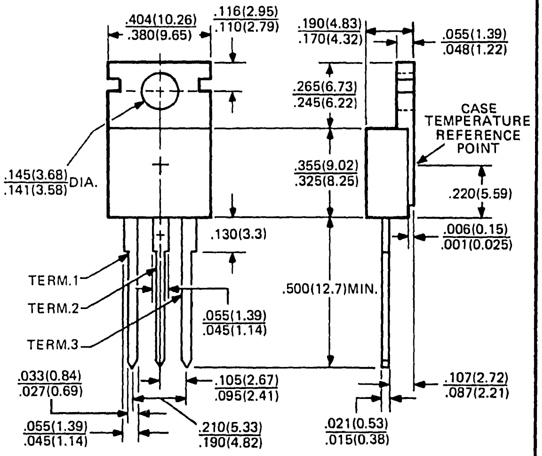
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF632	IRF633	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	8.0 5.0	8.0 5.0	A A
Pulsed Drain Current(1)	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF632 (V_{GS} = 0V, I_D = 250 μA) IRF633	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	8.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5.0A)	$R_{DS(ON)}$	—	0.4	0.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5.0A)	g_{fs}	2.4	3.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	150	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	30	150	pF

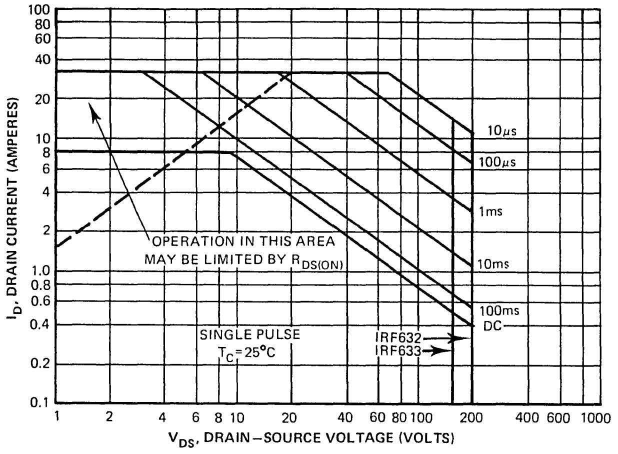
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 5.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

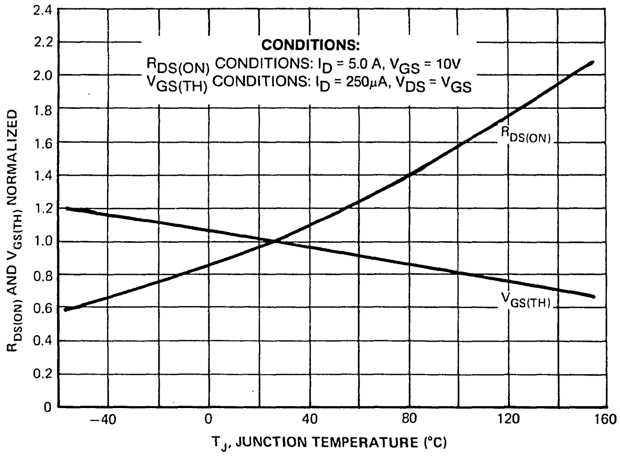
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	8.0	A
Pulsed Source Current	I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8.0A)	V_{SD}	—	1.0	1.8	Volts
Reverse Recovery Time (I_S = 9.0A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	300 2.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF640,641
D84EN2,M2

18 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.18 Ω

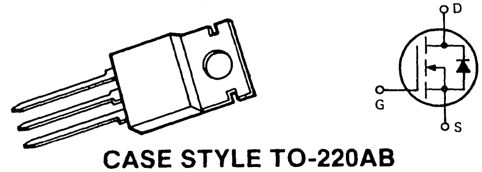
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

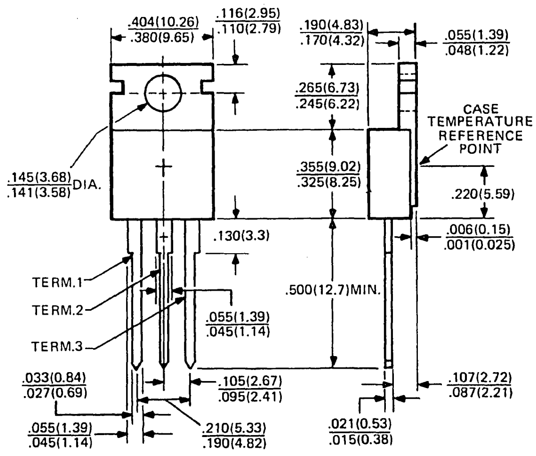
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF640/D84EN2	IRF641/D84EM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	18 11	18 11	A A
Pulsed Drain Current(1)	I_{DM}	72	72	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF640/D84EN2 IRF641/D84EM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	18	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 10A)		$R_{DS(ON)}$	—	0.14	0.18	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 10A)		g_{fs}	4.8	6.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	310	750	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	65	300	pF

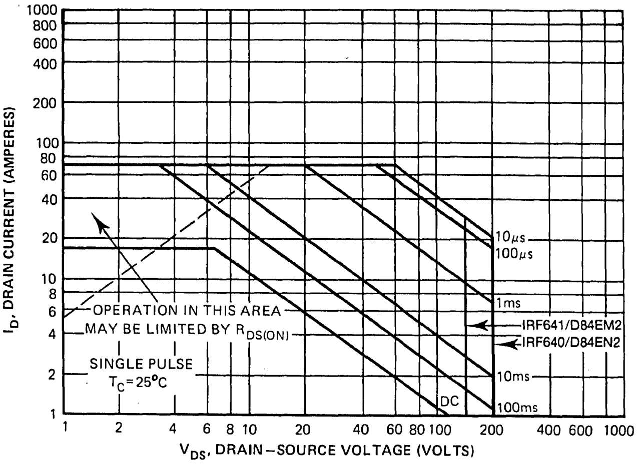
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 10A, V_{GS} = 15V	t_r	—	40	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

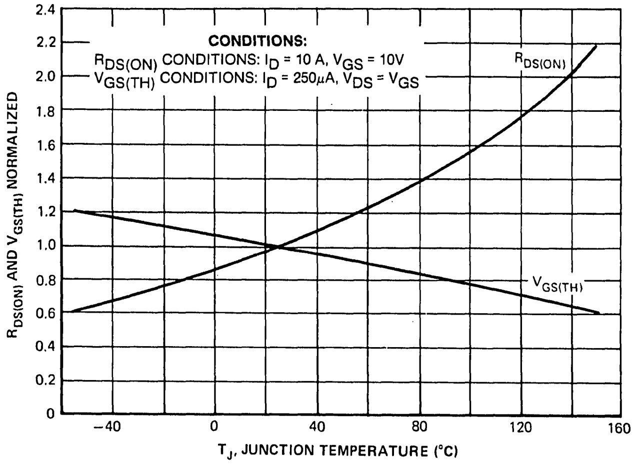
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	18	A
Pulsed Source Current	I_{SM}	—	—	72	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 18A)	V_{SD}	—	1.0	2.0	Volts
Reverse Recovery Time (I_S = 18A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	330 3.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF642,643

16 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.22 Ω

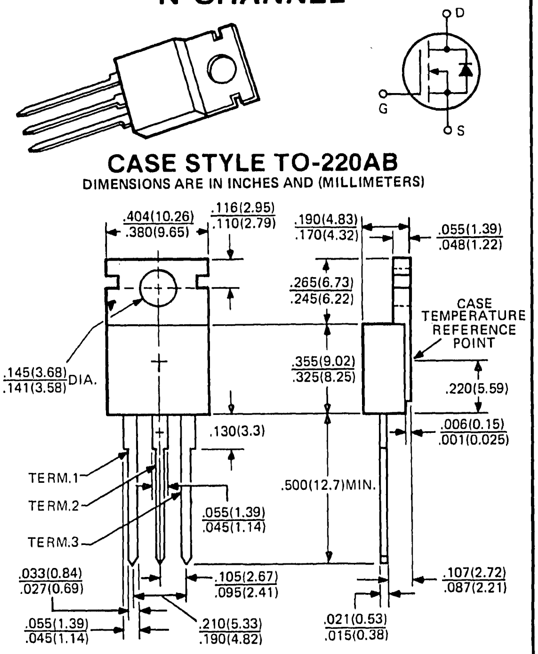
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF642	IRF643	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	16 10	16 10	A A
Pulsed Drain Current(1)	I_{DM}	64	64	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

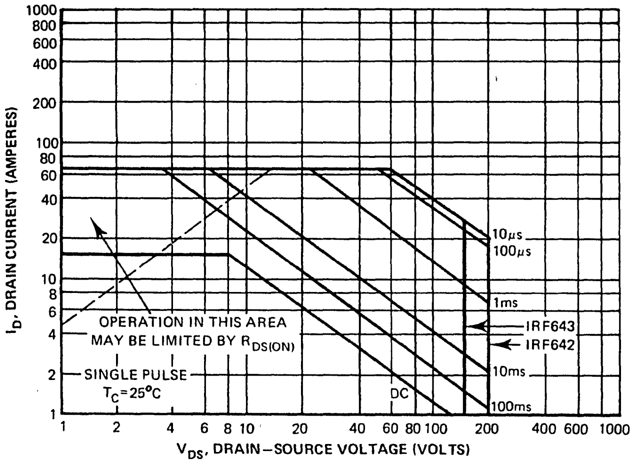
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

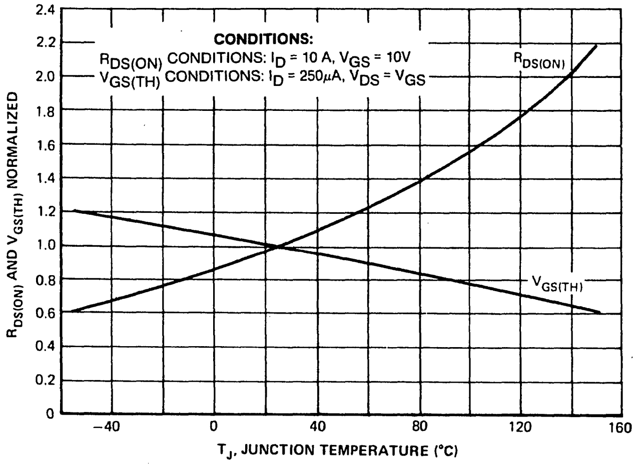
electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 µA)	IRF642 IRF643	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	µA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 µA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	16	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 10A)		$R_{DS(ON)}$	—	0.18	0.22	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 10A)		g_{fs}	4.8	6.0	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 10V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	310	750	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	65	300	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 0A, V_{GS} = 15V	t_r	—	40	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	16	A
Pulsed Source Current		I_{SM}	—	—	64	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 10V, I_S = 16A)		V_{SD}	—	1.0	1.9	Volts
Reverse Recovery Time (I_S = 18A, dI_s/dt = 100A/µsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	330 3.5	— —	ns µC

*Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF710,711
D84BQ2,BQ1

1.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 3.6 Ω

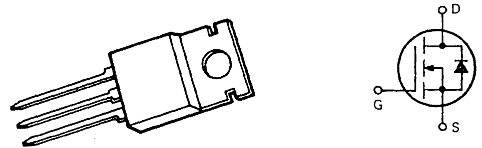
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

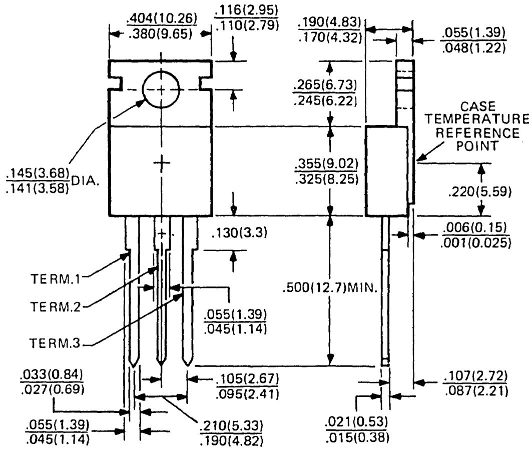
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF710/D84BQ2	IRF711/D84BQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	1.5 1.0	1.5 1.0	A
Pulsed Drain Current(1)	I_{DM}	6	6	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	6.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA) IRF710/D84BQ2 IRF711/D84BQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	1.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.5A)	$R_{DS(ON)}$	—	—	3.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.8A)	g_{fs}	.45	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	50	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	15	pF

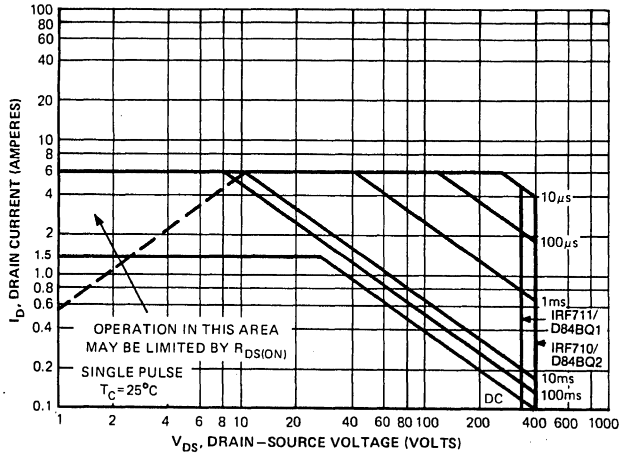
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	10	—	ns
Rise Time	I_D = 0.8A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

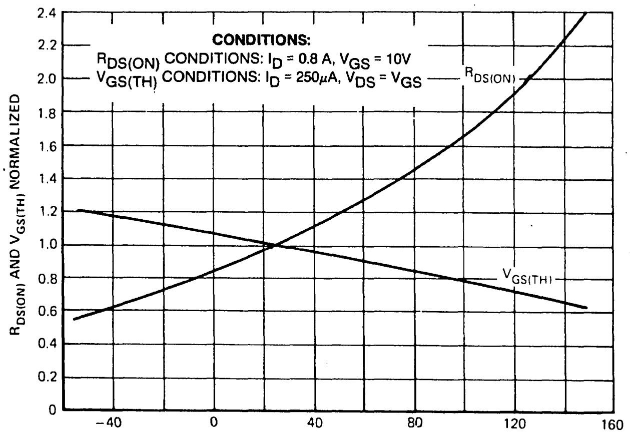
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	1.5	A
Pulsed Source Current	I_{SM}	—	—	6	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 1.5A)	V_{SD}	—	—	1.6	Volts
Reverse Recovery Time (I_S = 1.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	200 1.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF712,713

1.3 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 5\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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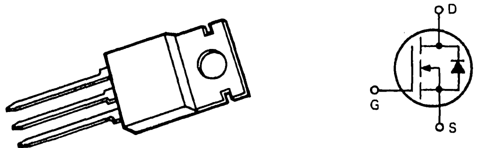
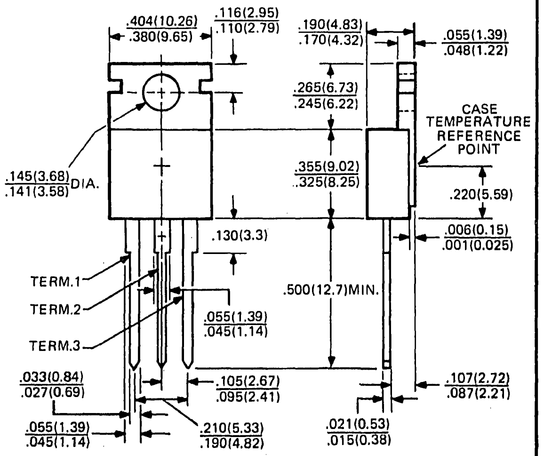
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF712	IRF713	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	1.3 0.8	1.3 0.8	A
Pulsed Drain Current(1)	I_{DM}	5.0	5.0	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	6.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF712 ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRF713	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)	$I_{D(ON)}$	1.3	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 0.8A$)	$R_{DS(ON)}$	—	—	5.0	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 0.8A$)	g_{fs}	.45	—	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	—	150	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	50	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	15	pF

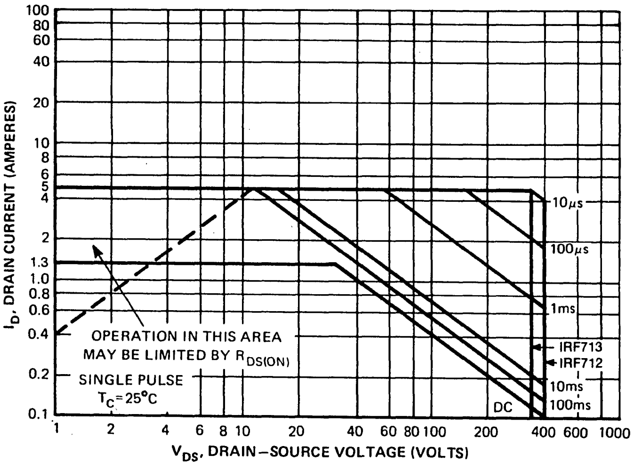
switching characteristics*

Turn-on Delay Time	$V_{DS} = 175V$	$t_{d(on)}$	—	10	—	ns
Rise Time	$I_D = 0.8A$, $V_{GS} = 15V$	t_r	—	15	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	10	—	ns

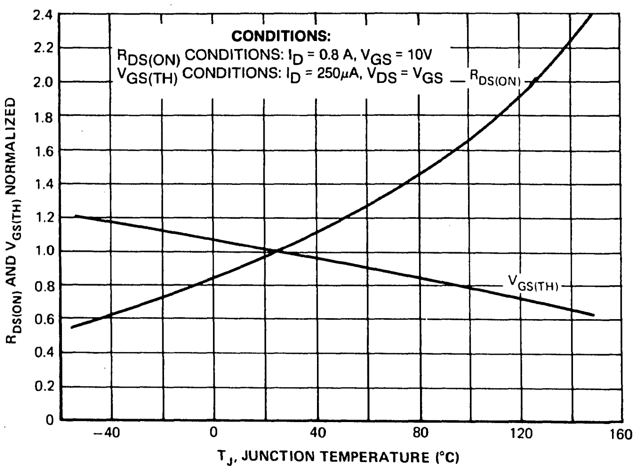
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	1.3	A
Pulsed Source Current	I_{SM}	—	—	5.0	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 1.3A$)	V_{SD}	—	—	1.5	Volts
Reverse Recovery Time ($I_S = 1.5A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	200 1.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF720,721
D84CQ2,Q1

3 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 1.8\ \Omega$

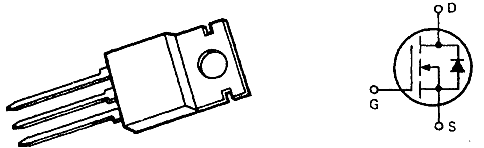
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

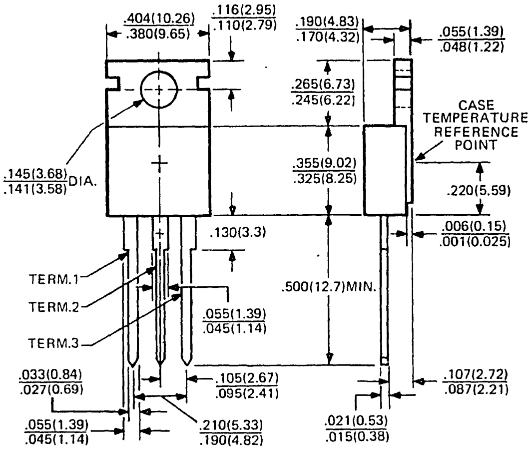
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF720/D84CQ2	IRF721/D84CQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	3 2	3 2	A A
Pulsed Drain Current(1)	I_{DM}	12	12	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	40 0.32	40 0.32	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF720/D84CQ2 (V_{GS} = 0V, I_D = 250 μA) IRF721/D84CQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25° C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	3.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.5A)	$R_{DS(ON)}$	—	1.4	1.8	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.5A)	g_{fs}	0.9	1.6	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	70	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	12	40	pF

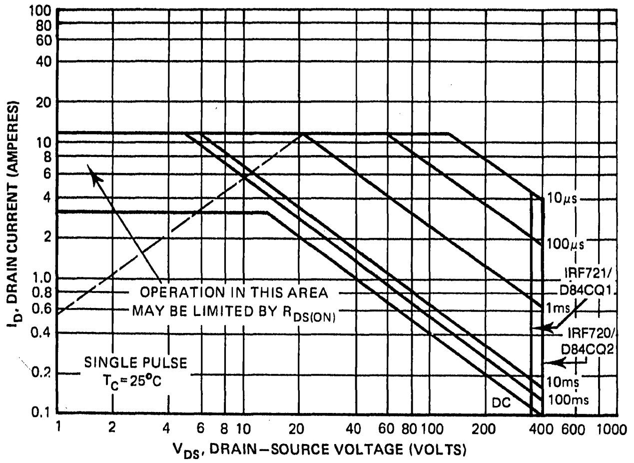
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 1.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	15	—	ns

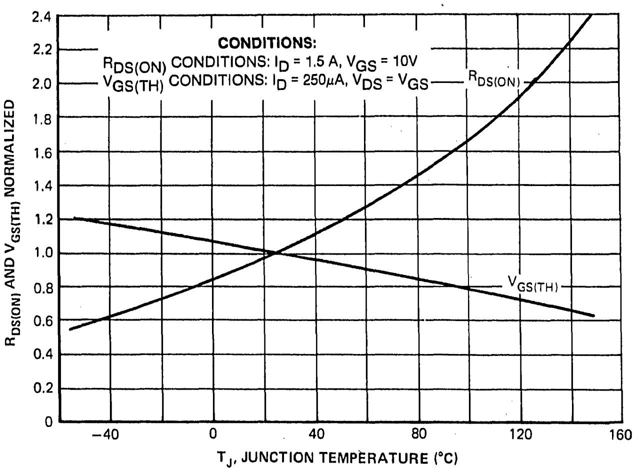
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	3	A
Pulsed Source Current	I_{SM}	—	—	12	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 3A)	V_{SD}	—	1.0	1.6	Volts
Reverse Recovery Time (I_S = 3A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	280 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF722,723

2.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 2.5\ \Omega$

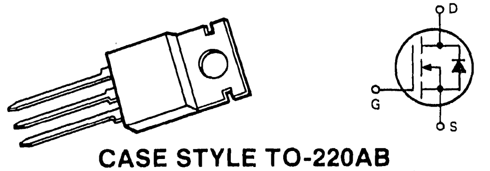
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

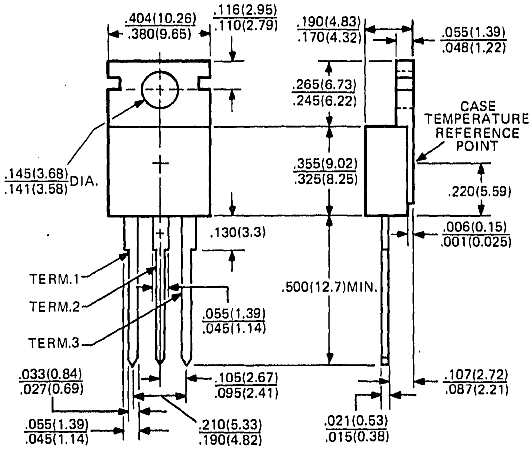
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF722	IRF723	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	2.5 1.5	2.5 1.5	A A
Pulsed Drain Current$^{(1)}$	I_{DM}	10	10	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	40 0.32	40 0.32	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF722 (V_{GS} = 0V, I_D = 250 μA) IRF723	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	2.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.5A)	$R_{DS(ON)}$	—	2.0	2.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.5A)	g_{fs}	0.9	1.6	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	70	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	12	40	pF

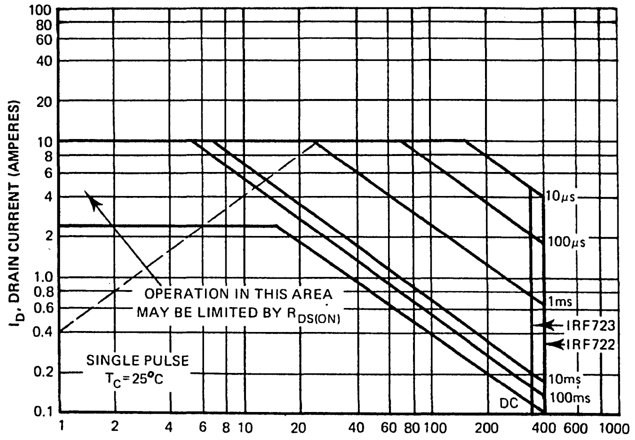
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 1.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	15	—	ns

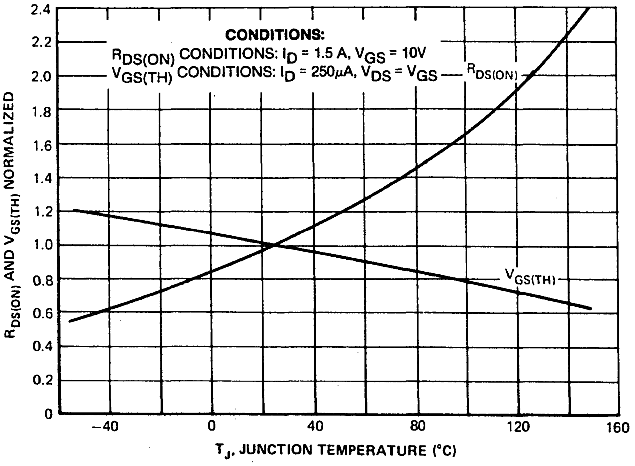
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.5	A
Pulsed Source Current	I_{SM}	—	—	10	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.5A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 3.0A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	280 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF730,731
D84DQ2,Q1

5.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 1.0 Ω

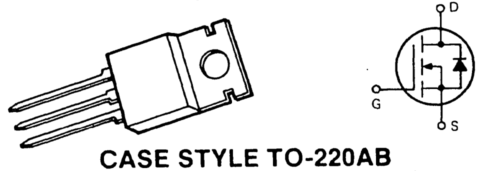
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

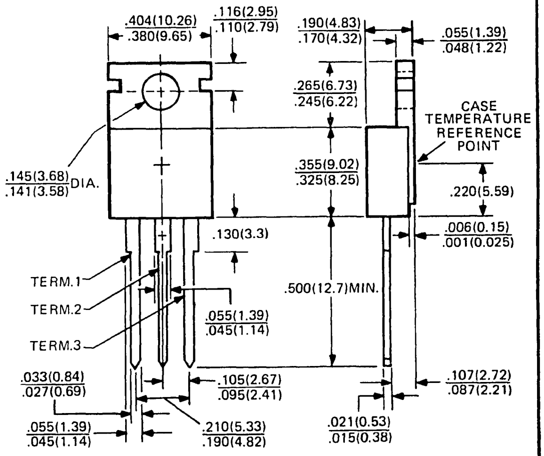
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF730/D84DQ2	IRF731/D84DQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	5.5 3.5	5.5 3.5	A A
Pulsed Drain Current(1)	I_{DM}	22	22	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	75 0.6	75 0.6	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF730/D84DQ2 IRF731/D84DQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	5.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 3A)		$R_{DS(ON)}$	—	0.8	1.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 3A)		g_{fs}	2.1	2.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	100	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

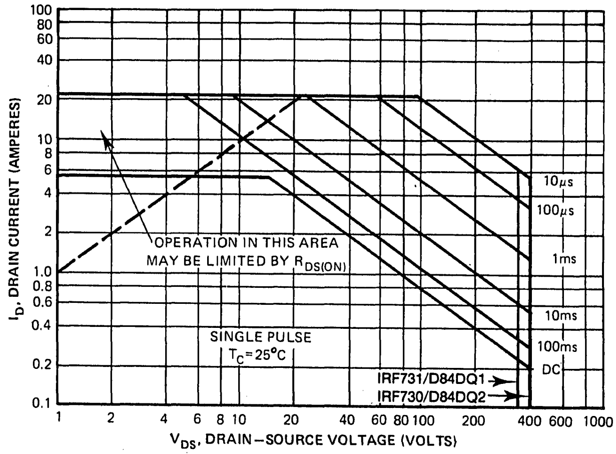
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 3A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

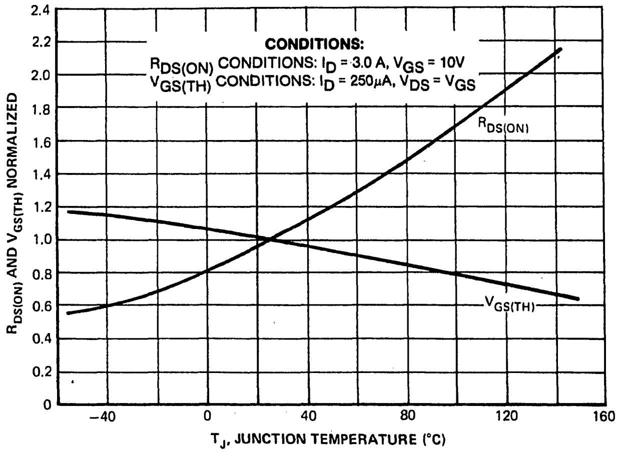
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	5.5	A
Pulsed Source Current	I_{SM}	—	—	22	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 5.5A)	V_{SD}	—	1.0	1.6	Volts
Reverse Recovery Time (I_S = 5.5A, dI_S/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	360 4.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF732,733

4.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 1.5 Ω

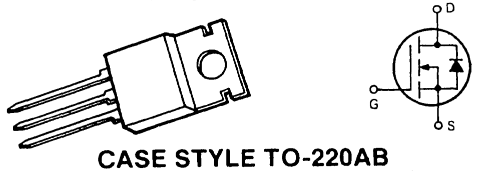
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

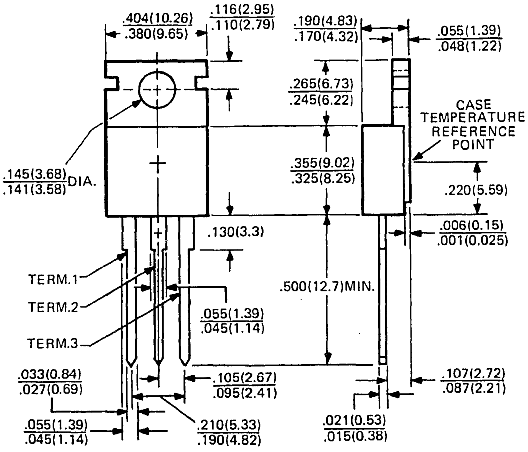
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF732	IRF733	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	4.5 3.0	4.5 3.0	A A
Pulsed Drain Current(1)	I_{DM}	18	18	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF732 IRF733	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	4.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 3.0A)		$R_{DS(ON)}$	—	1.2	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 3.0A)		g_{fs}	2.1	2.5	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	100	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

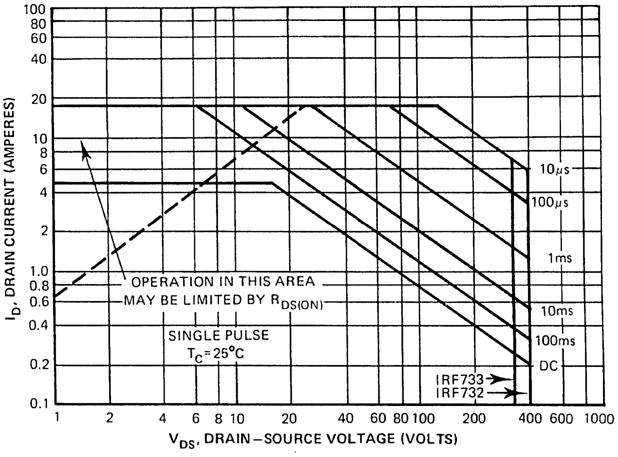
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 3A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

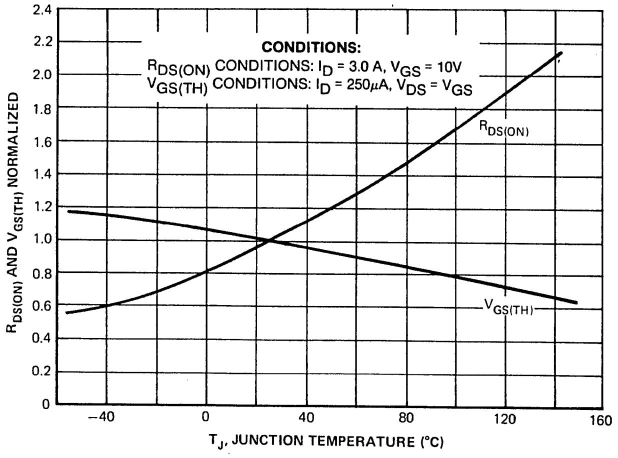
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	4.5	A
Pulsed Source Current	I_{SM}	—	—	18	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4.5A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 5.5A, dI_S/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	360 4.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRF740,741
D84EQ2,Q1

10.0 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.55 Ω

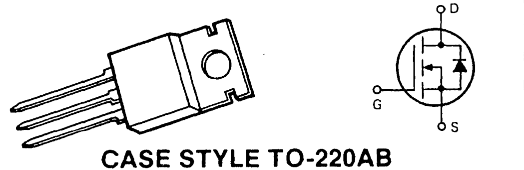
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

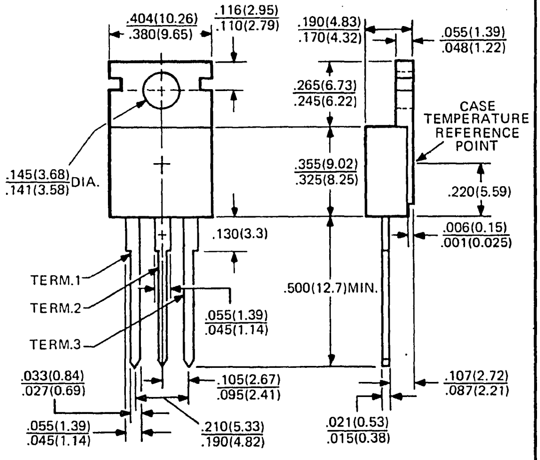
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF740/D84EQ2	IRF741/D84EQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	10 6	10 6	A A
Pulsed Drain Current⁽¹⁾	I_{DM}	40	40	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	125 1.0	125 1.0	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF740/D84EQ2 IRF741/D84EQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	10	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5A)		$R_{DS(ON)}$	—	0.48	0.55	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5A)		g_{fs}	3.2	4.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	210	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	37	150	pF

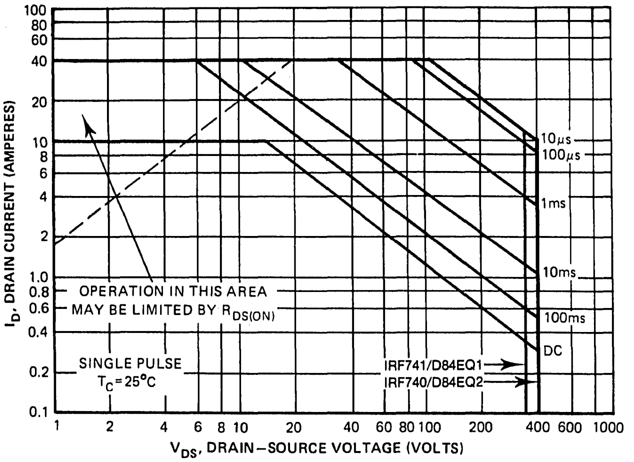
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 5A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	70	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

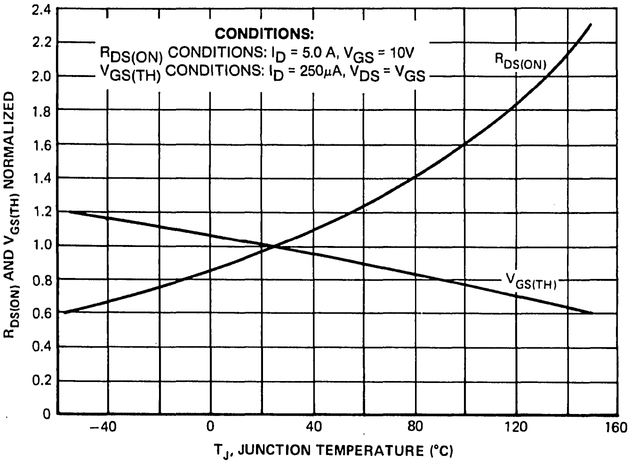
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	10	A
Pulsed Source Current		I_{SM}	—	—	40	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 10A)		V_{SD}	—	0.9	2.0	Volts
Reverse Recovery Time (I_S = 10A, dI_S/dt = 100A/μsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	420 5.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF742,743

8 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.80 Ω

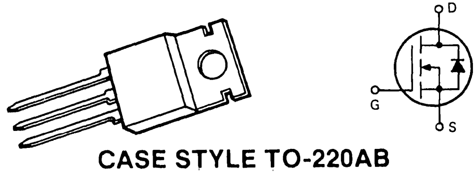
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

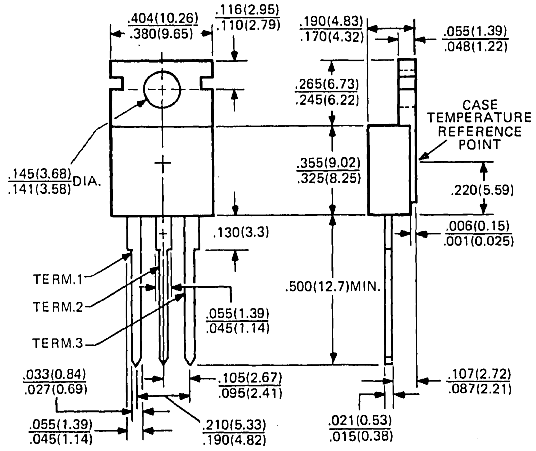
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF742	IRF743	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	8 5	8 5	A A
Pulsed Drain Current(1)	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF742 (V_{GS} = 0V, I_D = 250 μA) IRF743	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 5A)	$R_{DS(ON)}$	—	0.70	0.80	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 5A)	g_{fs}	3.2	4.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	210	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	37	150	pF

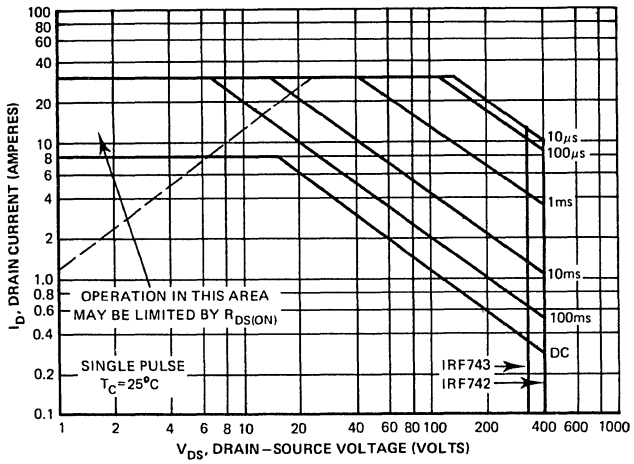
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 5A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	70	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

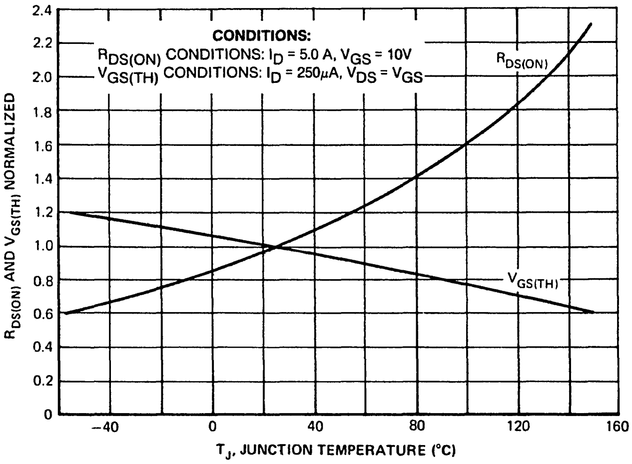
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	8	A
Pulsed Source Current	I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8A)	V_{SD}	—	0.8	1.9	Volts
Reverse Recovery Time (I_S = 10A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	420 5.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF820,821
D84CR2,R1

2.5 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 3.0 Ω

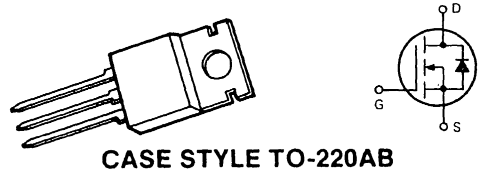
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

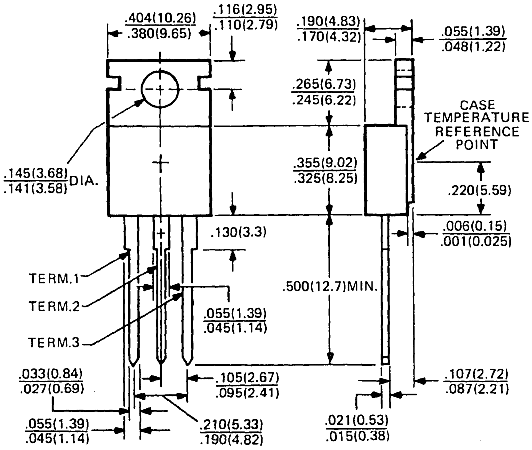
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF820/D84CR2	IRF821/D84CR1	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	2.5 1.5	2.5 1.5	A A
Pulsed Drain Current(1)	I_{DM}	10	10	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	40 0.32	40 0.32	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF820/D84CR2 IRF821/D84CR1	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	2.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.0A)		$R_{DS(ON)}$	—	2.5	3.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.0A)		g_{fs}	0.8	1.1	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	380	400	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	60	150	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	10	40	pF

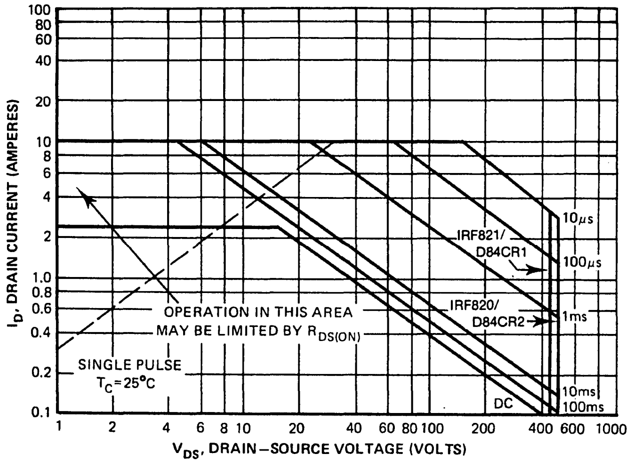
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 1.0A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

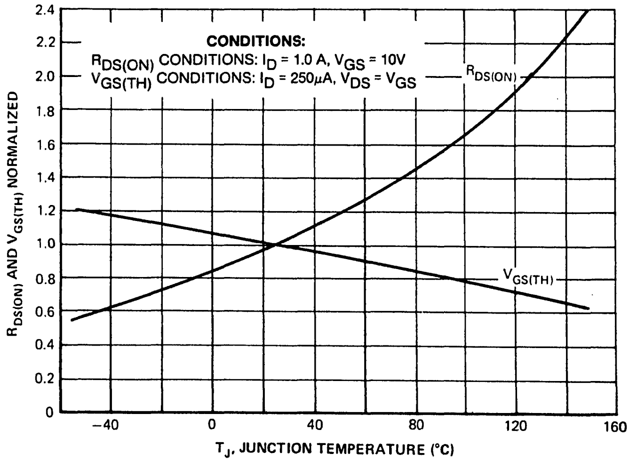
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.5	A
Pulsed Source Current	I_{SM}	—	—	10.0	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.5A)	V_{SD}	—	0.9	1.4	Volts
Reverse Recovery Time (I_S = 2.5A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	410 2.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF822,823

2.0 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 4.0\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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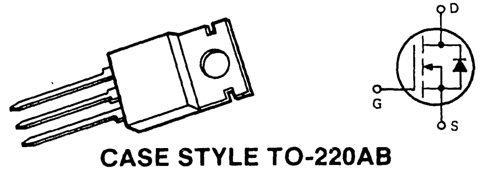
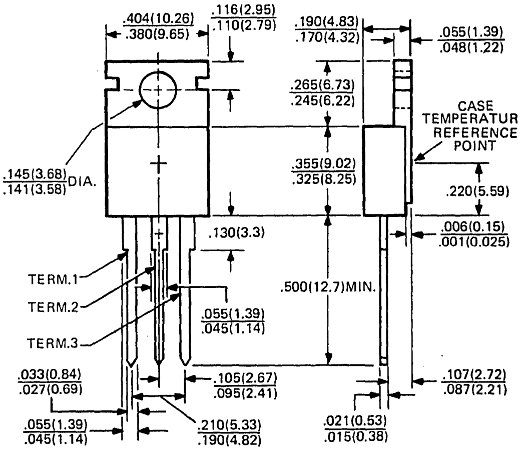
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF822	IRF823	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	2.0 1.0	2.0 1.0	A A
Pulsed Drain Current(1)	I_{DM}	8.0	8.0	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	40 0.32	40 0.32	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.12	3.12	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage IRF822 (V_{GS} = 0V, I_D = 250 μA) IRF823	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	2	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.0A)	$R_{DS(ON)}$	—	3.5	4.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.0A)	g_{fs}	.8	1.1	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	380	400	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	60	150	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	10	40	pF

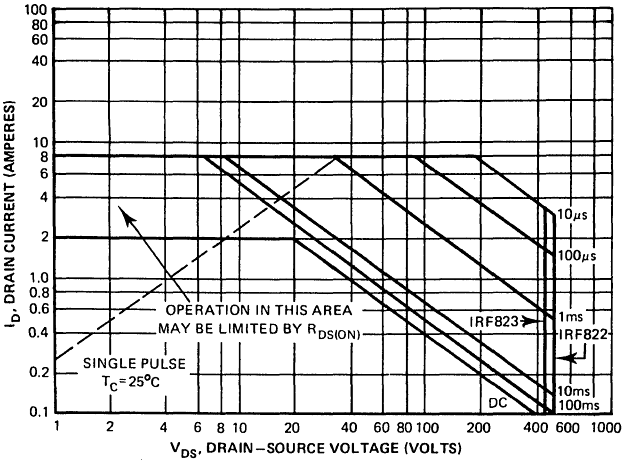
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 1.0A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

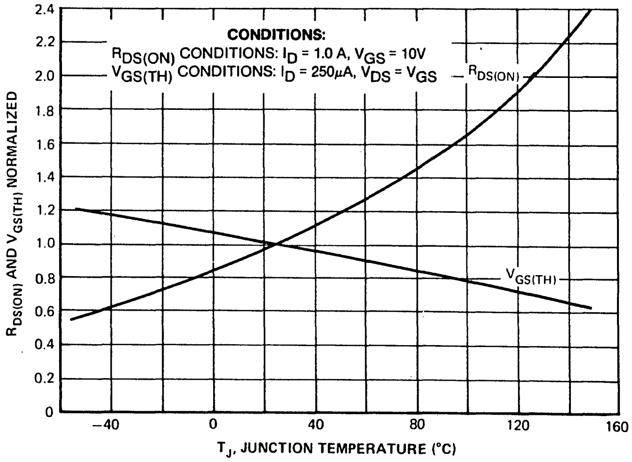
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.0	A
Pulsed Source Current	I_{SM}	—	—	8.0	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.0A)	V_{SD}	—	1.0	1.5	Volts
Reverse Recovery Time (I_S = 2.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	410 2.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRF830,831
D84DR2,R1

4.5 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 1.5 Ω

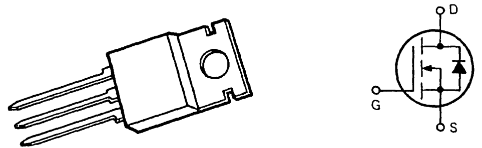
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

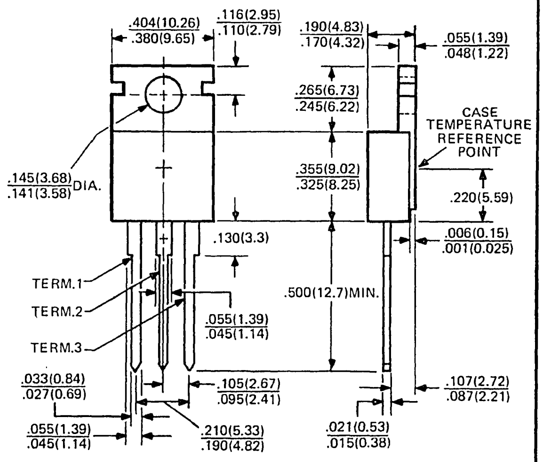
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF830/D84DR2	IRF831/D84DR1	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	4.5 3.0	4.5 3.0	A A
Pulsed Drain Current(1)	I_{DM}	18	18	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF830/D84DR2 IRF831/D84DR1	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	4.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.5A)		$R_{DS(ON)}$	—	1.3	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.5A)		g_{fs}	1.75	2.2	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	90	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	60	pF

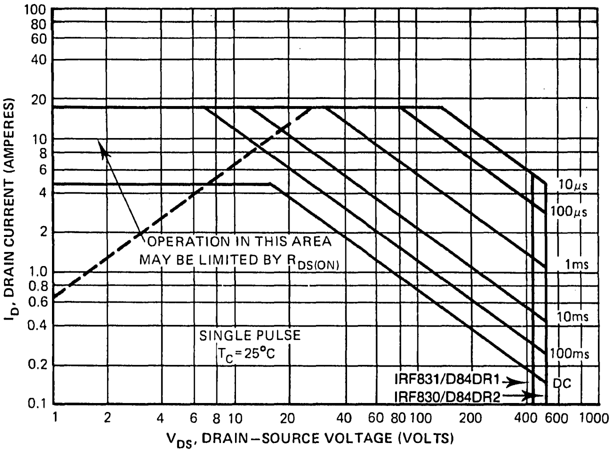
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	40	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

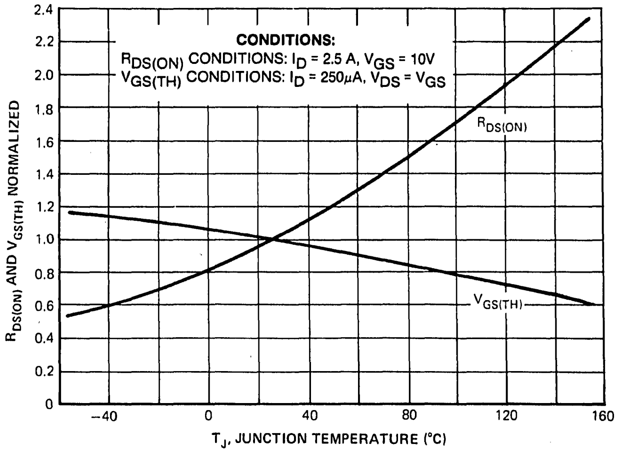
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	4.5	A
Pulsed Source Current	I_{SM}	—	—	18	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4.5A)	V_{SD}	—	1.0	1.4	Volts
Reverse Recovery Time (I_S = 4.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	460 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF832,833

4.0 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 2.0\ \Omega$

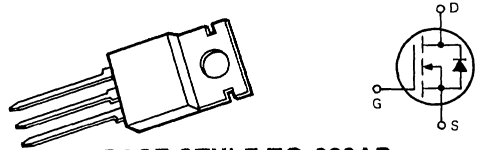
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

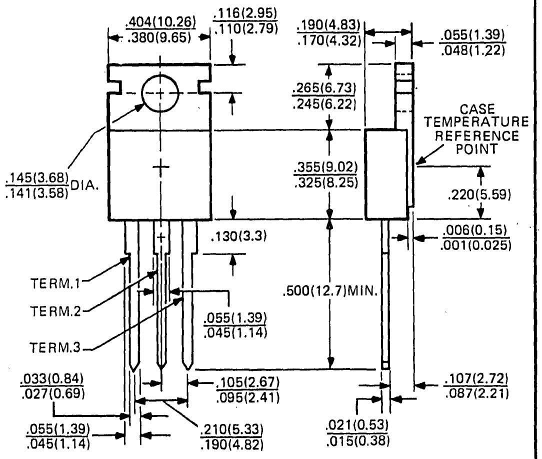
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRF832	IRF833	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	4.0 2.5	4.0 2.5	A A
Pulsed Drain Current(1)	I_{DM}	16	16	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF832	BV_{DSS}	500	—	—	Volts
(V_{GS} = 0V, I_D = 250 μA) IRF833		450	—	—	
Zero Gate Voltage Drain Current	I_{DSS}				
(V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C)		—	—	250	μA
(V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		—	—	1000	
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	4.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.5A)	$R_{DS(ON)}$	—	1.5	2.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.5A)	g_{fs}	1.75	2.2	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	650	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	90	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	60	pF

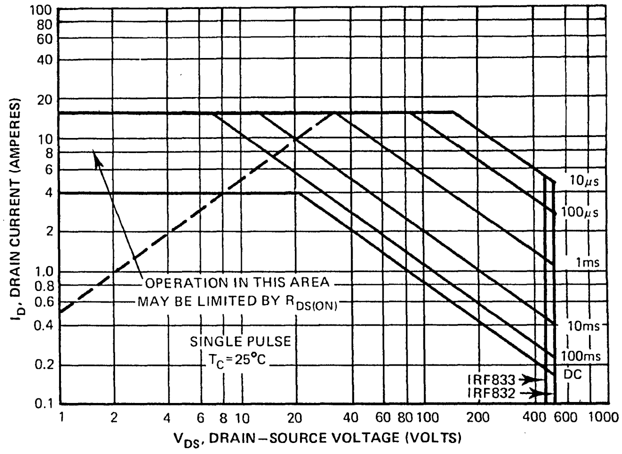
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.5A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	40	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

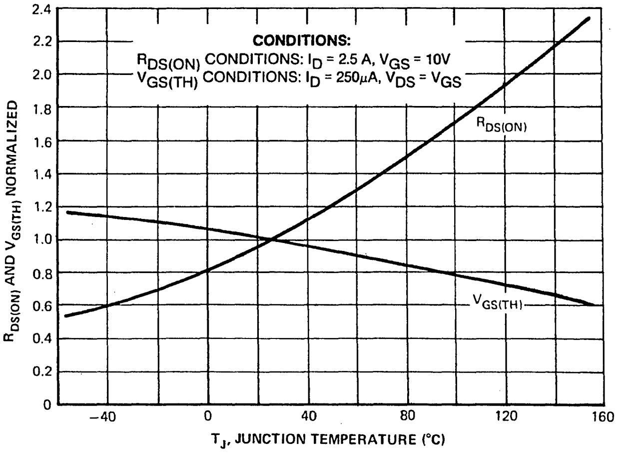
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	4.0	A
Pulsed Source Current	I_{SM}	—	—	16	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4.0A)	V_{SD}	—	1.0	1.3	Volts
Reverse Recovery Time (I_S = 4.5A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	460 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF840,841
D84ER2,R1

8 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 0.85 Ω

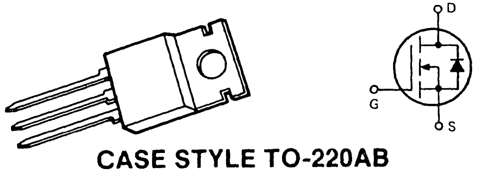
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

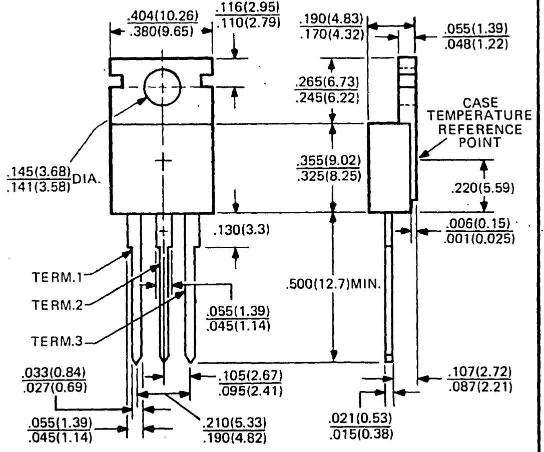
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF840/D84ER2	IRF841/D84ER1	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	8 5	8 5	A A
Pulsed Drain Current(1)	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRF840/D84ER2 (V_{GS} = 0V, I_D = 250 μA) IRF841/D84ER1	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4A)	$R_{DS(ON)}$	—	0.75	0.85	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4A)	g_{fs}	2.8	3.5	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	190	350	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	28	150	pF

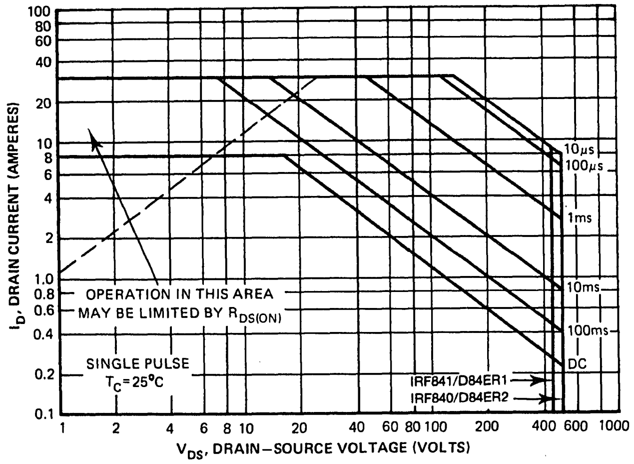
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 4A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns

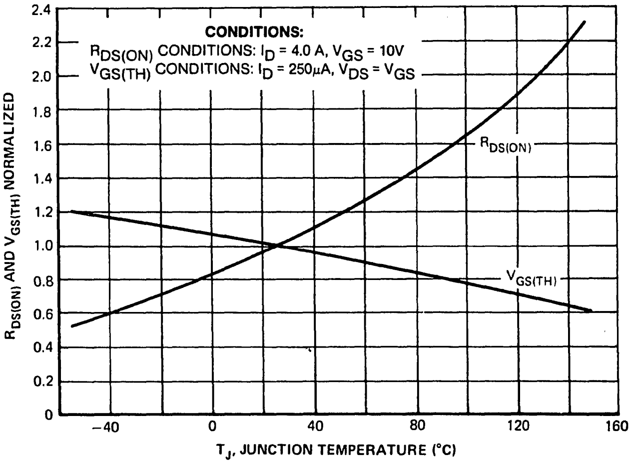
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	8	A
Pulsed Source Current	I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8A)	V_{SD}	—	0.9	2.0	Volts
Reverse Recovery Time (I_S = 8A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	520 6.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRF842,843

7 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 1.1 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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Features

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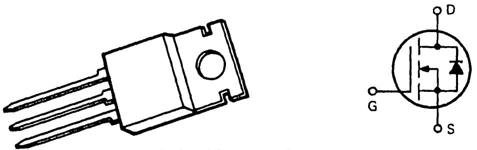
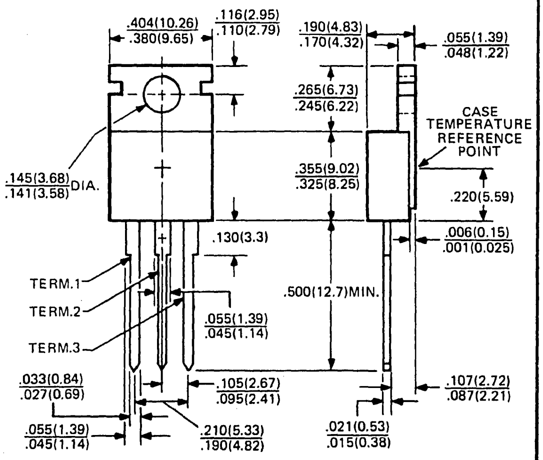
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRF842	IRF843	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	7 4	7 4	A A
Pulsed Drain Current(1)	I_{DM}	28	28	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

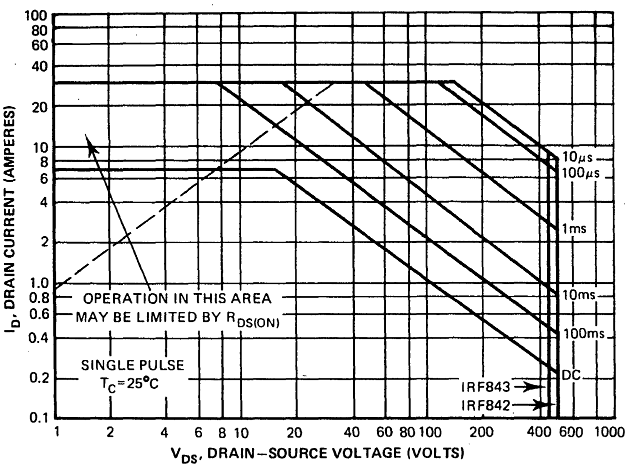
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.00	1.00	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	80	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

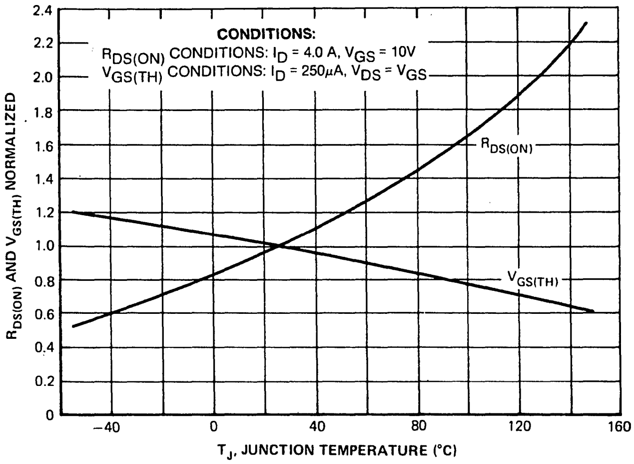
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRF842 IRF843	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	7	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4A)		$R_{DS(ON)}$	—	1.0	1.1	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4A)		g_{fs}	2.8	3.5	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	1400	1600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	190	350	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	28	150	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 4A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	60	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	30	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	7	A
Pulsed Source Current		I_{SM}	—	—	28	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 7A)		V_{SD}	—	0.8	1.9	Volts
Reverse Recovery Time (I_S = 8A, dI_S/dt = 100A/μsec, T_C = 125° C)		t_{rr} Q_{RR}	— —	520 6.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD110,111
D82BL2,K2

1.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.6 Ω

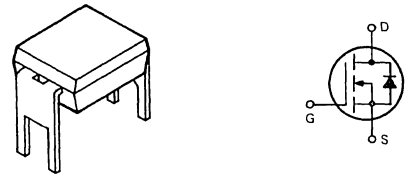
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

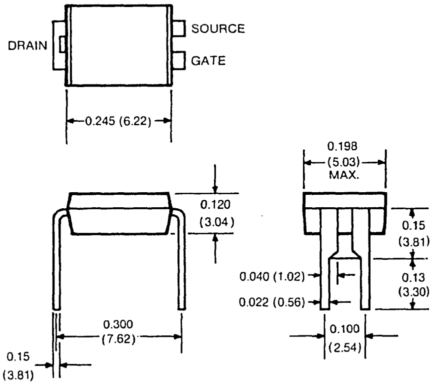
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD110/D82BL2	IRFD111/D82BK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	1.0 0.63	1.0 0.63	A A
Pulsed Drain Current(2)	I_{DM}	8.0	8.0	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.2 9.6	1.2 9.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	105	105	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD110/D82BL2 IRFD111/D82BK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	1.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.8A)		$R_{DS(ON)}$	—	0.5	0.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.8A)		g_{fs}	0.56	0.75	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	145	200	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	65	100	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	20	25	pF

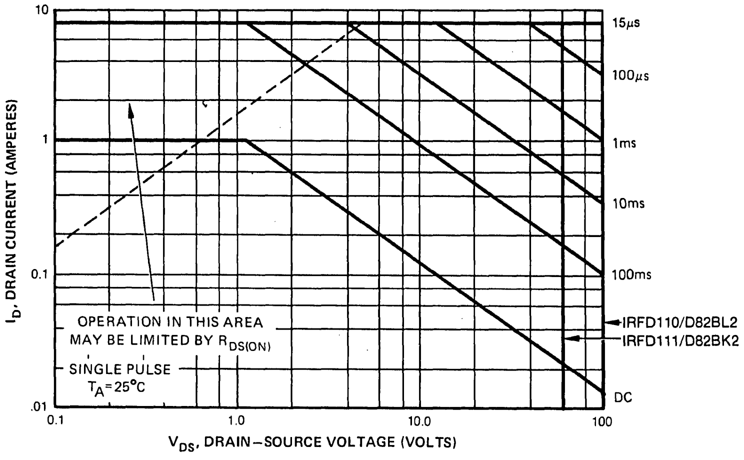
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.8A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

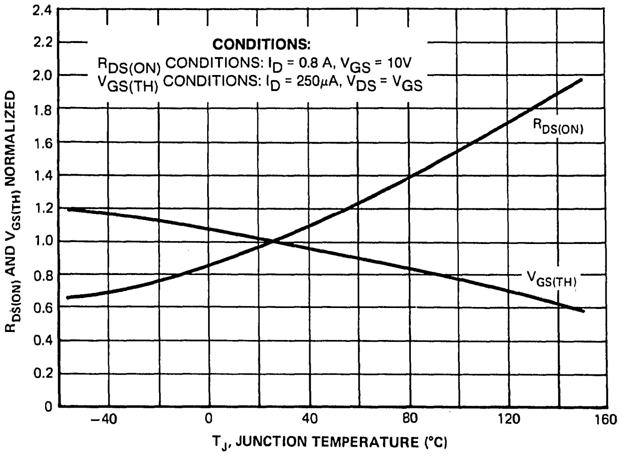
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	1.0	A
Pulsed Source Current	I_{SM}	—	—	8.0	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 1.0A)	V_{SD}	—	0.9	2.5	Volts
Reverse Recovery Time (I_S = 1.0A, di_S/dt = 100A/μs, T_A = 125°C)	t_{rr} Q_{RR}	— —	90 0.2	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD112,113

0.8 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.8\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

- Polysilicon gate — Improved stability and reliability
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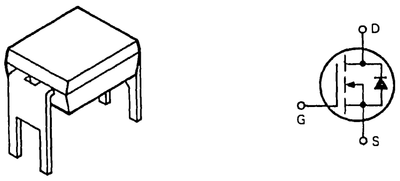
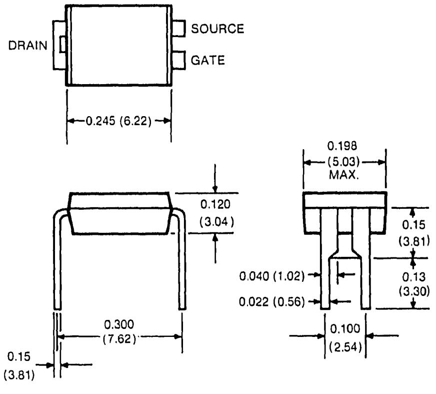
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFD112	IRFD113	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	100	60	Volts
Continuous Drain Current @ $T_A = 25°C^{(1)}$ @ $T_A = 100°C^{(1)}$	I_D	0.80 0.54	0.80 0.54	A A
Pulsed Drain Current$^{(2)}$	I_{DM}	6.4	6.4	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_A = 25°C$ Derate Above 25°C	P_D	1.2 9.6	1.2 9.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient$^{(1)}$	$R_{\theta JA}$	105	105	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFD112 (V_{GS} = 0V, I_D = 250 μA) IRFD113	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_A = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	0.8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.8A)	$R_{DS(ON)}$	—	0.60	0.80	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.8A)	g_{fs}	0.56	0.75	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	145	200	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	65	100	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	20	25	pF

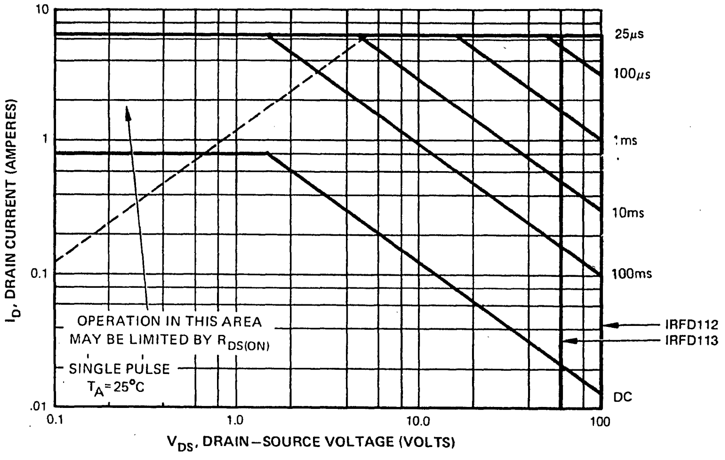
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.8A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

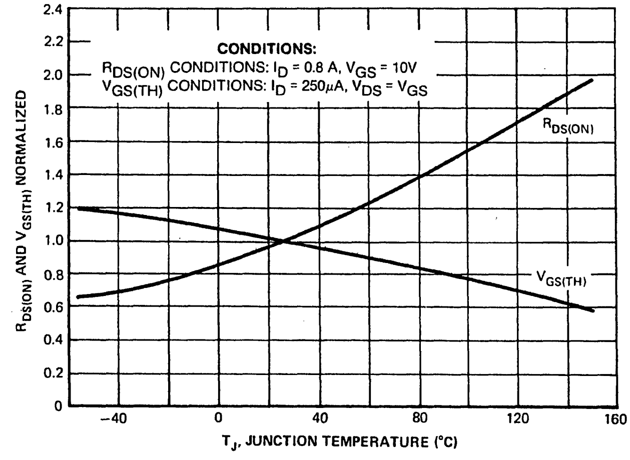
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.8	A
Pulsed Source Current	I_{SM}	—	—	6.4	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 0.8A)	V_{SD}	—	0.8	2.0	Volts
Reverse Recovery Time (I_S = 1.0A, di_S/dt = 100A/μs, T_A = 125°C)	t_{rr} Q_{RR}	— —	90 0.2	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD120,121
D82CL2,K2

1.3 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.3 Ω

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Features

- Polysilicon gate — Improved stability and reliability
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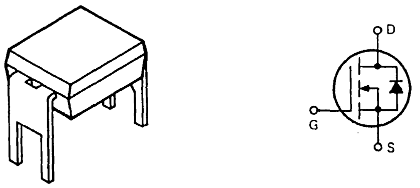
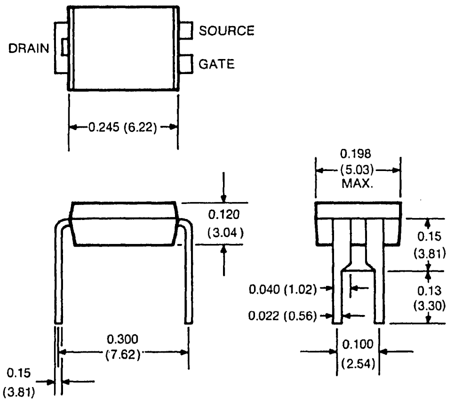
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD120/D82CL2	IRFD121/D82CK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	1.3 0.85	1.3 0.85	A A
Pulsed Drain Current(2)	I_{DM}	5.2	5.2	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.0 8	1.0 8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD120/D82CL2 IRFD121/D82CK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	1.3	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.6A)		$R_{DS(ON)}$	—	0.22	0.30	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.6A)		g_{fs}	.63	1.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	410	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	160	400	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	40	100	pF

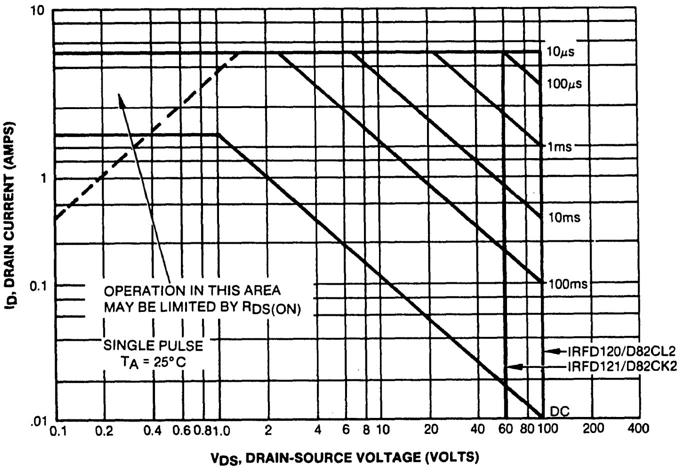
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.6A, V_{GS} = 15V	t_r	—	30	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

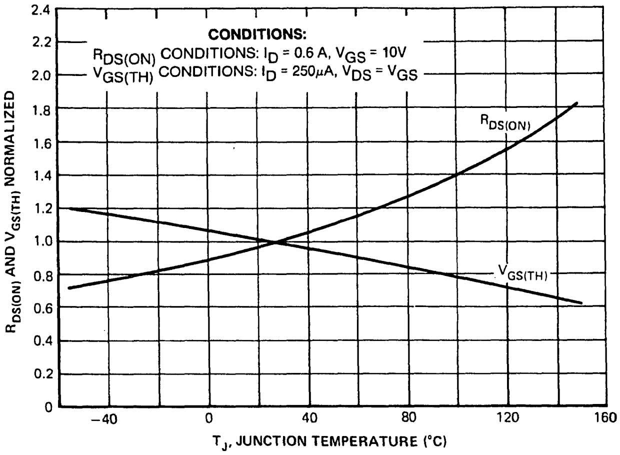
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	1.3	A
Pulsed Source Current		I_{SM}	—	—	5.2	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V)	I_S = 1.3A	V_{SD}	—	0.8	2.5	Volts
Reverse Recovery Time (I_S = 1.3A, di_S/dt = 100A/μs, T_A = 125°C)		t_{rr} Q_{RR}	— —	75 0.7	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD122,123

1.1 AMPERES
100, 60 VOLTS
$R_{DS(ON)} = 0.4\ \Omega$

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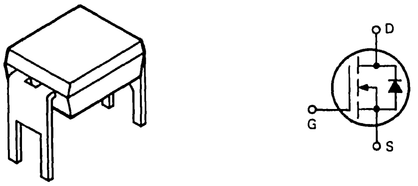
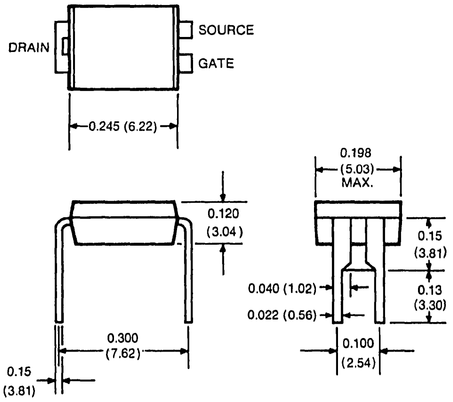
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFD122	IRFD123	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	100	60	Volts
Continuous Drain Current @ $T_A = 25°C$(1) @ $T_A = 100°C$(1)	I_D	1.1 0.70	1.1 0.70	A A
Pulsed Drain Current(2)	I_{DM}	4.4	4.4	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_A = 25°C$ Derate Above 25°C	P_D	1.0 8	1.0 8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRFD122 IRFD123	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_A = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_A = 125°C$)		I_{DSS}	 — —	 — —	 250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_A = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	1.1	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 0.6A$)		$R_{DS(ON)}$	—	0.30	0.40	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 0.6A$)		g_{fs}	.63	1.0	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	410	600	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	160	400	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	40	100	pF

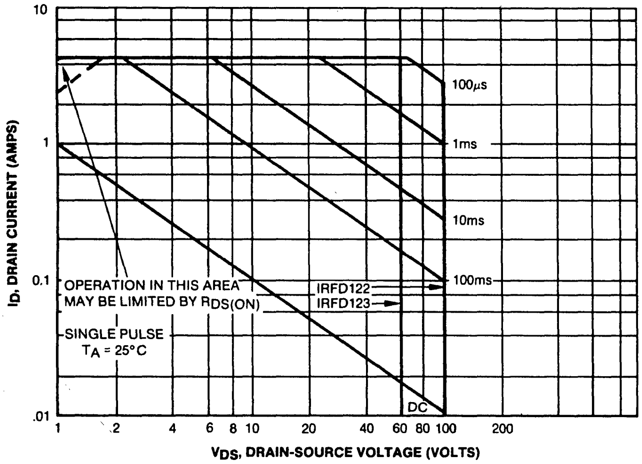
switching characteristics*

Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	15	—	ns
Rise Time	$I_D = 0.6A$, $V_{GS} = 15V$	t_r	—	30	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	10	—	ns

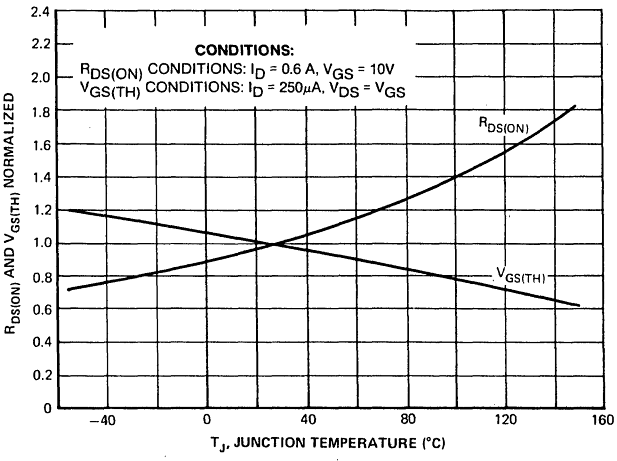
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	1.1	A
Pulsed Source Current		I_{SM}	—	—	4.4	A
Diode Forward Voltage ($T_A = 25°C$, $V_{GS} = 0V$)	$I_S = 1.1A$	V_{SD}	—	0.6	2.3	Volts
Reverse Recovery Time ($I_S = 1.3A$, $di_S/dt = 100A/\mu s$, $T_A = 125°C$)		t_{rr} Q_{RR}	— —	75 0.7	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD1Z0,1Z1
D82AL2,K2

0.5 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 2.4 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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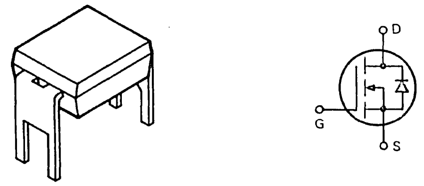
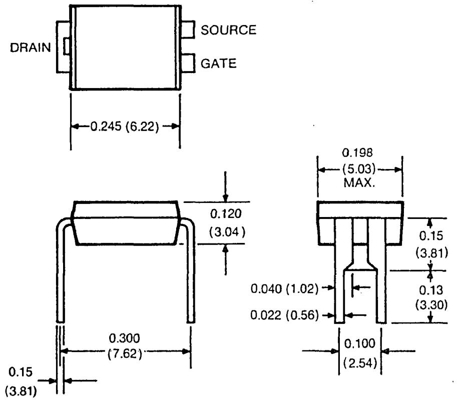
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD1Z0/D82AL2	IRFD1Z1/D82AK2	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C	I_D	0.50 0.31	0.50 0.31	A A
Pulsed Drain Current(2)	I_{DM}	4.0	4.0	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.2 9.6	1.2 9.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	105	105	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.5 in. minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFD1Z0/D82AL2 (V_{GS} = 0V, I_D = 250 μA) IRFD1Z1/D82AK2	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)	I_{DSS}	 — —	 — —	 250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_A = 25°C (V_{DS} = V_{GS}, I_D = 250μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
Drain Source On-State Voltage I_D = 0.25A (V_{GS} = 10V) I_D = 0.50A I_D = 0.25A, T_A = 125°C	$V_{DS(ON)}$	— — —	0.55 1.10 0.90	0.6 — —	Volts
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.25A)	$R_{DS(ON)}$	—	2.2	2.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.25A)	g_{fs}	—	0.2	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	36	70	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	20	30	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	7	10	pF

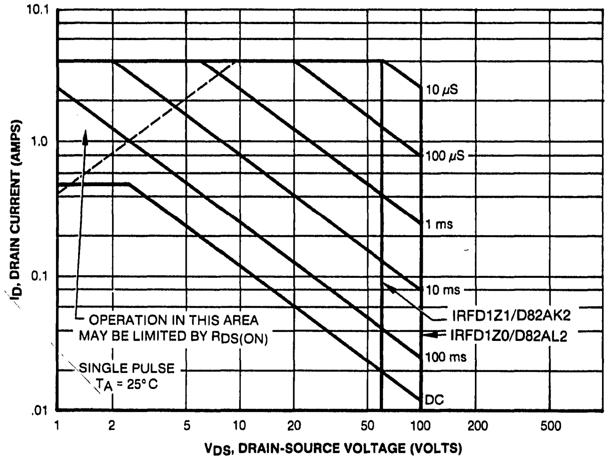
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	6	—	ns
Rise Time	I_D = 0.25A, V_{GS} = 15V	t_r	—	6	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	12	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	7	—	ns

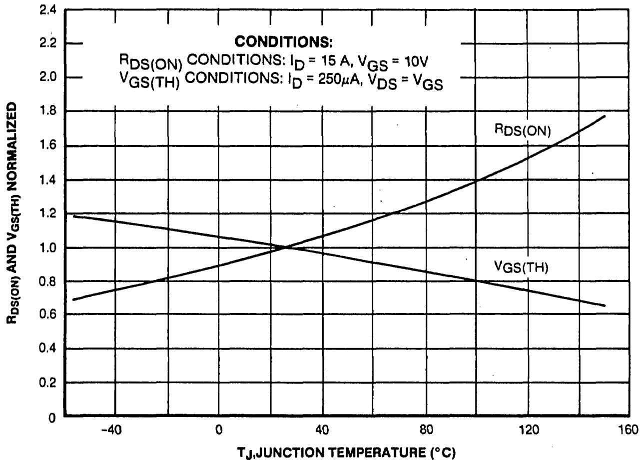
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.5	A
Pulsed Source Current	I_{SM}	—	—	4.0	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 0.5A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 0.5A, dI_s/dt = 100A/μs, V_{DS} = 40V Max., T_A = 125°C)	t_{rr}	—	65	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD1Z2,1Z3

0.5 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 2.4 Ω

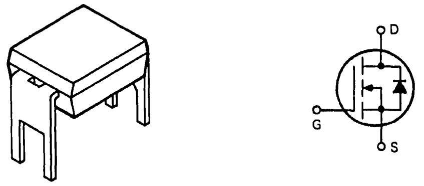
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

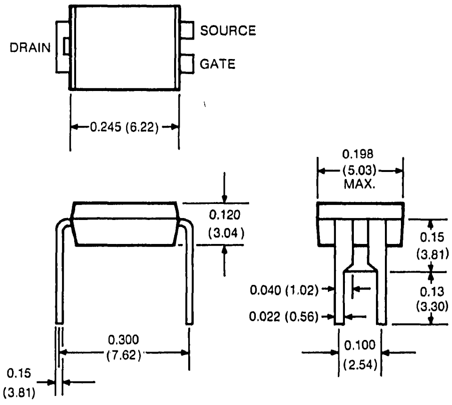
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD1Z2	IRFD1Z3	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	.40 .25	.40 .25	A A
Pulsed Drain Current(2)	I_{DM}	3.2	3.2	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.0 9.6	1.0 9.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	105	105	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.5 in. minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD1Z2 IRFD1Z3	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
Drain Source On-State Voltage (V_{GS} = 10V)	I_D = 0.25A I_D = 0.50A I_D = 0.25A, T_A = 125°C	$V_{DS(ON)}$	— — —	0.55 1.10 0.90	0.6 — —	Volts
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.25A)		$R_{DS(ON)}$	—	3.0	3.2	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.25A)		g_{fs}	—	0.2	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	36	70	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	20	30	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	7	10	pF

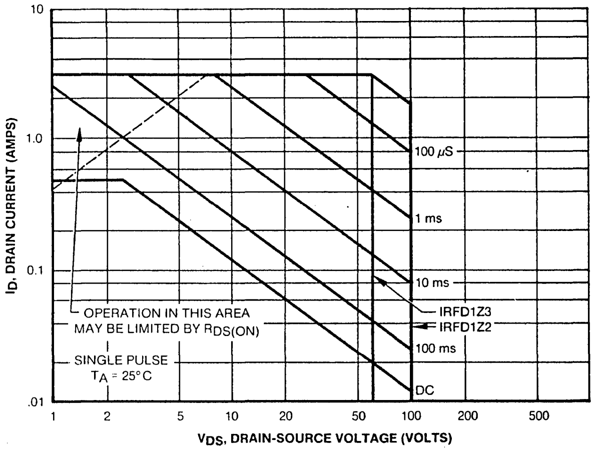
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	6	—	ns
Rise Time	I_D = 0.25A, V_{GS} = 15V	t_r	—	6	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	12	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	7	—	ns

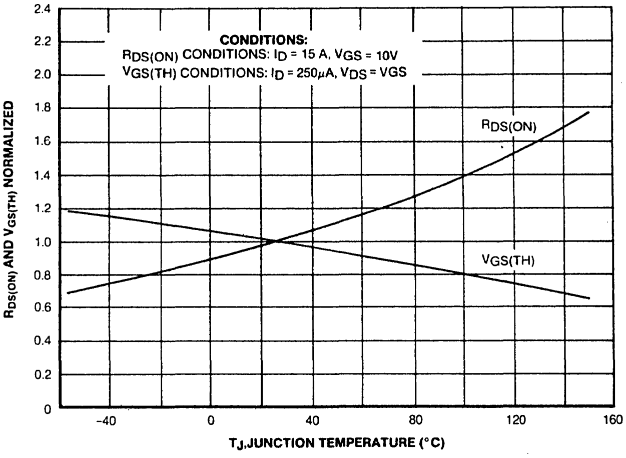
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.5	A
Pulsed Source Current	I_{SM}	—	—	3.2	A
Diode Forward Voltage (T_A = 25° C, V_{GS} = 0V, I_S = 0.5A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 0.5A, dI_s/dt = 100A/μs, V_{DS} = 40V Max., T_A = 125° C)	t_{rr}	—	65	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD210,211
D82BN2,M2

0.6 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 1.5 Ω

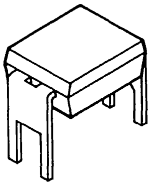
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

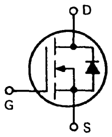
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

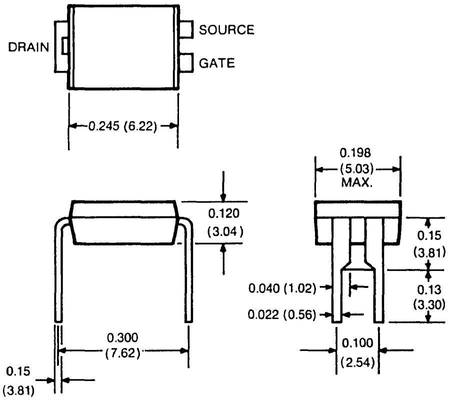
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD210/D82BN2	IRFD211/D82BM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	0.6 0.35	0.6 0.35	A A
Pulsed Drain Current(2)	I_{DM}	2.5	2.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.0 8	1.0 8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD210/D82BN2 IRFD211/D82BM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	0.6	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.3A)		$R_{DS(ON)}$	—	1.1	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.3A)		g_{fs}	0.35	0.4	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	120	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	40	80	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	10	25	pF

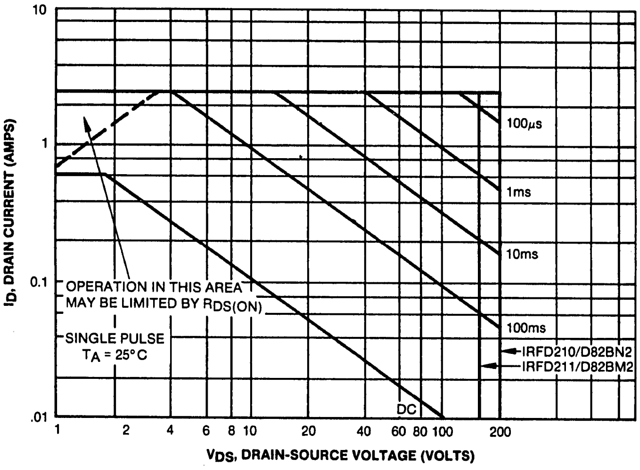
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	5	—	ns
Rise Time	I_D = 0.3A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

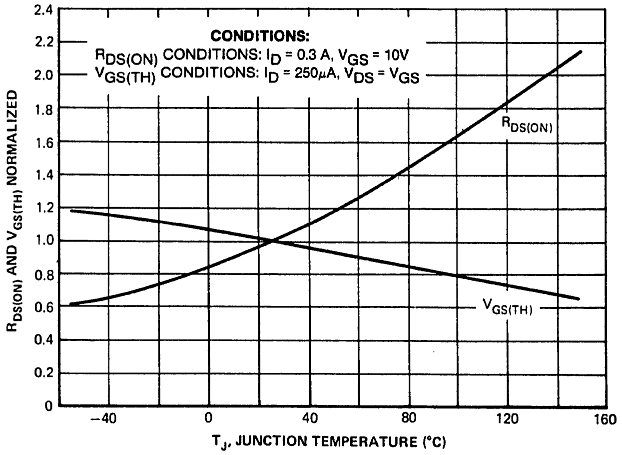
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	0.60	A
Pulsed Source Current		I_{SM}	—	—	2.5	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V)	I_S = 0.60A	V_{SD}	—	0.8	2.0	Volts
Reverse Recovery Time (I_S = 0.6A, di_S/dt = 100A/μs, T_A = 125°C)		t_{rr} Q_{RR}	— —	100 0.75	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD212,213

0.45 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 2.4 Ω

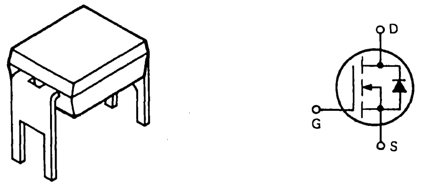
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

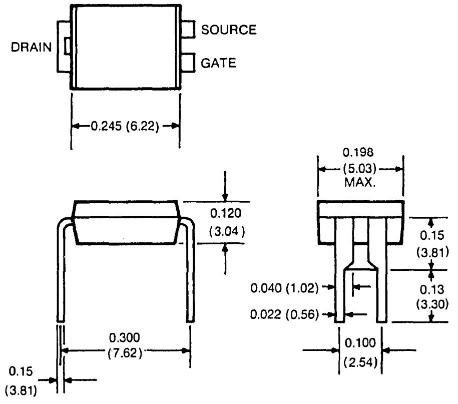
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD212	IRFD213	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	0.45 0.30	0.45 0.30	A A
Pulsed Drain Current(2)	I_{DM}	1.8	1.8	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.0 8	1.0 8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

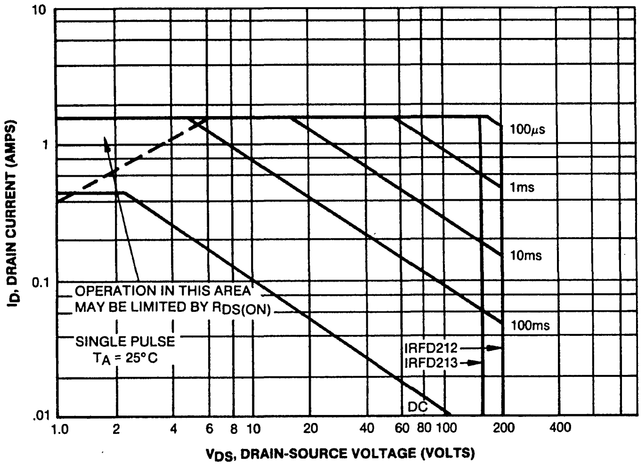
Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

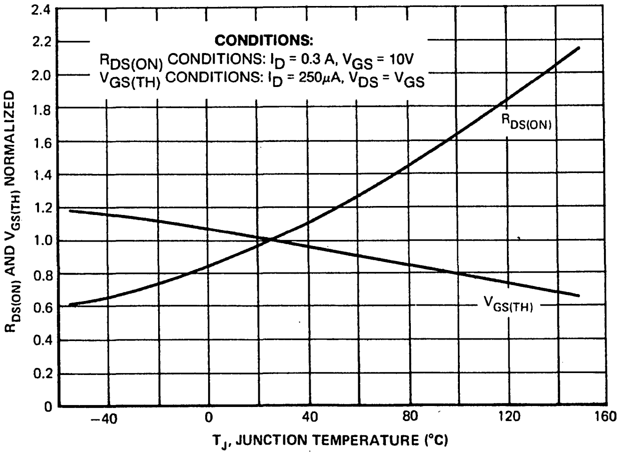
electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD212 IRFD213	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	0.45	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.3A)		$R_{DS(ON)}$	—	1.6	2.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.3A)		g_{fs}	0.35	0.4	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	120	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	40	80	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	10	25	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	5	—	ns
Rise Time	I_D = 0.3A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	0.45	A
Pulsed Source Current		I_{SM}	—	—	1.8	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V)	I_S = 0.45A	V_{SD}	—	0.7	1.8	Volts
Reverse Recovery Time (I_S = 0.6A, di_s/dt = 100A/μs, T_A = 125°C)		t_{rr} Q_{RR}	— —	100 0.75	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRFD220,221
D82CN2,M2

0.8 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.8 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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Features

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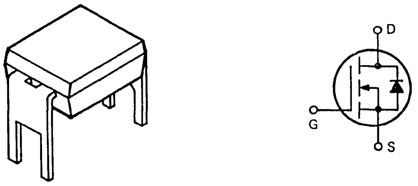
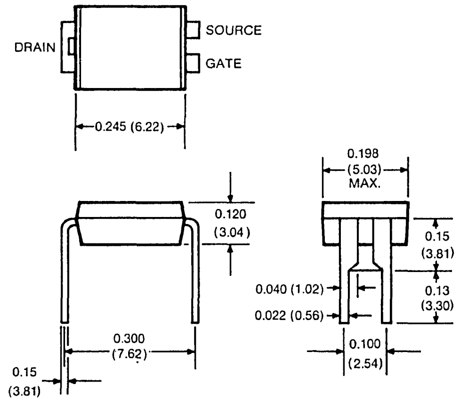
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD220/D82CN2	IRFD221/D82CM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	0.80 0.48	0.80 0.48	A A
Pulsed Drain Current(2)	I_{DM}	6.4	6.4	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.0 8	1.0 8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD220/D82CN2 IRFD221/D82CM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	0.8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.4A)		$R_{DS(ON)}$	—	0.6	0.8	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.4A)		g_{fs}	0.45	0.7	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	80	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

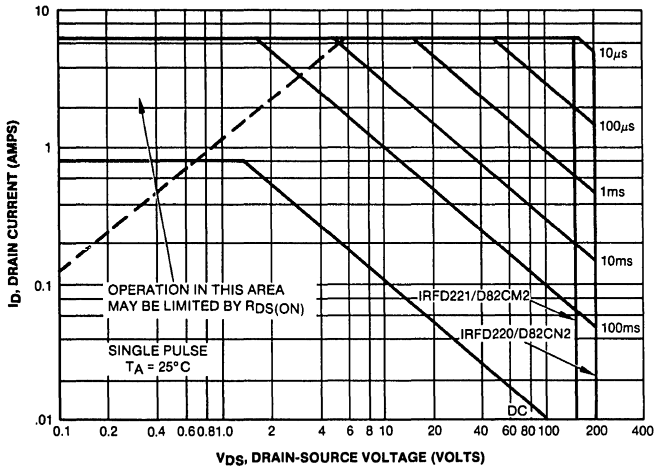
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.4A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

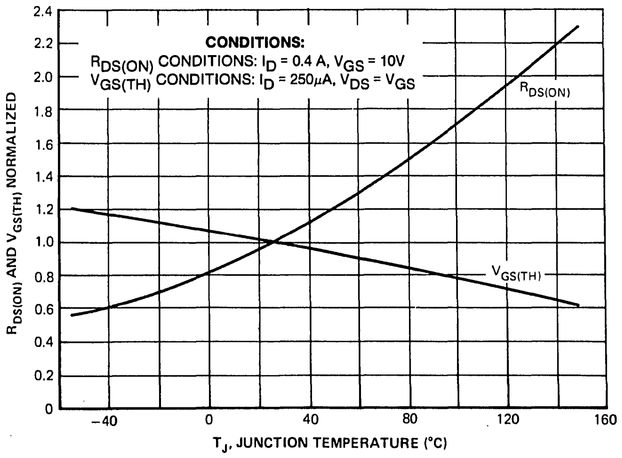
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	0.8	A
Pulsed Source Current		I_{SM}	—	—	6.4	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 0.8A)		V_{SD}	—	0.8	1.8	Volts
Reverse Recovery Time (I_S = 0.8A, di_S/dt = 100A/μs, T_A = 125°C)		t_{rr} Q_{RR}	— —	150 1.2	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD222,223

0.7 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 1.2 Ω

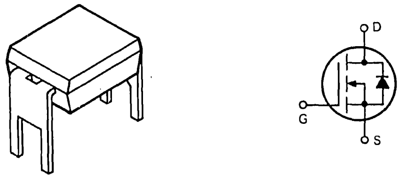
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

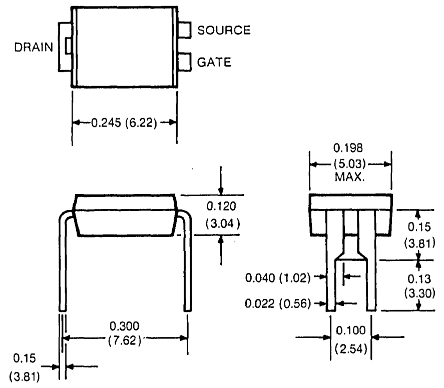
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD222	IRFD223	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	0.70 0.40	0.70 0.40	A A
Pulsed Drain Current(2)	I_{DM}	5.6	5.6	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	1.0 8.0	1.0 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFD222 IRFD223	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_A = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	0.7	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.4A)		$R_{DS(ON)}$	—	0.8	1.2	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.4A)		g_{fs}	0.45	0.7	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	80	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	15	80	pF

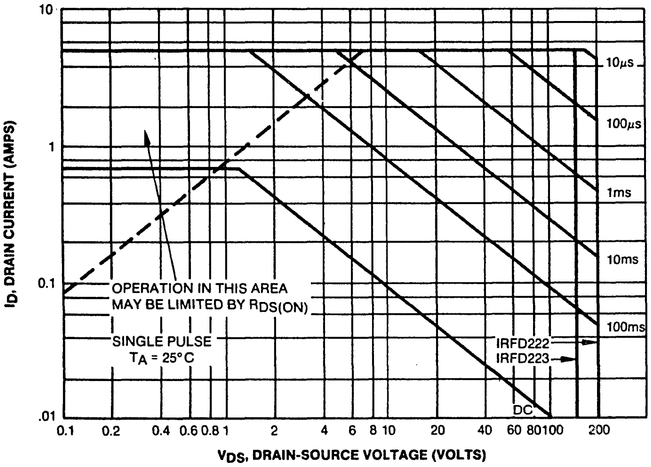
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.4A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

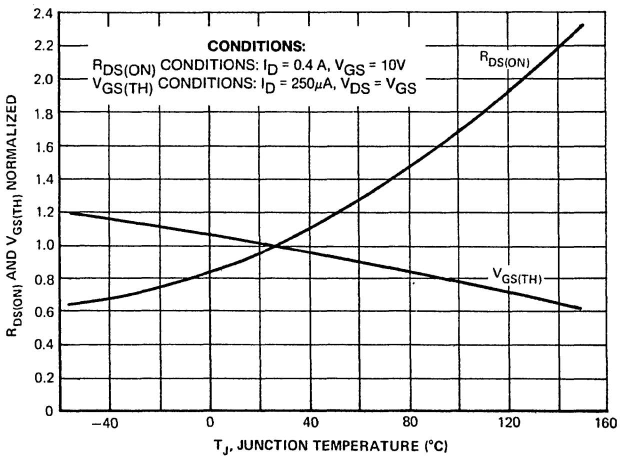
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.7	A
Pulsed Source Current	I_{SM}	—	—	5.6	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 0.7A)	V_{SD}	—	0.7	1.8	Volts
Reverse Recovery Time (I_S = 0.8A, di_S/dt = 100A/μs, T_A = 125°C)	t_{rr} Q_{RR}	— —	150 1.2	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD2Z0,2Z1
D82AN2,M2

0.32 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 5.0 Ω

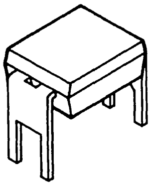
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

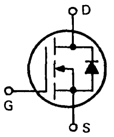
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

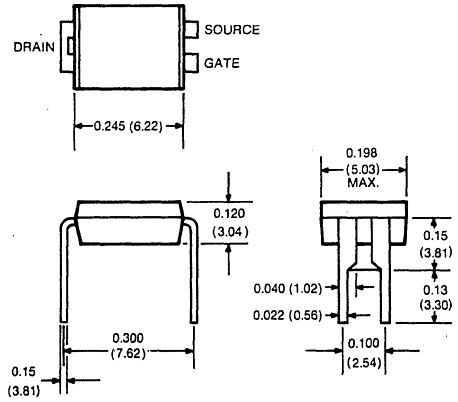
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD2Z0/D82AN2	IRFD2Z1/D82AM2	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_A = 25°C(1) @ T_A = 100°C(1)	I_D	0.32 0.20	0.32 0.20	A A
Pulsed Drain Current(2)	I_{DM}	1.5	1.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25°C(1) Derate Above 25°C	P_D	1.0 8	1.0 8	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width Limited by Max. Junction Temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRFD2Z0/D82AN2 IRFD2Z1/D82AM2	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_A = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_A = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1\mu A$) $T_A = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
Drain Source On-State Voltage ($V_{GS} = 10V$) $I_D = 0.15A$ $I_D = 0.32A$ $I_D = 0.15A$, $T_A = 125°C$	$V_{DS(ON)}$	— — —	0.66 1.41 1.05	0.75 — —	Volts
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 0.15A$)	$R_{DS(ON)}$	—	4.4	5.0	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 0.15A$)	g_{fs}	—	0.11	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	37	70	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	15	25	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	4	8	pF

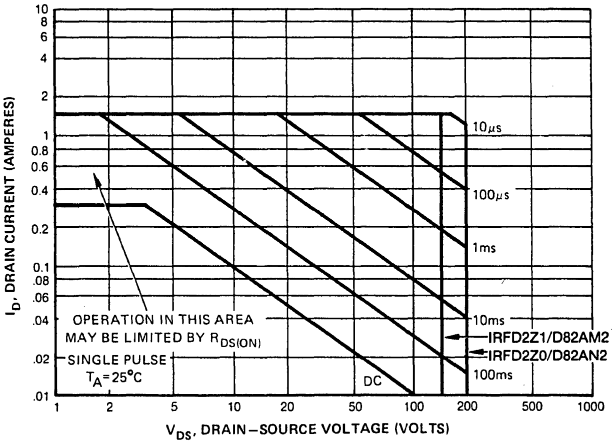
switching characteristics*

Turn-on Delay Time	$V_{DS} = 90V$	$t_{d(on)}$	—	15	—	ns
Rise Time	$I_D = 0.15A$, $V_{GS} = 15V$	t_r	—	10	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	22	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	28	—	ns

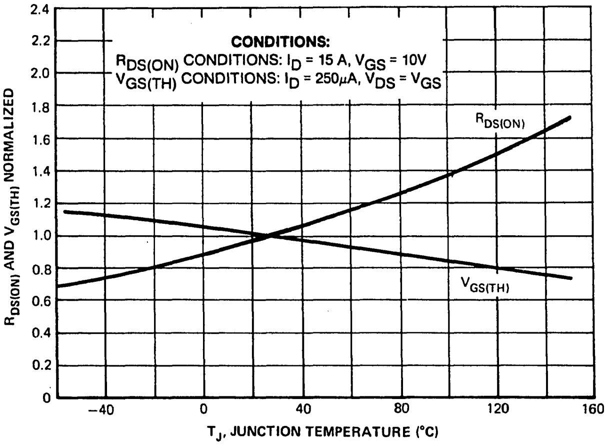
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.32	A
Pulsed Source Current	I_{SM}	—	—	1.5	A
Diode Forward Voltage ($T_A = 25°C$, $V_{GS} = 0V$, $I_S = 0.32A$)	V_{SD}	—	0.86	1.3	Volts
Reverse Recovery Time ($I_S = 0.32A$, $dI_S/dt = 100A/\mu s$, $V_{DS} = 80V$ Max., $T_A = 125°C$)	t_{rr}	—	125	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFD320,321
D82CQ2,Q1

0.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 1.8 Ω

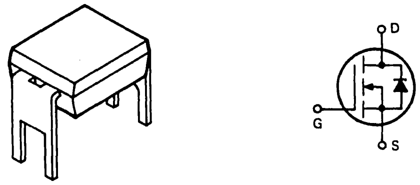
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

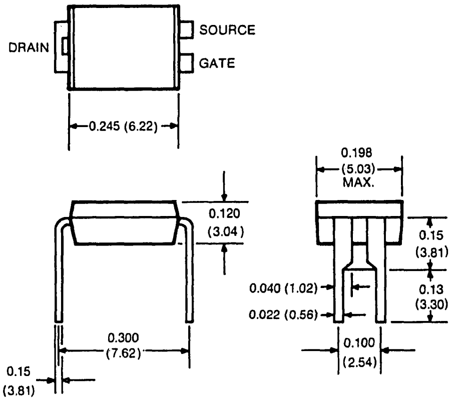
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE 4-PIN DIP
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFD320/D82CQ2	IRFD321/D82CQ1	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_A = 25° C(1) @ T_A = 100° C(1)	I_D	0.5 0.33	0.5 0.33	A A
Pulsed Drain Current(2)	I_{DM}	2.0	2.0	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25° C Derate Above 25° C	P_D	1.0 8	1.0 8	Watts mW/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	125	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	° C

(1) Device mounted to vertical pc board in free air with drain lead soldered to 0.20 in^2 minimum copper run area.
(2) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFD320/D82CQ2 (V_{GS} = 0V, I_D = 250 μA) IRFD321/D82CQ1	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_A = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	0.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.25A)	$R_{DS(ON)}$	—	1.4	1.8	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.25A)	g_{fs}	0.3	0.6	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	70	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	12	40	pF

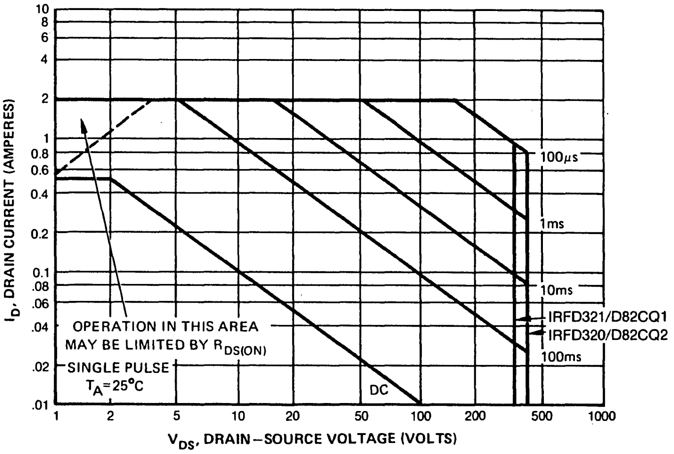
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.25A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	25	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	15	—	ns

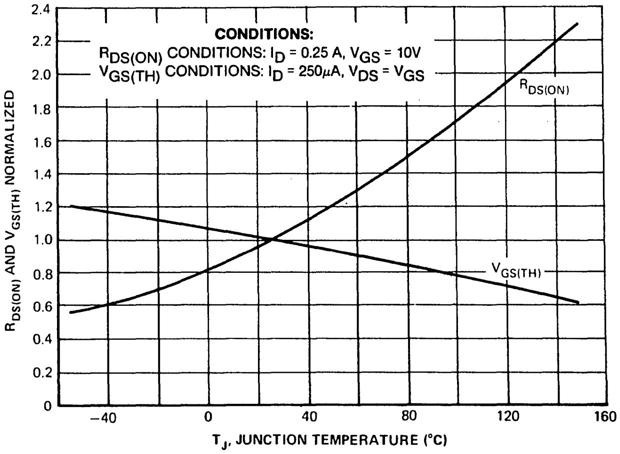
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.5	A
Pulsed Source Current	I_{SM}	—	—	2.0	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 0.5A)	V_{SD}	—	0.8	1.6	Volts
Reverse Recovery Time (I_S = 0.5A, di_S/dt = 100A/μs, T_A = 125°C)	t_{rr} Q_{RR}	— —	200 1.7	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF110,111

3.5 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.6 Ω

Preliminary

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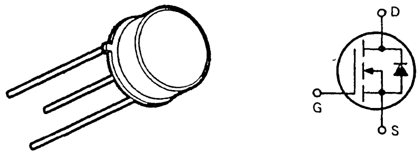
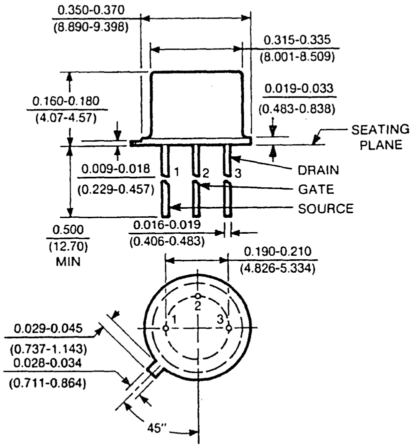
N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF110	IRFF111	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C	I_D	3.5	3.5	A
Pulsed Drain Current[1]	I_{DM}	14	14	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	15 0.12	15 0.12	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.33	8.33	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF110 IRFF111	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	3.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.5A)		$R_{DS(ON)}$	—	—	0.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.5A)		g_{fs}	0.7	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	200	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	100	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	25	pF

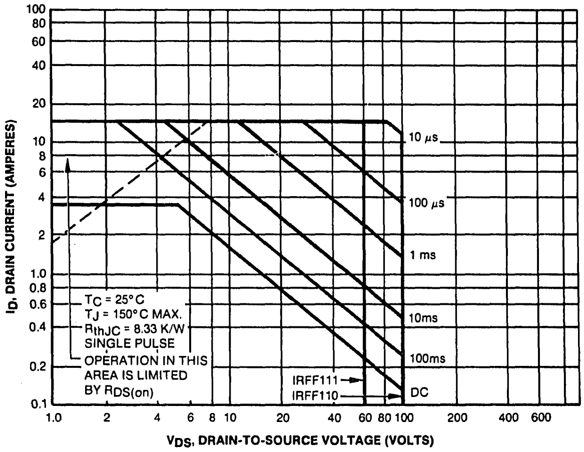
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	10	—	ns
Rise Time	I_D = 1.5A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	15	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

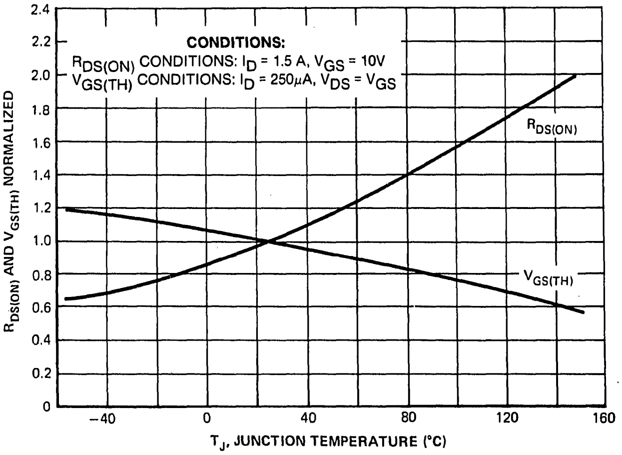
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	3.5	A
Pulsed Source Current	I_{SM}	—	—	14	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 3.5A)	V_{SD}	—	—	2.5	Volts
Reverse Recovery Time (I_S = 3.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	200 1.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF112,113

3.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.8 Ω

Preliminary

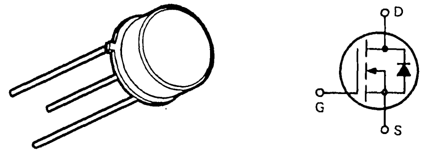
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

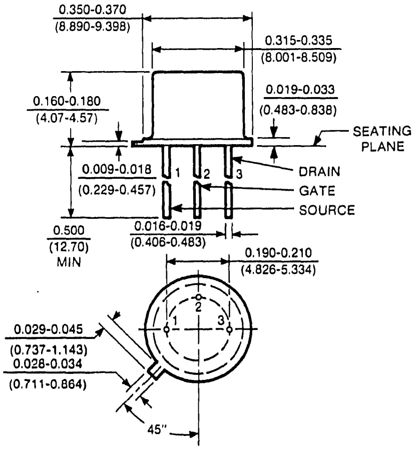
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF112	IRFF113	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25° C	I_D	3.0	3.0	A
Pulsed Drain Current⁽¹⁾	I_{DM}	12	12	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	15 0.12	15 0.12	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.33	8.33	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16″ from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF112 IRFF113	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	3.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.5A)		$R_{DS(ON)}$	—	—	0.8	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.5A)		g_{fs}	0.7	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	200	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	100	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	25	pF

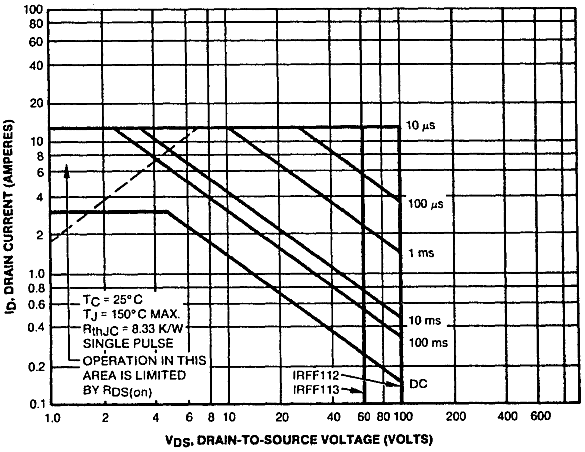
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	10	—	ns
Rise Time	I_D = 1.5A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	15	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	10	—	ns

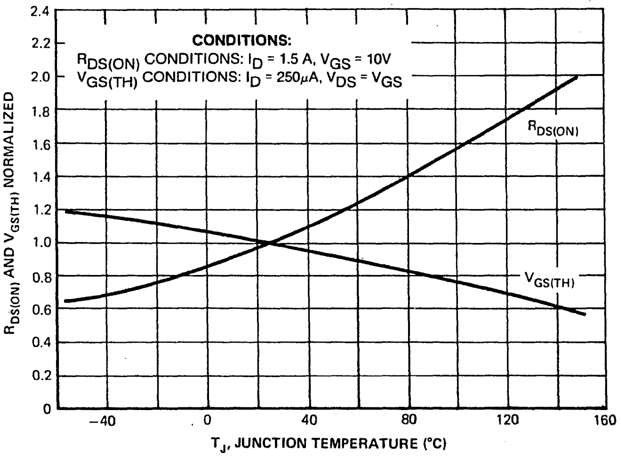
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	3.0	A
Pulsed Source Current	I_{SM}	—	—	12	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 3.5A)	V_{SD}	—	—	2.0	Volts
Reverse Recovery Time (I_S = 3.5A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	200 1.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF120,121

6.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.3 Ω

Preliminary

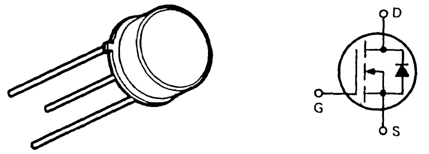
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

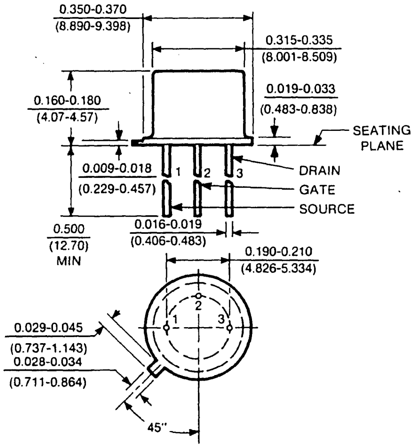
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF120	IRFF121	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25° C	I_D	6	6	A
Pulsed Drain Current(1)	I_{DM}	24	24	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	20 0.16	20 0.16	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRFF120 IRFF121	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	6.0	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 3A$)		$R_{DS(ON)}$	—	—	0.3	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 3A$)		g_{fs}	1.35	—	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 10V$	C_{iss}	—	—	600	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	400	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	100	pF

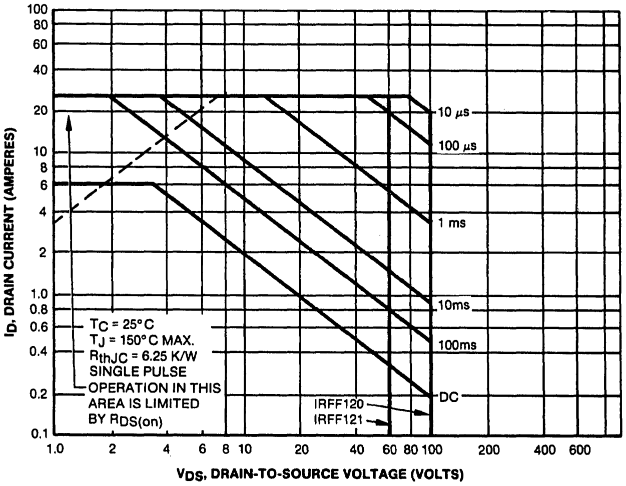
switching characteristics*

Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	20	—	ns
Rise Time	$I_D = 3A$, $V_{GS} = 15V$	t_r	—	35	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	35	—	ns

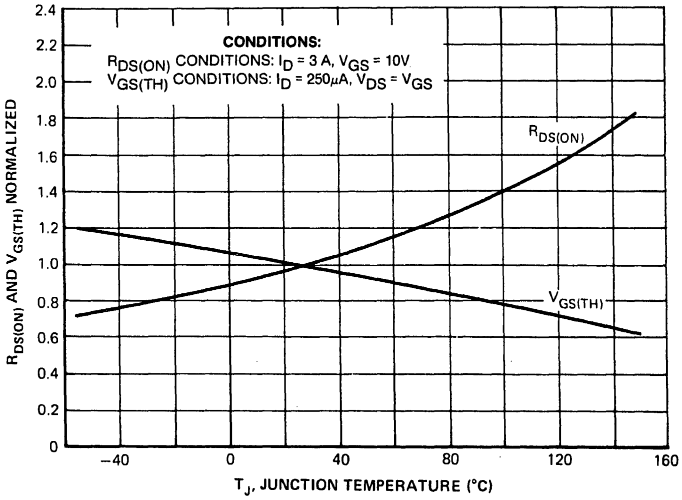
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	6	A
Pulsed Source Current	I_{SM}	—	—	24	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 6A$)	V_{SD}	—	—	2.5	Volts
Reverse Recovery Time ($I_S = 6A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	230 1.2	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF122,123

5.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.4 Ω

Preliminary

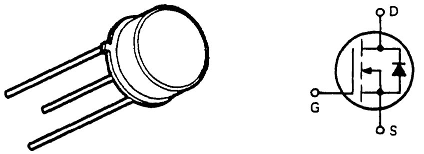
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

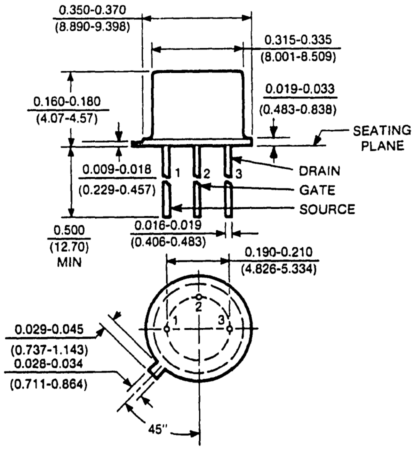
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF122	IRFF123	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C	I_D	5.0	5.0	A
Pulsed Drain Current(1)	I_{DM}	20	20	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF122 (V_{GS} = 0V, I_D = 250 μA) IRFF123	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	5.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 3A)	$R_{DS(ON)}$	—	—	0.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 3A)	g_{fs}	1.35	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	—	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	400	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	100	pF

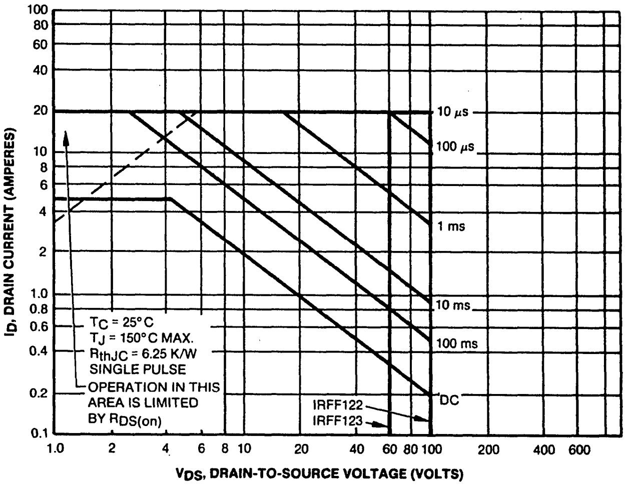
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 3.0A, V_{GS} = 15V	t_r	—	35	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	35	—	ns

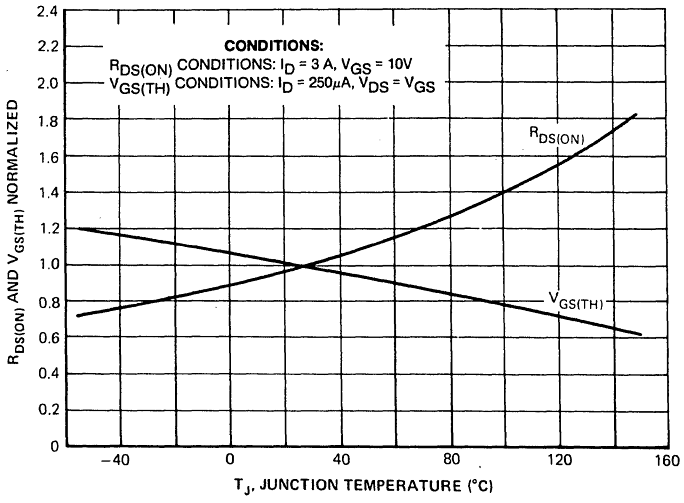
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	5	A
Pulsed Source Current	I_{SM}	—	—	20	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 5A)	V_{SD}	—	—	2.3	Volts
Reverse Recovery Time (I_S = 6A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	230 1.2	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF130,131

8.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.18 Ω

Preliminary

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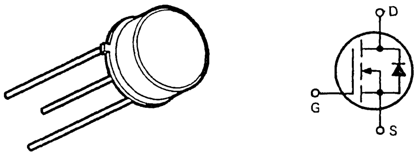
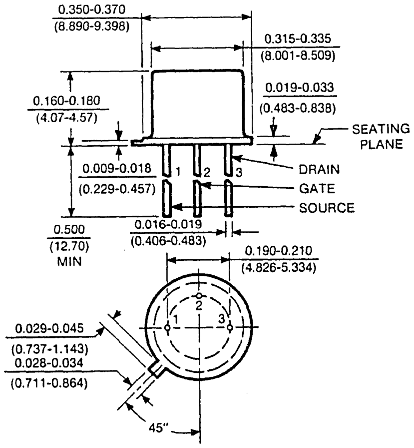
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF130	IRFF131	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C	I_D	8	8	A
Pulsed Drain Current(1)	I_{DM}	32	32	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25° C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF130 IRFF131	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	8.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4.0A)		$R_{DS(ON)}$	—	—	0.18	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4.0A)		g_{fs}	2.4	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	150	pF

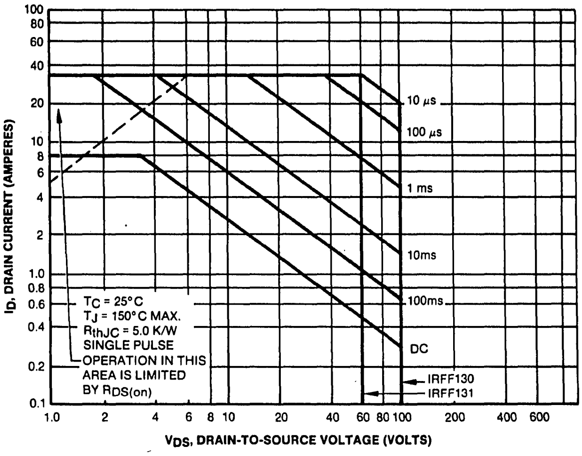
switching characteristics*

Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	30	—	ns
Rise Time	I_D = 4.0A, V_{GS} = 15V	t_r	—	80	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	80	—	ns

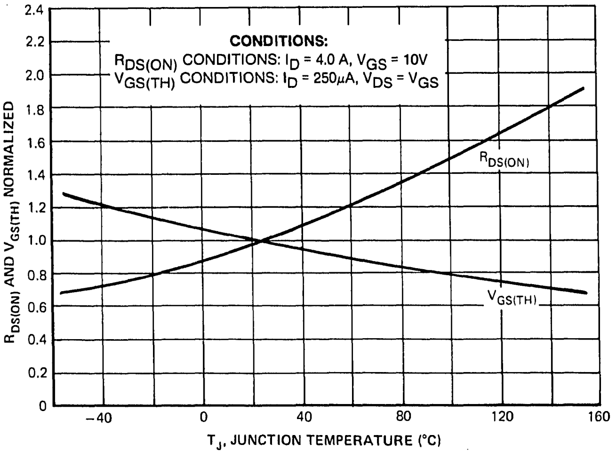
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	8	A
Pulsed Source Current	I_{SM}	—	—	32	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 8A)	V_{SD}	—	—	2.5	Volts
Reverse Recovery Time (I_S = 8A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	300 1.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRFF132,133

7.0 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.25 Ω

Preliminary

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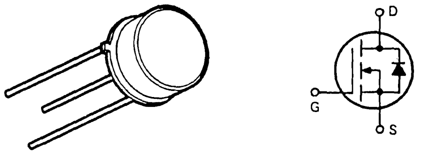
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

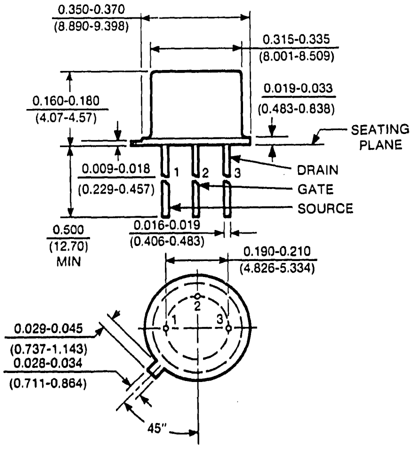
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF132	IRFF133	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25° C	I_D	7.0	7.0	A
Pulsed Drain Current⁽¹⁾	I_{DM}	28	28	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	25 0.2	25 0.2	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

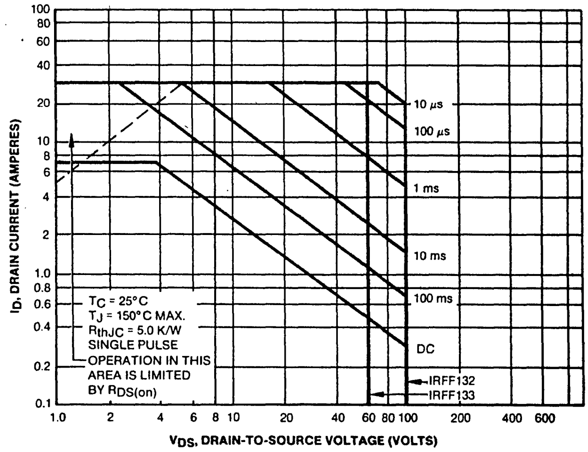
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

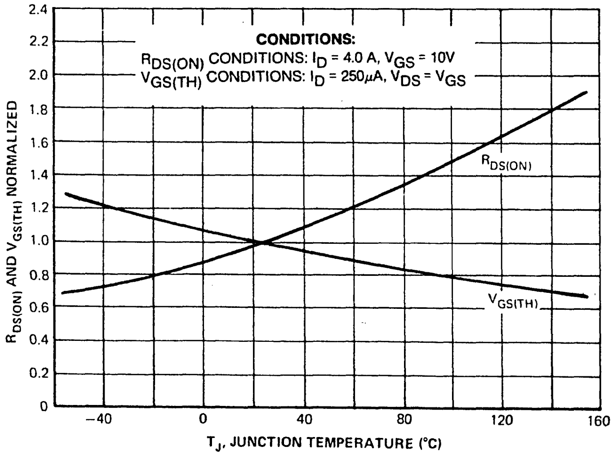
electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics						
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF132 IRFF133	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA
on characteristics*						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	7.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 4.0A)		$R_{DS(ON)}$	—	—	0.25	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 4.0A)		g_{fs}	2.4	—	—	mhos
dynamic characteristics						
Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	150	pF
switching characteristics*						
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	30	—	ns
Rise Time	I_D = 4A, V_{GS} = 15V	t_r	—	80	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	80	—	ns
source-drain diode ratings and characteristics*						
Continuous Source Current		I_S	—	—	7	A
Pulsed Source Current		I_{SM}	—	—	28	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 7A)		V_{SD}	—	—	2.3	Volts
Reverse Recovery Time (I_S = 8A, dI_s/dt = 100A/μsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	300 1.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF210,211

2.2 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 1.5\ \Omega$

Preliminary

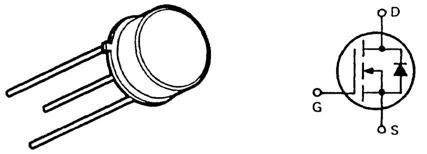
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

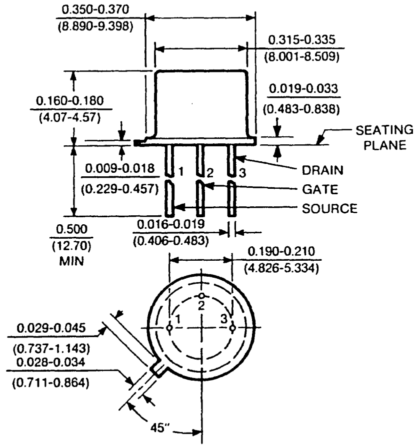
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFF210	IRFF211	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$	I_D	2.2	2.2	A
Pulsed Drain Current$^{(1)}$	I_{DM}	9	9	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	15 .12	15 .12	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150.	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.33	8.33	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF210 (V_{GS} = 0V, I_D = 250 μA) IRFF211	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	2.2	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.25A)	$R_{DS(ON)}$	—	—	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.25A)	g_{fs}	.72	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	80	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	25	pF

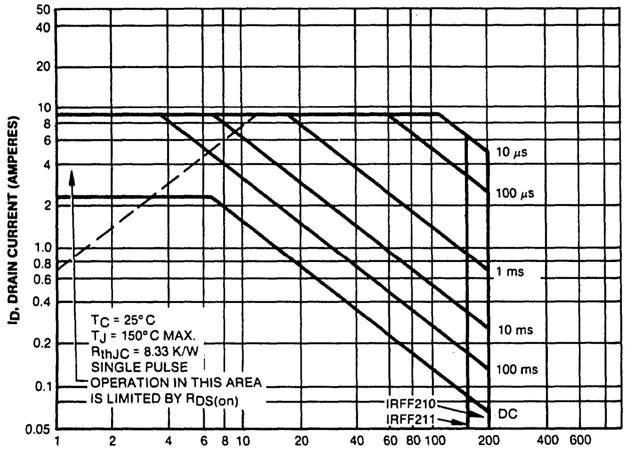
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	8	—	ns
Rise Time	I_D = 1.25A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	8	—	ns

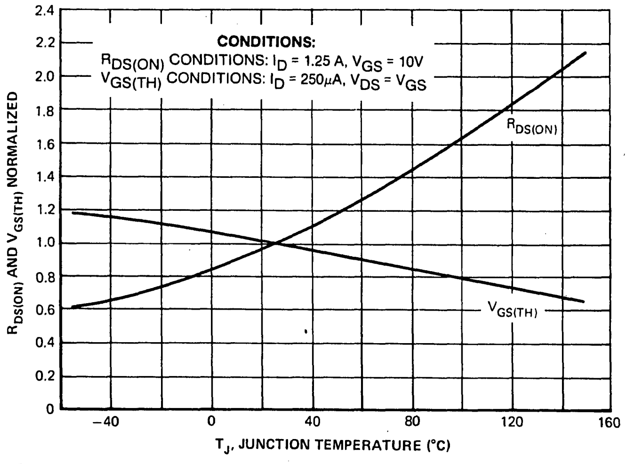
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.2	A
Pulsed Source Current	I_{SM}	—	—	9.0	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.5A)	V_{SD}	—	—	2.0	Volts
Reverse Recovery Time (I_S = 2.2A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	290 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF212,213

1.8 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 2.4 Ω

Preliminary

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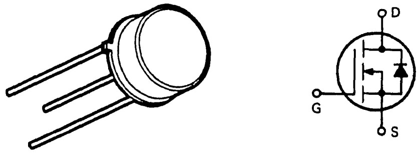
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

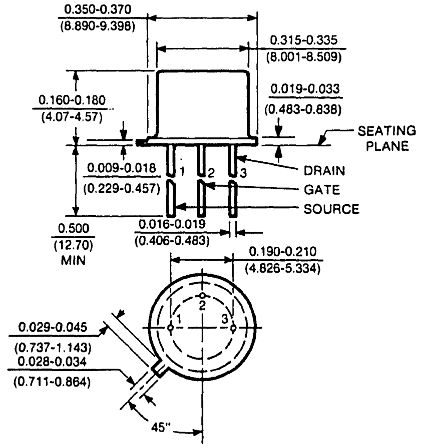
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF212	IRFF213	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25° C	I_D	1.8	1.8	A
Pulsed Drain Current⁽¹⁾	I_{DM}	7.5	7.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	15 .12	15 .12	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.33	8.33	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF212 (V_{GS} = 0V, I_D = 250 μA) IRFF213	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	1.8	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.25A)	$R_{DS(ON)}$	—	—	2.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.25A)	g_{fs}	0.72	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	80	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	25	pF

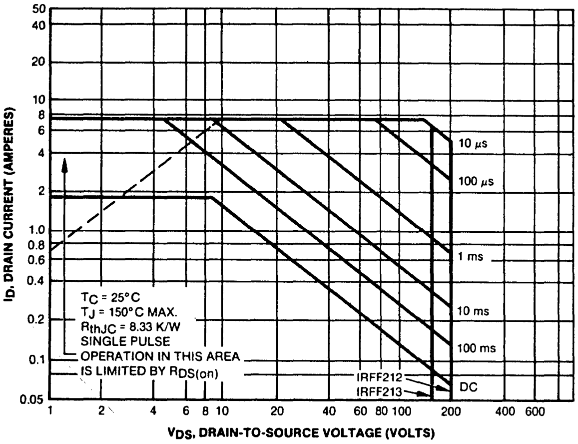
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	8	—	ns
Rise Time	I_D = 1.25A, V_{GS} = 15V	t_r	—	15	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	10	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	8	—	ns

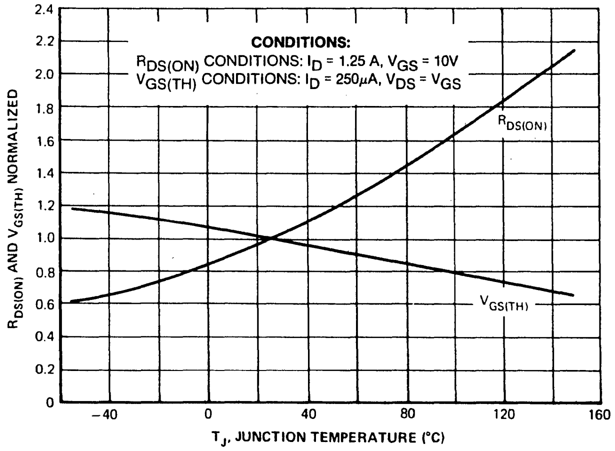
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	1.8	A
Pulsed Source Current	I_{SM}	—	—	7.5	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.0A)	V_{SD}	—	—	1.8	Volts
Reverse Recovery Time (I_S = 2.2A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	290 2.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRFF220,221

3.5 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.8\ \Omega$

Preliminary

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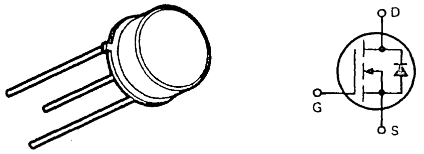
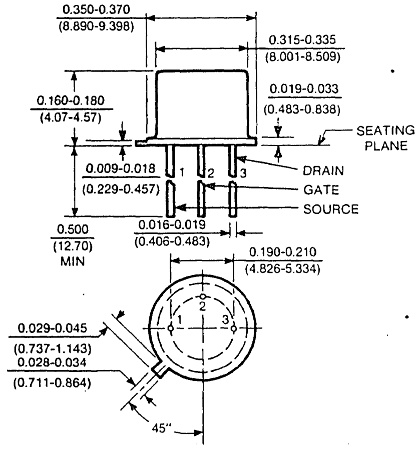
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFF220	IRFF221	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$	I_D	3.5	3.5	A
Pulsed Drain Current(1)	I_{DM}	14	14	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	20 1.6	20 1.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF220 ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRFF221	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)	$I_{D(ON)}$	3.5	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 2.0A$)	$R_{DS(ON)}$	—	—	0.8	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 2.0A$)	g_{fs}	1.2	—	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 10V$	C_{iss}	—	—	600	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	80	pF

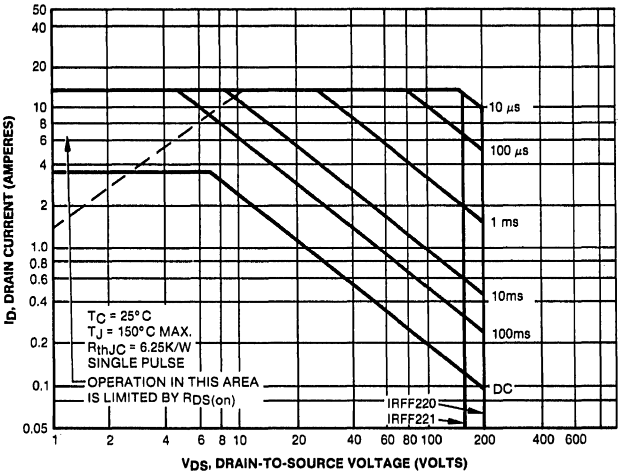
switching characteristics*

Turn-on Delay Time	$V_{DS} = 90V$	$t_{d(on)}$	—	20	—	ns
Rise Time	$I_D = 2.0A$, $V_{GS} = 15V$	t_r	—	30	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	30	—	ns

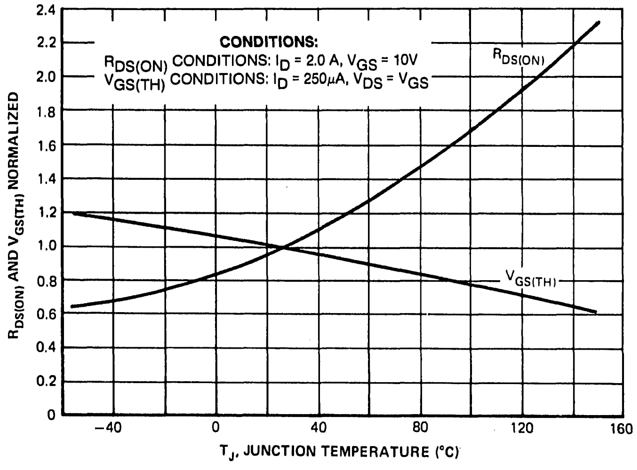
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	3.5	A
Pulsed Source Current	I_{SM}	—	—	14	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 3.5A$)	V_{SD}	—	—	2.0	Volts
Reverse Recovery Time ($I_S = 3.5A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	350 2.3	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF222,223

3 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 1.2\ \Omega$

Preliminary

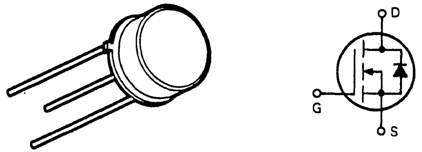
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

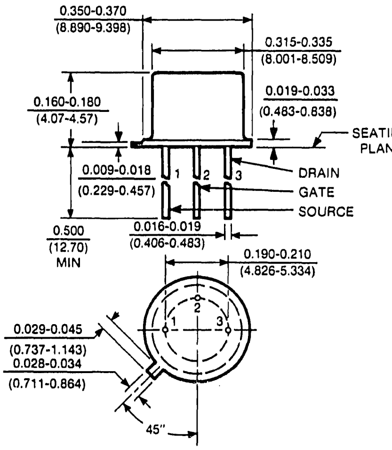
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFF222	IRFF223	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$	I_D	3.0	3.0	A
Pulsed Drain Current[(1)]	I_{DM}	12	12	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRFF222 IRFF223	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	3.0	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 2.0A$)		$R_{DS(ON)}$	—	—	1.2	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 2.0A$)		g_{fs}	1.2	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 10V$	C_{iss}	—	—	600	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	80	pF

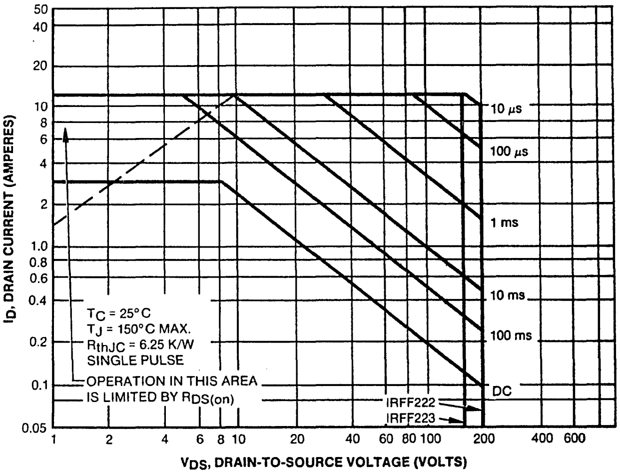
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	$V_{DS} = 90V$	$t_{d(on)}$	—	20	—	ns
Rise Time	$I_D = 2.0A$, $V_{GS} = 15V$	t_r	—	30	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	30	—	ns

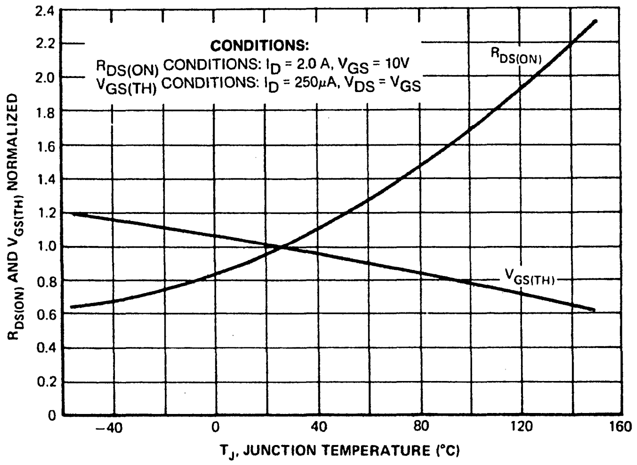
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	3	A
Pulsed Source Current	I_{SM}	—	—	12	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 3.0A$)	V_{SD}	—	—	1.8	Volts
Reverse Recovery Time ($I_S = 3.5A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	350 2.3	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF230,231

5.5 AMPERES
200, 150 VOLTS
$R_{DS(ON)} = 0.4\ \Omega$

Preliminary

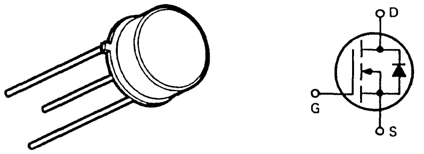
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

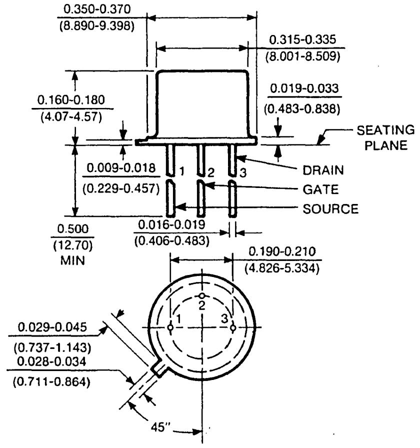
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFF230	IRFF231	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	200	150	Volts
Continuous Drain Current @ $T_C = 25°C$	I_D	5.5	5.5	A
Pulsed Drain Current(1)	I_{DM}	22	22	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF230 ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRFF231	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)	$I_{D(ON)}$	5.5	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 3.0A$)	$R_{DS(ON)}$	—	—	0.4	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 3.0A$)	g_{fs}	1.75	—	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	—	800	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	150	pF

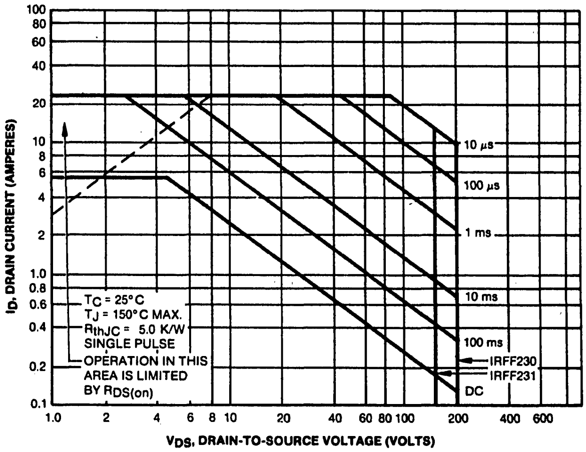
switching characteristics*

Turn-on Delay Time	$V_{DS} = 90V$	$t_{d(on)}$	—	15	—	ns
Rise Time	$I_D = 3.0A$, $V_{GS} = 15V$	t_r	—	25	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	20	—	ns

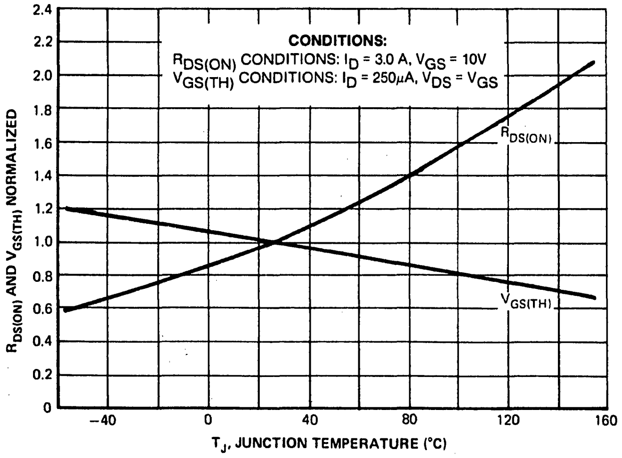
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	5.5	A
Pulsed Source Current	I_{SM}	—	—	22	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 5.5A$)	V_{SD}	—	—	2.0	Volts
Reverse Recovery Time ($I_S = 5.5A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	450 3.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF232,233

4.5 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.6 Ω

Preliminary

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Features

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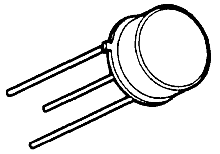
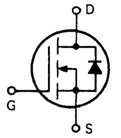
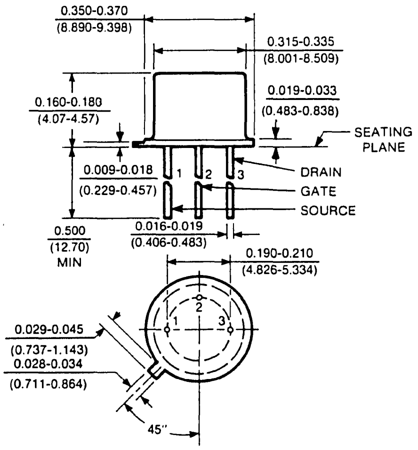
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF232	IRFF233	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C	I_D	4.5	4.5	A
Pulsed Drain Current[1]	I_{DM}	18	18	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF232 IRFF233	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	4.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 3.0A)		$R_{DS(ON)}$	—	—	0.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 3.0A)		g_{fs}	1.75	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	800	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	450	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	150	pF

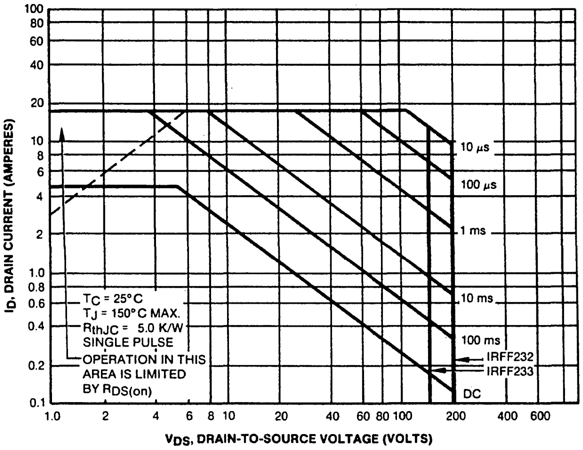
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 3.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

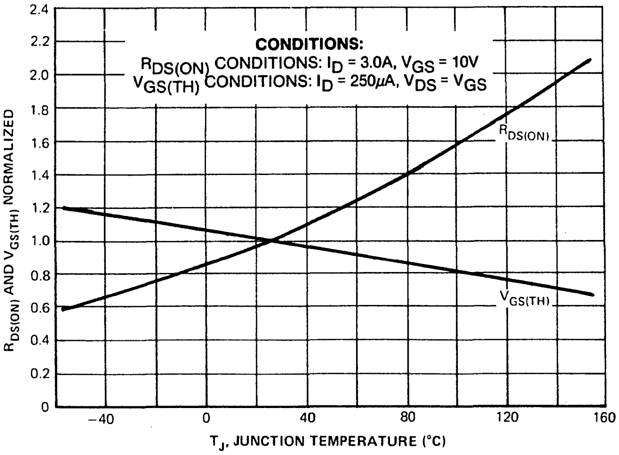
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	4.5	A
Pulsed Source Current	I_{SM}	—	—	18	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 4.5A)	V_{SD}	—	—	1.8	Volts
Reverse Recovery Time (I_S = 5.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	450 3.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRFF310,311

1.35 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 3.6 Ω

Preliminary

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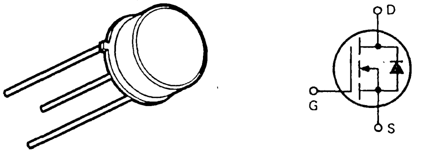
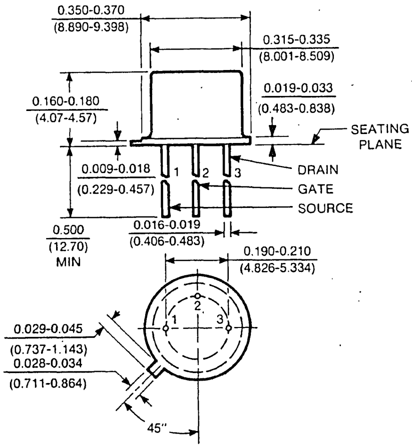
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF310	IRFF311	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C	I_D	1.35	1.35	A
Pulsed Drain Current[1]	I_{DM}	5.5	5.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	15 0.12	15 0.12	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.33	8.33	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16″ from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF310 IRFF311	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	1.35	—	—	Amp
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.8A)		$R_{DS(ON)}$	—	—	3.6	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.8A)		g_{fs}	0.4	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	150	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	50	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	15	pF

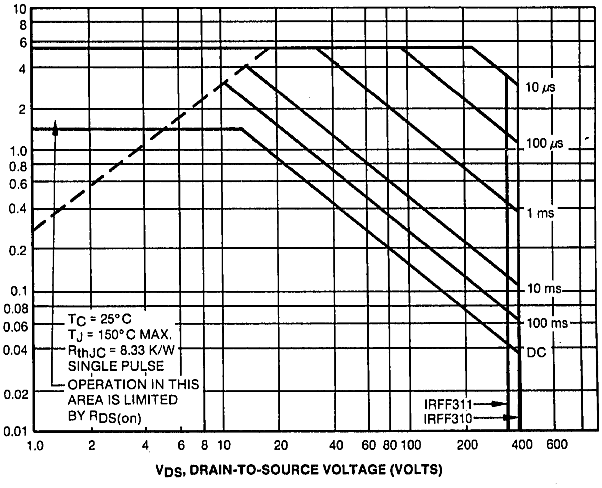
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	3	—	ns
Rise Time	I_D = 0.8A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	5	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	8	—	ns

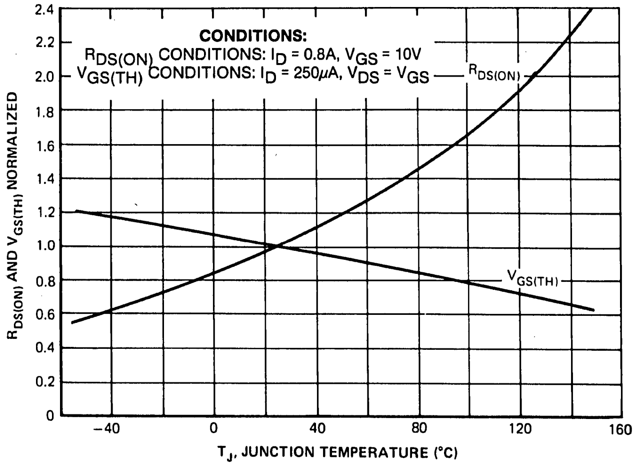
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	1.35	A
Pulsed Source Current	I_{SM}	—	—	5.5	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 1.35A)	V_{SD}	—	—	1.6	Volts
Reverse Recovery Time (I_S = 1.35A, di_S/dt = 100A/μs,, T_C = 125°C)	t_{rr}	—	380	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF312,313

1.15 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 5.0 Ω

Preliminary

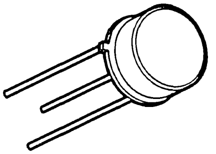
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

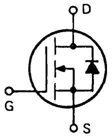
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

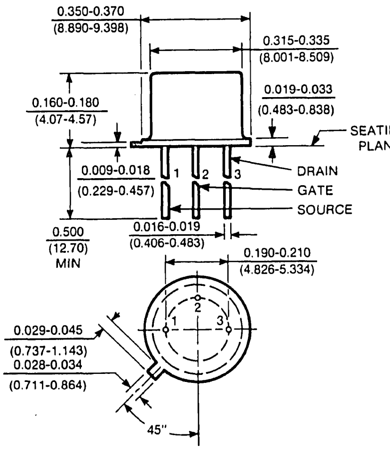
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF312	IRFF313	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25° C	I_D	1.15	1.15	A
Pulsed Drain Current(1)	I_{DM}	4.5	4.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	15 0.12	15 0.12	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.33	8.33	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF312 IRFF313	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25° C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	1.15	—	—	Amp
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.8A)		$R_{DS(ON)}$	—	—	5.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.8A)		g_{fs}	0.4	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	385	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	70	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	12	40	pF

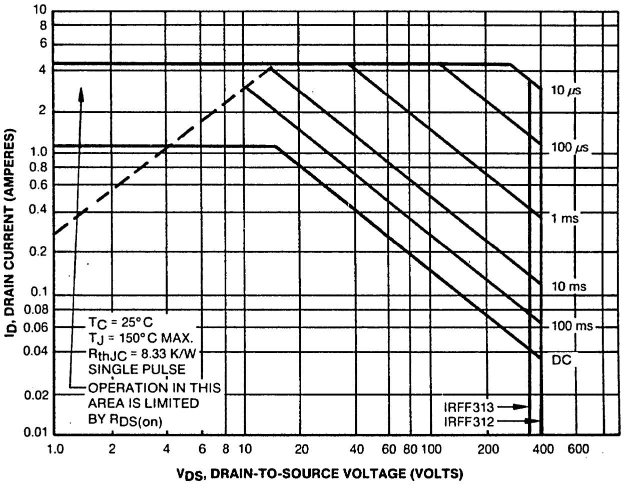
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	3	—	ns
Rise Time	I_D = 0.8A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	5	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	8	—	ns

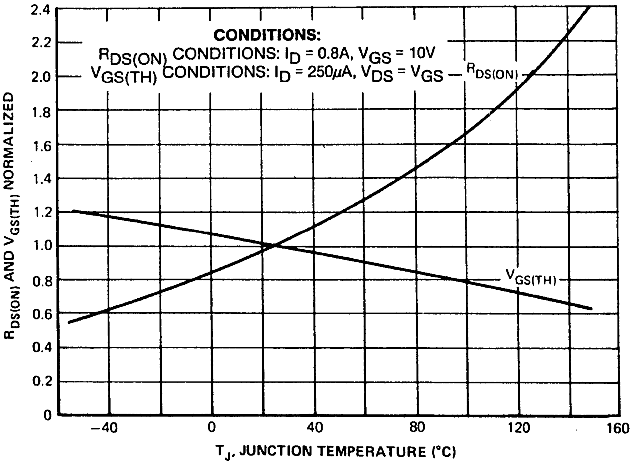
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	1.15	A
Pulsed Source Current	I_{SM}	—	—	4.5	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 1.15A)	V_{SD}	—	—	1.5	Volts
Reverse Recovery Time (I_S = 1.35A, di_S/dt = 100A/μs, Max., T_C = 125° C)	t_{rr}	—	380	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF320,321

2.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 1.8 Ω

Preliminary

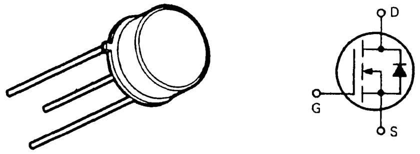
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

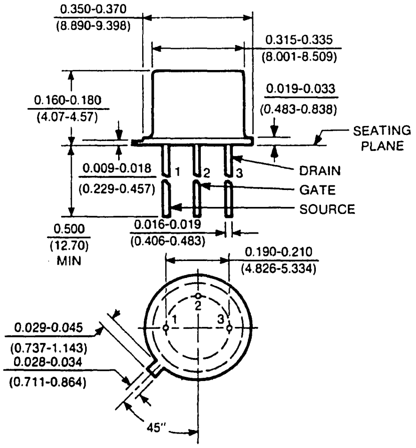
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF320	IRFF321	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25° C	I_D	2.5	2.5	A
Pulsed Drain Current[1]	I_{DM}	10	10	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	20 0.16	20 0.16	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA) IRFF320 IRFF321	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	2.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.25A)	$R_{DS(ON)}$	—	—	1.8	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.25A)	g_{fs}	0.8	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	—	600	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	40	pF

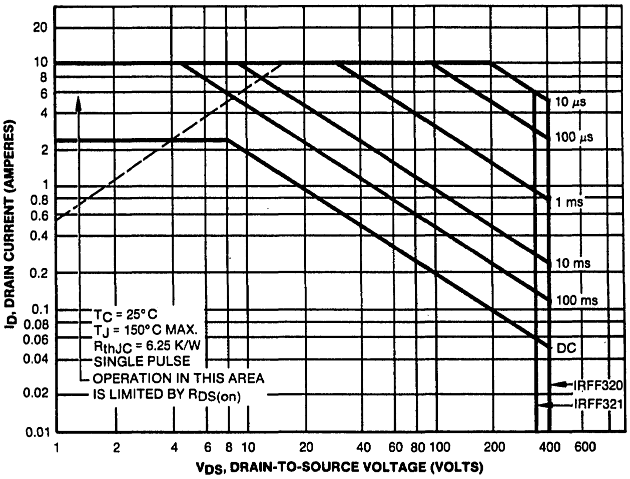
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 1.25A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	25	—	ns

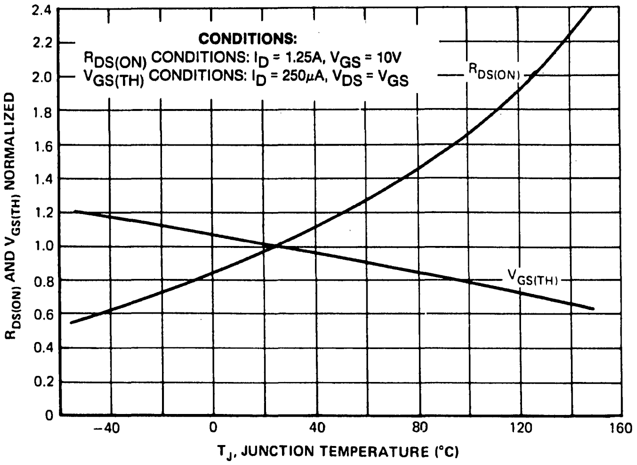
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.5	A
Pulsed Source Current	I_{SM}	—	—	10	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 2.5A)	V_{SD}	—	—	1.6	Volts
Reverse Recovery Time (I_S = 2.5A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	450 3.1	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF322,323

2.0 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 2.5\ \Omega$

Preliminary

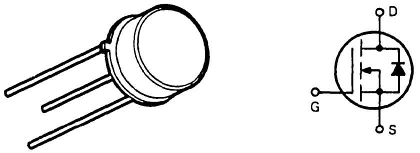
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

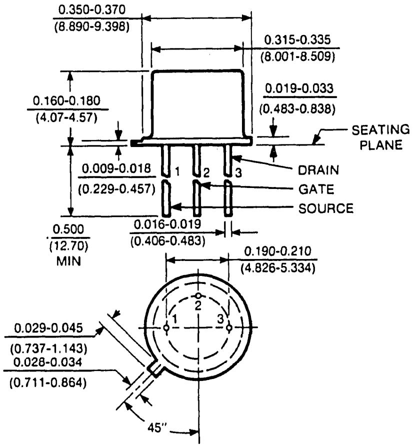
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFF322	IRFF323	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$	I_D	2.0	2.0	A
Pulsed Drain Current(1)	I_{DM}	8	8	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	20 0.16	20 0.16	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRFF322 IRFF323	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	2.0	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.25A$)		$R_{DS(ON)}$	—	—	2.5	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 1.25A$)		g_{fs}	0.8	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 10V$	C_{iss}	—	—	600	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	40	pF

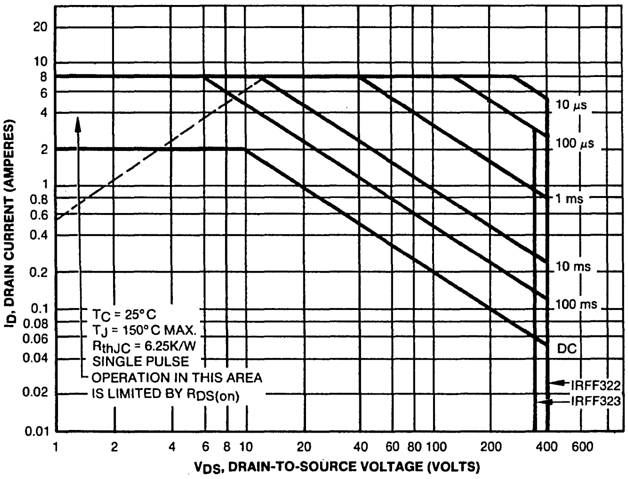
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	$V_{DS} = 175V$	$t_{d(on)}$	—	20	—	ns
Rise Time	$I_D = 1.25A$, $V_{GS} = 15V$	t_r	—	25	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	50	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	25	—	ns

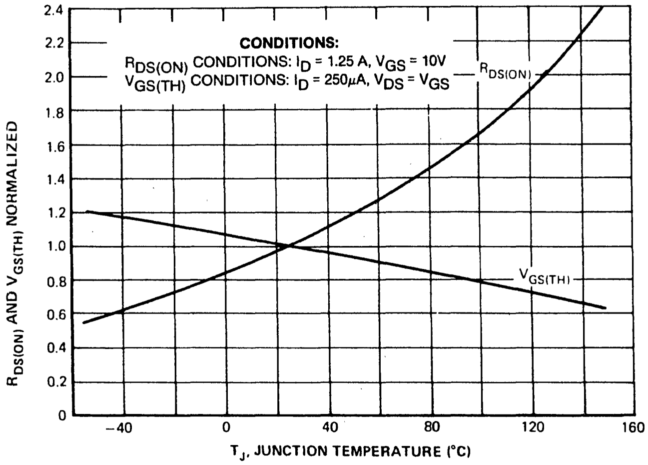
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	2.0	A
Pulsed Source Current	I_{SM}	—	—	8	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 2.0A$)	V_{SD}	—	—	1.5	Volts
Reverse Recovery Time ($I_S = 2.5A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	450 3.1	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF330,331

3.5 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 1.0\ \Omega$

Preliminary

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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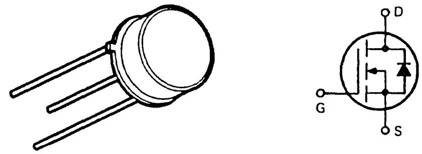
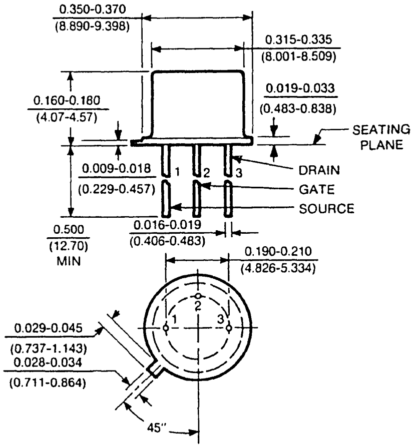
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF330	IRFF331	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C	I_D	3.5	3.5	A
Pulsed Drain Current⁽¹⁾	I_{DM}	14	14	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25° C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 µA)	IRFF330 IRFF331	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	µA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 µA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	3.5	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2A)		$R_{DS(ON)}$	—	—	1.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2A)		g_{fs}	1.6	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	900	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	80	pF

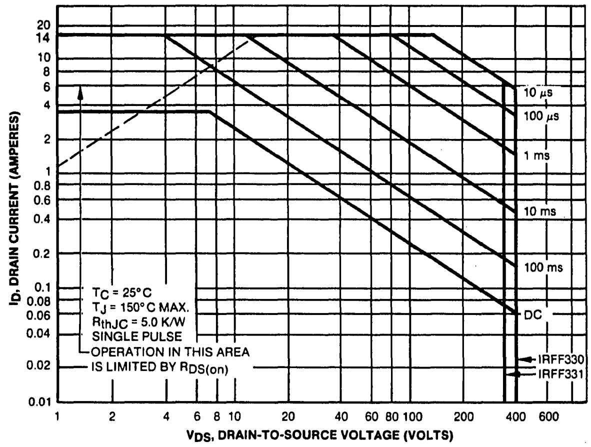
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

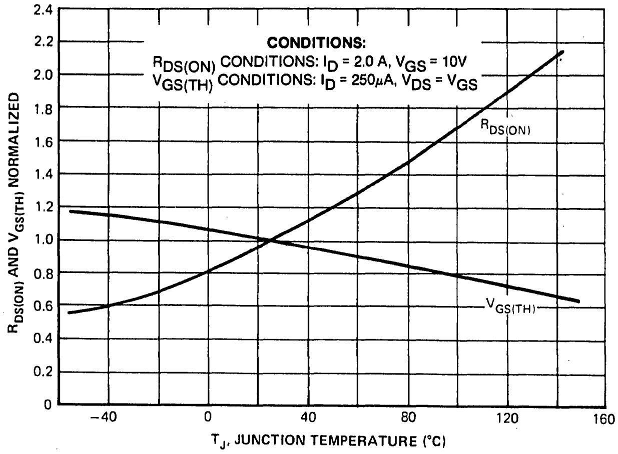
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	3.5	A
Pulsed Source Current	I_{SM}	—	—	14	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 3.5A)	V_{SD}	—	1.0	1.6	Volts
Reverse Recovery Time (I_S = 3.5A, dI_s/dt = 100A/µsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	600 4.0	— —	ns µC

*Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF332,333

3.0 AMPERES
400, 350 VOLTS
$R_{DS(ON)} = 1.5\ \Omega$

Preliminary

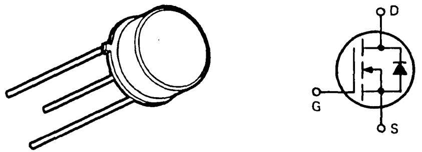
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

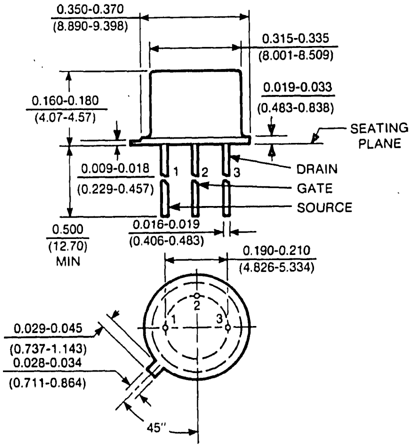
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFF332	IRFF333	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	400	350	Volts
Continuous Drain Current @ $T_C = 25°C$	I_D	3.0	3.0	A
Pulsed Drain Current(1)	I_{DM}	12	12	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF332 (V_{GS} = 0V, I_D = 250 μA) IRFF333	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	3.0	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 2.0A)	$R_{DS(ON)}$	—	—	1.5	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 2.0A)	g_{fs}	1.6	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	900	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	300	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	80	pF

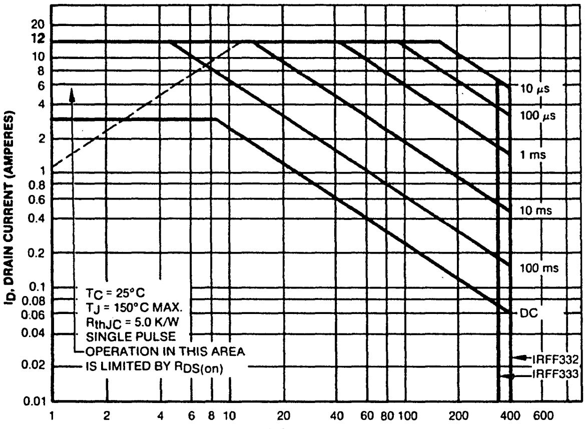
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 2.0A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	20	—	ns

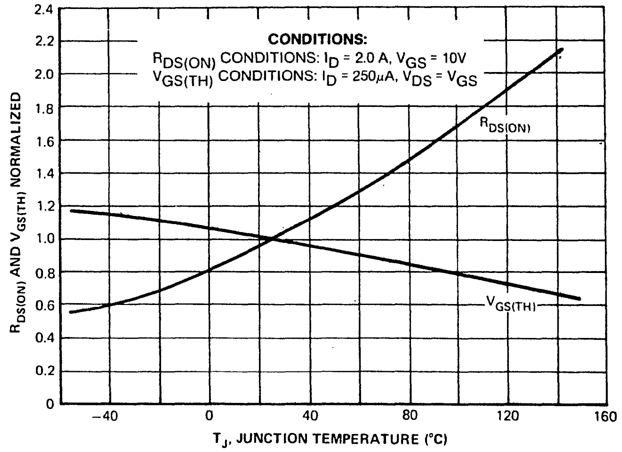
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	3.0	A
Pulsed Source Current	I_{SM}	—	—	12	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 3.0A)	V_{SD}	—	—	1.5	Volts
Reverse Recovery Time (I_S = 3.5A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	600 4.0	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF420,421

1.6 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 3.0\ \Omega$

Preliminary

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

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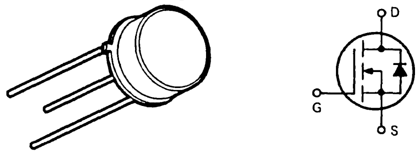
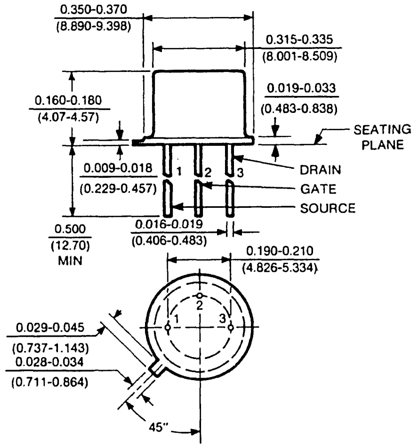
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF420	IRFF421	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25° C	I_D	1.6	1.6	A
Pulsed Drain Current[1]	I_{DM}	6.5	6.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25° C	P_D	20 .16	20 .16	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF420 (V_{GS} = 0V, I_D = 250 μA) IRFF421	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	1.6	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.0A)	$R_{DS(ON)}$	—	—	3.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.0A)	g_{fs}	0.8	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	—	400	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	150	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	40	pF

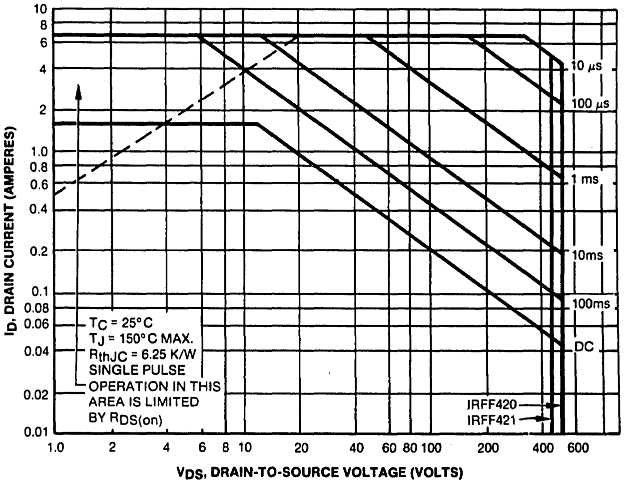
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	30	—	ns
Rise Time	I_D = 1.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	15	—	ns

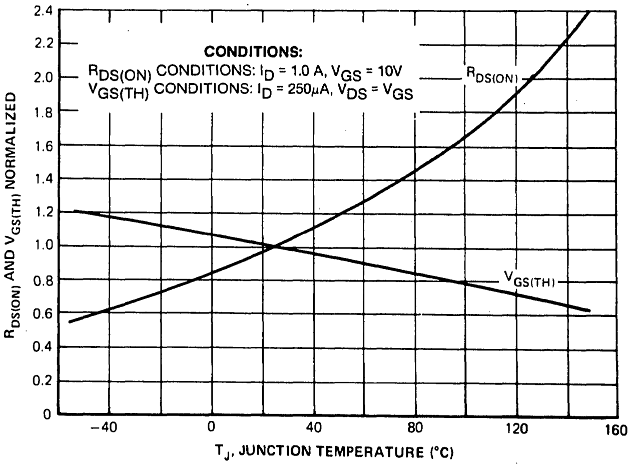
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	1.6	A
Pulsed Source Current	I_{SM}	—	—	6.5	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 1.6A)	V_{SD}	—	—	1.4	Volts
Reverse Recovery Time (I_S = 1.6A, dI_S/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	600 3.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF422,423

1.4 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 4.0 Ω

Preliminary

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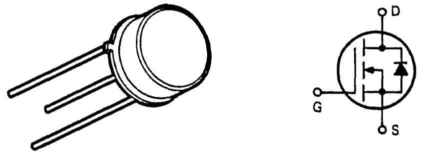
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

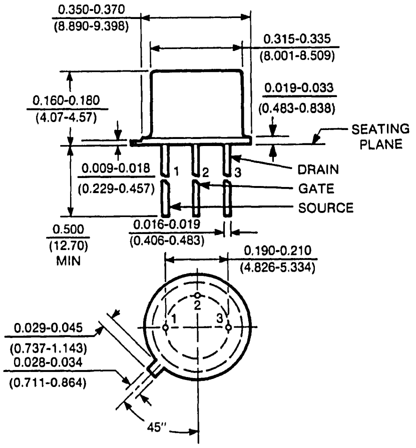
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF422	IRFF423	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25° C	I_D	1.4	1.4	A
Pulsed Drain Current(1)	I_{DM}	5.5	5.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	20 .16	20 .16	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.25	6.25	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFF422 IRFF423	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	1.4	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 1.0A)		$R_{DS(ON)}$	—	—	4.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 1.0A)		g_{fs}	0.8	—	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 10V	C_{iss}	—	—	400	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	150	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	40	pF

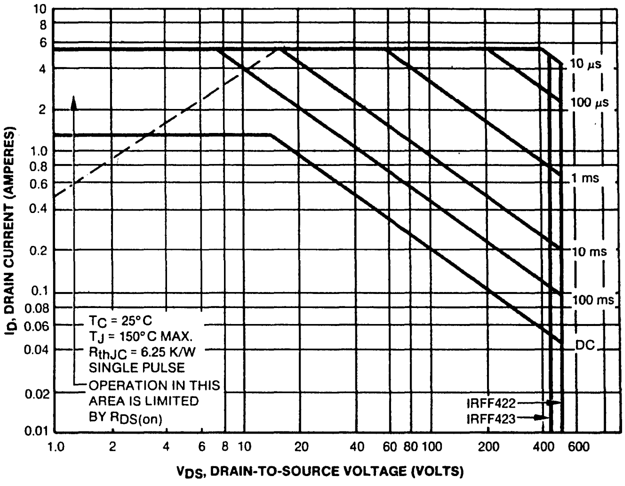
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	30	—	ns
Rise Time	I_D = 1.0A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	30	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	15	—	ns

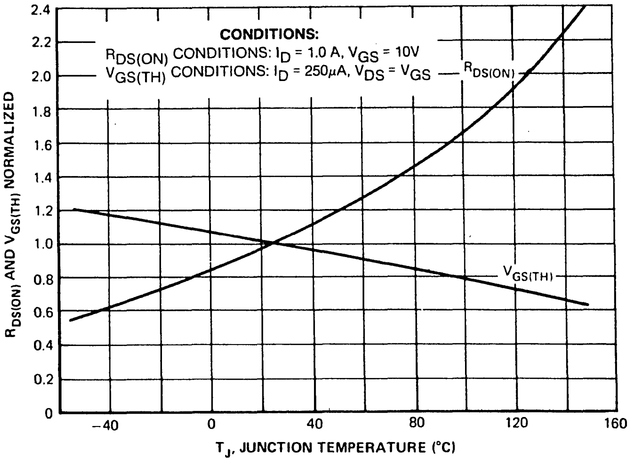
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	1.4	A
Pulsed Source Current		I_{SM}	—	—	5.6	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 1.4A)		V_{SD}	—	—	1.3	Volts
Reverse Recovery Time (I_S = 1.6A, dI_S/dt = 100A/μsec, T_C = 125°C)		t_{rr} Q_{RR}	— —	600 3.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF430,431

2.75 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 1.5\ \Omega$

Preliminary

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

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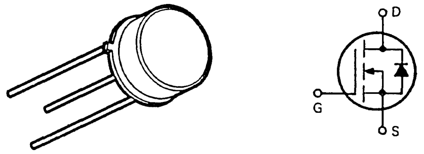
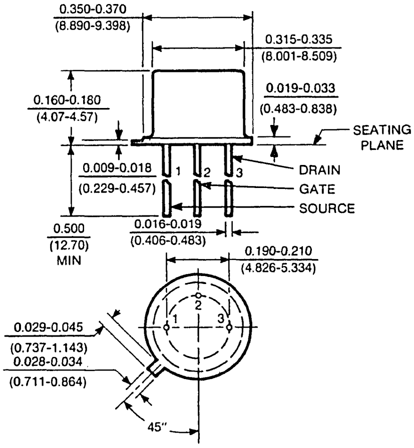
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF430	IRFF431	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C	I_D	2.75	2.75	A
Pulsed Drain Current⁽¹⁾	I_{DM}	11	11	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRFF430 IRFF431	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	2.75	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.5A$)		$R_{DS(ON)}$	—	—	1.5	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 1.5A$)		g_{fs}	1.35	—	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	—	800	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	60	pF

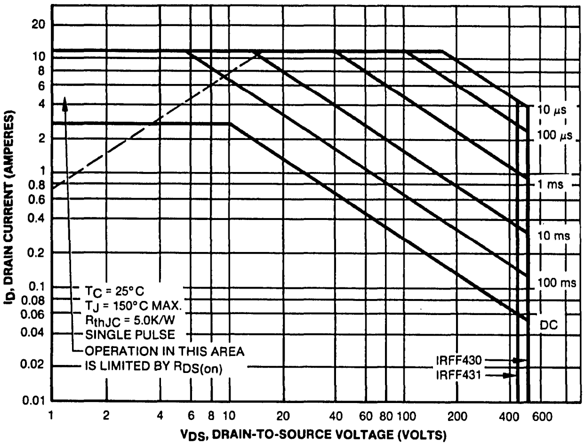
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	$V_{DS} = 225V$	$t_{d(on)}$	—	15	—	ns
Rise Time	$I_D = 1.5A$, $V_{GS} = 15V$	t_r	—	10	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	40	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	25	—	ns

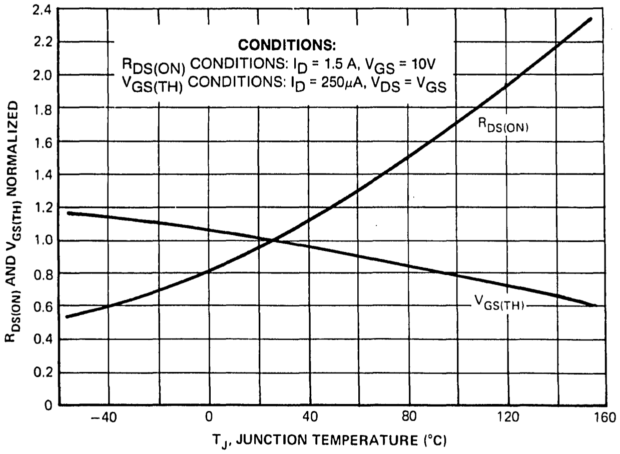
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	2.75	A
Pulsed Source Current	I_{SM}	—	—	11	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 4.5A$)	V_{SD}	—	—	1.4	Volts
Reverse Recovery Time ($I_S = 2.75A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	800 4.6	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFF432,433

2.25 AMPERES
500, 450 VOLTS
$R_{DS(ON)}$ = 2.0 Ω

Preliminary

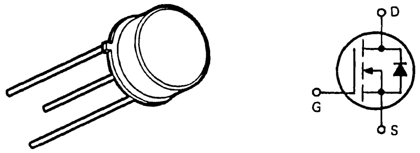
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

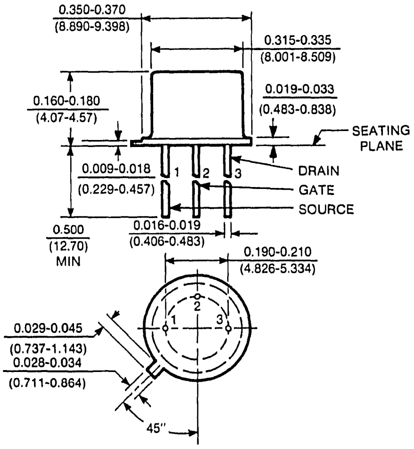
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFF432	IRFF433	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	500	450	Volts
Continuous Drain Current @ T_C = 25°C	I_D	2.25	2.25	A
Pulsed Drain Current[(1)]	I_{DM}	9	9	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	25 0.2	25 0.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	5.0	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	175	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFF432 ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRFF433	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±100	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)	$I_{D(ON)}$	2.25	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.5A$)	$R_{DS(ON)}$	—	—	2.0	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 1.5A$)	g_{fs}	1.35	—	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	—	800	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	—	200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	60	pF

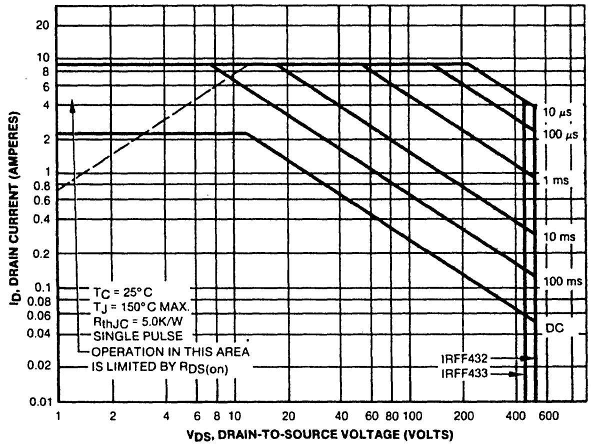
switching characteristics*

Turn-on Delay Time	$V_{DS} = 225V$	$t_{d(on)}$	—	15	—	ns
Rise Time	$I_D = 1.5A$, $V_{GS} = 15V$	t_r	—	10	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	40	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	25	—	ns

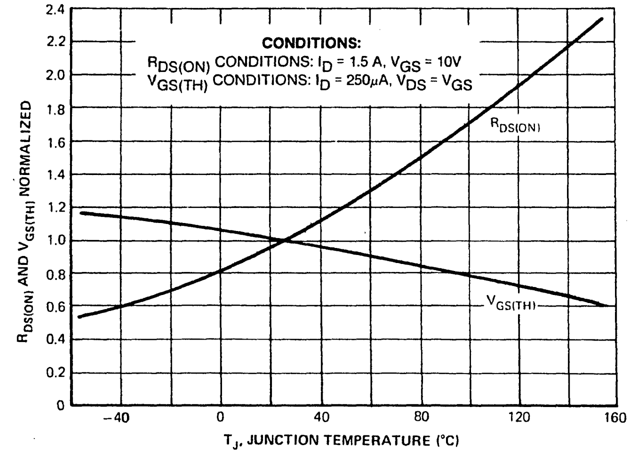
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	2.25	A
Pulsed Source Current	I_{SM}	—	—	9	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 2.25A$)	V_{SD}	—	1.0	1.3	Volts
Reverse Recovery Time ($I_S = 2.75A$, $dI_s/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	800 4.6	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP150,151
D88FL2,K2

40 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.055 Ω

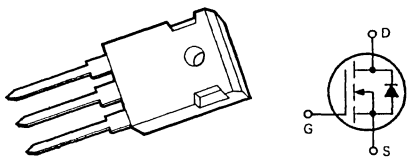
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

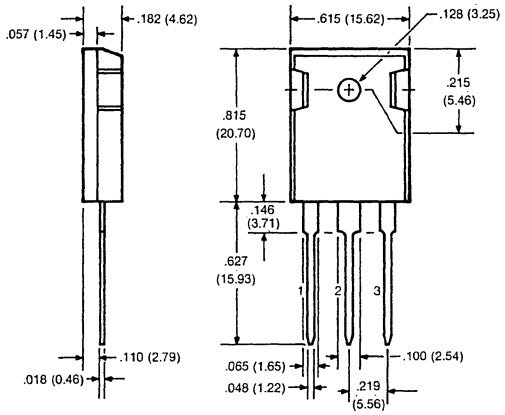
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP150/D88FL2	IRFP151/D88FK2	UNIT
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	40 25	40 25	A A
Pulsed Drain Current[(1)]	I_{DM}	160	160	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	150 1.2	150 1.2	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFP151/D88FK2 IRFP150/D88FL2	BV_{DSS}	60 100	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±100	nA

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)		$I_{D(ON)}$	40	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 20A)		$R_{DS(ON)}$	—	0.050	0.055	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 20A)		g_{fs}	8.1	10	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	1000	1500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	225	500	pF

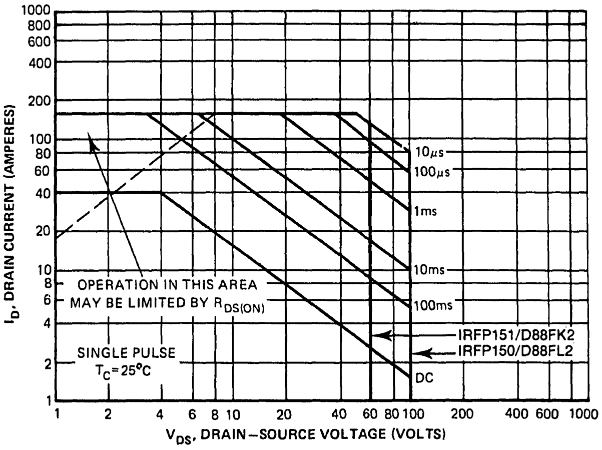
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 30V	$t_{d(on)}$	—	25	—	ns
Rise Time	I_D = 20A, V_{GS} = 15V	t_r	—	145	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	95	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	75	—	ns

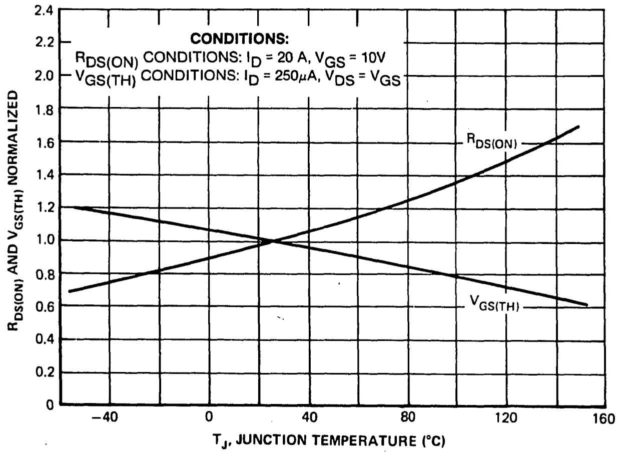
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	40	A
Pulsed Source Current	I_{SM}	—	—	160	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 40A)	V_{SD}	—	1.3	2.5	Volts
Reverse Recovery Time (I_S = 40A, dI_S/dt = 100A/μs, T_C = 125°C)	t_{rr} Q_{RR}	— —	300 2.8	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP152,153

33 AMPERES
100, 60 VOLTS
$R_{DS(ON)}$ = 0.08 Ω

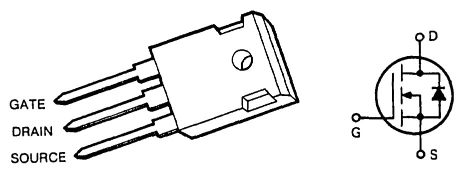
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

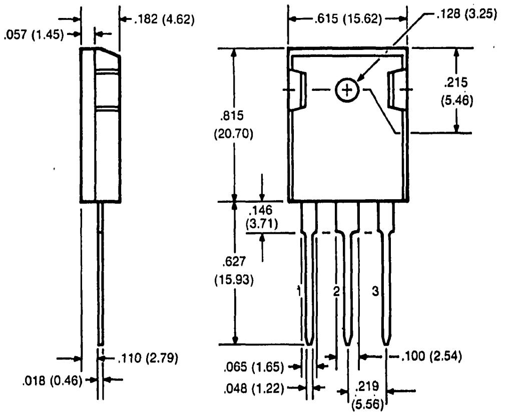
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP152	IRFP153	UNITS
Drain-Source Voltage	V_{DSS}	100	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	100	60	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	33 20	33 20	A A
Pulsed Drain Current(1)	I_{DM}	132	132	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFP152 ($V_{GS} = 0V$, $I_D = 250\ \mu A$) IRFP153	BV_{DSS}	100 60	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage $T_C = 25°C$ ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 3.0V$)	$I_{D(ON)}$	33	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 20A$)	$R_{DS(ON)}$	—	0.06	0.08	Ohms
Forward Transconductance ($V_{DS} = 2.7V$, $I_D = 20A$)	g_{fs}	8.1	10	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	2800	3000	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	1000	1500	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	225	500	pF

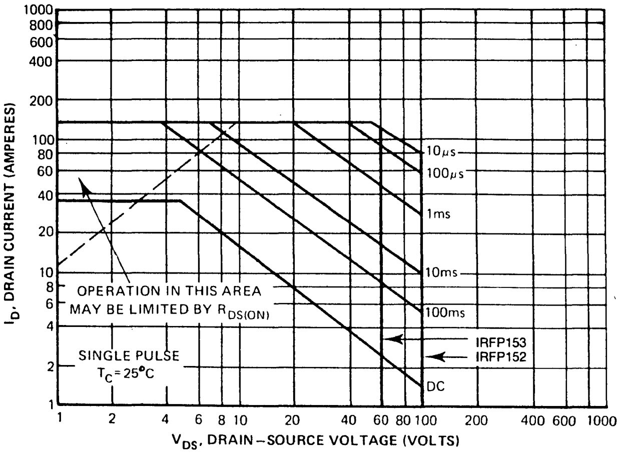
switching characteristics*

Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	25	—	ns
Rise Time	$I_D = 20A$, $V_{GS} = 15V$	t_r	—	145	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	95	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	75	—	ns

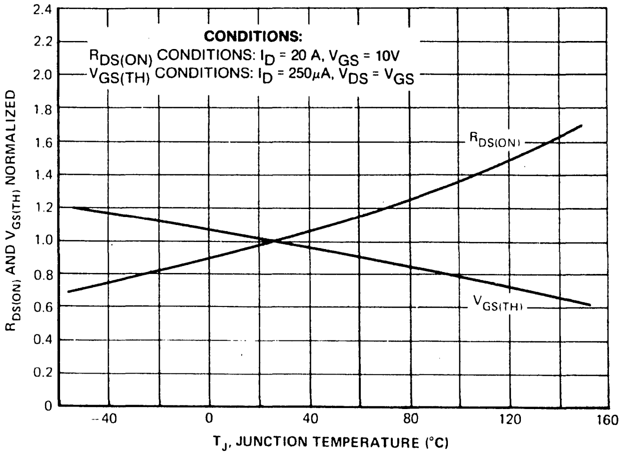
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	33	A
Pulsed Source Current	I_{SM}	—	—	132	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 33A$)	V_{SD}	—	1.2	2.3	Volts
Reverse Recovery Time ($I_S = 40A$, $dI_S/dt = 100A/\mu sec$, $T_C = 125°C$)	t_{rr} Q_{RR}	— —	300 2.8	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP250,251
D88FN2,M2

30 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.085 Ω

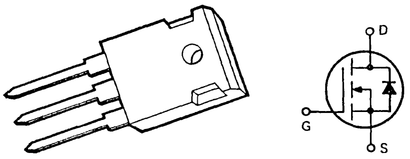
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

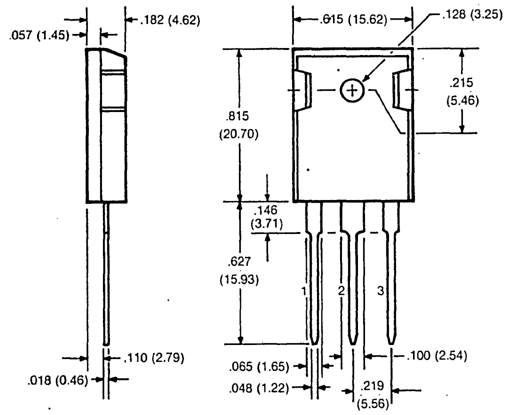
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP250/D88FN2	IRFP251/D88FM2	UNIT
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	30 19	30 19	A A
Pulsed Drain Current(1)	I_{DM}	120	120	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$)	IRFP251/D88FM2 IRFP250/D88FN2	BV_{DSS}	150 200	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_C = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_C = 125°C$)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$)	$T_C = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current ($V_{GS} = 10V$, $V_{DS} = 10V$)		$I_{D(ON)}$	30	—	—	A
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 16A$)		$R_{DS(ON)}$	—	0.075	0.085	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 16A$)		g_{fs}	7.2	10	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	2800	3000	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	520	1200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	500	pF

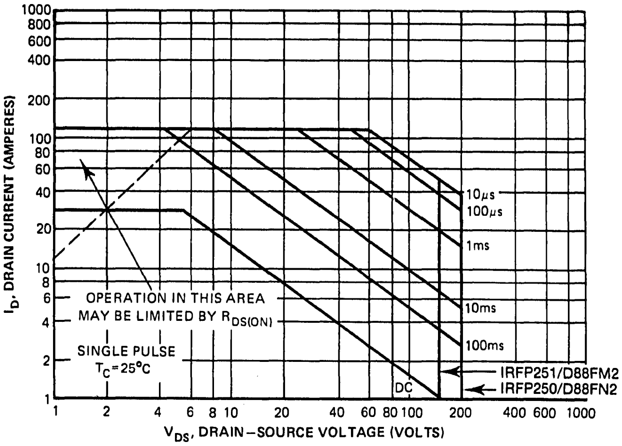
switching characteristics*

Turn-on Delay Time	$V_{DS} = 90V$	$t_{d(on)}$	—	20	—	ns
Rise Time	$I_D = 16A$, $V_{GS} = 15V$	t_r	—	75	—	ns
Turn-off Delay Time	$R_{GEN} = 50\Omega$, $R_{GS} = 12.5\Omega$	$t_{d(off)}$	—	90	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	65	—	ns

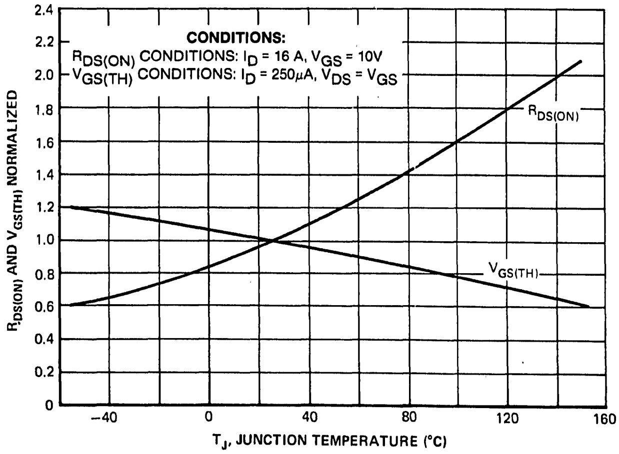
source-drain diode ratings and characteristics*

Continuous Source Current		I_S	—	—	30	A
Pulsed Source Current		I_{SM}	—	—	120	A
Diode Forward Voltage ($T_C = 25°C$, $V_{GS} = 0V$, $I_S = 40A$)		V_{SD}	—	1.3	2.0	Volts
Reverse Recovery Time ($I_S = 30A$, $dI_S/dt = 100A/\mu s$, $T_C = 125°C$)		t_{rr} Q_{RR}	— —	345 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

IRFP252,253

25 AMPERES
200, 150 VOLTS
$R_{DS(ON)}$ = 0.12 Ω

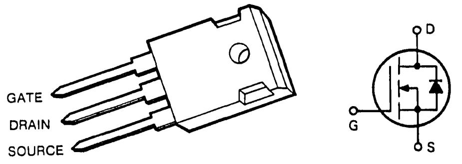
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

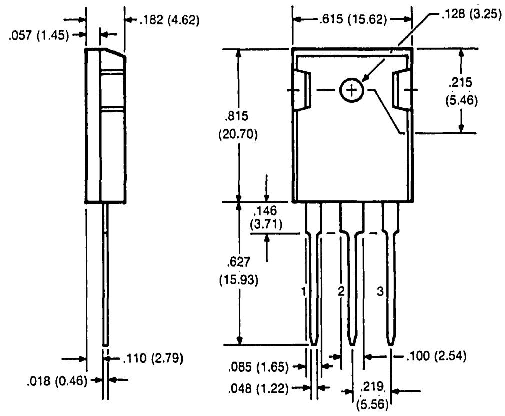
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP252	IRFP253	UNITS
Drain-Source Voltage	V_{DSS}	200	150	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	200	150	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	25 16	25 16	A A
Pulsed Drain Current(1)	I_{DM}	100	100	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFP252 IRFP253	BV_{DSS}	200 150	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 3.4V)		$I_{D(ON)}$	25	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 16A)		$R_{DS(ON)}$	—	0.10	0.12	Ohms
Forward Transconductance (V_{DS} = 3.1V, I_D = 16A)		g_{fs}	7.2	10	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	520	1200	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	120	500	pF

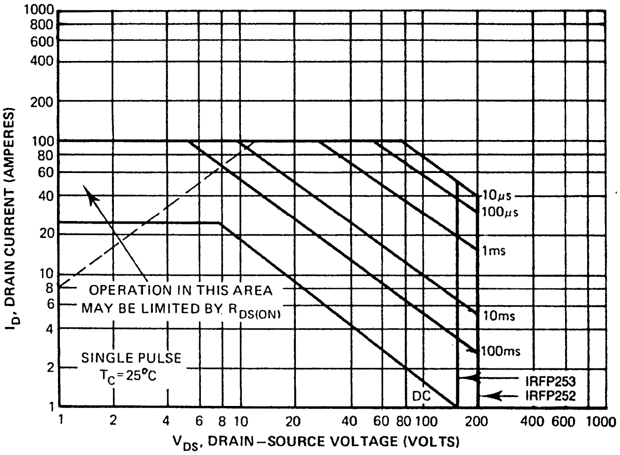
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 16A, V_{GS} = 15V	t_r	—	75	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	90	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	65	—	ns

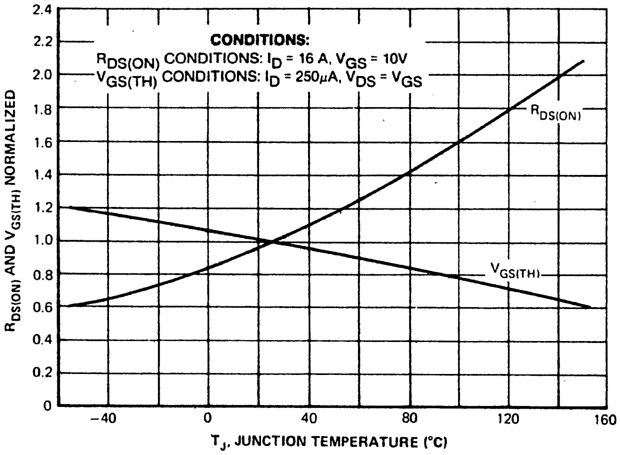
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	25	A
Pulsed Source Current	I_{SM}	—	—	100	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 25A)	V_{SD}	—	1.2	1.8	Volts
Reverse Recovery Time (I_S = 30A, dI_s/dt = 100A/μs, T_C = 125°C)	t_{rr} Q_{RR}	— —	345 4.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP350,351
D88FQ2,Q1

15 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.3 Ω

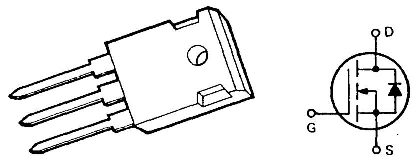
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

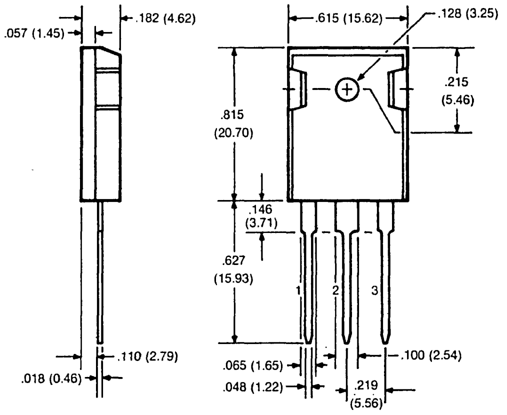
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP350/D88FQ2	IRFP351/D88FQ1	UNIT
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	15 9	15 9	A A
Pulsed Drain Current(1)	I_{DM}	60	60	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	150 1.2	150 1.2	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage IRFP351/D88FQ1 (V_{GS} = 0V, I_D = 250 μA) IRFP350/D88FQ2	BV_{DSS}	350 400	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	15	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)	$R_{DS(ON)}$	—	0.26	0.30	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 8A)	g_{fs}	5.6	8.0	—	mhos

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	300	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	60	200	pF

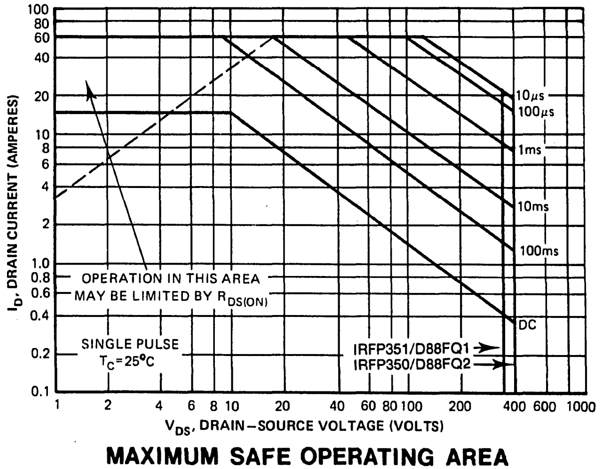
switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	110	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	70	—	ns

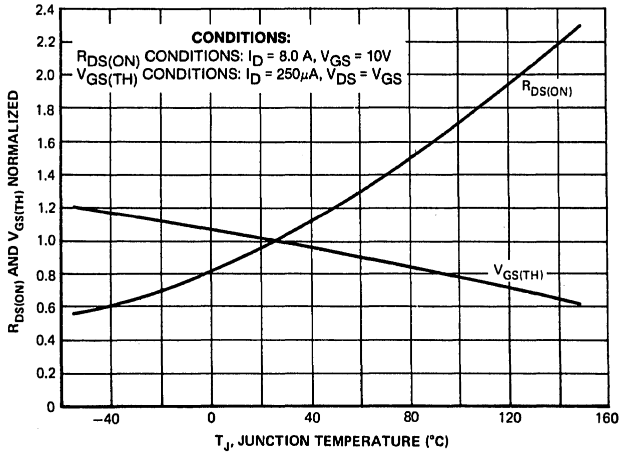
source-drain diode ratings and characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Continuous Source Current	I_S	—	—	15	A
Pulsed Source Current	I_{SM}	—	—	60	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 40A)	V_{SD}	—	1.0	1.6	Volts
Reverse Recovery Time (I_S = 15A, dI_S/dt = 100A/μs, T_C = 125°C)	t_{rr} Q_{RR}	— —	500 6.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP352,353

13 AMPERES
400, 350 VOLTS
$R_{DS(ON)}$ = 0.4 Ω

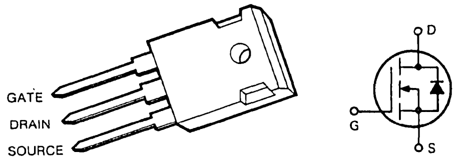
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

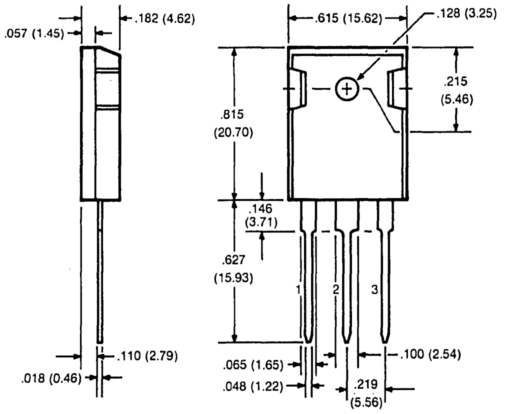
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP352	IRFP353	UNITS
Drain-Source Voltage	V_{DSS}	400	350	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	400	350	Volts
Continuous Drain Current @ T_C = 25°C @ T_C = 100°C	I_D	13 8	13 8	A A
Pulsed Drain Current(1)	I_{DM}	52	52	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 250 μA)	IRFP352 IRFP353	BV_{DSS}	400 350	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125°C)		I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)		I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	T_C = 25°C	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 5.8V)		$I_{D(ON)}$	13	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 8A)		$R_{DS(ON)}$	—	0.35	0.40	Ohms
Forward Transconductance (V_{DS} = 5.3V, I_D = 8A)		g_{fs}	5.6	8.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	300	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	60	200	pF

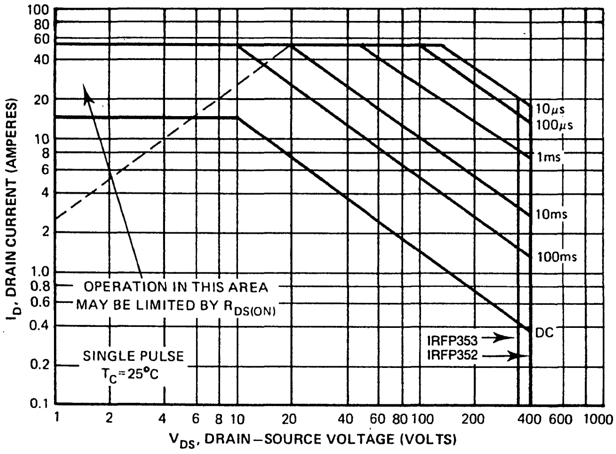
switching characteristics*

Turn-on Delay Time	V_{DS} = 175V	$t_{d(on)}$	—	20	—	ns
Rise Time	I_D = 8A, V_{GS} = 15V	t_r	—	25	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	110	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	70	—	ns

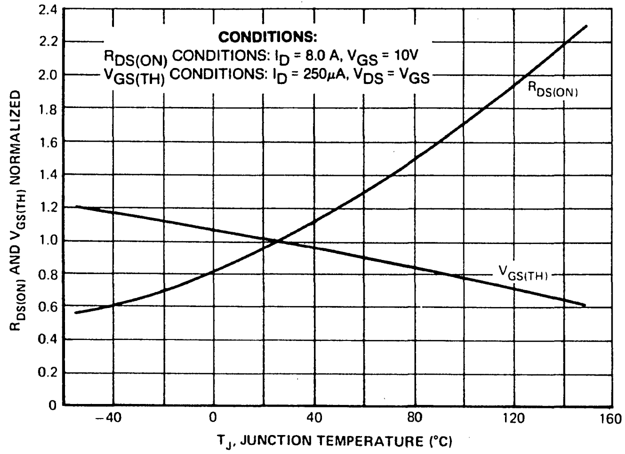
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	13	A
Pulsed Source Current	I_{SM}	—	—	52	A
Diode Forward Voltage (T_C = 25°C, V_{GS} = 0V, I_S = 13A)	V_{SD}	—	0.9	1.5	Volts
Reverse Recovery Time (I_S = 15A, dI_s/dt = 100A/μsec, T_C = 125°C)	t_{rr} Q_{RR}	— —	500 6.5	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP451, 450
D88FR1, R2

13 AMPERES
450, 500 VOLTS
$R_{DS(ON)}$ = 0.4 Ω

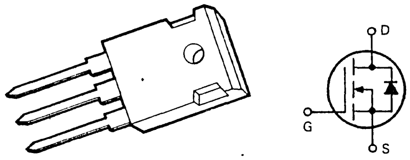
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

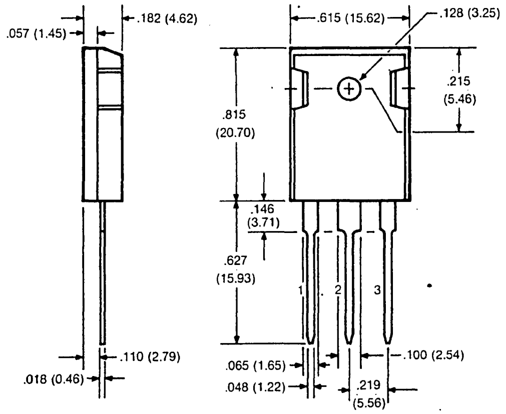
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IRFP451/D88FR1	IRFP450/D88FR2	UNIT
Drain-Source Voltage	V_{DSS}	450	500	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	450	500	Volts
Continuous Drain Current @ T_C = 25° C @ T_C = 100° C	I_D	13 8	13 8	A A
Pulsed Drain Current⁽¹⁾	I_{DM}	52	52	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	150 1.2	150 1.2	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFP451/D88FR1 (V_{GS} = 0V, I_D = 250 μA) IRFP450/D88FR2	BV_{DSS}	450 500	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25° C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 10V)	$I_{D(ON)}$	13	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 7A)	$R_{DS(ON)}$	—	0.3	0.4	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 7A)	g_{fs}	4.8	7.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	330	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	200	pF

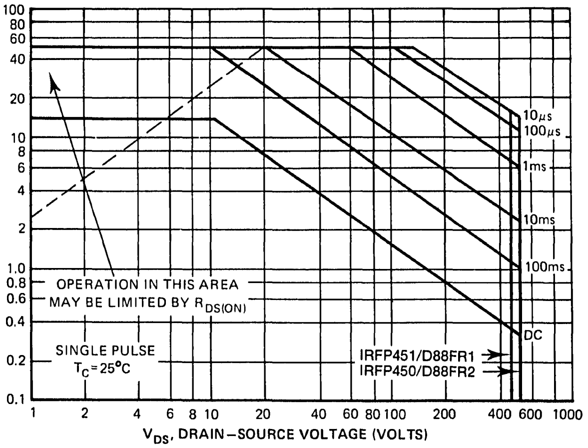
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	25	—	ns
Rise Time	I_D = 7A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	120	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	65	—	ns

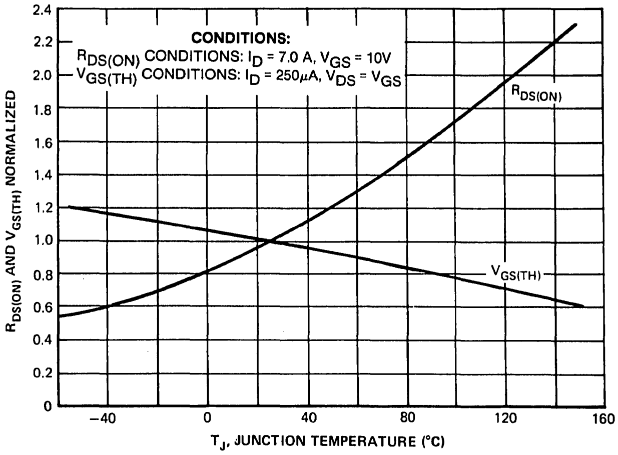
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	13	A
Pulsed Source Current	I_{SM}	—	—	52	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 40A)	V_{SD}	—	0.7	1.4	Volts
Reverse Recovery Time (I_S = 13A, dI_s/dt = 100A/μs, T_C = 125° C)	t_{rr} Q_{RR}	— —	590 7.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IRFP452,453

12 AMPERES
500, 450 VOLTS
$R_{DS(ON)} = 0.5\ \Omega$

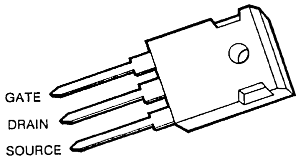
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

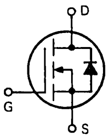
This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

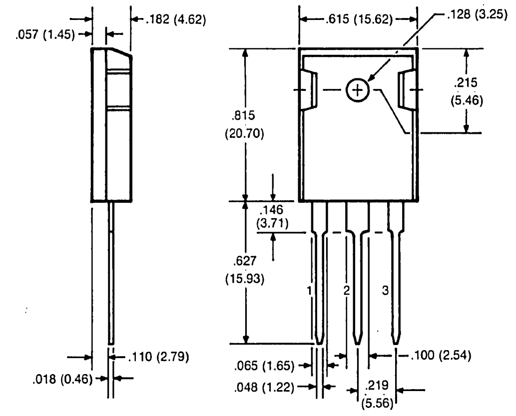
- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL





CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IRFP452	IRFP453	UNITS
Drain-Source Voltage	V_{DSS}	500	450	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	500	450	Volts
Continuous Drain Current @ $T_C = 25°C$ @ $T_C = 100°C$	I_D	12 7	12 7	A A
Pulsed Drain Current(1)	I_{DM}	48	48	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	150 1.2	150 1.2	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	0.83	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	40	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage IRFP452 (V_{GS} = 0V, I_D = 250 μA) IRFP453	BV_{DSS}	500 450	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_C = 25° C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_C = 125° C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
On-State Drain Current (V_{GS} = 10V, V_{DS} = 6.7V)	$I_{D(ON)}$	—	—	—	A
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 7A)	$R_{DS(ON)}$	—	0.4	0.5	Ohms
Forward Transconductance (V_{DS} = 6.1V, I_D = 7A)	g_{fs}	4.8	7.0	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	2800	3000	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	330	600	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	55	200	pF

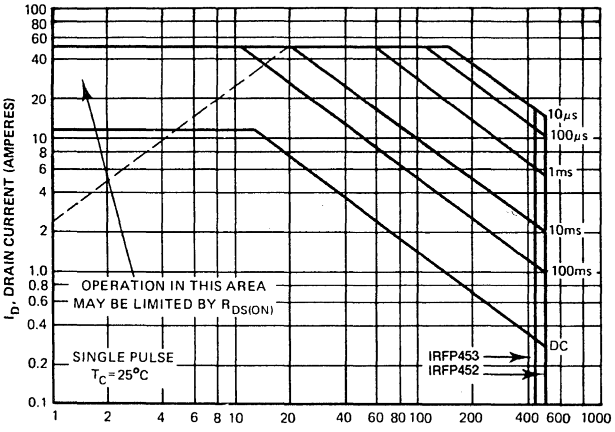
switching characteristics*

Turn-on Delay Time	V_{DS} = 225V	$t_{d(on)}$	—	25	—	ns
Rise Time	I_D = 7A, V_{GS} = 15V	t_r	—	20	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	120	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	65	—	ns

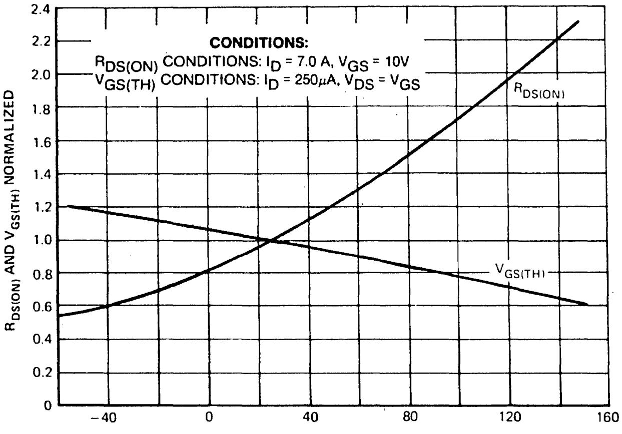
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	12	A
Pulsed Source Current	I_{SM}	—	—	48	A
Diode Forward Voltage (T_C = 25° C, V_{GS} = 0V, I_S = 12A)	V_{SD}	—	0.9	1.3	Volts
Reverse Recovery Time (I_S = 13A, dI_s/dt = 100A/μsec, T_C = 125° C)	t_{rr} Q_{RR}	— —	590 7.4	— —	ns μC

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

D80AK2,L2

0.45 AMPERES
60, 100 VOLTS
$R_{DS(ON)}$ = 2.4 Ω

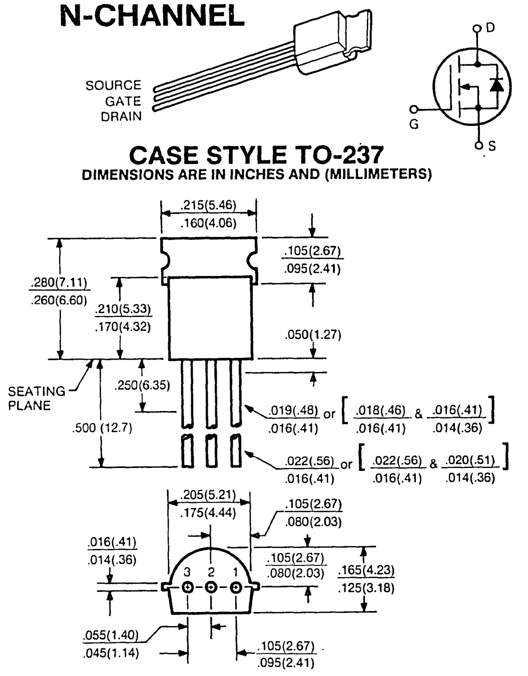
This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-237	SOURCE	GATE	DRAIN	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D80AK2	D80AL2	UNIT
Drain-Source Voltage	V_{DSS}	60	100	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	60	100	Volts
Continuous Drain Current @ T_A = 25° C(1) @ T_C = 100° C(2)	I_D	0.45 0.60	0.45 0.60	A A
Pulsed Drain Current(3)	I_{DM}	4.0	4.0	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ T_A = 25° C(1) Derate Above 25° C	P_D	1.0 8	1.0 8	Watts mW/° C
Total Power Dissipation @ T_C = 100° C(2) Derate Above 100° C	P_D	2.0 40	2.0 40	Watts mW/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	25	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	125	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	° C

(1) Device Lead Mounted in Free Air, No Heatsink. (2) Device Tab Soldered to Heatsink. (3) Repetitive Rating: Pulse Width Limited by Max. Junction Temperature

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 250\ \mu A$) D80AK2 D80AL2	BV_{DSS}	60 100	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$, $T_A = 25°C$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_A = 125°C$)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current ($V_{GS} = \pm 20V$)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 250\ \mu A$) $T_A = 25°C$	$V_{GS(TH)}$	2.0	—	4.0	Volts
Drain-Source On-State Voltage ($V_{GS} = 10V$) $I_D = 0.25A$ $I_D = 0.45A$ $I_D = 0.25A$, $T_A = 125°C$	$V_{DS(ON)}$	— — —	0.55 1.05 0.90	0.60 — —	Volts
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 0.25A$)	$R_{DS(ON)}$	—	2.2	2.4	Ohms
Forward Transconductance ($V_{DS} = 10V$, $I_D = 0.25A$)	g_{fs}	—	0.2	—	mhos

dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	36	70	pF
Output Capacitance	$V_{DS} = 25V$	C_{oss}	—	20	30	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	7	10	pF

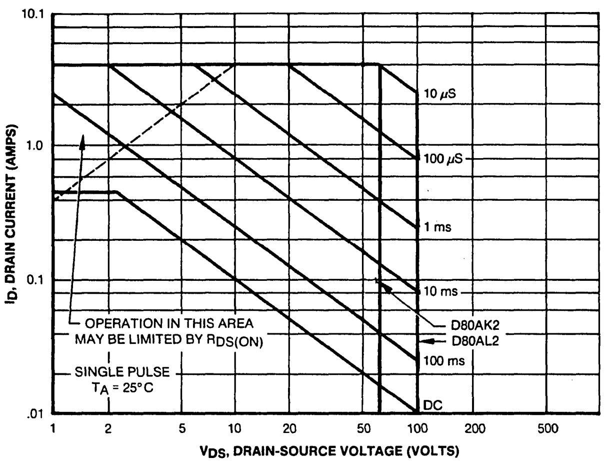
switching characteristics*

Turn-on Delay Time	$V_{DS} = 30V$	$t_{d(on)}$	—	6	—	ns
Rise Time	$I_D = 0.25A$, $V_{GS} = 15V$	t_r	—	6	—	ns
Turn-off Delay Time	$R_{GEN} = 50\ \Omega$, $R_{GS} = 12.5\ \Omega$	$t_{d(off)}$	—	12	—	ns
Fall Time	($R_{GS\ (EQUIV.)} = 10\Omega$)	t_f	—	7	—	ns

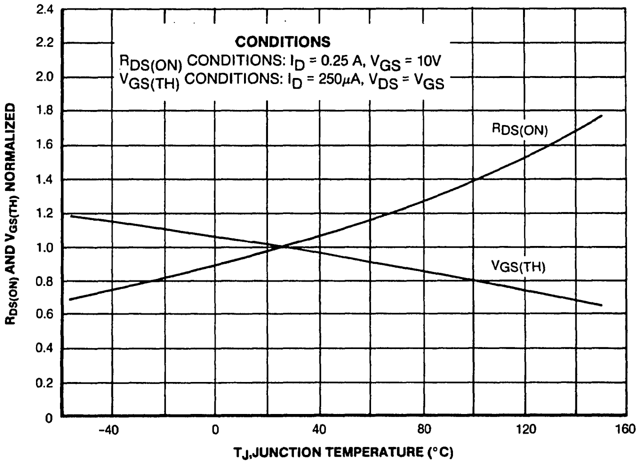
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.45	A
Pulsed Source Current	I_{SM}	—	—	4.0	A
Diode Forward Voltage ($T_A = 25°C$, $V_{GS} = 0V$, $I_S = 0.45A$)	V_{SD}	—	0.9	1.4	Volts
Reverse Recovery Time ($I_S = 0.45A$, $dI_S/dt = 100A/\mu s$, V_{DS} = 45 V Max., $T_A = 125°C$)	t_{rr}	—	65	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

D80AM2,N2

0.32 AMPERES
150, 200 VOLTS
$R_{DS(ON)} = 5.0\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

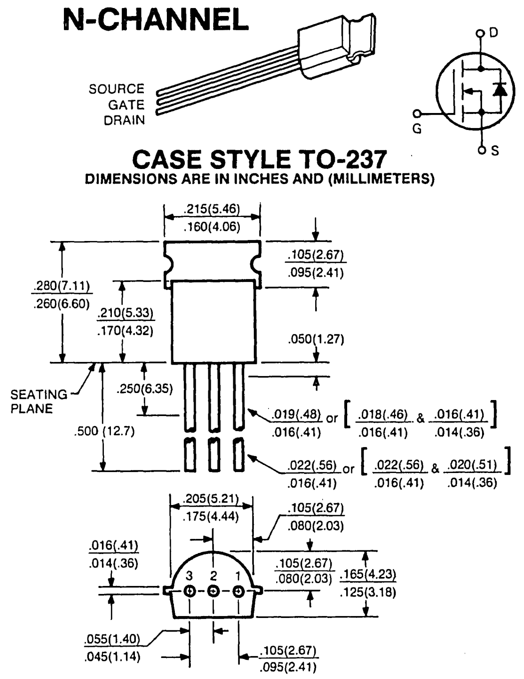
Features

- Polysilicon gate — Improved stability and reliability
- No secondary breakdown — Excellent ruggedness
- Ultra-fast switching — Independent of temperature
- Voltage controlled — High transconductance
- Low input capacitance — Reduced drive requirement
- Excellent thermal stability — Ease of paralleling

N-CHANNEL

CASE STYLE TO-237

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-237	SOURCE	GATE	DRAIN	DRAIN

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D80AM2	D80AN2	UNITS
Drain-Source Voltage	V_{DSS}	150	200	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	150	200	Volts
Continuous Drain Current @ $T_A = 25°C^{(1)}$ @ $T_C = 100°C^{(2)}$	I_D	0.32 0.43	0.32 0.43	A A
Pulsed Drain Current(3)	I_{DM}	1.5	1.5	A
Gate-Source Voltage	V_{GS}	±20	±20	Volts
Total Power Dissipation @ $T_A = 25°C^{(1)}$ Derate Above 25°C	P_D	1.0 8	1.0 8	Watts mW/°C
Total Power Dissipation @ $T_C = 100°C^{(2)}$ Derate Above 100°C	P_D	2.0 40	2.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	°C

(1) Device Lead Mounted in Free Air, No Heatsink. (2) Device Tab Soldered to Heatsink.
(3) Repetitive Rating: Pulse Width Limited by Max. Junction Temperature.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage D80AM2 (V_{GS} = 0V, I_D = 250 μA) D80AN2	BV_{DSS}	150 200	— —	— —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V, T_A = 25°C) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)	I_{DSS}	— —	— —	250 1000	μA
Gate-Source Leakage Current (V_{GS} = ±20V)	I_{GSS}	—	—	±500	nA

on characteristics*

Gate Threshold Voltage T_A = 25°C (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(TH)}$	2.0	—	4.0	Volts
Drain-Source On-State Voltage I_D = 0.15A (V_{GS} = 10V) I_D = 0.32A I_D = 0.15A, T_A = 125°C	$V_{DS(ON)}$	— — —	0.66 1.41 1.05	0.75 — —	Volts
Static Drain-Source On-State Resistance (V_{GS} = 10V, I_D = 0.15A)	$R_{DS(ON)}$	—	4.4	5.0	Ohms
Forward Transconductance (V_{DS} = 10V, I_D = 0.15A)	g_{fs}	—	0.11	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	37	70	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	15	25	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	4	8	pF

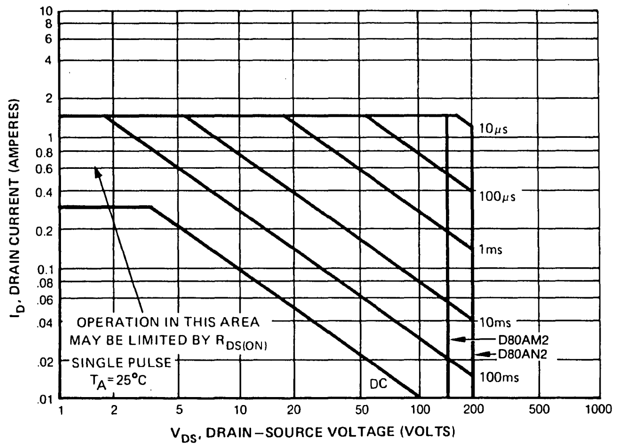
switching characteristics*

Turn-on Delay Time	V_{DS} = 90V	$t_{d(on)}$	—	15	—	ns
Rise Time	I_D = 0.15A, V_{GS} = 15V	t_r	—	10	—	ns
Turn-off Delay Time	R_{GEN} = 50Ω, R_{GS} = 12.5Ω	$t_{d(off)}$	—	22	—	ns
Fall Time	($R_{GS\ (EQUIV.)}$ = 10Ω)	t_f	—	28	—	ns

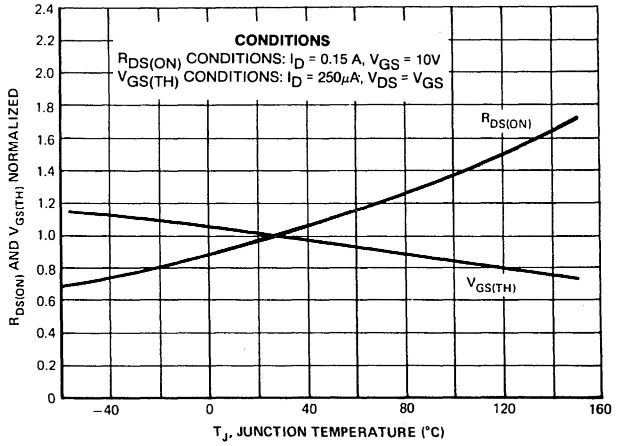
source-drain diode ratings and characteristics*

Continuous Source Current	I_S	—	—	0.32	A
Pulsed Source Current	I_{SM}	—	—	1.5	A
Diode Forward Voltage (T_A = 25°C, V_{GS} = 0V, I_S = 0.32A)	V_{SD}	—	0.86	1.3	Volts
Reverse Recovery Time (I_S = 0.32A, di_S/dt = 100A/μs, V_{DS} = 80V max., T_A = 125°C)	t_{rr}	—	125	—	ns

Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



MAXIMUM SAFE OPERATING AREA



TYPICAL NORMALIZED $R_{DS(ON)}$ AND $V_{GS(TH)}$ VS. TEMP.

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IVN5000,1
AN Series

.7 AMPERES
40-100 VOLTS
$R_{DS(ON)} = 2.5\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

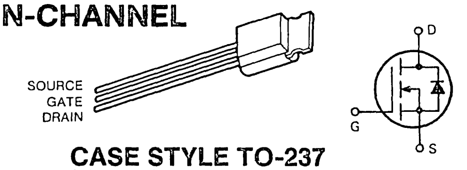
Applications

- LED and lamp drivers
- High gain, wide-band amplifiers
- High speed switches
- Line drivers
- Logic buffers
- Pulse amplifiers

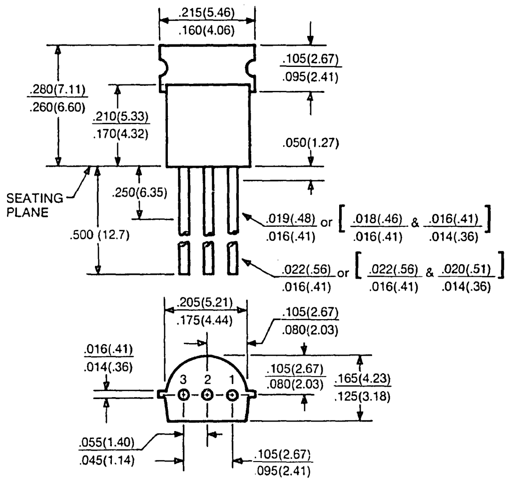
Features

- High speed, high peak current switching
- Inherent current sharing capability when paralleled
- Directly interface to CMOS, DTL, TTL logic
- Simple, straight-forward DC biasing
- Inherent protection from thermal runaway
- Reliable, low cost plastic package

N-CHANNEL



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-237	SOURCE	GATE	DRAIN	DRAIN

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D	E	F	H	UNITS
Drain-Source Voltage	V_{DSS}	40	60	80	100	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	40	60	80	100	Volts
Continuous Drain Current @ $T_A = 25°C$	I_D	0.7	0.7	0.7	0.7	A
Peak Drain Current(1)	I_{DM}	2.0	2.0	2.0	2.0	A
Gate-Source Voltage	V_{GS}	±30	±30	±30	±30	Volts
Total Power Dissipation @ $T_A = 25°C$ Derate Above 25°C	P_D	2.0 16	2.0 16	2.0 16	2.0 16	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	-55 to 150	-55 to 150	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	62.5	62.5	62.5	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	300	300	300	300	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 10 \mu A$) IVN5000,1AND	BV_{DSS}	40	—	—	Volts
IVN5000,1ANE		60	—	—	
IVN5000,1ANF		80	—	—	
IVN5000,1ANH		100	—	—	
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$)	I_{DSS}	—	—	10	μA
(V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_A = 125°C$)		—	—	500	
Gate-Source Leakage Current ($V_{GS} = 15V$, $V_{DS} = 0V$)	I_{GSS}	—	—	10	nA
($V_{GS} = 15V$, $V_{DS} = 0V$ - $T_A = 125°C$)		—	—	50	nA

on characteristics*

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1$ mA) IVN5000	$V_{GS(TH)}$	.8	—	2.0	Volts
IVN5001		.8	—	3.6	Volts
Drain-Source Saturation Voltage ($V_{GS} = 10V$, $I_D = 1.0A$) IVN5000	$V_{DS(ON)}$	—	2.0	2.5	
($V_{GS} = 12V$, $I_D = 1.0A$) IVN5001		—	1.9	2.5	Volts
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.0A$) IVN5000	$R_{DS(ON)}$	—	2.0	2.5	Ohms
($V_{GS} = 12V$, $I_D = 1.0A$) IVN5001		—	1.9	2.5	Ohms
On-State Drain Current ($V_{DS} = 24V$, $V_{GS} = 10V$) IVN5000	$I_{D(ON)}$	1.0	—	—	Amp
($V_{DS} = 24V$, $V_{GS} = 12V$) IVN5001		1.0	—	—	Amp
Forward Transconductance ($V_{DS} = 24V$, $I_D = 0.5A$, f = 1 KHz)	g_{fs}	.17	.28	—	mhos

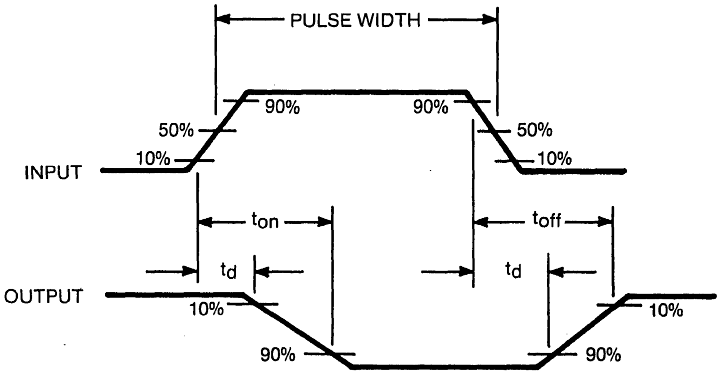
dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	40	50	pF
Output Capacitance	$V_{DS} = 24V$	C_{oss}	—	27	40	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	6	10	pF

switching characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	2	5	ns
Rise Time		t_r	—	2	5	ns
Turn-off Delay Time		$t_{d(off)}$	—	2	5	ns
Fall Time		t_f	—	2	5	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

IVN5000,1
TN Series

1.2 AMPERES
40-100 VOLTS
$R_{DS(ON)}$ = 2.5 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

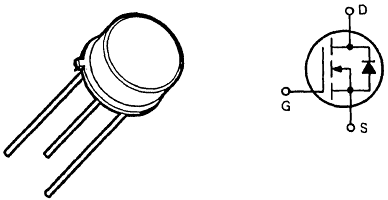
Applications

- LED and lamp drivers
- High gain, wide-band amplifiers
- High speed switches
- Line drivers
- Logic buffers
- Pulse amplifiers

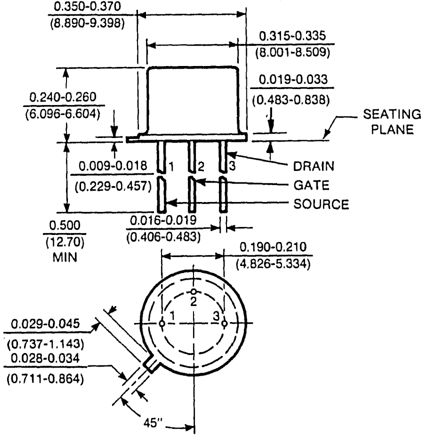
Features

- High speed, high peak current switching
- Inherent current sharing capability when paralleled
- Directly interface to CMOS, DTL, TTL logic
- Simple, straight-forward DC biasing
- Inherent protection from thermal runaway
- Reliable, low cost plastic package

N-CHANNEL



CASE STYLE TO-205AD (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AD	SOURCE	GATE	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D	E	F	H	UNITS
Drain-Source Voltage	V_{DSS}	40	60	80	100	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	40	60	80	100	Volts
Continuous Drain Current @ T_A = 25°C	I_D	1.2	1.2	1.2	1.2	A
Peak Drain Current(1)	I_{DM}	3.0	3.0	3.0	3.0	A
Gate-Source Voltage	V_{GS}	±30	±30	±30	±30	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	6.25 50	6.25 50	6.25 50	6.25 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	20	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	300	300	300	300	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 10\ \mu A$)	D E F H	BV_{DSS}	40 60 80 100	— — — —	— — — —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, $V_{GS} = 0V$) (V_{DS} = Max Rating, × 0.8, $V_{GS} = 0V$, $T_A = 125°C$)		I_{DSS}	— —	— —	10 500	μA
Gate-Source Leakage Current ($V_{GS} = 15V$, $V_{DS} = 0V$) ($V_{GS} = 15V$, $V_{DS} = 0V$ - $T_A = 125\ °C$)		I_{GSS}	— —	— —	10 50	nA nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1$ mA)	IVN5000 IVN5001	$V_{GS(TH)}$	.8 .8	— —	2.0 3.6	Volts Volts
Drain-Source Saturation Voltage ($V_{GS} = 10V$, $I_D = 1.0A$) ($V_{GS} = 12V$, $I_D = 1.0A$)	IVN5000 IVN5001	$V_{DS(ON)}$	— —	2.0 1.9	2.5 2.5	Volts
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.0A$) ($V_{GS} = 12V$, $I_D = 1.0A$)	IVN5000 IVN5001	$R_{DS(ON)}$	— —	2.0 1.9	2.5 2.5	Ohms Ohms
On-State Drain Current ($V_{DS} = 24V$, $V_{GS} = 10V$) ($V_{DS} = 24V$, $V_{GS} = 12V$)	IVN5000 IVN5001	$I_{D(ON)}$	1.0 1.0	— —	— —	Amp Amp
Forward Transconductance ($V_{DS} = 24V$, $I_D = 0.5A$, f = 1 KHz)		g_{fs}	.17	.28	—	mhos

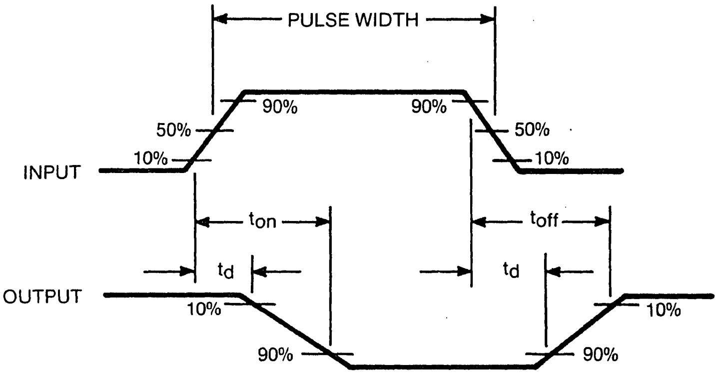
dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	40	50	pF
Output Capacitance	$V_{DS} = 24V$	C_{oss}	—	27	40	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	6	10	pF

switching characteristics*

Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	2	5	ns
Rise Time		t_r	—	2	5	ns
Turn-off Delay Time		$t_{d(off)}$	—	2	5	ns
Fall Time		t_f	—	2	5	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

VN10KMA

0.5 AMPERES
60 VOLTS
$R_{DS(ON)}$ = 5.0 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

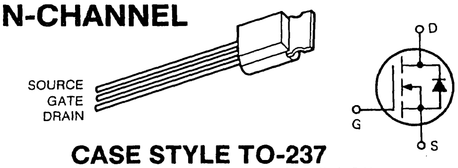
Applications

- LED and lamp drivers
- TTL and CMOS to high current interface
- High speed switches
- Line drivers
- Relay drivers
- Transformer drivers

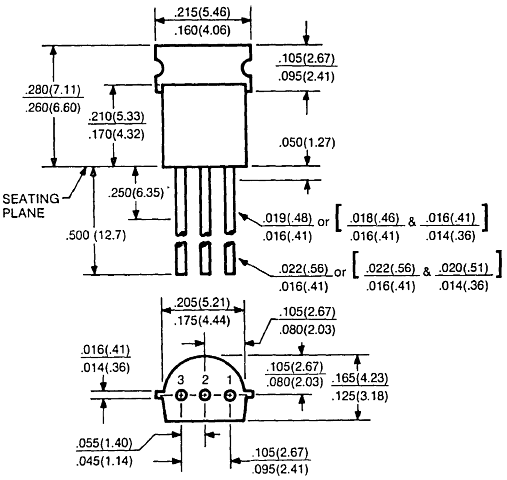
Features

- Directly drives inductive loads
- High speed, high peak current switching
- Inherent current sharing capability when paralleled
- Directly interfaces to CMOS, DTL, TTL logic
- Simple straight-forward DC biasing
- Inherently procection from thermal runaway

N-CHANNEL



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-237	SOURCE	GATE	DRAIN	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	VN10KMA	UNITS
Drain-Source Voltage	V_{DSS}	60	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	60	Volts
Continuous Drain Current @ T_A = 25° C	I_D	0.5	A
Peak Drain Current(1)	I_{DM}	1.0	A
Gate-Source Voltage	V_{GS}	±30	Volts
Total Power Dissipation @ T_A = 25° C Derate Above 25° C	P_D	1.0 8	Watts mW/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	20	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	300	° C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 100 μA)	BV_{DSS}	60	—	—	Volts
Zero Gate Voltage Drain Current (V_{DS} = 40V, V_{GS} = 0V)	I_{DSS}	—	—	10	μA
Gate-Source Leakage Current (V_{GS} = 15V, V_{DS} = 0V)	I_{GSS}	—	—	100	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1 mA)	$V_{GS(TH)}$	0.8	—	2.5	Volts
Drain-Source Saturation Voltage (V_{GS} = 10V, I_D = .5A)	$V_{DS(ON)}$	—	—	2.5	V
On-State Drain Current (V_{DS} = 25V, V_{GS} = 5V) (V_{DS} = 25V, V_{GS} = 10V)	$I_{D(ON)}$	0.25 0.50	— —	— —	A
Forward Transconductance (V_{DS} = 15V, I_D = 0.5A)	g_{fs}	.10	.20	—	mhos

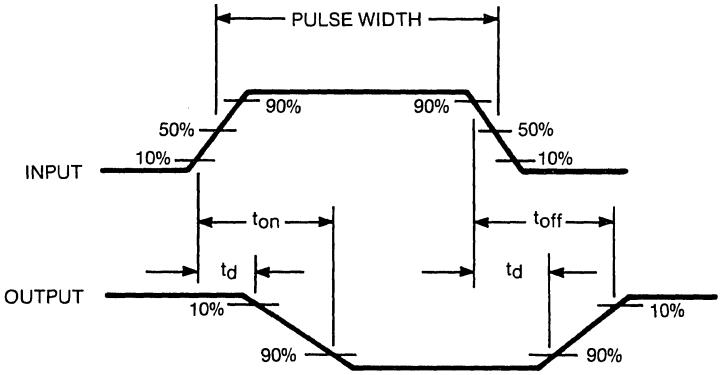
dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	48	—	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	16	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	2	—	pF

switching characteristics*

Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	5	—	ns
Turn-off Delay Time		$t_{d(off)}$	—	2	—	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

VN30ABA Series

1.2 AMPERES
35-90 VOLTS
$R_{DS(ON)}$ = 2.5-5.0 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

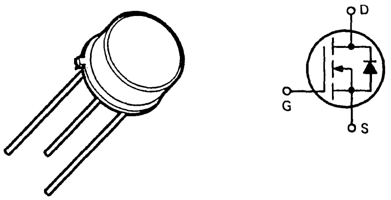
Applications

- Switching power supplies
- DC to DC inverters
- CMOS and TTL to high current interface
- Line drivers
- Logic buffers
- Pulse amplifiers

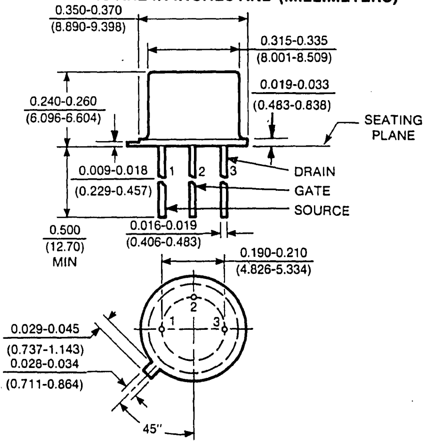
Features

- High speed, high current switching
- Current sharing capability when paralleled
- Directly interface to CMOS, DTL, TTL logic
- Simple DC biasing
- Extended safe operating area
- Inherently temperature stable

N-CHANNEL



CASE STYLE TO-205AD (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AD	SOURCE	GATE	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	VN30ABA/ VN35ABA	VN67ABA	VN89ABA	VN90ABA	UNITS
Drain-Source Voltage	V_{DSS}	35	60	80	90	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	35	60	80	90	Volts
Continuous Drain Current @ T_A = 25°C	I_D	1.2	1.2	1.2	1.2	A
Peak Drain Current(1)	I_{DM}	3.0	3.0	3.0	3.0	A
Gate-Source Voltage	V_{GS}	±30	±30	±30	±30	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	6.25 50	6.25 50	6.25 50	6.25 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	20	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	300	300	300	300	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25° C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage ($V_{GS} = 0V$, $I_D = 10\mu A$)	VN30ABA;VN35ABA VN67ABA VN89ABA VN90ABA	BV_{DSS}	35 60 80 90	— — — —	— — — —	Volts
Zero Gate Voltage Drain Current ($V_{DS} = 25$, $V_{GS} = 0V$)		I_{DSS}	—	—	10	µA
Gate-Source Leakage Current ($V_{GS} = 15V$, $V_{DS} = 0V$)		I_{GSS}	—	—	100	nA

on characteristics*

Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1$ mA)		$V_{GS(TH)}$	0.8	1.2	—	Volts
Static Drain Source On-State Resistance ($V_{GS} = 5V$) ($I_D = 0.3A$)	VN30ABA VN35ABA VN67ABA VN89ABA VN90ABA	$R_{DS(ON)}$	— — — — —	— — — — -	6.0 4.5 5.1 5.1 6.0	Ohms
Static Drain-Source On-State Resistance ($V_{GS} = 10V$, $I_D = 1.0A$)	VN30ABA VN35ABA VN67ABA VN89ABA VN90ABA	$R_{DS(ON)}$	— — — — —	— — — — —	5.0 2.5 3.5 4.5 5.0	Ohms
On-State Drain Current ($V_{DS} = 25V$, $V_{GS} = 10V$)		$I_{D(ON)}$	1	—	—	Amp
Forward Transconductance ($V_{DS} = 25V$, $I_D = 0.5A$)		g_{fs}	—	.25	—	mhos

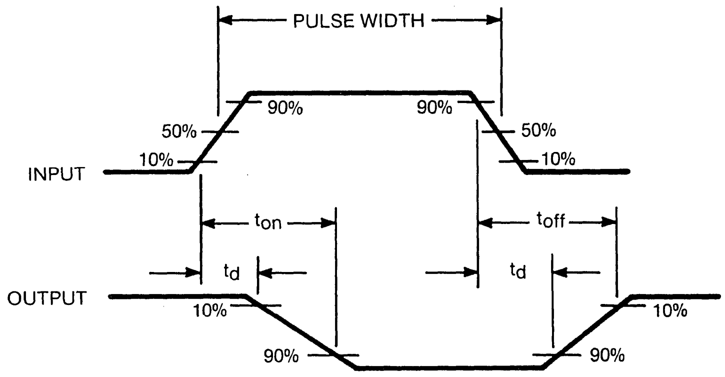
dynamic characteristics

Input Capacitance	$V_{GS} = 0V$	C_{iss}	—	—	50	pF
Output Capacitance	$V_{DS} = 24V$	C_{oss}	—	—	40	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	10	pF

switching characteristics*

Turn-on Delay Time	See switching times waveforms below	$t_{d(on)}$	—	—	10	ns
Turn-off Delay Time		$t_{d(off)}$	—	—	10	ns

*Pulse Test: Pulse width ≤ 300 µs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

VN35AK Series

1.2 AMPERES
35-90 VOLTS
$R_{DS(ON)}$ = 2.5-4.5 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

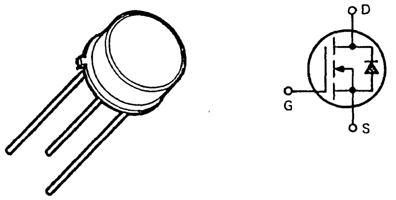
Applications

- High current analog switches
- RF power amplifiers
- Laser diode pulsers
- Line drivers
- Logic buffers
- Pulse amplifiers

Features

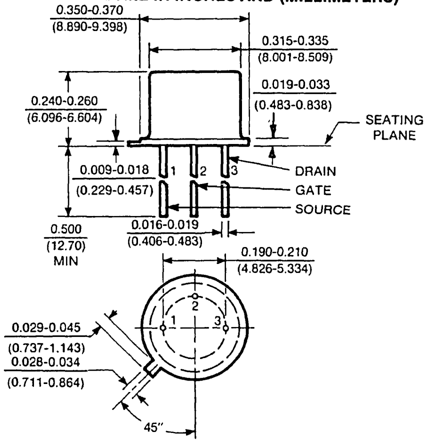
- High speed, high current switching
- High gain-bandwidth product
- Inherently temperature stable
- Extended safe operating area
- Simple DC biasing
- Requires almost zero current drive

N-CHANNEL



CASE STYLE TO-205AD (TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AD	SOURCE	GATE	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	VN35AK	VN66AK/67AK	VN98AK/99AK	UNITS
Drain-Source Voltage	V_{DSS}	35	60	90	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	35	60	90	Volts
Continuous Drain Current @ T_A = 25°C	I_D	1.2	1.2	1.2	A
Peak Drain Current(1)	I_{DM}	3.0	3.0	3.0	A
Gate-Source Voltage	V_{GS}	±30	±30	±30	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	6.25 50	6.25 50	6.25 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	300	300	300	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 10 μA)	VN35AK	BV_{DSS}	35	—	—	Volts
	VN66/67AK		60	—	—	
	VN98/99AK		90	—	—	
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V)		I_{DSS}	—	—	10	μA
(V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)			—	—	500	
Gate-Source Leakage Current (V_{GS} = 15V, V_{DS} = 0V)		I_{GSS}	—	—	100	nA
(V_{GS} = 15V, V_{DS} = 0V - T_A = 125 °C)			—	—	500	nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1 mA)		$V_{GS(TH)}$	0.8	—	2.0	Volts
Drain-Source Saturation Voltage (V_{GS} = 10V, I_D = 1.0A)	VN66AK	$V_{DS(ON)}$	—	—	3.0	Volts
	VN98AK		—	—	4.0	
Drain-Source Saturation Voltage (V_{GS} = 10V, I_D = 1.0A)	VN35AK	$V_{DS(ON)}$	—	—	2.5	Volts
	VN67AK		—	—	3.5	
	VN99AK		—	—	4.5	
On-State Drain Current (V_{DS} = 25V, V_{GS} = 10V)		$I_{D(ON)}$	1.0	—	—	Amps
Forward Transconductance (V_{DS} = 24V, I_D = 0.5A)		g_{fs}	.170	—	—	mhos

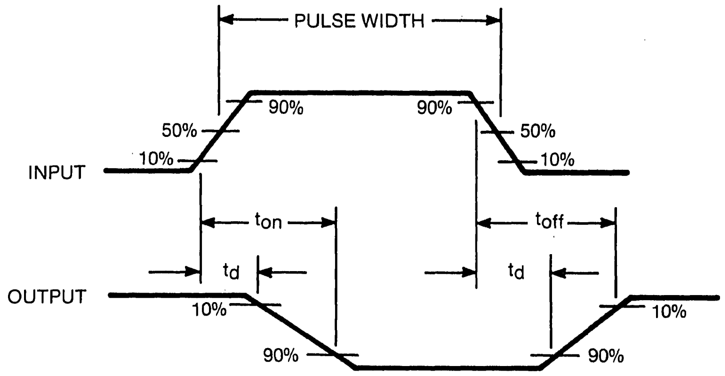
dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	50	pF
Output Capacitance	V_{DS} = 24V	C_{oss}	—	—	40	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	10	pF

switching characteristics*

Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	3	8	ns
Turn-off Delay Time		$t_{d(off)}$	—	3	8	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET

FIELD EFFECT POWER TRANSISTOR

VN40AFA Series

1.2 AMPERES
40-80 VOLTS
$R_{DS(ON)}$ = 3.5-5.0 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

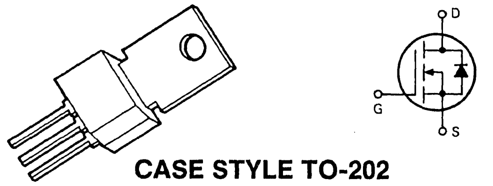
Applications

- Switching power supplies
- DC to DC inverters
- CMOS and TTL to high current interface
- Line drivers
- Logic buffers
- Pulse amplifiers

Features

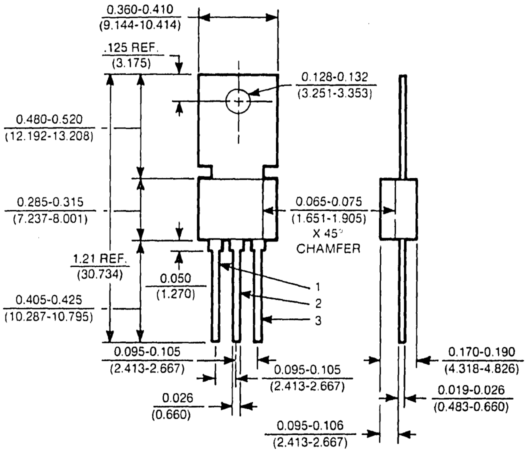
- High speed, high current switching
- Current sharing capability when paralleled
- Directly interface to CMOS, DTL, TTL logic
- Simple DC biasing
- Extended safe operating area
- Inherently temperature stable

N-CHANNEL



CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	SOURCE	GATE	DRAIN	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	VN40AFA	VN67AFA	VN89AFA	UNITS
Drain-Source Voltage	V_{DSS}	40	60	80	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	40	60	80	Volts
Continuous Drain Current @ T_A = 25°C	I_D	1.2	1.2	1.2	A
Peak Drain Current(1)	I_{DM}	3.0	3.0	3.0	A
Gate-Source Voltage	V_{GS}	±30	±30	±30	Volts
Total Power Dissipation @ T_A = 25°C Derate Above 25°C	P_D	12 96	12 96	12 96	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to 150	-40 to 150	-40 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	10.4	10.4	10.4	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16″ from Case for 10 Seconds	T_L	300	300	300	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage (V_{GS} = 0V, I_D = 10 μA)	VN40AFA VN67AFA VN89AFA	BV_{DSS}	40 60 80	— — —	— — —	Volts
Zero Gate Voltage Drain Current (V_{DS} = Max Rating, V_{GS} = 0V) (V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		I_{DSS}	— —	— —	10 100	μA
Gate-Source Leakage Current (V_{GS} = 15V, V_{DS} = 0V) (V_{GS} = 15V, V_{DS} = 0V - T_A = 125 °C)		I_{GSS}	— —	— —	100 500	nA nA

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1 mA)	VN40AFA VN67AFA VN89AFA	$V_{GS(TH)}$	0.6 0.8 0.8	1.2 1.2 1.2	— — —	Volts
Drain-Source Saturation Voltage (V_{GS} = 5V, I_D = 0.3A)	VN40AFA VN67AFA VN89AFA	$V_{DS(ON)}$	— — —	— — —	2.0 1.7 1.9	V
Drain-Source Saturation Voltage (V_{GS} = 10V, I_D = 1.0A)	VN40AFA VN67AFA VN89AFA	$V_{DS(ON)}$	— — —	— — —	5.0 3.5 4.5	V
On-State Drain Current (V_{DS} = 25V, V_{GS} = 10V)		$I_{D(ON)}$	1	—	—	A
Forward Transconductance (V_{DS} = 24V, I_D = 0.5A, f = 1 KHz)		g_{fs}	—	.25	—	mhos

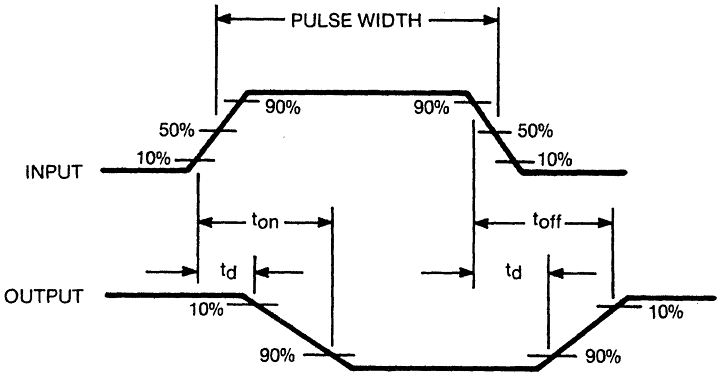
dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	50	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	50	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	10	pF

switching characteristics*

Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	2	5	ns
Rise Time		T_r	—	2	5	ns
Turn-off Delay Time		$t_{d(off)}$	—	2	5	ns
Fall Time		t_f	—	2	5	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

VN46AFA Series

1.2 AMPERES
40-80 VOLTS
$R_{DS(ON)}$ = 3.0, 4.0 Ω

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

Applications

- Switching power supplies
- DC to DC inverters
- CMOS and TTL to high current interface
- Line drivers
- Logic buffers
- Pulse amplifiers

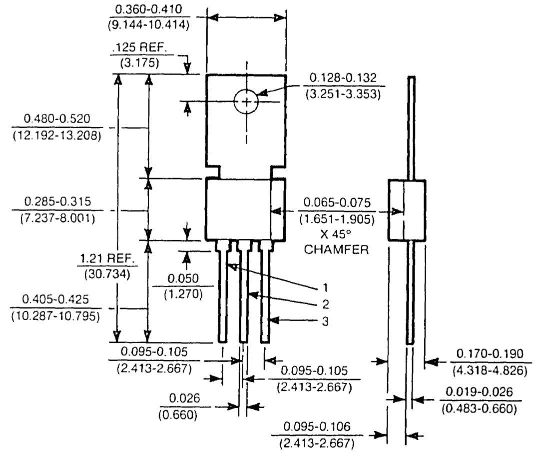
Features

- High speed, high current switching
- Current sharing capability when paralleled
- Directly interface to CMOS, DTL, TTL logic
- Simple DC biasing
- Extended safe operating area
- Inherently temperature stable

N-CHANNEL

CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	SOURCE	GATE	DRAIN	DRAIN

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	VN46AFA	VN66AFA	VN88AFA	UNITS
Drain-Source Voltage	V_{DSS}	40	60	80	Volts
Drain-Gate Voltage, R_{GS} = 1MΩ	V_{DGR}	40	60	80	Volts
Continuous Drain Current @ T_A = 25° C	I_D	1.2	1.2	1.2	A
Peak Drain Current	I_{DM}	3.0	3.0	3.0	A
Gate-Source Voltage	V_{GS}	±30	±30	±30	Volts
Total Power Dissipation @ T_A = 25° C Derate Above 25° C	P_D	12 96	12 96	12 96	Watts mW/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to 150	-40 to 150	-40 to 150	° C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	10.4	10.4	10.4	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	° C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage VN46AFA	BV_{DSS}	40	—	—	Volts
(V_{GS} = 0V, I_D = 10 μA) VN66AFA		60	—	—	
VN88AFA		80	—	—	
Zero Gate Voltage Drain Current					
(V_{DS} = Max Rating, V_{GS} = 0V)	I_{DSS}	—	—	10	μA
(V_{GS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)		—	—	100	
Gate-Source Leakage Current	I_{GSS}	—	0.01	10	μA
(V_{GS} = 10V, V_{DS} = 0V)					
(V_{GS} = 10V, V_{DS} = 0V - T_A = 125 °C)		—	—	100	

on characteristics

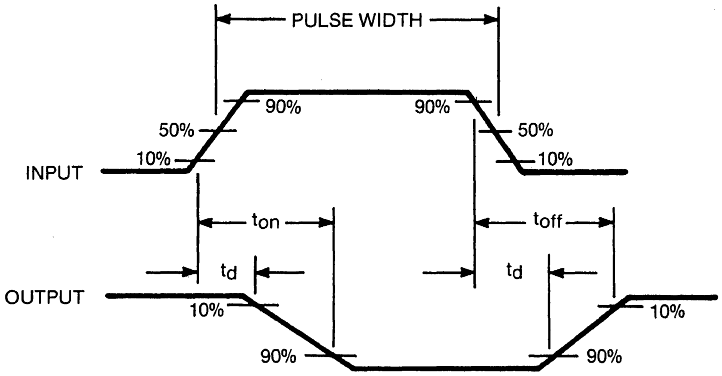
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1 mA)	$V_{GS(TH)}$	0.8	1.7	—	Volts
Drain-Source Saturation Voltage VN40AFA;VN66AFA	$V_{DS(ON)}$	—	—	3.0	A
(V_{GS} = 10V, I_D = 1.0A) VN88AFA		—	—	4.0	
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	—	—	3.0	Ohms
(V_{GS} = 10V, I_D = 1.0A)		—	—	4.0	
Forward Transconductance (V_{DS} = 24V, I_D = 0.5A, f = 1 KHz)	g_{fs}	.150	.25	—	mhos

dynamic characteristics

Input Capacitance	V_{GS} = 0V	C_{iss}	—	—	50	pF
Output Capacitance	V_{DS} = 25V	C_{oss}	—	—	50	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{rss}	—	—	10	pF

switching characteristics

Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	2	5	ns
Rise Time		T_r	—	2	5	ns
Turn-off Delay Time		$t_{d(off)}$	—	2	5	ns
Fall Time		t_f	—	2	5	ns



SWITCHING TIME TEST WAVEFORMS

POWER-MOS FET
FIELD EFFECT POWER TRANSISTOR

2N6660,1

1.2 AMPERES
60, 90 VOLTS
$R_{DS(ON)} = 3.0\ \Omega$

This series of N-Channel Enhancement-mode Power MOSFETs utilizes GE's advanced Power DMOS technology to achieve low on-resistance with excellent device ruggedness and reliability.

This design has been optimized to give superior performance in most switching applications including: switching power supplies, inverters, converters and solenoid/relay drivers. Also, the extended safe operating area with good linear transfer characteristics makes it well suited for many linear applications such as audio amplifiers and servo motors.

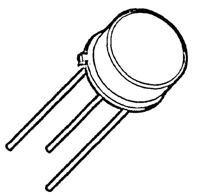
Applications

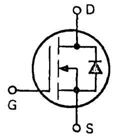
- Switching power supplies
- DC to DC inverters
- CMOS and TTL to high current interface
- Line drivers
- Logic buffers
- Pulse amplifiers
- High frequency linear amplifiers

Features

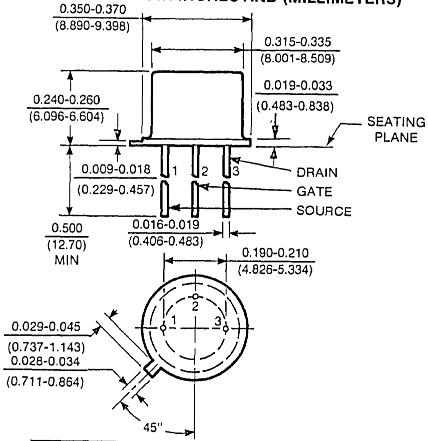
- High speed, high current switching
- Current sharing capability when paralleled
- Directly interface to CMOS, DTL, TTL logic
- Simple DC biasing
- Extended safe operating area
- Inherently temperature stable
- Typical t_{on} and $t_{off} < 5$ns

N-CHANNEL





CASE STYLE TO-205AD (TO-39)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AD	SOURCE	GATE	DRAIN

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	2N6660	2N6661	UNITS
Drain-Source Voltage	V_{DSS}	60	90	Volts
Drain-Gate Voltage, $R_{GS} = 1M\Omega$	V_{DGR}	60	90	Volts
Continuous Drain Current @ $T_A = 25°C$	I_D	1.2	1.2	A
Peak Drain Current⁽¹⁾	I_{DM}	3.0	3.0	A
Gate-Source Voltage	V_{GS}	±30	±30	Volts
Total Power Dissipation @ $T_A = 25°C$ Derate Above 25°C	P_D	6.25 50	6.25 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	20°C	20×C	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/16" from Case for 10 Seconds	T_L	300	300	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_A = 25° C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Drain-Source Breakdown Voltage 2N6660	BV_{DSS}	90	—	—	Volts
(V_{GS} = 0V, I_D = 10 μA) 2N6661		60	—	—	
(V_{GS} = 0V, I_D = 2.5 MA) 2N6660		90	—	—	
2N6661		60	—	—	
Zero Gate Voltage Drain Current	I_{DSS}	—	—	10	μA
(V_{DS} = Max Rating, V_{GS} = 0V)		—	—	500	
(V_{DS} = Max Rating, × 0.8, V_{GS} = 0V, T_A = 125°C)					
Gate-Source Leakage Current					
(V_{GS} = 15V, V_{DS} = 0V)	I_{GSS}	—	—	100	nA
(V_{GS} = 15V, V_{DS} = 0V - T_A = 125 °C)		—	—	500	

on characteristics*

Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1 mA)	$V_{GS(TH)}$	0.8	—	2.0	Volts
Drain-Source Saturation Voltage 2N6660	$V_{DS(ON)}$	—	—	1.5	Volts
(V_{GS} = 5V, I_D = 0.3A) 2N6661		—	—	1.6	
Drain-Source Saturation Voltage 2N6660	$V_{DS(ON)}$	—	—	3.0	Volts
(V_{GS} = 10V, I_D = 1.0A) 2N6661		—	—	4.0	
On-State Drain Current (V_{DS} = 25V, V_{GS} = 10V)	$I_{D(ON)}$	1.0	—	—	Amp
Forward Transconductance (V_{DS} = 24V, I_D = 0.5A)	g_{fs}	.17	.25	—	mhos

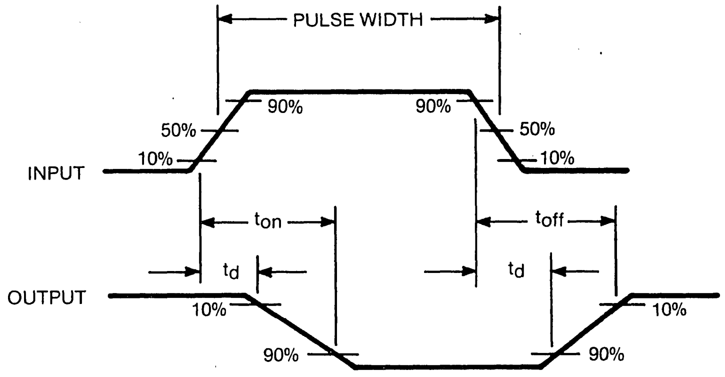
dynamic characteristics

Input Capacitance	V_{GS} = 0V, V_{DS} = 25V	C_{iss}	—	—	50	pF
Output Capacitance	f = 1 MHz	C_{oss}	—	—	40	pF
Reverse Transfer Capacitance	V_{DS} = 0V, V_{GS} = 0V	C_{rss}	—	—	10	pF
	f = 1.0 MHz	C_{rss}	—	—	35	pF

switching characteristics*

Turn-on Delay Time	See switching times waveform below	$t_{d(on)}$	—	2	5	ns
Rise Time		t_r	—	2	5	ns
Turn-off Delay Time		$t_{d(off)}$	—	2	5	ns
Fall Time		t_f	—	2	5	ns

*Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%



SWITCHING TIME TEST WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT4D10,E10

10 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)} = 0.27\ \Omega$

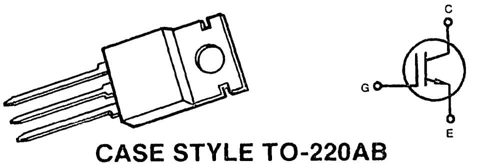
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

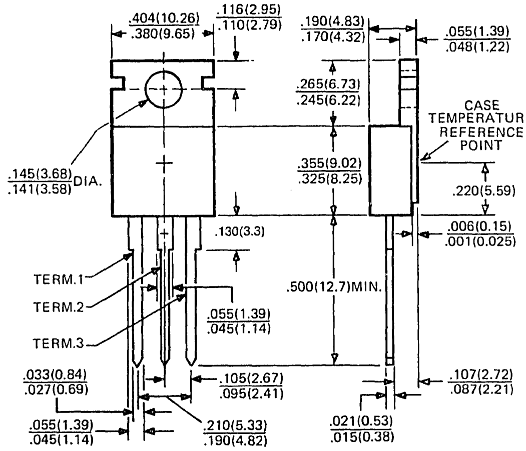
Features:

- Low $V_{CE(SAT)}$ — 2.5V typ @ 10A
- Ultra-fast turn-on — 150 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 10 amps @ 100° C

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS IGT	TO-220-AB	GATE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IGT4D10	IGT4E10	UNITS
Collector-Emitter Voltage, $V_{GE} = 0V$	V_{CES}	400	500	Volts
Collector-Gate Voltage, $R_{GE} = 1M\Omega$	V_{CGR}	400	500	Volts
Continuous Drain Current @ $T_C = 100°C$ @ $T_C = 25°C$	I_C	10 18	10 18	A A
Pulsed Collector Current$^{(1)}$	I_{CM}	40	40	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage ($I_C = 250\mu A$, $V_{GE} = 0V$)	IGT4D10	BV_{CES}	400	—	—	Volts
	IGT4E10		500	—	—	
Collector Cut-off Current (V_{CE} = Max Rating, $V_{GE} = 0V$, $T_C = 25°C$)		I_{CES}	—	—	250	μA
(V_{CE} = Max Rating, × 0.8, $V_{GE} = 0V$, $T_C = 150°C$)[1]			—	—	4.0	mA
Gate-Emitter Leakage Current ($V_{GE} = \pm 20V$)		I_{GES}	—	—	±500	nA

[1] Applies for 3.3°C per watt maximum thermal resistance, case to ambient.

on characteristics*

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage ($V_{CE} = V_{GE}$, $I_C = 250\mu A$)	$T_C = 25°C$	$V_{GE(TH)}$	2	4.0	5	Volts
	$T_C = 150°C$		—	2.5	—	
Collector-Emitter Saturation Voltage $I_C = 10\ A$, $T_C = 25°C$, $V_{GE} = 15V$		$V_{CE(SAT)}$	—	2.5	2.7	Volts
$I_C = 10\ A$, $T_C = 150°C$, $V_{GE} = 15V$			—	2.8	—	
$I_C = 10\ A$, $T_C = 25°C$, $V_{GE} = 10V$			—	2.9	—	

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	$V_{GE} = 0V$	C_{ies}	—	1050	—	pF
Output Capacitance	$V_{CE} = 25V$	C_{oes}	—	340	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics* (see figures 8 & 9)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	Resistive Load, $T_C = 150°C$	$t_{d(on)}$	—	100	—	ns
Rise Time	$I_C = 10A$, V_{CE} = Rated V_{CES}	t_r	—	150	—	ns
Turn-off Delay Time	$V_{GE} = 15V$	$t_{d(off)}$	—	0.5	—	μs
Fall Time	$R_{G(on)} = 50\Omega$, $R_{GE} = 100\Omega$	t_f	—	4	—	μs
Turn-off Delay Time	Inductive Load, $T_C = 150°C$, $L = 550\mu H$, $I_C = 10A$,	$t_{d(off)}$	—	1.0	1.5	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	4.5	6.5	μs
Equivalent Fall Time	$V_{GE} = 15V$	$t_{f(eq)}$	—	3.5	5.0	μs
Turn-off Switching Losses	$R_{G(on)} = 50\Omega$ $R_{GE} = 100\Omega$ IGT4D10	E_f	—	—	10	mJ
	IGT4E10				12.5	

*Pulse test: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

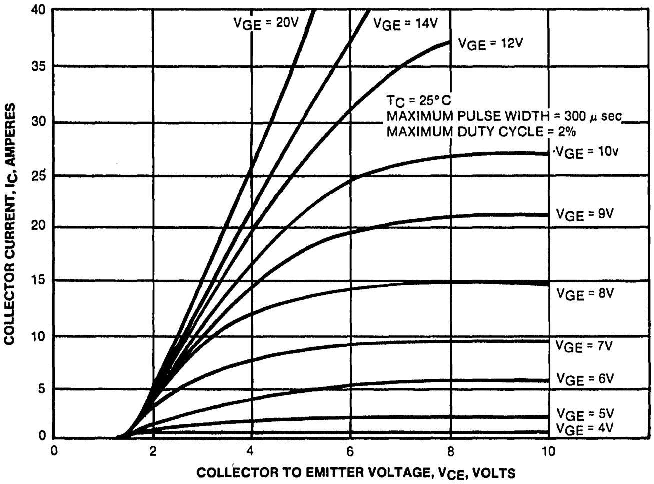


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

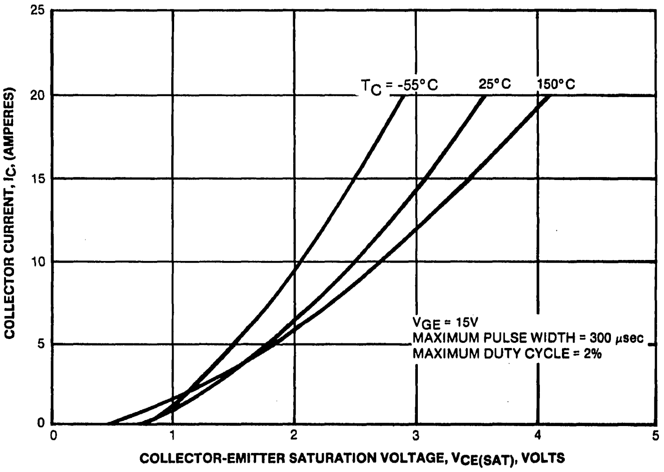


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

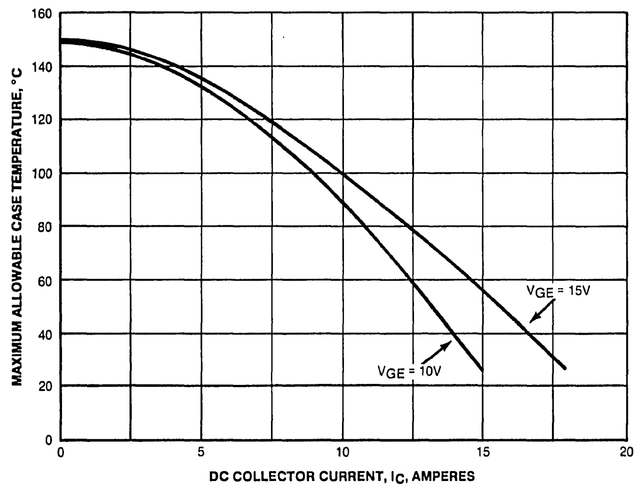


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT

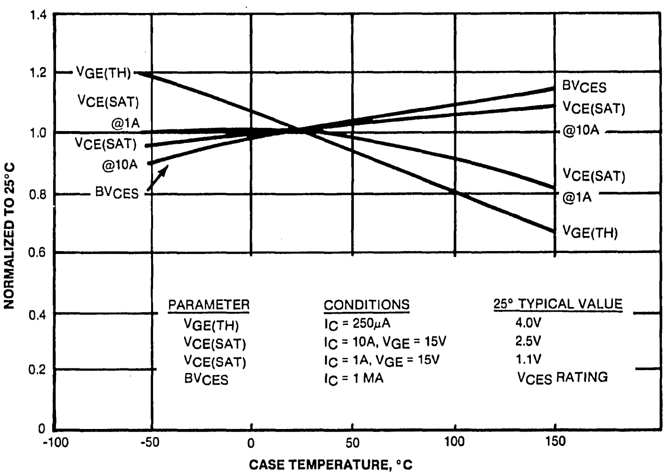


FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

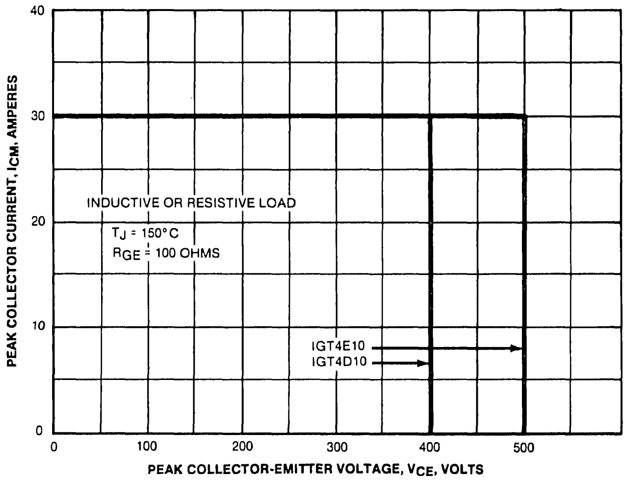


FIGURE 5. TURN-OFF SAFE OPERATING AREA

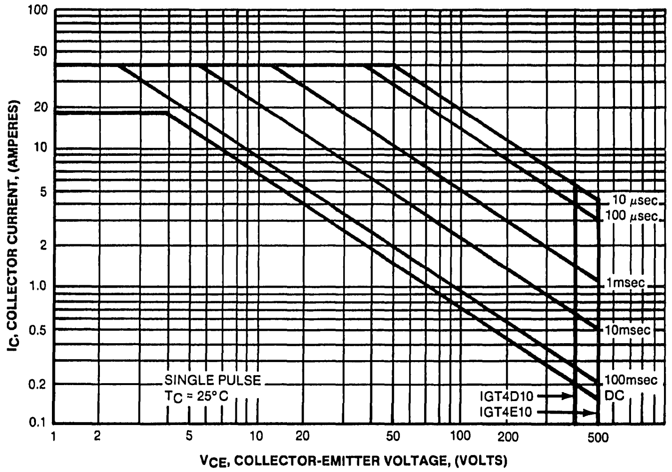


FIGURE 6. TURN-ON SAFE OPERATING AREA

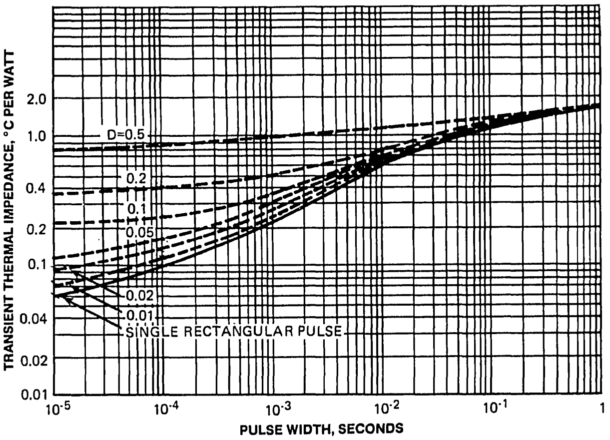
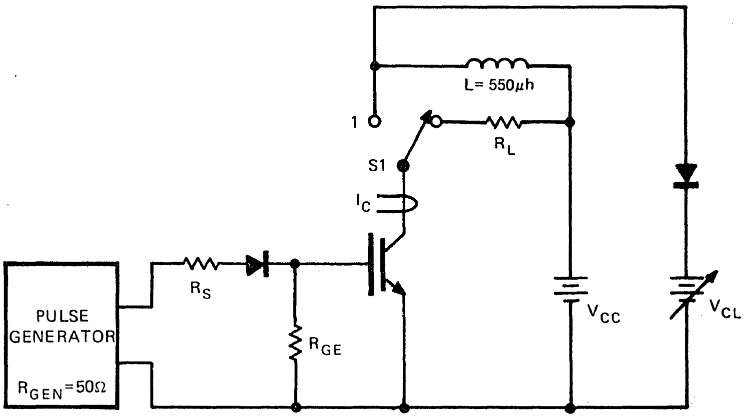


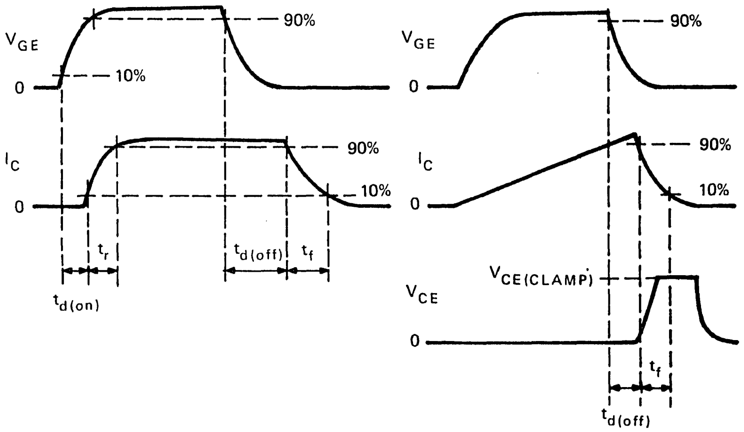
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD

INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT4D11,E11

10 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)}$ = 0.27 Ω

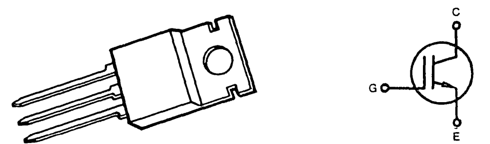
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

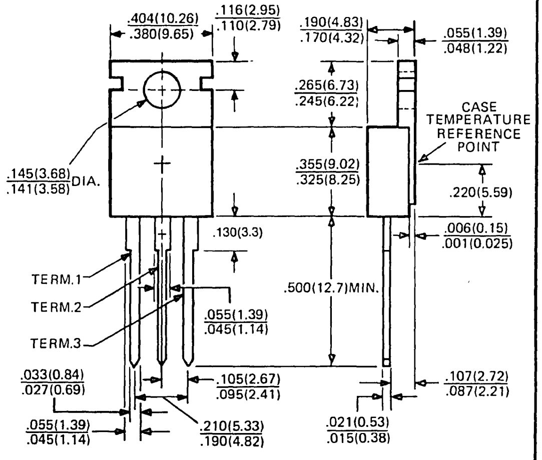
Features:

- Low $V_{CE(SAT)}$ — 2.5V typ @ 10A
- Ultra-fast turn-on — 100 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 10 amps @ 100° C

N-CHANNEL



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS IGT	TO-220-AB	GATE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IGT4D11	IGT4E11	UNITS
Collector-Emitter Voltage, V_{GE} = 0V	V_{CES}	400	500	Volts
Collector-Gate Voltage, R_{GE} = 1MΩ	V_{CGR}	400	500	Volts
Continuous Drain Current @ T_C = 100°C @ T_C = 25°C	I_C	10 18	10 18	A A
Pulsed Collector Current(1)	I_{CM}	40	40	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage V_{GE} = 0V, I_C = 250μA)	IGT4D11 IGT4E11	BV_{CES}	400 500	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25°C) (V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 150°C)[1]		I_{CES}	— —	— —	250 4.0	μA mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)		I_{GES}	—	—	±500	nA

[1] Applies for 3.3°C per watt maximum thermal resistance, case to ambient.

on characteristics*

Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 250μA)	T_C = 25°C T_C = 150°C	$V_{GE(TH)}$	2 —	4.0 2.5	5 —	Volts
Collector-Emitter Saturation Voltage I_C = 10 A, T_C = 25°C, V_{GE} = 15V I_C = 10 A, T_C = 150°C, V_{GE} = 15V I_C = 10 A, T_C = 25°C, V_{GE} = 10V		$V_{CE(SAT)}$	— — —	2.5 2.8 2.9	2.7 — —	Volts

dynamic characteristics

Input Capacitance	V_{GE} = 0V	C_{ies}	—	1050	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	340	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics* (see figures 8 & 9)

Turn-on Delay Time	Resistive Load T_C = 125°C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 10A, V_{CE} = Rated V_{CES}	t_r	—	100	—	ns
Turn-off Delay Time	V_{GE} = 15V	$t_{d(off)}$	—	0.4	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	2.5	—	μs
Turn-off Delay Time	Inductive Load, T_C = 125°C, L = 550μH, I_C = 10A,	$t_{d(off)}$	—	0.8	1.2	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	0.8	1.0	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	0.6	0.8	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT4D11 IGT4E11	E_f	—	1.3 1.6	1.6 2.0	mJ

*Pulse test: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

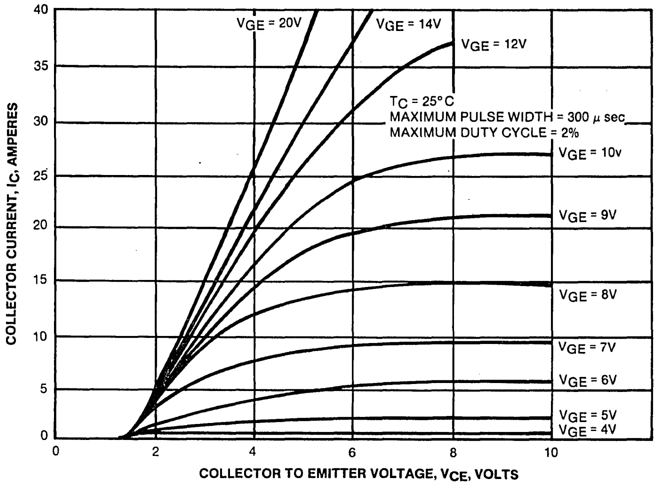


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

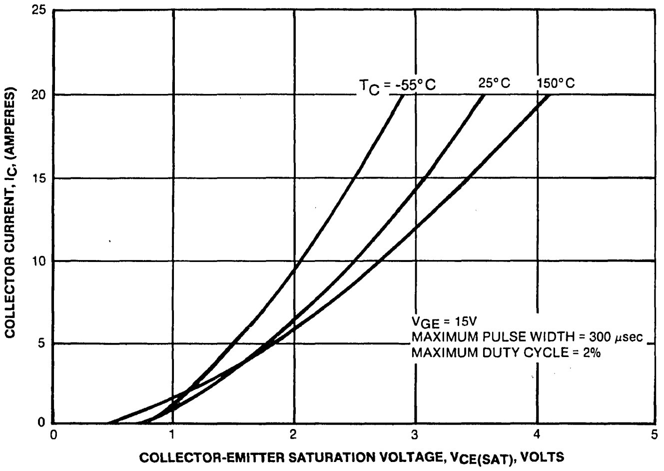


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

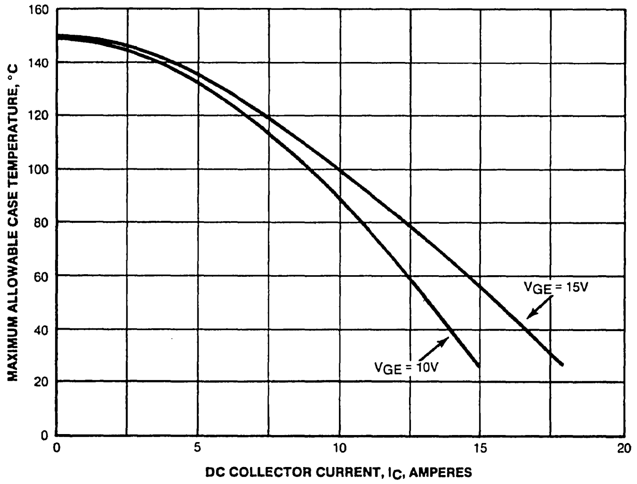


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT

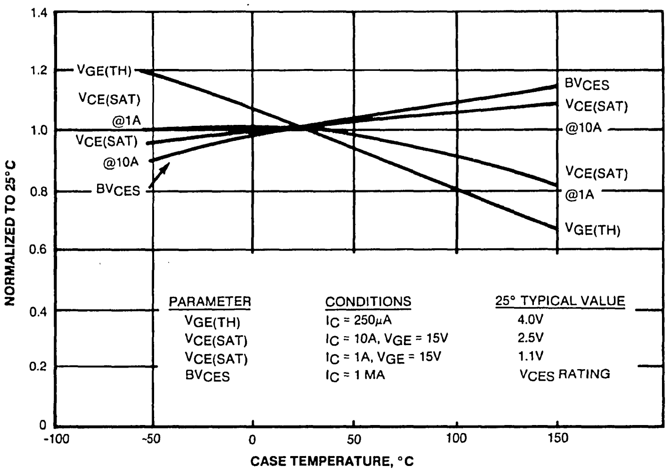


FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

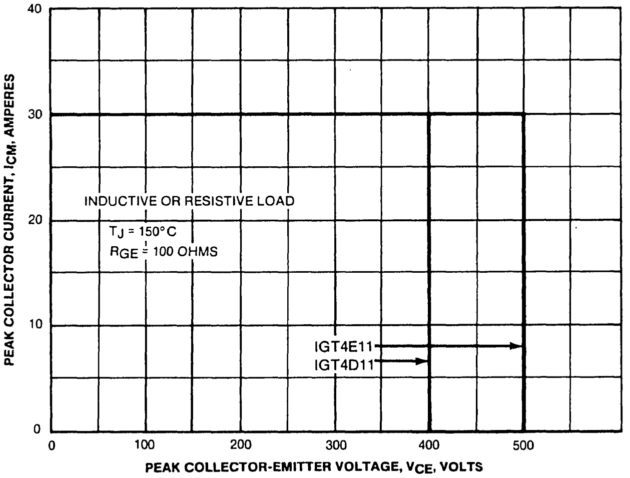


FIGURE 5. TURN-OFF SAFE OPERATING AREA

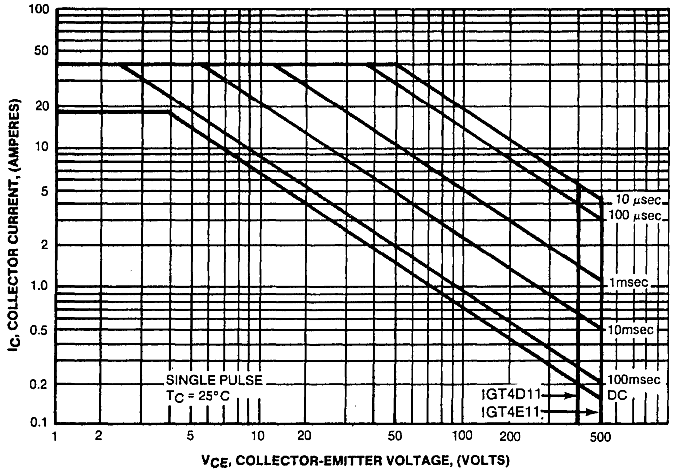


FIGURE 6. TURN-ON SAFE OPERATING AREA

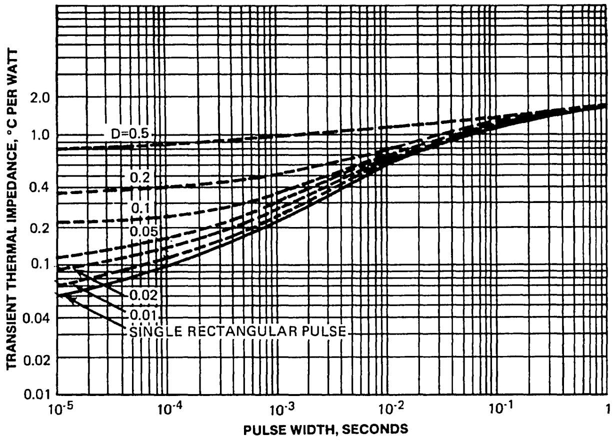
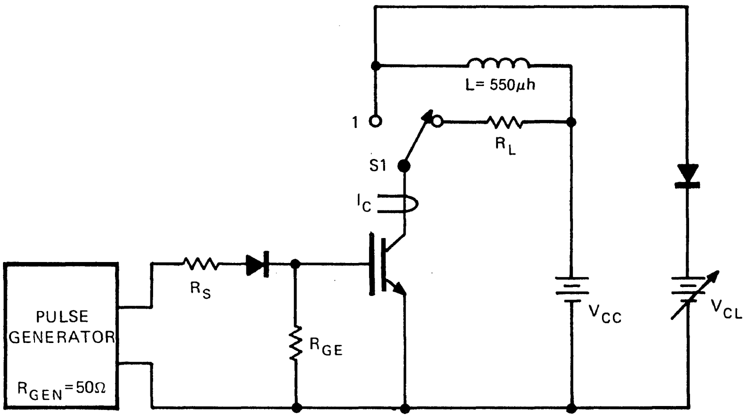


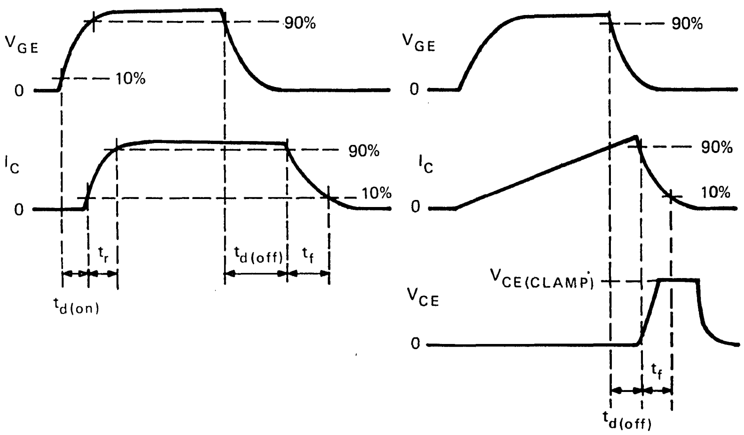
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) −1 CLAMPED INDUCTIVE LOAD
−2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

Preliminary 26.4 4/85

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT6D10,E10

10 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)}$ = 0.27 Ω

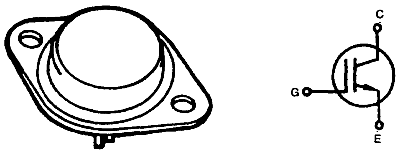
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

Features:

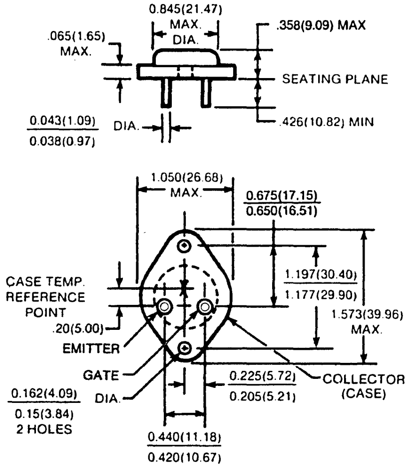
- Low $V_{CE(SAT)}$ — 2.5V typ @ 10A
- Ultra-fast turn-on — 150 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 10 amps @ 100° C

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IGT6D10	IGT6E10	UNITS
Collector-Emitter Voltage, V_{GE} = 0V	V_{CES}	400	500	Volts
Collector-Gate Voltage, R_{GE} = 1MΩ	V_{CGR}	400	500	Volts
Continuous Drain Current @ T_C = 100°C @ T_C = 25°C	I_C	10 18	10 18	A A
Pulsed Collector Current[(1)]	I_{CM}	40	40	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage IGT6D10 (I_C = 250μA, V_{GE} = 0V) IGT6E10	BV_{CES}	400 500	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25°C) (V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 150°C)[1]	I_{CES}	— —	— —	250 4.0	μA mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)	I_{GES}	—	—	±500	nA

[1] Applies for 3.3°C per watt maximum thermal resistance, case to ambient.

on characteristics*

Gate Threshold Voltage T_C = 25°C (V_{CE} = V_{GE}, I_C = 250μA) T_C = 150°C	$V_{GE(TH)}$	2 —	4.0 2.5	5 —	Volts
Collector-Emitter Saturation Voltage I_C = 10 A, T_C = 25°C, V_{GE} = 15V I_C = 10 A, T_C = 150°C, V_{GE} = 15V I_C = 10 A, T_C = 25°C, V_{GE} = 10V	$V_{CE(SAT)}$	— — —	2.5 2.8 2.9	2.7 — —	Volts

dynamic characteristics

Input Capacitance	V_{GE} = 0V	C_{ies}	—	1050	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	340	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics* (see figures 8 & 9)

Turn-on Delay Time	Resistive Load, T_C = 150°C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 10A, V_{CE} = Rated V_{CES}	t_r	—	150	—	ns
Turn-off Delay Time	V_{GE} = 15V	$t_{d(off)}$	—	0.5	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	4	—	μs
Turn-off Delay Time	Inductive Load, T_C = 150°C, L = 550μH, I_C = 10A,	td_{off}	—	1.0	1.5	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	4.5	6.5	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	3.5	5.0	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT6D10 IGT6E10	E_f	—	—	10 12.5	mJ

*Pulse test: Pulse width ≤ 300 μsec, duty cycle ≤ 2%.

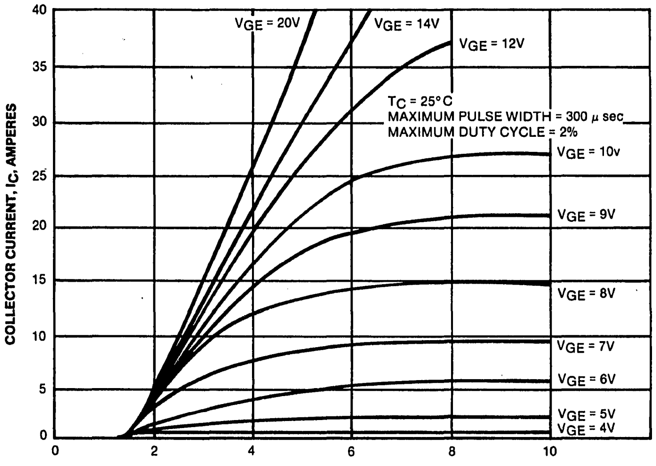


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

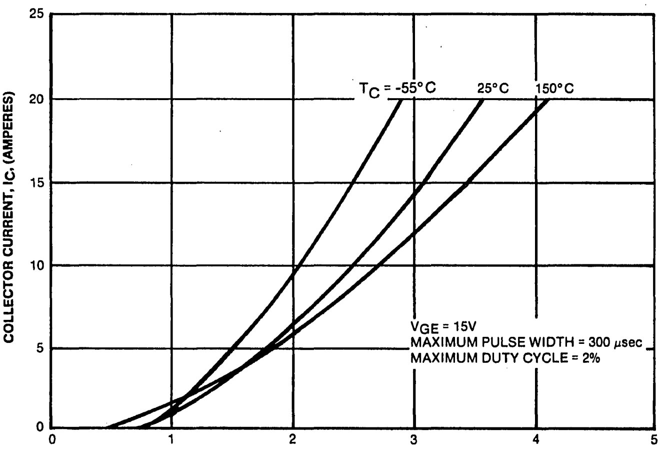


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

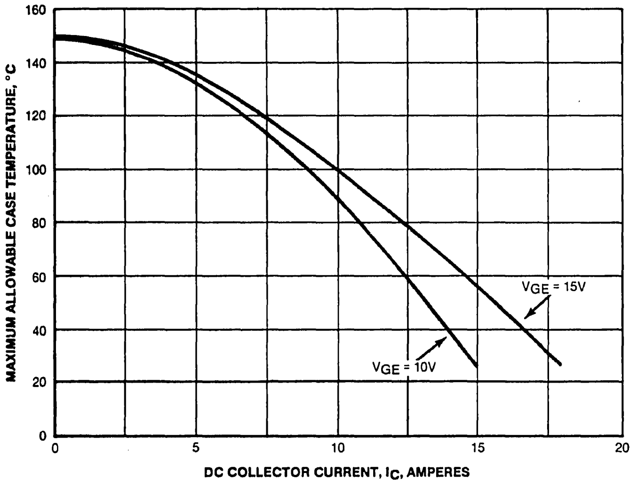
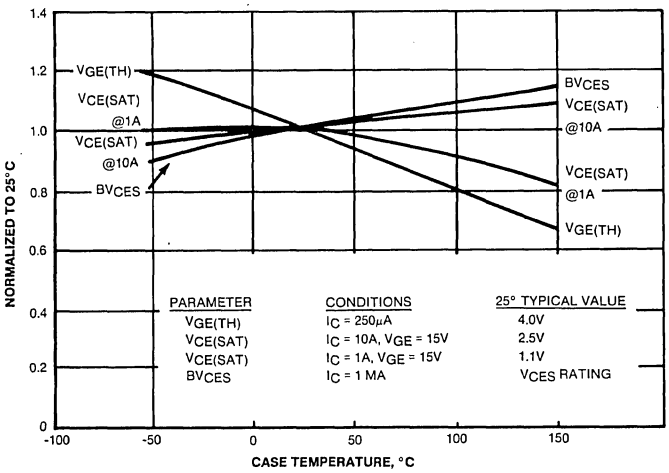


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT



PARAMETER	CONDITIONS	25° TYPICAL VALUE
$V_{GE(TH)}$	I_C = 250μA	4.0V
$V_{CE(SAT)}$	I_C = 10A, V_{GE} = 15V	2.5V
$V_{CE(SAT)}$	I_C = 1A, V_{GE} = 15V	1.1V
BV_{CES}	I_C = 1 MA	V_{CES} RATING

FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

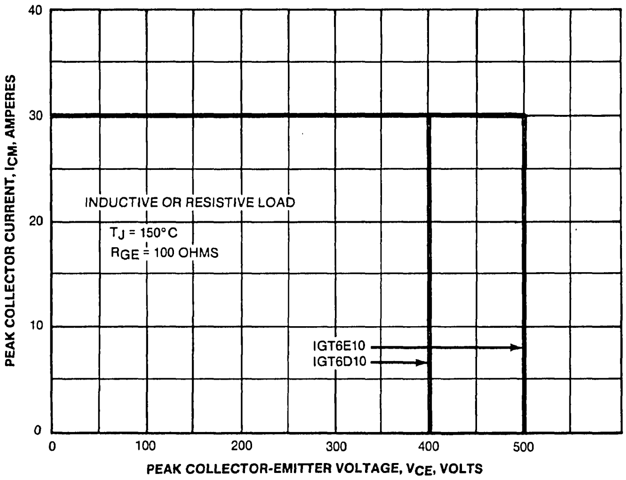


FIGURE 5. TURN-OFF SAFE OPERATING AREA

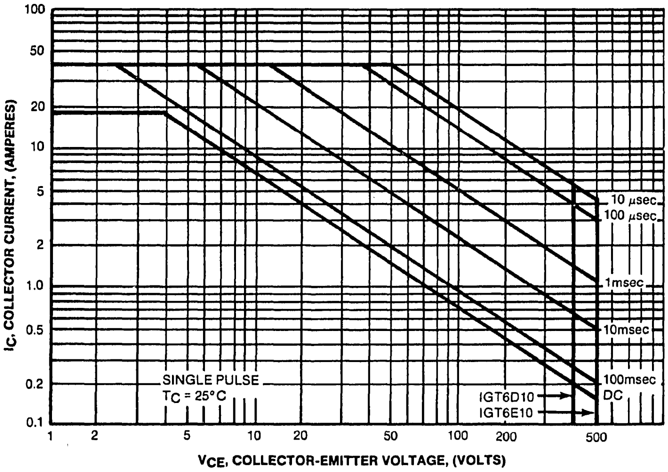


FIGURE 6. TURN-ON SAFE OPERATING AREA

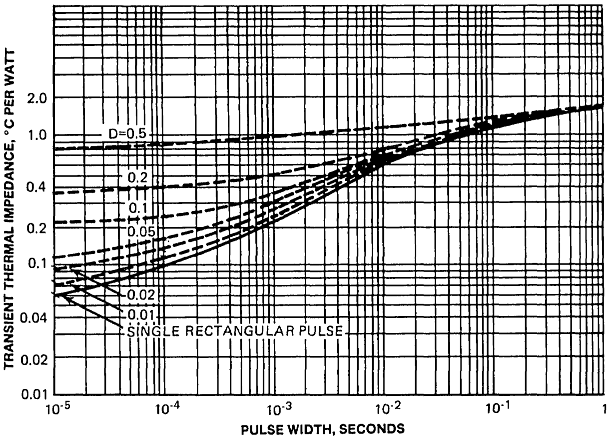
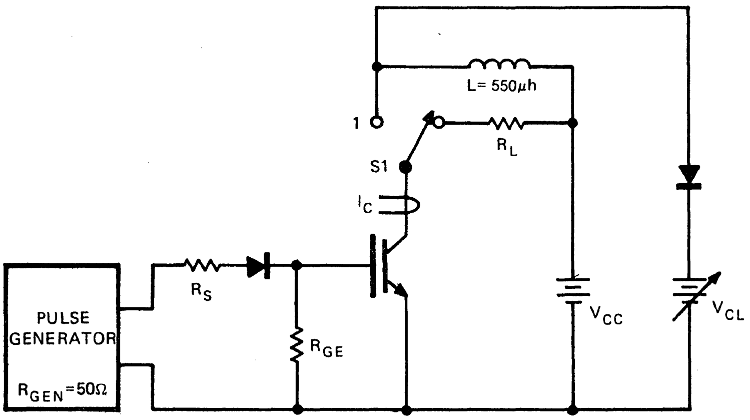


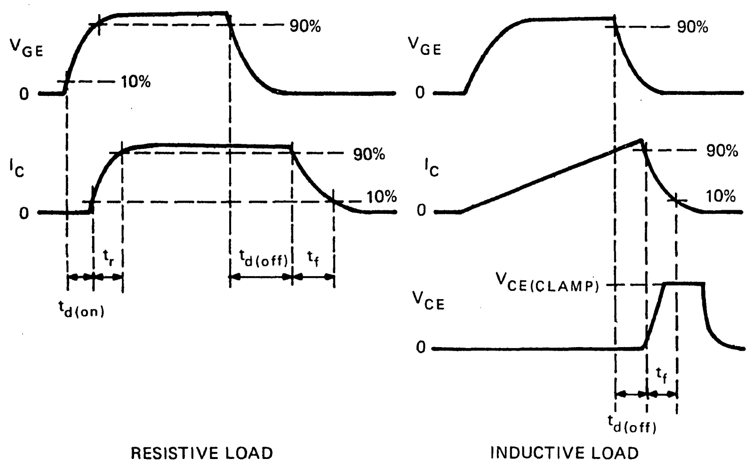
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT6D11,E11

10 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)}$ = 0.27 Ω

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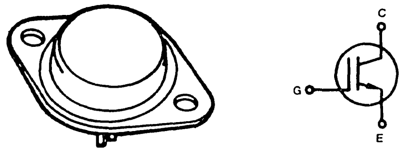
Features:

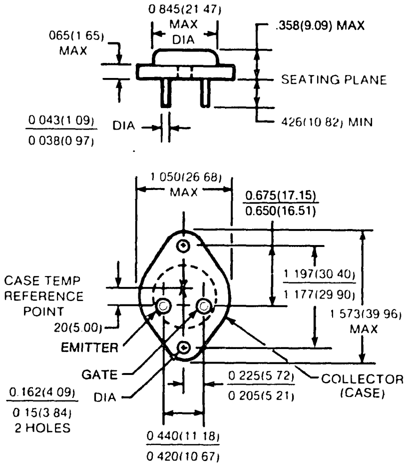
- Low $V_{CE(SAT)}$ — 2.5V typ @ 10A
- Ultra-fast turn-on — 100 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 10 amps @ 100° C

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IGT6D11	IGT6E11	UNITS
Collector-Emitter Voltage, V_{GE} = 0V	V_{CES}	400	500	Volts
Collector-Gate Voltage, R_{GE} = 1MΩ	V_{CGR}	400	500	Volts
Continuous Drain Current @ T_C = 100°C @ T_C = 25°C	I_C	10 18	10 18	A A
Pulsed Collector Current(1)	I_{CM}	40	40	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ T_C = 25° C Derate Above 25° C	P_D	75 0.6	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	1.67	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (V_{GE} = 0V, I_C = 250μA) IGT6D11	BV_{CES}	400	—	—	Volts
IGT6E11		500	—	—	
Collector Cut-off Current	I_{CES}				
(V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25° C)		—	—	250	μA
(V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 150° C)(2)		—	—	4.0	mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)	I_{GES}	—	—	±500	nA

(2) Applies for 3.3° C per watt maximum thermal resistance, case to ambient.

on characteristics(3)

Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 250μA) T_C = 25° C	$V_{GE(TH)}$	2	4.0	5	Volts
T_C = 150° C		—	2.5	—	
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$				Volts
I_C = 10 A, T_C = 25° C, V_{GE} = 15V		—	2.5	2.7	
I_C = 10 A, T_C = 150° C, V_{GE} = 15V		—	2.8	—	
I_C = 10 A, T_C = 25° C, V_{GE} = 10V		—	2.9	—	

dynamic characteristics

Input Capacitance	V_{GE} = 0V	C_{ies}	—	1050	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	340	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics(3) (see figures 8 & 9)

Turn-on Delay Time	Resistive Load, T_C = 125° C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 10A, V_{CE} = Rated V_{CES}	t_r	—	100	—	ns
Turn-off Delay Time	V_{GE} = 15V	$t_{d(off)}$	—	0.4	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	2.5	—	μs
Turn-off Delay Time	Inductive Load, T_C = 125° C, L = 550μH, I_C = 10A,	$t_{d(off)}$	—	0.8	1.2	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	0.8	1.0	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	0.6	0.8	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT6D11	E_f	—	1.3	1.6	mJ
	IGT6E11			1.6	2.0	

(3) Pulse test: Pulse widths ≤ 300 μsec, duty cycle ≤ 2%.

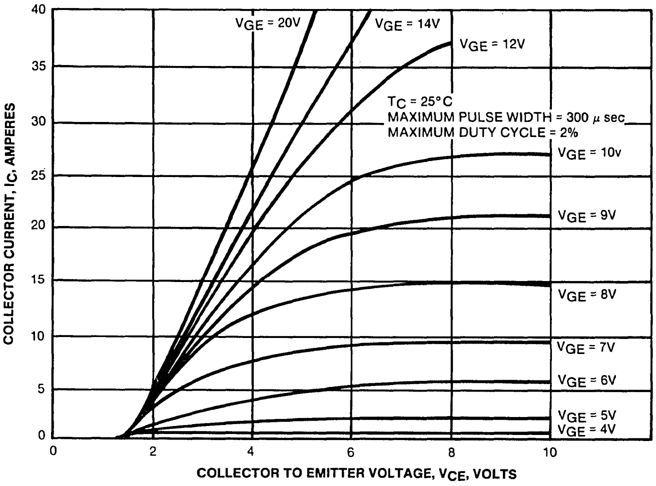


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

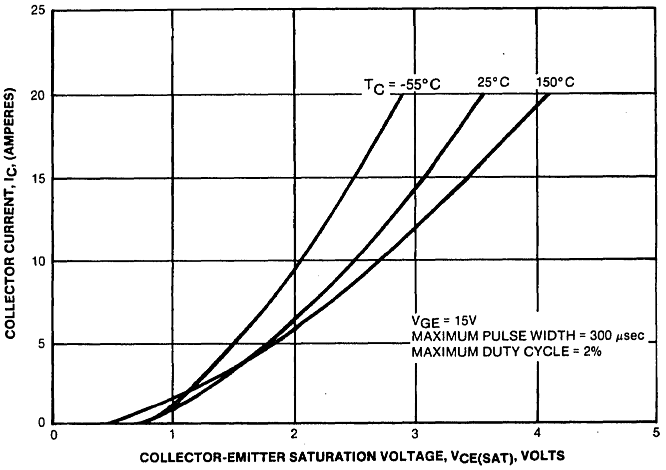


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

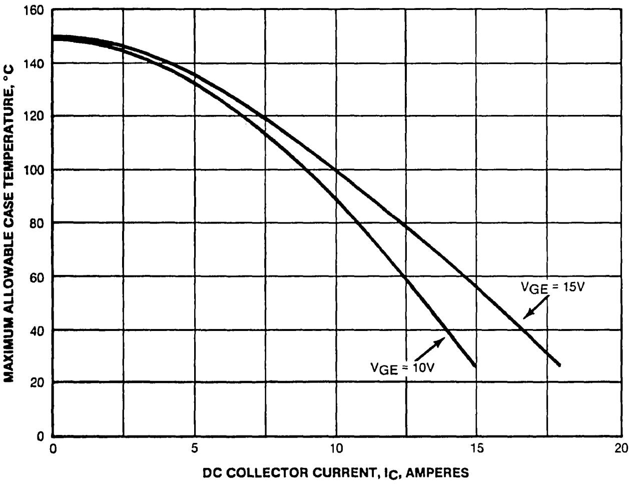


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT

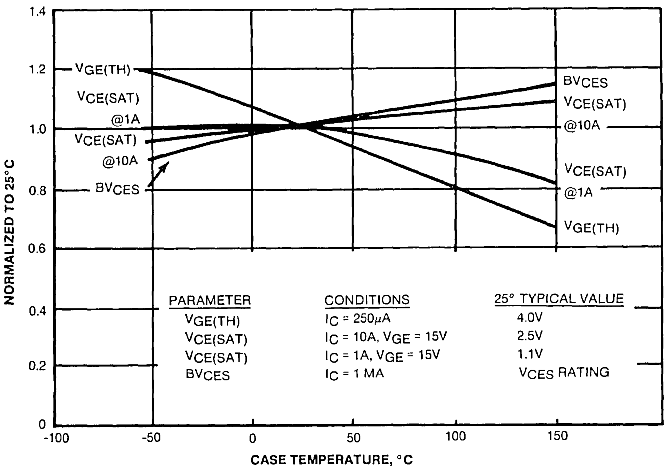


FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

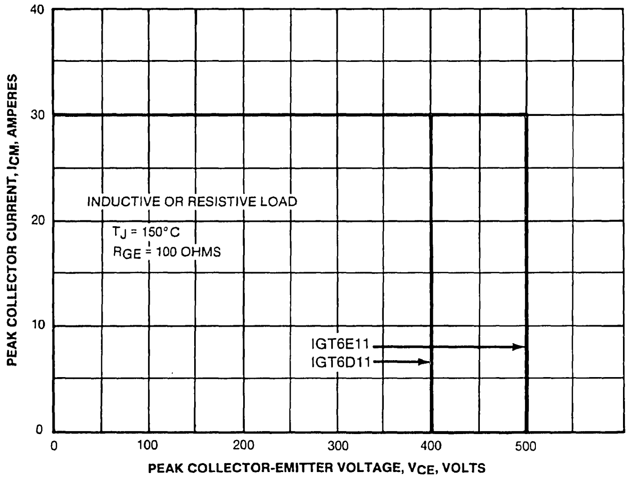


FIGURE 5. TURN-OFF SAFE OPERATING AREA

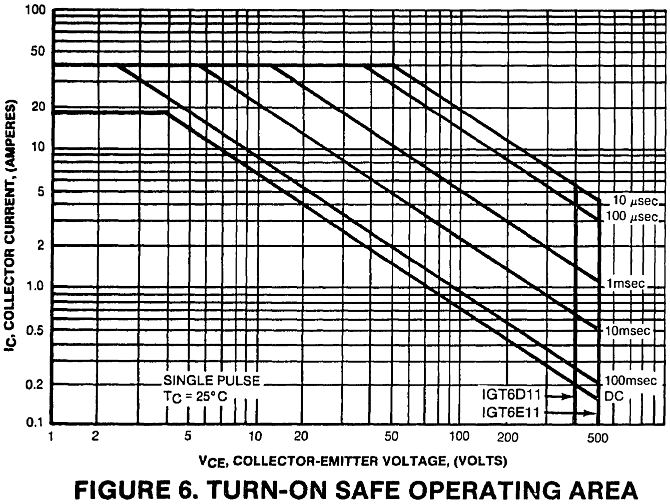


FIGURE 6. TURN-ON SAFE OPERATING AREA

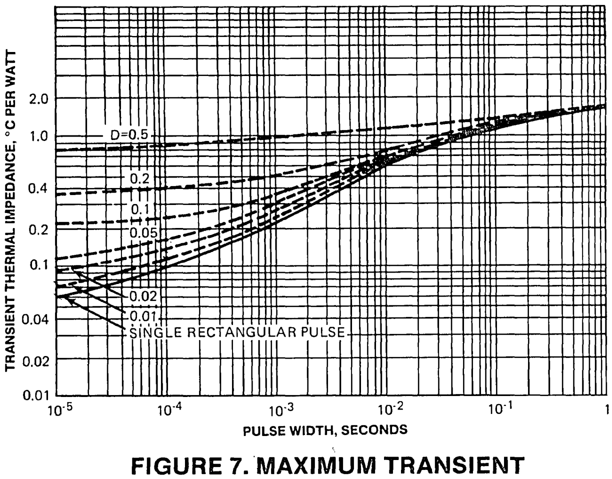
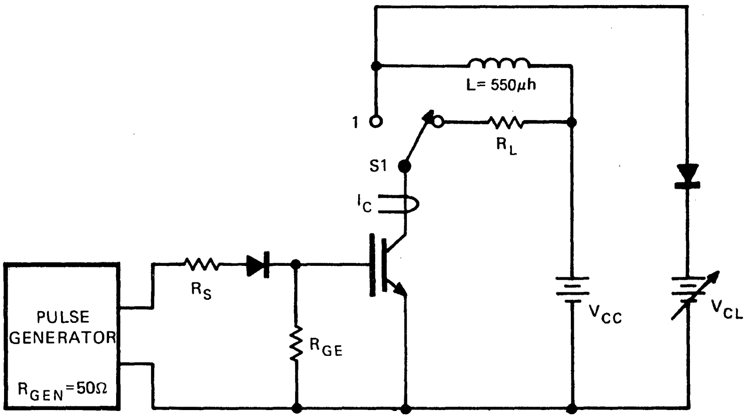


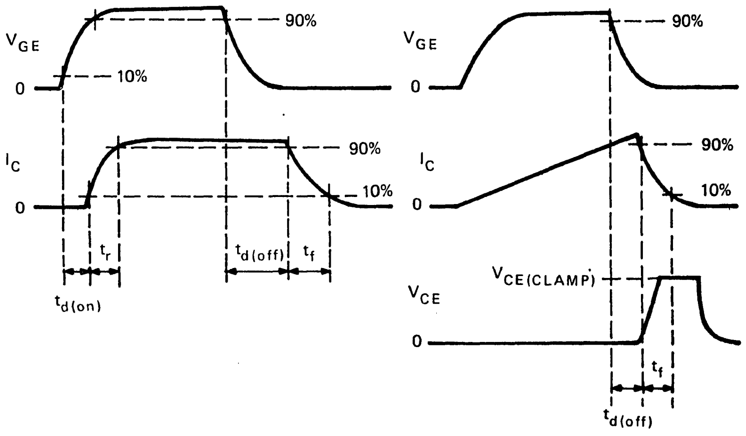
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT6D20,E20

20 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)}$ = 0.12 Ω

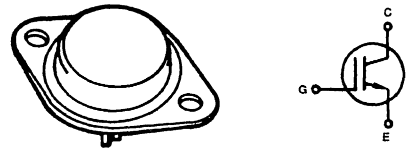
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

Features:

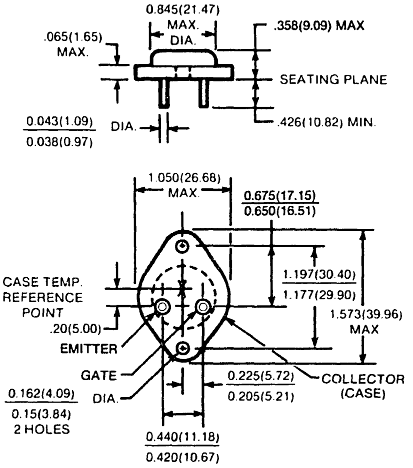
- Low $V_{CE(SAT)}$ — 2.3V typ @ 20A
- Ultra-fast turn-on — 200 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 20 amps @ 100° C

N-CHANNEL



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IGT6D20	IGT6E20	UNITS
Collector-Emitter Voltage, V_{GE} = 0V	V_{CES}	400	500	Volts
Collector-Gate Voltage, R_{GE} = 1MΩ	V_{CGR}	400	500	Volts
Continuous Drain Current @ T_C = 100°C @ T_C = 25°C	I_C	20 32	20 32	A A
Pulsed Collector Current(1)	I_{CM}	80	80	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (V_{GE} = 0V, I_C = 250μA)	IGT6D20 IGT6E20	BV_{CES}	400 500	— —	— —	Volts
Collector Cut-off Current		I_{CES}				
(V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25°C)			—	—	250	μA
(V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 125°C)[2]			—	—	4.0	mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)		I_{GES}	—	—	±500	nA

(2) Applies for 4°C per watt maximum thermal resistance, case to ambient.

on characteristics(3)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 500μA)	T_C = 25°C T_C = 150°C	$V_{GE(TH)}$	2 —	4 2	5 —	Volts
Collector-Emitter Saturation Voltage		$V_{CE(SAT)}$				Volts
I_C = 20 A, T_C = 25°C, V_{GE} = 15V			—	2.3	2.4	
I_C = 20 A, T_C = 150°C, V_{GE} = 15V			—	2.4	—	
I_C = 20 A, T_C = 25°C, V_{GE} = 10V			—	2.8	—	

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GE} = 0V	C_{ies}	—	2300	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	700	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics(3) (see figures 8 & 9)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	Resistive Load, T_C = 150°C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 20A, V_{CE} = Rated V_{CES}	t_r	—	200	—	ns
Turn-off Delay Time	V_{GE} = 15V	$t_{d(off)}$	—	0.65	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	5.0	—	μs
Turn-off Delay Time	Inductive Load, T_C = 150°C, L = 550μH, I_C = 20A,	$t_{d(off)}$	—	1.0	1.5	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	4.5	6.5	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	3.5	5.0	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT6D20 IGT6E20	E_f	—	14 17.5	20 25	mJ

(3) Pulse test: Pulse widths ≤ 300 μsec, duty cycle ≤ 2%.

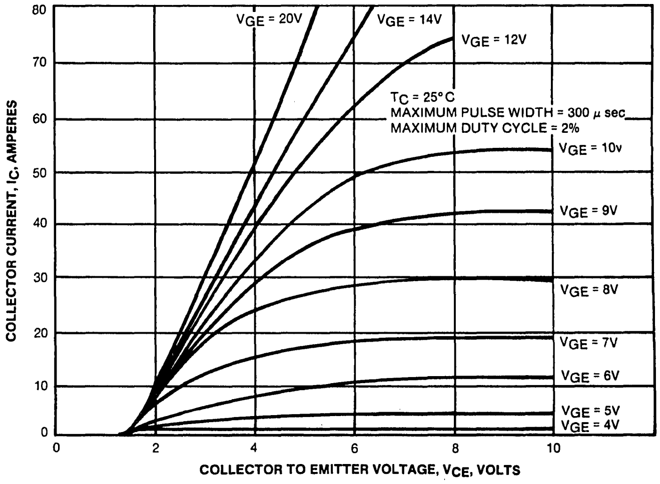


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

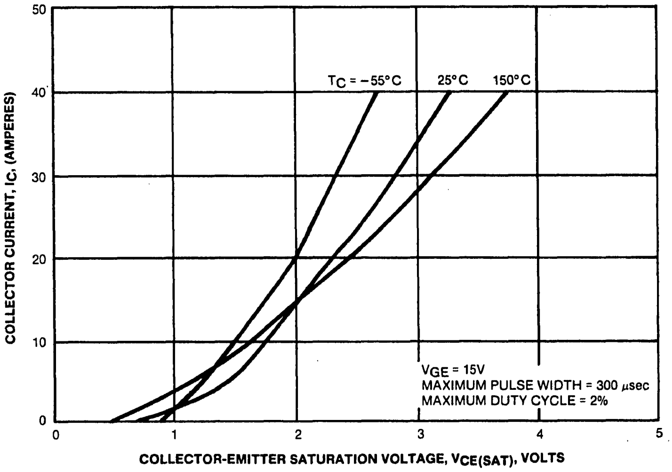


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

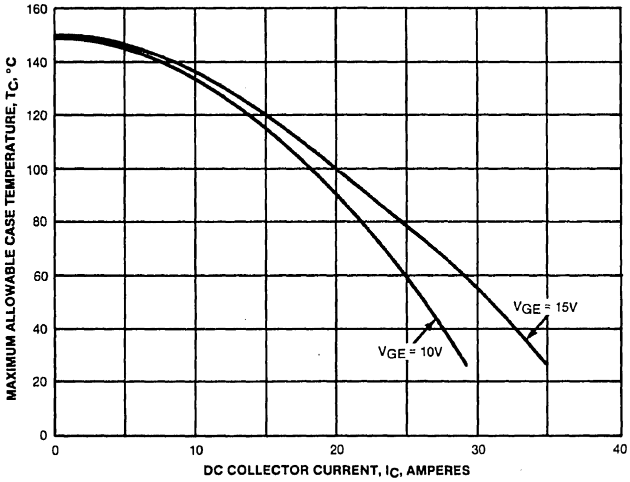
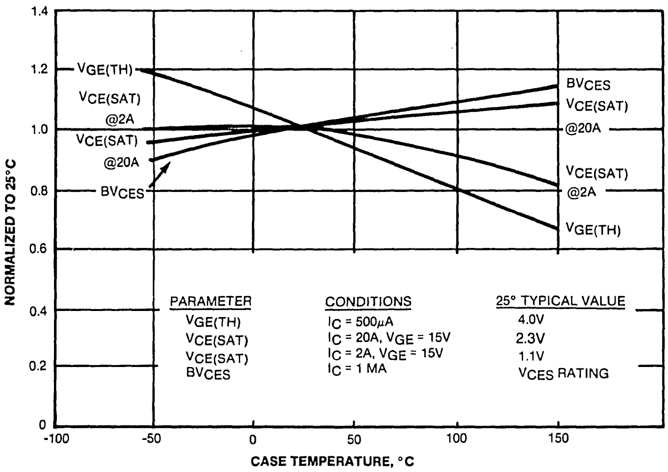


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT



PARAMETER	CONDITIONS	25° TYPICAL VALUE
$V_{GE(TH)}$	I_C = 500μA	4.0V
$V_{CE(SAT)}$	I_C = 20A, V_{GE} = 15V	2.3V
$V_{CE(SAT)}$	I_C = 2A, V_{GE} = 15V	1.1V
BV_{CES}	I_C = 1 MA	V_{CES} RATING

FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

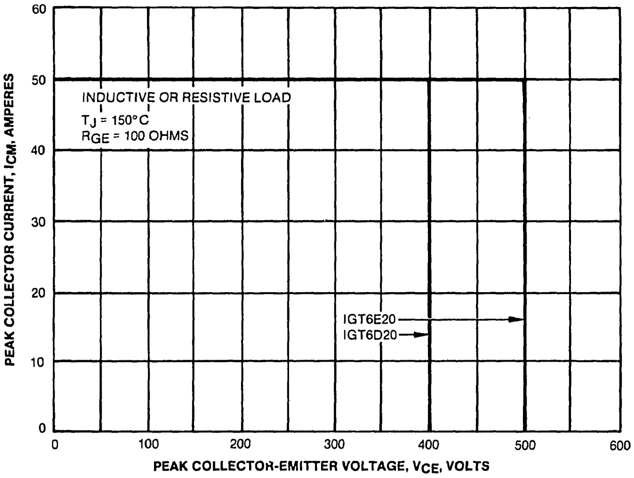


FIGURE 5. TURN-OFF SAFE OPERATING AREA

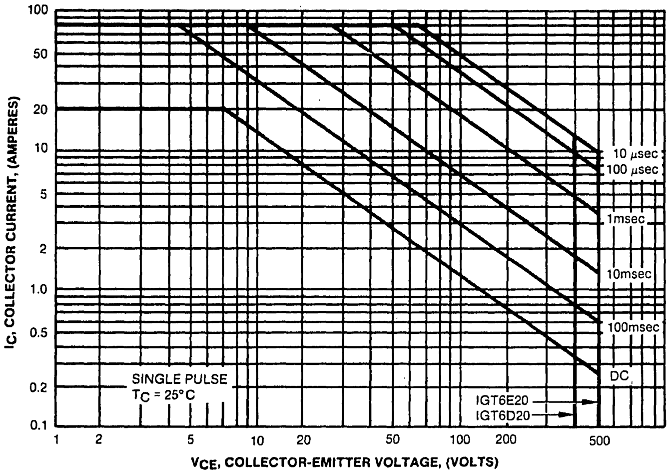


FIGURE 6. TURN-ON SAFE OPERATING AREA

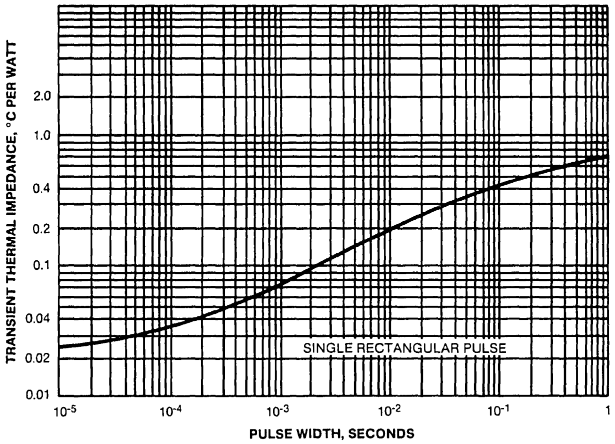
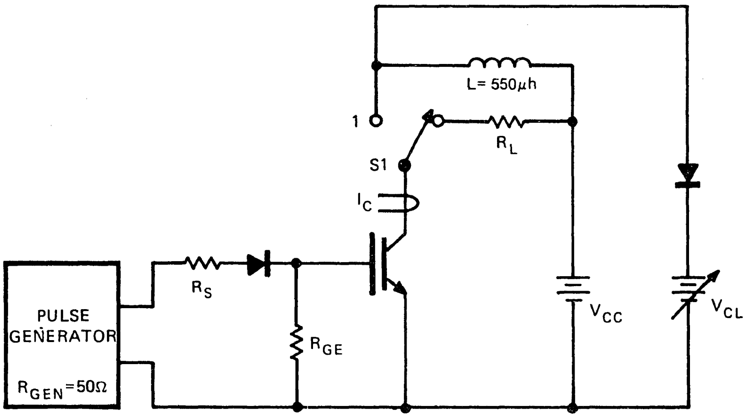


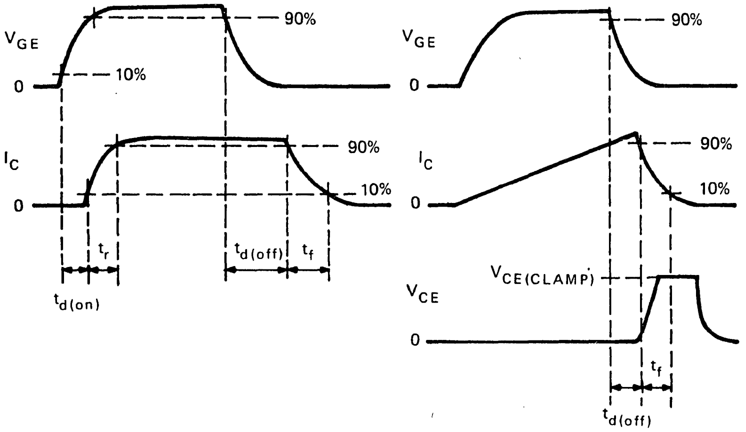
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}$, PULSE WIDTH≥60μsec, $V_{CC} = \frac{L \cdot I_{C(MAXIMUM)}}{\text{PULSE WIDTH}}$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD

INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT6D21,E21

20 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)}$ = 0.145 Ω

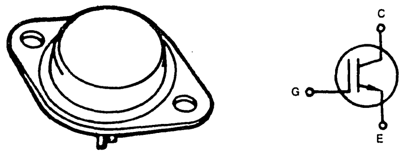
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

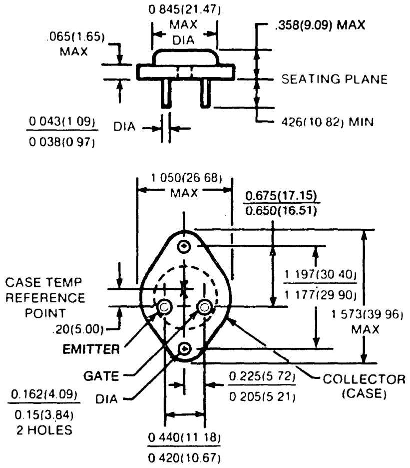
Features:

- Low $V_{CE(SAT)}$ — 2.5V typ @ 20A
- Ultra-fast turn-on — 150 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 20 amps @ 90° C

N-CHANNEL



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IGT6D21	IGT6E21	UNITS
Collector-Emitter Voltage, V_{GE} = 0V	V_{CES}	400	500	Volts
Collector-Gate Voltage, R_{GE} = 1MΩ	V_{CGR}	400	500	Volts
Continuous Drain Current @ T_C = 90°C @ T_C = 25°C	I_C	20 32	20 32	A A
Pulsed Collector Current(1)	I_{CM}	80	80	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

therrmal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (V_{GE} = 0V, I_C = 250μA) IGT6D21 IGT6E21	BV_{CES}	400 500	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25°C) (V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 125°C)(2)	I_{CES}	— —	— —	250 4.0	μA mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)	I_{GES}	—	—	±500	nA

(2) Applies for 4°C per watt maximum thermal resistance, case to ambient.

on characteristics(3)

Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 500μA) T_C = 25°C T_C = 150°C	$V_{GE(TH)}$	2 —	4 2	5 —	Volts
Collector-Emitter Saturation Voltage I_C = 20 A, T_C = 25°C, V_{GE} = 15V I_C = 20 A, T_C = 150°C, V_{GE} = 15V I_C = 20 A, T_C = 25°C, V_{GE} = 10V	$V_{CE(SAT)}$	— — —	2.5 2.6 3.0	2.9 — —	Volts

dynamic characteristics

Input Capacitance	V_{GE} = 0V	C_{ies}	—	2300	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	700	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics(3) (see figures 8 & 9)

Turn-on Delay Time	Resistive Load T_C= 125°C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 20A, V_{CE} = Rated V_{CES}	t_r	—	150	—	ns
Turn-off Delay Time	V_{GE} =15V	$t_{d(off)}$	—	0.60	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	3.0	—	μs
Turn-off Delay Time	Inductive Load, T_C = 125°C, L = 550μH, I_C = 20A,	$t_{d(off)}$	—	0.8	1.4	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	0.8	1.0	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	0.6	0.8	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT6D21 IGT6E21	E_f	—	2.6 3.2	3.2 4.0	mJ

(3) Pulse test: Pulse widths ≤ 300 μsec, duty cycle ≤ 2%.

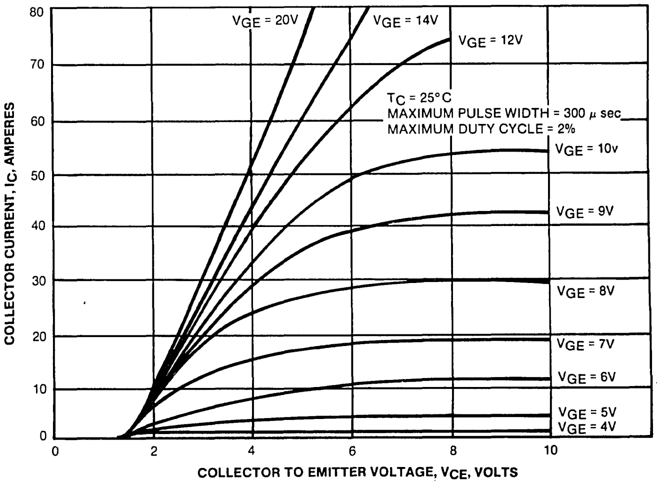


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

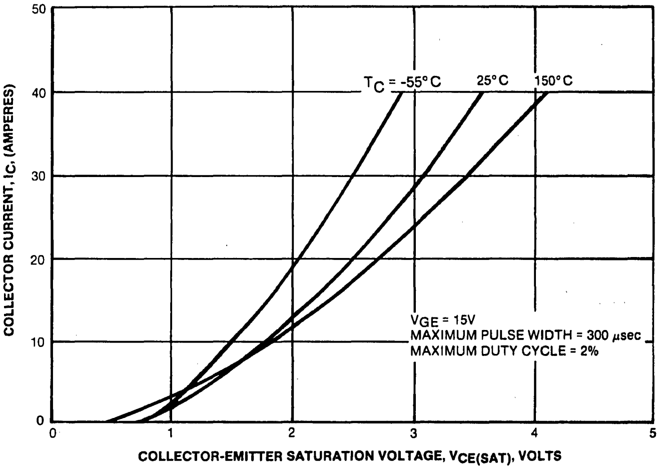


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

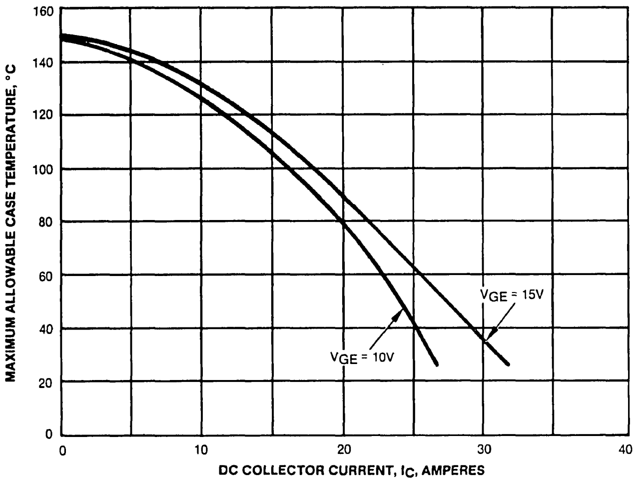
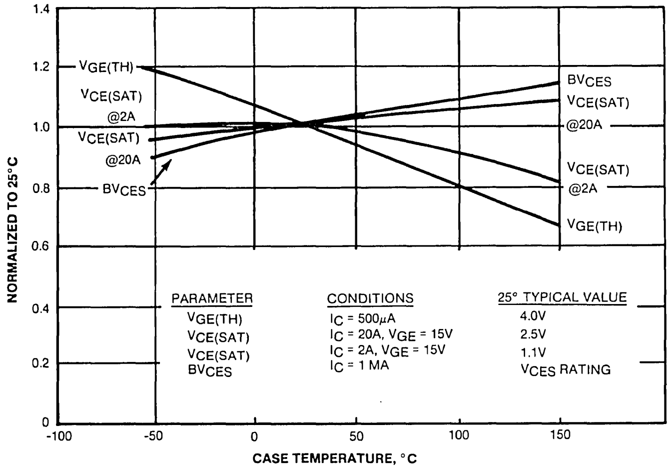


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT



PARAMETER	CONDITIONS	25° TYPICAL VALUE
$V_{GE(TH)}$	I_C = 500μA	4.0V
$V_{CE(SAT)}$	I_C = 20A, V_{GE} = 15V	2.5V
$V_{CE(SAT)}$	I_C = 2A, V_{GE} = 15V	1.1V
BV_{CES}	I_C = 1 MA	V_{CES} RATING

FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

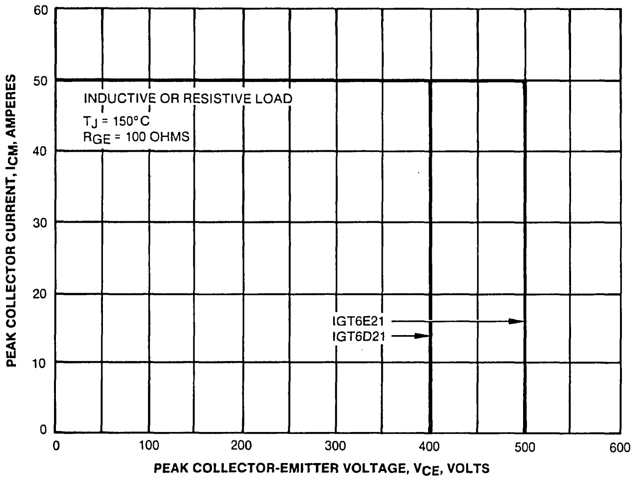


FIGURE 5. TURN-OFF SAFE OPERATING AREA

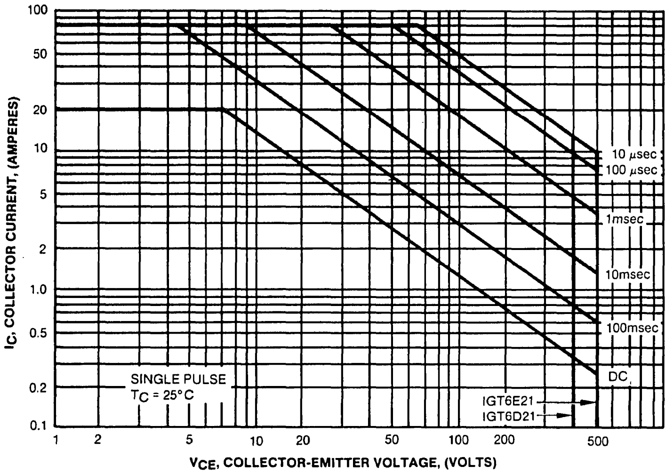


FIGURE 6. TURN-ON SAFE OPERATING AREA

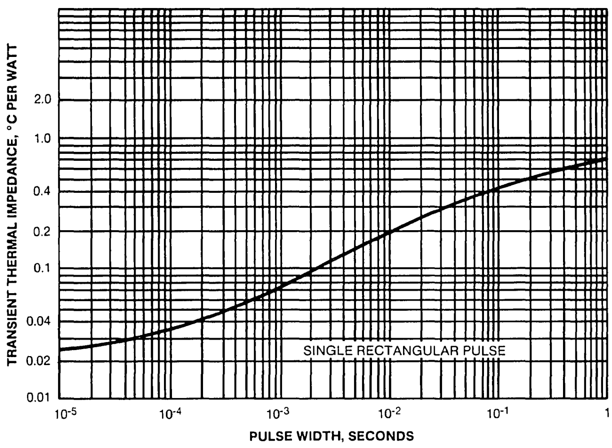
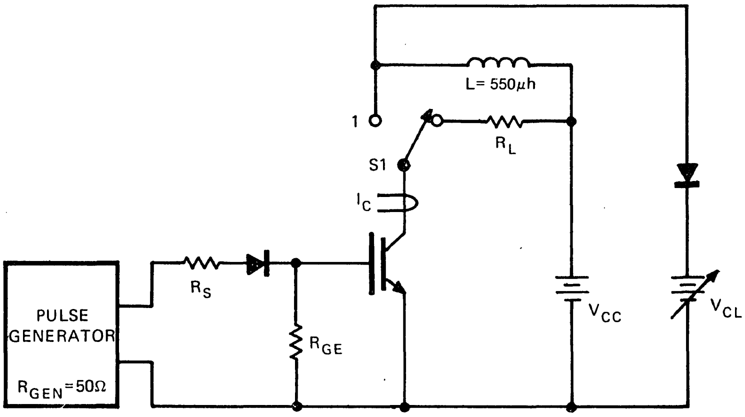


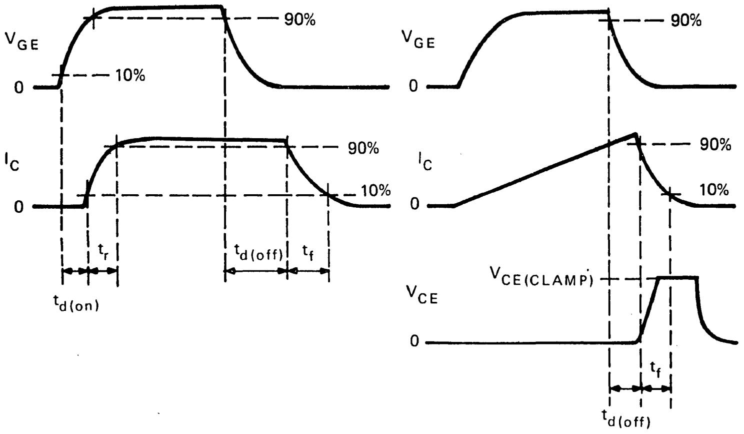
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C\,(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT8D20,E20

20 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)}$ = 0.12 Ω

This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

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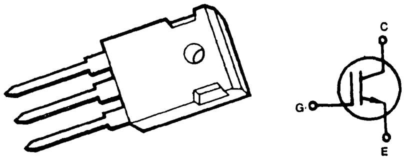
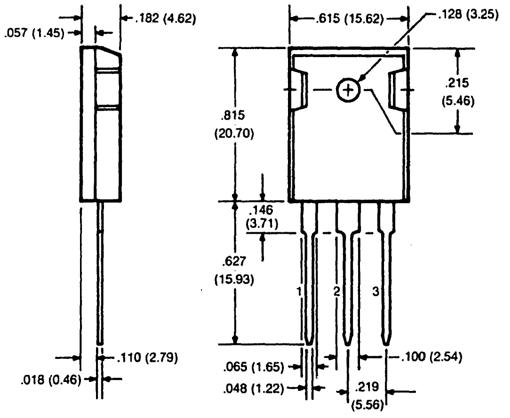
N-CHANNEL



CASE STYLE TO-247
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS IGT	TO-247	GATE	COLLECTOR	EMITTER	COLLECTOR

Features:

- Low $V_{CE(SAT)}$ — 2.3V typ @ 20A
- Ultra-fast turn-on — 200 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 20 amps @ 100° C

maximum ratings (T_C = 25° C) (unless otherwise specified)

RATING	SYMBOL	IGT8D20	IGT8E20	UNITS
Collector-Emitter Voltage, V_{GE} = 0V	V_{CES}	400	500	Volts
Collector-Gate Voltage, R_{GE} = 1MΩ	V_{CGR}	400	500	Volts
Continuous Drain Current @ T_C = 100°C @ T_C = 25°C	I_C	20 32	20 32	A A
Pulsed Collector Current(1)	I_{CM}	80	80	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ T_C = 25°C Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (V_{GE} = 0V, I_C = 250μA)	IGT8D20 IGT8E20	BV_{CES}	400 500	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25°C) (V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 150°C)(2)		I_{CES}	— —	— —	250 4.0	μA mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)		I_{GES}	—	—	±500	nA

(2) Applies for 4°C per watt maximum thermal resistance, case to ambient.

on characteristics(3)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage (V_{CE} = V_{GE}, I_C = 500μA)	T_C = 25°C T_C = 150°C	$V_{GE(TH)}$	2 —	4 2	5 —	Volts
Collector-Emitter Saturation Voltage I_C = 20 A, T_C = 25°C, V_{GE} = 15V I_C = 20 A, T_C = 150°C, V_{GE} = 15V I_C = 20 A, T_C = 25°C, V_{GE} = 10V		$V_{CE(SAT)}$	— — —	2.3 2.4 2.8	2.4 — —	Volts

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GE} = 0V	C_{ies}	—	2300	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	700	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics(3) (see figures 8 & 9)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	Resistive Load, T_C = 150°C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 20A, V_{CE} = Rated V_{CES}	t_r	—	200	—	ns
Turn-off Delay Time	V_{GE} =15V	$t_{d(off)}$	—	0.65	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	5.0	—	μs
Turn-off Delay Time	Inductive Load, T_C = 150°C, L = 550μH, I_C = 20A,	$t_{d(off)}$	—	1.0	1.5	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	4.5	6.5	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	3.5	5.0	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT8D20 IGT8E20	E_f	—	14 17.5	20 25	mJ

(3) Pulse test: Pulse widths ≤ 300 μsec, duty cycle ≤ 2%.

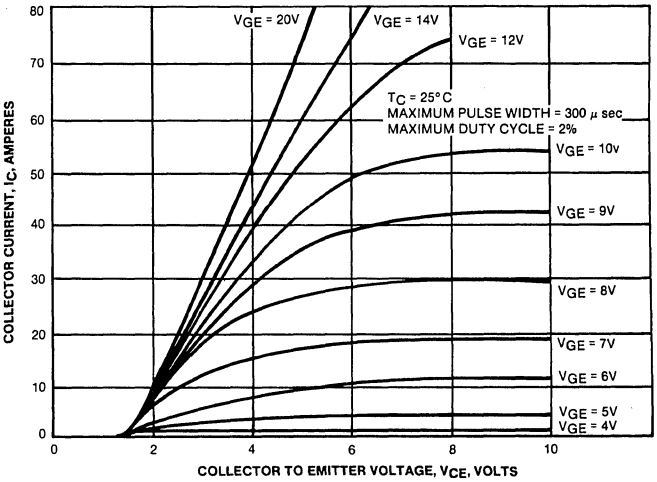


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

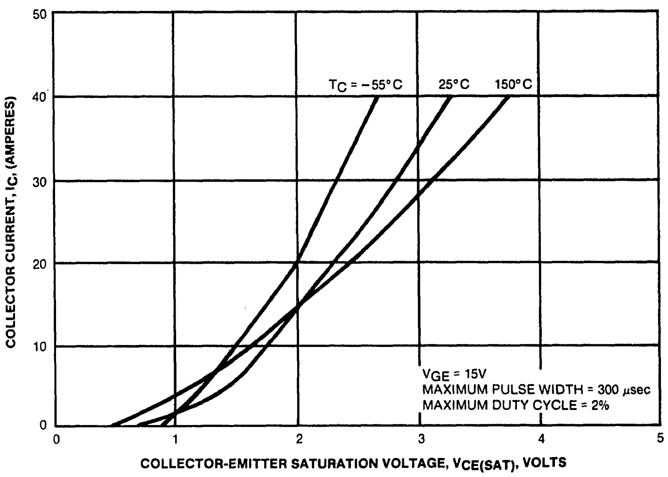


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

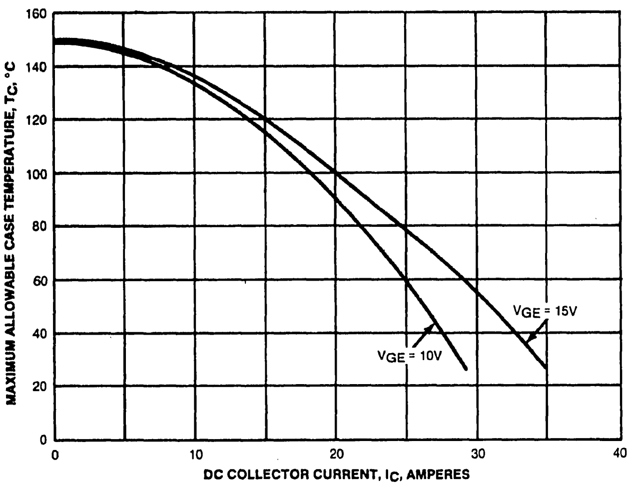


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT

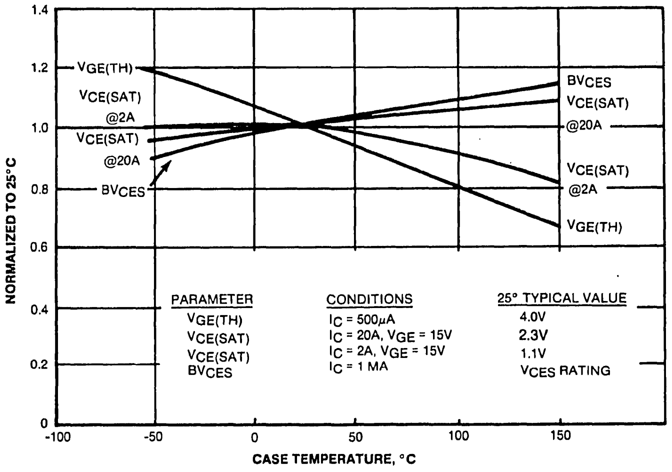


FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

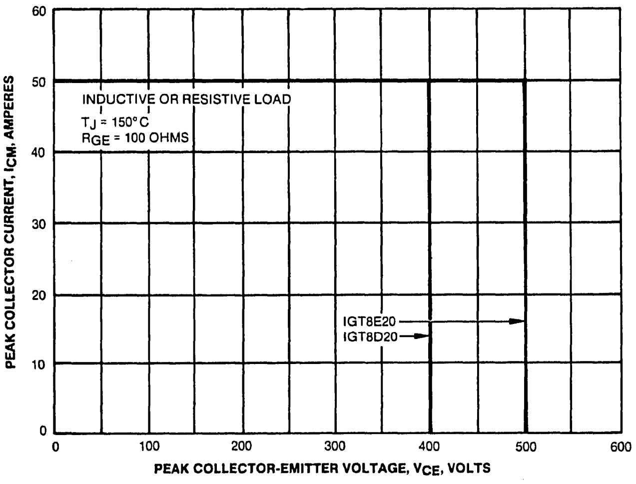


FIGURE 5. TURN-OFF SAFE OPERATING AREA

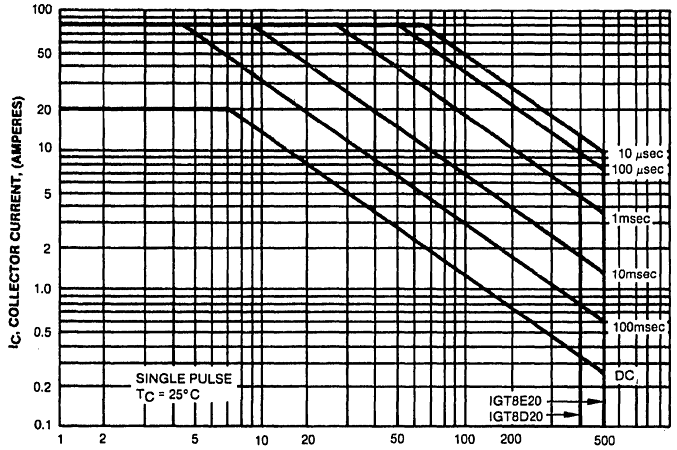


FIGURE 6. TURN-ON SAFE OPERATING AREA

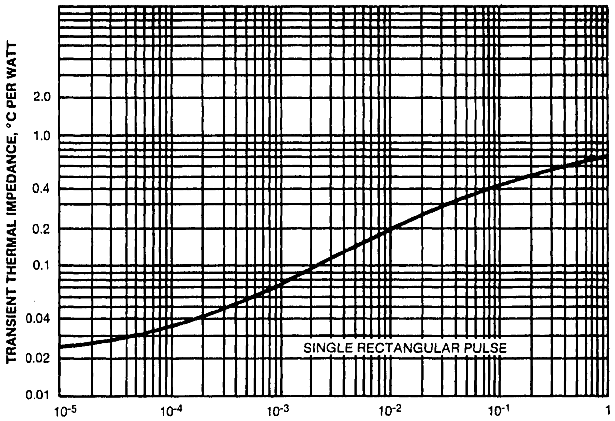
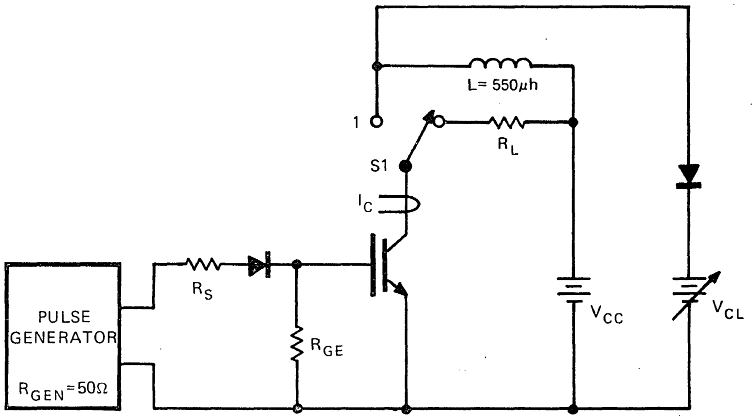


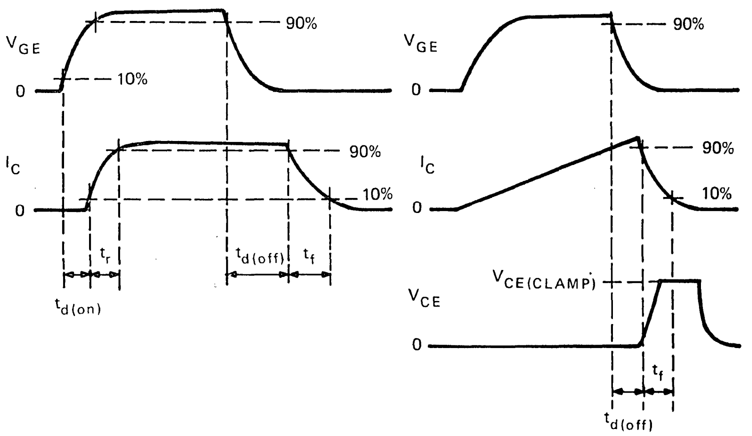
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}},\ \text{PULSE WIDTH} \geq 60\mu\text{sec},\ V_{CC} = \frac{L \cdot I_{C(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

IGT™ TRANSISTORS

Insulated Gate Bipolar Transistor

IGT8D21,E21

20 AMPERES
400, 500 VOLTS
EQUIV. $R_{DS(ON)} = 0.145\ \Omega$

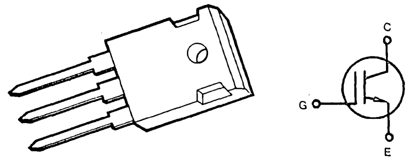
This IGT™ Transistor (Insulated Gate Bipolar Transistor) is a new type of MOS-gate turn on/off power switching device combining the best advantages of power MOSFETS and bipolar transistors. The result is a device that has the high input impedance of MOSFETS and the low on-state conduction losses similar to bipolar transistors. The device design and gate characteristics of the IGT™ Transistor are also similar to power MOSFETS. An important difference is the equivalent $R_{DS(ON)}$ drain resistance which is modulated to a low value (10 times lower) when the gate is turned on. The much lower on-state voltage drop also varies only moderately between 25° C and 150° C offering extended power handling capability.

The IGT™ Transistor is ideal for many high voltage switching applications operating at low frequencies and where low conduction losses are essential, such as; AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

Features:

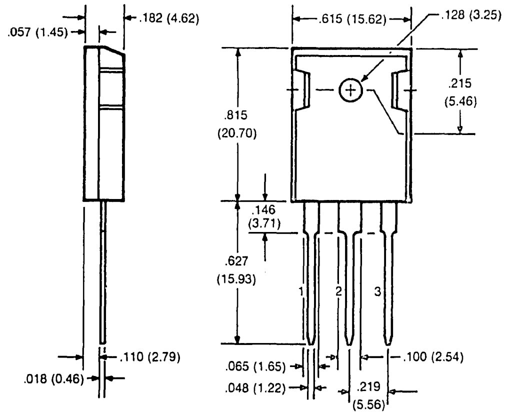
- Low $V_{CE(SAT)}$ — 2.5V typ @ 20A
- Ultra-fast turn-on — 150 ns typical
- Polysilicon MOS gate — Voltage controlled turn on/off
- High current handling — 20 amps @ 90° C

N-CHANNEL



CASE STYLE TO-247

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS IGT	TO-247	GATE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_C = 25°C$) (unless otherwise specified)

RATING	SYMBOL	IGT8D21	IGT8E21	UNITS
Collector-Emitter Voltage, $V_{GE} = 0V$	V_{CES}	400	500	Volts
Collector-Gate Voltage, $R_{GE} = 1M\Omega$	V_{CGR}	400	500	Volts
Continuous Drain Current @ $T_C = 90°C$ @ $T_C = 25°C$	I_C	20 32	20 32	A A
Pulsed Collector Current(1)	I_{CM}	80	80	A
Gate-Emitter Voltage	V_{GE}	±25	±25	Volts
Total Power Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	125 1.0	125 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	-55 to 150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Repetitive Rating: Pulse width limited by max. junction temperature.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage IGT8D21 (V_{GE} = 0V, I_C = 250μA) IGT8E21	BV_{CES}	400 500	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Max Rating, V_{GE} = 0V, T_C = 25°C) (V_{CE} = Max Rating, × 0.8, V_{GE} = 0V, T_C = 125°C)(2)	I_{CES}	— —	— —	250 4.0	μA mA
Gate-Emitter Leakage Current (V_{GE} = ±20V)	I_{GES}	—	—	±500	nA

(2) Applies for 3.3°C per watt maximum thermal resistance, case to ambient.

on characteristics(3)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Gate Threshold Voltage T_C = 25°C (V_{CE} = V_{GE}, I_C = 500μA) T_C = 150°C	$V_{GE(TH)}$	2 —	4 2	5 —	Volts
Collector-Emitter Saturation Voltage I_C = 20 A, T_C = 25°C, V_{GE} = 15V I_C = 20 A, T_C = 150°C, V_{GE} = 15V I_C = 20 A, T_C = 25°C, V_{GE} = 10V	$V_{CE(SAT)}$	— — —	2.5 2.6 3.0	2.9 — —	Volts

dynamic characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Input Capacitance	V_{GE} = 0V	C_{ies}	—	2300	—	pF
Output Capacitance	V_{CE} = 25V	C_{oes}	—	700	—	pF
Reverse Transfer Capacitance	f = 1 MHz	C_{res}	—	10	—	pF

switching characteristics(3) (see figures 8 & 9)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Delay Time	Resistive Load T_C = 125°C	$t_{d(on)}$	—	100	—	ns
Rise Time	I_C = 20A, V_{CE} = Rated V_{CES}	t_r	—	150	—	ns
Turn-off Delay Time	V_{GE} = 15V	$t_{d(off)}$	—	0.60	—	μs
Fall Time	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω	t_f	—	3.0	—	μs
Turn-off Delay Time	Inductive Load, T_C = 125°C, L = 550μH, I_C = 20A,	td_{off}	—	0.8	1.4	μs
Fall Time	$V_{CE(CLAMP)}$ = Rated V_{CES}	t_f	—	0.8	1.0	μs
Equivalent Fall Time	V_{GE} = 15V	$t_{f(eq)}$	—	0.6	0.8	μs
Turn-off Switching Losses	$R_{G(on)}$ = 50Ω, R_{GE} = 100Ω IGT8D21 IGT8E21	E_f	—	2.6 3.2	3.2 4.0	mJ

(3) Pulse test: Pulse widths ≤ 300 μsec, duty cycle ≤ 2%.

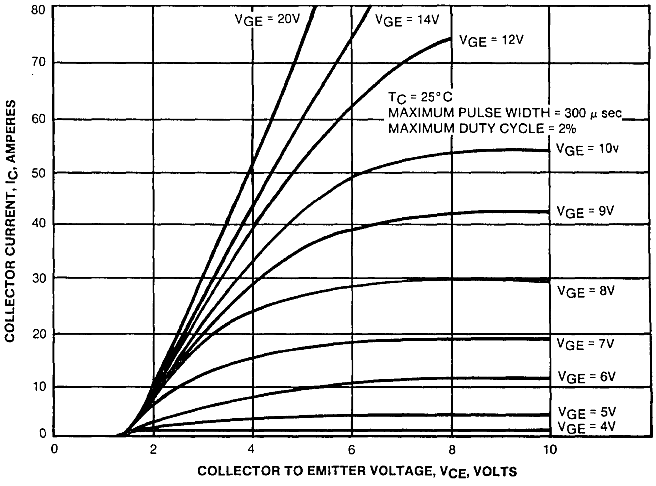


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

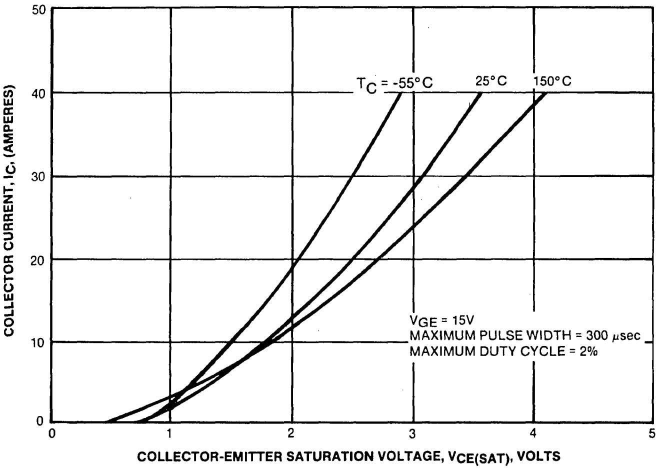


FIGURE 2. TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE

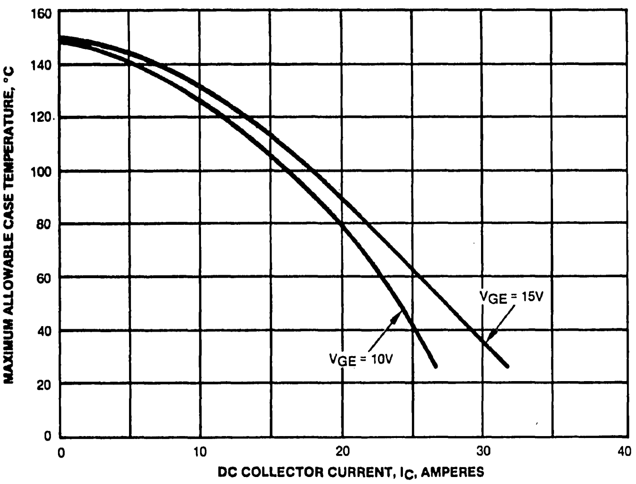


FIGURE 3. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. DC COLLECTOR CURRENT

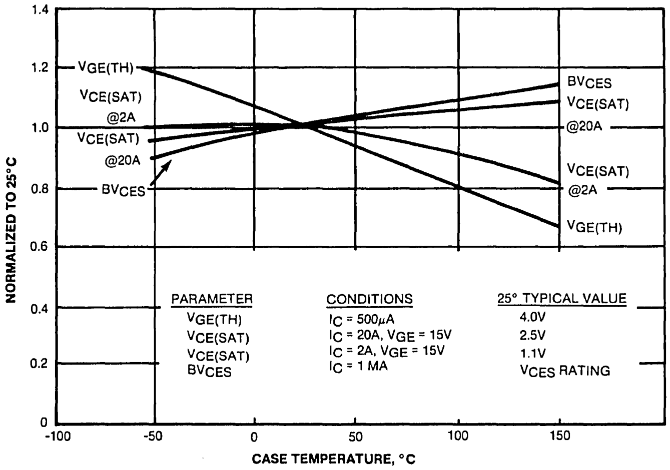


FIGURE 4. TYPICAL TEMPERATURE DEPENDENCE OF PARAMETERS

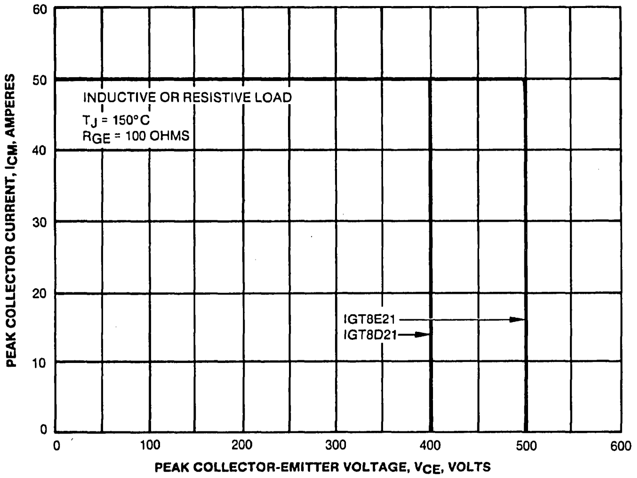


FIGURE 5. TURN-OFF SAFE OPERATING AREA

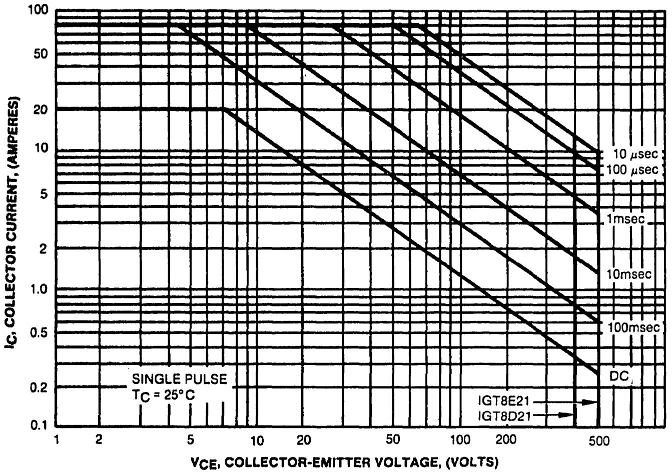


FIGURE 6. TURN-ON SAFE OPERATING AREA

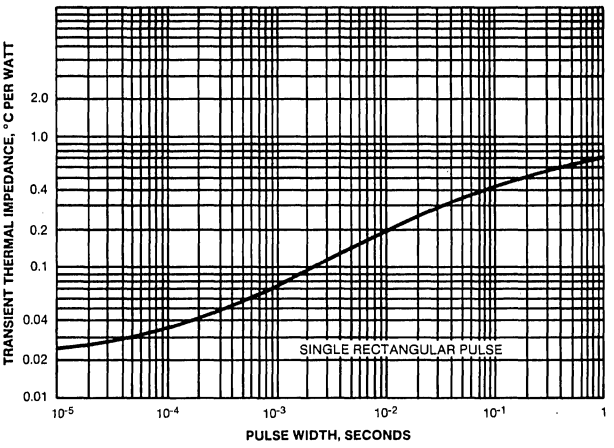
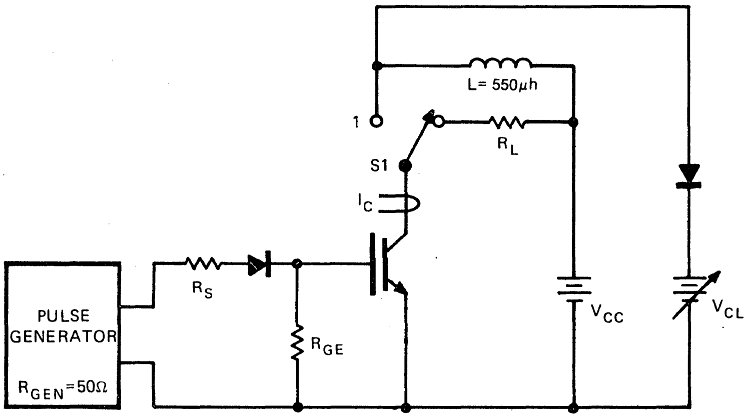


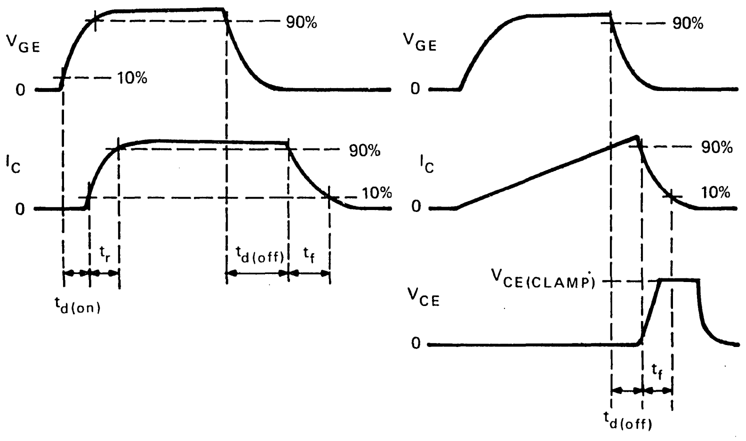
FIGURE 7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



S1 (SWITCH POSITION) –1 CLAMPED INDUCTIVE LOAD
–2 RESISTIVE LOAD

$$R_{G(ON)} = \frac{(R_{GEN}+R_S)(R_{GE})}{R_{GEN}+R_S+R_{GE}}, \text{ PULSE WIDTH} \geq 60\mu\text{sec}, V_{CC} = \frac{L \cdot I_{C\,(MAXIMUM)}}{\text{PULSE WIDTH}}$$

FIGURE 8. BASIC SWITCHING TEST CIRCUIT



RESISTIVE LOAD

INDUCTIVE LOAD

(WAVEFORMS NOT TO SCALE)

FIGURE 9. SWITCHING WAVEFORMS

GE
BIPOLAR
SPECIFICATIONS

VERY HIGH GAIN
NPN POWER DARLINGTON TRANSISTORS

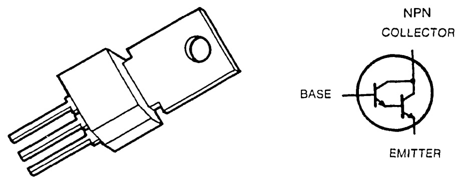
D40C Series

30-50 VOLTS
.5 AMP, 6.25 WATTS

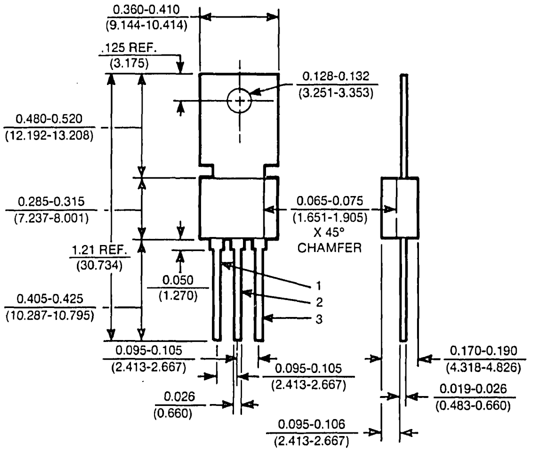
Designed for driver, regulator, touch switch, I.C. driver, audio output, relay substitute, oscillator, servo-amplifier, and capacitor multiplier applications.

Features:

- h_{FE} Min. — 10,000 and 40,000
- 1.33 Watt power dissipation at T_A = 25°



CASE STYLE TO-202
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40C1	D40C4	D40C7	UNITS
Collector-Emitter Voltage	V_{CEO}	30	40	50	Volts
Collector-Emitter Voltage	V_{CES}	30	40	50	Volts
Emitter Base Voltage	V_{EBO}	13	13	13	Volts
Collector Current — Continuous Peak[1]	I_C I_{CM}	.5 1.0	.5 1.0	.5 1.0	A
Base Current — Continuous	I_B	0.1	0.1	0.1	A
Total Power Dissipation @ T_A = 25° C @ T_C = 25° C	P_D	1.33 6.25	1.33 6.25	1.33 6.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage D40C1 (I_C = 10mA) D40C4 D40C7	V_{CEO}	30 40 50	— — —	— — —	Volts
Collector Cut-off Current (T_C = 25° C) (V_{CE} = Rated V_{CES}) (T_C = 150° C)	I_{CES} I_{CBO}	— —	— —	0.5 20	μA
Emitter Cutoff Current (V_{EB} = 13V)	I_{EBO}	—	—	0.1	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 2

on characteristics

DC Current Gain (I_C = 200mA, V_{CE} = 5V)	h_{FE}	10K	—	60K	
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 0.5mA)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 500mA, I_B = 0.5mA)	$V_{BE(sat)}$	—	—	2.0	Volts

dynamic characteristics

Collector Capacitance (V_{CE} = 10V, f = 1MHz)	C_{CBO}	—	—	220	pF
Current Gain - Bandwidth Product (I_C = 20mA, V_{CE} = 5V)	f_T	—	75	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 1mA V_{CC} = 30V, t_p = 25 μsec	$t_d + t_r$	—	100	—	ns
Storage Time		t_s	—	350	—	
Fall Time		t_f	—	800	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

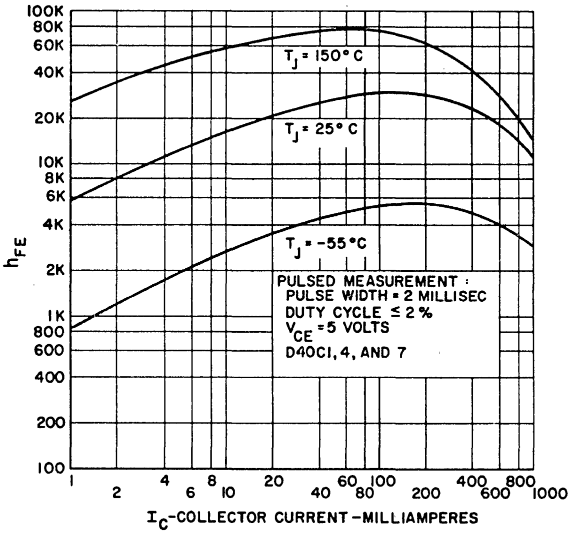


FIG 1. TYPICAL h_{FE} vs. I_C

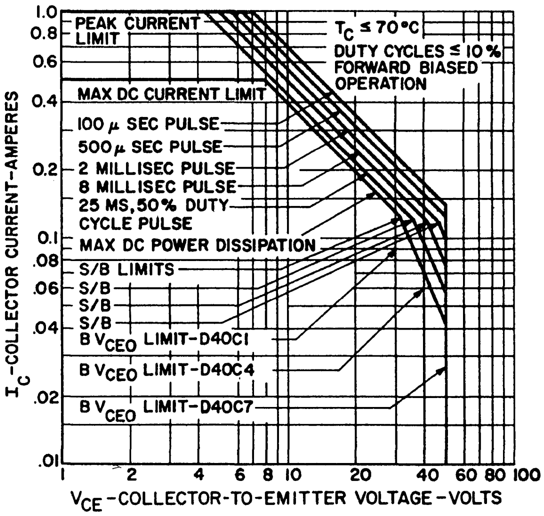


FIG. 2 SAFE REGION OF OPERATION

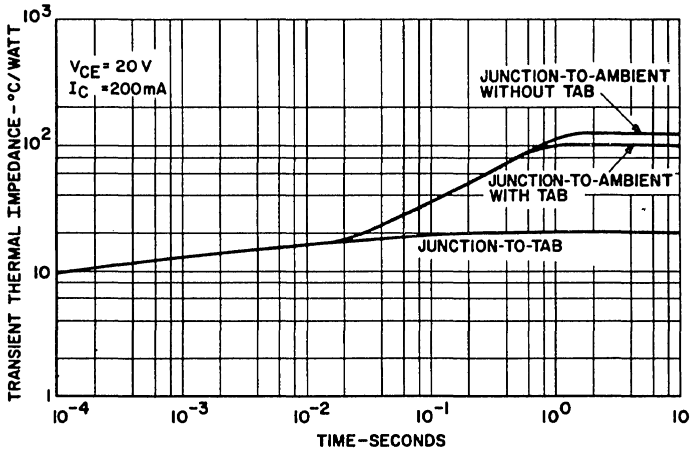


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

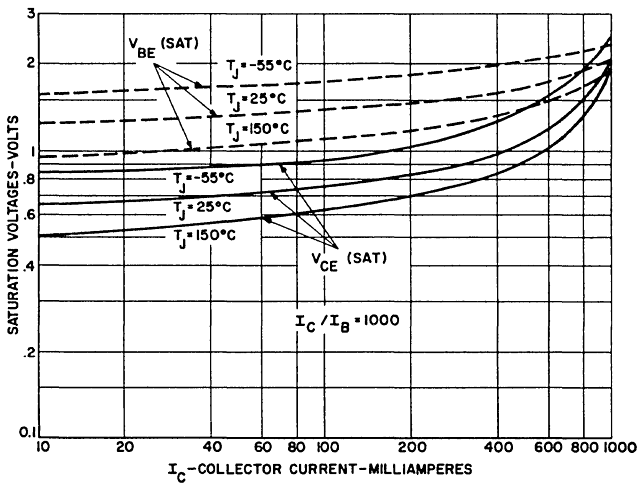


FIG. 4 TYPICAL SATURATION VOLTAGES

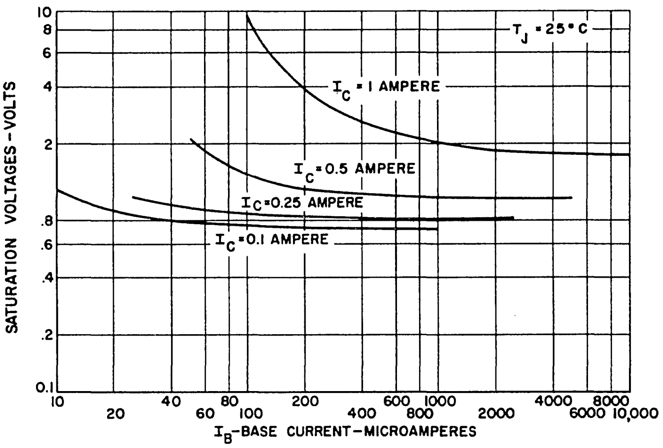


FIG. 5 TYPICAL SATURATION VOLTAGES

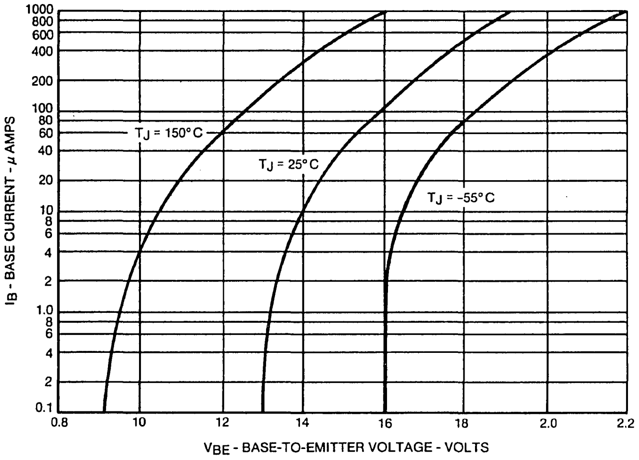


FIG. 6 TYPICAL INPUT CHARACTERISTICS

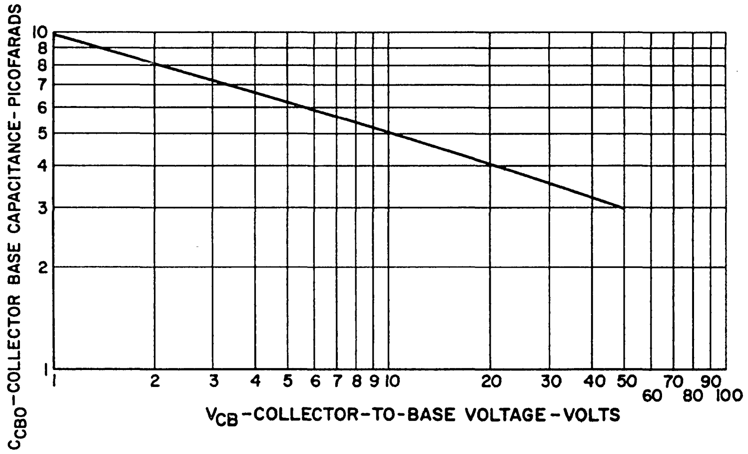


FIG. 7 TYPICAL C_{CBO} vs. VOLTAGE

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE D41D SERIES

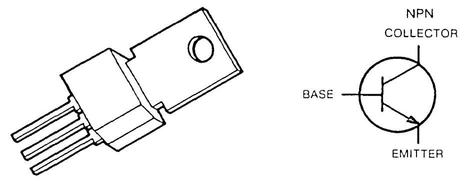
D40D Series

30 - 60 VOLTS
1 AMP, 6.25 WATTS

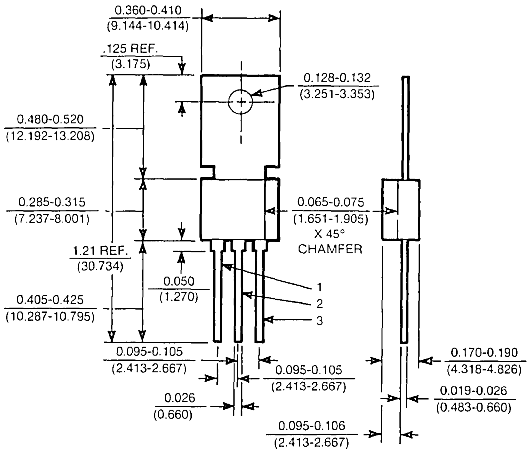
The General Electric D40D is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

Features:

- High free-air power dissipation
- NPN complement to D41D PNP
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast Switching



CASE STYLE TO-202
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D40D1, 2	D40D4, 5	D40D7, 8	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	Volts
Collector-Emitter Voltage	V_{CES}	45	60	75	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	1 1.5	1 1.5	1 1.5	A
Base Current — Continuous	I_B	.5	.5	.5	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25C$	P_D	1.67 6.25	1.67 6.25	1.67 6.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 10mA) D40D1, 2	$V_{CEO(sus)}$	30	—	—	Volts
D40D4, 5		45	—	—	
D40D7, 8		60	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CEO}) T_C = 25°C	I_{CES}	—	—	0.1	
(V_{CE} = Rated V_{CES}) T_C = 150° C		—	1.0	—	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	0.1	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4

on characteristics

DC Current Gain (I_C = 100mA, V_{CE} = 2V) D40D1, 4, 7	h_{FE}	50	—	150	—
D40D2, 5, 8		120	—	360	
(I_C = 1A, V_{CE} = 2V) D40D1, 4, 7	h_{FE}	10	—	—	—
D40D2		20	—	—	
D40D5, 8		10	—	—	
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA) D40D1, 2, 4, 5	$V_{CE(sat)}$	—	—	0.5	Volts
D40D7, 8		—	—	1.0	
Base-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)	$V_{BE(sat)}$	—	—	1.5	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = 10V, f = 1M_{Hz})	C_{CBO}	—	8	—	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 10V)	f_T	—	200	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A	$t_d + t_r$	—	25	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	200	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

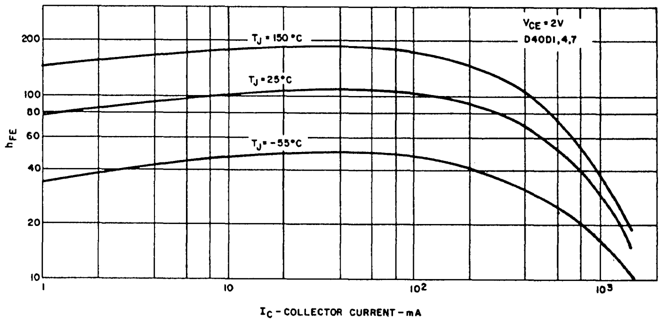


FIG. 1

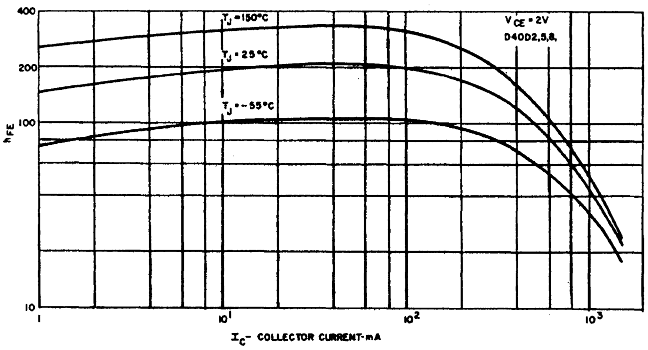


FIG. 2

TYPICAL H_{FE} VS I_C

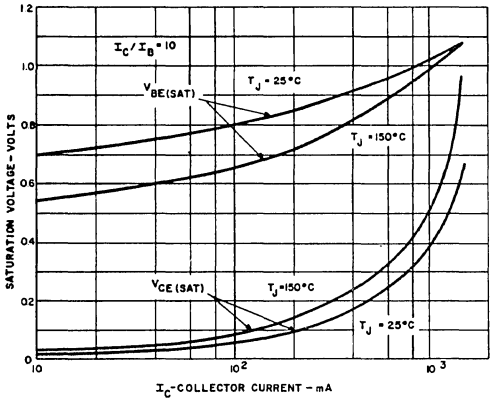


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

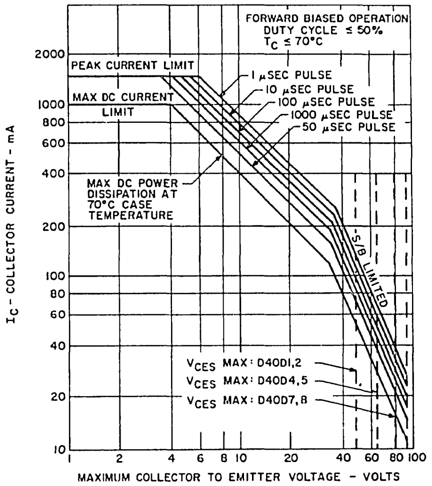


FIG. 4 SAFE REGION OF OPERATION

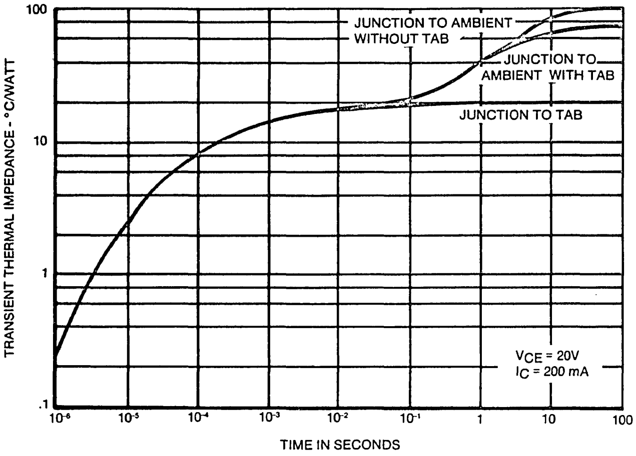


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE D40D SERIES

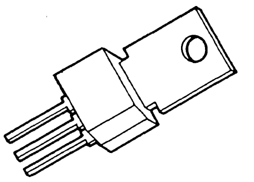
D41D Series

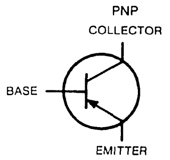
-30 - -60 VOLTS
-1 AMP, 6.25 WATTS

The General Electric D41D is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

Features:

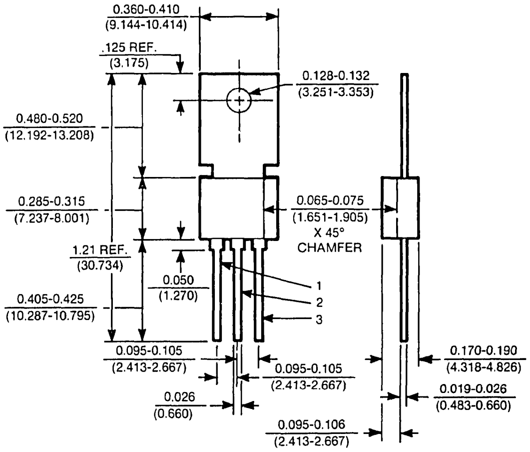
- High free-air power dissipation
- PNP complement to D40D NPN
- Low collector saturation voltage (–0.5V typ. @ 1.0A I_c)
- Excellent linearity
- Fast Switching





CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D41D1, 2	D41D4, 5	D41D7, 8	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	Volts
Collector-Emitter Voltage	V_{CES}	-45	-60	-75	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-1 -1.5	-1 -1.5	-1 -1.5	A
Base Current — Continuous	I_B	-.5	-.5	-.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25C	P_D	1.67 6.25	1.67 6.25	1.67 6.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics(1)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = 10mA)	D41D1, 2 D41D4, 5 D41D7, 8	$V_{CEO(sus)}$	-30 -45 -60	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CEO}) T_C = 25° C (V_{CE} = Rated V_{CES}) T_C = 150° C		I_{CES}	— —	— -1	-0.1 —	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	-0.1	μA

second breakdown

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 7			

on characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 100mA, V_{CE} = 2V)	D41D1, 4, 7 D41D2, 5, 8	h_{FE}	50 120	— —	150 360	—
(I_C = 1A, V_{CE} = 2V)	D41D1, 4, 7 D41D2 D41D5, 8	h_{FE}	10 20 10	— — —	— — —	—
Collector-Emitter Saturation Voltage (I_C = -500mA, I_B = -50mA)	D41D1, 2, 4, 5 D41D7, 8	$V_{CE(sat)}$	— —	— —	0.5 1.0	Volts
Base-Emitter Saturation Voltage (I_C = -500mA, I_B = -50mA)		$V_{BE(sat)}$	—	—	1.5	Volts

dynamic characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	—	10	—	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -10V)	f_T	—	150	—	MHz

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A	$t_d + t_r$	—	50	—	nS
Storage Time	V_{CC} = -30V, t_p = 25 μsec	t_s	—	75	—	
Fall Time		t_f	—	40	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

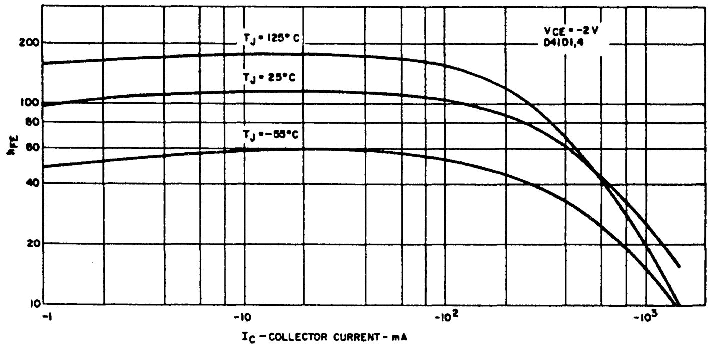


FIG. 1

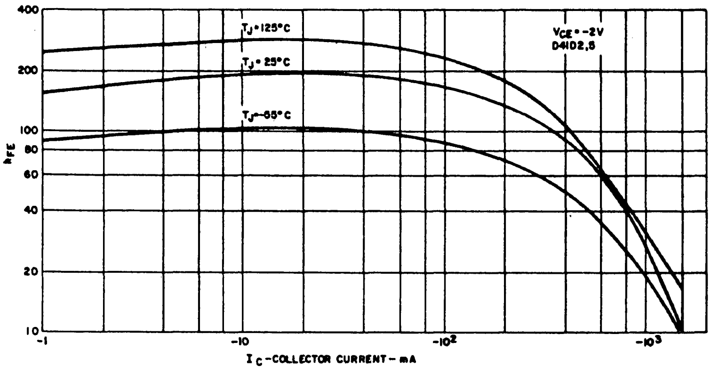


FIG. 2

TYPICAL h_{FE} VS. I_C

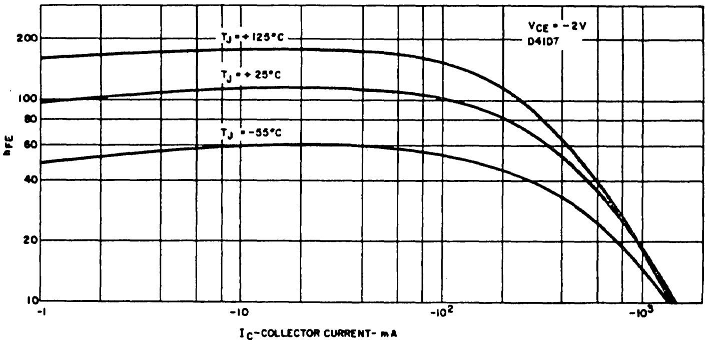


FIG. 3

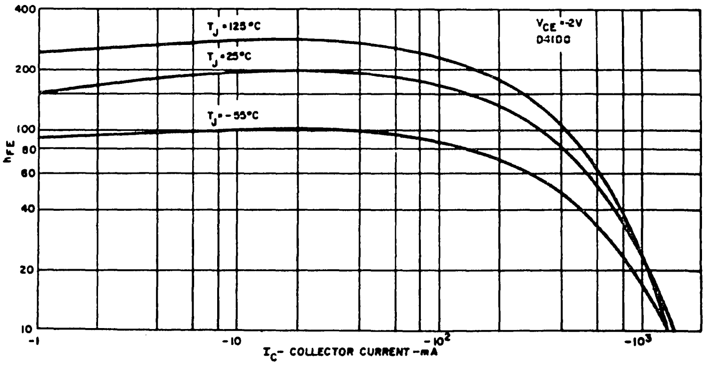


FIG. 4

TYPICAL hFE VS. IC

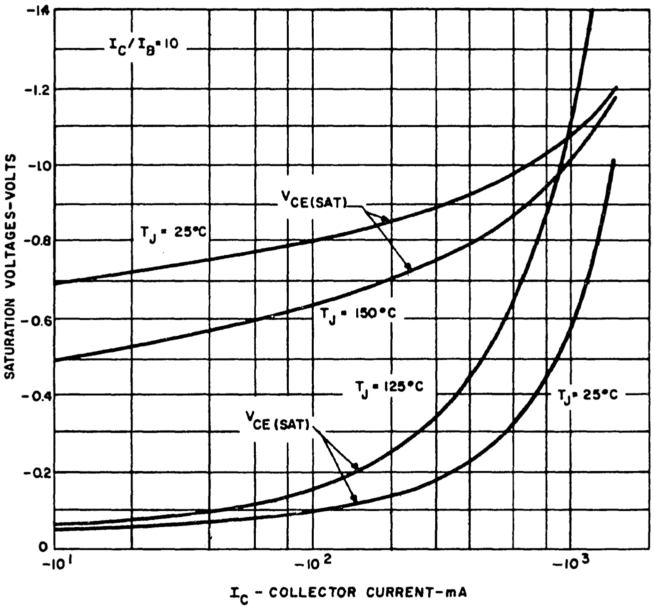


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

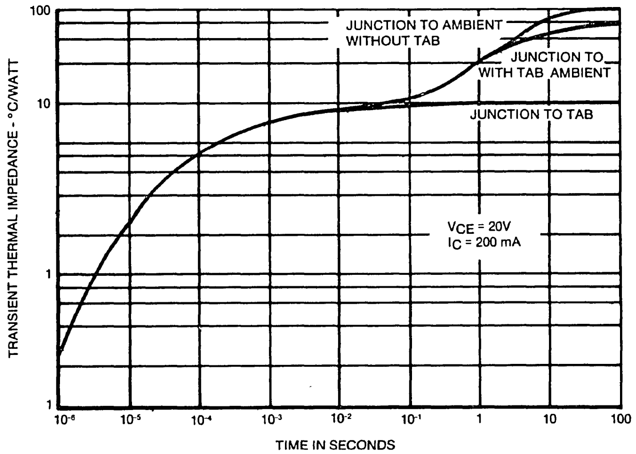


FIG. 6 MAXIMUM TRANSIENT THERMAL IMPEDANCE

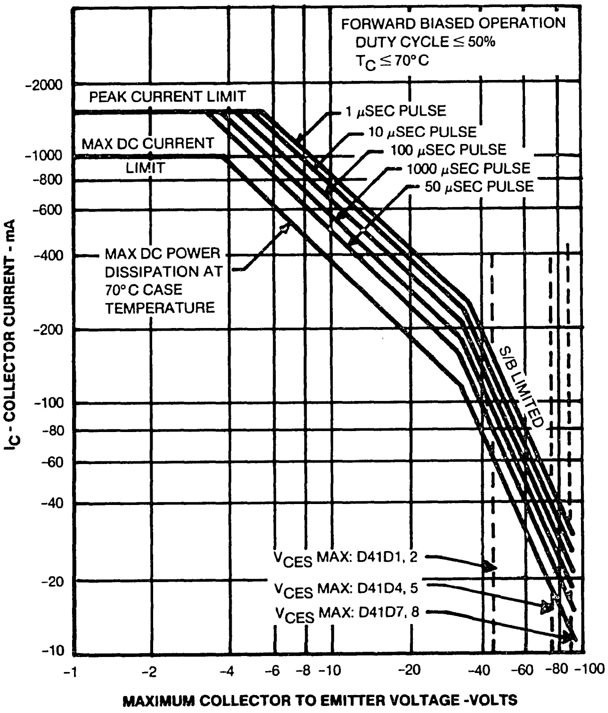


FIG. 7 SAFE REGION OF OPERATION

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE D41E SERIES

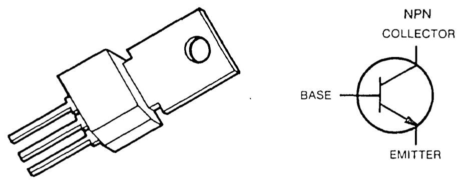
D40E Series

30 - 80 VOLTS
2 AMP, 8 WATTS

The General Electric D40E series are power transistors designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 0.1MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

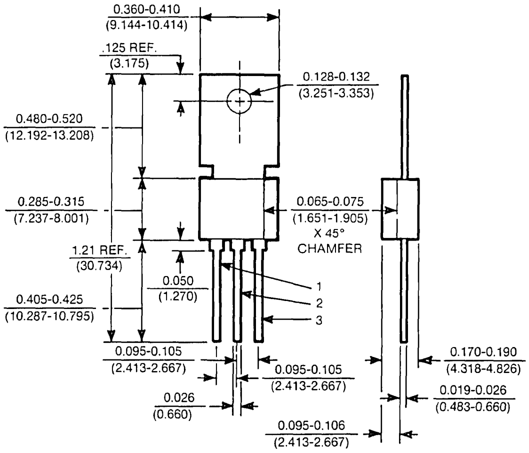
Features:

- High free-air power dissipation
- NPN complement to D41E PNP
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching



CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D40E1	D40E5	D40E7	UNITS
Collector-Emitter Voltage	V_{CEO}	30	60	80	Volts
Collector-Emitter Voltage	V_{CES}	45	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 3	2 3	2 3	A
Base Current — Continuous	I_B	1	1	1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.33 8	1.33 8	1.33 8	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics(1)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = 10mA)	D40E1 D40E5 D40E7	$V_{CEO(sus)}$	30 60 80	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	0.1	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	0.1	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1	

on characteristics

DC Current Gain (I_C = 100mA, V_{CE} = 2V) (I_C = 1A, V_{CE} = 2V)	h_{FE} h_{FE}	50 10	— —	— —	— —
Collector-Emitter Saturation Voltage (I_C = 1.0A, I_B = 0.1A)	$V_{CE(sat)}$	—	—	1.0	Volts
Base-Emitter Saturation Voltage (I_C = 1.0mA, I_B = 0.1A)	$V_{BE(sat)}$	—	—	1.3	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	—	9	—	pF
Current-Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V)	f_T	—	230	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A	$t_d + t_r$	—	130	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	400	—	
Fall Time		t_f	—	170	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

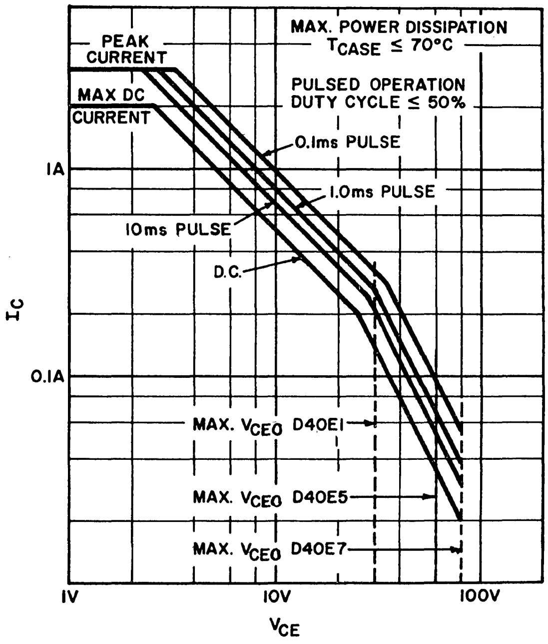


FIG. 1 SAFE REGION OF OPERATION

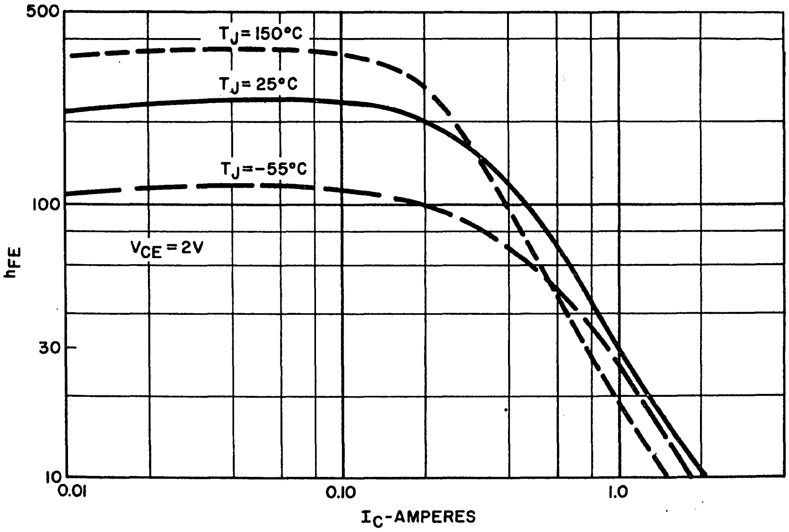


FIG. 2 TYPICAL H_{FE} VS I_C

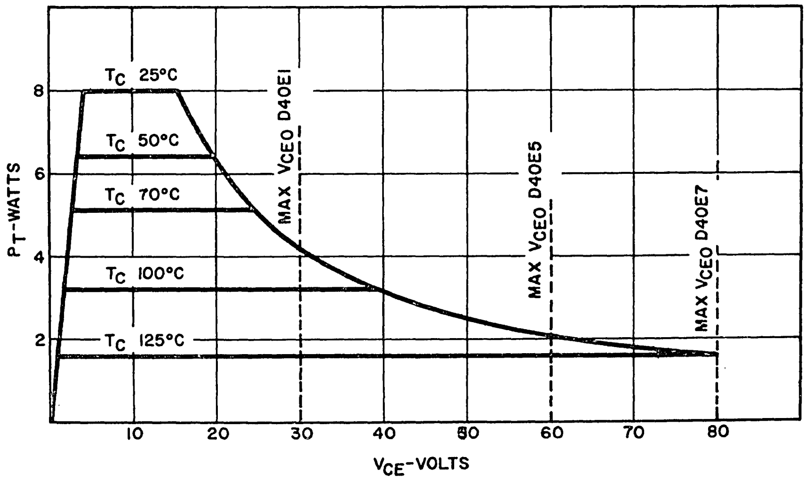


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

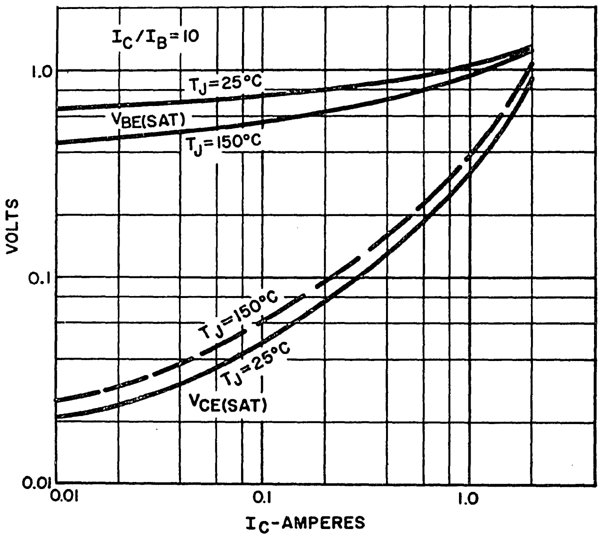


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

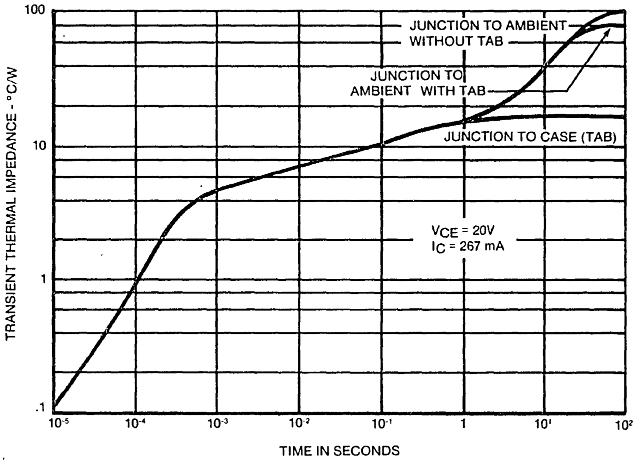


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE D40E SERIES

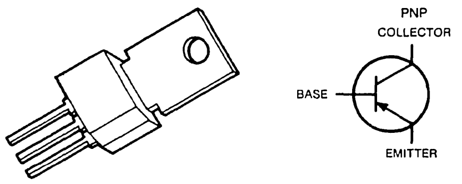
D41E Series

-30 - -80 VOLTS
-2 AMP, 8 WATTS

The General Electric D41E series are power transistors designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 0.1MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

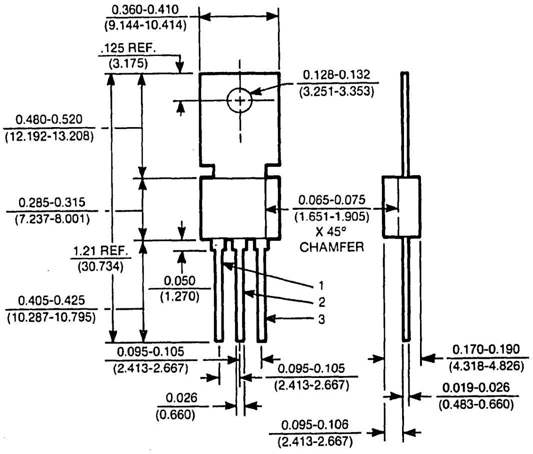
Features:

- High free-air power dissipation
- PNP complement to D40E NPN
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast Switching



CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D41E1	D41E5	D41E7	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-45	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-2 -3	-2 -3	-2 -3	A
Base Current — Continuous	I_B	-1	-1	-1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.33 8	1.33 8	1.33 8	Watts
Operating and Storage Junction Temperature Range	T_J,T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 10mA) D41E1 D41E5 D41E7	$V_{CEO(sus)}$	-30 -60 -80	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CES})	I_{CES}	—	—	-0.1	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	-0.1	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1

on characteristics

DC Current Gain (I_C = -100mA, V_{CE} = -2V) (I_C = -1A, V_{CE} = -2V)	 h_{FE} h_{FE}	 50 10	 — —	 — —	 — —
Collector-Emitter Saturation Voltage (I_C = -1.0A, I_B = -0.1A)	$V_{CE(sat)}$	—	—	1.0	Volts
Base-Emitter Saturation Voltage (I_C = 1.0mA, I_B = 0.1A)	$V_{BE(sat)}$	—	—	-1.3	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = -10V, f = 1M_{Hz})	C_{CBO}	—	13	—	pF
Current-Gain Bandwidth Product (I_C = -100mA, V_{CE} = -10V)	f_T	—	175	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A	$t_d + t_r$	—	180	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	250	—	
Fall Time		t_f	—	110	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

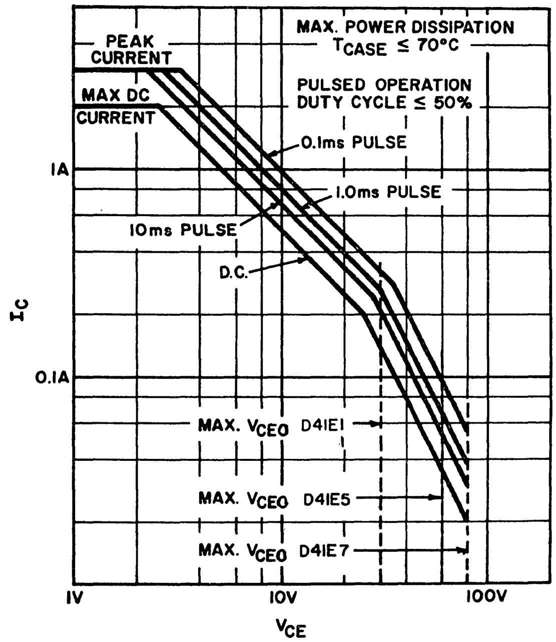


FIG. 1 SAFE REGION OF OPERATION

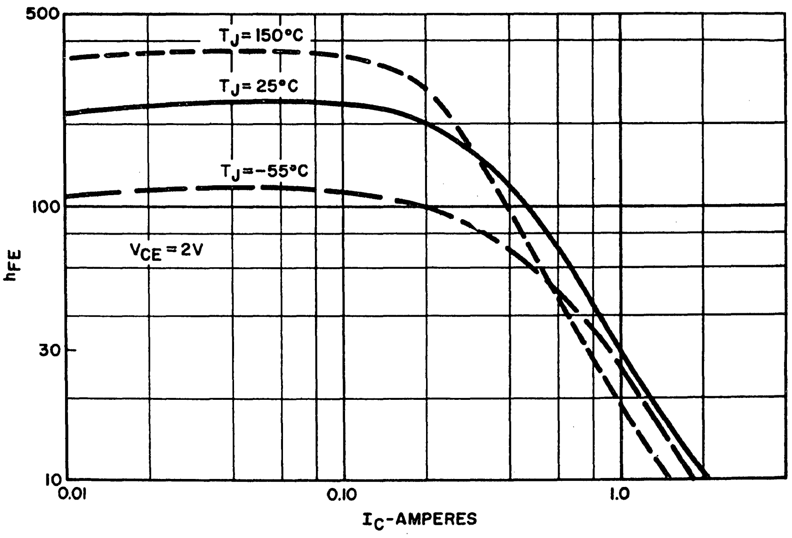


FIG. 2 TYPICAL H_{FE} VS I_C

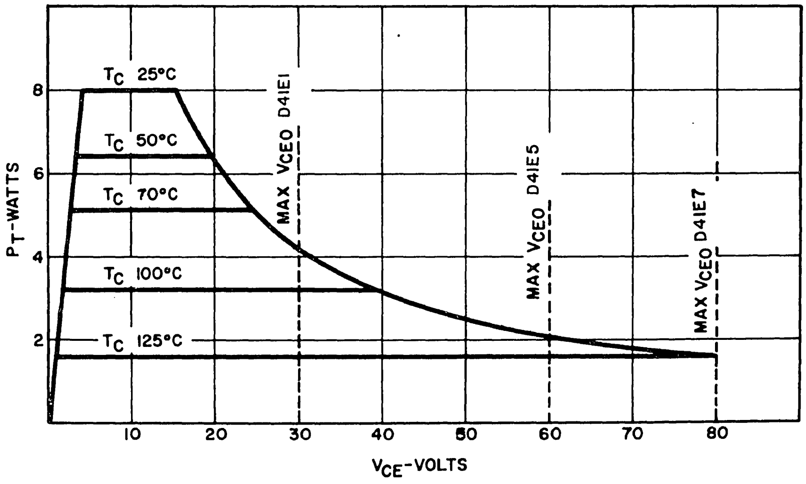


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

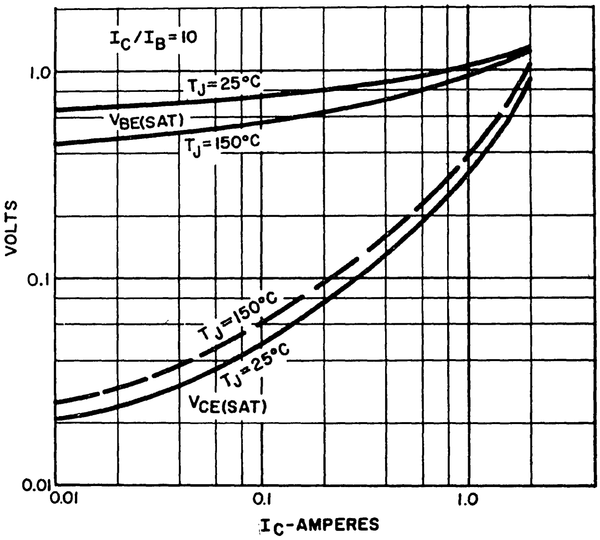


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

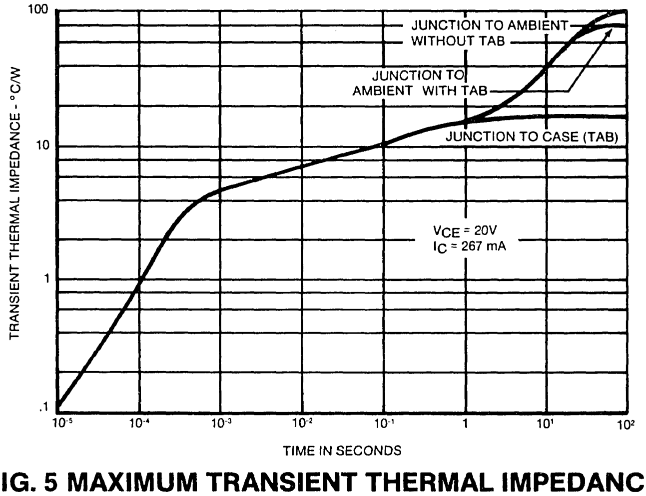


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

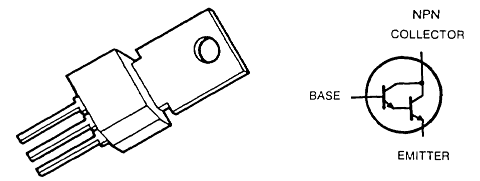
VERY HIGH GAIN
NPN POWER DARLINGTON TRANSISTORS
COMPLEMENTARY TO THE D41K SERIES

D40K Series

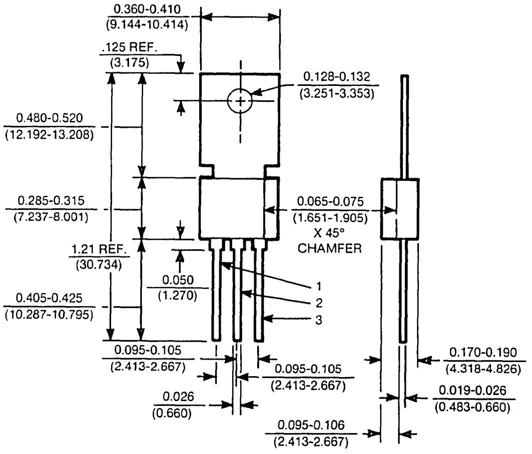
30-50 VOLTS
2 AMP, 10 WATTS

Applications:

- Driver
- Regulator
- Touch Switch
- I.C. Driver
- Capacitor Multiplier
- Audio Output
- Relay Substitute
- Oscillator
- Servo-Amplifier



CASE STYLE TO-202
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D40K1,3	D40K2,4	UNITS
Collector-Emitter Voltage	V_{CEO}	30	50	Volts
Collector-Emitter Voltage	V_{CES}	30	50	Volts
Emitter Base Voltage	V_{EBO}	13	13	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 3	2 3	A A
Base Current — Continuous	I_B	.2	.2	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.67 10	1.67 10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	12.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle $\leq 2\%$.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage D40K1,3 (I_C = 10mA) D40K2,4	V_{CEO}	30 50	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES})	I_{CES}	—	—	.5	μA
Emitter Cutoff Current (V_{EB} = 13V)	I_{EBO}	—	—	.1	μA

on characteristics

DC Current Gain (I_C = 200mA, V_{CE} = 5V)	h_{FE}	10K	—	—	—
(I_C = 1.5A, V_{CE} = 5V) D40K1,2 (I_C = 1A, V_{CE} = 5V) D40K3,4	h_{FE}	1K 1K	— —	— —	— —
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA) D40K1,2 (I_C = 1A, 1_B = 2mA) D40K3,4	$V_{CE(sat)}$	— —	— —	1.5 1.5	V V
Base-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA) D40K1,2 (I_C = 1A, I_B = 2mA) D40K3,4	$V_{BE(sat)}$	— —	— —	2.5 2.5	V

dynamic characteristics

Collector Capacitance (I_{CE} = 10V, f = 1MHz)	C_{CBO}	—	5	10	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 5V)	f_T	—	75	—	MHz

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

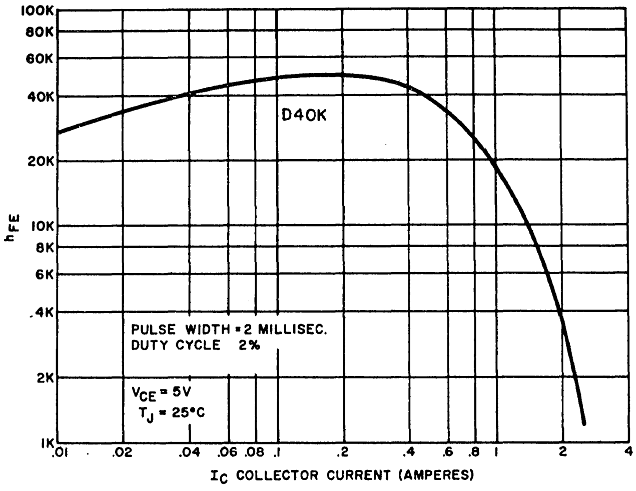


FIG. 1 TYPICAL h_{FE} vs. I_C

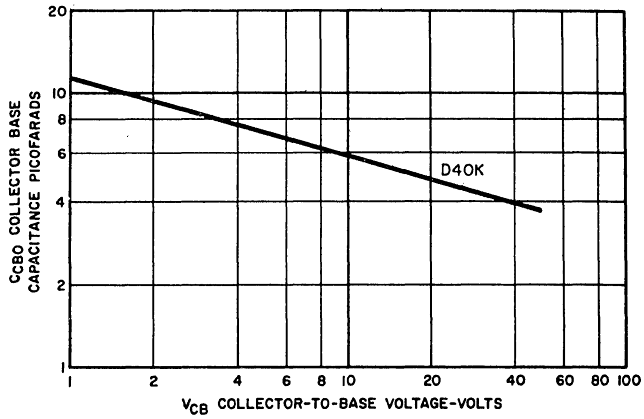
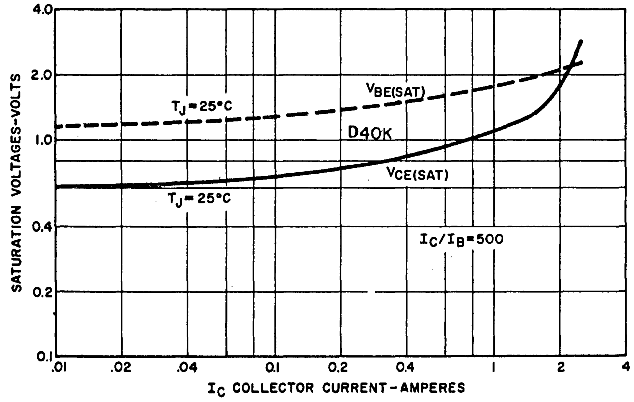


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

FIG. 3 TYPICAL SATURATION VOLTAGE



VERY HIGH GAIN
PNP POWER DARLINGTON TRANSISTORS

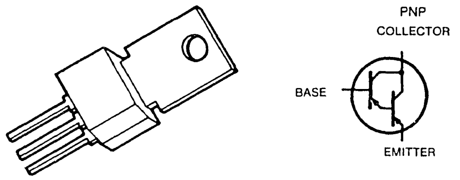
COMPLEMENTARY TO THE D40K SERIES

D41K Series

-30 - (-50) VOLTS
-2 AMP, 10 WATTS

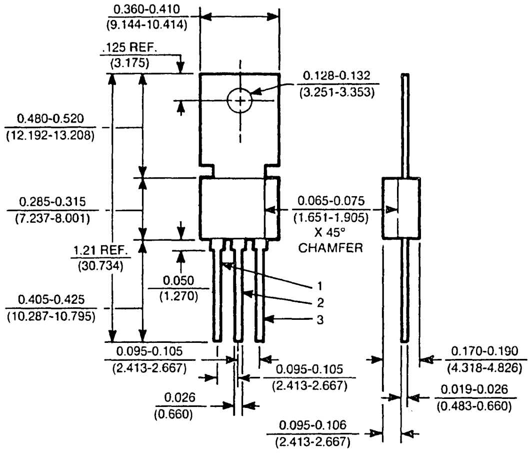
Applications:

- Driver
- Regulator
- Touch Switch
- I.C. Driver
- Capacitor Multiplier
- Audio Output
- Relay Substitute
- Oscillator
- Servo-Amplifier



CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D41K1,3	D41K2,4	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-50	Volts
Collector-Emitter Voltage	V_{CES}	-13	-13	Volts
Emitter Base Voltage	V_{EBO}	-30	-50	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-2 -3	-2 -3	A A
Base Current — Continuous	I_B	.2	.2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	-1.67 -10	-1.67 -10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	12.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
off characteristics(1)						
Collector-Emitter Voltage	D41K1,3	V_{CEO}	-30	—	—	Volts
I_C = 10mA)	D41K2,4		-50	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-.5	μA
Emitter Cutoff Current (V_{EB} = -13V)		I_{EBO}	—	—	-0.1	μA
on characteristics						
DC Current Gain (I_C = -200mA, V_{CE} = -5V)		h_{FE}	10K	—	—	—
(I_C = -1.5A, V_{CE} = -5V)	D41K1,2	h_{FE}	1K	—	—	—
(I_C = -1A, V_{CE} = -5V)	D41K3,4		1K	—	—	—
Collector-Emitter Saturation Voltage (I_C = -1.5A, I_B = -3mA)	D41K1,2	$V_{CE(sat)}$	—	—	1.5	Volts
(I_C = -1.0A, 1_B = -2mA)	D41K3,4		—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = -1.5A, I_B = -3mA)	D41K1,2	$V_{BE(sat)}$	—	—	2.5	Volts
(I_C = -1A, I_B = -2mA)	D41K3,4		—	—	2.5	
dynamic characteristics						
Collector Capacitance (V_{CE} = -10V, f = 1MHz)		C_{CBO}	—	9	15	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -5V)		f_T	—	100	—	MHz

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

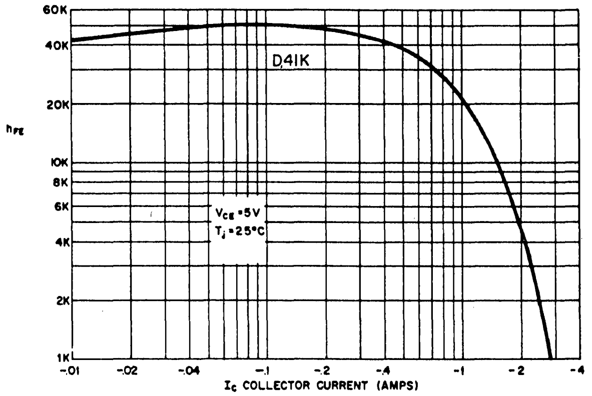


FIG. 1 TYPICAL h_{FE} vs. I_C

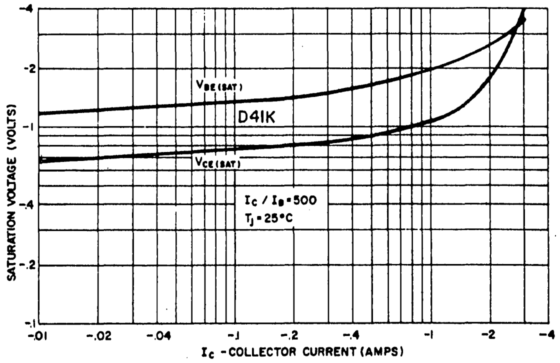


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

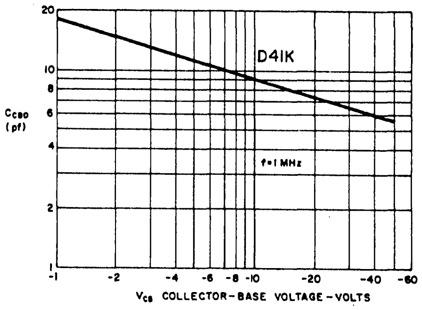


FIG. 3 TYPICAL SATURATION VOLTAGE

HIGH VOLTAGE VIDEO OUTPUT
NPN POWER TRANSISTORS

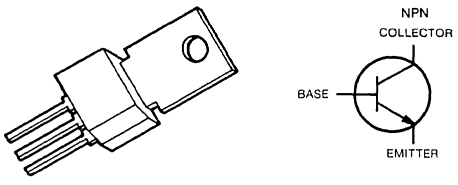
D40V Series

250-300 VOLTS
.1 AMP, 9 WATTS

The D40V is an encapsulated power transistor for TV video and color output stages. Other TV and general applications include: (1) Drive for the TV horizontal output transistor; (2) Audio output stage for portable TV sets; (3) High voltage transistor regulator; (4) Video display drivers for oscilloscopes, electroluminescent displays and calculators; and, (5) High voltage general usage.

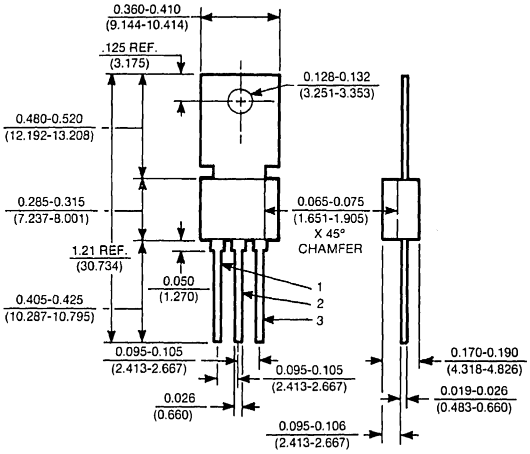
Features:

- Low C_{CB} (2.0 pF typical at V_{CB} = 20V)
- Excellent linearity



CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40V1,2	D40V3,4	D40V5,6	UNITS
Collector-Emitter Voltage	V_{CEO}	250	300	350	Volts
Collector-Emitter Voltage	V_{CES}	300	350	400	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous	I_C	.1	.1	.1	A
Base Current — Continuous	I_B	.1	.1	.1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	9 1.7	9 1.7	9 1.7	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	73.5	73.5	73.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	13.9	13.9	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics(1)					
Collector-Emitter Voltage (I_C = 5mA) D40V1,2 D40V3,4 D40V5,6	V_{CEO}	250 300 350	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = 300V) D40V1,2 (V_{CE} = 350V) D40V3,4 (V_{CE} = 400V) D40V5,6	I_{CES}	— — —	— — —	10 10 10	µA µA µA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	10	µA
second breakdown					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 6			
on characteristics(1)					
DC Current Gain					
(I_C = 5mA, V_{CE} = 10V) D40V1,3,5	h_{FE}	20	—	—	—
(I_C = 20mA, V_{CE} = 10V)		30	—	90	
(I_C = 40mA, V_{CE} = 10V)		20	—	—	
(I_C = 5mA, V_{CE} = 10V) D40V2,4,6	h_{FE}	30	—	—	
(I_C = 20mA, V_{CE} = 10V)		60	—	180	
(I_C = 40mA, V_{CE} = 10V)		30	—	—	
Collector-Emitter Saturation Voltage (I_C = 20mA, I_B = 2mA)	$V_{CE(sat)}$	—	—	1.0	V
dynamic characteristics					
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{CB}	—	2	3	pF
Current Gain Bandwidth Product (I_C = 100mA, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	50	—	—	MHz

(1) Pulse Test: Pulse Width - 300µs Duty Cycle ≤ 2%.

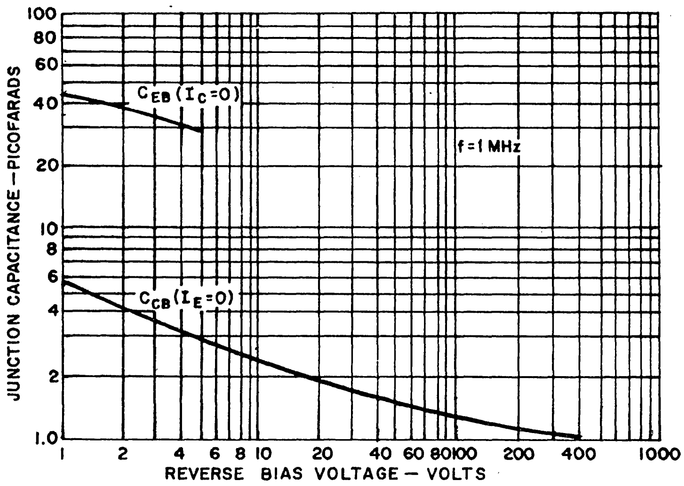


FIG. 1 JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

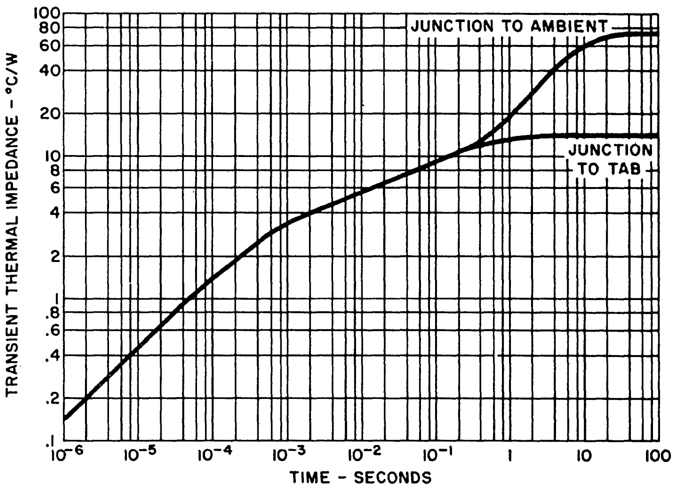


FIG. 2 MAXIMUM TRANSIENT THERMAL IMPEDANCE

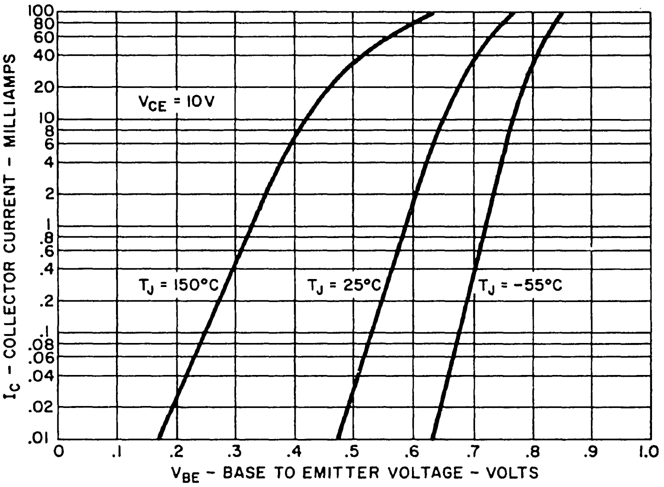


FIG. 3 TYPICAL TRANCONDUCTANCE CHARACTERISTICS

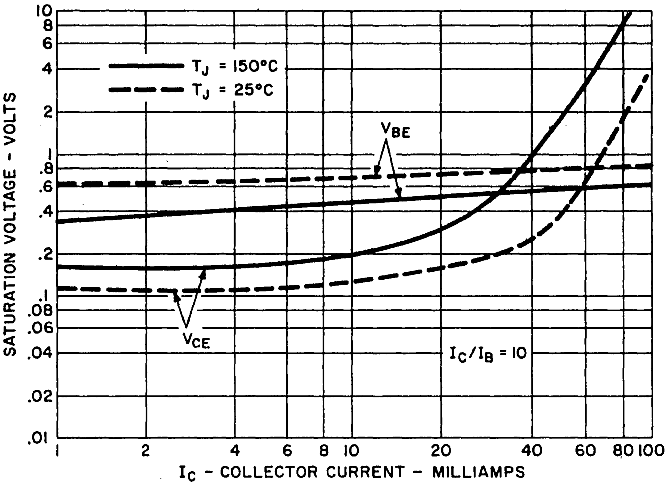


FIG. 4 TYPICAL SATURATION VOLTAGES

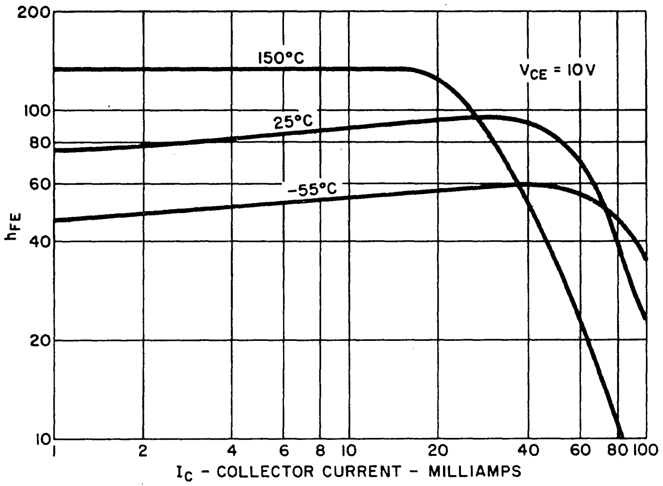


FIG. 5 TYPICAL h_{FE} VS. I_C

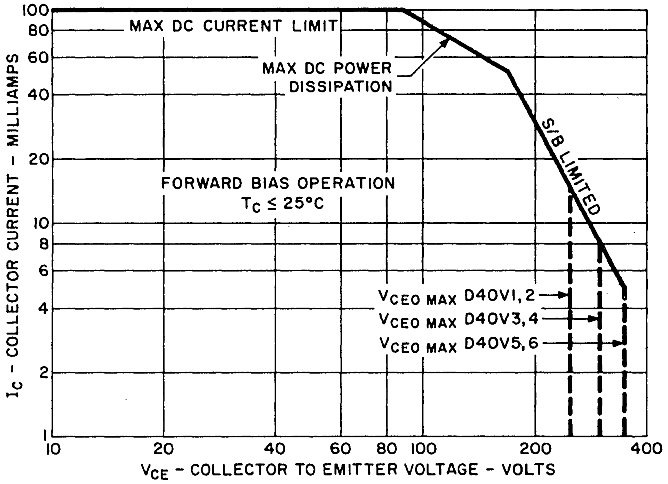


FIG. 6 SAFE REGION OF OPERATION

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE D43C SERIES

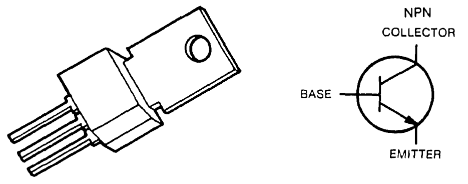
D42C Series

30-80 VOLTS
3 AMP, 12.5 WATTS

The General Electric D42C is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

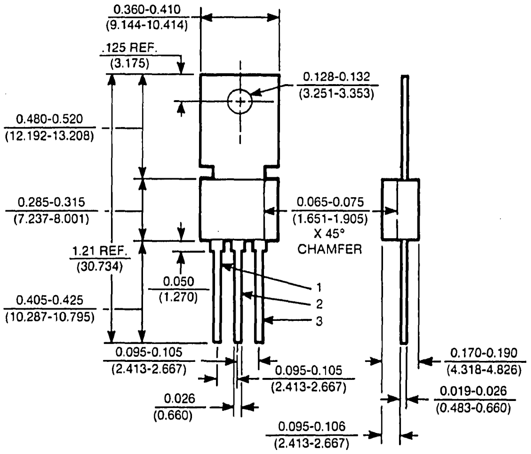
Features:

- High free-air power dissipation
- NPN complement to D43C PNP
- Low collector saturation voltage (0.5V typ. @ 3.0A I_C)
- Excellent linearity
- Fast Switching



CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	COLLECTOR	BASE	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D42C1, 2, 3	D42C4, 5, 6	D42C7, 8, 9	D42C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	80	Volts
Collector-Emitter Voltage	V_{CES}	40	55	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	3 5	3 5	3 5	3 5	A
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 12.5	2.1 12.5	2.1 12.5	2.1 12.5	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics⁽¹⁾

Collector-Emitter Sustaining Voltage (I_C = 100mA) D42C1, 2, 3	$V_{CEO(sus)}$	30	—	—	Volts
D42C4, 5, 6		45	—	—	
D42C7, 8, 9		60	—	—	
D42C10, 11, 12		80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})	I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	100	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURES 3 & 4

on characteristics⁽¹⁾

DC Current Gain (I_C = 200mA, V_{CE} = 1V) D42C1, 4, 7, 10	h_{FE}	25	—	—	—
D42C2, 5, 8, 11		100	—	220	
D42C3, 6, 9, 12		40	—	120	
(I_C = 1A, V_{CE} = 1V) D42C1, 4, 7, 10	h_{FE}	10	—	—	—
(I_C = 2A, V_{CE} = 1V) D42C2, 5, 8, 11		20	—	—	
D42C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 50mA) D42C2, 5, 8, 11	$V_{CE(sat)}$	—	—	0.5	Volts
D42C3, 6, 9, 12		—	—	0.5	
(I_C = 1A, I_B = 100mA) D42C1, 4, 7, 10	$V_{CE(sat)}$	—	—	0.5	Volts
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 100mA)	$V_{BE(sat)}$	—	—	1.3	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	—	—	100	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 4V)	f_T	—	50	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A,	$t_d + t_r$	—	100	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

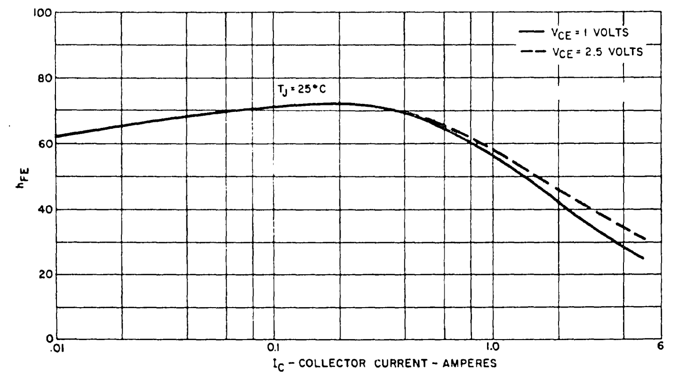


FIG. 1 TYPICAL h_{FE} VS. I_C

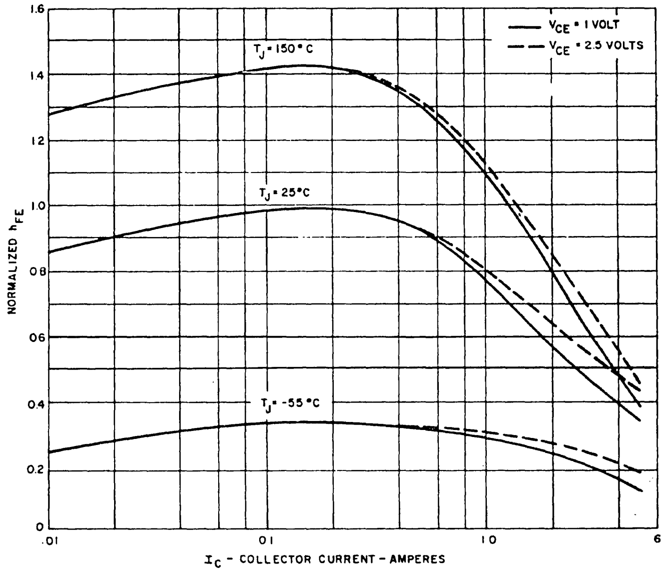


FIG. 2 TYPICAL NORMALIZED h_{FE} VS. I_C

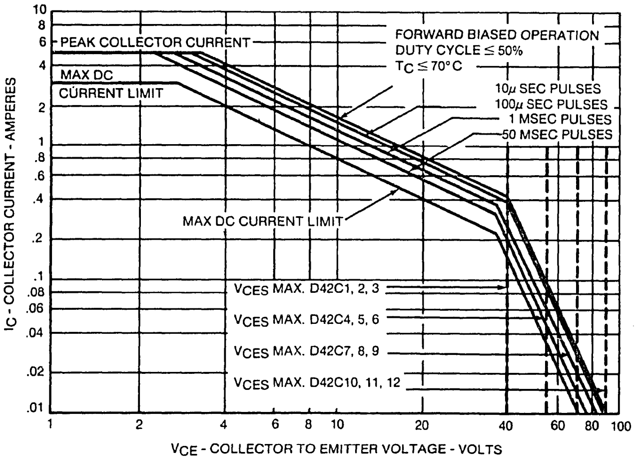


FIG. 3 SAFE REGION OF OPERATION

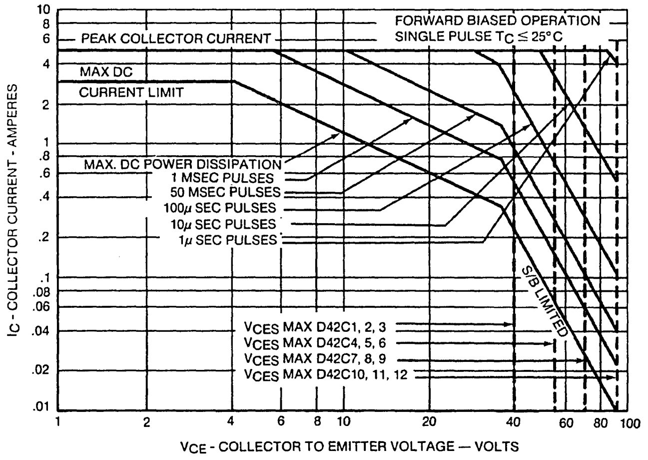


FIG. 4 SAFE REGION OF OPERATION

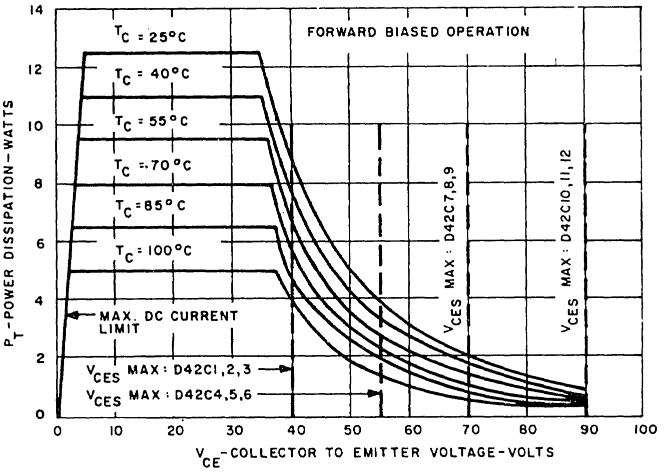


FIG. 5 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

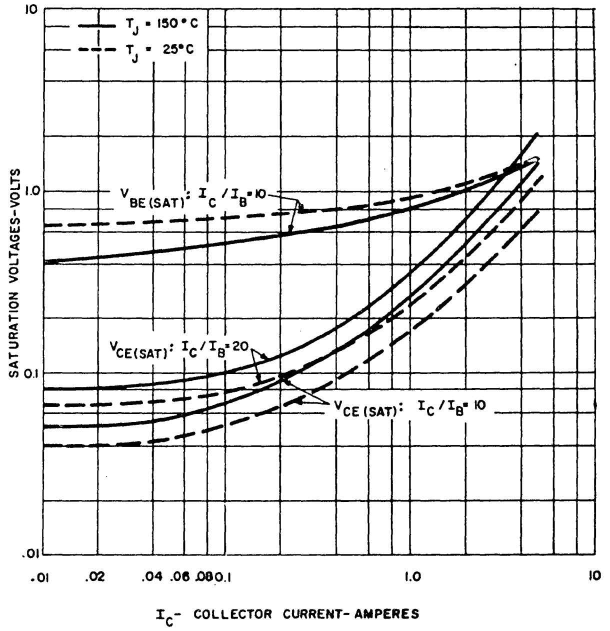


FIG. 6 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

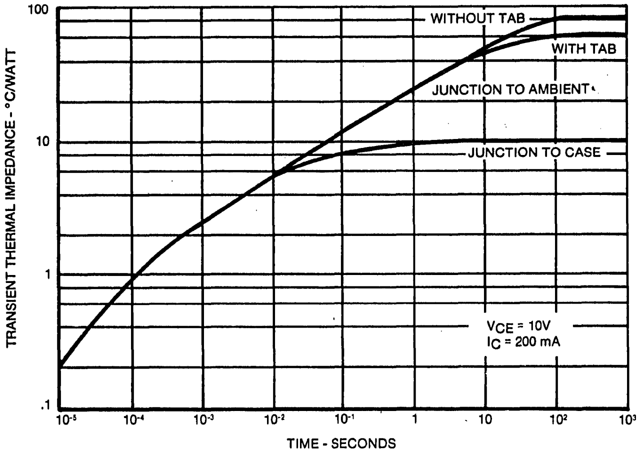


FIG. 7 MAXIMUM TRANSIENT THERMAL IMPEDANCE

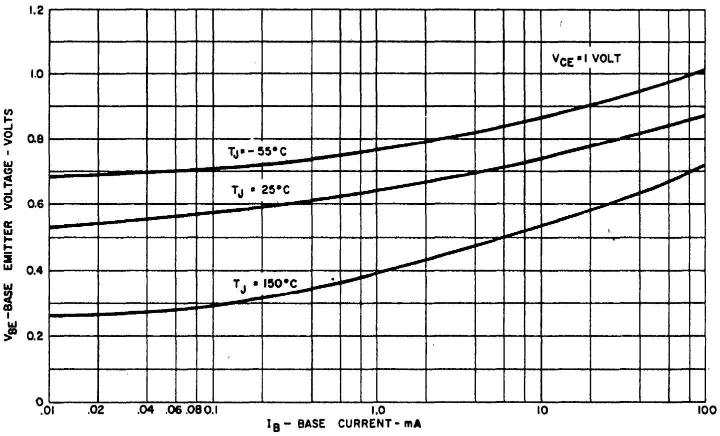


FIG. 8 TYPICAL INPUT CHARACTERISTICS

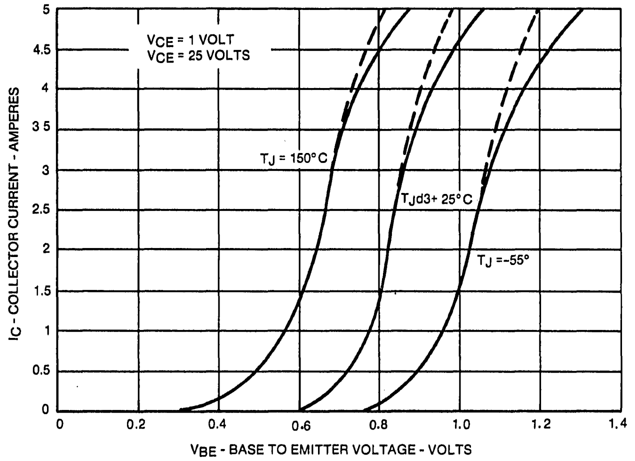


FIG. 9

TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

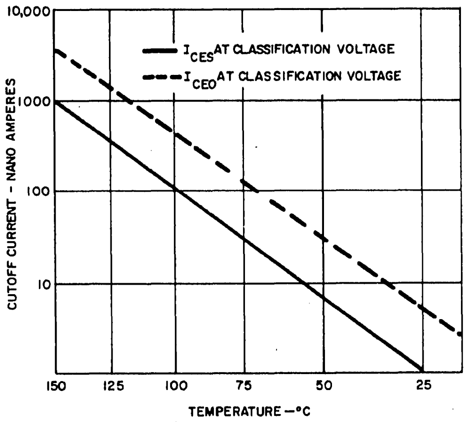


FIG. 10

TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE D42C SERIES

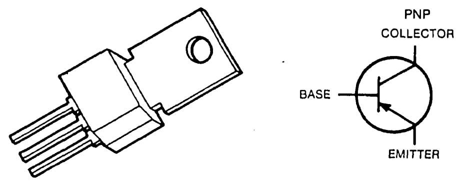
D43C Series

-30 - -80 VOLTS
-3 AMP, 12.5 WATTS

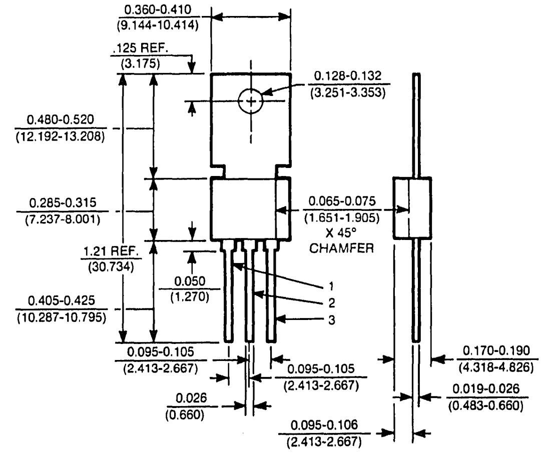
The General Electric D43C is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

Features:

- High free-air power dissipation
- PNP complement to D42C NPN
- Low collector saturation voltage (0.5V typ. @ 3.0A I_C)
- Excellent linearity
- Fast Switching



CASE STYLE TO-202
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	COLLECTOR	BASE	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D43C1, 2, 3	D43C4, 5, 6	D43C7, 8, 9	D43C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-40	-55	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-3 -5	-3 -5	-3 -5	-3 -5	A
Base Current — Continuous	I_B	-2	-2	-2	-2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 12.5	2.1 12.5	2.1 12.5	2.1 12.5	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 100mA) D43C1, 2, 3	$V_{CEO(sus)}$	-30	—	—	Volts
D43C4, 5, 6		-45	—	—	
D43C7, 8, 9		-60	—	—	
D43C10, 11, 12		-80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})	I_{CES}	—	—	-10	µA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	-100	µA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3			

on characteristics

DC Current Gain (I_C = -200mA, V_{CE} = -1V) D43C1, 4, 7, 10	h_{FE}	25	—	—	—
D43C2, 5, 8, 11		40	—	120	
D43C3, 6, 9, 12		40	—	120	
(I_C = -1A, V_{CE} = -1V) D43C1, 4, 7, 10	h_{FE}	10	—	—	—
D43C2, 5, 8, 11		20	—	—	
(I_C = -2A, V_{CE} = -1V) D43C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -50mA) D43C2, 5, 8, 11	$V_{CE(sat)}$	—	—	-0.5	Volts
D43C3, 6, 9, 12		—	—	-0.5	
(I_C = -1A, I_B = -100mA) D43C1, 4, 7, 10	$V_{CE(sat)}$	—	—	-0.5	Volts
Base-Emitter Saturation Voltage (I_C = -1A, I_B = -100mA)	$V_{BE(sat)}$	—	—	-1.3	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = -10V, f = 1M_{Hz})	C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -4V)	f_T	—	40	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A V_{CC} = 30V, t_p = 25 µsec	$t_d + t_r$	—	50	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

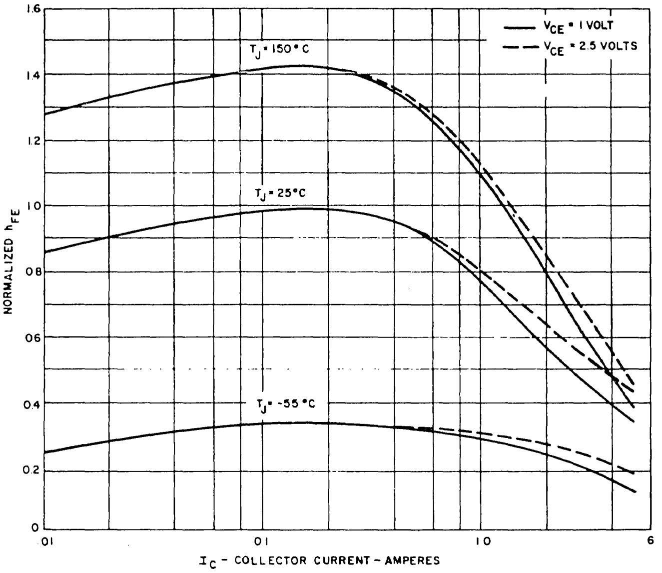


FIG. 1 TYPICAL NORMALIZED h_{FE} VS. I_C

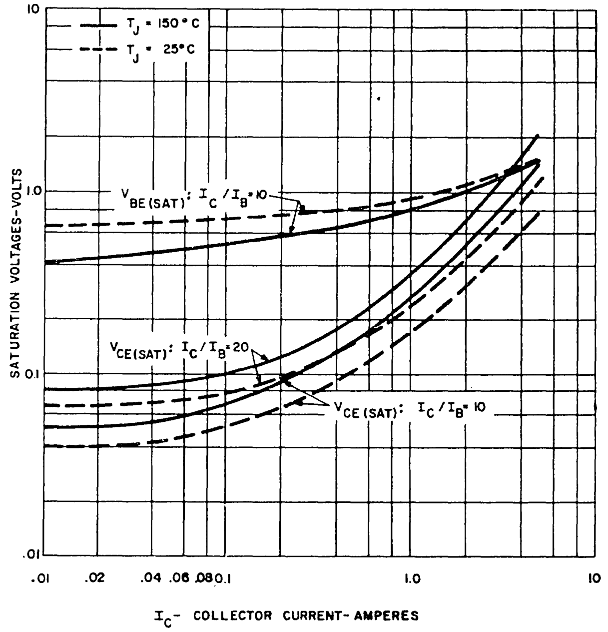


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

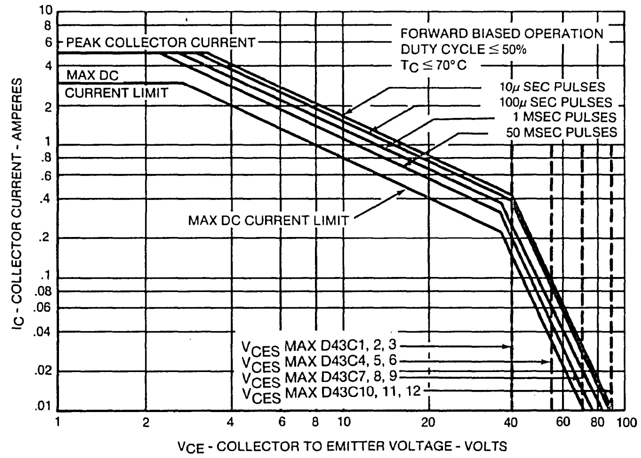


FIG. 3 SAFE REGION OF OPERATION

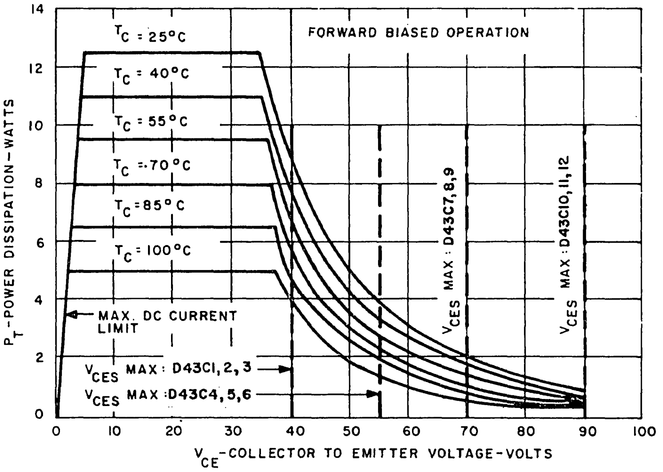


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

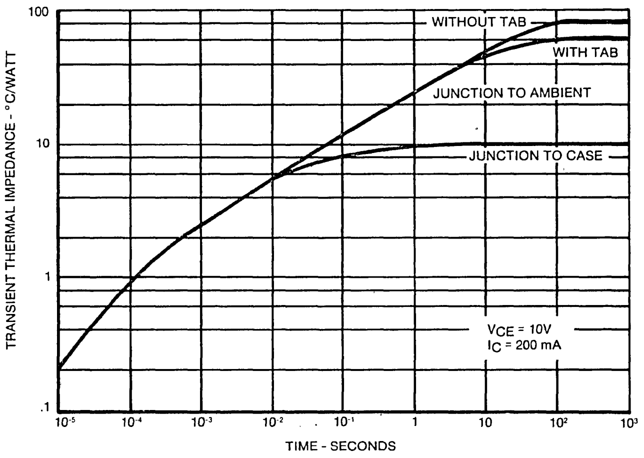


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE D45C SERIES

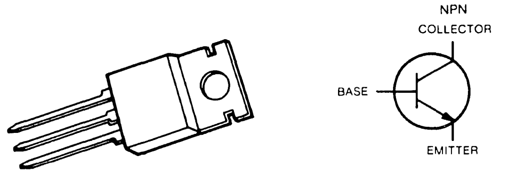
D44C Series

30-80 VOLTS
4 AMP, 30 WATTS

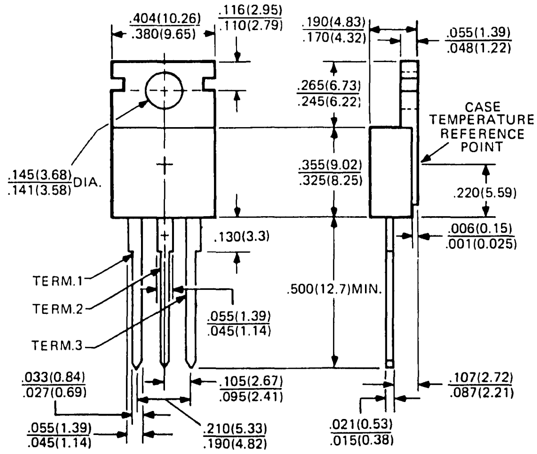
The General Electric D44C is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

Features:

- NPN complement to D45C PNP
- Very Low collector saturation voltage (0.5V typ. @ 3.0A I_c)
- Excellent linearity
- Fast switching



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44C1, 2, 3	D44C4, 5, 6	D44C7, 8, 9	D44C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	80	Volts
Collector-Emitter Voltage	V_{CES}	40	55	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	4 6	4 6	4 6	4 6	A
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 30	1.67 30	1.67 30	1.67 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 100mA)	D44C1, 2, 3	$V_{CEO(sus)}$	30	—	—	Volts
	D44C4, 5, 6		45	—	—	
	D44C7, 8, 9		60	—	—	
	D44C10, 11, 12		80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3

on characteristics(1)

DC Current Gain (I_C = 0.2A, V_{CE} = 1V)	D44C1, 4, 7, 10	h_{FE}	25	—	—	—
	D44C2, 5, 8, 11		100	—	220	
	D44C3, 6, 9, 12		40	—	120	
(I_C = 1A, V_{CE} = 1V)	D44C1, 4, 7, 10	h_{FE}	10	—	—	—
(I_C = 2A, V_{CE} = 1V)	D44C2, 5, 8, 11		20	—	—	
	D44C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 50mA)	D44C2, 5, 8, 11	$V_{CE(sat)}$	—	—	0.5	Volts
	D44C3, 6, 9, 12		—	—	0.5	
(I_C = 1A, I_B = 100mA)	D44C1, 4, 7, 10		—	—	0.5	
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 100mA)		$V_{BE(sat)}$	—	—	1.3	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = 10V, f = 1M_{Hz})	C_{CBO}	—	—	100	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 4V)	f_T	—	50	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A, V_{CC} = 30A, t_p = 25 μsec	$t_d + t_r$	—	100	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

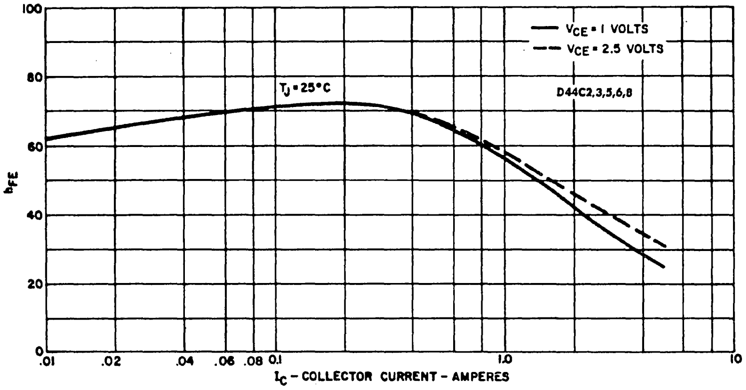


FIG. 1 TYPICAL h_{FE} VS. I_C

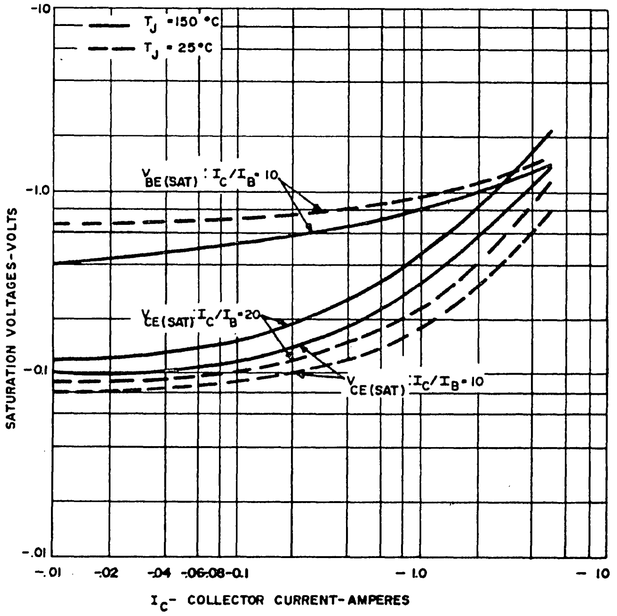


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

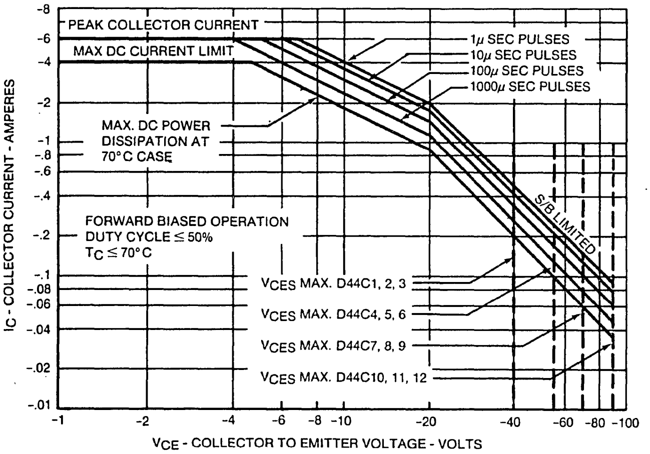


FIG. 3 SAFE REGION OF OPERATION

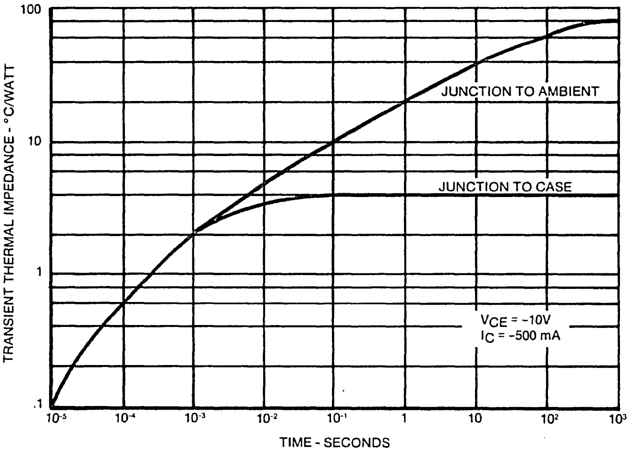


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE D44C SERIES

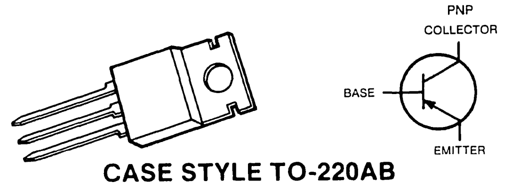
D45C Series

-30 - -80 VOLTS
-4 AMP, 30 WATTS

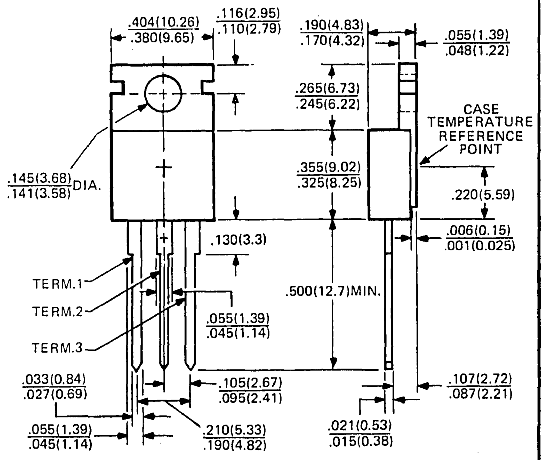
The General Electric D45C is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

Features:

- PNP complement to D44C NPN
- Very Low collector saturation voltage (−0.5V typ. @ −3.0A I_C)
- Excellent linearity
- Fast Switching



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45C1, 2, 3	D45C4, 5, 6	D45C7, 8, 9	D45C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-40	-55	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-4 -6	-4 -6	-4 -6	-4 -6	A
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 30	1.67 30	1.67 30	1.67 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = -100mA)	D45C1, 2, 3	$V_{CEO(sus)}$	-30	—	—	Volts
	D45C4, 5, 6		-45	—	—	
	D45C7, 8, 9		-60	—	—	
	D45C10, 11, 12		-80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	-100	μA

second breakdown

Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 3			

on characteristics(1)

DC Current Gain (I_C = -0.2A, V_{CE} = -1V)	D45C1, 4, 7, 10	h_{FE}	25	—	—	—
	D45C2, 5, 8, 11		40	—	120	
	D45C3, 6, 9, 12		40	—	120	
(I_C = -1A, V_{CE} = -1V)	D45C1, 4, 7, 10	h_{FE}	10	—	—	—
	D45C2, 5, 8, 11		20	—	—	
(I_C = -2A, V_{CE} = -1V)	D45C3, 6, 9, 12	h_{FE}	20	—	—	
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -50mA)	D45C2, 5, 8, 11	$V_{CE(sat)}$	—	—	-0.5	Volts
	D45C3, 6, 9, 12		—	—	-0.5	
(I_C = -1A, I_B = -100mA)	D43C1, 4, 7, 10		—	—	-0.5	
Base-Emitter Saturation Voltage (I_C = -1A, I_B = -100mA)		$V_{BE(sat)}$	—	—	-1.3	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = -10V, f = 1M_{Hz})		C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -4V)		f_T	—	40	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A, V_{CC} = -1A, t_p = 25 μsec	$t_d + t_r$	—	50	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

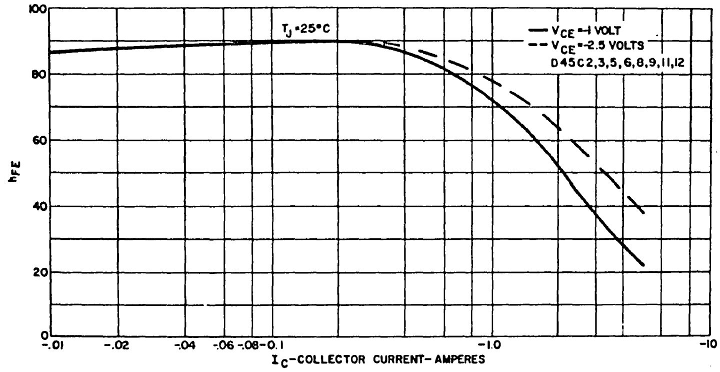


FIG. 1 TYPICAL h_{FE} VS. I_C

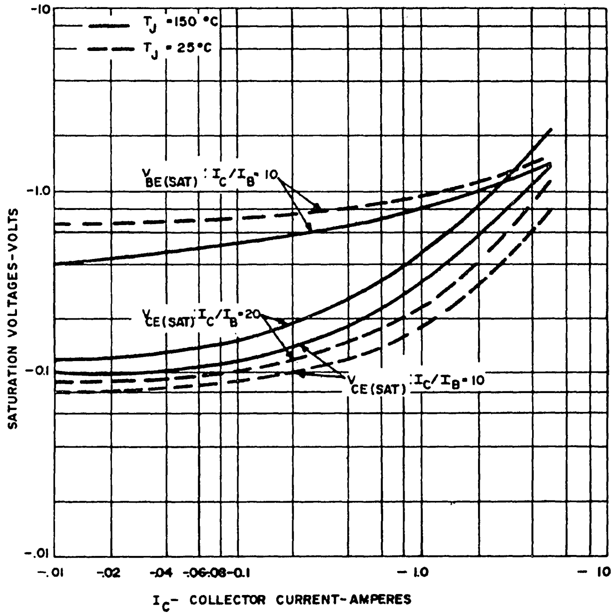


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

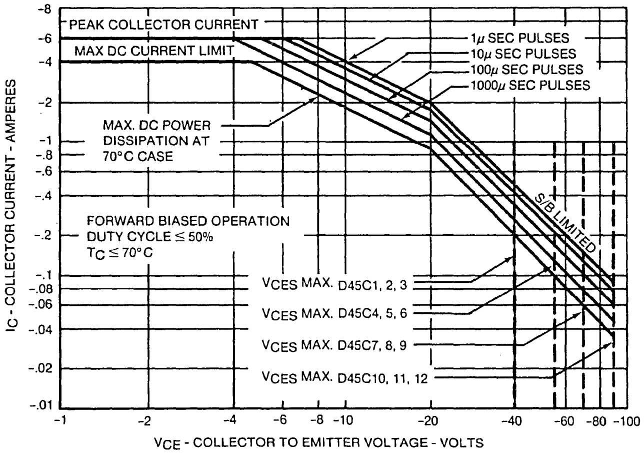


FIG. 3 SAFE REGION OF OPERATION

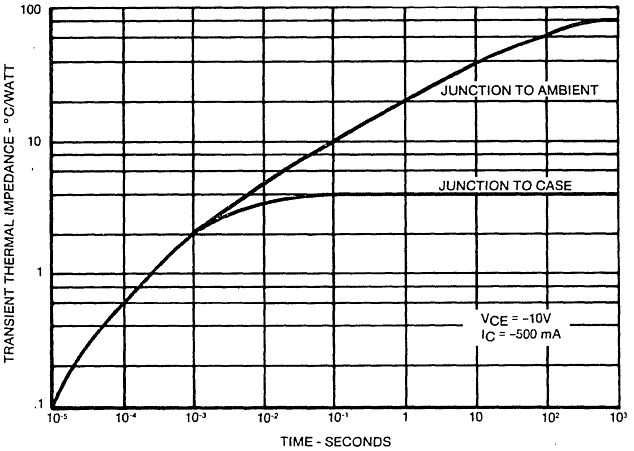


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

VERY HIGH GAIN

NPN POWER DARLINGTON TRANSISTORS

COMPLEMENTARY TO THE D45D SERIES

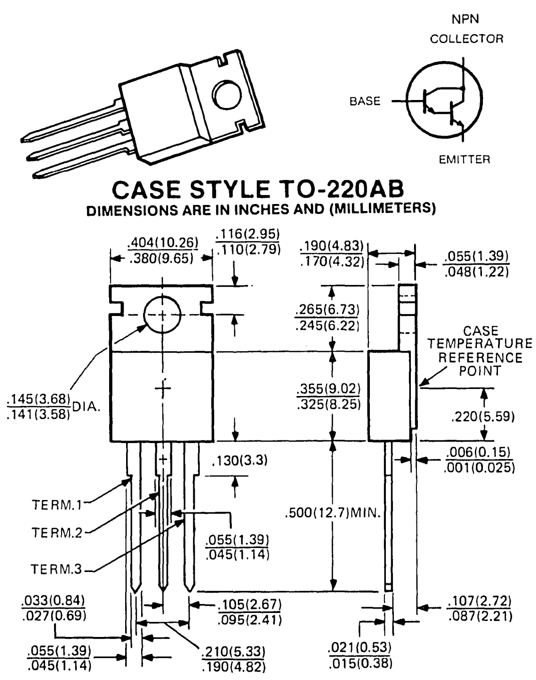
D44D Series

40-80 VOLTS
6 AMP, 30 WATTS

The General Electric D44D is a Darlington power transistor. It is designed for general purpose switching of multi-ampere loads directly from low level logic circuitry. A monolithic bias resistor is included for elevated temperature stability and bypass diode for reduced dissipation under negative transient conditions.

Applications:

- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator
- Inverter/Converter



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D44D1,2	D44D3,4	D44D5,6	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	Volts
Collector-Emitter Voltage	V_{CES}	50	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous	I_C	6	6	6	A
Base Current — Continuous	I_B	.5	.5	.5	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	2.1 30	2.1 30	2.1 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Breakdown Voltage I_C = 50mA)	D44D1,2	$V_{CEO(BR)}$	40	—	—	Volts
	D44D3,4		60	—	—	
	D44D5,6		80	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})	T_C = 25°C	I_{CES}	—	—	10	μA
(V_{CE} = Rated V_{CES}, V_{BE} = 0.4V)	T_C = 125°C	I_{CEV}	—	—	5	
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	10	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5	

on characteristics

DC Current Gain (I_C = 1A, V_{CE} = 2V)		h_{FE}	2,000	5,000	—	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 3mA)		$V_{CE(sat)}$	—	—	1.5	V
(I_C = 5A, 1_B = 5mA)	D44D2,4,6 only		—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 5mA)		$V_{BE(sat)}$	—	—	2.5	Volts

dynamic characteristics

Collector Capacitance (V_{CE} = 10V, f = 1MHz)		C_{CBO}	—	—	45	pF

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 3A, I_{B1} = I_{B2} = 3mA	$t_d + t_r$	—	0.5	—	μS
Storage Time	V_{CC} = 40V, t_p = 25 μsec	t_s	—	1.2	—	
Fall Time		t_f	—	0.8	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

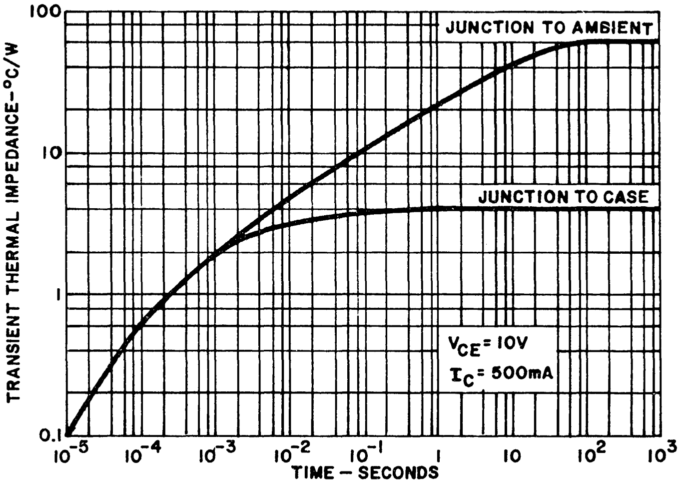


FIG. 1
MAXIMUM TRANSIENT THERMAL IMPEDANCE

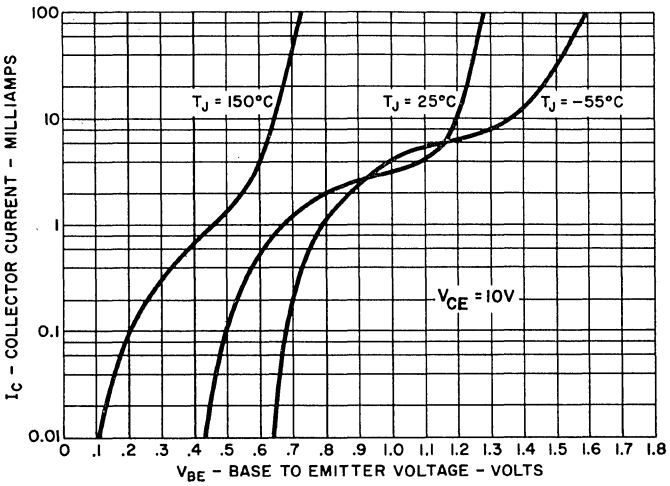


FIG. 2
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

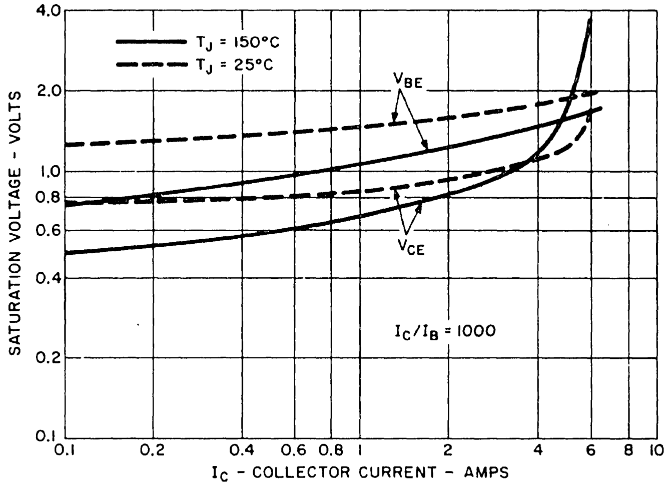


FIG. 3
TYPICAL SATURATION VOLTAGE CHARACTERISTICS

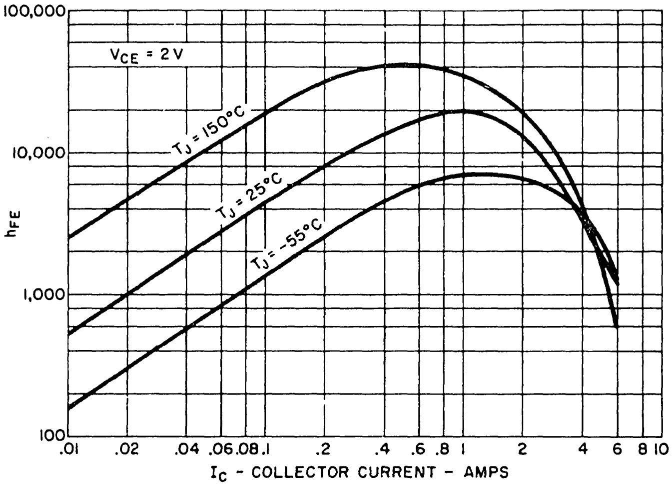


FIG. 4 TYPICAL h_{FE} VS. I_C

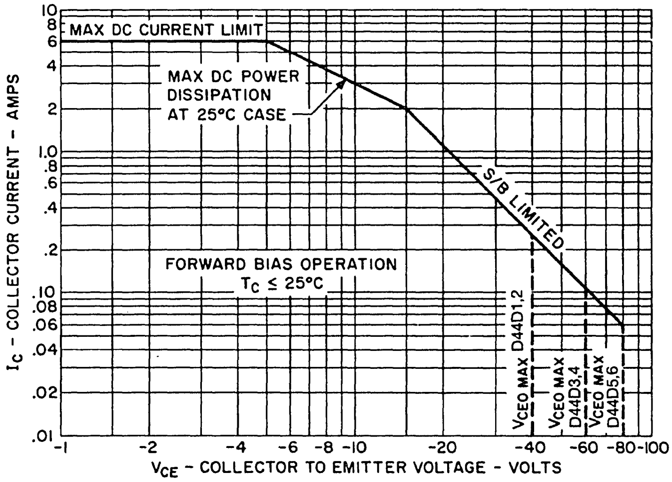


FIG. 5 SAFE REGION OF OPERATION

VERY HIGH GAIN
PNP POWER DARLINGTON TRANSISTORS
COMPLEMENTARY TO THE D44D SERIES

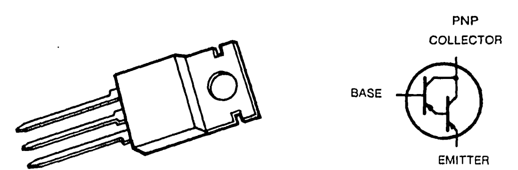
D45D Series

-40 - (-80) VOLTS
-6 AMP, 30 WATTS

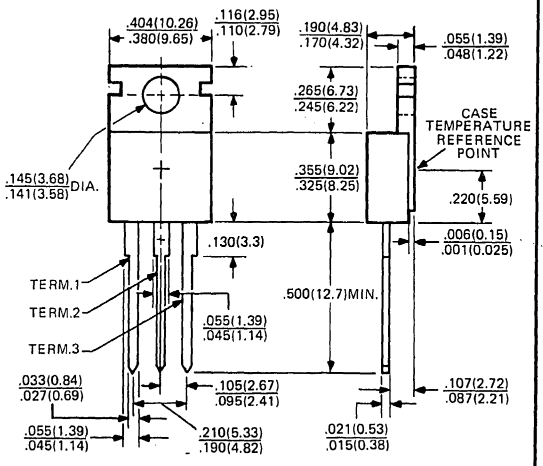
The General Electric D45D is a Darlington power transistor. It is designed for general purpose switching of multi-ampere loads directly from low level logic circuitry. A monolithic bias resistor is included for elevated temperature stability and bypass diode for reduced dissipation under reverse transient conditions.

Applications:

- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator
- Inverter/Converter



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45D1,2	D45D3,4	D45D5,6	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-50	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous	I_C	6	6	6	A
Base Current — Continuous	I_B	.5	.5	.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 30	2.1 30	2.1 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Breakdown Voltage I_C = -50mA)	D45D1,2 D45D3,4 D45D5,6	$V_{CEO(BR)}$	-40 -60 -80	— — —	— — —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES}) (V_{CE} = Rated V_{CES}, V_{BE} = -0.4V)	T_C = 25°C T_C = 125°C	I_{CES} I_{CEV}	— —	— —	-10 -5	µA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-10	µA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5

on characteristics

DC Current Gain (I_C = -1A, V_{CE} = -2V)		h_{FE}	2,000	5,000	—	—
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -3mA) (I_C = -5A, 1_B = -5mA)	 D45D2,4,6 only	$V_{CE(sat)}$	— —	— —	-1.5 -2.0	V V
Base-Emitter Saturation Voltage (I_C = -5A, I_B = -5mA)		$V_{BE(sat)}$	—	—	-2.5	Volts

dynamic characteristics

Collector Capacitance (V_{CE} = 10V, f = 1MHz)	C_{CBO}	—	—	-75	pF

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = -3A, I_{B1} = I_{B2} = -3mA	$t_d + t_r$	—	0.35	—	µs
Storage Time	V_{CC} = 40V, t_p = 25 µsec	t_s	—	0.4	—	
Fall Time		t_f	—	0.3	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

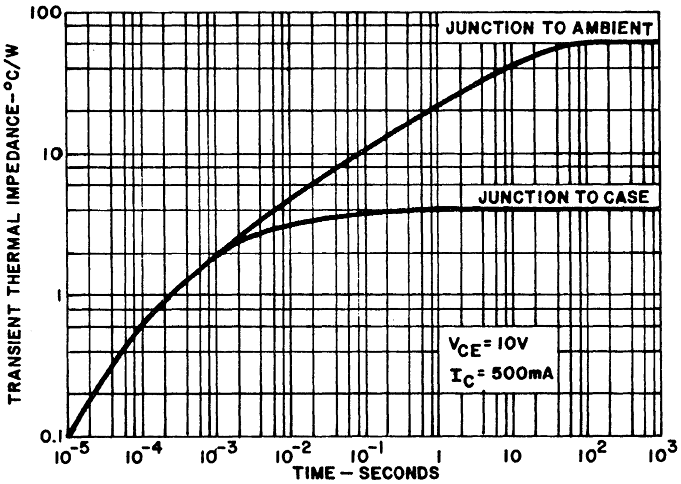


FIG. 1
MAXIMUM TRANSIENT THERMAL IMPEDANCE

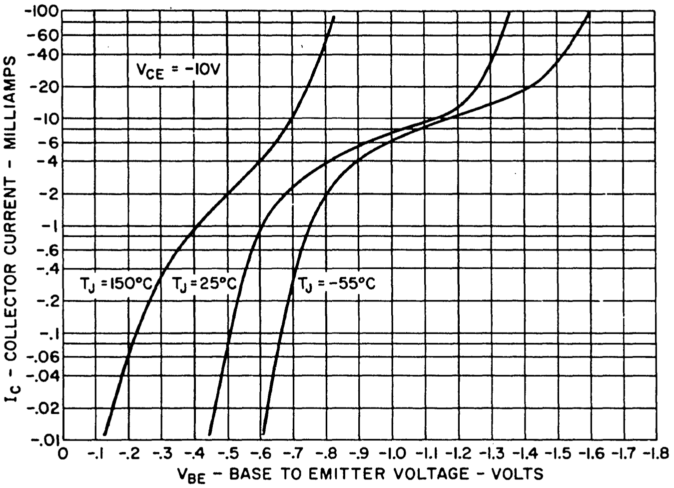


FIG. 2
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

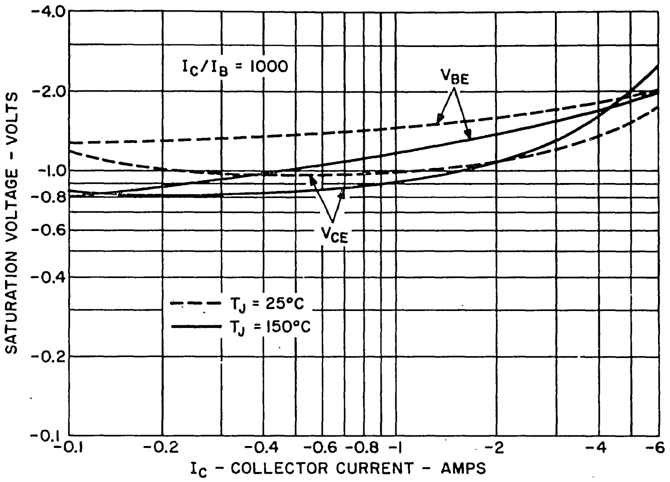


FIG. 3

TYPICAL SATURATION VOLTAGE CHARACTERISTICS

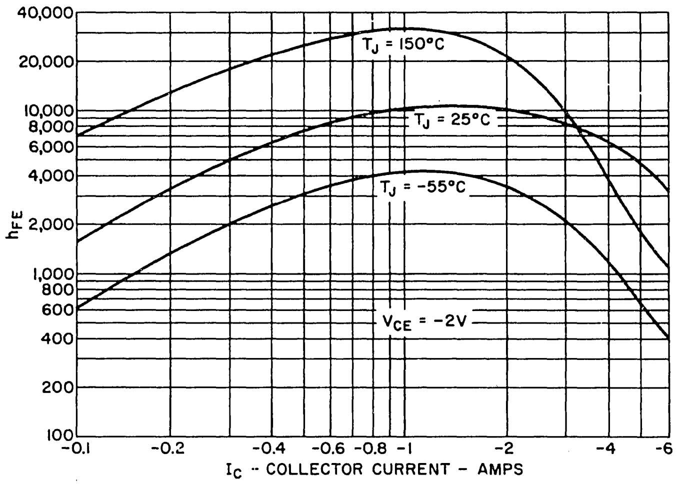


FIG. 4 TYPICAL h_{FE} VS. I_C

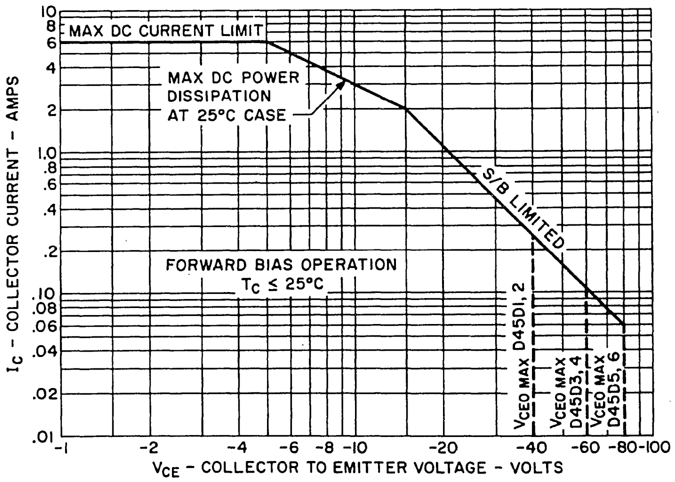


FIG. 5 SAFE REGION OF OPERATION

VERY HIGH GAIN

NPN POWER DARLINGTON TRANSISTORS

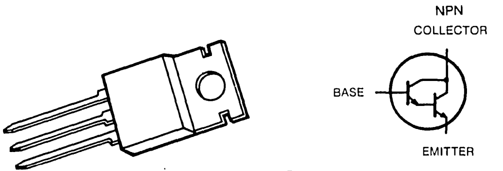
COMPLEMENTARY TO THE D45E SERIES

D44E Series

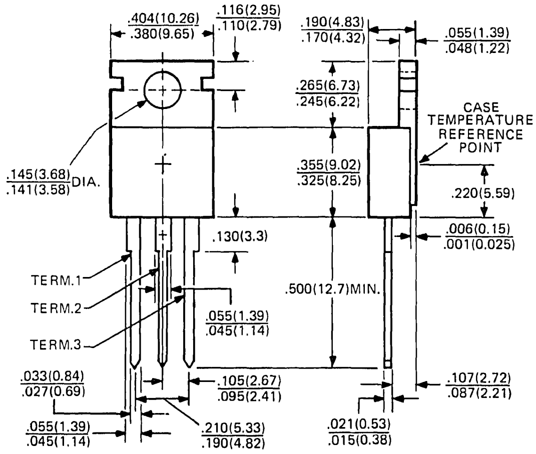
40-80 VOLTS
10 AMP, 50 WATTS

Applications:

- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator
- Inverter/Converter



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44E1	D44E2	D44E3	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	Volts
Collector-Emitter Voltage	V_{CES}	40	60	80	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	10 20	10 20	10 20	A
Base Current — Continuous	I_B	1	1	1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Voltage (I_C = 100mA)	D44E1 D44E2 D44E3	V_{CEO}	40 60 80	— — —	— — —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 7V)		I_{EBO}	—	—	1.0	μA

second breakdown

CHARACTERISTIC	SYMBOL	
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 6

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 5A, V_{CE} = 5V)	h_{FE}	1,000	—	—	—
Collector-Emitter Saturation Voltage (I_C = 5.0A, I_B = 10mA) (I_C = 10.0A, 1_B = 20mA)	$V_{CE(sat)}$	— —	— —	1.5 2.0	V V
Base-Emitter Saturation Voltage (I_C = 5.0A, I_B = 10mA)	$V_{BE(sat)}$	—	—	2.5	Volts

dynamic characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector Capacitance (V_{CE} = 10V, f = 1MHz)	C_{CBO}	—	—	130	pF

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time + Rise Time	I_C = 10A, I_{B1} = I_{B2} = 20mA V_{CC} = 40V, t_p = 25 μsec	$t_d + t_r$	—	0.6	—	μS
Storage Time		t_s	—	2.0	—	
Fall Time		t_f	—	0.5	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

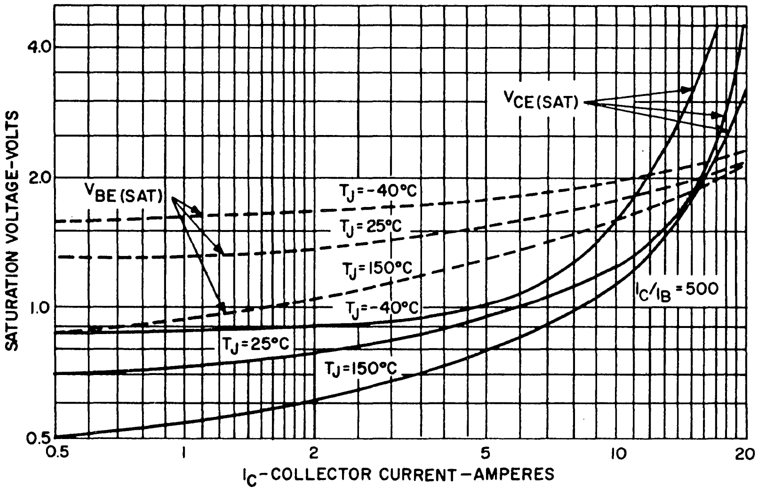


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

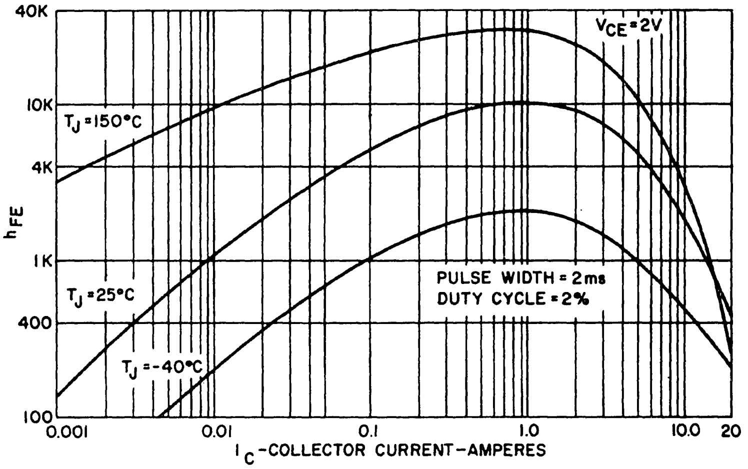


FIG. 2 TYPICAL GAIN CHARACTERISTIC

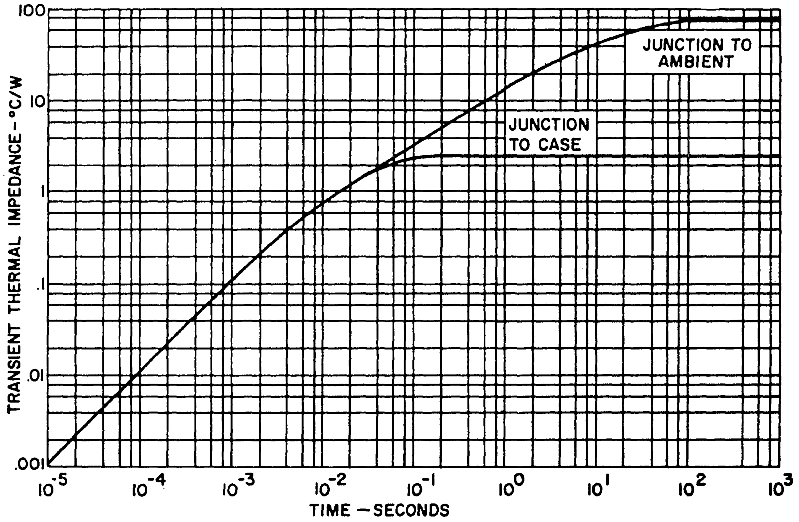


FIG. 3 TRANSIENT THERMAL IMPEDANCE

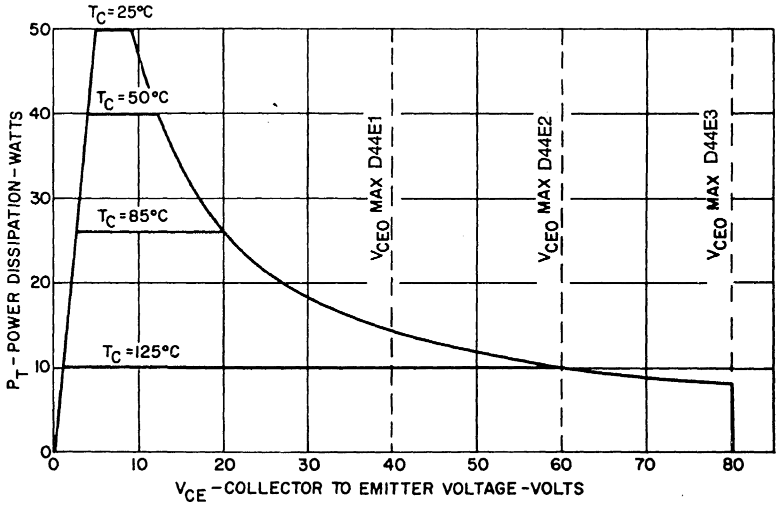


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

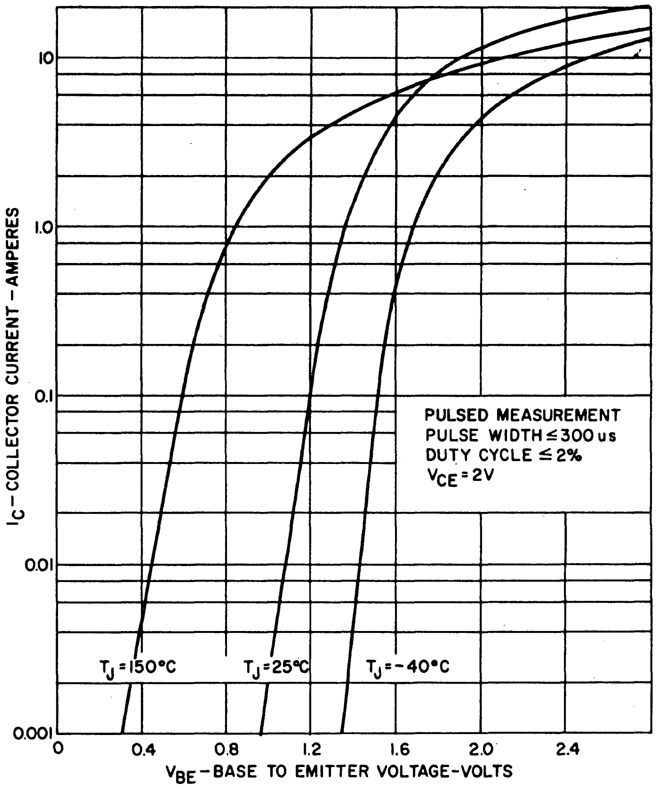


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

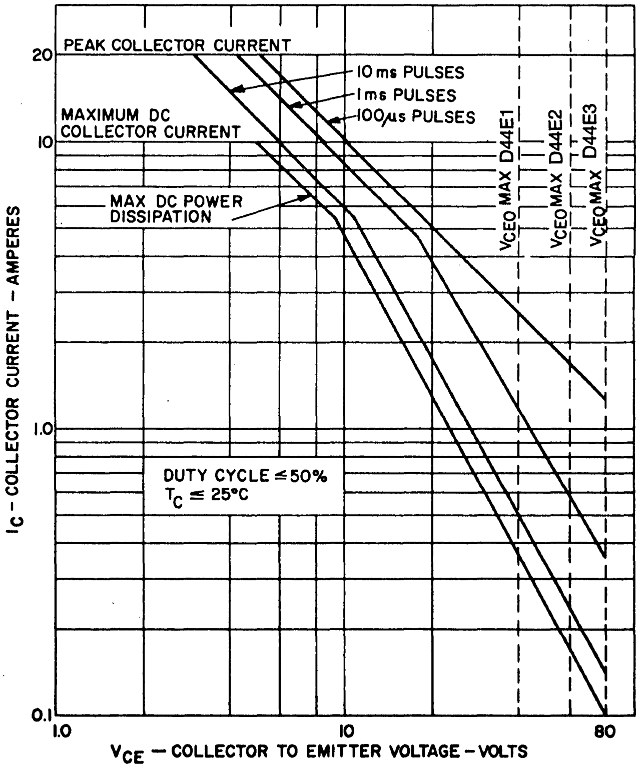


FIG. 6 SAFE REGION OF OPERATION

VERY HIGH GAIN

PNP POWER DARLINGTON TRANSISTORS

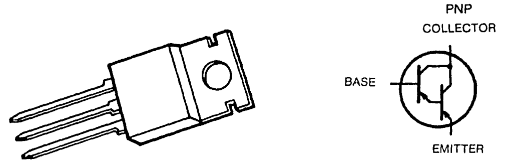
COMPLEMENTARY TO THE D44E SERIES

D45E Series

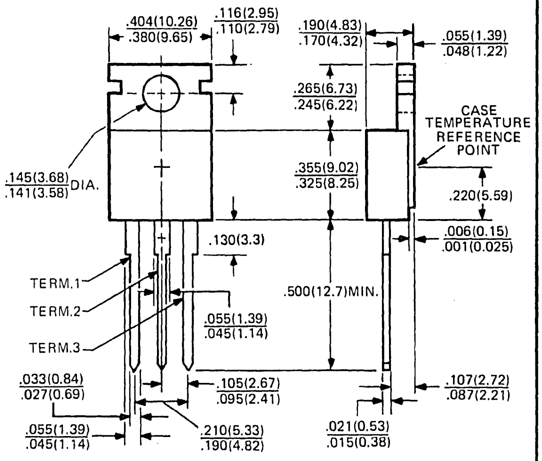
-40 - (-80) VOLTS
-10 AMP, 50 WATTS

Applications:

- Driver
- Regulator
- Capacitor Multiplier
- Solenoid Driver
- Inverter Power Supply
- Switch
- Audio Output
- Relay Substitute
- Oscillator
- Servo-Amplifier



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	D45E1	D45E2	D45E3	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-40	-60	-80	Volts
Emitter Base Voltage	V_{EBO}	-7	-7	-7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-10 -20	-10 -20	-10 -20	A
Base Current — Continuous	I_B	-1	-1	-1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage (I_C = -100mA)	D45E1	V_{CEO}	-40	—	—	Volts
	D45E2		-60	—	—	
	D45E3		-80	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = -7V)		I_{EBO}	—	—	-1.0	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 6

on characteristics

DC Current Gain (I_C = -5A, V_{CE} = -5V)	h_{FE}	1,000	—	—	—
Collector-Emitter Saturation Voltage (I_C = -5.0A, I_B = -10mA)	$V_{CE(sat)}$	—	—	-1.5	V
(I_C = -10.0A, 1_B = -20mA)		—	—	-2.0	V
Base-Emitter Saturation Voltage (I_C = -5.0A, I_B = -10mA)	$V_{BE(sat)}$	—	—	-2.5	Volts

dynamic characteristics

Collector Capacitance (V_{CE} = -10V, f = 1MHz)	C_{CBO}	—	—	220	pF

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = -10A, I_{B1} = I_{B2} = -20mA V_{CC} = -40V, t_p = 25μsec	$t_d + t_r$	—	0.6	—	μS
Storage Time		t_s	—	2.0	—	
Fall Time		t_f	—	0.5	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

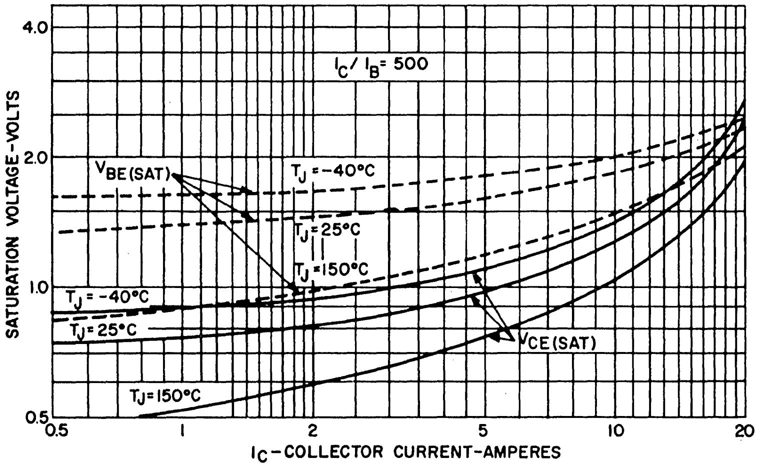


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

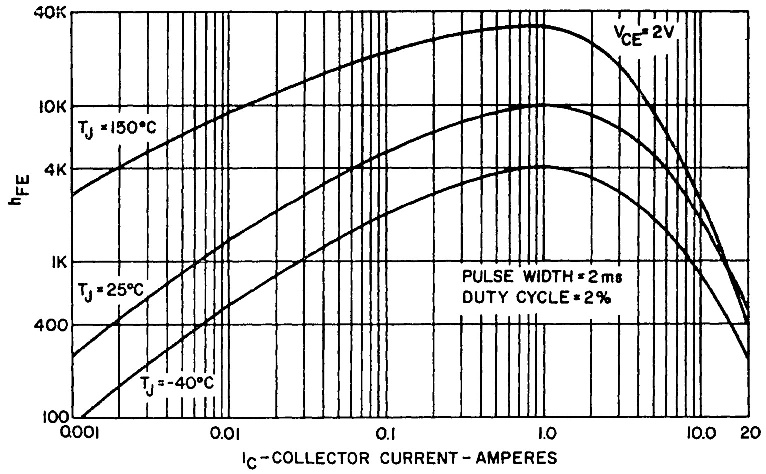


FIG. 2 TYPICAL GAIN CHARACTERISTIC

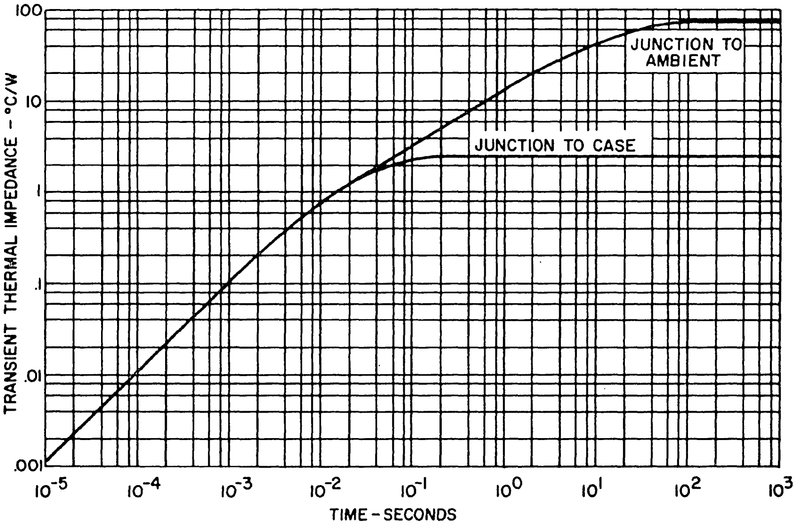


FIG. 3 TRANSIENT THERMAL IMPEDANCE

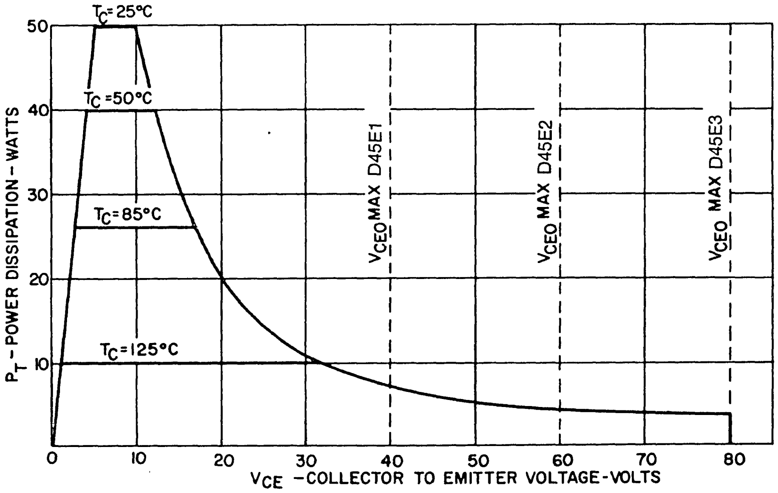


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

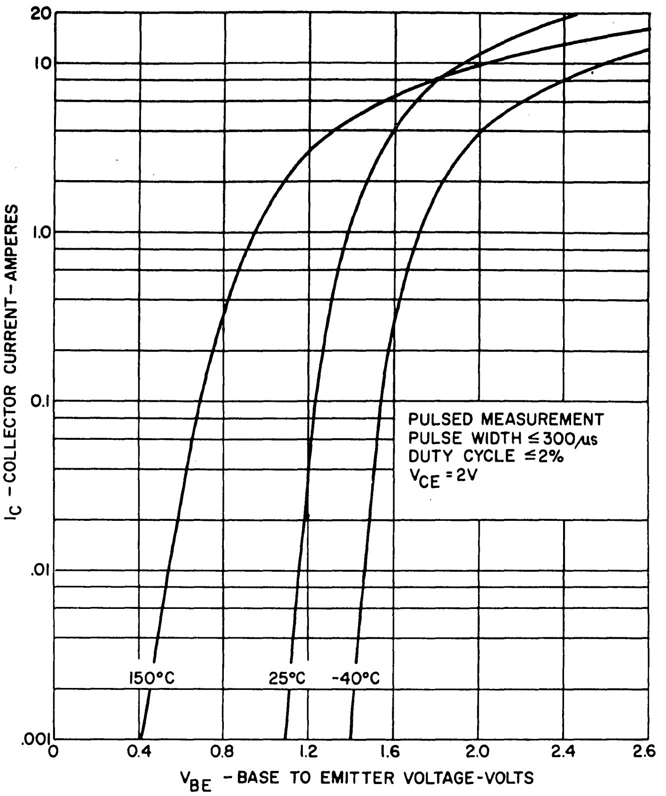


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

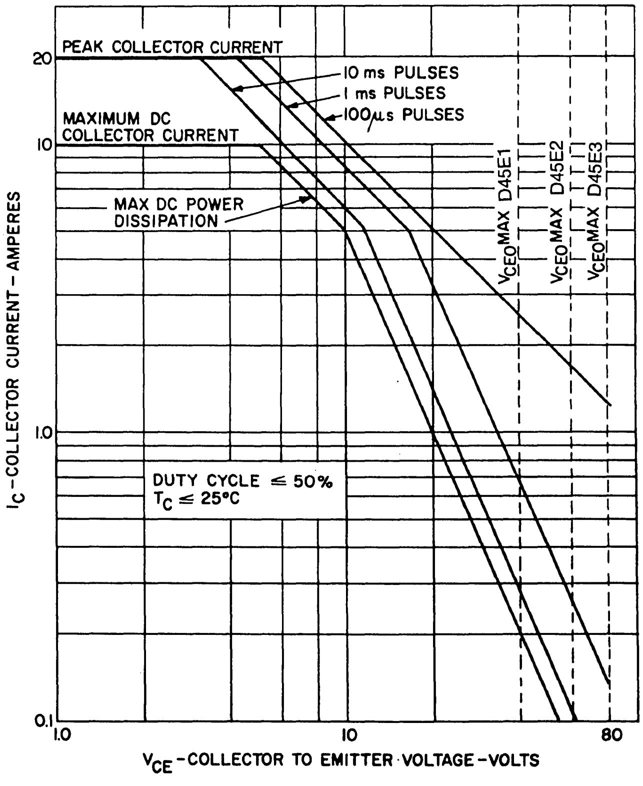


FIG. 6 SAFE REGION OF OPERATION

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE D45H SERIES

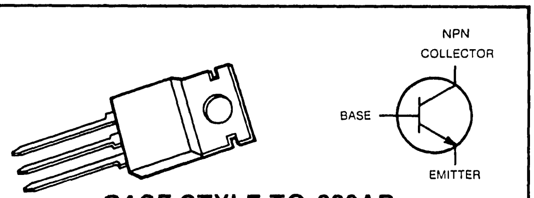
D44H Series

30 - 80 VOLTS
10 AMP, 50 WATTS

The General Electric D44H is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

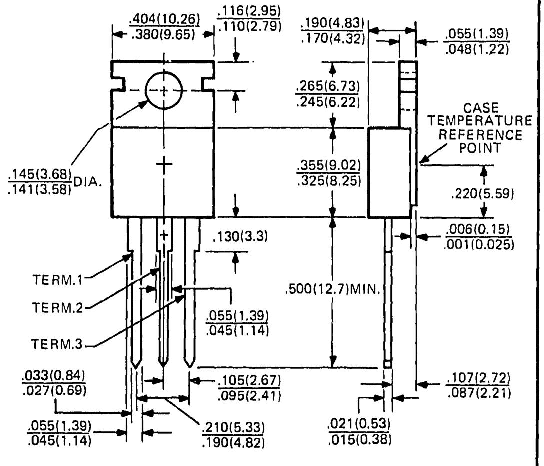
Features:

- NPN complement to D45H PNP
- Very Low collector saturation voltage
- Excellent linearity
- Fast switching



CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44H1, 2	D44H4, 5	D44H7, 8	D44H10, 11	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	80	Volts
Collector-Emitter Voltage	V_{CES}	30	45	60	80	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	10 20	10 20	10 20	10 20	A
Base Current — Continuous	I_B	5	5	5	5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 100mA) D44H1, 2	$V_{CEO(sus)}$	30	—	—	Volts
D44H4, 5		45	—	—	
D44H7, 8		60	—	—	
D44H10, 11		80	—	—	
Collector Cutoff Current (V_{CB} = Rated V_{CBO})	I_{CBO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	100	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4

on characteristics

DC Current Gain (I_C = 2A, V_{CE} = 1V) D44H1, 4, 7, 10	h_{FE}	35	—	—	—
D44H2, 5, 8, 11		60	—	—	
(I_C = 4A, V_{CE} = 1V) D44H1, 4, 7, 10	h_{FE}	20	—	—	—
D44H2, 5, 8, 11		40	—	—	
Collector-Emitter Saturation Voltage (I_C = 8A, I_B = 0.4A) D44H2, 5, 8, 11	$V_{CE(sat)}$	—	—	1.0	Volts
(I_C = 8A, I_B = 0.8A) D44H1, 4, 7, 10		—	—	1.0	
Base-Emitter Saturation Voltage (I_C = 8A, I_B = 0.8A)	$V_{BE(sat)}$	—	—	1.5	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	—	—	130	pF
Current-Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V)	f_T	—	50	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 5A, I_{B1} = I_{B2} = 0.5A	$t_d + t_r$	—	300	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	140	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

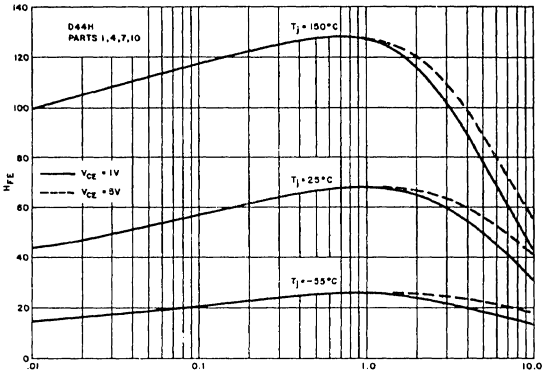


FIG. 1 TYPICAL GAIN CHARACTERISTICS

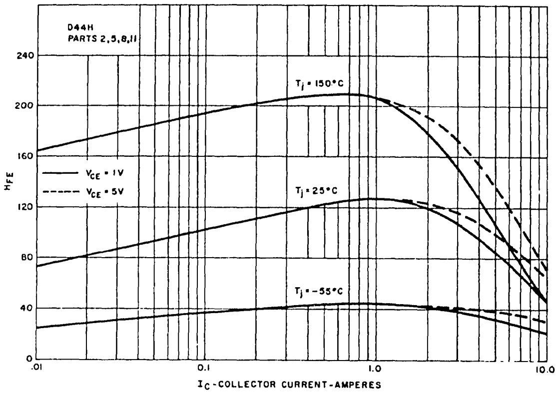


FIG. 2 TYPICAL GAIN CHARACTERISTICS

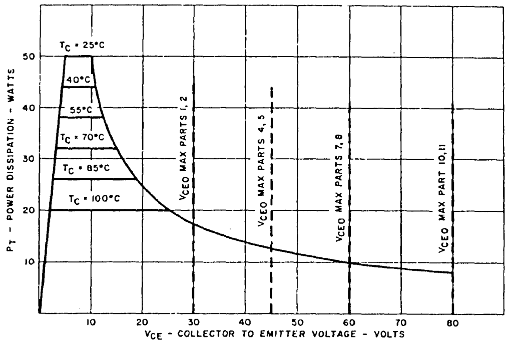


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

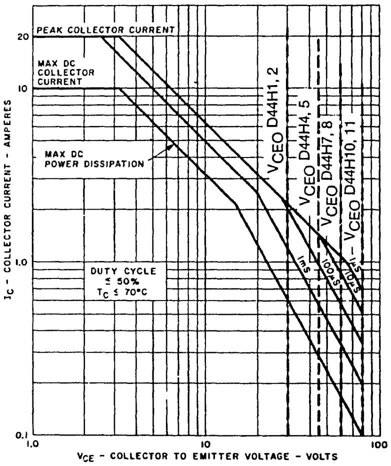


FIG. 4 SAFE REGION OF OPERATION

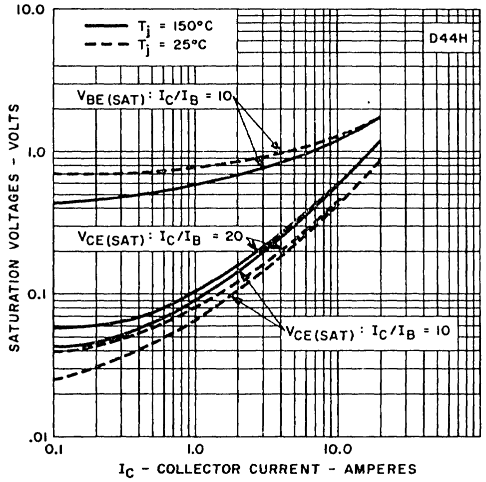


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

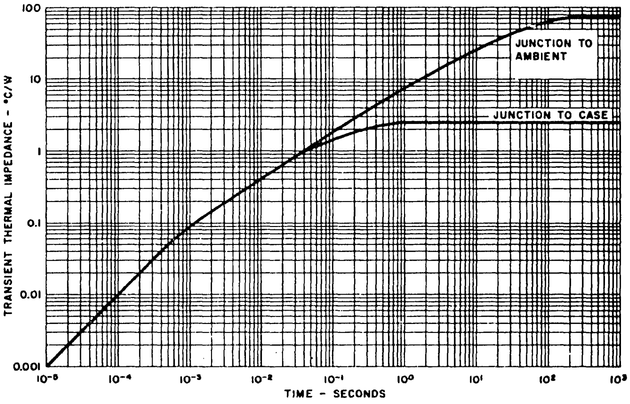


FIG. 6 TRANSIENT THERMAL IMPEDANCE

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE D44H SERIES

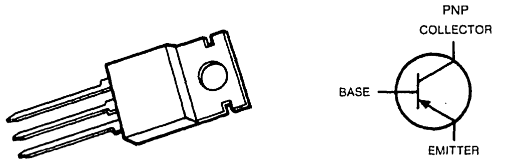
D45H Series

-30 - -80 VOLTS
-10 AMP, 50 WATTS

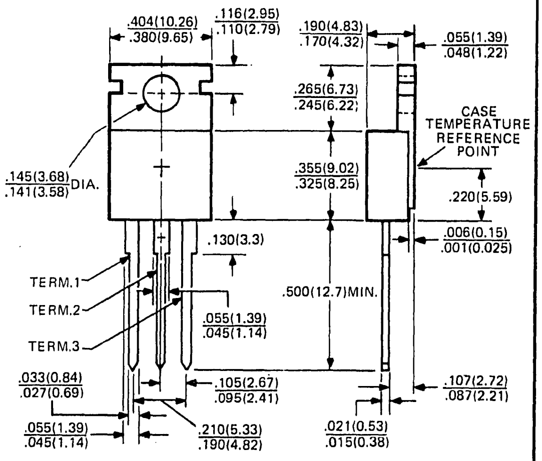
The General Electric D45H is a power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.

Features:

- PNP complement to D44H NPN
- Low collector saturation voltage
- Excellent linearity
- Fast switching



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45H1, 2	D45H4, 5	D45H7, 8	D45H10, 11	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-30	-45	-60	-80	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous	I_C	-10	-10	-10	-10	A
Peak(1)	I_{CM}	-20	-20	-20	-20	
Base Current — Continuous	I_B	-5	-5	-5	-5	A
Total Power Dissipation @ T_A = 25°C	P_D	1.67	1.67	1.67	1.67	Watts
@ T_C = 25°C		50	50	50	50	
Operating and Storage Junction Temperature Range	T_J,T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 100mA)	D45H1, 2	$V_{CEO(sus)}$	-30	—	—	Volts
	D45H4, 5		-45	—	—	
	D45H7, 8		-60	—	—	
	D45H10, 11		-80	—	—	
Collector Cutoff Current (V_{CB} = Rated V_{CBO})		I_{CBO}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-100	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4

on characteristics

DC Current Gain (I_C = -2A, V_{CE} = -1V)	D45H1, 4, 7, 10	h_{FE}	35	—	—	—
	D45H2, 5, 8, 11		60	—	—	
(I_C = -4A, V_{CE} = -1V)	D45H1, 4, 7, 10		20	—	—	
	D45H2, 5, 8, 11		40	—	—	
Collector-Emitter Saturation Voltage (I_C = -8A, I_B = -0.4A)	D45H1, 4, 7, 10	$V_{CE(sat)}$	—	—	-1.0	Volts
(I_C = -8A, I_B = -0.8A)	D45H2, 5, 8, 11		—	—	-1.0	
Base-Emitter Saturation Voltage (I_C = -8A, I_B = -0.8A)		$V_{BE(sat)}$	—	—	-1.5	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = -10V, f = 1M_{Hz})	C_{CBO}	—	230	—	pF
Current-Gain — Bandwidth Product (I_C = -500mA, V_{CE} = -10V)	f_T	—	40	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = -5A, I_{B1} = -0.5A	$t_d + t_r$	—	135	—	nS
Storage Time	I_C = -5A, I_{B1} = I_{B2} = -0.5A	t_s	—	500	—	
Fall Time		t_f	—	100	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

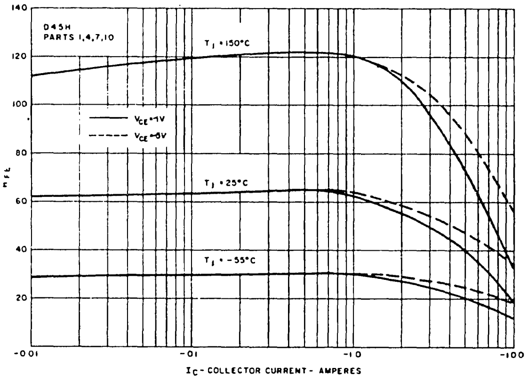


FIG. 1 TYPICAL GAIN CHARACTERISTICS

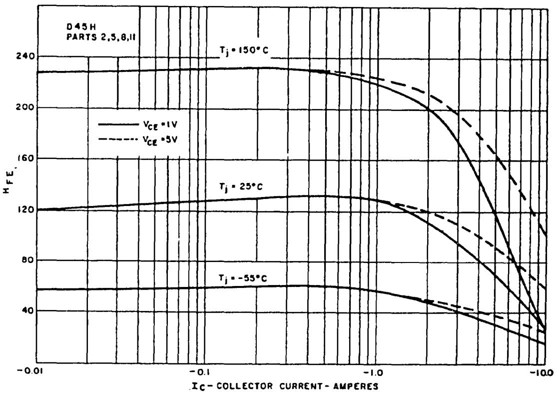


FIG. 2 TYPICAL GAIN CHARACTERISTICS

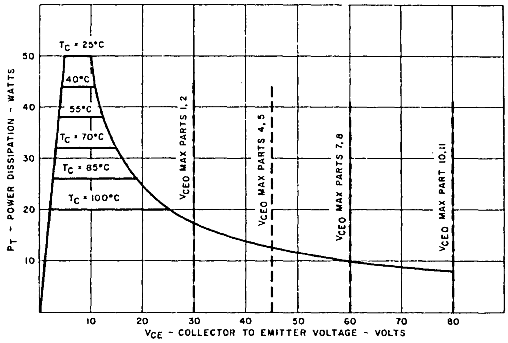


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

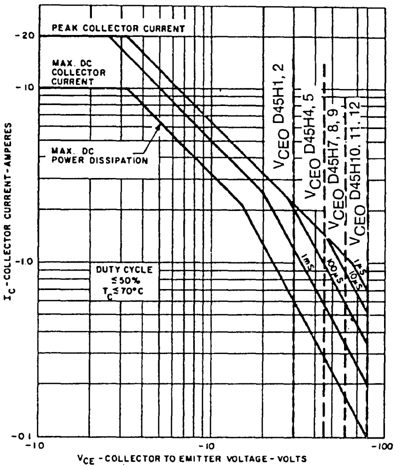


FIG. 4 SAFE REGION OF OPERATION

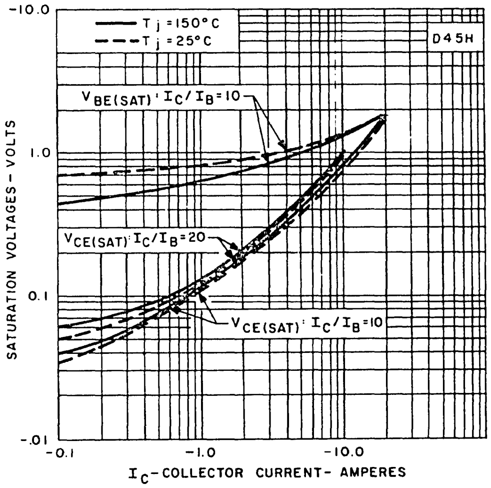


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

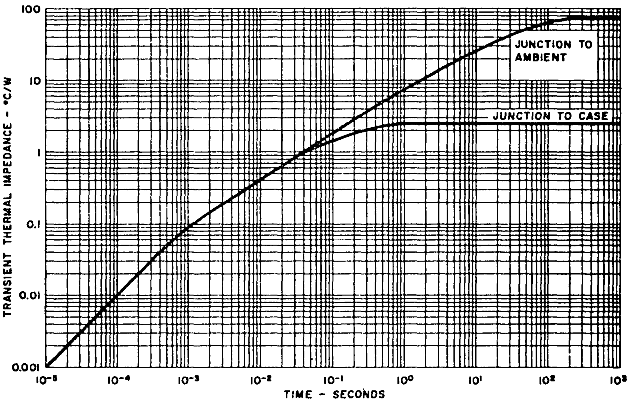


FIG. 6 TRANSIENT THERMAL IMPEDANCE

HIGH VOLTAGE
NPN POWER TRANSISTORS

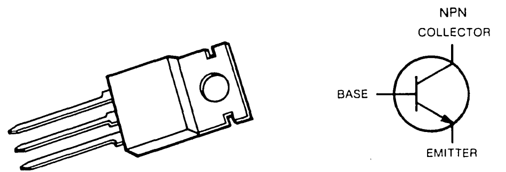
D44Q Series

125-225 VOLTS
4 AMP, 31.25 WATTS

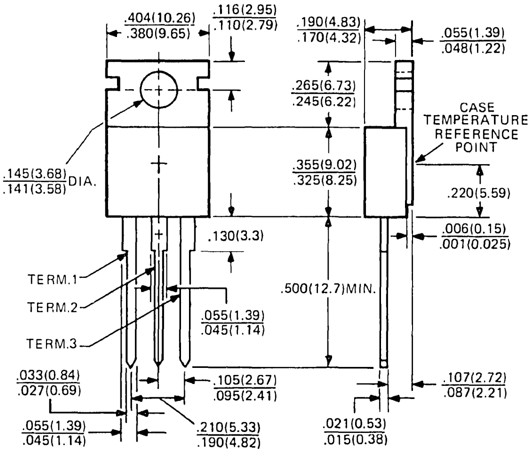
The General Electric D44Q is an encapsulated power transistor designed for various specific and general purpose applications such as: 120 V.A.C. line operated amplifiers; series, shunt and switching regulators; low thru high frequency inverters/converters; t-v and other display tube deflection; and many others.

Features:

- Very low collector saturation voltage
- Excellent linearity
- Fast switching



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44Q1	D44Q3	D44Q5	UNITS
Collector-Emitter Voltage	V_{CEO}	125	175	225	Volts
Collector-Emitter Voltage	V_{CES}	200	250	300	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous	I_C	4	4	4	A
Base Current — Continuous	I_B	2	2	2	A
Total Power Dissipation @ T_C = 25°C @ T_A = 25°C	P_D	31.25 1.67	31.25 1.67	31.25 1.67	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	4	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 10mA) D44Q1 D44Q3 D44Q5	$V_{CEO(sus)}$	125 175 225	—	—	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CEO})	I_{CBO}	—	—	10	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5

on characteristics(1)

DC Current Gain (I_C = 2A, V_{CE} = 10V) (I_C = 200mA, V_{CE} = 10V)	h_{FE}	 20 30	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 200mA)	$V_{CE(sat)}$	—	—	1	V
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 200mA)	$V_{BE(sat)}$	—	—	1.3	V

dynamic characteristics

Collector Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{CBO}	—	40	—	pF
Current Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V)	f_T	—	50	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	I_C = 1.0A, I_{B1} = I_{B2} = 100mA V_{CC} = 50V, t_p = 25 μsec	$t_d + t_r$	—	—	0.2	μs
Storage Time		t_s	—	—	2.0	
Fall Time		t_f	—	—	1.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

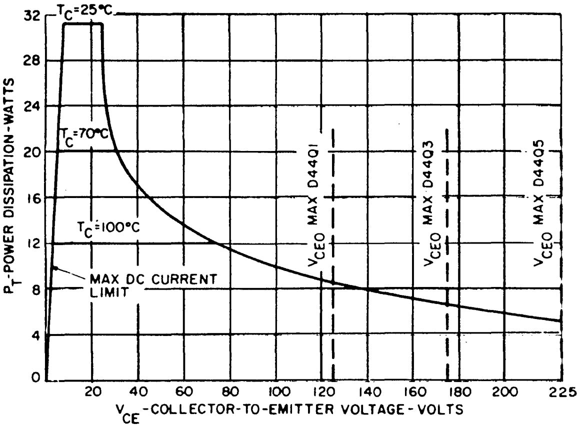


FIG. 1 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

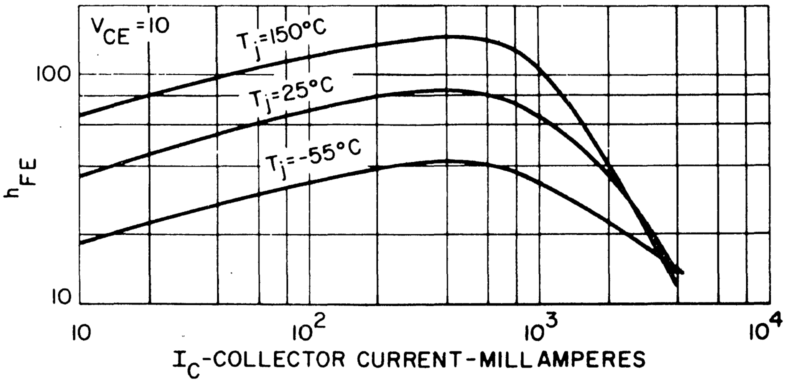


FIG. 2 TYPICAL h_{FE} vs. I_C

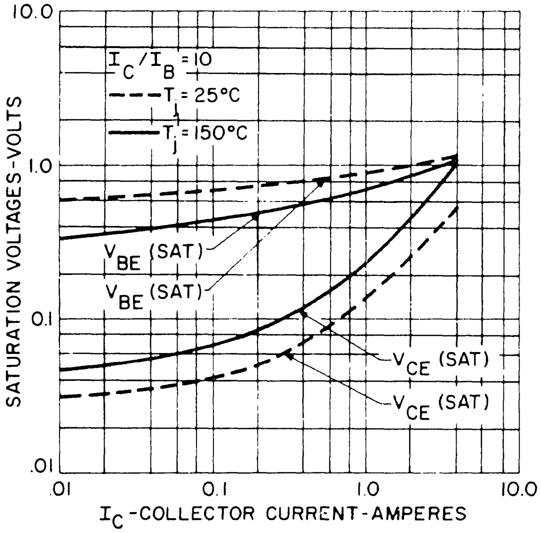


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

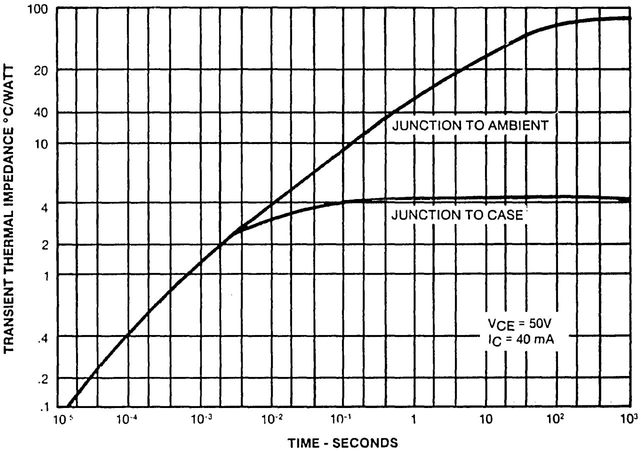


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

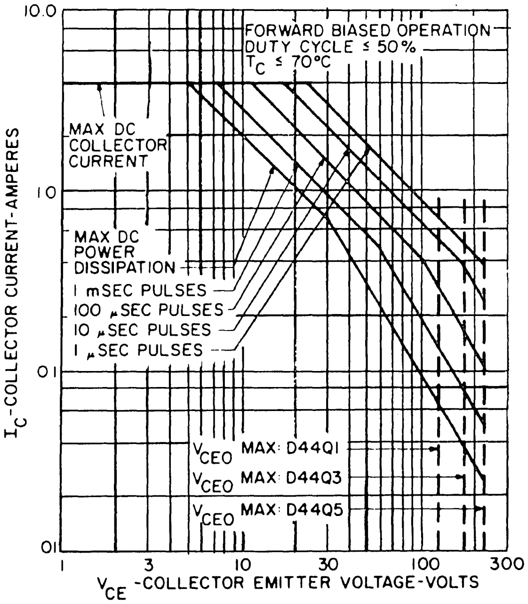


FIG. 5 FORWARD BIAS SAFE OPERATING AREA

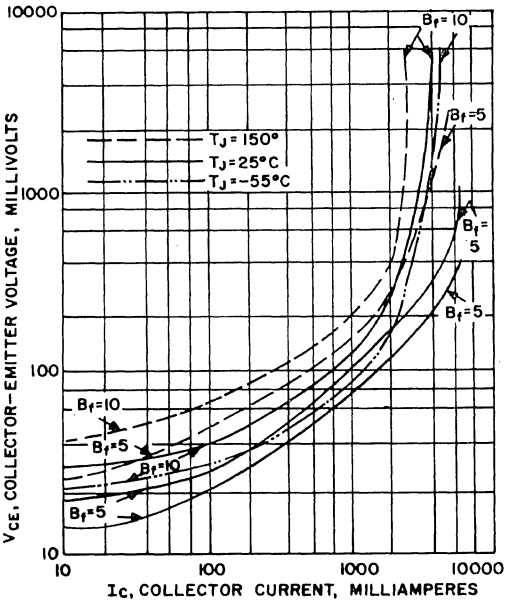


FIG. 6 $V_{CE(SAT)}$ vs. I_C TYPICAL

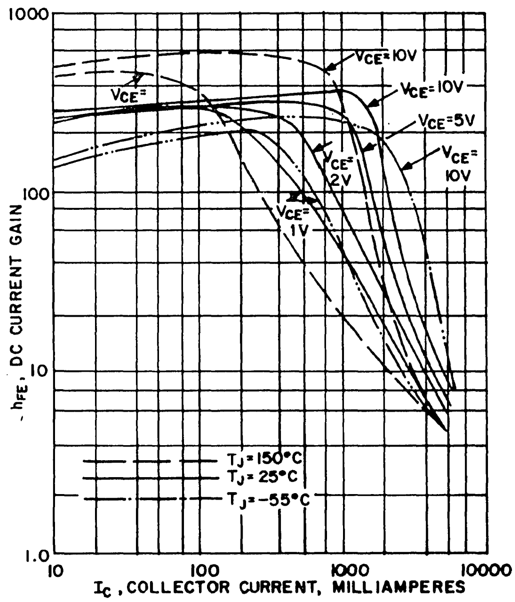


FIG. 7 DC CURRENT GAIN, TYPICAL

HIGH VOLTAGE
NPN POWER TRANSISTORS

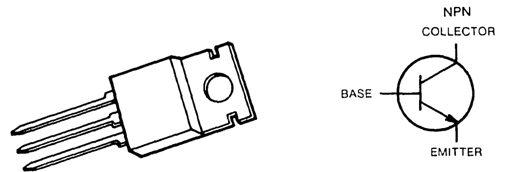
D44T Series

250-300 VOLTS
2 AMP, 31.2 WATTS

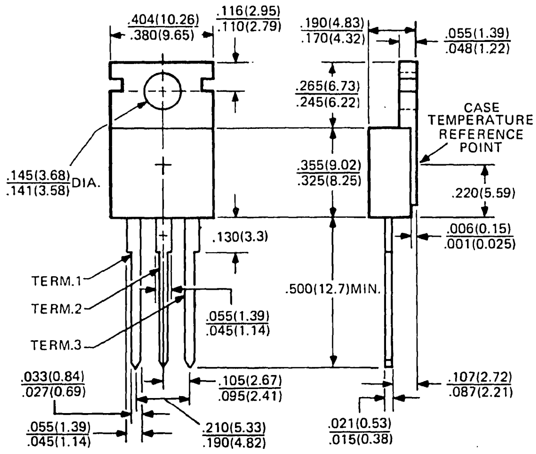
The General Electric D44T is an encapsulated power transistor designed for various specific and general purpose applications such as: 120 V.A.C. line operated amplifiers; series, shunt and switching regulators; low thru high frequency inverters/converters; t-v and other display tube deflection; and many others.

Features:

- Very low collector saturation voltage
- Excellent linearity
- Fast switching



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44T1,2	D44T3,4	UNITS
Collector-Emitter Voltage	V_{CEO}	250	300	Volts
Collector-Emitter Voltage	V_{CES}	300	400	Volts
Emitter Base Voltage	V_{EBO}	5	5	Volts
Collector Current — Continuous	I_C	2	2	A
Base Current — Continuous	I_B	0.5	0.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25C	P_D	2.1 31.2	2.1 31.2	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Breakdown Voltage ($I_C = 10\ \mu A$) D44T1,2 D44T3,4	BV_{CES}	300 400	—	—	Volts
Collector Cutoff Current (V_{CE} = Rated V_{ECS})	I_{CES}	—	—	10	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}	—	—	10	μA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5

on characteristics(1)

DC Current Gain					
($I_C = 500mA$, $V_{CE} = 10V$) D44T1,3	h_{FE}	30	—	—	
($I_C = 50mA$, $V_{CE} = 10V$)		40	—	—	
($I_C = 500mA$, $V_{CE} = 10V$) D44T2,4		75	—	175	
($I_C = 50mA$, $V_{CE} = 10V$)		40	—	—	
Collector-Emitter Saturation Voltage ($I_C = 500mA$, $I_B = 50mA$)	$V_{CE(sat)}$	—	—	1.0	V
Base Emitter Saturation Voltage ($I_C = 500mA$, $I_B = 50mA$)	$V_{BE(sat)}$	—	—	1.2	V

dynamic characteristics

Collector Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	25	—	pF
Current Gain — Bandwidth Product ($I_C = 100mA$, $V_{CE} = 10V$, $f_{test} = 1.0$ MHz))	f_T	—	45	—	MHz

switching characteristics

Resistive Load						
Delay Time + Rise Time	$I_C = 500mA$, $I_{B1} = I_{B2} = 50mA$ $V_{CC} = 50V$, $t_p = 25\mu sec$	$t_d + t_r$	—	0.2	—	μs
Storage Time		t_s	—	3.3	—	
Fall Time		t_f	—	0.6	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

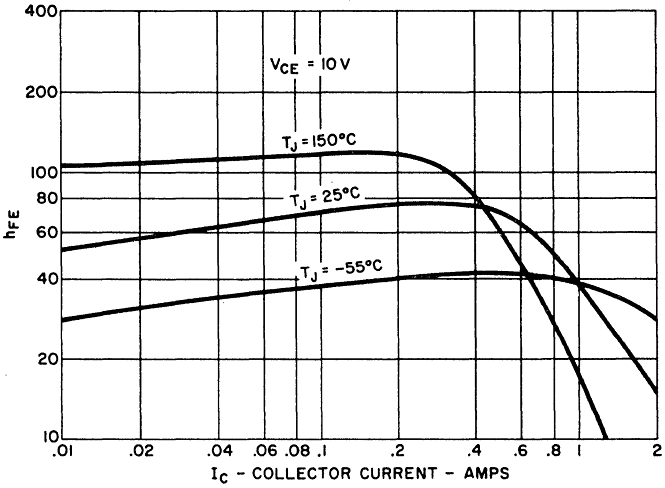


FIG. 1 TYPICAL h_{FE} VS. I_C

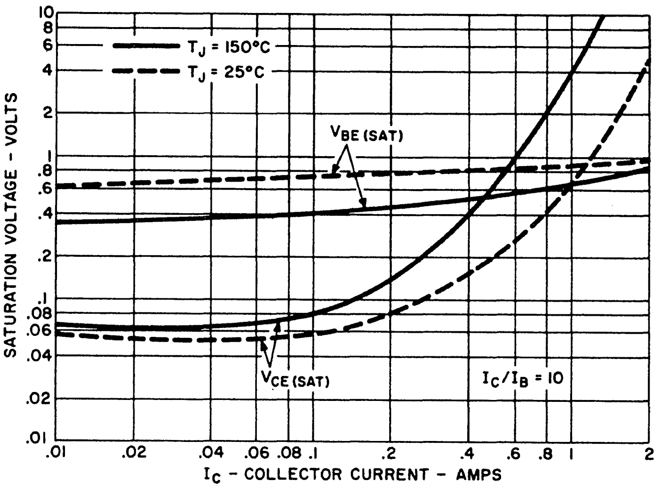


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

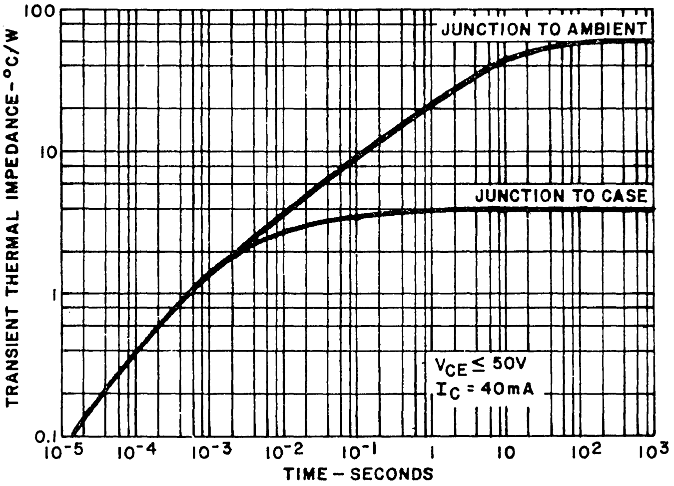


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

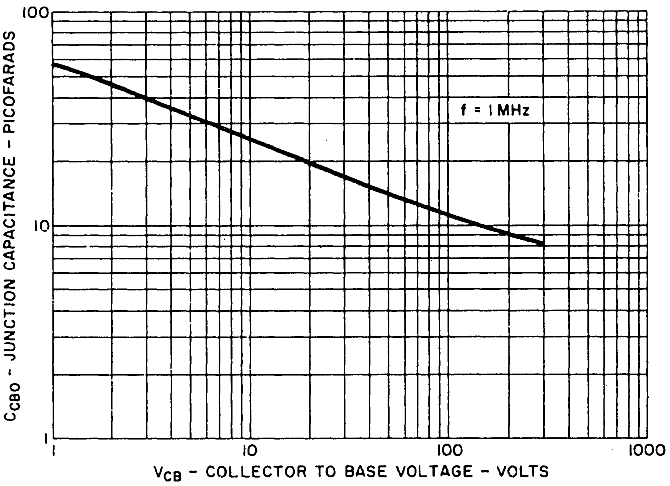


FIG. 4 COLLECTOR TO BASE JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

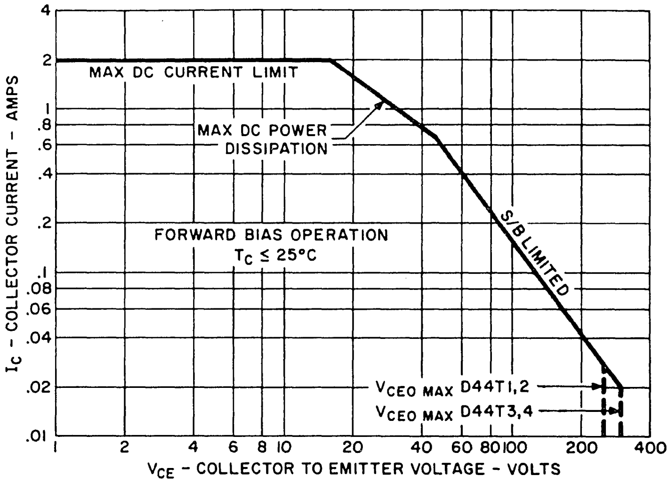


FIG. 5 SAFE REGION OF OPERATION

HIGH VOLTAGE/HIGH SPEED
NPN POWER TRANSISTORS

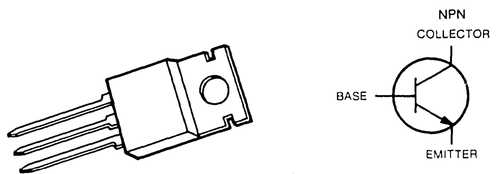
D44TD Series

300-400 VOLTS
2 AMP, 500 WATTS

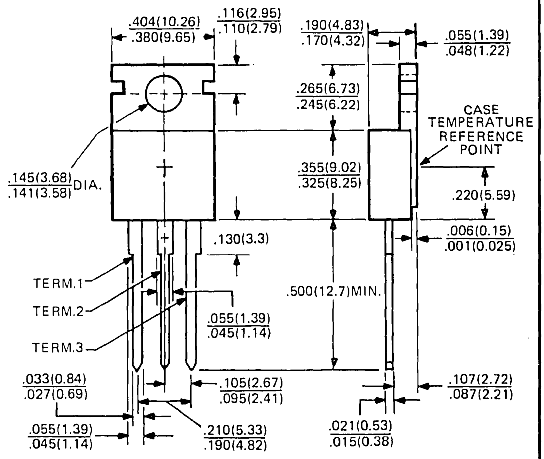
The D44TD series of NPN Power Transistors is designed for use in switching applications requiring high-voltage capability, fast switching speeds and low-saturation voltages. They are particularly suited for off-line switching power supplies, solid-state lighting ballast, invertes, solenoid/relay drivers and deflection circuits.

Features:

- Performance information tailored for switching applications
- 100°C maximum limits specified for:
  - Switching times
  - Saturation voltages
  - Leakage currents
- 300 to 400V $V_{CEO(sus)}$ in a TO-220AB Package
- Very fast turn-off, $t_f < 180$ nsec (typ.) @ 1.5A



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C)
(unless otherwise specified)

RATING	SYMBOL	D44TD3	D44TD4	D44TD5	UNITS
Collector-Emitter Voltage	V_{CEO}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEX}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEV}	400	500	600	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 4	2 4	2 4	A
Base Current — Continuous Peak(1)	I_B I_{BM}	.5 1	.5 1	.5 1	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	50 20 .4	50 20 .4	50 20 .4	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse condition, $t_p \leq$ 5msec.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 25mA, I_B = 0) D44TD3	$V_{CEO(sus)}$	300	—	Volts
D44TD4		350	—	
D44TD5		400	—	
Collector-Emitter Voltage (I_C = 2.0mA, I_{B1} = I_{B2} = .4A) (V_{BE} = -5V, L = 200 μh) D44TD3	V_{CEX}	300	—	Volts
D44TD4		350	—	
D44TD5		400	—	
Collector Cutoff Current	I_{CEV}			mA
(V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V)		—	0.1	
(V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V, T_C = 100° C)		—	1.0	
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	1.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 13		
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 14		

on characteristics(1)

DC Current Gain	h_{FE}			—
(I_C = 1A, V_{CE} = 2V)		8	—	
(I_C = 2A, V_{CE} = 3V)		5	—	
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$			Volts
(I_C = 1A, I_B = .2A)		—	0.6	
(I_C = 2A, I_B = .4A)		—	1.0	
(I_C = 1A, I_B = .2A, T_C = 100° C)		—	1.0	
Base-Emitter Saturation Voltage	$V_{BE(SAT)}$			Volts
(I_C = 2A, I_B = .4A)		—	1.2	
(I_C = 2A, I_B = .4A, T_C = 100° C)		—	1.2	

dynamic characteristics

Current Gain — Bandwidth Product (I_C = .25A, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	15	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{OB}	10	25	pF

switching characteristics

			MAXIMUM		
Resistive Load (See Figure 17 for Test Circuit)		T_C	25° C	100° C	
Delay Time	V_{CC} = 250V, I_C = 1.5A	t_d	.06	.08	μs
Rise Time	I_{B1} = I_{B2} = 0.3A, t_p = 25 μsec	t_r	0.6	0.8	μsec
Storage Time		t_s	2.5	3.0	μsec
Fall Time		t_f	0.5	0.8	μsec
Inductive Load, Clamped (See Figure 17 for Test Circuit)					
Storage Time	V_{CLAMP} = 250V, I_C = 1.5A,	t_{sv}	3.0	3.5	μs
Fall Time	I_{B1} = I_{B2} = 0.3A, t_p = 25μsec	t_f	0.3	0.6	μsec
	$V_{BE(OFF)}$ = -5V	TYPICAL			
Storage Time	L = 200 μh	t_s	2.1	2.6	μsec
Fall Time		t_f	0.18	0.23	μsec

(1) Pulse Duration = 300μs, Duty Factor ≤ 2%. Do not measure on a curve tracer.

TYPICAL DC CHARACTERISTICS

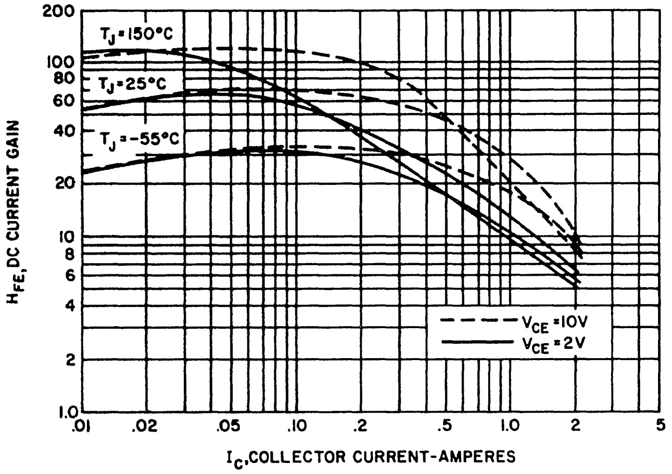


FIGURE 1. DC CURRENT GAIN

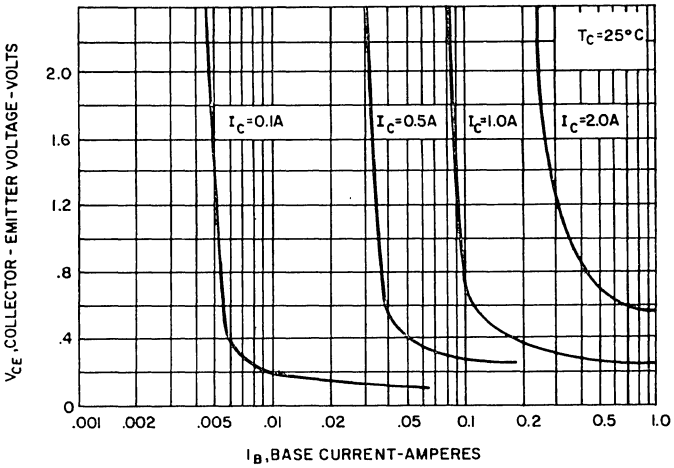


FIGURE 2. COLLECTOR SATURATION REGION

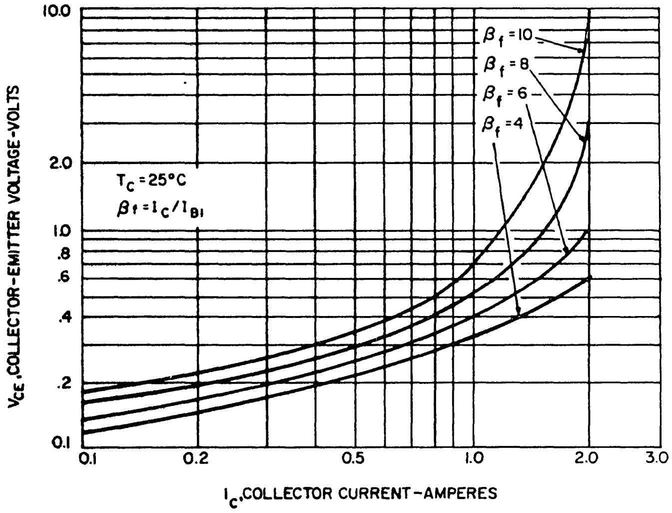


FIGURE 3. $V_{CE(SAT)}$ VS. I_C, T_C = 25°C

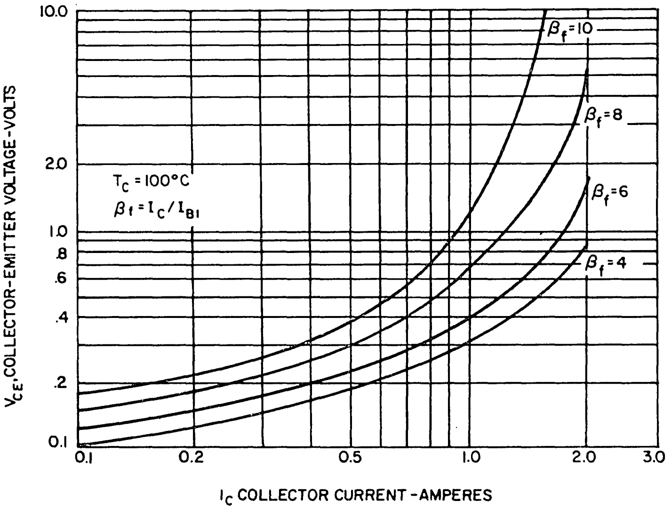


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_C = 100°C

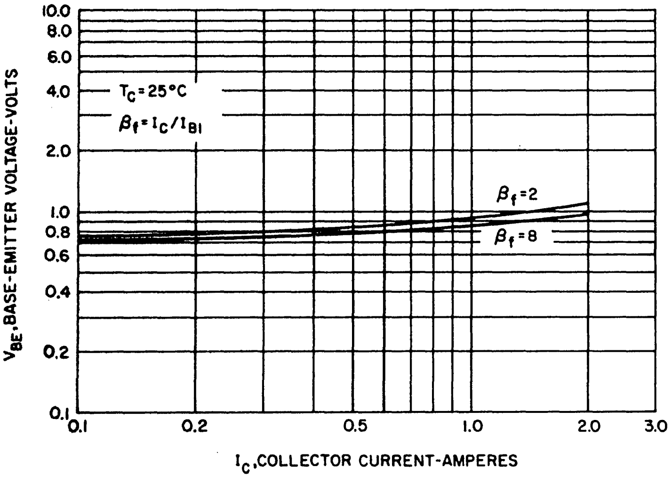


FIGURE 5. $V_{BE(SAT)}$ VS. I_C

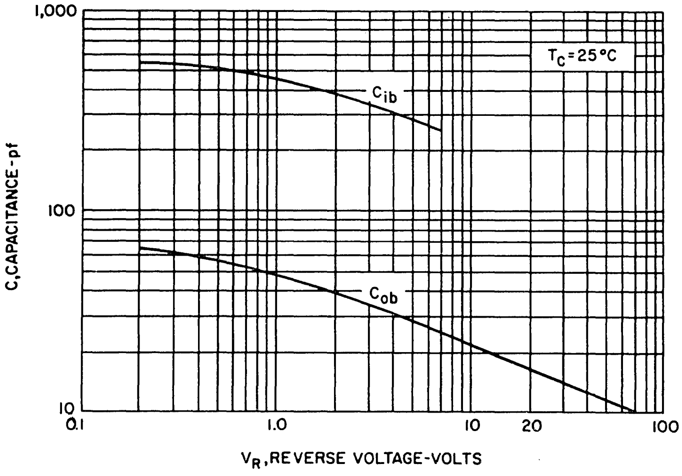


FIGURE 6. CAPACITANCE

TYPICAL SWITCHING CHARACTERISTICS

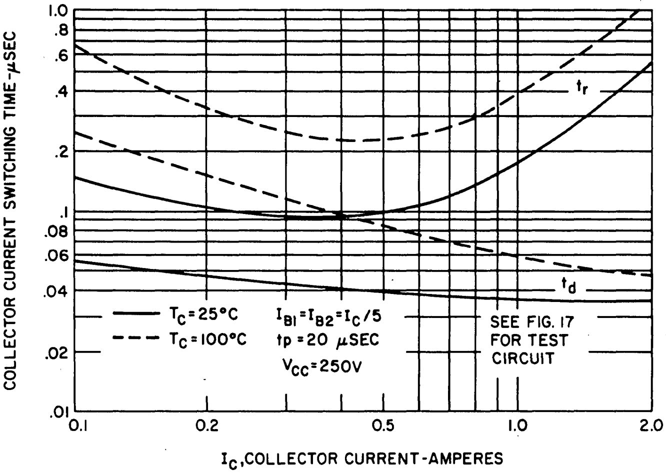


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

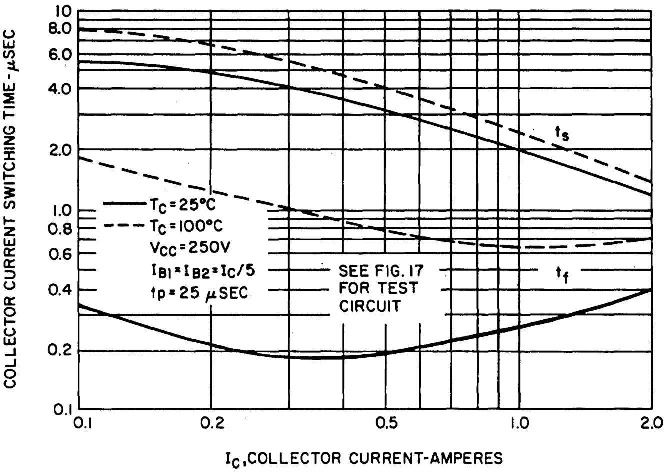


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

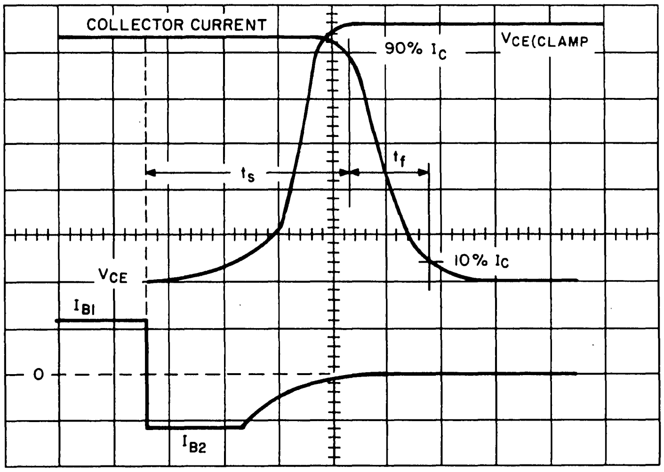


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

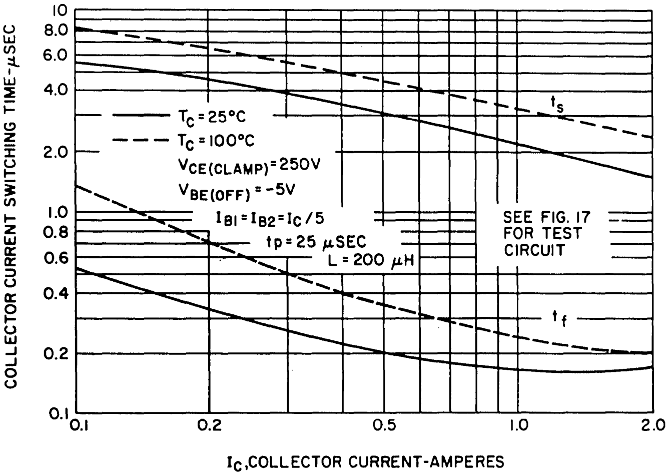


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

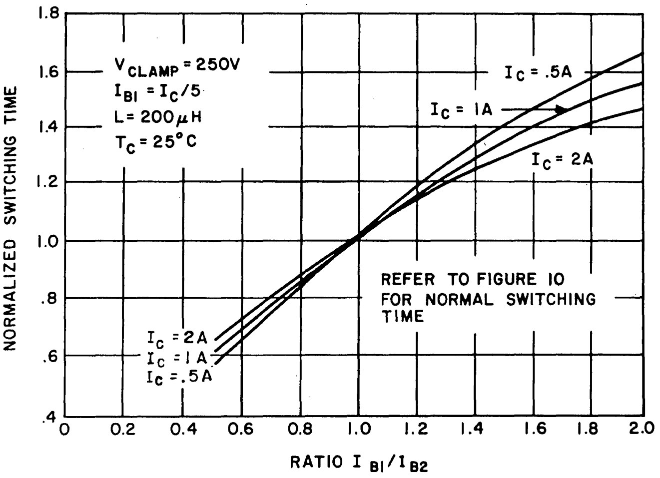


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

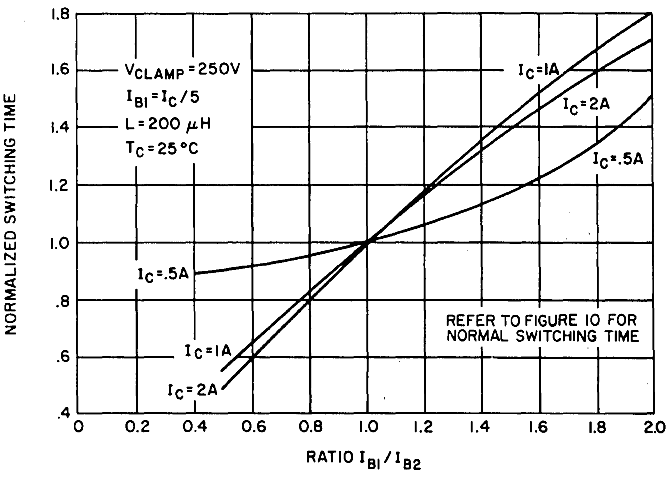


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

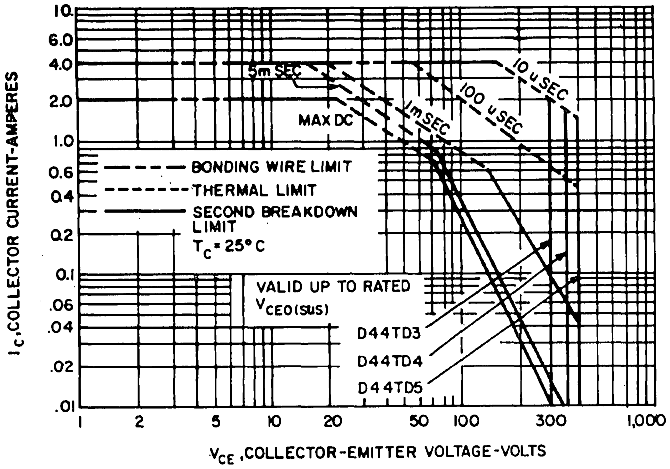


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

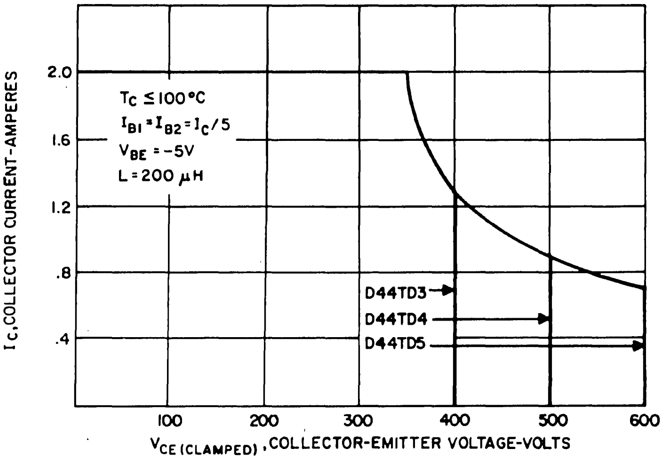


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

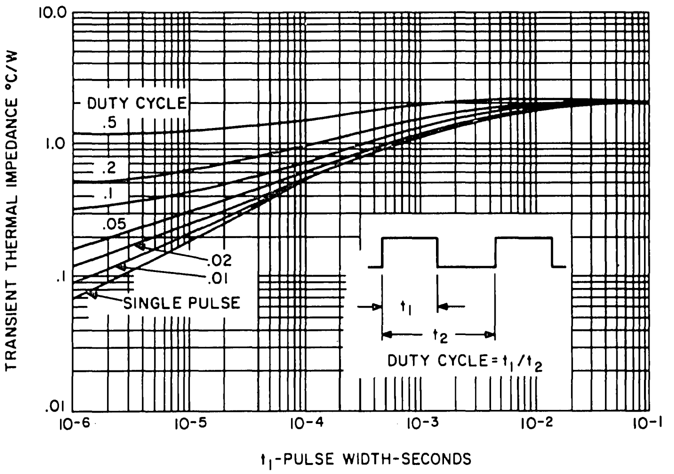


FIGURE 15. TRANSIENT THERMAL RESPONSE

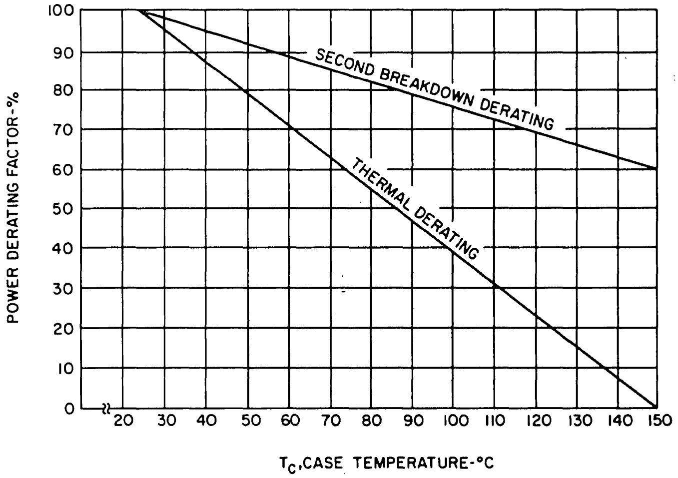
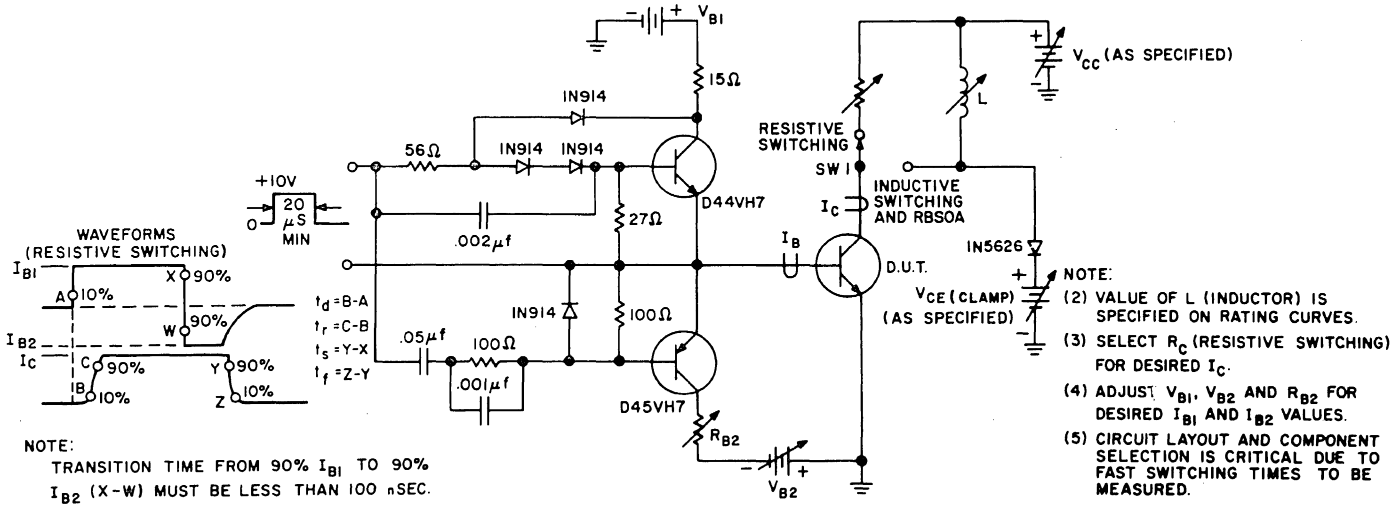


FIGURE 16. POWER DERATING CURVE



NOTE:
TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} (X-W) MUST BE LESS THAN 100 nSEC.

NOTE:
(2) VALUE OF L (INDUCTOR) IS SPECIFIED ON RATING CURVES.
(3) SELECT R_C (RESISTIVE SWITCHING) FOR DESIRED I_C.
(4) ADJUST V_{B1}, V_{B2} AND R_{B2} FOR DESIRED I_{B1} AND I_{B2} VALUES.
(5) CIRCUIT LAYOUT AND COMPONENT SELECTION IS CRITICAL DUE TO FAST SWITCHING TIMES TO BE MEASURED.

FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

HIGH SPEED
NPN POWER TRANSISTORS

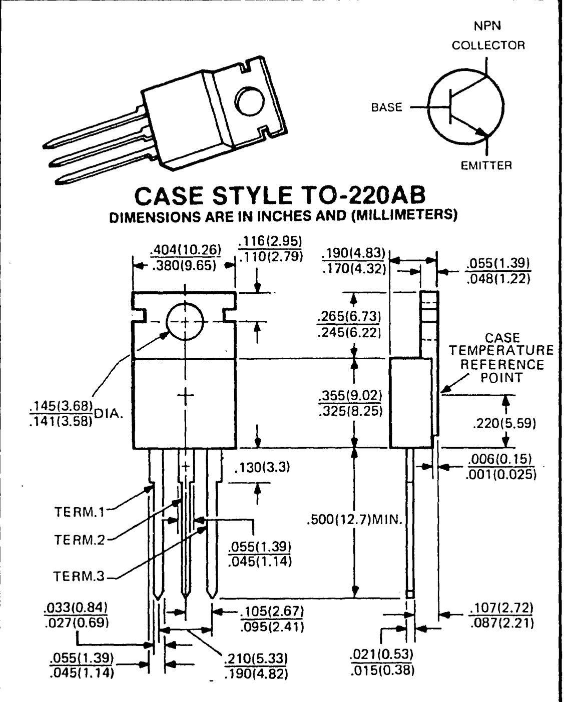
D44TQ1
D44TQ2

400-450 VOLTS
12 AMP, 100 WATTS

The D44TQ1 and D44TQ2 are designed for high-voltage, high-speed power switching inductive circuits where fall time is critical. They are particularly suited for 115 and 220V switch-mode applications such as switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

Features:

- $V_{CEO(sus)}$ 400V and 450 V
- Reverse Bias SOA with inductive loads @ T_C = 100° C
- 700 V blocking capability
- SOA and switching information.



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise noted)

RATING	SYMBOL	D44TQ1	D44TQ2	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	12 24	12 24	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	6 12	6 12	A
Total Power Dissipation @ Tc = 25° C Derate above 25° C	P_D	100 0.8	100 0.8	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	1.25	° C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage D44TQ1 (I_C = 10mA, I_B = 0) D44TQ2	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CE} = Rated Value, $V_{BE(OFF)}$ = 1.5V)	I_{CEV}	—	—	1	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 2

on characteristics(1)

DC Current Gain (I_C = 5A, V_{CE} = 5V) (I_C = 8A, V_{CE} = 5V)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.8A) (I_C = 12A, I_B = 3A)	$V_{CE(sat)}$	— — —	— — —	1 1.5 3	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A)	$V_{BE(sat)}$	— —	— —	1.2 1.6	V

switching characteristics

Resistive Load (Table 1)						
Delay Time	V_{CC} = 125V, I_C = 8A	t_d	—	0.06	0.1	μs
Rise Time	$I_{B1} = I_{B2}$ = 1.6A, t_p = 25 μs	t_r	—	0.45	1	
Storage Time	Duty Cycle < 1%	t_s	—	1.3	3	
Fall Time		t_f	—	0.2	0.7	
Inductive Load, Clamped (Table 1, Figure 13)						
Storage Time	(I_C = 8A, V_{CLAMP} = 300V)	t_{sv}	—	0.92	2.3	μs
Crossover Time	(I_{B1} = 1.6A, $V_{BE(OFF)}$ = 5V, T_C = 100° C)	t_c	—	0.12	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

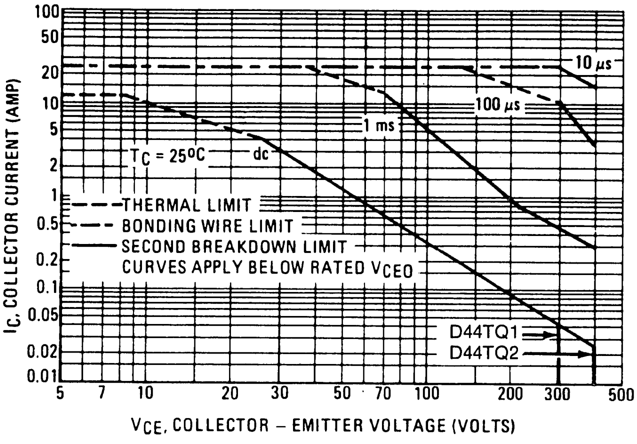


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

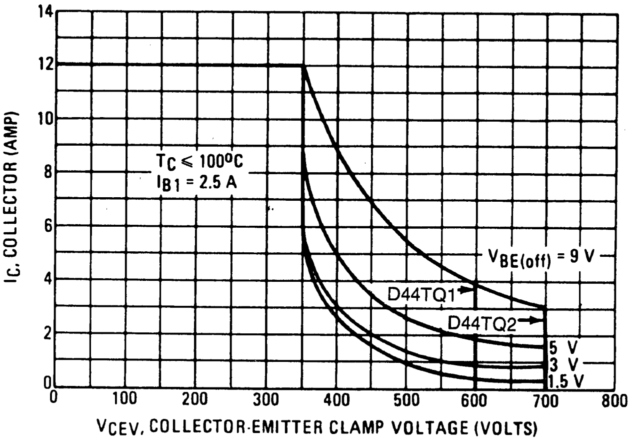


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

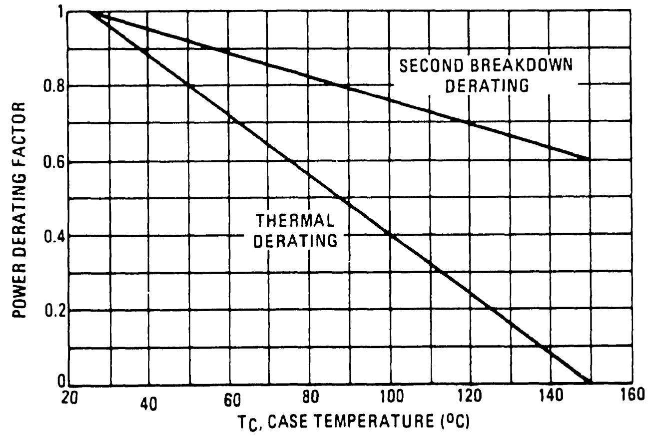


FIGURE 3 – FORWARD BIAS POWER DERATING

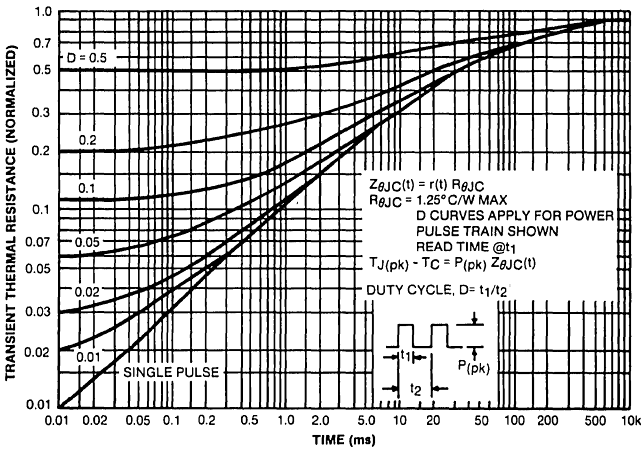


FIGURE 4 TYPICAL THERMAL RESPONSE [(ZθJC(t)]

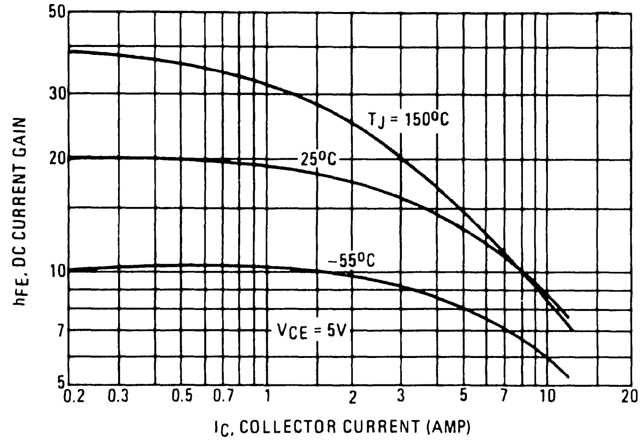


FIGURE 5 – DC CURRENT GAIN

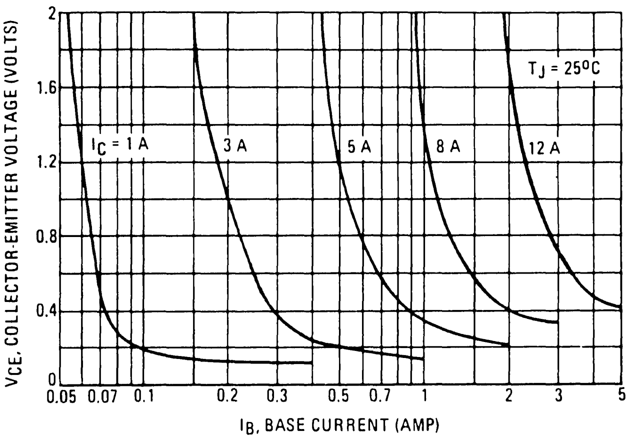


FIGURE 6 – COLLECTOR SATURATION REGION

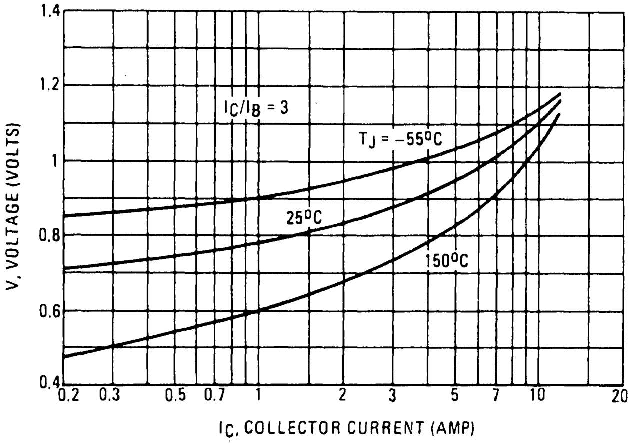


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

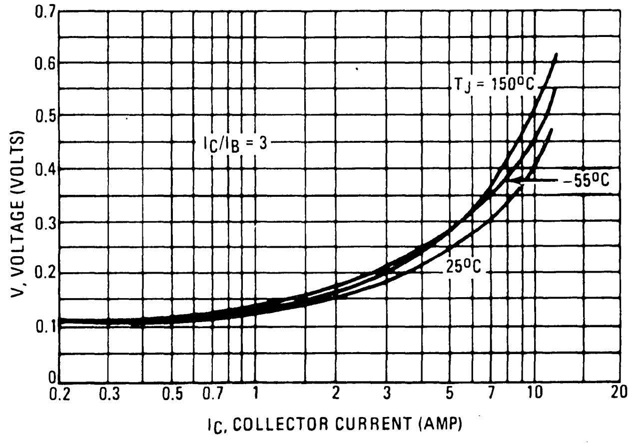


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

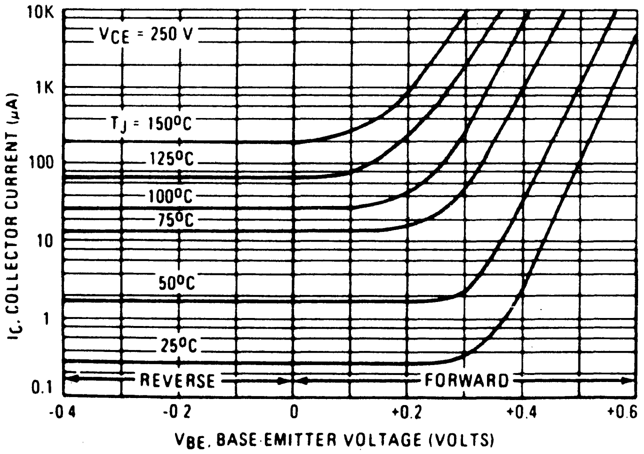


FIGURE 9 – COLLECTOR CUTOFF REGION

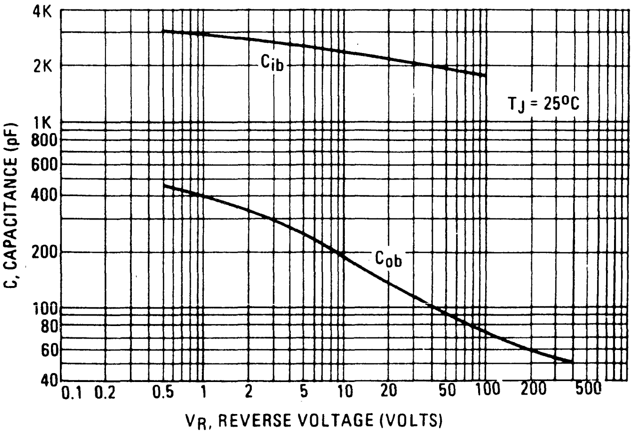


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

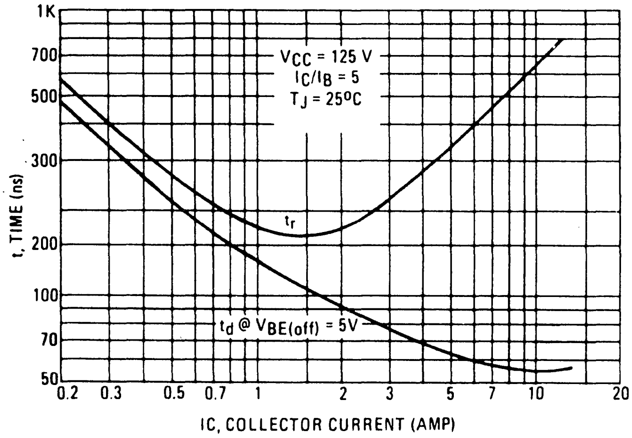


FIGURE 11 – TURN-ON TIME

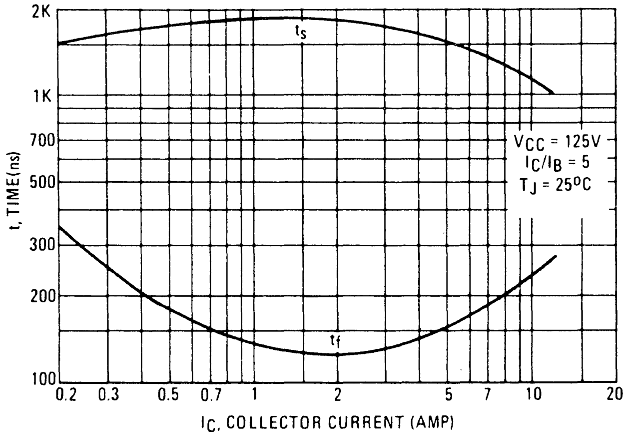


FIGURE 12 – TURN-OFF TIME

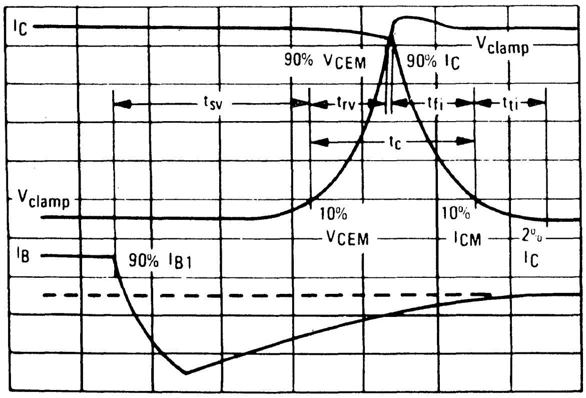


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

VERY HIGH SPEED
NPN POWER TRANSISTORS
COMPLEMENTARY TO THE D45VH SERIES

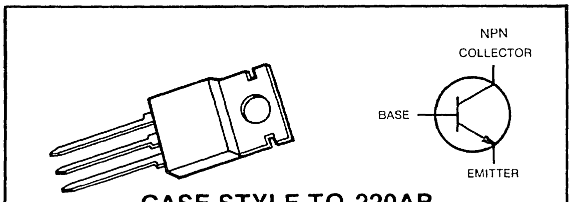
D44VH Series

30-80 VOLTS
15 AMP, 83 WATTS

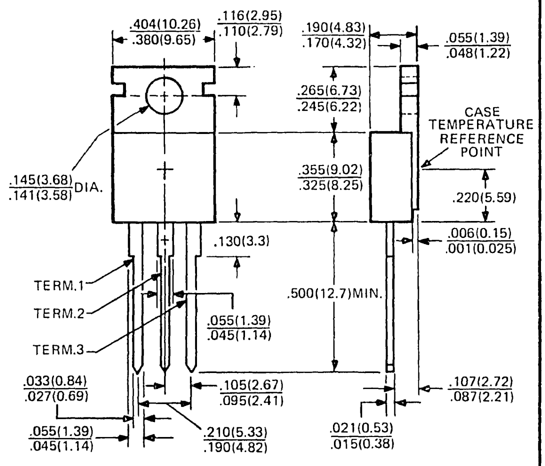
The D44VH is an NPN power transistor especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters and other applications where very fast switching and low-saturation voltages are necessary. This device complements the D45VH PNP power transistor and is characterized with performance information which relates directly to switching.

Features:

- Fast Switching $t_s \leqslant 700$ ns resistive
  $t_f \leqslant 200$ ns
- Low $V_{CE(sat)} \leqslant 0.4V$ @ $I_C = 8A$



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D44VH1	D44VH4	D44VH7	D44VH10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	30	45	60	80	V
Collector-Emitter Voltage	V_{CEX}	40	55	70	90	V
Collector-Emitter Voltage	V_{CEV}	50	65	80	100	V
Emitter Base Voltage	V_{EB}	7				V
Collector Current — Continuous — Peak (1)	I_C I_{CM}	15 20				A
Base Current — Continuous — Peak (1)	I_B I_{BM}	5 10				A
Total Power Dissipation @ $T_C = 25°C$ @ $T_C = 100°C$ Derate above 25°C	P_D	83 33 .67				Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150				°C

thermal characteristics

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	°C

(1) Pulse measurement condition PW ⩽ 6.0 ms, See Figure 14.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage(1) (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D44VH1		30	—	
D44VH4		45	—	
D44VH7		60	—	
D44VH10		80	—	
Collector-Emitter Voltage(2) (I_C = 1A, V_{CLAMP} = Rated V_{CEX}, T_C = 100° C)	V_{CEX}			V
D44VH1		40	—	
D44VH4		55	—	
D44VH7		65	—	
D44VH10		90	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V)		—	10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V, T_C = 100° C)		—	100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100° C)	I_{CER}	—	100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	10	μA

second breakdown

Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8

on characteristics(1)

DC Current Gain	h_{FE}			—
(I_C = 2 A, V_{CE} = 1V)		35	—	
(I_C = 4 A, V_{CE} = 1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = 8A, I_B = 0.4A)		—	0.4	
(I_C = 8A, I_B = 0.4A, T_C = 100° C)		—	0.5	
(I_C = 15A, I_B = 3.0A, T_C = 100° C)		—	0.8	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = 8A, I_B = 0.4A)		—	1.2	
(I_C = 8A, I_B = 0.4A, T_C = 100° C)		—	1.1	

dynamic characteristics

		Typical	
Current-Gain — Bandwidth Product (I_C = 0.1A, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	120	pF

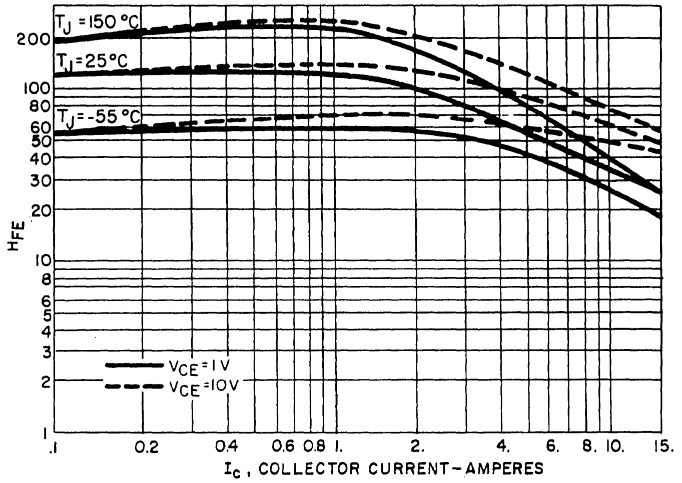
switching characteristics

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25° C	100° C	
Delay Time	V_{CC} = 20V, I_C = 8A I_{B1} = I_{B2} = 0.8A t_p = 25 μsec	t_d	50	—	nsec
Rise Time		t_r	250	—	nsec
Storage Time		t_s	700	—	nsec
Fall Time		t_f	200	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	V_{CC} = 20V, I_C = 8A V_{CLAMP} = Rated V_{CEX} I_{B1} = 0.8A, $V_{BE(off)}$ = −5V L = 200 μh	t_s	800	—	nsec
Fall Time		t_f	180	400	nsec
			Typical		
Storage Time		t_s	280	370	nsec
Fall Time		t_f	130	150	nsec

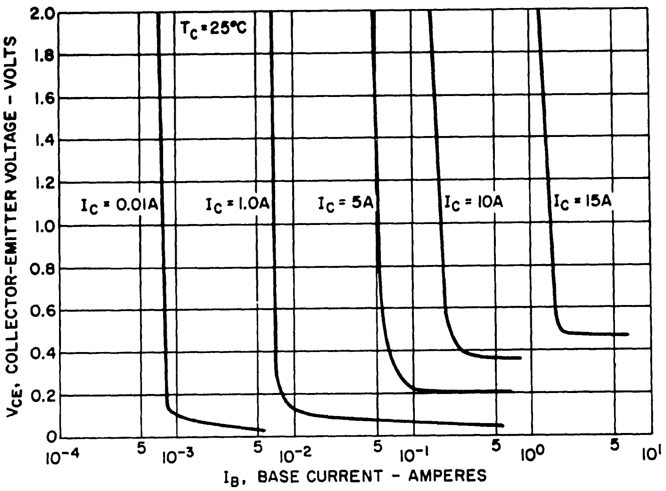
(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.

(2) See Figure 15 for Test Circuit.

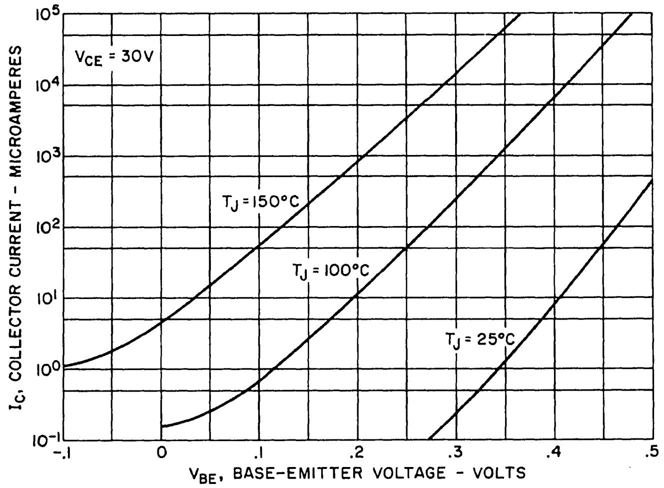
SAFE OPERATING AREA



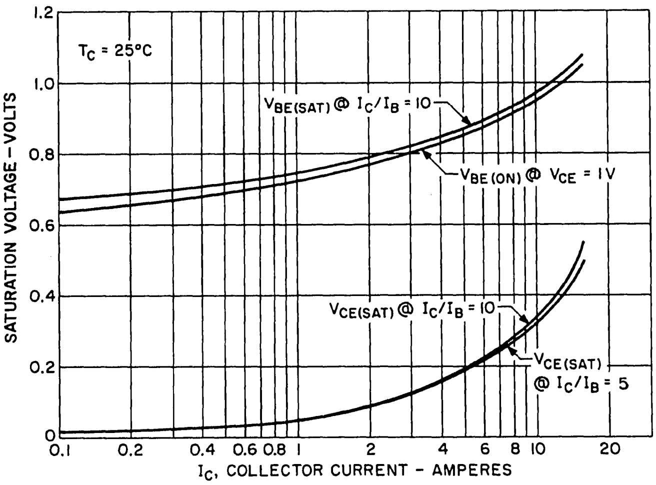
1. DC CURRENT GAIN



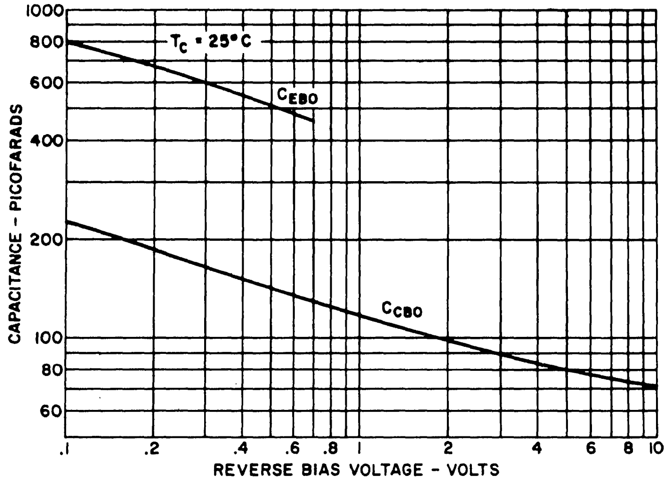
2. COLLECTOR SATURATION REGION



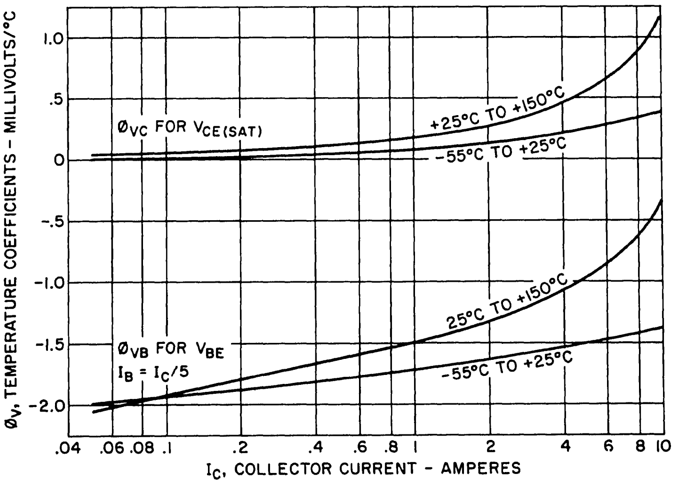
3. COLLECTOR CUTOFF REGION



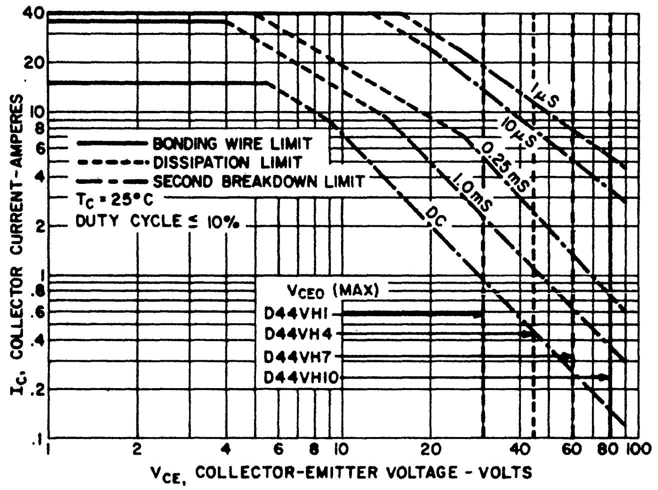
4. SATURATION VOLTAGE



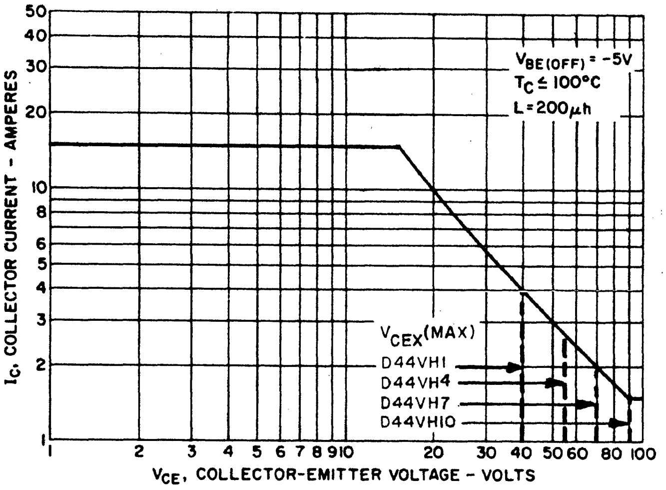
5. CAPACITANCE



6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

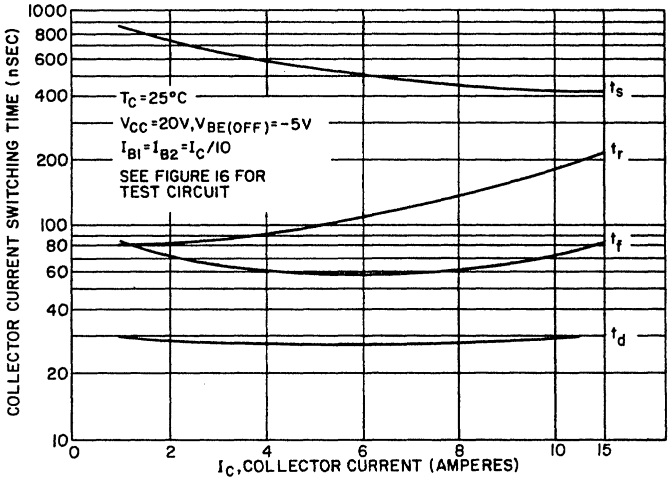


7. FORWARD BIAS SOA

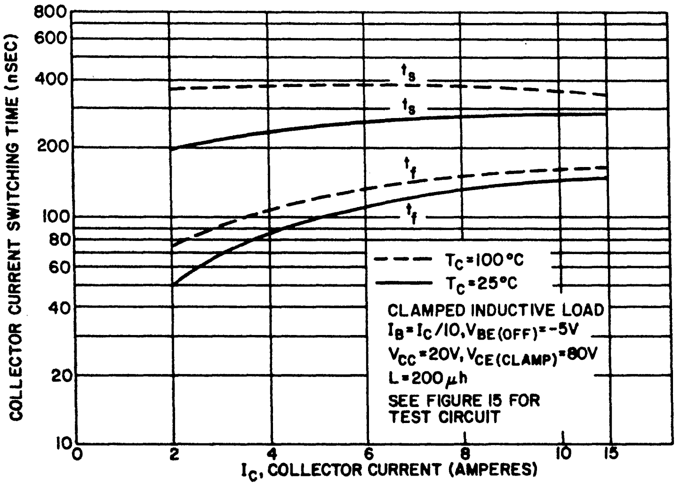


8. REVERSE BIAS SOA

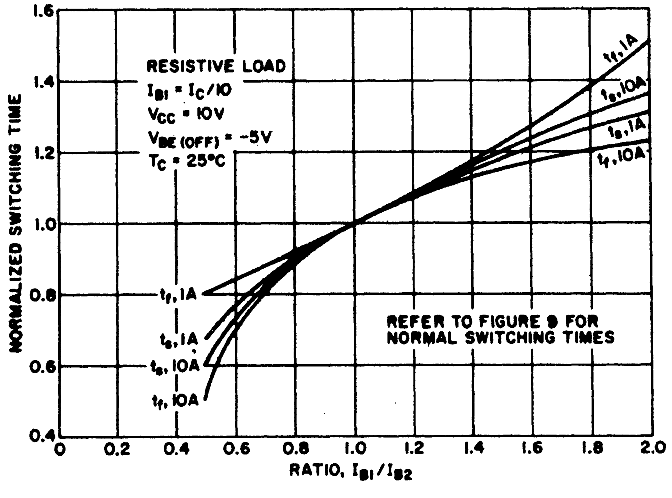
TYPICAL SWITCHING CHARACTERISTICS



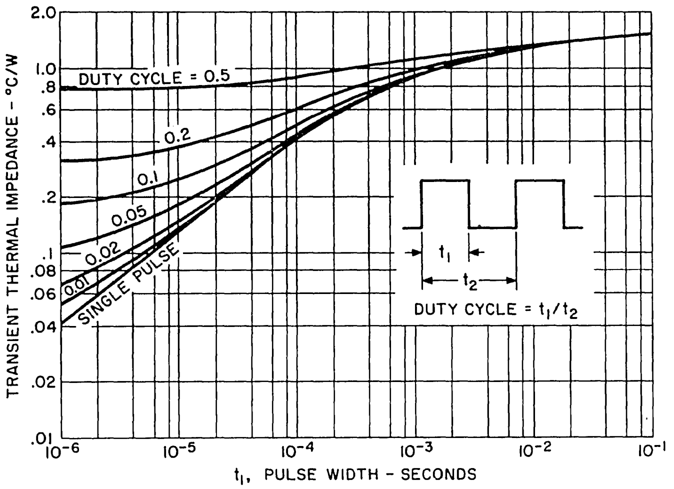
9. RESISTIVE SWITCHING TIME



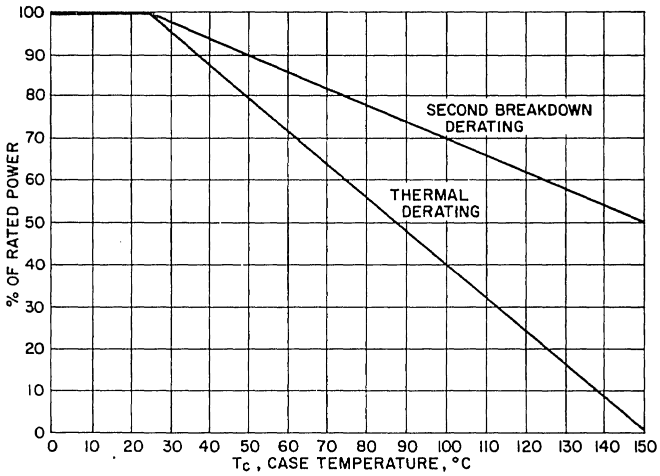
10. CLAMPED INDUCTIVE SWITCHING TIME



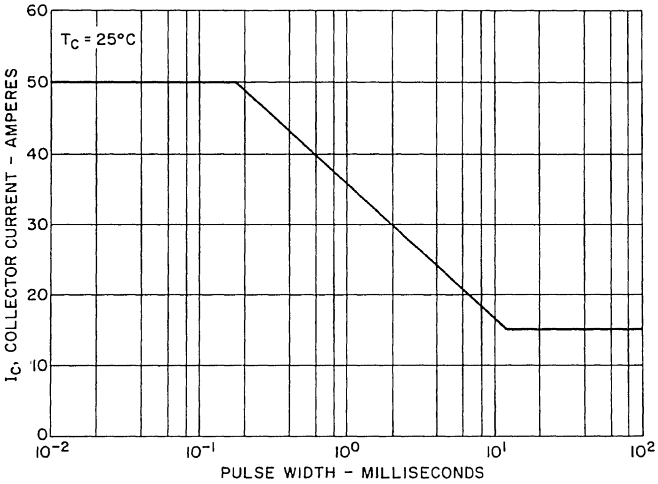
11. SWITCHING TIME VARIATION WITH I_{B2}



12. TRANSIENT THERMAL RESPONSE

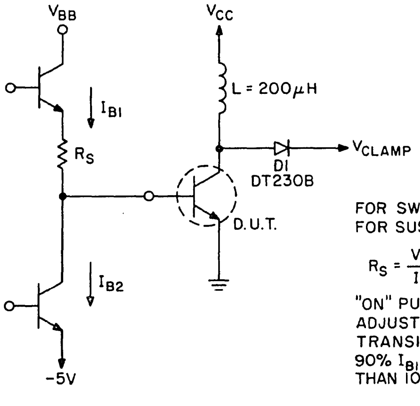


13. POWER DERATING FACTOR



14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS

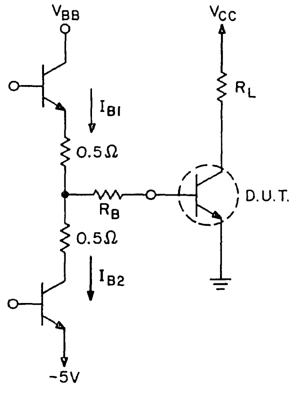


FOR SW. TIMES AND RBSOA
FOR SUSTAINING VOLTAGE

$R_S = \frac{V_{BB}}{I_{B1}}$

"ON" PULSE WIDTH AND V_{CC} ADJUSTED FOR DESIRED PEAK I_C. TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 nS.

15. INDUCTIVE SWITCHING AND V_{CEX}



$R_L = \frac{V_{CC}}{I_C}$, NONINDUCTIVE

$R_B = \frac{V_{BB}}{I_{B1}} - 0.5$

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 nS.

16. RESISTIVE SWITCHING

VERY HIGH SPEED
PNP POWER TRANSISTORS
COMPLEMENTARY TO THE D44VH SERIES

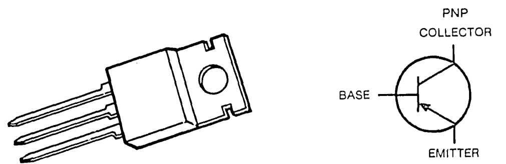
D45VH Series

-30 - -80 VOLTS
-15 AMP, 83 WATTS

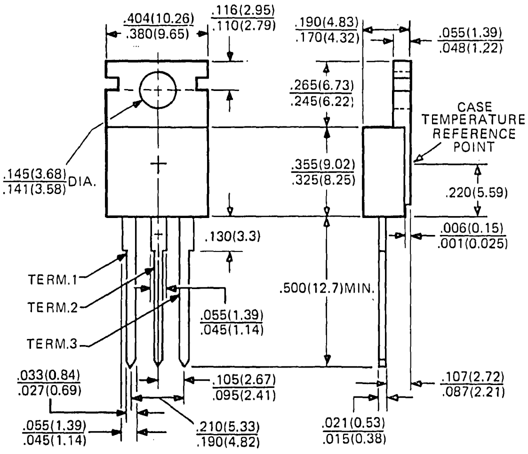
The D45VH is a PNP power transistor especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters and other applications where very fast switching and low-saturation voltages are necessary. This device complements the D44VH NPN power transistor and is characterized with performance information which relates directly to switching.

Features:

- Fast Switching $t_s \leqslant 500$ ns resistive
  $t_f \leqslant 100$ ns
- Low $V_{CE(sat)} \leqslant 1.0V$ @ $I_C = 8A$



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D45VH1	D45VH4	D45VH7	D45VH10	UNITS
Collector-Emitter Voltage	$V_{CEO(sus)}$	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CEX}	-40	-55	-70	-90	Volts
Collector-Emitter Voltage	V_{CEV}	-50	-70	-80	-100	Volts
Emitter Base Voltage	V_{EBO}	-7	-7	-7	-7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-15 -20	-15 -20	-15 -20	-15 -20	A
Base Current — Continuous Peak(1)	I_B I_{BM}	-5 -10	-5 -10	-5 -10	-5 -10	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	83 33 .67	83 33 .67	83 33 .67	83 33 .67	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	1.5	1.5	1.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	235	235	235	235	°C

(1) Pulse measurement condition PW ≤ 6.0 ms, see Figure 14.

electrical characteristics (T_c = 25° C) (unless otherwise specified)

off characteristics[1]

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
Collector-Emitter Sustaining Voltage[1] (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D45VH1		-30	—	
D45VH4		-45	—	
D45VH7		-60	—	
D45VH10		-80	—	
Collector-Emitter Voltage[2] (I_C = 10A, V_{CLAMP} = Rated V_{CEX}, T_C = 100° C)	V_{CEX}			V
D45VH1		-40	—	
D45VH4		-55	—	
D45VH7		-70	—	
D45VH10		-90	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V)		—	-10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V, T_C = 100° C)		—	-100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100° C)	I_{CER}	—	-100	μA
Emitter Cutoff Current (V_{EB} = -7V, I_C = 0)	I_{EBO}	—	-10	μA

second breakdown

CHARACTERISTICS	SYMBOL	MIN / MAX
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8

on characteristics[1]

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
DC Current Gain	h_{FE}			—
(I_C = -2 A, V_{CE} = -1V)		35	—	
(I_C = -4 A, V_{CE} = -1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = -8A, I_B = -0.8A)		—	-1.0	
(I_C = -8A, I_B = -0.8A, T_C = 100° C)		—	-1.1	
(I_C = -15A, I_B = -3.0A, T_C = 100° C)		—	-1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = -8A, I_B = -0.8A)		—	-1.4	
(I_C = -8A, I_B = -0.8A, T_C = 100° C)		—	-1.4	

dynamic characteristics

CHARACTERISTICS	SYMBOL	Typical	UNIT
Current-Gain — Bandwidth Product (I_C = -0.1A, V_{CE} = -10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = -10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	275	pF

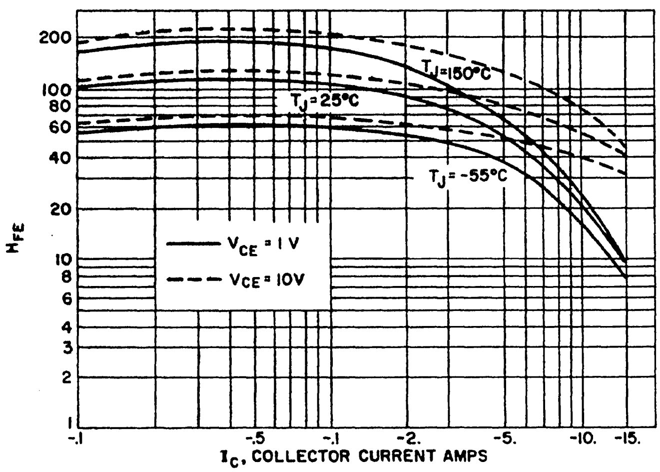
switching characteristics

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25° C	100° C	
Delay Time	V_{CC} = -20V, I_C = -8A I_{B1} = I_{B2} = -0.8A t_p = 25 μsec	t_d	50	—	nsec
Rise Time		t_r	250	—	nsec
Storage Time		t_s	500	—	nsec
Fall Time		t_f	100	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	V_{CC} = -20V, I_C = -8A V_{CLAMP} = Rated V_{CEX} I_{B1} = 0.8A, $V_{BE(off)}$ = -5V L = 200 μh	t_s	500	600	nsec
Fall Time		t_f	300	400	nsec
			Typical		
Storage Time		t_s	200	320	nsec
Fall Time		t_f	160	180	nsec

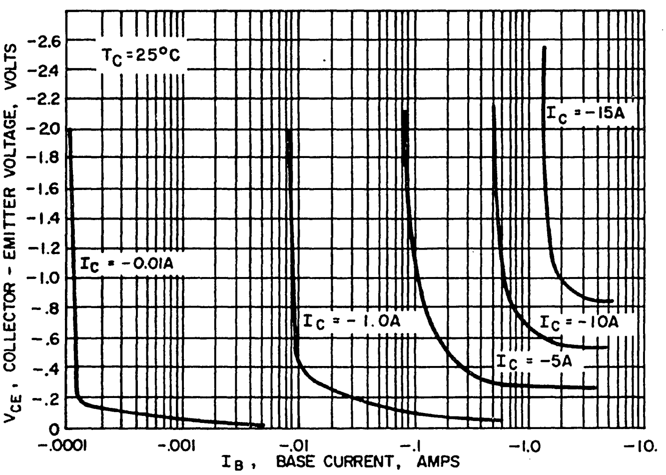
(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.

(2) See Figure 15 for Test Circuit.

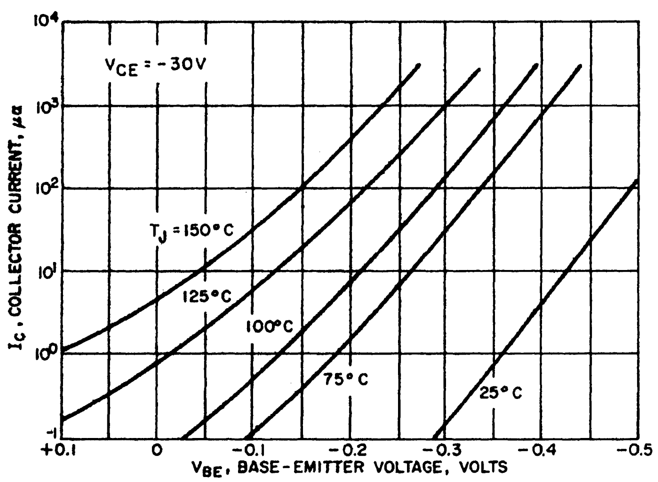
TYPICAL DC CHARACTERISTICS



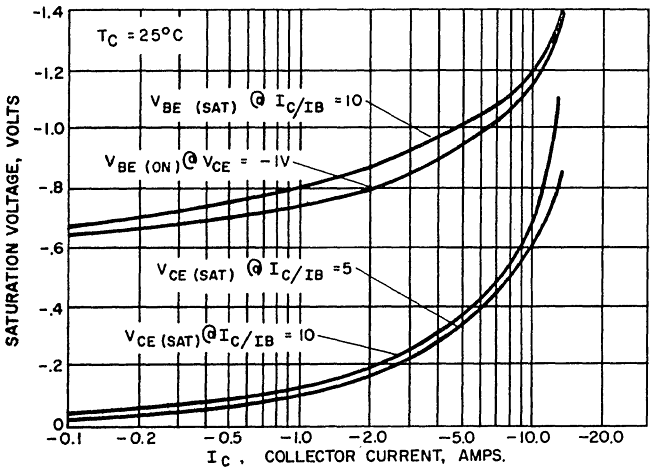
1. DC CURRENT GAIN



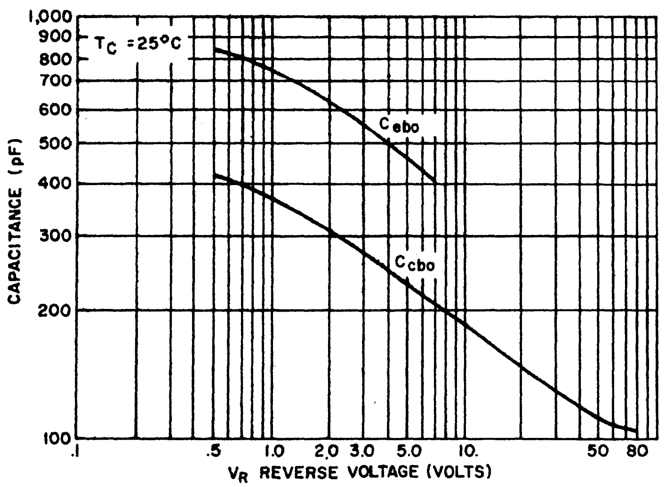
2. COLLECTOR SATURATION REGION



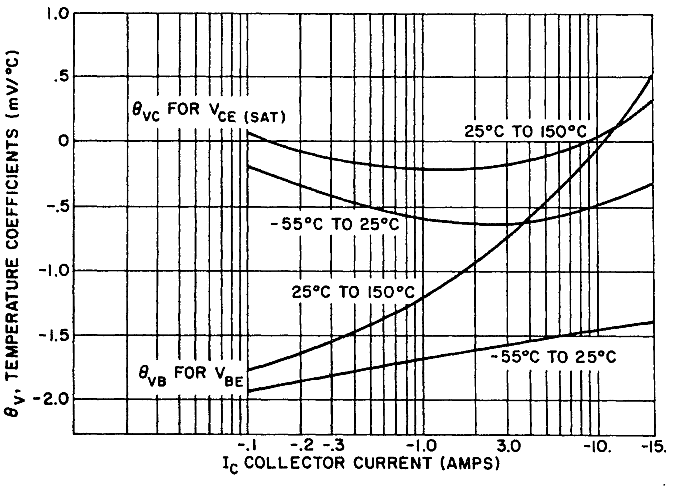
3. COLLECTOR CUTOFF REGION



4. SATURATION VOLTAGE

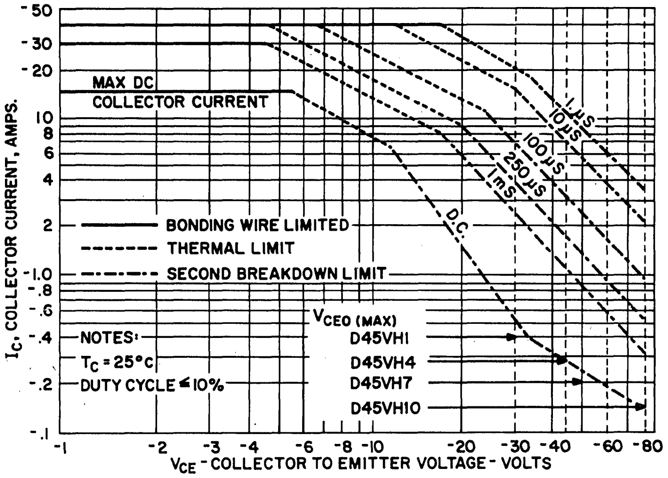


5. CAPACITANCE

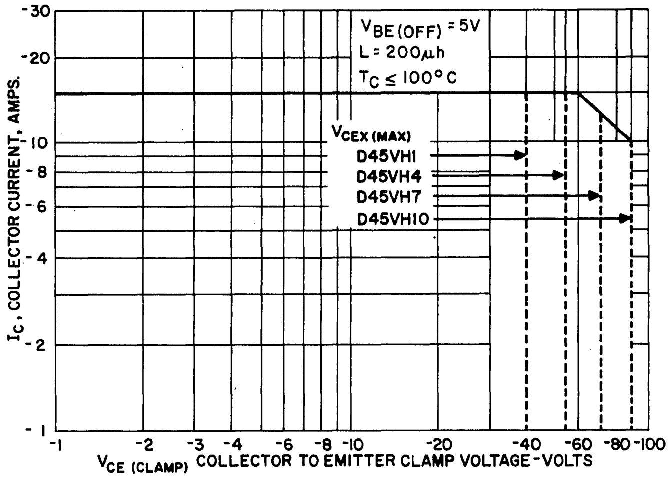


6. SATURATION VOLTAGE
TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

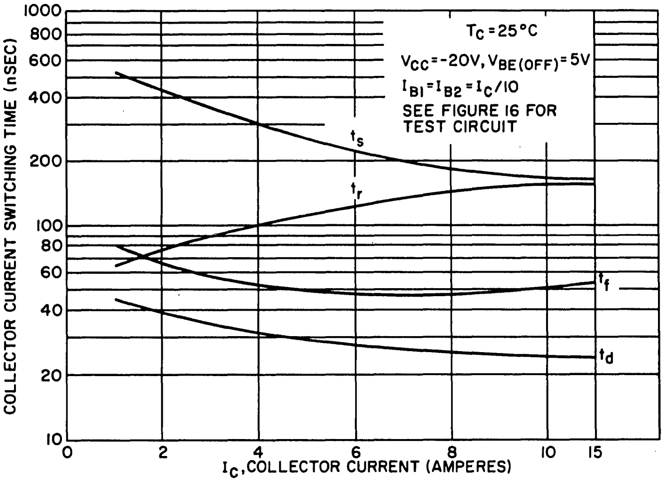


7. FORWARD BIAS SOA

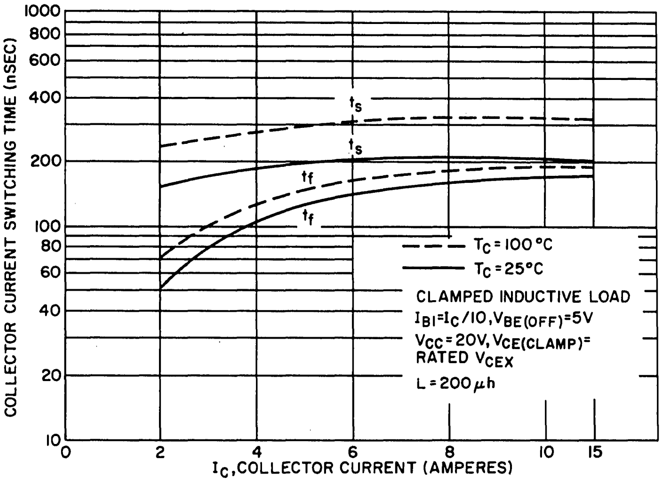


8. REVERSE BIAS SOA

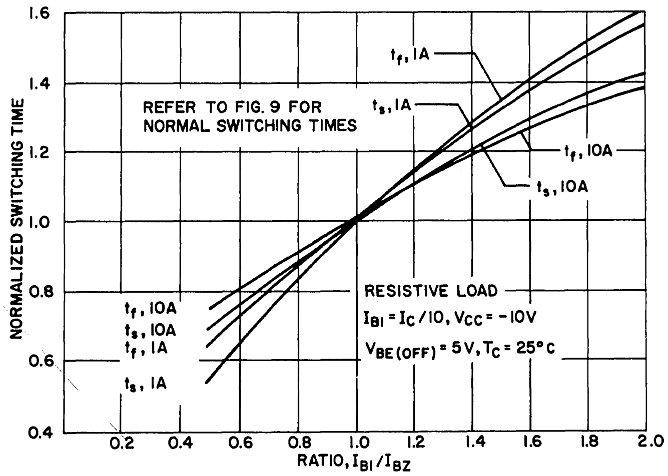
TYPICAL SWITCHING CHARACTERISTICS



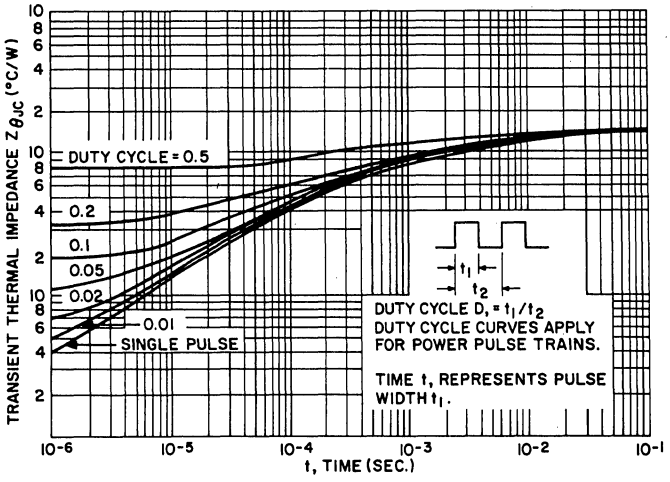
9. RESISTIVE SWITCHING TIME



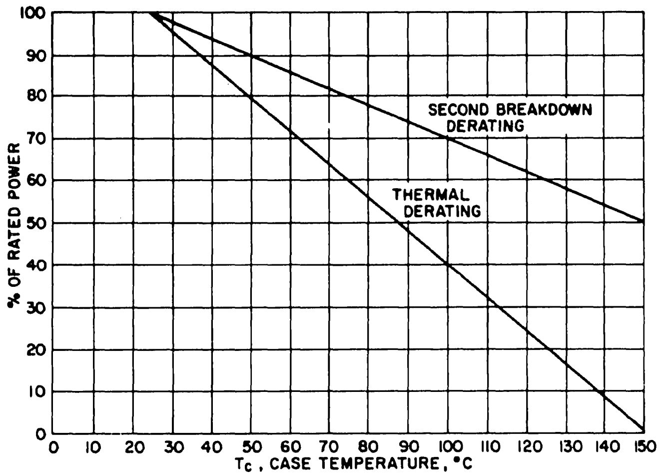
10. CLAMPED INDUCTIVE SWITCHING TIME



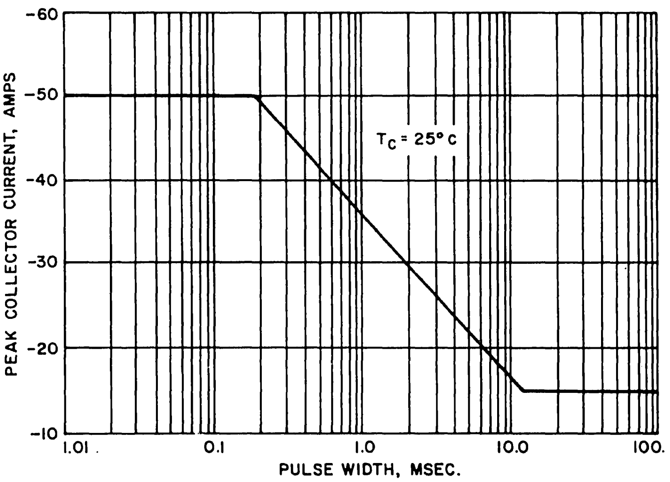
11. SWITCHING TIME VARIATION WITH I_{B2}



12. TRANSIENT THERMAL RESPONSE

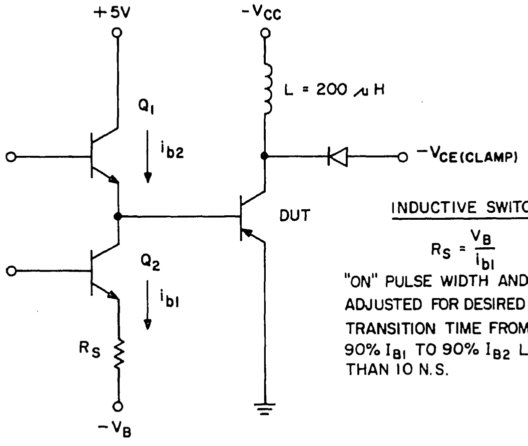


13. POWER DERATING FACTOR



14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS

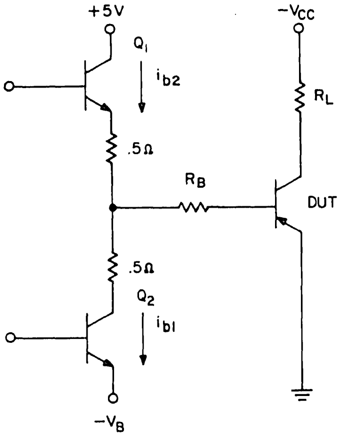


INDUCTIVE SWITCHING

$R_S = \frac{V_B}{i_{b1}}$

"ON" PULSE WIDTH AND V_{CC} ADJUSTED FOR DESIRED PEAK I_C.
TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 N.S.

15. INDUCTIVE SWITCHING AND V_{CEX}



RESISTIVE SWITCHING

$R_C = \frac{V_{CC}}{I_C}$, NON-INDUCTIVE

$R_B = \frac{V_B}{i_{b1}} - 0.5$

TRANSITION TIME 90% I_{B1} TO 90% I_{B2} LESS THAN 10 N.S.

16. RESISTIVE SWITCHING

VERY HIGH SPEED
NPN POWER TRANSISTORS
COMPLEMENTARY TO THE D45VM SERIES

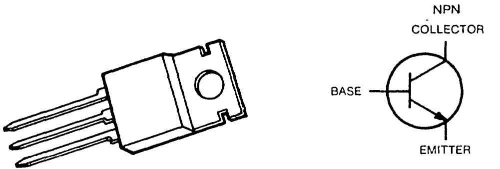
D44VM Series

30 - 80 VOLTS
8 AMP, 50 WATTS

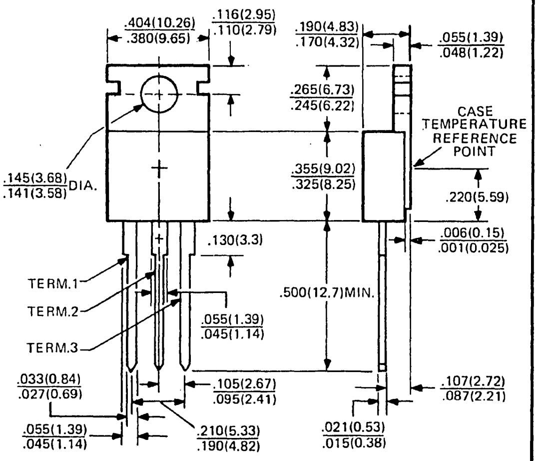
The D44VM is a NPN power transistor especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters and other applications where very fast switching and low-saturation voltages are necessary. This device is characterized with performance information which relates directly to switching, including 100° C maximum limits specified for switching times, saturation voltages, and leakage currents.

Features:

- Very Fast Switching $t_S \leqslant 500$ ns resistive
  $t_f \leqslant 75$ ns
- Very Low $V_{CE(sat)} \leqslant 0.4V$ @ $I_C = 4A$
- High Gain $H_{FE} \geqslant 40$ @ $I_C = 4A$



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D44VM1	D44VM4	D44VM7	D44VM10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	30	45	60	80	V
Collector-Emitter Voltage	V_{CEX}	30	45	60	80	V
Collector-Emitter Voltage	V_{CEV}	50	70	80	100	V
Emitter Base Voltage	V_{EB}		7			V
Collector Current — Continuous — Peak (1)	I_C I_{CM}		8 20			A
Base Current — Continuous — Peak (1)	I_B I_{BM}		2 5			A
Total Power Dissipation @ $T_C = 25°C$ @ $T_C = 100°C$ Derate above 25° C	P_D		50 20 0.4			Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}		-55 to +150			° C

thermal characteristics

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	° C/W
Maximum Lead Temperature for Soldering Purposes: 1/8″ from Case for 5 Seconds	T_L	235	° C

(1) Pulse measurement condition PW ⩽ 6.0 ms.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT

off characteristics(1)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
Collector-Emitter Sustaining Voltage(1) (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D44VM1		30	—	
D44VM4		45	—	
D44VM7		60	—	
D44VM10		80	—	
Collector-Emitter Voltage(2) (I_C = 3A, V_{CLAMP} = Rated V_{CEX}, $T_C \leqslant$ 100° C)	V_{CEX}			V
D44VM1		30	—	
D44VM4		45	—	
D44VM7		60	—	
D44VM10		80	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V)		—	10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V, T_C = 100° C)		—	100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100° C)	I_{CER}	—	100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	10	μA

second breakdown

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		

on characteristics(1)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
DC Current Gain	h_{FE}			—
(I_C = 4A, V_{CE} = 1V)		40	—	
(I_C = 6A, V_{CE} = 1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = 4A, I_B = 0.2A)		—	0.4	
(I_C = 6A, I_B = 0.3A)		—	0.6	
(I_C = 8A, I_B = 0.8A, T_C = 100° C)		—	1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = 4A, I_B = 0.2A)		—	1.2	
(I_C = 4A, I_B = 0.2A, T_C = 100° C)		—	1.2	

dynamic characteristics

CHARACTERISTICS	SYMBOL	Typical	UNIT
Current-Gain — Bandwidth Product (I_C = 0.1A, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	70	pF

switching characteristics

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25° C	100° C	
Delay Time	V_{CC} = 30V, I_C = 6A I_{B1} = I_{B2} = 0.6A t_p = 25 μsec	t_d	30	40	nsec
Rise Time		t_r	250	350	nsec
Storage Time		t_s	500	600	nsec
Fall Time		t_f	75	250	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CE(CLAMP)}$ = 30V, I_C = 6A	t_s	500	600	nsec
Fall Time	I_{B1} = I_{B2} = 0.6A, $V_{BE(OFF)}$ = -5V	t_f	70	100	nsec
			Typical		
Storage Time	L = 200 μh	t_s	340	430	nsec
Fall Time		t_f	40	57	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ⩽ 2%.

(2) See Figure 15 for Test Circuit.

TYPICAL DC CHARACTERISTICS

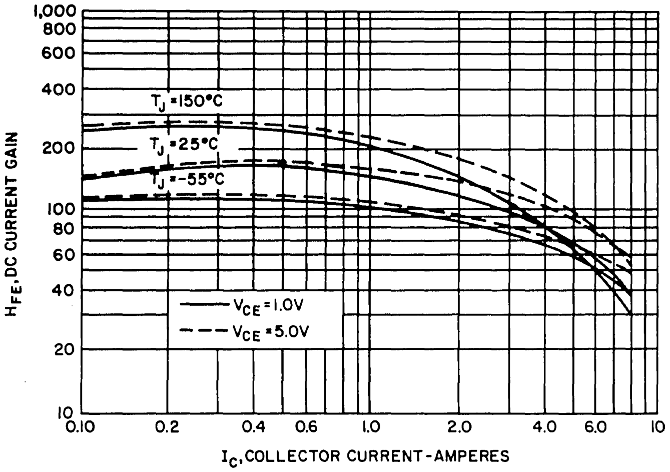


FIGURE 1. DC CURRENT GAIN

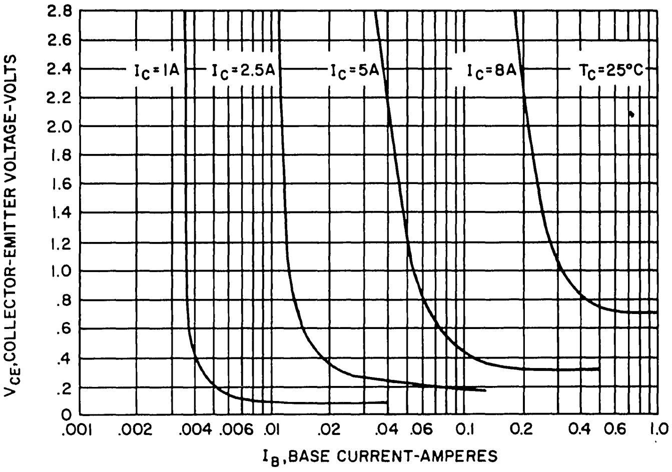


FIGURE 2. COLLECTOR SATURATION REGION

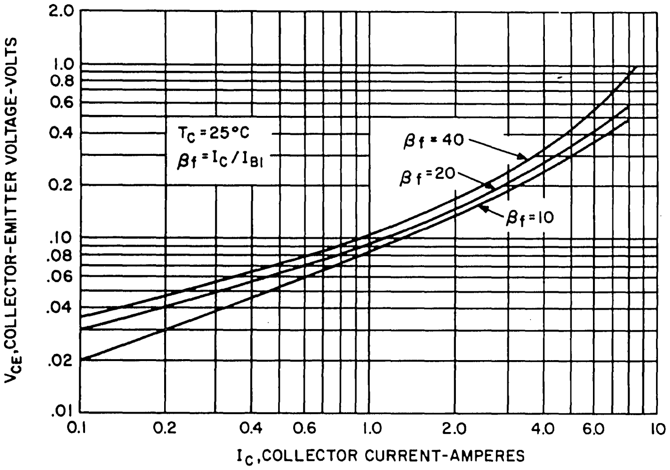


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

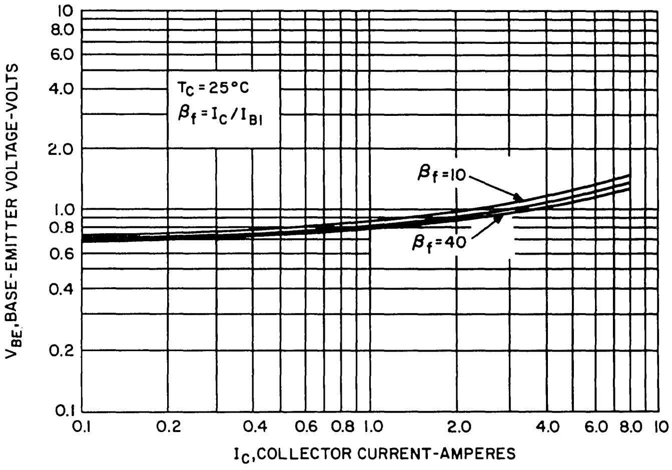


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

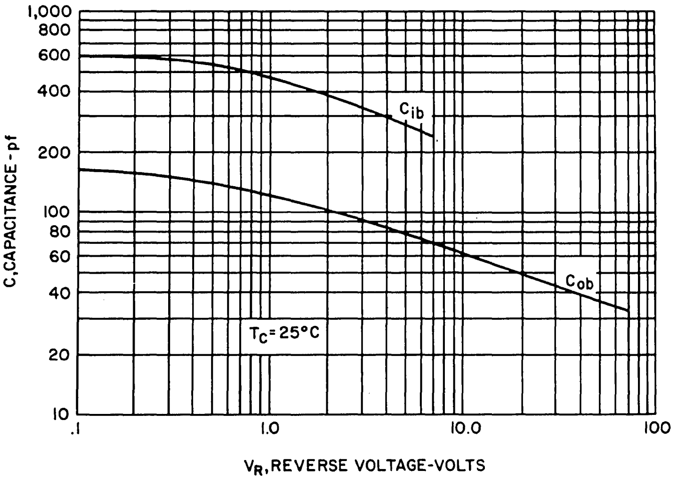


FIGURE 5. CAPACITANCE

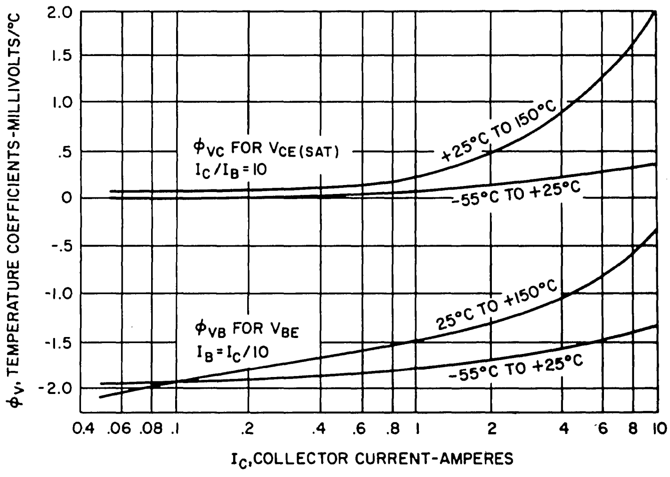


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

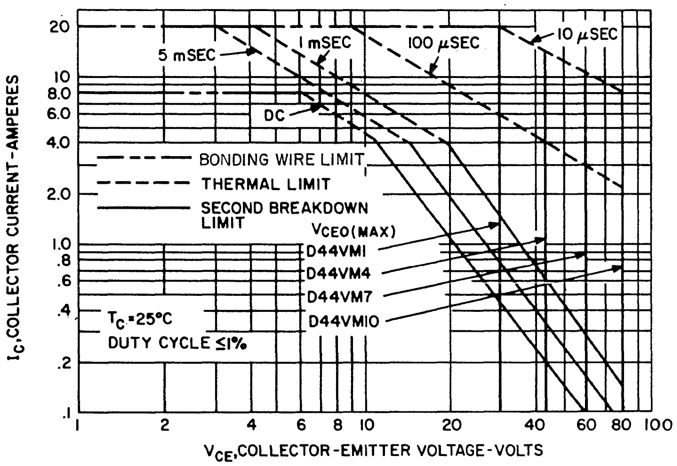


FIGURE 7. FORWARD BIAS SOA

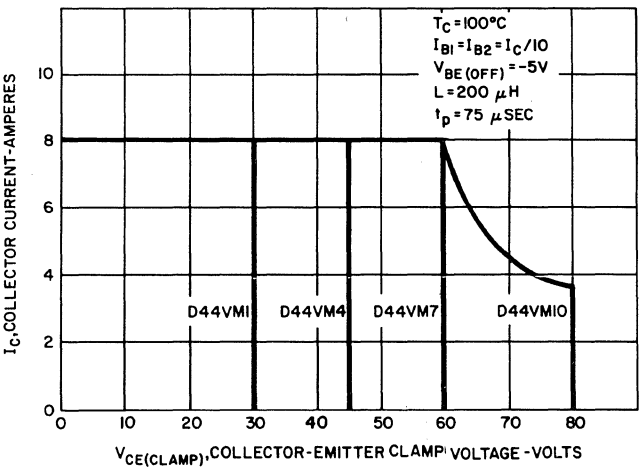


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

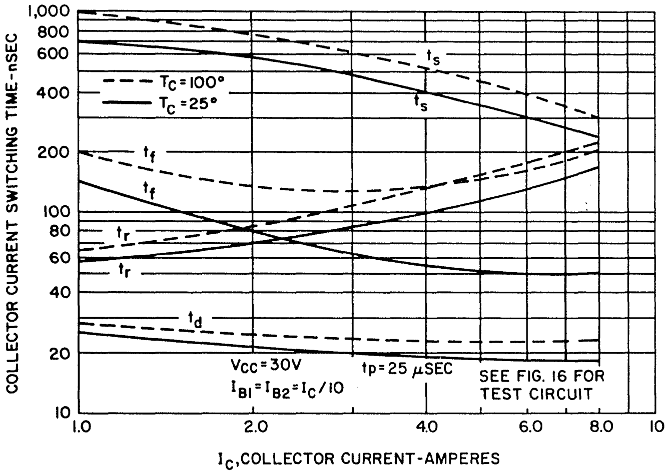


FIGURE 9. RESISTIVE SWITCHING TIME

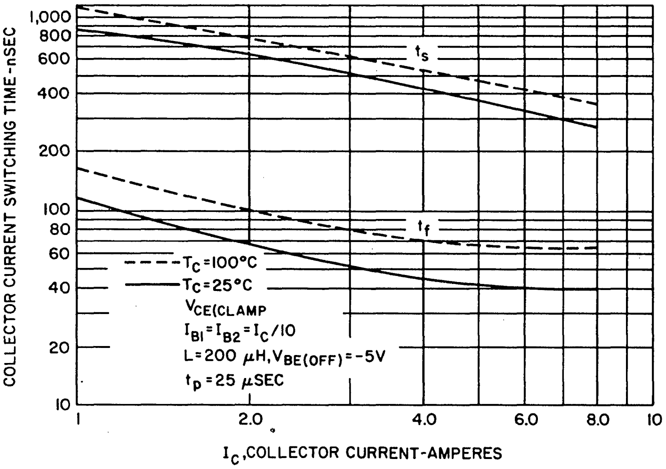


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

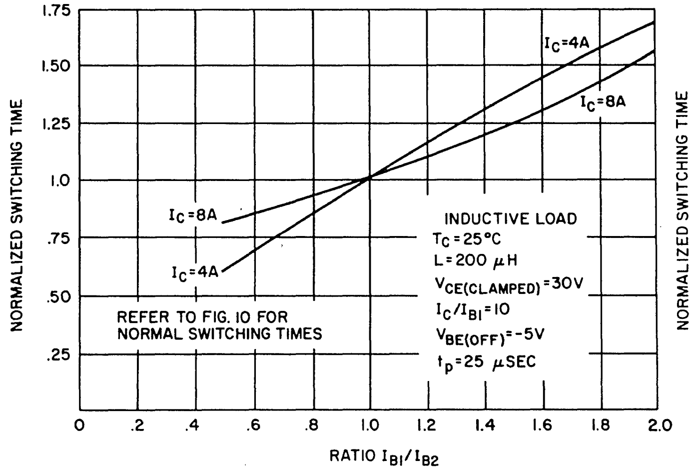


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

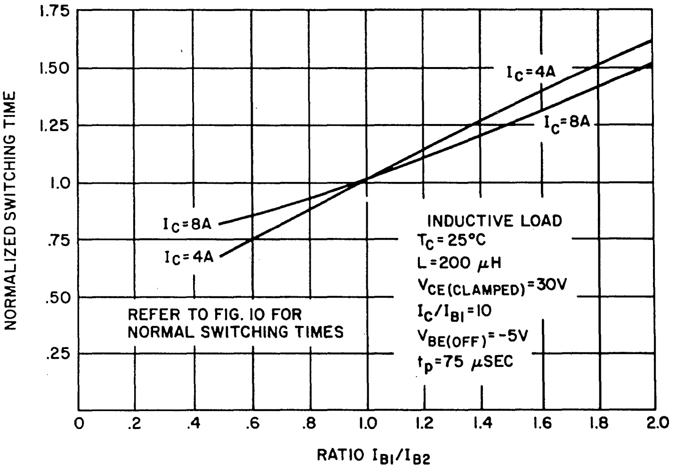


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

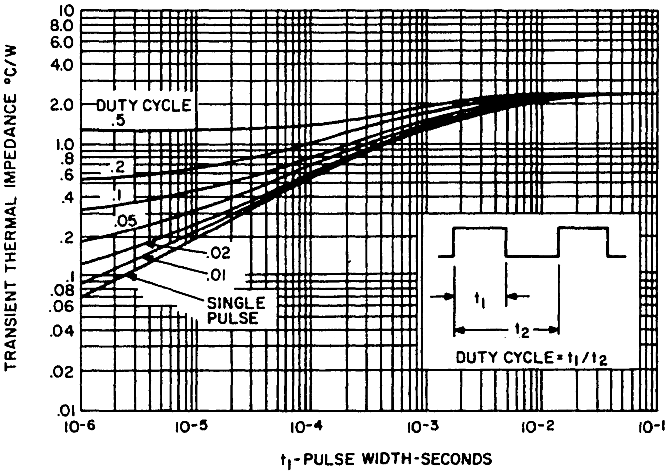


FIGURE 13. TRANSIENT THERMAL RESPONSE

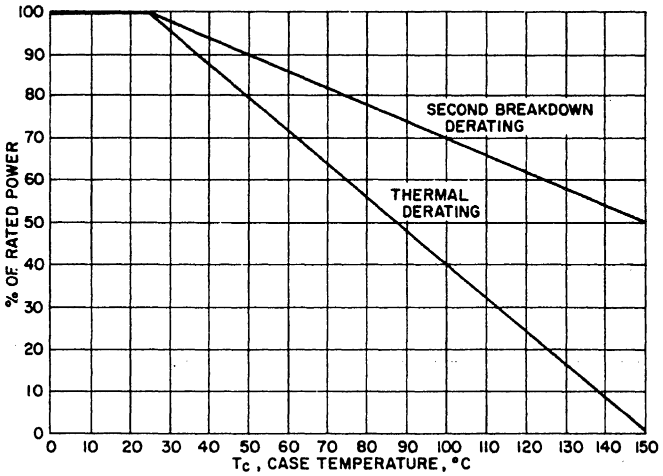
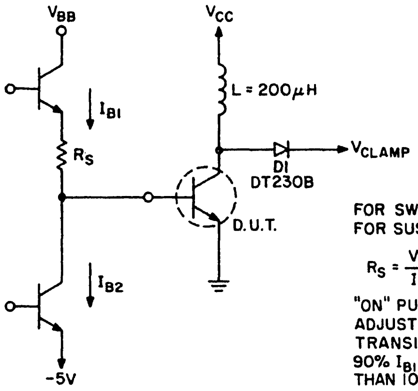


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS

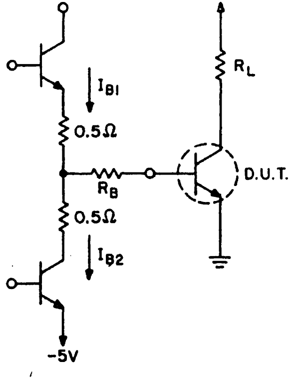


FOR SW. TIMES AND RBSOA
FOR SUSTAINING VOLTAGE

$R_S = \frac{V_{BB}}{I_{B1}}$

"ON" PULSE WIDTH AND V_{CC}
ADJUSTED FOR DESIRED PEAK I_C.
TRANSITION TIME FROM
90% I_{B1} TO 90% I_{B2} LESS
THAN 10 n S.

FIGURE 15. INDUCTIVE SWITCHING AND V_{CEX}



$R_L = \frac{V_{CC}}{I_C}$, NONINDUCTIVE

$R_B = \frac{V_{BB}}{I_{B1}} - 0.5$

TRANSITION TIME FROM
90% I_{B1} TO 90% I_{B2} LESS
THAN 10 n S.

FIGURE 16. RESISTIVE SWITCHING

VERY HIGH SPEED
PNP POWER TRANSISTORS
COMPLEMENTARY TO THE D44VM SERIES

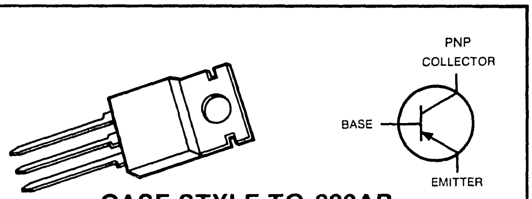
D45VM Series

-30 - -80 VOLTS
-8 AMP, 50 WATTS

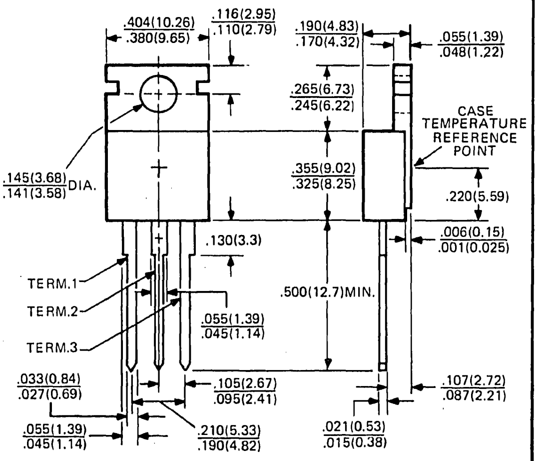
The D45VM is an PNP power transistor especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters and other applications where very fast switching and low-saturation voltages are necessary. This device is characterized with performance information which relates directly to switching, including 100° C maximum limits specified for switching times, saturation voltages, and leakage currents.

Features:

- Very Fast Switching $t_s \leqslant 500$ ns resistive
  $t_f \leqslant 75$ ns
- Very Low $V_{CE(sat)} \leqslant 0.4V$ @ $I_C = 4A$
- High Gain $H_{FE} \geqslant 40$ @ $I_C = 4A$



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D45VM1	D45VM4	D45VM7	D45VM10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	-30	-45	-60	-80	V
Collector-Emitter Voltage	V_{CEX}	-30	-45	-60	-80	V
Collector-Emitter Voltage	V_{CEV}	-50	-70	-80	-100	V
Emitter Base Voltage	V_{EBO}		-7			V
Collector Current — Continuous — Peak (1)	I_C I_{CM}		-8 -20			A
Base Current — Continuous — Peak (1)	I_B I_{BM}		-2 -5			A
Total Power Dissipation @ $T_C = 25°C$ @ $T_C = 100°C$ Derate above 25° C	P_D		50 20 0.4			Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}		-55 to +150			°C

thermal characteristics

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8″ from Case for 5 Seconds	T_L	235	°C

(1) Pulse measurement condition PW ⩽ 6.0 ms.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage(1) (I_C = -100mA, I_B = 0)	$V_{CEO(sus)}$			V
D45VM1		-30	—	
D45VM4		-45	—	
D45VM7		-60	—	
D45VM10		-80	—	
Collector-Emitter Voltage(2) (I_C = 3A, V_{CLAMP} = Rated V_{CEX}, $T_C \leqslant$ 100° C)	V_{CEX}			V
D45VM1		-30	—	
D45VM4		-45	—	
D45VM7		-60	—	
D45VM10		-80	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V)		—	-10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V, T_C = 100° C)		—	-100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100° C)	I_{CER}	—	-100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	-10	μA

second breakdown

Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8

on characteristics(1)

DC Current Gain	h_{FE}			—
(I_C = -4A, V_{CE} = -1V)		40	—	
(I_C = -6A, V_{CE} = -1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = -4A, I_B = -0.2A)		—	-0.4	
(I_C = -6A, I_B = -0.3A)		—	-0.6	
(I_C = -8A, I_B = -0.8A, T_C = 100°C)		—	-1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = -4A, I_B = -0.2A)		—	-1.2	
(I_C = -4A, I_B = -0.2A, T_C = 100°C)		—	-1.2	

dynamic characteristics

		Typical	
Current-Gain — Bandwidth Product (I_C = -0.1A, V_{CE} = -10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = -10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	70	pF

switching characteristics

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 30V, I_C = 6A I_{B1} = I_{B2} = 0.6A t_p = 25 μsec	t_d	30	40	nsec
Rise Time		t_r	250	350	nsec
Storage Time		t_s	500	600	nsec
Fall Time		t_f	75	250	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CE(CLAMP)}$ = 30V, I_C = 6A	t_s	500	600	nsec
Fall Time	I_{B1} = I_{B2} = 0.6A, $V_{BE(OFF)}$ = -5V	t_f	70	100	nsec
			Typical		
Storage Time	L = 200 μh	t_s	340	430	nsec
Fall Time		t_f	40	57	nsec

(1) Pulse Duration = 300 μsec, Duty Factor $\leqslant$ 2%.

(2) See Figure 15 for Test Circuit.

TYPICAL DC CHARACTERISTICS

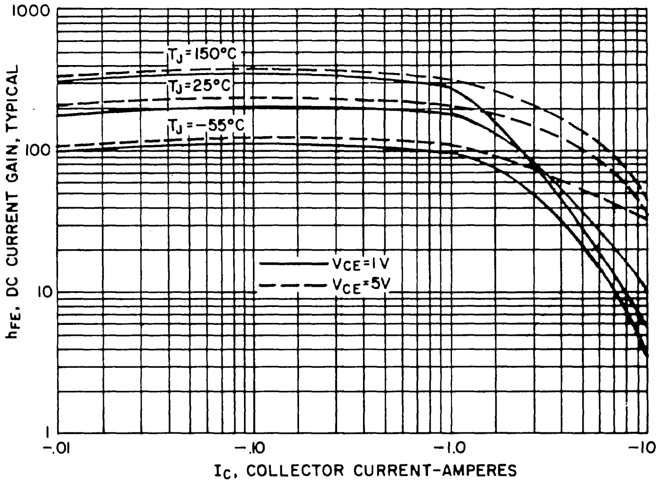


FIGURE 1. DC CURRENT GAIN

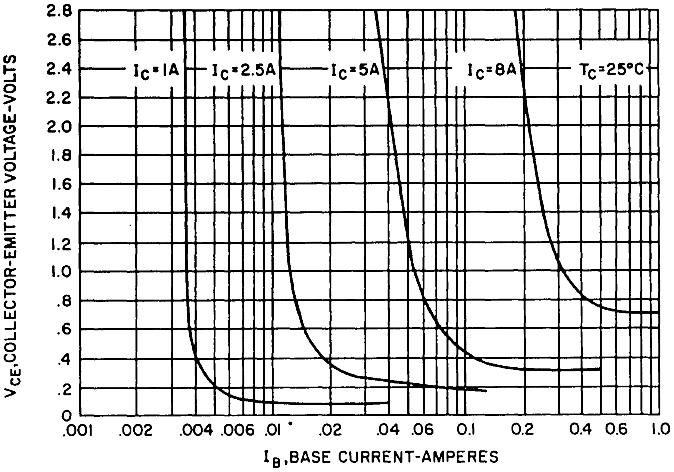


FIGURE 2. COLLECTOR SATURATION REGION

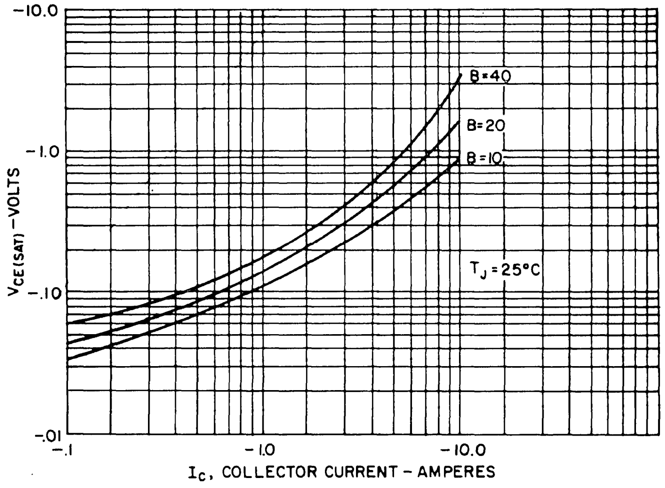


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

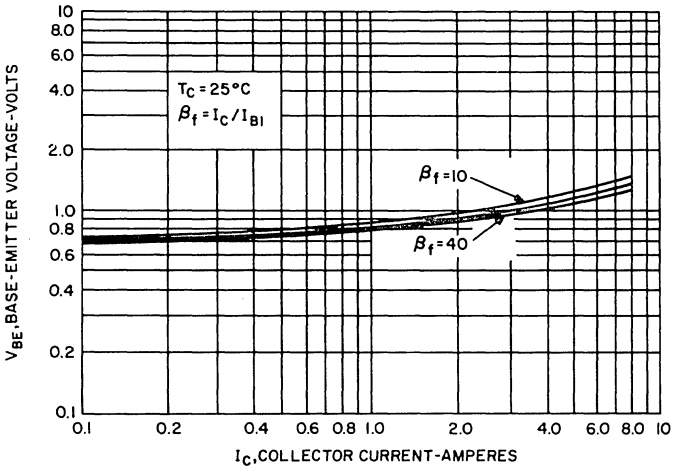


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

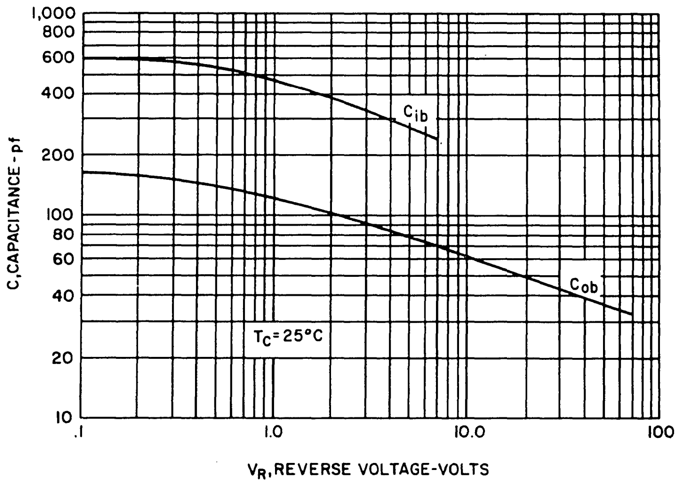


FIGURE 5. CAPACITANCE

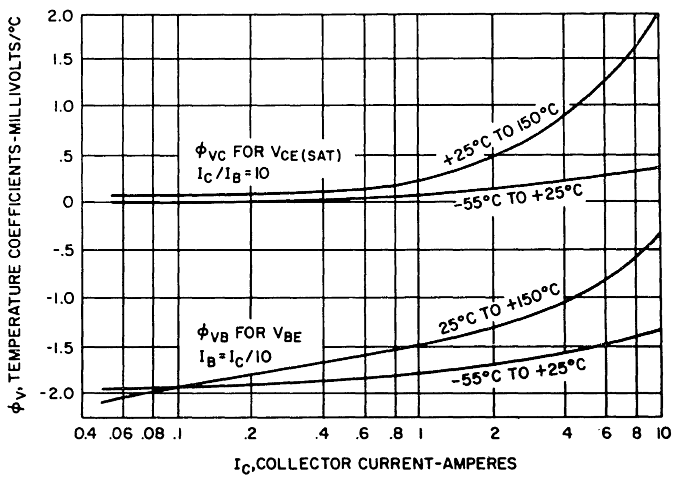


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

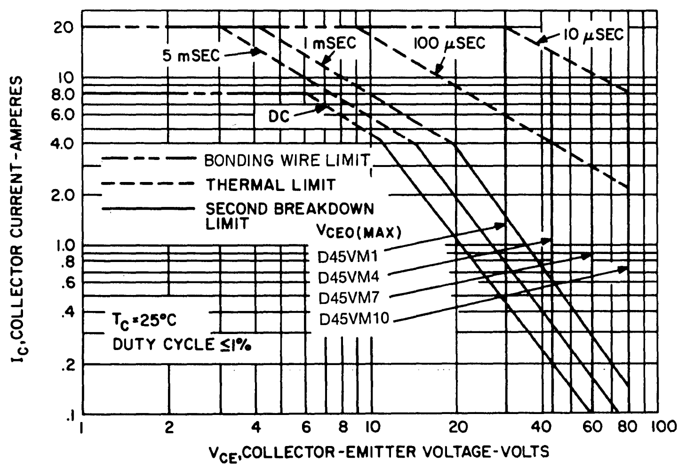


FIGURE 7. FORWARD BIAS SOA

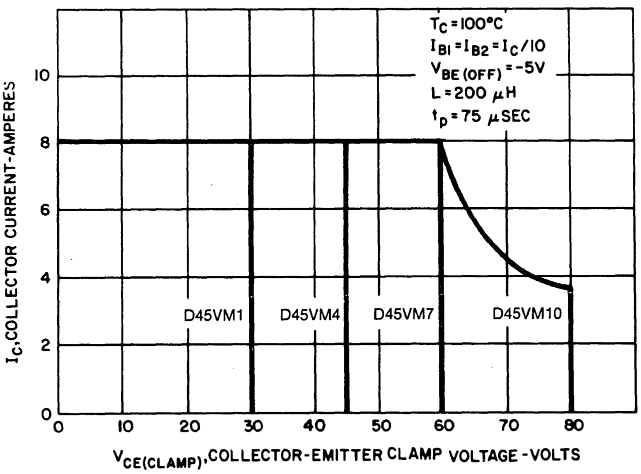


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

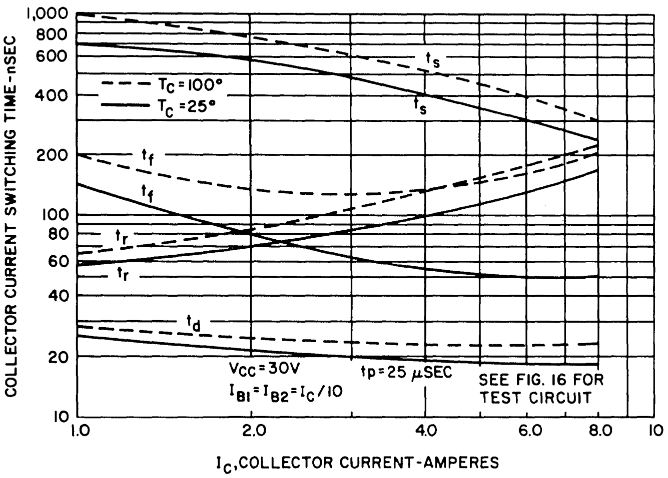


FIGURE 9. RESISTIVE SWITCHING TIME

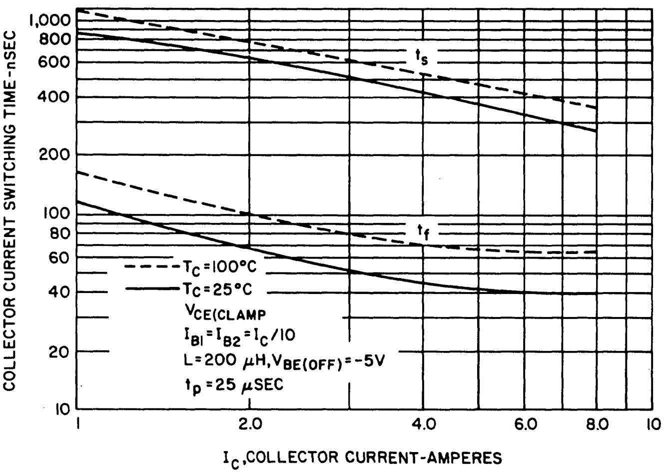


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

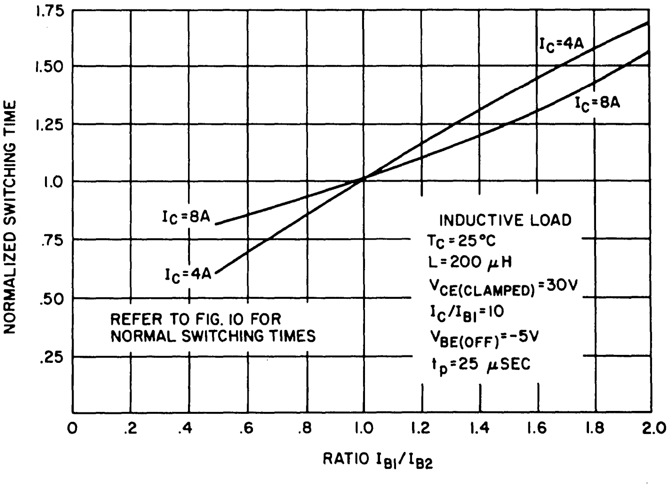


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

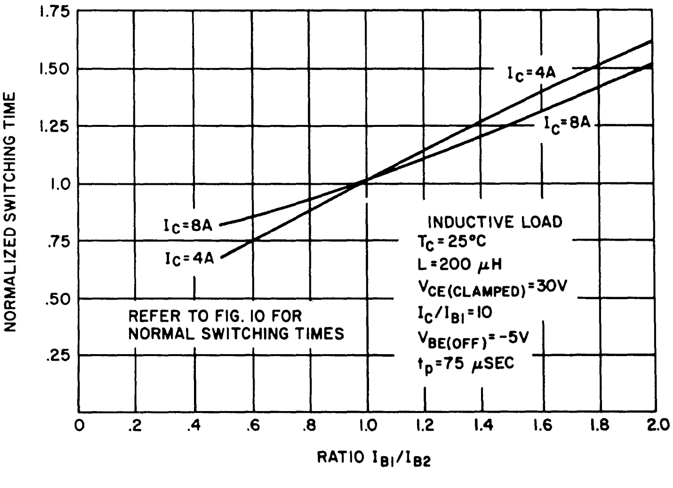


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

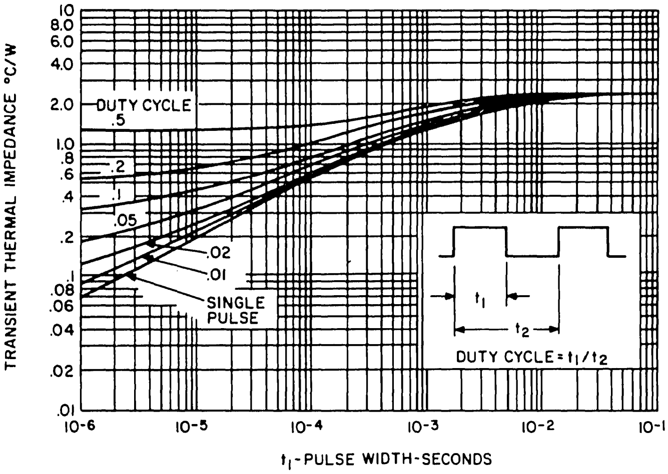


FIGURE 13. TRANSIENT THERMAL RESPONSE

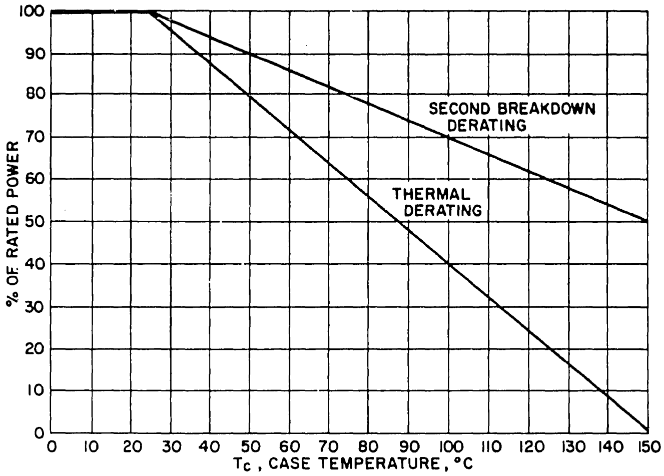
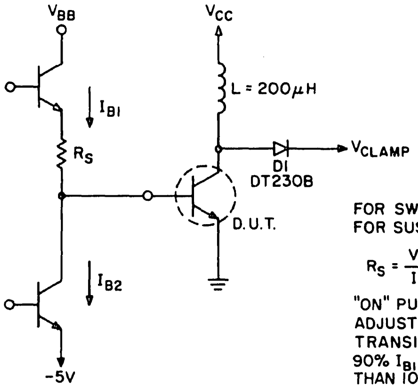


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS

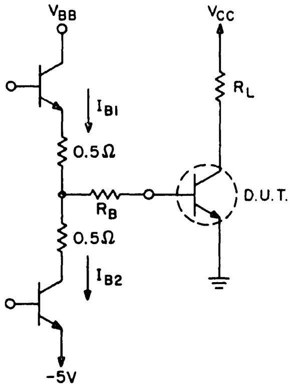


FOR SW. TIMES AND RBSOA
FOR SUSTAINING VOLTAGE

$R_S = \frac{V_{BB}}{I_{B1}}$

"ON" PULSE WIDTH AND V_{CC} ADJUSTED FOR DESIRED PEAK I_C. TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 nS.

FIGURE 15. INDUCTIVE SWITCHING AND V_{CEX}



$R_L = \frac{V_{CC}}{I_C}$, NONINDUCTIVE

$R_B = \frac{V_{BB}}{I_{B1}} - 0.5$

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10nS.

FIGURE 16. RESISTIVE SWITCHING

HIGH SPEED
NPN POWER TRANSISTORS

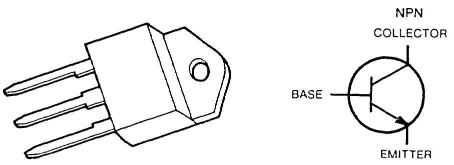
D46TQ1
D46TQ2

400-450 VOLTS
12 AMP, 110 WATTS

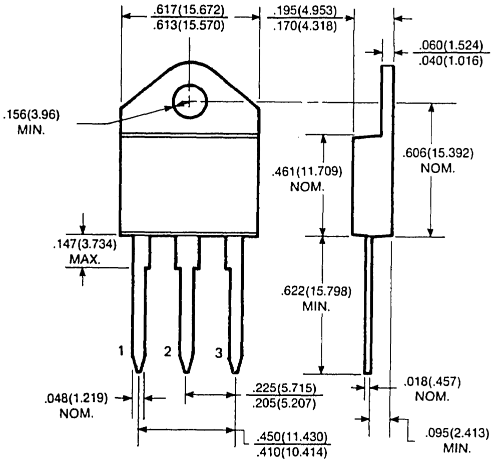
The D46TQ1 and D46TQ2 are designed for high-voltage, high-speed power switching inductive circuits where fall time is critical. They are particularly suited for 115 and 220V switch-mode applications such as switching regulators, inverters, motor controls, solenoid/relay drivers and deflection circuits.

Features:

- $V_{CEO(sus)}$ 400V and 450 V
- 700 V blocking capability
- SOA and switching information.



CASE STYLE TO-218
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-218	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise noted)

RATING	SYMBOL	D46TQ1	D46TQ2	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	12 24	12 24	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	6 12	6 12	A
Total Power Dissipation @ Tc = 25° C Derate above 25° C	P_D	110 0.88	110 0.88	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.1	1.1	° C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	° C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics(1)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = 10mA, I_B = 0)	D46TQ1 D46TQ2	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CE} = Rated Value, $V_{BE(OFF)}$ = 1.5V)		I_{CEV}	—	—	1	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)		I_{EBO}	—	—	1	mA

on characteristics(1)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 5A, V_{CE} = 5V) (I_C = 8A, V_{CE} = 5V)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.8A) (I_C = 12A, I_B = 3A)	$V_{CE(sat)}$	— — —	— — —	1 1.5 3	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A)	$V_{BE(sat)}$	— —	— —	1.2 1.6	V

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time	V_{CC} = 125V, I_C = 8A I_{B1} = I_{B2} = 1.6A, t_p = 25 μs Duty Cycle < 1%	t_d	—	0.06	0.1	μs
Rise Time		t_r	—	0.45	1	
Storage Time		t_s	—	1.3	3	
Fall Time		t_f	—	0.2	0.7	
Inductive Load, Clamped						
Storage Time	(I_C = 8A, V_{CLAMP} = 300V)	t_{sv}	—	0.92	2.3	μs
Crossover Time	(I_{B1} = 1.6A, $V_{BE(OFF)}$ = 5V T_C = 100° C)	t_c	—	0.12	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

NPN POWER DARLINGTON TRANSISTORS

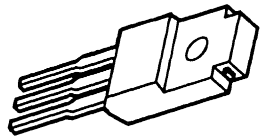
D54A7D

100 VOLTS
7 AMP, 30 WATTS

Designed for high power switching applications, hammer drive, pulse motor drive applications.

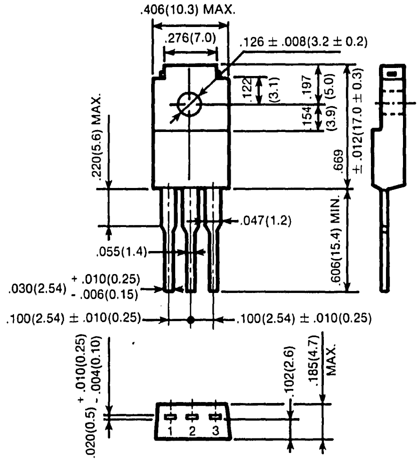
Features:

- High DC Current Gain:
  h_{FE} = 2000 (Min.) (at V_{CE} = 3V, I_C = 3A)
- Low Saturation Voltage:
  $V_{CE(sat)}$ = 1.5V (Max.) (at I_C = 3A)
- Complementary to D55A7D
- Isolated TO-220 package



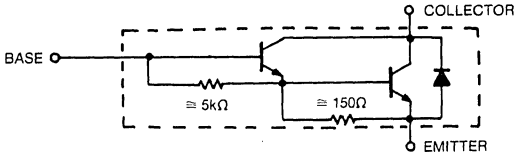
CASE STYLE TO-220IS

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D54A7D	UNITS
Collector-Emitter Voltage	V_{CEO}	100	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	7	A
Base Current — Continuous	I_B	0.2	A
Total Power Dissipation @ T_C = 25°C	P_D	30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 50mA)	$V_{(BR)CEO}$	100	—	—	Volts
Collector Cutoff Current (V_{CB} = 100V)	I_{CBO}	—	—	100	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	3.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9			

on characteristics

DC Current Gain (I_C = 3A, V_{CE} = 3V) (I_C = 7A, V_{CE} = 3V)	h_{FE}	2000 1000	— —	15000 —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA) (I_C = 7A, I_B = 14mA)	$V_{CE(sat)}$	— —	0.9 1.2	1.5 2.0	Volts
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{BE(sat)}$	—	1.5	2.5	Volts

switching characteristics

Turn-on Time	V_{CC} = 45V	t_{on}	—	0.8	—	μs
Storage Time	$I_{B1} = I_{B2}$ = 6μA	t_{stg}	—	3.0	—	
Fall Time	Duty Cycle ≤ 1%	t_f	—	2.5	—	

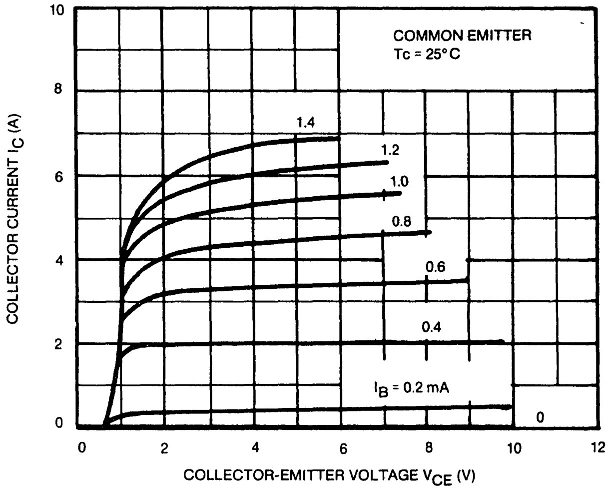


FIG. 1 I_C - V_{CE}

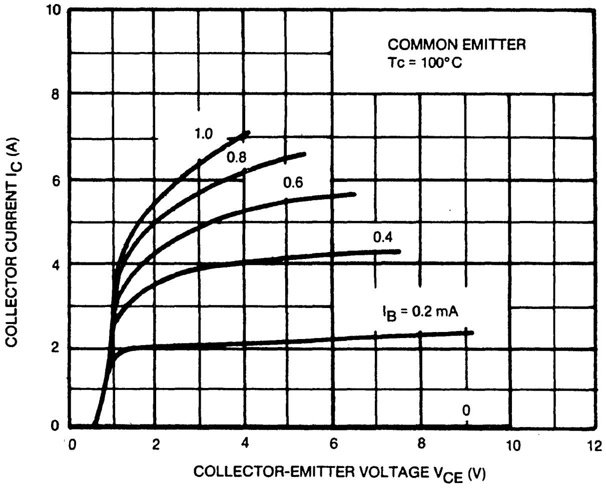


FIG. 2 I_C - V_{CE}

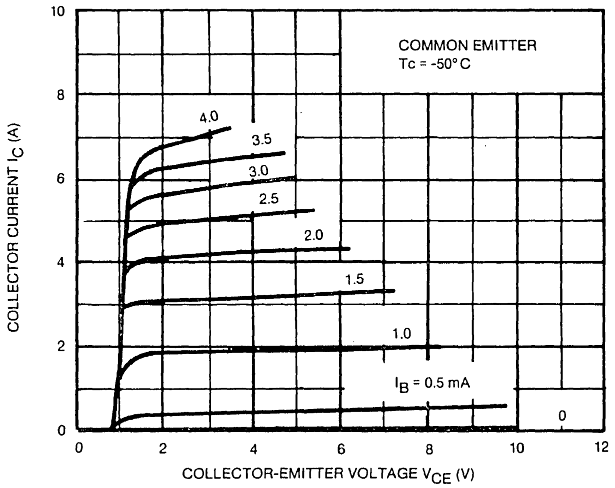


FIG. 3 I_C - V_{CE}

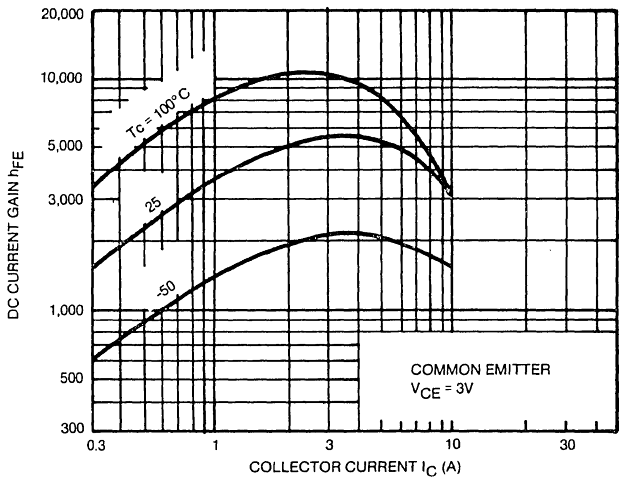


FIG. 4 h_{FE} - I_C

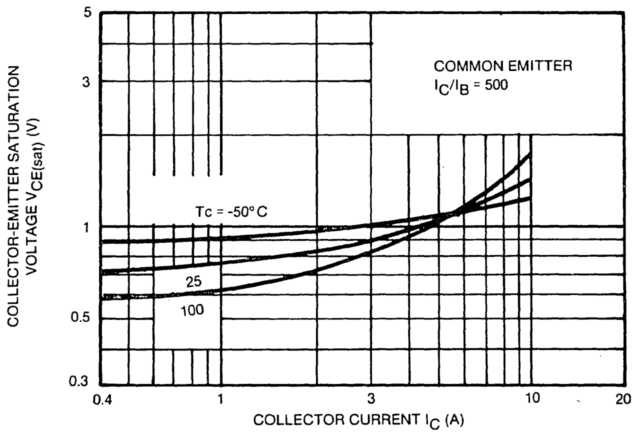


FIG. 5 $V_{CE(sat)}$ - I_C

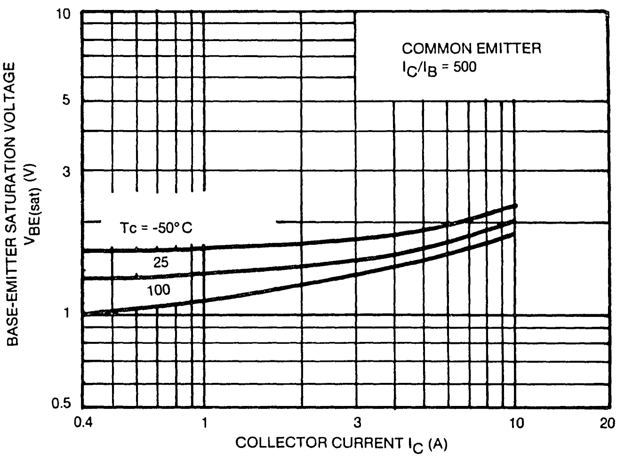


FIG. 6 $V_{BE(sat)}$ - I_C

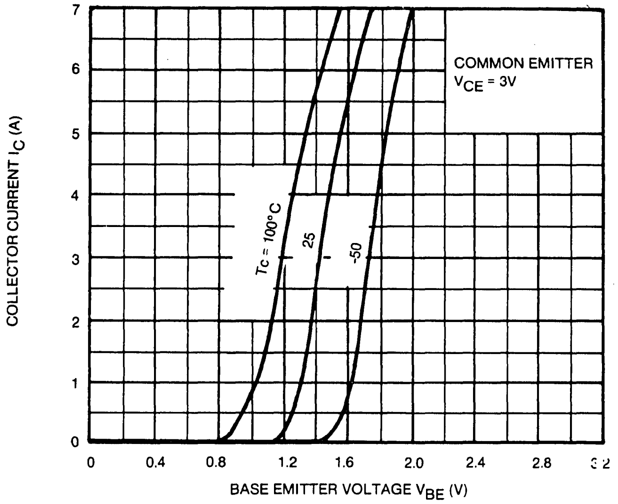


FIG. 7 I_C - V_{BE}

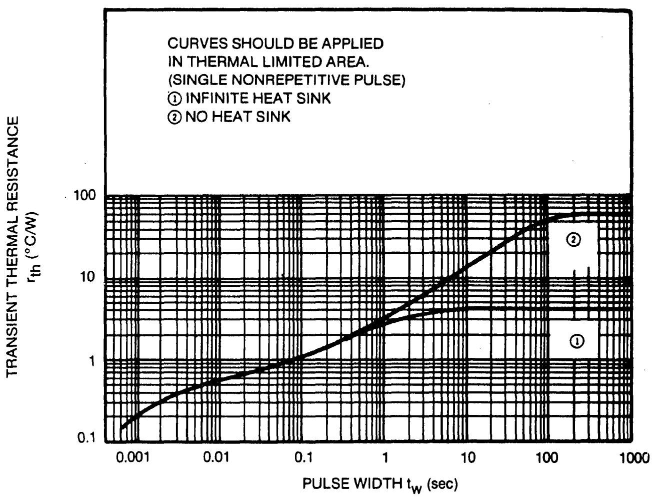


FIG. 8 r_{th} - t_w

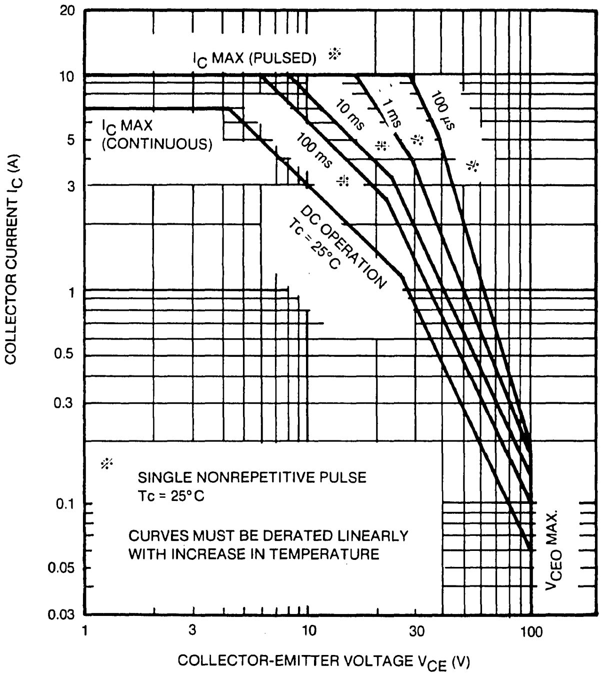


FIG. 9 SAFE OPERATING AREA

NPN POWER DARLINGTON TRANSISTORS

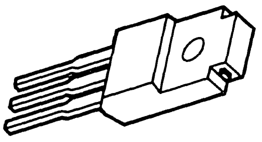
D54D6D

400 VOLTS
6 AMP, 25 WATTS

Designed for igniter applications, high voltage switching applications.

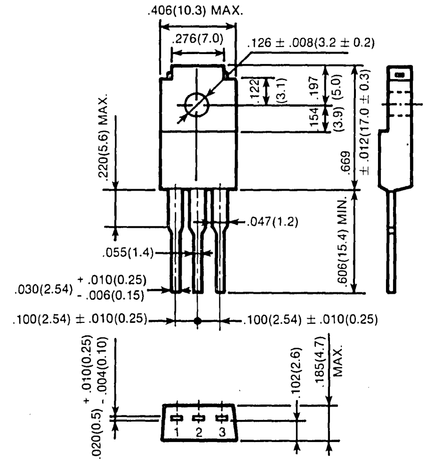
Features:

- High DC Current Gain:
  $h_{FE} = 600$ (Min.) (at $V_{CE} = 2V$, $I_C = 3A$)
- Monolithic construction with built-in base-emitter shunt resistor.
- Isolated TO-220 package.



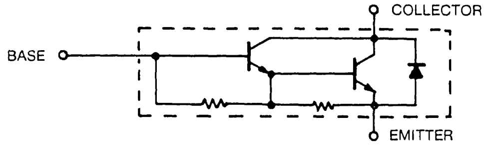
CASE STYLE TO-220IS

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D54D6D	UNITS
Collector-Emitter Voltage	V_{CEO}	400	Volts
Collector-Base Voltage	V_{CBO}	600	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	6	A
Base Current — Continuous	I_B	1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D P_D	2.0 25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA)	$V_{(BR)CEO}$	400	—	—	Volts
Collector Cutoff Current (V_{CB} = 600V)	I_{CBO}	—	—	0.5	mA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	3.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 6

on characteristics

DC Current Gain (I_C = 2A, V_{CE} = 2V) (I_C = 4A, V_{CE} = 2V)	h_{FE}	600 100	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 4A, I_B = 0.04A)	$V_{CE(sat)}$	—	—	2.0	Volts
Emitter-Collector Forward Voltage (I_E = 4A, I_B = 0)	V_{ECF}	—	—	3.0	Volts
Base-Emitter Saturation Voltage (I_C = 4A, I_B = 0.04A)	$V_{BE(sat)}$	—	—	2.5	Volts

switching characteristics

Turn-on Time	V_{CC} = 100V	t_{on}	—	—	1.0	μs
Storage Time	$I_{B1} = I_{B2}$ = 0.04A	t_{stg}	—	—	8.0	
Fall Time	Duty Cycle ≤ 1%	t_f	—	—	5.0	

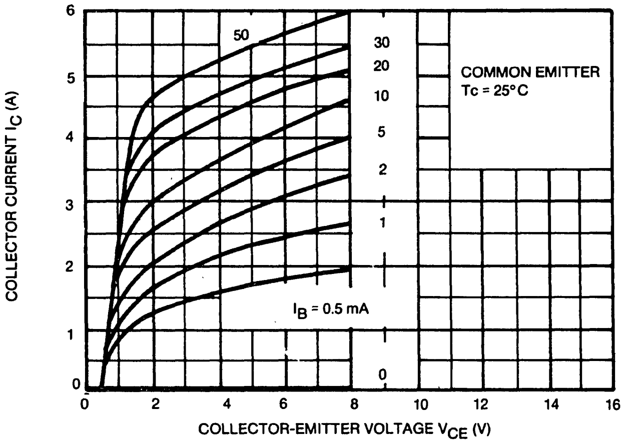


FIG. 1 I_C - V_{CE}

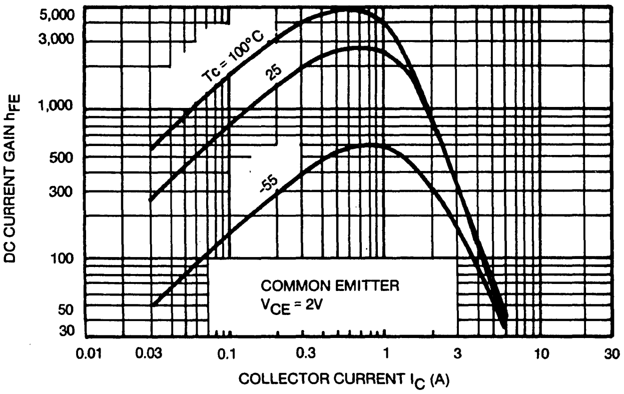


FIG. 2 h_{FE} - I_C

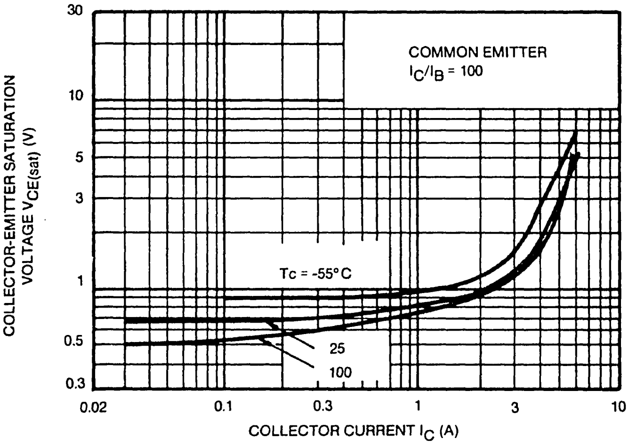


FIG. 3 $V_{CE(sat)}$ - I_C

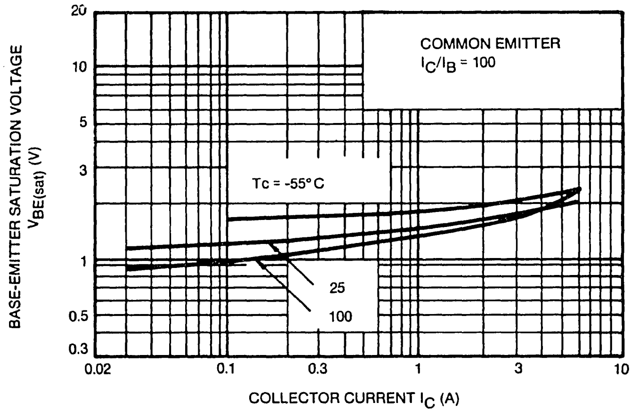


FIG. 4 $V_{BE(sat)}$ - I_C

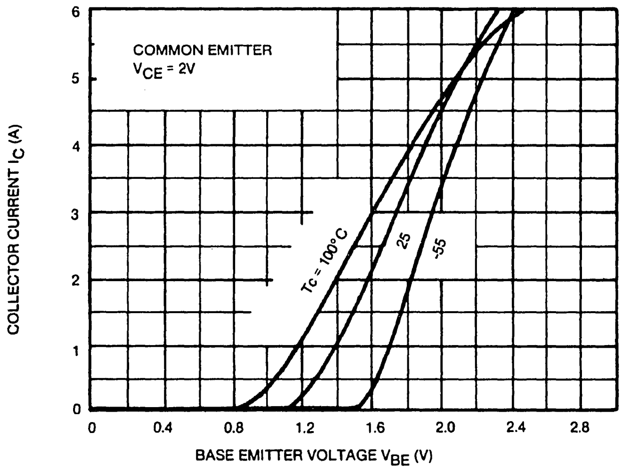


FIG. 5 I_C - V_{BE}

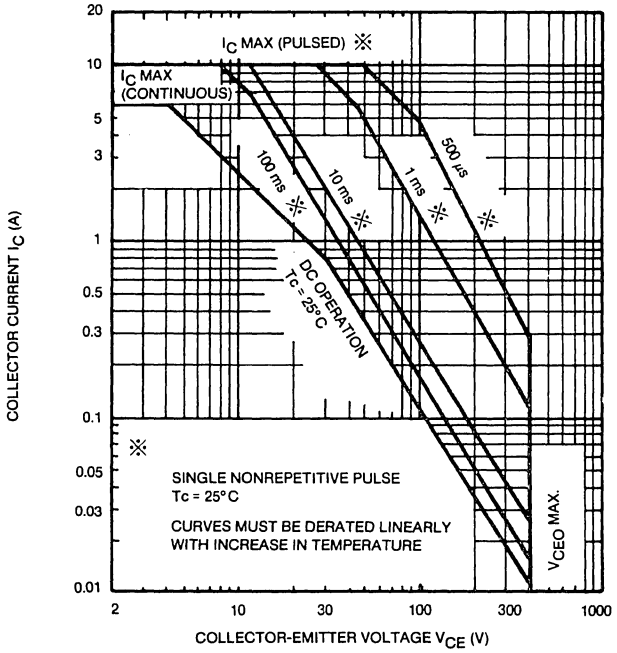


FIG. 6 SAFE OPERATING AREA

NPN POWER DARLINGTON TRANSISTORS

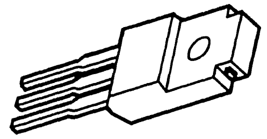
D54FY7D

80 VOLTS
7 AMP, 30 WATTS

Designed for high power switching applications, hammer drive, pulse motor drive applications.

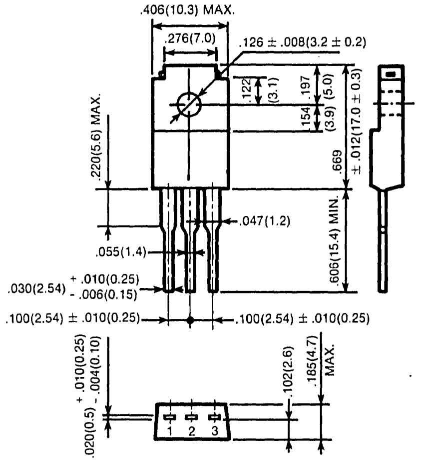
Features:

- High DC Current Gain:
  h_{FE} = 2000 (Min.) (at V_{CE} = 3V, I_C = 3A)
- Low Saturation Voltage:
  $V_{CE(sat)}$ = 1.5V (Max.) (at I_C = 3A)
- Complementary to D55FY7D
- Isolated TO-220 package



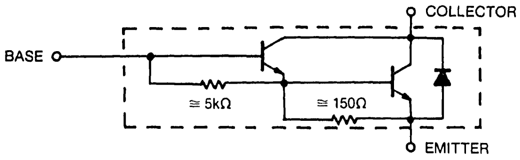
CASE STYLE TO-220IS

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D54FY7D	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	80	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	7	A
Base Current — Continuous	I_B	0.2	A
Total Power Dissipation @ T_C = 25° C	P_D	1.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 50mA)	$V_{(BR)CEO}$	80	—	—	Volts
Collector Cutoff Current (V_{CB} = 80V)	I_{CBO}	—	—	100	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	3.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9

on characteristics

DC Current Gain (I_C = 3A, V_{CE} = 3V) (I_C = 7A, V_{CE} = 3V)	h_{FE}	2000 1000	— —	15000 —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA) (I_C = 7A, I_B = 14mA)	$V_{CE(sat)}$	— —	0.9 1.2	1.5 2.0	V
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{BE(sat)}$	—	1.5	2.5	Volts

switching characteristics

Turn-on Time	V_{CC} = 45V	t_{on}	—	0.8	—	μs
Storage Time	$I_{B1} = I_{B2}$ = 6mA	t_{stg}	—	3.0	—	
Fall Time	Duty Cycle ≤ 1%	t_f	—	2.5	—	

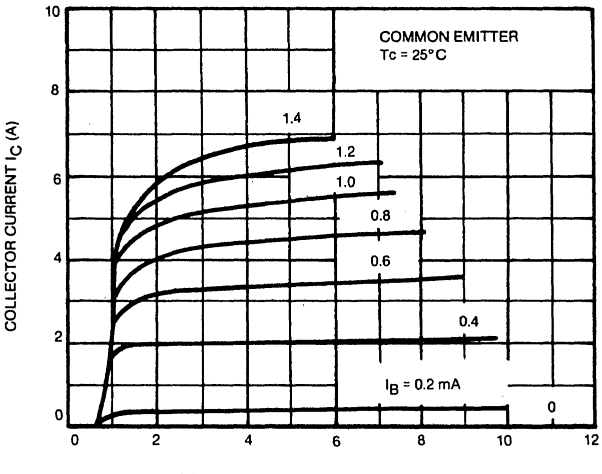


FIG. 1 $I_C - V_{CE}$

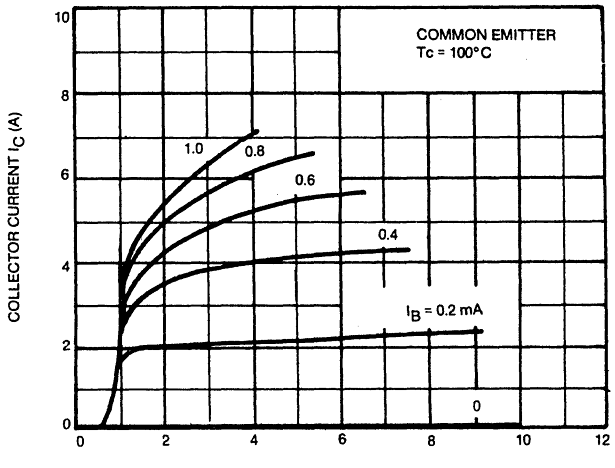


FIG. 2 $I_C - V_{CE}$

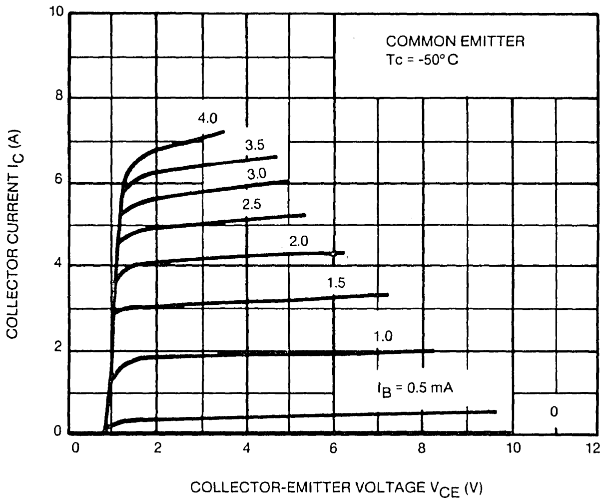


FIG. 3 I_C - V_{CE}

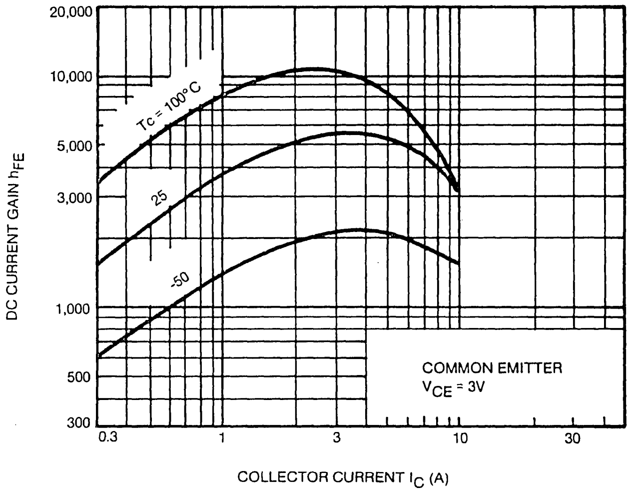


FIG. 4 h_{FE} - I_C

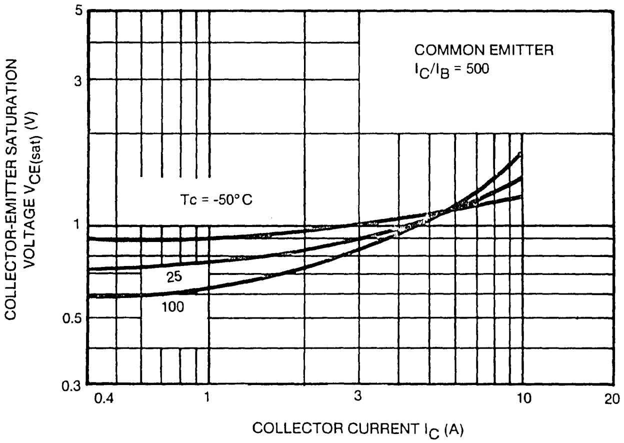


FIG. 5 $V_{CE(sat)}$ - I_C

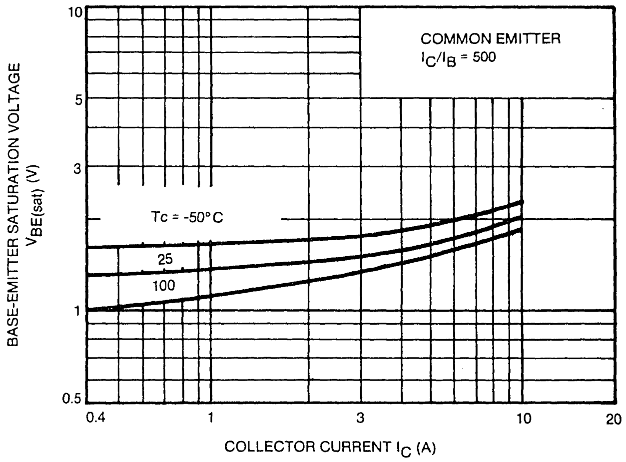


FIG. 6 $V_{BE(sat)}$ - I_C

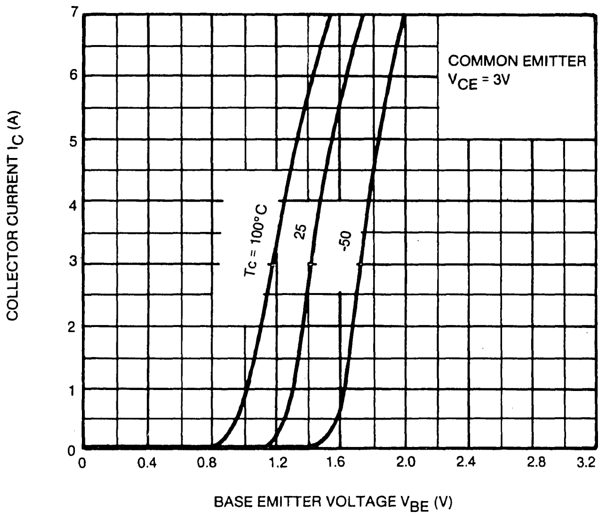


FIG. 7 I_C - V_{BE}

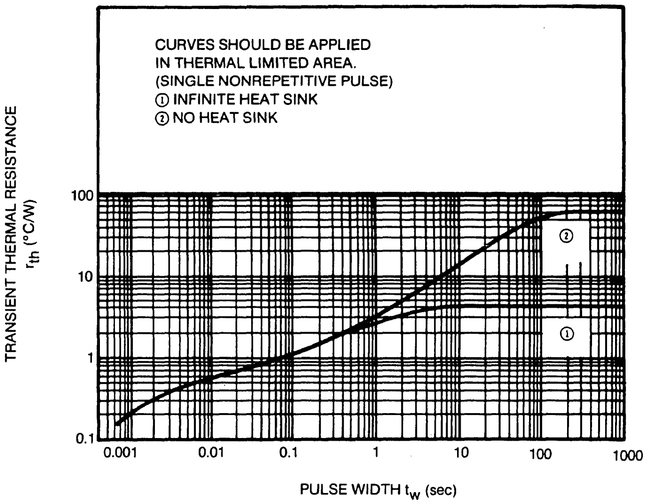


FIG. 8 r_{th} - t_w

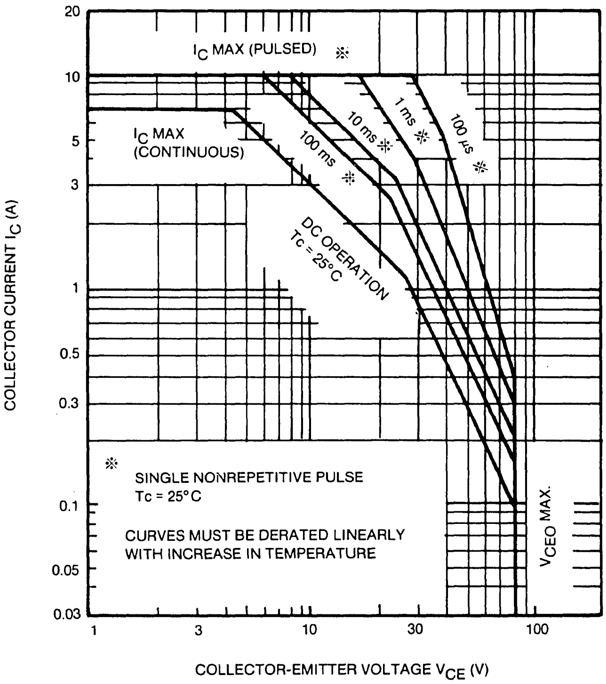


FIG. 9 SAFE OPERATING AREA

NPN POWER DARLINGTON TRANSISTORS

D54H6D

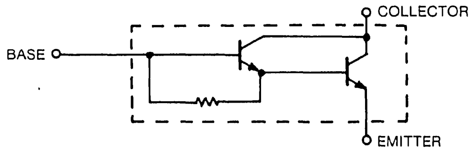
250 VOLTS
6 AMP, 25 WATTS

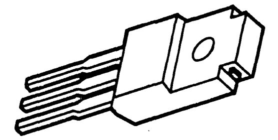
Designed for igniter applications, high voltage switching applications.

Features:

- High DC Current Gain: $h_{FE} = 2000$ (Min.) (at $V_{CE} = 2V$, $I_C = 2A$)
- Isolated TO-220 package.

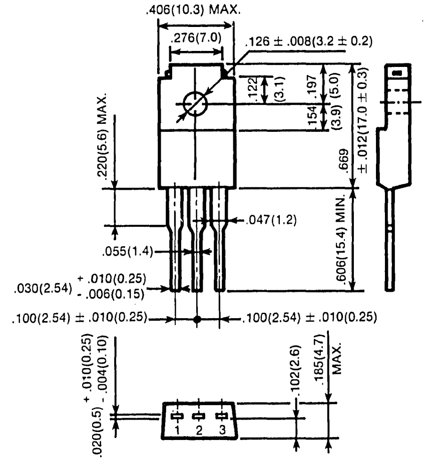
EQUIVALENT CIRCUIT





CASE STYLE TO-220IS

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D54H6D	UNITS
Collector-Emitter Voltage	V_{CEO}	250	Volts
Collector-Base Voltage	V_{CBO}	300	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	6	A
Base Current — Continuous	I_B	1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D P_D	2.0 25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = 0.5A, L = 40mH)	$V_{CEO(sus)}$	250	—	—	Volts
Collector Cutoff Current (V_{CB} = 300V)	I_{CBO}	—	—	0.5	mA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	0.5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4

on characteristics

DC Current Gain (I_C = 2A, V_{CE} = 2V) (I_C = 4A, V_{CE} = 2V)	h_{FE}	 2000 200	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 4A, I_B = 0.04A)	$V_{CE(sat)}$	—	—	2.0	Volts
Base-Emitter Saturation Voltage (I_C = 4A, I_B = 0.04A)	$V_{BE(sat)}$	—	—	2.5	Volts

switching characteristics

Turn-on Time	V_{CC} = 100V	t_{on}	—	1	—	μs
Storage Time	$I_{B1} = I_{B2}$ = 0.04A	t_{stg}	—	8	—	
Fall Time	Duty Cycle ≤ 1%	t_f	—	5	—	

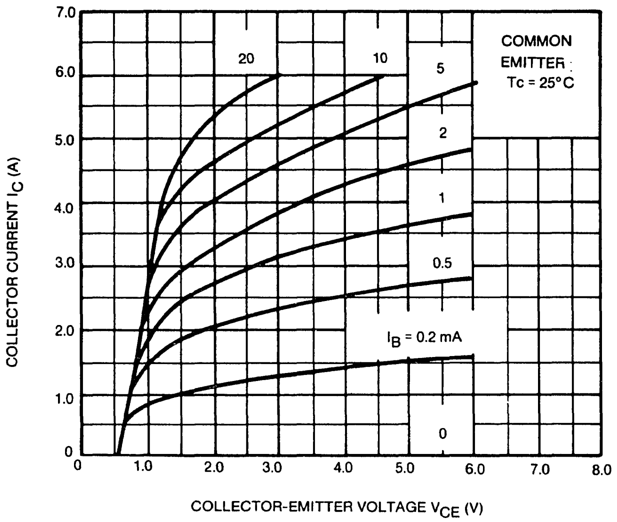


FIG. 1 I_C - V_{CE}

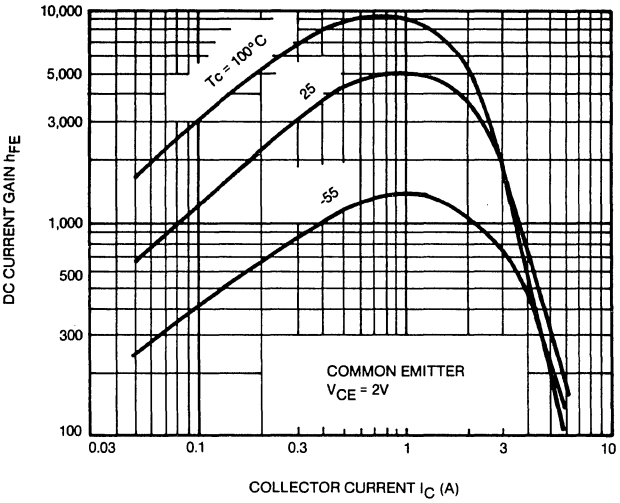


FIG. 2 h_{FE} - I_C

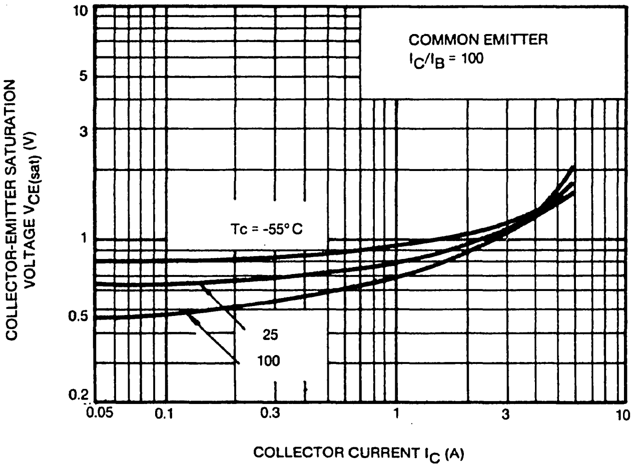


FIG. 3 $V_{CE(sat)}$ - I_C

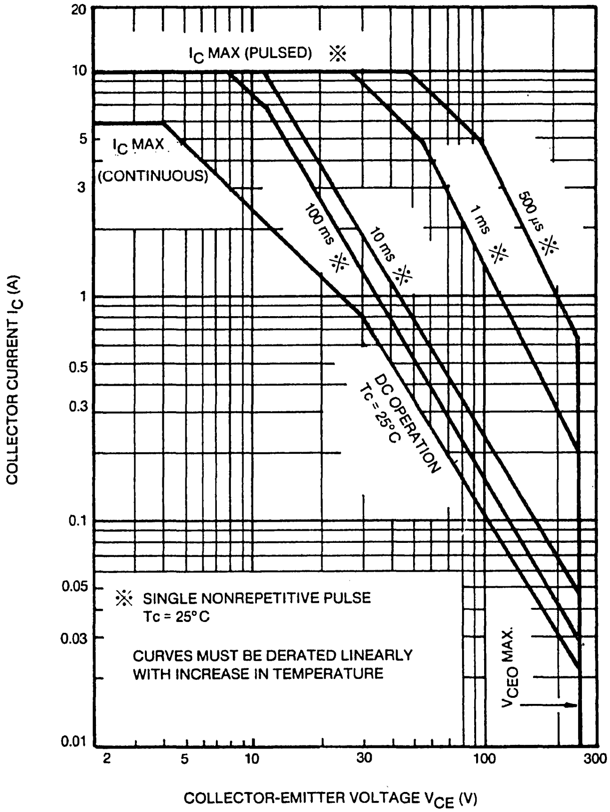


FIG. 4 SAFE OPERATING AREA

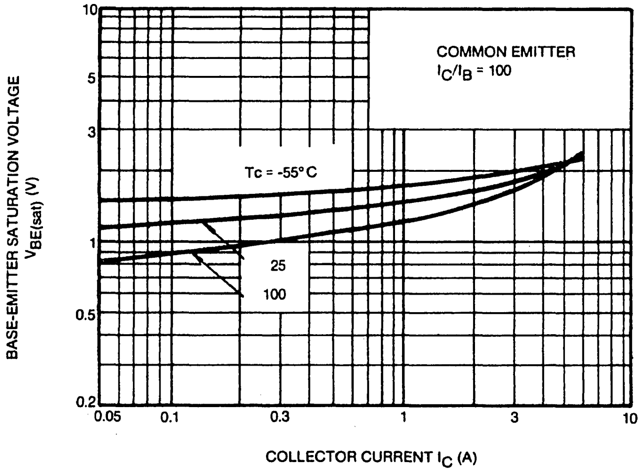


FIG. 5 $V_{BE(sat)}$ - I_C

PNP POWER DARLINGTON TRANSISTORS

D55A7D

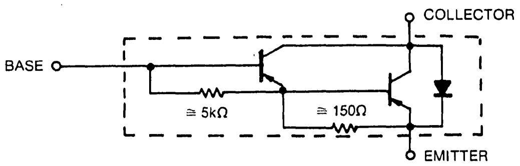
-100 VOLTS
-7 AMP, 30 WATTS

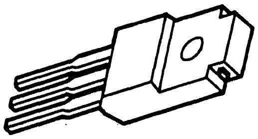
Designed for high power switching applications, hammer drive, pulse motor drive applications.

Features:

- High DC Current Gain:
  h_{FE} = 2000 (Min.) (at V_{CE} = -3V, I_C = -3A)
- Low Saturation Voltage:
  $V_{CE(sat)}$ = -1.5V (Max.) (at I_C = -3A)
- Complementary to D54A7D
- Isolated TO-220 package

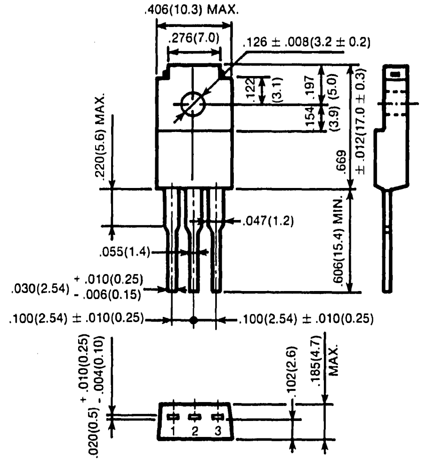
EQUIVALENT CIRCUIT





CASE STYLE TO-220IS

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D55A7D	UNITS
Collector-Emitter Voltage	V_{CEO}	-100	Volts
Collector-Base Voltage	V_{CBO}	-100	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-7	A
Base Current — Continuous	I_B	-0.2	A
Total Power Dissipation @ T_C = 25° C	P_D	30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = -50mA)	$V_{(BR)CEO}$	-100	—	—	Volts
Collector Cutoff Current (V_{CB} = -100V)	I_{CBO}	—	—	-100	μA
Emitter Cutoff Current (V_{EB} = -5V)	I_{EBO}	—	—	-4.0	mA

second breakdown

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = -3A, V_{CE} = -3V) (I_C = -7A, V_{CE} = -3V)	h_{FE}	2000 1000	— —	15000 —	—
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA) (I_C = -7A, I_B = -14mA)	$V_{CE(sat)}$ $V_{CE(sat)}$	— —	-0.95 -1.3	-1.5 -2.0	Volts
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{BE(sat)}$	—	-1.55	-2.5	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -45V	t_{on}	—	0.8	—	μs
Storage Time	I_{B1} = I_{B2} = 6mA	t_{stg}	—	2.0	—	
Fall Time	Duty Cycle ≤ 1%	t_f	—	2.5	—	

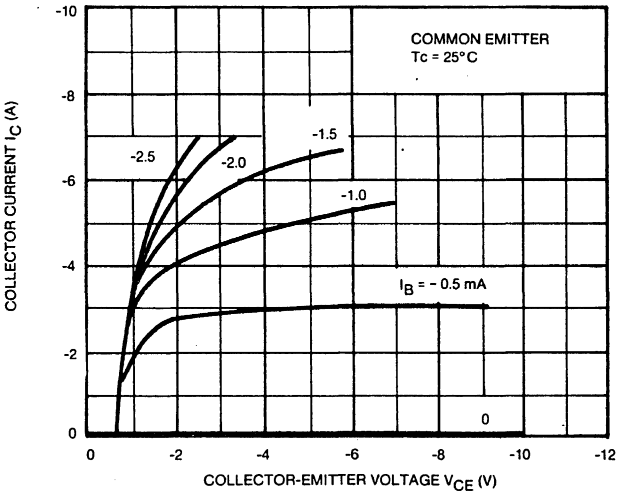


FIG. 1 I_C - V_{CE}

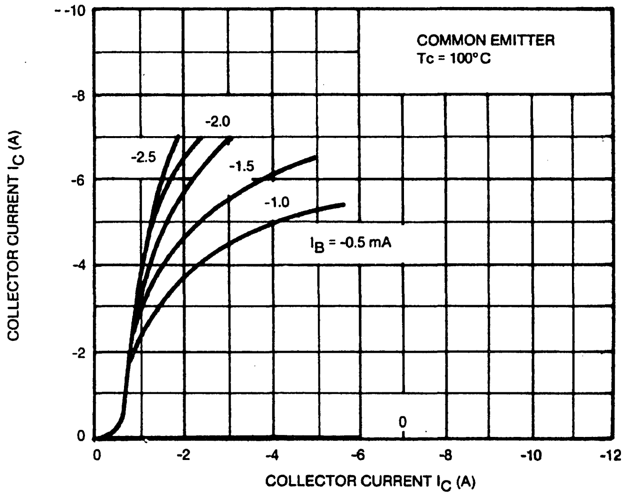


FIG. 2 I_C - V_{CE}

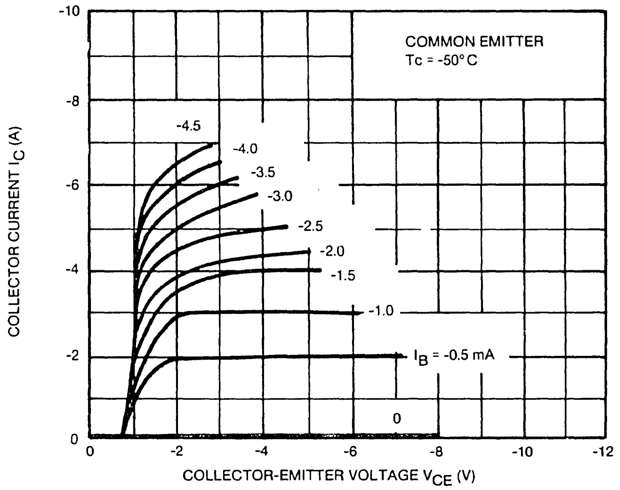


FIG. 3 I_C - V_{CE}

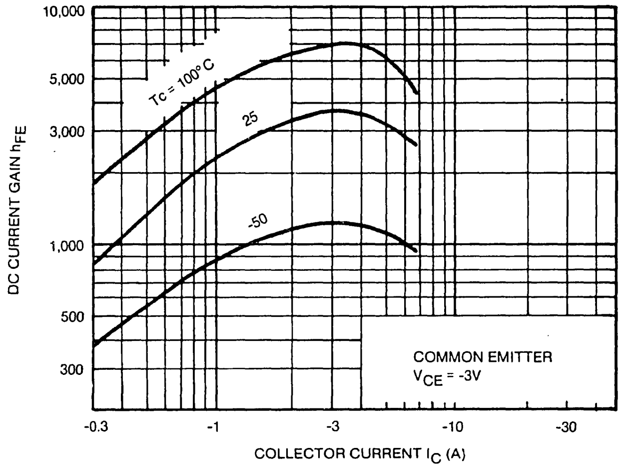


FIG. 4 h_{FE} - I_C

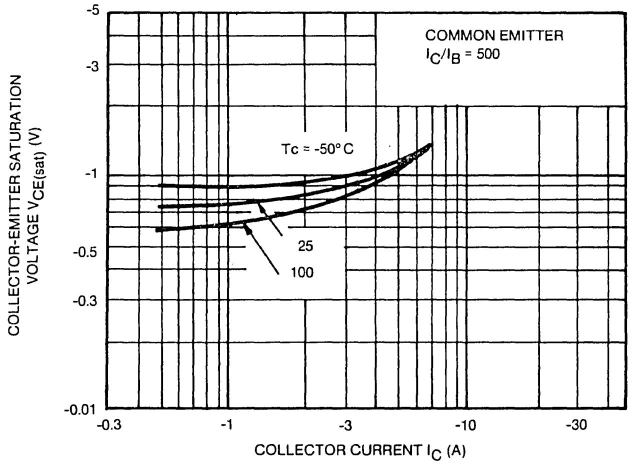


FIG. 5 $V_{CE(sat)}$ - I_C

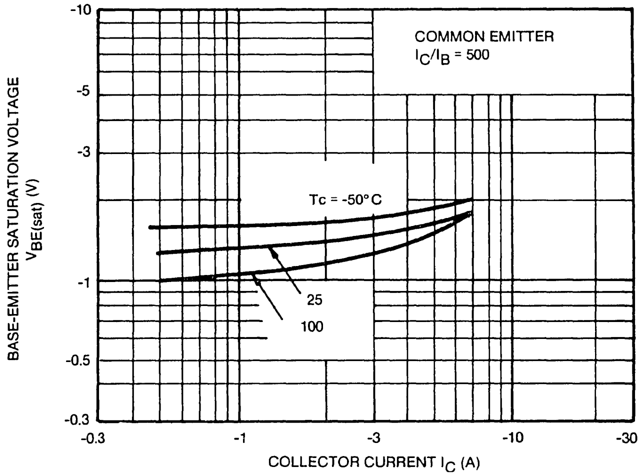


FIG. 6 $V_{BE(sat)}$ - I_C

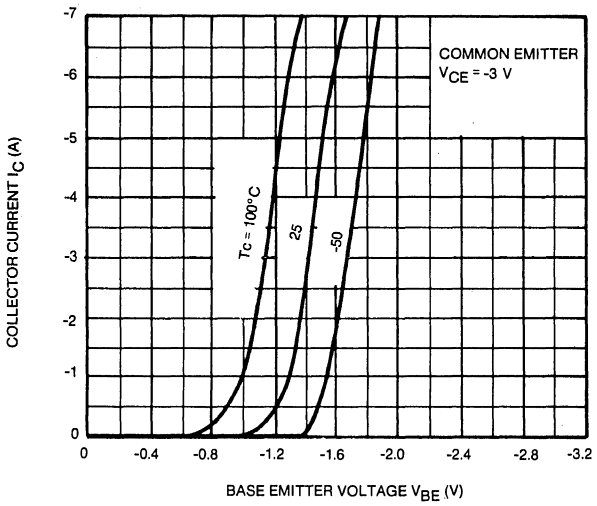


FIG. 7 I_C - V_{BE}

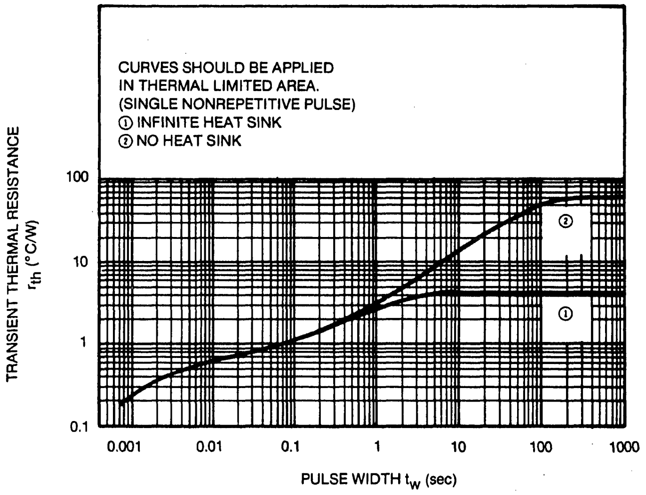


FIG. 8 r_{th} - t_w

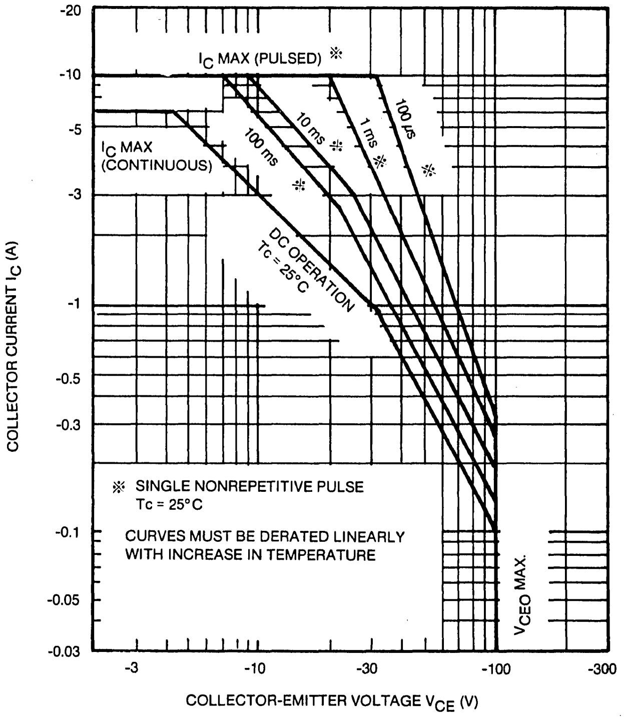


FIG. 9 SAFE OPERATING AREA

PNP POWER DARLINGTON TRANSISTORS

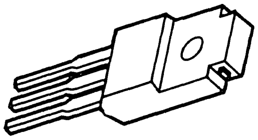
D55FY7D

-80 VOLTS
-7 AMP, 30 WATTS

Designed for high power switching applications, hammer drive, pulse motor drive applications.

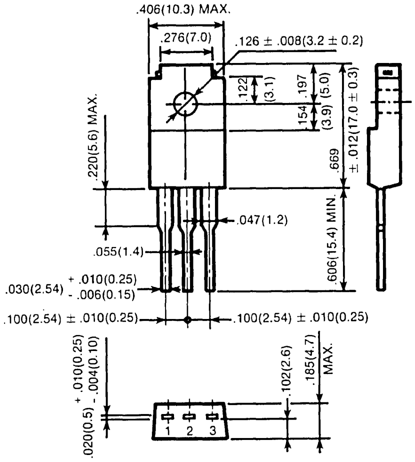
Features:

- High DC Current Gain:
  h_{FE} = 2000 (Min.) (at V_{CE} = -3V, I_C = -3A)
- Low Saturation Voltage:
  $V_{CE(sat)}$ = –1.5V (Max.) (at I_C = -3A)
- Complementary to D54FY7D
- Isolated TO-220 package



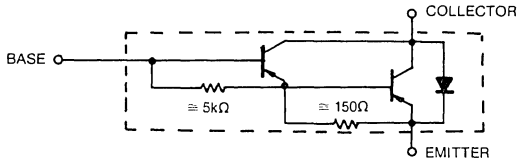
CASE STYLE TO-220IS

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D55FY7D	UNITS
Collector-Emitter Voltage	V_{CEO}	-80	Volts
Collector-Base Voltage	V_{CBO}	-80	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-7	A
Base Current — Continuous	I_B	-0.2	A
Total Power Dissipation @ T_C = 25°C	P_D	30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = -50mA)	$V_{(BR)CEO}$	-80	—	—	Volts
Collector Cutoff Current (V_{CB} = -80V)	I_{CBO}	—	—	-100	μA
Emitter Cutoff Current (V_{EB} = -5V)	I_{EBO}	—	—	-4.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9

on characteristics

DC Current Gain (I_C = -3A, V_{CE} = -3V) (I_C = -7A, V_{CE} = -3V)	h_{FE}	2000 1000	— —	15000 —	—
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA) (I_C = -7A, I_B = -14mA)	$V_{CE(sat)}$	— —	-0.95 -1.3	-1.5 -2.0	Volts
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{BE(sat)}$	—	-1.55	-2.5	Volts

switching characteristics

Turn-on Time	V_{CC} = -45V	t_{on}	—	0.8	—	μs
Storage Time	I_{B1} = I_{B2} = 6mA	t_{stg}	—	2.0	—	
Fall Time	Duty Cycle ≤ 1%	t_f	—	2.5	—	

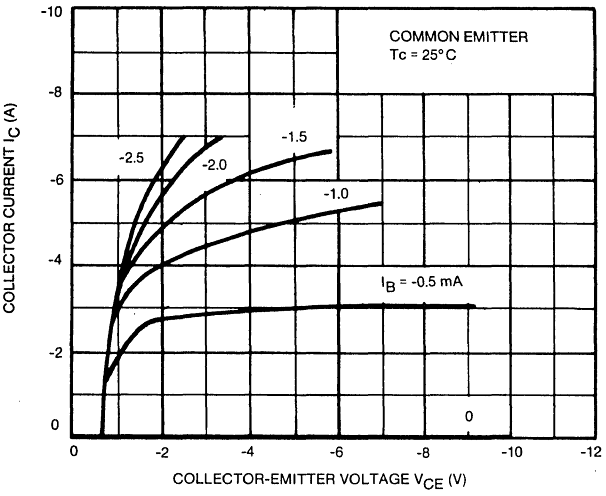


FIG. 1 I_C - V_{CE}

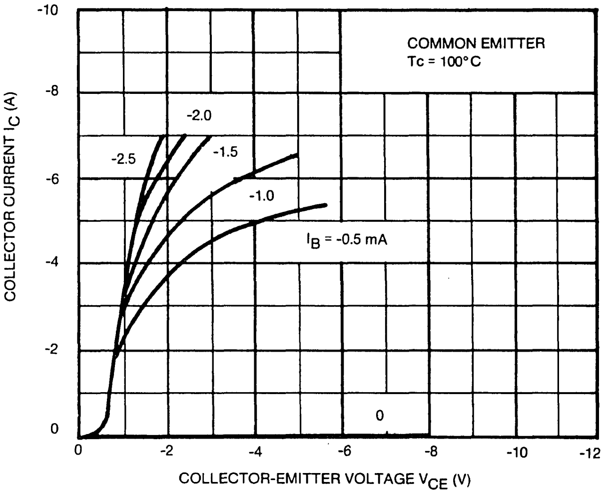


FIG. 2 I_C - V_{CE}

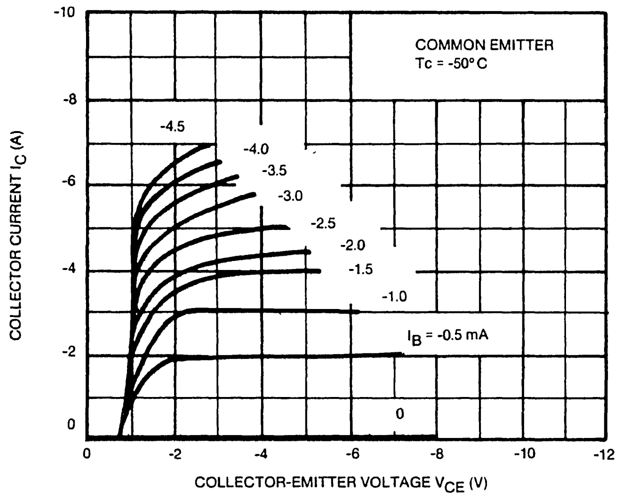


FIG. 3 $I_C - V_{CE}$

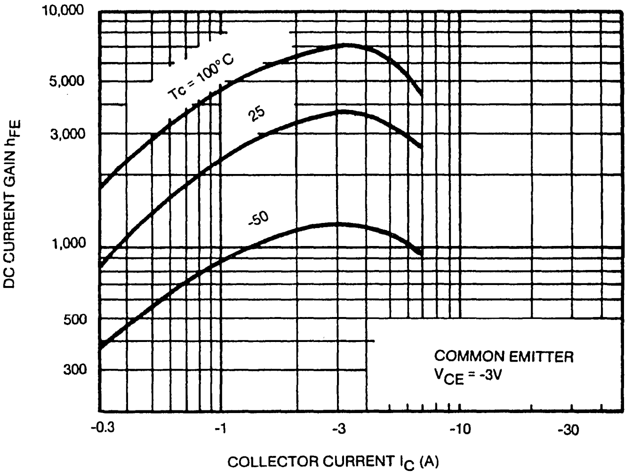


FIG. 4 $h_{FE} - I_C$

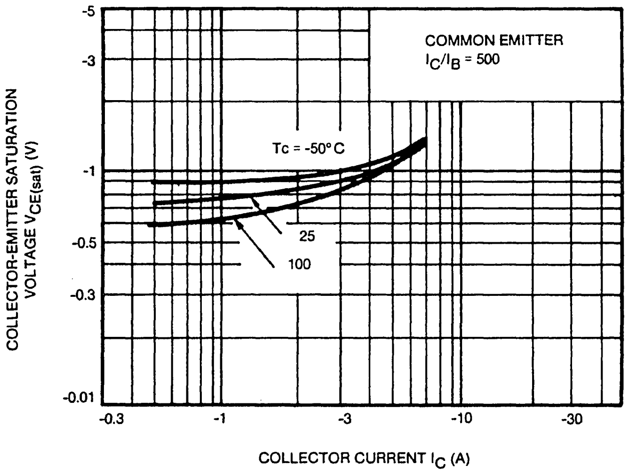


FIG. 5 $V_{CE(sat)} - I_C$

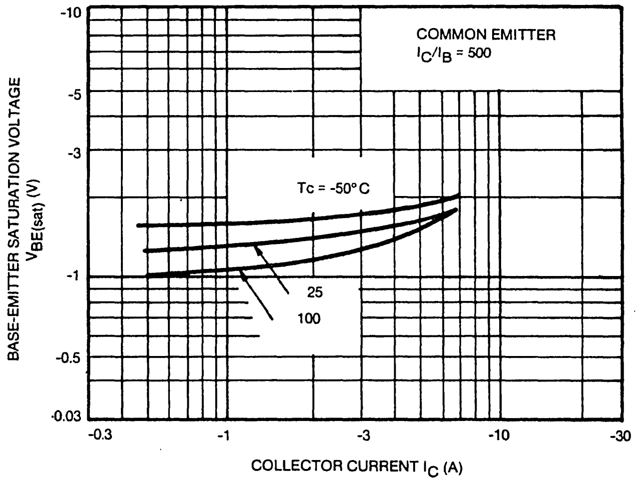


FIG. 6 $V_{BE(sat)} - I_C$

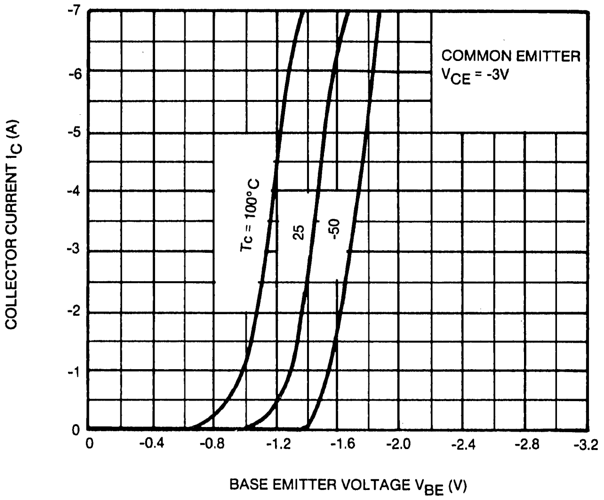


FIG. 7 I_C - V_{BE}

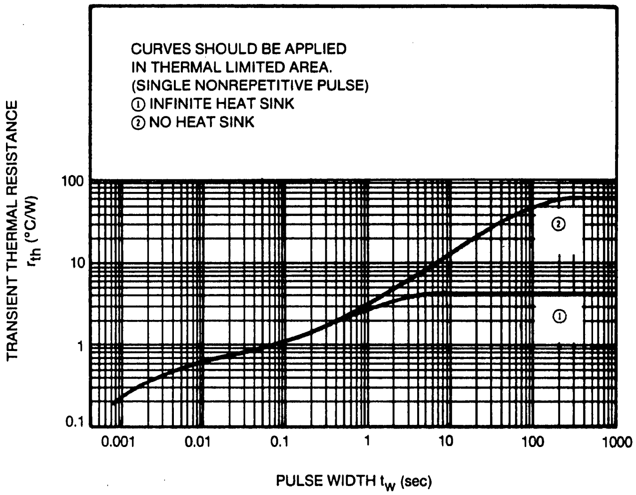


FIG. 8 r_{th} t_w

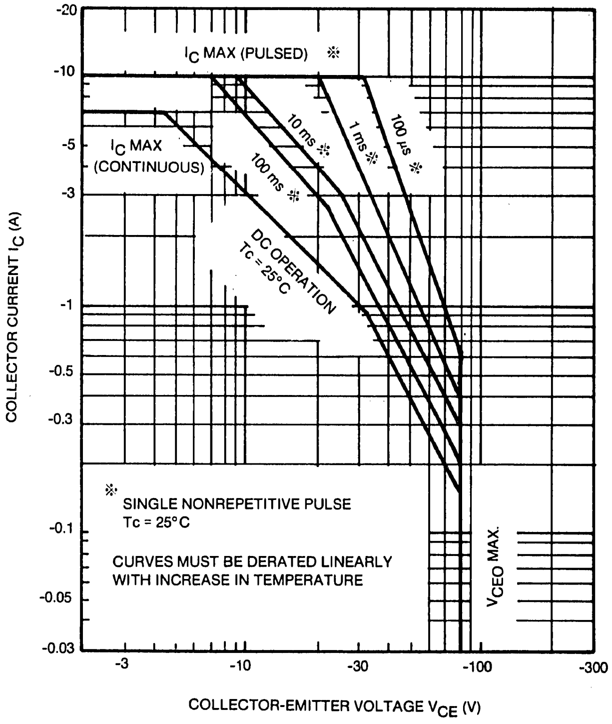


FIG. 9 SAFE OPERATING AREA

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

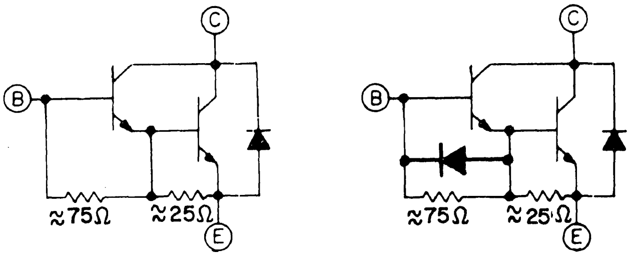
D64DS5,6,7
D64ES5,6,7

400-500 VOLTS
20 AMP, 125 WATTS

These devices are designed for use in high-speed switching applications, such as off-line switching power supplies PWM DC and AC motor control, UPS, ultrasonic equipment and other high frequency power conversion equipment.

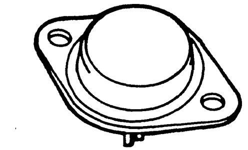
Features:

- High Speed: $t_s < 3.0$ µsec., $t_r < 1.0$ µsec.
- High Voltage: 400-500 $V_{CEO(SUS)}$
- High Gain: h_{FE} 40 Minimum @ I_C = 20A
- High Current: 30 Amperes, I_C (Peak)



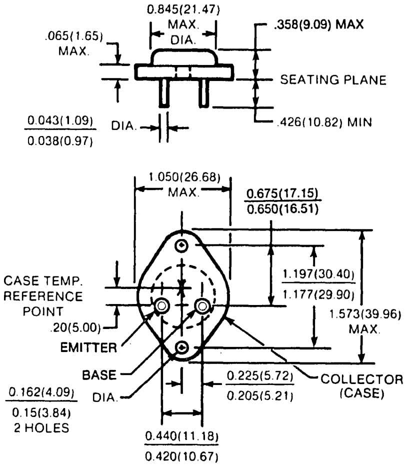
D64DS **D64ES**

DEVICE CIRCUIT



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	D64DS5/ES5	D64DS6/ES6	D64DS7/ES7	UNITS
Collector-Emitter Voltage	V_{CEV}	500	600	700	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage D64DS D64ES	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 30 50	20 30 50	20 30 50	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	5 10	5 10	5 10	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage D64DS5/ES5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = .5A) D64DS6/ES6		450	—	—	
(V_{clamp} = V_{CEO} Rated) D64DS7/ES7		500	—	—	
Collector Cutoff Current T_J = 25°C	I_{CEV}	—	—	1.0	mA
(V_{CE} = Rated Value, V_{BE} = -1.5V) T_J = 150°C		—	—	2.5	
Emitter Cutoff Current	I_{EBO}				
(V_{EB} = 4.5V, I_C = 0) D64DS		—	—	200	mA
(V_{EB} = 1.5V, I_C = 0) D64ES		—	—	200	

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 26

on characteristics

DC Current Gain	h_{FE}				
(I_C = 30A, V_{CE} = 5V)		20	35	—	—
(I_C = 20A, V_{CE} = 5V)		40	85	—	
(I_C = 10A, V_{CE} = 5V)		100	160	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 30A, I_B = 3A)		—	2.1	3.5	V
(I_C = 20A, I_B = 2A)		—	1.6	2.5	
(I_C = 10A, I_B = 1A)		—	1.2	1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 30A, I_B = 3A)		—	2.65	4	V
(I_C = 20A, I_B = 2A)		—	2.3	3	
(I_C = 10A, I_B = 1A)		—	1.8	2.5	

switching characteristics

				TYP.		MAX.		
Resistive Load				DS	ES	DS	ES	
Delay Time	V_{CC} = 250V	t_d	—	.05	.05	.5	.5	μs
Rise Time	I_C = 20A	t_r	—	.4	.4	1	1	
Storage Time	I_{B1} = 1A, I_{B2} = 2A	t_s	—	2.2	1.8	5	3	
Fall Time	t_p = 50 μsec	t_f	—	1.6	.45	3	1	

emitter-collector diode characteristics

Power Dissipation (I_{B1} = 0)	P_D	—	—	125	Watts
Forward Voltage (I_F = 10A)	V_F	—	1.95	3.20	Volts
(I_P = 25A)	V_F	—	2.80	4.00	Volts
(I_F = 25A, T_J = 150°C)	V_F	—	2.75	4.00	Volts
Reverse Recovery Time (I_F = 25A, di/dt = 15A/μsec, R_{B1E} = .25Ω)	T_{rr}	—	3.85	10	μsec
Forward Turn-On Time (I_F = 25A, di/dt = 50A/μsec)	T_{ON}	—	0.42	1.0	μsec
Single Cycle Surge Current (60Hz)	I_{FSM}	—	—	50	Amps
Thermal Resistance	$R_{\theta JC}$	—	—	1.0	°C/Watt

TYPICAL CHARACTERISTICS

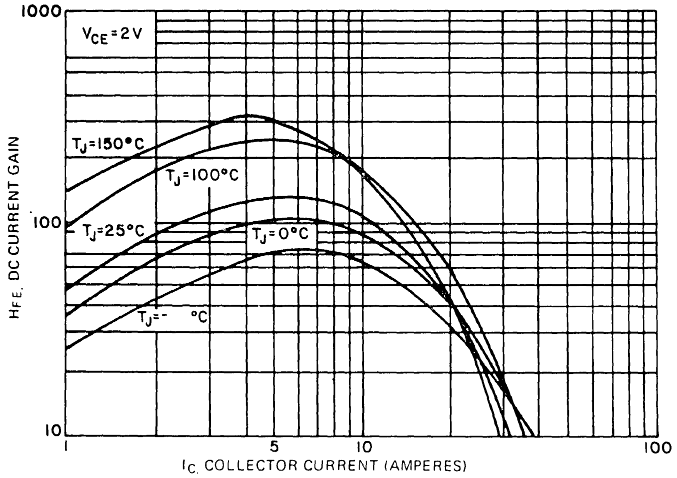


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

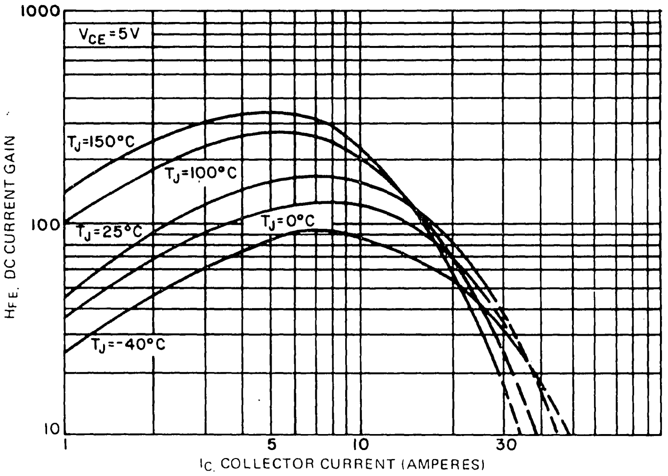


FIGURE 2. DC CURRENT GAIN (V_{CE} = 5V)

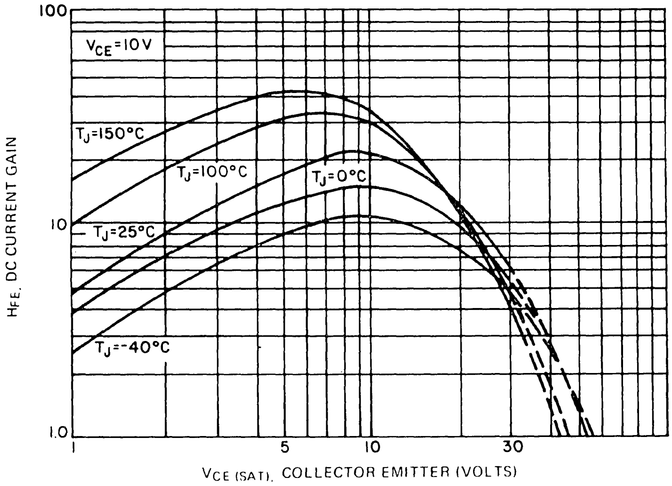


FIGURE 3. DC CURRENT GAIN (V_{CE} = 10V)

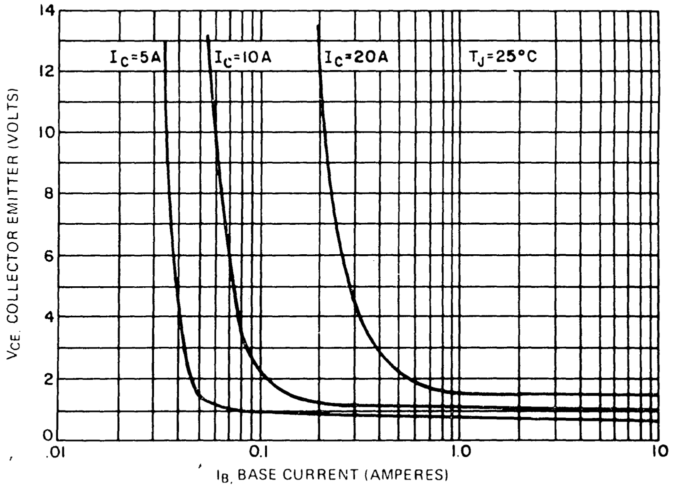


FIGURE 4. COLLECTOR SATURATION REGION

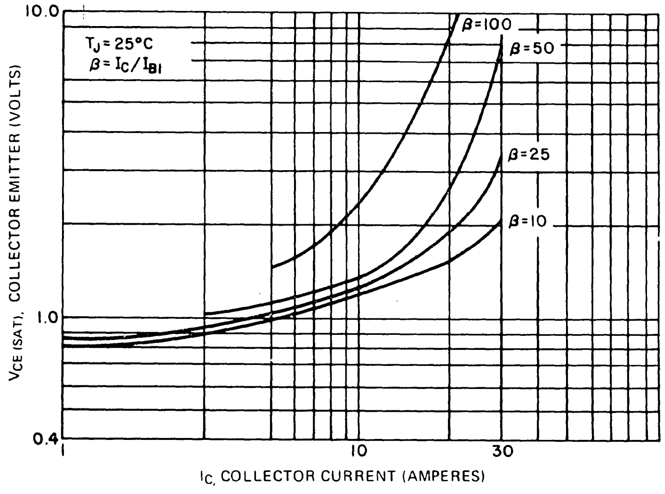


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

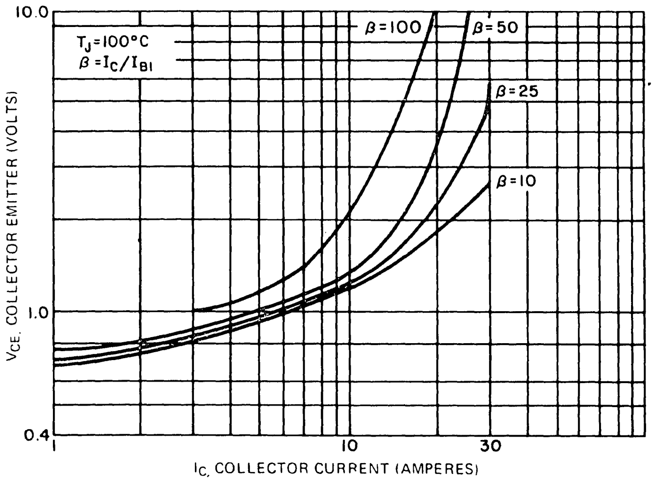


FIGURE 6. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

TYPICAL CHARACTERISTICS

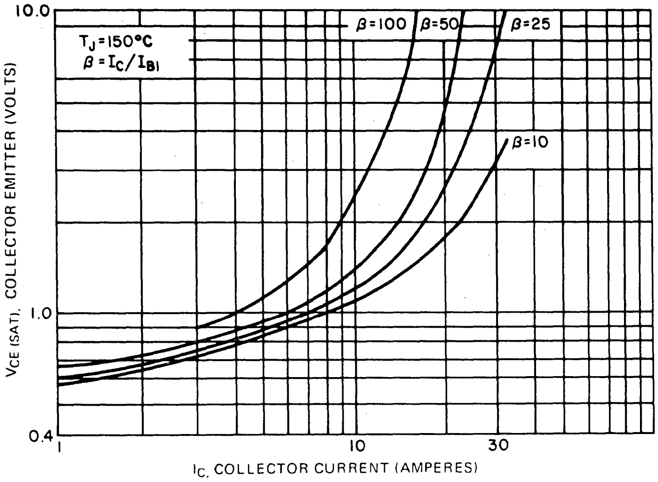


FIGURE 7. $V_{CE(SAT)}$ VS. I_C, T_J = 150°C

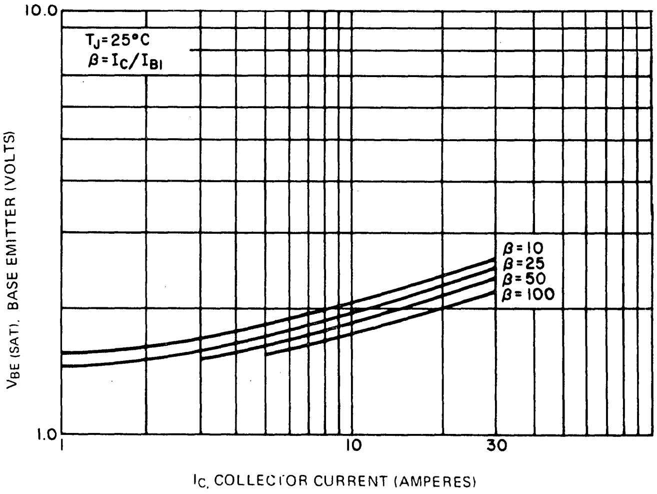


FIGURE 8. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

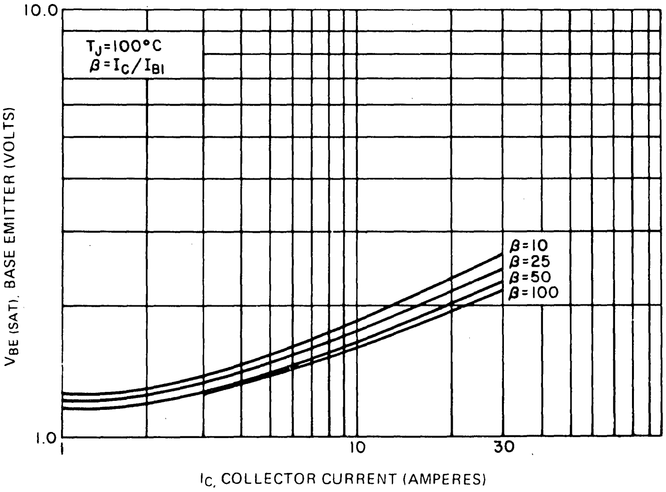


FIGURE 9. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

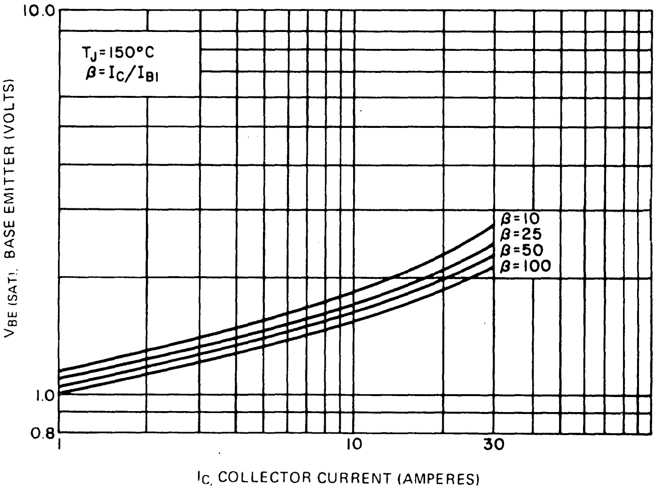


FIGURE 10. $V_{BE(SAT)}$ VS. I_C, T_J = 150°C

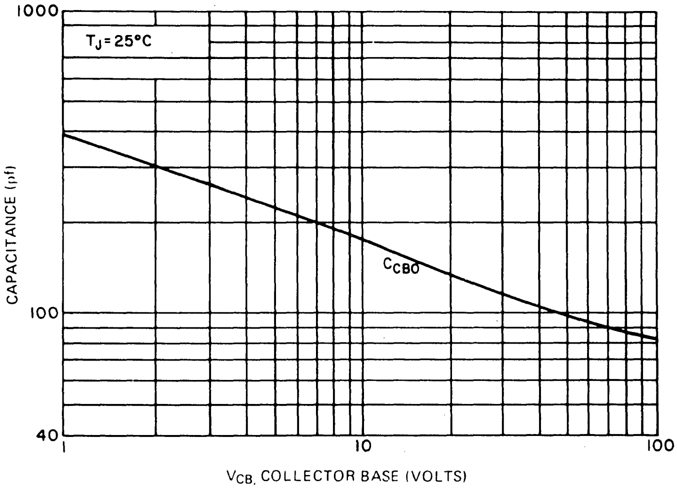


FIGURE 11. CAPACITANCE (C_{CBO})

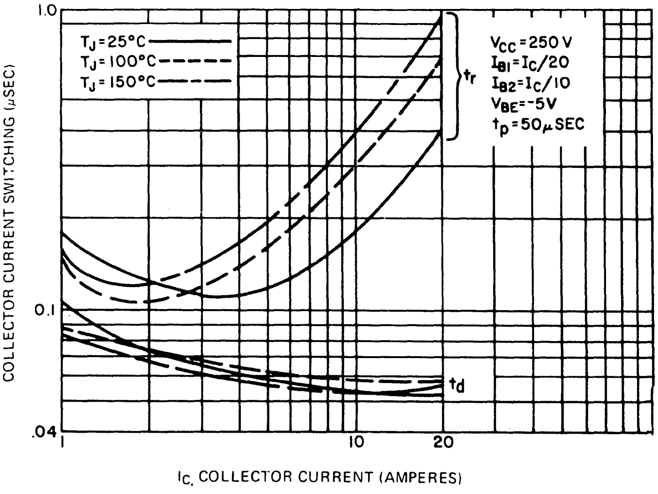


FIGURE 12. TURN-ON TIME (RESISTIVE LOAD) (D64DS ONLY)

TYPICAL CHARACTERISTICS

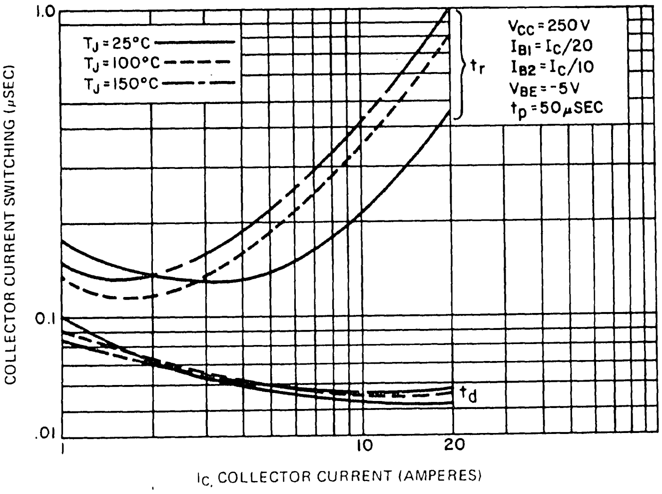


FIGURE 13. TURN-ON TIME (RESISTIVE) (D64ES ONLY)

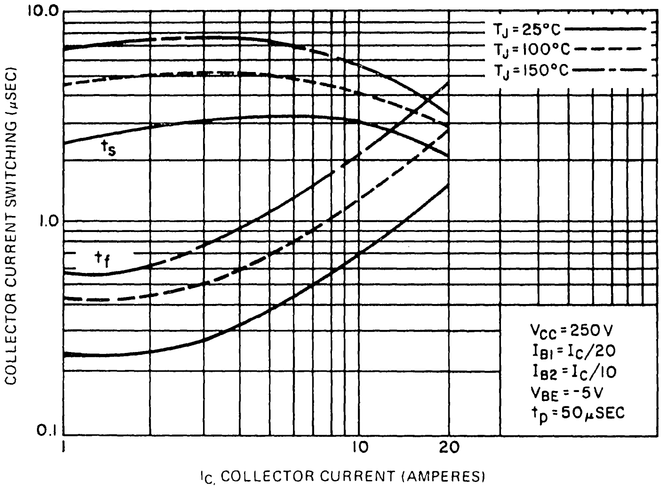


FIGURE 14. TURN-OFF TIME (RESISTIVE) (D64DS ONLY)

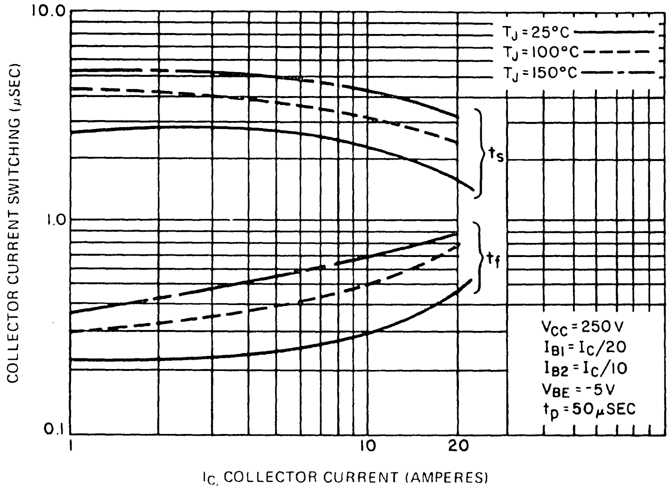


FIGURE 15. TURN-OFF TIME (RESISTIVE) (D64ES ONLY)

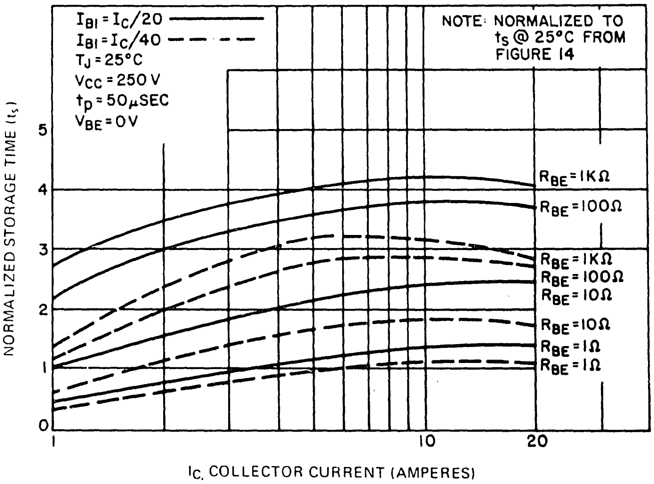


FIGURE 16. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D64DS ONLY)

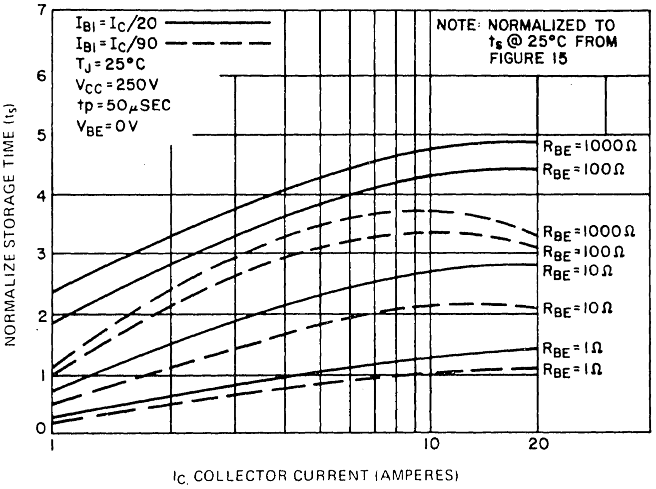


FIGURE 17. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D64ES ONLY)

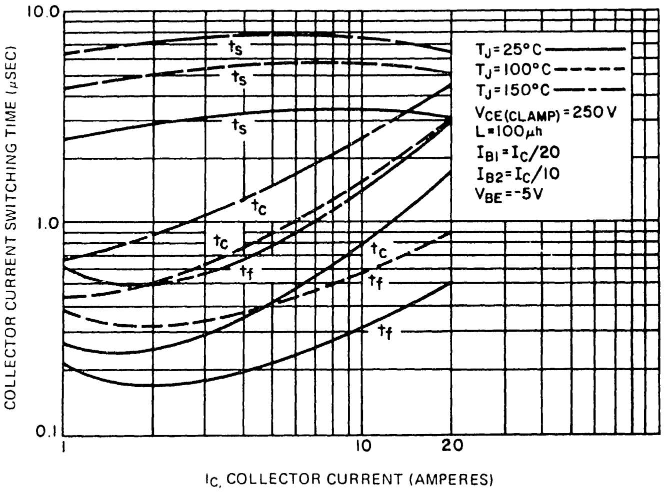


FIGURE 18. CLAMPED INDUCTIVE TURN-OFF TIME (D64DS ONLY)

TYPICAL CHARACTERISTICS

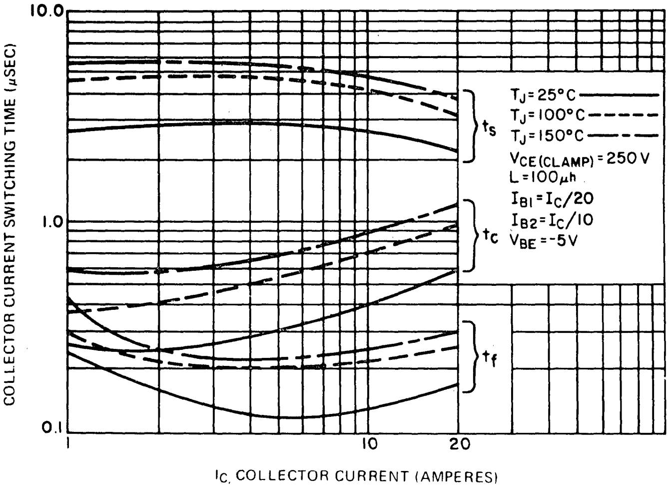


FIGURE 19. CLAMPED INDUCTIVE TURN-OFF TIME (D64ES ONLY)

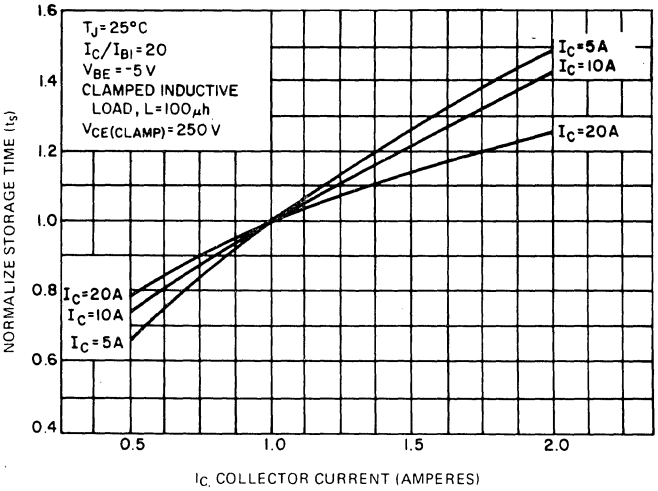


FIGURE 20. STORAGE TIME VARIATION WITH I_{B2} (D64DS ONLY)

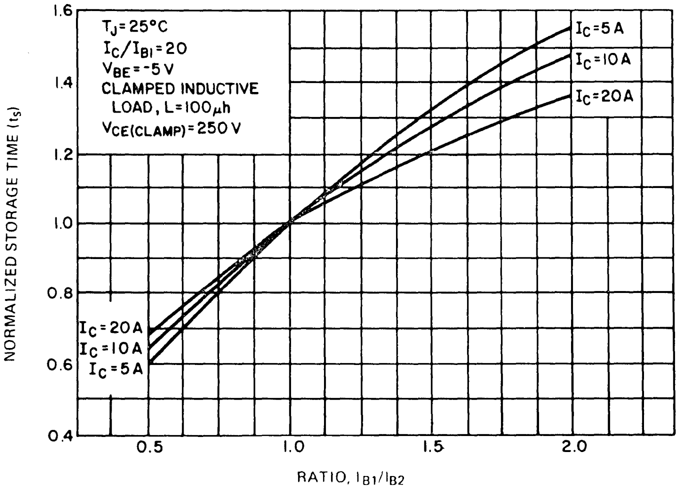


FIGURE 21. STORAGE TIME VARIATION WITH I_{B2} (D64ES ONLY)

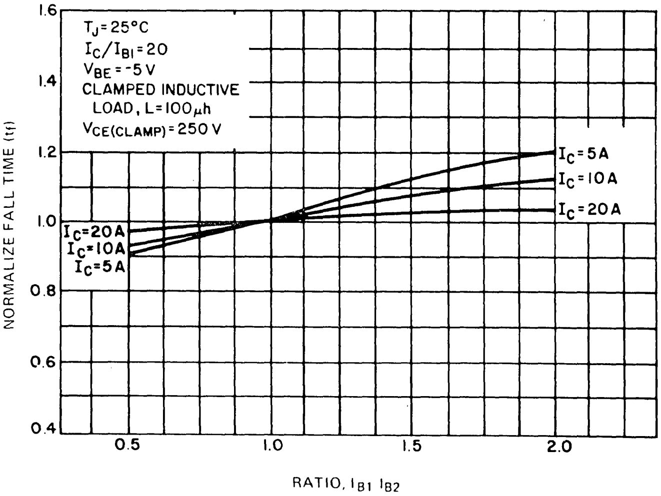


FIGURE 22. FALL TIME VARIATION WITH I_{B2} (D64DS ONLY)

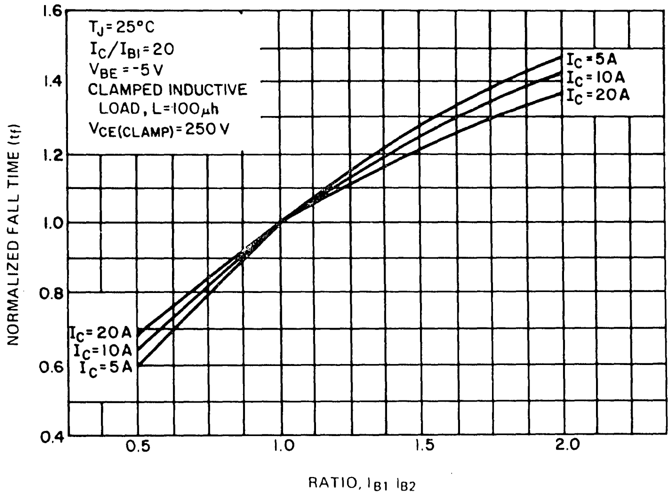


FIGURE 23. FALL TIME VARIATION WITH I_{B2} (D64ES ONLY)

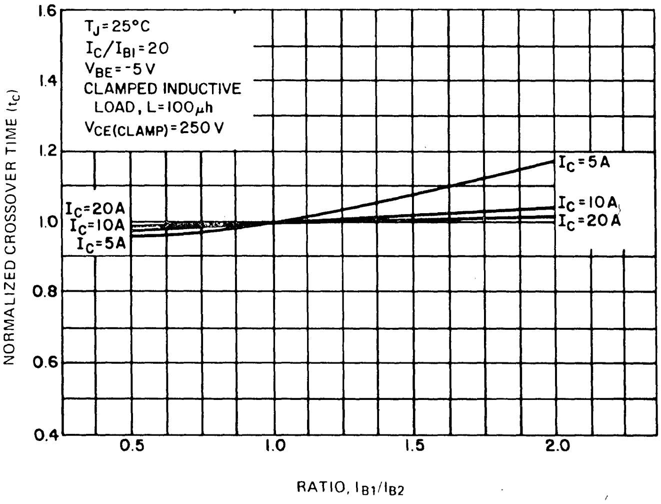


FIGURE 24. CROSS-OVER TIME VARIATION WITH I_{B2} (D64DS ONLY)

TYPICAL CHARACTERISTICS

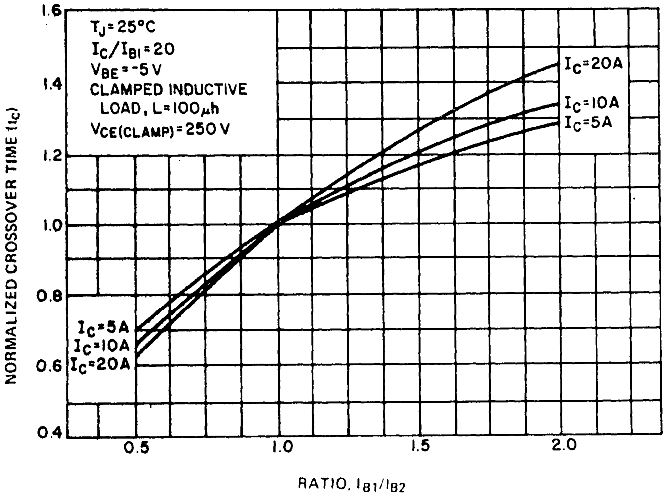


FIGURE 25. CROSS-OVER TIME VARIATION WITH I_{B2} (D64ES ONLY)

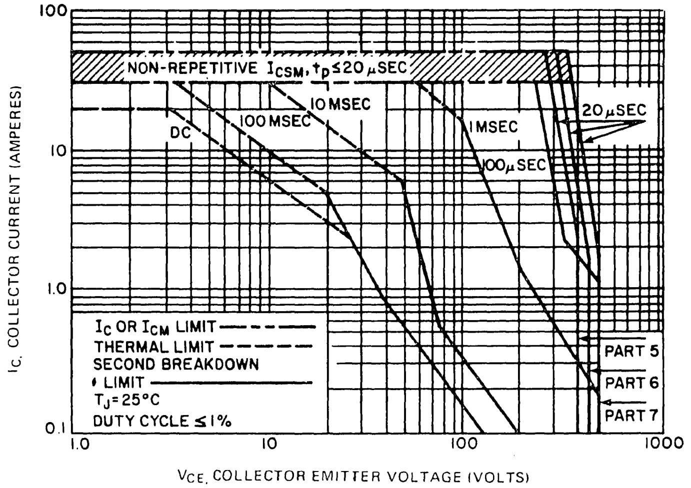


FIGURE 26. FORWARD BIAS SAFE OPERATING AREA

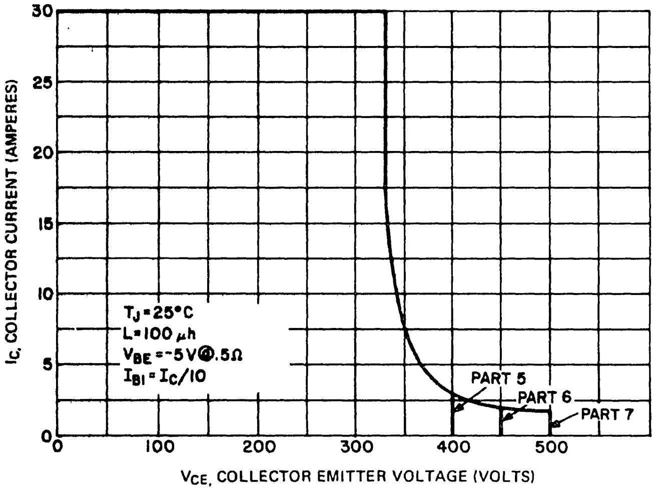


FIGURE 27. REVERSE BIAS SAFE OPERATING AREA

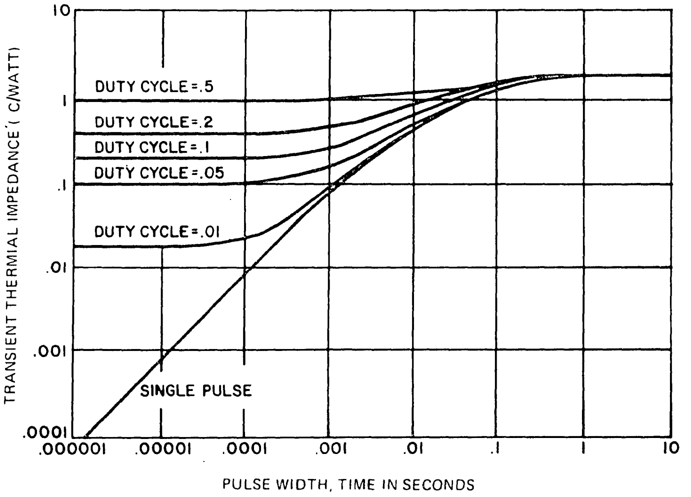


FIGURE 28. TRANSIENT THERMAL RESPONSE

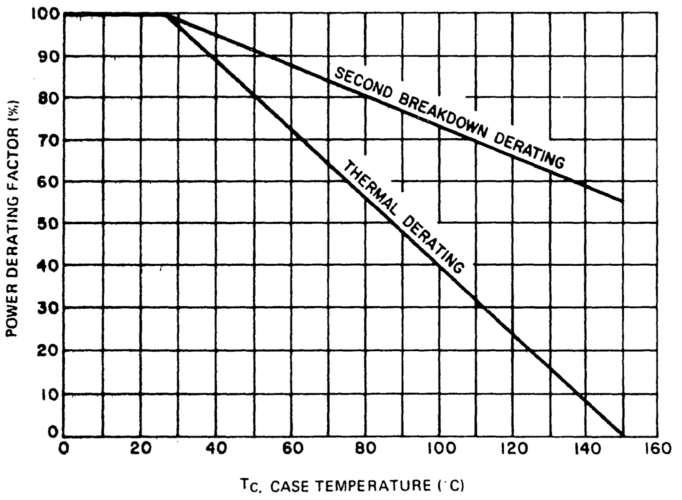


FIGURE 29. POWER DERATING

DIODE CHARACTERISTICS

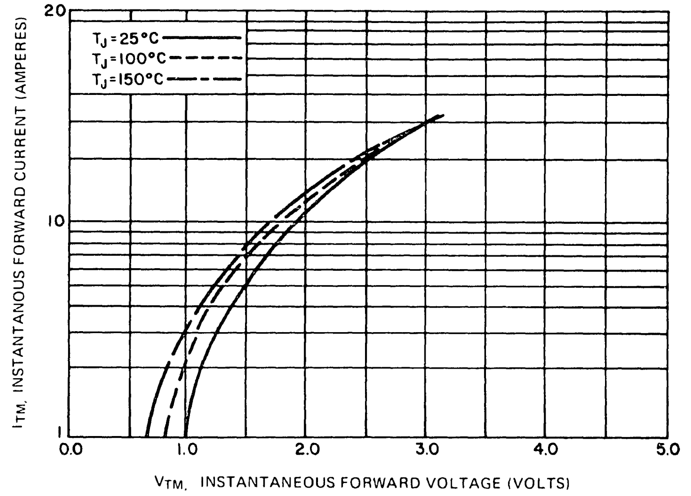


FIGURE 30. FORWARD CHARACTERISTICS

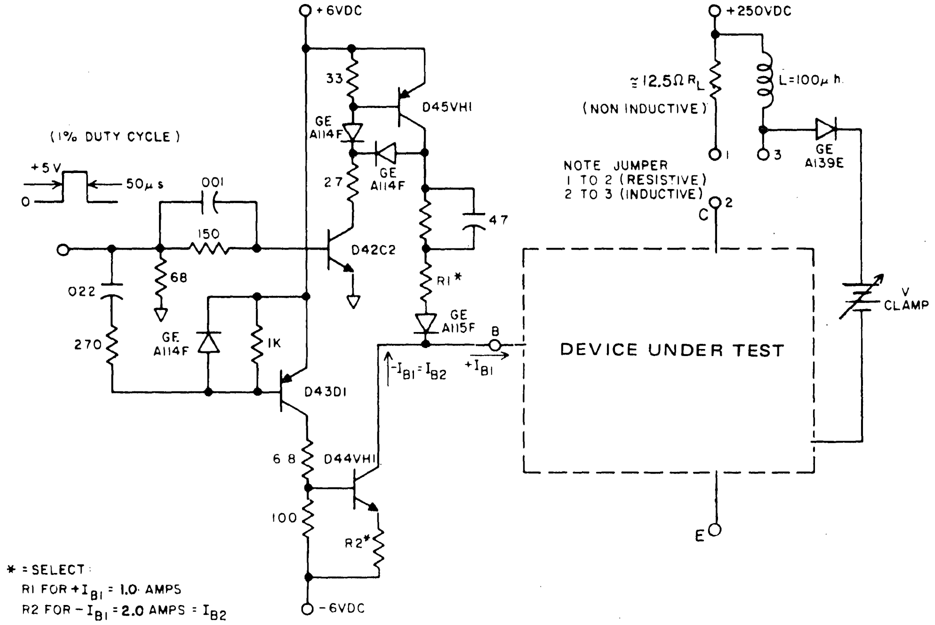


FIGURE 31. SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

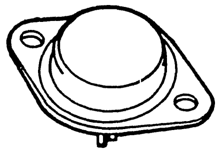
D64DV5,6,7
D64EV5,6,7

400-500 VOLTS
50 AMP, 180 WATTS

These devices are designed for use in high-speed switching applications, such as off-line switching power supplies, PWM DC & AC motor control, UPS systems, ultrasonic equipment and other high frequency power conversion equipment.

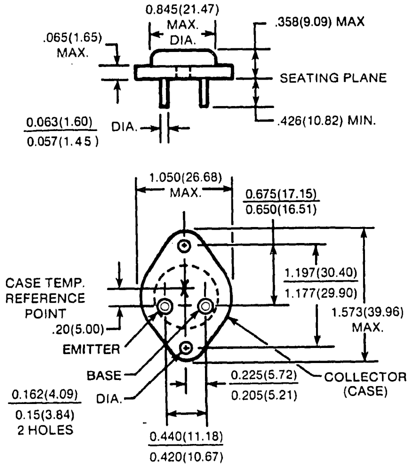
Features:

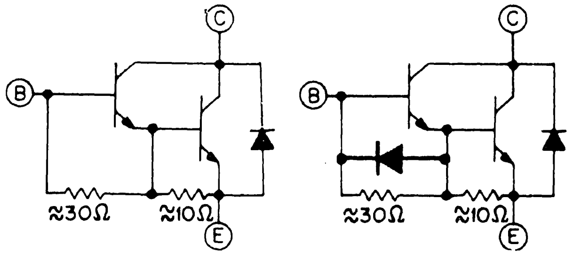
- High Speed: $t_s < 5.0$ μsec., $t_r < 3.0$ μsec.
- High Voltage: 400-500 V_{CEO}
- High Gain: h_{FE} 50 Minimum @ 50 Amperes, I_C
- High Current: 75 Amperes, I_C (Peak)



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





D64DV D64EV

DEVICE CIRCUIT

maximum ratings ($T_C = 25°C$) (unless otherwise noted)

RATING	SYMBOL	D64DV5/EV5	D64DV6/EV6	D64DV7/EV7	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Collector-Base Voltage	V_{CBO}	500	600	700	Volts
Emitter Base Voltage D64DV D64EV	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	50 75 125	50 75 125	50 75 125	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ $T_C = 25°C$	P_D	180	180	180	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	0.7	0.7	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage	D64DV5/EV5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = .5A)	D64DV6/EV6		450	—	—	
(V_{clamp} = V_{CEO} Rated)	D64DV6/EV7		500	—	—	
Collector Cutoff Current	T_J = 25°C	I_{CEV}	—	—	1.0	mA
(V_{CE} = Rated Value, V_{BE} = -1.5V)	T_J = 150°C		—	—	2.5	
Emitter Cutoff Current		I_{EBO}				
(V_{EB} = 4.5V, I_C = 0)	D64DV		—	—	350	mA
(V_{EB} = 1.5V, I_C = 0)	D64EV		—	—	350	

second breakdown

CHARACTERISTIC	SYMBOL	
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 23

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
(I_C = 75A, V_{CE} = 5V)		25	60	—	—
(I_C = 50A, V_{CE} = 5V)		50	135	—	
(I_C = 20A, V_{CE} = 5V)		100	250	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 75A, I_B = 5A)		—	2.2	3.0	V
(I_C = 50A, I_B = 4A)		—	1.7	2.0	
(I_C = 20A, I_B = 2A)		—	1.15	1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 75A, I_B = 5A)		—	2.8	3.5	V
(I_C = 50A, I_B = 4A)		—	2.45	3.0	
(I_C = 20A, I_B = 2A)		—	1.95	2.5	

switching characteristics

				TYP.		MAX.		
Resistive Load				DV	EV	DV	EV	
Delay Time	V_{CC} = 250V	t_d	—	0.09	.09	.5	.5	μs
Rise Time	I_C = 50A	t_r	—	.5	.5	1	1	
Storage Time	I_{B1} = 2.5A, I_{B2} = 5A	t_s	—	2.55	2	5	3	
Fall Time	t_p = 50 μsec	t_f	—	1.4	.64	3	1	

emitter-collector diode characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Power Dissipation	(I_{B1} = 0)	P_D	—	—	125	Watts
Forward Voltage	(I_F = 25A)	V_F	—	1.95	3.20	Volts
	(I_P = 50A)	V_F	—	2.60	3.80	Volts
	(I_F = 50A, T_J = 150°C)	V_F	—	2.30	3.50	Volts
Reverse Recovery Time (I_F = 50A, di/dt = 25A/μsec, R_{B1E} = .25Ω)		T_{rr}	—	3.85	10.0	μsec
Forward Turn-On Time (I_F = 100A, di/dt = 100A/μsec)		T_{ON}	—	0.75	1.5	μsec
Single Cycle Surge Current (60Hz)		I_{FSM}	—	—	150	Amps
Thermal Resistance		$R_{\theta JC}$	—	—	1.0	°C/Watt

TYPICAL CHARACTERISTICS

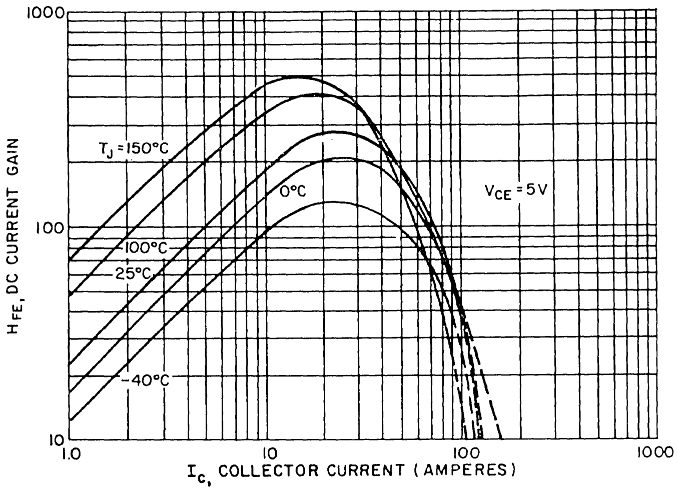


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

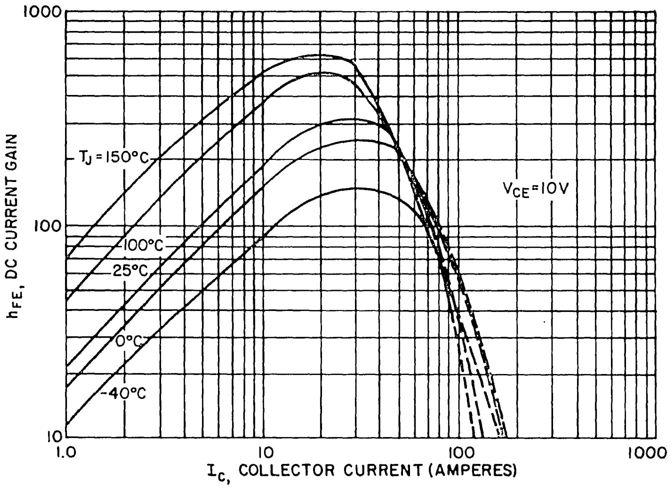


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

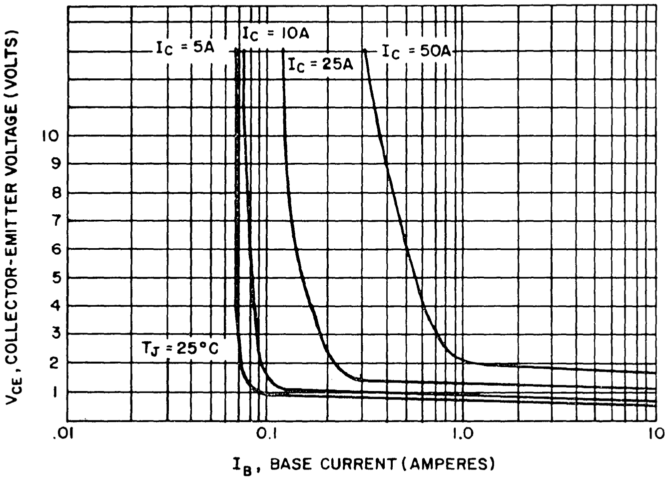


FIGURE 3. COLLECTOR SATURATION REGION

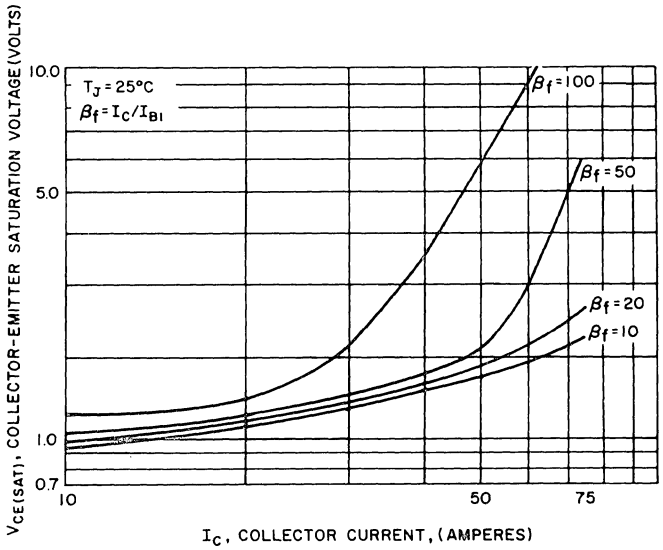


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C, T_J = 25°C

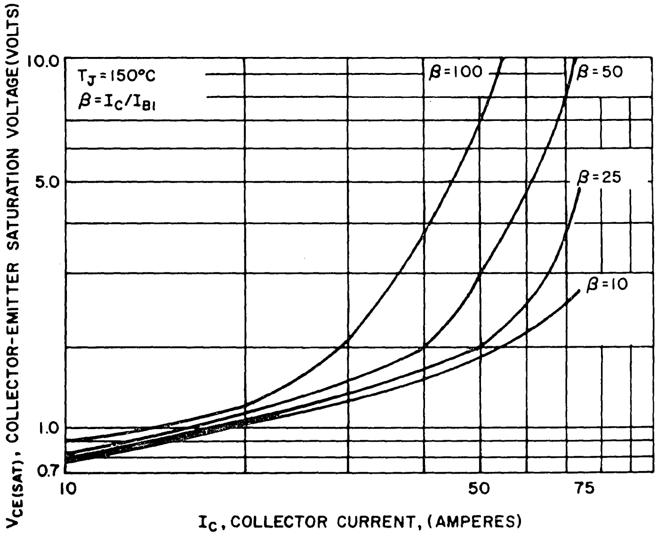


FIGURE 5. $V_{CE\ (SAT)}$ VS I_C, T_J = 150°C

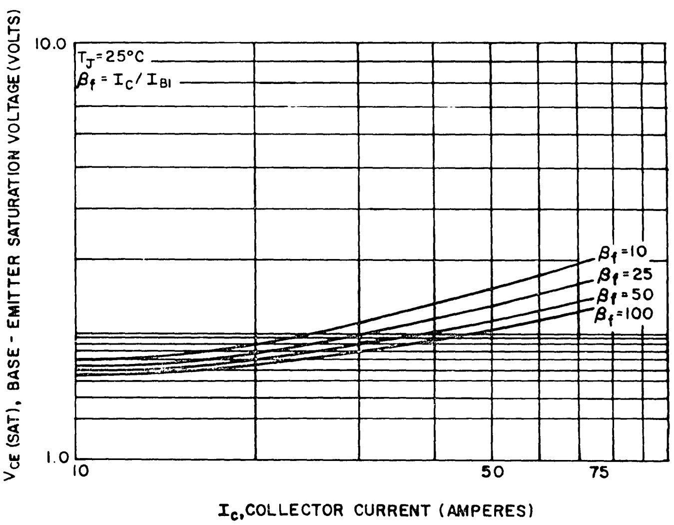


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C, T_J = 25°C

TYPICAL CHARACTERISTICS

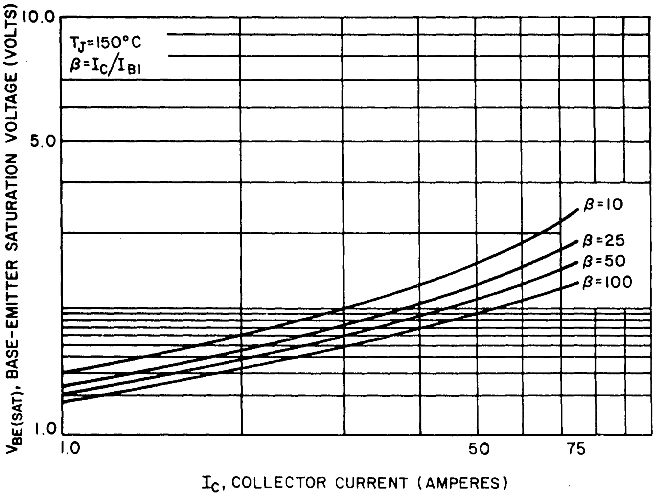


FIGURE 7. $V_{BE\ (SAT)}$ VS I_C, T_J = 150°C

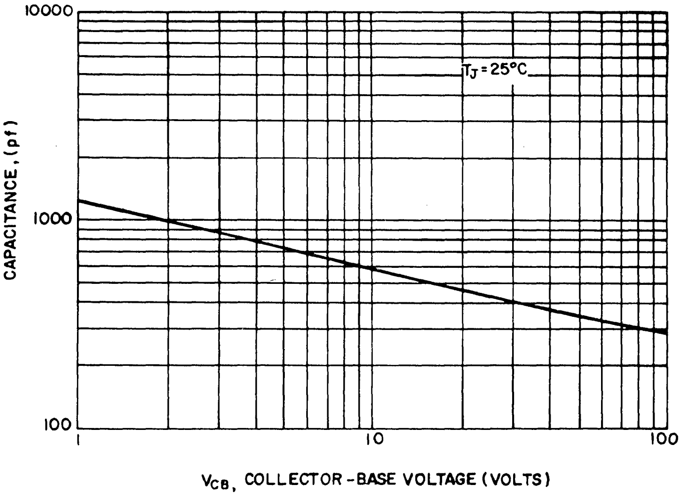


FIGURE 8. CAPACITANCE (C_{CBO})

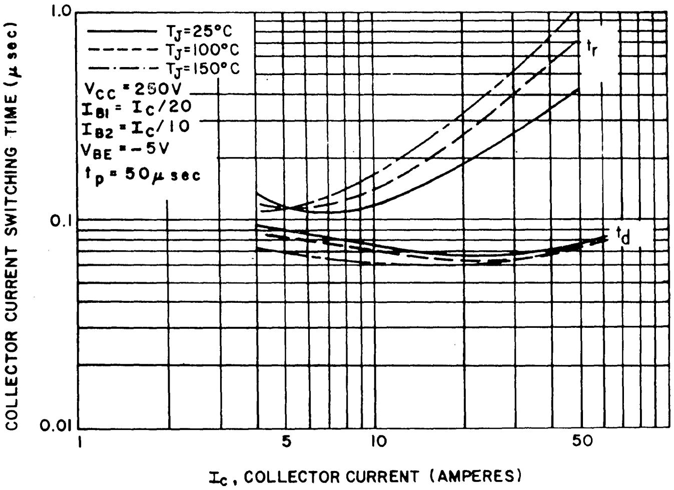


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD)
(D64DV ONLY)

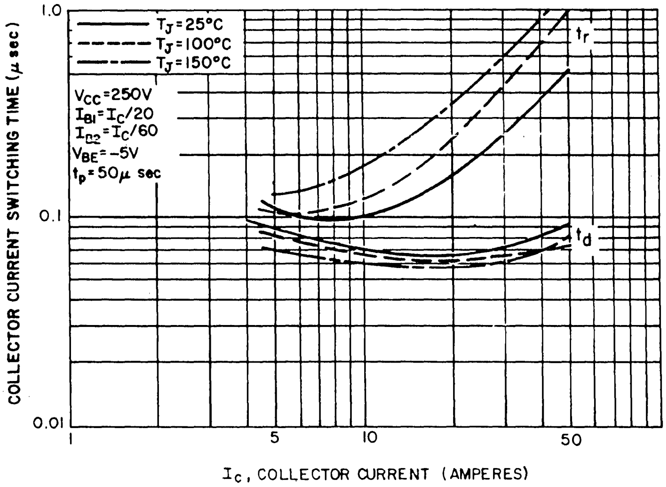


FIGURE 10. TURN-ON TIME (RESISTIVE LOAD)
(D64EV ONLY)

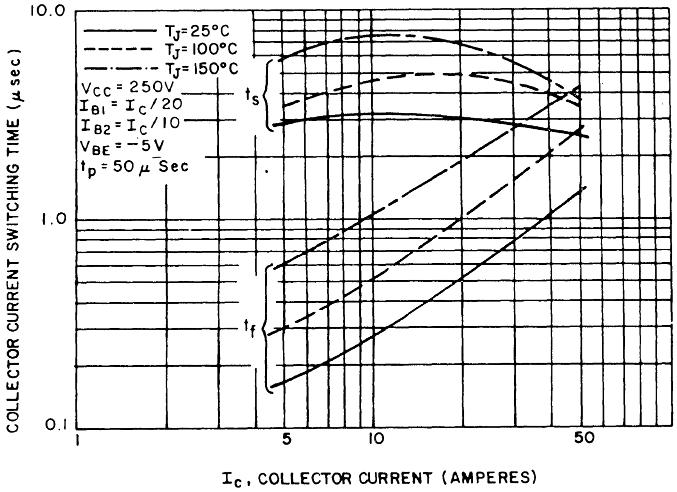


FIGURE 11. TURN-OFF TIME (RESISTIVE LOAD)
(D64DV ONLY)

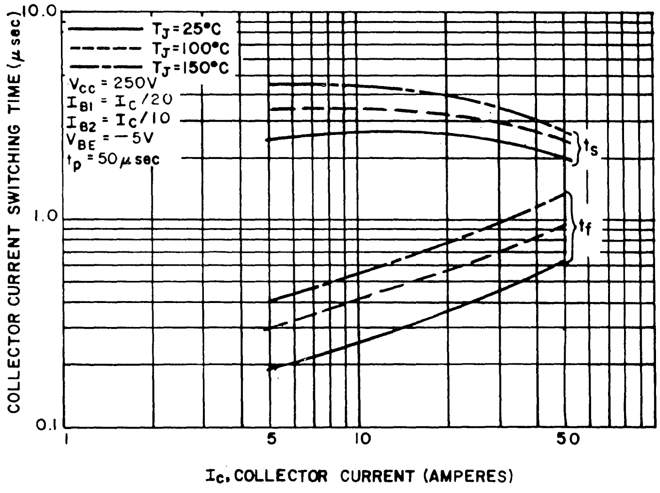


FIGURE 12. TURN-OFF TIME (RESISTIVE LOAD)
(D64EV ONLY)

TYPICAL CHARACTERISTICS

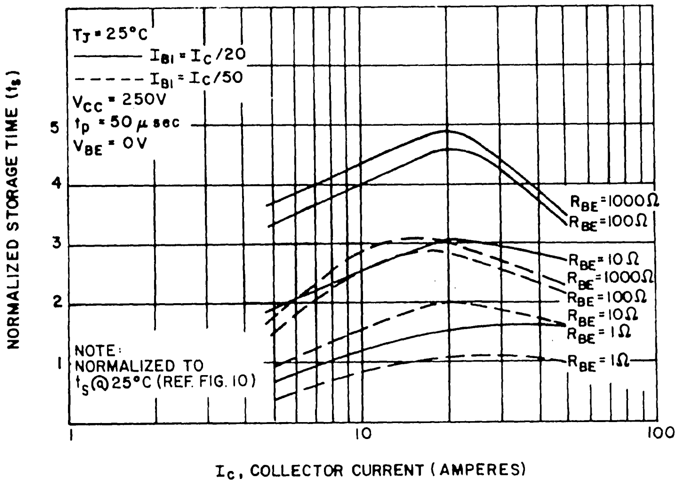


FIGURE 13. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARATIONS) VS COLLECTOR CURRENT (D64DV ONLY)

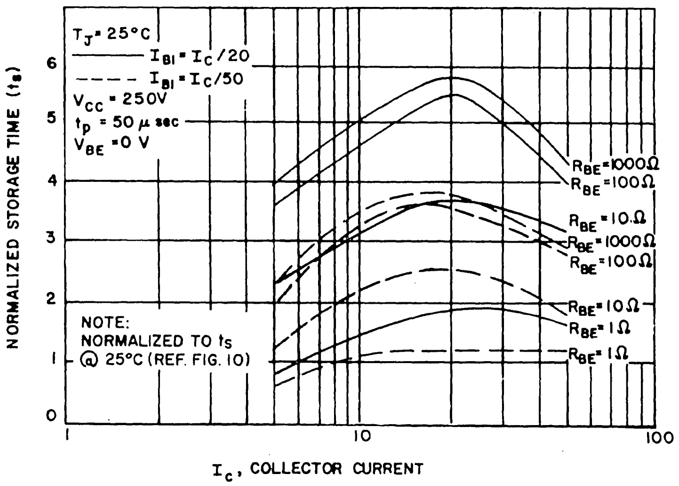


FIGURE 14. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARATIONS) VS COLLECTOR CURRENT (D64EV ONLY)

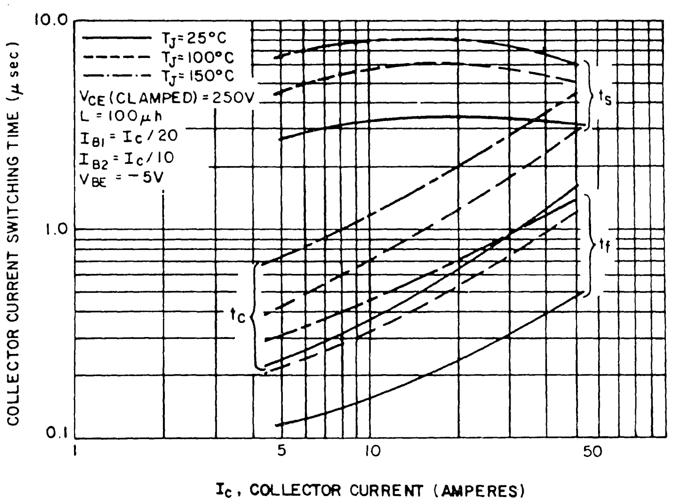


FIGURE 15. CLAMPING INDUCTIVE TURN-OFF TIME (D64DV ONLY)

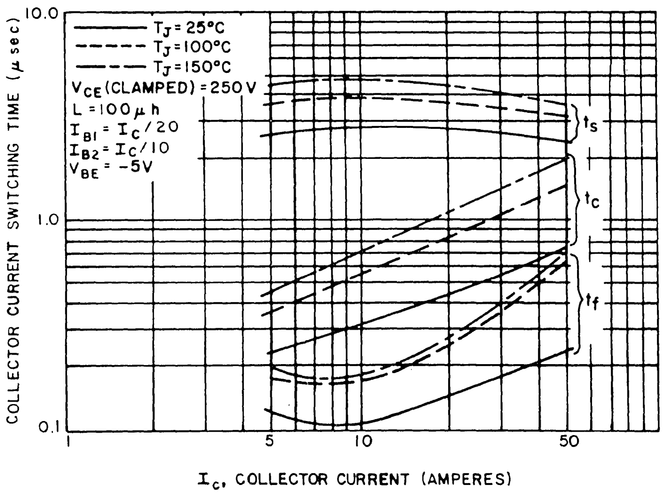


FIGURE 16. CLAMPING INDUCTIVE TURN-OFF TIME (D64EV ONLY)

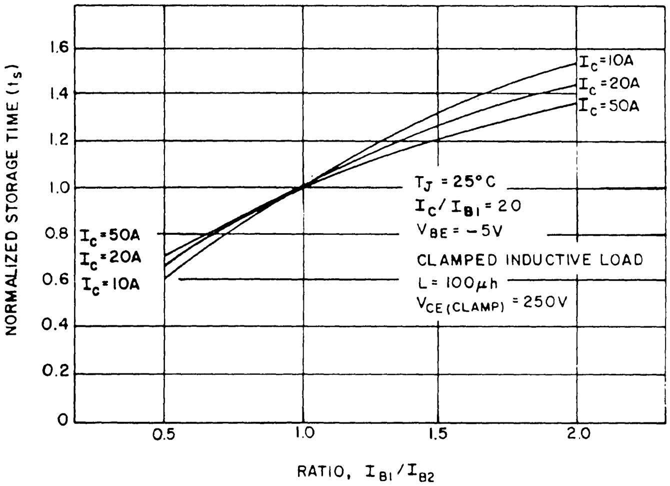


FIGURE 17. STORAGE TIME VARIATION WITH I_{B2} (D64DV ONLY)

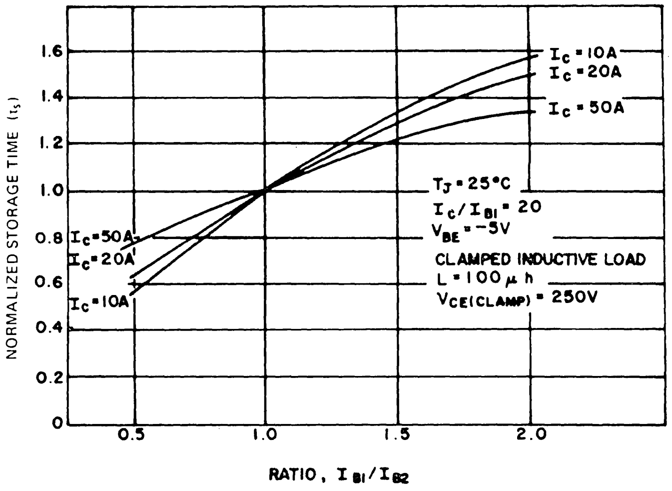


FIGURE 18. STORAGE TIME VARIATION WITH I_{B2} (D64EV ONLY)

TYPICAL CHARACTERISTICS

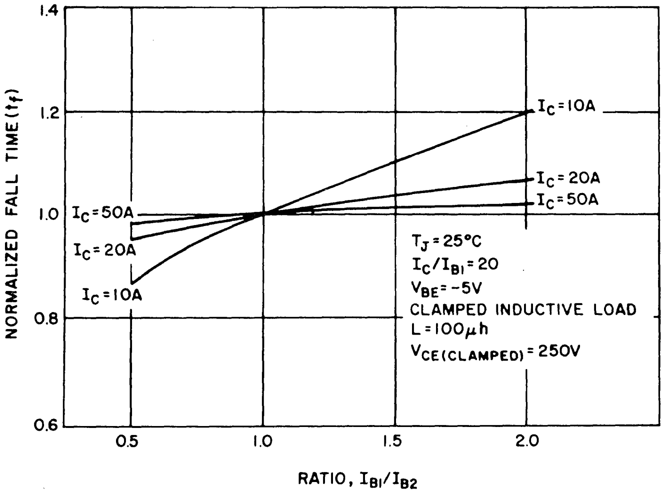


FIGURE 19. FALL TIME VARIATION WITH I_{B2} (D64DV ONLY)

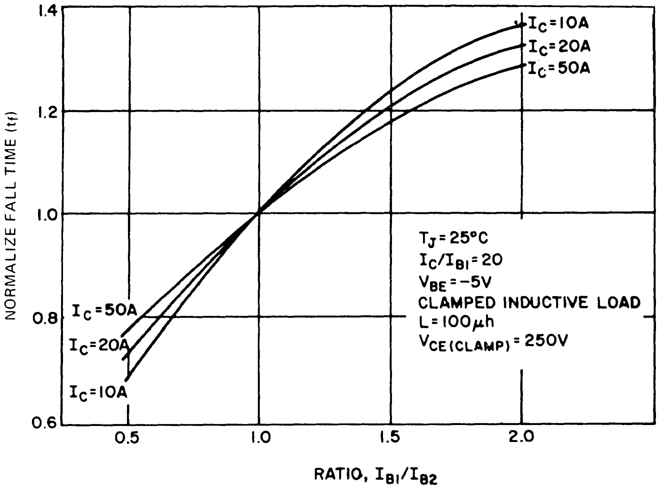


FIGURE 20. FALL TIME VARIATION WITH I_{B2} (D64EV ONLY)

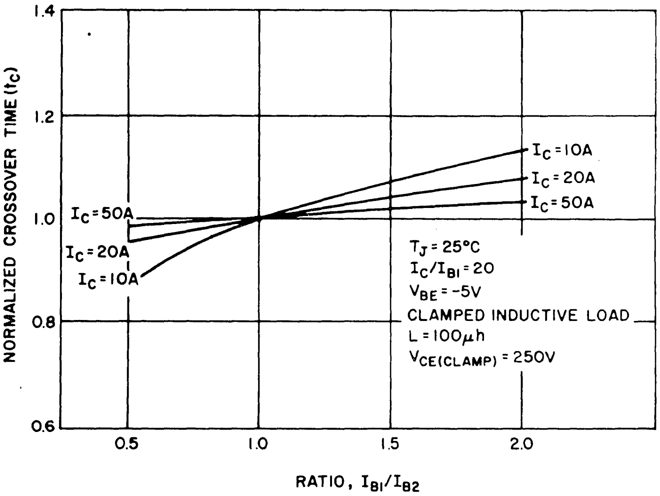


FIGURE 21. CROSSOVER TIME VARIATION WITH I_{B2} (D64DV ONLY)

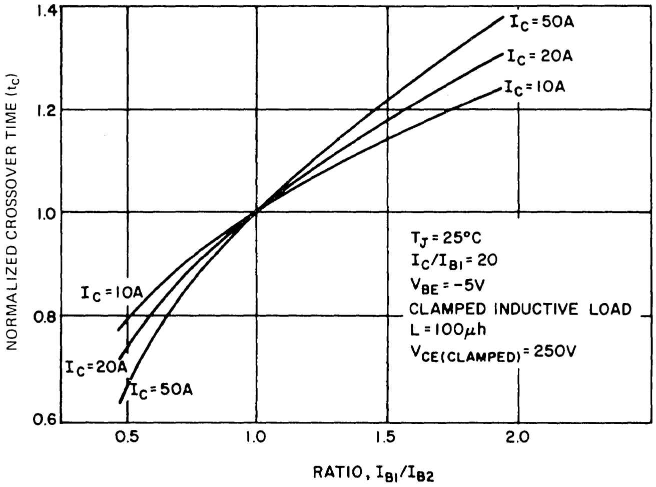


FIGURE 22. CROSSOVER TIME VARIATION WITH I_{B2} (D64EV ONLY)

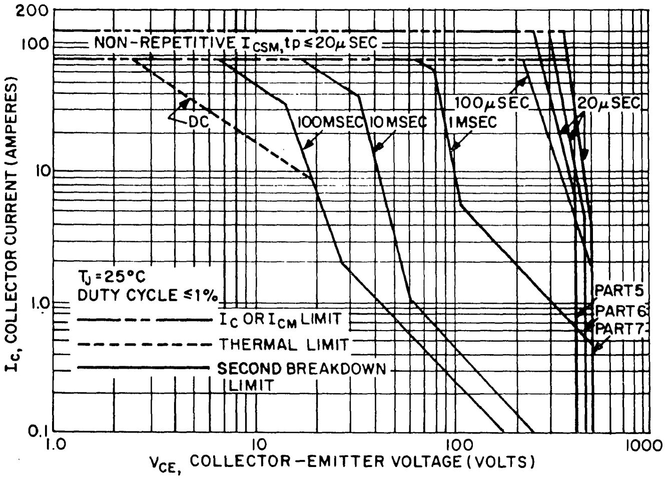


FIGURE 23. FORWARD BIAS SAFE OPERATING AREA

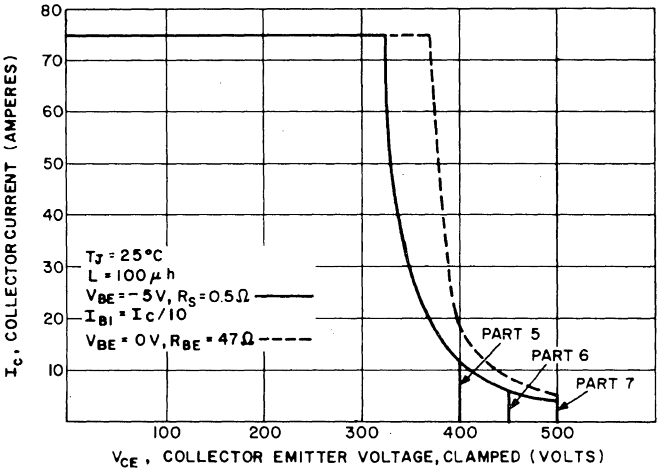


FIGURE 24. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

TYPICAL CHARACTERISTICS

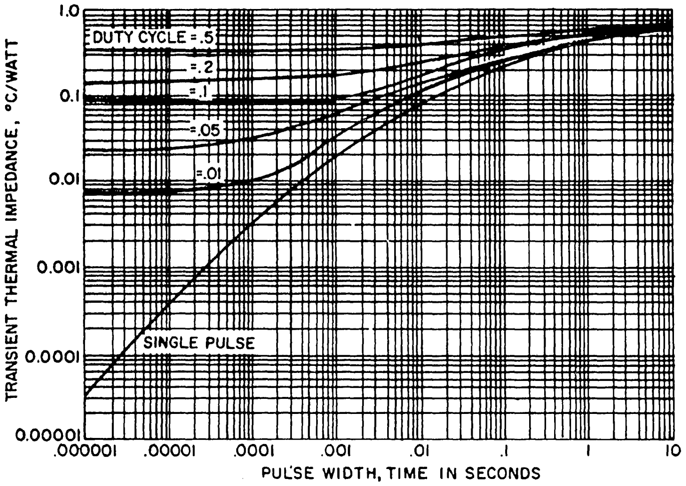


FIGURE 25. TRANSIENT THERMAL RESPONSE

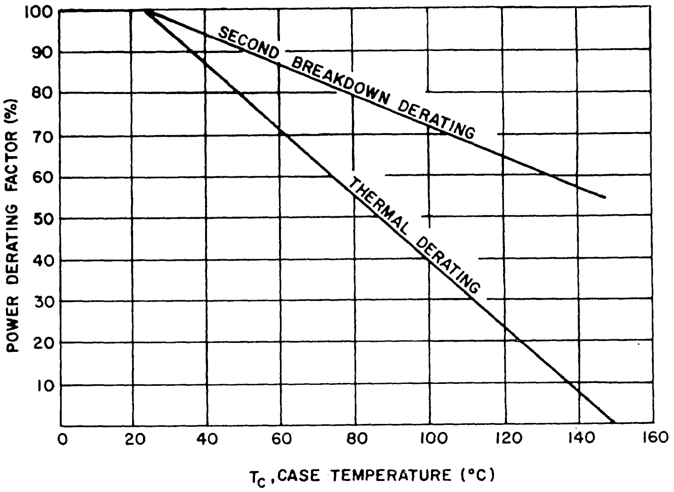


FIGURE 26. POWER DERATING

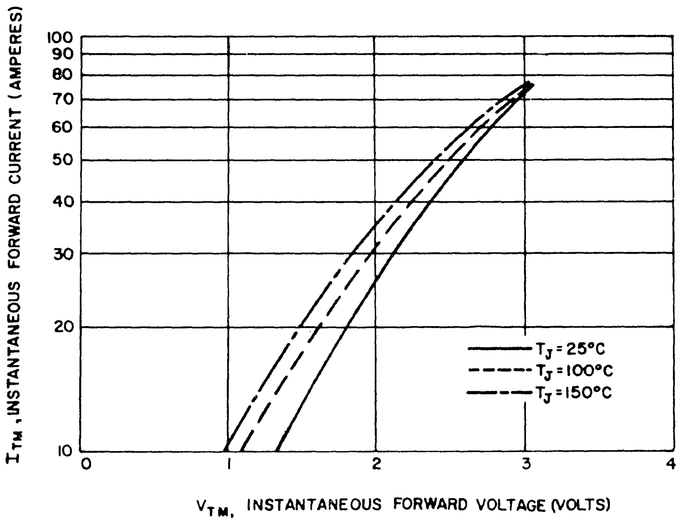
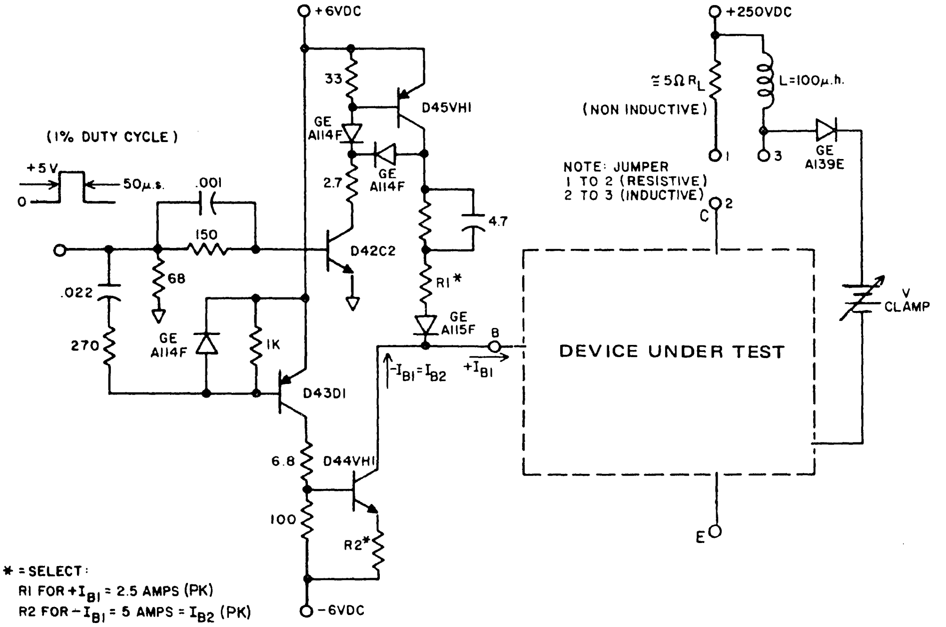


FIGURE 27. FORWARD CHARACTERISTICS



* = SELECT:
R1 FOR $+I_{B1}$ = 2.5 AMPS (PK)
R2 FOR $-I_{B1}$ = 5 AMPS = I_{B2} (PK)

FIGURE 28. SWITCHING TIME TEST CIRCUIT

HIGH VOLTAGE/HIGH SPEED
NPN POWER TRANSISTORS
JEDEC EQUIVALENT - 2N6676, 77, 78

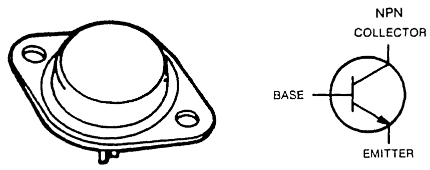
D64VS3,4,5

300-400 VOLTS
15 AMP, 195 WATTS

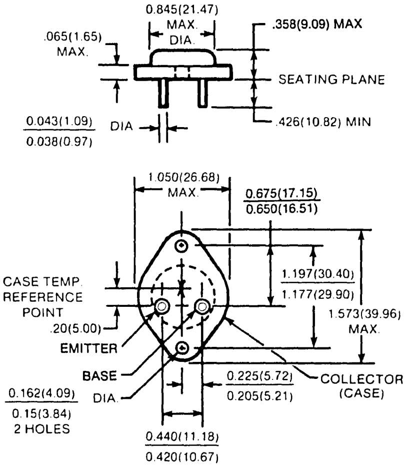
The D64VS series of NPN power transistors is designed for use in power switching applications requiring high-voltage capability, fast switching speeds and low-saturation voltages. These devices are optimized to provide a unique combination of ultra-low switching losses and high safe-operating area (SOA), ideally suited for off-line switching power supplies, converter circuits and pulse width modulated regulators.

Features:

- Performance information tailored for switching
- 100°C maximum limits specified for:
  - Switching times
  - Saturation voltages
  - Leakage currents
- RBSOA (V_{CEX} = 300 to 400V) at rated I_C continuous.
- Very fast turn-off, $t_f < 100$ nsec (typ.) @ 15A — Inductive Load



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings

RATING	SYMBOL	D64VS3	D64VS4	D64VS5	UNITS
Collector-Emitter Voltage	V_{CEO}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEX}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEV}	450	500	550	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak[(1)]	I_C I_{CM}	15 30	15 30	15 30	A
Base Current — Continuous Peak[(1)]	I_B I_{BM}	5 10	5 10	5 10	A
Emitter Current — Continuous Peak[(1)]	I_E I_{EM}	20 35	20 35	20 35	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	195 111 1.11	195 111 1.11	195 111 1.11	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	-65 to +200	-65 to +200	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.9	0.9	0.9	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	235	235	235	°C

(1) Pulse condition, $t_p \leq 5$msec.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage[1] (I_C = 100mA)	D64VS3 D64VS4 D64VS5	$V_{CEO(sus)}$	300 350 400	— — —	Volts
Collector-Emitter Voltage (I_C = 15A, I_{B1} = 2.5A, I_{B2} = 3.0A) ($V_{BE(OFF)}$ = -6V, L = 200 μh)	D64VS3 D64VS4 D64VS5	V_{CEX}	300 350 400	— — —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V) (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V, T_C = 100°C)		I_{CEV}	— —	0.1 1.0	mA
Emitter Cutoff Current (V_{EB} = 7V)		I_{EBO}	—	1.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 13
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 14

on characteristics

DC Current Gain (I_C = 10A, V_{CE} = 2V) (I_C = 15A, V_{CE} = 2V)	h_{FE}	10 8	— —	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 1.67A) (I_C = 15A, I_B = 2.5A) (I_C = 15A, I_B = 2.5A, T_C = 100°C)	$V_{CE(SAT)}$	— — —	0.7 1.0 1.5	Volts
Base-Emitter Saturation Voltage (I_C = 15A, I_B = 2.5A) (I_C = 15A, I_B = 2.5A, T_C = 100°C)	$V_{BE(SAT)}$	— —	1.5 1.5	Volts

dynamic characteristics

Current Gain — Bandwidth Product (I_C = 1.0A, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	15	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{OB}	150	360	pF

switching characteristics

			MAXIMUM		
Resistive Load (See Figure 17 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 250V, I_C = 15A	t_d	0.1	0.2	μs
Rise Time	I_{B1} = 2.5, I_{B2} = 3.0A, t_p = 50 μsec	t_r	0.5	0.7	μsec
Storage Time		t_s	2.5	3.0	μsec
Fall Time		t_f	0.4	0.7	μsec
Inductive Load, Clamped (See Figure 17 for Test Circuit)					
Storage Time	I_C = 15A, V_{CLAMP} = 250V	t_s	3.0	3.5	μs
Fall Time	I_{B1} = 2.5A, I_{B2} = 3.0A, $V_{BE(OFF)}$ = -6V L = 200 μh, t_p = 25μsec	t_f	0.3	0.6	μsec
			TYPICAL		
Storage Time		t_s	1.8	2.5	μsec
Fall Time		t_f	.085	.13	μsec

(1) Pulse Duration = 300μs, Duty Factor ≤ 2%. Do not measure on a curve tracer.

TYPICAL DC CHARACTERISTICS

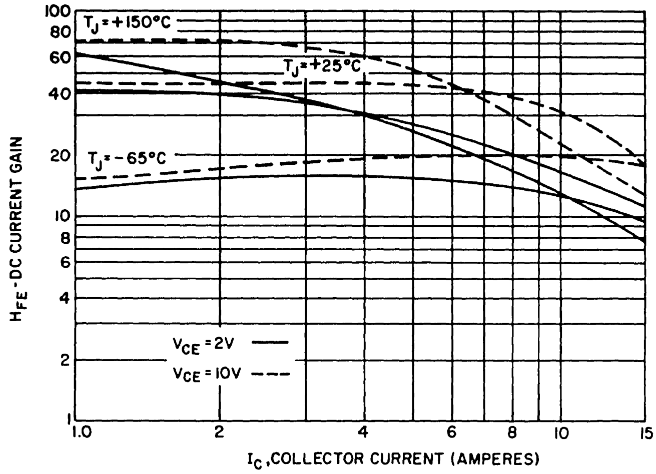


FIGURE 1. DC CURRENT GAIN

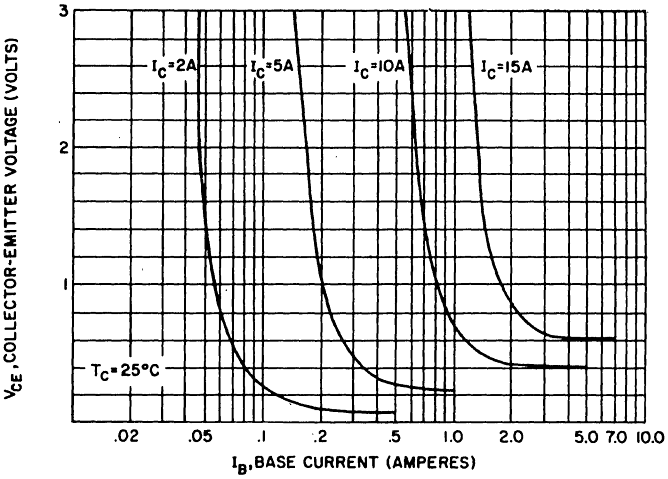


FIGURE 2. COLLECTOR SATURATION REGION

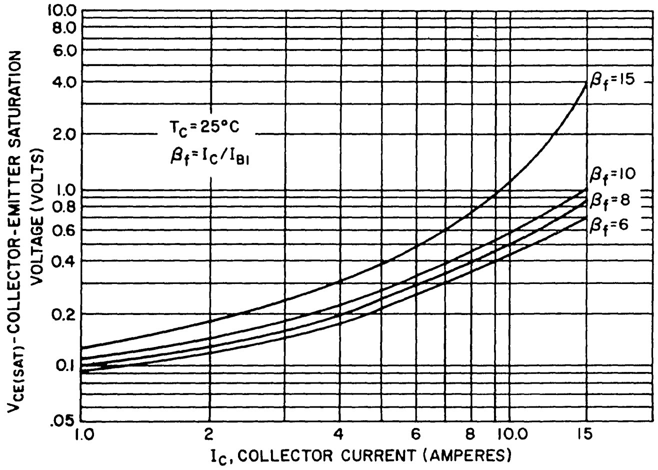


FIGURE 3. $V_{CE(sat)}$ vs I_C, T_C = 25°C

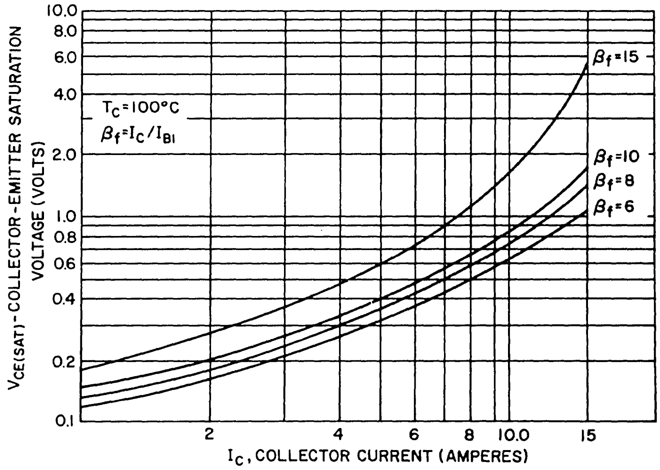


FIGURE 4. $V_{CE(sat)}$ vs I_C, T_C = 100°C

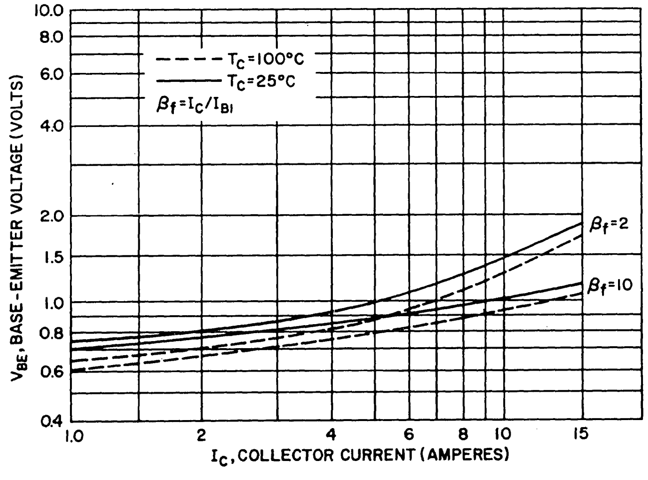


FIGURE 5. $V_{BE(sat)}$ vs I_C

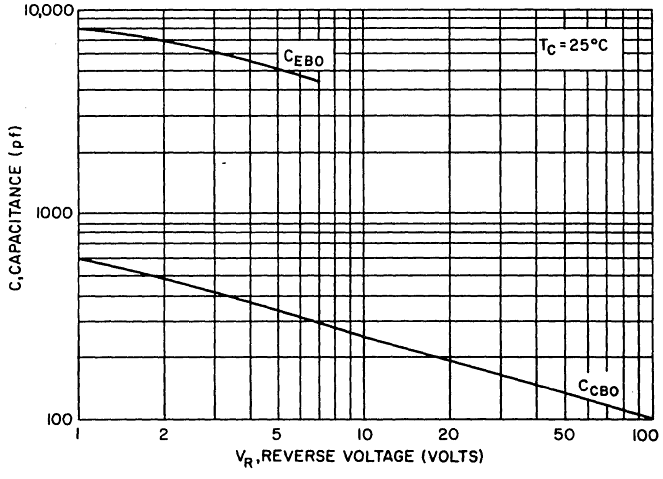


FIGURE 6. CAPACITANCE

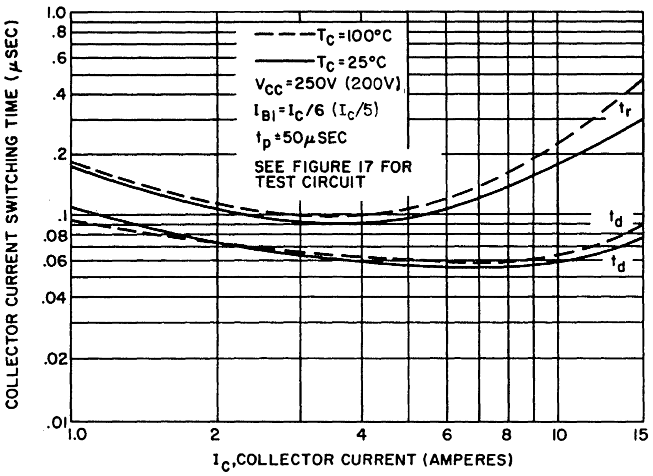


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

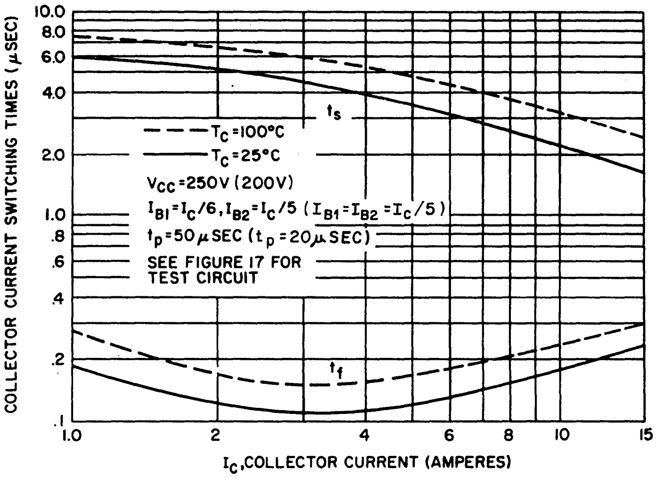


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

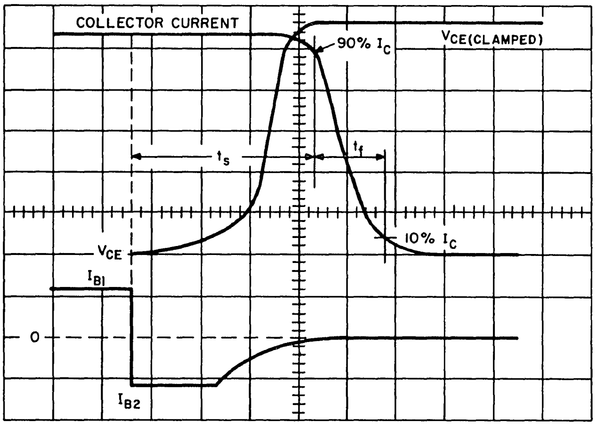


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

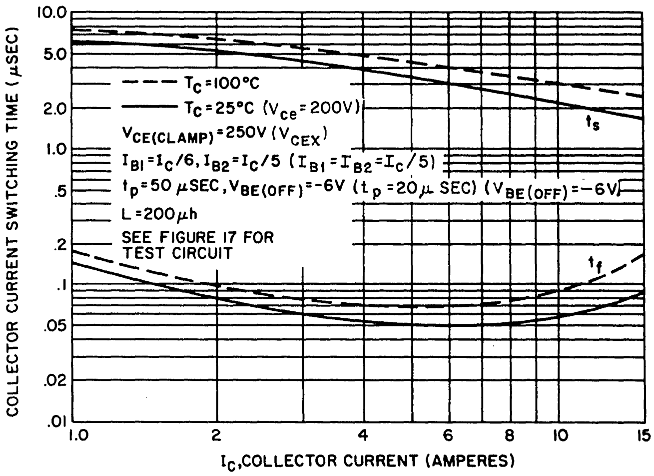


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

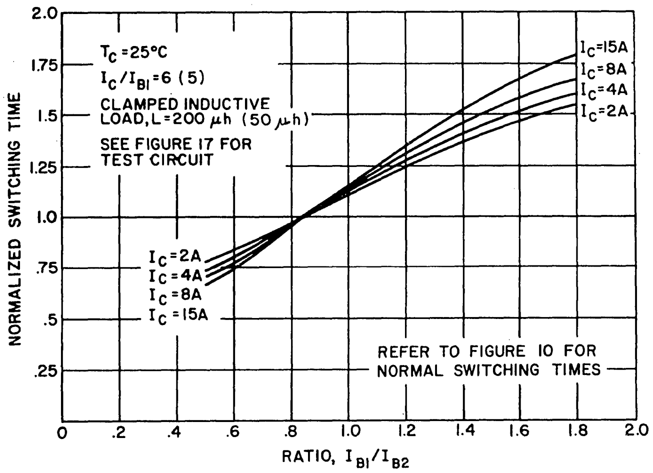


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

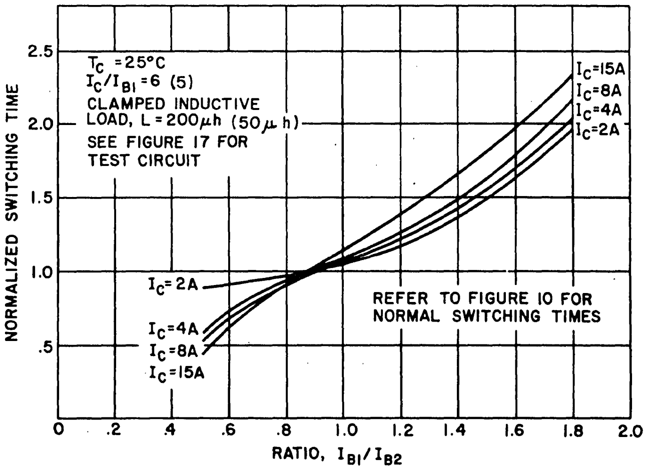


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

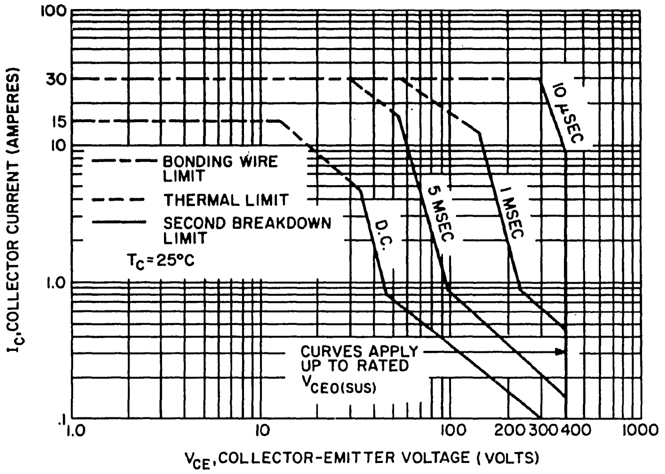


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

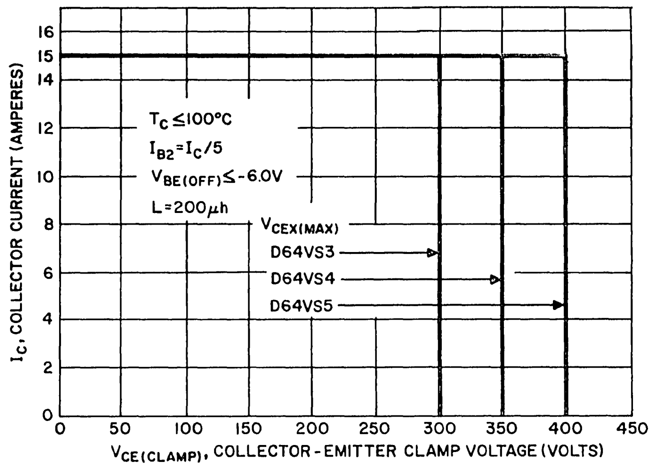


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

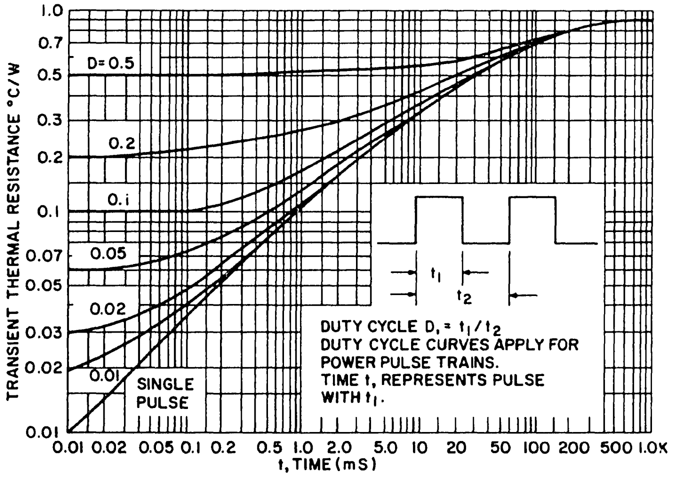


FIGURE 15. TRANSIENT THERMAL RESPONSE

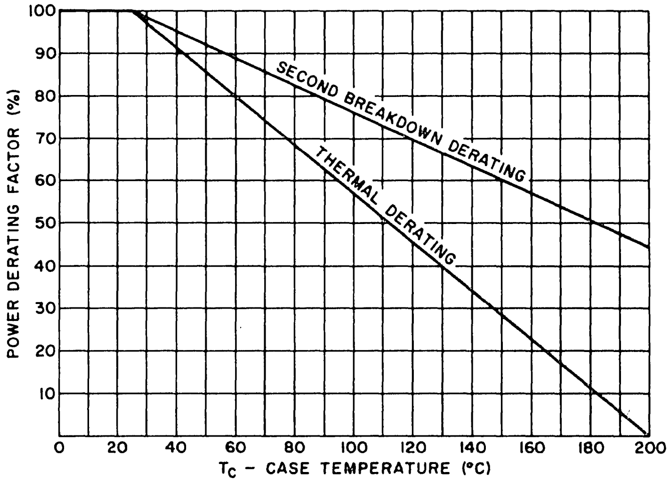
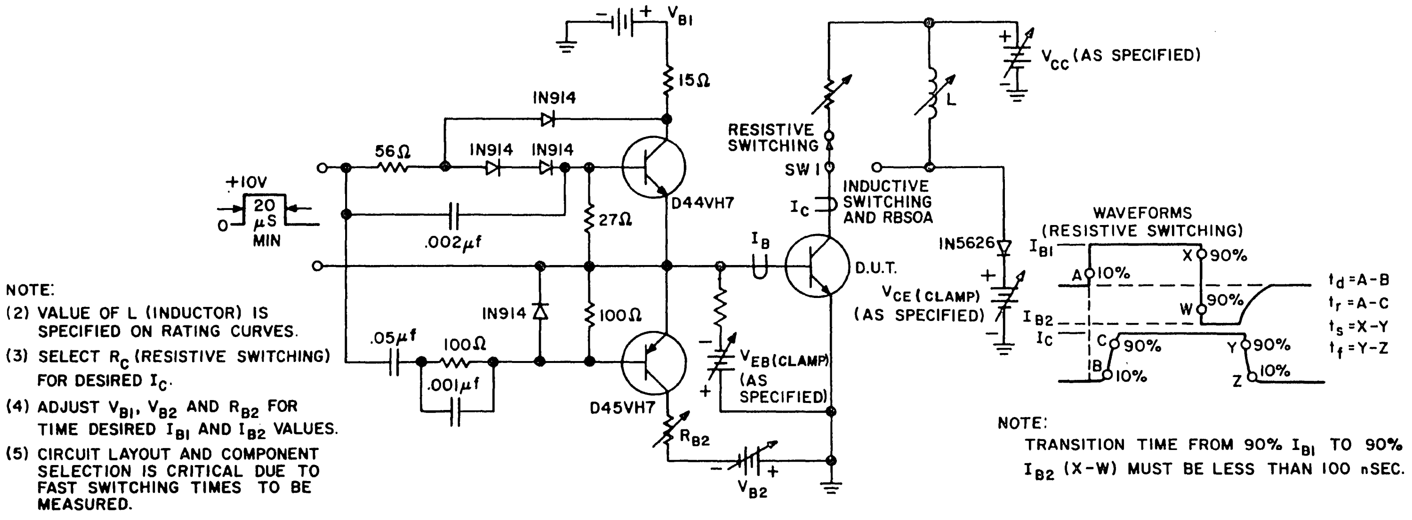


FIGURE 16. POWER DERATING



NOTE:

(2) VALUE OF L (INDUCTOR) IS SPECIFIED ON RATING CURVES.

(3) SELECT R_C (RESISTIVE SWITCHING) FOR DESIRED I_C.

(4) ADJUST V_{B1}, V_{B2} AND R_{B2} FOR TIME DESIRED I_{B1} AND I_{B2} VALUES.

(5) CIRCUIT LAYOUT AND COMPONENT SELECTION IS CRITICAL DUE TO FAST SWITCHING TIMES TO BE MEASURED.

NOTE:

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} (X-W) MUST BE LESS THAN 100 nSEC.

FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

HIGH POWER
NPN POWER DARLINGTON TRANSISTORS

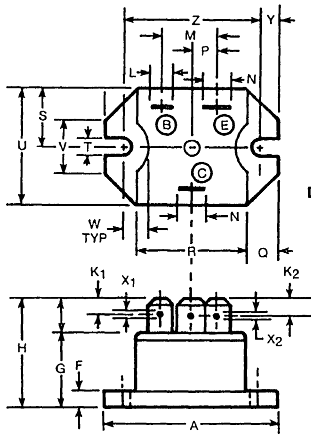
D66DS5,6,7
D66ES5,6,7

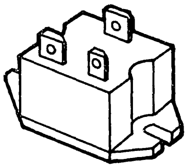
500-700 VOLTS
20 AMP, 62.5 WATTS

The General Electric D66DS/D66ES are high current power darlingtons. They feature collector isolation from the heat sink, an internal construction designed for stress-free operation at temperature extremes and quick connect electrical terminals. The devices are designed to meet UL creep, strike and isolation voltage. Major applications are for motor controls, switching power supplies, and UPS systems. The D66ES has a speed-up diode, the D66DS does not.

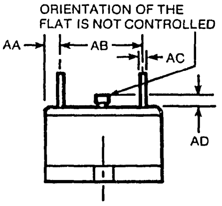
Features:

- High Voltage: 400-500 V_{CEO}
- High Current: 30 Amperes, I_C (Peak)
- High Gain: h_{FE} 40 Minimum @ 20 Amperes, I_C

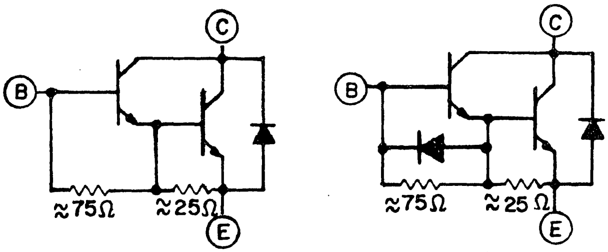




CASE STYLE D66
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)


ORIENTATION OF THE FLAT IS NOT CONTROLLED

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.505	1.540	38.22	39.12
F	.120	.132	3.04	3.35
G	.605	.645	15.36	16.40
H	.940	.980	23.87	24.19
J	.307	—	7.80	—
K_1	.120	.132	3.04	3.35
K_2	.171	.184	4.34	4.64
L	.184	.192	4.57	4.88
M	.464	.484	11.78	12.30
N	.247	.255	6.27	6.48
P	.210	.230	5.33	5.84
Q	.275	REF.	7.00	REF.
R	.970	REF.	24.64	REF.
S	.495	.510	12.57	12.95
T	.150	.170	3.81	4.32
U	.985	1.015	25.01	25.80
V	.450	REF.	11.43	REF.
W	.180	—	4.57	—
X_1	.050	.058	1.27	1.47
X_2	.065	.073	1.65	1.85
Y	.157	.177	3.98	4.50
Z	1.180	1.192	29.97	30.30
AA	.130	.165	3.30	4.30
AB	.684	.704	17.37	17.90
AC	.031	.035	.78	.90
AD	.100	REF.	2.54	REF.



D66DS **D66ES**

DEVICE CIRCUIT

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	D66DS5/ES5	D66DS6/ES6	D66DS7/ES7	UNITS
Collector-Emitter Voltage	V_{CEV}	500	600	700	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage D66DS D66ES	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 30 50	20 30 50	20 30 50	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	5 10	5 10	5 10	A
Total Power Dissipation @ T_C = 25°C	P_D	62.5	62.5	62.5	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to +150	-40 to +150	-40 to +150	°C
Isolation Voltage	V_{ISOL}	2500	2500	2500	$V_{(rms)}$

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	2	2	2	°C/W

See page 845 for mounting and handling considerations.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage D66DS5/ES5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = .5A) D66DS6/ES6		450	—	—	
(V_{clamp} = V_{CEO} Rated) D66DS7/ES7		500	—	—	
Collector Cutoff Current T_J = 25°C	I_{CEV}	—	—	1.0	mA
(V_{CE} = Rated Value, V_{BE} = -1.5V) T_J = 150°C		—	—	2.5	
Emitter Cutoff Current	I_{EBO}				
(V_{EB} = 4.5V, I_C = 0) D66DS		—	—	200	mA
(V_{EB} = 1.5V, I_C = 0) D66ES		—	—	200	

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 26			

on characteristics

DC Current Gain	h_{FE}				
(I_C = 30A, V_{CE} = 5V)		20	35	—	—
(I_C = 20A, V_{CE} = 5V)		40	85	—	
(I_C = 10A, V_{CE} = 5V)		100	160	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 30A, I_B = 3A)		—	2.1	3.5	V
(I_C = 20A, I_B = 2A)		—	1.6	2.5	
(I_C = 10A, I_B = 1A)		—	1.2	1.7	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 30A, I_B = 3A)		—	2.65	4	V
(I_C = 20A, I_B = 2A)		—	2.30	3	
(I_C = 10A, I_B = 1A)		—	1.80	2.5	

switching characteristics

				TYP.		MAX.		
Resistive Load				DS	ES	DS	ES	
Delay Time	V_{CC} = 250V	t_d	—	.05	.05	0.5	0.5	μs
Rise Time	I_C = 20A	t_r	—	.4	.4	1	1	
Storage Time	I_{B1} = 1A, I_{B2} = 2A	t_s	—	2.2	1.8	5	3	
Fall Time	t_p = 50 μsec	t_f	—	1.6	.45	3	1	

emitter-collector diode characteristics

Power Dissipation (I_{B1} = 0)	P_D	—	—	62.5	Watts
Forward Voltage (I_F = 10A)	V_F	—	1.95	3.20	Volts
(I_P = 25A)	V_F	—	2.80	4.00	Volts
(I_F = 25A, T_J = 150°C)	V_F	—	2.75	4.00	Volts
Reverse Recovery Time (I_F = 25A, di/dt = 10A/μsec, R_{B1E} = .25Ω)	T_{rr}	—	3.85	10	μsec
Forward Turn-On Time (I_F = 25A, di/dt = 50A/μsec)	T_{ON}	—	0.42	1.0	μsec
Single Cycle Surge Current (60Hz)	I_{FSM}	—	—	50	Amps
Thermal Resistance	$R_{\theta JC}$	—	—	2.0	°C/Watt

TYPICAL CHARACTERISTICS

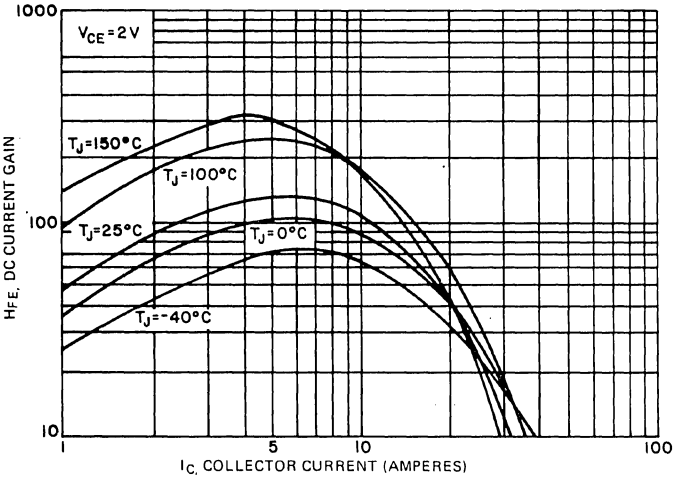


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

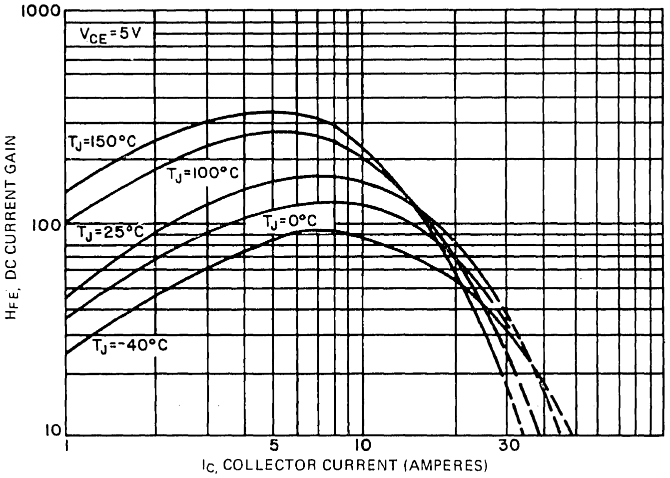


FIGURE 2. DC CURRENT GAIN (V_{CE} = 5V)

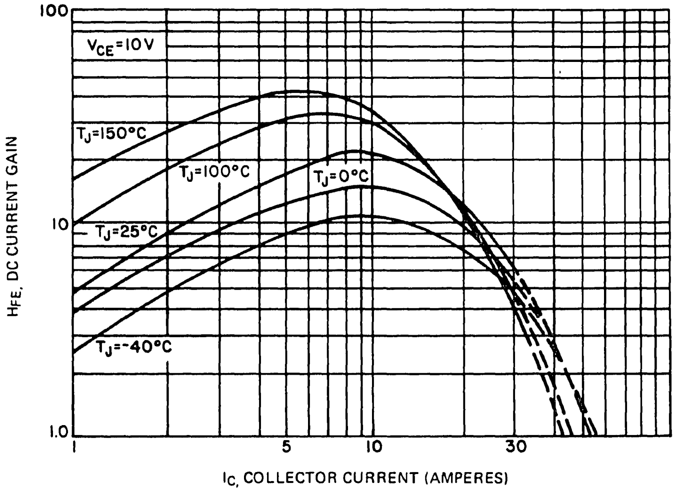


FIGURE 3. DC CURRENT GAIN (V_{CE} = 10V)

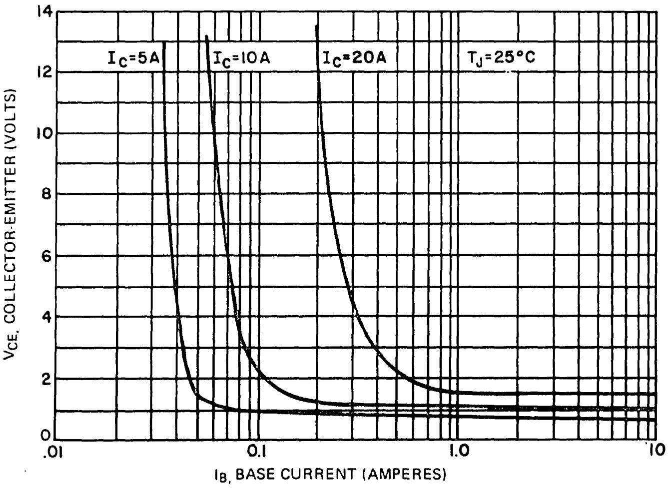


FIGURE 4. COLLECTOR SATURATION REGION

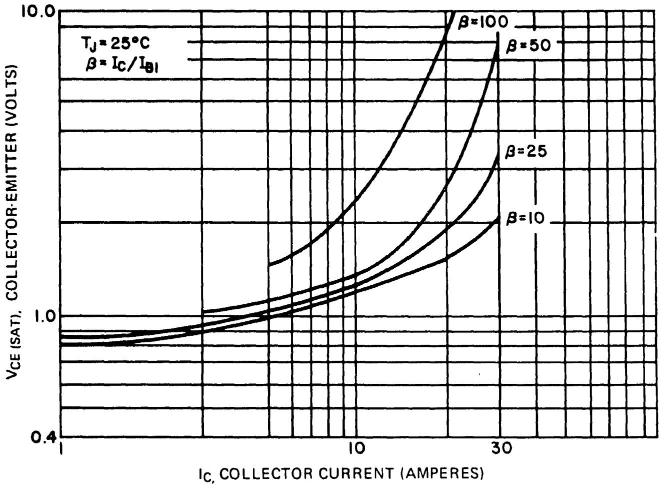


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

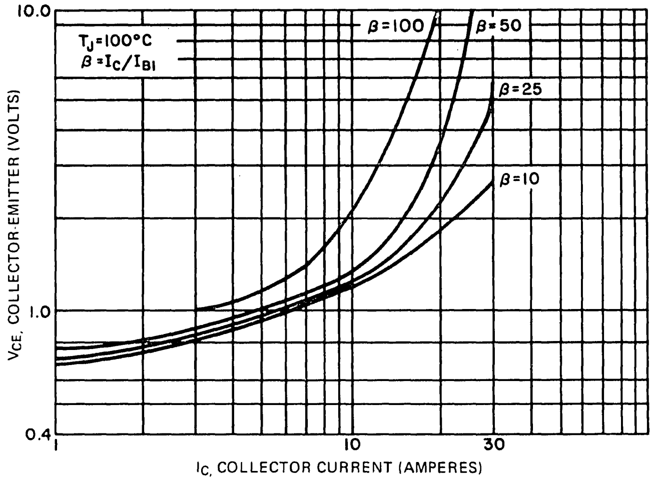


FIGURE 6. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

TYPICAL CHARACTERISTICS

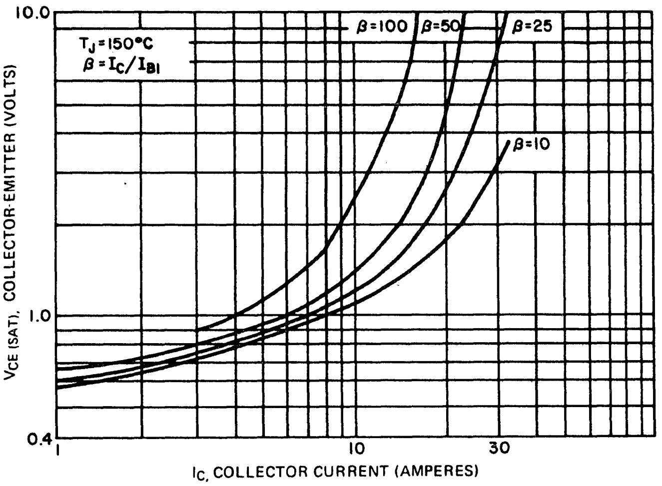


FIGURE 7. $V_{CE(SAT)}$ VS. I_C, T_J = 150°C

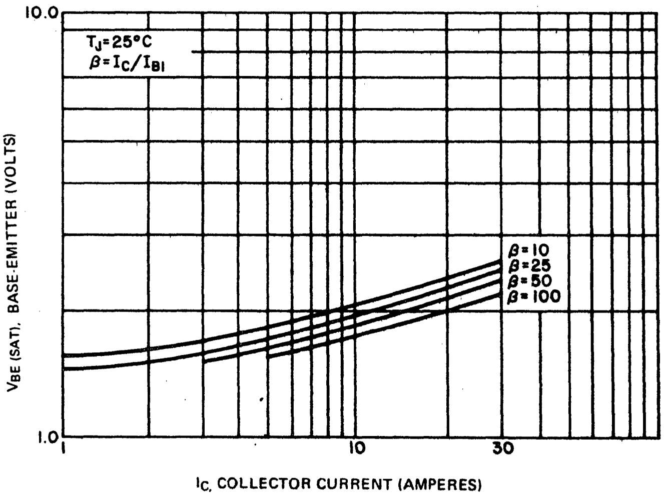


FIGURE 8. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

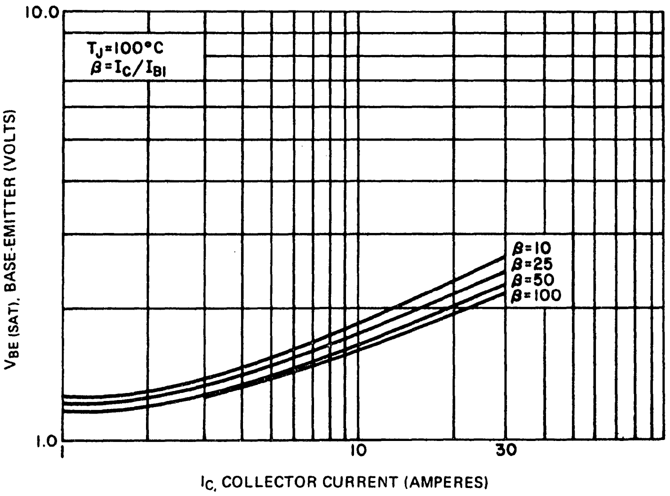


FIGURE 9. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

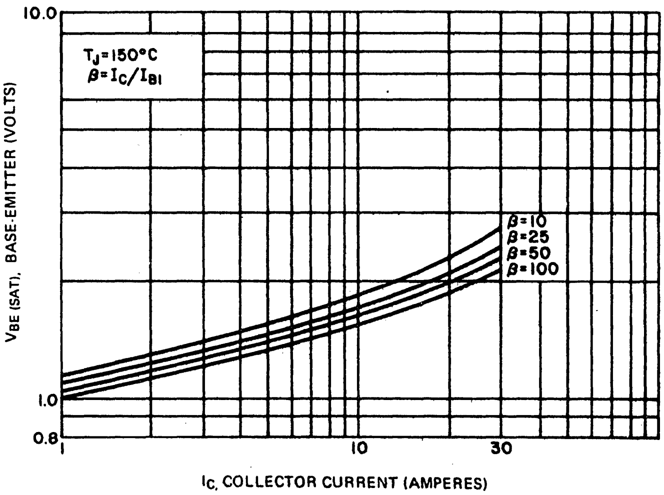


FIGURE 10. $V_{BE(SAT)}$ VS. I_C, T_J = 150°C

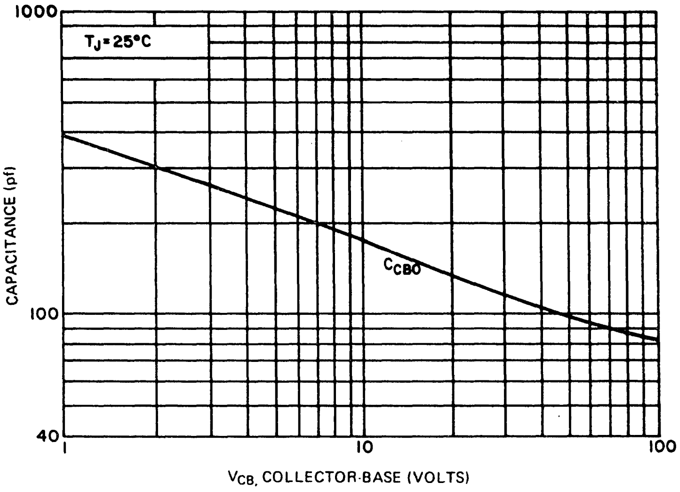


FIGURE 11. CAPACITANCE (C_{CBO})

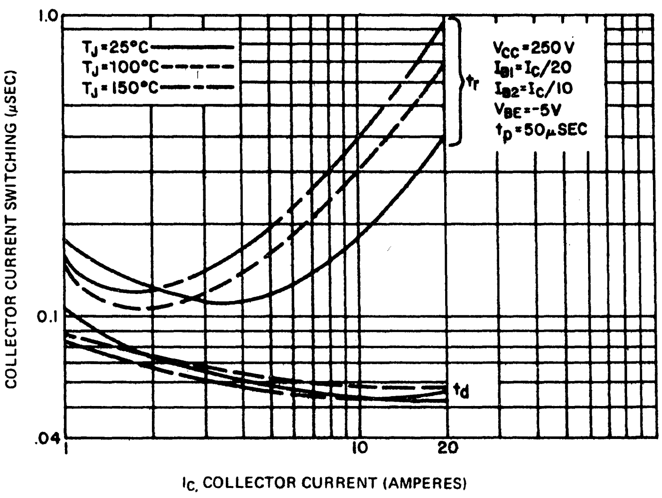


FIGURE 12. TURN-ON TIME (RESISTIVE LOAD) (D66DS ONLY)

TYPICAL CHARACTERISTICS

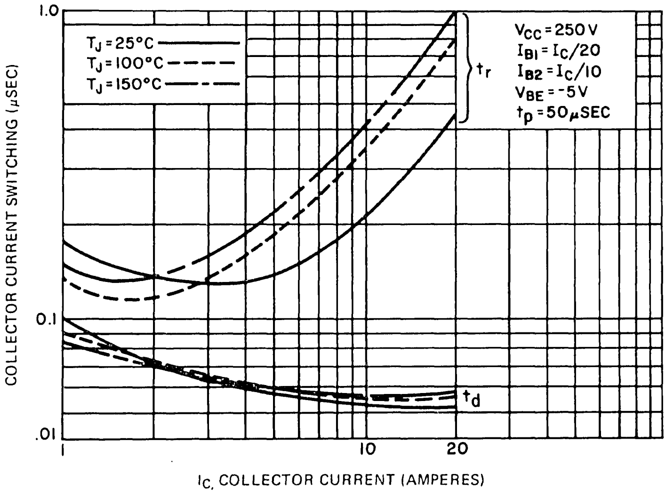


FIGURE 13. TURN-ON TIME (RESISTIVE) (D66ES ONLY)

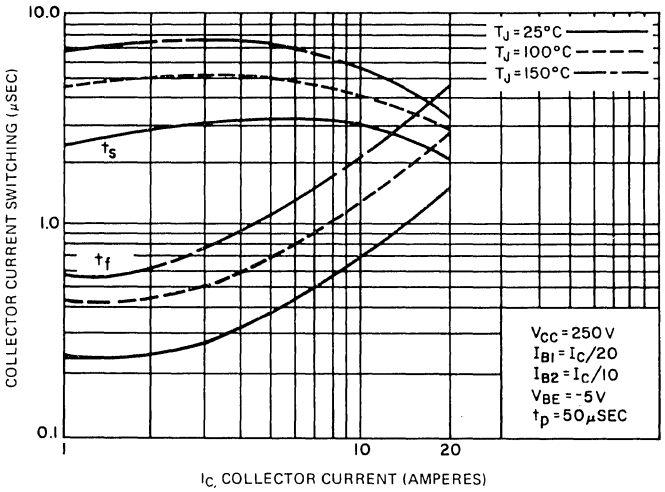


FIGURE 14. TURN-OFF TIME (RESISTIVE) (D66DS ONLY)

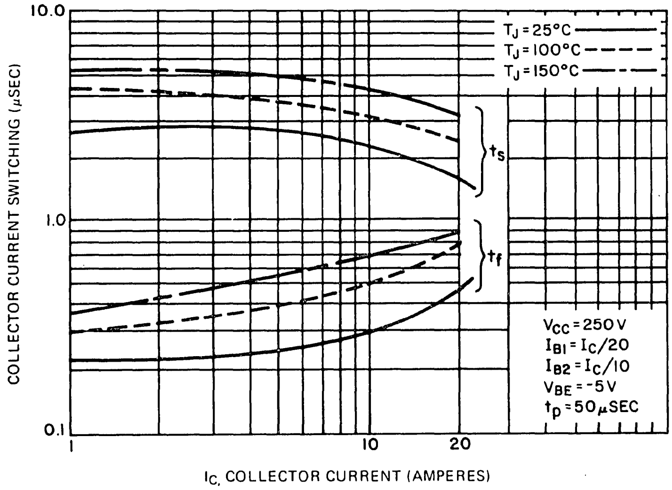


FIGURE 15. TURN-OFF TIME (RESISTIVE) (D66ES ONLY)

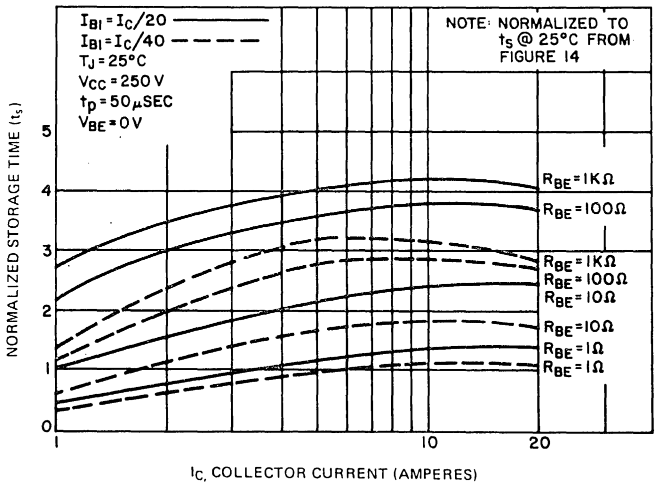


FIGURE 16. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D66DS ONLY)

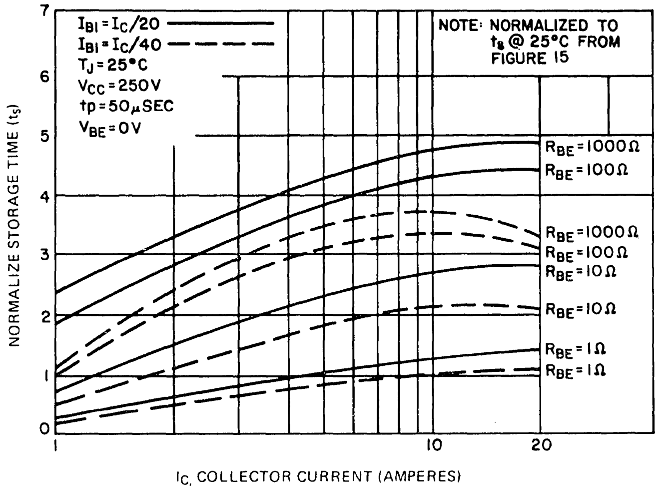


FIGURE 17. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D66ES ONLY)

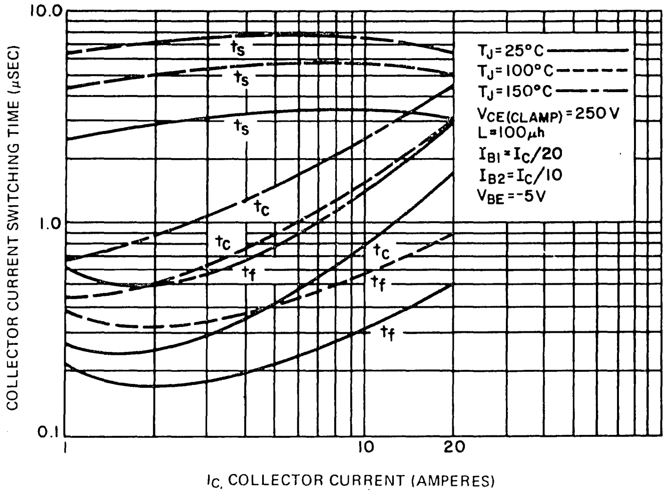


FIGURE 18. CLAMPED INDUCTIVE TURN-OFF TIME (D66DS ONLY)

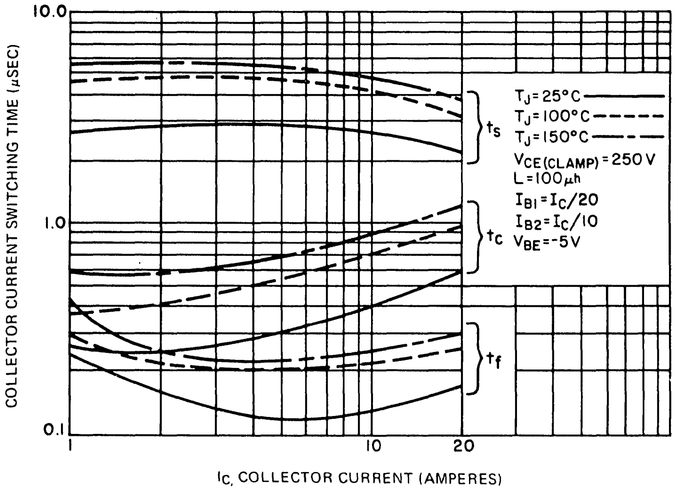


FIGURE 19. CLAMPED INDUCTIVE TURN-OFF TIME (D66ES ONLY)

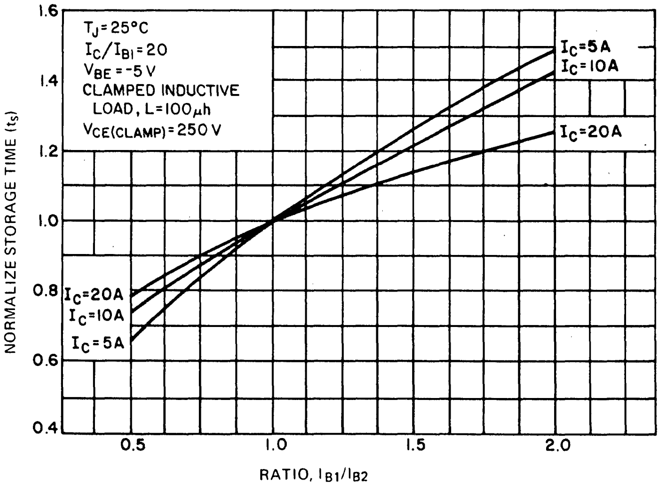


FIGURE 20. STORAGE TIME VARIATION WITH I_{B2} (D66DS ONLY)

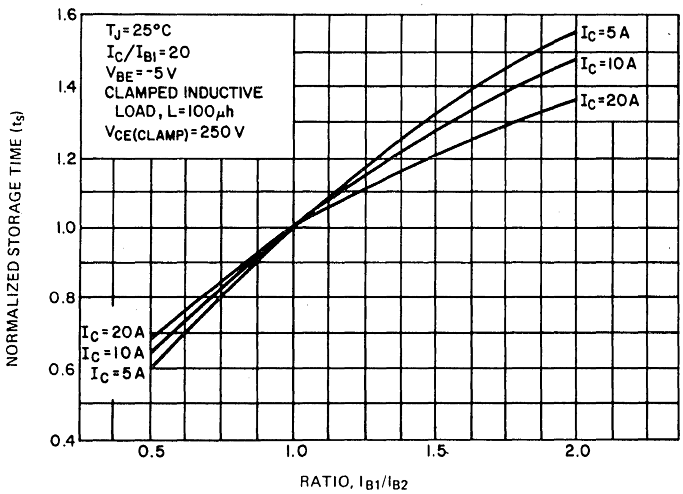


FIGURE 21. STORAGE TIME VARIATION WITH I_{B2} (D66ES ONLY)

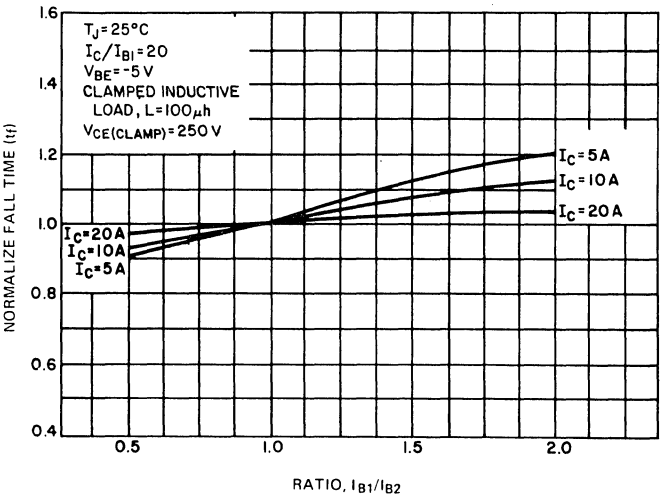


FIGURE 22. FALL TIME VARIATION WITH I_{B2} (D66DS ONLY)

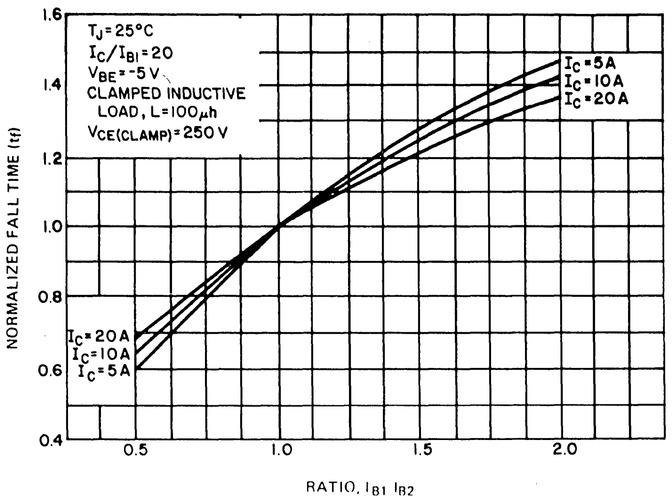


FIGURE 23. FALL TIME VARIATION WITH I_{B2} (D66ES ONLY)

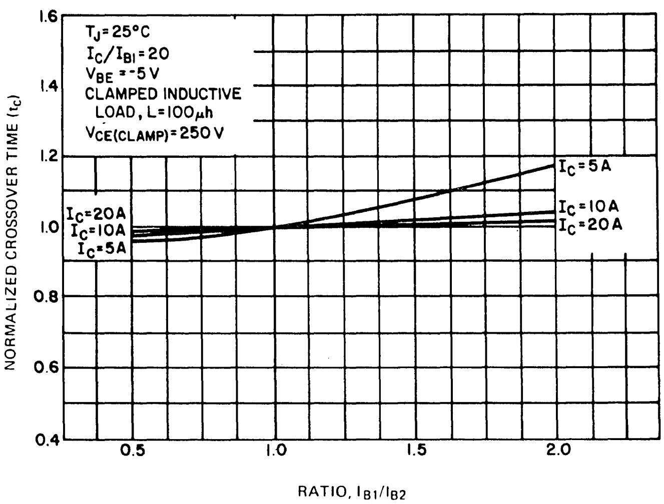


FIGURE 24. CROSS-OVER TIME VARIATION WITH I_{B2} (D66DS ONLY)

TYPICAL CHARACTERISTICS

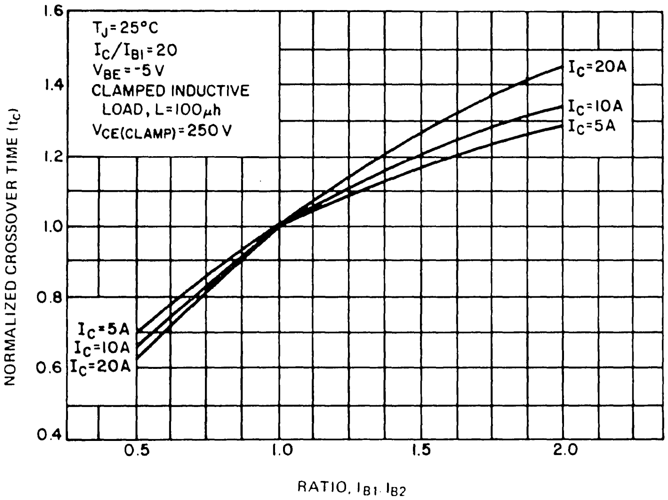


FIGURE 25. CROSS-OVER TIME VARIATION WITH I_{B2} (D66ES ONLY)

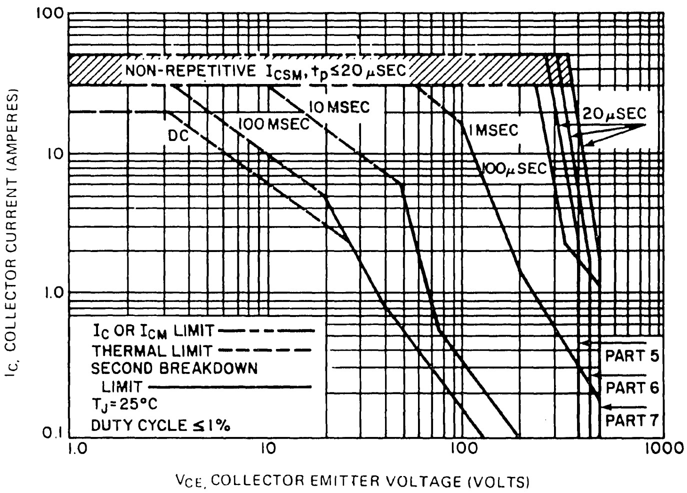


FIGURE 26. FORWARD BIAS SAFE OPERATING AREA

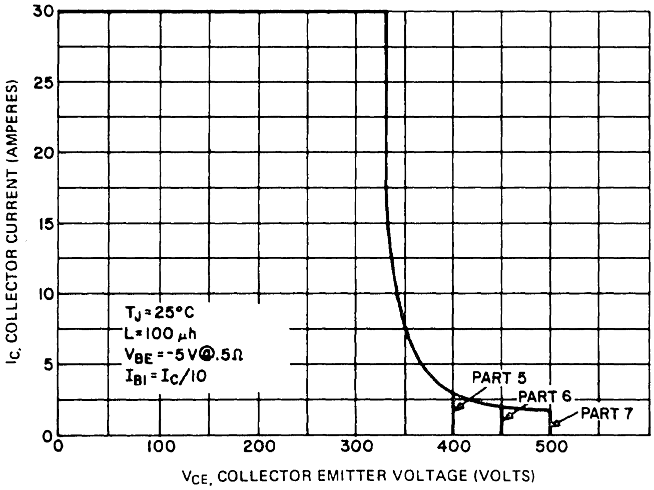


FIGURE 27. REVERSE BIAS SAFE OPERATING AREA

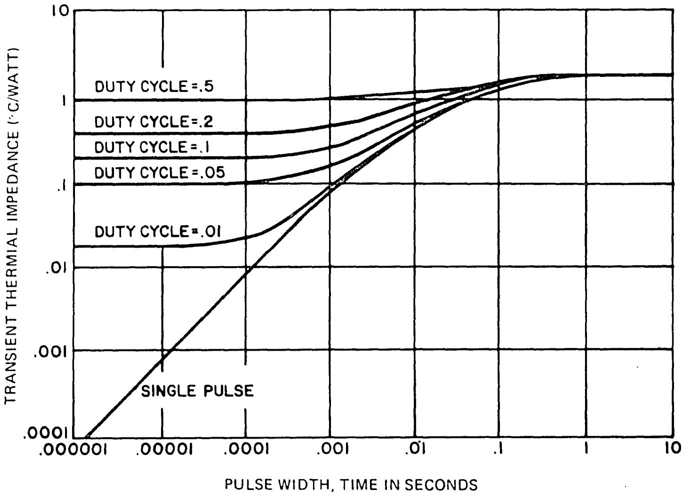


FIGURE 28. TRANSIENT THERMAL RESPONSE

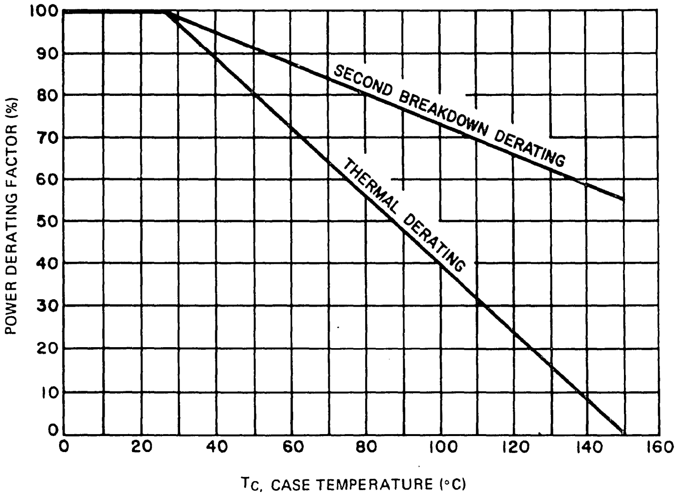


FIGURE 29. POWER DERATING

TYPICAL CHARACTERISTICS

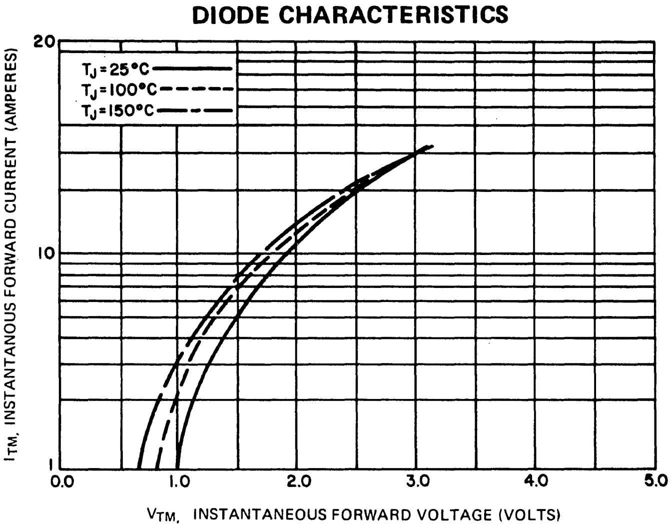


FIGURE 30. FORWARD CHARACTERISTICS

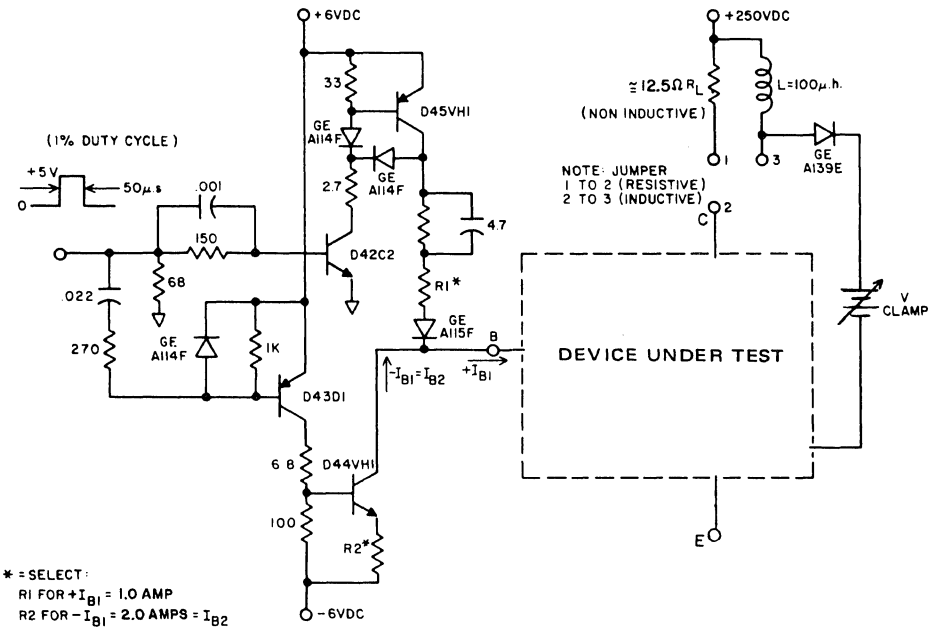


FIGURE 31. SWITCHING TIME TEST CIRCUIT

HIGH POWER
NPN POWER DARLINGTON TRANSISTORS

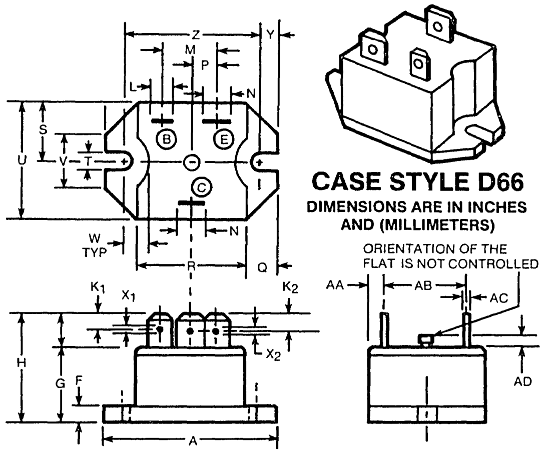
D66DV5,6,7
D66EV5,6,7

500-700 VOLTS
50 AMP, 125 WATTS

The General Electric D66DV and EV are high current power Darlingtons. They feature collector isolation from the heat sink, and internal construction designed for stress-free operation at temperature extremes and quick connect electrical terminals. They are designed to meet UL creep, strike and isolation voltage. Major applications are for motor controls, switching power supplies, and UPS systems.

Features:

- High Voltage: 400-500 $V_{CEO(SUS)}$; 500-700 V_{CEV}
- High Current: 75 Amperes, I_C (Peak)
- High Gain: h_{FE} 50 Minimum @ 50 Amperes, I_C (h_{FE} = 135, typical)

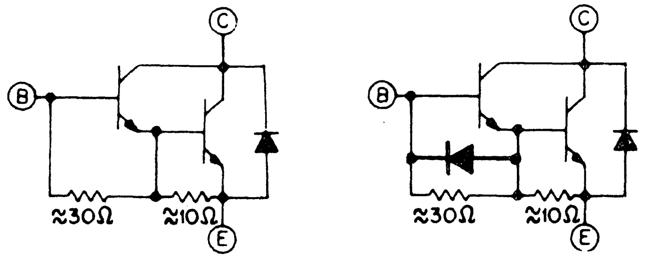


CASE STYLE D66
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.505	1.540	38.22	39.12
F	.120	.132	3.04	3.35
G	.605	.645	15.36	16.40
H	.940	.980	23.87	24.19
J	.307	—	7.80	—
K_1	.120	.132	3.04	3.35
K_2	.171	.184	4.34	4.64
L	.184	.192	4.57	4.88
M	.464	.484	11.78	12.30
N	.247	.255	6.27	6.48
P	.210	.230	5.33	5.84
Q	.275	REF.	7.00	REF.
R	.970	REF.	24.64	REF.

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
S	.495	.510	12.57	12.95
T	.150	.170	3.81	4.32
U	.985	1.015	25.01	25.80
V	.450	REF.	11.43	REF.
W	.180	—	4.57	—
X_1	.050	.058	1.27	1.47
X_2	.065	.073	1.65	1.85
Y	.157	.177	3.98	4.50
Z	1.180	1.192	29.97	30.30
AA	.130	.165	3.30	4.30
AB	.684	.704	17.37	17.90
AC	.031	.035	.78	.90
AD	.100	REF.	2.54	REF.



D66DV **D66EV**

DEVICE CIRCUIT

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	D66DV5/EV5	D66DV6/EV6	D66DV7/EV7	UNITS
Collector-Emitter Voltage	V_{CEV}	500	600	700	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage D66DV D66EV	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	50 75 125	50 75 125	50 75 125	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to +150	-40 to +150	-40 to +150	°C
Isolation Voltage	V_{ISOL}	2500	2500	2500	$V_{(rms)}$

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	4	°C/W

See page 845 for mounting and handling considerations.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage D66DV5/EV5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = 1A) D66DV6/EV6		450	—	—	
(V_{clamp} = V_{CEO} Rated) D66DV7/EV7		500	—	—	
Collector Cutoff Current T_J = 25°C	I_{CEV}	—	—	10	mA
(V_{CE} = Rated Value, V_{BE} = -1.5V) T_J = 150°C		—	—	2.5	
Emitter Cutoff Current	I_{EBO}				
(V_{EB} = 4.5V, I_C = 0) D66DV		—	—	350	mA
(V_{EB} = 1.5V, I_C = 0) D66EV		—	—	350	

second breakdown

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 23			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
(I_C = 75A, V_{CE} = 5V)		25	60	—	—
(I_C = 50A, V_{CE} = 5V)		50	135	—	
(I_C = 20A, V_{CE} = 5V)		100	250	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 75A, I_B = 5A)		—	2.2	3.0	V
(I_C = 50A, I_B = 4A)		—	1.7	2.0	
(I_C = 20A, I_B = 2A)		—	1.15	1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 75A, I_B = 5A)		—	2.8	3.5	V
(I_C = 50A, I_B = 4A)		—	2.45	3.0	
(I_C = 20A, I_B = 2A)		—	1.95	2.5	

switching characteristics

				TYP.		MAX.		
Resistive Load				DV	EV	DV	EV	
Delay Time	V_{CC} = 250V	t_d	—	.09	.09	.5	.5	μs
Rise Time	I_C = 50A	t_r	—	.5	.5	1	1	
Storage Time	I_{B1} = 2.5A, I_{B2} = 5A	t_s	—	2.55	2	5	3	
Fall Time	t_p = 50 μsec	t_f	—	1.4	.64	3	1	

emitter-collector diode characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Power Dissipation (I_{B1} = 0)	P_D	—	—	125	Watts
Forward Voltage (I_F = 25A)	V_F	—	1.95	3.20	Volts
(I_F = 50A)	V_F	—	2.60	3.80	Volts
(I_F = 50A, T_J = 150°C)	V_F	—	2.30	3.50	Volts
Reverse Recovery Time (I_F = 50A, $di/_{dt}$ = 25A/μsec, R_{B1E} = .25Ω)	T_{rr}	—	3.85	10.0	μsec
Forward Turn-On Time (I_F = 50A, $di/_{dt}$ = 100A/μsec)	T_{ON}	—	0.75	1.5	μsec
Single Cycle Surge Current (60Hz)	I_{FSM}	—	—	150	Amps
Thermal Resistance	$R_{\theta JC}$	—	—	1.0	°C/Watt

TYPICAL CHARACTERISTICS

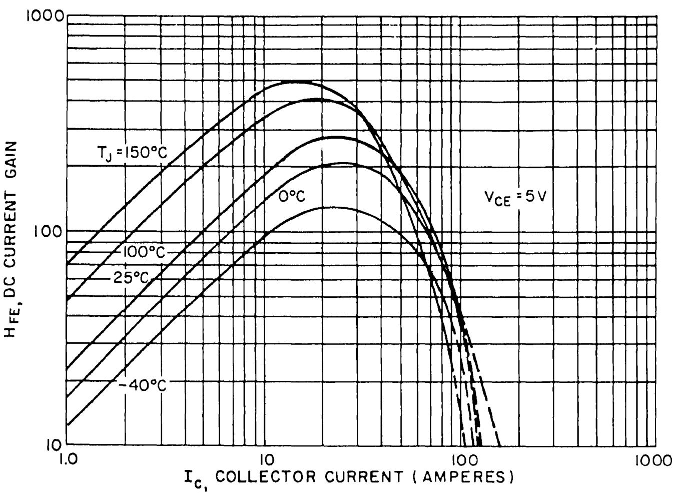


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

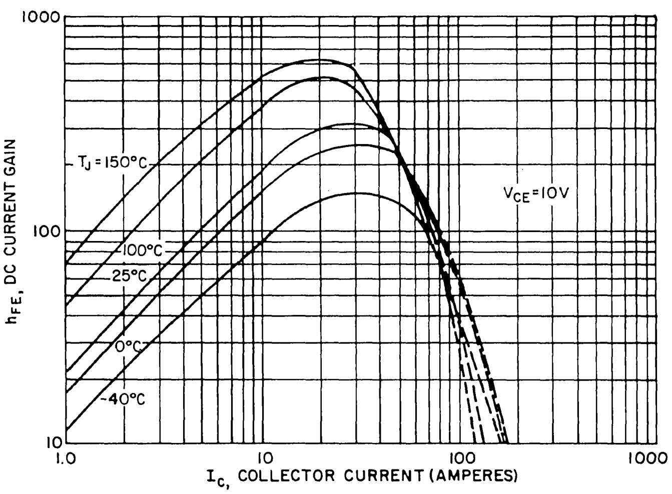


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

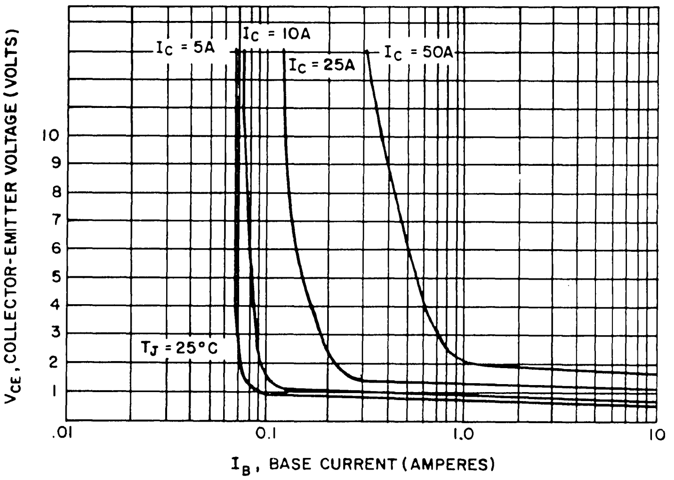


FIGURE 3. COLLECTOR SATURATION REGION

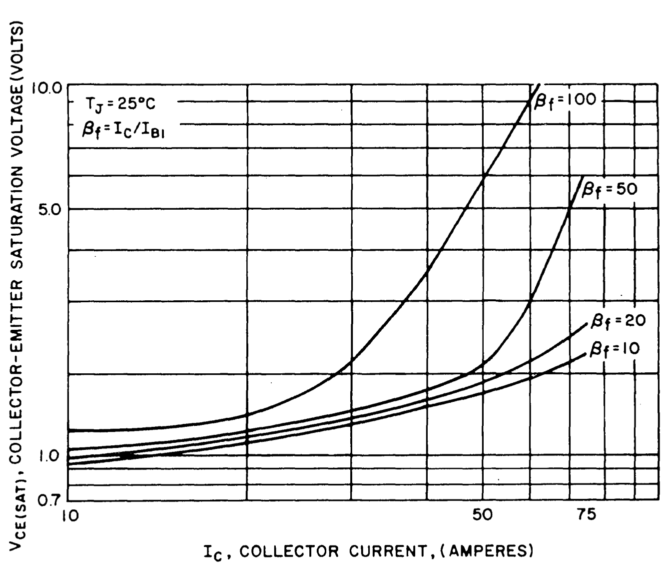


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C, T_J = 25°C

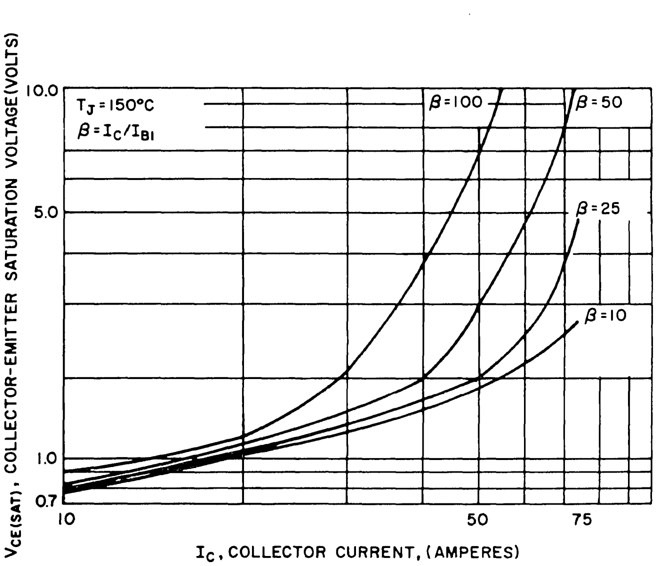


FIGURE 5. $V_{CE\ (SAT)}$ VS I_C, T_J = 150°C

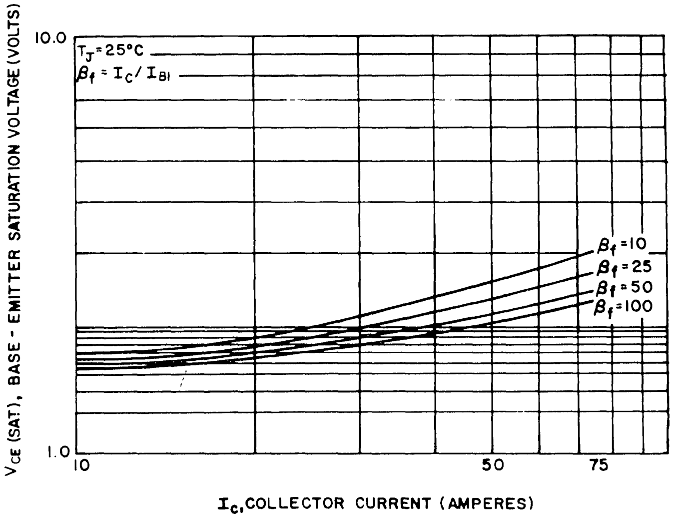


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C, T_J = 25°C

TYPICAL CHARACTERISTICS

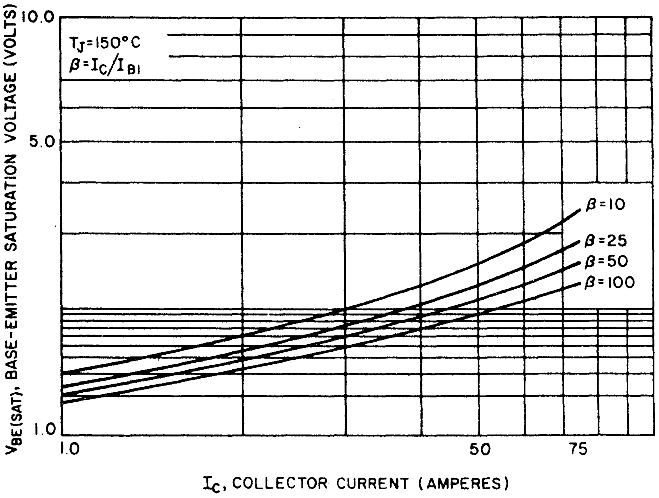


FIGURE 7. $V_{BE\ (SAT)}$ VS I_C, T_J = 150°C

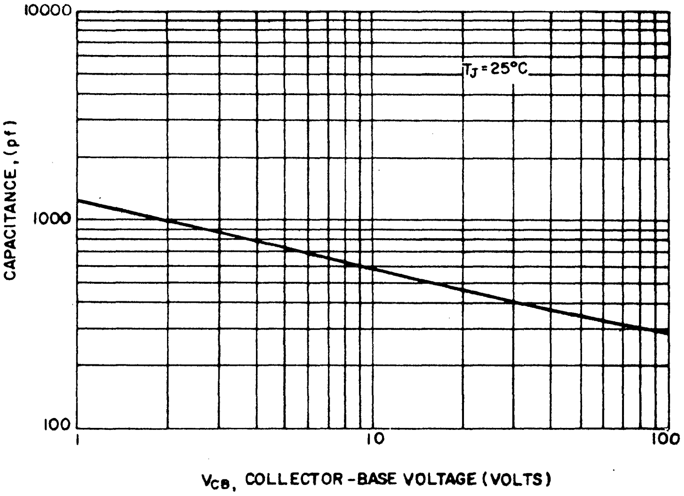


FIGURE 8. CAPACITANCE (C_{CBO})

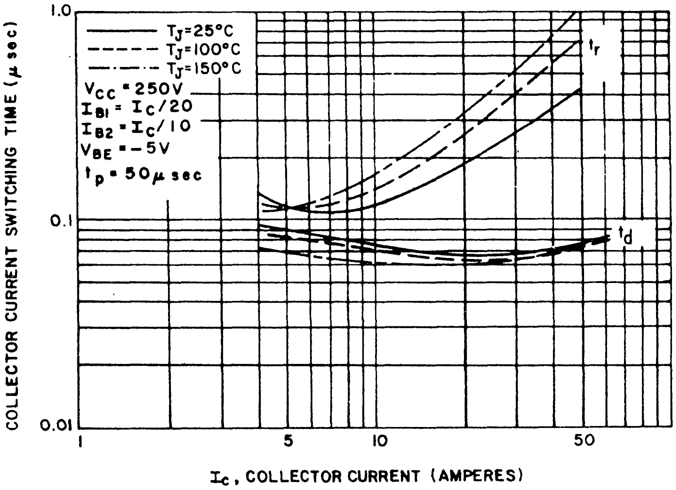


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD) (D66DV ONLY)

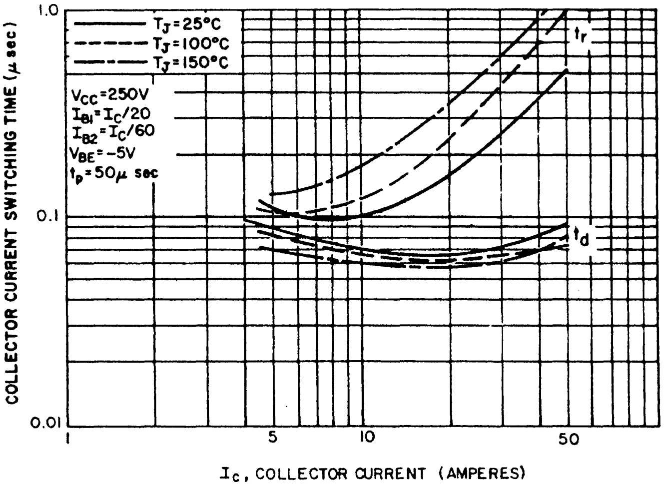


FIGURE 10. TURN-ON TIME (RESISTIVE LOAD) (D66EV ONLY)

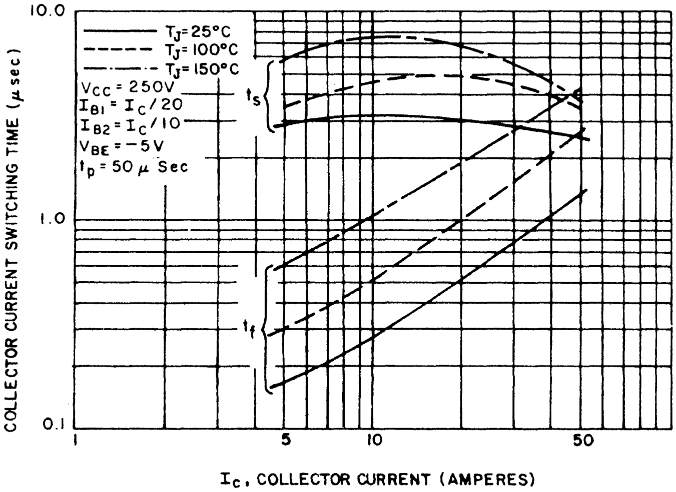


FIGURE 11. TURN-ON TIME (RESISTIVE LOAD) (D66DV ONLY)

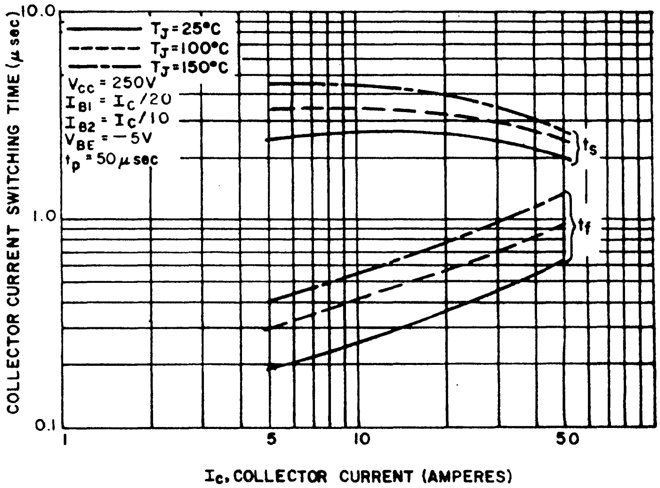


FIGURE 12. TURN-ON TIME (RESISTIVE LOAD) (D66EV ONLY)

TYPICAL CHARACTERISTICS

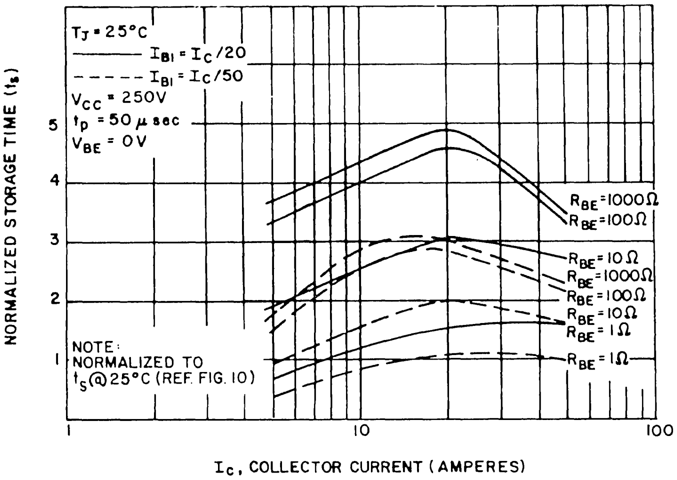


FIGURE 13. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS COLLECTOR CURRENT (D66DV ONLY)

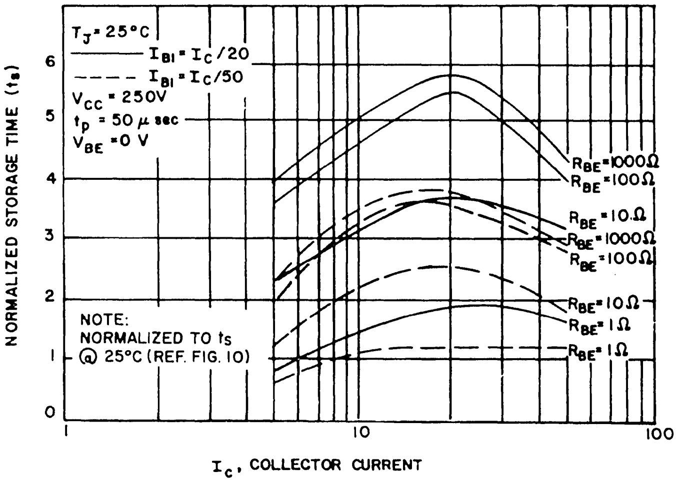


FIGURE 14. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS COLLECTOR CURRENT (D66EV ONLY)

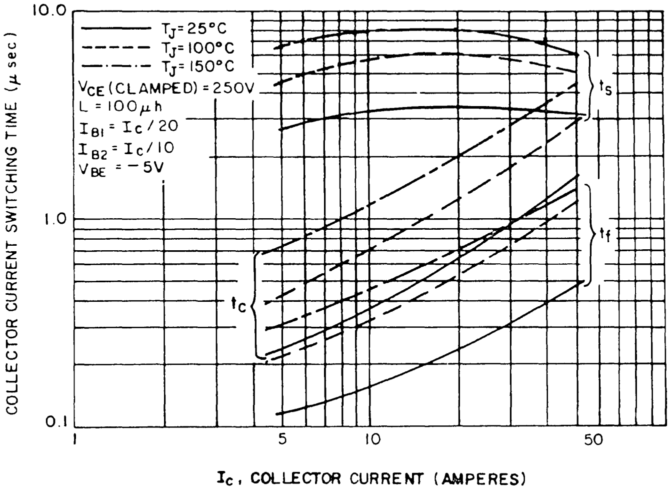


FIGURE 15. CLAMPING INDUCTIVE TURN-OFF TIME (D66DV ONLY)

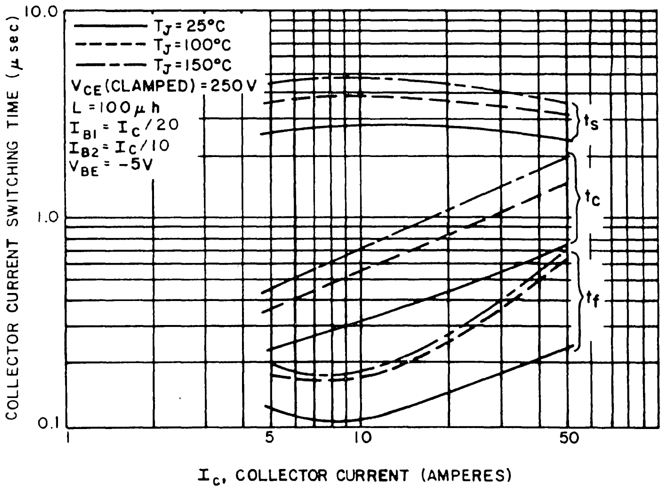


FIGURE 16. CLAMPING INDUCTIVE TURN-OFF TIME (D66EV ONLY)

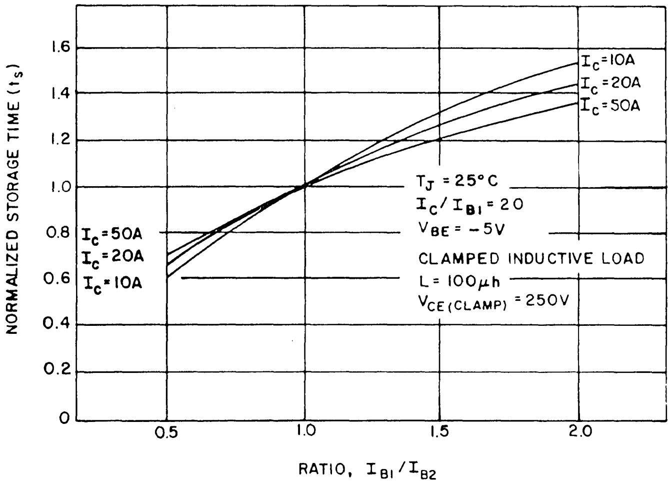


FIGURE 17. STORAGE TIME VARIATION WITH I_{B2} (D66DV ONLY)

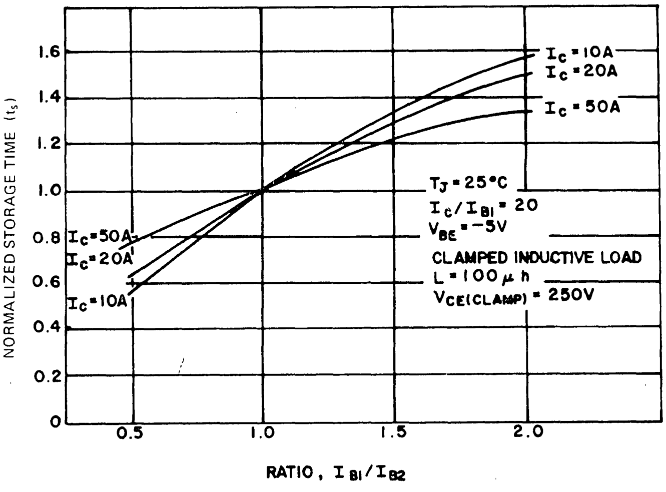


FIGURE 18. STORAGE TIME VARIATION WITH I_{B2} (D66EV ONLY)

TYPICAL CHARACTERISTICS

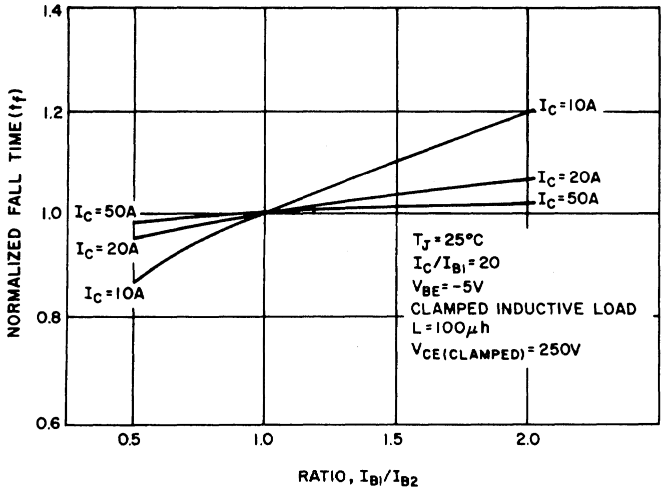


FIGURE 19. FALL TIME VARIATION WITH I_{B2} (D66DV ONLY)

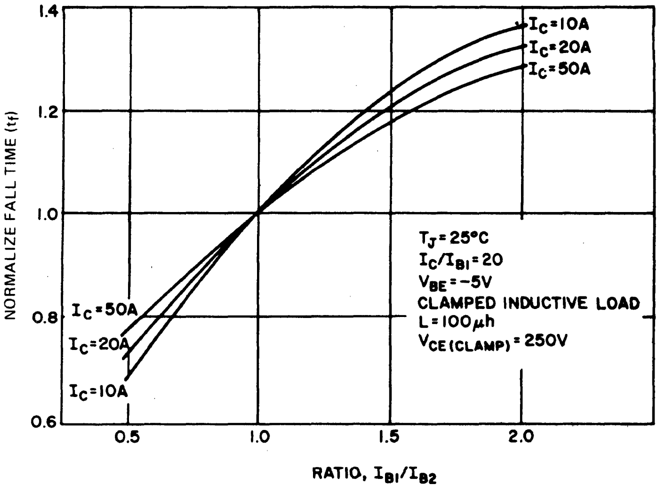


FIGURE 20. FALL TIME VARIATION WITH I_{B2} (D66EV ONLY)

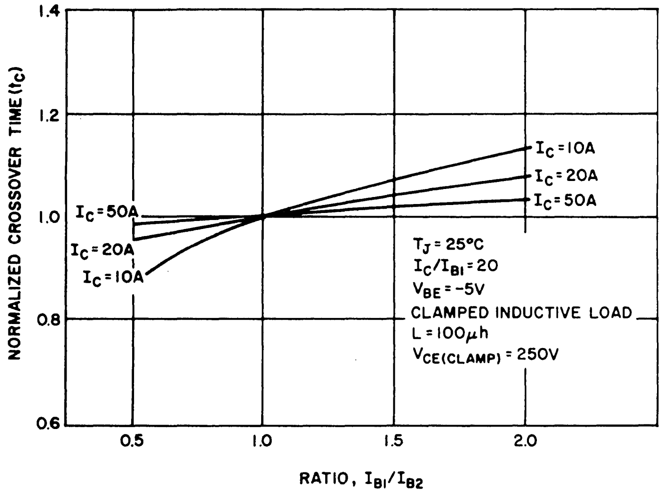


FIGURE 21. CROSSOVER TIME VARIATION WITH I_{B2} (D66DV ONLY)

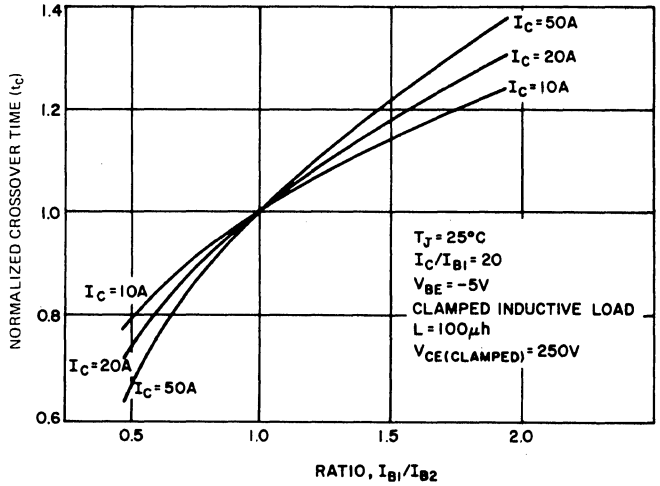


FIGURE 22. CROSSOVER TIME VARIATION WITH I_{B2} (D66EV ONLY)

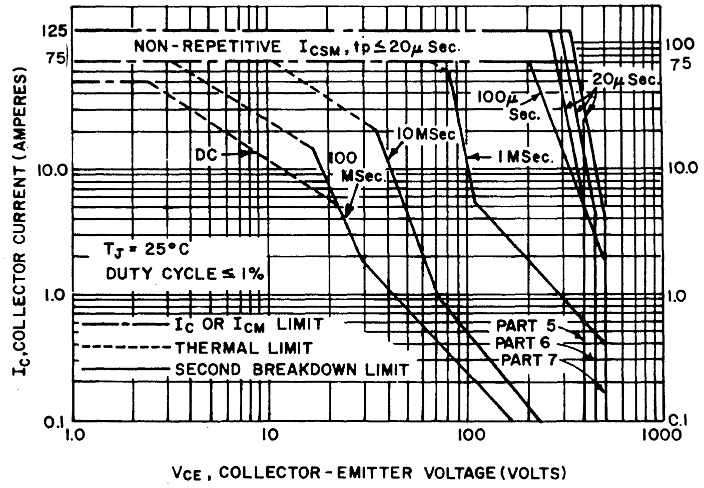


FIGURE 23. FORWARD BIAS SAFE OPERATING AREA

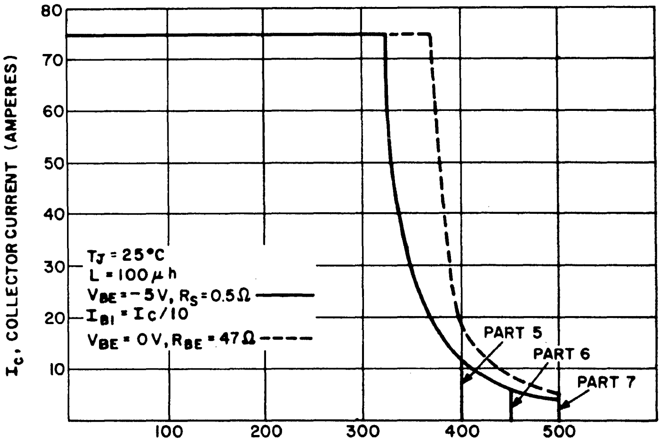


FIGURE 24. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

TYPICAL CHARACTERISTICS

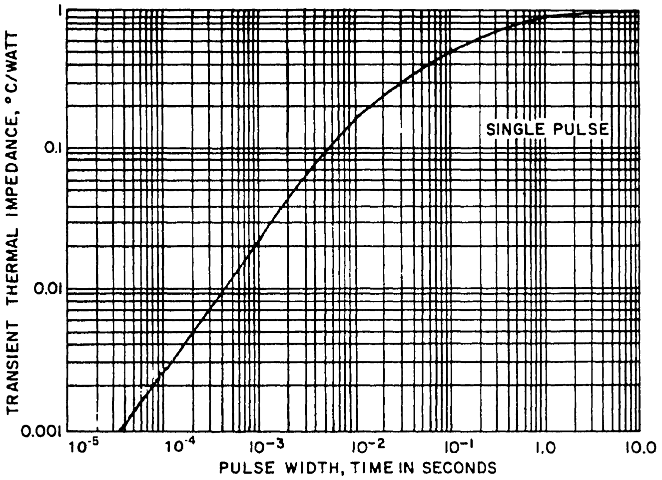


FIGURE 25. TRANSIENT THERMAL RESPONSE

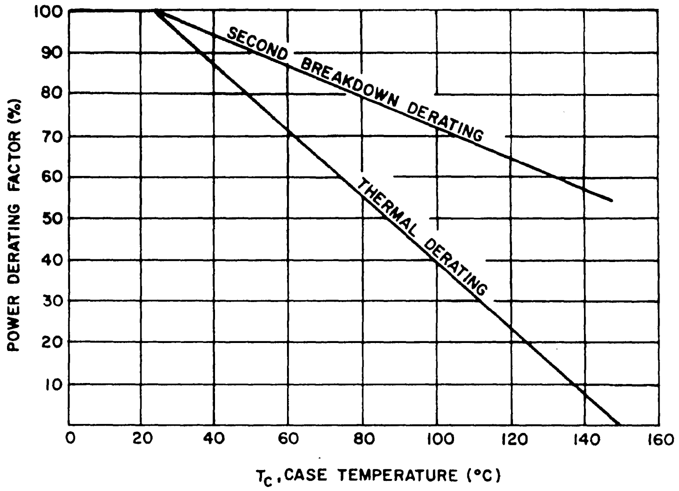


FIGURE 26. POWER DERATING

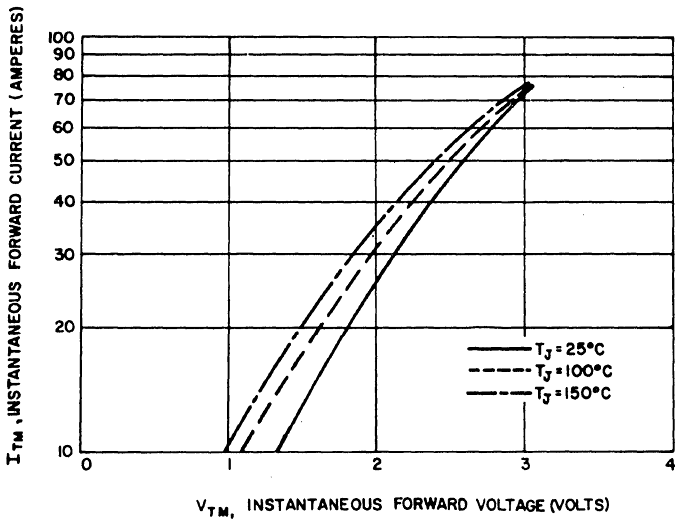


FIGURE 27. DIODE FORWARD CHARACTERISTICS

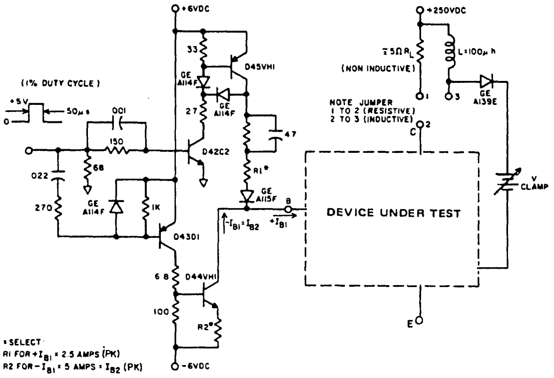


FIGURE 28. SWITCHING TIME TEST CIRCUIT

HIGH VOLTAGE
NPN POWER DARLINGTON TRANSISTORS

D66DW1,2,3
D66EW1,2,3

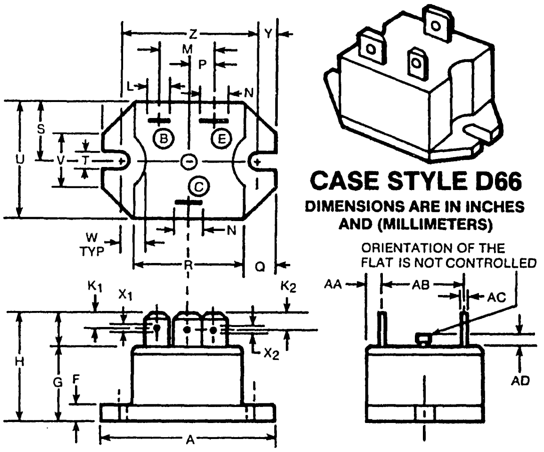
V_{CER} = 600-700 VOLTS
V_{CEV} = 800-900 VOLTS
50 AMP, 167 WATTS

The D66DW/EW is a high voltage NPN high current power Darlington especially designed for applications requiring high blocking voltage capability such as: 460VAC line motor controls, power supplies and UPS systems as well as European 380 VAC line operated systems. This device utilizes GE's latest advances in bipolar technology and features the D66 package offering: collector isolation from heat sink, TO-3 mounting compatibility and quick-connect terminals.

The D66DW/EW also features a discrete fast recovery anti-parallel high power diode which eliminates the need for an external flyback diode in most inverter applications.

Features:

- Very high blocking voltage — V_{CEV} 800 to 900 Volts
- High current — $I_{C(Peak)}$ 75 Amps
- Discrete high power flyback diode
- UL recognized industrial package
- Two versions — with or without speedup diode



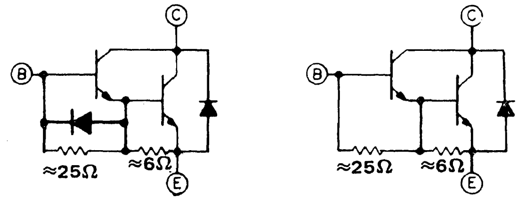
CASE STYLE D66

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.505	1.540	38.22	39.12
F	.120	.132	3.04	3.35
G	.605	.645	15.36	16.40
H	.940	.980	23.87	24.19
J	.307	—	7.80	—
K_1	.120	.132	3.04	3.35
K_2	.171	.184	4.34	4.64
L	.184	.192	4.57	4.88
M	.464	.484	11.78	12.30
N	.247	.255	6.27	6.48
P	.210	.230	5.33	5.84
Q	.275 REF.		7.00 REF.	
R	.970 REF.		24.64 REF.	

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
S	.495	.510	12.57	12.95
T	.150	.170	3.81	4.32
U	.985	1.015	25.01	25.80
V	.450 REF.		11.43 REF.	
W	.180	—	4.57	—
X_1	.050	.058	1.27	1.47
X_2	.065	.073	1.65	1.85
Y	.157	.177	3.98	4.50
Z	1.180	1.192	29.97	30.30
AA	.130	.165	3.30	4.30
AB	.684	.704	17.37	17.90
AC	.031	.035	.78	.90
AD	.100 REF.		2.54 REF.	



D66EW **D66DW**

DEVICE CIRCUIT

The collector-emitter diode is a discrete high power diode.

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	D66DW1/EW1	D66DW2/EW2	D66DW3/EW3	UNITS
Collector-Emitter Voltage	V_{CEV}	800	850	900	Volts
Collector-Emitter Voltage	V_{CER}	600	650	700	Volts
Emitter Base Voltage D66DW D66EW	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	50 75 125	50 75 125	50 75 125	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ T_C = 25° C Derate above 25° C	P_D	167 1.33	167 1.33	167 1.33	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to +150	-40 to +150	-40 to +150	° C
Isolation Voltage	V_{ISOL}	2500	2500	2500	$V_{(rms)}$

thermal characteristics

Thermal Resistance, (transistor) (diode)	$R_{\theta JC}$	.75 4	.75 4	.75 4	° C/W

See page 845 for mounting and handling considerations.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = 5A, $V_{clamp} = V_{CE}$ (Rated), R_{BE} = 10Ω) D66DW1/EW1 D66DW2/EW2 D66DW3/EW3	$V_{CER(sus)}$	600 650 700	— — —	— — —	Volts
Collector Cutoff Current T_J = 25°C (V_{CE} = Rated V_{CEV}, $V_{BE(off)}$ = 1.5V) T_J = 150°C	I_{CEV}	— —	— —	1.0 2.5	mA
Emitter Cutoff Current (V_{EB} = 4.5V, I_C = 0) D66DW (V_{EB} = 1.5V, I_C = 0) D66EW	I_{EBO}	—	—	350	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3			

on characteristics

DC Current Gain (I_C = 50A, V_{CE} = 5V) (I_C = 75A, V_{CE} = 10V)	h_{FE}	25 15	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 50A, I_B = 4A) (I_C = 20A, I_B = 2A)	$V_{CE(sat)}$	— —	— —	2.5 2.0	V
Base-Emitter Saturation Voltage (I_C = 50A, I_B = 4A) (I_C = 20A, I_B = 2A)	$V_{BE(sat)}$	— —	— —	3.5 3.0	V

switching characteristics

Resistive Load				TYP. DW	TYP. EW	MAX. DW	MAX. EW	
Delay Time	V_{CE} = 500V	t_d	—	—	0.75	0.5	.5	μs
Rise Time	I_C = 50A	t_r	—	—	.3	1.0	1	
Storage Time	I_{B1} = 4A, I_{B2} = 6A	t_s	—	—	5	10	15	
Fall Time	t_p = 50 μsec	t_f	—	—	1	2	4	

emitter-collector diode characteristics

Forward Voltage (I_F = 25A) (I_F = 50A)	V_F V_F	— —	— —	2.0 2.5	Volts Volts
Reverse Recovery Time (I_F = 50A, $di/_{dt}$ = 25A/μsec, R_{B1E} = .25Ω)	T_{rr}	—	2.0	—	μsec

TYPICAL CHARACTERISTICS

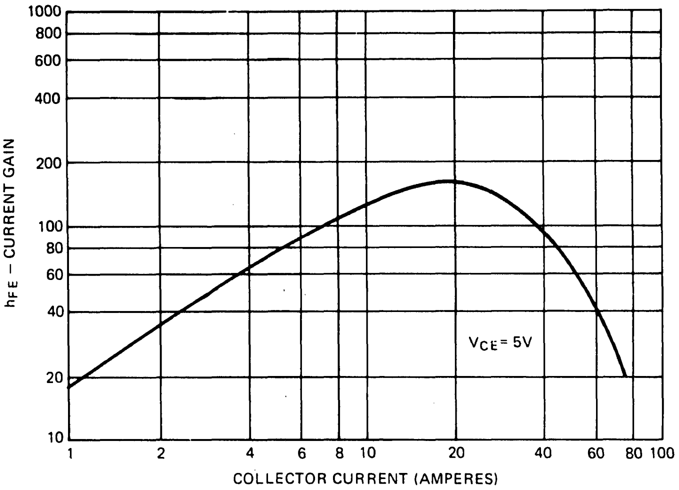


FIGURE 1. TYPICAL CURRENT GAIN

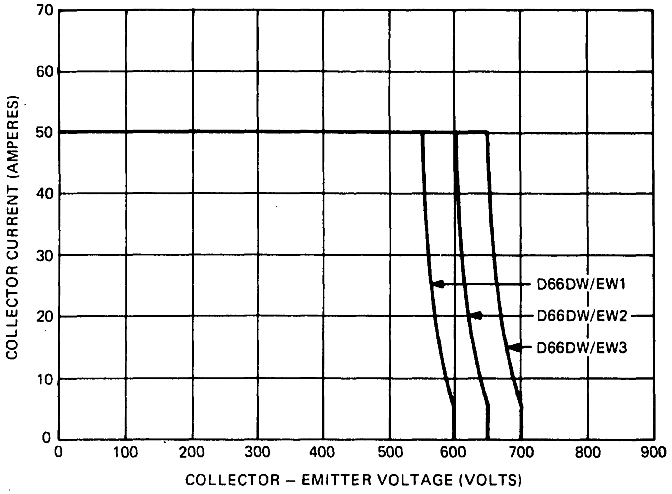


FIGURE 2. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

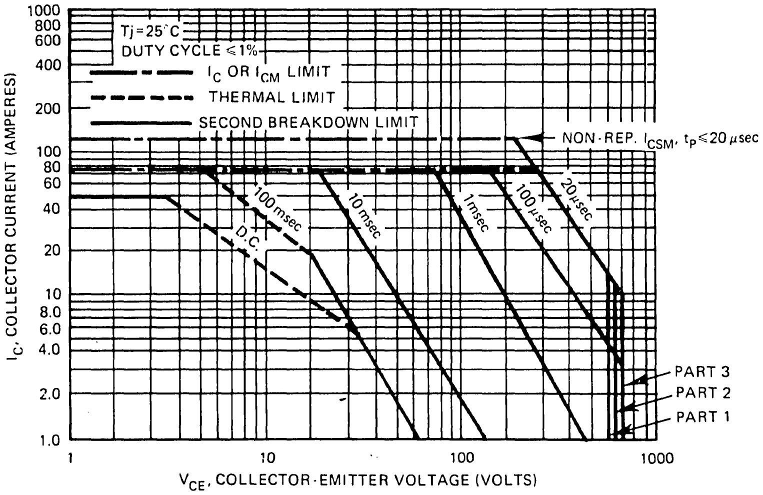


FIGURE 3. FORWARD BIAS SAFE OPERATING AREA

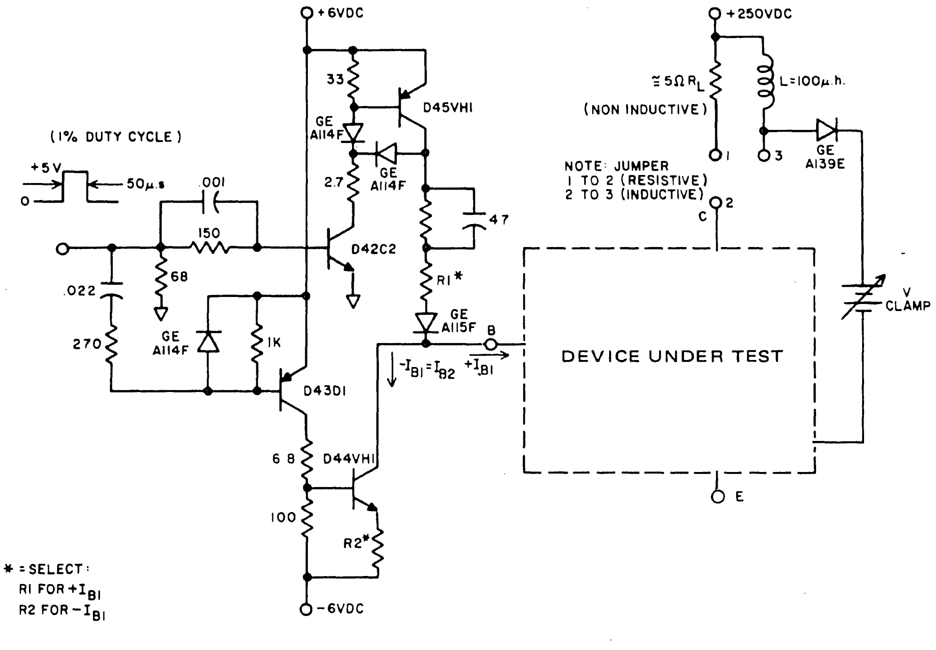


FIG. 4 SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

D66GV5,6,7

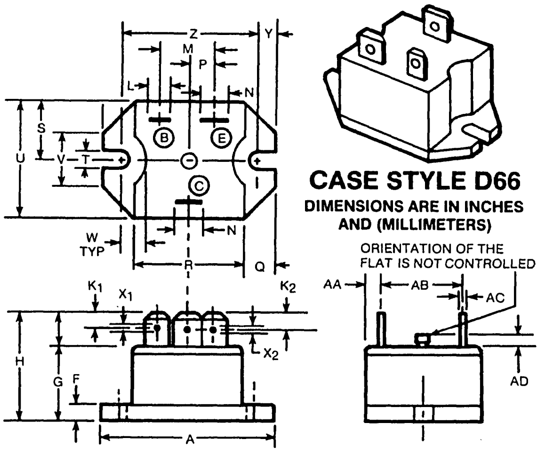
400-500 VOLTS
50 AMP, 125 WATTS

The D66GV is a high voltage NPN high current power darlington especially designed for use in PWM applications where fast and efficient switching is required. This device utilizes GE's latest advances in bipolar technology and features the D66 Package offering: collector isolation from heat sink, TO-3 mounting compatibility and quick-connect terminals.

The D66GV also features a discrete fast recovery antiparallel high power diode which eliminates the need for an external flyback diode in motor control and other inverter applications such as power supplies and UPS systems.

Features:

- Fast switching — $t_{f(TYP)}$ 0.5 μs
- High blocking voltage — V_{CEV} 500 to 700 Volts
- High current — $I_{C(Peak)}$ 75 Amps
- High gain — $h_{FE(MIN)}$ 50 @ 50 Amps
- Discrete high power fast recovery diode
- UL recognized isolated base package



CASE STYLE D66

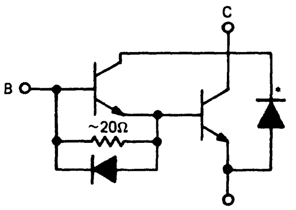
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.505	1.540	38.22	39.12
F	.120	.132	3.04	3.35
G	.605	.645	15.36	16.40
H	.940	.980	23.87	24.19
J	.307	—	7.80	—
K_1	.120	.132	3.04	3.35
K_2	.171	.184	4.34	4.64
L	.184	.192	4.57	4.88
M	.464	.484	11.78	12.30
N	.247	.255	6.27	6.48
P	.210	.230	5.33	5.84
Q	.275	REF.	7.00	REF.
R	.970	REF.	24.64	REF.

SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
S	.495	.510	12.57	12.95
T	.150	.170	3.81	4.32
U	.985	1.015	25.01	25.80
V	.450	REF.	11.43	REF.
W	.180	—	4.57	—
X_1	.050	.058	1.27	1.47
X_2	.065	.073	1.65	1.85
Y	.157	.177	3.98	4.50
Z	1.180	1.192	29.97	30.30
AA	.130	.165	3.30	4.30
AB	.684	.704	17.37	17.90
AC	.031	.035	.78	.90
AD	.100	REF.	2.54	REF.

DEVICE CIRCUIT



*NOTE: The collector-emitter diode is a discrete fast-recovery high power diode.

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	D66GV5	D66GV6	D66GV7	UNITS
Collector-Emitter Voltage	V_{CEV}	500	600	700	Volts
Collector-Emitter Voltage	V_{CER}	400	450	500	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	50 75 125	50 75 125	50 75 125	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ T_C = 25° C Derate above 25° C	P_D	125 1.0	125 1.0	125 1.0	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to +150	-40 to +150	-40 to +150	° C
Isolation Voltage	V_{ISOL}	2500	2500	2500	$V_{(rms)}$

thermal characteristics

Thermal Resistance, (transistor) (diode)	$R_{\theta JC}$	1.0 2.5	1.0 2.5	1.0 2.5	° C/W

(1) Pulse Test: Pulse Width = 300 ms. Duty Cycle ≤ 2%.

See page 845 for mounting and handling considerations.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage D66GV5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = 1A, R_{BE} = 10Ω) D66GV6		450	—	—	
D66GV7		550	—	—	
Collector Cutoff Current T_J = 25°C	I_{CEV}	—	—	1.0	mA
(V_{CE} = Rated V_{CEV}, $V_{BE(off)}$ = 1.5V) T_J = 150°C		—	—	2.5	
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	10	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 24			

on characteristics

DC Current Gain	h_{FE}				
(I_C = 75A, V_{CE} = 5V)		25	150	—	—
(I_C = 50A, V_{CE} = 5V)		50	300	—	
(I_C = 20A, V_{CE} = 5V)		100	350	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 75A, I_B = 5A)		—	1.6	3.0	V
(I_C = 50A, I_B = 4A)		—	1.3	2.0	
(I_C = 20A, I_B = 2A)		—	1.0	1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 75A, I_B = 5A)		—	2.2	3.5	V
(I_C = 50A, I_B = 4A)		—	2.0	3.0	
(I_C = 20A, I_B = 2A)		—	—	2.5	V

switching characteristics

Resistive Load						
Delay Time	V_{CE} = 250V	t_d	—	0.1	0.5	μs
Rise Time	I_C = 50A	t_r	—	6.5	1.0	
Storage Time	I_{B1} = 2.5A, I_{B2} = 5A	t_s	—	2.5	3.0	
Fall Time	PW = 50 μsec	t_f	—	0.6	0.75	

emitter-collector diode characteristics

Forward Voltage (I_F = 25A)					
@ T_J = 25°C	V_P	—	1.3	2.0	Volts
@ T_J = 150°C	V_P	—	1.3	2.5	Volts
Reverse Recovery Time (I_F = 50A, $di/_{dt}$ = 100A/μsec, $V_{BE(off)}$ = 1.5V)	T_{rr}	—	0.5	1.0	μsec

TYPICAL CHARACTERISTICS

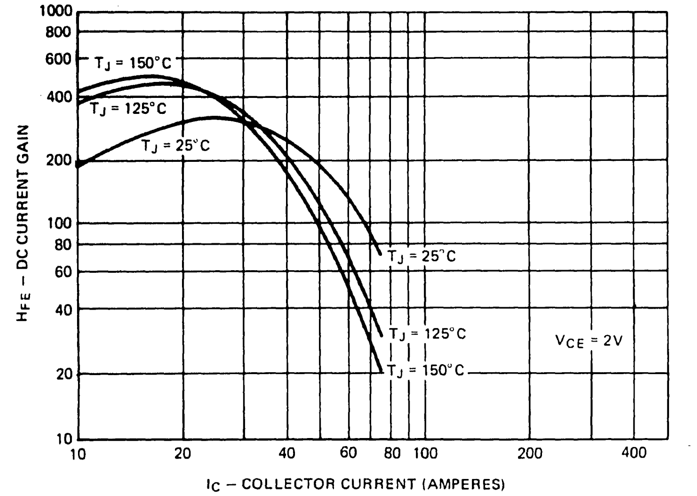


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V), TYPICAL

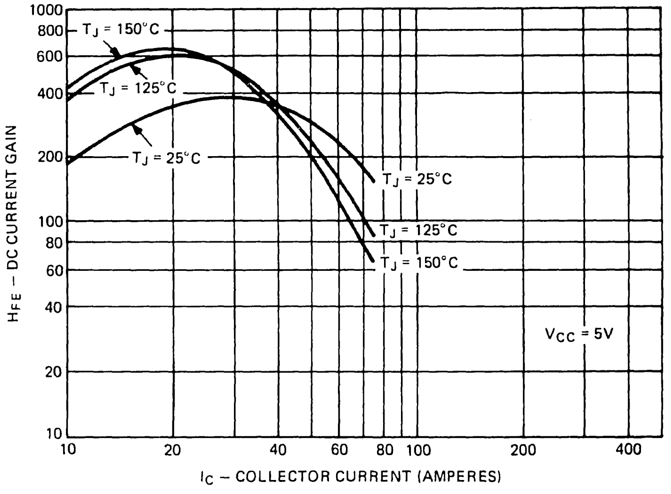


FIGURE 2. DC CURRENT GAIN (V_{CE} = 5V), TYPICAL

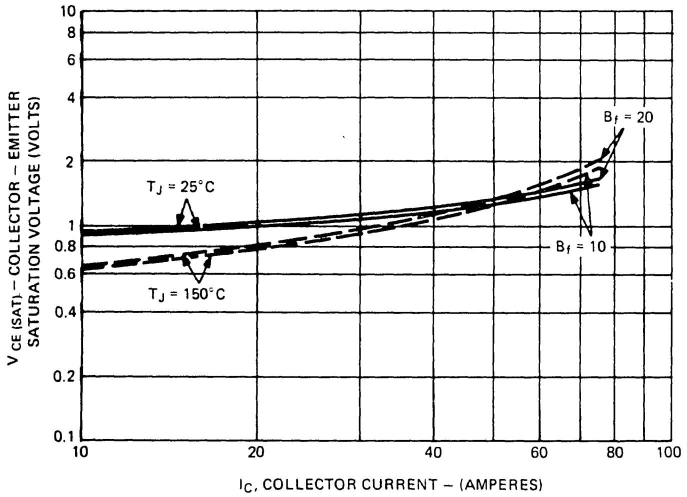


FIGURE 3. $V_{CE(SAT)}$ vs. I_C, TYPICAL

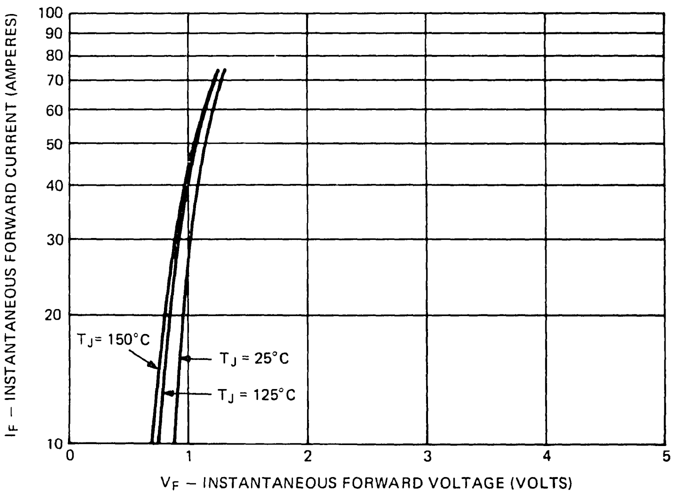


FIGURE 4. DIODE FORWARD CHARACTERISTICS

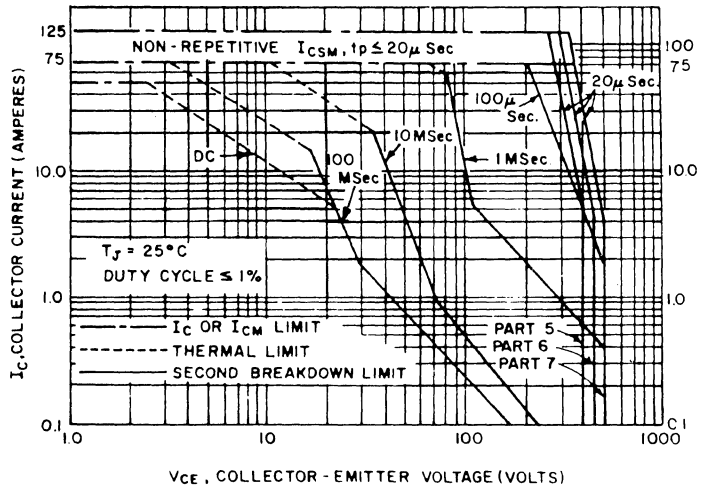


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA

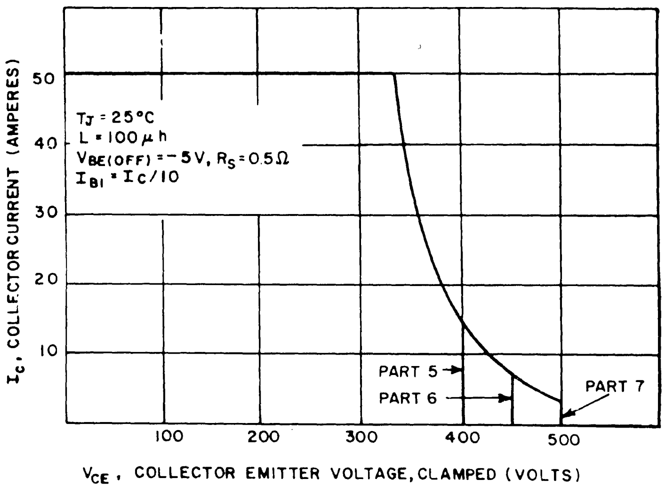
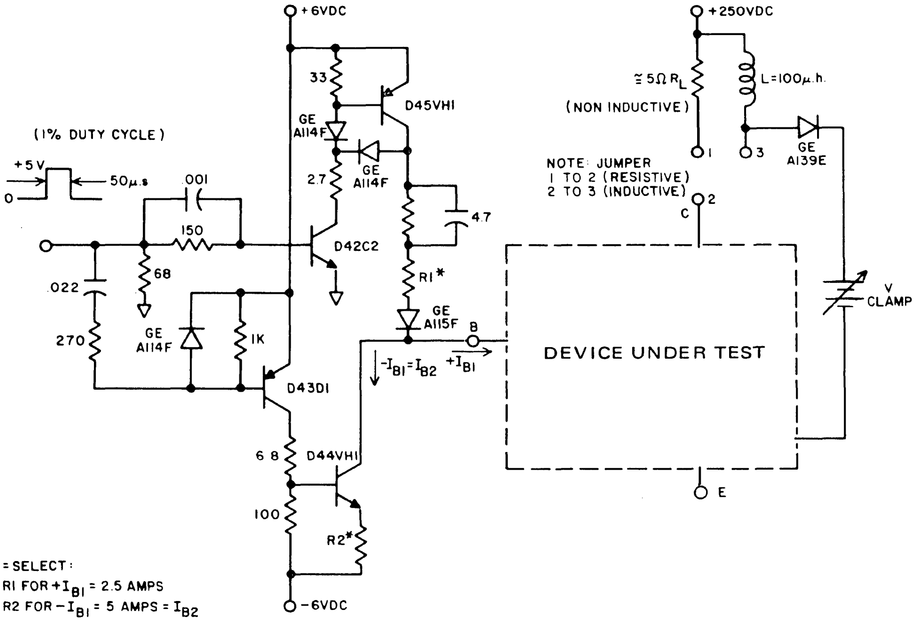


FIGURE 6. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)



* = SELECT:
R1 FOR $+I_{B1}$ = 2.5 AMPS
R2 FOR $-I_{B1}$ = 5 AMPS = I_{B2}

FIGURE 7. SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

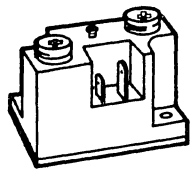
D67DE5,6,7

500-700 VOLTS
100 AMP, 312.5 WATTS

The General Electric D67DE is a high current power darlington. It features collector isolation from the heat sink, an internal construction designed for stress-free operation at temperature extremes, hefty screw terminals for emitter and collector connection and quick electrical terminals for B1 and B2. The device is designed to meet UL creep, strike and isolation voltage. Major applications are for motor controls, switching power supplies and UPS systems.

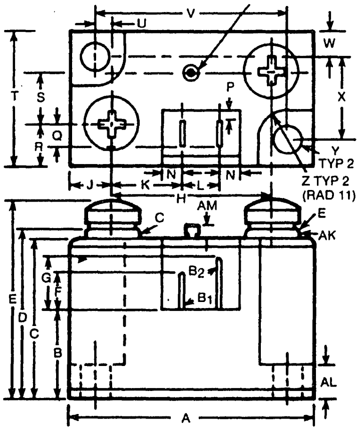
Features:

- High Voltage: 400-500 $V_{CEO(sus)}$; 500-700 V_{CEV}
- High Current: 150 Amperes, I_C (Peak)
- High Gain: h_{FE} 50 Minimum @ 100 Amperes I_C (h_{FE} 200 typical)
- Both Base 1 and Base 2 connections are available
- UL recognized industrial package

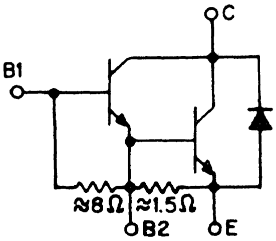


CASE STYLE D67
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED



SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.785	1.815	45.33	46.10
B	.615	.685	15.62	17.40
C	11.48	11.98	29.15	30.43
D	1.215	1.270	30.86	32.36
E	—	1.470	—	37.34
F	.245	—	6.20	—
G	.335	—	8.50	—
H	1.170	1.190	29.71	30.23
J	.295	.325	7.50	8.26
K	.518	REF.	13.16	REF.
L	.260	.290	6.60	7.37
N	.150	REF.	3.81	REF.
P	.070	REF.	1.80	REF.
Q	.170	REF.	4.30	REF.
R	.300	.320	7.60	8.13
S	.370	.390	9.40	9.90
T	.985	1.015	25.00	25.80
U	.110	.130	2.80	3.30
V	1.410	1.430	35.80	36.32
W	.175	.205	4.44	5.20
X	.610	.630	15.50	16.00
Y	.199	.221	5.05	5.61
Z	.190	.230	4.82	5.84
AA	.047	REF.	1.20	REF.
AB	.312	REF.	7.90	REF.
AC	M5 (MED FIT)		M5 (MED FIT)	
AD	.184	.192	4.67	4.90
AE	.031	.034	.78	.86
AF	.119	.132	3.02	3.35
AG	.050	.060	1.27	1.52
AH	.065	.075	1.65	1.90
AJ	.204	.211	5.18	5.36
AK	.365	.385	9.27	9.80
AL	.235	.265	5.96	6.73
AM	—	.125	—	3.20



DEVICE CIRCUIT

maximum ratings ($T_C = 25°C$) (unless otherwise noted)

RATING	SYMBOL	D67DE5	D67DE6	D67DE7	UNITS
Collector-Base Voltage	V_{CBO}	500	600	700	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage	V_{EBO}	8	8	8	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	100 150 250	100 150 250	100 150 250	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ $T_C = 25°C$	P_D	312.5	312.5	312.5	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to +150	-40 to +150	-40 to +150	°C
Isolation Voltage	V_{ISOL}	2500	2500	2500	$V_{(rms)}$

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	4	°C/W

See page 845 for mounting and handling considerations.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage D67DE5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = 1A) D67DE6		450	—	—	
(V_{clamp} = V_{CEO}, R_{BE} = 10Ω) D67DE7		500	—	—	
Collector Cutoff Current T_J = 25°C	I_{CEV}	—	—	1.0	mA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V) T_J = 150°C		—	—	2.5	
Emitter Cutoff Current (V_{EB} = 3.5V, I_C = 0)	I_{EBO}	—	—	500	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 16			

on characteristics

DC Current Gain	h_{FE}				
(I_C = 150A, V_{CE} = 5V)		25	90	—	—
(I_C = 100A, V_{CE} = 5V)		50	200	—	
(I_C = 40A, V_{CE} = 5V)		100	275	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 150A, I_B = 10A)		—	1.9	3.0	V
(I_C = 100A, I_B = 8A)		—	1.4	2.0	
(I_C = 40A, I_B = 4A)		—	1.0	1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 150A, I_B = 10A)		—	2.75	3.5	V
(I_C = 100A, I_B = 8A)		—	2.3	3.0	

switching characteristics

Resistive Load						
Delay Time	V_{CC} = 250V	t_d	—	.105	0.5	μs
Rise Time	I_C = 100A	t_r	—	.45	1.0	
Storage Time	I_{B1} = 5A, I_{B2} = 10A	t_s	—	3.2	5.0	
Fall Time		t_f	—	1.1	3.0	

emitter-collector diode characteristics

Forward Voltage (I_F = 100A)					
(T_J = 25°C)	V_F	—	1.9	3.25	Volts
(T_J = 150°C)	V_F	—	1.75	3.00	Volts
Reverse Recovery Time (T_J = 25°C) (I_F = 100A, $di/_{dt}$ = 25A/μsec, R_{B1E} = .25Ω)	T_{rr}	—	4.5	10.0	μsec
Forward Turn-On Time (T_J = 25°C) (I_F = 100A, $di/_{dt}$ = 100A/μsec)	T_{ON}	—	1.7	2.5	μsec
Thermal Resistance	$R_{\theta JC}$	—	—	0.4	°C/Watt

TYPICAL CHARACTERISTICS

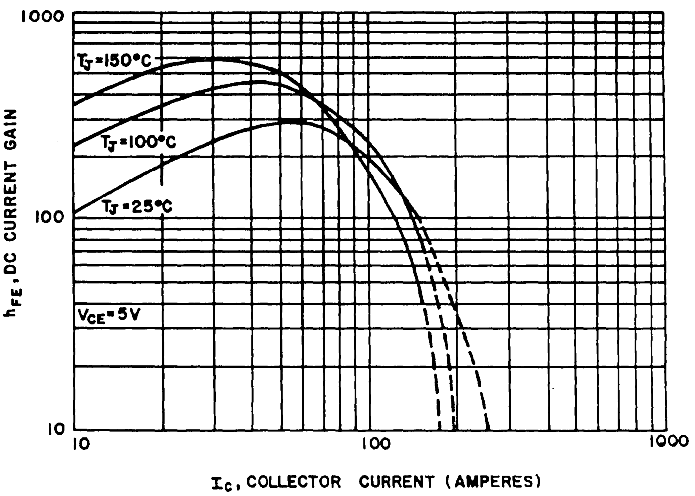


FIGURE 1: DC CURRENT GAIN (V_{CE}= 5V)

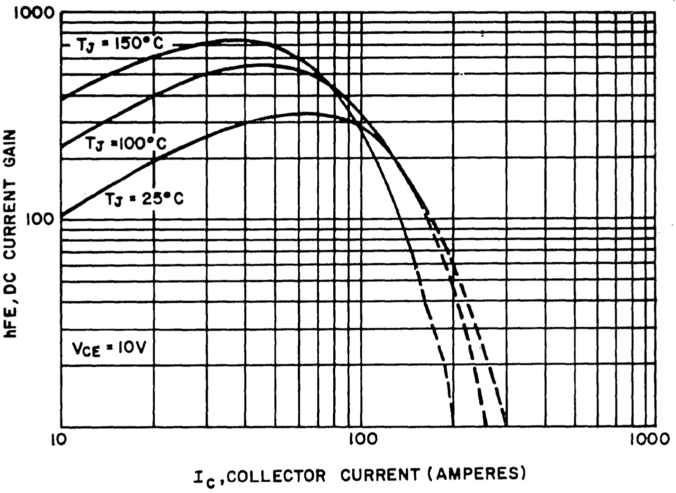


FIGURE 2: DC CURRENT GAIN (V_{CE}=10V)

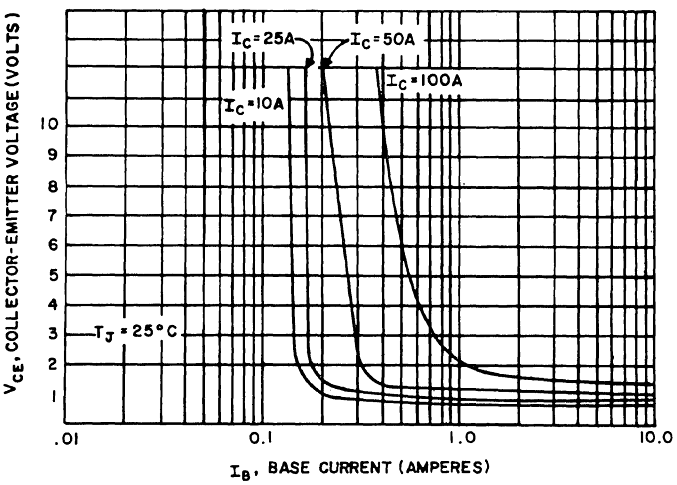


FIGURE 3: COLLECTOR SATURATION REGION

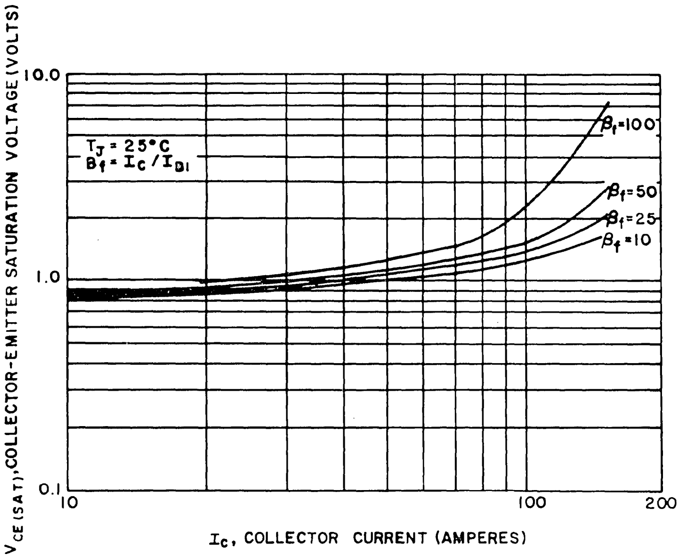


FIGURE 4: $V_{CE(SAT)}$ VS I_C, T_J=25°C

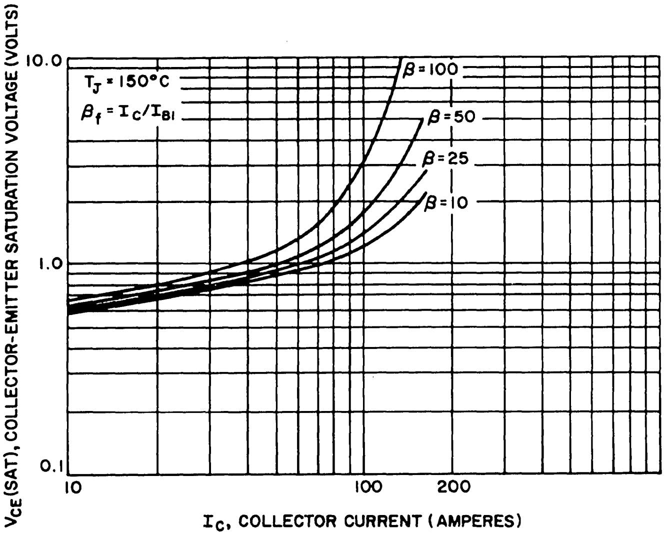


FIGURE 5: $V_{CE(SAT)}$ VS I_C, T_J=150°C

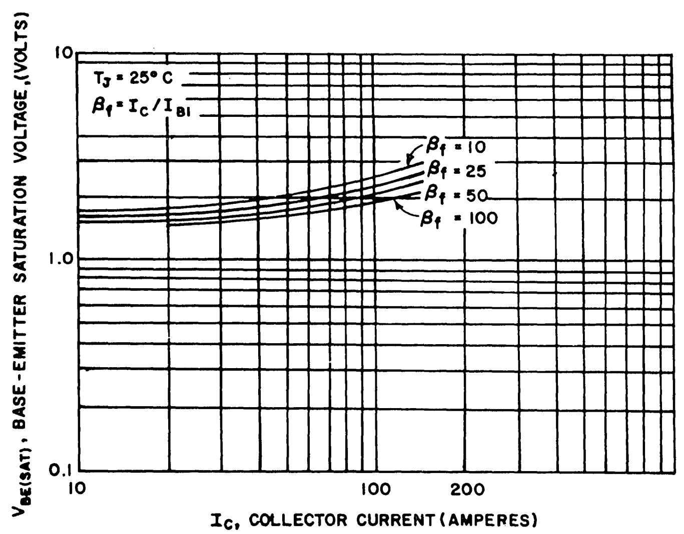


FIGURE 6: $V_{BE(SAT)}$ VS I_C, T_J=25°C

TYPICAL CHARACTERISTICS

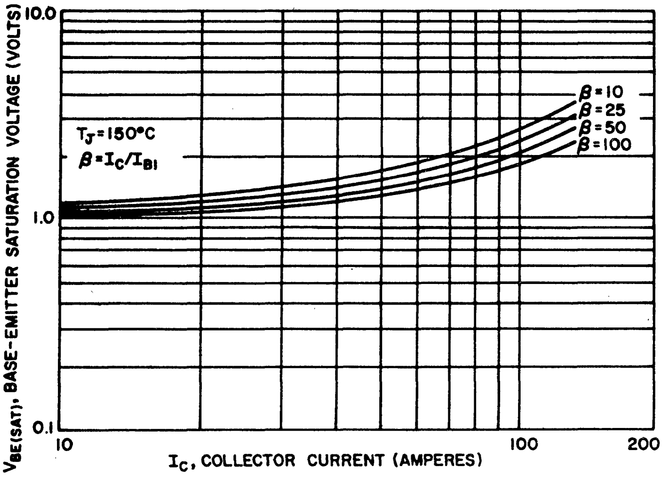


FIGURE 7: $V_{BE(SAT)}$ VS I_C, T_J=150°C

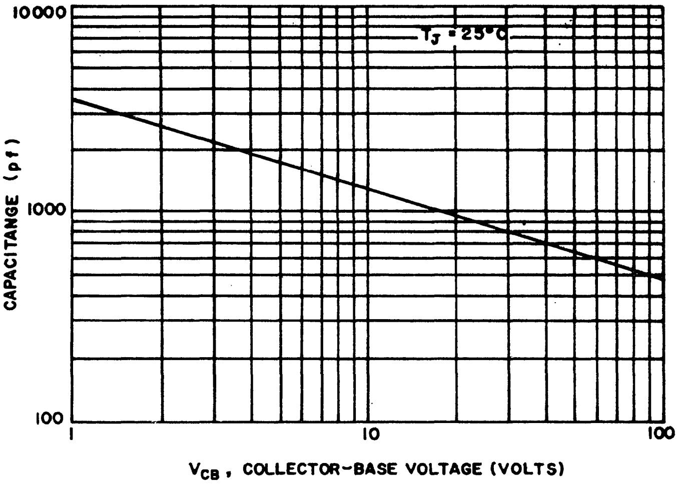


FIGURE 8: CAPACITANCE (Ccbo)

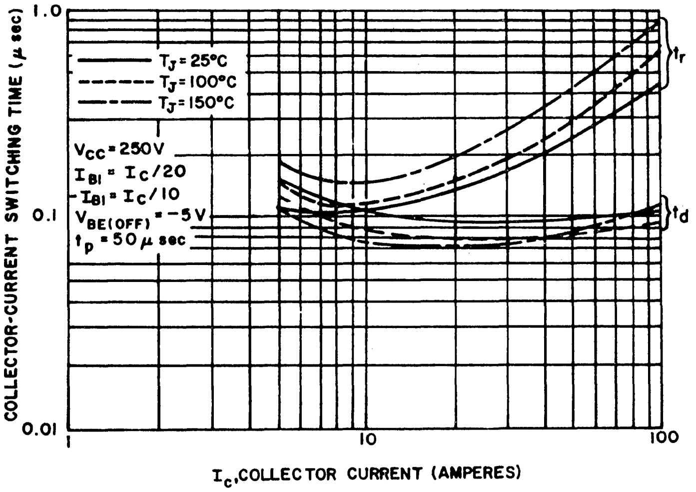


FIGURE 9: TURN-ON TIME (RESISTIVE LOAD)

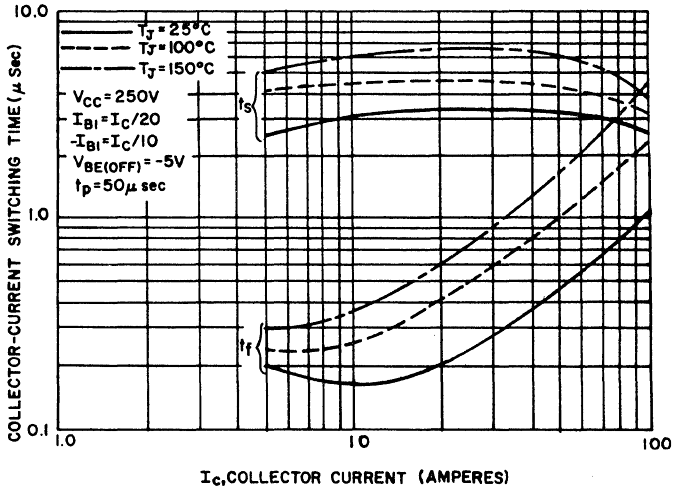


FIGURE 10: TURN-OFF TIME (RESISTIVE LOAD)

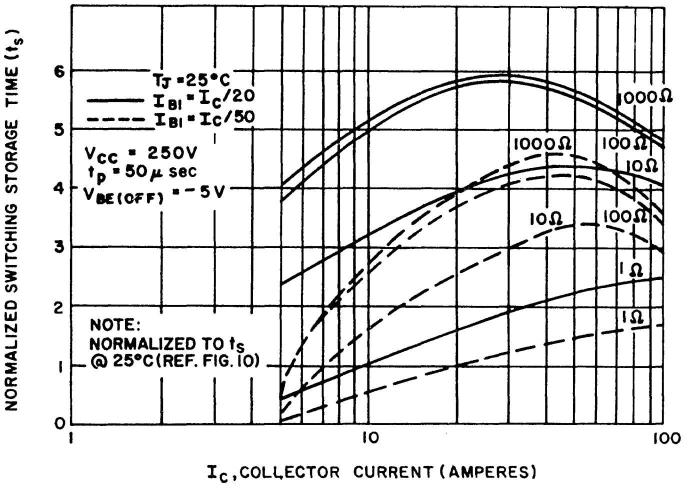


FIGURE 11: NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS COLLECTOR CURRENT

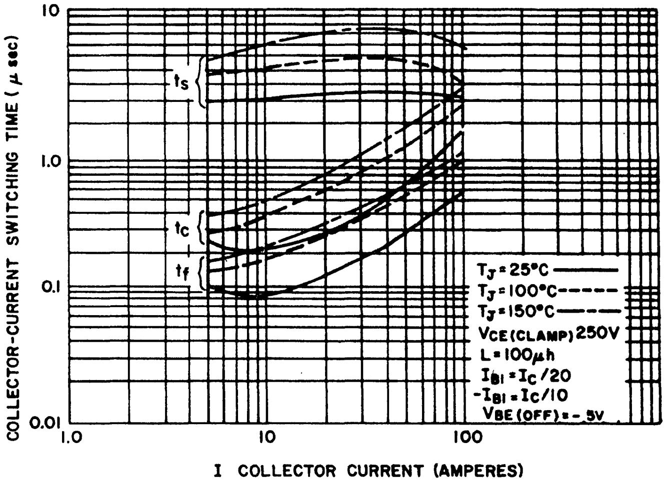


FIGURE 12: CLAMPED INDUCTIVE TURN-OFF TIME

TYPICAL CHARACTERISTICS

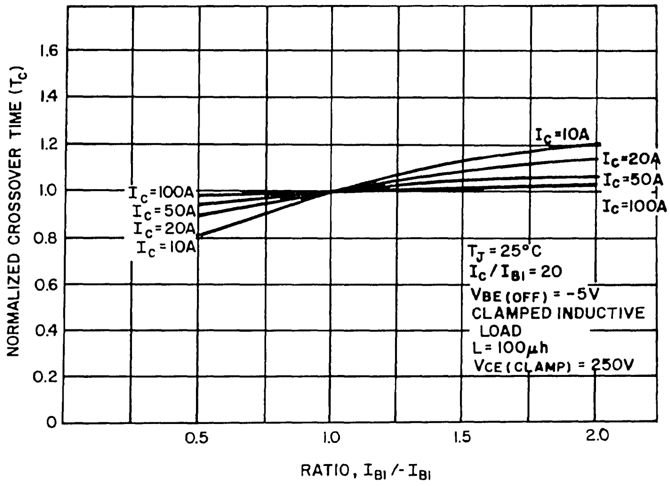


FIGURE 13: CROSSOVER TIME VARIATION WITH $-I_{B1}$

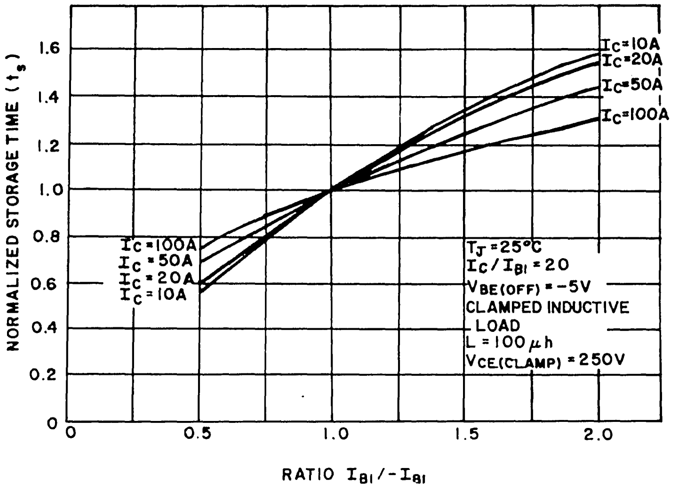


FIGURE 14: STORAGE TIME VARIATION WITH $-I_{B1}$

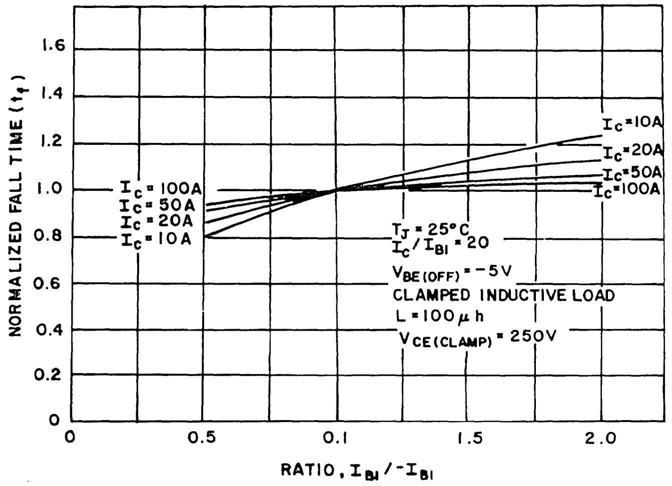


FIGURE 15: FALL TIME VARIATION WITH $-I_{B1}$

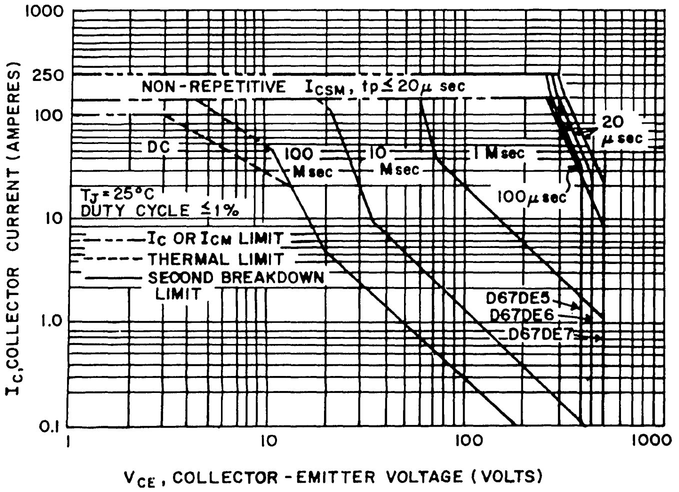


FIGURE 16: FORWARD BIAS SAFE OPERATING AREA

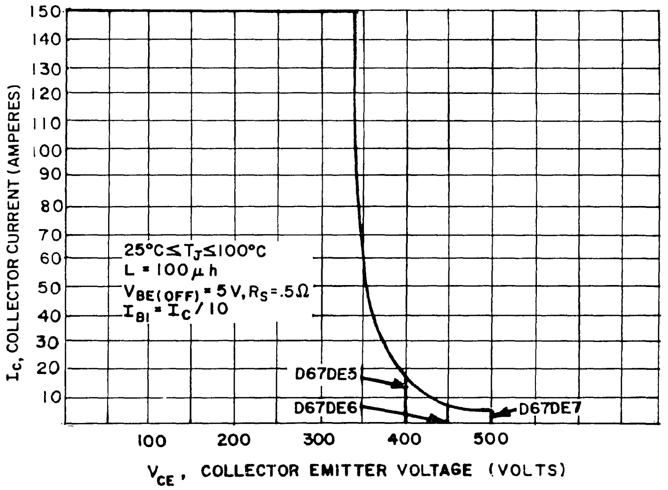


FIGURE 17: REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

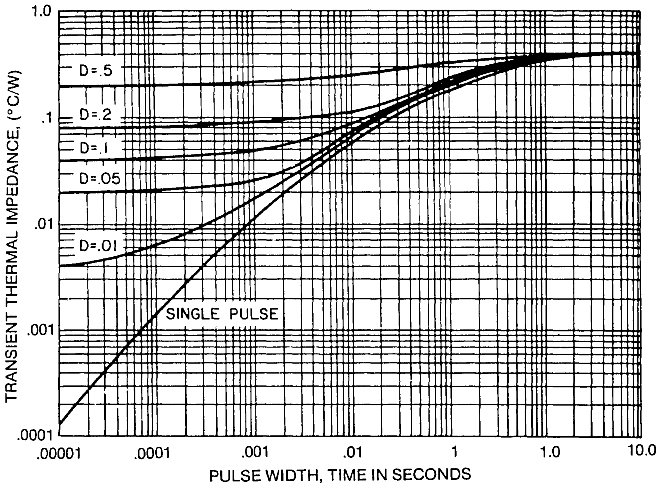


FIGURE 18: TRANSIENT THERMAL RESPONSE

TYPICAL CHARACTERISTICS

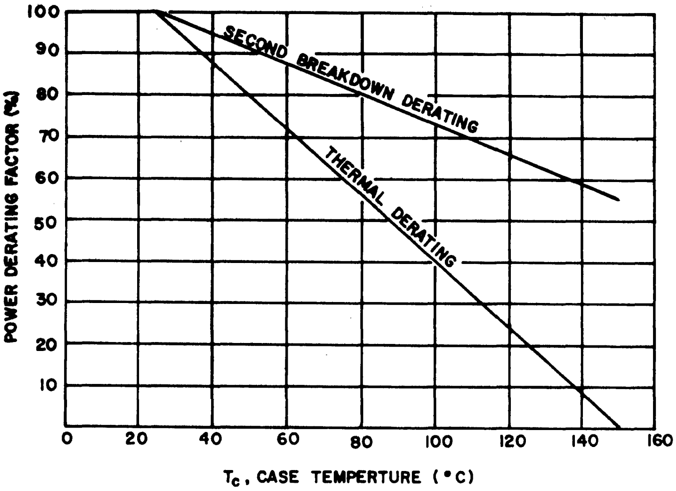


FIGURE 19: POWER DERATING

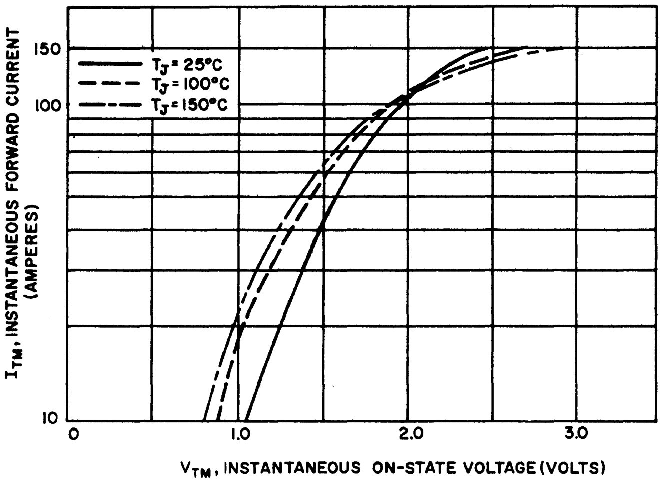
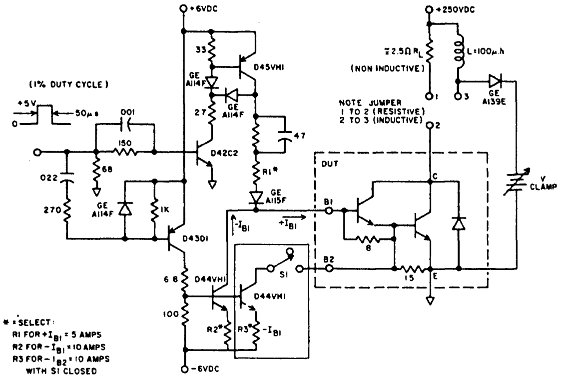


FIGURE 20: DIODE FORWARD CHARACTERISTICS



NOTE JUMPER
1 TO 2 (RESISTIVE)
2 TO 3 (INDUCTIVE)

* = SELECT:
R1 FOR $+I_{B1}$ = 5 AMPS
R2 FOR $-I_{B1}$ = 10 AMPS
R3 FOR $-I_{B2}$ = 10 AMPS
WITH S1 CLOSED

NOTE UTILIZING SECOND BASE CONNECTION DURING TURN-OFF (S1 CLOSED), TYPICAL REDUCTIONS IN TURN-OFF TIMES (t_s, t_f, t_c) RANGE FROM 2:1 TO 10:1 REDUCTION IS PROPORTIONAL TO $-I_{B2}$

FIGURE 21: SWITCHING TIME TEST CIRCUITS FOR:
- RESISTIVE & INDUCTIVE SWITCHING
- USING BASE 1 ONLY
- USING BASE 1 AND BASE 2

HIGH SPEED

NPN POWER DARLINGTON TRANSISTORS

D67FP5,6,7

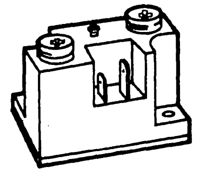
500-700 VOLTS
100 AMP, 312.5 WATTS

The D67FP is a high voltage NPN high current power darlington especially designed for use in PWM applications where fast and efficient switching is required. This device utilizes GE's latest advances in bipolar technology and features the D67 Package offering: collector isolation from heat sink, heft screw terminals for the emitter and collector and quick-connect terminals for Base 1 and Base 2.

The D67FP also features a discrete fast recovery antiparallel high power diode which eliminates the need for an external flyback diode in motor control and other inverter applications such as power supplies and UPS systems.

Features:

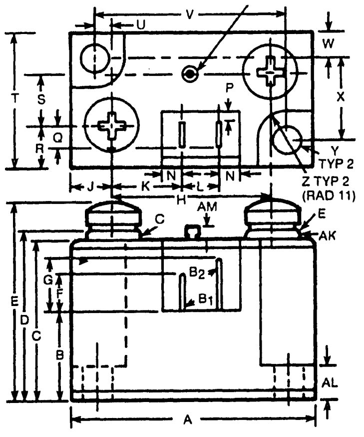
- Fast switching — $t_{f(TYP)}$ 0.6 μs
- High blocking voltage — V_{CEV} 500 to 700 Volts
- High current — $I_{C(Peak)}$ 150 Amps
- High gain — $h_{FE(MIN)}$ 50 @ 100 Amps
- Discrete high power fast recovery diode
- Both Base 1 and Base 2 connections are available
- UL recognized industrial package



CASE STYLE D67

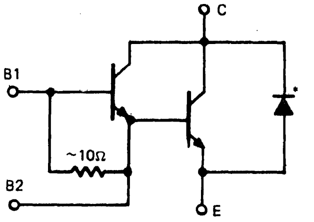
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED



S Y M	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.785	1.815	45.33	46.10
B	.615	.685	15.62	17.40
C	11.48	11.98	29.15	30.43
D	1.215	1.270	30.86	32.36
E	—	1.470	—	37.34
F	.245	—	6.20	—
G	.335	—	8.50	—
H	1.170	1.190	29.71	30.23
J	.295	.325	7.50	8.26
K	.518	REF.	13.16	REF.
L	.260	.290	6.60	7.37
N	.150	REF.	3.81	REF.
P	.070	REF.	1.80	REF.
Q	.170	REF.	4.30	REF.
R	.300	.320	7.60	8.13
S	.370	.390	9.40	9.90
T	.985	1.015	25.00	25.80
U	.110	.130	2.80	3.30
V	1.410	1.430	35.80	36.32
W	.175	.205	4.44	5.20
X	.610	.630	15.50	16.00
Y	.199	.221	5.05	5.61
Z	.190	.230	4.82	5.84
AA	.047	REF.	1.20	REF.
AB	.312	REF.	7.90	REF.
AC	M5 (MED FIT)		M5 (MED FIT)	
AD	.184	.192	4.67	4.90
AE	.031	.034	.78	.86
AF	.119	.132	3.02	3.35
AG	.050	.060	1.27	1.52
AH	.065	.075	1.65	1.90
AJ	.204	.211	5.18	5.36
AK	.365	.385	9.27	9.80
AL	.235	.265	5.96	6.73
AM	—	.125	—	3.20

DEVICE CIRCUIT



*NOTE: The collector-emitter diode is a discrete fast-recovery high power diode.

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	D67FP5	D67FP6	D67FP7	UNITS
Collector-Emitter Voltage	V_{CEV}	500	600	700	Volts
Collector-Emitter Voltage	V_{CER}	400	450	500	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	100 150 250	100 150 250	100 150 250	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	312.5 2.5	312.5 2.5	312.5 2.5	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-40 to +150	-40 to +150	-40 to +150	°C
Isolation Voltage	V_{ISOL}	2500	2500	2500	$V_{(rms)}$

thermal characteristics

Thermal Resistance, (transistor) (diode)	$R_{\theta JC}$	.40 1.5	.40 1.5	.40 1.5	°C/W

See page 845 for mounting and handling considerations.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = 1.0A, R_{BE} = 10Ω)	D67FP5 D67FP6 D67FP7	$V_{CEO(sus)}$	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, $V_{BE(off)}$ = 1.5V)	T_J = 25°C T_J = 150°C	I_{CEV}	— —	— —	1.0 2.5	mA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)		I_{EBO}	—	—	10	mA

second breakdown

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 150A, V_{CE} = 5V) (I_C = 100A, V_{CE} = 5V) (I_C = 40A, V_{CE} = 5V)	h_{FE}	25 50 100	150 300 350	— — —	—
Collector-Emitter Saturation Voltage (I_C = 150A, I_B = 10A) (I_C = 100A, I_B = 8A) (I_C = 40A, I_B = 4A)	$V_{CE(sat)}$	— — —	1.9 1.3 0.8	3.0 2.0 1.5	V
Base-Emitter Saturation Voltage (I_C = 150A, I_B = 10A) (I_C = 100A, I_B = 8A)	$V_{BE(sat)}$	— —	2.75 2.3	3.5 3.0	V

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time	V_{CE} = 250V	t_d	—	0.1	0.5	μs
Rise Time	I_C = 100A	t_r	—	0.45	1.0	
Storage Time	I_{B1} = 5A, -I_{B2} = 10A	t_s	—	3.2	5.0	
Fall Time	t_p = 50 μsec	t_f	—	1.0	3.0	

e-c diode characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Forward Voltage @ T_J = 25°C @ T_J = 150°C	(I_F = 100A)	V_P V_P	— —	1.3 1.3	2.0 2.5	Volts Volts
Reverse Recovery Time (I_F = 100A, di/dt = 100A/μsec, $V_{BE(off)}$ = 1.5V)		T_{rr}	—	0.5	1.0	μsec

TYPICAL CHARACTERISTICS

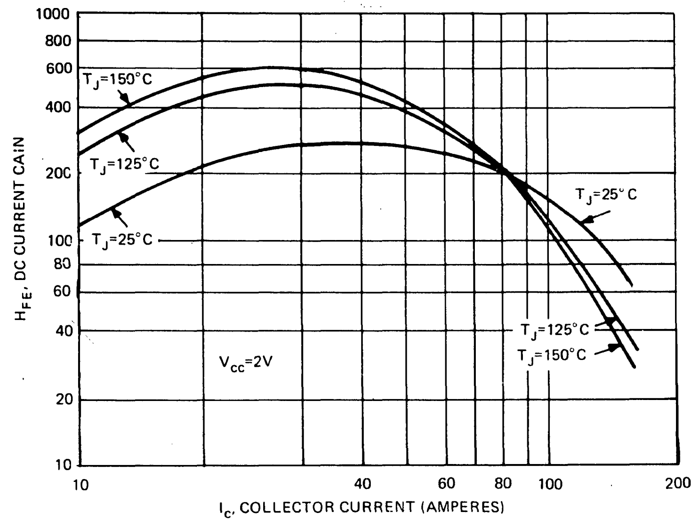


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V), TYPICAL

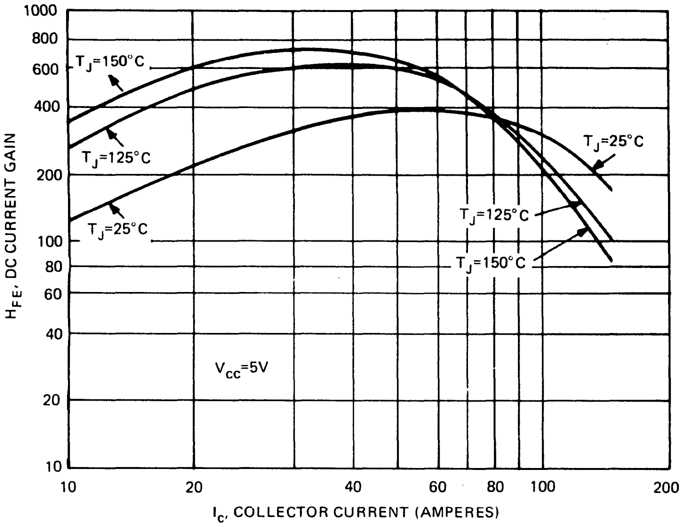


FIGURE 2. DC CURRENT GAIN (V_{CE} = 5V), TYPICAL

TYPICAL CHARACTERISTICS

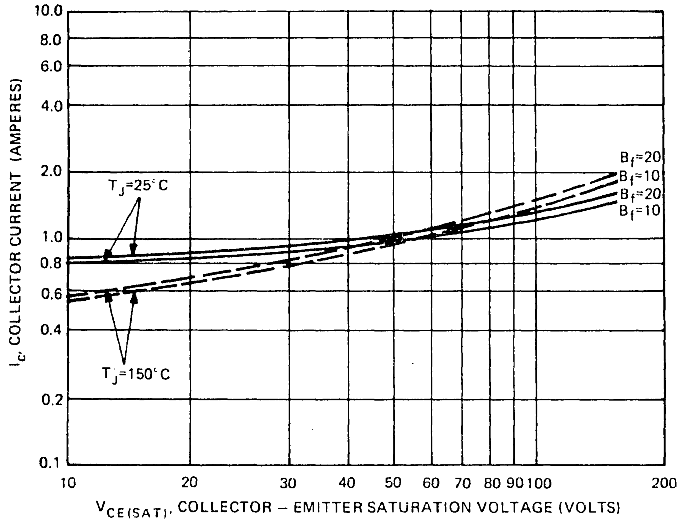


FIGURE 3. $V_{CE(SAT)}$ vs. I_C, TYPICAL

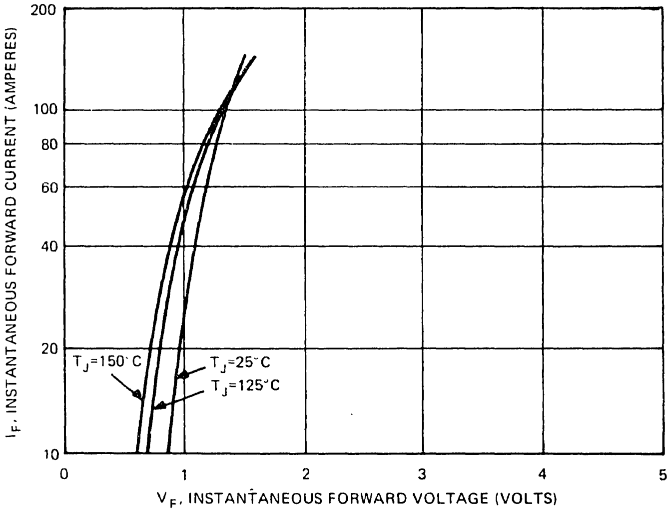


FIGURE 4. DIODE FORWARD CHARACTERISTICS

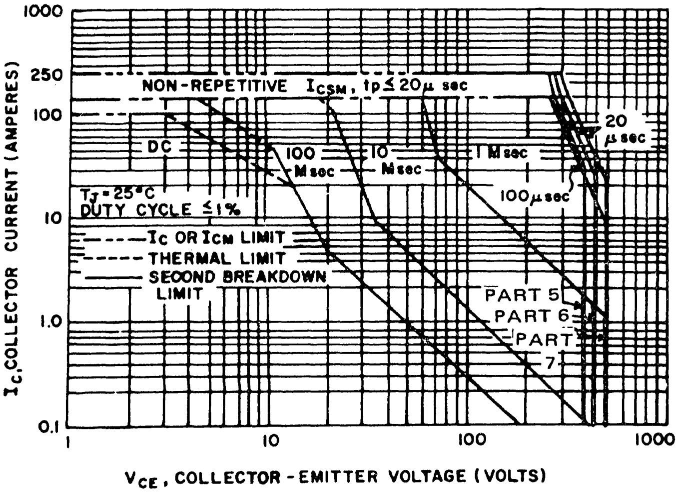


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA

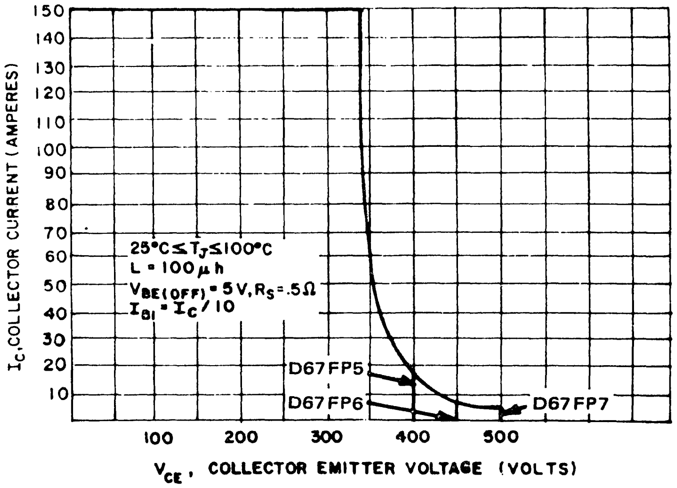
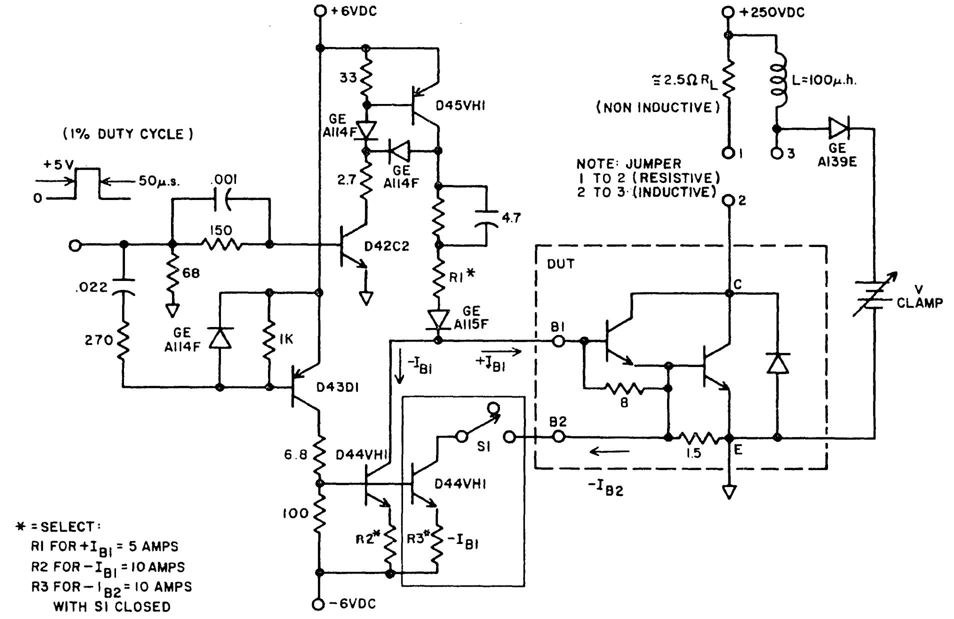


FIGURE 6. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)



NOTE: UTILIZING SECOND BASE CONNECTION DURING TURN-OFF (S1 CLOSED), TYPICAL REDUCTIONS IN TURN-OFF TIMES (t_s, t_f, t_c) RANGE FROM 2:1 TO 10:1. REDUCTION IS PROPORTIONAL TO $-I_{B2}$.

FIGURE 7. SWITCHING TIME TEST CIRCUIT

SURFACE-MOUNT
NPN POWER TRANSISTORS

D70F2T1

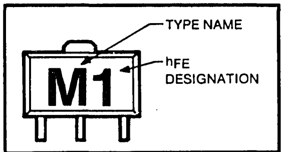
50 VOLTS
2 AMP, 500 mWATTS

Designed for power amplifier applications, power switching applications.

Features:

- Low saturation voltage
  : $V_{CE(sat)} = 0.5V$ (Max.) ($I_C = 1A$)
- High speed switching time: $t_{stg} = 1.0\mu s$ (Typ.)
- $P_D=1 \sim 2W$ (Mounted on ceramic substrate)
- Small flat package
- Complementary to D71F2T1
- See page 840 for mounting and handling considerations.

MARKING SYSTEM

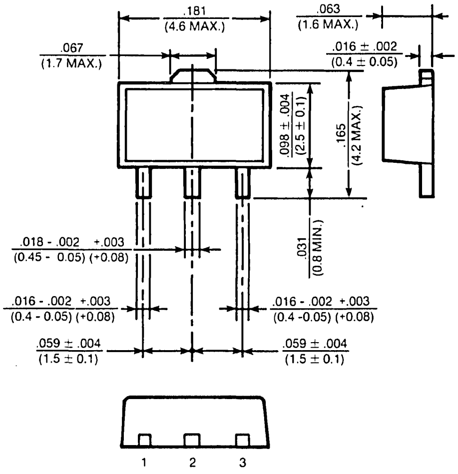


h_{FE} DESIGNATION

1) 70-240
2) 70-140
3) 120-240

CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D70F2T1	UNITS
Collector-Emitter Voltage	V_{CEO}	50	Volts
Collector-Base Voltage	V_{CBO}	50	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	2	A
Base Current — Continuous	I_B	0.4	A
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C @ $T_C = 25°C^{(1)}$	P_D	500 1000	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate ($250mm^2 \times 0.8t$).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_E = 0)	$V_{(BR)CEO}$	50	—	—	Volts
Collector Cutoff Current (V_{CB} = 50V, I_E = 0)	I_{CBO}	—	—	0.1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	0.1	μA

on characteristics

DC Current Gain(3) (I_C = 0.5A, V_{CE} = 2V)	h_{FE}	70	—	240	—
(I_C = 2.0A, V_{CE} = 2V)		20	—	—	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 0.05A)	$V_{CE(sat)}$	—	—	0.5	V
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 0.05A)	$V_{BE(sat)}$	—	—	1.2	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V	t_{on}	—	0.1	—	μs
Storage Time	I_{B1} = $-I_{B2}$ = 0.05A	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.1	—	

(3) See page 44 for h_{FE} ranges.

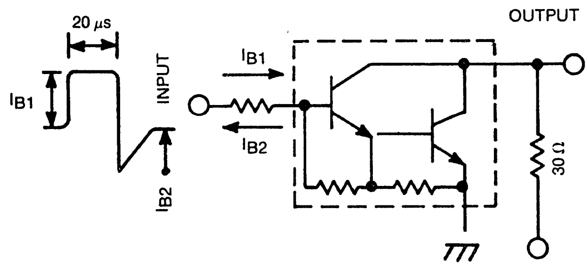


FIG. 1 SWITCHING TIME TEST CIRCUIT

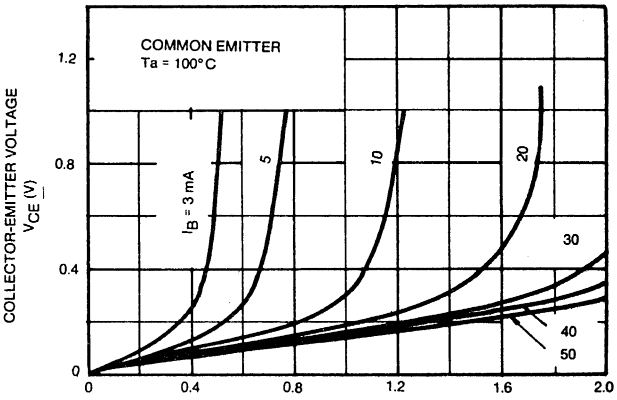


FIG. 2 V_{CE} - I_C

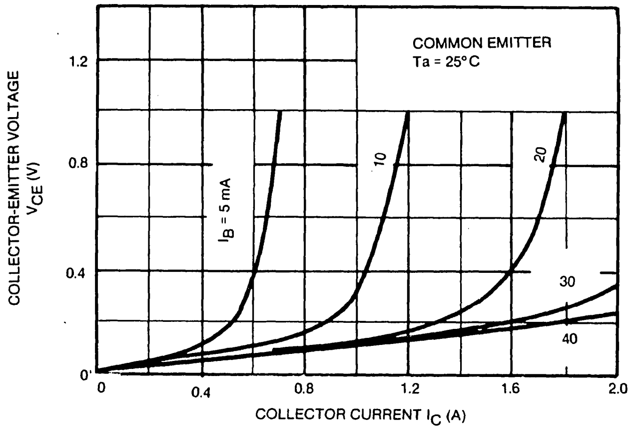


FIG. 3 V_{CE} - I_C

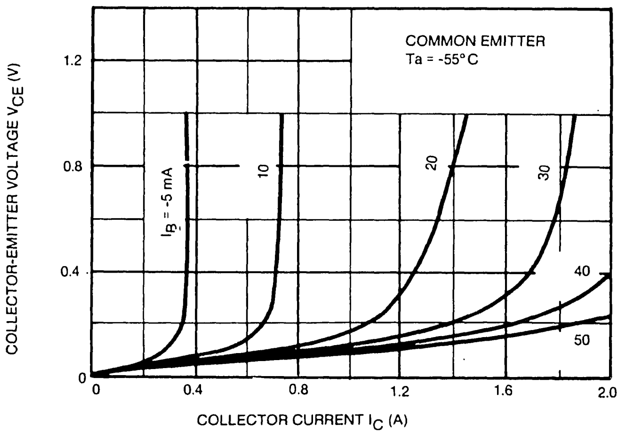


FIG. 4 V_{CE} - I_C

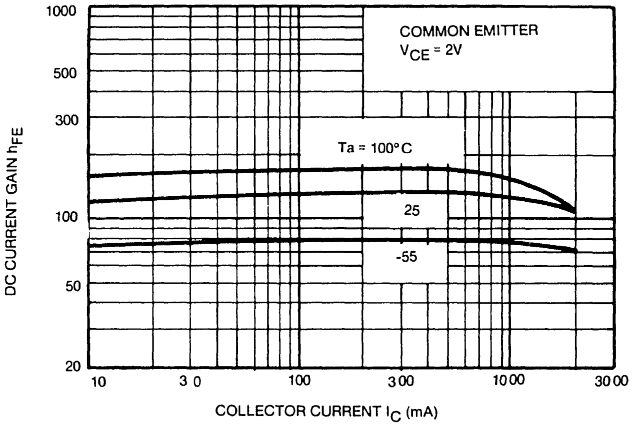


FIG. 5 h_{FE} - I_C

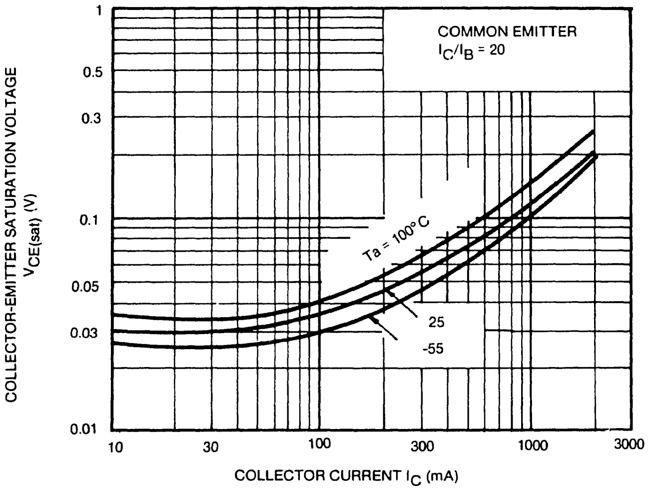


FIG. 6 $V_{CE(sat)}$ - I_C

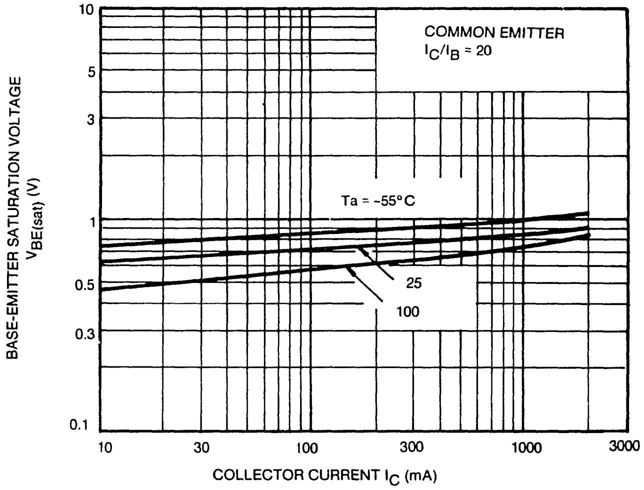


FIG. 7 $V_{BE(sat)}$ - I_C

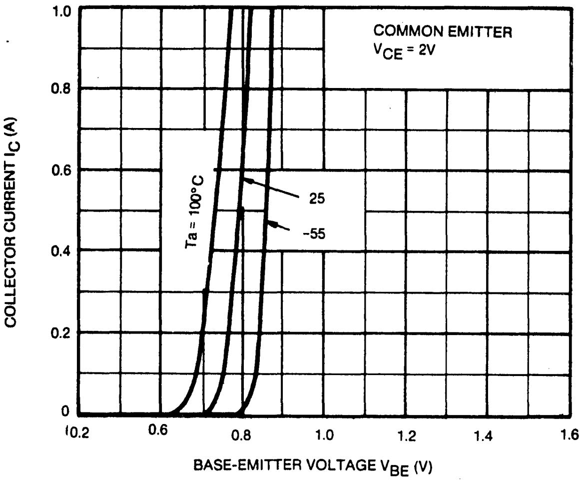


FIG. 8 I_C - V_{BE}

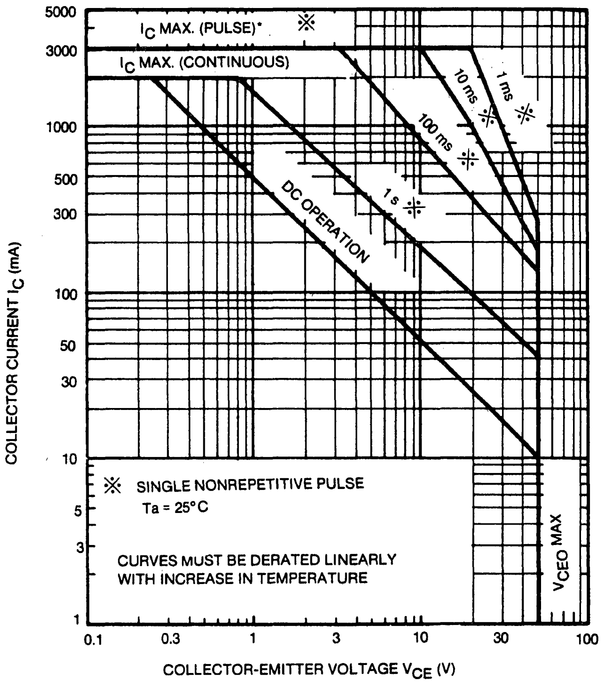


FIG. 9 SAFE OPERATING AREA

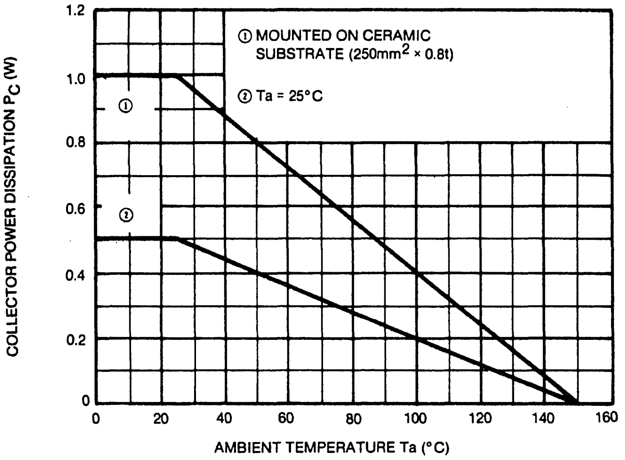


FIG. 10 P_C - Ta

SURFACE-MOUNT

NPN POWER TRANSISTORS

D70G.05T1

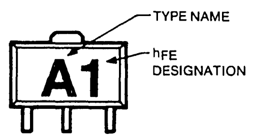
150 VOLTS
50 mAMP, 500 mWATTS

Designed for high voltage switching applications.

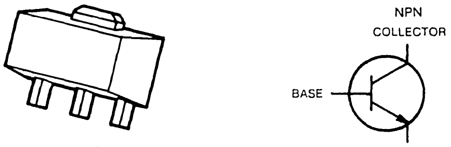
Features:

- High voltage: V_{CEO} = 150V
- High transition frequency: f_T = 120MHz
- P_D=1 ~ 2W (Mounted on ceramic substrate)
- Small flat package
- Complementary to D71G.05T1
- See page 840 for mounting and handling considerations.

MARKING SYSTEM

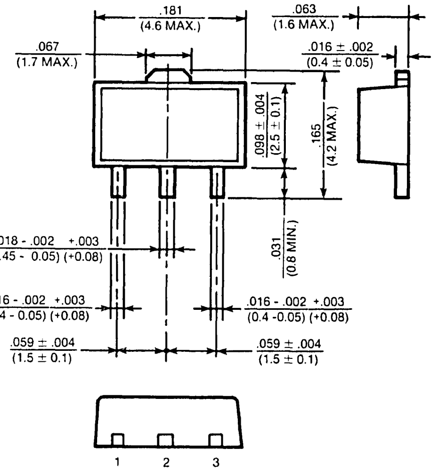


h_{FE} DESIGNATION
1) 70-240
2) 70-140
3) 120-240



CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D70G.05T1	UNITS
Collector-Emitter Voltage	V_{CEO}	150	Volts
Collector-Base Voltage	V_{CBO}	200	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	50	mA
Base Current — Continuous	I_B	10	mA
Total Power Dissipation @ T_C = 25° C(1) @ T_C = 25° C	P_D	800 500	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate (250mm² × 0.8t).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Sustaining Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	150	—	—	Volts
Collector Cut-off Current (V_{CB} = 200V, I_E = 0)	I_{CBO}	—	—	0.1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	0.1	μA
on characteristics					
DC Current Gain(3) (I_C = 10mA, V_{CE} = 5V)	h_{FE}	70	—	240	—
Collector-Emitter Saturation Voltage (I_C = 10mA, I_B = 1mA)	$V_{CE(sat)}$	—	—	0.5	V
Base-Emitter Voltage (V_{CE} = 5V, I_C = 30mA)	$V_{BE(on)}$	—	—	1	V

(3) See page 44 for h_{FE} ranges.

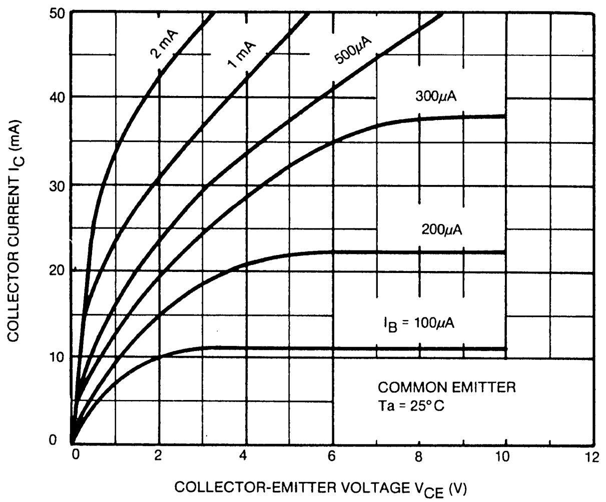


FIG. 1 I_C - V_{CE}

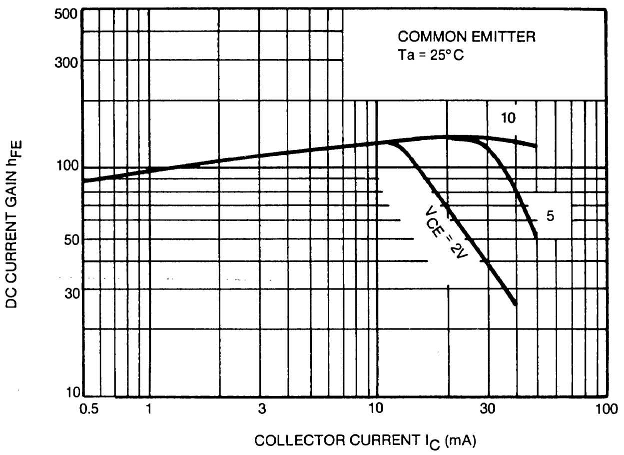


FIG. 2 h_{FE} - I_C

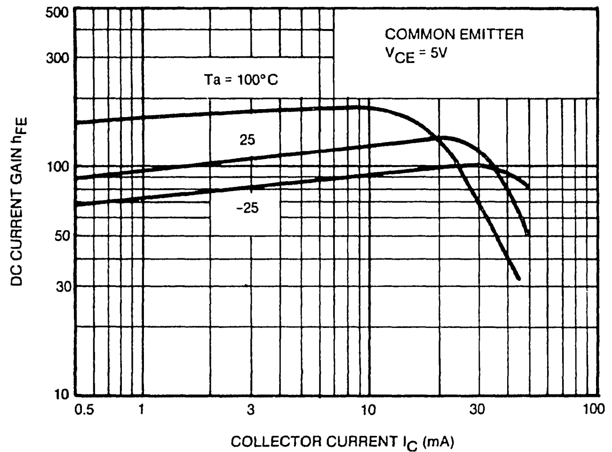


FIG. 3 h_{FE} - I_C

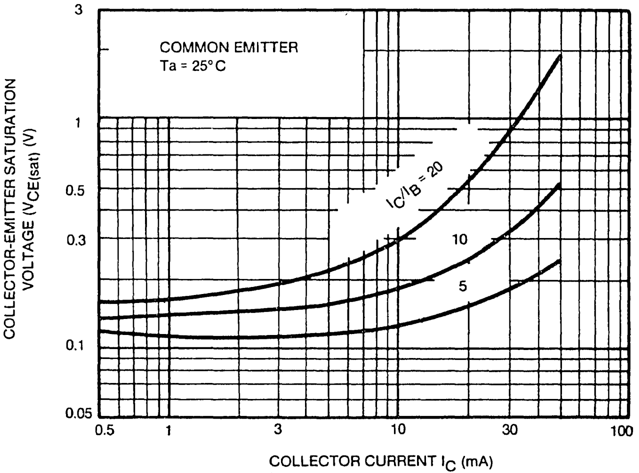


FIG. 4 $V_{CE(sat)}$ - I_C

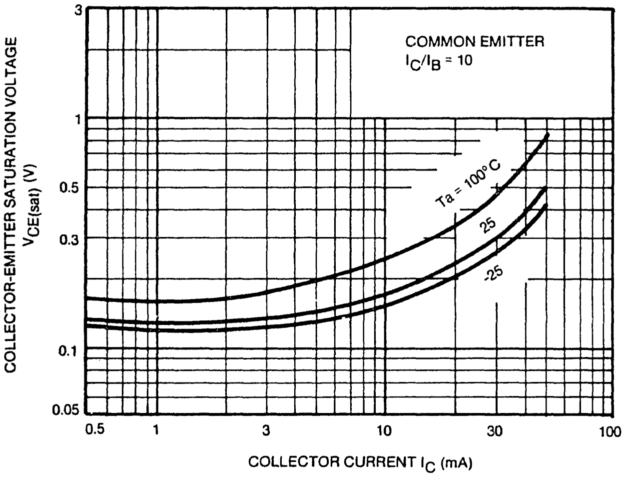


FIG. 5 $V_{CE(sat)}$ - I_C

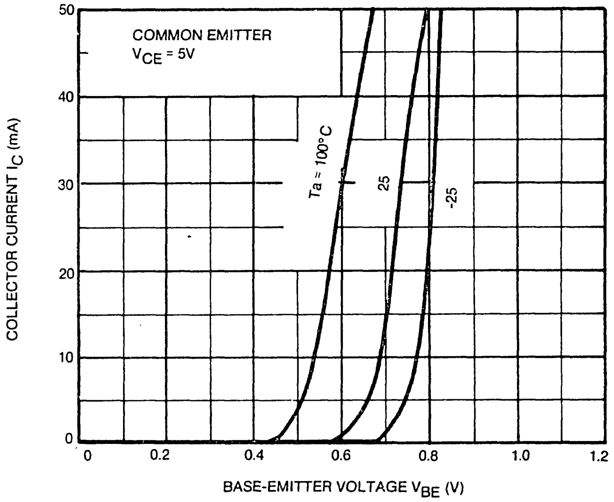


FIG. 6 I_C - V_{BE}

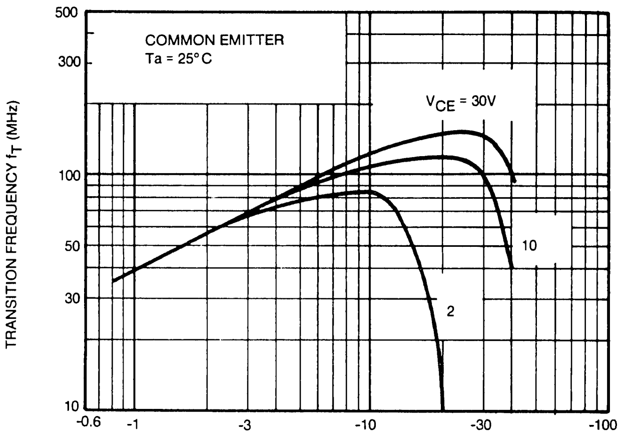


FIG. 7 f_T - I_E

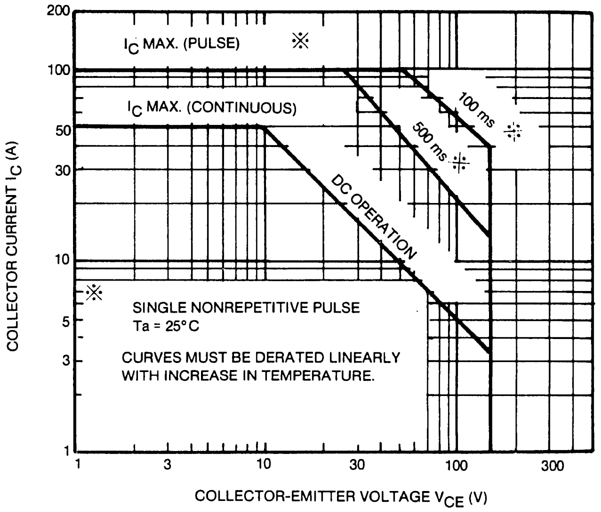


FIG. 8 SAFE OPERATING AREA

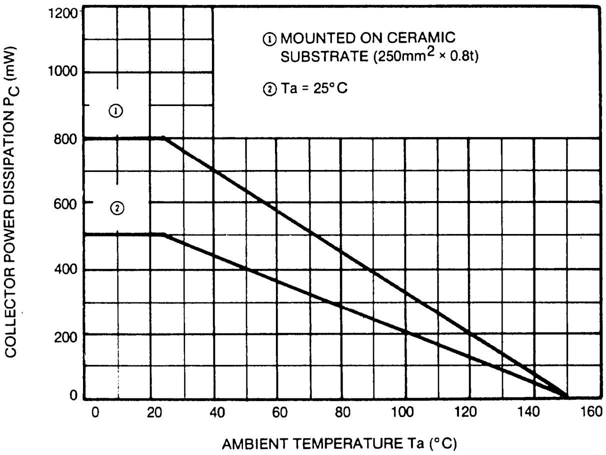


FIG. 9 P_C - Ta

SURFACE-MOUNT
NPN POWER TRANSISTORS

D70Y.8T1

30 VOLTS
800 mAMP, 500 mWATTS

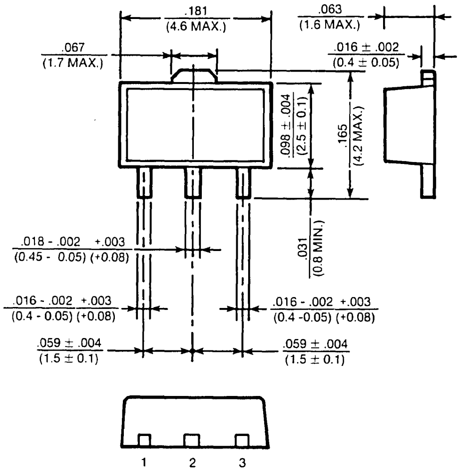
Designed for audio frequency amplifier applications.

Features:

- High DC current: $h_{FE} = 100 \sim 320$
- Suitable for output stage of 1-Watt amplifier
- $P_D = 1 \sim 2W$ (Mounted on ceramic substrate)
- Small flat package
- Complementary to D71Y.8T1
- See page 840 for mounting and handling considerations.

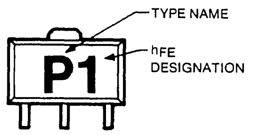
CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

MARKING SYSTEM



h_{FE} DESIGNATION
1) 70-240
2) 70-140
3) 120-240

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D70Y.8T1	UNITS
Collector-Emitter Voltage	V_{CEO}	30	Volts
Collector-Base Voltage	V_{CBO}	35	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	800	mA
Base Current — Continuous	I_B	160	mA
Total Power Dissipation @ $T_C = 25°C$ @ $T_C = 25°C^{(1)}$	P_D	500 1000	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate ($250mm^2$ x 0.8t).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Volts
Collector Cut-off Current (V_{CB} = 35V, I_E = 0)	I_{CBO}	—	—	100	nA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	100	nA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain(3) (I_C = 100mA, V_{CE} = 1V) (I_C = 700mA, V_{CE} = 1V)	h_{FE}	100 35	— —	320 —	—
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 20mA)	$V_{CE(sat)}$	—	—	0.5	V
Base-Emitter Voltage (V_{CE} = 1V, I_C = 10mA)	$V_{BE(on)}$	0.5	—	0.8	V

(3) See page 44 for h_{FE} range.

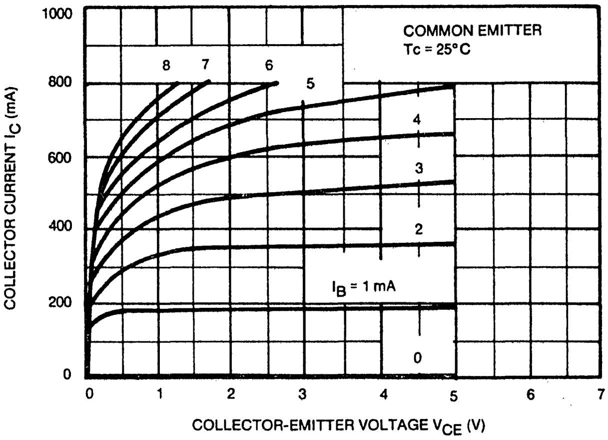


FIG. 1 I_C - V_{CE}

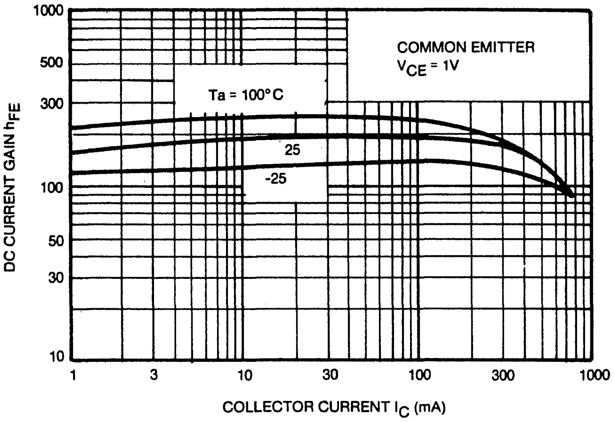


FIG. 2 h_{FE} - I_C

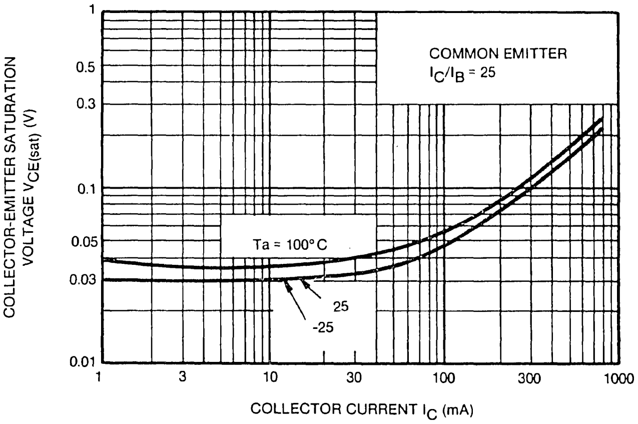


FIG. 3 $V_{CE(sat)}$ - I_C

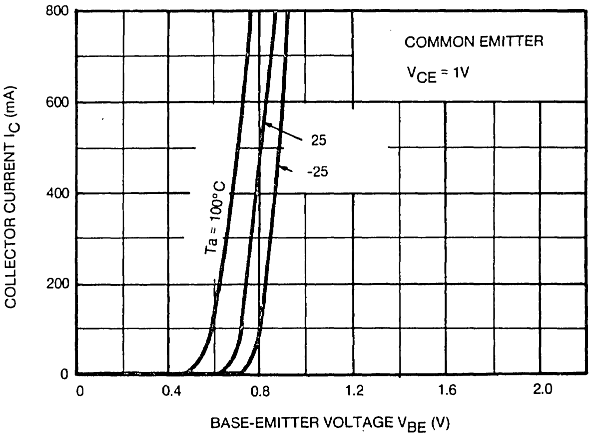


FIG. 4 I_C - V_{BE}

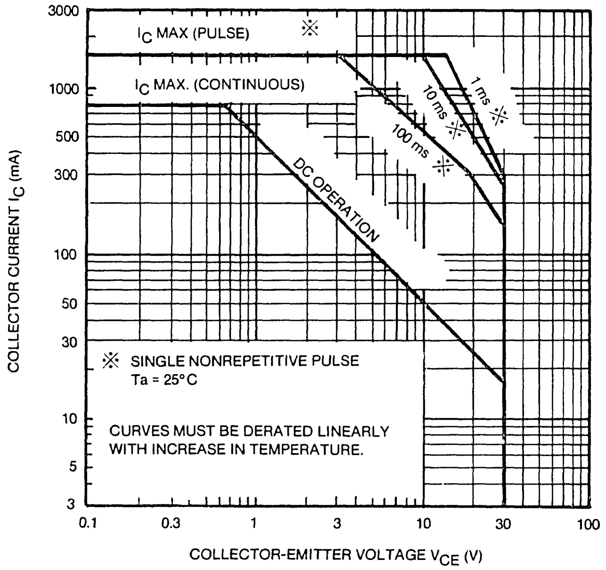


FIG. 5 SAFE OPERATING AREA

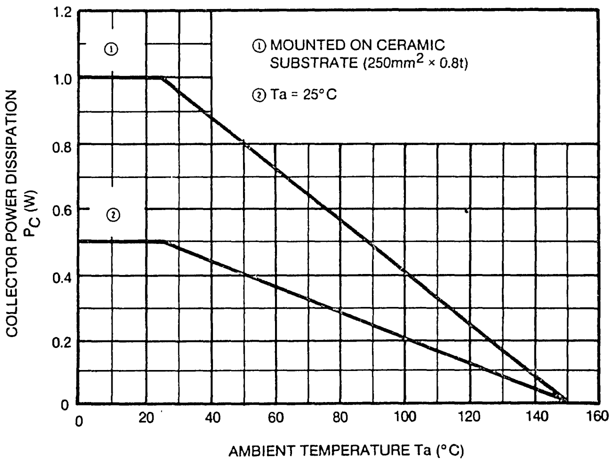


FIG. 6 P_C - Ta

SURFACE-MOUNT
NPN POWER TRANSISTORS

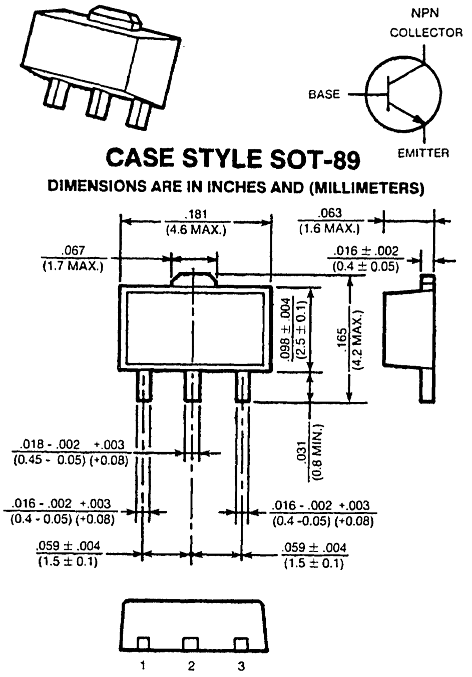
D70Y1.5T1

30 VOLTS
1.5 AMP, 500 mWATTS

Designed for audio frequency amplifier applications.

Features:

- Suitable for output stage of 3-Watt amplifier
- P_D=1 ~ 2W (Mounted on ceramic substrate)
- Small flat package
- Complementary to D71Y1.5T1
- See page 840 for mounting and handling considerations.

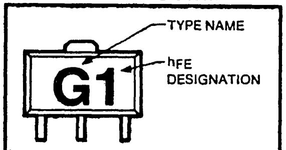


CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

MARKING SYSTEM



h_{FE} DESIGNATION
1) 70-240
2) 70-140
3) 120-240

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D70Y1.5T	UNITS
Collector-Emitter Voltage	V_{CEO}	30	Volts
Collector-Base Voltage	V_{CBO}	30	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	1.5	A
Base Current — Continuous	I_B	0.3	A
Total Power Dissipation @ T_C = 25°C @ T_C = 25°C(1)	P_D	500 1000	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate (250mm² × 0.8t).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Volts
Collector Cut-off Current (V_{CB} = 30V, I_E = 0)	I_{CBO}	—	—	100	nA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	100	nA

on characteristics

DC Current Gain(3) (I_C = 500mA, V_{CE} = 2V)	h_{FE}	100	—	320	—
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 0.03A)	$V_{CE(sat)}$	—	—	2.0	V
Base-Emitter Voltage (V_{CE} = 2V, I_C = 500mA)	$V_{BE(on)}$	—	—	1.0	V

(3) See page 44 for h_{FE} range.

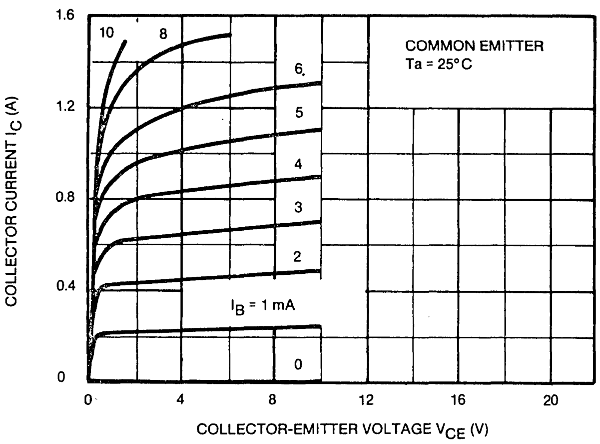


FIG. 1 I_C - V_{CE}

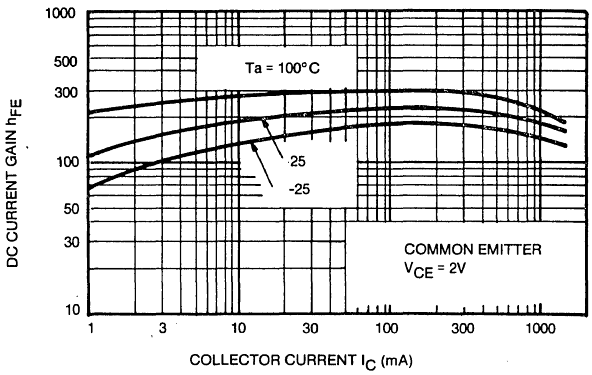


FIG. 2 h_{FE} - I_C

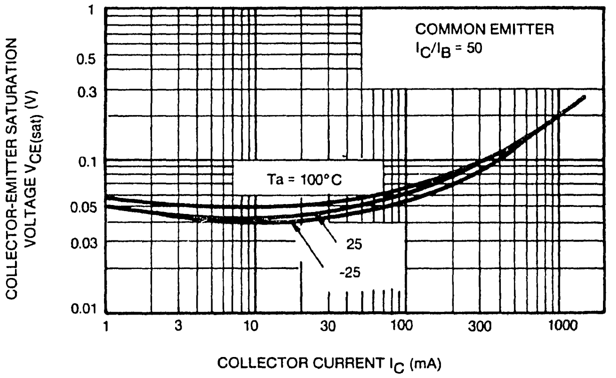


FIG. 3 $V_{CE(sat)}$ - I_C

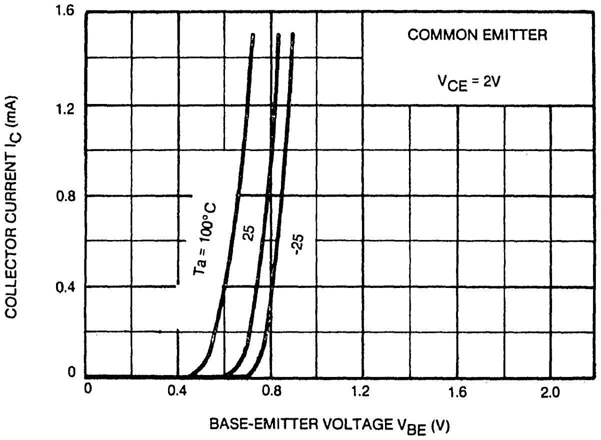


FIG. 4 I_C - V_{BE}

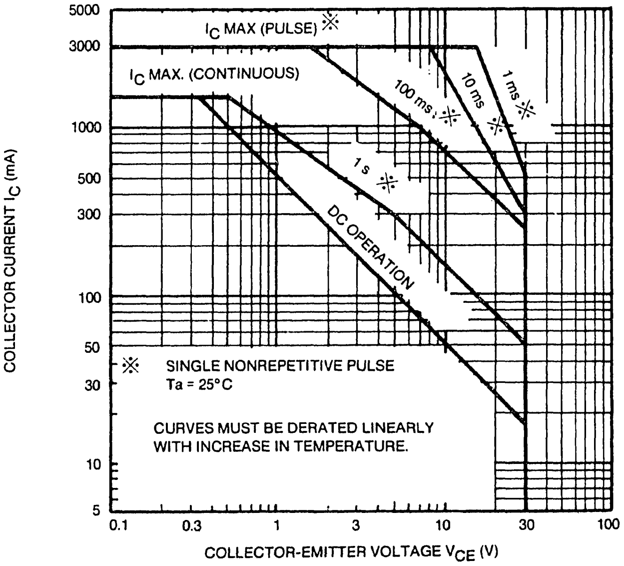


FIG. 5 SAFE OPERATING AREA

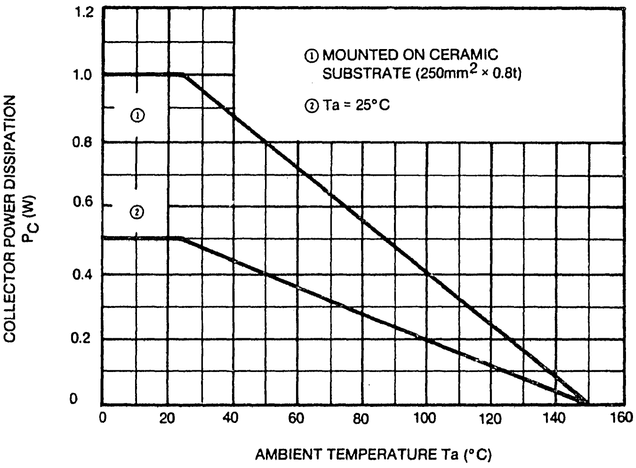


FIG. 6 P_C - Ta

SURFACE-MOUNT
PNP POWER TRANSISTORS

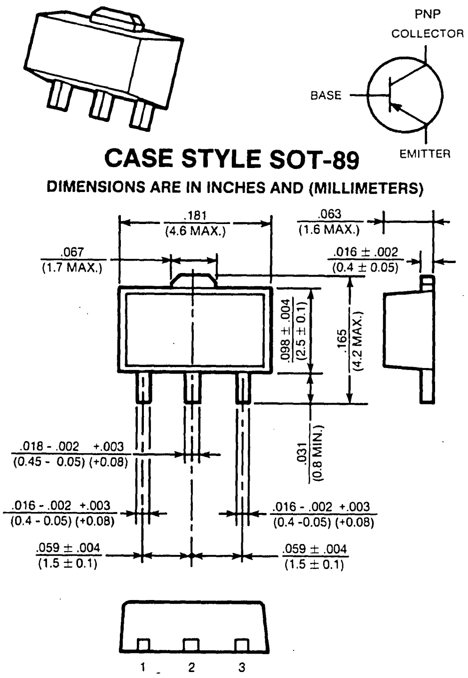
D71F2T1

-50 VOLTS
-2 AMP, 500mWATTS

Designed for power amplifier applications, power switching applications.

Features:

- Low saturation voltage
  : $V_{CE(sat)} = -0.5V$ (Max.) ($I_C = -1A$)
- High speed switching time: $t_{stg} = 1.0\mu s$ (Typ.)
- $P_D = 1 \sim 2W$ (Mounted on ceramic substrate)
- Small flat package
- Complementary to D70F2T1
- See page 840 for mounting and handling considerations.

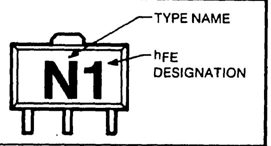


CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

MARKING SYSTEM



h_{FE} DESIGNATION
1) 70-240
2) 70-140
3) 120-240

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D71F2T	UNITS
Collector-Emitter Voltage	V_{CEO}	-50	Volts
Collector-Base Voltage	V_{CBO}	-50	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-2	A
Base Current — Continuous	I_B	-0.4	A
Total Power Dissipation @ $T_C = 25°C$ @ $T_C = 25°C^{(1)}$	P_D	500 1000	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics$^{(2)}$

(1) Mounted on ceramic substrate (250mm² × 0.8t).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = -10mA, I_E = 0)	$V_{(BR)CEO}$	-50	—	—	Volts
Collector Cutoff Current (V_{CB} = -50V, I_E = 0)	I_{CBO}	—	—	-0.1	μA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-0.1	μA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain(3) (I_C = -0.5A, V_{CE} = -2V)	h_{FE}	70	—	240	—
(I_C = -2.0A, V_{CE} = -2V)		20	—	—	
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -0.05A)	$V_{CE(sat)}$	—	—	-0.5	V
Base-Emitter Saturation Voltage (I_C = -1A, I_B = -0.05A)	$V_{BE(sat)}$	—	—	-1.2	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -30V	t_{on}	—	0.1	—	μs
Storage Time	I_{B1} = I_{B2} = 0.05A	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.1	—	

(3) See page 44 for h_{FE} range

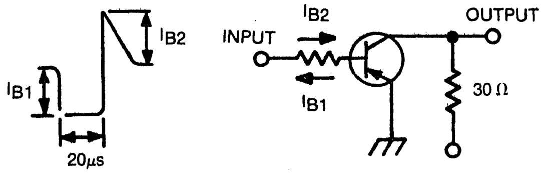


FIG. 1 SWITCHING TIME TEST CIRCUIT

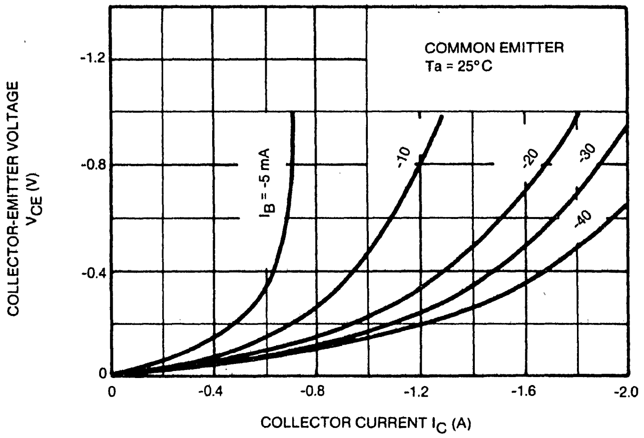


FIG. 2 V_{CE} - I_C

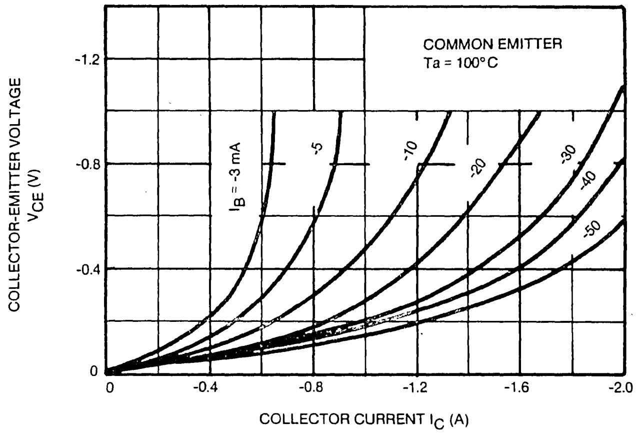


FIG. 3 V_{CE} - I_C

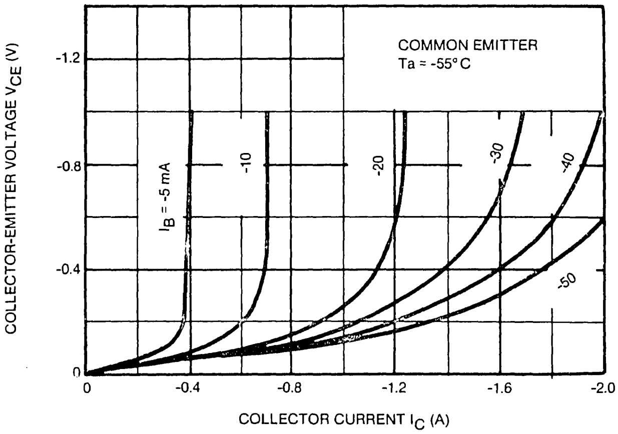


FIG. 4 V_{CE} - I_C

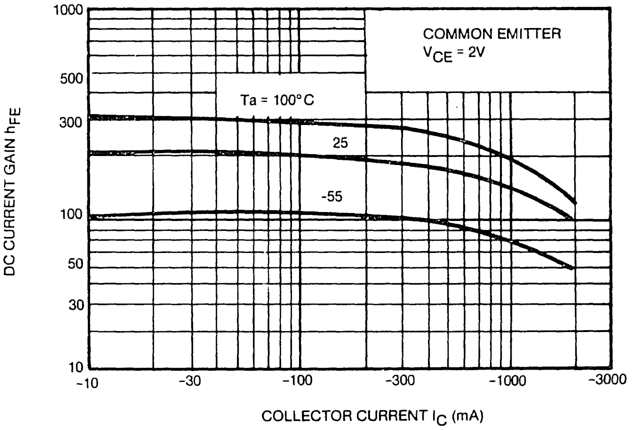


FIG. 5 h_{FE} - I_C

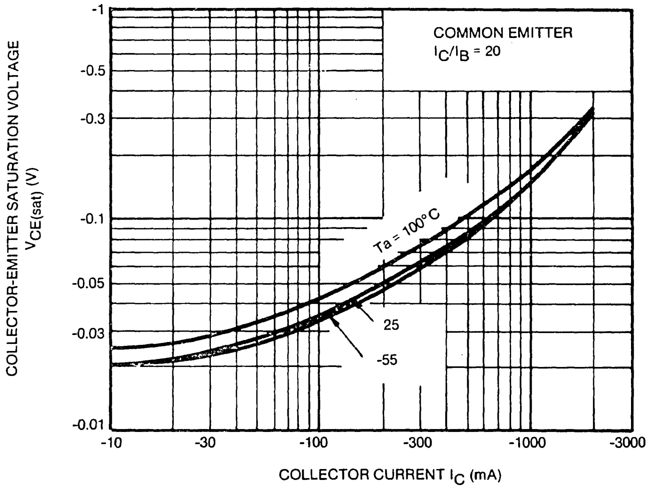


FIG. 6 $V_{CE(sat)}$ - I_C

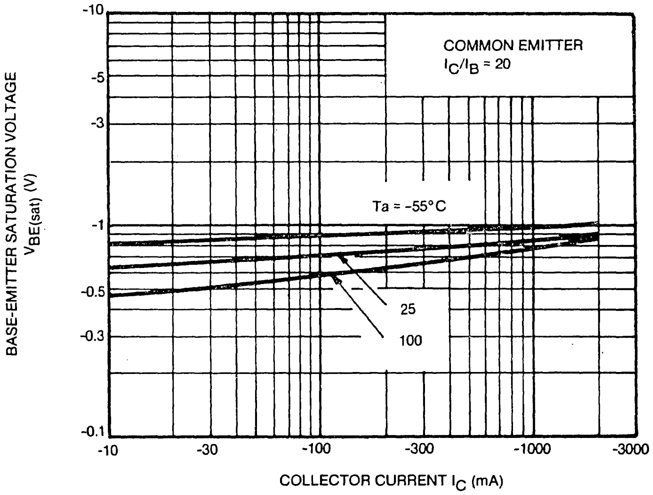


FIG. 7 $V_{BE(sat)}$ - I_C

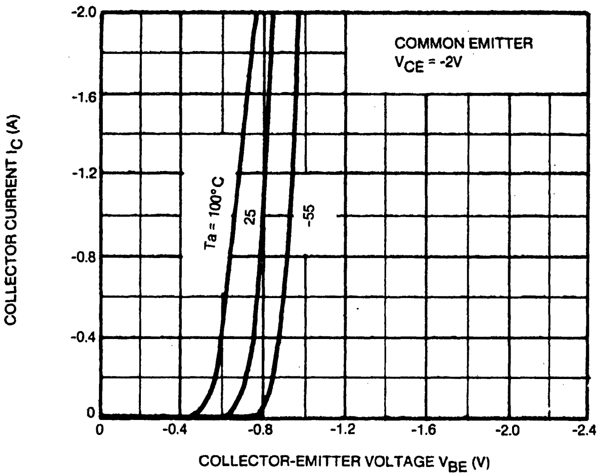


FIG. 8 I_C - V_{BE}

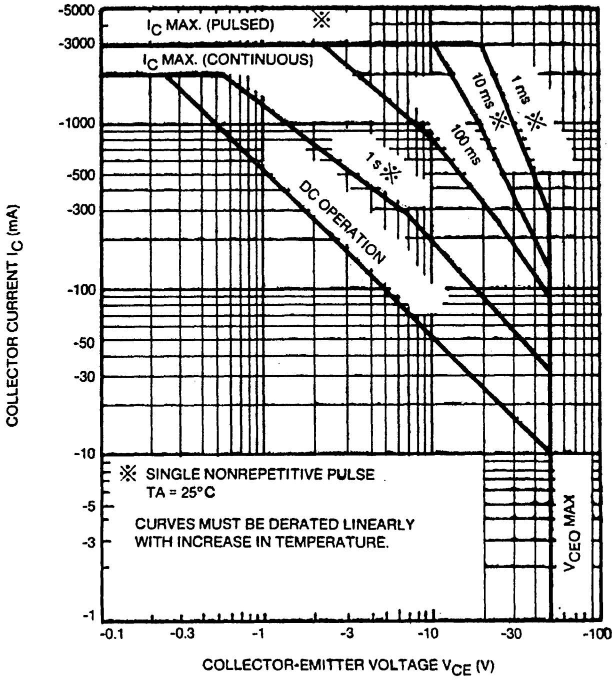


FIG. 9 SAFE OPERATING AREA

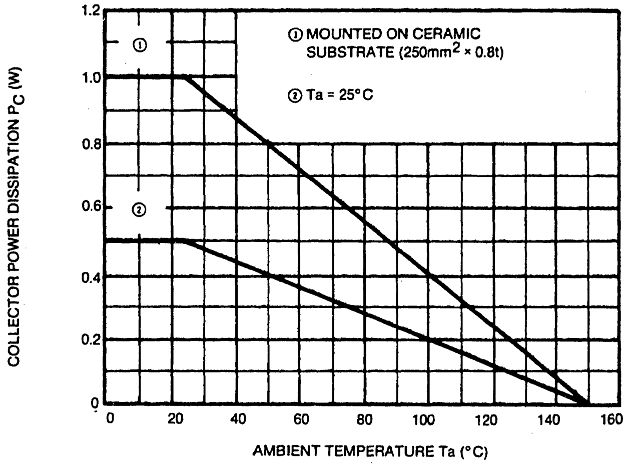


FIG. 10 P_C - Ta

SURFACE-MOUNT
PNP POWER TRANSISTORS

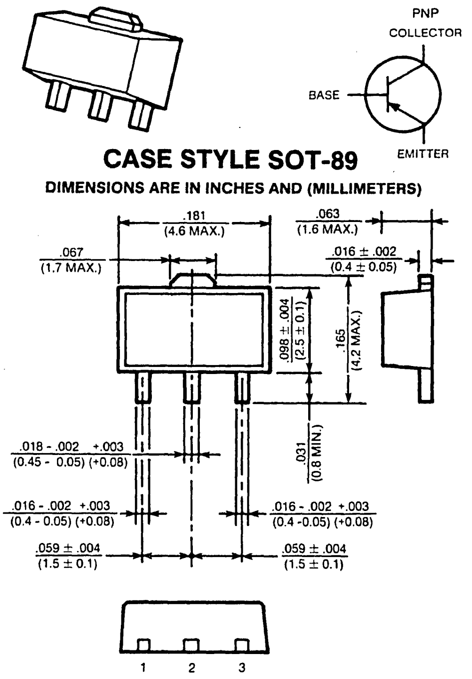
D71G.05T1

-150 VOLTS
-50 mAMP, 500 mWATTS

Designed for high voltage switching applications.

Features:

- High voltage: V_{CEO} = -150V
- High transition frequency: f_T = 120MHz
- P_D=1 ~ 2W (Mounted on ceramic substrate)
- Small flat package
- Complementary to D70G.05T1
- See page 840 for mounting and handling considerations.

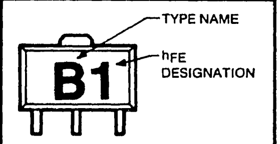


CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

MARKING SYSTEM



hFE DESIGNATION

1) 70-240
2) 70-140
3) 120-240

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D71G.05T1	UNITS
Collector-Emitter Voltage	V_{CEO}	-150	Volts
Collector-Base Voltage	V_{CBO}	-150	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-50	mA
Base Current — Continuous	I_B	-10	mA
Total Power Dissipation @ T_C = 25° C @ T_C = 25° C(1)	P_D	500 800	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate (250mm² × 0.8t).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = -10mA, I_B = 0)	$V_{CEO(sus)}$	150	—	—	Volts
Collector Cut-off Current (V_{CB} = -150V, I_E = 0)	I_{CBO}	—	—	-0.1	nA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-0.1	nA

on characteristics

DC Current Gain(3) (I_C = -10mA, V_{CE} = -5V)	h_{FE}	70	—	240	—
Collector-Emitter Saturation Voltage (I_C = -10mA, I_B = -1mA)	$V_{CE(sat)}$	—	—	-0.8	V
Base-Emitter Voltage (V_{CE} = -5V, I_C = -30mA)	$V_{BE(on)}$	—	—	-0.9	V

(3) See page 44 for h_{FE} range.

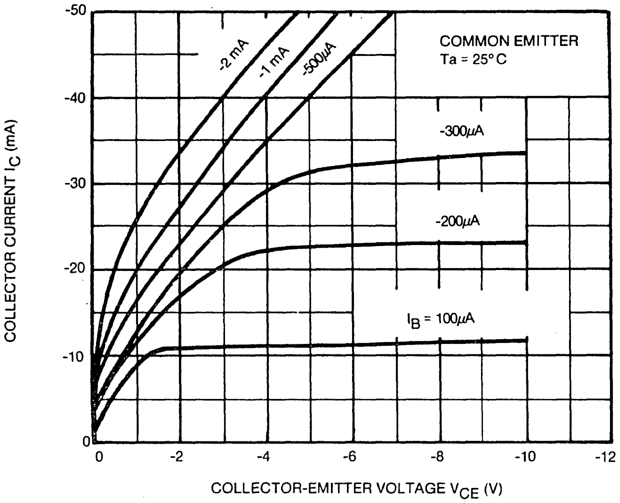


FIG. 1 I_C - V_{CE}

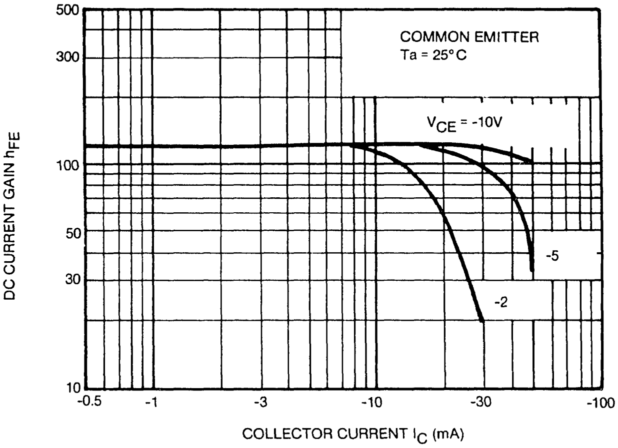


FIG. 2 h_{FE} - I_C

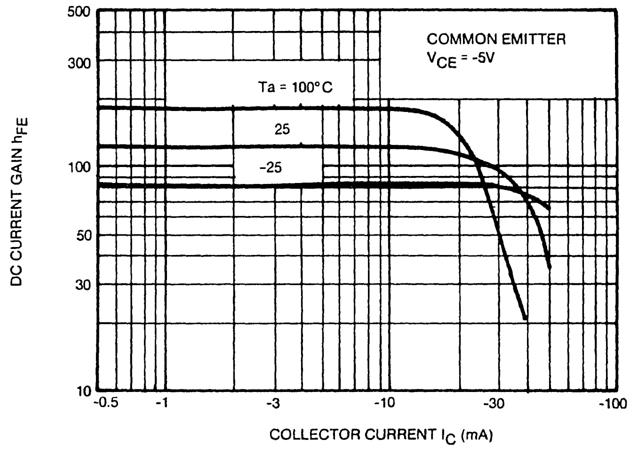


FIG. 3 $h_{FE} - I_C$

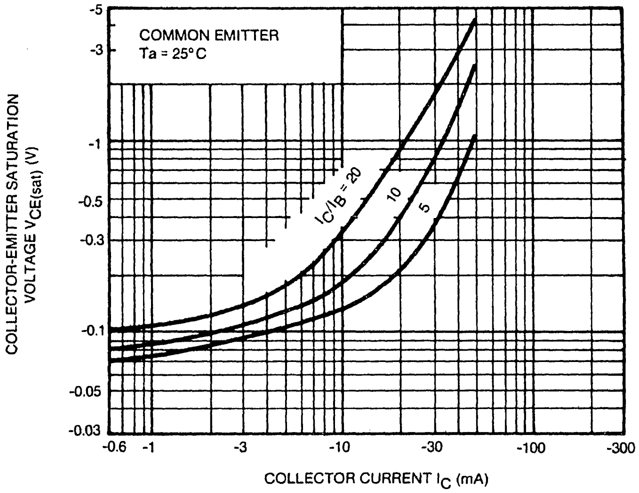


FIG. 4 $V_{CE(sat)} - I_C$

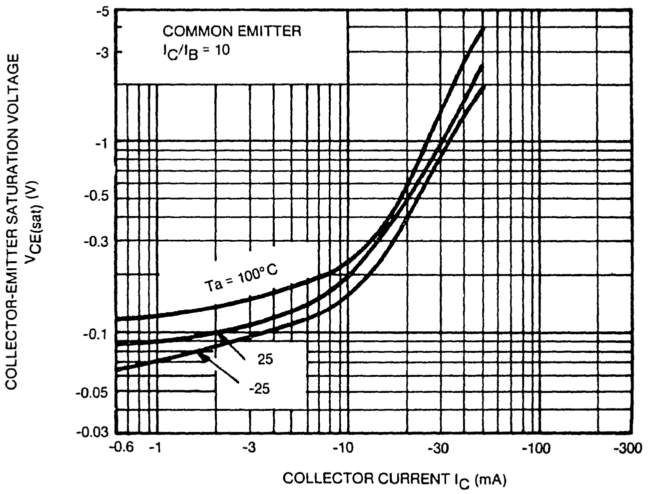


FIG. 5 $V_{CE(sat)} - I_C$

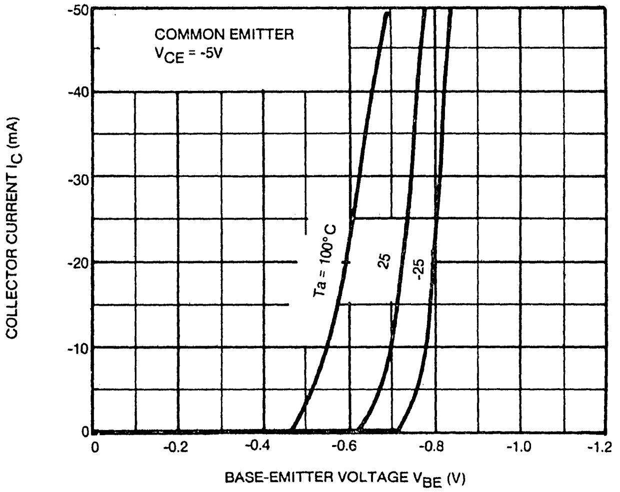


FIG. 6 $I_C - V_{BE}$

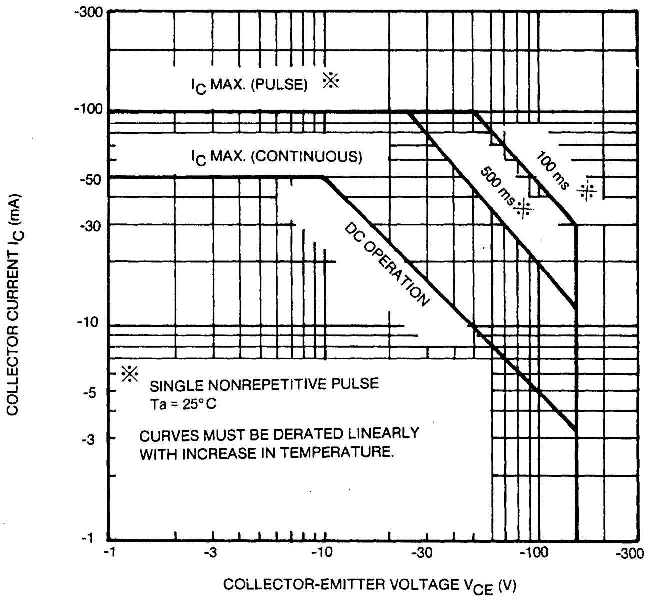


FIG. 7 SAFE OPERATING AREA

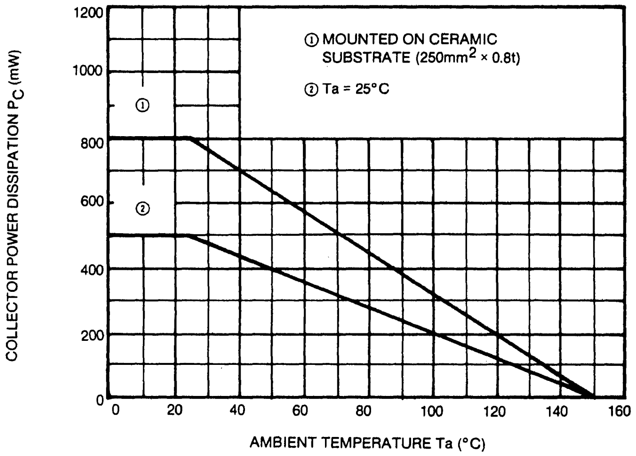


FIG. 8 P$_C$ - Ta

SURFACE-MOUNT
PNP POWER TRANSISTORS

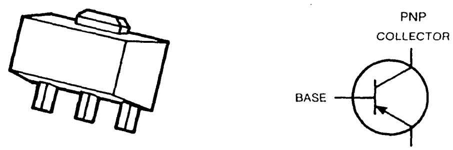
D71Y.8T1

-30 VOLTS
-800 mAMP, 500 mWATTS

Designed for audio frequency amplifier applications.

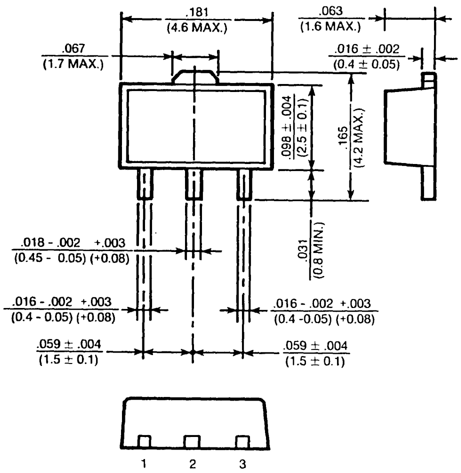
Features:

- High DC current gain: h_{FE} = 100 ~ 320
- Suitable for output stage of 1-Watt amplifier
- P_D=1 ~ 2W (Mounted on ceramic substrate)
- Small flat package
- Complementary to D70Y.8T1
- See page 840 for mounting and handling considerations.



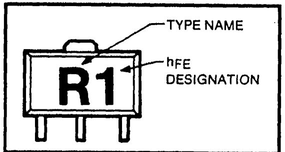
CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

MARKING SYSTEM



h_{FE} DESIGNATION

1) 70-240
2) 70-140
3) 120-240

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D71Y.8T1	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	Volts
Collector-Base Voltage	V_{CBO}	-35	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-800	mA
Base Current — Continuous	I_B	-160	mA
Total Power Dissipation @ T_C = 25°C @ T_C = 25°C(1)	P_D	500 1000	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate (250mm² × 0.8t).
(2) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = -10mA, I_B = 0)	$V_{(BR)CEO}$	-30	—	—	Volts
Collector Cut-off Current (V_{CB} = -35V, I_E = 0)	I_{CBO}	—	—	-100	nA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-100	nA

on characteristics

DC Current Gain(3) (I_C = -100mA, V_{CE} = -1V)	h_{FE}	100	—	320	—
(I_C = -700mA, V_{CE} = -1V)		35	—	—	
Collector-Emitter Saturation Voltage (I_C = -500mA, I_B = -20mA)	$V_{CE(sat)}$	—	—	-0.7	V
Base-Emitter Voltage (V_{CE} = -1V, I_C = -10mA)	$V_{BE(on)}$	-0.5	—	-0.8	V

(3) See page 44 for h_{FE} range.

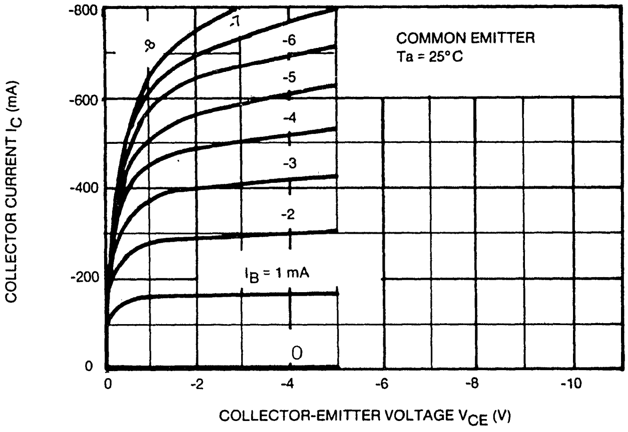


FIG. 1 $I_C - V_{CE}$

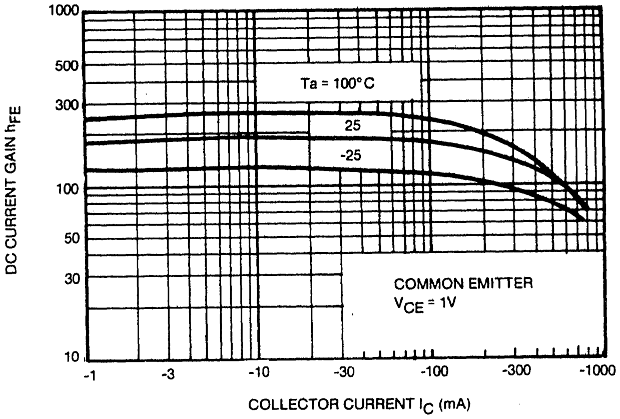


FIG. 2 $h_{FE} - I_C$

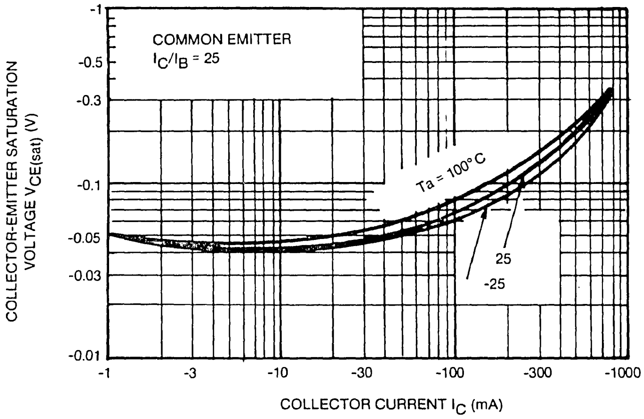


FIG. 3 $V_{CE(sat)}$ - I_C

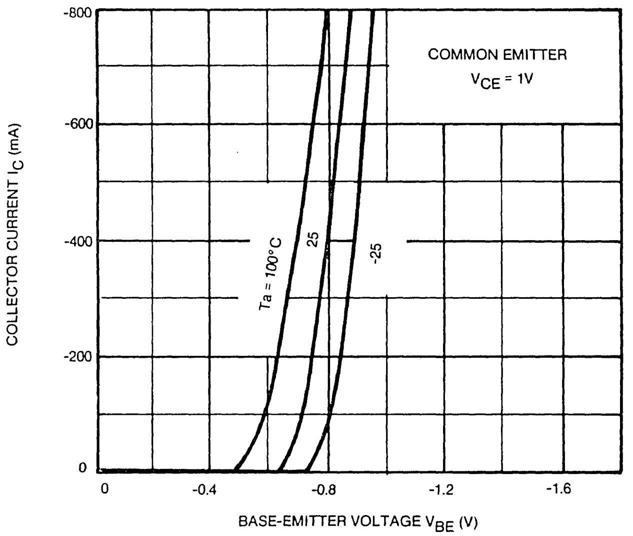


FIG. 4 I_C - V_{BE}

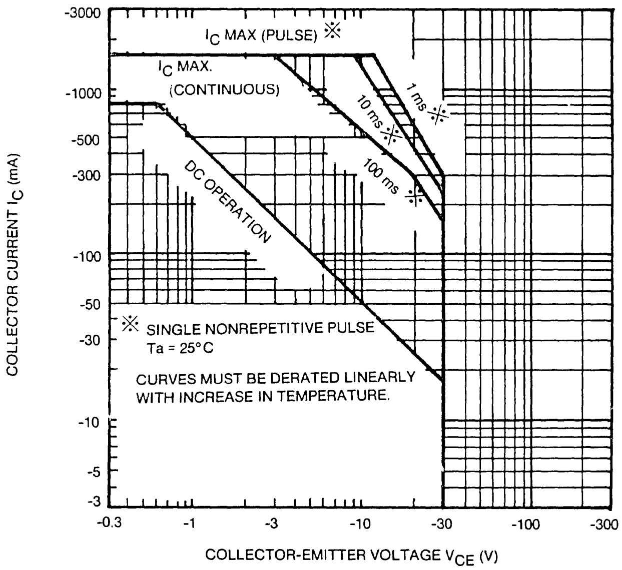


FIG. 5 SAFE OPERATING AREA

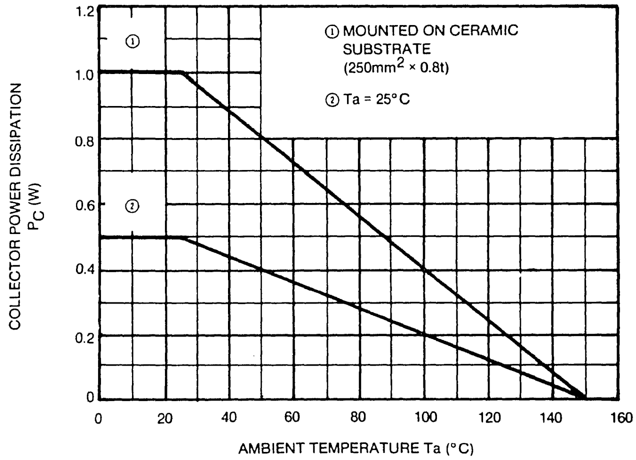


FIG. 6 P_C - Ta

SURFACE-MOUNT
PNP POWER TRANSISTORS

D71Y1.5T1

-30 VOLTS
-1.5mAMP, 500mWATTS

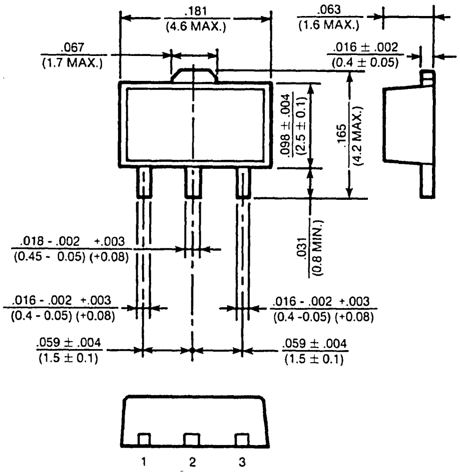
Designed for audio frequency amplifier applications.

Features:

- Suitable for output stage of 3 watt amplifier
- P_D=1 ~ 2W (Mounted on ceramic substrate)
- Small flat package
- Complementary to D70Y1.5T1
- See page 840 for mounting and handling considerations.

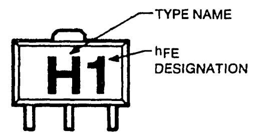
CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

MARKING SYSTEM



h_{FE} DESIGNATION

1) 70-240
2) 70-140
3) 120-240

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D71Y1.5T1	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	Volts
Collector-Base Voltage	V_{CBO}	-30	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-1.5	A
Base Current — Continuous	I_B	-0.3	A
Total Power Dissipation @ T_C = 25° C @ T_C = 25° C(1)	P_D	500 1000	mWatts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(2)

(1) Mounted on ceramic substrate (250mm² x 0.8t).
(2) See page 841 for mounting and thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Breakdown Voltage (I_C = -10mA, I_B = 0)	$V_{(BR)CEO}$	-30	—	—	Volts
Emitter Base Breakdown Voltage (I_E = -1mA, I_C = 0)	$V_{(BR)EBO}$	-5	—	—	V
Collector Cutoff Current (V_{CB} = -30V, I_E = 0)	I_{CBO}	—	—	-100	nA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-100	nA
on characteristics					
DC Current Gain (3) (I_C = -500mA, V_{CE} = -2V)	h_{FE}	100	—	320	—
Collector-Emitter Saturation Voltage (I_C = -1.5mA, I_B = -0.03A)	$V_{CE(sat)}$	—	—	-2.0	V
Base-Emitter Voltage (V_{CE} = -2V, I_C = -500mA)	$V_{BE(on)}$	—	—	-1.0	V

(3) See page 44 for h_{FE} range.

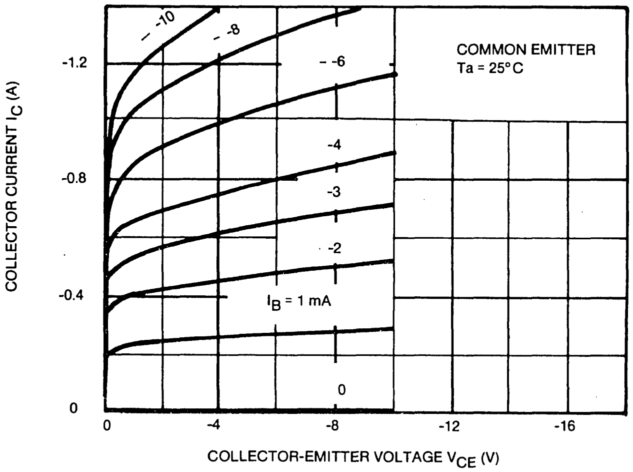


FIG. 1 I_C - V_{CE}

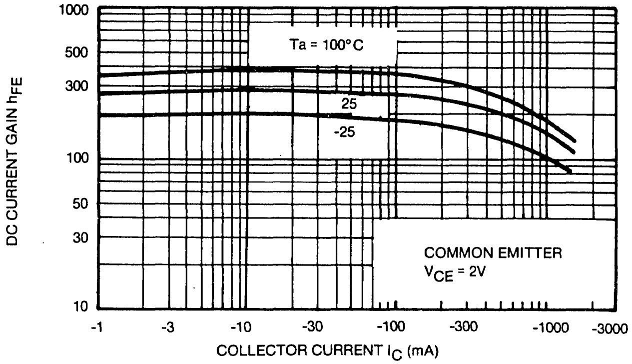


FIG. 2 h_{FE} - I_C

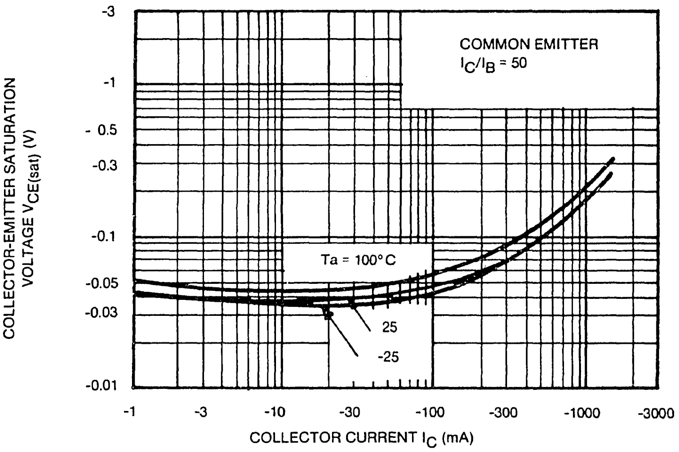


FIG. 3 $V_{CE(sat)}$ - I_C

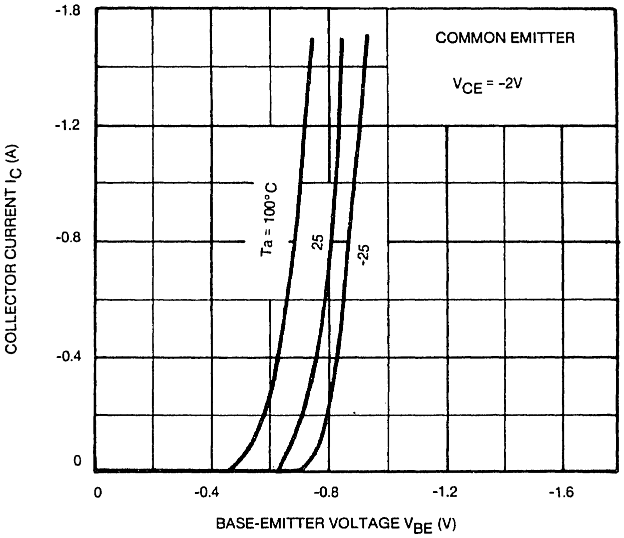


FIG. 4 I_C - V_{BE}

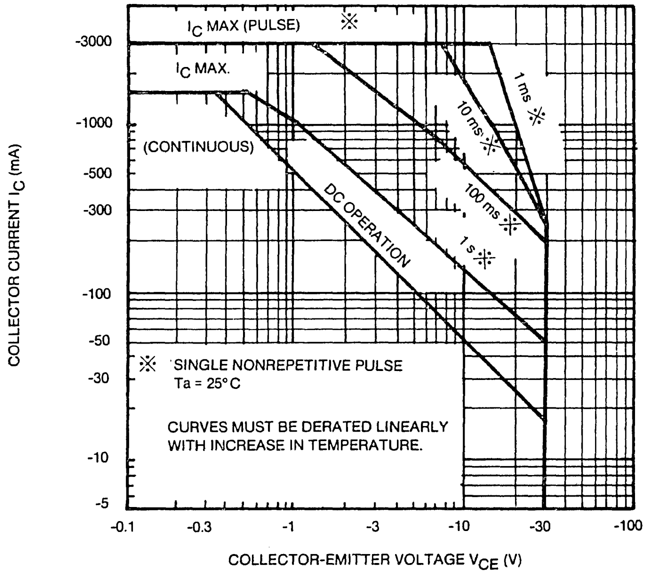


FIG. 5 SAFE OPERATING AREA

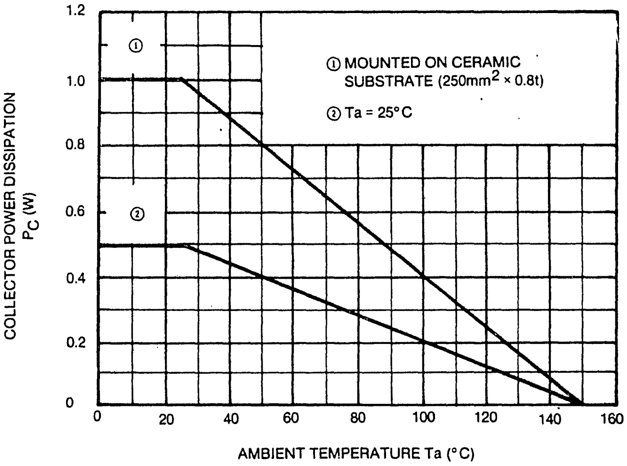


FIG. 6 P_C - Ta

SURFACE-MOUNT
NPN POWER TRANSISTORS

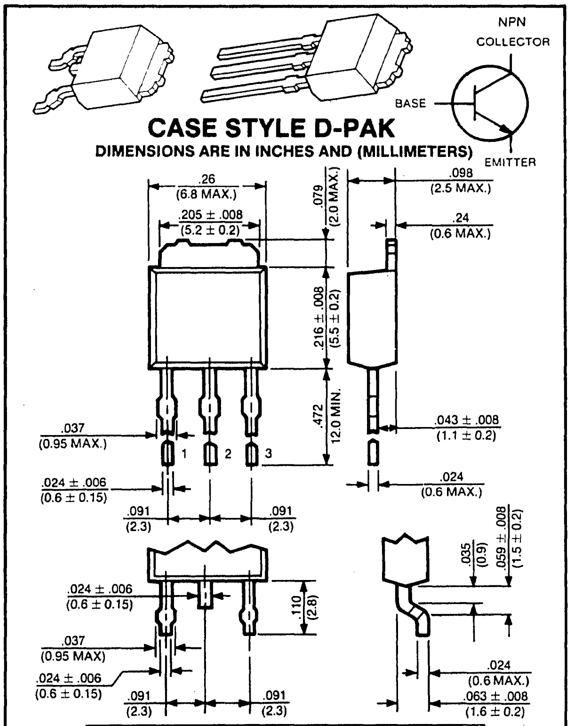
D72F5T1,2

50 VOLTS
5 AMP, 20 WATTS

Designed for high current switching applications.

Features:

- Low Collector Saturation Voltage
  : $V_{CE(sat)} = 0.4V$ (Max.) (at $I_C = 3A$)
- High Speed Switching Time : $t_{stg} = 1.0\mu s$ (Typ.)
- Complementary to D73F5T1,2
- Suffix "2" designates lead formed version
- See page 840 for mounting and handling considerations.



CASE STYLE D-PAK
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D72F5T1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	50	Volts
Collector-Base Voltage	V_{CBO}	60	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	5	A
Base Current — Continuous	I_B	1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.0 20	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

(1) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Volts
Collector Cut-off Current (V_{CB} = 50V, I_E = 0)	I_{CBO}	—	—	1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	1	μA
second breakdown					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			
on characteristics					
DC Current Gain⁽²⁾ (I_C = 1A, V_{CE} = 1V) (I_C = 3A, V_{CE} = 1V)	h_{FE} h_{FE}	70 30	— —	240 —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 0.15A)	$V_{CE(sat)}$	—	0.2	0.4	V
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 0.15A)	$V_{BE(sat)}$	—	0.9	1.2	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V	t_{on}	—	0.1	—	μs
Storage Time	I_{B1} = $-I_{B2}$ = 0.15A	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.1	—	

(2) See page 43 for h_{FE} ranges.

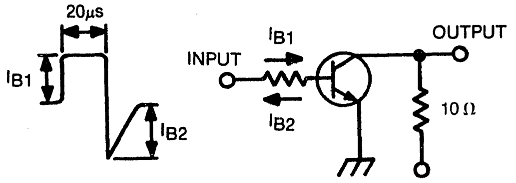


FIG. 1 SWITCHING TIME TEST CIRCUIT

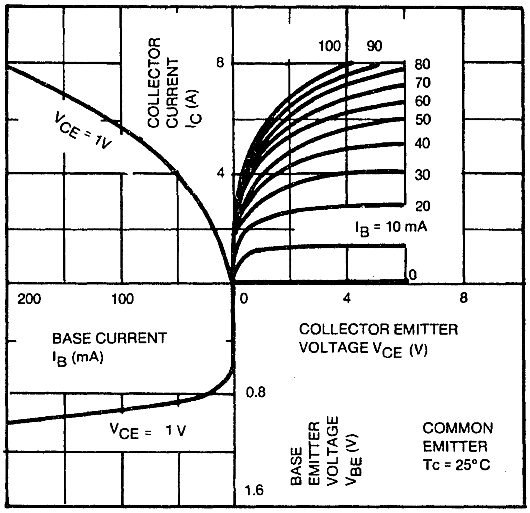


FIG. 2 STATIC CHARACTERISTICS

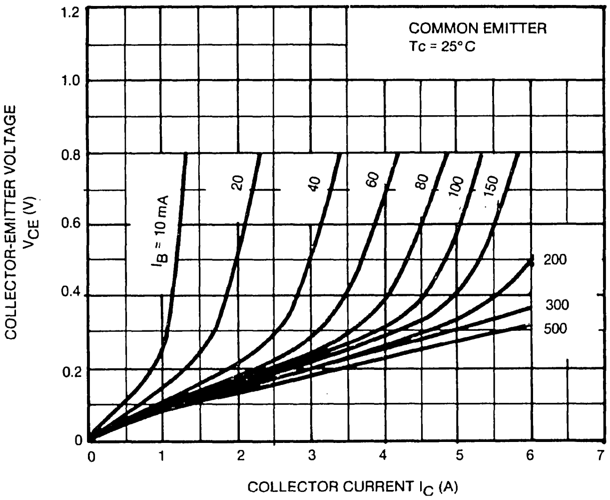


FIG. 3 V_{CE} - I_C

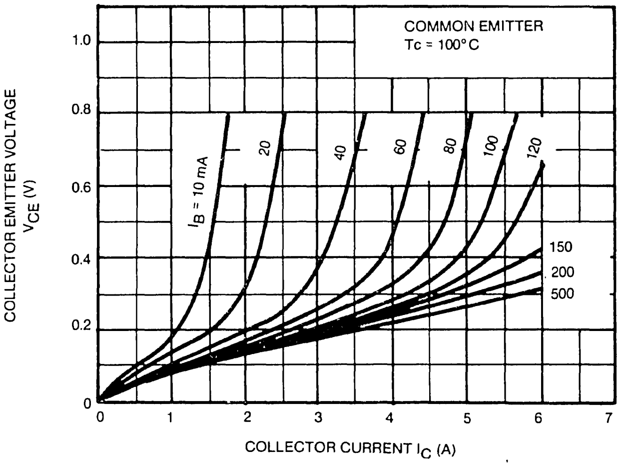


FIG. 4 V_{CE} - I_C

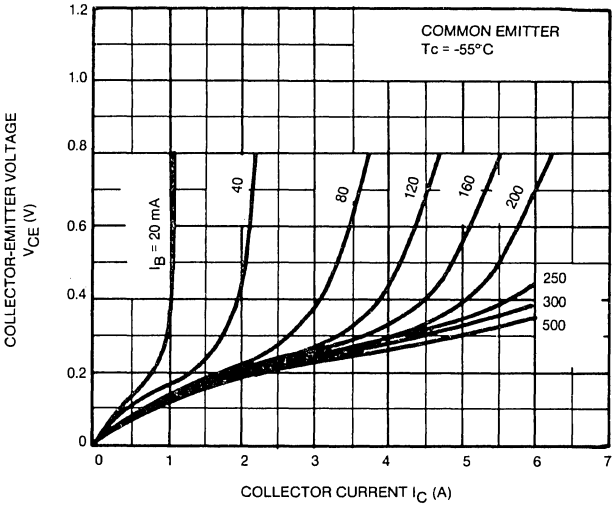


FIG. 5 V_{CE} - I_C

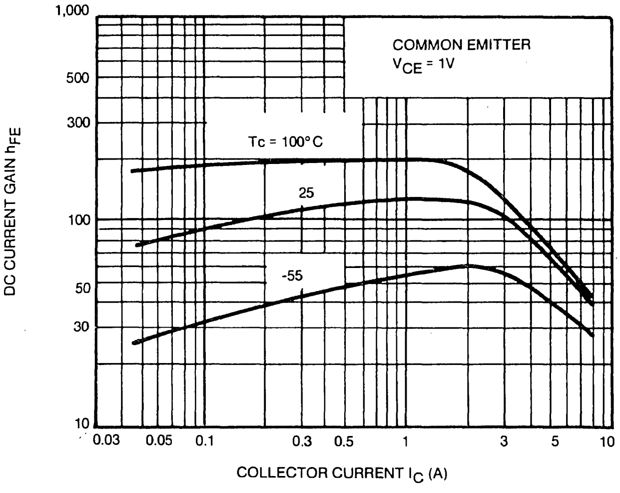


FIG. 6 h_{FE} - I_C

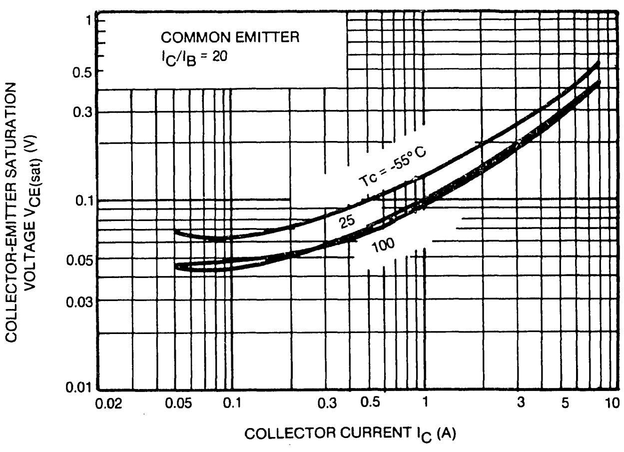


FIG. 7 $V_{CE(sat)}$ - I_C

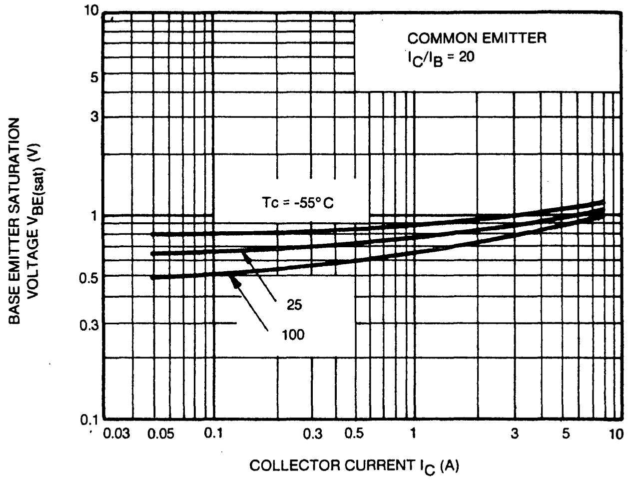


FIG. 8 $V_{BE(sat)}$ - I_C

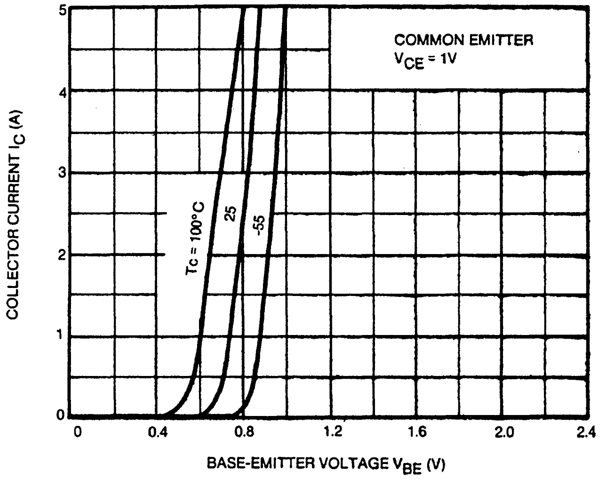


FIG. 9 I_C - V_{BE}

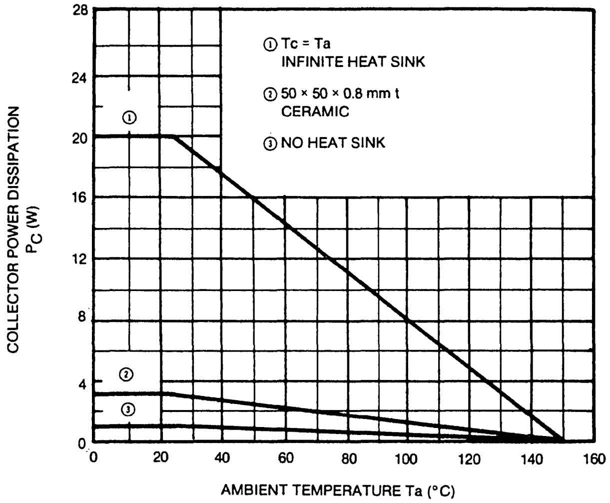


FIG. 10 P_C - Ta

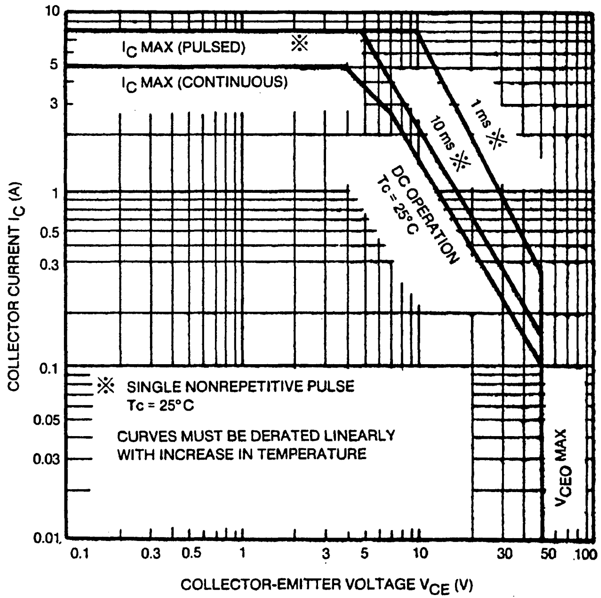


FIG. 11 SAFE OPERATING AREA

SURFACE-MOUNT
NPN POWER DARLINGTON TRANSISTORS

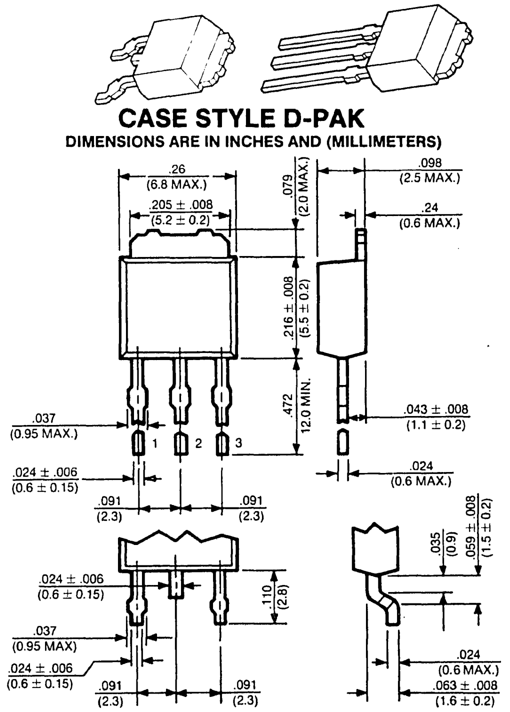
D72FY4D1,2

80 VOLTS
4 AMP, 15 WATTS

Designed for switching applications, hammer drive, pulse motor drive applications, power amplifier applications.

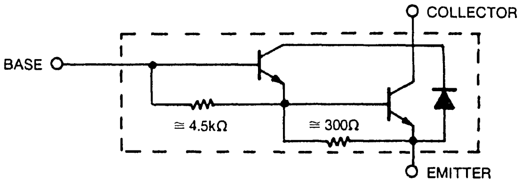
Features:

- High DC Current Gain
  : $h_{FE(1)} = 2000$(Min.) ($V_{CE} = 2V$, $I_C = 1A$)
- Low Saturation Voltage
  : $V_{CE(sat)} = 1.5V$ (Max.) ($I_C = 3A$)
- Complementary to D73FY4D1,2
- Suffix "2" designates lead formed version
- See page 840 for mounting and handling considerations.


CASE STYLE D-PAK
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D72FY4D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	4	A
Base Current — Continuous	I_B	-1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	80	—	—	Volts
Collector Cutoff Current (V_{CB} = 100V, I_E = 0)	I_{CBO}	—	—	-20	µA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	-2.5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10

on characteristics

DC Current Gain[(2)] (I_C = 1A, V_{CE} = 2V) (I_C = 3A, V_{CE} = 2V)	h_{FE} h_{FE}	2000 1000	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V	t_{on}	—	0.2	—	µs
Storage Time	I_{B1} = $-I_{B2}$ = 6mA	t_{stg}	—	1.5	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.6	—	

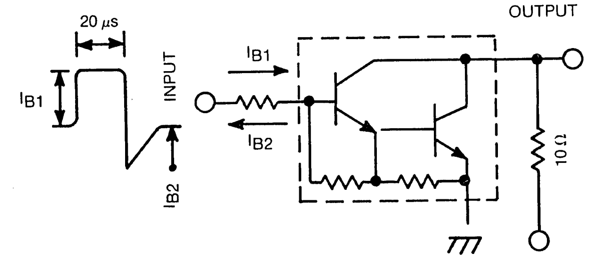


FIG. 1 SWITCHING TIME TEST CIRCUIT

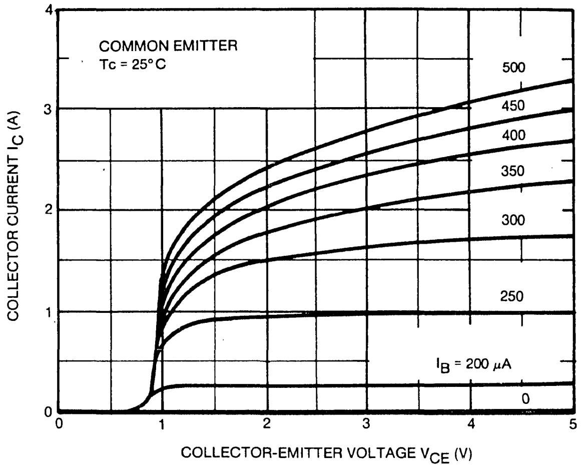


FIG. 2 I_C - V_{CE}

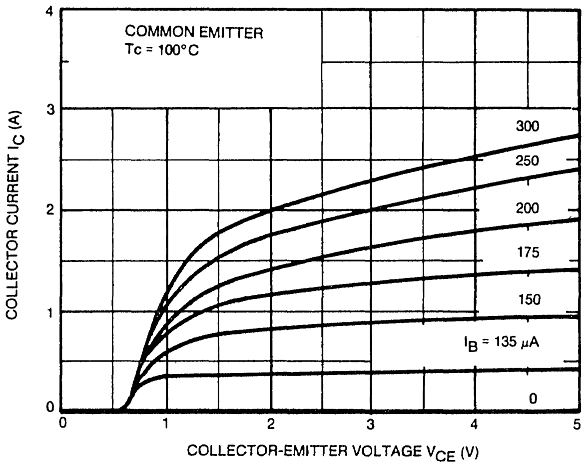


FIG. 3 $I_C - V_{CE}$

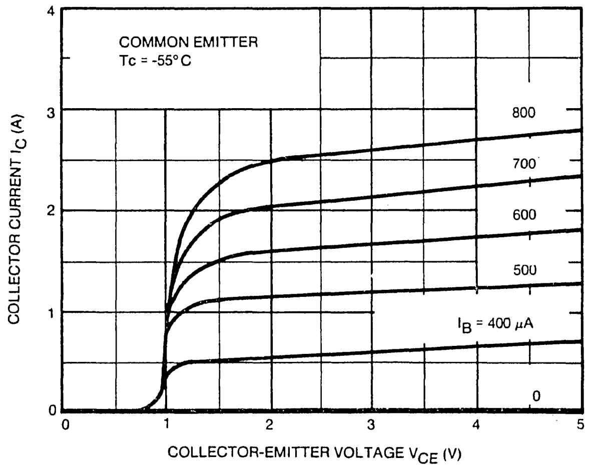


FIG. 4 $I_C - V_{CE}$

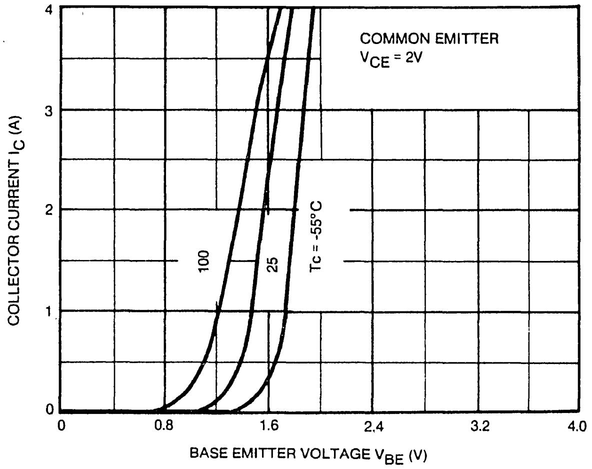


FIG. 5 $I_C - V_{BE}$

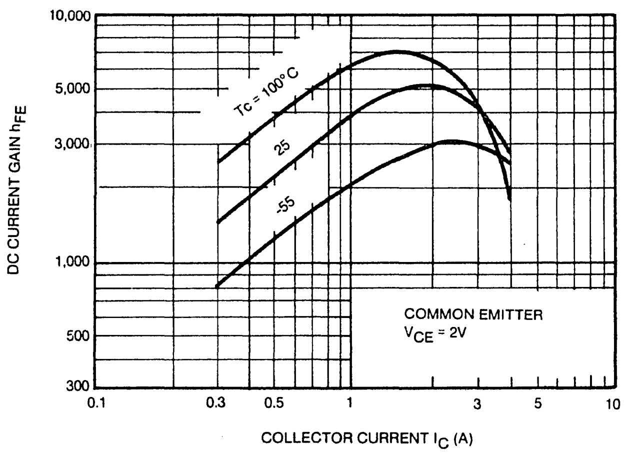


FIG. 6 $h_{FE} - I_C$

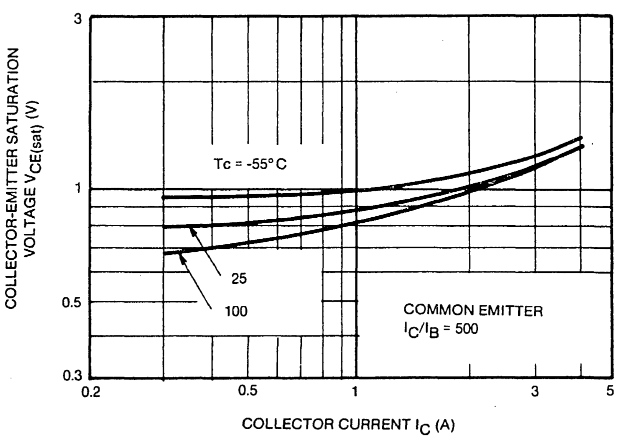


FIG. 7 $V_{CE(sat)} - I_C$

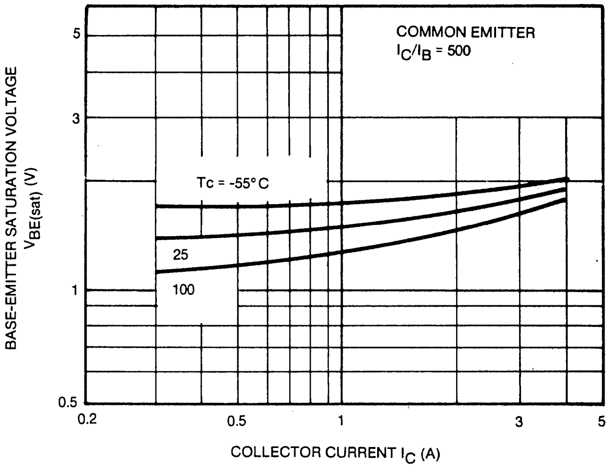


FIG. 8 $V_{BE(sat)}$ - I_C

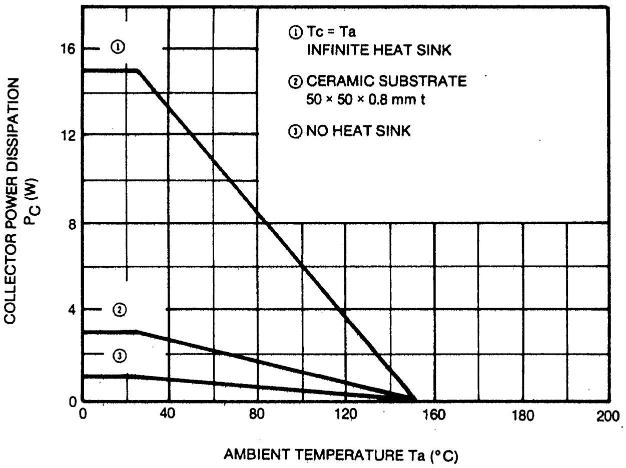


FIG. 9 P_C - Ta

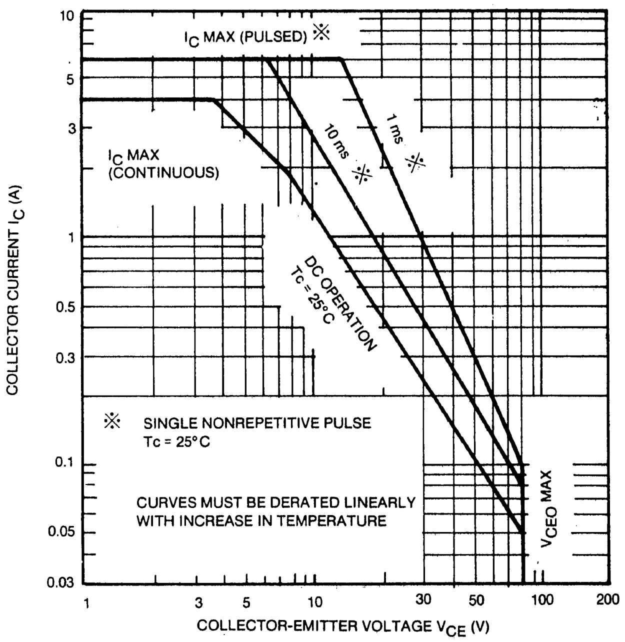


FIG. 10 SAFE OPERATING AREA

SURFACE-MOUNT
NPN POWER DARLINGTON TRANSISTORS

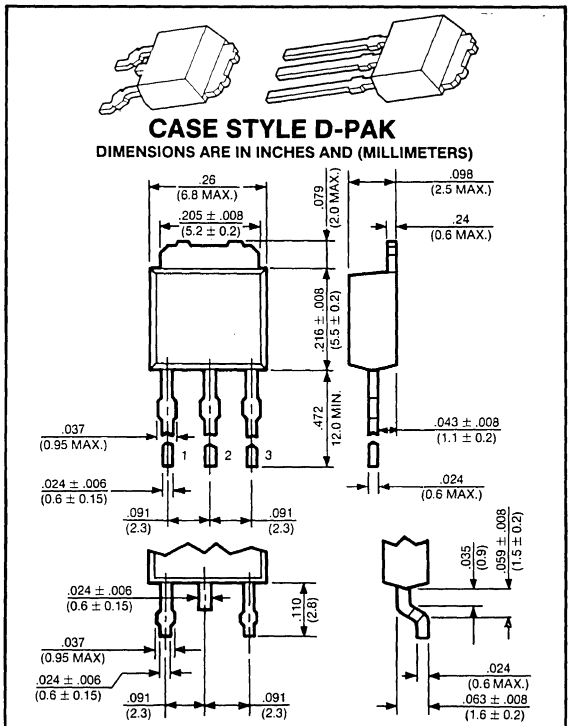
D72K3D1,2

40 VOLTS
3 AMP, 15 WATTS

Designed for switching applications, hammer drive, pulse motor drive applications, power amplifier applications.

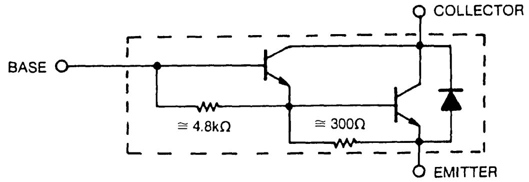
Features:

- High DC Current Gain
  : $h_{FE(1)} = 2000$(Min.) ($V_{CE} = 2V$, $I_C = 1A$)
- Low Saturation Voltage
  : $V_{CE(sat)} = 1.5V$ (Max.) ($I_C = 2A$)
- Complementary to D73K3D1,2
- Suffix “2” designates lead formed version
- See page 840 for mounting and handling considerations.


CASE STYLE D-PAK
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D72K3D	UNITS
Collector-Emitter Voltage	V_{CEO}	40	Volts
Collector-Base Voltage	V_{CBO}	60	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	3	A
Base Current — Continuous	I_B	0.3	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(1)

Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	235	°C

(1) See page 841 for thermal considerations.

electrical characteristics ($T_A = 25° C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 25mA, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Volts
Collector Cutoff Current (V_{CB} = 60V, I_E = 0)	I_{CBO}	—	—	20	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	2.5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10

on characteristics

DC Current Gain[2] (I_C = 1A, V_{CE} = 2V) (I_C = 3A, V_{CE} = 2V)	h_{FE} h_{FE}	2000 1000	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 4mA)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 4mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V	t_{on}	—	0.1	—	μs
Storage Time	$I_{B1} = -I_{B2}$ = 6mA	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.2	—	

(3) See page 43 for h_{FE} ranges.

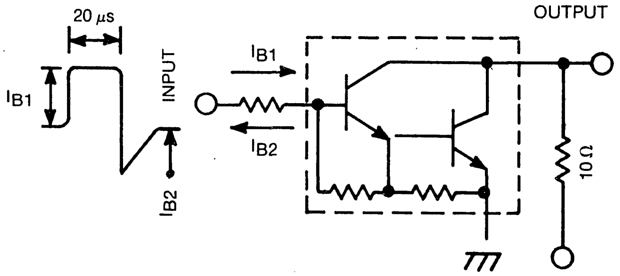


FIG. 1 SWITCHING TIME TEST CIRCUIT

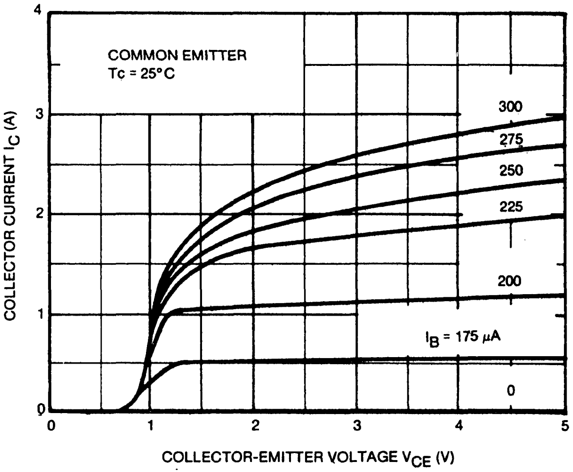


FIG. 2 I_C - V_{CE}

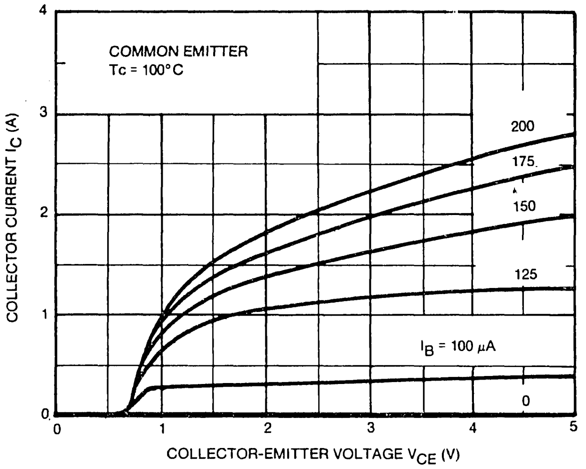


FIG. 3 $I_C - V_{CE}$

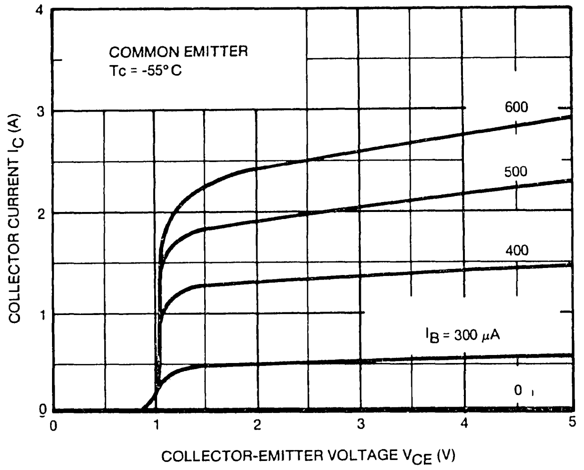


FIG. 4 $I_C - V_{CE}$

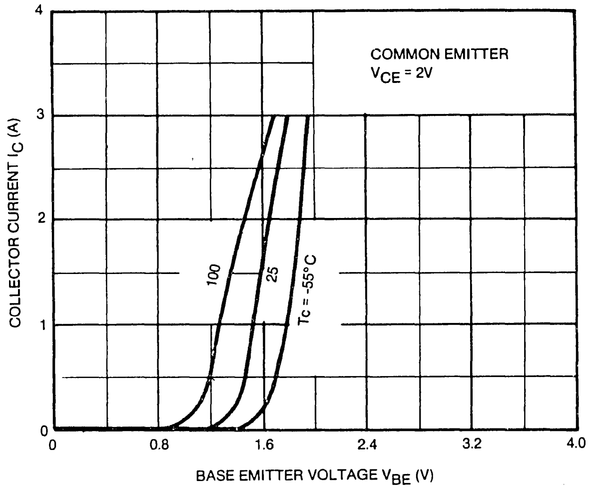


FIG. 5 $I_C - V_{BE}$

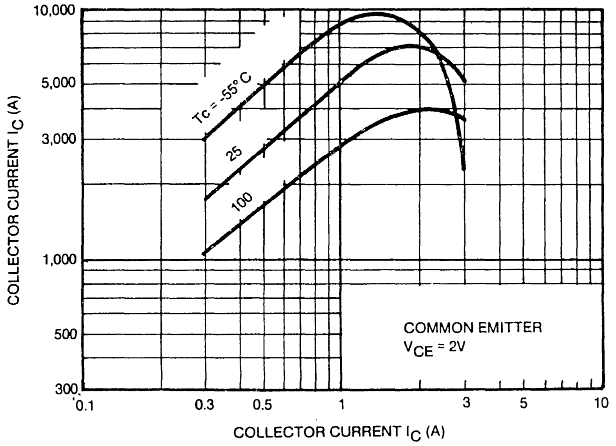


FIG. 6 $h_{FE} - I_C$

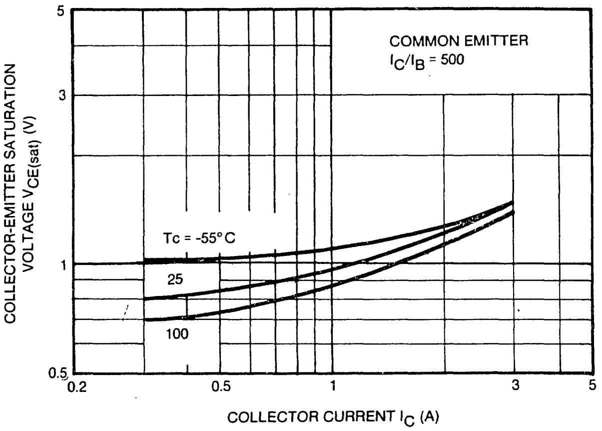


FIG. 7 $V_{CE(sat)} - I_C$

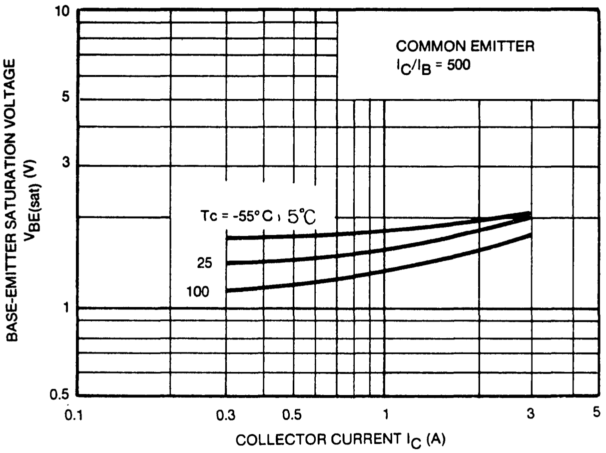


FIG. 8 $V_{BE(sat)}$ - I_C

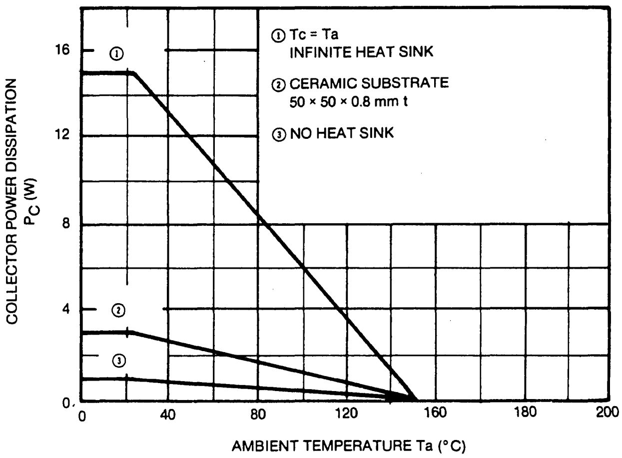


FIG. 9 P_C - Ta

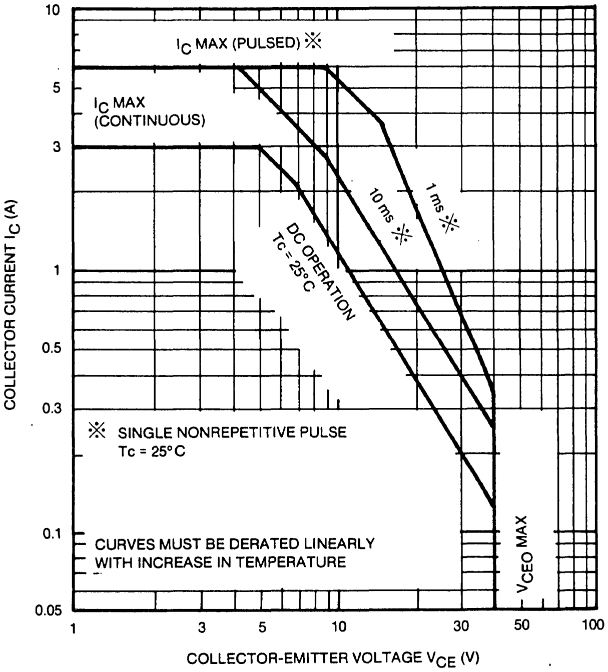


FIG. 10 SAFE OPERATING AREA

SURFACE-MOUNT
NPN POWER DARLINGTON TRANSISTORS

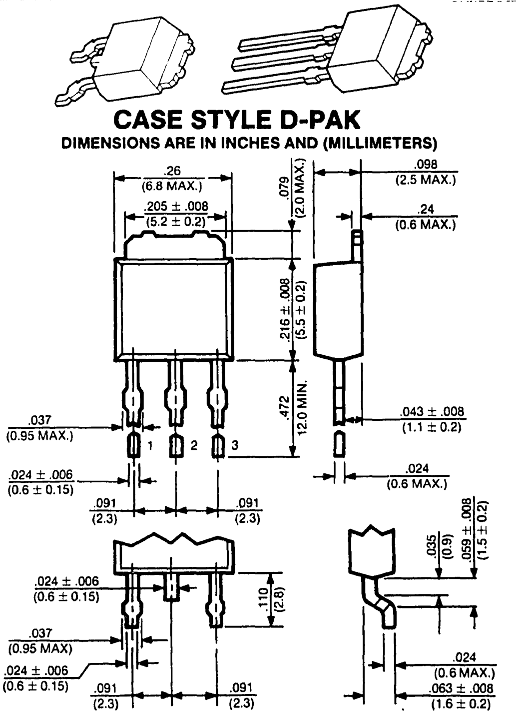
D72Y1.5D1,2

30 VOLTS
1.5 AMP, 10 WATTS

Designed for pulse motor drive, hammer drive applications, switching applications, power amplifier applications.

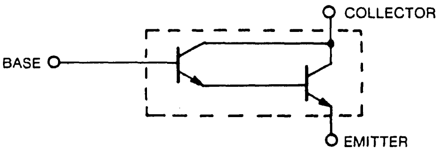
Features:

- High DC Current Gain
  : h_{FE} = 4000(Min.) (V_{CE} = 2V, I_C = 150mA)
- Low Saturation Voltage
  : $V_{CE(sat)}$ = 1.5V (Max.) (I_C = 1A, I_B = 1mA)
- Suffix "2" designates lead formed version
- See page 840 for mounting and handling considerations.



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D72Y1.5D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	30	Volts
Collector-Base Voltage	V_{CBO}	30	Volts
Emitter Base Voltage	V_{EBO}	10	Volts
Collector Current — Continuous	I_C	1.5	A
Base Current — Continuous	I_B	0.15	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 841 for thermal considerations.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Volts
Collector Cutoff Current ($V_{CB} = 30V$, $I_E = 0$)	I_{CBO}	—	—	10	μA
Emitter Cutoff Current ($V_{EB} = 10V$, $I_C = 0$)	I_{EBO}	—	—	-10	μA
second breakdown					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
on characteristics					
DC Current Gain ($I_C = 150mA$, $V_{CE} = 2V$)	h_{FE}	4000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 1mA$)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 1mA$)	$V_{BE(sat)}$	—	—	2.2	Volts
switching characteristics					
Turn-on Time — $V_{CC} = 15V$	t_{on}	—	0.18	—	μs
Storage Time — $I_{B1} = -I_{B2} = 1mA$	t_{stg}	—	0.6	—	
Fall Time — Duty Cycle ≦ 1%	t_f	—	0.3	—	

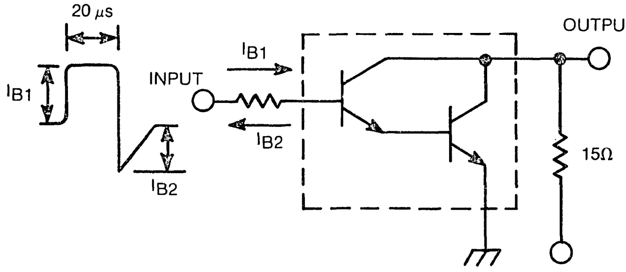


FIG. 1 SWITCHING TIME TEST CIRCUIT

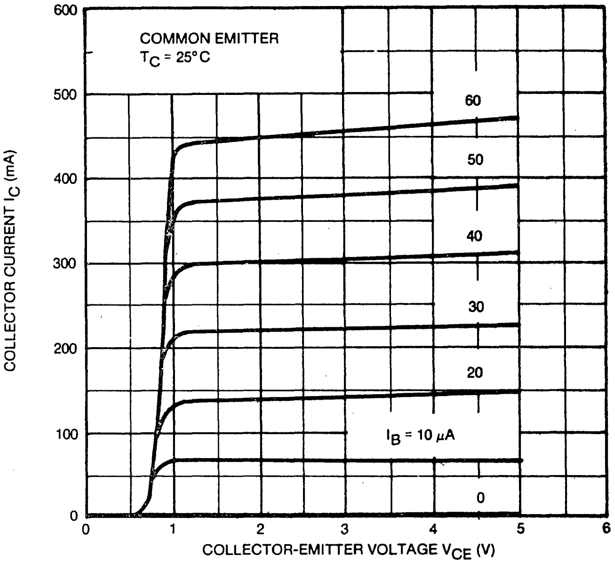


FIG. 2 I_C - V_{CE}

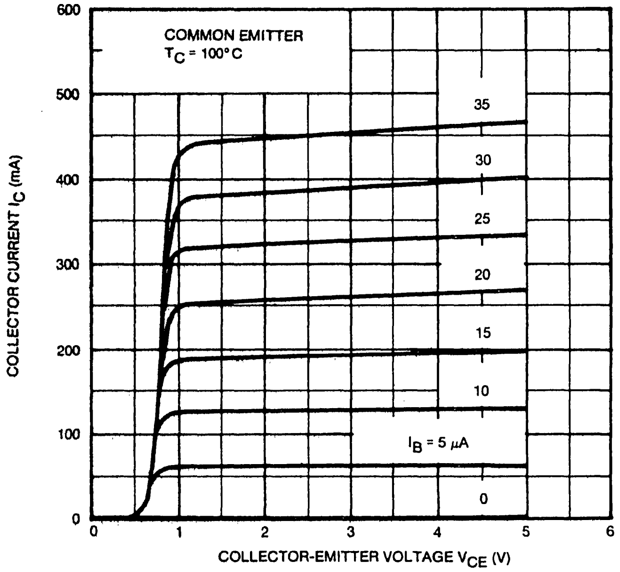


FIG. 3 I_C - V_{CE}

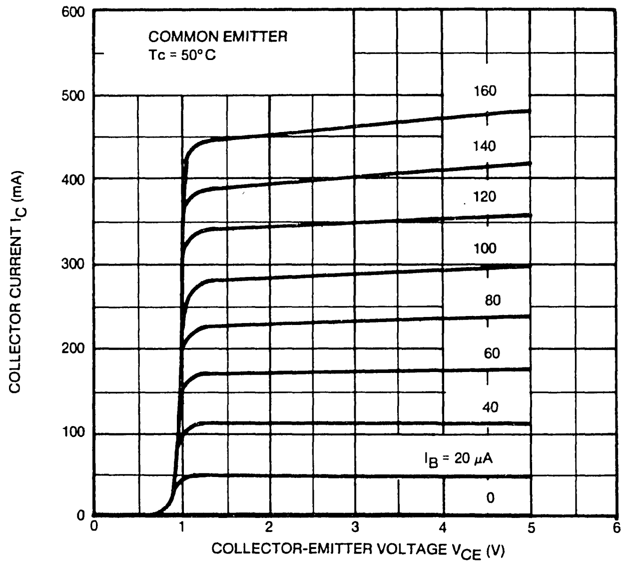


FIG. 4 I_C - V_{CE}

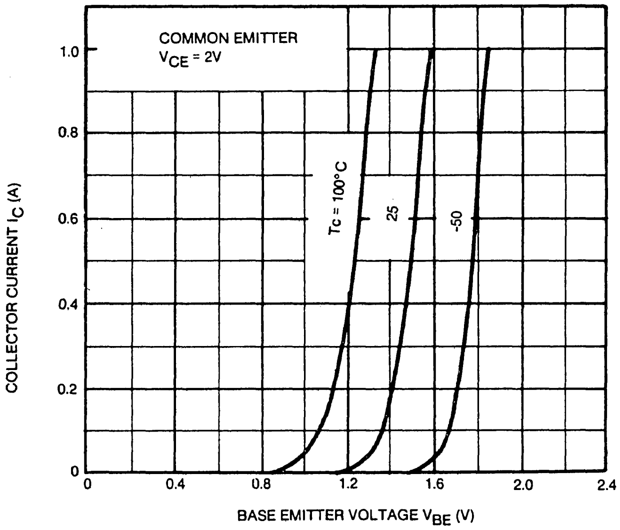


FIG. 5 I_C - V_{BE}

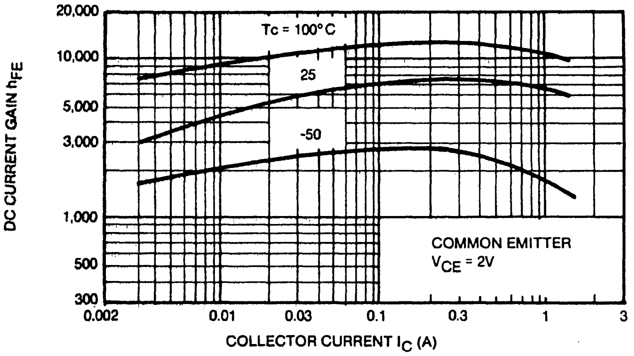


FIG. 6 h_{FE} - I_C

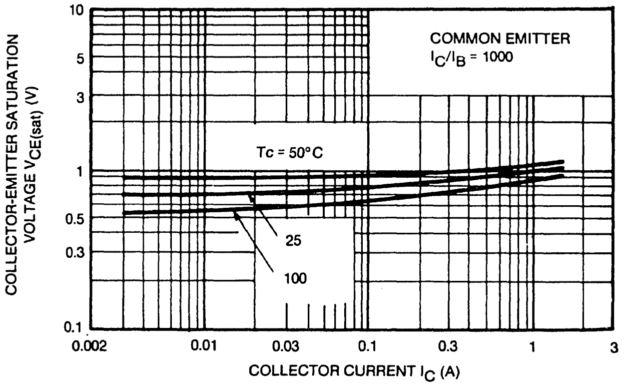


FIG. 7 $V_{CE(sat)}$ - I_C

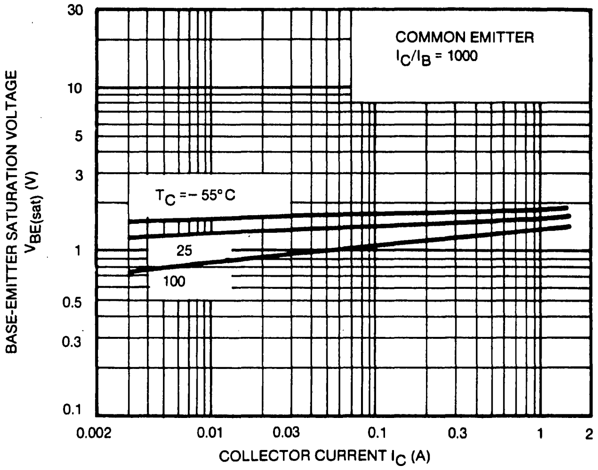


FIG. 8 $V_{BE(sat)}$ - I_C

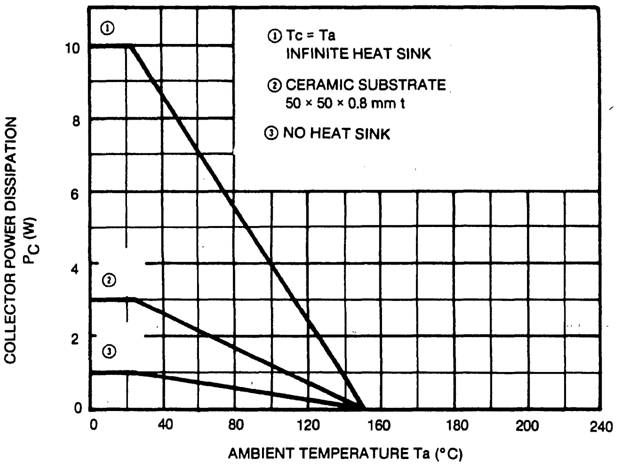


FIG. 9 P_C - Ta

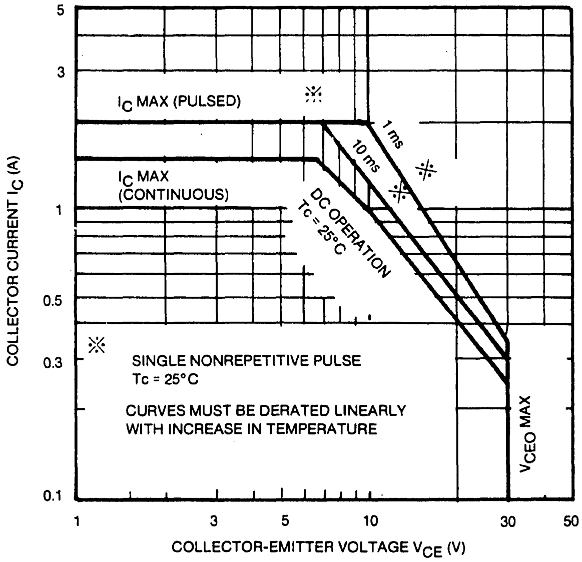


FIG. 10 SAFE OPERATING AREA

SURFACE-MOUNT
PNP POWER TRANSISTORS

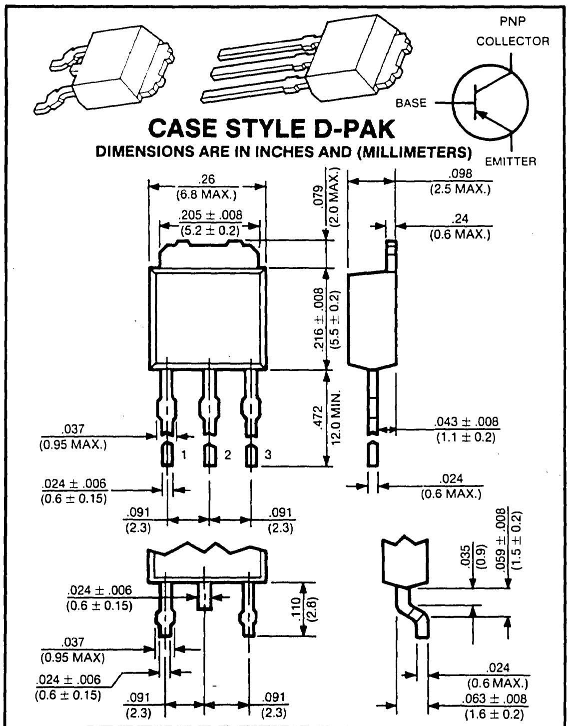
D73F5T1,2

-50 VOLTS
-5 AMP, 20 WATTS

Designed for high current switching applications.

Features:

- Low Collector Saturation Voltage : $V_{CE(sat)} = -0.4V$ (Max.) (at $I_C = 3A$)
- High Speed Switching Time : $t_{stg} = 1.0 \mu s$ (Typ.)
- Complementary to D72F5T1,2
- Suffix “2” designates lead formed version
- See page 840 for mounting and handling considerations.



CASE STYLE D-PAK

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D73F5T1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	-50	Volts
Collector-Base Voltage	V_{CBO}	-60	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-5	A
Base Current — Continuous	I_B	-1	A
Total Power Dissipation @ $T_C = 25°C$ @ $T_C = 25°C$	P_D	1.0 20	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics[1]

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 841 for thermal considerations.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	-50	—	—	Volts
Collector Cutoff Current (V_{CB} = 50V, I_E = 0)	I_{CBO}	—	—	-1	µA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	-1	µA

second breakdown

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain(2) (I_C = -1A, V_{CE} = -1V)	h_{FE}	70	—	240	—
(I_C = -3A, V_{CE} = -1V)	h_{FE}	30	—	—	
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -0.15A)	$V_{CE(sat)}$	—	-0.2	-0.4	V
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -0.15A)	$V_{BE(sat)}$	—	-0.9	-1.2	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -30V	t_{on}	—	0.1	—	µs
Storage Time	$-I_{B1} = I_{B2}$ = 0.15A	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.1	—	

(2) See page 43 for h_{FE} ranges.

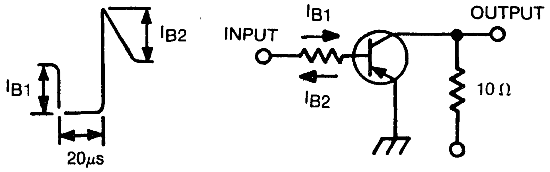


FIG. 1 SWITCHING TIME TEST CIRCUIT

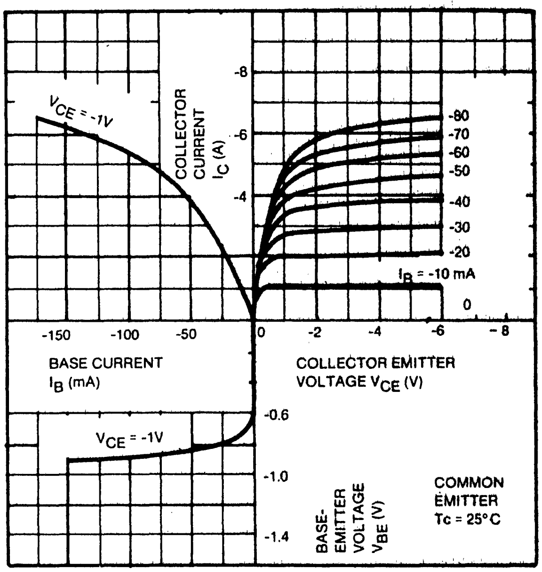


FIG. 2 STATIC CHARACTERISTICS

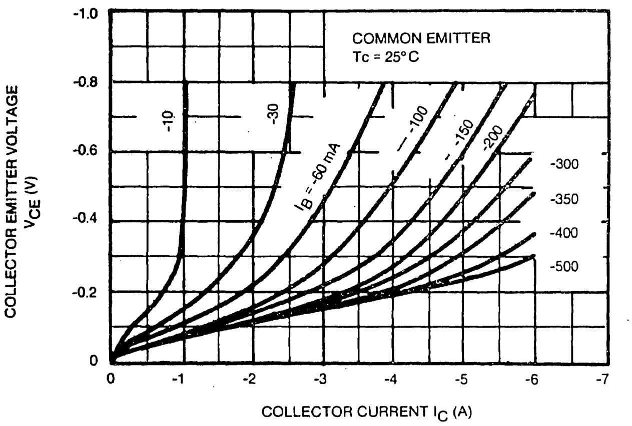


FIG. 3 V_{CE} - I_C

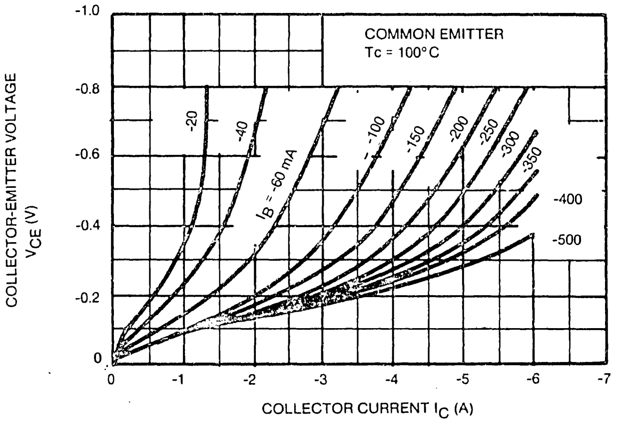


FIG. 4 V_{CE} - I_C

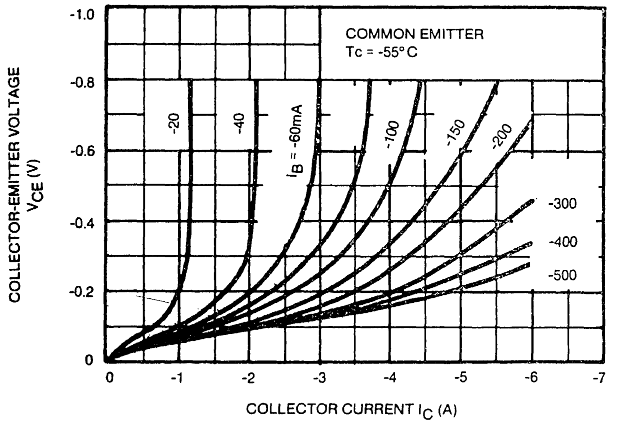


FIG. 5 V_{CE} - I_C

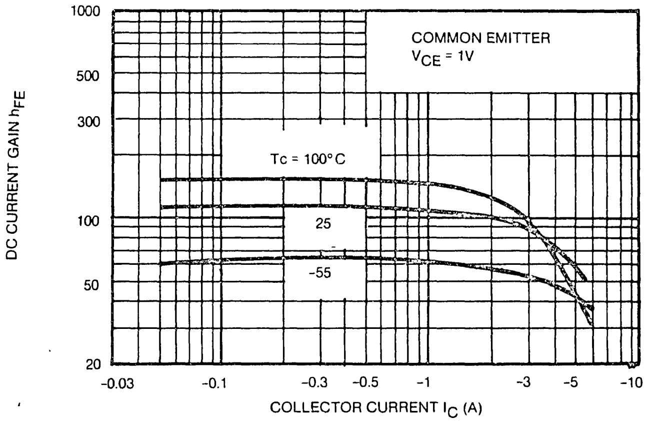


FIG. 6 h_{FE} - I_C

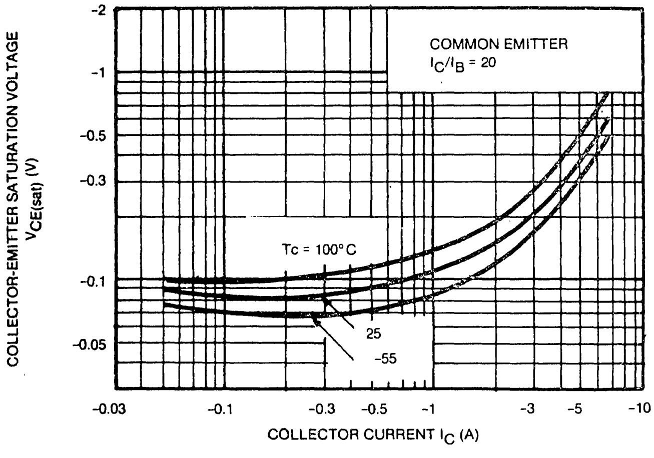


FIG. 7 $V_{CE(sat)}$ - I_C

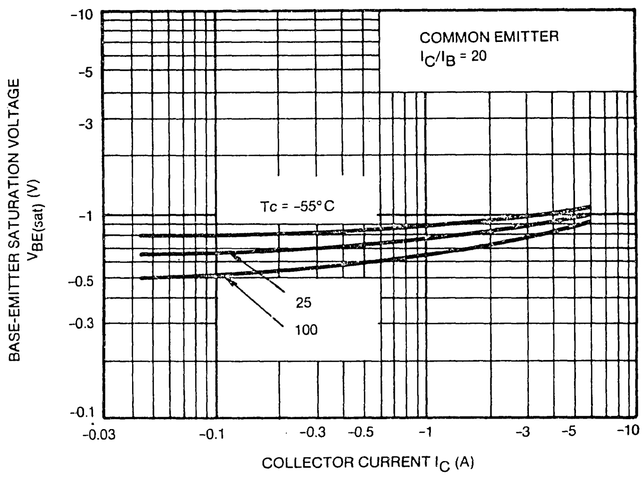


FIG. 8 $V_{BE(sat)}$ - I_C

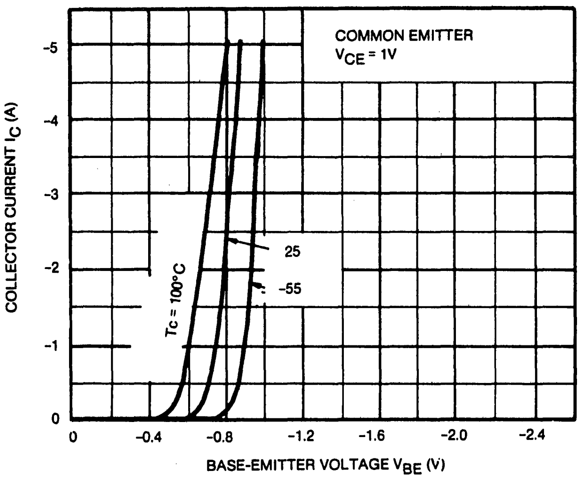


FIG. 9 I_C - V_{BE}

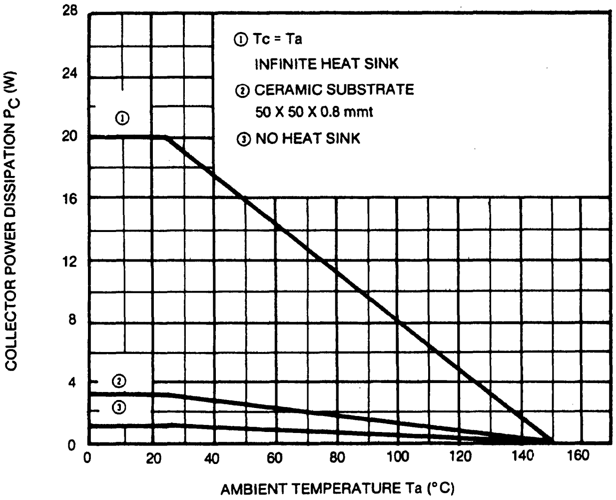


FIG. 10 P_C - Ta

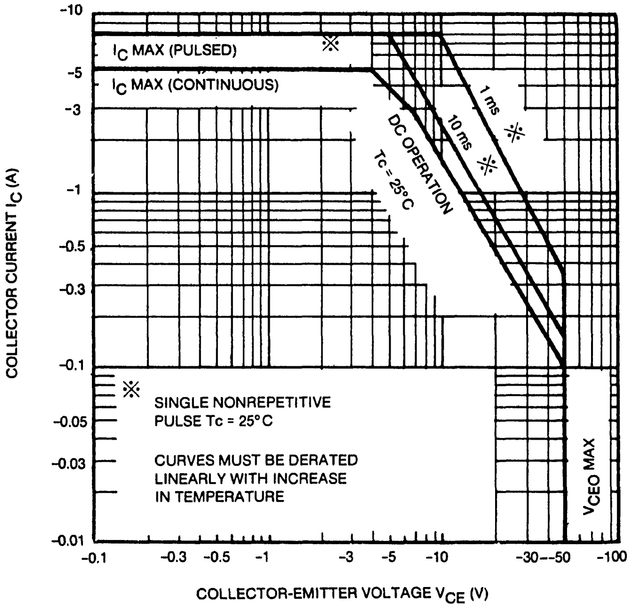


FIG. 11 SAFE OPERATING AREA

SURFACE-MOUNT
PNP POWER DARLINGTON TRANSISTORS

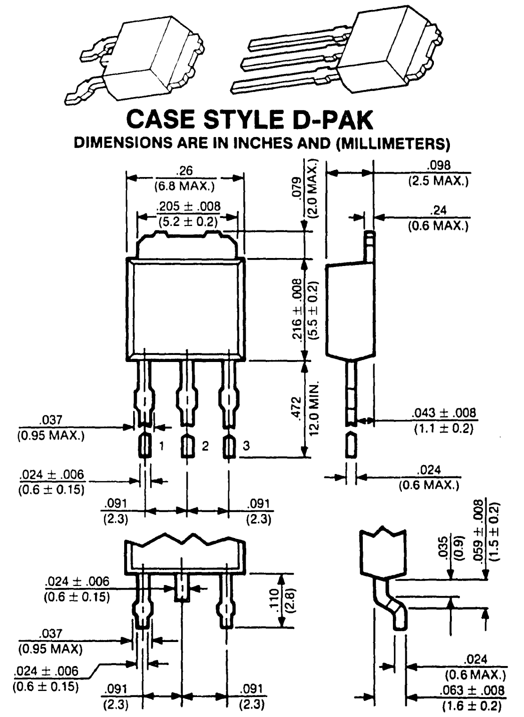
D73FY4D1,2

-80 VOLTS
-4 AMP, 15 WATTS

Designed for switching applications, hammer drive, pulse motor drive applications, power amplifier applications.

Features:

- High DC Current Gain
  : $h_{FE(1)} = 2000$ (Min.) ($V_{CE} = -2V$, $I_C = -1A$)
- Low Saturation Voltage
  : $V_{CE(sat)} = -1.5$ (Max.) ($I_C = 3A$)
- Complementary to D72FY4D1
- Suffix "2" designates lead formed version
- See page 840 for mounting and handling considerations.

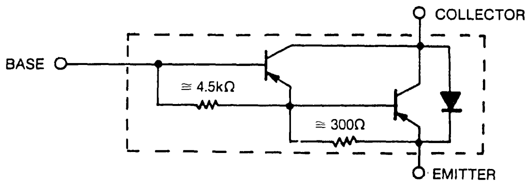


CASE STYLE D-PAK

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D73FY4D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	-80	Volts
Collector-Base Voltage	V_{CBO}	-100	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-4	A
Base Current — Continuous	I_B	-0.4	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 841 for thermal considerations.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = -10mA, I_B = 0)	$V_{(BR)CEO}$	-80	—	—	Volts
Collector Cutoff Current (V_{CB} = -100V, I_E = 0)	I_{CBO}	—	—	-20	µA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-2.5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9			

on characteristics

DC Current Gain[2] (I_C = -1A, V_{CE} = -2V)	h_{FE}	2000	—	—	—
(I_C = -3A, V_{CE} = -2V)	h_{FE}	1000	—	—	
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{BE(sat)}$	—	—	-2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = -30V	t_{on}	—	0.15	—	µs
Storage Time	$-I_{B1} = I_{B2}$ = 6mA	t_{stg}	—	0.80	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.40	—	

(2) See page 43 for h_{FE} ranges.

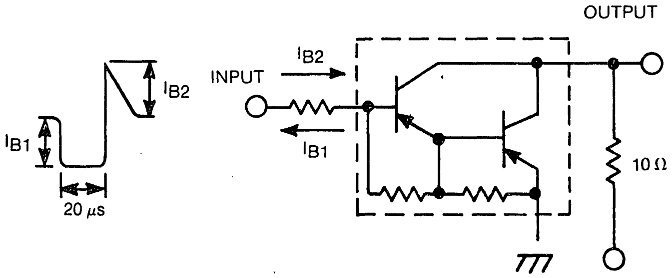


FIG. 1 SWITCHING TIME TEST CIRCUIT

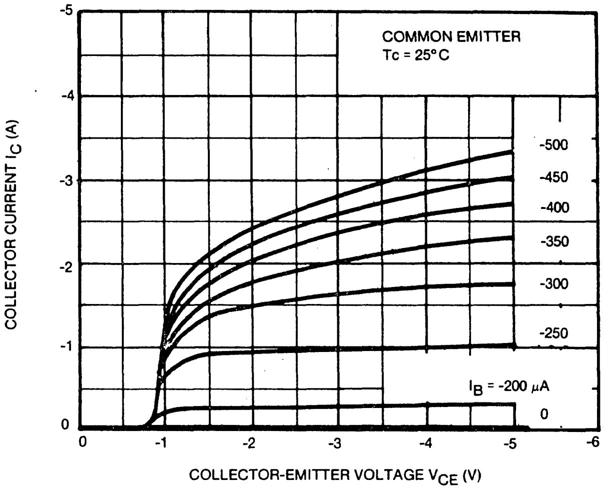


FIG. 2 I_C - V_{CE}

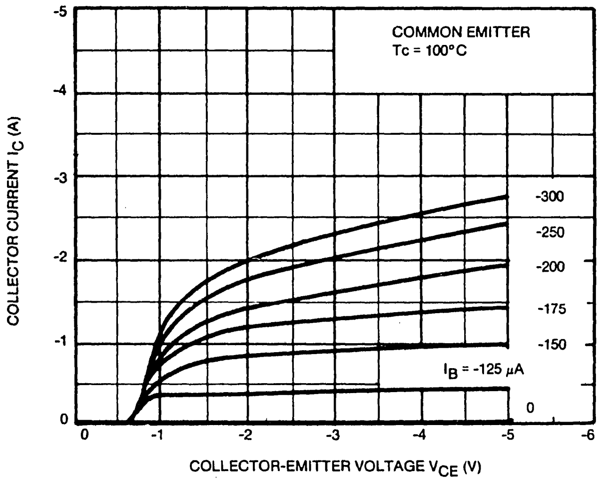


FIG. 3 I_C - V_{CE}

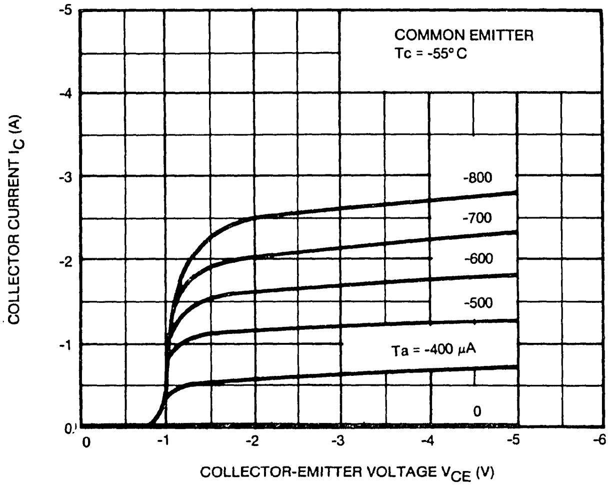


FIG. 4 I_C - V_{CE}

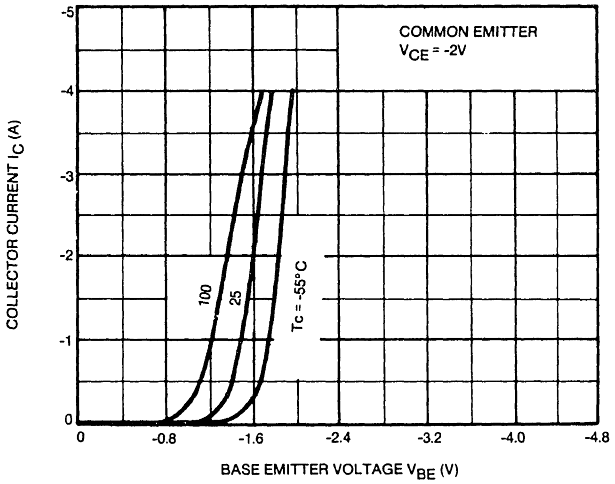


FIG. 5 I_C - V_{BE}

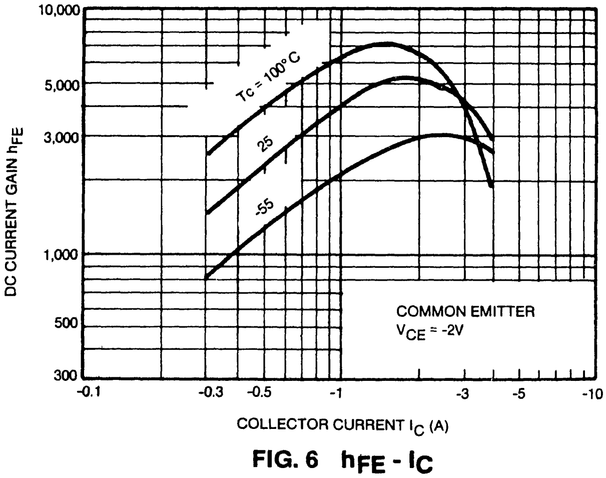


FIG. 6 h_{FE} - I_C

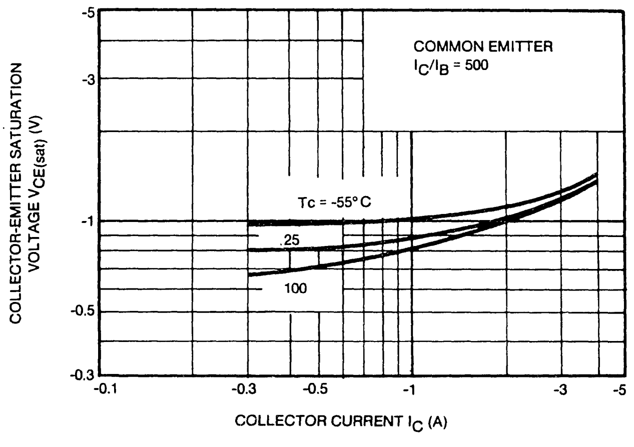


FIG. 7 $V_{CE(sat)}$ - I_C

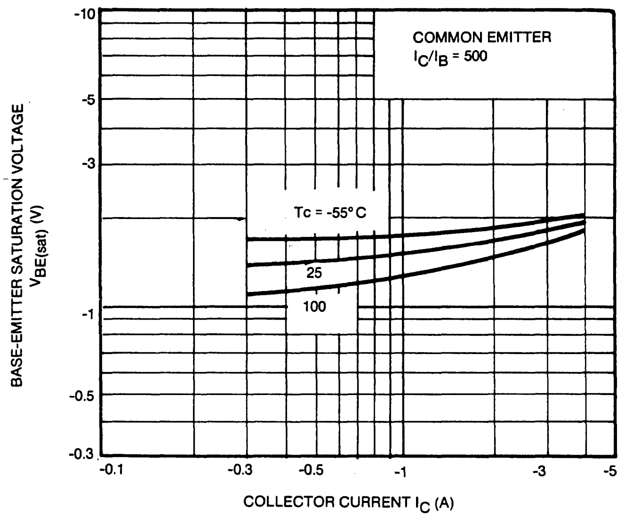


FIG. 8 $V_{BE(sat)}$ - I_C

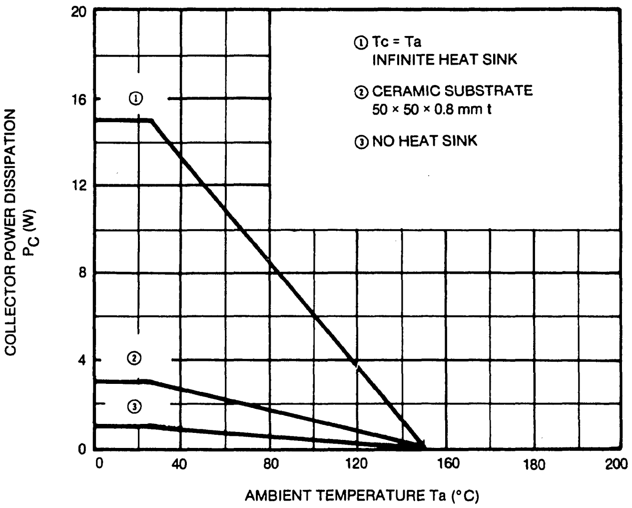


FIG. 9 P_C - Ta

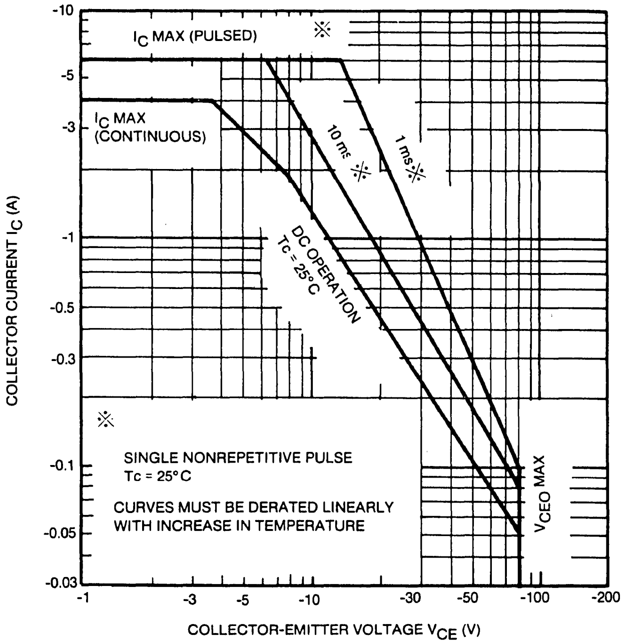


FIG. 10 SAFE OPERATING AREA

SURFACE-MOUNT
PNP POWER DARLINGTON TRANSISTORS

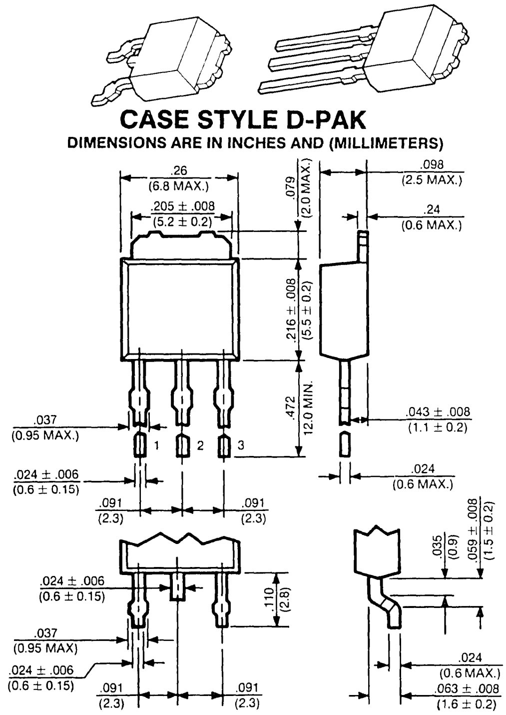
D73K3D1,2

-40 VOLTS
-3 AMP, 15 WATTS

Designed for switching applications, hammer drive, pulse motor drive applications, power amplifier applications.

Features:

- High DC Current Gain
  : $h_{FE(1)} = 2000$ (Min.) ($V_{CE} = -2V$, $I_C = -1A$)
- Low Saturation Voltage
  : $V_{CE(sat)} = -1.5V$ (Max.) ($I_C = -2A$)
- Complementary to D72K3D1,2
- Suffix "2" designates lead formed version
- See page 840 for mounting and handling considerations.

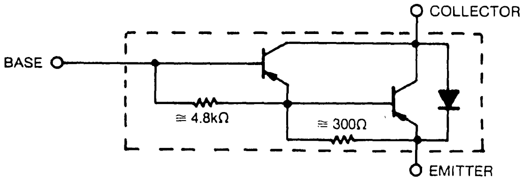


CASE STYLE D-PAK

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D73K3D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	Volts
Collector-Base Voltage	V_{CBO}	-60	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-3	A
Base Current — Continuous	I_B	-0.3	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics(1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 841 for thermal considerations.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = -25mA, I_B = 0)	$V_{(BR)CEO}$	-40	—	—	Volts
Collector Cutoff Current (V_{CB} = -60V, I_E = 0)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-2.5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10

on characteristics

DC Current Gain(2) (I_C = -1A, V_{CE} = -2V)	h_{FE}	2000	—	—	—
(I_C = -3A, V_{CE} = -2V)	h_{FE}	1000	—	—	
Collector-Emitter Saturation Voltage (I_C = -2A, I_B = -4mA)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Saturation Voltage (I_C = -2A, I_B = -4mA)	$V_{BE(sat)}$	—	—	-2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = -30V	t_{on}	—	0.30	—	μs
Storage Time	$-I_{B1} = I_{B2}$ = 6mA	t_{stg}	—	0.60	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.25	—	

(2) See page 43 for h_{FE} ranges.

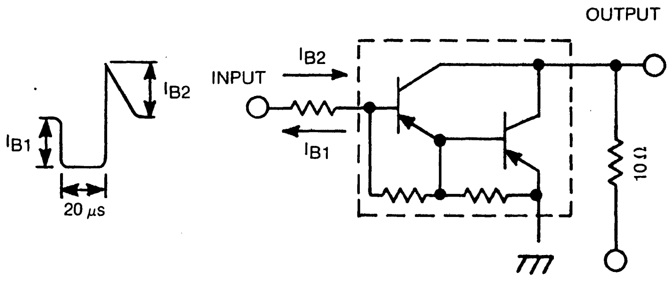


FIG. 1 SWITCHING TIME TEST CIRCUIT

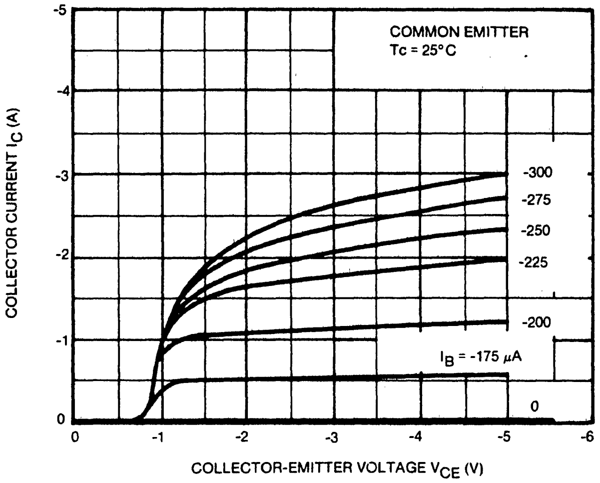


FIG. 2 I_C - V_{CE}

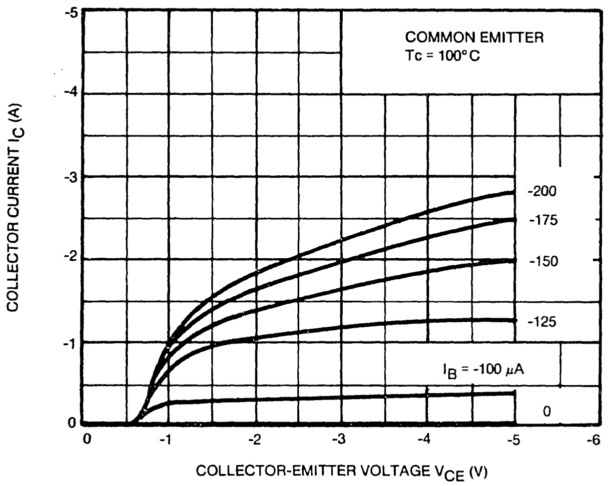


FIG. 3 I_C - V_{CE}

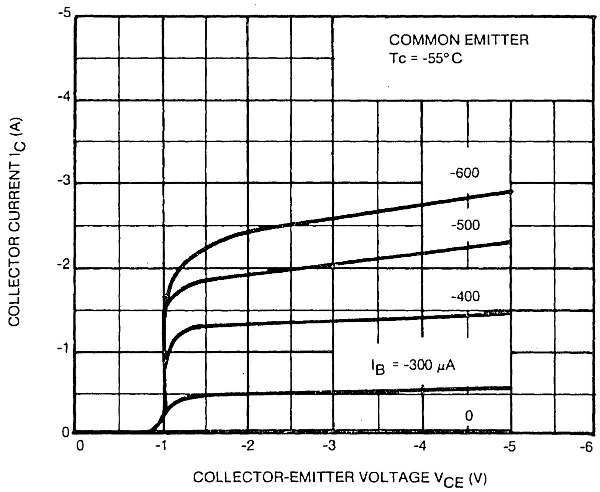


FIG. 4 I_C - V_{CE}

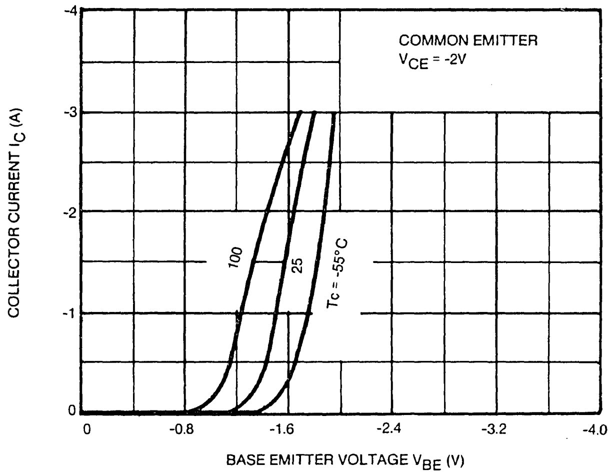


FIG. 5 I_C - V_{BE}

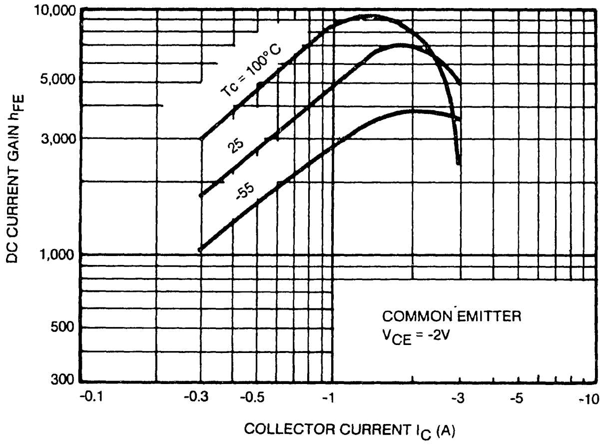


FIG. 6 h_{FE} - I_C

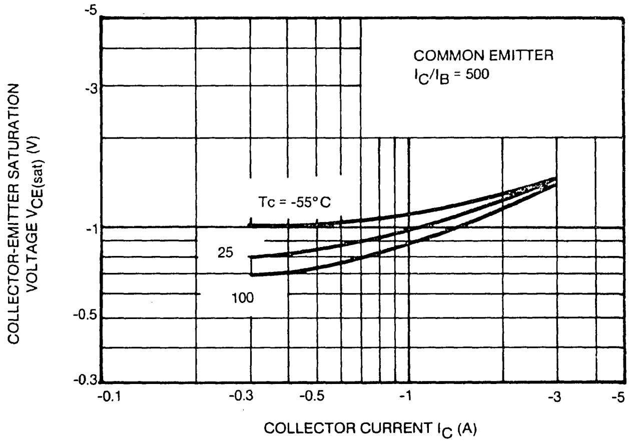


FIG. 7 $V_{CE(sat)}$ - I_C

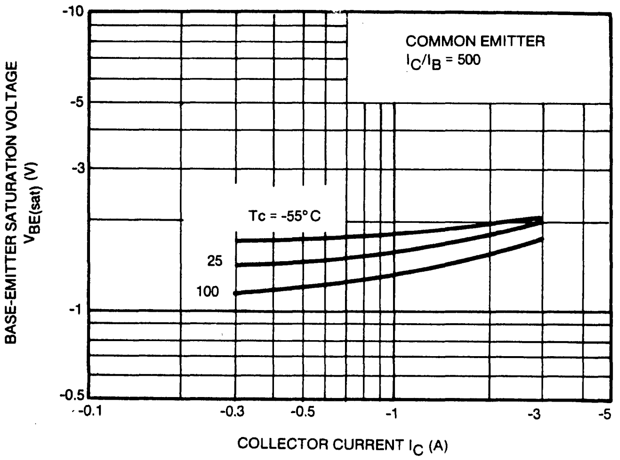


FIG. 8 $V_{BE(sat)}$ - I_C

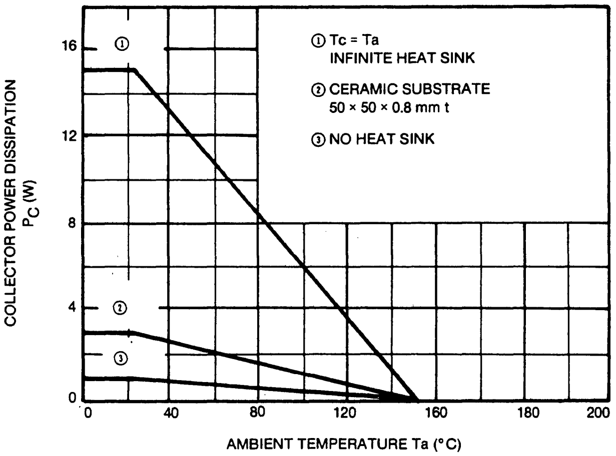


FIG. 9 P_C - Ta

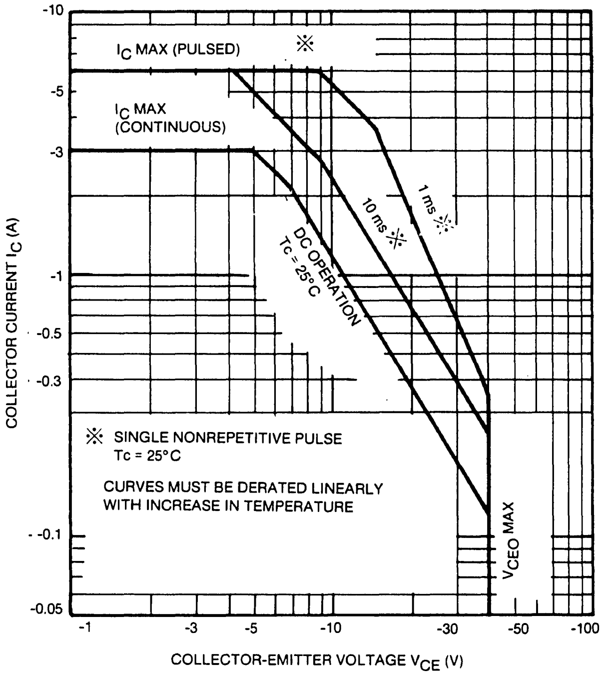


FIG. 10 SAFE OPERATING AREA

NPN POWER DARLINGTON TRANSISTOR ARRAY

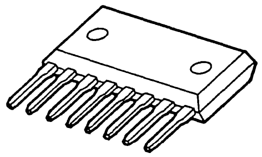
D74A5D

100 VOLTS
5 AMP, 3 WATTS

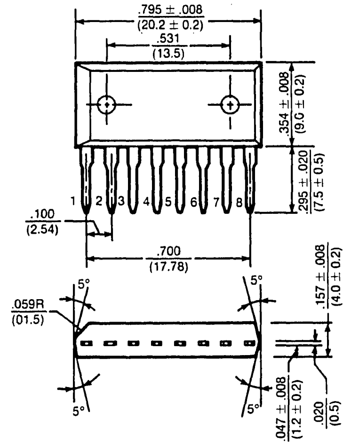
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

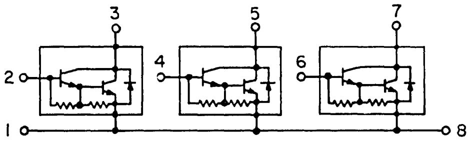
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- High collector power dissipation: P_D = 3W @ T_A = 25°C (Three device action)
- High collector current: I_C = 5A (Max.)
- High DC current gain: h_{FE} = 1000 (Min.) @ V_{CE} = 3V, I_C = 3A



CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	D74A5D	UNITS
Collector-Emitter Voltage	V_{CEO}	100	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	5 8	A
Base Current — Continuous	I_B	0.1	A
Collector Power Dissipation (One Device Action, T_A = 25°C)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, T_A = 25°C)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 30mA, I_B = 0)	$V_{BR(CEO)}$	100	—	—	Volts
Collector Cutoff Current (V_{CE} = 50V, I_B = 0)	I_{CEO}	—	—	0.5	mA
Collector Cutoff Current (V_{CB} = 100V, I_E = 0)	I_{CBO}	—	—	200	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	2	mA

on characteristics

DC Current Gain	h_{FE}				
(I_C = 0.5A, V_{CE} = 3V)		1000	—	—	—
(I_C = 3A, V_{CE} = 3V)		1000	—	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 3A, I_B = 12mA)		—	—	2	Volts
(I_C = 5A, I_B = 20mA)		—	—	4	
Base-Emitter Voltage (V_{CE} = 3V, I_C = 3A)	$V_{BE(on)}$	—	—	2.5	Volts

switching characteristics

Turn-on Time	I_C = 3A, I_{B1} = $-I_{B2}$ = 12mA $V_{BE(off)}$ = 5V, R_L = 10Ω	t_{on}	—	1.5	—	μs
Turn-off Time		t_f	—	8.5	—	

NPN POWER DARLINGTON TRANSISTOR ARRAY

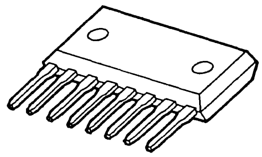
D74FI2D

60 VOLTS
2 AMP, 3 WATTS

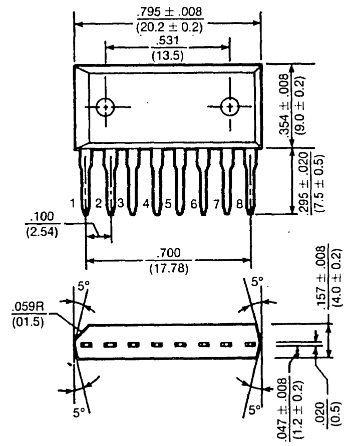
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

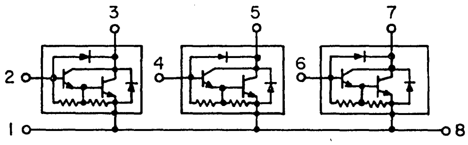
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- Zener diode included between collector and base
- High collector power dissipation: $P_D = 3W$ @ $T_A = 25°C$ (Three device action)
- High collector current: $I_C = 2A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1A$



CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D74FI2D	UNITS
Collector-Emitter Voltage	V_{CEO}	60 ± 10	Volts
Collector-Base Voltage	V_{CBO}	60 ± 10	Volts
Emitter Base Voltage	V_{EBO}	8	Volts
Collector Current — Continuous Peak	I_C I_{CM}	2 3	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Three Device Action)	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	50	60	70	Volts
Collector-Base Breakdown Voltage (I_C = 10mA, I_E = 0)	$V_{BR(CBO)}$	50	60	70	Volts
Collector Cutoff Current (V_{CB} = 45V, I_E = 0)	I_{CBO}	—	—	10	μA
Collector Cutoff Current (V_{CE} = 45V, I_B = 0)	I_{CEO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 8V, I_C = 0)	I_{EBO}	0.8	—	4.0	mA

on characteristics

DC Current Gain (I_C = 1A, V_{CE} = 2V)	h_{FE}	2000	—	—	—
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 1mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 1mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V I_{B1} = -I_{B2} = 1mA Duty Cycle = 1%	t_{on}	—	0.4	—	μs
Storage Time		t_{stg}	—	4.0	—	
Fall Time		t_f	—	0.6	—	

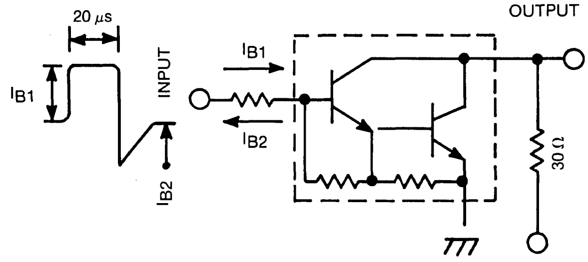


FIG. 1 SWITCHING TIME TEST CIRCUIT

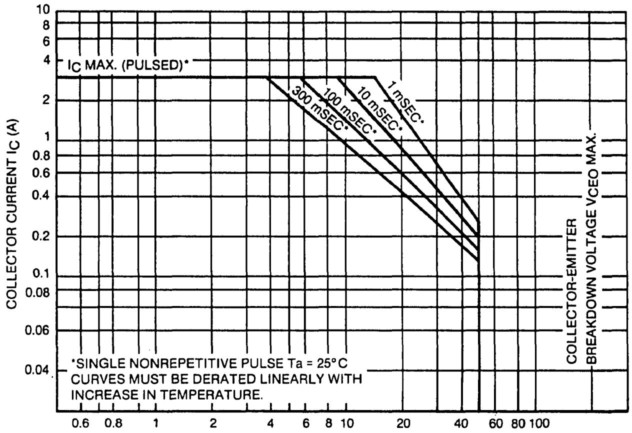


FIG. 2 SAFE OPERATING AREA

NPN POWER DARLINGTON TRANSISTOR ARRAY

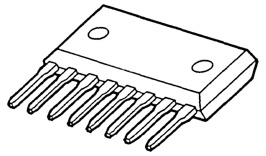
D74FI4D

60 VOLTS
4 AMP, 3 WATTS

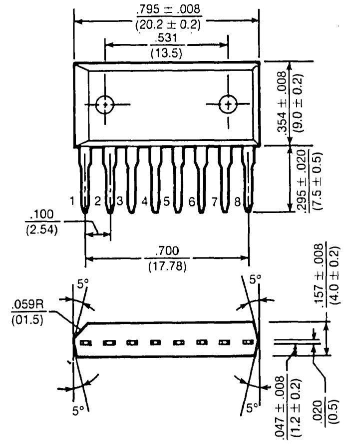
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

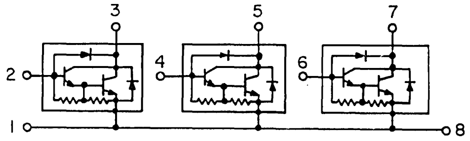
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- Zener diode included between collector and base
- High collector power dissipation: $P_D = 3W$ @ $T_A = 25°C$ (Three device action)
- High collector current: $I_C = 4A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1A$



CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D74FI4D	UNITS
Collector-Emitter Voltage	V_{CEO}	60 ± 10	Volts
Collector-Base Voltage	V_{CBO}	60 ± 10	Volts
Emitter Base Voltage	V_{EBO}	6	Volts
Collector Current — Continuous Peak	I_C I_{CM}	4 6	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Three Device Action)	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{BR(CEO)}$	50	60	70	Volts
Collector-Base Breakdown Voltage ($I_C = 10mA$, $I_E = 0$)	$V_{BR(CBO)}$	50	60	70	Volts
Collector Cutoff Current ($V_{CB} = 45V$, $I_E = 0$)	I_{CBO}	—	—	10	µA
Collector Cutoff Current ($V_{CE} = 45V$, $I_B = 0$)	I_{CEO}	—	—	10	µA
Emitter Cutoff Current ($V_{EB} = 6V$, $I_C = 0$)	I_{EBO}	0.6	—	2.0	mA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
($I_C = 1A$, $V_{CE} = 2V$)		2000	—	15000	—
($I_C = 3A$, $V_{CE} = 2V$)		1000	—	—	
Collector-Emitter Saturation Voltage ($I_C = 3A$, $I_B = 10mA$)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage ($I_C = 3A$, $I_B = 10mA$)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	$V_{CC} = 30V$ $I_{B1} = -I_{B2} = 10mA$ Duty Cycle = 1%	t_{on}	—	0.2	—	µs
Storage Time		t_{stg}	—	3.0	—	
Fall Time		t_f	—	0.5	—	

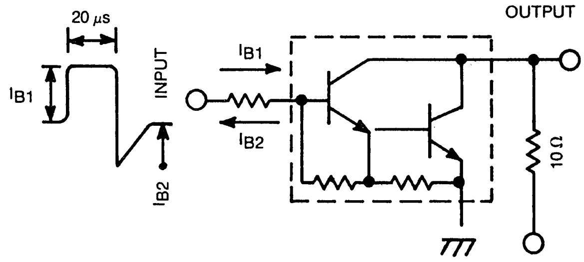


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER DARLINGTON TRANSISTOR ARRAY

D74FY2D

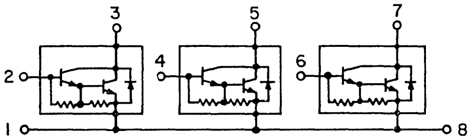
80 VOLTS
2 AMP, 3 WATTS

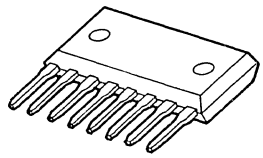
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

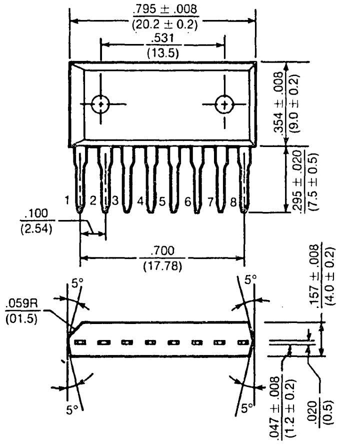
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- High collector power dissipation: $P_D = 3W$ @ $T_A = 25°C$ (Three device action)
- High collector current: $I_C = 2A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1A$

ARRAY CONFIGURATION





CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D74FY2D	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	80	Volts
Emitter Base Voltage	V_{EBO}	8	Volts
Collector Current — Continuous Peak	I_C I_{CM}	2 3	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	80	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	80	—	—	Volts
Collector Cutoff Current (V_{CB} = 80V, I_E = 0)	I_{CBO}	—	—	10	µA
Collector Cutoff Current (V_{CE} = 80V, I_B = 0)	I_{CEO}	—	—	20	µA
Emitter Cutoff Current (V_{EB} = 8V, I_C = 0)	I_{EBO}	—	—	4	mA

on characteristics

DC Current Gain (I_C = 1A, V_{CE} = 2V)	h_{FE}	2000	—	—	—
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 1mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 1mA)	$V_{BE(sat)}$	—	—	2.5	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 1mA Duty Cycle = 1%	t_{on}	—	0.4	—	µs
Storage Time		t_{stg}	—	4.0	—	
Fall Time		t_f	—	0.6	—	

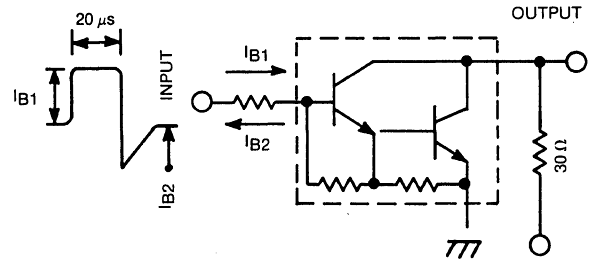


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER DARLINGTON TRANSISTOR ARRAY

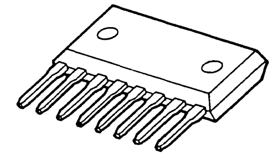
D74FY4D

80 VOLTS
4 AMP, 3 WATTS

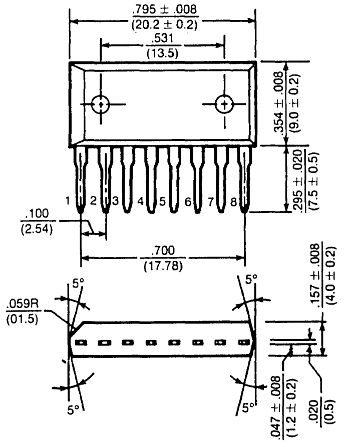
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

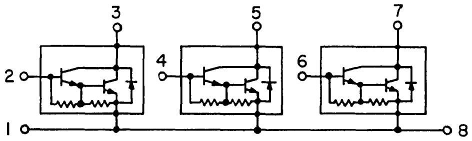
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- High collector power dissipation: $P_D = 3W$ @ $T_A = 25°C$ (Three device action)
- High collector current: $I_C = 4A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1A$



CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D74FY4D	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	4 6	A
Base Current — Continuous	I_B	0.4	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	80	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	100	—	—	Volts
Collector Cutoff Current (V_{CB} = 100V, I_E = 0)	I_{CBO}	—	—	20	μA
Collector Cutoff Current (V_{CE} = 80V, I_B = 0)	I_{CEO}	—	—	20	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	2.5	mA
on characteristics					
DC Current Gain (I_C = 1A, V_{CE} = 2V) (I_C = 3A, V_{CE} = 2V)	h_{FE}	 2000 1000	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 6mA Duty Cycle = 1%	t_{on}	—	0.2	—	μs
Storage Time		t_{stg}	—	1.5	—	
Fall Time		t_f	—	0.6	—	

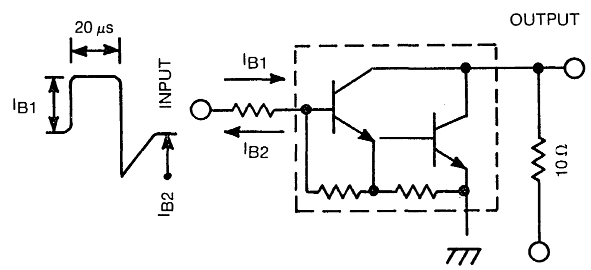


FIG. 1 SWITCHING TIME TEST CIRCUIT

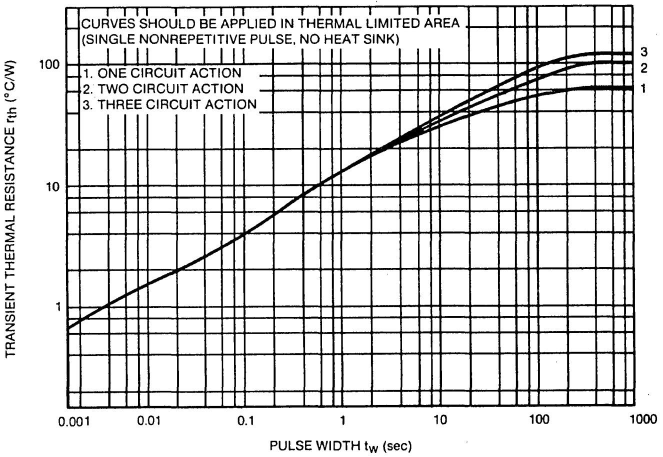


FIG. 2 TRANSIENT THERMAL RESISTANCE vs. PULSE WIDTH

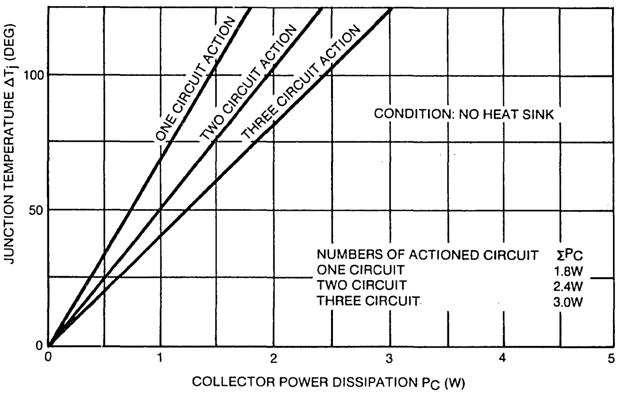


FIG. 3 COLLECTOR POWER DISSIPATION vs. JUNCTION TEMPERATURE

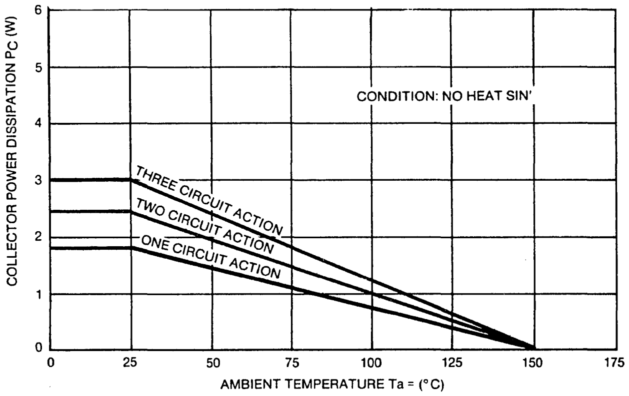


FIG. 4 TOTAL COLLECTOR POWER DISSIPATION

PNP POWER DARLINGTON TRANSISTOR ARRAY

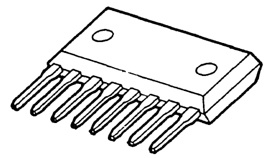
D75FY2D

-80 VOLTS
-2 AMP, 3 WATTS

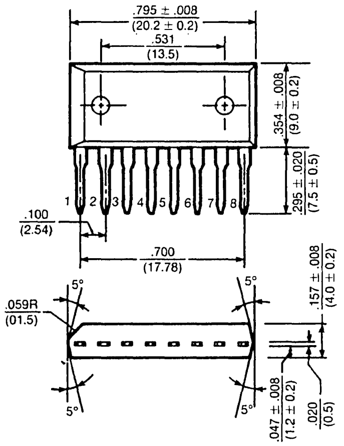
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

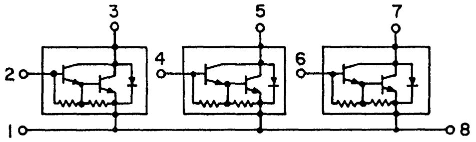
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- High collector power dissipation: $P_D = 3W$ @ $T_A = 25°C$ (Three device action)
- High collector current: $I_C = -2A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = -2V$, $I_C = -1A$



CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D75FY2D	UNITS
Collector-Emitter Voltage	V_{CEO}	-80	Volts
Collector-Base Voltage	V_{CBO}	-80	Volts
Emitter Base Voltage	V_{EBO}	-8	Volts
Collector Current — Continuous Peak	I_C I_{CM}	-2 -3	A
Base Current — Continuous	I_B	-0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)	$V_{BR(CEO)}$	-80	—	—	Volts
Collector-Base Breakdown Voltage (I_C = -10mA, I_E = 0)	$V_{BR(CBO)}$	-80	—	—	Volts
Collector Cutoff Current (V_{CB} = -80V, I_E = 0)	I_{CBO}	—	—	-10	µA
Collector Cutoff Current (V_{CE} = -80V, I_B = 0)	I_{CEO}	—	—	-10	µA
Emitter Cutoff Current (V_{EB} = -8V, I_C = 0)	I_{EBO}	—	—	-4	mA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = -1A, V_{CE} = -2V)	h_{FE}	2000	—	—	—
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -1mA)	$V_{CE(sat)}$	—	—	-1.5	Volts
Base-Emitter Saturation Voltage (I_C = -1A, I_B = -1mA)	$V_{BE(sat)}$	—	—	-2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 1mA Duty Cycle = 1%	t_{on}	—	0.4	—	µs
Storage Time		t_{stg}	—	2.0	—	
Fall Time		t_f	—	0.4	—	

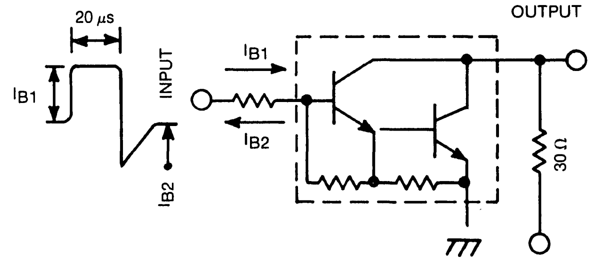


FIG. 1 SWITCHING TIME TEST CIRCUIT

PNP POWER DARLINGTON TRANSISTOR ARRAY

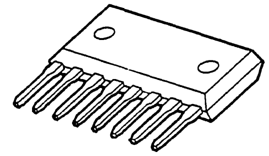
D75FY4D

-80 VOLTS
-4 AMP, 3 WATTS

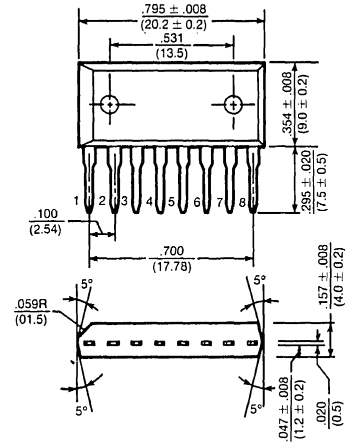
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

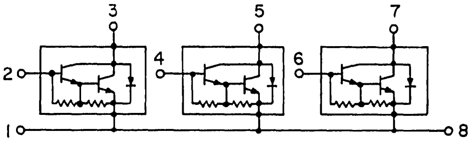
- High reliability small-sized available (3 in 1)
- Epoxy single-inline package (8 pin)
- High collector power dissipation: $P_D = 3W$ @ $T_A = 25°C$ (Three device action)
- High collector current: $I_C = -4A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = -2V$, $I_C = -1A$



CASE STYLE SIP-8 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D75FY4D	UNITS
Collector-Emitter Voltage	V_{CEO}	-80	Volts
Collector-Base Voltage	V_{CBO}	-100	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	-4 -6	A
Base Current — Continuous	I_B	-0.4	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	1.8	Watts
Collector Power Dissipation (Three Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$\Sigma R_{\theta JA}$	41.7	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = -10mA, I_B = 0)	$V_{BR(CEO)}$	-80	—	—	Volts
Collector-Base Breakdown Voltage (I_C = -1mA, I_E = 0)	$V_{BR(CBO)}$	-100	—	—	Volts
Collector Cutoff Current (V_{CB} = -100V, I_E = 0)	I_{CBO}	—	—	-20	μA
Collector Cutoff Current (V_{CE} = -80V, I_B = 0)	I_{CEO}	—	—	-20	μA
Emitter Cutoff Current (V_{EB} = -5V, I_C =)	I_{EBO}	—	—	-2.5	mA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
(I_C = -1A, V_{CE} = -2V)		2000	—	—	—
(I_C = -3A, V_{CE} = -2V)		1000	—	—	
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{CE(sat)}$	—	—	-1.5	Volts
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{BE(sat)}$	—	—	-2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -30V I_{B1} = -I_{B2} = 6mA Duty Cycle = 1%	t_{on}	—	0.15	—	μs
Storage Time		t_{stg}	—	0.80	—	
Fall Time		t_f	—	0.40	—	

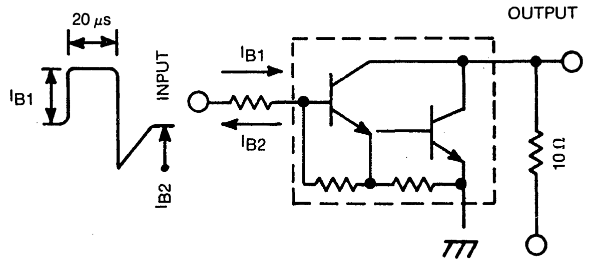


FIG. 1 SWITCHING TIME TEST CIRCUIT

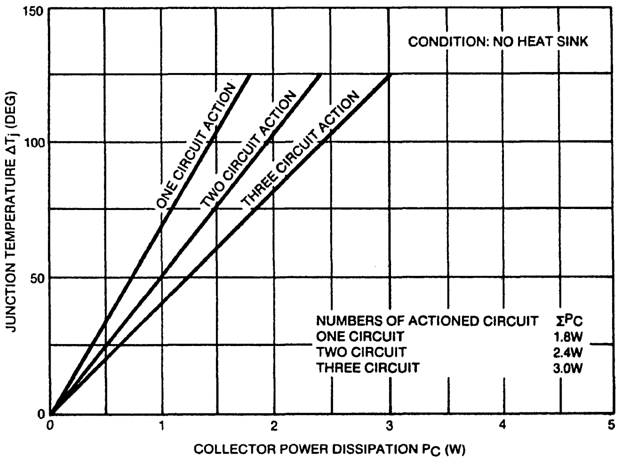


FIG. 2 POWER DISSIPATION vs. JUNCTION TEMPERATURE

NPN POWER DARLINGTON TRANSISTOR ARRAY

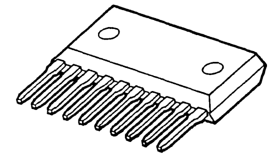
D76A3D

100 VOLTS
3 AMP, 4.0 WATTS

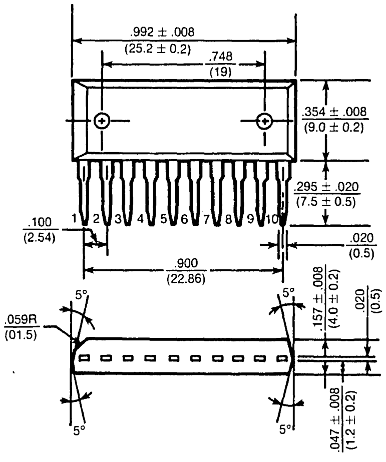
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

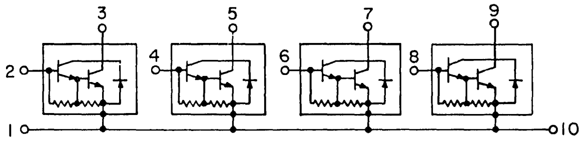
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- High collector power dissipation: $P_D = 4W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = 3A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1.5A$



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D76A3D	UNITS
Collector-Emitter Voltage	V_{CEO}	100	Volts
Collector-Base Voltage	V_{CBO}	120	Volts
Emitter Base Voltage	V_{EBO}	6	Volts
Collector Current — Continuous Peak	I_C I_{CM}	3 6	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, T_A = 25°C)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, T_A = 25°C)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	100	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	120	—	—	Volts
Collector Cutoff Current (V_{CB} = 120V, I_E = 0)	I_{CBO}	—	—	10	μA
Collector Cutoff Current (V_{CE} = 100V, I_B = 0)	I_{CEO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	2.5	mA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
(I_C = 1.5A, V_{CE} = 2V)		2000	—	12000	—
(I_C = 3A, V_{CE} = 2V)		1000	—	—	
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V I_{B1} = -I_{B2} = 3mA Duty Cycle = 1%	t_{on}	—	0.3	—	μs
Storage Time		t_{stg}	—	2	—	
Fall Time		t_f	—	0.4	—	

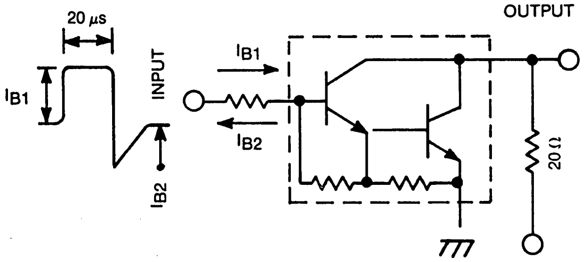


FIG. 1. SWITCHING TIME TEST CIRCUIT

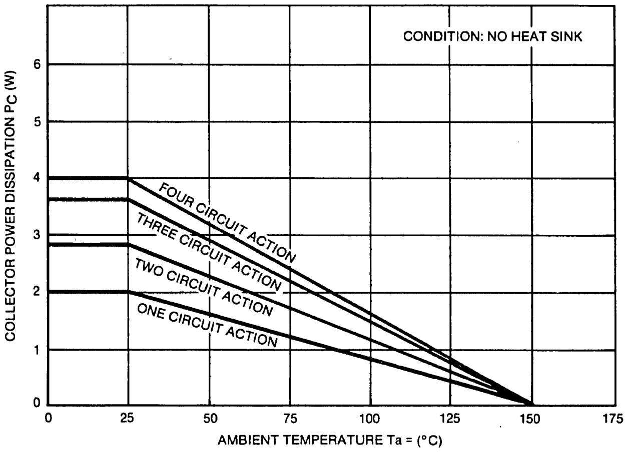


FIG. 2 TOTAL COLLECTOR POWER DISSIPATION

NPN POWER DARLINGTON TRANSISTOR ARRAY

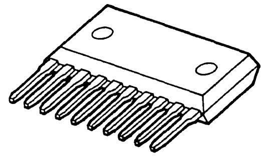
D76A5D

100 VOLTS
5 AMP, 4 WATTS

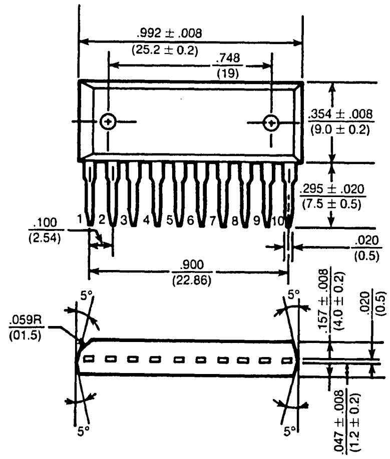
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

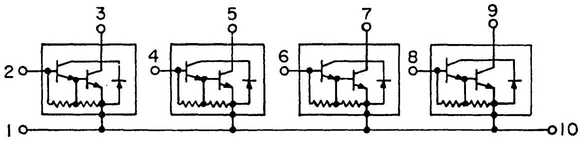
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- High collector power dissipation: $P_D = 4W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = 5A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 3V$, $I_C = 3A$



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D76A5D	UNITS
Collector-Emitter Voltage	V_{CEO}	100	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	5 8	A
Base Current — Continuous	I_B	0.1	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, $T_A = 25°C$)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 30mA, I_B = 0)	$V_{BR(CEO)}$	100	—	—	Volts
Collector Cutoff Current (V_{CE} = 50V, I_B = 0)	I_{CEO}	—	—	0.5	mA
Collector Cutoff Current (V_{CB} = 100V, I_E = 0)	I_{CBO}	—	—	200	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	2	mA

on characteristics

DC Current Gain	h_{FE}				
(I_C = .5A, V_{CE} = 3V)		1000	—	—	—
(I_C = 3a, V_{CE} = 3V)		1000	—	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 3A, I_B = 12mA)		—	—	2	Volts
(I_C = 5A, I_B = 20mA)		—	—	4	
Base-Emitter Voltage (I_C = 3V, I_B = 3A)	$V_{BE(on)}$	—	—	2.5	Volts

switching characteristics

Turn-on Time	I_C = 3A, I_{B1} = -I_{B2} = 12mA $V_{BE(off)}$ = -5V, R_L = 10Ω	t_{on}	—	1.5	—	μs
Fall Time		t_f	—	8.5	—	

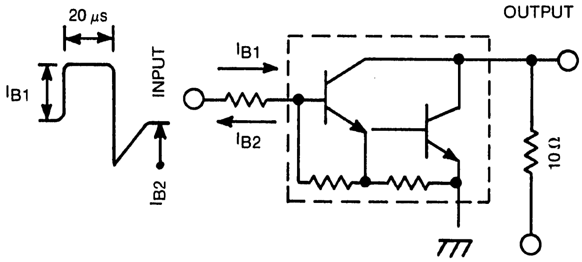


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER DARLINGTON TRANSISTOR ARRAY

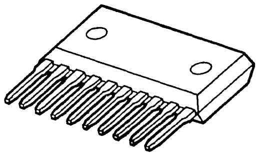
D76FI2D

60 VOLTS
2 AMP, 4 WATTS

Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

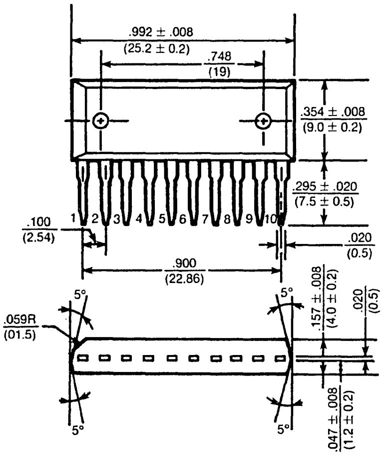
Features:

- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- Zener diode included between collector and base
- High collector power dissipation: $P_D = 4W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = 2A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1A$

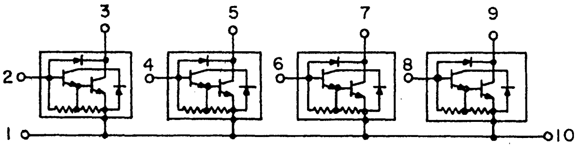


CASE STYLE SIP-10 PIN

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D76FI2D	UNITS
Collector-Emitter Voltage	V_{CEO}	60 ± 10	Volts
Collector-Base Voltage	V_{CBO}	60 ± 10	Volts
Emitter Base Voltage	V_{EBO}	8	Volts
Collector Current — Continuous Peak	I_C I_{CM}	2 3	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, $T_A = 25°C$)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{BR(CEO)}$	50	60	70	Volts
Collector-Base Breakdown Voltage ($I_C = 10mA$, $I_E = 0$)	$V_{BR(CBO)}$	50	60	70	Volts
Collector Cutoff Current ($V_{CB} = 45V$, $I_E = 0$)	I_{CBO}	—	—	10	µA
Collector Cutoff Current ($V_{CE} = 45V$, $I_B = 0$)	I_{CEO}	—	—	10	µA
Emitter Cutoff Current ($V_{EB} = 8V$, $I_C = 0$)	I_{EBO}	0.8	—	4.0	mA
on characteristics					
DC Current Gain ($I_C = 1A$, $V_{CE} = 2V$)	h_{FE}	2000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 1mA$)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 1mA$)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	$V_{CC} = 30V$ $I_{B1} = -I_{B2} = 1mA$ Duty Cycle = 1%	t_{on}	—	0.4	—	µs
Storage Time		t_{stg}	—	4.0	—	
Fall Time		t_f	—	0.6	—	

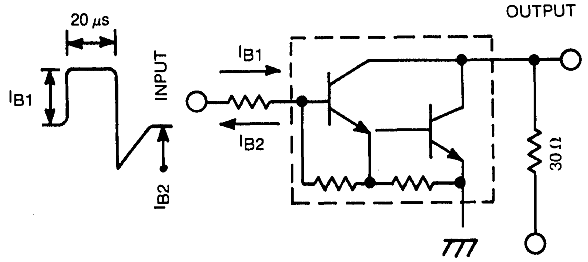


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER TRANSISTOR ARRAY

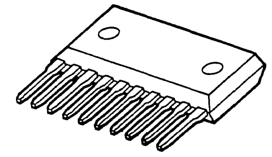
D76FI3T

60 VOLTS
3 AMP, 4.0 WATTS

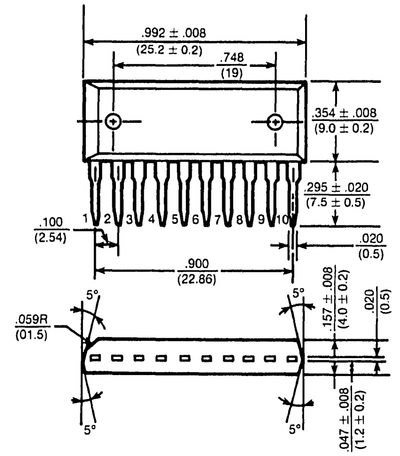
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

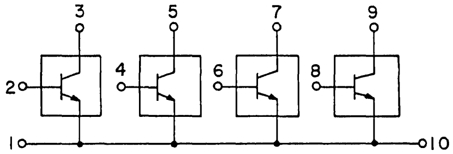
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- High collector power dissipation: $P_D = 4.0W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = \pm 3A$ (Max.)
- High DC current gain: $h_{FE} = 500$ (Min.) @ $V_{CE} = \pm 1V$, $I_C = \pm .4A$



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D76FI3T	UNITS
Collector-Emitter Voltage	V_{CEO}	60	Volts
Collector-Base Voltage	V_{CBO}	60	Volts
Emitter Base Voltage	V_{EBO}	6	Volts
Collector Current — Continuous Peak	I_C I_{CM}	3 5	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, $T_A = 25°C$)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25° C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	60	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	60	—	—	Volts
Collector Cutoff Current (V_{CB} = 60V, I_E = 0)	I_{CBO}	—	—	10	μA
Collector Cutoff Current (V_{CE} = 60V, I_B = 0)	I_{CEO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	1	A

on characteristics

DC Current Gain (I_C = 0.4A, V_{CE} = 1V)	h_{FE}	500	—	—	—
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 50mA)	$V_{CE(sat)}$	—	—	1.0	Volts
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 50mA)	$V_{BE(sat)}$	—	—	1.5	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V	t_{on}	—	2.0	—	μs
Storage Time	$I_{B1} = -I_{B2}$ = 50mA	t_{stg}	—	5.0	—	
Fall Time	Duty Cycle = 1%	t_f	—	2.0	—	

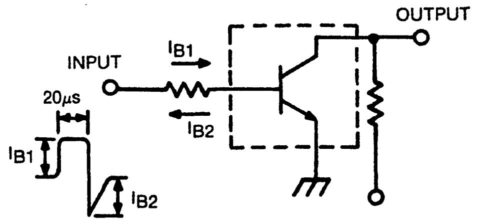


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER DARLINGTON TRANSISTOR ARRAY

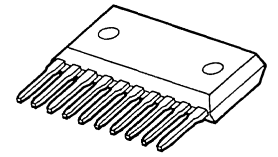
D76FI4D

60 VOLTS
4 AMP, 4 WATTS

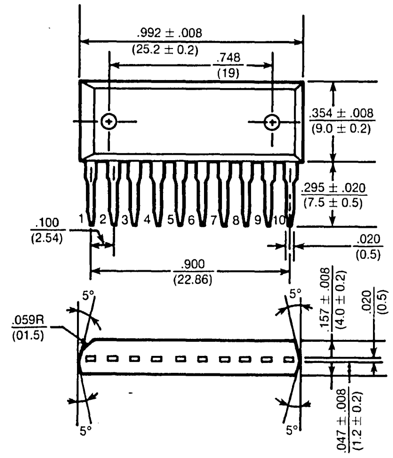
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

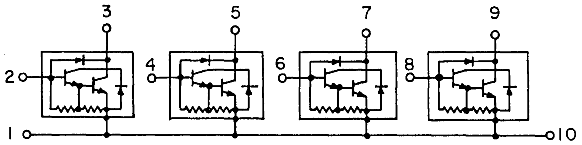
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- High collector power dissipation: $P_D = 4W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = 4A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1A$



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D76FI4D	UNITS
Collector-Emitter Voltage	V_{CEO}	60 ± 10	Volts
Collector-Base Voltage	V_{CBO}	60 ± 10	Volts
Emitter Base Voltage	V_{EBO}	6	Volts
Collector Current — Continuous Peak	I_C I_{CM}	4 6	A
Base Current — Continuous	I_B	.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, $T_A = 25°C$)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	50	60	70	Volts
Collector-Base Breakdown Voltage (I_C = 10mA, I_E = 0)	$V_{BR(CBO)}$	50	60	70	Volts
Collector Cutoff Current (V_{CB} = 45V, I_E = 0)	I_{CBO}	—	—	10	μA
Collector Cutoff Current (V_{CE} = 45V, I_B = 0)	I_{CEO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	0.6	—	2.0	mA

second breakdown

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Foward Biased	FBSOA	SEE FIGURE 13			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 1A, V_{CE} = 2V) (I_C = 3A, V_{CE} = 2V)	h_{FE}	 2000 1000	 — —	 15000 —	—
Collector-Emitter Saturation Voltage (I_C = 3, I_B = 10mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 10mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 10mA Duty Cycle = 1%	t_{on}	—	0.2	—	μs
Storage Time		t_{stg}	—	3.0	—	
Fall Time		t_f	—	0.5	—	

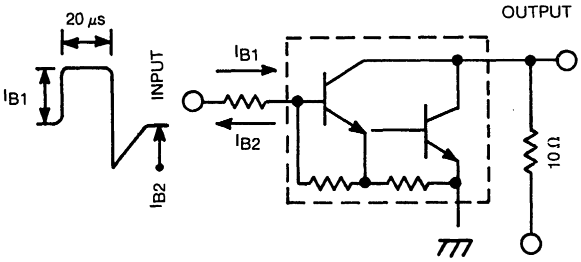


FIG. 1 SWITCHING TIME TEST CIRCUIT

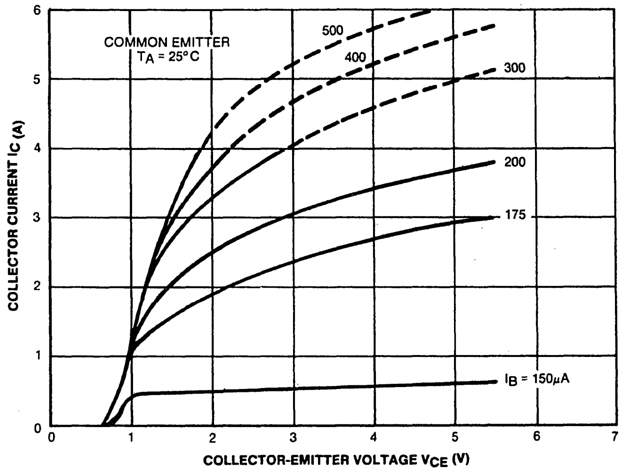


FIG. 2 I_C — V_{CE}

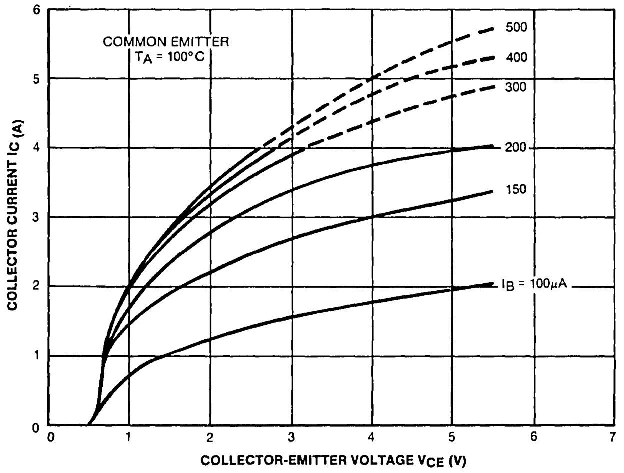


FIG. 3 I_C — V_{CE}

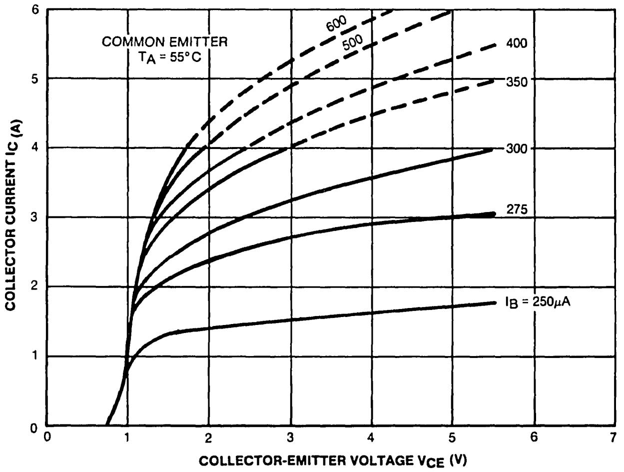


FIG. 4 I_C — V_{CE}

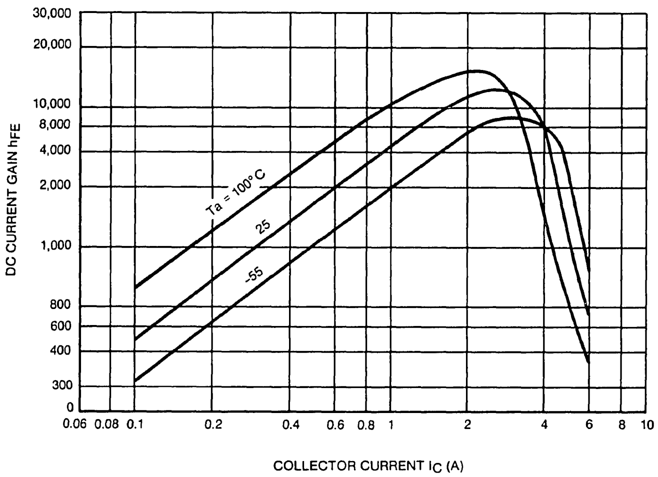


FIG. 5 h_{FE} - I_C

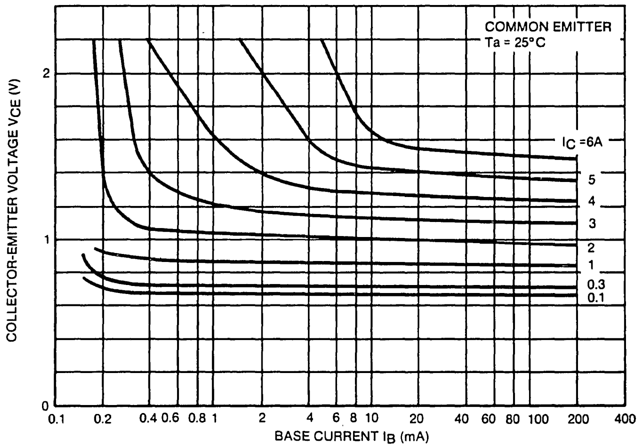


FIG. 6 I_B - V_{CE}

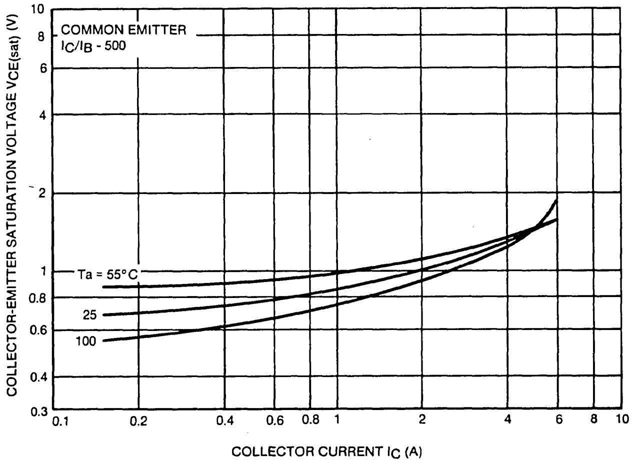


FIG. 7 $V_{CE(sat)}$ - I_C

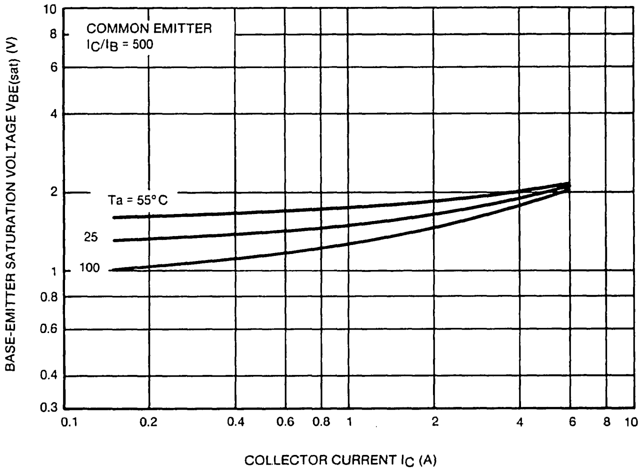


FIG. 8 $V_{BE(sat)}$ - I_C

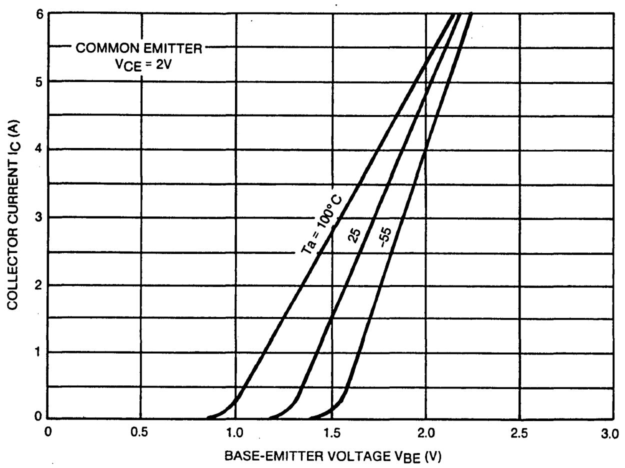


FIG. 9 IC - VBE

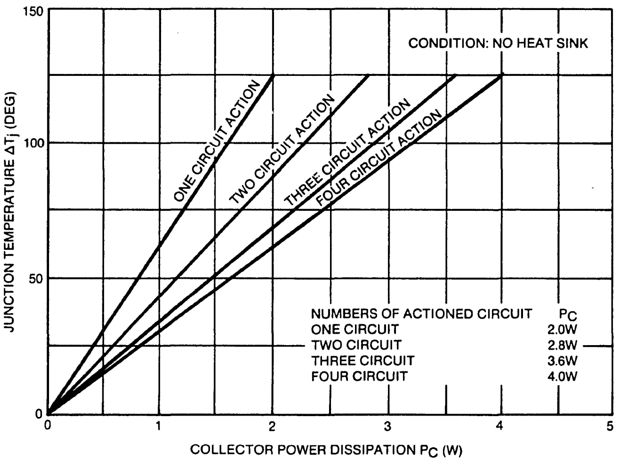


FIG. 10

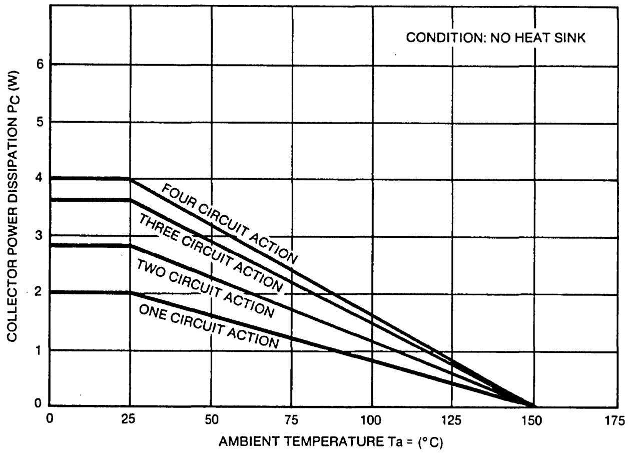


FIG. 11 TOTAL COLLECTOR POWER DISSIPATION

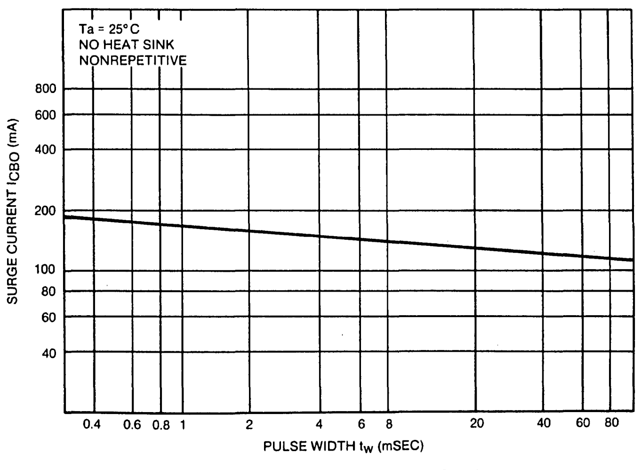


FIG. 12 ICBO VERSUS tw

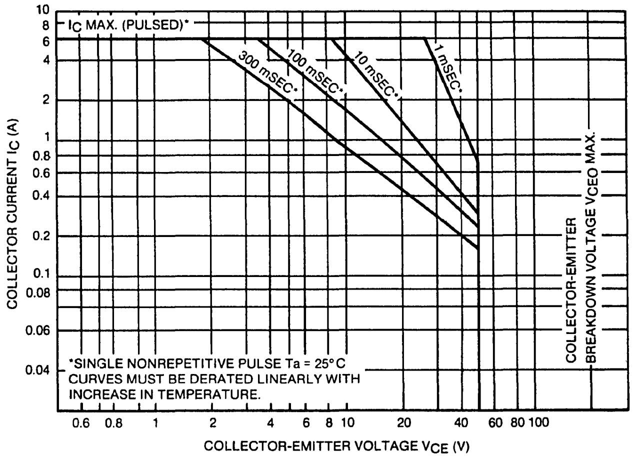


FIG. 13 SAFE OPERATING AREA

NPN/PNP POWER DARLINGTON TRANSISTOR ARRAY

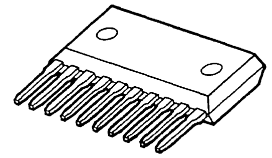
D76FY2D

80 VOLTS
2 AMP, 4.0 WATTS

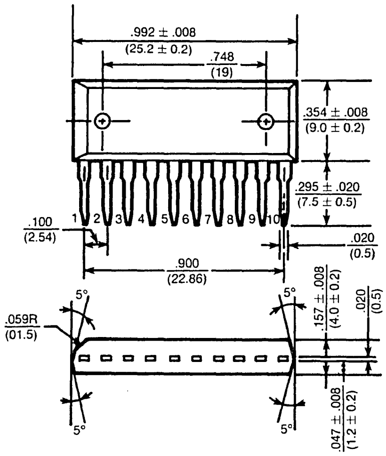
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

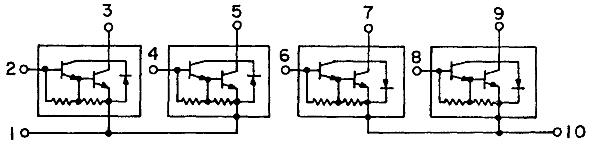
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- Zener diode included between collector and base
- High collector power dissipation: $P_D = 4.0W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = \pm 2A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = \pm 2V$, $I_C = \pm 1A$



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D76FY2D	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	80	Volts
Emitter Base Voltage	V_{EBO}	8	Volts
Collector Current — Continuous Peak	I_C I_{CM}	2 3	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, $T_A = 25°C$)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{BR(CEO)}$	80	—	—	Volts
Collector-Base Breakdown Voltage ($I_C = 1mA$, $I_E = 0$)	$V_{BR(CBO)}$	80	—	—	Volts
Collector Cutoff Current ($V_{CB} = 80V$, $I_E = 0$)	I_{CBO}	—	—	10	μA
Collector Cutoff Current ($V_{CE} = 80V$, $I_B = 0$)	I_{CEO}	—	—	50	μA
Emitter Cutoff Current ($V_{EB} = 8V$, $I_C = 0$)	I_{EBO}	—	—	4	mA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain ($I_C = 1A$, $V_{CE} = 1V$)	h_{FE}	2000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 1mA$)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 1mA$)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	$V_{CC} = 30V$ $I_{B1} = -I_{B2} = 1mA$ Duty Cycle = 1%	t_{on}	—	0.4	—	μs
Storage Time		t_{stg}	—	4.0	—	
Fall Time		t_f	—	0.6	—	

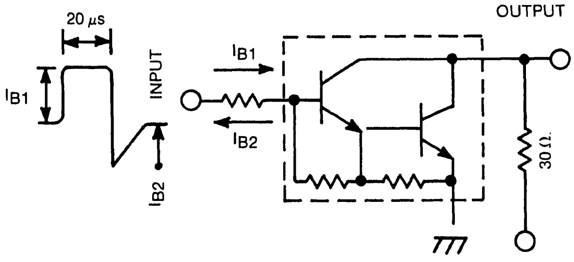


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER TRANSISTOR ARRAY

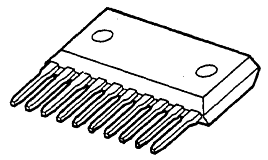
D76FY2T

80 VOLTS
2 AMP, 4.0 WATTS

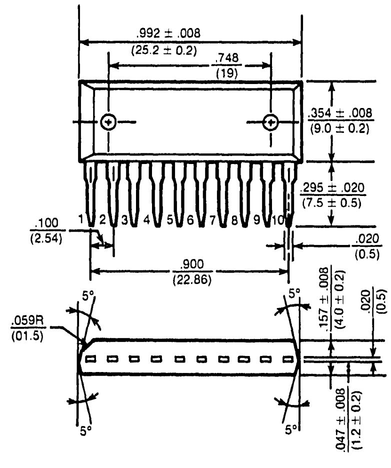
Designed for switching applications, solenoid drive applications.

Features:

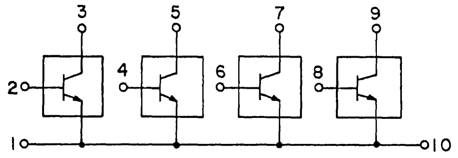
- Epoxy single-inline package (10 pin)
- High DC current gain: h_{FE} = 500 (Min.) (I_C = 400mA)
- Low saturation voltage: $V_{CE(sat)}$ = 0.5V (Max.) (I_C = 300mA)



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D76FY2T	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	80	Volts
Emitter Base Voltage	V_{EBO}	7	Volts
Collector Current — Continuous	I_C	2	A
Base Current — Continuous	I_B	0.5	A
Collector Power Dissipation	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	80	—	—	Volts
Collector Cutoff Current (V_{CB} = 80V, I_E = 0)	I_{CBO}	—	—	1	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	—	1	μA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 400mA, V_{CE} = 1V)	h_{FE}	500	—	—	—
Collector-Emitter Saturation Voltage (I_C = 300mA, I_B = 1mA)	$V_{CE(sat)}$	—	0.3	0.5	Volts
Base-Emitter Saturation Voltage (I_C = 300mA, I_B = 1mA)	$V_{BE(sat)}$	—	—	1.1	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 1mA Duty Cycle ≦ 1%	t_{on}	—	2.0	—	μs
Storage Time		t_{stg}	—	5.0	—	
Fall Time		t_f	—	2.0	—	

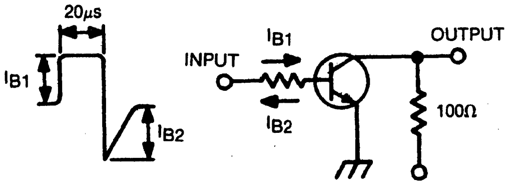


FIG. 1 SWITCHING TIME TEST CIRCUIT

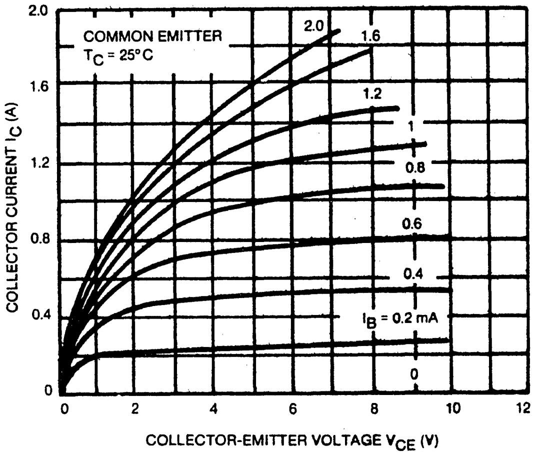


FIG. 2 I_C - V_{CE}

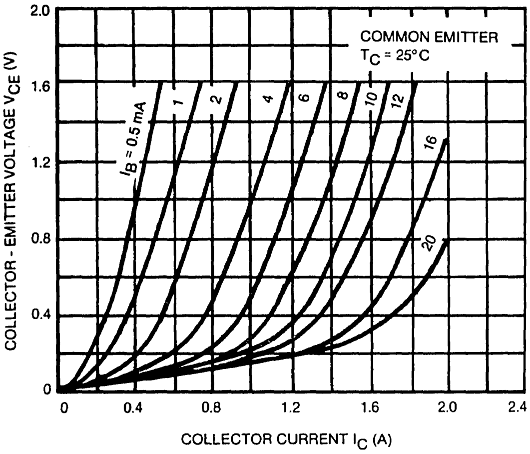


FIG. 3 V_{CE} - I_C

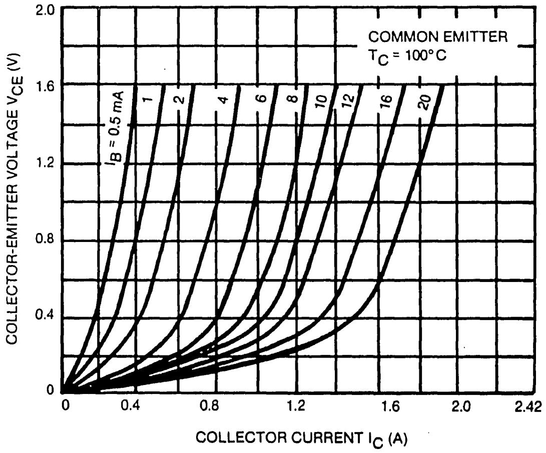


FIG. 4 V_{CE} - I_C

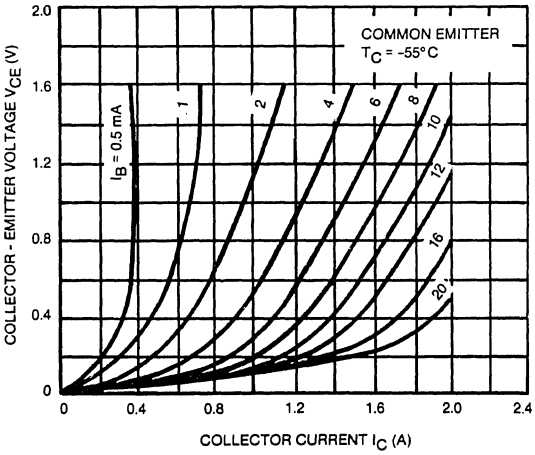


FIG. 5 V_{CE} - I_C

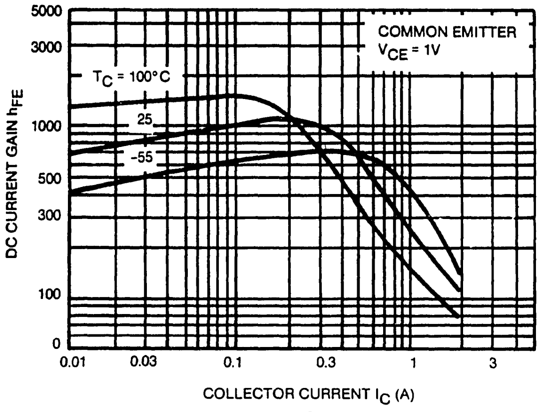


FIG. 6 h_{FE} - I_C

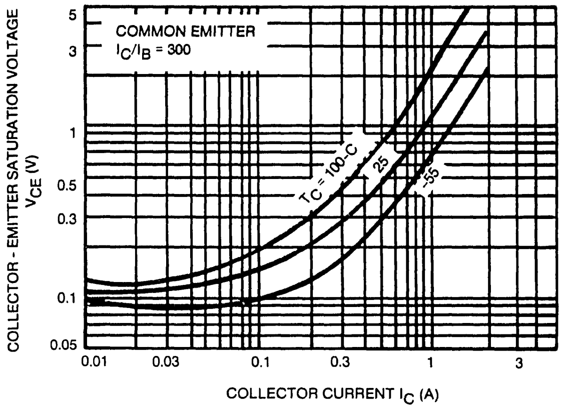


FIG. 7 $V_{CE(sat)}$ - I_C

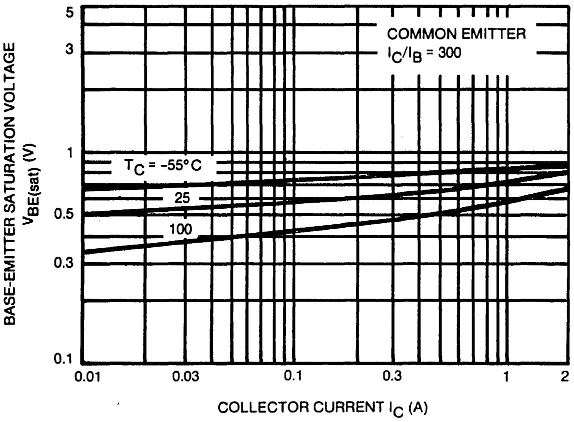


FIG. 8 $V_{BE(sat)} - I_C$

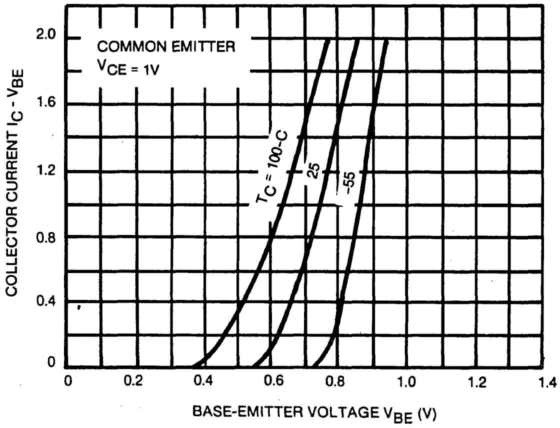


FIG. 9 $I_C - V_{BE}$

NPN/PNP POWER DARLINGTON TRANSISTOR ARRAY

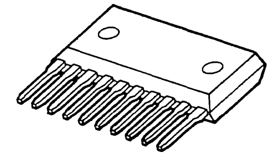
D76FY4D

80 VOLTS
4 AMP, 4.0 WATTS

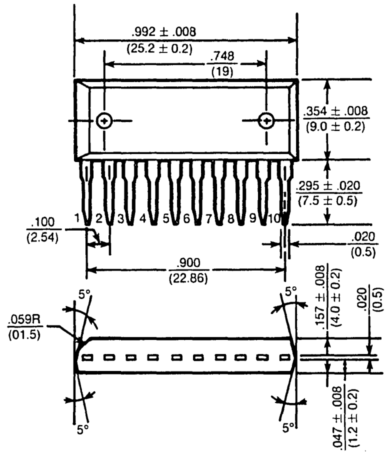
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

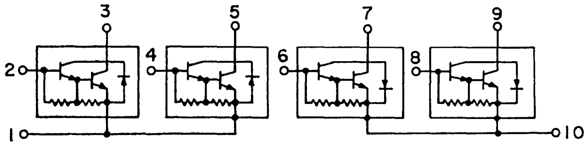
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package (10 pin)
- High collector power dissipation: $P_D = 4.0W @ T_A = 25°C$ (Four device action)
- High collector current: $I_C = \pm 4A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = \pm 2V$, $I_C = \pm 1A$



CASE STYLE SIP-10 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D76FY4D	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	4 6	A
Base Current — Continuous	I_B	0.4	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	2.0	Watts
Collector Power Dissipation (Four Device Action, $T_A = 25°C$)	P_D	4.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	31.3	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{BR(CEO)}$	80	—	—	Volts
Collector-Base Breakdown Voltage ($I_C = 1mA$, $I_E = 0$)	$V_{BR(CBO)}$	100	—	—	Volts
Collector Cutoff Current ($V_{CB} = 100V$, $I_E = 0$)	I_{CBO}	—	—	20	µA
Collector Cutoff Current ($V_{CE} = 80V$, $I_B = 0$)	I_{CEO}	—	—	20	µA
Emitter Cutoff Current ($V_{EB} = 5V$, $I_C = 0$)	I_{EBO}	—	—	2.5	mA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain					
($I_C = 1A$, $V_{CE} = 2V$)	$h_{FE(1)}$	2000	—	—	—
($I_C = 3A$, $V_{CE} = 2V$)	$h_{FE(2)}$	1000	—	—	
Collector-Emitter Saturation Voltage ($I_C = 3A$, $I_B = 6mA$)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage ($I_C = 3A$, $I_B = 6mA$)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	$V_{CC} = 30V$ $I_{B1} = -I_{B2} = 6mA$ Duty Cycle = 1%	t_{on}	—	0.2	—	µs
Storage Time		t_{stg}	—	1.5	—	
Fall Time		t_f	—	0.6	—	

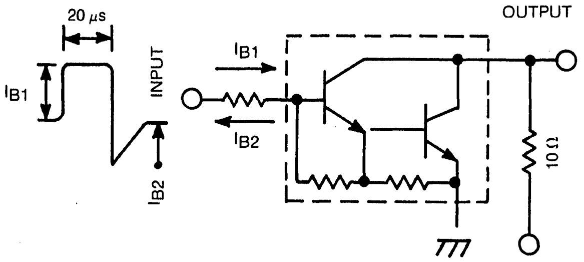


FIG. 1 SWITCHING TIME TEST CIRCUIT

NPN POWER DARLINGTON TRANSISTOR ARRAY

D78A3D1

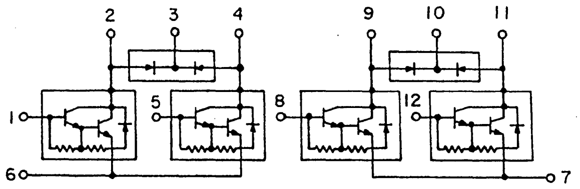
100 VOLTS
3 AMP, 25 WATTS

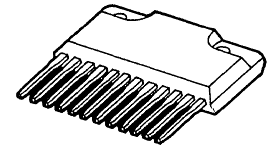
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

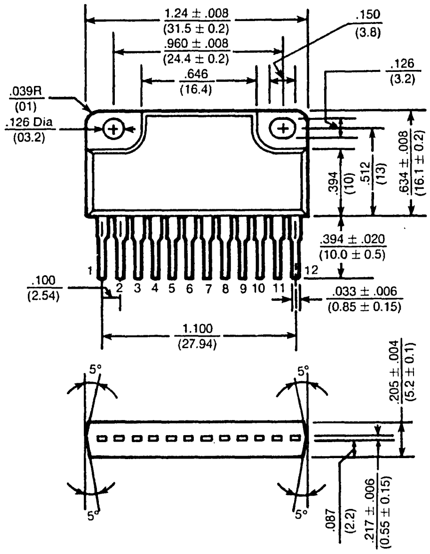
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package with heat sink (12 pin)
- High collector power dissipation: $P_D = 25W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = 3A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = 2V$, $I_C = 1.5A$

ARRAY CONFIGURATION





CASE STYLE SIP-12 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D78A3D1	UNITS
Collector-Emitter Voltage	V_{CEO}	100	Volts
Collector-Base Voltage	V_{CBO}	120	Volts
Emitter Base Voltage	V_{EBO}	6	Volts
Collector Current — Continuous Peak	I_C I_{CM}	3 6	A
Base Current — Continuous	I_B	0.5	A
Maximum Forward Current	I_{FM}	3	A
Surge Current (1 sec)	I_{FSM}	6	A
Reverse Voltage	V_R	100	A
Collector Power Dissipation (One Device Action, T_A = 25° C)	P_D	3.0	Watts
Collector Power Dissipation (Four Device Action) T_A , 25°C T_C = 25°C	P_D	5.0 25	Watts
Isolation Voltage (Between Fin to 1 ~ 12 pin)	V_{Isol}	1000	Volts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	25	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	100	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	120	—	—	Volts
Collector Cutoff Current (V_{CB} = 120V, I_E = 0)	I_{CBO}	—	—	10	μA
Collector Cutoff Current (V_{CE} = 100V, I_B = 0)	I_{CEO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	0.5	—	2.5	mA

second breakdown

Second Breakdown with Base Foward Biased	FBSOA	SEE FIGURE 13

on characteristics

DC Current Gain (I_C = 1.5A, V_{CE} = 2V) (I_C = 3A, V_{CE} = 2V)	h_{FE}	2000 1000	— —	12000 —	—
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 3mA Duty Cycle = 1%	t_{on}	—	0.3	—	μs
Storage Time		t_{stg}	—	2	—	
Fall Time		t_f	—	0.4	—	

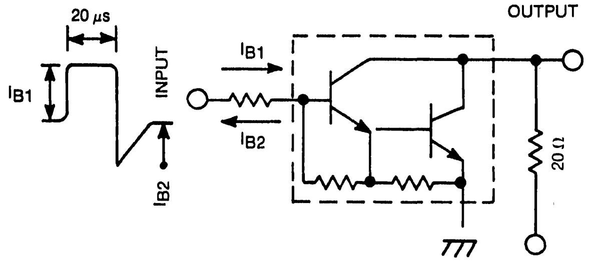


FIG. 1 SWITCHING TIME TEST CIRCUIT

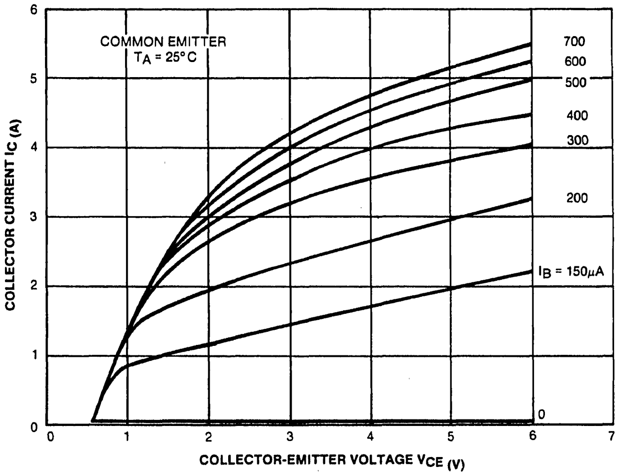


FIG. 2 I_C — V_{CE}

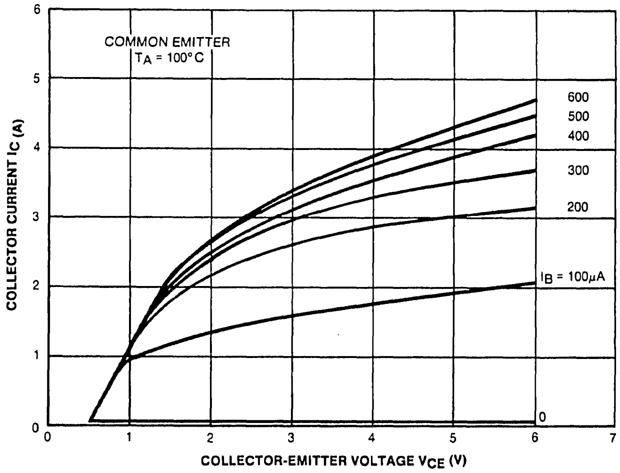


FIG. 3 IC — VCE

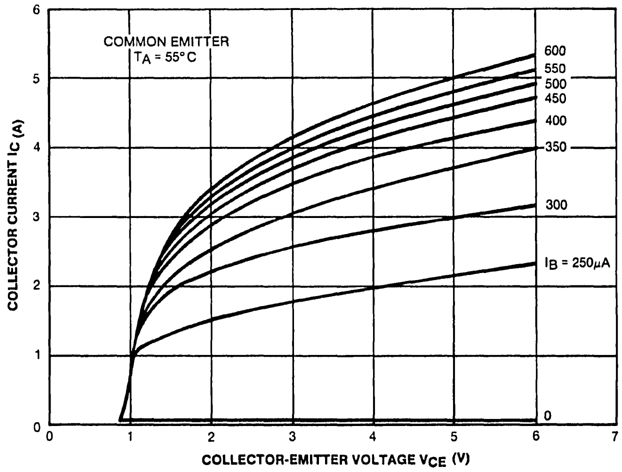


FIG. 4 IC — VCE

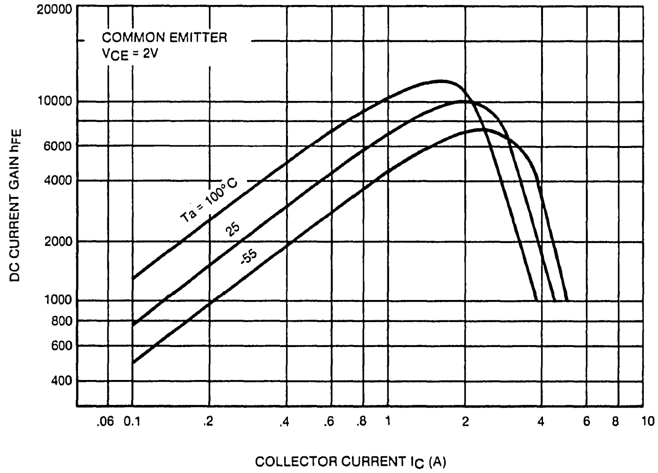


FIG. 5 hFE - IC

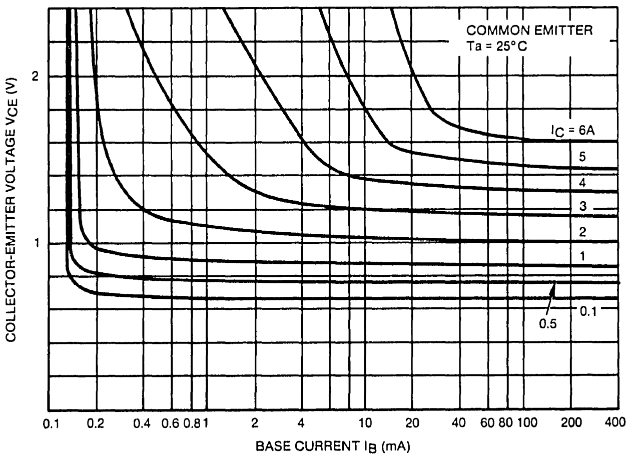


FIG. 6

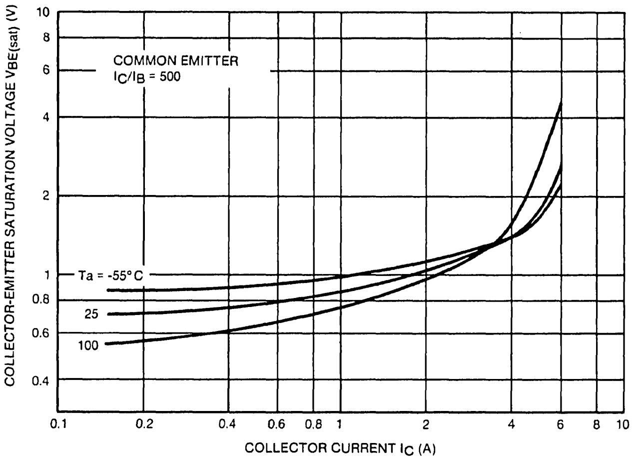


FIG. 7 VCE(sat) - IC

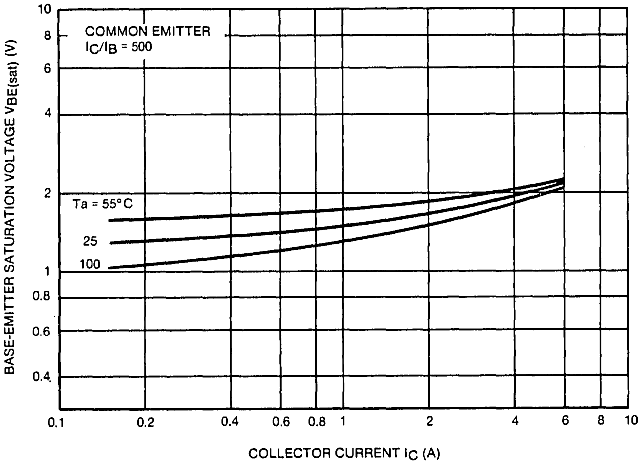


FIG. 8 VBE(sat) - IC

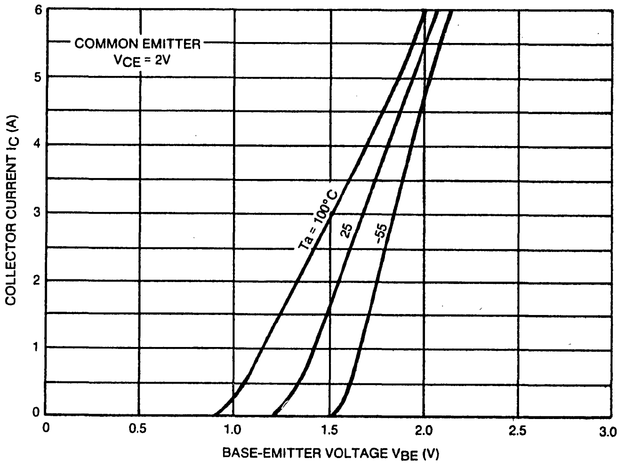


FIG. 9 I_C - V_{BE}

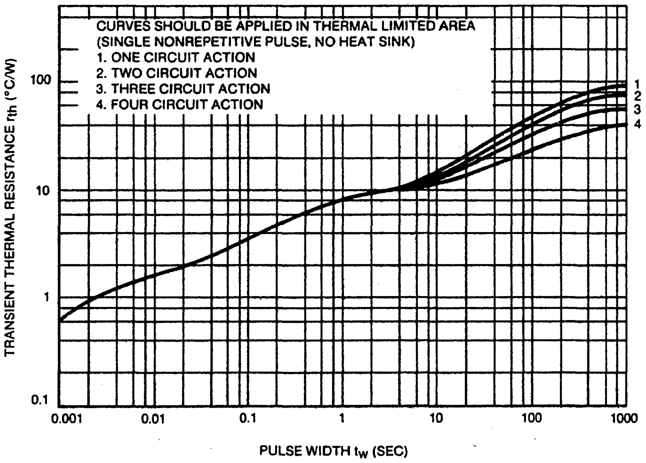


FIG. 10 rth - tw

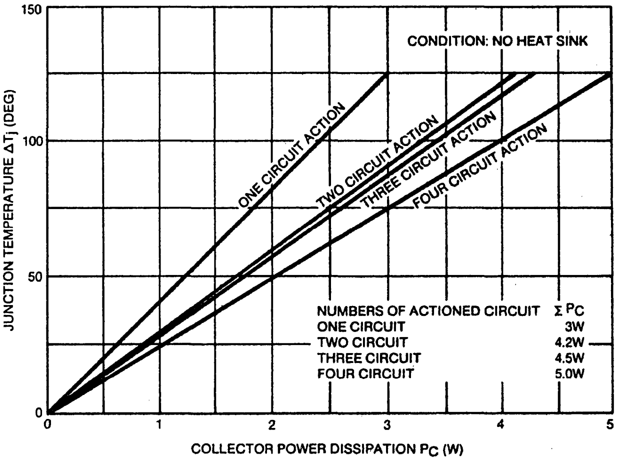


FIG. 11

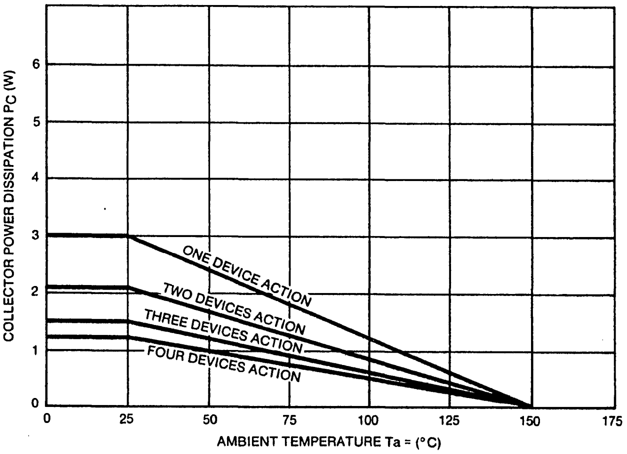


FIG. 12 P_C - Ta

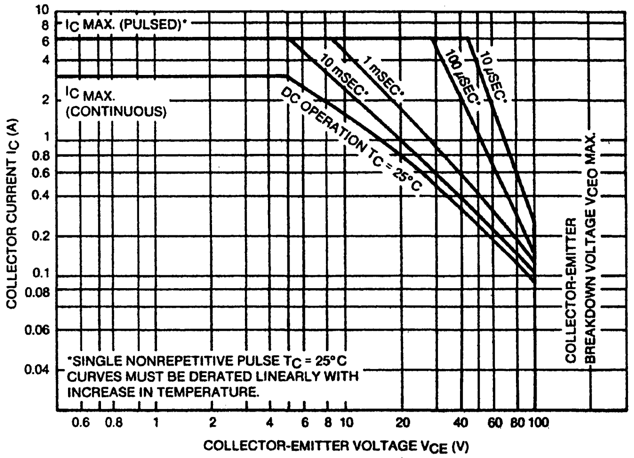


FIG. 13 SAFE OPERATING AREA

NPN POWER DARLINGTON TRANSISTOR ARRAY

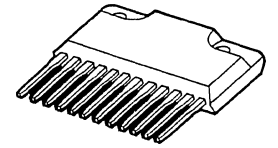
D78A3D2

100 VOLTS
3 AMP, 25 WATTS

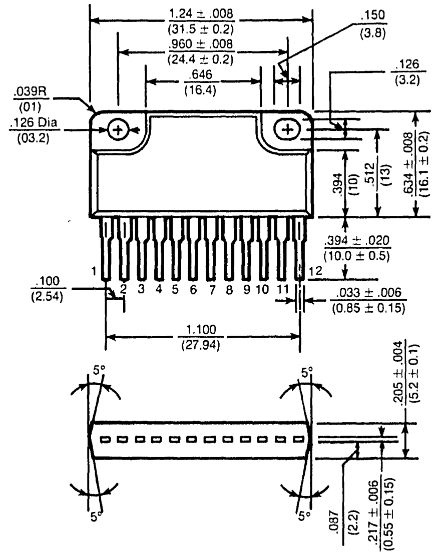
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

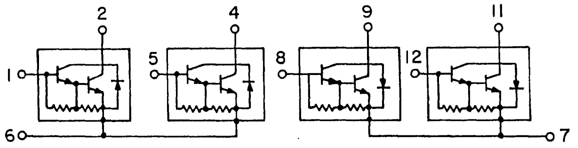
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package with heat sink (12 pin)
- High collector power dissipation: P_D = 25W @ T_A = 25°C (Four device action)
- High collector current: I_C = 3A (Max.)
- High DC current gain: h_{FE} = 2000 (Min.) @ V_{CE} = 2V, I_C = 1.5A



CASE STYLE SIP-12 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D78A3D2	UNITS
Collector-Emitter Voltage	V_{CEO}	100	Volts
Collector-Base Voltage	V_{CBO}	120	Volts
Emitter Base Voltage	V_{EBO}	6	Volts
Collector Current — Continuous Peak	I_C I_{CM}	3 6	A
Base Current — Continuous	I_B	0.5	A
Maximum Forward Current	I_{FM}	3	A
Surge Current (1 sec)	I_{FSM}	6	A
Reverse Voltage	V_R	100	A
Collector Power Dissipation (One Device Action, T_A = 25° C)	P_D	3.0	Watts
Collector Power Dissipation T_A = 25°C (Four Device Action) T_C = 25°C	P_D	5.0 25	Watts
Isolation Voltage (Between Fin to 1 ~ 12 pin)	V_{Isol}	1000	Volts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	25	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	100	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	120	—	—	Volts
Collector Cutoff Current (V_{CB} = 120V, I_E = 0)	I_{CBO}	—	—	10	μA
Collector Cutoff Current (V_{CE} = 100V, I_B = 0)	I_{CEO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	0.5	—	2.5	mA

second breakdown

Second Breakdown with Base Foward Biased	FBSOA	SEE FIGURE 13

on characteristics

DC Current Gain	h_{FE}				
(I_C = 1.5A, V_{CE} = 2V)		2000	—	12000	—
(I_C = 3A, V_{CE} = 2V)		1000	—	—	
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 3mA Duty Cycle = 1%	t_{on}	—	0.3	—	μs
Storage Time		t_{stg}	—	2	—	
Fall Time		t_f	—	0.4	—	

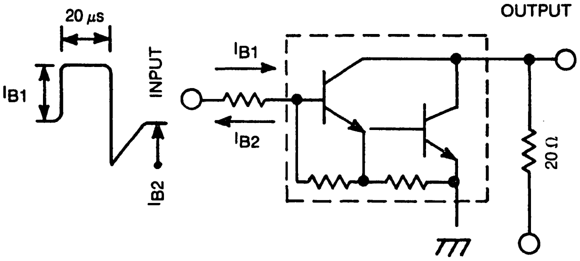


FIG. 1 SWITCHING TIME TEST CIRCUIT

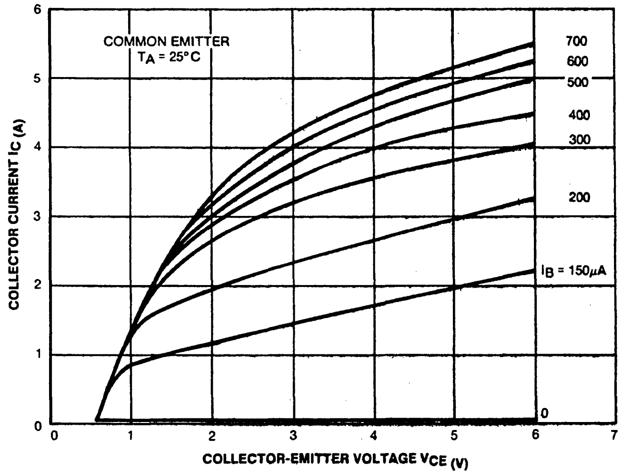


FIG. 2 IC — VCE

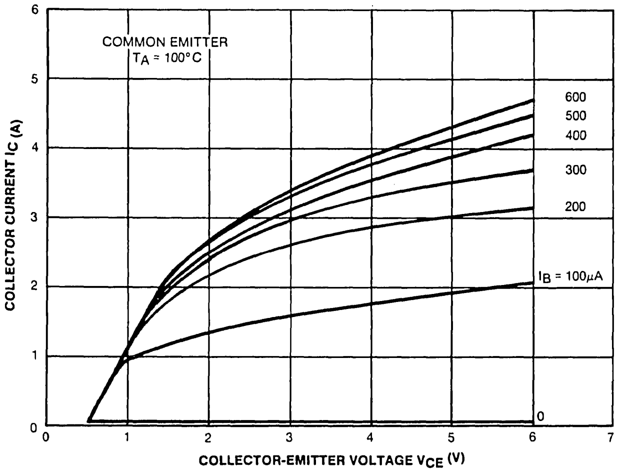


FIG. 3 I_C — V_{CE}

FIG. 4 I_C — V_{CE}

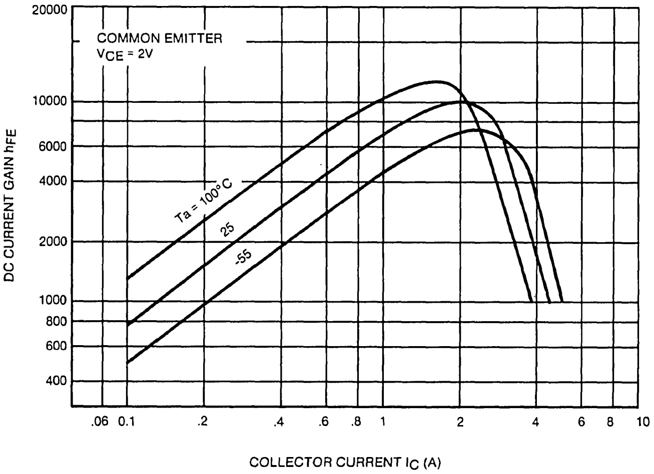


FIG. 5 h_{FE} - I_C

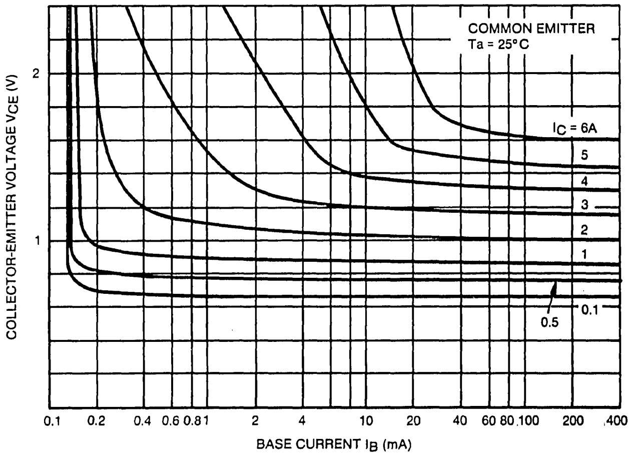


FIG. 6 I_B - V_{CE}

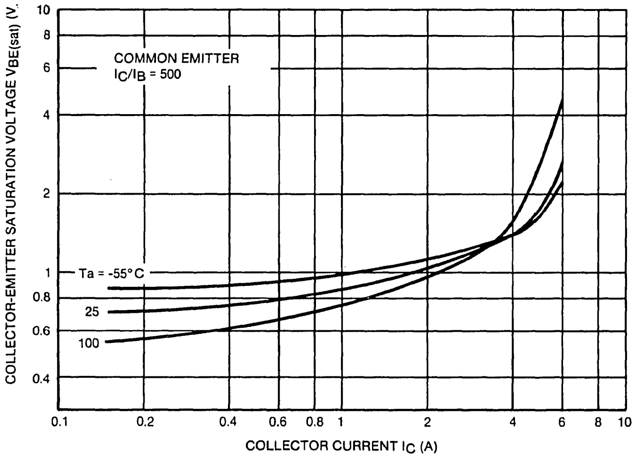


FIG. 7 $V_{CE(sat)}$ - I_C

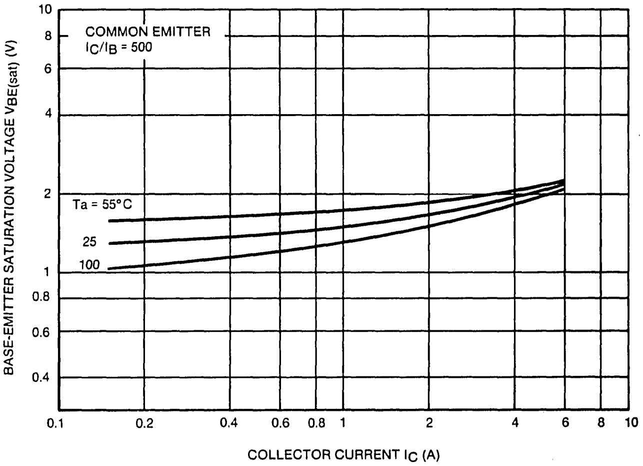


FIG. 8 $V_{BE(sat)}$ - I_C

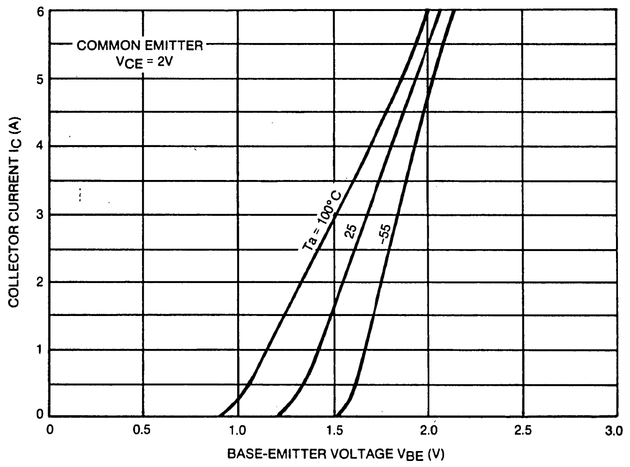


FIG. 9 **IC - VBE**

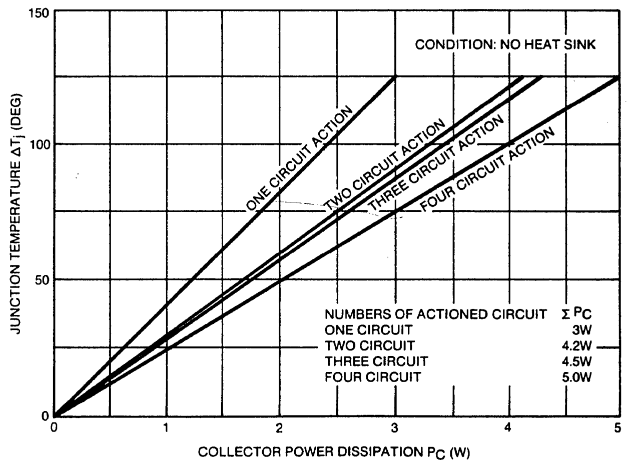


FIG. 10

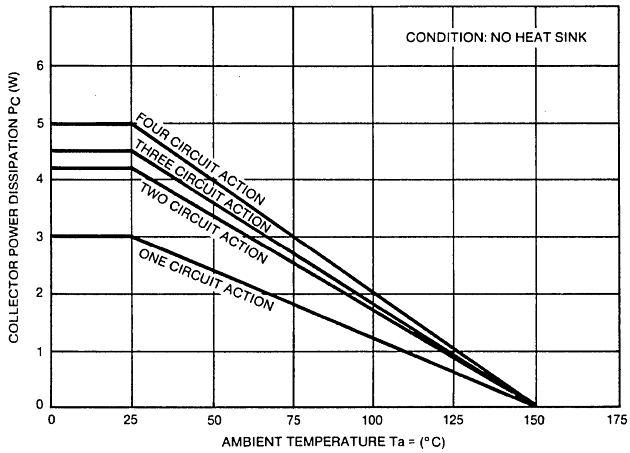


FIG. 11 TOTAL COLLECTOR POWER DISSIPATION

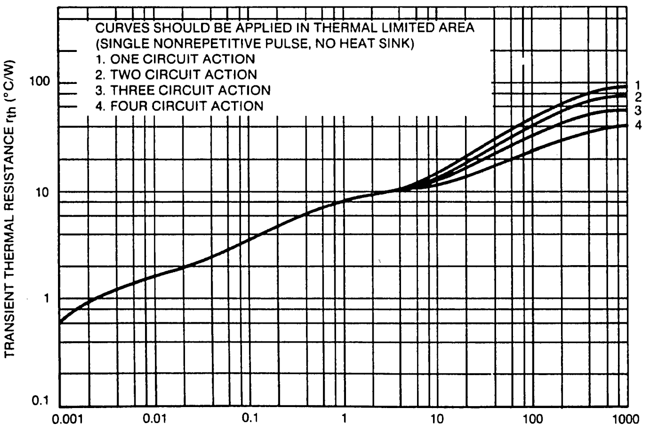


FIG. 12 **rth - tw**

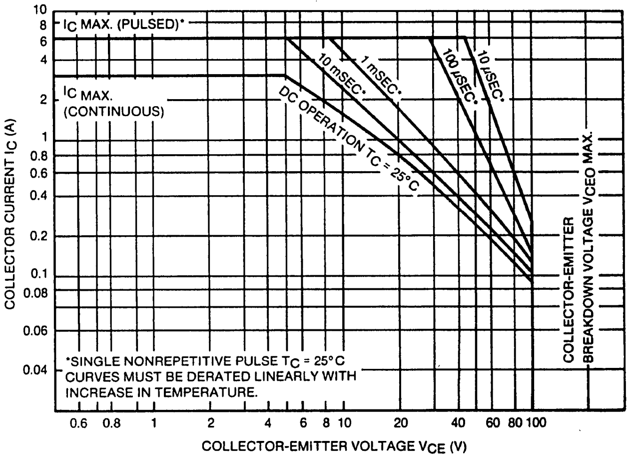


FIG. 13 SAFE OPERATING AREA

NPN/PNP POWER DARLINGTON TRANSISTOR ARRAY

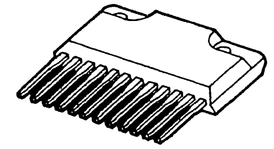
D78FY4D

80 VOLTS
4 AMP, 25 WATTS

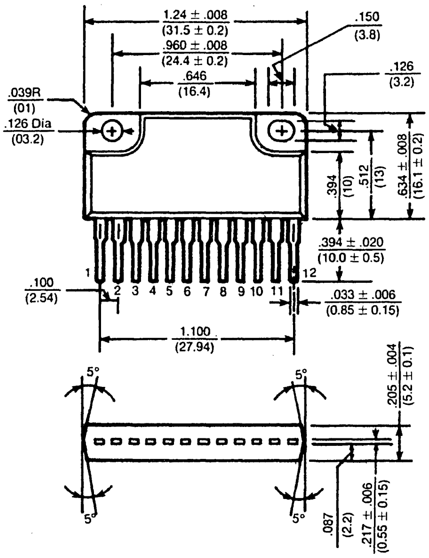
Designed for high power switching applications, hammer drive, pulse motor drive and inductive load drive applications.

Features:

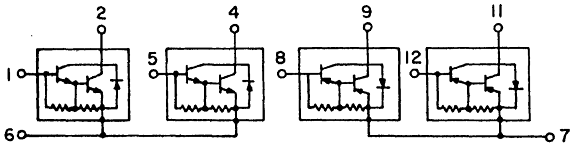
- High reliability small-sized available (4 in 1)
- Epoxy single-inline package with heat sink (12 pin)
- High collector power dissipation: $P_D = 5W$ @ $T_A = 25°C$ (Four device action)
- High collector current: $I_C = \pm 4A$ (Max.)
- High DC current gain: $h_{FE} = 2000$ (Min.) @ $V_{CE} = \pm 2V$, $I_C = \pm 1A$



CASE STYLE SIP-12 PIN
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



ARRAY CONFIGURATION



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	D78FY4D	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	4 6	A
Base Current — Continuous	I_B	0.4	A
Maximum Forward Current	I_{FM}	3	A
Surge Current (1 sec)	I_{FSM}	6	A
Reverse Voltage	V_R	80	A
Collector Power Dissipation (One Device Action, $T_A = 25°C$)	P_D	3.0	Watts
Collector Power Dissipation (Four Device Action) T_A, 25°C $T_C = 25°C$	P_D	5.0 25	Watts
Isolation Voltage (Between Fin to 1 ~ 12 pin)	V_{Isol}	1000	Volts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case (Four Device Action)	$\Sigma R_{\theta JC}$	5.0	°C/W
Thermal Resistance, Junction to Ambient (Four Device Action)	$\Sigma R_{\theta JA}$	25	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{BR(CEO)}$	80	—	—	Volts
Collector-Base Breakdown Voltage (I_C = 1mA, I_E = 0)	$V_{BR(CBO)}$	100	—	—	Volts
Collector Cutoff Current (V_{CB} = 100V, I_E = 0)	I_{CBO}	—	—	20	µA
Collector Cutoff Current (V_{CE} = 80V, I_B = 0)	I_{CEO}	—	—	20	µA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	2.5	mA

on characteristics

DC Current Gain (I_C = 1A, V_{CE} = 2V) (I_C = 3A, V_{CE} = 2V)	h_{FE}	2000 1000	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{CE(sat)}$	—	—	1.5	Volts
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{BE(sat)}$	—	—	2.0	Volts

switching characteristics

Turn-on Time	V_{CC} = 30V I_{B1} = $-I_{B2}$ = 6mA Duty Cycle = 1%	t_{on}	—	0.2	—	µs
Storage Time		t_{stg}	—	1.5	—	
Fall Time		t_f	—	0.6	—	

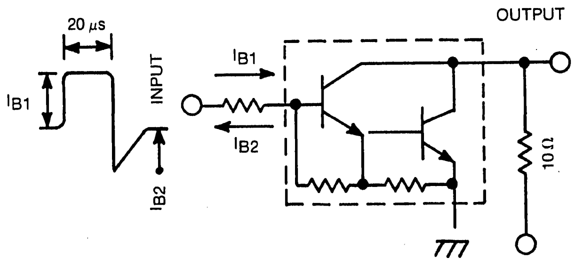


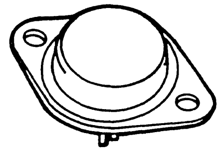
FIG. 1 SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

GE10000-
GE10009

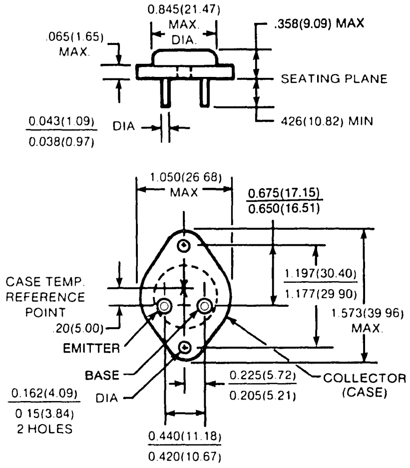
500 VOLTS
10-20 AMPS, 175 WATTS

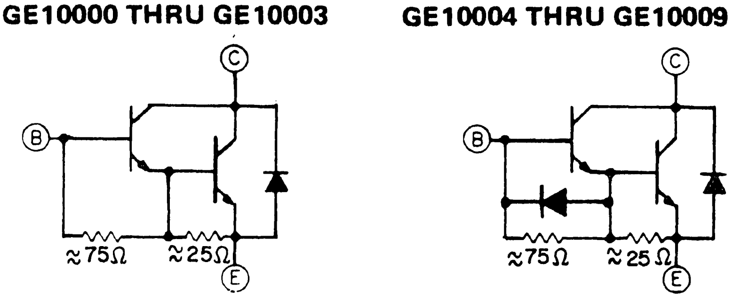
These devices are designed for use in high speed switching applications, such as off-line switching power supplies, AC & DC motor control, UPS systems, ultrasonic equipment and other high frequency power conversion equipment.



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





GE10000 THRU GE10003 **GE10004 THRU GE10009**

DEVICE CIRCUIT

absolute maximum ratings (25° C)
(unless otherwise specified)

Voltages	GE 10000	GE 10001	GE 10002	GE 10003	GE 10004	GE 10005	GE 10006	GE 10007	GE 10008	GE 10009	Units
$V_{CEO(SUS)}$	350	400	350	400	350	400	350	400	450	500	Volts
V_{CEX}, (T_C = 100° C)	400	450	400	450	400	450	400	450	450	500	
V_{CEV}	450	500	450	500	450	500	450	500	650	700	Volts
V_{EBO}	8	8	8	8	8	8	8	8	8	8	Volts
Currents											
I_C	20	20	10	10	20	20	10	10	20	20	Amps
I_{CM}	30	30	20	20	30	30	20	20	30	30	Amps
I_B	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Amps
I_{BM}	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	Amps
Power Dissipation											
P_D(T_C = 25°C)	175	175	150	150	175	175	150	150	175	175	Watts
P_D(T_C = 100°C)	100	100	85	85	100	100	85	85	100	100	Watts
Derate above 25° C	1.0	1.0	.86	.86	1.0	1.0	.86	.86	1.0	1.0	W/°C
Temperatures											
T_{stg} and T_J	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	°C
T_L[1]	+275	+275	+275	+275	+275	+275	+275	+275	+275	+275	°C
Thermal Resistance	1.0	1.0	1.17	1.17	1.0	1.0	1.17	1.17	1.0	1.0	°C/Watt

1) Max. Lead Temperature for soldering purposes 1/8" from case for 5 seconds.

device electrical characteristics

(Test Conditions in Next Section; T_C = 25°C Except as Notes)

STATIC		GE 10000	GE 10001	GE 10002	GE 10003	GE 10004	GE 10005	GE 10006	GE 10007	GE 10008	GE 10009	Units
(1) $V_{CEO(SUS)}$	Min.	350	400	350	400	350	400	350	400	450	500	Volts
(2) $V_{CEX(SUS)}$, (T_C = 100°C)	Min.	400	450	400	450	400	450	400	450	450	500	Volts
(3) $V_{CEX(SUS)}$, (T_C = 100°C)	Min.	295	345	315	365	295	345	315	365	295	345	Volts
(4) I_{CEV}	Max.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	mA
I_{CEV}, (T_C = 150°C)	Max.	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	mA
(5) I_{CER}, (T_C = 100°C)	Max.	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	mA
(6) I_{EBO}	Max.	200	200	200	200	200	200	200	200	200	200	mA
(7) $I_{s/b}$	See Figure	15	15	16	16	15	15	16	16	17	17	
(8) h_{FE}	Min. Max.	50 600	50 600	40 500	40 500	50 600	50 600	40 500	40 500	40 400	40 400	
(9) h_{FE}	Min. Max.	40 400	40 400	30 300	30 300	40 400	40 400	30 300	30 300	30 300	30 300	
(10) $V_{CE(SAT)}$	Max.	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	Volts
(11) $V_{CE(SAT)}$	Max.	3.0	3.0	2.9	2.9	3.0	3.0	2.9	2.9	3.5	3.5	Volts
(12) $V_{CE(SAT)}$, (T_C = 100°C)	Max.	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5	Volts
(13) $V_{BE(SAT)}$	Max.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Volts
$V_{BE(SAT)}$, (T_C = 100°C)	Max.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Volts
(14) DIODE V_F	Typ. Max.	1.95 5.0	1.95 5.0	1.5 5.0	1.5 5.0	1.95 5.0	1.95 5.0	1.5 5.0	1.5 5.0	1.95 5.0	1.95 5.0	Volts Volts
DYNAMIC												
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{TEST} = 1MHz)	Typ. Max.	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	pF pF
SWITCHING												
(1) Resistive t_d	Typ. Max.	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.04 .25	.04 .25	μs μs
t_r	Typ. Max.	.23 .60	.23 .60	.14 .40	.14 .40	.22 .60	.22 .60	.11 .40	.11 .40	.18 1.0	.18 1.0	μs μs
t_s	Typ. Max.	1.7 3.5	1.7 3.5	1.5 3.0	1.5 3.0	1.2 1.5	1.2 1.5	1.3 1.5	1.3 1.5	1.2 2.0	1.2 2.0	μs μs
t_f	Typ. Max.	.85 2.4	.85 2.4	.40 1.5	.40 1.5	.25 .50	.25 .50	.15 .50	.15 .50	.20 .60	.20 .60	μs μs
(2) Inductive (T_C = 100°C) t_s	Typ. Max.	4.4 6.5	4.4 6.5	4.2 6.0	4.2 6.0	2.9 4.0	2.9 4.0	3.2 4.0	3.2 4.0	3.0 4.0	3.0 4.0	μs μs
t_f	Typ. Max.	.54 1.5	.54 1.5	.39 1.5	.39 1.5	.19 1.0	.19 1.0	.18 1.0	.18 1.0	.20 1.0	.20 1.0	μs μs
t_c	Typ. Max.	1.7 3.0	1.7 3.0	1.0 2.5	1.0 2.5	.62 1.5	.62 1.5	.46 1.5	.46 1.5	.60 1.5	.60 1.5	μs μs
(3) Inductive t_s	Typ.	2.2	2.2	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	μs
t_f	Typ.	.30	.30	.20	.20	.10	.10	.10	.10	.10	.10	μs
t_c	Typ.	1.0	1.0	.50	.50	.30	.30	.22	.22	.30	.30	μs

STATIC TEST CONDITIONS

(1) $V_{CEX(SUS)}$	APPLIES TO
a) I_C = 250mA, I_B = 0, V_{CLAMP} = V_{CEO} Rated	GE10000 Thru GE10007
b) I_C = 100mA, I_B = 0, V_{CLAMP} = V_{CEO} Rated	GE10008, 9

(2) $V_{CEX(SUS)}$	APPLIES TO
a) I_C = 2A, V_{CLAMP} = V_{CEX} Rated	GE10000, 1, 4, 5, 8, 9
b) I_C = 1A, V_{CLAMP} = V_{CEX} Rated	GE10002, 3, 6, 7

(3) $V_{CEX(SUS)}$	APPLIES TO
a) I_C = 10A, V_{CLAMP} = V_{CEX} Rated	GE10000, 1, 4, 5, 8, 9
b) I_C = 5A, V_{CLAMP} = V_{CEX} Rated	GE10002, 3, 6, 7

(4) I_{CEV}	APPLIES TO
V_{CEV} = Rated Valve, V_{BE} = 1.5V	All

(5) I_{CER}	APPLIES TO
V_{CE} = Rated Valve, R_{BE} = 50Ω	All

(6) I_{EBO}	APPLIES TO
V_{EB} = 8V, I_C = 0	GE10000, 1, 2, 3
V_{EB} = 2V, I_C = 0	GE10004, 5, 6, 7, 8, 9

(7) $I_{s/b}$ SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE

(8) h_{FE}	APPLIES TO
(a) I_C = 5A, V_{CE} = 5V	GE10000, 1, 4, 5, 8, 9
(b) I_C = 2.5A, V_{CE} = 5V	GE10002, 3, 6, 7

(9) h_{FE}	APPLIES TO
I_C = 10A, V_{CE} = 5V	GE10000, 4, 5, 8, 9
I_C = 5A, V_{CE} = 5V	GE10002, 3, 6, 7

(10) $V_{CE(SAT)}$	APPLIES TO
a) I_C = 10A, I_B = .4A	GE10000, 1, 4, 5
b) I_C = 5A, I_B = .25A	GE10002, 3, 6, 7
c) I_C = 5A, I_B = .5A	GE10008, 9

(11) $V_{CE(SAT)}$	APPLIES TO
a) I_C = 20A, I_B = 1A	GE10000, 1, 4, 5
b) I_C = 10A, I_B = 1A	GE10002, 3, 6, 7
c) I_C = 20A, i_B = 2A	GE10008, 9

(12) $V_{CE(SAT)}$
SAME AS (10) BUT T_C = 100°C

(13) $V_{BE(SAT)}$	APPLIES TO
a) I_C = 10A, I_B = .4A	GE10000, 1, 4, 5
b) I_C = 5A, I_B = .25A	GE10002, 3, 6, 7
c) I_C = 10A, I_B = .5A	GE10008, 9

(14) DIODE V_F	APPLIES TO
a) I_F = 10A	GE10000, 4, 5, 8, 9
b) I_F = 5A	GE10002, 3, 6, 7

SWITCHING TEST CONDITIONS

(1) RESISTIVE — APPLIES TO

V_{CC}=250V, t_p=50μs, Duty ≤ 2%

a) I_C = 10A, I_{B1} = .4A, I_{B2} = 1.6A — GE10000, 1, 4, 5

b) I_C = 5A, I_{B1} = .25A, I_{B2} = 1A — GE10002, 3, 6, 7

c) I_C = 10A, I_{B1} = .5A, I_{B2} = 2A — GE10008, 9

(2) INDUCTIVE — APPLIES TO

V_{CLAMP} = 250V, L = 100μh, T_C = 100°C

a) I_C = 10A, I_{B1} = .4A, I_{B2} = 1.6A — GE10000, 1, 4, 5

b) I_C = 5A, I_B = .25A, I_{B2} = 1A — GE10002, 3, 6, 7

c) I_C = 10A, I_B = .5A, I_{B2} = 2A — GE10008, 9

(3) INDUCTIVE

SAME AS (2), BUT T_C = 25°C

NOTE: See FIGURE 24 for Switching Time Test Circuit.

TYPICAL CHARACTERISTICS

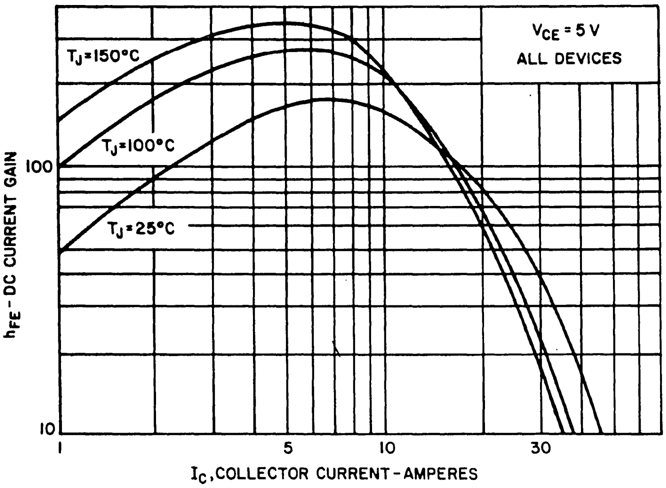


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

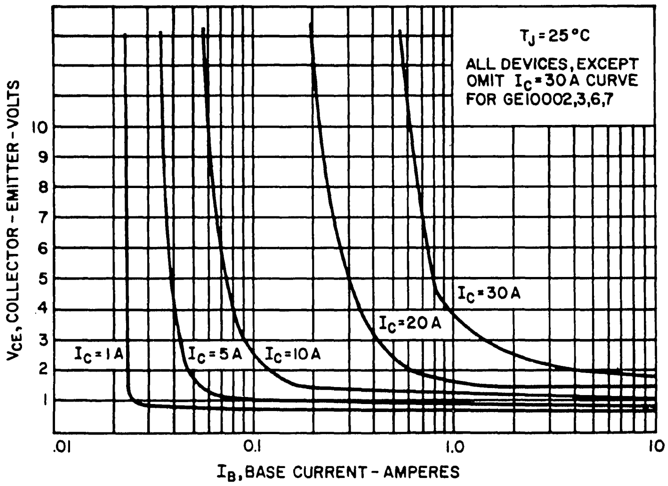


FIGURE 2. COLLECTOR SATURATION REGION

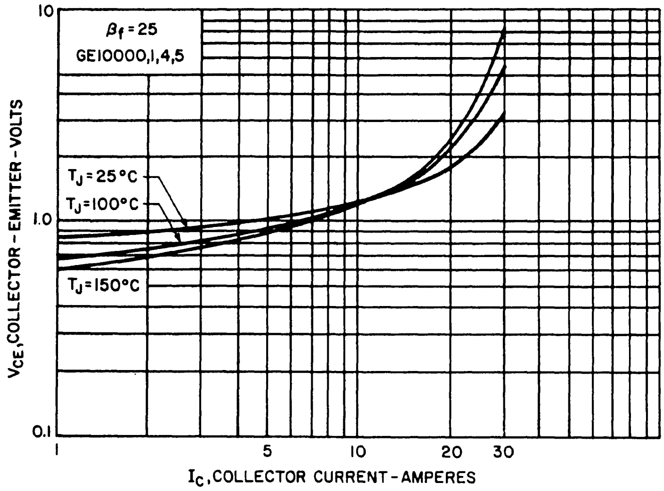


FIGURE 3. $V_{CE\ (SAT)}$ VS I_C

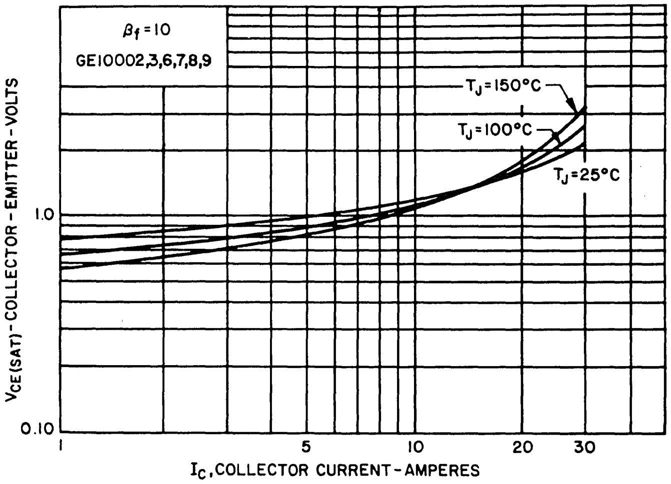


FIGURE 4. I_C COLLECTOR CURRENT (AMPERES)

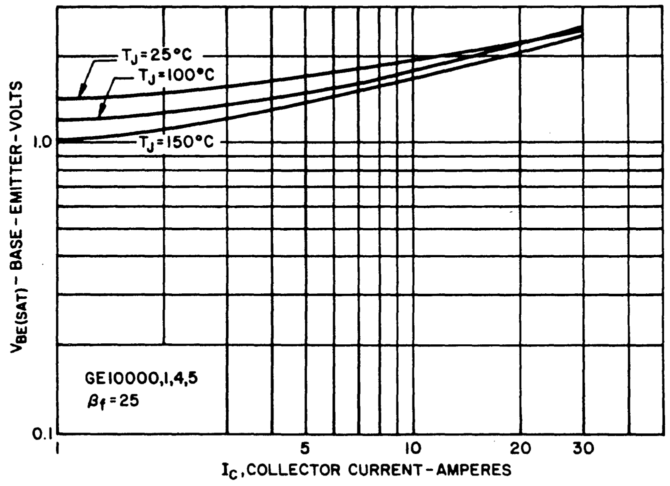


FIGURE 5. $V_{BE\ (SAT)}$ VS I_C

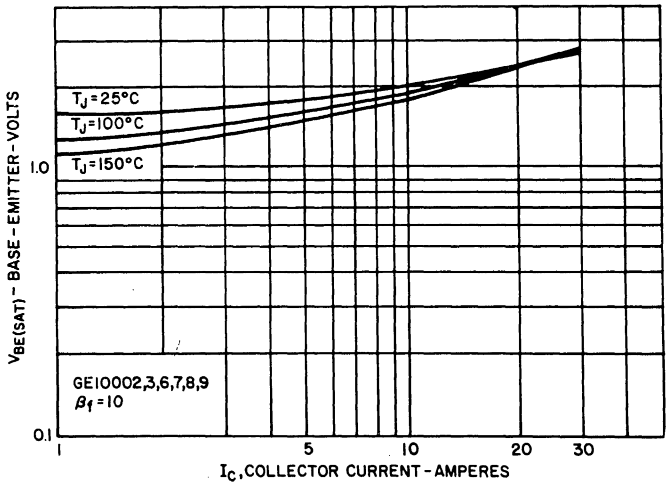


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C

TYPICAL CHARACTERISTICS

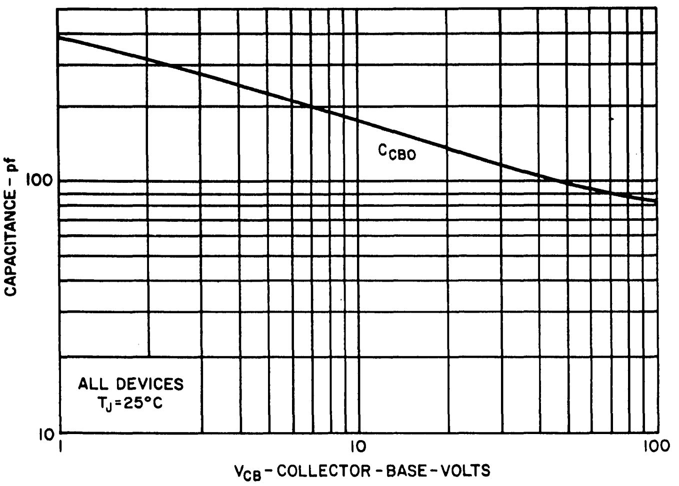


FIGURE 7. CAPACITANCE (C_{CBO})

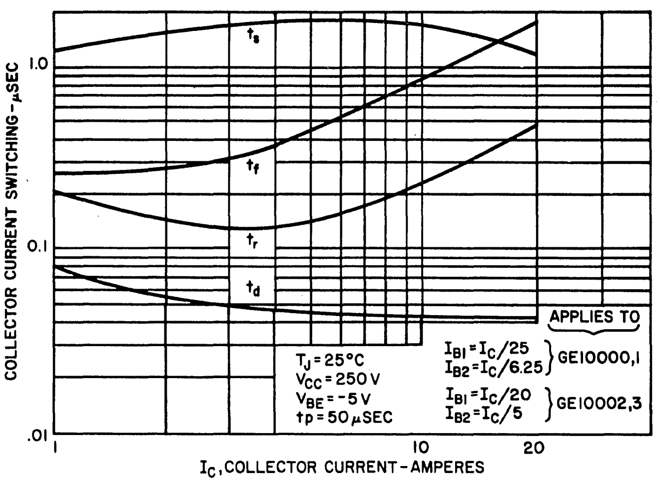


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

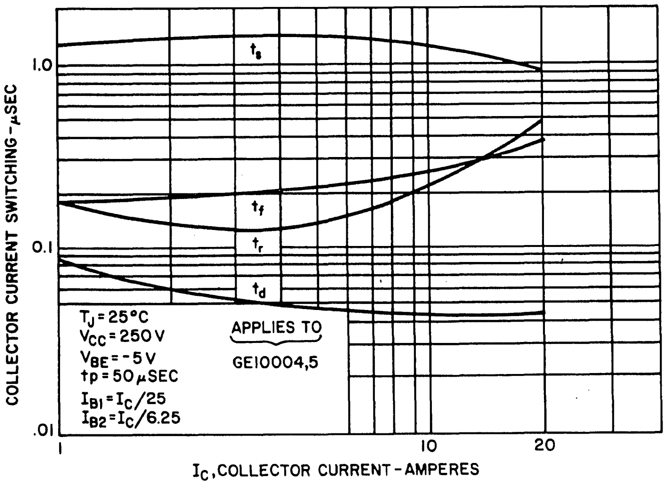


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

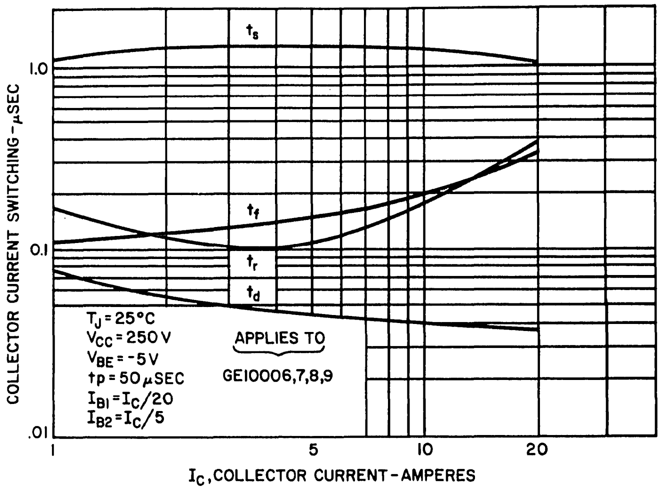


FIGURE 10. RESISTIVE SWITCHING PERFORMANCE

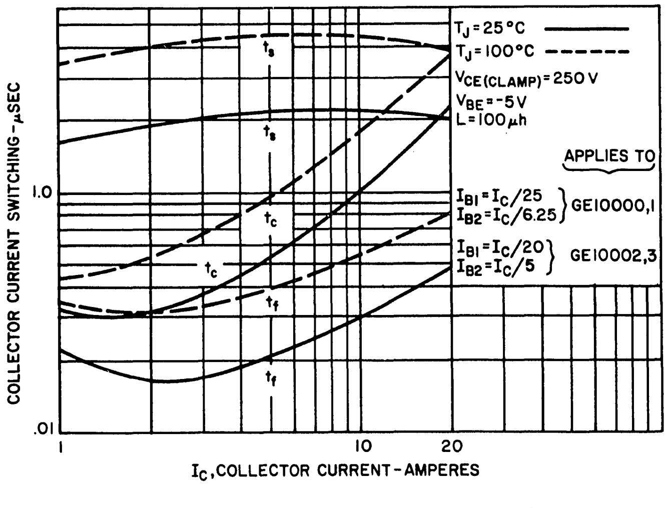


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

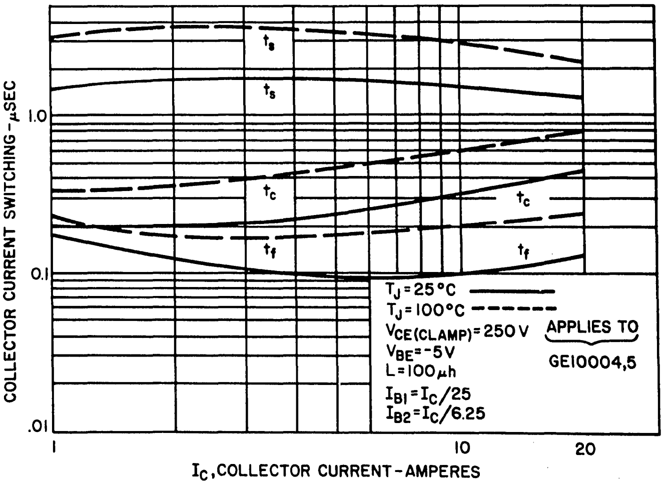


FIGURE 12. INDUCTIVE SWITCHING PERFORMANCE

TYPICAL CHARACTERISTICS

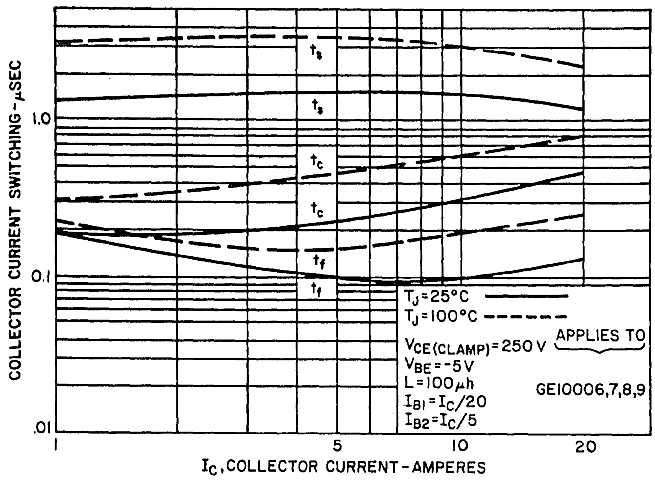


FIGURE 13. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

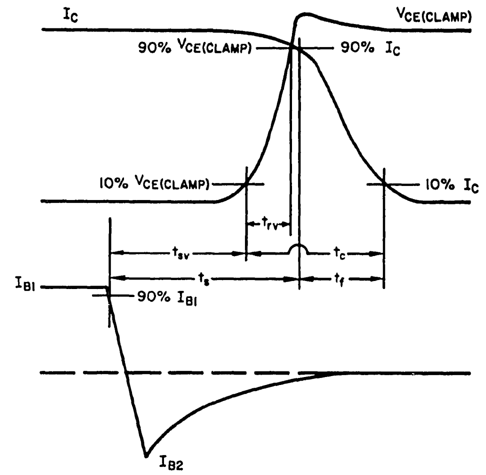


FIGURE 14. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

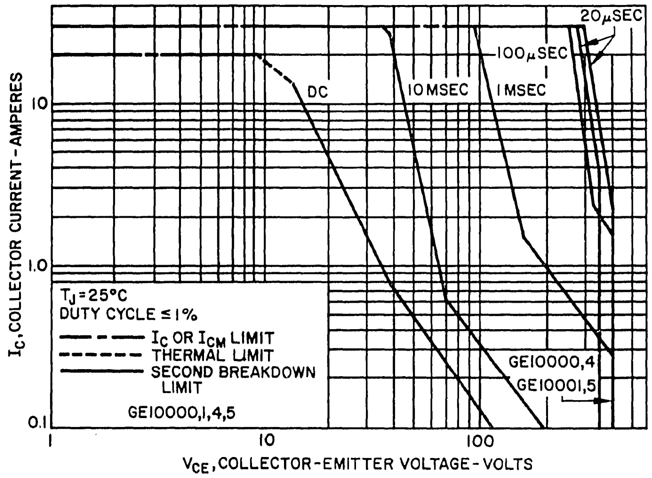


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

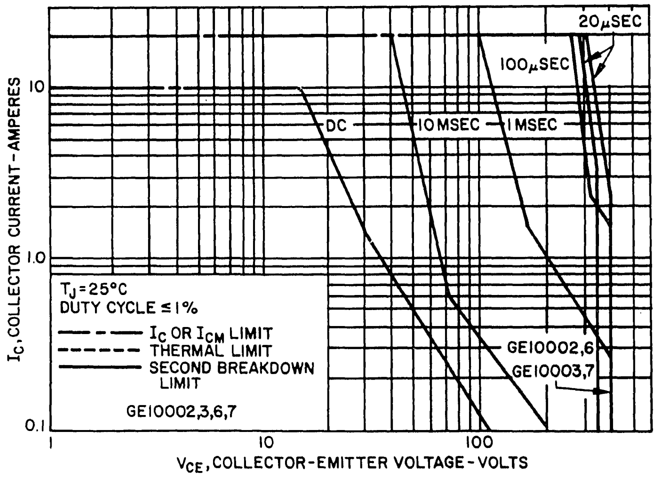


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

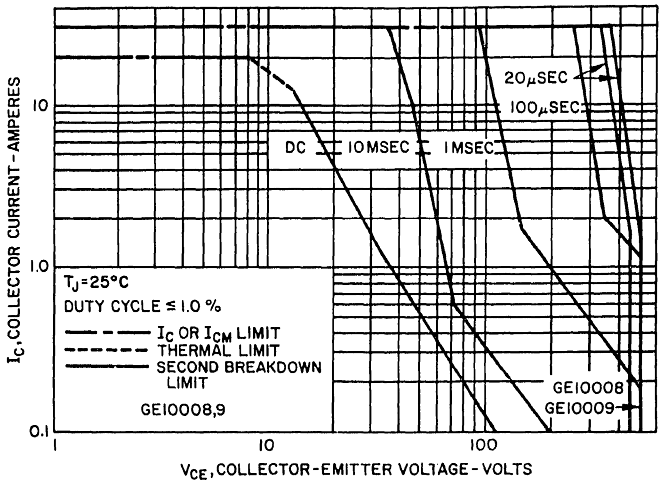


FIGURE 17. FORWARD BIAS SAFE OPERATING AREA

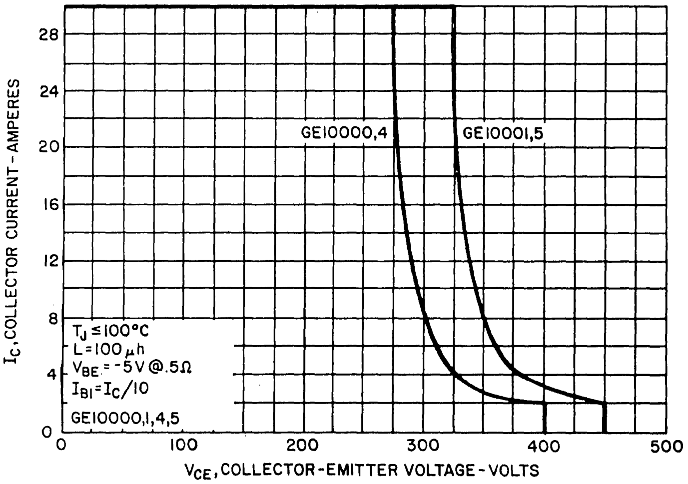


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

TYPICAL CHARACTERISTICS

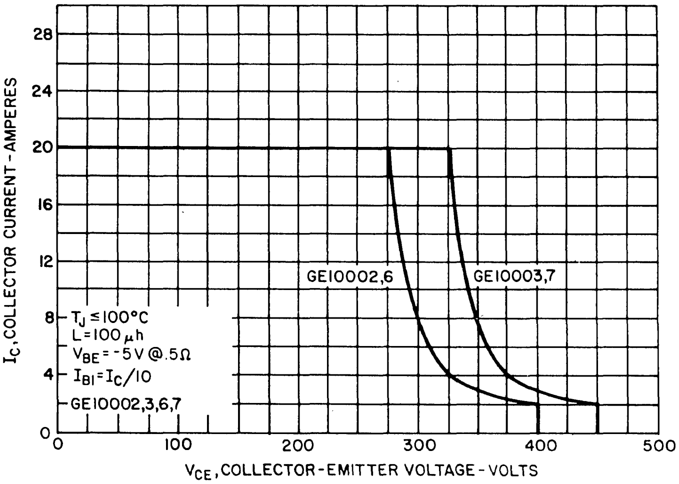


FIGURE 19. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

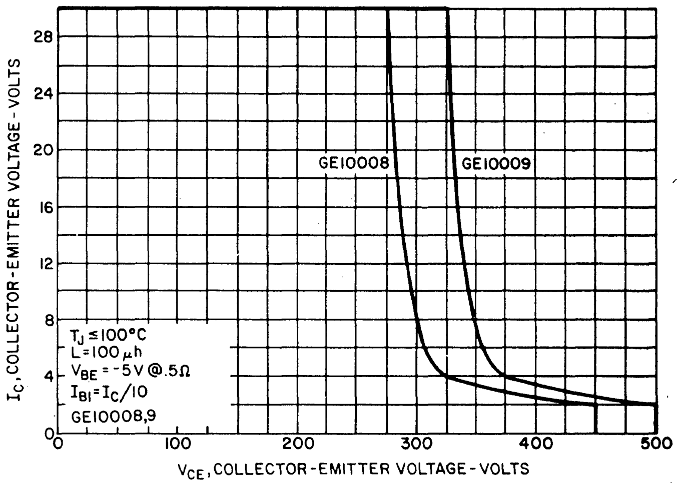


FIGURE 20. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

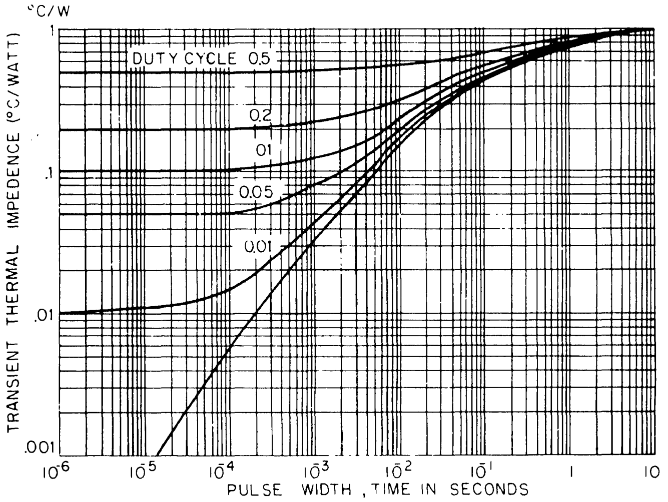


FIGURE 21. TRANSIENT THERMAL RESPONSE

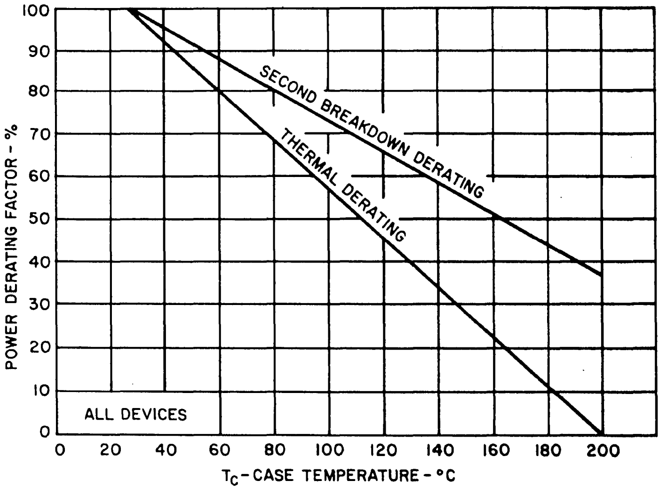


FIGURE 22. POWER DERATING

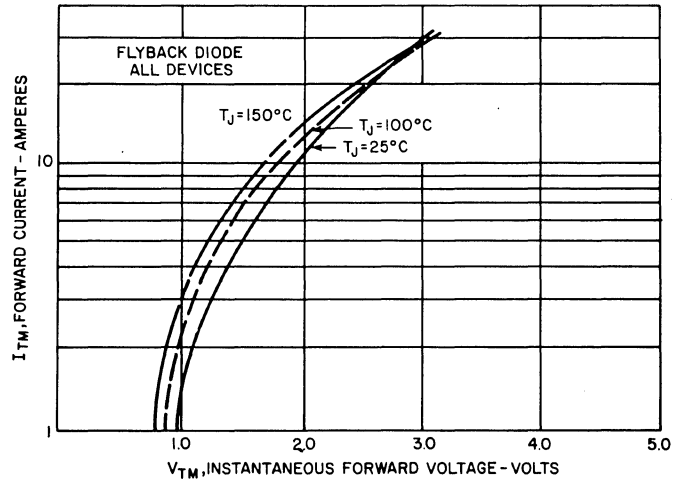


FIGURE 23. FORWARD CHARACTERISTICS

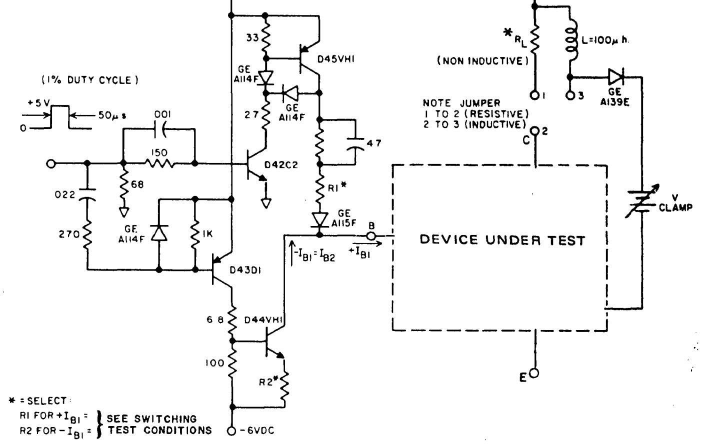


FIGURE 24. SWITCHING TIME TEST CIRCUIT

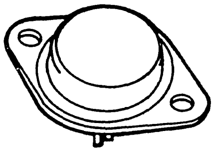
HIGH SPEED

NPN POWER DARLINGTON TRANSISTORS

GE10015,16, 20,21,22,23

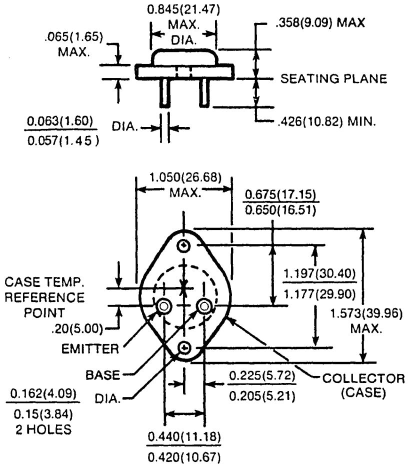
500 VOLTS
40-60 AMPS, 250 WATTS

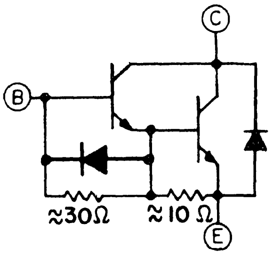
These devices are designed for use in high speed switching applications, such as off-line switching power supplies, AC & DC motor control, UPS systems, ultra sonic equipment and other high frequency power conversion equipment.



CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





DEVICE CIRCUIT

absolute maximum ratings (25° C) (unless otherwise specified)

Voltages	Symbol	GE 10015	GE 10016	GE 10020	GE 10021	GE 10022	GE 10023	Units
Collector Emitter	$V_{CEO(SUS)}$	400	500	200	250	350	400	Volts
Collector Emitter	V_{CEV}	600	700	300	350	450	600	Volts
Emitter Base	V_{EBO}	8.0	8.0	8.0	8.0	8.0	8.0	Volts
Currents								
Collector Current (continuous)	I_C	50	50	60	60	40	40	Amps
Collector Current (peak)	I_{CM}	75	75	100	100	60	60	Amps
Base Current (continuous)	I_B	10	10	20	20	20	20	Amps
Base Current (peak)	I_{BM}	15	15	30	30	30	30	Amps
Power Dissipation								
Power Dissipation	$P_D(T_C = 25°C)$	250	250	250	250	250	250	Watts
Power Dissipation	$P_D(T_C = 100°C)$	143	143	143	143	143	143	Watts
	Derate above 25° C	1.43	1.43	1.43	1.43	1.43	1.43	W/° C
Temperatures								
Storage and Junction	T_{stg} and T_J	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	° C
Soldering[1]	T_L[1]	+275	+275	+275	+275	+275	+275	°C
Thermal Resistance	$R_{\theta JC}$	0.7	0.7	0.7	0.7	0.7	0.7	°C/Watt

1) Max. lead temperature for soldering purposes 1/8" from case for 5 seconds.

device electrical characteristics

(Test Conditions in Next Section; T_C = 25°C Except as Notes)

STATIC		**GE 10015**	**GE 10016**	**GE 10020**	**GE 10021**	**GE 10022**	**GE 10023**	**Units**
(1) $V_{CEO(SUS)}$	Min.	400	500	200	250	350	400	Volts
(2) I_{CEV} I_{CEV} (T_C = 150°C)	Max. Max.	.25 5.00	.25 5.00	.25 5.00	.25 5.00	.25 5.00	.25 5.00	mA mA
(3) I_{EBO}	Max.	350	350	175	175	175	175	mA
(4) $I_{s/b}$	See Figure	13	13	14	14	15	15	
(5) h_{FE}	Min. Max.	25 —	25 —	75 1000	75 1000	50 600	50 600	
(6) h_{FE}	Min. Max.	10 —	10 —	— —	— —	— —	— —	
(7) $V_{CE(SAT)}$	Max.	2.2	2.2	2.2	2.2	2.2	2.2	Volts
(8) $V_{CE(SAT)}$	Max.	5	5	4	4	5	5	Volts
(9) $V_{CE(SAT}$	Max.	2.5	2.5	2.4	2.4	2.5	2.5	Volts
(10) $V_{BE(SAT}$	Max.	2.75	2.75	3.00	3.00	2.5	2.5	Volts
(11) $V_{BE(SAT)}$, (T_C = 100°C)	Max.			3.5	3.5	2.5	2.5	Volts
(12) DIODE V_F	Typ. Max.	1.9 5.0	1.9 5.0	2.1 5.0	2.1 5.0	1.9 5.0	1.9 5.0	Volts Volts
DYNAMIC								
OUTPUT CAPACITANCE (V_{CB} = 10V, I_E = 0, f_{TEST} = 1MHz)	Typ. Max.	580 750	580 750	580 750	580 750	580 750	580 750	pF pF
SWITCHING								
(1) Resistive t_d	Typ. Max.	.09 .30	.09 .30	.095 .20	.095 .20	.09 .25	.09 .25	μs μs
t_r	Typ. Max.	.20 1.00	.20 1.00	.32 1.00	.32 1.00	.20 1.00	.20 1.00	μs μs
t_s	Typ. Max.	1.45 2.5	1.45 2.5	1.50 3.5	1.50 3.5	1.45 2.5	1.45 2.5	μs μs
t_f	Typ. Max.	.25 1.0	.25 1.0	.30 .50	.30 .50	.25 .90	.25 .90	μs μs
(2) Inductive (T_C = 100°C) t_s	Typ. Max.	2.8 —	2.8 —	2.7 4.5	2.7 4.5	2.8 5.0	2.8 5.0	μs μs
t_f	Typ. Max.	.21 —	.21 —	.30 1.0	.30 1.0	.21 1.0	.21 1.0	μs μs
t_c	Typ. Max.	.68 —	.68 —	.85 2.0	.85 2.0	.68 2.0	.68 2.0	μs μs
(3) Inductive (T_C = 25°C) t_s	Typ. Max.	1.6 3.0	1.6 3.0	1.8 —	1.8 —	1.6 —	1.6 —	μs μs
t_f	Typ. Max.	.10 .50	.10 .50	.12 —	.12 —	.10 —	.10 —	μs μs
t_c	Typ. Max.	.30 1.0	.30 1.0	.40 —	.40 —	.30 —	.30 —	μs μs

TEST CONDITIONS

STATIC

(1) $V_{CEO(SUS)}$	APPLIES TO
$I_C = 100mA$,	All
$V_{CLAMP} = V_{CEO}$ Rated	

(2) I_{CEV}	APPLIES TO
V_{CEV} = Rated Valve,	All
$V_{BE} = -1.5V$	

(3) I_{EBO}	APPLIES TO
I_{EB} = 2.0 Volts	All

(4) $I_{s/b}$
SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE

(5) h_{FE}	APPLIES TO
(a) $I_C = 10A$, $V_{CE} = 5V$	GE10022, 23
(b) $I_C = 15A$, $V_{CE} = 5V$	GE10020, 21
(c) $I_C = 20A$, $V_{CE} = 5V$	GE10015, 16

(6) h_{FE}	APPLIES TO
$I_C = 40A$, $V_{CE} = 5V$	GE10015, 16

(7) $V_{CE(SAT)}$	APPLIES TO
a) $I_C = 20A$, $I_B = 1A$	GE10015, 16, 22, 23
b) $I_C = 30A$, $I_B = 1.2A$	GE10020, 21

(8) $V_{CE(SAT)}$	APPLIES TO
(a) $I_C = 40A$, $V_{CE} = 5V$	GE10022, 23
(b) $I_C = 50A$, $V_{CE} = 10V$	GE10015, 16
(c) $I_C = 60A$, $V_{CE} = 5V$	GE10020, 21

(9) $V_{CE(SAT)}$	APPLIES TO
(a) $I_C = 20A$, $I_B = 1A$	GE10015, 16, 22, 23
(b) $I_C = 30A$, $I_B = 1.2A$	GE10020, 21

(10) $V_{BE(SAT)}$	APPLIES TO
(a) $I_C = 20A$, $I_B = 1A$	GE10015, 16, 22, 23
(b) $I_C = 30A$, $I_B = 1.2A$	GE10020, 21

(11) $V_{BE(SAT)}$
SAME AS (10) BUT $T_C = 100°C$

(12) DIODE V_F	APPLIES TO
a) $I_F = 20A$	GE10015, 16, 22, 23
b) $I_F = 30A$	GE10020, 21

SWITCHING

(1) RESISTIVE	APPLIES TO
$t_p = 50\mu s$, Duty Cycle $\leq 2\%$	
a) $V_{CC} = 250V$, $I_C = 20A$, $I_{B1} = 1A$, $I_{B2} = 4A$	GE10015, 16, 22, 23
b) $V_{CC} = 175V$, $I_C = 30A$, $I_{B1} = 1A$, $I_{B2} = 4A$	GE10020, 21

(2) INDUCTIVE	APPLIES TO
$L = 100\mu h$, $I_{B1} = 1A$, $I_{B2} = 4A$, $T_C = 100°C$	
a) $I_C = 20A$, $V_{CLAMP} = 250V$	GE10015, 16, 22, 23
b) $I_C = 30A$, $V_{CLAMP} = 175V$	GE10020, 21

(3) INDUCTIVE
SAME AS (2), BUT $T_C = 25°C$

NOTE: See FIGURE 22 for Switching Time Test Circuit.

TYPICAL CHARACTERISTICS

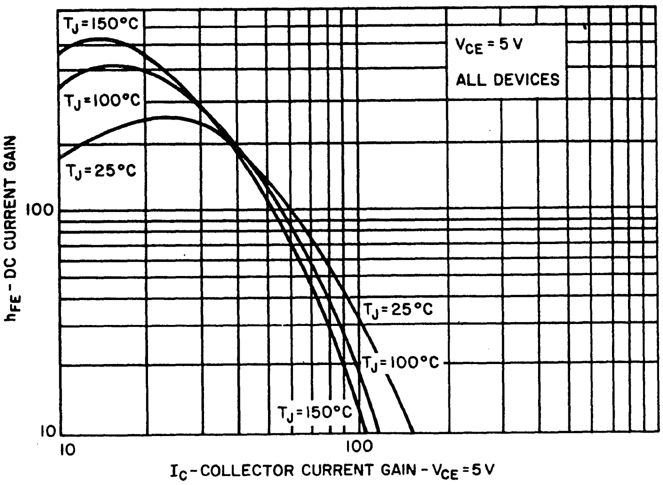


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

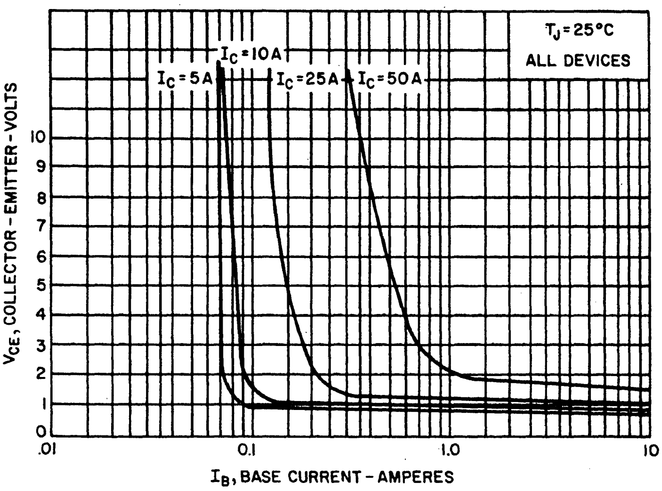


FIGURE 2. COLLECTOR SATURATION REGION

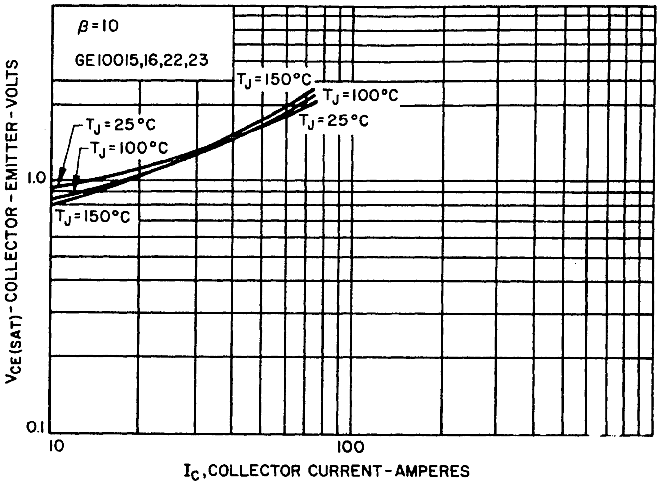


FIGURE 3. $V_{CE\ (SAT)}$ VS I_C

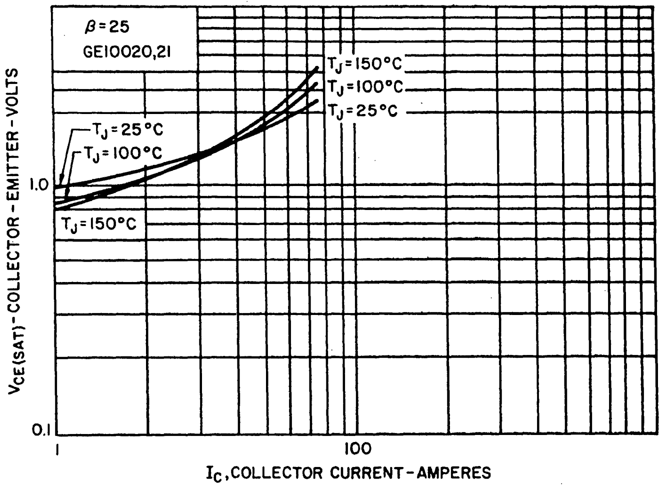


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C

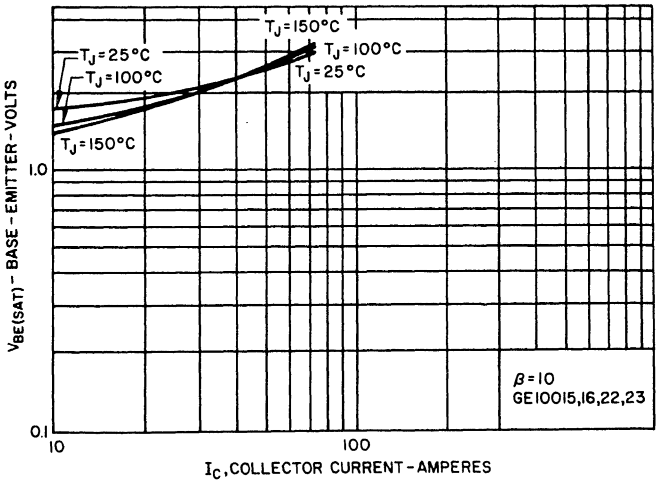


FIGURE 5. $V_{BE\ (SAT)}$ VS I_C

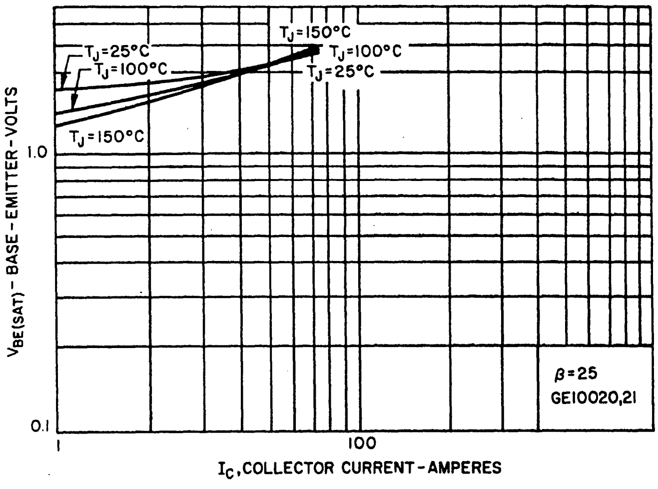


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C

TYPICAL CHARACTERISTICS

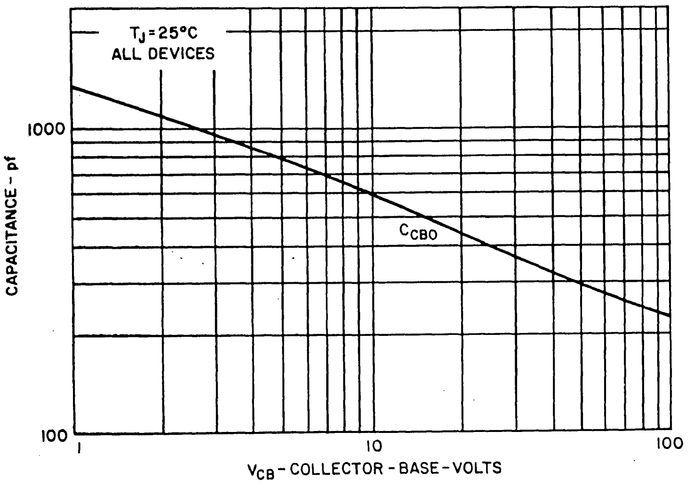


FIGURE 7. CAPACITANCE (C_{CBO})

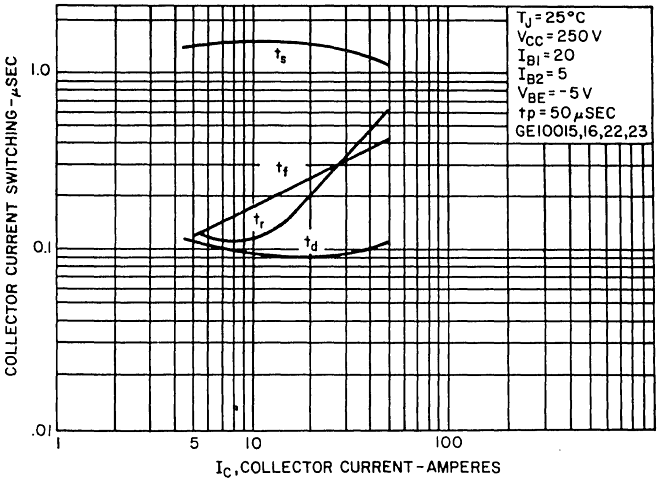


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

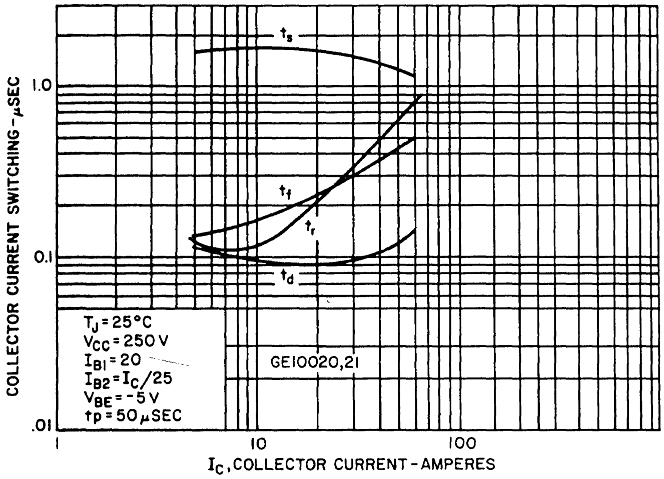


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

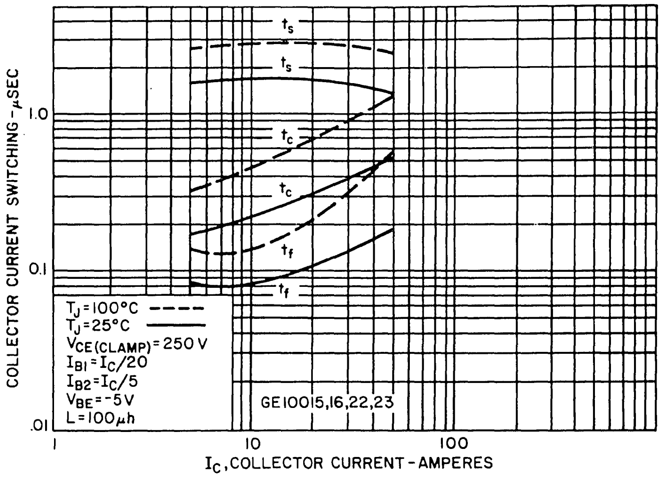


FIGURE 10. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

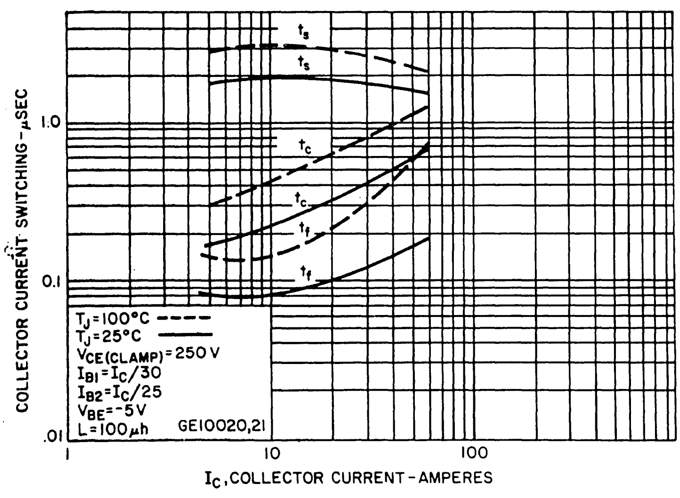


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

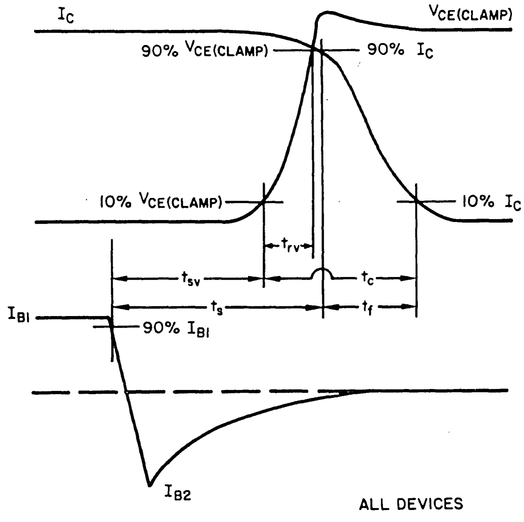


FIGURE 12. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

TYPICAL CHARACTERISTICS

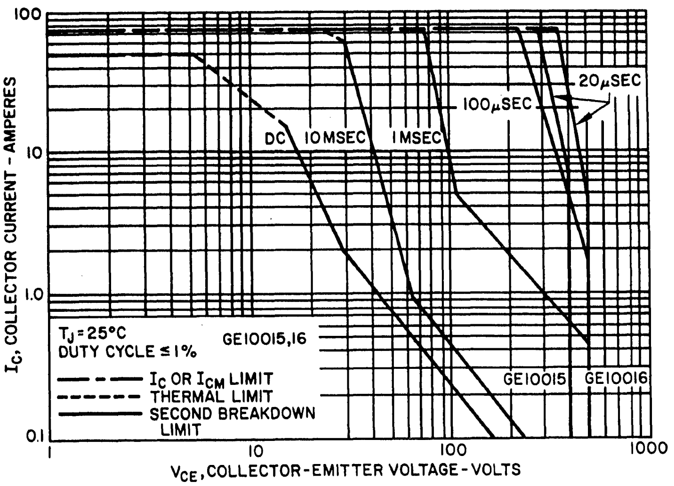


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

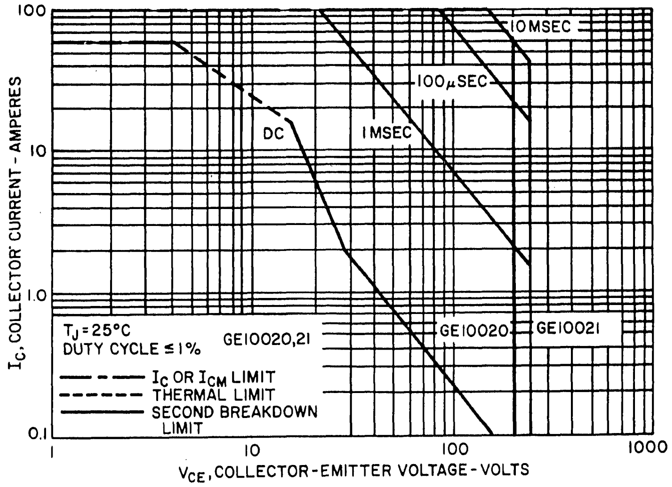


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

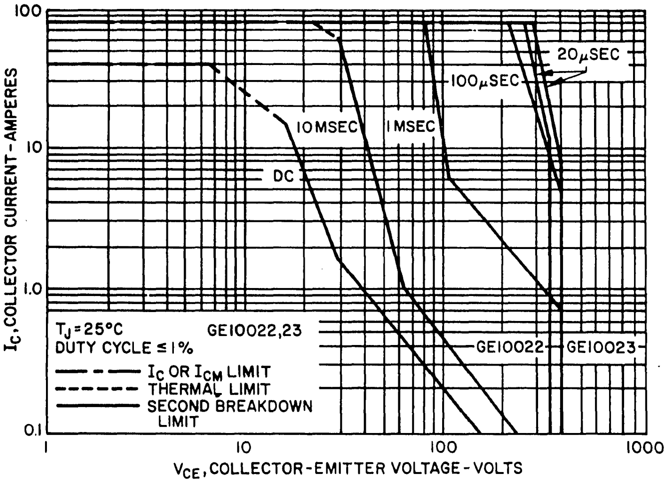


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

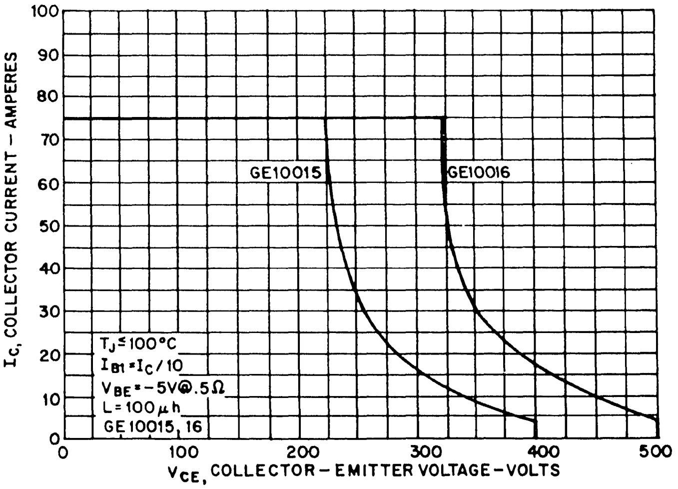


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA (CLAMPED)

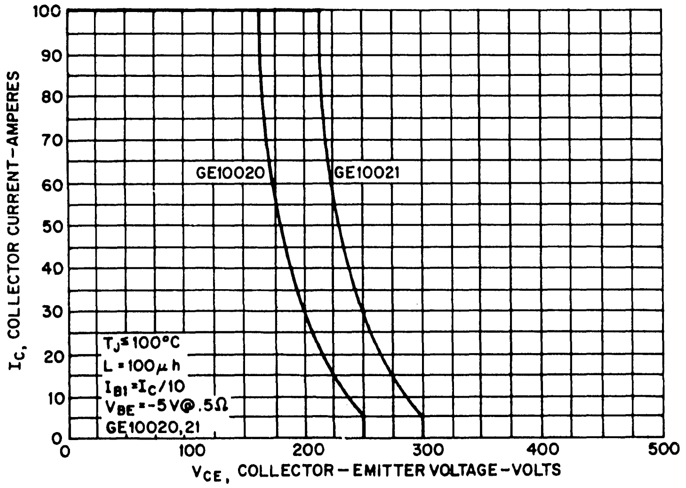


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

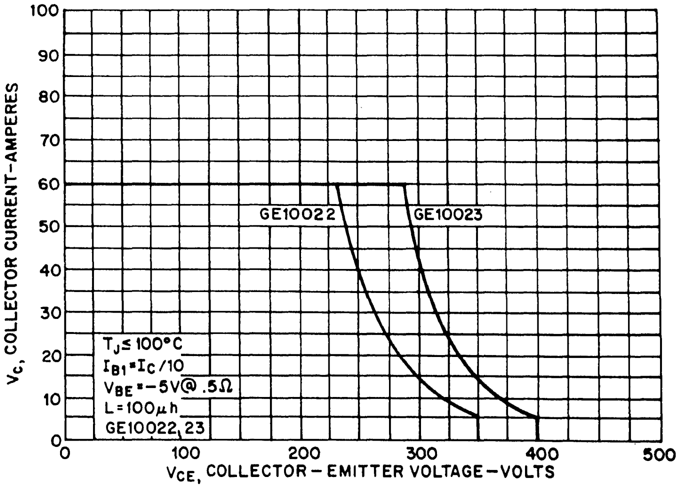


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

TYPICAL CHARACTERISTICS

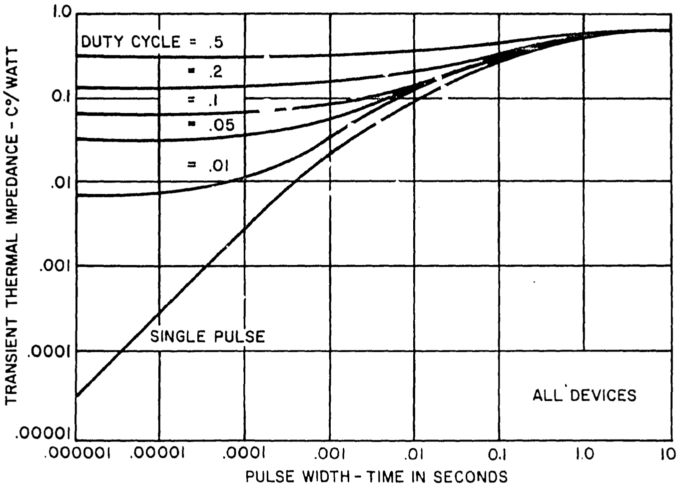


FIGURE 19. TRANSIENT THERMAL RESPONSE

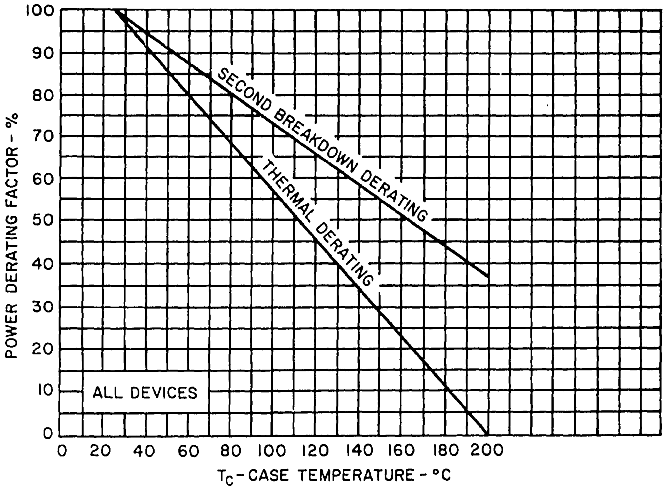


FIGURE 20. POWER DERATING

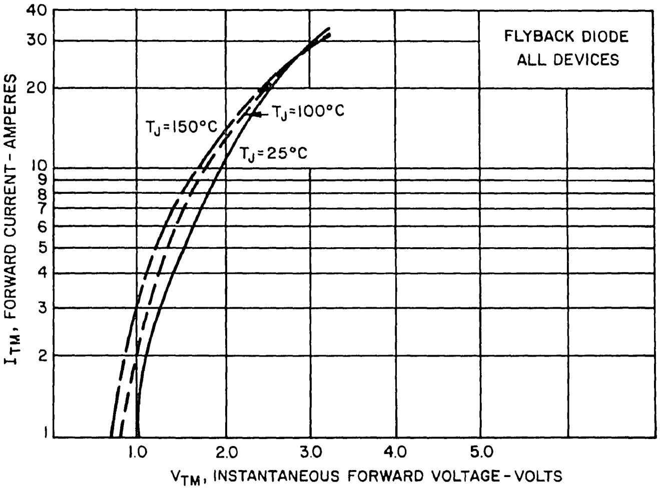
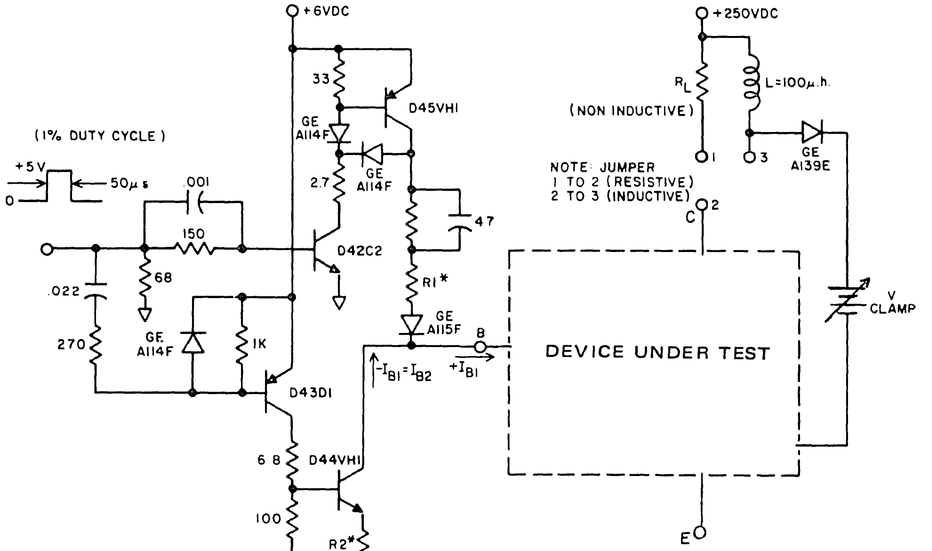


FIGURE 21. FORWARD CHARACTERISTICS



* = SELECT:
R1 FOR $+I_{B1}$ = 1.0 AMP
R2 FOR $-I_{B1}$ = 4.0 AMPS = I_{B2}

FOR:	R_L =
GE10015, 16	5.0Ω
GE10020, 21	4.17Ω
GE10022, 23	6.25Ω

FIGURE 22. SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER TRANSISTORS

GE13070P
GE13071P

400 & 450 VOLTS
5 AMPS, 100 WATTS

The GE13070P and GE13071P transistors are designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical. They are particularly suited for line-operated switch-mode applications such as:

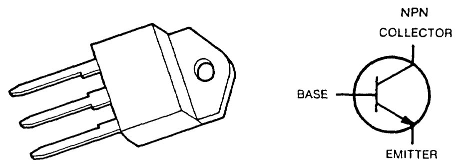
Features:

- Switching regulators
- Inverters
- Solenoid and relay drivers
- Motor controls
- Deflection circuits

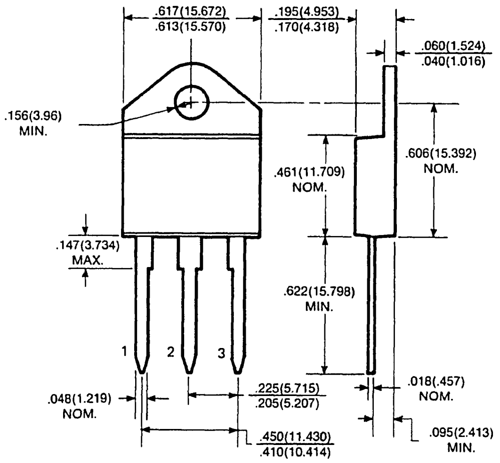
Fast Turn-Off Times:
100 ns inductive fall time @ 25° C (Typ)
150 ns inductive crossover time @ 25° C (Typ)
400 ns inductive storage time @ 25° C (Typ)

Operating temperature range -65 to +150° C

100° C Performance Specified for:
Switching times with inductive loads —
Saturation voltages
Leakage currents



CASE STYLE TO-218
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-218	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	GE13070P	GE13071P	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	5 8	5 8	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	2 4	2 4	A
Total Power Dissipation @ Tc = 25° C @ Tc = 100° C Derate above 25° C	P_D	100 40 0.8	100 40 0.8	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	1.25	° C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	° C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage GE13070P (I_C = 100mA, I_B = 0) GE13071P	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V, T_C = 100°C)	I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100°C)	I_{CER}	—	—	3.0	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	1.0	mA

on characteristics(1)

DC Current Gain (I_C = 3A, V_{CE} = 5V)	h_{FE}	8	—	—	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = .6A) (I_C = 5A, I_B = 1A) (I_C = 3A, I_B = .6A, T_C = 100°C)	$V_{CE(sat)}$	— — —	— — —	1 3 2	V
Base-Emitter Saturation Voltage (I_C = 3A, I_B = .6A) (I_C = 3A, I_B = .6A, T_C = 100°C)	$V_{BE(sat)}$	— —	— —	1.5 1.5	V

switching characteristics

Resistive Load							
Delay Time	(V_{CC} = 250V, I_C = 3A		t_d	—	.03	.05	µs
Rise Time	I_{B1} = .4A, t_p = 30 µs		t_r	—	.10	.4	
Storage Time	Duty Cycle < 2%, $V_{BE(OFF)}$ = 5V)		t_s	—	.4	1.5	
Fall Time			t_f	—	.175	.5	
Inductive Load, Clamped							
Storage Time	$I_{C(pk)}$ = 3A	(T_J = 100°C)	t_{sv}	—	.7	2	µs
Crossover Time	I_{B1} = .4A		t_c	—	.28	.5	
Fall Time	$V_{BE(off)}$ = 5V		t_{fi}	—	.15	.3	
Storage Time	$V_{CE(PK)}$ = 250V	(T_J = 25°C)	t_{sv}	—	.4	—	
Crossover Time			t_c	—	.15	—	
Fall Time			t_{fi}	—	.1	—	

(1) Pulse Test: Pulse Width - 300µs Duty Cycle ≤ 2%.

HIGH SPEED

NPN POWER TRANSISTORS

GE13080P
GE13081P

400-450 VOLTS
8 AMP, 110 WATTS

The GE13080P and GE13081P transistors are designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical. They are particularly suited for line-operated switch-mode applications such as:

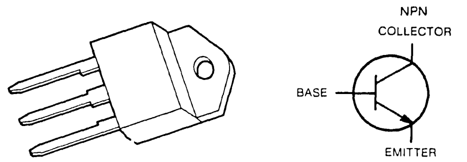
Features:

- Switching regulators
- Inverters
- Solenoid and relay drivers
- Motor controls
- Deflection circuits

Fast Turn-Off Times:
100 ns inductive fall time @ 25° C (Typ)
150 ns inductive crossover time @ 25° C (Typ)
400 ns inductive storage time @ 25° C (Typ)

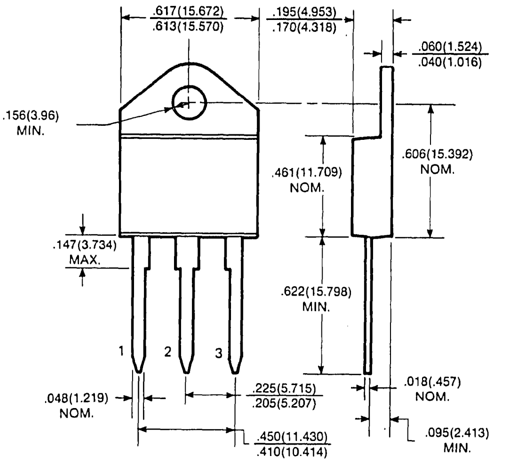
Operating temperature range -65 to +150° C

100° C Performance Specified for:
Switching times with inductive loads —
Saturation voltages
Leakage currents



CASE STYLE TO-218

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-218	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	GE13080P	GE13081P	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6.0	6.0	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	8.0 12	8.0 12	A
Base Current — Continuous	I_B	3.0	3.0	A
Total Power Dissipation @ Tc = 25° C @ Tc = 100° C	P_D	110 44	110 44	Watts
Derate above 25° C		.88	.88	W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.1	1.1	° C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	° C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics(1)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = 100mA, I_B = 0)	GE13080P GE13081P	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V, T_C = 100° C)		I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100° C)		I_{CER}	—	—	3.0	mA
Emitter Cutoff Current (V_{EB} = 6.0V, I_C = 0)		I_{EBO}	—	—	1.0	mA

on characteristics(1)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 5.0A, V_{CE} = 3.0V)	h_{FE}	8.0	—	—	—
Collector-Emitter Saturation Voltage (I_C = 5.0A, I_B = 1.0A) (I_C = 8.0A, I_B = 1.6A) (I_C = 5.0A, I_B = 1.0A, T_C = 100°C)	$V_{CE(sat)}$	— — —	— — —	1.0 3.0 2.0	V
Base-Emitter Saturation Voltage (I_C = 5.0A, I_B = 1.0A) (I_C = 5.0A, I_B = 1.0A, T_C = 100°C)	$V_{BE(sat)}$	— —	— —	1.5 1.5	V

dynamic characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Output Capacitance (V_{CB} = 10V, I_E = 0A, f_{test} = 1.0 kHz)	C_{ob}	—	—	300	pF

switching characteristics

CHARACTERISTIC			SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load							
Delay Time	(V_{CC} = 250V, I_C = 5.0A I_{B1} = 0.7A, t_p = 30 μs Duty Cycle < 2%, $V_{BE(OFF)}$ = 5.0V)		t_d	—	0.025	0.05	μs
Rise Time			t_r	—	0.10	0.50	
Storage Time			t_s	—	0.50	1.50	
Fall Time			t_f	—	0.15	0.50	
Inductive Load, Clamped							
Storage Time	$I_{C(pk)}$ = 5.0A I_{B1} = 0.7A $V_{BE(off)}$ = 5.0V $V_{CE(PK)}$ = 250V	(T_J = 100° C)	t_{sv}	—	0.75	2.20	μs
Crossover Time			t_c	—	0.22	0.40	
Fall Time			t_{fi}	—	0.175	0.35	
Storage Time		(T_J = 25° C)	t_{sv}	—	0.40	—	
Crossover Time			t_c	—	0.15	—	
Fall Time			t_{fi}	—	0.10	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

HIGH SPEED
NPN POWER TRANSISTORS

GE13080T
GE13081T

400-450 VOLTS
8 AMP, 90 WATTS

The GE13080T and GE13081T transistors are designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical. They are particularly suited for line-operated switch-mode applications such as:

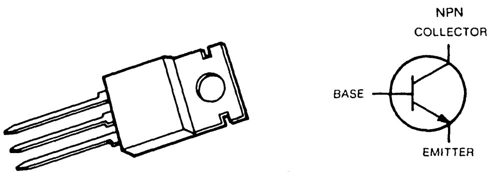
Features:

- Switching regulators
- Inverters
- Solenoid and relay drivers
- Motor controls
- Deflection circuits

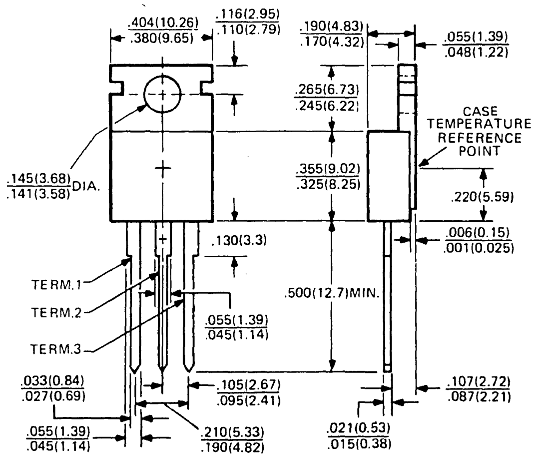
Fast Turn-Off Times:
  100 ns inductive fall time @ 25° C (Typ)
  150 ns inductive crossover time @ 25° C (Typ)
  400 ns inductive storage time @ 25° C (Typ)

Operating temperature range -65 to +150° C

100° C Performance Specified for:
  Switching times with inductive loads —
  Saturation voltages
  Leakage currents



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	GE13080T	GE13081T	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CES}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	8 12	8 12	A
Base Current — Continuous	I_B	3	3	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25° C	P_D	90 36 72	90 36 72	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage GE13080T (I_C = 100mA, I_B = 0) GE13081T	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V, T_C = 100° C)	I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100° C)	I_{CER}	—	—	3.0	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	1.0	mA

second breakdown

Second Breakdown with Base Forward Biased	$I_{S/b}$	SEE FIGURE 12
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 13

on characteristics(1)

DC Current Gain (I_C = 5A, V_{CE} = 3V)	h_{FE}	8.0	—	—	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A) (I_C = 5A, I_B = 1A, T_C = 100° C)	$V_{CE(sat)}$	— — —	— — —	1 3 2	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 5A, I_B = 1A, T_C = 100° C)	$V_{BE(sat)}$	— —	— —	1.5 1.5	V

dynamic characteristics

Output Capacitance (V_{CB} = 10V, I_E = 0, f_{test} = 1 kHz)	C_{ob}	—	—	300	pF

switching characteristics

Resistive Load							
Delay Time	(V_{CC} = 250V, I_C = 5A		t_d	—	.025	.05	μs
Rise Time	I_{B1} = .7A, t_p = 30 μs		t_r	—	.10	.50	
Storage Time	Duty Cycle < 2%, $V_{BE(OFF)}$ = 5V)		t_s	—	.5	1.5	
Fall Time			t_f	—	.15	.5	
Inductive Load, Clamped							
Storage Time	$I_{CC(PK)}$ = 5A	(T_J = 100° C)	t_{sv}	—	.75	2.2	μs
Crossover Time	I_{B1} = .7A		t_c	—	.22	.4	
Fall Time	$V_{BE(OFF)}$ = 5V		t_{fi}	—	.175	.35	
Storage Time	$V_{CE(PK)}$ = 250V	(T_J = 25° C)	t_{sv}	—	.40	—	
Crossover Time			t_c	—	.15	—	
Fall Time			t_{fi}	—	.10	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

TYPICAL ELECTRICAL CHARACTERISTICS

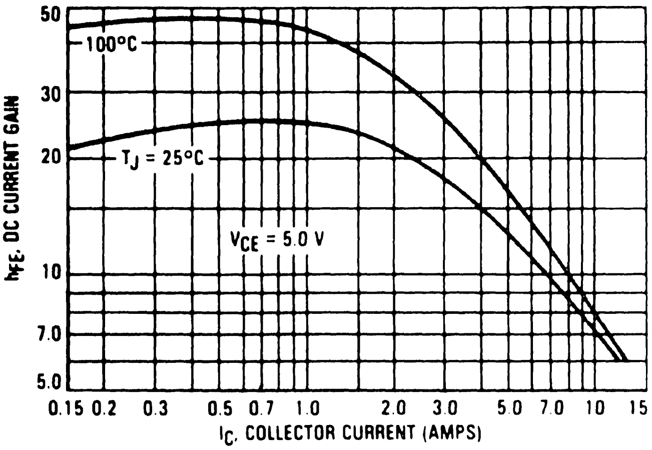


FIGURE 1 — DC CURRENT GAIN

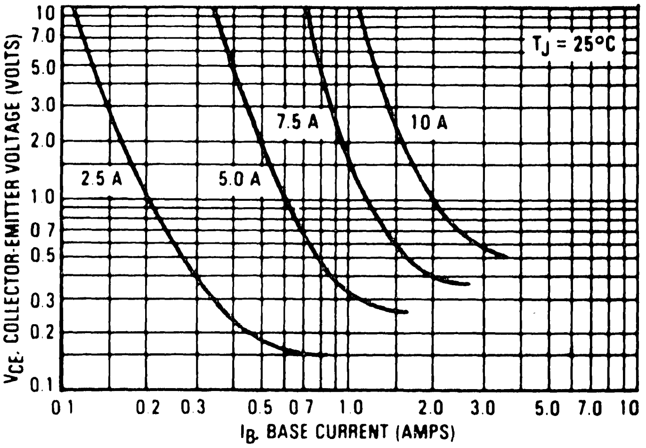


FIGURE 2 — COLLECTOR SATURATION REGION

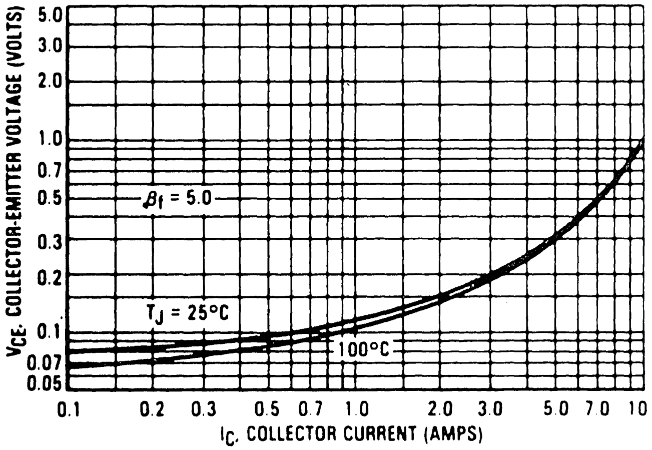


FIGURE 3 — COLLECTOR-EMITTER SATURATION VOLTAGE

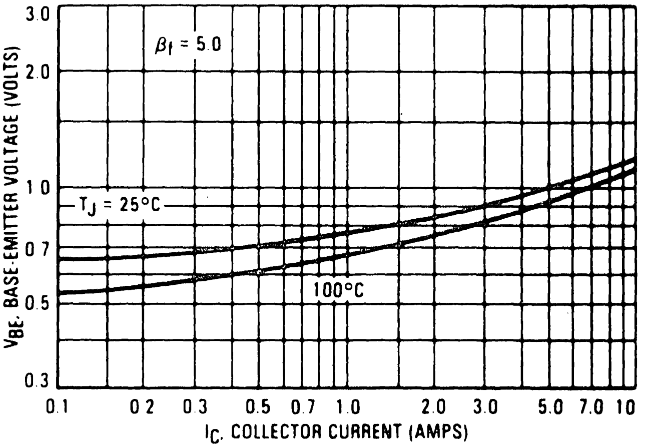


FIGURE 4 — BASE-EMITTER VOLTAGE

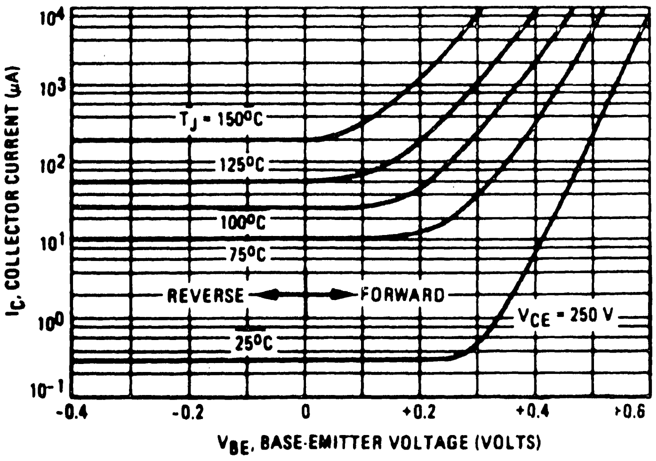


FIGURE 5 — COLLECTOR CUTOFF REGION

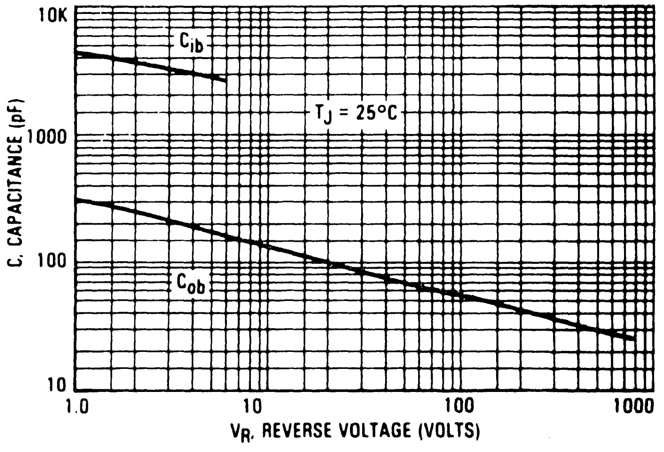


FIGURE 6 — CAPACITANCE

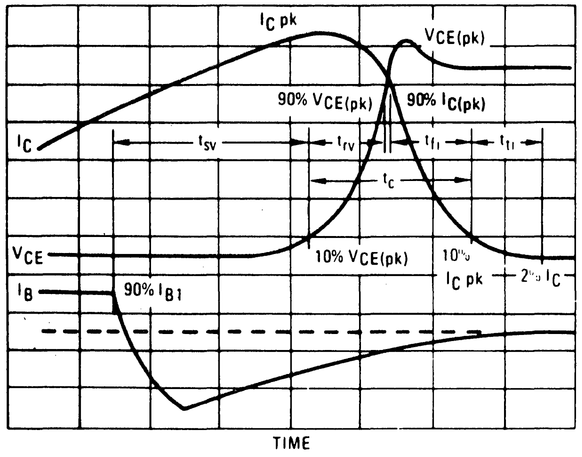


FIGURE 7 — INDUCTIVE SWITCHING MEASUREMENTS

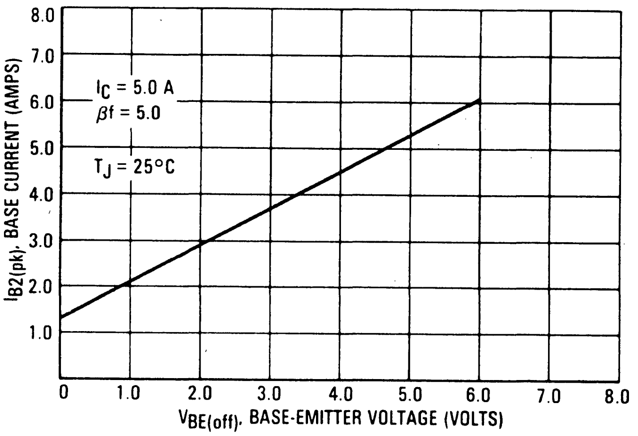


FIGURE 8 — PEAK REVERSE CURRENT

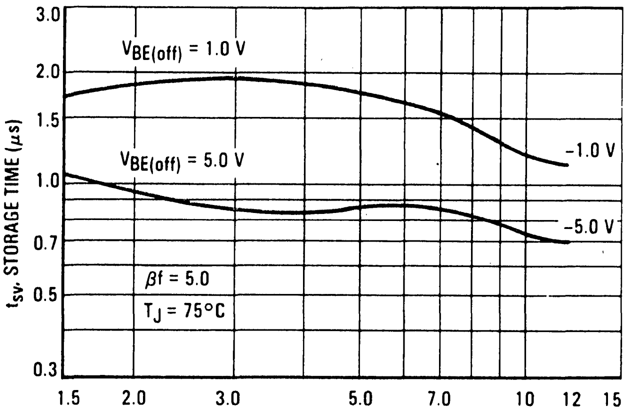


FIGURE 9 — STORAGE TIME

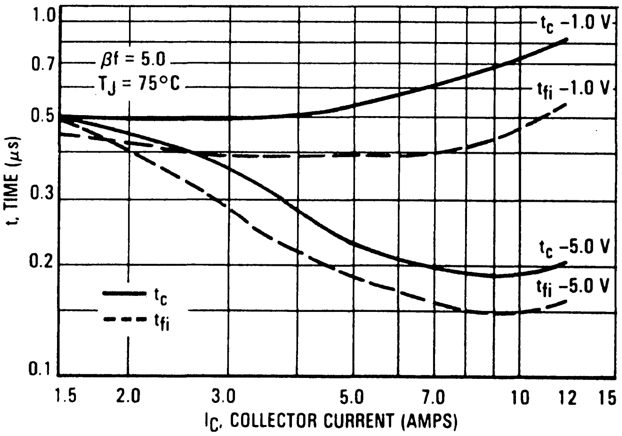


FIGURE 10 — CROSSOVER AND FALL TIMES

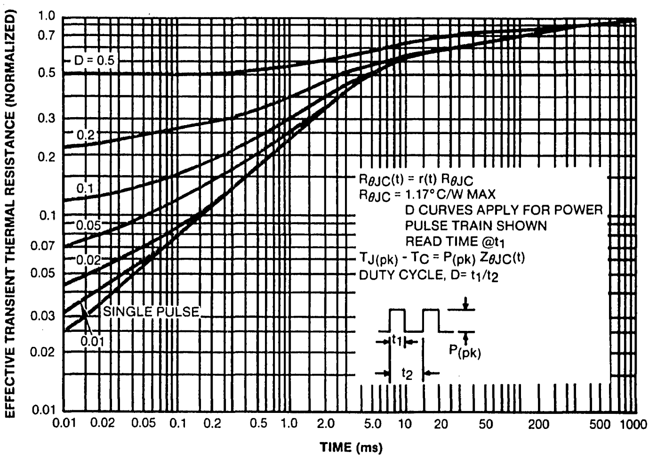


FIG. 11 THERMAL RESPONSE

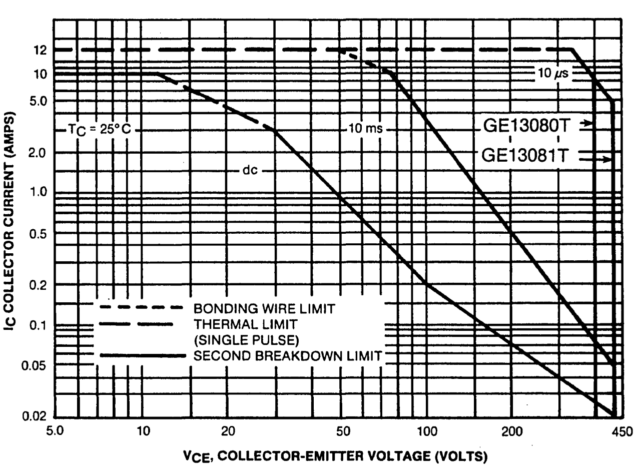


FIGURE 12 — FORWARD BIAS SAFE OPERATING AREA

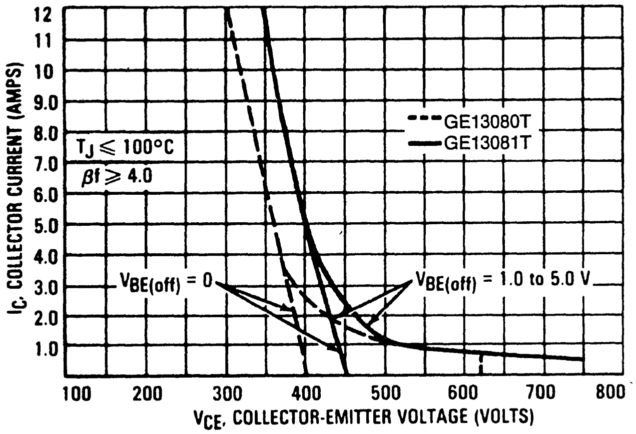


FIGURE 13 — REVERSE BIAS SAFE OPERATING AREA

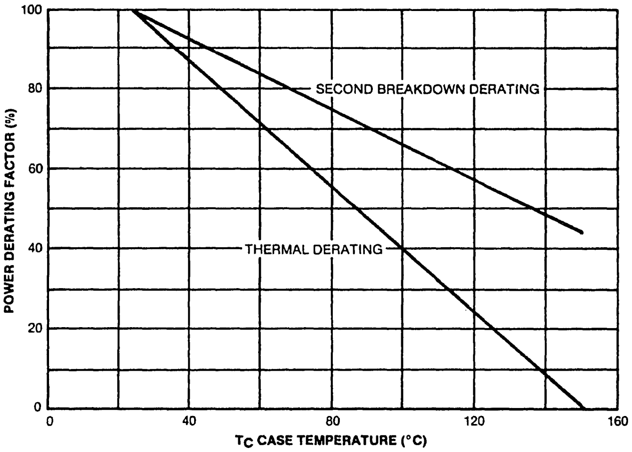


FIG. 14 POWER DERATING

HIGH SPEED
NPN POWER TRANSISTORS

GE13100P
GE13101P

400 & 450 VOLTS
20 AMPS, 125 WATTS

The GE13100P and GE13101P transistors are designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical. They are particularly suited for line-operated switch-mode applications such as:

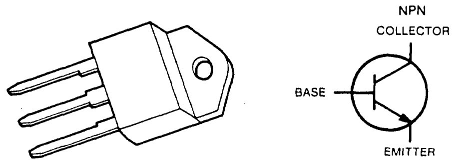
Features:

- Switching regulators
- Inverters
- Solenoid and relay drivers
- Motor controls
- Deflection circuits

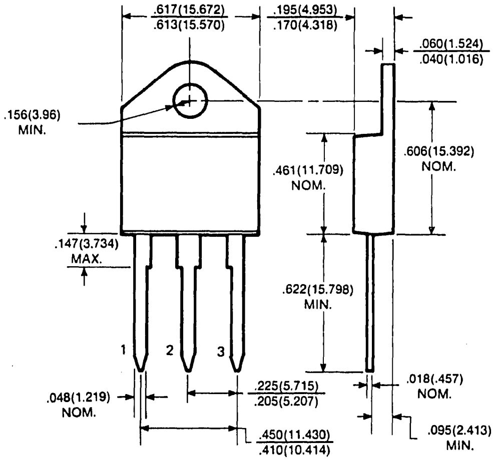
Fast Turn-Off Times:
30 ns inductive fall time @ 25°C (Typ)
50 ns inductive crossover time @ 25°C (Typ)
900 ns inductive storage time @ 25°C (Typ)

Operating temperature range -65 to +150°C

100°C Performance Specified for:
Switching times with inductive loads —
50 ns inductive fall time (Typ)
Saturation voltages
Leakage currents



CASE STYLE TO-218
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-218	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	GE13100P	GE13101P	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	20 30	20 30	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	10 15	10 15	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	125 50 1.0	125 50 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage (I_C = 100mA, I_B = 0)	GE13100P GE13101P	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V, T_C = 100° C)		I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100° C)		I_{CER}	—	—	3	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)		I_{EBO}	—	—	1.0	mA

on characteristics

DC Current Gain (I_C = 15A, V_{CE} = 3V)	h_{FE}	8	—	40	—
Collector-Emitter Saturation Voltage (I_C = 15A, I_B = 3A) (I_C = 20A, I_B = 4A) (I_C = 15A, I_B = 3A, T_C = 100° C)	$V_{CE(sat)}$	— — —	— — —	1 3 2	V
Base-Emitter Saturation Voltage (I_C = 15A, I_B = 3A) (I_C = 15A, I_B = 3A, T_C = 100° C)	$V_{BE(sat)}$	— —	— —	1.5 1.5	V

switching characteristics

Resistive Load							
Delay Time	(V_{CC} = 250V, I_C = 15A I_{B1} = 2A, t_p = 30 μs Duty Cycle < 2%, $V_{BE(OFF)}$ = 5V)		t_d	—	0.02	0.05	μs
Rise Time			t_r	—	0.13	0.50	
Storage Time			t_s	—	0.90	3.5	
Fall Time			t_f	—	0.10	0.5	
Inductive Load, Clamped							
Storage Time	$I_{C(pk)}$ = 15A I_{B1} = 2A $V_{BE(off)}$ = 5V $V_{CE(PK)}$ = 250V	(T_J = 100° C)	t_{sv}	—	1.25	4	μs
Crossover Time			t_c	—	0.15	.5	
Fall Time			t_{fi}	—	0.13	.4	
Storage Time		(T_J = 25° C)	t_{sv}	—	0.9	—	
Crossover Time			t_c	—	0.05	—	
Fall Time			t_{fi}	—	0.03	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

NPN POWER TRANSISTORS

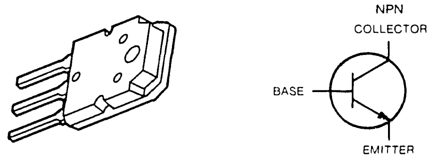
GE3055P

80 VOLTS
10 AMP, 70 WATTS

General purpose transistor designed for power regulator, switching and solenoid drive applications.

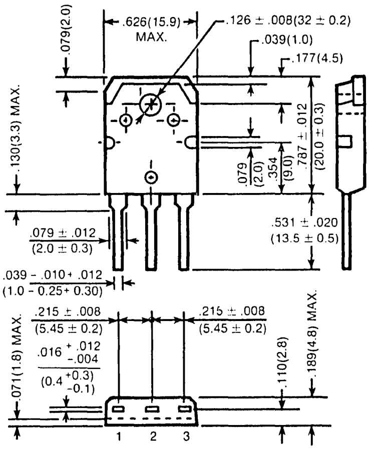
Features:

- High gain at high current:
  $h_{FE} = 20 \sim 100$ @ $V_{CE} = 4V$, $I_C = 4A$
- Low saturation voltage:
  $V_{CE(sat)} < 1.1V$ @ $I_C = 4A$, $I_B = 0.4A$



CASE STYLE TO-247S

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-247S	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	GE3055P	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Emitter Voltage	V_{CEX}	80	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	10	A
Base Current — Continuous	I_B	6	A
Total Power Dissipation @ $T_C = 25°C$ Derate above 25° C	P_D	70 0.56	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

thermal characteristics

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Sustaining Voltage I_C = 200mA)	$V_{CEO(sus)}$	80	—	—	Volts
Collector Cutoff Current (V_{CE} = 80V, V_{BE} = -1.5V)	I_{CEX}	—	—	1.0	mA
Collector Cutoff Current (V_{CE} = 80V)	I_{CEO}	—	—	0.7	mA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	5	mA
second breakdown					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5			
on characteristics					
DC Current Gain	h_{FE}				
(I_C = 4A, V_{CE} = 4V)		20	—	100	—
(I_C = 10A, V_{CE} = 4V)		5	—	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 4A, I_B = 0.4A)		—	—	1.1	V
(I_C = 10A, I_B = 3.3A)		—	—	8.0	
Base-Emitter Voltage (I_C = 4A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	1.8	V

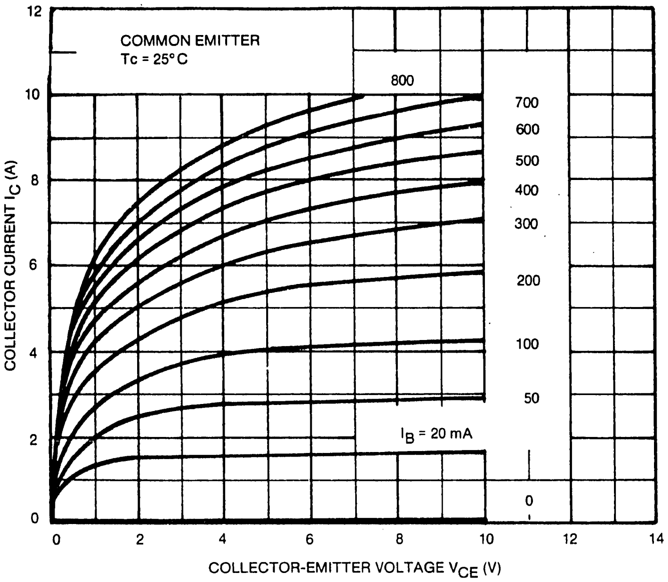


FIG. 1 I_C - V_{CE}

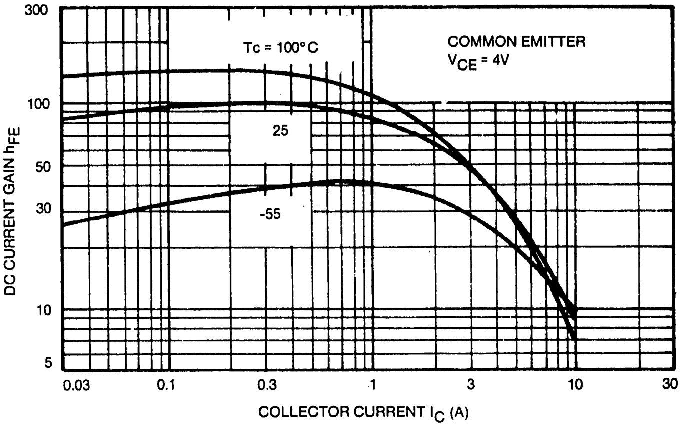


FIG. 2 h_{FE} - I_C

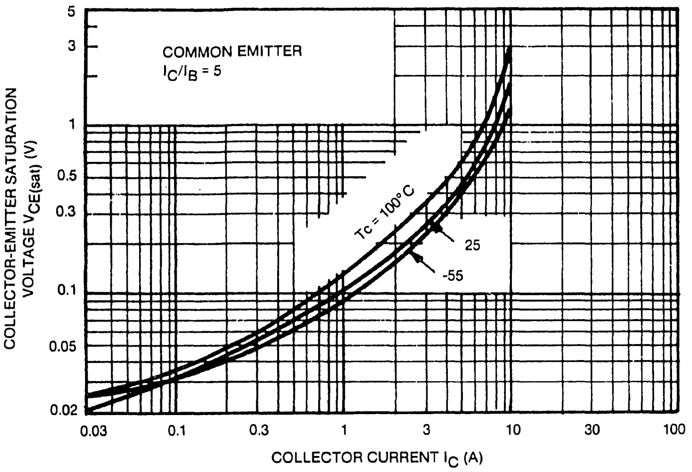


FIG. 3 $V_{CE(sat)}$ - I_C

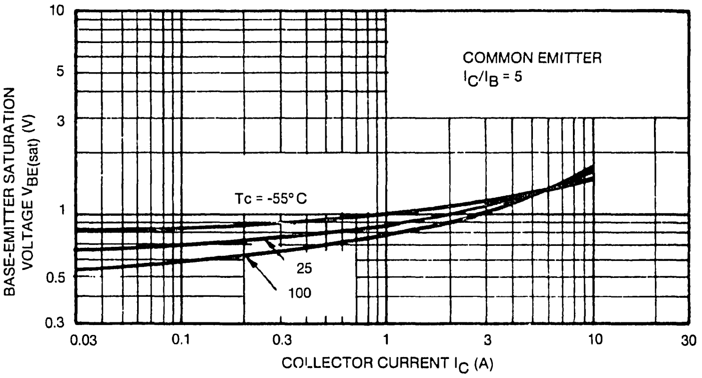


FIG. 4 $V_{BE(sat)}$ - I_C

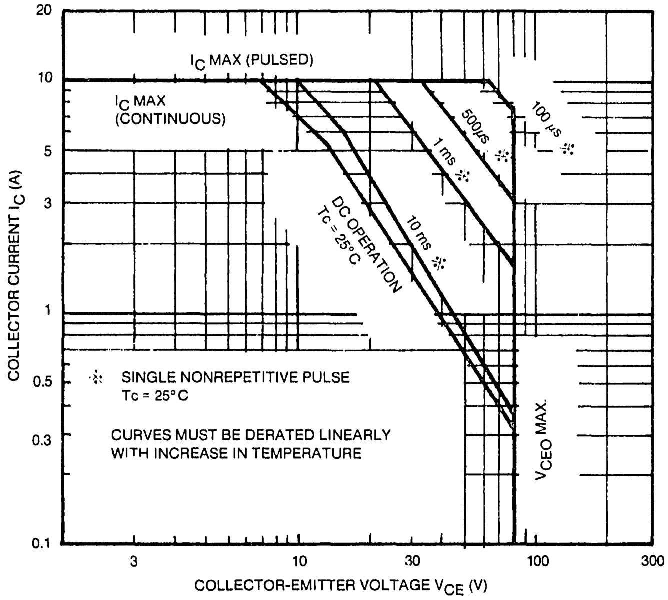


FIG. 5 SAFE OPERATING AREA

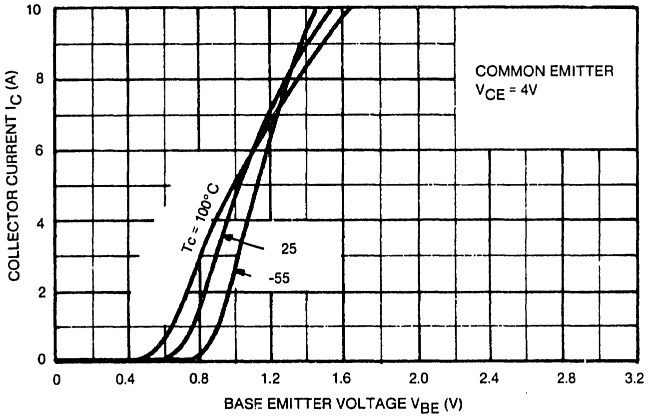


FIG. 6 I_C - V_{BE}

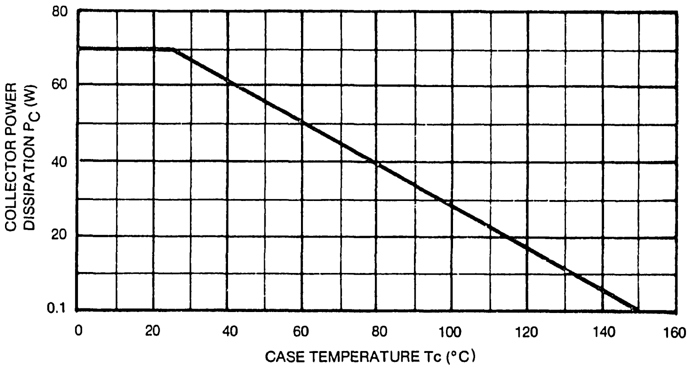


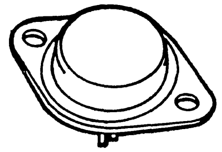
FIG. 7 P_C - Tc

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

GE5060,1,2

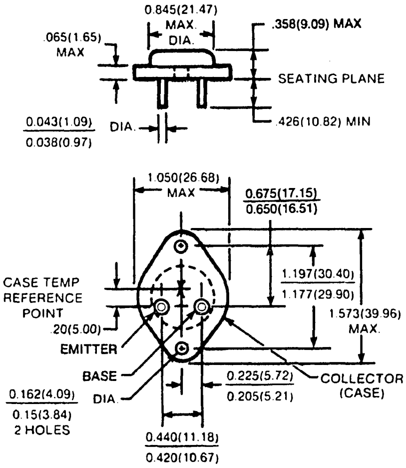
400-500 VOLTS
20 AMP, 125 WATTS

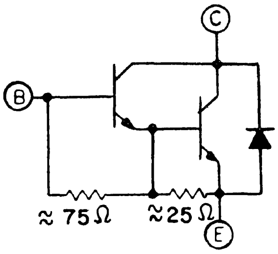
These devices are designed for use in high speed switching applications, such as off-line switching power supplies, AC & DC motor control, UPS systems, ultrasonic equipment and other high frequency power conversion equipment.



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





DEVICE CIRCUIT

maximum ratings ($T_C = 25°C$) (unless otherwise noted)

RATING	SYMBOL	GE5060	GE5061	GE5062	UNITS
Collector-Base Voltage	V_{CBO}	400	450	500	Volts
Collector-Emitter Voltage	V_{CEO}	350	400	450	Volts
Emitter Base Voltage	V_{EBO}	8	8	8	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 25 42.5	20 25 42.5	20 25 42.5	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	4 6	4 6	4 6	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	300	300	300	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics[(1)]

Collector-Emitter Sustaining Voltage (I_C = .5mA) (V_{clamp} = V_{CEO} Rated)	GE5060 GE5061 GE5062	$V_{CEO(sus)}$	350 400 450	— — —	— — —	Volts
Collector-Base Voltage (I_C = 0.25mA)	GE5060 GE5061 GE5062	V_{CBO}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V_{CB} = V_{CBO} Rated)		I_{CBO}	—	—	.25	mA
Emitter Cutoff Current (V_{EB} = 4.5V, I_C = 0)		I_{EBO}	—	—	200	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 16
Clamped Inductive soa with Base Reversed Bias	RBSOA	SEE FIGURE 17

on characteristics

DC Current Gain (I_C = 10A, V_{CE} = 5V) (I_C = 15A, V_{CE} = 5V) (I_C = 20A, V_{CE} = 5V)	h_{FE}	100 40 15	160 115 65	— — —	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 1A) (I_C = 10A, I_B = 2A) (I_C = 20A, I_B = 2.0A)	$V_{CE(sat)}$	— — —	1.20 1.15 1.6	1.5 1.4 2.0	V
Base-Emitter Voltage (I_C = 10A, I_B = 1A) (I_C = 20A, I_B = 2A)	$V_{BE(sat)}$	— —	1.95 2.3	2.5 3.5	V

switching characteristics

Resistive Load						
Rise Time	I_C = 15A, I_{B1} = .75A, I_{B2} = 1.5A V_{CC} = 300V, t_p = 50 µsec	t_r	—	0.3	—	µs
Storage Time		t_s	—	2.7	—	
Fall Time		t_f	—	1.15	—	
Inductive Load, Clamped						
Storage Time	V_{CC} = 300V, L = 100 µH I_C = 15A, I_{B1} = .75A, I_{B2} = 1.5A	t_s	—	3.3	—	µs
Crossover Time		t_c	—	1.7	—	
Fall Time		t_f	—	0.4	—	

emitter-collector diode characteristics

Forward Voltage I_F = 10A I_F = 25A	V_F	— —	1.9 2.8	— —	Volts

TYPICAL CHARACTERISTICS

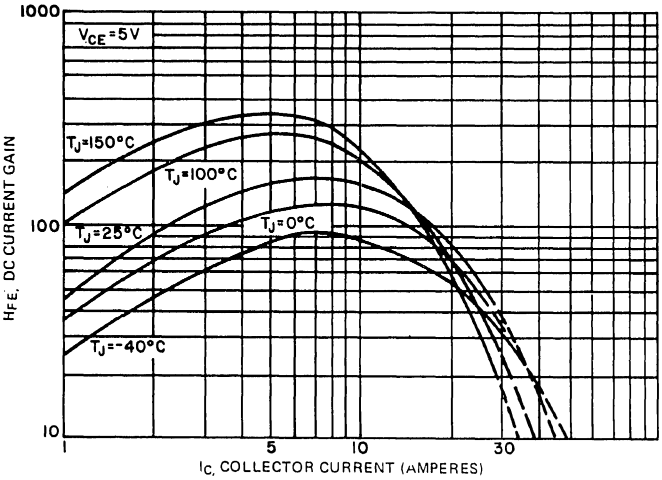


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

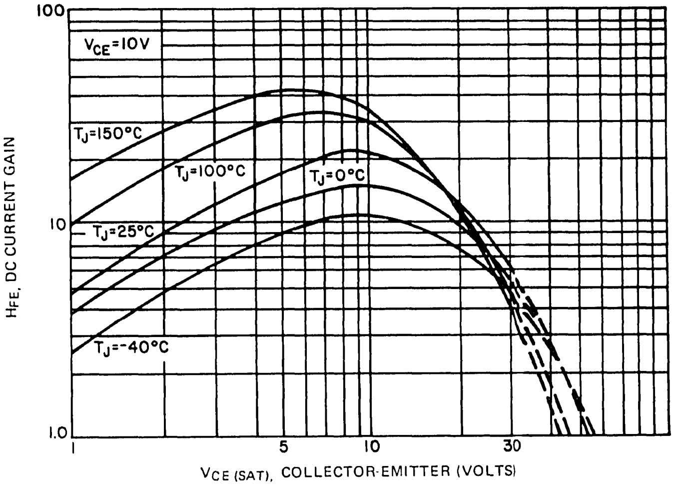


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

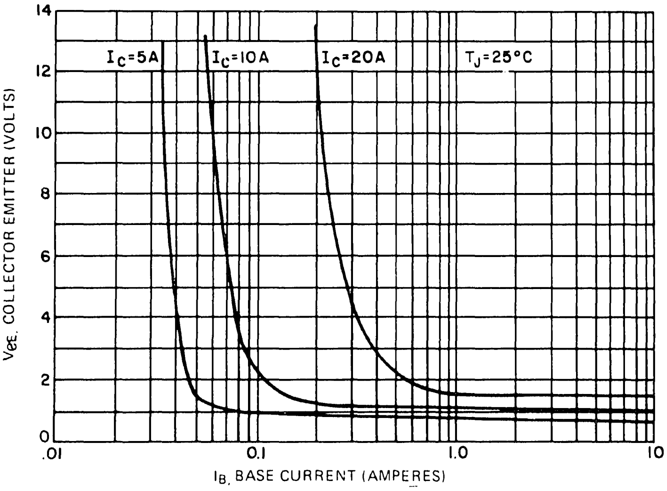


FIGURE 3. COLLECTOR SATURATION REGION

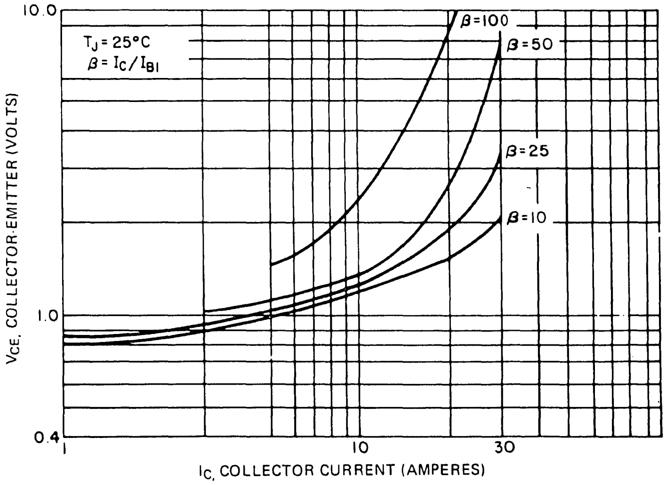


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

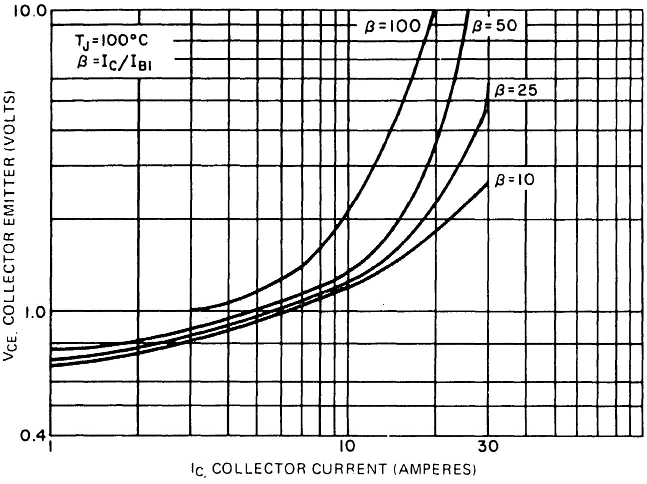


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

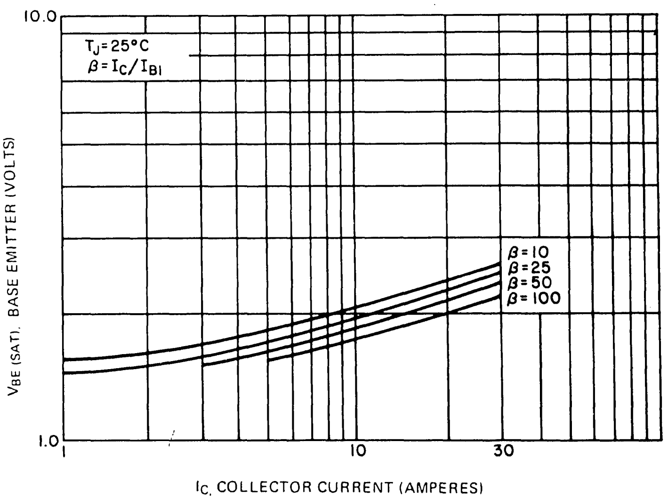


FIGURE 6. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

TYPICAL CHARACTERISTICS

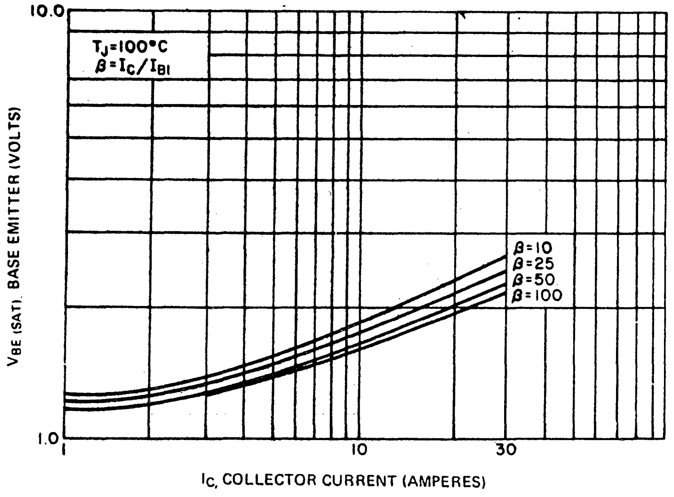


FIGURE 7. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

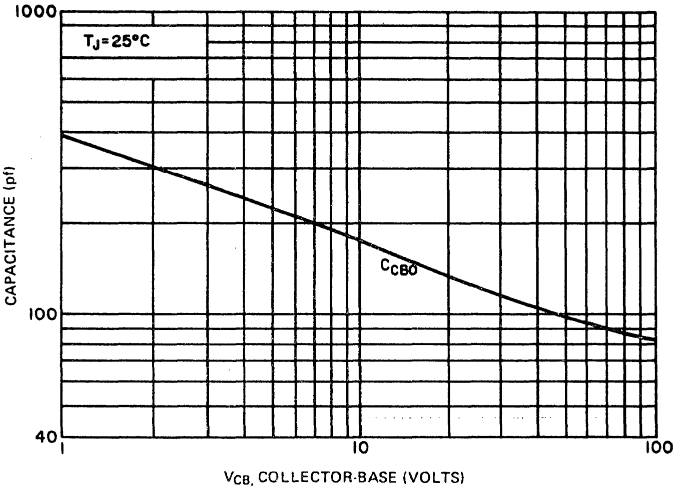


FIGURE 8. CAPACITANCE (C_{CBO})

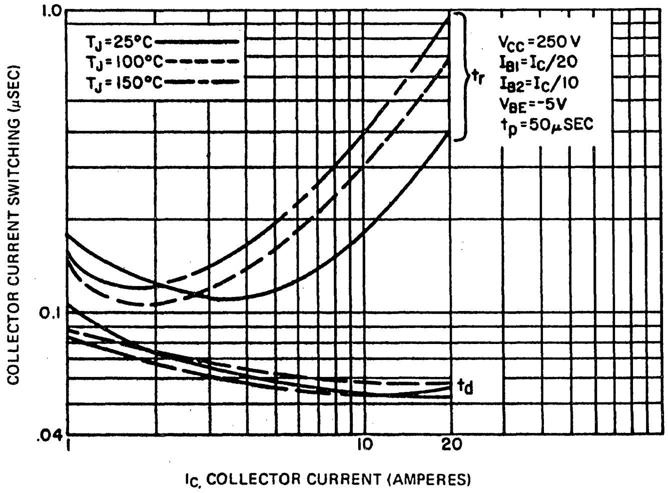


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD)

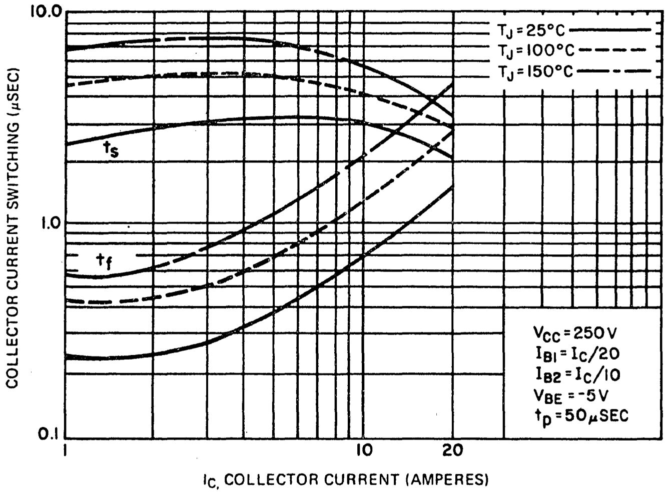


FIGURE 10. TURN-OFF TIME (RESISTIVE)

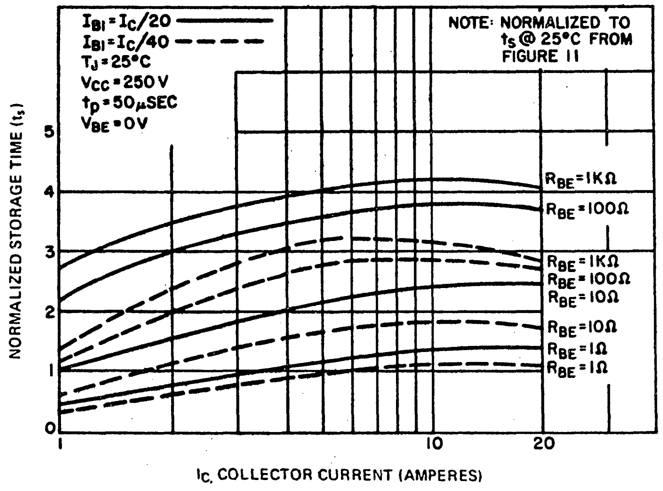


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

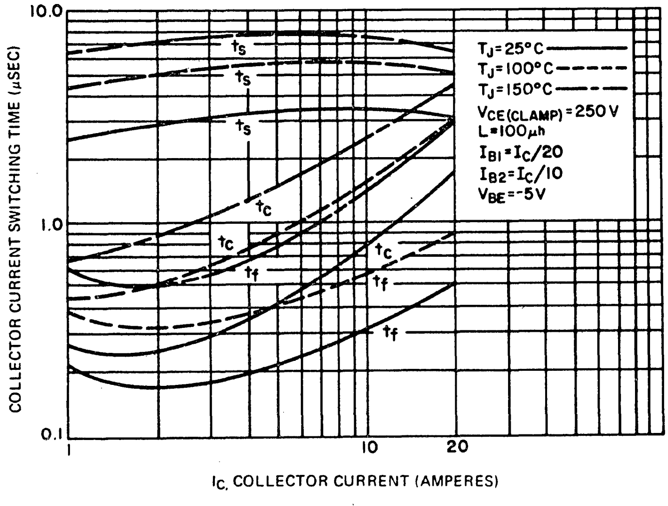


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

TYPICAL CHARACTERISTICS

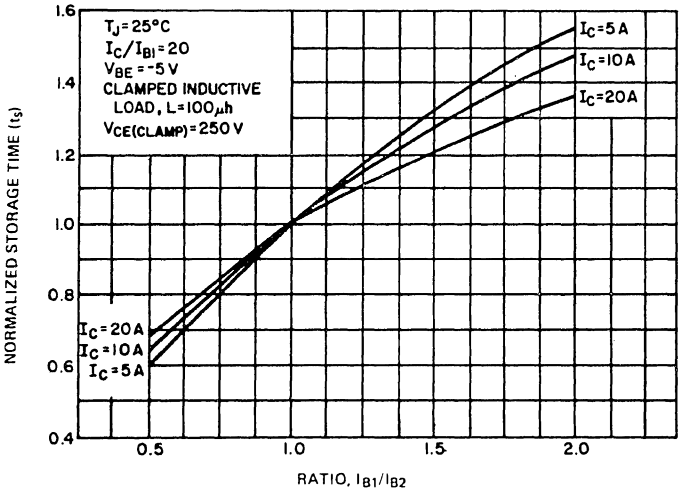


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

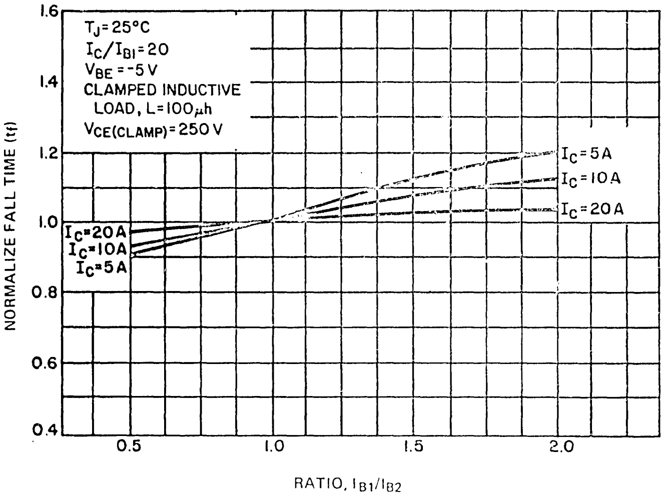


FIGURE 14. FALL TIME VARIATION WITH I_{B2}

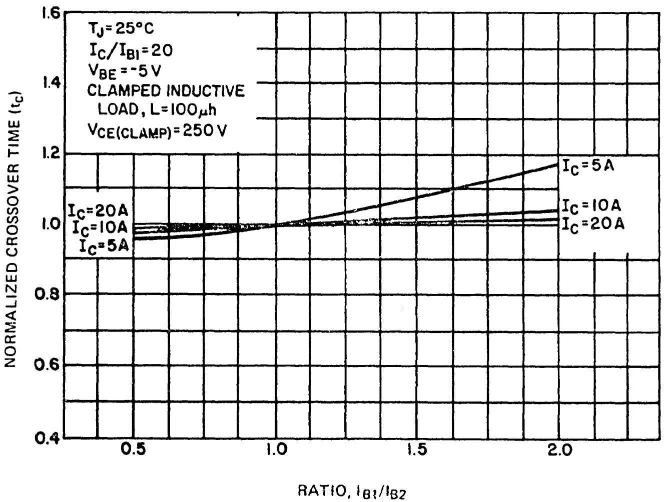


FIGURE 15. CROSS-OVER TIME VARIATION WITH I_{B2}

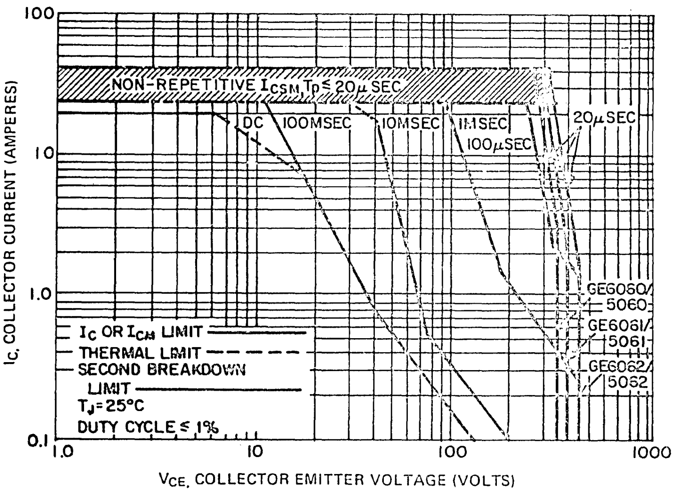


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

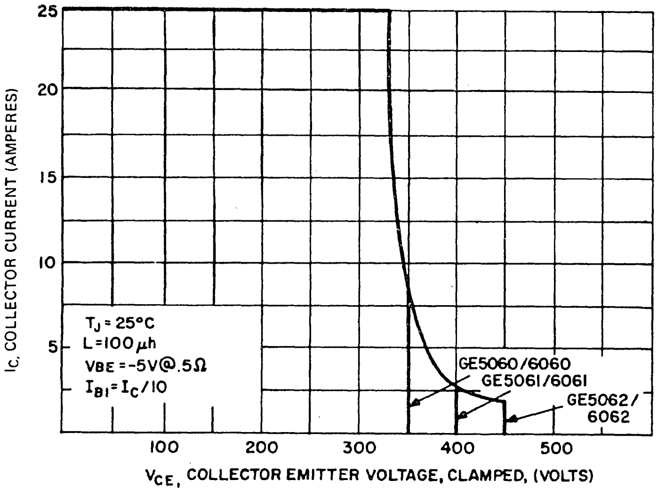


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

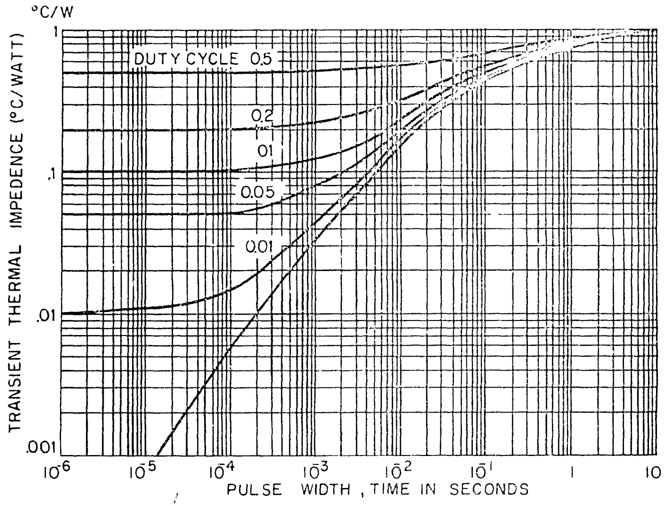


FIGURE 18. TRANSIENT THERMAL RESPONSE

TYPICAL CHARACTERISTICS

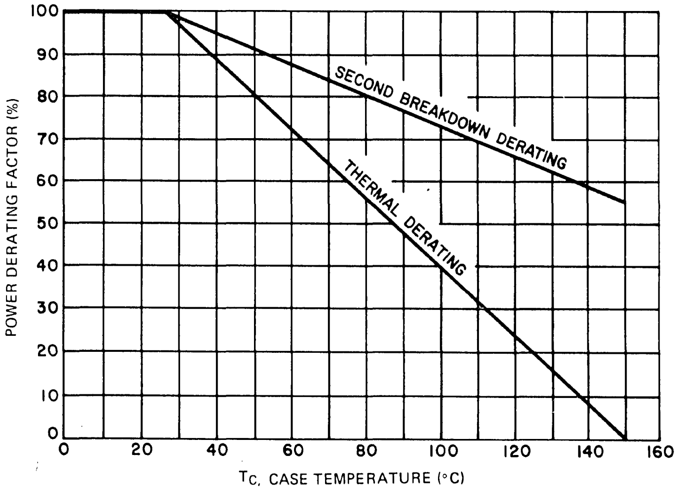


FIGURE 19. POWER DERATING

DIODE CHARACTERISTICS

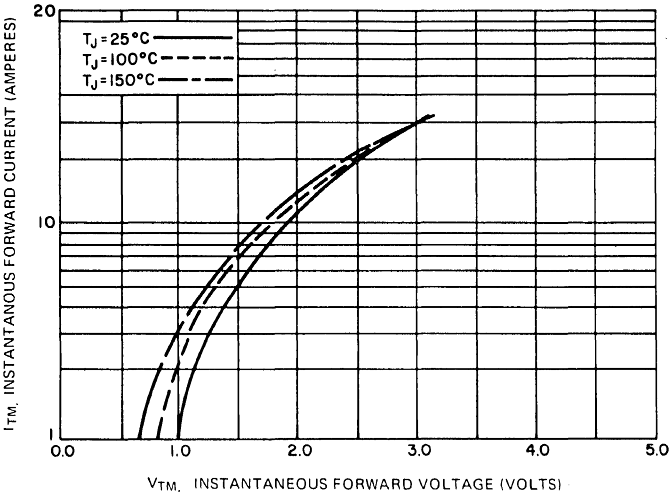
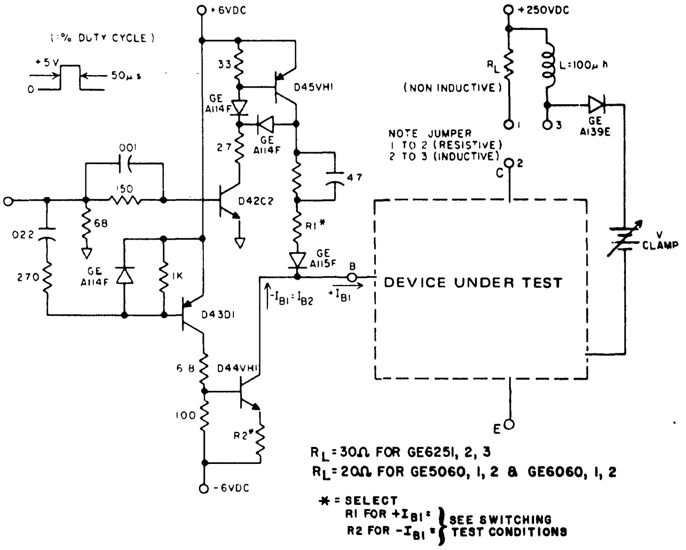


FIGURE 20. FORWARD CHARACTERISTICS



R_L=30Ω FOR GE6251, 2, 3

R_L=20Ω FOR GE5060, 1, 2 & GE6060, 1, 2

* = SELECT
R1 FOR $+I_{B1}$ = } SEE SWITCHING
R2 FOR $-I_{B1}$ = } TEST CONDITIONS

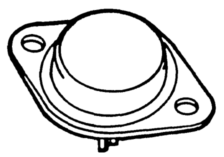
FIGURE 21. SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

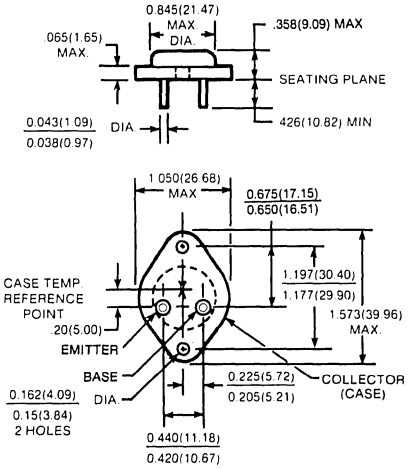
GE6060,1,2

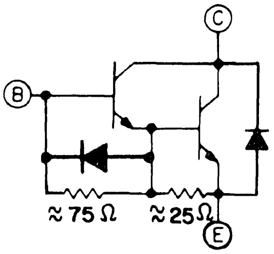
400-500 VOLTS
20 AMP, 125 WATTS

These devices are designed for use in high speed switching applications, such as off-line switching power supplies, AC & DC motor control, UPS systems, ultrasonic equipment and other high frequency power conversion equipment.



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





DEVICE CIRCUIT

maximum ratings ($T_C = 25°C$) (unless otherwise noted)

RATING	SYMBOL	GE6060	GE6061	GE6062	UNITS
Collector-Base Voltage	V_{CBO}	400	450	500	Volts
Collector-Emitter Voltage	V_{CEO}	350	400	450	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 25 42.5	20 25 42.5	20 25 42.5	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	4 6	4 6	4 6	A
Total Power Dissipation @ $T_C = 25°C$	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	300	300	300	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = .5mA) ($V_{clamp} = V_{CEO}$ Rated)	GE6060 GE6061 GE6062	$V_{CEO(sus)}$	350 400 450	— — —	— — —	Volts
Collector-Base Voltage (I_C = 0.25mA)	GE6060 GE6061 GE6062	V_{CBO}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current ($V_{CB} = V_{CBO}$ Rated)		I_{CBO}	—	—	0.25	mA
Emitter Cutoff Current (V_{EB} = 1.5V, I_C = 0)		I_{EBO}	—	—	200	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 14
Clamped Inductive soa with Base Reversed Bias	RBSOA	SEE FIGURE 17

on characteristics

DC Current Gain	h_{FE}				
(I_C = 10A, V_{CE} = 5V)		40	160	—	—
(I_C = 15A, V_{CE} = 5V)		30	115	—	
(I_C = 20A, V_{CE} = 5V)		10	65	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 10A, I_B = 1A)		—	1.2	1.5	
(I_C = 10A, I_B = 2A)		—	1.15	1.4	
(I_C = 20A, I_B = 2A)		—	1.6	2	V
Base-Emitter Voltage	$V_{BE(sat)}$				
(I_C = 5A, I_B = .5A)		—	1.95	2.5	V
(I_C = 20A, I_B = 2A)		—	2.3	3.5	

switching characteristics

Resistive Load						
Rise Time	V_{CC} = 300V, t_p = 50 μs I_C = 15A, I_{B1} = 1.5A, I_{B2} = 2.25A	t_r	—	0.3	0.4	μs
Storage Time		t_s	—	2.3	2.5	
Fall Time		t_f	—	0.5	1.0	
Inductive Load, Clamped						
Storage Time	V_{CC} = 300V, L = 100 μH I_C = 15A, I_{B1} = 1.5A, I_{B2} = 2.25A	t_s	—	2.6	—	μs
Crossover Time		t_c	—	0.5	—	
Fall Time		t_f	—	0.12	—	

emitter-collector diode characteristics

Forward Voltage	V_F				
I_F = 10A		—	1.9	—	Volts
I_F = 25A		—	2.8	—	

TYPICAL CHARACTERISTICS

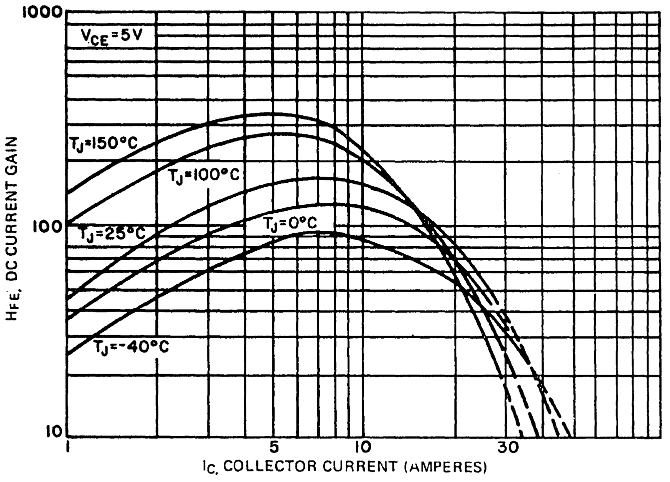


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

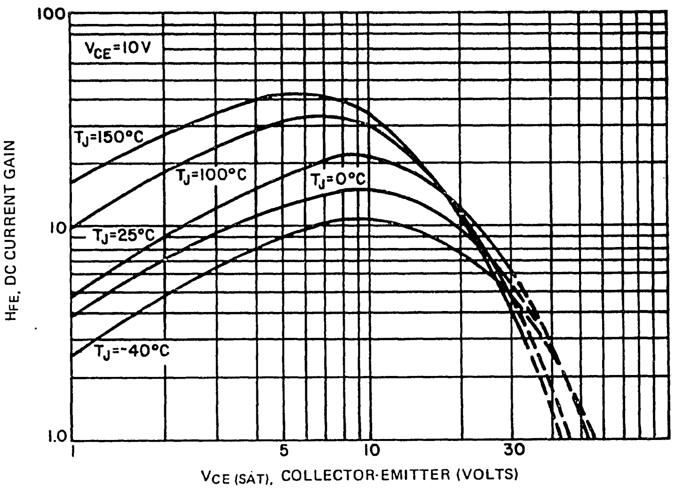


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

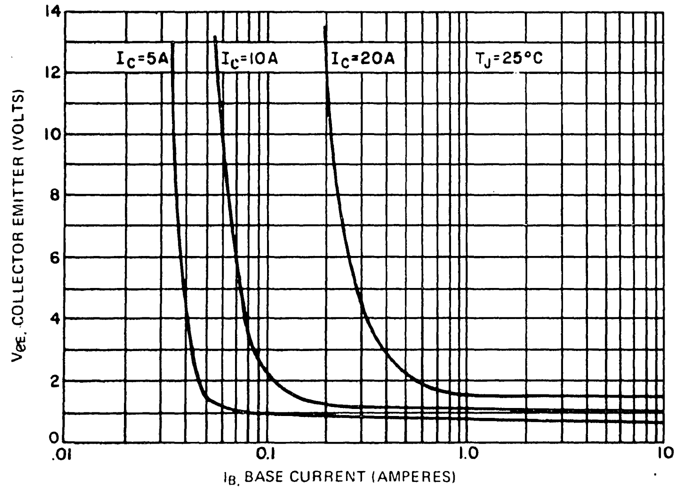


FIGURE 3. COLLECTOR SATURATION REGION

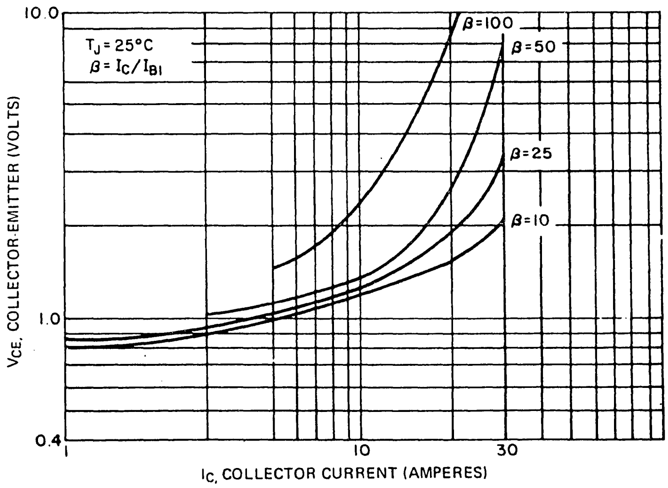


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

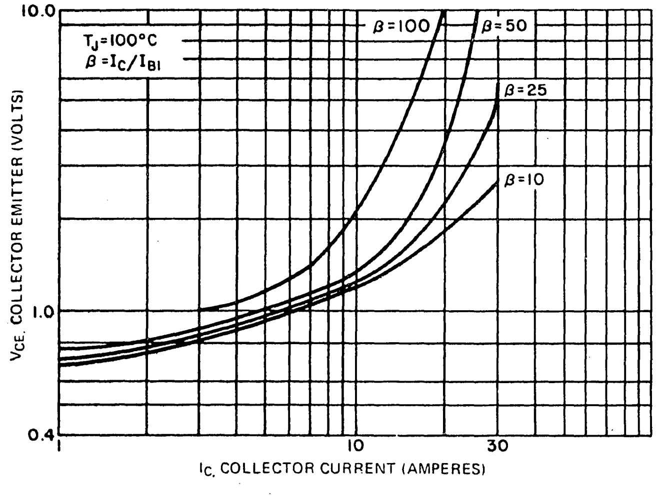


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

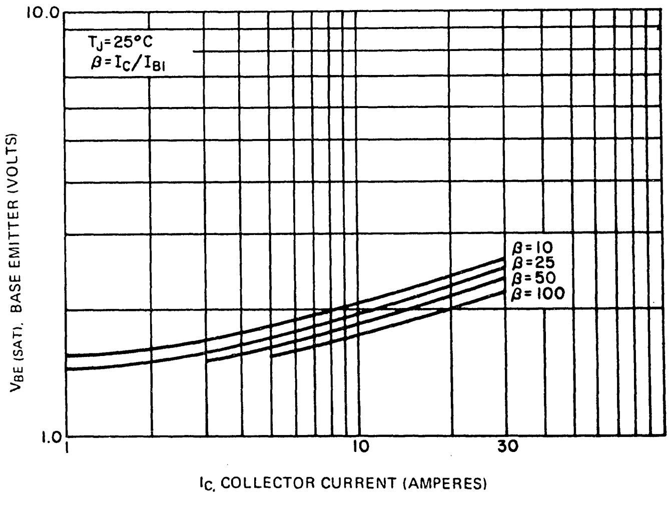


FIGURE 6. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

TYPICAL CHARACTERISTICS

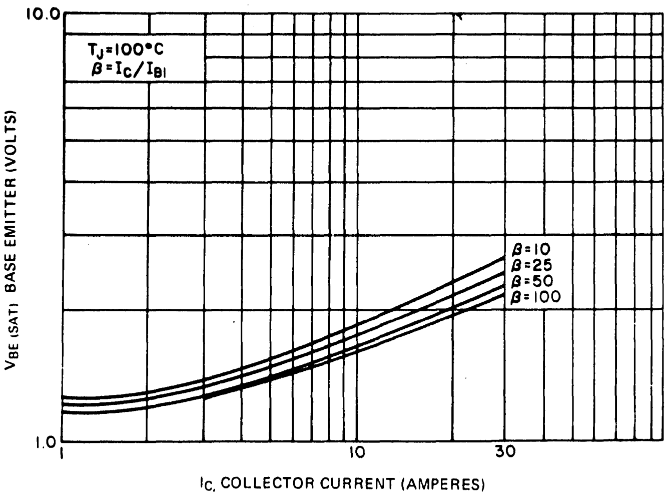


FIGURE 7. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

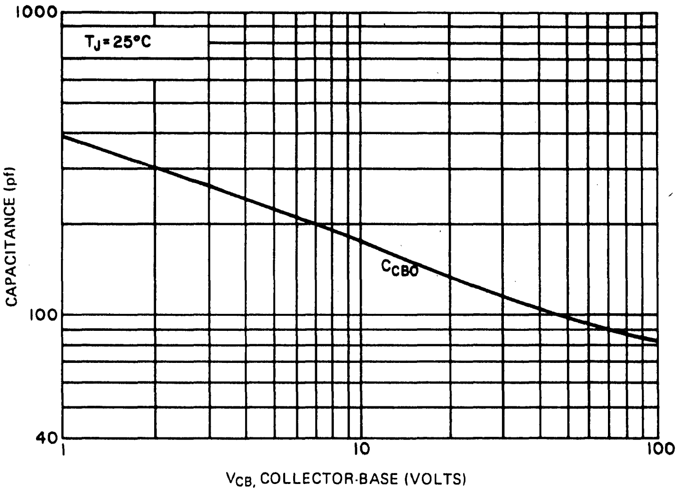


FIGURE 8. CAPACITANCE (C_{CBO})

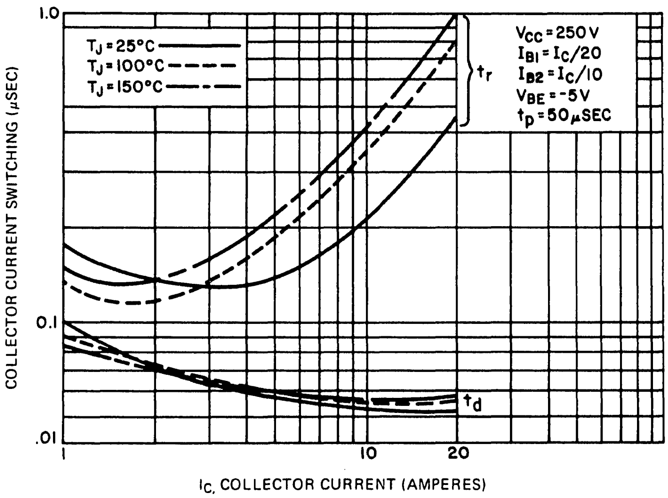


FIGURE 9. TURN-ON TIME (RESISTIVE)

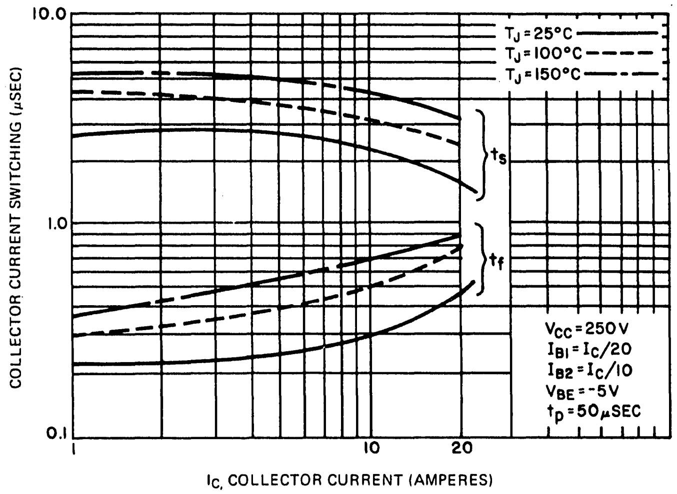


FIGURE 10. TURN-OFF TIME (RESISTIVE)

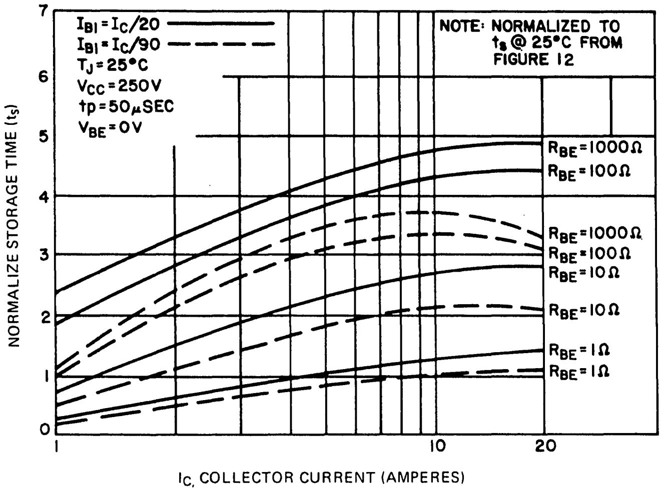


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

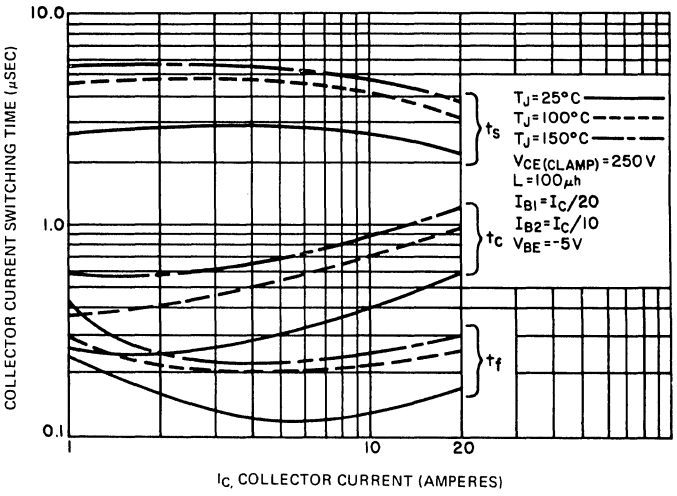


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

TYPICAL CHARACTERISTICS

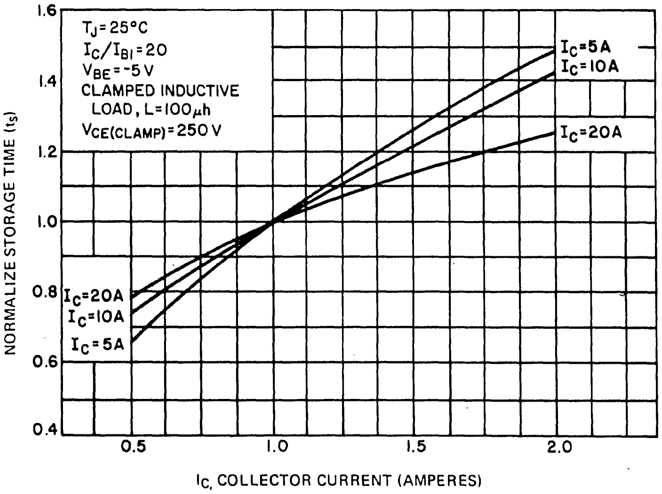


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

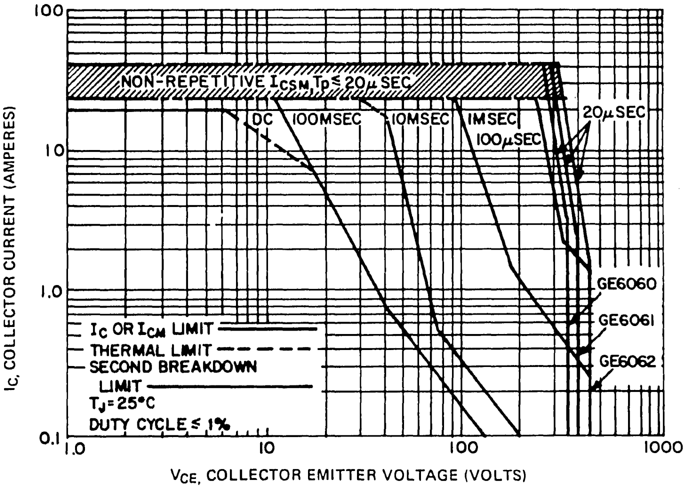


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

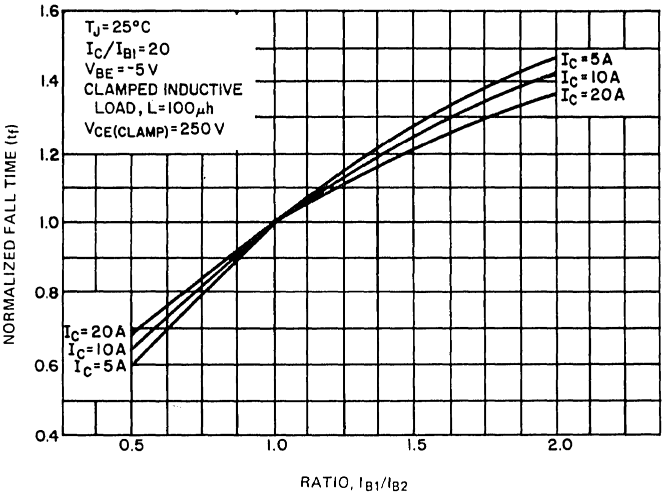


FIGURE 15. FALL TIME VARIATION WITH I_{B2}

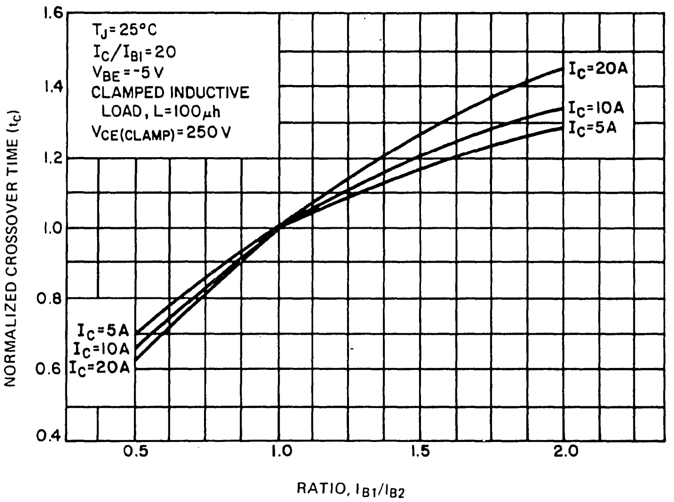


FIGURE 16. CROSS-OVER TIME VARIATION WITH I_{B2}

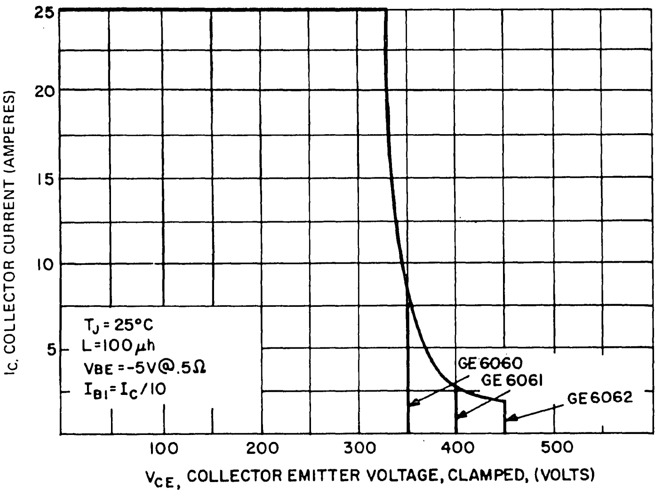


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

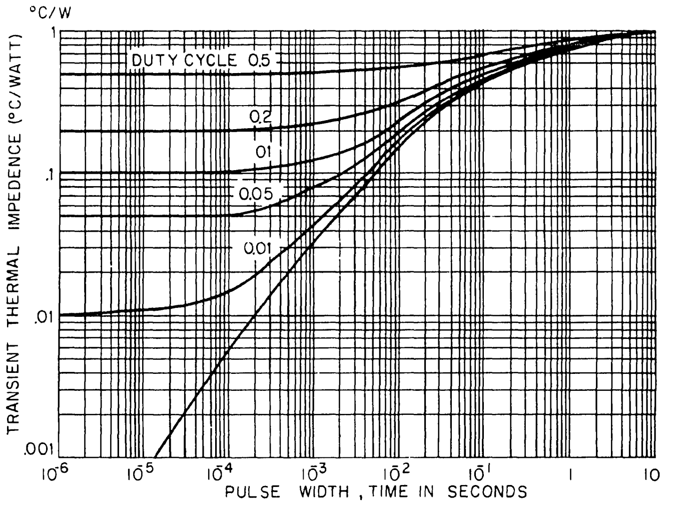


FIGURE 18. TRANSIENT THERMAL RESPONSE

TYPICAL CHARACTERISTICS

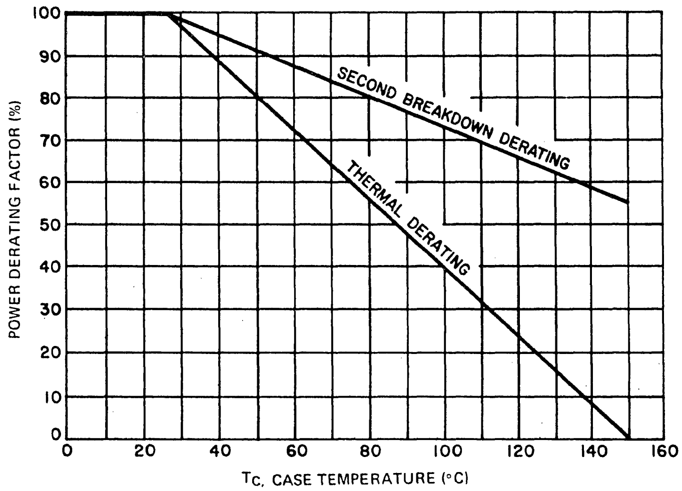


FIGURE 19. POWER DERATING

DIODE CHARACTERISTICS

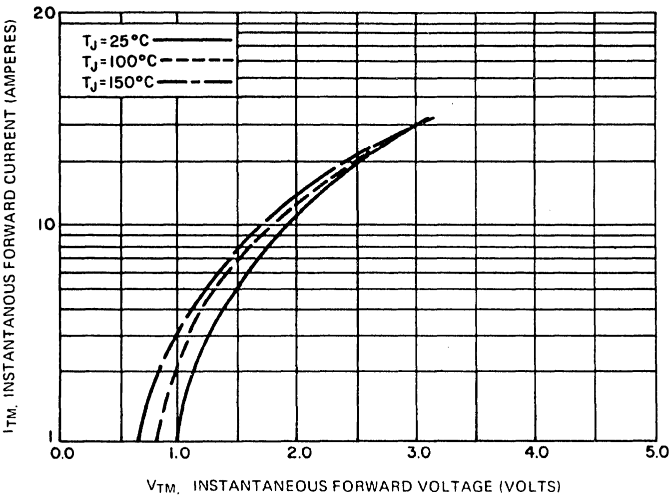
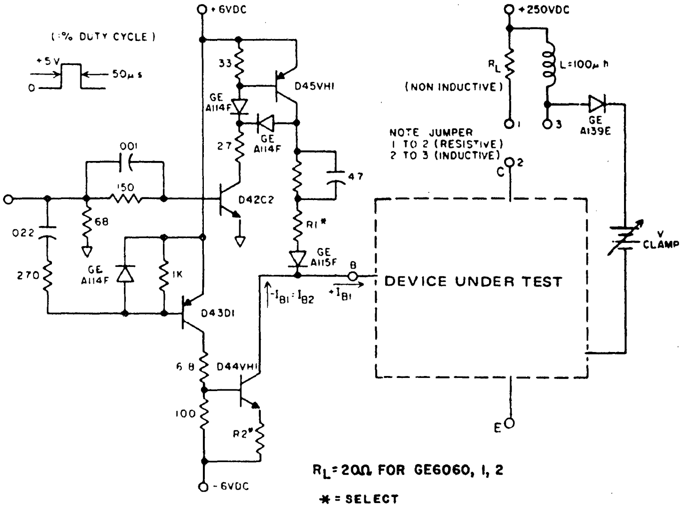


FIGURE 20. FORWARD CHARACTERISTICS



R_L=20Ω FOR GE6060, 1, 2

* = SELECT
R1 FOR $+I_{B1}$ }
R2 FOR $-I_{B1}$ } SEE SWITCHING TEST CONDITIONS

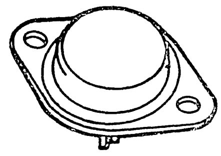
FIGURE 21. SWITCHING TIME TEST CIRCUIT

HIGH SPEED
NPN POWER DARLINGTON TRANSISTORS

GE6251,2,3

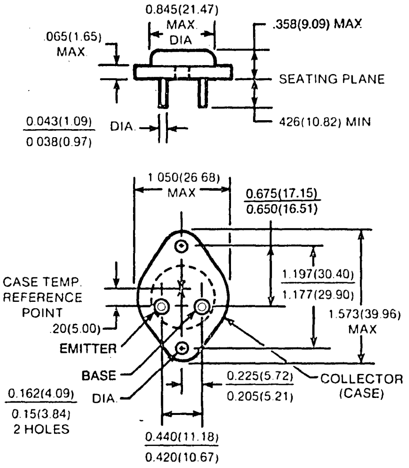
450-550 VOLTS
10 AMP, 125 WATTS

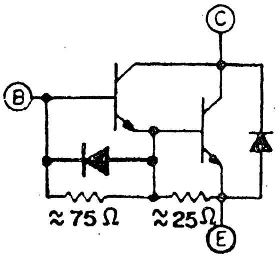
These devices are designed for use in high speed switching applications, such as off-line switching power supplies, AC & DC motor control, UPS systems, ultrasonic equipment and other high frequency power conversion equipment.



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





DEVICE CIRCUIT

maximum ratings ($T_C = 25°C$) (unless otherwise noted)

RATING	SYMBOL	GE6251	GE6252	GE6253	UNITS
Collector-Base Voltage	V_{CBO}	450	500	550	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	10 15 25	10 15 25	10 15 25	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	3 5	3 5	3 5	A
Total Power Dissipation @ $T_C = 25°C$	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage GE6251	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = .5A) GE6252		450	—	—	
(V_{clamp} = V_{CEO} Rated) GE6253		500	—	—	
Collector-Base Voltage GE6251	V_{CBO}	450	—	—	Volts
(I_C = 1.0mA) GE6252		500	—	—	
GE6253		550	—	—	
Collector Cutoff Current (V_{CB} = V_{CBO} Rated)	I_{CBO}	—	—	1	mA
Emitter Cutoff Current (V_{EB} = 1.5V, I_C = 0)	I_{EBO}	—	—	200	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 16
Clamped Inductive SOA with Base Reversed Biased	RBSOA	SEE FIGURE 19

on characteristics

DC Current Gain	h_{FE}				
(I_C = 3A, V_{CE} = 5V)		60	125	—	—
(I_C = 5A, V_{CE} = 5V)		50	170	—	
(I_C = 10A, V_{CE} = 5V)		30	160	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 5A, I_B = .5A)		—	1.0	1.5	V
(I_C = 10A, I_B = 2A)		—	1.15	2.0	
Base-Emitter Voltage (I_C = 5A, I_B = .5A)	$V_{BE(sat)}$	—	1.75	2.5	V

switching characteristics

Resistive Load						
Rise Time	V_{CC} = 300V, t_p = 50 μsec	t_r	—	0.2	.25	μs
Storage Time	I_C = 10A, I_{B1} = 1A, I_{B2} = 2A	t_s	—	2.1	2.5	
Fall Time		t_f	—	.2	1.0	
Inductive Load, Clamped						
Storage Time	V_{CC} = 300V, L = 100 μH	t_s	—	2.35	—	μs
Crossover Time	I_C = 10A, I_{B1} = 1A, I_{B2} = 2A	t_c	—	.28	—	
Fall Time		t_f	—	.09	—	

emitter-collector diode characteristics

Forward Voltage I_F = 10A	V_F	—	1.9	—	Volts

TYPICAL CHARACTERISTICS

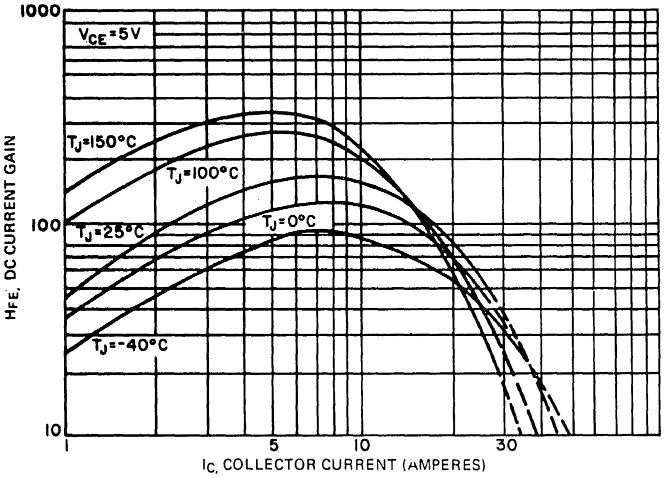


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

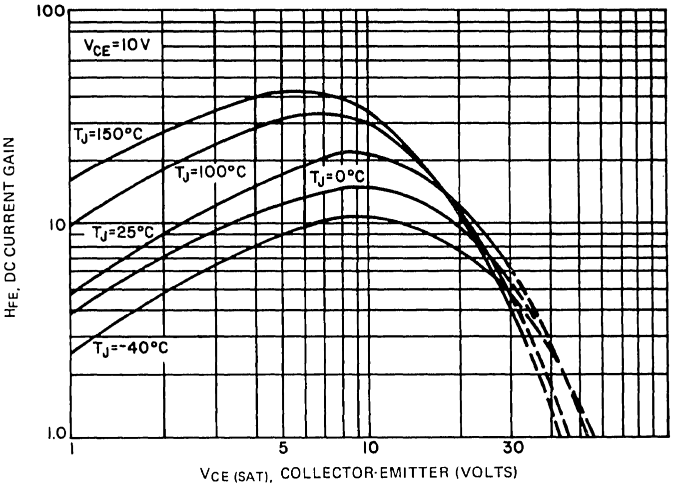


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

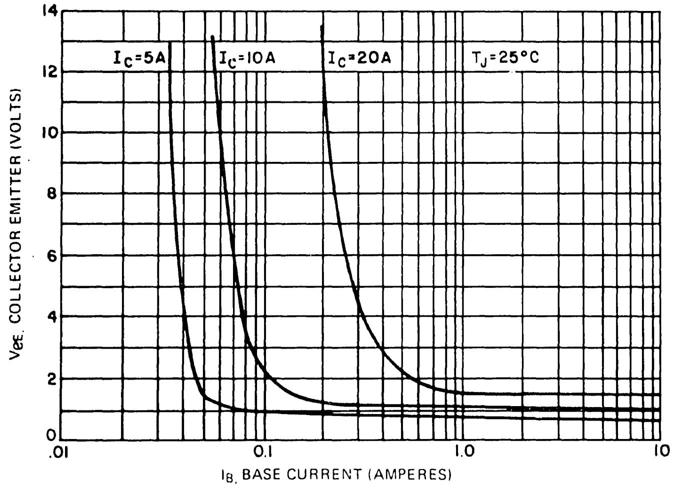


FIGURE 3. COLLECTOR SATURATION REGION

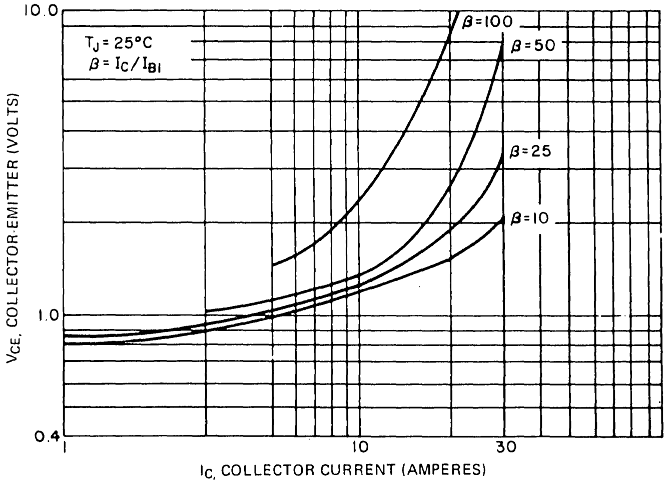


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

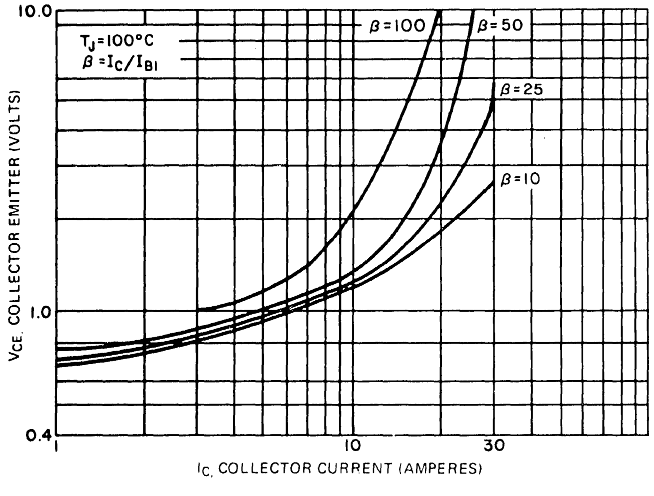


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

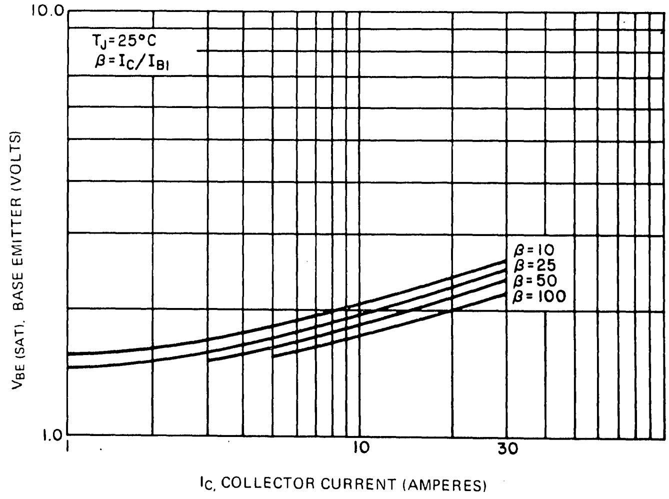


FIGURE 6. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

TYPICAL CHARACTERISTICS

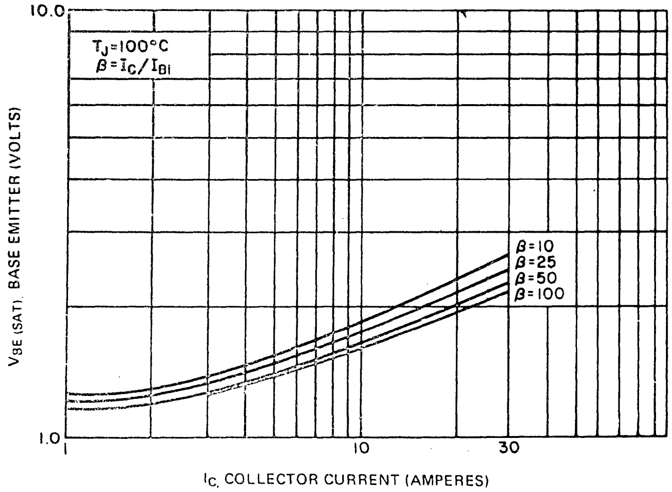


FIGURE 7. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

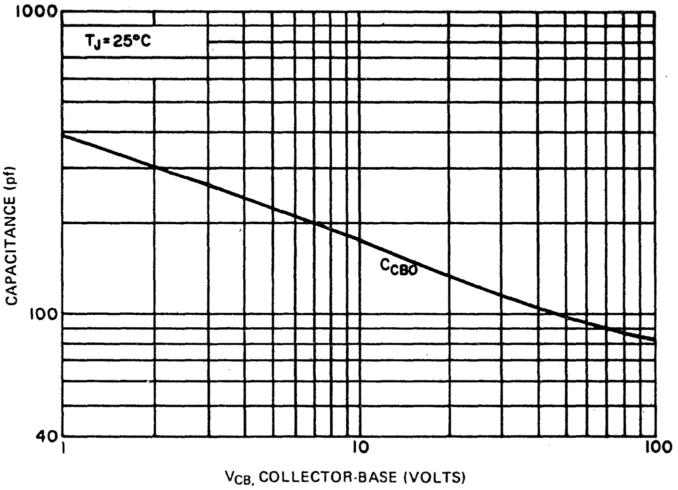


FIGURE 8. CAPACITANCE (C_{CBO})

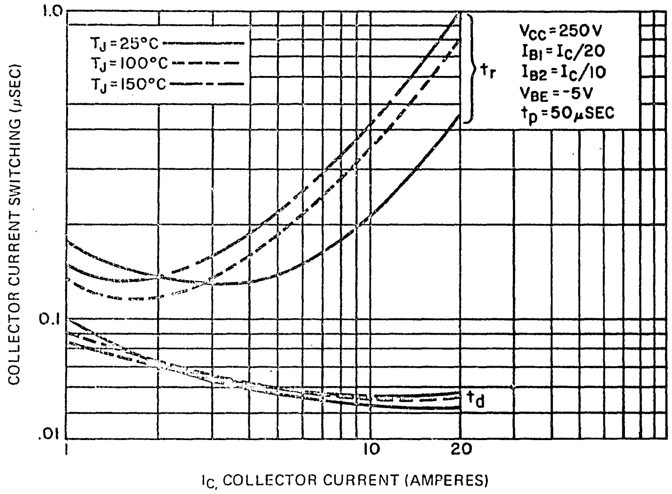


FIGURE 9. TURN-ON TIME (RESISTIVE)

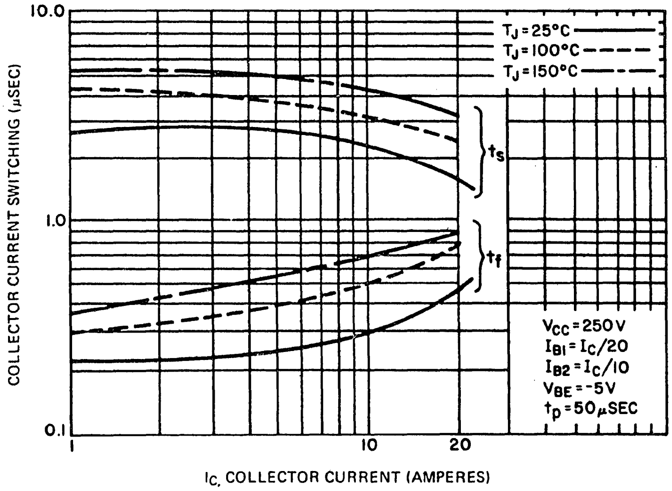


FIGURE 10. TURN-OFF TIME (RESISTIVE)

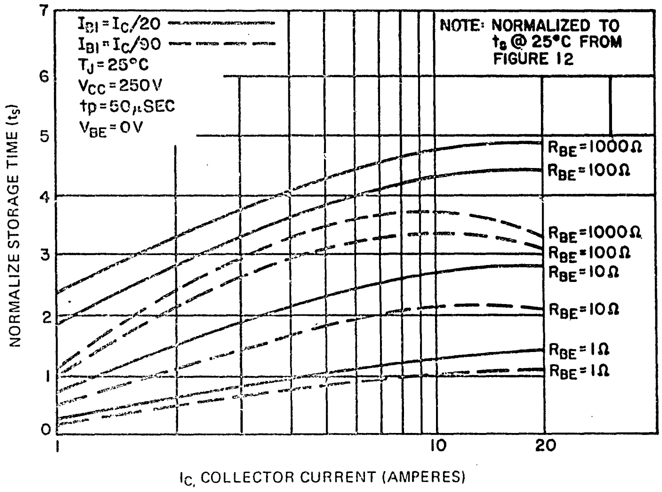


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

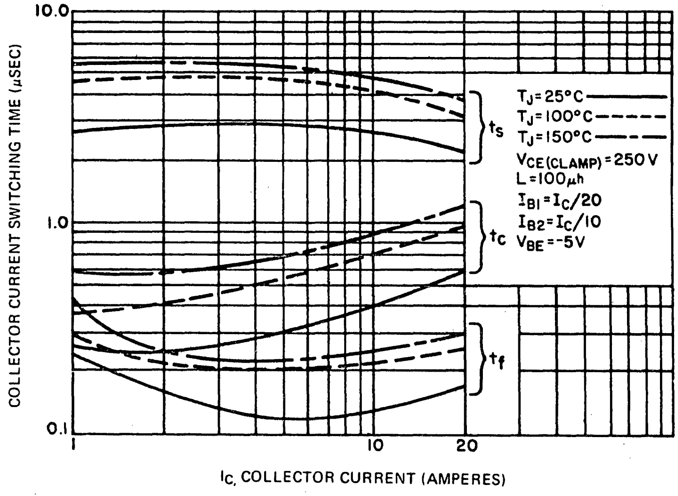


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

TYPICAL CHARACTERISTICS

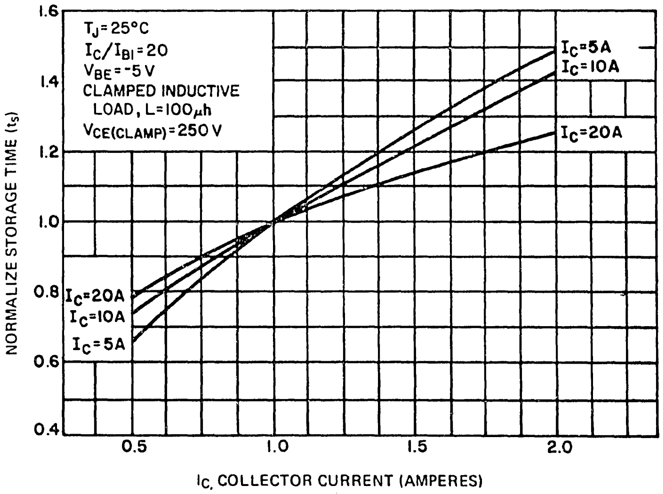


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

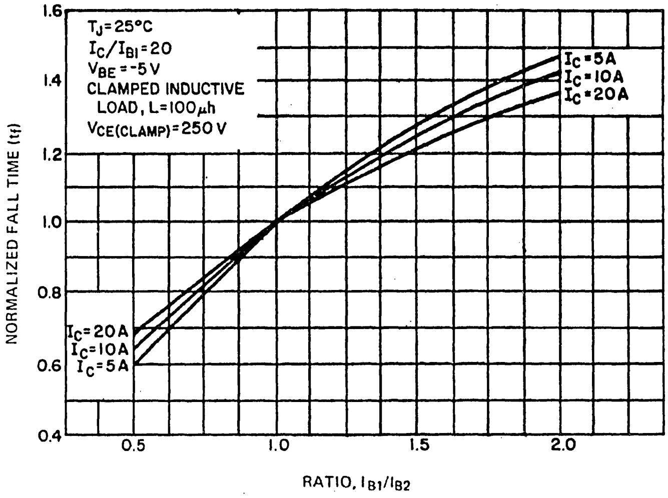


FIGURE 14. FALL TIME VARIATION WITH I_{B2}

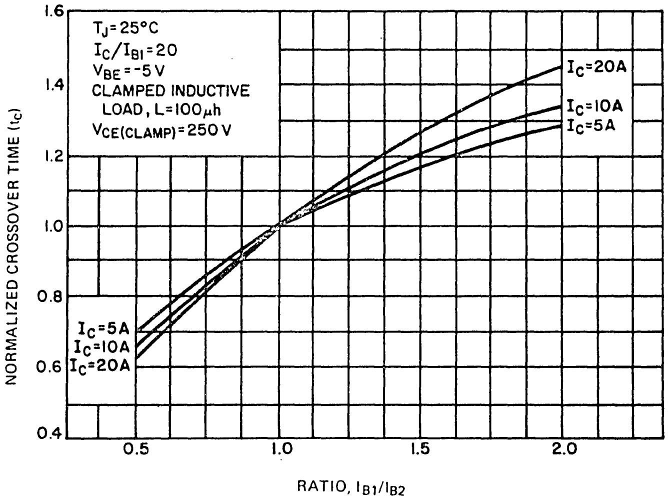


FIGURE 15. CROSS-OVER TIME VARIATION WITH I_{B2}

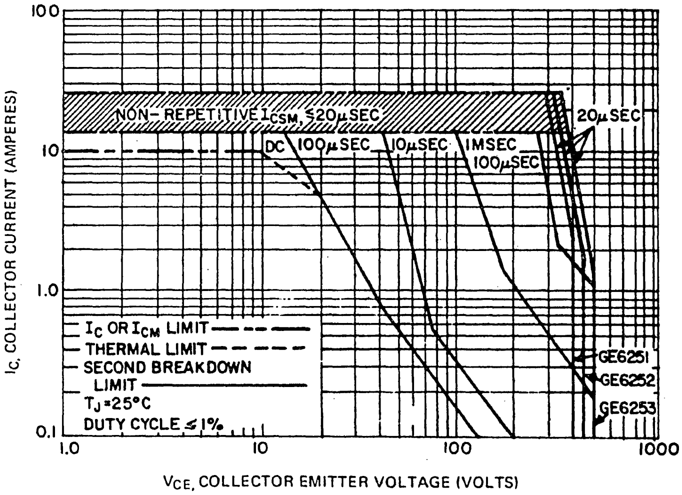


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

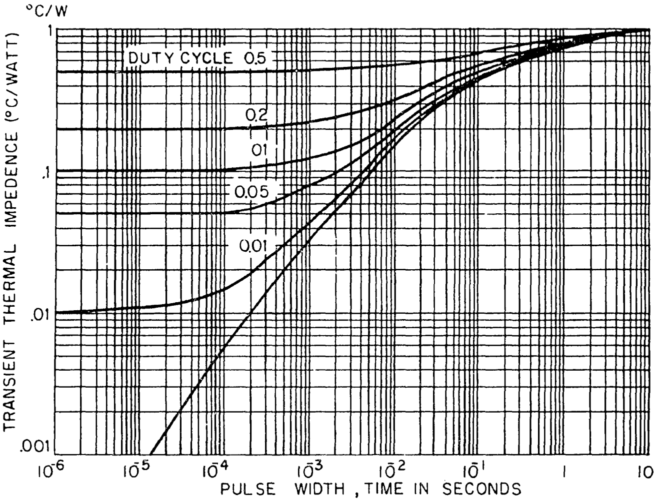


FIGURE 17. TRANSIENT THERMAL RESPONSE

DIODE CHARACTERISTICS

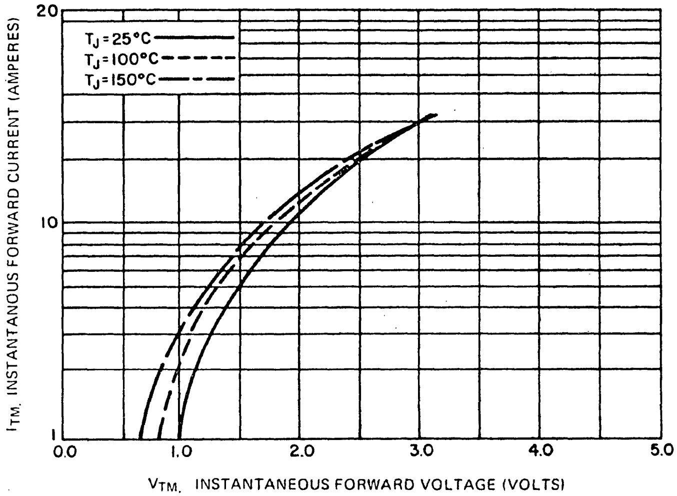


FIGURE 18. FORWARD CHARACTERISTICS

TYPICAL CHARACTERISTICS

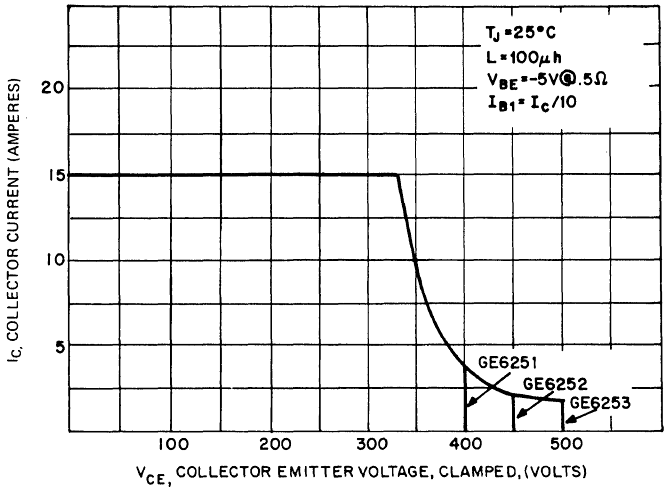


FIGURE 19. REVERSE BIAS SAFE OPERATING AREA

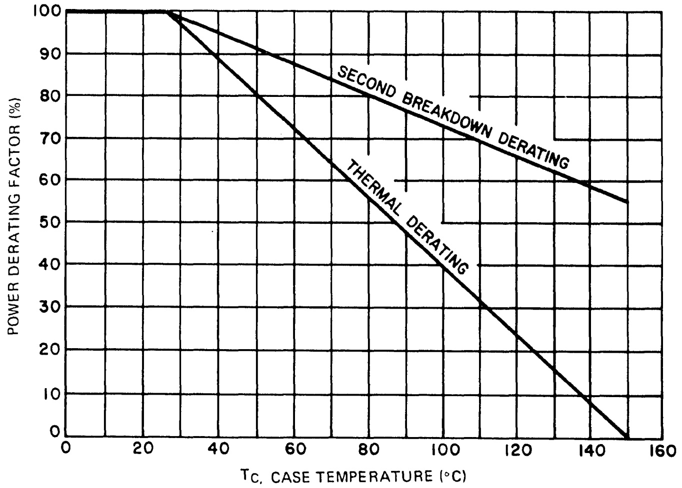
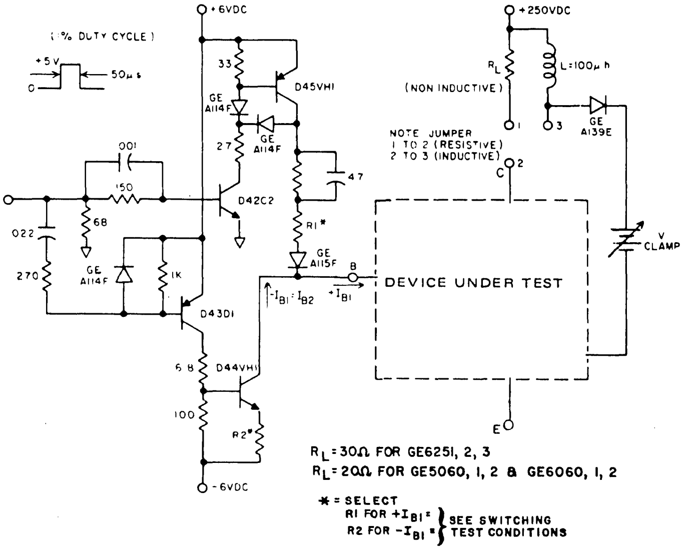


FIGURE 20. POWER DERATING



R_L = 30Ω FOR GE6251, 2, 3
R_L = 20Ω FOR GE5060, 1, 2 & GE6060, 1, 2

* = SELECT
R1 FOR $+I_{B1}$ = } SEE SWITCHING
R2 FOR $-I_{B1}$ = } TEST CONDITIONS

FIGURE 21. SWITCHING TIME TEST CIRCUIT

NPN POWER TRANSISTORS

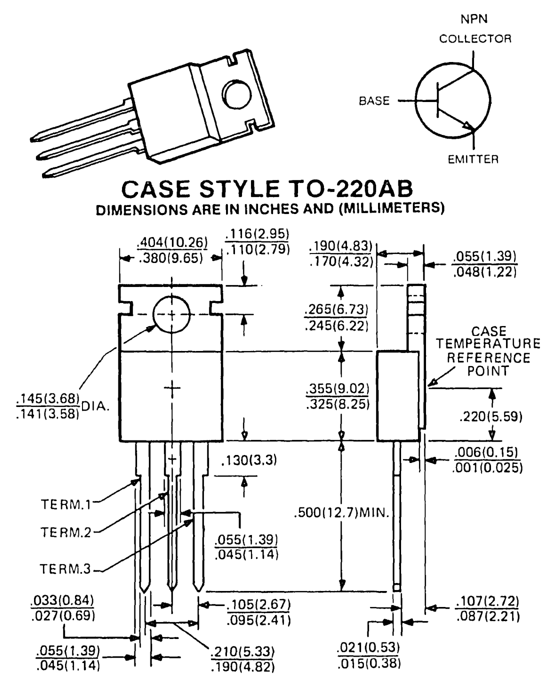
MJE13004

300 VOLTS
4 AMP, 75 WATTS

Designed for switching regulator, DC-DC converter, AC-DC inverter, high voltage, high speed switching applications.

Features:

- $V_{CEO(sus)}$ = 300V (Min).
- V_{CEV} = 600V blocking capability
- Excellent switching time: t_r = 0.7 μs (Max.), t_f = 0.9 μs (Max.)



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	MJE13004	UNITS
Collector-Emitter Voltage	V_{CEO}	300	Volts
Collector-Emitter Voltage	V_{CEV}	600	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	4 8	A
Base Current — Continuous Pulse	I_B I_{BP}	2 4	A
Emitter Current — Continuous Pulse	I_E I_{EP}	6 12	A
Collector Power Dissipation T_A = 25°C Derate above 25° C	P_C	2 16	Watts mW/° C
Collector Power Dissipation T_C = 25°C Derate above 25° C	P_C	75 600	Watts mW/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	275	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	300	—	—	Volts
Collector Cutoff Current					
(V_{CE} = 600V, V_{BE} = -1.5V)	I_{CEV}	—	—	1	mA
(V_{CE} = 600V, V_{BE} = -1.5V, T_C = 100° C)		—	—	5	
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 12

on characteristics(1)

DC Current Gain					
(I_C = 1A, V_{CE} = 5V)	h_{FE}	10	—	60	—
(I_C = 2A, V_{CE} = 5V)		8	—	40	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 1A, I_B = 0.2A)		—	—	0.5	V
(I_C = 2A, I_B = 0.5A)		—	—	0.6	
(I_C = 4A, I_B = 1A)		—	—	1	
(I_C = 2A, I_B = 0.5A, T_C = 100° C)		—	—	1	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 1A, I_B = 0.2A)		—	—	1.2	V
(I_C = 2A, I_B = 0.5A)		—	—	1.6	
(I_C = 2A, I_B = 0.5A, T_C = 100° C)		—	—	1.5	

dynamic characteristics

Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{ob}	—	55	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	4	—	—	MHz

switching characteristics

Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 2A	t_d	—	—	0.1	µs
Rise Time	I_{B1} = $-I_{B2}$ = 0.4A, t_p = 25 µs	t_r	—	—	0.7	
Storage Time	Duty Cycle < 1%)	t_s	—	—	4	
Fall Time		t_f	—	—	0.9	
Inductive Load, Clamped						
Storage Time	(I_C = 2A, V_{clamp} = 300V	t_{sv}	—	—	4	µs
Crossover Time	I_{B1} = 0.4A, $V_{BE(off)}$ = -5V, T_C = 100° C)	t_c	—	—	0.9	
Fall Time		t_f	—	0.16	—	

(1) Pulse Test: Pulse Width - 300µs Duty Cycle ≤ 2%.

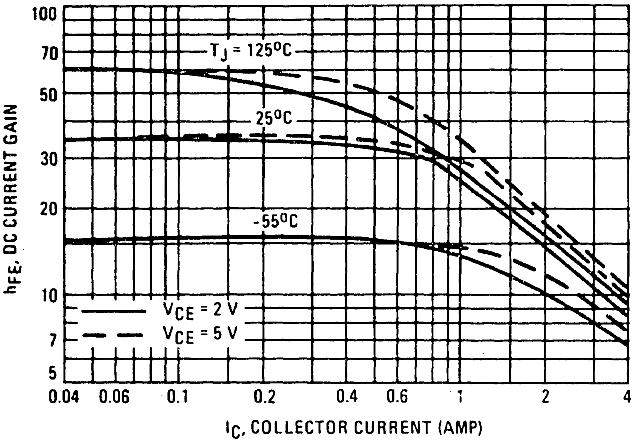


FIGURE 1 – DC CURRENT GAIN

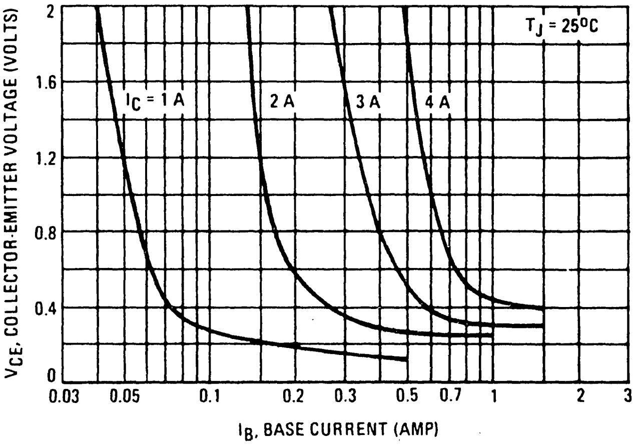


FIGURE 2 – COLLECTOR SATURATION REGION

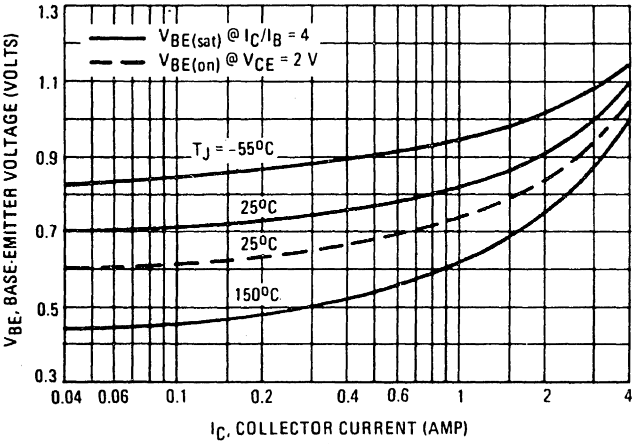


FIGURE 3 – BASE-EMITTER VOLTAGE

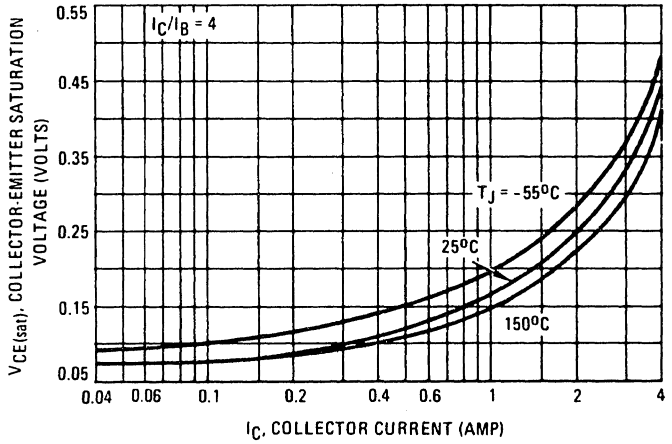


FIGURE 4 – COLLECTOR–EMITTER SATURATION VOLTAGE

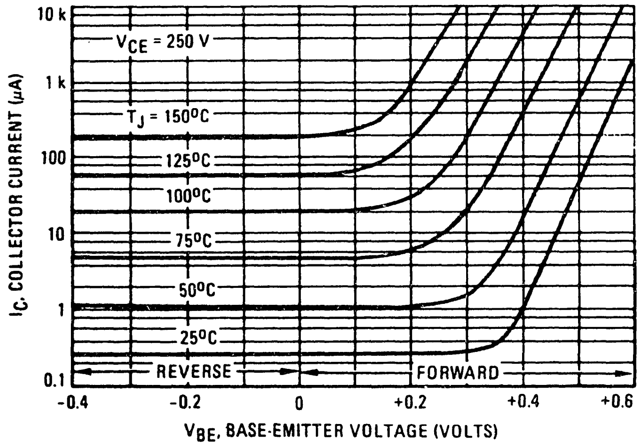


FIGURE 5 – COLLECTOR CUTOFF REGION

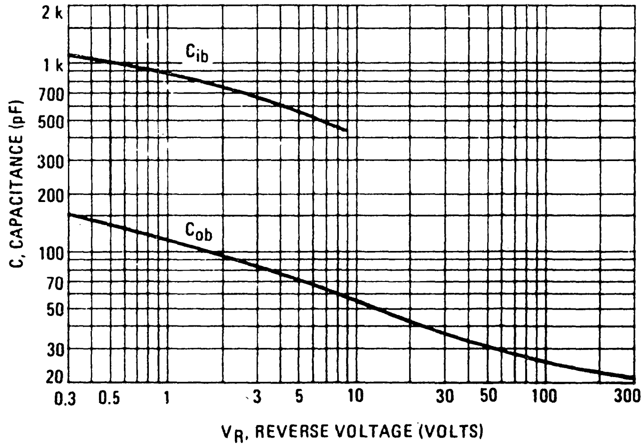


FIGURE 6 – CAPACITANCE

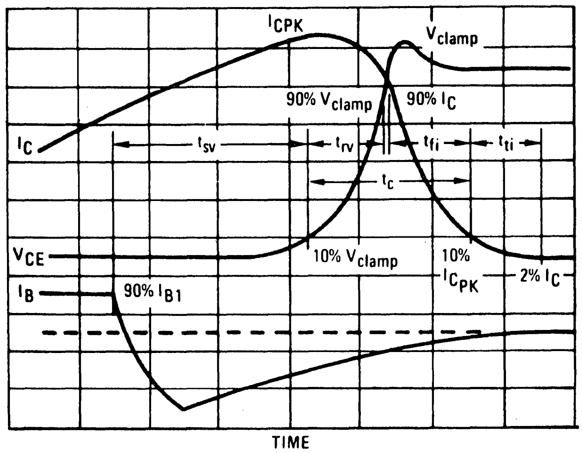


FIGURE 7 – INDUCTIVE SWITCHING MEASUREMENTS

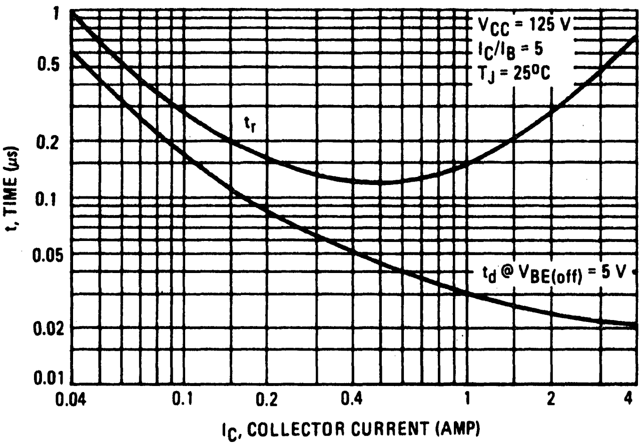


FIGURE 8 – TURN-ON TIME

RESISTIVE SWITCHING PERFORMANCE

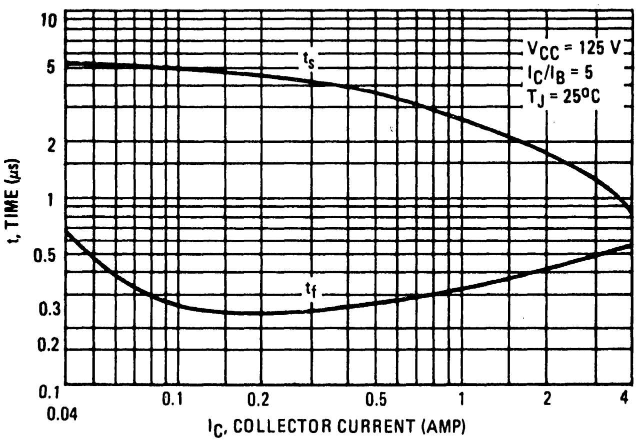


FIGURE 9 — TURN-OFF TIME

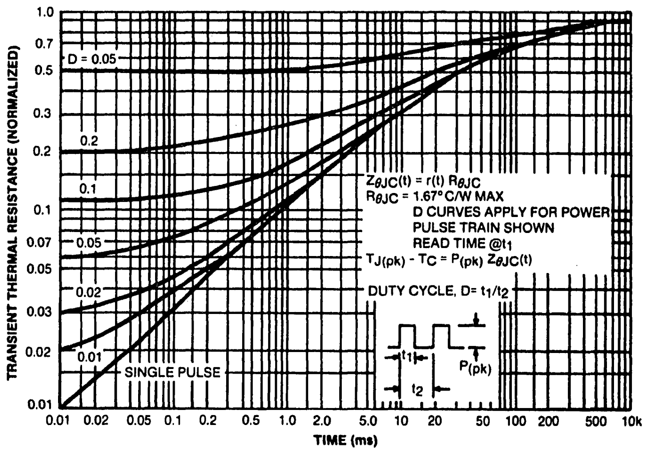


FIGURE 10 TYPICAL THERMAL RESPONSE [(ZθJC(t)]

The Safe Operating Area Figures 11 and 12 are specified ratings for these devices under the test conditions shown.

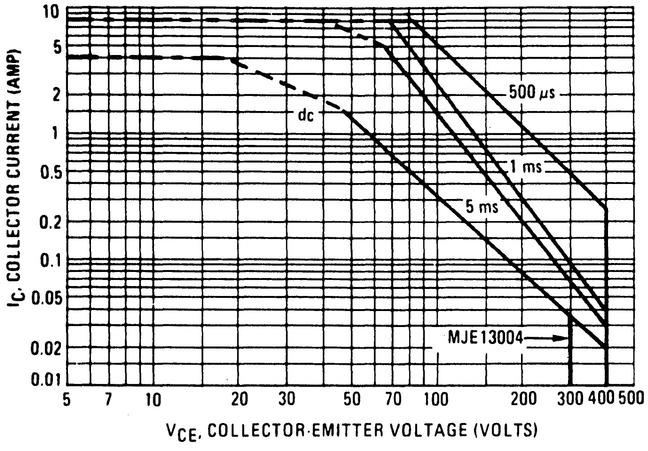


FIGURE 11 – FORWARD BIAS SAFE OPERATING AREA

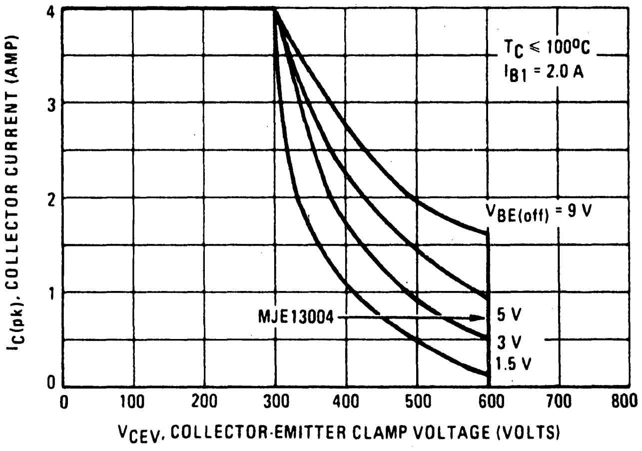


FIGURE 12– REVERSE BIAS SWITCHING SAFE OPERATING AREA

NPN POWER TRANSISTORS

MJE13005

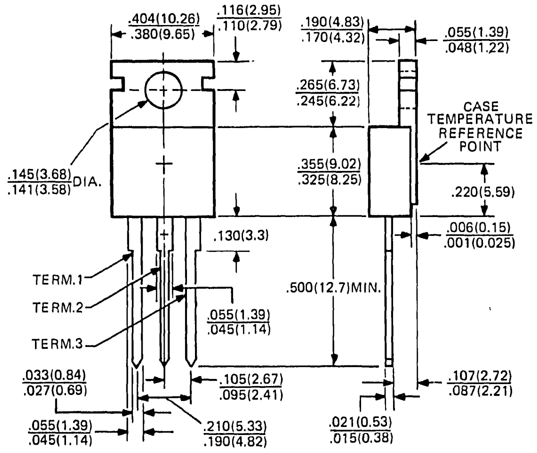
400 VOLTS
4 AMP, 75 WATTS

Designed for switching regulator, DC-DC converter, AC-DC inverter, high voltage, high speed switching applications.

Features:

- $V_{CEO(sus)}$ = 400V (Min).
- V_{CEV} = 700V blocking capability
- Excellent switching time: t_r = 0.7 μs (Max.),
  t_f = 0.9 μs (Max.)

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING		SYMBOL	MJE13005	UNITS
Collector-Emitter Voltage		V_{CEO}	400	Volts
Collector-Emitter Voltage		V_{CEV}	700	Volts
Emitter Base Voltage		V_{EBO}	9	Volts
Collector Current — Continuous Pulse		I_C I_{CP}	4 8	A
Base Current — Continuous Pulse		I_B I_{BP}	2 4	A
Emitter Current — Continuous Pulse		I_E I_{EP}	6 12	A
Collector Power Dissipation Derate above 25° C	T_A = 25° C	P_C	2 16	Watts mW/° C
Collector Power Dissipation Derate above 25° C	T_C = 25° C	P_C	75 600	Watts mW/° C
Operating and Storage Junction Temperature Range		T_J, T_{STG}	-65 to +150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	°C

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{CEO(sus)}$	400	—	—	Volts
Collector Cutoff Current ($V_{CE} = 700V$, $V_{BE} = -1.5V$) ($V_{CE} = 700V$, $V_{BE} = -1.5V$, $T_C = 100°C$)	I_{CEV}	— —	— —	1 5	mA
Emitter Cutoff Current ($V_{EB} = 9V$, $I_C = 0$)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 12

on characteristics(1)

DC Current Gain ($I_C = 1A$, $V_{CE} = 5V$) ($I_C = 2A$, $V_{CE} = 5V$)	h_{FE}	10 8	— —	60 40	—
Collector-Emitter Saturation Voltage ($I_C = 1A$, $I_B = 0.2A$) ($I_C = 2A$, $I_B = 0.5A$) ($I_C = 4A$, $I_B = 1A$) ($I_C = 2A$, $I_B = 0.5A$, $T_C = 100°C$)	$V_{CE(sat)}$	— — — —	— — — —	0.5 0.6 1 1	V
Base-Emitter Saturation Voltage ($I_C = 1A$, $I_B = .2A$) ($I_C = 2A$, $I_B = .5A$) ($I_C = 2A$, $I_B = .5A$, $T_C = 100°C$)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

dynamic characteristics

Output Capacitance ($V_{CB} = 10V$, $I_E = 0$)	C_{ob}	—	55	—	pF
Current Gain — Bandwidth Product ($I_C = 500mA$, $V_{CE} = 10V$, $f_{test} = 1.0$ MHz)	f_T	4	—	—	MHz

switching characteristics

Resistive Load						
Delay Time	($V_{CC} = 125V$, $I_C = 2A$ $I_{B1} = -I_{B2} = 0.4A$, $t_p = 25\ \mu s$ Duty Cycle < 1%)	t_d	—	—	0.1	μs
Rise Time		t_r	—	—	0.7	
Storage Time		t_s	—	—	4	
Fall Time		t_f	—	—	0.9	
Inductive Load, Clamped						
Storage Time	($I_C = 2A$, $V_{clamp} = 300V$ $I_{B1} = 0.4A$, $V_{BE(off)} = -5V$, $T_C = 100°C$)	t_{sv}	—	—	4	μs
Crossover Time		t_c	—	—	0.9	
Fall Time		t_f	—	0.16	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

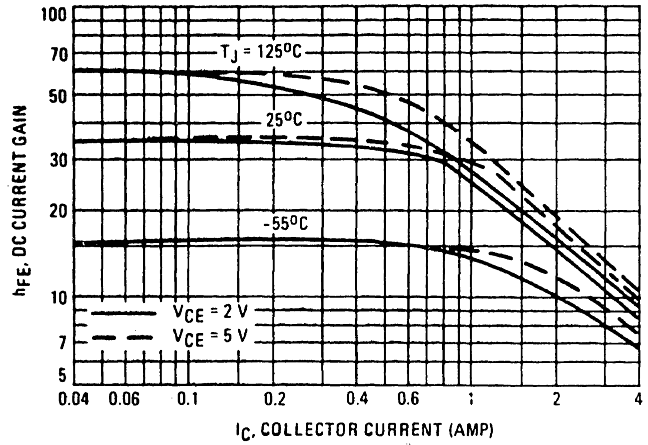


FIGURE 1 – DC CURRENT GAIN

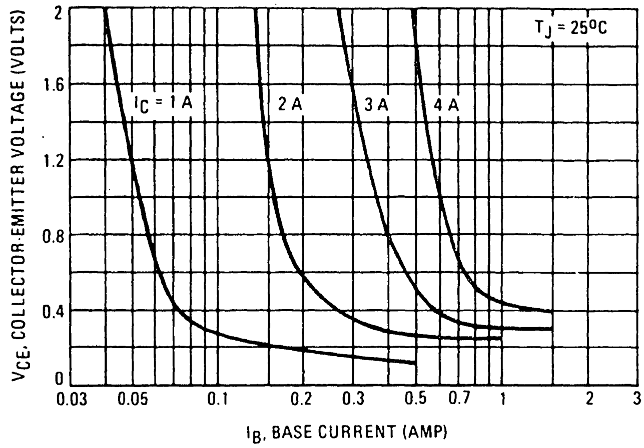


FIGURE 2 – COLLECTOR SATURATION REGION

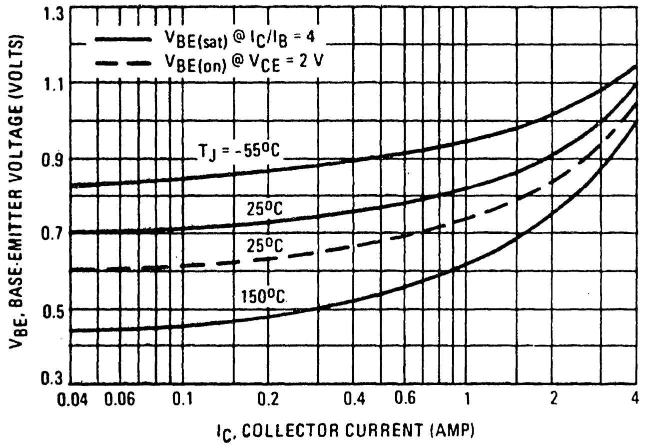


FIGURE 3 – BASE-EMITTER VOLTAGE

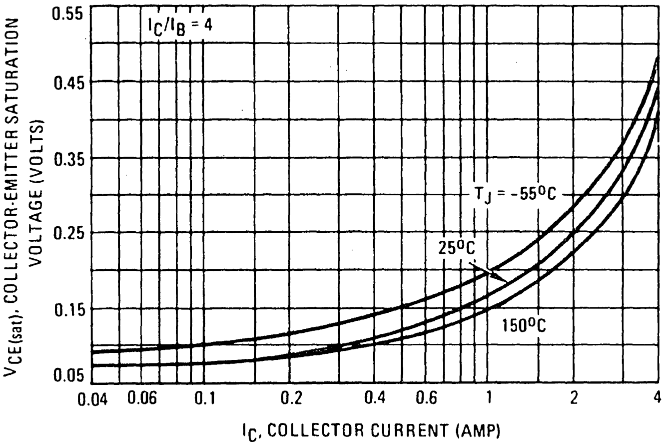


FIGURE 4 – COLLECTOR-EMITTER SATURATION VOLTAGE

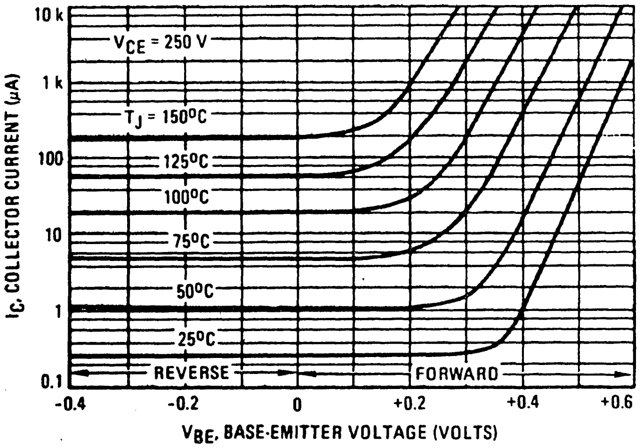


FIGURE 5 – COLLECTOR CUTOFF REGION

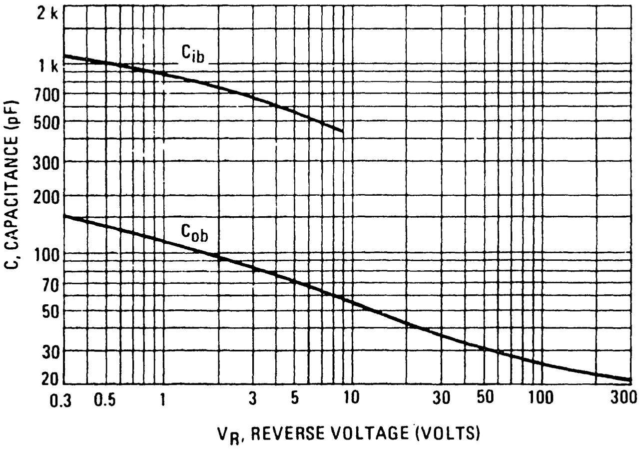


FIGURE 6 – CAPACITANCE

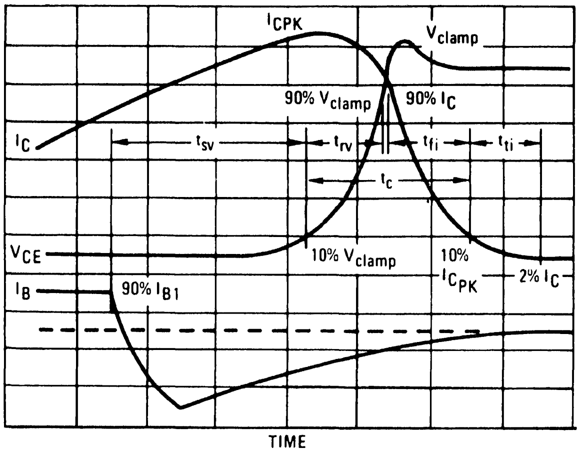


FIGURE 7 — INDUCTIVE SWITCHING MEASUREMENTS

RESISTIVE SWITCHING PERFORMANCE

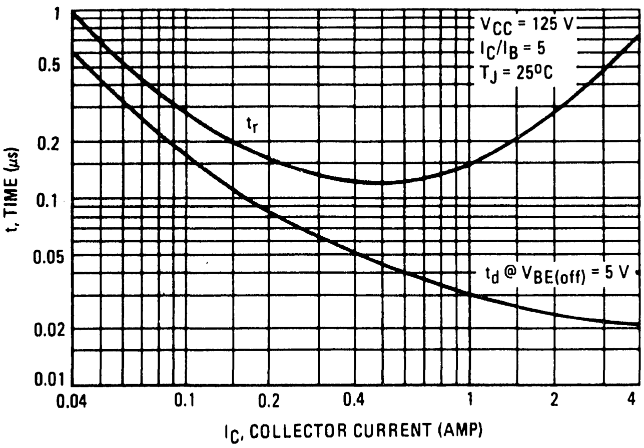


FIGURE 8 — TURN-ON TIME

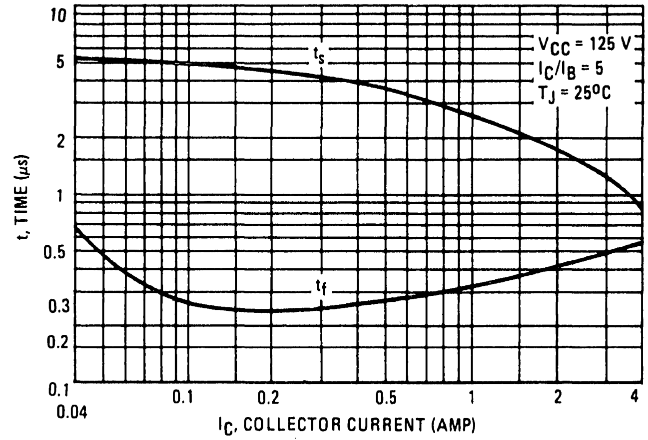


FIGURE 9 — TURN-OFF TIME

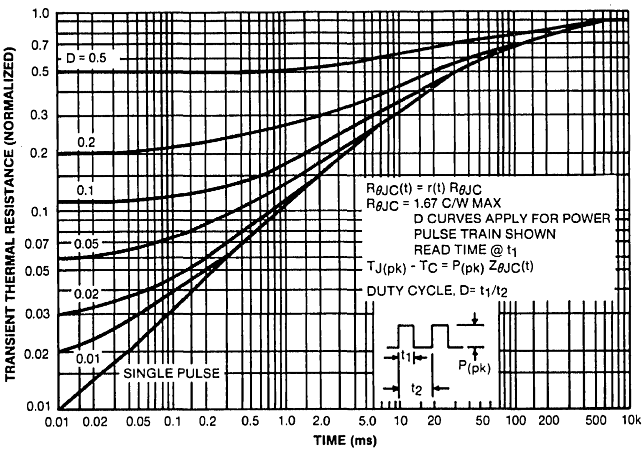


FIGURE 10 TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$)]

The Safe Operating Area Figures 11 and 12 are specified ratings for these devices under the test conditions shown.

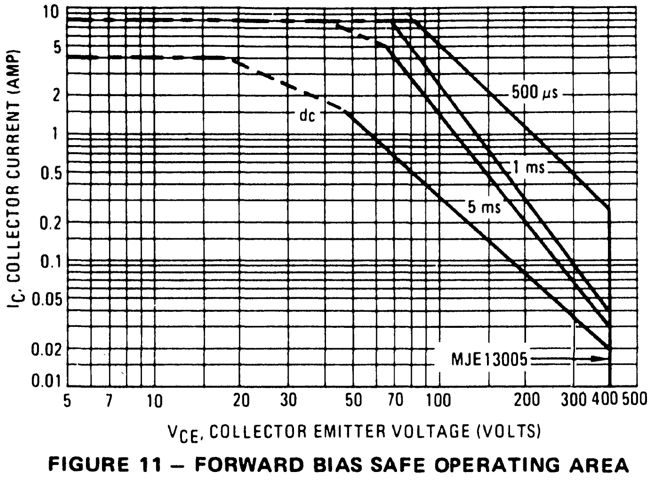


FIGURE 11 — FORWARD BIAS SAFE OPERATING AREA

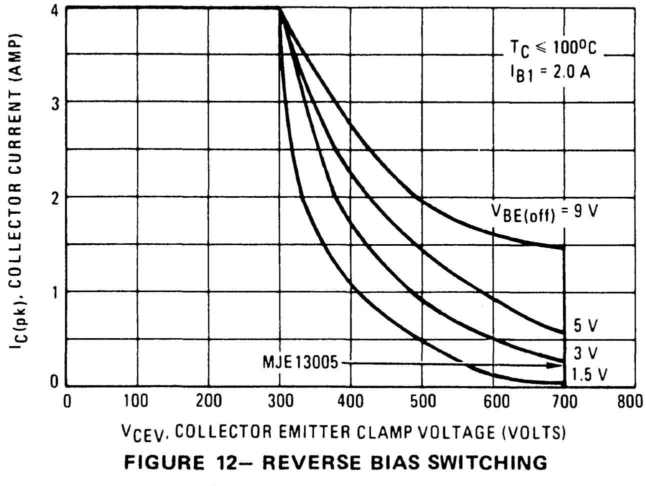


FIGURE 12— REVERSE BIAS SWITCHING SAFE OPERATING AREA

NPN POWER TRANSISTORS

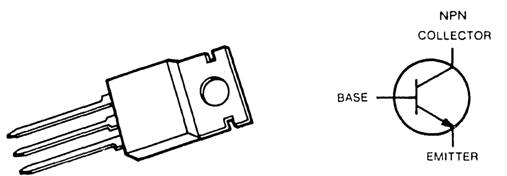
MJE13006

300 VOLTS
8 AMP, 80 WATTS

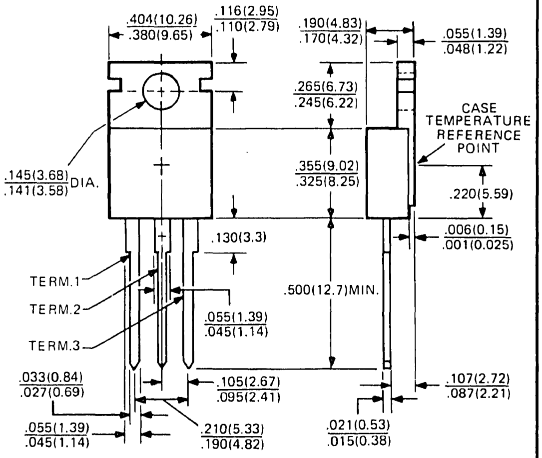
Designed for switching regulator, DC-DC converter, AC-DC inverter, high voltage, high speed switching applications.

Features:

- $V_{CEO(sus)} = 300V$ (Min).
- $V_{CEV} = 600V$ blocking capability
- Excellent switching time: $t_r = 1.5\ \mu s$ (Max.),
  $t_f = 0.7\ \mu s$ (Max.)



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	MJE13006	UNITS
Collector-Emitter Voltage	V_{CEO}	300	Volts
Collector-Emitter Voltage	V_{CEV}	600	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	8 16	A
Base Current — Continuous Pulse	I_B I_{BP}	4 8	A
Emitter Current — Continuous Pulse	I_E I_{EP}	12 24	A
Collector Power Dissipation $T_A = 25°C$ Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation $T_C = 25°C$ Derate above 25°C	P_C	80 640	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	275	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	300	—	—	Volts
Collector Cutoff Current					
(V_{CE} = 600V, V_{BE} = -1.5V)	I_{CEV}	—	—	1	mA
(V_{CE} = 600V, V_{BE} = -1.5V, T_C = 100°C)		—	—	5	
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1			
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 2			

on characteristics(1)

DC Current Gain					
(I_C = 2A, V_{CE} = 5V)	h_{FE}	8	—	60	—
(I_C = 5A, V_{CE} = 5V)		5	—	30	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 2A, I_B = 0.4A)		—	—	1	V
(I_C = 5A, I_B = 1A)		—	—	2	
(I_C = 8A, I_B = 2A)		—	—	3	
(I_C = 5A, I_B = 1A, T_C = 100°C)		—	—	3	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 2A, I_B = 0.4A)		—	—	1.2	V
(I_C = 5A, I_B = 1A)		—	—	1.6	
(I_C = 5A, I_B = 1A, T_C = 100°C)		—	—	1.5	

dynamic characteristics

Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{ob}	—	90	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	4	—	—	MHz

switching characteristics

Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 5A I_{B1} = $-I_{B2}$ = 1A, t_p = 25 μs Duty Cycle < 1%)	t_d	—	—	0.1	μs
Rise Time		t_r	—	—	1.5	
Storage Time		t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	Inductive Load (I_C = 5A, V_{clamp} = 300V, I_{B1} = 1A, $V_{BE(off)}$ = -5V, T_C = 100°C)	t_{sv}	—	—	2.3	μs
Crossover Time		t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

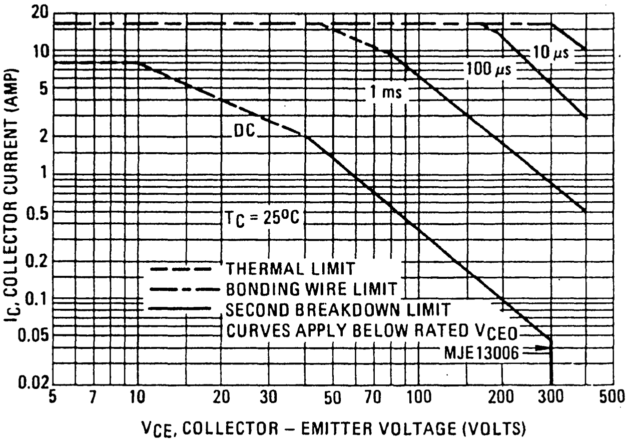


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

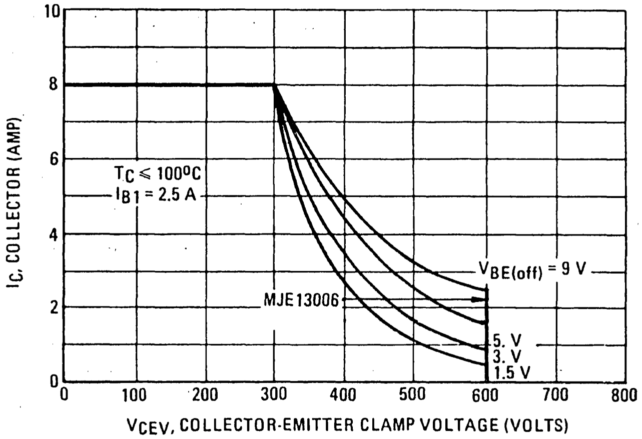


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

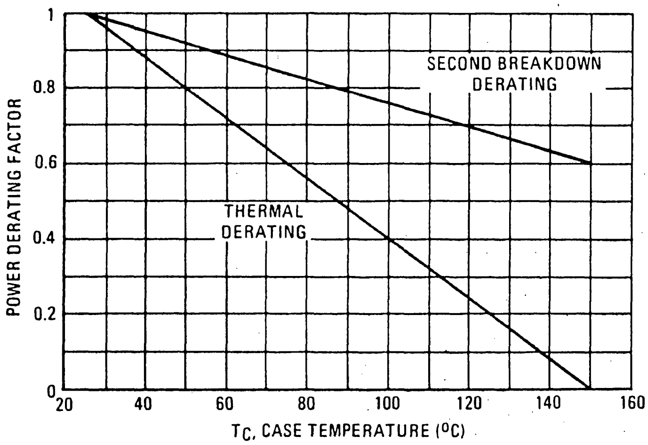


FIGURE 3 – FORWARD BIAS POWER DERATING

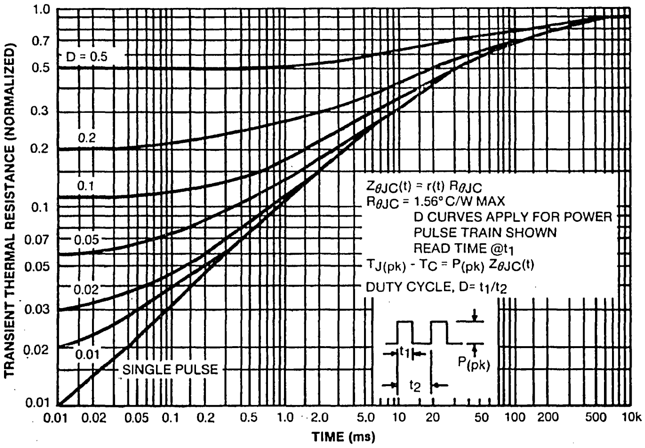


FIGURE 4 TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$)]

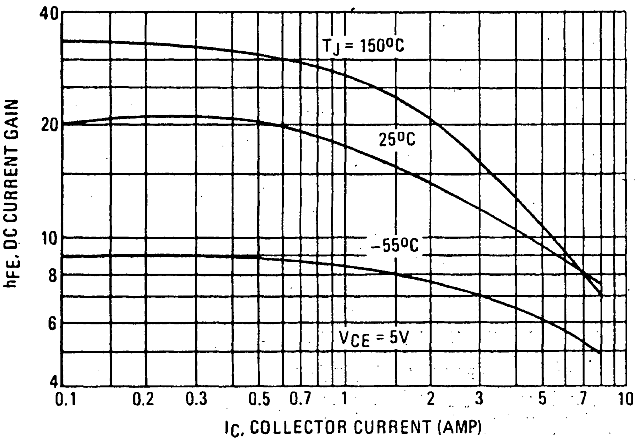


FIGURE 5 –DC CURRENT GAIN

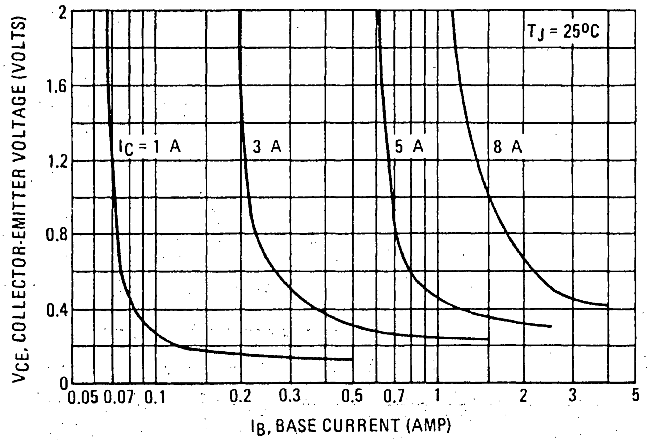


FIGURE 6 – COLLECTOR SATURATION REGION

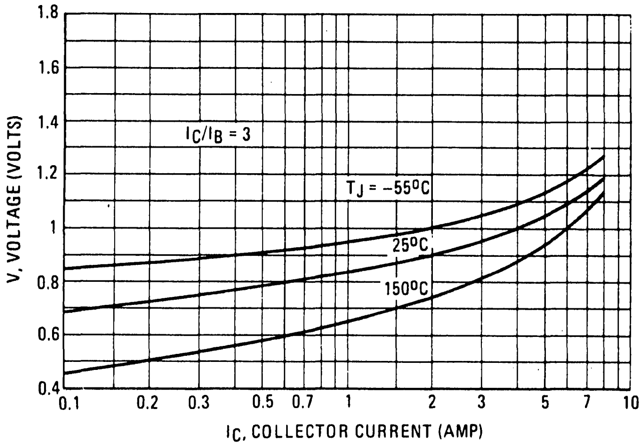


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

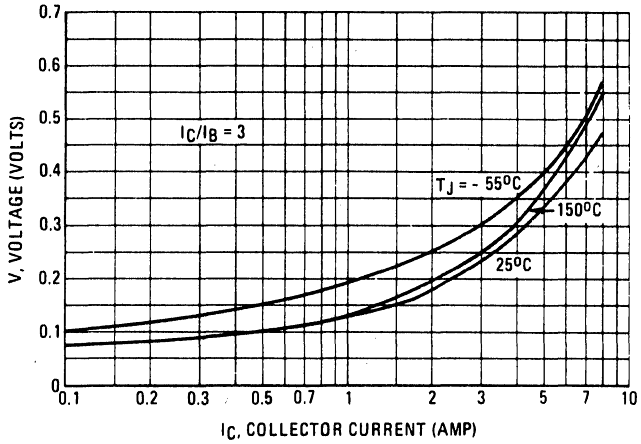


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

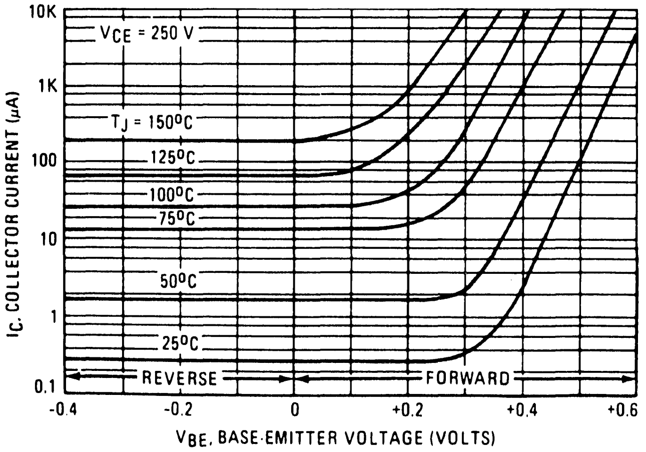


FIGURE 9 – COLLECTOR CUTOFF REGION

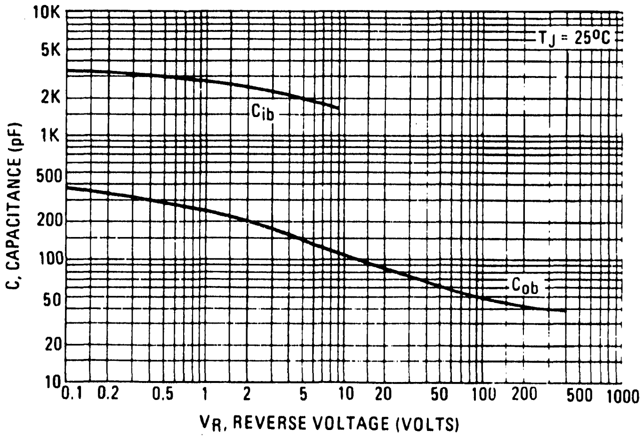


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

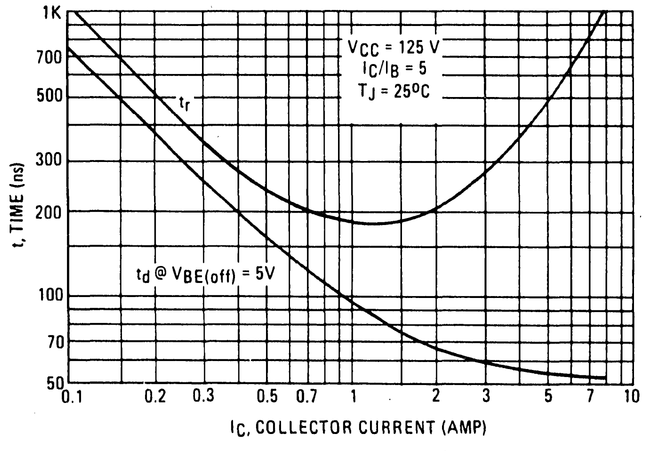


FIGURE 11 – TURN-ON TIME

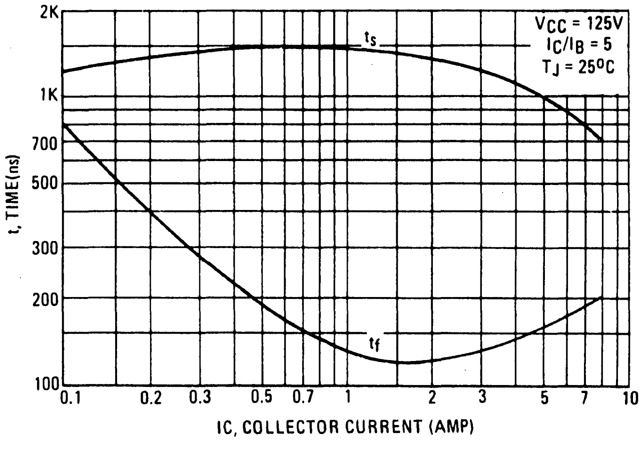


FIGURE 12 – TURN-OFF TIME

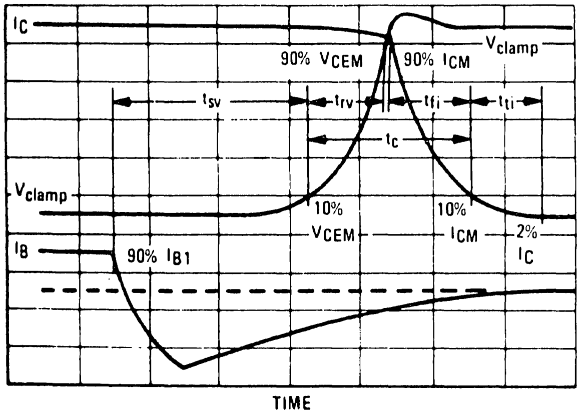


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

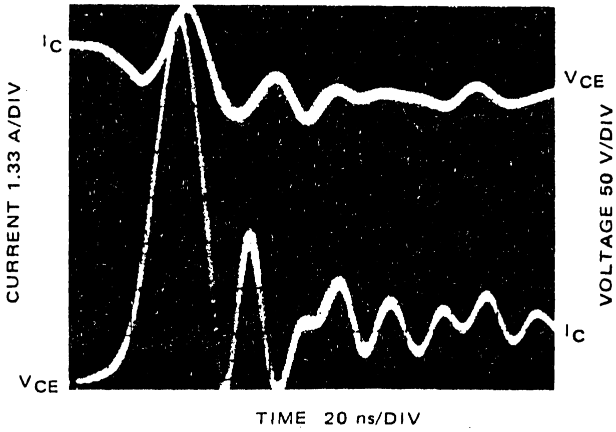


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 8A with I_{B1} = 1.6A and $V_{BE(off)}$ = 5 V)

NPN POWER TRANSISTORS

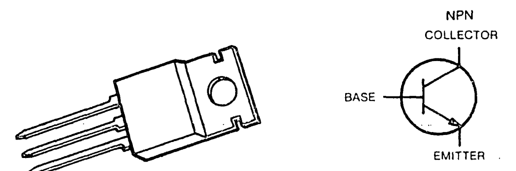
MJE13007

400 VOLTS
8 AMP, 80 WATTS

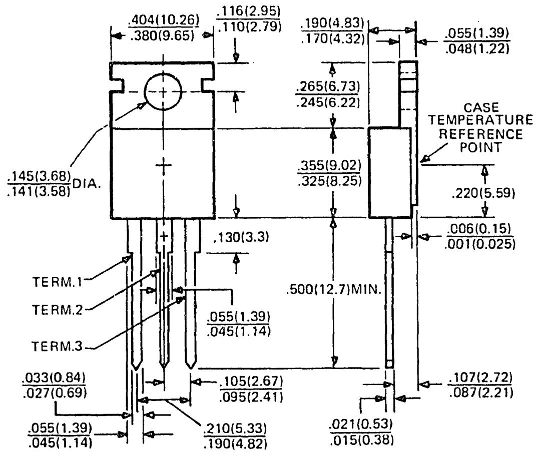
Designed for switching regulator, DC-DC converter, AC-DC inverter, high voltage, high speed switching applications.

Features:

- $V_{CEO(sus)}$ = 400V (Min).
- V_{CEV} = 700V blocking capability
- Excellent switching time: $t_r = 1.5\ \mu s$ (Max.), $t_f = 0.7\ \mu s$ (Max.)



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	MJE13007	UNITS
Collector-Emitter Voltage	V_{CEO}	400	Volts
Collector-Emitter Voltage	V_{CEV}	700	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	8 16	A
Base Current — Continuous Pulse	I_B I_{BP}	4 8	A
Emitter Current — Continuous Pulse	I_E I_{EP}	12 24	A
Collector Power Dissipation $T_A = 25°C$ Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation $T_C = 25°C$ Derate above 25°C	P_C	80 640	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage ($I_C = 10mA$, $I_B = 0$)	$V_{CEO(sus)}$	400	—	—	Volts
Collector Cutoff Current ($V_{CE} = 700V$, $V_{BE} = -1.5V$) ($V_{CE} = 700V$, $V_{BE} = -1.5V$, $T_C = 100°C$)	I_{CEV}	— —	— —	1 5	mA
Emitter Cutoff Current ($V_{EB} = 9V$, $I_C = 0$)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 2

on characteristics(1)

DC Current Gain ($I_C = 2A$, $V_{CE} = 5V$) ($I_C = 5A$, $V_{CE} = 5V$)	h_{FE}	8 5	— —	60 30	—
Collector-Emitter Saturation Voltage ($I_C = 2A$, $I_B = 0.4A$) ($I_C = 5A$, $I_B = 1A$) ($I_C = 8A$, $I_B = 2A$) ($I_C = 5A$, $I_B = 1A$, $T_C = 100°C$)	$V_{CE(sat)}$	— — — —	— — — —	1 2 3 3	V
Base-Emitter Saturation Voltage ($I_C = 2A$, $I_B = 0.4A$) ($I_C = 5A$, $I_B = 1A$) ($I_C = 5A$, $I_B = 1A$, $T_C = 100°C$)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

dynamic characteristics

Output Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 0.1$ MHz)	C_{ob}	—	90	—	pF
Current Gain — Bandwidth Product ($I_C = 500mA$, $V_{CE} = 10V$, $f_{test} = 1.0$ MHz)	f_T	4	—	—	MHz

switching characteristics

Resistive Load						
Delay Time	($V_{CC} = 125V$, $I_C = 2A$ $I_{B1} = -I_{B2} = 0.4A$, $t_p = 25\ \mu s$ Duty Cycle $< 1\%$)	t_d	—	—	0.1	μs
Rise Time		t_r	—	—	1.5	
Storage Time		t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	Inductive Load ($I_C = 5A$, $V_{clamp} = 300V$, $I_{B1} = 1A$, $V_{BE(off)} = -5V$, $T_C = 100°C$)	t_{sv}	—	—	2.3	μs
Crossover Time		t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle $\leq 2\%$.

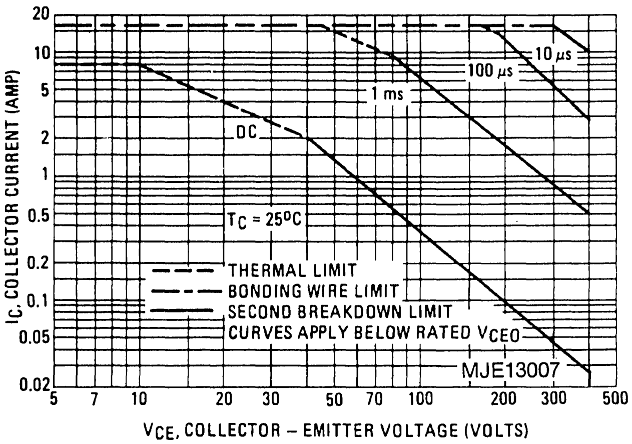


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

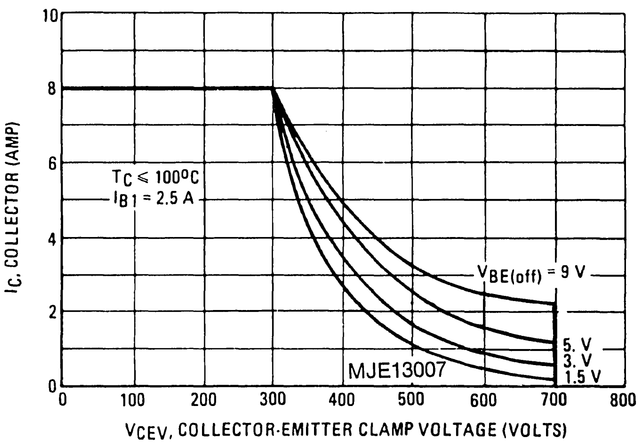


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

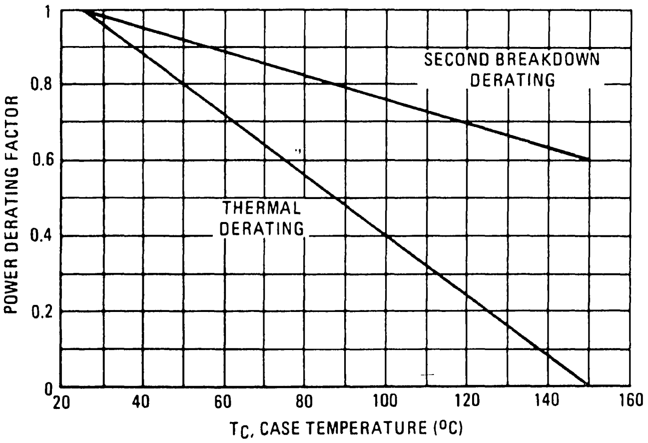


FIGURE 3 – FORWARD BIAS POWER DERATING

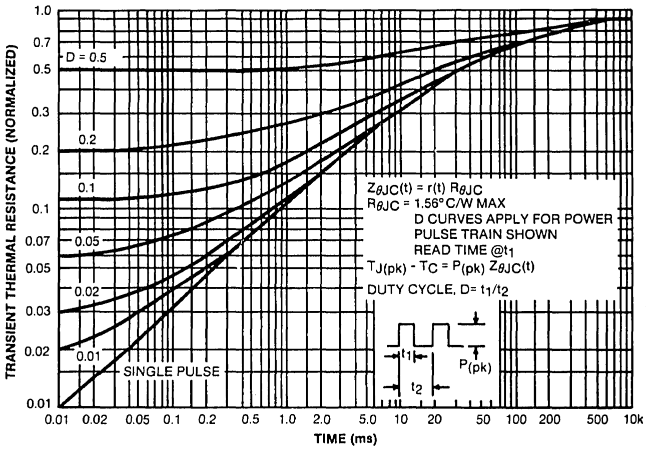


FIGURE 4 TYPICAL THERMAL RESPONSE [(Z$_{\theta JC}$(t))]

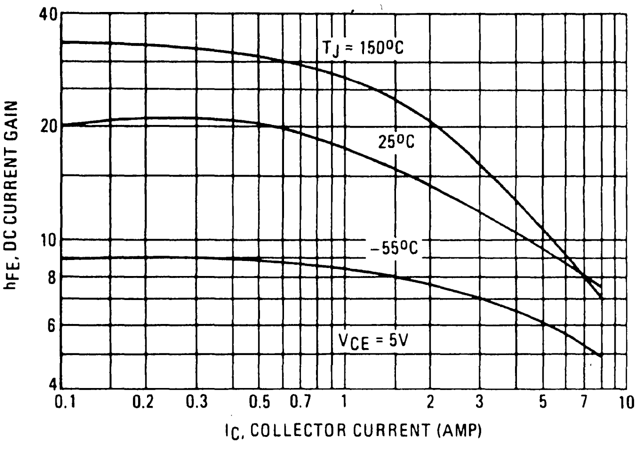


FIGURE 5 –DC CURRENT GAIN

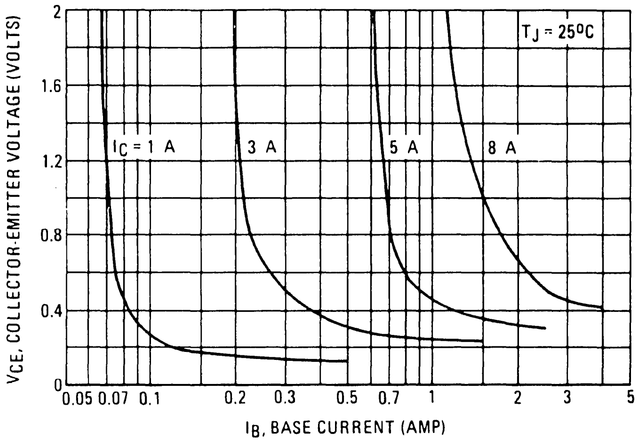


FIGURE 6 – COLLECTOR SATURATION REGION

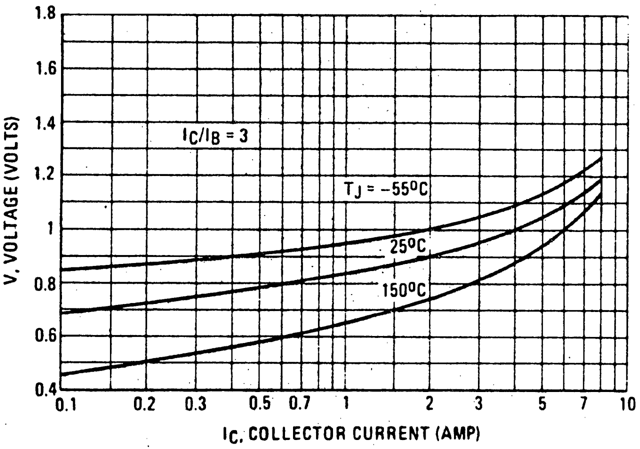


FIGURE 7 — BASE-EMITTER SATURATION VOLTAGE

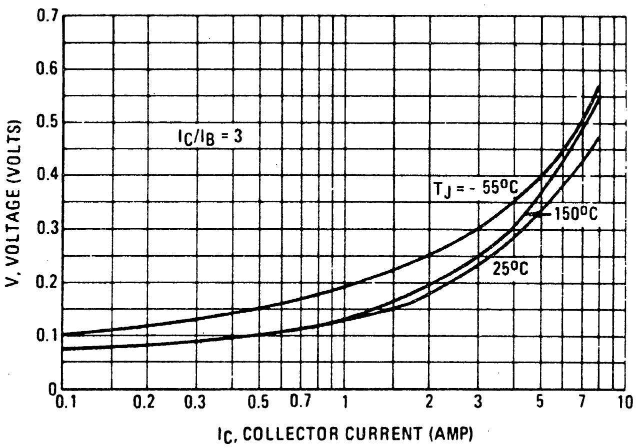


FIGURE 8 — COLLECTOR-EMITTER SATURATION VOLTAGE

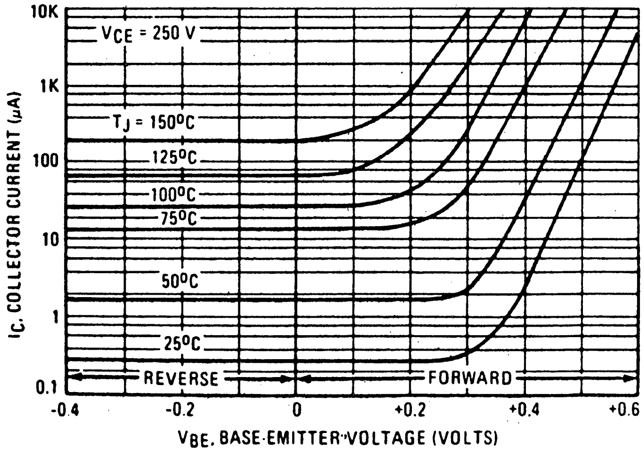


FIGURE 9 — COLLECTOR CUTOFF REGION

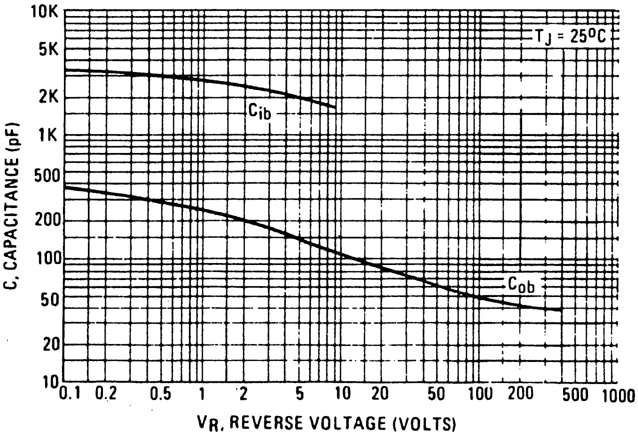


FIGURE 10 — CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

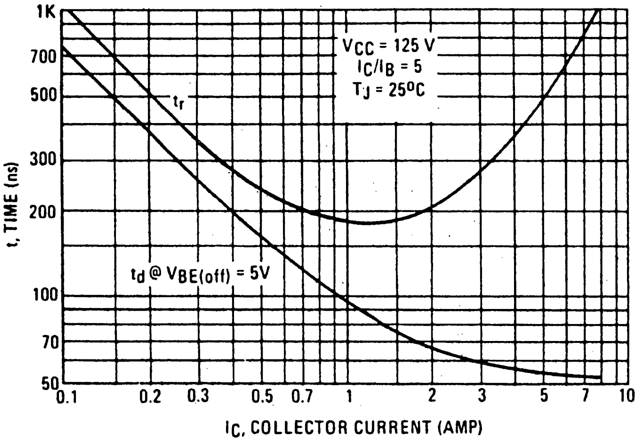


FIGURE 11 — TURN-ON TIME

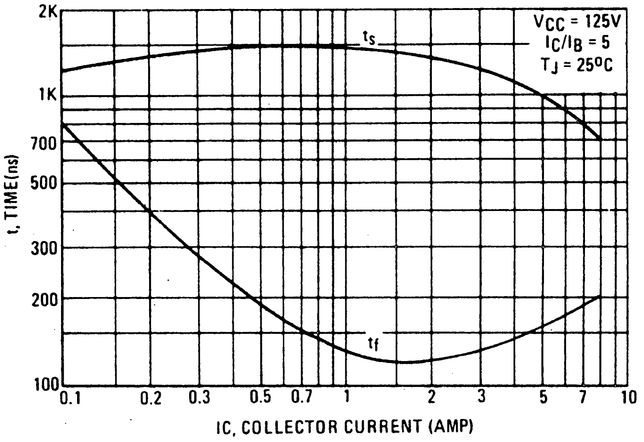


FIGURE 12 — TURN-OFF TIME

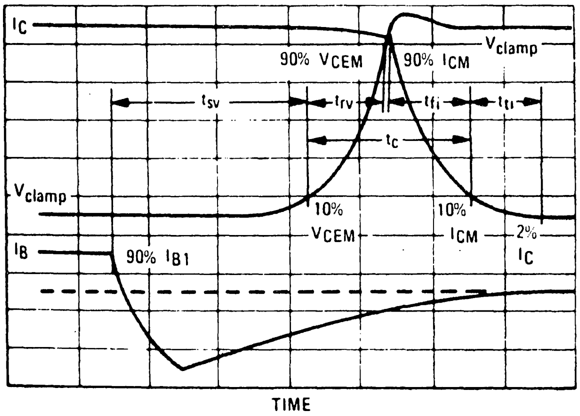


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

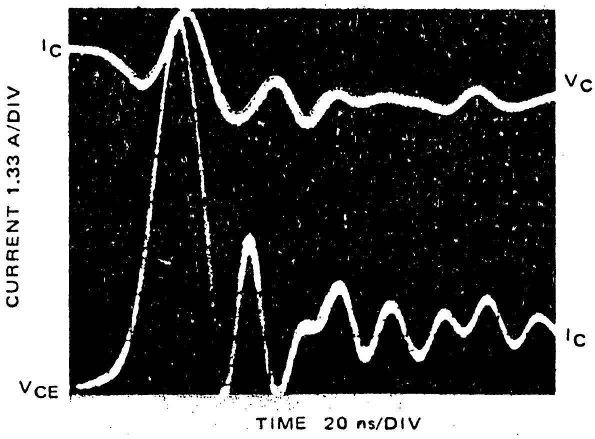


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 8A with I_{B1} = 1.6A and $V_{BE(off)}$ = 5 V)

NPN POWER TRANSISTORS

MJE13008

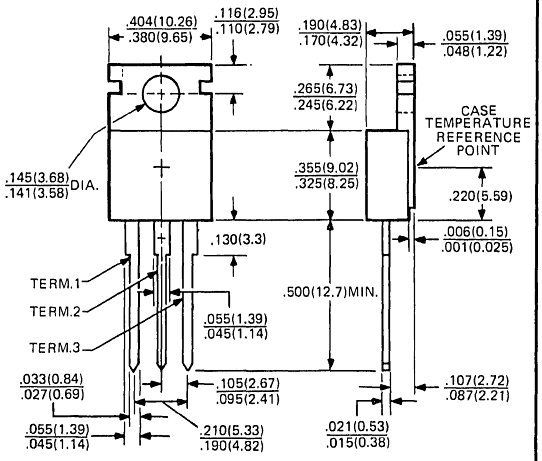
300 VOLTS
12 AMP, 100 WATTS

Designed for switching regulator, DC-DC converter, AC-DC inverter, high voltage, high speed switching applications.

Features:

- $V_{CEO(sus)}$ = 300V (Min).
- V_{CEV} = 600V blocking capability
- Excellent switching time: t_r = 1 μs (Max.), t_f = 0.7 μs (Max.)

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	MJE13008	UNITS
Collector-Emitter Voltage	V_{CEO}	300	Volts
Collector-Emitter Voltage	V_{CEV}	600	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	12 24	A
Base Current — Continuous Pulse	I_B I_{BP}	6 12	A
Emitter Current — Continuous Pulse	I_E I_{EP}	18 36	A
Collector Power Dissipation T_A = 25°C Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation T_C = 25°C Derate above 25°C	P_C	100 800	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage ($I_C = 10mA, I_B = 0$)	$V_{CEO(sus)}$	300	—	—	Volts
Collector Cutoff Current ($V_{CE} = 600V, V_{BE} = -1.5V$) ($V_{CE} = 600V, V_{BE} = -1.5V, T_C = 100°C$)	I_{CEV}	— —	— —	1 5	mA
Emitter Cutoff Current ($V_{EB} = 9V, I_C = 0$)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 2

on characteristics(1)

DC Current Gain ($I_C = 5A, V_{CE} = 5V$) ($I_C = 8A, V_{CE} = 5V$)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage ($I_C = 5A, I_B = 1A$) ($I_C = 8A, I_B = 1.6A$) ($I_C = 12A, I_B = 3A$) ($I_C = 8A, I_B = 1.6A, T_C = 100°C$)	$V_{CE(sat)}$	— — — —	— — — —	1 1.5 3 2	V
Base-Emitter Saturation Voltage ($I_C = 5A, I_B = 1A$) ($I_C = 8A, I_B = 1.6A$) ($I_C = 8A, I_B = 1.6A, T_C = 100°C$)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

dynamic characteristics

Output Capacitance ($V_{CB} = 10V, I_E = 0, f = 0.1 MHz$)	C_{ob}	—	130	—	pF
Current Gain — Bandwidth Product ($I_C = 500mA, V_{CE} = 10V, f_{test} = 1.0 MHz$)	f_T	4	—	—	MHz

switching characteristics

Resistive Load						
Delay Time	($V_{CC} = 125V, I_C = 8A$ $I_{B1} = -I_{B2} = 1.6A, t_p = 25\ \mu s$ Duty Cycle < 1%)	t_d	—	—	0.1	μs
Rise Time		t_r	—	—	1	
Storage Time		t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	($I_C = 8A, V_{clamp} = 300V$ $I_{B1} = 1.6A, V_{BE(off)} = -5V, T_C = 100°C$)	t_{sv}	—	—	2.3	μs
Crossover Time		t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

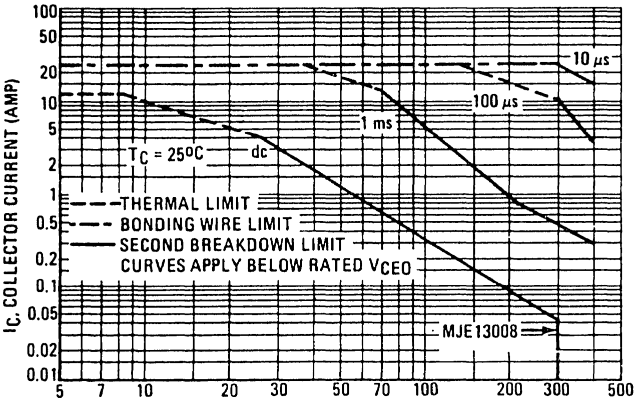


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

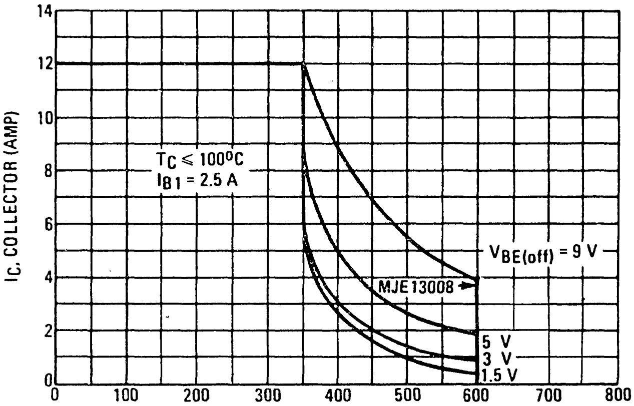


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

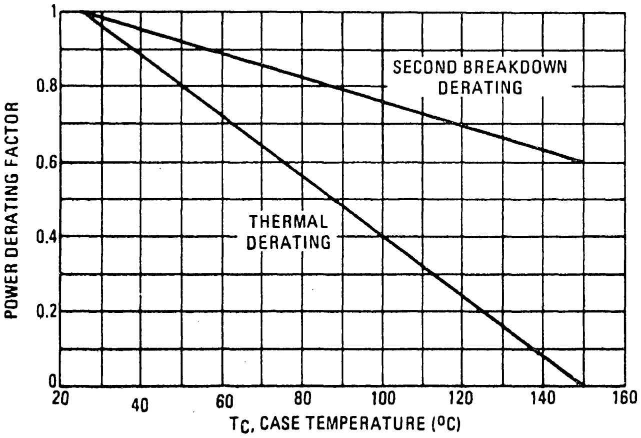


FIGURE 3 – FORWARD BIAS POWER DERATING

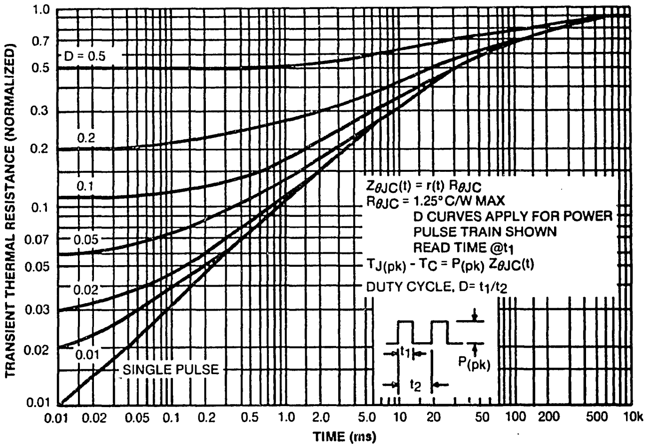


FIGURE 4 TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$]

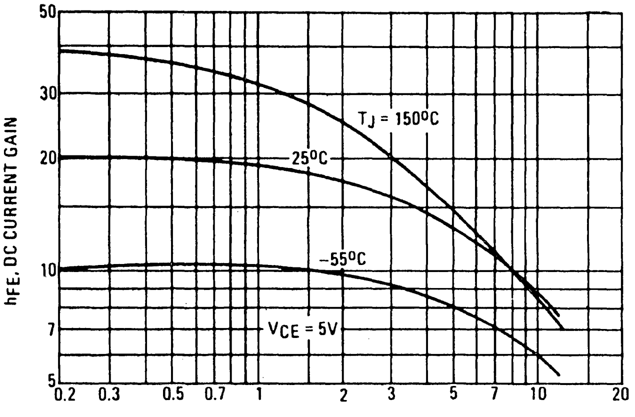


FIGURE 5 –DC CURRENT GAIN

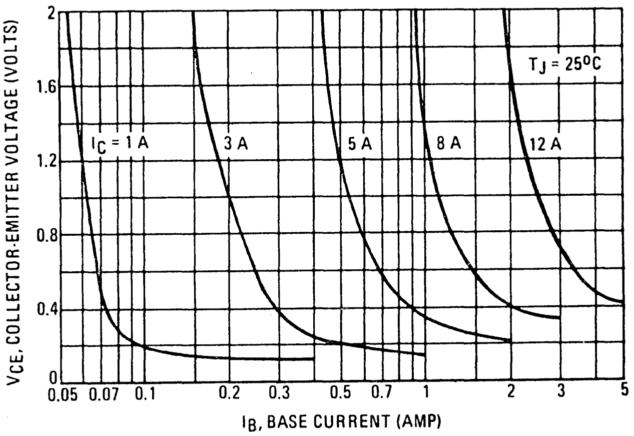


FIGURE 6 – COLLECTOR SATURATION REGION

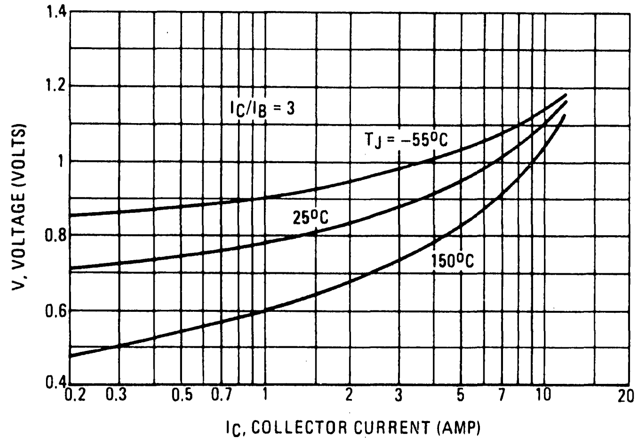


FIGURE 7 — BASE-EMITTER SATURATION VOLTAGE

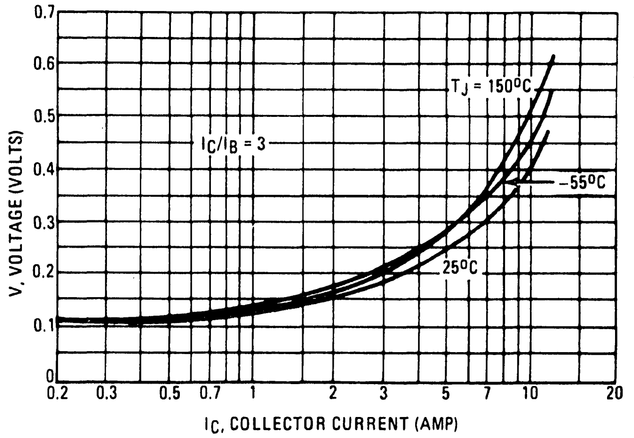


FIGURE 8 — COLLECTOR-EMITTER SATURATION VOLTAGE

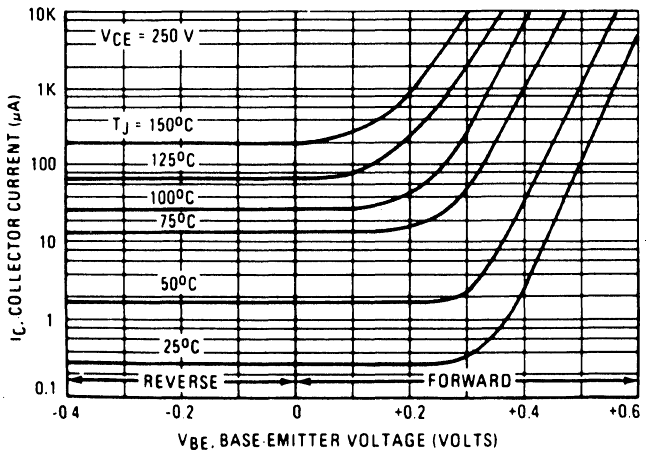


FIGURE 9 — COLLECTOR CUTOFF REGION

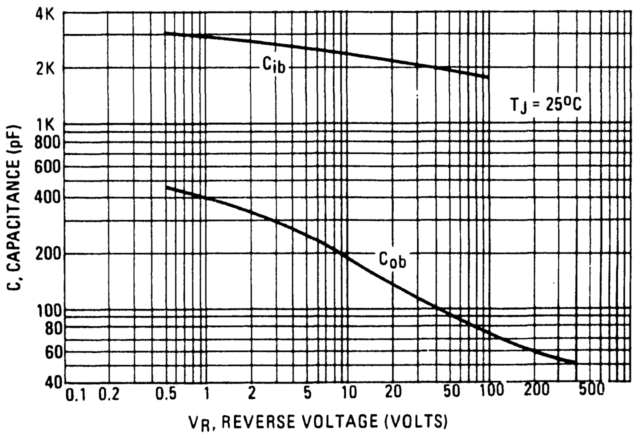


FIGURE 10 — CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

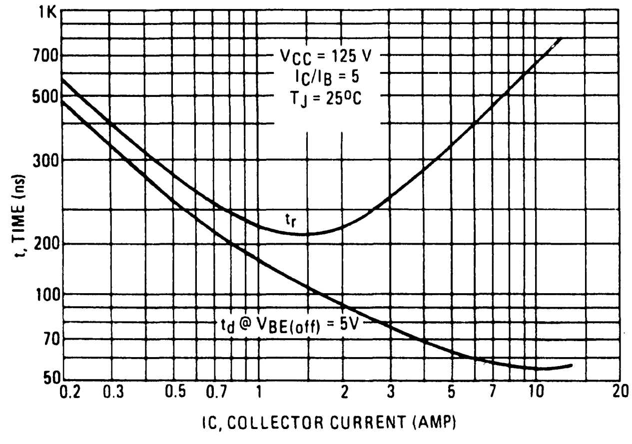


FIGURE 11 — TURN-ON TIME

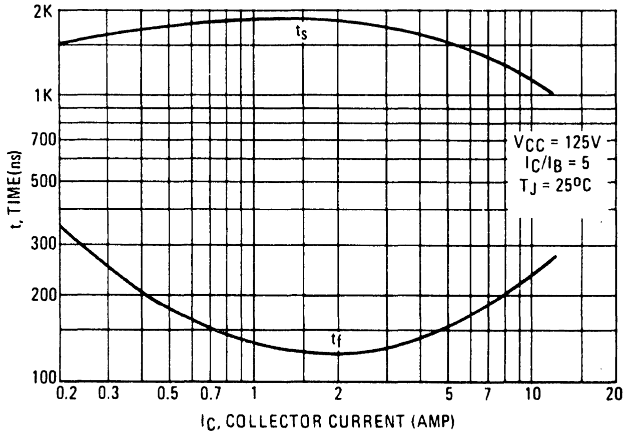


FIGURE 12 — TURN-OFF TIME

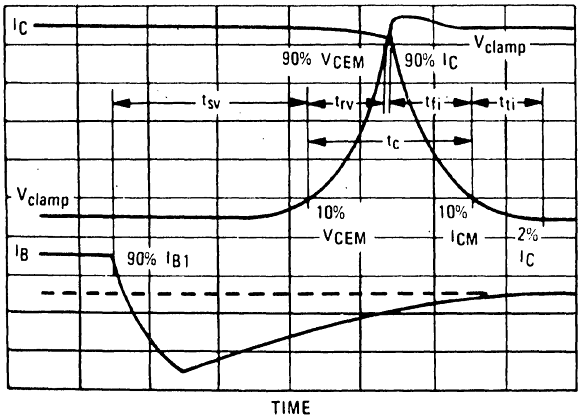


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

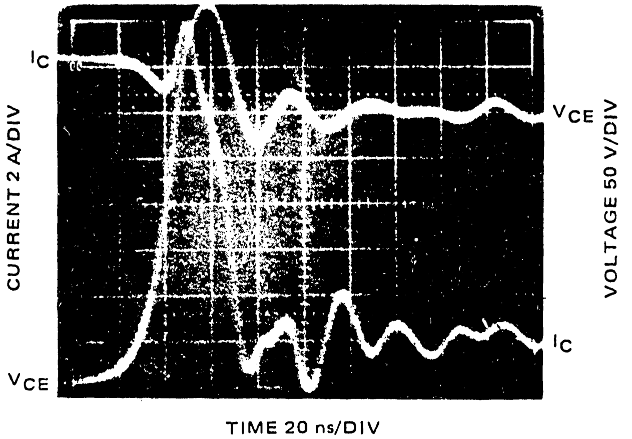


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 12 A with I_{B1} = 2.4 A and $V_{BE(off)}$ = 5 V)

NPN POWER TRANSISTORS

MJE13009

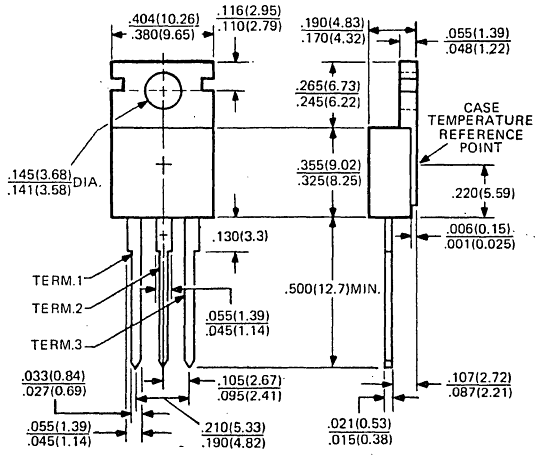
400 VOLTS
12 AMP, 100 WATTS

Designed for switching regulator, DC-DC converter, AC-DC inverter, high voltage, high speed switching applications.

Features:

- $V_{CEO(sus)}$ = 400V (Min).
- V_{CEV} = 700V blocking capability
- Excellent switching time: t_r = 1 μs (Max.),
  t_f = 0.7 μs (Max.)

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	MJE13009	UNITS
Collector-Emitter Voltage	$V_{CEO(sus)}$	400	Volts
Collector-Emitter Voltage	V_{CEV}	700	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	12 24	A
Base Current — Continuous Pulse	I_B I_{BP}	6 12	A
Emitter Current — Continuous Pulse	I_E I_{EP}	18 36	A
Collector Power Dissipation T_A = 25°C Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation T_C = 25°C Derate above 25°C	P_C	100 800	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	275	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	400	—	—	Volts
Collector Cutoff Current (V_{CE} = 700V, V_{BE} = -1.5V) (V_{CE} = 700V, V_{BE} = -1.5V, T_C = 100° C)	I_{CEV}	— —	— —	1 5	mA
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1
Clamped Inductive soa with Base Reversed Bias	RBSOA	SEE FIGURE 2

on characteristics(1)

DC Current Gain (I_C = 5A, V_{CE} = 5V) (I_C = 8A, V_{CE} = 5V)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A) (I_C = 12A, I_B = 3A) (I_C = 8A, I_B = 1.6A, T_C = 100° C)	$V_{CE(sat)}$	— — — —	— — — —	1 1.5 3 2	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A) (I_C = 8A, I_B = 1.6A, T_C = 100° C)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

dynamic characteristics

Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz	C_{ob}	—	130	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	4	—	—	MHz

switching characteristics

Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 8A	t_d	—	—	0.1	μs
Rise Time	I_{B1} = -I_{B2} = 1.6A, t_p = 25 μs	t_r	—	—	1	μs
Storage Time	Duty Cycle < 1%)	t_s	—	—	3	
Fall Time		t_f	—	—	.7	
Inductive Load, Clamped						
Storage Time	(I_C = 8A, V_{clamp} = 300V	t_{sv}	—	—	2.3	μs
Crossover Time	I_{B1} = 1.6A, $V_{BE(off)}$ = 5V, T_C = 100° C)	t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300 μs Duty Cycle ≤ 2%.

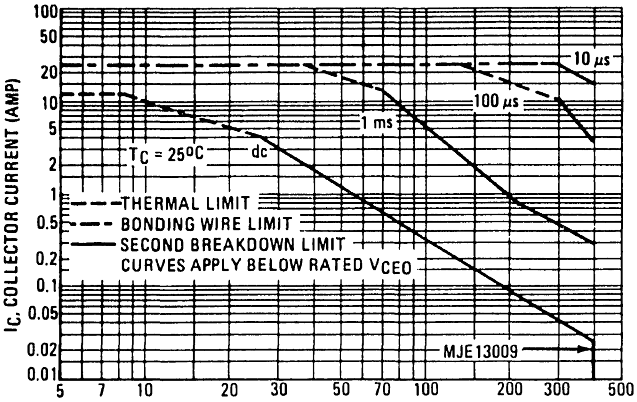


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

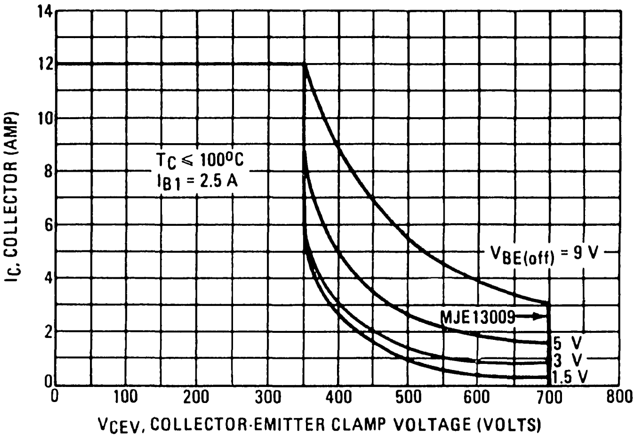


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

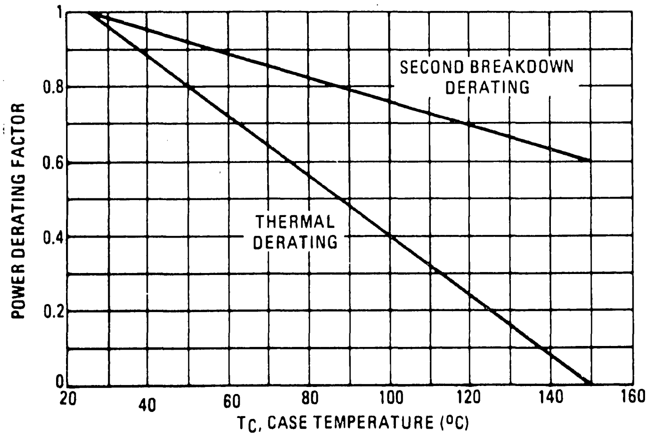


FIGURE 3 – FORWARD BIAS POWER DERATING

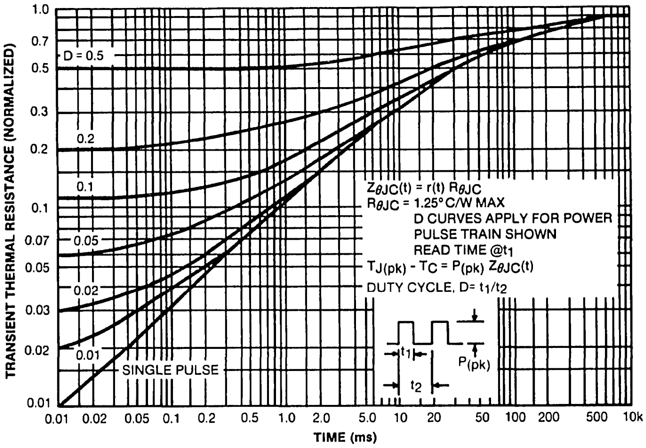


FIGURE 4 – TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$)]

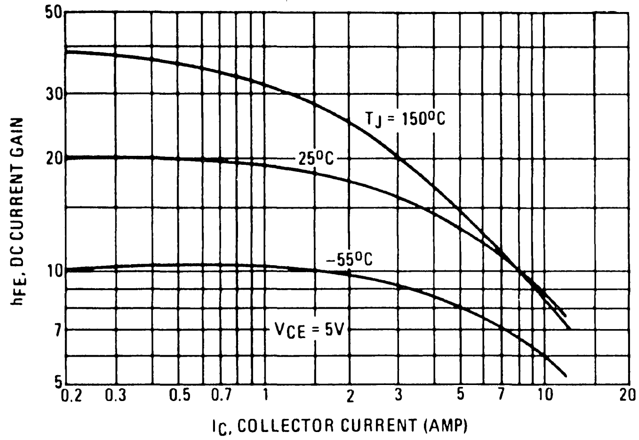


FIGURE 5 – DC CURRENT GAIN

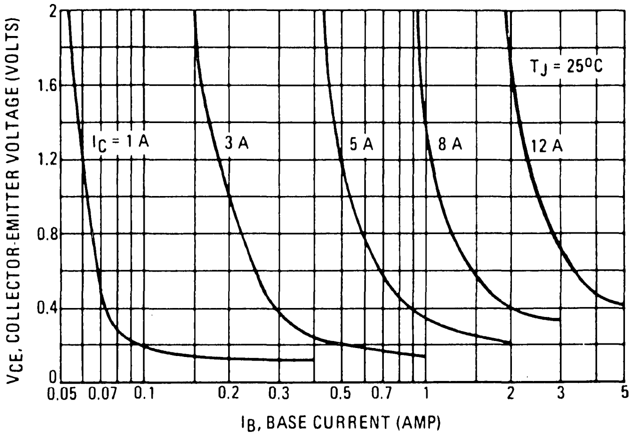


FIGURE 6 – COLLECTOR SATURATION REGION

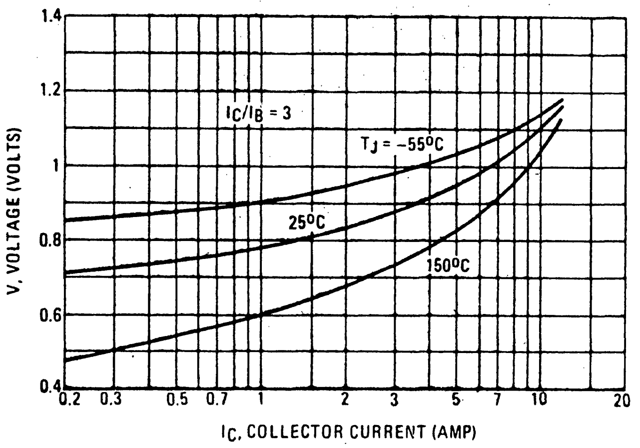


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

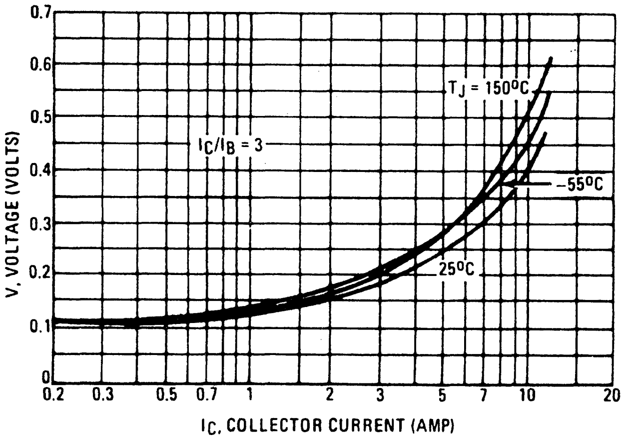


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

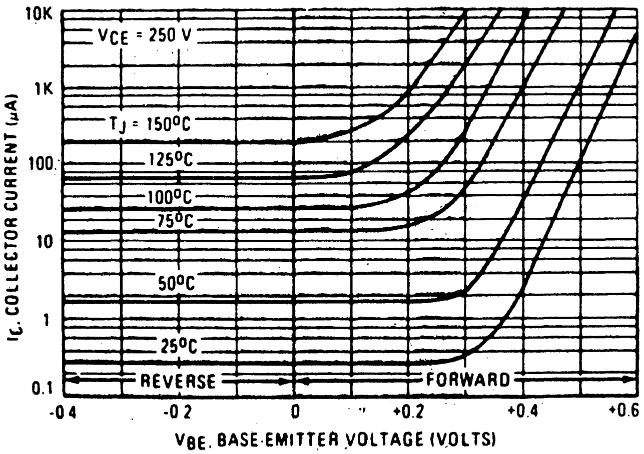


FIGURE 9 – COLLECTOR CUTOFF REGION

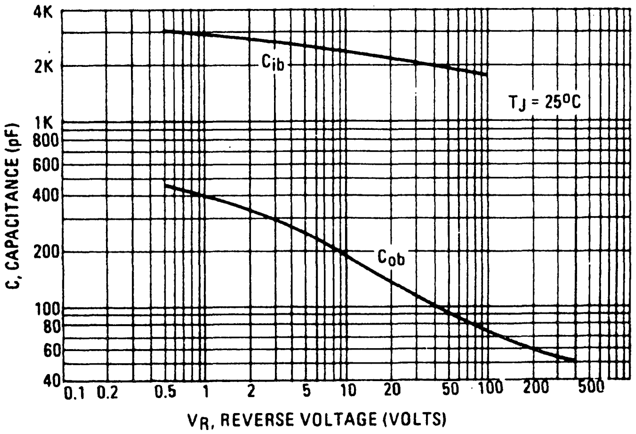


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

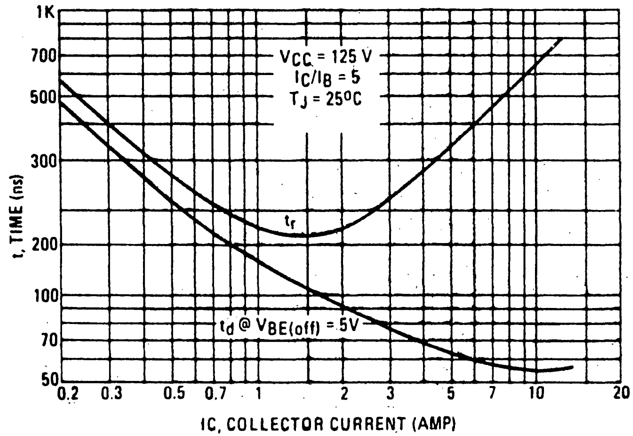


FIGURE 11 – TURN-ON TIME

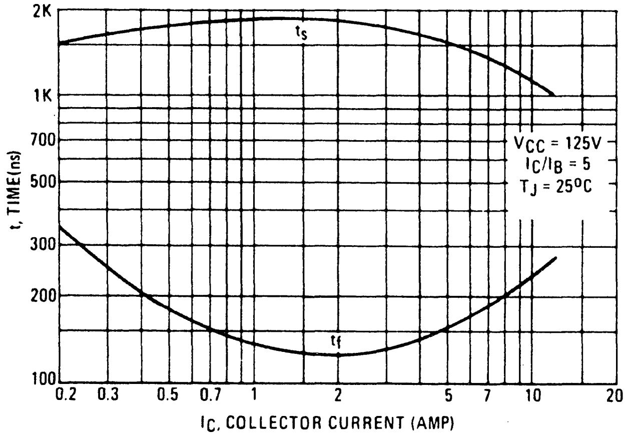


FIGURE 12 – TURN-OFF TIME

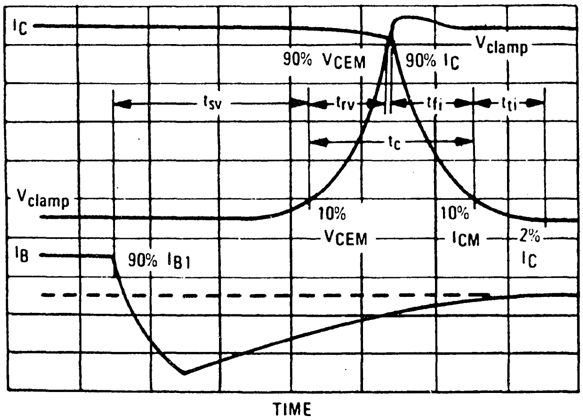


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

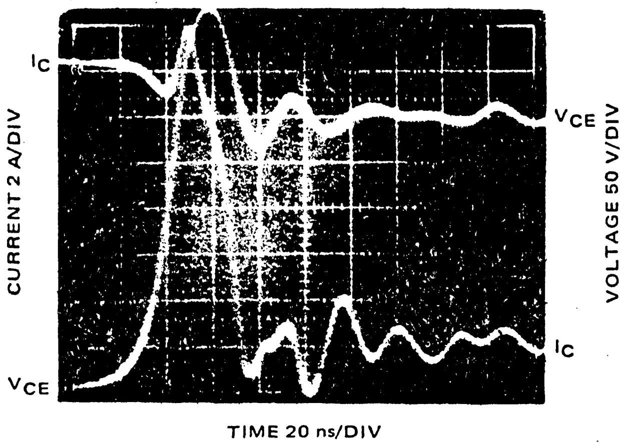


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 12 A with I_{B1} = 2.4 A and $V_{BE(off)}$ = 5 V)

HIGH VOLTAGE/HIGH SPEED
NPN POWER TRANSISTORS

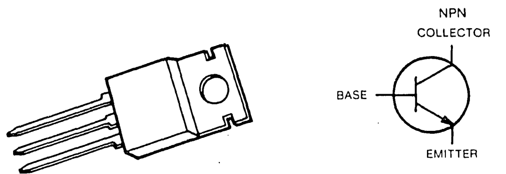
MJE13070
MJE13071

400-450 VOLTS
5 AMP, 80 WATTS

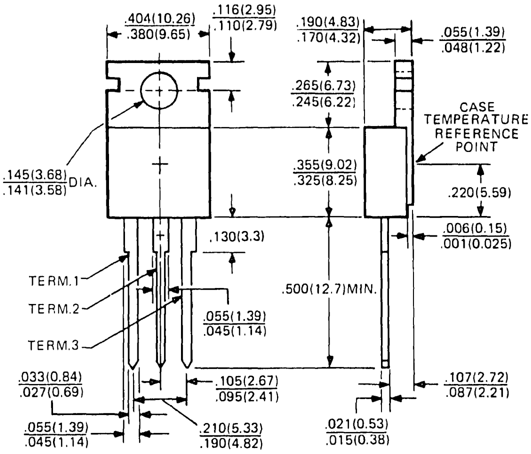
The MJE13070 and MJE13071 are high-voltage, high-speed power switching transistors, designed for use with inductive circuits, including: switching regulators, inverters, solenoid and relay drivers, motor controls, deflection circuits and other line-operated switching applications.

Features:

- Fast Turn-Off Times:
  100 ns inductive fall time @ 25° C (Typ)
  150 ns inductive crossover time @ 25° C (Typ)
  400 ns inductive storage time @ 25° C (Typ)
- Operating temperature range -65 to +150° C
- 100° C Performance Specified for:
  Switching times with inductive loads — 50 ns inductive fall time (Typ)
  Saturation voltages
  Leakage currents



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	MJE13070	MJE13071	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EB}	6.0	6.0	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	5.0 8.0	5.0 8.0	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	2.0 4.0	2.0 4.0	A
Total Power Dissipation @ Tc = 25° C @ Tc = 100° C Derate above 25° C	P_D	80 32 0.64	80 32 0.64	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	1.56	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage MJE13070 (I_C = 100mA, I_B = 0) MJE13071	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5V, T_C = 100° C)	I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100° C)	I_{CER}	—	—	3.0	mA
Emitter Cutoff Current (V_{EB} = 6.0V, I_C = 0)	I_{EBO}	—	—	1.0	mA

second breakdown

Second Breakdown with Base Forward Biased	$I_{S/b}$	SEE FIGURE 12
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 13

on characteristics(1)

DC Current Gain (I_C = 3.0A, V_{CE} = 5.0V)	h_{FE}	8.0	—	—	—
Collector-Emitter Saturation Voltage (I_C = 3.0A, I_B = 0.6A) (I_C = 5.0A, I_B = 1.0A) (I_C = 3.0A, I_B = 0.6A, T_C = 100° C)	$V_{CE(sat)}$	— — —	— — —	1.0 3.0 2.0	V
Base-Emitter Saturation Voltage (I_C = 3.0A, I_B = 0.6A) (I_C = 3.0A, I_B = 0.6A, T_C = 100° C)	$V_{BE(sat)}$	— —	— —	1.5 1.5	V

dynamic characteristics

Output Capacitance (V_{CB} = 10V, I_E = 0A, f_{test} = 1.0 kHz)	C_{ob}	—	—	250	pF

switching characteristics

Resistive Load							
Delay Time	(V_{CC} = 250V, I_C = 3.0A I_{B1} = 0.4A, t_p = 30 μs Duty Cycle < 2%, $V_{BE(OFF)}$ = 5.0V)		t_d	—	0.03	0.05	μs
Rise Time			t_r	—	0.10	0.40	
Storage Time			t_s	—	0.40	1.50	
Fall Time			t_f	—	.175	0.50	
Inductive Load, Clamped							
Storage Time	$I_{C(pk)}$ = 3.0A I_{B1} = 0.4A $V_{BE(off)}$ = 5.0V $V_{CE(PK)}$ = 250V	(T_J = 100° C)	t_{sv}	—	0.70	2.0	μs
Crossover Time			t_c	—	0.28	0.50	
Fall Time			t_{fi}	—	0.15	0.30	
Storage Time		(T_J = 25° C)	t_{sv}	—	0.40	—	
Crossover Time			t_c	—	0.15	—	
Fall Time			t_{fi}	—	0.10	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

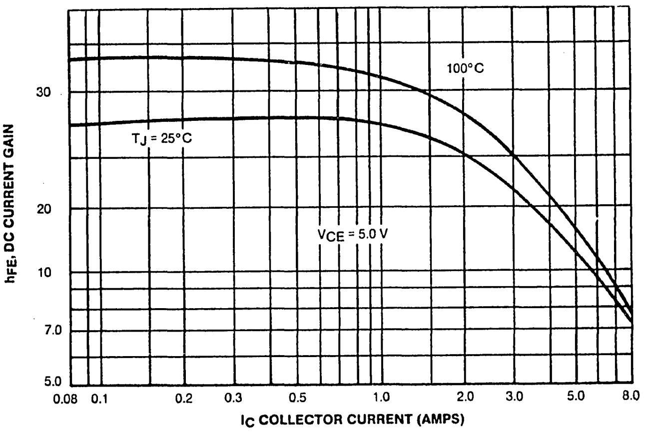


FIGURE 1 — DC CURRENT GAIN

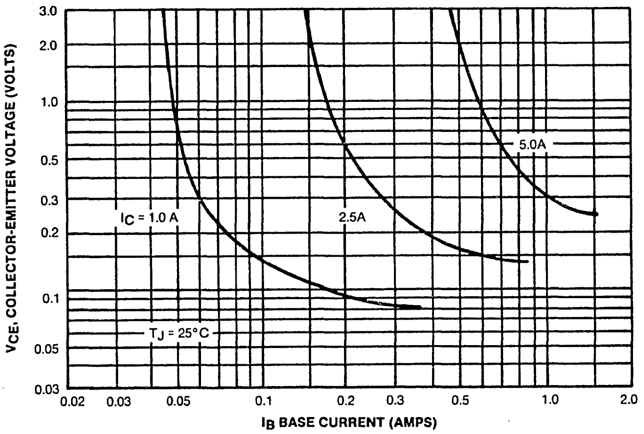


FIGURE 2 — COLLECTOR SATURATION REGION

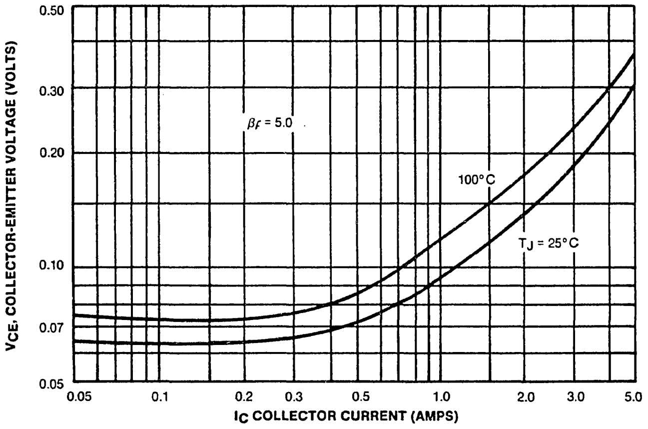


FIGURE 3 — COLLECTOR-EMITTER SATURATION VOLTAGE

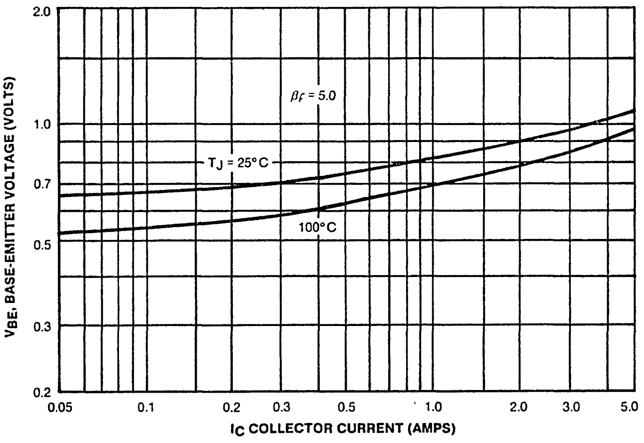


FIGURE 4 — BASE-EMITTER VOLTAGE

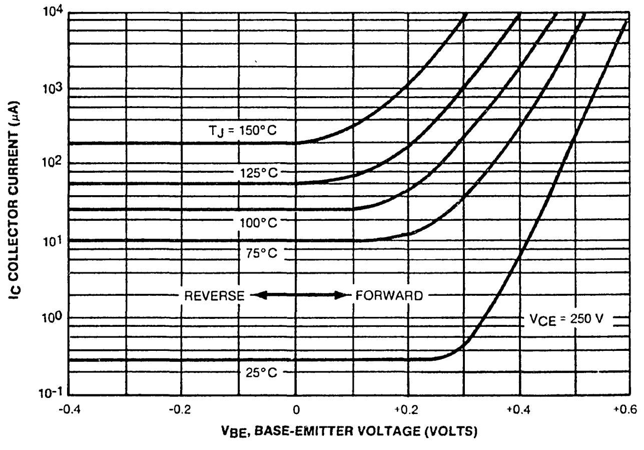


FIGURE 5 — COLLECTOR CUTOFF REGION

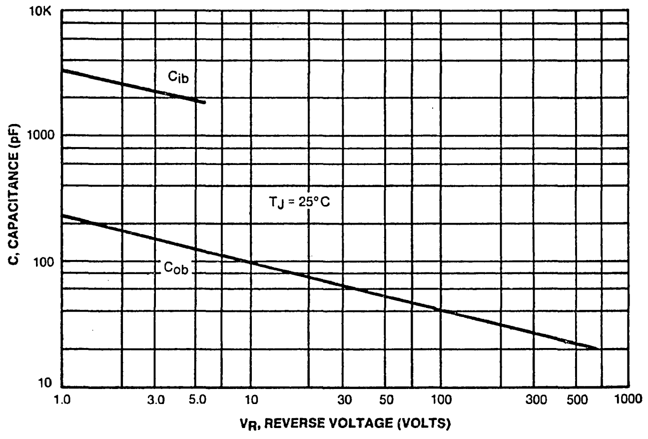


FIGURE 6 — CAPACITANCE

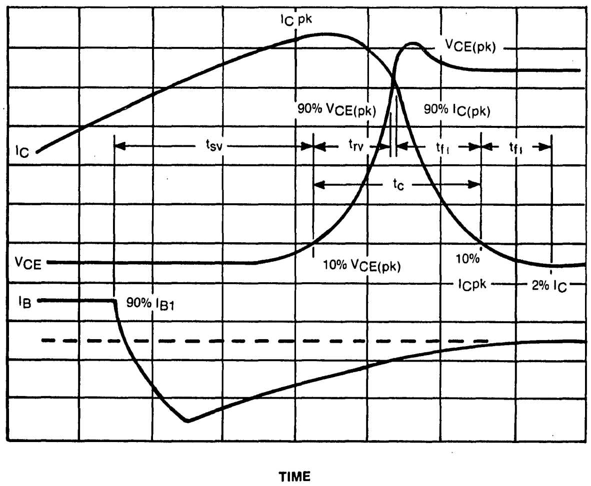


FIGURE 7 — INDUCTIVE SWITCHING MEASUREMENTS

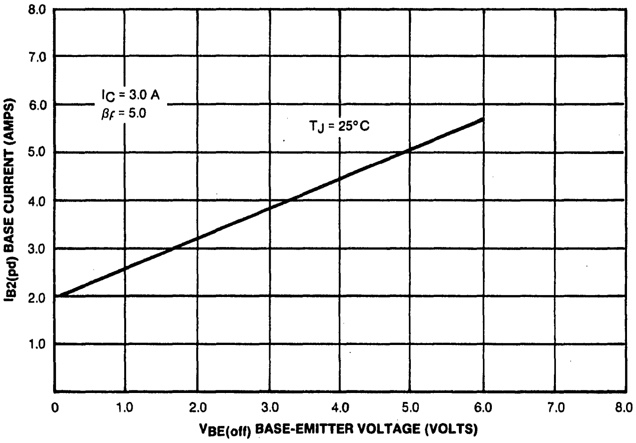


FIGURE 8 — PEAK REVERSE CURRENT

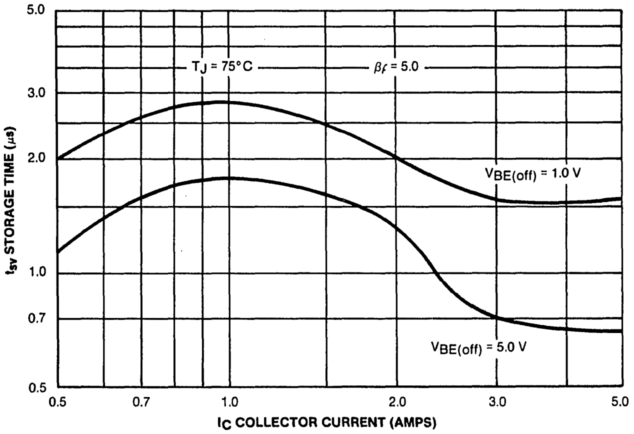


FIGURE 9 — STORAGE TIME

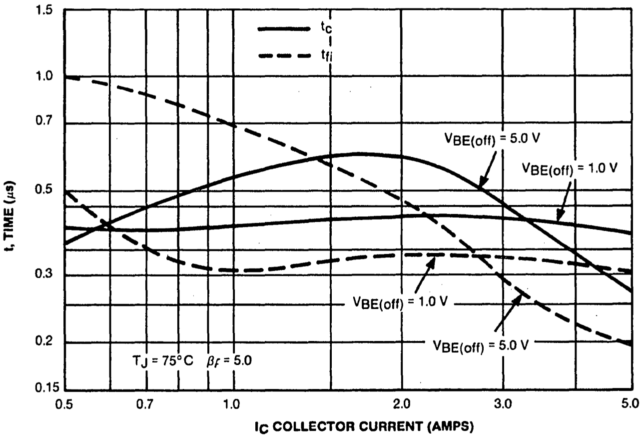


FIGURE 10 — CROSSOVER AND FALL TIMES

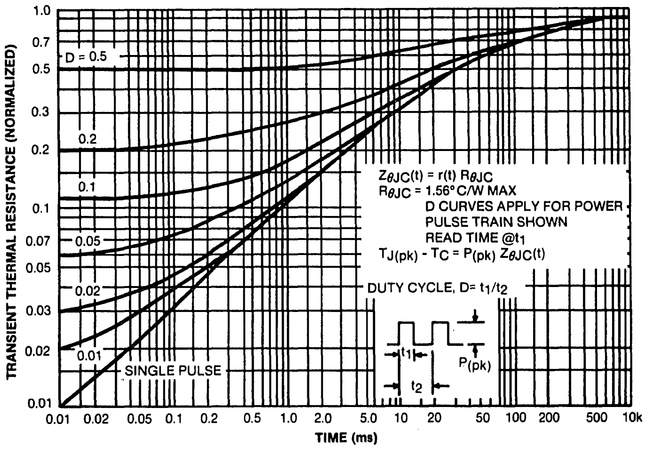


FIGURE 11 TYPICAL THERMAL RESPONSE [(ZθJC(t)]

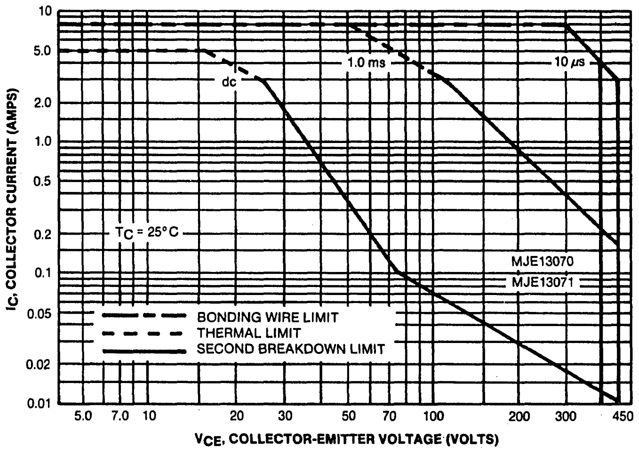


FIGURE 12 MAXIMUM FORWARD BIAS SAFE OPERATING AREA

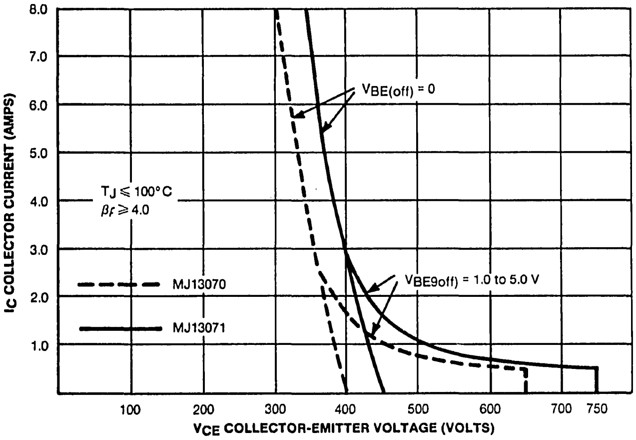


FIGURE 13 — MAXIMUM RATED REVERSE BIAS SAFE OPERATING AREA

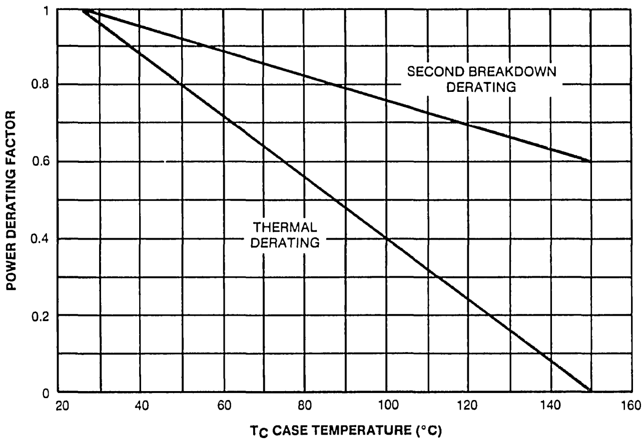


FIGURE 14 — POWER DERATING

HIGH SPEED NPN POWER TRANSISTORS

MJH13090
MJH13091

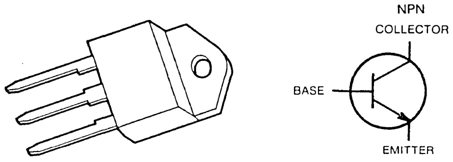
400 & 450 VOLTS
15 AMPS, 125 WATTS

The MJH13090 and MJH13091 transistors are designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical. They are particularly suited for line operated switch-mode applications such as:

Features:

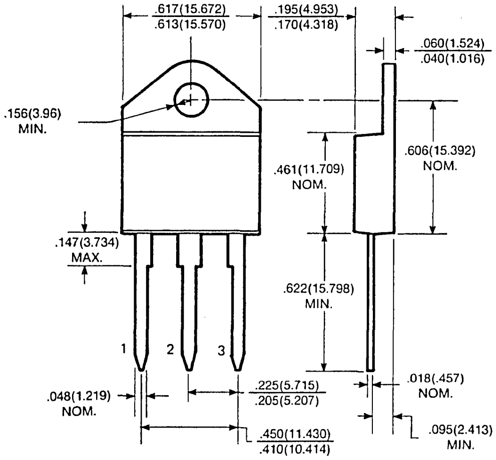
- Switching regulators
- Inverters
- Solenoid and Relay drivers
- Motor Controls
- Deflection circuits

100° C Performance Specified for:
  Reverse-Biased SOA with inductive loads
  Switching times with inductive loads —
    50 ns inductive fall time (Typ)
  Saturation voltages
  Leakage currents



CASE STYLE TO-218

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-218	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise noted)

RATING	SYMBOL	MJH13090	MJH13091	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	15 20	15 20	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	5 10	5 10	A
Total Power Dissipation @ Tc = 25° C @ Tc = 100°C Derate above 25° C	P_D	125 50 1	125 50 1	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	° C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	° C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics(1)

Collector-Emitter Sustaining Voltage MJH13090	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = 100mA, I_B = 0) MJH13091		450	—	—	
Collector Cutoff Current	I_{CEV}				
(V_{CEV} = Rated Value, $V_{BE(OFF)}$ = 1.5V)		—	—	0.5	mA
(V_{CEV} = Rated Value, $V_{BE(OFF)}$) = 1.5V, T_C = 100° C)		—	—	2.5	
Collector Cutoff Current (V_{CE} = Rate V_{CEV}, R_{BE} = 50Ω, T_C = 100° C)	I_{CER}	—	—	3	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 12
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 13

on characteristics

DC Current Gain (I_C = 10A, V_{CE} = 3V)	h_{FE}	8.0	—	—	—
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
(I_C = 10A, I_B = 2A)		—	—	1	V
(I_C = 15A, I_B = 3A)		—	—	3	
(I_C = 10A, I_B = 2A, T_C = 100° C)		—	—	2	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				
(I_C = 10A, I_B = 2A)		—	—	1.5	V
(I_C = 10A, I_B = 2A, T_C = 100° C)		—	—	1.5	

switching characteristics

Resistive Load							
Delay Time	V_{CC} = 250V, I_C = 10A		t_d	—	0.03	0.05	μs
Rise Time	I_{B1} = I_{B2} = 1.25A,		t_r	—	0.13	0.5	
Storage Time	t_p = 30 μsec		t_s	—	0.55	2.5	
Fall Time			t_f	—	0.10	0.5	
Inductive Load, Clamped							
Storage Time	$I_{CC(PK)}$ = 10A	(T_J = 100° C)	t_{sv}	—	0.8	3	μs
Crossover Time	I_{B1} = 1.25A		t_c	—	.175	.4	
Fall Time	$V_{BE(OFF)}$ = 5V	(T_J = 25° C)	t_{fi}	—	.15	.3	
Storage Time	$V_{CE(PK)}$ = 250V		t_{sv}	—	.50	—	
Crossover Time			t_c	—	.15	—	
Fall Time			t_{fi}	—	.10	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2.%

TYPICAL ELECTRICAL CHARACTERISTICS

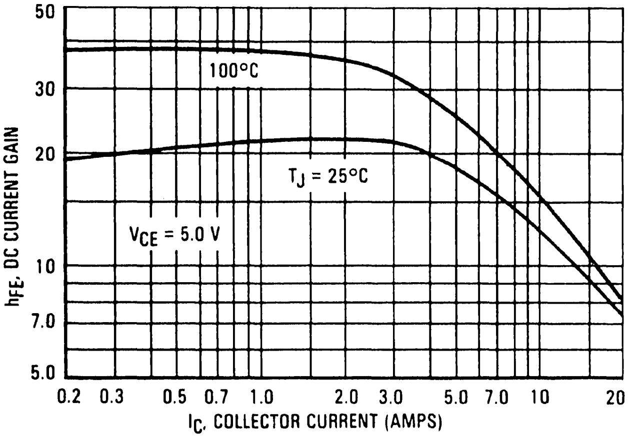


FIGURE 1 — DC CURRENT GAIN

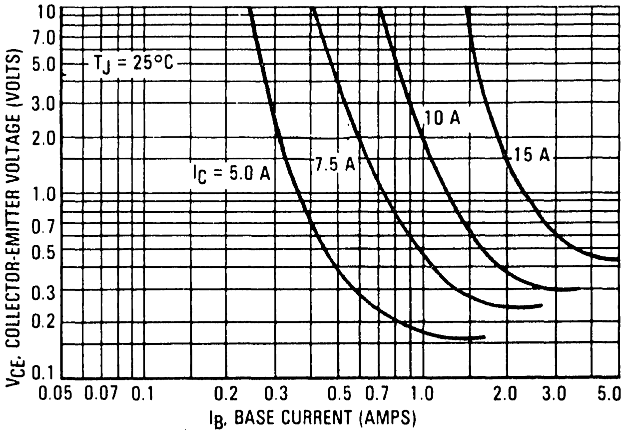


FIGURE 2 — COLLECTOR SATURATION REGION

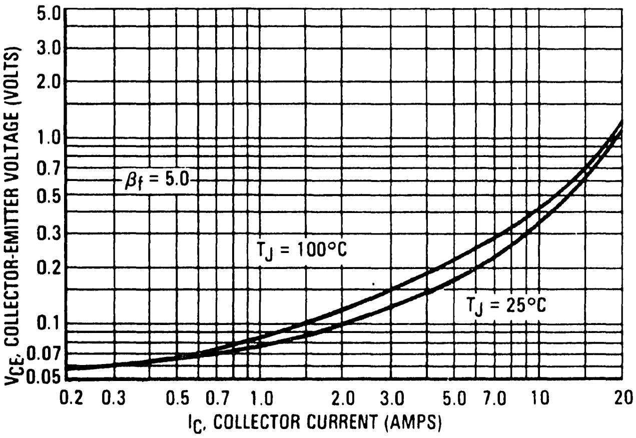


FIGURE 3 — COLLECTOR-EMITTER SATURATION VOLTAGE

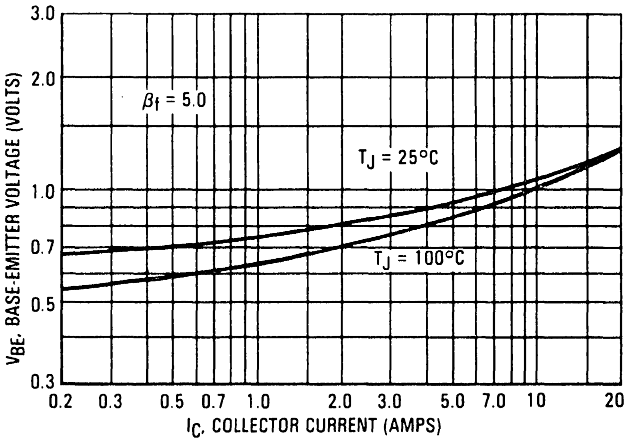


FIGURE 4 — BASE-EMITTER VOLTAGE

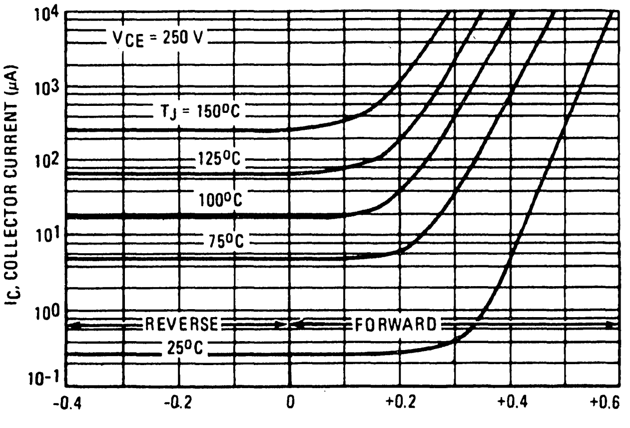


FIGURE 5 — COLLECTOR CUTOFF REGION

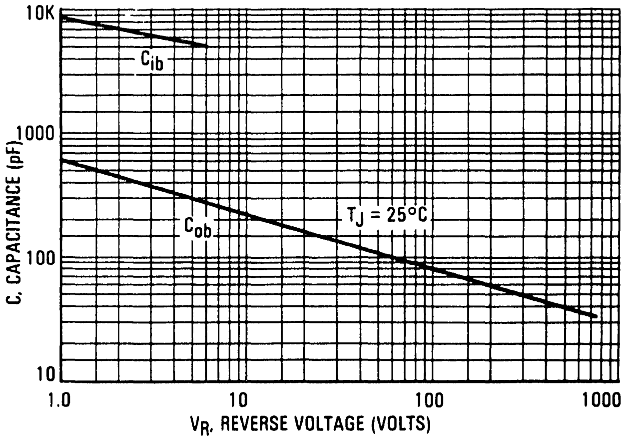


FIGURE 6 — CAPACITANCE

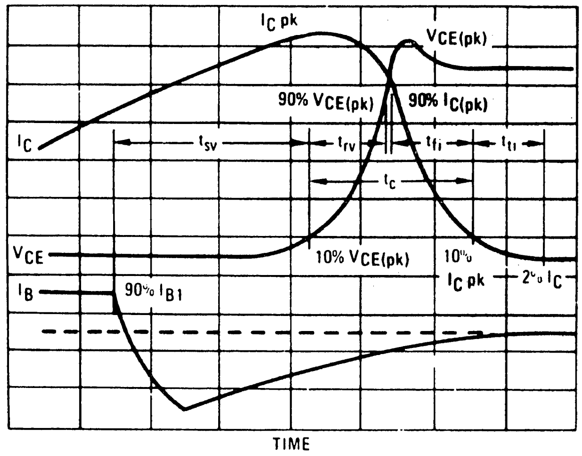


FIGURE 7 — INDUCTIVE SWITCHING MEASUREMENTS

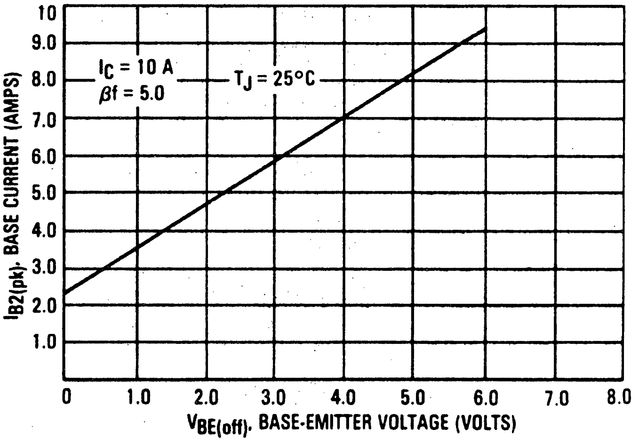


FIGURE 8 — PEAK REVERSE CURRENT

INDUCTIVE SWITCHING

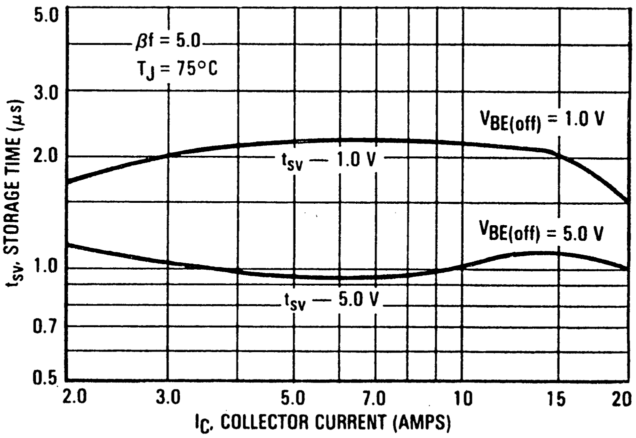


FIGURE 9 — STORAGE TIME

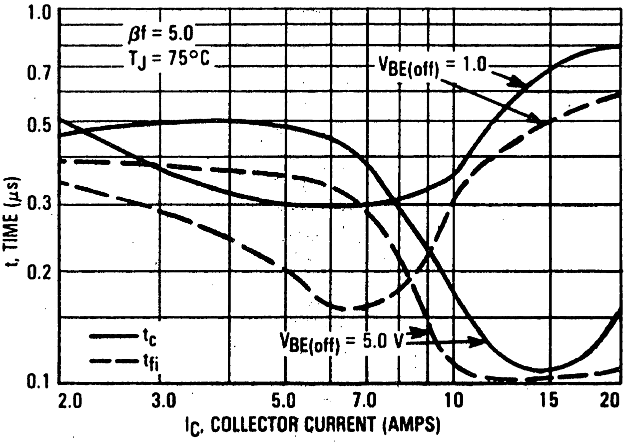


FIGURE 10 — CROSSOVER AND FALL TIMES

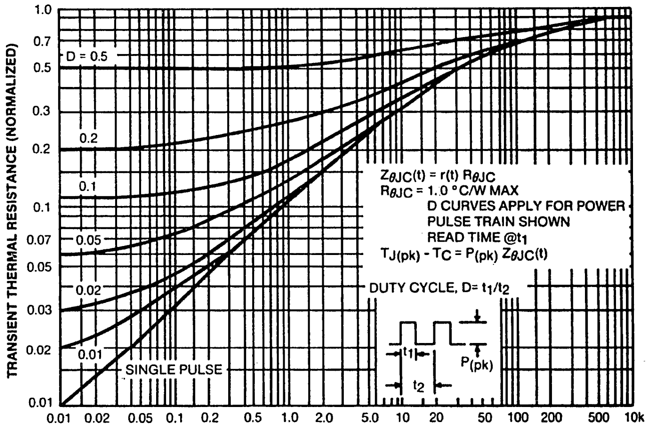


FIGURE 11 TYPICAL THERMAL RESPONSE [$(Z_{\theta JC}(t))$]

The Safe Operating Area figures shown in Figures 12 and 13 are specified for these devices under the test conditions shown.

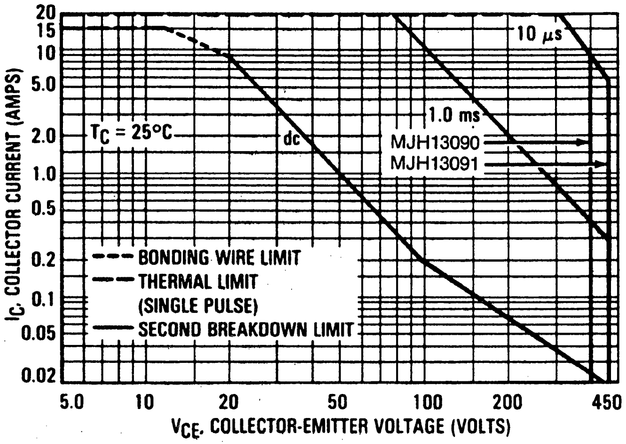


FIGURE 12 — FORWARD BIAS SAFE OPERATING AREA

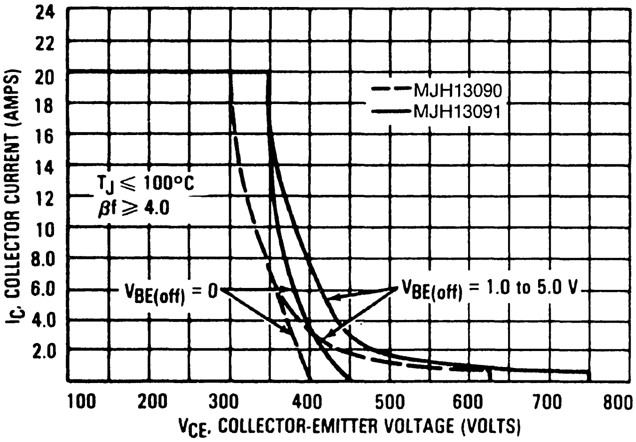


FIGURE 13 — REVERSE BIAS SAFE OPERATING AREA

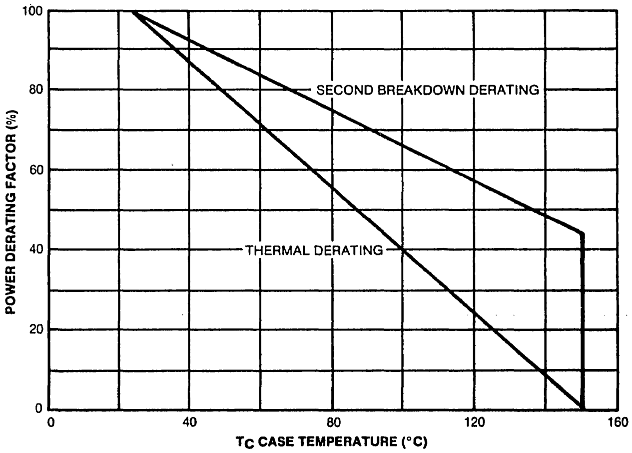


FIGURE 14 — POWER DERATING

NPN POWER DARLINGTON TRANSISTORS

COMPLEMENTARY TO THE TIP125, TIP126, TIP127

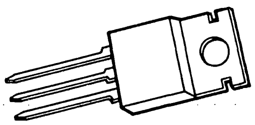
TIP120,121, TIP122

60-100 VOLTS
5 AMP, 65 WATTS

High power switching applications, designed for hammer drive, pulse motor drive and inductive load drive applications.

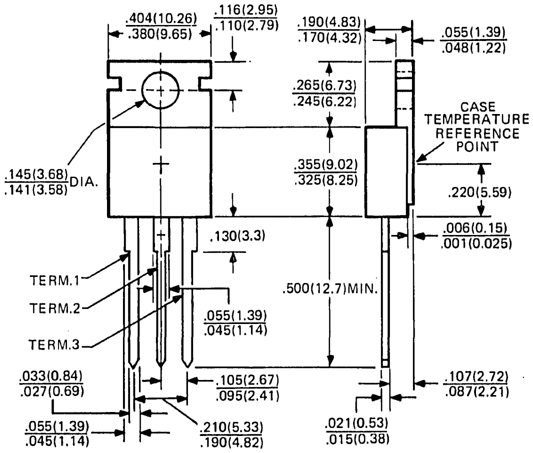
Features:

- High collector power dissipation: $P_D = 65W$ @ $T_C = 25°C$
- High collector current: $I_{C(DC)} = 5A$ (Max.)
- High DC current gain: $h_{FE} = 1000$ (Min.) @ $V_{CE} = 3V$, $I_C = 3A$
- Complementary to TIP125, TIP126, TIP127



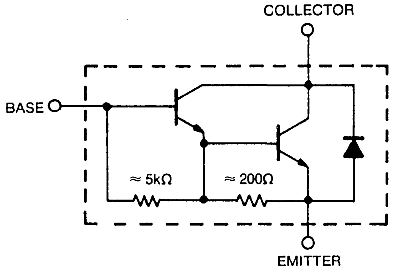
CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	TIP120	TIP121	TIP122	UNITS
Collector-Emitter Voltage	V_{CEO}	60	80	100	Volts
Collector-Base Voltage	V_{CBO}	60	80	100	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	5 8	5 8	5 8	A
Base Current — Continuous	I_B	0.1	0.1	0.1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	2 65	2 65	2 65	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	62.5	62.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.92	1.92	1.92	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 30mA)	TIP120 TIP121 TIP122	$V_{BR(CEO)}$	60 80 100	— — —	— — —	Volts
Collector Cutoff Current (V_{CB} = 80V)		I_{CBO}	—	—	200	μA
Collector Cutoff Current (V_{CE} = 40V)		I_{CEO}	—	—	0.5	mA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	2	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 13

on characteristics

DC Current Gain (I_C = 0.5A, V_{CE} = 3V) (I_C = 3A, V_{CE} = 3V)	h_{FE}	1000 1000	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 12mA) (I_C = 5A, I_B = 20mA)	$V_{CE(sat)}$	— —	— —	2 4	V V
Base-Emitter Voltage (I_C = 3A, V_{CE} = 3V)	$V_{BE(on)}$	—	—	2.5	V

switching characteristics

Turn-on Time	I_C = 3A, R_L = 10Ω I_{B1} = $-I_{B2}$ = 12mA $V_{BE(off)}$ = -5V	t_{on}	—	1.5	—	μs
Turn-off Time		t_{off}	—	8.5	—	

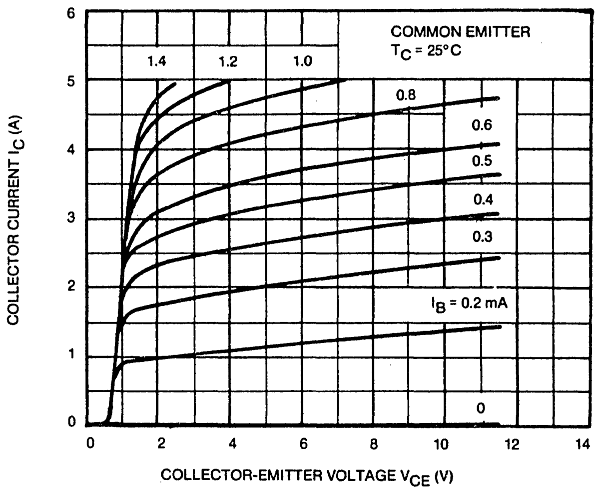


FIG. 1 I_C - V_{CE}

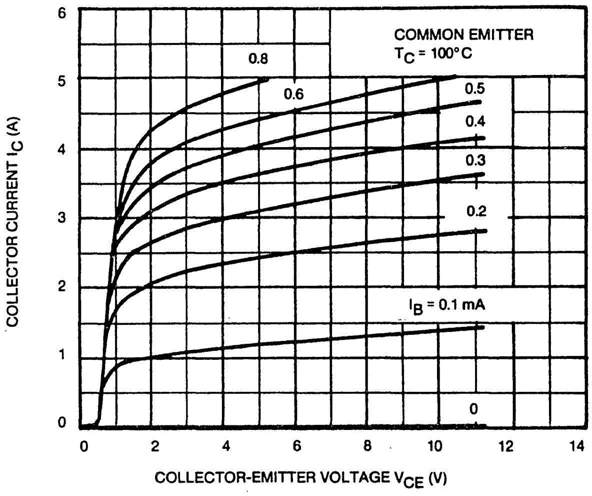


FIG. 2 I_C - V_{CE}

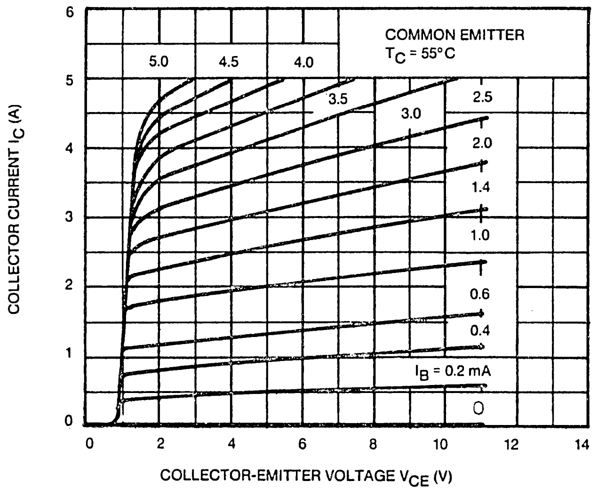


FIG. 3 I_C - V_{CE}

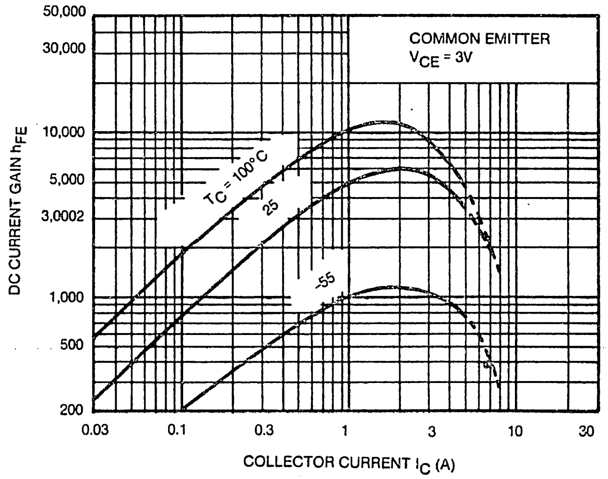


FIG. 4 h_{FE} - I_C

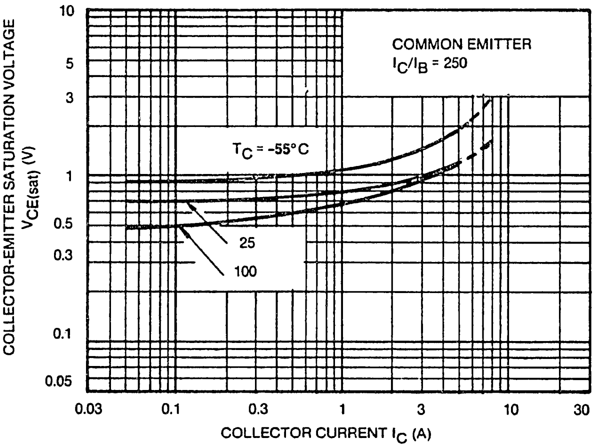


FIG. 5 $V_{CE(sat)}$ - I_C

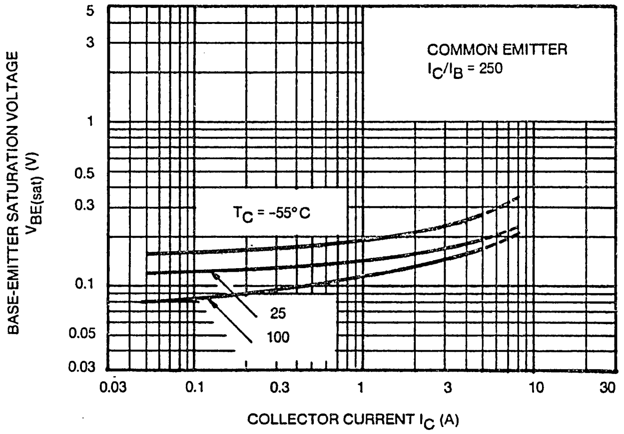


FIG. 6 $V_{BE(sat)}$ - I_C

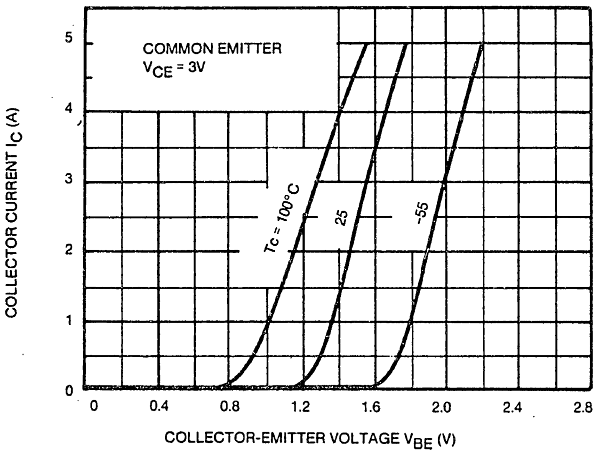


FIG. 7 I_C - V_{BE}

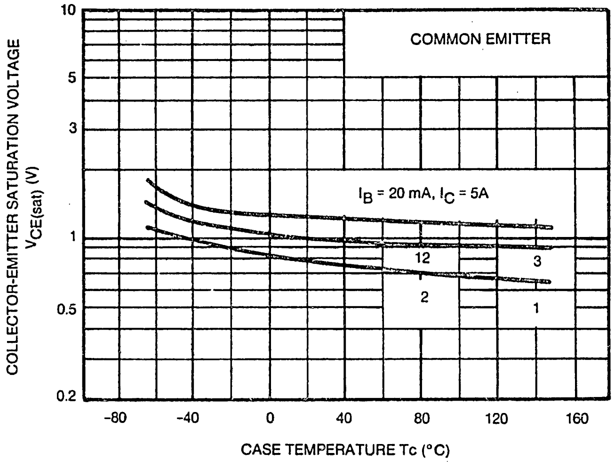


FIG. 8 $V_{CE(sat)}$ - Tc

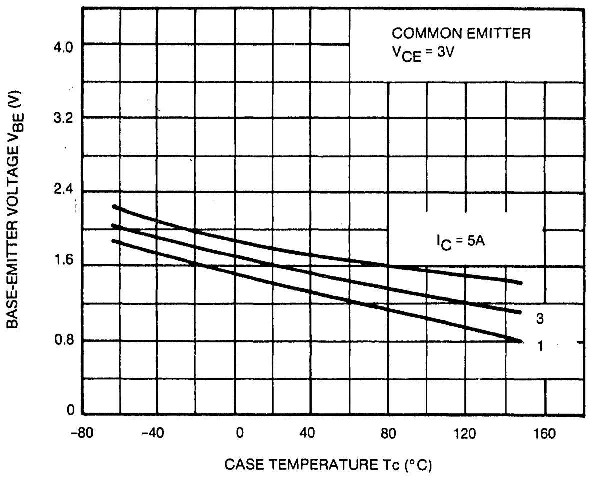


FIG. 9 V_{BE} - Tc

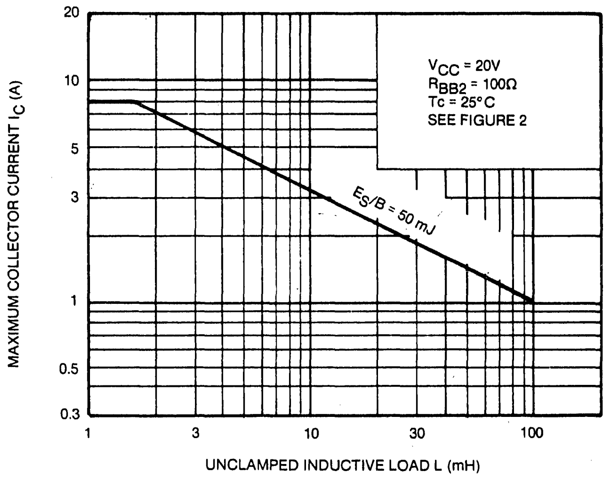


FIG. 10 I_C - L (UNCLAMPED INDUCTIVE LOAD)

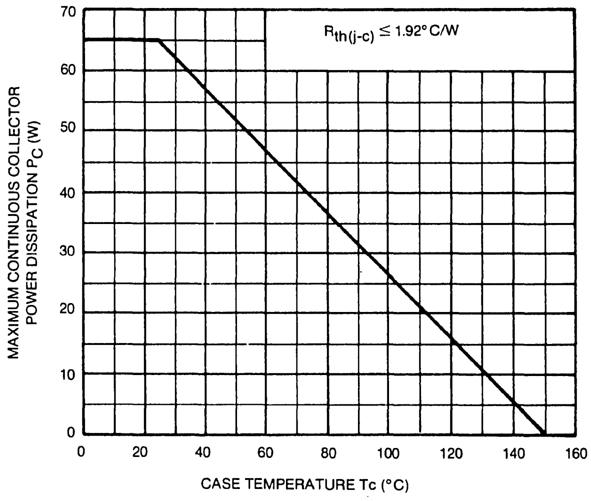


FIG. 11 P_C - Tc

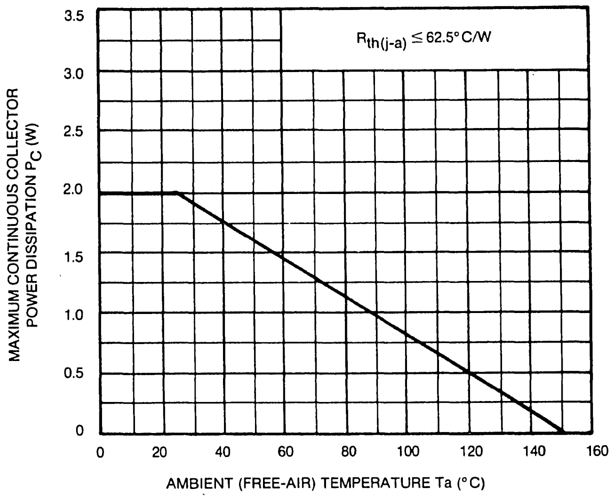


FIG. 12 P_C - Ta

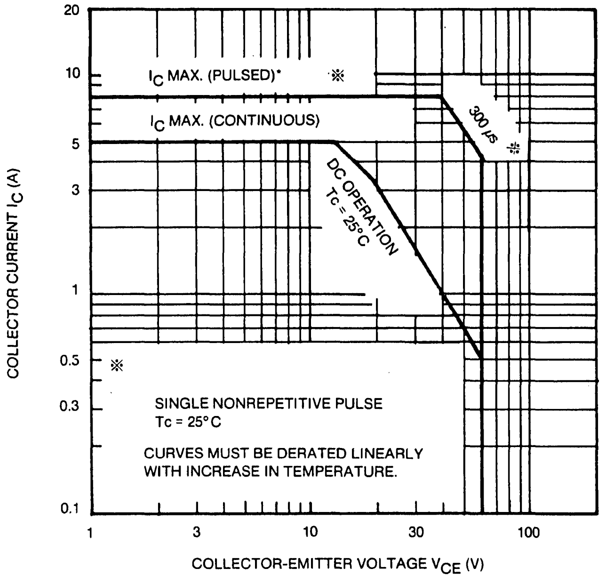
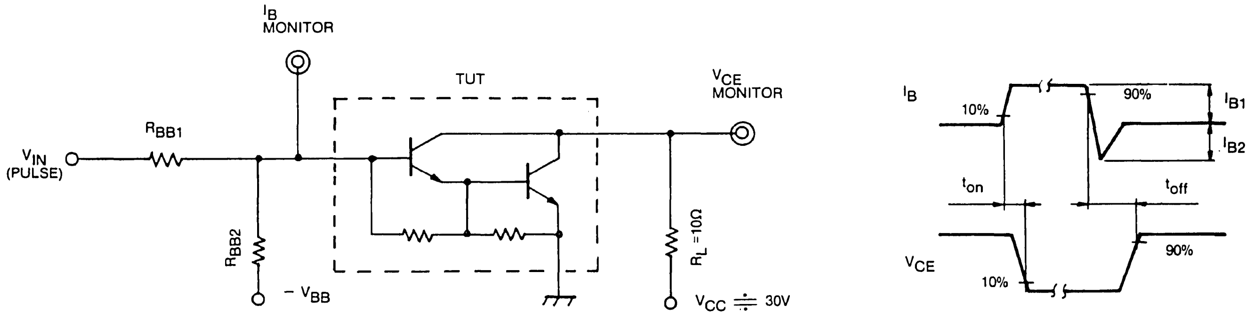


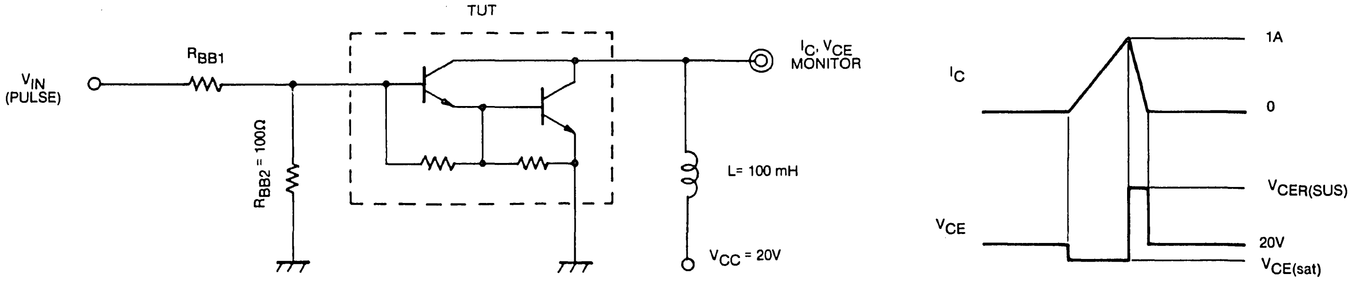
FIG. 13 SAFE OPERATING AREA



(A) The V_{IN} waveform is obtained by using amplifier circuit and the signal source is supplied by generator with the following characteristics: t_r, $t_f < 15ns$, $t_w = 20\mu s$, $Du \leq 1\%$

(B) V_{IN}, R_{BB1} and R_{BB2} are varied to obtain desired base current levels.

FIG. 14 SWITCHING TIME MEASUREMENT CIRCUIT



INPUT PULSE WIDTH IS INCREASED UNTIL $I_{CP} = 1A$.

FIG. 15 INDUCTIVE LOAD SWITCHING TEST

PNP POWER DARLINGTON TRANSISTORS

COMPLEMENTARY TO THE TIP120, TIP121, TIP122

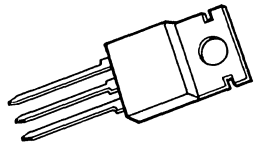
TIP125,126, TIP127

-60 - -100 VOLTS
-5 AMP, 65 WATTS

High power switching applications, designed for hammer drive, pulse motor drive and inductive load drive applications.

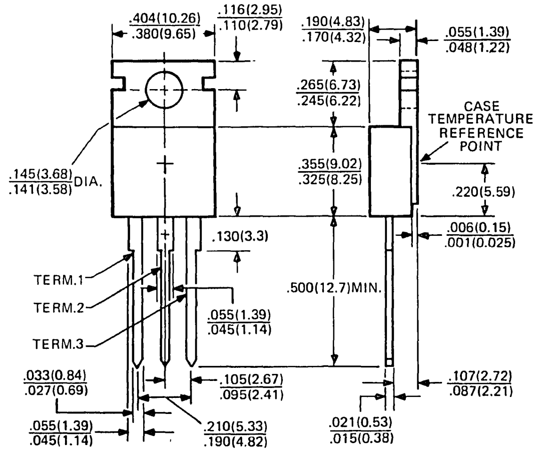
Features:

- High collector power dissipation: $P_D = 65W$ @ $T_C = 25°C$
- High collector current: $I_{C(DC)} = -5A$ (Max.)
- High DC current gain: $h_{FE} = 1000$ (Min.) @ $V_{CE} = -3V$, $I_C = -3A$
- Complementary to TIP120, TIP121, TIP122



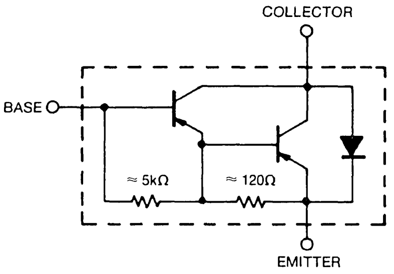
CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

EQUIVALENT CIRCUIT



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	TIP125	TIP126	TIP127	UNITS
Collector-Emitter Voltage	V_{CEO}	-60	-80	-100	Volts
Collector-Base Voltage	V_{CBO}	-60	-80	-100	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	-5 -8	-5 -8	-5 -8	A
Base Current — Continuous	I_B	-0.1	-0.1	-0.1	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	2 65	2 65	2 65	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	62.5	62.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.92	1.92	1.92	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	260	260	260	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage TIP125 (I_C = -30mA) TIP126 TIP127	$V_{BR(CEO)}$	-60 -80 -100	— — —	— — —	Volts
Collector Cutoff Current (V_{CB} = -80V)	I_{CBO}	—	—	-200	μA
Collector Cutoff Current (V_{CE} = -40V)	I_{CEO}	—	—	-0.5	mA
Emitter Cutoff Current (V_{EB} = -5V)	I_{EBO}	—	—	-2	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 13

on characteristics

DC Current Gain (I_C = -0.5A, V_{CE} = -3V) (I_C = -3A, V_{CE} = -3V)	h_{FE}	1000 1000	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -12mA) (I_C = -5A, I_B = -20mA)	$V_{CE(sat)}$	— —	— —	-2 -4	V V
Base-Emitter Voltage (I_C = -3A, V_{CE} = -3V)	$V_{BE(on)}$	—	—	-2.5	V

switching characteristics

Turn-on Time	I_C = -3A, R_L = 10Ω I_{B1} = $-I_{B2}$ = -12mA $V_{BE(off)}$ = 5V	t_{on}	—	1.5	—	μs
Turn-off Time		t_{off}	—	8.5	—	

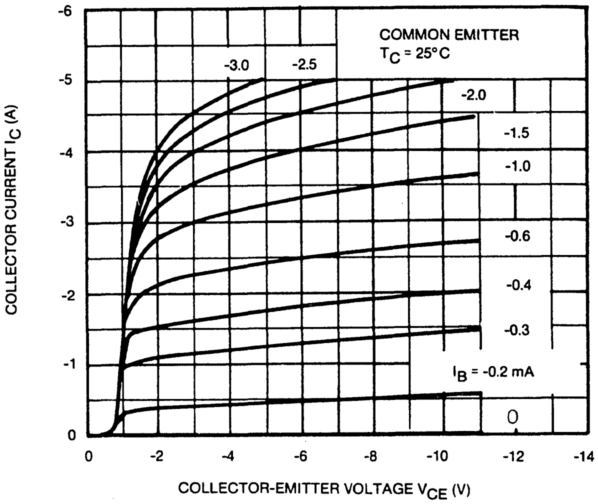


FIG. 1 I_C - V_{CE}

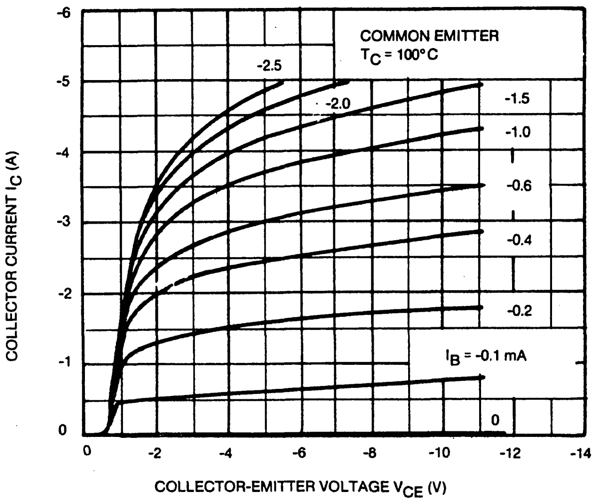


FIG. 2 I_C - V_{CE}

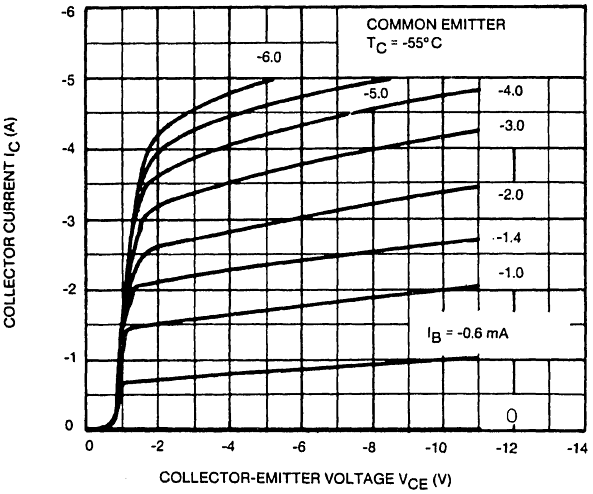


FIG. 3 **I_C - V_{CE}**

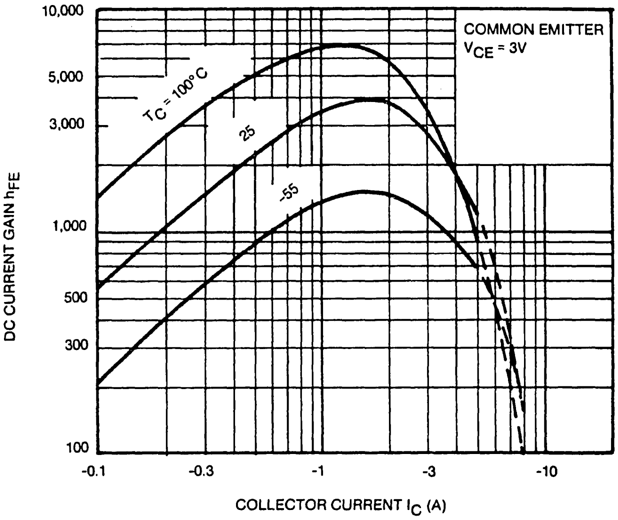


FIG. 4 **h_{FE} - I_C**

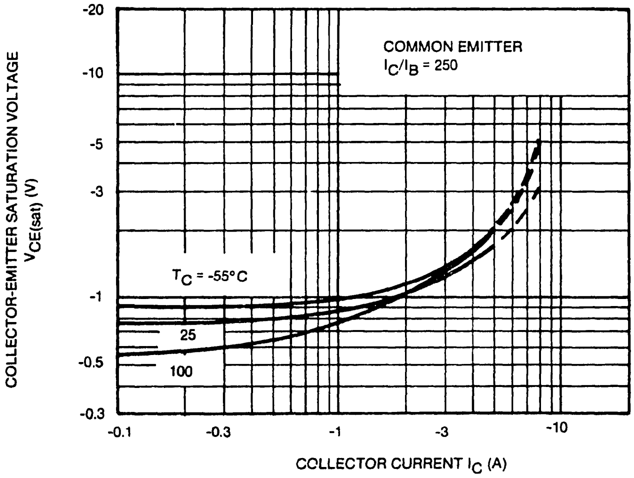


FIG. 5 **$V_{CE(sat)}$ - I_C**

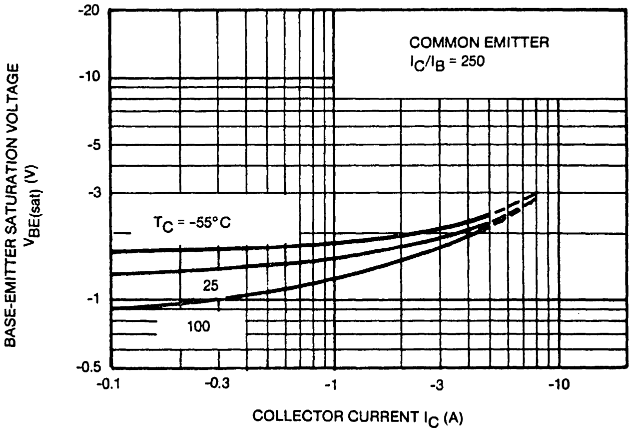


FIG. 6 **$V_{BE(sat)}$ - I_C**

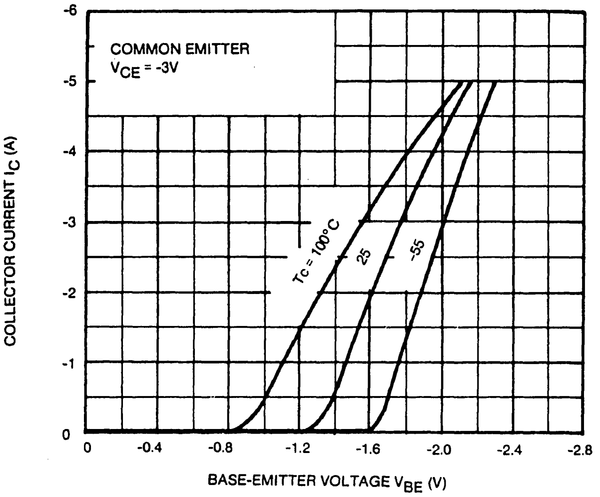


FIG. 7 **I_C - V_{BE}**

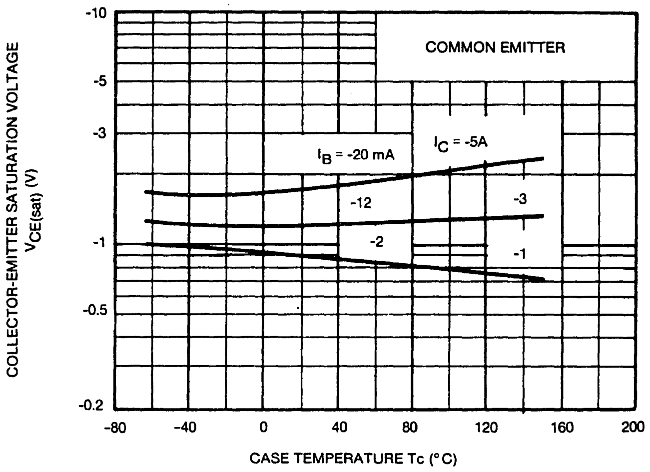


FIG. 8 **$V_{CE(sat)}$ - Tc**

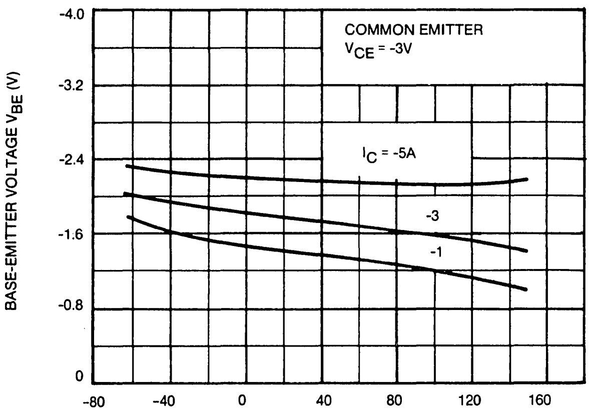


FIG. 9 V_{BE} - Tc

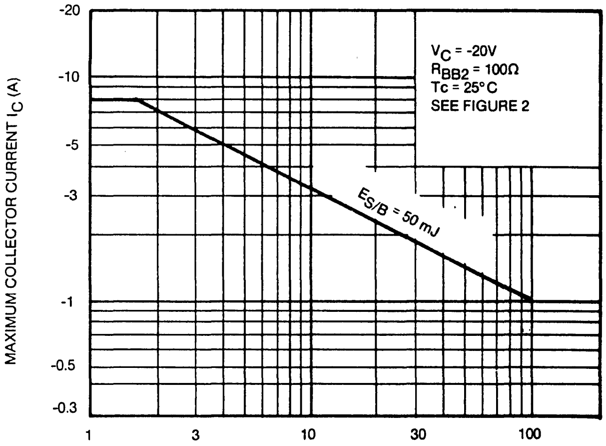


FIG. 10 I_C - L (UNCLAMPED INDUCTIVE LOAD)

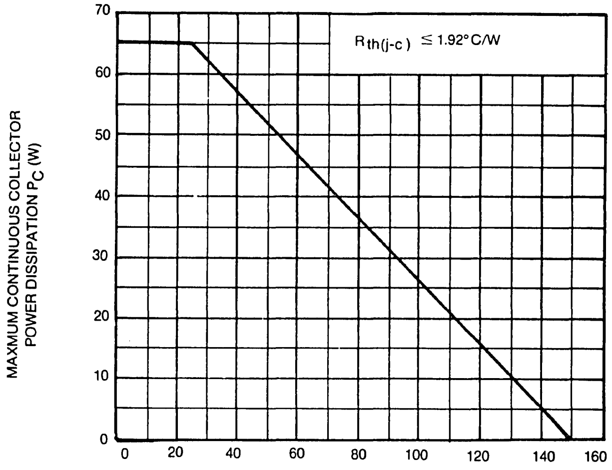


FIG. 11 P_C - Tc

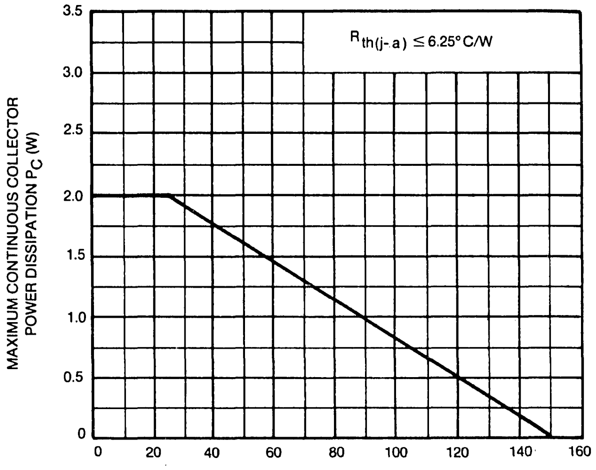


FIG. 12 P_C Ta

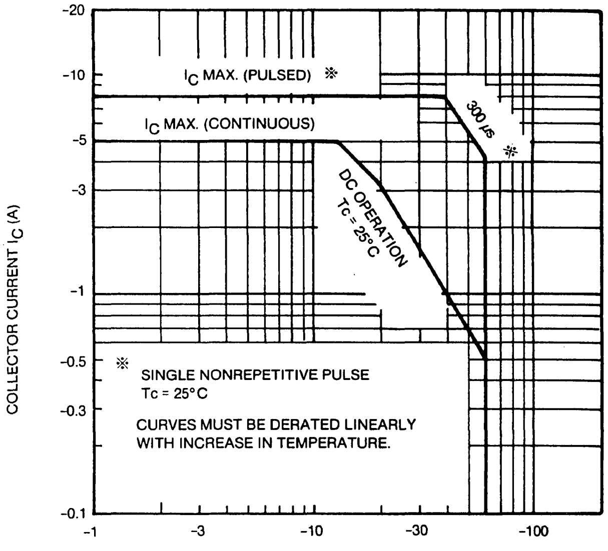
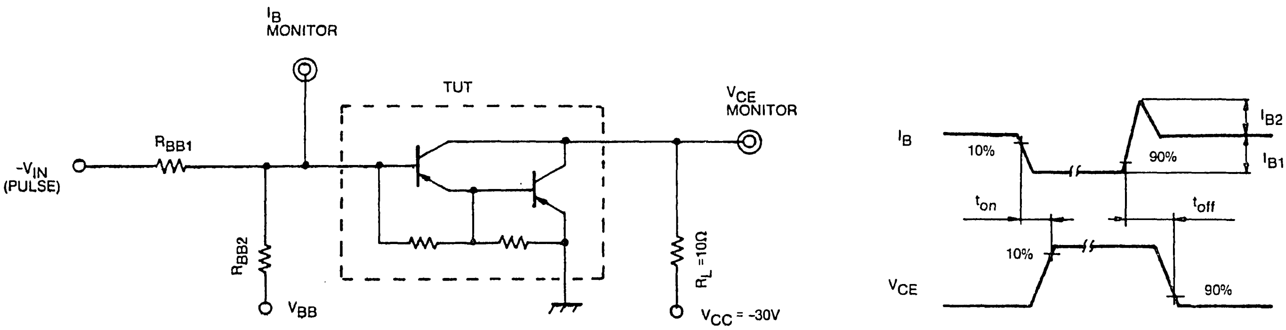


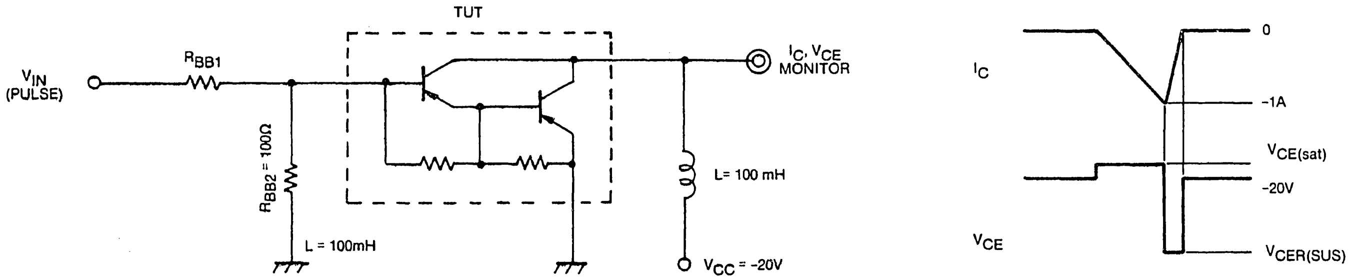
FIG. 13 SAFE OPERATING AREA



(A) The V_{IN} waveform is obtained by using amplifier circuit and the signal source is supplied by generator with the following characteristics: t_r, $t_f < 15ns$, $t_w = 20\mu s$, $Du \leq 1\%$

(B) $-V_{IN}$, R_{BB1} and R_{BB2} are varied to obtain desired base current levels.

FIG. 14 SWITCHING TIME MEASUREMENT CIRCUIT



INPUT PULSE WIDTH IS INCREASED UNTIL $I_{CP} = -1A$.

FIG. 15 INDUCTIVE LOAD SWITCHING TEST

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE TIP30 SERIES

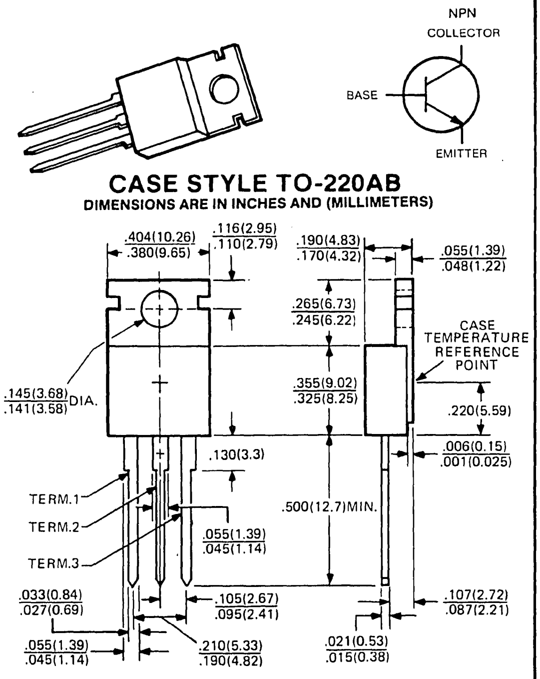
TIP 29 Series

40-100 VOLTS
1 AMP, 30 WATTS

The TIP29 Series power transistors are designed for use in general purpose amplifier and switching applications.

Features:

- Designed for complementary use with TIP30 series
- 30W at 25°C case temperature
- 1A continuous collector current
- 3A peak collector current
- Minimum f_T of 3 MHz at 10V, 0.02A
- Customer-specified selections available



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25°C) (unless otherwise noted)

RATING	SYMBOL	TIP29	TIP29A	TIP29B	TIP29C	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	100	Volts
Collector-Base Voltage	V_{CBO}	80	100	120	140	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	1 3	1 3	1 3	1 3	A
Base Current — Continuous	I_B	0.4	0.4	0.4	0.4	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2 30	2 30	2 30	2 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.17	4.17	4.17	4.17	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	250	250	250	250	°C

electrical characteristics ($T_C = 25° C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 30mA)	TIP29	V_{CEO}	40	—	—	Volts
	TIP29A		60	—	—	
	TIP29B		80	—	—	
	TIP29C		100	—	—	
Collector Cutoff Current		I_{CEO}				
(V_{CE} = 30V)	TIP29, TIP29A		—	—	0.3	mA
(V_{CE} = 60V)	TIP29B, TIP29C		—	—	0.3	
Collector Cutoff Current		I_{CES}				
(V_{CE} = 80V)	TIP29		—	—	0.2	mA
(V_{CE} = 100V)	TIP29A		—	—	0.2	
(V_{CE} = 120V)	TIP29B		—	—	0.2	
(V_{CE} = 140V)	TIP29C		—	—	0.2	
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)		I_{EBO}	—	—	1	mA

second breakdown

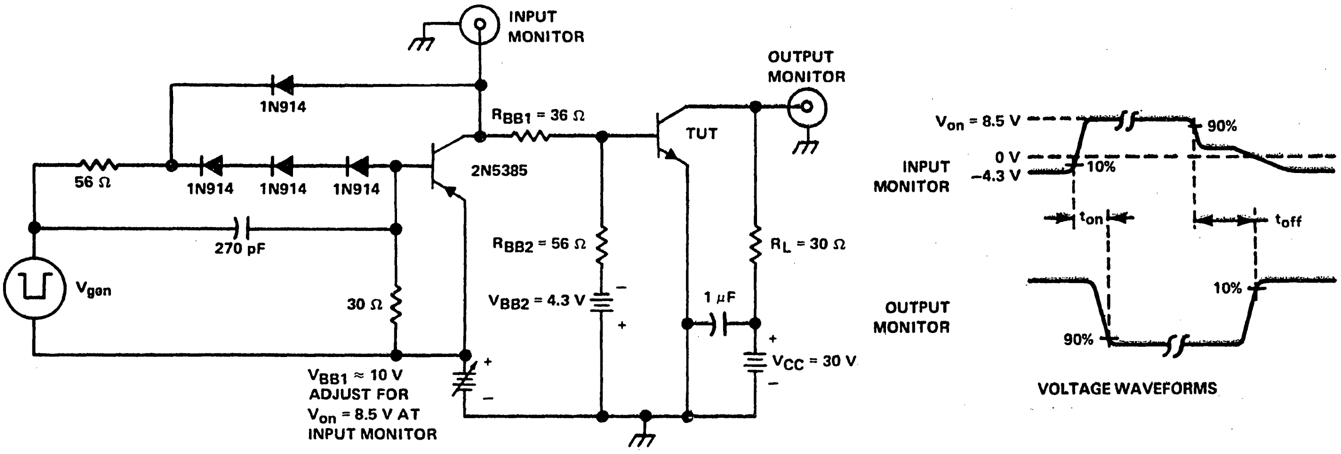
CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
(I_C = .2A, V_{CE} = 4V)		40	—	—	—
(I_C = 1A, V_{CE} = 4V)		15	—	75	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 125mA)	$V_{CE(sat)}$	—	—	0.7	V
Base-Emitter Voltage (I_C = 1A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	1.3	V

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	$R_L = 30\Omega$, I_C = 1A $I_{B1} = I_{B2}$ = 0.1A $V_{BE(off)}$ = -4.3V	t_{on}	—	0.5	—	µs
Turn-off Time		t_{off}	—	2	—	

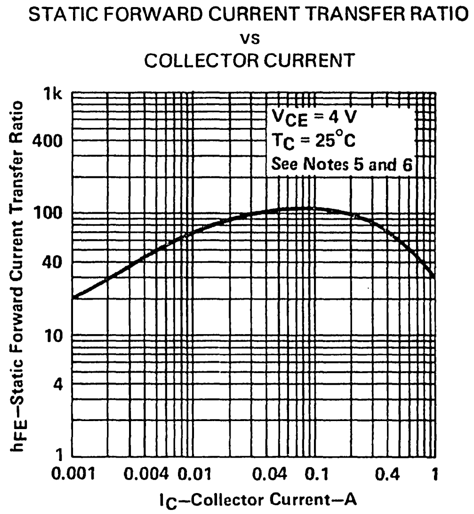


TEST CIRCUIT

VOLTAGE WAVEFORMS

NOTES:
- A. V_{gen} is a − 30-V pulse into a 50 Ω termination.
- B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leqslant 15$ ns, $t_f \leqslant 15$ ns, $Z_{out} = 50\,\Omega$, $t_w = 20\,\mu s$, duty cycle $\leqslant 2\%$.
- C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leqslant 15$ ns, $R_{in} \geqslant 10\,M\Omega$, $C_{in} \leqslant 11.5$ pF.
- D. Resistors must be noninductive types.
- E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING



NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

FIGURE 2. **TYPICAL CHARACTERISTICS**

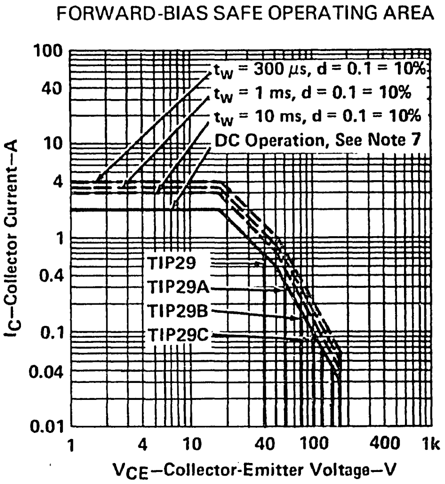


FIGURE 3 MAXIMUM SAFE OPERATING AREA

NOTE 7. This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

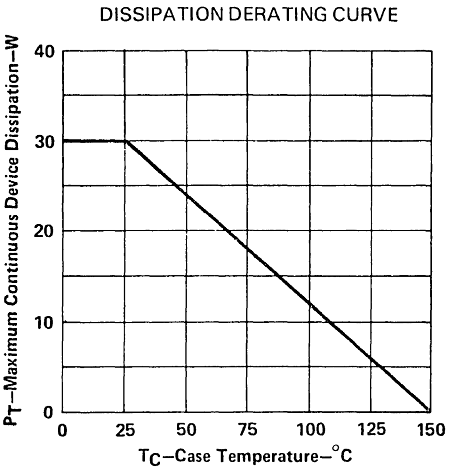


FIGURE 4 THERMAL INFORMATION

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE TIP29 SERIES

TIP 30 Series

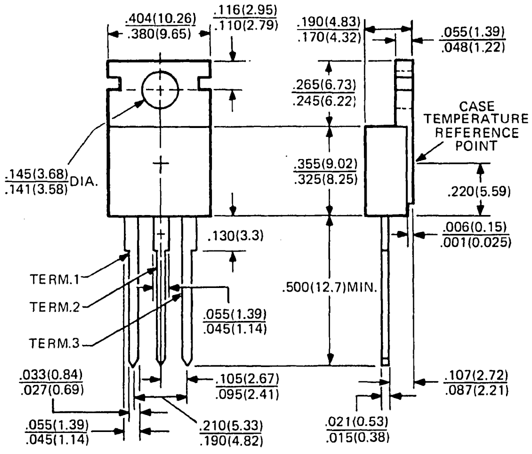
-40 ~ -100 VOLTS
-1 AMP, 30 WATTS

The TIP30 Series power transistors are designed for use in general purpose amplifier and switching applications.

Features:

- Designed for complementary use with TIP29 series
- 30W at 25° C case temperature
- -1A continuous collector current
- -3A peak collector current
- Minimum f_T of 3 MHz at 10V, 0.02A
- Customer-specified selections available
- Designed for power amplifier and high-speed switching applications

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	TIP30	TIP30A	TIP30B	TIP30C	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	-100	Volts
Collector-Base Voltage	V_{CBO}	-80	-100	-120	-140	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	-1 -3	-1 -3	-1 -3	-1 -3	A
Base Current — Continuous	I_B	-0.4	-0.4	-0.4	-0.4	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2 30	2 30	2 30	2 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.17	4.17	4.17	4.17	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	250	250	250	250	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage ($I_C = -30mA$)	TIP30	V_{CEO}	-40	—	—	Volts
	TIP30A		-60	—	—	
	TIP30B		-80	—	—	
	TIP30C		-100	—	—	
Collector Cutoff Current		I_{CEO}				
($V_{CE} = -30V$)	TIP30, TIP30A		—	—	-0.3	mA
($V_{CE} = -60V$)	TIP30B, TIP30C		—	—	-0.3	
Collector Cutoff Current		I_{CES}				
($V_{CE} = -80V$)	TIP30		—	—	-0.2	mA
($V_{CE} = -100V$)	TIP30A		—	—	-0.2	
($V_{CE} = -120V$)	TIP30B		—	—	-0.2	
($V_{CE} = -140V$)	TIP30C		—	—	-0.2	
Emitter Cutoff Current ($V_{EB} = -5V$, $I_C = 0$)		I_{EBO}	—	—	-1	mA

second breakdown

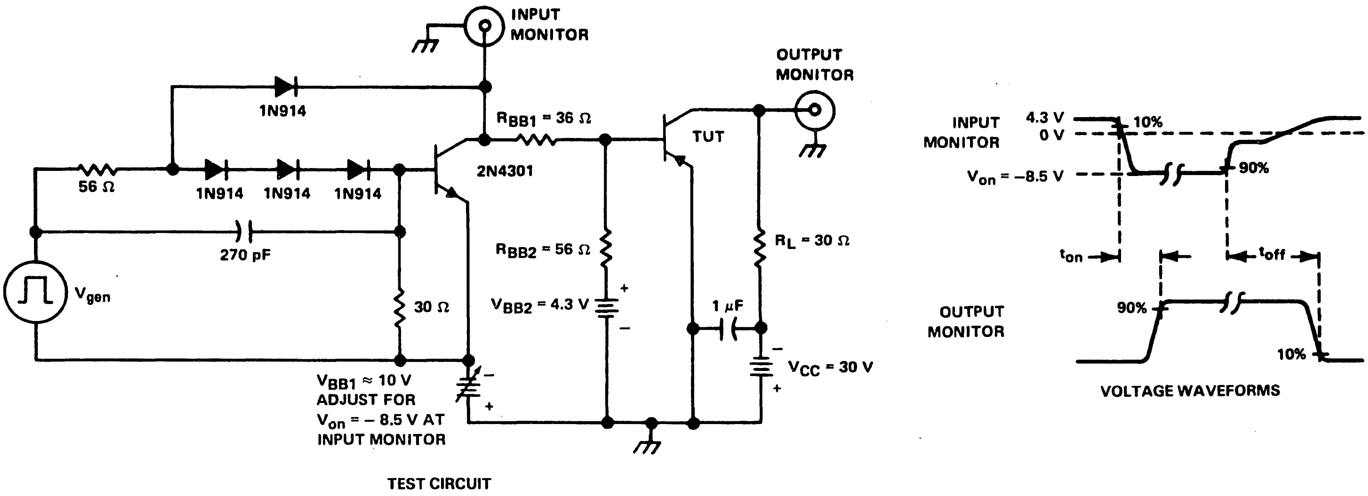
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3

on characteristics

DC Current Gain	h_{FE}				
($I_C = -0.2A$, $V_{CE} = -4V$)		20	—	—	—
($I_C = 1A$, $V_{CE} = 4V$)		15	—	75	
Collector-Emitter Saturation Voltage ($I_C = -1A$, $I_B = -125mA$)	$V_{CE(sat)}$	—	—	-0.7	V
Base-Emitter Voltage ($I_C = -1A$, $V_{CE} = -4V$)	$V_{BE(on)}$	—	—	-1.3	V

switching characteristics

Turn-on Time	$R_L = 30\Omega$, $I_C = -1A$ $I_{B1} = I_{B2} = 0.1A$ $V_{BE(off)} = 4.3V$	t_{on}	—	0.3	—	μs
Turn-off Time		t_{off}	—	1	—	



NOTES:
- A. V_{gen} is a 30-V pulse into a 50 Ω termination.
- B. The V_{gen} waveform is supplied by the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\Omega$, $t_w = 20\ \mu s$, duty cycle ≤ 2%.
- C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10\ M\Omega$, $C_{in} \leq 11.5$ pF.
- D. Resistors must be noninductive types.
- E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

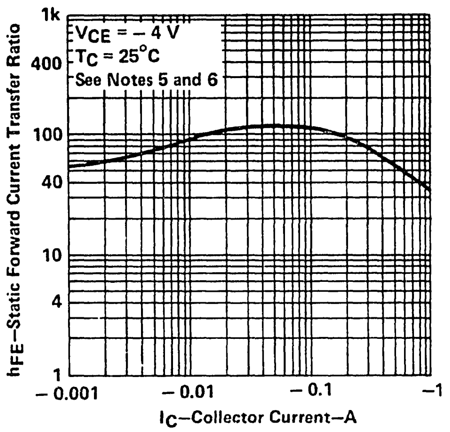

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

FIGURE 2. TYPICAL CHARACTERISTICS

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

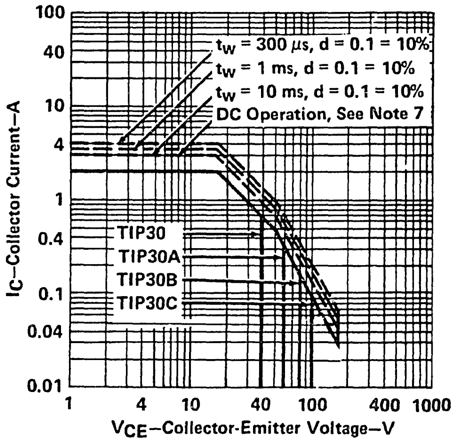

FORWARD-BIAS SAFE OPERATING AREA

FIGURE 3 MAXIMUM SAFE OPERATING AREA

NOTE 7: This combination of maximum voltage and current values may be achieved only when switching from saturation to cutoff with a clamped inductive load.

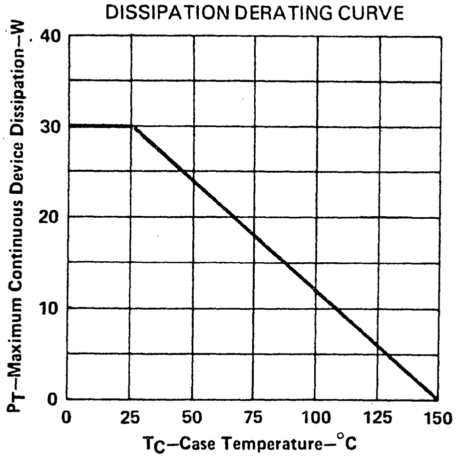

DISSIPATION DERATING CURVE

FIGURE 4 THERMAL INFORMATION

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE TIP32 SERIES

TIP 31 Series

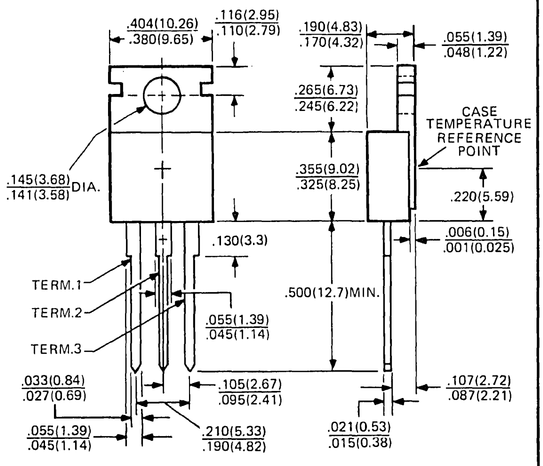
40-100 VOLTS
3 AMP, 40 WATTS

The TIP31 Series power transistors are designed for use in general purpose amplifier and switching applications.

Features:

- 40W at 25° C case temperature
- 3A continuous collector current
- 5A peak collector current
- Minimum f_T of 3 MHz at 10V, 0.5A
- Customer-specified selections available

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	TIP31	TIP31A	TIP31B	TIP31C	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	100	Volts
Collector-Base Voltage	V_{CBO}	80	100	120	140	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	3 5	3 5	3 5	3 5	A
Base Current — Continuous	I_B	1	1	1	1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2 40	2 40	2 40	2 40	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.125	3.125	3.125	3.125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	250	250	250	250	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 30mA) TIP31	V_{CEO}	40	—	—	Volts
TIP31A		60	—	—	
TIP31B		80	—	—	
TIP31C		100	—	—	
Collector Cutoff Current	I_{CEO}				
(V_{CE} = -30V) TIP31, TIP31A		—	—	0.3	mA
(V_{CE} = 60V) TIP31B, TIP31C		—	—	0.3	
Collector Cutoff Current	I_{CES}				
(V_{CE} = 80V) TIP31		—	—	0.2	mA
(V_{CE} = 100V) TIP31A		—	—	0.2	
(V_{CE} = 120V) TIP31B		—	—	0.2	
(V_{CE} = 140V) TIP31C		—	—	0.2	
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

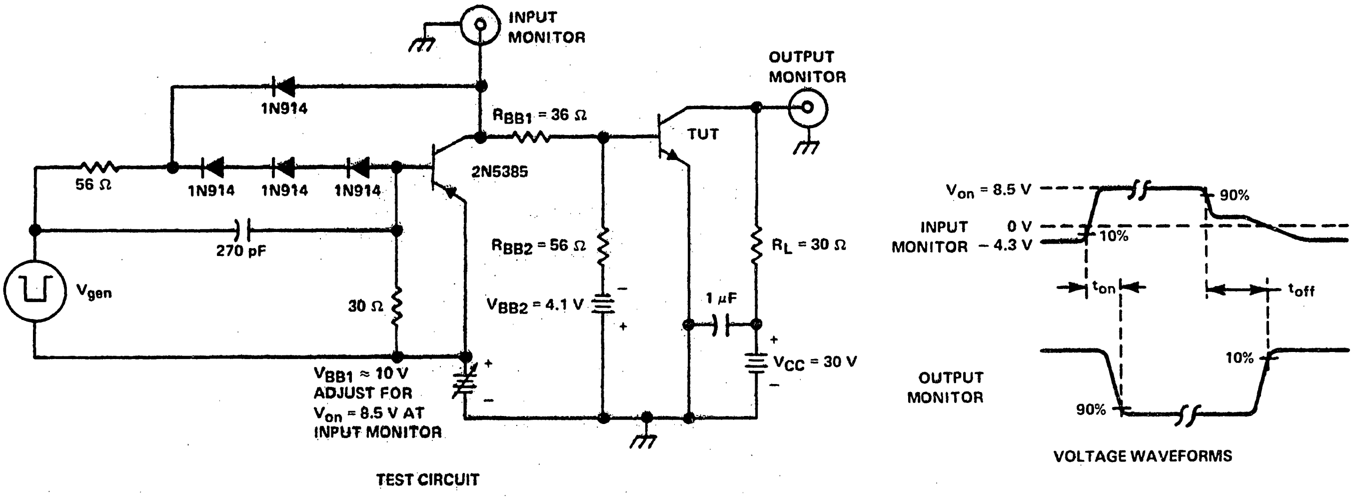
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3

on characteristics

DC Current Gain	h_{FE}				
(I_C = 1A, V_{CE} = 4V)		25	—	—	—
(I_C = 3A, V_{CE} = 4V)		10	—	50	
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 375mA)	$V_{CE(sat)}$	—	—	1.2	V
Base-Emitter Voltage (I_C = 3A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	1.8	V

switching characteristics

Turn-on Time	R_L = 30Ω, I_C = 1A I_{B1} = I_{B2} = 0.1A $V_{BE(off)}$ = -4.3V	t_{on}	—	0.5	—	μs
Turn-off Time		t_{off}	—	2	—	



NOTES:
- A. V_{gen} is a – 30-V pulse into a 50 Ω termination.
- B. The V_{gen} waveform is supplied by the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, Z_{out} = 50 Ω, t_w = 20 μs, duty cycle ≤ 2%.
- C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.
- D. Resistors must be noninductive types.
- E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

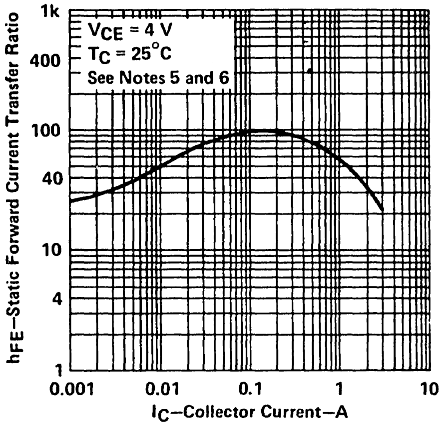


FIGURE 2. TYPICAL CHARACTERISTICS

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

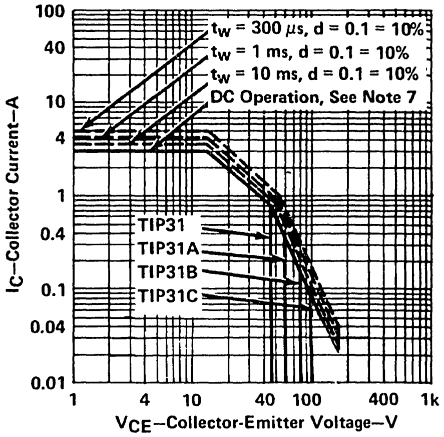


FIGURE 3 MAXIMUM SAFE OPERATING AREA

NOTE 7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

DISSIPATION DERATING CURVE

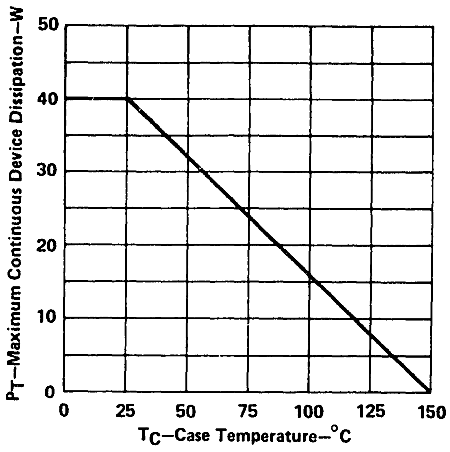


FIGURE 4 THERMAL INFORMATION

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE TIP31 SERIES

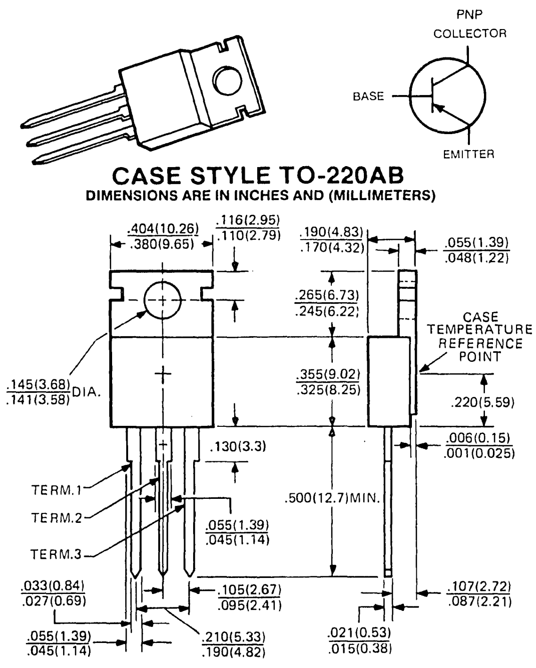
TIP 32 Series

-40 ~ -100 VOLTS
-3 AMP, 40 WATTS

The TIP32 Series power transistors are designed for use in general purpose amplifier and switching applications.

Features:

- Designed for complementary use with TIP31 series
- 40W at 25° C case temperature
- 3A continuous collector current
- 5A peak collector current
- Minimum f_T of 3 MHz at 10V, 0.5A
- Customer-specified selections available



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	TIP32	TIP32A	TIP32B	TIP32C	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	-100	Volts
Collector-Base Voltage	V_{CBO}	-80	-100	-120	-140	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous	I_C	-3	-3	-3	-3	A
Peak	I_{CM}	-5	-5	-5	-5	
Base Current — Continuous	I_B	-1	-1	-1	-1	A
Total Power Dissipation @ T_A = 25°C	P_D	2	2	2	2	Watts
@ T_C = 25°C		40	40	40	40	
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.125	3.125	3.125	3.125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	250	250	250	250	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = -30mA) TIP32	V_{CEO}	-40	—	—	Volts
TIP32A		-60	—	—	
TIP32B		-80	—	—	
TIP32C		-100	—	—	
Collector Cutoff Current	I_{CEO}				
(V_{CE} = -30V) TIP32, TIP32A		—	—	-0.3	mA
(V_{CE} = -60V) TIP32B, TIP32C		—	—	-0.3	
Collector Cutoff Current	I_{CES}				
(V_{CE} = -80V) TIP32		—	—	-0.2	mA
(V_{CE} = -100V) TIP32A		—	—	-0.2	
(V_{CE} = -120V) TIP32B		—	—	-0.2	
(V_{CE} = -140V) TIP32C		—	—	-0.2	
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-1	mA

second breakdown

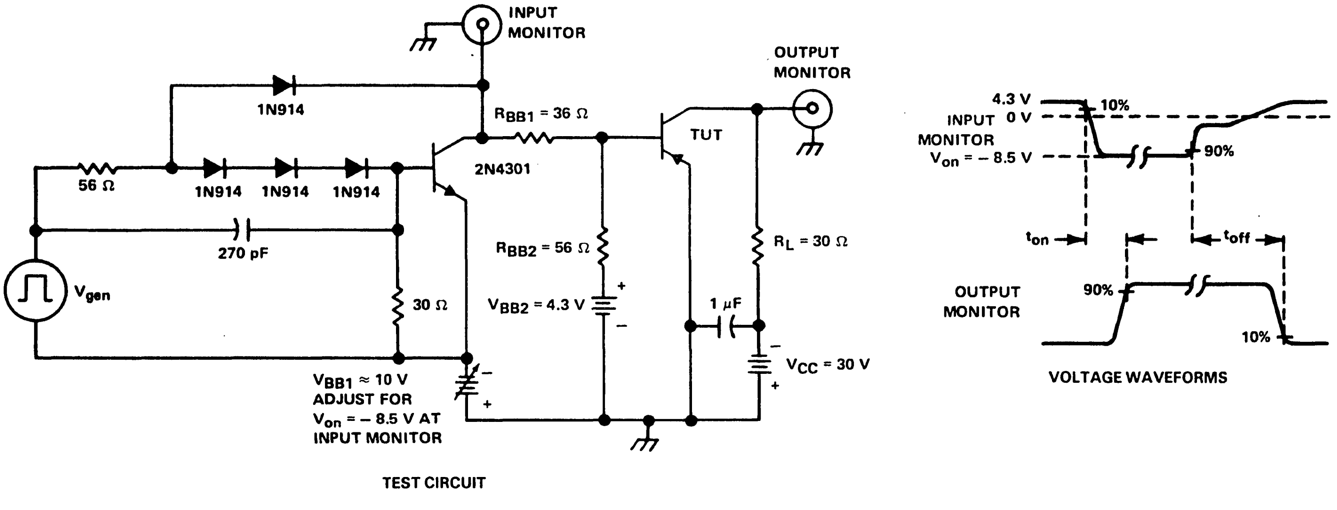
CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3			

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain	h_{FE}				
(I_C = -4A, V_{CE} = -1V)		25	—	—	—
(I_C = -3A, V_{CE} = -4V)		10	—	50	
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -375mA)	$V_{CE(sat)}$	—	—	-1.2	V
Base-Emitter Voltage (I_C = -3A, V_{CE} = -4V)	$V_{BE(on)}$	—	—	-1.8	V

switching characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	R_L = 30Ω, I_C = 1A I_{B1} = I_{B2} = 0.1A $V_{BE(off)}$ = 4.3V	t_{on}	—	0.3	—	μs
Turn-off Time		t_{off}	—	1	—	



TEST CIRCUIT

VOLTAGE WAVEFORMS

NOTES: A. V_{gen} is a 30-V pulse into a 50 Ω termination.

B. The V_{gen} waveform is supplied by the following characteristics: $t_r \leqslant 15$ ns, $t_f \leqslant 15$ ns, Z_{out} = 50 Ω, t_w = 20 μs, duty cycle ⩽ 2%.

C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leqslant 15$ ns, $R_{in} \geqslant 10$ MΩ, $C_{in} \leqslant 11.5$ pF.

D. Resistors must be noninductive types.

E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

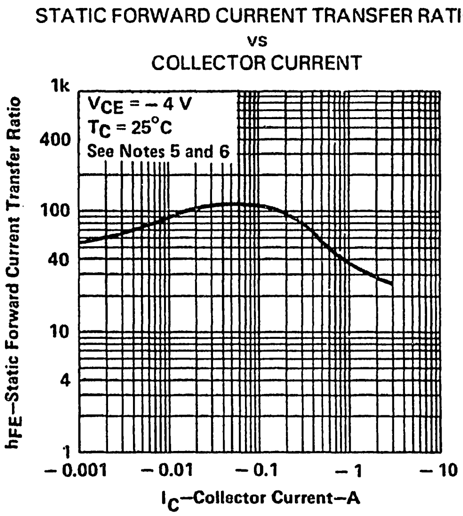

STATIC FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT

FIGURE 2. **TYPICAL CHARACTERISTICS**

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

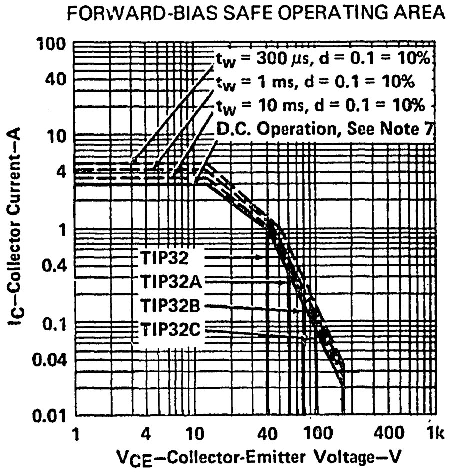

FORWARD-BIAS SAFE OPERATING AREA

FIGURE 3 MAXIMUM SAFE OPERATING AREA

NOTE 7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

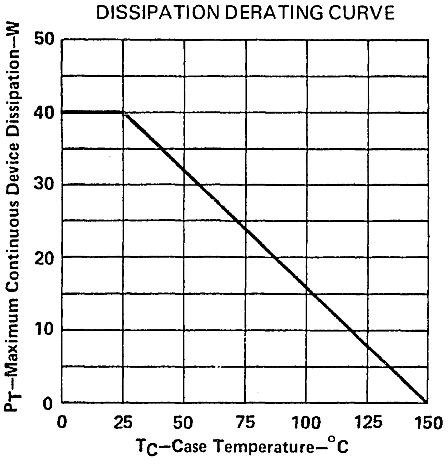

DISSIPATION DERATING CURVE

FIGURE 4 THERMAL INFORMATION

NPN POWER TRANSISTORS

COMPLEMENTARY TO THE TIP42 SERIES

TIP 41 Series

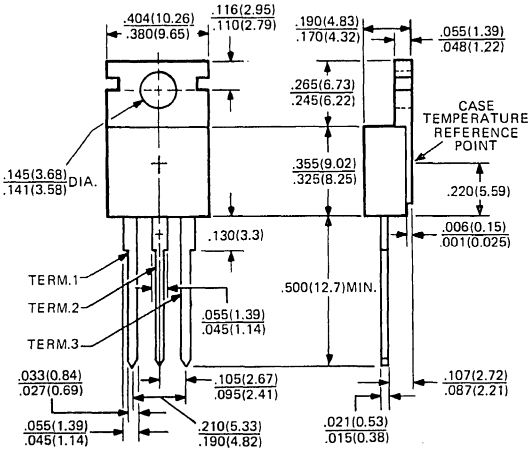
40-100 VOLTS
6 AMP, 65 WATTS

The TIP41 Series power transistors are designed for use in general purpose amplifier and switching applications.

Features:

- Designed for complementary use with TIP42 series
- 65W at 25° C case temperature
- 6A continuous collector current
- 10A peak collector current
- Minimum f_T of 3 MHz at 10V, 0.5A
- Customer-specified selections available

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	TIP41	TIP41A	TIP41B	TIP41C	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	100	Volts
Collector-Base Voltage	V_{CBO}	80	100	120	140	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	6 10	6 10	6 10	6 10	A
Base Current — Continuous	I_B	3	3	3	3	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2 65	2 65	2 65	2 65	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.92	1.92	1.92	1.92	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	250	250	250	250	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 30mA) TIP41	V_{CEO}	40	—	—	Volts
TIP41A		60	—	—	
TIP41B		80	—	—	
TIP41C		100	—	—	
Collector Cutoff Current	I_{CEO}				
(V_{CE} = 30V) TIP41, TIP41A		—	—	0.7	mA
(V_{CE} = 60V) TIP41B, TIP41C		—	—	0.7	
Collector Cutoff Current	I_{CES}				
(V_{CE} = 80V) TIP41		—	—	0.4	mA
(V_{CE} = 100V) TIP41A		—	—	0.4	
(V_{CE} = 120V) TIP41B		—	—	0.4	
(V_{CE} = 140V) TIP41C		—	—	0.4	
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	1	mA

second breakdown

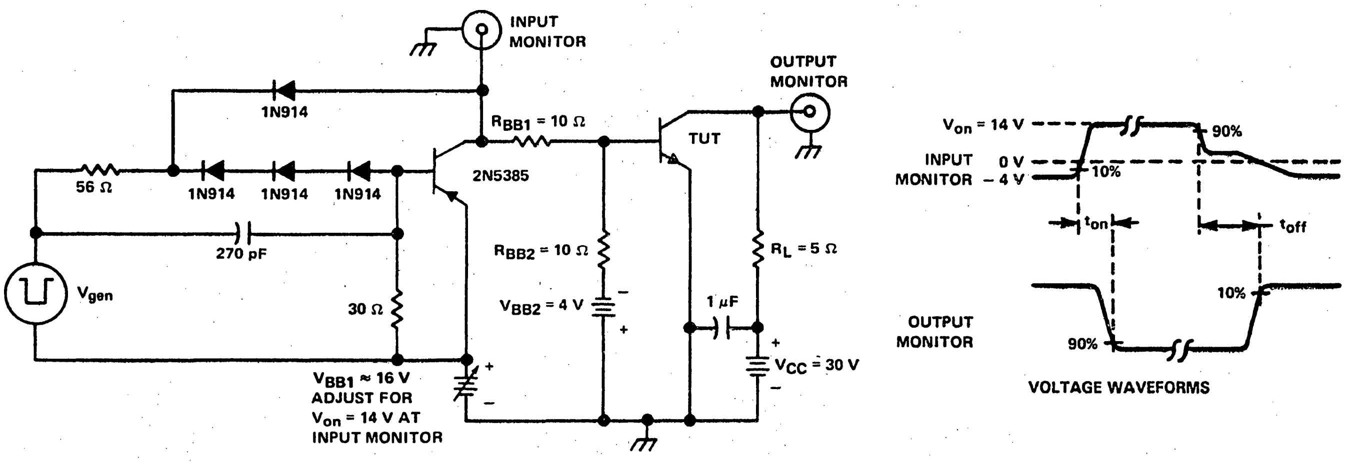
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3

on characteristics

DC Current Gain	h_{FE}				
(I_C = .3A, V_{CE} = 4V)		30	—	—	—
(I_C = 3A, V_{CE} = 4V)		15	—	75	
Collector-Emitter Saturation Voltage (I_C = 6A, I_B = .6A)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Voltage (I_C = 6A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	2.0	V

switching characteristics

Turn-on Time	I_C = 6A, R_L = 5Ω I_{B1} = I_{B2} = 0.6A $V_{BE(off)}$ = -4V	t_{on}	—	0.6	—	μs
Turn-off Time		t_{off}	—	1	—	



TEST CIRCUIT

VOLTAGE WAVEFORMS

NOTES:
A. V_{gen} is a – 30-V pulse into a 50 Ω termination.
B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, Z_{out} = 50 Ω, t_w = 20 μs, duty cycle ≤ 2%.
C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.
D. Resistors must be noninductive types.
E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

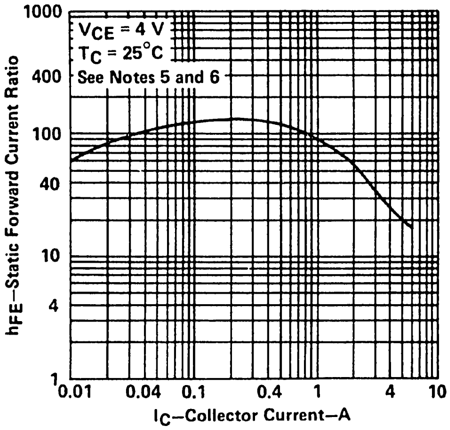


FIGURE 2. TYPICAL CHARACTERISTICS

NOTES: 5. These parameters must be measured using pulse techniques, $t_W = 300\ \mu s$, duty cycle $\leqslant$ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

FORWARD-BIAS SAFE OPERATING AREA

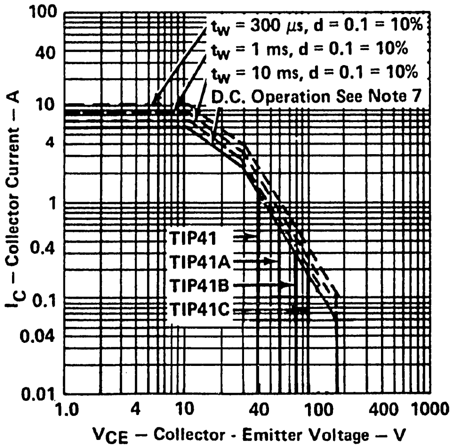


FIGURE 3 MAXIMUM SAFE OPERATING AREA

NOTES: 7. This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.

DISSIPATION DERATING CURVE

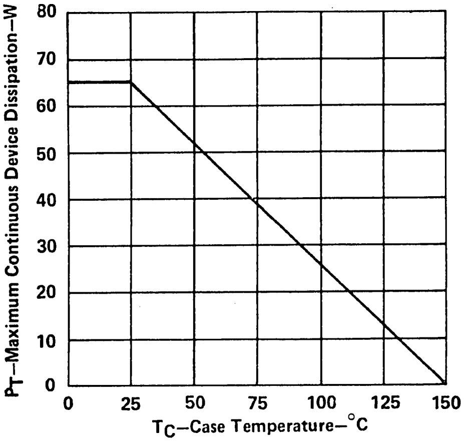


FIGURE 4 THERMAL INFORMATION

PNP POWER TRANSISTORS

COMPLEMENTARY TO THE TIP41 SERIES

TIP 42 Series

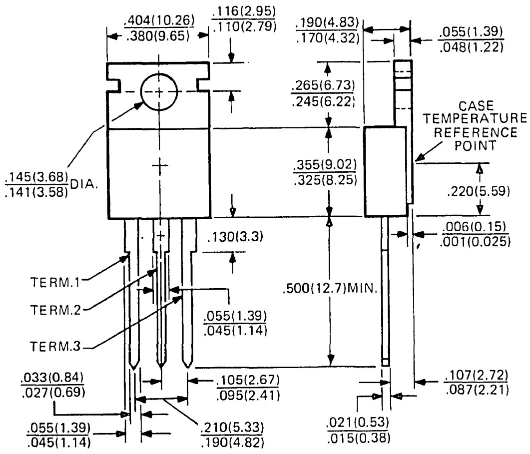
-40 ~ -100 VOLTS
-6 AMP, 65 WATTS

The TIP42 Series power transistors are designed for use in general purpose amplifier and switching applications.

Features:

- 65W at 25° C case temperature
- 6A continuous collector current
- 10A peak collector current
- Minimum f_T of 3 MHz at 10V, 0.5A
- Customer-specified selections available

CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_C = 25° C) (unless otherwise noted)

RATING	SYMBOL	TIP42	TIP42A	TIP42B	TIP42C	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	-100	Volts
Collector-Base Voltage	V_{CBO}	-80	-100	-120	-140	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	-6 -10	-6 -10	-6 -10	-6 -10	A
Base Current — Continuous	I_B	-3	-3	-3	-3	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2 65	2 65	2 65	2 65	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.92	1.92	1.92	1.92	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	250	250	250	250	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Breakdown Voltage (I_C = 30mA)	TIP42	V_{CEO}	-40	—	—	Volts
	TIP42A		-60	—	—	
	TIP42B		-80	—	—	
	TIP42C		-100	—	—	
Collector Cutoff Current		I_{CEO}				
(V_{CE} = -30V)	TIP42, TIP42A		—	—	-0.7	mA
(V_{CE} = -60V)	TIP42B, TIP42C		—	—	-0.7	
Collector Cutoff Current		I_{CES}				
(V_{CE} = -80V)	TIP42		—	—	-0.4	mA
(V_{CE} = -100V)	TIP42A		—	—	-0.4	
(V_{CE} = -120V)	TIP42B		—	—	-0.4	
(V_{CE} = -140V)	TIP42C		—	—	-0.4	
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)		I_{EBO}	—	—	-1	mA

second breakdown

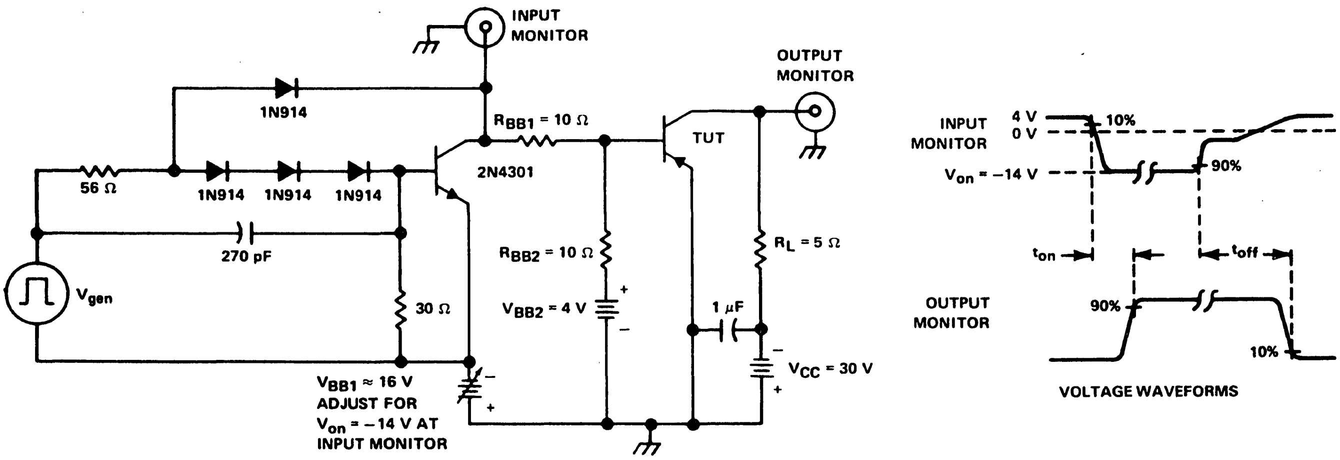
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3

on characteristics

DC Current Gain	h_{FE}				
(I_C = -.3A, V_{CE} = -4V)		30	—	—	—
(I_C = -3A, V_{CE} = -4V)		15	—	75	
Collector-Emitter Saturation Voltage (I_C = -6A, I_B = -.6A)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Voltage (I_C = -6A, V_{CE} = -4V)	$V_{BE(on)}$	—	—	-2	V

switching characteristics

Turn-on Time	R_L = 5Ω, I_C = -6A I_{B1} = I_{B2} = 0.6A $V_{BE(off)}$ = 4V	t_{on}	—	0.4	—	μs
Turn-off Time		t_{off}	—	0.7	—	



TEST CIRCUIT

VOLTAGE WAVEFORMS

NOTES:
- A. V_{gen} is a 30-V pulse into a 50 Ω termination.
- B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leqslant$ 15 ns, $t_f \leqslant$ 15 ns, Z_{out} = 50 Ω, t_w = 20 μs, duty cycle ⩽ 2%.
- C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leqslant$ 15 ns, $R_{in} \geqslant$ 10 MΩ, $C_{in} \leqslant$ 11.5 pF.
- D. Resistors must be noninductive types.
- E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

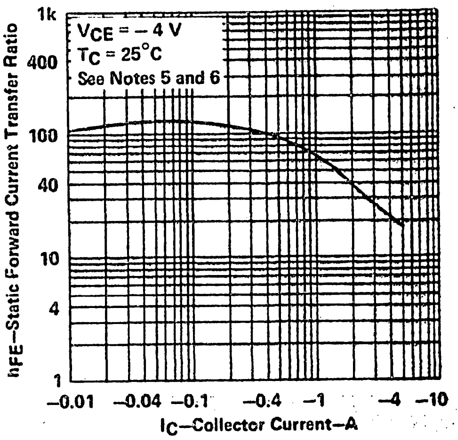


FIGURE 2. **TYPICAL CHARACTERISTICS**

FORWARD-BIAS SAFE OPERATING AREA

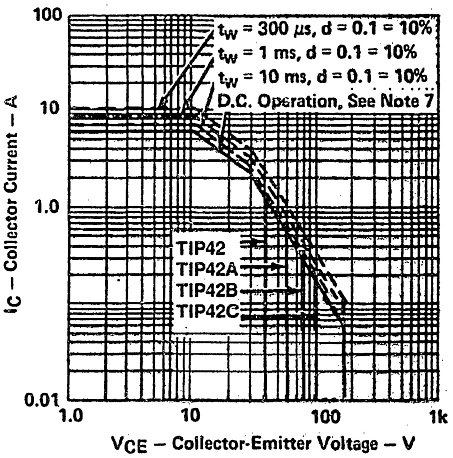


FIGURE 3 MAXIMUM SAFE OPERATING AREA

NOTE 7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive-load.

DISSIPATION DERATING CURVE

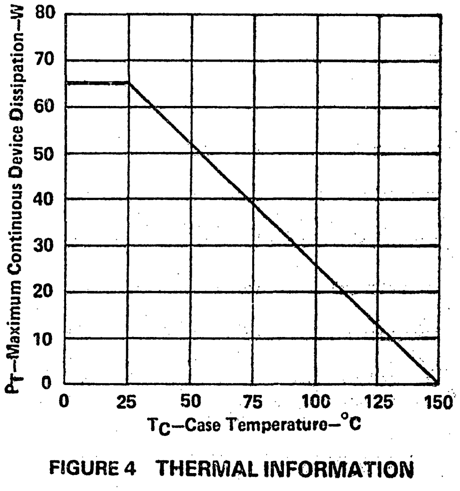


FIGURE 4 THERMAL INFORMATION

NPN POWER TRANSISTORS

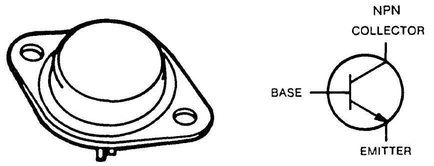
2N3055

60 VOLTS
15 AMP, 115 WATTS

General purpose power transistor designed for power regulator, switching and solenoid drive applications.

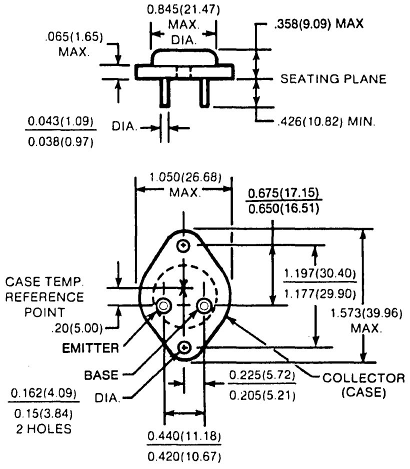
Features:

- High gain at high current
- Low saturation voltage: $V_{CE(sat)} < 1.1V$, @ $I_C = 4A$, $I_B = 0.4A$
- Excellent safe area of operation.



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	2N3055	UNITS
Collector-Emitter Voltage	V_{CEO}	60	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	7	Volts
Collector Current — Continuous	I_C	15	A
Base Current — Continuous	I_B	7	A
Total Power Dissipation @ $T_C = 25°C$ Derate Linearly Above 25°C	P_D	115 0.66	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	—	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = 200mA)	$V_{CEO(sus)}$	60	—	—	Volts
Collector-Emitter Sustaining Voltage (I_C = 200mA, R_{BE} = 100Ω)	$V_{CER(sus)}$	70	—	—	Volts
Collector Cutoff Current (V_{CE} = 30V)	I_{CEO}	—	—	0.7	mA
Collector Cutoff Current (V_{CE} = 100V, $V_{EB(off)}$ = -1.5V) (V_{CE} = 100V, $V_{BE(off)}$ = -1.5V, T_C = 150°C)	I_{CEX}	— —	— —	5 30	mA
Emitter Cutoff Current (V_{EB} = 7V)	I_{EBO}	—	—	5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5

on characteristics

DC Current Gain (I_C = 4A, V_{CE} = 4V) (I_C = 10A, V_{CE} = 4V)	h_{FE}	20 5	— —	70 —	— —
Collector-Emitter Saturation Voltage (I_C = 4A, I_B = .4A) (I_C = 10A, I_B = 3.3A)	$V_{CE(sat)}$	— —	— —	1.1 8	V V
Base-Emitter Voltage (I_C = 4A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	1.8	V

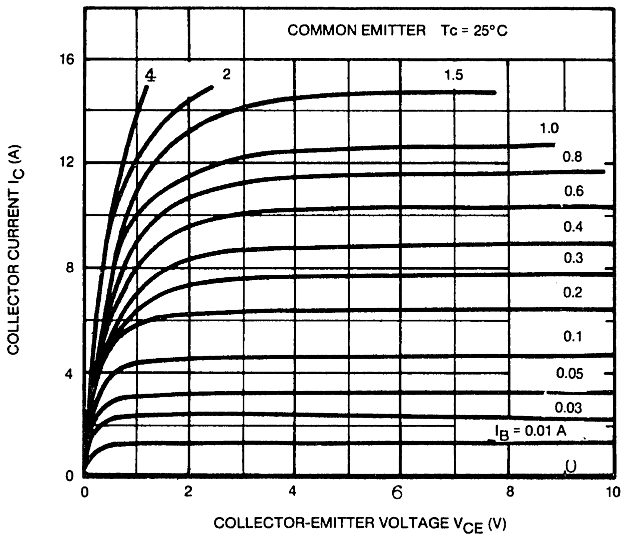


FIG. 1 $I_C - V_{CE}$

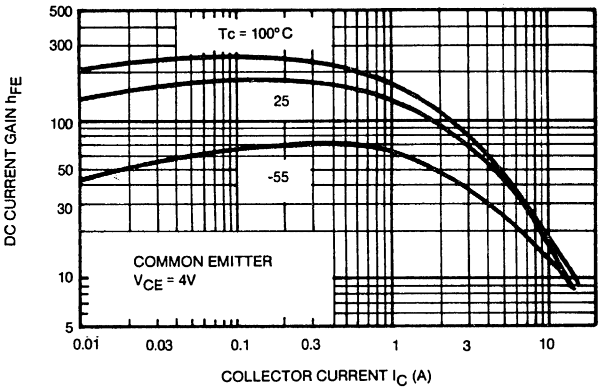


FIG. 2 $h_{FE} - I_C$

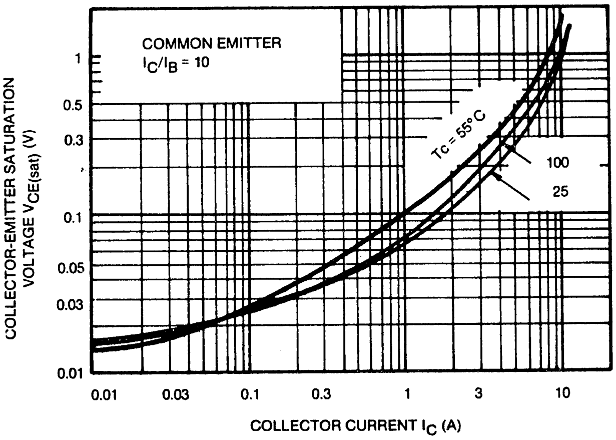


FIG. 3 $V_{CE(sat)} - I_C$

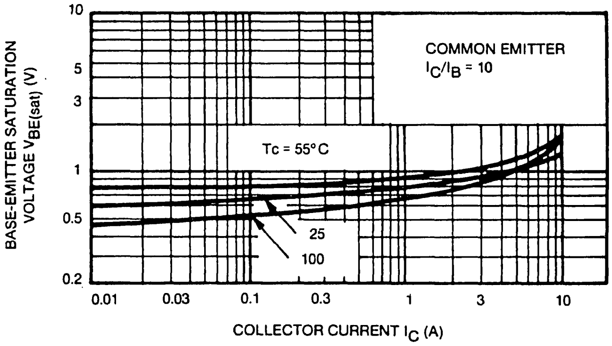


FIG. 4 $V_{BE(sat)}$ - I_C

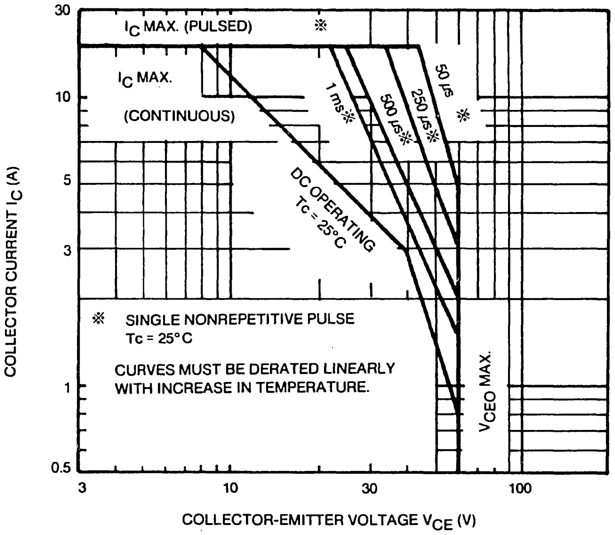


FIG. 5 SAFE OPERATING AREA

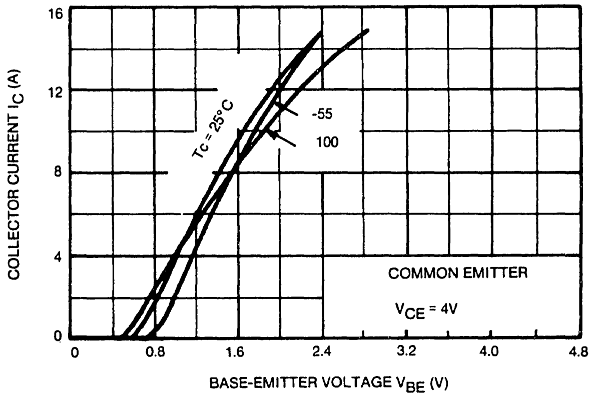


FIG. 6 I_C - V_{BE}

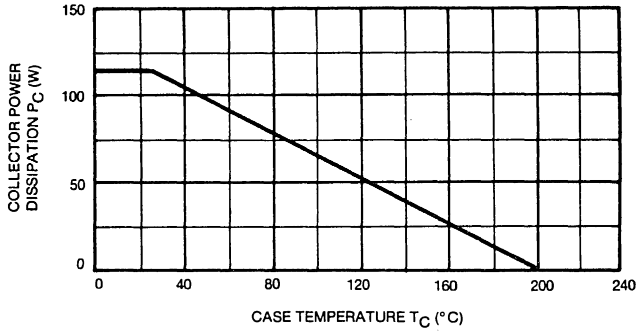


FIG. 7 P_C - T_C

HIGH POWER
NPN POWER TRANSISTORS

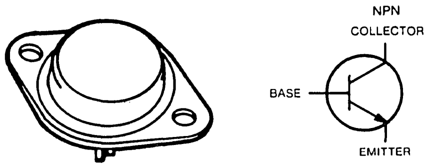
2N3771

40 VOLTS
30 AMP, 150 WATTS

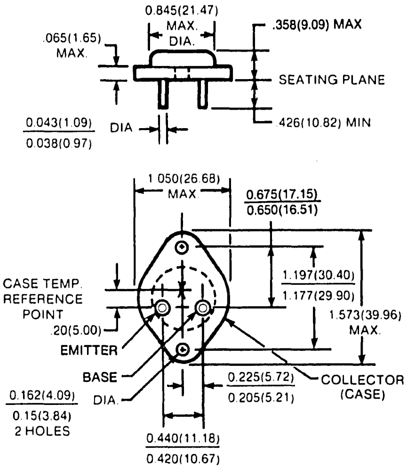
These high power NPN power transistors are designed for linear amplifiers, series pass regulators, and inductive switching applications.

Features:

- Forward biased second breakdown current capability
  $I_{S/b}$ = 3.75 Adc @ V_{CE} = 40 Vdc



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	2N3771	UNITS
Collector-Emitter Voltage	V_{CEO}	40	Volts
Collector-Base Voltage	V_{CBO}	50	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	30 30	A
Base Current — Continuous	I_B	7.5 15	A
Total Power Dissipation @ T_C = 25°C Derate above 25° C	P_D	150 0.855	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = .2A)	$V_{CEO(sus)}$	40	—	—	Volts
Collector-Emitter Sustaining Voltage (I_C = .2A, V_{EB} = -1.5V, R_{BE} = 100 Ohms)	V_{CEX}	50	—	—	Volts
Collector Cutoff Current (V_{CB} = 50V)	I_{CBO}	—	—	2	mA
Collector Cutoff Current (V_{CE} = 30V)	I_{CEO}	—	—	10	mA
Emitter Cutoff Current (V_{EB} = 5V)	—	—	—	5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3

on characteristics

DC Current Gain (I_C = 15A, V_{CE} = 4V) (I_C = 30A, V_{CE} = 4V)	h_{FE}	 15 5	 — —	 60 —	—
Collector-Emitter Saturation Voltage (I_C = 15A, I_B = 1.5A) (I_C = 30A, I_B = 6A)	$V_{CE(sat)}$	 — —	 — —	 2 4	 V V
Base-Emitter Voltage (I_C = 15A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	2.7	V

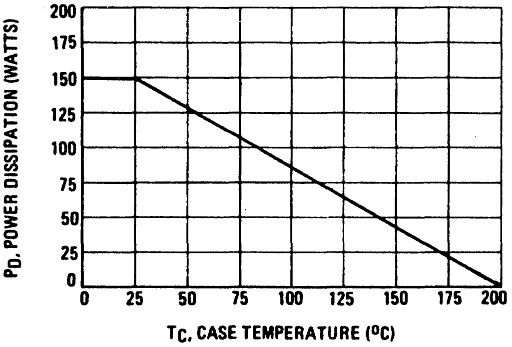


FIGURE 1 – POWER DERATING

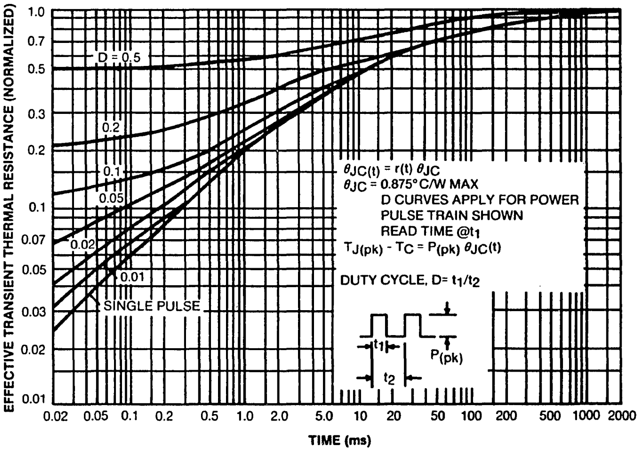


FIGURE 2- THERMAL RESPONSE

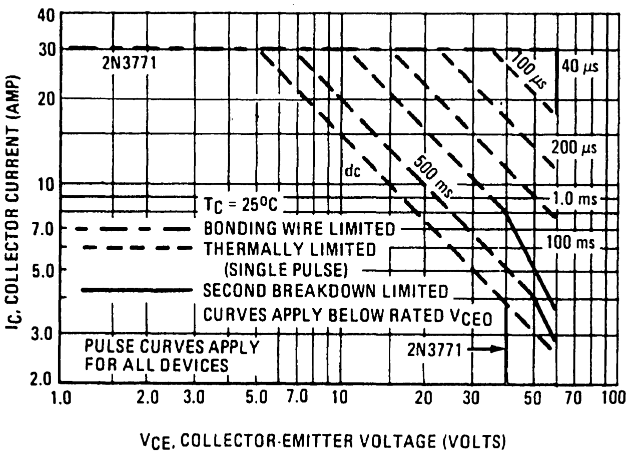
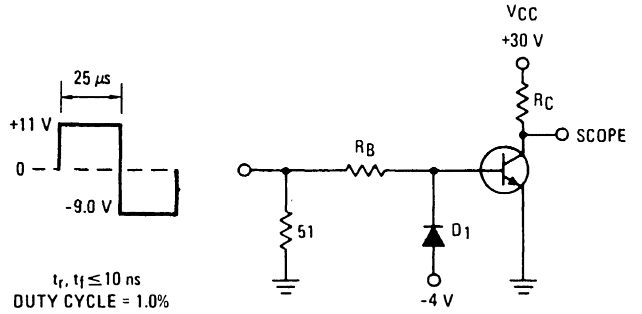


FIGURE 3 – ACTIVE-REGION SAFE OPERATING AREA



RB AND RC ARE VARIED TO OBTAIN DESIRED CURRENT LEVELS

D1 MUST BE FAST RECOVERY TYPE, eg:
MBD5300 USED ABOVE IB ≈100 mA
MSD6100 USED BELOW IB ≈100 mA

FIGURE 4 – SWITCHING TIME TEST CIRCUIT

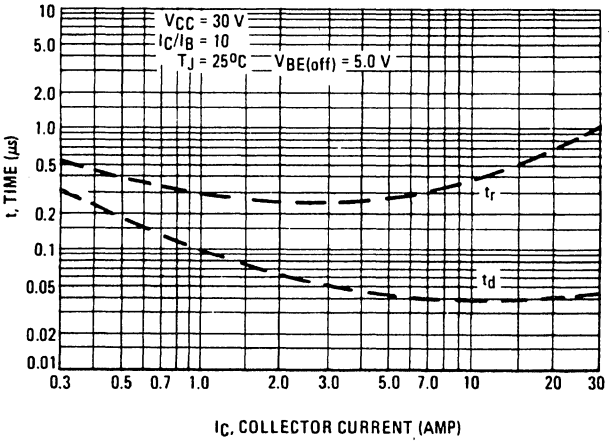


FIGURE 5 – TURN-ON TIME

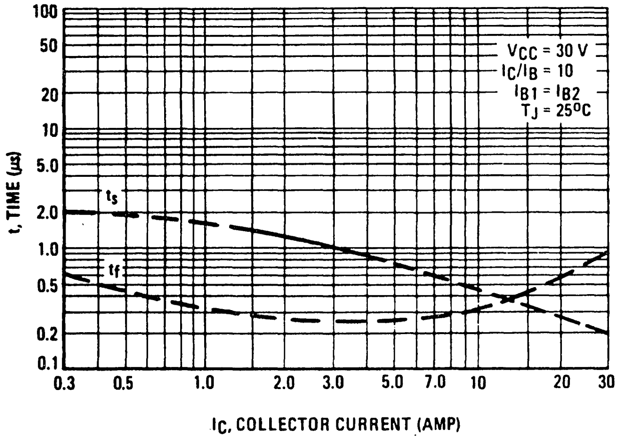


FIGURE 6 – TURN-OFF TIME

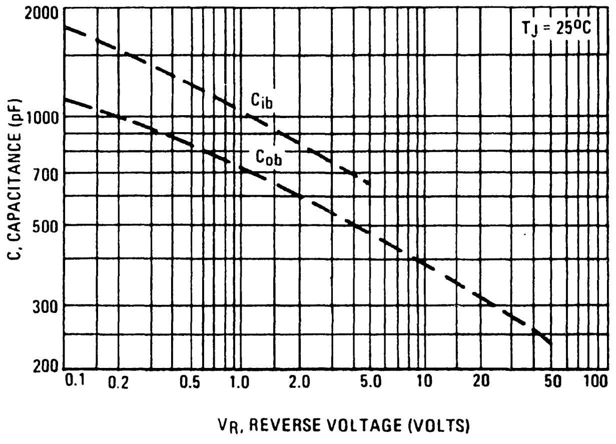


FIGURE 7 – CAPACITANCE

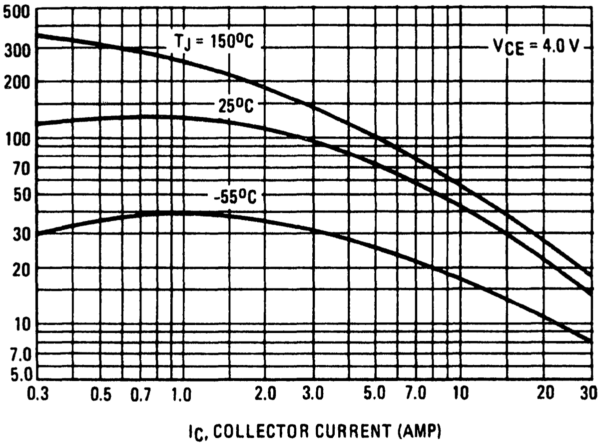


FIGURE 8 – DC CURRENT GAIN

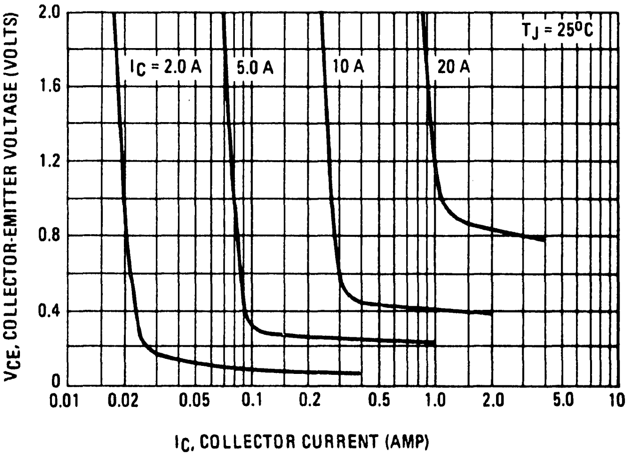


FIGURE 9 – COLLECTOR SATURATION REGION

HIGH POWER
NPN POWER TRANSISTORS

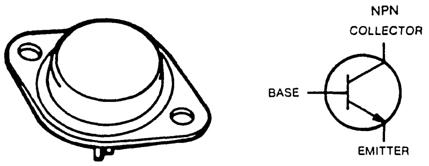
2N3772

60 VOLTS
20 AMP, 150 WATTS

These high power NPN power transistors are designed for linear amplifiers, series pass regulators, and inductive switching applications.

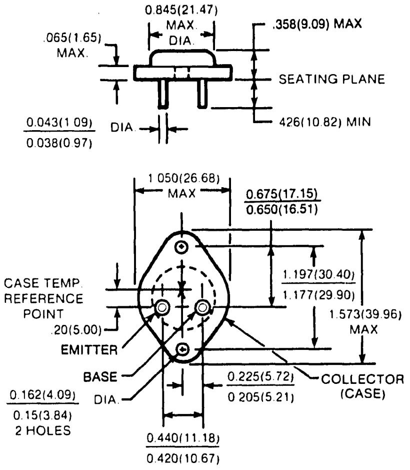
Features:

- Forward biased second breakdown current capability $I_{S/b} = 2.5\text{ A} @ V_{CE} = 60\text{ V}$



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	2N3772	UNITS
Collector-Emitter Voltage	V_{CEO}	60	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	7	Volts
Collector Current — Continuous Peak	I_C I_{CM}	20 30	A
Base Current — Continuous	I_B	5 15	A
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	150 0.855	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Sustaining Voltage ($I_C = .2A$)	$V_{CEO(sus)}$	60	—	—	Volts
Collector-Emitter Sustaining Voltage ($I_C = .2A$, $V_{EB(off)} = -1.5V$, $R_{BE} = 100$ Ohms)	V_{CEX}	80	—	—	Volts
Collector Cutoff Current ($V_{CB} = 100V$)	I_{CBO}	—	—	5	mA
Collector Cutoff Current ($V_{CE} = 50V$)	I_{CEO}	—	—	10	
Emitter Cutoff Current ($V_{EB} = 7V$)	I_{EBO}	—	—	5	mA
second breakdown					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3			
on characteristics					
DC Current Gain ($I_C = 10A$, $V_{CE} = 4V$) ($I_C = 20A$, $V_{CE} = 4V$)	h_{FE}	15 5	— —	60 —	—
Collector-Emitter Saturation Voltage ($I_C = 10A$, $I_B = 1.0A$) ($I_C = 20A$, $I_B = 4A$)	$V_{CE(sat)}$	— —	— —	1.4 4	V V
Base-Emitter Voltage ($I_C = 10A$, $V_{CE} = 4V$)	$V_{BE(on)}$	—	—	2.2	V

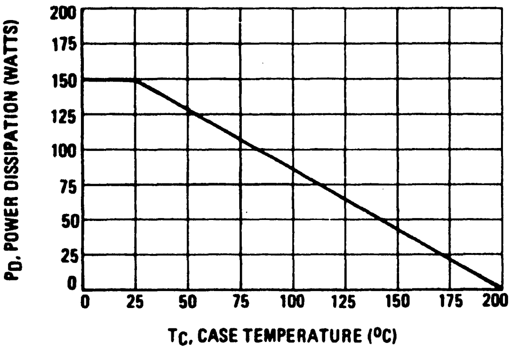


FIGURE 1 — POWER DERATING

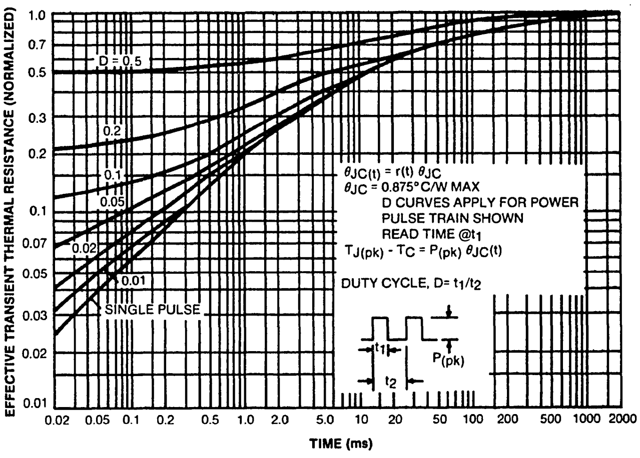


FIGURE 2- THERMAL RESPONSE

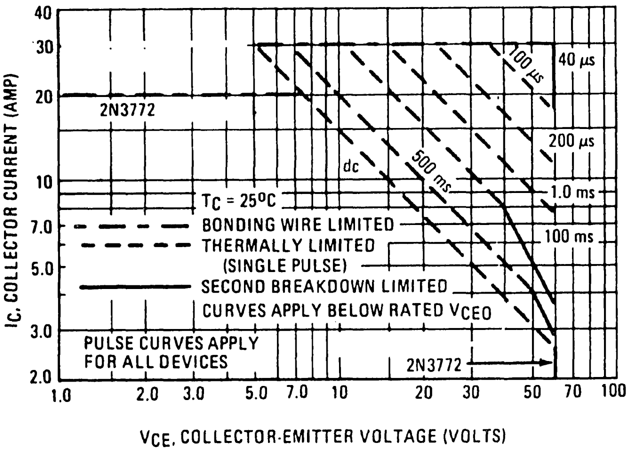
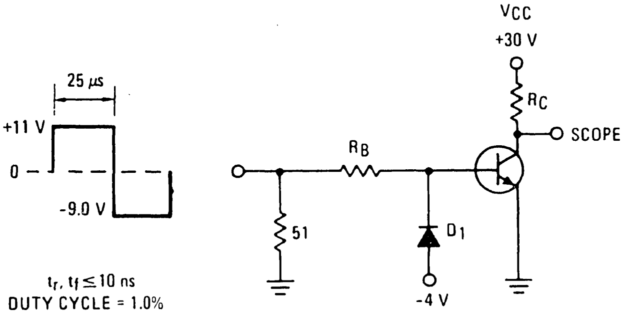


FIGURE 3 – ACTIVE-REGION SAFE OPERATING AREA



R_B AND R_C ARE VARIED TO OBTAIN DESIRED CURRENT LEVELS

D_1 MUST BE FAST RECOVERY TYPE, eg:

MBD5300 USED ABOVE $I_B \approx 100$ mA

MSD6100 USED BELOW $I_B \approx 100$ mA

FIGURE 4 – SWITCHING TIME TEST CIRCUIT

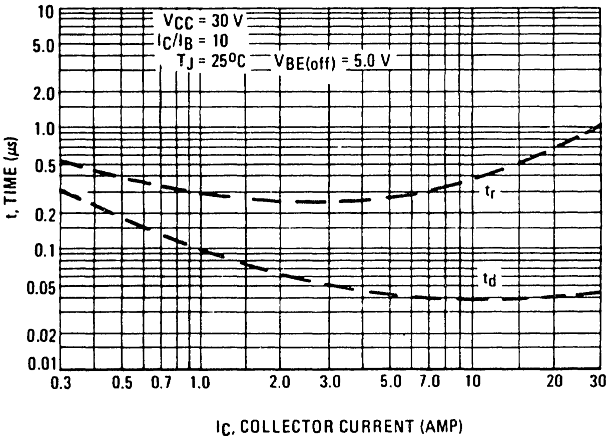


FIGURE 5 – TURN-ON TIME

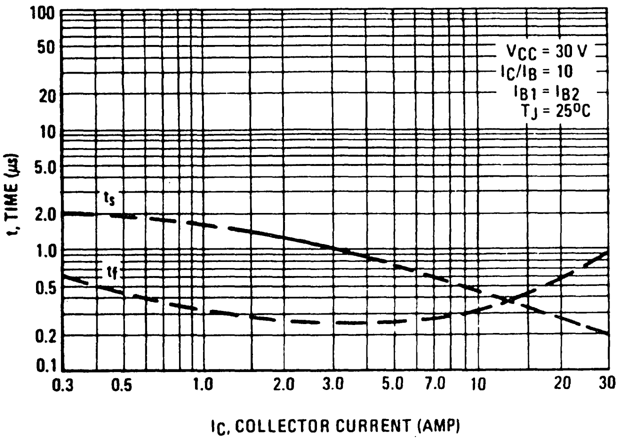


FIGURE 6 – TURN-OFF TIME

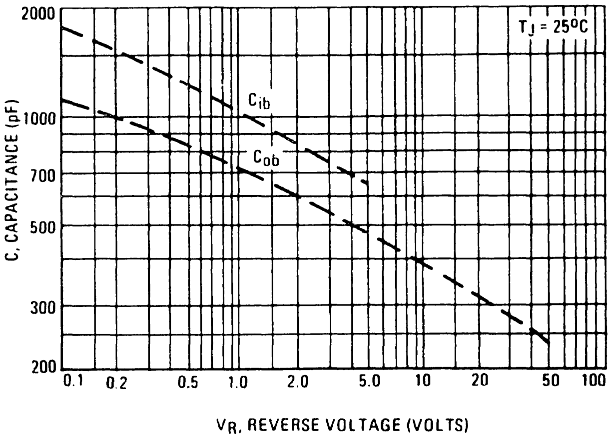


FIGURE 7 – CAPACITANCE

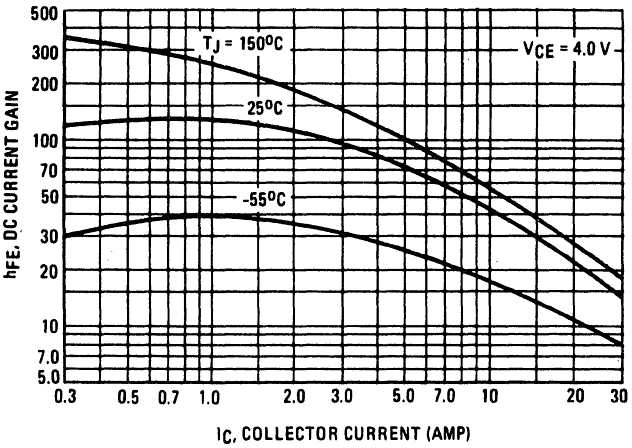


FIGURE 8 — DC CURRENT GAIN

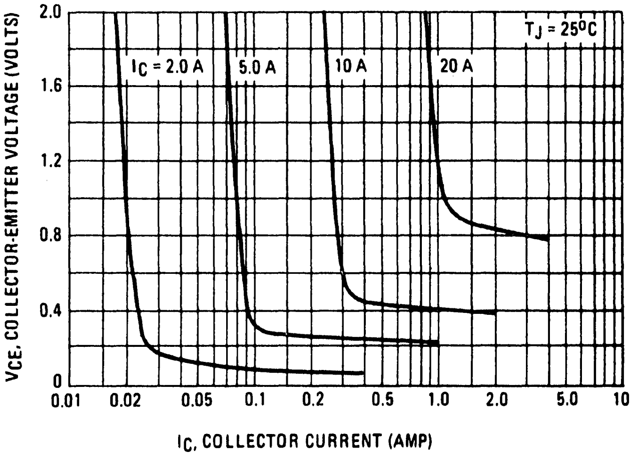


FIGURE 9 — COLLECTOR SATURATION REGION

NPN POWER TRANSISTORS

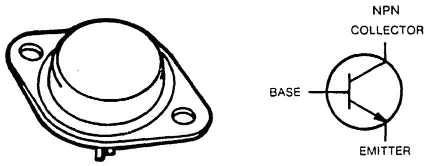
2N3773

140 VOLTS
16 AMP, 150 WATTS

The 2N3773 is a power transistor designed for high power audio, disk head positioners and other linear applications. The device can also be used in power switching circuits such as relay or solenoid drivers, dc to dc converters or inverters.

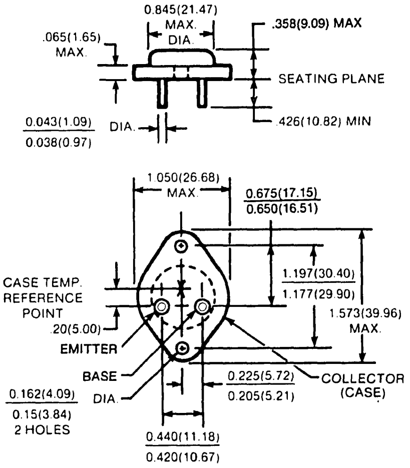
Features:

- High safe operating area: 150 W @ 100 V
- Completely characterized for linear operation
- High DC current gain and low saturation voltage
  h_{fe} = 15 (Min) @ 8 A, 4 V
  $V_{CE(sat)}$ = 1.4 V (Max) @ I_C = 8 A, I_B = 0.8 A
- For low distortion complementary designs



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	2N3773	UNITS
Collector-Emitter Voltage	V_{CEO}	140	Volts
Collector-Base Voltage	V_{CBO}	160	Volts
Emitter Base Voltage	V_{EBO}	7	Volts
Collector Current — Continuous Peak	I_C I_{CM}	16 30	A
Base Current — Continuous Peak	I_B	4 15	A
Total Power Dissipation @ T_C = 25°C Derate above 25° C	P_D	150 0.855	Watts W/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	° C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	° C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	° C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = .2A)	$V_{CEO(sus)}$	140	—	—	Volts
Collector-Emitter Sustaining Voltage (I_C = .1mA, $V_{EB(off)}$ = 1.5V, R_{BE} = 100 Ohms)	V_{CEX}	160	—	—	Volts
Collector Cutoff Current (V_{CE} = 120V)	I_{CEO}	—	—	10	mA
Collector Cutoff Current (V_{CE} = 140V, V_{BE} = -1.5V) (V_{CE} = 140V, V_{BE} = -1.5V, T_C = 150° C)	I_{CEX}	— —	— —	2 10	mA
Emitter Cutoff Current (V_{EB} = 7V)	I_{EBO}	—	—	5	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4

on characteristics

DC Current Gain (I_C = 8V, V_{CE} = 4V) (I_C = 16A, V_{CE} = 4V)	h_{FE}	15 5	— —	60 —	—
Collector-Emitter Saturation Voltage (I_C = 8A, I_B = 800mA) (I_C = 16A, I_B = 3.2A)	$V_{CE(sat)}$	— —	— —	1.4 4	V V
Base-Emitter Voltage (I_C = 8A, V_{CE} = 4V)	$V_{BE(on)}$	—	—	2.2	V

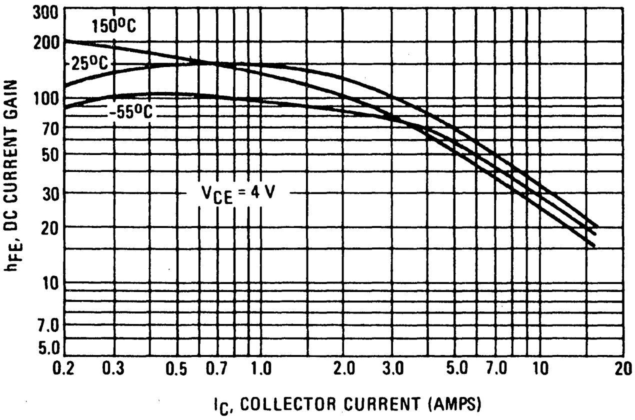


FIGURE 1 – DC CURRENT GAIN

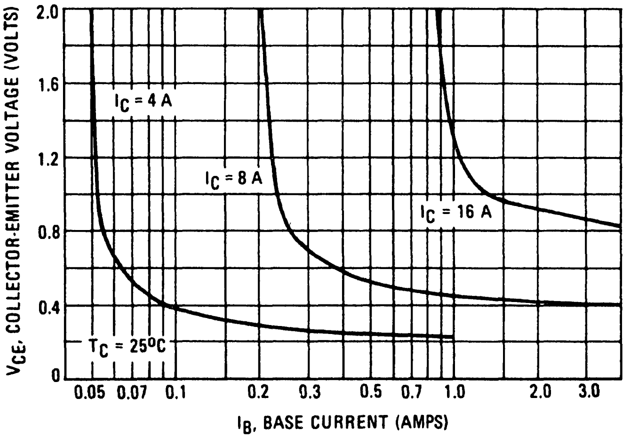


FIGURE 2 – COLLECTOR SATURATION REGION

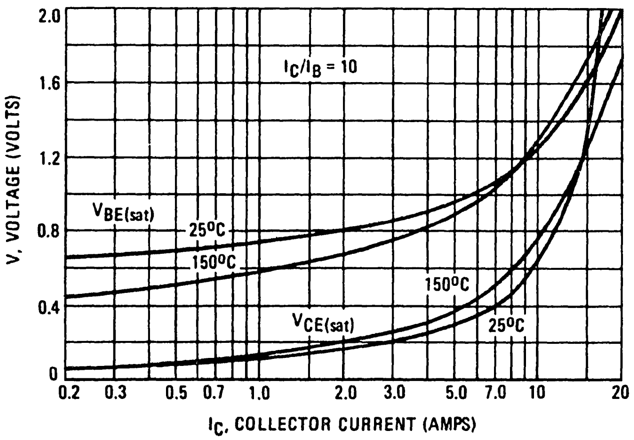


FIGURE 3 – "ON" VOLTAGE

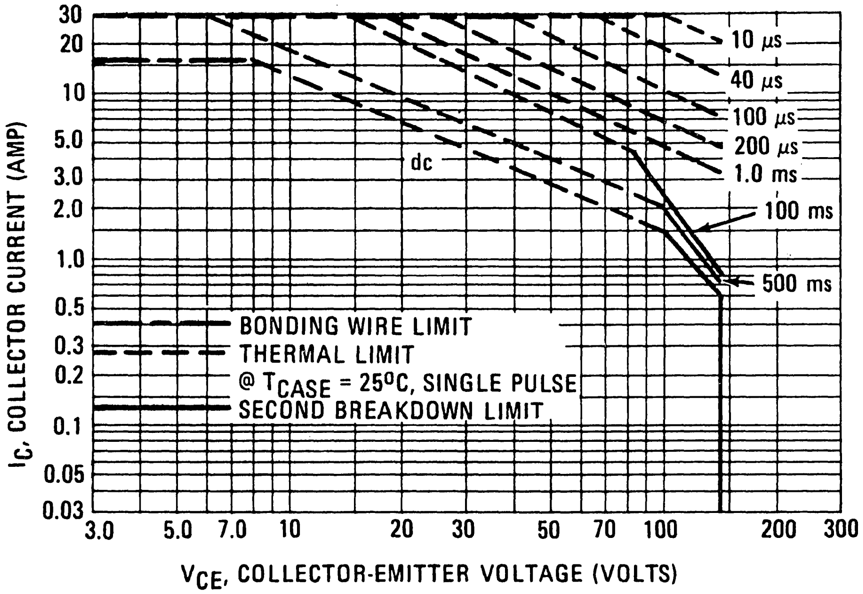


FIGURE 4 – FORWARD BIAS SAFE OPERATING AREA

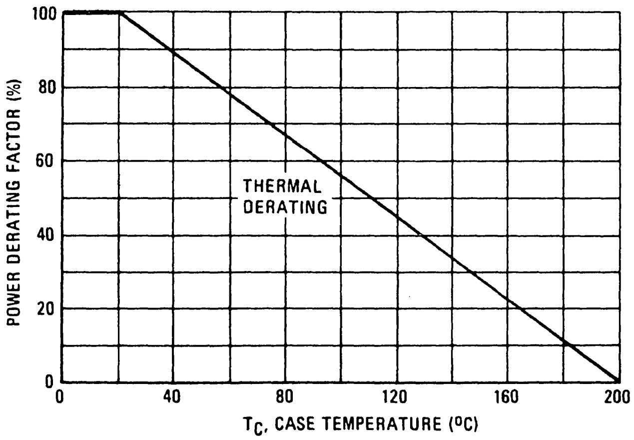


FIGURE 5 – POWER DERATING

NPN POWER TRANSISTORS

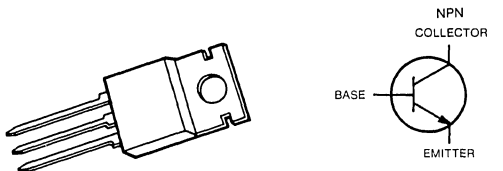
2N6292

70 VOLTS
7 AMP, 40 WATTS

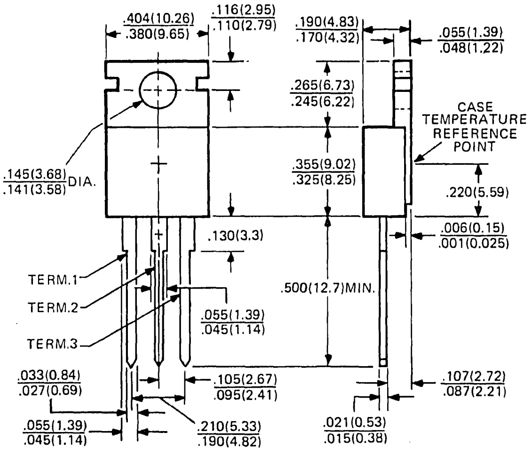
These general-purpose medium-power transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

Features:

- Low saturation voltages
- Thermal-cycling ratings
- Maximum safe-area-of-operation curves specified for dc operation.



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings ($T_A = 25°C$) (unless otherwise specified)

RATING	SYMBOL	2N6292	UNITS
Collector-Emitter Voltage	V_{CEO}	70	Volts
Collector-Base Voltage	V_{CBO}	80	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous Peak	I_C I_{CM}	7	A
Base Current — Continuous	I_B	3	A
Total Power Dissipation @ $T_A = 25°C$ @ $T_C = 25°C$	P_D	1.8 40	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	70	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.125	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	235	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage (I_C = .1mA)	$V_{CEO(sus)}$	70	—	—	Volts
Collector-Emitter Sustaining Voltage (I_C = .1mA, I_B = 1.5V)	$V_{CER(sus)}$	80	—	—	Volts
Collector Cutoff Current (V_{CE} = 60V)	I_{CEO}	—	—	1	mA
Collector Cutoff Current (V_{CE} = 75V, V_{EB} = 1.5V)	I_{CEX}	—	—	0.1	mA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	—	1	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 2

on characteristics

DC Current Gain (I_C = 2A, V_{CE} = 4V) (I_C = 7A, V_{CE} = 4V)	h_{FE}	30 2.3	— —	150 —	—
Collector-Emitter Saturation Voltage (I_C = 2.5A, I_B = .25A) (I_C = 7A, I_B = 3A)	$V_{CE(sat)}$	— —	— —	1 3.5	V V
Base-Emitter Voltage (I_C = 2A, V_{CE} = 4V) (I_C = 7A, V_{CE} = 4V)	$V_{BE(on)}$	— —	— —	1.5 3	V

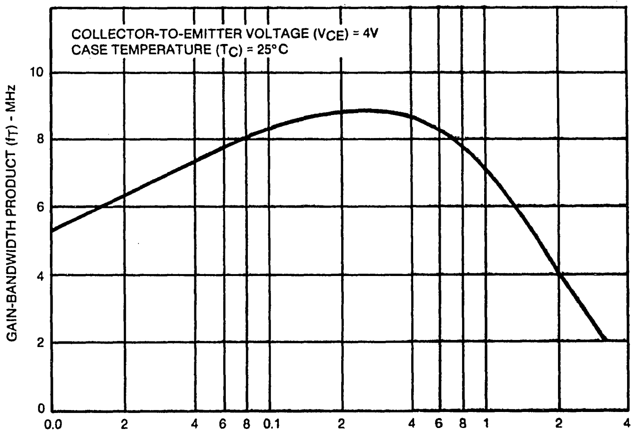


FIG. 1 TYPICAL GAIN-BANDWIDTH

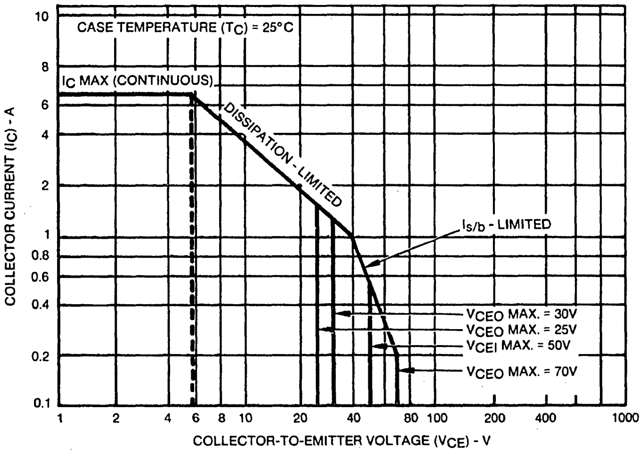


FIG. 2 MAXIMUM OPERATING AREA

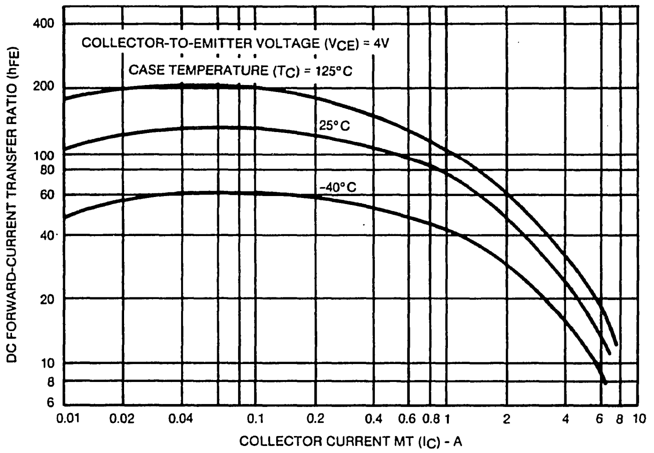


FIG. 3 TYPICAL CHARACTERISTICS

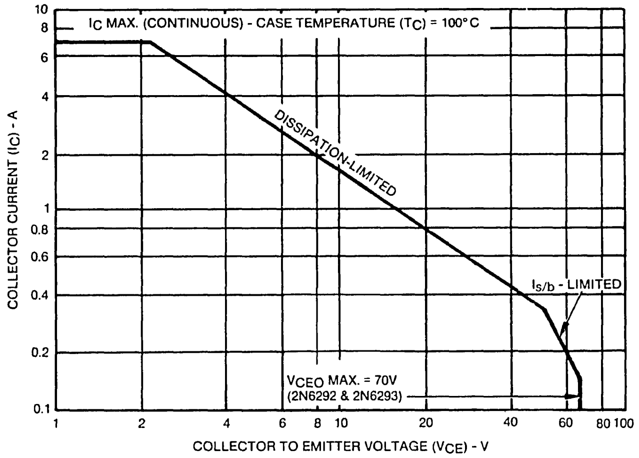


FIG. 4 MAXIMUM OPERATING AREA

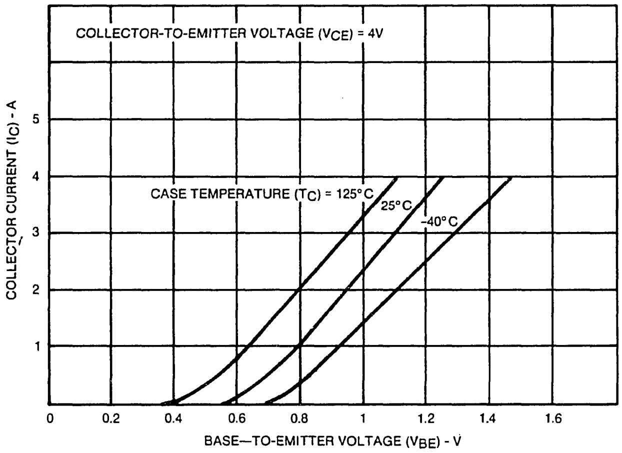


FIG. 5 TYPICAL TRANSFER CHARACTERISTICS

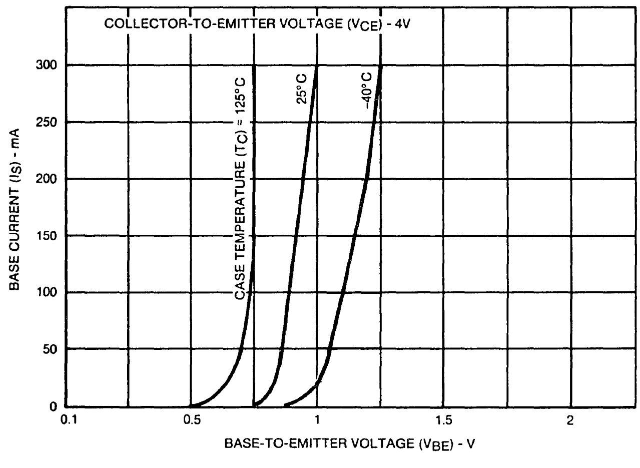


FIG. 6 TYPICAL INPUT CHARACTERISTICS

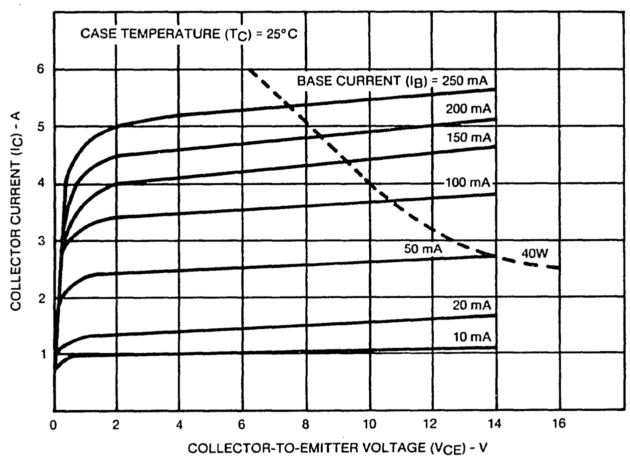


FIG. 7 TYPICAL OUTPUT CHARACTERISTICS

NPN POWER TRANSISTORS

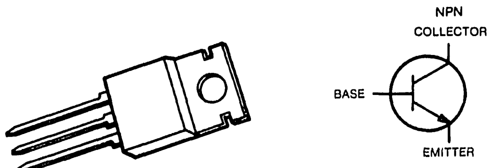
2N6487

60 VOLTS
15 AMP, 75 WATTS

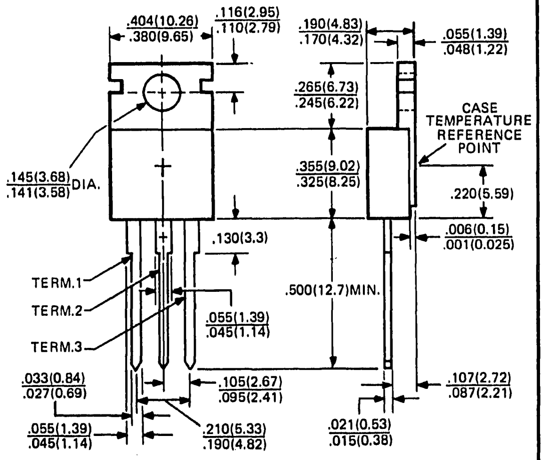
These are designed for use in general-purpose amplifier and switching applications.

Features:

- DC Current Gain specified to 15 Amperes
  h_{FE} = 20-150 @ I_C = 5.0 A
  = 5.0 (Min) @ I_C = 15 A
- Collector-Emitter Sustaining Voltage — $V_{CEO(sus)}$ = 60 V (Min)
- TO-220AB Compact Package



CASE STYLE TO-220AB
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	2N6487	UNITS
Collector-Emitter Voltage	V_{CEO}	60	Volts
Collector-Base Voltage	V_{CBO}	70	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	15	A
Base Current — Continuous	I_B	5	A
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	75 0.6	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	70	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.67	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Sustaining Voltage (I_C = 200mA, I_B = 0)	$V_{CEO(sus)}$	60	—	—	Volts
Collector-Emitter Sustaining Voltage (I_C = 200mA, V_{BE} = -1.5V)	V_{CEX}	70	—	—	Volts
Collector Cutoff Current (V_{CE} = 30V, I_B = 0)	I_{CEO}	—	—	1	mA
Collector Cutoff Current (V_{CE} = 60V, $V_{EB(OFF)}$ = -1.5V, T_C = 150° C)	I_{CEX}	—	—	5	mA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	1	mA
second breakdown					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5			
on characteristics					
DC Current Gain (I_C = 5A, V_{CE} = 4V) (I_C = 15A, V_{CE} = 4V)	h_{FE}	20 5	— —	150 —	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = .5A) (I_C = 15A, I_B = 5A)	$V_{CE(sat)}$	— —	— —	1.3 3.5	V V
Base-Emitter Voltage (I_C = 5A, V_{CE} = 4V) (I_C = 15A, V_{CE} = 4V)	$V_{BE(on)}$	— —	— —	1.3 3.5	V

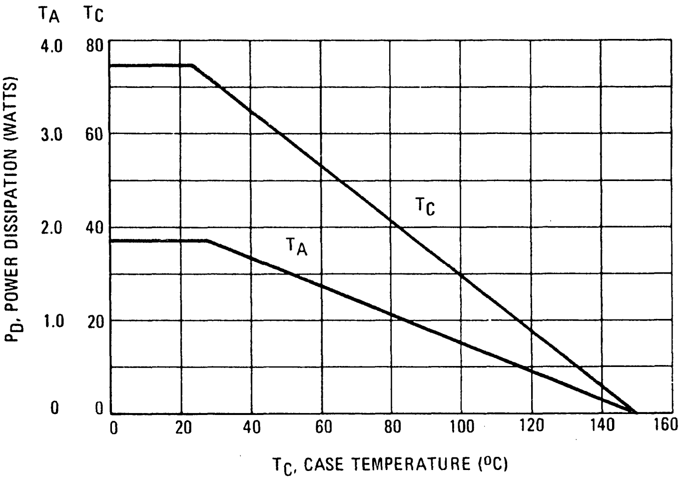
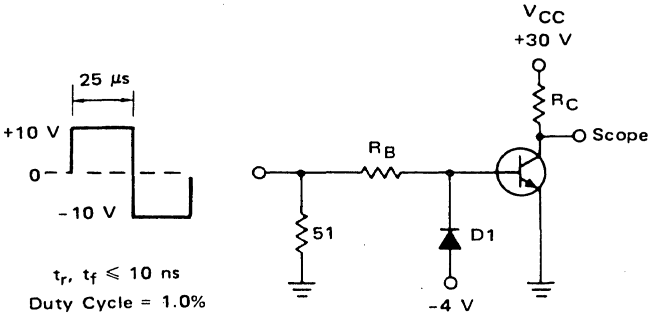


FIGURE 1 – POWER DERATING



t_r, t_f ≤ 10 ns
Duty Cycle = 1.0%

R_B and R_C varied to obtain desired current levels.
For PNP reverse all polarities.

D1 must be fast recovery type, e.g.;
MBD5300 used above I_B ≈ 100 mA
MSD6100 used below I_B ≈ 100 mA

FIGURE 2 – SWITCHING TIME TEST CIRCUIT

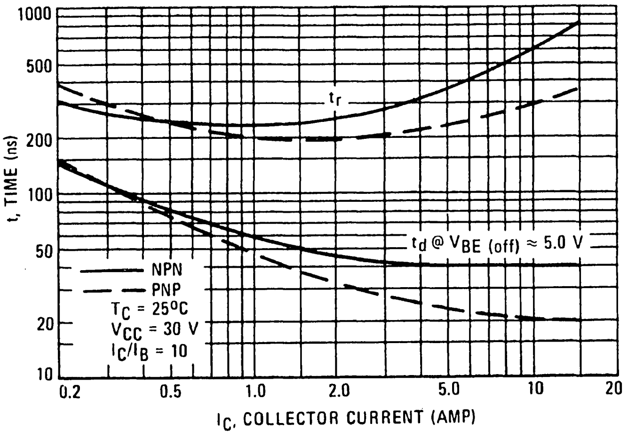


FIGURE 3 — TURN-ON TIME

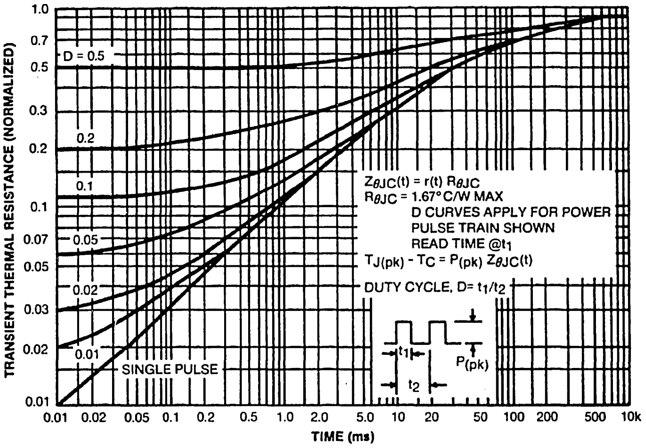


FIGURE 4 - THERMAL RESPONSE

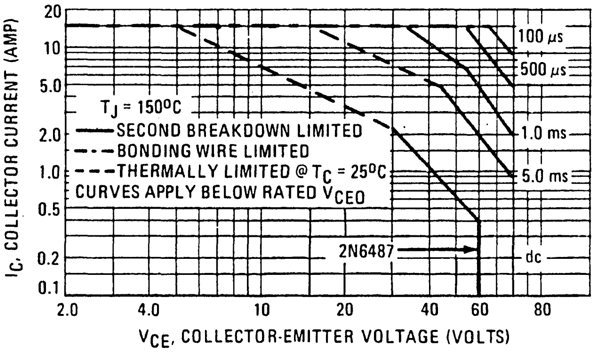


FIGURE 5 — ACTIVE-REGION SAFE OPERATING AREA

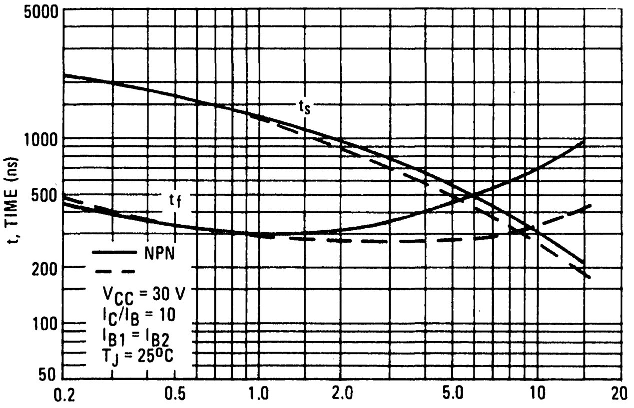


FIGURE 6 – TURN-OFF TIME

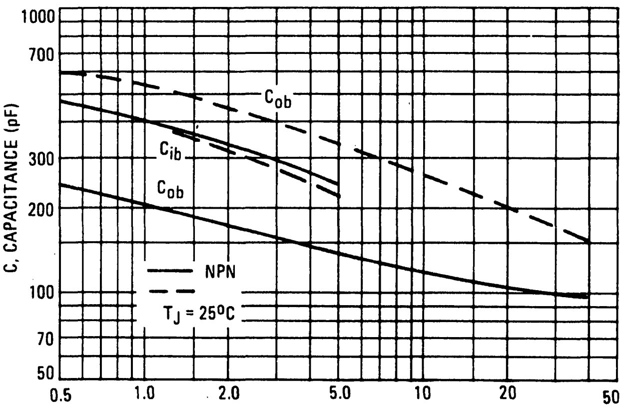


FIGURE 7 – CAPACITANCES

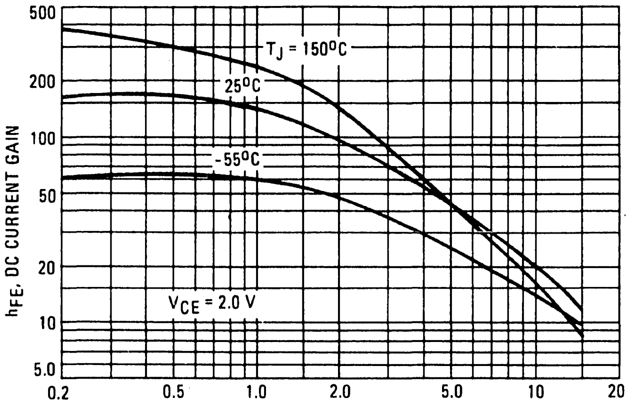


FIGURE 8 – DC CURRENT GAIN

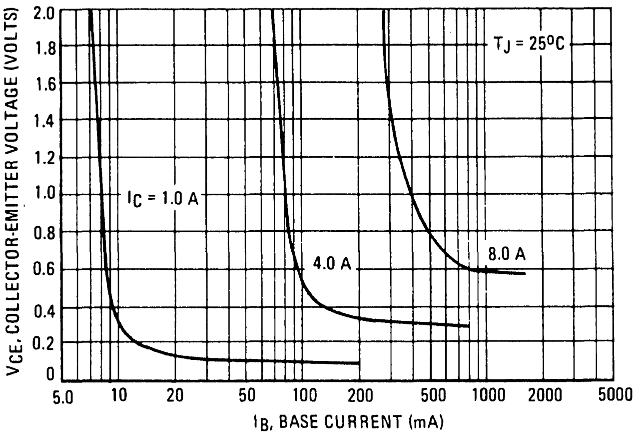


FIGURE 9 – COLLECTOR SATURATION REGION

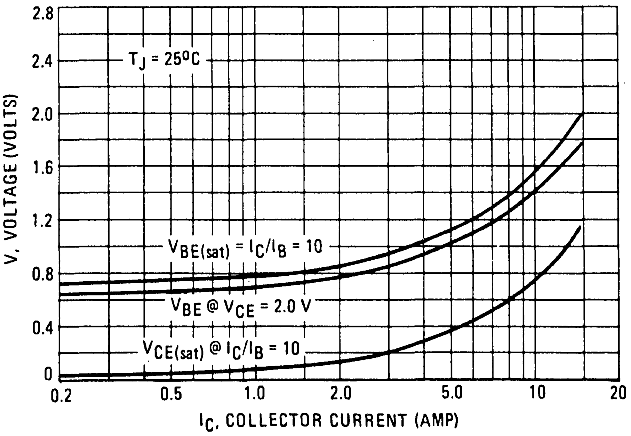


FIGURE 10 – "ON" VOLTAGES

NPN POWER TRANSISTORS

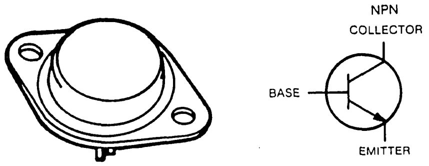
2N6547

400 VOLTS
15 AMP, 175 WATTS

The 2N6547 transistor is designed for high-voltage, high-speed power switching in inductive circuits where fall time is critical. It is particularly suited for 115 and 220 volt line operated switch-mode applications such as: switching regulators, PWM inverters and motor controls, solenoid and relay drivers, and deflection circuits.

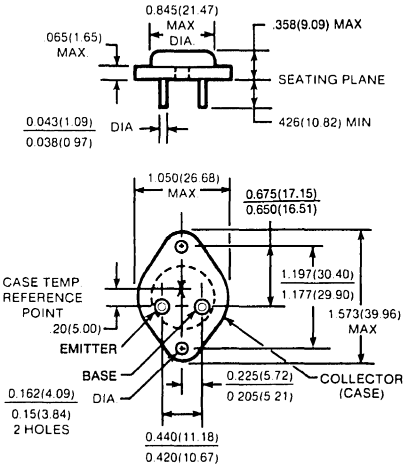
Features:

- High temperature performance specified
- Reversed biased SOA with inductive loads
- Switching times with inductive loads
- Saturation Voltages
- Leakage currents



CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	2N6547	UNITS
Collector-Emitter Voltage	V_{CEO}	400	Volts
Collector-Emitter Voltage	V_{CEX}	450	Volts
Emitter Base Voltage	V_{EBO}	9.0	Volts
Collector Current — Continuous Peak	I_C I_{CM}	15 30	A
Base Current — Continuous Peak	I_B I_{BM}	10 20	A
Total Power Dissipation @ T_C = 100°C @ T_C = 25°C Derate above 25° C	P_D	100 175 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	275	°C

electrical characteristics ($T_C = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage ($I_C = 100mA$)	$V_{CEO(sus)}$	400	—	—	Volts
Collector-Emitter Sustaining Voltage ($I_C = 8.0mA$, V_{clamp} = Rated V_{CEX}, $T_C = 100°C$) ($I_C = 15A$, V_{clamp} = Rated V_{CEO} - 100V, $T_C = 100°C$)	V_{CEX}	450 300	— —	— —	Volts Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)} = -1.5V$) (V_{CEV} = Rated Value, $V_{BE(off)} = -1.5V$, $T_C = 100°C$)	I_{CEV}	— —	— —	1.0 4.0	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, $R_{BE} = 50\Omega$, $T_C = 100°C$)	I_{CER}	—	—	5.0	mA
Emitter Cutoff Current ($V_{EB} = 9.0V$)	I_{EBO}	—	—	1.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 7
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 8

on characteristics

DC Current Gain ($I_C = 5A$, $V_{CE} = 2V$) ($I_C = 10A$, $V_{CE} = 2V$)	h_{FE}	12 6	— —	60 30	—
Collector-Emitter Saturation Voltage ($I_C = 10A$, $I_B = 2A$) ($I_C = 15A$, $I_B = 3A$) ($I_C = 10A$, $I_B = 2A$, $T_C = 100°C$)	$V_{CE(sat)}$	— — —	— — —	1.5 5.0 2.5	V
Base-Emitter Saturation Voltage ($I_C = 10A$, $I_B = 2.0A$) ($I_C = 10A$, $I_B = 2.0A$, $T_C = 100°C$)	$V_{BE(sat)}$	— —	— —	1.6 1.6	V

switching characteristics

Resistive Load						
Delay Time	$V_{CC} = 250V$, $I_C = 10A$	t_d	—	—	.05	μs
Rise Time	$I_{B1} = I_{B2} = 2A$, $t_p = 100\mu s$	t_r	—	—	1.0	
Storage Time	Duty Cycle < 2.0%	t_s	—	—	4.0	
Fall Time		t_f	—	—	0.7	

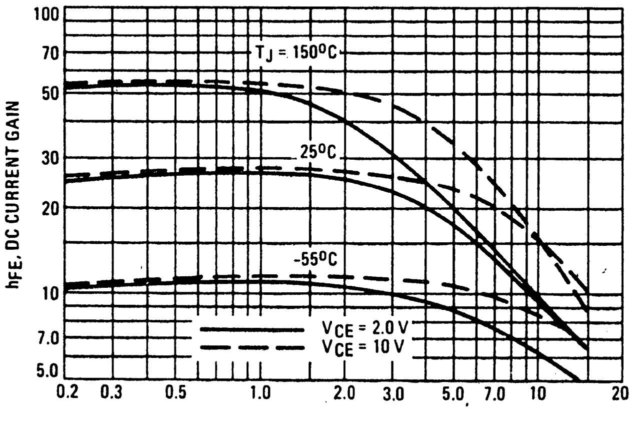


FIGURE 1 – DC CURRENT GAIN

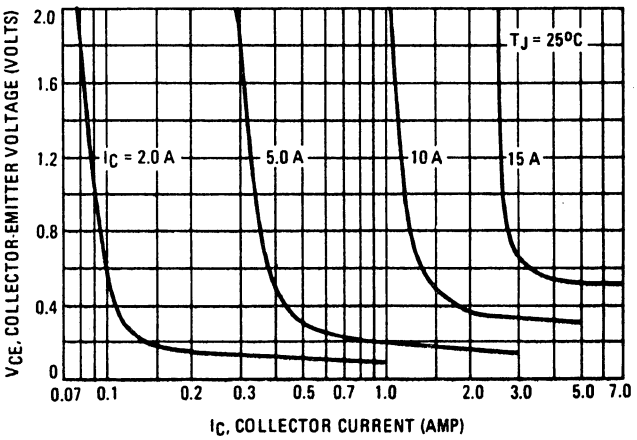


FIGURE 2 – COLLECTOR SATURATION REGION

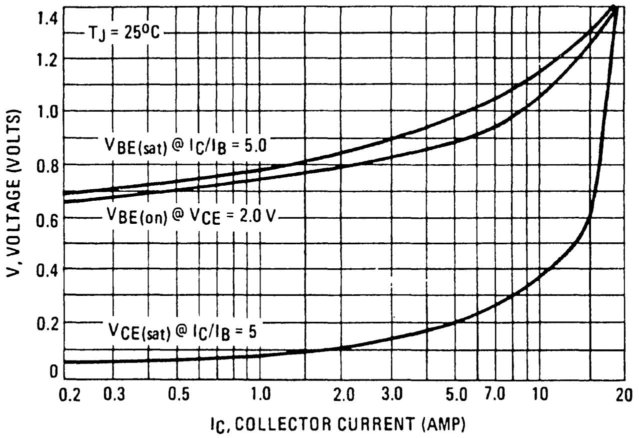


FIGURE 3 – "ON" VOLTAGE

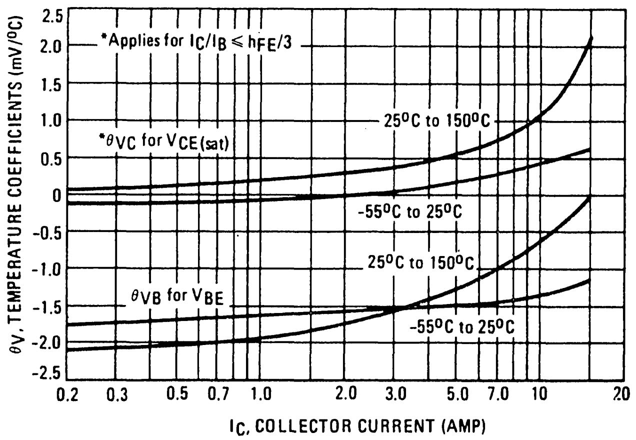


FIGURE 4 – TEMPERATURE COEFFICIENTS

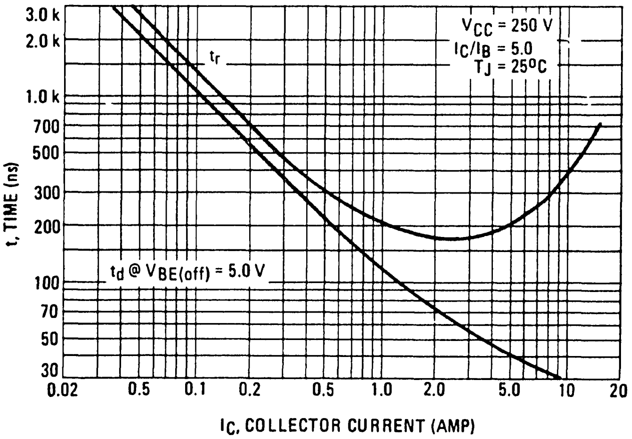


FIGURE 5 – TURN-ON TIME

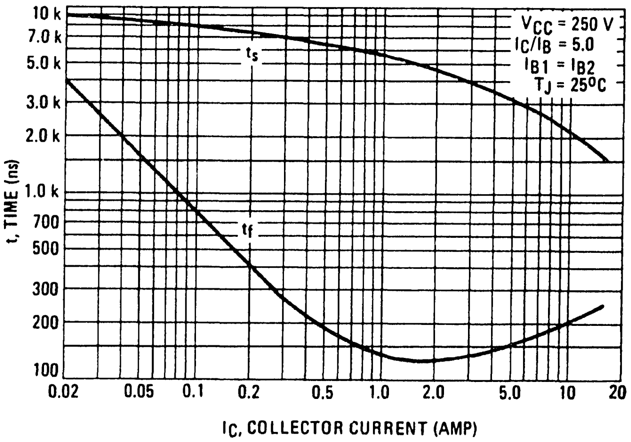


FIGURE 6 – TURN-OFF TIME

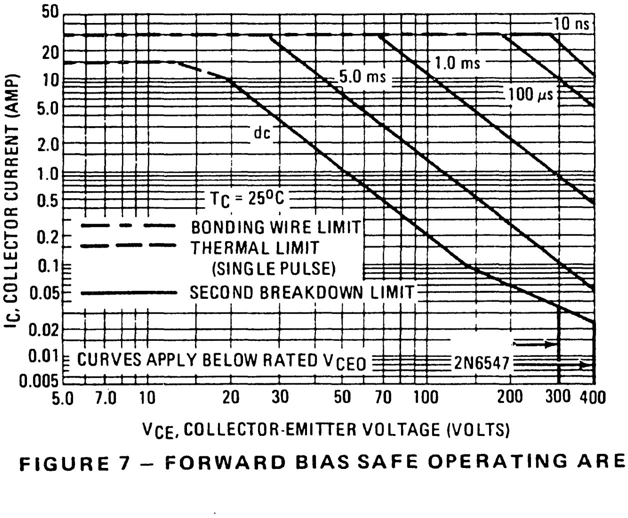


FIGURE 7 – FORWARD BIAS SAFE OPERATING AREA

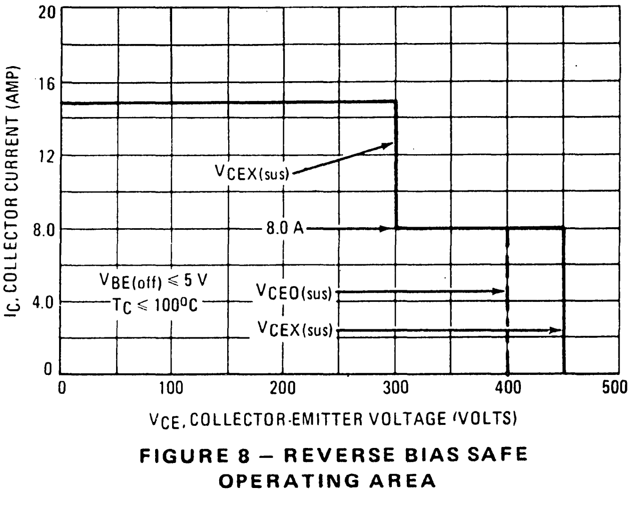


FIGURE 8 – REVERSE BIAS SAFE OPERATING AREA

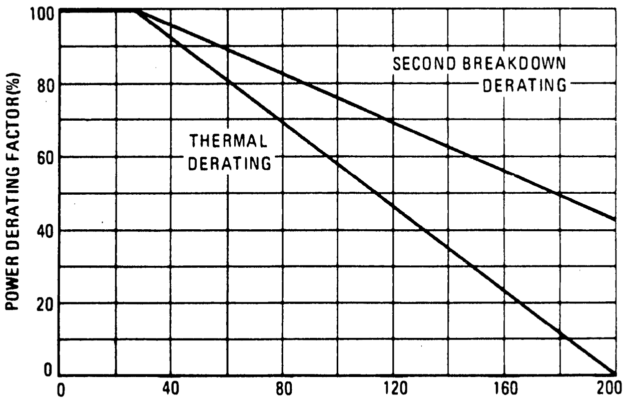


FIGURE 9 – POWER DERATING

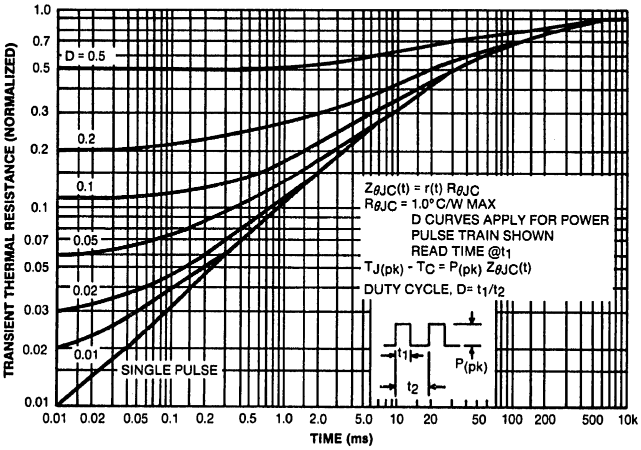


FIGURE 10 - THERMAL RESPONSE

HIGH VOLTAGE/HIGH SPEED
NPN POWER TRANSISTORS
GE EQUIVALENT D64VS3, 4, 5

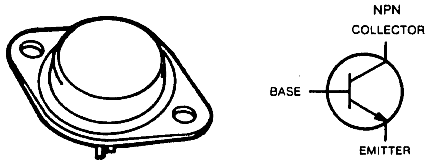
2N6676,77,78

300-400 VOLTS
15 AMP, 175 WATTS

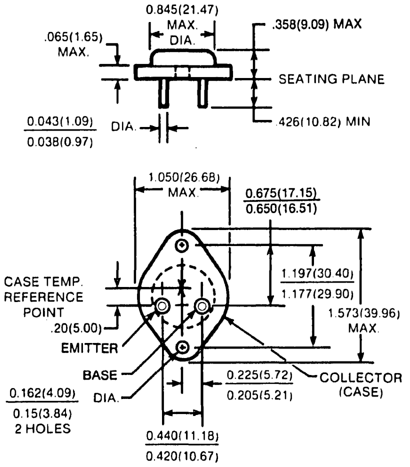
The 2N6676, 2N6677 and 2N6678 series of NPN power transistors is designed for use in power switching applications requiring high-voltage capability, fast switching speeds and low-saturation voltages. These devices are optimized to provide a unique combination of ultra-low switching losses and high safe-operating area (SOA), ideally suited for off-line Switching Power Supplies, converter circuits and pulse width modulated regulators.

Features:

- 100°C maximum limits specified for:
  - Switching times
  - Saturation voltages
  - Leakage currents
- RBSOA (V_{CEX} = 350 to 450V) at rated I_C continuous.
- Very fast turn-off: $t_f < 100$ nsec (typ.) @ 15A — Inductive Load



CASE STYLE TO-204AA (TO-3)
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



maximum ratings

RATING	SYMBOL	2N6676	2N6677	2N6678	UNITS
Collector-Emitter Voltage	V_{CEO}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEX}	350	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	450	550	650	Volts
Emitter Base Voltage	V_{EBO}	8	8	8	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	15 20	15 20	15 20	A
Base Current — Continuous Peak(1)	I_B I_{BM}	5 10	5 10	5 10	A
Emitter Current — Continuous Peak(1)	I_E I_{EM}	20 30	20 30	20 30	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	178 111 1.0	178 111 1.0	178 111 1.0	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	-65 to +200	-65 to +200	°C

thermal characteristics

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	235	235	235	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage(1) (I_C = 100mA, I_B = 0)	2N6676 2N6677 2N6678	$V_{CEO(sus)}$	300 350 400	— — —	Volts
Collector-Emitter Voltage (I_C = 15A, I_{B1} = 3A, I_{B2} = 3.0A) ($V_{BE(OFF)}$ = -6V, L = 50 μh)	2N6676 2N6677 2N6678	V_{CEX}	350 400 450	— — —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = -1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = -1.5V, T_C = 100° C)		I_{CEV}	— —	0.1 1.0	mA
Emitter Cutoff Current (V_{EB} = 8V, I_C = 0)		I_{EBO}	—	2.0	mA

second breakdown

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 13
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 14

on characteristics

DC Current Gain (I_C = 10A, V_{CE} = 2V) (I_C = 15A, V_{CE} = 3V)	h_{FE}	10 8	— —	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 2.0A) (I_C = 15A, I_B = 3.0A) (I_C = 15A, I_B = 3.0A, T_C = 100°C)	$V_{CE(SAT)}$	— — —	0.7 1.5 2.0	Volts
Base-Emitter Saturation Voltage (I_C = 15A, I_B = 3.0A) (I_C = 15A, I_B = 3.0A, T_C = 100°C)	$V_{BE(SAT)}$	— —	1.5 1.5	Volts

dynamic characteristics

Current Gain — Bandwidth Product (I_C = 1.0A, V_{CE} = 10V, f_{test} = 1.0 MHz)	f_T	15	50	MHz
Small Signal Current Gain (I_C = 2.0A, V_{CE} = 10V, f_{test} = 5 MHz)	h_{FE}	3	10	—
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{OB}	150	500	pF

switching characteristics

			MAXIMUM		
Resistive Load (See Figure 17 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 200V, I_C = 15A	t_d	0.1	0.2	μs
Rise Time	I_{B1} = I_{B2} = 3A, V_{BE} = -6V	t_r	0.6	1.0	μsec
Storage Time	t_p = 20 μsec	t_s	2.5	4.0	μsec
Fall Time		t_f	0.5	1.0	μsec
Inductive Load, Clamped (See Figure 17 for Test Circuit)					
Storage Time	V_{CC} = 200V, I_C = 15A	t_s	3.0	4.5	μs
Fall Time	V_{CLAMP} = Rated V_{CEX}	t_f	0.3	0.6	μsec
Switch Time	I_{B2} = 3.0A, $V_{BE(OFF)}$ = -6V L = 50μh, $R_C \leq 13.5\Omega$ t_p = 20 μsec	t_c	0.5	0.8	μsec

(1) Pulse Duration = 300μs, Duty Factor ≤2%. Do not measure on a curve tracer.

* In accordance with JEDEC Registered Data.

TYPICAL DC CHARACTERISTICS

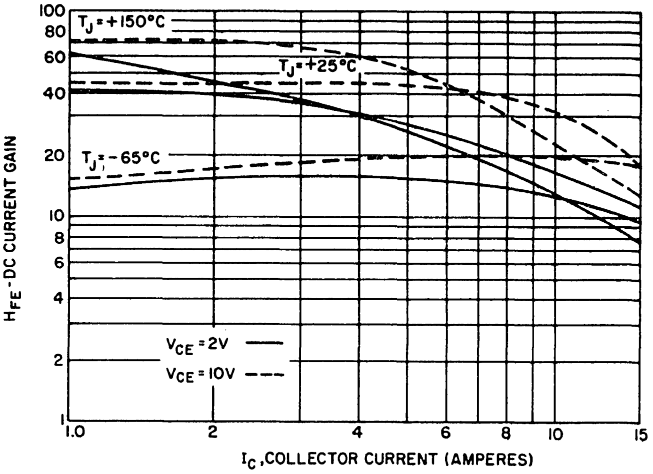


FIGURE 1. DC CURRENT GAIN

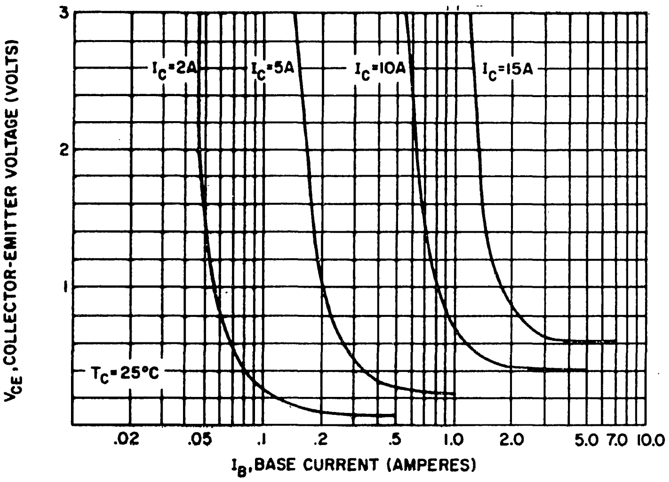


FIGURE 2. COLLECTOR SATURATION REGION

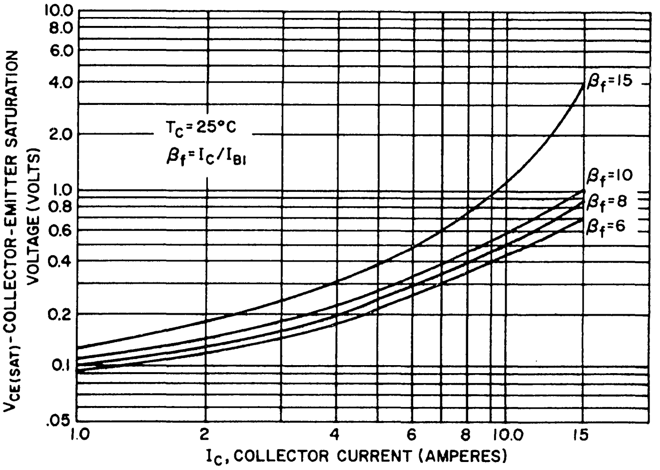


FIGURE 3. $V_{CE(sat)}$ vs I_C, $T_C = 25°C$

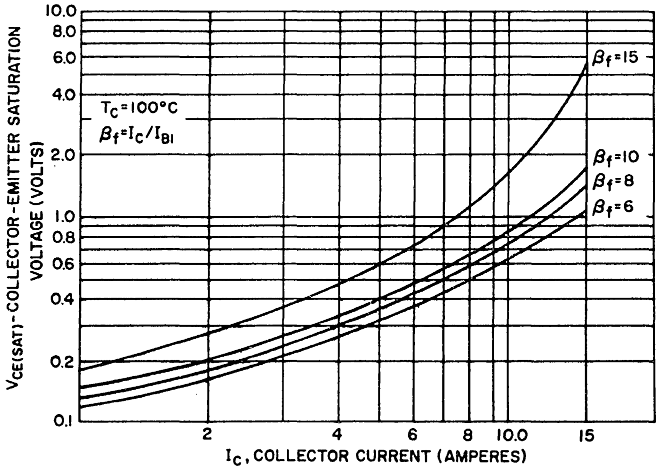


FIGURE 4. $V_{CE(sat)}$ vs I_C, $T_C = 100°C$

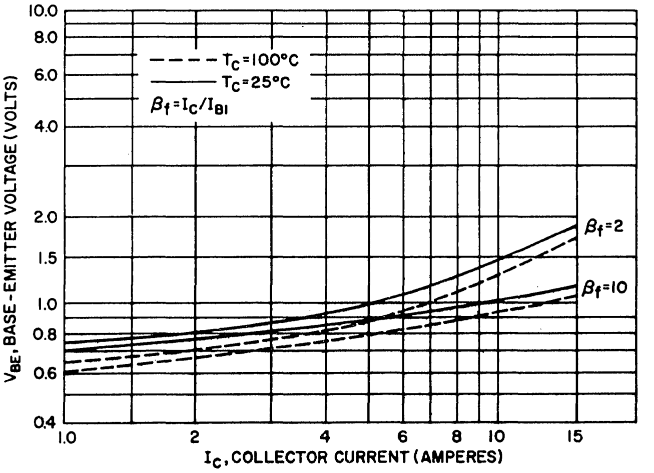


FIGURE 5. $V_{BE(sat)}$ vs I_C

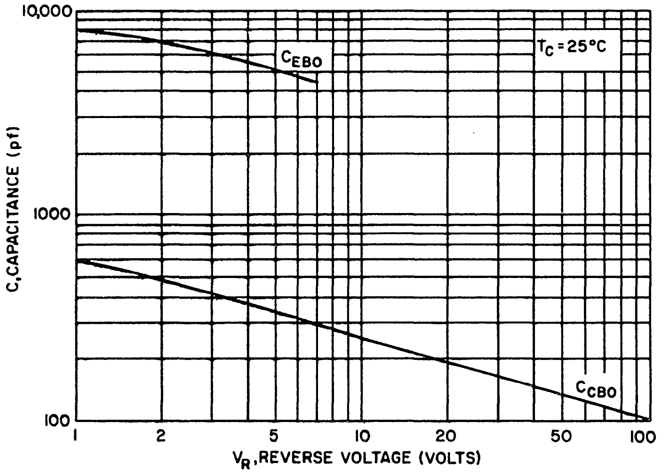


FIGURE 6. CAPACITANCE

TYPICAL SWITCHING CHARACTERISTICS

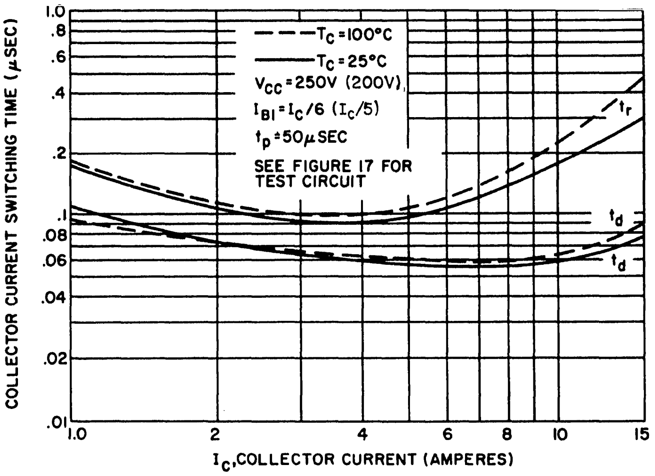


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

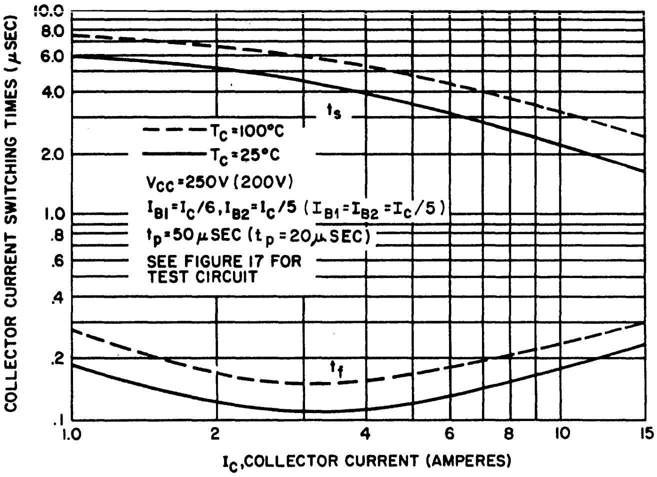


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

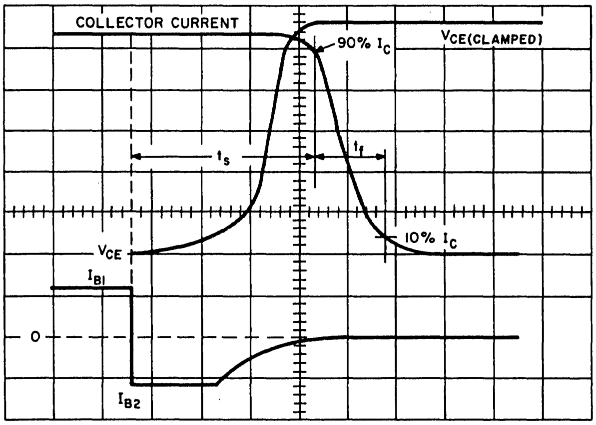


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

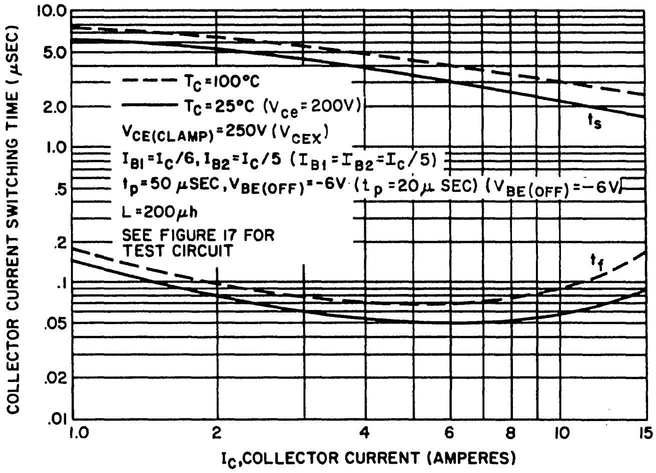


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

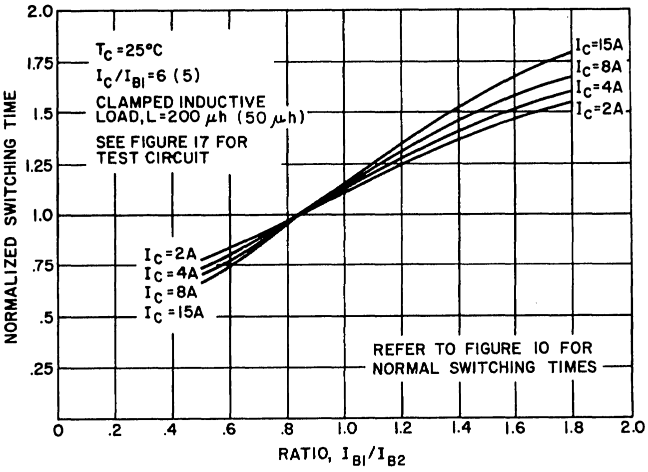


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

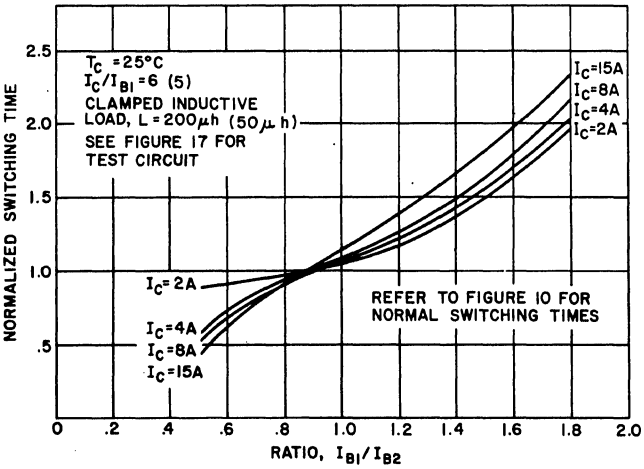


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

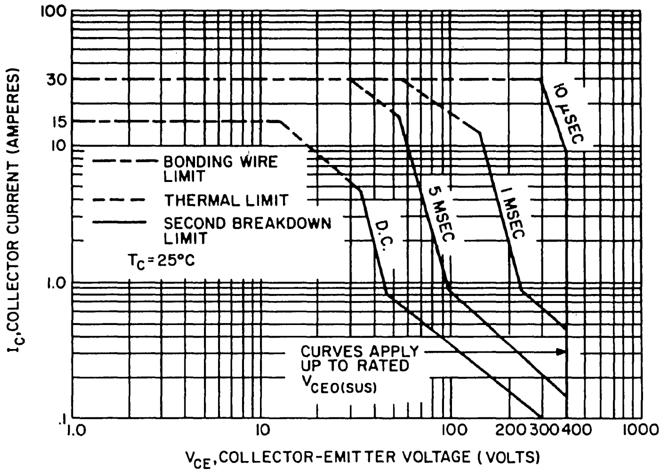


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

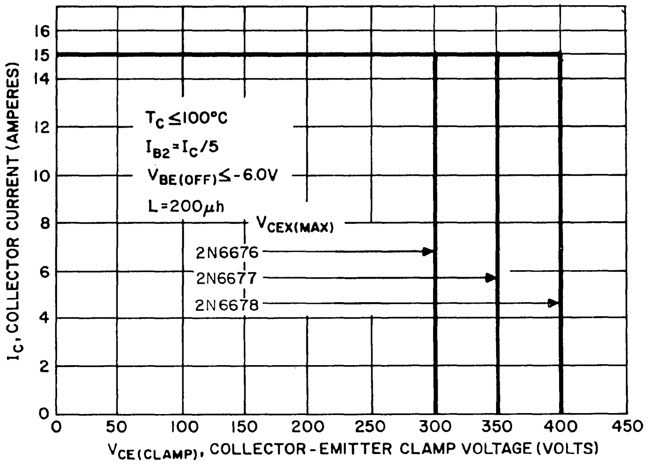


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

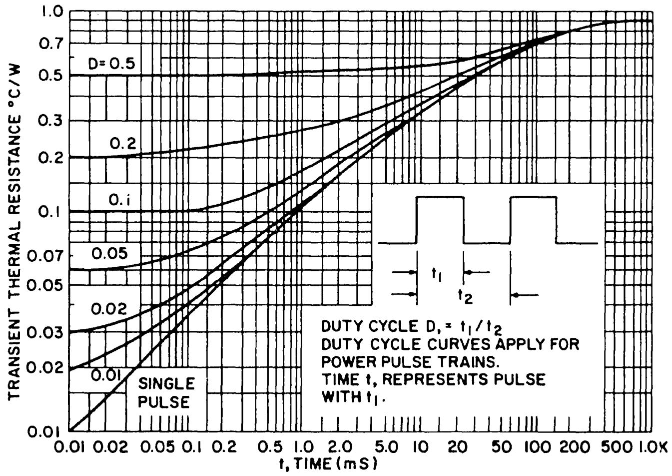


FIGURE 15. TRANSIENT THERMAL RESPONSE

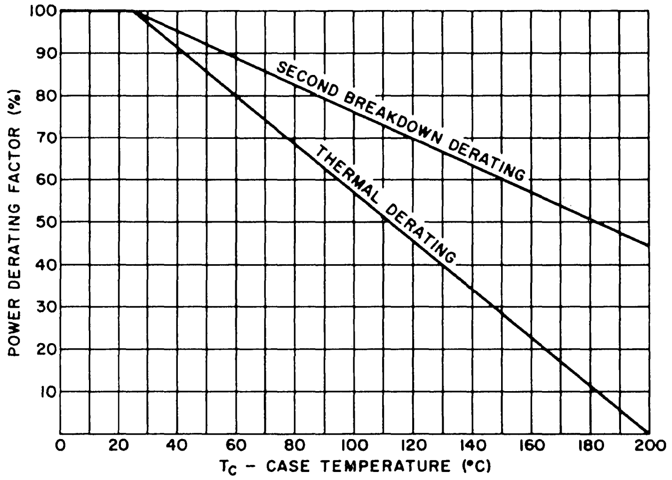
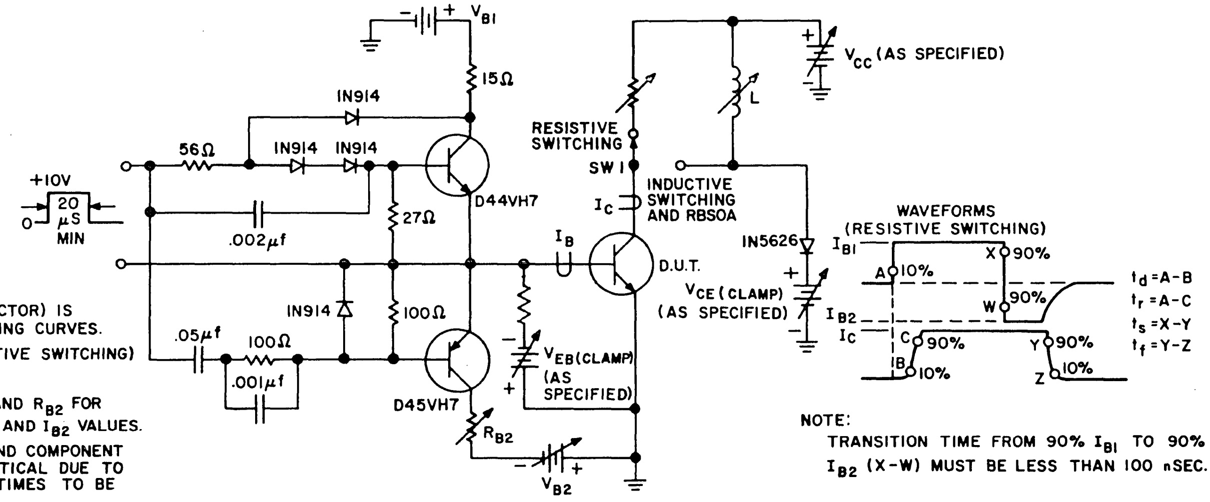


FIGURE 16. POWER DERATING



NOTE:

(2) VALUE OF L (INDUCTOR) IS SPECIFIED ON RATING CURVES.

(3) SELECT R_C (RESISTIVE SWITCHING) FOR DESIRED I_C.

(4) ADJUST V_{B1}, V_{B2} AND R_{B2} FOR TIME DESIRED I_{B1} AND I_{B2} VALUES.

(5) CIRCUIT LAYOUT AND COMPONENT SELECTION IS CRITICAL DUE TO FAST SWITCHING TIMES TO BE MEASURED.

NOTE:

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} (X-W) MUST BE LESS THAN 100 nSEC.

FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

NPN POWER TRANSISTORS

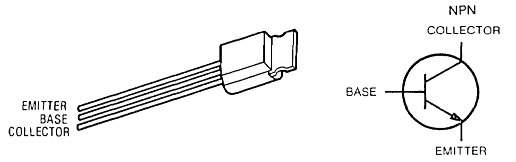
COMPLEMENTARY TO THE
2N6726, 27/92GU51, 51A SERIES

92GU01,01A
2N6714,15

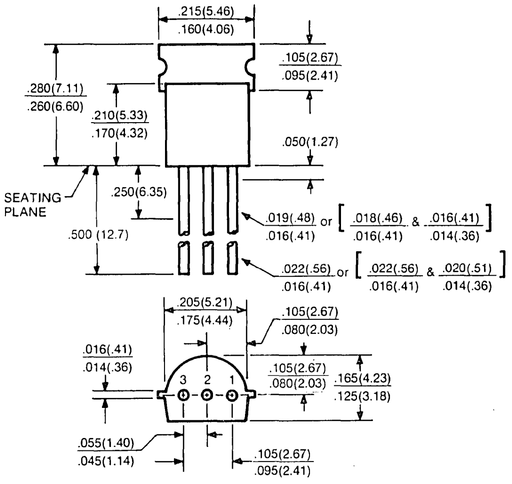
30-40 VOLTS
2 AMP, 1.2 WATTS

Applications:

- Class "B" audio outputs/drivers
- General purpose switching and lamp drive in industrial and automotive circuits.



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM.1	TERM.2	TERM.3	TAB
TO-237	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	92GU01/2N6714	92GU01A/2N6715	UNITS
Collector-Emitter Voltage	V_{CEO}	30	40	Volts
Collector-Base Voltage	V_{CB}	40	50	Volts
Emitter Base Voltage	V_{EB}	5	5	Volts
Collector Current — Continuous	I_C	2.0	2.0	A
Total Power Dissipation @ T_A = 25°C	P_{DP}*	1.2	1.2	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	167	167	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	50	°C/W

*P_{DP} = Practical Power Dissipation, i.e., that power which can be dissipated with the device installed in a typical manner on a printed circuit board with total copper run area equal to 1.0 in.^{2} minimum.

electrical characteristics ($T_A = 25°C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
off characteristics					
Collector-Emitter Sustaining Voltage 92GU01,2N6714 (I_C = 10mA, I_B = 0A) 92GU01A,2N6715	$V_{CEO(sus)}$	30 40	— —	— —	Volts
Collector Cut-off Current (V_{CB} = 40V, I_E = 0)92GU01,2N6714 (V_{CB} = 50V, I_E = 0) 92GU01A,2N6715	I_{CBO}	—	—	0.1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	0.1	μA
on characteristics					
DC Current Gain	h_{FE}				—
(I_C = 10mA, V_{CE} = 1.0V)		55	—	—	
(I_C = 100mA, V_{CE} = 1.0V)		60	—	—	
(I_C = 1000mA, V_{CE} = 1.0V)		50	—	—	
Base-Emitter On Voltage (I_C = 1.0A, V_{CE} = 1V	$V_{BE(on)}$	—	—	1.2	V
Collector-Emitter Saaturation Voltage (I_C = 1.0A, I_B = 100mA)	$V_{CE(sat)}$	—	—	.5	Volts
dynamic characteristics					
Collector Capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{BO}	—	—	30	pF
Current-Gain Bandwidth Product (I_C = 50mA, V_{CE} = 10V, f = 1MHz)	f_T	50	—	—	MHz

NPN POWER TRANSISTORS

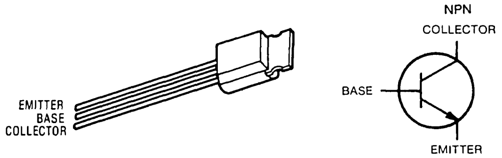
COMPLEMENTARY TO THE
2N6728, 29/92GU55, 56 SERIES

92GU05,06
2N6716,17

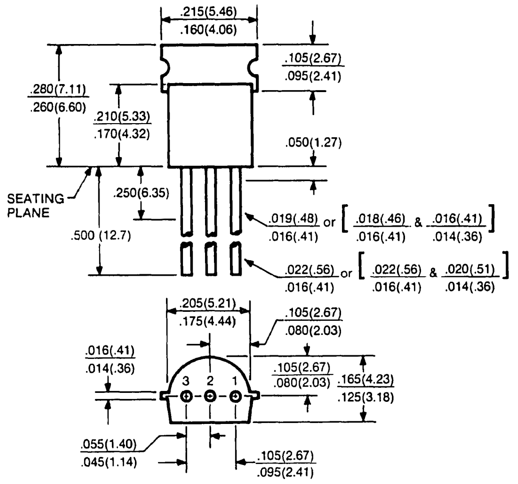
60-80 VOLTS
2 AMPS, 1.2 WATTS

Applications:

- High V_{CE} ratings:
  92GU05 = 60V min. V_{CEO}
  92GU06 = 80V min. V_{CEO}
- Exceptional power-to-price ratio



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM.1	TERM.2	TERM.3	TAB
TO-237	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	92GU05/2N6716	92GU06A/2N6717	UNITS
Collector-Emitter Voltage	V_{CEO}	60	80	Volts
Collector-Base Voltage	V_{CB}	60	80	Volts
Emitter Base Voltage	V_{EB}	4.0	4.0	Volts
Collector Current — Continuous	I_C	2.0	2.0	A
Total Power Dissipation @ T_A = 25°C	P_{DP}*	1.2	1.2	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	167	167	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	50	°C/W

*P_{DP} = Practical Power Dissipation, i.e., that power which can be dissipated with the device installed in a typical manner on a printed circuit board with total copper run area equal to 1.0 in.^{2} minimum.

electrical characteristics ($T_A = 25° C$) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = 10mA, I_B = 0A)	92GU05,2N6716 92GU06,2N6717	$V_{CEO(sus)}$	60 80	— —	— —	Volts
Collector Cut-off Current	(V_{CB} = 40V, I_E = 0A) (V_{CB} = 50V, I_E = 0A)	I_{CBO}	— —	— —	0.1 0.1	μA
Emitter Cutoff Current (V_{EB} = 4V, I_C = 0A)		I_{EBO}	—	—	100	μA

on characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 50mA, V_{CE} = 1V) (I_C = 250mA, V_{CE} = 1V) (I_C = 500mA, V_{CE} = 1V)	h_{FE}	80 50 20	— — —	— — —	— — —
Base-Emitter On Voltage (I_C = 250mA, V_{CE} = 1V)	$V_{BE(on)}$	—	—	1.2	V
Base-Emitter Saturation Voltage (I_C = 250mA, I_B = 10mA) (I_C = 250mA, I_B = 25mA)	$V_{BE(sat)}$	— —	— —	.5 .35	Volts

dynamic characteristics

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector Capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{BO}	—	—	30	pF
Current-Gain Bandwidth Product (I_C = 200mA, V_{CE} = 5V, f = 100MHz)	f_T	50	—	—	MHz

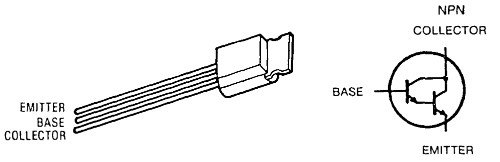
NPN POWER DARLINGTON TRANSISTORS

92GU45,45A
2N6724,25

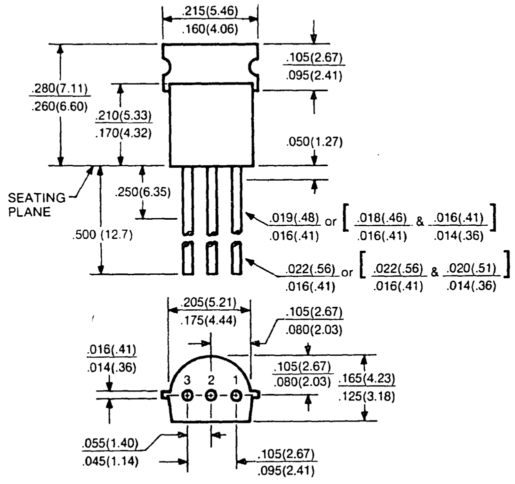
40-50 VOLTS
2 AMPS, 1 WATTS

Features:

- Lamp driver
- Digit driver
- Directly compatible with bipolar and MOS I/C drive



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM.1	TERM.2	TERM.3	TAB
TO-237	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	92GU45/2N6724	92GU45A/2N6725	UNITS
Collector-Emitter Voltage	V_{CEO}	40	50	Volts
Collector-Emitter Voltage	V_{CES}	50	60	Volts
Emitter Base Voltage	V_{EBO}	12	12	Volts
Collector Current — Continuous	I_C	2.0	2.0	A
Total Power Dissipation @ T_A = 25°C	P_{DP}*	1.0	1.0	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	62.5	62.5	°C/W

* P_{DP} = Practical Power Dissipation, i.e., that power which can be dissipated with the device installed in a typical manner on a printed circuit board with total copper run area equal to 1.0 in.^{2} minimum.

electrical characteristics (T_C = 25° C) (unless otherwise specified)

off characteristics

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 1.0mA, V_{BE} = 0V)	92GU45,2N6724 92GU45A,2N6725	BV_{CES}	40 50	— —	— —	Volts
Collector Cutoff Current (V_{CB} = 30V, I_E = 0A) (V_{CB} = 40V, I_E = 0A)	92GU45,2N6724 92GU45A,2N6725	I_{CBO}	—	—	100	nA
Emitter Cutoff Current (V_{EB} = 10V, I_C = 0)		I_{EBO}	—	—	100	μA

on characteristics

DC Current Gain	h_{FE}				
(I_C = 1mA, V_{CE} = 5V)		25,000	—	—	—
(I_C = 500mA, V_{CE} = 5V)		15,000	—	—	—
(I_C = 1000mA, V_{CE} = 5V)		4,000	—	—	—
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				V
(I_C = 1000mA, I_B = 2mA)		—	—	1.5	
(I_C = 200mA, I_B = 2mA)		—	—	1.0	
Base-Emitter Saturation Voltage (I_C = 1000mA, V_{CE} = 2mA)	$V_{BE(sat)}$	—	—	2.0	Volts
Base-Emitter On Voltage (I_C = 1000mA, V_{CE} = 5V)	$V_{BE(on)}$	—	—	2.0	Volts

PNP POWER TRANSISTORS

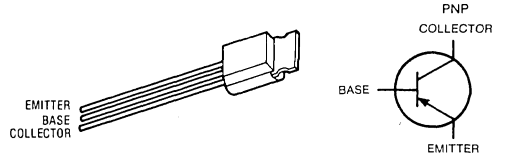
COMPLEMENTARY TO THE
2N6714, 15/92GU01, 01A SERIES

92GU51,51A
2N6726,27

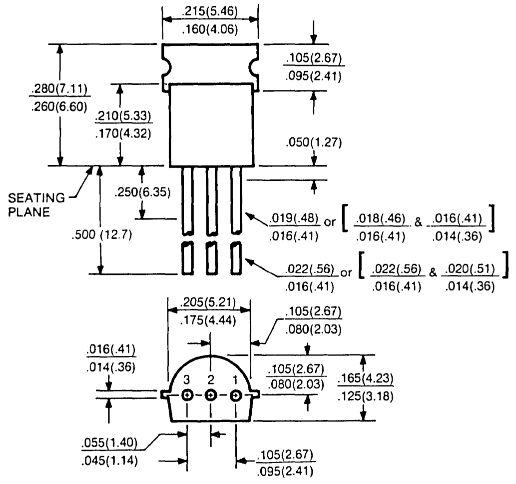
-30-(-40) VOLTS
2 AMPS, 1.2 WATTS

Applications:

- Class "B" audio outputs/drivers.
- General purpose switching and lamp drive in industrial and automotive circuits.



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM.1	TERM.2	TERM.3	TAB
TO-237	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	92GU51/2N6726	92GU51A/2N6727	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-40	Volts
Collector-Base Voltage	V_{CB}	-40	-50	Volts
Emitter Base Voltage	V_{EB}	-5	-5	Volts
Collector Current — Continuous	I_C	-2.0	-2.0	A
Total Power Dissipation @ T_A = 25°C	P_{DP}*	1.2	1.2	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	167	167	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	50	°C/W

*P_{DP} = Practical Power Dissipation, i.e., that power which can be dissipated with the device installed in a typical manner on a printed circuit board with total copper run area equal to 1.0 in.^{2} minimum.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage 92GU51,2N6726	$V_{CEO(sus)}$	-30	—	—	Volts
(I_C = -10mA, I_B = 0A) 92GU51A,2N6727		-40	—	—	
Collector Cut-off Current (V_{CB} = -40V, I_E = 0A)	I_{CBO}	—	—	-.1	μA
(V_{CB} = -50V, I_E = 0A)		—	—	-.1	
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0A)	I_{EBO}	—	—	-.1	μA

on characteristics

DC Current Gain	h_{FE}				
(I_C = -10mA, V_{CE} = -1V)		-55	—	—	
(I_C = -100A, V_{CE} = -1V)		-60	—	—	—
(I_C = -100A, V_{CE} = -1V)		-50	—	—	—
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -100mA)	$V_{CE(sat)}$	—	—	-.5	V
Base-Emitter On Voltage (I_C = -1A, V_{CE} = -1V)	$V_{BE(on)}$	—	—	-1.2	Volts

dynamic characteristics

Collector Capacitance (V_{CB} = -10V, I_E = 0, f = 1MHz)	C_{BO}	—	—	30	pF
Current-Gain Bandwidth Product (I_C = -50mA, V_{CE} = -10V, f = 1MHz)	f_T	50	—	—	MHz

PNP POWER TRANSISTORS

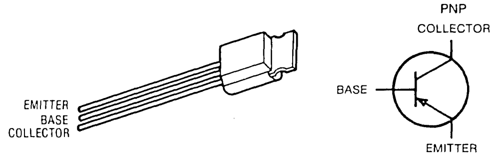
COMPLEMENTARY TO THE
2N6716, 17/92GU05, 06 SERIES

92GU55,56
2N6728,29

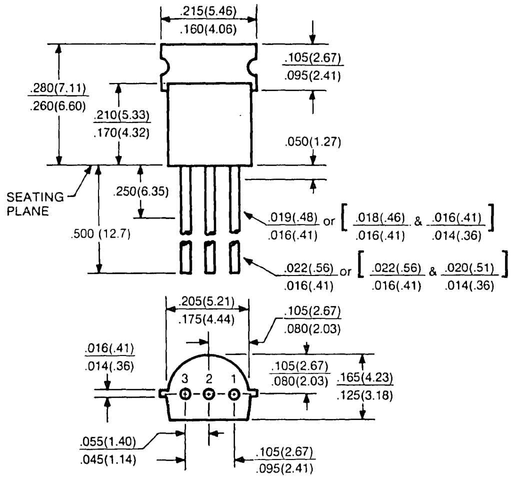
-60-(-80) VOLTS
2 AMPS, 1.2 WATTS

Applications:

- High V_{CE} ratings:
  92GU55 = 60V min. V_{CEO}
  92GU56 = 80V min. V_{CEO}
- Exceptional power-to-price ratio



CASE STYLE TO-237
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM.1	TERM.2	TERM.3	TAB
TO-237	EMITTER	BASE	COLLECTOR	COLLECTOR

maximum ratings (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	92GU55/2N6728	92GU56/2N6729	UNITS
Collector-Emitter Voltage	V_{CEO}	-60	-80	Volts
Collector-Base Voltage	V_{CB}	-60	-80	Volts
Emitter Base Voltage	V_{EB}	-4.0	-4.0	Volts
Collector Current — Continuous	I_C	-2.0	-2.0	A
Total Power Dissipation @ T_A = 25°C	P_{DP}*	1.2	1.2	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

thermal characteristics

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	167	167	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	50	°C/W

*P_{DP} = Practical Power Dissipation, i.e., that power which can be dissipated with the device installed in a typical manner on a printed circuit board with total copper run area equal to 1.0 in.^{2} minimum.

electrical characteristics (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

off characteristics

Collector-Emitter Sustaining Voltage 92GU55,2N6728 (I_C = -1.0mA, I_B = 0A) 92GU56,2N6729	$V_{CEO(sus)}$	-60 -80	— —	— —	Volts
Collector Cut-off Current (V_{CB} = -40V, I_E = 0)92GU55,2N6728 (V_{CB} = -50V, I_E =0) 92GU56,2N6729	I_{CBO}	— —	— —	-.1 -.1	μA
Emitter Cutoff Current (V_{EB} = -4V, I_C = 0)	I_{EBO}	—	—	-100	μA

on characteristics

DC Current Gain	h_{FE}				
(I_C = -50mA, V_{CE} = -1V)		-80	—	—	—
(I_C = -250mA, V_{CE} = -1V)		-50	—	—	—
(I_C = -500mA, V_{CE} = -1V)		-20	—	—	—
Base-Emitter On Voltage (I_C = -250mA, V_{CE} = -1V)	$V_{BE(on)}$	—	—	-1.2	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Volts
(I_C = -250mA, I_B = -10mA)		—	—	-.5	
(I_C = -250mA, I_B = -25mA)		—	—	-.35	

dynamic characteristics

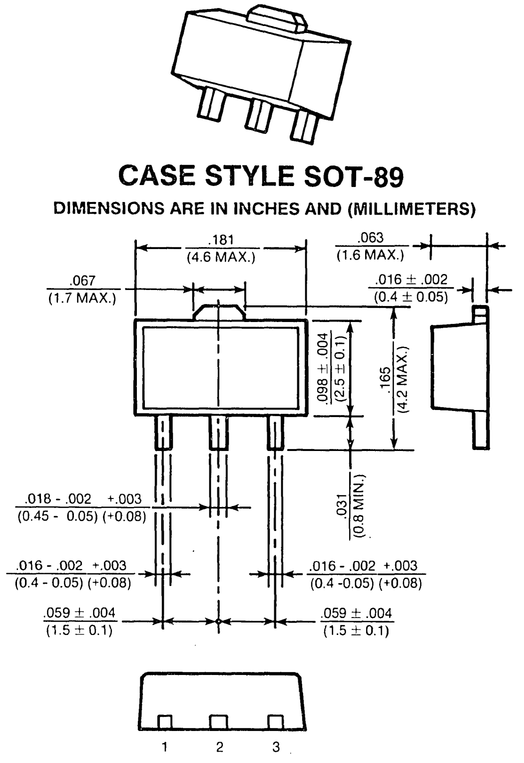
Collector Capacitance (V_{CB} = -10V, I_E = 0, f = 1MHz)	C_{BO}	—	—	30	pF
Current-Gain Bandwidth Product (I_C = -200mA, V_{CE} = -5V, f = 100MHz)	f_T	50	—	—	MHz

MOUNTING & HANDLING CONSIDERATIONS

MOUNTING AND HANDLING CONSIDERATIONS

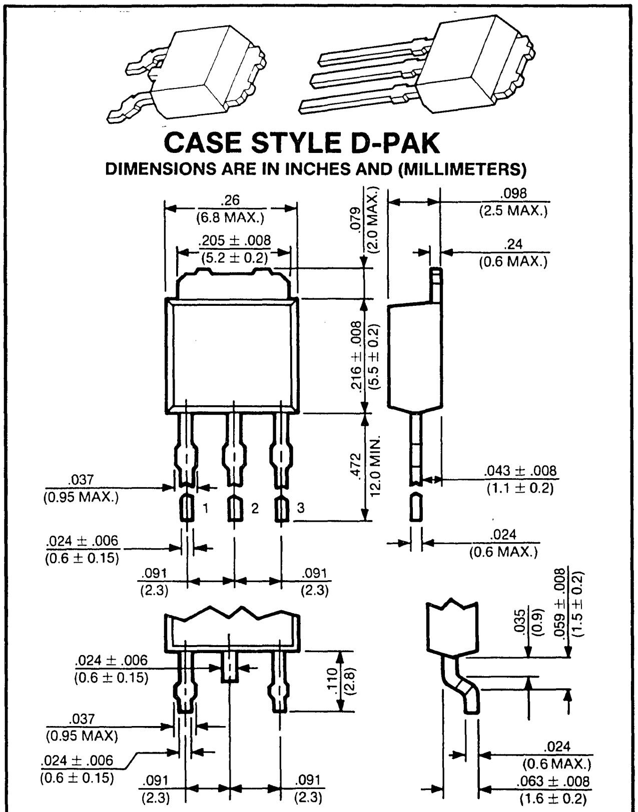
For Surface-Mounted Devices

Surface-mounted devices are packaged and assembled with different methods than conventional transistors, and require special consideration during mounting and handling to insure optimum performance. This section describes these considerations for two types of surface-mounted devices:



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR

FIGURE 1. OUTLINE DRAWING OF SOT-89 PACKAGE



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

FIGURE 2. OUTLINE DRAWING OF D-PAK PACKAGE

Figure 1 shows the dimensions of the SOT-89 transistor package. The small size (2.5 x 4.5 x 1.5mm) and flat package design allows the transistor to be mounted directly to a ceramic substrate. Flat emitter, base, and collector leads are flush-mounted to the connector runs of the substrate; while a flat collector tab (soldered to the substrate) increases ability of the device to dissipate power.

Figure 2 shows the dimensions of the D-Pak transistor package. The epoxy portion of the device (5.5 x 6.5 x 2.3mm) is smaller than an equivalent TO-220-packaged device. Collector power dissipation is increased by directly soldering the collector tab to the ceramic substrate.

HANDLING CONSIDERATIONS

General — Since the external epoxy portions of the surface-mounted devices are much smaller than on conventional transistor packages, these devices are often more susceptible to high-temperature/high-humidity conditions. Thus, these surface-mounted devices should be coated or encapsulated when used in high-temperature/high-humidity environment.

Flux removal — After surface-mounted devices have been soldered to the circuit board/substrate, excess flux must be removed to prevent corrosion of the device and lead wires. Organic flux may be removed by rinsing; but inorganic flux must be cleaned with an olefin cleaner such as Freon TE or Di-Freon Solvent S3-E.

Preheating — Both SOT-89 and D-Pak transistors must be preheated prior to being mounted on circuit boards. There are several methods of preheating, including use of an infrared heat panel, parabolic infrared lamp, or hot air circulation. Preheat the devices at 100-150°C for two minutes, raising the temperature as gradually as possible, since the device pellets may be damaged by an abrupt thermal shock.

SOLDERING CONSIDERATIONS

Both SOT-89 and D-Pak transistors are specified for 250°C solder temperature for 20 seconds duration. It is important to use a solder with a melting temperature of 190°C or lower. In general, soldering conditions range from 220-240°C for 3-5 seconds.

When using molten solder in the metal mask method, avoid uneven printing and deformation. Recommended uniform solder printing thickness is at least 200μm to ensure lead wire solderability.

When using a soldering iron to mount a device to the circuit board, care should be taken to avoid damage and/or dislocation of the device. (For this reason, soldering irons are recommended only for experimental or repair work.) For proper bonding, the soldering iron tip should be 1mm or less in diameter, and 250°C for 3 seconds or less. Never touch the epoxy package with the soldering iron.

Figures 3 and 4 show the relationship between soldering temperature and preheating time for various device mounting procedures.

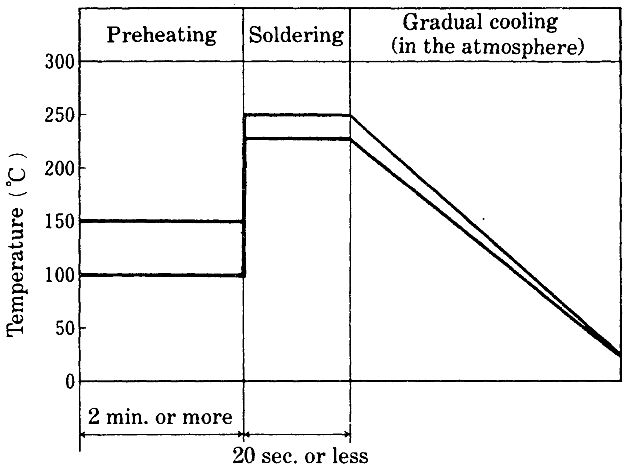


FIGURE 3. SOLDER DIP METHOD

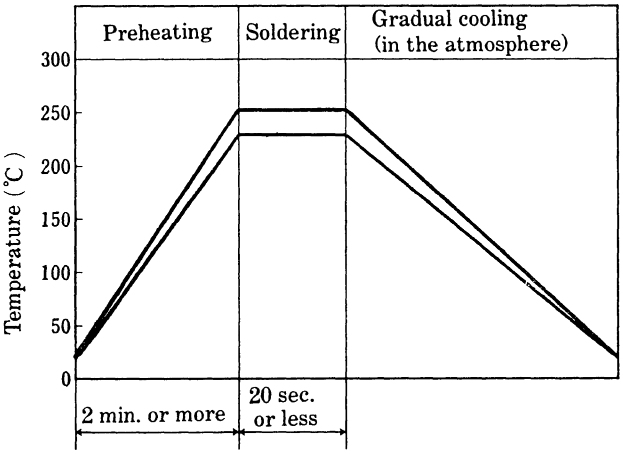


FIGURE 4. REFLOW SOLDER METHOD

POWER DISSIPATION CONSIDERATIONS

Maximum power dissipation for surface-mount transistor packages is different for individual devices than for those mounted to a circuit board or substrate. For example:

> SOT-89 transistor — Since this transistor package is so small, the maximum power dissipation of a device in free air is 500 mW. However, the same device mounted directly to a circuit board has a maximum power dissipation of 1-2W because of additional thermal diffusion to the circuit board from the collector tab.

Figure 5 illustrates the maximum power dissipation for two GE SOT-89-packaged transistors mounted to a ceramic substrate.

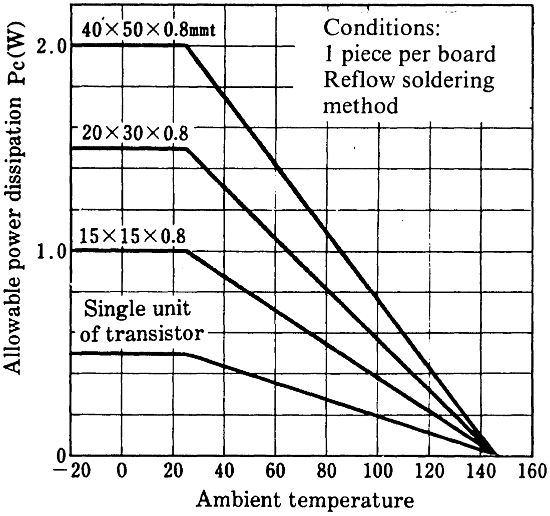


FIGURE 5. $P_{D(MAX)}$ VS. T_A CHARACTERISTICS OF D70F2T1 and D71F2T1 TRANSISTORS MOUNTED ON CERAMIC SUBSTRATE

D-Pak transistor — Maximum power dissipation for the straight-lead version is 1W; however, when the lead-formed version is mounted directly to a ceramic substrate, the power dissipation is increased to 2-3W. Figure 6 illustrates the maximum power dissipation for two GE D-Pak-packaged transistors mounted to a ceramic substrate.

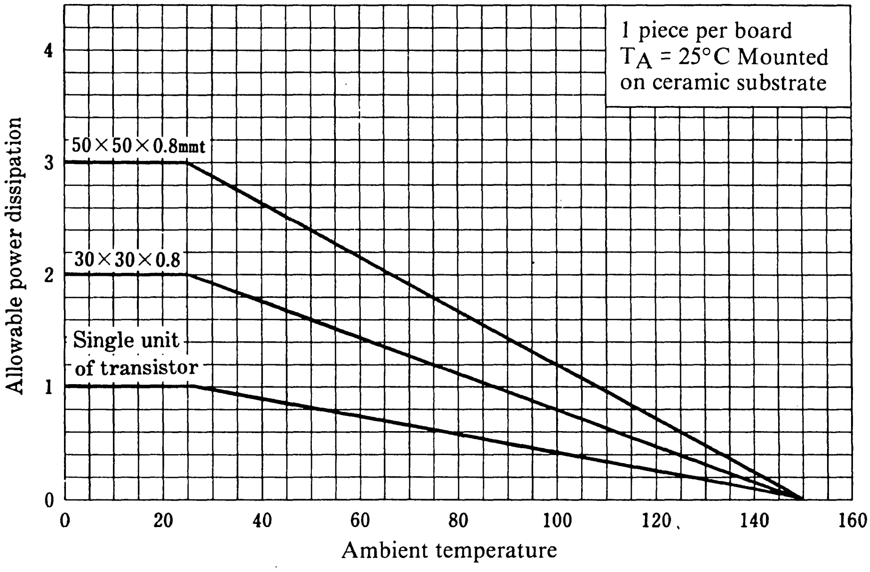


FIGURE 6. $P_{D(MAX)}$ VS. T_A CHARACTERISTICS OF D72F5T1 and D73F5T1 TRANSISTORS MOUNTED ON CERAMIC SUBSTRATE

MAXIMUM POWER DISSIPATION (TRANSIENT CONDITIONS)

Certain circuit designs (such as motor drives and flash circuits) require devices to be rated for transient conditions as well as for their overall power dissipation capability. The relationship between maximum power dissipation and pulse width under transient conditions for both SOT-89 and D-Pak transistors is shown in Figures 7 and 8, respectively.

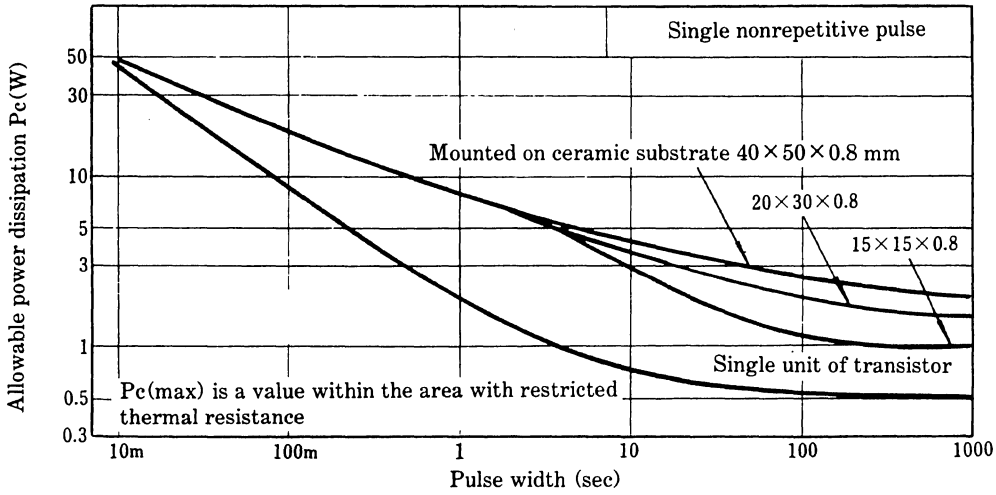


FIGURE 7. P_D VS. T_A CHARACTERISTICS OF D70F2T1 and D71F2T1 UNDER TRANSIENT CONDITIONS

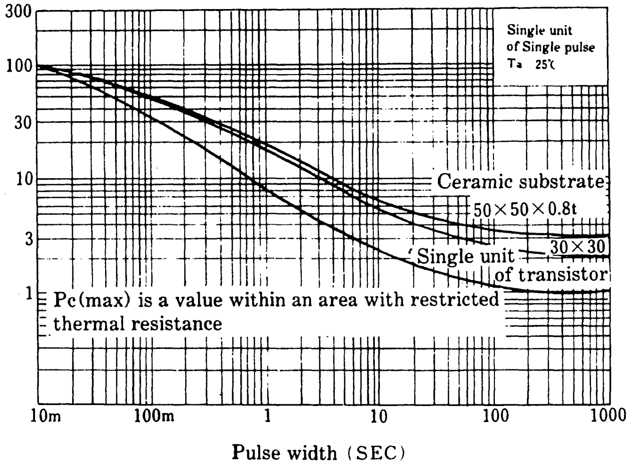


FIGURE 8. P_D VS. T_A CHARACTERISTICS OF D72F5T1 and D73F5T1 UNDER TRANSIENT CONDITIONS

NOTE: Power dissipation (P_D) is a value inside the area of restricted thermal resistance; and both Figures 7 and 8 depict power dissipation under a single non-repetitive pulse.

MINIMUM MOUNTING PAD AREA

Figure 9 shows the lead mounting locations and minimum pad size for SOT-89 transistors. Since the maximum power dissipation is affected substantially by the collector connecting area, a large pad area is recommended.

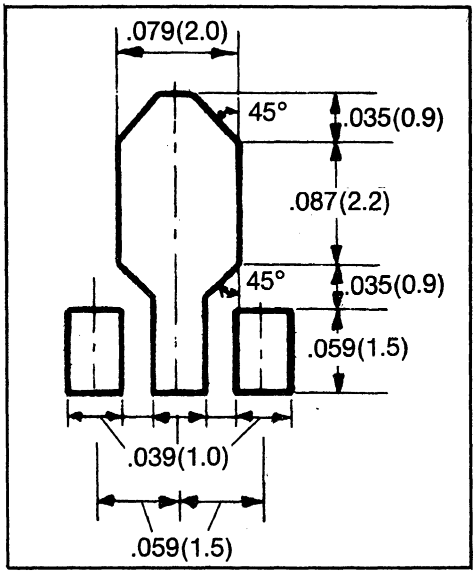


FIGURE 9. MINIMUM RECOMMENDED PAD SIZE FOR SOT-89 TRANSISTORS

Figure 10 shows the minimum pad area for a D-Pak transistor. Since the thermal radiation of D-Pak transistors is dependent on the collector tab connection to the circuit board, an increased board area will also increase the device's maximum power dissipation. Thus, the collector area should be as large as possible.

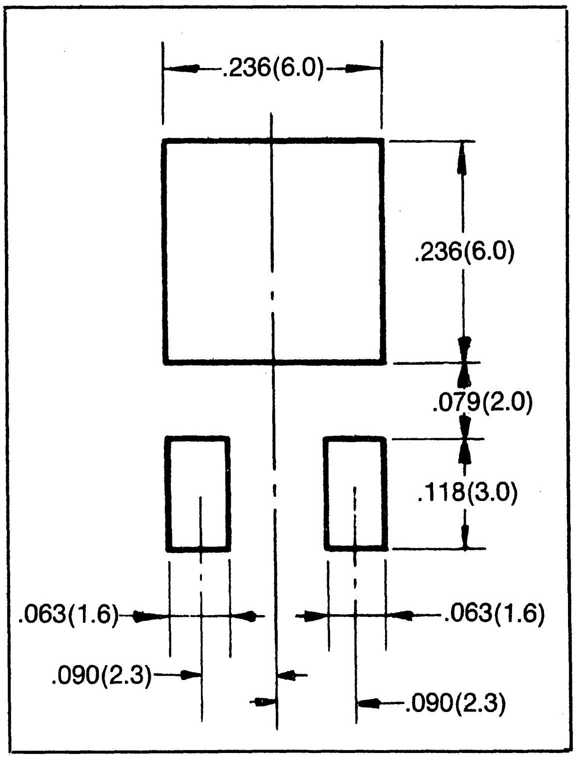
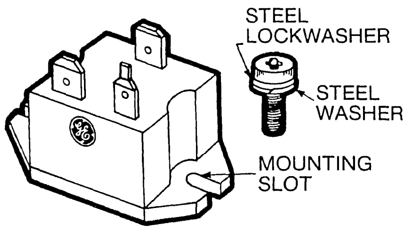


FIGURE 10. MINIMUM RECOMMENDED PAD SIZE FOR D-PAK TRANSISTORS

MOUNTING AND ELECTRICAL TERMINATION PROCEDURES

For D66 & D67 Power Darlington Transistor Modules



ALL D66 DEVICES

MOUNTING

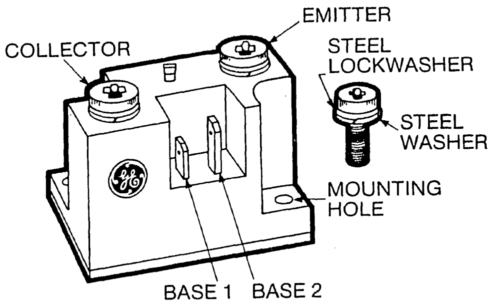
HARDWARE:
Screws - Standard #6 or M3
Washers - OD = 5/16"-3/8" (8-9 mm)

TORQUE: 6-8 lb.-in. (0.7-0.9 NM)

ELECTRICAL TERMINATION

COLLECTOR & EMITTER:
FASTON - AMP #41450
(or equivalent)

BASE:
FASTON - AMP #61339-1
(or equivalent)



ALL D67 DEVICES

MOUNTING

HARDWARE: Standard #10 or M5
7/16"-1/2" OD
(11" 13mm) OD

TORQUE: 19-25 lb.-in. (2-3 NM)

ELECTRICAL TERMINATION

COLLECTOR & EMITTER:
Screw: M5 x 8mm
Lockwasher: 9.2-13mm OD
Torque: 25-28 lb.-in.
(2.8-3.2 NM)

BASE:
Base 1: FASTON-AMP #640917-1
Base 2: FASTON-AMP #640903-1
(or equivalents)

HEAT SINK FLATNESS

Heat sink surfaces must be flat within ±1.5 mils/inch (0.015mm/cm) over the mounting area and must have a surface finish of $<$ 64 micro inches (1.62 microns).

THERMAL COMPOUND

To minimize the effects of flatness differential and/or voids between the base plate and the heat sink, apply a very thin layer of GE #6644 or Dow Corning #4 thermal compound to the back of the base plate and the heat sink. NOTE: excessive thermal compound *will not* squeeze out from underneath the device during mountdown. After applying thermal compound to the device and the heat sink, place the device on the heat sink and rotate slowly to distribute grease. Check both surfaces for uniform coverage before applying torque to mounting screws.

WARNING

THESE MODULES SHOULD BE HANDLED WITH CARE. THE CERAMIC PORTION (INTERNAL ISOLATION) OF THIS PRODUCT MAY CONTAIN BERYLLIUM OXIDE AS A MAJOR INGREDIENT.

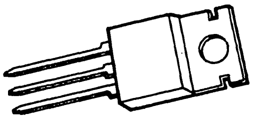
DO NOT CRUSH, GRIND, OR ABRADE THESE PORTIONS OF THE PRODUCT. THE DUST RESULTING FROM SUCH ACTION MAY BE HAZARDOUS IF INHALED.

GE
POWER TRANSISTOR
OUTLINE DRAWINGS

POWER TRANSISTOR OUTLINE DRAWINGS

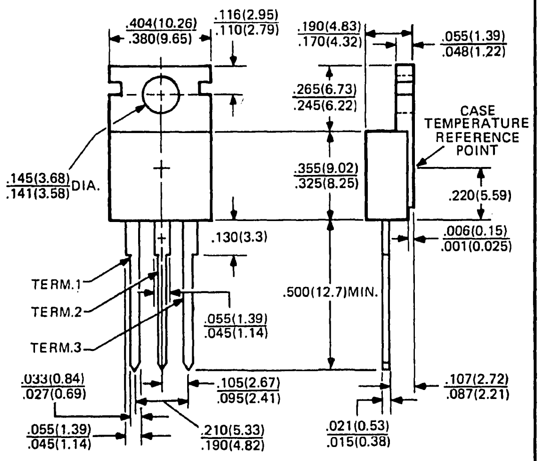
POWER MOS DRAWINGS

N-CHANNEL



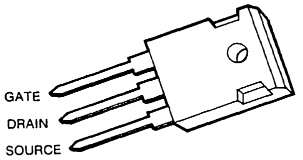
CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



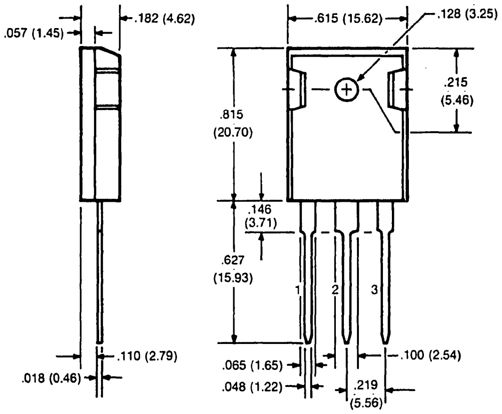
UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-220-AB	GATE	DRAIN	SOURCE	DRAIN

N-CHANNEL



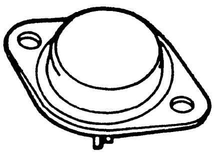
CASE STYLE TO-247

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



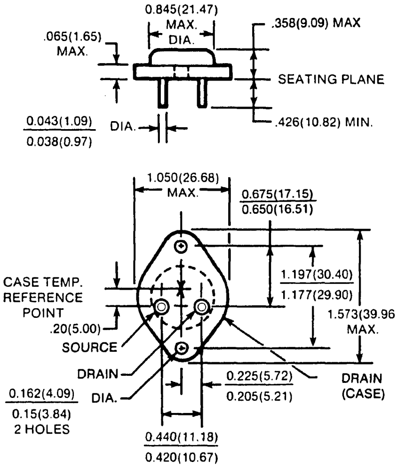
UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO 247	GATE	DRAIN	SOURCE	DRAIN

N-CHANNEL



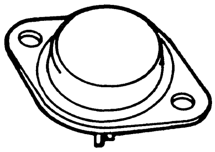
CASE STYLE TO-204AA (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



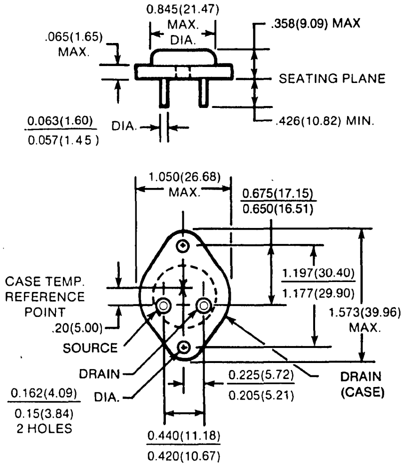
Power MOS Drawings (Cont.)

N-CHANNEL

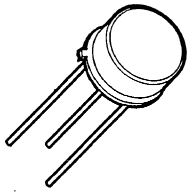


CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

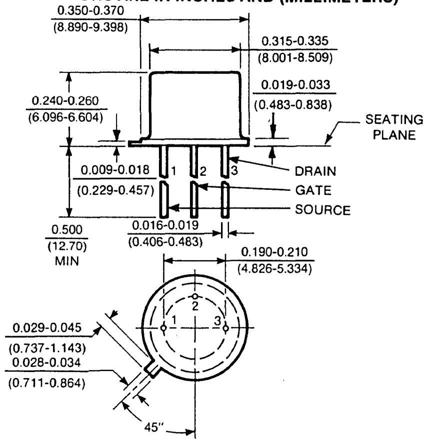


N-CHANNEL



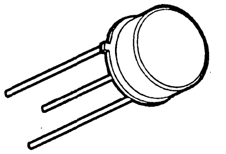
CASE STYLE TO-205AD(TO-39)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



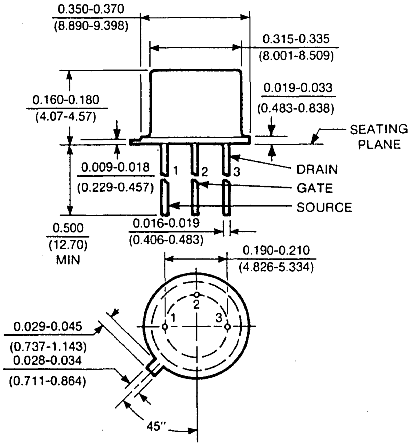
TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AD	SOURCE	GATE	DRAIN

N-CHANNEL



CASE STYLE TO-205AF (TO-39)

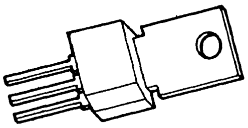
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3
TO-205AF	SOURCE	GATE	DRAIN

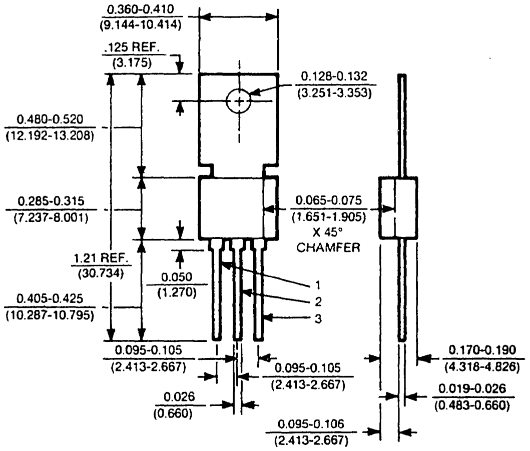
Power MOS Drawings (Cont.)

N-CHANNEL



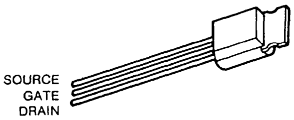
CASE STYLE TO-202

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



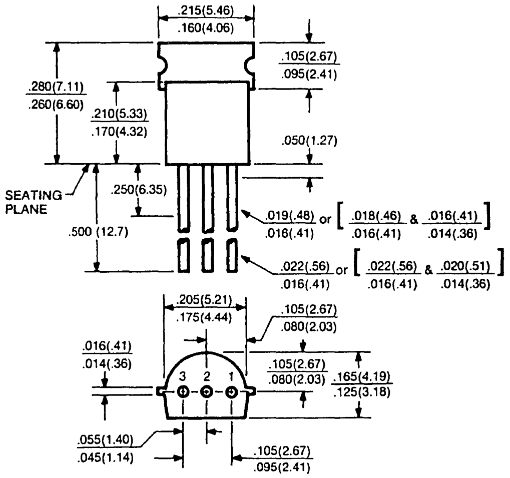
TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	SOURCE	GATE	DRAIN	DRAIN

N-CHANNEL



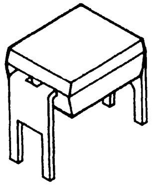
CASE STYLE TO-237

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



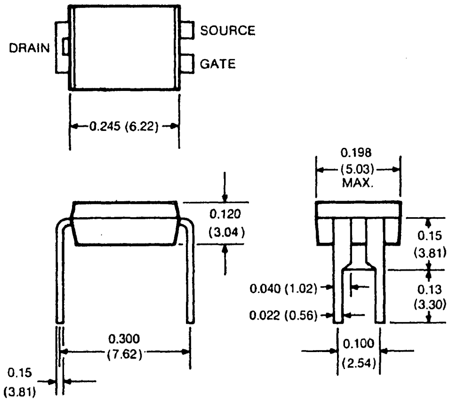
UNIT	TYPE	TERM.1	TERM.2	TERM.3	TAB
POWER MOS FET	TO-237	SOURCE	GATE	DRAIN	DRAIN

N-CHANNEL

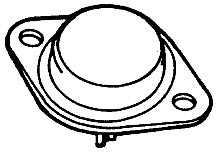


CASE STYLE 4-PIN DIP

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

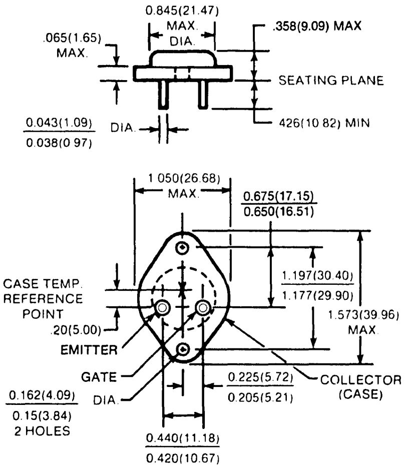


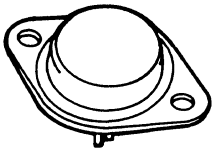
IGT DRAWINGS



CASE STYLE TO-204AA (TO-3)

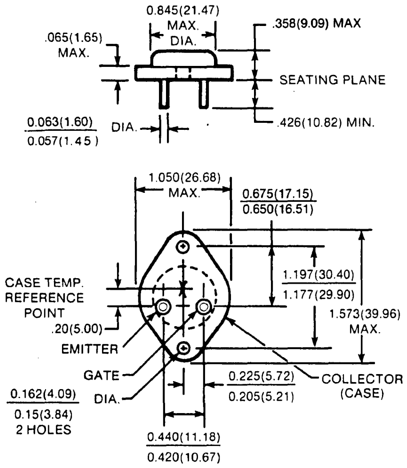
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

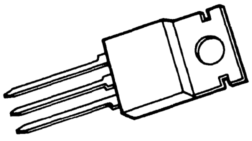




CASE STYLE TO-204AE (TO-3)

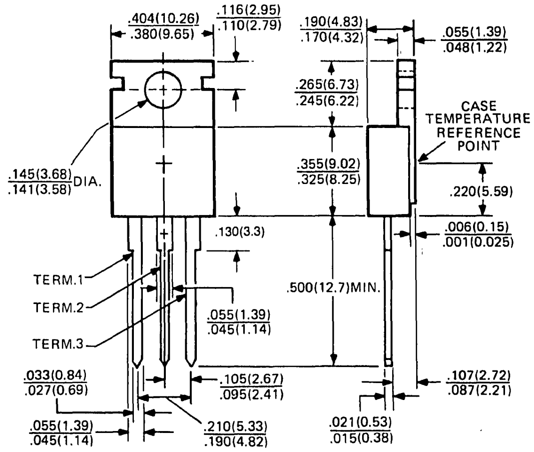
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



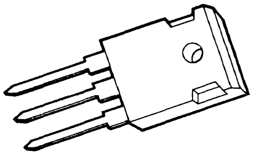


CASE STYLE TO-220AB

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

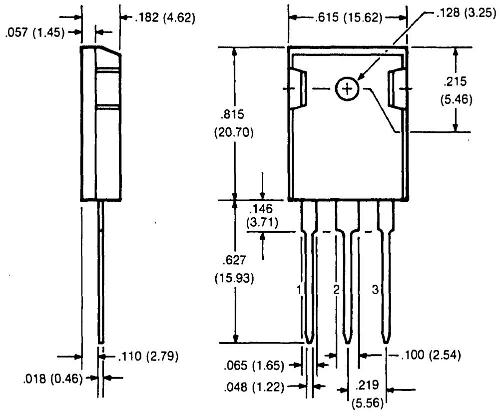


UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS IGT	TO-220-AB	GATE	COLLECTOR	EMITTER	COLLECTOR



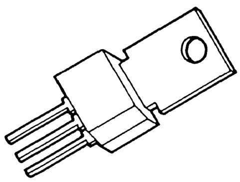
CASE STYLE TO-247

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



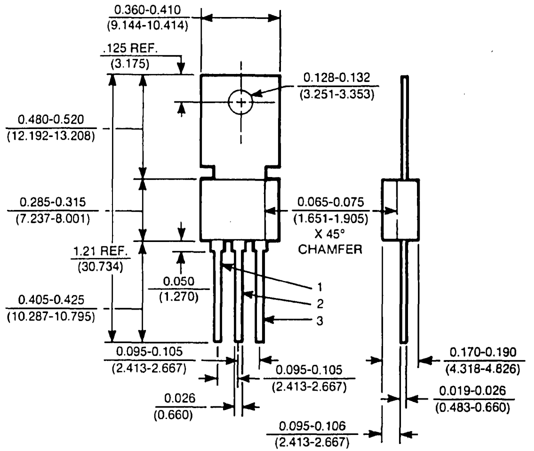
UNIT	TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
POWER MOS IGT	TO-247	GATE	COLLECTOR	EMITTER	COLLECTOR

BIPOLAR DRAWINGS



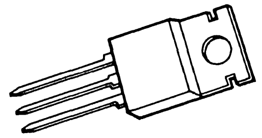
CASE STYLE TO-202*

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



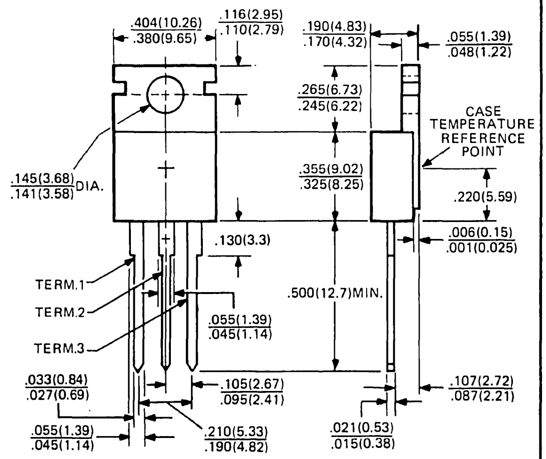
TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-202	EMITTER	BASE	COLLECTOR	COLLECTOR

Also available in BCE configuration

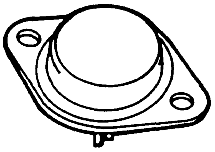


CASE STYLE TO-220AB*

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

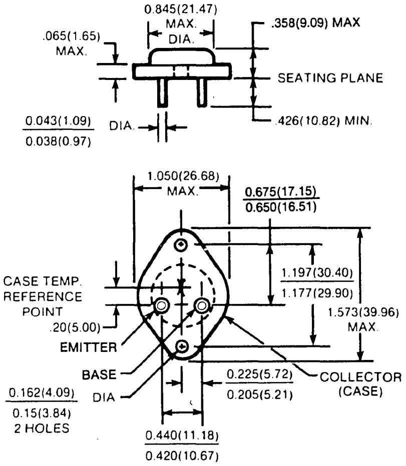


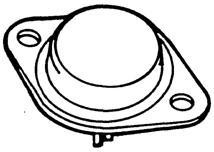
TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220-AB	BASE	COLLECTOR	EMITTER	COLLECTOR



CASE STYLE TO-204AA (TO-3)

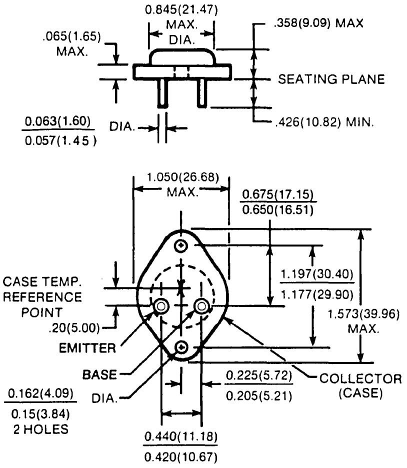
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)





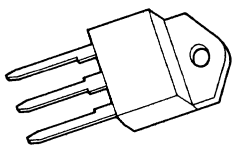
CASE STYLE TO-204AE (TO-3)

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



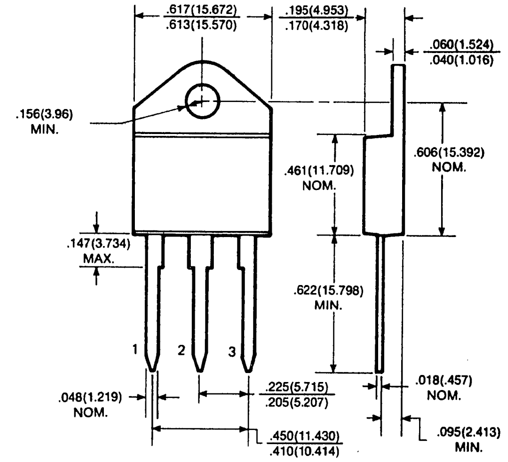
*Indicates additional lead-formed options available.

Bipolar Drawings (Cont.)

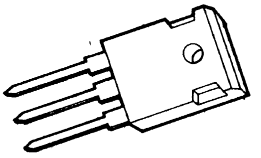


CASE STYLE TO-218 *

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

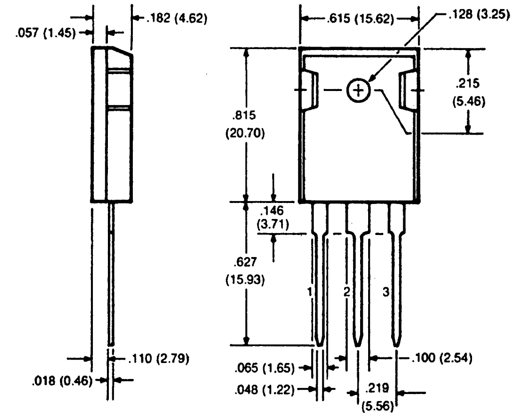


TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-218	BASE	COLLECTOR	EMITTER	COLLECTOR

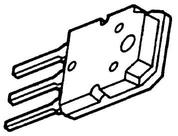


CASE STYLE TO-247

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

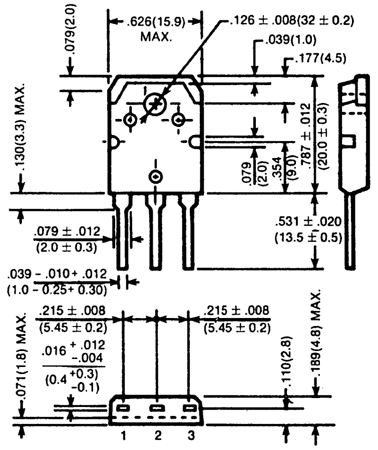


TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-247	BASE	COLLECTOR	EMITTER	COLLECTOR

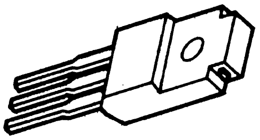


CASE STYLE TO-247S

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

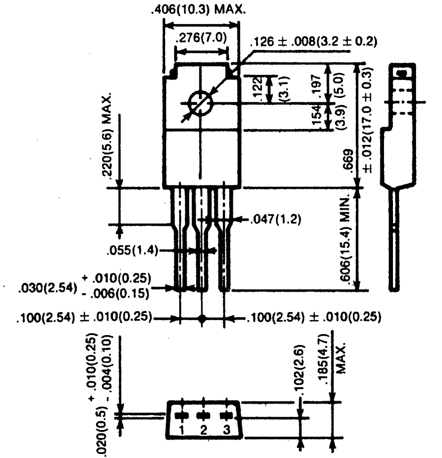


TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-247S	BASE	COLLECTOR	EMITTER	COLLECTOR



CASE STYLE TO-220IS

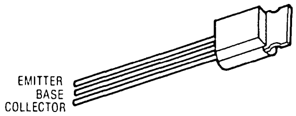
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
TO-220IS	BASE	COLLECTOR	EMITTER	COLLECTOR

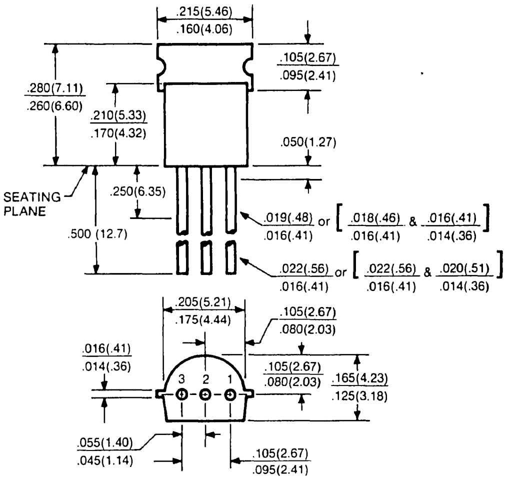
*Indicates additional lead-formed options available.

Bipolar Drawings (Cont.)

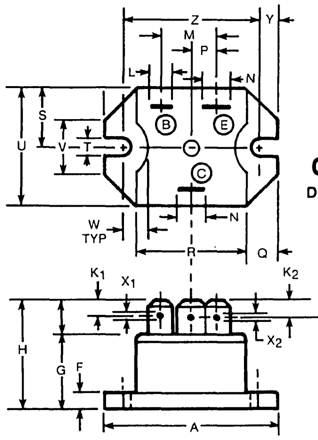


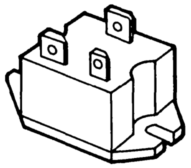
CASE STYLE TO-237

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



TYPE	TERM.1	TERM.2	TERM.3	TAB
TO-237	EMITTER	BASE	COLLECTOR	COLLECTOR

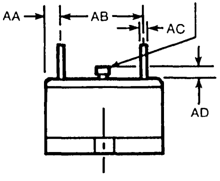




CASE STYLE D66

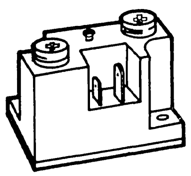
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED



SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.505	1.540	38.22	39.12
F	.120	.132	3.04	3.35
G	.605	.645	15.36	16.40
H	.940	.980	23.87	24.19
J	.307	—	7.80	—
K_1	.120	.132	3.04	3.35
K_2	.171	.184	4.34	4.64
L	.184	.192	4.57	4.88
M	.464	.484	11.78	12.30
N	.247	.255	6.27	6.48
P	.210	.230	5.33	5.84
Q	.275	REF.	7.00	REF.
R	.970	REF.	24.64	REF.

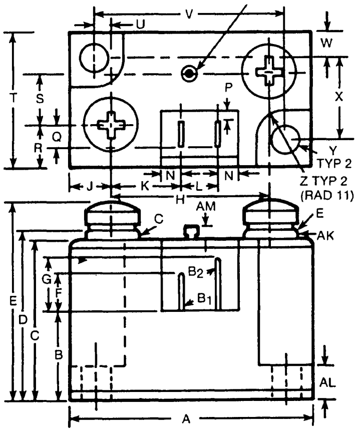
SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
S	.495	.510	12.57	12.95
T	.150	.170	3.81	4.32
U	.985	1.015	25.01	25.80
V	.450	REF.	11.43	REF.
W	.180	—	4.57	—
X_1	.050	.058	1.27	1.47
X_2	.065	.073	1.65	1.85
Y	.157	.177	3.98	4.50
Z	1.180	1.192	29.97	30.30
AA	.130	.165	3.30	4.30
AB	.684	.704	17.37	17.90
AC	.031	.035	.78	.90
AD	.100	REF.	2.54	REF.



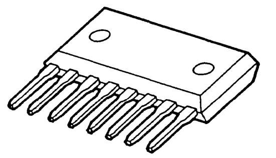
CASE STYLE D67

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

ORIENTATION OF THE FLAT IS NOT CONTROLLED

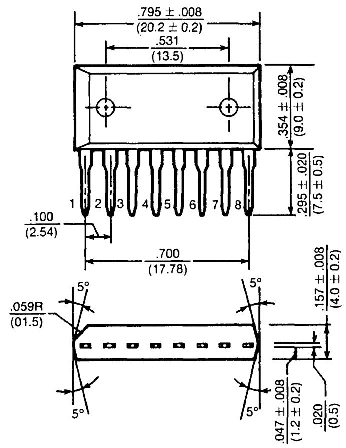


SYM	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	1.785	1.815	45.33	46.10
B	.615	.685	15.62	17.40
C	11.48	11.98	29.15	30.43
D	1.215	1.270	30.86	32.36
E	—	1.470	—	37.34
F	.245	—	6.20	—
G	.335	—	8.50	—
H	1.170	1.190	29.71	30.23
J	.295	.325	7.50	8.26
K	.518	REF.	13.16	REF.
L	.260	.290	6.60	7.37
N	.150	REF.	3.81	REF.
P	.070	REF.	1.80	REF.
Q	.170	REF.	4.30	REF.
R	.300	.320	7.60	8.13
S	.370	.390	9.40	9.90
T	.985	1.015	25.00	25.80
U	.110	.130	2.80	3.30
V	1.410	1.430	35.80	36.32
W	.175	.205	4.44	5.20
X	.610	.630	15.50	16.00
Y	.199	.221	5.05	5.61
Z	.190	.230	4.82	5.84
AA	.047	REF.	1.20	REF.
AB	.312	REF.	7.90	REF.
AC	M5 (MED FIT)		M5 (MED FIT)	
AD	.184	.192	4.67	4.90
AE	.031	.034	.78	.86
AF	.119	.132	3.02	3.35
AG	.050	.060	1.27	1.52
AH	.065	.075	1.65	1.90
AJ	.204	.211	5.18	5.36
AK	.365	.385	9.27	9.80
AL	.235	.265	5.96	6.73
AM	—	.125	—	3.20

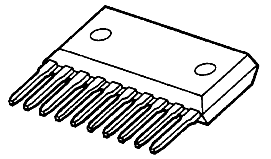


CASE STYLE SIP-8 PIN

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

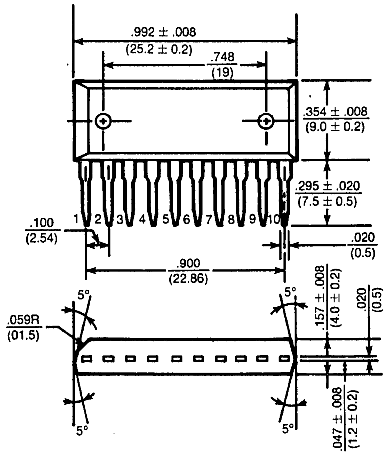


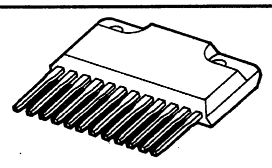
Bipolar Drawings (Cont.)



CASE STYLE SIP-10 PIN

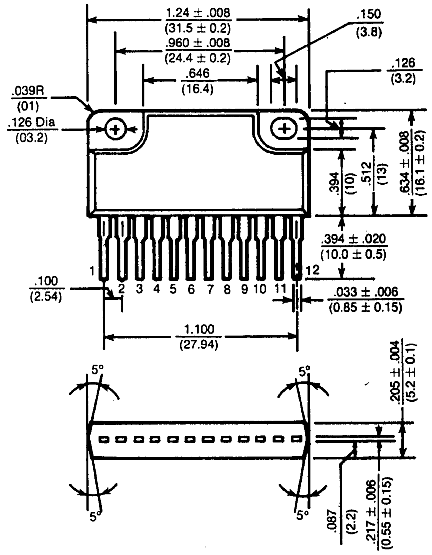
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

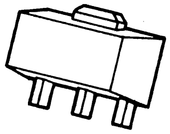




CASE STYLE SIP-12 PIN

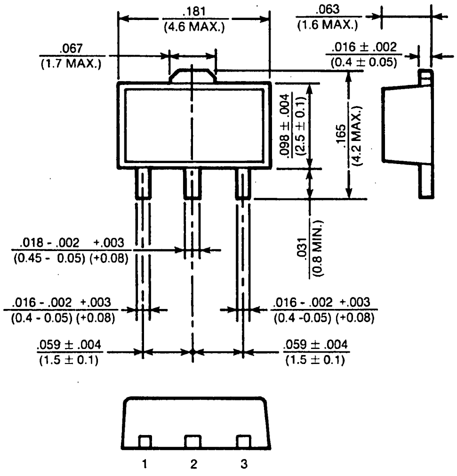
DIMENSIONS ARE IN INCHES AND (MILLIMETERS)



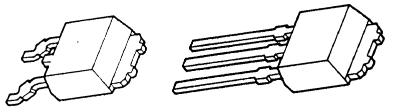


CASE STYLE SOT-89

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

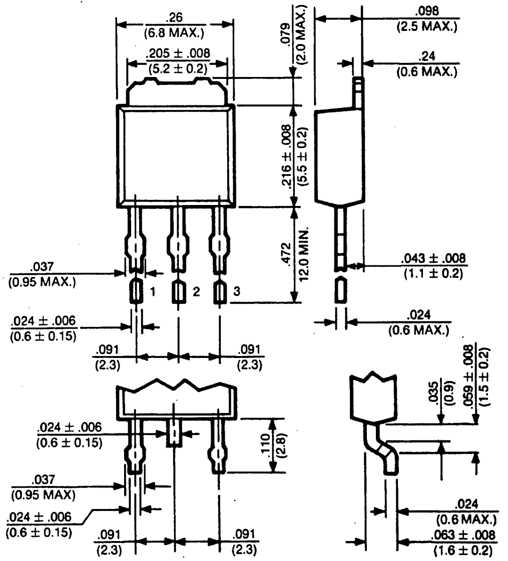


TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
SOT-89	BASE	COLLECTOR	EMITTER	COLLECTOR



CASE STYLE D-PAK

DIMENSIONS ARE IN INCHES AND (MILLIMETERS)

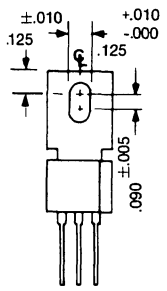


TYPE	TERM. 1	TERM. 2	TERM. 3	TAB
D-PAK	BASE	COLLECTOR	EMITTER	COLLECTOR

PACKAGE ALTERNATIVES

TO-202

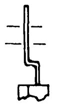
NOTE: NOT
BASIC FORM.
FOR REF. USE.



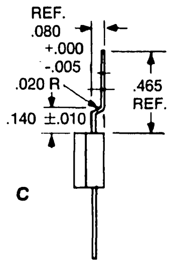
MAKE FROM
TYPE A

B

D



OTHERWISE
SAME
AS C



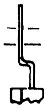
C

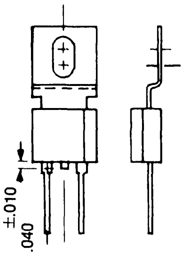
MAKE FROM
TYPE B

C & D

F

OTHERWISE
SAME AS E

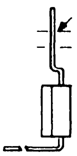




E

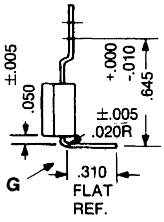
OTHERWISE SAME
AS TYPE C OR D

E & F



H

OTHERWISE
SAME
AS E



G

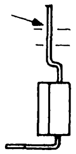
* = CRITICAL DIM.

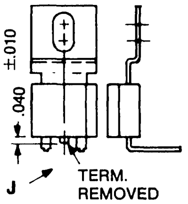
OTHERWISE SAME
AS TYPE C

G & H

K

OTHERWISE
SAME
AS J



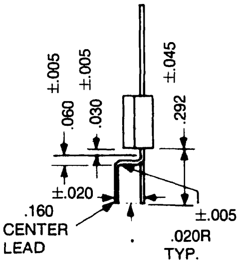


J

OTHERWISE SAME
AS G

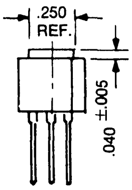
J & K

* = ENDS OF BOTTOM
LEADS TO BE PARALLEL
WITHIN .020 TOTAL
ON A GIVEN PART.



MAKE FROM
TYPE A

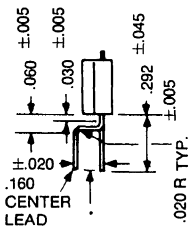
L



MAKE FROM TYPE A

N

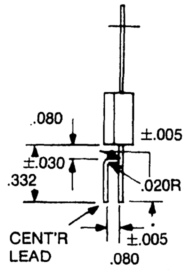
* = ENDS OF BOTTOM
LEADS TO BE PARALLEL
WITHIN .020 TOTAL
ON A GIVEN PART.



OTHERWISE SAME
AS TYPE N

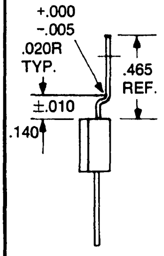
P

* = ENDS OF BOTTOM
LEADS TO BE
PARALLEL WITHIN
.020 TOTAL ON A
GIVEN PART.



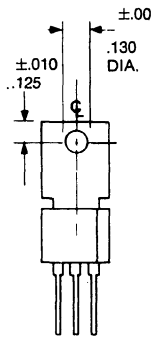
MAKE FROM
TYPE A

U



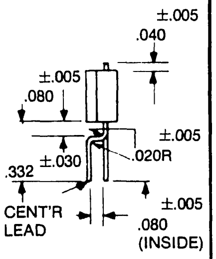
MAKE FROM
TYPE A

T

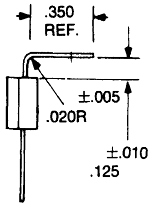


W

* = ENDS OF BOTTOM
LEADS TO BE
PARALLEL WITHIN
.020 TOTAL ON A
GIVEN PART.



X



MAKE FROM
TYPE A

Y

TO-218

FIG. A

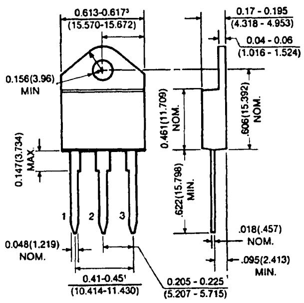


FIG. B

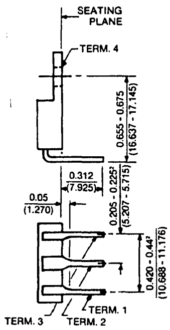
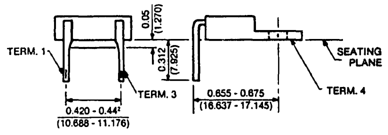


FIG. C

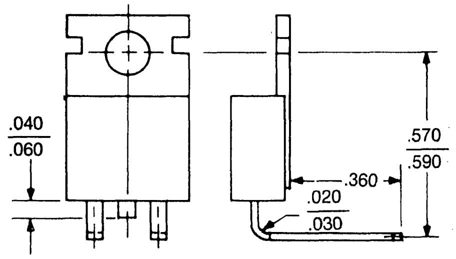


NOTES:

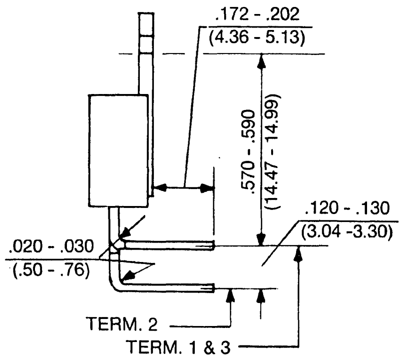
1. POSITION OF LEAD TO BE MEASURED 4.699-4.826.
2. POSITION OF LEAD TO BE MEASURED 1.270-1.397 BELOW SEATING PLANE.
3. TAB OUTLINE OPTIONAL WITH BOUNDARIES OF OVERALL TAB WIDTH AND TAB MOUNTING HOLE DIAMETER.

Package Alternatives (Cont.)

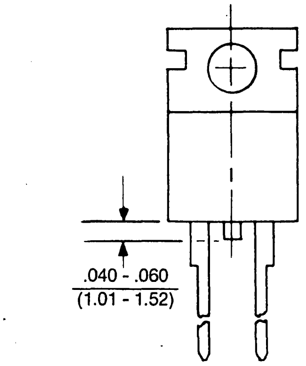
TO-220



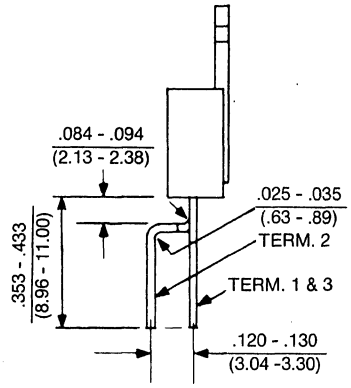
B



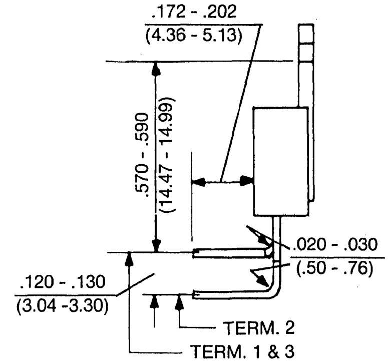
C



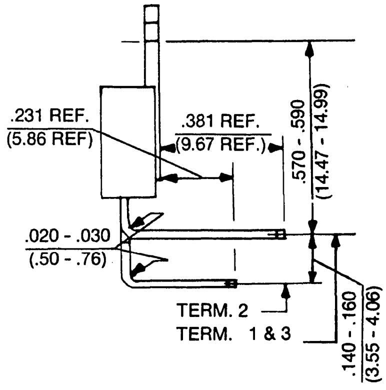
D



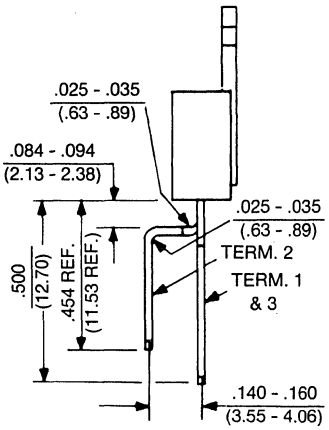
E



F



G



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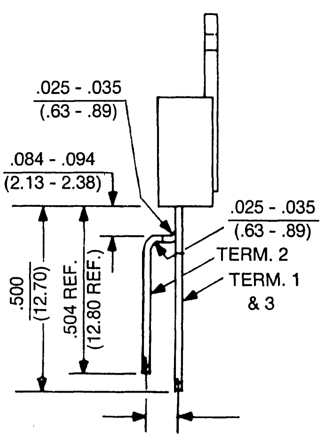
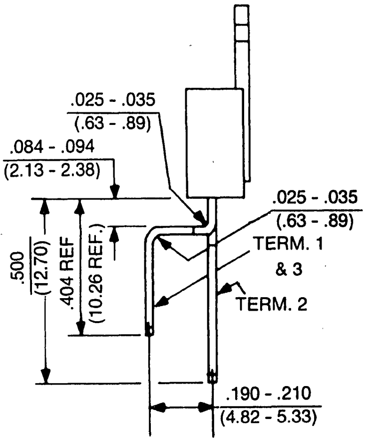


J



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