

DATA BOOK

Bipolar Power Devices

Power Transistors

Silicon Rectifiers

Bipolar Power Devices

Harris Semiconductor, one of four business sectors within the Harris Corporation (the others are Information Systems, Communications, and Government Systems), is a leading manufacturer of semiconductor products that represent the state-of-the-art in complexity and performance.

In December 1988, the Harris Semiconductor Sector merged with GE Solid State, a consolidation of GE Semiconductor, RCA Solid State, and Intersil. The new Harris Semiconductor unites the strengths of four broad-based semiconductor suppliers and markets products under the Harris, RCA, GE and Intersil brands.

The products formerly supplied separately by Harris Semiconductor, GE Semiconductor, RCA Solid State, and Intersil have been integrated into eight major product lines within two major operating units as follows:

Commercial Products Group

- Digital Products
- Signal Processing Products
- ASIC Products
- Discrete Power Products
- Smart Power Products

Military and Aerospace Division

- Standard Products
- Custom Products
- Microwave Products

Because of the vast experience and expertise in innovation, design, production, and application of semiconductors realized by the merger, Harris offers one of the industry's most comprehensive and reliable product lines in a wide variety of formats, options, and packages. Continuing research and development maintains our position as the sixth largest U.S. merchant producer of semiconductors with one of the broadest and most varied product lines.



What your vision of the future demands. Today.

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Bipolar Power Devices

Harris Semiconductor offers an extensive line of bipolar power devices for use in a wide range of consumer, industrial, and high-reliability applications. This Data Book contains detailed technical information on the full line of more than 750 power transistors, power hybrid circuits, and silicon rectifiers, including ultra-fast-recovery and fast-recovery types. A complete index of these types is included on the following pages.

Three separate data sections provide definitive ratings and characteristics for each major device category. Data sheets in all sections are arranged in numeric-alphanumeric sequence. Because some devices are grouped together to show similarity of function or data, some individual type numbers may be out of sequence. To determine if a particular device type is covered by a data sheet in this book, check the **Index to Devices**.

This Data Book also contains information on high-reliability power devices, package information, and abstracts of pertinent application notes.

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Printed in USA/3-89

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GE6062	2-647	15.85
GE6251	2-653	15.86
GE6252	2-653	15.86
GE6253	2-653	15.86
GE10000	2-659	15.77
GE10001	2-659	15.77
GE10002	2-659	15.77
GE10003	2-659	15.77
GE10004	2-659	15.77
GE10005	2-659	15.77
GE10006	2-659	15.77
GE10007	2-659	15.77
GE10008	2-659	15.77
GE10009	2-659	15.77
GE10015	2-666	15.78
GE10016	2-666	15.78
GE10020	2-666	15.78
GE10021	2-666	15.78
GE10022	2-666	15.78
GE10023	2-666	15.78
GE13070P	2-673	15.79
GE13071P	2-673	15.79
MJ2955	2-387	994
MJ13090	2-675	1870
MJ13091	2-675	1870
MJ15001	2-678	1093
MJ15002	2-678	1093

Type No.	Page No.	Bulletin File No.
MJ15003	2-734	1060
MJ15004	2-266	1061
MJ15022	2-748	1293
MJ15024	2-748	1293
MJ16010	2-682	1839
MJ16012	2-682	1839
MJ16014	2-686	1871
MJ16016	2-686	1871
MJE13004	2-690	1840
MJE13005	2-690	1840
MJE13006	2-693	15.89
MJE13007	2-698	15.90
MJE13008	2-703	15.91
MJE13009	2-708	15.92
MJE13070	2-713	1841
MJE13071	2-713	1841
MJE16002	2-716	1842
MJE16004	2-716	1842
MJH13090	2-719	15.94
MJH13091	2-719	15.94
MJH16010	2-683	1839
MJH16012	2-683	1839
RCA1000	2-724	594
RCA1001	2-724	594
RCA1B04	2-727	908
RCA1B05	2-727	908
RCA3054	2-729	618
RCA3055	2-729	618
RCA3773	2-734	1060
RCA6340	2-739	1205
RCA6341	2-739	1205
RCA8638C	2-734	1060
RCA8638D	2-734	1060
RCA8638E	2-734	1060
RCA8766	2-744	973
RCA8766A	2-744	973
RCA8766B	2-744	973
RCA8766C	2-744	973
RCA8766D	2-744	973
RCA8766E	2-744	973
RCA9116C	2-266	1061
RCA9116D	2-266	1061
RCA9116E	2-266	1061
RCA9166A	2-748	1293
RCA9166B	2-748	1293
RCA9202A	2-752	1414
RCA9202B	2-752	1414
RCA9202C	2-752	1414
RCA9203A	2-756	1413
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POWER TRANSISTORS

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RCA9228B	2-760	1448
RCA9228C	2-760	1448
RCA9228D	2-760	1448
RCA9229A	2-760	1448
RCA9229B	2-760	1448
RCA9229C	2-760	1448
RCA9229D	2-760	1448
RJH6674	2-286	1164
RJH6675	2-286	1164
RJH6676	2-292	1165
RJH6677	2-292	1165
RJH6678	2-292	1165
RJH6686	2-298	1171
RJH6687	2-298	1171
RJH6688	2-298	1171
TIP29	2-764	990
TIP29A	2-764	990
TIP29B	2-764	990
TIP29C	2-764	990
TIP30	2-768	988
TIP30A	2-768	988
TIP30B	2-768	988
TIP30C	2-768	988
TIP31	2-772	991
TIP31A	2-772	991
TIP31B	2-772	991
TIP31C	2-772	991
TIP32	2-776	987
TIP32A	2-776	987
TIP32B	2-776	987
TIP32C	2-776	987
TIP41	2-780	992
TIP41A	2-780	992
TIP41B	2-780	992
TIP41C	2-780	992
TIP42	2-783	996
TIP42A	2-783	996
TIP42B	2-783	996
TIP42C	2-783	996
TIP47	2-786	978
TIP48	2-786	978
TIP49	2-786	978
TIP50	2-786	978
TIP100	2-790	1153
TIP101	2-790	1153
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TIP110	2-793	1336
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TIP116	2-797	1387
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TIP120	2-801	998
TIP121	2-801	998
TIP122	2-801	998
TIP125	2-805	997
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TIP562	2-809	1212
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POWER HYBRID CIRCUITS

Type No.	Page No.	Bulletin File No.
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SILICON RECTIFIERS

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1N4245	4-2	2093
1N4246	4-2	2093
1N4247	4-2	2093
1N4248	4-2	2093
1N4249	4-2	2093
1N5059	4-5	2176
1N5060	4-5	2176
1N5061	4-5	2176
1N5062	4-5	2176
1N5624	4-8	2181
1N5625	4-8	2181
1N5626	4-8	2181
1N5627	4-8	2181
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A14C	4-11	2178
A14E	4-11	2178
A14F	4-11	2178
A14P	4-11	2178
A15A	4-14	2175
A15F	4-14	2175
A114A	4-17	2179
A114B	4-17	2179
A114C	4-17	2179
A114D	4-17	2179
A114E	4-17	2179
A114F	4-17	2179
A114M	4-17	2179
A115A	4-20	2180
A115B	4-20	2180
A115C	4-20	2180
A115D	4-20	2180
A115E	4-20	2180
A115F	4-20	2180
A115M	4-20	2180
A214A	4-23	2164
A214B	4-23	2164
A214F	4-23	2164
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BYW51-150	4-29	1412
BYW51-200	4-29	1412
DB1A	4-31	2097
DB1B	4-31	2097
DB1D	4-31	2097
DB1F	4-31	2097
DB1M	4-31	2097

Type No.	Page No.	Bulletin File No.
DB1N	4-31	2097
DB1P	4-31	2097
GE1001	4-34	2161
GE1002	4-34	2161
GE1003	4-34	2161
GE1004	4-34	2161
GE1101	4-37	2165
GE1102	4-37	2165
GE1103	4-37	2165
GE1104	4-37	2165
GE1301	4-40	2166
GE1302	4-40	2166
GE1303	4-40	2166
GE1304	4-40	2166
GER4001	4-43	2177
GER4002	4-43	2177
GER4003	4-43	2177
GER4004	4-43	2177
GER4005	4-43	2177
GER4006	4-43	2177
GER4007	4-43	2177
MUR-810	4-46	1355
MUR-815	4-46	1355
MUR-820	4-46	1355
MUR-840	4-48	2091
MUR-850	4-48	2091
MUR-860	4-48	2091
MUR-1610CT	4-50	1885
MUR-1615CT	4-50	1885
MUR-1620CT	4-50	1885
RUR-810	4-46	1355
RUR-815	4-46	1355
RUR-820	4-46	1355
RUR-840	4-48	2091
RUR-850	4-48	2091
RUR-860	4-48	2091
RUR-1610CT	4-50	1885
RUR-1615CT	4-50	1885
RUR-1620CT	4-50	1885
RURD-810	4-54	1356
RURD-815	4-54	1356
RURD-820	4-54	1356
RURD-1610	4-56	1383
RURD-1615	4-56	1383
RURD-1620	4-56	1383

POWER TRANSISTOR CHIPS

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PC44E	5-2	1932
PC44H	5-2	1933
PC45E	5-2	1934
PC45H	5-2	1935
PC1482	5-2	1792
PC2102	5-2	1416
PC3439	5-2	1417
PC3442	5-2	1793
PC3585	5-2	1794
PC3879	5-2	1795
PC4036	5-2	1418
PC5038	5-2	1796
PC5240	5-2	1797
PC5303	5-2	1395
PC5320	5-2	1419
PC5322	5-2	1420
PC5415	5-2	1421
PC5671	5-2	1798
PC6079	5-2	1799
PC6107	5-2	1391
PC6213	5-2	1800
PC6247	5-2	1801
PC6284	5-2	1392
PC6287	5-2	1393
PC6292	5-2	1390
PC6354	5-2	1802
PC6385	5-2	1803
PC6388	5-2	1407
PC6476	5-2	1804
PC6478	5-2	1805
PC6488	5-2	1806
PC6491	5-2	1807
PC6650	5-2	1808
PC6668	5-2	1408
PC6673	5-2	1409
PC6678	5-2	1404
PC6688	5-2	1403
PC6704	5-2	1809
PC6754	5-2	1810
PC6773	5-2	1410
PC8638	5-2	1400
PC8766	5-2	1402
PC9116	5-2	1401
PC9166	5-2	1399
PC9202	5-2	1396
PC9203	5-2	1398
PC13005	5-2	2149
PC16010	5-2	2150
PCTIP110	5-2	1405
PCTIP115	5-2	1406

Power Transistors

Technical Data

2

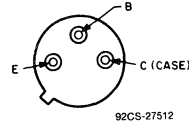
Silicon N-P-N Planar Transistor

For High-Speed Switching Service in
Electronic Data-Processing Systems

Features:

- Characteristics stabilized by prolonged baking at 300° C
- Typical pulse beta = 75
- Low saturation voltages

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The 2N697 is a silicon n-p-n transistor designed for use in high-speed-switching applications in military and industrial data processing equipment.

This transistor is especially designed and processed to assure stability of characteristics and reliable performance under conditions of severe thermal and mechanical stress, and other environmental hazards.

The 2N697 is supplied in a TO-205AD package.

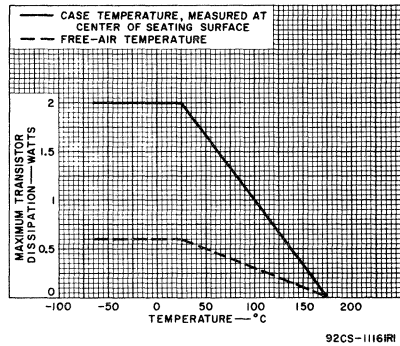


Fig. 1 - Current derating chart.

MAXIMUM RATINGS, Absolute-Maximum Values

* V_{CB0}	60	V
* V_{CER} ($R_{BE} = 10 \Omega$)	40	V
* V_{EBO}	5	V
* I_C	0.5	A
* P_T		
At $T_C \leq 25^\circ C$	2	W
At $T_C > 25^\circ C$	See Fig. 1	
At $T_A \leq 25^\circ C$	0.6	W
At $T_A > 25^\circ C$	See Fig. 1	
* T_{sto}, T_J	-65 to +175	°C
* T_L		
At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.	300	°C

* In accordance with JEDEC registration data.

ELECTRICAL CHARACTERISTICS, at Ambient Temperature (T_A) = 25°C,
unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS			UNITS
	VOLTAGE V dc		CURRENT mA dc			Min.	Typ.	Max.	
	V _{CB}	V _{CE}	I _C	I _E	I _B				
* I _{CBO} T _A = 150°C	30			0		—	0.01	1	μA
	30			0		—	1	100	
* h _{FE}		10	150 ^b			40	75	120	
V _{(BR)CBO}			0.1	0		60	75	—	V
V _{(BR)EBO}			0	0.1		5	7.5	—	V
* V _{CE} (sus) R _{BE} = 10 Ω			100 ^a			40	60	—	V
* V _{CE} (sat)			150 ^b		15	—	0.8	1.5	V
* V _{BE} (sat)			150 ^b		15	—	1	1.3	V
* h _{fe} f = 20 MHz		10	50			2.5	10	—	
* C _{ob}	10			0		—	20	35	pF
f _T						—	100	—	MHz

^a Pulsed to prevent excessive heating of collector junction

^b Pulsed: Pulse duration ≤ 300 μs, duty factor ≤ 2%.

* In accordance with JEDEC registration data.

Silicon N-P-N Power Transistors

General-Purpose Types for Medium-Power Applications

Features:

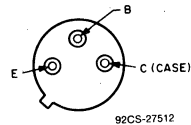
- High-temperature characterization
- High dc beta at 200 mA
- Full switching-time characterization at 200 mA

The 2N1479 — 2N1482 are silicon n-p-n power transistors. These transistors are intended for a wide variety of applications in industrial and military equipment.

They are particularly useful in power-switching circuits such as in dc-to-dc converters, inverters, choppers, solenoid and relay control; in oscillator, regulator, and pulse-amplifier circuits; and as class A and class B push-pull audio and servo amplifiers.

These transistors feature high beta at high current, and excellent high-temperature performance. They employ the JEDEC TO-205AD hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

	2N1479	2N1480	
	2N1481	2N1482	
Maximum Ratings, Absolute-Maximum Values:			
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100
			V
*COLLECTOR-TO-EMITTER VOLTAGE:			
With base open, sustaining	$V_{CEO(sus)}$	40	55
With emitter-to-base reverse biased			
($V_{EB} = 1.5$ volts)	V_{CEX}	60	100
			V
*EMITTER-TO-BASE VOLTAGE	V_{EB}	12	12
			V
*COLLECTOR CURRENT	I_C	1.5	1.5
			A
*EMITTER CURRENT	I_E	-1.75	-1.75
			A
*BASE CURRENT	I_B	1	1
			A
*TRANSISTOR DISSIPATION:	P_T		
(See Rating Chart Fig. 1):			
At case temperature of 25° C		5	5
At case temperature of 100° C		2.86	2.86
			W
TEMPERATURE RANGE:			
Operating and Storage		-65 to +200	°C

*In accordance with JEDEC registration data

2N1479, 2N1480, 2N1481, 2N1482

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS								UNITS
		VOLTAGE V dc			CURRENT mA dc			2N1479		2N1480		2N1481		2N1482		
		V _{CB}	V _{CE}	V _{EB}	I _C	I _B	I _E	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
* Collector Cutoff Current: T _C = 150°C	I _{CBO}	30				0		10		10		10		10	μA	
* Emitter Cutoff Current	I _{EBO}	30				0		500		500		500		500	μA	
* Collector-To-Emitter Voltage: With base-emitter junction reverse-biased	V _{CEX}			1.5	0.25			60		100		60		100	V	
* With base open, sustaining	V _{CEO(sus)}				50	0		40		55		40		55	V	
* Base-To-Emitter Voltage	V _{BE}		4		200			3		3		3		3	V	
* DC Current Transfer Ratio	h _{FE}		4		200			20	60	20	60	35	100	35	100	
* Small-Signal Current Transfer Ratio	h _{fe}		4		5			50 Typ.		50 Typ.		50 Typ.		50 Typ.		
* DC Collector-To-Emitter Saturation Resistance	R _s				200 200	20 10		7		7		7		7	Ω	
* Collector-To-Base Capacitance	C _{ob}	40						150 Typ.		150 Typ.		150 Typ.		150 Typ.	pF	
* Thermal Time Constant	τ ₁							10 Typ.		10 Typ.		10 Typ.		10 Typ.	ms	
* Alpha-Cutoff Frequency	f _{αb}	28			5			1.5 Typ.		1.5 Typ.		1.5 Typ.		1.5 Typ.	MHz	
* Switching Time:																
Delay Time	t _d [*]							0.2 Typ.		0.2 Typ.		0.2 Typ.		0.2 Typ.	μs	
Rise Time	t _r [*]							1 Typ.		1 Typ.		1 Typ.		1 Typ.		
Storage Time	t _s [*]							0.6 Typ.		0.6 Typ.		0.6 Typ.		0.6 Typ.		
Fall Time	t _f [*]							1 Typ.		1 Typ.		1 Typ.		1 Typ.		
* Thermal Resistance:																
Junction-to-case	R _{θJC}							35		35		35		35	°C/W	
Junction-to-free air	R _{θJFA}							200		200		200		200		

*In accordance with JEDEC registration data

*I_C = 200 mA, I_{B1} = 20 mA, I_{B2} = -8.5 mA; see Figs. 6 and 7.

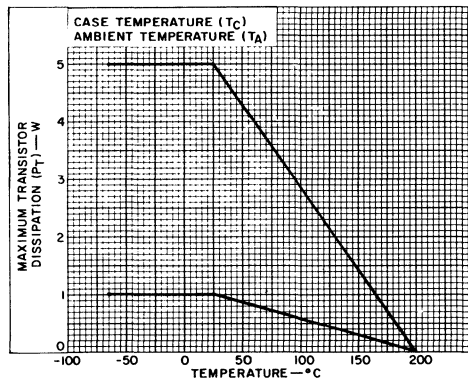


Fig. 1 - Derating chart for all types.

92CS-10446 R4

2N1479, 2N1480, 2N1481, 2N1482

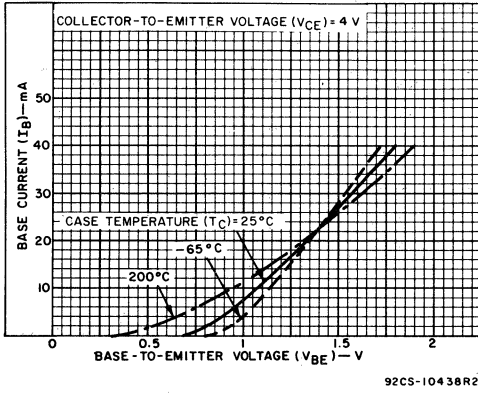


Fig.2 — Typical input characteristics for all types.

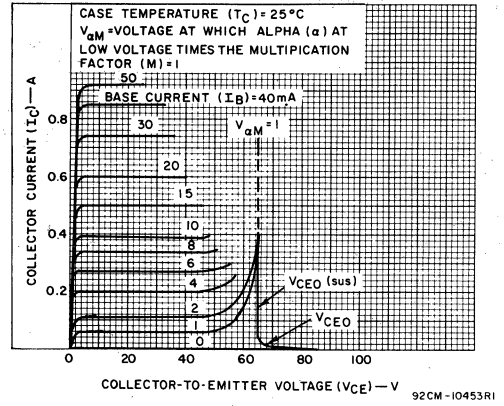


Fig.3 — Typical output characteristics for all types.

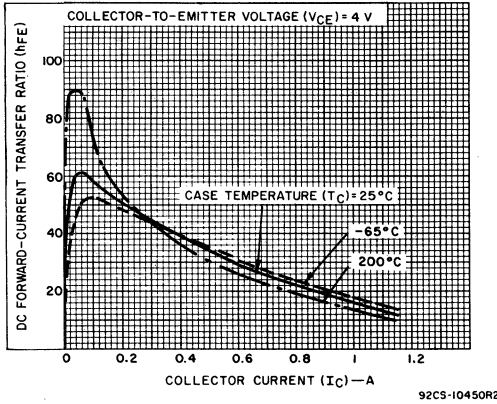


Fig.4 — Typical dc beta characteristics for all types.

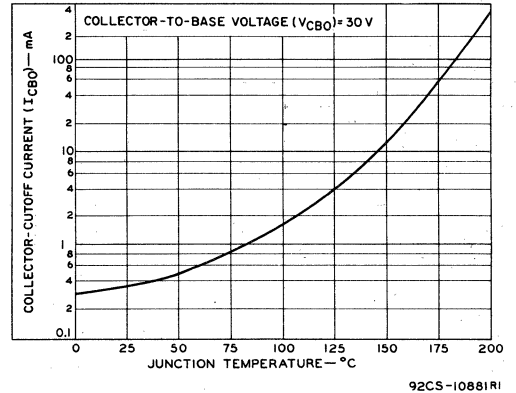


Fig.5 — Typical leakage characteristics for all types.

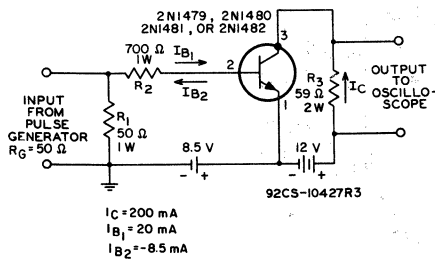


Fig.6 — Test circuit for measurement of saturated switching times.

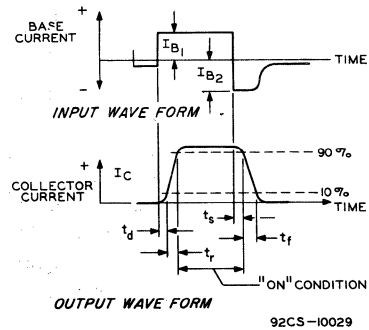


Fig.7 — Oscilloscope display for measurement of switching times (test circuit in Fig. 6).

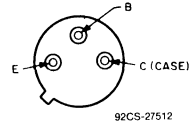
Medium-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications
In Industrial and Commercial Equipment

2N2102 Features:

- Gain bandwidth product (f_T) = 120 MHz (typ.); useful in applications from dc to 20 MHz
- High breakdown voltage:
 $V_{\text{BR}(CBO)} = 120 \text{ V min. at } I_C = 0.1 \text{ mA}$
- Low saturation voltages:
 $V_{\text{CE}}(\text{sat}) = 0.5 \text{ V max. at } I_C = 150 \text{ mA}$
 $V_{\text{BE}}(\text{sat}) = 1.1 \text{ V max. at } I_C = 150 \text{ mA}$
- Beta (h_{FE}) controlled over 5 decades of I_C

TERMINAL DESIGNATIONS



JEDEC TO-205AD

2

The 2N1613 and 2N2102 are silicon n-p-n planar transistors intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. They feature exceptionally low noise, low leakage, high switching speed, and high nulsed beta.

The 2N2102 is a direct replacement for the 2N1613. In addition, because of its junction design, the 2N2102 has higher breakdown-voltage ratings, higher dissipation ratings, lower saturation voltages, higher sustaining voltages, and lower output capacitance.

These transistors are supplied in the JEDEC TO-205AD hermetic package.

Features for Both Types:

- For operation at junction temperature up to 200°C
- Planar construction for low noise and low leakage
- Low output capacitance

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N2102	2N1613	
* V_{CBO}	120	75	V
* $V_{\text{CER}}(\text{SUS})$ $R_{\text{BE}} = 10 \Omega$	80	50	V
* $V_{\text{CEO}}(\text{SUS})$	65	—	V
* V_{EBO}	7	7	V
* I_C	1*	1	A
* P_T :			
At $T_C \leq 25^\circ \text{C}$	5	3	W
At $T_A \leq 25^\circ \text{C}$	1	0.8	W
At $T_C > 25^\circ \text{C}$	2.86	17.1	mW/°C
At $T_A > 25^\circ \text{C}$	5.7	4.57	mW/°C
* T_J, T_{sig}	—65 to +200		°C
* T_L (During soldering): At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.	300		°C

* In accordance with JEDEC registration data format.

2N1613, 2N2102

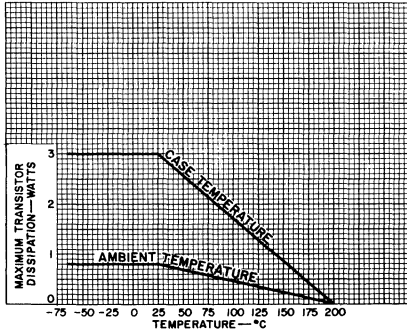
ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	Voltage V dc		Current mA dc		2N1613		2N2102		
	V _{CB}	V _{CE}	I _C	I _B	Min.	Max.	Min.	Max.	
I _{CBO}	60				—	0.01	—	0.002	μA
At T _C =150°C	60				—	10	—	2	
I _{EBO} V _{EB} =5 V			0		—	0.01	—	0.002	μA
h _{FE}		10	0.01		—	—	10	—	
		10	0.1		20	—	20	—	
		10	10 ^a		35	—	35	—	
		10	150 ^a		40	120	40	120	
		10	500 ^a		20	—	25	—	
At T _C =-55°C		10	10 ^a		20	—	20	—	
V _{RT} V _{EB} =1.5 V, I _E =0					—	—	120	—	V
V(BR)CBO I _E =0			0.1		75	—	120	—	V
V(BR)EBO I _E =0.1 mA			0		7	—	7	—	V
V _{CEO} (sus)			100 ^a	0	—	—	65	—	V
V _{CER} (sus) R _{BE} =10 Ω			100 ^a		50	—	80	—	V
V _{BE} (sat)			150 ^a	15	—	1.3	—	1.1	V
V _{CE} (sat)			150 ^a	15	—	1.5	—	0.5	V
h _{fe} f=1 kHz		5 10	1 5		30 35	100 150	30 35	100 150	
|h _{fe}|| f=20 MHz		10	50		3	—	3	—	
h _{ib} f=1 kHz		5 10	1 5		24 4	34 8	24 4	34 8	Ω
h _{rb} f=1 kHz		5 10 10	1 1 5		— — —	3x10 ⁻⁴ 3x10 ⁻⁴ —	— — —	3x10 ⁻⁴ — 3x10 ⁻⁴	
h _{ob} f=1 kHz		5 10	1 5		0.05 0.05	0.5 0.5	0.01 0.01	0.5 1	μmho
C _{ob} I _E =0		10			—	25	—	15	pF
C _{ib} V _{EB} =0.5 V			0		—	80	—	80	pF
NF BW=1 Hz Ref.sig.freq.=1 kHz R _G =510 Ω (2N1613) Z _G =1000 Ω (2N2102)		10	0.3		—	12	—	6	dB
t _d + t _r + t _f ^b					—	30	—	30	ns
R _{θJC}					—	58.3	—	35	°C/W
R _{θJA}					—	219	—	175	

* In accordance with JEDEC registration data format.

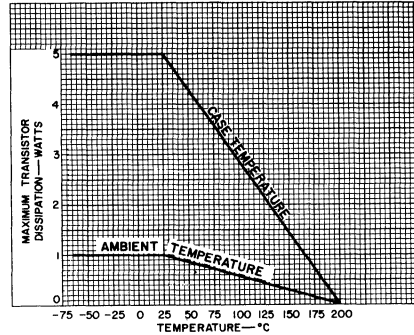
^a Pulsed, pulse duration=300 μs, duty factor=1.8% (2N2102) ≤ 2% (2N1613). ^b See Fig. 14.

2N1613, 2N2102



92CS-1173R2

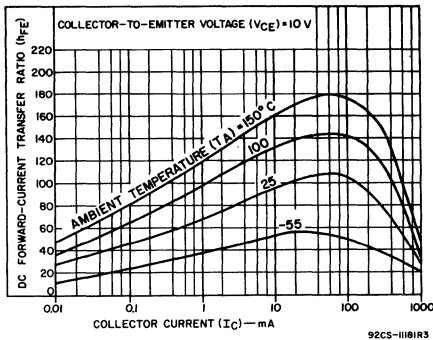
Fig. 1 - Rating chart for 2N1613.



92CS-11172R2

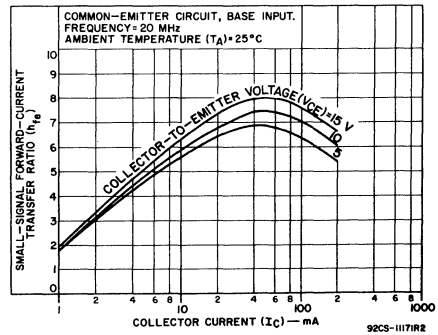
Fig. 2 - Rating chart for 2N2102.

2



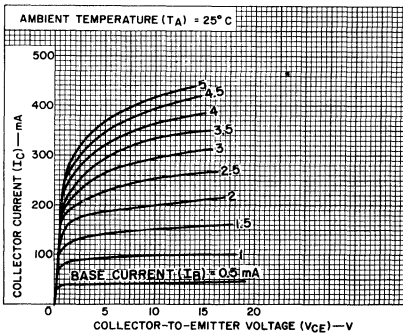
92CS-11181R3

Fig. 3 - Typical dc beta characteristics for both types.



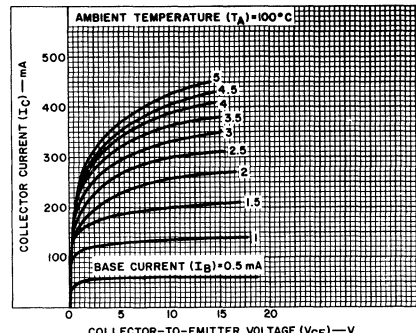
92CS-11171R2

Fig. 4 - Typical small-signal beta characteristics for both types.



92CS-12667R1

Fig. 5 - Typical output characteristics for both types.



92CS-12665R1

Fig. 6 - Typical output characteristics for both types at $T_A = 100^\circ\text{C}$.

2N1613, 2N2102

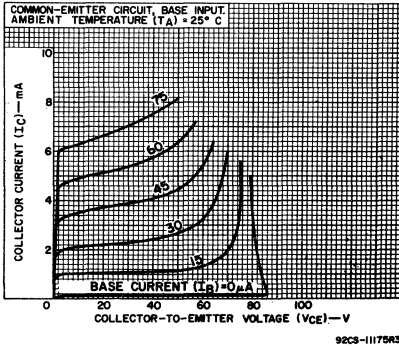


Fig. 7 - Typical high-current output characteristics for both types.

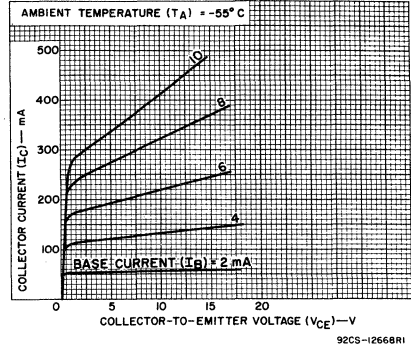


Fig. 8 - Typical output characteristics for both types at $T_A = -55^\circ\text{C}$.

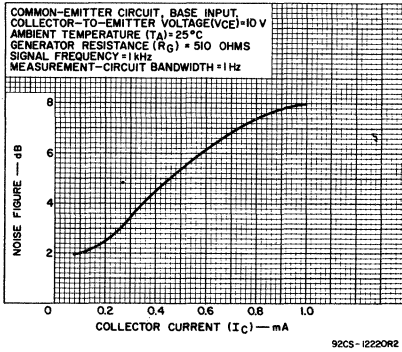


Fig. 9 - Typical noise figure characteristics for both types.

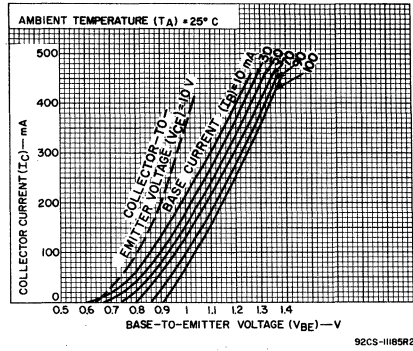


Fig. 10 - Typical transfer characteristics for both types.

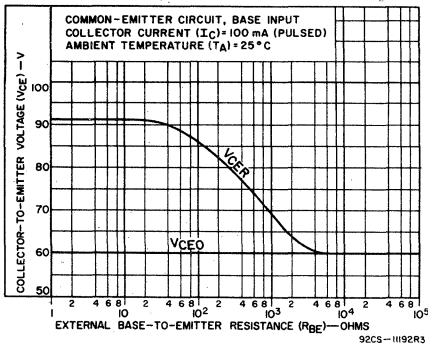


Fig. 11 - Typical sustaining voltage vs. base-to-emitter resistance for 2N1613.

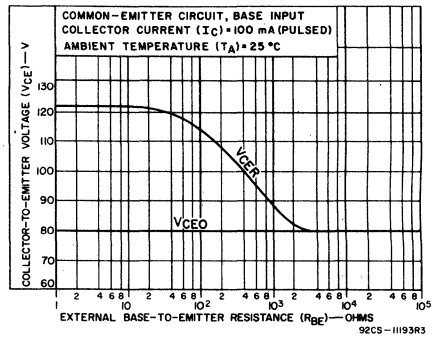


Fig. 12 - Typical sustaining voltage vs. base-to-emitter resistance for 2N2102.

2N1613, 2N2102

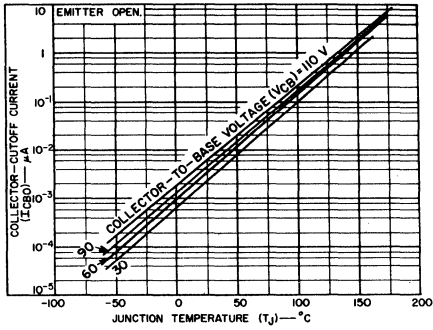


Fig. 13 — Typical leakage characteristics for both types.

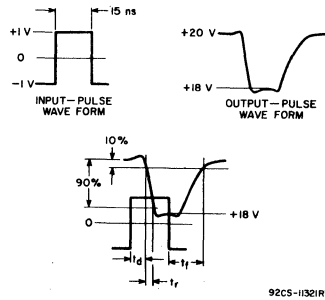
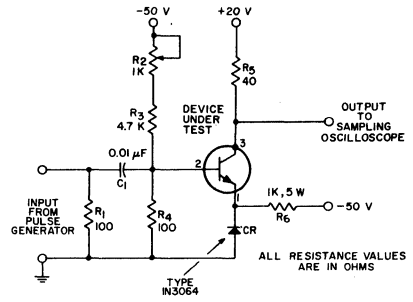


Fig. 14 — Circuit for measurement of switching time, and associated waveforms.

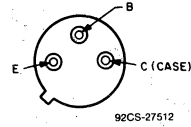
Silicon N-P-N Power-Switching Transistor

For Switching Applications

Features:

- Operation at high junction temperatures

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The 2N1700 silicon n-p-n transistor is intended for a wide variety of uses in industrial equipment. They are particularly useful in applications such as inverters, choppers, voltage and current regulators, and relay-actuating circuits.

The 2N1700 is supplied in a JEDEC TO-205AD package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N1700	
* V_{CBO}	60	V
* V_{CEX} $V_{BE} = -1.5$ V	60	V
* $V_{CEO(SUS)}$	40	V
* V_{EBO}	6	V
* I_C	1	A
* I_B	0.75	A
* P_T $T_C \leq 25^\circ\text{C}$	5	W
$T_C > 25^\circ\text{C}$	0.029	°C/W
* T_{stg}, T_J	-65 to +200	°C
* T_L At distance $\geq 1/16$ in. $\pm 1/32$ in. (1.58 mm \pm 0.8 mm) from seating plane for 10 s max.	255	°C

*In accordance with JEDEC registration data format.

ELECTRICAL CHARACTERISTICS, $T_C=25^\circ\text{C}$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		2N1700		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
I_{CBO} $V_{CB}=30\text{ V}$ $V_{CB}=60\text{ V}$					—	75 25	μA
$T_C=150^\circ\text{C}$, $V_{CB}=30\text{ V}$					—	1	mA
I_{EBO}		-6	0		—	25	μA
$V_{CEO}(\text{sus})$			0.05 ^a	0	40 ^b	—	V
V_{CEX}		-1.5	0.0005		60 ^b	—	V
h_{FE}	4		0.1 ^a		20	80	
	20		1 ^a		6	—	
V_{BE}	4		0.1		—	2	V
	20		1		—	12.5	V
$r_{CE}(\text{sat})$			0.1	0.01	—	10	Ω
$V_{CE}(\text{sat})$			1 ^a	0.5	—	12	V
h_{fe} $f=1\text{ MHz}$	4		5		40	—	
f_{htb} $V_{CB}=6\text{ V}$ $V_{CB}=28\text{ V}$				0.005	400	—	kHz
			0.0005		1.2 (typ.)		MHz
C_{obo} $V_{CB}=40\text{ V}$, $f=1\text{ MHz}$					150 (typ.)		pF
τ_i					10 (typ.)		ms
$R_{\theta C}$					—	35	$^\circ\text{C/W}$
$R_{\theta A}$					—	200	

^aIn accordance with JEDEC registration data format.

^aPulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.

^bCAUTION: The sustaining voltages $V_{CEO}(\text{sus})$ and $V_{CEX}(\text{sus})$ MUST NOT be measured on a curve tracer.

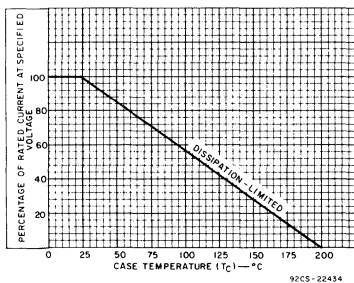


Fig. 1 - Derating curve.

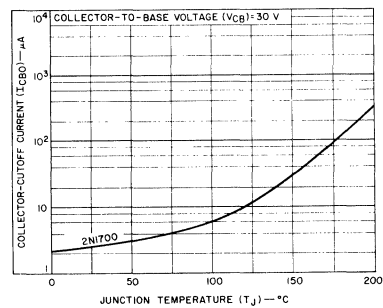


Fig. 2 - Typical collector-cutoff current characteristics.

2N1700

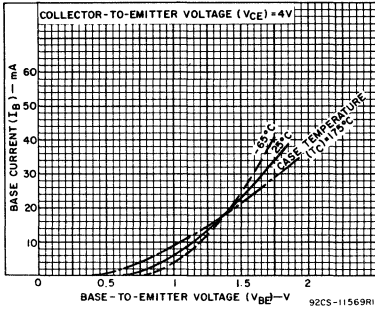


Fig. 3 - Typical input characteristics.

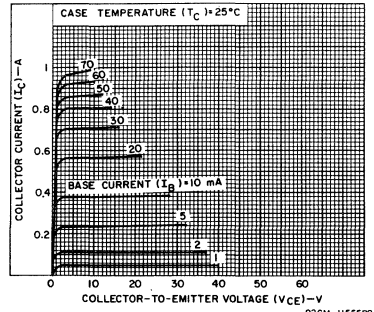


Fig. 4 - Typical output characteristics.

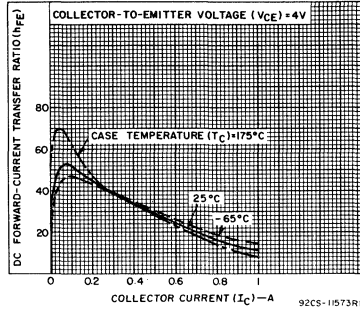
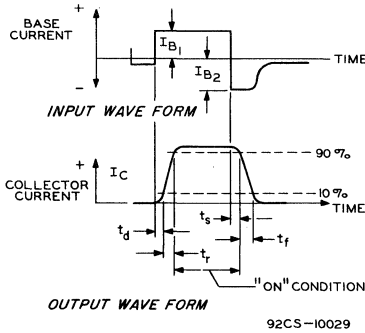
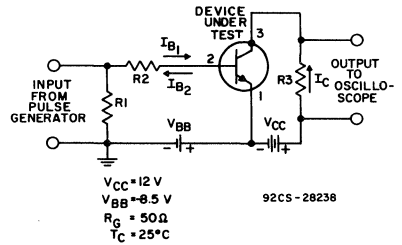


Fig. 5 - Typical dc beta characteristics.



92CS-10029



92CS-28238

2N1700

Test Conditions:

R ₁	1 W	50	Ω
R ₂	1 W	700	Ω
R ₃	2 W	59	Ω
I _C		200	mA
I _{B1}		20	mA
I _{B2}		-8.5	mA

Switching Times:

t _d	0.2	μS
t _r	1	μS
t _s	0.6	μS
t _f	1	μS

Fig. 6 - Test circuit and oscilloscope display for measurement of switching times.

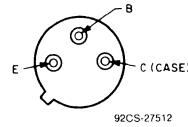
Medium-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications
In Industrial and Commercial Equipment

Features:

- For operation at junction temperature up to 200°C
- Planar construction for low noise and low leakage
- Low output capacitance

TERMINAL DESIGNATIONS



JEDEC TO-205AD

2

The 2N1893 and 2N2405* are silicon n-p-n planar transistors intended for a variety of small-signal and medium-power applications. They feature exceptionally high collector-to-emitter sustaining voltage, low leakage characteristics, high switching speeds, and high pulse beta (h_{FE}).

The 2N2405 is a direct replacement for type 2N1893 for most applications. In addition, the 2N2405 has high voltage ratings, lower saturation voltages, and higher sustaining voltages than the 2N1893.

The 2N1893 and 2N2405 are supplied in the TO-205AD package.

*Formerly Dev. Type TA2235A.

2N2405 Features:

- Minimum gain-bandwidth product (f_T) of 120 MHz; useful in application from dc to 50 MHz
- High sustaining voltage:
 $V_{CEO(sus)} = 90$ V min.
- Low saturation voltages:
 $V_{CE(sat)} = 0.5$ V max. at $I_C = 150$ mA
 $V_{BE(sat)} = 1.1$ V max. at $I_C = 150$ mA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N1893	2N2405	
* COLLECTOR-TO-BASE VOLTAGE	120	120	V
* COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) $\leq 10 \Omega$	100	140	V
With base open	80	90	V
* EMITTER-TO-BASE VOLTAGE	7	7	V
* COLLECTOR CURRENT	0.5	1	A
* TRANSISTOR DISSIPATION:			
At case temperature up to 25°C	3	5	W
At free-air temperatures up to 25°C	0.8	1	W
At temperatures above 25°C	See Figs 1 & 2		
* TEMPERATURE RANGE:			
Storage and operating (Junction)	-65 to +200		°C
* LEAD TEMPERATURE (During soldering):			
At distance from seating plane for 10 s max.			
$\geq 1/16$ in. (1.58 mm) for 2N1893 and			
$\geq 1/32$ in. (0.8 mm) for 2N2405	255		C

* In accordance with JEDEC registration data format (JS-9 RDF-2).

2N1893, 2N2405

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc		CURRENT mA dc			2N1893		2N2405		
	V_{CB}	V_{CE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
* I_{CBO} $T_C = 150^\circ C$	90			0		—	0.01	—	0.01	μA
* I_{EBO} $V_{BE} = -5 V$			0			—	0.01	—	0.01	μA
* $V_{CEO(sus)}$			100 ^a 30 ^a	0	0	—	—	90 90	— —	V
* $V_{CER(sus)}$ $R_{BE} = 10 \Omega$ $R_{BE} = 500 \Omega$			100 ^a 100 ^a			100 —	— —	140 120	— —	V
* $V_{(BR)CBO}$			0.1	0		120	—	120	—	V
* $V_{(BR)EBO}$			0	0.1		7	—	7	—	V
* $V_{CE(sat)}$			150 ^a 50 ^a	15	5	— 5	1.5	—	0.5 0.2	V
* $V_{BE(sat)}$			150 ^a 50 ^a	15	5	— 5	1.3 0.9	—	1.1 0.9	V
* h_{FE}		10	150 ^a			40	120	60	200	
* h_{FE}		10	10 ^a			35	—	35	—	
* h_{FE}		10	0.1			20	—	—	—	
* h_{FE} $T_C = 55^\circ C$		10	10			20	—	20	—	
* h_{fe} $f = 1 \text{ kHz}$		5	1			30	100	—	—	
* h_{fe} 1 kHz		5	5			—	—	50	275	
* h_{fe} 1 kHz		10	5			45	—	—	—	
* h_{fe} 20 MHz		10	50			2.5	—	6	—	
* h_{ib} $f = 1 \text{ kHz}$	5 10		1 5			20 4	30 8	24 4	34 8	Ω
* h_{rb} $f = 1 \text{ kHz}$	5 10		1 5			— —	1.25×10^{-4} 1.5×10^{-4}	— —	3×10^{-4} 3×10^{-4}	
* h_{ob} $f = 1 \text{ kHz}$	5 10		1 5			— —	0.5 0.5	— —	0.5 0.5	μmho
* C_{obo}	10			0		—	15	—	15	pF
* C_{ib} $V_{BE} = -0.5 V$			0			—	85	—	80	pF
* NF RG = 500 Ω BW = 15 kHz $f = 1 \text{ kHz}$	10		0.3			—	—	—	6	dB
* $R_{\theta J-C}$						—	58.3	—	35	$^\circ C/W$
* $R_{\theta J-A}$						—	219	—	175	

^a Pulsed. Pulse duration = 300 μsec max.; duty factor $\leq 2\%$.
* In accordance with JEDEC registration data format (JS-9 RDF-2).

2N1893, 2N2405

2

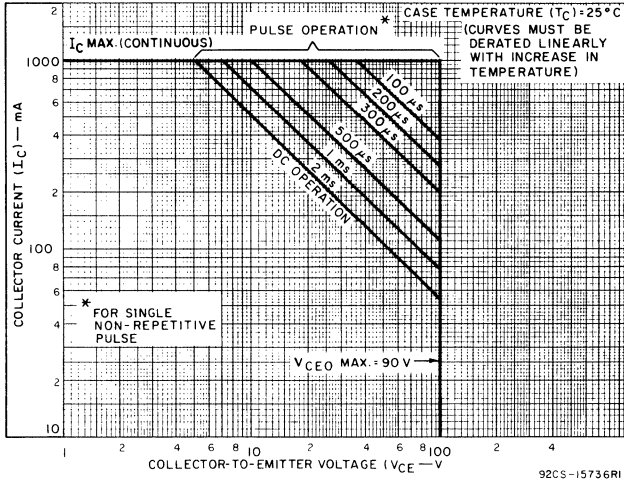


Fig. 1 — Maximum operating areas for type 2N2405.

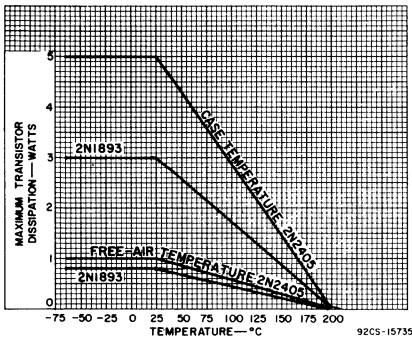


Fig. 2 — Dissipation derating curves for types 2N1893, and 2N2405.

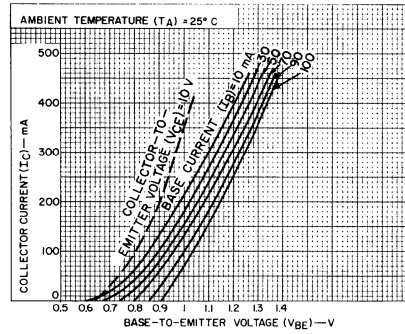


Fig. 3 — Typical transfer characteristics for types 2N1893 and 2N2405.

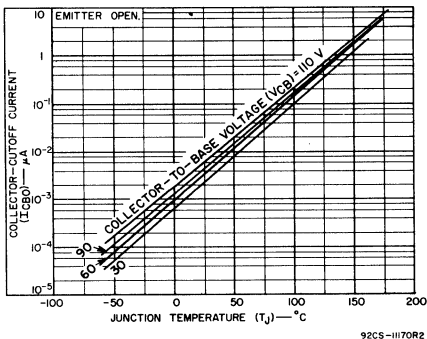


Fig. 4 — Typical cutoff characteristics for types 2N1893 and 2N2405.

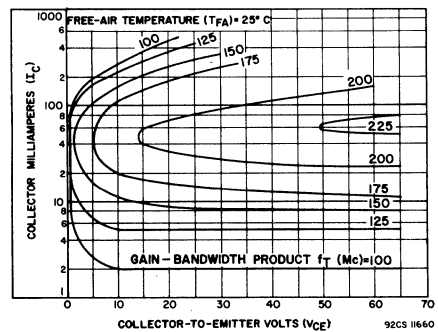


Fig. 5 — Typical gain bandwidth product characteristics for types 2N1893 and 2N2405.

2N1893, 2N2405

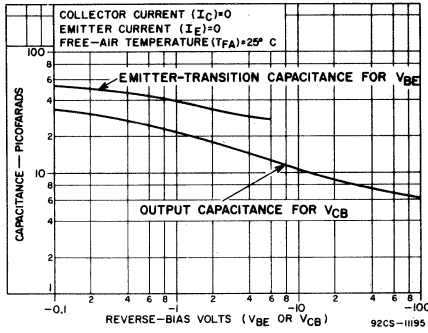


Fig. 6 - Typical capacitance characteristics for types 2N1893 and 2N2405.

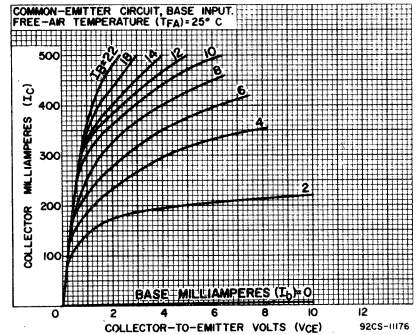


Fig. 7 - Typical collector characteristics at 25°C for type 2N2405.

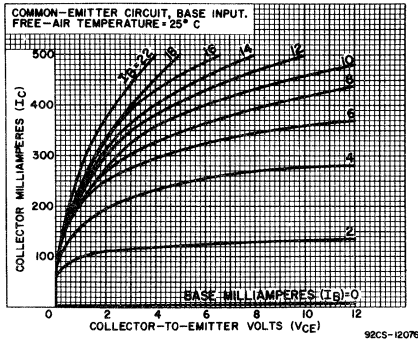


Fig. 8 - Typical collector characteristics at 25°C for type 2N1893.

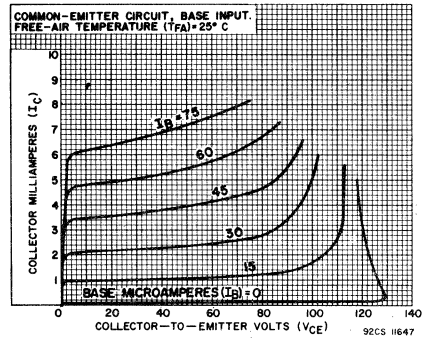


Fig. 9 - Typical collector characteristics at 25°C for type 2N2405.

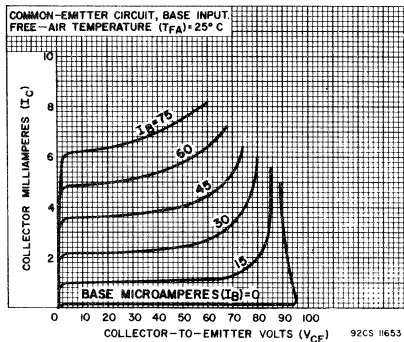


Fig. 10 - Typical collector characteristics at 25°C for type 2N1893.

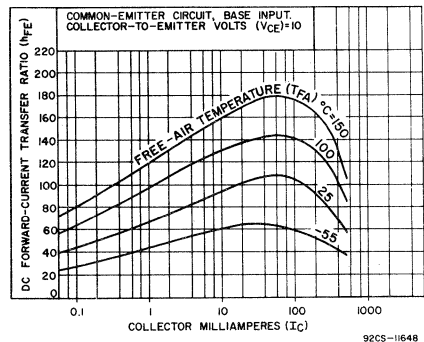


Fig. 11 - Typical dc-beta characteristics for types 2N1893 and 2N2405.

2N1893, 2N2405

2

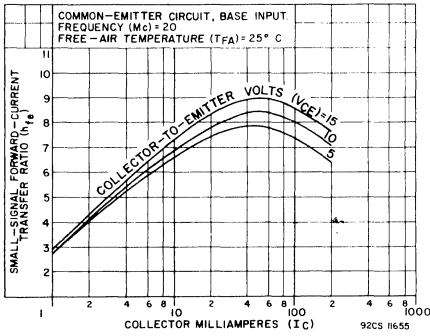


Fig. 12 - Typical small-signal beta characteristics for types 2N1893 and 2N2405.

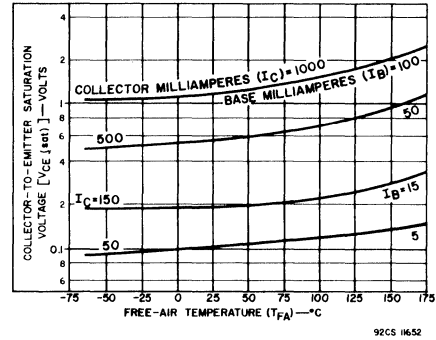


Fig. 13 - Typical saturation characteristics for types 2N1893 and 2N2405.

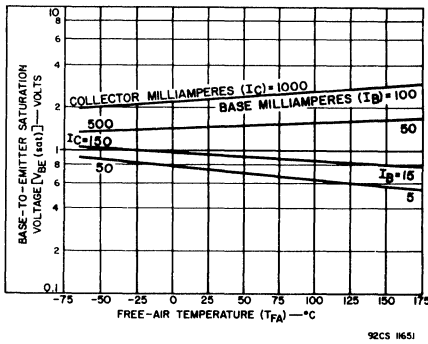


Fig. 14 - Typical saturation characteristics for types 2N2405 and 2N1893.

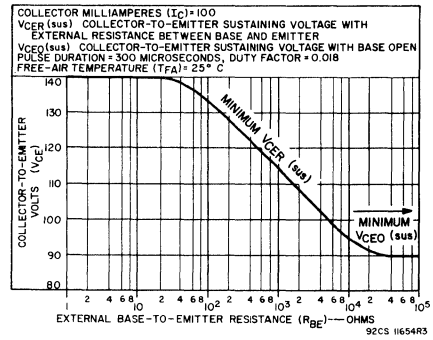


Fig. 15 - Sustaining voltage characteristic for type 2N2405.

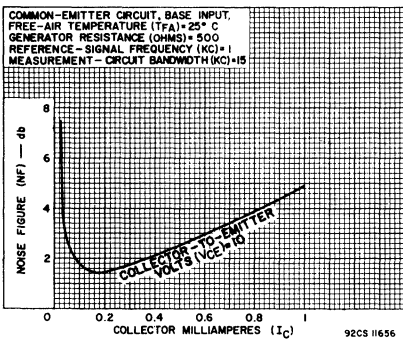


Fig. 16 - Typical wide-band noise characteristic for type 2N2405.

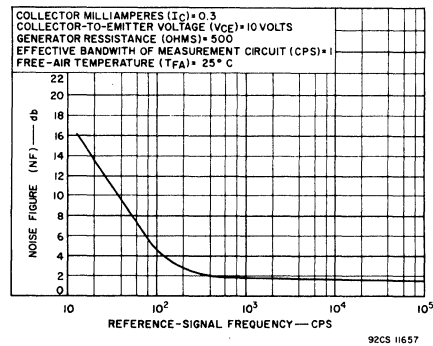


Fig. 17 - Typical narrow-band noise characteristic for type 2N2405.

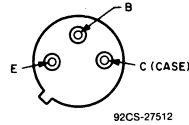
Silicon N-P-N Planar Transistor

General-Purpose Type for Small-Signal,
Medium-Power Applications

Features:

- Minimum gain-bandwidth product = 100 MHz;
useful in applications from dc to 20 MHz
- Operation at high junction temperatures
- Planar construction for low-noise and low-leakage characteristics
- Very low output capacitances

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The 2N2270 is a silicon n-p-n planar transistor intended for a wide variety of small-signal and medium-power applications in military and industrial equipment. It features exceptionally low noise and leakage characteristics, and very low output capacitance.

The 2N2270 is supplied in a TO-205AD package.

MAXIMUM RATINGS, Absolute-Maximum Values:

* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	V
* COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) $\leq 10 \Omega$	V_{CER}	60	V
With base open	V_{CEO}	45	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
* COLLECTOR CURRENT	I_C	1	A
* TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		5	W
At case temperatures above 25°C		See Fig. 1	
At free-air temperatures up to 25°C		1	W
At free-air temperatures above 25°C		See Fig. 1	
* TEMPERATURE RANGE:			
Storage and operating (Junction)	T_{stg}, T_J	-65 to +200	°C
* LEAD TEMPERATURE (During soldering):			
At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.	T_L	255	°C

* In accordance with JEDEC registration data format (JS-6 RDF-1).

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS		UNITS
	VOLTAGE V dc			CURRENT mA dc		2N2270		
	V _{CB}	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	
* I _{CBO} T _C = 150°C	60 60					— —	0.05 50	μA
* I _{EBO}			—5	0		—	0.1	μA
* V _{(BR)EBO} I _E = 0.1 mA				0		7	—	V
* V _{(BR)CBO}				0.1		60	—	V
* V _{CER(sus)} ^a R _{BE} = 10 Ω				100 ^b		60	—	V
* V _{CEO(sus)} ^a				100 ^b	0	45	—	V
* V _{CE(sat)}				150 ^b	15		0.9	
* V _{BE(sat)}				150	15	—	1.2	V
* h _{FE}		10 10		150 ^b 1		50 30	200 —	
* h _{fe} f = 1 kHz		10		5		50	275	
* |h _{fe}| f = 20 MHz		10		50		5	—	
* f _T		10		50		100	—	MHz
* NF f = 1 kHz R _G = 1 KΩ BW = 1 Hz		10		0.3		—	10	dB
* t _{ON} + t _{OFF} (See Fig. 8)							30	ns
* C _{ob} I _E = 0	10					—	15	pF
* C _{ib}			—0.5	0		—	80	pF
* R _{θJC}						—	35	°C/W
* R _{θJA}						—	175	

* In accordance with JEDEC registration data.

^a CAUTION: The sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.^b Pulsed; pulse duration ≤ 300 μs, duty factor ≤ 1.8%.

2N2270

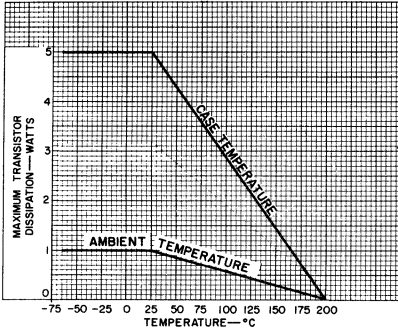


Fig. 1 - Rating Chart.

92CS-11172R2

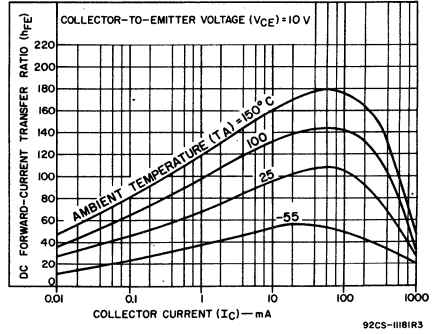


Fig. 2 - Typical dc forward-current transfer ratio characteristics.

92CS-11181R3

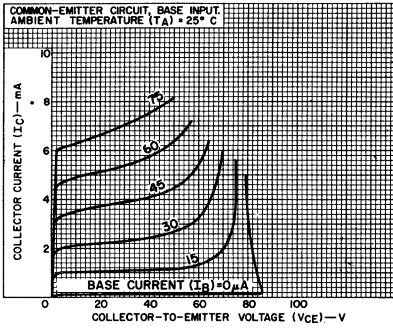


Fig. 3 - Typical collector characteristics.

92CS-11175R3

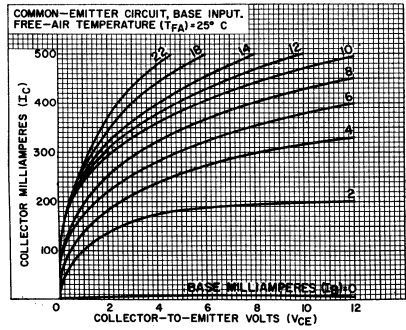


Fig. 4 - Typical collector characteristics.

92CS-11189

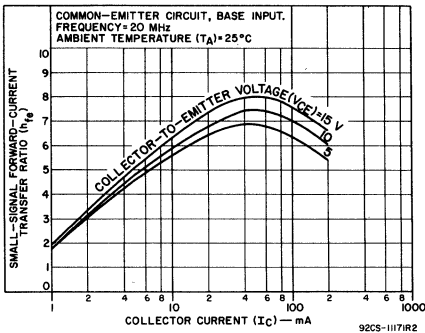


Fig. 5 - Typical small-signal forward-current ratio characteristics.

92CS-11171R2

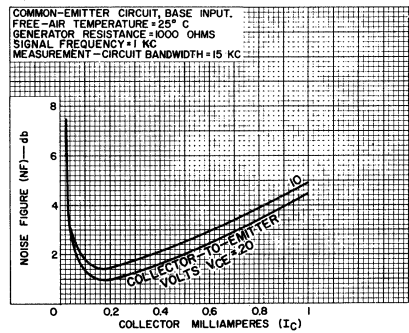


Fig. 6 - Typical noise-figure characteristics.

92CS-11179R1

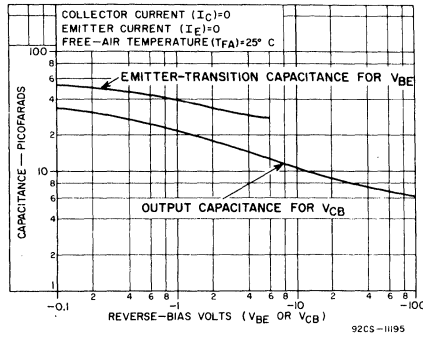


Fig. 7 — Typical emitter-transition-capacitance and output-capacitance characteristics.

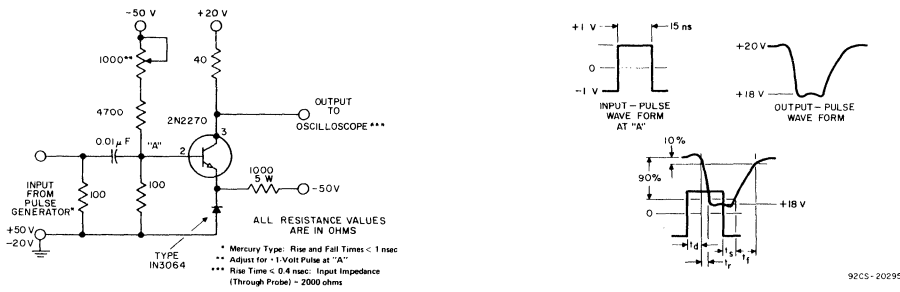


Fig. 8 — Test circuit for measurement of saturated switching time and associated waveforms.

2N3053, 2N3053A

File Number **960**

General-Purpose, Medium-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications

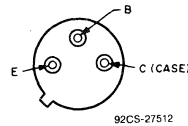
Features:

- Maximum safe-area-of-operation curve
- High gain-bandwidth product
 $f_T = 100 \text{ MHz}$
- Low leakage current

Applications:

- Audio amplifiers
- Controlled amplifiers
- Power supplies
- Power oscillators

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The 2N3053 and 2N3053A are silicon n-p-n planar transistors useful up to 20 MHz in small-signal, medium-power applications. These types are supplied in the JEDEC TO-205AD package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N3053	2N3053A	
* V_{CBO}	60	80	V
$V_{CER(SUS)}$ $R_{BE} = 10 \Omega$	50	70	V
* $V_{CEO(SUS)}$	40	60	V
$V_{CEV(SUS)}$ $V_{BE} = -1.5 \text{ V}$	60	80	V
* V_{EBO}	5	5	V
* I_C	0.7	0.7	A
* P_T $T_C \leq 25^\circ \text{C}$	5	5	W
$T_A \leq 25^\circ \text{C}$	1	1	W
$T_C > 25^\circ \text{C}$	Derate linearly 0.0286		W/ $^\circ \text{C}$
* T_{stg}, T_J	-65 to +200		$^\circ \text{C}$
* T_L At distance $1/16 \pm 1/32 \text{ in. (1.58 mm } \pm 0.8 \text{ mm)}$ from seating plane for 10 s max.	235		$^\circ \text{C}$

* In accordance with JEDEC registration data.

2N3053, 2N3053AELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25° C

CHARACTERISTICS	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT mA dc		2N3053		2N3053A		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEV}	30 60	—	-1.5 -1.5	— —	— —	— —	0.25 —	— —	— 0.25	μA
I_{BEV}	—	60	-1.5	—	—	—	—	—	0.25	μA
I_{EBO}	—	—	-4	0	—	—	0.25	—	0.25	μA
h_{FE}	—	2.5 10	— —	150 150 ^a	— —	25 50	— 250	25 50	— 250	
$V_{IBRICBO}$	—	—	—	0.1	—	60	—	80	—	V
$V_{IBRIEBO}$ $I_E = 0.1$ mA	—	—	—	0	—	5	—	5	—	V
$V_{CEO(SUS)}$	—	—	—	0.1 ^a	0	40	—	60	—	V
$V_{CER(SUS)}$ $R_{BE} = 10 \Omega$	—	—	—	100 ^a	—	50	—	70	—	V
$V_{BE(sat)}$	—	—	—	150	15	—	1.7	0.6	1	V
$V_{CE(sat)}$	—	—	—	150	15	—	1.4	—	0.3	V
V_{BE}	—	2.5	—	150	—	—	1.7	—	1	V
h_{fe} $f = 20$ MHz	—	10	—	50	—	5	—	5	—	
C_{obo} $f = 140$ kHz	10	—	—	—	—	—	15	—	15	pF
C_{ib} $f = 140$ kHz	—	—	-0.5	0	—	—	80	—	80	pF
$R\theta_{JC}$	—	—	—	—	—	—	35	—	35	°C/W
$R\theta_{JA}$	—	—	—	—	—	—	175	—	175	°C/W

* In accordance with JEDEC registration data.

^a Pulsed; pulse duration = 300 μs , duty factory < 2%.

2

2N3053, 2N3053A

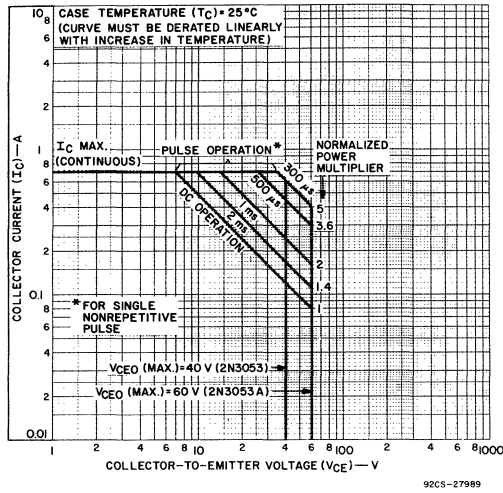


Fig. 1 - Maximum operating areas for 2N3053, 2N3053A.

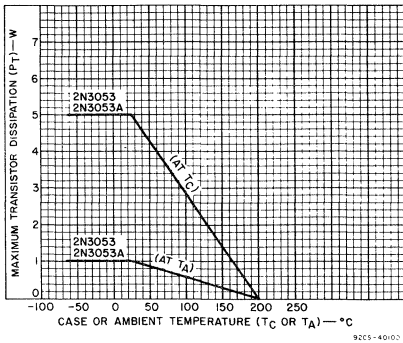


Fig. 2 - Dissipation derating curves for all types.

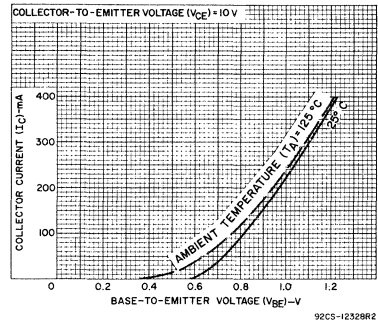


Fig. 3 - Typical transfer characteristics for all types.

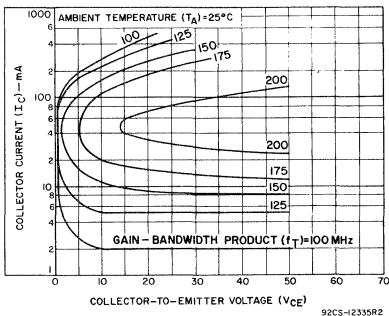


Fig. 4 - Typical dc beta characteristics for all types.

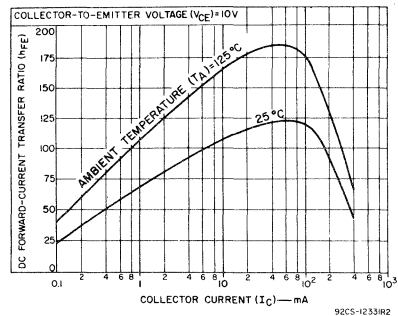


Fig. 5 - Typical variation of gain-bandwidth product with I_c and V_{ce} for all types.

2N3053, 2N3053A

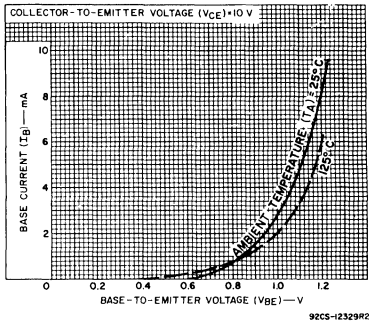


Fig. 6 - Typical input characteristics for all types.

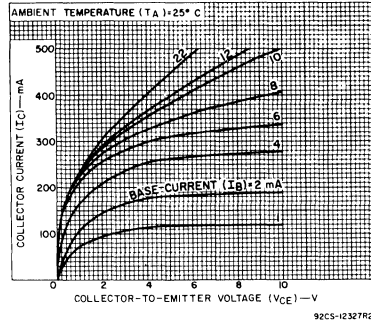


Fig. 7 - Typical output characteristics for all types.

General-Purpose Power Transistor

Broadly Applicable Devices for
Industrial and Commercial Use

Features:

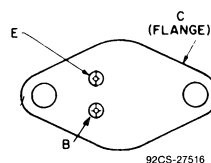
- High gain at high current
- Low Saturation Voltage: $V_{CE(sat)} < 1.1 \text{ V}$, @ $I_C=4 \text{ A}$, $I_B=0.4 \text{ A}$
- Excellent safe operating area

The 2N3055 silicon n-p-n transistor intended for a wide variety of medium-voltage, high-current applications.

Typical applications for this transistor include power-switching circuits, audio amplifiers, series and shunt regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer) relay driver service.

This device employs the popular JEDEC TO-204AA/TO-3 package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA/TO-3

MAXIMUM RATINGS, Absolute-Maximum Values:

*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	100 V
*COLLECTOR-EMITTER SUSTAINING VOLTAGE, $V_{CER(SUS)}$ ($R_{BE}=100 \Omega$).....	70 V
*COLLECTOR-EMITTER SUSTAINING VOLTAGE, $V_{CEO(SUS)}$	60 V
*EMITTER-BASE VOLTAGE, V_{EBO}	7 V
*COLLECTOR CURRENT, I_C	15 A
*BASE CURRENT, I_B	7 A
*COLLECTOR POWER DISSIPATION, P_C	115 W
($T_C=25^\circ\text{C}$)	
Derate Linearly above 25°C	0.66 W/ $^\circ\text{C}$
*JUNCTION TEMPERATURE, T_J	200°C
*STORAGE TEMPERATURE, T_{STG}	$-65 \sim 200^\circ\text{C}$

*In accordance with JEDEC registration data.

2N3055

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS						LIMITS			UNITS
	VOLTAGE V dc			CURRENT A dc			Min.	Typ.	Max.	
	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B				
I_{CEX}	100		-1.5				—	—	5	mA
$I_{CEX}, T_C=150^\circ C$	100		-1.5				—	—	30	
I_{CEO}	30					0	—	—	0.7	
I_{EBO}		7		0			—	—	5	
$V_{CEr(sus)}^{**}$ $R_{BE}=100 \Omega$				0.2			70	—	—	V
$V_{CEo(sus)}^{**}$				0.2	0		60	—	—	
h_{FE}	4			4			20	—	70	
	4			10			5	—	—	
V_{BE}	4			4			—	—	1.8	V
$V_{CE(sat)}$				4	0.4		—	—	1.1	
				10	3.3		—	—	8	
$f_{hfe}, f=10 \text{ kHz}$	4			1			20	—	—	
$|h_{fe}|, f=1 \text{ MHz}$	4			1			0.8	—	—	
$I_{S/B}, t=1 \text{ s}$ (non-repetitive)	60						1.95	—	—	A

2

*In accordance with JEDEC registration data.

**The sustaining voltages $V_{CEr(sus)}$ and $V_{CEo(sus)}$ MUST NOT be measured on a curve tracer.

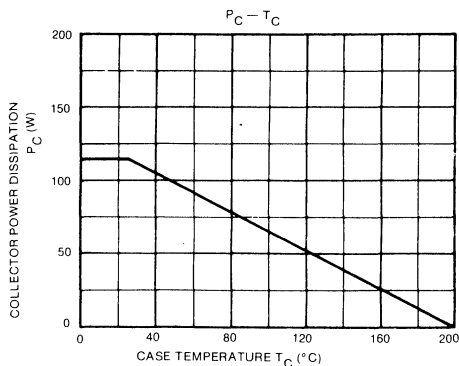


Fig. 1 - Power dissipation vs. temperature derating curve for 2N3055.

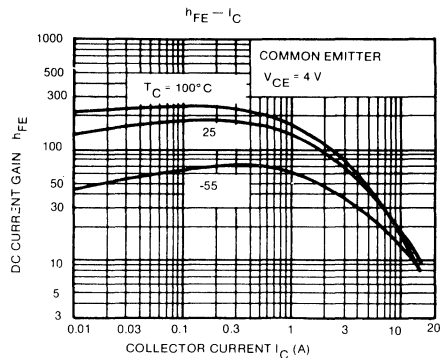


Fig. 2 - Typical dc-beta characteristics for 2N3055.

2N3055

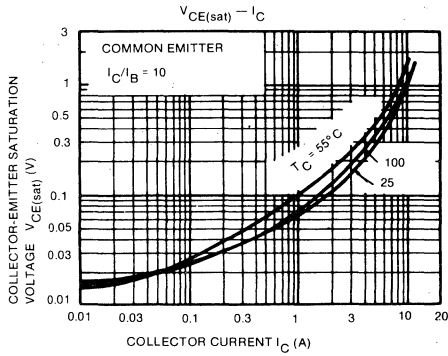


Fig. 3 - Typical collector-to-emitter saturation voltage characteristics for type 2N3055.

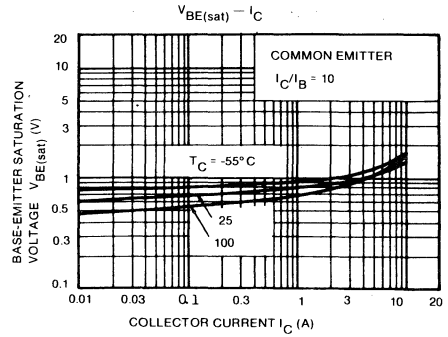


Fig. 4 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3055.

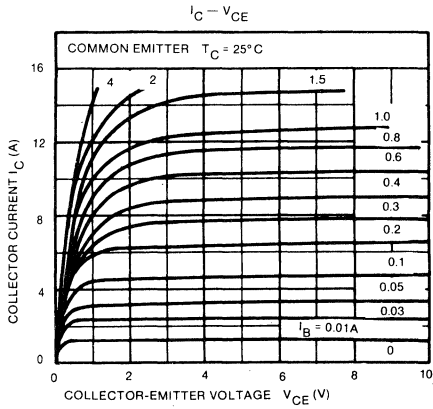


Fig. 5 - Typical output characteristics for 2N3055.

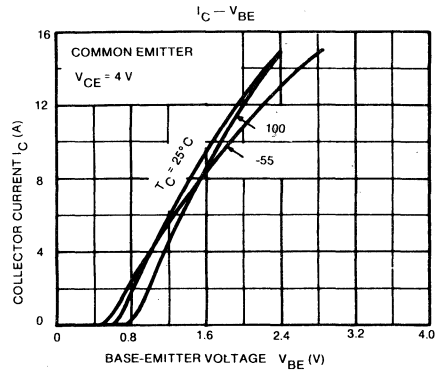


Fig. 6 - Typical transfer characteristics for 2N3055.

High-Voltage Silicon N-P-N Planar Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

- **High voltage ratings:**
 $V_{CBO} = 450\text{ V max. (2N3439, 2N4063)}$
 $= 300\text{ V max. (2N3440, 2N4064)}$
 $V_{CEO(SUS)} = 350\text{ V max. (2N3439, 2N4063)}$
 $= 250\text{ V max. (2N3440, 2N4064)}$
- **Maximum safe-area-of-operation curves**
- **Low saturation voltages**

The 2N3439*, 2N3440**, 2N4063 and 2N4064 are epitaxial-base silicon n-p-n planar transistors with high breakdown voltages, high-frequency response, and fast switching speeds.

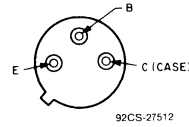
These transistors are intended for industrial, commercial, and military equipment. Typical applications include high-voltage differential and operational amplifiers, high-voltage inverters, and high-voltage, low-current switching and series regulators.

The 2N3439 and the 2N3440 differ primarily in their voltage ratings. They are supplied in the JEDEC TO-205AD hermetic package.

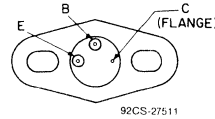
The 2N4063 and 2N4064 have the same voltage ratings as the 2N3439 and 2N3440 respectively, but employ a flange package.

*Formerly RCA Dev. No. TA2458.
 **Formerly RCA Dev. No. TA2470.

TERMINAL DESIGNATIONS



JEDEC TO-205AD



JEDEC TO-205AD WITH FLANGE

2

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N3439 2N4063	2N3440 2N4064	
* V_{CBO}	450	300	V
* $V_{CEO(SUS)}$	350	250	V
* V_{EBO}	7	7	V
* I_C	1	1	A
* I_B	0.5	0.5	A
Pr:			
$T_C \leq 25^\circ\text{C}$	10	10	W
* $T_A \leq 50^\circ\text{C}$	1	1	W
$T_C > 50^\circ\text{C}$	Derate linearly at		
* T_{stg}, T_J	0.057		W/ $^\circ\text{C}$
* T_L (During soldering)	-65 to +200		$^\circ\text{C}$
At distance 1/32 in. (0.8 mm) from case for 10 s max.	255		$^\circ\text{C}$

*2N-types in accordance with JEDEC registration data.

2N3439, 2N3440, 2N4063, 2N4064

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT mA dc		2N3439 2N4063		2N3440 2N4064		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
* I _{CBO} I _E = 0	360 250				— —	20 —	— —	— 20	μA
I _{CEO}	300 200			0 0	— —	20 —	— —	— 50	μA
I _{CEV}	450 300	-1.5 -1.5			— —	0.5 —	— —	— 0.5	mA
* I _{EBO}		-6	0		—	20	—	20	μA
* h _{FE}	10 10		20 ^a 2 ^a		40 30	160 —	40 —	160 —	
V _{CEO(sus)}			50 ^a	0	350 ^b	—	250 ^b	—	V
V _{BE(sat)}			50 ^a	4	—	1.3	—	1.3	V
V _{CE(sat)}			50 ^a	4	—	0.5	—	0.5	V
* Re(h _{ie}) f = 1 MHz	10		5		—	300	—	300	Ω
* h _{fe} f = 1 kHz	10		5		25	—	25	—	
* |h _{fe}| f = 5 MHz	10		10		3	—	3	—	
* C _{obo} V _{CB} = 10 V, I _E = 0 f = 1 MHz					—	10	—	10	pF
C _{ib} f = 1 MHz		-5	0		—	75	—	75	pF
I _{S/b} t = 1 s, nonrep.	200				50	—	50	—	mA
R _{θJC}					—	17.5	—	17.5	°C/W
R _{θJA} 2N3439, 2N3440					—	150	—	150	

* 2N-types in accordance with JEDEC registration data.

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.^b CAUTION: Sustaining voltage V_{CEO(sus)} **MUST NOT** be measured on a curve tracer.

2N3439, 2N3440, 2N4063, 2N4064

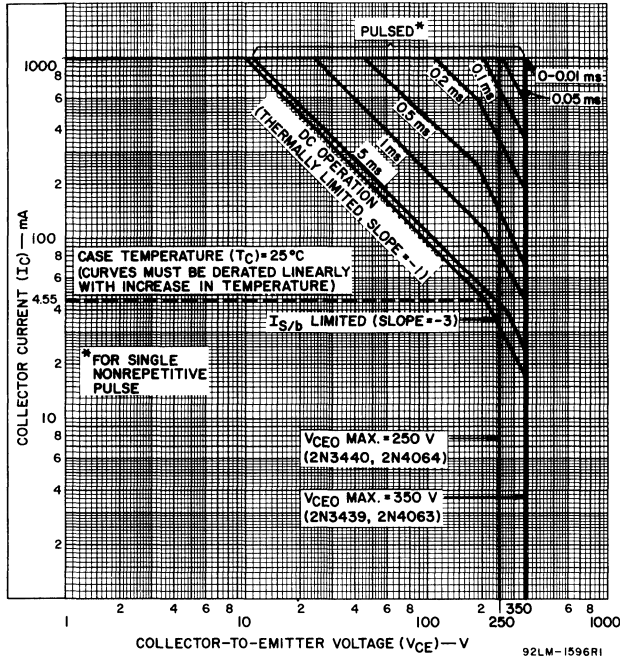


Fig. 1 — Maximum operating areas for 2N3439, 2N3440, 2N4063, and 2N4064.

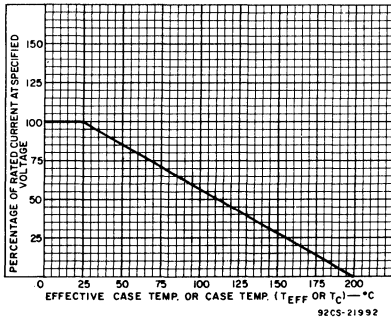


Fig. 2 — Current derating curve for all types.

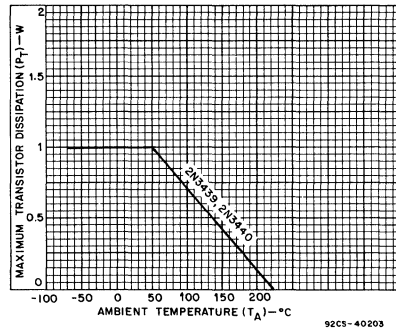


Fig. 3 — Dissipation derating curve for 2N3439 and 2N3440.

2N3439, 2N3440, 2N4063, 2N4064

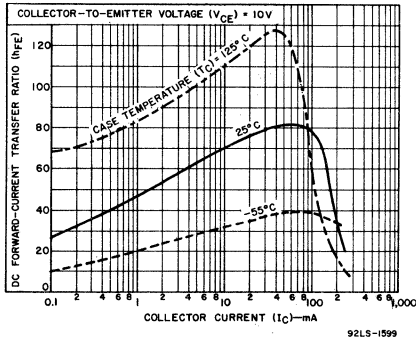


Fig. 4 — Typical dc beta characteristics for all types.

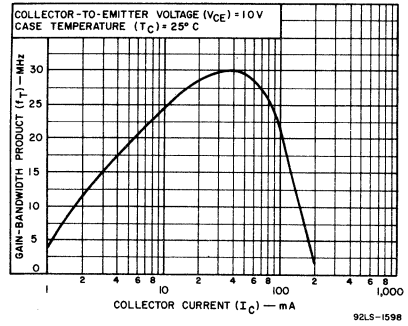


Fig. 5 — Typical gain bandwidth product for all types

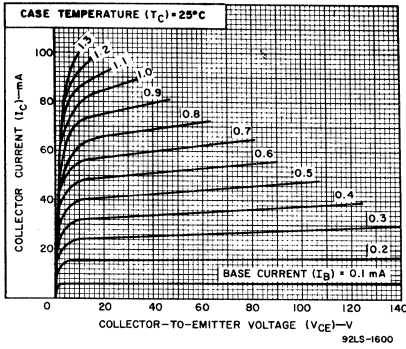


Fig. 6 — Typical output characteristics for all types.

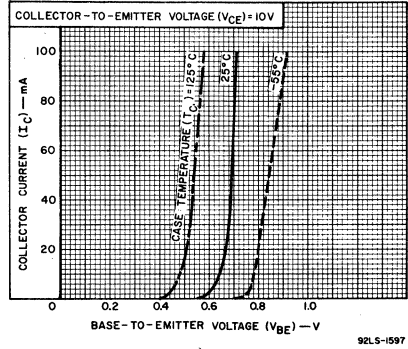


Fig. 7 — Typical transfer characteristics for all types.

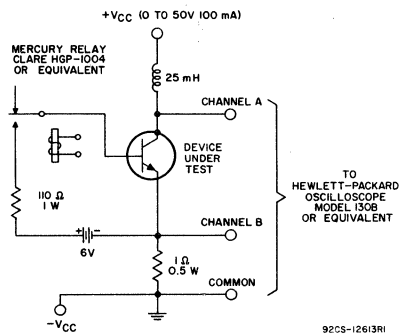
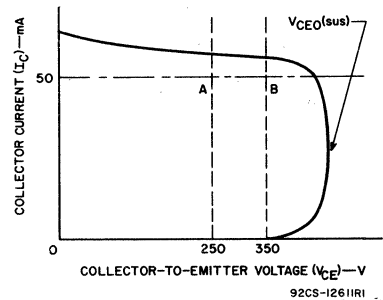


Fig. 8 — Circuit used to measure sustaining voltage $V_{CE0}(sus)$ for all types.



The sustaining voltage $V_{CE0}(sus)$ is acceptable when the trace falls to the right and above point "A" for types 2N3440 and 2N4064. The trace must fall to the right and above point "B" for types 2N3439 and 2N4063.

Fig. 9 — Oscilloscope display for measurement of sustaining voltages.

Medium-Power Silicon N-P-N Transistors

Rugged Devices for Intermediate, Power Applications
in Industrial and Commercial Equipment

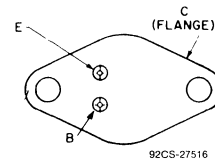
Features:

- 2N6264: premium type from 2N3441 family
- Maximum safe-area-of-operation curves for dc and pulse operation
- High voltage ratings
- Low saturation voltages

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power switching circuits
- Solenoid drivers

TERMINAL DESIGNATIONS



JEDEC TO-213AA

2

The 2N3441, 2N6263, and 2N6264 are silicon n-p-n transistors intended for a wide variety of medium-to-high power, high-voltage applications.

These devices employ the JEDEC TO-213AA package; they differ in maximum ratings for voltage, current, and power.

MAXIMUM RATINGS, Absolute-Maximum Values:

		2N6263	2N3441	2N6264	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
* With base open	$V_{CEO}(\text{sus})$	120	140	150	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(\text{sus})$	130	150	160	V
With base reverse-biased ($V_{BE} = -1.5$ V)	$V_{CEV}(\text{sus})$	140	160	170	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	3	3	3	A
PEAK COLLECTOR CURRENT		4	4	4	A
*CONTINUOUS BASE CURRENT	I_B	2	2	2	A
TRANSISTOR DISSIPATION:	P_T				
* At case temperature up to 25 $^{\circ}$ C		20	25	50	W
* At temperatures above 25 $^{\circ}$ C		————— See Figs. 2&4 —————			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		————— -65 to 200 —————			$^{\circ}$ C
*PIN TEMPERATURE (During Soldering):					
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.		————— 235 —————			$^{\circ}$ C

*In accordance with JEDEC registration data format JS-6 RDF-2

2N3441, 2N6263, 2N6264

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C, Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS						UNITS	
		VOLTAGE V dc			CURRENT A dc		2N6263		2N3441		2N6264			
		V _{CE}	V _{EB}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.		
Collector-Cutoff Current: * With base open	I _{CEO}	100 130 140				0 0 0	— — —	5 — —	— — —	— — 100	— — —	— — —	1 — —	mA
Collector-Cutoff Current: With base-emitter junction reversed biased	I _{CEX}	120 140 140 150		-1.5 -1.5 -1.5 -1.5			— — — —	2* — — —	— — — —	— — 1 —	— — — —	— — — 0.05*	— — — —	mA
	I _{CEX} (T _C = 150°C)	120 140 140 150		-1.5 -1.5 -1.5 -1.5			— — — —	10* — — —	— — — —	— — 6* 5	— — — —	— — — —	— — — 1*	mA
* Emitter-Cutoff Current	I _{EBO}		5 7				— —	2 —	— —	— 1	— —	— —	— 0.2	mA
Collector-to-Emitter Sustaining Voltage: ^a * With base open	V _{CEO(sus)}				0.1	0	120	—	140	—	150	—		V
With external base-to-emitter resistance (R _{BE}) = 100 Ω	V _{CER(sus)}				0.1		130	—	150	—	160	—		
With base-emitter junction reversed biased	V _{CEV(sus)}			-1.5	0.1		140	—	160	—	170	—		
* DC Forward-Current Transfer Ratio	h _{FE}	2 2 4 4			1 3 0.5 2.7		— 3 20 —	— — 100 —	— — 25 5	— — 100 —	— — — —	20 5 — —	60 — — —	
Collector-to-Emitter Saturating Voltage	V _{CE(sat)}				0.5 1 2.7	0.05 0.1 0.9	— — —	1.2* — —	— — —	— — 6*	— — —	— — —	— 0.5* —	V
Base-to-Emitter Voltage	V _{BE}	2 4 4			1 0.5 2.7		— — —	— 2* —	— — —	— 1.7 6*	— — —	— — —	— — 1.5*	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 40 kHz)	|h _{fe}|	4			0.5		5	—	5	—	5	—		
Gain-Bandwidth Product	f _T	4			0.2		200	—	200	—	200	—		kHz
* Common-Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 1 kHz)	h _{fe}	4 4			0.1 0.5		25 —	— —	— 15	— 75	25 —	— —		
Forward-Bias Second Breakdown Collector Current, Pulse Duration (non-repetitive) = 1 s	I _{S/b}	120 120 120					0.167 — —	— — —	— — 0.21	— — —	— — 0.417	— — —		A
Thermal Resistance: Junction-to-Case	R _{θJC}						—	8.75	—	7	—	3.5		°C/W

*In accordance with JEDEC registration data format (JS-6 RDF-2).

^aCAUTION: The sustaining voltage V_{CEO(sus)}, V_{CER(sus)}, and V_{CEV(sus)} MUST NOT be measured on a curve tracer.

2N3441, 2N6263, 2N6264

2

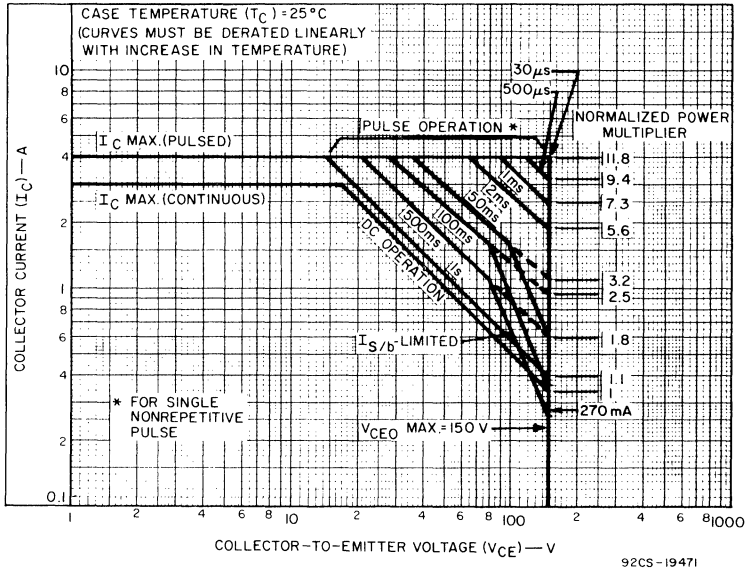


Fig. 1 — Maximum operating areas for type 2N6264.

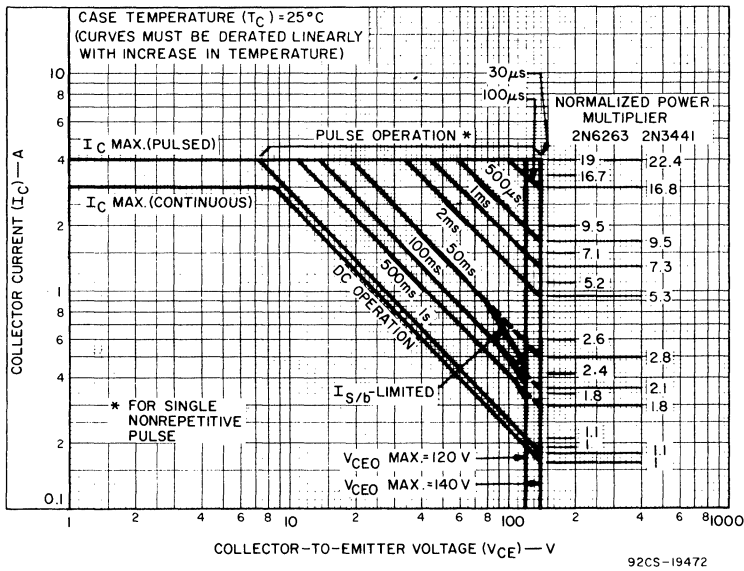


Fig. 2 — Maximum operating areas for types 2N6263 and 2N3441.

2N3441, 2N6263, 2N6264

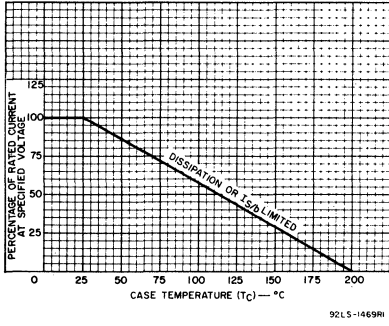


Fig. 3 — Current derating curve for all types.

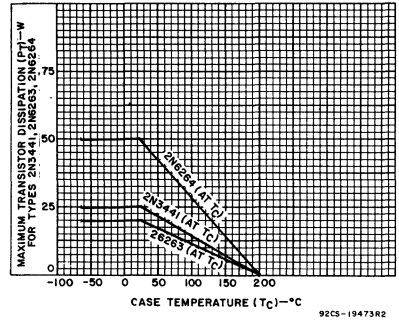


Fig. 4 — Dissipation derating curves for all types.

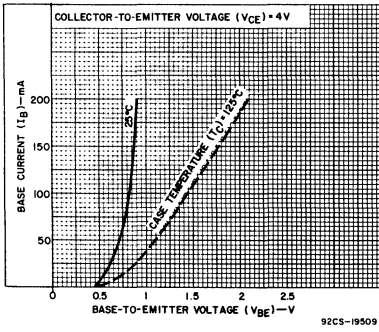


Fig. 5 — Typical input characteristics for type 2N6264.

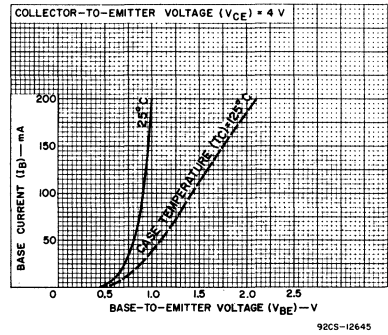


Fig. 6 — Typical input characteristics for type 2N3441.

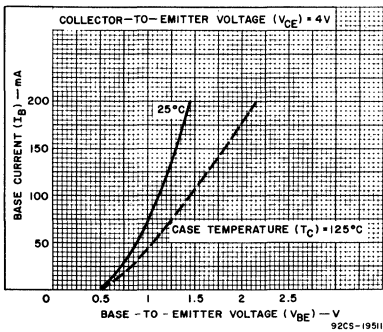


Fig. 7 — Typical input characteristics for type 2N6263.

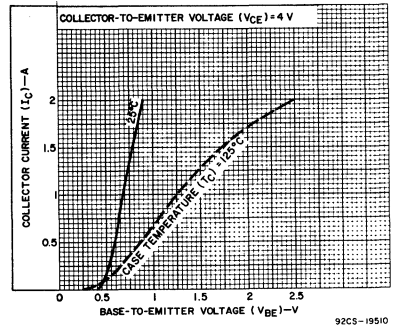


Fig. 8 — Typical transfer characteristics for type 2N6264.

2N3441, 2N6263, 2N6264

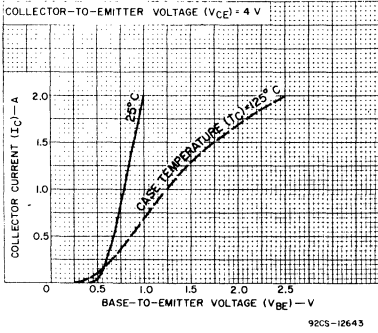


Fig. 9 — Typical transfer characteristics for type 2N3441.

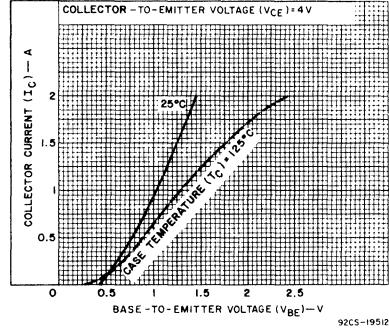


Fig. 10 — Typical transfer characteristics for type 2N6263.

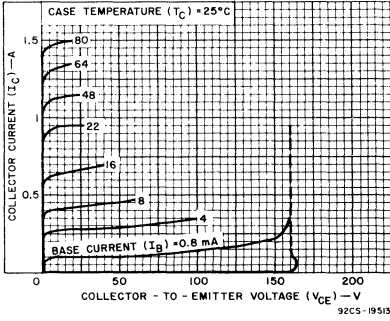


Fig. 11 — Typical output characteristics for type 2N6264.

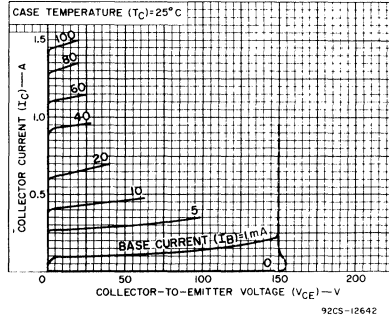


Fig. 12 — Typical output characteristics for type 2N3441.

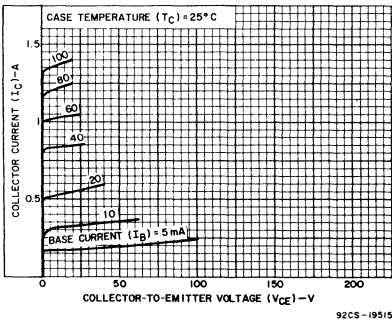


Fig. 13 — Typical output characteristics for type 2N6263.

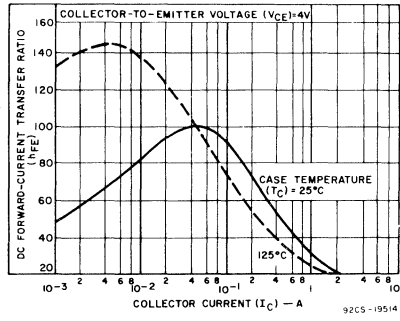


Fig. 14 — Typical dc beta characteristics for type 2N6264.

2N3441, 2N6263, 2N6264

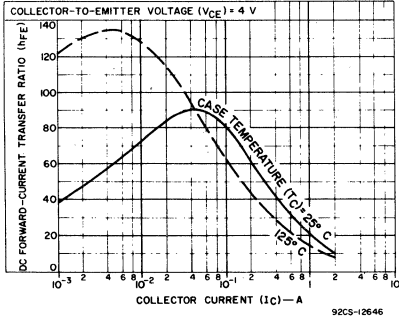


Fig. 15 — Typical dc beta characteristics for type 2N3441.

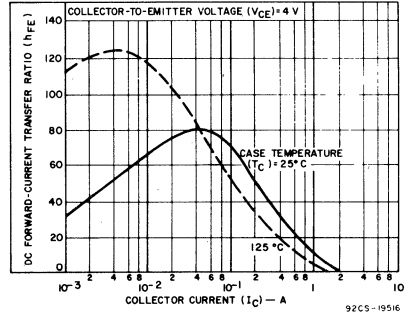


Fig. 16 — Typical dc beta characteristics for type 2N6263.

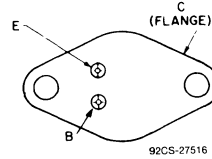
High-Voltage Silicon N-P-N Transistors

High-Power Devices for Applications in Industrial and Commercial Equipment

Features:

- Low saturation voltages
- High dissipation capability — 100 W (2N4347)
— 117 W (2N3442)
— 150 W (2N6262)
- Maximum area-of-operation curves for dc and pulse operation

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The 2N3442, 2N4347, and 2N6262 are silicon n-p-n transistors intended for a wide variety of high-power, high-voltage applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, and solenoid (hammer)/relay driver service.

These devices employ the popular JEDEC TO-204AA package; they differ in maximum ratings for voltage, current, and power.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N4347	2N3442	2N6262	
*V _{CB0}	140	160	170	V
*V _{CEO}	120	140	150	V
V _{CEX} (V _{BE} = -1.5 V)	140*	160	170	V
*V _{EBO}	7	7	7	V
*I _C				
Continuous	5	10	10	A
Peak	10*	15	15	A
*I _B				
Continuous	3	7	7	A
Peak	8*	—	—	A
*P _T				
At T _C up to 25°C	100	117	150	W
At T _C above 25°C	See Figs. 1, 2, 3, & 4			
*T _J , T _{stg}	-65 to +200			°C
*T _L (During Soldering):				
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.	235			°C

*In accordance with JEDEC registration data format (JS-6, RDF-2).

2N3442, 2N4347, 2N6262

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N4347		2N3442		2N6262		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$ $V_{CB} = 140$ V					—	—	—	1*	—	1	mA
* I_{CEX}	120 140 140 150	-1.5 -1.5 -1.5 -1.5			— — — —	2 — — —	— — — —	— 5 1 —	— — — —	— — — 0.1	mA
* $T_C = 150^\circ\text{C}$	125 140 140 150	-1.5 -1.5 -1.5 -1.5			— — — —	10 — — —	— — — —	— 30 10 —	— — — —	— — — 2	mA
* I_{CEO}	100 110 140				— — —	200 — —	— — —	— — 200	— — —	— 1 —	mA
* I_{EBO}		-7	0		—	5	—	5	—	0.2	mA
* h_{FE}	2 2 4 4 4 4		3 ^a 10 ^a 2 ^a 3 ^a 5 ^a 10 ^a		— — 15 — 10 —	— — 60 — — —	— — — 20 — —	— — — 70 — —	20 5 — — — —	70 — — — — —	
$V_{CEV(sus)}$		-1.5 -1.5	0.1 0.2		140 —	— —	160 —	— —	— 170	— —	V
$V_{CER(sus)}$ (R_{BE}) = 100Ω			0.1 0.2		130 —	— —	— 150	— —	— 160	— —	V
* $V_{CEO(sus)}$			0.2 ^a 0.2 ^a	0 0	120 —	— —	140 —	— —	— 150	— —	V
* V_{BE}	2 4 4 4 4		3 ^a 3 ^a 2 ^a 5 ^a 10 ^a		— — — — —	— — 2 3 —	— — — — —	— 1.7 — — 5.7	— — — — —	1 — — — —	V
* $V_{CE(sat)}$			2 ^a 3 ^a 5 ^a 10 ^a	0.2 0.3 0.63 2	— — — —	1 — 2 —	— — — —	— 1 — 5	— — — —	— 0.5 — —	V
$I_{S/b}$	67 78 100		1.5 1.5 1.5		1 — —	— — —	— 1 —	— — —	— — 1	— — —	s
* $|h_{fe}|$ f = 50 kHz	4		0.5		4	—	—	—	—	—	
f = 40 kHz	4 4		1 2		— —	— —	— 2	— —	2 —	— —	
* h_{fe} f = 1 kHz	4 4 4		0.5 1 2		40 — —	— — —	— — 12	— — 72	— 10 —	— — —	
$R_{\theta JC}$					—	1.75	—	1.5	—	1.17	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2

^a Pulse test; pulse duration = 300 μs, rep. rate = 60 Hz

2N3442, 2N4347, 2N6262

2

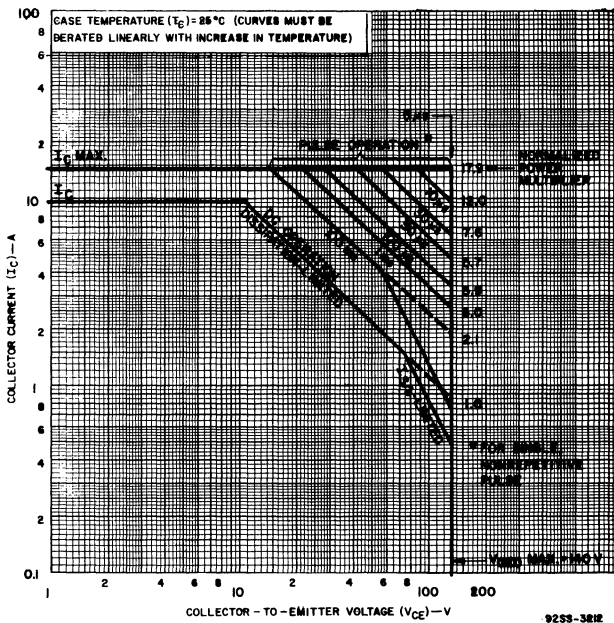


Fig. 1 — Maximum operating areas for type 2N3442.

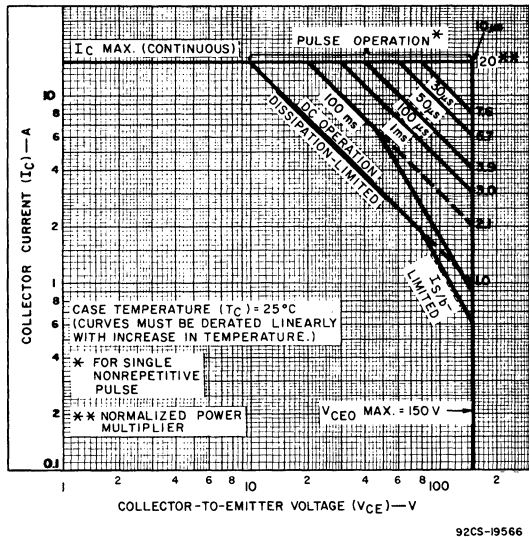


Fig. 2 — Maximum operating areas for type 2N6262.

2N3442, 2N4347, 2N6262

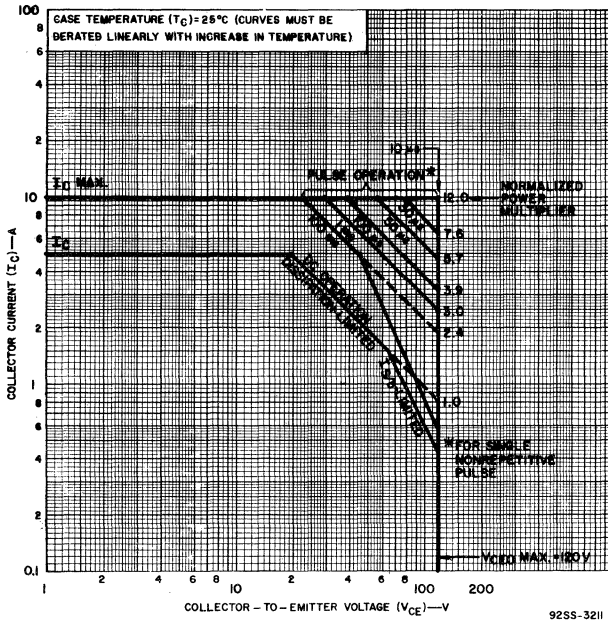


Fig. 3 — Maximum operating areas for type 2N4347.

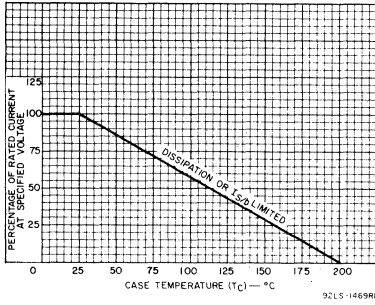


Fig. 4 — Current derating curve for all types.

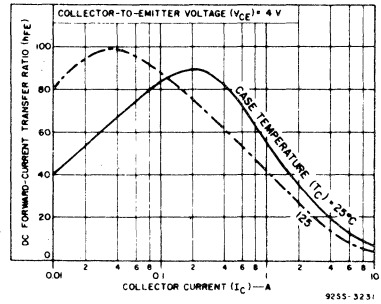


Fig. 5 — Typical dc beta characteristics for type 2N3442.

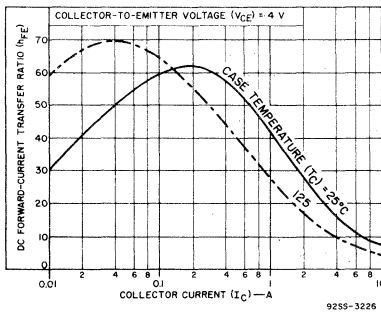


Fig. 6 — Typical dc beta characteristics for type 2N4347.

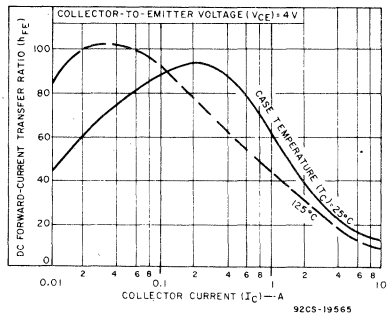


Fig. 7 — Typical dc beta characteristics for type 2N6262.

2N3442, 2N4347, 2N6262

2

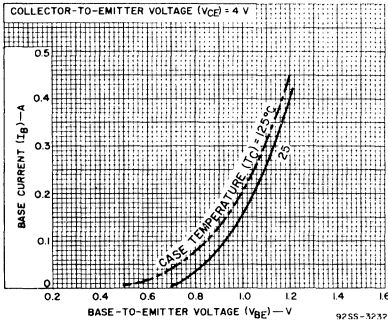


Fig. 8 — Typical input characteristics for type 2N3442.

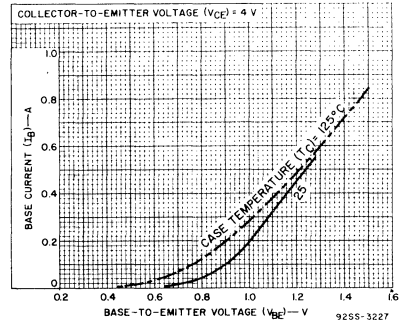


Fig. 9 — Typical input characteristics for type 2N4347.

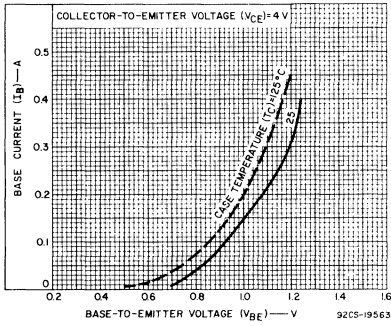


Fig. 10 — Typical input characteristics for type 2N6262.

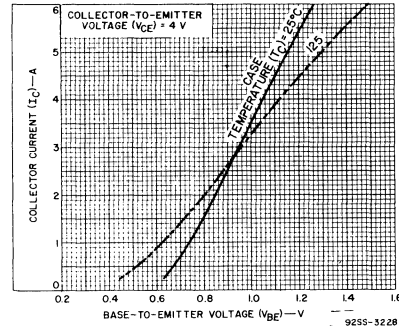


Fig. 11 — Typical transfer characteristics for type 2N3442 and 2N4347.

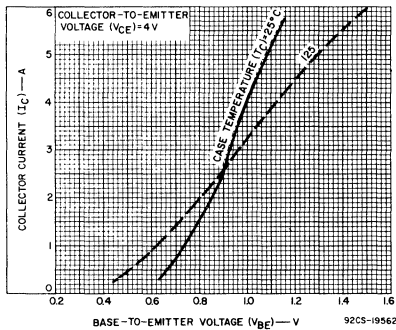


Fig. 12 — Typical transfer characteristics for type 2N6262.

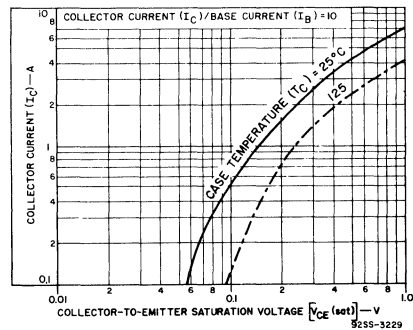


Fig. 13 — Typical saturation-voltage characteristics for all types.

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

- Freedom from second breakdown
- Economy types for ac/dc circuits
- Fast turn-on time at high collector current

The 2N3583*, 2N3584*, 2N3585*, and 2N4240*, are silicon n-p-n transistors with high breakdown voltages and fast switching speeds.

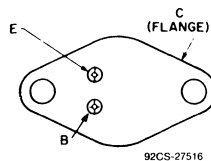
Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection and hi-fi amplifiers.

These transistors are also intended for a wide variety of applications in ac/dc commercial equipment.

All types utilize the JEDEC TO-213AA package.

*Formerly Dev. Nos. TA2510, TA2511, TA2512, and TA2871 respectively.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N3583	2N3584	2N3585 2N4240	
* COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	250	375	500	V
* COLLECTOR-TO-EMITTER VOLTAGE, Sustaining, $V_{CEO(SUS)}$	175	250	300	V
* EMITTER-TO-BASE VOLTAGE, V_{EBO}	6	6	6	V
* CONTINUOUS COLLECTOR CURRENT, I_C	1	2	2	A
* PEAK COLLECTOR CURRENT	5	5	5	A
* CONTINUOUS BASE CURRENT, I_B	1	1	1	A
* TRANSISTOR DISSIPATION, P_T				
At Case Temperature (T_C) = 25°C	35	35	35	W
At Case Temperatures Above 25°C	Derate Linearly at 0.2			W/°C
For Other Conditions	Derate Linearly to 200			°C
* TEMPERATURE RANGE:				
Storage and Operating (Junction)	-65 to +200			°C
* PIN TEMPERATURE:				
At distance 1/16 in. (1.58 mm) from seating plane for 10 s. max.	235	235	235	°C

* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3583), JS-6 RDF-1 (2N3584, 2N3585, 2N4240).

2N3583-2N3585, 2N4240

ELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS								UNITS	
		VOLTAGE V dc				CURRENT mA dc		2N3583		2N3584		2N3585		2N4240			
		V _{CB}	V _{CE}	V _{EB}	V _{BE}	I _C	I _E	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.		MAX.
Collector-Cutoff Current	I _{CEO}		150					0	—	10	—	5	—	5	—	5	mA
Collector-Cutoff Current	I _{CEX}		225		—1.5				—	1.0	—	—	—	—	—	—	mA
			340		—1.5				—	—	—	1.0	—	—	—	—	mA
At $T_C = 150^\circ\text{C}$	I _{CEX}		450		—1.5				—	—	—	—	1.0	—	2.0	—	mA
			225		—1.5				—	3	—	—	—	—	—	—	mA
Emitter-Cutoff Current	I _{EBO}		300		—1.5				—	—	—	3	—	3	—	5.0	mA
				6	—6			0	—	5.0	—	0.5	—	0.5	—	0.5	mA
DC Forward-Current Transfer Ratio	h _{FE}		2					750 ^a	—	—	—	—	—	10	100	—	
			2					1 A ^a	—	—	—	—	—	8	80	—	
			10					100 ^a	40	—	40	—	40	—	40	—	
			10					500 ^a	40	200	—	—	—	—	—	—	
			10					750 ^a	—	—	—	—	—	—	—	30	150
			10			1 A ^a	10	—	25	100	25	100	—	—	—		
Collector-to-Emitter Sustaining Voltage:																	V
With base open	V _{CEO(sus)}						200	0	175*	—	250*	—	300*	—	300*	—	
With external base-to-emitter resistance (R _{BE}) = 50Ω	I _{CER}		250						—	1.0	—	—	—	—	—	—	mA
			300						—	—	—	—	—	—	—	—	
			400						—	—	—	—	1.0	—	1.0	—	
Base-to-Emitter Saturation Voltage	V _{BE(sat)}						750 ^a	75	—	—	—	—	—	—	—	1.8	V
							1 A ^a	100	—	1.4	—	1.4	—	1.4	—	—	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}						750 ^a	75	—	—	—	—	—	—	—	1.0	V
							1 A ^a	125	—	5	—	0.75	—	0.75	—	—	
Small-Signal Forward Current Transfer Ratio f = 5 MHz	h _{fe}		10				200		3	—	3	—	3	—	3	—	
			30				100		25	350	—	—	—	—	—	—	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio f = 5 MHz	|h _{fe}|		10				200		2	—	2	—	2	—	3	—	
Output Capacitance: V _{CB} = 10 V, f = 1 MHz	C _{obo}		10					0	—	120	—	120	—	120	—	120	pF
Second-Breakdown Collector Current with base forward-biased** (See Figs. 1 & 2)	I _{S/b}								350	—	350	—	350	—	350	—	mA
Saturated Switching Time (V _{CC} = 200 V): Rise Time	t _r		(V _{CC}) 200				1 A 750	100 75	— —	— —	— —	3 —	— —	3 —	— —	— 0.5	
Storage Time	t _s		(V _{CC}) 200				1 A 750	100 75	— —	— —	— —	4 —	— —	4 —	— —	— 6	μs
Fall Time	t _f		(V _{CC}) 200				750 1 A	75 100	— —	— —	— —	— 3	— —	— 3	— —	3 —	
Thermal Resistance: Junction-to-Case	R _{θJC}								—	5	—	5	—	5	—	5	°C/W
Junction-to-Ambient	R _{θJA}								—	70	—	70	—	70	—	70	

*In accordance with JEDEC registration data format JS-6 RDF-2 (2N3583), JS-6 RDF-1 (2N3584, 2N3585, 2N4240)

• CAUTION: The sustaining voltages V_{CEO(sus)} MUST NOT be measured on a curve tracer.** Specified value of I_{S/b} for given value of V_{CE} as base voltage is increased from zero in a positive direction.^a Pulsed, pulse duration = 300 μs; duty factor ≤ 2%.

2N3583-2N3585, 2N4240

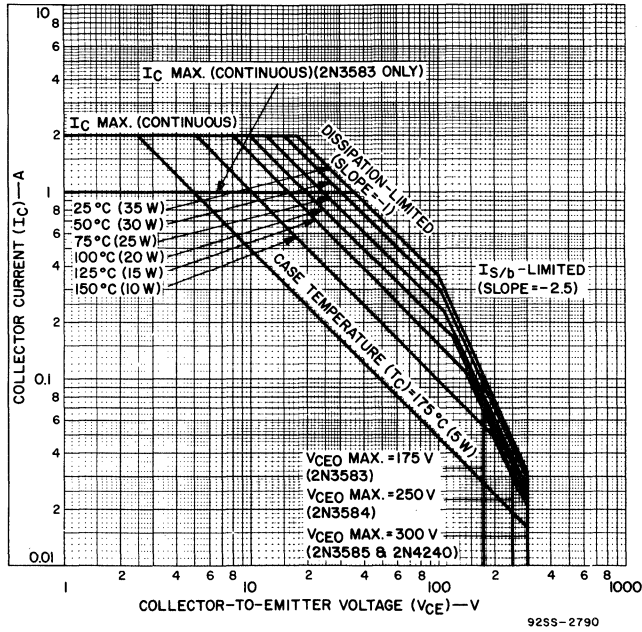


Fig. 1 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (dc conditions).

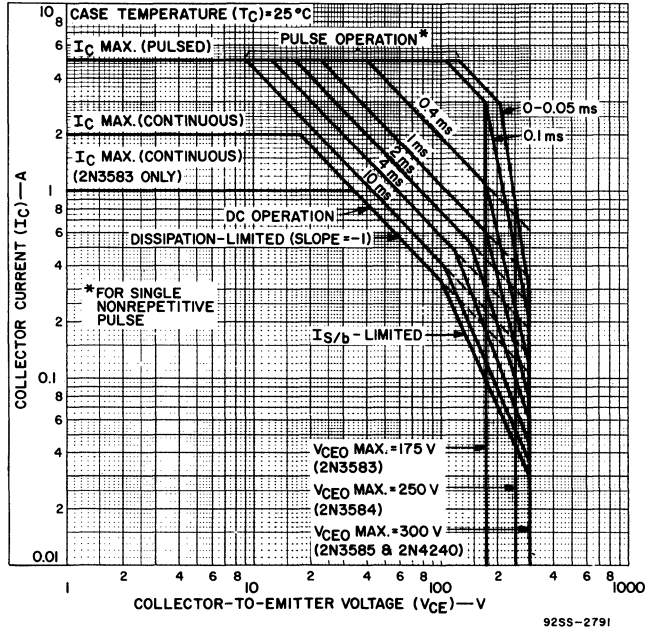


Fig. 2 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (pulse conditions).

2N3583-2N3585, 2N4240

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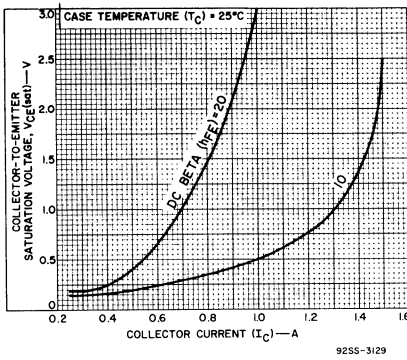


Fig. 3 - Typical collector-to-emitter saturation voltage vs. current for types 2N3584 and 2N3585.

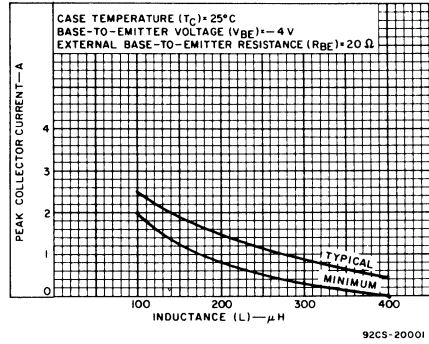


Fig. 4 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

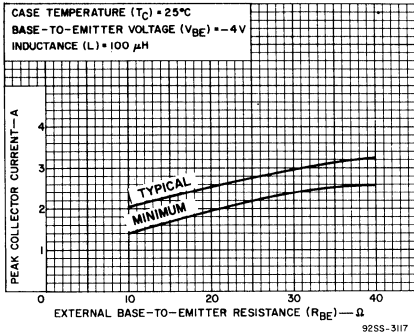


Fig. 5 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

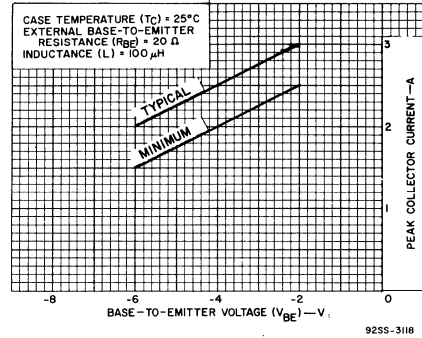


Fig. 6 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

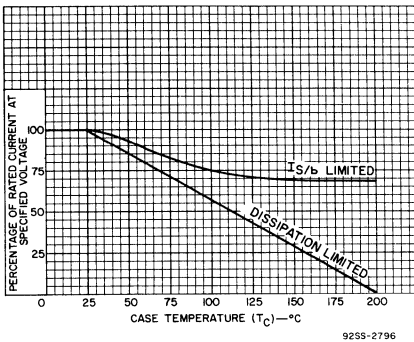


Fig. 7 - Dissipation derating curves for all types.

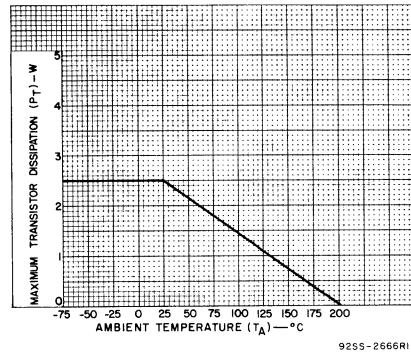


Fig. 8 - Dissipation derating curve for types 2N3583, 2N3585, and 2N4240.

2N3583-2N3585, 2N4240

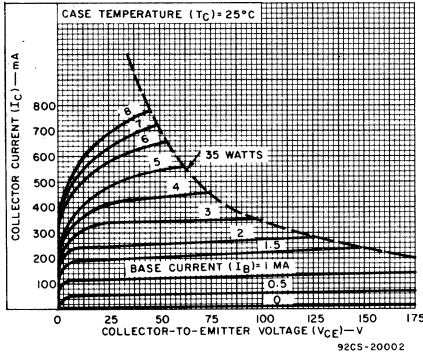


Fig. 9 - Typical output characteristics for type 2N3583.

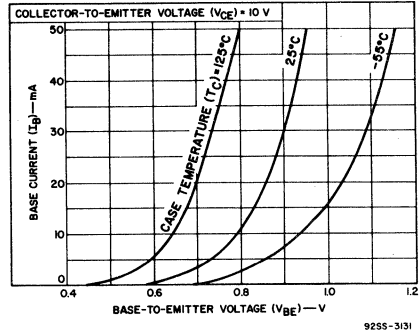


Fig. 10 - Typical input characteristics for all types.

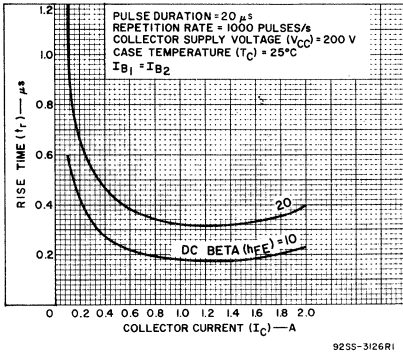


Fig. 11 - Typical rise time vs. collector current for types 2N3584 and 2N3585.

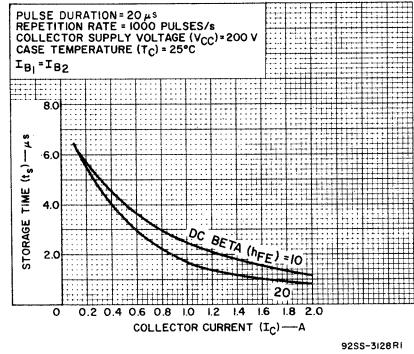


Fig. 12 - Typical storage time vs. collector current for types 2N3584 and 2N3585.

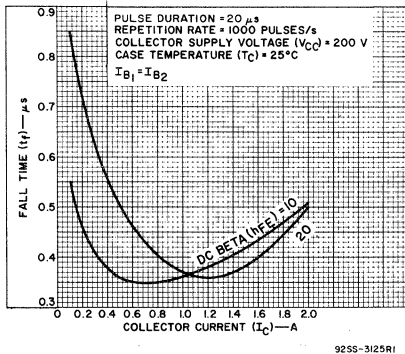


Fig. 13 - Typical fall time vs. collector current for types 2N3584 and 2N3585.

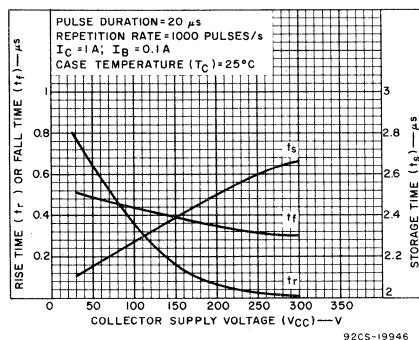


Fig. 14 - Typical rise time, fall time, and storage time vs. collector supply voltage for types 2N3584 and 2N3585.

2N3583-2N3585, 2N4240

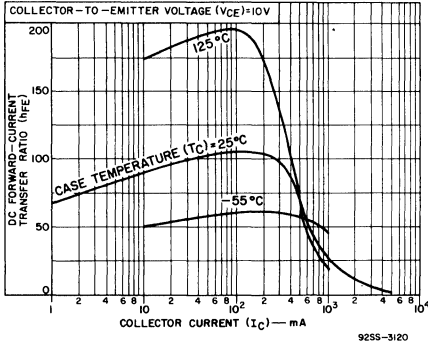


Fig. 15 - Typical dc beta vs. collector current for types 2N3583, and 2N4240.

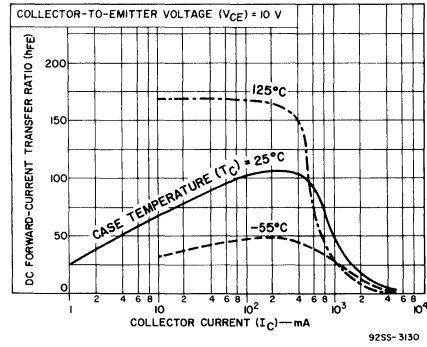


Fig. 16 - Typical dc beta vs. collector current for types 2N3584 and 2N3585.

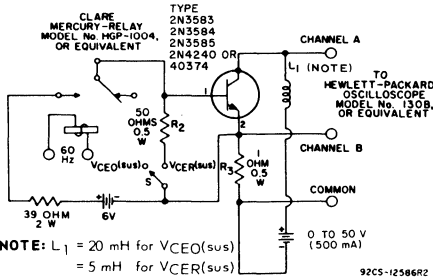
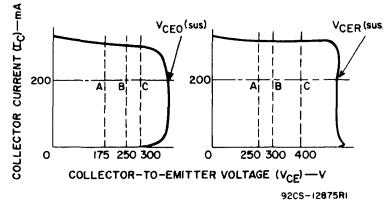


Fig. 17 - Circuit used to measure sustaining voltages $V_{CE0(sus)}$ and $V_{CEr(sus)}$ for all types.



NOTE: The sustaining voltages $V_{CE0(sus)}$ and $V_{CEr(sus)}$ are acceptable when the trace falls to the right and above point "A" for types 2N3583 and 40374, point "B" for type 2N3584, and point "C" for types 2N3585 and 2N4240.

Fig. 18 - Oscilloscope display for measurement of sustaining voltages.

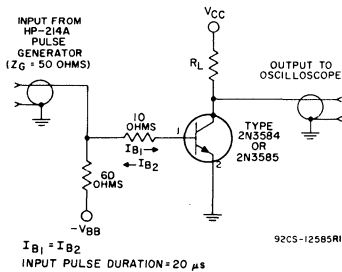


Fig. 19 - Circuit used to measure switching times for types 2N3584 and 2N3585.

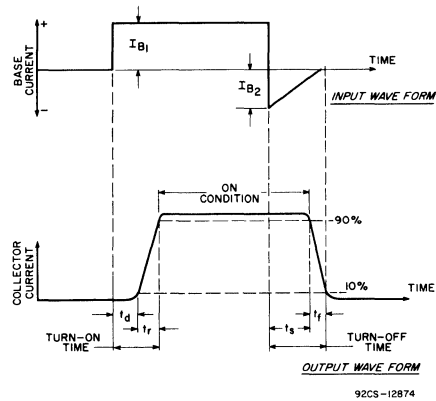


Fig. 20 - Phase relationship between input and output currents, showing reference points for specification of switching times.

High-Current Power Transistors

Broadly Applicable Devices for Industrial and Commercial Use

Features:

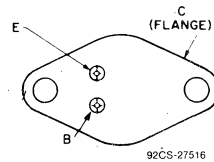
- High collector dissipation: $P_C=150\text{ W}$ ($T_C=25^\circ\text{C}$)
- High collector current:
 - 2N3771 $I_C=30\text{ A}$ (dc)
 - 2N3772 $I_C=20\text{ A}$ (dc)

The 2N3771 and 2N3772 are silicon n-p-n transistors intended for a wide variety of medium-voltage, high-current applications.

Typical applications for these transistors include power-switching circuits, audio amplifiers, series- and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

These devices employ the popular JEDEC TO-204AA/TO-3 package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA/TO-3

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N3771	2N3772	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	50	100	V
*COLLECTOR-EMITTER VOLTAGE ($V_{BE}=-1.5\text{ V}$, $R_{BE}=100\ \Omega$), V_{CEX}	50	100	V
*COLLECTOR-EMITTER VOLTAGE, V_{CEO}	40	60	V
*EMITTER-BASE VOLTAGE, V_{EBO}	5	7	V
*COLLECTOR CURRENT			
DC, I_C	30	20	A
Peak, I_{CM}	30	30	A
*BASE CURRENT			
DC, I_B	7.5	5	A
Peak, I_{BM}	15	15	A
*COLLECTOR POWER DISSIPATION, P_C	150	150	W
($T_C=25^\circ\text{C}$)			
Derate Linearly above 25°C	0.855	0.855	W/ $^\circ\text{C}$
*JUNCTION TEMPERATURE, T_J	200	200	$^\circ\text{C}$
*STORAGE TEMPERATURE, T_{stg}	-65 ~ 200	-65 ~ 200	$^\circ\text{C}$

*In accordance with JEDEC registration data.

2N3771, 2N3772

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS							LIMITS						UNITS
	VOLTAGE V dc				CURRENT A dc			2N3771			2N3772			
	V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CBO}	50					0		—	—	2	—	—	—	
	100					0		—	—	—	—	—	5	
I_{CEX}		50		1.5				—	—	2	—	—	—	
		100		1.5				—	—	—	—	—	5	
$I_{CEX}, T_C=150^\circ C$		30		1.5				—	—	10	—	—	—	
		30		1.5				—	—	—	—	—	10	
I_{CEO}		30				0		—	—	10	—	—	—	
		50				0		—	—	—	—	—	10	
I_{EBO}			5		0			—	—	5	—	—	—	
			7		0			—	—	—	—	—	5	
$V_{IBRICEO}$					0.2	0		40	—	—	—	—	—	
					0.2	0		—	—	—	60	—	—	
h_{FE}		4			15			15	—	60	—	—	—	
		4			30			5	—	—	—	—	—	
		4			10			—	—	—	15	—	60	
		4			20			—	—	—	5	—	—	
V_{BE}		4			15			—	—	2.7	—	—	—	
		4			10			—	—	—	1	2.2	—	
$V_{CE(sat)}$					15	1.5		—	—	2	—	—	—	
					30	6		—	—	4	—	—	—	
					10	1		—	—	—	—	0.3	1.4	
					20	4		—	—	—	—	—	4	
f_T		4			1			0.2	—	—	—	—	—	
		4			1			—	—	—	0.2	—	—	
$ h_{re} , f=1\text{ kHz}$		4			1			40	—	—	—	—	—	
		4			1			—	—	—	40	—	—	
$I_{S,b}, t=1\text{ s}$ (non-repetitive)		40						3.75	—	—	—	—	—	
		60						—	—	—	2.5	—	—	

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*2N-types in accordance with JEDEC registration data.

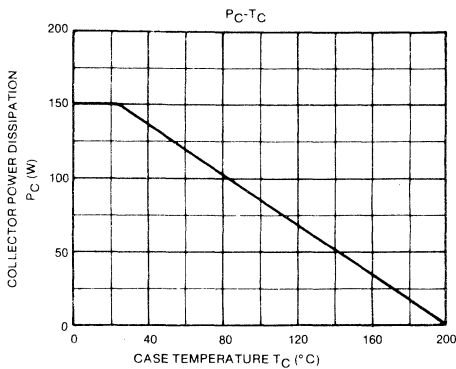


Fig. 1 - Power dissipation vs. temperature derating curve for both types.

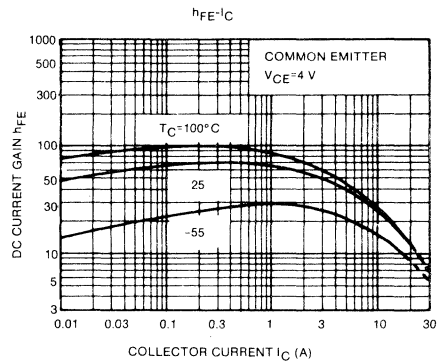


Fig. 2 - Typical dc-beta characteristics for 2N3771.

2N3771, 2N3772

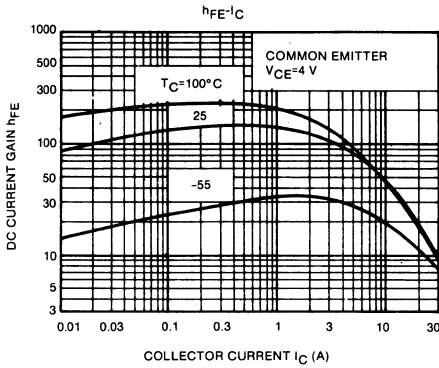


Fig. 3 - Typical dc-beta characteristics for 2N3772.

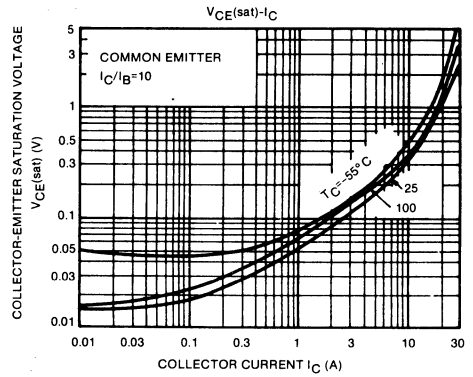


Fig. 4 - Typical collector-to-emitter saturation voltage characteristics for type 2N3771.

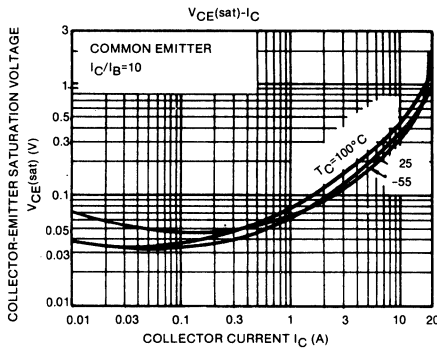


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for type 2N3772.

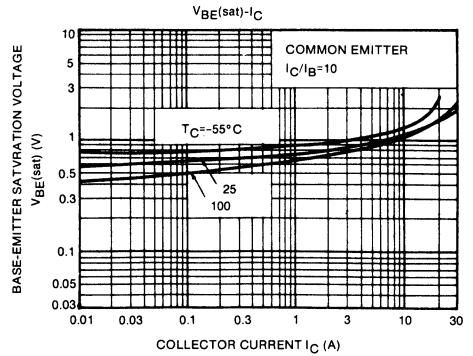


Fig. 6 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3771.

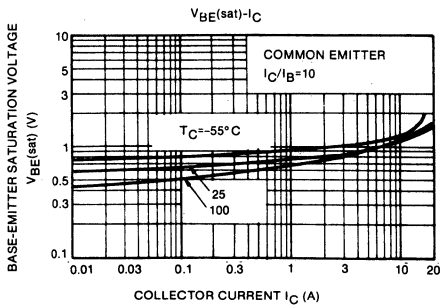


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3772.

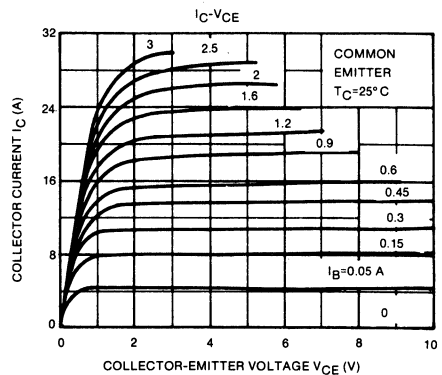


Fig. 8 - Typical output characteristics for 2N3771.

2N3771, 2N3772

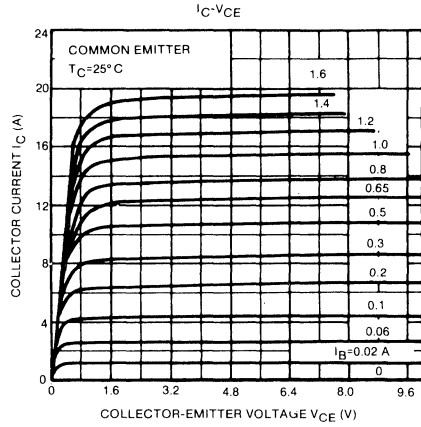


Fig. 9 - Typical output characteristics for 2N3772.

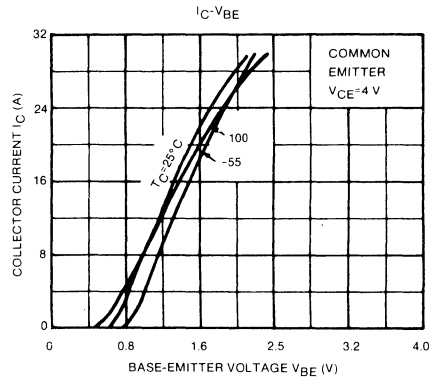


Fig. 10 - Typical transfer characteristics for 2N3772.

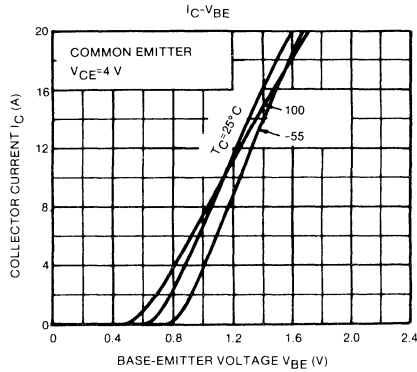


Fig. 11 - Typical transfer characteristics for 2N3771.

2

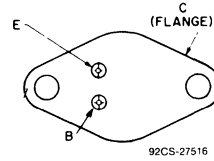
High-Voltage, High-Current Power Transistors

Broadly Applicable Devices for Industrial and Commercial Use

Features:

- High dissipation capability —
120 W (2N4348), 150 W (2N3773), 250 W (2N6259)
- 5-A specification for h_{FE} , V_{BE} , and $V_{CE(sat)}$ (2N4348)
- 8-A specification for h_{FE} , V_{BE} , and $V_{CE(sat)}$ (2N3773, 2N6259)

TERMINAL DESIGNATIONS



JEDEC TO-204AA/TO-3

The 2N3773, 2N4348, and 2N6259 are silicon n-p-n transistors intended for a wide variety of medium-voltage, high-current applications. Typical applications for these transistors include power-switching circuits, audio amplifiers, series and shunt-regulator driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

This device employs the popular JEDEC TO-204AA/TO-3 package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N4348	2N3773	2N6259	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	140	160	170	V
*COLLECTOR-EMITTER VOLTAGE, V_{CEX}	140	160	170	V
*COLLECTOR-EMITTER VOLTAGE, V_{CEO}	120	140	150	V
*EMITTER-BASE VOLTAGE, V_{EBO}	7	7	7	V
*COLLECTOR CURRENT				
DC, I_C	10	16	16	A
Peak, I_{CM}	30	30	30	A
*BASE CURRENT				
DC, I_B	4	4	4	A
Peak, I_{BM}	15	15	15	A
*COLLECTOR POWER DISSIPATION, P_T	120	150	250	W
($T_c = 25^\circ\text{C}$)				
Derate Linearly above 25°C	0.686	0.857	1.43	W/ $^\circ\text{C}$
*JUNCTION TEMPERATURE, T_j	200			$^\circ\text{C}$
*STORAGE TEMPERATURE, T_{stg}	-65 to +200			$^\circ\text{C}$

*In accordance with JEDEC registration data.

2N3773, 2N4348, 2N6259

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N4348		2N3773		2N6259		
		V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	
* Collector-Cutoff Current: With emitter open, V _{CB} =140 V	I _{CBO}					-	-	-	2	-	-	mA
With base-emitter junction reverse-biased	I _{CEX}	120 140 150	-1.5 -1.5 -1.5			-	2	-	-	-	-	mA
With base-emitter junction reverse-biased and T _C = 150°C	I _{CEX}	120 140 150	-1.5 -1.5 -1.5			-	10	-	-	10	-	mA
With base open	I _{CEO}	100 120				-	200	-	-	10	2	mA
* Emitter-Cutoff Current	I _{EBO}		-7	0		-	5	-	5	-	2	mA
* DC Forward Current Transfer Ratio	h _{FE}	4		5 ^a		15	60	-	-	-	-	
		4		8 ^a		-	-	15	60	-	-	
		2		8 ^a		-	-	-	-	15	60	
		4		10 ^a		10	-	-	-	-	-	
4		16 ^a		-	-	5	-	10	-			
Collector-to-Emitter Sustaining Voltage:**	V _{CEX(sus)}		-1.5	0.1		140	-	160	-	170	-	V
With base-emitter junction reverse-biased (R _{BE} = 100Ω)	V _{CEX(sus)}			0.2 ^a		140	-	150	-	160	-	V
With external base-to-emitter resistance (R _{BE}) = 100Ω	V _{CEX(sus)}			0.2 ^a	0	120	-	140	-	150	-	V
* Base-to-Emitter Voltage	V _{BE}	4 4 2 4		5 ^a 8 ^a 8 ^a 10 ^a		-	2	-	-	2.2	-	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			5 ^a 8 ^a 10 ^a 16 ^a	0.5 0.8 1.25 3.2	-	1	-	-	1.4	-	V
Second-Breakdown Collector Current With base forward-biased and 1-s nonrepetitive pulse	I _{S/b}	80 100				1.5	-	-	-	-	-	A
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 50 kHz)	|h _{fe}|	4		1		4	-	4	-	4	-	
* Common-Emitter, Small- Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h _{fe}	4		1		40	-	40	-	40	-	
Thermal Resistance Junction-to-Case	R _{θJC}					-	1.46	-	1.17	-	0.7	°C/W

*In accordance with JEDEC registration data.

**The sustaining voltages V_{CEX(sus)} and V_{CEO(sus)} MUST NOT be measured on a curve tracer.^aPulsed; pulse duration = 300μs, rep. rate = 60 Hz, duty factor ≤ 2%.

2N3773, 2N4348, 2N6259

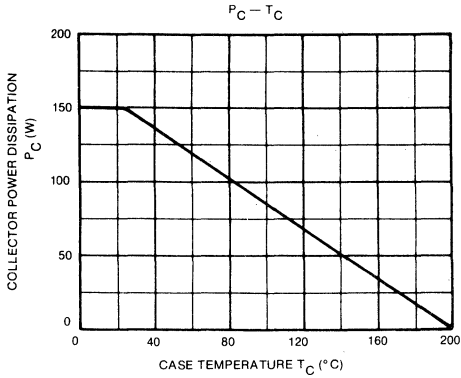


Fig. 1 — Dissipation derating curve for all types.

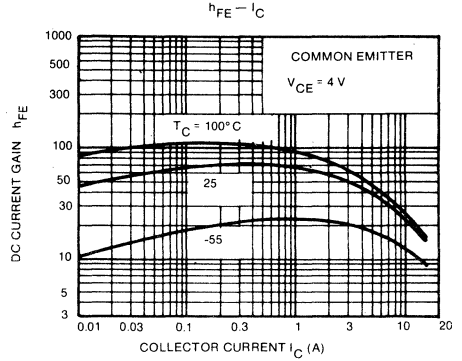


Fig. 2 — Typical dc-beta characteristics for all types.

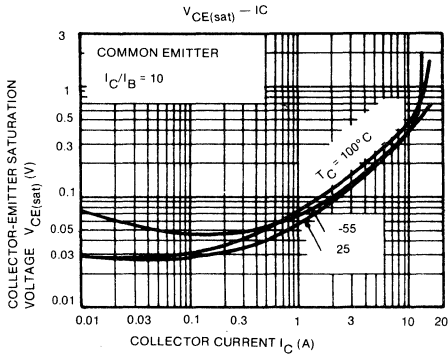


Fig. 3 — Typical collector-to-emitter saturation voltage characteristics for all types.

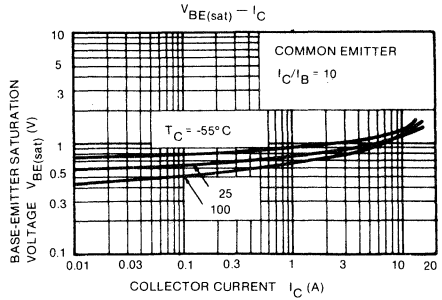


Fig. 4 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

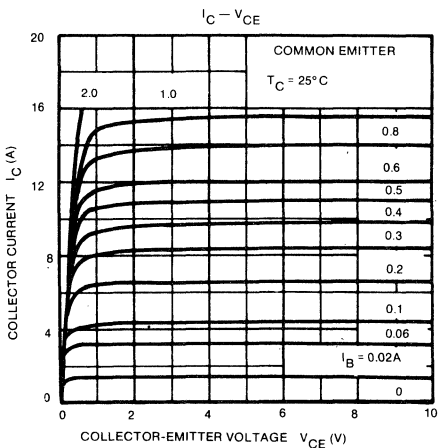


Fig. 5 — Typical output characteristics for all types.

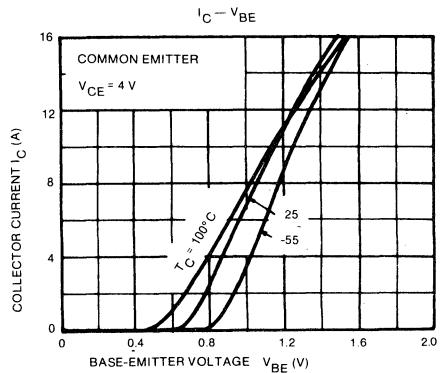


Fig. 6 — Typical transfer characteristics for 2N3773 and 2N4348.

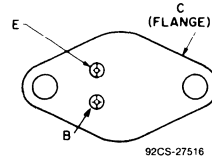
Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

Features:

- High dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- High gain at high current

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The 2N3791 and 2N3792 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. They may be used as complements to the n-p-n types 2N3715 and 2N3716, respectively. These devices are intended for medium-speed switching and amplifier applications and feature a dissipation capability of 150 watts at case temperatures up to 25°C.

They differ in voltage ratings and in the currents at which the parameters are controlled. Both are supplied in the steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N3791	2N3792	
* V _{CB0}	-60	-80	V
* V _{CEO}	-60	-80	V
* V _{EBO}	-7	-7	V
* I _C	-10	-10	A
* I _{CM}	-10	-10	A
* I _B	-4	-4	A
* P _T			
At T _C ≤ 25°C	150	150	W
At T _C > 25°C	derate linearly		W/°C
* T _J , T _{stg}	-65 to 200		°C

* In accordance with JEDEC registration data.

2N3791, 2N3792

ELECTRICAL CHARACTERISTICS, at Case Temperature
(T_C) = 25°C Unless Otherwise Specified

CHARACTERISTICS	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N3791		2N3792		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CEX}	-60 -80	1.5 1.5	- -	-- -	- -	-1 -	- -	- -1	mA
$T_C = 150^\circ\text{C}$	-60 -80	1.5 1.5	- -	- -	- -	-5 -	- -	- -5	
* I_{CEO}	-30 -40		- -	- -	- -	-10 -10	- -	-10 -10	mA
* I_{EBO}		7	-	-	-	-5	-	-5	mA
* $V_{CEO(sus)}^b$			-0.2	0	-60	-	-80	-	V
* h_{FE}^a	-2 -2 -4		-1 -3 -10	- - -	50 30 4	150 - -	50 30 4	150 - -	
* V_{BE}	-2 -4		-5 -10	- -	- -	-1.8 -4.0	- -	-1.8 -4.0	V
* $V_{BE(sat)}^a$			-5 -10	-0.5 -2.0	- -	-1.5 -4	- -	-1.5 -4	V
* $V_{CE(sat)}^a$			-5 -10	-0.5 -2.0	- -	-1 -4	- -	-1 -4	V
* f_{hfe}	-10		-0.5	-	30	-	30	-	KHz
* h_{fe} f = 1 KHz	-10		-0.5	-	25	250	25	250	
* $|h_{fe}|$ f = 1 MHz	-10		-0.5	-	4	-	4	-	
* I_S/b tp = 1s	40				2.7	-	2.95	-	A
* C_{ob} $V_{CB} = 10\text{ V}$ f = 1 MHz			0		-	500	-	500	pF
* $R_{\theta JC}$					-	1.17	-	1.17	°C/W

* In accordance with JEDEC registration data.

^a Pulsed; pulse duration = 200 μs , duty factor = 1.5%.

^b CAUTION: Sustaining voltage, $V_{CEO(sus)}$, *MUST NOT* be measured on a curve tracer.

2N3791, 2N3792

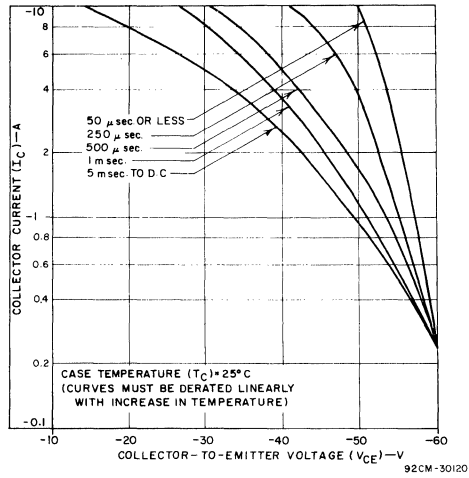


Fig. 1 — Maximum operating areas for 2N3791.

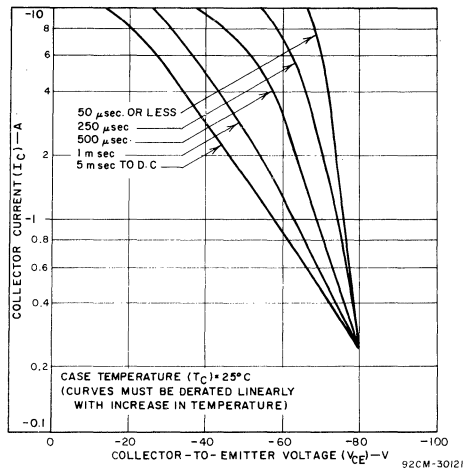


Fig. 2 — Maximum operating areas for 2N3792.

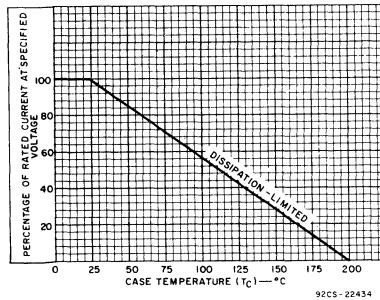


Fig. 3 — Derating curve.

2N3791, 2N3792

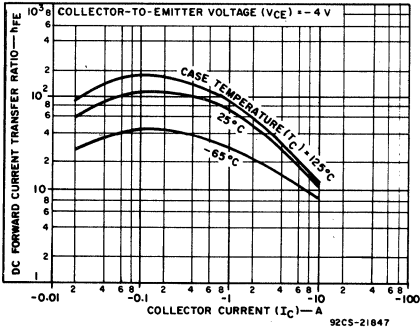


Fig. 4 – Typical dc beta characteristics for both types.

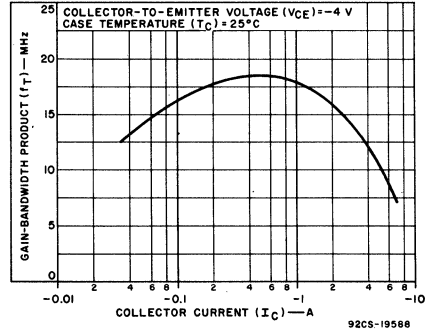


Fig. 5 – Typical gain-bandwidth product for both types.

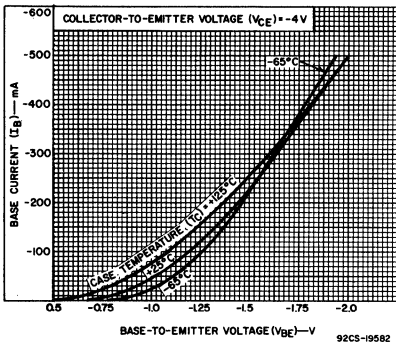


Fig. 6 – Typical input characteristics for both types.

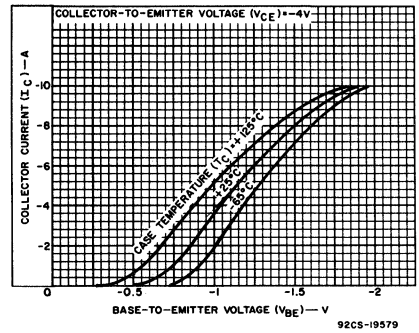


Fig. 7 – Typical transfer characteristics for both types.

High-Speed, Epitaxial-Collector Silicon N-P-N Planar Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

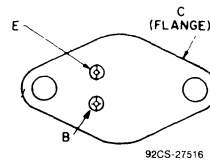
- Maximum-area-of-operation curves for dc and pulse operation.
- High sustaining voltage
- Total saturated transition time less than 1 μ s for 2N3879, 2N5202, and 2N6500

The 2N3878, 2N3879, 2N5202, and 2N6500* are epitaxial silicon n-p-n transistors. The 2N3878 is an amplifier type intended for audio-, ultrasonic-, and radio-frequency circuits. Types 2N3879, 2N5202, and 2N6500 are switching transistors intended for use in high-current, high-speed switching circuits.

Typical applications for these transistors include: low-distortion power amplifiers, oscillators, switching regulators, series regulators, converters, and inverters.

*Formerly RCA Dev. Type Nos. TA2509, TA2509A, TA7285, and TA8932, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, Absolute-Maximum Values:

		2N3878	2N3879	2N5202	2N6500	
*COLLECTOR-TO-BASE VOLTAGE	V_{CB0}	120	120	100	120	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE: With external base-to-emitter resistance (R_{BE}) = 50 Ω . With base open.	$V_{CER(sus)}$ $V_{CEO(sus)}$	65 50*	90 75*	75* 50	110* 90*	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	6	7	V
*CONTINUOUS COLLECTOR CURRENT	I_C	4	7	4	4	A
PEAK COLLECTOR CURRENT	I_{CM}	10	10	5	5	A
*CONTINUOUS BASE CURRENT	I_B	4	5	2	3	A
*TRANSISTOR DISSIPATION	P_T	35	35	35	35	W
At case temperature (T_C) = 25°C At case temperatures above 25°C For other conditions			Derate linearly at 0.2 W/°C See Figs. 1, 3 and 4			
*TEMPERATURE RANGE: Storage & operating (Junction)			-65 to 200			°C
*PIN TEMPERATURE: 1/32 in. (0.8 mm) from seating plane for 10 s max.		235	235	235	235	°C

* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3878); JS-6 RDF-1 (2N3879, 2N5202, 2N6500).

2N3878, 2N3879, 2N5202, 2N6500

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified:

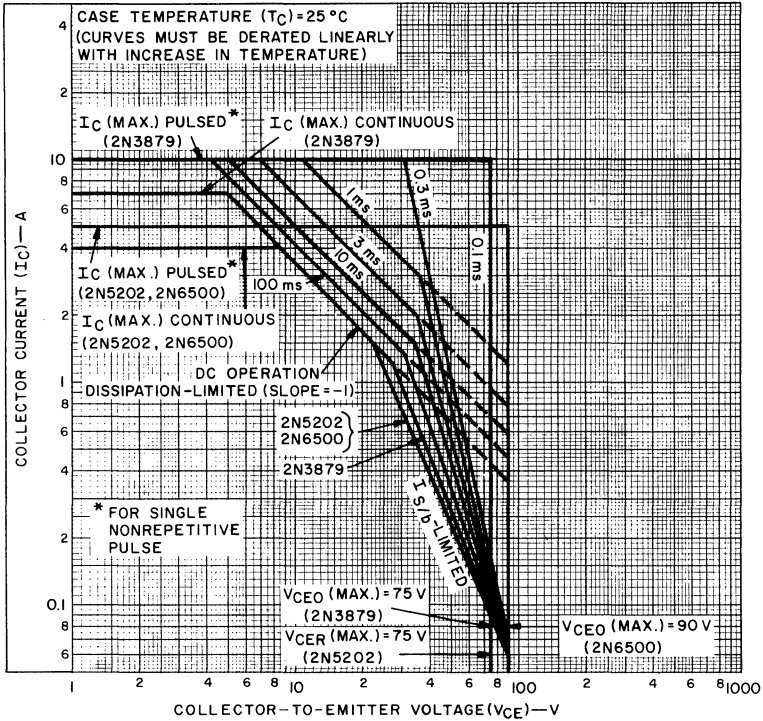
CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS	
		VOLTAGE V dc		CURRENT A dc		2N3878		2N3879		2N5202		2N6500			
		V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
* Collector Cutoff Current: With base-emitter junction reverse-biased	I _{CEV}	100	-1.5			-	-	-	-	-	10	-	-	mA	
		110	0			-	-	-	-	-	-	5			
* With base-emitter junction reverse-biased and $T_C = 150^\circ\text{C}$	I _{CEV}	100	-1.5			-	4	-	4	-	10	-	-	mA	
		110	0			-	-	-	-	-	-	10	-		
With base open	I _{CEO}	40			0	-	5*	-	5	-	-	-	5	mA	
	I _{CEO}	70			0	-	-	-	-	-	-	-	-	mA	
* Emitter Cutoff Current	I _{EBO}		-6 -7			-	-	-	10	-	10	-	25	mA	
Collector-to-Emitter Sustaining Voltage With base open	V _{CEO(sus)}			0.2	0	50 ^a	-	75 ^a	-	50 ^a	-	90 ^a	-	V	
With external base-to-emitter resistance (R_{BE}) = 50 Ω	V _{CER(sus)}			0.2	0	65 ^a	-	90 ^a	-	75 ^a	-	110 ^a	-	V	
DC Forward-Current Transfer Ratio	h _{FE}	1.2		4 ^b		-	-	-	-	10*	100*	-	-		
		2		0.5 ^b		40*	200*	-	-	-	-	-	-		
		2		3 ^b		-	-	-	-	-	-	-	15*		60*
		2		4 ^b		8*	-	12*	100*	-	-	-	-		-
		5		4 ^b		20*	-	20	80	-	-	-	-		-
5		0.5 ^b		50*	200*	40	-	-	-	-	-	-			
* Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			3 ^b 4 ^b	0.3 0.4	-	-	-	-	-	-	-	1.5	V	
* Base-to-Emitter Voltage	V _{BE}	2		4 ^b	-	-	2.5	-	-	-	-	-	-	V	
* Base-to-Emitter Saturation Voltage	V _{BE(sat)}			3 ^b 4 ^b	0.3 0.4	-	-	-	-	-	2	-	2.5	V	
Collector-to-Base Output Capacitance (f = 1 MHz, V _{CB} = 10 V)	C _{ob}					-	175*	-	175	-	175	-	175	pF	
Second Breakdown Collector Current: With base forward-biased and 1- μ s nonrepetitive pulse	I _{S/b}	40				750	-	500	-	400	-	400	-	mA	
* Magnitude of Common Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 10 MHz)	|h _{fe}|	10		0.5		4	-	4	-	6	-	6	-		
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h _{fe}	30		0.1		40	-	-	-	-	-	-	-		
Thermal Resistance Junction-to-case	R _{θJC}					-	5	-	5	-	5	-	5	°C/W	

* In accordance with JEDEC registration data format JS-6 RDF-2 (2N3878); JS-6 RDF-1 (2N3879, 2N5202, 2N6500).

^a CAUTION: Sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.

^b Pulsed, pulse duration = 300 μs, duty factor ≤ 2 %.

2N3878, 2N3879, 2N5202, 2N6500



92CS-23756

Fig. 1 - Maximum operating areas for 2N3879, 2N5202, and 2N6500.

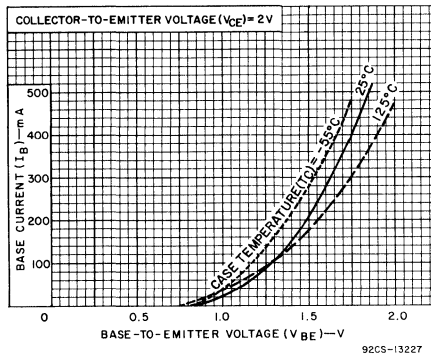
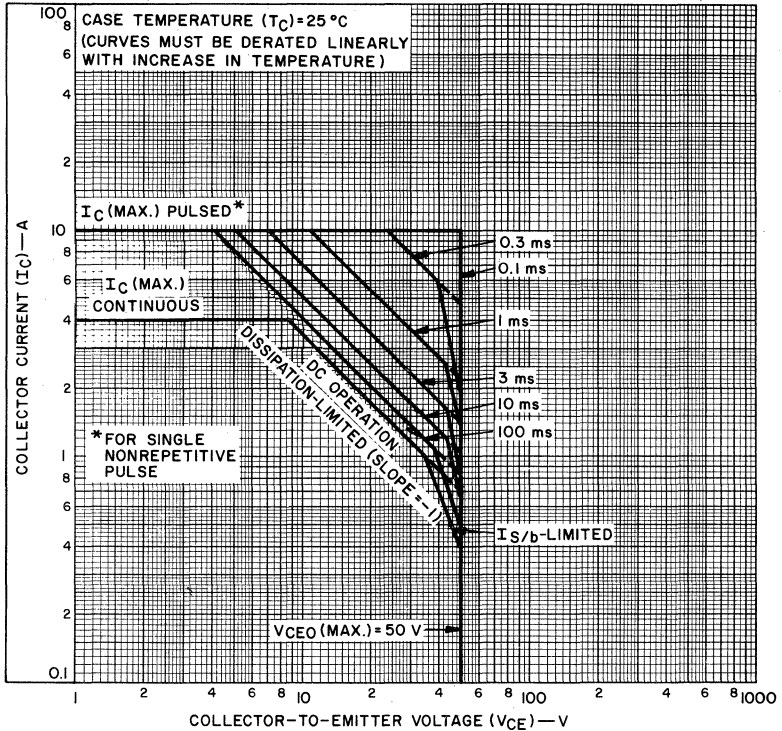


Fig. 2 - Typical input characteristics for all types.

2N3878, 2N3879, 2N5202, 2N6500



92CS-23755RI

Fig. 3 - Maximum operating areas for 2N3878.

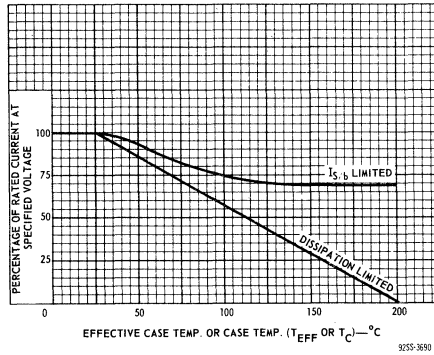


Fig. 4 - Dissipation derating for all types.

2N3878, 2N3879, 2N5202, 2N6500

2

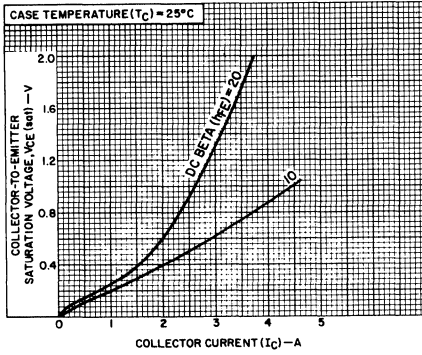


Fig. 5 - Typical saturation-voltage characteristics for 2N3878, and 2N3879.

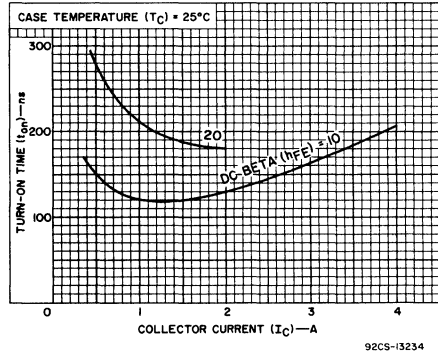


Fig. 6 - Typical turn-on time for 2N3879, 2N5202, and 2N6500.

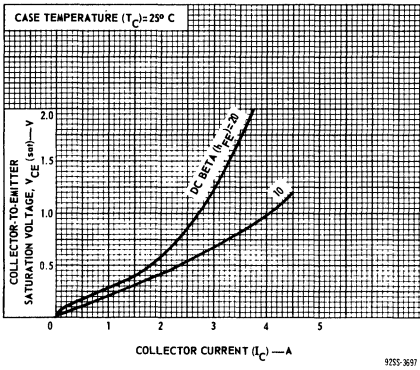


Fig. 7 - Typical saturation-voltage characteristics for 2N5202.

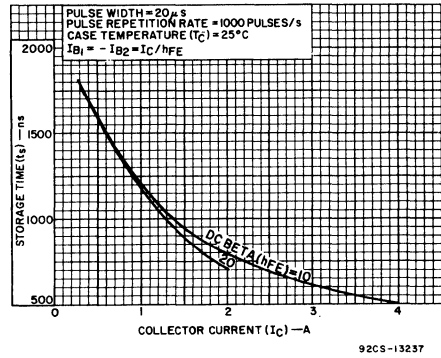


Fig. 8 - Typical storage time for 2N3879, 2N5202, and 2N6500.

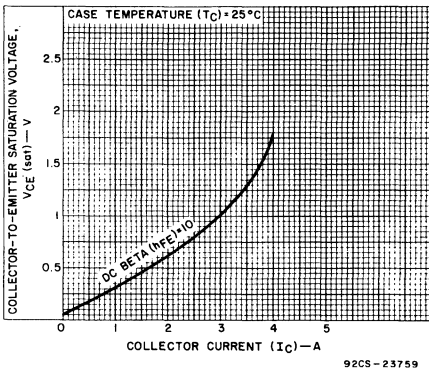


Fig. 9 - Typical saturation-voltage characteristics for 2N6500.

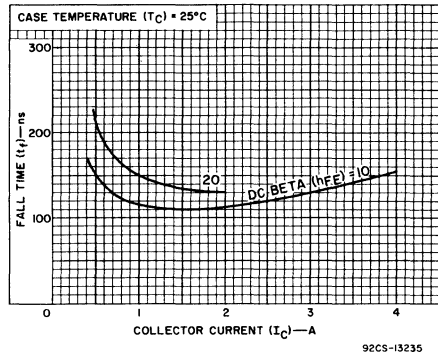


Fig. 10 - Typical fall time for 2N3879, 2N5202, and 2N6500.

2N3878, 2N3879, 2N5202, 2N6500

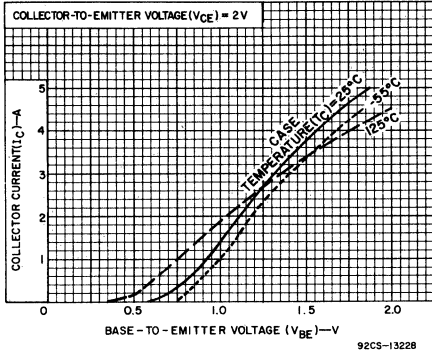


Fig. 11 — Typical transfer characteristics for all types.

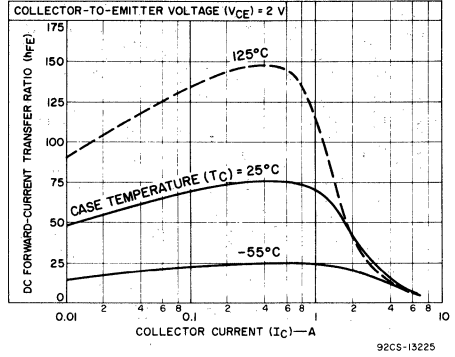


Fig. 12 — Typical dc beta characteristics for 2N3878 and 2N3879.

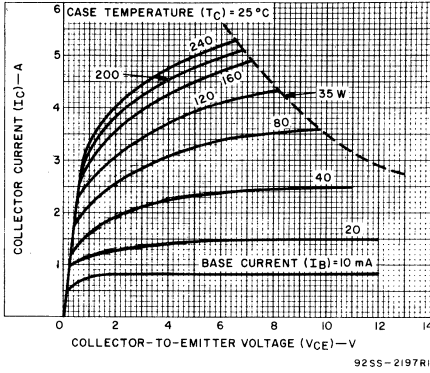


Fig. 13 — Typical output characteristics for 2N3878, 2N3879 and 2N5202.

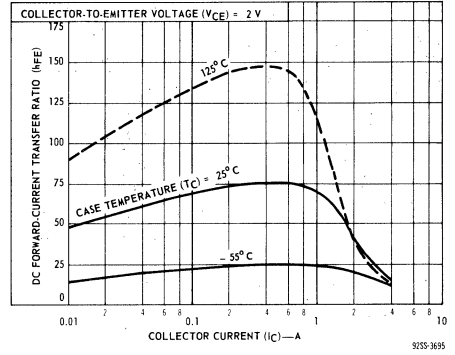


Fig. 14 — Typical dc beta characteristics for 2N5202.

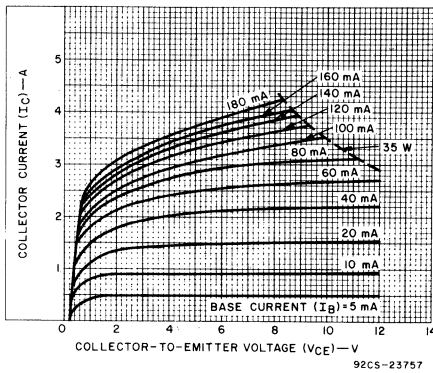


Fig. 15 — Typical output characteristics for 2N6500.

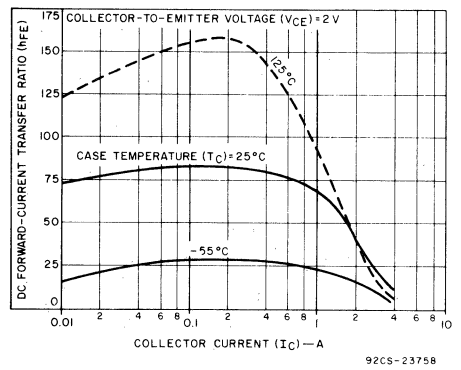


Fig. 16 — Typical dc beta characteristics for 2N6500.

2N3878, 2N3879, 2N5202, 2N6500

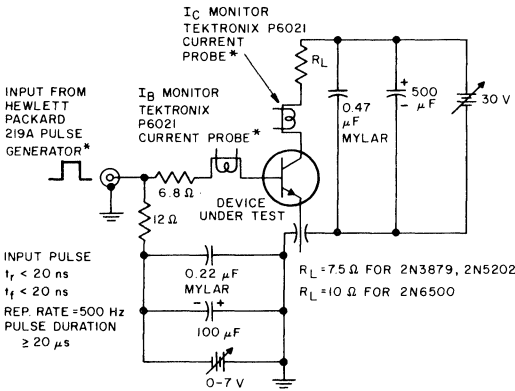
TRANSITION AND STORAGE-TIME CHARACTERISTICS FOR SWITCHING TYPES, At Case Temperature (T_C) = 25°C:

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
		VOLTAGE	CURRENT		2N3879		2N5202		2N6500		
		V dc	Ic	Ib	Min.	Max.	Min.	Max.	Min.	Max.	
Saturated Switching Time	t_d	30	3	0.3 ^a	—	—	—	—	—	40	ns
		30	4	0.4 ^a	—	40	—	—	—	—	
		30	4	0.8 ^a	—	—	—	40	—	—	
Delay time	t_r	30	3	0.3 ^a	—	—	—	—	—	400	
		30	4	0.4 ^a	—	400	—	—	—	—	
		30	4	0.8 ^a	—	—	—	400	—	—	
Rise time	t_s	30	3	0.3 ^a	—	—	—	—	—	1000	
		30	4	0.4 ^a	—	800	—	—	—	—	
		30	4	0.8 ^a	—	—	—	1200	—	—	
Storage time	t_f	30	3	0.3 ^a	—	—	—	—	—	500	
		30	4	0.4 ^a	—	400	—	—	—	—	
		30	4	0.8 ^a	—	—	—	400	—	—	

2

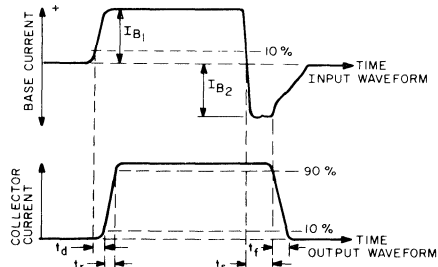
* In accordance with JEDEC registration data format (JS-6, RDF-1)

^a $I_{B1} = I_{B2}$



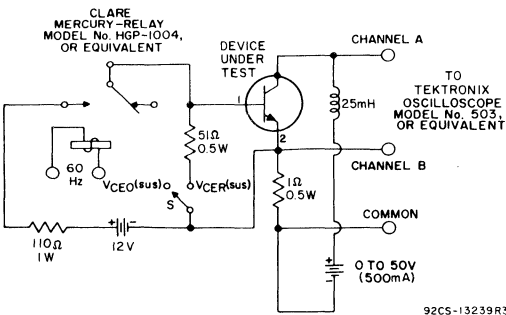
92CS-23754

Fig. 17 - Circuit used to measure switching times for 2N3879, 2N5202, and 2N6500.



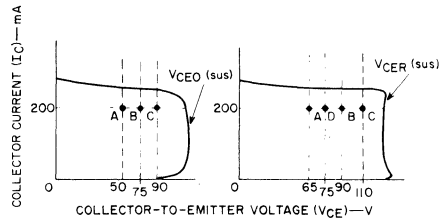
92CS-23760

Fig. 18 - Oscilloscope display for measurement of switching times. (Circuit shown in Fig. 1).



92CS-13239R3

Fig. 19 - Circuit used to measure sustaining voltages, $V_{CE0}(sus)$ and $V_{CEr}(sus)$ for all types.



92CS-13240R7

The sustaining voltages $V_{CE0}(sus)$ and $V_{CEr}(sus)$ are acceptable when the traces fall to the right and above point "A" for types 2N3878, 40375, and 2N5202; point "B" for type 2N3879; and point "C" for type 2N6500. The sustaining voltage $V_{CEr}(sus)$ is acceptable when the trace falls to the right and above point "D" for type 2N5202.

Fig. 20 - Oscilloscope display for measurement of sustaining voltages.

Medium-Power Silicon P-N-P Planar Transistors

General-Purpose Types for Industrial and Commercial Applications

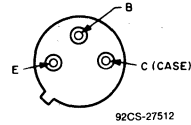
Features:

- Gain-bandwidth product (f_T) = 60 MHz min.
- High breakdown voltages
- Planar construction provides low noise and low leakage
- Low saturation voltages
- High pulsed beta at high collector current

The 2N4036, 2N4037, and 2N4314 are doubled-diffused, epitaxial-planar, silicon p-n-p transistors; they differ in breakdown-voltage ratings, leakage-current, and saturation characteristics. They are supplied in the JEDEC TO-205AD hermetic package.

These transistors are intended for a wide variety of small-signal medium-power applications. With a minimum gain-bandwidth product (f_T) of 60 MHz, these devices provide useful gain at high frequencies. In addition, the 2N4036 is useful in high-speed saturated switching applications.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N4036	2N4037	2N4314	
* V_{CBO}	-90	-60	-90	V
$V_{CEV(SUS)}$				
$V_{BE} = +1.5 V$	-85	-60	-85	V
$V_{CER(SUS)}$				
$R_{BE} \leq 200 \Omega$	-85	-60	-85	V
* $V_{CEO(SUS)}$	-65	-40	-65	V
* V_{EBO}	-7	-7	-7	V
* I_C	-1.0	-1.0	-1.0	A
* I_B	-0.5	-0.5	-0.5	A
* P_T				
$T_C \leq 25^\circ C$	7	7	7	W
	—	1	—	W
$T_C, T_A > 25^\circ C$	—	See Fig. 2	—	$^\circ C$
Pulsed	—	See Fig. 1	—	$^\circ C$
* T_{sig}, T_J	—	-65 to 200	—	$^\circ C$
* T_L (During soldering):				
At distance $\geq 1/16$ in. (1.58 mm)				
from seating plane for 10 s max.	—	230	—	$^\circ C$

* In accordance with JEDEC registration data format (JS-6 RDF-1 2N4036; JS-9 RDF-2 2N4037, 2N4314).

2N4036, 2N4037, 2N4314

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT mA dc		2N4036		2N4037		2N4314		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	-90*				-	-0.1*	-	-	-	-	mA
	-60*				-	-0.02	-	-0.25*	-	-0.25*	μ A
I_{CEO}	-30			0	-	-0.5*	-	-5*	-	-5*	μ A
I_{CEX} $T_C = 150^\circ\text{C}$	-85	1.5			-	-100*	-	-	-	-	mA
	-30	1.5			-	-0.1*	-	-	-	-	mA
I_{EBO}		7	0		-	-0.1*	-	-	-	-	mA
		5	0		-	-0.02	-	-1*	-	-1*	μ A
$V_{(BR)CBO}$ $I_E = 0$			-0.1		-90	-	-60*	-	-90*	-	V
$V_{(BR)EBO}$ $I_E = -0.1$ mA			0	-	-7	-	-7	-	-7	-	V
$V_{CEV(sus)}$		1.5	-100		-85 ^b	-	-60 ^b	-	-85 ^b	-	V
$V_{CER(sus)}$ $R_{BE} \leq 200 \Omega$			-100		-85 ^b	-	-60 ^b	-	-85 ^b	-	V
$V_{CEO(sus)}$			-100	0	-65 ^b	-	-40 ^b	-	-65 ^b	-	V
$V_{CE(sat)}$			-150	-15	-	-0.65	-	-1.4	-	-1.4	V
V_{BE}	-10		-150		-	-1.1	-	-1.5*	-	-1.5*	V
$V_{BE(sat)}$			-150	-15	-	-1.4	-	-	-	-	V
h_{FE}	-2		-150		20	200	-	-	-	-	
	-10		-0.1		20	-	-	-	-	-	
	-10		-1.0		-	-	15	-	15	-	
	-10		-150 ^a		40	140	50	250	50	250	
	-10		-500 ^a		20	-	-	-	-	-	
$|h_{fe}|$ f = 20 MHz	-10		-50		3	-	3	10	3	10	
C_{cb} $I_E = 0$, f = 1 MHz	-10*				-	30	-	30*	-	30*	pF
C_{ib}		0.5	0		-	90	-	90	-	90	pF
t_r	-30		-150	-15	-	70	-	-	-	-	
t_s	-30		-150	-15	-	600	-	-	-	-	
t_f	-30		-150	-15	-	100	-	-	-	-	ns
t_{ON}	-30		-150	-15	-	110	-	-	-	-	
t_{OFF}	-30		-150	-15	-	700	-	-	-	-	
$R_{\theta JC}$					-	25*	-	25	-	25	$^\circ\text{C/W}$
$R_{\theta JA}$					-	165	-	165	-	165	$^\circ\text{C/W}$

* "2N"-types in accordance with JEDEC registration data format (JS-6 RDF-1 2N4036; JS-9 RDF-2 2N4037, 2N4314).

• V_{CB}

a Pulsed, pulse duration = 300 μ s, duty factor < 2%.

b CAUTION: The sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEV(sus)}$ MUST NOT be measured on a curve tracer. They should be measured by the pulse method (Note 'a').

2N4036, 2N4037, 2N4314

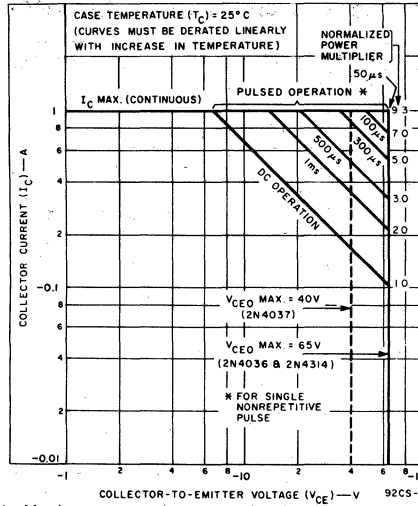


Fig. 1 - Maximum operating areas for 2N4036, 2N4037, and 2N4314.

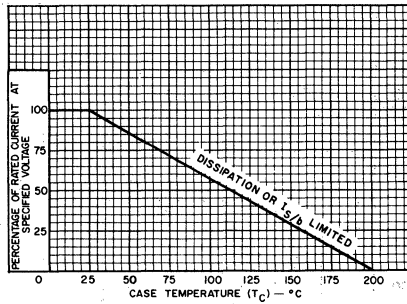


Fig. 2 - Dissipation derating curve for 2N4036, 2N4037, and 2N4314.

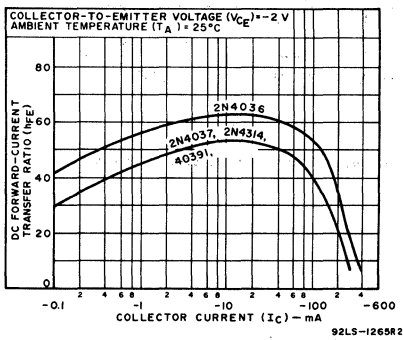


Fig. 3 - Typical dc beta characteristics for all types.

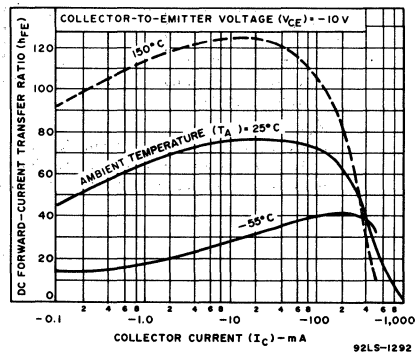


Fig. 4 - Typical dc beta characteristics for 2N4037 and 2N4314.

2N4036, 2N4037, 2N4314

2

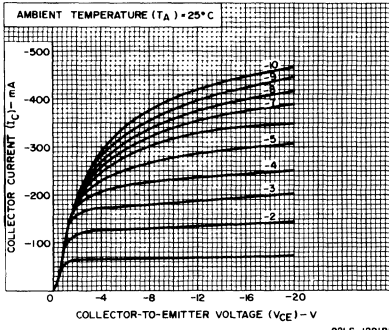


Fig. 5 - Typical large-signal output characteristics for 2N4037 and 2N4314.

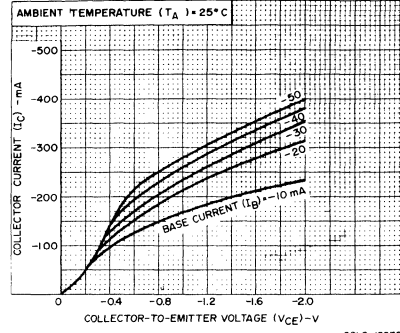


Fig. 6 - Typical small-signal output characteristics for 2N4037 and 2N4314.

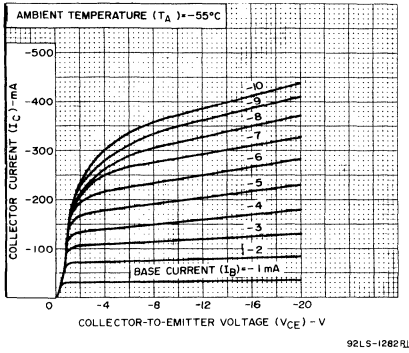


Fig. 7 - Typical output characteristics at $T_A = -55^\circ\text{C}$ for 2N4037 and 2N4314.

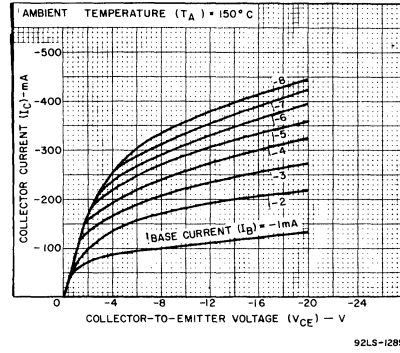


Fig. 8 - Typical output characteristics at $T_A = 150^\circ\text{C}$ for 2N4037 and 2N4314.

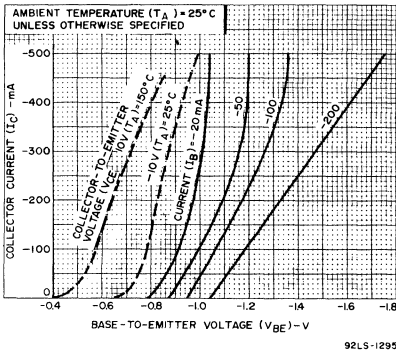


Fig. 9 - Typical transfer characteristics for 2N4037 and 2N4314.

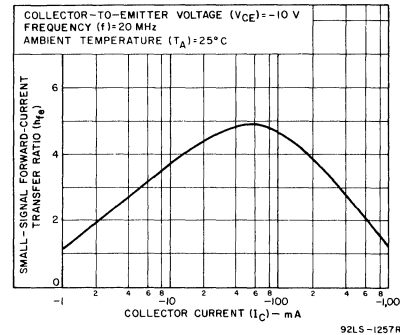


Fig. 10 - Typical small-signal beta characteristic for all types.

2N4036, 2N4037, 2N4314

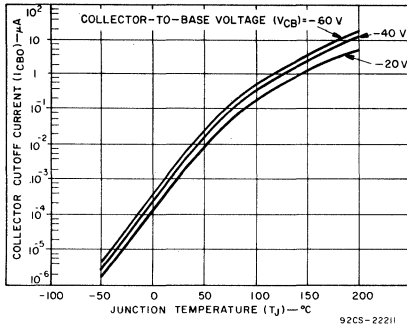


Fig. 11 - Typical collector cutoff current vs. junction temperature for 2N4036.

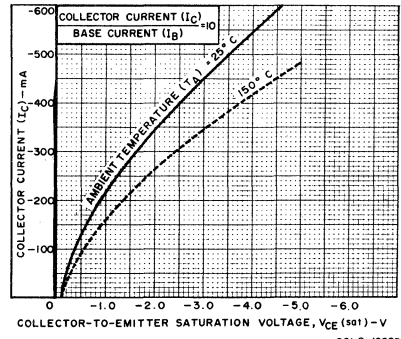


Fig. 12 - Typical saturation-voltage characteristics for 2N4036.

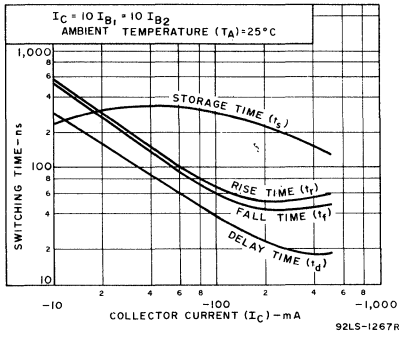


Fig. 13 - Typical saturated switching times for type 2N4036.

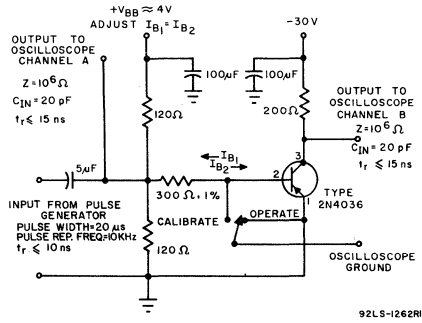


Fig. 14 - Circuit used to measure switching times for type 2N4036.

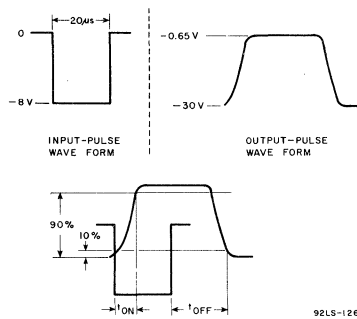


Fig. 15 - Oscilloscope display for measurement of switching times.

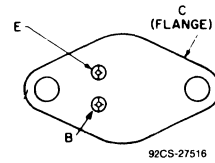
Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Applications

Features:

- Low saturation voltages
- Maximum safe-area-of-operation curves

TERMINAL DESIGNATIONS



JEDEC TO-213AA

The 2N4898, 2N4899 and 2N4900 are multiple-epitaxial p-n-p transistors. All are supplied in the JEDEC TO-213AA package.

All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series regulators and output stages of high-fidelity amplifiers.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N4898	2N4899	2N4900	
* V_{CB0}	40	60	80	V
* $V_{CEX(SUS)}$ $V_{BE} = -1.5 V, R_{BE} = 100 \Omega$	40	60	80	V
$V_{CE0(SUS)}$	40	60	80	V
* V_{EBO}	5	5	5	V
* I_C	1	1	1	A
I_{CM}	4	4	4	A
* I_B	1	1	1	A
* P_T At T_c up to 25°C	25	25	25	W
At T_c above 25°C	See Figs. 1 & 3			
* T_J, T_{stg}	-65 to +200			°C
* T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	+235			°C

* In accordance with JEDEC registration data.

2N4898, 2N4899, 2N4900

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTICS	TEST CONDITIONS				LIMITS						UNITS	
	VOLTAGE V dc		CURRENT A dc		2N4898		2N4899		2N4900			
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.		
* I _{CB0}	40 ^a 60 ^a 80 ^a				—	100	—	—	—	—	—	μA
* I _{CEX} R _{BE} = 100 Ω	40 60 80	-1.5 -1.5 -1.5			—	100	—	—	—	—	—	μA
* R _{BE} = 100 Ω T _C = 150°C	40 60 80	-1.5 -1.5 -1.5			—	1	—	—	—	—	—	mA
* I _{CEO}	20 30 40				—	0.5	—	—	—	—	—	mA
* I _{EBO}		-5			—	1	—	1	—	1	—	mA
* h _{FE}	1 1 1		0.5 ^b 0.05 ^b 1 ^b		20 ^c 40 10	100 — —	20 40 10	100 — —	20 40 10	100 — —	—	
* V _{CEO(sus)} ^c			0.1 ^b		40	—	60	—	80	—	—	V
V _{BE(sat)}			1 ^b	0.1	—	1.3	—	1.3	—	1.3	—	V
* V _{BE}	1		1 ^b		—	1.3	—	1.3	—	1.3	—	V
* V _{CE(sat)}			1 ^b	0.1	—	0.6	—	0.6	—	0.6	—	V
* h _{fe} f = 1 kHz	10		0.25		25	—	25	—	25	—	—	
* f _T f = 1 MHz	10		0.25		3	—	3	—	3	—	—	MHz
C _{obo}	10 ^a				—	100	—	100	—	100	—	pF
R _{θJC}					—	7	—	7	—	7	—	°C/W

* In accordance with JEDEC registration data.

^a V_{CB} value.^b Pulsed, pulse duration = 300 μs, duty factor = 1.8%.^c CAUTION: Sustaining voltage, V_{CEO(sus)}, *MUST NOT* be measured on a curve tracer. (See Figs. 2 and 4.)

2N4898, 2N4899, 2N4900

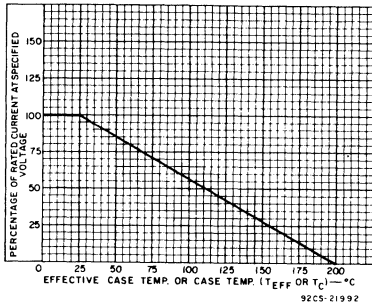


Fig. 1 - Current derating chart for all types.

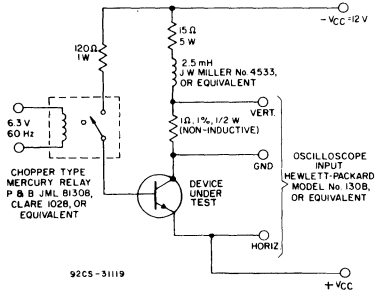


Fig. 2 - Circuit used to measure sustaining voltage, $V_{CE0(sus)}$.

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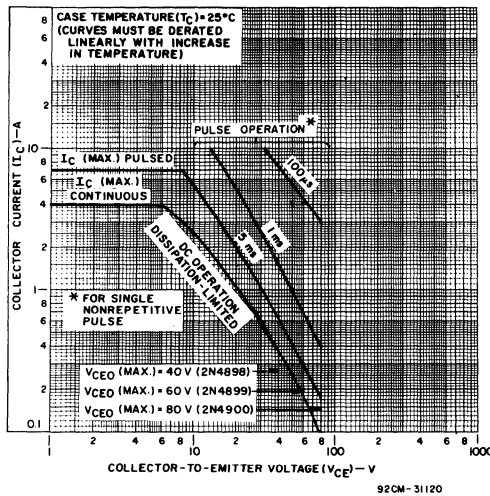
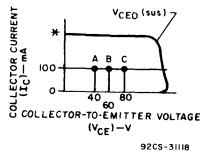


Fig. 3 - Maximum operating areas for all types. ($T_C = 25^\circ C$).

* PULSE CURRENT (I_p) RANGE MUST BE 0.2-0.4A



The sustaining voltage, $V_{CE0(sus)}$, is acceptable when the trace falls to the right of point "A" for type 2N4898; point "B" for type 2N4899; and point "C" for type 2N4900.

Fig. 4 - Oscilloscope display for measurement of sustaining voltages.

High-Current, High-Power High-Speed Silicon N-P-N Planar Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

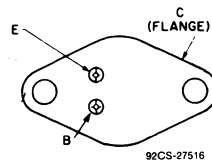
Features:

- Maximum operating area curves for dc and pulse operation
- $I_{S/P}$ -limit line beginning at 28 V
- High collector current rating
- High-dissipation capability

The 2N5038, 2N5039 and 2N6496 are epitaxial silicon n-p-n planar transistors. They differ in breakdown-voltage ratings, leakage-current, and dc-beta values.

The high current-handling capability of these transistors in conjunction with fast switching speeds make these devices especially suited for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the JEDEC TO-204AA package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5038	2N5039	2N6496	
*COLLECTOR-TO-BASE VOLTAGE V_{CBO}	150	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With -1.5 volts (V_{BE}) of reverse bias and external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CEX(sus)}$ 150	120	-	V
With $R_{BE} \leq 50 \Omega$	$V_{CER(sus)}$ 110	95	130	V
With base open	$V_{CEO(sus)}$ 90	75	110	V
*EMITTER-TO-BASE VOLTAGE V_{EBO}	7	7	7	V
*CONTINUOUS COLLECTOR CURRENT I_C	20	20	15	A
*PEAK COLLECTOR CURRENT	30	30	-	A
*CONTINUOUS BASE CURRENT I_B	5	5	5	A
*TRANSISTOR DISSIPATION: P_T				
At case temperatures up to 25°C and V_{CE} up to 28 V	140	140	140	W
At case temperature of 100°C and V_{CB} of 20 V	80	80	80	W
At case temperatures up to 25°C and V_{CE} above 28 V	← See Fig. 1. →			
At case temperatures above 25°C and V_{CE} above 28 V	← See Figs. 1 & 2. →			
*TEMPERATURE RANGE:				
Storage & Operating (Junction)	← -65 to 200 →			°C
PIN TEMPERATURE (During Soldering)				
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	← 230 →			°C

*In accordance with JEDEC registration data format (JS-6, RDF-1)

2N5038, 2N5039, 2N6496

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS						UNITS		
		VOLTAGE V dc				CURRENT A dc		2N5038		2N5039		2N6496				
		V _{CB}	V _{CE}	V _{EB}	V _{BE}	I _C	I _E	I _B	Min.	Max.	Min.	Max.	Min.		Max.	
Collector Cutoff Current: With base open	I _{CEO}	55	70					0		—	—	—	20	—	—	mA
* With base-emitter junction reverse-biased	I _{CEV}	110	140	130	—1.5	—1.5	0			—	—	—	50	—	—	
* At T _C = 150°C		85	100	130	—1.5	—1.5	0			—	—	—	10	—	—	
* Emitter Cutoff Current	I _{EBO}			5	7			0		—	5	—	15	—	—	mA
DC Forward-Current Transfer Ratio	h _{FE}	5	5	5	2			2 ^a		50	200	30	150	—	—	
* * * * *								10 ^a		—	—	20	100	—	—	
* * * * *								12 ^a		20	100	—	—	—	—	
* * * * *								8 ^a		—	—	—	—	12	100	
* Magnitude of Small-Signal Forward-Current Transfer Ratio (At f = 5 MHz)	|h _{fe}|	10						2		12	—	12	—	12	—	
* Collector-to-Emitter Sustaining Voltage: With base open	V _{CEO(sus)} ^b							0.2		0	90	—	75	—	110	V
* With base-emitter junction reverse biased and external base-to-emitter resistance (R _{BE}) = 100 Ω	V _{CEx(sus)} ^b					—1.5	0.2			0	150	—	120	—	—	
* With R _{BE} ≤ 50 Ω	V _{CER(sus)} ^b						0.2			0	110	—	95	—	130	
Emitter-to-Base Voltage	V _{EBO}							0	0.05		7	—	7	—	7	V
Base-to-Emitter Voltage	V _{BE}	5	5	2				10 ^a		—	—	—	1.8	—	—	V
* * * * *								12 ^a		—	1.8	—	—	—	—	
* * * * *								8 ^a		—	—	—	—	—	1.6	
* * * * *								10 ^a	1.0	—	—	—	1.0	—	—	V
* * * * *								12 ^a	1.2	—	1.0	—	—	—	—	
* * * * *								20 ^a	5	—	2.5	—	2.5	—	—	
* * * * *								8 ^a	0.8	—	—	—	—	—	1.0	
* Base-to-Emitter Saturation Voltage	V _{BE(sat)}							20 ^a	5	—	3.3	—	3.3	—	—	V
* * * * *								8 ^a	0.8	—	—	—	—	—	2.0	
Output Capacitance	C _{ob}	10								—	400	—	400	—	400	pF
Second-Breakdown Collector Current ^e (With base forward biased)	I _{S/b} ^d		28	45						5.0	—	5.0	—	5.0	—	A
* * * * *										0.9	—	0.9	—	0.9	—	
Second-Breakdown Energy (With base reverse biased, R _B = 20 Ω, L = 180 μH)	E _{S/b} ^f				—4	—4	12	8		13	—	13	—	—	—	mJ
* Sat. Switching Rise Time	t _r	V _{CC} = 30 V					10	12	8	1.0 ^e	—	—	—	0.5	—	—
* * * * *										1.2 ^e	—	—	—	—	—	
* * * * *										0.8 ^e	—	—	—	—	0.5	
* Sat. Switching Storage Time	t _s	V _{CC} = 30 V					10	12	8	1.0 ^e	—	—	—	1.5	—	—
* * * * *										1.2 ^e	—	—	—	—	—	
* * * * *										0.8 ^e	—	—	—	—	1.5	
* Sat. Switching Fall Time	t _f	V _{CC} = 30 V					10	12	8	1.0 ^e	—	—	—	0.5	—	—
* * * * *										1.2 ^e	—	—	—	—	—	
* * * * *										0.8 ^e	—	—	—	—	0.5	
Thermal Resistance (Junction-to-Case)	R _{θJC}		10				10			—	1.25	—	1.25	—	1.25	°C/W

^a Pulsed; pulse duration ≤ 350 μs, duty factor = 2%.^b CAUTION: The sustaining voltages V_{CEO(sus)}, V_{CER(sus)}, and V_{CEx(sus)} MUST NOT be measured on a curve tracer.^c I_{B1} = I_{B2} = value shown.^d In accordance with JEDEC registration data format (JS-6, RDF-1)^d I_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.^e Pulsed; 1-s non-repetitive pulse.^f E_{S/b} is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. E_{S/b} = ½LI² where L is a series load or leakage inductance and I is the peak collector current.

2N5038, 2N5039, 2N6496

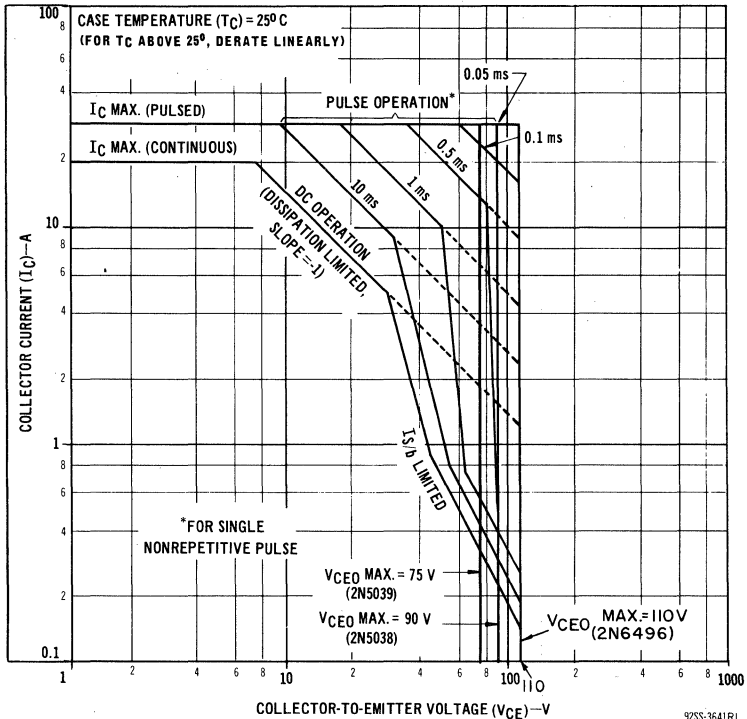


Fig. 1 — Maximum operating areas for all types.

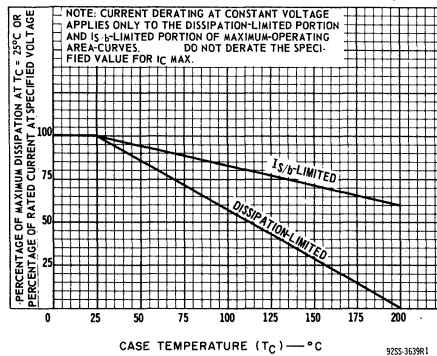


Fig. 2 — Dissipation derating curves for all types.

2N5038, 2N5039, 2N6496

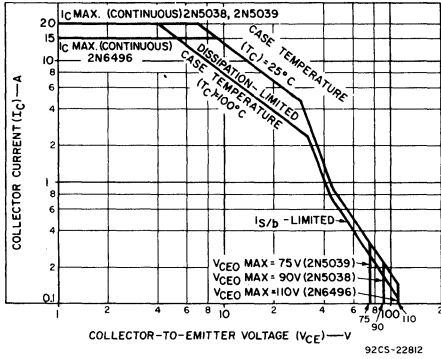


Fig. 3 - Maximum operating areas for all types.

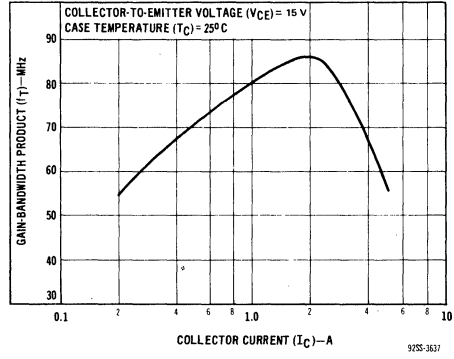


Fig. 4 - Typical gain-bandwidth product for all types.

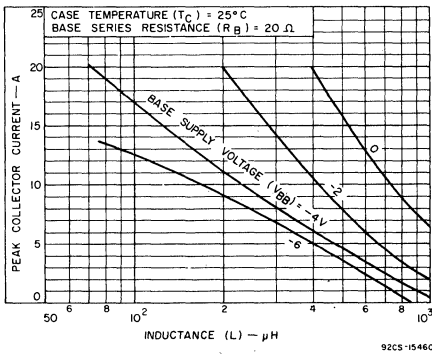


Fig. 5 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

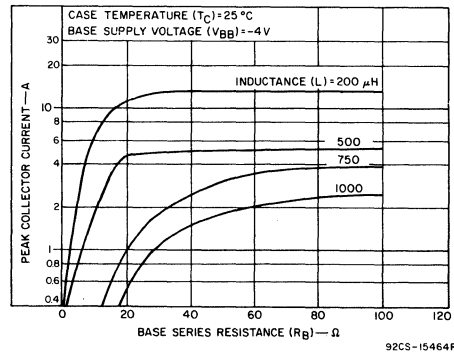


Fig. 6 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

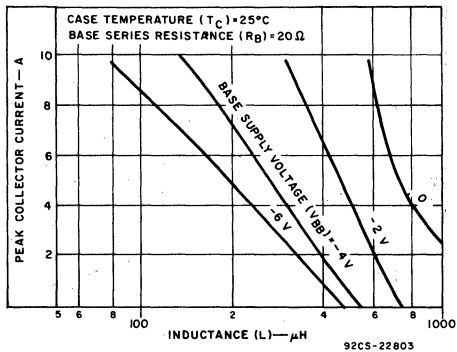


Fig. 7 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

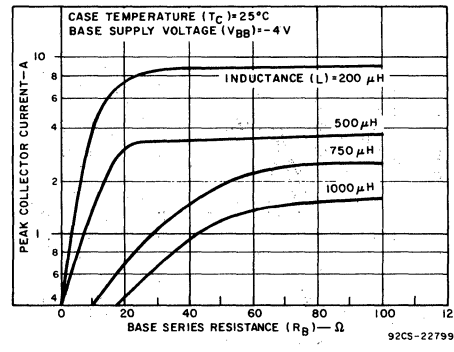


Fig. 8 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

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2N5038, 2N5039, 2N6496

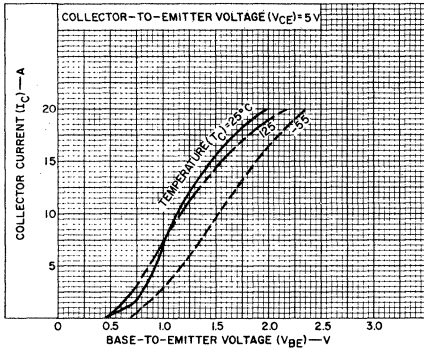


Fig. 9 - Typical transfer characteristics for 2N5038.

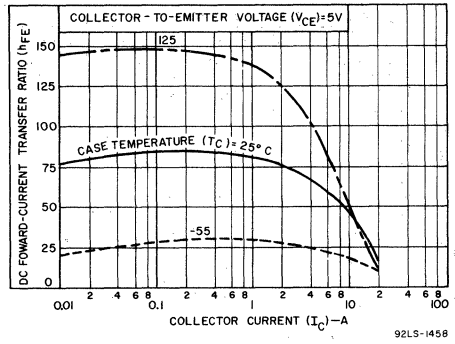


Fig. 10 - Typical dc beta characteristics for 2N5038.

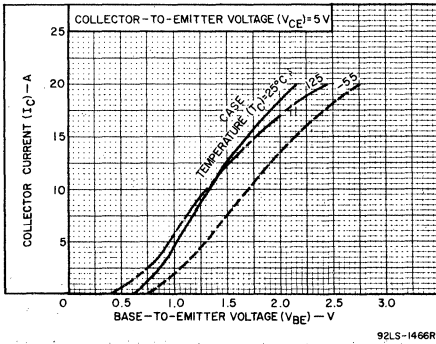


Fig. 11 - Typical transfer characteristics for 2N5039.

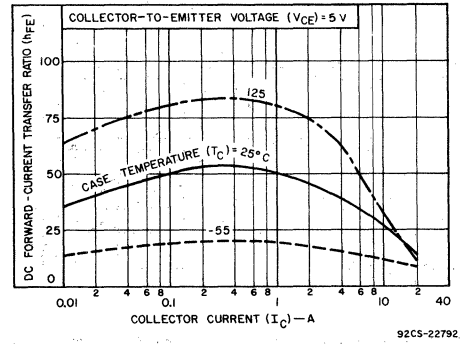


Fig. 12 - Typical dc beta characteristics for 2N5039.

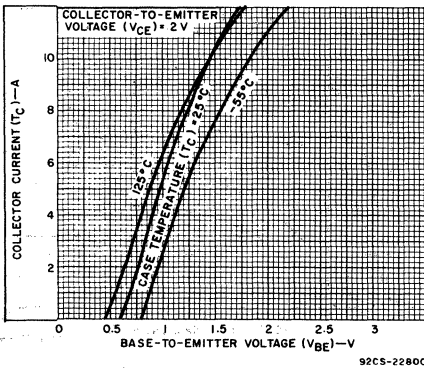


Fig. 13 - Typical transfer characteristics for 2N6496.

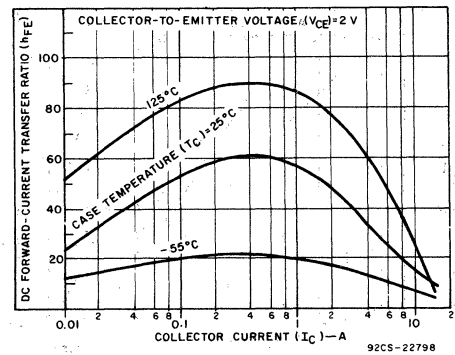


Fig. 14 - Typical dc beta characteristics for 2N6496.

2N5038, 2N5039, 2N6496

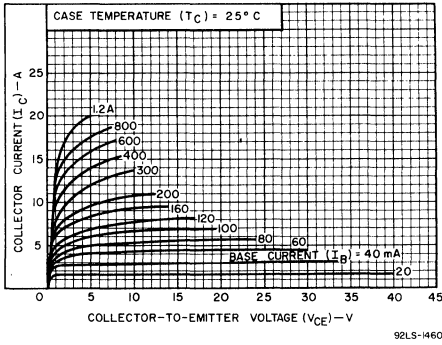


Fig. 15 - Typical output characteristics for 2N5038.

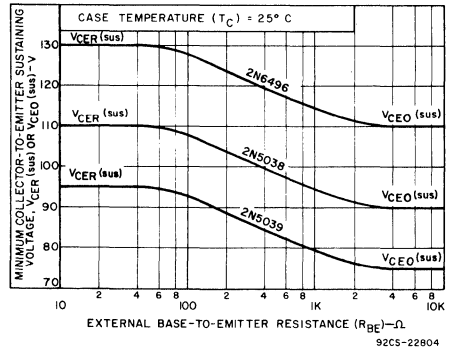


Fig. 16 - Collector-to-emitter sustaining voltage characteristic for all types.

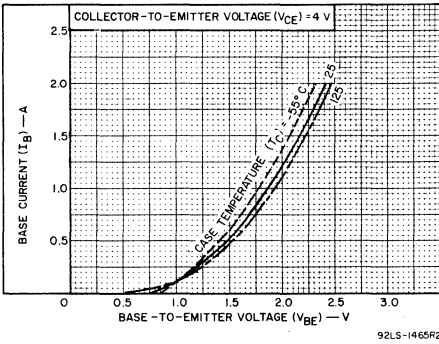


Fig. 17 - Typical input characteristics for 2N5039.

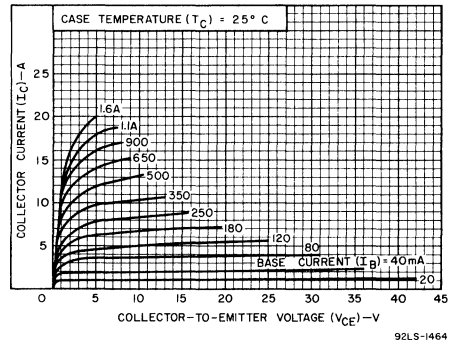


Fig. 18 - Typical input characteristics for 2N5038 and 2N5039.

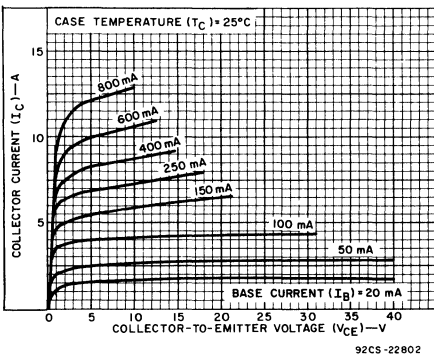


Fig. 19 - Typical output characteristics for 2N6496.

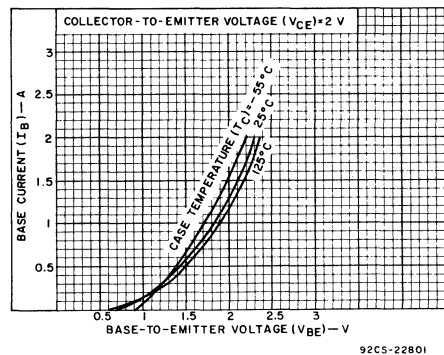


Fig. 20 - Typical input characteristics for 2N6496.

2

2N5038, 2N5039, 2N6496

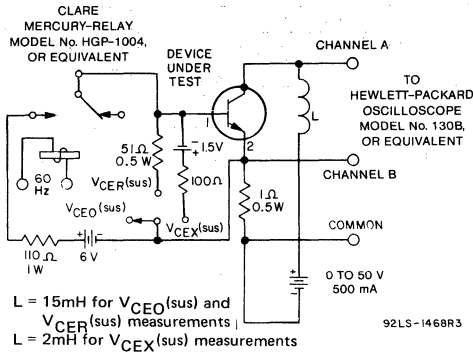
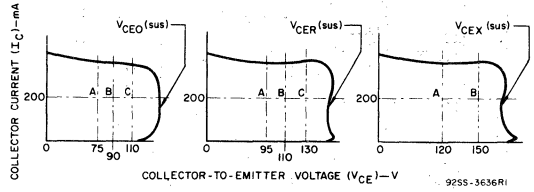


Fig. 21 - Circuit used to measure sustaining voltages $V_{CE0}(\text{sus})$, $V_{CER}(\text{sus})$, and $V_{CEX}(\text{sus})$.



The sustaining voltages ($V_{CE0}(\text{sus})$, $V_{CER}(\text{sus})$, and $V_{CEX}(\text{sus})$) are acceptable when the traces fall to the right of point "A" for type 2N5039, point "B" for type 2N5038 and point "C" for type 2N6496. (NOTE: 2N6496 is not tested for $V_{CEX}(\text{sus})$.)

Fig. 22 - Oscilloscope display for measurement of sustaining voltages (Test circuit shown in Fig. 22).

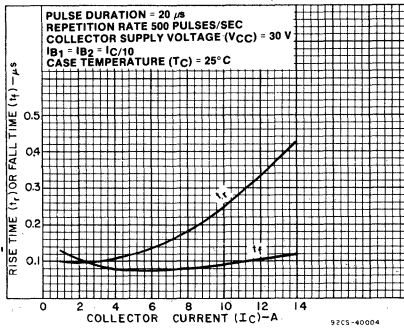


Fig. 23 - Typical rise-time and fall-time characteristics for all types.

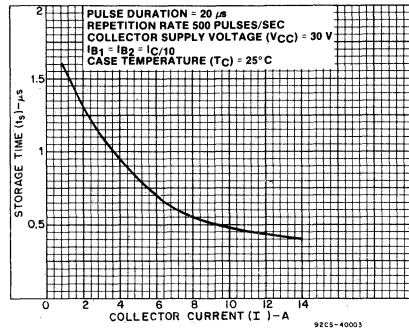


Fig. 24 - Typical storage time characteristic for all types.

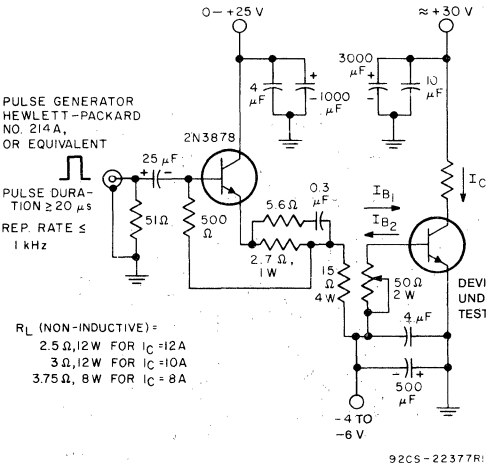


Fig. 25 - Circuit used to measure switching times for all types.

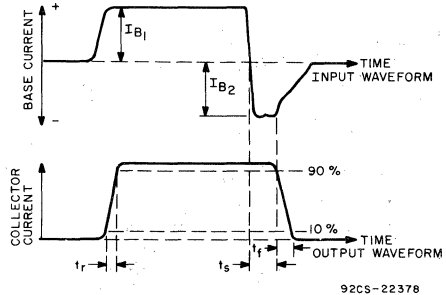


Fig. 26 - Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 26).

High-Voltage, Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications in Industrial and Commercial Service

Features:

- **High voltage ratings:** $V_{CER(SUS)}$
 =350 V, $R_{BE} \leq 50 \Omega$ (2N5240)
 =250 V, $R_{BE} \leq 50 \Omega$ (2N5239)
- **High power dissipation rating:**
 $P_T = 100 \text{ W}$ at $V_{CE} = 125 \text{ V}$, $T_C = 25^\circ \text{C}$
- **For switching applications where circuit values and operating conditions require a transistor with a high second-breakdown rating (I_S/b) (limit line begins at 125 V)**
- **Exceptional second-breakdown: 0.8 A at $V_{CE} = 125 \text{ V}$**
- **Maximum area-of-operation curves for dc and pulse operation**

2

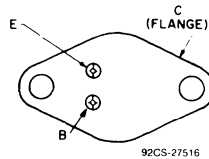
The 2N5239 and 2N5240* are multi epitaxial silicon n-p-n power transistors.

The high breakdown voltage ratings and exceptional second-breakdown capabilities of these transistors make them especially suitable for use in series regulators, power amplifiers, inverters, deflection circuits, switching regulators, and high-voltage bridge amplifiers.

These types differ in breakdown voltage and leakage current values. The 2N5239 and 2N5240 are supplied in steel JEDEC TO-204AA hermetic packages.

* RCA Dev. No. TA2765 and TA2765A, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5239	2N5240	
* V_{CBO}	300	375	V
$V_{CER(SUS)}$			
$R_{BE} \leq 50 \Omega$	250	350	V
* $V_{CEO(SUS)}$	225	300	V
* V_{EBO}		6	V
* I_C		5	A
* I_B		2	A
* P_T :			
$T_C \leq 25^\circ \text{C}$ and $V_{CE} \leq 125 \text{ V}$		100	W
$T_C \leq 25^\circ \text{C}$ and $V_{CE} \leq 125 \text{ V}$		See Fig. 1	
$T_C > 25^\circ \text{C}$ and $V_{CE} > 125 \text{ V}$		See Fig. 1	
* T_{sig, T_J}		-65 to 200	$^\circ \text{C}$
T_L			
At distance $\geq 1/32$ in. (0.8 mm)			
from seating plane for 10 s max.		230	$^\circ \text{C}$

* In accordance with JEDEC registration data

2N5239, 2N5240

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_c) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N5239		2N5240		
	V _{CE}	V _{BE}	I _c	I _b	Min.	Max.	Min.	Max.	
I _{CEO}	200			0	—	5	—	2	mA
I _{CEV}	300	-1.5			—	4	—	—	
	375	-1.5			—	—	—	2	
($T_c = 150^\circ\text{C}$)	300	-1.5			—	5	—	3	
I _{EBO} (V _{EB} = 5 V)			0		—	5	—	1	mA
	(V _{EB} = 6 V)		0		—	20	—	20	
V _{EBO}				0.02	6	—	6	—	V
V _{CEO(sus)} ^a			0.2 ^b		225	—	300	—	
V _{CEr(sus)} ^a (R _{BE} ≤ 50 Ω)			0.2 ^b		250	—	350	—	
h _{FE}	10		0.4 ^b		20	80	20	80	—
	10		2 ^b		20	80	20	80	
	10		4.5 ^b		5	—	5	—	
V _{BE}	10		2 ^b		—	3	—	3	V
V _{CE(sat)}			2 ^b	0.25	—	2.5	—	2.5	
			4.5 ^b	1.125	—	5	—	5	
I _{S/b} (t = 1 s)	125				0.8	—	0.8	—	A
|h _{fe}| (f = 1 MHz)	10		0.2		2	—	2	—	—
h _{fe} (f = 1 kHz)	10		4		20	—	20	—	
f _T	10		0.2		2	—	2	—	MHz
C _{obo} (f = 1 MHz)	10 ^c		0		—	250	—	250	pF
R _{θJC}					—	1.75	—	1.75	°C/W

^a In accordance with JEDEC registration data.

^a CAUTION: The sustaining voltages V_{CEO(sus)} and V_{CEr(sus)} MUST NOT be measured on a curve tracer.

^b Pulsed; pulse duration ≤ 350 μs, duty factory ≤ 2%.

^c V_{CB} value.

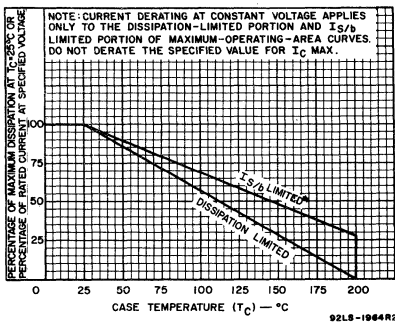


Fig. 1 - Derating curves for both types.

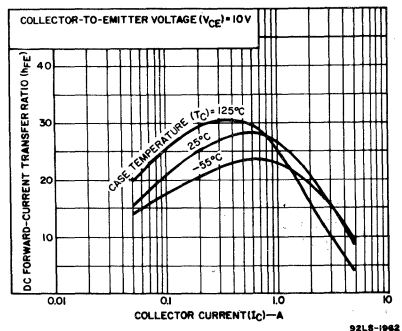


Fig. 2 - Typical dc beta characteristics for both types.

2N5239, 2N5240

2

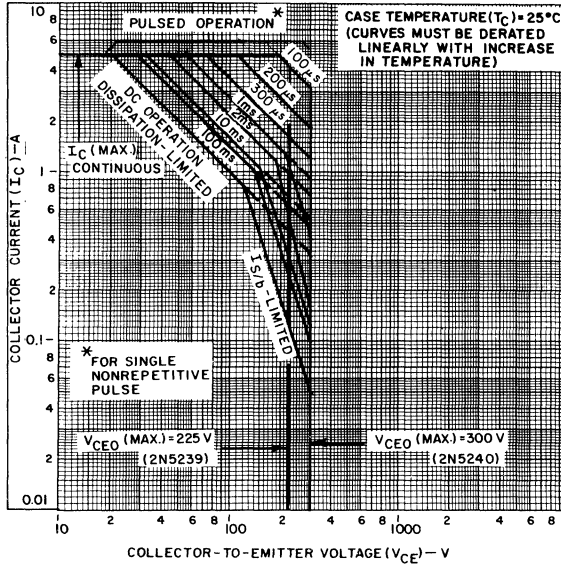


Fig. 3 — Maximum operating areas for both types.

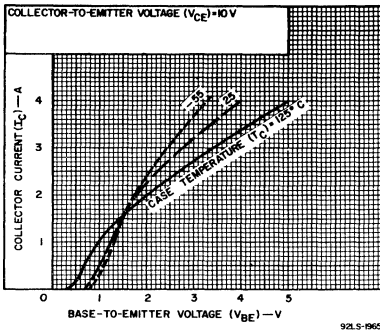


Fig. 4 — Typical transfer characteristics for both types.

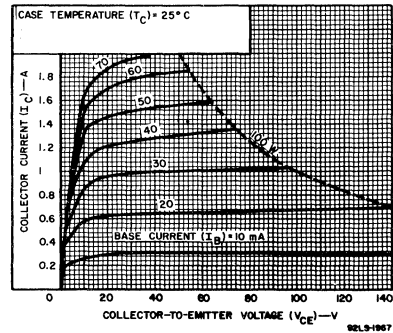


Fig. 5 — Typical output characteristics for both types.

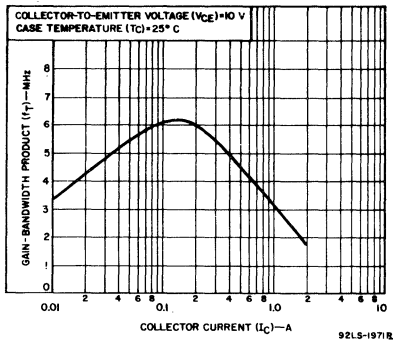


Fig. 6 — Typical gain-bandwidth product as a function of collector current for both types.

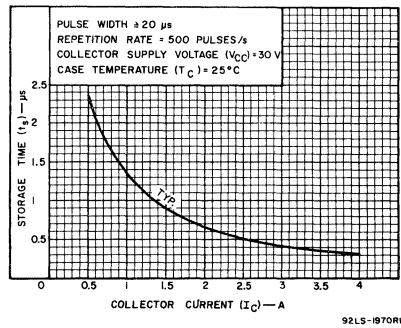


Fig. 7 — Typical saturated-storage time (storage) as a function of collector current for both types.

2N5239, 2N5240

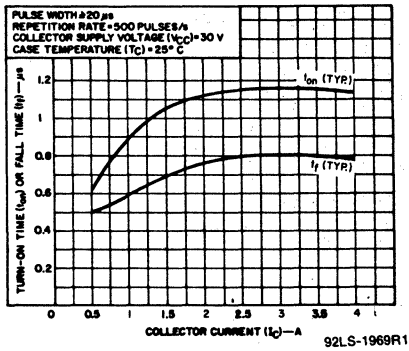


Fig. 8 — Typical saturated-time (turn-on or fall) as a function of collector current for both types.

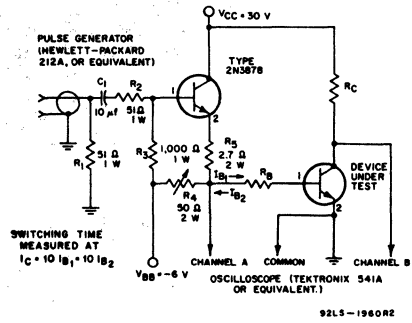


Fig. 9 — Circuit used to measure sustaining voltages, $V_{CE0}(sus)$ and $V_{CER}(sus)$ for both types.

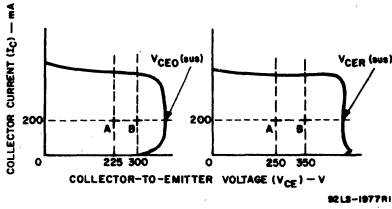


Fig. 10 — Oscilloscope display for $V_{CE0}(sus)$ and $V_{CER}(sus)$ measurement.

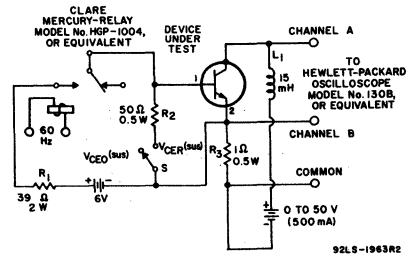


Fig. 11 — Circuit used to measure switching times for both types.

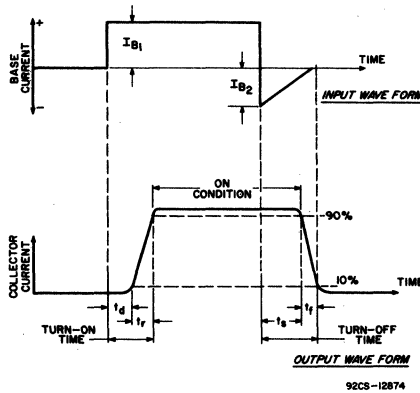


Fig. 12 — Phase relationship between input and output currents showing reference points for specification of switching times.

Silicon N-P-N Transistors

General-Purpose Types for Medium-Power Switching and Amplifier Applications

Features:

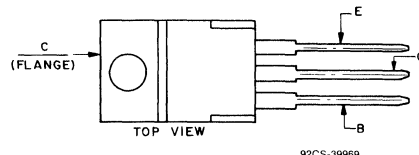
- Low saturation voltage -
 $V_{ce(sat)} = 1\text{ V max. at } I_c = 0.5\text{ A (2N5294)}$
 $= 1\text{ V max. at } I_c = 1\text{ A (2N5296)}$
 $= 1\text{ V max. at } I_c = 1.5\text{ A (2N5298)}$
- Maximum safe-area-of-operation curves specified for DC and pulse service

The 2N5294, 2N5296, and 2N5298 are triple-diffused silicon n-p-n transistors. They are intended for a wide variety of medium-power switching and amplifier applications such as series and shunt regulators, and in driver and output stages of high-fidelity amplifiers.

These plastic power transistors differ in voltage ratings and in the currents at which the parameters are controlled.

All types are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5294	2N5296	2N5298	
*COLLECTOR-TO-BASE VOLTAGE.....	80	60	80	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With -1.5 volts (V_{BE}) of reverse bias.....	80	60	80	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	75	50	70	V
With base open.....	70	40	60	V
*EMITTER-TO-BASE VOLTAGE.....	7	5	5	V
*COLLECTOR CURRENT.....	4	4	4	A
*BASE CURRENT.....	2	2	2	A
*TRANSISTOR DISSIPATION, P_T				
At case temperatures up to 25°C.....	36	36	36	W
At case temperatures above 25°C.....	Derate linearly at 0.288 or see Figs. 1 & 2			W/°C
At ambient temperatures up to 25°C.....	1.8	1.8	1.8	W
At ambient temperatures above 25°C.....	Derate linearly at 0.0144			W/°C
*TEMPERATURE RANGE:				
Storage & Operating (Junction).....	-65 to +150			°C
LEAD TEMPERATURE (During Soldering):				
At distance $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	235			°C

*In accordance with JEDEC registration data.

2N5294, 2N5296, 2N5298

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C, Unless Otherwise Specified.

Characteristic	Symbol	TEST CONDITIONS						LIMITS						Units
		DC Collector Voltage (V)		DC Emitter or Base Voltage (V)		DC Current (A)		2N5294		2N5296		2N5298		
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.		
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}	65 35		-1.5 -1.5			-	0.5	-	-	-	0.5	mA	
	I_{CEV} ($T_C = 150^\circ\text{C}$)	65 35		-1.5 -1.5			-	3	-	-	-	3	mA	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	50					-	0.5	-	-	-	0.5	mA	
	I_{CER} ($T_C = 150^\circ\text{C}$)	50					-	2	-	-	-	2	mA	
Emitter-Cutoff Current	I_{EBO}		7 5				-	1	-	-	-	1	mA	
DC Forward-Current Transfer Ratio	h_{FE}^c	4			0.5		30	120	-	-	-	-		
		4			1		-	-	30	120	-	-		
		4			1.5		-	-	-	-	20	80		
Collector-to-Emitter Sustaining Voltage With base open	$V_{CE0(sus)}^c$				0.1	0	70	-	-	-	-	-	V	
					0.1	0	-	-	40	-	-	-	-	
					0.1	0	-	-	-	-	60	-	-	
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}^c$				0.1		75	-	-	-	-	-	V	
					0.1		-	-	50	-	-	-	-	
					0.1		-	-	-	-	70	-	-	
With base-emitter junction reverse biased	$V_{CEV(sus)}^c$			-1.5	0.1		80	-	-	-	-	-	V	
				-1.5	0.1		-	-	60	-	-	-	-	
				-1.5	0.1		-	-	-	-	80	-	-	
				-1.5	0.1		-	-	-	-	-	-	-	
Base-to-Emitter Voltage	V_{BE}^c	4			0.5		-	1.1	-	-	-	-	V	
		4			1		-	-	-	1.3	-	-	-	
		4			1.5		-	-	-	-	-	1.5	-	
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}^c$				0.5	0.05	-	1	-	-	-	-	V	
					1	0.1	-	-	-	1	-	-	-	
					1.5	0.15	-	-	-	-	-	1	-	
Gain-Bandwidth Product	f_T	4			0.2		0.8	-	0.8	-	0.8	-	MHz	
Sat. Switching Time	Turn-On (See Figs. 22 - 24)	t_{on}	$V_{CC} = 30$		0.5	0.05 ^a	-	5	-	-	-	-	-	μs
					1	0.1 ^a	-	-	-	5	-	-	-	-
					1.5	0.15 ^a	-	-	-	-	-	-	5	-
Turn-Off (See Figs. 22 - 24)	t_{off}	$V_{CC} = 30$		0.5	-0.05 ^a	-	15	-	-	-	-	-	-	μs
				1	-0.1 ^b	-	-	-	15	-	-	-	-	
				1.5	-0.15 ^b	-	-	-	-	-	-	15	-	-
Thermal Resistance (Junction-to-Case)	θ_{J-C}						-	3.5	-	3.5	-	3.5	$^\circ\text{C/W}$	
(Junction-to-Ambient)	θ_{J-A}						-	70	-	70	-	70	$^\circ\text{C/W}$	

^a I_{B1} value (turn-on base current).^b I_{B2} value (turn-off base current).^c Pulsed, pulse duration = 300 μs , duty factor = .018.

*In accordance with JEDEC registration data.

2N5294, 2N5296, 2N5298

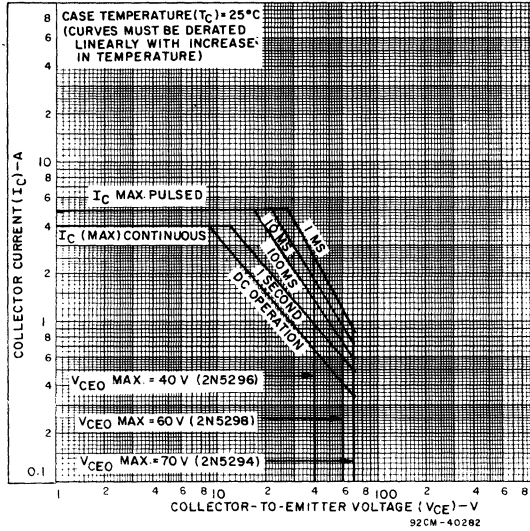


Fig. 1 - Maximum operating areas for all types.

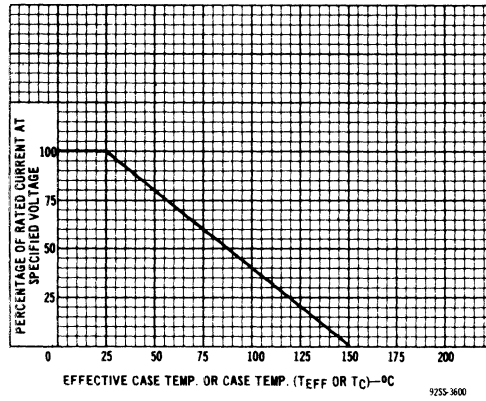


Fig. 2 - Derating curve for all types.

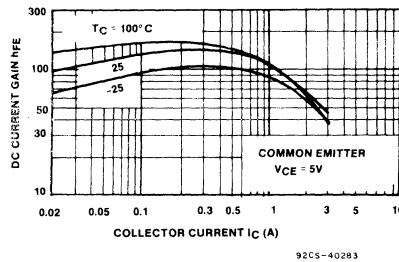


Fig. 3 - Typical DC beta characteristics for all types.

2

2N5294, 2N5296, 2N5298

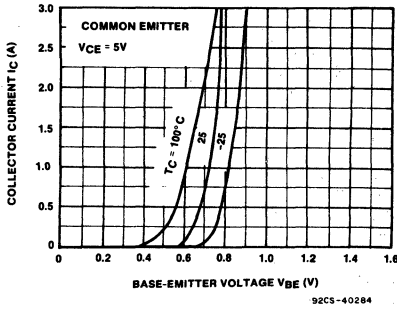


Fig. 4 - Typical input characteristics for all types.

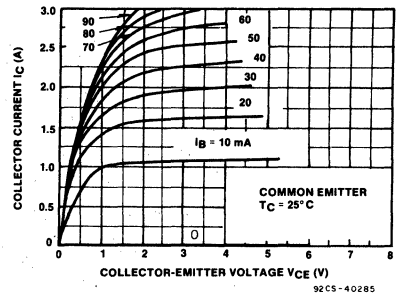


Fig. 5 - Typical output characteristics for all types.

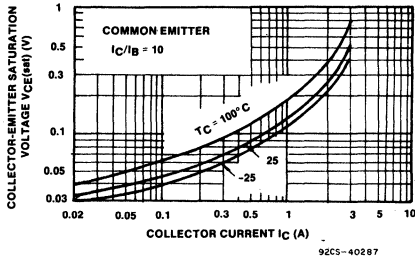


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

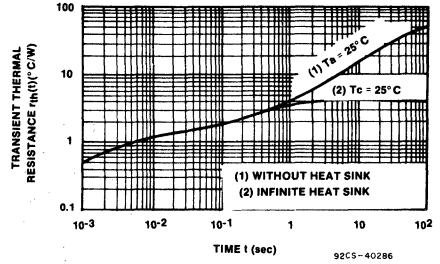


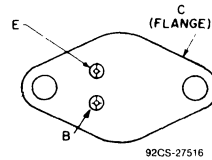
Fig. 7 - Transient thermal resistance characteristics for all types.

High-Current High-Power High-Speed N-P-N Power Transistors

Features:

- Specification for h_{FE} and $V_{CE(sat)}$ up to 30 A
- Current gain-bandwidth product $f_T = 2$ MHz min. at 1 A
- Low saturation voltage with high beta
- High dissipation capability

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The 2N5301, 2N5302 and 2N5303 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings and $V_{CE(sat)}$, $V_{BE(sat)}$, and V_{BE} characteristics. All are supplied in JEDEC TO-204AA hermetic steel packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5301	2N5302	2N5303	
* V_{CBO}	40	60	80	V
* $V_{CEO(SUS)}$	40	60	80	V
* V_{EBO}	_____	5	_____	V
* I_C	_____	30	_____	A
* I_{CM}	_____	50	_____	A
* I_B	_____	7.5	_____	A
* I_{BM}	_____	15	_____	A
* P_T	_____	_____	_____	_____
At $T_C \leq 25^\circ\text{C}$	_____	200	_____	W
At $T_C > 25^\circ\text{C}$	_____	1.15	_____	W/ $^\circ\text{C}$
		See Figs. 1 & 2		
* T_J, T_{stg}	_____	-65 to 200	_____	$^\circ\text{C}$
* T_L	_____	_____	_____	_____
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	_____	230	_____	$^\circ\text{C}$

* In accordance with JEDEC registration data format JS-6 RDF-2.

2N5301, 2N5302, 2N5303

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS	
	VOLTAGE V dc		CURRENT A dc		2N5301		2N5302		2N5303			
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.		
* I _{CBO}	40 ^a 60 ^a 80 ^a				—	1	—	—	1	—	—	mA
* I _{CEX}	40 60 80	-1.5 -1.5 -1.5			—	1	—	—	1	—	—	
* I _{CEX} T _C = 150°C	40 60 80	-1.5 -1.5 -1.5			—	10	—	—	10	—	—	
* I _{CEO}	40 60 80				—	5	—	—	5	—	—	
* I _{EBO}		-5			—	5	—	—	5	—	—	
* h _{FE}	2 2 3 2 3		1 ^b 10 ^b 15 ^b 20 ^b 30 ^b		40 — 15 — 5	— — 60 — —	40 — 15 — 5	— — 60 — —	40 15 — 5 —	— — — — —	60 — — — —	V
* V _{CEO(sus)}			0.2		40	—	60	—	80	—		
* V _{BE}	2 2 4 4		10 ^b 15 ^b 20 ^b 30 ^b		— — — —	— 1.7 — 3	— — — —	— 1.7 — 3	— — — —	— — — —	1.5 — 2.5 —	
* V _{BE(sat)}			10 ^b 15 ^b 20 ^b 20 ^b	1 1.5 2 4	— — — —	1.7 1.8 2.5 —	— — — —	1.7 1.8 2.5 —	— — — —	— — — —	1.7 2 — 2.5	
* V _{CE(sat)}			10 ^b 15 ^b 20 ^b 20 ^b 30 ^b	1 1.5 2 4 6	— — — — —	0.75 — 2 — 3	— — — — —	0.75 — 2 — 3	— — — — —	— — — — —	1 1.5 — — —	
I _{S/b} t _p = 1 s nonrep.	20				10	—	10	—	10	—		A
* |h _{fe}| f = 1 MHz	10		1	—	2	—	2	—	2	—		
* h _{fe} f = 1 kHz	10		1	—	40	—	40	—	40	—		
* t _r (See Fig.8)	V _{CC} =		10	1	—	1	—	1	—	1		μs
* t _s	30		10	1 ^c	—	2	—	2	—	2		
* t _f			10	1 ^c	—	1	—	1	—	1		
R _{θJC}	20		5	—	—	0.875	—	0.875	—	0.875		°C/W

* In accordance with JEDEC registration data format JS-6 RDF-1.

^a V_{CB}^b Pulsed; pulse duration = 300 μs, duty factor = 1.8%^c I_{B1} = -I_{B2}

2N5301, 2N5302, 2N5303

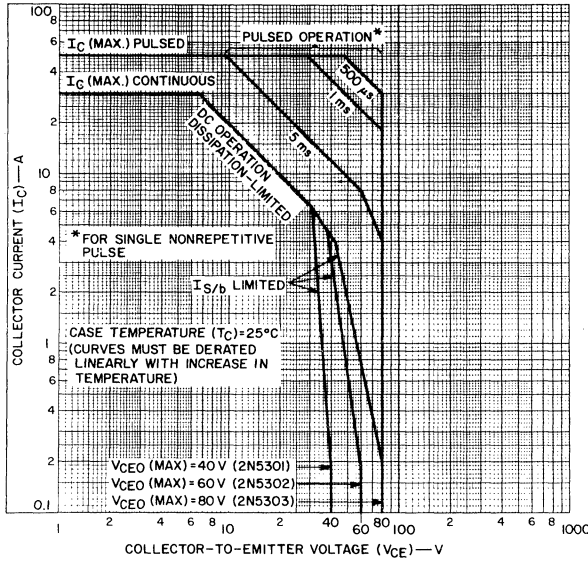


Fig. 1 — Maximum operating areas for 2N5301, 2N5302, and 2N5303.

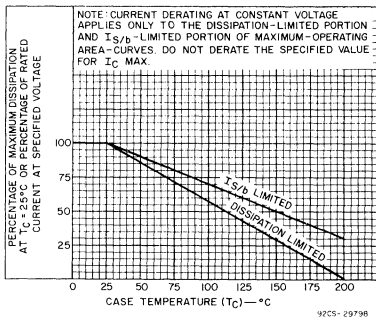


Fig. 2 — Derating curves for 2N5301, 2N5302, and 2N5303.

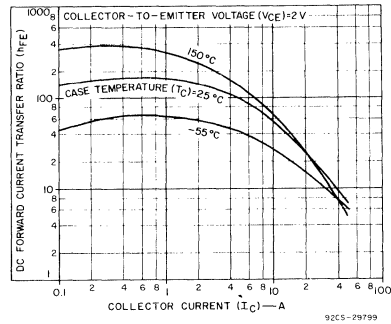


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

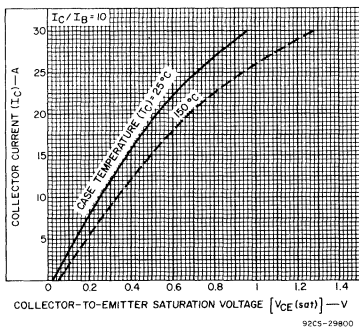


Fig. 4 — Typical saturation voltage characteristics for 2N5301, 2N5302, and 2N5303.

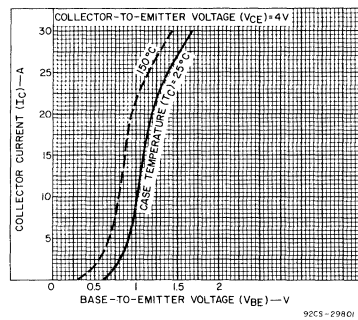


Fig. 5 — Typical transfer characteristics for 2N5301, 2N5302, and 2N5303.

2N5301, 2N5302, 2N5303

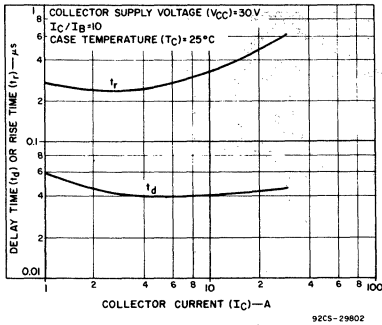


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

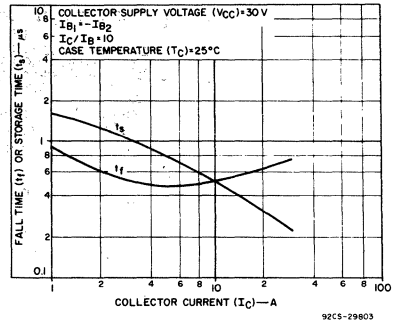


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

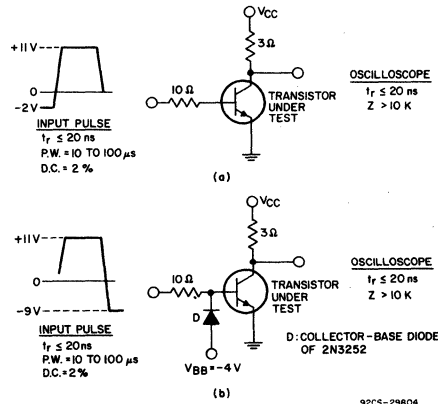


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5301, 2N5302, and 2N5303.

2N5320, 2N5321, 2N5322, 2N5323

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C, unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS	
	VOLTAGE V dc		CURRENT mA dc		2N5320		2N5321		2N5322		2N5323			
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
I _{CBO}	80 [▲] 60 [▲] -80 [▲] -60 [▲]				-	0.5	-	-	-	-	-	-	μA	
* I _{CEX}	100 75 -100 -75	-1.5 -1.5 1.5 1.5			-	0.1	-	0.1	-	-	-0.1	-	mA	
T _C = 150°C	70 45 -70 -45	-1.5 -1.5 1.5 1.5			-	5	-	5	-	-	-5	-	mA	
* I _{EBO}		-7 -5 7 5	0 0 0 0		-	0.1	-	-	0.1	-	-0.1	-	mA	
		-5 -4 5 4	0 0 0 0		-	0.1	-	0.5	-	-	-0.1	-	μA	
V _{(BR)CEV}		-1.5 1.5	0.1 -0.1		100	-	75	-	-	-100	-	-75	V	
V _{CER(sus)} ^a R _{BE} = 100Ω			100 ^b -100 ^b		90	-	65	-	-	-90	-	-65	V	
* V _{CEO(sus)} ^a			100 ^b -100 ^b	0 0	75	-	50	-	-	-75	-	-50	V	
* V _{CE(sat)}			500 ^b -500 ^b	50 -50	-	0.5	-	0.8	-	-	-0.7	-	V	
* V _{BE}	4 -4		500 ^b -500 ^b		-	1.1	-	1.4	-	-	-1.1	-	V	
* h _{FE}	4 -4 2 -2		500 ^b -500 ^b 1000 ^b -1000 ^b		30 - 10 -	130 - - -	40 - - -	250 - - -	- 30 - 10	- 130 - -	- 40 - -	250 - -		
* |h _{fe}| f = 10 MHz	4 -4		50 -50		5 -	- -	5 -	- -	- 5	- -	- 5	- -		
I _{Sy} ^d	50 -35				200	-	200	-	-	-285	-	-285	mA	
* t _{ON}	30 -30		500 -500	50 -50	-	80	-	80	-	-	100	-	100	ns
* t _{OFF}	30 -30		500 -500	50 -50	-	800	-	800	-	-	1000	-	1000	ns
* R _{θJC}					-	17.5	-	17.5	-	17.5	-	17.5	°C/W	
R _{θJA}					-	150	-	150	-	150	-	150	°C/W	

▲ V_{CB}

* In accordance with JEDEC registration data format (JS-6 RDF-1)

a CAUTION: The sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.**b** Pulsed; pulse duration < 300 μs, duty factor < 0.02.**d** Pulsed; 0.4 s non-repetitive pulse.

2N5320, 2N5321, 2N5322, 2N5323

2

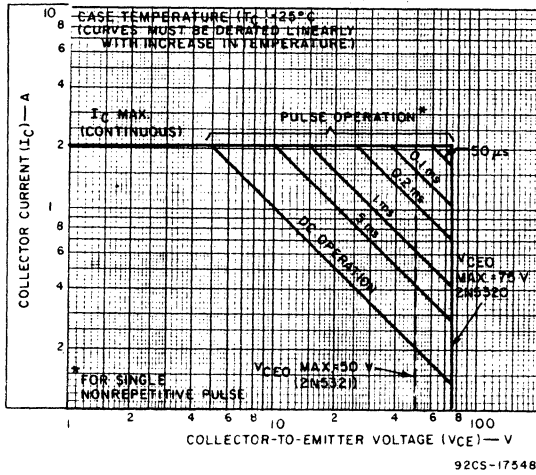


Fig. 1 - Maximum operating areas for types 2N5320 and 2N5321.

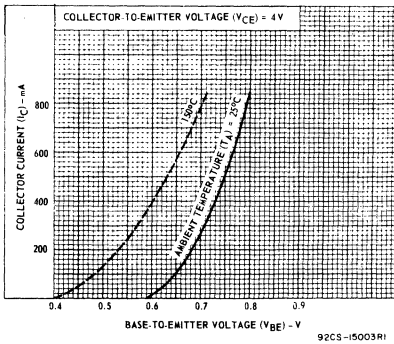


Fig. 2 - Typical static beta characteristics for types 2N5320 and 2N5321.

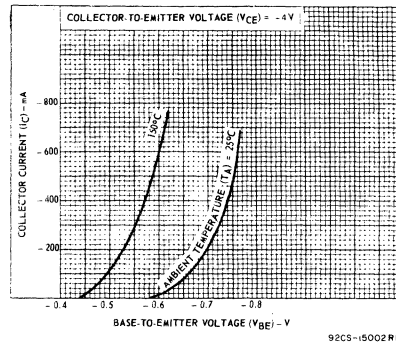


Fig. 3 - Typical static beta characteristics for types 2N5322 and 2N5323.

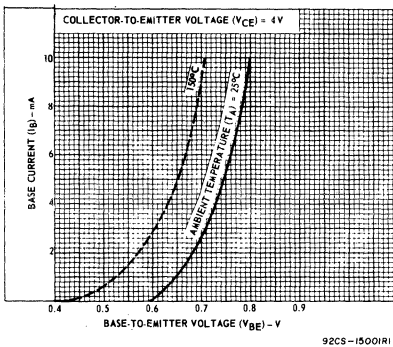


Fig. 4 - Typical output characteristics for types 2N5320 and 2N5321.

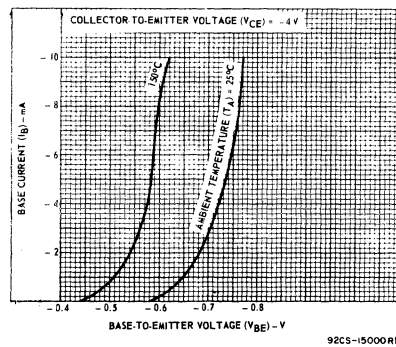


Fig. 5 - Typical output characteristics for types 2N5322 and 2N5323.

2N5320, 2N5321, 2N5322, 2N5323

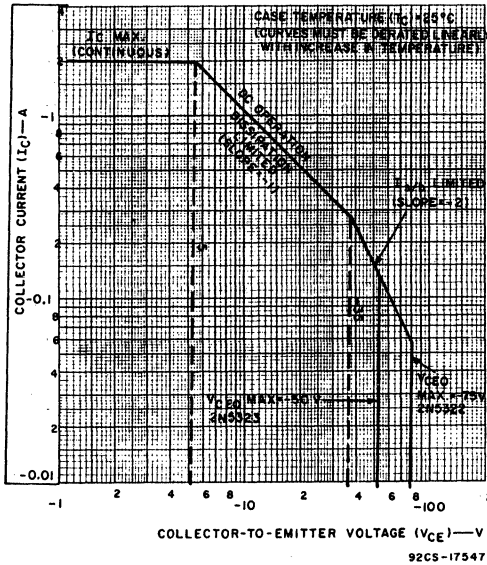


Fig.6 — Maximum operating areas for types 2N5322 and 2N5323.

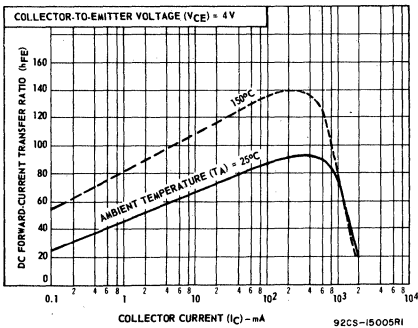


Fig.7 — Typical transfer characteristics for types 2N5320 and 2N5321.

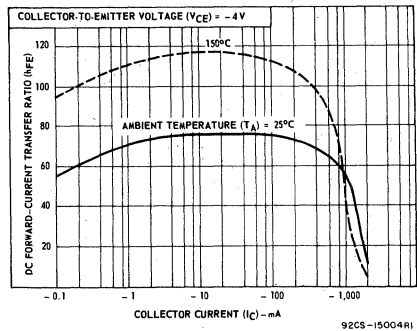


Fig.8 — Typical transfer characteristics for types 2N5322 and 2N5323.

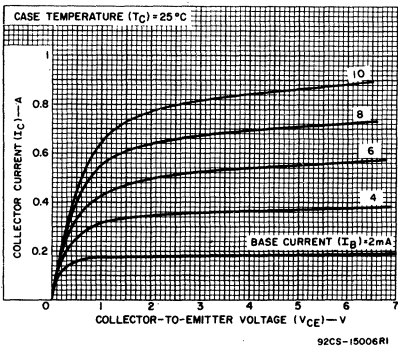


Fig.9 — Typical input characteristics for types 2N5320 and 2N5321.

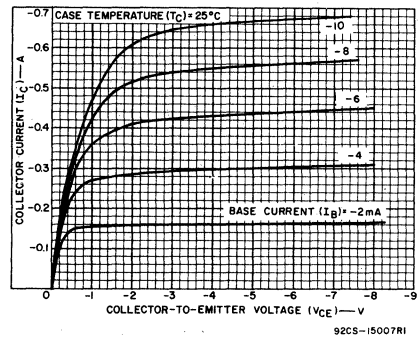


Fig.10 — Typical input characteristics for types 2N5322 and 2N5323.

2N5320, 2N5321, 2N5322, 2N5323

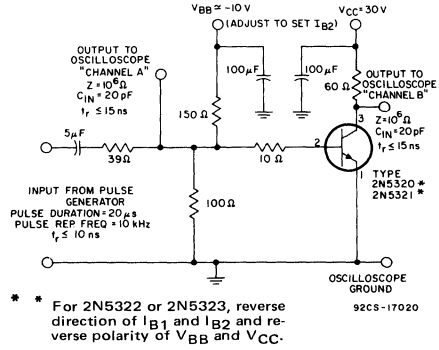


Fig. 11 — Circuit used to measure switching times for all types.

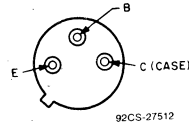
Silicon P-N-P High-Voltage Planar Transistors

For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

Features:

- 2N5415: *p-n-p complement of 2N3440**
- 2N5416: *p-n-p complement of 2N3439**
- Maximum safe-area-of-operation curves
- High voltage ratings:
 - $V_{CBO} = -350$ V max. (2N5416)
 - $V_{CEO} = -300$ V max. (2N5416)
 - -200 V max. (2N5415)

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The 2N5415 and 2N5416[®] are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds.

These transistors differ primarily in their voltage ratings. Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters; and high-voltage, low-current switching and series regulators.

The 2N5415 and 2N5416 are supplied in the JEDEC TO-205AD package.

- Formerly RCA Dev. Types TA2819 and TA2819A.
- *Data on types 2N3439 and 2N3440 are given in RCA data bulletin File No. 64.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5415	2N5416	
* V_{CBO}	-200	-350	V
V_{CER}			
$R_{BE} = 50 \Omega$	—	-350	V
* V_{CEO}	-200	-300	V
* V_{EBO}	-4	-6	V
* I_C	-1	-1	A
* I_B	-0.5	-0.5	A
* P_T			
$T_C \leq 25^\circ C$	10	10	W
$T_C > 25^\circ C$	See Figs. 1 & 2		
$T_C \leq 50^\circ C$	1	1	W
$T_C > 50^\circ C$	6.7	6.7	mW/°C
Derate linearly at			
* T_{stg}, T_J	-65 to +200		°C
* T_L			
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	255		°C

*In accordance with JEDEC registration data format (JS-9 RDF-8).

2N5415, 2N5416

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT mA dc		2N5415		2N5416		
	V _{CB}	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	
I _{CEO}		-250 -150			0 0	-	-	-	-50	μA
* I _{CBO} I _E = 0	-280 -175					-	-	-	-50	μA
I _{CEV}		-300 -200	1.5 1.5			-	-	-	-50	μA
* I _{EBO}			6 4	0 0		-	-	-	-20	μA
* h _{FE}		-10 -10		-50 ^b -50 ^b		30 150		30 -	120 -	
V _{CEO(sus)}				-50	0	-200 ^a	-	-300 ^a	-	V
V _{CER(sus)} R _{BE} = 50 Ω				-50		-	-	-350 ^a	-	V
V _{BE}		-10		-50 ^b		-	-1.5	-	-1.5	V
V _{CE(sat)}				-50 ^b	-5	-	-2.5	-	-2	V
* h _{fe} f = 1 kHz		-10		-5		25	-	25	-	
* |h _{fe}| f = 5 MHz		-10		-10		3	-	3	-	
* Re(h _{ie}) f = 1 MHz		-10		-5		-	300	-	300	Ω
* C _{ib} f = 1 MHz			5	0		-	75	-	75	pF
* C _{ob} f = 1 MHz	-10					-	15	-	15	pF
I _{S/b} t _p = 0.4 s nonrep.		-100				-100	-	-100	-	mA
R _{θJC}						-	17.5	-	17.5	°C/W

* In accordance with JEDEC registration data format (JS-9 RDF-8).

^a CAUTION: The sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.

^b Pulsed: Pulse = 300 μs; duty factor ≤ 2%.

2N5415, 2N5416

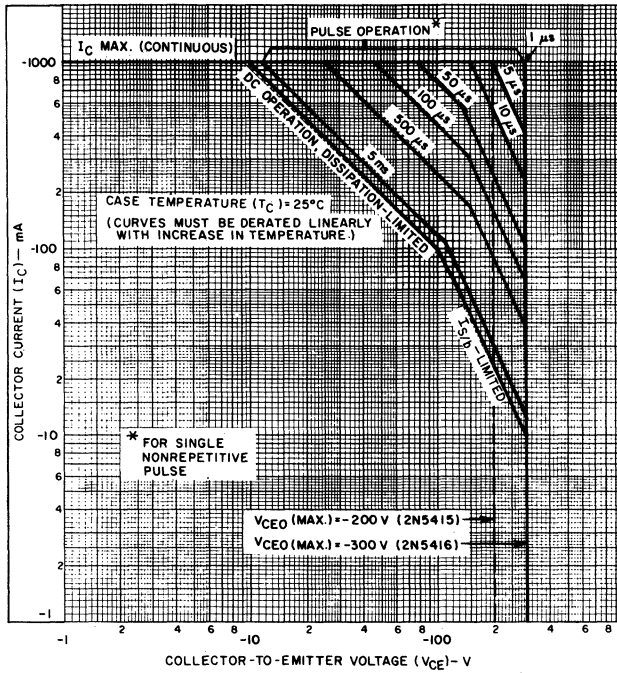


Fig. 1 - Maximum safe operating areas.

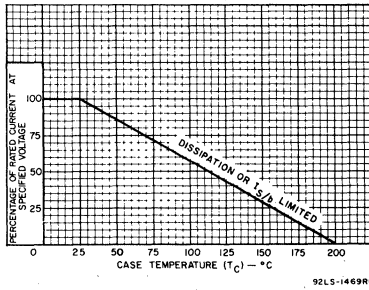


Fig. 2 - Dissipation derating curve.

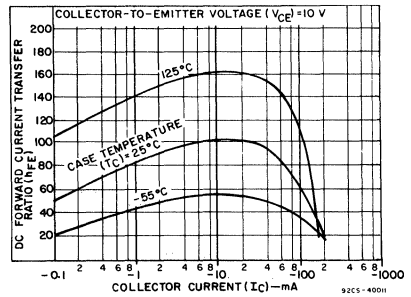


Fig. 3 - Typical dc beta characteristics for both types.

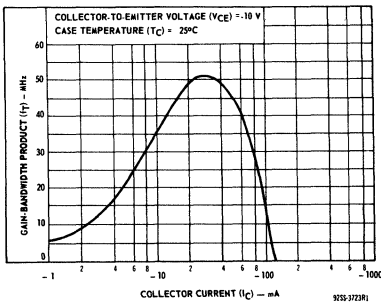


Fig. 4 - Typical gain-bandwidth product for both types.

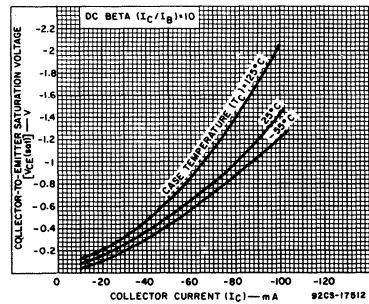


Fig. 5 - Typical collector-to-emitter saturation voltage for both types.

2N5415, 2N5416

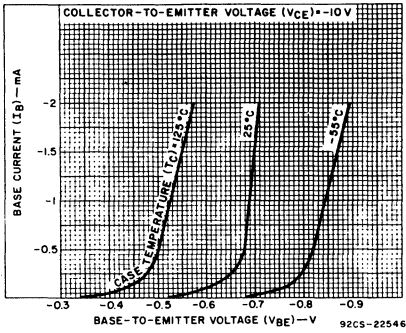


Fig. 6 - Typical input characteristics for both types.

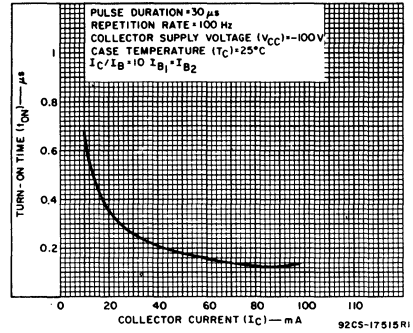


Fig. 7 - Typical turn-on time characteristic for both types.

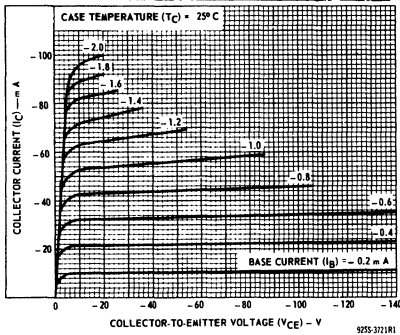


Fig. 8 - Typical output characteristics for both types.

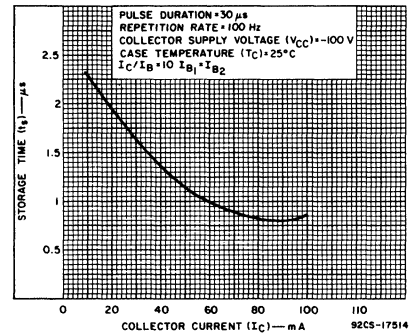


Fig. 9 - Typical storage-time characteristic for both types.

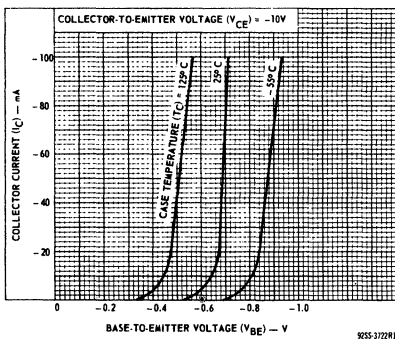


Fig. 10 - Typical transfer characteristics for both types.

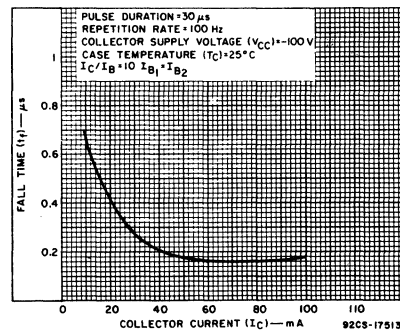


Fig. 11 - Typical fall-time characteristic for both types.

2

Silicon N-P-N VERSAWATT Transistors

General-Purpose Types for Medium-Power
Switching and Amplifier Applications

Features:

- Low saturation voltage —
 $V_{CE(sat)} = 1\text{ V max. at } I_C = 2\text{ A (2N5490, 2N5491)}$
 $1\text{ V max. at } I_C = 2.5\text{ A (2N5492, 2N5493)}$
 $1\text{ V max. at } I_C = 3\text{ A (2N5494, 2N5495)}$
 $1\text{ V max. at } I_C = 3.5\text{ A (2N5496, 2N5497)}$

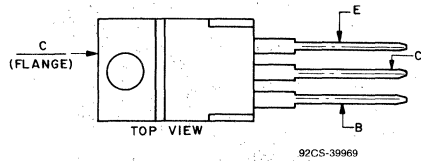
The 2N5490, 2N5491, 2N5492, 2N5493, 2N5494, 2N5495, 2N5496 and 2N5497* are silicon n-p-n transistors. They are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

Types 2N5491, 2N5493, 2N5494, and 2N5497 have formed emitter and base leads for insertion into TO-213AA sockets. Types 2N5490, 2N5492, 2N5494, and 2N5496 are electrically identical to the 2N5491, 2N5493, 2N5495, and 2N5497 but have straight leads.

These plastic-package power transistors differ in voltage ratings and in the currents at which the parameters are controlled.

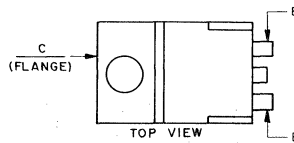
*Formerly RCA Dev. Nos. TA7317, TA7318, TA7315, TA7316, TA7313, TA7314, TA7311, TA7312, respectively.

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB



92CS-40186

JEDEC TO-220AA

Maximum Ratings, Absolute-Maximum Values:

	2N5490 2N5491 2N5494 2N5495	2N5492 2N5493	2N5496 2N5497	
COLLECTOR-TO-BASE VOLTAGE	60	75	90	V_{CBO} V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With -1.5 volts (V_{BE}) of reverse bias	60	75	90	$V_{CEV(sus)}$ V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	50	65	80	$V_{CER(sus)}$ V
With base open	40	55	70	$V_{CEO(sus)}$ V
EMITTER-TO-BASE VOLTAGE	5	5	5	V_{EBO} V
COLLECTOR CURRENT	7	7	7	I_C A
BASE CURRENT	3	3	3	I_B A
TRANSISTOR DISSIPATION:				P_T
At case temperatures up to 25 $^{\circ}$ C	50	50	50	W
At ambient temperatures up to 25 $^{\circ}$ C	1.8	1.8	1.8	W
At case temperatures above 25 $^{\circ}$ C	Derate linearly at 0.4 W/ $^{\circ}$ C or see Figs. 2 & 3.			
At ambient temperatures above 25 $^{\circ}$ C	Derate linearly at 0.0144 W/ $^{\circ}$ C			
TEMPERATURE RANGE:				
Storage & Operating (Junction)	← -65 to 150 →			$^{\circ}$ C
LEAD TEMPERATURE (During Soldering):				
At distance \geq 1/8 in. (3.17 mm) from case for 10 s max	← 235 →			$^{\circ}$ C

2N5490-2N5497

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

Characteristic	Symbol	TEST CONDITIONS				LIMITS								Units	
		DC Voltage (V)		DC Current (A)		Types 2N5496 2N5497		Types 2N5494 2N5495		Types 2N5492 2N5493		Types 2N5490 2N5491			
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}	85	-1.5			-	1	-	-	-	-	-	-	mA	
		55	-1.5			-	-	-	1	-	-	-	-		
	I_{CEV} ($T_C = 150^\circ\text{C}$)	85	-1.5			-	5	-	-	-	-	-	-	mA	
		55	-1.5			-	-	-	5	-	-	-	-		
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	70				-	0.5	-	-	-	-	-	-	mA	
		40				-	-	-	0.5	-	-	-	2		
	I_{CER} ($T_C = 150^\circ\text{C}$)	70				-	3.5	-	-	-	-	-	-	mA	
		40				-	-	-	3.5	-	-	-	5		
Emitter-Cutoff Current	I_{EBO}		-5			-	1	-	1	-	1	-	1	mA	
DC Forward-Current Transfer Ratio	h_{FE}^c	4		3.5		20	100	-	-	-	-	-	-		
		4		3		-	-	20	100	-	-	-	-		
		4		2.5		-	-	-	-	20	100	-	-		
		4		2		-	-	-	-	-	-	20	100		
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}^c$			0.1	0	70	-	40	-	55	-	40	-	V	
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}^c$			0.1		80	-	50	-	65	-	50	-	V	
With base-emitter junction reverse biased	$V_{CEV(sus)}^c$		-1.5	0.1		90	-	60	-	75	-	60	-	V	
Base-to-Emitter Voltage	V_{BE}^c	4		3.5		-	1.7	-	-	-	-	-	-	V	
		4		3		-	-	-	1.5	-	-	-	-		
		4		2.5		-	-	-	-	-	1.3	-	-		
		4		2		-	-	-	-	-	-	-	1.1		
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}^c$			3.5	0.35	-	1	-	-	-	-	-	-	V	
				3	0.3	-	-	-	1	-	-	-	-		
				2.5	0.25	-	-	-	-	-	1	-	-		
				2	0.2	-	-	-	-	-	-	-	1		
Gain-Bandwidth Product	f_T	4		0.5		0.8	-	0.8	-	0.8	-	0.8	-	MHz	
Sat. Switching Time: Turn-On	t_{on}	$V_{CC} = 30$		3.5	0.35 ^a	-	5	-	-	-	-	-	-	μs	
				3	0.3 ^a	-	-	-	5	-	-	-	-		
				2.5	0.25 ^a	-	-	-	-	-	5	-	-		-
				2	0.2	-	-	-	-	-	-	-	-		5
Turn-Off	t_{off}	$V_{CC} = 30$		3.5	0.35 ^b	-	15	-	-	-	-	-	-	μs	
				3	0.3 ^b	-	-	-	15	-	-	-	-		
				2.5	0.25 ^b	-	-	-	-	-	15	-	-		-
				2	0.2	-	-	-	-	-	-	-	-		15

^a I_{B1} value (turn-on base current).^b I_{B2} value (turn-off base current).^c Pulsed, pulse duration = 300 μs

2N5490-2N5497

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified (Cont'd.)

Characteristic	Symbol	TEST CONDITIONS				LIMITS								Units
		DC Voltage (V)		DC Current (A)		Types 2N5496 2N5497		Types 2N5494 2N5495		Types 2N5492 2N5493		Types 2N5490 2N5491		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Thermal Resistance: Junction-to-Case	θ_{J-C}					-	2.5	-	2.5	-	2.5	-	2.5	$^{\circ}C/W$
Junction-to-Ambient	θ_{J-A}					-	70	-	70	-	70	-	70	$^{\circ}C/W$

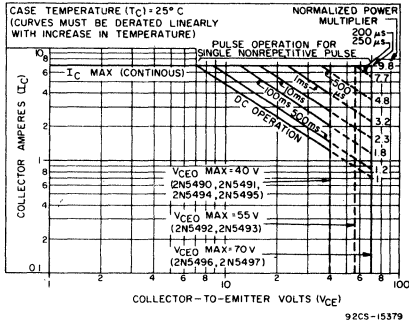


Fig. 1 — Maximum operating areas for types 2N5490 through 2N5497 inclusive.

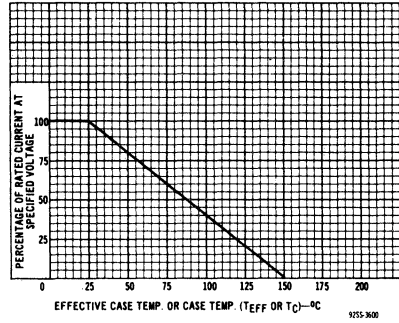


Fig. 2 — Derating curve for all types.

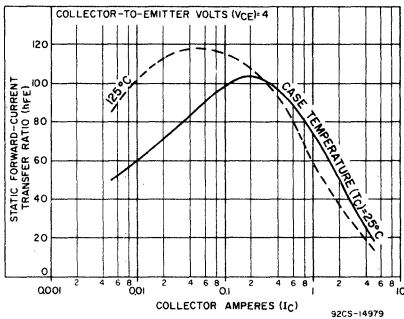


Fig. 3 — Typical static beta characteristics for types 2N5496 and 2N5497.

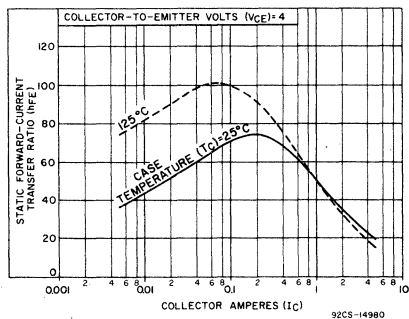


Fig. 4 — Typical static beta characteristics for types 2N5494 and 2N5495.

2N5490-2N5497

2

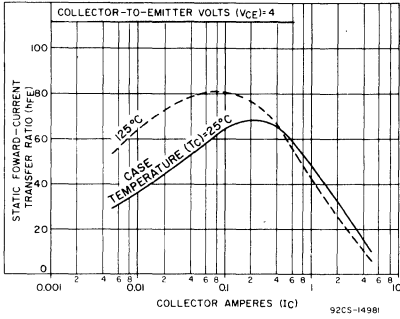


Fig. 5 — Typical static beta characteristics for types 2N5490 through 2N5493 inclusive.

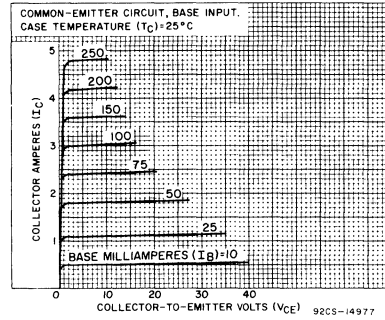


Fig. 6 — Typical output characteristics for types 2N5494 through 2N5497 inclusive.

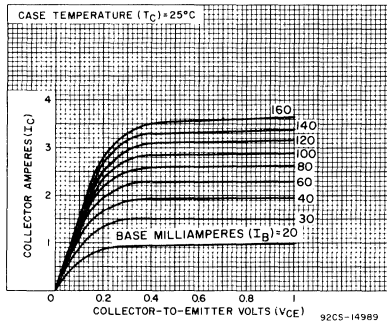


Fig. 7 — Typical output characteristics for types 2N5494 and 2N5495.

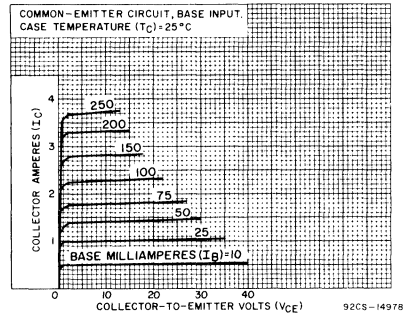


Fig. 8 — Typical output characteristics for types 2N5494 through 2N5493 inclusive.

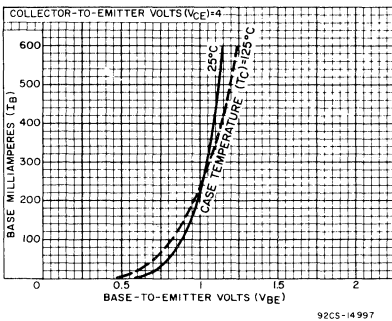


Fig. 9 — Typical input characteristics for types 2N5494 through 2N5497 inclusive.

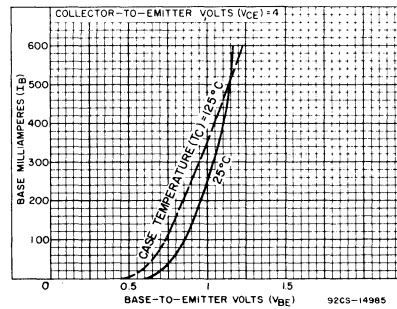


Fig. 10 — Typical input characteristics for types 2N5490 through 2N5493 inclusive.

2N5490-2N5497

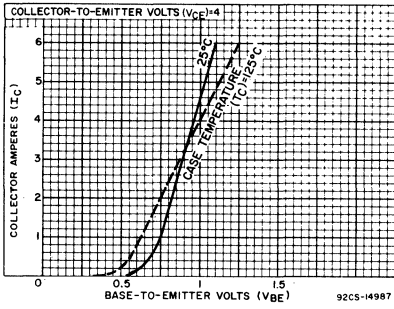


Fig. 11 — Typical transfer characteristics for types 2N5494 through 2N5497 inclusive.

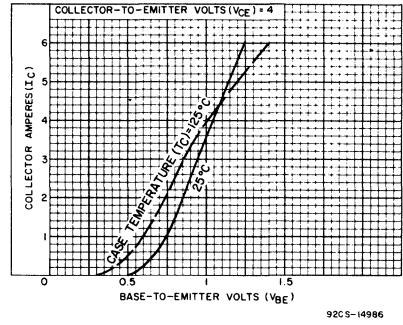


Fig. 12 — Typical transfer characteristics for types 2N5490 through 2N5493 inclusive.

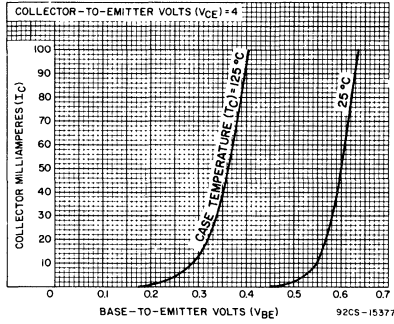


Fig. 13 — Typical transfer characteristics for types 2N5490 through 2N5497 inclusive.

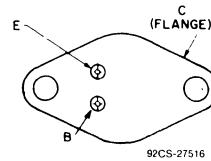
Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

Features:

- High dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- High gain at high current

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N5629, 2N5630 and 2N5631 are epitaxial-base silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings. They are supplied in JEDEC TO-204AA hermetic steel packages.

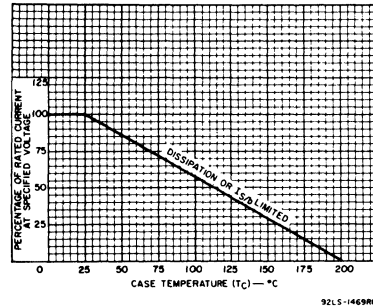


Fig. 1 — Current derating curve for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5629	2N5630	2N5631	
* V _{CEO}	100	120	140	V
* V _{CB0}	100	120	140	V
* V _{EBO}	7	7	7	V
* I _c	16	16	16	A
* I _{CM}	20	20	20	A
* I _B	5	5	5	A
* P _T				W
At T _c ≤ 25°C		200		
At T _c > 25°C		1.14		derate linearly
* T _J , T _{stg}		-65 to 200		°C
* T _L at 1/16 ± 1/32 in. (1.58 ± 0.8 mm) from case for 10 s		235		°C

* In accordance with JEDEC registration data.

2N5629, 2N5630, 2N5631

ELECTRICAL CHARACTERISTICS, At Case Temperature $T_C = 25^\circ\text{C}$
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N5629		2N5630		2N5631		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEX}	100	-1.5	-	-	-	1	-	-	-	-	mA
	120	-1.5	-	-	-	-	-	1	-	-	
	140	-1.5	-	-	-	-	-	-	-	1	
$T_C = 150^\circ\text{C}$	100	-1.5	-	-	-	5	-	-	-	-	mA
	120	-1.5	-	-	-	-	-	5	-	-	
	140	-1.5	-	-	-	-	-	-	-	5	
* I_{CEO}	50	-	-	0	-	1	-	-	-	-	mA
	60	-	-	0	-	-	-	1	-	-	
	70	-	-	0	-	-	-	-	-	1	
I_{CBO} $I_E = 0$	100 ^a	-	-	-	-	1	-	-	-	-	mA
	120 ^a	-	-	-	-	-	-	1	-	-	
	140 ^a	-	-	-	-	-	-	-	-	1	
* I_{EBO}	-	7	0	-	-	1	-	1	-	1	mA
* $V_{CEO(sus)}^b$	-	-	0.2 ^c	0	100	-	120	-	140	-	V
* h_{FE}^a	2	-	8 ^c	-	25	100	20	80	15	60	
	2	-	16 ^c	-	4	-	4	-	4	-	
* V_{BE}^a	2	-	8 ^c	-	-	1.5	-	1.5	-	1.5	V
* $V_{BE(sat)}^a$	-	-	10 ^c	1	-	1.8	-	1.8	-	1.8	V
* $C_{obo} f = 0.1\text{ MHz}$ $I_E = 0$	10 ^a	-	-	-	-	500	-	500	-	500	pF
* $V_{CE(sat)}^a$	-	-	10 ^c	1	-	1	-	1	-	1	V
	-	-	16 ^c	4	-	2	-	2	-	2	
* f_T $f = 0.5\text{ MHz}$	20	-	1	-	1	-	1	-	1	-	MHz
* h_{fe} $f = 1\text{ kHz}$	10	-	4	-	15	-	15	-	15	-	
I_S/b $t_p = 1\text{ s nonrep.}$	30	-	-	-	6.67	-	6.67	-	6.67	-	A
$R_{\theta JC}$	10	-	10	-	-	0.875	-	0.875	-	0.875	$^\circ\text{C/W}$

* In accordance with JEDEC registration data.

^a V_{CB} value.

^b CAUTION: Sustaining voltage, $V_{CEO(sus)}$ MUST NOT BE measured on a curve tracer.

^c Pulsed; pulse duration $\leq 300\ \mu\text{s}$. Duty factor $\leq 2\%$.

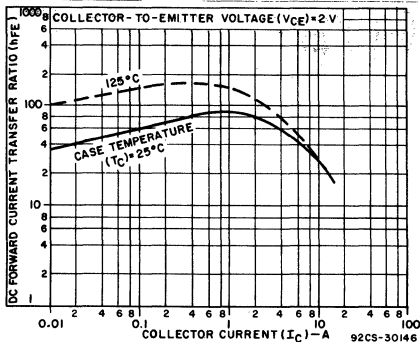


Fig. 2 - Typical dc beta characteristics as a function of collector current for all types.

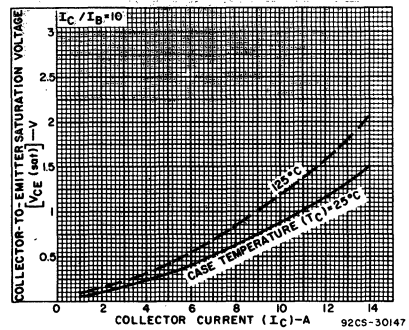


Fig. 3 - Typical saturation voltage characteristics for all types.

2N5629, 2N5630, 2N5631

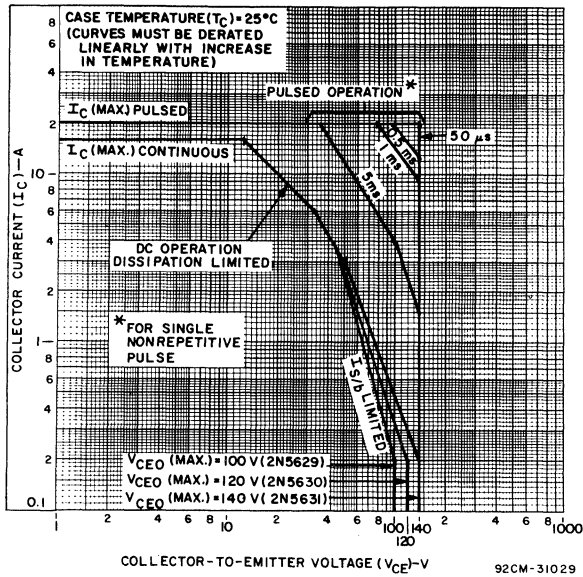


Fig. 4 — Maximum operating areas for all types ($T_C = 25^\circ C$).

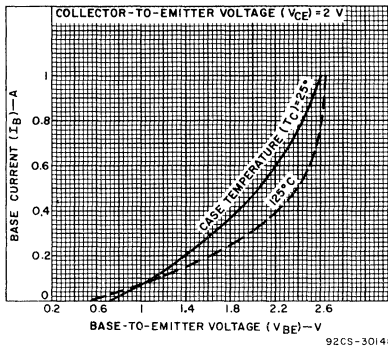


Fig. 5 — Typical input characteristics for all types.

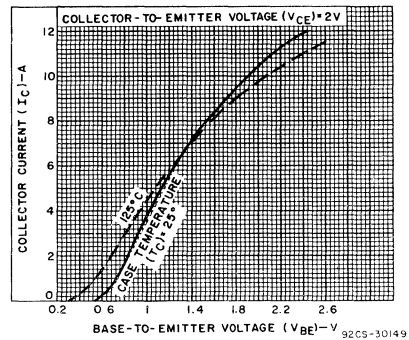


Fig. 6 — Typical transfer characteristics for all types.

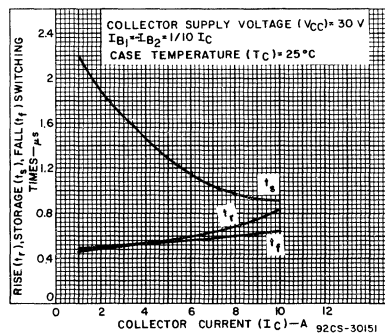


Fig. 7 — Typical saturated-switching times for all types.

High-Current, High-Power, High-Speed Silicon N-P-N Planar Transistors

For Switching and Amplifier Applications in Military, Industrial and Commercial Equipment

Features:

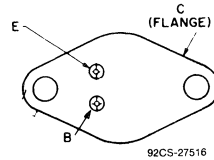
- **Maximum Safe-Area-of-Operation Curves** - $I_{S/B}$ limit line beginning at 24 V
- **Fast Turn-On Time** - $t_{ON} = 0.5 \mu s$ max. at $I_C = 15 A$

Types 2N5671 and 2N5672* are epitaxial silicon n-p-n transistors having high current and high power handling capability and fast switching speed. The 2N5672 is similar to the 2N5671 except that it has higher voltage ratings and lower leakage currents. These devices are especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits, converters, inverters, control circuits. Other recommended applications included DC-RF amplifiers and power oscillators.

These types are supplied in the JEDEC TO-204AA hermetic steel package.

*Formerly Dev. Types TA7323 and TA7323A, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5671	2N5672	
* COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open, $V_{CE0(SUS)}$	90	120	V
With external base-to-emitter resistance ($R_{BE} \leq 50 \Omega$, $V_{CE0(SUS)}$)	110	140	V
With external base-to-emitter resistance ($R_{BE} \leq 50 \Omega$ & $V_{BE} = -1.5$, $V_{CE0(SUS)}$)	120	150	V
* EMITTER-TO-BASE VOLTAGE, V_{EBO}	7	7	V
* COLLECTOR CURRENT, I_C	30	30	A
* BASE CURRENT, I_B	10	10	A
* TRANSISTOR DISSIPATION, P_T :			
At case temperatures up to 25°C and V_{CE} up to 24 V	140	140	W
At case temperatures up to 25°C and V_{CE} above 24 V		See Fig. 1	
At case temperatures above 25°C and V_{CE} above 24 V		See Figs. 1 & 2	
* TEMPERATURE RANGE:			
Storage and Operating (Junction)	-65 to +200		°C
* PIN TEMPERATURE (During Soldering):			
At distances $\geq 1/32$ in. from seating plane for 10 s max.	230		°C

*In accordance with JEDEC registration data format (JS-6, RFD-1).

2N5671, 2N5672

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS				UNITS		
		DC Collector Voltage(V)		DC Emitter or Base Voltage (V)		DC Current (A)		Type 2N5671		Type 2N5672				
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.		Max.	
* Collector-Cutoff Current	I_{CEO}	-	80	-	-	-	-	0	-	10	-	10	mA	
	I_{CEV}	-	110	-	-1.5	-	-	-	-	12	-	-	mA	
	I_{CEV}	-	135	-	-1.5	-	-	-	-	-	-	10	mA	
	I_{CEV} ($T_C=150^\circ\text{C}$)	-	100	-	-1.5	-	-	-	-	15	-	10	mA	
* Emitter-Cutoff Current	I_{EBO}	-	-	7	-	0	-	-	-	10	-	10	mA	
Collector-to-Emitter Sustaining Voltage:	$V_{CEO(sus)}$	-	-	-	-	0.2	-	0	90 ^a	-	120 ^a	-	V	
With base open														
With external base-to-emitter resistance ($R_{BE} \leq 50\ \Omega$)	$V_{CER(sus)}$	-	-	-	-	0.2	-	0	110 ^a	-	140 ^a	-	V	
With base-emitter junction reverse biased & $R_{BE} \leq 50\ \Omega$	$V_{CEX(sus)}$	-	-	-	-1.5	0.2	-	-	120 ^a	-	150 ^a	-	V	
* Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$	-	-	-	-	15	-	1.2	-	1.5	-	1.5	V	
Base-to-Emitter Voltage	V_{BE}	-	5	-	-	15	-	-	-	1.6	-	1.6	V	
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$	-	-	-	-	15	-	1.2	-	0.75	-	0.75	V	
* DC Forward-Current Transfer Ratio	h_{FE}	-	2	-	-	15	-	-	20	20	20	100		
		-	5	-	-	20	-	-	20	-	20	-		
Second-Breakdown Collector Current ^c With base forward biased	$I_{S/b}^b$	-	24	-	-	-	-	-	5.8 ^c	-	5.8 ^c	-	A	
		-	45	-	-	-	-	-	0.9 ^c	-	0.9 ^c	-	A	
Second-Breakdown Energy With base reverse biased $R_{BE} = 20\ \Omega$, $L = 180\ \mu\text{H}$	$E_{S/b}^d$	-	-	-	-4	15	-	-	20	-	20	-	mJ	
Gain-Bandwidth Product	f_T	-	10	-	-	2	-	-	50	-	50	-	MHz	
Output Capacitance (At 1 MHz)	C_{ob}	10	-	-	-	-	0	-	-	900	-	900	pF	
* Saturated Switching Turn-On Time (Delay Time + Rise Time)	t_{on}	$V_{CC} = 30\ \text{V}$	-	-	-	15	-	-	$I_{B1} = I_{B2} = 1.2$	-	0.5	-	0.5	μs
* Saturated Switching Storage Time	t_s	$V_{CC} = 30\ \text{V}$	-	-	-	15	-	-	$I_{B1} = I_{B2} = 1.2$	-	1.5	-	1.5	μs
* Saturated Switching Fall Time	t_f	$V_{CC} = 30\ \text{V}$	-	-	-	15	-	-	$I_{B1} = I_{B2} = 1.2$	-	0.5	-	0.5	μs
Thermal Resistance (Junction-to-Case)	θ_{J-C}	-	40	-	-	0.5	-	-	-	1.25	-	1.25	$^\circ\text{C/W}$	

^a CAUTION: The sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEX(sus)}$ MUST NOT be measured on a curve tracer.

^b $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

^c Pulsed; 1-s, non-repetitive pulse.

^d $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = \frac{1}{2}LI^2$, where L is a series load or leakage inductance and I is the peak collector current.

* In accordance with JEDEC registration data format (JS-6, RFD-1)

2N5671, 2N5672

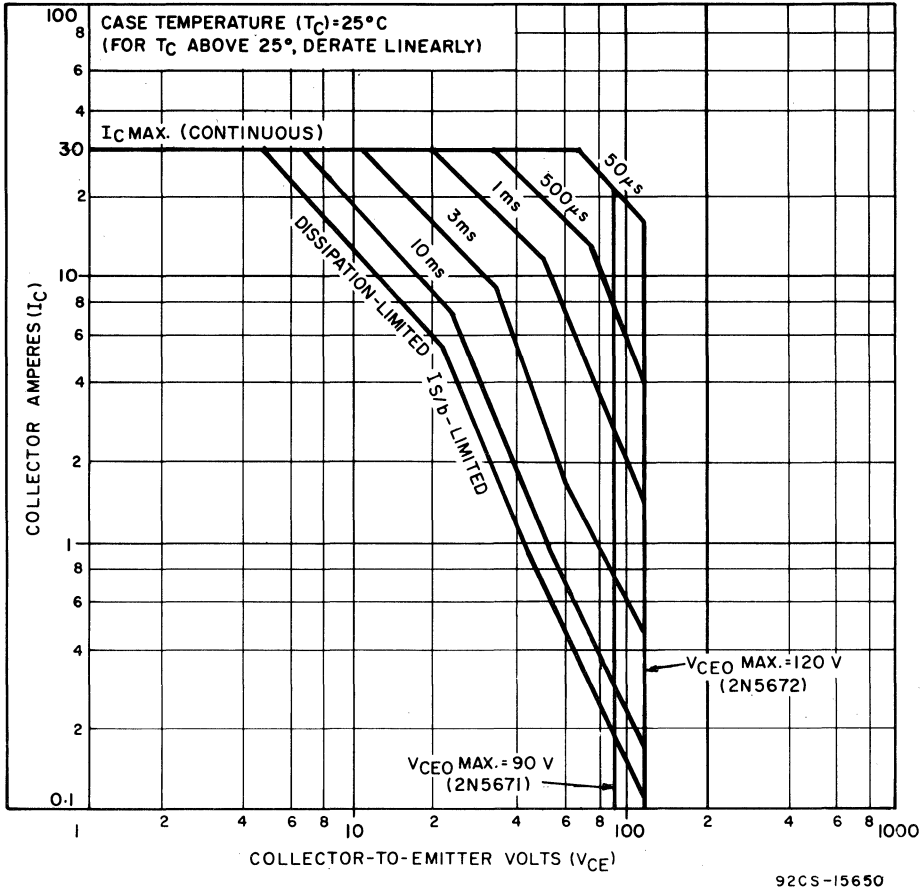


Fig. 1 - Maximum operating areas for types 2N5671 & 2N5672.

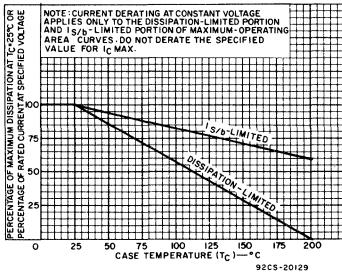


Fig. 2 - Dissipation derating curves for types 2N5671 & 2N5672.

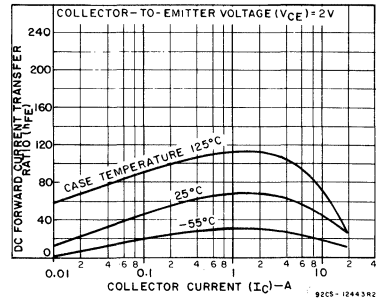


Fig. 3 - Typical dc beta characteristics for types 2N5671 & 2N5672.

2N5671, 2N5672

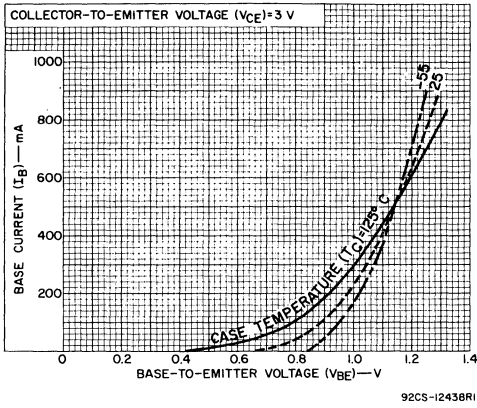


Fig. 4 - Typical input characteristics for types 2N5671 & 2N5672.

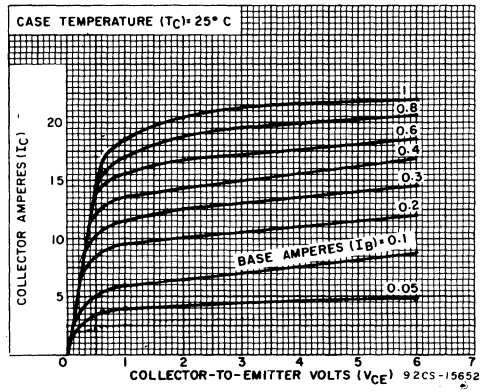


Fig. 5 - Typical output characteristics for types 2N5671 & 2N5672.

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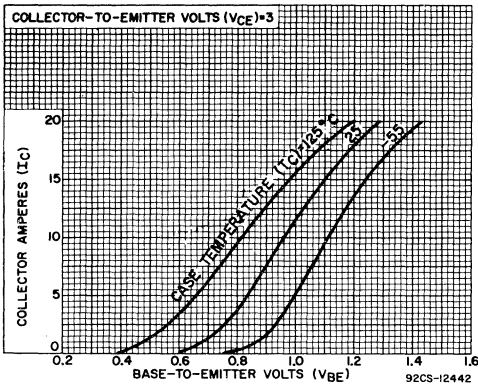


Fig. 6 - Typical transfer characteristics for types 2N5671 & 2N5672.

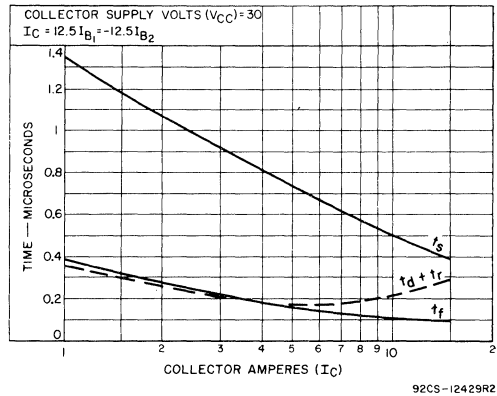


Fig. 7 - Typical saturated switching characteristics for types 2N5671 & 2N5672.

Silicon N-P-N and P-N-P Epitaxial-Base Complementary-Symmetry Transistors

General-Purpose Types for Switching and Linear-Amplifier Applications

Features:

- Low saturation voltages
- Maximum safe-area-of-operation curves
- High gain at high current
- High breakdown voltages

The 2N5781, 2N5782, and 2N5783 are epitaxial-base silicon p-n-p transistors -- complements of the silicon n-p-n types 2N5784, 2N5785, and 2N5786*, respectively.

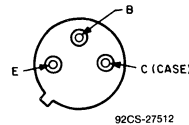
The three types in each family differ primarily in voltage ratings and saturation characteristics.

These transistors are intended for medium-power switching and complementary-symmetry audio amplifier applications.

All types are supplied in the JEDEC TO-205AD package.

- Formerly RCA Dev. Types TA7270, TA7271, TA7272, TA7289, TA7290, and TA7291 respectively.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, Absolute-Maximum Values:

	P-N-P	2N5781 [♦]	2N5782 [♦]	2N5783 [♦]	
	N-P-N	2N5784	2N5785	2N5786	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	80	65	45	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$	80	65	45	V
With base open	$V_{CEO(sus)}$	65	50	40	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	3.5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	3.5	3.5	3.5	A
*CONTINUOUS BASE CURRENT	I_B	1	1	1	A
*TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		10	10	10	W
At ambient temperatures up to 25°C		1	1	1	W
At case temperatures above 25°C Derate linearly		0.057 W/°C, or see Fig. 7.			
At ambient temperatures above 25°C Derate linearly		0.0057			W/°C
*TEMPERATURE RANGE:		----- -65 to +200 -----			°C
Storage and operating (Junction)					
*LEAD TEMPERATURE (During soldering):					
At distance \geq 1/32 in. (0.8 mm) from seating plane for 10 s max.		----- 230 -----			°C

*In accordance with JEDEC registration data format JS-6 RDF-2.

♦For p-n-p devices, voltage and current values are negative.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS [♦]				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5781 p-n-p		2N5784 n-p-n		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω At T_C = 150°C	I_{CER}	65				–	–10	–	10	μA
		65				–	–1	–	1	mA
* With base-emitter junction reverse- biased and external base-to-emitter resistance (R_{BE}) = 100 Ω At T_C = 150°C	I_{CEX}	–75	1.5			–	–10	–	–	μA
		75	–1.5			–	–	–	10	
* With base open	I_{CEO}	–75	1.5			–	–1	–	–	mA
		75	–1.5			–	–	–	1	
* With base open	I_{CEO}	50			0	–	–100	–	100	μA
* Emitter Cutoff Current	I_{EBO}		–5	0		–	–10	–	10	μA
* DC Forward-Current Transfer Ratio	h_{FE}	2		1 ^a		20	100	20	100	
		2		3.2 ^a		4	–	4	–	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	$V_{CEO(sus)}$			0.1 ^a	0	–65 ^b	–	65 ^b	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$			0.1 ^a		–80 ^b	–	80 ^b	–	
* Base-to-Emitter Voltage	V_{BE}	2		1 ^a		–	–1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case) ^c	$V_{CE(sat)}$			1 ^a	0.1	–	–0.5	–	0.5	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ^d f = 4 MHz	$|h_{fe}|$	–2		–0.1		2	15	–	–	
f = 200 kHz		2		0.1				5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Turn-on ($t_d + t_r$)	t_{ON}			–1	–0.1	–	0.5	–	–	μs
				1	0.1	–	–	–	5	
Turn-off ($t_s + t_f$)	t_{OFF}			–1	–0.1	–	2.5	–	–	
				1	0.1	–	–	–	15	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					–	17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	

* In accordance with JEDEC registration data format JS-6 RDF-2. ♦ For p-n-p devices, voltage and current values are negative.

^a Pulsed, pulse duration = 300 μs , duty factor = 1.8%^c Lead resistance is critical in this test.^b CAUTION: Sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ MUST NOT be measured on a curve tracer.^d Measured at a frequency where $|h_{fe}|$ is decreasing at approximately 6 dB per octave.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS [♦]				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5782 p-n-p		2N5785 n-p-n		
		V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω At T_C = 150°C	I _{CER}	50				–	–10	–	10	μA
		50				–	–1	–	1	mA
* With base-emitter junction reverse- biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I _{CEX}	–60	1.5			–	–10	–	–	μA
		60	–1.5			–	–	–	10	
* At T_C = 150°C		–60	1.5			–	–1	–	–	mA
		60	–1.5			–	–	–	1	
* With base open	I _{CEO}	35			0	–	–100	–	100	μA
* Emitter Cutoff Current	I _{EBO}		–5	0		–	–10	–	10	μA
* DC Forward-Current Transfer Ratio	h _{FE}	2		1.2 ^a		20	100	20	100	
		2		3.2 ^a		4	–	4	–	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	V _{CEO(sus)}			0.1 ^a	0	–50 ^b	–	50 ^b	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V _{CER(sus)}			0.1 ^a		–65 ^b	–	65 ^b	–	
* Base-to-Emitter Voltage	V _{BE}	2		1.2 ^a		–	–1.5	–	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case) ^c	V _{CE(sat)}			1.2 ^a	0.12	–	–0.75	–	0.75	V
				3.2 ^a	0.8	–	–2	–	2	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ^d f = 4 MHz	|h _{fe}|	–2		–0.1		2	15	–	–	
f = 200 kHz		2		0.1		–	–	5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h _{fe}	2		0.1		25	–	25	–	
Saturated Switching Time (V _{CC} = 30 V, I _{B1} = I _{B2}): Turn-on (t _d + t _r)	t _{ON}			–1	–0.1	–	0.5	–	–	μs
Turn-off (t _s + t _f)	t _{OFF}			–1	–0.1	–	2.5	–	–	
				1	0.1	–	–	–	15	
Thermal Resistance: Junction-to-case	R _{θJC}						17.5	–	17.5	°C/W
Junction-to-ambient	R _{θJA}						–	175	–	

* In accordance with JEDEC registration data format JS-6 RDF-2.

a Pulsed, pulse duration = 300 μs, duty factor = 1.8%.

b CAUTION: Sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.

♦ For p-n-p devices, voltage and current values are negative.

c Lead resistance is critical in this test.

d Measured at a frequency where |h_{fe}| is decreasing at approximately 6 dB per octave.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS [♦]				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5783 p-n-p		2N5786 n-p-n		
		V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω At T_C = 150°C	I _{CER}	40				-	-10	-	10	μ A
		40				-	-1	-	1	mA
* With base-emitter junction reverse- biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I _{CEX}	-45	1.5			-	-10	-	-	μ A
		45	-1.5			-	-	-	10	μ A
* At T_C = 150°C		-45	1.5			-	-1	-	-	mA
		45	-1.5			-	-	-	1	mA
* With base open	I _{CEO}	25			0	-	-100	-	100	μ A
* Emitter Cutoff Current	I _{EBO}		-3.5	0		-	-10	-	10	μ A
* DC Forward-Current Transfer Ratio	h _{FE}	2		1.6 ^a		20	100	20	100	
		2		3.2 ^a		4	-	4	-	
* Collector-to-Emitter Sustaining Voltage (see Figs. 2 and 3): With base open	V _{CEO(sus)}			0.1 ^a	0	-40 ^b	-	40 ^b	-	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V _{CER(sus)}			0.1 ^a		-45 ^b	-	45 ^b	-	V
* Base-to-Emitter Voltage	V _{BE}	2		1.6 ^a		-	-1.5	-	1.5	V
* Collector-to-Emitter Saturation Voltage (measured 0.25 in (6.35 mm) from case) ^c	V _{CE(sat)}			1.6 ^a	0.16	-	-1	-	1	V
				3.2 ^a	0.8	-	-2	-	2	V
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ^d f = 4 MHz	|h _{fe}|	-2		-0.1		2	15	-	-	
f = 200 kHz		2		0.1		-	-	5	20	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h _{fe}	2		0.1		25	-	25	-	
Saturated Switching Time (V _{CC} = 30 V, I _{B1} = I _{B2}):										
Turn-on (t _d + t _r)	t _{ON}			-1	-0.1	-	0.5	-	-	μ s
				1	0.1	-	-	-	5	
Turn-off (t _s + t _f)	t _{OFF}			-1	-0.1	-	2.5	-	-	
				1	0.1	-	-	-	15	
Thermal Resistance :										
Junction-to-case	R _{θJC}						17.5	-	17.5	$^{\circ}$ C/W
Junction-to-ambient	R _{θJA}						-	175	-	175

* In accordance with JEDEC registration data format JS-6 RDF-2.

♦ For p-n-p devices, voltage and current values are negative.

a Pulsed, pulse duration = 300 μ s, duty factor = 1.8%.

c Lead resistance is critical in this test.

b CAUTION: Sustaining voltages V_{CEO(sus)}, and V_{CER(sus)}
MUST NOT be measured on a curve tracer.d Measured at a frequency where |h_{fe}| is decreasing at
approximately 6 dB per octave.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

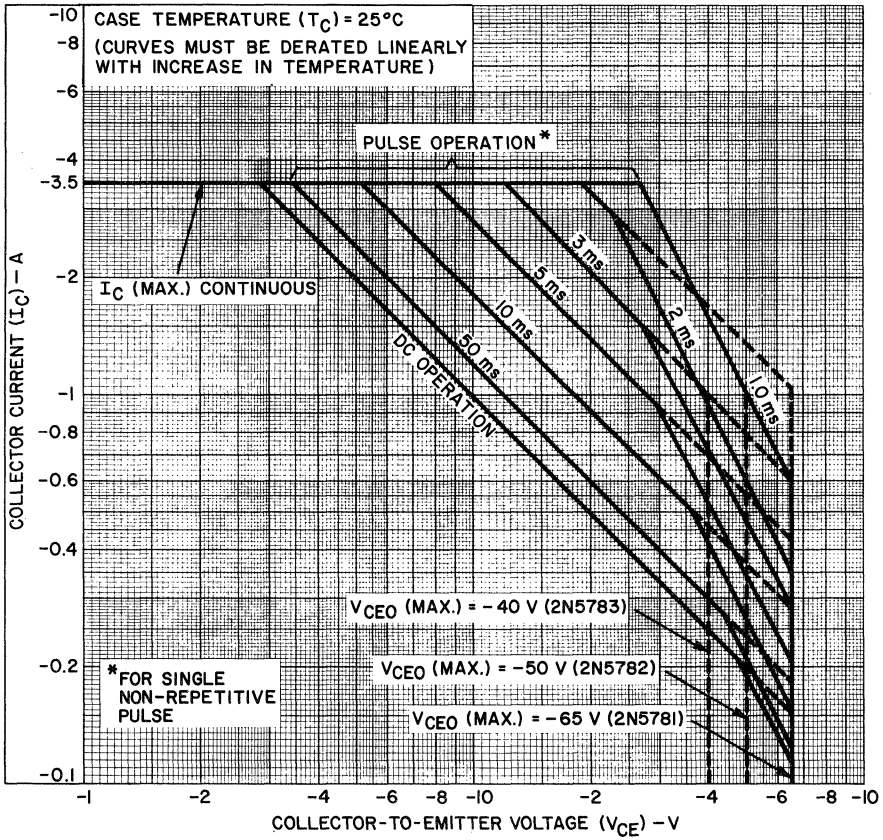
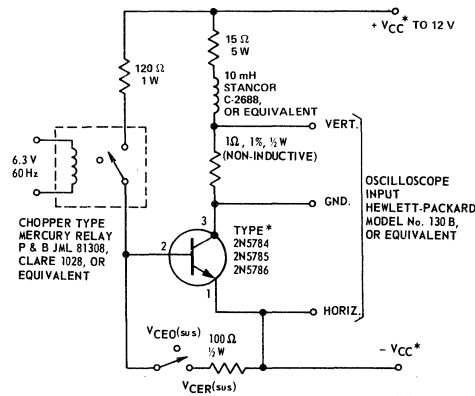


Fig. 1 - Maximum operating areas for types 2N5781, 2N5782, and 2N5783.

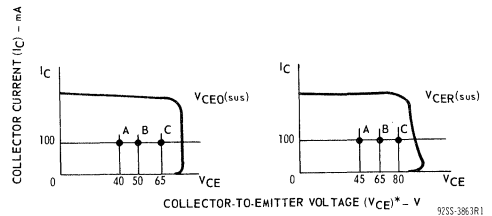
92CS-23943



* FOR P-N-P TYPES 2N5781, 2N5782, & 2N5783, REVERSE POLARITY OF V_{CC} .

92SS-3862R2

Fig. 2 - Circuit used to measure sustaining voltages $V_{CE0(sus)}$ and $V_{CER(sus)}$.



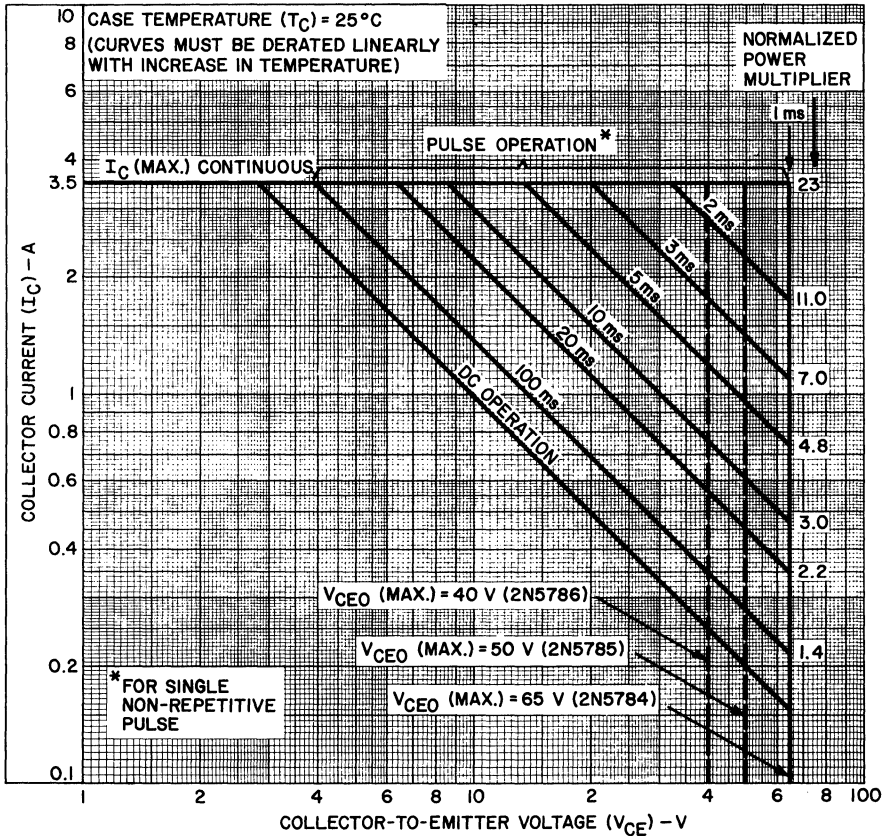
92SS-3863R1

* FOR TYPES 2N5781, 2N5782, AND 2N5783, THE VALUES FOR I_C AND V_{CE} ARE NEGATIVE.

The sustaining voltages $V_{CE0(sus)}$ and $V_{CER(sus)}$ are acceptable when the trace fails to the right and above point "A" (2N5783 & 2N5786), "B" (2N5782 & 2N5785), or "C" (2N5781 & 2N5784).

Fig. 3 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 2).

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786



92CS-23944

Fig. 4 - Maximum operating areas for types 2N5784, 2N5785, and 2N5786.

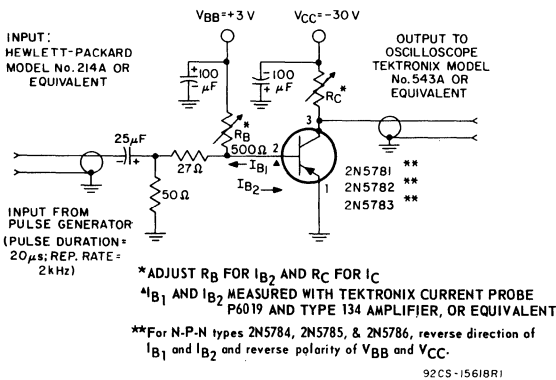


Fig. 5 - Circuit used to measure saturated switching times.

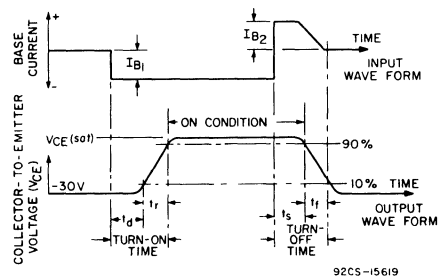


Fig. 6 - Oscilloscope display for measurement of switching times. (Test circuit shown in Fig. 5).

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

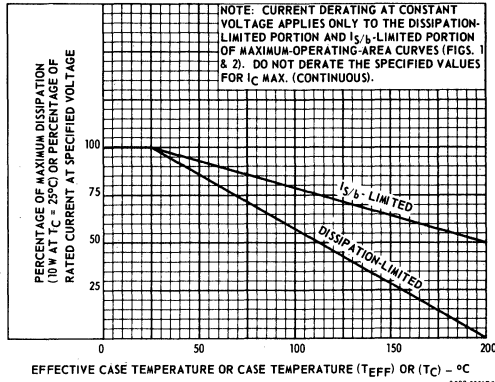


Fig. 7 — Dissipation derating curve for all types.

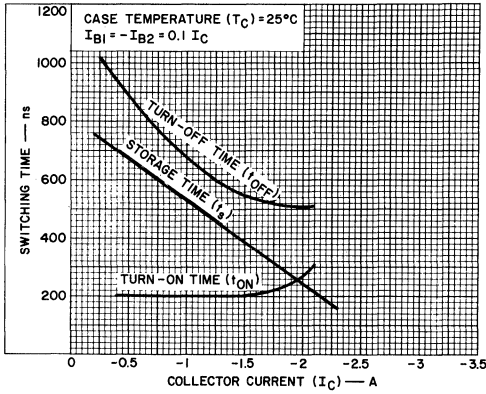


Fig. 8 — Typical saturated switching characteristics for types 2N5781, 2N5782, and 2N5783.

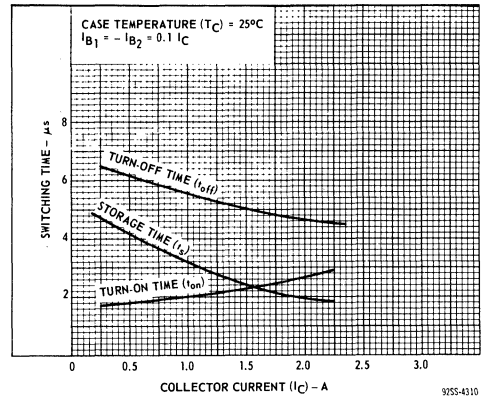


Fig. 9 — Typical saturated switching characteristics for types 2N5784, 2N5785, and 2N5786.

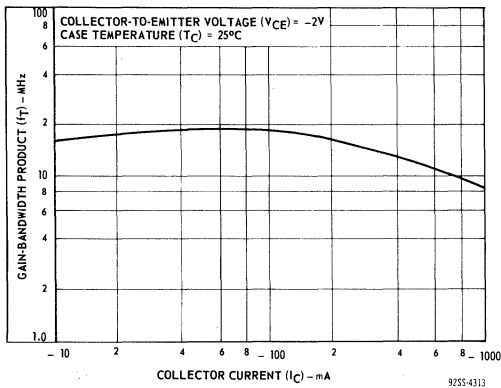


Fig. 10 — Typical gain-bandwidth product for types 2N5781, 2N5782, and 2N5783.

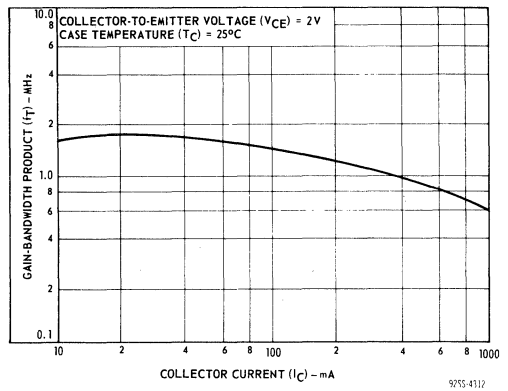


Fig. 11 — Typical gain-bandwidth product for types 2N5784, 2N5785, and 2N5786.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

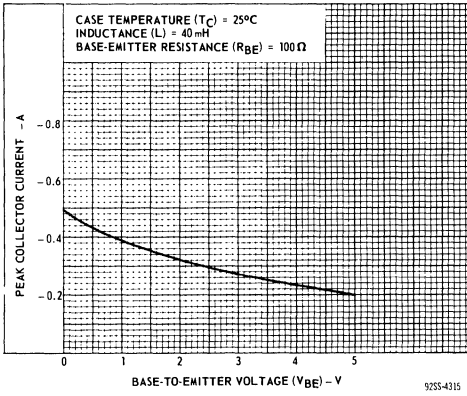


Fig. 12 – Reverse-bias second-breakdown characteristics for types 2N5781, 2N5782, and 2N5783.

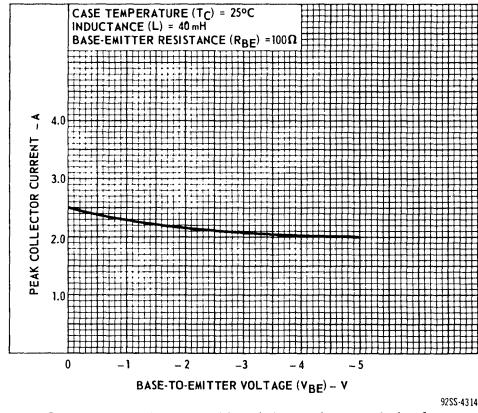


Fig. 13 – Reverse-bias second-breakdown characteristics for types 2N5784, 2N5785, and 2N5786.

2

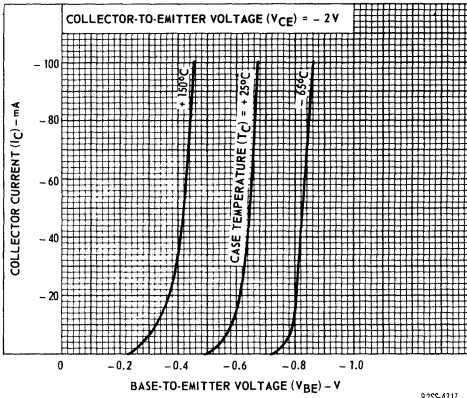


Fig. 14 – Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

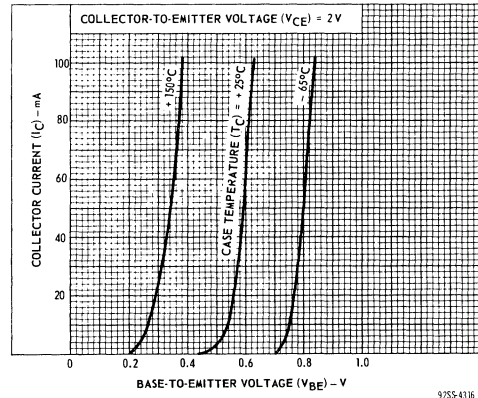


Fig. 15 – Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

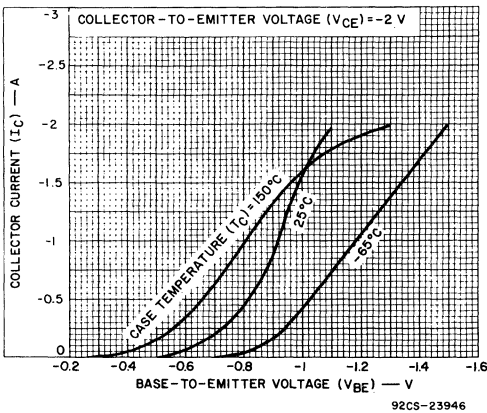


Fig. 16 – Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

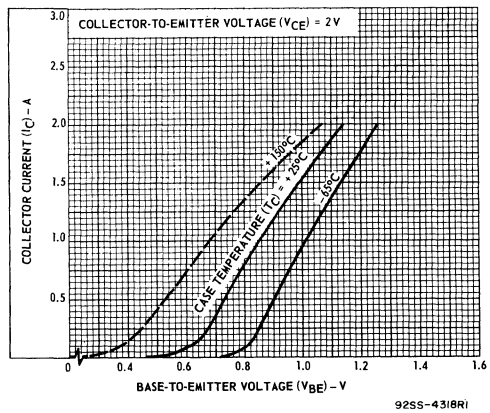


Fig. 17 – Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

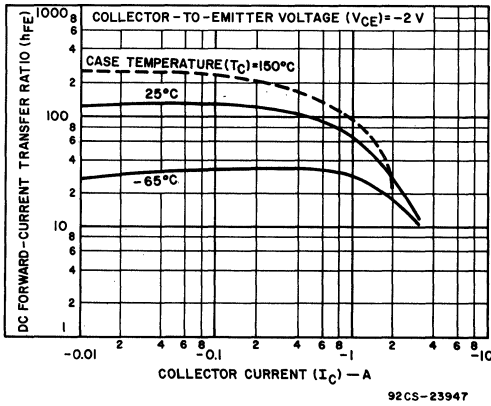


Fig. 18 - Typical dc beta characteristics for type 2N5781.

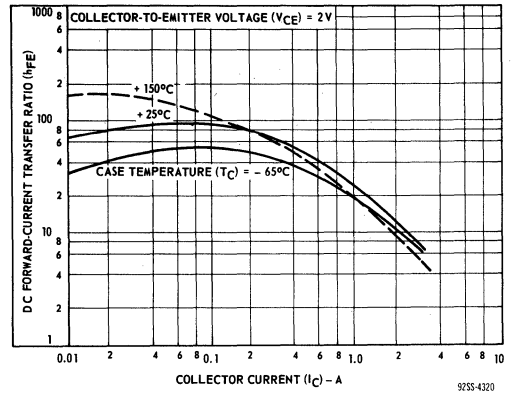


Fig. 19 - Typical dc beta characteristics for type 2N5784.

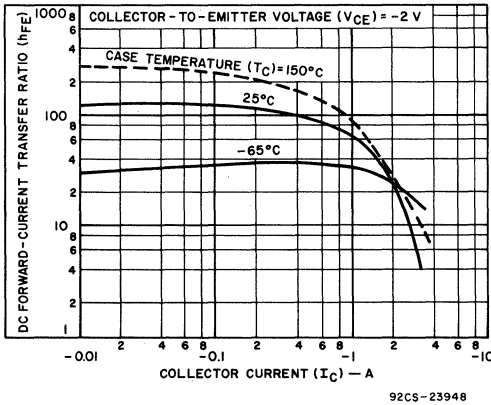


Fig. 20 - Typical dc beta characteristics for type 2N5782.

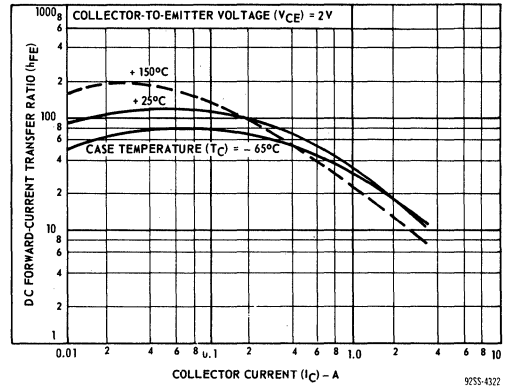


Fig. 21 - Typical dc beta characteristics for type 2N5785.

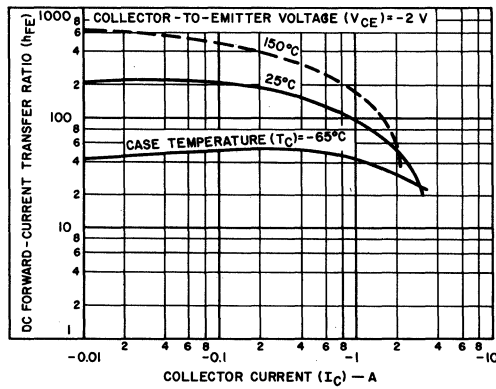


Fig. 22 - Typical dc beta characteristics for type 2N5783.

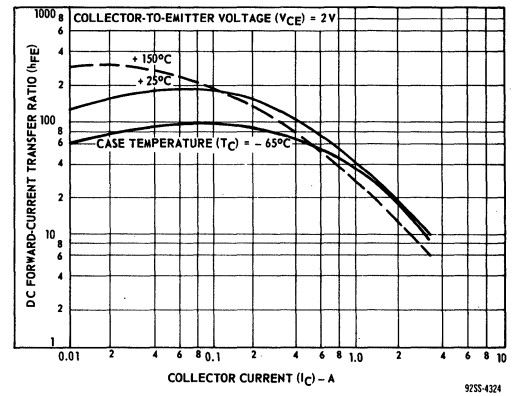


Fig. 23 - Typical dc beta characteristics for type 2N5786.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

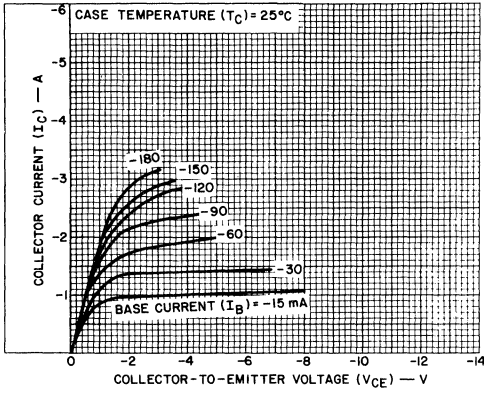


Fig. 24 - Typical output characteristics for type 2N5781.

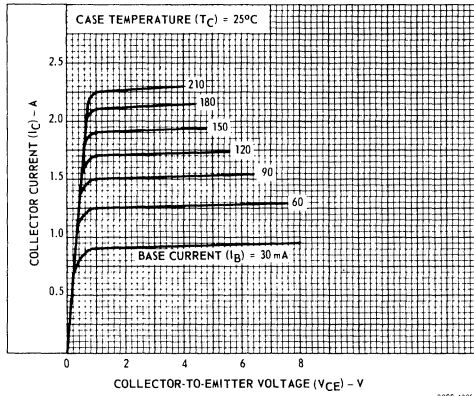


Fig. 25 - Typical output characteristics for type 2N5784.

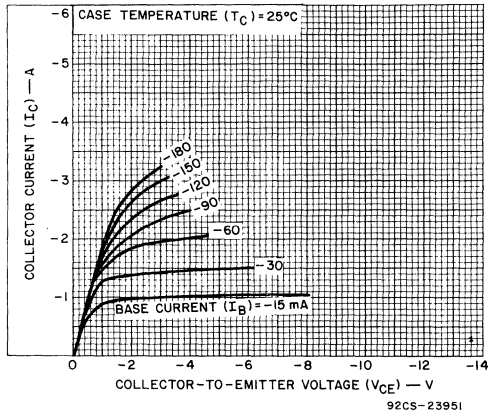


Fig. 26 - Typical output characteristics for type 2N5782.

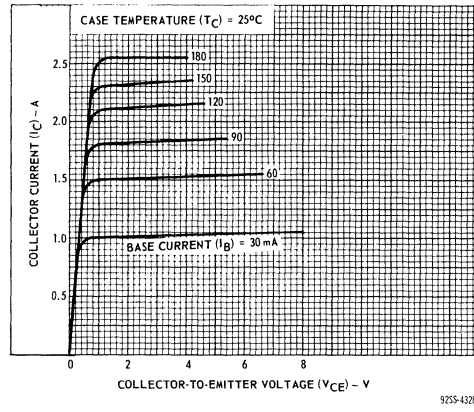


Fig. 27 - Typical output characteristics for type 2N5785.

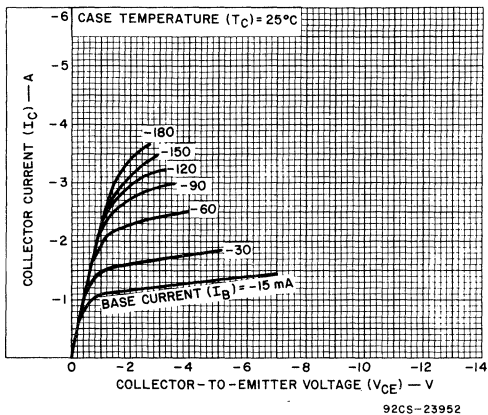


Fig. 28 - Typical output characteristics for type 2N5783.

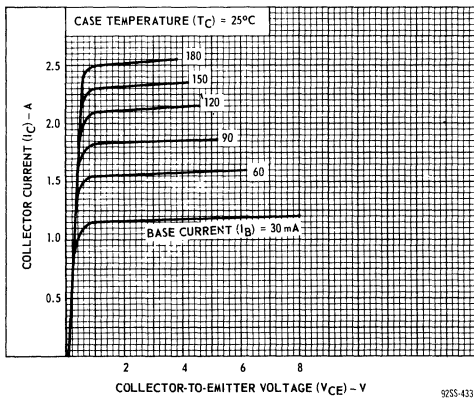


Fig. 29 - Typical output characteristics for type 2N5786.

2

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786

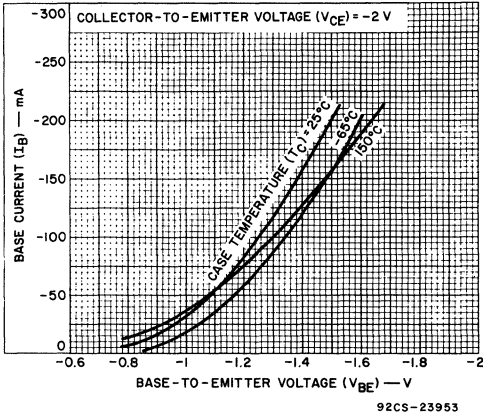


Fig. 30 - Typical input characteristics for type 2N5781.

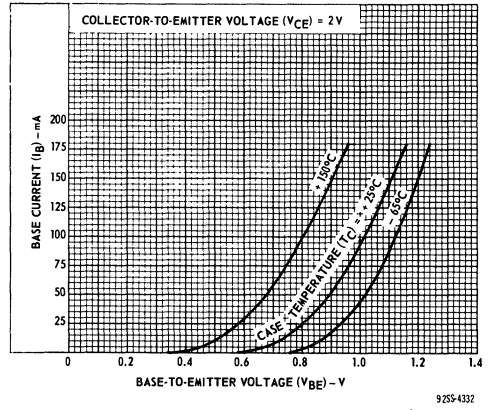


Fig. 31 - Typical input characteristics for type 2N5784.

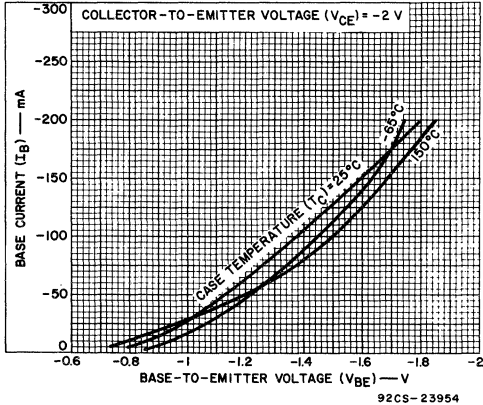


Fig. 32 - Typical input characteristics for type 2N5782.

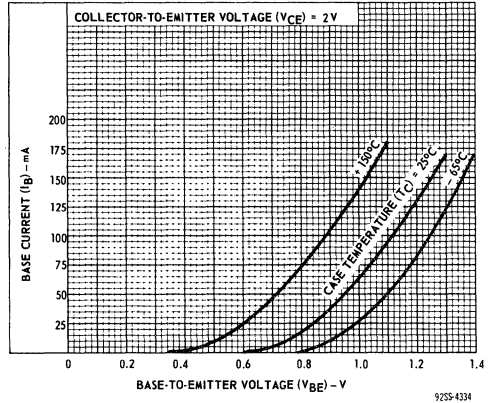


Fig. 33 - Typical input characteristics for type 2N5785.

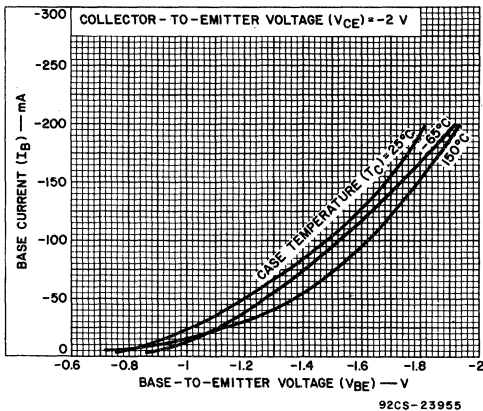


Fig. 34 - Typical input characteristics for type 2N5783.

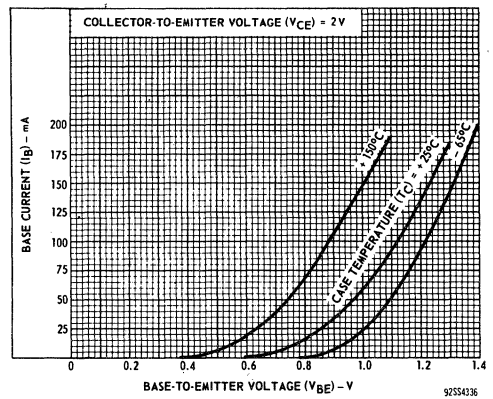


Fig. 35 - Typical input characteristics for type 2N5786.

High-Voltage, High-Power Silicon N-P-N Power Transistors

For Switching and Linear Applications in Military, Industrial, and Commercial Equipment

Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High voltage ratings

$$V_{CE(sus)} = 375 \text{ V [2N5840]}$$

$$300 \text{ V [2N5839]}$$

$$275 \text{ V [2N5838]}$$

- High dissipation rating
 $P_T = 100 \text{ W}$

The 2N5838, 2N5839 and 2N5840[■] are epitaxial silicon n-p-n power transistors. These devices employ the popular JEDEC TO-204AA package; they differ mainly in voltage, current-gain, and $V_{CE(sat)}$ ratings.

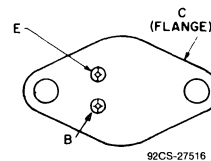
Featuring high breakdown voltage ratings and low-saturation voltage values, the 2N5838, 2N5839 and 2N5840 are especially suitable for use in inverters, deflection circuits, switching regulators, high-voltage bridged amplifiers, ignition circuits, and other high-voltage switching applications.

■ Formerly RCA Dev. Types TA7513, TA7530, and TA7420A, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5838	2N5839	2N5840	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	275	300	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open $V_{CE0(sus)}$	250	275	350	V
With reverse bias (V_{BE}) of -1.5 V, (V_{CEV}) (sus) •	275	300	375	V
With external base-to-emitter resistance (R_{BE}) $\leq 50 \Omega$, $V_{CE(sus)}$	275	300	375	V
*EMITTER-TO-BASE VOLTAGE, V_{EBO}	6	6	6	V
*COLLECTOR CURRENT, I_C				
Continuous	3	3	3	A
Peak	5	5	5	A
*CONTINUOUS BASE CURRENT, I_B	1.5	1.5	1.5	A
*TRANSISTOR DISSIPATION, P_T :				
At case temperature up to 25°C and V_{CE} up to 40 V	100	100	100	W
At case temperatures up to 25°C and V_{CE} above 40 V		See Fig. 1.		
At case temperatures up to 25°C and V_{CE} above 40 V		See Figs. 1 & 2.		
*TEMPERATURE RANGE:				
Storage and operating (Junction)		-65 to +200		°C
*PIN TEMPERATURE (During soldering):				
At distances $\geq 1/32$ in. (0.8 mm) from case for 10 s max		230		°C
* In accordance with JEDEC registration data format (JS-6, RDF-1).				
• Shown as $V_{CE(sus)}$ in JEDEC Registration Data.				

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2N5838, 2N5839, 2N5840

Characteristic	Symbol	Test Conditions						Limits									Units	
		DC Collector Voltage (V)		DC Emitter or Base Voltage (V)		DC Current (A)		Type 2N5838			Type 2N5839			Type 2N5840				
		V _{CE}	V _{EB}	V _{BE}	I _C	I _B	I _E	Min.	Max.	Typ.	Min.	Max.	Typ.	Min.	Max.	Typ.		
Collector-Cutoff Current: With base open	I _{CEO}	200						2			2			2			mA	
With base-emitter junction reverse biased	I _{CEV}	265		-1.5				5			2						mA	
		290		-1.5														
		360		-1.5										2				
With base-emitter junction reverse biased	I _{CEV} T _C 100 °C	265		-1.5				8			5						mA	
		290		-1.5														
		360		-1.5										5				
Emitter-Cutoff Current	I _{EBO}		-6					1			1			1			mA	
Collector-to-Emitter Sustaining Voltage: (See Figs. 4, 5, & 6) With base open	V _{CEO(sus)}				0.2			250 ^b			275 ^b			350 ^b			V	
				-1.5	0.1			275 ^b			300 ^b			375 ^b				
					0.2			275 ^b			300 ^b			375 ^b				
With external base-to-emitter resistance (R _{BE}) = 50 Ω	V _{CE(sus)}				0.2			275 ^b			300 ^b			375 ^b				
Emitter-to-Base Voltage	V _{EBO}					0.02	6			6			6				V	
DC Forward-Current Transfer Ratio	h _{FE}	5			0.5 ^b			20			20			20				
		3			2 ^b						10			50			10	50
		2			3 ^b			8			40							
Base-to-Emitter Saturation Voltage	V _{BE(sat)}				2	0.2						2				2	V	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				2	0.2						1.5				1.5	V	
					3	0.375			1									
Output Capacitance (At 1 MHz)	C _{obo}		10d				0		150			150			150		pF	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	10			0.2			5			5			5				
Second Breakdown Collector Current (With base forward biased) Pulse duration (non-repetitive) = 1 s	I _{S/bC}	40						2.5			2.5			2.5			A	
Switching Times:	t _d	V _{CC} = 200			2	0.2 ^e							0.07			0.07		
					3	0.375 ^e				0.06								
					2	0.2 ^e					1.5	0.8		1.5	0.6		1.75	0.6
					3	0.375 ^e												
Rise	t _r	V _{CC} = 200			2	0.2 ^e						3.75	1.75		3.0	1.75		
					3	0.375 ^e				3.0	1.0							
Storage	t _s	V _{CC} = 200			2	0.2 ^e												
					3	0.375 ^e												
Fall	t _f	V _{CC} = 200			2	0.2 ^e						1.5	0.35		1.5	0.35		
					3	0.375 ^e				1.5	0.4							
Thermal Resistance (Junction-to-Case)	θ _{J-C}	10			5				1.75			1.75			1.75		°C/W	

a Pulsed; pulse duration ≤ 350 μs, Duty factor = 2%.

b CAUTION: The sustaining voltages V_{CEO(sus)}, V_{CEx(sus)} and V_{CEr(sus)}, MUST NOT be measured on a curve tracer.

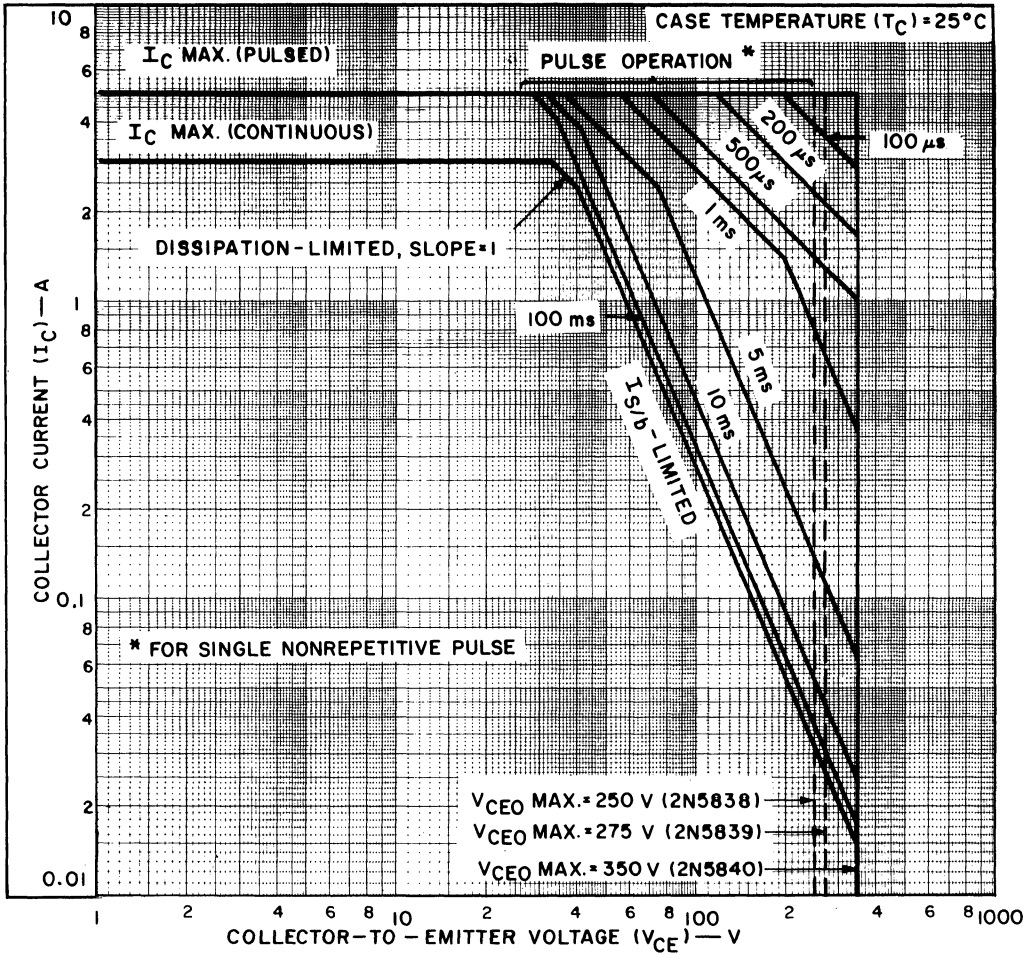
c I_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

d V_{CB}

e I_{B1} = I_{B2} = value shown.

* In accordance with JEDEC registration data format (JS-6 RDF-1).

2N5838, 2N5839, 2N5840



2

Fig. 1 — Maximum operating areas for all types.

92CS-15905

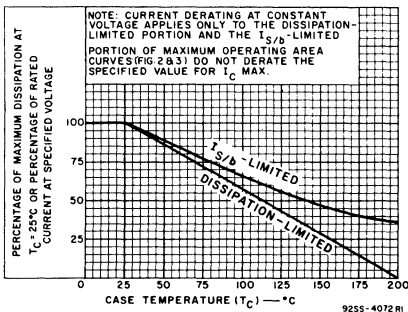


Fig. 2 — Derating curves for all types.

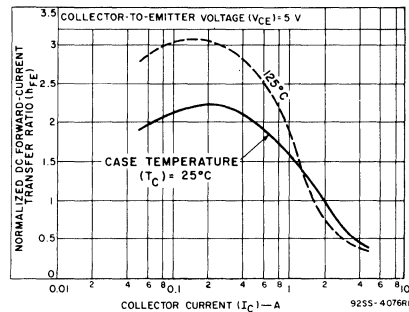
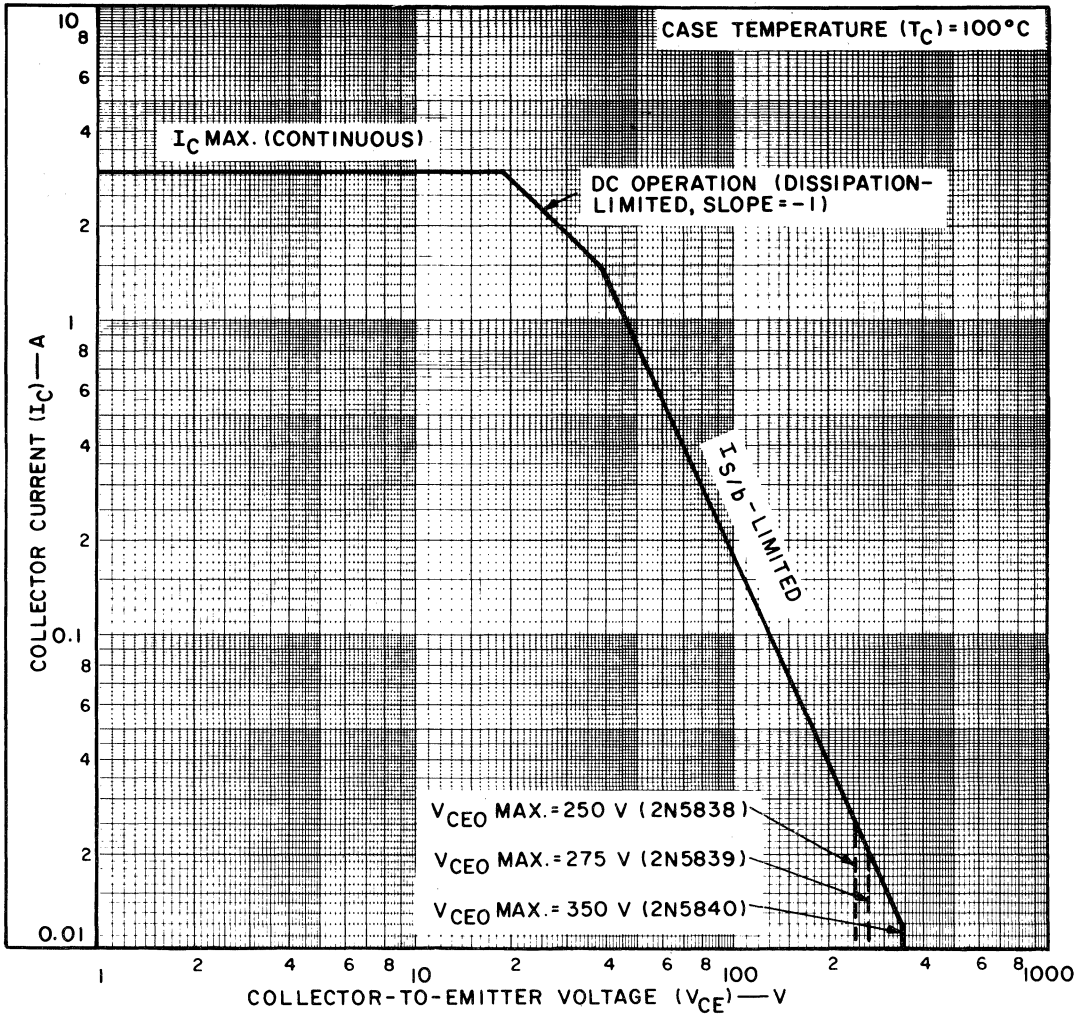


Fig. 3 — Typical normalized dc beta characteristics for all types.

2N5838, 2N5839, 2N5840



92CS-15906

Fig. 4 — Maximum operating areas for all types.

2N5838, 2N5839, 2N5840

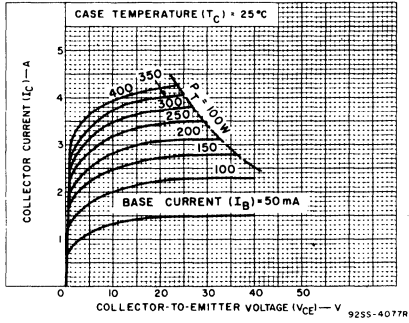


Fig. 5 — Typical output characteristics for all types.

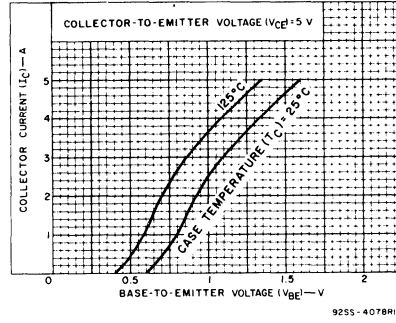


Fig. 6 — Typical transfer characteristics for all types.

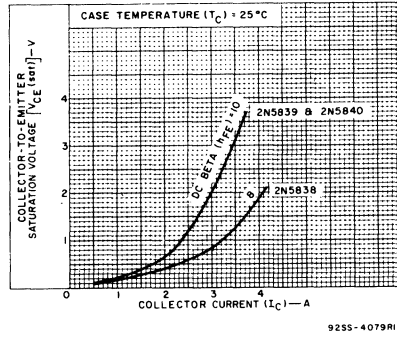


Fig. 7 — Typical saturation voltage characteristics for all types.

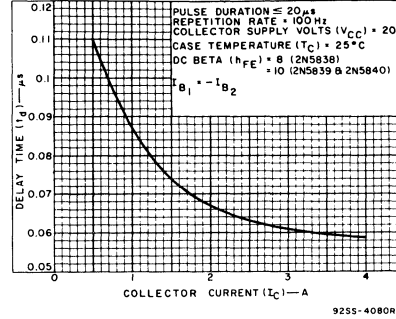


Fig. 8 — Typical delay-time characteristics for all types.

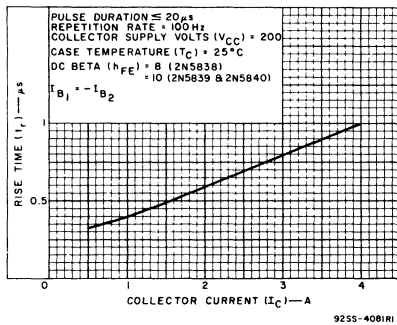


Fig. 9 — Typical rise-time characteristics for all types.

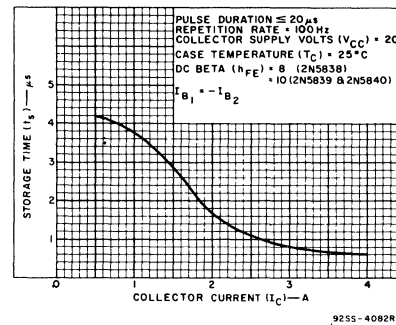


Fig. 10 — Typical storage-time characteristics for all types.



2N5838, 2N5839, 2N5840

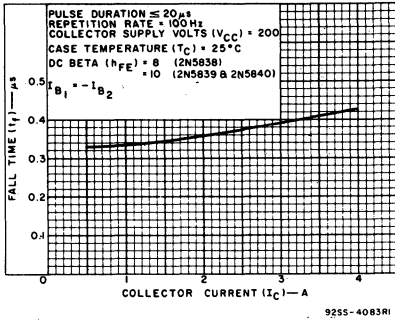


Fig. 11 — Typical fall-time characteristics for all types.

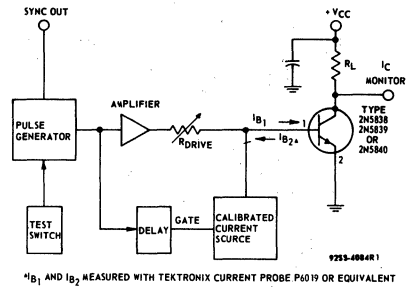


Fig. 12 — Circuit used to measure switching times for all types.

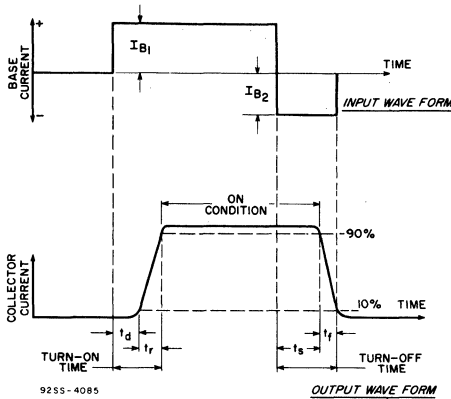


Fig. 13 — Phase relationship between input and output currents showing reference points for specification of switching times.

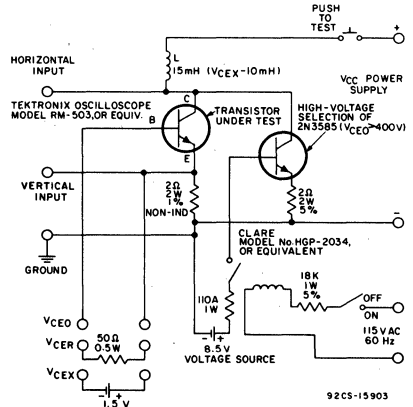
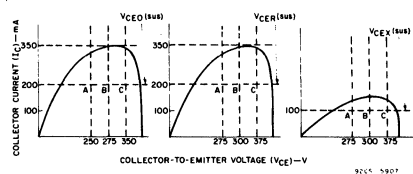


Fig. 14 — Circuit used to measure sustaining voltages $V_{CE0(sus)}$, $V_{CEB(sus)}$, and $V_{CEX(sus)}$ for all types.



The sustaining voltages $V_{CE0(sus)}$, $V_{CEB(sus)}$, and $V_{CEX(sus)}$ are acceptable when the traces fall to the right and above point "A" for type 2N5838, point "B" for type 2N5839, and point "C" for type 2N5840.

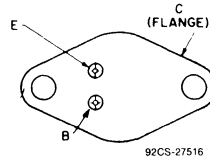
Fig. 15 — Oscilloscope display for measurement of sustaining voltages.

High-Current, High Power, High-Speed N-P-N Power Transistors

Features:

- Specification for h_{FE} and V_{CE} [sat] up to 25 A
- Current gain bandwidth product $f_T = 4 \text{ MHz}$ [min.] at 1 A
- Low saturation voltage with high beta
- High dissipation capability

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The 2N5885 and 2N5886 are epitaxial-base, silicon n-p-n transistors intended for a wide variety of high-power, high-current applications, such as power-switching circuits, driver and output stages for series and shunt regulators, dc-to-dc converters, inverters, and solenoid (hammer)/relay drivers.

These devices differ in maximum voltage ratings. They are supplied in the JEDEC TO-204AA hermetic steel packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5885	2N5886	
* V_{CBO}	60	80	V
* $V_{CEO(SUS)}$	60	80	V
* V_{EBO}	5	5	V
* I_C	25	25	A
* I_{CM}	50	50	A
* I_B	7.5	7.5	A
I_{BM}	15	15	A
* P_T :			
At $T_C \leq 25^\circ\text{C}$	200	200	W
At $T_C > 25^\circ\text{C}$	Derate linearly	1.15	W/ $^\circ\text{C}$
		See Figs. 1 and 2	
* T_{stg}, T_J	-65 to 200	-65 to 200	$^\circ\text{C}$
T_L			
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	230	230	$^\circ\text{C}$

* In accordance with JEDEC registration data format JS-6 RDF-1.

2N5885, 2N5886

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N5885		2N5886		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
* I _{CBO}	60 ^a 80 ^a				—	1	—	—	mA
* I _{CEX}	60 80	-1.5 -1.5			—	1	—	—	
* I _{CEX} T _C = 150°C	60 80	-1.5 -1.5			—	10	—	—	
* I _{CEO}	30 40				—	2	—	—	
* I _{EBO}		-5			—	1	—	1	
* h _{FE}	4 4 4		3 ^b 10 ^b 25 ^b		35 20 4	— 100 —	35 20 4	— 100 —	
* V _{CEO(sus)}			0.2		60	—	80	—	
* V _{BE}	4		10		—	1.5	—	1.5	
* V _{BE(sat)}			25 ^b	6.25	—	2.5	—	2.5	
* V _{CE(sat)}			15 ^b 25 ^b	1.5 6.25	— —	1 4	— —	1 4	
I _{S/b} t _p = 1 s nonrep.	20				10	—	10	—	A
* |h _{fe}| f = 1 MHz	10		1		4	—	4	—	
* h _{fe} f = 1 kHz	4		3		20	—	20	—	
* C _{obo} f = 1 MHz	10 ^a				—	500	—	500	pF
* t _r (See Fig. 8)	V _{CC} = 30		10	1	—	0.7	—	0.7	μs
* t _s			10	1 ^c	—	1	—	1	
* t _f			10	1 ^c	—	0.8	—	0.8	
R _{θJC}	20		5		—	0.875	—	0.875	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-1.

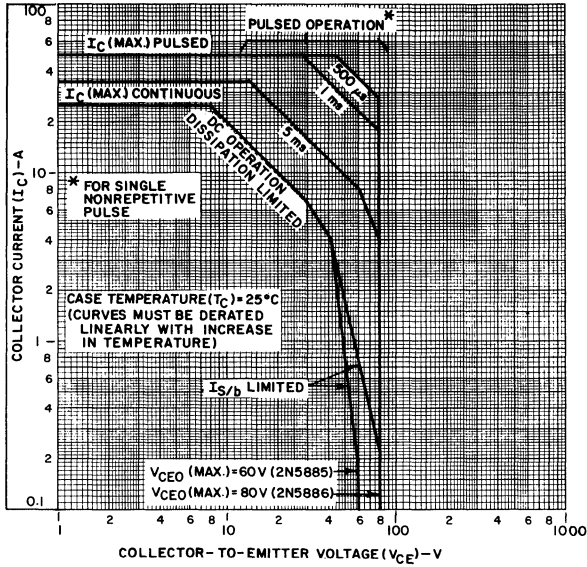
^aV_{CB}.

^bPulsed; pulse duration = 300 μs, duty factor = 1.8%.

^cI_{B1} = -I_{B2}.

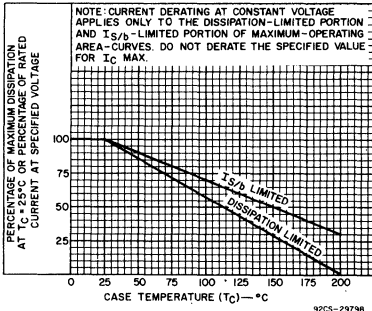
2N5885, 2N5886

2



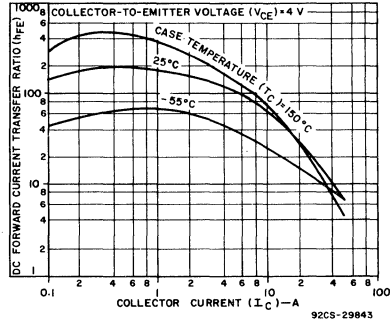
92CS-29846

Fig. 1 — Maximum operating areas for 2N5885 and 2N5886.



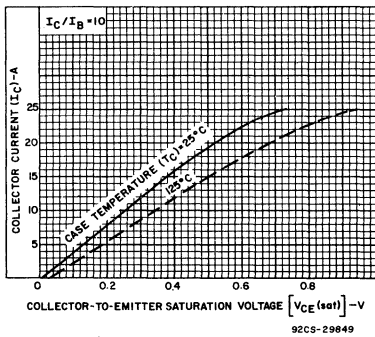
92CS-29798

Fig. 2 — Derating curves for 2N5885 and 2N5886.



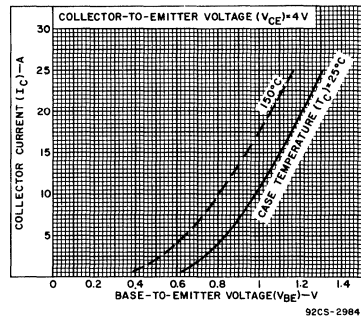
92CS-29843

Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5885 and 2N5886.



92CS-29849

Fig. 4 — Typical saturation voltage characteristics for 2N5885 and 2N5886.



92CS-29847

Fig. 5 — Typical transfer characteristics for 2N5885 and 2N5886.

2N5885, 2N5886

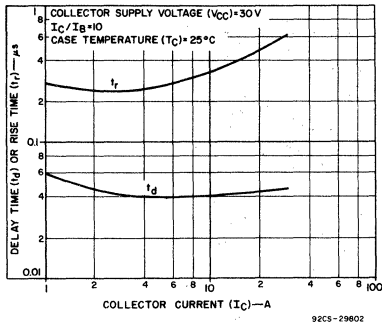


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5885 and 2N5886.

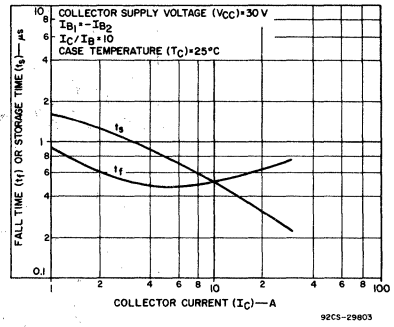


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5885 and 2N5886.

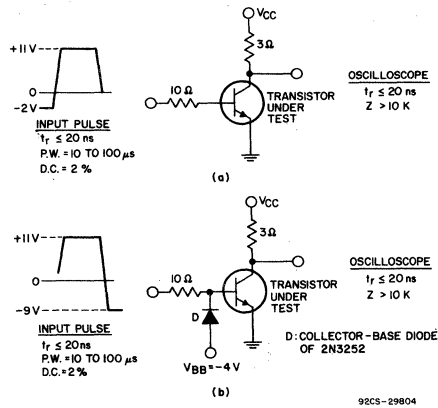


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5885 and 2N5886.

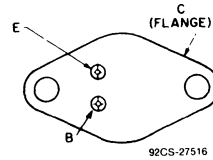
Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Applications

Features:

- Low saturation voltages
- Maximum-safe-area-of-operation curves
- High gain at high current

TERMINAL DESIGNATIONS



JEDEC TO-213AA

2

The 2N5954, 2N5955, and 2N5956* are multiple-epitaxial p-n-p transistors. All are supplied in the JEDEC TO-213AA package.

All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series regulators and output stages of high-fidelity amplifiers.

*Formerly RCA Dev. Nos. TA7264, TA7265, and TA7266, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5954	2N5955	2N5956	
* V_{CB0}	-90	-70	-50	V
* $V_{CEX(SUS)}$ $V_{BE} = 1.5 V, R_{BE} = 100 \Omega$	-90	-70	-50	V
$V_{CER(SUS)}$ $R_{BE} = 100 \Omega$	-85	-65	-45	V
$V_{CEO(SUS)}$	-80	-60	-40	V
* V_{EBO}	-5	-5	-5	V
* I_C	-6	-6	-6	A
* I_B	-2	-2	-2	A
* P_T At T_C up to 25°C	40	40	40	W
At T_C above 25°C	See Figs. 1 and 2			
* T_J, T_{stg}	-65 to +200			°C
* T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	235			°C

* JEDEC types in accordance with JEDEC registration data format JS-6-RDF-2.

2N5954, 2N5955, 2N5956

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N5956		2N5955		2N5954		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CER} $R_{BE} = 100 \Omega$	-35	—	—	—	—	-100	—	—	—	—	μA
	-55	—	—	—	—	—	—	-100	—	—	
	-75	—	—	—	—	—	—	—	—	-100	
* I_{CEX} $R_{BE} = 100 \Omega$	-45	1.5	—	—	—	-100	—	—	—	—	μA
	-65	1.5	—	—	—	—	—	-100	—	—	
	-85	1.5	—	—	—	—	—	—	—	-100	
* $R_{BE} = 100 \Omega$, $T_C = 150^\circ C$	-45	1.5	—	—	—	-2	—	—	—	—	mA
	-65	1.5	—	—	—	—	—	-2	—	—	
	-85	1.5	—	—	—	—	—	—	—	-2	
* I_{CEO}	-25	—	—	—	—	-1	—	—	—	—	mA
	-45	—	—	—	—	—	—	-1	—	—	
	-65	—	—	—	—	—	—	—	—	-1	
* I_{EBO}	—	5	—	—	—	-0.1	—	-0.1	—	-0.1	mA
* h_{FE}	-4	—	-3 ^a	—	20	100	—	—	—	—	
	-4	—	-2.5 ^a	—	—	—	20	100	—	—	
	-4	—	-2 ^a	—	—	—	—	—	20	100	
	-4	—	-6 ^a	—	5	—	5	—	5	—	
* $V_{CEO(SUS)}$	—	—	-0.1 ^a	—	-40 ^b	—	-60 ^b	—	-80 ^b	—	V
$V_{CER(SUS)}$ $R_{BE} = 100 \Omega$	—	—	-0.1 ^a	—	-45 ^b	—	-65 ^b	—	-85 ^b	—	
$V_{CEX(SUS)}$ $R_{BE} = 100 \Omega$	—	1.5	-0.1 ^a	—	-50 ^b	—	-70 ^b	—	-90 ^b	—	
* V_{BE}	-4	—	-3 ^a	—	—	-2	—	—	—	—	V
	-4	—	-2.5 ^a	—	—	—	—	-2	—	—	
	-4	—	-2 ^a	—	—	—	—	—	—	-2	
* $V_{CE(sat)}$	—	—	-3 ^a	-0.3	—	-1	—	—	—	—	V
	—	—	-2.5 ^a	-0.25	—	—	—	-1	—	—	
	—	—	-2 ^a	-0.2	—	—	—	—	—	-1	
* $|h_{re}|$ $f = 1 \text{ MHz}$	-4	—	-1	—	5	—	5	—	5	—	
* h_{re} $f = 1 \text{ kHz}$	-4	—	-0.5	—	25	—	25	—	25	—	
$R\theta_{JC}$	—	—	—	—	—	4.3	—	4.3	—	4.3	$^\circ C/W$

* In accordance with JEDEC registration data format JS-6-RDF-2.

^aPulsed, pulse duration = 300 μs , duty factor = 1.8%.^bCAUTION: Sustaining voltage $V_{CEO(SUS)}$, $V_{CER(SUS)}$, and $V_{CEX(SUS)}$ MUST NOT be measured on a curve tracer.

2N5954, 2N5955, 2N5956

2

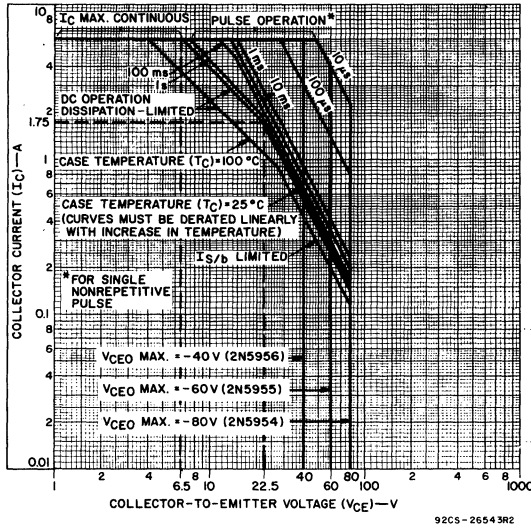


Fig. 1 - Maximum operating areas for all types.

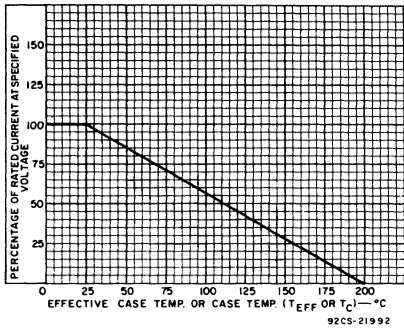


Fig. 2 - Current derating chart for all types.

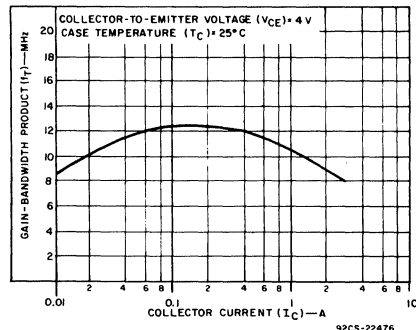


Fig. 3 - Typical gain-bandwidth product for all types.

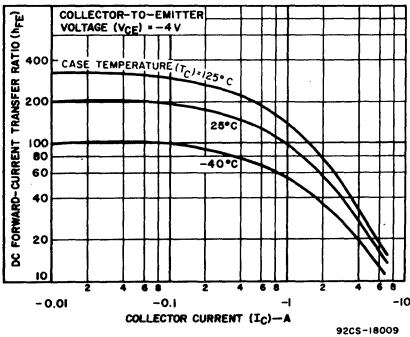


Fig. 4 - Typical dc beta characteristics for 2N5954-2N5956.

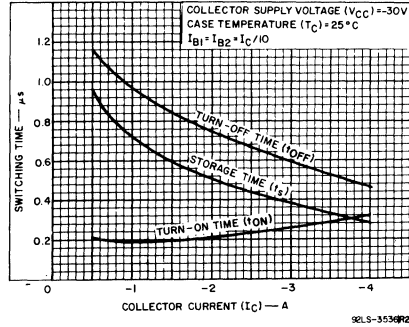


Fig. 5 - Typical saturated switching characteristics for 2N5954-2N5956.

2N5954, 2N5955, 2N5956

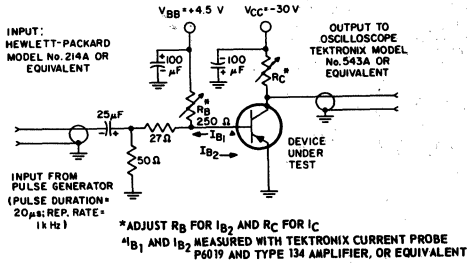


Fig. 6 - Circuit used to measure saturated switching times for 2N5954-2N5956.

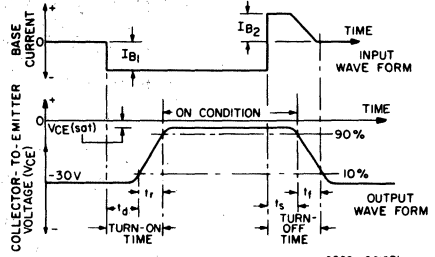


Fig. 7 - Oscilloscope display for measurement of switching times for 2N5954-2N5956.

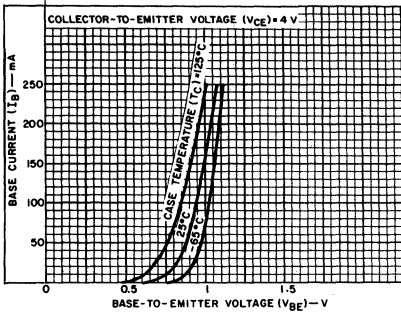


Fig. 8 - Typical input characteristics for all types.

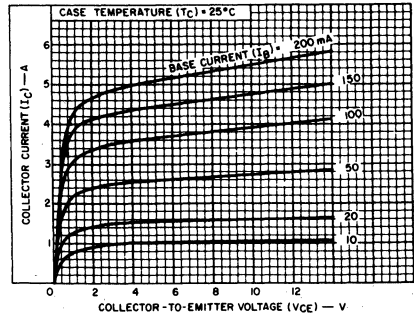


Fig. 9 - Typical output characteristics for all types.

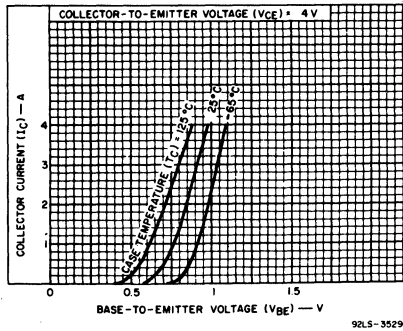


Fig. 10 - Typical transfer characteristics for all types.

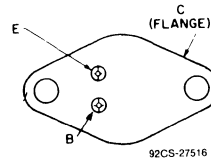
High-Current, High-Speed High-Power Transistors

Silicon N-P-N Types for High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

Features:

- Low $V_{CE(sat)}=1\text{ V max. at }40\text{ A, }1.3\text{ V max. at }50\text{ A}$
- Maximum safe-area-of-operation curves
 $I_{S/B}$ limit line beginning at 24 V
- Fast storage time:
 $t_s=1.5\mu\text{s max. at }I_C=40\text{ A (2N6033), }50\text{ A (2N6032)}$

TERMINAL DESIGNATIONS



JEDEC TO-204AE



The 2N6032 and 2N6033* are epitaxial silicon n-p-n transistors having high-current and high-power handling capability and fast switching speed. The 2N6033 is similar to the 2N6032; they differ in maximum values for continuous collector current and sustaining voltage.

They are supplied in the JEDEC TO-204AE hermetic steel package with 0.060-inch diameter pins.

*Formerly RCA Dev. Types TA7337 and TA7337A, respectively.

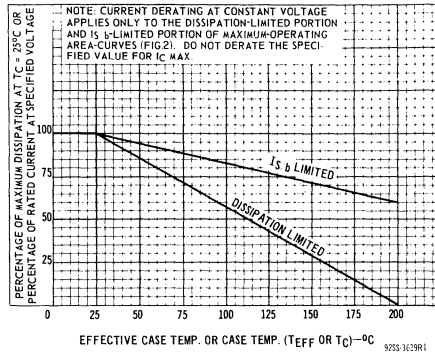


Fig. 1 - Derating curves for both types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6032	2N6033	
* COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open, $V_{CEO(sus)}$	90	120	V
With external base-to-emitter resistance ($R_{BE} \leq 50 \Omega$), $V_{CER(sus)}$	110	140	V
* With external base-to-emitter resistance ($R_{BE} \leq 50 \Omega$ & $V_{BE} = -1.5\text{ V}$, $V_{CEX(sus)}$	120	150	V
* EMITTER-TO-BASE VOLTAGE, V_{EBO}	7	7	V
* CONTINUOUS COLLECTOR CURRENT, I_C	50	40	A
* BASE CURRENT, I_B	10	10	A
* EMITTER CURRENT, I_E	50	40	A
* TRANSISTOR DISSIPATION, P_T :			
At case temperatures up to 25°C and V_{CE} up to 24 V	140	140	W
At case temperatures up to 25°C and V_{CE} above 24 V	See Fig. 2		
At case temperatures above 25°C and V_{CE} above 24 V	See Figs. 2 & 3		
* TEMPERATURE RANGE:			
Storage & Operating (Junction)	-65 to +200		°C
* PIN TEMPERATURE (During Soldering):			
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	230		°C

*In accordance with JEDEC registration data format (JS-6 RDF-1).

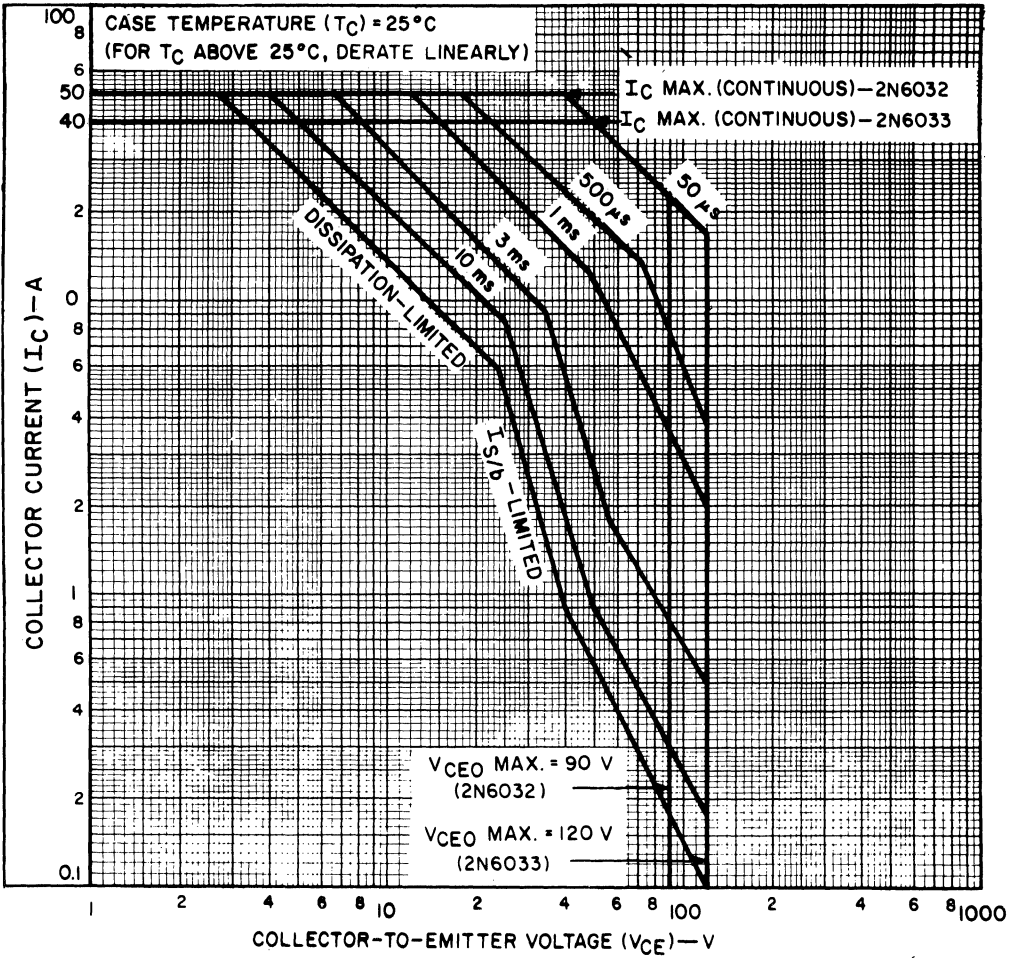
2N6032, 2N6033

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS							LIMITS				UNITS
		DC Collector Voltage (V)		DC Emitter or Base Voltage (V)		DC Current (A)			Type 2N6032		Type 2N6033		
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	—	80	—	—	—	—	0	—	10	—	10	mA
* With base-emitter junction reverse biased ($T_C = 150^\circ\text{C}$)	I_{CEV}	—	110	—	-1.5	—	—	—	—	12	—	—	mA
		—	135	—	-1.5	—	—	—	—	—	—	10	mA
		—	100	—	-1.5	—	—	—	—	15	—	10	mA
* Emitter-Cutoff Current	I_{EBO}	—	—	7	—	0	—	—	—	10	—	10	mA
Collector-to-Emitter Sustaining Voltage: (See Figs. 12 & 13) With base open	$V_{CEO(sus)}$	—	—	—	—	0.2	—	0	90 ^a	—	120 ^a	—	V
With external base to emitter resistance ($R_{BE} \leq 50 \Omega$)	$V_{CER(sus)}$	—	—	—	—	0.2	—	0	110 ^a	—	140 ^a	—	
With base-emitter junction reverse biased & $R_{BE} \leq 50 \Omega$	$V_{CEX(sus)}$	—	—	—	-1.5	0.2	—	0	120 ^a	—	150 ^a	—	
* Base-to-Emitter Saturation Voltage ^c	$V_{BE(sat)}$	—	—	—	—	50	—	5	—	2	—	—	V
		—	—	—	—	40	—	4	—	—	—	2	V
Base-to-Emitter Voltage	V_{BE}	—	2	—	—	50	—	—	—	2	—	—	V
		—	2	—	—	40	—	—	—	—	—	2	V
* Collector-to-Emitter Saturation Voltage ^c	$V_{CE(sat)}$	—	—	—	—	50	—	5	—	1.3	—	—	V
		—	—	—	—	40	—	4	—	—	—	1	V
* DC Forward-Current Transfer Ratio ^c	h_{FE}	—	2.6	—	—	50	—	—	10	50	—	—	
		—	2	—	—	40	—	—	—	—	10	50	
Second-Breakdown Collector Current With base forward biased	$I_{S/b}$ ^b	—	24	—	—	—	—	—	5.8 ^c	—	5.8 ^c	—	A
		—	40	—	—	—	—	—	0.9 ^c	—	0.9 ^c	—	A
* Magnitude of common-emitter small-signal, short-circuit, forward-current transfer ratio (at 5 MHz)	$|h_{fe}|$	—	10	—	—	—	—	—	10	—	10	—	
Gain-Bandwidth Product	f_T	—	10	—	—	2	—	—	50	—	50	—	MHz
Output Capacitance (at 1 MHz)	C_{obo}	10	—	—	—	—	0	—	—	800	—	800	pF
Saturated Switching Time: Turn-On (Delay Time + Rise Time)	t_{on}	$V_{CC} = 30V$	—	—	—	50	—	5 ^e	—	1	—	—	μs
			—	—	—	40	—	4 ^e	—	—	—	1	μs
* Rise	t_r	$V_{CC} = 30V$	—	—	—	50	—	5 ^e	—	1	—	—	μs
			—	—	—	40	—	4 ^e	—	—	—	1	μs
* Storage	t_s	$V_{CC} = 30V$	—	—	—	50	—	5 ^e	—	1.5	—	—	μs
			—	—	—	40	—	4 ^e	—	—	—	1.5	μs
* Fall	t_f	$V_{CC} = 30V$	—	—	—	50	—	5 ^e	—	0.5	—	—	μs
			—	—	—	40	—	4 ^e	—	—	—	0.5	μs
Thermal Resistance (Junction-to-Case)	θ_{J-C}	—	20	—	—	2.5	—	—	—	1.25	—	1.25	$^\circ\text{C/W}$

^a CAUTION: The sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEX(sus)}$ MUST NOT be measured on a curve tracer.^b $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.^c Pulsed; 1-s, non-repetitive pulse.^e $I_{B1} = I_{B2}$ *In accordance with JEDEC registration format JS-6 RDF-1.

2N6032, 2N6033



92CS-16020R1

Fig. 2 - Maximum operating area for both types.

2

2N6032, 2N6033

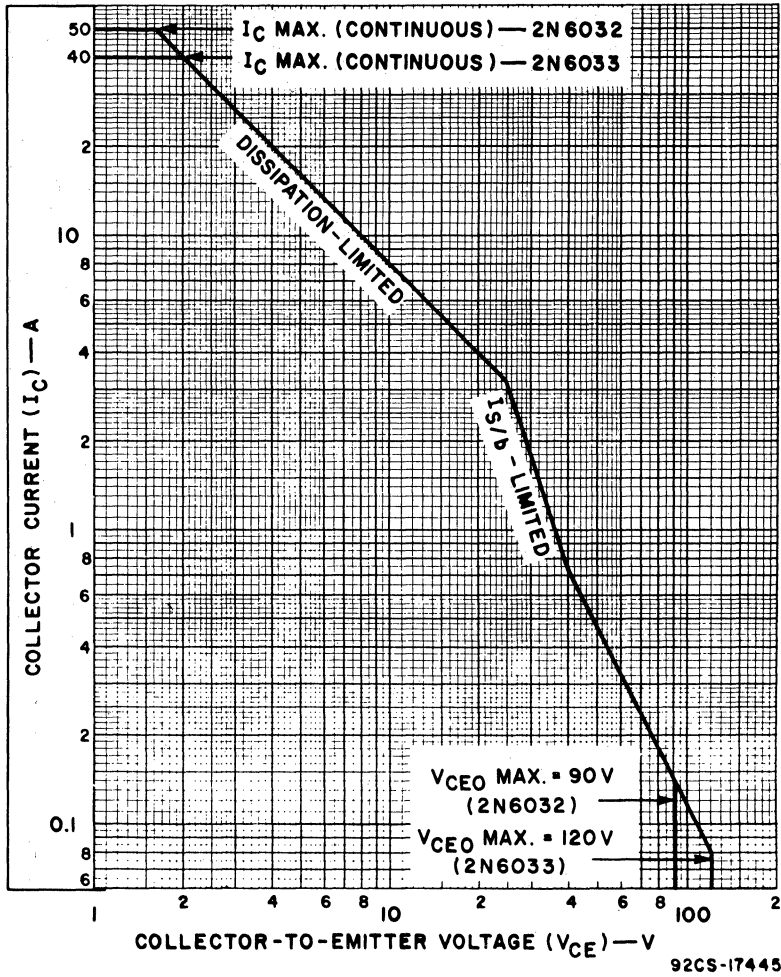


Fig. 3 - Maximum operating areas for both types at case temperature (T_c) = 100°C.

2N6032, 2N6033

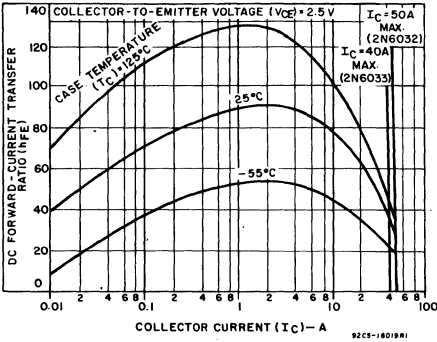


Fig. 4 - Typical dc-beta characteristics for both types.

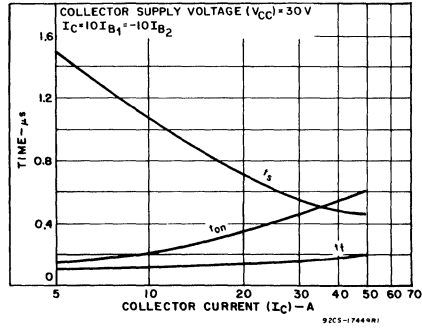


Fig. 5 - Typical saturated switching characteristics for both types.

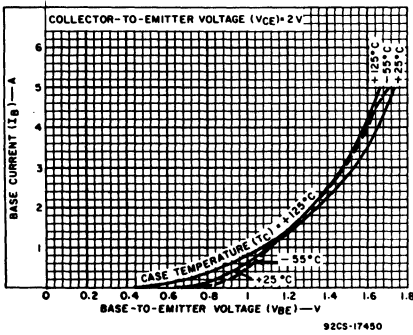


Fig. 6 - Typical input characteristics for both types.

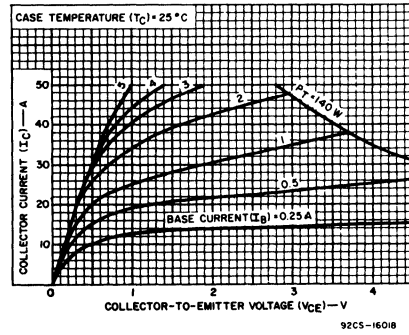


Fig. 7 - Typical collector characteristics for both types.

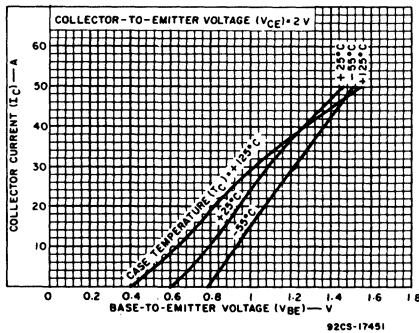


Fig. 8 - Typical transfer characteristics for both types.

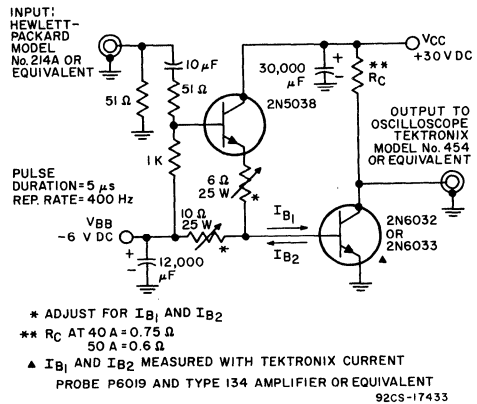


Fig. 9 - Switching-time test set.

2N6043, 2N6044, 2N6045

File Number 1151

8-Ampere N-P-N Darlington Power Transistors

60-, 80-, 100-Volts, 75 Watts
 Gain of 1000 at 4 A (2N6043, 2N6044)
 Gain of 1000 at 3 A (2N6045)

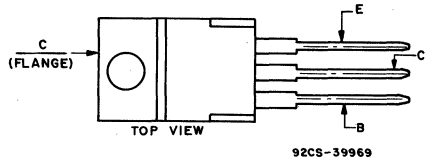
Features:

- Operates from IC without predriver

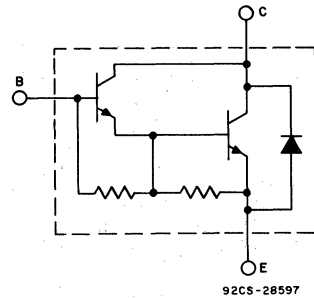
Applications:

- Power switching
- Hammer drivers
- Audio amplifiers
- Series and shunt regulators

TERMINAL DESIGNATIONS



JEDEC TO-220AB



The 2N6043, 2N6044, and 2N6045 are monolithic silicon n-p-n Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6043	2N6044	2N6045	
*V _{CBO}	60	80	100	V
V _{CEO(SUS)}	60	80	100	V
*V _{EBO}		5		V
*I _C		8		A
I _{CM}		16		A
*I _B		0.12		A
*P _T		75		W
T _C ≥ 25°C		See Fig. 2		
T _C > 25°C		-65 to 150		°C
*T _{stg} T _J				
*T _L		235		°C
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.				

*In accordance with JEDEC registration data.

2N6043, 2N6044, 2N6045

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6043		2N6044		2N6045		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	100 80 60			0 0 0	— — 20	— — 20	— — —	— 20 —	— — —	20 — —	
* I_{CEV}	100 80 60	-1.5 -1.5 -1.5			— — 20	— — 20	— — —	— 20 —	— — —	20 — —	μA
$T_C=125^\circ C$	100 80 60	-1.5 -1.5 -1.5			— — 200	— — 200	— — —	— 200 —	— — —	200 — —	
* I_{EBO}			5	0	—	2	—	2	—	2	mA
* $V_{CEO(sus)}$			0.1 ^a	0	60	—	80	—	100	—	V
* I_{CBO}	100 ^b 80 ^b 60 ^b				— — —	— — 20	— — —	— 20 —	— — —	20 — —	μA
* h_{FE}	4 4 4		4 3 8		1000 — 100	20,000 — —	1000 — 100	20,000 — —	— 1000 100	— 20,000 —	
* V_{BE}	4 4		4 3		— —	2.8 —	— —	2.8 —	— —	— 2.8	V
* $V_{BE(sat)}$			8	0.08	—	4.5	—	4.5	—	4.5	
* $V_{CE(sat)}$			4 3 8	0.016 0.012 0.08	— — —	2 — 4	— — —	2 — 4	— — —	— 2 4	V
V_F			-8 ^a		—	4	—	4	—	4	V
* h_{fe} $f=1$ kHz	4		3		300	—	300	—	300	—	
* $|h_{fe}|$ $f=1$ MHz	4		3		4	—	4	—	4	—	
* C_{obo} $f=1$ MHz	10 ^b				—	200	—	200	—	200	pF
$I_{S/b}$ $t=1$ s, nonrep.	30				2.5	—	2.5	—	2.5	—	A
$R_{\theta JC}$					—	1.67	—	1.67	—	1.67	$^\circ C/W$

* In accordance with JEDEC registration data.

^a Pulsed: Pulse duration = 300 μs , duty factor = 1.8%.^b V_{CB} value.

2N6043, 2N6044, 2N6045

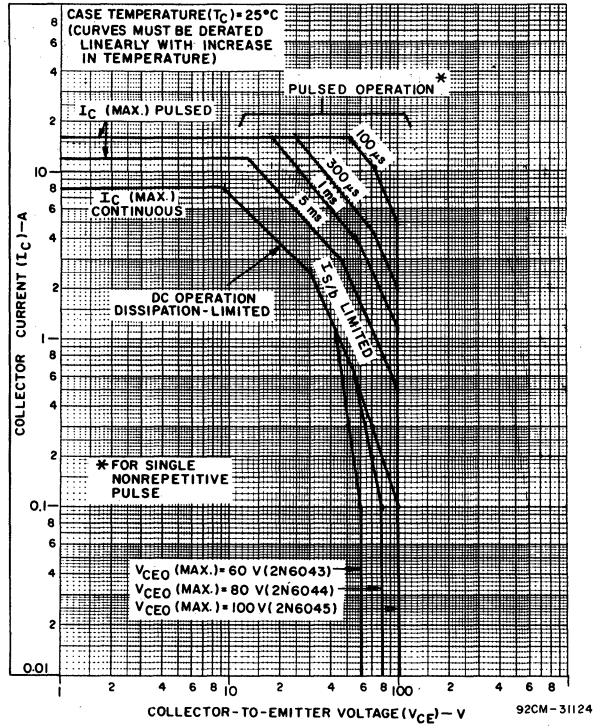


Fig. 2 - Maximum operating areas for all types ($T_c = 25^\circ C$).

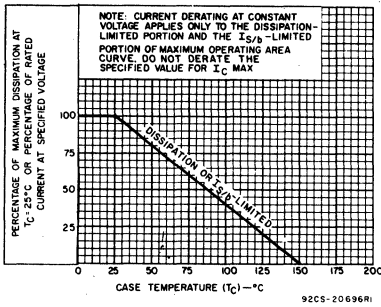


Fig. 3 - Derating curve for all types.

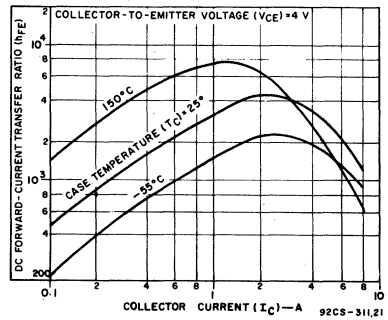


Fig. 4 - Typical dc beta characteristics for all types.

2N6043, 2N6044, 2N6045

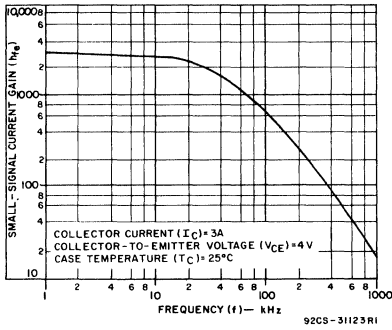


Fig. 5 — Typical small-signal gain for all types.

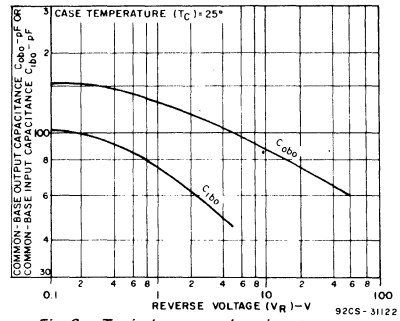


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of reverse voltage for all types.

2

12-Ampere Complementary P-N-P and N-P-N Monolithic Darlington Power Transistors

60-80-100 Volts, 150 Watts

Gain of 7000 (Typ.) at 5 A (2N6050, 2N6051, 2N6052)

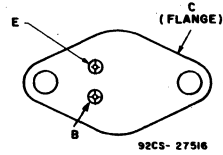
Gain of 4000 (Typ.) at 5 A (2N6057, 2N6058, 2N6059)

Features:

- Operates from IC without predriver
- Monolithic construction
- High voltage ratings:

$V_{CEO(sus)}$ = 60 V Min. — 2N6050[•], 2N6057
 = 80 V Min. — 2N6051[•], 2N6058
 = 100 V Min. — 2N6052[•], 2N6059

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6050, 2N6051, and 2N6052 p-n-p types and the 2N6057, 2N6058, and 2N6059 n-p-n types are complementary monolithic silicon Darlington transistors designed for general-purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. These devices are supplied in the JEDEC TO-204AA hermetic steel package.

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6050 [•] 2N6057	2N6051 [•] 2N6058	2N6052 [•] 2N6059	
* V_{CBO}	60	80	100	V
* $V_{CEO(sus)}$	60	80	100	V
* V_{EBO}	_____	5	_____	V
* I_C	_____	12	_____	A
* I_{CM}	_____	20	_____	A
* I_B	_____	0.2	_____	A
* P_T	_____	_____	_____	W
$T_C \leq 25^\circ C$	_____	150	_____	W
$T_C > 25^\circ C$	_____	0.857	_____	W/°C
* T_{stg}, T_J	_____	-65 to 200	_____	°C
* T_L	_____	_____	_____	°C
At distances $\geq 1/16$ in. (1.58 mm) from case for 10 s max. _____ 235 _____ °C				

* In accordance with JEDEC registration data. • For p-n-p devices, voltage and current values are negative.

2N6050, 2N6051, 2N6052, 2N6057, 2N6058, 2N6059

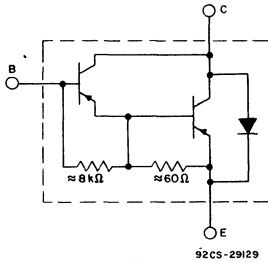


Fig. 1 — Schematic diagram for 2N6050, 2N6051, and 2N6052.

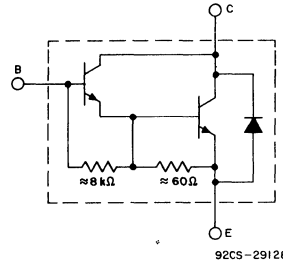


Fig. 2 — Schematic diagram for 2N6057, 2N6058, and 2N6059.

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS					UNITS	
	VOLTAGE V dc		CURRENT A dc		2N6050 [•] 2N6057		2N6051 [•] 2N6058		2N6052 [•] 2N6059		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.		MAX.
* I_{CEO}	30 40 50			0 0 0	— — —	1 — —	— — —	— 1 —	— — —	— — 1	mA
* I_{CEX}	60 80 100	-1.5 -1.5 -1.5			— — —	0.5 — —	— — —	— 0.5 —	— — 0.5		
$T_C = 150^\circ\text{C}$	60 80 100	-1.5 -1.5 -1.5			— — —	5 — —	— — —	— 5 —	— — 5		
* I_{EBO}		-5	0		—	2	—	2	—	2	mA
* $V_{CEO}(\text{sus})$			0.1 ^a	0	60	—	80	—	100	—	V
* h_{FE}	3 3		12 ^a 6 ^a		100 750	— 18,000	100 750	— 18,000	100 750	— 18,000	
* $V_{CE}(\text{sat})$			12 ^a 6 ^a	0.12 0.024	— —	3 2	— —	3 2	— —	3 2	V
* V_{BE}	3		6 ^a		—	2.8	—	2.8	—	2.8	V
* $V_{BE}(\text{sat})$			12 ^a	0.12	—	4	—	4	—	4	V
* h_{fe} $f = 1 \text{ kHz}$	3		5		300	—	300	—	300	—	
* $|h_{fe}|$ $f = 1 \text{ MHz}$	3		5		4	—	4	—	4	—	
* C_{ob} $V_{CB} = 10 \text{ V}, I_E = 0,$ $f = 0.1 \text{ MHz}$ 2N6050-52 2N6057-59					— —	500 300	— —	500 300	— —	500 300	pF
$I_{S/b}$ $t = 1 \text{ s, nonrep.}$	30				5	—	5	—	5	—	A
$R_{\theta JC}$						1.17	—	1.17	—	1.17	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

[•] For p-n-p devices, voltage and current values are negative.

* In accordance with JEDEC registration data.

2N6050, 2N6051, 2N6052, 2N6057, 2N6058, 2N6059

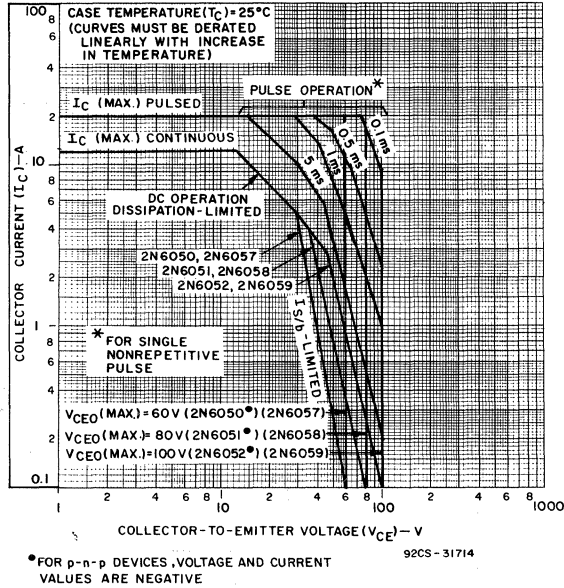


Fig. 3 - Maximum operating areas for all types.

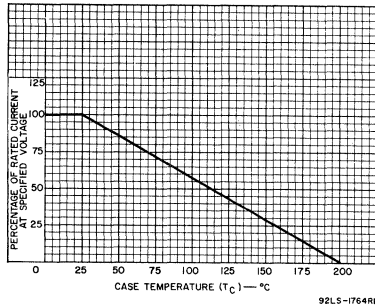


Fig. 4 - Current derating curve for all types.

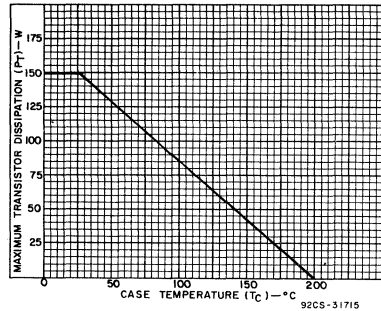


Fig. 5 - Power derating curve for all types.

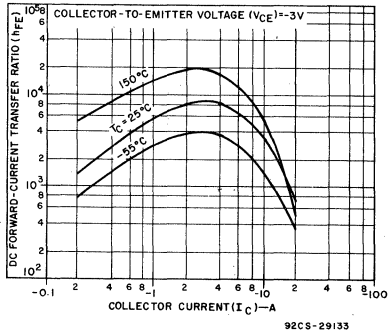


Fig. 6 - Typical dc beta characteristics for 2N6050, 2N6051, and 2N6052.

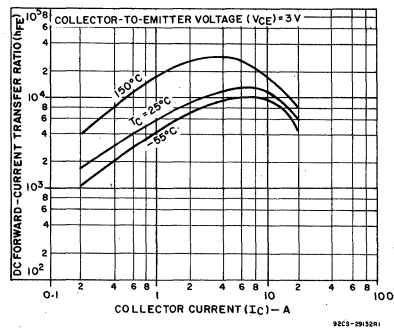
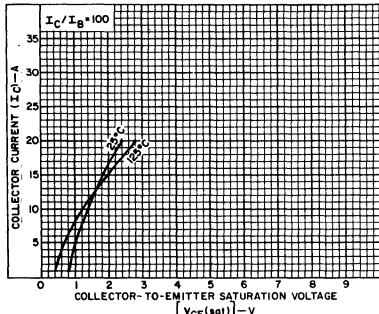


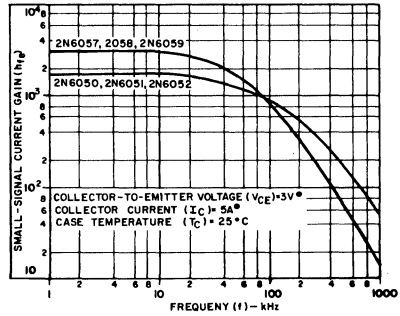
Fig. 7 - Typical dc beta characteristics for 2N6057, 2N6058, and 2N6059.

2N6050, 2N6051, 2N6052, 2N6057, 2N6058, 2N6059



FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE
92CS-31712

Fig. 8 - Typical saturation characteristics for all types.



FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE
92CS-31713

Fig. 9 - Typical small-signal current gain for all types.

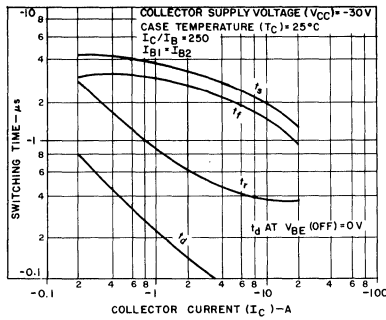


Fig. 10 - Typical switching times for 2N6050, 2N6051, and 2N6052.

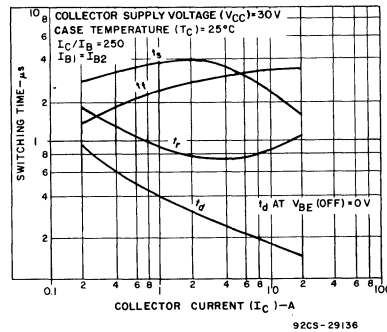
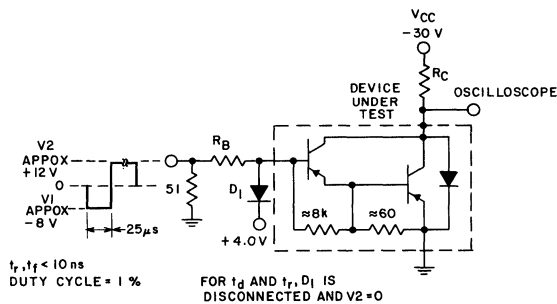


Fig. 11 - Typical switching times for 2N6057, 2N6058, and 2N6059.



$t_r, t_f < 10 ns$
DUTY CYCLE = 1 %

FOR t_d AND t_r , D_1 IS DISCONNECTED AND $V_2 = 0$

R_B & R_C VARIED TO OBTAIN DESIRED CURRENT LEVELS
 D_1 MUST BE FAST RECOVERY TYPE

FOR n-p-n TEST CIRCUIT REVERSE DIODE AND VOLTAGE POLARITIES

92CS-29138

Fig. 12 - Switching times test circuit.



8-Ampere Silicon N-P-N Darlington Power Transistors

60- and 80-Volt, 100-Watt Types

With Gain of 750 at 4 Amperes

Features:

- Operation from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Audio amplifiers
- Series and shunt regulators

The 2N6055 and 2N6056 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability. Their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-204AA (VERSAWATT) plastic package.

TERMINAL DESIGNATIONS

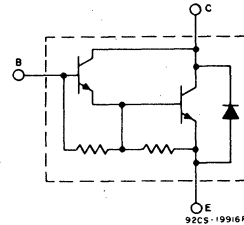
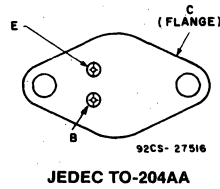


Fig.1 – Schematic diagram of 2N6055 and 2N6056 Darlington power transistors.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6055	2N6056	
* V_{CBO}	60	80	V
$V_{CER}(sus)$ $R_{BE} = 100 \Omega$	60	80	V
* V_{CEO}	60	80	V
$V_{CEV}(sus)$ $V_{BE} = -1.5 V$	60	80	V
* V_{EBO}	5	5	V
* I_C	8	8	A
I_{CM}	16	16	A
* I_B	120	120	mA
* P_T $T_C \leq 25^\circ C$	100	100	W
$T_C > 25^\circ C$	— See Figs. 2 and 4 —		
* T_{stg}, T_J	— -65 to +200 —		$^\circ C$
* T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	235		$^\circ C$

* In accordance with JEDEC registration format JS-6 RDF-2.

2N6055, 2N6056

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS						LIMITS				UNITS
	DC VOLTAGE V			DC CURRENT A			2N6055		2N6056		
	V _{CE}	V _{EB}	V _{BE}	I _C	I _E	I _B	MIN.	MAX.	MIN.	MAX.	
* I _{CEO}	30 40					0 0	— —	0.5 —	— —	— 0.5	mA
I _{CEX}	60 80		-1.5 -1.5				— —	0.5 —	— —	— 0.5	
I _{CEX} T _C = 150°C	60 80		-1.5 -1.5				— —	5 —	— —	— 5	
* I _{EBO}		5		0			—	2	—	2	mA
* h _{FE}	3 3			8 ^a 4 ^a			100 750	— 18,000	100 750	— 18,000	
V _{CEO} (sus)				0.1 ^a			60 ^a	—	80 ^a	—	V
V _{CER} (sus) R _{BE} = 100 Ω				0.1 ^a			60 ^a	—	80 ^a	—	
V _{CEX} (sus)			-1.5	0.1 ^a			60 ^a	—	80 ^a	—	
* V _{CE} (sat)				4 ^a 8 ^a		0.016 0.08	— —	2 3	— —	2 3	V
* V _{BE}	3			4 ^a			—	2.8	—	2.8	V
V _{BE} (sat)				8 ^a		0.08	—	4	—	4	
* |h _{fe}| f = 1 MHz	3			3			4	—	4	—	
* C _{obo} f = 0.1 MHz, V _{CB} = 10 V					0		—	200	—	200	pF
* h _{fe} f = 1 kHz	3			3			300	—	300	—	
I _S /b t = 1 s, non rep.	33.3 40						3 —	— —	3 2	— —	A
R _{θJC}							—	1.75	—	1.75	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-2.

^a Pulsed: Pulse duration = 300 μs, duty factor = 2%.

2N6055, 2N6056

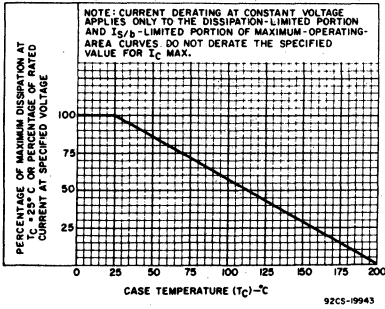


Fig. 2 - Derating curve for both types.

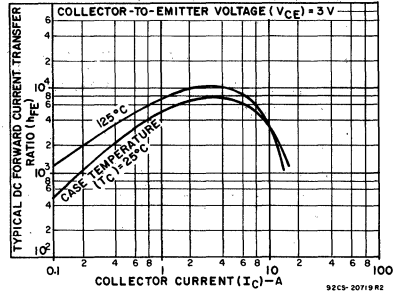


Fig. 3 - Typical dc beta characteristics for both types.

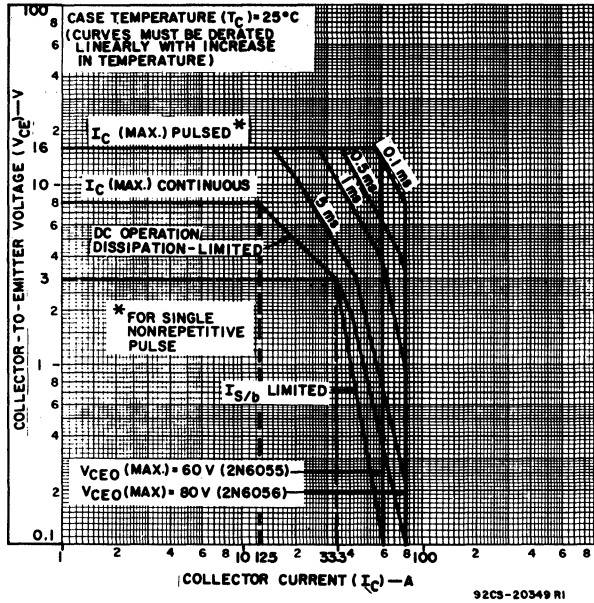


Fig. 4 - Maximum operating areas for types 2N6055 and 2N6056.

2N6055, 2N6056

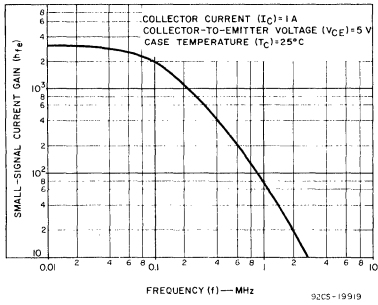


Fig. 5 — Typical small-signal gain for both types.

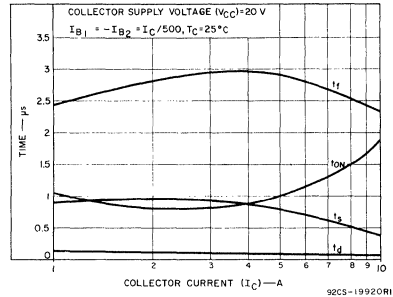


Fig. 6 — Typical saturated switching-time characteristics for both types.

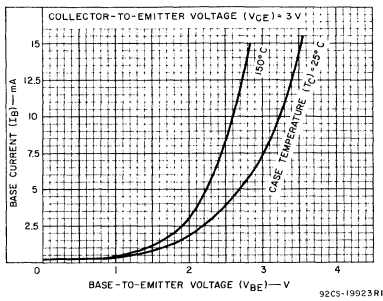


Fig. 7 — Typical input characteristics for both types.

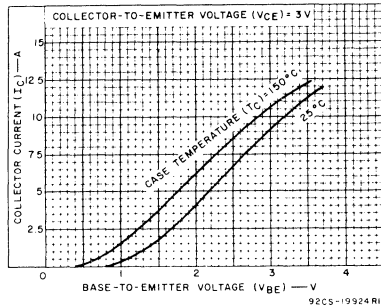


Fig. 8 — Typical transfer characteristics for both types.

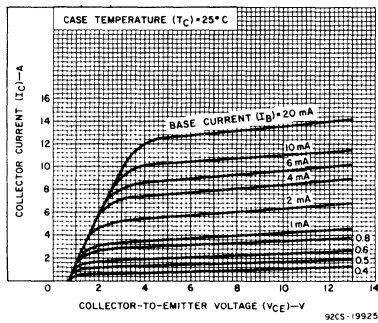


Fig. 9 — Typical output characteristics for both types.

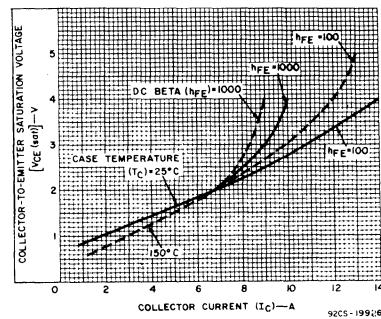


Fig. 10 — Typical saturation-voltage characteristics for both types.

2

2N6055, 2N6056

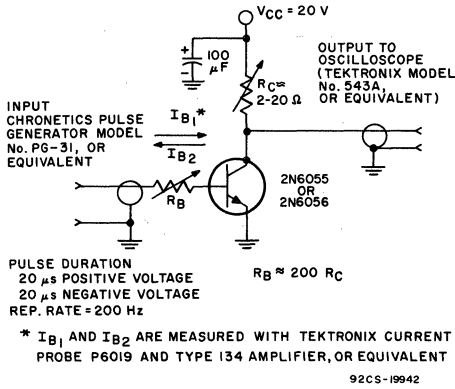


Fig. 11 — Circuit used to measure saturated switching times.

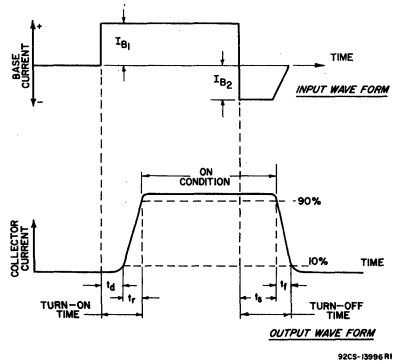


Fig. 12 — Phase relationship between input current and output current showing reference points for specification of switching times.

High-Voltage, High Power Silicon N-P-N Transistors

For Switching and Linear Applications

Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High voltage ratings:
 - $V_{CE(SUS)} = 300\text{ V}$ [2N6077]
 - $= 275\text{ V}$ [2N6078]
 - $= 375\text{ V}$ [2N6079]
- High dissipation ratings: $P_T = 45\text{ W}$

The 2N6077, 2N6078, and 2N6079 are multiple epitaxial silicon n-p-n transistors. Multiple-epitaxial construction maximizes the voltampere characteristic of the device and provides fast switching speeds.

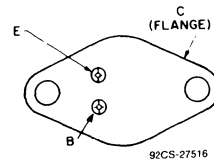
These devices use the popular JEDEC TO-213AA package; they differ mainly in voltage ratings, leakage-current limits, and $V_{CE(sat)}$ ratings.

The 2N6077 is characterized for switching applications with load lines in the active region. These applications include sweep circuits and all circuits using the transistor as an active voltage clamp.

Type 2N6078 is characterized for switching applications with the load line extending into the reverse-bias region. Its voltage ratings make this device useful for switching regulators operating directly from a rectified 110-V or 220-V power line. The unit is rated to take surge currents up to 5 A and maintain saturation.

The 2N6079 is characterized for use in inverters operating directly from a rectified 110-V power line. The leakage current is specified at 450 volts; therefore the device can also be used in a series bridge configuration on a 220-V line. The V_{EBO} rating of 9 volts eases requirements on the drive transformer in inverter applications. Storage time, an important factor in the frequency stability of an inverter, is specified in Fig. 12, which shows variation in storage time with variation in load current from zero to maximum (4 A).

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6077	2N6078	2N6079	
*COLLECTOR-TO-BASE VOLTAGE.....	V_{CBO} 300	275	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open.....	$V_{CEO(SUS)}$ 275	250	350	V
With reverse bias (V_{BE}) of -1.5 V	$V_{CEX(SUS)}$ 300	275	375	V
With external base-to-emitter resistance (R_{BE}) $\leq 50\Omega$...	$V_{CER(SUS)}$ 300	275	375	V
*EMITTER-TO-BASE VOLTAGE.....	V_{EBO} 6	6	9	V
*COLLECTOR CURRENT:	I_C			
Continuous.....	7	7	7	A
Peak.....	10	10	10	A
*CONTINUOUS BASE CURRENT.....	I_B 4	4	4	A
*TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C and V_{CE} up to 40 V.....	45	45	45	W
At case temperatures up to 25°C and V_{CE} above 40 V.....		See Fig. 1		
At case temperatures above 25°C and V_{CE} above 40 V... ..		See Figs. 1, 2, & 3		
*TEMPERATURE RANGE:				
Storage & Operating (Junction).....		-65 to $+200$		$^\circ\text{C}$
*PIN TEMPERATURE (During Soldering):				
At distances $\geq 1/32$ in. (0.8 mm)				
from case for 10 s max.		230		$^\circ\text{C}$

* In accordance with JEDEC registration data format (JS-6, RDF-1).

2N6077, 2N6078, 2N6079

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C

Characteristic	Symbol	Test Conditions						Limits									Units
		DC Collector Voltage (V)		DC Emitter Voltage (V)		DC Current (A)		Type 2N6077			Type 2N6078			Type 2N6079			
		V_{CE}	V_{CB}	V_{BE}	I_C	I_B	I_E	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	250				0			2								mA
* With base-emitter junction reverse biased	I_{CEV}	250 450		-1.5 -1.5					5			0.05				0.5	mA
* With base-emitter junction reverse biased	I_{CEV} $T_C = 125^\circ\text{C}$	250 450		-1.5 -1.5					8			0.2				5	mA
* Emitter-Cutoff Current	I_{EBO}			-6 -9	0 0				1			1				1	mA
* Collector-to-Emitter Sustaining Voltage (see Figs. 15 & 16) With base open	$V_{CEO(sus)b}$					0.2			275 ^b			250 ^b			350 ^b		V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER(sus)b}$					0.2			300 ^b			275 ^b			375 ^b		V
* Emitter-to-Base Voltage	V_{EBO}						0.001		6			6			9		V
* DC Forward-Current Transfer Ratio	h_{FE}	1							12	28	70	12	28	70	12	28	
* Base-to-Emitter Saturation Voltage	$V_{BE(sat)a}$				1.2 3 4 5	0.2 0.6 0.8 1			1.0 1.2	1.6 1.9		1.0 1.5	1.6 2		1.0 1.3	1.6 2	V
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)a}$				1.2 3 4 5	0.2 0.6 0.8 1			0.15 0.25	0.5 1		0.15 0.8	0.5 3		0.15 0.5	0.5 3	V
Output Capacitance (At 1 MHz)	C_{obo}		10				0				150			150		150	pF
* Magnitude of Common Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ($f = 1$ MHz)	$|h_{fe}|$	10				0.2			1	7		1	7		1	7	
Second Breakdown Collector Current (With base forward biased) Pulse duration (non-repetitive) = 1 s	$I_{S/b}^c$	50							0.9			0.9			0.9		A
Second Breakdown ^c Energy (With base reverse biased) $R_B = 50 \Omega$, $L = 100 \mu\text{H}$	$E_{S/b}^d$			-4		3			0.45			0.45			0.45		mJ
Switching Times: Delay (See Figs. 10, 17, & 18)	t_d	$V_{CC} = 250$ V				1.2	0.2 ^b			0.02			0.02			0.02	
* Rise (See Figs. 13, 17, & 18)	t_r	$V_{CC} = 250$ V				1.2	0.2 ^b			0.3	0.75		0.3	0.75		0.3	0.75
* Storage (See Figs. 11, 12, 17E & 18)	t_s	$V_{CC} = 250$ V				1.2	0.2 ^b			2.8	5		2.8	5		2.8	5
* (See Figs. 14, 17, & 18)	t_f	$V_{CC} = 250$ V				1.2	0.2 ^b			0.3	0.75		0.3	0.75		0.3	0.75
Thermal Resistance (Junction-to-Case)	θ_{J-C}	20				2.5					3.9			3.9		3.9	°C/W

^a Pulsed; pulse duration $\leq 350 \mu\text{s}$, Duty factor = 2%.

^b CAUTION: The sustaining voltages $V_{CEO(sus)}$, and $V_{CER(sus)}$, MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 15.

^c $I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

^d $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = 1/2 LI^2$ where L is a series load or leakage inductance, and I is the peak collector current.

^e $|B_1| = |B_2| =$ value shown.

* In accordance with JEDEC registration data format (JS-6 RDF-1).

2N6077, 2N6078, 2N6079

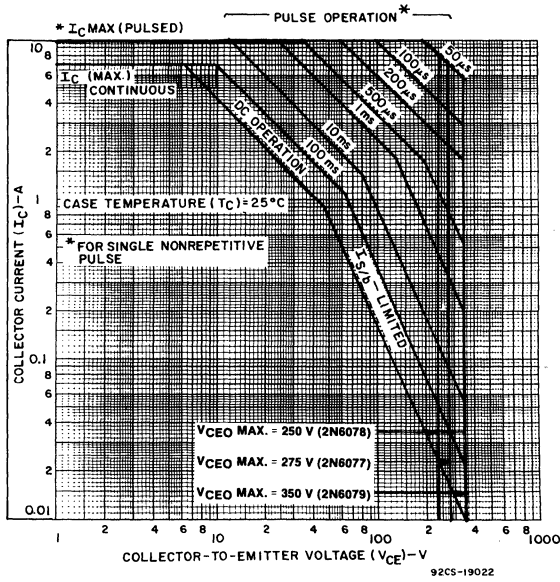


Fig.1—Maximum operating areas for all types.

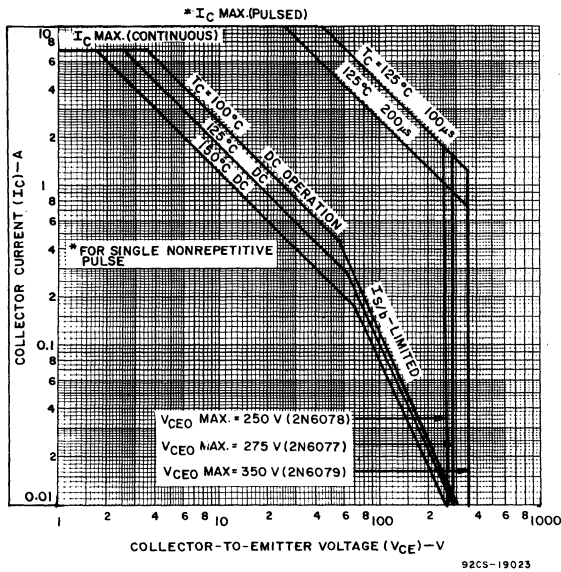


Fig.2—Maximum operating areas for all types.

2N6077, 2N6078, 2N6079

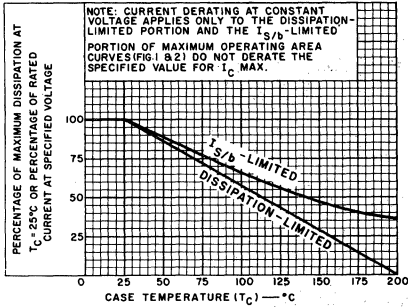


Fig. 3—Derating curve for all types.

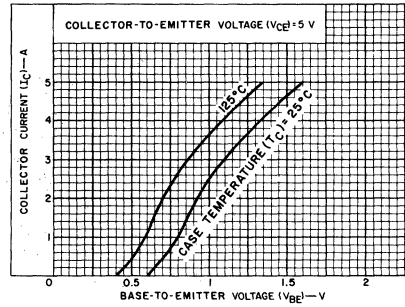


Fig. 4—Typical transfer characteristics for all types.

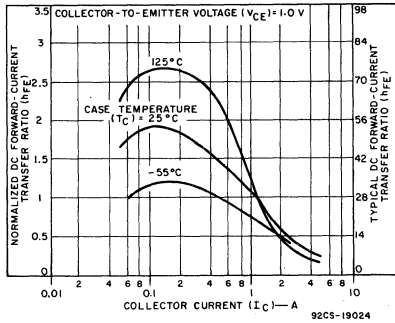


Fig. 5—Typical normalized dc beta characteristics for all types.

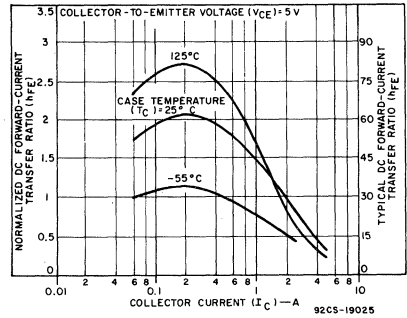


Fig. 6—Typical normalized dc beta characteristics for all types.

Note (Figs. 5 & 6): To estimate min., max. h_{FE} at any current and temperature, read normalized dc forward-current transfer ratio and multiply by min., max. specifications given in Electrical Characteristics Chart (p. 2).

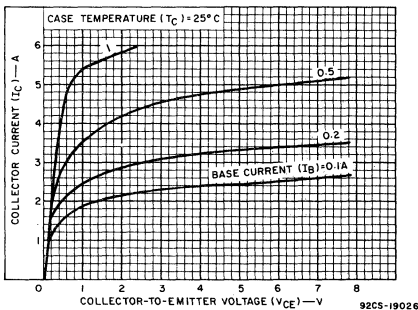


Fig. 7—Typical output characteristics for all types.

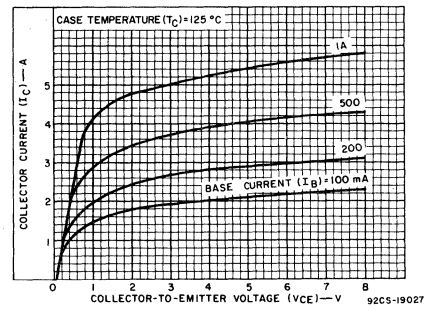


Fig. 8—Typical output characteristics for all types.

2N6077, 2N6078, 2N6079

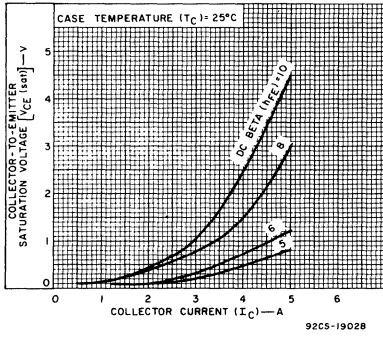


Fig. 9—Typical saturation voltage characteristics for all types.

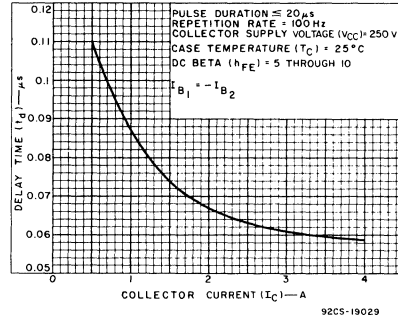


Fig. 10—Typical delay-time characteristic for all types.

2

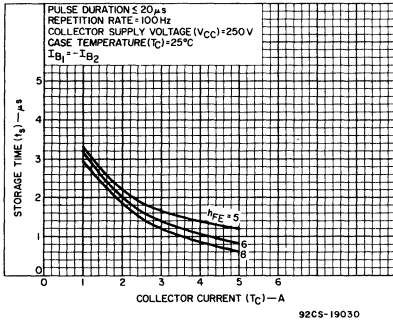


Fig. 11—Typical storage-time characteristic for all types (with constant forced gain).

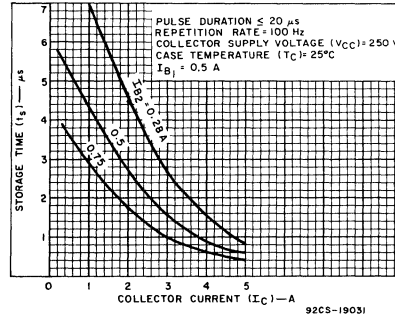


Fig. 12—Typical storage-time characteristic for all types (with constant-base drives).

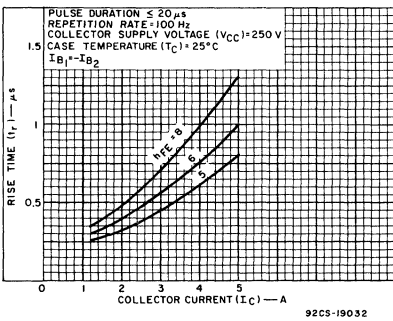


Fig. 13—Typical rise-time characteristic for all types.

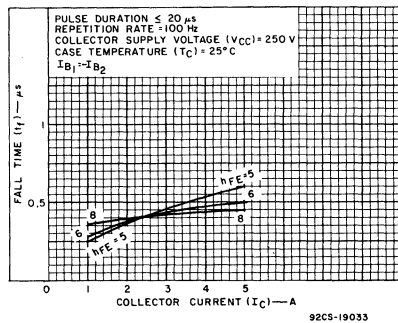


Fig. 14—Typical fall-time characteristic for all types.

2N6077, 2N6078, 2N6079

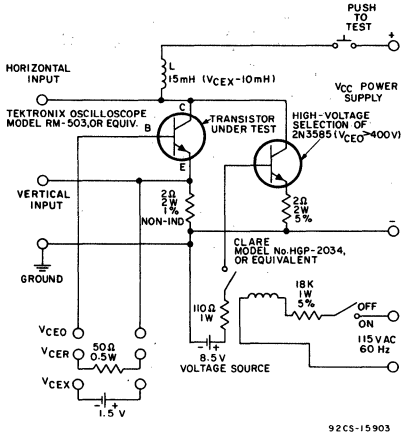
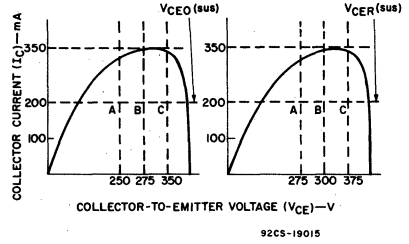


Fig.15—Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$ for all types.



The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ are acceptable when the traces fall to the right and above point "A" for type 2N6078 point "B" for type 2N6077 and point "C" for type 2N6079.

Fig.16—Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 15).

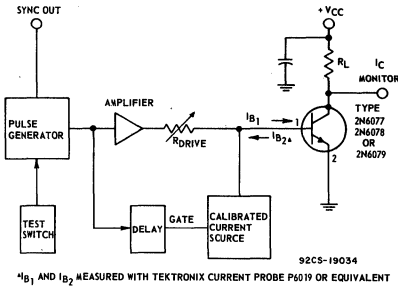


Fig.17—Circuit used to measure switching times for all types.

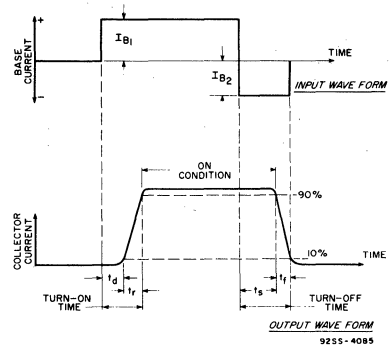


Fig.18—Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 17).

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

Features:

- Low saturation voltages
- Complementary n-p-n and p-n-p types
- Maximum safe-area-of-operation curves specified for dc operation

The 2N6106-2N6111, 2N6288-2N6293, and 2N6473-2N6476 are epitaxial-base silicon transistors supplied in a VERSAWATT package. The 2N6288-2N6293, 2N6473, and 2N6474* are n-p-n complements of p-n-p types 2N6106-2N6111, 2N6475, and 2N6476†, respectively. All these 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.

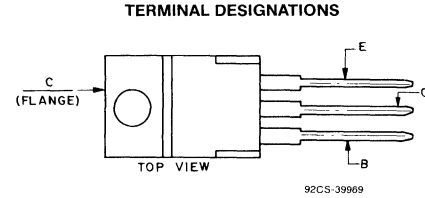
The 2N6289, 2N6291, and 2N6293 n-p-n types and 2N6106, 2N6108, and 2N6110 p-n-p devices fit into TO-213AA sockets. The remaining types are supplied in the JEDEC TO-220AB straight-lead version of the VERSAWATT package. All of these devices are also available on special order in a variety of lead-form configurations.

- *Formerly RCA Dev. Nos. TA7784, TA8323, TA7783, TA8232, TA7782, TA8231, TA8444, and TA8723, respectively.
- †Formerly RCA Dev. Nos. TA8210, TA7741, TA8211, TA7742, TA8212, TA7743, TA8445, and TA8722, respectively.

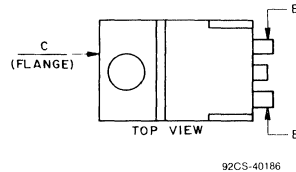
MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6288		2N6290		2N6292		2N6473	2N6474	
	N-P-N	2N6289	2N6291	2N6293	2N6475	2N6476			
* V_{CBO}		40	60	80	110	130			V
* $V_{CEX(SUS)}$ $R_{\theta\theta} = 100 \Omega, V_{BB} = 0 V$		40	60	80	110	130			V
$V_{CEO(SUS)}$		30	50	70	100	120			V
* V_{EBO}				5					V
* $I_C (T_C \leq 106^\circ C)$			7			4			A
* $I_B (T_C \leq 130^\circ C)$			3			2			A
* P_T									
* $T_C \leq 25^\circ C$				40					W
$T_C > 25^\circ C \leq 100^\circ C$				16					W
$T_C > 25^\circ C$				Derate linearly 0.32					W/°C
* $T_A \leq 25^\circ C$				1.8					W
$T_A > 25^\circ C$				Derate linearly 0.0144					W/°C
* T_{stg}, T_J				-65 to 150					°C
* T_L At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.				235					°C

*In accordance with JEDEC registration data.



JEDEC TO-220AB



JEDEC TO-220AA

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

ELECTRICAL CHARACTERISTICS At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS [♦]				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6292 2N6293 2N6106 [♦] 2N6107 [♦]		2N6290 2N6291 2N6108 [♦] 2N6109 [♦]		2N6288 2N6289 2N6110 [♦] 2N6111 [♦]		
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I _{CER} (R _{BE} = 100 Ω)	75				—	0.1	—	—	—	—	mA
	55				—	—	—	0.1	—	—	
	35				—	—	—	—	—	0.1	
(R _{BE} = 100 Ω, T _C = 150°C)	70				—	2	—	—	—	—	
	50				—	—	—	2	—	—	
	30				—	—	—	—	—	2	
* I _{CEx} (R _{BE} = 100 Ω)	75	-1.5			—	0.1	—	—	—	—	
	56	-1.5			—	—	—	0.1	—	—	
	37.5	-1.5			—	—	—	—	—	0.1	
(R _{BE} = 100 Ω, T _C = 150°C)	70	-1.5			—	2	—	—	—	—	
	50	-1.5			—	—	—	2	—	—	
	30	-1.5			—	—	—	—	—	2	
* I _{CEO}	60			0	—	1	—	—	—	—	
	40			0	—	—	—	1	—	—	
	20			0	—	—	—	—	—	1	
* I _{EBO}		-5	0		—	1	—	1	—	1	
* V _{CEO(sus)} ^b			0.1 ^a	0	70	—	50	—	30	—	V
V _{CER(sus)} ^b (R _{BE} = 100 Ω)			0.1 ^a		80	—	60	—	40	—	
* h _{FE}	4		2 ^a		30	150	—	—	—	—	
	4		2.5 ^a		—	—	30	150	—	—	
	4		3 ^a		—	—	—	—	30	150	
	4		7 ^a		2.3	—	2.3	—	2.3	—	
* V _{BE}	4		2 ^a		—	1.5	—	—	—	—	
	4		2.5 ^a		—	—	—	1.5	—	—	
	4		3 ^a		—	—	—	—	—	1.5	
	4		7 ^a		—	3	—	3	—	3	
* V _{CE(sat)}			2 ^a	0.2	—	1	—	—	—	—	
			2.5 ^a	0.25	—	—	—	1	—	—	
			3 ^a	0.3	—	—	—	—	—	1	
			7 ^a	3	—	3.5	—	3.5	—	3.5	
* |h _{fe}| (f = 1 MHz) 2N6288-93	4		0.5		4	—	4	—	4	—	
	2N6106-11	-4	-0.5		10	—	10	—	10	—	
* h _{fe} (f = 50 kHz)	4		0.5		20	—	20	—	20	—	
* f _T	2N6288-93	4	0.5		10	—	10	—	10	—	
	2N6106-11	-4	-0.5		10	—	10	—	10	—	
* C _{obo} (f = 1 MHz)	10 ^c		0		—	250	—	250	—	250	
R _{θJC}					—	3.125	—	3.125	—	3.125	
R _{θJA}					—	70	—	70	—	70	

* In accordance with JEDEC registration data.

^a Pulsed: Pulse duration = 300 μs, duty factor = 0.018.^b CAUTION: The sustaining voltage V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.^c V_{CB} value.[♦] For p-n-p devices, voltage and current values are negative.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

ELECTRICAL CHARACTERISTICS At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6474 2N6476 [†]		2N6473 2N6475 [†]		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER} ($R_{BE} = 100 \Omega$)	120				-	0.1	-	-	mA
	100				-	-	-	0.1	
($R_{BE} = 100 \Omega$ $T_C = 100^\circ\text{C}$)	120				-	2	-	-	
	100				-	-	-	2	
* I_{CEX} ($R_{BE} = 100 \Omega$)	120	-1.5			-	0.1	-	-	
	100	-1.5			-	-	-	0.1	
($R_{BE} = 100 \Omega$, $T_C = 100^\circ\text{C}$)	120	-1.5			-	2	-	-	
	100	-1.5			-	-	-	2	
* I_{CEO}	60			0	-	1	-	-	
	50			0	-	-	-	1	
* I_{EBO}		-5		0	-	1	-	1	
* $V_{CEO(sus)}^b$			0.1 ^a	0	120	-	100	-	V
$V_{CER(sus)}^b$ ($R_{BE} = 100 \Omega$)			0.1 ^a		130	-	110	-	
* h_{FE}	4		1.5 ^a		15	150	15	150	
	2.5		4 ^a		2	-	2	-	
* V_{BE}	4		1.5 ^a		-	2	-	2	V
	2.5		4 ^a		-	3.5	-	3.5	
* $V_{CE(sat)}$			1.5 ^a	0.15	-	1.2	-	1.2	
			4 ^a	2	-	2.5	-	2.5	
* $|h_{fe}|$ (f = 1 MHz)									
2N6473-74	4		0.5		4	-	4	-	
2N6475-76	-4		-0.5		5	-	5	-	
* h_{fe} (f = 50 kHz)	4		0.5		20	-	20	-	MHz
f_T									
2N6473-74	4		0.5		4	-	4	-	
2N6475-76	-4		-0.5		5	-	4	-	
* C_{obo} (f = 1 MHz)	10 ^c		0		-	250	-	250	pF
$R_{\theta JC}$					-	3.125	-	3.125	°C/W
$R_{\theta JA}$					-	70	-	70	

* In accordance with JEDEC registration data

^a Pulsed: Pulse duration = 300 μs , duty factor = 0.018.^b CAUTION: The sustaining voltage $V_{CEO(sus)}$ are $V_{CER(sus)}$ MUST NOT be measured on a curve tracer.^c V_{CB} value.[†] For p-n-p devices, voltage and current values are negative.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

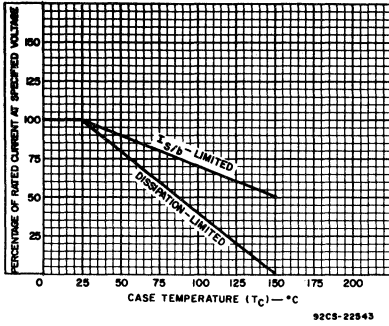


Fig. 1 - Current derating curves for all types.

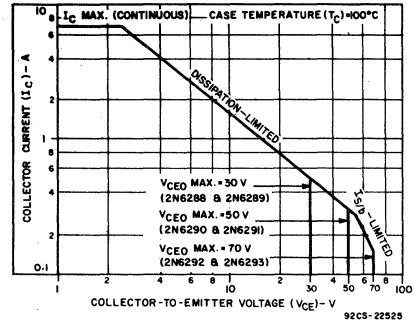


Fig. 2 - Maximum operating areas for 2N6288 - 2N6293 ($T_C = 100^\circ C$).

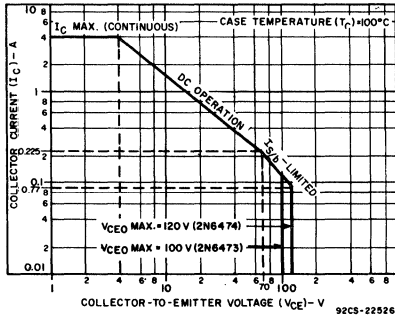


Fig. 3 - Maximum operating areas for 2N6473 - 2N6474 ($T_C = 100^\circ C$).

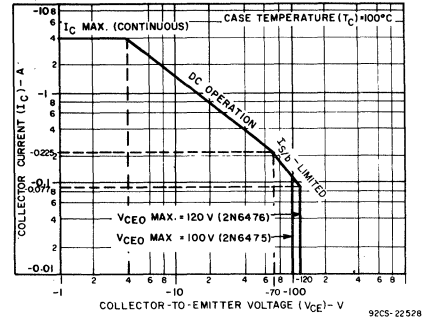


Fig. 4 - Maximum operating areas for 2N6475 and 2N6476 ($T_C = 100^\circ C$).

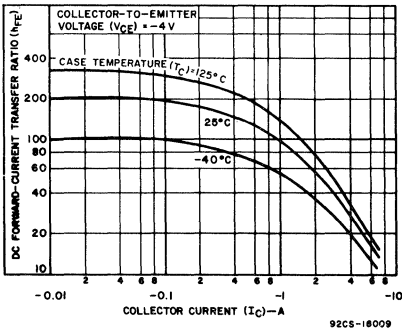


Fig. 5 - Typical dc beta characteristics for 2N6106 - 2N6111.

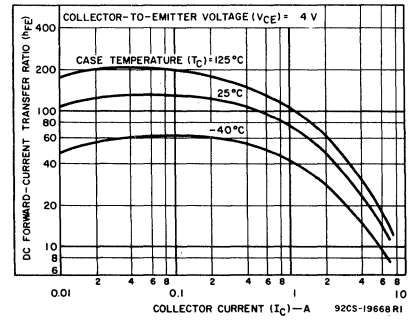


Fig. 6 - Typical dc beta characteristics for 2N6288 - 2N6293.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

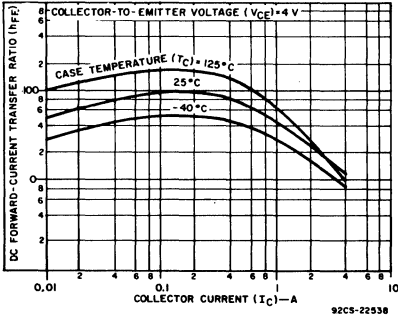


Fig. 7 - Typical dc beta characteristics for 2N6473 and 2N6474.

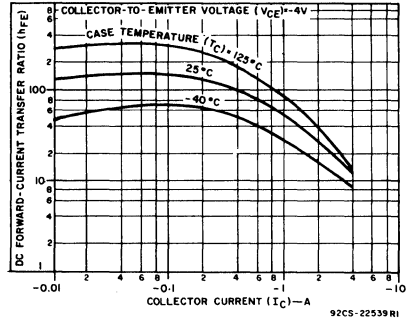


Fig. 8 - Typical dc beta characteristics for 2N6475 and 2N6476.

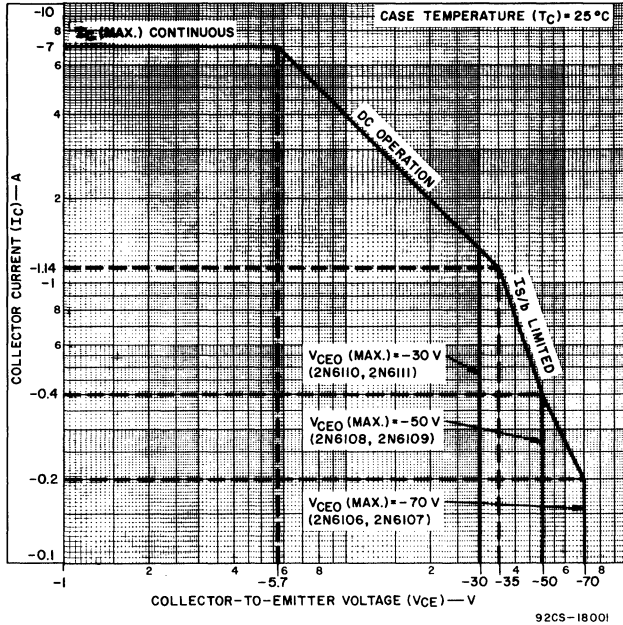


Fig. 9 - Maximum operating areas for 2N6106 - 2N6111 ($T_C = 25^\circ\text{C}$).

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

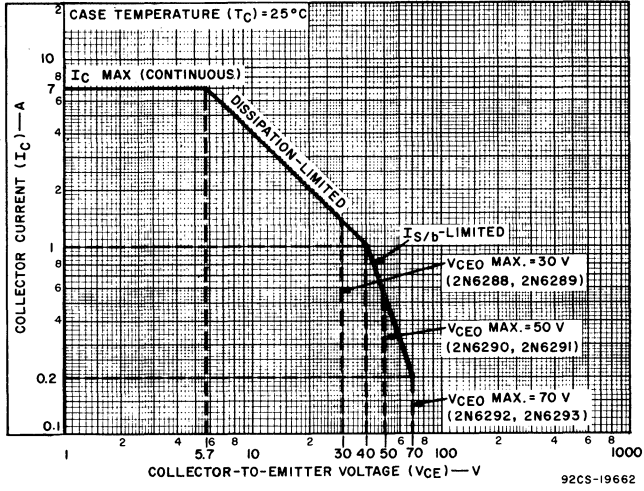


Fig. 10 - Maximum operating areas for 2N6288-2N6293 ($T_C = 25^\circ C$).

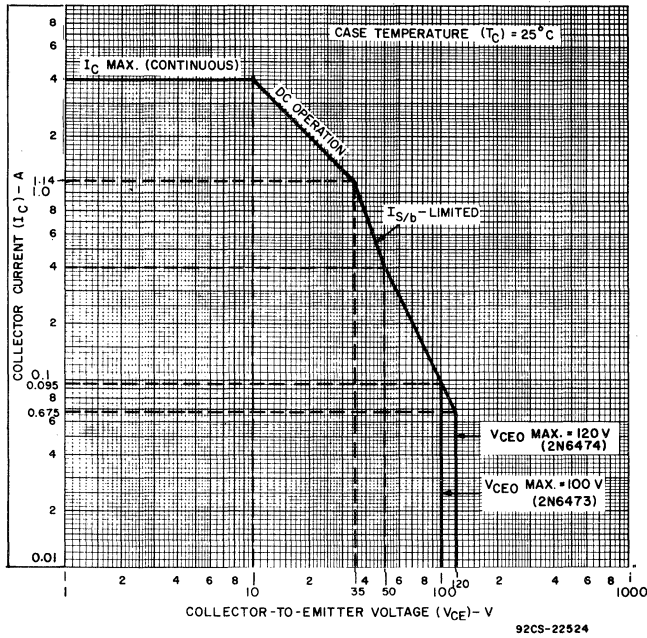


Fig. 11 - Maximum operating areas for 2N6473 and 2N6474 ($T_C = 25^\circ C$).

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

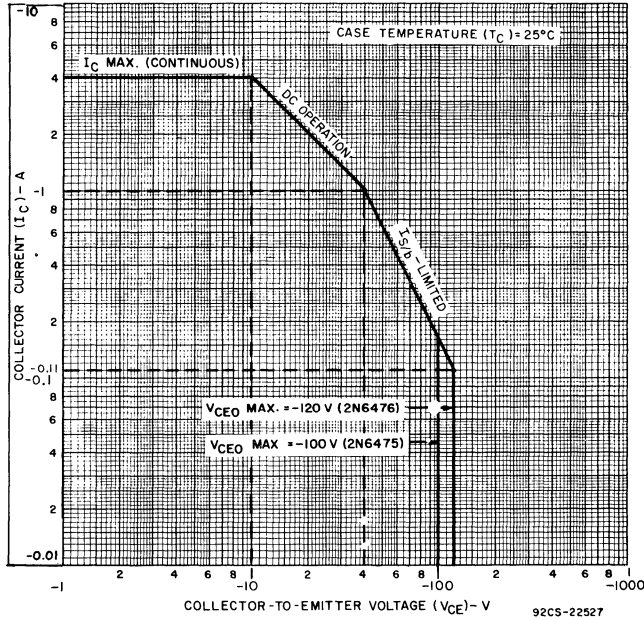


Fig. 12 - Maximum operating areas for 2N6475 - 2N6476 ($T_C = 25^\circ C$).

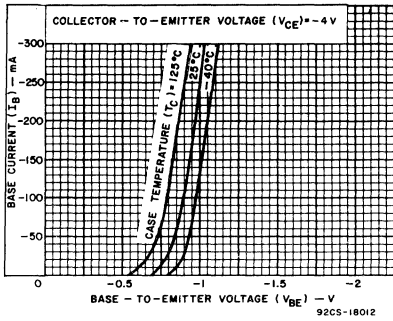


Fig. 13 - Typical input characteristics for 2N6106 - 2N6111, 2N6475, and 2N6476.

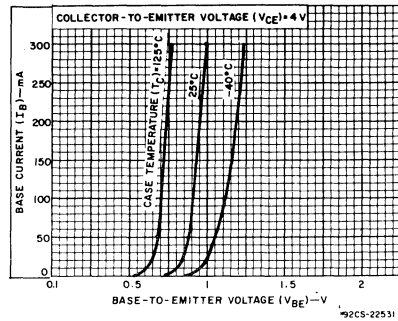


Fig. 14 - Typical input characteristics for 2N6288 - 2N6293.

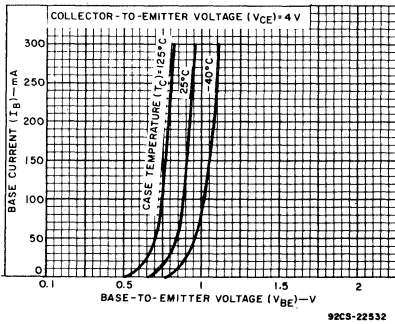


Fig. 15 - Typical input characteristics for 2N6473 and 2N6474.

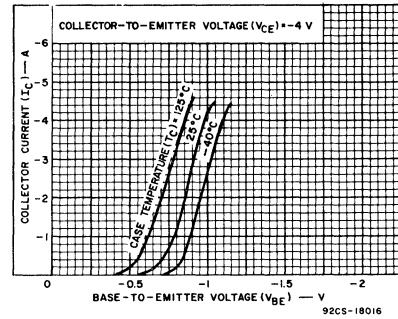


Fig. 16 - Typical transfer characteristics for 2N6106 - 2N6111.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

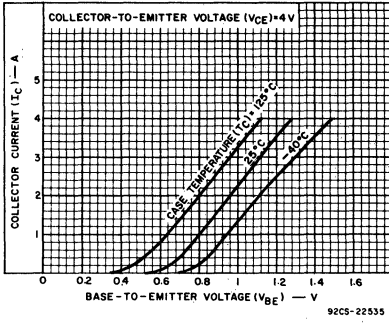


Fig. 17 - Typical transfer characteristics for 2N6288 - 2N6293.

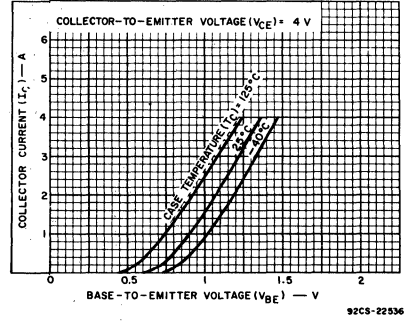


Fig. 18 - Typical transfer characteristics for 2N6473 and 2N6474.

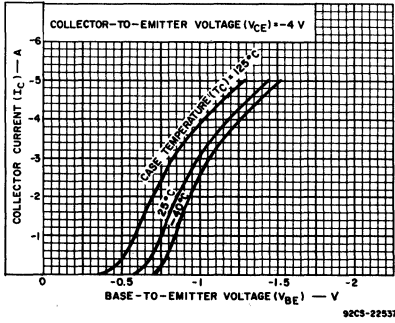


Fig. 19 - Typical transfer characteristics for 2N6475 and 2N6476.

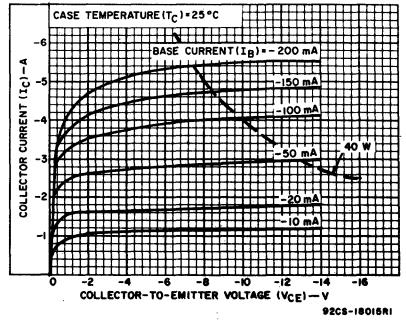


Fig. 20 - Typical output characteristics for 2N6106 - 2N6111.

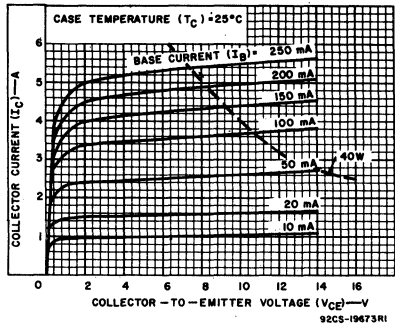


Fig. 21 - Typical output characteristics for 2N6288 - 2N6293.

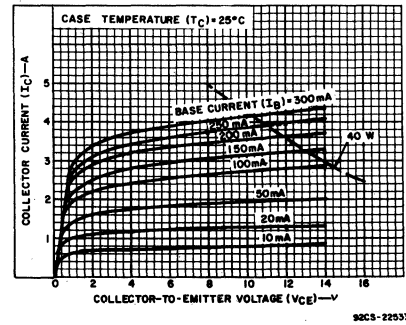


Fig. 22 - Typical output characteristics for 2N6473 and 2N6474.

2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

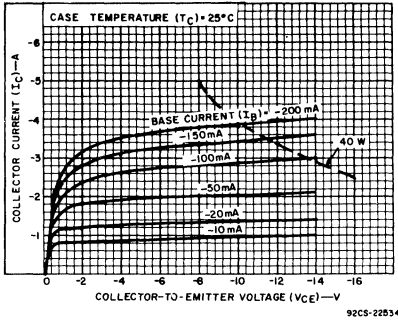


Fig. 23 - Typical output characteristics for 2N6475 and 2N6476.

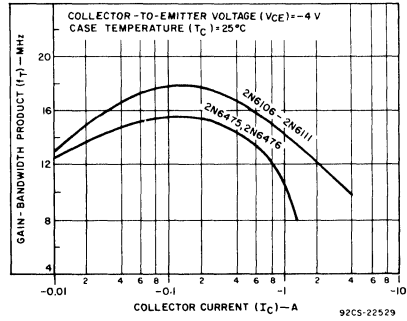


Fig. 24 - Typical gain-bandwidth product 2N6106 - 2N6111, 2N6475, and 2N6476.

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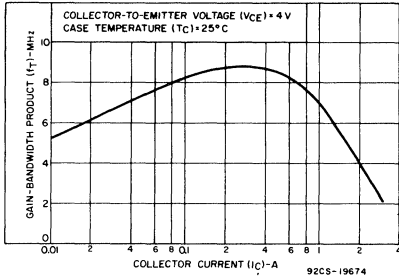


Fig. 25 - Typical gain-bandwidth product for 2N6288 - 2N6293.

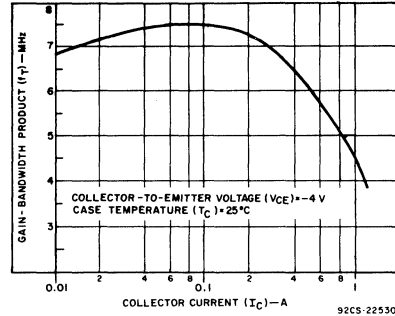


Fig. 26 - Typical gain-bandwidth product for 2N6473 and 2N6474.

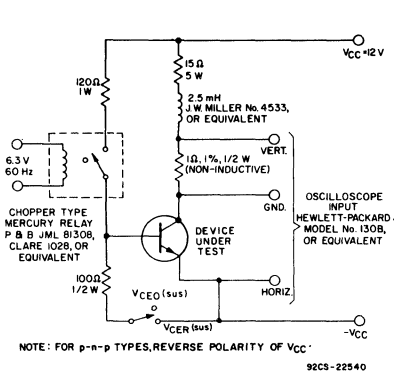
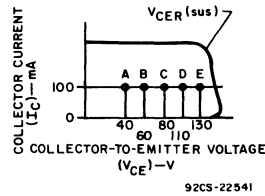


Fig. 27 - Circuit used to measure sustaining voltage $V_{CE}(sus)$ for all types.



Note: Curve will be inverted and polarity reversed for p-n-p types. The sustaining voltage, $V_{CE}(sus)$, is acceptable when the traces fall to the right and above the designated points:
 Point A: 2N6110, 2N6111, 2N6288, 2N6289
 Point B: 2N6108, 2N6109, 2N6290, 2N6291
 Point C: 2N6106, 2N6107, 2N6292, 2N6293
 Point D: 2N6475, 2N6473
 Point E: 2N6476, 2N6474

Fig. 28 - Oscilloscope delay for measurement of sustaining voltage (test circuit shown in Fig. 27).

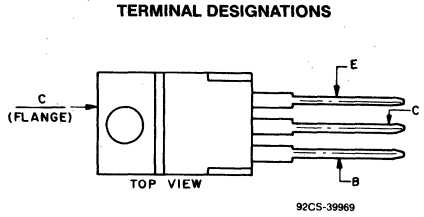
2N6121-2N6123, 2N6124-2N6126

**Epitaxial-Base, Silicon
N-P-N and P-N-P
VERSAWATT Transistors**

General-Purpose Medium-Power Types for Switching and Amplifier Applications

Features:

- Low saturation voltages
- Complementary n-p-n and p-n-p types
- Maximum safe-area-of-operation curves specified for dc operation



The 2N6121, 2N6122, and 2N6123 are epitaxial-base n-p-n transistors. The 2N6124, 2N6125, and 2N6126 are epitaxial-base p-n-p transistors. They are complements to 2N6121, 2N6122, and 2N6123, respectively.

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.

All these 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.

MAXIMUM RATINGS, Absolute-Maximum Values:

	N-P-N 2N6121	2N6122 2N6125	2N6123 2N6126	
*V _{CBO}			80	V
*V _{CEO(SUS)}	45	60	80	V
*V _{EBO}	45	60	80	V
*I _C	5	4		A
*I _B	1	1		A
P _T				
*T _C ≥ 25°C		40		W
T _C > 25°C ≤ 100°C		16		W
T _C > 25°C		Derate linearly 0.32		W/°C
T _A ≤ 25°C		1.8		W
T _A > 25°C		Derate linearly 0.0144		W/°C
*T _{stg} , T _J		-65 to 150		°C
T _L		235		°C

At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.

*In accordance with JEDEC registration data.

For p-n-p devices, voltage and current values are negative.

2N6121-2N6123, 2N6124-2N6126

ELECTRICAL CHARACTERISTICS At Case Temperature (T_C) = 25°C

Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS [†]				LIMITS					UNITS	
	VOLTAGE V dc		CURRENT A dc		2N6121 2N6124 [‡]		2N6122 2N6125 [‡]		2N6123 2N6126 [‡]		
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.		MAX.
I _{CBO}	45 ^a 60 ^a 80 ^a				-	0.1	-	-	-	-	mA
* I _{CEX}	45 60 80	-1.5 -1.5 -1.5			-	0.1	-	-	-	-	
T _C = 125°C	45 60 80	-1.5 -1.5 -1.5			-	2	-	-	-	2	
* I _{CEO}	45 60 80			0 0 0	-	1	-	-	-	-	V
* I _{EBO}		-5	0		-	1	-	1	-	1	
* V _{CEO (sus)} ^b			0.1 ^c	0	45	-	60	-	80	-	V
* h _{FE}	2 2		1.5 ^c 4 ^c		25 10	100	25 10	100	20 7	80	V
* V _{BE}	2		1.5 ^c		-	1.2	-	1.2	-	1.2	
V _{CE(sat)}			1.5 ^c 4 ^c	0.15 1	- -	0.6 1.4	- -	0.6 1.4	- -	0.6 1.4	
* |h _{fe}| (f=1 MHz)	4		1		2.5	-	2.5	-	2.5	-	°C/W
* h _{fe} (f=1 kHz)	2		0.1		25	-	25	-	25	-	
R _{θJC}					-	3.125	-	3.125	-	3.125	

* In accordance with JEDEC registration data.

b CAUTION: The sustaining voltage V_{CEO(sus)} **MUST NOT** be measured on a curve tracer.

^a V_{CB} value.

^c Pulsed: Pulse duration = 300 μs, duty factor = 0.018.

[‡] For p-n-p devices, voltage and current values are negative.

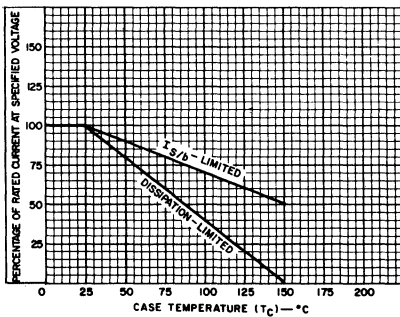


Fig. 1 - Current derating curves for all types.

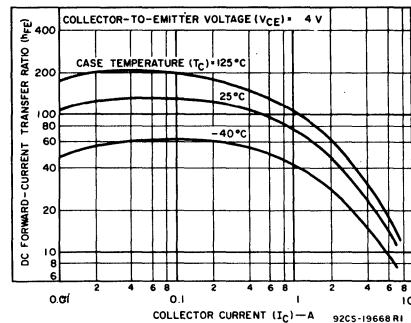


Fig. 2 - Typical dc beta characteristics for all types.

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2N6121-2N6123, 2N6124-2N6126

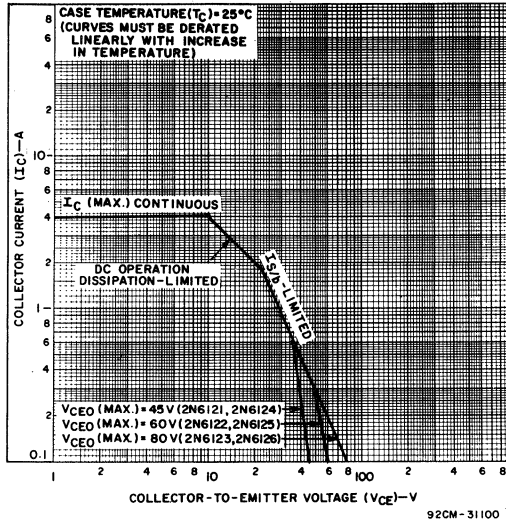


Fig. 3 - Maximum operating areas for all types.

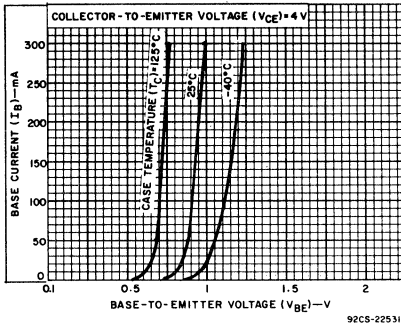


Fig. 4 - Typical input characteristics for all types.

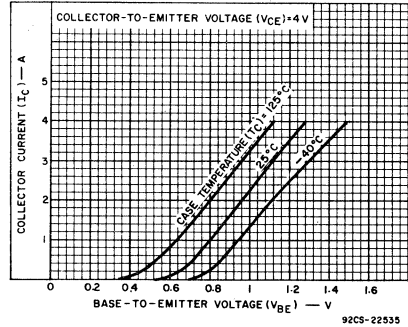


Fig. 5 - Typical transfer characteristics for all types.

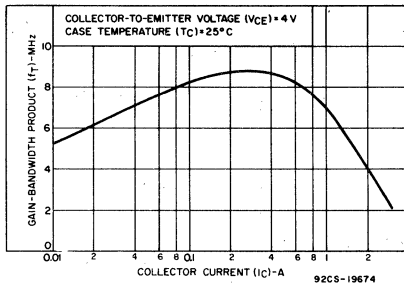


Fig. 6 - Typical gain-bandwidth product.

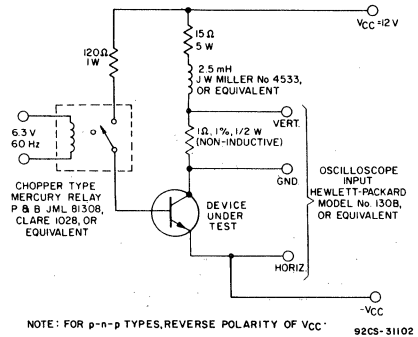


Fig. 7 - Circuit used to measure sustaining voltage $V_{ceO}(sus)$ for all types.

High-Voltage Medium-Power Silicon P-N-P Transistors

For Switching and Amplifier Applications in Military, Industrial, and Commercial Equipment

Features:

- High voltage ratings:
 - $V_{CEO(SUS)} = -400\text{ V max. (2N6214)}$
 - $= -350\text{ V max. (2N6213)}$
 - $= -300\text{ V max. (2N6212)}$
 - $= -225\text{ V max. (2N6211)}$

Applications:

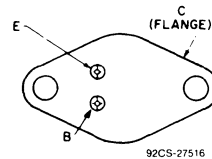
- Power-Switching circuits
- Switching regulators
- Converters
- Inverters
- High-Fidelity amplifiers



The types 2N6211, 2N6212, 2N6213, and 2N6214* are epitaxial silicon p-n-p transistors with high breakdown voltage ratings and fast switching speeds. They are supplied in the popular JEDEC TO-213AA package; they differ in breakdown-voltage ratings and leakage current values.

*Formerly RCA Dev. Nos. TA7719, TA7410, TA8330, and TA8331, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6211	2N6212	2N6213	2N6214	
* COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-275	-350	-400	-450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open, $V_{CEO(SUS)}$	-225	-300	-350	-400	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω , $V_{CER(SUS)}$	-250	-325	-375	-425	V
* With base-emitter junction reverse-biased ($V_{BE} = 1.5\text{ V}$), $V_{CEX(SUS)}$	-275	-350	-400	-450	V
* EMITTER-TO-BASE VOLTAGE, V_{EBO}	-6	-6	-6	-6	V
* COLLECTOR CURRENT (Continuous), I_C	-2	-2	-2	-2	A
* BASE CURRENT (Continuous), I_B	-1	-1	-1	-1	A
TRANSISTOR DISSIPATION, P_T :					
* At case temperatures up to 100°C and V_{CE} up to 50 V	20	20	20	20	W
At case temperatures up to 25°C and V_{CE} up to 40 V	35	35	35	35	W
At case temperatures up to 25°C and V_{CE} above 40 V	See Fig. 1				
At case temperatures above 25°C and V_{CE} above 40 V	See Figs. 1 & 3.				
* TEMPERATURE RANGE:					
Storage & Operating (Junction)	-65 to +200				°C
* LEAD TEMPERATURE (During Soldering):					
At distance $\geq 1/32$ in. (0.8 mm) from case for 10 s max.	230				°C

2N6211, 2N6212, 2N6213, 2N6214

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS								UNITS
		Voltage V dc		Current A dc				2N6211		2N6212		2N6213		2N6214		
		V_{CE}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Collector-Cutoff Current: With base open	I_{CEO}	-150				0	-	-5	-	-5	-	-5	-	-5	mA	
With base-emitter junction reverse-biased	I_{CEV}	-250	1.5				-	-0.5	-	-0.5	-	-	-	-		
		-315	1.5				-	-	-	-	-	-	-	-		
		-360	1.5				-	-	-	-	-	-	-	-		
With base-emitter junction reverse biased and $T_C = 100^\circ\text{C}$	I_{CEV}	-410	1.5				-	-	-	-	-	-	-	-1		
		-250	1.5				-	-5	-	-	-	-	-	-		
		-315	1.5				-	-	-	-5	-	-	-	-		
	I_{EBO}	-360	1.5				-	-	-	-	-5	-	-	-10		
	-410	1.5					-	-	-	-	-	-	-	-		
Emitter-Cutoff Current	I_{EBO}		6	0			-	-1	-	-0.5	-	-0.5	-	-0.5	mA	
DC Forward-Current Transfer Ratio	h_{FE}	-2.8		-1 ^a			10	100	-	-	-	-	-	-		
	h_{FE}	-3.2		-1 ^a			-	-	10	100	-	-	-	-		
		-4		-1 ^a			-	-	-	-	10	100	-	-		
		-5		-1 ^a			-	-	-	-	-	-	10	100		
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}$			-0.2 ^a		0	-225	-	-300	-	-350	-	-400	-	V	
With external base-to-emitter resistance ($R_{BE} = 50 \Omega$)	$V_{CER(sus)}$			-0.2			-250	-	-325	-	-375	-	-425	-		
With base-emitter junction reverse biased and external base-to-emitter resistance ($R_{BE} = 50 \Omega$)	$V_{CEX(sus)}$		1.5	-0.2			-275	-	-350	-	-400	-	-450	-		
Emitter-to-Base Voltage	V_{EBO}					0.5 mA 1 mA	-6	-	-6	-	-6	-	-6	-	V	
Emitter-to-Base Saturation Voltage	$V_{BE(sat)}$			-1 ^a		-0.125	1.4	-	-1.4	-	-1.4	-	-1.4	-	V	
Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			-1 ^a		-0.125	1.4	-	-1.6	-	-2	-	-2.5	-	V	
Output Capacitance ($f = 1 \text{ MHz}$)	C_{obo}	-10 (V_{CB})				0	-	220	-	220	-	220	-	220	pF	
Second-Breakdown Collector Current (Base forward-biased)	$I_{S/b}$	-40					-0.875	-	-0.875	-	-0.875	-	-0.875	-	A	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ($f = 5 \text{ MHz}$)	$|h_{fe}|$	-10		-0.2			4	-	4	-	4	-	4	-		
Saturated Switching Times:																
Rise time	t_r	$V_{CC} = -200 \text{ V}$		-1		$I_{B1} \& I_{B2} -0.125$	-	0.6	-	0.6	-	0.6	-	0.6	μs	
Storage time	t_s	$V_{CC} = -200 \text{ V}$		-1		$I_{B1} \& I_{B2} -0.125$	-	2.5	-	2.5	-	2.5	-	2.5		
Fall time	t_f	$V_{CC} = -200 \text{ V}$		-1		$I_{B1} \& I_{B2} -0.125$	-	0.6	-	0.6	-	0.6	-	0.6		
Thermal Resistance (Junction-to-case)	$R_{\theta JC}$	-10		-1			5	-	5	-	5	-	5	-	$^\circ\text{C/W}$	

^aIn accordance with JEDEC registration data format JS-6 RDF-1.

^aPulsed: Pulse duration = 300 μs ; duty factor $\leq 2\%$.

2N6211, 2N6212, 2N6213, 2N6214

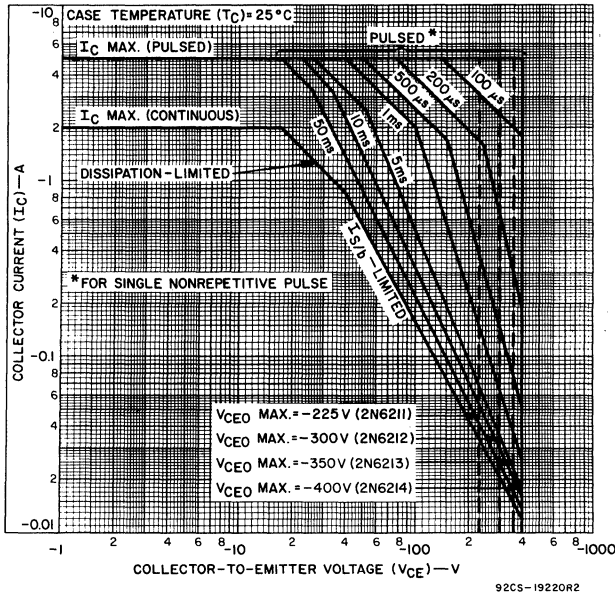


Fig. 1 - Maximum operating areas for all types.

2

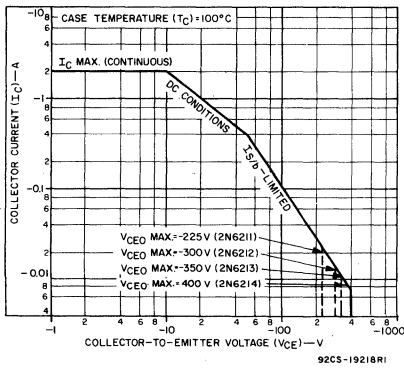


Fig. 2 - Maximum operating areas for all types.

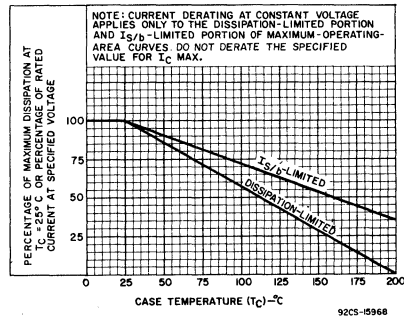


Fig. 3 - Derating curves for all types.

2N6211, 2N6212, 2N6213, 2N6214

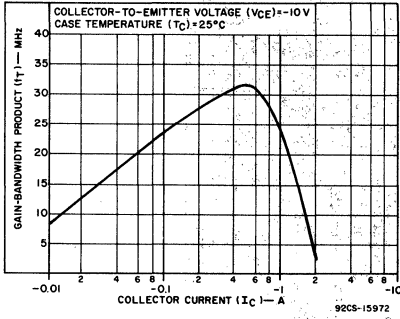


Fig. 4 - Typical gain-bandwidth product for all types.

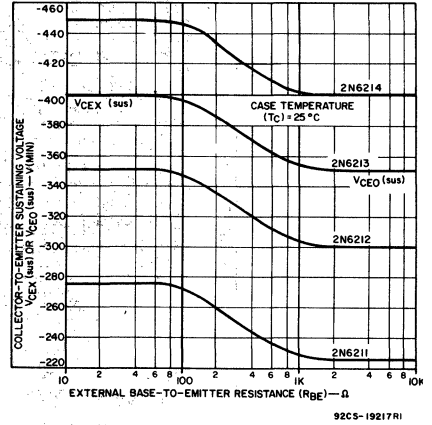


Fig. 5 - Collector-to-emitter sustaining-voltage characteristics for all types.

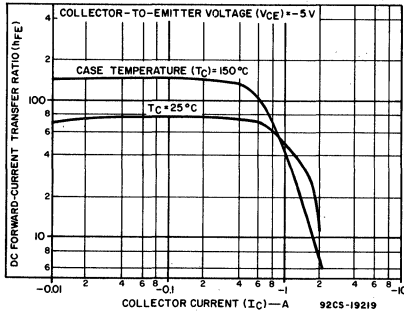


Fig. 6 - Typical dc beta characteristic for all types.

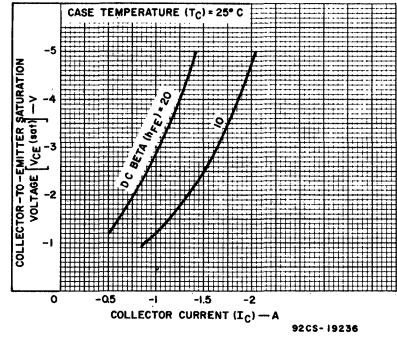


Fig. 7 - Typical saturation-voltage characteristics for all types.

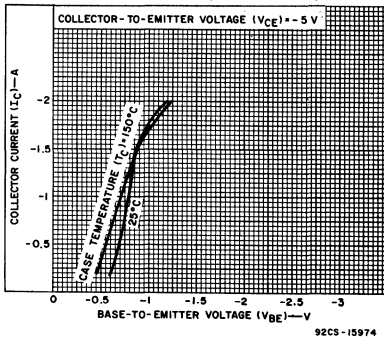


Fig. 8 - Typical transfer characteristics for all types.

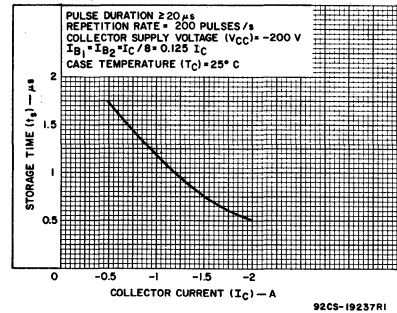


Fig. 9 - Typical storage-time characteristics for all types.

2N6211, 2N6212, 2N6213, 2N6214

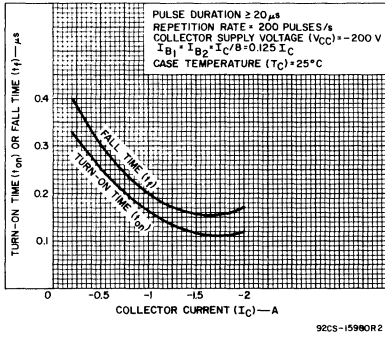


Fig. 10 - Typical turn-on time and fall-time characteristics for all types.

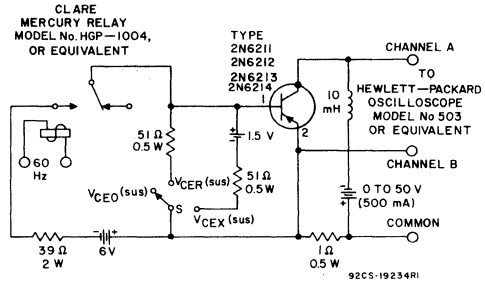


Fig. 11 - Circuit used to measure sustaining voltages $V_{CE0(sus)}$, $V_{CEr(sus)}$ and $V_{CEX(sus)}$ for all types.

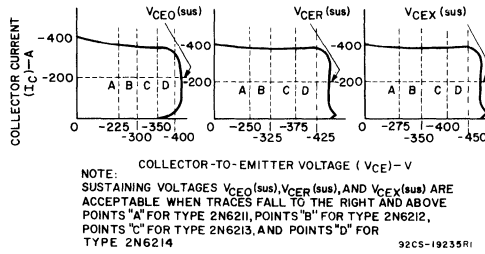


Fig. 12 - Oscilloscope display for measurement of sustaining voltages.

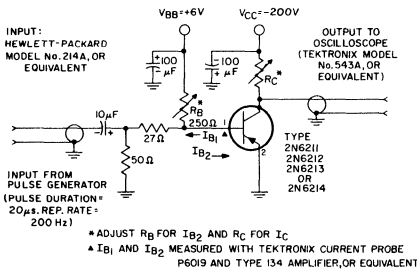


Fig. 13 - Circuit used to measure saturated switching times for all types.

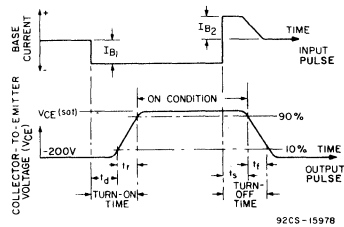


Fig. 14 - Phase relationship between input current and output voltage showing reference points for specification of switching times.

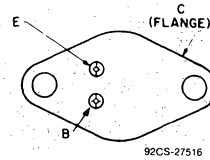
Silicon P-N-P Epitaxial-Base, High-Power Transistors

General-Purpose Types of Switching and Linear-Amplifier Applications

Features:

- High dissipation capability: 125 W at 25°C
- Low saturation voltages
- Maximum safe-area-of-operation curves
- High gain at high current

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6246, 2N6247, 2N6248, and 2N6469 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. All of these devices have a dissipation capability of 125 watts at case temperatures up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the JEDEC TO-204AA package.

▲ Formerly RCA Dev. Nos. TA7281, TA7280, TA7279, and TA8724, respectively.

Maximum Ratings, Absolute-Maximum Values:

	2N6469	2N6246	2N6247	2N6248	
*COLLECTOR-TO-BASE VOLTAGE	-50	-70	-90	-110	V
COLLECTOR-TO-EMITTER VOLTAGE:					
* With external base-to-emitter					
resistance (R _{BE}) = 100 Ω	-50	-70	-90	-110	V
With base open	-40	-60	-80	-100	V
*EMITTER-TO-BASE VOLTAGE	-5	-5	-5	-5	V
*CONTINUOUS COLLECTOR CURRENT	-15	-15	-15	-10	A
*CONTINUOUS BASE CURRENT	-5	-5	-5	-5	A
*TRANSISTOR DISSIPATION:					P _T
At case temperatures up to 25°C	125	125	125	125	W
At case temperatures above 25°C	← See Fig. 2 →				
*TEMPERATURE RANGE:					°C
Storage & Operating (Junction)	← -65 to +200 →				
*PIN TEMPERATURE (During Soldering):					°C
At distances ≥ 1/32" (0.8 mm) from					
seating plane for 10 s max.	← +235 →				

* In accordance with JEDEC registration data format (JS-6 RDF-2).

2N6246, 2N6247, 2N6248, 2N6469

ELECTRICAL CHARACTERISTICS FOR P-N-P TYPES, At case temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6469		2N6246		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	-35 -55				- -	-200 -	- -	- -200	μA
* With base-emitter junction reverse-biased	I_{CEX}	-45 -65	1.5 1.5			- -	-200 -	- -	- -200	μA
* With reverse bias and $T_C = 150^\circ C$		-45 -55	1.5 1.5			- -	-5 -	- -	- -5	mA
* With base open	I_{CEO}	-20 -30			0 0	- -	-1 -	- -	- -1	mA
* Emitter-Cutoff Current	I_{EBO}		5		0	-	-5	-	-5	mA
* DC Forward-Current Transfer Ratio	h_{FE}	-4 -4 -4		-5 ^a -7 ^a -15 ^a		20 - 5	150 - -	- 20 5	- 100 -	
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}$			-0.2	0	-40 ^b	-	-60 ^b	-	V
With external base-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$			-0.2		-45 ^b	-	-65 ^b	-	V
* Base-to-Emitter Voltage	V_{BE}	-4 -4		-15 ^a -7 ^a		- -	-3.5 -	- -	- -2	V
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			-5 ^a -7 ^a -15 ^a -15 ^a	-0.5 -0.7 -5 -3	- - - -	-1.3 - -3.5 -	- - - -	- -1.3 - -2.5	V
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 2 MHz	$|h_{fe}|$	-4		-1		5	-	5	-	
* Common-Emitter, Small-Signal Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}	-4		-1		25	-	25	-	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					-	1.4	-	1.4	$^\circ C/W$

* In accordance with JEDEC registration data format (JS-6 RDF-2).

^a Pulsed; pulse duration = 300 μs , duty factor = 1.8%.^b CAUTION: CAUTION: Sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$
MUST NOT be measured on a curve tracer.

2N6246, 2N6247, 2N6248, 2N6469

ELECTRICAL CHARACTERISTICS FOR P-N-P TYPES, At case temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6247		2N6248		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	-75 -95				-	-200	-	-	μA
* With base-emitter junction reverse-biased	I_{CEX}	-85 -100	1.5 1.5			-	-200	-	-	μA
* With reverse bias, at $T_C = 150^\circ C$		-70 -90	1.5 1.5			-	-5	-	-	mA
* With base open	I_{CEO}	-40 -50			0 0	-	-1	-	-	mA
* Emitter-Cutoff Current	I_{EBO}		5		0	-	-1	-	-1	mA
* DC Forward-Current Transfer Ratio	h_{FE}	-4 -4 -4 -4		-5 ^a -6 ^a -10 ^a -15 ^a		20 -	100 -	20 5	100 -	
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO(sus)}$			-0.2	0	-80 ^b	-	-100 ^b	-	V
With external base-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$			-0.2		-85 ^b	-	-105 ^b	-	
* Base-to-Emitter Voltage	V_{BE}	-4 -4		-6 ^a -5 ^a		-	-1.8	-	-	V
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			-5 ^a -6 ^a -15 ^a -10 ^a	-0.5 -0.6 -4 -2	-	-	-	-1.3	V
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 2 MHz	$|h_{fe}|$	-4		-1		5	-	5	-	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h_{fe}	-4		-1		25	-	25	-	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					-	1.4	-	1.4	$^\circ C/W$

* In accordance with JEDEC registration data format (JS-6 RDF-2).

^a Pulsed; pulse duration = 300 μs , duty factor = 1.8%.^b CAUTION: Sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$
MUST NOT be measured on a curve tracer.

2N6246, 2N6247, 2N6248, 2N6469

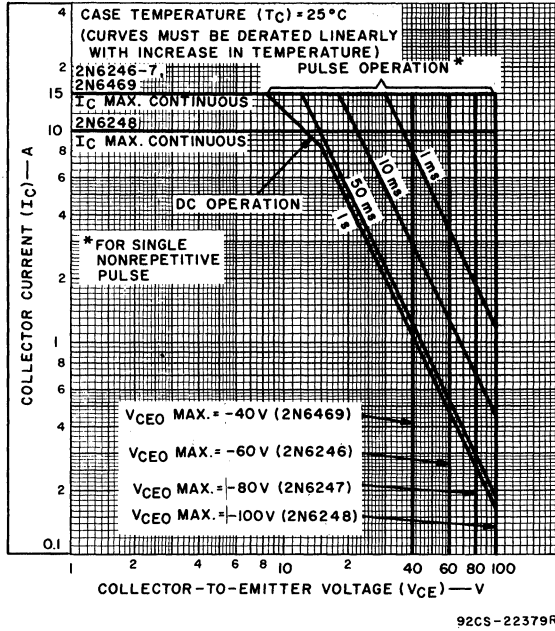


Fig. 1 — Maximum operating areas for all types.

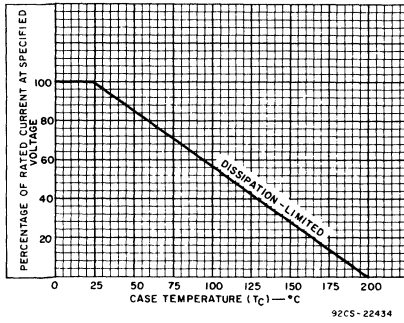


Fig. 2 — Current derating for all types.

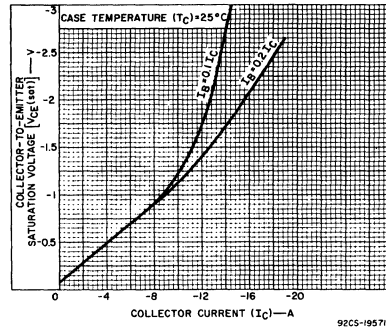
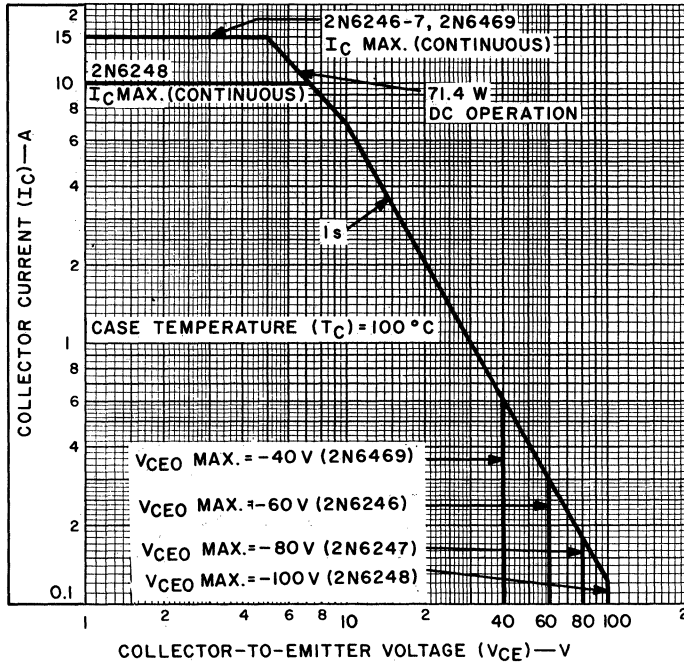


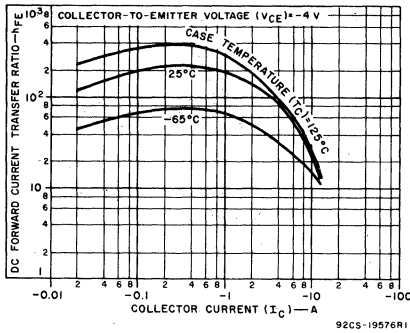
Fig. 3 — Typical collector-to-emitter saturation-voltage characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

2N6246, 2N6247, 2N6248, 2N6469



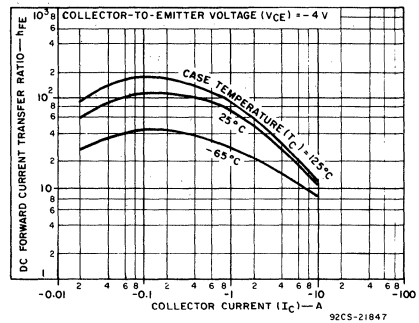
92CS-22380R1

Fig. 4 — Maximum operating areas for all types.



92CS-19576R1

Fig. 5 — Typical dc beta characteristics for 2N6246, 2N6247, and 2N6469.



92CS-21847

Fig. 6 — Typical dc beta characteristics for 2N6248.

2N6246, 2N6247, 2N6248, 2N6469

2

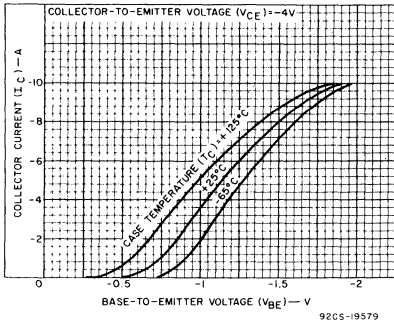


Fig. 7 — Typical transfer characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

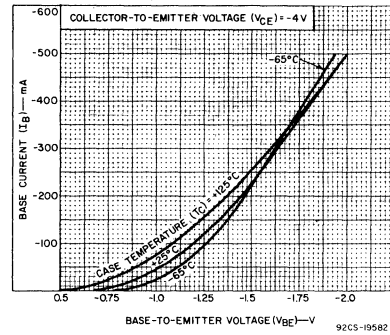


Fig. 8 — Typical input characteristics for 2N6246, 2N6247, and 2N6469.

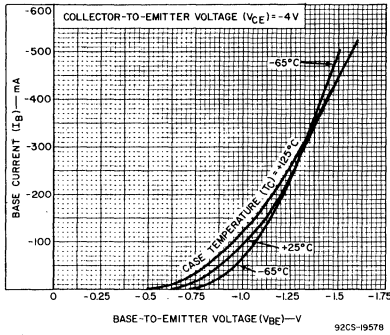


Fig. 9 — Typical input characteristics for 2N6248.

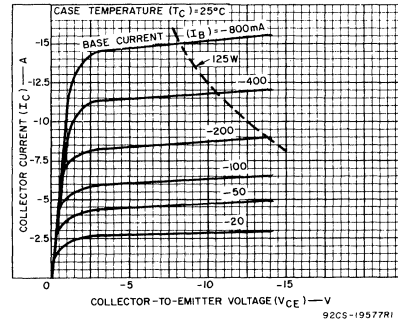


Fig. 10 — Typical output characteristics for 2N6246, 2N6247, and 2N6469.

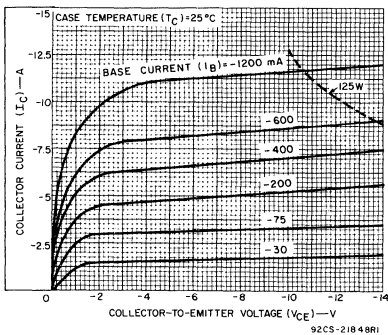


Fig. 11 — Typical output characteristics for 2N6248.

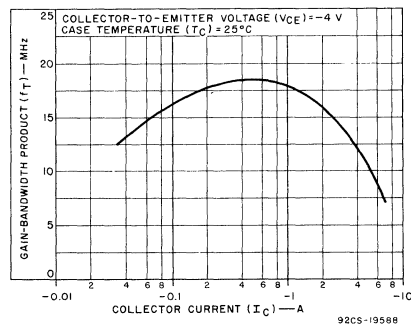


Fig. 12 — Typical gain-bandwidth product vs. collector current for 2N6246, 2N6247, 2N6248, and 2N6469.

2N6246, 2N6247, 2N6248, 2N6469

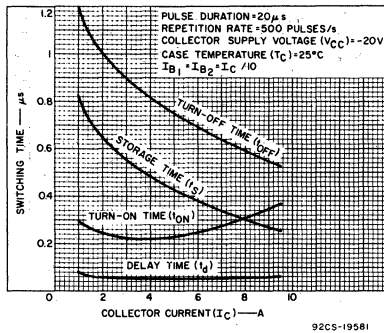


Fig. 13 — Typical saturated switching characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

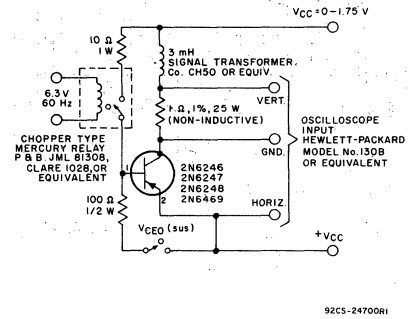


Fig. 14 — Circuit used to measure sustaining voltages $V_{CE0}(sus)$ and $V_{CEr}(sus)$ for all types.

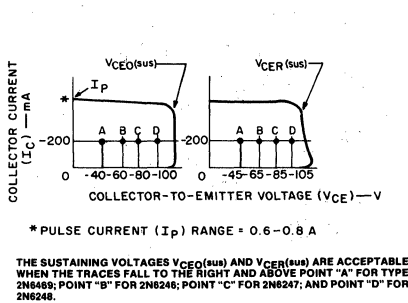


Fig. 15 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 14).

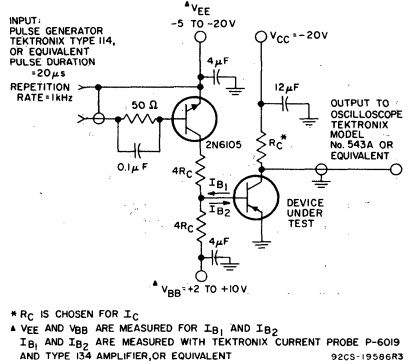


Fig. 16 — Circuit used to measure switching times for 2N6246, 2N6247, 2N6248, and 2N6469.

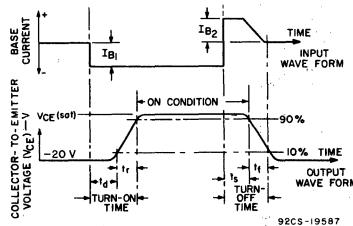


Fig. 17 — Oscilloscope display for measurement of switching times.

450-V, 30-A, 175-W Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

Features:

- *High voltage ratings:*
 $V_{CBO} = 450\text{ V (2N6251)}$
 375 V (2N6250)
 300 V (2N6249)
- *High dissipation rating:*
 $P_T = 175\text{ W}$
- *Low saturation voltages*
- *Maximum safe-area-of-operation curves*

The 2N6249, 2N6250 and 2N6251 are multiple epitaxial silicon n-p-n power transistors. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds.

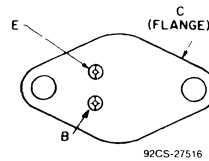
These devices use the popular JEDEC TO-204AA package; they differ mainly in voltage ratings, leakage-current limits, and $V_{CE(sat)}$ ratings.

The exceptional second-breakdown capabilities and high voltage-breakdown ratings make these transistors especially suitable for offline inverters, switching regulators motor controls, and deflection circuit applications.

The high gain and high $E_{s,b}$ energy-handling capability of the 2N6249 make it an excellent choice for motor-control applications in which large winding inductances are encountered and high surge currents are required to start the motor.

The high breakdown voltages, low saturation voltages, and fast-switching capability of the 2N6250 and 2N6251 make them especially suitable for inverter circuits operating directly off the rectified 115-V power line or a bridge configuration operating from the rectified 220-V line.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6249	2N6250	2N6251	
* V_{CBO}	300	375	450	V
$V_{CEO}(SUS)$	200	275	350	V
* $V_{CEX}(SUS) (V_{BE} = 0\text{ V})$	225	300	375	V
$V_{CER}(SUS) (R_{BE} \leq 50\ \Omega)$	225	300	375	V
* V_{EBO}	6	6	6	V
* I_C	10	10	10	A
I_{CM}	30	30	30	A
* I_B	10	10	10	A
* P_T				
At T_C up to 25°C and V_{CE} up to 30 V	175	175	175	W
At T_C up to 25°C and V_{CE} above 30 V	Derate Linearly at 1 _____			$^\circ\text{C/W}$
* T_J, T_{stg}	-65 to +200			$^\circ\text{C}$
* T_L				
At distances $\geq 1/32$ in. (0.8 mm) from case for 10 s max.	230			$^\circ\text{C}$

* 2N-Series types in accordance with JEDEC registration data format (JS-6, RDF-1).

2N6249, 2N6250, 2N6251

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS			LIMITS									UNITS	
	DC VOLTAGE (V)	DC CURRENT (A)	2N6249			2N6250			2N6251					
			I_C	I_B	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.		MAX.
I_{CEO}	150 225 300		0 0 0	- - -	- - -	5 - -	- - -	- - -	5 - -	- - -	- - -	5	mA	
* I_{CEV} $V_{BE} = -1.5$	225 300 375			- - -	- - -	5 - -	- - -	- - -	5 - -	- - -	- - -	5		
* I_{CEV} $V_{BE} = -1.5$ $T_C = 125^\circ C$	225 300 375			- - -	- - -	10 - -	- - -	- - -	10 - -	- - -	- - -	10		
* I_{EBO} $V_{BE} = -6$				- - -	- - -	1 - -	- - -	- - -	1 - -	- - -	- - -	1	mA	
* $V_{CEO(sus)}$		0.2		200 ^b	-	-	275 ^b	-	-	350 ^b	-	-	V	
$V_{CER(sus)}$ $R_{BE} = 50 \Omega$		0.2		225 ^b	-	-	300 ^b	-	-	375 ^b	-	-	V	
* V_{EBO} $I_E = 1 \text{ mA}$				6	-	-	6	-	-	6	-	-	V	
* h_{FE}	3	10 ^a		10	-	50	-	-	-	-	-	-		
	3	10 ^a		-	-	-	8	-	50	-	-	-		
	3	10 ^a		-	-	-	-	-	-	6	-	50		
* $V_{BE(sat)}$		10 ^a 10 ^a 10 ^a	1 1.25 1.67	- - -	- - -	2.25 - -	- - -	- - -	2.25 - -	- - -	- - -	2.25	V	
* $V_{CE(sat)}$		10 ^a 10 ^a 10 ^a	1 1.25 1.67	- - -	- - -	1.5 - -	- - -	- - -	1.5 - -	- - -	- - -	1.5	V	
* $|h_{fe}|$ $f = 1 \text{ MHz}$	10	1		2.5	8	-	2.5	8	-	2.5	8	-		
* I_S/b $t_p = 1 \text{ s nonrep.}$	30			5.8	-	-	5.8	-	-	5.8	-	-	A	
* E_S/b $V_{BE} = -4$ $R_B = 50 \Omega$ $L = 50 \mu H$		10 ^c		2.5	-	-	2.5	-	-	2.5	-	-	mJ	
* t_r $V_{CC} = 200 \text{ V}$ $I_{B1} = -I_{B2}$	10	1		-	0.8	2	-	-	-	-	-	-	μs	
	10	1.25		-	-	-	-	0.8	2	-	-	-		
	10	1.67		-	-	-	-	-	-	0.8	2	-		
* t_s $V_{CC} = 200 \text{ V}$ $I_{B1} = -I_{B2}$	10	1		-	1.8	3.5	-	-	-	-	-	-	μs	
	10	1.25		-	-	-	-	1.8	3.5	-	-	-		
	10	1.67		-	-	-	-	-	-	1.8	3.5	-		
* t_f $V_{CC} = 200 \text{ V}$ $I_{B1} = -I_{B2}$	10	1		-	0.5	1	-	-	-	-	-	-	μs	
	10	1.25		-	-	-	-	0.5	1	-	-	-		
	10	1.67		-	-	-	-	-	-	0.5	1	-		
$R_{\theta JC}$	10	5		-	-	1	-	-	1	-	-	1	°C/W	

* 2N-Series types in accordance with JEDEC registration data format (JS-6 RDF-1).

^a Pulsed; pulse duration $\leq 300 \mu s$, duty factor = 2%.

^b CAUTION: The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ MUST NOT be measured on a curve tracer.

2N6249, 2N6250, 2N6251

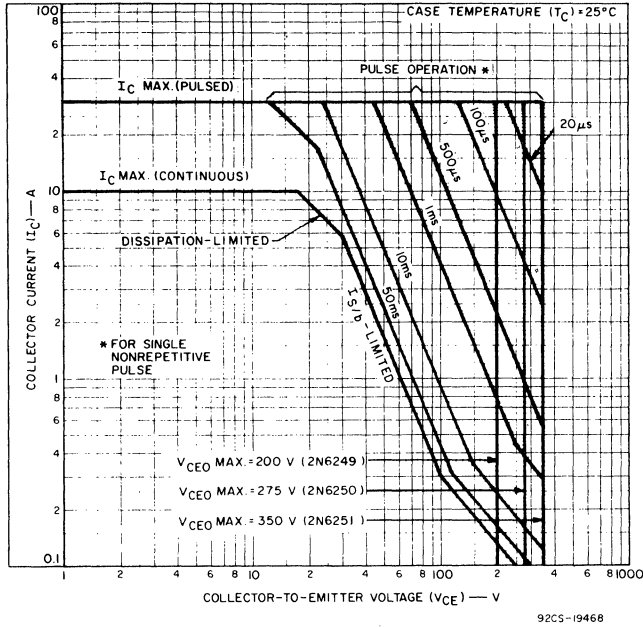


Fig. 1 - Maximum operating areas for all types at $T_c = 25^\circ C$.

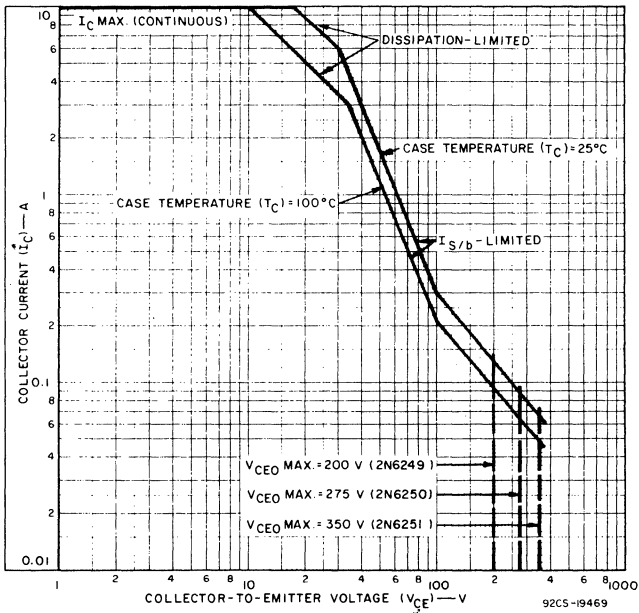


Fig. 2 - Maximum operating areas for all types at $T_c = 100^\circ C$.

2N6249, 2N6250, 2N6251

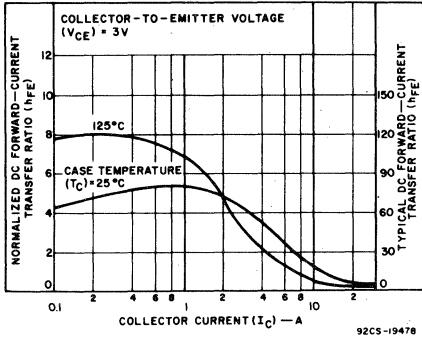


Fig. 3 - Typical normalized dc beta characteristics for all types.

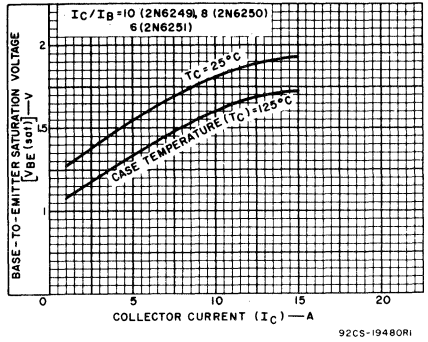


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for all types.

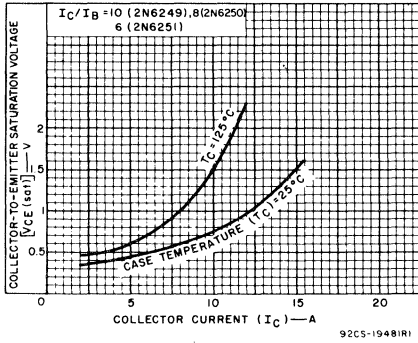


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

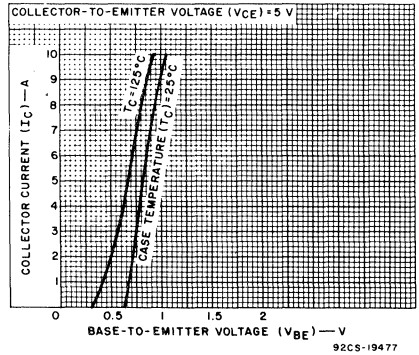


Fig. 6 - Typical transfer characteristics for all types.

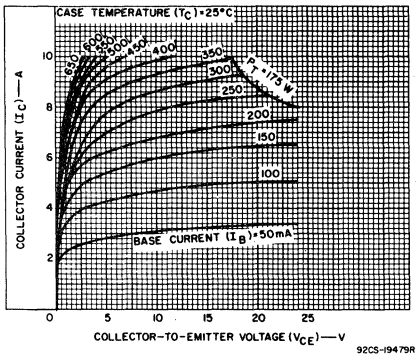


Fig. 7 - Typical output characteristics for all types.

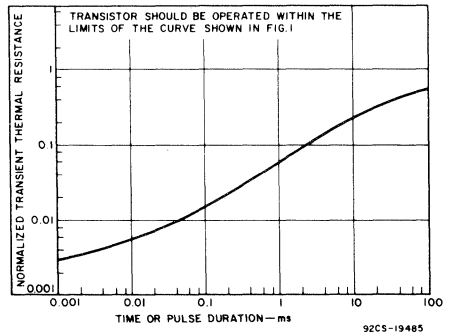


Fig. 8 - Typical thermal response characteristics for all types.

2N6249, 2N6250, 2N6251

2

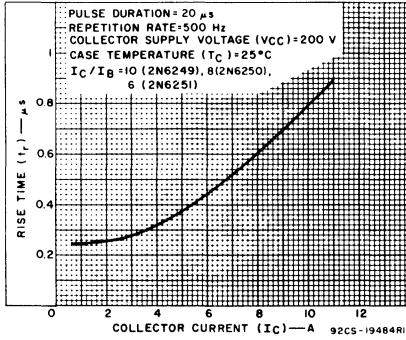


Fig. 9 - Typical rise-time characteristics for all types.

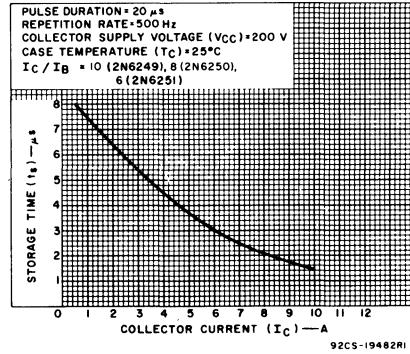


Fig. 10 - Typical storage-time characteristics for all types (with constant forced gain).

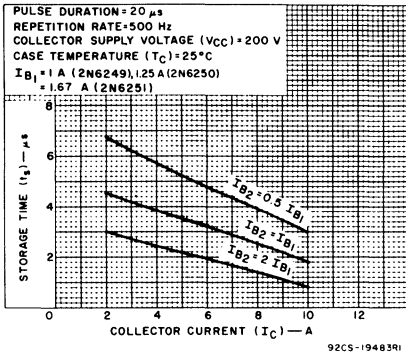


Fig. 11 - Typical storage-time characteristics for all types (with constant base drive).

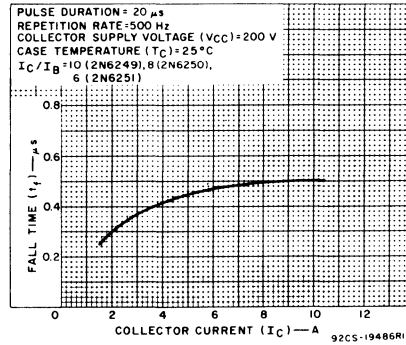


Fig. 12 - Typical fall-time characteristic for all types.

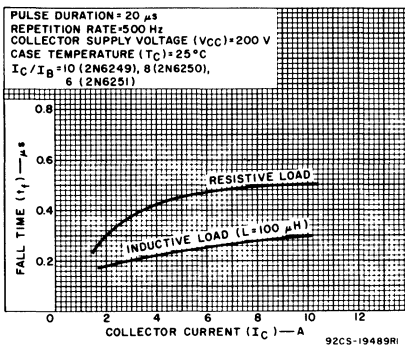


Fig. 13 - Typical inductive- and resistive-load fall-time characteristics for all types.

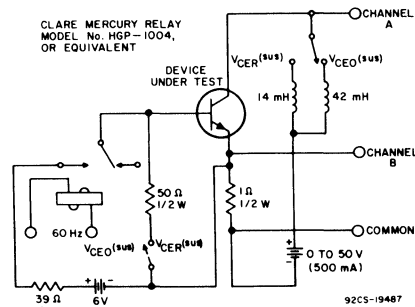
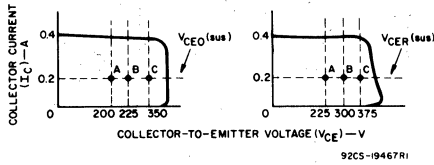


Fig. 14 - Circuit used to measure sustaining voltage $V_{CE0}(sus)$ and $V_{CEr}(sus)$ for all types.

2N6249, 2N6250, 2N6251



The sustaining voltages $V_{CE0(sus)}$ and $V_{CER(sus)}$ are acceptable when the traces fall to the right of point "A" for type 2N6249, point "B" for type 2N6250, and point "C" for type 2N6251 ($I_C = 0.2$ A).

Fig. 15 - Oscilloscope display for measurement of sustaining voltages.

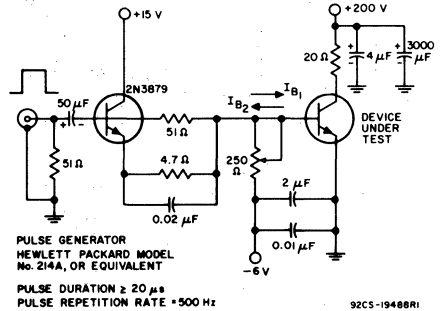


Fig. 16 - Circuit used to measure switching times for all types.

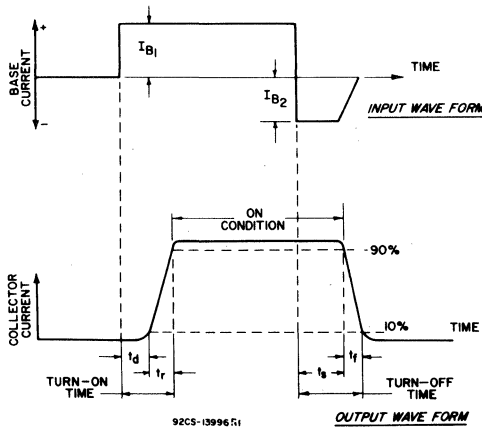


Fig. 17 - Phase relationship between input and output currents showing reference points for specifications of switching times.

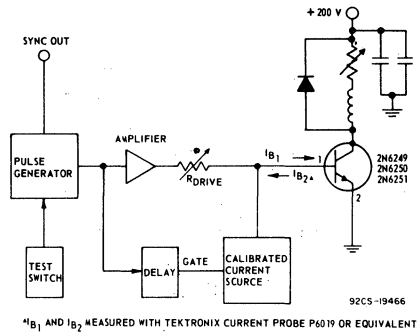


Fig. 18 - Circuit used to measure inductive-load switching times for all types.

High-Power Silicon N-P-N Transistors

For Industrial and Commercial Use

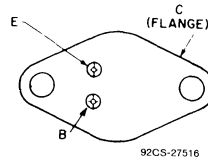
Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation capability

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The RCA-2N6253, 2N6254, and 2N6371 are silicon n-p-n transistors intended for a wide variety of high-power applications. The construction of these devices renders them highly resistant to second breakdown over a wide range of operating conditions.

These devices differ in maximum ratings for voltage and power dissipation. All are supplied in JEDEC TO-204AA hermetic steel packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6253	2N6254	2N6371	
* V_{CB0}	55	100	50	V
* $V_{CEr(SUS)}$ $R_{BE} = 100 \Omega$	55	85	45	V
* $V_{CEO(SUS)}$	45	80	40	V
$V_{CEV(SUS)}$ $V_{BE} = -1.5 V$	55	90	50	V
* V_{EBO}	5	7	5	V
* I_C	15	15	15	A
* I_B	7	7	7	A
* P_T : $\leq 25^\circ C$	115	150	117	W
$> 25^\circ C$	Derate Linearly to 200°C			
* T_j, T_{stg}	-65 to +200			°C
* T_L : During soldering, at distances 1/32 in. (0.8 mm) from seating plane for 10 s max.	235			°C

* In accordance with JEDEC registration data formats JS-6 RDF-2; 2N6253, 2N6254, 2N6371.

2N6253, 2N6254, 2N6371

ELECTRICAL CHARACTERISTICS, $T_c = 25^\circ\text{C}$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		2N6253		2N6254		2N6371		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	25	—	—	0	—	1.5	—	—	—	1.5	mA
	60	—	—	0	—	—	—	1	—	—	
I_{CEX}	45	-1.5	—	—	—	—	—	—	—	2	mA
	55	-1.5	—	—	—	2	—	—	—	—	
	100	-1.5	—	—	—	—	—	0.5	—	—	
$T_c = 150^\circ\text{C}$	40	-1.5	—	—	—	—	—	—	—	10	mA
	50	-1.5	—	—	—	10	—	—	—	—	
	100	-1.5	—	—	—	—	—	5	—	—	
I_{EBO}	—	-5	—	—	—	10	—	—	—	10	mA
	—	-7	—	—	—	—	—	0.5	—	—	
$V_{CEO}(SUS)$	—	—	0.2 ^a	0	45	—	80	—	40	—	V
$V_{CEB}(SUS)$ $R_{BE} = 100 \Omega$	—	—	0.2 ^a	—	55	—	85	—	45	—	
$V_{CEV}(SUS)$	—	-1.5	0.1 ^a	—	55	—	90	—	50	—	
h_{FE}	4	—	3 ^a	—	20	70	—	—	—	—	
	2	—	5 ^a	—	—	—	20	70	—	—	
	4	—	8 ^a	—	—	—	—	—	15	60	
	4	—	15 ^a	—	3	—	5	—	—	—	
	4	—	16 ^a	—	—	—	—	—	4	—	
V_{BE}	4	—	3 ^a	—	—	1.7	—	—	—	—	V
	2	—	5 ^a	—	—	—	—	1.5	—	—	
	4	—	16 ^a	—	—	—	—	—	—	4	
$V_{CE}(sat)$	—	—	3 ^a	0.3 ^a	—	1	—	—	—	—	V
	—	—	5 ^a	0.5 ^a	—	—	—	0.5	—	—	
	—	—	8 ^a	0.8 ^a	—	—	—	—	—	1.5	
	—	—	15 ^a	3 ^a	—	—	—	4	—	—	
	—	—	15 ^a	5 ^a	—	4	—	—	—	—	
—	—	16 ^a	4 ^a	—	—	—	—	—	4		
h_{ie} $f = 1 \text{ kHz}$	4	—	1	—	10	—	10	—	10	—	
f_T	4	—	1	—	—	—	—	—	800	—	kHz
$|h_{ie}|$ $f = 0.4 \text{ MHz}$	4	—	1	—	2	—	2	—	2	—	
f_{hfe}	4	—	1	—	10	—	10	—	—	—	kHz
$I_{S/B}$ $t_p = 1 \text{ s}$ nonrep.	40	—	—	—	—	—	—	—	2.9	—	A
	45	—	—	—	2.55	—	—	—	—	—	
	80	—	—	—	—	—	1.87	—	—	—	
$R\theta_{JC}$	—	—	—	—	—	1.5	—	1.17	—	1.5	$^\circ\text{C/W}$

* In accordance with JEDEC registration data formats JS-6 RDF-2; 2N6253, 2N6254, 2N6371.

^aPulsed: Pulse duration = 300 μs , duty factor = 1.8%.

2N6253, 2N6254, 2N6371

2

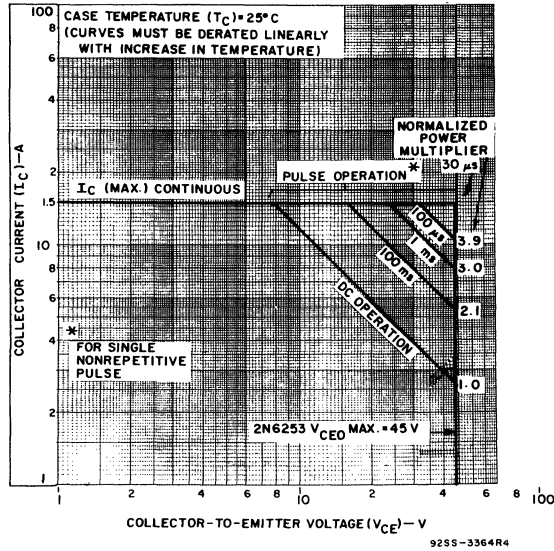


Fig. 1 - Maximum operating areas for 2N6253.

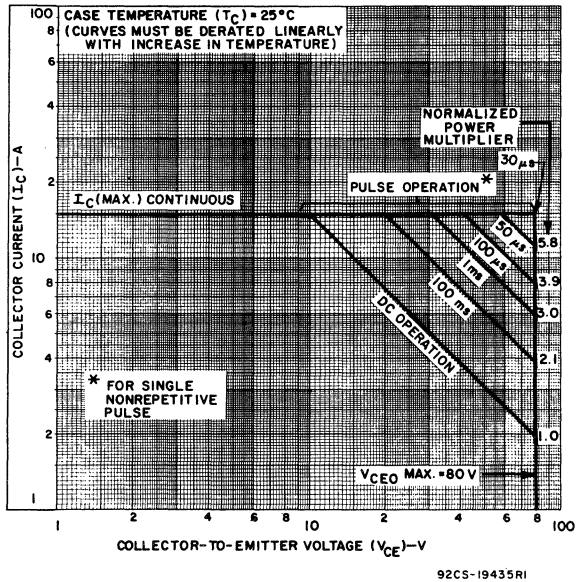


Fig. 2 - Maximum operating areas for 2N6254.

2N6253, 2N6254, 2N6371

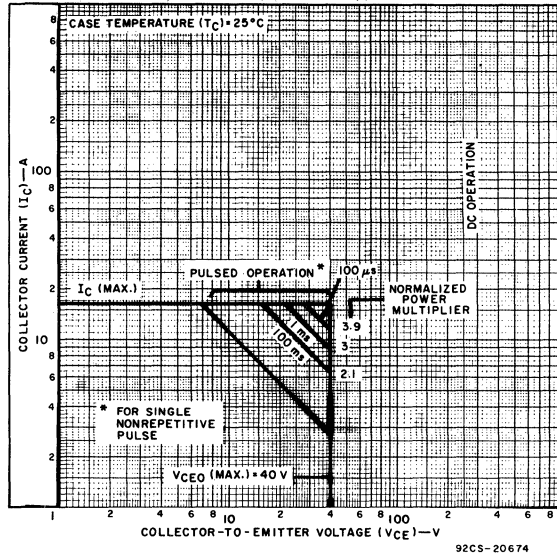


Fig. 3 - Maximum safe-area-of-operation at case temperature of 25° C for 2N6371.

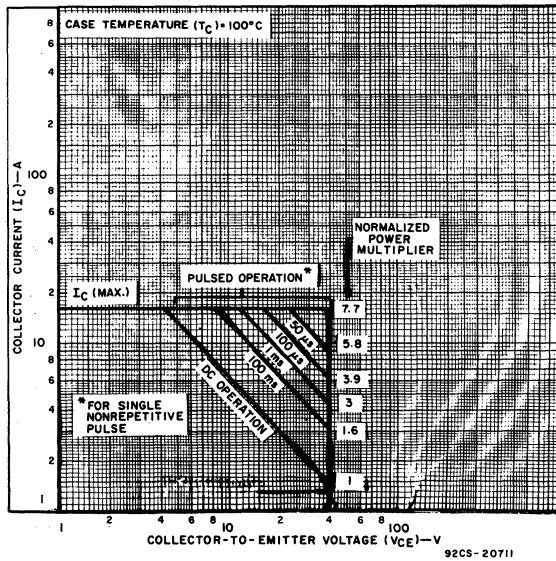


Fig. 4 - Maximum safe-area-of-operation at case temperature of 100° C for 2N6371.

2N6253, 2N6254, 2N6371

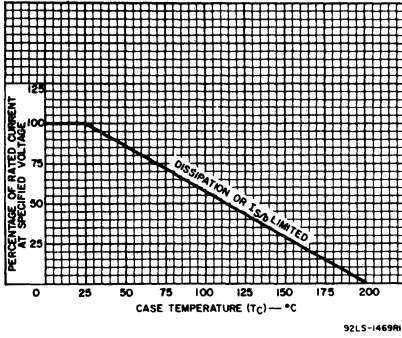


Fig. 5 - Current derating curve for all types.

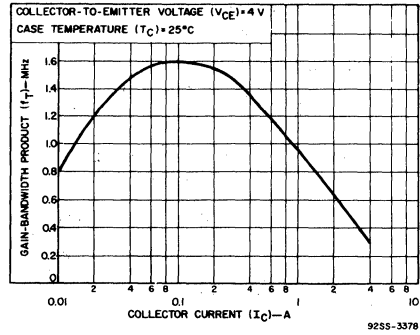


Fig. 6 - Typical gain-bandwidth product for all types.

2

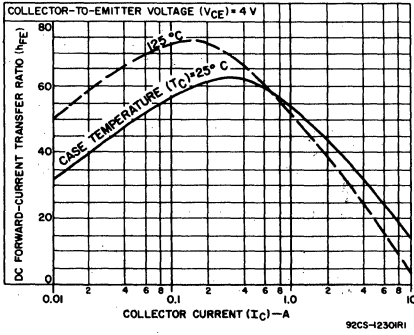


Fig. 7 - Typical dc-beta characteristics for 2N6371.

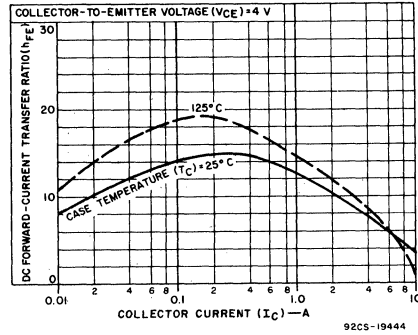


Fig. 8 - Typical dc-beta characteristics for 2N6253.

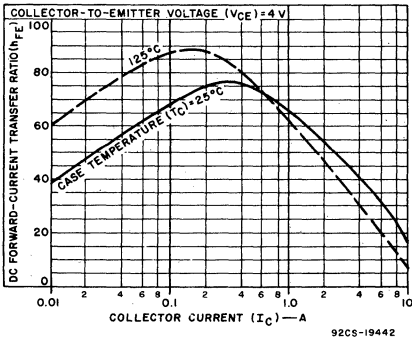


Fig. 9 - Typical dc-beta characteristics for 2N6254.

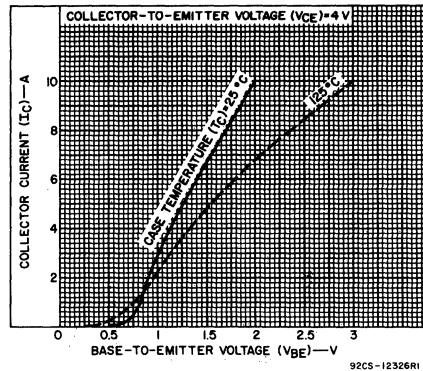


Fig. 10 - Typical transfer characteristics for 2N6253.

2N6253, 2N6254, 2N6371

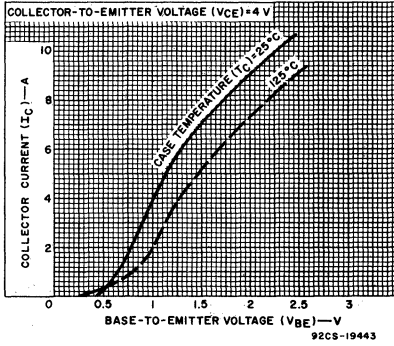


Fig. 11 - Typical transfer characteristics for 2N6254.

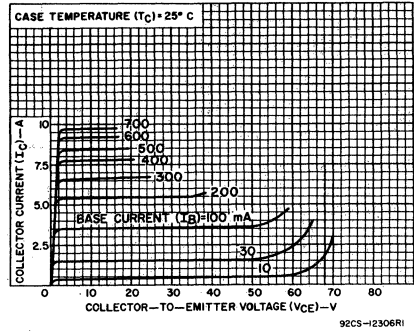


Fig. 12 - Typical output characteristics for 2N6371.

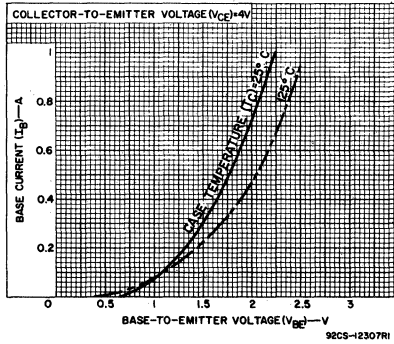


Fig. 13 - Typical input characteristics for 2N6371.

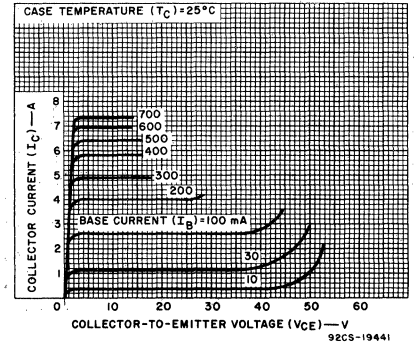


Fig. 14 - Typical output characteristics for 2N6254.

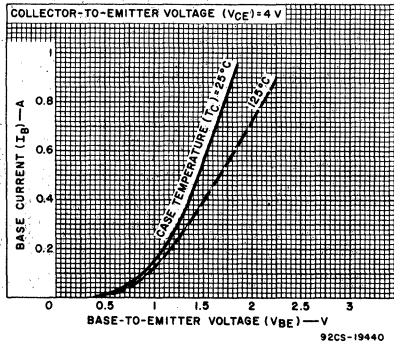


Fig. 15 - Typical input characteristics for 2N6253.

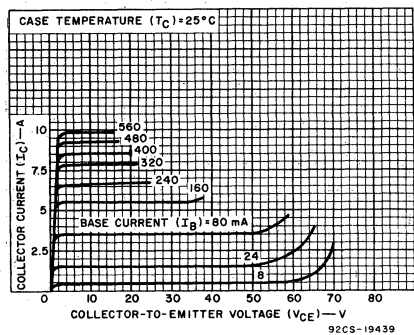


Fig. 16 - Typical output characteristics for 2N6254.

20-Ampere Complementary N-P-N and P-N-P Monolithic Darlington Power Transistors

60-80-100 Volts, 160 Watts

Gain of 2400 (Typ.) at 10 A (2N6282, 2N6283, 2N6284)

Gain of 3500 (Typ.) at 10 A (2N6285, 2N6286, 2N6287)

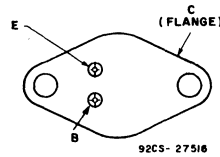
Features:

- Operates from IC without predriver
- Monolithic construction

The 2N6282, 2N6283, and 2N6284 and the 2N6285, 2N6286, and 2N6287 are complementary n-p-n and p-n-p monolithic silicon Darlington transistors designed for general purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

■ High voltage ratings:

- $V_{CEO(sus)} = 60 \text{ V Min.} - 2N6282, 2N6285^{\bullet}$
- $= 80 \text{ V Min.} - 2N6283, 2N6286^{\bullet}$
- $= 100 \text{ V Min.} - 2N6284, 2N6287^{\bullet}$

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6282 2N6285 [•]	2N6283 2N6286 [•]	2N6284 2N6287 [•]	
* V_{CBO}	60	80	100	V
* $V_{CEO(sus)}$	60	80	100	V
* V_{EBO}	5	5	5	V
* I_C	20	20	20	A
* I_{CM}	40	40	40	A
* I_B	0.5	0.5	0.5	A
* P_T				
$T_C \leq 25^{\circ}\text{C}$	160	160	160	W
$T_C > 25^{\circ}\text{C}$	Derate linearly			0.915 W/ $^{\circ}\text{C}$
* $T_{stg, TJ}$	-65 to 200			$^{\circ}\text{C}$
* T_L	At distances $\geq 1/16$ in. (1.58 mm) from case for 10 s max.			235 $^{\circ}\text{C}$

* In accordance with JEDEC registration data.

• For p-n-p devices, voltage and current values are negative.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287

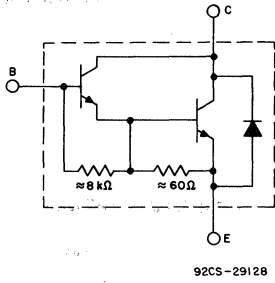


Fig. 1 - Schematic diagram for 2N6282, 2N6283, and 2N6284.

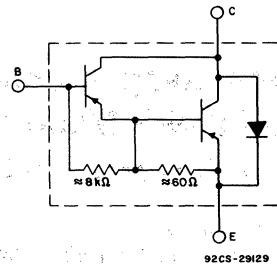


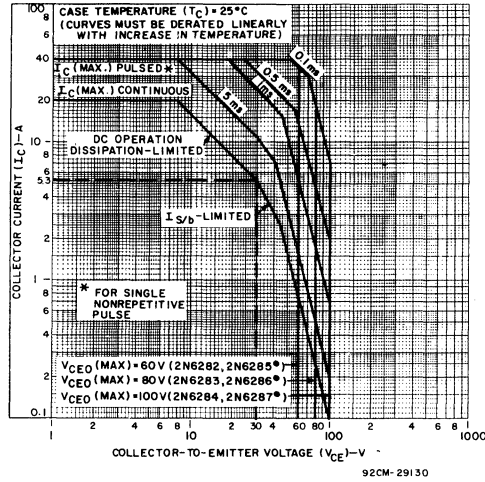
Fig. 2 - Schematic diagram for 2N6285, 2N6286, and 2N6287.

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6282 2N6285*		2N6283 2N6286*		2N6284 2N6287*		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30			0	-	1	-	-	-	-	mA
	40			0	-	-	-	1	-	-	
	50			0	-	-	-	-	-	1	
* I_{CEX}	60	-1.5			-	0.5	-	-	-	-	mA
	80	-1.5			-	-	-	0.5	-	-	
	100	-1.5			-	-	-	-	-	0.5	
$T_C = 150^\circ C$	60	-1.5			-	5	-	-	-	-	mA
	80	-1.5			-	-	-	5	-	-	
	100	-1.5			-	-	-	-	-	5	
* I_{EBO}		-5	0		-	2	-	2	-	2	mA
* $V_{CEO(sus)}$			0.1 ^a	0	60	-	80	-	100	-	V
* h_{FE}	3		20 ^a		100	-	100	-	100	-	
	3		10 ^a		750	18,000	750	18,000	750	18,000	
* $V_{CE(sat)}$			20 ^a 10 ^a	0.2 0.04	-	3 2	-	3 2	-	3 2	V
* V_{BE}	3		10 ^a		-	2.8	-	2.8	-	2.8	V
* $V_{BE(sat)}$			20 ^a	0.2	-	4	-	4	-	4	V
* h_{fe} f = 1 kHz	3		10		300	-	300	-	300	-	
* $|h_{fe}|$ f = 1 MHz	3		10		4	-	4	-	4	-	
* C_{ob} $V_{CB} = 10 V, I_E 0,$ f = 0.1 MHz											pF
2N6282-84 2N6285-87					-	400 600	-	400 600	-	400 600	
I_S/b t = 1 s, nonrep.	30				5.3	-	5.3	-	5.3	-	A
$R_{\theta JC}$						1.09	-	1.09	-	1.09	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%. • For p-n-p devices, voltage and current values are negative.
* In accordance with JEDEC registration data.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287



* FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

Fig. 3 - Maximum operating areas for all types.

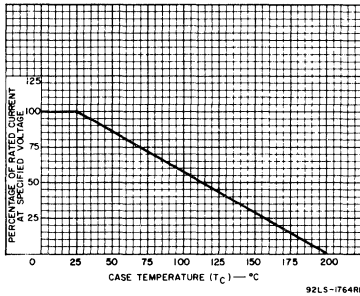


Fig. 4 - Current derating curve for all types.

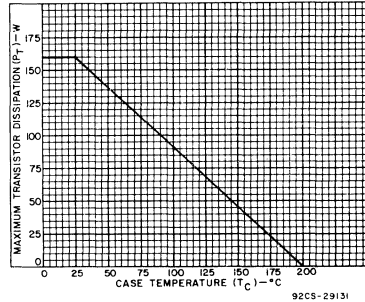


Fig. 5 - Power derating curve for all types.

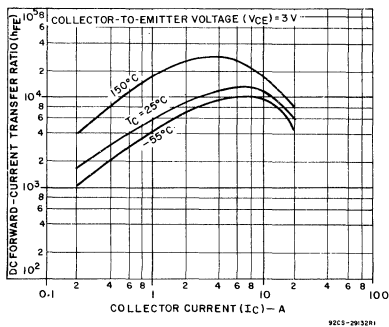


Fig. 6 - Typical dc beta characteristics for 2N6282, 2N6283, and 2N6284.

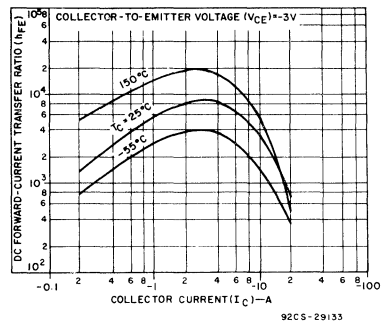
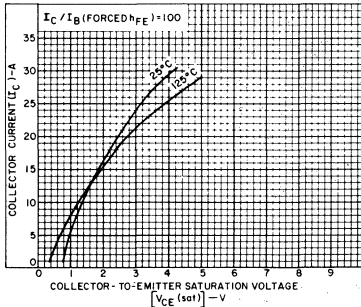


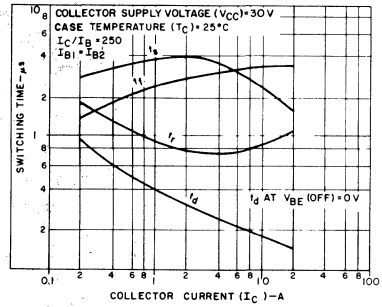
Fig. 7 - Typical dc beta characteristics for 2N6285, 2N6286, and 2N6287.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287



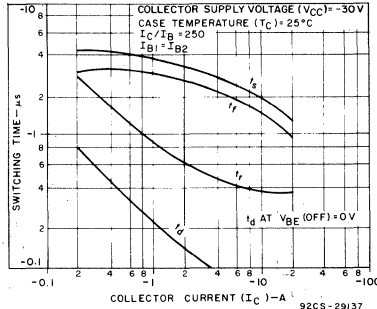
FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE
92CS-29135

Fig. 8 — Typical saturation characteristics for all types.



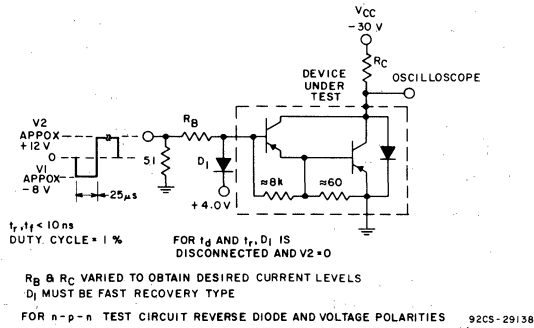
92CS-29136

Fig. 9 — Typical switching times for 2N6282, 2N6283, and 2N6284.



92CS-29137

Fig. 10 — Typical switching times for 2N6285, 2N6286, and 2N6287.



92CS-29138

Fig. 11 — Switching times test circuit.

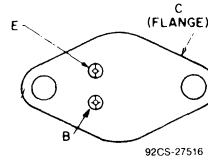
120-V, 10-A, 140-W Silicon N-P-N Planar Transistor

For Switching Applications in
Military and Industrial Equipment

Features:

- High $V_{CE0(sus)}$: 120 V
- Maximum safe-area-of operation curves
- Low saturation voltage: $V_{CE(sat)} \leq 0.5$ V
- Fast switching speeds
- High dissipation ratings: $P_T = 80$ W at 100° C
= 140 W at 25° C

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The type 2N6354* is an epitaxial silicon n-p-n planar transistor with a multiple-emitter-site structure. The device is supplied in the JEDEC TO-204AA package.

Typical high-speed switching applications for the 2N6354 include switching-control amplifiers operated from a 48-V (nominal) power supply, power gates, switching regulators, dc-dc converters, and power oscillators.

- Formerly RCA Dev. No. TA7534.

MAXIMUM RATINGS, Absolute-Maximum Values:

* COLLECTOR-TO-BASE VOLTAGE, V_{CB0}	150 V
COLLECTOR-TO-EMITTER VOLTAGE:	
With base open, sustaining, $V_{CE0(sus)}$	120 V
* With external base-to-emitter resistance (R_{BE}) = 500 Ω , V_{CEX}	130 V
* EMITTER-TO-BASE VOLTAGE, V_{EB0}	6.5 V
* COLLECTOR CURRENT (Continuous), I_C	10 A
COLLECTOR CURRENT (Peak)	12 A
* BASE CURRENT (Continuous), I_B	5 A
* TRANSISTOR DISSIPATION, P_T	
At case temperatures up to 25° C and V_{CE} up to 25 V	140 W
At case temperature of 100° C and V_{CB} of 20 V	80 W
At case temperatures up to 25° C and V_{CE} above 25 V	See Figs. 1 & 3
At case temperatures above 25° C and V_{CE} above 25 V	See Figs. 1, 2, & 3
* TEMPERATURE RANGE:	
Storage & Operating (Junction)	-65 to 200° C
* PIN TEMPERATURE (During Soldering):	
At distance $\geq 1/32$ in. (0.8 mm) from case for 10 s max.	230° C

* In accordance with JEDEC registration data format JS-6' RDF-1.

2N6354

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified.

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS		UNITS
		DC VOLTAGE (V)				DC CURRENT (A)		2N6354		
		V _{CE}	V _{CB}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	
Collector-Cutoff Current With emitter open	I _{CB0}		150					—	5	mA
With base open	I _{CEO}	100				0		—	20	
With base-emitter junction reverse-biased	I _{CEV}	140			0			—	10	
At $T_C = 125^\circ\text{C}$	I _{CEV}	140			0			—	20	
Emitter-Cutoff Current	I _{EBO}			6.5		0		—	5	mA
Emitter-to-Base Voltage	V _{EBO}					0.005		6.5	—	V
Collector-to-Emitter Voltage: At breakdown, with base open	V _{(BR)CEO}					0.2	0	120 ^b	—	V
With external base-to emitter resistance ($R_{BE} \leq 100 \Omega$)	V _{CER(sus)} ^f					0.2	0	130 ^b	—	
Saturation Voltage: Collector-to-Emitter	V _{CE(sat)}					5 ^a 10 ^a	0.5 1.0	— —	0.5 1	V
Base-to-Emitter	V _{BE(sat)}					5 ^a 10 ^a	0.5 1.0	— —	1.3 2	
DC Forward Current Transfer Ratio	h _{FE}	2 2				5 ^a 10 ^a		20 10	150 100	
Forward-Bias Second- Breakdown Collector Current ^d	I _{S/b} ^c	25 45						5.5 0.5	— —	A
Second-Breakdown Energy (With base reverse biased, $R_{BE}=51 \Omega$, $L = 25 \mu\text{H}$)	E _{S/b} ^g			1		5		0.3	—	mJ
Magnitude of Common Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio ($f = 10 \text{ MHz}$)	|h _{fe}|	10				1		8	—	
Saturated Switching Time: (See Figs. 11 & 12) Rise Time	t _r					5 10	0.5 ^e 1 ^e	— —	0.3 1	μs
Storage Time	t _{s1}					5 10	0.5 ^e 1 ^e	— —	1 0.6	
Storage Time (No Load)	t _{s2}					0.5	0.5 ^e	—	2	
Fall Time	t _f					5 10	0.5 ^e 1 ^e	— —	0.2 0.2	
Output Capacitance ($f = 1 \text{ MHz}$)	C _{obo}		10					—	300	pF
Thermal Resistance: Junction-to-Case	R _{θJC}	20				1		—	1.25	°C/W

¹In accordance with JEDEC registration data format JS-6 RDF-1.^aPulsed: pulse duration $\leq 350 \mu\text{s}$, duty factor = 2%.^bCAUTION: The collector-to-emitter voltages, V_{(BR)CEO} and V_{CER(sus)}, MUST NOT be measured on a curve tracer. These voltages should be measured by means of the test circuit shown in Fig. 5.^cI_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.^dPulsed; 1-s non-repetitive pulse.^eI_{B1} = I_{B2} = value shown.^fL = 15 mH^gE_{S/b} is defined as the energy at which second breakdown occurs under specified reverse bias conditions. $E_{S/b} = \frac{1}{2}LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

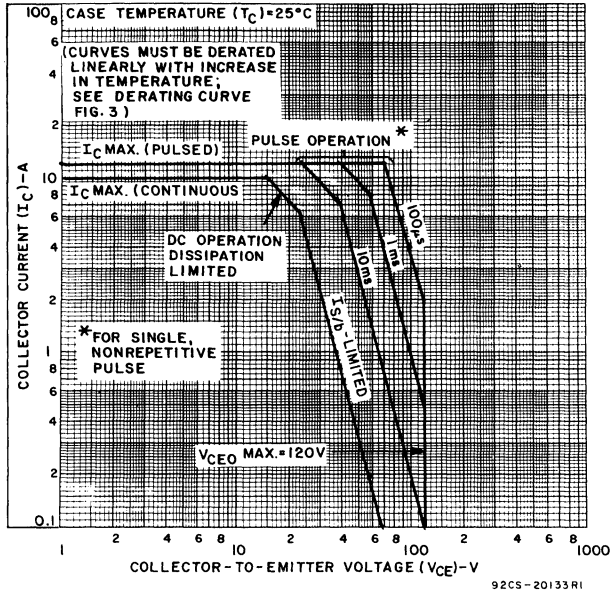


Fig. 1 - Maximum operating areas.

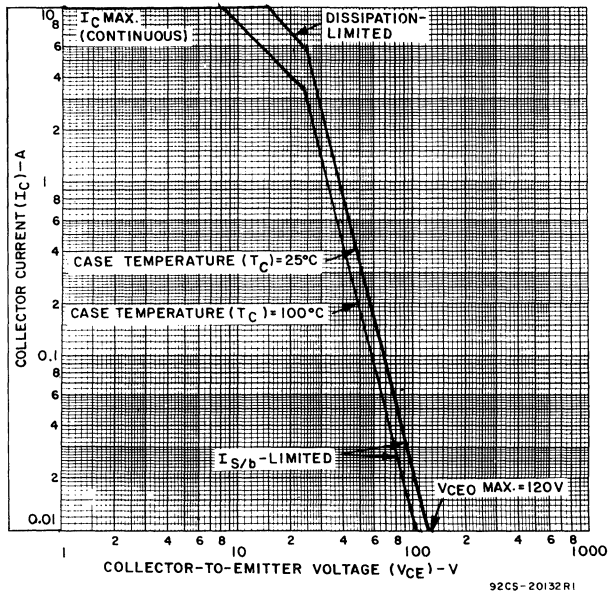


Fig. 2 - Maximum operating areas.

2N6354

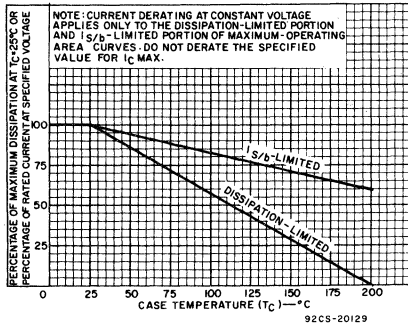


Fig. 3 - Derating curves.

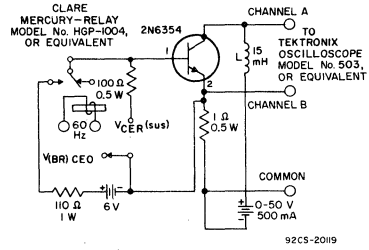
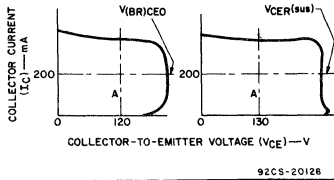


Fig. 4 - Circuit used to measure voltages $V_{(BR)CEO}$ and $V_{cER(sus)}$.



NOTE: The voltages $V_{(BR)CEO}$ and $V_{cER(sus)}$ are acceptable when the trace falls to the right of and above point "A".

Fig. 5 - Oscilloscope display for $V_{(BR)CEO}$ and $V_{cER(sus)}$ measurement (test circuit shown in Fig. 5).

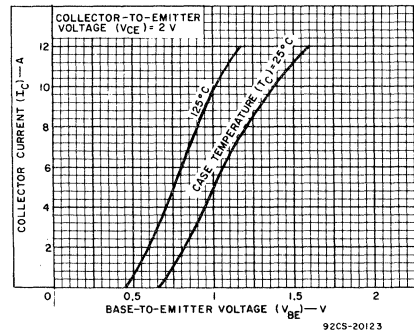


Fig. 6 - Typical transfer characteristics.

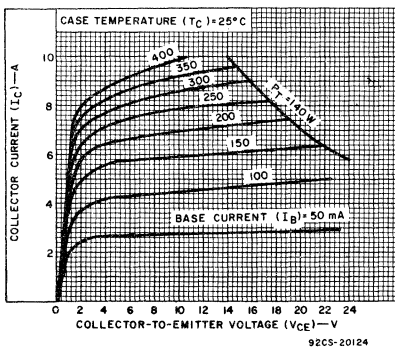


Fig. 7 - Typical output characteristics.

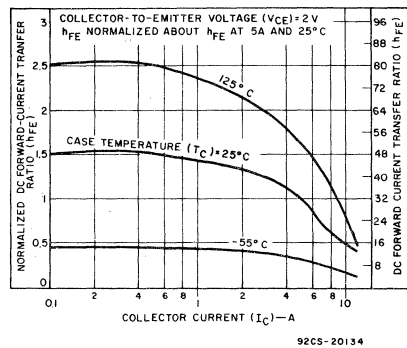


Fig. 8 - Typical normalized dc beta characteristics.

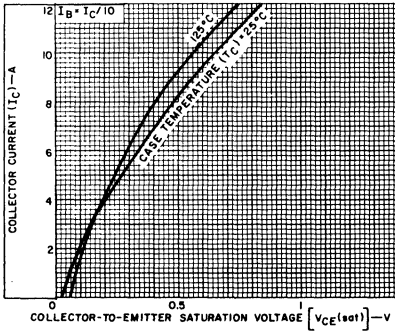


Fig. 9 - Typical saturation voltage characteristics.

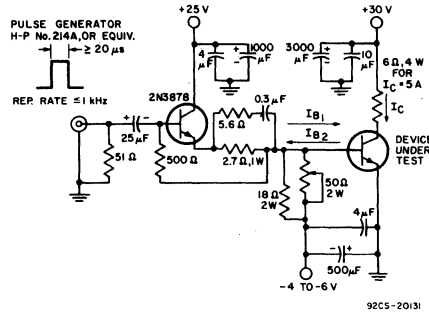


Fig. 10 - Circuit used to measure switching times.

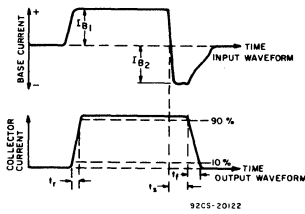


Fig. 11 - Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 11).

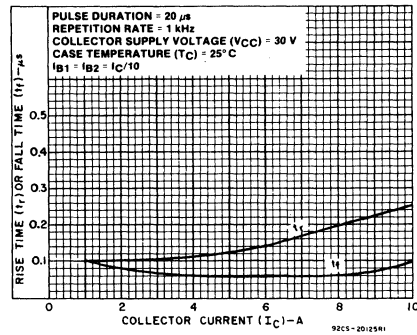


Fig. 12 - Typical rise and fall-time characteristics.

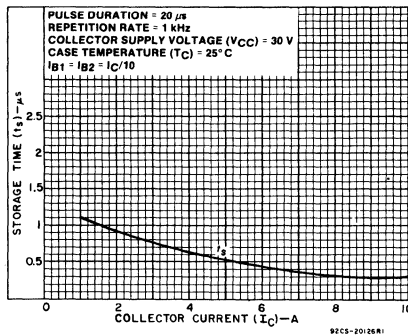


Fig. 13 - Typical storage-time characteristics.

10-Ampere N-P-N Darlington Power Transistors

40-60-80 Volts, 100 Watts
Gain of 1000 at 5 A

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

The 2N6383, 2N6384, and 2N6385[•] are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-break-down capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

[•]Formerly RCA Dev. Nos. TA8349, TA8486, and TA8348.

TERMINAL DESIGNATIONS

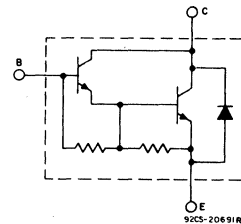
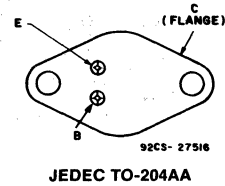


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6385	2N6384	2N6383	
*V _{CBO}	80	60	40	V
V _{CER(sus)} R _{BE} = 100 Ω	80	60	40	V
*V _{CEO(sus)}	80	60	40	V
*V _{CEX} V _{BE} = -1.5 V, R _{BB} = 100 Ω	80	60	40	V
*V _{EBO}	5	5	5	V
*I _C	10	10	10	A
I _{CM}	15	15	15	A
*I _B	0.25	0.25	0.25	A
*P _T T _C ≤ 25°C	100	100	100	W
T _C > 25°C	See Fig.2			
*T _{stg} , T _J	-65 to +200			°C
*T _L At distances ≥ 1/32 in. (0.8mm) from seating plane for 10 s max.	235			°C

* In accordance with JEDEC registration data format JS-6 RDF-2.

2N6383, 2N6384, 2N6385

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS					UNITS	
	VOLTAGE V dc			CURRENT A dc		2N6385		2N6384		2N6383		
	V _{CE}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.		MAX.
* I _{CEO}	80 60 40				0 0 0	— — —	1 — —	— — —	— 1 —	— — —	— — 1	mA
* I _{CEV} T _C = 150°C	80 60 40		-1.5 -1.5 -1.5			— — —	0.3 — —	— — —	— 0.3 —	— — 0.3		
	80 60 40		-1.5 -1.5 -1.5			— — —	3 — —	— — —	— 3 —	— — 3		
* I _{EBO}		5		0		—	5	—	5	—	5	mA
* V _{CEO(sus)}				0.2 ^a	0	80	—	60	—	40	—	V
* V _{CER(sus)} R _{BE} = 100Ω				0.2 ^a		80	—	60	—	40	—	
* V _{CEV(sus)}			-1.5	0.2 ^a		80	—	60	—	40	—	
* h _{FE}	3 3			5 ^a 10 ^a		1000 100	20,000 —	1000 100	20,000 —	1000 100	20,000 —	
* V _{BE}	3 3			5 ^a 10 ^a		— —	2.8 4.5	— —	2.8 4.5	— —	2.8 4.5	V
* V _{CE(sat)}				5 ^a 10 ^a	0.01 ^a 0.1 ^a	— —	2 3	— —	2 3	— —	2 3	V
V _F				-10		—	4	—	4	—	4	
* h _{fe} f = 1 kHz	5			1		1000	—	1000	—	1000	—	
* |h _{fe}| f = 1 MHz	5			1		20	—	20	—	20	—	
* C _{obo} f = 1 MHz	V _{CB} = 10				I _E = 0	—	200	—	200	—	200	pF
I _S /b t = 1 s, non rep.	75 55 30					0.22 — 3.33	— — —	— 0.55 3.33	— — —	— — 3.33	— — —	A
R _{θJC}						—	1.75	—	1.75	—	1.75	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

* In accordance with JEDEC registration data format JS-6 RDF-2.

2

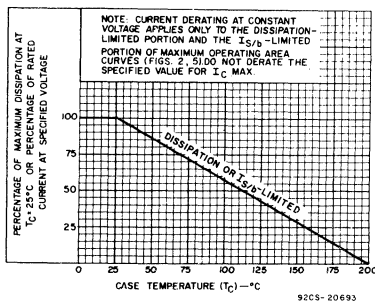


Fig. 2 — Derating curves for all types.

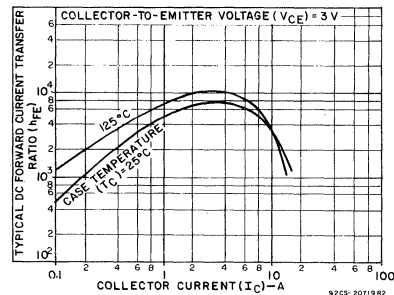


Fig. 3 — Typical dc-beta characteristics for all types.

2N6383, 2N6384, 2N6385

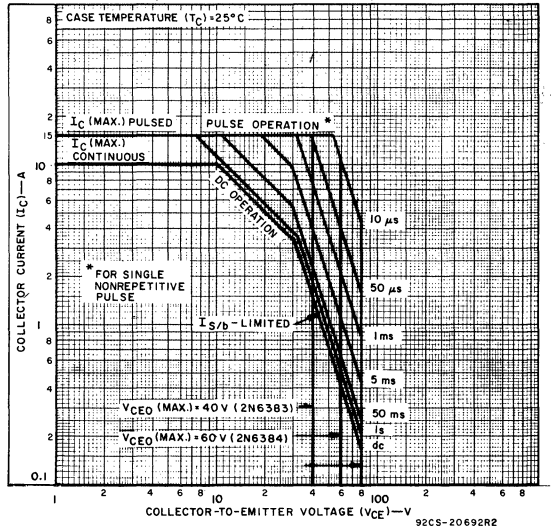


Fig.4 — Maximum operating area for all types.

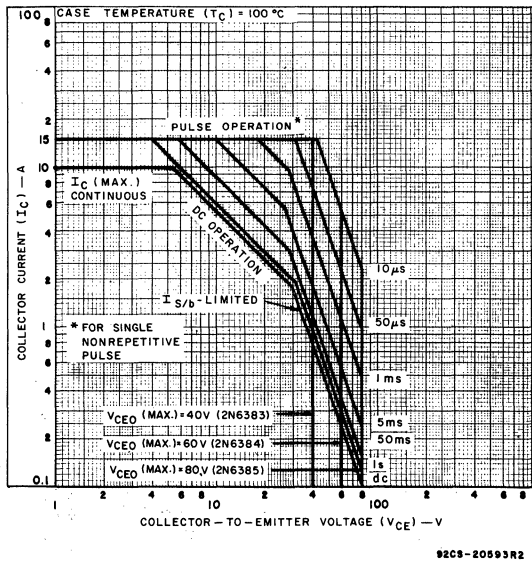


Fig.5 — Maximum operating area for all types.

2N6383, 2N6384, 2N6385

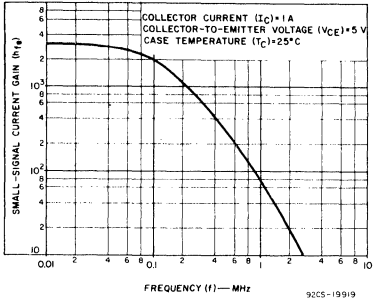


Fig. 6 — Typical small-signal gain for all types.

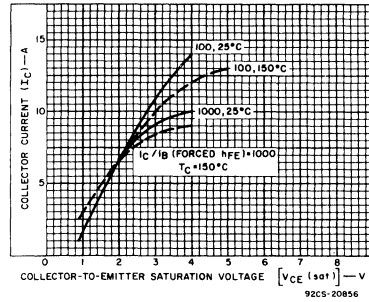


Fig. 7 — Typical saturation characteristics for all types.

2

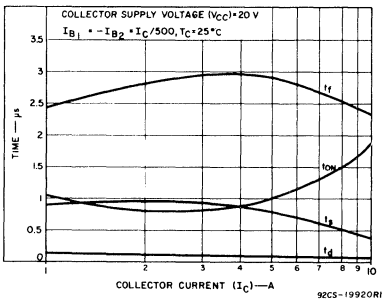


Fig. 8 — Typical saturated switching-time characteristics for all types.

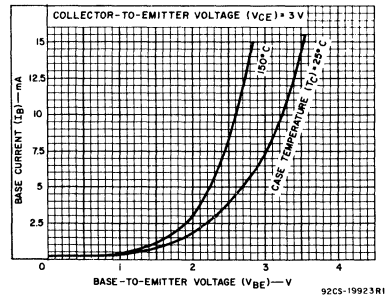


Fig. 9 — Typical input characteristics for all types.

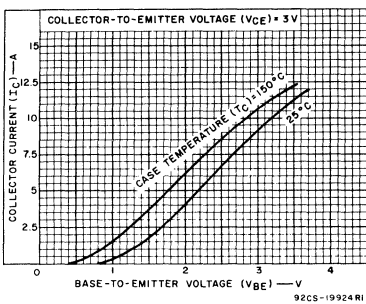


Fig. 10 — Typical transfer characteristics for all types.

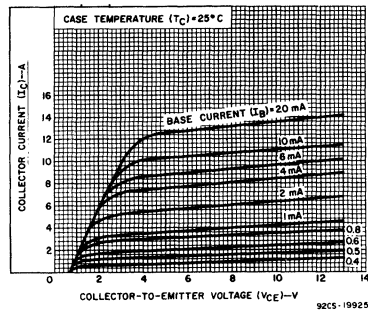


Fig. 11 — Typical output characteristics for all types.

2N6383, 2N6384, 2N6385

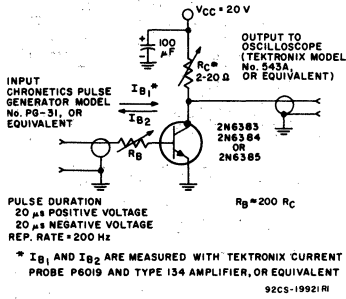


Fig. 12 — Circuit used to measure saturated-switching-times.

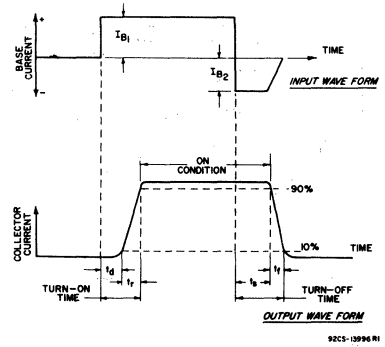


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times (test circuit shown in Fig. 14).

10-Ampere N-P-N Darlington Power Transistors

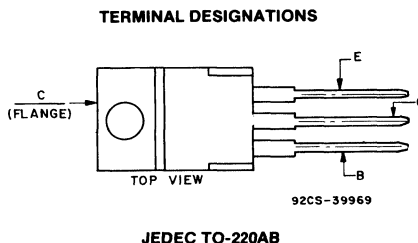
40-60-80 Volts, 65 Watts
 Gain of 1000 at 5 A (2N6387, 2N6388)
 Gain of 1000 at 3 A (2N6386)

Features:

- Operates from IC without predriver

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators



The 2N6386, 2N6387, and 2N6388[•] are monolithic silicon n-p-n Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices make it possible for them to be driven directly from integrated circuits. The 2N6386 is complementary to the 2N6666, the 2N6387 is complementary to the 2N6667, and the 2N6388 is complementary to the 2N6668. These devices are supplied in the JEDEC TO-220AB (VERSA-WATT) plastic package.

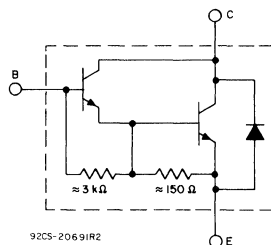


Fig.1 — Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6386	2N6387	2N6388	
* V_{CB0}	40	60	80	V
$V_{CER(sus)}$				
$R_{BE} = 100 \Omega$	40	60	80	V
$V_{CEO(sus)}$	40	60	80	V
* $V_{CEV(sus)}$				
$V_{BE} = -1.5 V$	40	60	80	V
* V_{EBO}	5	5	5	V
* I_C	8	10	10	A
I_{CM}	15	15	15	A
* I_B	0.25	0.25	0.25	A
* P_T				
$T_C \leq 25^\circ C$	65	65	65	W
$T_C > 25^\circ C$	See Fig.2			
* T_{stg}, T_J	-65 to +150			$^\circ C$
* T_L	235			$^\circ C$
At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.				

[•] In accordance with JEDEC registration data format JS-6 RDF-2.

2N6386, 2N6387, 2N6388

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS					UNITS	
	VOLTAGE V dc		CURRENT A dc		2N6386		2N6387		2N6388		
	VCE	VBE	IC	IB	MIN.	MAX.	MIN.	MAX.	MIN.		MAX.
* ICEO	80			0	—	—	—	—	—	1	mA
	60			0	—	—	—	1	—	—	
	40			0	—	1	—	—	—	—	
* ICEV	80	-1.5			—	—	—	—	—	0.3	
	60	-1.5			—	—	—	0.3	—	—	
	40	-1.5			—	0.3	—	—	—	—	
$T_C = 125^\circ\text{C}$	80	-1.5			—	—	—	—	—	3	
	60	-1.5			—	—	—	3	—	—	
	40	-1.5			—	3	—	—	—	—	
* IEBO		5	0		—	5	—	5	—	5	mA
* VCEO(sus)			0.2 ^a	0	40	—	60	—	80	—	V
V _{CE} R(sus) R _{BE} = 100 Ω			0.2 ^a		40	—	60	—	80	—	
VCEV(sus)		-1.5	0.2 ^a		40	—	60	—	80	—	
* h _{FE}	3		3 ^a		1000	20,000	—	—	—	—	
	3		5 ^a		—	—	1000	20,000	1000	20,000	
	3		8 ^a		100	—	—	—	—	—	
	3		10 ^a		—	—	100	—	100	—	
* V _{BE}	3		3 ^a		—	2.8	—	—	—	—	V
	3		5 ^a		—	—	—	2.8	—	2.8	
	3		8 ^a		—	4.5	—	—	—	—	
	3		10 ^a		—	—	—	4.5	—	4.5	
* V _{CE(sat)}			3 ^a	0.006 ^a	—	2	—	—	—	—	V
			5 ^a	0.01 ^a	—	—	—	2	—	2	
			8 ^a	0.08 ^a	—	3	—	—	—	—	
			10 ^a	0.1 ^a	—	—	—	3	—	3	
* V _F			-3 ^a		—	4	—	—	—	—	V
			-10 ^a		—	—	—	4	—	4	
* h _{fe} f = 1 kHz	5		1		1000	—	1000	—	1000	—	
* |h _{fe}| f = 1 MHz	5		1		20	—	20	—	20	—	
* C _{ob} V _{CB} = 10 V, f = 1 MHz					—	200	—	200	—	200	pF
* I _S /b t = 1 s, nonrep.	25				2.6	—	2.6	—	2.6	—	A
R _{θJC}					—	1.92	—	1.92	—	1.92	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.
* In accordance with JEDEC registration data format JS-6 RDF-2.

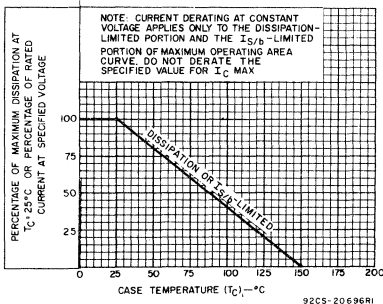


Fig. 2 — Derating curve for all types.

Fig. 3 — Typical dc-beta characteristics for all types.

2N6386, 2N6387, 2N6388

2

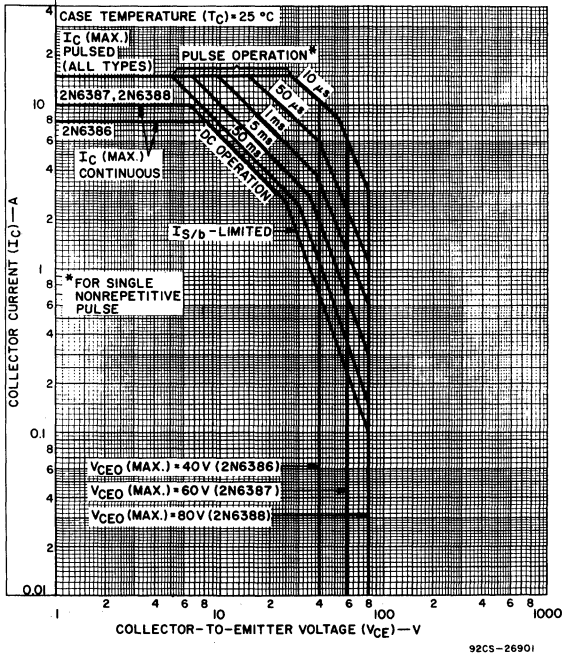


Fig. 4 — Maximum operating areas for all types.

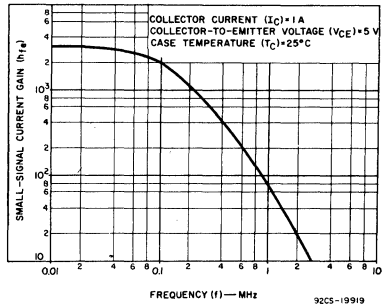


Fig. 5 — Typical small-signal gain for all types.

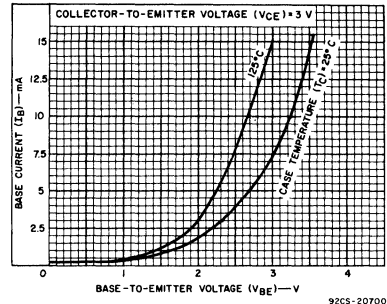


Fig. 6 — Typical input characteristics for all types.

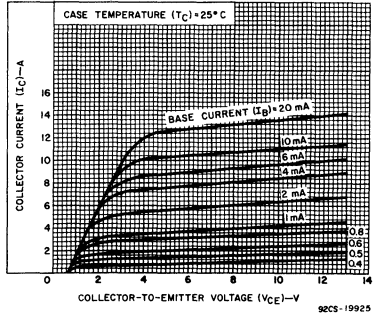


Fig. 7 — Typical output characteristics for all types.

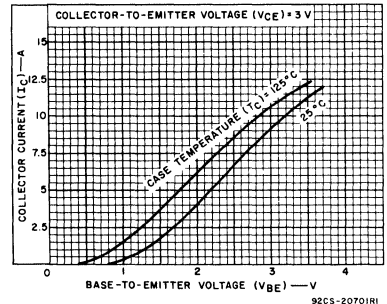


Fig. 8 — Typical transfer characteristics for all types.

2N6386, 2N6387, 2N6388

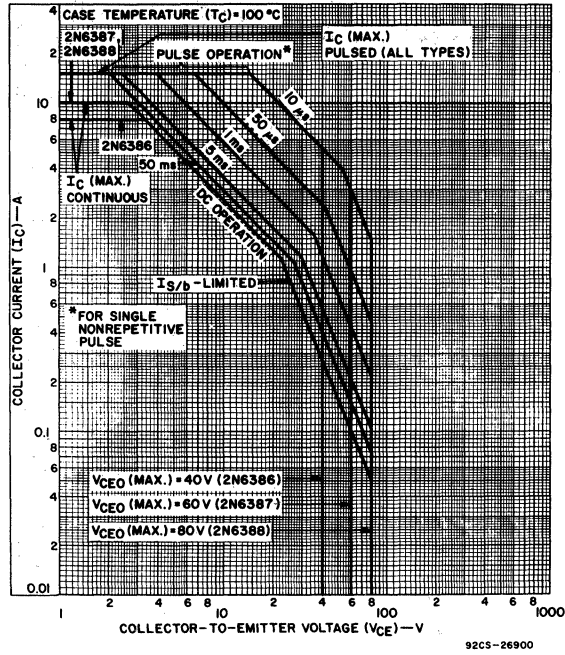


Fig. 9 — Maximum operating areas for all types at $T_C = 100^\circ C$.

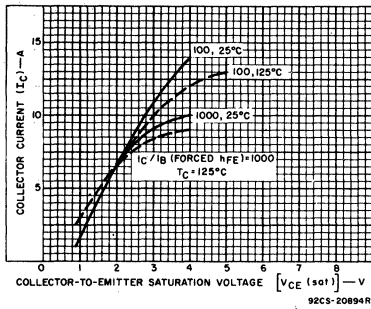


Fig. 10 — Typical saturation characteristics for all types.

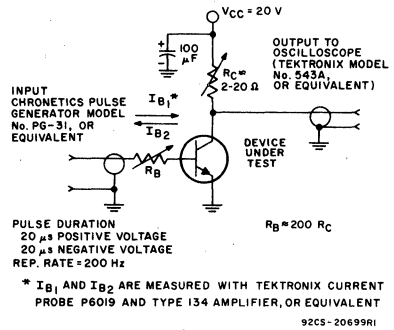


Fig. 11 — Circuit used to measure saturated switching times.

2N6386, 2N6387, 2N6388

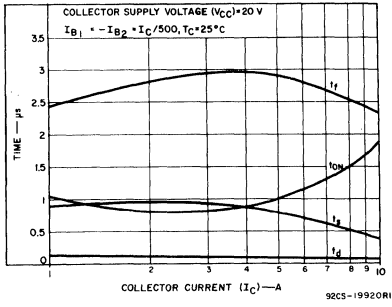


Fig. 12 — Typical saturated switching-time characteristics for all types.

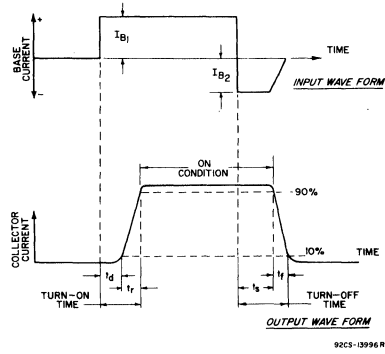


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times.

2

High-Voltage Medium-Power Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications

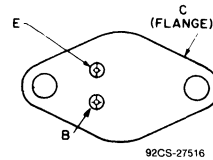
Features:

- High voltage ratings:
 - $V_{CE0(sus)} = -175 \text{ V max. (2N6420)}$
 - $= -250 \text{ V max. (2N6421)}$
 - $= -300 \text{ V max. (2N6422)}$
 - $= -300 \text{ V max. (2N6423)}$
- Large safe-operating area

The 2N6420, 2N6421, 2N6422, and 2N6423 are epitaxial silicon p-n-p power transistors with high-voltage ratings and fast switching speeds. Typical applications for these transistors include high-voltage operational amplifiers, switching regulators, converters, inverters, deflection stages and high-fidelity amplifiers.

These types are supplied in steel JEDEC TO-213AA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6420	2N6421	2N6422	2N6423	
* V_{CB0}	-250	-375	-550	-550	V
* $V_{CE0(sus)}$	-175	-250	-300	-300	V
* V_{EB0}			-6		V
* I_c	-1		-2		A
I_{CM}			-5		A
* I_B			-1		A
P_T					
$T_C \leq 100^\circ\text{C}, V_{CE} \leq 50\text{V}$			20		W
* $T_C \leq 25^\circ\text{C}, V_{CE} \leq 40\text{V}$			35		W
$T_C \leq 25^\circ\text{C}, V_{CE} > 40\text{V}$			See Fig. 1		
$T_C < 25^\circ\text{C}, V_{CE} > 40\text{V}$			See Figs. 1 & 3		
* $T_{stg}, *T_J$			-65 to +200		$^\circ\text{C}$
* T_L					
At distances $\geq 1/32$ in. (0.8 mm)					
from case for 10 s max			235		$^\circ\text{C}$

*In accordance with JEDEC registration date

2N6420, 2N6421, 2N6422, 2N6423

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						Units
	VOLTAGE V dc		CURRENT A dc		2N6420		2N6421 2N6422		2N6423		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEO}	-150				-	-10	-	-5	-	-5	mA
* I_{CEX}	-225	1.5			-	-1	-	-	-	-	
2N6421	-340	1.5			-	-	-	-1	-	-	
2N6422	-450	1.5			-	-	-	-1	-	-	
	-450	1.5			-	-	-	-	-	-2	
* I_{CEX} $T_C=150^\circ\text{C}$	-225	1.5			-	-3	-	-	-	-	
	-300	1.5			-	-	-	-3	-	-5	
* I_{EBO}		6	0		-	-5	-	-0.5	-	-0.5	
* h_{FE}	-10		-0.1 ^a		40	-	40	-	40	-	
	-10		-0.5 ^a		40	200	-	-	-	-	
	-2		-0.75 ^a		-	-	-	-	10	100	
	-10		-0.75 ^a		-	-	-	-	30	150	
	-2		-1 ^a		-	-	8	80	-	-	
	-10		-1 ^a		10	-	25	100	-	-	
V_{BE}	-10		-1 ^a		-	-1.4	-	-1.4	-	-1.4	V
* $V_{BE(sat)}$			-0.75 ^a	-0.075	-	-	-	-	-1.8	-	
			-1 ^a	-0.1	-	-1.4	-	-1.4	-	-	
$V_{CE(sat)}$			-0.75 ^a	-0.075	-	-	-	-	-	-1	
			-1 ^a	-0.125	-	-5	-	-0.75	-	-	
* $V_{CEO(sus)}^b$			-0.05 ^a	0	-175	-	-	-	-300	-	
2N6421			-0.05 ^a	0	-	-	-250	-	-	-	
2N6422			-0.05 ^a	0	-	-	-300	-	-	-	
I_S/b	-100				-0.15	-	-0.15	-	-0.15	-	A
* $|h_{fe}|$											
$f = 5\text{ MHz}$	-10		-0.2		2	-	2	-	3	-	
$f = 1\text{ kHz}$	-30		-0.1		25	350	-	-	-	-	
* C_{obo} $V_{CB}=10\text{ V}$ $f=1\text{ MHz}$			0		-	180	-	180	-	180	pF
* t_r^c			-0.75	-0.075 ^d	-	-	-	-	3	-	0.5
			-1	-0.1 ^d	-	-	-	-	-	-	-
* t_s^c			-0.75	-0.075 ^d	-	-	-	-	4	-	6
			-1	-0.1 ^d	-	-	-	-	-	-	-
* t_f^c			-0.75	-0.075 ^d	-	-	-	-	3	-	3
			-1	-0.1 ^d	-	-	-	-	-	-	-
$R\theta_{JC}$	-10		-1		-	5	-	5	-	5	°C/W

* In accordance with JEDEC registration data.

^a Pulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.^b CAUTION: The sustaining voltage $V_{CEO(sus)}$

MUST NOT be measured on a curve tracer.

^c $V_{CC} = -200\text{ V}$, $t_p = 20\ \mu\text{s}$ ^d $-I_{B1} = I_{B2}$

2N6420, 2N6421, 2N6422, 2N6423

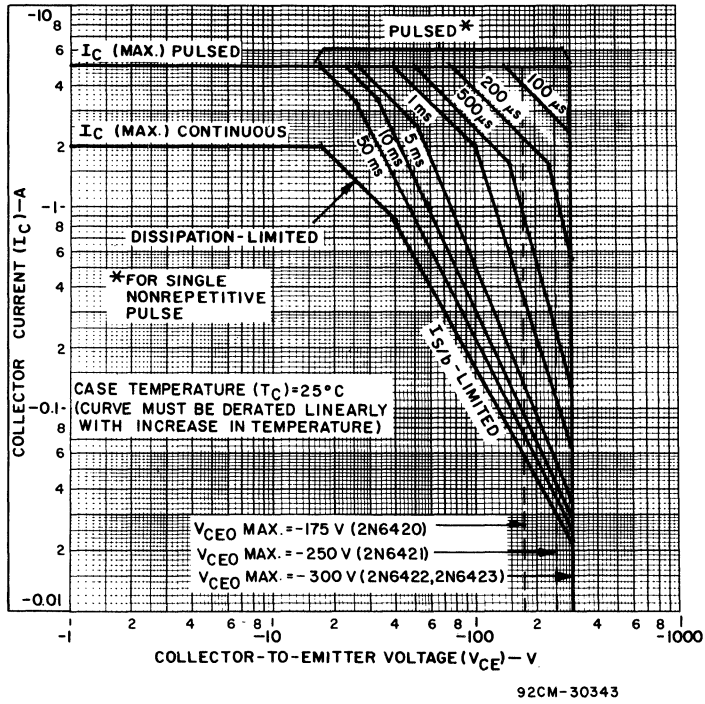


Fig. 1 — Maximum operating areas for all types.

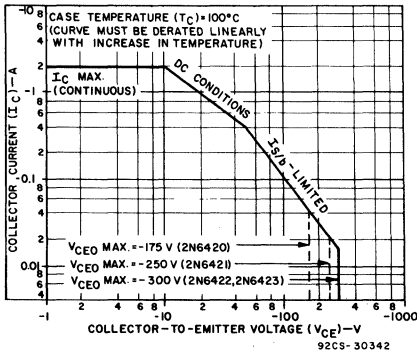


Fig. 2 — Maximum operating areas for all types.

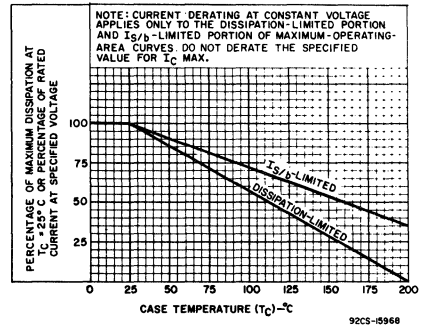


Fig. 3 — Derating curves for all types.

2N6420, 2N6421, 2N6422, 2N6423

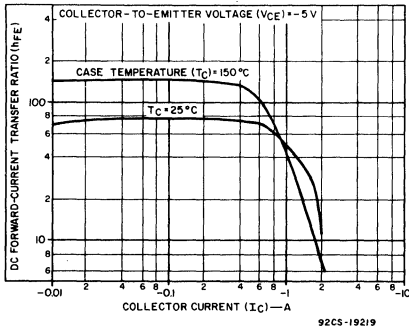


Fig. 4 — Typical dc beta characteristics for all types.

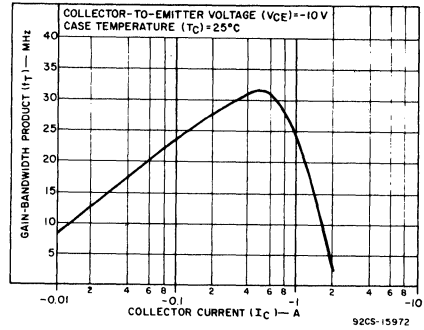


Fig. 5 — Typical gain-bandwidth product for all types.

2

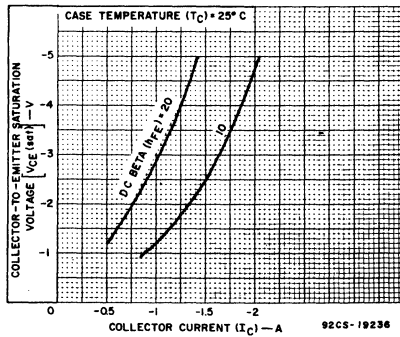


Fig. 6 — Typical saturation-voltage characteristics for all types.

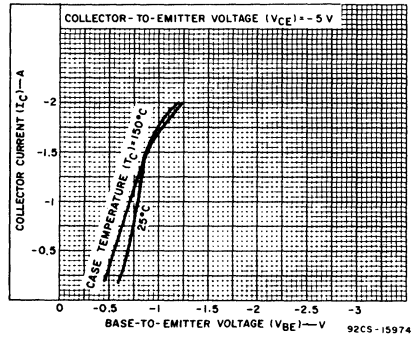


Fig. 7 — Typical transfer characteristics for all types.

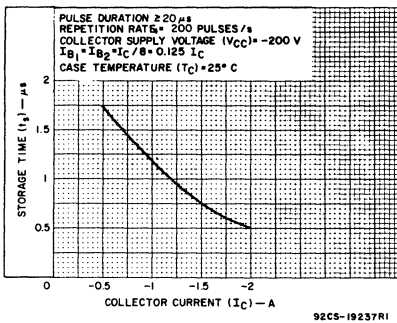


Fig. 8 — Typical storage time characteristic for all types.

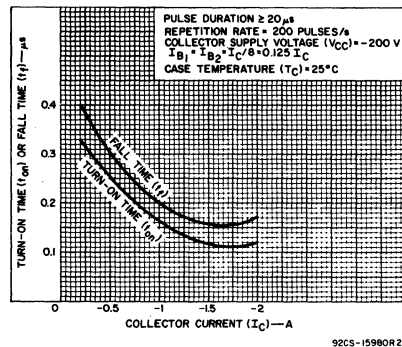


Fig. 9 — Typical turn-on time and fall-time characteristics for all types.

2N6420, 2N6421, 2N6422, 2N6423

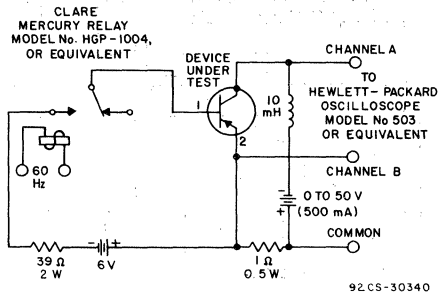
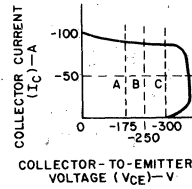


Fig. 10 — Circuit used to measure sustaining voltage $V_{CE0} (sus)$ for all types.



NOTE:
SUSTAINING VOLTAGES $V_{CE0} (sus)$ ARE ACCEPTABLE WHEN TRACES FALL TO THE RIGHT AND ABOVE POINTS "A" FOR TYPE 2N6420 POINTS "B" FOR TYPE 2N6421 AND POINTS "C" FOR TYPES 2N6422 AND 2N6423.

Fig. 11 — Oscilloscope display for measurement of sustaining voltages.

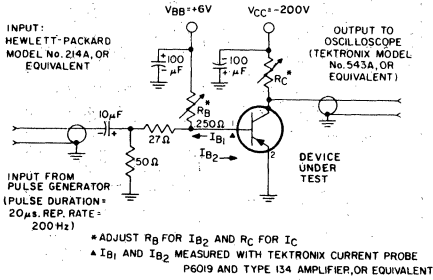


Fig. 12 — Circuit used to measure saturated switching times for all types.

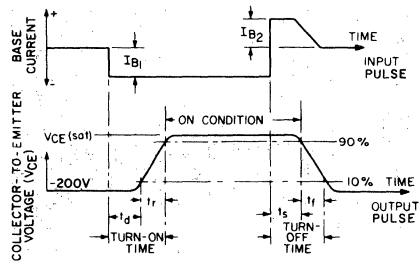


Fig. 13 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Application

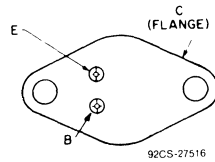
Features:

- Low saturation voltages
- Maximum-safe-area-of-operation curves

The RCA-2N6467 and 2N6468▲ are multiple-epitaxial p-n-p transistors. These devices differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the JEDEC TO-213AA package.

▲Formerly RCA Dev Nos. TA8710, and TA8709, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

2

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6467	2N6468	
*V _{CBO}	-110	-130	V
*V _{CEX(SUS)} V _{BE} = 1.5 V, R _{BE} = 100 Ω	-110	-130	V
V _{CER(SUS)} R _{BE} = 100 Ω	-105	-125	V
V _{CEO(SUS)}	-100	-120	V
*V _{EBO}	-5	-5	V
*I _C	-4	-4	A
*I _B	-2	-2	A
*P _T Up to 25°C	40	40	W
Above 25°C	See Figs. 1, 2 and 3		
*T _J , T _{stg}	-65 to +200		°C
*T _L At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	+235		°C

*In accordance with JEDEC registration data format JS-6-RDF-2.

2N6467, 2N6468

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified.

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6467		2N6468		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER} $R_{BE} = 100 \Omega$	-95 -100				—	-100	—	-100	μA
$*I_{CEX}$ $R_{BE} = 100 \Omega$	-100	1.5			—	-100	—	-100	μA
	-120	1.5			—	—	—	-100	μA
$R_{BE} = 100 \Omega$ $T_C = 150^\circ C$	-100	1.5			—	-2	—	—	mA
	-120	1.5			—	—	—	-2	mA
$*I_{CEO}$	-50 -60				—	-1	—	-1	mA
$*I_{EBO}$		5			—	-0.1	—	-0.1	mA
$*h_{FE}$	-4		-1.5a		15	150	15	150	
	-4		-4a		5	—	5	—	
$*V_{CEO}(sus)$			-0.1a		-100 ^b	—	-120 ^b	—	
$V_{CER}(sus)$ $R_{BE} = 100 \Omega$			-0.1a		-105 ^b	—	-125 ^b	—	V
$*V_{CEX}(sus)$ $R_{BE} = 100 \Omega$		1.5	-0.1a		-110 ^b	—	-130 ^b	—	V
$*V_{BE}$	-4		-1.5a		—	-2	—	-2	V
	-4		-4a		—	-3.5	—	-3.5	V
$V_{CE}(sat)$			-1.5a -4a	-0.15 -0.8	—	-1.2 -4*	—	-1.2 -4*	V
$*|h_{fe}|$ $f = 1 \text{ MHz}$	-4		1		5	—	5	—	
$*h_{fe}$ $f = 1 \text{ kHz}$	-4		0.5		25	—	25	—	
$R_{\theta JC}$					—	4.3	—	4.3	$^\circ C/W$

*In accordance with JEDEC registration data format JS-6 RDF-2.

a Pulsed, pulse duration = 300 μs , duty factor = 1.8%

b CAUTION: Sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer.

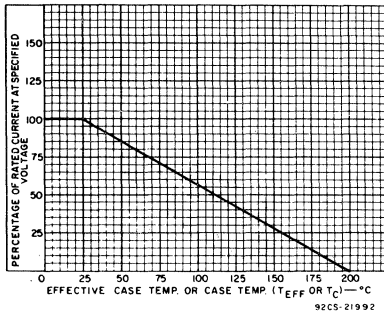


Fig. 1 — Current derating curve for all types.

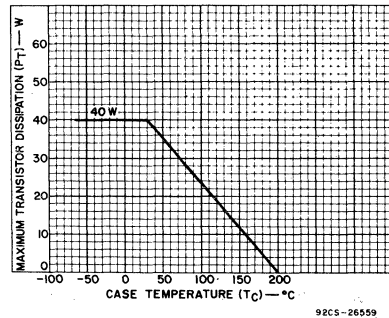


Fig. 2 — Dissipation derating curve for all types.

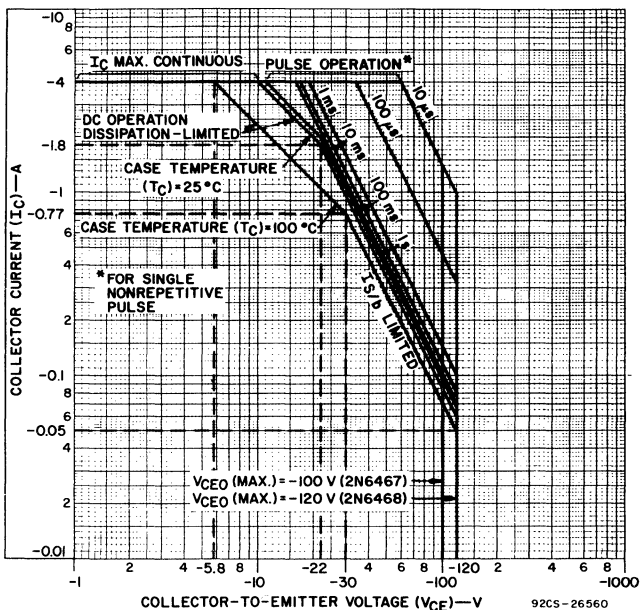


Fig. 3 — Maximum operating areas for 2N6467 and 2N6468.

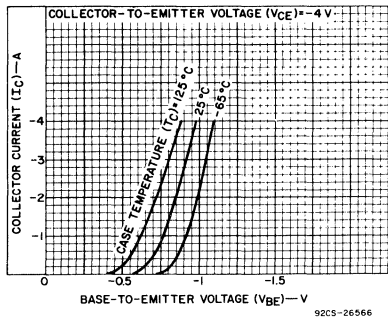


Fig. 4 — Typical transfer characteristics for 2N6467 and 2N6468.

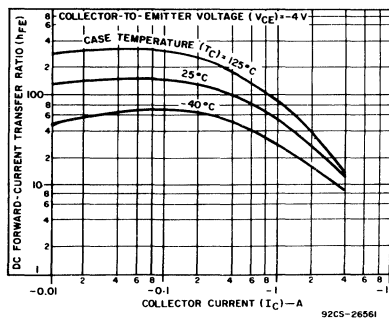


Fig. 5 — Typical dc beta characteristics for 2N6467 and 2N6468.

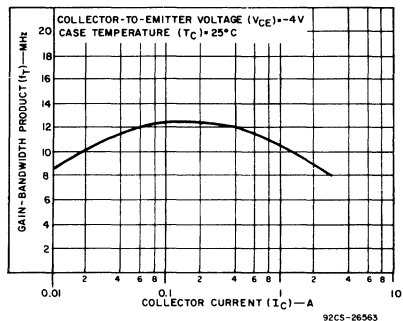


Fig. 6 — Typical gain-bandwidth product by 2N6467 and 2N6468.

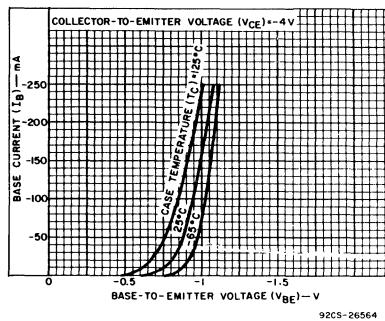


Fig. 7 — Typical input characteristics for 2N6467 and 2N6468.

2N6467, 2N6468

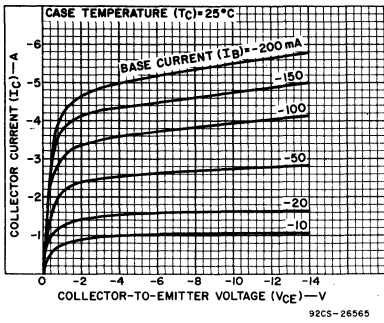


Fig. 8 — Typical output characteristics for 2N6467 and 2N6468.

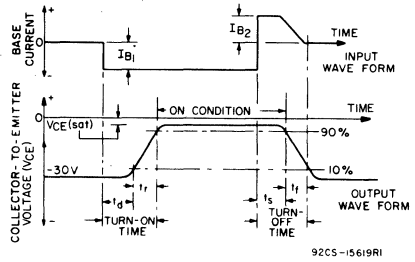


Fig. 9 — Oscilloscope display for measurement of switching times for 2N6467 and 2N6468.

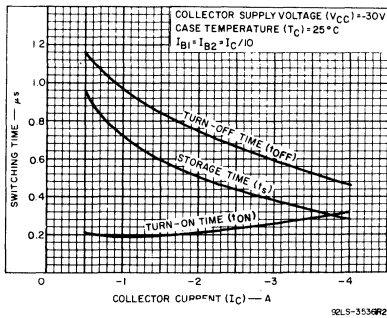
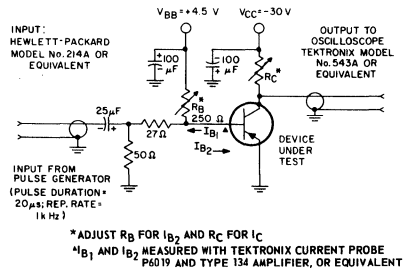


Fig. 10 — Typical saturated switching characteristics for 2N6467 and 2N6468.



* ADJUST R_B FOR I_{B2} AND R_C FOR I_C
 † I_{B1} AND I_{B2} MEASURED WITH TEKTRONIX CURRENT PROBE P6019 AND TYPE 134 AMPLIFIER, OR EQUIVALENT

92CS-24894

Fig. 11 — Circuit used to measure saturated switching times for 2N6467 and 2N6468.

Medium-Power Silicon N-P-N Transistors

For Intermediate Power Applications in Industrial and Commercial Equipment

Features:

- Maximum safe-area-of-operation curves for dc and pulse operation
- High voltage ratings
- Low saturation voltages

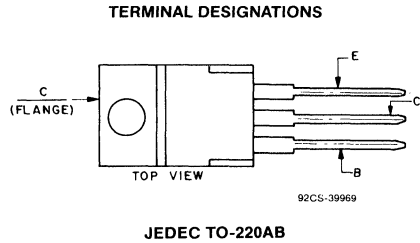
Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power switching circuits
- Solenoid drivers

RCA 2N6477 and 2N6478^Δ are silicon n-p-n transistors intended for a wide variety of medium-to-high power, high-voltage applications. These devices, which are voltage extensions of the 2N5298 family, are especially useful in vertical output stages in color and black-and-white TV. The units differ in voltage ratings and in the currents at which parameters are controlled.

The 2N6477 and 2N6478 are supplied in the JEDEC TO-220AB plastic package.

^ΔFormerly RCA Dev. Nos. TA8405 and TA8343.



MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6477	2N6478		
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open	$V_{CEO(sus)}$	120	140	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$	130	150	V
* With base reverse-biased ($V_{BE} = -1.5$ V)	$V_{CEV(sus)}$	140	160	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	2.5	2.5	A
PEAK COLLECTOR CURRENT		4	4	A
*CONTINUOUS BASE CURRENT	I_B	1	1	A
TRANSISTOR DISSIPATION:	P_T			
* At case temperature up to 25°C		50	50	W
* At case temperatures above 25°C		See Fig. 2		
At ambient temperatures up to 25°C		1.8	1.8	W
At ambient temperatures above 25°C		Derate linearly at 0.0144		W/°C
*TEMPERATURE RANGE:				
Storage and Operating (Junction)		-65 to 150		°C
*PIN TEMPERATURE (During Soldering):				
At distances \geq 1/32 in. (0.8 mm) from seating plane for 10 s max.		235		°C

* In accordance with JEDEC registration data format JS-6 RDF-2.

2N6477, 2N6478

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT A dc		2N6477		2N6478		
		V _{CE}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current: With base open	I _{CEO}	80 100			0 0		— 2	— —	— 2	mA	
With base-emitter junction reverse-biased	I _{CEV}	130 150		-1.5 -1.5		— —	2 —	— 2			
At T _C = 150°C	I _{CEV}	120 140		-1.5 -1.5		— —	10 —	— 10			
* Emitter-Cutoff Current	I _{EBO}		5		0		— 2	— —	2	mA	
* Collector-to-Emitter Sustaining Voltage: With base open	V _{CEO(sus)}				0.1 ^a	0	120	—	140	V	
With external base-to-emitter resistance (R _{BE}) = 100 Ω	V _{CER(sus)}				0.1 ^a		130	—	150		
With base-emitter junction reverse-biased	V _{CEV(sus)}			-1.5	0.1 ^a		140	—	160		
* DC Forward-Current Transfer Ratio	h _{FE}	4 4			1 ^a 2.5 ^a		25 5	150 —	25 5	150 —	
* Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				1 ^a 2.5 ^a	0.1 0.5	— 2	1 —	— 2	1 2	
* Base-to-Emitter Voltage	V _{BE}	4 4			1 ^a 2.5 ^a		— —	1.8 3	— —	1.8 3	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (f = 40 kHz)	|h _{fe}|	4			0.5		5	—	5	—	
* Gain-Bandwidth Product	f _T	4			0.5		200	—	200	—	
* Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h _{fe}	4			0.1		25	—	25	—	
Thermal Resistance: Junction-to-Case	R _{θJC}						—	2.5	—	2.5	
Junction-to-Ambient	R _{θJA}						—	70	—	70	

* In accordance with JEDEC registration data format (JS-6 RDF-2).

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.CAUTION: The sustaining voltage V_{CEO(sus)}, V_{CER(sus)}, and V_{CEV(sus)} MUST NOT be measured on a curve tracer.

2N6477, 2N6478

2

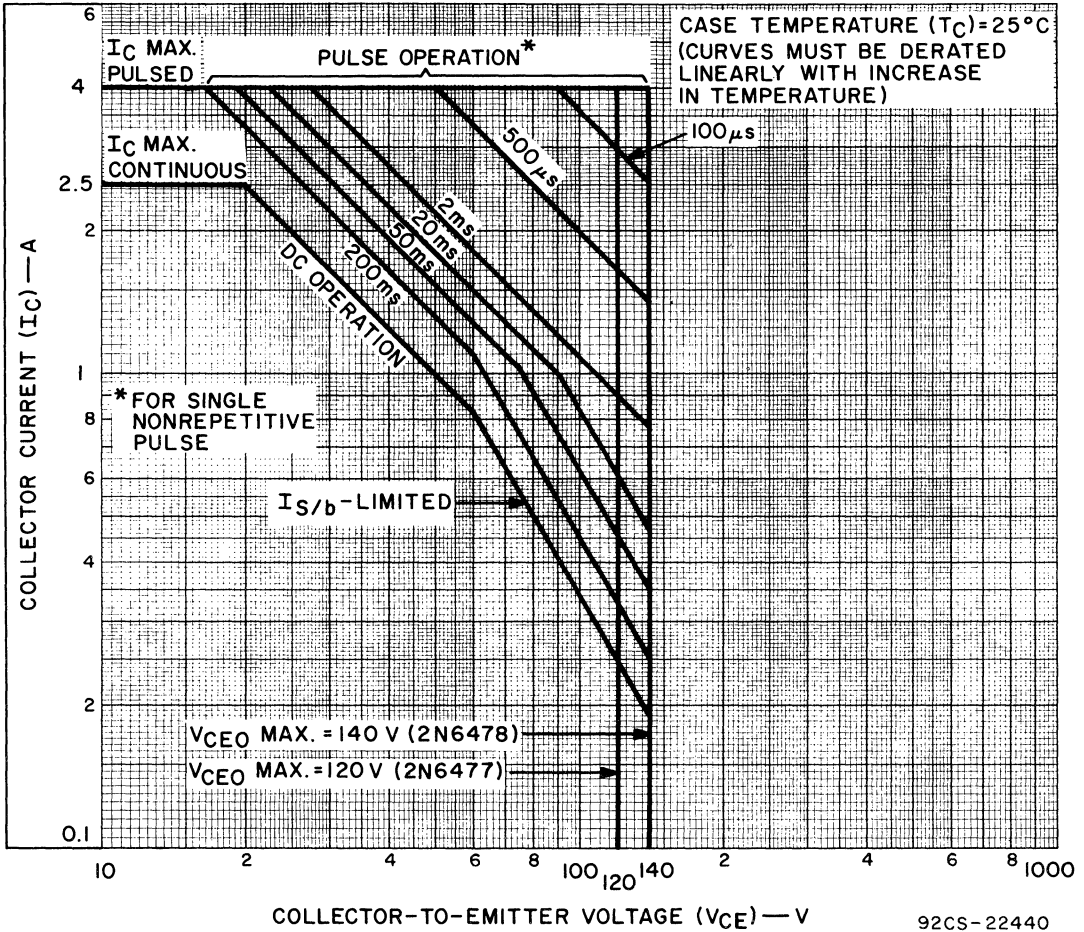


Fig. 1 — Maximum operating areas for both types.

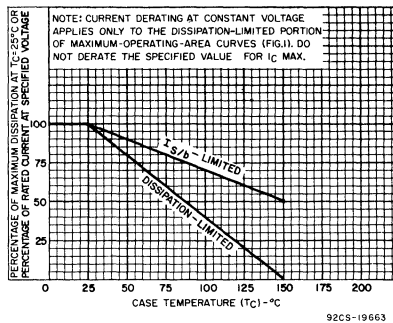
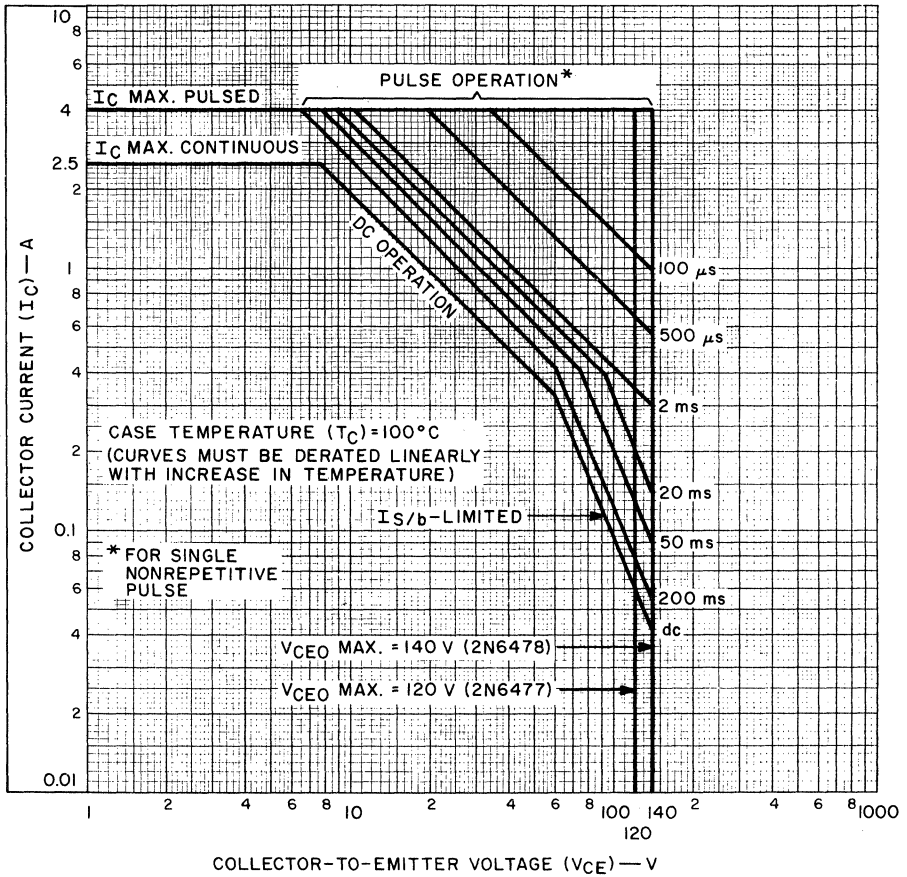


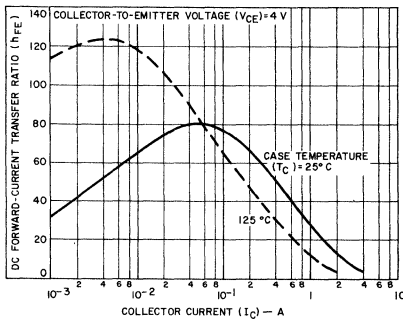
Fig. 2 — Current derating curve for both types.

2N6477, 2N6478



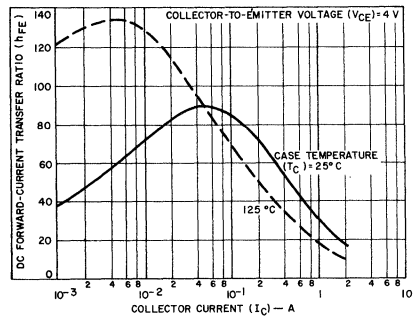
92CS-22442

Fig. 3 — Maximum operating areas for both types.



92CS-22443

Fig. 4 — Typical dc beta characteristics for 2N6477.



92CS-22444

Fig. 5 — Typical dc beta characteristics for 2N6478.

2N6477, 2N6478

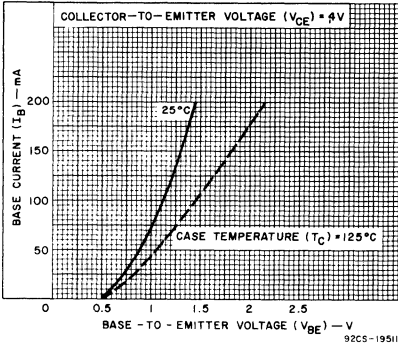


Fig. 6 — Typical input characteristics for 2N6477.

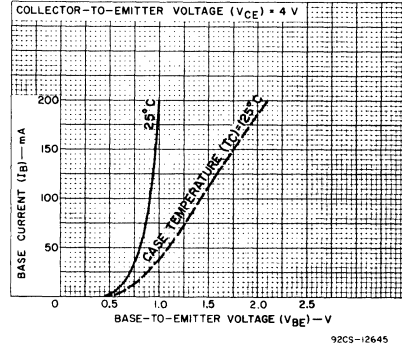


Fig. 7 — Typical input characteristics for 2N6478.

2

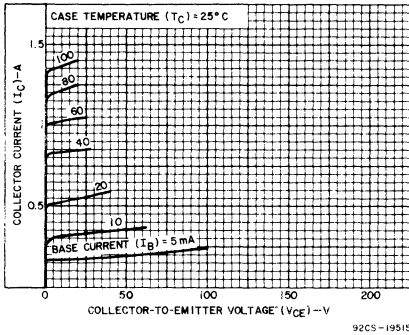


Fig. 8 — Typical output characteristics for 2N6477.

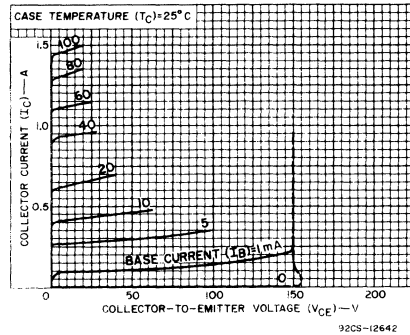


Fig. 9 — Typical output characteristics for 2N6478.

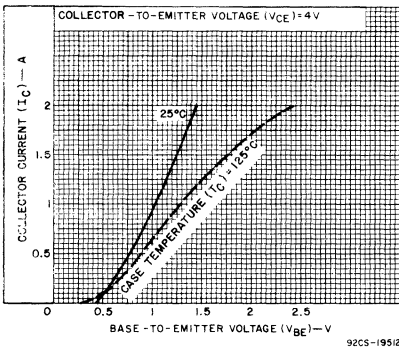


Fig. 10 — Typical transfer characteristics for 2N6477.

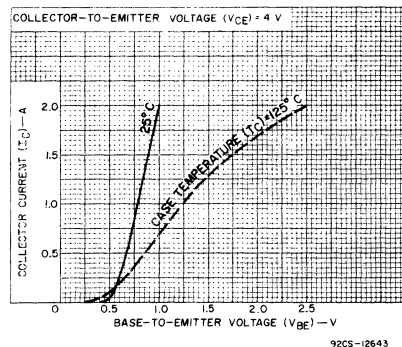


Fig. 11 — Typical transfer characteristics for 2N6478.

15-A, 75-W, Silicon N-P-N and P-N-P Epitaxial-Base VERSAWATT Transistors

Complementary Pairs for General-Purpose Switching and Amplifier Applications

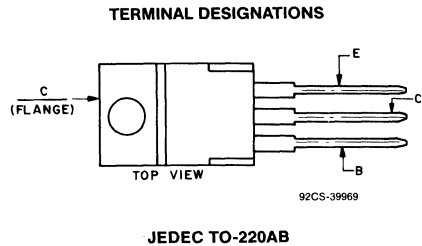
Features:

- Maximum safe-area-of-operation curves

RCA-2N6486—2N6491*, inclusive, are epitaxial-base silicon transistors. The 2N6486, 2N6487, and 2N6488 are n-p-n complements of p-n-p types 2N6489, 2N6490, and 2N6491, respectively. All these devices are intended for a wide variety of medium-power switching and amplifier applications, and are particularly useful in high-fidelity amplifiers utilizing complementary-symmetry circuits.

These devices are supplied in the TO-220AB (VERSAWATT) plastic package.

- Formerly RCA Dev. Nos. TA8325, TA8324, TA8323, TA8328, TA8327, and TA8326, respectively.



MAXIMUM RATINGS, Absolute-Maximum Values:

		N-P-N	2N6486	2N6487	2N6488	
		P-N-P	2N6489†	2N6490†	2N6491†	
*COLLECTOR-TO-BASE VOLTAGE.....	V_{CBO}		50	70	90	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With 1.5 volts (V_{BE}) of reverse bias, and external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CEX}		50	70	90	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}		45	65	85	V
With base open	V_{CEO}		40	60	80	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}		5	5	5	V
*CONTINUOUS COLLECTOR CURRENT	I_C		15	15	15	A
*CONTINUOUS BASE CURRENT	I_B		5	5	5	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C			57	75	75	W
At ambient temperatures up to 25°C			1.8	1.8	1.8	W
At case temperatures above 25°C				Derate linearly 0.6		W/°C
At ambient temperatures above 25°C				Derate linearly 0.0144		W/°C
*TEMPERATURE RANGE:						
Storage and operating (Junction)				-65 to +150		°C
*LEAD TEMPERATURE (During soldering):						
At distance \geq 1/8 in. (3.17 mm) from seating plane for 10 s max.				235		°C

* In accordance with JEDEC registration data format JS-6 RDF-2.

† For p-n-p devices, voltage and current values are negative.

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

ELECTRICAL CHARACTERISTICS, At case temperature (T_C) = 25°C unless otherwise specified

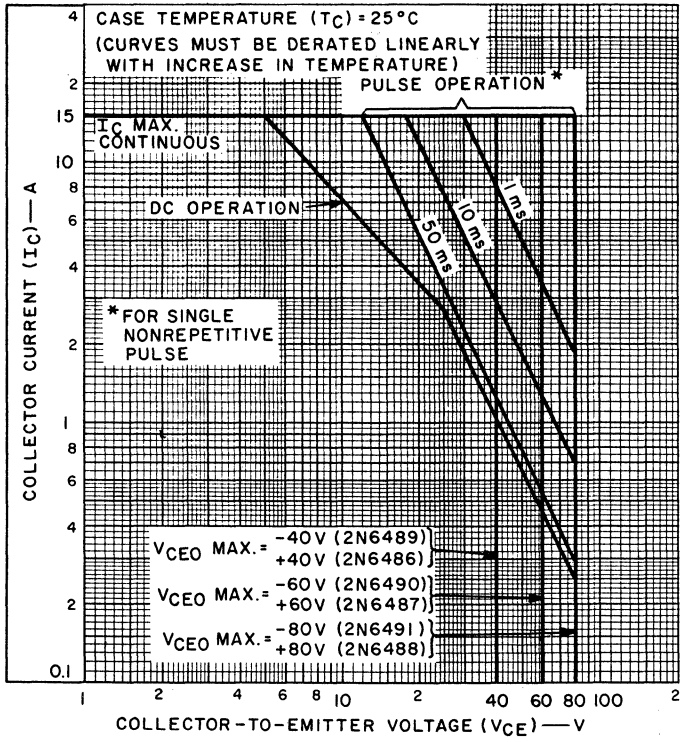
CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS	
		VOLTAGE V dc		CURR. A dc	2N6486 2N6489♦		2N6487 2N6490♦		2N6488 2N6491♦			
		V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.		
Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100Ω	I_{CER}	35 55 75			—	500	—	—	—	—	—	μA
* With base-emitter junction reverse biased and external base-to-emitter resistance (R_{BE}) = 100Ω	I_{CEX}	45 65 85	-1.5 -1.5 -1.5		—	500	—	—	—	—	—	μA
* At $T_C = 150^\circ\text{C}$		40 60 80	-1.5 -1.5 -1.5		—	5	—	—	—	—	—	mA
* With base open		I_{CEO}	20 30 40			—	1	—	—	—	—	—
* Emitter-Cutoff Current	I_{EBO}		-5	0	—	1	—	1	—	1	—	mA
* DC Forward-Current Transfer Ratio	h_{FE}	4 4		5 ^a 15 ^a	20 5	150 —	20 5	150 —	20 5	150 —		
* Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO(sus)}$			0.2	40 ^b	—	60 ^b	—	80 ^b	—		V
With external base-emitter resistance (R_{BE}) = 100Ω	$V_{CER(sus)}$			0.2	45 ^b	—	65 ^b	—	85 ^b	—		
With base-emitter junction reverse- biased and external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CEX(sus)}$		-1.5	0.2	50 ^b	—	70 ^b	—	90 ^b	—		
* Base-to-Emitter Voltage	V_{BE}	4 4		5 ^a 15 ^a	—	1.3 3.5	—	1.3 3.5	—	1.3 3.5	—	V
* Collector-to-Emitter Saturation Voltage $\left[\begin{array}{l} I_B = 0.5 \text{ A} \\ I_B = 5 \text{ A} \end{array} \right.$	$V_{CE(sat)}$			5 ^a 15 ^a	—	1.3 3.5	—	1.3 3.5	—	1.3 3.5	—	V
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: $f = 1 \text{ MHz}$	$|h_{fe}|$	4		1	5	—	5	—	5	—		
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ($f = 1 \text{ kHz}$)	h_{fe}	4		1	25	—	25	—	25	—		
Thermal Resistance: Junction-to-case	$R_{\theta JC}$				—	1.67	—	1.67	—	1.67		°C/W
Junction-to-ambient	$R_{\theta JA}$				—	—	—	70	—	70		

* In accordance with JEDEC registration data format (JS-6 RDF-2). ^b CAUTION: Sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEX(sus)}$ MUST NOT be measured on a curve tracer.

^a Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

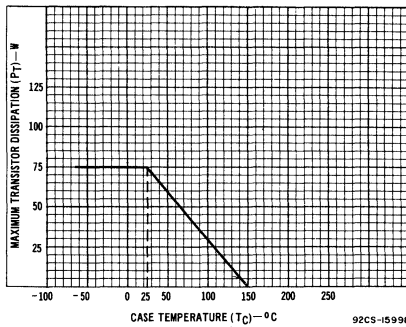
♦ For p-n-p devices, voltage and current values are negative.

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491



92CS-22805

Fig. 1 — Maximum operating areas for all types†.



92CS-15998

Fig. 2 — Derating chart for all types

† For p-n-p devices, voltage and current values are negative.

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

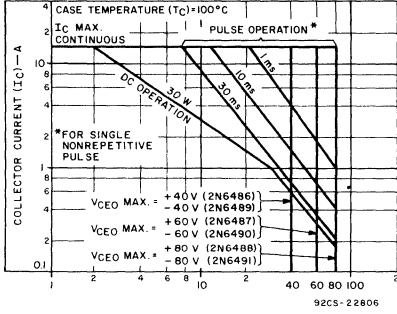


Fig. 3 — Maximum operating areas for all types†.

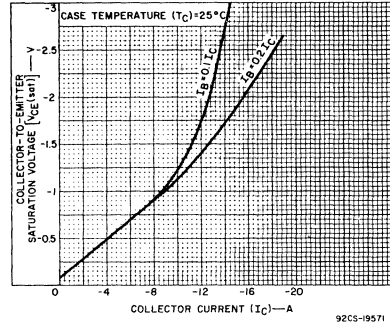


Fig. 4 — Typical collector-to-emitter saturation-voltage characteristics for all types.

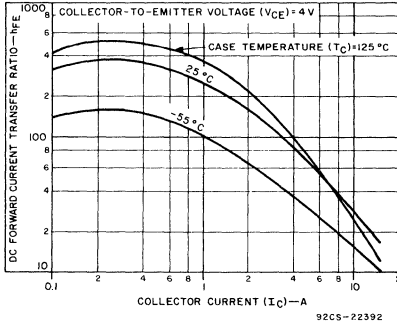


Fig. 5 — Typical dc beta characteristics for 2N6486, 2N6487, and 2N6488.

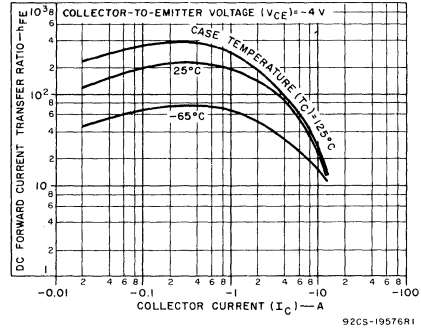


Fig. 6 — Typical dc beta characteristics for 2N6489, 2N6490, and 2N6491.

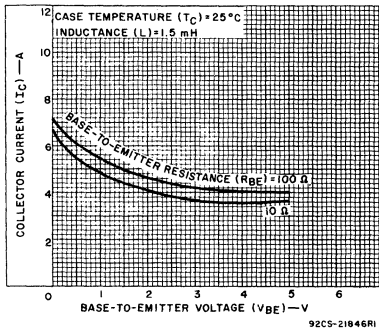


Fig. 7 — Minimum reverse-bias second-breakdown characteristics for all types†.

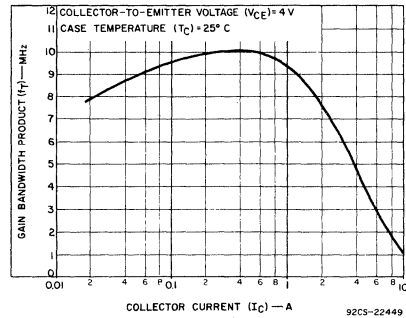


Fig. 8 — Typical gain-bandwidth product vs. collector current for all types†.

† For p-n-p devices, voltage and current values are negative.

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

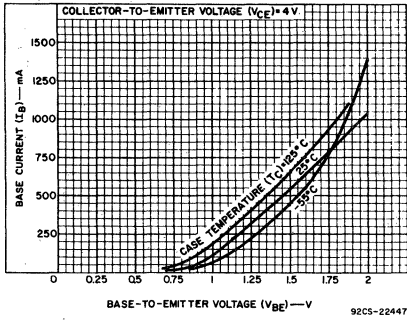


Fig. 9 — Typical input characteristics for all types†.

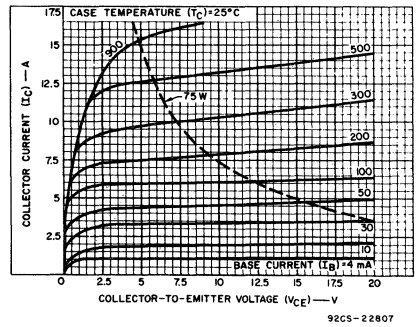


Fig. 10 — Typical output characteristics for all types†.

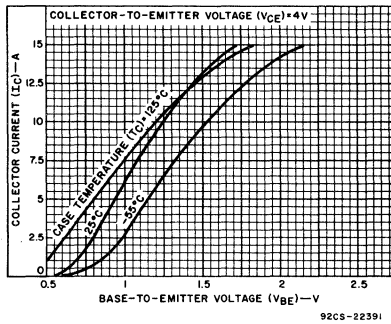


Fig. 11 — Typical transfer characteristics for all types†.

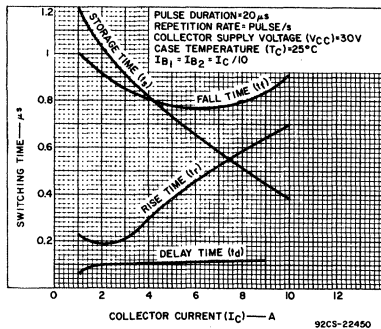


Fig. 12 — Typical saturated switching characteristics for 2N6486, 2N6487, and 2N6488.

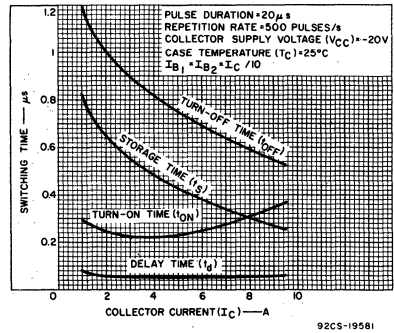


Fig. 13 — Typical saturated switching characteristics for 2N6489, 2N6490, and 2N6491.

† For p-n-p devices, voltage and current values are negative.

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

2

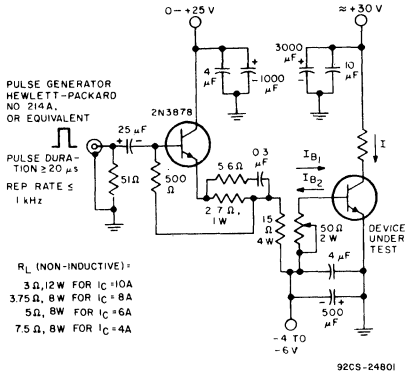


Fig. 14 — Circuit used to measure switching times for 2N6486, 2N6487, and 2N6488.

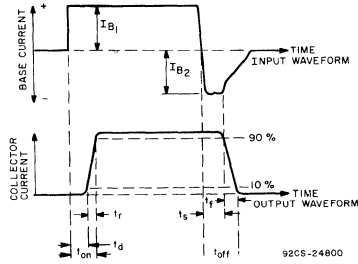


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 14).

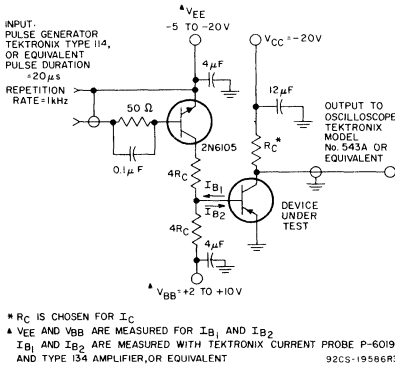


Fig. 16 — Circuit used to measure switching times for 2N6489, 2N6490, and 2N6491.

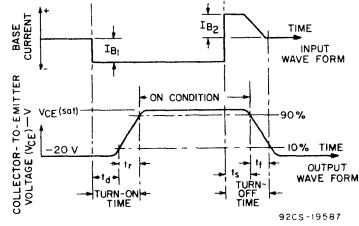


Fig. 17 — Oscilloscope display for measurement for switching times (test circuit shown in Fig. 16).

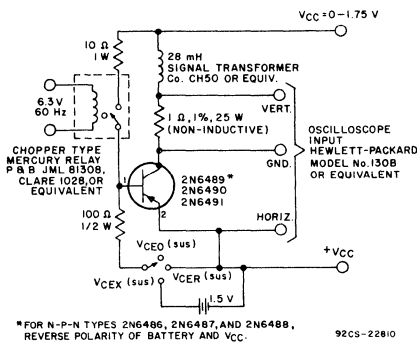
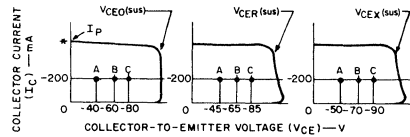


Fig. 18 — Circuit used to measure sustaining voltages $V_{ce0}(sus)$, $V_{ceR}(sus)$, and $V_{ceX}(sus)$ for all types.



THE SUSTAINING VOLTAGES $V_{ce0}(sus)$, $V_{ceR}(sus)$, AND $V_{ceX}(sus)$ ARE ACCEPTABLE WHEN THE TRACES FALL TO THE RIGHT AND ABOVE POINT "A" FOR TYPES 2N6486 AND 2N6488, POINT "B" FOR 2N6487 AND 2N6490; AND POINT "C" FOR 2N6488 AND 2N6491.

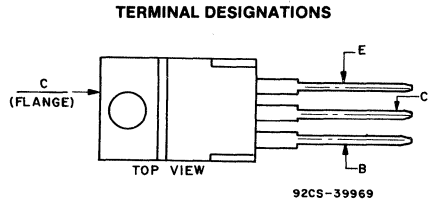
92CS-2281I

Fig. 19 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 18).

8-Ampere N-P-N Darlington Power Transistors

80, 100, 120 Volts, 60 Watts
 Gain of 1000 at 5 A (2N6530, 2N6532)
 Gain of 1000 at 3 A (2N6533)
 Gain of 500 at 3 A (2N6531)

- | | |
|--|--|
| Features: | Applications: |
| <ul style="list-style-type: none"> ■ Operate from IC without predriver ■ Low leakage at high temperature | <ul style="list-style-type: none"> ■ Power switching ■ Hammer drivers ■ Series and shunt regulators ■ Audio amplifiers |



JEDEC TO-220AB

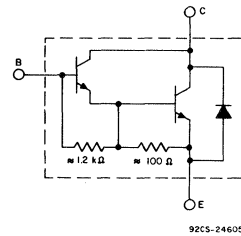


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6530	2N6531	2N6532	2N6533	
*V _{CBO}	80	100	100	120	V
V _{CER(sus)}					
R _{BE} = 100 Ω	80	100	100	120	V
V _{CEO(sus)}	80	100	100	120	V
*V _{CEV(sus)}					
V _{BE} = -1.5 V	80	100	100	120	V
*V _{EBO}	5	5	5	5	V
*I _C	8	8	8	8	A
I _{CM}	15	15	15	15	A
*I _B	0.25	0.25	0.25	0.25	A
*P _T					
Up to 25°C	65	65	65	65	W
Above 25°C		See Fig. 3			
*T _J , T _{stg}		-65 to +150			°C
*T _L					
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235			°C

* In accordance with JEDEC registration data format JS-6, RDF-4.

2N6530, 2N6531, 2N6532, 2N6533

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6530		2N6531		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	80 100			0 0	— —	1 —	— —	— 1	mA
* I_{CEV}	80 100	-1.5 -1.5			— —	0.5 —	— 0.5		
* $T_C = 125^\circ\text{C}$	80 100	-1.5 -1.5			— —	5 —	— 5		
I_{EBO}		-5	0		—	5	—	5	mA
* h_{FE}	3 3 3		5 ^a 3 ^a 8 ^a		1,000 — 100	10,000 — 5,000	— 500 100	— 10,000 5,000	
$V_{CEO(sus)}$			0.2	0	80 ^b	—	100 ^b	—	V
$V_{CER(sus)}$ $R_{BE} = 100\ \Omega$			0.2		80 ^b	—	100 ^b	—	
* $V_{CEV(sus)}$		-1.5	0.2		80 ^b	—	100 ^b	—	
V_{BE}	3 3 3		5 ^a 3 ^a 8 ^a		— — —	2.8 — 4.5*	— — —	— 2.8 4.5*	V
$V_{CE(sat)}$			3 ^a 5 ^a 8 ^a	0.006 0.01 0.08	— — —	— 2 3*	— — —	3 — 3*	V
V_F			5 ^a 3 ^a		— —	— 5	— —	4 —	V
h_{fe} $f = 1\ \text{kHz}$	5		1		1,000	—	1,000	—	
* $|h_{fe}|$ $f = 1\ \text{MHz}$	5		1		20	—	20	—	
C_{obo} $V_{CB} = 10\ \text{V}$ $f = 1\ \text{MHz}$					—	200	—	200	pF
* I_S/b $t = 0.5\ \text{s}$, nonrep.	24				2.7	—	2.7	—	A
$R_{\theta JC}$					—	1.92	—	1.92	°C/W

* In accordance with JEDEC registration data format JS-6, RDF 4.

^d Pulsed, pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: Sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEV(sus)}$ MUST NOT be measured on a curve tracer.

2N6530, 2N6531, 2N6532, 2N6533

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

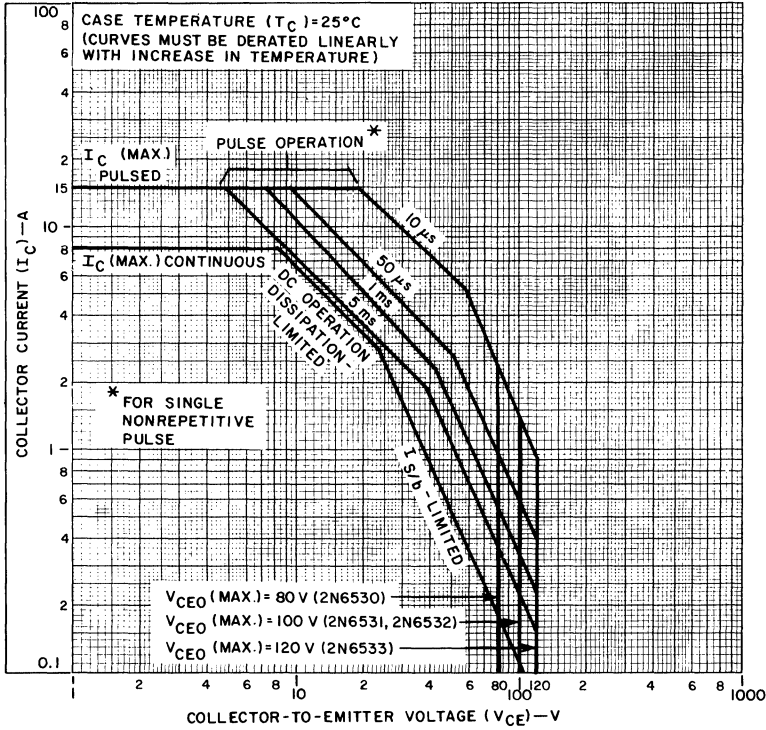
CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6532		2N6533		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	120 100			0 0	— —	— 1	— —	1 —	mA
* I_{CEV}	120 100	-1.5 -1.5			— —	— 0.5	— —	0.5 —	
* $T_C = 125^\circ\text{C}$	120 100	-1.5 -1.5			— —	— 5	— —	5 —	
I_{EBO}		-5	0		—	5	—	5	mA
* h_{FE}	3 3 3		3 ^a 5 ^a 8 ^a		— 1,000 100	— 10,000 5,000	1,000 — 100	10,000 — 5,000	
$V_{CEO(sus)}$			0.2	0	100 ^b	—	120 ^b	—	V
$V_{CER(sus)}$ $R_{BE} = 100\ \Omega$			0.2		100 ^b	—	120 ^b	—	
* $V_{CEV(sus)}$		-1.5	0.2		100 ^b	—	120 ^b	—	
V_{BE}	3 3 3		3 ^a 5 ^a 8 ^a		— — —	— 2.8 4.5*	— — —	2.8 — 4.5*	V
$V_{CE(sat)}$			3 ^a 5 ^a 8 ^a	0.006 0.01 0.08	— — —	— 2 3*	— — —	2 — 3*	V
V_F			5 ^a 8 ^a		— —	— 5	— —	4 —	V
h_{fe} $f = 1\ \text{kHz}$	5		1		1,000	—	1,000	—	
* $|h_{fe}|$ $f = 1\ \text{MHz}$	5		1		20	—	20	—	
C_{obo} $V_{CB} = 10\ \text{V}$ $f = 1\ \text{MHz}$					—	200	—	200	pF
* I_S/b $t = 0.5\ \text{s}$, nonrep.	24				2.7	—	2.7	—	A
$R_{\theta JC}$					—	1.92	—	1.92	°C/W

* In accordance with JEDEC registration data format JS-6, RDF-4.

^a Pulsed, pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: Sustaining voltages $V_{CEO(sus)}$, $V_{CER(sus)}$, and $V_{CEV(sus)}$ MUST NOT be measured on a curve tracer.

2N6530, 2N6531, 2N6532, 2N6533



92CS-24603R1

Fig. 2—Maximum operating areas for all types at case temperature of 25°C.

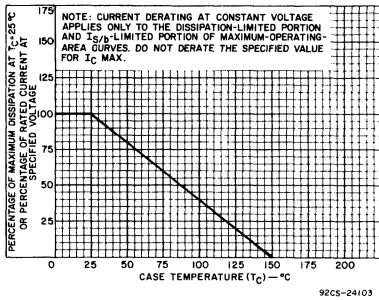


Fig. 3—Dissipation derating curve for all types.

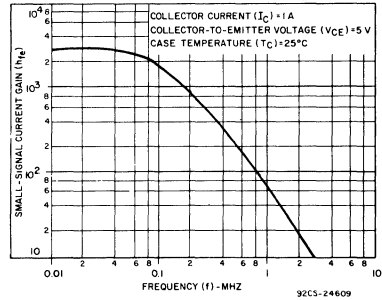


Fig. 4 — Typical small-signal current gain for all types.

2N6530, 2N6531, 2N6532, 2N6533

2N6530, 2N651, 2N6532, 2N6533

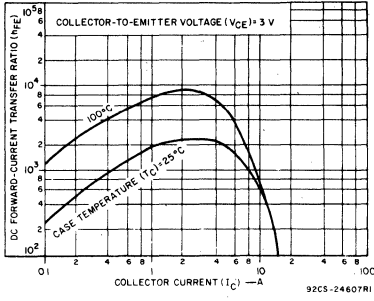


Fig. 5 — Typical dc beta characteristics for all types.

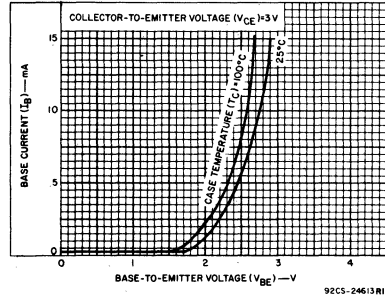


Fig. 6 — Typical input characteristics for all types.

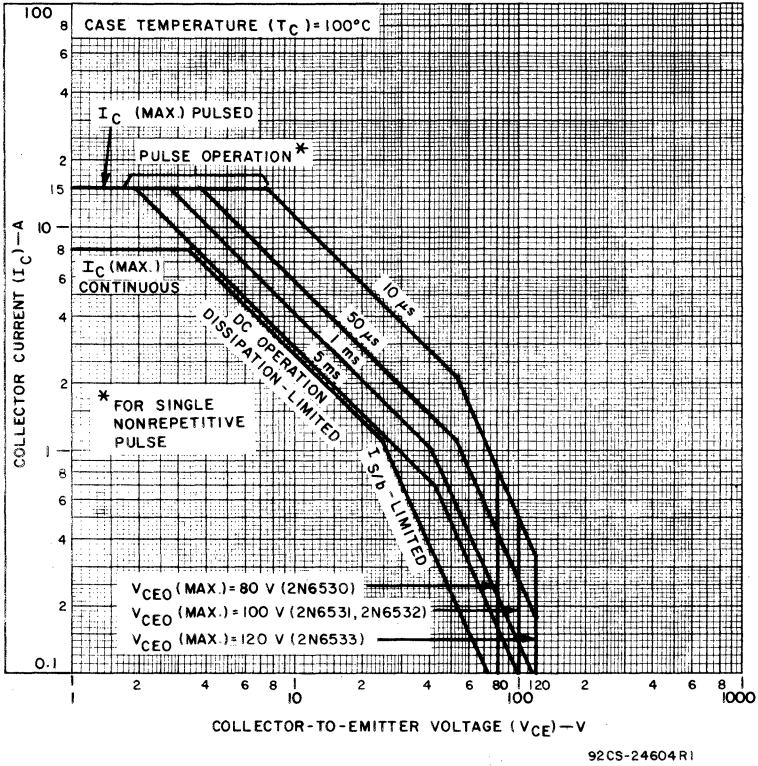


Fig. 7—Maximum operating areas for all types at case temperature of 100°C .

2N6530, 2N6531, 2N6532, 2N6533

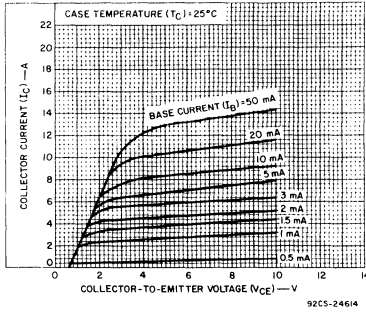


Fig. 8 — Typical output characteristics for all types.

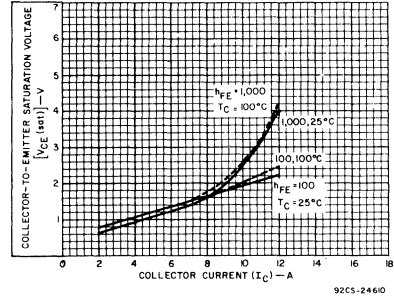


Fig. 9 — Typical saturation characteristics for all types.

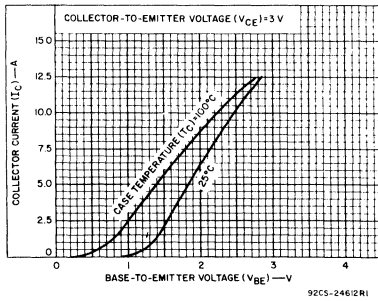


Fig. 10 — Typical transfer characteristics for all types.

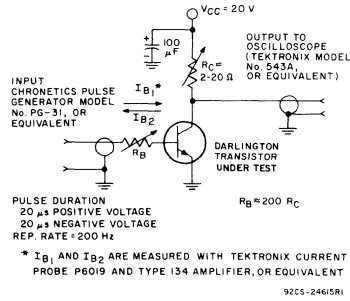


Fig. 11 — Circuit used to measure saturated switching-times.

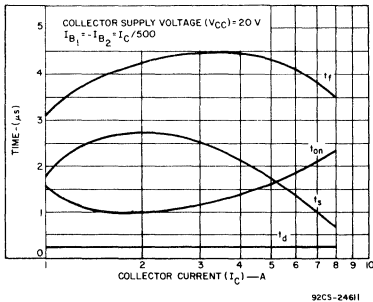


Fig. 12 — Typical saturated switching-time characteristics for all types.

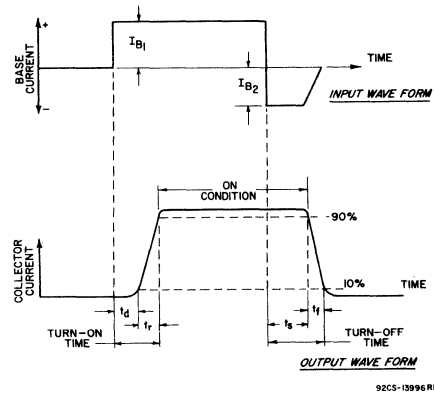


Fig. 13 — Phase relationship between input current and output current, showing reference points for specification of switching-times.

3-, 5-, and 10-A Power-Switching Transistors

High-Voltage N-P-N Type for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- 100% High Temperature Tested for 100°C Parameters
- Fast Switching Speed
- High voltage rating
 $V_{CEX} = 350\text{ V}$
 $= 450\text{ V [2N6545]}$
- Low $V_{CE(sat)}$ at $I_C = 3\text{-}, 5\text{-},$ and 10-A

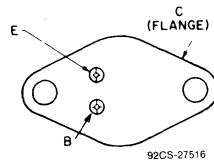
Applications:

- Off-Line Power Supplies
- High Voltage Inverters
- Switching Regulators

The 2N6542, 2N6544, 2N6545, and 2N6546 series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are characterized at 100°C; as well as at 25°C, to provide information necessary for worst-case design.

The 2N6542, 2N6544, 2N6545, and 2N6546 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6542	2N6544	2N6545	2N6546	
* V_{CEV} $V_{BE} = -1.5\text{ V}$	650	650	850	650	V
* V_{CEX} (Clamped) $V_{BE} = -1.5\text{ V}$	350	350	450	350	V
* V_{CEO}	300	300	400	300	V
* V_{EBO}		8			V
$I_C(sat)$	3	5	5	10	A
* I_C	5	8	8	15	A
* I_{CM}	10	16	16	30	A
* I_B	5	8	8	10	A
* P_T T_C up to 25°C	100	125	125	175	W
T_C above 25°C, derate linearly	0.57	0.714	0.714	1	W/°C
* T_{stg}, T_J		-65 to 200			°C
* T_L At distance $\geq 1/8$ in. (3.17 mm) from seating plane for 5 s max.		275			°C

* In accordance with JEDEC registration data.

2N6542, 2N6544, 2N6545, 2N6546

ELECTRICAL CHARACTERISTICS $T_c = 25^\circ\text{C}$

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N6542		2N6544		2N6545		2N6546		
	VCE	VBE	IC	Ib	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
* ICEV	650	-1.5	—	—	—	0.5	—	0.5	—	—	—	1	mA
	850	-1.5	—	—	—	—	—	—	—	0.5	—	—	
* IEBO	—	-8	0	—	—	1	—	1	—	1	—	1	
* VCE(sus) ^b	—	—	0.1 ^a	—	300	—	300	—	400	—	300	—	V
* hFE	2	—	3 ^a	—	7	35	—	—	—	—	—	—	
	2	—	1.5 ^a	—	12	60	—	—	—	—	—	—	
	3	—	5 ^a	—	—	—	7	35	7	35	—	—	
	3	—	2.5 ^a	—	—	—	12	60	12	60	—	—	
	2	—	10 ^a	—	—	—	—	—	—	—	6	30	
	2	—	5 ^a	—	—	—	—	—	—	—	12	60	
* VBE(sat)	—	—	3 ^a	0.6	—	1.4	—	—	—	—	—	—	V
	—	—	5 ^a	1	—	—	—	1.6	—	1.6	—	—	
	—	—	10 ^a	2	—	—	—	—	—	—	—	1.6	
* VCE(sat)	—	—	3 ^a	0.6	—	1	—	—	—	—	—	—	V
	—	—	5 ^a	1	—	5	—	1.5	—	1.5	—	—	
	—	—	8 ^a	2	—	—	—	5	—	5	—	—	
	—	—	10 ^a	2	—	—	—	—	—	—	—	1.5	
	—	—	15 ^a	3	—	—	—	—	—	—	—	5	
* IS/b t = 1 s	100	—	—	—	0.2	—	0.2	—	0.2	—	0.2	—	A
fr f = 1 MHz	10	—	0.2	—	6	28	—	—	—	—	—	—	MHz
	10	—	0.3	—	—	—	6	28	6	28	—	—	
	10	—	0.5	—	—	—	—	—	—	—	6	28	
* Cob f = 1 MHz	10 ^d	—	—	—	50	200	75	300	75	300	125	500	pF
* t _d ^{e,g}	—	—	3	0.6	—	0.05	—	—	—	—	—	—	μS
	—	—	5	1	—	—	—	0.05	—	0.05	—	—	
	—	—	10	2	—	—	—	—	—	—	—	0.05	
* t _r ^{e,g}	—	—	3	0.6	—	0.7	—	—	—	—	—	—	μS
	—	—	5	1	—	—	—	1	—	1	—	—	
	—	—	10	2	—	—	—	—	—	—	—	1	
* t _s ^{e,g}	—	—	3	0.6	—	4	—	—	—	—	—	—	μS
	—	—	5	1	—	—	—	4	—	4	—	—	
	—	—	10	2	—	—	—	—	—	—	—	4	
* t _f ^{e,g}	—	—	3	0.6	—	0.8	—	—	—	—	—	—	μS
	—	—	5	1	—	—	—	1	—	1	—	—	
	—	—	10	2	—	—	—	—	—	—	—	—	

* In accordance with JEDEC registration data.

2

2N6542, 2N6544, 2N6545, 2N6546ELECTRICAL CHARACTERISTICS $T_c = 100^\circ\text{C}$

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N6542		2N6544		2N6545		2N6546		
	VCE	VBE	IC	IB	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
* ICEV	650	-1.5	—	—	—	2.5	—	2.5	—	—	—	4	mA
	850	-1.5	—	—	—	—	—	—	—	2.5	—	—	
* ICER RBE = 50 Ω	650	—	—	—	—	3	—	3	—	—	—	5	
	850	—	—	—	—	—	—	—	—	3	—	—	—
* VCEX(sus) ^{b,c} VCC = 20 V L = 180 μH , RC = 0.05 Ω Vclamp = Rated VCEX	—	—	2.6 ^a	—	350	—	—	—	—	—	—	—	V
	—	—	4.5 ^a	—	—	—	350	—	450	—	—	—	
	—	—	8 ^a	—	—	—	—	—	—	—	350	—	
	—	—	5 ^a	—	200	—	—	—	—	—	—	—	V
	—	—	8 ^a	—	—	—	200	—	300	—	—	—	
	—	—	15 ^a	—	—	—	—	—	—	—	200	—	
* VBE(sat)	—	—	3 ^a	0.6	—	1.4	—	—	—	—	—	—	V
	—	—	5 ^a	1	—	—	—	1.6	—	1.6	—	—	
	—	—	10 ^a	2	—	—	—	—	—	—	—	1.6	
* VCE(sat)	—	—	3 ^a	0.6	—	2	—	—	—	—	—	—	V
	—	—	5 ^a	1	—	—	—	2.5	—	2.5	—	—	
	—	—	10 ^a	2	—	—	—	—	—	—	—	2.5	
* ts ^{f,g}	—	-5	3	0.6	—	4	—	—	—	—	—	—	μS
	—	-5	5	1	—	—	—	4	—	4	—	—	
	—	-5	10	2	—	—	—	—	—	—	—	5	
* tr ^{f,g}	—	-5	3	0.6	—	0.8	—	—	—	—	—	—	μS
	—	-5	5	1	—	—	—	0.9	—	0.9	—	—	
	—	-5	10	2	—	—	—	—	—	—	—	1.5	
* R θ JC	—	—	—	—	—	1.75	—	1.4	—	1.4	—	1	$^\circ\text{C/W}$

* In accordance with JEDEC registration data.

^a Pulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.**CAUTION:** The sustaining voltage VCEO(sus) and VCEX(sus) *MUST NOT* be measured on a curve tracer.^c VCC = 20 V, L = 180 μH , RC = 0.05 Ω ^d VCB value^e Resistive load, VCC = 250 V, tp = 100 μs , IB1 = -IB2^f Inductive load, Vclamp = Rated VCEX(sus), IB1 = -IC/5, L = 180 μH , RC = 0.05 Ω , VCC = 20 V^g For switching speed test methods, see Application Note AN-6820.

2N6542, 2N6544, 2N6545, 2N6546

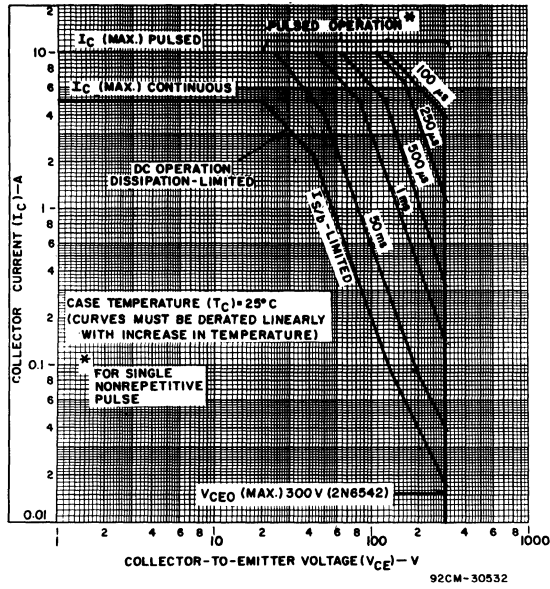


Fig. 1 - Maximum operating areas for type 2N6542 ($T_c = 25^\circ$).

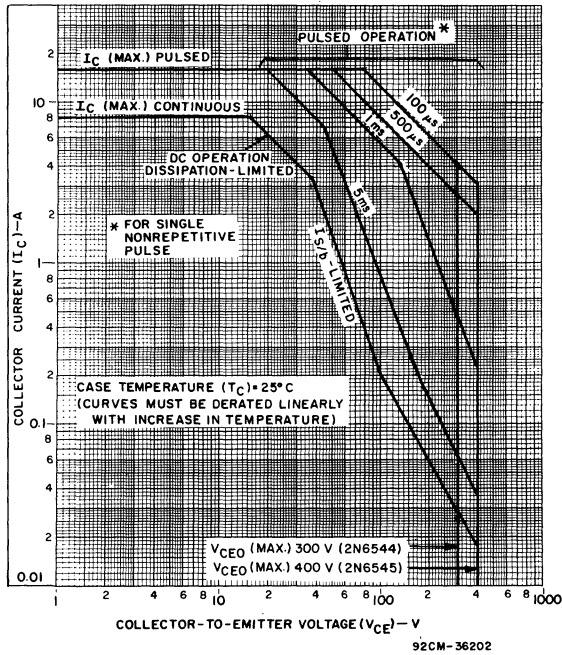


Fig. 2 - Maximum operating areas for type 2N6544 and 2N6545 ($T_c = 25^\circ\text{C}$).

2N6542, 2N6544, 2N6545, 2N6546

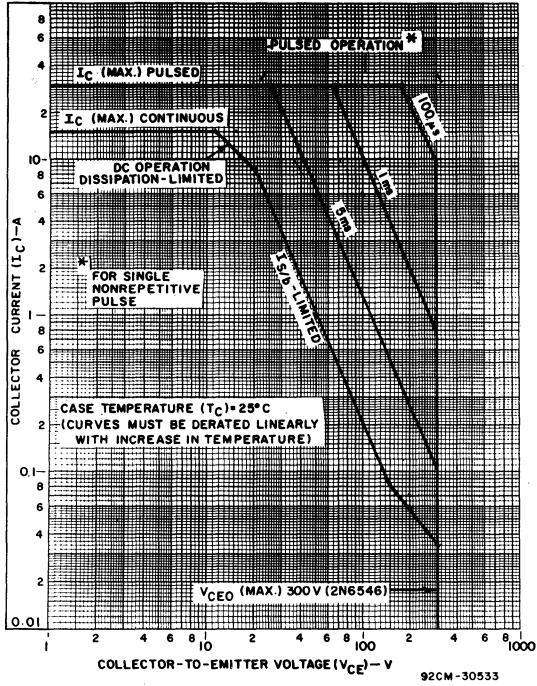


Fig. 3 - Maximum operating areas for type 2N6546 ($T_c = 25^\circ$)

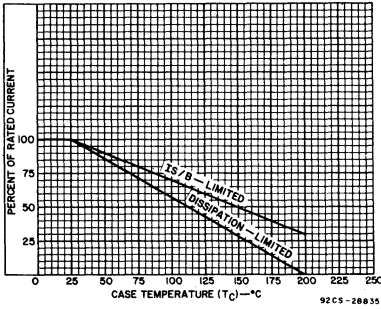


Fig. 4 - Dissipation and I_s/B derating curves for all types.

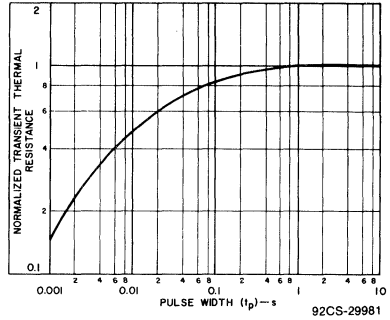


Fig. 5 - Typical thermal-response characteristics for types 2N6542, 2N6544 and 2N6545.

2N6542, 2N6544, 2N6545, 2N6546

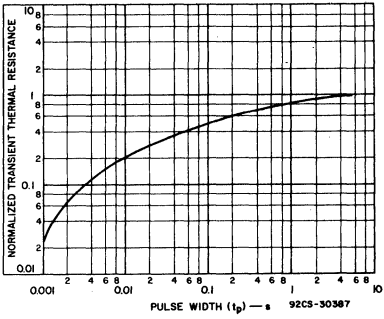


Fig. 6 — Typical thermal-response characteristics for type 2N6546.

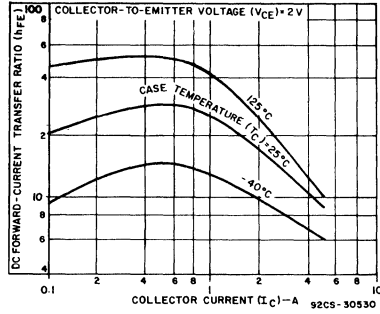


Fig. 7 — Typical dc beta characteristics for type 2N6542.

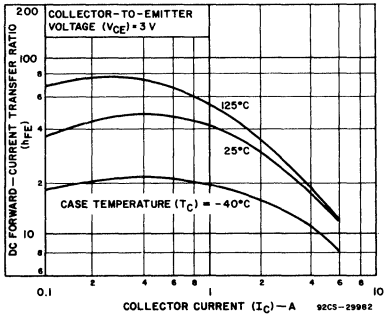


Fig. 8 — Typical dc beta characteristics for type 2N6544.

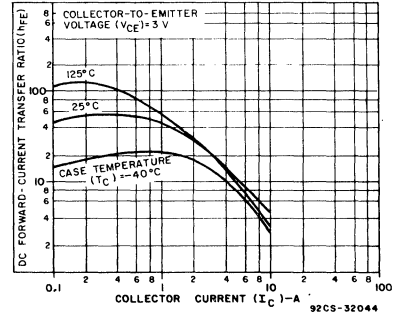


Fig. 9 — Typical dc beta characteristics for type 2N6545.

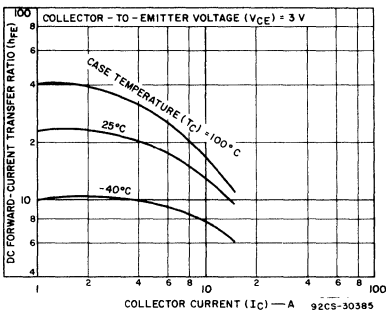


Fig. 10 — Typical dc beta characteristics for type 2N6546.

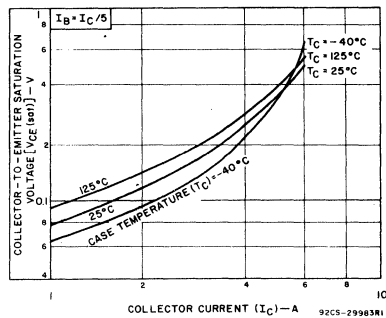


Fig. 11 — Typical collector-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

2N6542, 2N6544, 2N6545, 2N6546

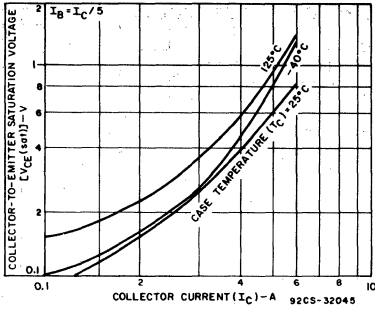


Fig. 12 — Typical collector-to-emitter saturation voltage as a function of collector current for type 2N6545.

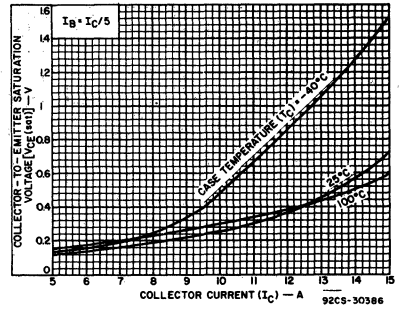


Fig. 13 — Typical collector-to-emitter saturation voltage characteristics for type 2N6546.

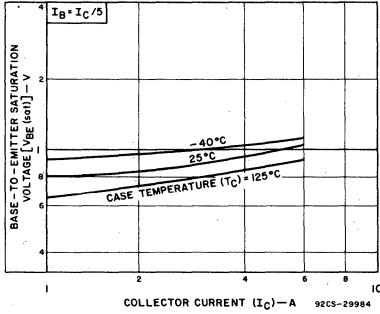


Fig. 14 — Typical base-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

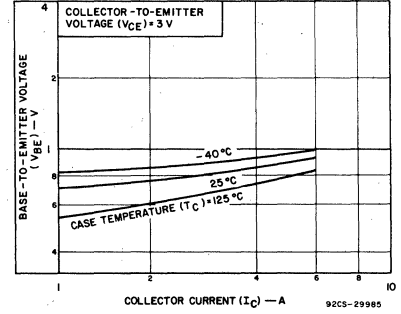


Fig. 15 — Typical base-to-emitter voltage as a function of collector current for types 2N6542 and 2N6544.

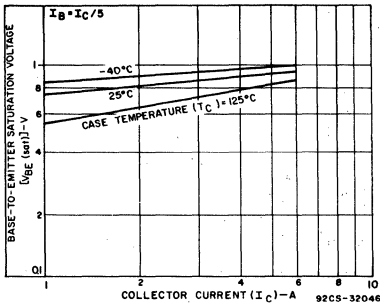


Fig. 16 — Typical base-to-emitter saturation voltage as a function of collector current for type 2N6545.

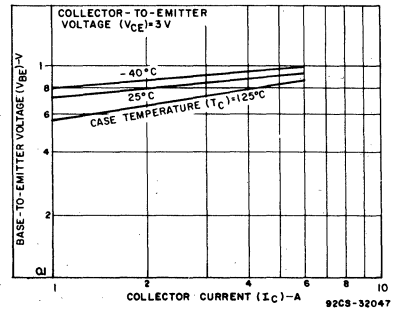


Fig. 17 — Typical base-to-emitter voltage as a function of collector current for type 2N6545.

2N6542, 2N6544, 2N6545, 2N6546

2

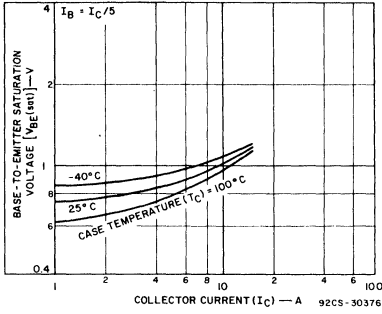


Fig. 18 — Typical base-to-emitter saturation voltage characteristics for type 2N6546.

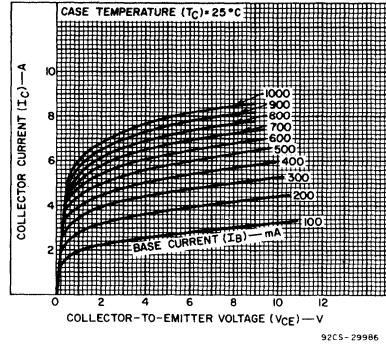


Fig. 19 — Typical output characteristics for types 2N6542 and 2N6544.

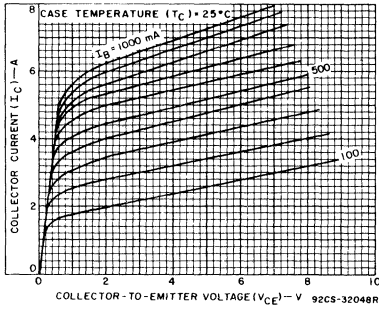


Fig. 20 — Typical output characteristics for type 2N6545.

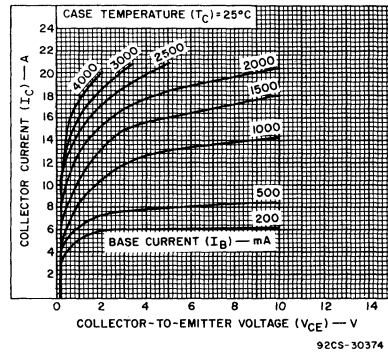


Fig. 21 — Typical output characteristics for type 2N6546.

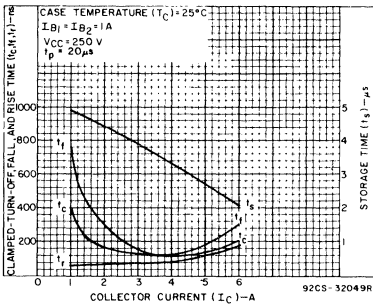


Fig. 22 — Typical saturated switching time characteristics for type 2N6545.

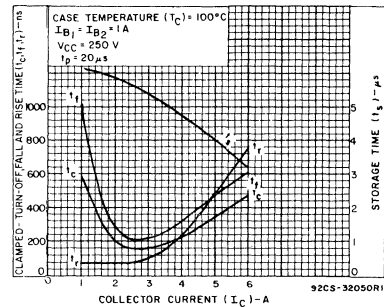


Fig. 23 — Typical saturated switching time characteristics for type 2N6546.

2N6542, 2N6544, 2N6545, 2N6546

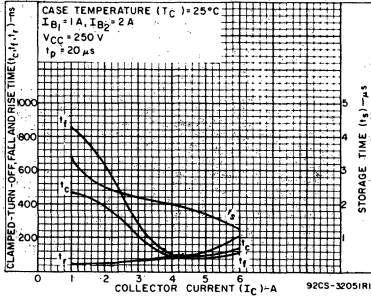


Fig. 24 — Typical saturated switching time characteristics for type 2N6545.

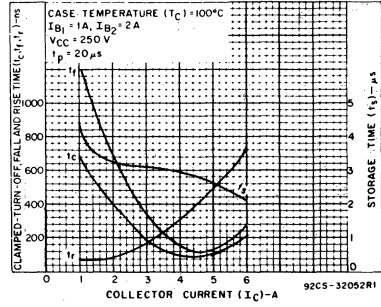


Fig. 25 — Typical saturated switching time characteristics for type 2N6545.

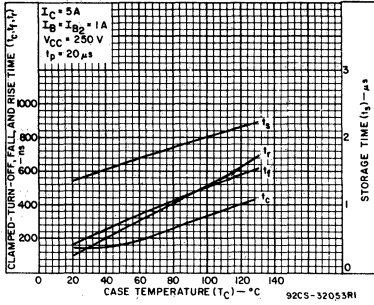


Fig. 26 — Typical saturated switching time characteristics as a function of case temperature for type 2N6545.

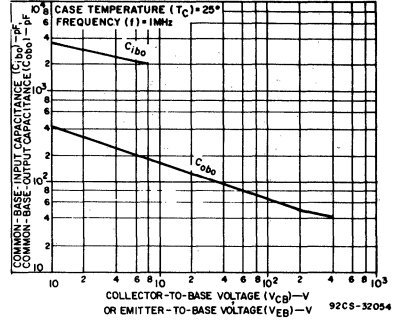


Fig. 27 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for type 2N6545.

15-Ampere Power-Switching Transistors

2

Features:

- 100% High temperature tested for 100° C parameters
- Fast switching speed
- High voltage rating $V_{CEX} = 450V$
- Low $V_{CE(sat)}$ at $I_C = 2-$ and $3-A$

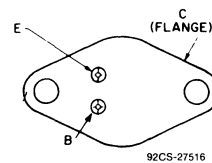
Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

The 2N6547 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits.

These devices are supplied in the JEDEC TO-204AA hermetic packages.

TERMINAL DESIGNATION



JEDEC TO-204AA

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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	Volts
Collector Current — Continuous	I_C	15	A
Peak	I_{CM}	30	
Base Current — Continuous	I_B	10	A
Peak	I_{BM}	20	
Total Power Dissipation @ $T_C = 100^\circ C$	P_D	100	Watts
@ $T_C = 25^\circ C$		175	
Derate above 25° C		1	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	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	275	°C

2N6547

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)	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 4	mA
Collector Cutoff Current (V _{CE} = Rated V _{CEV} , R _{BE} = 50Ω, T _C = 100°C)	I _{CER}	—	—	5	mA
Emitter Cutoff Current (V _{EB} = 9.0V)	I _{EBO}	—	—	1	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⁽¹⁾

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 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 I _{B1} = -I _{B2} = 2A, t _p = 100μs Duty Cycle < 2.0%	t _d	—	—	0.05
Rise Time		t _r	—	—	1
Storage Time		t _s	—	—	4
Fall Time		t _f	—	—	0.7

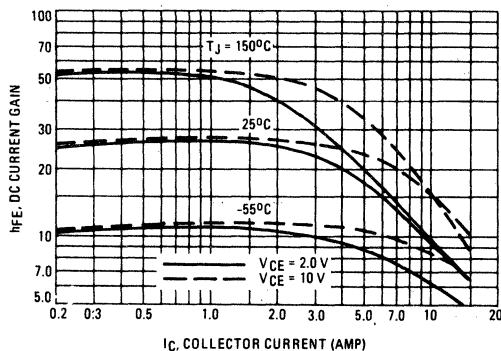


FIGURE 1 - DC CURRENT GAIN

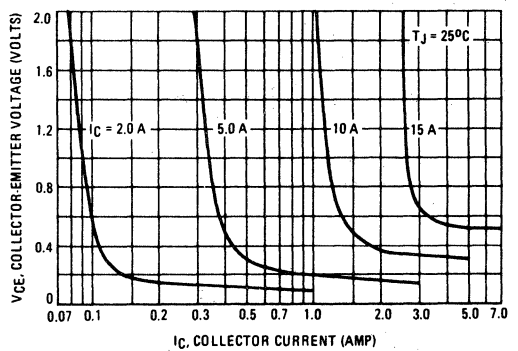


FIGURE 2 - COLLECTOR SATURATION REGION

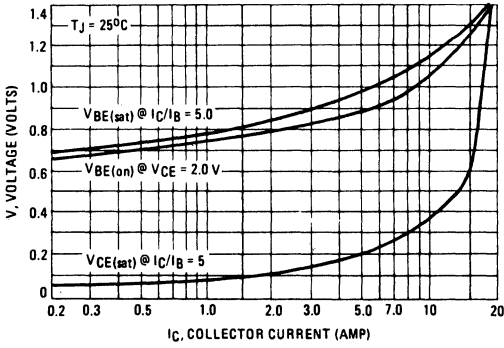


FIGURE 3 - "ON" VOLTAGE

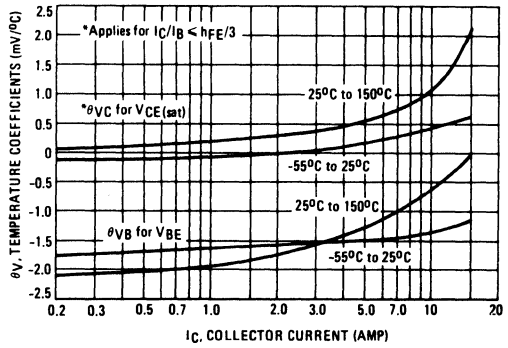


FIGURE 4 - TEMPERATURE COEFFICIENTS

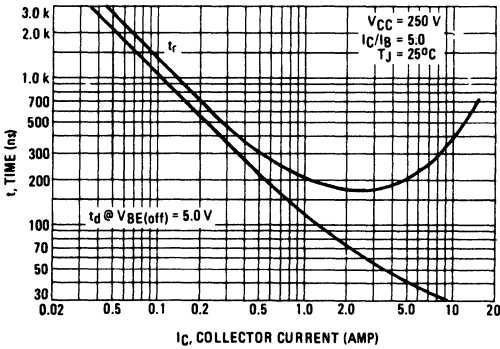


FIGURE 5 - TURN-ON TIME

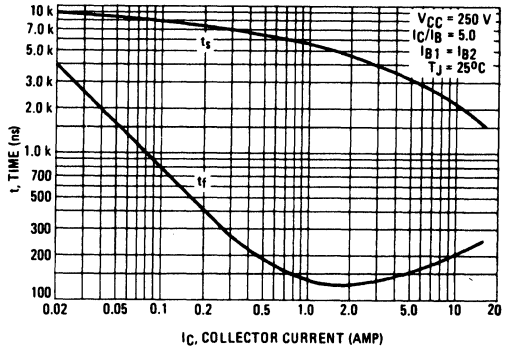


FIGURE 6 - TURN-OFF TIME

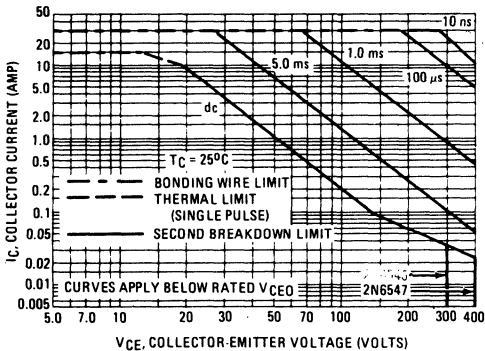


FIGURE 7 - FORWARD BIAS SAFE OPERATING AREA

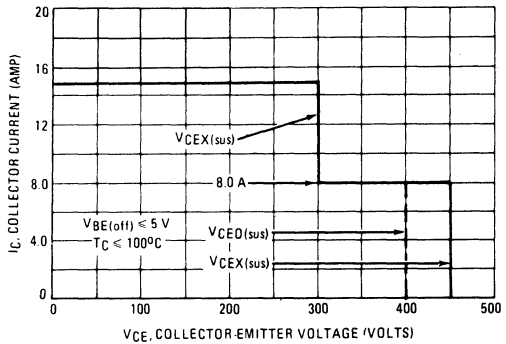


FIGURE 8 - REVERSE BIAS SAFE OPERATING AREA

2N6547

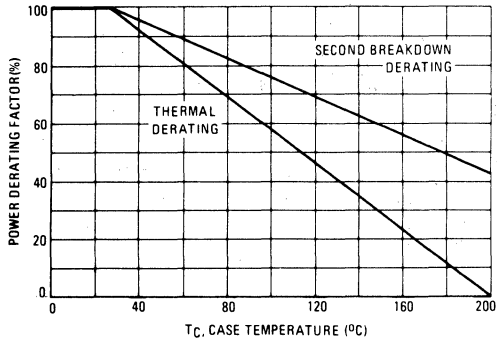


FIGURE 9 - POWER DERATING

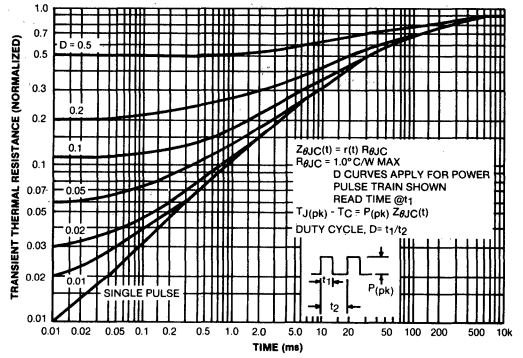


FIGURE 10 - THERMAL RESPONSE

15-Ampere N-P-N Darlington Power Transistors

60, 90, 120 Volts, 120 Watts
Gain of 2000 at 4 A

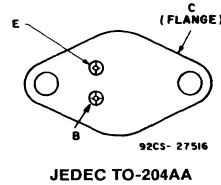
Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

TERMINAL DESIGNATIONS



2

The 2N6576, 2N6577, and 2N6578 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

All types utilize the steel JEDEC TO-204AA/ TO-3 hermetic package.

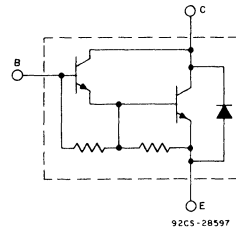


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6576	2N6577	2N6578	
* V_{CBO}	60	90	120	V
* $V_{CEO(sus)}$	60	90	120	V
* V_{EBO}		7		V
* I_C		15		A
* I_{CM}		30		A
* I_B		0.25		A
* P_T		120		W
$T_C \leq 25^\circ C$				
$T_C > 25^\circ C$		See Fig. 2		
* T_{stg}, T_J		-65 to 200		$^\circ C$
* T_L		235		$^\circ C$
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.				

* In accordance with JEDEC registration data.

2N6576, 2N6577, 2N6578

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS						UNITS
	VOLTAGE V dc			CURRENT A dc		2N6576		2N6577		2N6578		
	V _{CE}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I _{CBO}	60 ^a 90 ^a 120 ^a					—	0.5	—	—	—	—	mA
* I _{CEO}	60 90 120				0 0 0	— — —	1	— — —	— 1 —	— — 1		
* I _{CER} R _{BE} = 10K T _C = 150°C	60 90 120					— — —	5	— — —	— 5 —	— — 5		
* I _{CEX} T _C = 175°C	60 90 120		-1.5 -1.5 -1.5			— — —	5	— — —	— 5 —	— — 5		
* I _{EBO}		7		0		—	7.5	—	7.5	—	7.5	
* V _{CEO(sus)}				0.2 ^b	0	60	—	90	—	120	—	V
* h _{FE}	3 3 3 4			0.4 ^b 4 ^b 10 ^b 15 ^b		200 2000 500 100	— 20000 5000 —	200 2000 500 100	— 20000 5000 —	200 2000 500 100	— 20000 5000 —	
* V _{BE(sat)}			10 15	0.1 ^b 0.15 ^b		— —	3.5 4.5	— —	3.5 4.5	— —	3.5 4.5	V
* V _{CE(sat)}				10 ^b 15 ^b	0.1 0.15	— —	2.8 4	— —	2.8 4	— —	2.8 4	V
V _F				-15		—	4.5	—	4.5	—	4.5	
* h _{fe} f = 1 MHz	3			3		4	40	4	40	4	40	
* t _d ^c				10	0.1	—	0.15	—	0.15	—	0.15	μs
* t _r ^c				10	0.1	—	1	—	1	—	1	
* t _s ^c				10	0.1 ^d	—	2	—	2	—	2	
* t _f ^c				10	0.1 ^d	—	7	—	7	—	7	
I _S /b t = 1 s, non rep.	20					6	—	6	—	6	—	A
R _{θJC}						—	1.46	—	1.46	—	1.46	°C/W

* In accordance with JEDEC registration data.

^a V_{CB} value.^b Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.^c V_{CC} = 30 V, t_p = 300 μs, duty cycle = 2%.^d I_{B1} = -I_{B2}.

2N6576, 2N6577, 2N6578

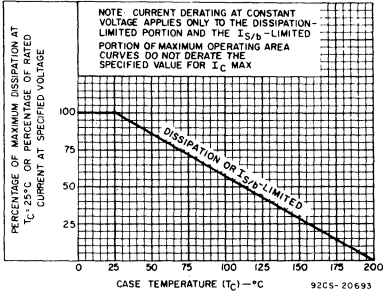


Fig. 2 — Derating curves for all types.

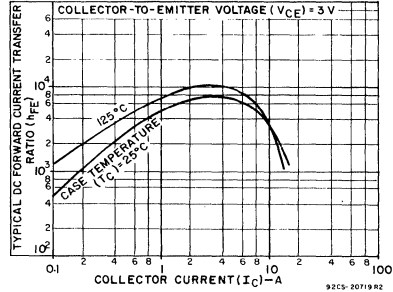


Fig. 3 — Typical dc-beta characteristics for all types.

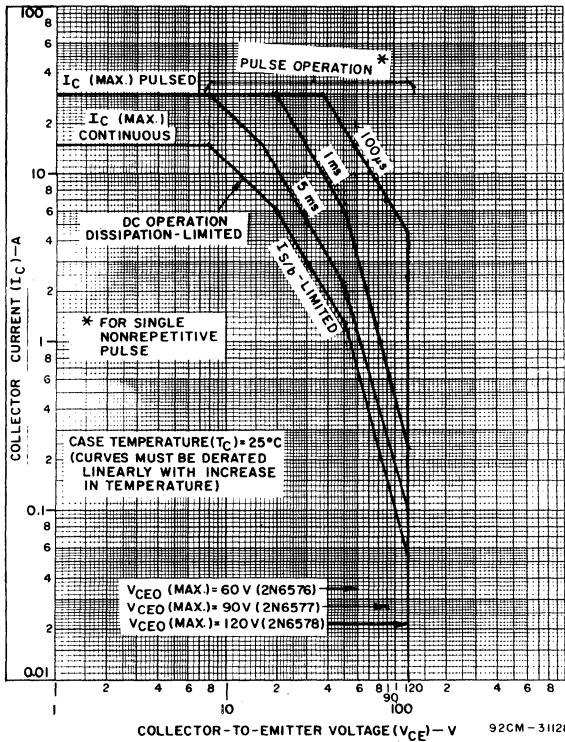


Fig. 4 — Maximum operating areas for all types.

2N6576, 2N6577, 2N6578

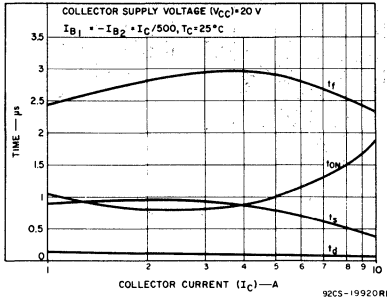


Fig. 5 - Typical saturated switching time characteristics for all types.

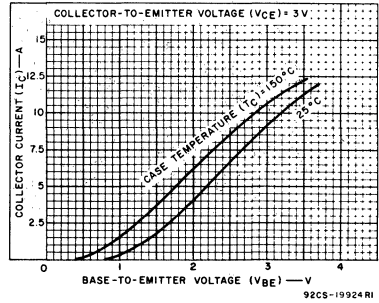


Fig. 6 - Typical transfer characteristics for all types.

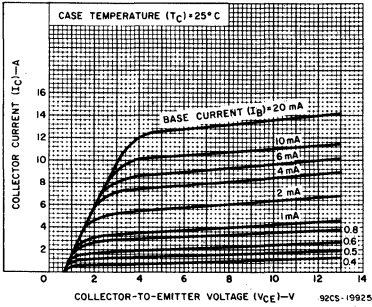


Fig. 7 - Typical output characteristics for all types.

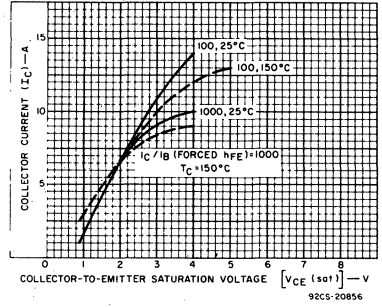


Fig. 8 - Typical saturation characteristics for all types.

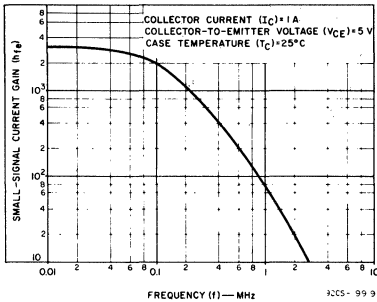


Fig. 9 - Typical small-signal gain for all types.

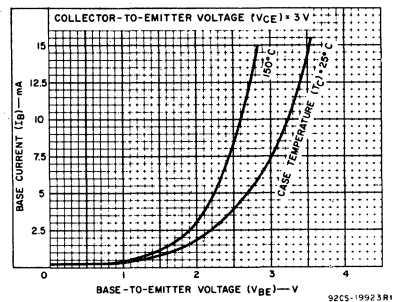


Fig. 10 - Typical input characteristics for all types.

2N6576, 2N6577, 2N6578

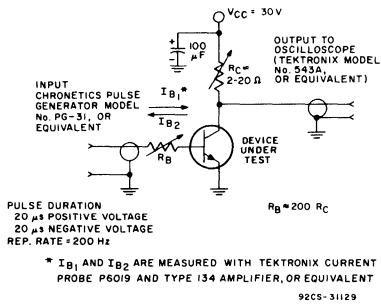
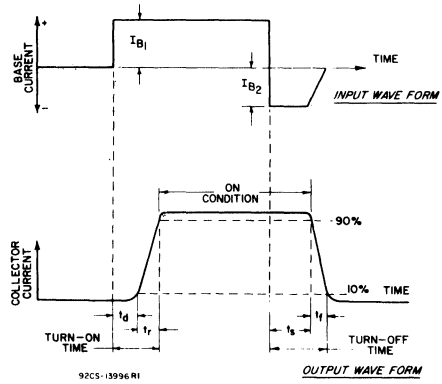


Fig. 11 — Circuit used to measure saturated-switching times.



Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

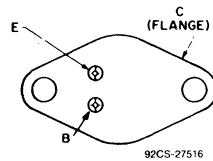
Features:

- High-dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- $f_T = 2$ MHz
- High gain at high current

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6609, MJ15004, RCA9116C, RCA9116D, and RCA9116E are ballasted epitaxial-base silicon p-n-p transistors featuring high gain at high current. They may be used as complements to the n-p-n types RCA3773, MJ15003, RCA8638C, RCA8638D, and RCA8638E, respectively.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204AA packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6609	MJ15004	RCA9116C	RCA9116D	RCA9116E	
* V_{CBO}	-160	-140	-140	-120	-100	V
$V_{CEX(SUS)}$ $V_{BE} = -1.5$ V; $R_{BE} = 100 \Omega$	-160	—	—	—	—	V
$V_{CER(SUS)}$ $R_{BE} = 100 \Omega$	-150	-150	-150	-130	-110	V
* $V_{CEO(SUS)}$	-140	-140	-140	-120	-100	V
* V_{EBO}	-7	—	—	-5	—	V
* I_C	-16	—	—	-200	—	A
* I_B	-4	—	—	-5	—	A
* P_T At $T_C \leq 25^\circ$ C	150	250	200	200	200	W
At $T_C > 25^\circ$ C Derate Linearly	0.857	1.43	—	1.14	—	W/°C
* T_{sto}, T_J	—	—	-65 to +200	—	—	°C
* T_L At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	265	—	—	230	—	°C

* 2N-type in accordance with JEDEC registration data format JS25RDF1, Issue 1.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C Unless Otherwise Specified.

CHARACTERISTIC	TEST CONDITIONS			LIMITS				UNITS	
	VOLTAGE V dc		CUR- RENT A dc	2N6609		MJ15004			
	V _{CE}	V _{BE}	I _C	Min.	Max.	Min.	Max.		
* I _{CBO}	-160 ^a -140 ^a			-	-4 -2	-	- -1	mA	
I _{CEX}	-140	1.5		-	-	-	-0.1		
I _{CEX} T _C = 150°C	-140	1.5		-	-	-	-2		
* I _{CEV}	-140	1.5		-	-2	-	-		
* I _{CEV} T _C = 150°C	-140	1.5		-	-10	-	-		
I _{CEO} I _B = 0	-140 -120			-	- -10	-	-0.25 -		
* I _{EBO}		-7 -5		-	-5 -	-	- -0.1	V	
* h _{FE}	-4 -4 -2 -2		-8 ^c -16 ^c -5 ^c -10 ^c	15 5	60	- -	- - 25 10		
V _{CEX(sus)} ^b R _{BE} = 100Ω		1.5	-0.2	-160	-	-	-		
V _{CER(sus)} ^b R _{BE} ≤ 100Ω			-0.2	-150	-	-150	-		
* V _{CEO(sus)} ^b			-0.2	-140	-	-140	-		
V _{EBO} I _E = -1 mA			0	-7	-	-5 ^d	-		
V _{BE}	-4 -2		-8 ^c -5 ^c	-	-2.2	-	- -2		
* V _{CE(sat)} I _B = -3.2A = -0.8A = -0.5A			-16 ^c -8 ^c -5 ^c	-	-4 -1.4	-	- - -1		
I _{S/b} t _p = 1 s nonrep.	-100 -50			-1.5 -	-	-1 -5	- -		A
* |h _{fe}| f = 0.05 = 0.5 MHz	-4 -10		-1 -0.5	4 4	-	- 4	- -		MHz
f _T				2	-	2	-		
* h _{fe} f = 1 kHz	-4		-1	40	-	-	-		
C _{ob} f = 0.1 MHz	-10 ^a			-	1000	-	1000	pF	
R _{θJC}	-10		-10	-	1.17	-	0.7	°C/W	

See page 3 for footnotes.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
Unless Otherwise Specified (Cont'd)

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS	
	VOLTAGE V dc		CURRENT A dc	RCA9116C		RCA9116D		RCA9116E			
	V _{CE}	V _{BE}		Min.	Max.	Min.	Max.	Min.	Max.		
I _{CBO}	-140 ^a -120 ^a -100 ^a			-	-1	-	-	-	-	-	
I _{CEX}	-140 -120	1.5 1.5		-	-1	-	-	-1	-	-	
I _{CEX} T _C = 150°C	-140 -120	1.5 1.5		-	-5	-	-	-5	-	-	
I _{CEO} I _B = 0	-70 -60			-	-1	-	-	-1	-	-	
I _{EBO}		-5		-	-1	-	-1	-	-1		
h _{FE}	-2 -2 -2		-5 ^c -7.5 ^c -10 ^c	25 - 10	150 - -	25 - 10	150 - -	- 10 -	- 100 -		
V _{CER(sus)} ^b R _{BE} ≤ 100Ω			-0.2	-150	-	-130	-	-110	-		
V _{CEO(sus)} ^b			-0.2	-140	-	-120	-	-100	-		
V _{EBO} I _E = -1 mA			0	-5	-	-5	-	-5	-		V
V _{BE}	-2 -2		-7.5 ^c -5 ^c	- -	- -2	- -	- -2	- -	- -	-3	
V _{CE(sat)} I _B = -0.75A = -0.5A			-7.5 ^c -5 ^c	- -	- -1	- -	- -1	- -	-1.5		
I _{S/b} t _p = 1 s nonrep.	-35 -25			-5.71 -	- -	-5.71 -	- -	- -8	- -		A
|h _{fe}| f = 0.5 MHz	-10		-0.5	4	-	4	-	4	-		
f _T				2	-	2	-	2	-		MHz
C _{ob} f = 0.1 MHz	-10 ^a			-	1000	-	1000	-	1000		pF
R _{θJC}	-10		-10	-	0.875	-	0.875	-	0.875		°C/W

* 2N-types in accordance with JEDEC registration data format JS25 RDF1, Issue 1.

^a V_{CB} ^b CAUTION: Sustaining voltages V_{CEX(sus)}, V_{CER(sus)}, and V_{CEO(sus)} MUST NOT be measured on a curve tracer. See Figs. 8 and 9.

^c Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

^d Measured at I_E = -0.1 mA.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

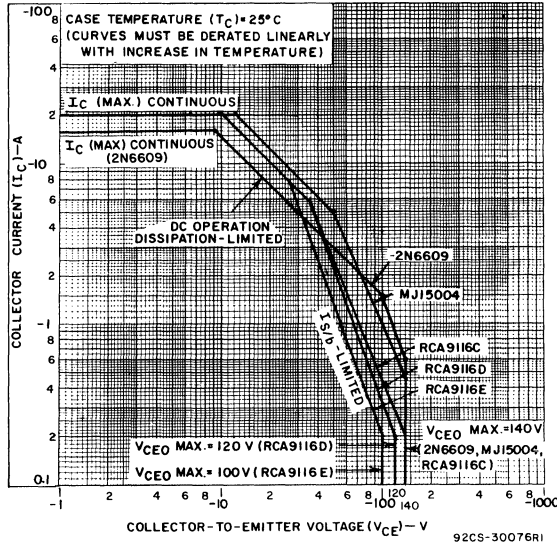


Fig. 1 - Maximum operating areas for all types.

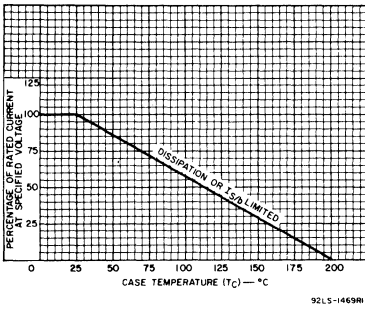


Fig. 2 - Current derating curve for all types.

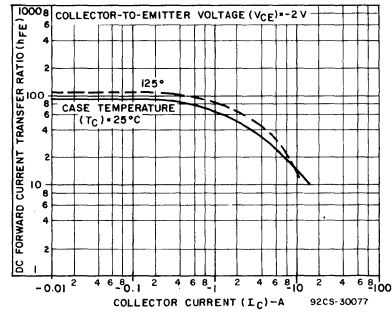


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

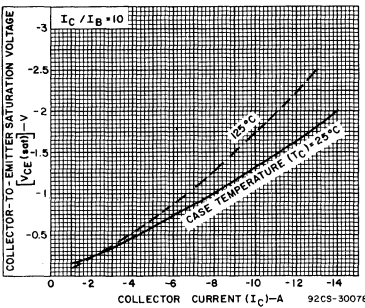


Fig. 4 - Typical saturation voltage characteristics for all types.

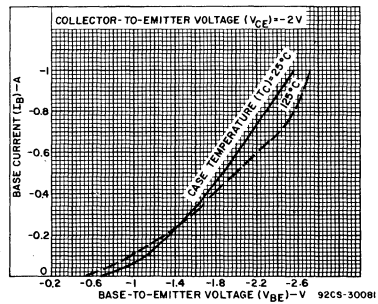


Fig. 5 - Typical input characteristics for all types.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

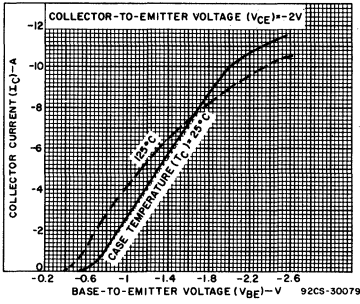


Fig. 6 - Typical transfer characteristics for all types.

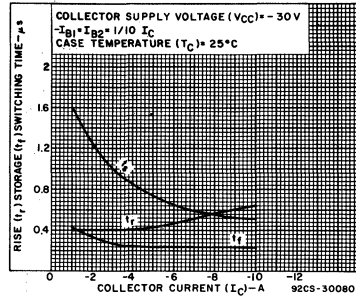


Fig. 7 - Typical saturated-switching times for all types.

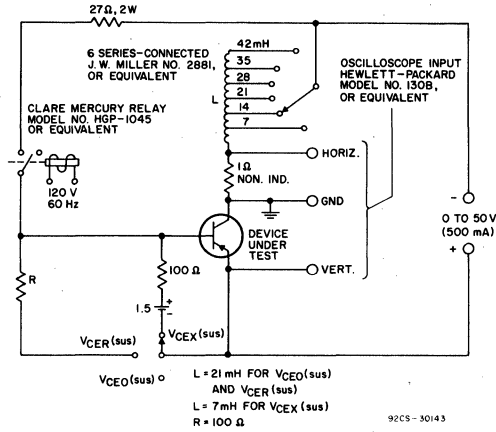
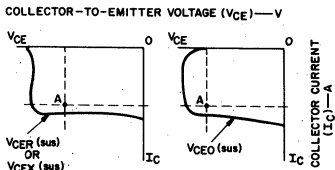
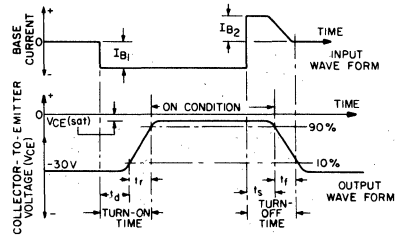


Fig. 8 - Circuit used to measure sustaining voltages $V_{CE0}(\text{sus})$, $V_{CEr}(\text{sus})$, and $V_{CEX}(\text{sus})$ for all types.



NOTE: The sustaining Voltages $V_{CE0}(\text{sus})$, $V_{CEr}(\text{sus})$ or $V_{CEX}(\text{sus})$ are acceptable when the trace falls to the left and below point "A". (For values of current and voltage, see Electrical Characteristics.)

92CS-30144



92CS-15619R1

Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

Fig. 10 - Oscilloscope display for measurement of switching times for all types.

File Number 1013

2N6648, 2N6649, 2N6650

10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 70 Watts
Gain of 1000 at 5 A

Features:

- Operates from IC without predriver

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

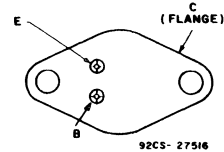
The 2N6648, 2N6649 and 2N6650[●] are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. They are complementary to the 2N6383, 2N6384, and 2N6385[▲].

The 2N6648, 2N6649, and 2N6650 are supplied in hermetic steel JEDEC TO-204AA packages.

[●] Formerly RCA Dev. Nos. TA8351, TA8488, and TA8350, respectively.

[▲] Technical data for 2N6383, 2N6384, and 2N6385 are given in RCA bulletin File No. 609.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

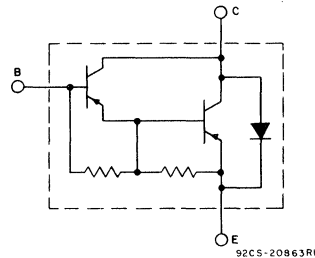


Fig.1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6648	2N6649	2N6650	
* V_{CBO}	-40	-60	-80	V
$V_{CER}^{(sus)}$ $R_{BE} = 100 \Omega$	-40	-60	-80	V
* $V_{CEO}^{(sus)}$	-40	-60	-80	V
$V_{CEV}^{(sus)}$ $V_{BE} = -1.5 V$	-40	-60	-80	V
* V_{EBO}	-5	-5	-5	V
* I_C	-10	-10	-10	A
I_{CM}	-15	-15	-15	A
* I_B	-0.25	-0.25	-0.25	A
* P_T $T_C \leq 25^\circ C$	70	70	70	W
$T_C > 25^\circ C$	Derate linearly			W/ $^\circ C$
* $T_{stg} - T_J$	-65 to +150			$^\circ C$
* T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	235			$^\circ C$

* In accordance with JEDEC registration data format (JS-6 RDF-4)

2N6648, 2N6649, 2N6650

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS					UNITS	
	VOLTAGE V dc		CURRENT A dc		2N6648		2N6649		2N6650		
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.		MAX.
I _{CEO}	-40 -60 -80			0 0 0	-	-1	-	-	-	-	mA
* I _{CEV}	-40 -60 -80	1.5 1.5 1.5			-	-0.3	-	-	-	-	
T _C = 150°C	-40 -60 -80	1.5 1.5 1.5			-	-3	-	-	-	-3	
* I _{EBO}		5	0		-	-10	-	-10	-	-10	mA
* V _{CEO} (sus)			-0.2 ^a	0	-40	-	-60	-	-80	-	
V _{CER} (sus) R _{BE} = 100 Ω			-0.2 ^a		-40	-	-60	-	-80	-	
V _{CEV} (sus)		1.5	-0.2 ^a		-40	-	-60	-	-80	-	V
* h _{FE}	-3 -3		-5 ^a -10 ^a		1000 100	20,000	1000 100	20,000	1000 100	20,000	
V _{BE}	-3 -3		-5 ^a -10 ^a		-	-2.8 -4.5*	-	-2.8 -4.5*	-	-2.8 -4.5*	
V _{CE} (sat)			-5 ^a -10 ^a	-0.01 ^a -0.1 ^a	-	-2 -3*	-	-2 -3*	-	-2 -3*	V
V _F			10 ^a		-	4	-	4	-	4	
h _{fe} f = 1 kHz	-5		-1		1000	-	1000	-	1000	-	
* |h _{fe}|| f = 1 MHz	-5		-1		20	-	20	-	20	-	A
I _S /b t = 1 s, nonrep.	-35 -25				-1 -2.8	-	-1 -2.8	-	-1 -2.8	-	
R _θ JC					-	1.75	-	1.75	-	1.75	

* In accordance with JEDEC registration data format (JS-6 RDF-4).

a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

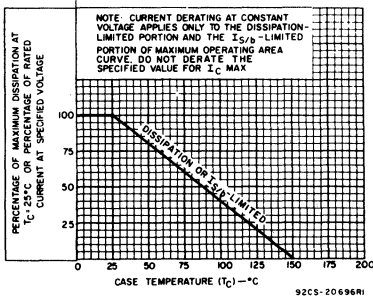


Fig. 2 — Derating curve for all types.

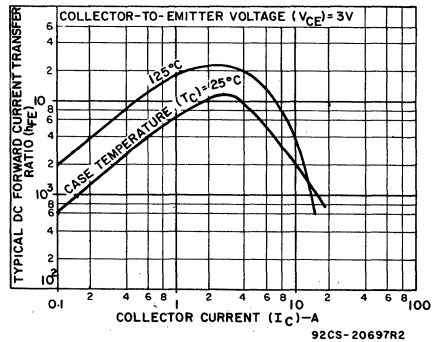


Fig. 3 — Typical dc beta characteristics for all types.

2N6648, 2N6649, 2N6650

2

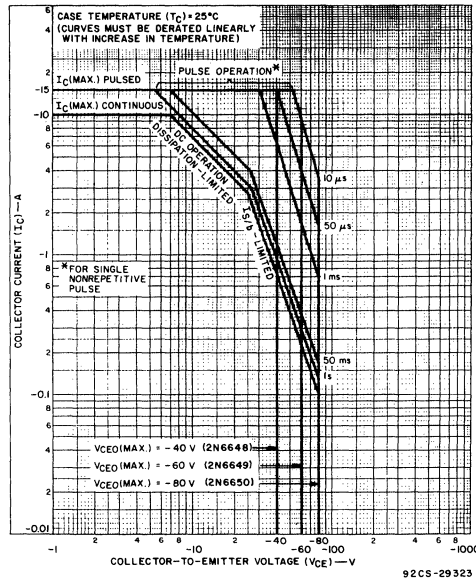


Fig. 4 — Maximum operating areas for all types.

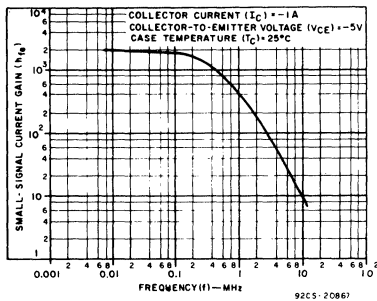


Fig. 5 — Typical small-signal gain for all types.

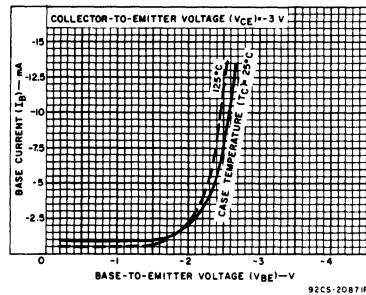


Fig. 6 — Typical input characteristics for all types.

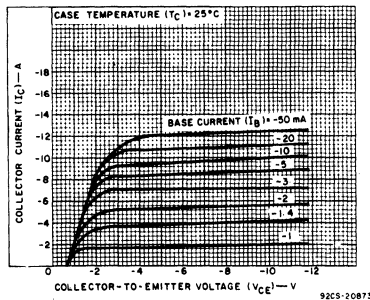


Fig. 7 — Typical output characteristics for all types.

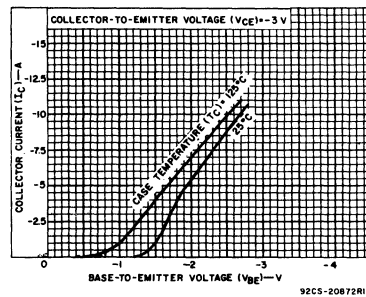


Fig. 8 — Typical transfer characteristics for all types.

2N6648, 2N6649, 2N6650

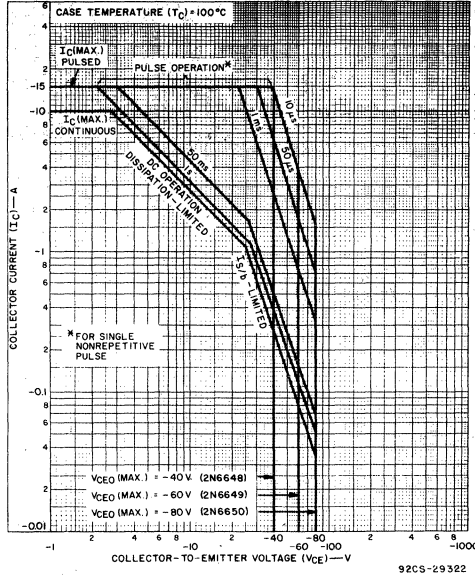


Fig. 9 — Maximum operating areas for all types at $T_c = 100^\circ\text{C}$.

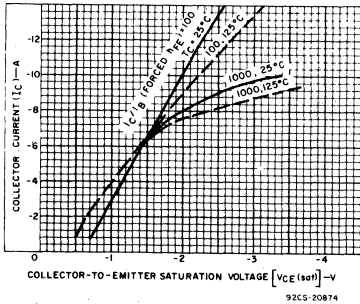


Fig. 10 — Typical saturation characteristics for all types.

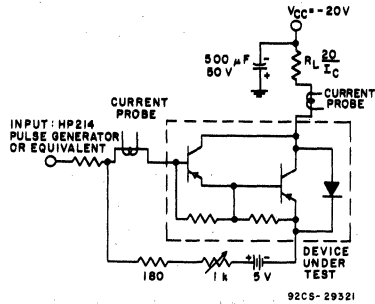


Fig. 11 — Circuit used to measure saturated switching times.

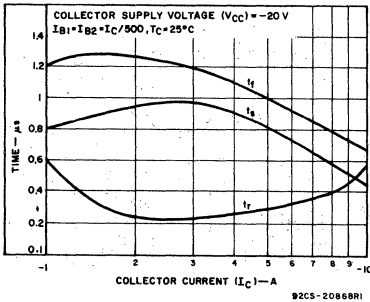


Fig. 12 — Typical saturated switching-time characteristics for all types.

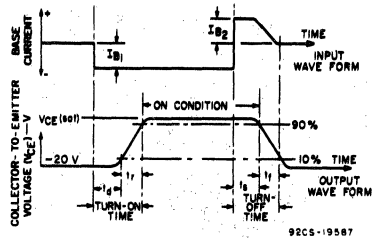


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching times.

10-Ampere P-N-P Darlington Power Transistors

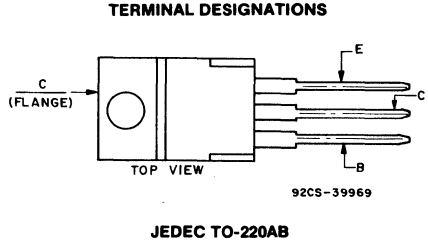
40-60-80 Volts, 65 Watts
 Gain of 1000 at 3 A (2N6666)
 Gain of 1000 at 5 A (2N6667, 2N6668)

Features:

- Operates from IC without predriver

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators



2

The 2N6666, 2N6667 and 2N6668[●] are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. They are complementary to the 2N6386, 2N6387 and 2N6388[▲].

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) plastic package.

[●]Formerly RCA Dev. Nos. TA8204, TA8487 and TA8203, respectively.

[▲]Technical data for 2N6386-2N6388 are given in RCA Bulletin File No. 610.

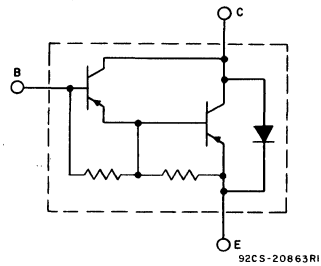


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6666	2N6667	2N6668	
* V_{CBO}	-40	-60	-80	V
$V_{CER(sus)}$ $R_{BE} = 100 \Omega$	-40	-60	-80	V
$V_{CEO(sus)}$	-40	-60	-80	V
$V_{CEV(sus)}$ $V_{BE} = -1.5 V$	-40	-60	-80	V
* V_{EBO}	-5	-5	-5	V
* I_C	-8	-10	-10	A
I_{CM}	-15	-15	-15	A
* I_B	-0.25	-0.25	-0.25	A
* P_T $T_C \leq 25^\circ C$	65	65	65	W
$T_C > 25^\circ C$	derate linearly			W/ $^\circ C$
* T_{stg}, T_J	-65 to +150			$^\circ C$
* T_L At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	235			$^\circ C$

*In accordance with JEDEC registration data format (JS-6 RDF-4).

2N6666, 2N6667, 2N6668

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6666		2N6667		2N6668		
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I _{CEO}	-80 -60 -40			0 0 0	- - -	- - -1	- - -	- -1 -	- - -	-1 - -	mA
* I _{CEV}	-80 -60 -40	1.5 1.5 1.5			- - -0.3	- - -	- - -	-0.3 - -	- - -	- - -	
$T_C = 125^\circ\text{C}$	-80 -60 -40	1.5 1.5 1.5			- - -3	- - -	- - -	-3 - -	- - -	-3 - -	
I _{EBO}		5	0		-	-10	-	-10	-	-10	mA
* V _{CEO(sus)}			-0.2 ^a	0	-40	-	-60	-	-80	-	V
V _{CER(sus)} R _{BE} = 100 Ω			-0.2 ^a		-40	-	-60	-	-80	-	
V _{CEV(sus)}		1.5	-0.2 ^a		-40	-	-60	-	-80	-	
* h _{FE}	-3 -3 -3 -3		-3 ^a -5 ^a -8 ^a -10 ^a		1000 20,000 100 -	20,000 - - -	1000 20,000 - -	1000 20,000 - -	1000 20,000 - -	20,000 - -	
V _{BE}	-3 -3 -3 -3		-3 ^a -5 ^a -8 ^a -10 ^a		- - -4.5 -	-2.8 - - -	- - -2.8 -	- - - -4.5	- - - -	-2.8 - -4.5 -	V
* V _{CE(sat)}			-3 ^a -5 ^a -8 ^a -10 ^a	-0.006 ^a -0.01 ^a -0.08 ^a -0.1 ^a	- - -3 -	-2 - - -	- - -2 -	- - - -3	- - - -	-2 - -3 -	V
V _F			8 ^a 10 ^a		- -	4 -	- -	4 -	- -	4 -	V
h _{fe} f = 1 kHz	-5		-1		1000	-	1000	-	1000	-	
* |h _{fe}| f = 1 MHz	-5		-1		20	-	20	-	20	-	
I _{S/b} t = 1 s, nonrep.	-20				-3.2	-	-3.2	-	-3.2	-	A
R _{θJC}					-	1.92	-	1.92	-	1.92	°C/W

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

* In accordance with JEDEC registration data format (JS-6 RDF-4).

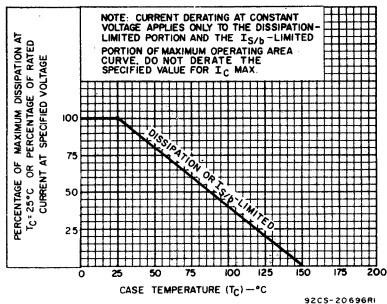


Fig. 2 — Derating curve for all types.

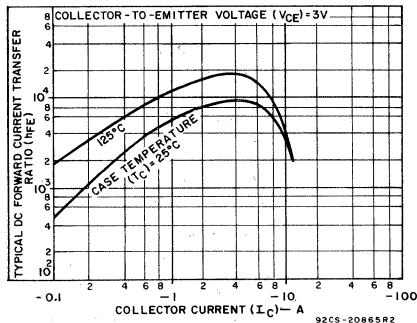
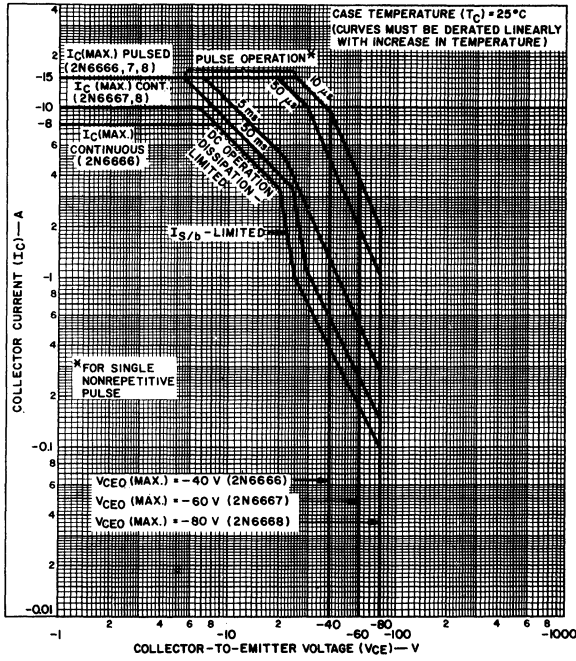


Fig. 3 — Typical dc beta characteristics for all types.

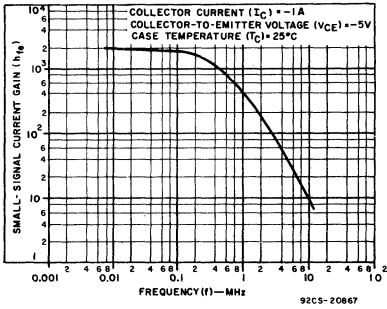
2N6666, 2N6667, 2N6668

2



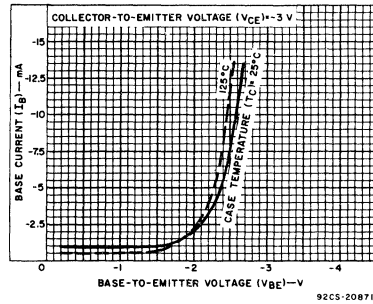
92CS-30192

Fig. 4 — Maximum operating areas for all types at $T_c = 25^\circ C$.



92CS-20867

Fig. 5 — Typical small-signal gain for all types.



92CS-20871R1

Fig. 6 — Typical input characteristics for all types.

2N6666, 2N6667, 2N6668

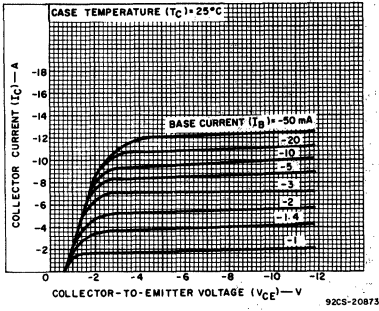


Fig. 7 — Typical output characteristics for all types.

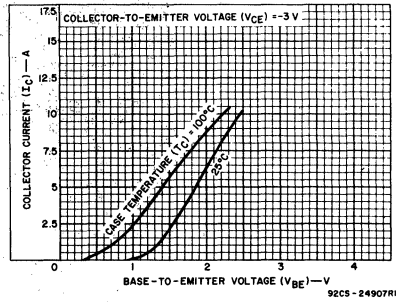


Fig. 8 — Typical transfer characteristics for all types.

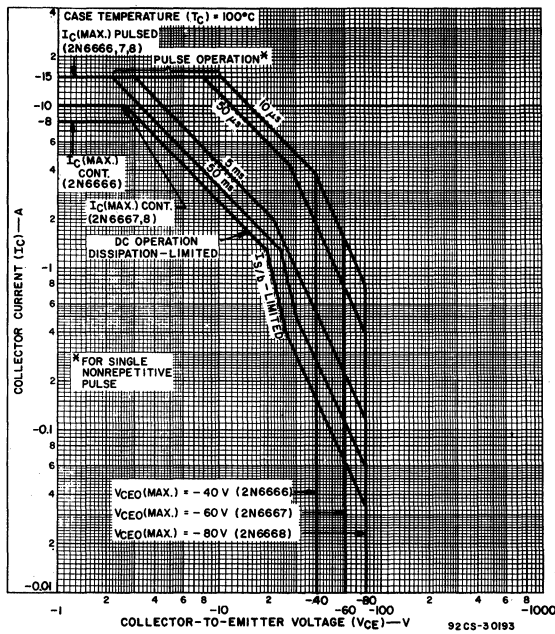


Fig. 9 — Maximum operating areas for all types $T_C = 100^\circ C$.

2N6666, 2N6667, 2N6668

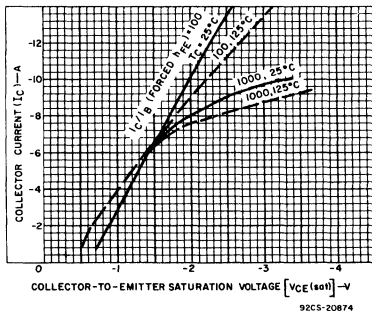


Fig. 10 — Typical saturation characteristics for all types.

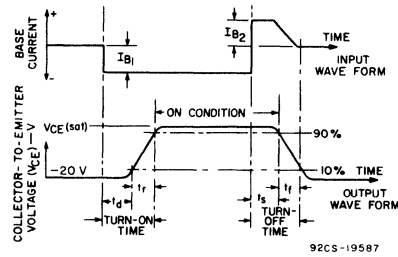


Fig. 11 — Phase relationship between input current and output current showing reference points for specification of switching times.

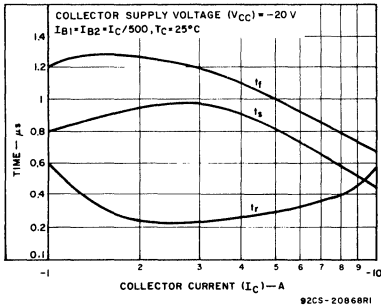
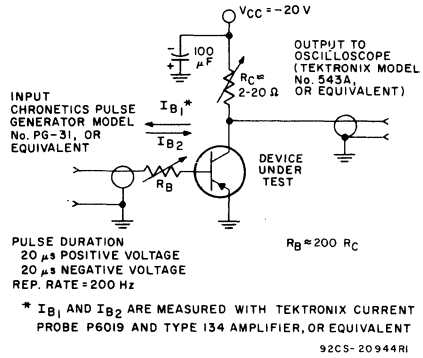


Fig. 12 — Typical saturated switching-time characteristics for all types.



* I_{B1} AND I_{B2} ARE MEASURED WITH TEKTRONIX CURRENT PROBE P6019 AND TYPE 134 AMPLIFIER, OR EQUIVALENT

Fig. 13 — Circuit used to measure saturated switching times.

5-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

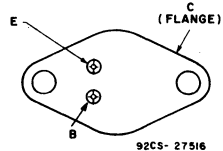
Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
 $V_{CEX} = 350\text{ V to }450\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 5\text{ A}$
- Steel hermetic TO-204AA package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



The 2N6671, 2N6672, and 2N6673* SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power

switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The 2N6671, 2N6672, and 2N6673 series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

*Formerly RCA8767, RCA8767A, and RCA8767B, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6671	2N6672	2N6673	
* V_{CEV} $V_{BE} = -1.5\text{ V}$	450	550	650	V
* V_{CEX} (Clamped) $V_{BE} = -1.5\text{ V}$	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}	8	8	8	V
* $I_{C(sat)}$	5	5	5	A
* I_C	8	8	8	A
* I_{CM}	10	10	10	A
* I_B	4	4	4	A
* P_T T_C up to 25°C	150	150	150	W
T_C above 25°C, derate linearly	0.86	0.86	0.86	W/°C
* T_{stg} , T_J	-65 to 200	-65 to 200	-65 to 200	°C
* T_L At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.	235	235	235	°C

* In accordance with JEDEC registration data.

2N6671, 2N6672, 2N6673

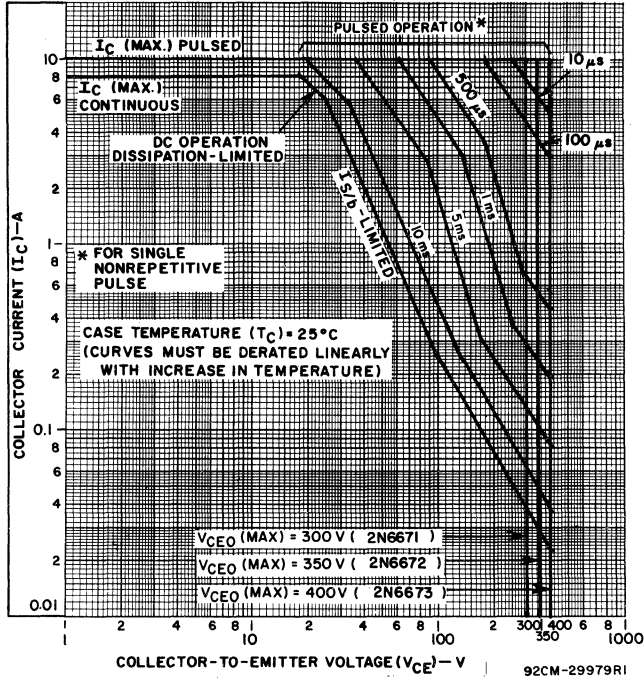


Fig. 1 — Maximum operating areas for all types ($T_C = 25^\circ C$).

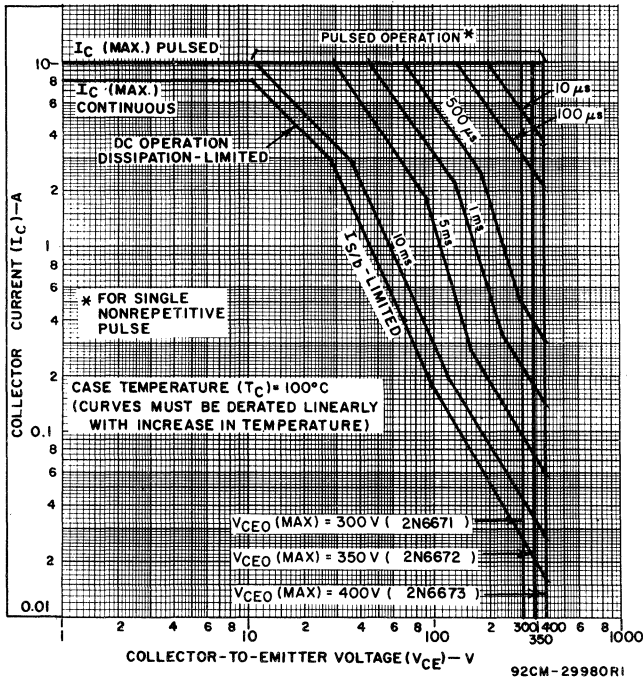


Fig. 2 — Maximum operating areas for all types ($T_C = 100^\circ C$).

2N6671, 2N6672, 2N6673

2

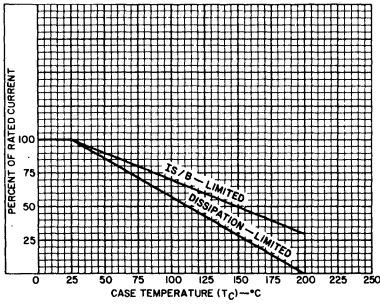


Fig. 3 — Dissipation and I_B/I_B derating curves for all types.

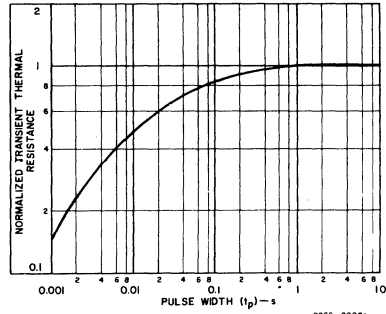


Fig. 4 — Typical thermal-response characteristic for all types.

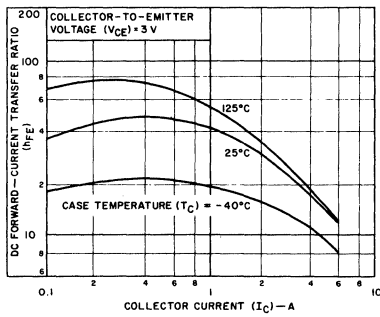


Fig. 5 — Typical dc beta characteristics for all types.

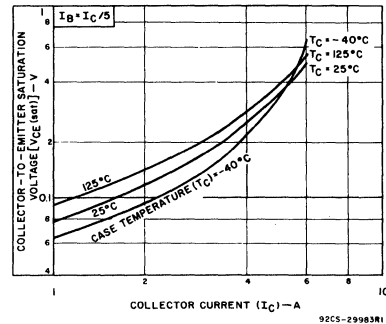


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

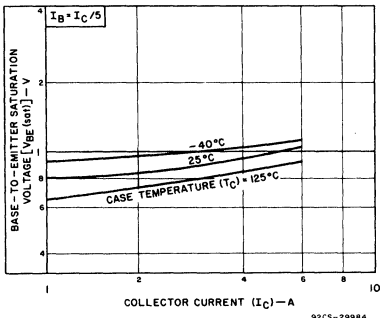


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

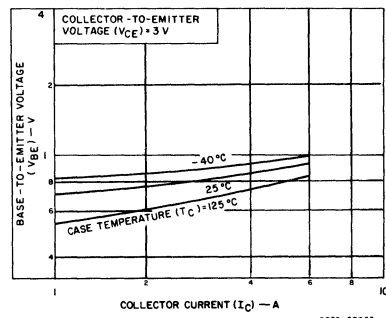


Fig. 8 — Typical base-to-emitter voltage as a function of collector current for all types.

2N6671, 2N6672, 2N6673

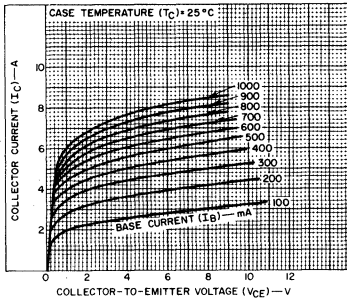


Fig. 9 — Typical output characteristics for all types.

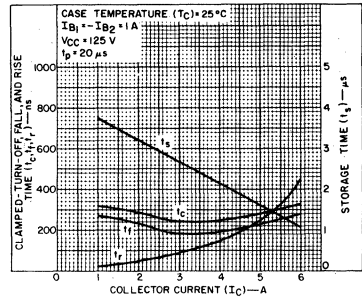


Fig. 10 — Typical saturated switching time characteristics for all types.

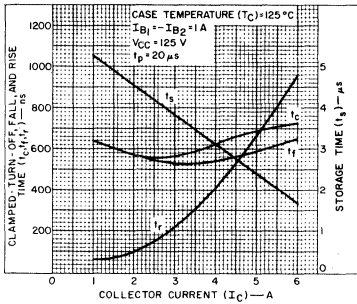


Fig. 11 — Typical saturated switching time characteristics for all types.

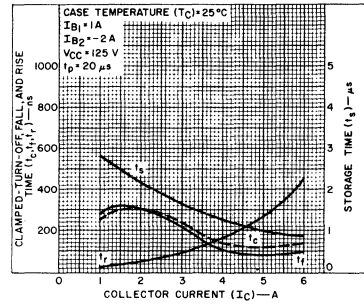


Fig. 12 — Typical saturated switching time characteristics for all types.

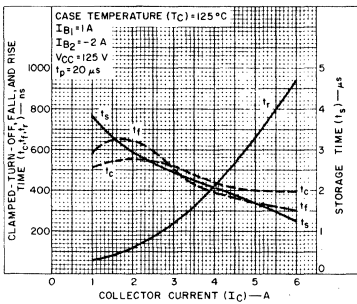


Fig. 13 — Typical saturated switching time characteristics for all types.

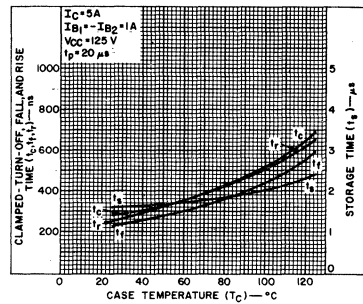


Fig. 14 — Typical saturated switching time characteristics as a function of

2N6671, 2N6672, 2N6673

2

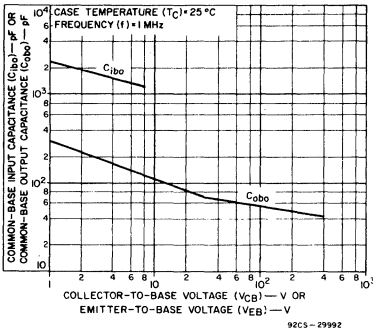


Fig. 15 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

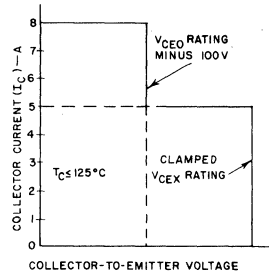


Fig. 16 — Maximum operating conditions for switching between saturation and cutoff.

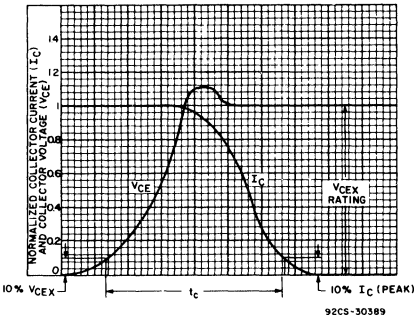


Fig. 17 — Oscilloscope display for measurement of clamped induction switching time (t_c).

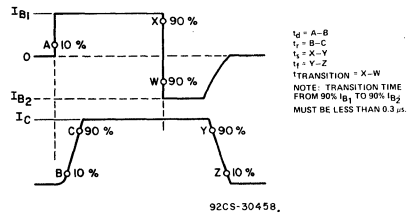


Fig. 18 — Phase relationship between input and output currents showing reference points for specification of switching times.

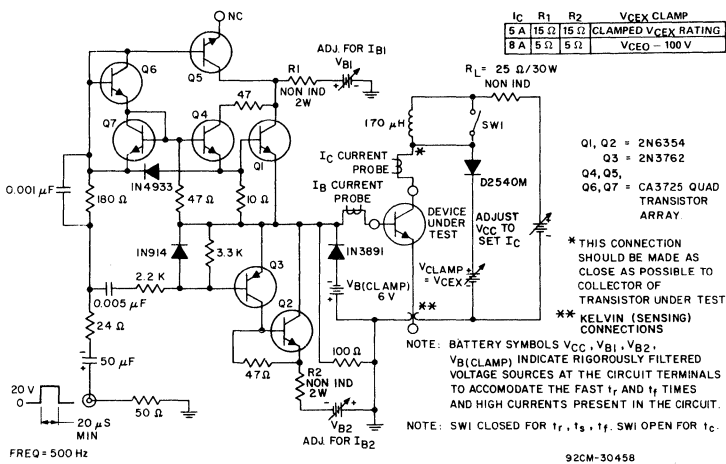


Fig. 19 — Circuit for measuring switching times.

2N6674, 2N6675, RJH6674, RJH6675

File Number 1164

10-A **SwitchMax**
Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

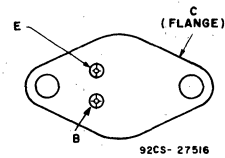
Features:

- Fast switching speed
- High voltage ratings:
V_{CEX}=350 V to 450 V
- Low V_{CE(sat)} at I_C=10 A

Applications:

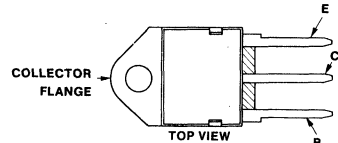
- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



2N6674
2N6675

JEDEC TO-204AA



RJH6674
RJH6675

JEDEC TO-218AC

92CS-40257

The 2N6674, 2N6675, RJH6674, and RJH6675 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and

saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The 2N6674 and 2N6675 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The RJH6674 and RJH6675 transistors are supplied in JEDEC TO-218AC plastic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RJH6674	RJH6675	2N6674	2N6675	
*V _{CEV}					
V _{BE} =-1.5 V	450	650	450	650	V
*V _{CEX} (Clamped)					
V _{BE} =-1.5 V	350	450	350	450	V
*V _{CEO}	300	400	300	400	V
*V _{EBO}			7		V
I _C (sat)			10		A
*I _C			15		A
I _{CM}			20		A
*I _B			5		A
*P _T					
T _C up to 25° C			175		W
T _C above 25° C, derate linearly	1.4	1.4	1	1	W/°C
*T _{stg} , T _J	-65 to 150		-65 to 200		°C
*T _L					
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max			235		°C
TL					
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max		235			°C

*In accordance with JEDEC registration data (2N6674, 2N6675 only).

2N6674, 2N6675, RJH6674, RJH6675

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6674 RJH6674		2N6675 RJH6675		
	V _{CE}	V _{BE}	I _c	I _B	Min.	Max.	Min.	Max.	

T_c=25° C

I _{CEV}	450 650	-1.5 -1.5			—	0.1	—	—	mA
I _{ES0}		-7	0		—	2	—	2	
V _{CE0(sus)} ^b			0.2 ^a	0	300	—	400	—	V
h _{FE}	2		10 ^a		8	20	8	20	
V _{BE(sat)}			10 ^a	2	—	1.5	—	1.5	V
V _{CE(sat)}			10 ^a 15 ^a	2 5	—	1 5	—	1 5	
V _{CEX} ^b (Clamped E _{S,0}) L=50 μH, R _{BB} =2 Ω		-4	10	2	350	—	450	—	
I _{S,0}	30 100		5.9 0.25		1 1	—	1 1	—	s
|h _{re}| f=5 MHz	10		1		3	10	3	10	
f _T	10		1		15	50	15	50	MHz
C _{obs} f=0.1 MHz	10 ^c				150	500	150	500	pF
t _d ^d		-6	10	2	—	0.1	—	0.1	μs
t _r ^d		-6	10	2	—	0.6	—	0.6	
t _s ^d		-6	10	2 ^e	—	2.5	—	2.5	
t _f ^d		-6	10	2 ^e	—	0.5	—	0.5	
t _c V _{CC} =135 V, L=50 μH, R _c ≤ 13.5 Ω, Collector clamped to V _{CEX}		-6	10	2 ^e	—	0.5	—	0.5	

T_c=100° C

I _{CEV}	450 650	-1.5 -1.5			—	1	—	—	mA
V _{CE(sat)}			10 ^a	2	—	2	—	2	V
t _d ^d		-6	10	2	—	1	—	1	μs
t _s ^d		-6	10	2 ^e	—	4	—	4	
t _f ^d		-6	10	2 ^e	—	1	—	1	
t _c V _{CC} =135 V, L=50 μH, R _c ≤ 13.5 Ω, Collector clamped to V _{CEX}		-6	10	2 ^e	—	0.8	—	0.8	

R _{θJC} 2N6674, 2N6675	10		5		—	1	—	1	°C/W
R _{θJC} RJH6674, RJH6675	10		5		—	0.71	—	0.71	°C/W

^aPulsed: pulse duration=300 μs, duty factor ≤ 2%.^bCAUTION: The sustaining voltage V_{CE0(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.^cIn accordance with JEDEC registration data (2N6674, 2N6675 only).^dV_{CB} value.^eV_{CC}=135 V, t_p=20 μs.^fI_{B1}=-I_{B2}.

2

2N6674, 2N6675, RJH6674, RJH6675

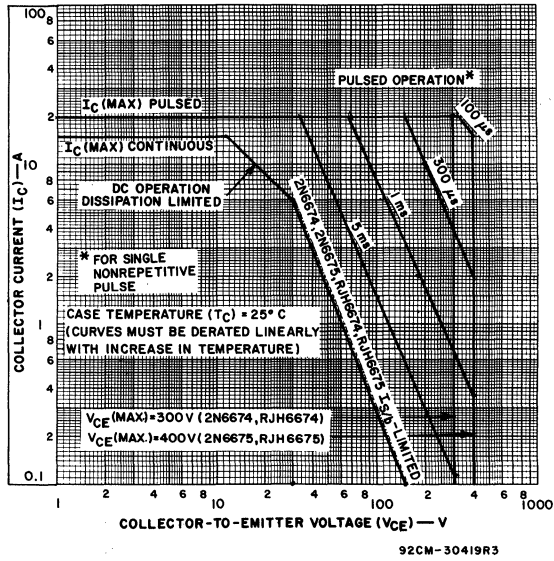


Fig. 1 - Maximum operating areas for all types ($T_c=25^\circ\text{C}$).

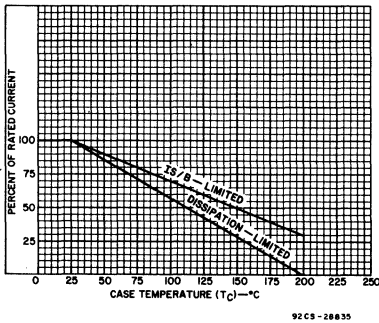


Fig. 2 — Dissipation and $I_{S/B}$ derating curves for 2N6674 and 2N6675.

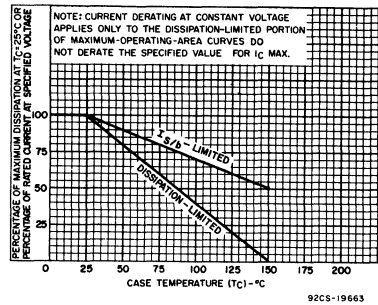


Fig. 3 — Dissipation and $I_{S/B}$ derating curves for RJH6674 and RJH6675.

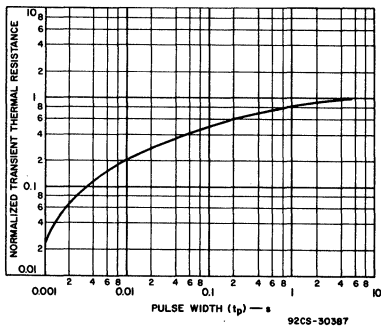


Fig. 4 - Typical thermal-response characteristic for all types.

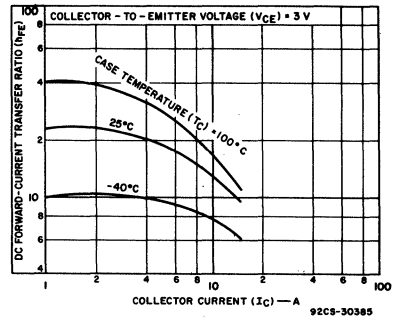


Fig. 5 - Typical dc beta characteristics for all types.

2N6674, 2N6675, RJH6674, RJH6675

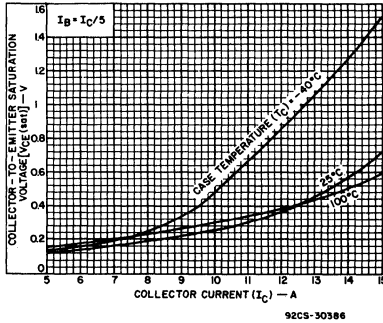


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

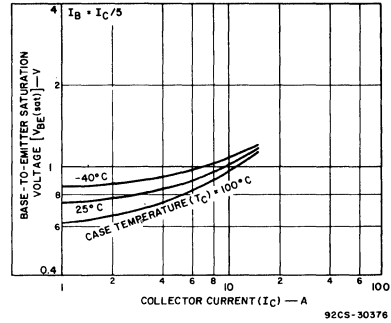


Fig. 7 - Typical base-to-emitter saturation voltage characteristics for all types.

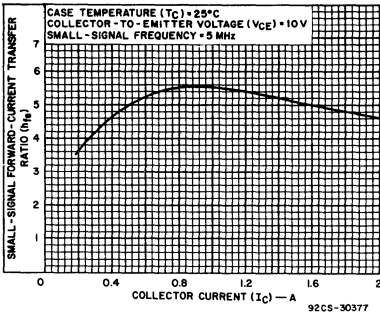


Fig. 8 - Typical small-signal forward current transfer ratio characteristic for all types ($f=5\text{ MHz}$).

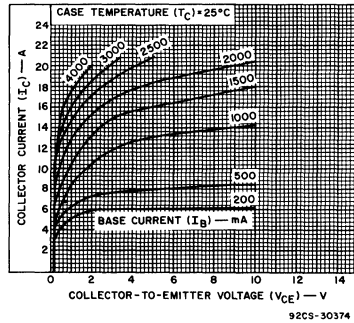


Fig. 9 - Typical output characteristics for all types.

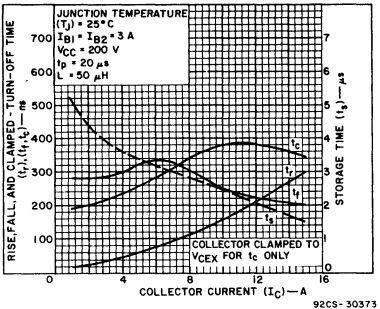


Fig. 10 - Typical saturated-switching-time characteristics at $T_J=25^\circ\text{C}$ as a function of collector current for all types.

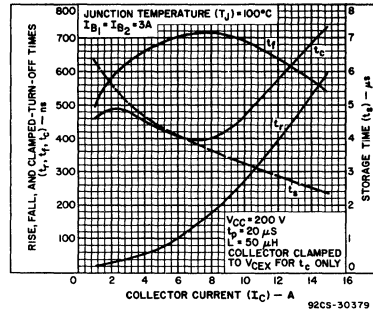


Fig. 11 - Typical saturated-switching-time characteristics at $T_J=100^\circ\text{C}$ as a function of collector current for all types.

2N6674, 2N6675, RJH6674, RJH6675

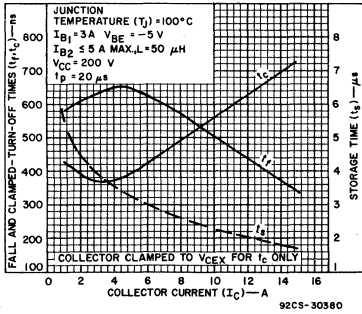


Fig. 12 - Typical saturated-switching-time characteristics at $T_J=100^\circ\text{C}$ as a function of collector current for all types.

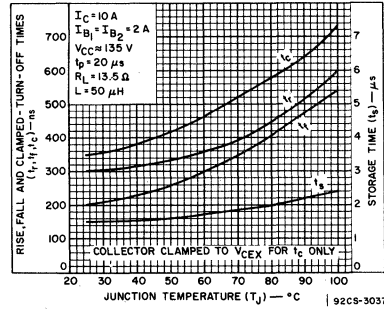


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

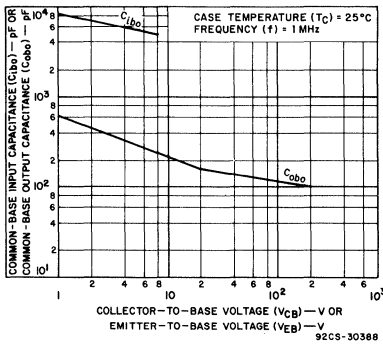


Fig. 14 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

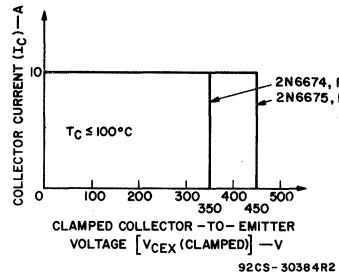


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

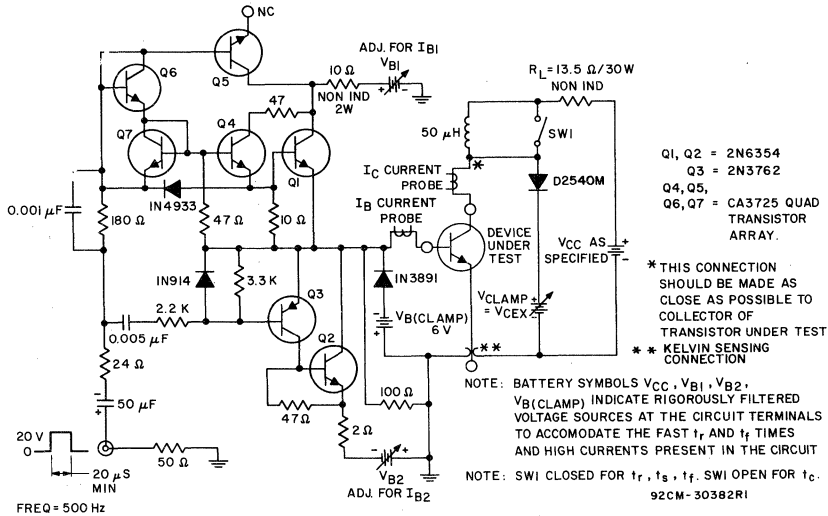


Fig. 16 - Circuit for measuring switching times.

2N6674, 2N6675, RJH6674, RJH6675

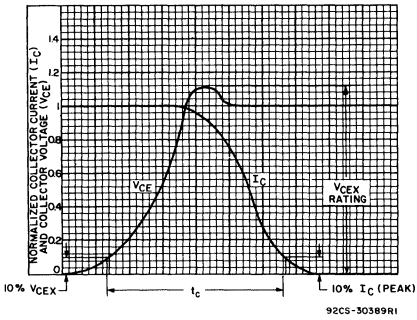


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

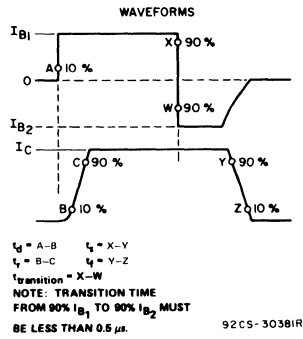


Fig. 18 - Phase relationship between input and output currents showing reference points for specification of switching times.

15-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

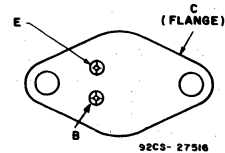
Features:

- Fast switching speed
- High voltage ratings:
 $V_{CEX} = 350\text{ V to }450\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 15\text{ A}$

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS

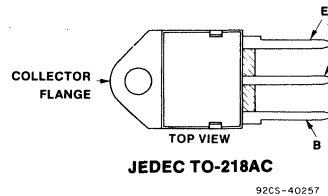


2N6676
2N6677
2N6678

JEDEC TO-204AA

The 2N6676, 2N6677 and 2N6678, RJH6676, RJH6677, and RJH6678 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The 2N6676, 2N6677, and 2N6678 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The RJH6676, RJH6677, and RJH6678 transistors are supplied in JEDEC TO-218AC plastic packages.



RJH6676
RJH6677
RJH6678

JEDEC TO-218AC

MAXIMUM RATINGS, Absolute-Maximum Values:

	RJH6676	RJH6677	RJH6678	2N6676	2N6677	2N6678	
* V_{CEV}							
$V_{BE} = -1.5\text{ V}$	450	550	650	450	550	650	V
* V_{CEX} (Clamped)							
$V_{BE} = -1.5\text{ V}$	350	400	450	350	400	450	V
* V_{CEO}	300	350	400	300	350	400	V
* V_{EBO}							V
$I_C(sat)$				8			A
* I_C				15			A
I_{CM}				20			A
* I_B				5			A
* P_T							
T_C up to 25°C				175			W
T_C above 25°C, derate linearly		1.4			1		W/°C
* T_{stg}, T_J		-65 to 150			-65 to 200		°C
* T_L							
At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.					235		°C
T_L							
At distance $\geq 1/8$ " in. (3.17 mm) from seating plane for 10 s max.		235					°C

* In accordance with JEDEC registration data (2N6676, 2N6677, 2N6678 only).

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE		CURRENT		2N6676		2N6677		2N6678		
	V _{dc}	V _{dc}	A _{dc}	A _{dc}	RJH6676		RJH6677		RJH6678		
V _{CE}	V _{BE}	I _c	I _b	Min.	Max.	Min.	Max.	Min.	Max.		

T_C=25°C

I _{CEV}	450 550 650	-1.5 -1.5 -1.5			—	0.1	—	—	—	—	—	—	mA
I _{EBO}		-8	0		—	2	—	2	—	2	—	—	V
V _{CE0(sus)} ^b			0.2 ^a	0	300	—	350	—	400	—	—	—	V
h _{FE}	3		15 ^a		8	—	8	—	8	—	—	—	
V _{BE(sat)}			15 ^a	3	—	1.5	—	1.5	—	1.5	—	1.5	V
V _{CE(sat)}			15 ^a	3	—	1	—	1	—	1	—	1	V
V _{CEX} ^b (Clamped E _{S,b}) L=50 μH, R _{BB} =2 Ω		-6	15	3	350	—	400	—	450	—	—	—	V
I _{S,b}	30 100		5.9 0.25		1 1	—	1 1	—	1 1	—	—	—	s
|h _{rel}| f=5 MHz	10		1		3	10	3	10	3	10			
f _r	10		1		15	50	15	50	15	50			MHz
C _{ob0} f=0.1 MHz	10 ^c				150	500	150	500	150	500			pF
t _d ^d		-6	15	3	—	0.1	—	0.1	—	0.1	—	0.1	μs
t _r ^d		-6	15	3	—	0.6	—	0.6	—	0.6	—	0.6	μs
t _s ^d		-6	15	3 ^e	—	2.5	—	2.5	—	2.5	—	2.5	μs
t _f ^d		-6	15	3 ^e	—	0.5	—	0.5	—	0.5	—	0.5	μs
t _c ^f V _{CC} =200 V, L=50 μH, R _C ≤ 13.5 Ω		-6	15	3 ^e	—	0.5	—	0.5	—	0.5	—	0.5	μs

T_C=100°C

I _{CEV}	450 550 650	-1.5 -1.5 -1.5			—	1	—	—	—	—	—	—	mA
V _{CE(sat)}			15 ^a	3	—	2	—	2	—	2	—	2	V
t _r ^d		-6	15	3	—	1	—	1	—	1	—	1	μs
t _s ^d		-6	15	3 ^e	—	4	—	4	—	4	—	4	μs
t _f ^d		-6	15	3 ^e	—	1	—	1	—	1	—	1	μs
t _c ^f V _{CC} =200 V, L=50 μH, R _C ≤ 13.5 Ω		-6	15	3 ^e	—	0.8	—	0.8	—	0.8	—	0.8	μs

R _{θJC}	2N6676, 2N6677, 2N6678	10		5	—	1	—	1	—	1	—	1	°C/W
R _{θJC}	RJH6676, RJH6677, RJH6678	10		5	—	0.71	—	0.71	—	0.71	—	0.71	°C/W

^aPulsed: pulse duration=300 μs, duty factor ≤ 2%.^bCAUTION: The sustaining voltage V_{CE0(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.^cIn accordance with JEDEC registration data (2N6676, 2N6677, 2N6678 only).^dV_{CB} value.^eV_{CC}=200 V, t_p=20 μs.^fI_{B1}=-I_{B2}.^fCollector clamped to V_{CEX}.

2

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

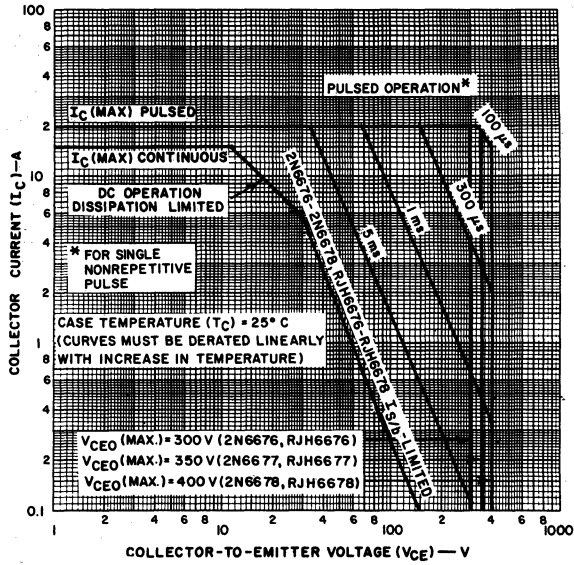


Fig. 1 - Maximum operating areas for all types ($T_c = 25^\circ C$).

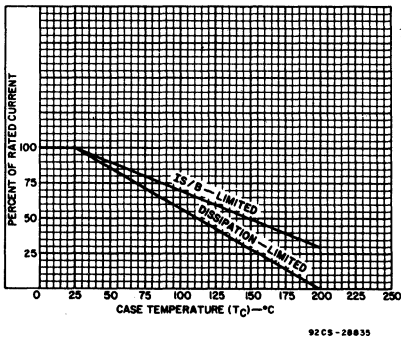


Fig. 2 - Dissipation and I_{S/I_B} derating curves for 2N6676, 2N6677, and 2N6678.

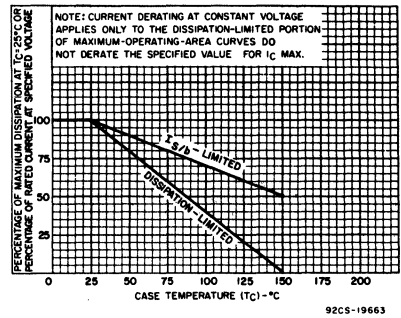


Fig. 3 - Dissipation and I_{S/I_B} derating curves for RJH6676, RJH6677, and RJH6678.

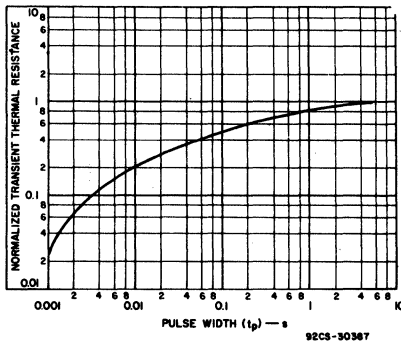


Fig. 4 - Typical thermal-response characteristic for all types.

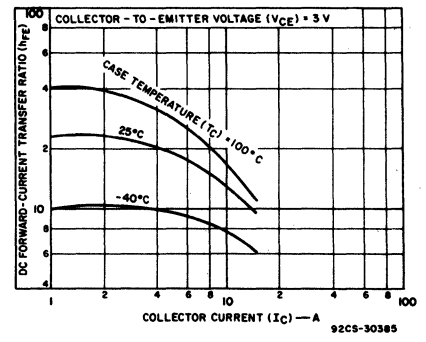


Fig. 5 - Typical dc beta characteristics for all types.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

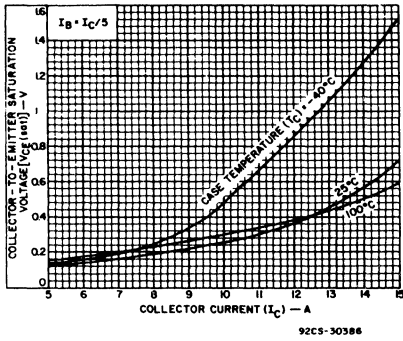


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

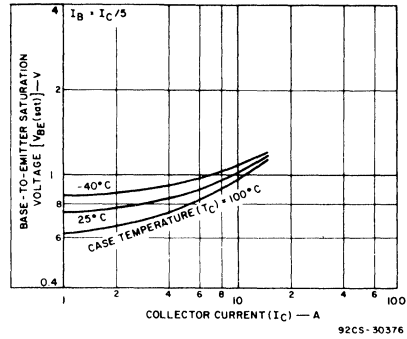


Fig. 7 - Typical base-to-emitter saturation voltage characteristics for all types.

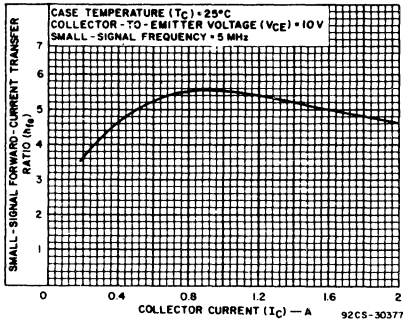


Fig. 8 - Typical small-signal forward current transfer ratio characteristic for all types ($f = 5\text{ MHz}$).

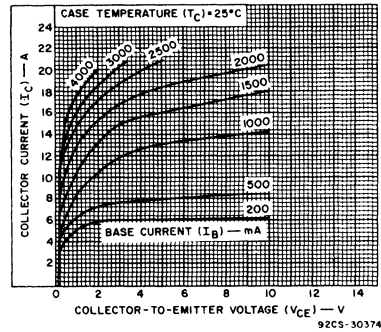


Fig. 9 - Typical output characteristics for all types.

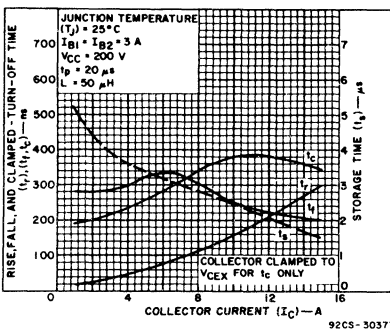


Fig. 10 - Typical saturated-switching-time characteristics at $T_J = 25^\circ\text{C}$ as a function of collector current for all types.

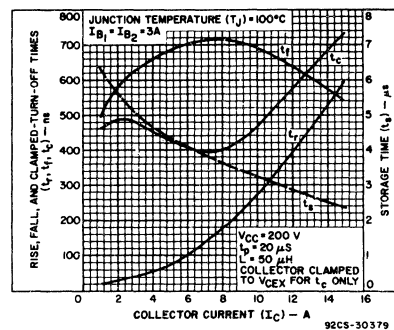


Fig. 11 - Typical saturated-switching-time characteristics at $T_J = 100^\circ\text{C}$ as a function of collector current for all types.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

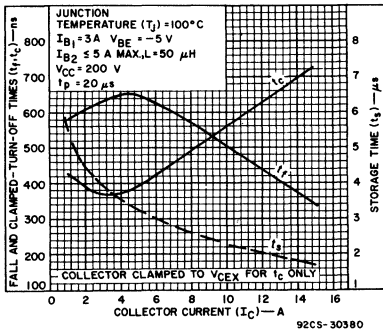


Fig. 12 - Typical saturated-switching-time characteristics at $T_j = 100^\circ C$ as a function of collector current for all types.

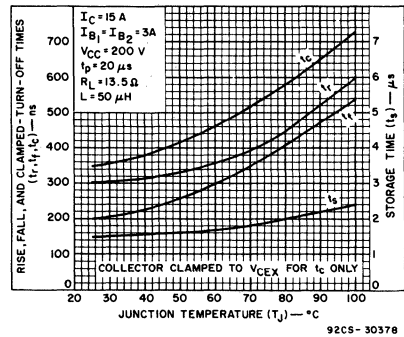


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

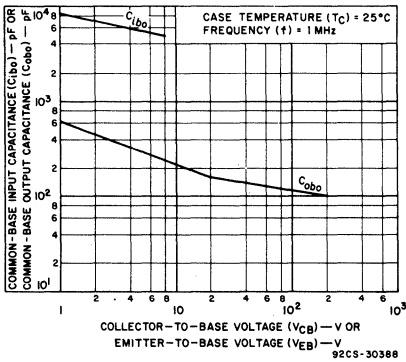


Fig. 14 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

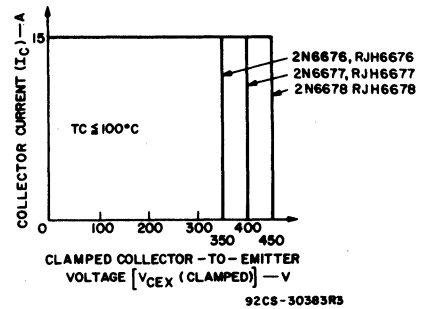


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

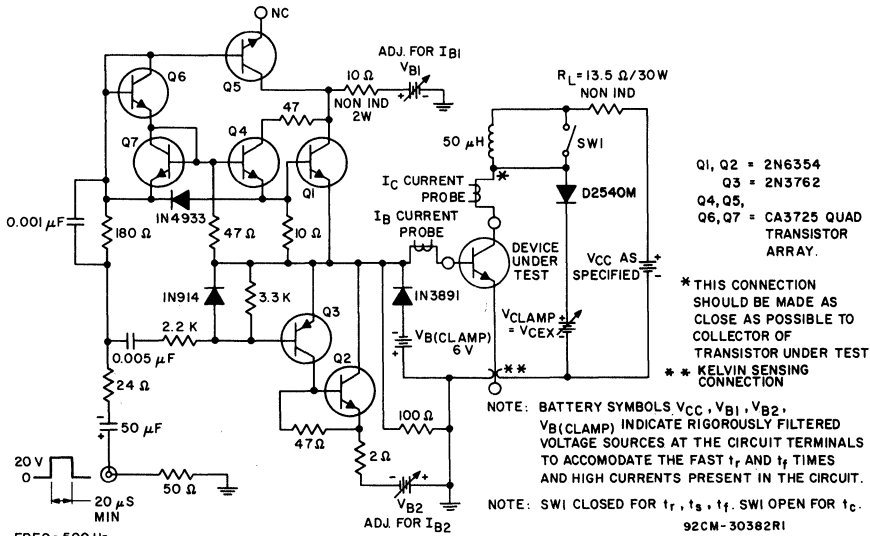


Fig. 16 - Circuit for measurement switching times.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

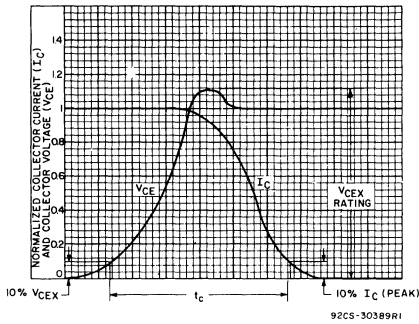


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

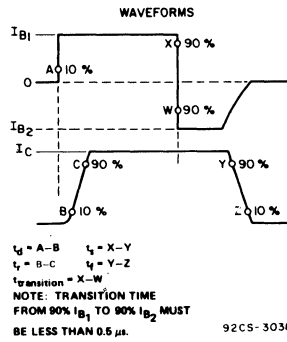


Fig. 18 - Phase relationship between input and output currents showing reference points for specification of switching times.

**2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688**

File Number **1171**

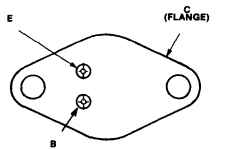
25-A SwitchMax Power Transistors

N-P-N Types for Power Supplies and Other High Voltage Switching Applications

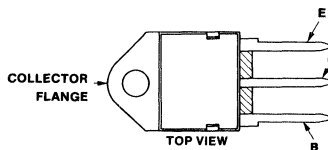
Features:

- High-temperature parameters guaranteed
- Fast switching speed
- Low $V_{CE(sat)}$

TERMINAL DESIGNATIONS



JEDEC TO-204AA



JEDEC TO-218AC

The RCA 2N6686, 2N6687 and 2N6688*, RJH6686, RJH6687, and RJH6688 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits. These high-current, high-speed transistors are 100-percent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are

guaranteed at 125°C as well as at 25°C, to provide information necessary for worst-case design.

The 2N6686, 2N6687, and 2N6688 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The RJH6686, RJH6687, and RJH6688 transistors are supplied in JEDEC TO-218AC plastic packages.

*Formerly RCA Dev. Type Nos. TA9119A, TA9119B, TA9119C, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RJH6686	RJH6687	RJH6688	2N6686	2N6687	2N6688	
* V_{CEV}							
$V_{BE} = -1.5$ V	260	280	300	260	280	300	V
* V_{CEX} (Clamped)							
$V_{BE} = -1.5$ V	210	230	250	210	230	250	V
* V_{CEO}	160	180	200	160	180	200	V
* V_{EBO}				8			V
* I_C (sat)	25	25	20	25	25	20	A
* I_C	25	25	20	25	25	20	A
* I_{CM}				50			A
* I_B				8			A
* P_T							
T_C up to 25°C				200			W
T_C above 25°C, derate linearly		1.6			1.14		W/°C
* T_{stg}, T_J		-65 to 150			-65 to 200		°C
* T_L							
At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.					235		°C
* T_L							
At distance $\geq 1/8$ in. (3.17 mm) from seating plane for 10 s max.		235					°C

* In accordance with JEDEC registration data (2N6686, 2N6687, 2N6688 only).

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688
ELECTRICAL CHARACTERISTICS $T_C = 25^\circ\text{C}$

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686 RJH6686		2N6687 RJH6687		2N6688 RJH6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	260	-1.5	—	—	—	50	—	—	—	—	μA
	280	-1.5	—	—	—	—	—	50	—	—	
	300	-1.5	—	—	—	—	—	—	—	50	
I_{EBO}	—	-8	0	—	—	100	—	100	—	100	V
$V_{CE0}(\text{SUS})^b$	—	—	0.2 ^a	0	160	—	180	—	200	—	V
h_{FE}	2	—	1 ^a	—	30	—	30	—	25	—	—
	2	—	10 ^a	—	25	100	25	100	20	80	
	2	—	20 ^a	—	—	—	—	—	15	—	
	2	—	25 ^a	—	15	—	15	—	—	—	
$V_{BE}(\text{sat})$	—	—	20 ^a	2	—	—	—	—	—	1.8	V
	—	—	25 ^a	2.5	—	1.8	—	1.8	—	—	
$V_{CE}(\text{sat})$	—	—	20 ^a	2	—	—	—	—	—	1.5	V
	—	—	25 ^a	2.5	—	1.5	—	1.5	—	—	
V_{CEX}^b (Clamped $E_{S,b}$) $L = 25 \mu\text{H}$, $R_{BB} = 10 \Omega$	—	-4	25	3	210	—	230	—	250	—	V
$I_{S,b}$ 2N6686, 2N6687, 2N6688	18	—	11.1	—	1	—	1	—	1	—	s
					0.5	—	0.5	—	0.5	—	
$|h_{re}|$ $f = 5 \text{ MHz}$	10	—	1	—	4	20	4	20	4	20	—
f_T	10	—	1	—	20	100	20	100	20	100	MHz
C_{obo} $f = 0.1 \text{ MHz}$	10 ^c	—	—	—	300	650	300	650	300	650	pF
t_d^d	—	-4	20	2	—	—	—	—	—	0.1	—
	—	-4	25	2.5	—	0.1	—	0.1	—	—	
t_r^d	—	-4	20	2	—	—	—	—	—	0.60	—
	—	-4	25	2.5	—	0.60	—	0.60	—	—	
t_s^d	—	-4	20	2 ^e	—	—	—	—	—	1.50	μs
	—	-4	25	2.5 ^e	—	1.50	—	1.50	—	—	
t_r^d	—	-4	20	2 ^e	—	—	—	—	—	0.25	μs
	—	-4	25	2.5 ^e	—	0.25	—	0.25	—	—	
t_c $V_{CC} = 80 \text{ V}$, $L = 25 \mu\text{H}$, $R_c \leq 4 \Omega$, Collector clamped to V_{CEX}	—	-4	20	3 ^e	—	—	—	—	—	0.5	—
	—	-4	25	3 ^e	—	0.5	—	0.5	—	—	

2

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

ELECTRICAL CHARACTERISTICS $T_c = 25^\circ\text{C}$

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686 RJH6686		2N6687 RJH6687		2N6688 RJH6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	260	-1.5	—	—	—	0.5	—	—	—	—	mA
	280	-1.5	—	—	—	—	—	0.5	—	—	
	300	-1.5	—	—	—	—	—	—	—	0.5	
$V_{CE(sat)}$	—	—	20 ^a	2	—	—	—	—	—	1.5	V
	—	—	25 ^a	2.5	—	1.5	—	1.5	—	—	
t_r^d	—	-4	20	2	—	—	—	—	—	0.8	μs
	—	-4	25	2.5	—	0.8	—	0.8	—	—	
t_s^d	—	-4	20	2	—	—	—	—	—	2.5	
	—	-4	25	2.5 ^e	—	2.5	—	2.5	—	—	
t_f^d	—	-4	20	2	—	—	—	—	—	0.8	
	—	-4	25	2.5 ^e	—	0.8	—	0.8	—	—	
t_c $V_{CC} = 80\text{ V}$, $L = 25\ \mu\text{H}$, $R_C \leq 4\ \Omega$, Collector Clamped to V_{CEX}	—	-4	20	3 ^e	—	—	—	—	—	0.8	
	—	-4	25	3 ^e	—	0.8	—	0.8	—	—	
$R_{\theta_{JC}}$ 2N6686, 2N6687, 2N6688	10	—	5	—	—	0.875	—	0.875	—	0.875	$^\circ\text{C/W}$
$R_{\theta_{JC}}$ RJH6686, RJH6687, RJH6688	10	—	5	—	—	0.625	—	0.625	—	0.625	

* In accordance with JEDEC registration data.

^a Pulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: The sustaining voltage $V_{CE0(sus)}$ and V_{CEX} **MUST NOT** be measured on a curve tracer.

^c V_{CB} value.

^d $V_{CC} = 80\text{ V}$, $t_p = 20\ \mu\text{s}$.

^e $I_{B1} = -I_{B2}$.

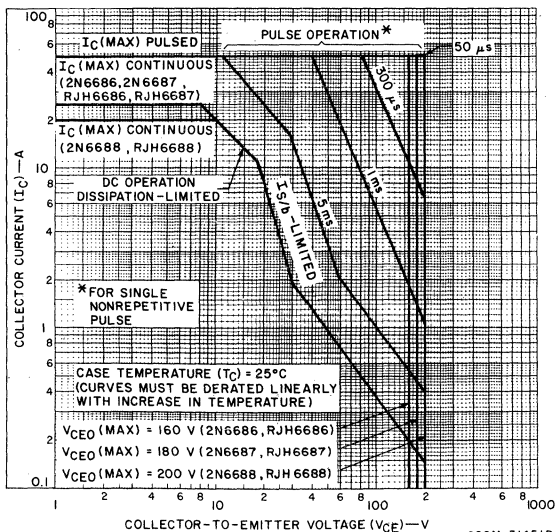


Fig. 1 - Maximum operation areas of all types. ($T_c = 25^\circ$).

**2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688**

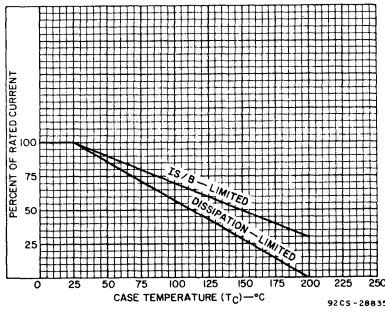


Fig. 2 - Dissipation and $I_{s/b}$ derating curves for 2N6686, 2N6687, and 2N6688.

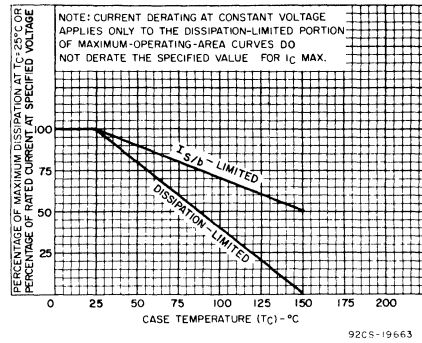


Fig. 3 - Dissipation and $I_{s/b}$ derating curves for RJH6686, RJH6687, and RJH6688.

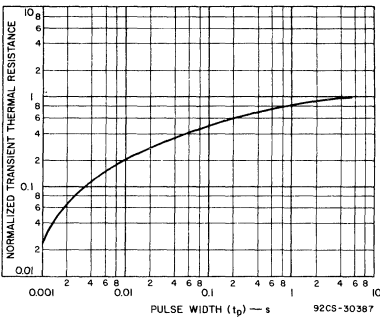


Fig. 4 - Typical thermal-response characteristic for all types.

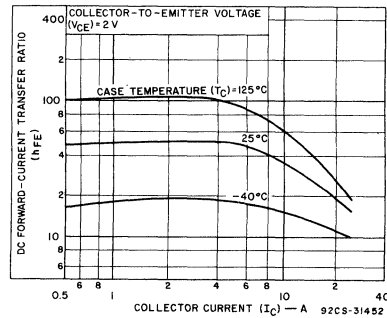


Fig. 5 - Typical dc beta characteristics for all types.

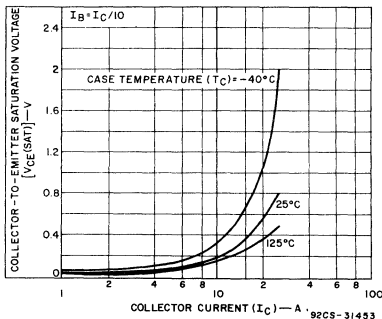


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

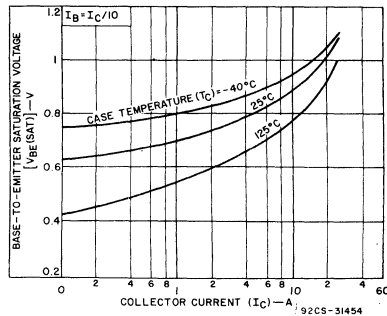


Fig. 7 - Typical base-to-emitter saturation voltage characteristic for all types.

2

2N6686, 2N6687, 2N6688
 RJH6686, RJH6687, RJH6688

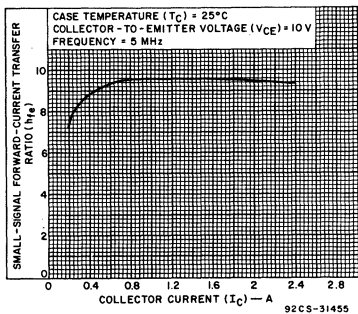


Fig. 8 - Typical small-signal forward-current transfer ratio characteristic for all types ($f = 5$ MHz).

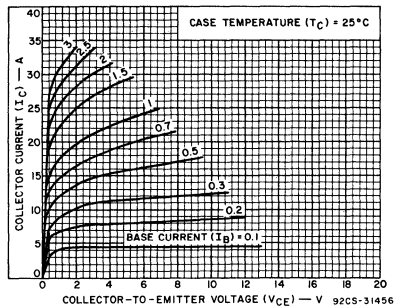


Fig. 9 - Typical output characteristics for all types.

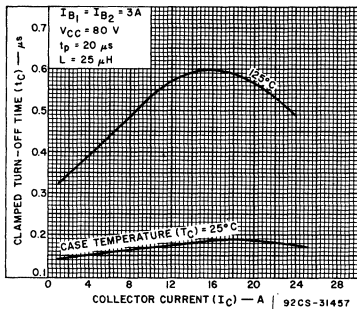


Fig. 10 - Typical clamped turn-off time characteristics for all types.

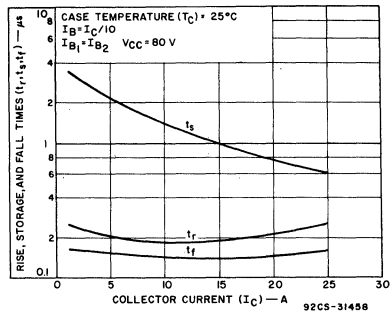


Fig. 11 - Typical saturated-switching-time characteristics as a function of collector current for all types.

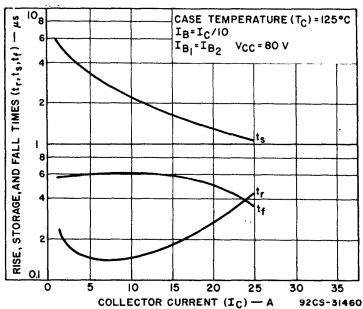


Fig. 12 - Typical saturated-switching-time characteristics at $T_C = 125^\circ C$ as a function of collector current for all types.

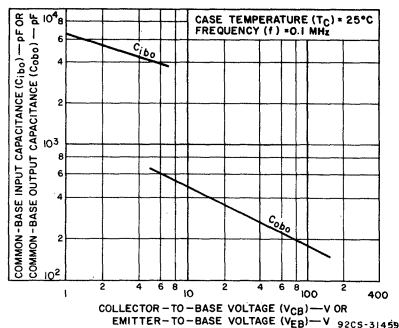


Fig. 13 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

**2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688**

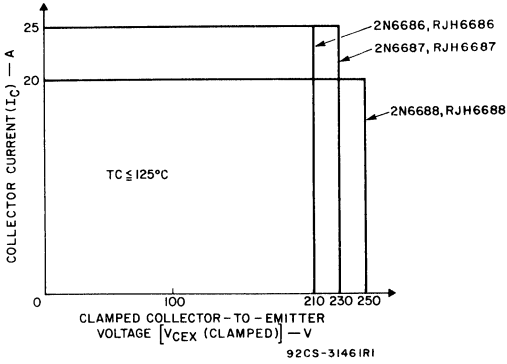


Fig. 14 - Maximum operating conditions for switching between saturation and cutoff for all types.

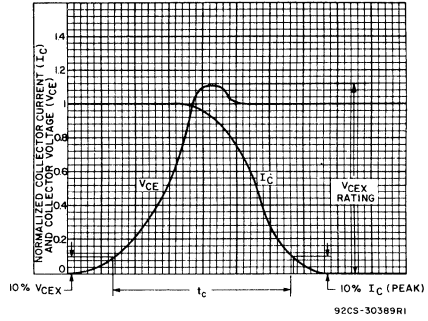


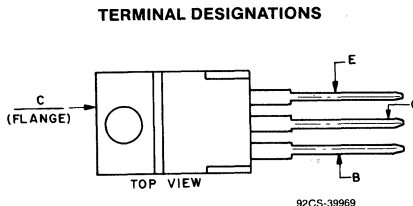
Fig. 15 - Oscilloscope display for normalized measurements of clamped inductive switching time (t_c).

High-Current, Silicon N-P-N VERSAWATT Transistors

Switching Applications

Features:

- Fast switching speed at temperatures up to 125°C
- Low $V_{CE(sat)}$
- VERSAWATT plastic package



The 2N6702, 2N6703 and 2N6704* epitaxial-base silicon n-p-n power transistors which feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

The 2N6702, 2N6703, and 2N6704 transistors are supplied in the JEDEC TO-220AB (RCA VERSAWATT) plastic packages.

*Formerly RCA Dev. Type Nos. TA9164A, TA9164B, TA9164C, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6702	2N6703	2N6704	
* V_{CEV} $V_{BE} = -1.5 V$	140	160	180	V
* V_{CEO}	90	110	130	V
* V_{EBO}		7		V
* $I_{C(sat)}$	5	5	4	A
* I_C		7		A
* I_{CM}		10		A
* I_B		5		A
* P_T T_C up to 25°C		50		W
T_C above 25°C		0.4		Derate Linearly W/°C
* T_{stg}, T_J		-65 to 150		°C
* T_L At distance $\geq 1/8$ in. (3.16 mm) from seating plane for 10 s max.		235		°C

*In accordance with JEDEC registration data.

2N6702, 2N6703, 2N6704

ELECTRICAL CHARACTERISTICS, at Case Temperature $T_C = 25^\circ\text{C}$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS	
	VOLTAGE V dc		CURRENT A dc		2N6702		2N6703		2N6704			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.		
* I_{CEV}	140	-1.5			-	100	-	-	-	-	μA	
	160	-1.5			-	-	-	100	-	-		
	180	-1.5			-	-	-	-	-	100		
	$T_C = 125^\circ\text{C}$	140	-1.5			-	1	-	-	-	-	mA
		160	-1.5			-	-	-	1	-	-	
		180	-1.5			-	-	-	-	-	1	
* I_{EBO}		-7	0		-	100	-	100	-	100	μA	
* $V_{CE0(sus)b}$			0.01 ^a	0	90	-	110	-	130	-	V	
* h_{FE}	2		0.2 ^a		30	-	30	-	30	-		
	2		4 ^a		-	-	-	-	20	-		
	2		5 ^a		20	-	20	-	-	-		
* $V_{BE(sat)}$			4 ^a	0.4	-	-	-	-	-	1.4	V	
			5 ^a	0.5	-	1.5	-	1.5	-	-		
* $V_{CE(sat)}$			4 ^a	0.4	-	-	-	-	-	0.7	V	
			5 ^a	0.5	-	0.8	-	0.8	-	-		
			7 ^a	0.7	-	1.5	-	1.5	-	1.5		
* I_S/b	20		2.5		1	-	1	-	1	-	s	
* $|h_{fe}|$ $f = 5\text{ MHz}$	10		0.5		10	40	10	40	10	40		
* f_T	10		0.5		50	200	50	200	50	200	MHz	
* C_{obo} $f = 0.1\text{ MHz}$	10 ^c				50	150	50	150	50	150	pF	
* t_d^d		-4	4	0.4	-	-	-	-	-	0.1	μs	
* t_r^d		-4	4	0.4	-	-	-	-	-	0.25		
			5	0.5	-	0.25	-	0.25	-	-		
* t_s^d		-4	4	0.4 ^e	-	-	-	-	-	1		
			5	0.5 ^e	-	1	-	1	-	-		
* t_f^d		-4	4	0.4 ^e	-	-	-	-	-	0.5		
			5	0.5 ^e	-	0.5	-	0.5	-	-		
* $R_{\theta JC}$	4		5		-	2.5	-	2.5	-	2.5	$^\circ\text{C/W}$	

* In accordance with JEDEC registration data.

^a Pulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: The sustaining voltage $V_{CE0(sus)}$ MUST NOT be measured on a curve tracer.

^c V_{CB} value.

^d $V_{CC} = 70\text{ V}$, $t_p = 20\ \mu\text{s}$

^e $I_{B1} = -I_{B2}$.

2N6702, 2N6703, 2N6704

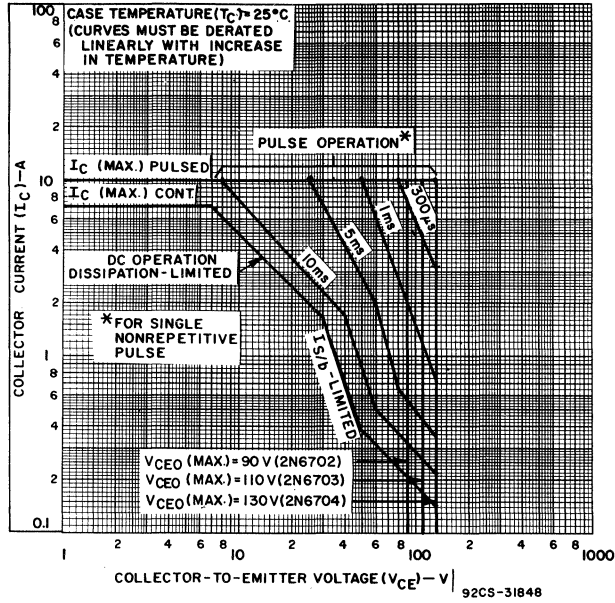


Fig. 1 - Maximum operating areas for all types ($T_C = 25^\circ C$).

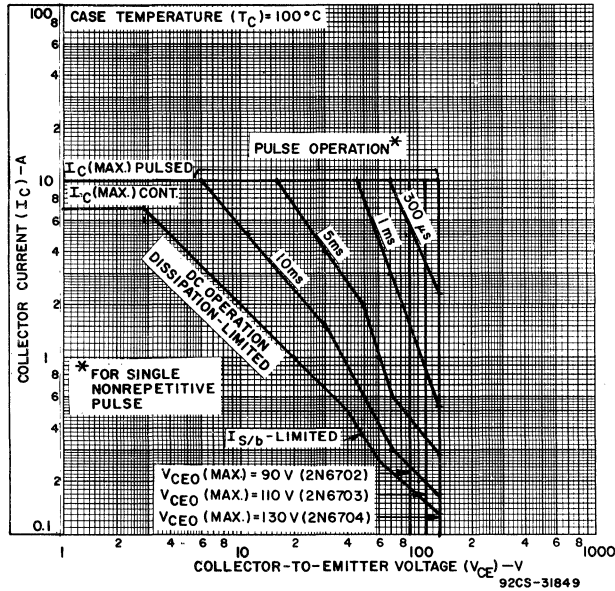


Fig. 2 - Maximum operating areas for all types ($T_C = 100^\circ C$).

2N6702, 2N6703, 2N6704

2

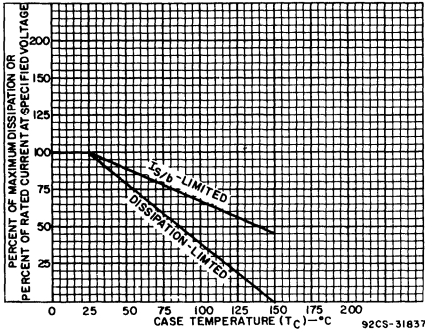


Fig. 3 - Dissipation and $I_{S/b}$ derating curves for all types.

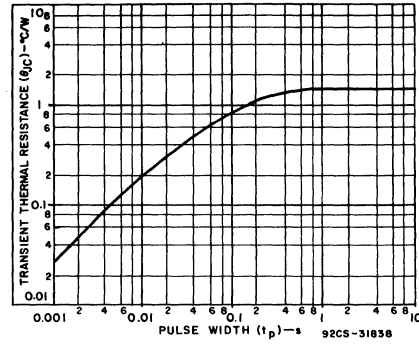


Fig. 4 - Typical thermal-response characteristic for all types.

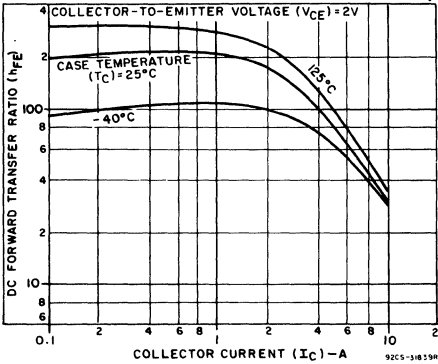


Fig. 5 - Typical dc beta characteristics for all types.

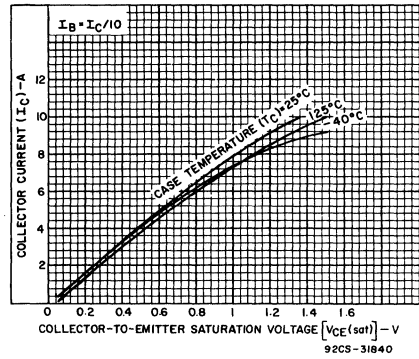


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

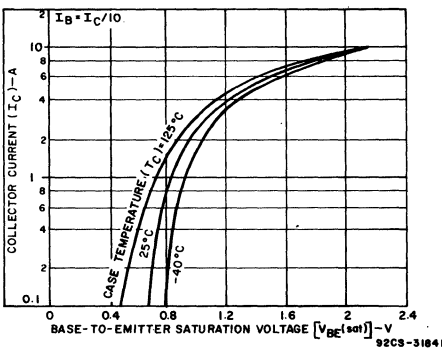


Fig. 7 - Typical base-to-emitter saturation voltage characteristic for all types.

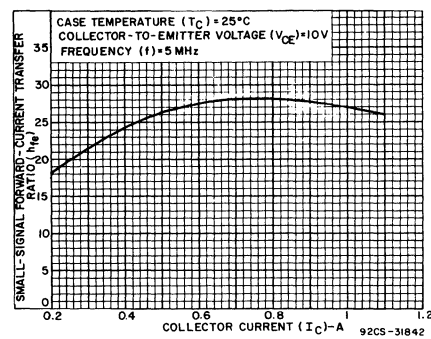


Fig. 8 - Typical small-signal forward-current transfer ratio characteristic for all types ($f = 5 \text{ MHz}$).

2N6702, 2N6703, 2N6704

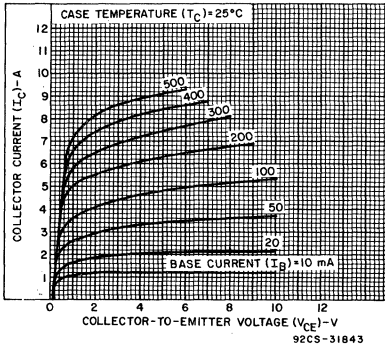


Fig. 9 - Typical output characteristics for all types.

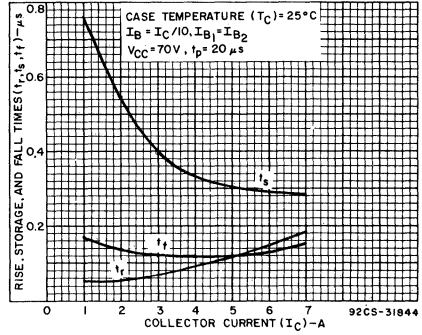


Fig. 10 - Typical saturated-switching-time characteristics as a function of collector current for all types ($T_C = 25^\circ C$).

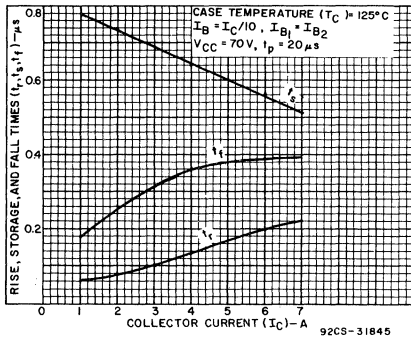


Fig. 11 - Typical saturated-switching-time characteristics as a function of collector current for all types ($T_C = 125^\circ C$).

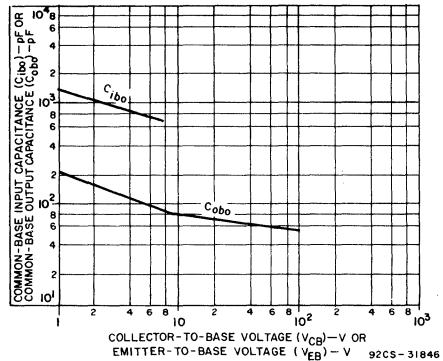


Fig. 12 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

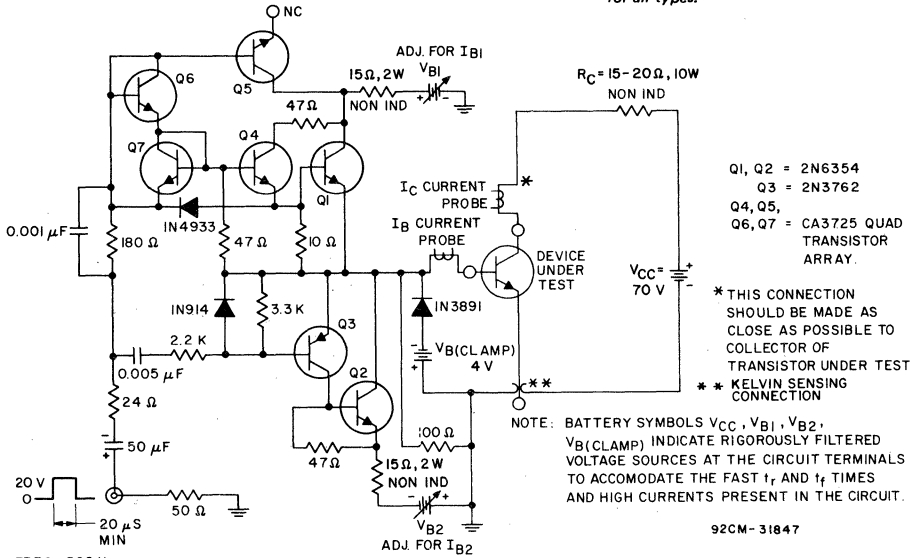
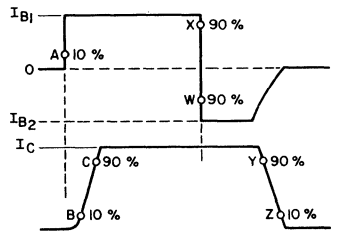


Fig. 13 - Circuit for measuring switching times.

2N6702, 2N6703, 2N6704


 $t_d = A-B$
 $t_s = X-Y$
 $t_f = B-C$
 $t_r = Y-Z$
 $t_{\text{transition}} = X-W$

NOTE: TRANSITION TIME
FROM 90% I_{B1} TO 90% I_{B2} MUST
BE LESS THAN 0.5 μs .

92CS-3038IR1

2

Fig. 14 - Phase relationship between input and output currents showing reference points for specification of switching times.

5-A *SwitchMax* Power Transistors

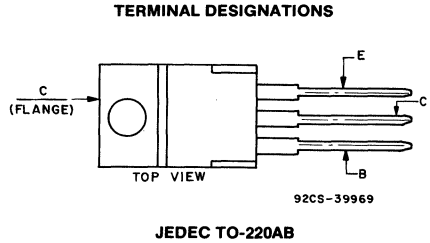
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
 $V_{CEX} = 350\text{ V to }450\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 5\text{ A}$
- VERSAWATT package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators



The 2N6738, 2N6739, and 2N6740* SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that

are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The 2N6738, 2N6739, and 2N6740 series transistors are supplied in the JEDEC TO-220AB package.

*Formerly Dev. Type Nos. TA9141A, TA9141B, and TA9141C, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6738	2N6739	2N6740	
* V_{CEV} $V_{BE} = -1.5\text{ V}$	450	550	650	V
* $V_{CEX}(\text{Clamped})$ $V_{BE} = -1.5\text{ V}$	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}	_____	8	_____	V
* $I_C(\text{sat})$	_____	5	_____	A
* I_C	_____	8	_____	A
* I_{CM}	_____	10	_____	A
* I_B	_____	4	_____	A
* P_T T_C up to 25°C	_____	100	_____	W
T_C above 25°C, derate linearly	_____	0.8	_____	W/°C
* T_{stg}, T_J	_____	-65 to 150	_____	°C
* T_L At distance $\geq 1/8"$ in. (3.17 mm) from seating plane for 10 s max.	_____	235	_____	°C

*In accordance with JEDEC registration data.

ELECTRICAL CHARACTERISTICS

2N6738, 2N6739, 2N6740

CHARACTERISTIC	TEST CONDITIONS				LIMITS					UNITS	
	VOLTAGE		CURRENT		2N6738		2N6739		2N6740		
	V dc	V dc	A dc	A dc	Min.	Max.	Min.	Max.	Min.		Max.
$T_C=25^\circ\text{C}$											
* I_{CEV}	450	-1.5			—	0.1	—	—	—	—	mA
	550	-1.5			—	—	—	0.1	—	—	
	650	-1.5			—	—	—	—	—	0.1	
* I_{EBO}		-8	0		—	2	—	2	—	2	
* $V_{CEO(sus)}^b$			0.2 ^a	0	300	—	350	—	400	—	V
* hFE	3		5 ^a		10	40	10	40	10	40	
* $V_{BE(sat)}$			5 ^a	1	—	1.6	—	1.6	—	1.6	
* $V_{CE(sat)}$			5 ^a	1	—	1	—	1	—	1	V
			8 ^a	4	—	2	—	2	—	2	
* V_{CEX}^b (Clamped E_S/b) $L=170\ \mu\text{H}$, $R_{BB}=5\ \Omega$		-5	5	1 ^e	350	—	400	—	450	—	V
		-5	8	3 ^e	200	—	250	—	300	—	
* I_S/b	25		4		0.5	—	0.5	—	0.5	—	s
* $|h_{fe}|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
* t_T	10		0.2		15	60	15	60	15	60	MHz
* C_{obo} f=0.1 MHz	10 ^c				50	300	50	300	50	300	pF
* t_d^d			5	1	—	0.1	—	0.1	—	0.1	μs
* t_r^d			5	1	—	0.5	—	0.5	—	0.5	
* t_s^d			5	1 ^e	—	2.5	—	2.5	—	2.5	
* t_f^d			5	1 ^e	—	0.4	—	0.4	—	0.4	
* t_c $V_{CC}=125\ \text{V}$, $L=170\ \mu\text{H}$, $R_C=25\ \Omega$ Collector clamped to V_{CEX}			5	1 ^e	—	0.4	—	0.4	—	0.4	
$T_C=125^\circ\text{C}$											
* I_{CEV}	450	-1.5			—	1	—	—	—	—	mA
	550	-1.5			—	—	—	1	—	—	
	650	-1.5			—	—	—	—	—	1	
* $V_{CE(sat)}$			5 ^a	1	—	2	—	2	—	2	V
* t_r^d			5	1	—	0.8	—	0.8	—	0.8	μs
* t_s^d			5	1 ^e	—	4	—	4	—	4	
* t_f^d			5	1 ^e	—	0.8	—	0.8	—	0.8	
* t_c $V_{CC}=125\ \text{V}$, $L=170\ \mu\text{H}$, $R_C=25\ \Omega$ Collector clamped to V_{CEX}			5	1 ^e	—	0.8	—	0.8	—	0.8	
* $R_{\theta JC}$	10		5		—	1.25	—	1.25	—	1.25	$^\circ\text{C/W}$
* $R_{\theta JA}$					—	70	—	70	—	70	$^\circ\text{C/W}$

*In accordance with JEDEC registration data.

^c V_{CB} value.^e $I_{B1} = -I_{B2}$.^aPulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.^d $V_{CC} = 125\ \text{V}$, $t_p = 20\ \mu\text{s}$.^bCAUTION: The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} MUST NOT be measured on a curve tracer.

2N6738, 2N6739, 2N6740

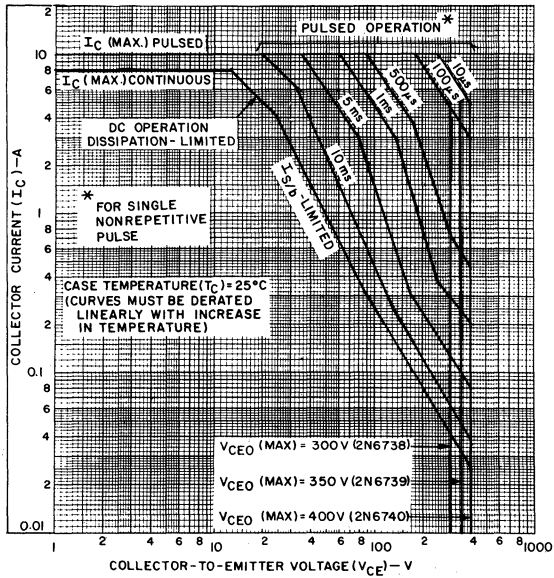


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

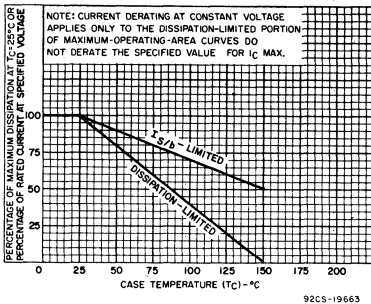


Fig. 2 — Dissipation and derating curve for all types.

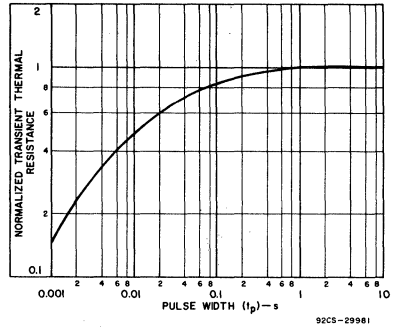


Fig. 3 — Typical thermal-response characteristic for all types.

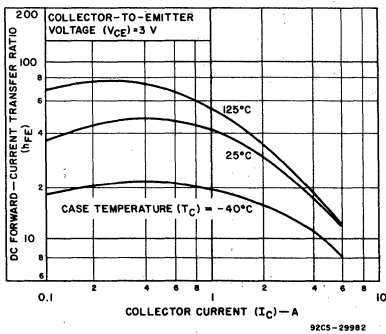


Fig. 4 — Typical dc beta characteristics for all types.

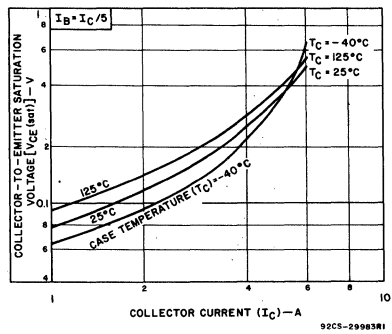


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6738, 2N6739, 2N6740

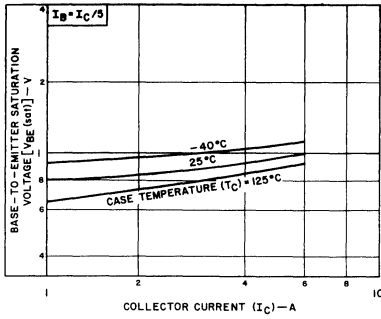


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

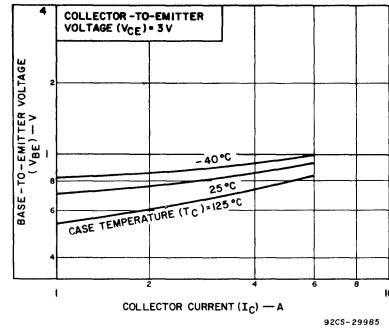


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

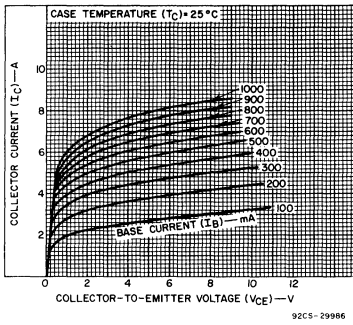


Fig. 8 — Typical output characteristics for all types.

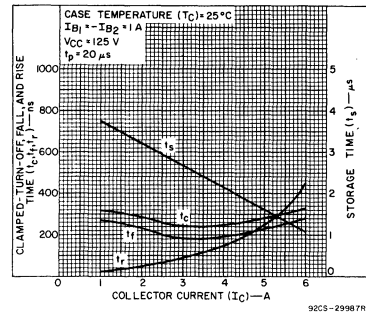


Fig. 9 — Typical saturated switching time characteristics for all types.

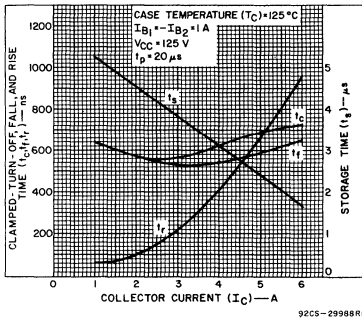


Fig. 10 — Typical saturated switching time characteristics for all types.

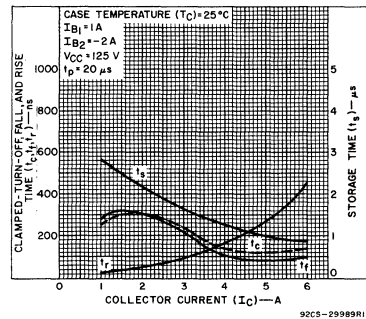


Fig. 11 — Typical saturated switching time characteristics for all types.

2N6738, 2N6739, 2N6740

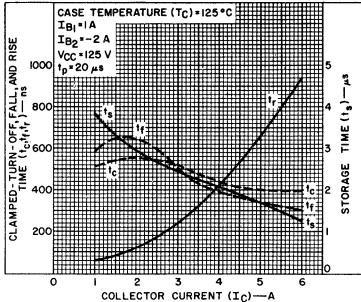


Fig. 12 — Typical saturated switching time characteristics for all types.

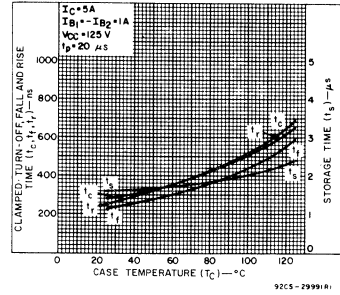


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

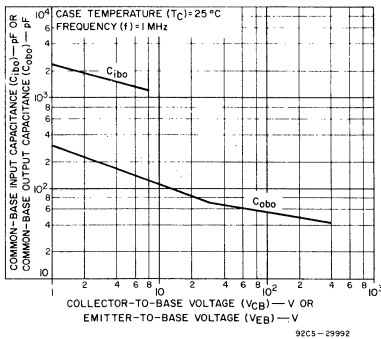


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

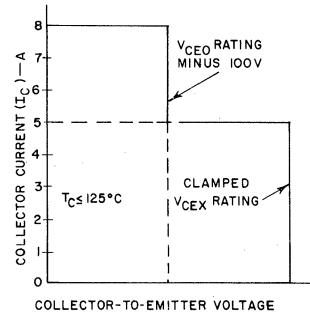


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

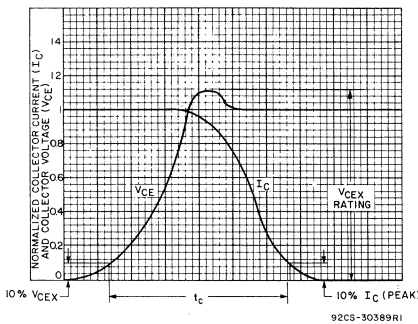


Fig. 16 — Oscilloscope display for measurement of clamped induction switching-time (t_c).

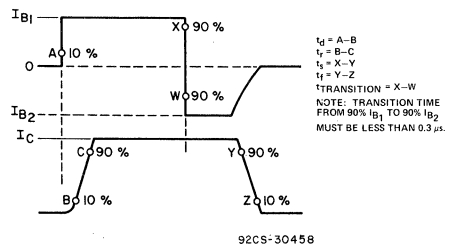


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N6738, 2N6739, 2N6740

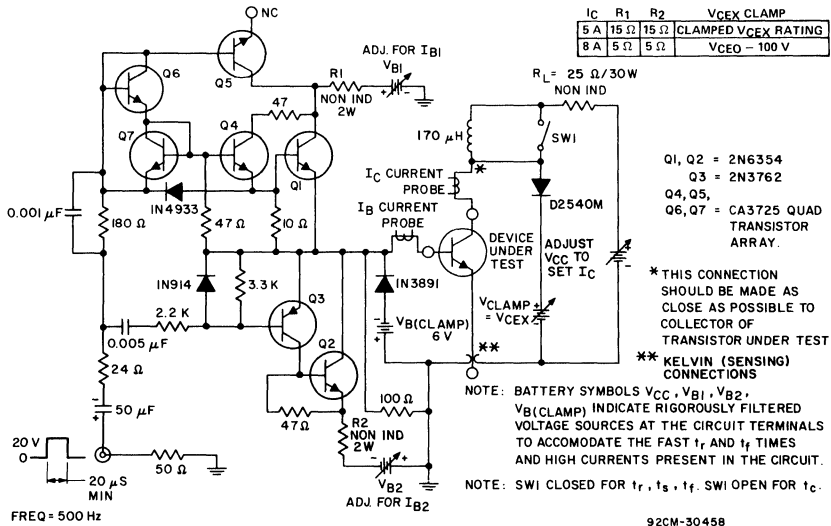


Fig. 18 — Circuit for measuring switching times.

5-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

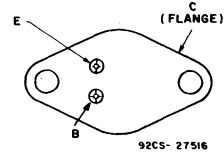
Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
 $V_{CEX} = 450\text{ V} - 550\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 5\text{ A}$
- Steel hermetic TO-204AA package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AA

(200 mil diameter pin isolation)

The 2N6751, 2N6752, 2N6753, and 2N6754 SwitchMax series* of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits.

Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The 2N6751, 2N6752, 2N6753, and 2N6754 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

*Formerly TA9153, TA9153A, TA9153B,

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6751	2N6752	2N6753	2N6754	
* V_{CEV} $V_{BE} = -1.5\text{ V}$	800	850	900	1000	V
* $V_{CEX}(\text{Clamped})$ $V_{BE} = -1.5\text{ V}$	450	500	550	550	V
* V_{CEO}	400	450	500	500	V
* V_{EBO}	_____	8	_____	_____	V
* $I_C(\text{sat})$	_____	5	_____	_____	A
* I_C	_____	10	_____	_____	A
* I_{CM}	_____	10	_____	_____	A
* I_B	_____	5	_____	_____	A
* P_T $T_C \leq 25^\circ\text{C}$	_____	150	_____	_____	W
* $T_C \geq 25^\circ\text{C}$, derate linearly	_____	1	_____	_____	W/°C
* T_J	_____	-65 to 175	_____	_____	°C
* T_{stg}	_____	-65 to 200	_____	_____	°C
* T_L At distance $\geq 1/16\text{ in. (1.58 mm)}$ from seating plane for 10 s max.	_____	235	_____	_____	°C

* In accordance with JEDEC registration data.

2N6751, 2N6752, 2N6753, 2N6754

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE		CURRENT		2N6751		2N6752		
	V dc		A dc		Min.	Max.	Min.	Max.	
	V _{CE}	V _{BE}	I _C	I _B					

 $T_C = 25^\circ\text{C}$

* I _{CEV}	800 850	-1.5 -1.5			— —	0.1 —	— —	— 0.1	mA
* I _{EBO}		-8	0		—	2	—	2	
* V _{CE0(sus)^b}			0.2 ^a	0	400	—	450	—	V
* h _{FE}	3		5 ^a		8	40	8	40	
* V _{BE(sat)}			5 ^a	1	—	1.3	—	1.3	V
* V _{CE(sat)}			5 ^a 10 ^a	1 3	— —	1 3	— —	1 3	
V _{CEX^b} (Clamped E _{S/b}) L = 170 μH		-6	5	1 ^c	450	—	500	—	
I _{S/b}	30		5		1	—	1	—	s
* |h _{fe}| f = 5 MHz	10		0.2		3	12	3	12	
f _T	10		0.2		15	60	15	60	MHz
* C _{obo} f = 0.1 MHz	10 ^d				50	250	50	250	pF
* t _{d^e}		-6	5	1	—	0.1	—	0.1	μs
* t _{r^e}		-6	5	1	—	0.4	—	0.4	
* t _{s^e}		-6	5	1 ^c	—	3	—	3	
* t _{f^e}		-6	5	1 ^c	—	0.4	—	0.4	
* t _c V _{CC} = 250 V, L = 170 μH, R _C = 50 Ω, Collector clamped to V _{CEX}		-6	5	1 ^c	—	0.4	—	0.4	

 $T_C = 100^\circ\text{C}$

* I _{CEV}	800 850	-1.5 -1.5			— —	1 —	— —	— 1	mA
* V _{CE(sat)}			5 ^a	1	—	1.5	—	1.5	
* t _{r^e}		-6	5	1	—	0.6	—	0.6	μs
* t _{s^e}		-6	5	1 ^c	—	5	—	5	
* t _{f^e}		-6	5	1 ^c	—	0.7	—	0.7	
* t _c V _{CC} = 250 V, L = 170 μH, R _C = 50 Ω, Collector clamped to V _{CEX}		-6	5	1 ^c	—	0.7	—	0.7	

* R _{θJC}	10		5		—	1	—	1	°C/W
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* In accordance with JEDEC registration data.

^a Pulsed duration = 300 μs, duty factor ≤ 2%.^b CAUTION: The sustaining voltage V_{CE0(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.^c I_{B1} = -I_{B2} ^d V_{CB} value ^e V_{CC} = 250 V, t_p = 20 μs

2N6751, 2N6752, 2N6753, 2N6754

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE		CURRENT		2N6753		2N6754		
	V dc		A dc		Min.	Max.	Min.	Max.	
	V _{CE}	V _{BE}	I _C	I _B					

T_C = 25°C

* I _{CEV}	900 1000	-1.5 -1.5			—	0.1	—	—	mA
* I _{EBO}		-8	0		—	2	—	2	
* V _{CEO(sus)} ^b			0.2 ^a	0	500	—	500	—	V
* h _{FE}	3		5 ^a		8	40	8	40	
* V _{BE(sat)}			5 ^a	1	—	1.3	—	1.3	V
* V _{CE(sat)}			5 ^a 10 ^a	1 3	—	1 3	—	1 3	
V _{CEX} ^b (Clamped E _{S/b}) L = 170 μH		-6	5	1 ^c	550	—	550	—	
I _{S/b}	30		5		1	—	1	—	s
* |h _{fe}| f = 5 MHz	10		0.2		3	12	3	12	
* f _T	10		0.2		15	60	15	60	MHz
* C _{obo} f = 0.1 MHz	10 ^d				50	250	50	250	pF
* t _d ^e		-6	5	1	—	0.1	—	0.1	μs
* t _r ^e		-6	5	1	—	0.4	—	0.4	
* t _s ^e		-6	5	1 ^c	—	3	—	3	
* t _f ^e		-6	5	1 ^c	—	0.4	—	0.4	
* t _c V _{CC} = 250 V, L = 170 μH, R _C = 50 Ω, Collector clamped to V _{CEX}		-6	5	1 ^c	—	0.4	—	0.4	

T_C = 100°C

* I _{CEV}	900 1000	-1.5 -1.5			—	1	—	—	mA
* V _{CE(sat)}			5 ^a	1	—	1.5	—	1.5	
* t _r ^e		-6	5	1	—	0.6	—	0.6	μs
* t _s ^e		-6	5	1 ^c	—	5	—	5	
* t _f ^e		-6	5	1 ^c	—	0.7	—	0.7	
* t _c V _{CC} = 250 V, L = 170 μH, R _C = 50 Ω, Collector clamped to V _{CEX}		-6	5	1 ^c	—	0.7	—	0.7	

* R _{θJC}	10		5		—	1	—	1	°C/W
--------------------	----	--	---	--	---	---	---	---	------

^a In accordance with JEDEC registration data.

^a Pulsed duration = 300 μs, duty factor ≤ 2%.

^b CAUTION: The sustaining voltage V_{CEO(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.

^c I_{B1} = -I_{B2} ^d V_{CB} value ^e V_{CC} = 250 V, t_p = 20 μs

2N6751, 2N6752, 2N6753, 2N6754

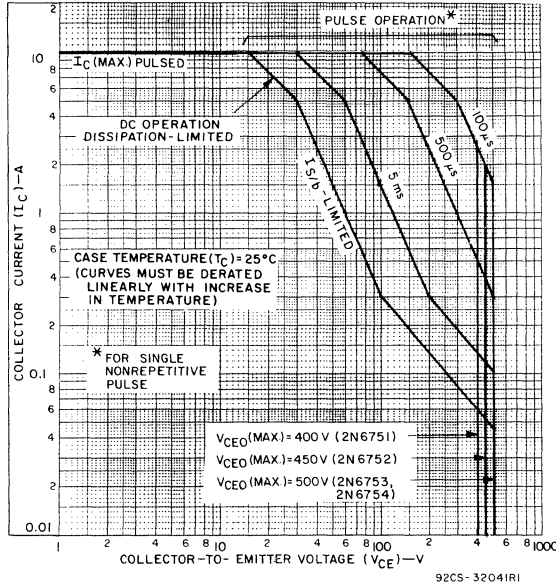


Fig. 1 — Maximum operating areas for all type (T_cC).

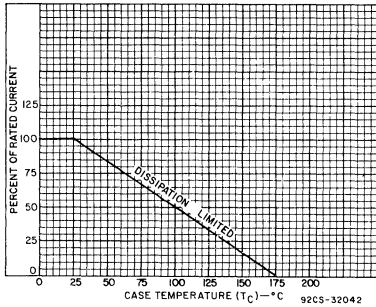


Fig. 2 — Dissipation derating curves for all types.

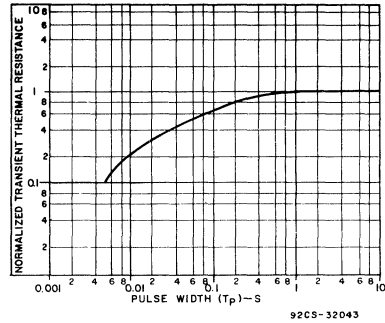


Fig. 3 — Typical thermal-response characteristic for all types.

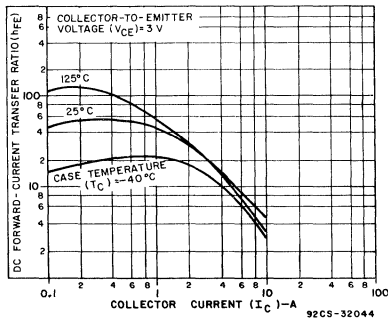


Fig. 4 — Typical dc beta characteristics for all types.

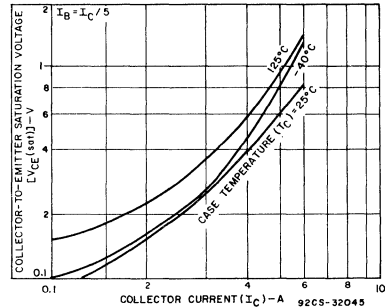


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6751, 2N6752, 2N6753, 2N6754

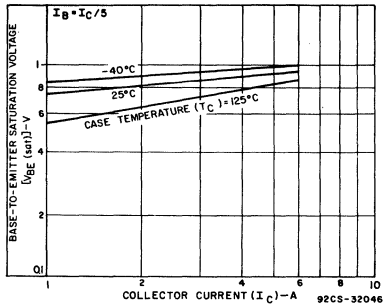


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

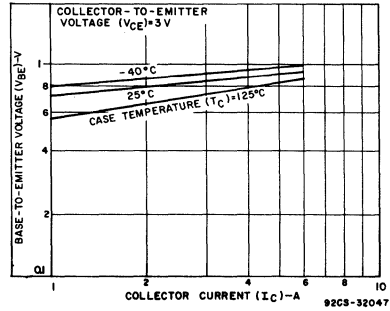


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

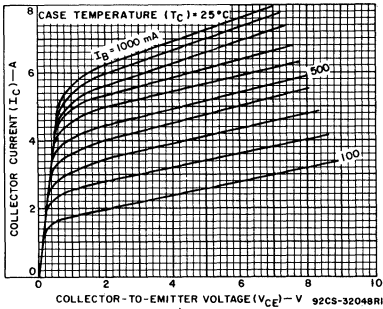


Fig. 8 — Typical output characteristics for all types.

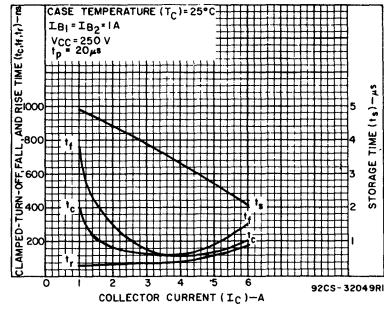


Fig. 9 — Typical saturated switching time characteristics for all types.

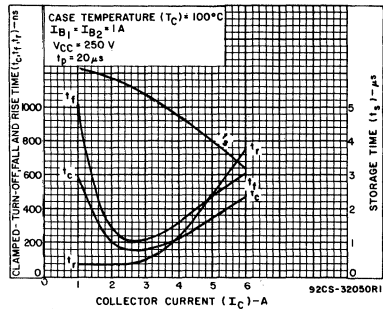


Fig. 10 — Typical saturated switching time characteristics for all types.

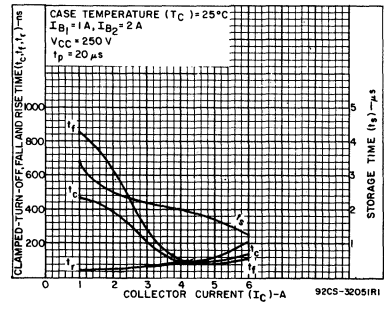


Fig. 11 — Typical saturated switching time characteristics for all types.

2N6751, 2N6752, 2N6753, 2N6754

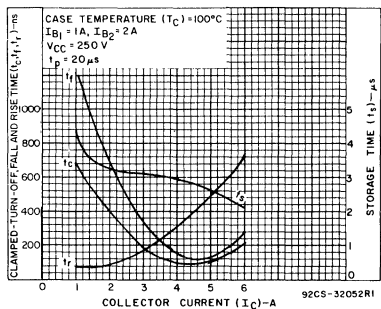


Fig. 12 — Typical saturated switching time characteristics for all types.

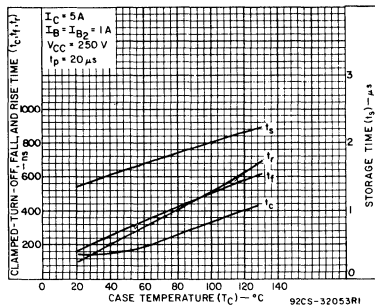


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

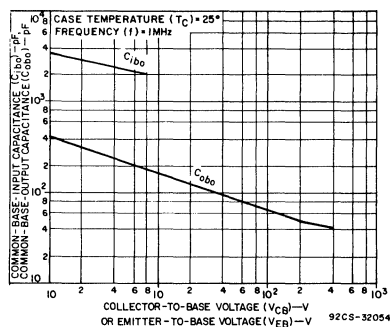


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

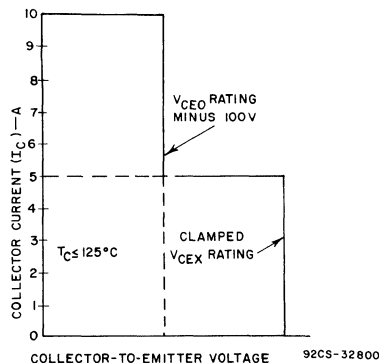


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

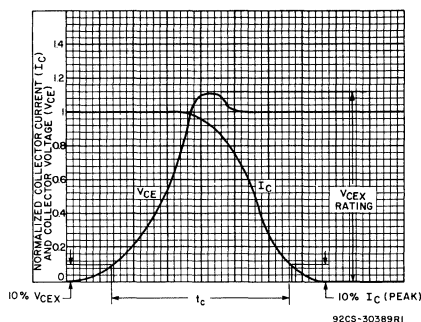


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

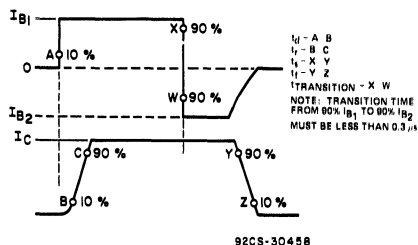


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N6751, 2N6752, 2N6753, 2N6754

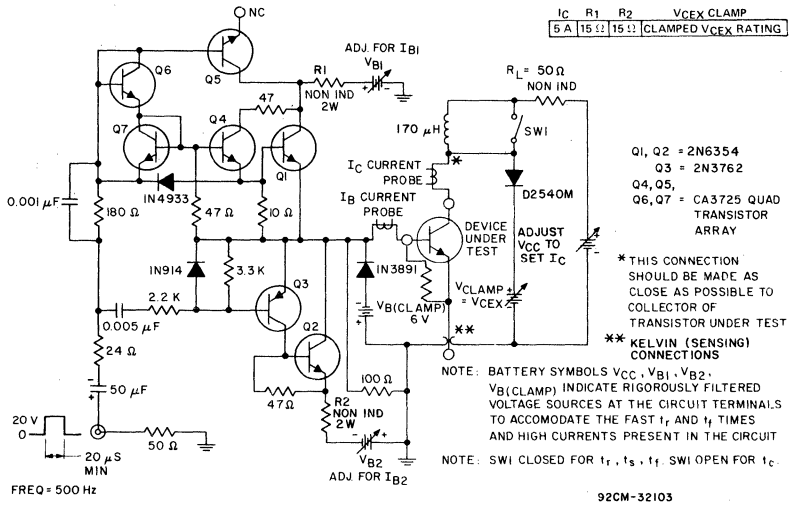


Fig. 18 — Circuit for measuring switching times.

1-A *SwitchMax* VERSAWATT Transistors

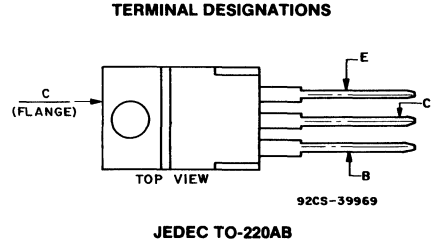
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
V_{CEX} = 350 V to 450 V
- Low V_{CE}(sat) at I_C = 1 A
- VERSAWATT package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators



2

The 2N6771, 2N6772, and 2N6773* SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching

times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The 2N6771, 2N6772, and 2N6773 series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic packages.

*Formerly RCA8863A, RCA8863B, and RCA8863C, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N6771	2N6772	2N6773	
* V _{CEV} V _{BE} = -1.5 V	450	550	650	V
* V _{CEX} (Clamped) V _{BE} = -1.5 V	350	400	450	V
* V _{CEO}	300	350	400	V
* V _{EBO}		8		V
I _C (sat)		1		A
* I _C		1		A
I _{CM}		2		A
* I _B		0.6		A
* P _T				
T _C up to 25°C		40		W
T _C above 25°C, derate linearly		0.32		W/°C
* T _{stg} T _J		-65 to 150		°C
* T _L At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.		235		°C

*In accordance with JEDEC registration data.

2N6771, 2N6772, 2N6773

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE		CURRENT		2N6771		2N6772		2N6773		
	V dc		A dc		Min.	Max.	Min.	Max.	Min.	Max.	
	V _{CE}	V _{BE}	I _C	I _B							

T_C=25° C

I _{CEV}	450	-1.5			—	0.1	—	—	—	—	mA
	550	-1.5			—	—	—	0.1	—	—	
	650	-1.5			—	—	—	—	—	0.1	
I _{EBO}		-8	0		—	2	—	2	—	2	
V _{CEO(sus)} ^b			0.2 ^a	0	300	—	350	—	400	—	V
V _{CE(sat)}			1 ^a	0.2	—	1.0	—	1.0	—	1.0	
V _{BE(sat)}			1 ^a	0.2	—	1.2	—	1.2	—	1.2	
h _{FE}	3		0.3 ^a		20	100	20	100	20	100	
	3		1 ^a		10	50	10	50	10	50	
V _{CEX} ^b (Clamped E _S /b) L=450 μH, R _{BB} =50 Ω		-5	1	0.1 ^e	350	—	400	—	450	—	V
|S/b	100		0.4		0.5	—	0.5	—	0.5	—	s
|h _{fe}| f=1 MHz	10		0.2		10	50	10	50	10	50	
f _T	10		0.2		10	50	10	50	10	50	MHz
C _{obo} f=0.1 MHz	10 ^c				20	60	20	60	20	60	pF
t _d ^d			1	0.2	—	0.05	—	0.05	—	0.05	μs
t _r ^d			1	0.2	—	0.4	—	0.4	—	0.4	
t _s ^d			1	0.2 ^e	—	2.5	—	2.5	—	2.5	
t _f ^d			1	0.2 ^e	—	0.6	—	0.6	—	0.6	
t _c V _{CC} =200 V, L=450 μH, R _C =200 Ω Collector clamped to V _{CEX}			1	0.2 ^e	—	0.6	—	0.6	—	0.6	

T_C=125° C

I _{CEV}	450	-1.5			—	1	—	—	—	—	mA
	550	-1.5			—	—	—	1	—	—	
	650	-1.5			—	—	—	—	—	1	
V _{CE(sat)}			1 ^a	0.2	—	2	—	2	—	2	V
t _r ^d			1	0.2	—	0.8	—	0.8	—	0.8	
t _s ^d			1	0.2 ^e	—	4.5	—	4.5	—	4.5	
t _f ^d			1	0.2 ^e	—	1.5	—	1.5	—	1.5	
t _c V _{CC} =200 V, L=450 μH, R _C =200 Ω Collector clamped. to V _{CEX}			1	0.2 ^e	—	1.5	—	1.5	—	1.5	μs
R _{θJC}	20		1		—	3.12	—	3.12	—	3.12	°C/W
R _{θJA}					—	70	—	70	—	70	°C/W

^aIn accordance with JEDEC registration data.

^bPulsed: pulse duration = 300 μs, duty factor ≤ 2%.

^cCAUTION: The sustaining voltage V_{CEO(sus)}

and V_{CEX} MUST NOT be measured on a curve tracer.

^cV_{CB} value.

^eI_{B1} = -I_{B2}

^dV_{CC} = 200 V, t_p = 20 μs.

2N6771, 2N6772, 2N6773

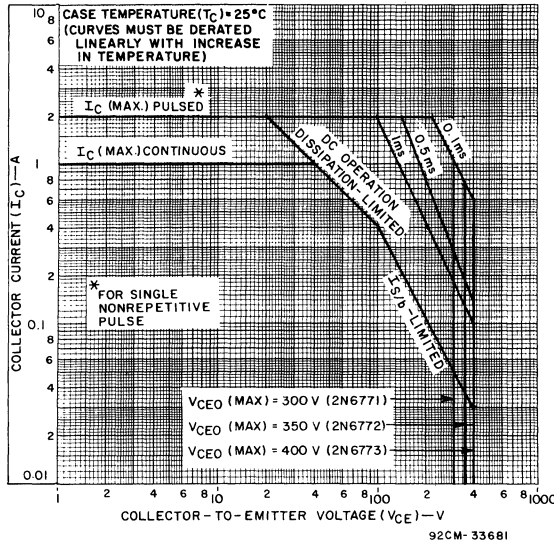


Fig. 1 — Maximum operating areas for all types.

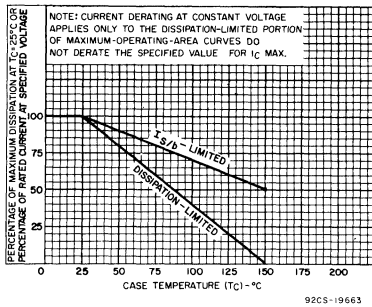


Fig. 2 — Derating curve for all types.

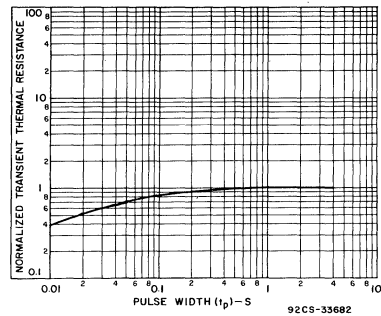


Fig. 3 — Typical thermal-response characteristics for all types.

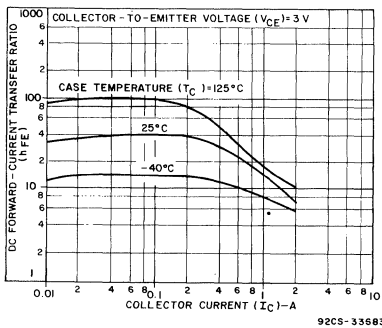


Fig. 4 — Typical dc beta characteristics for all types.

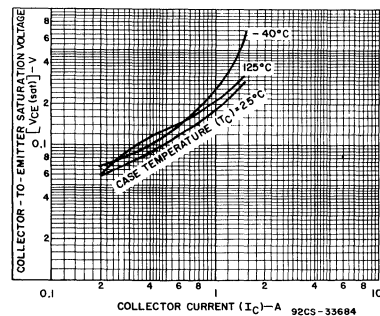


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6771, 2N6772, 2N6773

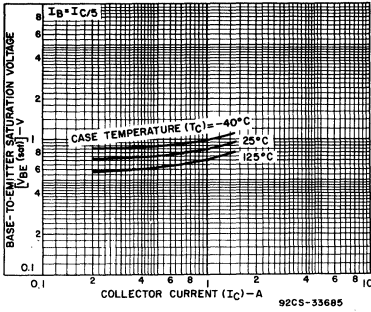


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

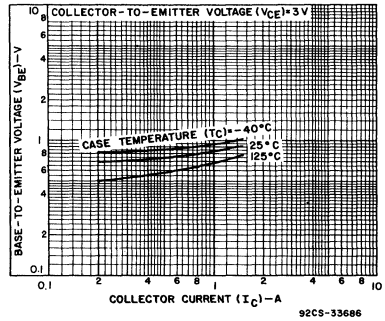


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

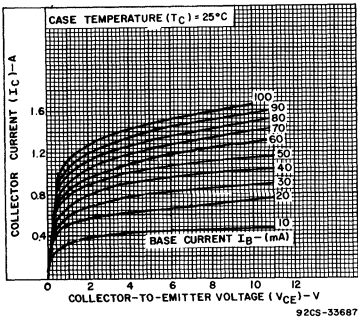


Fig. 8 — Typical output characteristics for all types.

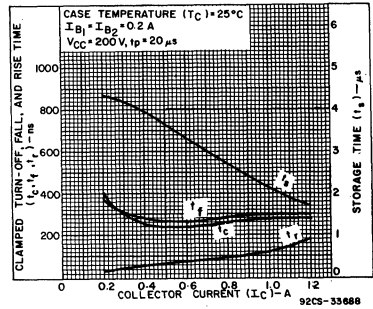


Fig. 9 — Typical saturated-switching-time characteristics for all types.

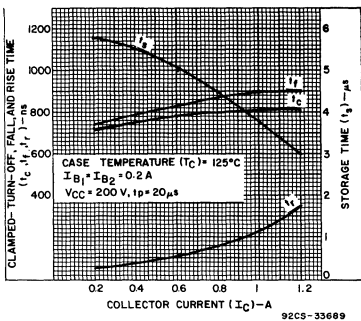


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

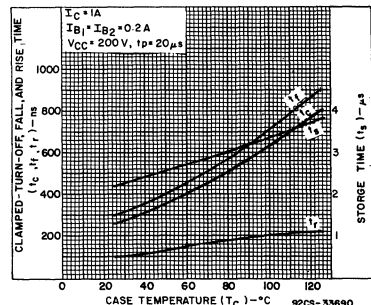


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

2N6771, 2N6772, 2N6773

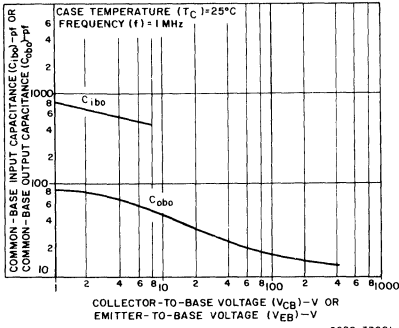


Fig. 12 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

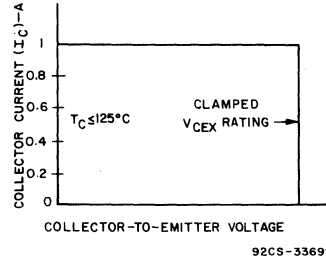


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff.

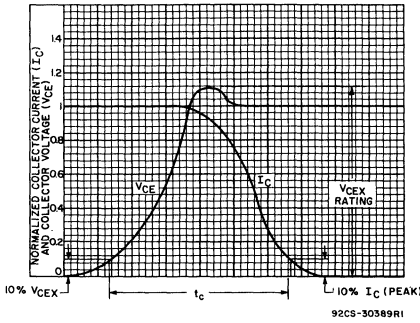


Fig. 14 — Oscilloscope display for measurement of clamped induction switching time (t_c).

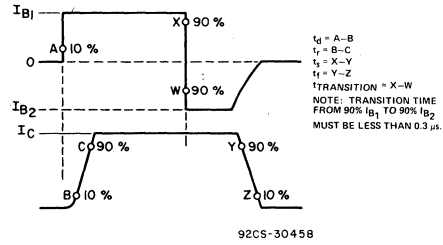


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times.

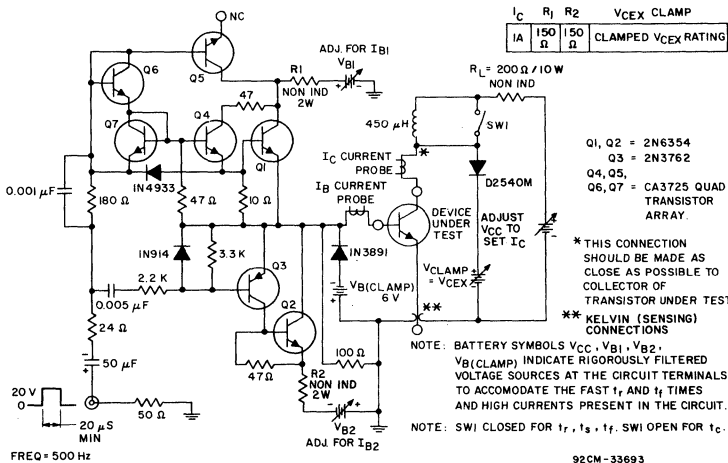


Fig. 16 — Circuit for measuring switching times.

Medium-Power Silicon N-P-N Planar Transistors

For High-Voltage Switching and Linear-Amplifier Applications

Features:

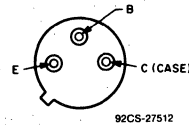
- For operation at junction temperature up to 200° C
- Planar construction for low noise and low leakage

The 40346 and 40412 are silicon n-p-n transistors having high breakdown voltages, high frequency-response capability, and fast switching speeds.

These transistors are intended for a wide variety of low- and medium-power, high-voltage applications. Type 40346 is especially useful in differential and operational amplifiers. Type 40412 is especially suited for class A ac/dc audio-amplifier service.

Types 40346 and 40412 are supplied in a JEDEC TO-205AD hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, Absolute-Maximum Values:

	40346	40412	
V _{CE} (SUS)			V
R _{BE} = 1000 Ω	175	—	V
R _{BE} = 10,000 Ω	—	250	V
I _C	1	1	A
I _B	0.5	0.5	A
P _T			W
T _C ≤ 25° C	10	10	W
T _A ≤ 50°	1	1	W
T _A ≤ 25° C	—	—	W
At other temperatures	See Fig. 1		
T _{stg} , T _J	-65 to +200		° C
T _L			° C
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 s max.	+265		° C

40346, 40412

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE		CURRENT		40346		40412		
	V dc		mA dc		Min.	Max.	Min.	Max.	
	V _{CE}	V _{BE}	I _C	I _B					
I _{CEO}	100			0	—	5	—	—	μA
I _{CER} R _{BE} = 10 kΩ	100				—	—	—	1	mA
I _{CEV}	200	-1.5			—	10	—	—	μA
T _C = 150°C	150	-1.5			—	—	—	2	mA
	200	-1.5			—	1	—	—	mA
I _{EBO}		-4	0		—	5	—	—	μA
		-3	0		—	—	—	100	
h _{FE}	10		10		25	—	—	—	
	20		30		—	—	40	—	
V _{CE} (sus) R _{BE} = 1 kΩ R _{BE} = 10 kΩ			50		175 ^a	—	—	—	V
			50		—	—	250 ^a	—	
V _{BE}	10		10		—	1	—	—	V
V _{CE} (sat)			10	1	—	0.5	—	—	V
|h _{fe} l f = 5 MHz	10		10		2	—	2	—	
C _{obo} V _{CB} = 10 V f = 1 MHz					—	—	—	10	pF
I _S /b t = 1 s, nonrep.					—	—	50	—	mA
R _{θJC}	40346 40412				—	15	—	—	°C/W
					—	—	—	15	

^a CAUTION: Sustaining voltage V_{CE}(sus), MUST NOT be measured on a curve tracer.

2

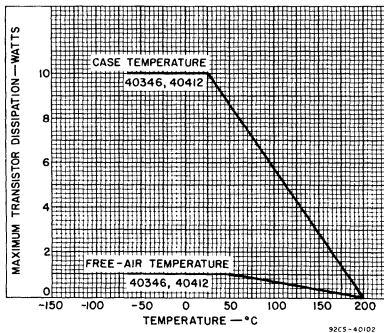


Fig. 1 - Dissipation derating curves.

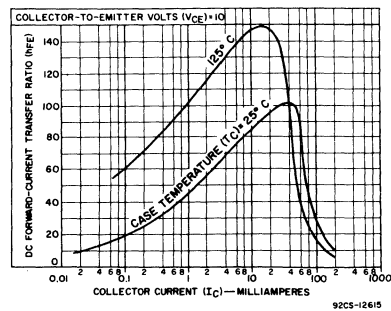


Fig. 2 - Typical dc beta characteristics for all types.

40346, 40412

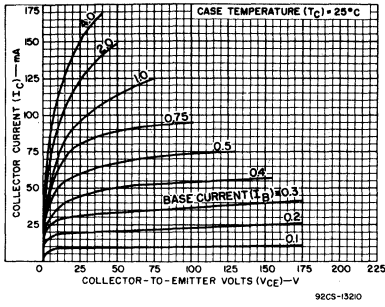


Fig. 3 - Typical output characteristics for all types.

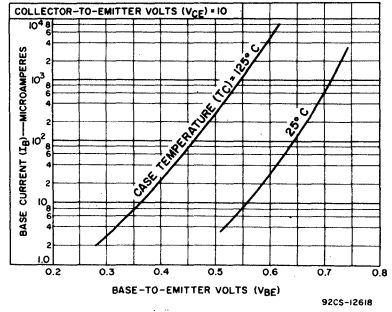


Fig. 4 - Typical input characteristics for all types.

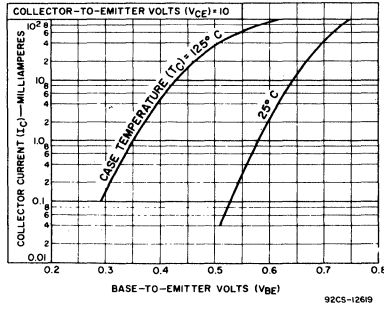


Fig. 5 - Typical transfer characteristics for all types.

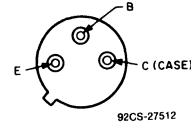
Silicon N-P-N Medium- and High-Voltage Transistors

General-Purpose Transistors for Industrial and Commercial Equipment

Features:

- High second-breakdown resistance
- $V_{CE}(sat)$ typically less than 1 V at 1 A for 40347 and 40348
- Hermetically sealed packages

TERMINAL DESIGNATIONS



JEDEC TO-205AA

The 40347 and 40348 are silicon n-p-n transistors intended for a wide variety of low- and medium-power applications requiring medium- and high-voltage power transistors. These devices differ primarily in their breakdown-voltage ratings.

Typical applications for these transistors include switching regulators, converters, inverters, relay controls, oscillators, pulse amplifiers, and audio amplifiers (in low-power driver and output stages). These transistors are especially suitable for use in low-cost ac/dc amplifier circuits.

MAXIMUM RATINGS, Absolute-Maximum Values:

		40347	40348	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	90	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With -1.5 V (V_{BE}) of reverse bias	V_{CEV}	60	90	V
With base open	V_{CEO}	40	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	1.5	1.5	A
PEAK COLLECTOR CURRENT	I_{CM}	3.0	3.0	A
CONTINUOUS BASE CURRENT	I_B	0.5	0.5	A
TRANSISTOR DISSIPATION	P_T			
At case temperature up to 25°C		8.75	8.75	W
At case temperature above 25°C		See Figs. 1 & 2		
At ambient temperature up to 25°C		1.0	1.0	W
TEMPERATURE RANGE:				
Storage and Operating (Junction)		-65 to 200		°C
LEAD TEMPERATURE (During soldering):				
At distances \geq 1/32 in. (0.8 mm) from seating plane for 10 s max.		230		°C

40347, 40348

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

Characteristic	Symbol	TEST CONDITIONS					LIMITS				Units
		Voltage V dc			Current A dc		40347		40348		
		V _{CE}	V _{EB}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current With external base-to-emitter resistance ($R_{BE} = 1\text{ k}\Omega$)	I _{CER}	30					—	1	—	—	μA
		60					—	—	—	1	
		90					—	—	—	—	
With $R_{BE} = 1\text{ k}\Omega$ and $T_C = 150^\circ\text{C}$	I _{CER}	30					—	1	—	—	mA
		60					—	—	—	1	
		90					—	—	—	—	
Emitter-Cutoff Current	I _{EBO}		7				—	10	—	10	μA
DC Forward-Current Transfer Ratio	h _{FE}	4			0.15		—	—	—	—	
		4			0.30		—	—	30	125	
		4			0.45		25	100	—	—	
		4			1.00		—	—	10	—	
Collector-to-Emitter Sustaining Voltage:	V _{CEV(sus)}										V
				-1.5	0.050		60	—	90	—	
With base open	V _{CEO(sus)}				0.050		40	—	65	—	V
Base-to-Emitter Voltage	V _{BE}	4			0.15		—	—	—	—	V
		4			0.30		—	—	—	1.3	
		4			0.45		—	1.5	—	—	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				0.15	15 mA	—	—	—	—	V
					0.30	30 mA	—	—	—	0.75	
					0.45	45 mA	—	1	—	—	
Forward-Bias Second Break- down Collector Current (1-s non-repetitive pulse)	I _{S/b}	38					345	—	—	—	mA
		63					—	—	208	—	
		138					—	—	—	—	
Thermal Resistance Junction-to-Case	R _{θJC}						—	20	—	20	$^\circ\text{C/W}$

^a Pulsed; pulse duration = 300 μs , duty factor $\leq 2\%$.

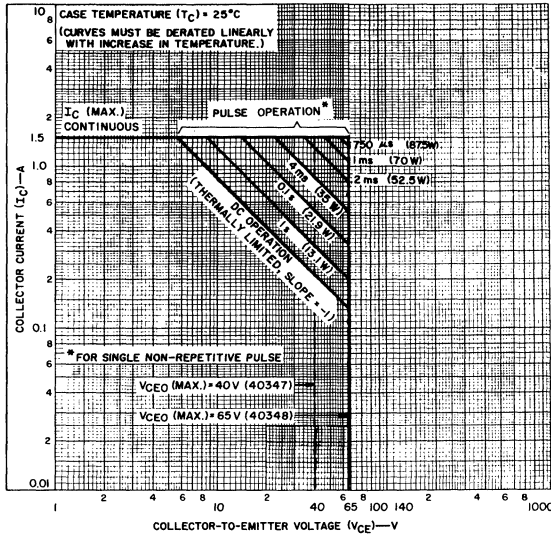


Fig. 1 — Maximum operating areas for types 40347 and 40348.

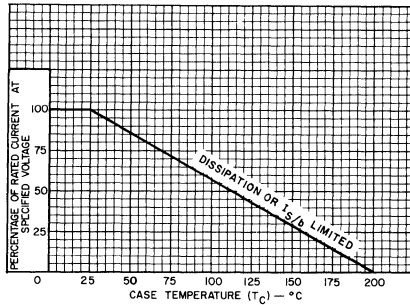


Fig. 2 — Dissipation derating curve for types 40347 and 40348.

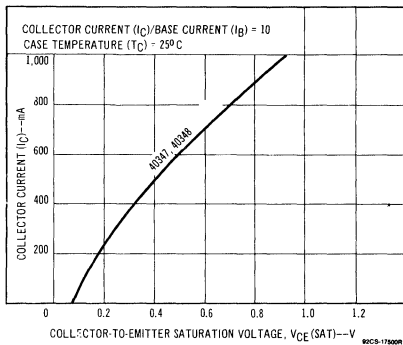


Fig. 3 — Typical saturation characteristics for types 40347 and 40348.

40347, 40348

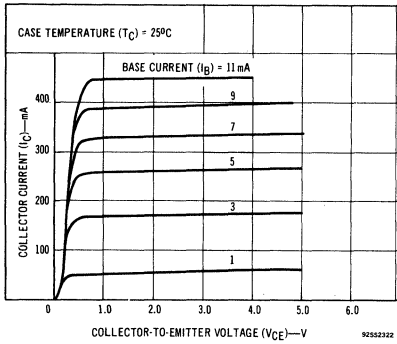


Fig. 4 — Typical output characteristics for type 40347.

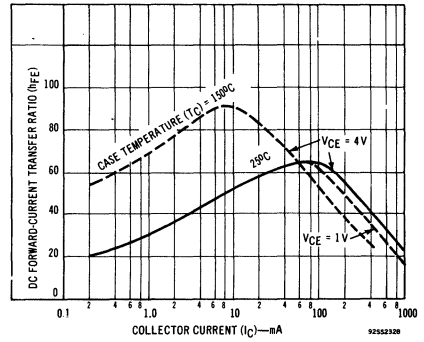


Fig. 5 — Typical dc-beta characteristics for type 40347.

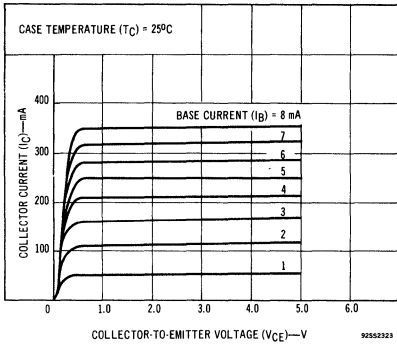


Fig. 6 — Typical output characteristics for type 40348.

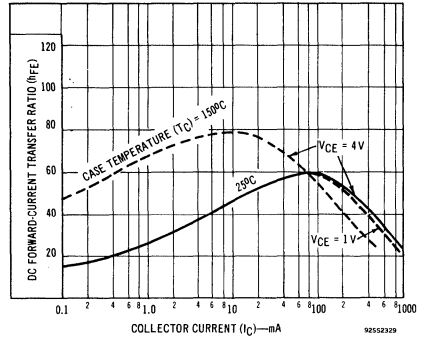


Fig. 7 — Typical dc-beta characteristics for type 40348.

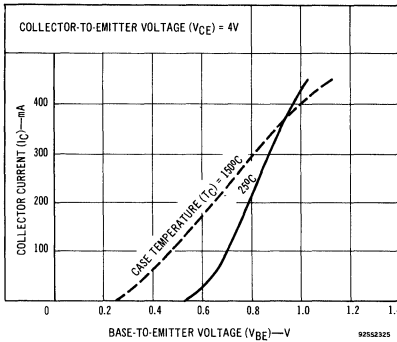


Fig. 8 — Typical transfer characteristics for type 40347.

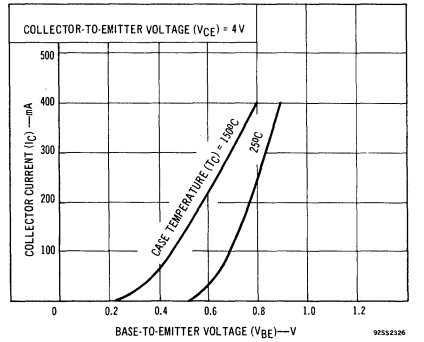


Fig. 9 — Typical transfer characteristics for type 40348.

Silicon N-P-N and P-N-P Power Transistors

For Audio-Amplifier Applications

Features:

40406 & 40407

- $V_{CEO(sus)} = -50 V$ max. (40406)
- $V_{CEO(sus)} = 50 V$ max. (40407)
- 40406 is p-n-p complement of 40407
- 1 W dissipation rating

40408

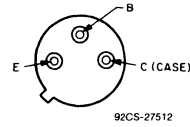
- $V_{CEO(sus)} = 90 V$ max.
- 1 W dissipation rating

40411

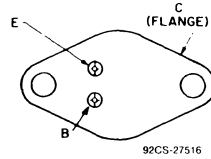
- $V_{CEr(sus)} = 90$ max.
- 150 W dissipation rating

RCA-40406, 40407, 40408 and the 40411 are silicon n-p-n and p-n-p transistors intended for use in audio amplifiers. Giving high-quality performance economically, these four devices have power dissipation ratings of 1 to 150 W. Types 40406, 40407, and 40408 are supplied in JEDEC TO-205AD hermetic packages. The 40411 unit, intended for use in audio output stages, is in a steel JEDEC TO-204AA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-205AD



JEDEC TO-204AA

2

MAXIMUM RATINGS, Absolute-Maximum Values:

	40406	40407	40408	40411	
$V_{CEO(sus)}$	-50	50	90	—	V
$V_{CEr(sus)}$	—	—	—	90	V
$R_{BE} = 100 \Omega$	—	—	—	4	V
V_{EBO}	-0.7	0.7	0.7	30	A
I_C	-0.2	0.2	0.2	15	A
I_B	—	—	—	—	W
P_T	—	—	—	150	W
$T_A \leq 25^\circ C$	1	1	1	—	W
$T_C \leq 25^\circ C$	—	—	—	—	W
T_J	-65 to +200			—	$^\circ C$

40406, 40407, 40408, 40411

ELECTRICAL CHARACTERISTICS, $T_C = 25^\circ$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS			LIMITS					UNITS	
	VOLTAGE V dc	CURRENT A dc		40406# 40407		40408		40411		
		V _{CE}	I _C	I _B	Min.	Max.	Min.	Max.		Min.	Max.
I _{CBO} I _E = 0	10*			—	0.25*	—	—	—	—	μA
I _{CEO}	40 80			— —	1 —	— —	— 1	— —	— —	μA
T _C = 150° C										
40406	40			—	0.01	—	—	—	—	mA
40407	40			—	0.1	—	—	—	—	
40408	80			—	—	—	0.25	—	—	
I _{CER} R _{BE} = 100 Ω	80			—	—	—	—	—	500	μA
T _C = 150° C	80			—	—	—	—	—	2	mA
I _{EBO} V _{BE} = -4 V		0		—	100	—	100	—	500	μA
V _{CEO(sus)}		0.1 ^a	0	50 ^b	—	90 ^b	—	—	—	V
V _{CER(sus)} R _{BE} = 100 Ω		0.1 0.2			—	—	—	—	90	V
V _{BE}	10 4 4 4	0.001 ^a 0.01 ^a 0.15 ^a 4 ^a		— — — —	0.8 ^c — — —	— — — —	— 1 — —	— — — —	— — — 1.2	V
V _{CE(sat)}		0.15 ^a 4 ^a	0.015 0.4	— —	— —	— —	1.4 —	— —	— 0.8	V
h _{FE}	40406 40407 40408 40411	10 10 4 4	0.1 mA ^a 0.001 ^a 0.01 ^a 4 ^a	30 40 — —	200 200 — —	— — 40 —	— — 200 —	— — — 35	— — — 100	
h _{fe} f = 20 MHz	10	0.05		6 ^b	—	—	—	—	—	
f _T	4	0.05		100 (typ.)	100 (typ.)	—	—	—	—	MHz
	4	4		—	—	—	—	800 (typ.)	—	kHz
C _{obo} I _E = 0 f = 1 MHz	10*			15 ^b	—	—	—	—	—	pF
I _{S/b} t = 1 s nonrep	30			—	—	—	—	5	—	A
R _{θJC}				—	35	—	35	—	1.17	°C/W
R _{θJA}				—	175	—	175	—	—	

For p-n-p devices, voltage and current values are negative

• V_{CB} ♦ 40407 only^a Pulsed; pulse duration = 300 μs, duty factor ≤ 2%^b CAUTION: The sustaining voltage V_{CEO(sus)} MUST NOT be measured on a curve tracer. V_{CEO(sus)} should be measured by the pulse method (Note 'a').^c 40406 tested at I_C = -0.1 mA

40406, 40407, 40408, 40411

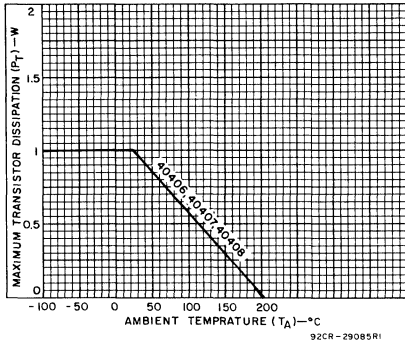


Fig. 1 - Dissipation derating curves for 40406, 40407, and 40408.

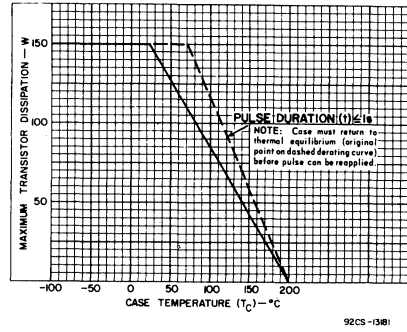


Fig. 2 - Dissipation derating curve for 40411.

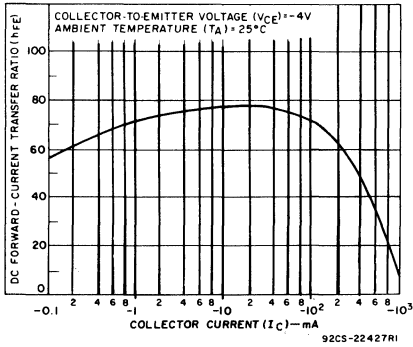


Fig. 3 - Typical dc beta characteristic for 40406.

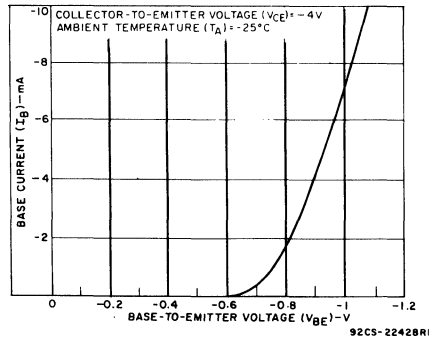


Fig. 4 - Typical input characteristic for 40406.

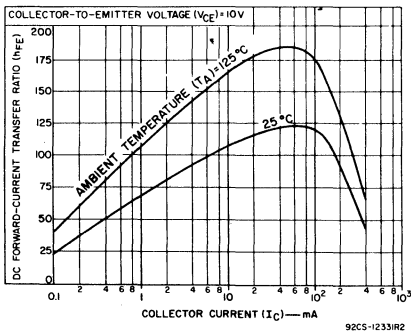


Fig. 5 - Typical dc beta characteristics for 40407 and 40408.

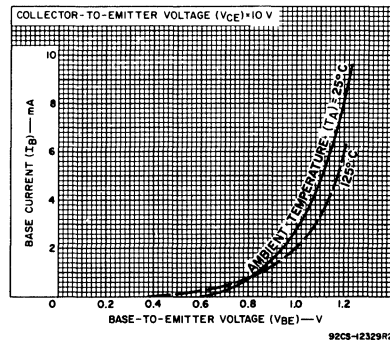


Fig. 6 - Typical input characteristics for 40407 and 40408.

40406, 40407, 40408, 40411

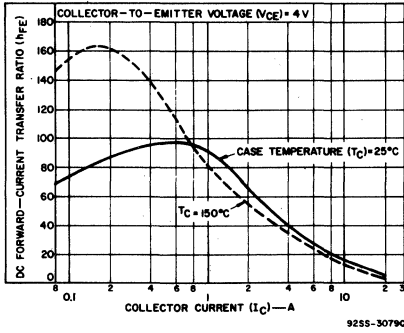


Fig. 7 - Typical dc beta characteristics for 40411.

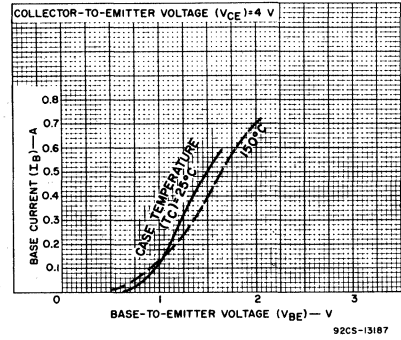


Fig. 8 - Typical input characteristics for 40411.

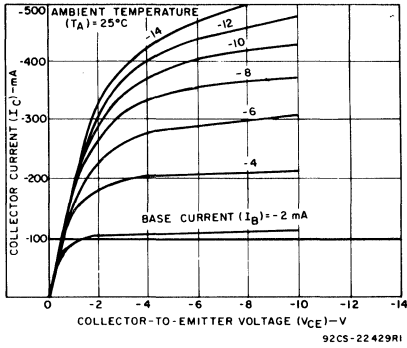


Fig. 9 - Typical output characteristics for 40406.

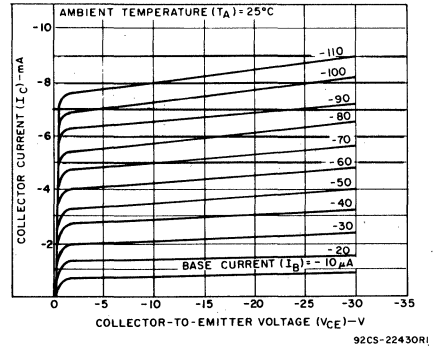


Fig. 10 - Typical large-signal output characteristics for 40406.

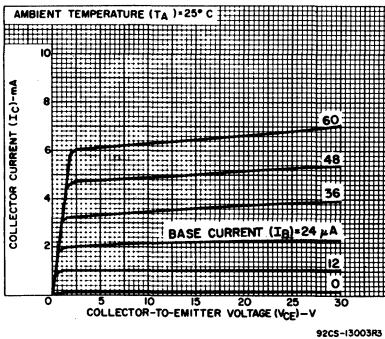


Fig. 11 - Typical output characteristics for 40407 and 40408.

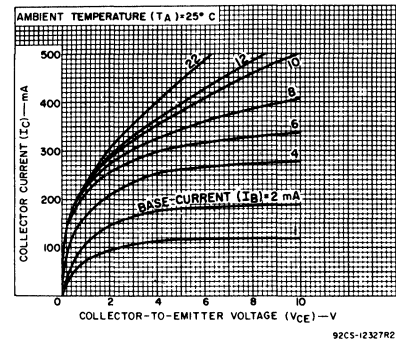


Fig. 12 - Typical large-signal output characteristics for 40407 and 40408.

40406, 40407, 40408, 40411

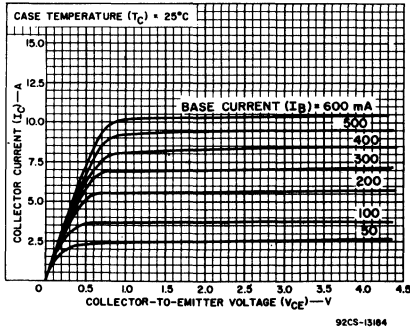


Fig. 13 - Typical output characteristics for 40411.

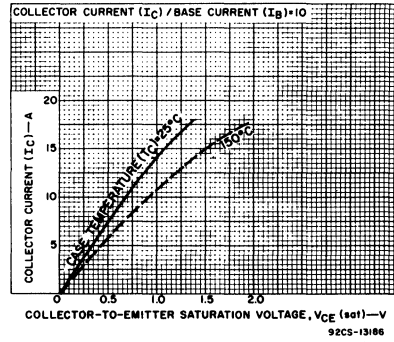


Fig. 14 - Typical saturation-voltage characteristics for 40411.

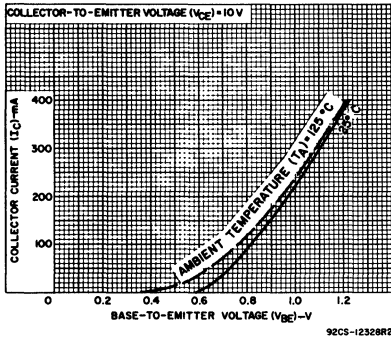


Fig. 15 - Typical transfer characteristics for 40407 and 40408.

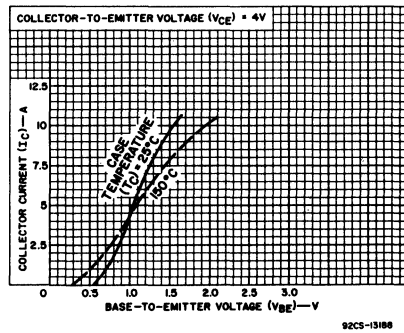


Fig. 16 - Typical transfer characteristics for 40411.

High-Power Silicon N-P-N Transistor

General-Purpose Device
For Commercial Use

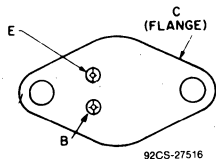
Features:

- Maximum-safe-area-of-operation curves
- Low saturation voltage
- High dissipation rating

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers
- 12-V audio and inverter circuits

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BD142 is a silicon n-p-n transistor intended for a wide variety of intermediate-power and high-power applications. It is especially suited for use in audio and inverter circuits at 12 volts.

This type is supplied in the steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open	$V_{CEO(sus)}$	45	V
With base reverse bias $V_{BE} = -1.5$ V	$V_{CEV(sus)}$	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	15	A
CONTINUOUS BASE CURRENT	I_B	7	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		117	W
At case temperatures above 25°C		See Figs. 1 & 2	
TEMPERATURE RANGE:			
Storage and Operating (Junction)		-65 to +200	°C
PIN TEMPERATURE (During Soldering):			
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.		235	°C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified.

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc				
		V _{CE}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	
Collector Cutoff Current: With base-emitter junction reverse-biased	I _{CEV}	40		-1.5			-	2	mA
Emitter Cutoff Current	I _{EBO}		7				-	1	mA
Collector-to-Emitter Sustaining Voltage: With base open	V _{CEO(sus)}				0.2	0	45	-	V
With base-emitter junction reverse-biased	V _{CEV(sus)}			-1.5	0.1		50	-	
DC Forward Current Transfer Ratio	h _{FE}	4			4 ^a		12.5	160	
Base-to-Emitter Voltage	V _{BE}	4			4 ^a		-	1.5	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				4 ^a	0.4	-	1.1	V
Common-Emitter, Small- Signal, Short-Circuit, Forward Current Transfer Ratio (f = 1 kHz)	h _{fe}	4			1		10	-	
Magnitude of Common- Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	|h _{fe}|	4			1		2	-	
Gain-Bandwidth Product	f _T	4			1		800	-	kHz
Forward-Bias Second-Break- down Collector Current (t ≥ 1 s)	I _{S/b}	39					3	-	A
Thermal Resistance (Junction-to-Case)	R _{θJC}						-	1.5	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 2%.

BD142

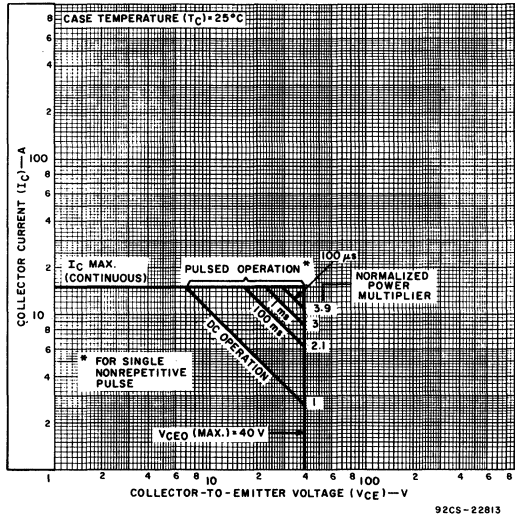


Fig. 1 — Maximum safe area of operation.

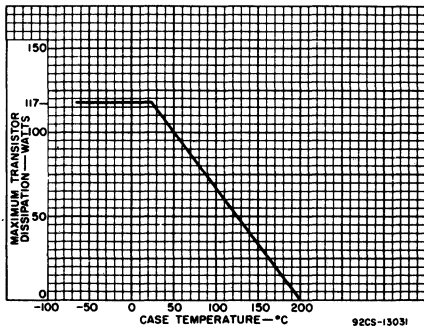


Fig. 2 — Dissipation derating curve.

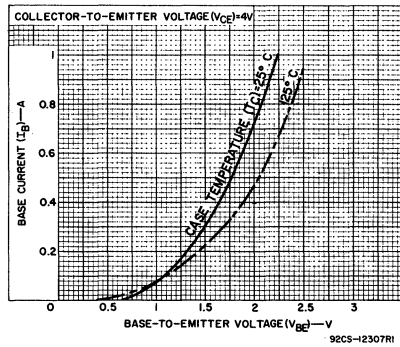


Fig. 3 — Typical input characteristics.

BD142

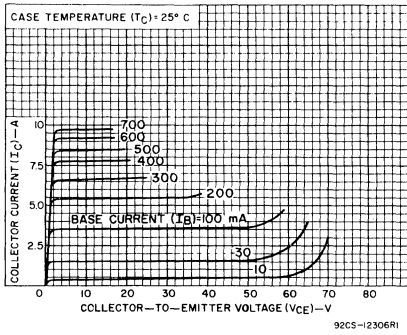


Fig. 4 — Typical output characteristics.

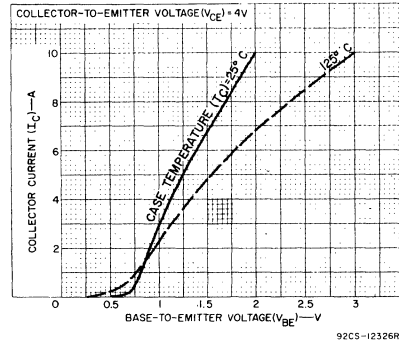


Fig. 5 — Typical transfer characteristics.

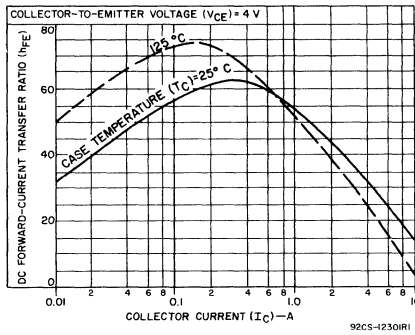


Fig. 6 — Typical dc-beta characteristics.

BD181, BD182, BD183

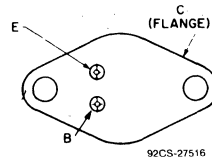
High-Power Silicon N-P-N Transistors

Broadly Applicable Devices
For Commercial Use

Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation ratings

TERMINAL DESIGNATIONS



JEDEC TO-204AA

RCA-BD181, BD182 and BD183 are silicon n-p-n transistors intended for a wide variety of high-power applications. Typical applications include power-switching circuits, audio amplifiers, solenoid drivers, and series and shunt regulators.

These devices are supplied in the popular JEDEC TO-204AA package.

MAXIMUM RATINGS, Absolute-Maximum Values:

		BD181	BD182	BD183	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	55	70	85	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$	55	70	85	V
With base open	$V_{CEO(sus)}$	45	60	80	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	15	15	15	A
CONTINUOUS BASE CURRENT	I_B	7	7	7	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		117	117	117	W
At case temperatures above 25 C		← See Fig. 2 →			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← -65 to +200 →			°C
PIN TEMPERATURE (During Soldering):					
At distances \geq 1/32 in. (0.8 mm) from seating plane for 10 s max.		← 235 →			°C

BD181, BD182, BD183

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS						UNITS
		VOLTAGE V dc				CUR- RENT A dc		BD181		BD182		BD183		
		V _{CB}	V _{CE}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector-Cutoff Current: With emitter open and $T_C = 200^\circ\text{C}$	I _{CBO}	45 60 80					0 0 0	- - -	2 - -	- - -	- 5 -	- - 5	- - 5	mA
With base-emitter junction reverse-biased	I _{CEX}		45 60 80		-1.5 -1.5 -1.5			- - -	1 - -	- - -	1 - -	- - 1		
Emitter-Cutoff Current	I _{EBO}			7				-	5	-	5	-	5	mA
Collector-to-Emitter Sustaining Voltage: With base open	V _{CEO(sus)}					0.2 ^a	0	45	-	60	-	80	-	V
With external base-to-emitter resistance (R _{BE})=100 Ω	V _{CER(sus)}					0.2 ^a		55	-	70	-	85	-	
DC Forward Current Transfer Ratio	h _{FE}		4 4			4 ^a 3 ^a		- 20	- 70	20 -	70 -	- 20	- 70	
Base-to-Emitter Voltage	V _{BE}		4 4			3 ^a 4 ^a		- -	1.5 -	- -	- 1.5	- -	1.5 -	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}					4 ^a 3 ^a	0.4 ^a 0.3 ^a	- -	- 1	- -	1 -	- -	- 1	V
Magnitude of Common-Emitter, Small- Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	|h _{fe}|		4			1		2	-	2	-	2	-	
Gain-Bandwidth Product	f _T					1		800	-	800	-	800	-	kHz
Common-Emitter, Short-Circuit, Small- Signal, Forward Current Transfer Ratio Cutoff Frequency	f _{hfe}		4			0.3		15	-	15	-	15	-	kHz
Forward-Bias Second Breakdown Collector Current (t ≥ 1 s)	I _{S/b}		30					3.95	-	3.95	-	3.95	-	A
Thermal Resistance (Junction-to-Case)	R _{θJC}							-	1.5	-	1.5	-	1.5	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

BD181, BD182, BD183

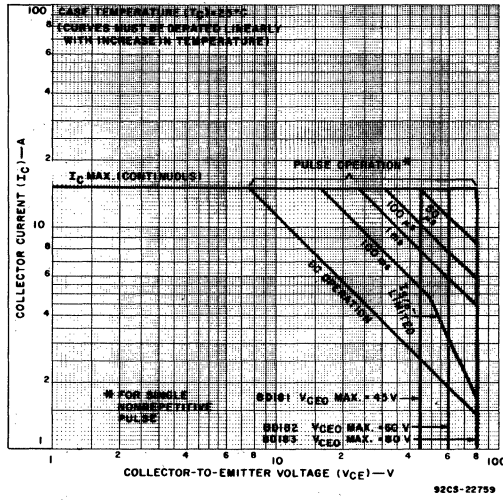


Fig. 1 — Maximum operating areas for all types.

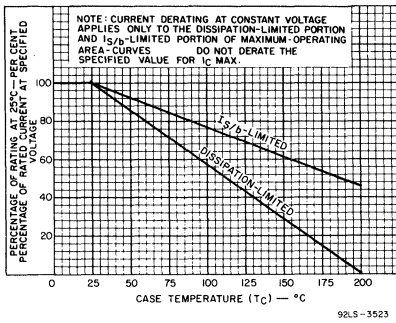


Fig. 2 — Dissipation and I_{Sb} derating of all types.

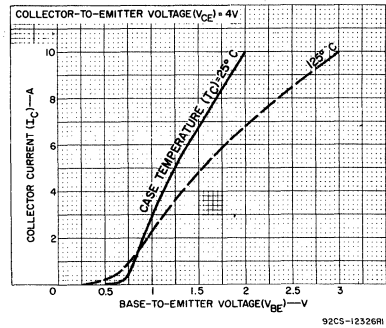


Fig. 3 — Typical transfer characteristics for all types.

BD181, BD182, BD183

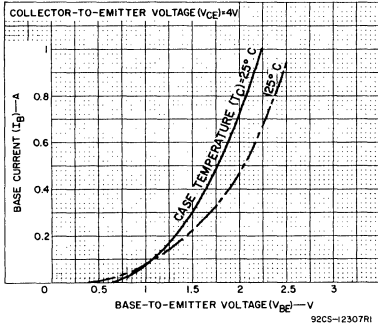


Fig. 4 — Typical input characteristics for BD182.

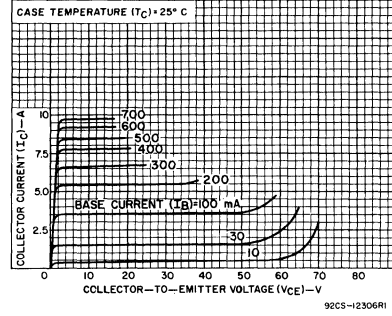


Fig. 5 — Typical output characteristics for BD182.

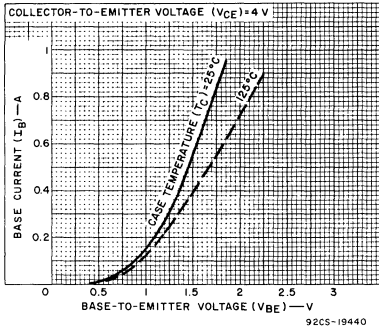


Fig. 6 — Typical input characteristics for BD181 and BD183.

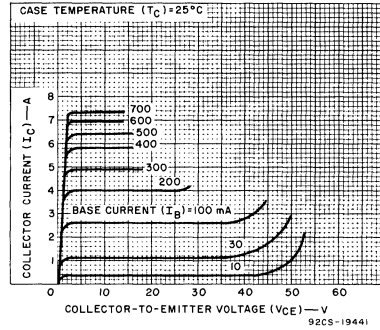


Fig. 7 — Typical output characteristics for BD181 and BD183.

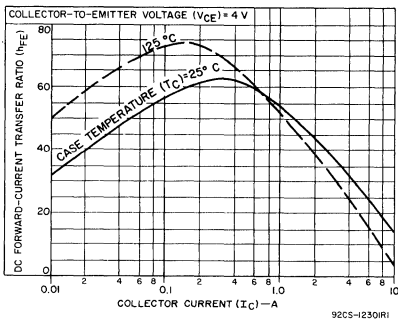


Fig. 8 — Typical dc-beta characteristics for BD182.

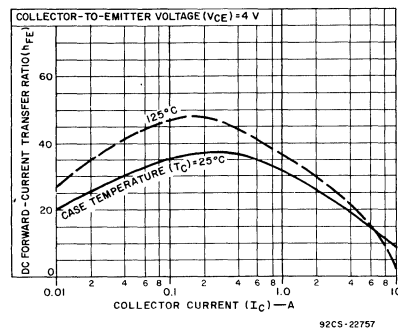


Fig. 9 — Typical dc-beta characteristics for BD181 and BD183.

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

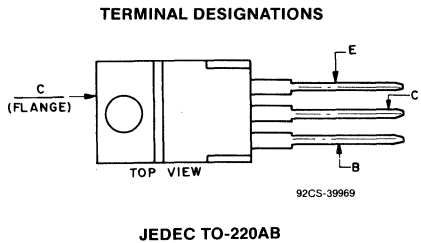
For Power-Amplifier and
High-Speed-Switching Applications

Features:

- 30 W at 25°C case temperature
- 4-A rated collector current
- Min. f_T of 3 MHz at 10 V, 200 mA
- Complements of p-n-p types BD240, BD240A, BD240B, and BD240C

Types BD239, BD239A, BD239B, and BD239C are epitaxial-base silicon n-p-n transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD239-series power transistors are complements of the devices in the BD240 series. (The BD240-series devices are described in File No. 670.)

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.



MAXIMUM RATINGS, Absolute-Maximum Values:

	BD239	BD239A	BD239B	BD239C		
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION: P_T						
At case temperatures up to 25°C		30	30	30	30	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		← See Fig. 2 →				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← -65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

BD239, BD239A, BD239B, BD239C

ELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

2

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD239		BD239A		BD239B		BD239C		
		V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I _{CEO}	30			0	—	0.3	—	0.3	—	—	—	—	mA
		60			0	—	—	—	—	—	0.3	—	0.3	
	I _{CES}	45	0			—	0.2	—	—	—	—	—	—	
		60	0			—	—	—	0.2	—	—	—	—	
		80	0			—	—	—	—	0.2	—	—		
		100	0			—	—	—	—	—	—	0.2		
Emitter Cutoff Current	I _{EBO}		-5	0		—	1	—	1	—	1	—	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	V _{BR(CEO)}			0.03 ^a	0	45	—	60	—	80	—	100	—	V
DC Forward-Current Transfer Ratio	h _{FE}	4		0.2 ^a		40	—	40	—	40	—	40	—	
		4		1 ^a		15	—	15	—	15	—	15	—	
Base-to-Emitter Voltage	V _{BE}	4		1 ^a		—	1.3	—	1.3	—	1.3	—	1.3	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			1 ^a	0.2	—	0.7	—	0.7	—	0.7	—	0.7	V
Common-Emitter Small-Signal Short- Circuit Forward- Current Transfer Ratio (f = 1 kHz)	h _{fe}	10		0.2		20	—	20	—	20	—	20	—	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward- Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	10		0.2		3	—	3	—	3	—	3	—	
Thermal Resistance: Junction-to-Case	R _{θJC}					—	4.17	—	4.17	—	4.17	—	4.17	°C/W
	R _{θJA}					—	62.5	—	62.5	—	62.5	—	62.5	

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

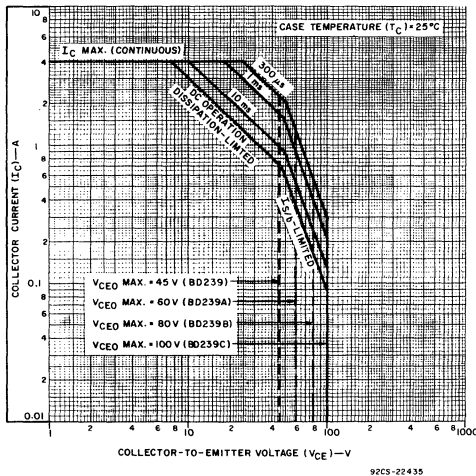


Fig. 1— Maximum safe operating areas for all types.

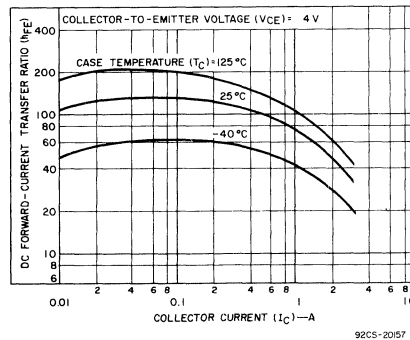


Fig. 2— Typical dc beta characteristics for all types.

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

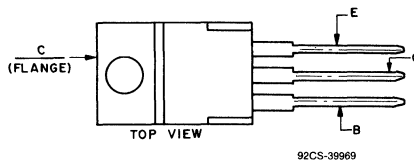
Features:

- 30 W at 25°C case temperature
- 4-A rated collector current
- Min. f_T of 3 MHz at 10 V, 200 mA
- Complements of n-p-n types BD239, BD239A, BD239B, and BD239C

Types BD240, BD240A, BD240B, and BD240C are epitaxial-base silicon p-n-p transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD240-series power transistors are complements of the devices in the BD239 series. (The BD239-series devices are described in File No. 669.)

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, Absolute-Maximum Values:

	BD240	BD240A	BD240B	BD240C	
COLLECTOR-TO-EMITTER VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER} -55	-70	-90	-115	V
With base open	V_{CEO} -45	-60	-80	-100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO} -5	-5	-5	-5	V
CONTINUOUS COLLECTOR CURRENT	I_C -4	-4	-4	-4	A
CONTINUOUS BASE CURRENT	I_B -1	-1	-1	-1	A
TRANSISTOR DISSIPATION:					
At case temperatures up to 25°C	P_T 30	30	30	30	W
At ambient temperatures up to 25°C	2	2	2	2	W
At case temperatures above 25°C	← See Fig. 2 →				
TEMPERATURE RANGE:					
Storage & Operating (Junction)	← -65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):					
At distance 1/8 in. (3.17 mm) from case for 10 s max.	← 235 →				°C

BD240, BD240A, BD240B, BD240C

ELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS	
		VOLTAGE V dc		CURRENT A dc		BD240		BD240A		BD240B		BD240C			
		V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Collector Cutoff Current: With base open	I _{CEO}	-30 -60			0 0	-	-0.3	-	-0.3	-	-	-	-	0.3	mA
With base-to-emitter junction short-circuited	I _{CES}	-45 -60 -80 -100	0 0 0 0			-	-0.2	-	-0.2	-	-	-0.2	-	-0.2	
Emitter Cutoff Current	I _{EBO}		5	0		-	-1	-	-1	-	-	-1	-	-1		mA
Collector-to-Emitter Breakdown Voltage: With base open	V _{BR(CEO)}			-0.03 ^a	0	-45	-	-60	-	-80	-	-100	-	-	V
DC Forward-Current Transfer Ratio	h _{FE}	-4 -4		-0.2 ^a -1 ^a		40 15	-	40 15	-	40 15	-	40 15	-	-	
Base-to-Emitter Voltage	V _{BE}	-4		-1 ^a		-	-1.3	-	-1.3	-	-	-1.3	-	-1.3	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			-1 ^a	-0.2	-	-0.7	-	-0.7	-	-	-0.7	-	-0.7	V
Common-Emitter Small-Signal Short- Circuit Forward- Current Transfer Ratio (f = 1 kHz)	h _{fe}	-10		-0.2		20	-	20	-	20	-	20	-	20	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward- Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	-10		-0.2		3	-	3	-	3	-	3	-	3	
Thermal Resistance: Junction-to-Case	R _{θJC}					-	4.17	-	4.17	-	4.17	-	4.17	4.17	°C/W
Junction-to-Ambient	R _{θJA}					-	62.5	-	62.5	-	62.5	-	62.5	62.5	

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

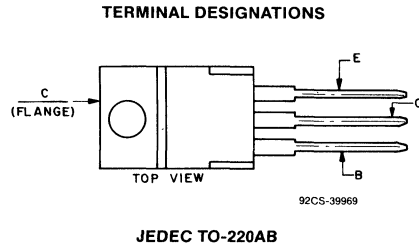
For Power-Amplifier and
High-Speed-Switching Applications

Features:

- 40 W at 25°C case temperature
- 5-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of p-n-p types BD242, BD242A, BD242B, and BD242C

Types BD241, BD241A, BD241B, and BD241C are epitaxial-base silicon n-p-n transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD241-series power transistors are complements of the devices in the BD242 series. (The BD242-series devices are described in File No. 672.)

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.



MAXIMUM RATINGS, Absolute-Maximum Values:

	BD241	BD241A	BD241B	BD241C		
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	5	5	5	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C	P_T	40	40	40	40	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		← See Fig. 2 →				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← -65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

BD241, BD241A, BD241B, BD241CELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS	
		VOLTAGE V dc		CURRENT A dc		BD241		BD241A		BD241B		BD241C			
		V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Collector Cutoff Current: With base open	I _{CEO}	30 60			0 0	— —	0.3 —	— —	0.3 —	— —	— 0.3	— —	— 0.3	mA	
With base-to-emitter junction short-circuited	I _{CES}	45 60 80 100	0 0 0 0			— — — —	0.2 — — —	— — — —	— 0.2 — —	— — 0.2 —	— — — —	— — — 0.2			
Emitter Cutoff Current	I _{EBO}		—5	0		—	1	—	1	—	1	—	1		mA
Collector-to-Emitter Breakdown Voltage: With base open	V _{BR(CEO)}			0.03 ^a	0	45	—	60	—	80	—	100	—		V
DC Forward-Current Transfer Ratio	h _{FE}	4 4		1 ^a 3 ^a		25 10	— —	25 10	— —	25 10	— —	25 10	— —		
Base-to-Emitter Voltage	V _{BE}	4		3 ^a		—	1.8	—	1.8	—	1.8	—	1.8	V	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			3 ^a	0.6	—	1.2	—	1.2	—	1.2	—	1.2	V	
Common-Emitter Small-Signal Short- Circuit Forward- Current Transfer Ratio (f = 1 kHz)	h _{fe}	10		0.5		20	—	20	—	20	—	20	—		
Magnitude of Common Emitter Small-Signal Short-Circuit Forward- Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	10		0.5		3	—	3	—	3	—	3	—		
Thermal Resistance: Junction-to-Case	R _{θJC}					—	3.125	—	3.125	—	3.125	—	3.125	°C/W	
Junction-to-Ambient	R _{θJA}					—	62.5	—	62.5	—	62.5	—	62.5		

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

BD241, BD241A, BD241B, BD241C

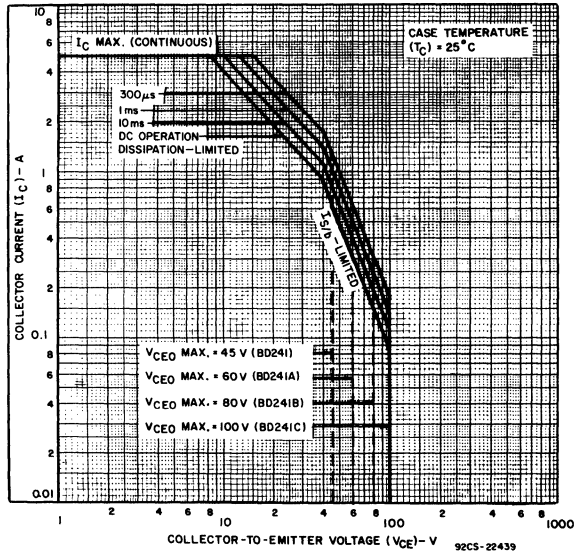


Fig. 1— Maximum safe operating areas for all types.

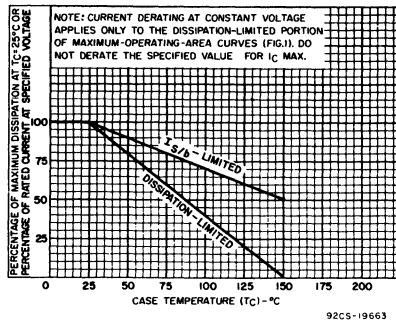


Fig. 2— Derating curves for all types.

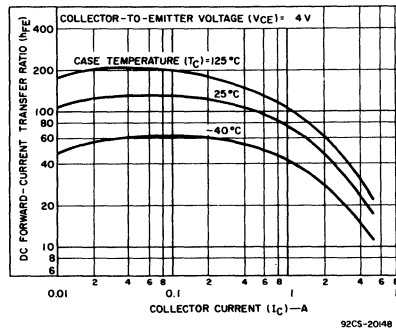


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

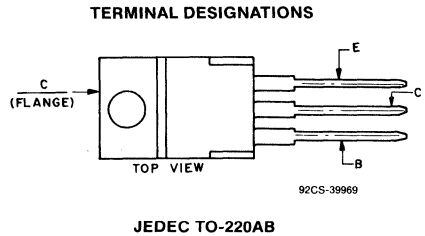
For Power-Amplifier and
High-Speed-Switching Applications

Features:

- 40 W at 25°C case temperature
- 5-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of n-p-n types BD241, BD241A, BD241B, and BD241C

Types BD242, BD242A, BD242B, and BD242C are epitaxial-base silicon p-n-p transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD242-series power transistors are complements of the devices in the BD241 series. (The BD241-series devices are described in File No. 671.)

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.



MAXIMUM RATINGS, Absolute-Maximum Values:

	BD242	BD242A	BD242B	BD242C		
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	-55	-70	-90	-115	V
With base open	V_{CEO}	-45	-60	-80	-100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	-5	-5	-5	-5	V
CONTINUOUS COLLECTOR CURRENT	I_C	-5	-5	-5	-5	A
CONTINUOUS BASE CURRENT	I_B	-1	-1	-1	-1	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C	P_T	40	40	40	40	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		← See Fig. 2 →				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← -65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

BD242, BD242A, BD242B, BD242CELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS		
		VOLTAGE V _{dc}		CURRENT A _{dc}		BD242		BD242A		BD242B		BD242C				
		V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.			
Collector Cutoff Current: With base open	I _{CEO}	-30 -60			0 0	-	-0.3	-	-0.3	-	-	-	-	-	-	mA
With base-to-emitter junction short-circuited	I _{CES}	-45 -60 -80 -100	0 0 0 0			-	-0.2	-	-	-	-	-	-	-	-	
Emitter Cutoff Current	I _{EBO}		5	0		-	-1	-	-1	-	-	-	-	-	-	
Collector-to-Emitter Breakdown Voltage: With base open	V _{BR(CEO)}			-0.03 ^a	0	-45	-	-60	-	-80	-	-100	-	-	-	V
DC Forward-Current Transfer Ratio	h _{FE}	-4 -4		-1 ^a -3 ^a		25 10	-	25 10	-	25 10	-	25 10	-	25 10	-	
Base-to-Emitter Voltage	V _{BE}	-4		-3 ^a		-	-1.8	-	-1.8	-	-	-1.8	-	-	-1.8	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			-3 ^a	-0.6	-	-1.2	-	-1.2	-	-	-1.2	-	-	-1.2	V
Common-Emitter Small-Signal Short- Circuit Forward- Current Transfer Ratio (f = 1 kHz)	h _{fe}	-10		-0.5		20	-	20	-	20	-	20	-	20	-	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward- Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	-10		-0.5		3	-	3	-	3	-	3	-	3	-	
Thermal Resistance: Junction-to-Case	R _{θJC}					-	3.125	-	3.125	-	3.125	-	3.125	-	3.125	°C/W
Junction-to-Ambient	R _{θJA}					-	62.5	-	62.5	-	62.5	-	62.5	-	62.5	

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

BD242, BD242A, BD242B, BD242C

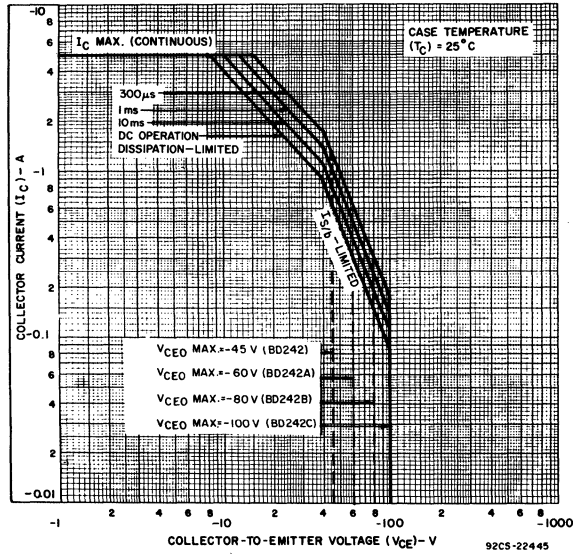


Fig. 1— Maximum safe operating areas for all types.

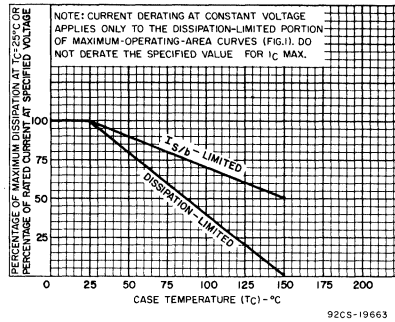


Fig. 2— Derating curves for all types.

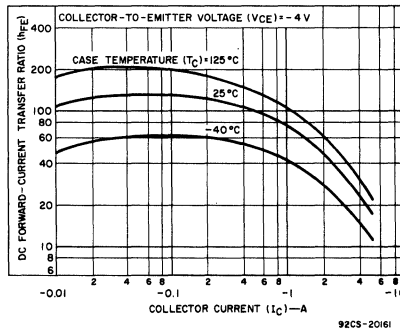


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

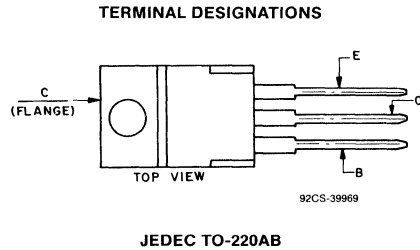
For Power-Amplifier and
High-Speed-Switching Applications

Features:

- 65 W at 25°C case temperature
- 7-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of p-n-p types BD244, BD244A, BD244B, and BD244C

Types BD243, BD243A, BD243B, and BD243C are epitaxial-base silicon n-p-n transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD243-series power transistors are complements of the devices in the BD244 series. (The BD244-series devices are described in File No. 674.)

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.



MAXIMUM RATINGS, Absolute-Maximum Values:

	BD243	BD243A	BD243B	BD243C		
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	7	7	7	7	A
PEAK COLLECTOR CURRENT	I_C (PEAK)	10	10	10	10	A
CONTINUOUS BASE CURRENT	I_B	3	3	3	3	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C	P_T	65	65	65	65	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		← See Fig. 2 →				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← -65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

BD243, BD243A, BD243B, BD243CELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS	
		VOLTAGE V dc		CURRENT A dc		BD243		BD243A		BD243B		BD243C			
		V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Collector Cutoff Current: With base open	I _{CEO}	30			0	–	0.7	–	0.7	–	–	–	–	mA	
		60			0	–	–	–	–	–	–	0.7	–		
	I _{CES}	45	0			–	0.4	–	–	–	–	–	–		
		60	0			–	–	–	–	0.4	–	–	–		
		80	0			–	–	–	–	–	0.4	–			
		100	0			–	–	–	–	–	–	0.4			
Emitter Cutoff Current	I _{EBO}		–5	0		–	1	–	1	–	1	–	1	mA	
Collector-to-Emitter Breakdown Voltage: With base open	V _{BR(CEO)}			0.03 ^a	0	45	–	60	–	80	–	100	–	V	
DC Forward-Current Transfer Ratio	h _{FE}	4		0.3 ^a		30	–	30	–	30	–	30	–		
		4		3 ^a		15	–	15	–	15	–	15	–		
Base-to-Emitter Voltage	V _{BE}	4		6 ^a		–	2	–	2	–	2	–	2	V	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			6 ^a	1	–	1.5	–	1.5	–	1.5	–	1.5	V	
Common-Emitter Small-Signal Short- Circuit Forward- Current Transfer Ratio (f = 1 kHz)	h _{fe}	10		0.5		20	–	20	–	20	–	20	–		
Magnitude of Common Emitter Small-Signal Short-Circuit Forward- Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	10		0.5		3	–	3	–	3	–	3	–		
Thermal Resistance: Junction-to-Case	R _{θJC}					–	1.92	–	1.92	–	1.92	–	1.92	°C/W	
						–	62.5	–	62.5	–	62.5	–	62.5		
Junction-to-Ambient	R _{θJA}					–	62.5	–	62.5	–	62.5	–	62.5		

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

BD243, BD243A, BD243B, BD243C

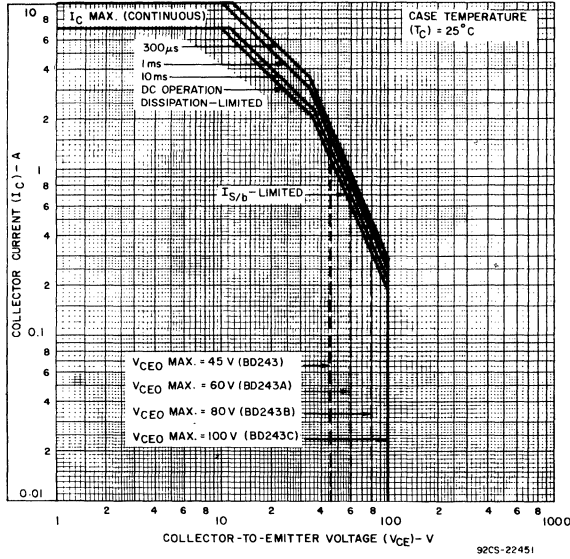


Fig. 1— Maximum safe operating areas for all types.

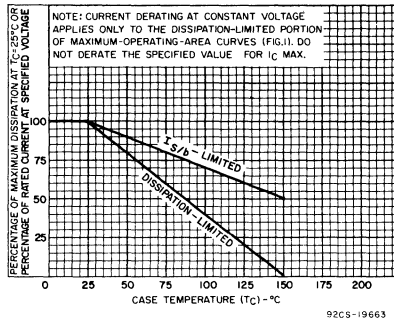


Fig. 2— Derating curves for all types.

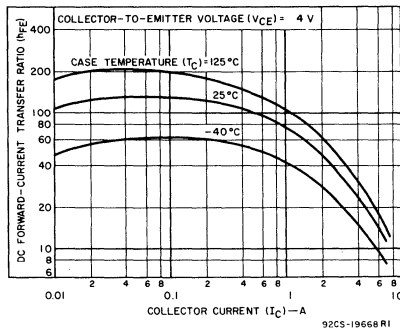


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

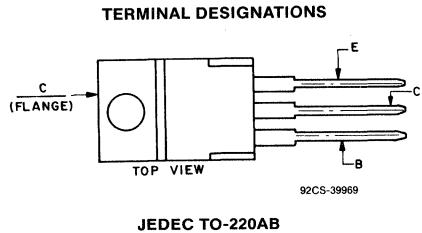
For Power-Amplifier and
High-Speed-Switching Applications

Features:

- 65 W at 25°C case temperature
- 7-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of n-p-n types BD243, BD243A, BD243B, and BD243C

Types BD244, BD244A, BD244B, and BD244C are epitaxial-base silicon p-n-p transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD244-series power transistors are complements of the devices in the BD243 series. (The BD243-series devices are described in File No. 673.)

All types utilize the JEDEC TO-220AB (VERSAWATT) plastic package.



MAXIMUM RATINGS, Absolute-Maximum Values:

	BD244	BD244A	BD244B	BD244C	
COLLECTOR-TO-EMITTER VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER} -55	-70	-90	-115	V
With base open	V_{CEO} -45	-60	-80	-100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO} -5	-5	-5	-5	V
CONTINUOUS COLLECTOR CURRENT	I_C -7	-7	-7	-7	A
PEAK COLLECTOR CURRENT	I_C (PEAK) -10	-10	-10	-10	A
CONTINUOUS BASE CURRENT	I_B -3	-3	-3	-3	A
TRANSISTOR DISSIPATION: P_T					
At case temperatures up to 25°C	65	65	65	65	W
At ambient temperatures up to 25°C	2	2	2	2	W
At case temperatures above 25°C	← See Fig. 2 →				
TEMPERATURE RANGE:					
Storage & Operating (Junction)	← -65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):					
At distance 1/8 in. (3.17 mm) from case for 10 s max.	← 235 →				°C

BD244, BD244A, BD244B, BD244C

ELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS			
		VOLTAGE V _{dc}		CURRENT A _{dc}		BD244		BD244A		BD244B		BD244C					
		V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.				
Collector Cutoff Current: With base open	I _{CEO}	-30 -60			0 0	-	-0.7	-	-	-	-0.7	-	-	-	-0.7	mA	
With base-to-emitter junction short-circuited	I _{CES}	-45 -60 -80 -100	0 0 0 0			-	-0.4	-	-	-	-	-	-	-	-		-0.4
Emitter Cutoff Current	I _{EBO}		5	0		-	-1	-	-	-	-1	-	-	-	-		-1	mA
Collector-to-Emitter Breakdown Voltage: With base open	V _{BR(CEO)}			-0.03 ^a	0	-45	-	-60	-	-	-80	-	-	-100	-	-	V
DC Forward-Current Transfer Ratio	h _{FE}	-4 -4		-0.3 ^a -3 ^a		30 15	-	30 15	-	30 15	-	30 15	-	30 15	-	-	
Base-to-Emitter Voltage	V _{BE}	-4		-6 ^a		-	-2	-	-	-2	-	-	-2	-	-	-2	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}			-6 ^a	-1	-	-1.5	-	-	-1.5	-	-	-1.5	-	-	-1.5	V
Common-Emitter Small-Signal Short- Circuit Forward- Current Transfer Ratio (f = 1 kHz)	h _{fe}	-10		-0.5		20	-	20	-	20	-	20	-	20	-	-	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward- Current Transfer Ratio (f = 1 MHz)	|h _{fe}|	-10		-0.5		3	-	3	-	3	-	3	-	3	-	-	
Thermal Resistance: Junction-to-Case	R _{θJC}					-	1.92	-	1.92	-	1.92	-	1.92	-	1.92	-	°C/W
Junction-to-Ambient	R _{θJA}					-	62.5	-	62.5	-	62.5	-	62.5	-	62.5	-	°C/W

^aPulsed: Pulse duration = 300 μs, duty factor = 2%.

BD244, BD244A, BD244B, BD244C

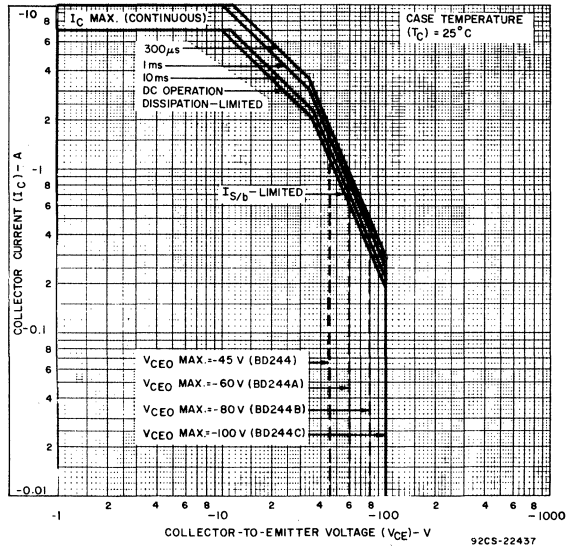


Fig. 1— Maximum safe operating areas for all types.

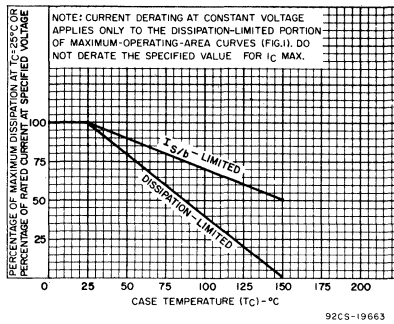


Fig. 2— Derating curves for all types.

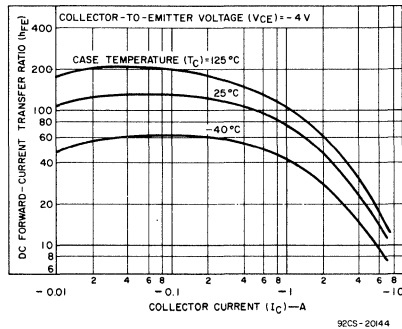


Fig. 3 — Typical dc beta characteristics for all types.

7-A, 70-W, Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

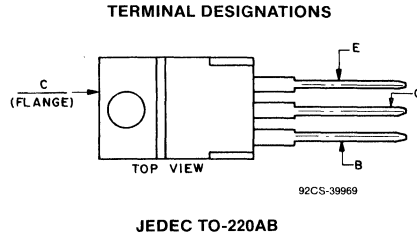
For Applications in Series and Shunt Regulators

Features:

- Maximum safe-area-of-operation curves
- Low saturation voltage
- How power-dissipation capability

Type BD277 is an epitaxial-base silicon p-n-p transistor supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

The BD277 is useful in series regulators and shunt regulators because of its low saturation voltage and high power-dissipation capability.



MAXIMUM RATINGS, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CB0}	-45	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CE0}	-45	V
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EB0}	-4	V
COLLECTOR CURRENT (Continuous)	I_C	-7	A
BASE CURRENT (Continuous)	I_B	-3	A
TRANSISTOR DISSIPATION:			
At case temperatures up to 25°C	P_T	70	W
At case temperatures above 25°C			
Derate linearly at 0.56 W/°C (see Fig. 2.)			
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 150	°C
LEAD TEMPERATURE (During Soldering):			
At distance $\geq 1/8$ in. (3.17 mm) from case for 10 s max.		235	°C

BD277

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless specified otherwise

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc			MIN.	MAX.	
		V _{CE}	V _{CB}	V _{EB}	I _C	I _B	I _E			
Collector Cutoff Current: With emitter open	I _{CBO}		-45				0	-	-0.1	mA
With emitter open and $T_C = 150^\circ\text{C}$			-40				0	-	-2.0	
With base open	I _{CEO}	-30				0	-	-1.0		
Emitter Cutoff Current: With collector open	I _{EBO}			-4	0			-	-1.0	mA
Collector-to-Emitter Breakdown Voltage: With base open	V _{(BR)CEO}				-0.1*	0		-45	-	V
Base-to-Emitter Voltage	V _{BE}	-2			-1.75*			-	1.2	V
DC Forward-Current Transfer Ratio	h _{FE}	-2			-1.75*			30	150	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				-1.75*	-0.1		-	-0.5	V
Gain-Bandwidth Product	f _T	-4			-0.5			10	-	MHz
Thermal Resistance: Junction-to-Case	R _{θJC}							-	1.78	°C/W
Junction-to-Ambient	R _{θJA}							-	70	

* Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

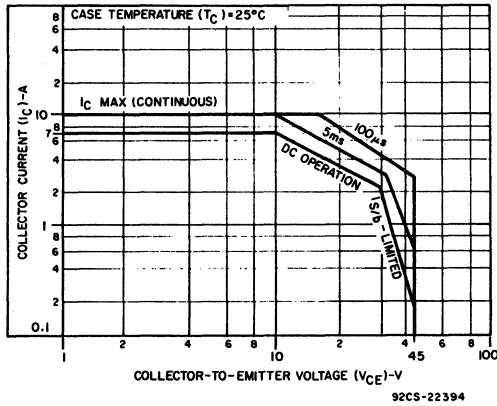


Fig.1 – Maximum operating area.

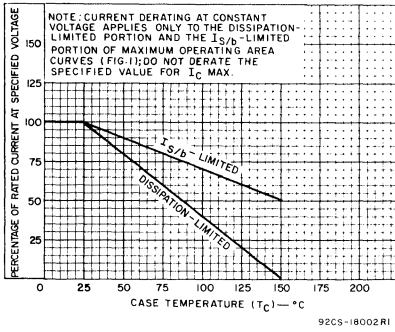


Fig. 2 — Derating curves.

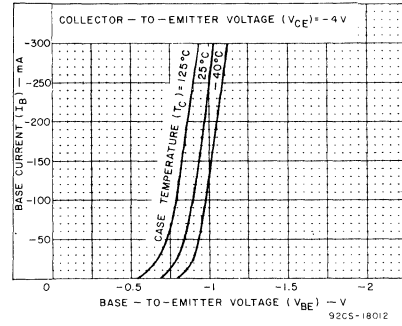


Fig. 3 — Typical input characteristics.

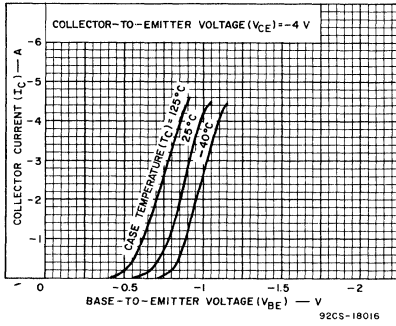


Fig. 4 — Typical transfer characteristics.

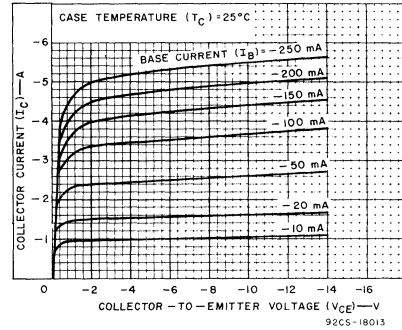


Fig. 5 — Typical output characteristics.

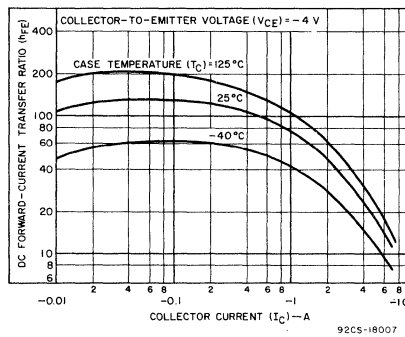
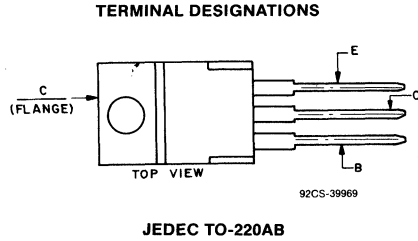


Fig. 6 — Typical dc beta characteristics.

BD500, BD500B, BD501B

File Number **1108**

Silicon Transistors for Full-Complementary-Symmetry Audio Amplifiers



The BD500-Series and BD501B types are p-n-p and n-p-n epitaxial-base silicon transistors, respectively, especially suitable for audio-output applications.

The BD500-Series and BD501B types are supplied in a JEDEC TO-220AB (RCA VERSAWATT) plastic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BD500*	BD501B BD500B*	N-P-N P-N-P
V_{CBO}	60	90	V
V_{CEO}	50	80	V
$V_{CER}(R_{BE} = 100 \Omega)$	55	85	V
V_{EBO}			V
I_C		5	A
I_B		10	A
P_T		4	
At $T_C \leq 25^\circ C$		75	W
At $T_C > 25^\circ C$		See Figs. 1 and 2	
$T_{slgr} T_J$		-65 to 150	°C
T_L			
At distances $\geq 1/32$ in. (0.8 mm) from case for 10 s max.		230	°C

*For p-n-p devices, voltage and current values are negative.

BD500, BD500B, BD501B

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS	LIMITS [▲]				UNITS
		BD500 [•]		BD500B [•] BD5001B		
		Min.	Max.	Min.	Max.	
I_{CER} $R_{BE} = 100 \Omega$	$V_{CE} = 45 V$ $V_{CE} = 75 V$	—	1	—	—	mA
I_{EBO}	$V_{EB} = 5 V$	—	1	—	1	mA
V_{CEO}	$I_C = 0.1 A$	50	—	80	—	V
V_{CER}	$I_C = 0.1 A; R_{BE} = 100 \Omega$	55	—	85	—	V
f_T	$I_C = 1 A; V_{CE} = 4 V$	5	—	5	—	MHz
h_{FE}	$I_C = 5 A; V_{CE} = 4 V$ $I_C = 3.5 A; V_{CE} = 4 V$	15 —	90 —	— 20	— 120	—
$V_{CE(sat)}$	$I_C = 5 A; I_B = 0.5 A$ $I_C = 3.5 A; I_B = 0.35 A$	— —	1.2 —	— —	— 1	V
V_{BE}	$I_C = 5 A; V_{CE} = 4 V$ $I_C = 3.5 A; V_{CE} = 4 V$	— —	1.8 —	— —	— 1.5	V
$I_{S/b}$	$V_{CE} = 20 V; t = 0.5 s$ $V_{CE} = 30 V; t = 0.5 s$	3.75 —	— —	— 2.5	— —	A

▲For characteristics curves and test conditions, refer to published data for prototypes 2N6488 (BD501B); 2N6490 (BD500); 2N6491 (BD500B).

•For p-n-p devices, voltage and current values are negative.

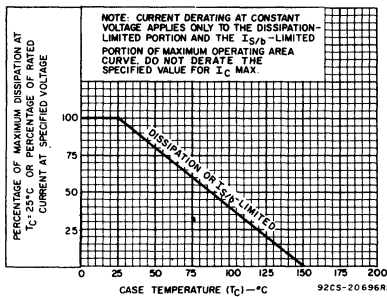


Fig. 1 — Derating curve for all types.

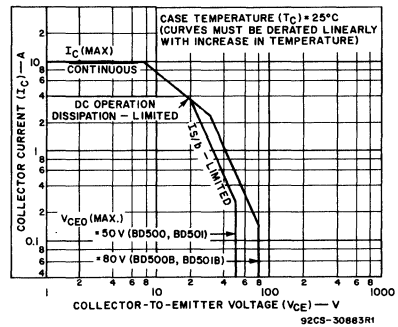


Fig. 2 — Maximum operating areas for all types.

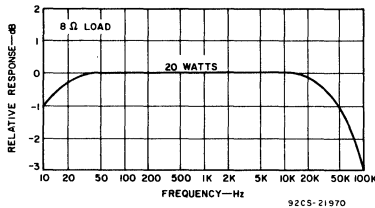


Fig. 3 — Typical frequency response.

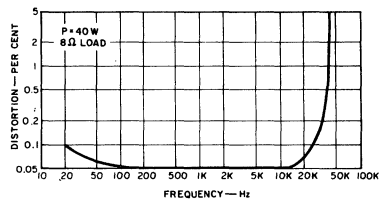


Fig. 4 — Typical total harmonic distortion as a function of frequency.

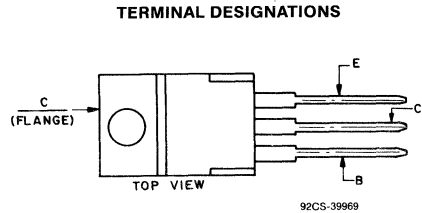
2

**Epitaxial-Base, Silicon
N-P-N and P-N-P
VERSAWATT Transistors**

General-Purpose Medium-Power Types for Switching and Amplifier Applications

Features:

- Low saturation voltages
- Complementary n-p-n and p-n-p types
- Maximum safe-area-of-operation curves



JEDEC TO-220AB

The RCA-BD533-BD538 are epitaxial-base silicon transistors 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.

The BD533, BD535, and BD537 are n-p-n complements of p-n-p types BD534, BD536, and BD538, respectively.

All types are supplied in the JEDEC TO-220AB (VERSAWATT)

MAXIMUM RATINGS, Absolute-Maximum Values:

V_{CBO} .....	.....
$V_{CES(sus)}$ .....	.....
$V_{CEC(sus)}$ .....	.....
V_{EBO} .....	.....
I_C .....	.....
I_B .....	.....
P_T .....	.....
$T_C \leq 25^\circ C$ .....	.....
$T_C > 25^\circ C$ derate linearly .....	.....
T_{stg} .....	.....
T_J .....	.....
T_L .....	.....
At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	

	BD533	BD535	BD537	
N-P-N	BD534 ■	BD536 ■	BD538 ■	
	45	60	80	V
	45	60	80	V
	45	60	80	V
	.....	5	.....	V
	.....	8	.....	A
	.....	1	.....	A
	.....	50	.....	W
	.....	0.4	.....	W/°C
	.....	-65 to 150	.....	°C
	.....	235	.....	°C

■For p-n-p devices, voltage and current values are negative.

BD533, BD534, BD535, BD536, BD537, BD538

ELECTRICAL CHARACTERISTICS at Case Temperature (T_C) = 25°C

Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS [▲]				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BD533 BD534 [▲]		BD535 BD536 [▲]		BD537 BD538 [▲]		
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I _{CBO}	45 [Ⓢ]				—	100	—	—	—	—	μA
	60 [Ⓢ]				—	—	—	100	—	—	
	80 [Ⓢ]				—	—	—	—	—	100	
I _{CES}	45				—	100	—	—	—	—	μA
	60				—	—	—	100	—	—	
	80				—	—	—	—	—	100	
I _{EBO}		5			—	1	—	1	—	1	mA
V _{CEO(sus)} ■			0.1*	0	45	—	60	—	80	—	V
h _{FE}	5		0.01*		20	—	20	—	15	—	
	2		0.5*		40	—	40	—	40	—	
	2		2*		25	—	25	—	15	—	
h _{FE} Groups											
	J	2		2*	30	75	30	75	30	75	
		2		3*	15	—	15	—	15	—	
K	2		2*		40	100	40	100	40	100	
	2		3*		20	—	20	—	20	—	
L	2		2*		60	150	—	—	—	—	
	2		3*		30	—	—	—	—	—	
(For BD533, BD534 only)											
V _{BE}	2		2*		—	1.5	—	1.5	—	1.5	
V _{CE(sat)}			2*	0.2	—	0.8	—	0.8	—	0.8	V
			6*	0.6	0.8 ●	—	0.8 ●	—	0.8 ●	—	
f _T	1		0.5		3	12 ●	3	12 ●	3	12 ●	MHz
R _{θJC}					—	2.5	—	2.5	—	2.5	°C/W

▲ For p-n-p devices, voltage and current values are negative.

Ⓢ V_{CB} value

■ **CAUTION:** The sustaining voltage V_{CEO(sus)} *MUST NOT* be measured on a curve tracer.

* Pulsed: Pulse duration = 300 μs, duty factor = 1.5%.

● Typical values.

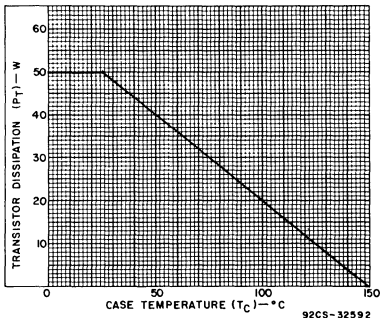


Fig. 1—Derating curve for all types.

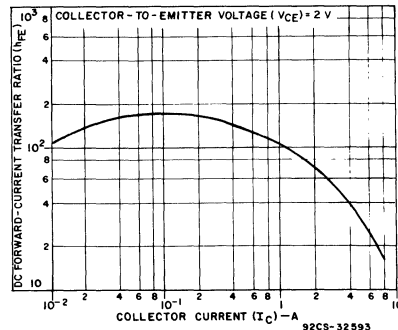


Fig. 2—Typical dc beta characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

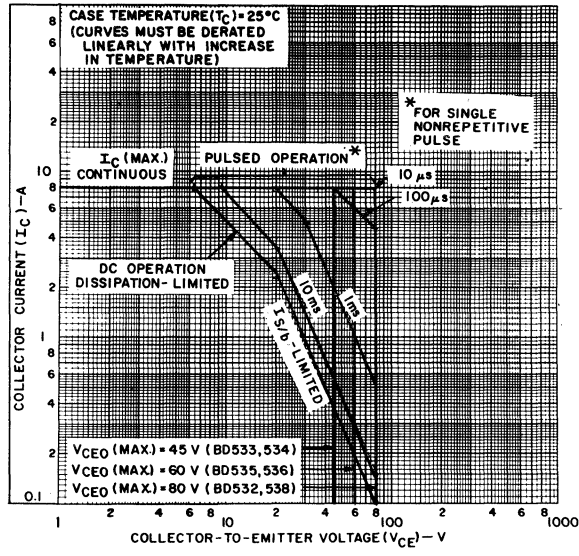


Fig. 3—Maximum safe-operating areas for all types.

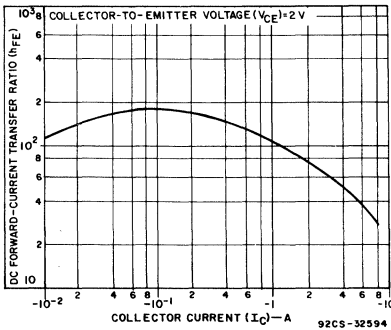


Fig. 4—Typical dc beta characteristic for BD534, BD536, and BD538 types.

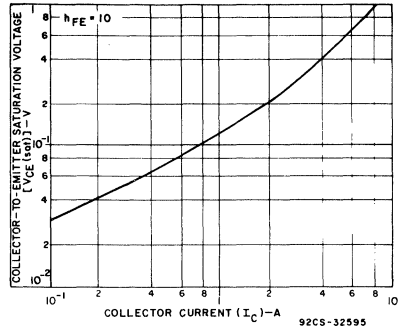


Fig. 5—Typical collector to-emitter saturation voltage characteristic for BD533, BD535, and BD537 types.

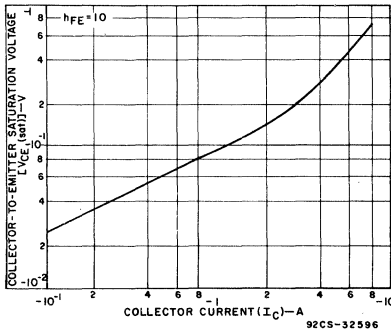


Fig. 6—Typical collector-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

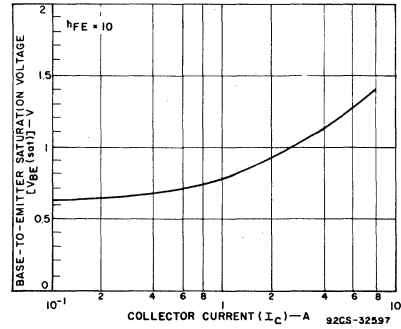


Fig. 7—Typical base-to-emitter saturation voltage characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

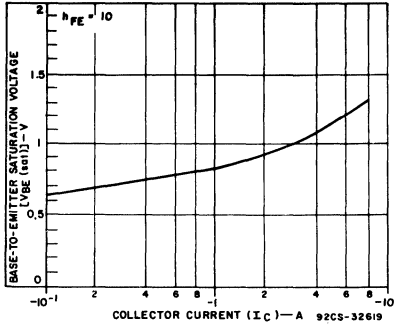


Fig. 8—Typical base-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

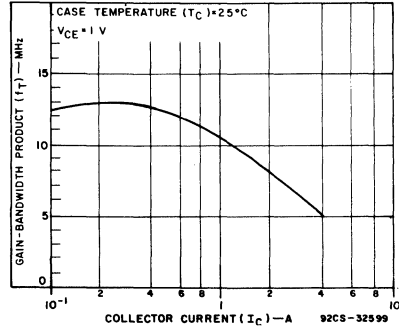


Fig. 9—Typical gain-bandwidth product characteristic for BD533, BD535, and BD537 types.

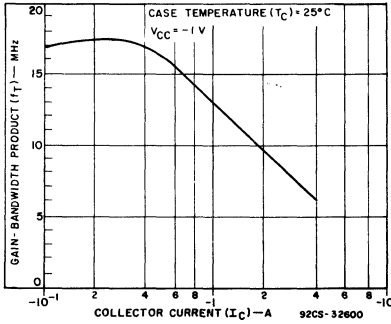


Fig. 10—Typical gain-bandwidth product characteristic for BD534, BD536, and BD538 types.

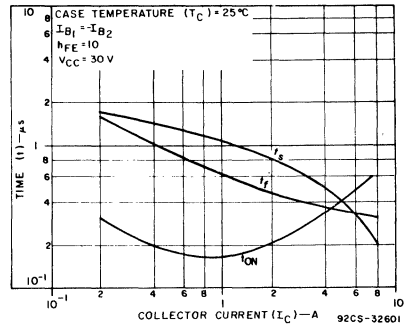


Fig. 11—Typical saturated-switching time characteristics for BD533, BD535, and BD537 types.

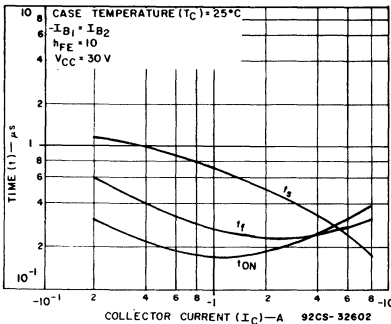


Fig. 12—Typical saturated switching time characteristics for BD534, BD536, and BD538 types.

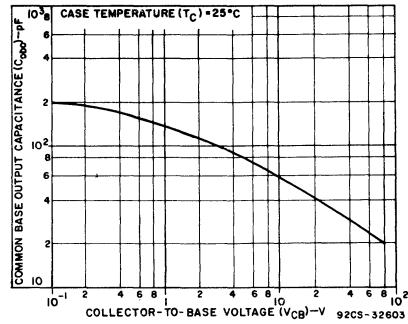


Fig. 13—Typical common-base output capacitance characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

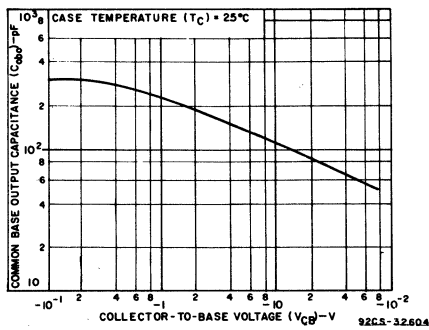
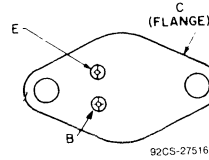


Fig. 14—Typical common-base output capacitance characteristic for BD534, BD536, and BD538 types.

Silicon Transistors for Quasi-Complementary-Symmetry Audio Amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BD550 and BD550B are silicon n-p-n transistors especially suitable for applications in audio-amplifier circuits, in which they may be used as either driver or output unit.

The devices, together with a variety of other transistors that serve as input devices, V_{BE} amplifiers for biasing, current sources, load-line limiters (for overload protection), and pre-drivers, may be used to develop several hundred watts of audio output power in quasi-complementary-symmetry audio amplifier configurations that employ parallel output transistors.

The BD-550-series is supplied in the JEDEC TO-204AA hermetic steel case.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BD550	BD550B	
V_{CBO}	130	275	V
V_{CEO}	110	250	V
$V_{CER}(R_{BE} = 100 \Omega)$	130	275	V
V_{EBO}	5	5	V
I_C	7	7	A
I_B	2	2	A
P_T	150	150	W
At $T_C \leq 25^\circ C$	See Fig. 1	See Fig. 1	$W/^\circ C$
At $T_C > 25^\circ C$	-65 to 200	-65 to 200	$^\circ C$
T_{stg}, T_J			$^\circ C$
T_L	230	230	$^\circ C$
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.			

BD550, BD550B

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS	LIMITS				UNITS
		BD550		BD550B●		
		Min.	Max.	Min.	Max.	
I_{CER} $R_{BE} = 100 \Omega$	$V_{CE} = 110 \text{ V}$ $V_{CE} = 250 \text{ V}$	—	1	—	—	mA
I_{CEO}	$V_{CE} = 95 \text{ V}$ $V_{CE} = 200 \text{ V}$	—	5	—	5	mA
I_{EBO}	$V_{EB} = 5 \text{ V}$	—	1	—	1	mA
V_{CEO}	$I_C = 0.2 \text{ A}$	110	—	250	—	V
V_{CER}	$I_C = 0.2 \text{ A}; R_{BE} = 100 \Omega$	130	—	275	—	V
f_T	$I_C = 0.2 \text{ A}; V_{CE} = 10 \text{ V}$	5 typ.		5 typ.		MHz
h_{FE}	$I_C = 4 \text{ A}; V_{CE} = 4 \text{ V}$ $I_C = 2 \text{ A}; V_{CE} = 4 \text{ V}$	15	75	—	—	
$V_{CE(sat)}$	$I_C = 4 \text{ A}; I_B = 0.5 \text{ A}$ $I_C = 2 \text{ A}; I_B = 0.25 \text{ A}$	—	2	—	—	V
V_{BE}	$I_C = 4 \text{ A}; V_{CE} = 4 \text{ V}$ $I_C = 2 \text{ A}; V_{CE} = 4 \text{ V}$	0.75	1.75	—	—	V
$I_{S/b}$	$V_{CE} = 80 \text{ V}; t = 1 \text{ S}$ $V_{CE} = 140 \text{ V}; t = 1 \text{ S}$	1.87	—	—	—	A

▲For characteristics curves and test conditions, refer to published data for prototype RCA8638D (File 1060).

●For characteristics curves and test conditions, refer to published data for prototype 2N5240 (File 321).

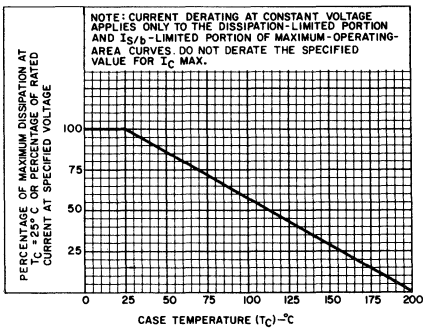


Fig. 1 — Derating curve for all types.

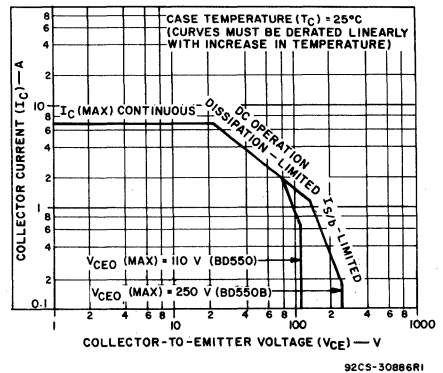


Fig. 2 — Maximum operating areas for all types.

8-Ampere N-P-N Darlington Power Transistors

45-60-80 Volts, 70 Watts
Gain of 750 at 3A

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

The BD643, BD645, BD647, and BD649 are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO 220AB (VERSAWATT) plastic package.

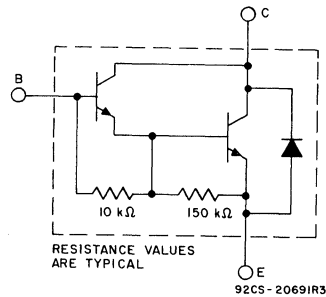
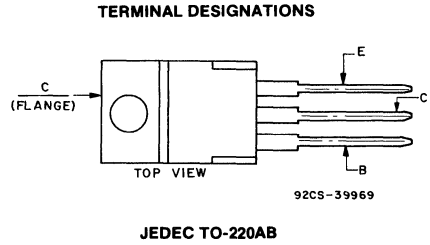


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BD643	BD645	BD647	BD649	
V _{CBO}	45	60	80	100	V
V _{CEO(sus)}	45	60	80	100	V
V _{EBO}	5				V
I _C	8				A
I _{CM}	12				A
I _B	0.15				A
P _T					
T _C ≤ 25°C	62.5				W
T _C > 25°C	Derate linearly 0.5				W/°C
T _{stg} , T _J	-55 to 150				°C
T _L					
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

BD643, BD645, BD647, BD649

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc			CUR- RENT A dc	BD643		BD645		
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		20 30			— —	0.5 —	— —	— 0.5	mA
I_{CBO}	45 60				— —	0.2 —	— 0.2		
$T_C = 100^\circ\text{C}$	45 60				— —	2 —	— 2		
I_{EBO}			-5	0	—	2	—	2	V
$V_{(BR)CEO}$				0.1 ^a	45	—	60	—	
$V_{(BR)CBO}$				0.005	45	—	60	—	
$V_{(BR)EBO}$ $I_E = 2\text{ mA}$					5	—	5	—	
h_{FE}		3		0.5 ^a	1500 ^b	—	1500 ^b	—	
		3		3 ^a	750	—	750	—	
		3		6 ^a	750 ^b	—	750 ^b	—	
V_{BE}		3		3 ^a	—	2.5	—	2.5	V
$V_{CE(sat)}$ $I_B = 12\text{ mA}$				3 ^a	—	2	—	2	
f_T $f = 1\text{ MHz}$		3 3		3 3	1 10 ^b	—	1 10 ^b	—	MHz
$R_{\theta JC}$					—	2	—	2	°C/W

^a Pulsed; pulse duration = 200 μs , duty factor = 1%.

^b Typical value.

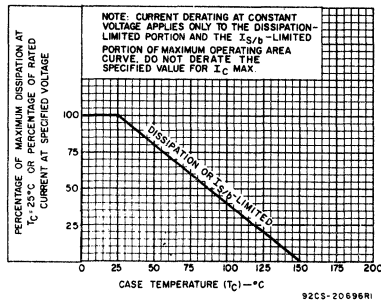


Fig. 2—Derating curve for all types.

BD643, BD645, BD647, BD649

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc			CUR- RENT A dc	BD647		BD649		
	V _{CB}	V _{CE}	V _{BE}	I _C	Min.	Max.	Min.	Max.	
I _{CEO}		40 50			—	0.5	—	—	mA
I _{CBO}	80 100				—	0.2	—	—	
T _C = 100°C	80 100				—	2	—	—	
I _{EBO}			—5	0	—	2	—	2	V
V _{(BR)CEO}				0.1 ^a	80	—	100	—	
V _{(BR)CBO}				0.005	80	—	100	—	
V _{(BR)EBO} I _E = 2 mA					5	—	5	—	
h _{FE}		3 3 3		0.5 ^a 3 ^a 6 ^a	1500 ^b 750 750 ^b	—	1500 ^b 750 750 ^b	—	V
V _{BE}		3		3 ^a	—	2.5	—	2.5	
V _{CE(sat)} I _B = 12 mA				3 ^a	—	2	—	2	
f _T f = 1 MHz		3 3		3 3	1 10 ^b	—	1 10 ^b	—	MHz
R _{θJC}					—	2	—	2	°C/W

^a Pulsed; pulse duration = 200 μs, duty factor = 1%.

^b Typical value.

BD643, BD645, BD647, BD649

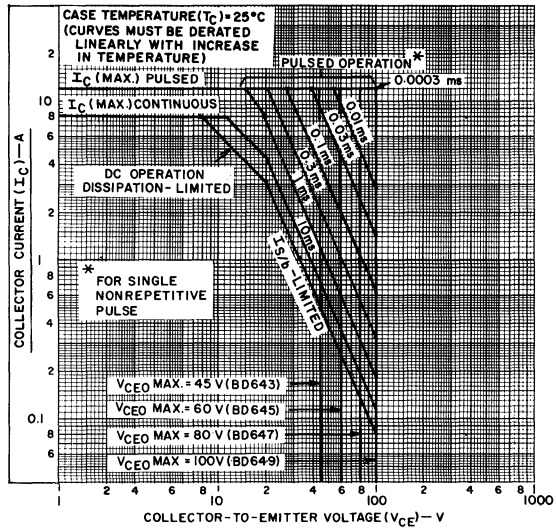


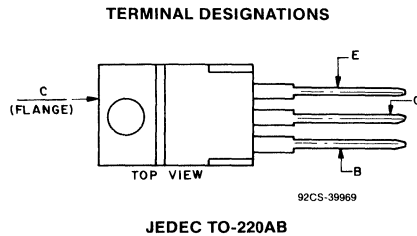
Fig. 3—Maximum operating area for all types.

Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

General-Purpose Medium-Power Types for Switching and Amplifier Applications

Features:

- Low saturation voltages
- Complementary n-p-n and p-n-p types
- Maximum safe-area-of-operation curves



The BD795, BD797, BD799, and BD801 n-p-n transistors and their p-n-p complements BD796, BD798, BD800, and BD802, respectively, are epitaxial-base silicon types 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.

These transistors are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	N-P-N	BD795	BD797	BD799	BD801	
	P-N-P	BD796*	BD798*	BD800*	BD802*	
V_{CBO}		45	60	80	100	V
$V_{CEO}(sus)$		45	60	80	100	V
V_{EBO}				5		V
I_C				8		A
I_B				3		A
P_T						
$T_C \leq 25^\circ C$				65		W
$T_C > 25^\circ C$				Derate Linearly 0.522		W/°C
T_{stg} , T_J				-55 to 150		°C
T_L						
At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.				235		°C

*For p-n-p devices, voltage and current values are negative.

**BD795, BD796, BD797, BD798,
BD799, BD800, BD801, BD802**

**ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
Unless Otherwise Specified**

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD795 BD796 ●		BD797 BD798 ●		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO}	45 60					—	0.1	—	—	mA
I_{EBO}			-5	0		—	1	—	1	
V_{CE0}^b				0.1 ^a	0	45	—	60	—	V
h_{FE}		2		1 ^a		40	—	40	—	V
$V_{BE(ON)}$		2		3 ^a		—	1.6	—	1.6	
$V_{CE(sat)}$				3 ^a	0.3	—	1	—	1	MHz
f_T $f = 1$ MHz		10		0.25		3	—	3	—	
$R_{\theta JC}$						—	1.92	—	1.92	°C/W

^a Pulsed; Pulse duration = 300 μ s, duty factor = 1.8%.

^b CAUTION: The sustaining voltage $V_{CE0(sus)}$ *MUST NOT* be measured on a curve tracer.

● For p-n-p devices, voltage and current values are negative.

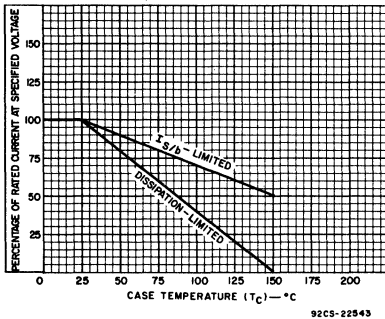


Fig. 1—Current derating curves for all types.

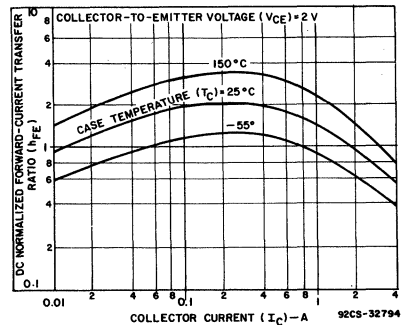


Fig. 2—Normalized dc-beta characteristics for all types.

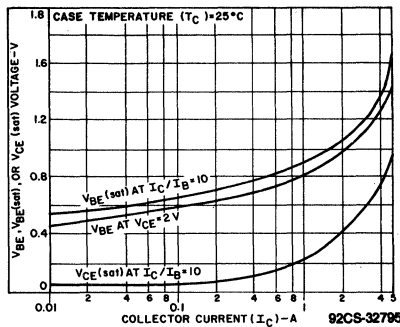


Fig. 3—Typical "on" voltage characteristics for all types.

**BD795, BD796, BD797, BD798,
BD799, BD800, BD801, BD802**

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD799 BD800 ●		BD801 BD802 ●		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO}	80 100					—	0.1	—	—	mA
I_{EBO}			-5	0		—	1	—	1	
V_{CE0}^b				0.1 ^a	0	80	—	100	—	V
h_{FE}		2		1 ^a		30	—	30	—	
		2		3 ^a		15	—	15	—	
$V_{BE(ON)}$		2		3 ^a		—	1.6	—	1.6	V
$V_{CE(sat)}$				3 ^a	0.3	—	1	—	1	
f_T f = 1 MHz		10		0.25		3	—	3	—	MHz
$R_{\theta JC}$						—	1.92	—	1.92	°C/W

^a Pulsed; Pulse duration = 300 μs, duty factor = 1.8%.

^b CAUTION: The sustaining voltage $V_{CE0(sus)}$ MUST NOT be measured on a curve tracer.

● For p-n-p devices, voltage and current values are negative.

2

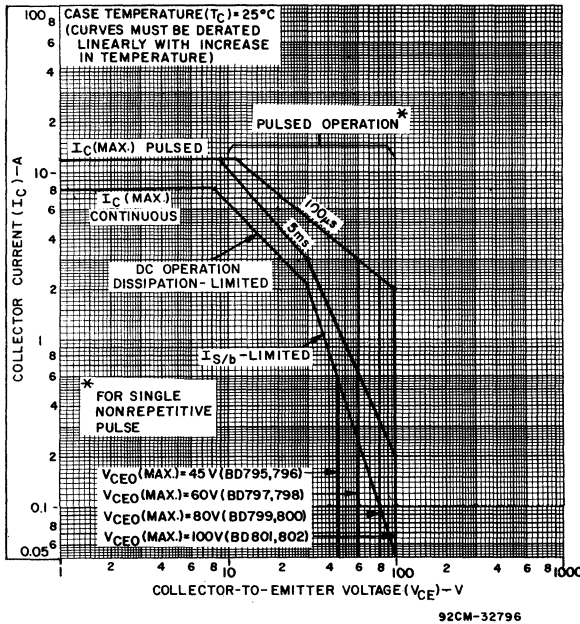


Fig. 4 — Maximum operating areas for all types.

8-Ampere N-P-N Darlington Power Transistors

45-60-80-100-Volts, 70 Watts

Gain of 750 at 4 A
(BD895A, BD897A, BD899A)

Gain of 750 at 3 A
(BD895, BD897, BD899, BD901)

Features:

- Operated from IC without predriver
- Low Leakage at high temperature

Applications:

- Power Switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

The BD895, BD645, BD895A, BD897, BD897A, BD899, BD899A, and BD901 are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO 220AB (VERSAWATT) plastic package.

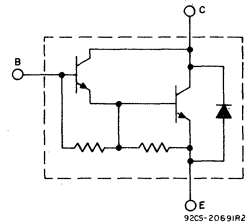
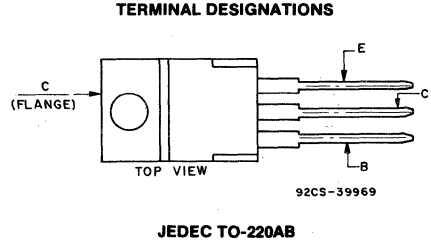


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BD895	BD897	BD899	BD901	
	BD895A	BD897A	BD899A	—	
V _{CB0}	45	60	80	100	V
V _{CE0(sus)}	45	60	80	100	V
V _{EBO}	5				V
I _C	8				A
I _B	0.1				A
P _T					
T _C ≤ 25°C.....	70				W
T _C > 25°C.....	Derate linearly 0.56				W/°C
T _{stg} , T _J	-65 to 150				°C
T _L					
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.....	235				°C

BD895, BD895A, BD897, BD897A, BD899, BD899A, BD901

ELECTRICAL CHARACTERISTICS, At Case Temperature ($T_C = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD895 BD895A		BD897 BD897A		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		20 30			0 0	— —	500 —	— —	— 500	μA
I_{CBO}	45 60					— —	0.2 —	— —	— 0.2	mA
	$T_C = 100^\circ\text{C}$	45 60				— —	2 —	— —	— 2	
I_{EBO}			-5	0		—	2	—	2	
$V_{CEO(sus)}$				0.1 ^a	0	45	—	60	—	V
h_{FE} BD895, BD897 BD895A, BD897A		3		3 ^a		750	—	750	—	
		3		4 ^a		750	—	750	—	
V_{BE} BD895, BD897 BD895A, BD897A		3		3 ^a		—	2.5	—	2.5	V
		3		4 ^a		—	2.5	—	2.5	
$V_{CE(sat)}$ BD895 BD897 BD895A, BD897A				3 ^a	0.012	—	2.5	—	2.5	V
				4 ^a	0.016	—	2.8	—	2.8	
h_{fe} $f = 1\text{ MHz}$		3		3		1	—	1	—	
$R_{\theta JC}$						—	1.78	—	1.78	$^\circ\text{C/W}$

2

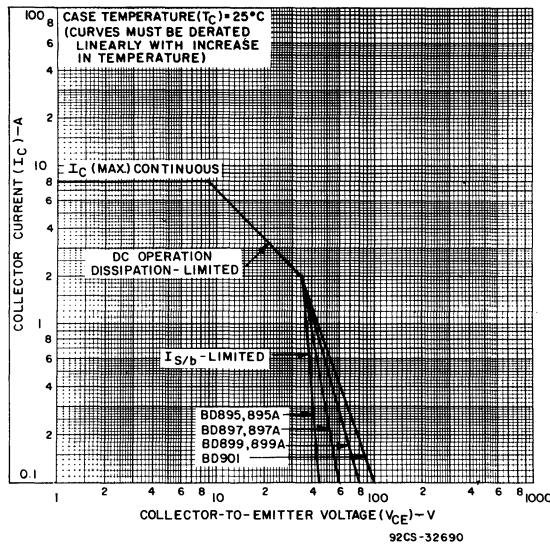


Fig. 2—Maximum operating areas for all types.

BD895, BD895A, BD897, BD897A, BD899, BD899A, BD901

ELECTRICAL CHARACTERISTICS, At Case Temperature ($T_C = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BD899 BD899A		BD901		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		40 50			0 0	— —	500 —	— —	— 500	μA
I_{CBO}	80 100					— —	0.2 —	— —	— 0.2	mA
	$T_C = 100^\circ\text{C}$	80 100				— —	2 —	— —	— 2	
I_{EBO}			-5	0		—	2	—	2	
$V_{CEO}(\text{sus})$				0.1 ^a	0	80	—	100	—	V
h_{FE} BD899, BD901		3		3 ^a		750	—	750	—	
	BD899A only	3		4 ^a		750	—	—	—	
V_{BE} BD899, BD901		3		3 ^a		—	2.5	—	2.5	V
	BD899A only	3		4 ^a		—	2.5	—	—	
$V_{CE}(\text{sat})$ BD899 BD901				3 ^a	0.012	—	2.5	—	2.5	
	BD899A only			4 ^a	0.016	—	2.8	—	—	
h_{fe} f = 1 MHz		3		3 ^a		1	—	1	—	
$R_{\theta JC}$						—	1.78	—	1.78	$^\circ\text{C/W}$

^a Pulsed: Pulse duration = 300 μs , duty factor = 1.8%.

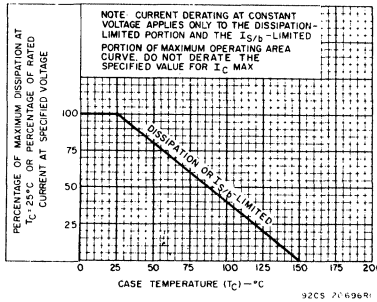


Fig. 3—Derating curve for all types.

Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

Features:

- High dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- High gain at high current

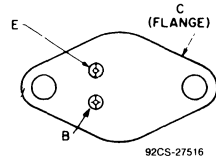
Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

The RCA-BDX18 and MJ2955 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. These devices have a dissipation capability of 115 watts (BDX18), and 150 watts (MJ2955) at case temperatures up to 25°C.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204AA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDX18	MJ2955	
V_{CBO}	-100		V
$V_{CER(SUS)}$	-70		V
$R_{BE} = 100 \Omega$	-60		V
$V_{CEO(SUS)}$	-7		V
V_{EBO}	-15		A
I_C	-7		A
I_B			
P_T			
At $T_C \leq 25^\circ C$	} 150 (MJ2955)		W
	} 115 (BDX18)		
At $T_C > 25^\circ C$	} 0.86 (MJ2955)		W/°C
Derate linearly	} 0.66 (BDX18)		
T_{stg}, T_J	-65 to 200		°C
T_L			
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	235		°C

BDX18, MJ2955

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_c) = 25°C Unless Otherwise Specified.

CHARACTERISTIC	TEST CONDITIONS					LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		BDX18 MJ2955			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.		
I_{CEX}	BDX18	-100	1.5	—	—	—	-5	mA
	MJ2955	-100	1.5	—	—	—	-1	
I_{CEX} , $T_c = 150^\circ\text{C}$	MJ2955	-100	1.5	—	—	—	-5	mA
	BDX18	-60	1.5	—	—	—	-10	
I_{CEO}		-30	—	—	—	—	-0.7	mA
I_{EBO}		—	7	—	—	—	-5	mA
$V_{CEO}(\text{sus})$		—	—	-0.2	—	-60 ^b	—	V
$V_{CER}(\text{sus})$ $R_{BE} = 100 \Omega$		—	—	-0.2	—	-70 ^b	—	V
h_{FE}	BDX18, MJ2955	-4	—	-4 ^a	—	20	70	
	Except BDX18	-4	—	-10 ^a	—	5	—	
V_{BE}		-4	—	-4 ^a	—	—	-1.8	V
$V_{CE}(\text{sat})$	BDX18, MJ2955	—	—	-4 ^a	-0.4	—	-1.1	V
	MJ2955 only	—	—	-10 ^a	-3.3	—	-3	
f_{Tfe} $f = 10$ kHz	MJ2955	-4	—	-1	—	10	—	kHz
$|h_{fe}|$ $f = 1$ MHz	BDX18	-4	—	-1	—	2.5	—	
	MJ2955	-4	—	-0.5	—	4	—	
h_{fe} $f = 1$ kHz		-4	—	-1	—	15	120	
$I_{S/B}$ $t_p = 1$ s nonrep.		-40	—	—	—	2.87	—	A
$R_{\theta JC}$	BDX18	—	—	—	—	—	1.5	°C/W
	MJ2955	—	—	—	—	—	1.17	

^aPulsed; pulse duration = 300 μ s, duty factor = 1.8%.

^bCAUTION: Sustaining voltages $V_{CEO}(\text{sus})$ and $V_{CER}(\text{sus})$ MUST NOT be measured on a curve tracer.

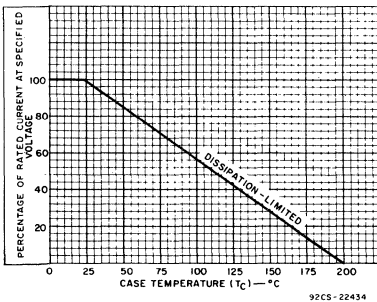


Fig. 1 — Derating curve.

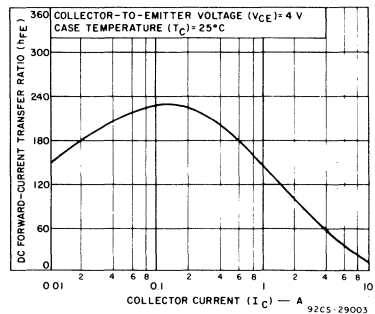


Fig. 2 — Typical dc beta characteristics.

BDX18, MJ2955

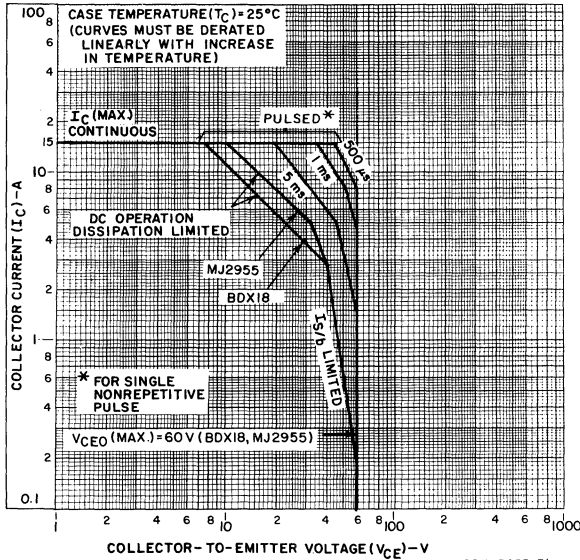


Fig. 3 — Maximum operating areas for BDX18 and MJ2955.

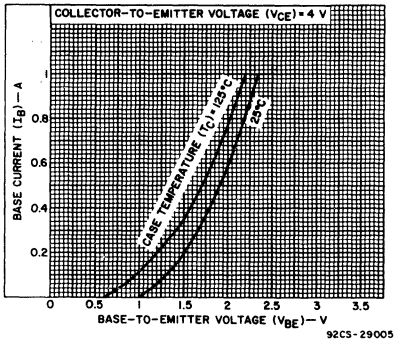


Fig. 4 — Typical input characteristics.

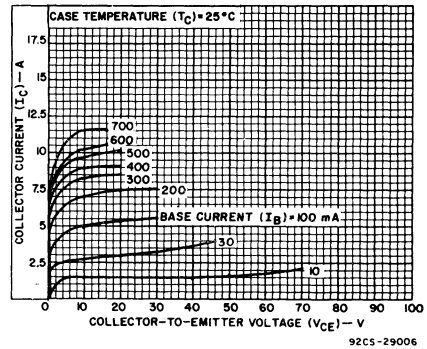


Fig. 5 — Typical output characteristics.

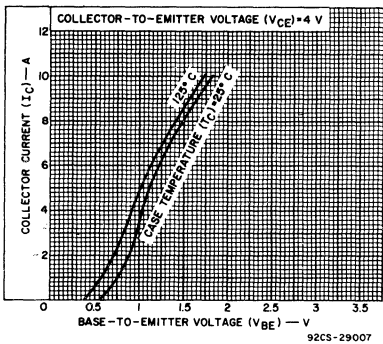


Fig. 6 — Typical transfer characteristics.

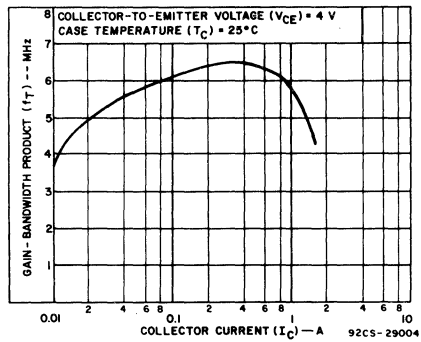


Fig. 7 — Typical gain-bandwidth product.

10-Ampere N-P-N Darlington Power Transistors

45-60-80-100-120 Volts, 70 Watts

Gain of 750 at 4 A (BDX33, BDX33A)

Gain of 750 at 3 A (BDX33B, BDX33C, BDX33D)

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

The BDX33, BDX33A, BDX33B, BDX33C, and BDX33D are monolithic silicon Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The BDX33, BDX33A, BDX33B, and BDX33C are complementary to the BDX34, BDX34B, and BDX34C, described in File 694.

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) plastic package.

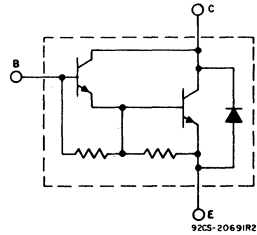
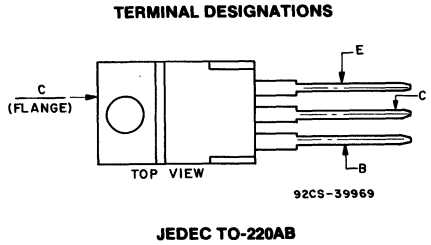


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDX33	BDX33A	BDX33B	BDX33C	BDX33D	
V_{CBO}	45	60	80	100	120	V
$V_{CER(sus)}$ (R_{BE}) = 100 Ω	45	60	80	100	120	V
$V_{CEO(sus)}$	45	60	80	100	120	V
$V_{CEX(sus)}$ $V_{BE} = -1.5$ V	45	60	80	100	120	V
V_{EBO}	5	5	5	5	5	V
I_C	10	10	10	10	10	A
I_B	0.25	0.25	0.25	0.25	0.25	A
P_T $T_C \leq 25^\circ\text{C}$	70	70	70	70	70	W
$T_C > 25^\circ\text{C}$	Derate linearly 0.56					W/ $^\circ\text{C}$
T_{stg}, T_J	-65 to +150					$^\circ\text{C}$
T_L At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	235					$^\circ\text{C}$

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc			CUR- RENT A dc	BDX33		BDX33A		BDX33B		
	V _{CB}	V _{CE}	V _{BE}	I _C	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CEO}		40			—	—	—	—	—	0.5	mA
		30			—	—	—	0.5	—	—	
		20			—	0.5	—	—	—	—	
T _C = 100°C		40			—	—	—	—	—	10	
		30			—	—	—	10	—	—	
		20			—	10	—	—	—	—	
I _{CBO}	80				—	—	—	—	—	1	
	60				—	—	—	1	—	—	
	45				—	1	—	—	—	—	
T _C = 100°C	80				—	—	—	—	—	5	
	60				—	—	—	5	—	—	
	45				—	5	—	—	—	—	
I _{EBO}			—5	0	—	10	—	10	—	10	mA
V _{CEO(sus)}				0.1 ^a	45	—	60	—	80	—	V
V _{CER(sus)} (R _{BE}) = 100 Ω				0.1 ^a	45	—	60	—	80	—	
V _{CEV(sus)}			—1.5	0.1 ^a	45	—	60	—	80	—	
h _{FE}		3		3 ^a	—	—	—	—	750	—	
		3		4 ^a	750	—	750	—	—	—	
V _{BE}		3		3 ^a	—	—	—	—	—	2.5	V
		3		4 ^a	—	2.5	—	2.5	—	—	
V _{CE(sat)} I _B = 0.006 I _B = 0.008				3 ^a	—	—	—	—	—	2.5	V
				4 ^a	—	2.5	—	2.5	—	—	
V _F				8	—	4	—	4	—	4	V
h _{fe} f = 1 kHz		5		1	1000	—	1000	—	1000	—	
|h _{fe}| f = 1.0 MHz		5		1	20	—	20	—	20	—	
I _{S/b} t _p = 0.5 s non-rep.		25			2.8	—	2.8	—	2.8	—	A
		36			1	—	1	—	1	—	
R _{θJC}					—	1.78	—	1.78	—	1.78	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.

BDX33, BDX33A, BDX33B, BDX33C, BDX33DELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX33C		BDX33D		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		60			0	–	–	–	0.5	mA
		50			0	–	0.5	–	–	
$T_C = 100^\circ\text{C}$		60			0	–	–	–	10	
		50			0	–	10	–	–	
I_{CBO}	120					–	–	–	1	
	100					–	1	–	–	
$T_C = 100^\circ\text{C}$	120					–	–	–	5	
	100					–	5	–	–	
I_{EBO}			–5	0		–	10	–	10	mA
$V_{CEO(sus)}$				0.1 ^a	0	100	–	120	–	V
$V_{CER(sus)}$ ($R_{BE} = 100\Omega$)				0.1 ^a		100	–	120	–	
$V_{CEV(sus)}$			–1.5	0.1 ^a		100	–	120	–	
h_{FE}		3		3 ^a		750	–	750	–	
V_{BE}		3		3 ^a		–	2.5	–	2.5	V
$V_{CE(sat)}$				3 ^a	0.006	–	2.5	–	2.5	V
V_F				8		–	4	–	4	V
h_{fe} $f = 1\text{ kHz}$		5		1		1000	–	1000	–	
$|h_{fe}|$ $f = 1.0\text{ MHz}$		5		1		20	–	20	–	
I_S/b $t_p = 0.5\text{ s non-rep.}$		25				2.8	–	2.8	–	A
		36				1	–	1	–	
$R_{\theta JC}$						–	1.78	–	1.78	°C/W

^a Pulsed: Pulse duration = 300 μs , duty factor = 1.8%.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

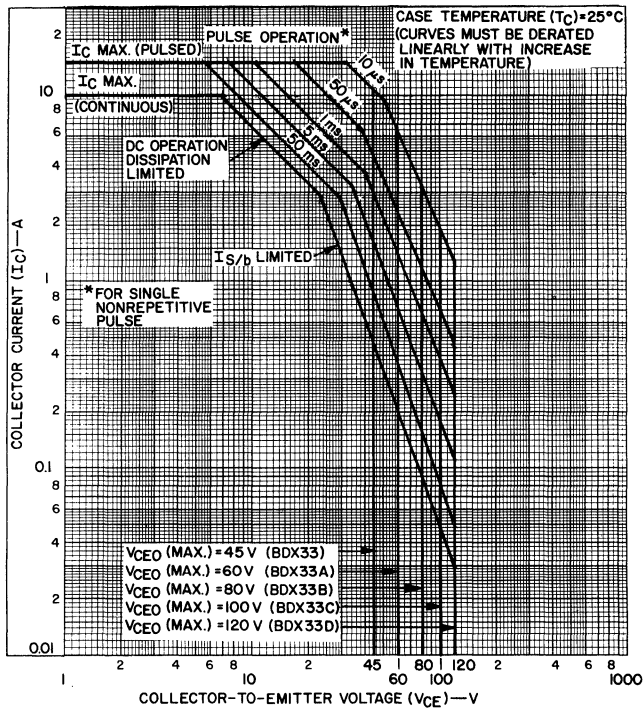


Fig. 2. — Maximum operating areas for BDX33-series types.

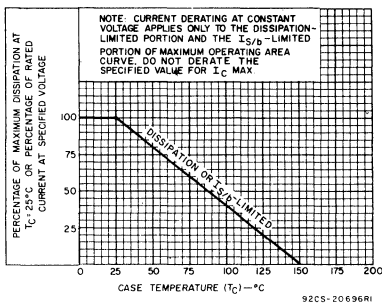


Fig. 3 — Derating curve for all types.

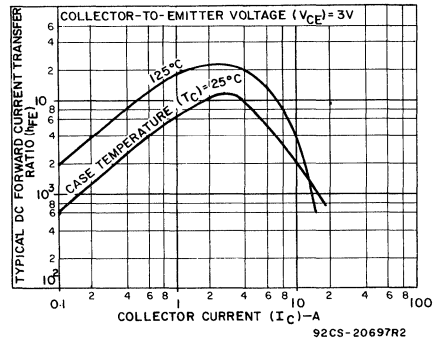


Fig. 4 — Typical dc-beta characteristics for all types.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

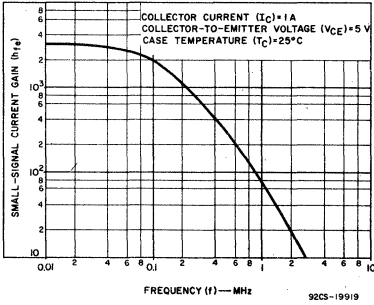


Fig. 5 — Typical small-signal gain for all types.

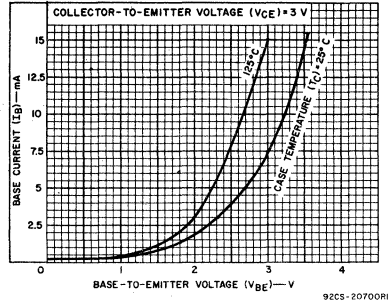


Fig. 6 — Typical Input characteristics for all types.

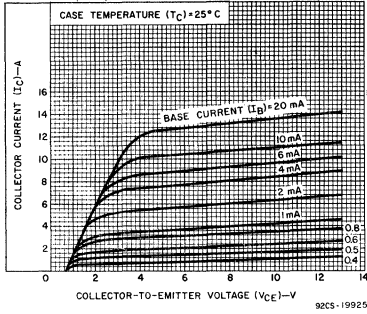


Fig. 7 — Typical output characteristics for all types.

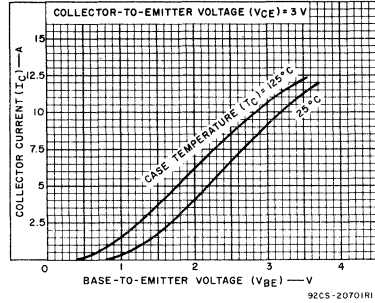


Fig. 8 — Typical transfer characteristics for all types.

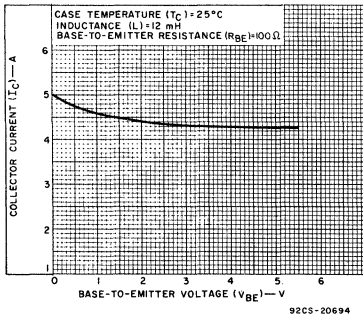


Fig. 9 — Typical saturation characteristics for all types.

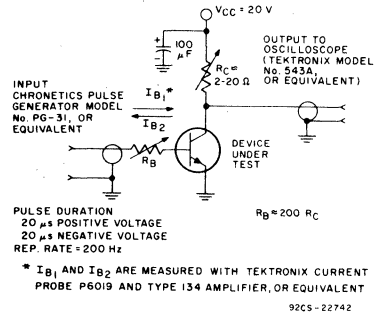


Fig. 10 — Circuit used to measure saturated switching times.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

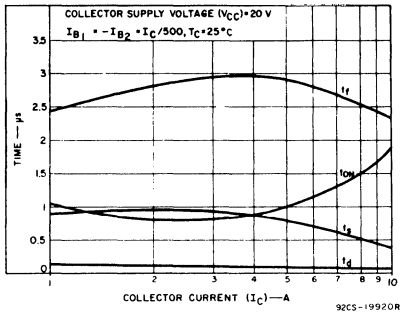


Fig. 11 — Typical saturated switching-time characteristics for all types.

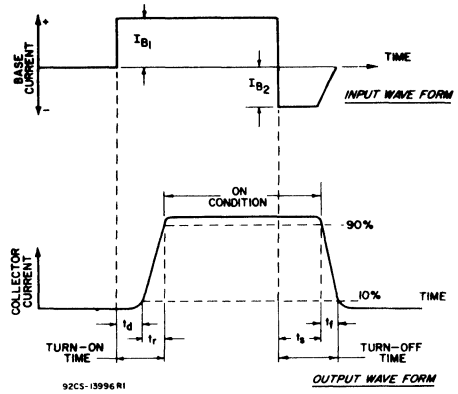


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching times (test circuit shown in Fig. 13).

10-Ampere P-N-P Darlington Power Transistors

45-60-80-100-120 Volts, 70 Watts
 Gain of 750 at 4 A (BDX34, BDX34A)
 Gain of 750 at 3 A (BDX34B, BDX34C, BDX34D)

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

The BDX34, BDX34A, BDX34B, BDX34C, and BDX34D are monolithic p-n-p silicon Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. They are complementary to the BDX33, BDX33A, BDX33B, BDX33C, and BDX33D described in Data Sheet File No. 693.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

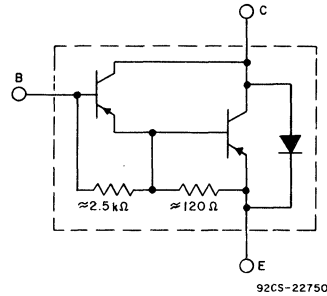
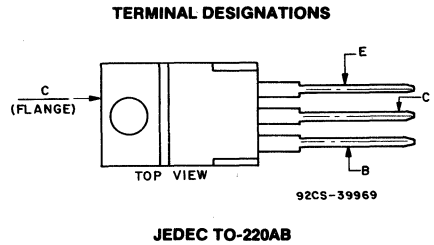


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDX34	BDX34A	BDX34B	BDX34C	BDX34D	
V _{CB0}	-45	-60	-80	-100	-120	V
V _{CER(sus)} (R _{BE})=100 Ω	-45	-60	-80	-100	-120	V
V _{CEO(sus)}	-45	-60	-80	-100	-120	V
V _{CEx(sus)} V _{BE} =-1.5 V	-45	-60	-80	-100	-120	V
V _{EBO}	-----		-5	-----		V
I _C	-----		-10	-----		A
I _B	-----		-0.25	-----		A
P _T						
T _C ≤ 25°C	-----		70	-----		W
T _C > 25°C	Derate linearly 0.56					W/°C
T _{stg} , T _J	-----		-65 to +150	-----		°C
T _L						
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	-----		235	-----		°C

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C)=25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc			CURRENT A dc	BDX34		BDX34A		BDX34B		
	V _{CB}	V _{CE}	V _{BE}		I _C	Min.	Max.	Min.	Max.	Min.		Max.
I _{CEO}		-40 -30 -20			—	—	—	—	—	-0.5	mA
T _C =100°C		-40 -30 -20			—	—	—	—	—	-10	
I _{CBO}	-80 -60 -45				—	—	—	—	—	-1	
T _C =100°C	-80 -60 -45				—	—	—	—	—	-5	
I _{EBO}			5	0	—	-10	—	-10	—	-10	
V _{CEO} (sus)				-0.1 ^a	-45	—	-60	—	-80	—	
V _{CER} (sus) (R _{BE})=100 Ω				-0.1 ^a	-45	—	-60	—	-80	—	
V _{CEV} (sus)			1.5	-1.0 ^a	-45	—	-60	—	-80	—	
h _{FE}		-3 -3		-3 ^a -4 ^a	— 750	—	— 750	—	—	750	V
V _{BE}		-3 -3		-3 ^a -4 ^a	—	—	—	—	—	-2.5	
V _{CE} (sat) I _B =-0.006 A =-0.008 A				-3 ^a -4 ^a	— —	—	—	—	—	-2.5	
V _F				-8	—	-4	—	-4	—	-4	A
h _{fe} (f=1.0 kHz)		-5		-1	1000	—	1000	—	1000	—	
h _{fe} (f=1.0 MHz)		-5		-1	20	—	20	—	20	—	
I _S /b t _p =0.5s non-rep.		-20 -33			-3.5 -1	—	-3.5 -1	—	-3.5 -1	—	°C/W
R _{θJC}					—	1.78	—	1.78	—	1.78	

^aPulsed: Pulse duration=300 μs, duty factor=1.8%.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C)=25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc	BDX34C		BDX34D		
	V _{CB}	V _{CE}	V _{BE}	I _C	Min.	Max.	Min.	Max.	
I _{CEO}		-60 -50			— —	— -0.5	— —	-0.5 —	mA
T _C =100°C		-60 -50			— —	— -10	— —	-10 —	
I _{CBO}	-120 -100				— —	— -1	— —	-1 —	
T _C =100°C	-120 -100				— —	— -5	— —	-5 —	
I _{EBO}			5	0	—	-10	—	-10	
V _{CEO(sus)}				-0.1 ^a	-100	—	-120	—	
V _{CER(sus)} (R _{BE})=100 Ω				-0.1 ^a	-100	—	-120	—	
V _{CEV(sus)}			1.5	-1.0 ^a	-100	—	-120	—	
h _{FE}		-3		-3 ^a	750	—	750	—	V
V _{BE}		-3		-3 ^a	—	-2.5	—	-2.5	
V _{CE(sat)} I _B =-0.006 A				-3 ^a	—	-2.5	—	-2.5	
V _F				-8	—	-4	—	-4	
h _{fe} (f=1.0 kHz)		-5		-1	1000	—	1000	—	
|h _{fe}| (f=1.0 MHz)		-5		-1	20	—	20	—	
I _{S/b} t _p =0.5 s non-rep.		-20 -33			-3.5 -1	— —	-3.5 -1	— —	A
R _{θJC}					—	1.78	—	1.78	°C/W

^aPulsed: Pulse duration=300 μs, duty factor=1.8%.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

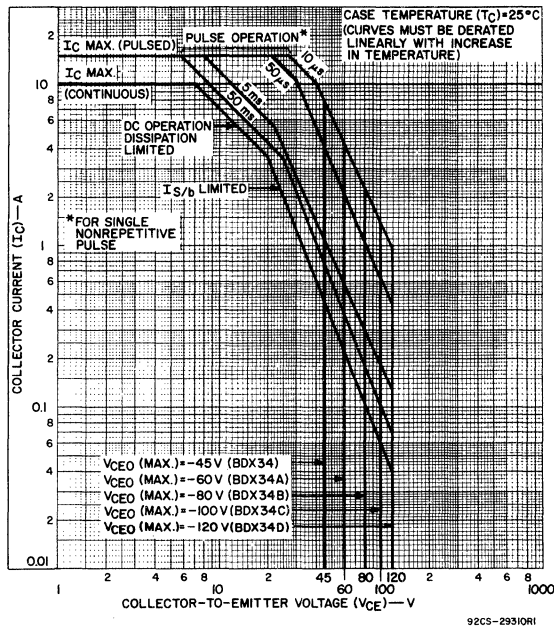


Fig. 2 - Maximum operating areas for BDX34-series types.

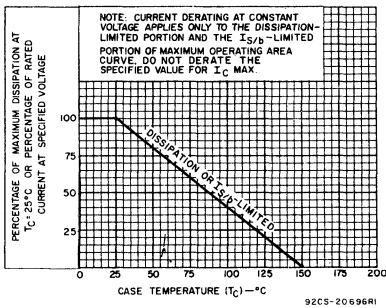


Fig. 3 - Current derating curve for all types.

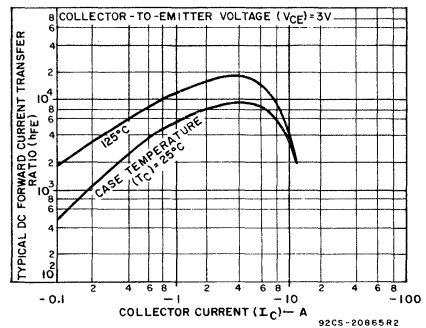


Fig. 4 - Typical dc beta characteristics for all types.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

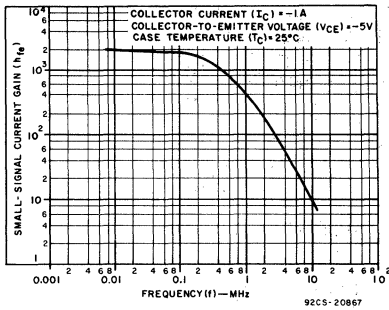


Fig. 5 — Typical small-signal gain for all types.

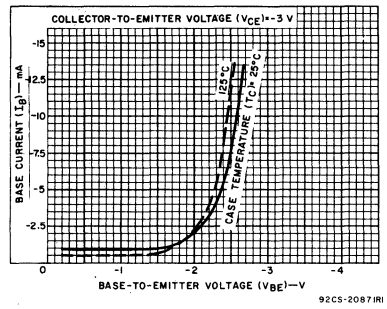


Fig. 6 — Typical input characteristics for all types.

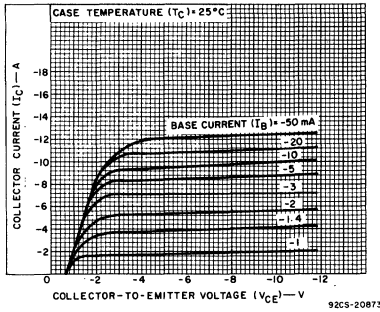


Fig. 7 — Typical output characteristics for all types.

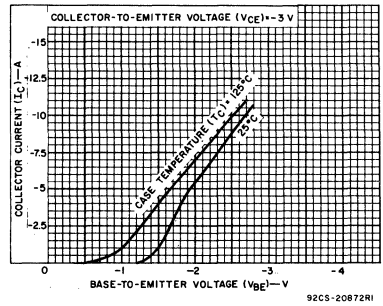


Fig. 8 — Typical transfer characteristics for all types.

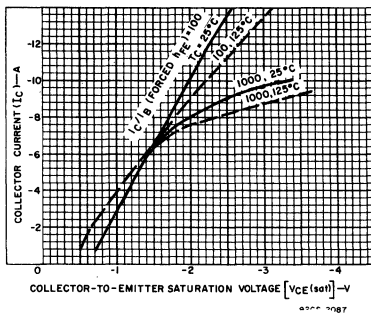


Fig. 9 — Typical saturation characteristics for all types.

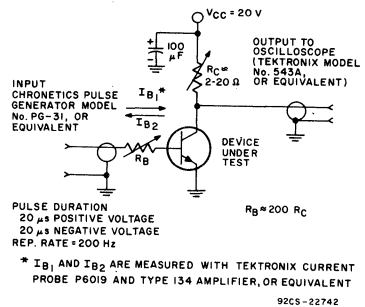


Fig. 10 — Circuit used to measure saturated switching times.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

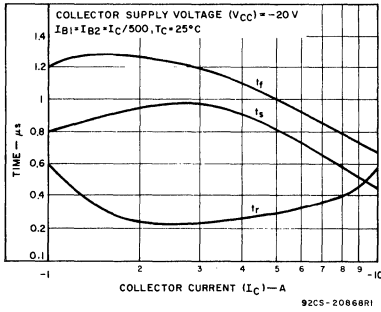


Fig. 11 — Typical saturated switching-time characteristics for all types.

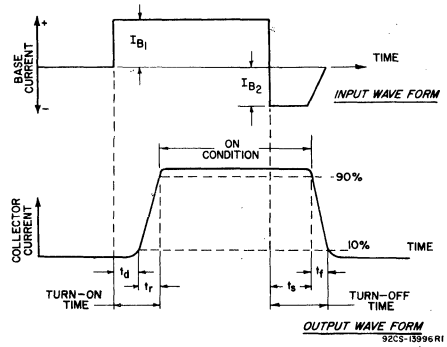


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching.

2

8-Ampere N-P-N Darlington Power Transistors

45-60-80-100 Volts, 60 Watts
Gain of 750 at 3 A

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators

The BDX53, BDX53A, BDX53B, and BDX53C are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO 220AB (VERSAWATT) plastic package.

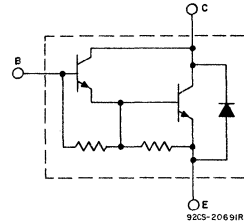
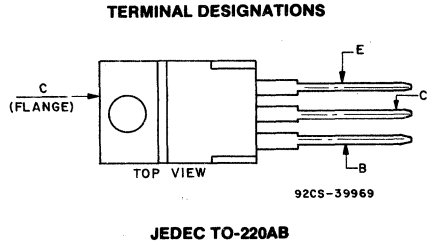


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDX53	BDX53A	BDX53B	BDX53C	
V _{CB0}	45	60	80	100	V
V _{CEO(sus)}	45	60	80	100	V
V _{EBO}			5		V
I _C			8		A
I _B			0.2		A
P _T			60		W
T _C ≤ 25°C					
T _C > 25°C			Derate linearly 0.48		W/°C
T _{stg} , T _J			-65 to +150		°C
T _L					
At distances ≥ 1/18 in. (3.17 mm) from case for 10 s max.			235		°C

BDX53, BDX53A, BDX53B, BDX53C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX53		BDX53A		
	V _{CB}	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
I _{CEO}		22 30			0 0	— —	500 —	— —	— 500	μA
I _{CBO}	45 60					— —	200 —	— 200		
I _{EBO}			—5	0		—	2	—	2	mA
V _{CEO(sus)}				0.1 ^a	0	45	—	60	—	V
h _{FE}		3		3 ^a		750	—	750	—	
V _{BE(sat)}				3 ^a	0.012	—	2.5	—	2.5	V
V _{CE(sat)}				3 ^a	0.012	—	2	—	2	
V _F				3 ^b 8 ^b		— 2.5 ^c	1.8 —	— 2.5 ^c	1.8 —	
R _{θJC}						—	2.08	—	2.08	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.5%. ^b I_F value. ^c Typical value.

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX53B		BDX53C		
	V _{CB}	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
I _{CEO}		40 50			0 0	— —	500 —	— —	— 500	μA
I _{CBO}	80 100					— —	200 —	— 200		
I _{EBO}			—5	0		—	2	—	2	mA
V _{CEO(sus)}				0.1 ^a	0	80	—	100	—	V
h _{FE}		3		3 ^a		750	—	750	—	
V _{BE(sat)}				3 ^a	0.012	—	2.5	—	2.5	V
V _{CE(sat)}				3 ^a	0.012	—	2	—	2	
V _F				3 ^b 8 ^b		— 2.5 ^c	1.8 —	— 2.5 ^c	1.8 —	
R _{θJC}						—	2.08	—	2.08	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.5%. ^b I_F value. ^c Typical value.

BDX53, BDX53A, BDX53B, BDX53C

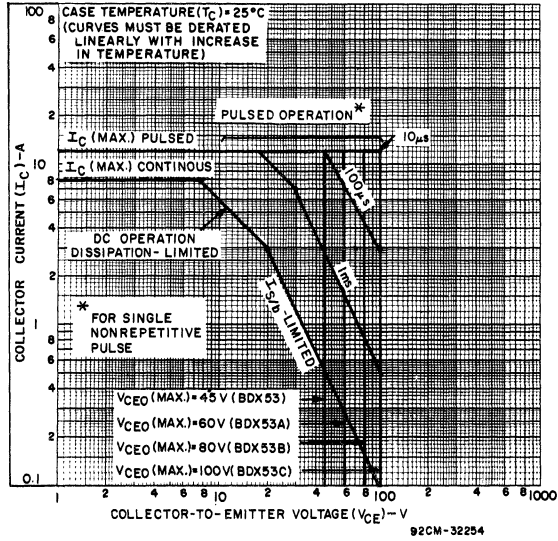


Fig. 2—Maximum operating areas for all types.

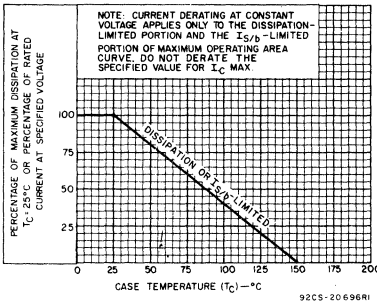


Fig. 3—Derating curve for all types.

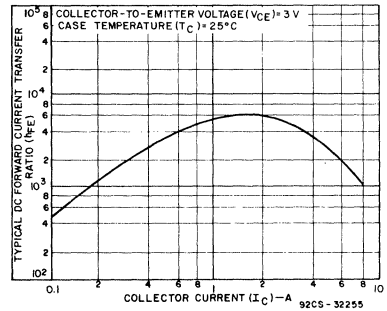


Fig. 4—Typical dc-beta characteristics for all types.

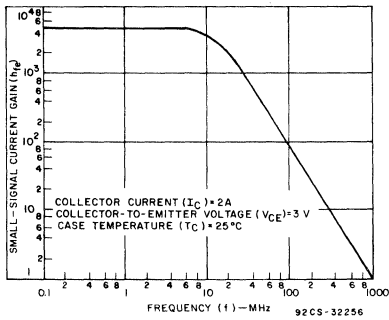


Fig. 5—Typical small-signal gain for all types.

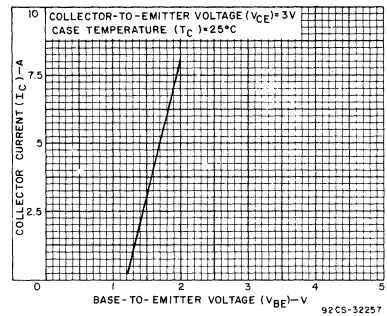


Fig. 6—Typical transfer characteristics for all types.

BDX53, BDX53A, BDX53B, BDX53C

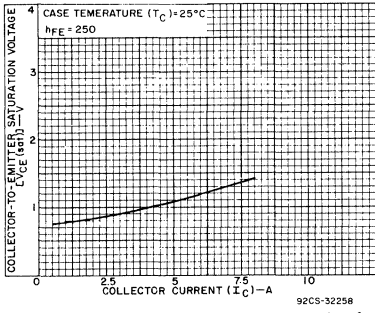


Fig. 7—Typical saturation characteristics for all types.

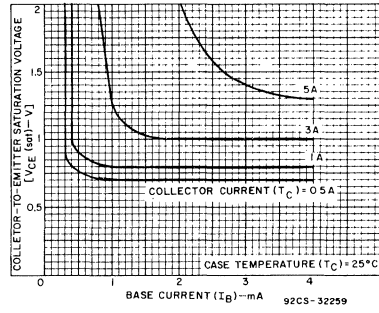


Fig. 8—Typical saturation characteristics for all types.

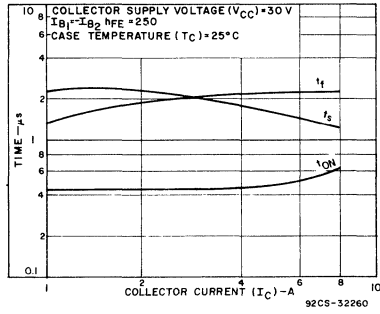


Fig. 9—Typical saturated switching-time characteristics for all types.

15-Ampere N-P-N Darlington Power Transistors

40-60-80-100 Volts, 125 Watts
Gain of 1000 at 5 Amperes

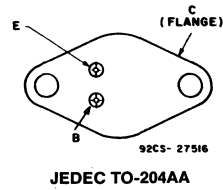
Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

TERMINAL DESIGNATIONS



The BDX83, BDX83A, BDX83B, and BDX83C are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO 220AA steel hermetic package.

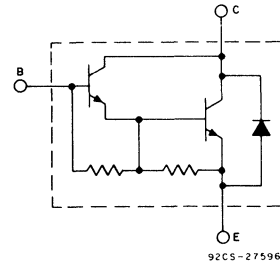


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDX83	BDX83A	BDX83B	BDX83C	
V_{CBO}	45	60	80	100	V
$V_{CEO(sus)}$	45	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	10	10	10	10	A
I_{CM}	15	15	15	15	A
I_B	0.25	0.25	0.25	0.25	A
P_T					
$T_C \leq 25^\circ C$	125	125	125	125	W
$T_C > 25^\circ C$	Derate linearly at 0.714 W/°C				
T_{stg}, T_J	-65 to +200				°C
T_L					
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	235				°C

BDX83, BDX83A, BDX83B, BDX83C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS				UNITS	
	VOLTAGE V dc			CURRENT A dc		BDX83		BDX83A			
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.		
I_{CEO}	20				0	—	1	—	—	mA	
	30				0	—	—	—	1		
I_{CEV}	45		-1.5			—	0.5	—	—		
	60		-1.5			—	—	—	0.5		
$T_C = 150^\circ\text{C}$											
I_{CEV}	45		-1.5			—	3	—	—		
	60		-1.5			—	—	—	3		
I_{EBO}		5		0		—	5	—	5		mA
$V_{CEO}(sus)$				0.1 ^a	0	45	—	60	—		V
h_{FE}	3			1 ^a		750	—	750	—		
	3			5 ^a		1000	—	1000	—		
	3			10 ^a		250	—	250	—		
V_{BE}	3			5 ^a		—	2.8	—	2.8	V	
	3			10 ^a		—	4.5	—	4.5		
$V_{CE}(sat)$				5 ^a	0.01 ^a	—	2	—	2	V	
V_F				-10		—	4	—	4	V	
h_{fe} f = 1 kHz	5			1		1000	—	1000	—		
$|h_{fe}|$ f = 1 MHz	5			1		20	—	20	—		
$I_{S/b}$ t = 1 s, non rep.	35					2.2	—	—	—	A	
	50					—	—	0.9	—		
	30					4.16	—	4.16	—		
$R_{\theta JC}$						—	1.4	—	1.4	°C/W	

^apulsed: Pulse duration = 300 μ s, duty factor = 1.8%.

2

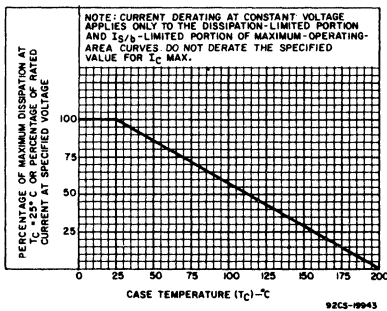


Fig. 2—Derating curves for all types.

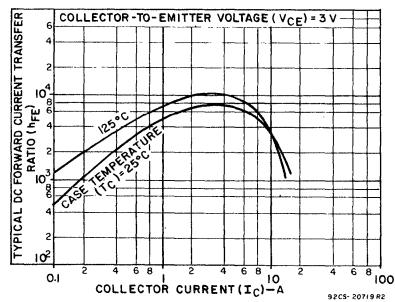


Fig. 3 — Typical dc-beta characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS					LIMITS				UNITS	
	VOLTAGE V dc			CURRENT A dc		BDX83B		BDX83C			
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.		
I_{CEO}	40				0	—	1	—	—	mA	
	50				0	—	—	—	1		
I_{CEV}	80		-1.5			—	0.5	—	—		
	100		-1.5			—	—	—	0.5		
$T_C = 150^\circ\text{C}$	80		-1.5			—	3	—	—		
	100		-1.5			—	—	—	3		
I_{EBO}		5		0		—	5	—	5		mA
$V_{CEO(sus)}$				0.1 ^a	0	80	—	100	—		V
h_{FE}	3			1 ^a		750	—	750	—		
	3			5 ^a		1000	—	1000	—		
	3			10 ^a		250	—	250	—		
V_{BE}	3			5 ^a		—	2.8	—	2.8	V	
	3			10 ^a		—	4.5	—	4.5		
$V_{CE(sat)}$				5 ^a	0.01 ^a	—	2	—	2	V	
V_F				-10		—	4	—	4	V	
h_{fe} f = 1 kHz	5			1		1000	—	1000	—		
$|h_{fe}|$ f = 1 MHz	5			1		20	—	20	—		
$I_{S/b}$ t = 1 s, non rep.	70					0.37	—	—	—	A	
	85					—	—	0.25	—		
	30					4.16	—	4.16	—		
$R_{\theta JC}$						—	1.4	—	1.4	°C/W	

^aPulsed: Pulse duration = 300 μs, duty factor = 1.8%.

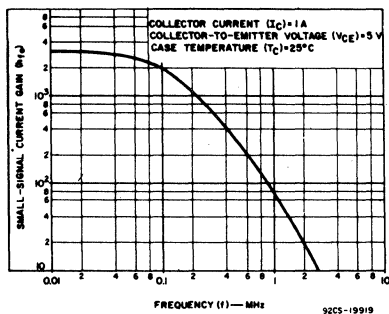


Fig. 4 — Typical small-signal gain for all types.

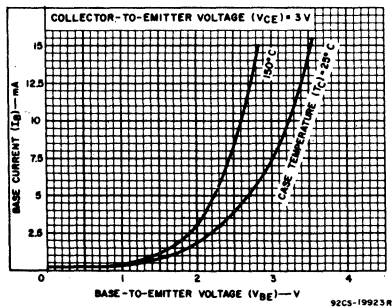


Fig. 5 — Typical input characteristic for all types.

BDX83, BDX83A, BDX83B, BDX83C

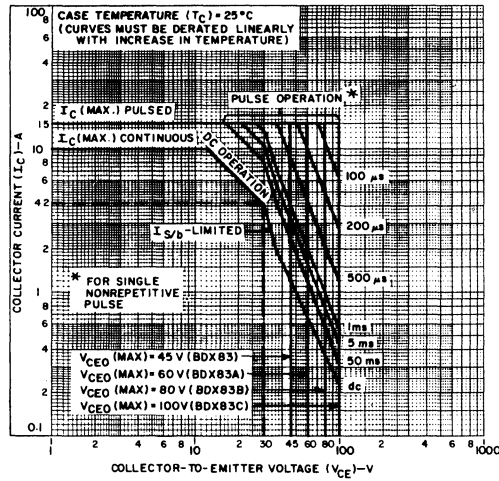


Fig. 6 — Maximum operating area for all types.

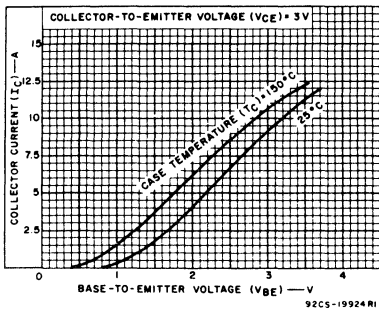


Fig. 7 — Typical transfer characteristics for all types.

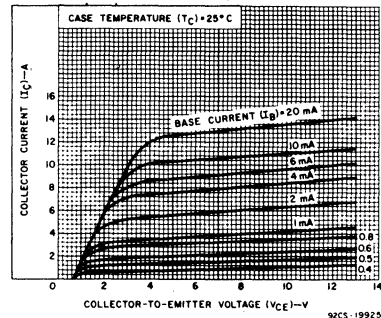


Fig. 8 — Typical output characteristics for all types.

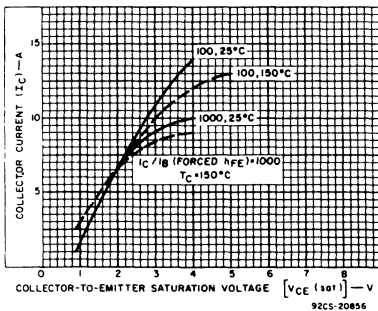


Fig. 9 — Typical saturation characteristics for all types.

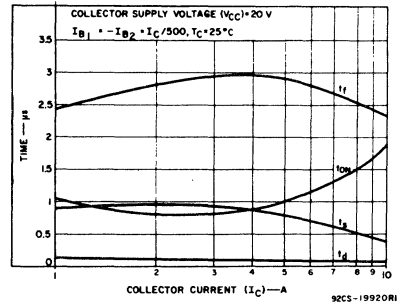


Fig. 10 — Typical saturated switching-time characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

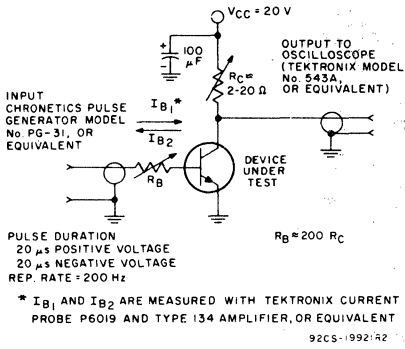


Fig. 11 — Circuit used to measure saturated-switching times.

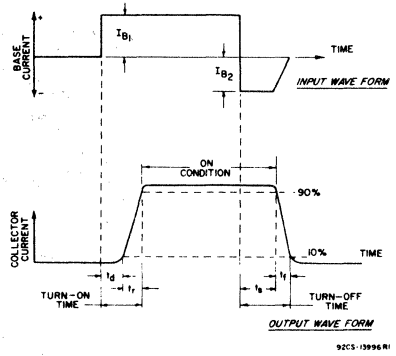


Fig. 12 — Phase relationship between input current and output current showing reference points for specification of switching times.

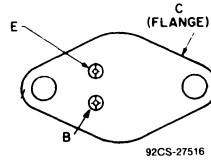
High-Power High-Current Transistor

Silicon N-P-N Devices for Applications in Industrial and Commercial Equipment

Features:

- High dissipation capability
- High V_{CEX} ratings
- 15-A specification for h_{FE} and $V_{CE(sat)}$
- Low saturation voltage with high beta

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BDY29 is a silicon n-p-n transistor intended for a wide variety of high-power high-current applications: Typical applications for the BDY29 include power-switching circuits, audio amplifiers, series and shunt-regulators, driver and output stages, dc-to-dc converters, inverters, and solenoid (hammer)/relay driver service.

The device is supplied in the popular JEDEC TO-204AA package.

MAXIMUM RATINGS, Absolute-Maximum Values:

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	100	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With $-1.5\text{ V } (V_{BE})$ & $R_{BE} = 100\ \Omega$	V_{CEX}	90	V
With base open	V_{CEO}	75	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	30	A
PEAK COLLECTOR CURRENT	I_{CM}	30	A
CONTINUOUS BASE CURRENT	I_B	7.5	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		220	W
At case temperatures above 25°C		See Figs. 1 and 2	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-65 to 200	$^\circ\text{C}$
PIN TEMPERATURE (During soldering):			
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.		230	$^\circ\text{C}$

BDY29

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
		VOLTAGE V dc			CURRENT A dc		BDY29		
		V _{CB}	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	
Collector Cutoff Current: With emitter open	I _{CBO}	100					–	1	mA
With base-emitter junction reverse-biased	I _{CEX}		100	–1.5			–	1	mA
With base-emitter junction reverse-biased & T _C = 150°C	I _{CEX}		100	–1.5			–	10	mA
With base open	I _{CEO}		60			0	–	2	mA
Emitter Cutoff Current	I _{EBO}			–7	0		–	2	mA
DC Forward Current Transfer Ratio	h _{FE}		2		15 ^a		15	60	
Collector-to-Emitter Sustaining Voltage: With base-emitter junction reverse-biased (R _{BE}) = 100 Ω	V _{CEX(sus)}			–1.5	0.2		90	–	V
With external base-to-emitter resistance (R _{BE}) = 100 Ω	V _{CER(sus)}				0.2		85	–	V
With base open	V _{CEO(sus)}				0.2	0	75	–	V
Base-to-Emitter Voltage	V _{BE}		4		30 ^a		–	3.5	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				15 ^a	1.5	–	1.2	V
Second-Breakdown Collector Current: With base forward-biased and 1- μ s, nonrepetitive pulse	I _{S/b} ^b		60				3.66	–	A
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 0.05 MHz	|h _{fe}|		4		1		4	16 (Typ.)	
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 1 kHz	h _{fe}		4		1		40	–	
Thermal Resistance: Junction-to-Case	R _{θJC}						–	0.8	°C/W

^aPulsed; pulse duration = 300 μ s, rep. rate = 60 Hz; duty factor \leq 2%.^bI_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

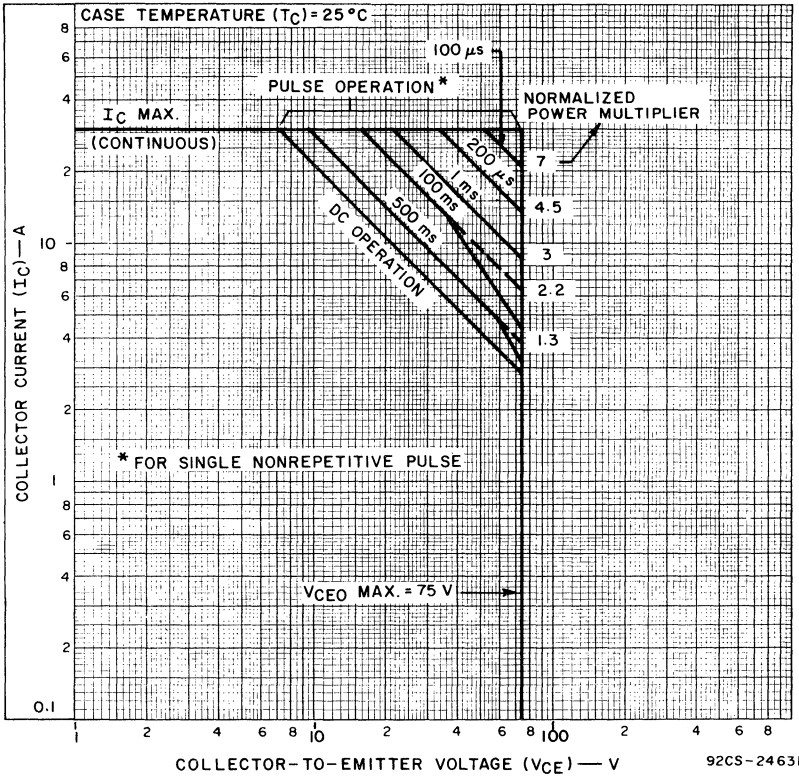


Fig. 1 — Maximum operating areas.

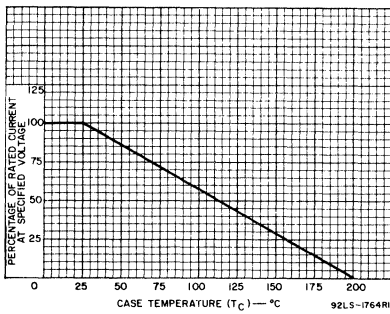


Fig. 2 — Dissipation derating curve.

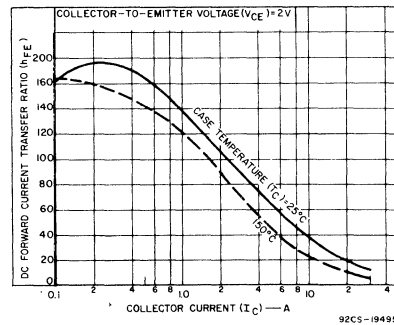


Fig. 3 — Typical dc beta characteristics.

BDY29

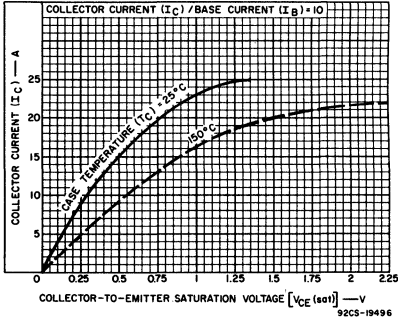


Fig. 4 — Typical saturation-voltage characteristics.

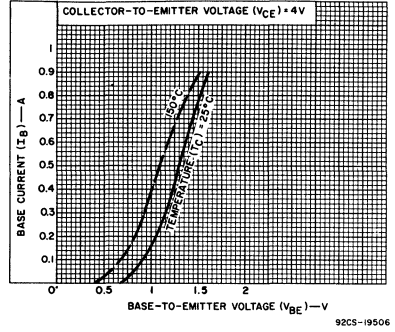


Fig. 5 — Typical input characteristics.

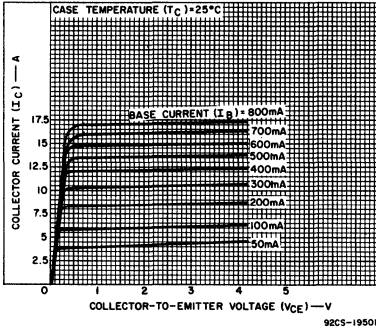


Fig. 6 — Typical output characteristics.

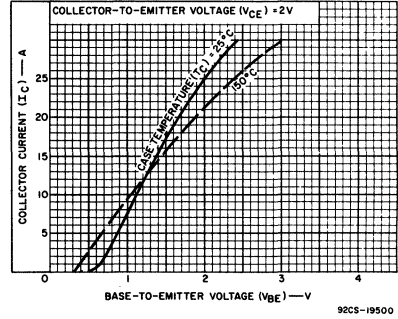


Fig. 7 — Typical transfer characteristics.

High-Current, High-Power, High-Speed Silicon N-P-N Planar Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

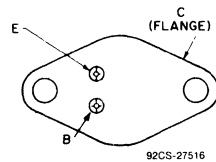
Features:

- Maximum operating area curves for dc and pulse operation
- Large-signal power amplification
- High-current fast switching

The RCA-BDY55 and BDY56 are epitaxial silicon n-p-n planar transistors. They differ in voltage ratings and leakage-current.

The high current-handling capability of these transistors in conjunction with fast switching speeds make them especially suited for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the steel JEDEC TO-204AA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDY55	BDY56	
V_{CBO}	100	150	V
V_{CEO}	60	120	V
V_{EBO}		7	V
I_C		15	A
I_B		7	A
P_T $T_C = 25^\circ C$		117	W
T_{stg}, T_J		-65 to +200	$^\circ C$
T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.		230	$^\circ C$

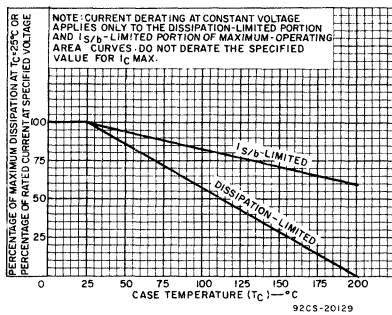


Fig. 1 - Dissipation derating curves for both types.

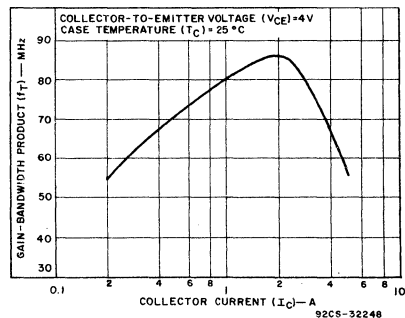


Fig. 2 - Typical gain-bandwidth product for both types.

BDY55, BDY56

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25 °C Unless Otherwise Specified.

CHARACTERISTIC	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDY55		BDY56		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	30 60				0 0	— —	0.7 —	— —	— 0.5	mA
I_{CEV}	100 150		-1.5 -1.5			— —	5 —	— —	— 3	
At $T_C = 150\text{ °C}$	100 150		-1.5 -1.5			— —	30 —	— —	— 30	
I_{EBO}		7		0		—	5	—	3	mA
h_{FE}	4 4			4 ^a 10 ^a		20 10	70 —	20 10	70 —	
f_T	4			1		10	—	10	—	MHz
$V_{CEP(sus)}^b$				0.2	0	60	—	120	—	V
V_{BE}	4			4		—	1.8	—	1.8	
$V_{CE(sat)}$				4 10	4 3.3	— —	1.1 2.5	— —	1.1 2.5	
t_{ON} $V_{CC} = 50\text{ V}$				5	1.0	—	0.5	—	0.5	μS
t_{OFF} $V_{CC} = 50\text{ V}$				5	$I_{B1} = 1\text{ A}$ $I_{B2} = -0.5\text{ A}$	—	2	—	2	
$R_{\theta JC}$	10			10		—	1.5	—	1.5	°C/W

^a Pulsed; pulse duration $\leq 350\ \mu\text{s}$, duty factor = 2%.

^b **CAUTION:** The sustaining voltages $V_{CEO(sus)}$, *MUST NOT* be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit.

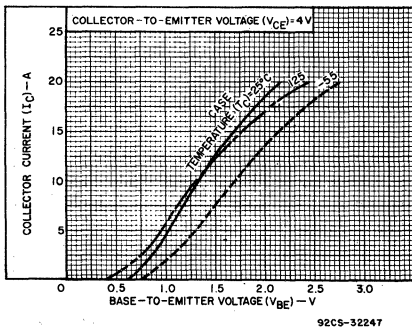


Fig. 3 - Typical transfer characteristics for both types.

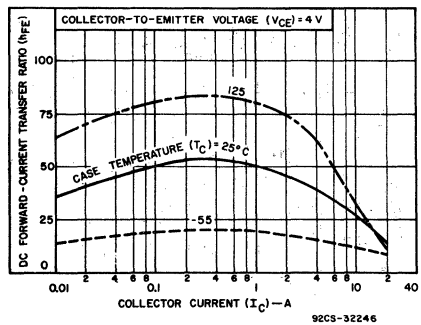


Fig. 4 - Typical dc beta characteristics for both types.

BDY55, BDY56

2

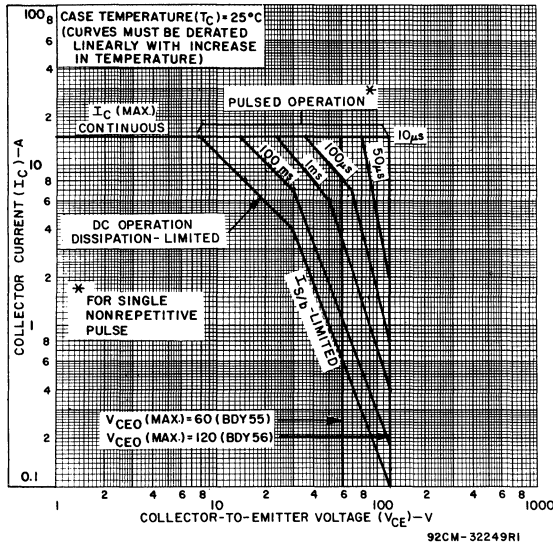


Fig. 5 - Maximum operating areas for both types.

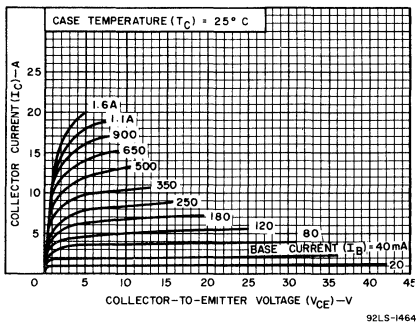


Fig. 6 - Typical output characteristics for both types.

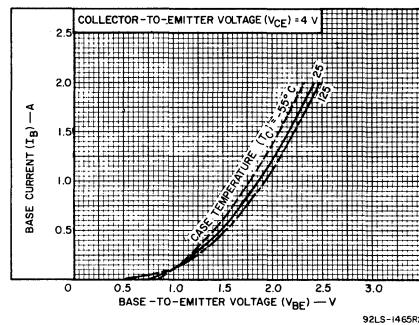


Fig. 7 - Typical input characteristics for both types.

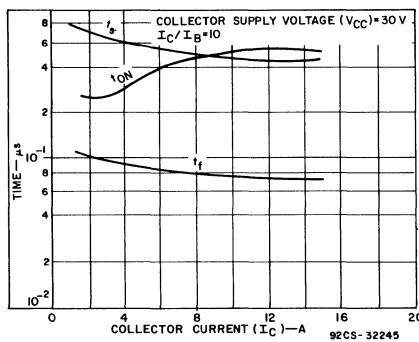


Fig. 8 - Switching-time characteristics as a function of collector current for both types.

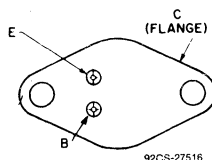
Silicon N-P-N Switching Transistors

For Switching Applications in
Industrial and Commercial Equipment

Features:

- $V_{CEO} - 160V$
- $I_C - 25 A$
- $P_T - 175 W$

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BDY58R is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating (SOA) ratings. It is specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power switching circuits.

The RCA-BDY58R transistor is supplied in a steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

BDY58R

V_{CBO}	250 V
V_{CEO}	160 V
V_{CEX} $V_{BE} = -1.5 V$	250 V
V_{EBO}	8 V
I_C	25 A
I_{CM}	50 A
I_B	8 A
P_T At T_C up to 25°	175 W
T_J, T_{stg}	-65 to +200°C
T_L At distances $\geq 1/16$ in. (1.58 mm) from case for 10 s max.	235°C

BDY58R

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE		CURRENT		BDY58R			
	V dc		A dc		Min.	Typ.	Max.	
	V_{CE}	V_{BE}	I_C	I_B				
I_{CBO}	V_{CB} = 200	—	—	0	—	0.1	1	mA
I_{CER} $R_{BE} = 10 \Omega$, $T_C = 100^\circ C$	180	—	—	—	—	—	10	
I_{EBO}	—	-5	0	—	—	0.1	0.5	V
$V_{CEO(sus)}^b$	—	—	0.2 ^a	—	160 ^a	—	—	
$V_{(BR)EBO}$ $I_E = 0.05 A$	—	—	0	—	8	—	—	
$V_{BE(sat)}$	—	—	10 ^a	1	—	0.9	2	
$V_{CE(sat)}$	—	—	10 ^a	1	—	0.2	1.4	
h_{FE}	4	—	10 ^a	—	20	—	60	
$T_C = -30^\circ C$	4	—	20 ^a	—	—	20	—	
$T_C = -30^\circ C$	4	—	10 ^a	—	10	—	—	
f_T	15	—	1	—	10	48	—	MHz
t_{on}	V_{CC}	—	15	1.5	—	0.3	1	μs
t_{off} ($I_{B1} = I_{B2}$)	= 75 V	—	15	1.5	—	1.2	2	
$R_{\theta JC}$	—	—	—	—	—	—	1	$^\circ C/W$

^aPulsed, pulse duration = 300 μs , duty factor $\leq 2\%$.

^bCAUTION: Sustaining Voltage $V_{CEO(sus)}$ *MUST NOT* be measured on a curve tracer.

2

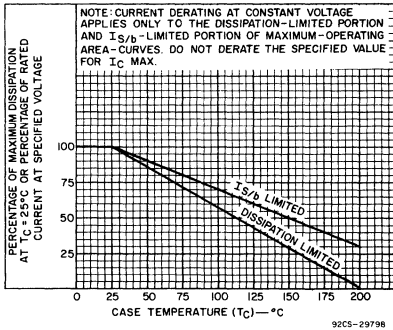


Fig. 1 — Dissipation and I_{S/I_B} derating curve.

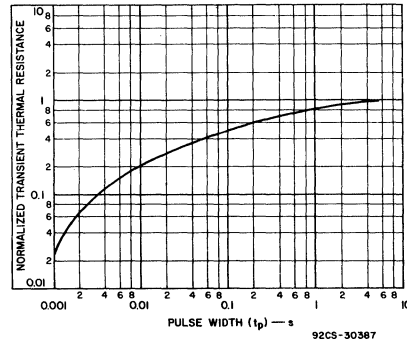


Fig. 2 — Typical thermal-response characteristic.

BDY58R

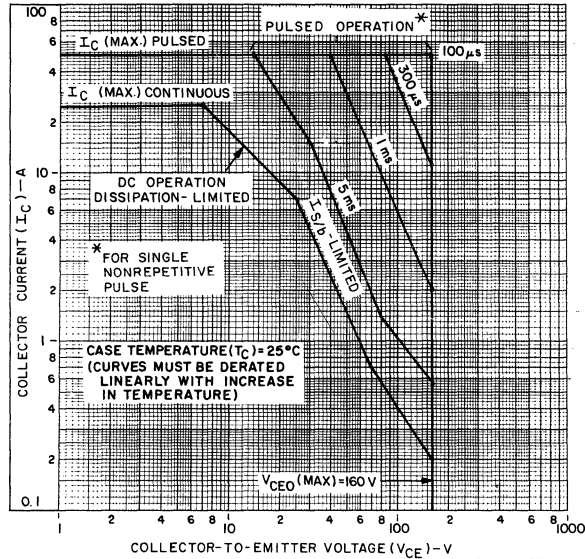


Fig. 3 — Maximum safe-operating areas ($T_C = 25^\circ\text{C}$).

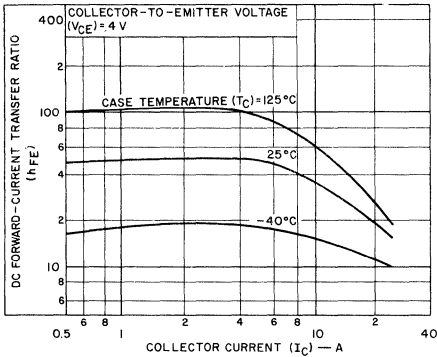


Fig. 4 — Typical dc beta characteristics.

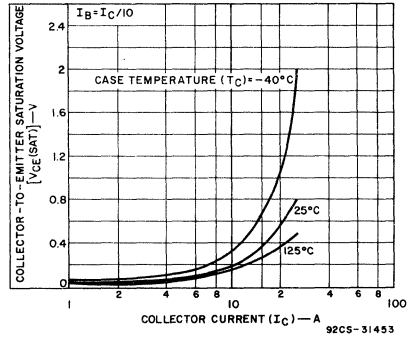


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

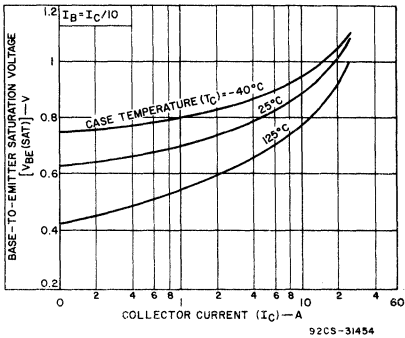


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

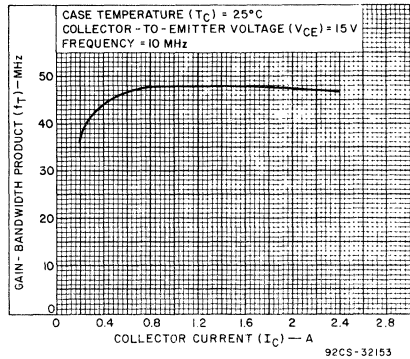


Fig. 7 — Typical gain-bandwidth product.

BDY58R

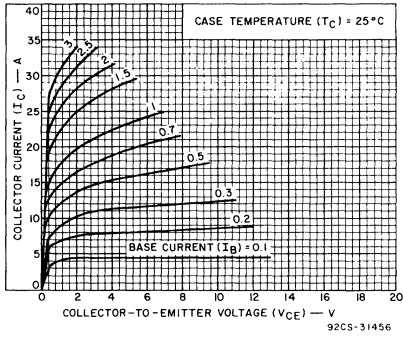


Fig. 8 — Typical output characteristics.

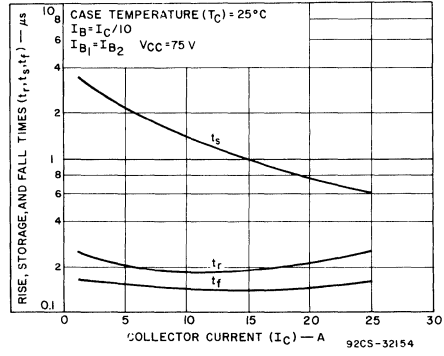


Fig. 9 — Typical saturated-switching-time characteristics as a function of collector current.

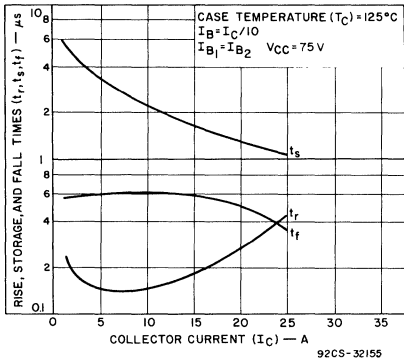


Fig. 10 — Typical switching-time characteristics at $T_c = 125^\circ\text{C}$ as a function of collector current.

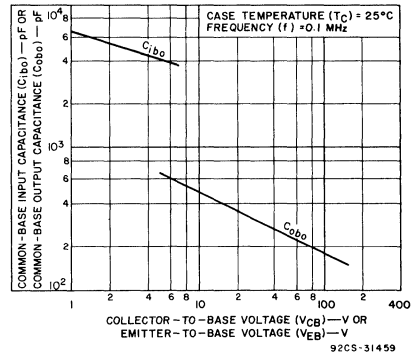


Fig. 11 — Typical common-base input (C_{ibo}) of output (C_{obo}) capacitance characteristics.

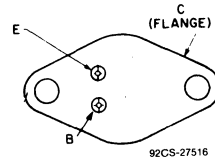
High-Speed Silicon N-P-N Planar Transistors

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

Features:

- Maximum operating area curves for dc and pulse operation

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BDY90, BDY91, and BDY92 are epitaxial silicon n-p-n planar transistors. They differ in breakdown-voltage ratings, leakage-current, and dc-beta values.

The high current-handling capability of these transistors in conjunction with fast switching speeds make them especially suited for switching-control amplifiers, power gates, switching regulators, converters, and inverters. Other recommended applications include dc-rf amplifiers and power oscillators. These transistors are supplied in the steel JEDEC TO-204AA hermetic plackage.

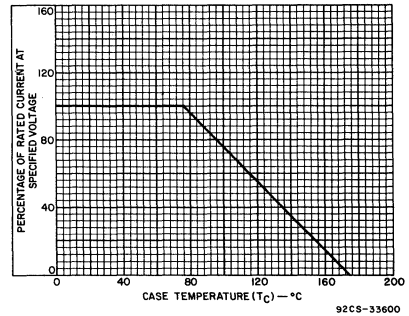


Fig. 1 - Dissipation derating curves for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BDY90	BDY91	BDY92	
V _{CBO}	120	100	80	V
V _{CEx} (SUS)				
V _{BE} = -1.5 V	120	100	80	V
V _{CE0} (SUS)	100	80	60	V
V _{EBO}		6		V
I _C		10		A
I _{CM}		15		A
I _B		2		A
P _T				
T _C ≤ 75° C		40		W
T _C ≤ 25° C, V _{CE} > 28 V	See Fig. 1			
T _C > 25° C, V _{CE} > 28 V	See Figs. 1 & 4			
T _J , T _{stg}		-65 to 175		°C
T _L				
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		175		°C

BDY90, BDY91, BDY92

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C

Unless Otherwise Specified

Characteristic	Test Conditions				Limits					Units	
	Voltage V dc		Current A dc		BDY90		BDY91		BDY92		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.		Max.
I _{CEX} T _C = 150°C	120 100 80	-1.5 -1.5 -1.5			— — —	3 — —	— — —	— 3 —	— — 3	— — —	mA
h _{FE}	2 5 5		1 ^a 5 ^a 10 ^a		35 30 20	— 120 —	35 30 20	— 120 —	35 30 20	— 120 —	
|h _{fe}| f = 5 MHz	5		0.5		14 Typ.	—	14 Typ.	—	14 Typ.	—	
V _{CEO(sus)} ^b			0.2	0	100	—	80	—	60	—	V
V _{CEX(sus)} ^b		-1.5	0.2	0	120	—	100	—	80	—	
V _{EBO} I _E = 0.05 A			0		6	—	6	—	6	—	
V _{CE(sat)}			5 ^a 10 ^a	0.5 1	— —	0.5 1.5	— —	0.5 1.5	— —	0.5 1.0	V
V _{BE(sat)}			5 ^a 10 ^a	0.5 1	— —	1.2 1.5	— —	1.2 1.5	— —	1.2 1.5	V
t _{ON} V _{CC} = 30 V			5	0.5 ^c	—	0.35	—	0.35	—	0.35	μs
t _s V _{CC} = 30 V			5	0.5 ^c	—	1.3	—	1.3	—	1.3	
t _f V _{CC} = 30 V			5	0.5 ^c	—	0.2	—	0.2	—	0.2	
R _{θJC}	10		10		—	2.5	—	2.5	—	2.5	°C/W

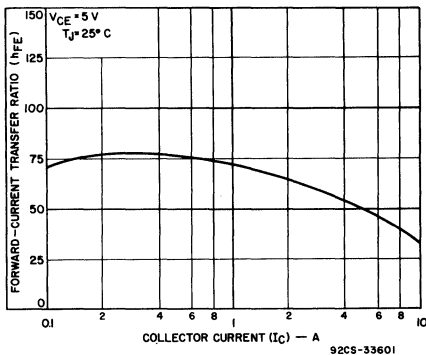
a Pulsed: pulse duration = 300 μs, duty factor ≤ 2%. c |I_{B1} = -I_{B2}b CAUTION: The sustaining voltage V_{CEO(sus)} and V_{VEX} MUST NOT be measured on a curve tracer.

Fig.2 - Typical dc beta characteristics for all types.

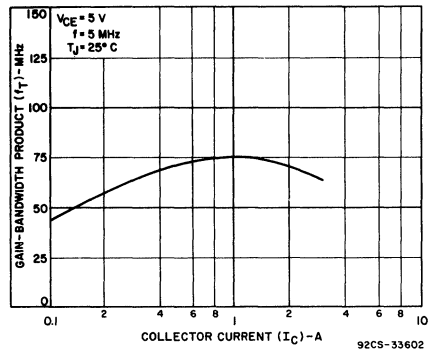


Fig.3 - Typical gain-bandwidth product for all types.

BDY90, BDY91, BDY92

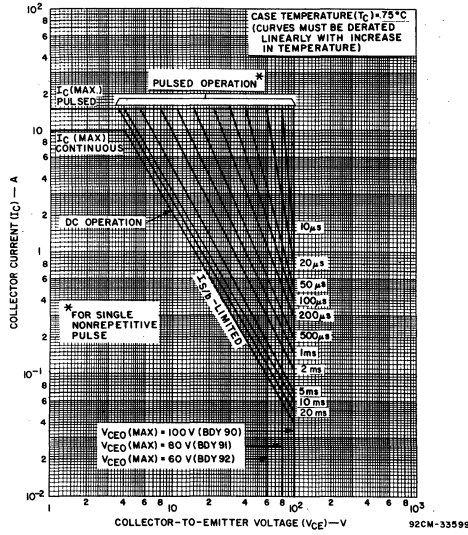


Fig. 4 - Maximum operating areas for all types.

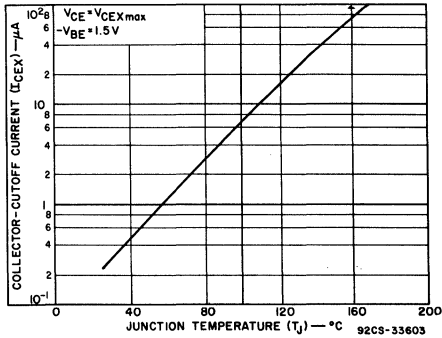


Fig. 5 - Typical collector leakage current vs. junction temperature for all types.

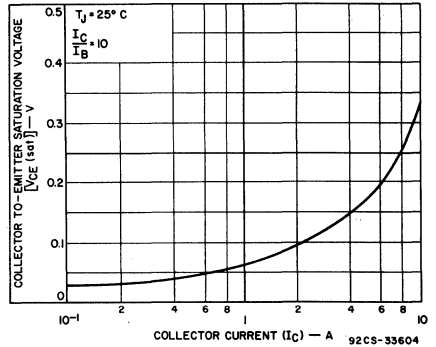


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics as a function of collector current for all types.

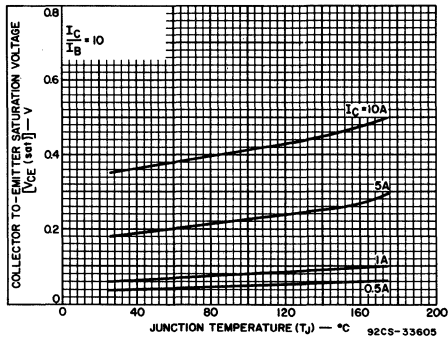


Fig. 7 - Typical collector-to-emitter saturation voltage characteristics as a function of junction temperature for all types.

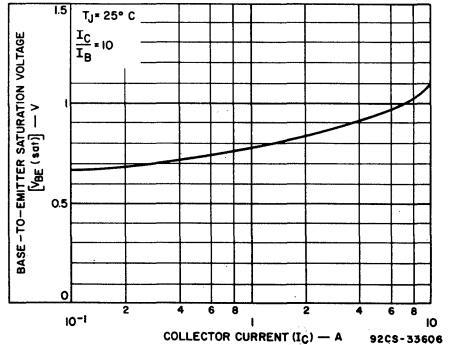


Fig. 8 - Typical base-to-emitter saturation voltage characteristics as a function of collector current for all types.

BDY90, BDY91, BDY92

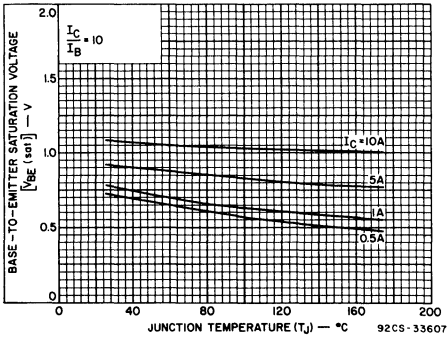


Fig.9 - Typical base-to-emitter saturation voltage characteristics as a function of junction temperature.

BFT19, BFT19A, BFT19B

**Silicon P-N-P
High-Voltage Planar Transistors**

For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

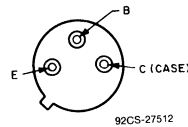
Features:

- Maximum safe-area-of-operation curves
- High voltage ratings:
 $V_{CBO} = -400$ V max. (BFT19B); -300 V max. (BFT19A);
 -200 V max. (BFT19)
 $V_{CEO(sus)} = -350$ V max. (BFT19B); -250 V max. (BFT19A);
 -150 V max. (BFT19)

RCA-BFT19, BFT19A, and BFT19B are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. These transistors differ in their voltage ratings.

Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters, and high-voltage, low-current switching and series regulators.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, Absolute-Maximum Values:

		BFT19	BFT19A	BFT19B	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	-200	-300	-400	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open	$V_{CEO(sus)}$	-150	-250	-350	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER(sus)}$	-200	-300	-400	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	-5	-5	-5	V
COLLECTOR CURRENT (Continuous)	I_C	-1	-1	-1	A
BASE CURRENT (Continuous)	I_B	-0.5	-0.5	-0.5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		5	5	5	W
At case temperatures above 25°C		See Figs. 1 & 4.			
At ambient temperatures up to 25°C		1	1	1	W
At ambient temperatures above 25°C		Derate linearly at 5.7 mW/°C			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← -65 to 200 →			°C
PIN TEMPERATURE (During Soldering):					
At distance \geq 1/32 in. (0.8 mm) from case for 10 s max.		← 255 →			°C

BFT19, BFT19A, BFT19B

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS						UNITS		
		VOLTAGE V dc			CURRENT mA			BFT19		BFT19A		BFT19B				
		V _{CB}	V _{CE}	V _{EB}	I _C	I _E	I _B	Min.	Max.	Min.	Max.	Min.	Max.			
Collector-Cutoff Current: With emitter open	I _{CBO}	-100 -200 -300					0 0 0	-	-100	-	-	-100	-	-	-	μA
Emitter-Cutoff Current	I _{EBO}			-5	0				-100		-100			-100		μA
DC Forward-Current Transfer Ratio	h _{FE}		-10 -10 -10		-10 -30 -50			20 25 20	-	20 25 20	-	20 25 20	-	20 25 20	-	
Collector-to-Emitter Sustaining Voltage (See Figs. 2 and 3): With base open	V _{CE(sus)}				-10		0	-150 ^a	-	-250 ^a	-	-350 ^a	-	-	-	V
With external base-to-emitter resistance (R _{BE}) = 100 Ω	V _{CER(sus)}				-10			-200 ^a	-	-300 ^a	-	-400 ^a	-	-	-	V
Base-to-Emitter Saturation Voltage	V _{BE(sat)}				-30		-3	-	-1.8	-	-1.8	-	-1.8	-	-1.8	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				-10 -30		-1 -3	-	-1 -2.5	-	-1 -2.5	-	-1 -2.5	-	-1 -2.5	V
Common-Emitter, Small-Signal, Short- Circuit, Forward-Current Transfer Ratio (at 1 kHz)	h _{fe}		-10		-5			25	-	25	-	25	-	25	-	
Magnitude of Common-Emitter, Small- Signal, Short-Circuit Forward- Current Transfer Ratio (at 5 MHz)	|h _{fe}|		-10		-30			5	-	5	-	5	-	5	-	
Common-Base, Short-Circuit, Input Capacitance (at 1 MHz)	C _{ib}			-5	0			-	75	-	75	-	75	-	75	pF
Output Capacitance (at 1 MHz)	C _{ob}	-10					0	-	15	-	15	-	15	-	15	pF
Second-Breakdown ^b Collector Current: With base forward biased ^c	I _{S/B} ^d	-100						-50	-	-50	-	-50	-	-50	-	mA
Thermal Resistance: (Junction-to-Case)	R _{θJC}							-	35	-	35	-	35	-	35	°C/W

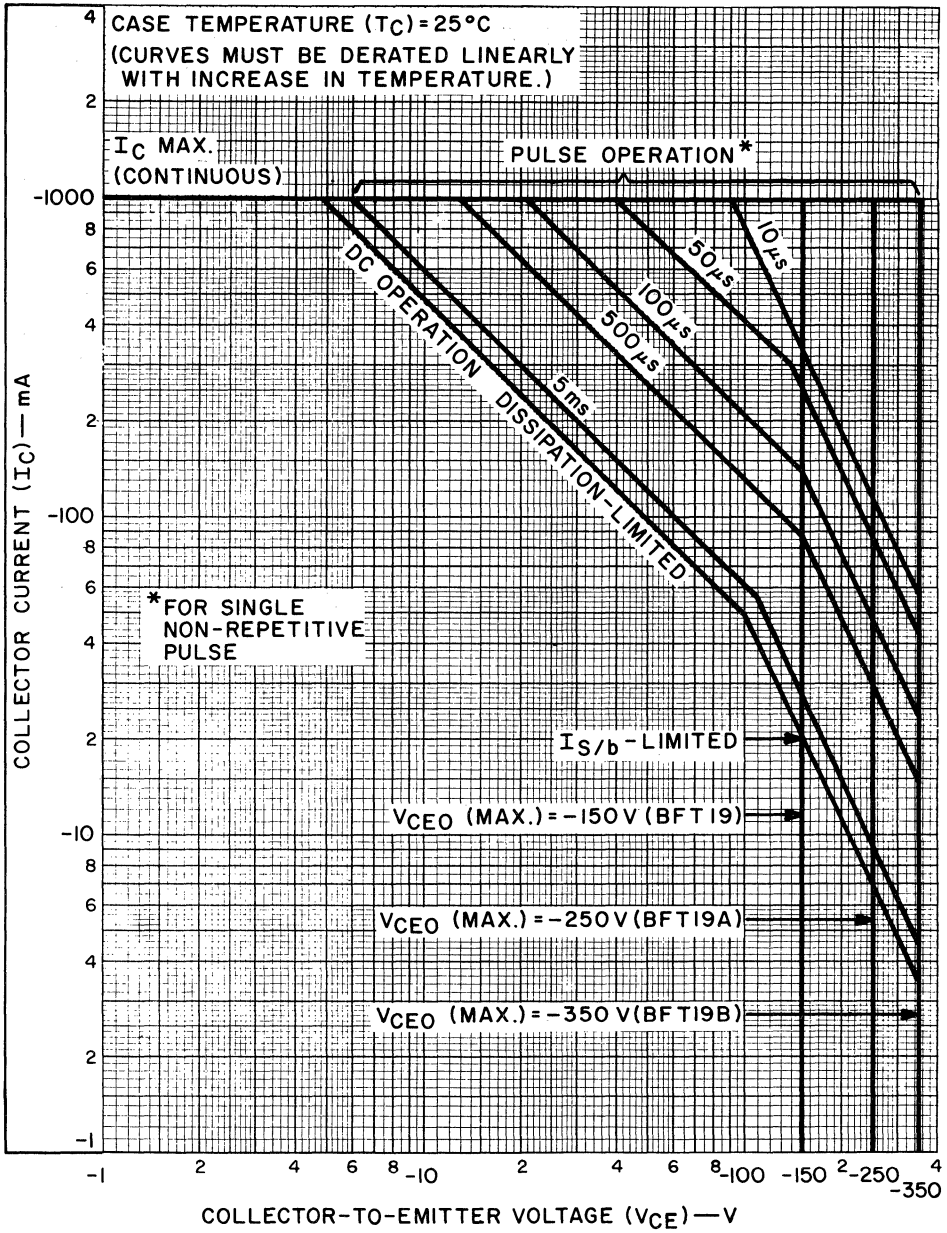
^a CAUTION: The sustaining voltages V_{CE(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 2.

^b Regions for safe-operation with forward bias are shown in Fig. 1.

^c Specified value of I_{S/B} for given value of V_{CE} as base voltage is increased from zero in a positive direction.

^d I_{S/B} is defined as the current at which second breakdown occurs at a specified collector voltage.

BFT19, BFT19A, BFT19B



92CS-22544

BFT19, BFT19A, BFT19B

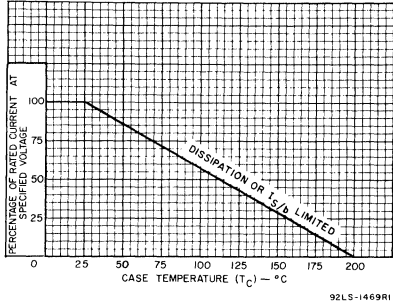


Fig. 2 — Dissipation derating curve.

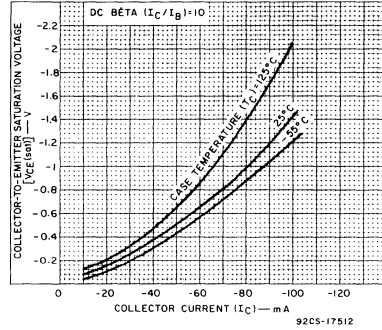


Fig. 3 — Typical collector-to-emitter saturation voltage.

2

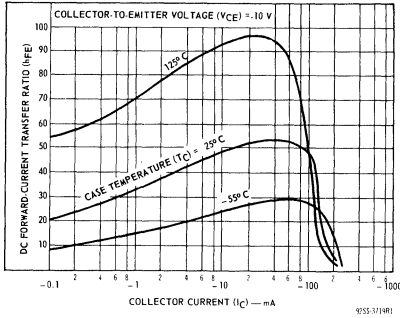


Fig. 4 — Typical dc-beta characteristics.

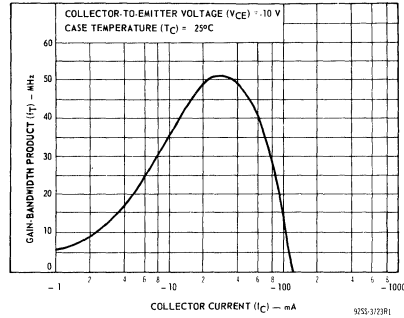


Fig. 5 — Typical gain-bandwidth product.

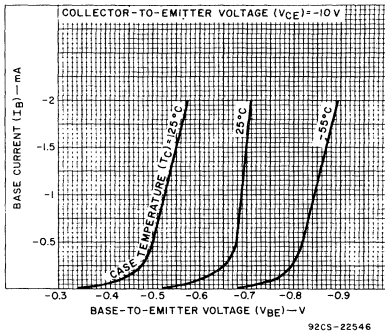


Fig. 6 — Typical input characteristics.

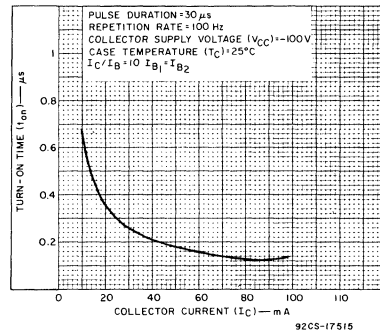


Fig. 7 — Typical turn-on time characteristic.

BFT19, BFT19A, BFT19B

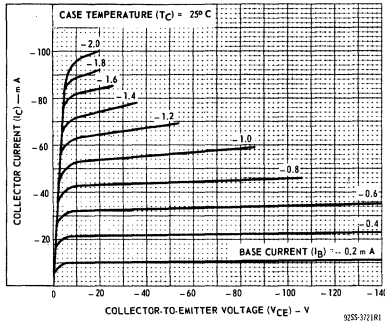


Fig. 8 — Typical output characteristics.

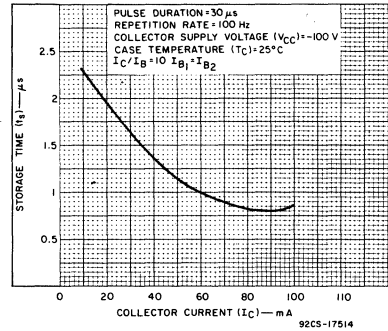


Fig. 9 — Typical storage-time characteristic.

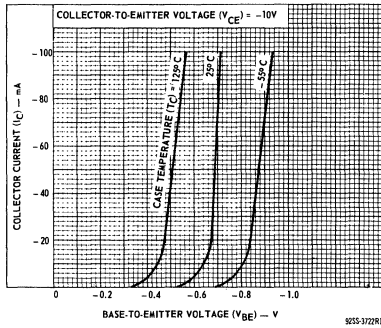


Fig. 10 — Typical transfer characteristics.

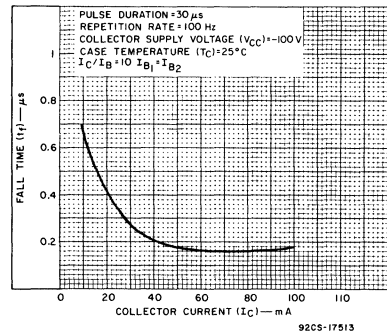


Fig. 11 — Typical fall-time characteristic.

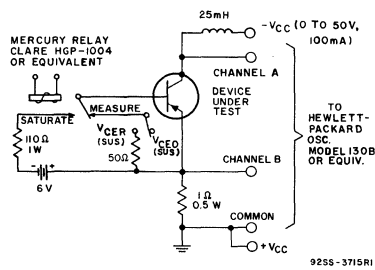
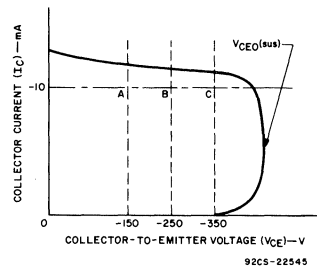


Fig. 12 — Circuit used to measure sustaining voltages, $V_{CE0}(\text{sus})$ and $V_{CER}(\text{sus})$.



The sustaining voltage $V_{CE0}(\text{sus})$ is acceptable when the trace falls to the right and above point "A" for type BFT19. The trace must fall to the right and above point "B" for type BFT19A, and point "C" for BFT19B.

Fig. 13 — Oscilloscope display for measurement of sustaining voltages.

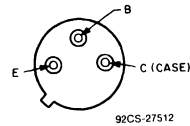
Silicon P-N-P High-Voltage Transistors

For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

Features:

- Maximum safe-area-of-operation curves
- High voltage ratings:
 - $V_{CBO} = -150$ V max. (BFT 28); -200 V max. (BFT28A); -250 V max. (BFT 28 B); -300 V max. (BFT28C)
 - $V_{CEO(sus)} = -100$ V max. (BFT 28); -150 V max. (BFT28A); -200 V max. (BFT28B); -250 V max. (BFT28C)

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The RCA-BFT28, BFT28A, BFT28B and BFT28C are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds.

These transistors differ primarily in their voltage ratings. Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters; and high-voltage, low-current switching and series regulators.

All types are supplied in the JEDEC TO-205AD package.

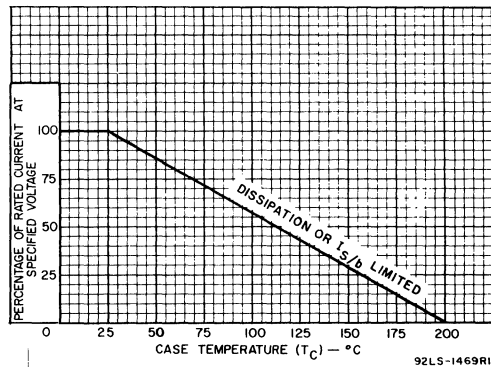


Fig. 1 — Dissipation derating curve.

MAXIMUM RATINGS, Absolute-Maximum Values:

- COLLECTOR-TO-BASE VOLTAGE V_{CBO}
- COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:
 - With external base-to-emitter resistance (R_{BE}) = 100Ω $V_{CER(sus)}$
 - With base open $V_{CEO(sus)}$
- EMITTER-TO-BASE VOLTAGE V_{EBO}
- COLLECTOR CURRENT I_C
- BASE CURRENT I_B
- TRANSISTOR DISSIPATION:
 - At case temperatures up to 25°C
 - At case temperatures above 25°C
 - At ambient temperatures up to 50°C
 - At ambient temperatures above 50°C Derate linearly at
- TEMPERATURE RANGE:
 - Storage and Operating (Junction)
- LEAD TEMPERATURE (During soldering):
 - At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.

	BFT28	BFT28A	BFT28B	BFT28C	
V_{CBO}	-150	-200	-250	-300	V
$V_{CER(sus)}$	-150	-200	-250	-300	V
$V_{CEO(sus)}$	-100	-150	-200	-250	V
V_{EBO}	-4	-4	-4	-4	V
I_C	-1	-1	-1	-1	A
I_B	-0.5	-0.5	-0.5	-0.5	A
Power Dissipation	5	5	5	5	W
	See Figs. 1 and 2				
	1	1	1	1	W
	5.7	5.7	5.7	5.7	mW/ $^\circ\text{C}$
Temperature Range	-65 to +200				$^\circ\text{C}$
Lead Temperature	255				$^\circ\text{C}$

BFT28, BFT28A, BFT28B, BFT28CELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		BFT28		BFT28A		
		V _{CB}	V _{CE}	V _{EB}	I _C	I _B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I _{CBO}	-50 -75					-	-1	-	-	μA
Emitter-Cutoff Current	I _{EBO}			-4	0		-	-100	-	-100	μA
DC Forward-Current Transfer Ratio	h _{FE}		-10		-10 ^c		20	-	20	-	
Collector-to-Emitter Sustaining Voltage: With base open (See Figs. 12 and 13)	V _{CEO(sus)}				-10	0	-100 ^a	-	-150 ^a	-	V
With external base-to-emitter resistance (R _{BE}) = 100 Ω	V _{CER(sus)}				-10		-150 ^a	-	-200 ^a	-	V
Base-to-Emitter Saturation Voltage	V _{BE(sat)}				-30 ^c	-3	-	-1.5	-	-1.5	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				-10 ^c	-1	-	-0.6	-	-0.6	V
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h _{fe}		-10		-5		25	-	25	-	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 5 MHz	|h _{fe}|		-10		-30		5	-	5	-	
Common-Base, Short-Circuit, Input Capacitance: f = 1 MHz	C _{ib}			-5	0		-	75	-	75	pF
Output Capacitance: f = 1 MHz	C _{ob}	-10					-	15	-	15	pF
Forward-Bias, Second-Breakdown Collector Current: 1-s non-repetitive pulse	I _{S/b} ^b		-80				-62.5	-	-62.5	-	mA
Thermal Resistance: Junction-to-Case	R _{θJC}						-	35	-	35	°C/W

^aCAUTION: The sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 12.

^bI_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage.

^cPulsed, pulse duration = 300 μs; duty factor ≤ 2%.

BFT28, BFT28A, BFT28B, BFT28C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT mA dc		BFT28B		BFT28C		
		V _{CB}	V _{CE}	V _{EB}	I _C	I _B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I _{CBO}	-150					-	-5	-	-5	μA
Emitter-Cutoff Current	I _{EBO}			-4	0		-	-100	-	-100	μA
DC Forward-Current Transfer Ratio	h _{FE}		-10		-10 ^c		20	-	20	-	
Collector-to-Emitter Sustaining Voltage: With base open (See Figs. 12 and 13)	V _{CEO(sus)}				-10	0	-200 ^a	-	-250 ^a	-	V
With external base-to-emitter resistance (R _{BE}) = 100Ω	V _{CER(sus)}				-10		-250 ^a	-	-300 ^a	-	V
Base-to-Emitter Saturation Voltage	V _{BE(sat)}				-30 ^c	-3	-	-1.5	-	-1.5	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				-10 ^c	-1	-	-5	-	-5	V
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio: f = 1 kHz	h _{fe}		-10		-5		25	-	25	-	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio: f = 5 MHz	|h _{fe}|		-10		-30		5	-	5	-	
Common-Base, Short-Circuit, Input Capacitance: f = 1 MHz	C _{ib}			-5	0		-	75	-	75	pF
Output Capacitance: f = 1 MHz	C _{ob}	-10					-	15	-	15	pF
Forward-Bias, Second-Breakdown Collector Current: 1- μ s non-repetitive pulse	I _{S/b} ^b		-80				-62.5	-	-62.5	-	mA
Thermal Resistance: Junction-to-Case	R _{θJC}						-	35	-	35	°C/W

^aCAUTION: The sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 12.

^bI_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage.

^cPulsed, pulse duration = 300 μs; duty factor ≤ 2%.

BFT28, BFT28A, BFT28B, BFT28C

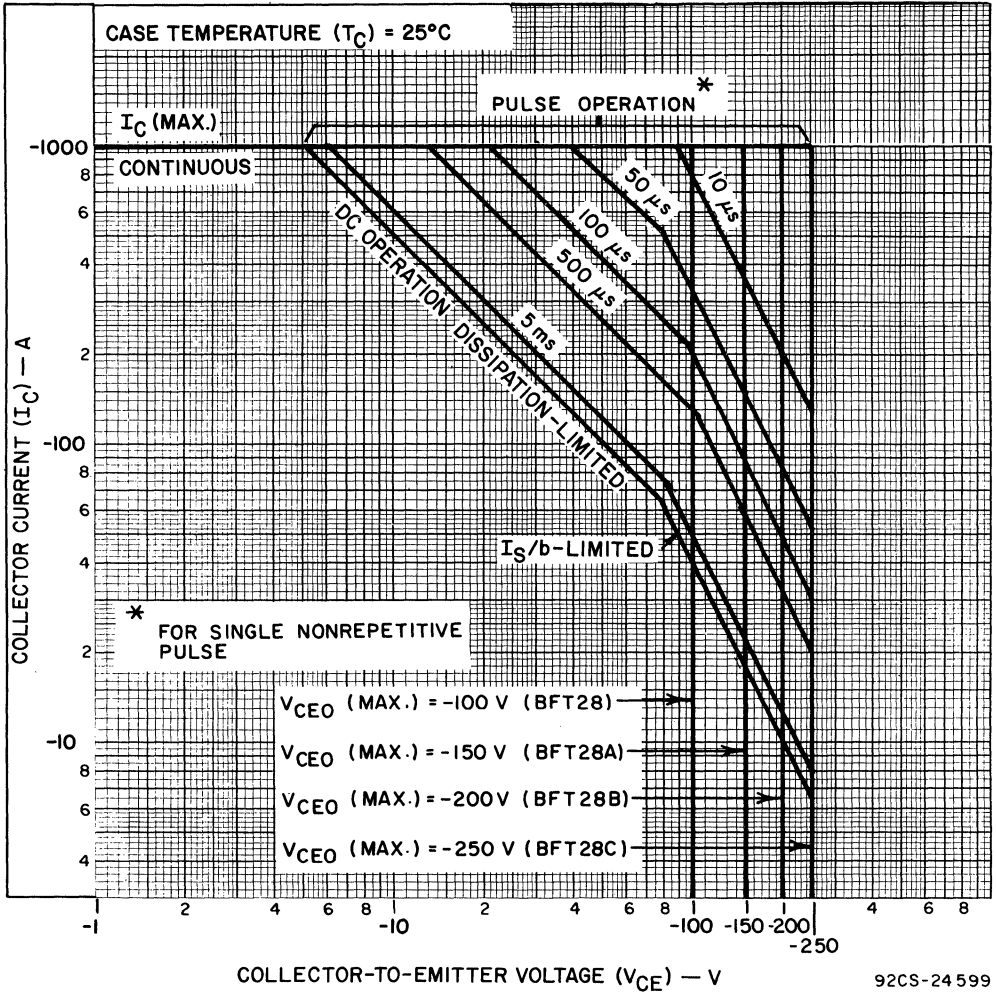


Fig. 2 - Maximum safe operating areas.

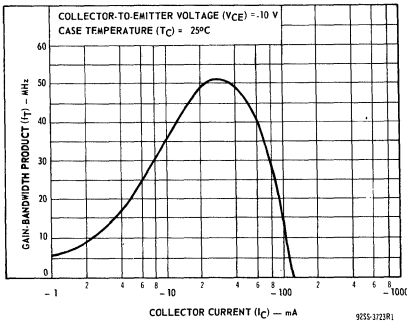


Fig. 3 - Typical gain-bandwidth product for all types.

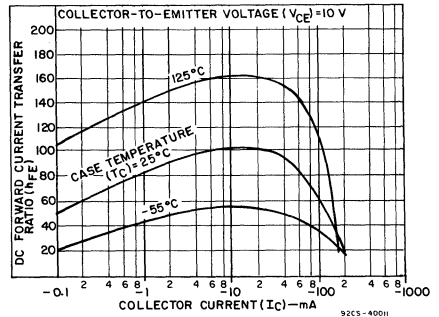


Fig. 4 - Typical dc beta characteristics for all types.

BFT28, BFT28A, BFT28B, BFT28C

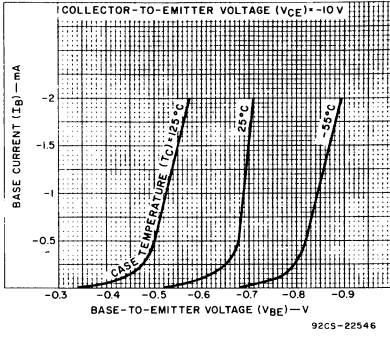


Fig. 5 - Typical input characteristics for all types.

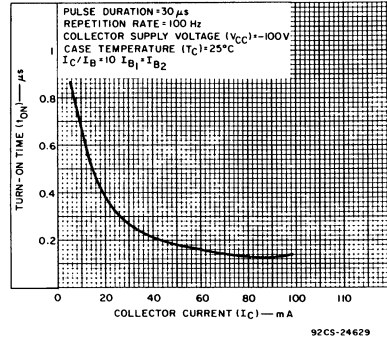


Fig. 6 - Typical turn-on time characteristic for all types.

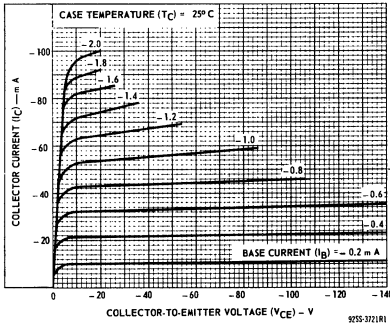


Fig. 7 - Typical output characteristics for all types.

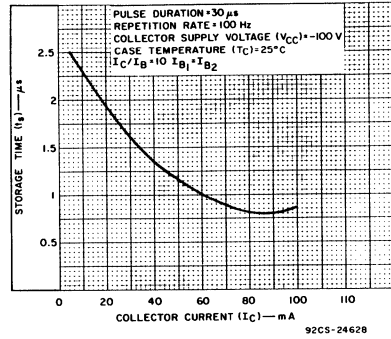


Fig. 8 - Typical storage-time characteristic for all types.

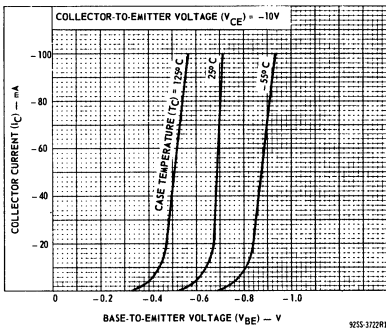


Fig. 9 - Typical transfer characteristics for all types.

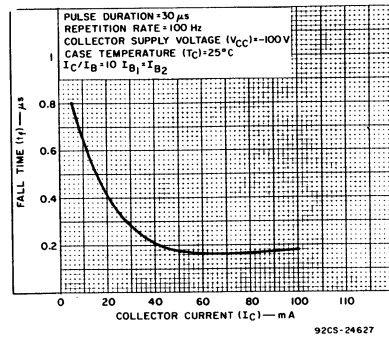


Fig. 10 - Typical fall-time characteristic for all types.

BFT28, BFT28A, BFT28B, BFT28C

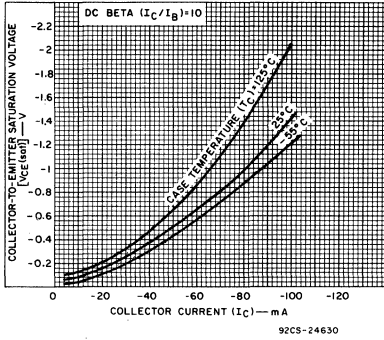


Fig. 11 - Typical collector-to-emitter saturation voltage for all types.

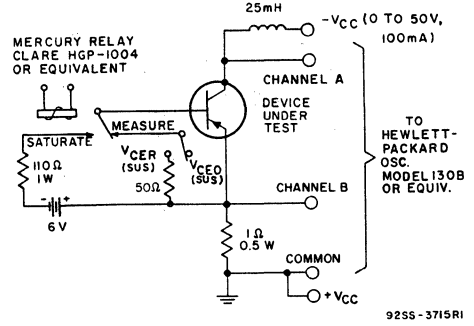
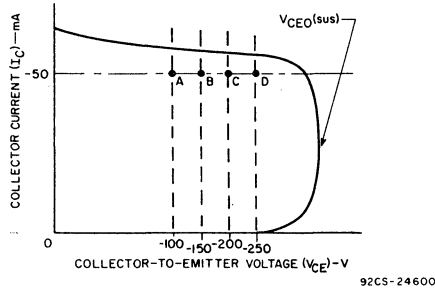


Fig. 12 - Circuit used to measure sustaining voltages, $V_{CEO(sus)}$ and $V_{CER(sus)}$.



The sustaining voltage $V_{CEO(sus)}$ is acceptable when the trace falls to the right and above point "A" for type BFT28. The trace must fall to the right and above point "B" for BFT28A; point "C" for BFT28B; and point "D" for BFT28C.

Fig. 13 - Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 12).

1-A *SwitchMax* VERSAWATT Transistors

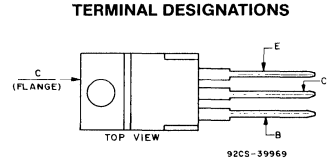
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- High-temperature parameters guaranteed
- Fast Switching Speed
- High Voltage Ratings:
 $V_{CEX} = 350\text{ V to }450\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 1\text{ A}$

Applications:

- Off-Line Power Supplies
- High-Voltage Inverters
- Switching Regulators



JEDEC TO-220AB

2

The RCA-BUW40, BUW40A, and BUW40B SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-percent tested for parameters that are essential to the

design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The RCA-BUW40, BUW40A, and BUW40B series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUW40	BUW40A	BUW40B	
$V_{CER}, R_{BE} = 100\ \Omega$	350	400	450	V
V_{CEV}	450	550	650	V
$V_{BE} = -1.5\text{ V}$	350	400	450	V
$V_{CEX}(\text{Clamped})$	300	350	400	V
$V_{BE} = -1.5\text{ V}$	8			V
V_{CEO}	1			A
V_{EBO}	1			A
$I_C(\text{sat})$	2			A
I_C	0.6			A
I_{CM}		40		W
I_B		0.32		W/°C
P_T		-65 to 150		°C
T_C up to 25°C				
T_C above 25°C, derate linearly				
T_{stg}, T_J				
T_L		235		°C
At distance $\geq 1/8"$ in. (3.17 mm) from seating plane for 10 s max.				

BUW40, BUW40A, BUW40B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS					UNITS
	VOLTAGE		CURRENT		BUW40		BUW40A	BUW40B		
	V _{dc}		A _{dc}		Min.	Max.	Min.	Max.	Min.		Max.

T_C = 25° C

I _{CEV}	450	-1.5			—	0.1	—	—	—	—	mA
	550	-1.5			—	—	—	0.1	—	—	
	650	-1.5			—	—	—	—	—	0.1	
I _{EBO}		-8	0		—	2	—	2	—	2	
V _{CEO(sus)} ^b			0.2 ^a	0	300	—	350	—	400	—	V
V _{CE(sat)}			1 ^a	0.2	—	1.0	—	1.0	—	1.0	
V _{BE(sat)}			1 ^a	0.2	—	1.2	—	1.2	—	1.2	
h _{FE}	3		0.3 ^a		20	100	20	100	20	100	
	3		1 ^a		10	50	10	50	10	50	
V _{CEX} ^b (Clamped E _S /b) L=450 μH, R _{BB} =50 Ω		-5	1	0.1 ^e	350	—	400	—	450	—	V
I _S /b	100		0.4		0.5	—	0.5	—	0.5	—	s
|h _{fe}| f=1 MHz	10		0.2		10	50	10	50	10	50	
f _T	10		0.2		10	50	10	50	10	50	MHz
C _{obo} f=0.1 MHz	10 ^c				20	60	20	60	20	60	pF
t _d ^d			1	0.2	—	0.05	—	0.05	—	0.05	μs
t _r ^d			1	0.2	—	0.4	—	0.4	—	0.4	
t _s ^d			1	0.2 ^e	—	2.5	—	2.5	—	2.5	
t _f ^d			1	0.2 ^e	—	0.6	—	0.6	—	0.6	
t _c V _{CC} =200 V, L=450 μH, R _C =200 Ω Collector clamped to V _{CEX}			1	0.2 ^e	—	0.6	—	0.6	—	0.6	

T_C = 125° C

I _{CEV}	450	-1.5			—	1	—	—	—	—	mA
	550	-1.5			—	—	—	1	—	—	
	650	-1.5			—	—	—	—	—	1	
V _{CE(sat)}			1 ^a	0.2	—	2	—	2	—	2	V
t _r ^d			1	0.2	—	0.8	—	0.8	—	0.8	μs
t _s ^d			1	0.2 ^e	—	4.5	—	4.5	—	4.5	
t _f ^d			1	0.2 ^e	—	1.5	—	1.5	—	1.5	
t _c V _{CC} =200 V, L=450 μH, R _C =200 Ω Collector clamped to V _{CEX}			1	0.2 ^e	—	1.5	—	1.5	—	1.5	

R _{θJC}	20		1		—	3.12	—	3.12	—	3.12	°C/W
R _{θJA}					—	70	—	70	—	70	°C/W

^aPulsed: pulse duration = 300 μs, duty factor ≤ 2%.

^bCAUTION: The sustaining voltage V_{CEO(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.

^cV_{CB} value.

^dV_{CC} = 200 V, t_p = 20 μs.

^eI_{B1} = -I_{B2}.

BUW40, BUW40A, BUW40B

2

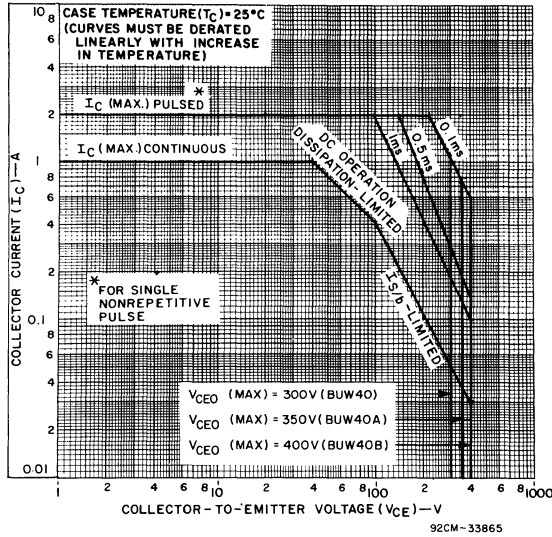


Fig. 1 — Maximum operating areas for all types.

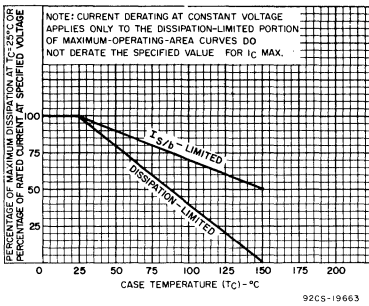


Fig. 2 — Derating curve for all types.

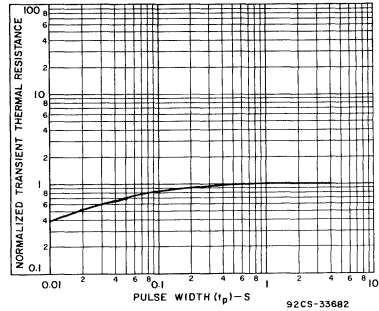


Fig. 3 — Typical thermal-response characteristics for all types.

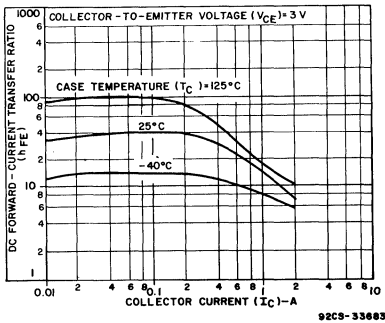


Fig. 4 — Typical dc beta characteristics for all types.

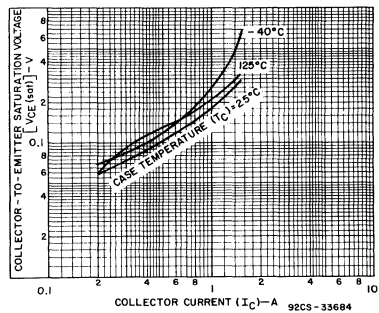


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

BUW40, BUW40A, BUW40B

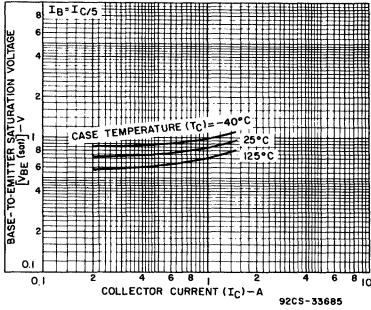


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

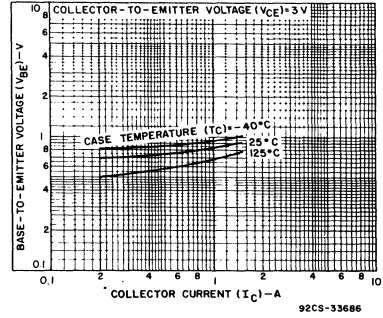


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

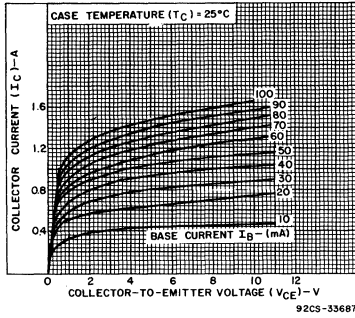


Fig. 8 — Typical output characteristics for all types.

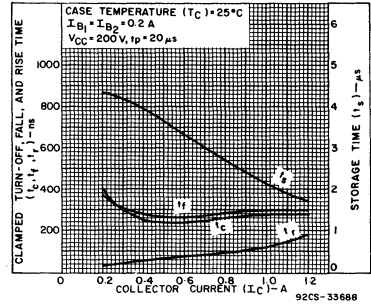


Fig. 9 — Typical saturated-switching-time characteristics for all types.

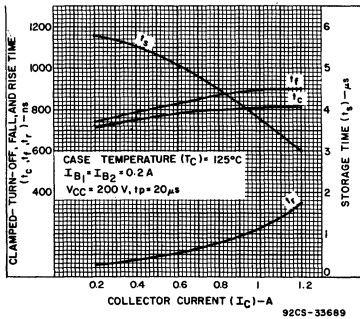


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

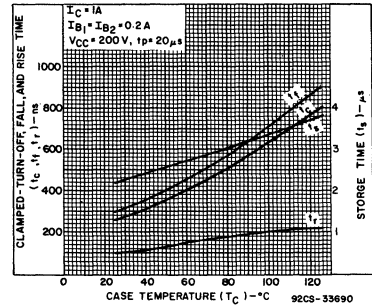


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

BUW40, BUW40A, BUW40B

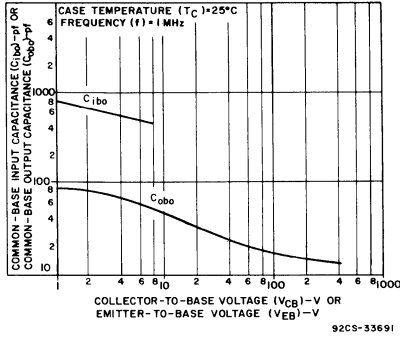


Fig. 12 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

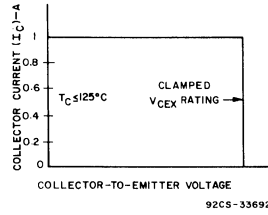


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff.

2

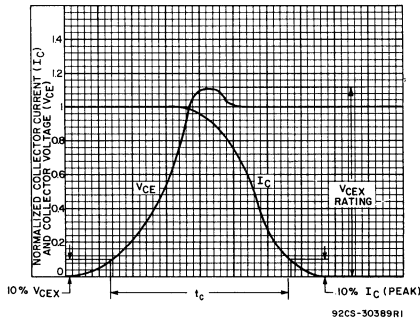


Fig. 14 — Oscilloscope display for measurement of clamped induction switching time (t_c).

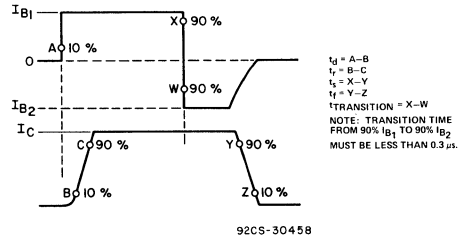


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching

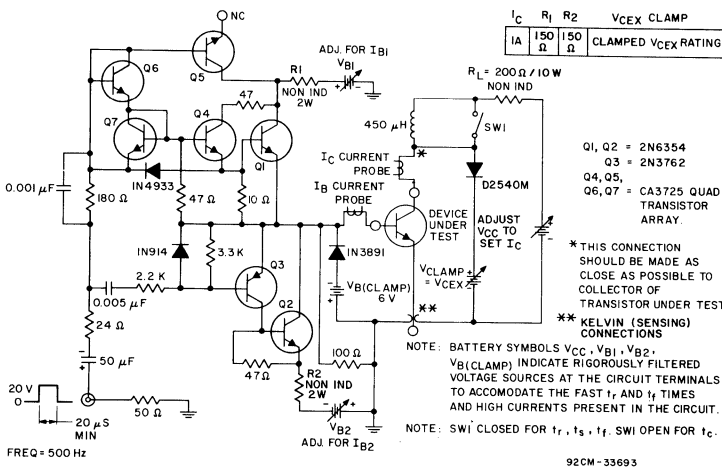


Fig. 16 — Circuit for measuring switching times.

5-A *SwitchMax* Power Transistors

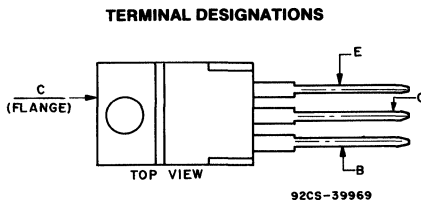
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
 $V_{CEX} = 350\text{ V to }450\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 5\text{ A}$
- **VERSAWATT** package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators



JEDEC TO-220AB

The BUW41, BUW41A, and BUW41B SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that

are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The BUW41, BUW41A and BUW41B series transistors are supplied in JEDEC TO-220AB (VERSAWATT) plastic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUW41	BUW41A	BUW41B	
$V_{CER}, R_{BE} = 100\Omega$	350	400	450	V
V_{CEV} $V_{BE} = -1.5\text{ V}$	450	550	650	V
V_{CEX} (clamped) $V_{BE} = -1.5\text{ V}$	350	400	450	V
V_{CEO}	300	350	400	V
V_{EBO}	8	8	8	V
$I_C(sat)$	5	5	5	A
I_C	8	8	8	A
I_{CM}	10	10	10	A
I_B	4	4	4	A
P_T T_C up to 25°C	100	100	100	W
T_C above 25°C, derate linearly	0.8	0.8	0.8	W/°C
T_{stg}, T_J	-65 to 150	-65 to 150	-65 to 150	°C
T_L At distance $\geq 1/8$ in. (3.17 mm) from seating plane for 10 s max.	235	235	235	°C

BUW41, BUW41A, BUW41B

ELECTRICAL CHARACTERISTICS

Characteristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUW41		BUW41A		BUW41B		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	

T_C = 25° C

I _{CEV}	450	-1.5			—	0.1	—	—	—	—	mA
	550	-1.5			—	—	—	0.1	—	—	
	650	-1.5			—	—	—	—	—	0.1	
I _{IEBO}		-8	0		—	2	—	2	—	2	
V _{CEO(sus)} ^b			0.2 ^a	0	300	—	350	—	400	—	V
h _{FE}	3		5 ^a		10	40	10	40	10	40	
V _{BE(sat)}			5 ^a	1	—	1.6	—	1.6	—	1.6	V
V _{CE(sat)}			5 ^a	1	—	1	—	1	—	1	
			8 ^a	4	—	2	—	2	—	2	
V _{CEX} ^b (Clamped E _{S/b}) L = 170 μH R _{BB} = 5 Ω		-5	5	1 ^e	350	—	400	—	450	—	V
		-5	8	3 ^e	200	—	250	—	300	—	
I _{S/b}	25		4		0.5	—	0.5	—	0.5	—	s
|h _{fe}| f=5 MHz	10		0.2		3	12	3	12	3	12	
f _T	10		0.2		15	60	15	60	15	60	MHz
C _{obo} f=0.1 MHz	10 ^c				50	300	50	300	50	300	pF
t _d ^d			5	1	—	0.1	—	0.1	—	0.1	μs
t _r ^d			5	1	—	0.5	—	0.5	—	0.5	
t _s ^d			5	1 ^e	—	2.5	—	2.5	—	2.5	
t _f ^d			5	1 ^e	—	0.4	—	0.4	—	0.4	
t _c V _{CC} = 125 V, L = 170 μH, R _C = 25 Ω Collector clamped to V _{CEX}			5	1 ^e	—	0.4	—	0.4	—	0.4	

2

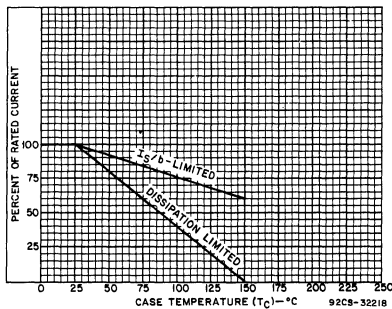


Fig. 1 — Dissipation and I_{S/b} derating curves for all types.

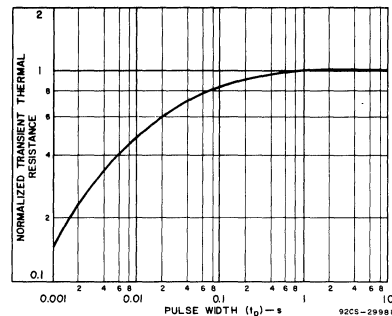


Fig. 2 — Typical thermal-response characteristics for all types.

BUW41, BUW41A, BUW41B

ELECTRICAL CHARACTERISTICS Continued

Characteristic	Test Conditions				Limits					Units	
	Voltage V dc		Current A dc		BUW41		BUW41A		BUW41B		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.		Max.
<i>T_C = 125°C</i>											
I _{CEV}	450	-1.5			—	1	—	—	—	—	mA
	550	-1.5			—	—	—	1	—	—	
	650	-1.5			—	—	—	—	—	1	
V _{CE(sat)}			5 ^a	1	—	2	—	2	—	2	V
t _{r^d}			5	1	—	0.8	—	0.8	—	0.8	μs
t _{s^d}			5	1 ^e	—	4	—	4	—	4	
t _{f^d}			5	1 ^e	—	0.8	—	0.8	—	0.8	
t _c V _{CC} = 125 V, L = 170 μH, R _C = 25 Ω Collector clamped to V _{CEX}			5	1 ^e	—	0.8	—	0.8	—	0.8	
R _{θJC}					—	1.25	—	1.25	—	1.25	°C/W
R _{θJA}					—	70	—	70	—	70	°C/W

^aPulsed: pulse duration = 300 μs, duty factor ≤ 2%.

^bCAUTION: The sustaining voltage V_{CEO(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.

^cV_{CB} value.

^dV_{CC} = 125 V, t_p = 20 μs.

^eI_{B1} = -I_{B2}.

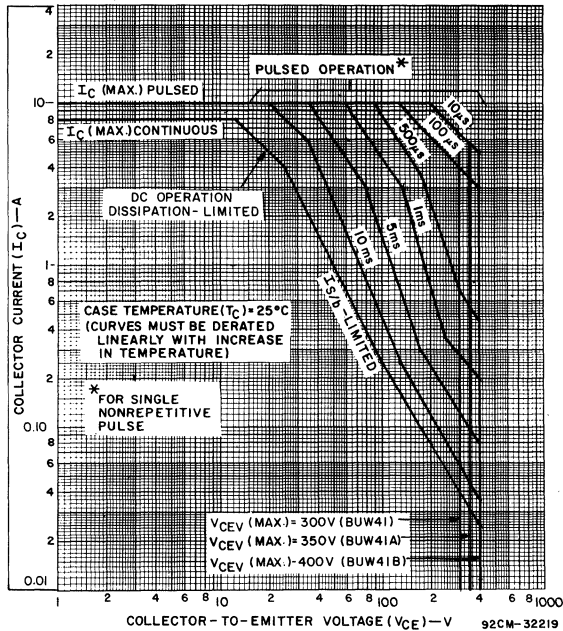


Fig. 3 — Maximum operating areas for all types [T_C = 25°C].

BUW41, BUW41A, BUW41B

2

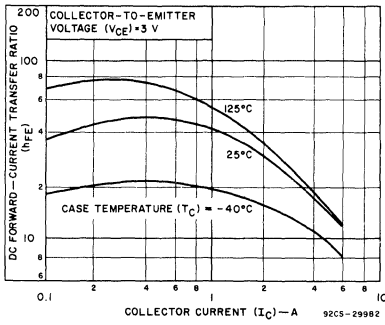


Fig. 4 — Typical dc beta characteristics for all types.

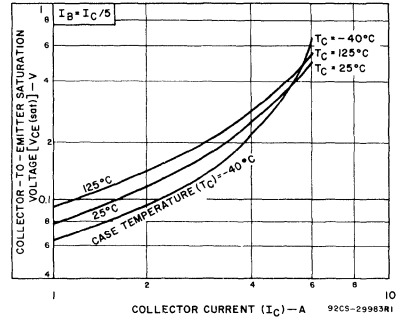


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

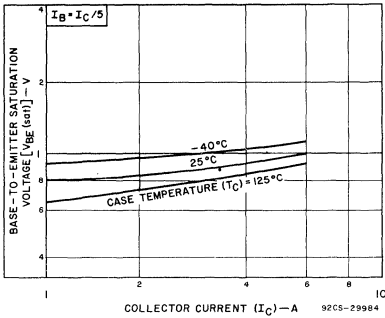


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

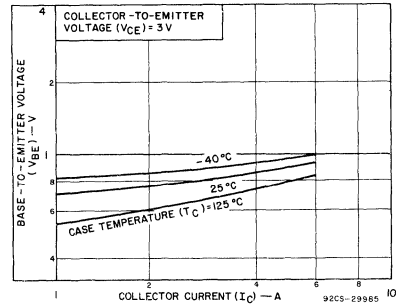


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

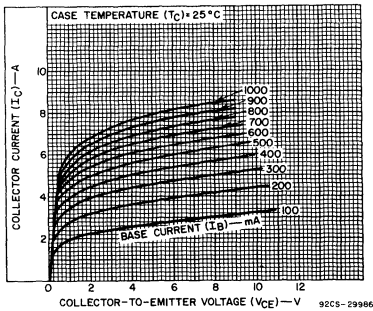


Fig. 8 — Typical output characteristics for all types.

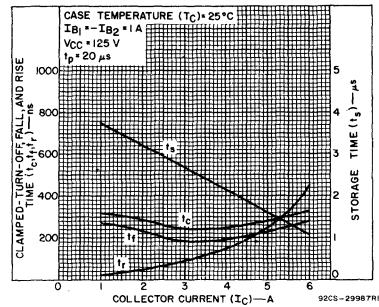


Fig. 9 — Typical saturated-switching-time characteristics for all types.

BUW41, BUW41A, BUW41B

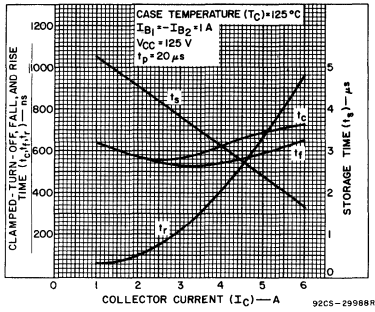


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

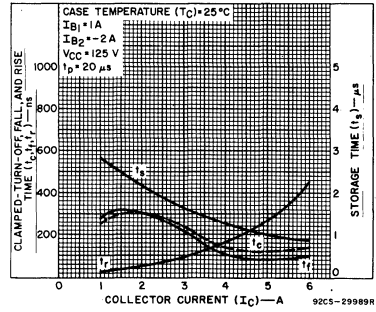


Fig. 11 — Typical saturated-switching-time characteristics for all types.

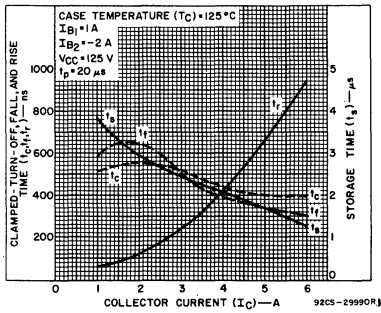


Fig. 12 — Typical saturated-switching-time characteristics for all types.

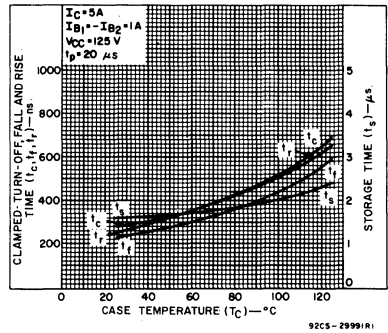


Fig. 13 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

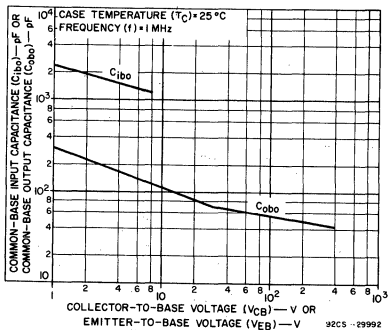


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

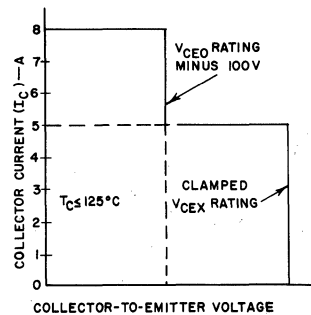


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

BUW41, BUW41A, BUW41B

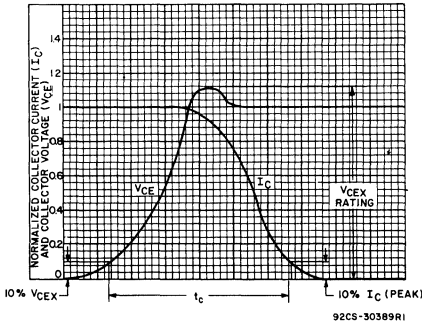


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

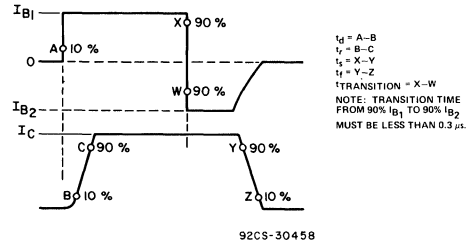


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

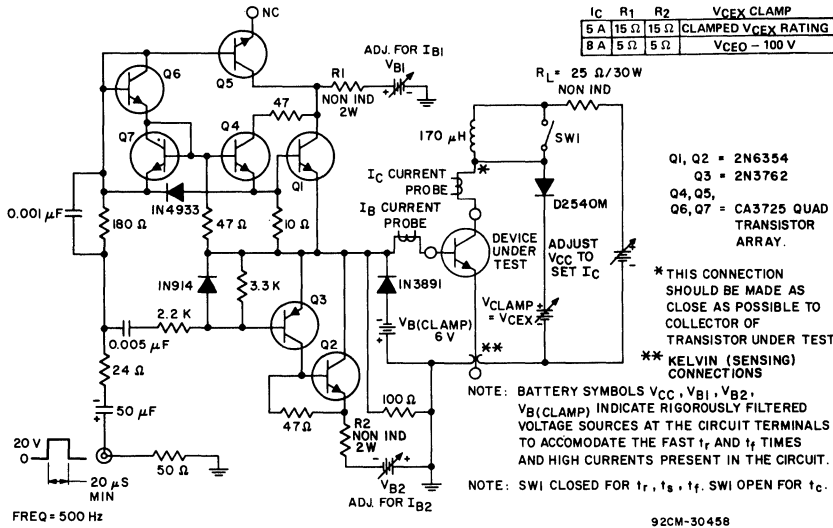


Fig. 18 — Circuit for measuring switching times.

BUW64A, BUW64B, BUW64C

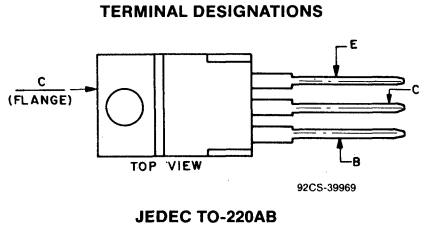
File Number **1199**

**High-Current, Silicon N-P-N
VERSAWATT Transistors**

Switching Applications

Features:

- Fast switching speed at temperatures up to 125° C
- Low $V_{CE(sat)}$
- **VERSAWATT** plastic package



RCA-BUW64A, BUW64B, and BUW64C are epitaxial-base silicon n-p-n power transistors which feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

The BUW64A, BUW64B, and BUW64C transistors are supplied in the JEDEC TO-220AB (RCA VERSAWATT) plastic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUW64A	BUW64B	BUW64C	
V_{CEV}				V
$V_{BE} = -1.5 V$	140	160	180	V
V_{CEO}	90	110	130	V
V_{EBO}		7		V
$I_C(sat)$	5	5	4	A
I_C		7		A
I_{CM}		10		A
I_B		5		A
P_T				W
T_C up to 25° C		50		W/° C
T_C above 25° C		0.4		Derate Linearly
T_{stg}, T_J		-65 to 150		° C
T_L				° C
At distance $\geq 1/8$ in. (3.16 mm) from seating plane for 10 s max. ...		235		

BUW64A, BUW64B, BUW64C

ELECTRICAL CHARACTERISTICS, at Case Temperature $T_C = 25^\circ\text{C}$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BUW64A		BUW64B		BUW64C		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	140	-1.5			-	100	-	-	-	-	μA
	160	-1.5			-	-	-	100	-	-	
	180	-1.5			-	-	-	-	-	100	
$T_C = 125^\circ\text{C}$	140	-1.5			-	1	-	-	-	-	mA
	160	-1.5			-	-	-	1	-	-	
	180	-1.5			-	-	-	-	-	1	
I_{EBO}		-7	0		-	100	-	100	-	100	μA
$V_{CEO(sus)}^b$			0.01 ^a	0	90	-	110	-	130	-	V
h_{FE}	2		0.2 ^a		30	-	30	-	30	-	
	2		4 ^a		-	-	-	-	20	-	
	2		5 ^a		20	-	20	-	-	-	
$V_{BE(sat)}$			4 ^a	0.4	-	-	-	-	-	1.4	V
			5 ^a	0.5	-	1.5	-	1.5	-	-	
$V_{CE(sat)}$			4 ^a	0.4	-	-	-	-	-	0.7	V
			5 ^a	0.5	-	0.8	-	0.8	-	-	
			7 ^a	0.7	-	1.5	-	1.5	-	1.5	
I_S/b	20		2.5		1	-	1	-	1	-	s
$|h_{fe}|$ f = 5 MHz	10		0.5		10	40	10	40	10	40	
f_T	10		0.5		50	200	50	200	50	200	MHz
C_{obo} f = 0.1 MHz	10 ^c				50	150	50	150	50	150	pF
t_d^d		-4	4	0.4	-	-	-	-	-	0.1	μs
			5	0.5	-	0.1	-	0.1	-	-	
t_r^d		-4	4	0.4	-	-	-	-	-	0.25	
			5	0.5	-	0.25	-	0.25	-	-	
t_s^d		-4	4	0.4 ^e	-	-	-	-	-	1	
			5	0.5 ^e	-	1	-	1	-	-	
t_f^d		-4	4	0.4 ^e	-	-	-	-	-	0.5	
$R_{\theta JC}$	4		5		-	2.5	-	2.5	-	2.5	$^\circ\text{C/W}$

^a Pulsed: pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: The sustaining voltage $V_{CEO(sus)}$ *MUST NOT* be measured on a curve tracer.

^c V_{CB} value.

^d $V_{CC} = 70\text{ V}$, $t_p = 20\ \mu\text{s}$

^e $I_{B1} = -I_{B2}$.

BUW64A, BUW64B, BUW64C

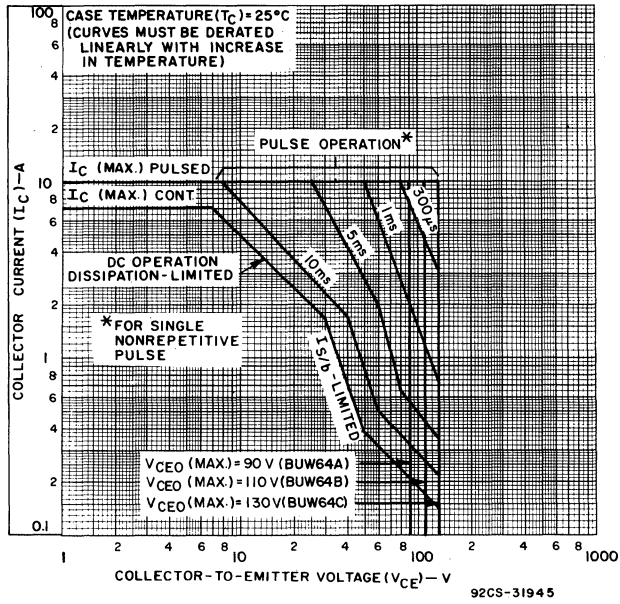


Fig. 1 - Maximum operating areas for all types ($T_C = 25^\circ C$).

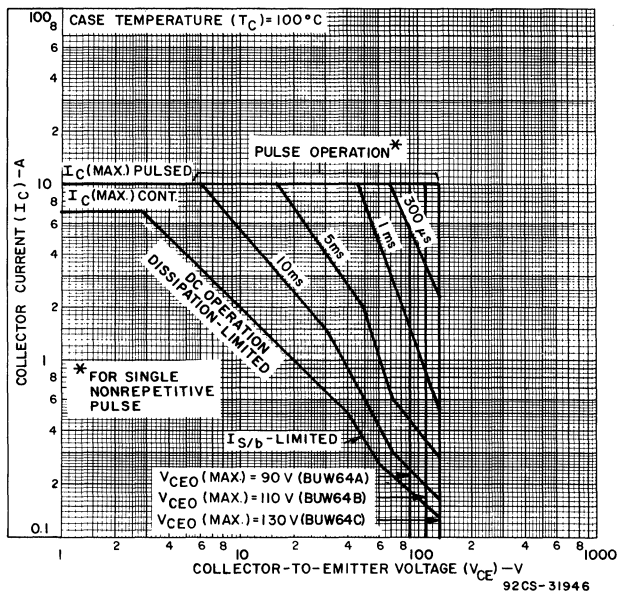


Fig. 2 - Maximum operating areas for all types ($T_C = 100^\circ C$).

BUW64A, BUW64B, BUW64C

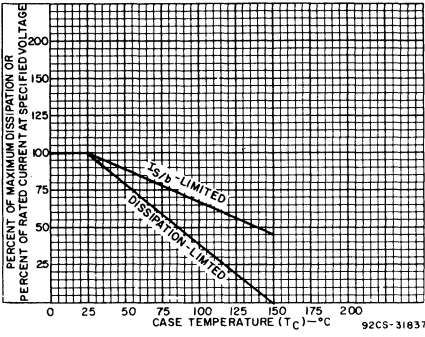


Fig. 3 - Dissipation and I_{S/I_b} derating curves for all types.

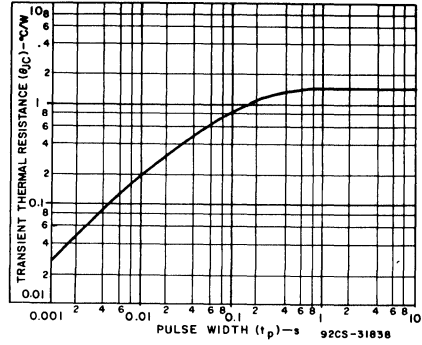


Fig. 4 - Typical thermal-response characteristic for all types.

2

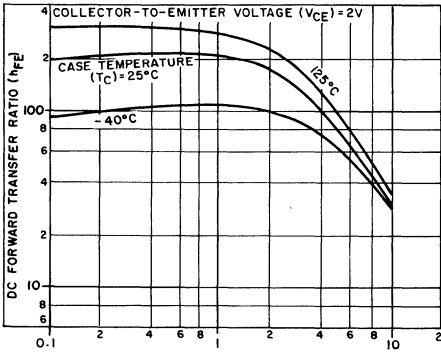


Fig. 5 - Typical dc beta characteristics for all types.

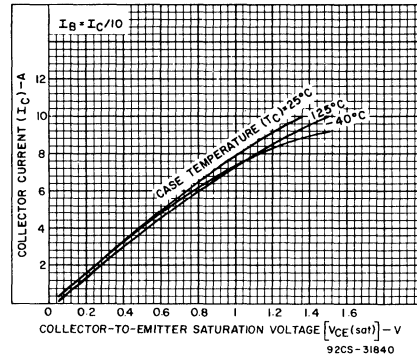


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

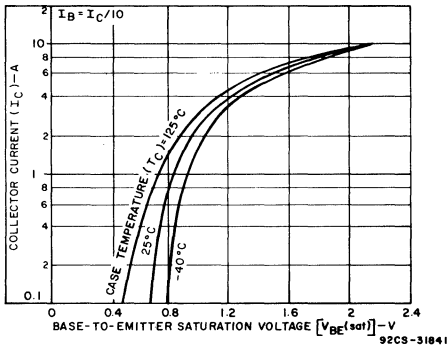


Fig. 7 - Typical base-to-emitter saturation voltage characteristic for all types.

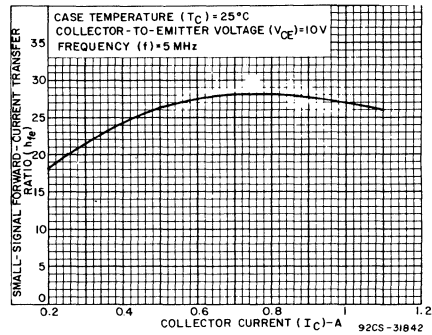


Fig. 8 - Typical small-signal forward-current transfer ratio characteristic for all types ($f = 5 \text{ MHz}$).

BUW64A, BUW64B, BUW64C

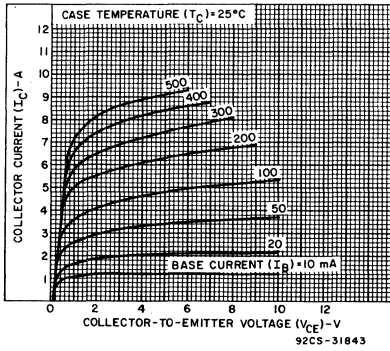


Fig. 9 - Typical output characteristics for all types.

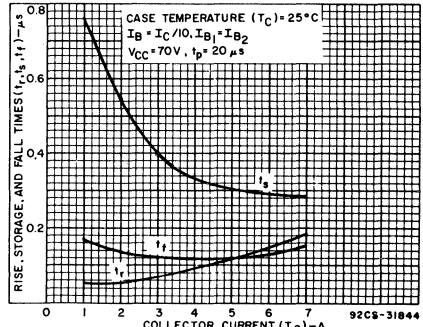


Fig. 10 - Typical saturated-switching-time characteristics as a function of collector current for all types ($T_C = 25^\circ C$).

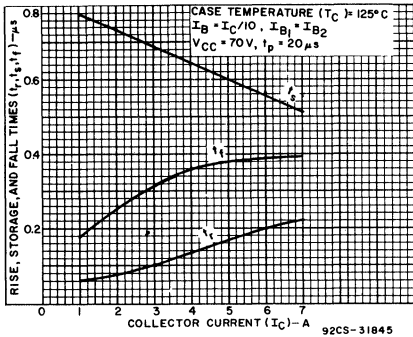


Fig. 11 - Typical saturated-switching-time characteristics as a function of collector current for all types ($T_C = 125^\circ C$).

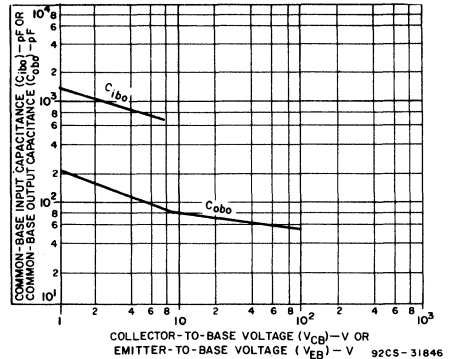


Fig. 12 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

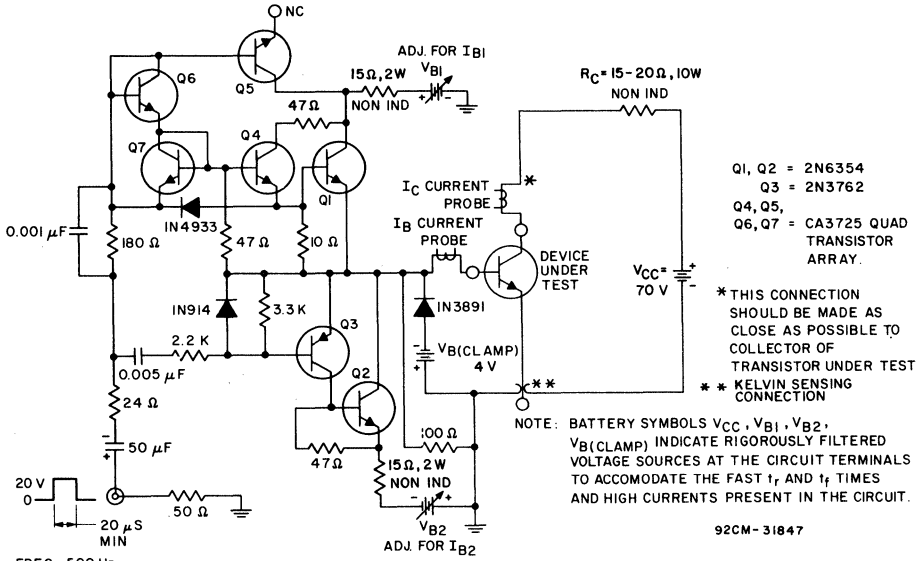


Fig. 13 - Circuit for measuring switching times.

BUW64A, BUW64B, BUW64C

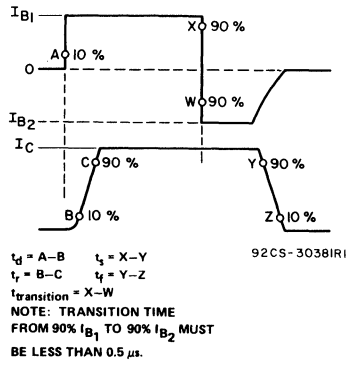


Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

BUX10A

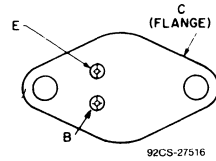
File Number 1216

High-Current, High-Power High-Speed Silicon N-P-N Planar Transistor

Features:

- V_{CE0} — 125 V
- I_C — 25 A
- P_T — 150 W

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX10A is an epitaxial silicon n-p-n planar transistor having high-voltage and high-current capabilities and featuring fast-switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX10A is supplied in a steel JEDEC TO-204AA hermetic package.

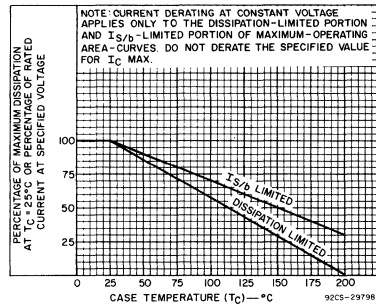


Fig. 1—Derating curves for $I_{S/B}$ and dissipation.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX10A	
V_{CB0}	170	V
V_{CER}	160	V
$R_{BE} = 100 \Omega$	125	V
V_{CE0}	170	V
V_{CEX}	7	V
$V_{BE} = -1.5 \text{ V}$	25	A
V_{EBO}	30	A
I_C	5	A
I_{CM}	150	W
I_B	0.86	W/°C
P_T	-65 to +200	°C
$T_C \leq 25^\circ\text{C}$	Derate linearly	
$T_C > 25^\circ\text{C}$		
T_{ST0}, T_J	235	°C
T_L		
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.		

BUX10A

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX10A			
	VCE	VBE	IC	IB	Min.	Typ.	Max.	
I_{CEO}	125			0	—	—	5	mA
$V_{(BR)EBO}$ $I_E = 50$ mA			0		7	—	—	V
I_{EBO}		-5	0		—	—	1	mA
$V_{CEO(sus)}^b$			0.2 ^a	0	125	—	—	V
$V_{CER(sus)}^b$ $R_{BE} = 100 \Omega$			0.2 ^a		160	—	—	
h_{FE}	2 4		10 20		20 10	— —	70 —	
$V_{BE(sat)}$			20 ^a	2	—	1.5	2	V
$V_{CE(sat)}$			10 ^a 20 ^a	1 2	— —	0.3 0.7	0.6 1.5	
f_T $f = 10$ MHz	10		2		50	—	—	MHz
I_S/b $t = 1$ s, nonrepetitive	25				6	—	—	A
t_{ON}			20	2	—	1	1.5	μ s
t_s $I_{B1} = I_{B2}$	VCE = 30 V		20	2	—	0.6	1.2	
t_f $I_{B1} = I_{B2}$			20	2	—	0.15	0.2	
$R_{\theta JC}$					—	—	1.17	°C/W

^a Pulsed; pulse duration = 300 μ s, duty factor \leq 2%.

^b CAUTION: The sustaining voltages $V_{CEO(sus)}$ and $V_{CER(sus)}$ MUST NOT be measured on a curve tracer.

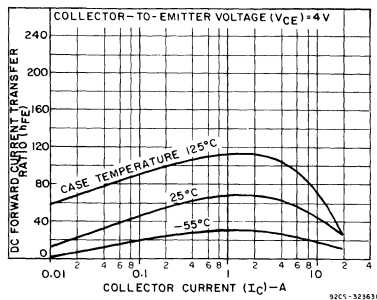


Fig. 2—Typical dc beta characteristics.

BUX10A

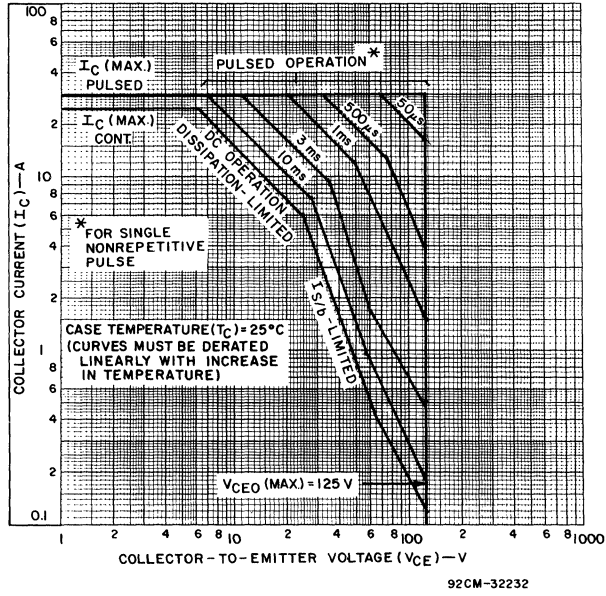


Fig. 3—Maximum safe-operating areas ($T_C = 25^\circ\text{C}$).

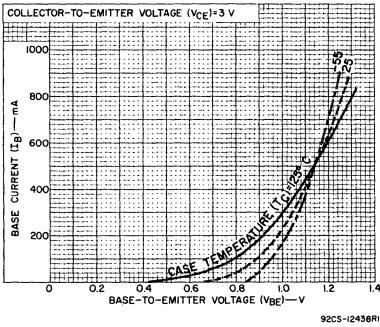


Fig. 4—Typical input characteristics.

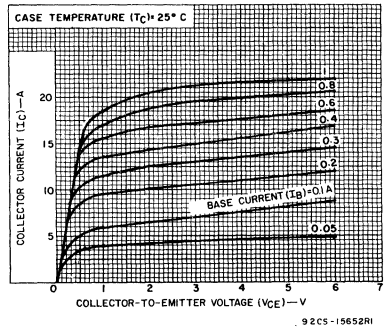


Fig. 5—Typical output characteristics.

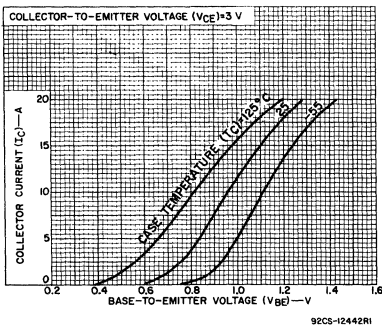


Fig. 6—Typical transfer characteristics.

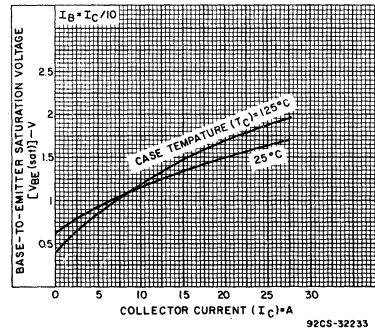


Fig. 7—Typical base-to-emitter saturation voltage characteristics.

BUX10A

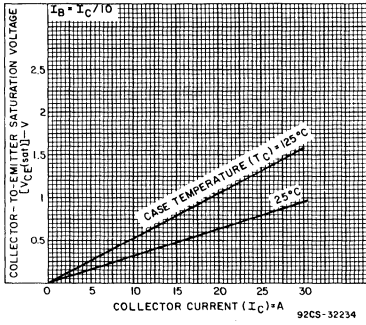


Fig. 8—Typical collector-to-emitter saturation voltage characteristics.

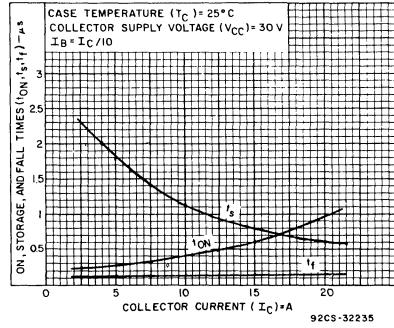


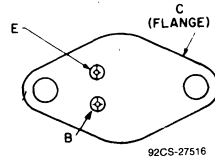
Fig. 9—Typical switching time characteristics.

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

Features:

- $V_{CE0} - 190\text{ V}$
- $I_C - 20\text{ A}$
- $P_T - 200\text{ W}$

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX11A epitaxial-base silicon n-p-n transistor features high-voltage and high-current capabilities together with fast switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX11A is supplied in a steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX11A	
V_{CBO}	250	V
V_{CER} $R_{BE} = 100\ \Omega$	240	V
V_{CEO}	190	V
V_{CEX} $V_{BE} = -1.5\text{ V}$	250	V
V_{EBO}	7	V
I_C	20	A
I_{CM}	25	A
I_B	4	A
P_T $T_C \leq 25^\circ\text{C}$	200	W
$T_C > 25^\circ\text{C}$ derate linearly	1.14	W/ $^\circ\text{C}$
T_{stg}, T_J	-65 to + 200	$^\circ\text{C}$
T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max	235	$^\circ\text{C}$

BUX11A

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_c) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE		CURRENT		BUX11A		
	V _{CE}	V _{BE}	I _c	I _B	Min.	Max.	
I _{CEO}	160			0	—	1.5	mA
I _{CEX}	250	-1.5			—	1.5	
I _{CEX} T _C = 125°C	250	-1.5			—	6	
I _{EBO}		-5			—	1	V
V _{CEO(SUS)} ^a			0.2 ^b		190	—	
V _{I(BR)EBO} I _E = 50 mA			0		7	—	
h _{FE}	2		8 ^b		20	60	V
	4		15 ^b		10	—	
V _{BE(sat)}			15 ^b	1.88	—	1.8	
V _{CE(sat)}			8 ^b	0.8	—	0.6	V
			15 ^b	1.88	—	1.5	
I _{S/B} t _p = 1s nonrep.	140				0.15	—	A
	18				11.1	—	
f _T	15		1	—	8	—	MHz
t _{ON}	150 ^c					1	μs
			15	1.88	—		
t _s I _{B1} = I _{B2}	150 ^c				—	1.5	
t _f I _{B1} = I _{B2}	150 ^c				—	0.4	
Rθ _{JC}					—	0.875	°C/W

2

^aCAUTION: The sustaining voltage V_{CEO(SUS)} *MUST NOT* be measured on a curve tracer.

^bPulsed; pulse duration = 300 μs, duty factor ≤ 2%.

^cV_{CC}.

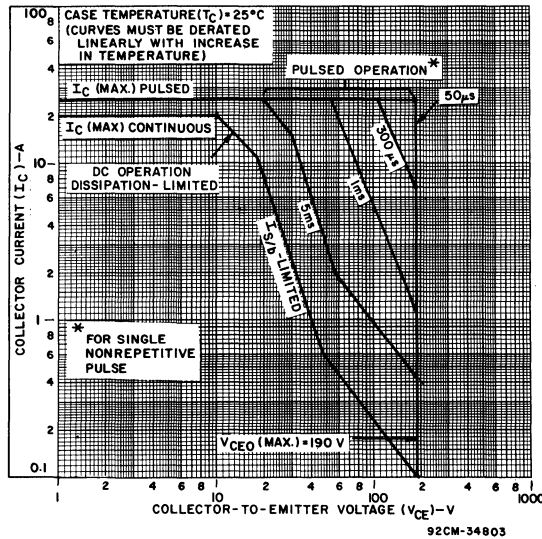


Fig. 1 — Maximum safe-operating areas for BUX11A ($T_c = 25^\circ\text{C}$).

BUX11A

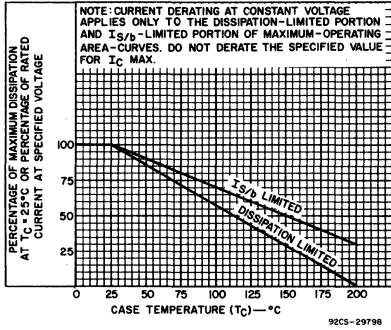


Fig. 2 — Derating curves for $I_{S/B}$ and dissipation.

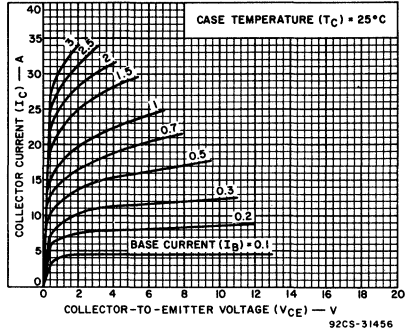


Fig. 3 — Typical output characteristics.

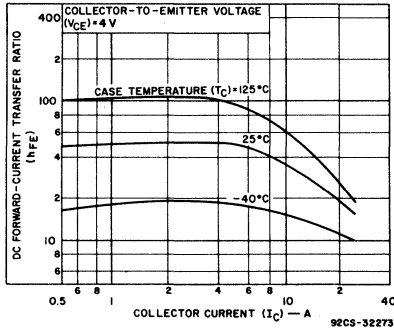


Fig. 4 — Typical dc beta characteristics.

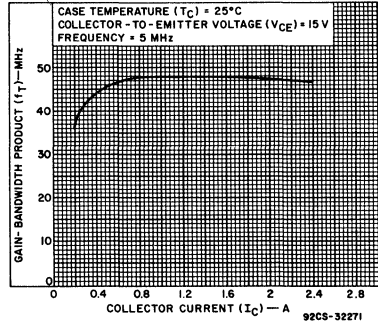


Fig. 5 — Typical gain-bandwidth product.

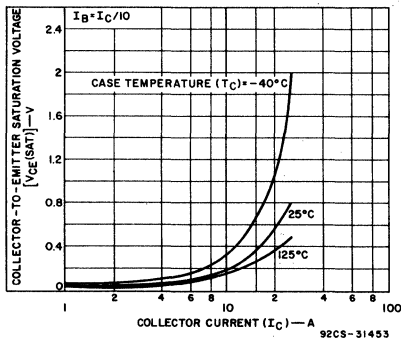


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics.

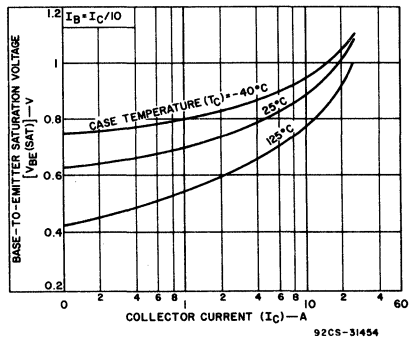


Fig. 7 — Typical base-to-emitter saturation voltage characteristics.

BUX11A

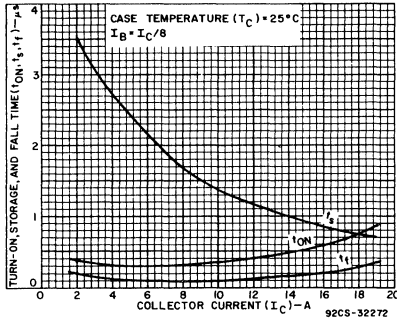


Fig. 8 — Typical saturated-switching times as a function of collector current.

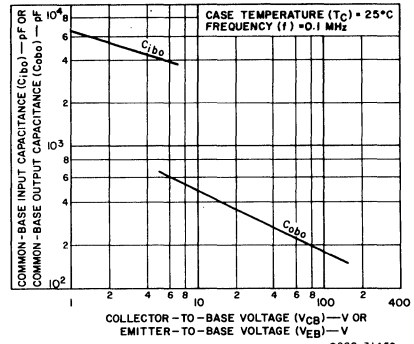


Fig. 9 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic.

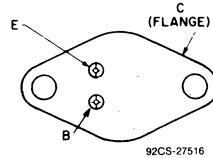
Silicon N-P-N Switching Transistor

For High-Voltage Switching and Amplifier Applications in Industrial and Commercial Equipment

Features:

- V_{CE0} — 400V
- I_C — 10 A
- P_T — 150 W

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX14 is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. It is especially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX14 transistor is supplied in a steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX14
V_{CBO}	450 V
V_{CEO}	400 V
V_{CEX} $V_{BE} = -1.5V$	450 V
V_{CER} $R_{BE} = 100 \Omega$	440 V
V_{EBO}	7 V
I_C	10 A
I_{CM}	15 A
I_B	2 A
P_T At T_C up to 25°C	150 W
T_{jstg}	-65 to +200 °C
T_L At distances $\geq 1/16$ in. (1.58 mm) from case for 10 s max.	235°C

BUX14

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX14			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	320	—	—	0	—	—	1.5	mA
I_{CEX}	450	-1.5	—	—	—	—	1.5	
$T_C = 125^\circ\text{C}$	450	-1.5	—	—	—	—	6	
I_{EBO}	—	-5	0	—	—	—	1	V
$V_{CEO(sus)}^b$	—	—	0.2 ^a	0	400 ^a	—	—	
$V_{(BR)EBO} \quad I_E = 0.05 \text{ A}$	—	—	0	—	7	—	—	V
$V_{BE(sat)}$	—	—	6 ^a	1.2	—	1	1.5	
$V_{CE(sat)}$	—	—	3 ^a	0.6	—	0.2	0.6	
			6 ^a	1.2	—	0.5	1.5	
h_{FE}	4	—	3 ^a	—	15	—	60	
	4	—	6 ^a	—	8	—	—	
I_S/b t = 1 s, nonrepetitive	140	—	—	—	0.15	—	—	A
	30	—	—	—	5	—	—	
f_T	15	—	1	—	8	—	—	MHz
t_{on}	V_{CC}	—	6	1.2	—	0.5	1.4	
t_s	=	—	6	1.2 ^c	—	1	3	μs
t_f	30 V	—	6	1.2 ^c	—	0.3	1.2	
$R_{\theta JC}$	—	—	—	—	—	—	1.17	$^\circ\text{C/W}$

^aPulsed, pulse duration = 300 μs , duty factor $\leq 2\%$.

^bCAUTION: Sustaining Voltage $V_{CEO(sus)}$ MUST NOT be measured on a curve tracer.

^c $I_{B1} = I_{B2}$.

2

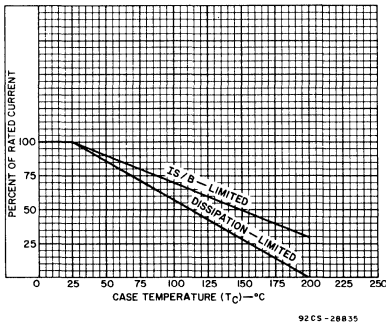


Fig. 1 — Dissipation and $I_{S/B}$ derating curves.

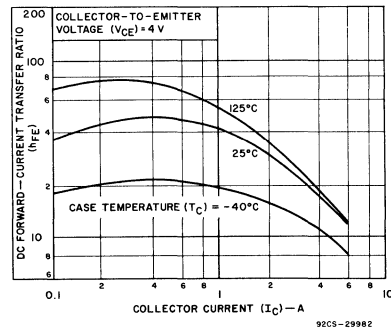


Fig. 2 — Typical dc beta characteristics.

BUX14

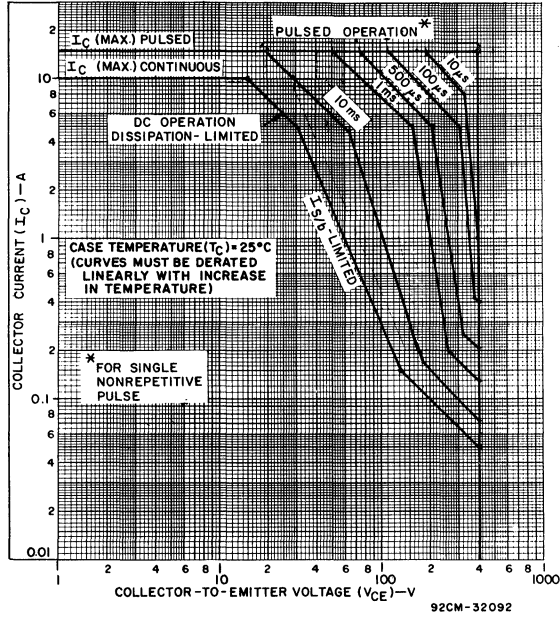


Fig. 3 — Maximum safe-operating areas ($T_c = 25^\circ\text{C}$).

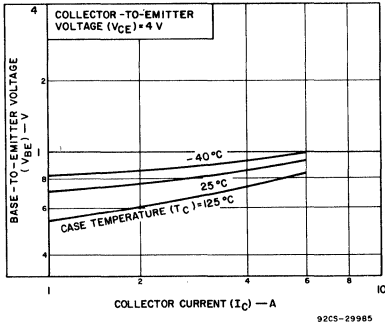


Fig. 4 — Typical base-to-emitter voltage as a function of collector current.

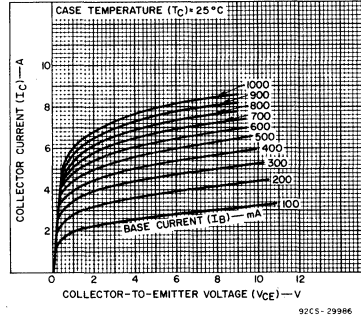


Fig. 5 — Typical output characteristics.

BUX14

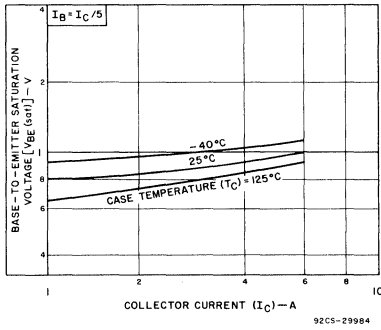


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

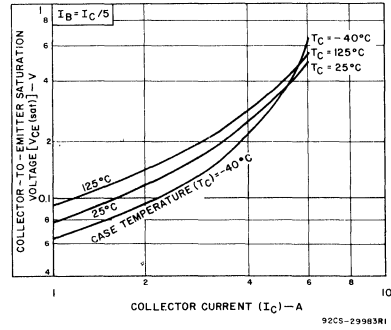


Fig. 7 — Typical collector-to-emitter saturation voltage as a function of collector current.

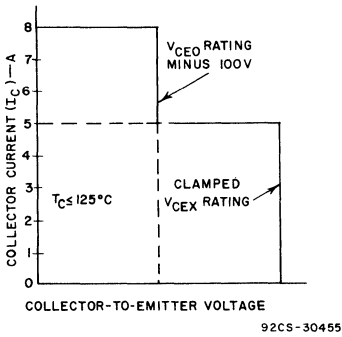


Fig. 8 — Maximum operating conditions for switching between saturation and cutoff.

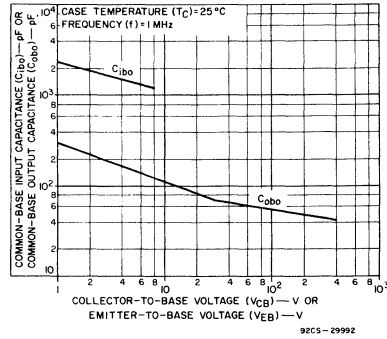


Fig. 9 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

BUX16, BUX16A, BUX16B, BUX16C

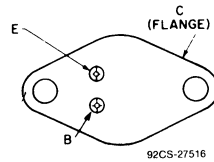
High-Voltage, High-Power Silicon N-P-N Power Transistor

For Switching and Linear Applications in Industrial, and Commercial Equipment

Features:

- High voltage ratings: $V_{CE(sus)}$ up to 400 V, $R_{BE} \leq 50 \Omega$
 $V_{CEO(sus)}$ up to 350 V
- High power dissipation rating: $P_T = 100$ W at $V_{CE} = 135$ V, $T_C = 25^\circ\text{C}$
- Maximum area-of-operation curves for dc and pulse operation

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX16-series devices are multiple epitaxial silicon n-p-n power transistors employing a new overlay construction with several emitter sites. All devices employ the popular JEDEC TO-204AA package; they differ in breakdown-voltage, leakage-current, and current-gain values.

The high breakdown-voltage ratings and exceptional second-breakdown capabilities of these transistors make them especially suitable for use in series regulators, power amplifiers, inverters, deflection circuits, switching regulators, and high-voltage bridge amplifiers.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX16	BUX16A	BUX16B	BUX16C		
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	250	325	375	425	V
COLLECTOR-TO-EMITTER VOLTAGE:						
With base reverse-biased ($V_{BE} = -1.5$ V)	$V_{CEV(sus)}$	250	325	375	425	V
With external base-to-emitter resistance ($R_{BE} \leq 50 \Omega$)	$V_{CER(sus)}$	225	300	350	400	V
With base open	$V_{CEO(sus)}$	200	250	300	350	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
CONTINUOUS COLLECTOR CURRENT	I_C	5	5	5	5	A
CONTINUOUS BASE CURRENT	I_B	2	2	2	2	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C and V_{CE} up to 135 V		100	100	100	100	W
At case temperatures up to 25°C and V_{CE} above 135 V		See Fig. 1 & 2				
At case temperatures above 25°C and V_{CE} above 135 V		See Fig. 1 & 2				
TEMPERATURE RANGE:						
Storage and operating (Junction)		-65 to 200				$^\circ\text{C}$
PIN TEMPERATURE (During soldering):						
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	T_P	230				$^\circ\text{C}$

BUX16, BUX16A, BUX16B, BUX16C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BUX16		BUX16A		BUX16B		BUX16C		
		V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With base reverse-biased	I _{CEV}	250	-1.5	-	-	-	5	-	-	-	-	-	-	-
		325	-1.5	-	-	-	-	-	5	-	-	-	-	-
		375	-1.5	-	-	-	-	-	-	-	2	-	-	-
		425	-1.5	-	-	-	-	-	-	-	-	-	2	-
With base reverse-biased T _C = 150°C	I _{CEV}	250	-1.5	-	-	-	8	-	8	-	3	-	3	
With base open	I _{CEO}	175	-	-	0	-	5	-	2	-	-	-	-	
		250	-	-	0	-	-	-	-	-	5	-	2	
Emitter Cutoff Current: V _{EB} = 5 V	I _{EBO}	-	-	0	-	-	5	-	5	-	2	-	2	
Collector-to-Emitter Sustaining Voltage ^a With base open	V _{CEO(sus)}	-	-	0.2	0	200	-	250	-	300	-	350	-	
		-	-	0.2	-	225	-	300	-	350	-	400	-	
With external base-to-emitter resistance (R _{BE}) ≤ 50 Ω	V _{CER(sus)}	-	-	0.2	-	225	-	300	-	350	-	400	-	
Emitter-to-Base Voltage	V _{EBO}	-	-	0	0.02	6	-	6	-	6	-	6	-	
DC Forward-Current Transfer Ratio	h _{FE}	10	-	0.4 ^b	-	15	130	15	130	15	130	15	130	
		10	-	2 ^b	-	15	-	15	-	12	-	12	-	
		10	-	4.5 ^b	-	5	-	5	-	5	-	5	-	
Base-to-Emitter Voltage	V _{BE}	10	-	2 ^b	-	3	-	3	-	3	-	3		
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}	-	-	2 ^b	0.25	-	2.5	-	2.5	-	2.5	-	2.5	
		-	-	4.5 ^b	1.125	-	5	-	5	-	5	-	5	
Gain-Bandwidth Product	f _T	10	-	0.2	-	5	-	5	-	5	-	5		
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio ^c (at 1 MHz)	|h _{fe}|	10	-	0.2	-	5	-	5	-	5	-	5		
Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (at 1 kHz)	h _{fe}	10	-	4	-	20	-	20	-	20	-	20		
Output Capacitance (at 1 MHz): V _{CB} = 10 V, I _E = 0	C _{obo}	-	-	-	-	-	150	-	150	-	150	-	150	
Second-Breakdown Collector Current ^d : (With base forward-biased) Pulse duration (nonrepetitive) = 1 s	I _{S/b}	135	-	-	-	0.75	-	0.75	-	0.75	-	0.75	-	
Thermal Resistance: Junction-to-case	R _{θJC}	-	-	-	-	-	1.75	-	1.75	-	1.75	-	1.75	

^a CAUTION: Sustaining voltages V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.^b Pulsed, pulse duration ≤ 350 μs, duty factor = 2%.^c Measured at a frequency where |h_{fe}| is decreasing at approximately 6 dB per octave.^d I_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward biased for transistor operation in the active region.

BUX16, BUX16A, BUX16B, BUX16C

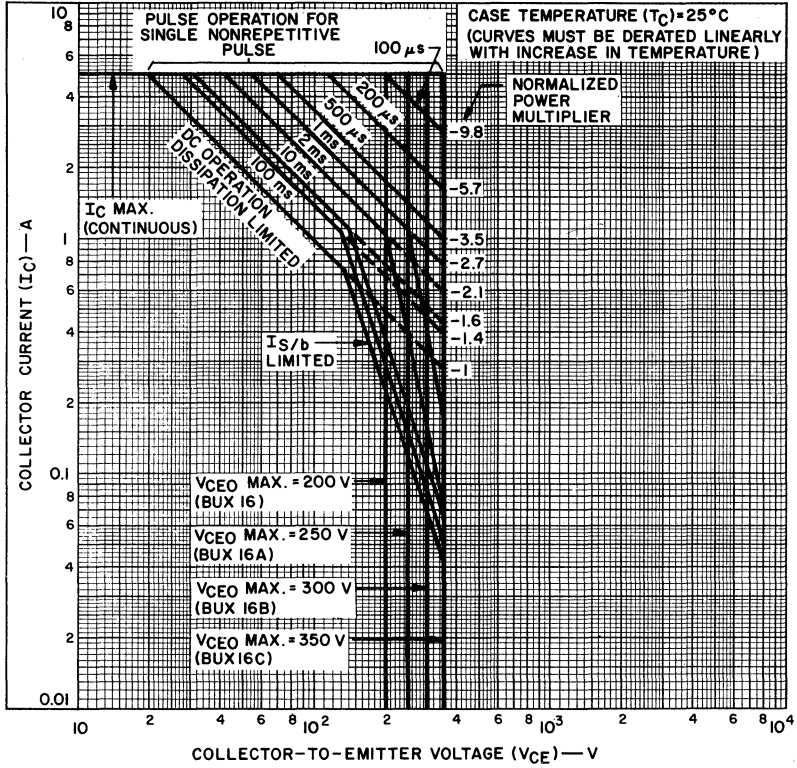


Fig. 1 — Maximum operating areas for all types.

92CS-24283

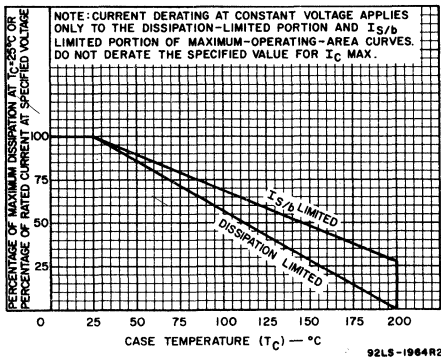


Fig. 2 — Dissipation and I_S/b derating curves for all types.

92LS-1984R2

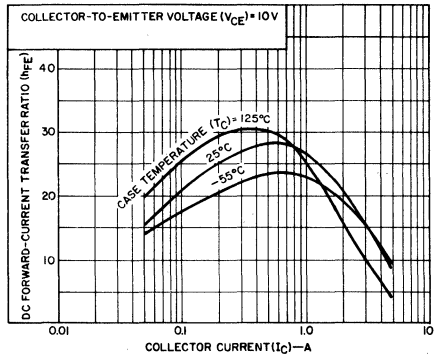


Fig. 3 — Typical DC beta vs. collector current for all types.

92LS-1962

BUX16, BUX16A, BUX16B, BUX16C

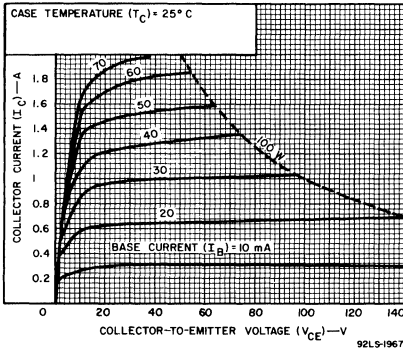


Fig. 4 — Typical output characteristics for all types.

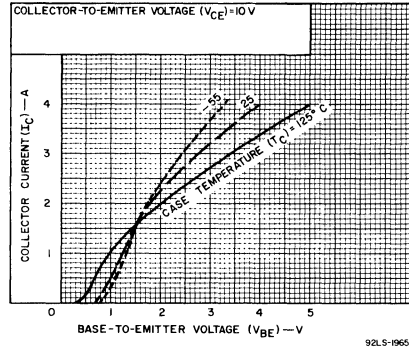


Fig. 5 — Typical transfer characteristics for all types.

2

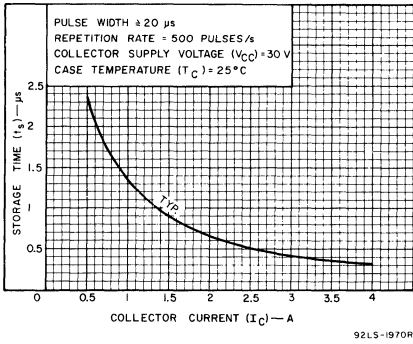


Fig. 6 — Saturated switching time (storage) vs. collector current for all types.

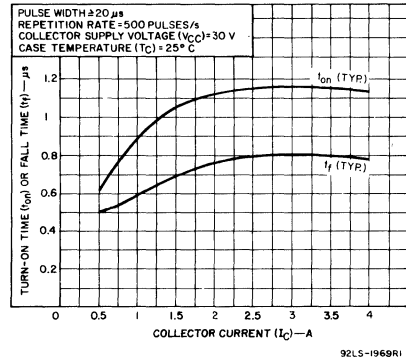


Fig. 7 — Saturated switching-times (turn-on and fall) vs. collector current for all types.

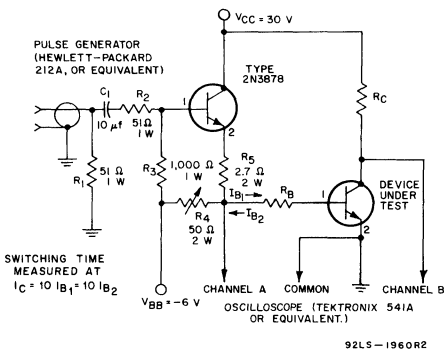


Fig. 8 — Circuit used to measure switching times for all types.

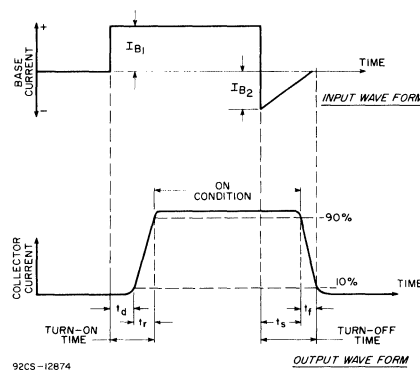


Fig. 9 — Oscilloscope display of switching times (test circuit shown in Fig. 8).

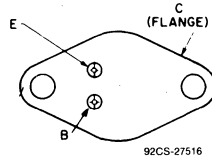
Silicon N-P-N Switching Transistor

For Switching Applications in
Industrial and Commercial Equipment

Features:

- $V_{CE0} - 200V$
- $I_C - 40 A$
- $P_T - 250 W$

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX21 is a silicon n-p-n power transistor featuring fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. It is specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power switching circuits.

The RCA-BUX21 transistor is supplied in a steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX21	
V_{CBO}	250	V
$V_{CE0(SUS)}$	200	V
$V_{CEX(SUS)}$		
$V_{BE} = -1.5V$	250	V
$V_{CER(SUS)}$		
$R_{BE} = 100 \Omega$	240	V
V_{EBO}	7	V
I_C	40	A
I_{CM}	50	A
I_B	8	A
P_T		
At T_C up to $25^\circ C$ and V_{CE} up to $20 V$	250	W
$T_{J, T_{stg}}$	-65 to +200	$^\circ C$
T_L		
At distances $\geq 1/16$ in. (1.58 mm) from case for 10 s max.	200	$^\circ C$

BUX21

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX21			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	160	—	—	0	—	—	3	mA
I_{CEV}	250	-1.5	—	—	—	—	3	
$T_C = 125^\circ\text{C}$	250	-1.5	—	—	—	—	12	
I_{EBO}	—	-5	0	—	—	—	1	
$V_{CEO(sus)}^b$	—	—	0.2 ^a	—	200 ^a	—	—	V
$V_{(BR)EBO} I_E = 0.05 \text{ A}$	—	—	0	—	7	—	—	V
$V_{BE(sat)}$	—	—	25 ^a	3	—	1.2	1.5	
$V_{CE(sat)}$	—	—	12 ^a 25 ^a	1.2 3	—	0.2 0.7	0.6 1.5	
h_{FE}	2 4	—	12 ^a 25 ^a	—	20 10	—	60 —	
$I_{S/b}$ $t = 1 \text{ s, nonrepetitive}$	140 20	—	—	—	0.15 12.5	—	—	A
f_T $f = 10 \text{ MHz}$	15	—	2	—	8	—	—	MHz
t_{on}	$V_{CC} = 100 \text{ V}$	—	25	3	—	0.3	1.2	μs
t_s ($I_{B1} = I_{B2}$)	$V_{CC} = 100 \text{ V}$	—	25	3	—	1.0	1.8	
t_f ($I_{B1} = I_{B2}$)	$V_{CC} = 100 \text{ V}$	—	25	3	—	0.2	0.4	
$R_{\theta JC}$	—	—	—	—	—	—	0.7	$^\circ\text{C/W}$

^a Pulsed, pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: Sustaining Voltages $V_{CEO(sus)}$ **MUST NOT** be measured on a curver tracer.

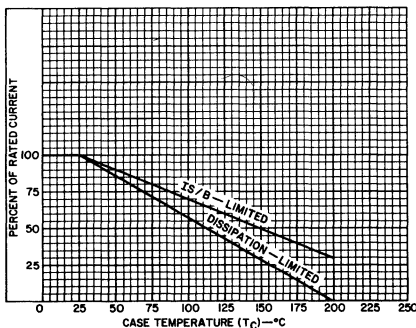


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

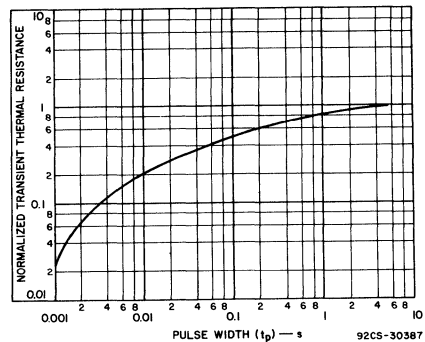


Fig. 2 — Typical thermal-response characteristic.

2

BUX21

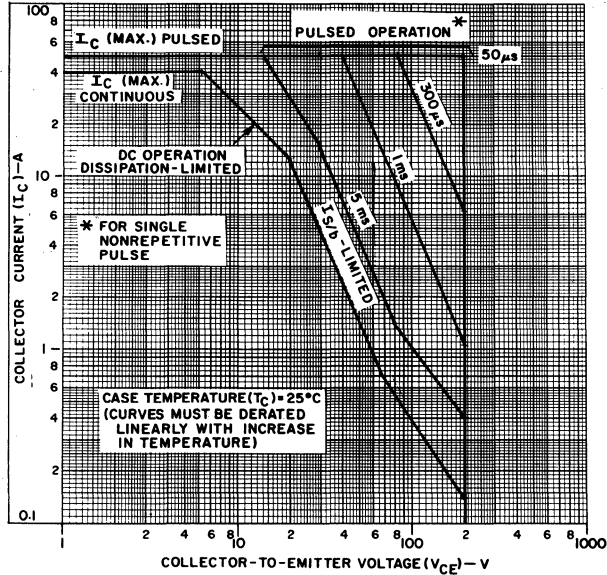


Fig. 3 — Maximum operating areas ($T_C = 25^\circ C$). 92CM-31448

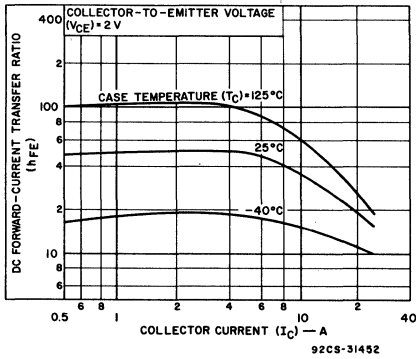


Fig. 4 — Typical dc beta characteristics.

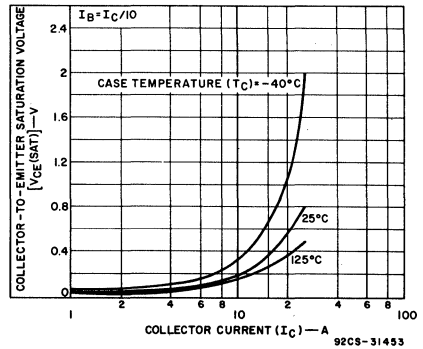


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

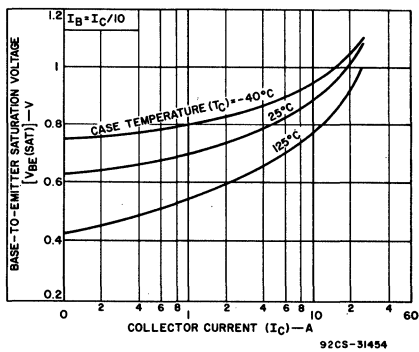


Fig. 6 — Typical base-to-emitter saturation voltage characteristics.

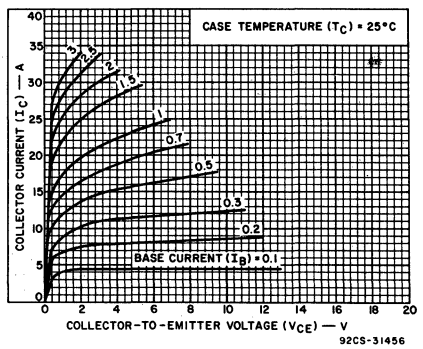


Fig. 7 — Typical output characteristics.

BUX21

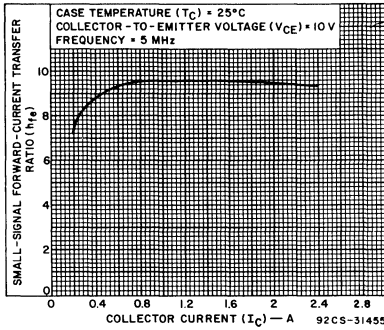


Fig. 8 — Typical small-signal forward-current transfer ratio characteristics.

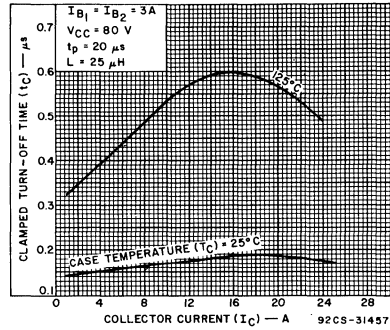


Fig. 9 — Typical clamped turn-off time characteristics.

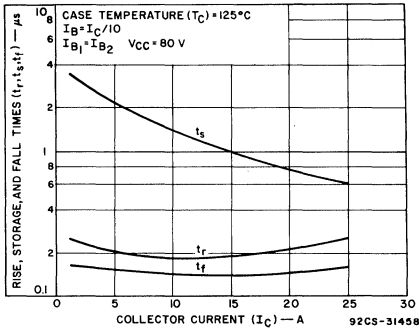


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current.

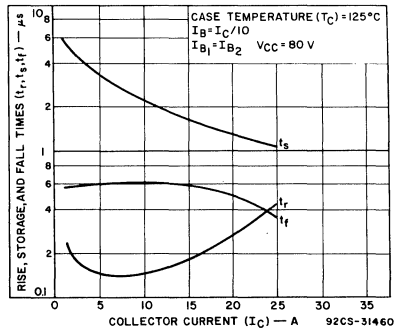


Fig. 11 — Typical-switching-time characteristics at $T_C = 125^\circ C$ as a function of collector current.

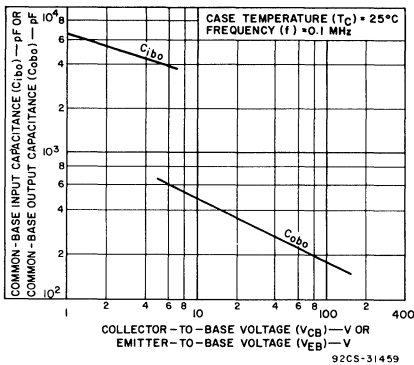


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

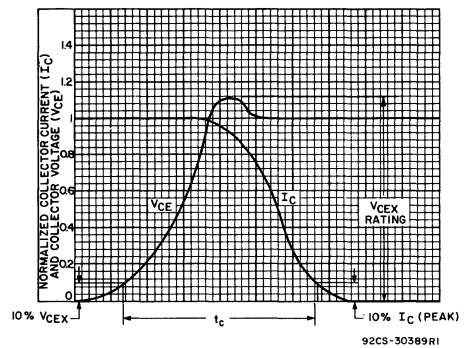


Fig. 13 — Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

BUX21

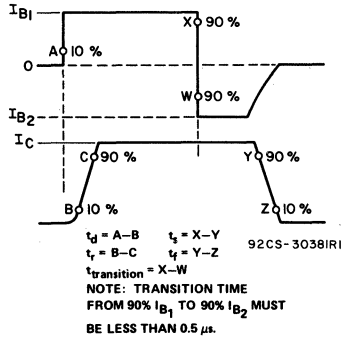


Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

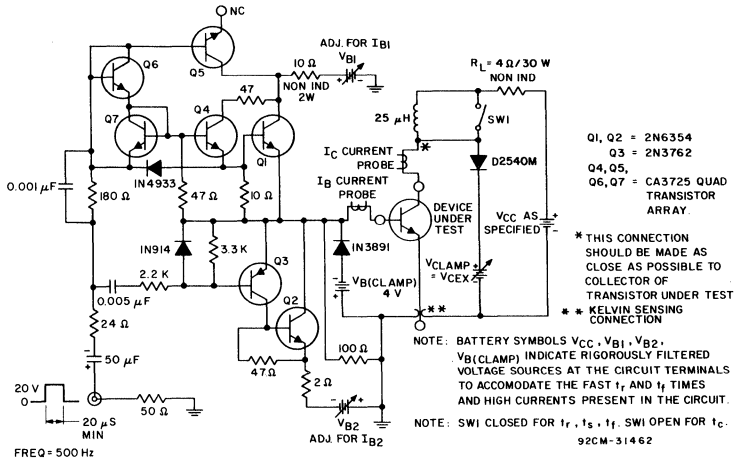


Fig. 15 — Circuit for measuring switching times.

6-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

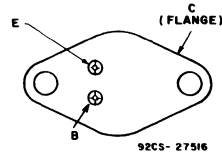
Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
V_{CEX} = 450 V — 550 V
- Low V_{CE}(sat) at I_C = 6 A
- Steel hermetic TO-204AA package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AA

(200 mil diameter pin isolation)

2

The BUX32 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high speed transistors are 100-per-cent

tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The BUX32-series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX32	BUX32A	BUX32B	
V _{CEV}				
V _{BE} =-1.5 V	800	900	1000	V
V _{CER} R _{BE} ≤ 10 Ω	800	900	1000	V
V _{CEx} (Clamped)				
V _{BE} =-1.5 V	450	500	550	V
V _{CEO}	400	450	500	V
V _{EBO}	8	8	8	V
I _C (sat)	6	6	6	A
I _C	8	8	8	A
I _{CM}	10	10	10	A
I _B	4	4	4	A
P _T				
T _C up to 25°C	150	150	150	W
T _C above 25°C, derate linearly	1.0	1.0	1.0	W/°C
T _J	-65 to 175	-65 to 175	-65 to 175	°C
T _{stg}	-65 to 200	-65 to 200	-65 to 200	°C
T _L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235	235	235	°C

BUX32, BUX32A, BUX32B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE		CURRENT		BUX32		BUX32A		BUX32B		
	V dc		A dc		Min.	Max.	Min.	Max.	Min.	Max.	
	V _{CE}	V _{BE}	I _C	I _B							
<i>T_C</i> =25° C											
I _{CEV}	800	-1.5			—	0.1	—	—	—	—	mA
	900	-1.5			—	—	—	0.1	—	—	
	1000	-1.5			—	—	—	—	—	0.1	
I _{CER} R _{BE} ≤ 10 Ω	800				—	0.2	—	—	—	—	mA
	900				—	—	—	0.2	—	—	
	1000				—	—	—	—	—	0.2	
I _{EBO}		-8	0		—	2	—	2	—	2	
V _{CEO(sus)} ^b			0.2 ^a	0	400	—	450	—	500	—	V
h _{FE}	3		6		8	40	8	40	8	40	
V _{BE(sat)}			6	1.2	—	1.3	—	1.3	—	1.3	V
V _{CE(sat)}			6	1.2	—	1	—	1	—	1	
			8	2	—	2	—	2	—	2	
V _{CEX} ^b (Clamped E _{S/b}) L=170 μH		-5	6	1.2 ^e	450	—	500	—	550	—	
I _{S/b}	30		5		1	—	1	—	1	—	s
|h _{fe}| f=5 MHz	10		0.2		3	12	3	12	3	12	
f _T	10		0.2		15	60	15	60	15	60	MHz
C _{obo} f=0.1 MHz	10 ^c				50	250	50	250	50	250	pF
t _d ^d			6	1.2	—	0.1	—	0.1	—	0.1	μs
t _r ^d			6	1.2	—	0.45	—	0.45	—	0.45	
t _s ^d			6	1.2 ^e	—	3.0	—	3.0	—	3.0	
t _f ^d			6	1.2 ^e	—	0.4	—	0.4	—	0.4	
t _c V _{CC} =250 V, L=170 μH, R _C =50 Ω Collector clamped to V _{CEX}			6	1.2 ^e	—	0.4	—	0.4	—	0.4	
<i>T_C</i> =100° C											
I _{CEV}	800	-1.5			—	1	—	—	—	—	mA
	900	-1.5			—	—	—	1	—	—	
	1000	-1.5			—	—	—	—	—	1	
I _{CER} R _{BE} ≤ 10 Ω	800				—	3	—	—	—	—	mA
	900				—	—	—	3	—	—	
	1000				—	—	—	—	—	3	
V _{CE(sat)}			6	1.2	—	1.5	—	1.5	—	1.5	V
t _d ^d			6	1.2	—	0.6	—	0.6	—	0.6	μs
t _s ^d			6	1.2 ^e	—	4	—	4	—	4	
t _f ^d			6	1.2 ^e	—	0.7	—	0.7	—	0.7	
t _c V _{CC} =250 V, L=170 μH, R _C =50 Ω Collector clamped to V _{CEX}			6	1.2 ^e	—	0.8	—	0.8	—	0.8	

BUX32, BUX32A, BUX32B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE		CURRENT		BUX32		BUX32A		BUX32B		
	V _{dc}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	
$R_{\theta JC}$	10	5			—	1.0	—	1.0	—	1.0	°C/W

^aPulsed; pulse duration=300 μ s, duty factor \leq 2%.

^bCAUTION: The sustaining voltage $V_{CE0(sus)}$ and V_{CEX} MUST NOT be measured on a curve tracer.

^c V_{CEB} value.

^d $V_{CC}=250$ V, $t_p=20$ μ s.

^e $I_{B1}=-I_{B2}$.

2

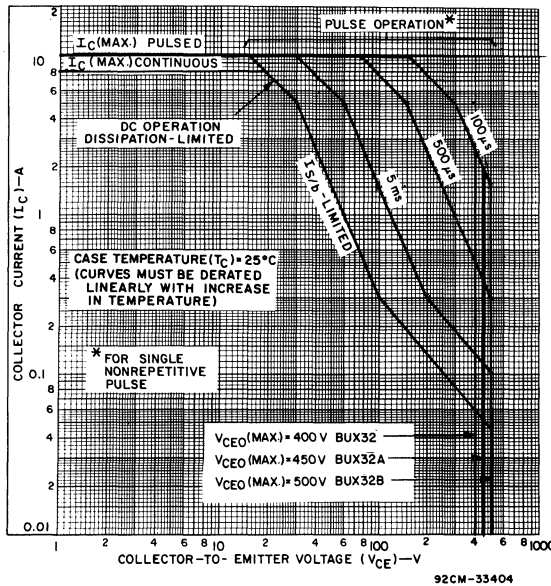


Fig. 1 — Maximum operating areas for all types (T_C).

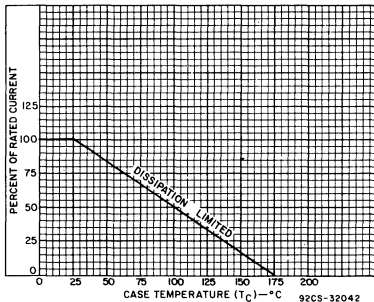


Fig. 2 — Dissipation derating curve for all types.

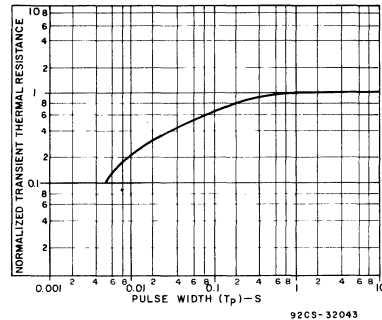


Fig. 3 — Typical thermal-response characteristic for all types.

BUX32, BUX32A, BUX32B

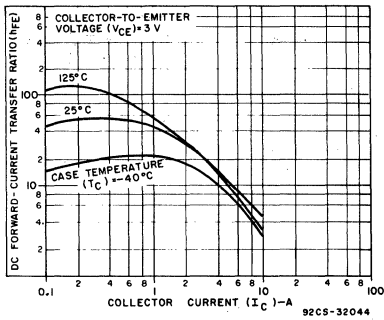


Fig. 4 — Typical dc beta characteristics for all types.

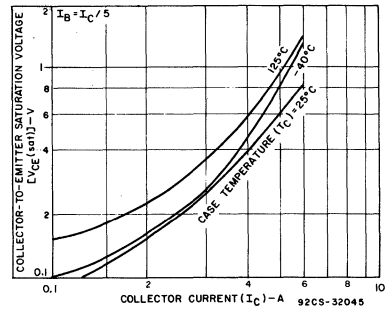


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

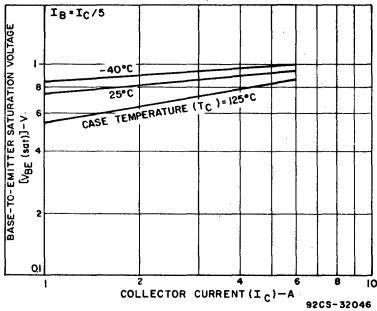


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

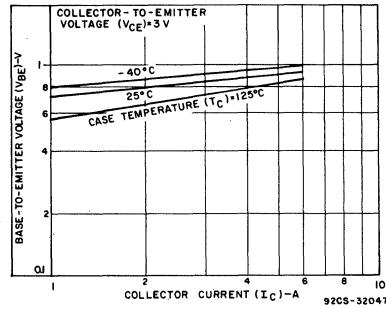


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

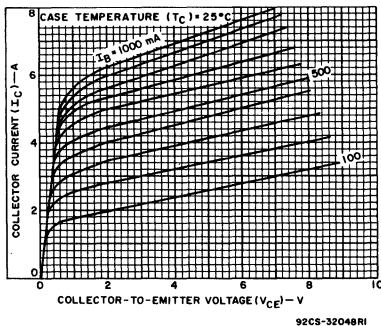


Fig. 8 — Typical output characteristics for all types.

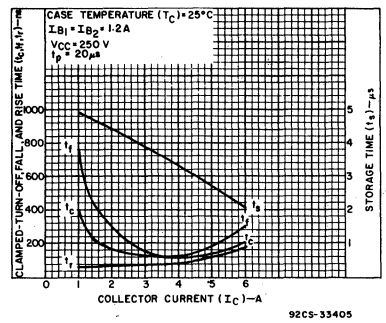


Fig. 9 — Typical saturated switching time characteristics for all types.

BUX32, BUX32A, BUX32B

2

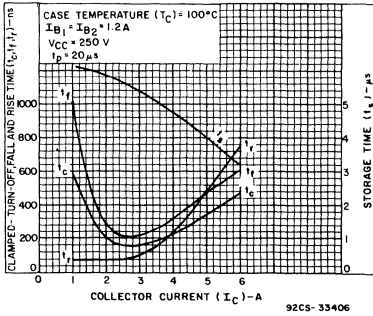


Fig. 10 — Typical saturated switching time characteristics for all types.

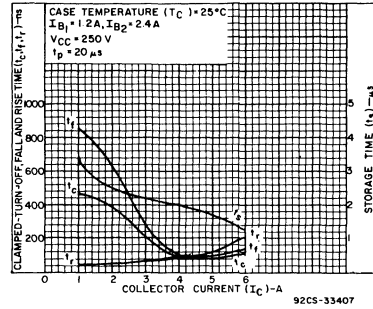


Fig. 11 — Typical saturated switching time characteristics for all types.

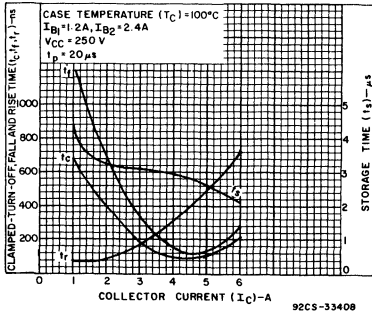


Fig. 12 — Typical saturated switching time characteristics for all types.

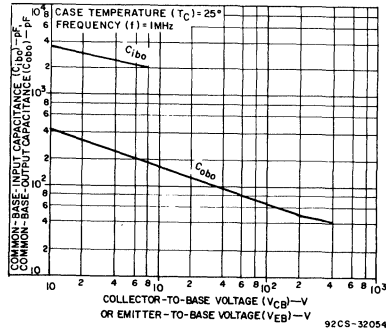


Fig. 13 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

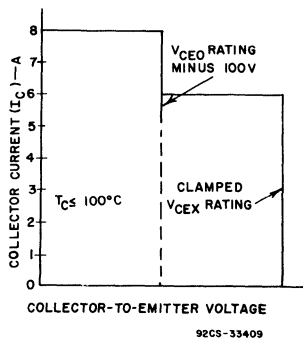


Fig. 14 — Maximum operating conditions for switching between saturation and cutoff.

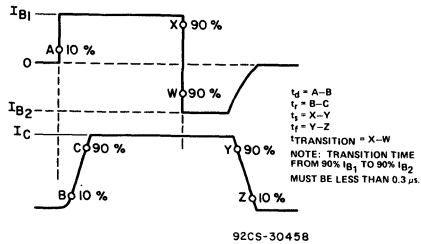


Fig. 15 — Phase relationship between input and output current showing reference points for specification of switching times.

8-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

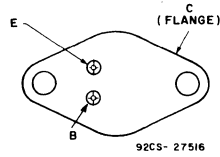
Features:

- High-temperature parameters guaranteed
- Fast switching speed
- High voltage ratings:
V_{CEX} = 450 V — 550 V
- Low V_{CE} (sat) at I_C = 8 A
- Steel hermetic TO-204AA package

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AA

(200 mil diameter pin isolation)

2

The BUX33 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a side range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent

tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The BUX33-series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX33	BUX33A	BUX33B	
V _{CEV}				
V _{BE} = 1.5 V	800	900	1000	V
V _{CER} R _{BE} ≤ 10 Ω	800	900	1000	V
V _{CEX} (Clamped)				
V _{BE} = -1.5 V	450	500	550	V
V _{CEO}	400	450	500	V
V _{EBO}	8			V
I _C (sat)	8			A
I _C	12			A
I _{CM}	15			A
I _B	4			A
P _T				
T _C up to 25°C	150			W
T _C above 25°C, derate linearly	1.0			W/°C
T _J	-65 to 175			°C
T _{stg}	-65 to 200			°C
T _L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235			°C

BUX33, BUX33A, BUX33B

ELECTRICAL CHARACTERISTICS

CHARAC- TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BUX33		BUX33A		BUX33B		
	V _{CE}	V _{BE}	I _c	I _b	Min.	Max.	Min.	Max.	Min.	Max.	

T_c = 25° C

I _{CEV}	800	-1.5			—	0.1	—	—	—	—	mA
	900	-1.5			—	—	—	0.1	—	—	
	1000	-1.5			—	—	—	—	—	0.1	
I _{CER} R _{BE} ≤ 10 Ω	800				—	0.2	—	—	—	—	mA
	900				—	—	—	0.2	—	—	
	1000				—	—	—	—	—	0.2	
I _{EBO}		-8	0			2		2		2	V
V _{CEO(SUS)} ^b			0.2 ^a	0	400	—	450	—	500	—	V
h _{FE}	3		8		6	40	6	40	6	40	V
V _{BE(sat)}			8	2	—	1.3	—	1.3	—	1.3	
V _{CE(sat)}			8	2	—	1	—	1	—	1	
V _{CE(sat)}			12	3	—	4	—	4	—	4	
V _{CEX} ^b (Clamped E _{S(B)}) L = 170 μH		-5	8	2	450	—	500	—	550	—	
I _{S(B)}	30		5		1	—	1	—	1	—	s
|h _{FE}| f = 5 MHz	10		0.2		3	12	3	12	3	12	MHz
f _T	10		0.2		15	60	15	60	15	60	
C _{Obd} f = 0.1 MHz	10 ^c				50	250	50	250	50	250	pF
t _d ^d			8	2	—	0.1	—	0.1	—	0.1	μs
t _r ^d			8	2	—	0.45	—	0.45	—	0.45	
t _s ^d			8	2°	—	3.0	—	3.0	—	3.0	
t _f ^d			8	2°	—	0.4	—	0.4	—	0.4	
t _c V _{CC} = 240 V, L = 170 μH, R _C = 30 Ω Collector clamped to V _{CEX}			8	2°	—	0.4	—	0.4	—	0.4	

T_c = 100° C

I _{CEV}	800	-1.5			—	1	—	—	—	—	mA
	900	-1.5			—	—	—	1	—	—	
	1000	-1.5			—	—	—	—	—	1	
I _{CER} R _{BE} ≤ 10 Ω	800				—	3	—	—	—	—	mA
	900				—	—	—	3	—	—	
	1000				—	—	—	—	—	3	
V _{CE(sat)}			8	2	—	1.5	—	1.5	—	1.5	V
t _d ^d			8	2	—	0.6	—	0.6	—	0.6	μs
t _r ^d			8	2°	—	4	—	4	—	4	
t _s ^d			8	2°	—	0.7	—	0.7	—	0.7	
t _f ^d			8	2°	—	0.7	—	0.7	—	0.7	
t _c V _{CC} = 240 V, L = 170 μH, R _C = 30 Ω Collector clamped to V _{CEX}			8	2°	—	0.8	—	0.8	—	0.8	

R _{θJC}	10	5			—	1.0	—	1.0	—	1.0	°C/W
------------------	----	---	--	--	---	-----	---	-----	---	-----	------

^aPulsed; pulse duration = 300 μs, duty factor ≤ 2%.

^bCAUTION; The sustaining voltage V_{CEO(SUS)} and V_{CEX} MUST NOT be measured on a curve tracer.

^cV_{CE} value.

^dV_{CC} = 240 V, t_p = 20 μs.

^eI_{B1} = -I_{B2}.

BUX33, BUX33A, BUX33B

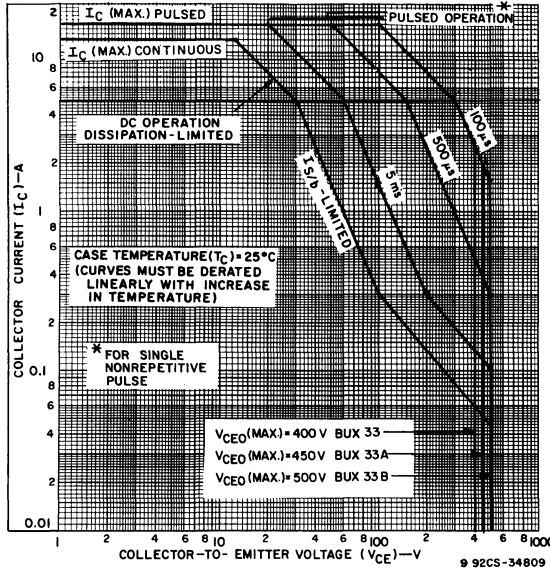


Fig. 1 — Maximum operating areas for all types (T_c).

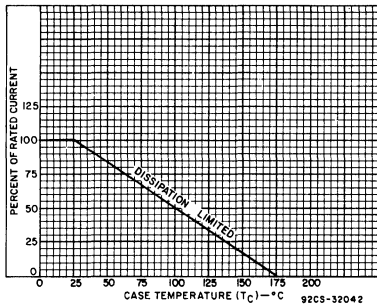


Fig. 2 — Dissipation derating curve for all types.

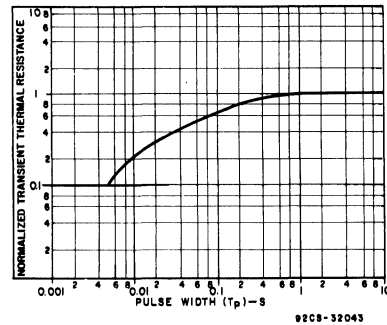


Fig. 3 — Typical thermal-response characteristic for all types.

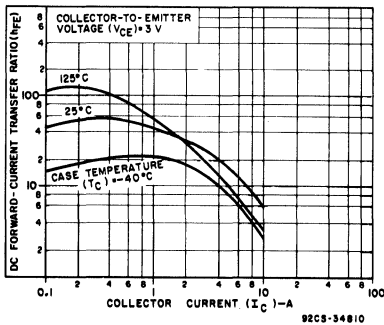


Fig. 4 — Typical dc beta characteristics for all types.

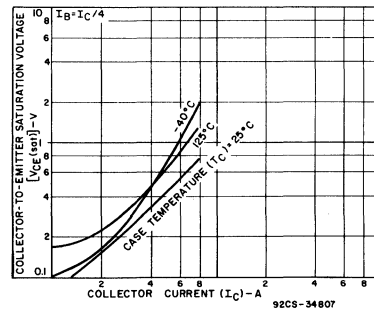


Fig. 5 — Typical collector-to-emitter saturation voltage for all types.

BUX33, BUX33A, BUX33B

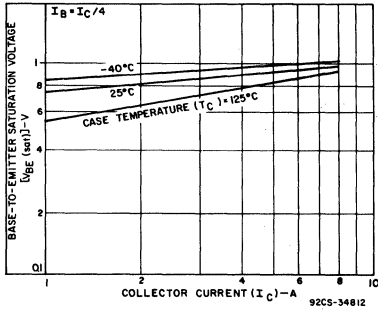


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

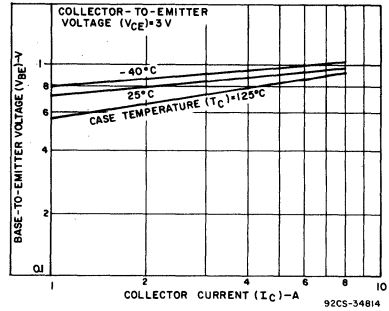


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

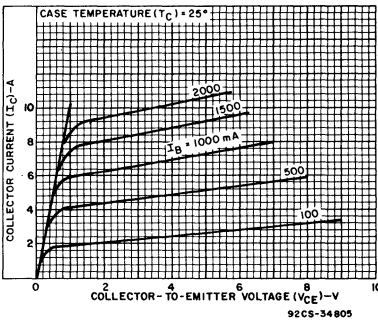


Fig. 8 — Typical output characteristics for all types.

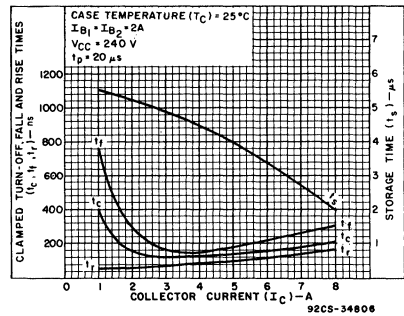


Fig. 9 — Typical saturated switching time characteristics for all types.

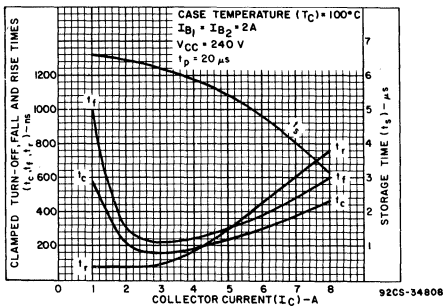


Fig. 10 — Typical saturated switching time characteristics for all types.

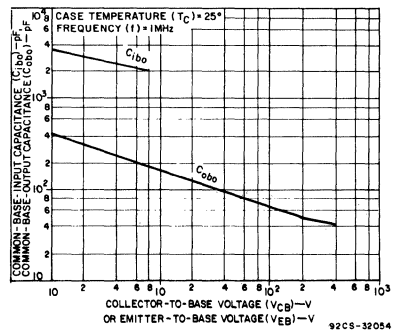


Fig. 11 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

BUX33, BUX33A, BUX33B

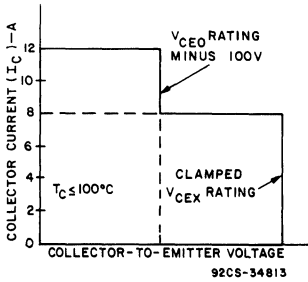


Fig. 12 — Maximum operating conditions for switching between saturation and cutoff.

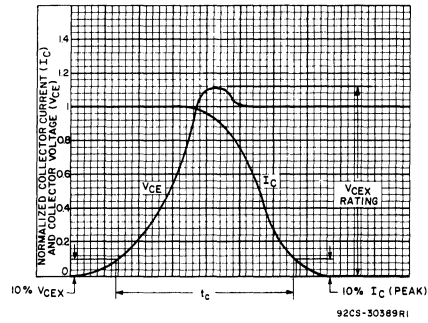


Fig. 13 — Oscilloscope display for measurement of clamped induction switching time (t_c).

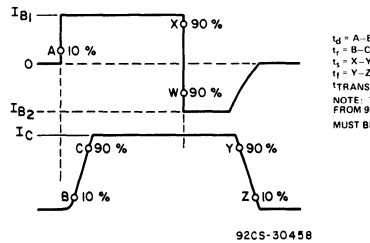


Fig. 14 — Phase relationship between input and output current showing reference points for specification of switching times.

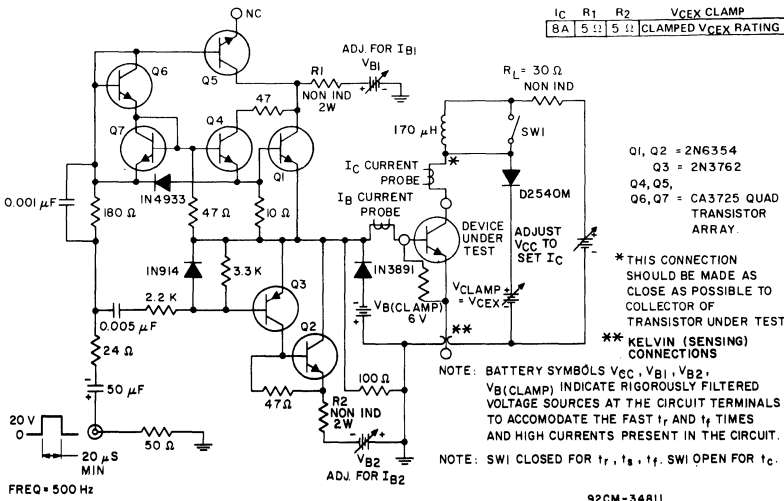


Fig. 15 — Circuit for measuring switching times.

15-Ampere N-P-N Monolithic Darlington Power Transistor

400 V , 35 W
Gain of 20 at 15A

Features:

- High voltage breakdown

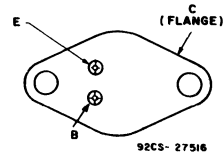
Applications:

- Power switching
- Automotive Ignition
- Solenoid drivers
- Series and shunt regulators

The BUX37 is a monolithic n-p-n silicon Darlington transistor designed for automotive electronic power applications. The construction of this device provides good forward and reverse second-breakdown capability.

The BUX37 is supplied in the JEDEC TO-204AA steel hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

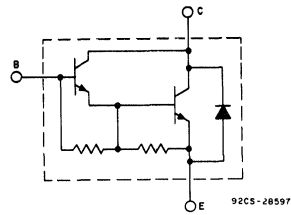


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

$V_{CEO(sus)}$	400	V
V_{EBO}	7	V
I_C	15	A
I_B	4	A
P_T	35	W
$T_C < 100^\circ\text{C}$		
$T_C > 100^\circ\text{C}$	Derate Linearly 0.7	W/ $^\circ\text{C}$
T_{stg}, T_J	-65 to 150	$^\circ\text{C}$
T_L		
At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	235	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		BUX37		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
I_{CEO}	400			0	—	0.25	mA
$V_{CEO(sus)}^b$ L = 1.5 mH			5 ^a	0	400	—	V
$V_{(BR)EBO}$ $I_E = 50$ mA			0		7	—	
h_{FE}	5		15 ^a		20	—	V
$V_{BE(sat)}$			10 ^a	0.15	—	2.7	
$T_C = -40^\circ\text{C}$			10 ^a	0.15	—	3.5	
$V_{CE(sat)}$			7 ^a	0.07	—	1.5	
			10 ^a	0.15	—	2	V
$T_C = -40^\circ\text{C}$			10 ^a	0.15	—	2.9	
$R_{\theta JC}$					—	1.5	$^\circ\text{C/W}$

^a Pulsed; pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: The sustaining voltage $V_{CEO(sus)}$ *MUST NOT* be measured on a curve tracer.

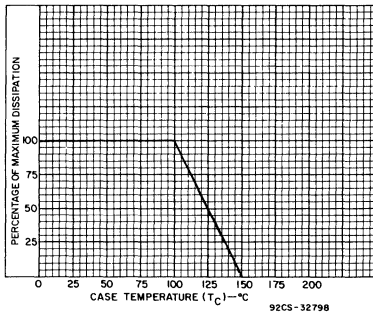


Fig. 2 — Derating curve.

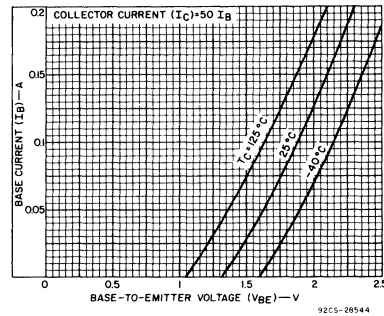


Fig. 3 — Typical input characteristics.

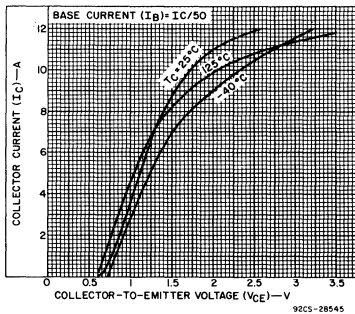


Fig. 4 — Typical output characteristics.

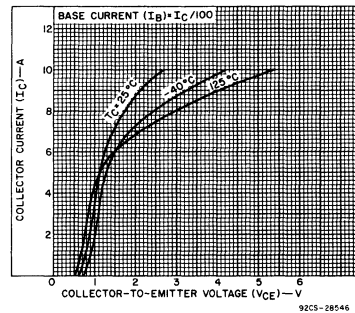


Fig. 5 — Typical output characteristics.

BUX37

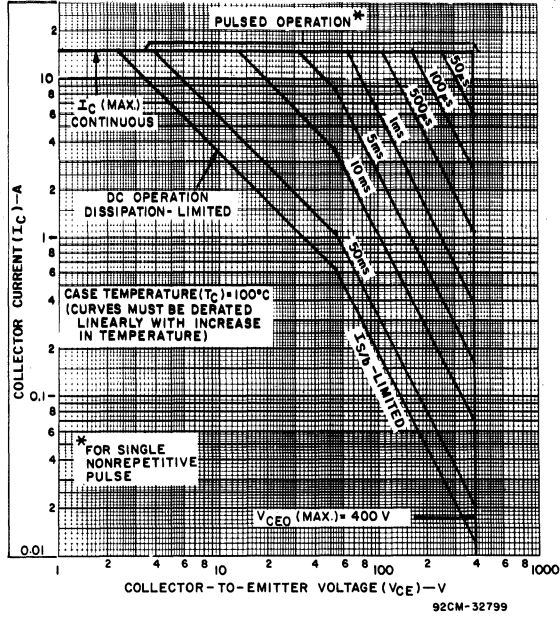


Fig. 6 — Maximum operating areas ($T_c = 100^\circ C$).

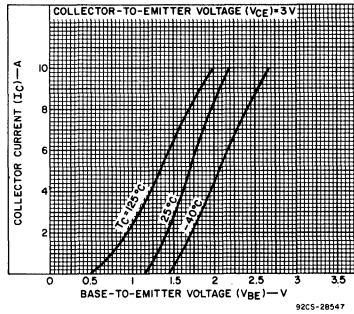


Fig. 7 — Typical transfer characteristics.

High-Current, High-Speed, High-Power Silicon N-P-N Planar Transistors

For Switching and Amplifier Applications in Industrial and Commercial Service

Features:

- Maximum area-of-operation curves for dc and pulse operation - $I_{S/B}$ limit begins at 25 V
- Fast turn-on time - 1 μ s at $I_C = 15$ A
- High-current capability - β_{FE} , $V_{CE(sat)}$, $V_{BE(sat)}$ measured at $I_C = 10$ A

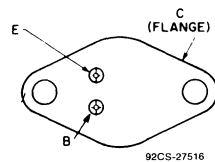
2

The RCA BUX39 is an epitaxial silicon n-p-n planar transistor that has high current and high power handling capability and fast switching speed.

This device is especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits converters, inverters, control circuits. Other recommended applications include dc-rf amplifiers, and power oscillators.

The BUX39 is supplied in a steel JEDEC TO-204AA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

V_{CBO}	120 V
V_{CEX} $V_{BE} = -1.5$ V	120 V
V_{CER} $R_{BE} = 100 \Omega$	110 V
$V_{CEO(SUS)}$	90 V
V_{EBO}	7 V
I_C	30 A
I_{CM}	40 A
I_B	6 A
P_T $T_C \leq 25^\circ\text{C}$	120 W
$T_C \geq 25^\circ\text{C}$, derate linearly	0.68 W/ $^\circ\text{C}$
T_{stg} , T_J	-65 to 100 $^\circ\text{C}$
T_L At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	230 $^\circ\text{C}$

BUX39

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		Min.	Typ.	Max.	
	V_{CE}	V_{BE}	I_C	I_B				
I_{CEO}	70				—	—	1	mA
I_{CEX}	120	-1.5			—	—	1	
$T_C = 125^\circ C$	120	-1.5			—	—	5	
I_{EBO}		-5	0		—	—	1	V
$V_{CEO(sus)}^a$ L = 25 mH			0.2 ^b	0	90	—	—	
$V_{(BR)EBO}$ $I_E = 50$ mA			0		7	—	—	V
h_{FE}	4 4		12 ^b 20 ^b		15 8	— —	45 —	
$V_{BE(sat)}$			20 ^b	2.5	—	2.1	2.5	V
$V_{CE(sat)}$			12 ^b 20 ^b	1.2 2.5	— —	0.7 1.25	1.2 1.6	
$I_{S/b}$ t = 1 s	45 30				1 4	— —	— —	A
f_T	15		1		8	—	—	MHz
t_{ON} $t_d + t_r$	$V_{CC} =$ 30 V		20	2.5	—	0.8	1.5	μS
t_s			20	2.5 ^c	—	0.55	1	
t_f			20	2.5 ^c		0.15	0.3	
$R_{\theta JC}$					—	—	1.46	$^\circ C/W$

A CAUTION: The sustaining voltage $V_{CEO(sus)}$ **MUST NOT** be measured on a curve tracer.

b Pulsed; pulse duration $\leq 300 \mu s$, duty factor $\leq 2\%$.

c $I_{B1} = -I_{B2}$.

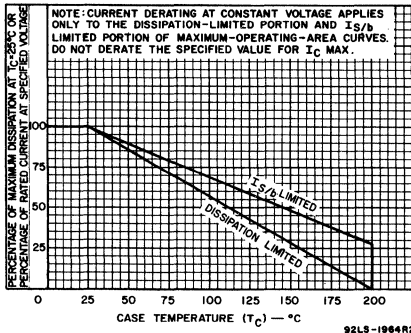


Fig. 1 - Derating curves.

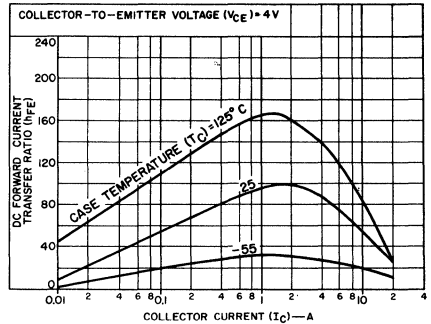


Fig. 2 - Typical DC beta characteristics.

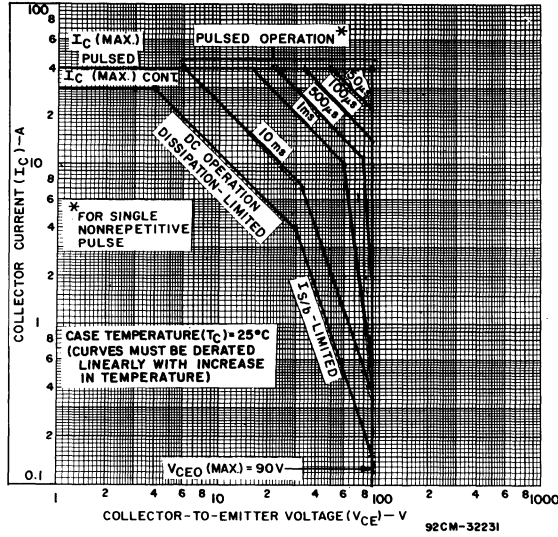


Fig. 3 - Maximum operating areas.

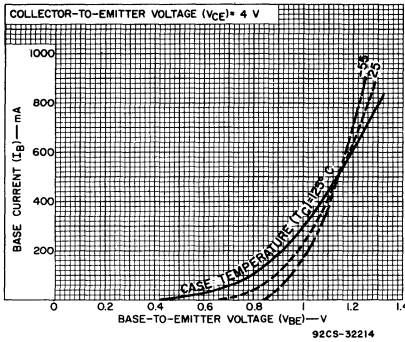


Fig. 4 - Typical input characteristics.

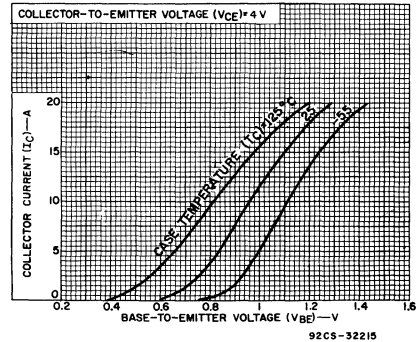


Fig. 5 - Typical transfer characteristics.

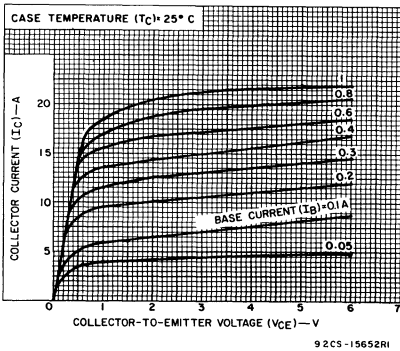


Fig. 6 - Typical output characteristics.

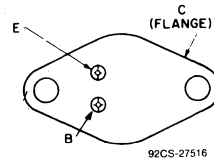
BUX45

**High-Voltage, High-Power
Silicon N-P-N
Power-Switching Transistors**

Features:

- V_{CE0} — 500V
- I_C — 5A
- P_T — 120W

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX45 is an epitaxial-base silicon n-p-n transistor having high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. It is specially designed for use in off-line power supplies and is also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUX45 is supplied in a steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

BUX45

V_{CBO}	500	V
V_{CER} $R_{BE} = 100\Omega$	500	V
V_{CE0}	500	V
V_{CEX} $V_{BE} = -1.5V$	500	V
V_{EBO}	7	V
I_C	5	A
I_{CM}	7	A
I_B	1	A
P_T $I_C \leq 25^\circ C$	120	W
$T_C > 25^\circ C$ derate linearly	0.69	W/ $^\circ C$
T_{stg} T_J	-65 to +200	$^\circ C$
T_L At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	235	$^\circ C$

BUX45

ELECTRICAL CHARACTERISTICS, Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX45			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	400			0	—	—	1	mA
I_{CEX}	500	-1.5			—	—	1	
$T_C = 125^\circ\text{C}$	500	-1.5			—	—	5	
I_{EBO}		-5	0		—	—	1	V
$V_{CEO(sus)}^b$			0.2 ^a	0	500	—	—	
$V_{(BR)EBO} \ I_E = 50 \text{ mA}$			0		7	—	—	
h_{FE}	4		1 ^a		15	—	45	
	4		2 ^a		8	—	—	
$V_{BE(sat)}$			2 ^a	0.4	—	0.8	2	V
$V_{CE(sat)}$			1 ^a	0.125	—	0.15	1	
			2 ^a	0.4	—	0.15	2	
f_T	15		1		8	—	—	MHz
I_S/b $t = 1 \text{ s, nonrepetitive}$	135				0.15	—	—	A
	30				4	—	—	
t_{ON}	V_{CC}		2	0.4	—	0.4	1	μs
$t_s \ |B_1 = |B_2$	=		2	0.4	—	3.5	5	
$t_f \ |B_1 = |B_2$	100 V		2	0.4	—	0.6	1.2	
$R_{\theta JC}$					—	—	1.46	$^\circ\text{C/W}$

^a Pulsed; pulse duration = 300 μs , duty factor $\leq 2\%$.

^b CAUTION: The sustaining voltage $V_{CEO(sus)}$ *MUST NOT* be measured on a curve tracer.

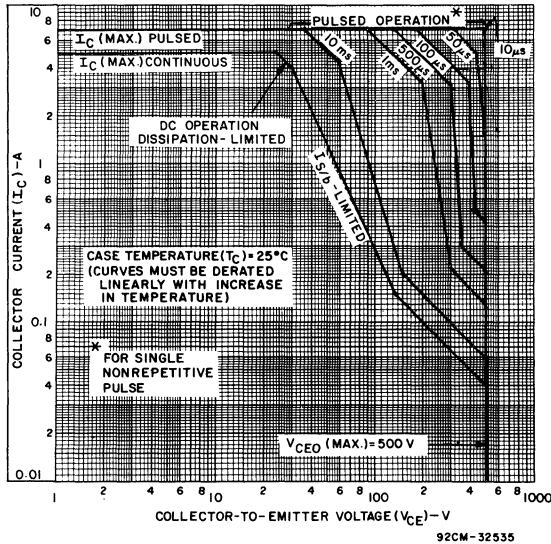


Fig. 1 — Maximum safe-operating areas ($T_C = 25^\circ\text{C}$).

BUX45

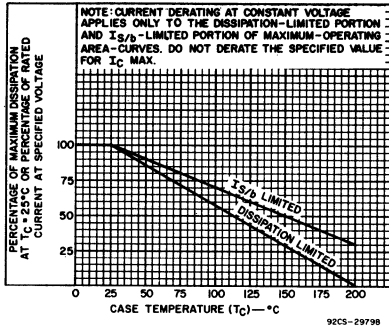


Fig. 2 — Derating curves for $I_{S/B}$ and dissipation.

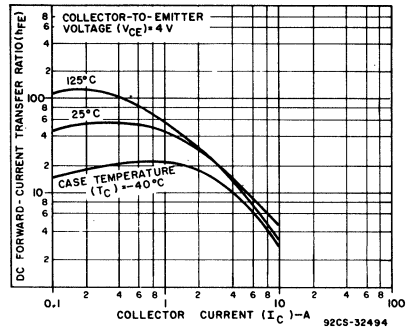


Fig. 3 — Typical dc beta characteristics.

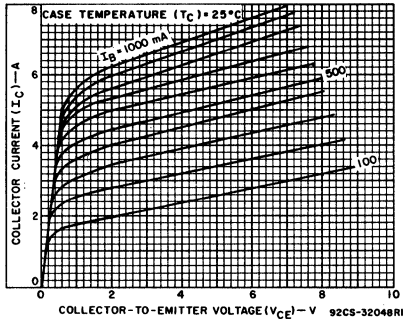


Fig. 4 — Typical output characteristics.

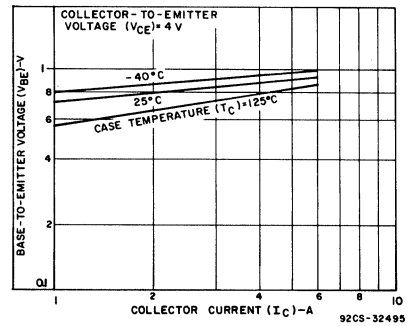


Fig. 5 — Typical base-to-emitter voltage as a function of collector current.

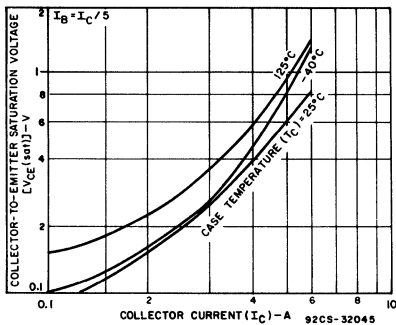


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current.

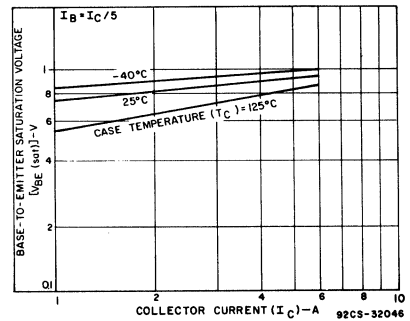


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current.

BUX45

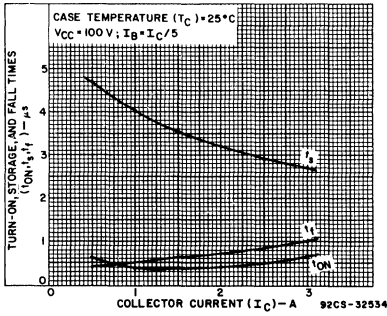


Fig. 8 — Typical saturated-switching times as a function of collector current.

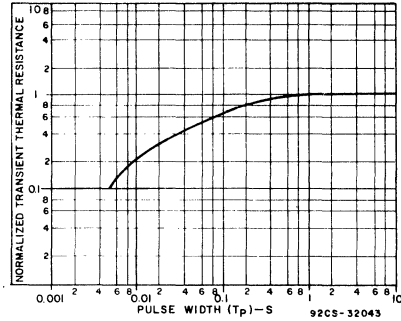


Fig. 9 — Typical thermal-response characteristic.

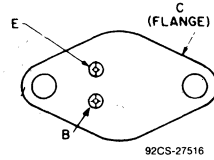
High Voltage Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

- **High voltage ratings:**
 $V_{CE0(SUS)} = -150 \text{ V max. (BUX66)}$
 $= -250 \text{ V max. (BUX66A)}$
 $= -300 \text{ V max. (BUX66B)}$
 $= -350 \text{ V max. (BUX66C)}$
- **Large safe-operating area.**

TERMINAL DESIGNATIONS



JEDEC TO-213AA

The RCA-BUX66, BUX66A, BUX66B, and BUX66C are silicon p-n-p transistors with high breakdown voltages and fast switching speeds. These transistors are intended for a wide variety of applications in ac/dc commercial equipment.

Typical applications include high-voltage operational and linear amplifiers, high-voltage switches, switching regulators, converters, and inverters.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUX66	BUX66A	BUX66B	BUX66C	
V_{CBO}	-200	-300	-350	-400	V
$V_{CEV(SUS)}$ $V_{BE} = -1.5 \text{ V}$	-200	-300	-350	-400	V
$V_{CER(SUS)}$ $R_{BE} = 100\Omega$	-175	-275	-325	-375	V
$V_{CEO(SUS)}$	-150	-250	-300	-350	V
V_{EBO}	-6	-6	-6	-6	V
I_C	-2	-2	-2	-2	A
I_{CM}	-5	-5	-5	-5	A
I_B	-1	-1	-1	-1	A
P_T Up to 25°C	35	35	35	35	W
Above 25°C, Derate linearly.	0.2	0.2	0.2	0.2	W/°C
T_J, T_{stg}	-65 to 200				°C
T_L At distance 1/16 in. (1.58 mm) from seating plane for 10 s max.	235	235	235	235	°C

BUX66, BUX66A, BUX66B, BUX66C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BUX66		BUX66A		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
I _{CEO}	-150			0	-	-10	-	-10	mA
I _{CEX}	-200	1.5			-	-8	-	-	
	-300	1.5			-	-	-	-8	
$T_C = 100^\circ\text{C}$	-200	1.5			-	-10	-	-	mA
	-300	1.5			-	-	-	-10	
I _{EBO}		6	0		-	-1	-	-1	mA
h _{FE}	-5		-1 ^a		10	150	10	150	
V _{CEO(sus)}			-0.2 ^a	0	-150 ^c	-	-250 ^c	-	V
V _{CER(sus)} R _{BE} = 50 Ω			-0.2		-175 ^c	-	-275 ^c	-	
V _{BE(sat)}			-1 ^a	-0.15	-	-1.5	-	-1.5	V
V _{CE(sat)}			-1 ^a	-0.15	-	-2.5	-	-2.5	V
C _{obo} V _{CB} = 10 V f = 1 MHz					-	220	-	220	pF
I _{S/b} t = 1 s, nonrep.	-40				-875	-	-875	-	mA
|h _{fe}| f = 5 MHz	-10		-0.2		4	-	4	-	
t _r V _{CC} = -200 V			-1	-0.10 ^b	-	0.6	-	0.6	μs
t _s V _{CC} = -200 V			-1	-0.10 ^b	-	2.5	-	2.5	
t _f V _{CC} = -200 V			-1	-0.10 ^b	-	0.6	-	0.6	
R _{θJC}					-	5	-	5	°C/W

^a Pulsed: Pulse duration = 300 μs; duty factor ≤ 2%.

^b I_{B1} = I_{B2}

^c Sustaining voltages, V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.

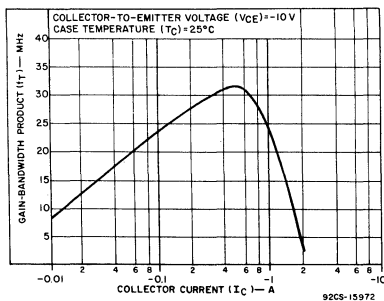


Fig. 1 — Typical gain-bandwidth product for all types.

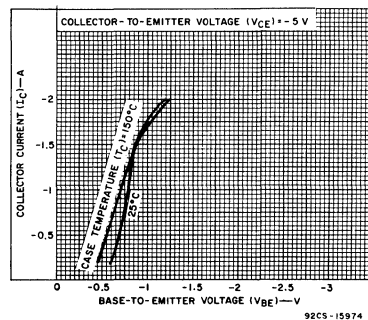


Fig. 2 — Typical transfer characteristics for all types.

BUX66, BUX66A, BUX66B, BUX66C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BUX66B		BUX66C		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
I _{CEO}	-150			0	-	-5	-	-5	mA
I _{CEX}	-350	1.5			-	-8	-	-	
	-400	1.5			-	-	-	-8	
T _C = 100°C	-350	1.5			-	-10	-	-	
	-400	1.5			-	-	-	-10	
I _{EBO}		6	0		-	-1	-	-1	mA
h _{FE}	-5		-1 ^a		10	150	10	150	
V _{CEO(sus)}			-0.2 ^a	0	-300 ^c	-	-350 ^c	-	
V _{CER(sus)} R _{BE} = 50 Ω			-0.2		-325 ^c	-	-375 ^c	-	V
V _{BE(sat)}			-1 ^a	-0.15	-	-1.5	-	-1.5	V
V _{CE(sat)}			-1 ^a	-0.15	-	-2.5	-	-2.5	V
C _{obo} V _{CB} = 10 V f = 1 MHz					-	220	-	220	pF
I _{S/b} t = 1 s, nonrep.	-40				-875	-	-875	-	mA
|h _{fe} l f = 5 MHz	-10		-0.2		4	-	4	-	
t _r V _{CC} = -200 V			-1	-0.10 ^b	-	0.6	-	0.6	μs
t _s V _{CC} = -200 V			-1	-0.10 ^b	-	2.5	-	2.5	
t _f V _{CC} = -200 V			-1	-0.10 ^b	-	0.6	-	0.6	
R _{θJC}					-	5	-	5	°C/W

^a Pulsed: Pulse duration = 300 μs; duty factor ≤ 2%.

^b I_{B1} = I_{B2}

^c Sustaining voltages, V_{CEO(sus)} and V_{CER(sus)} MUST NOT be measured on a curve tracer.

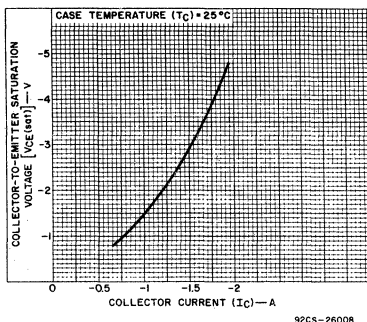


Fig. 3 - Typical saturation-voltage characteristic for all types.

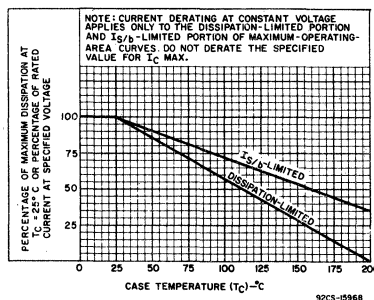
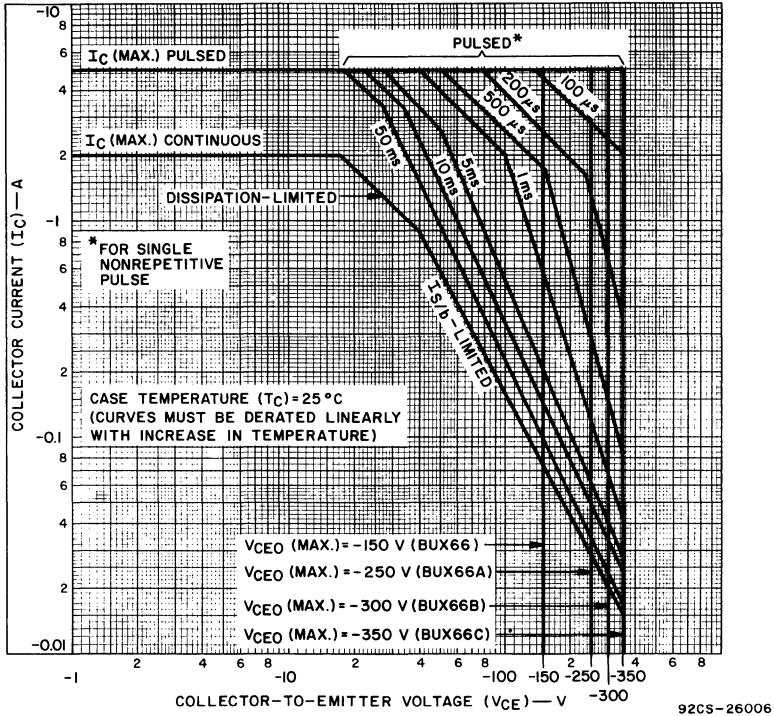


Fig. 4 - Derating curve for all types.

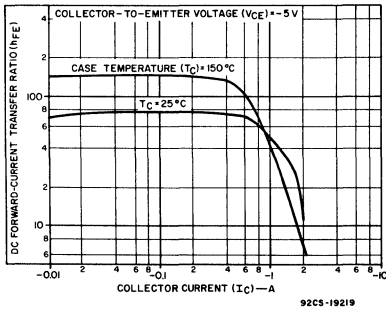
BUX66, BUX66A, BUX66B, BUX66C

2



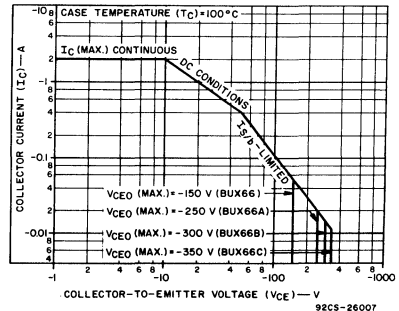
92CS-26006

Fig.5 — Maximum operating areas for all types.



92CS-19219

Fig. 6 — Typical dc beta characteristics for all types.



92CS-26007

Fig. 7 — Maximum operating areas for all types at $T_c = 100^\circ\text{C}$.

BUX66, BUX66A, BUX66B, BUX66C

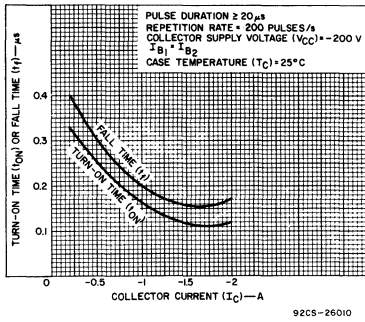


Fig. 8 — Typical turn-on time and fall-time characteristics for all types.

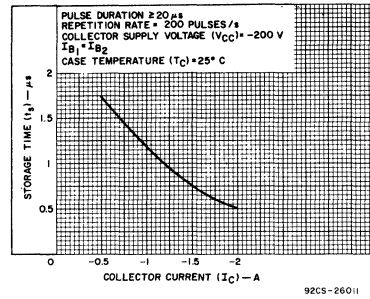


Fig. 9 — Typical storage-time characteristic for all types.

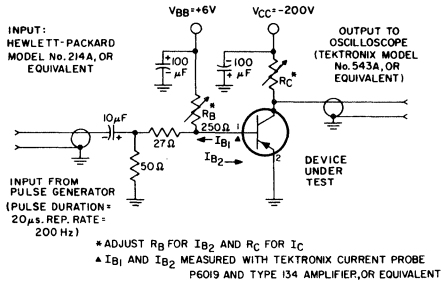


Fig. 10 — Circuit used to measure saturated switching times for all types.

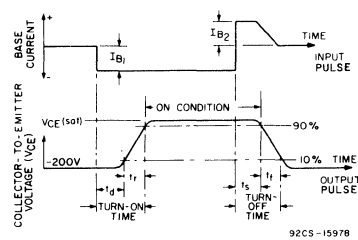


Fig. 11 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

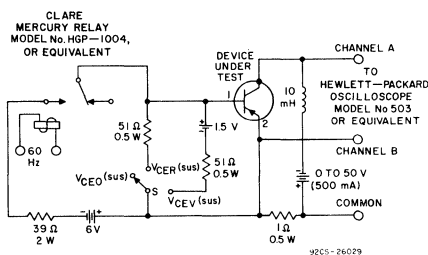
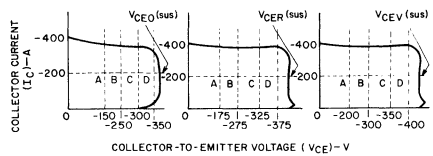


Fig. 12 — Circuit used to measure sustaining voltages $V_{CE0}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ for all types.



NOTE: Sustaining voltages are acceptable when traces fall to the right and above points "A" for BUX66, points "B" for BUX66A, points "C" for BUX66B, and points "D" for BUX66C.

Fig. 13 — Oscilloscope display for measurement of sustaining voltages.

High Voltage Silicon N-P-N Power Transistors

For Horizontal-Deflection Circuits and Other High-Voltage Switching Applications

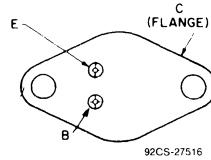
Features:

- Fast Switching Speed
- High Voltage Ratings: $V_{CEX} = 500-1000V$

Applications:

- Off-Line Power Supplies
- High-Voltage Inverters
- Switching Regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AA



The RCA-BUY69 series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, together with high safe-operating-area (SOA) ratings.

They are intended for horizontal-deflection circuit application in black and white television, CRT's, off-line power supplies and a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUY69 series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	BUY69A	BUY69B	BUY69C	
V_{CBO}	1000	800	500	V
V_{CEO}	400	325	200	V
V_{CEX}				
$V_{BE} = -2 V$	1000	800	500	V
V_{EBO}	_____	8	_____	V
I_C	_____	10	_____	A
$I_{CM}(tp = 500 \mu s)$	_____	15	_____	A
I_B	_____	3	_____	A
P_T				
$T_C = 25^\circ C$	_____	100	_____	W
T_J	_____	200	_____	$^\circ C$
T_{stg}	_____	-65 to 200	_____	$^\circ C$
T_L				
At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.	_____	235	_____	$^\circ C$

BUY69A, BUY69B, BUY69C

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		BUY69A		BUY69B		BUY69C		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CEX}	1000 800 500	-2 -2 -2			- - -	0.1 - -	- - -	- 0.1 -	- - -	- - 0.1	mA
I _{EBO}		-5	0		-	1	-	1	-	1	
V _{CEO(sus)} ^b			0.2 ^a	0	400	-	325	-	200	-	V
h _{FE}	10		2.5 ^a		15	-	15	-	15	-	
V _{BE(sat)}			8 ^a	2.5	-	2.2	-	2.2	-	2.2	V
V _{CE(sat)}			8 ^a	2.5	-	3.3	-	3.3	-	3.3	
V(BR)CBO			0.1		1000	-	800	-	500	-	
V(BR)EBO I _E = 10 mA					8	-	8	-	8	-	
I _{S/b} t = 1 s	25				4	-	4	-	4	-	A
f _T f = 10 MHz	10		0.5		6 (typ.)		6 (typ.)		6 (typ.)		MHz
t _f	V _{CC} = 40		8	2.5 ^c	-	1	-	1	-	1	μs
R _{θJC}					-	1.75	-	1.75	-	1.75	°C/W

^a Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

^c I_{B1} = -I_{B2}

^b CAUTION: The sustaining voltage V_{CEO(sus)} and V_{CEX} MUST NOT be measured on a curve tracer.

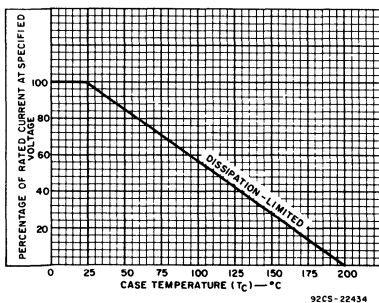


Fig. 1 — Dissipation derating curve for all types.

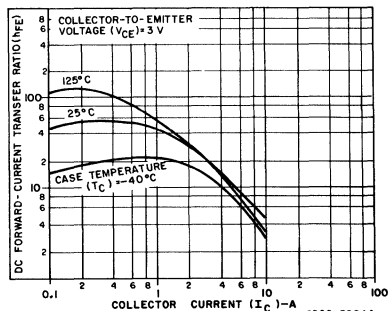


Fig. 2 — Typical dc beta characteristics for all types.

BUY69A, BUY69B, BUY69C

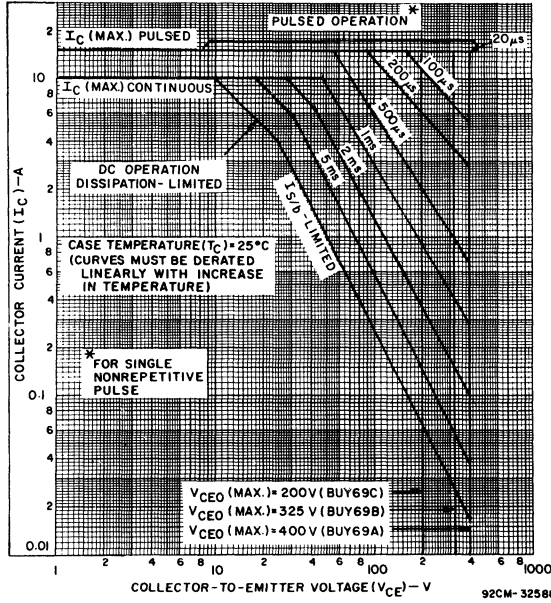


Fig. 3 — Maximum operating areas for all types ($T_C=25^\circ C$).

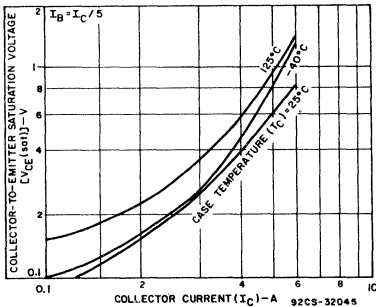


Fig. 5 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

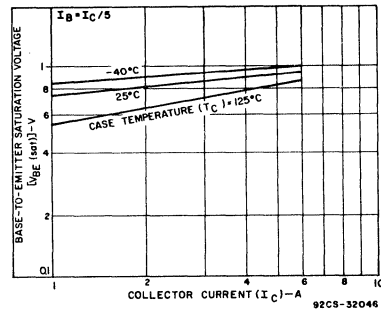


Fig. 4 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

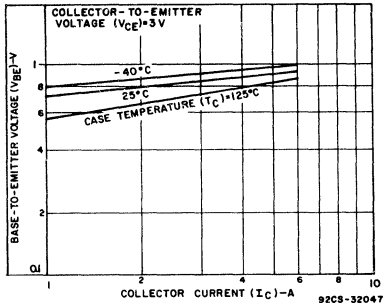


Fig. 6 — Typical base-to-emitter voltage as a function of collector current for all types.

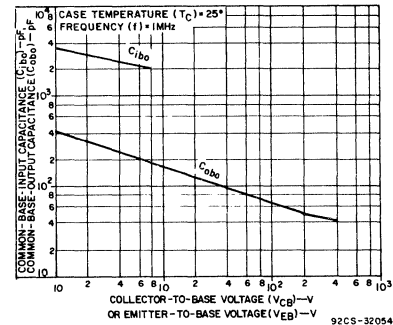


Fig. 7 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

BUY69A, BUY69B, BUY69C

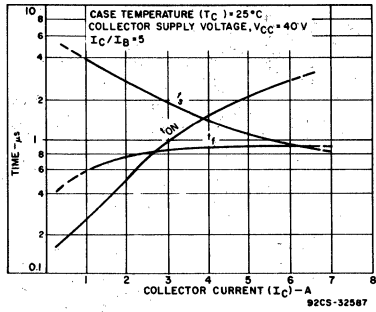


Fig. 8 — Typical switching-time characteristics as a function of collector current.

0.5-Ampere N-P-N Darlington Power Transistors

h_{FE} Min. — 10,000

1.33 Watt power dissipation at $T_A = 25^\circ$

Features:

- Operates from IC without predriver

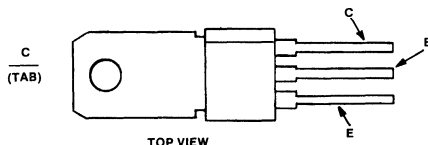
Application:

- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator

The D40C-series silicon n-p-n Darlington power transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

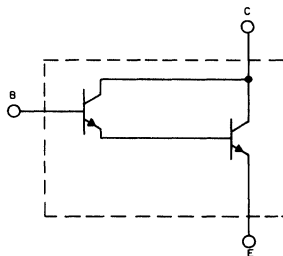
These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB



92CS-43150

Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ$ 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	I_C	0.5	0.5	0.5	A
Peak ⁽¹⁾	I_{CM}	1.0	1.0	1.0	
Base Current — Continuous	I_B	0.1	0.1	0.1	A
Total Power Dissipation @ $T_A = 25^\circ$ C	P_D	1.33	1.33	1.33	Watts
@ $T_C = 25^\circ$ C		6.25	6.25	6.25	
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	$^\circ$ C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	$^\circ$ C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	$^\circ$ C/W
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{16}$ " from Case for 5 Seconds	T_L	260	260	260	$^\circ$ C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle \leq 2%.

D40C Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = 10mA$)	D40C1 D40C4 D40C7	V_{CE0}	30 40 50	— — —	— — —	Volts
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CEs}$)	($T_C = 25^\circ C$) ($T_C = 150^\circ C$)	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⁽¹⁾

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 ($V_{CB} = 10V, f = 1MHz$)	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	$I_C = 1A, I_{B1} = I_{B2} = 1mA$ $V_{CC} = 30V, t_p = 25 \mu sec$	$t_d + t_r$	—	100	—
Storage Time		t_s	—	350	—
Fall Time		t_f	—	800	—

(1) Pulse Test: PW \leq 300ms Duty Cycle \leq 2%.

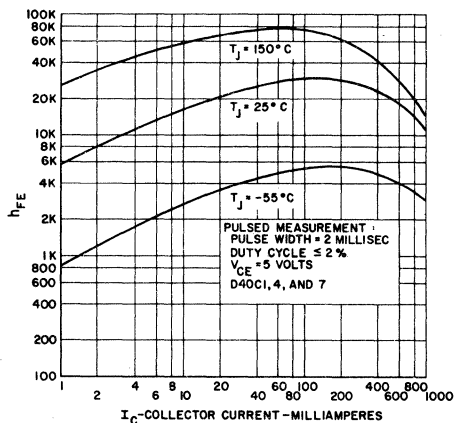


FIG 1. TYPICAL h_{FE} vs. I_C

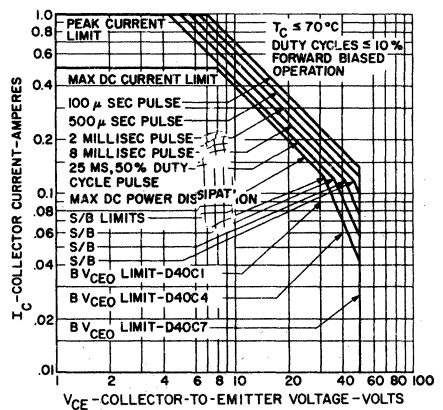


FIG. 2 SAFE REGION OF OPERATION

D40C Series

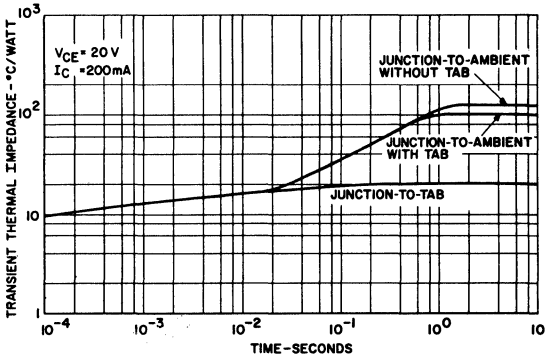


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

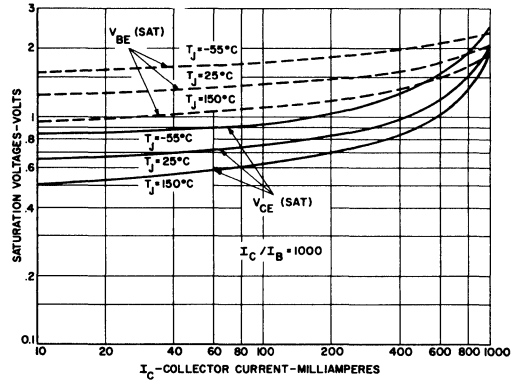


FIG. 4 TYPICAL SATURATION VOLTAGES

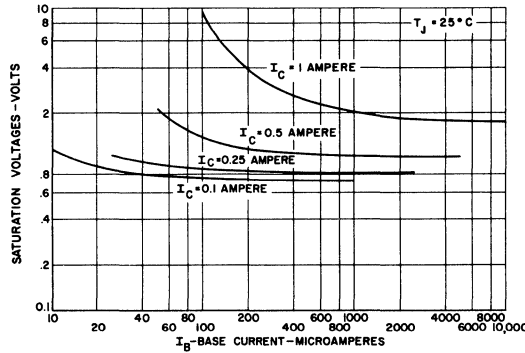


FIG. 5 TYPICAL SATURATION VOLTAGES

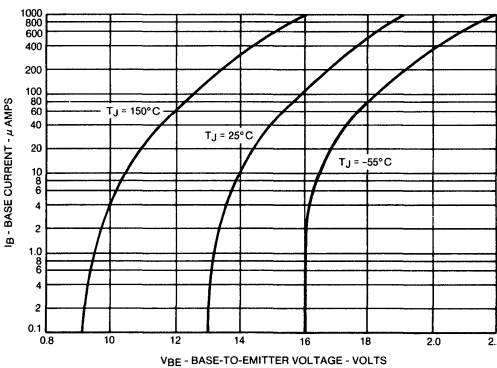


FIG. 6 TYPICAL INPUT CHARACTERISTICS

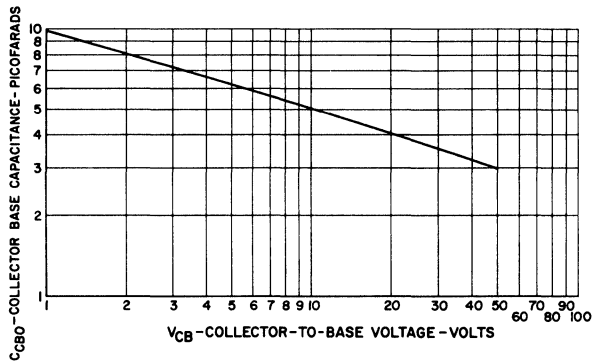


FIG. 7 TYPICAL C_{CBO} vs. VOLTAGE

2

D40D Series

File Number 15.2

1-Ampere Silicon N-P-N Power Transistors

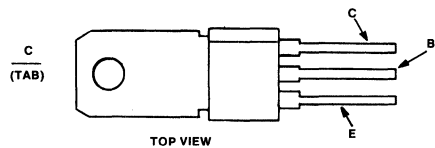
Complementary to the D41D Series

Features:

- High free-air power dissipation
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching

The D40D-series of silicon n-p-n power transistors are 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 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS

92CS-43222

JEDEC TO-202AB**MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)**

RATING	SYMBOL	D40D1, 2	D40D4, 5	D40D7, 8	UNITS
Collector-Emitter Voltage	V_{CE0}	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	I_C	1	1	1	A
Peak ⁽¹⁾	I_{CM}	1.5	1.5	1.5	
Base Current — Continuous	I_B	0.5	0.5	0.5	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle \leq 2%.

D40D Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 10\text{mA}$)	D40D1, 2 D40D4, 5 D40D7, 8	$V_{CEO(sus)}$	30 45 60	— — —	— — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEO}$) ($V_{CE} = \text{Rated } V_{CES}$)	$T_C = 25^\circ\text{C}$ $T_C = 150^\circ\text{C}$	I_{CES}	— —	— 1.0	0.1 —	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$)		I_{EBO}	—	—	0.1	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 100\text{mA}$, $V_{CE} = 2\text{V}$)	D40D1, 4, 7 D40D2, 5, 8	h_{FE}	50 120	—	150 360	—
($I_C = 1\text{A}$, $V_{CE} = 2\text{V}$)	D40D1, 4, 7 D40D2 D40D5, 8	h_{FE}	10 20 10	— — —	— — —	—
Collector-Emitter Saturation Voltage ($I_C = 500\text{mA}$, $I_B = 50\text{mA}$)	D40D1, 2, 4, 5 D40D7, 8	$V_{CE(sat)}$	— —	— —	0.5 1.0	Volts
Base-Emitter Saturation Voltage ($I_C = 500\text{mA}$, $I_B = 50\text{mA}$)		$V_{BE(sat)}$	—	—	1.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = 10\text{V}$, $f = 1\text{MHz}$)	C_{CBO}	—	8	—	pF
Current-Gain — Bandwidth Product ($I_C = 20\text{mA}$, $V_{CE} = 10\text{V}$)	f_T	—	200	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = 1\text{A}$, $I_{B1} = I_{B2} = 0.1\text{A}$	$t_d + t_r$	—	25	—	nS
Storage Time							$t_s$	—	200	—
Fall Time	$V_{CC} = 30\text{V}$, $t_p = 25 \mu\text{sec}$	t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle \leq 2%.

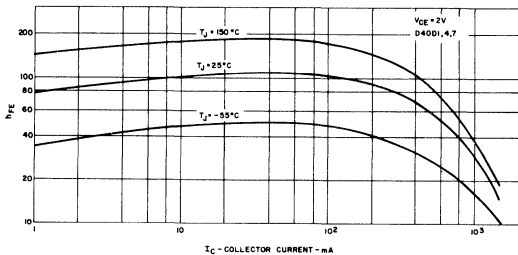


FIG. 1

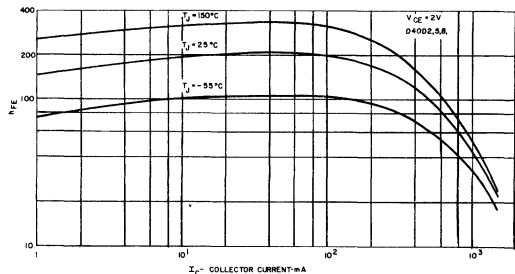


FIG. 2

TYPICAL h_{FE} VS I_C

D40D Series

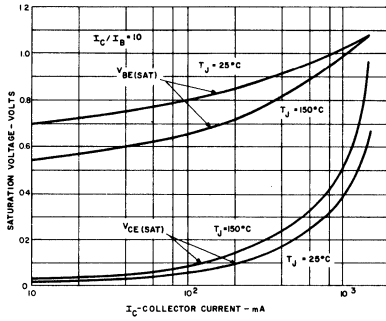


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

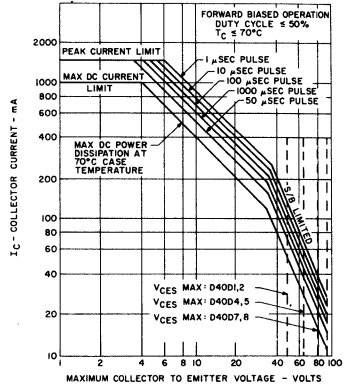


FIG. 4 SAFE REGION OF OPERATION

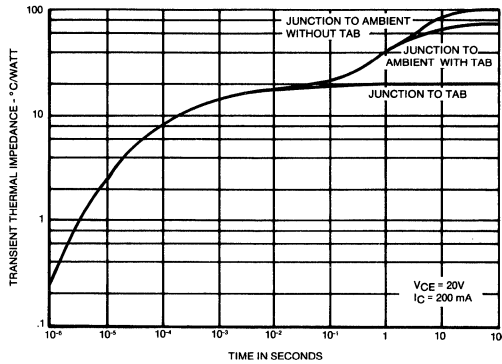


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

2-Ampere Silicon N-P-N Power Transistors

Complementary to the D41E Series

2

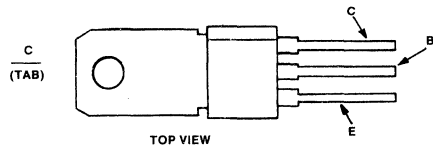
Features:

- High free-air power dissipation
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching

The D40E-series of silicon n-p-n power transistors are 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 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	2	2	2	A
Peak ⁽¹⁾	I_{CM}	3	3	3	
Base Current — Continuous	I_B	1	1	1	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle \leq 2%.

D40E Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 10mA$)	D40E1 D40E5 D40E7	$V_{CEO(sus)}$	30 60 80	— — —	— — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CES}$)		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
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ON CHARACTERISTICS⁽¹⁾

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	$I_C = 1A, I_{B1} = I_{B2} = 0.1A$ $V_{CC} = 30V, t_p = 25 \mu sec$	$t_d + t_r$	—	130	—
Storage Time		t_s	—	400	—
Fall Time		t_f	—	170	—

(1) Pulse Test PW = 300ms Duty Cycle $\leq 2\%$.

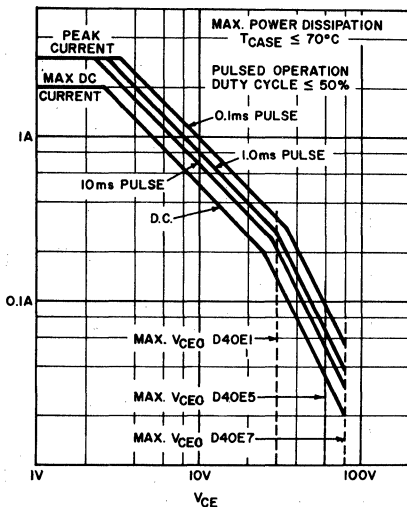


FIG. 1 SAFE REGION OF OPERATION

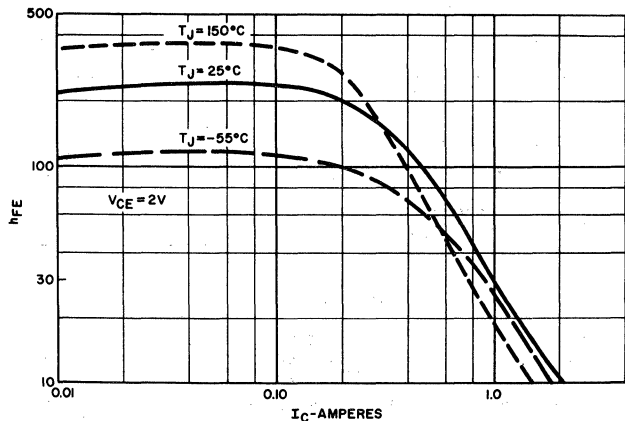


FIG. 2 TYPICAL h_{FE} VS I_C

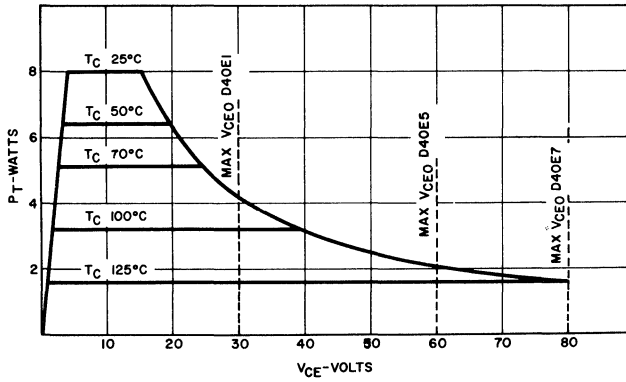


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

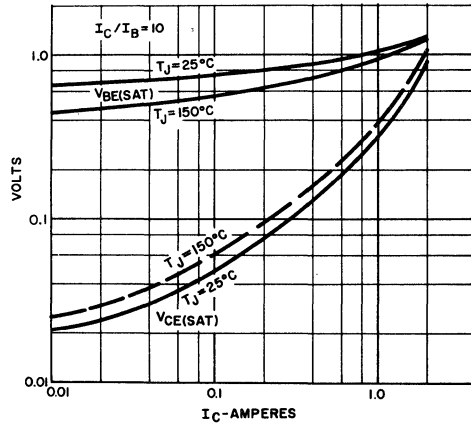


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

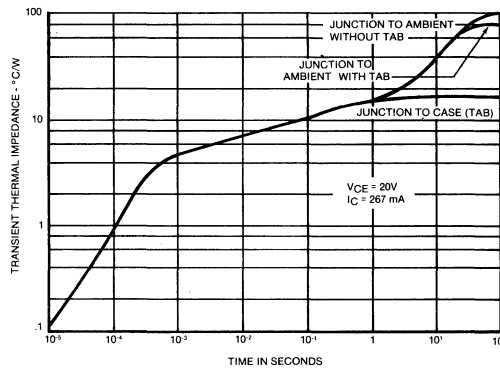


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

2-Ampere N-P-N Darlington Power Transistors

Complementary to the D41K Series

Features:

- Operates from IC without predriver

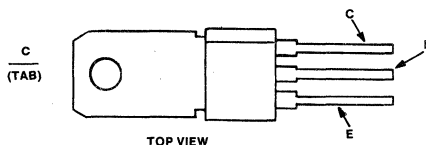
Applications:

- Switching regulator
- Lamp driver
- Touch switch
- Solenoid driver

The D40K-series of silicon n-p-n Darlington power transistors are designed for use in general purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

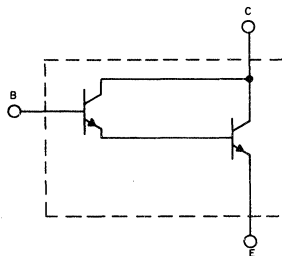
These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



92CS-4322

JEDEC TO-202AB



92CS-43150

Schematic diagram for all types.

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	I _C	2	2	A
Peak ⁽¹⁾	I _{CM}	3	3	A
Base Current — Continuous	I _B	0.2	0.2	A
Total Power Dissipation @ T _A = 25° C	P _D	1.67	1.67	Watts
@ T _C = 25° C		10	10	
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 _{θJA}	75	75	°C/W
Thermal Resistance, Junction to Case	R _{θJC}	12.5	12.5	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T _L	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D40K Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 10mA$)	D40K1,3 D40K2,4	V_{CEO}	30 50	— —	— —	Volts
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	.5	μA
Emitter Cutoff Current ($V_{EB} = 13V$)		I_{EBO}	—	—	.1	μA

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 200mA, V_{CE} = 5V$)		h_{FE}	10K	—	—	—
($I_C = 1.5A, V_{CE} = 5V$) ($I_C = 1A, V_{CE} = 5V$)	D40K1,2 D40K3,4	h_{FE}	1K 1K	— —	— —	— —
Collector-Emitter Saturation Voltage ($I_C = 1.5A, I_B = 3mA$) ($I_C = 1A, I_B = 2mA$)	D40K1,2 D40K3,4	$V_{CE(sat)}$	— —	— —	1.5 1.5	V V
Base-Emitter Saturation Voltage ($I_C = 1.5A, I_B = 3mA$) ($I_C = 1A, I_B = 2mA$)	D40K1,2 D40K3,4	$V_{BE(sat)}$	— —	— —	2.5 2.5	V V

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = 10V, f = 1MHz$)		C_{CBO}	—	5	10	pF
Current-Gain — Bandwidth Product ($I_C = 20mA, V_{CE} = 5V$)		f_T	—	75	—	MHz

(1) Pulse Test: PW \leq 300ms Duty Cycle \leq 2%.

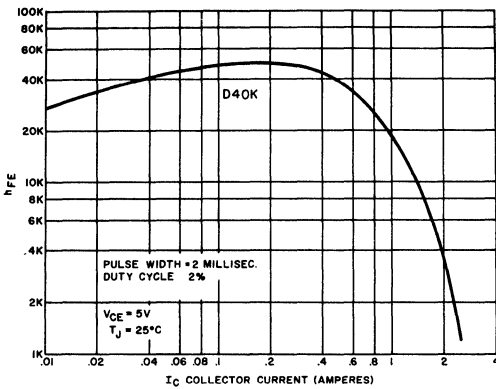


FIG. 1 TYPICAL h_{FE} vs. I_C

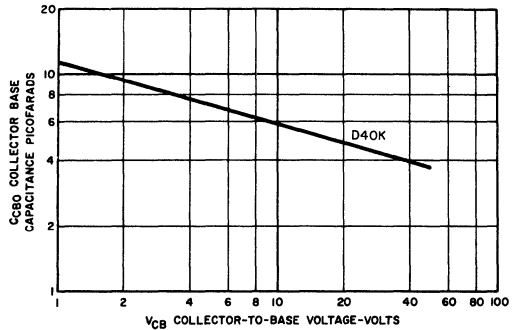
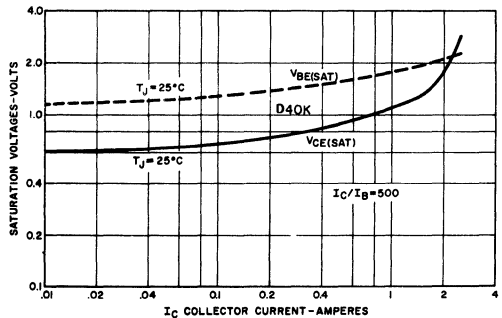


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

FIG. 3
TYPICAL
SATURATION
VOLTAGE



D40V Series

File Number **15.8**

Silicon N-P-N Power Transistors

General-Purpose Types for Medium-Power
Switching and Amplifier Applications

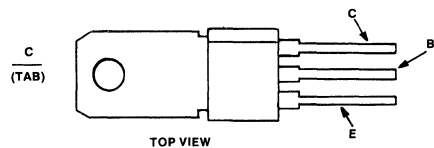
Features:

- Low C_{CB} (2 pF typical at $V_{CB} = 20V$)
- Excellent linearity

The D40V-series of silicon n-p-n power transistors are designed for general-purpose high-voltage usage. Applications include: TV horizontal driver and output stage; audio output stage of portable TV sets; high-voltage regulators; and video display drivers.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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	0.1	0.1	0.1	A
Base Current — Continuous	I_B	0.1	0.1	0.1	A
Total Power Dissipation @ $T_A = 25^\circ C$ @ $T_C = 25^\circ C$	P_D	1.7 9	1.7 9	1.7 9	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	$^\circ C$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	73.5	73.5	73.5	$^\circ C/W$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	13.9	13.9	$^\circ C/W$
Maximum Lead Temperature for Soldering Purpose: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	260	260	260	$^\circ C$

D40V Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = 5mA$)	D40V1,2 D40V3,4 D40V5,6	V_{CE0}	250 300 350	— — —	— — —	Volts
Collector Cutoff Current ($V_{CE} = 300V$) ($V_{CE} = 350V$) ($V_{CE} = 400V$)	D40V1,2 D40V3,4 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
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 5mA, V_{CE} = 10V$) ($I_C = 20mA, V_{CE} = 10V$) ($I_C = 40mA, V_{CE} = 10V$)	D40V1,3,5	h_{FE}	20 30 20	— — —	— 90 —	—
($I_C = 5mA, V_{CE} = 10V$) ($I_C = 20mA, V_{CE} = 10V$) ($I_C = 40mA, V_{CE} = 10V$)	D40V2,4,6	h_{FE}	30 60 30	— — —	— 180 —	—
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	μF
Current Gain Bandwidth Product ($I_C = 100mA, V_{CE} = 10V, f_{test} = 1.0 MHz$)	f_T	50	—	—	MHz

(1) Pulse Test: Pulse Width - 300 μs Duty Cycle $\leq 2\%$.

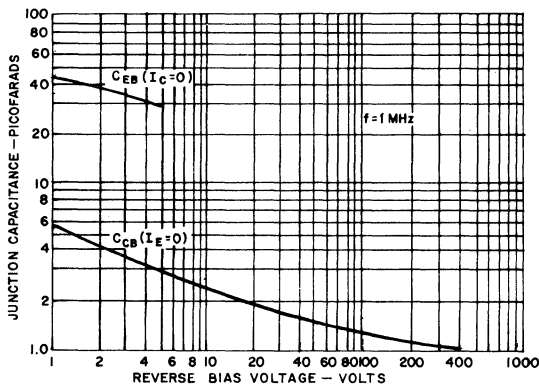


FIG. 1 JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

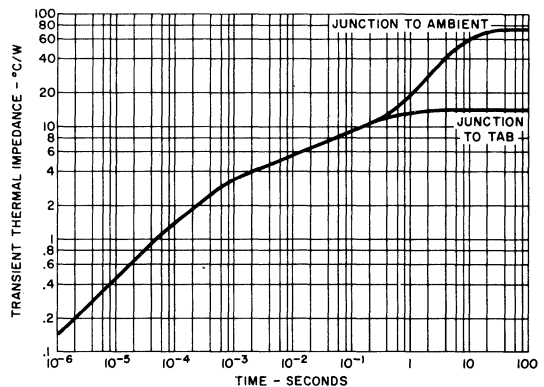


FIG. 2 MAXIMUM TRANSIENT THERMAL IMPEDANCE

D40V Series

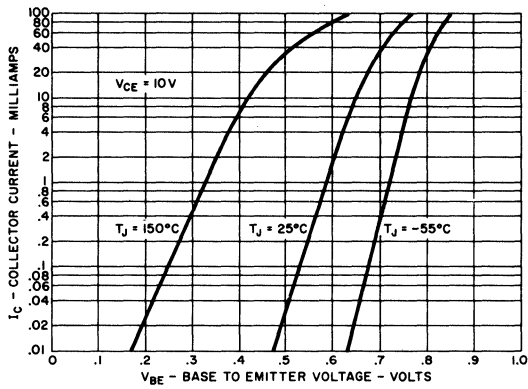


FIG. 3 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

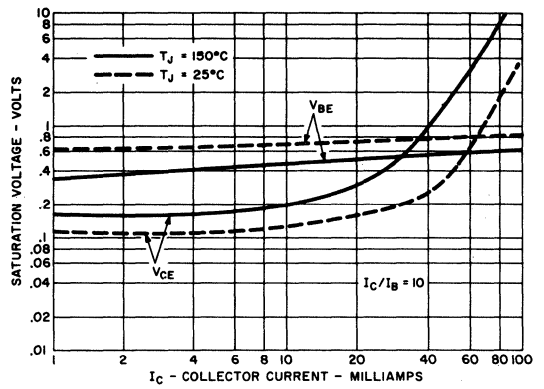


FIG. 4 TYPICAL SATURATION VOLTAGES

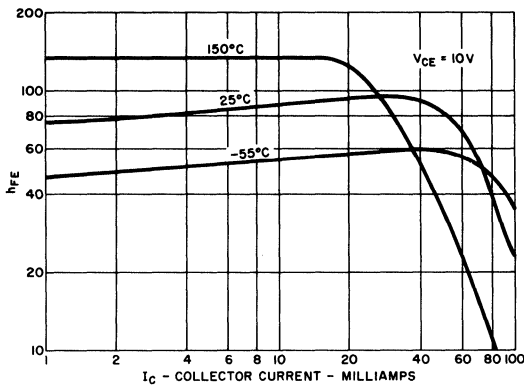


FIG. 5 TYPICAL h_{FE} VS. I_C

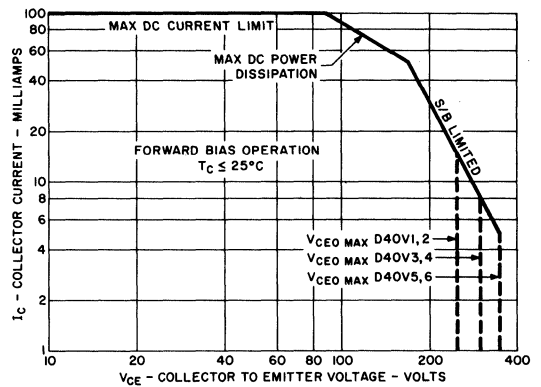


FIG. 6 SAFE REGION OF OPERATION

1-Ampere Silicon P-N-P Power Transistors

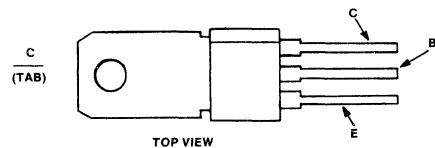
Complementary to the D40D Series

2

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -1A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB

The D41D-series of silicon p-n-p power transistors are 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 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	-1	-1	-1	A
Peak ⁽¹⁾	I_{CM}	-1.5	-1.5	-1.5	A
Base Current — Continuous	I_B	-0.5	-0.5	-0.5	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle $\leq 2\%$.

D41D Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = -10\text{mA}$)	D41D1, 2 D41D4, 5 D41D7, 8	$V_{CEO(sus)}$	-30 -45 -60	— — —	— — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEO}$) ($V_{CE} = \text{Rated } V_{CES}$)	$T_C = 25^\circ\text{C}$ $T_C = 150^\circ\text{C}$	I_{CES}	— —	— -1	-0.1 —	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$)		I_{EBO}	—	—	-0.1	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 7
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -100\text{mA}$, $V_{CE} = -2\text{V}$)	D41D1, 4, 7 D41D2, 5, 8	h_{FE}	50 120	— —	150 360	—
($I_C = -1\text{A}$, $V_{CE} = -2\text{V}$)	D41D1, 4, 7 D41D2 D41D5, 8	h_{FE}	10 20 10	— — —	— — —	—
Collector-Emitter Saturation Voltage ($I_C = -500\text{mA}$, $I_B = -50\text{mA}$)	D41D1, 2, 4, 5 D41D7, 8	$V_{CE(sat)}$	— —	— —	-0.5 -1.0	Volts
Base-Emitter Saturation Voltage ($I_C = -500\text{mA}$, $I_B = -50\text{mA}$)		$V_{BE(sat)}$	—	—	-1.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}$, $f = 1\text{MHz}$)	C_{CBO}	—	10	—	—	pF
Current-Gain — Bandwidth Product ($I_C = -20\text{mA}$, $V_{CE} = -10\text{V}$)	f_T	—	150	—	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = -1\text{A}$, $I_{B1} = I_{B2} = -0.1\text{A}$ $V_{CC} = -30\text{V}$, $t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	50	—	nS
Storage Time		t_s	—	75	—	
Fall Time		t_f	—	40	—	

(1) Pulse Test PW = 300ms Duty Cycle $\leq 2\%$.

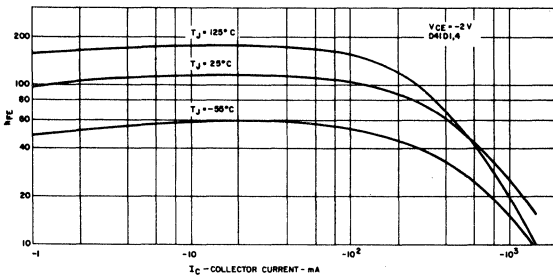


FIG. 1

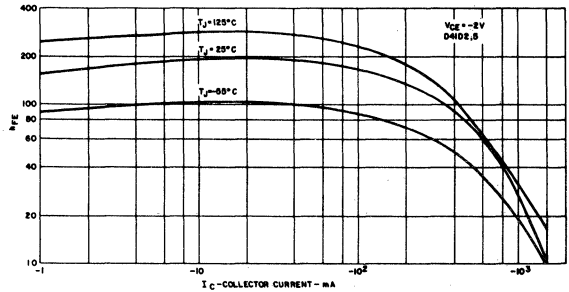


FIG. 2

TYPICAL h_{FE} VS. I_C

D41D Series

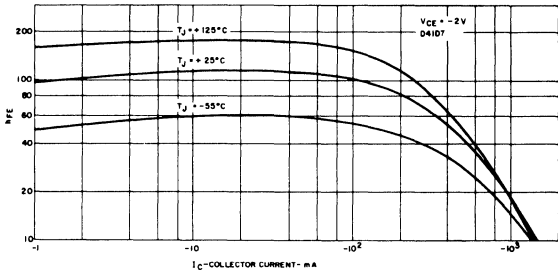


FIG. 3

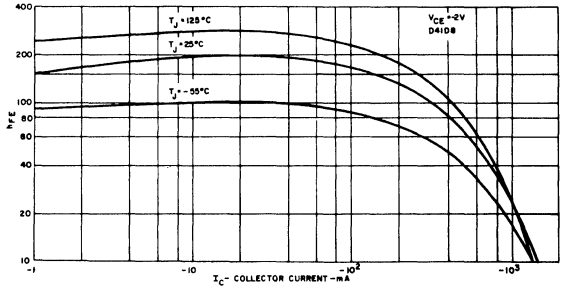


FIG. 4

TYPICAL hFE VS. IC

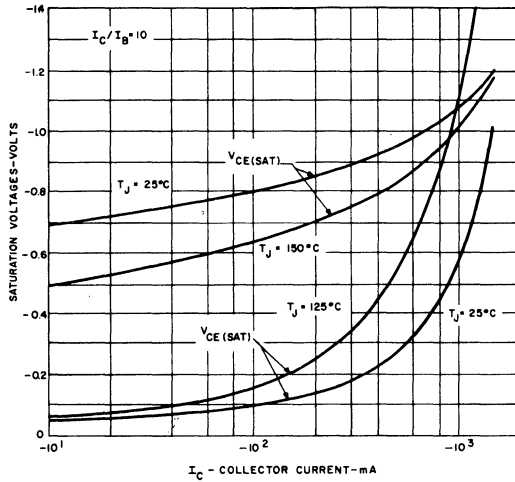


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

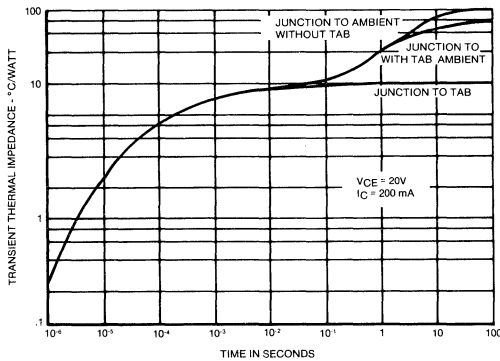


FIG. 6 MAXIMUM TRANSIENT THERMAL IMPEDANCE

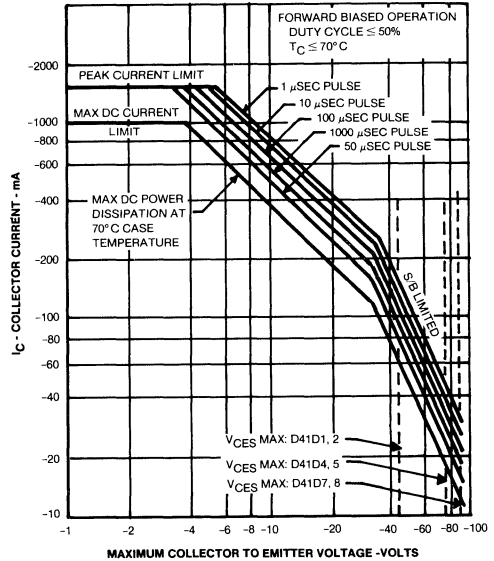


FIG. 7 SAFE REGION OF OPERATION

2

D41E Series

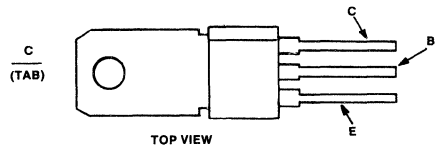
File Number 15.5

2-Ampere Silicon P-N-P Power Transistors

Complementary to the D40E Series

Features:

- High free-air power dissipation
- Low collector saturation voltage ($-0.5V$ typ. @ $-1A I_C$)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS

92CS-43222

JEDEC TO-202AB

The D41E-series of silicon p-n-p power transistors are 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 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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	I_C	-2	-2	-2	A
Peak ⁽¹⁾	I_{CM}	-3	-3	-3	
Base Current — Continuous	I_B	-1	-1	-1	A
Total Power Dissipation @ $T_A = 25^\circ C$ @ $T_C = 25^\circ C$	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	$^\circ C$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	$^\circ C/W$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	$^\circ C/W$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{16}$ " from Case for 5 Seconds	T_L	+260	+260	+260	$^\circ C$

(1) Pulse Test Pulse Width = 300ms Duty Cycle \leq 2%.

D41E Series

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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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 _{CE(s)})		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
---	-------	--------------

2

ON CHARACTERISTICS⁽¹⁾

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 _{CB0}	—	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		t _s	—	250	—	
Fall Time		t _f	—	110	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

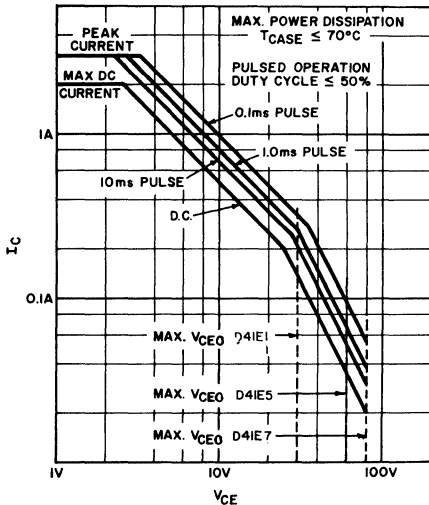


FIG. 1 SAFE REGION OF OPERATION

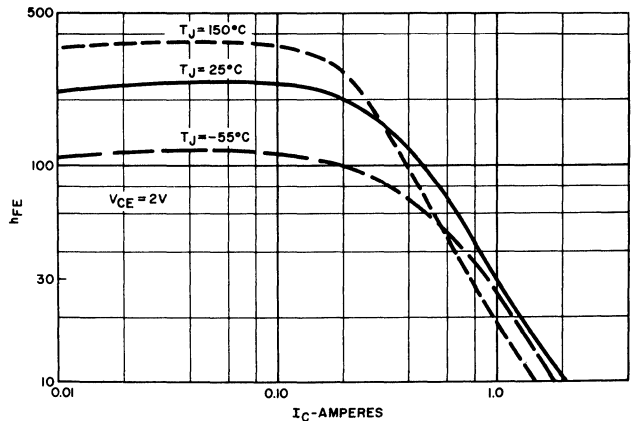


FIG. 2 TYPICAL H_{FE} VS I_C

D41E Series

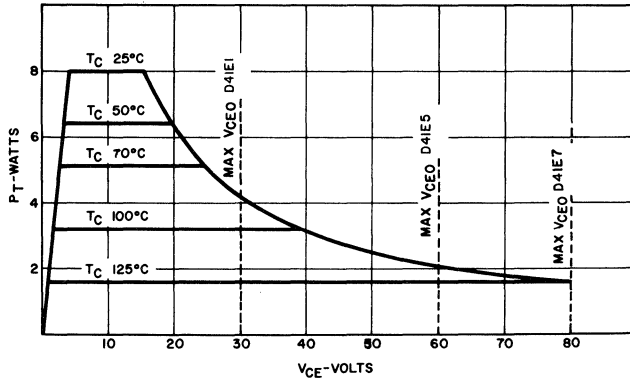


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

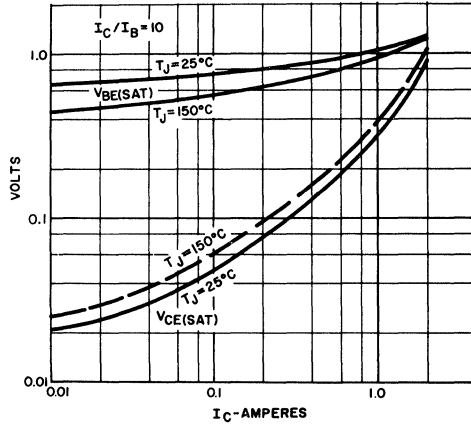


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

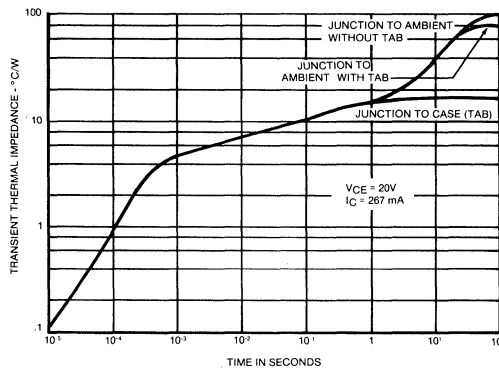


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

2-Ampere Silicon P-N-P Power Transistors

Complementary to the D40K Series

Features:

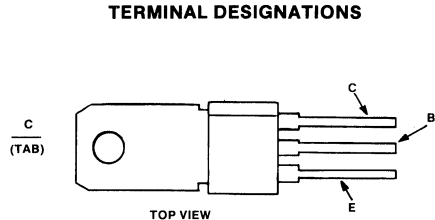
- Operates from IC without predriver

Applications:

- Switching regulator
- Lamp driver
- Touch switch
- Solenoid driver

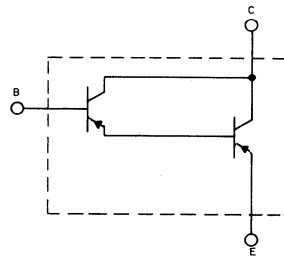
The D41K-series of silicon p-n-p Darlington power transistors are designed for general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

These devices are supplied in the JEDEC TO-202AB plastic package.



92CS-43222

JEDEC TO-202AB



92CS-43261

Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

RATING	SYMBOL	D41K1,3	D41K2,4	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	I_C	-2	-2	A
Peak ⁽¹⁾	I_{CM}	-3	-3	A
Base Current — Continuous	I_B	-0.2	-0.2	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	12.5	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	260	260	$^\circ\text{C}$

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle \leq 2%.

D41K Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = -10\text{mA}$)	D41K1,3 D41K2,4	V_{CEO}	-30 -50	— —	— —	Volts
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	-0.5	μA
Emitter Cutoff Current ($V_{EB} = -13\text{V}$)		I_{EBO}	—	—	-0.1	μA

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -200\text{mA}$, $V_{CE} = -5\text{V}$)		h_{FE}	10K	—	—	—
($I_C = -1.5\text{A}$, $V_{CE} = -5\text{V}$)	D41K1,2	h_{FE}	1K	—	—	—
($I_C = -1\text{A}$, $V_{CE} = -5\text{V}$)	D41K3,4	h_{FE}	—	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -1.5\text{A}$, $I_B = -3\text{mA}$)	D41K1,2	$V_{CE(sat)}$	—	—	-1.5	Volts
($I_C = -1.0\text{A}$, $I_B = -2\text{mA}$)	D41K3,4	$V_{CE(sat)}$	—	—	-1.5	Volts
Base-Emitter Saturation Voltage ($I_C = -1.5\text{A}$, $I_B = -3\text{mA}$)	D41K1,2	$V_{BE(sat)}$	—	—	-2.5	Volts
($I_C = -1\text{A}$, $I_B = -2\text{mA}$)	D41K3,4	$V_{BE(sat)}$	—	—	-2.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}$, $f = 1\text{MHz}$)	C_{CBO}	—	9	15	pF
Current-Gain — Bandwidth Product ($I_C = -20\text{mA}$, $V_{CE} = -5\text{V}$)	f_T	—	100	—	MHz

(1) Pulse Test: $PW \leq 300\text{ms}$ Duty Cycle $\leq 2\%$.

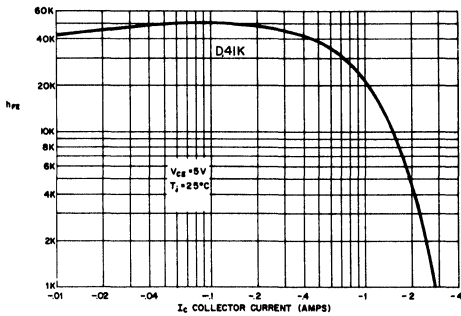


FIG. 1 TYPICAL h_{FE} vs. I_C

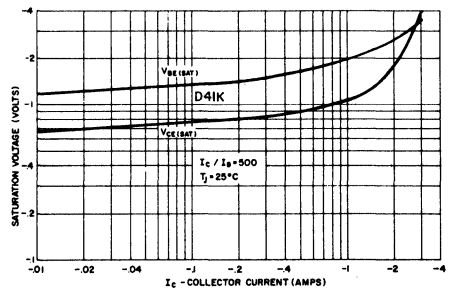


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

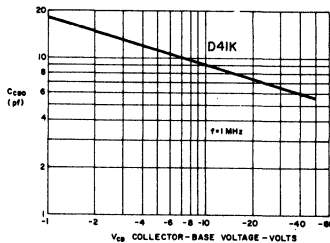


FIG. 3 TYPICAL SATURATION VOLTAGE

3-Ampere Silicon N-P-N Power Transistors

Complementary to the D43C Series

2

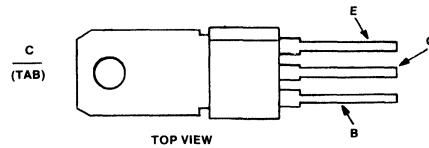
Features:

- High free-air power dissipation
- Low collector saturation voltage (0.5V typ. @ 3A I_C)
- Excellent linearity
- Fast switching

The D42C-series of silicon n-p-n power transistors are 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 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



92CS-43473

JEDEC TO-202AB

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	3	3	3	3	A
Peak ⁽¹⁾	I_{CM}	5	5	5	5	
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	$^\circ\text{C}/\text{W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	+260	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle \leq 2%.

D42C Series**ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)**

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 100\text{mA}$)	D42C1, 2, 3 D42C4, 5, 6 D42C7, 8, 9 D42C10, 11, 12	$V_{CEO(sus)}$	30 45 60 80	— — — —	— — — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	10	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$)		I_{EBO}	—	—	100	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURES 3 & 4
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 200\text{mA}$, $V_{CE} = 1\text{V}$)	D42C1, 4, 7, 10 D42C2, 5, 8, 11 D42C3, 6, 9, 12	h_{FE}	25 100 40	— — —	— 220 120	—
($I_C = 1\text{A}$, $V_{CE} = 1\text{V}$) ($I_C = 2\text{A}$, $V_{CE} = 1\text{V}$)	D42C1, 4, 7, 10 D42C2, 5, 8, 11 D42C3, 6, 9, 12	h_{FE}	10 20 20	— — —	— — —	—
Collector-Emitter Saturation Voltage ($I_C = 1\text{A}$, $I_B = 50\text{mA}$)	D42C2, 5, 8, 11 D42C3, 6, 9, 12	$V_{CE(sat)}$	— —	— —	0.5 0.5	Volts
($I_C = 1\text{A}$, $I_B = 100\text{mA}$)	D42C1, 4, 7, 10	$V_{CE(sat)}$	—	—	0.5	Volts
Base-Emitter Saturation Voltage ($I_C = 1\text{A}$, $I_B = 100\text{mA}$)		$V_{BE(sat)}$	—	—	1.3	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = 10\text{V}$, $f = 1\text{MHz}$)	C_{CBO}	—	—	100	pF
Current-Gain — Bandwidth Product ($I_C = 20\text{mA}$, $V_{CE} = 4\text{V}$)	f_T	—	50	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load					
Delay Time + Rise Time	$I_C = 1\text{A}$, $I_{B1} = I_{B2} = 0.1\text{A}$, $V_{CC} = 30\text{V}$, $t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	100	nS
Storage Time		t_s	—	500	
Fall Time		t_f	—	75	

(1) Pulse Test PW = 300ms Duty Cycle \leq 2%.

D42C Series

2

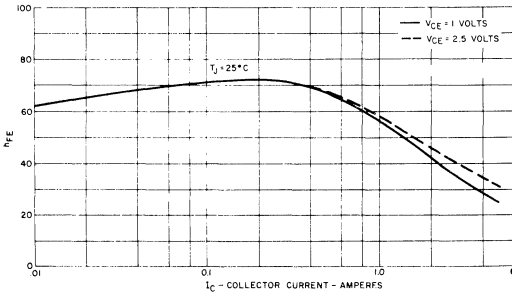


FIG. 1 TYPICAL h_{FE} VS. I_C

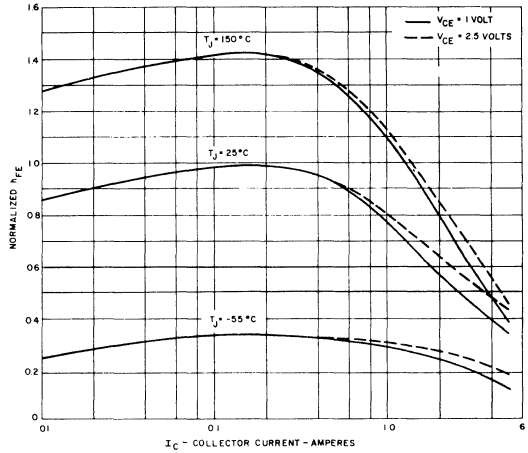


FIG. 2 TYPICAL NORMALIZED h_{FE} VS. I_C

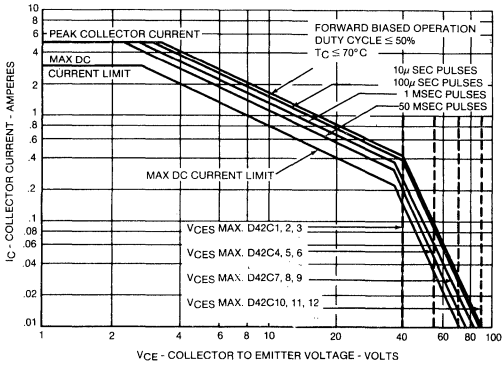


FIG. 3 SAFE REGION OF OPERATION

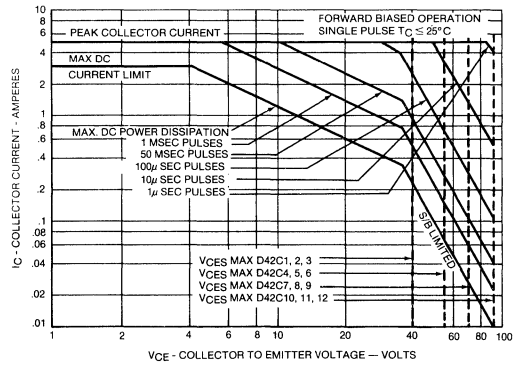


FIG. 4 SAFE REGION OF OPERATION

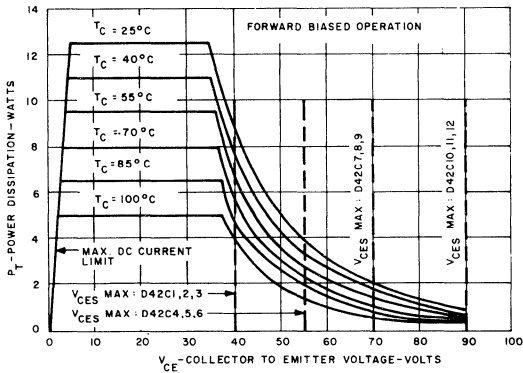


FIG. 5 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

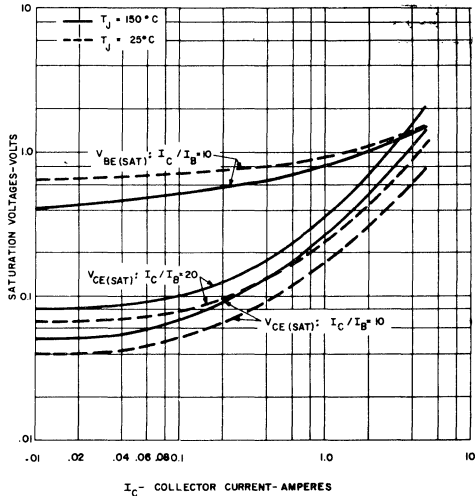


FIG. 6 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

D42C Series

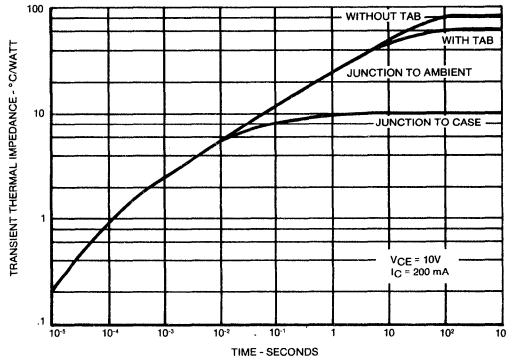


FIG. 7 MAXIMUM TRANSIENT THERMAL IMPEDANCE

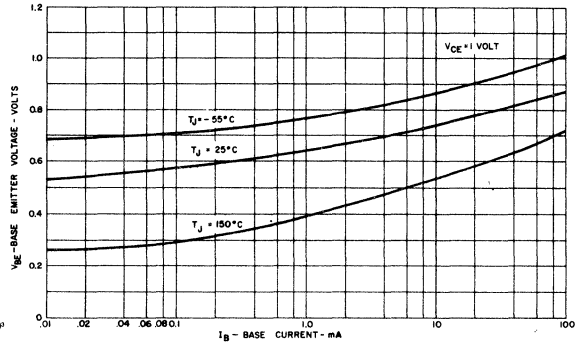


FIG. 8 TYPICAL INPUT CHARACTERISTICS

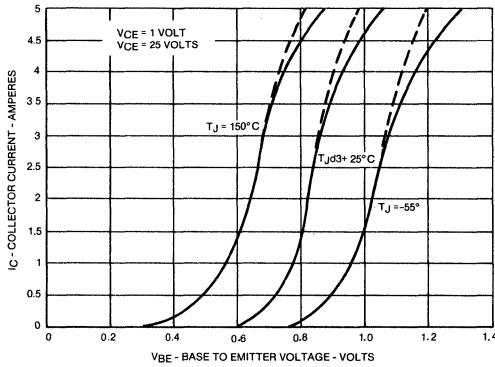


FIG. 9 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

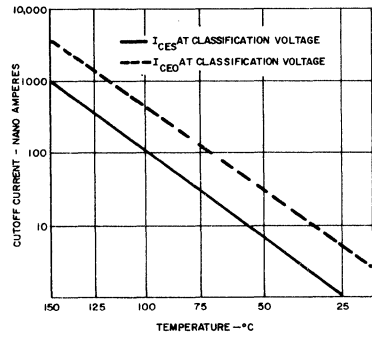


FIG. 10 TYPICAL I_{CES} , I_{CES} VS. TEMPERATURE

3-Ampere Silicon P-N-P Power Transistors

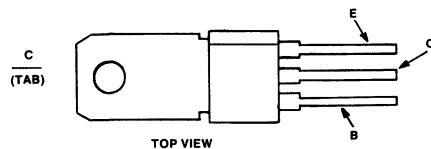
Complementary to the D42C Series

2

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -3A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



92CS-43473

JEDEC TO-202AB

The D43C-series of silicon p-n-p power transistors are 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 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	-3	-3	-3	-3	A
Peak ⁽¹⁾	I_{CM}	-5	-5	-5	-5	A
Base Current — Continuous	I_B	-2	-2	-2	-2	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	$^\circ\text{C}/\text{W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	+260	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle \leq 2%.

D43C Series**ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$)** (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = -100\text{mA}$)	D43C1, 2, 3 D43C4, 5, 6 D43C7, 8, 9 D43C10, 11, 12	$V_{CEO(sus)}$	-30 -45 -60 -80	— — — —	— — — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	-10	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$)		I_{EBO}	—	—	-100	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -200\text{mA}$, $V_{CE} = -1\text{V}$)	D43C1, 4, 7, 10 D43C2, 5, 8, 11 D43C3, 6, 9, 12	h_{FE}	25 40 40	— — —	— 120 120	—
($I_C = -1\text{A}$, $V_{CE} = -1\text{V}$)	D43C1, 4, 7, 10 D43C2, 5, 8, 11	h_{FE}	10 20	— —	— —	—
($I_C = -2\text{A}$, $V_{CE} = -1\text{V}$)	D43C3, 6, 9, 12		20	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -1\text{A}$, $I_B = -50\text{mA}$)	D43C2, 5, 8, 11 D43C3, 6, 9, 12	$V_{CE(sat)}$	— —	— —	-0.5 -0.5	Volts
($I_C = -1\text{A}$, $I_B = -100\text{mA}$)	D43C1, 4, 7, 10	$V_{CE(sat)}$	—	—	-0.5	Volts
Base-Emitter Saturation Voltage ($I_C = -1\text{A}$, $I_B = -100\text{mA}$)		$V_{BE(sat)}$	—	—	-1.3	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}$, $f = 1\text{MHz}$)	C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product ($I_C = -20\text{mA}$, $V_{CE} = -4\text{V}$)	f_T	—	40	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = -1\text{A}$, $I_{B1} = I_{B2} = -0.1\text{A}$ $V_{CC} = 30\text{V}$, $t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	50	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle \leq 2%.

D43C Series

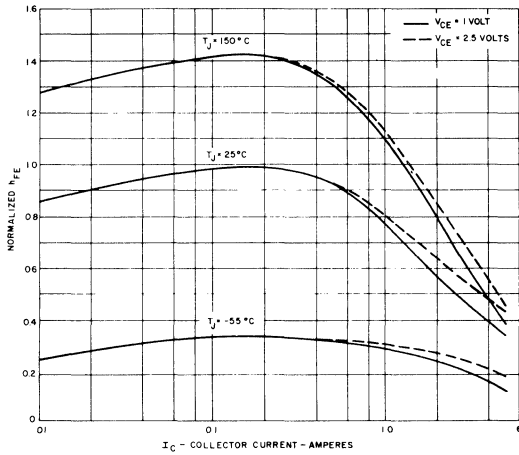


FIG. 1 TYPICAL NORMALIZED h_{FE} VS. I_C

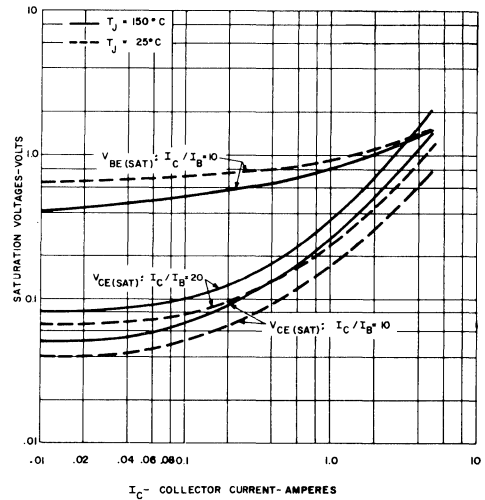


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

2

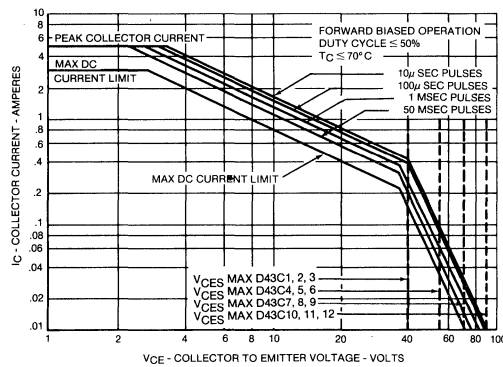


FIG. 3 SAFE REGION OF OPERATION

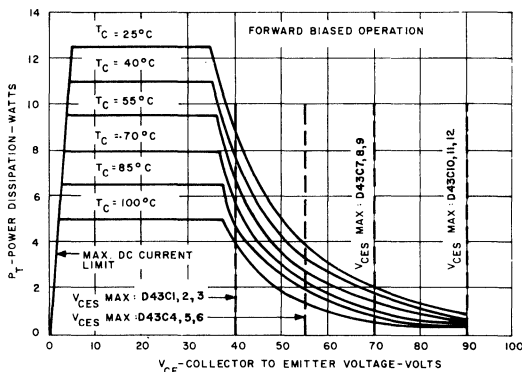


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

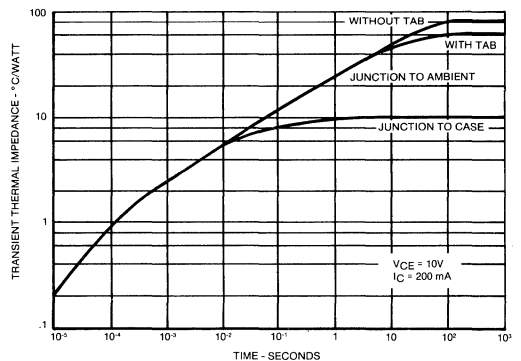


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

D44C Series

File Number **15.11**

Silicon N-P-N Transistors

Complementary to the D45C Series

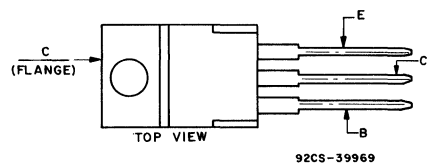
General-Purpose Types for Medium-Power Switching and Amplifier Applications

Features:

- Very low collector saturation voltage [0.5V typ. @ 3.0A I_C]
- Excellent linearity
- Fast switching

D44C-series n-p-n power transistors are 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, and low and high frequency inverters/converters.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	4	4	4	4	A
Peak ⁽¹⁾	I_{CM}	6	6	6	6	
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	4.2	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	+260	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle \leq 2%.

D44C Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT	
OFF CHARACTERISTICS⁽¹⁾						
Collector-Emitter Sustaining Voltage ($I_C = 100\text{mA}$)	D44C1, 2, 3 D44C4, 5, 6 D44C7, 8, 9 D44C10, 11, 12	$V_{CEO(sus)}$	30 45 60 80	— — — —	— — — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	10	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$)		I_{EBO}	—	—	100	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3			
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 0.2\text{A}, V_{CE} = 1\text{V}$)	D44C1, 4, 7, 10 D44C2, 5, 8, 11 D44C3, 6, 9, 12	h_{FE}	25 100 40	— — —	— 220 120	—
($I_C = 1\text{A}, V_{CE} = 1\text{V}$) ($I_C = 2\text{A}, V_{CE} = 1\text{V}$)	D44C1, 4, 7, 10 D44C2, 5, 8, 11 D44C3, 6, 9, 12	h_{FE}	10 20 20	— — —	— — —	—
Collector-Emitter Saturation Voltage ($I_C = 1\text{A}, I_B = 50\text{mA}$) ($I_C = 1\text{A}, I_B = 100\text{mA}$)	D44C2, 5, 8, 11 D44C3, 6, 9, 12 D44C1, 4, 7, 10	$V_{CE(sat)}$	— — —	— — —	0.5 0.5 0.5	Volts
Base-Emitter Saturation Voltage ($I_C = 1\text{A}, I_B = 100\text{mA}$)		$V_{BE(sat)}$	—	—	1.3	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = 10\text{V}, f = 1\text{MHz}$)	C_{CBO}	—	—	100	μF
Current-Gain — Bandwidth Product ($I_C = 20\text{mA}, V_{CE} = 4\text{V}$)	f_T	—	50	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = 1\text{A}, I_{B1} = I_{B2} = 0.1\text{A},$ $V_{CC} = 30\text{A}, t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	100	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle \leq 2%.

D44C Series

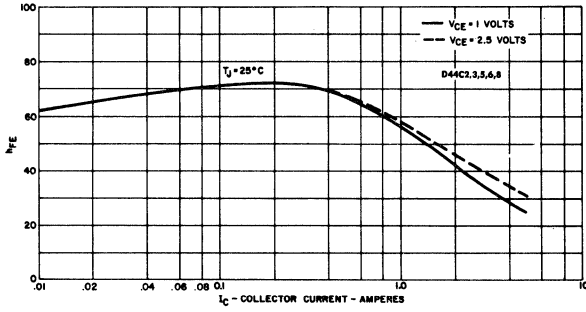


FIG. 1 TYPICAL h_{FE} VS. I_C

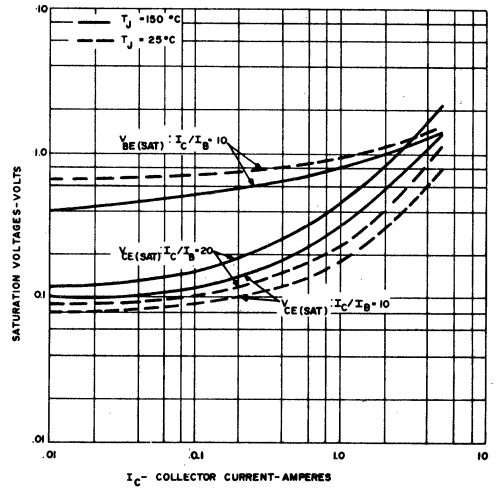


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

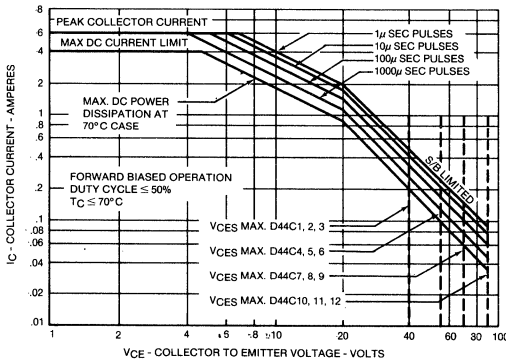


FIG. 3 SAFE REGION OF OPERATION

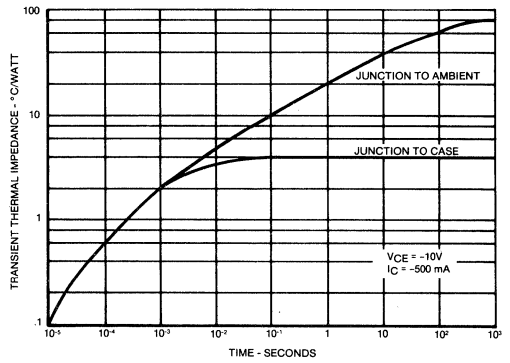


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

6-Ampere N-P-N Darlington Power Transistors

Complementary to the D45D Series

40, 60, and 80 Volts, 30 Watts
Gain of 2000 at 1 A

Features:

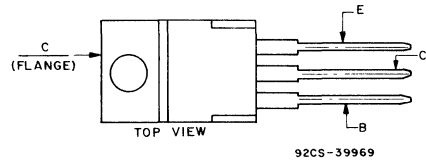
- Operates from IC without predriver

Applications:

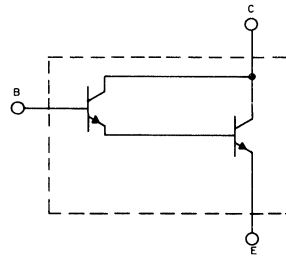
- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator
- Inverter/Converter

The D44D-series n-p-n Darlington power transistors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 2000.

TERMINAL DESIGNATIONS



JEDEC TO-220AB



92CS-43150

Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	0.5	0.5	0.5	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	260	260	260	$^\circ\text{C}$

D44D Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Breakdown Voltage ($I_C = 50\text{mA}$)	D44D1,2 D44D3,4 D44D5,6	$V_{CEO(BR)}$	40 60 80	— — —	— — —	Volts
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CES}$) ($V_{CE} = \text{Rated } V_{CES}, V_{BE} = 0.4\text{V}$)	$T_C = 25^\circ\text{C}$ $T_C = 125^\circ\text{C}$	I_{CES} I_{CEV}	— —	— —	10 5	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$)		I_{EBO}	—	—	10	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 1\text{A}, V_{CE} = 2\text{V}$)		h_{FE}	2,000	5,000	—	—
Collector-Emitter Saturation Voltage ($I_C = 3\text{A}, I_B = 3\text{mA}$) ($I_C = 5\text{A}, I_B = 5\text{mA}$)	D44D2,4,6 only	$V_{CE(sat)}$	— —	— —	1.5 1.5	V V
Base-Emitter Saturation Voltage ($I_C = 5\text{A}, I_B = 5\text{mA}$)		$V_{BE(sat)}$	—	—	2.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = 10\text{V}, f = 1\text{MHz}$)	C_{CBO}	—	—	45	pF
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SWITCHING CHARACTERISTICS

Resistive Load	$I_C = 3\text{A}, I_{B1} = I_{B2} = 3\text{mA}$ $V_{CC} = 40\text{V}, t_p = 25 \mu\text{sec}$									
Delay Time + Rise Time						$t_d + t_r$	—	0.5	—	μS
Storage Time						t_s	—	1.2	—	
Fall Time						t_f	—	0.8	—	

(1) Pulse Test: $PW \leq 300\text{ms}$ Duty Cycle $\leq 2\%$.

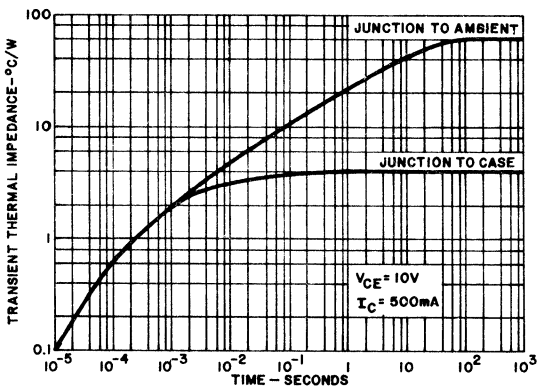


FIG. 1
MAXIMUM TRANSIENT THERMAL IMPEDANCE

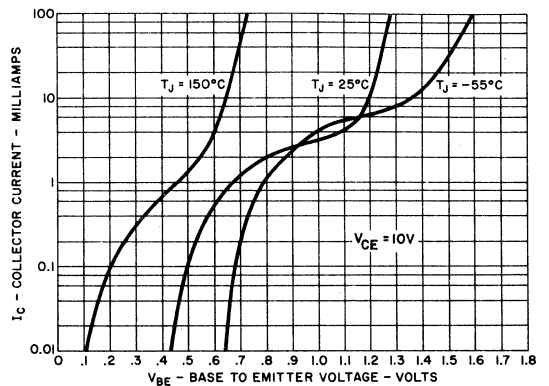


FIG. 2
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

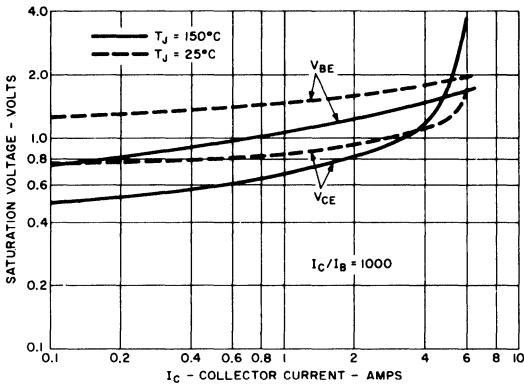


FIG. 3
TYPICAL SATURATION VOLTAGE CHARACTERISTICS

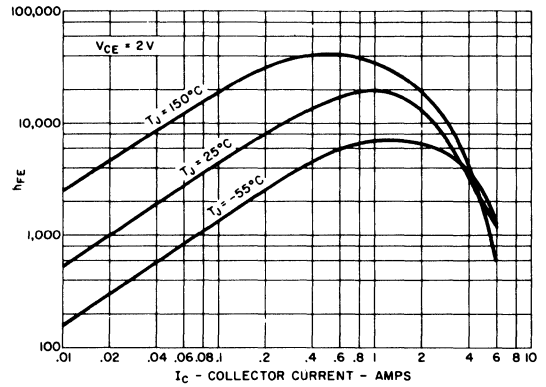


FIG. 4 TYPICAL h_{FE} VS. I_C

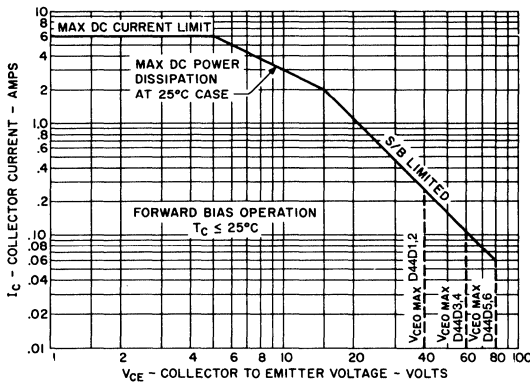


FIG. 5 SAFE REGION OF OPERATION

D44E Series

File Number **15.15**

10-Ampere N-P-N Darlington Power Transistors

Complementary to the D45E Series

40, 60, and 80 Volts, 50 Watts
Gain of 2000 at 5 A

Features:

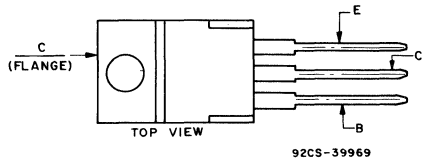
- Operates from IC without predriver

Applications:

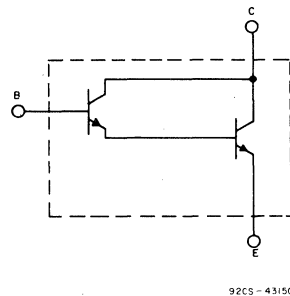
- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator
- Inverter/Converter

The D44E-series n-p-n Darlington power transistors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 1000.

TERMINAL DESIGNATIONS



JEDEC TO-220AB



Schematic diagram for all types.

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	I _C	10	10	10	A
Peak ⁽¹⁾	I _{CM}	20	20	20	A
Base Current — Continuous	I _B	1	1	1	A
Total Power Dissipation @ T _A = 25° C	P _D	1.67	1.67	1.67	Watts
@ T _C = 25° C		50	50	50	
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 _{θJA}	75	75	75	°C/W
Thermal Resistance, Junction to Case	R _{θJC}	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T _L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D44E Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = 100\text{mA}$)	D44E1	V_{CE0}	40	—	—	Volts
	D44E2		60	—	—	
	D44E3		80	—	—	
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	10	μA
Emitter Cutoff Current ($V_{EB} = 7\text{V}$)		I_{EBO}	—	—	1.0	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 6
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 5\text{A}, V_{CE} = 5\text{V}$)	h_{FE}	1,000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 5.0\text{A}, I_B = 10\text{mA}$) ($I_C = 10.0\text{A}, I_B = 20\text{mA}$)	$V_{CE(sat)}$	—	—	1.5	V
		—	—	2.0	V
Base-Emitter Saturation Voltage ($I_C = 5.0\text{A}, I_B = 10\text{mA}$)	$V_{BE(sat)}$	—	—	2.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}, f = 1\text{MHz}$)	C_{CBO}	—	—	130	pF
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SWITCHING CHARACTERISTICS

Resistive Load		$I_C = 10\text{A}, I_{B1} = I_{B2} = 20\text{mA}$ $V_{CC} = 40\text{V}, t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	0.6	—	μS
Delay Time + Rise Time							
Storage Time	t_s						
Fall Time	t_f						

(1) Pulse Test: $PW \leq 300\text{ms}$ Duty Cycle $\leq 2\%$.

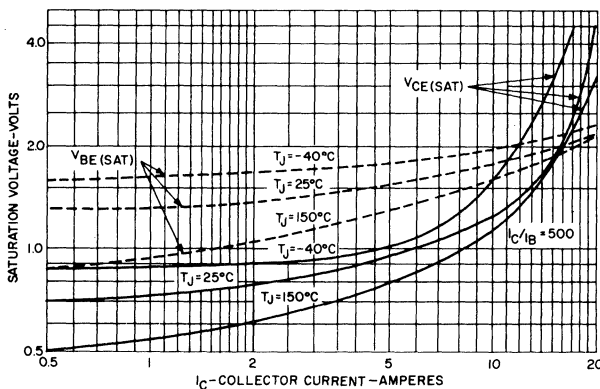


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

2

D44E Series.

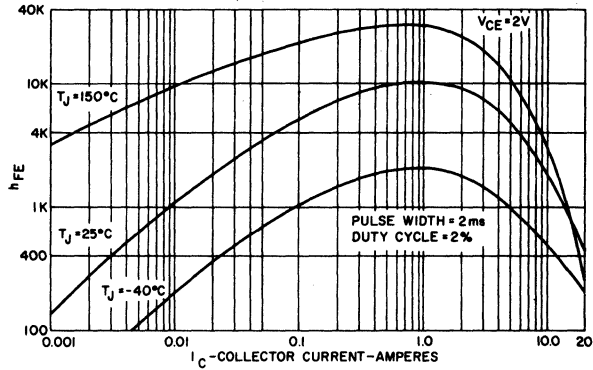


FIG. 2 TYPICAL GAIN CHARACTERISTIC

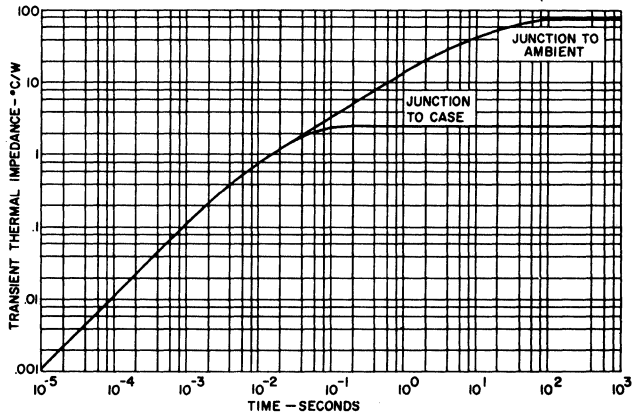


FIG. 3 TRANSIENT THERMAL IMPEDANCE

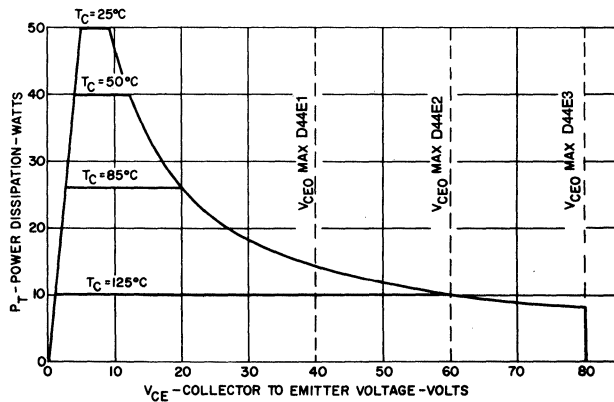


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

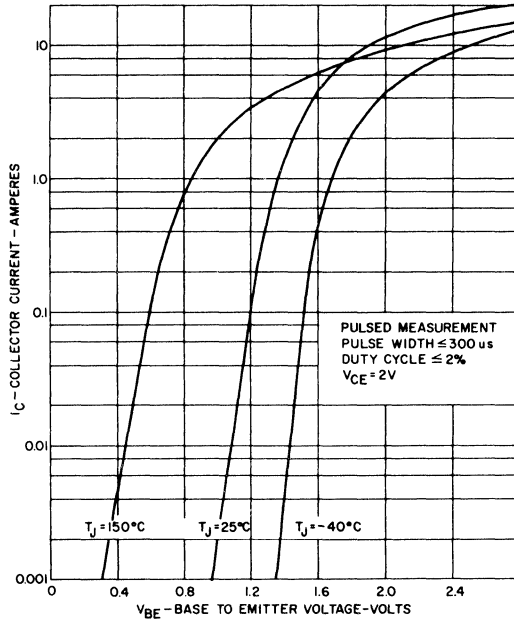


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

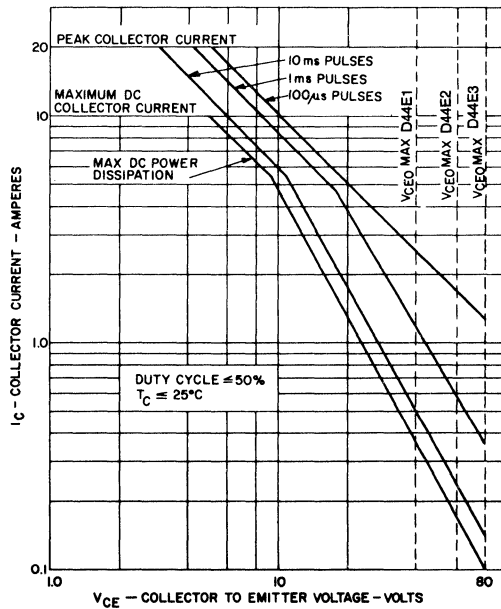


FIG. 6 SAFE REGION OF OPERATION

D44H Series

File Number **15.17****Silicon N-P-N Transistors**

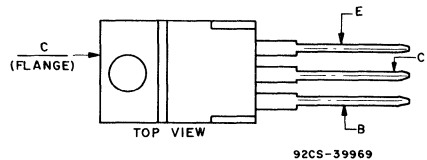
Complementary to the D45H Series

For Switching and Linear Applications

Features:

- Very low collector saturation voltage
- Excellent linearity
- Fast switching

D44H-series n-p-n power transistors are 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, and low and high frequency inverters/converters.

TERMINAL DESIGNATIONS**JEDEC TO-220AB****MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)**

RATING	SYMBOL	D44H1, 2	D44H4, 5	D44H7, 8	D44H10, 11	UNITS
Collector-Emitter Voltage	V_{CE0}	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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	2.5	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	+260	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle $\leq 2\%$.

D44H Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS⁽¹⁾					
Collector-Emitter Sustaining Voltage ($I_C = 100\text{mA}$)	D44H1, 2 D44H4, 5 D44H7, 8 D44H10, 11	$V_{CEO(sus)}$	30 45 60 80	— — — —	Volts
Collector Cutoff Current ($V_{CB} = \text{Rated } V_{CBO}$)		I_{CBO}	—	—	10 μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$)		I_{EBO}	—	—	100 μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 2\text{A}, V_{CE} = 1\text{V}$)	D44H1, 4, 7, 10 D44H2, 5, 8, 11	h_{FE}	35 60	— —	— —	—
($I_C = 4\text{A}, V_{CE} = 1\text{V}$)	D44H1, 4, 7, 10 D44H2, 5, 8, 11	h_{FE}	20 40	— —	— —	—
Collector-Emitter Saturation Voltage ($I_C = 8\text{A}, I_B = 0.4\text{A}$)	D44H2, 5, 8, 11 D44H1, 4, 7, 10	$V_{CE(sat)}$	— —	— —	1.0 1.0	Volts
($I_C = 8\text{A}, I_B = 0.8\text{A}$)						
Base-Emitter Saturation Voltage ($I_C = 8\text{A}, I_B = 0.8\text{A}$)		$V_{BE(sat)}$	—	—	1.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = 10\text{V}, f = 1\text{MHz}$)	C_{CBO}	—	—	130	μF
Current-Gain — Bandwidth Product ($I_C = 500\text{mA}, V_{CE} = 10\text{V}$)	f_T	—	50	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = 5\text{A}, I_{B1} = I_{B2} = 0.5\text{A}$	$t_d + t_r$	—	300	—	nS
Storage Time		t_s	—	500	—	
Fall Time	$V_{CC} = 30\text{V}, t_p = 25 \mu\text{sec}$	t_f	—	140	—	

(1) Pulse Test PW = 300ms Duty Cycle $\leq 2\%$.

D44H Series

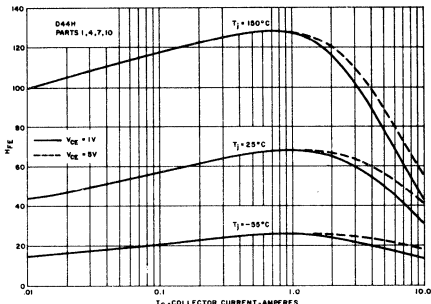


FIG. 1 TYPICAL GAIN CHARACTERISTICS

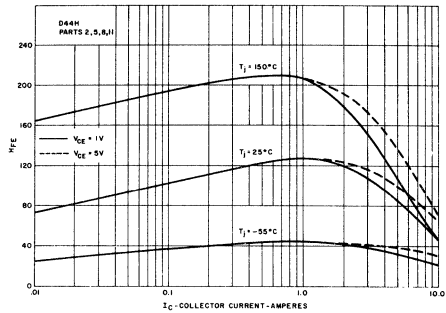


FIG. 2 TYPICAL GAIN CHARACTERISTICS

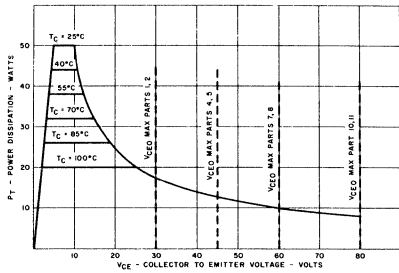


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

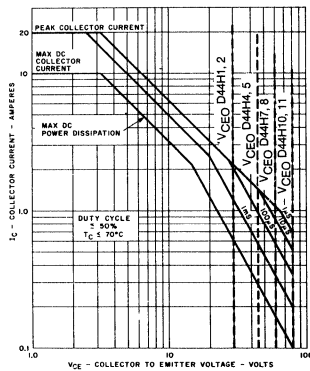


FIG. 4 SAFE REGION OF OPERATION

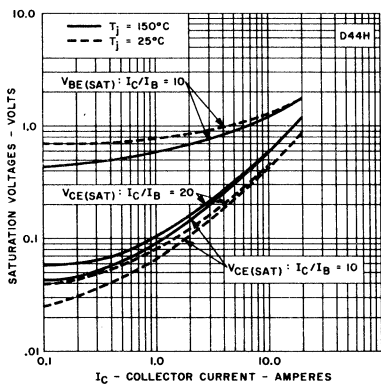


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

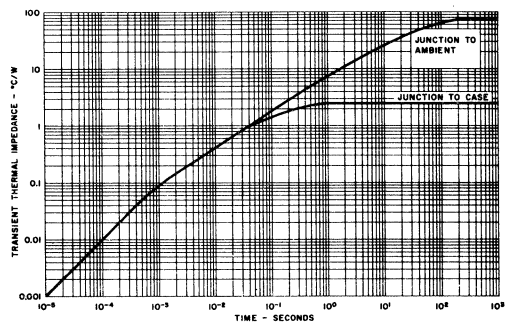


FIG. 6 TRANSIENT THERMAL IMPEDANCE

Silicon N-P-N Transistors

For Switching and Linear Applications

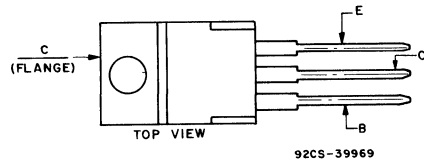
Features:

- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

2

The D44Q-series n-p-n power transistors feature low collector saturation voltage, excellent linearity, and fast switching speed. They are useful for general purposes applications such as: 120 V ac line operated amplifiers, regulators (series, shunt, and switching), high-frequency inverters/converters and tv deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ \text{C}$) (unless otherwise specified)

RATING	SYMBOL	D44Q1	D44Q3	D44Q5	UNITS
Collector-Emitter Voltage	V_{CE0}	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 @ $T_A = 25^\circ \text{C}$ @ $T_C = 25^\circ \text{C}$	P_D	1.67 31.25	1.67 31.25	1.67 31.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	$^\circ \text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	$^\circ \text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	4	$^\circ \text{C/W}$
Maximum Lead Temperature for Soldering Purpose: $\frac{1}{16}$ " from Case for 5 Seconds	T_L	260	260	260	$^\circ \text{C}$

D44Q Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS⁽¹⁾					
Collector-Emitter Sustaining Voltage ($I_C = 10mA$)	D44Q1 D44Q3 D44Q5	$V_{CE(sus)}$	125 175 225	—	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CE}$)		I_{CBO}	—	10	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5
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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 ($V_{CB} = 10V, f = 1 \text{ MHz}$)	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	$I_C = 1.0A, I_{B1} = I_{B2} = 100mA$ $V_{CC} = 50V, t_p = 25 \mu sec$	$t_d + t_r$	—	—	0.2	μs
Storage Time		t_s	—	—	2.0	
Fall Time		t_f	—	—	1.7	

(1) Pulse Test: Pulse Width - 300 μs Duty Cycle \leq 2%.

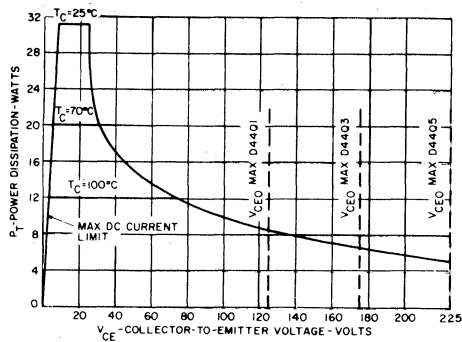


FIG. 1 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

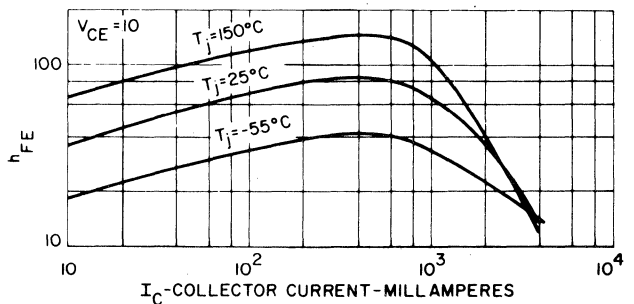


FIG. 2 TYPICAL h_{FE} vs. I_C

D44Q Series

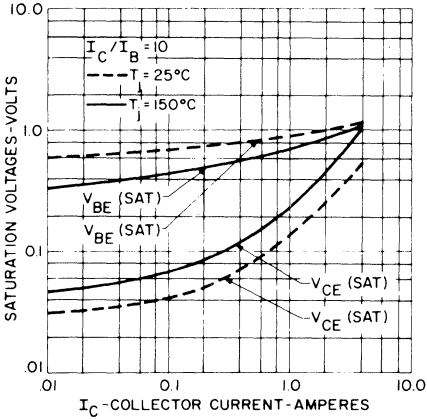


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

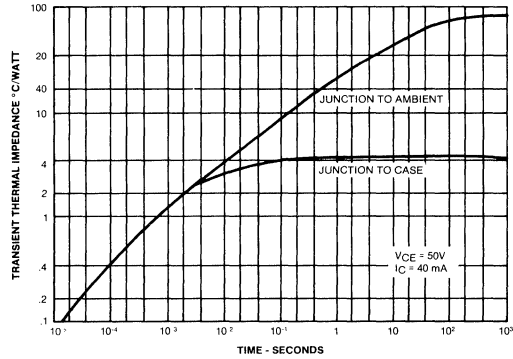


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

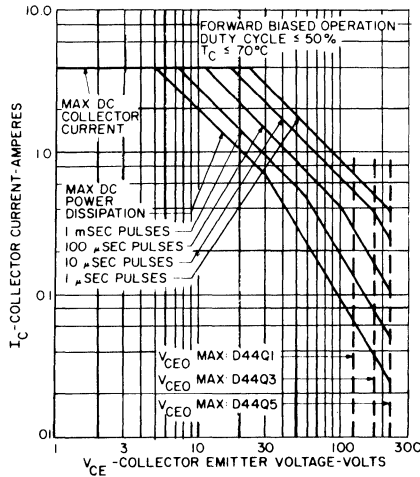


FIG. 5 FORWARD BIAS SAFE OPERATING AREA

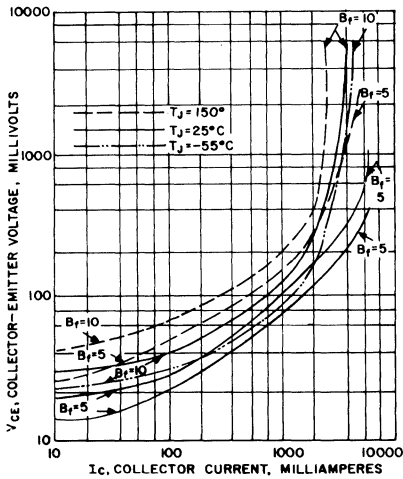


FIG. 6 $V_{CE(SAT)}$ vs. I_C TYPICAL

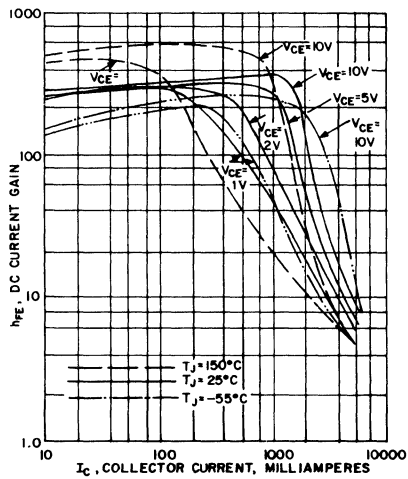


FIG. 7 DC CURRENT GAIN, TYPICAL

D44T Series

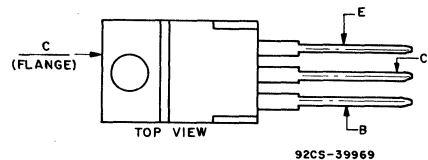
File Number **15.20****Silicon N-P-N Transistors**

For Switching and Linear Applications

Features:

- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

The D44T-series n-p-n power transistors feature low collector saturation voltage, excellent linearity, and fast switching speed. They are useful for general purpose applications such as: 120 V ac line operated amplifiers, regulators (series, shunt, and switching), high frequency inverters/converters, and tv deflection circuits.

TERMINAL DESIGNATIONS**JEDEC TO-220AB****MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)**

RATING	SYMBOL	D44T1,2	D44T3,4	UNITS
Collector-Emitter Voltage	V_{CE0}	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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purpose: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	260	260	$^\circ\text{C}$

D44T Series

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Breakdown Voltage (I _C = 10 μA)	D44T1,2 D44T3,4	BV _{CES}	300 400	— —	— —	Volts
Collector Cutoff Current (V _{CE} = Rated V _{CES})		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
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain (I _C = 500mA, V _{CE} = 10V) (I _C = 50mA, V _{CE} = 10V) (I _C = 500mA, V _{CE} = 10V) (I _C = 50mA, V _{CE} = 10V)	D44T1,3 D44T2,4	h _{FE}	30 40 75 40	— — — —	— — 175 —	—
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	I _C = 500mA, I _{B1} = I _{B2} = 50mA V _{CC} = 50V, t _p = 25μsec					μs				
Delay Time + Rise Time							t _d + t _r	—	0.2	—
Storage Time							t _s	—	3.3	—
Fall Time							t _f	—	0.6	—

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

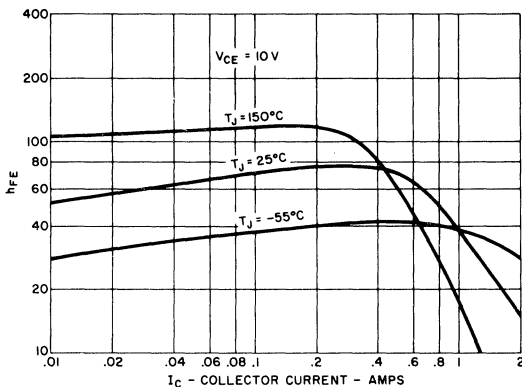


FIG. 1 TYPICAL h_{FE} VS. I_C

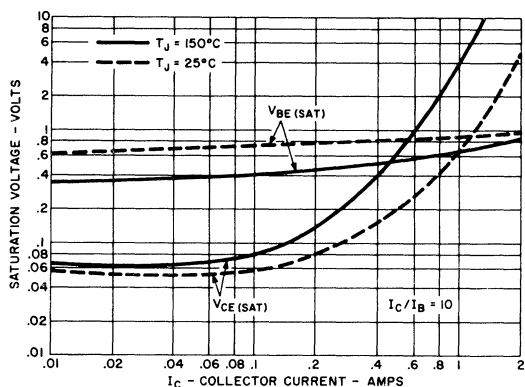


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

D44T Series

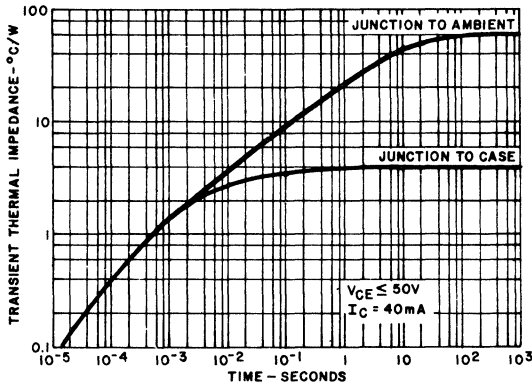


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

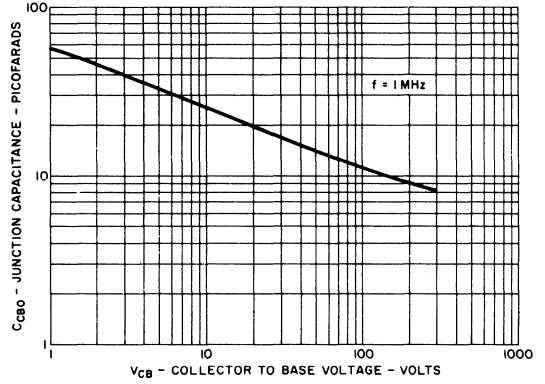


FIG. 4 COLLECTOR TO BASE JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

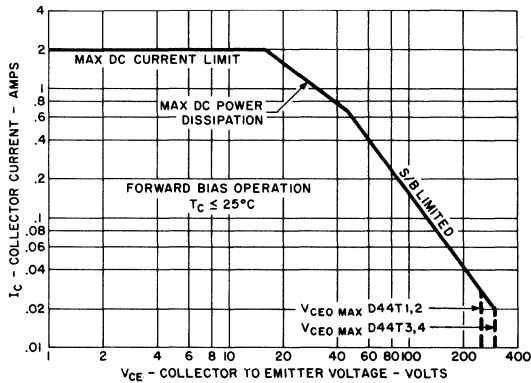


FIG. 5 SAFE REGION OF OPERATION

2-A Power-Switching Transistors

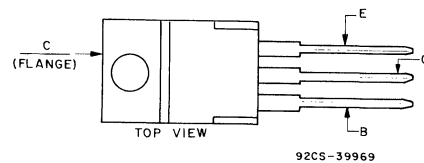
High-Voltage N-P-N Types for Off-Line Power Supplies and Other Switching Applications

Features:

- Performance information tailored for switching applications
- 100° C maximum limits specified for:
 - Switching times
 - Saturation voltages
 - Leakage currents
- 300 to 400V $V_{CEO(sus)}$
- Very fast turn-off $t_f < 180 \text{ nsec (typ.)}@1.5A$

The D44TD-series of n-p-n power transistors are 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, inverters, solenoid/relay drivers, and deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ \text{C}$) (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	I_C	2	2	2	A
Peak ⁽¹⁾	I_{CM}	4	4	4	
Base Current — Continuous	I_B	0.5	0.5	0.5	A
Peak ⁽¹⁾	I_{BM}	1	1	1	
Total Power Dissipation @ $T_c = 25^\circ \text{C}$	P_D	50	50	50	Watts
@ $T_c = 100^\circ \text{C}$		20	20	20	
Derate above 25° C		0.4	0.4	0.4	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: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse condition, $t_p \leq 5 \text{ msec}$.

D44TD Series**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 D44TD4 D44TD5	V _{CEO(sus)}	300 350 400	— — —	Volts
Collector-Emitter Voltage (I _C = 2.0mA, I _{B1} = I _{B2} = .4A) (V _{BE} = -5V, L = 200 μh)	D44TD3 D44TD4 D44TD5	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 _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 (I _C = 1A, V _{CE} = 2V) (I _C = 2A, V _{CE} = 3V)	h _{FE}	8 5	— —	—
Collector-Emitter Saturation Voltage (I _C = 1A, I _B = .2A) (I _C = 2A, I _B = .4A) (I _C = 1A, I _B = .2A, T _C = 100° C)	V _{CE(SAT)}	— — —	0.6 1.0 1.0	Volts
Base-Emitter Saturation Voltage (I _C = 2A, I _B = .4A) (I _C = 2A, I _B = .4A, T _C = 100° C)	V _{BE(SAT)}	— —	1.2 1.2	Volts

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 I _{B1} = I _{B2} = 0.3A, t _p = 25 μsec	t _d	.06	.08	μs
Rise Time		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, I _{B1} = I _{B2} = 0.3A, t _p = 25μsec V _{BE(OFF)} = -5V	t _{sv}	3.0	3.5	μs
Fall Time		t _f	0.3	0.6	μsec
		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

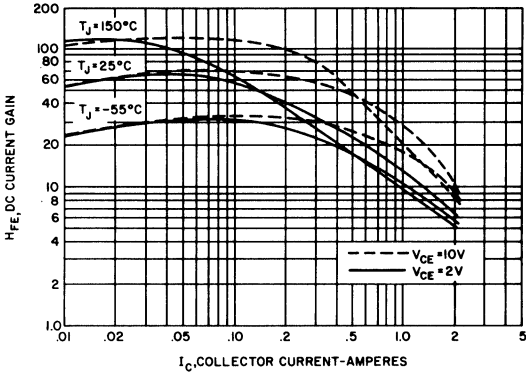


FIGURE 1. DC CURRENT GAIN

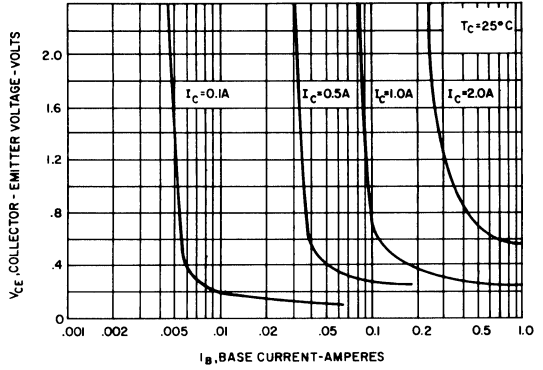


FIGURE 2. COLLECTOR SATURATION REGION

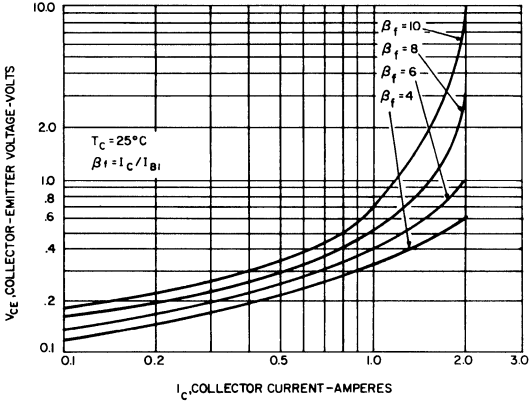


FIGURE 3. $V_{CE(SAT)}$ VS. I_C , $T_C = 25^\circ\text{C}$

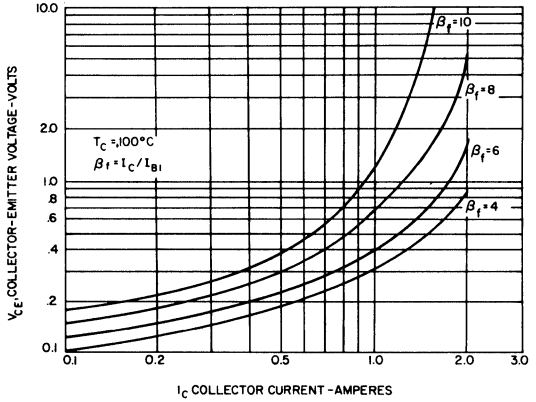


FIGURE 4. $V_{CE(SAT)}$ VS. I_C , $T_C = 100^\circ\text{C}$

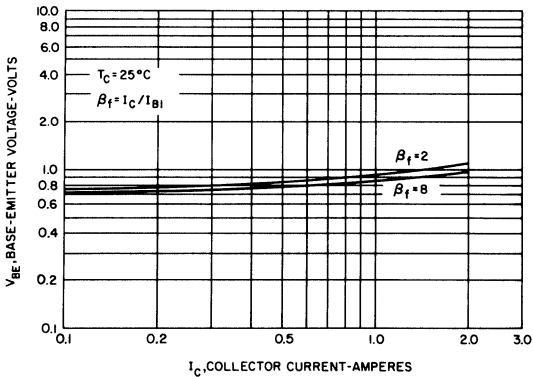


FIGURE 5. $V_{BE(SAT)}$ VS. I_C

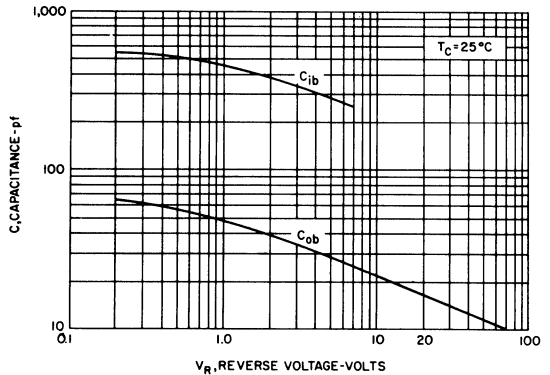


FIGURE 6. CAPACITANCE

D44TD Series

TYPICAL SWITCHING CHARACTERISTICS

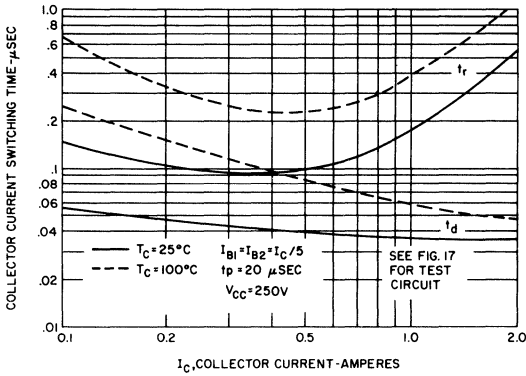


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

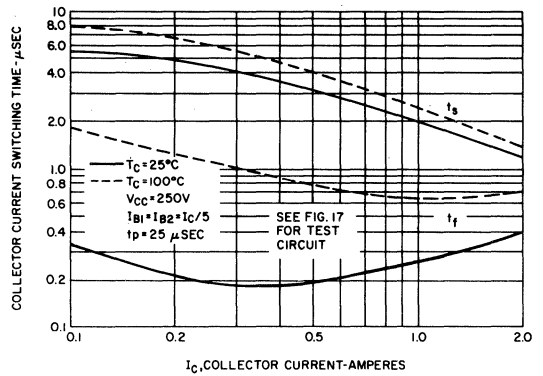


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

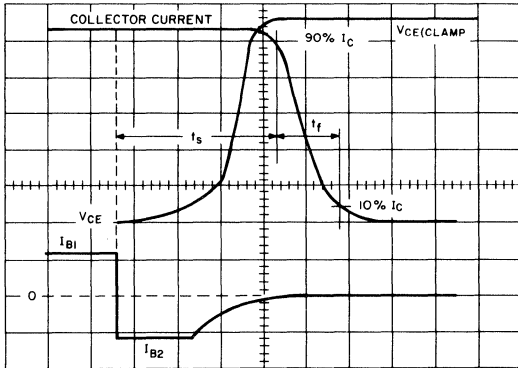


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

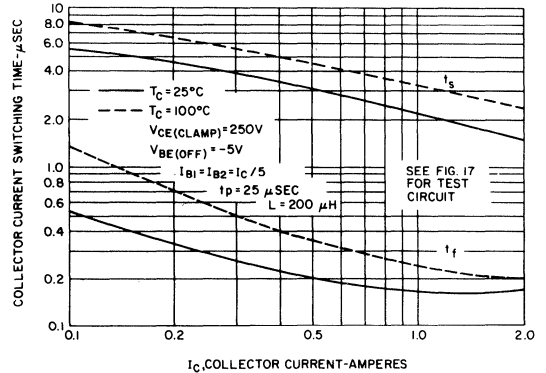


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

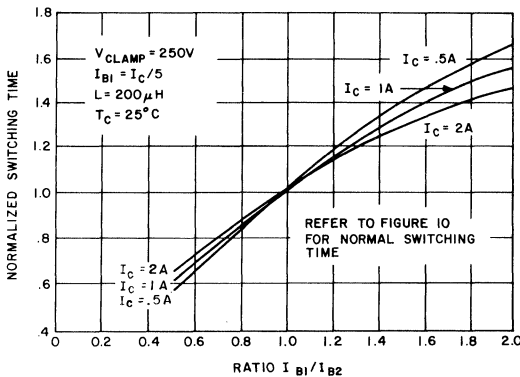


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

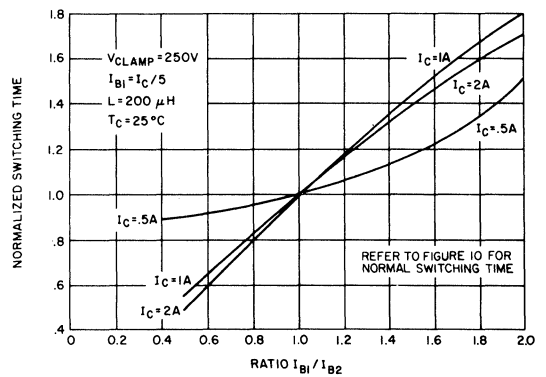


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D44TD Series

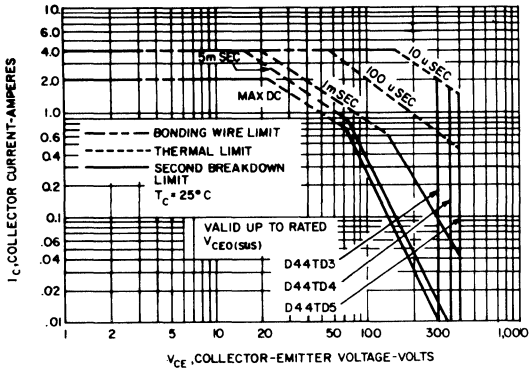


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

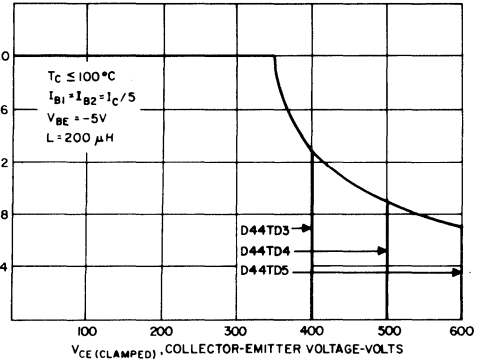


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

2

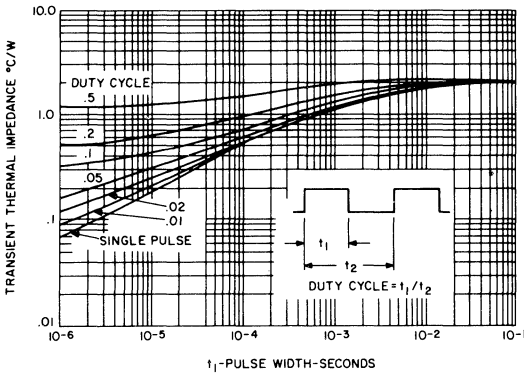


FIGURE 15. TRANSIENT THERMAL RESPONSE

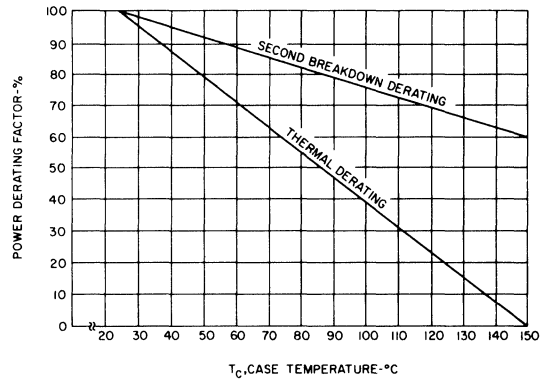


FIGURE 16. POWER DERATING CURVE

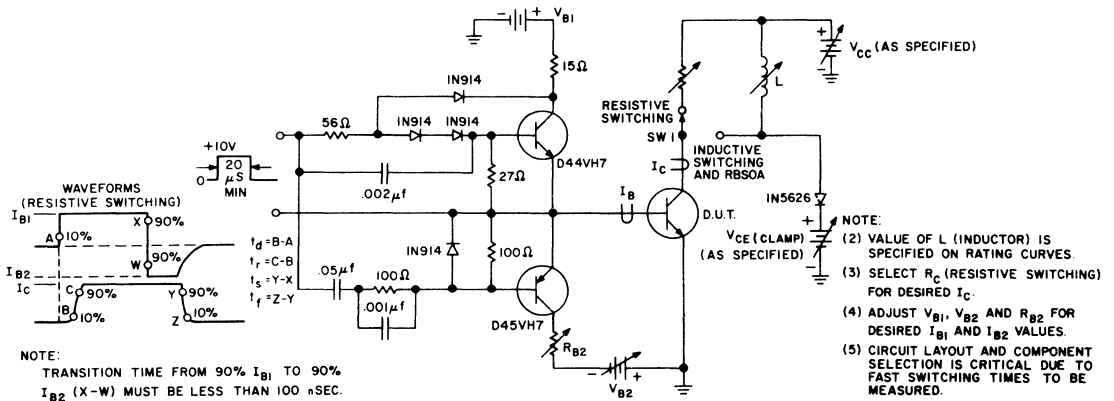


FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

D44VH Series

File Number 15.23

Silicon N-P-N Transistors

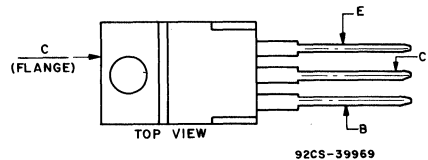
Complementary to the D45VH Series

Features:

- Fast Switching $t_s \leq 700$ ns resistive
 $t_f \leq 200$ ns
- Low $V_{CE(sat)} \leq 0.4V$ @ $I_C = 8A$

The D44VH series of silicon n-p-n power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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_{EBO}	7				V
Collector Current — Continuous	I_C	15				A
— Peak (1)	I_{CM}	20				
Base Current — Continuous	I_B	5				A
— Peak (1)	I_{BM}	10				
Total Power Dissipation @ $T_C = 25^\circ C$	P_D	83				Watts
@ $T_C = 100^\circ C$		33				
Derate above 25°C		0.67				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 $PW \leq 6.0$ ms, See Figure 14.

D44VH Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
-----------------	--------	-----	-----	------

OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ⁽¹⁾ ($I_C = 100\text{mA}$, $I_B = 0$) D44VH1 D44VH4 D44VH7 D44VH10	$V_{CE0(sus)}$	30 45 60 80	— — — —	V
Collector-Emitter Voltage ⁽²⁾ ($I_C = 1\text{A}$, $V_{CLAMP} = \text{Rated } V_{CEX}$, $T_C = 100^\circ\text{C}$) D44VH1 D44VH4 D44VH7 D44VH10	V_{CEX}	40 55 65 90	— — — —	V
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = -4.0\text{V}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = -4.0\text{V}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	— —	10 100	μA
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEV}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	100	μA
Emitter Cutoff Current ($V_{EB} = 7\text{V}$, $I_C = 0$)	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 ($I_C = 2\text{A}$, $V_{CE} = 1\text{V}$) ($I_C = 4\text{A}$, $V_{CE} = 1\text{V}$)	h_{FE}	35 20	— —	—
Collector-Emitter Saturation Voltage ($I_C = 8\text{A}$, $I_B = 0.4\text{A}$) ($I_C = 8\text{A}$, $I_B = 0.4\text{A}$, $T_C = 100^\circ\text{C}$) ($I_C = 15\text{A}$, $I_B = 3.0\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — —	0.4 0.5 0.8	V
Base-Emitter Saturation Voltage ($I_C = 8\text{A}$, $I_B = 0.4\text{A}$) ($I_C = 8\text{A}$, $I_B = 0.4\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— —	1.2 1.1	V

DYNAMIC CHARACTERISTICS

Typical

Current-Gain — Bandwidth Product ($I_C = 0.1\text{A}$, $V_{CE} = 10\text{V}$, $f_{test} = 1\text{MHz}$)	f_T	50	MHz
Output Capacitance ($V_{CB} = 10\text{V}$, $I_E = 0$, $f_{test} = 1\text{MHz}$)	C_{OB}	120	pF

SWITCHING CHARACTERISTICS

Maximum

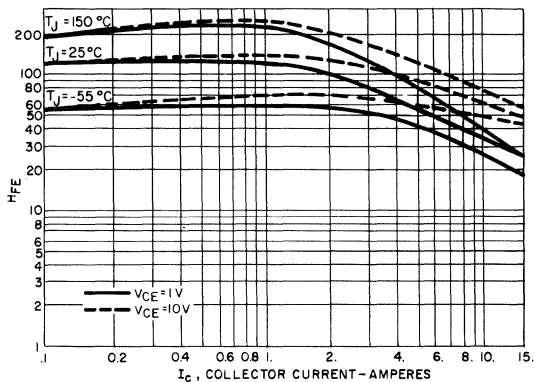
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	$V_{CC} = 20\text{V}$, $I_C = 8\text{A}$ $I_{B1} = I_{B2} = 0.8\text{A}$ $t_p = 25\ \mu\text{sec}$	t_d	50	—	nsec
Rise Time		t_r	250	—	nsec
Storage Time		t_s	700	—	nsec
Fall Time		t_f	200	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CC} = 20\text{V}$, $I_C = 8\text{A}$ $V_{CLAMP} = \text{Rated } V_{CEX}$ $I_{B1} = 0.8\text{A}$, $V_{BE(off)} = -5\text{V}$	t_s	800	—	nsec
Fall Time		t_f	180	400	nsec
Typical					
Storage Time	$L = 200\ \mu\text{H}$	t_s	280	370	nsec
Fall Time		t_f	130	150	nsec

(1) Pulse Duration = 300 μsec , Duty Factor $\leq 2\%$.

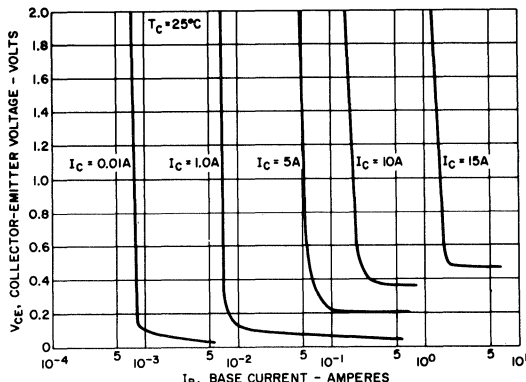
(2) See Figure 15 for Test Circuit.

D44VH Series

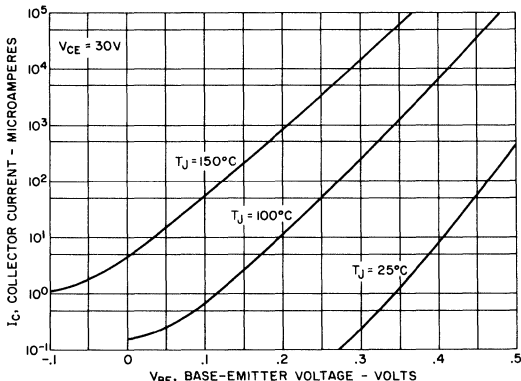
SAFE OPERATING AREA



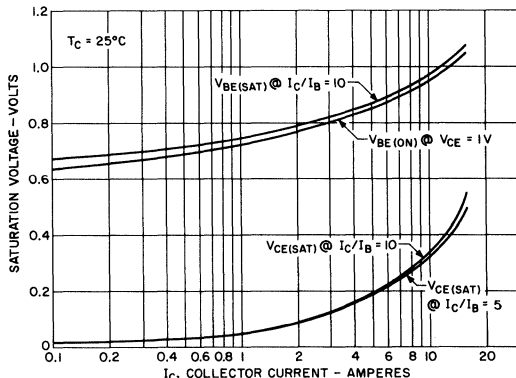
1. DC CURRENT GAIN



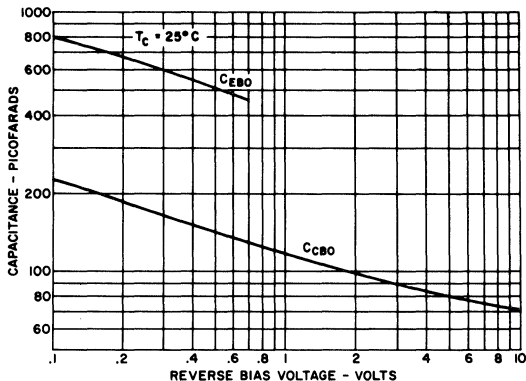
2. COLLECTOR SATURATION REGION



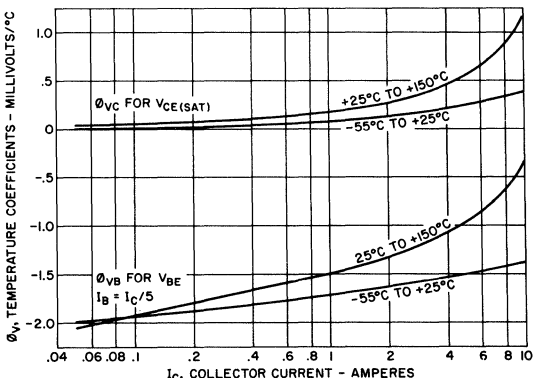
3. COLLECTOR CUTOFF REGION



4. SATURATION VOLTAGE



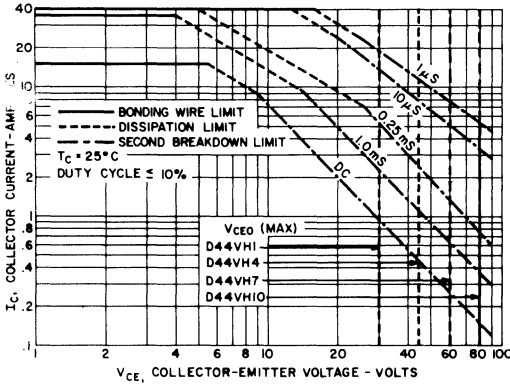
5. CAPACITANCE



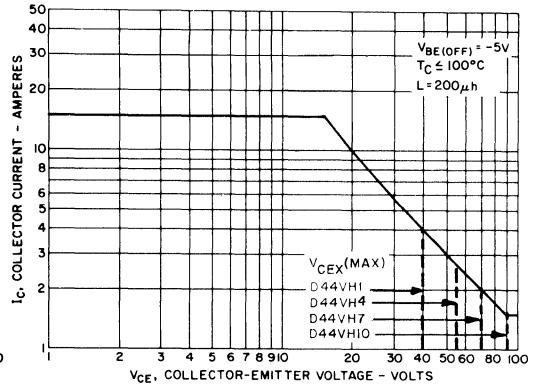
6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

D44VH Series

2

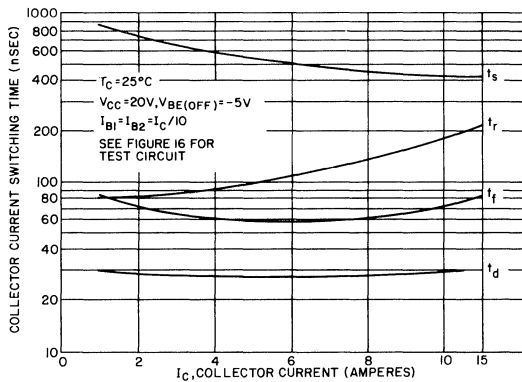


7. FORWARD BIAS SOA

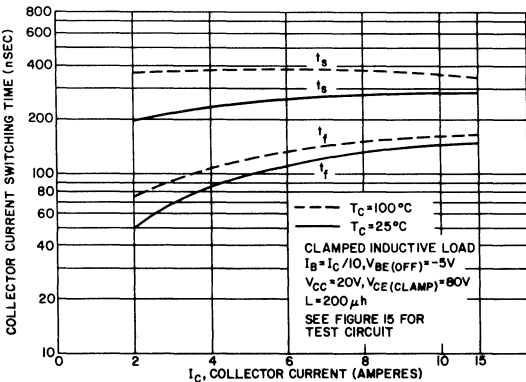


8. REVERSE BIAS SOA

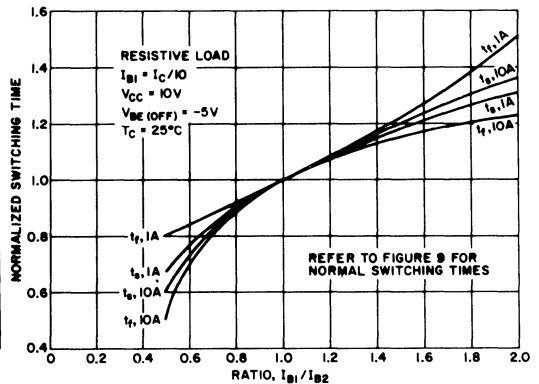
TYPICAL SWITCHING CHARACTERISTICS



9. RESISTIVE SWITCHING TIME

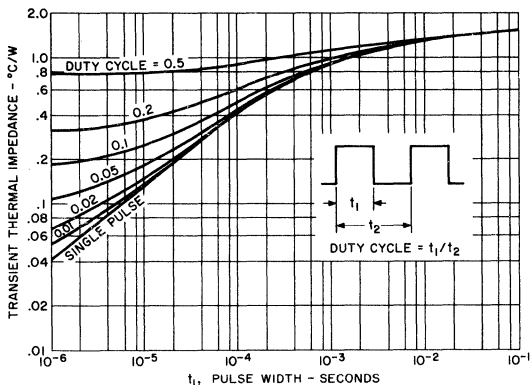


10. CLAMPED INDUCTIVE SWITCHING TIME

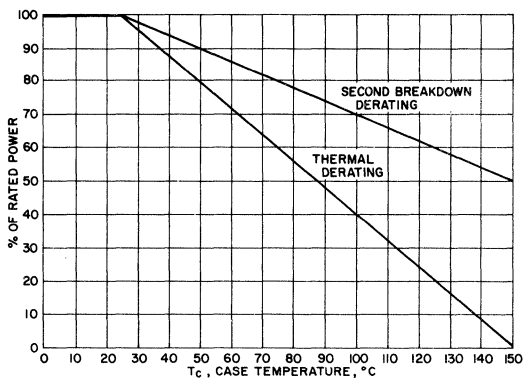


11. SWITCHING TIME VARIATION WITH I_{B2}

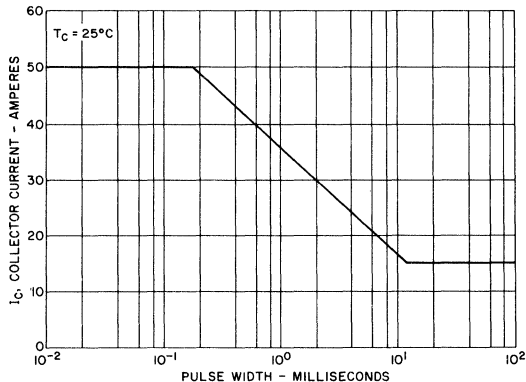
D44VH Series



12. TRANSIENT THERMAL RESPONSE

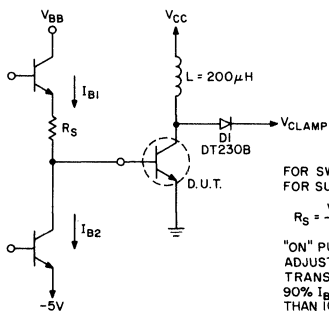


13. POWER DERATING FACTOR



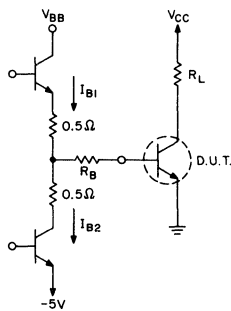
14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS



FOR SW. TIMES AND R_{BSOA} 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

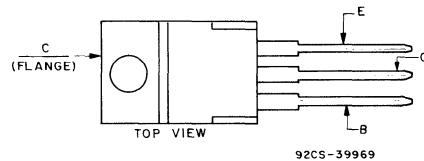
Silicon N-P-N Transistors

Complementary to the D45VM Series

Features:

- Fast Switching $t_s \leq 500$ ns resistive
 $t_f \leq 75$ ns
- Very Low $V_{CE(sat)} \leq 0.4V$ @ $I_C = 4A$
- High Gain $H_{FE} \geq 40$ @ $I_C = 4A$

The D44VM-series of silicon n-p-n power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS**JEDEC TO-220AB****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	I_C	8				A
— Peak (1)	I_{CM}	20				
Base Current — Continuous	I_B	2				A
— Peak (1)	I_{BM}	5				
Total Power Dissipation @ $T_C = 25^\circ C$	P_D	50				Watts
Derate above 25° C @ $T_C = 100^\circ C$		20				
		0.4				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 $PW \leq 6.0$ ms.

D44VM Series

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) D44VM1 D44VM4 D44VM7 D44VM10	V _{CEO(sus)}	30 45 60 80	— — — —	V
Collector-Emitter Voltage ⁽²⁾ (I _C = 3A, V _{CLAMP} = Rated V _{CEX} , T _C ≤ 100°C) D44VM1 D44VM4 D44VM7 D44VM10	V _{CEX}	30 45 60 80	— — — —	V
Collector Cutoff Current (V _{CEV} = Rated Value, V _{BE(off)} = -4.0V) (V _{CEV} = Rated Value, V _{BE(off)} = -4.0V, T _C = 100°C)	I _{CEV}	— —	10 100	μA
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 (I _C = 4A, V _{CE} = 1V) (I _C = 6A, V _{CE} = 1V)	h _{FE}	40 20	— —	—
Collector-Emitter Saturation Voltage (I _C = 4A, I _B = 0.2A) (I _C = 6A, I _B = 0.3A) (I _C = 8A, I _B = 0.8A, T _C = 100°C)	V _{CE(sat)}	— — —	0.4 0.6 1.0	V
Base-Emitter Saturation Voltage (I _C = 4A, I _B = 0.2A) (I _C = 4A, I _B = 0.2A, T _C = 100°C)	V _{BE(sat)}	— —	1.2 1.2	V

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 I _{B1} = I _{B2} = 0.6A, V _{BE(OFF)} = -5V	t _s	500	600	nsec
Fall Time		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

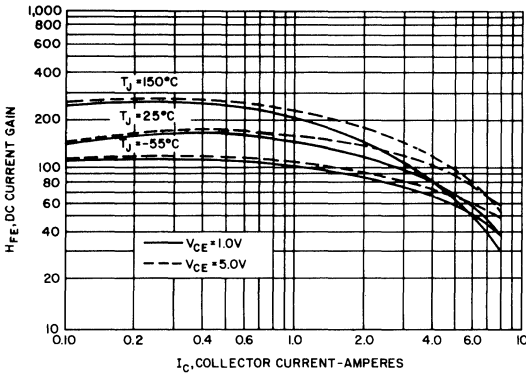


FIGURE 1. DC CURRENT GAIN

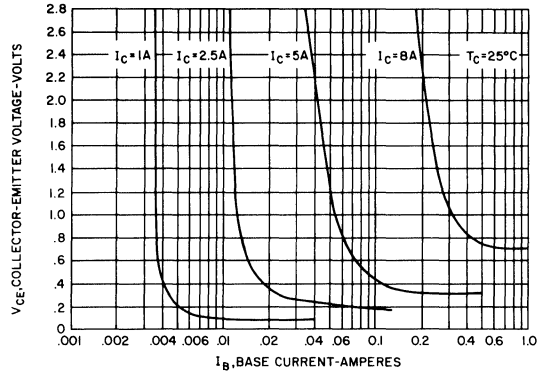


FIGURE 2. COLLECTOR SATURATION REGION

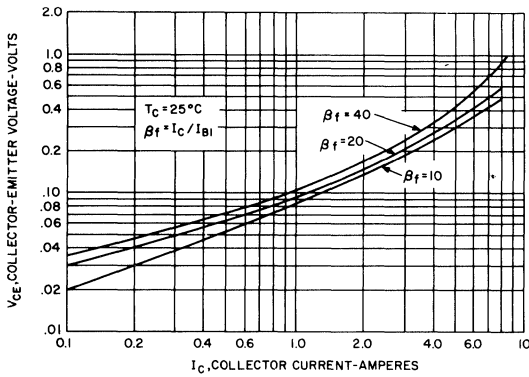


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

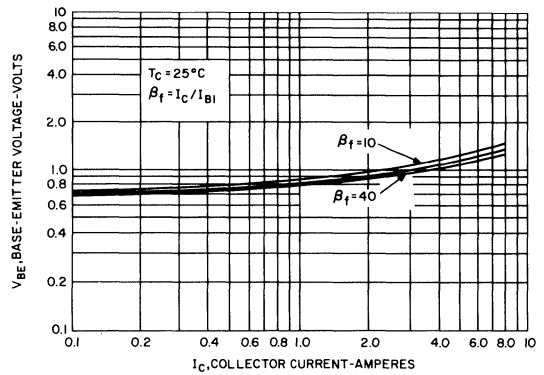


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

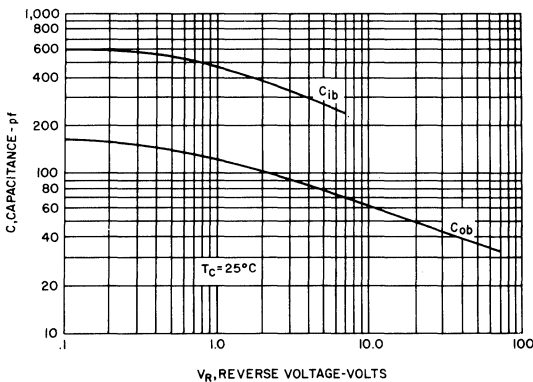


FIGURE 5. CAPACITANCE

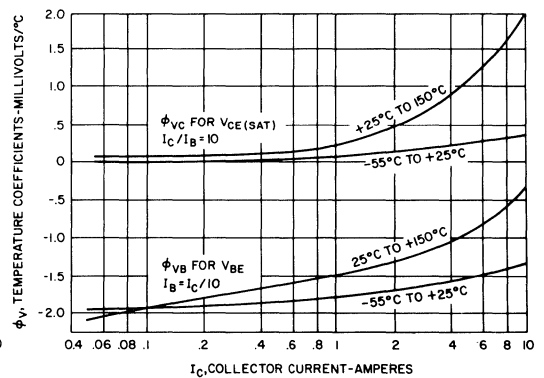


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

2

D44VM Series

SAFE OPERATING AREA

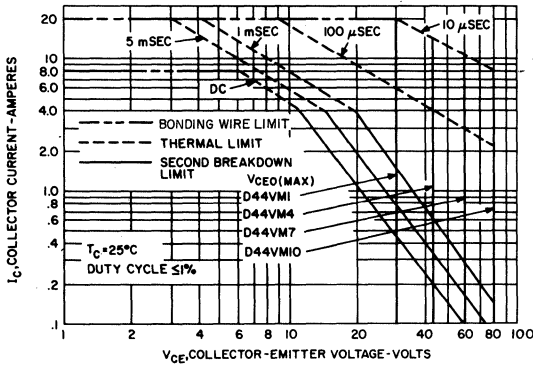


FIGURE 7. FORWARD BIAS SOA

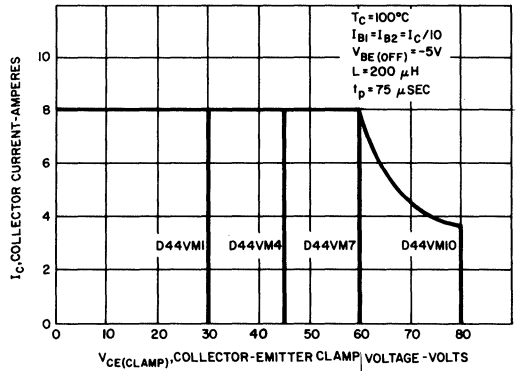


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

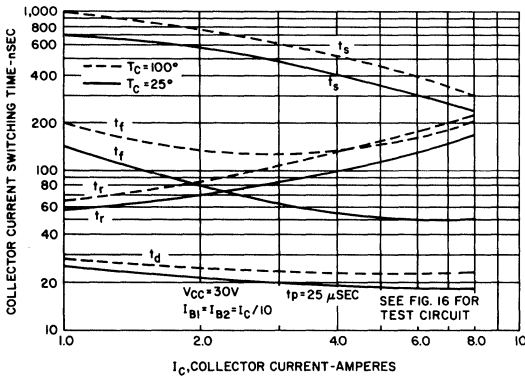


FIGURE 9. RESISTIVE SWITCHING TIME

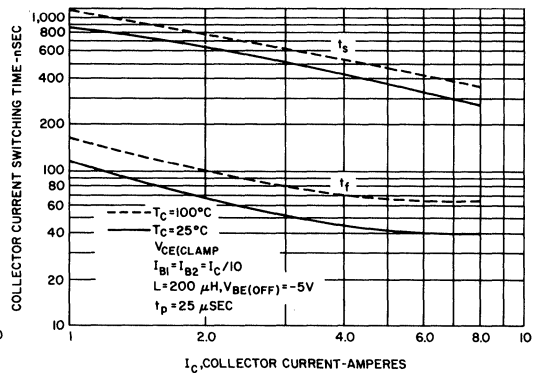


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

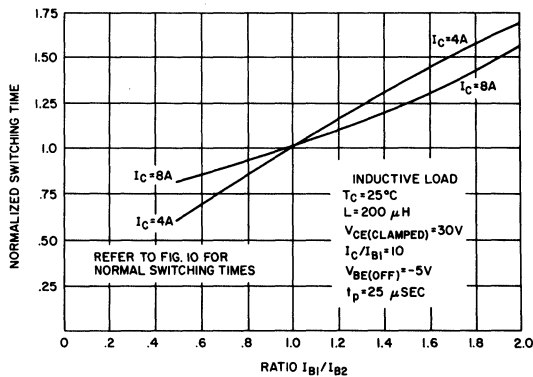


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

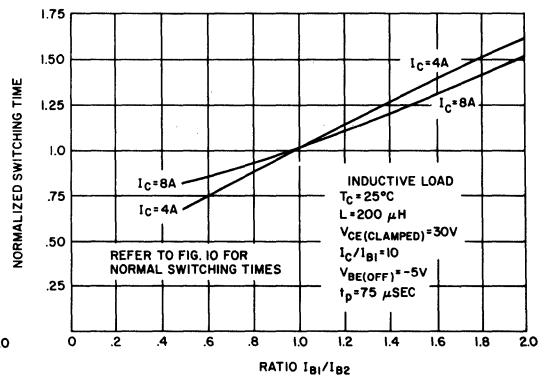


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D44VM Series

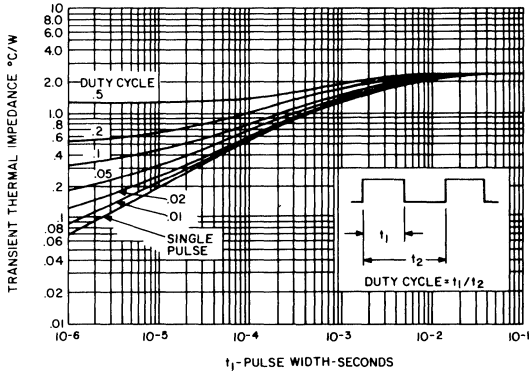


FIGURE 13. TRANSIENT THERMAL RESPONSE

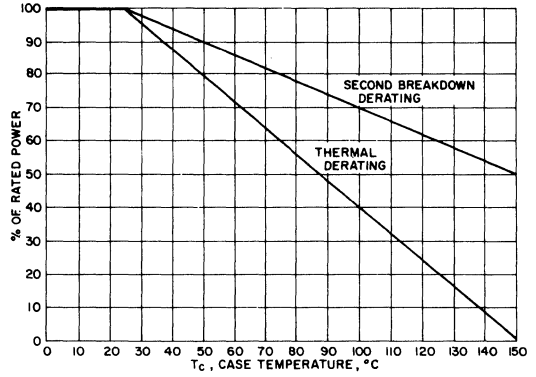


FIGURE 14. POWER DERATING FACTOR

2

TEST CIRCUITS

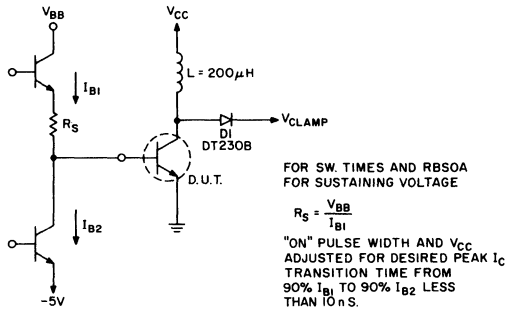


FIGURE 15. INDUCTIVE SWITCHING AND V_{CEX}

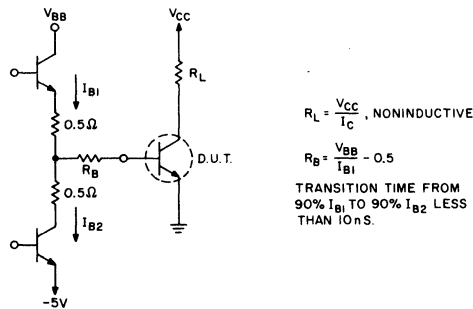


FIGURE 16. RESISTIVE SWITCHING

D45C Series

File Number 15.12

Silicon P-N-P Transistors

Complementary to the D44C Series

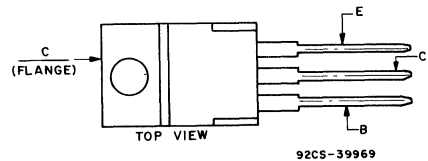
General-Purpose Types for Medium-Power Switching and Amplifier Applications

Features:

- Very low collector saturation voltage [$-0.5V$ typ. @ $-3.0A$ I_C]
- Excellent linearity
- Fast switching

D45C-series p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequency from DC to greater than 1.0 MHz, series, shunt and switching regulators, and low and high frequency inverters/converters.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (unless otherwise specified)

RATING	SYMBOL	D45C1, 2, 3	D45C4, 5, 6	D45C7, 8, 9	D45C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CE0}	-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	I_C	-4	-4	-4	-4	A
Peak ⁽¹⁾	I_{CM}	-6	-6	-6	-6	
Base Current — Continuous	I_B	-2	-2	-2	-2	A
Total Power Dissipation @ $T_A = 25^\circ C$ @ $T_C = 25^\circ C$	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	$^\circ C$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	$^\circ C/W$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	4.2	$^\circ C/W$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	+260	+260	+260	+260	$^\circ C$

(1) Pulse Test Pulse Width = 300ms Duty Cycle $\leq 2\%$.

D45C Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	.MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = -100\text{mA}$)	D45C1, 2, 3 D45C4, 5, 6 D45C7, 8, 9 D45C10, 11, 12	$V_{CEO(sus)}$	-30 -45 -60 -80	— — — —	— — — —	Volts
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CES}$)		I_{CES}	—	—	-10	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$)		I_{EBO}	—	—	-100	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 3
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -0.2\text{A}$, $V_{CE} = -1\text{V}$)	D45C1, 4, 7, 10 D45C2, 5, 8, 11 D45C3, 6, 9, 12	h_{FE}	25 40 40	— — —	— 120 120	—
($I_C = -1\text{A}$, $V_{CE} = -1\text{V}$)	D45C1, 4, 7, 10 D45C2, 5, 8, 11	h_{FE}	10 20	— —	— —	—
($I_C = -2\text{A}$, $V_{CE} = -1\text{V}$)	D45C3, 6, 9, 12	h_{FE}	20	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -1\text{A}$, $I_B = -50\text{mA}$)	D45C2, 5, 8, 11 D45C3, 6, 9, 12	$V_{CE(sat)}$	— —	— —	-0.5 -0.5	Volts
($I_C = -1\text{A}$, $I_B = -100\text{mA}$)	D43C1, 4, 7, 10	$V_{CE(sat)}$	—	—	-0.5	Volts
Base-Emitter Saturation Voltage ($I_C = -1\text{A}$, $I_B = -100\text{mA}$)		$V_{BE(sat)}$	—	—	-1.3	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}$, $f = 1\text{MHz}$)		C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product ($I_C = -20\text{mA}$, $V_{CE} = -4\text{V}$)		f_T	—	40	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = -1\text{A}$, $I_{B1} = I_{B2} = -0.1\text{A}$, $V_{CC} = -1\text{A}$, $t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	50	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle \leq 2%.

D45C Series

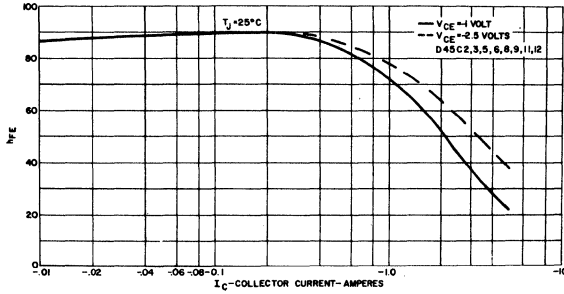


FIG. 1 TYPICAL h_{FE} VS. I_C

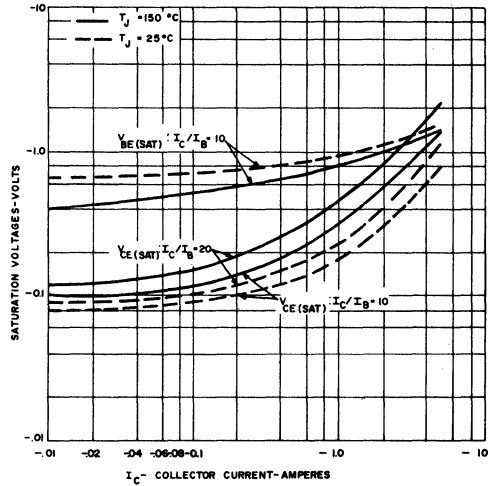


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

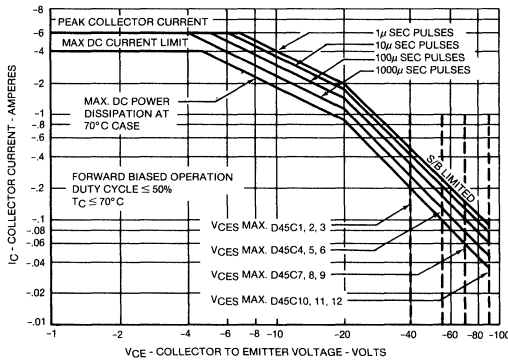


FIG. 3 SAFE REGION OF OPERATION

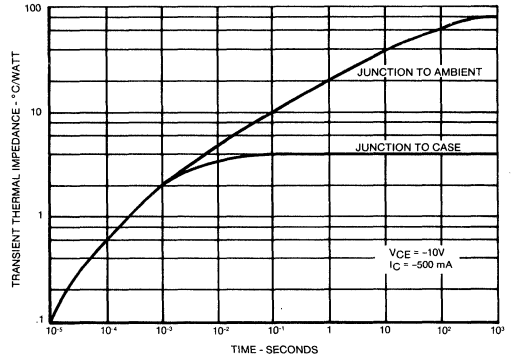


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

6-Ampere P-N-P Darlington Power Transistors

Complementary to the D44D Series

-40, -60, and -80 Volts, 30 Watts
Gain of 2000 at -1 A

Features:

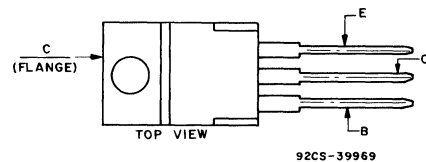
- Operates from IC without predriver

Applications:

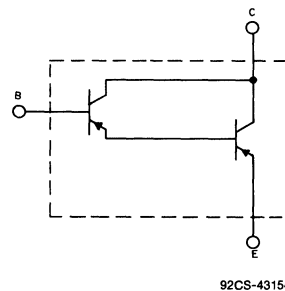
- Solenoid Driver
- Lamp Driver
- Relay Substitute
- Switching Regulator
- Inverter/Converter

The D45D-series p-n-p Darlington power transistors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 2000.

TERMINAL DESIGNATIONS



JEDEC TO-220AB



Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	-0.5	-0.5	-0.5	A
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	260	260	260	$^\circ\text{C}$

D45D Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Breakdown Voltage ($I_C = -50\text{mA}$)	D45D1,2 D45D3,4 D45D5,6	$V_{CEO(BR)}$	-40 -60 -80	— — —	— — —	Volts
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CES}$) ($V_{CE} = \text{Rated } V_{CES}, V_{BE} = 0.4\text{V}$)	$T_C = 25^\circ\text{C}$ $T_C = 125^\circ\text{C}$	I_{CES} I_{CEV}	— —	— —	-10 -5	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$)		I_{EBO}	—	—	-10	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 5
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -1\text{A}, V_{CE} = -2\text{V}$)		h_{FE}	2,000	5,000	—	—
Collector-Emitter Saturation Voltage ($I_C = -3\text{A}, I_B = -3\text{mA}$) ($I_C = -5\text{A}, I_B = -5\text{mA}$)	D45D2,4,6 only	$V_{CE(sat)}$	— —	— —	-1.5 -2.0	V V
Base-Emitter Saturation Voltage ($I_C = -5\text{A}, I_B = -5\text{mA}$)		$V_{BE(sat)}$	—	—	-2.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}, f = 1\text{MHz}$)	C_{CBO}	—	—	75	pF
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SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = -3\text{A}, I_{B1} = I_{B2} = -3\text{mA}$ $V_{CC} = 40\text{V}, t_p = 25 \mu\text{sec}$	$t_d + t_r$	—	0.35	—	μs
Storage Time		t_s	—	0.4	—	
Fall Time		t_f	—	0.3	—	

(1) Pulse Test: $PW \leq 300\text{ms}$ Duty Cycle $\leq 2\%$.

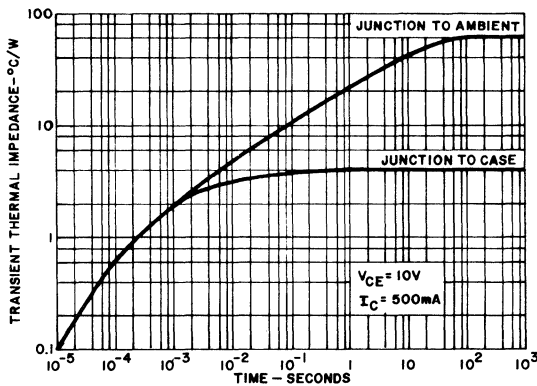


FIG. 1 MAXIMUM TRANSIENT THERMAL IMPEDANCE

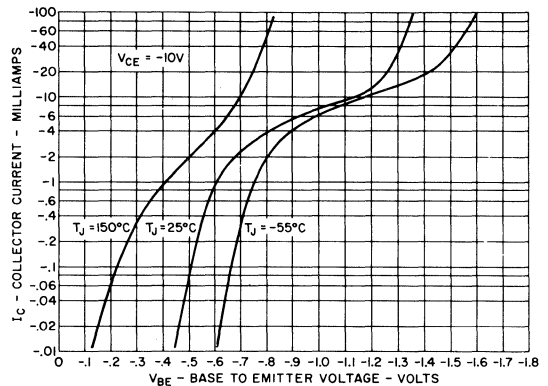


FIG. 2 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

D45D Series

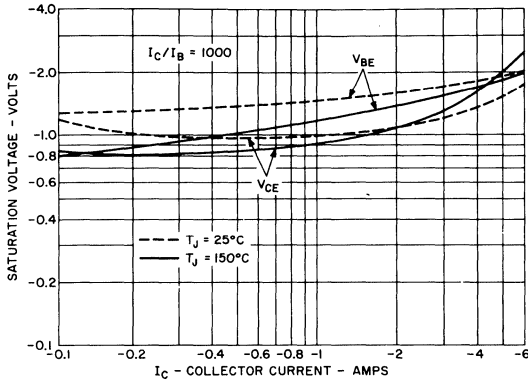


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

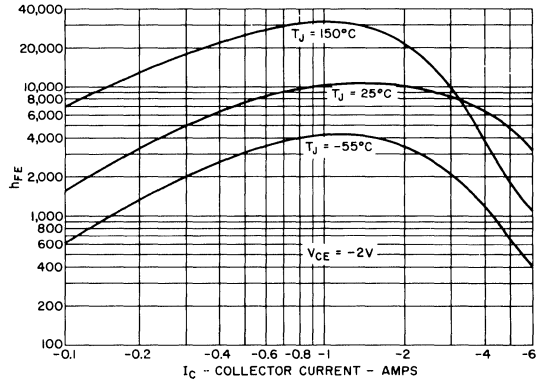


FIG. 4 TYPICAL h_{FE} VS. I_C

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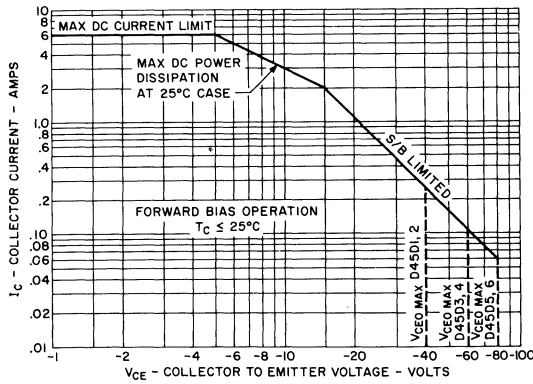


FIG. 5 SAFE REGION OF OPERATION

10-Ampere P-N-P Darlington Power Transistors

Complementary to the D44E Series

-40, -60, and -80 Volts, 50 Watts
Gain of 1000 at -5 A

Features:

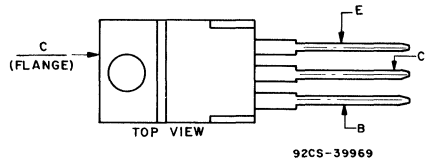
- Operates from IC without predriver

Applications:

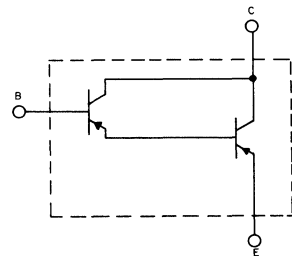
- Driver
- Regulator
- Capacitor Multiplier
- Solenoid Driver
- Inverter Power Supply
- Switch
- Audio Output
- Relay Substitute
- Oscillator
- Servo-Amplifier

The D45E-series p-n-p Darlington power transistors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 1000.

TERMINAL DESIGNATIONS



JEDEC TO-220AB



Schematic diagram for all types.

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	I _C	-10	-10	-10	A
Collector Current — Peak ⁽¹⁾	I _{CM}	-20	-20	-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 _{θJA}	75	75	75	°C/W
Thermal Resistance, Junction to Case	R _{θJC}	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T _L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D45E Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS ⁽¹⁾

Collector-Emitter Voltage ($I_C = -100\text{mA}$)	D45E1 D45E2 D45E3	V_{CE0}	-40 -60 -80	— — —	— — —	Volts
Collector Cut-off Current ($V_{CE} = \text{Rated } V_{CEs}$)		I_{CES}	—	—	-10	μA
Emitter Cutoff Current ($V_{EB} = -7\text{V}$)		I_{EBO}	—	—	-1.0	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 6
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ON CHARACTERISTICS ⁽¹⁾

DC Current Gain ($I_C = -5\text{A}$, $V_{CE} = -5\text{V}$)	h_{FE}	1,000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -5.0\text{A}$, $I_B = -10\text{mA}$) ($I_C = -10.0\text{A}$, $I_B = -20\text{mA}$)	$V_{CE(sat)}$	— —	— —	-1.5 -2.0	V V
Base-Emitter Saturation Voltage ($I_C = -5.0\text{A}$, $I_B = -10\text{mA}$)	$V_{BE(sat)}$	—	—	-2.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}$, $f = 1\text{MHz}$)	C_{CBO}	—	—	220	μF
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SWITCHING CHARACTERISTICS

Resistive Load					
Delay Time + Rise Time	$I_C = -10\text{A}$, $I_{B1} = I_{B2} = -20\text{mA}$ $V_{CC} = -40\text{V}$, $t_p = 25\mu\text{sec}$	$t_d + t_r$	—	0.6	—
Storage Time		t_s	—	2.0	—
Fall Time		t_f	—	0.5	—

(1) Pulse Test: $PW \leq 300\text{ms}$ Duty Cycle $\leq 2\%$.

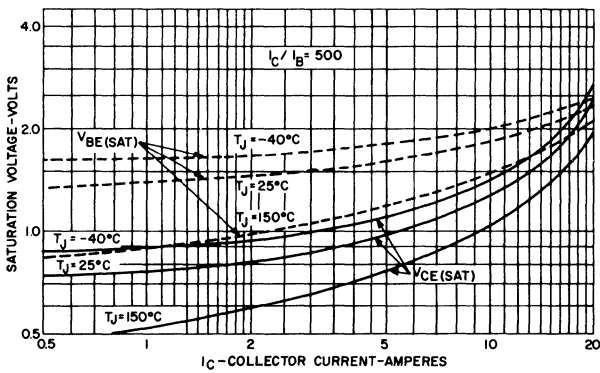


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

D45E Series

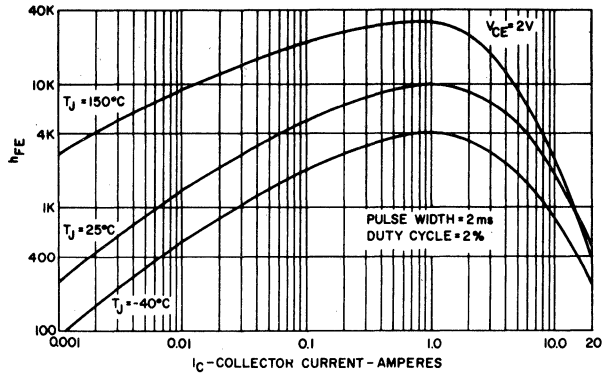


FIG. 2 TYPICAL GAIN CHARACTERISTIC

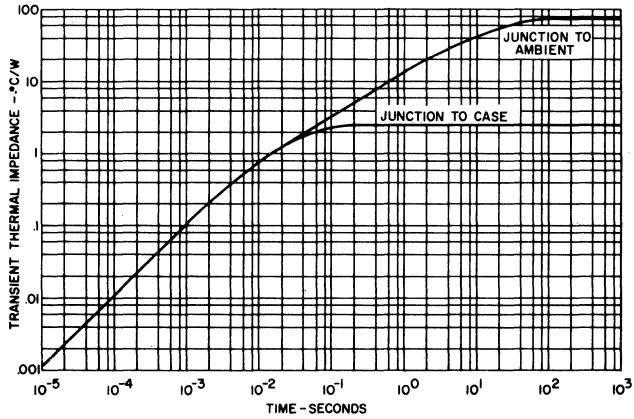


FIG. 3 TRANSIENT THERMAL IMPEDANCE

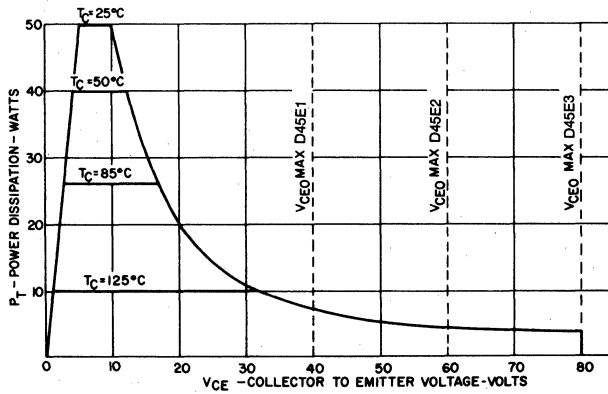


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

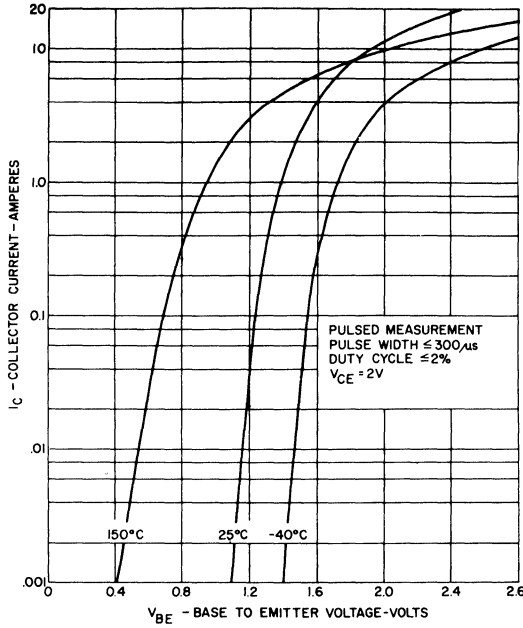


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

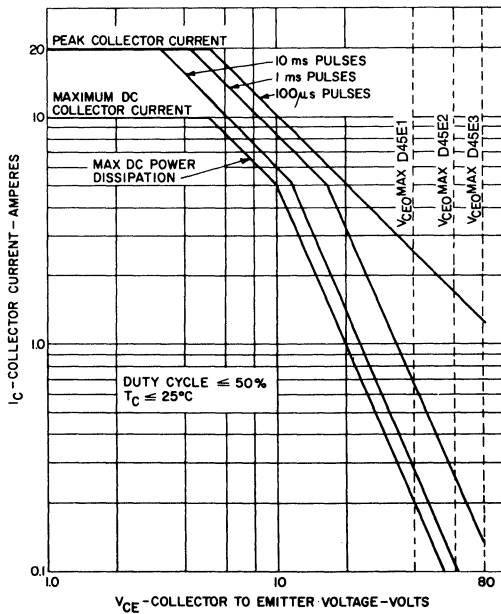


FIG. 6 SAFE REGION OF OPERATION

D45H Series

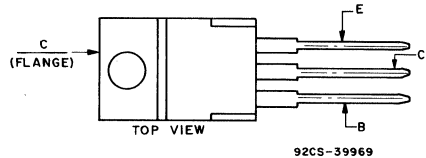
File Number **15.18****Silicon P-N-P Transistors****Complementary to the D44H Series**

For Switching and Linear Applications

Features:

- Very low collector saturation voltage
- Excellent linearity
- Fast switching

D45H-series p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequency from DC to greater than 1.0 MHz, series, shunt and switching regulators, and low and high frequency inverters/converters.

TERMINAL DESIGNATIONS**JEDEC TO-220AB****MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	2.5	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	+260	+260	+260	+260	$^\circ\text{C}$

(1) Pulse Test Pulse Width = 300ms Duty Cycle $\leq 2\%$.

D45H Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = -100\text{mA}$)	D45H1, 2 D45H4, 5 D45H7, 8 D45H10, 11	$V_{CE(sus)}$	-30 -45 -60 -80	— — — —	— — — —	Volts
Collector Cutoff Current ($V_{CB} = \text{Rated } V_{CBO}$)		I_{CBO}	—	—	-10	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$)		I_{EBO}	—	—	-100	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 4
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ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -2\text{A}, V_{CE} = -1\text{V}$) ($I_C = -4\text{A}, V_{CE} = -1\text{V}$)	D45H1, 4, 7, 10 D45H2, 5, 8, 11 D45H1, 4, 7, 10 D45H2, 5, 8, 11	h_{FE}	35 60 20 40	— — — —	— — — —	—
Collector-Emitter Saturation Voltage ($I_C = -8\text{A}, I_B = -0.4\text{A}$) ($I_C = -8\text{A}, I_B = -0.8\text{A}$)	D45H1, 4, 7, 10 D45H2, 5, 8, 11	$V_{CE(sat)}$	— —	— —	-1.0 -1.0	Volts
Base-Emitter Saturation Voltage ($I_C = -8\text{A}, I_B = -0.8\text{A}$)		$V_{BE(sat)}$	—	—	-1.5	Volts

DYNAMIC CHARACTERISTICS

Collector Capacitance ($V_{CB} = -10\text{V}, f = 1\text{MHz}$)	C_{CBO}	—	230	—	pF
Current-Gain — Bandwidth Product ($I_C = -500\text{mA}, V_{CE} = -10\text{V}$)	f_T	—	40	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	$I_C = -5\text{A}, I_{B1} = -0.5\text{A}$	$t_d + t_r$	—	135	—	nS
Storage Time	$I_C = -5\text{A}, I_{B1} = I_{B2} = -0.5\text{A}$	t_s	—	500	—	
Fall Time		t_f	—	100	—	

(1) Pulse Test $PW = 300\text{ms}$ Duty Cycle $\leq 2\%$.

D45H Series

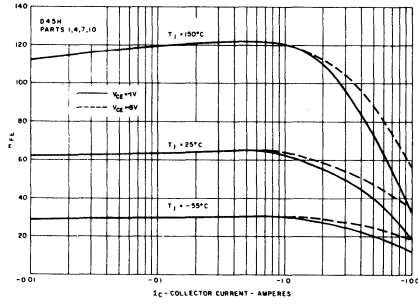


FIG. 1 TYPICAL GAIN CHARACTERISTICS

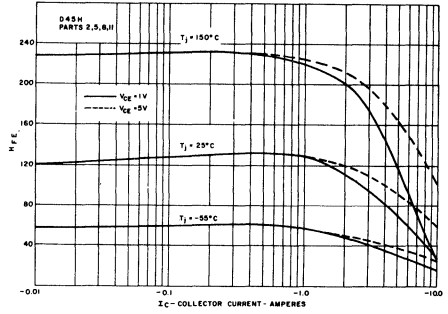


FIG. 2 TYPICAL GAIN CHARACTERISTICS

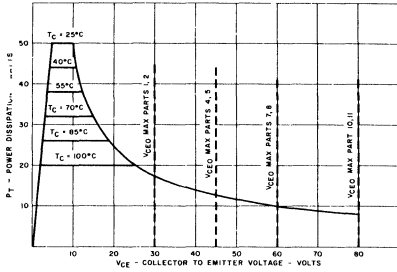


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

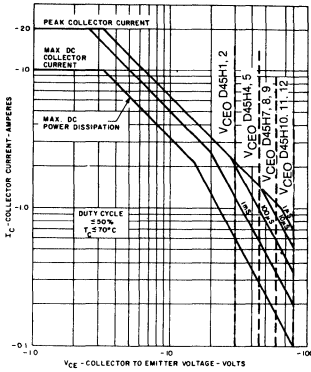


FIG. 4 SAFE REGION OF OPERATION

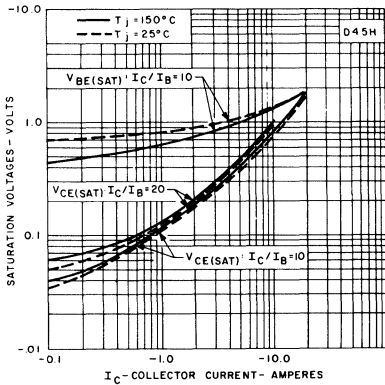


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

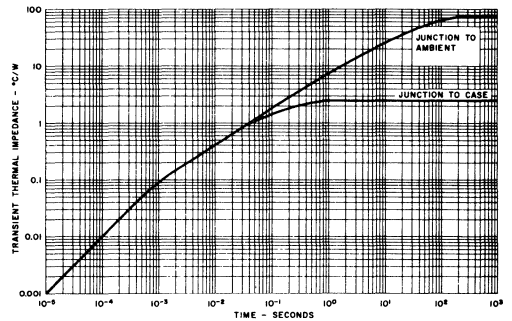


FIG. 6 TRANSIENT THERMAL IMPEDANCE

Silicon P-N-P Transistors

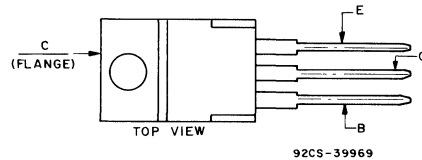
Complementary to the D44VH Series

Features:

- Fast Switching $t_s \leq 500$ ns resistive
 $t_f \leq 100$ ns
- Low $V_{CE(sat)} \leq 1.0V$ @ $I_C = 8A$

The D45VH-series of silicon p-n-p power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	-15	-15	-15	-15	A
Peak ⁽¹⁾	I_{CM}	-20	-20	-20	-20	
Base Current — Continuous	I_B	-5	-5	-5	-5	A
Peak ⁽¹⁾	I_{BM}	-10	-10	-10	-10	
Total Power Dissipation @ $T_c = 25^\circ\text{C}$	P_D	83	83	83	83	Watts
@ $T_c = 100^\circ\text{C}$		33	33	33	33	
Derate above 25°C		0.67	0.67	0.67	0.67	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: 1/8" from Case for 5 Seconds	T_L	235	235	235	235	°C

(1) Pulse measurement condition $PW \leq 6.0$ ms, see Figure 14.

D45VH Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS⁽¹⁾				
Collector-Emitter Sustaining Voltage ⁽¹⁾ ($I_C = -100\text{mA}$, $I_B = 0$) D45VH1 D45VH4 D45VH7 D45VH10	$V_{CE0(sus)}$	-30 -45 -60 -80	—	V
Collector-Emitter Voltage ⁽²⁾ ($I_C = -10\text{A}$, $V_{CLAMP} = \text{Rated } V_{CEX}$, $T_C = 100^\circ\text{C}$) D45VH1 D45VH4 D45VH7 D45VH10	V_{CEX}	-40 -55 -70 -90	—	V
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 4.0\text{V}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 4.0\text{V}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	— —	-10 -100	μA
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEV}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	-100	μA
Emitter Cutoff Current ($V_{EB} = -7\text{V}$, $I_C = 0$)	I_{EBO}	—	-10	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 7
Second Breakdown with Base Reverse Biased	RBSOA	SEE FIGURE 8

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = -2\text{A}$, $V_{CE} = -1\text{V}$) ($I_C = -4\text{A}$, $V_{CE} = -1\text{V}$)	h_{FE}	35 20	— —	—
Collector-Emitter Saturation Voltage ($I_C = -8\text{A}$, $I_B = -0.8\text{A}$) ($I_C = -8\text{A}$, $I_B = -0.8\text{A}$, $T_C = 100^\circ\text{C}$) ($I_C = -15\text{A}$, $I_B = -3.0\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — —	-1.0 -1.1 -1.5	V
Base-Emitter Saturation Voltage ($I_C = -8\text{A}$, $I_B = -0.8\text{A}$) ($I_C = -8\text{A}$, $I_B = -0.8\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— —	-1.4 -1.4	V

DYNAMIC CHARACTERISTICS

Typical

Current-Gain — Bandwidth Product ($I_C = -0.1\text{A}$, $V_{CE} = -10\text{V}$, $f_{test} = 1\text{MHz}$)	f_T	50	MHz
Output Capacitance ($V_{CB} = -10\text{V}$, $I_E = 0$, $f_{test} = 1\text{MHz}$)	C_{OB}	275	pF

SWITCHING CHARACTERISTICS

Maximum

Resistive Load (See Figure 16 for Test Circuit)					
Delay Time	$V_{CC} = -20\text{V}$, $I_C = -8\text{A}$ $I_{B1} = I_{B2} = -0.8\text{A}$ $t_p = 25\ \mu\text{sec}$	T_C	25°C	100°C	
Rise Time		t_d	50	—	nsec
Storage Time		t_r	250	—	nsec
Fall Time		t_s	500	—	nsec
		t_f	100	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CC} = -20\text{V}$, $I_C = -8\text{A}$ $V_{CLAMP} = \text{Rated } V_{CEX}$ $I_{B1} = -0.8\text{A}$, $V_{BE(off)} = 5\text{V}$ $L = 200\ \mu\text{H}$	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	

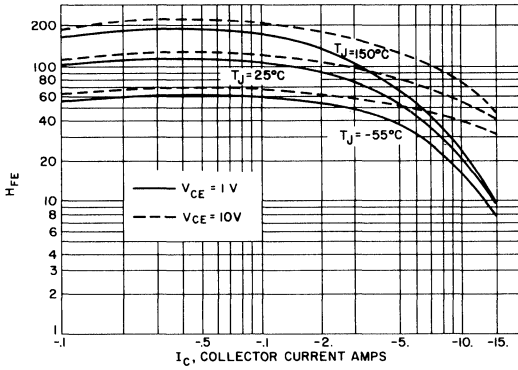
(1) Pulse Duration = 300 μsec , Duty Factor $\leq 2\%$.

(2) See Figure 15 for Test Circuit.

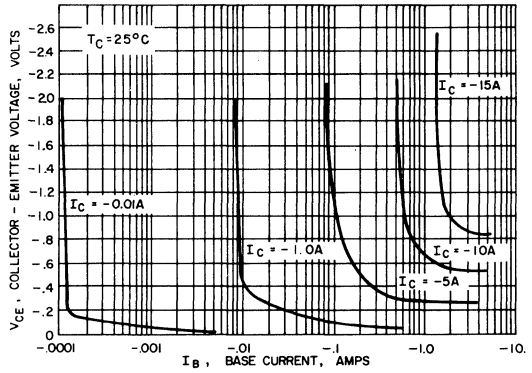
D45VH Series

TYPICAL DC CHARACTERISTICS

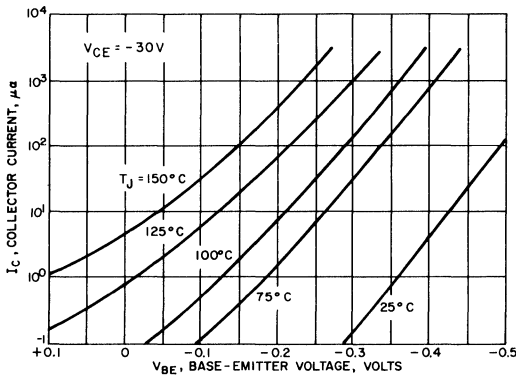
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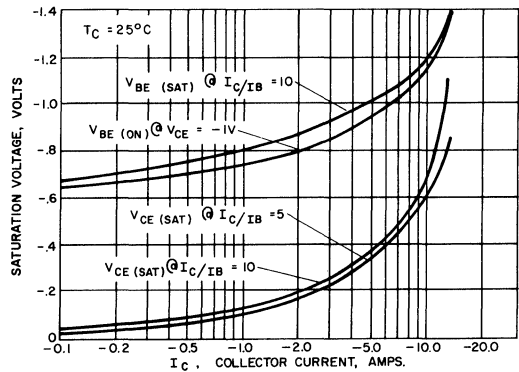
1. DC CURRENT GAIN



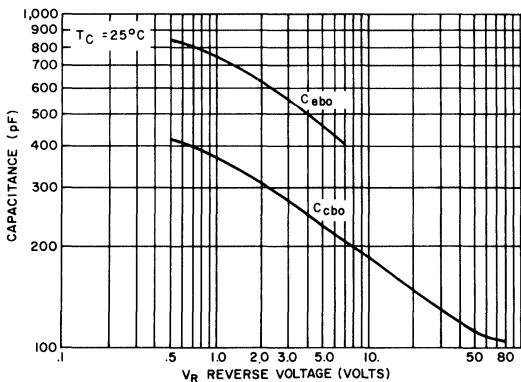
2. COLLECTOR SATURATION REGION



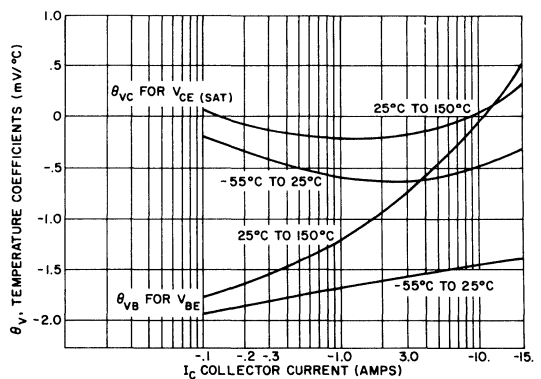
3. COLLECTOR CUTOFF REGION



4. SATURATION VOLTAGE



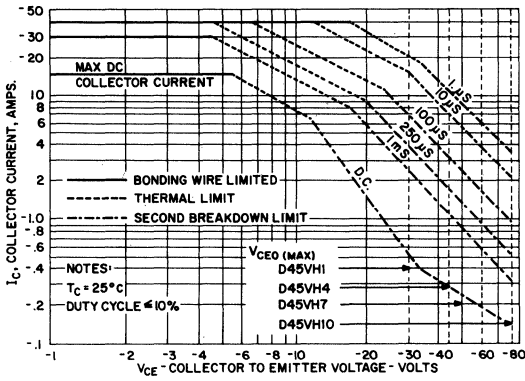
5. CAPACITANCE



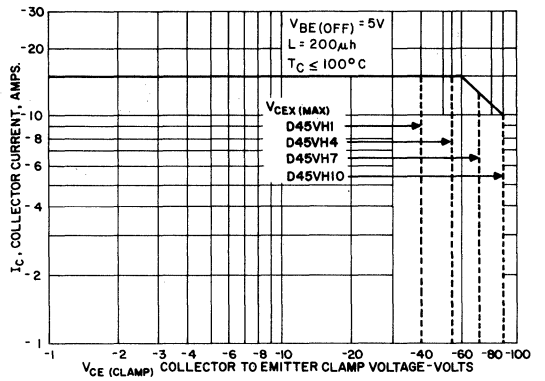
6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

D45VH Series

SAFE OPERATING AREA

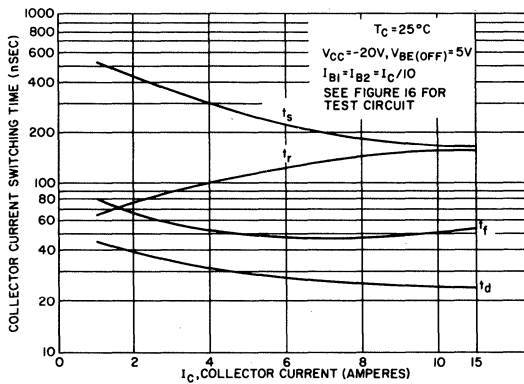


7. FORWARD BIAS SOA

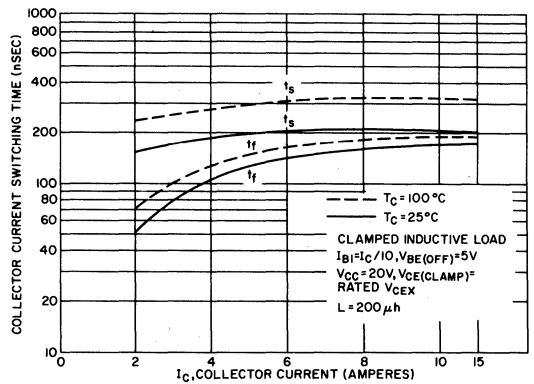


8. REVERSE BIAS SOA

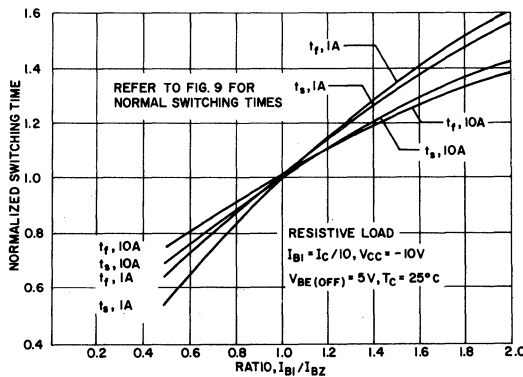
TYPICAL SWITCHING CHARACTERISTICS



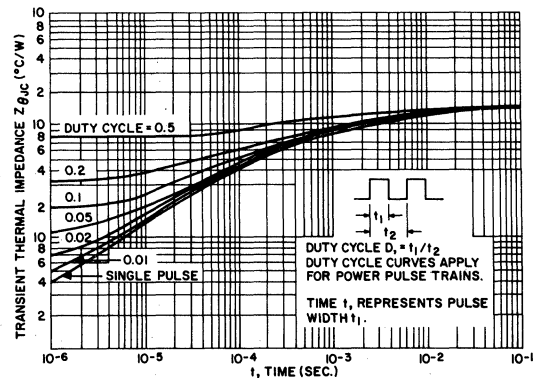
9. RESISTIVE SWITCHING TIME



10. CLAMPED INDUCTIVE SWITCHING TIME

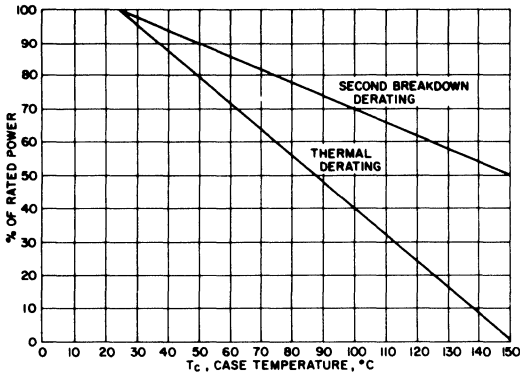


11. SWITCHING TIME VARIATION WITH I_{B2}

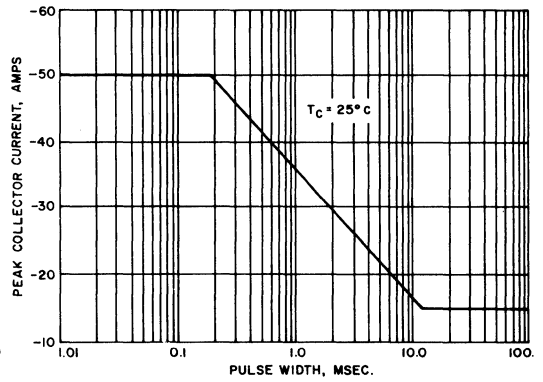


12. TRANSIENT THERMAL RESPONSE

D45VH Series



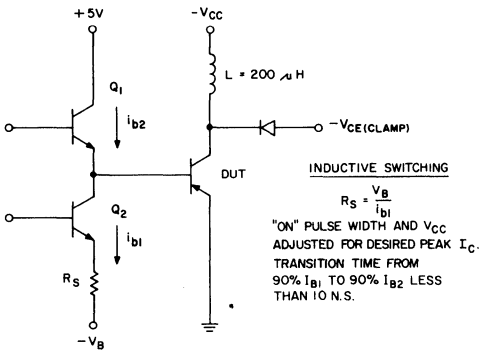
13. POWER DERATING FACTOR



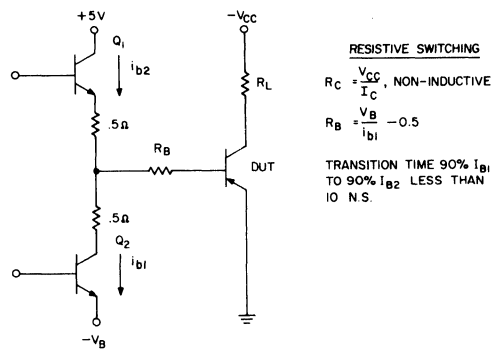
14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

2

TEST CIRCUITS



15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

Silicon P-N-P Transistors

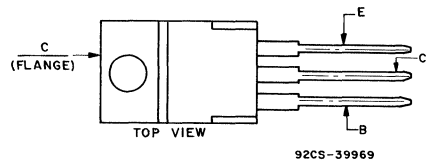
Complementary to the D44VM Series

Features:

- Very Fast Switching $t_s \leq 500$ ns resistive
 $t_f \leq 75$ ns
- Very low $V_{CE(sat)} \leq 0.4$ V @ $I_C = 4$ A
- High gain $H_{FE} \geq 40$ @ $I_C = 4$ A

The D45VM-series of silicon p-n-p power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design..

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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	I_C	-8				A
— Peak (1)	I_{CM}	-20				
Base Current — Continuous	I_B	-2				A
— Peak (1)	I_{BM}	-5				
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	P_D	50				Watts
Derate above 25°C		20				W/°C
@ $T_C = 100^\circ\text{C}$		0.4				
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 $PW \leq 6.0$ ms.

D45VM Series

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
-----------------	--------	-----	-----	------

OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ⁽¹⁾ ($I_C = -100\text{mA}$, $I_B = 0$) D45VM1 D45VM4 D45VM7 D45VM10	$V_{CEO(sus)}$	-30 -45 -60 -80	— — — —	V
Collector-Emitter Voltage ⁽²⁾ ($I_C = -3\text{A}$, $V_{CLAMP} = \text{Rated } V_{CEX}$, $T_C \leq 100^\circ\text{C}$) D45VM1 D45VM4 D45VM7 D45VM10	V_{CEX}	-30 -45 -60 -80	— — — —	V
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 4.0\text{V}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 4.0\text{V}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	— —	-10 -100	μA
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEV}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	-100	μA
Emitter Cutoff Current ($V_{EB} = -7\text{V}$, $I_C = 0$)	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 ($I_C = -4\text{A}$, $V_{CE} = -1\text{V}$) ($I_C = -6\text{A}$, $V_{CE} = -1\text{V}$)	h_{FE}	40 20	— —	—
Collector-Emitter Saturation Voltage ($I_C = -4\text{A}$, $I_B = -0.2\text{A}$) ($I_C = -6\text{A}$, $I_B = -0.3\text{A}$) ($I_C = -8\text{A}$, $I_B = -0.8\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — —	-0.4 -0.6 -1.0	V
Base-Emitter Saturation Voltage ($I_C = -4\text{A}$, $I_B = -0.2\text{A}$) ($I_C = -4\text{A}$, $I_B = -0.2\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— —	-1.2 -1.2	V

DYNAMIC CHARACTERISTICS

Typical

Current-Gain — Bandwidth Product ($I_C = -0.1\text{A}$, $V_{CE} = -10\text{V}$, $f_{test} = 1\text{MHz}$)	f_T	50	MHz
Output Capacitance ($V_{CB} = -10\text{V}$, $I_E = 0$, $f_{test} = 1\text{MHz}$)	C_{OB}	70	pF

SWITCHING CHARACTERISTICS

Maximum

Resistive Load (See Figure 16 for Test Circuit)	T_C	25°C	100°C		
Delay Time	$V_{CC} = 30\text{V}$, $I_C = -6\text{A}$ $I_{B1} = I_{B2} = 0.6\text{A}$ $t_p = 25\ \mu\text{sec}$	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	$V_{CE(CLAMP)} = 30\text{V}$, $I_C = -6\text{A}$ $I_{B1} = I_{B2} = 0.6\text{A}$, $V_{BE(OFF)} = 5\text{V}$ $L = 200\ \mu\text{h}$	t_s	500	600	nsec
Fall Time		t_f	70	100	nsec
		Typical			
Storage Time		t_s	340	430	nsec
Fall Time	t_f	40	57	nsec	

(1) Pulse Duration = 300 μsec , Duty Factor $\leq 2\%$.

(2) See Figure 15 for Test Circuit.

D45VM Series

TYPICAL DC CHARACTERISTICS

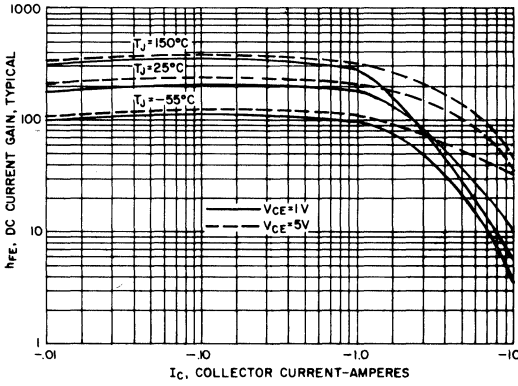


FIGURE 1. DC CURRENT GAIN

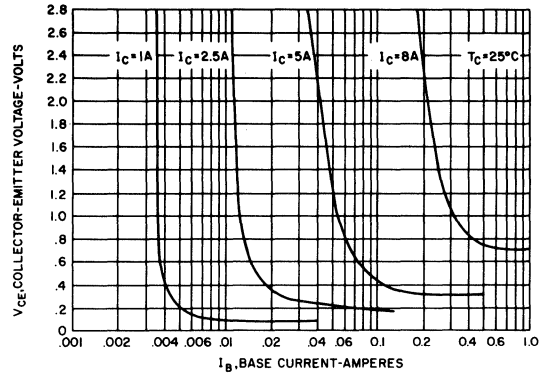


FIGURE 2. COLLECTOR SATURATION REGION

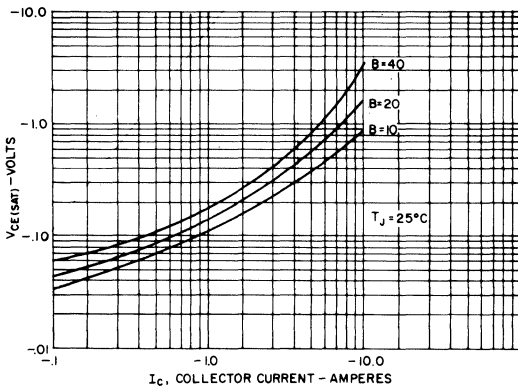


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

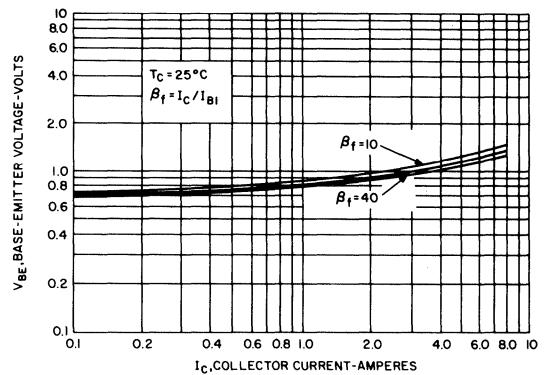


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

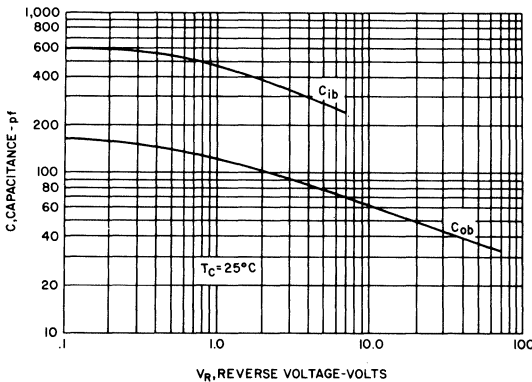


FIGURE 5. CAPACITANCE

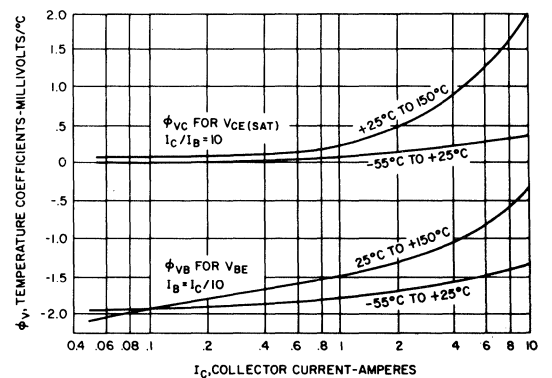


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

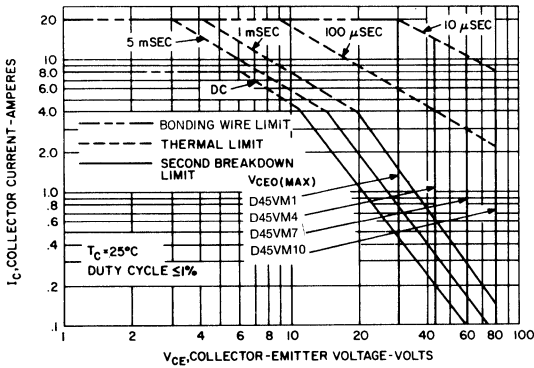


FIGURE 7. FORWARD BIAS SOA

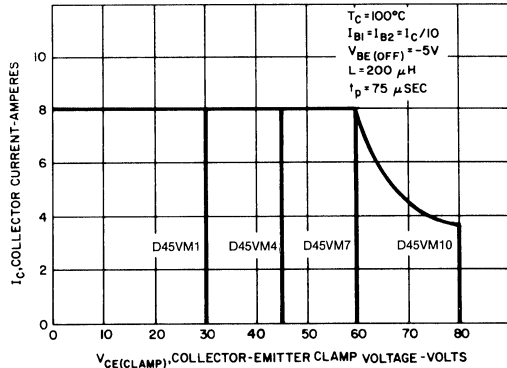


FIGURE 8. CLAMPED REVERSE BIAS SOA

2

TYPICAL SWITCHING CHARACTERISTICS

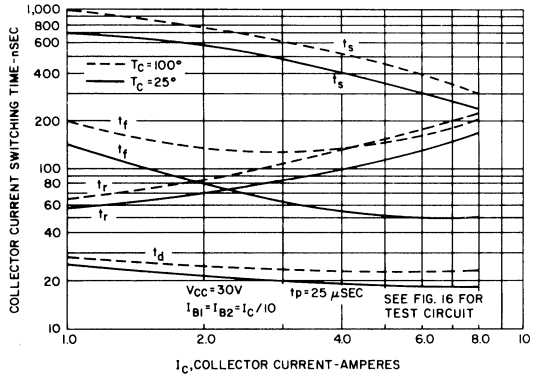


FIGURE 9. RESISTIVE SWITCHING TIME

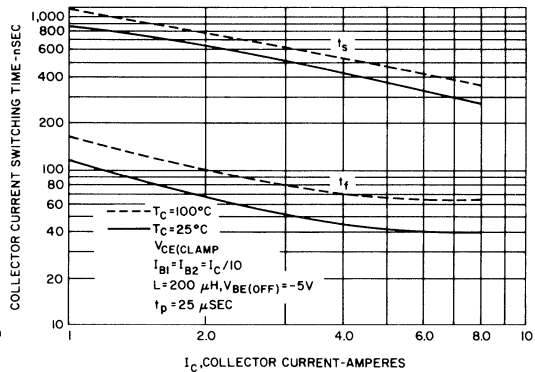


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

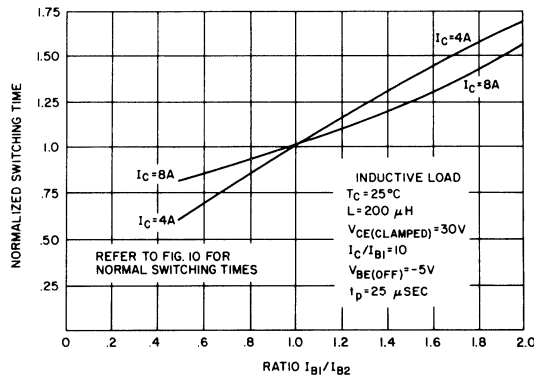


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

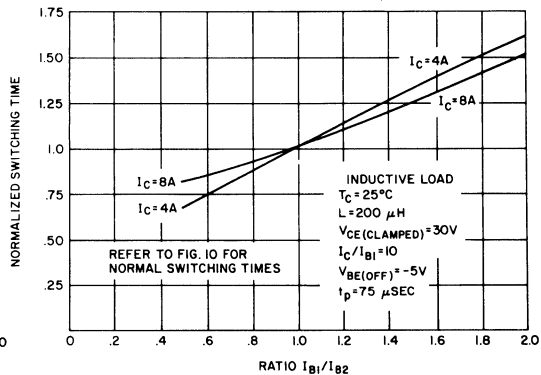


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D45VM Series

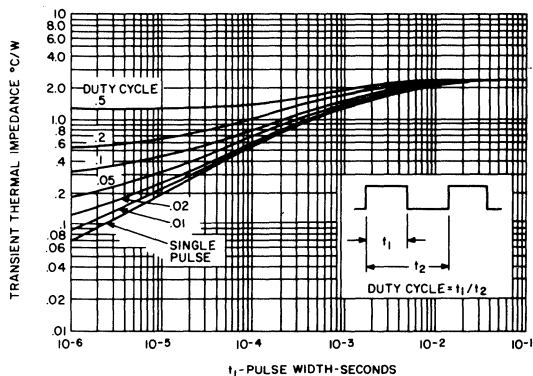


FIGURE 13. TRANSIENT THERMAL RESPONSE

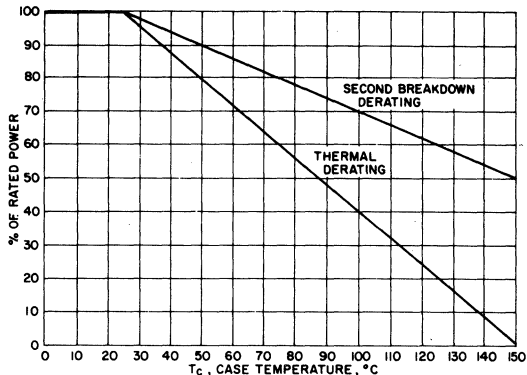
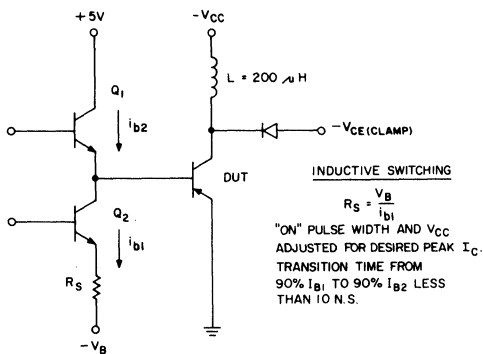
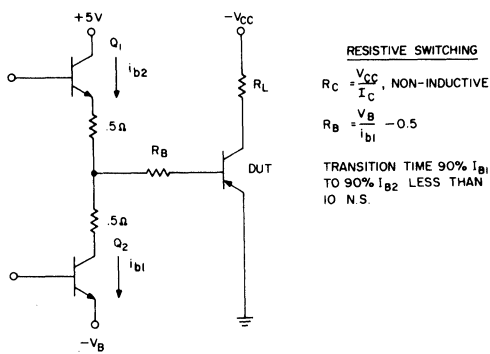


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS



15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

High-Speed Silicon N-P-N Power Transistors

Devices for Switching Applications

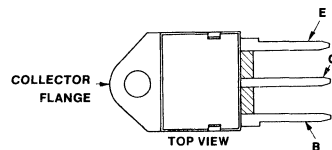
2

Features:

- $V_{CEO(sus)}$ 400 V and 450 V
- 700 V blocking capability
- SOA and switching information

The D46TQ1 and D46TQ2 are silicon n-p-n power transistors designed for high-voltage, high-speed power switching of inductive circuits where fall time is critical. They are particularly suited for off-line switch-mode applications such as switching regulators, inverters, motor controls, solenoid/relay drivers, and deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-218AC

92CS-40257

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

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	I_C	12	12	A
Peak (Repetitive) ⁽¹⁾	I_{CM}	24	24	
Base Current — Continuous	I_B	6	6	A
Peak (Non-Repetitive) ⁽¹⁾	I_{BM}	12	12	
Total Power Dissipation @ $T_c = 25^\circ\text{C}$	P_D	110	110	Watts
Derate above 25°C		0.88	0.88	W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.1	1.1	$^\circ\text{C}/\text{W}$
Maximum Lead Temperature for Soldering Purpose: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	275	275	$^\circ\text{C}$

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle \leq 10%.

D46TQ1, D46TQ2**ELECTRICAL CHARACTERISTICS (T_C = 25° C)** (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

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⁾

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						
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) (I _{B1} = 1.6A, V _{BE(OFF)} = -5V T _C = 100° C)	t _{sv}	—	0.92	2.3	μs
Crossover Time		t _c	—	0.12	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

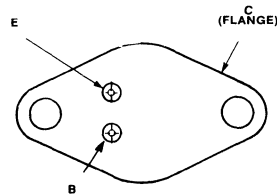
20-Ampere N-P-N Darlington Power Transistors

Features:

- High speed $t_g < 3.0 \mu\text{sec.}$, $t_r < 1.0 \mu\text{sec.}$
- High voltage: 400-500 $V_{CEO(SUS)}$
- High gain: h_{FE} 40 minimum @ $I_C = 20A$
- High current: 30 amperes, I_C (Peak)

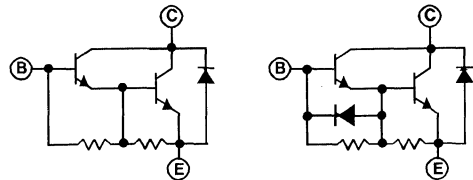
The D64DS and D64ES series of silicon n-p-n power Darlington transistors are designed for use in high-speed switching applications. These applications include off-line switching power supplies, PWM ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

TERMINAL DESIGNATIONS



92CS-27516

JEDEC TO-204AA



D64DS

D64ES

DEVICE CIRCUIT

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

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	V_{EBO}	8	8	8	Volts
		5	5	5	
Collector Current — Continuous	I_C	20	20	20	A
Peak (Repetitive)	I_{CM}	30	30	30	
Peak (Non-Repetitive)	I_{CSM}	50	50	50	
Base Current — Continuous	I_B	5	5	5	A
Peak (Non-Repetitive)	I_{BM}	10	10	10	
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	300	300	300	$^\circ\text{C}$

D64DS5,6,7**D64ES5,6,7****ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)**

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Sustaining Voltage (I _C = 0.5A) (V _{clamp} = V _{CEO} Rated)	D64DS5/ES5 D64DS6/ES6 D64DS7/ES7	V _{CEO(sus)}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V _{CE} = Rated Value, V _{BE} = -1.5V)	T _J = 25°C T _J = 150°C	I _{CEV}	— —	— —	1.0 2.5	mA
Emitter Cutoff Current (V _{EB} = 4.5V, I _C = 0) (V _{EB} = 1.5V, I _C = 0)	D64DS D64ES	I _{EBO}	— —	— —	200 200	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 26
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ON CHARACTERISTICS

DC Current Gain (I _C = 30A, V _{CE} = 5V) (I _C = 20A, V _{CE} = 5V) (I _C = 10A, V _{CE} = 5V)	h _{FE}	20 40 100	35 85 160	— — —	—
Collector-Emitter Saturation Voltage (I _C = 30A, I _B = 3A) (I _C = 20A, I _B = 2A) (I _C = 10A, I _B = 1A)	V _{CE(sat)}	— — —	2.1 1.6 1.2	3.5 2.5 1.5	V
Base-Emitter Saturation Voltage (I _C = 30A, I _B = 3A) (I _C = 20A, I _B = 2A) (I _C = 10A, I _B = 1A)	V _{BE(sat)}	— — —	2.65 2.3 1.8	4 3 2.5	V

SWITCHING CHARACTERISTICS**TYP. MAX.**

Resistive Load				DS	ES	DS	ES	μsec
Delay Time	V _{CC} = 250V	t _d	—	0.05	0.05	0.5	0.5	
Rise Time	I _C = 20A	t _r	—	0.4	0.4	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		P _D	—	—	125	Watts
Forward Voltage	(I _F = 10A)	V _F	—	1.95	3.20	Volts
	(I _F = 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 _{θJC}	—	—	1.0	°C/Watt

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

2

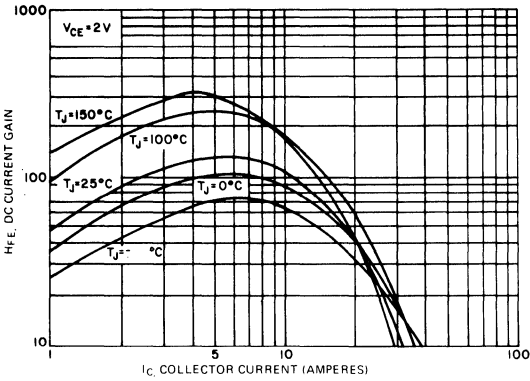


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 2V$)

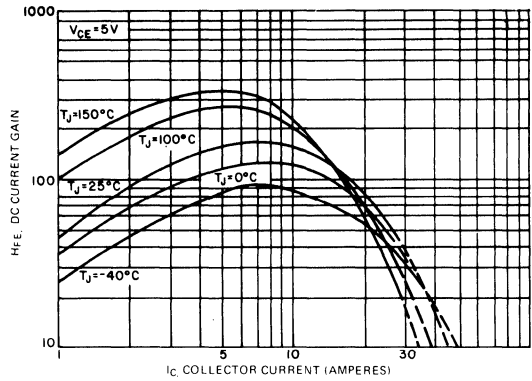


FIGURE 2. DC CURRENT GAIN ($V_{CE} = 5V$)

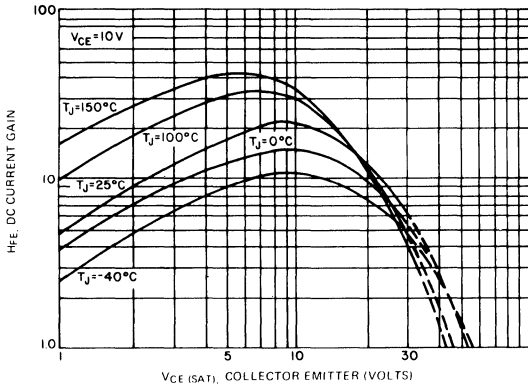


FIGURE 3. DC CURRENT GAIN ($V_{CE} = 10V$)

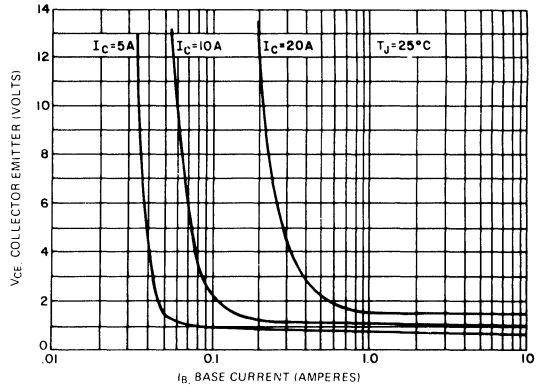


FIGURE 4. COLLECTOR SATURATION REGION

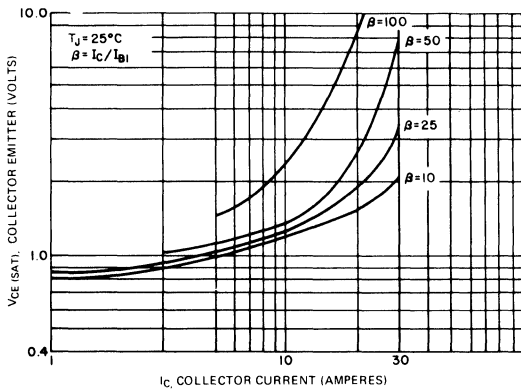


FIGURE 5. $V_{CE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

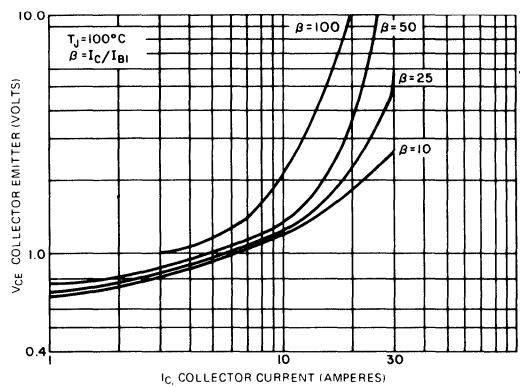


FIGURE 6. $V_{CE(SAT)}$ VS. I_C , $T_J = 100^\circ C$

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

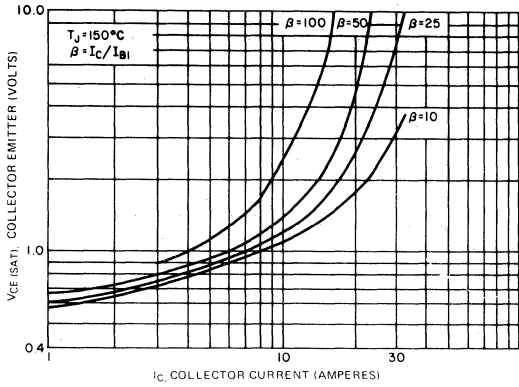


FIGURE 7. $V_{CE(SAT)}$ VS. I_C , $T_J = 150^\circ\text{C}$

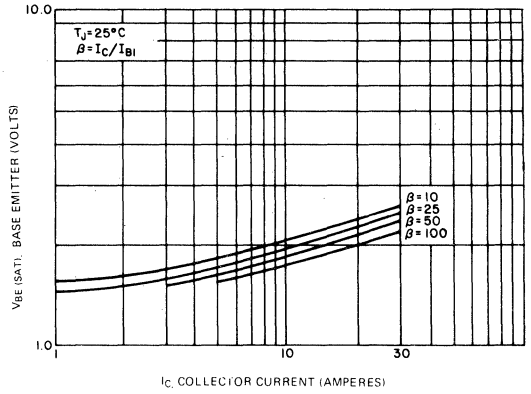


FIGURE 8. $V_{BE(SAT)}$ VS. I_C , $T_J = 25^\circ\text{C}$

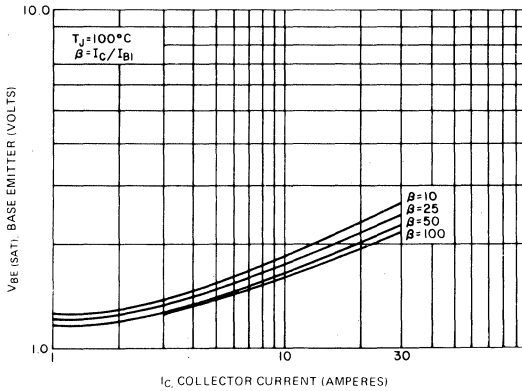


FIGURE 9. $V_{BE(SAT)}$ VS. I_C , $T_J = 100^\circ\text{C}$

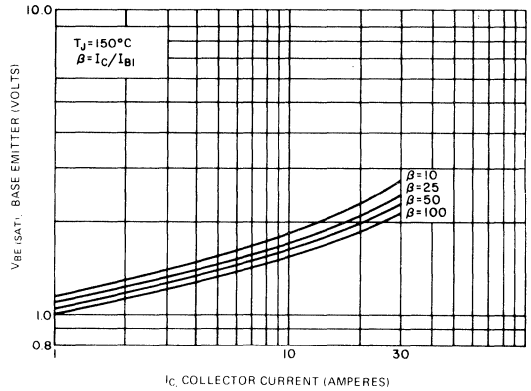


FIGURE 10. $V_{BE(SAT)}$ VS. I_C , $T_J = 150^\circ\text{C}$

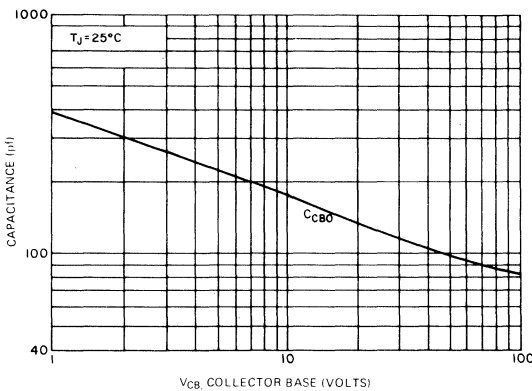


FIGURE 11. CAPACITANCE (C_{CB0})

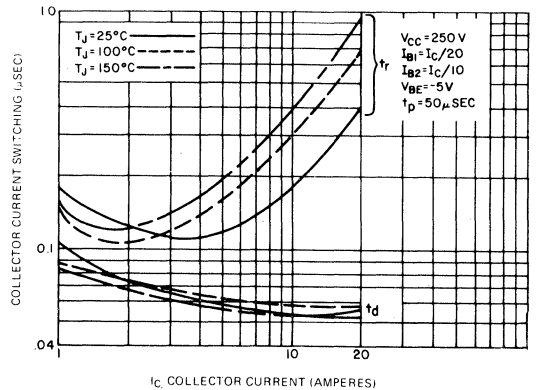


FIGURE 12. TURN-ON TIME (RESISTIVE LOAD) (D64DS ONLY)

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

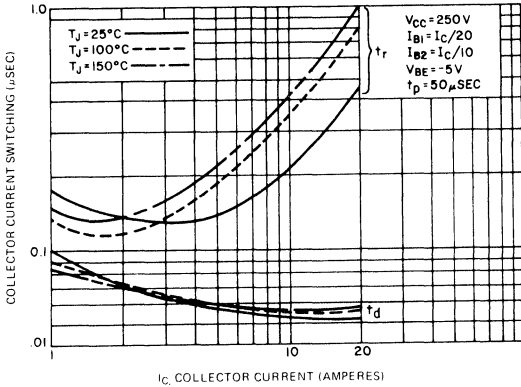


FIGURE 13. TURN-ON TIME (RESISTIVE) (D64ES ONLY)

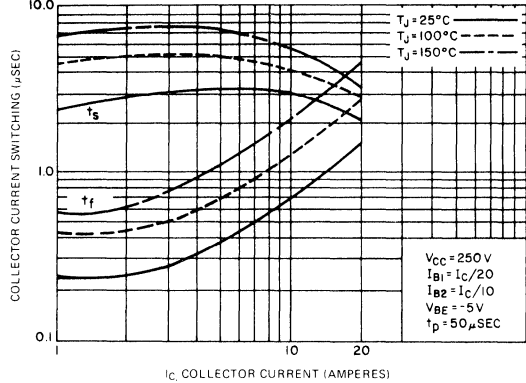


FIGURE 14. TURN-OFF TIME (RESISTIVE) (D64DS ONLY)

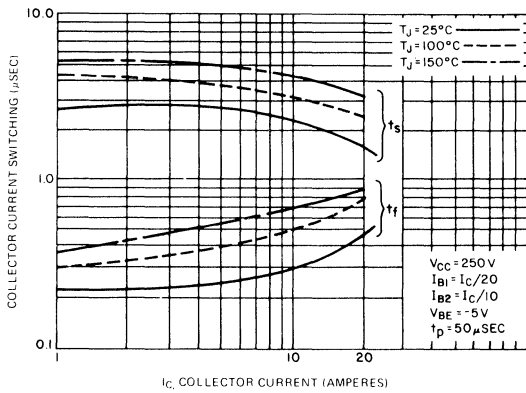


FIGURE 15. TURN-OFF TIME (RESISTIVE) (D64ES ONLY)

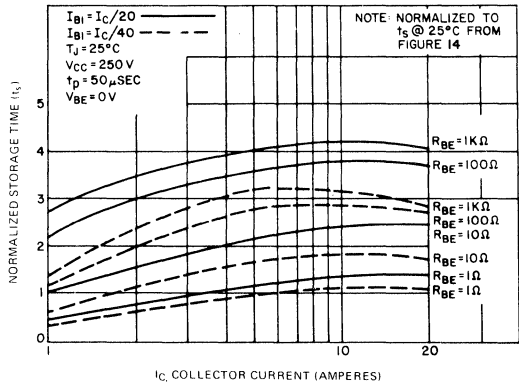


FIGURE 16. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D64DS ONLY)

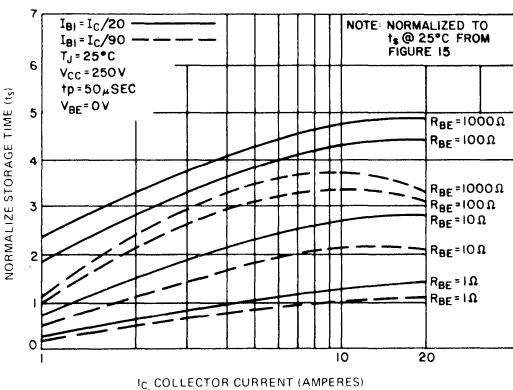


FIGURE 17. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D64ES ONLY)

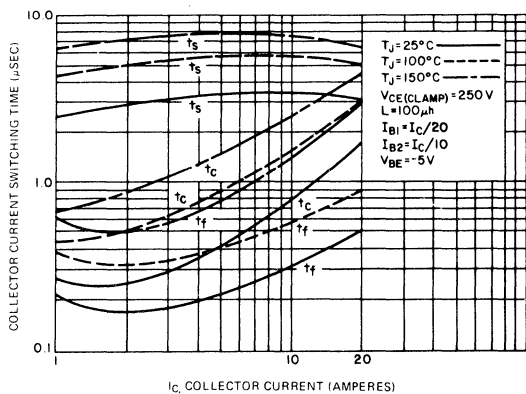


FIGURE 18. CLAMPED INDUCTIVE TURN-OFF TIME (D64DS ONLY)

2

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

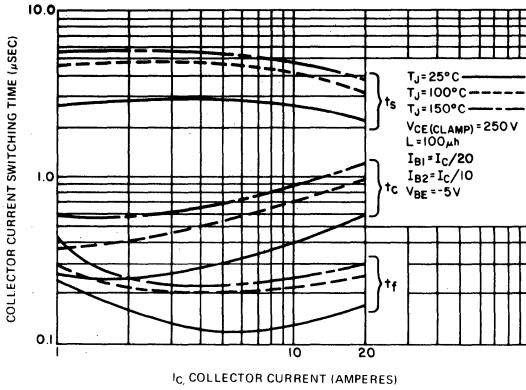


FIGURE 19. CLAMPED INDUCTIVE TURN-OFF TIME (D64ES ONLY)

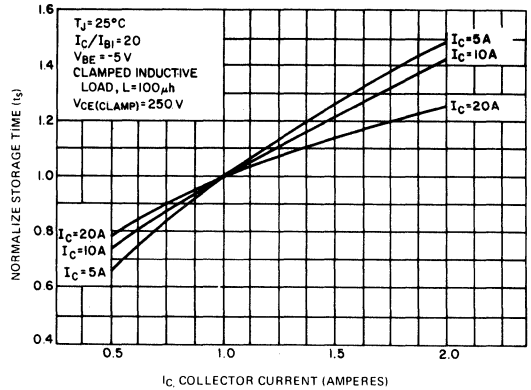


FIGURE 20. STORAGE TIME VARIATION WITH I_{B2} (D64DS ONLY)

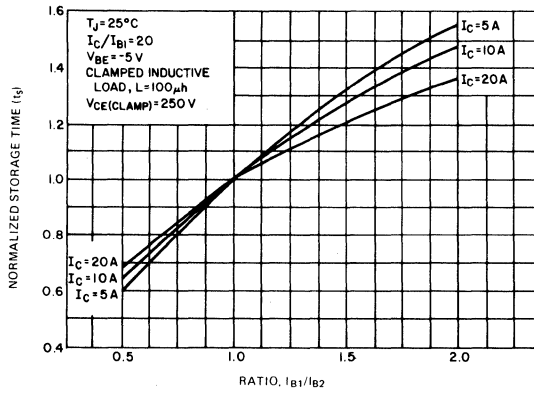


FIGURE 21. STORAGE TIME VARIATION WITH I_{B2} (D64ES ONLY)

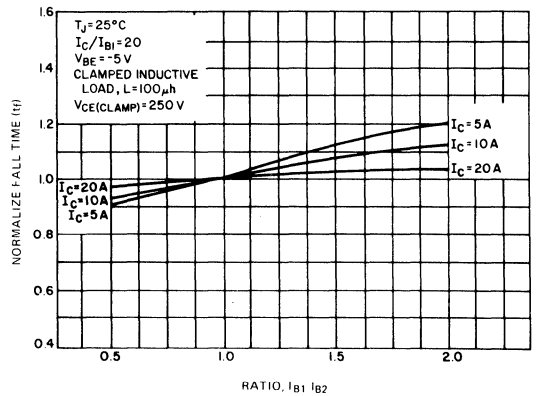


FIGURE 22. FALL TIME VARIATION WITH I_{B2} (D64DS ONLY)

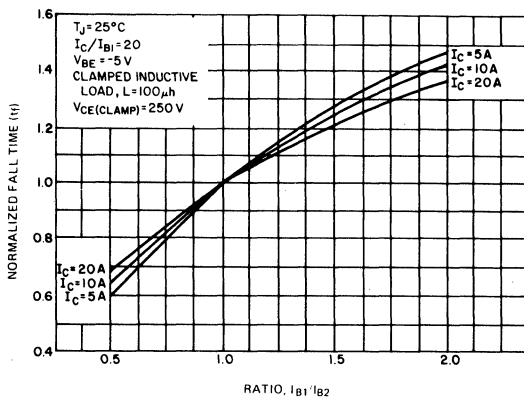


FIGURE 23. FALL TIME VARIATION WITH I_{B2} (D64ES ONLY)

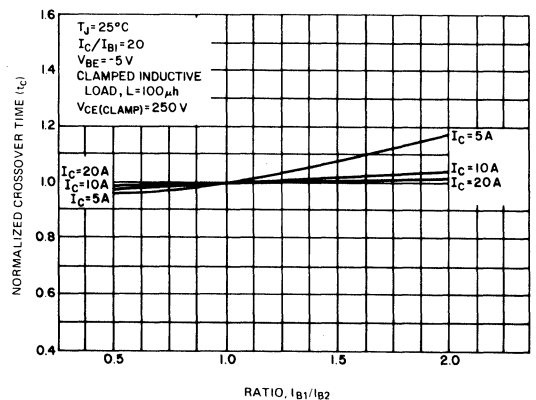


FIGURE 24. CROSS-OVER TIME VARIATION WITH I_{B2} (D64DS ONLY)

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

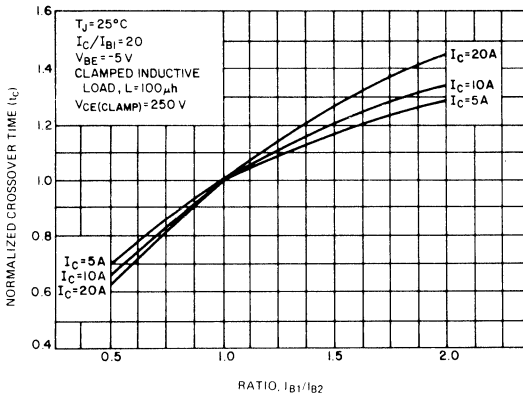


FIGURE 25. CROSS-OVER TIME VARIATION WITH I_{B2} (D64ES ONLY)

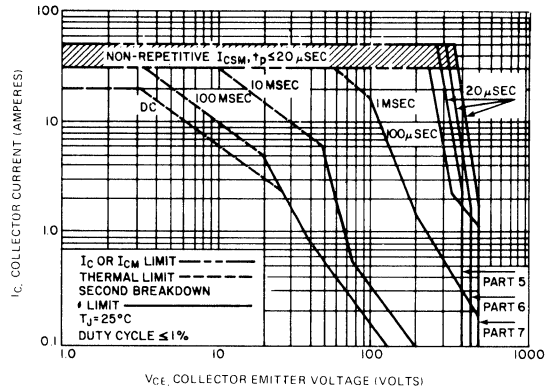


FIGURE 26. FORWARD BIAS SAFE OPERATING AREA

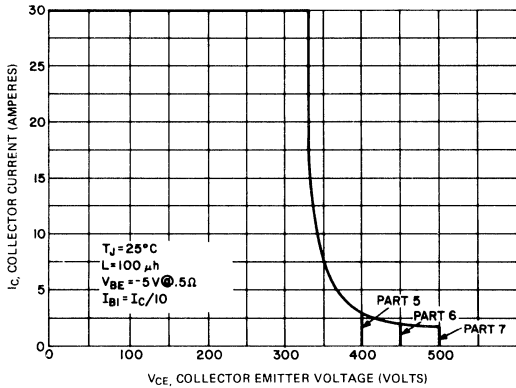


FIGURE 27. REVERSE BIAS SAFE OPERATING AREA

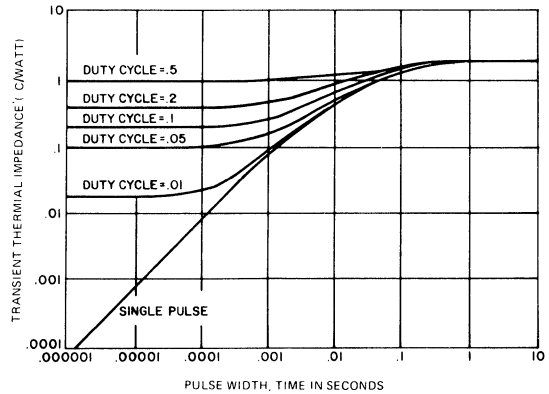


FIGURE 28. TRANSIENT THERMAL RESPONSE

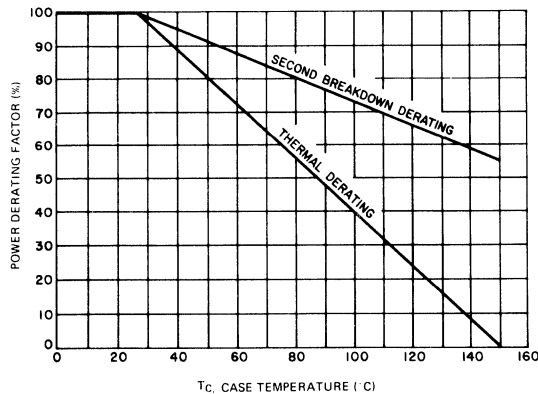


FIGURE 29. POWER DERATING

2

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

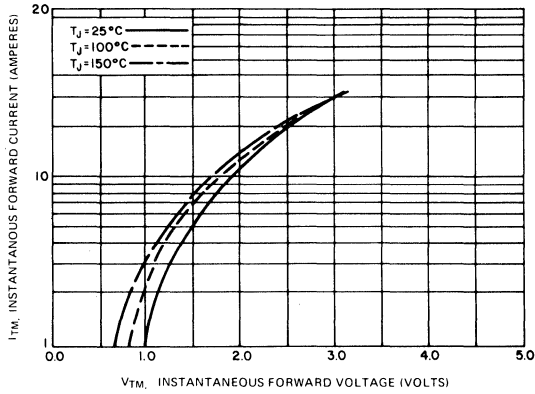


FIGURE 30. DIODE CHARACTERISTICS

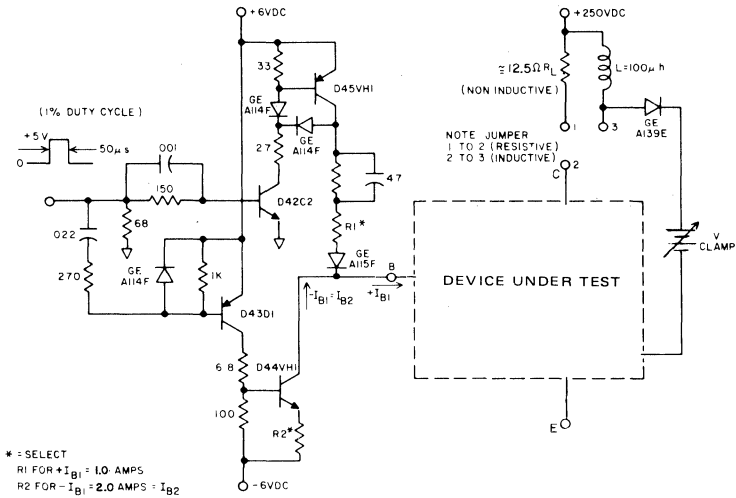


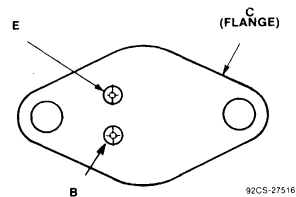
FIGURE 31. SWITCHING TIME TEST CIRCUIT

File Number **15.35****D64DV5,6,7**
D64EV5,6,7

50-Ampere N-P-N Darlington Power Transistors

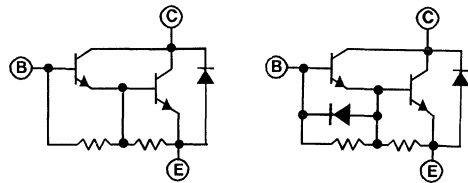
Features:

- High speed $t_s < 5.0 \mu\text{sec.}$, $t_r < 3.0 \mu\text{sec.}$
- High voltage: 400-500 V_{CEO}
- High gain: h_{FE} 50 minimum @ 50 amperes, I_C
- High current: 75 amperes, I_C (Peak)

TERMINAL DESIGNATIONS**JEDEC TO-204AE**

The D64DV and D64EV series of silicon n-p-n power Darlington transistors are designed for use in high-speed switching applications. These applications include off-line switching power supplies, PWM ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

**D64DV****D64EV****DEVICE CIRCUIT****MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)**

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	V_{EBO}	8	8	8	Volts
		5	5	5	
Collector Current — Continuous	I_C	50	50	50	A
Peak (Repetitive)	I_{CM}	75	75	75	
Peak (Non-Repetitive)	I_{CSM}	125	125	125	
Base Current — Continuous	I_B	10	10	10	A
Peak (Non-Repetitive)	I_{BM}	20	20	20	
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	0.7	0.7	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	300	300	300	$^\circ\text{C}$

2

D64DV5,6,7

D64EV5,6,7

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT	
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage (I _C = 0.5A) (V _{clamp} = V _{CEO} Rated)	D64DV5/EV5 D64DV6/EV6 D64DV6/EV7	V _{CEO(sus)}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V _{CE} = Rated Value, V _{BE} = -1.5V)	T _J = 25°C T _J = 150°C	I _{CEV}	— —	— —	1.0 2.5	mA
Emitter Cutoff Current (V _{EB} = 4.5V, I _C = 0) (V _{EB} = 1.5V, I _C = 0)	D64DV D64EV	I _{EBO}	— —	— —	350 350	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 23
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ON CHARACTERISTICS

DC Current Gain (I _C = 75A, V _{CE} = 5V) (I _C = 50A, V _{CE} = 5V) (I _C = 20A, V _{CE} = 5V)	h _{FE}	25 50 100	60 135 250	— — —	—
Collector-Emitter Saturation Voltage (I _C = 75A, I _B = 5A) (I _C = 50A, I _B = 4A) (I _C = 20A, I _B = 2A)	V _{CE(sat)}	— — —	2.2 1.7 1.15	3.0 2.0 1.5	V
Base-Emitter Saturation Voltage (I _C = 75A, I _B = 5A) (I _C = 50A, I _B = 4A) (I _C = 20A, I _B = 2A)	V _{BE(sat)}	— — —	2.8 2.45 1.95	3.5 3.0 2.5	V

SWITCHING CHARACTERISTICS

		TYP.		MAX.			
Resistive Load				DV	EV		
Delay Time	V _{CC} = 250V	t _d	—	0.09	0.09	0.5	μs
Rise Time	I _C = 50A	t _r	—	0.5	0.5	1	
Storage Time	I _{B1} = 2.5A, I _{B2} = -5A	t _s	—	2.55	2	5	
Fall Time	t _p = 50 μsec	t _f	—	1.4	0.64	3	

EMITTER-COLLECTOR DIODE CHARACTERISTICS

Power Dissipation		P _D	—	—	125	Watts
Forward Voltage	(I _F = 25A) (I _F = 50A) (I _F = 50A, T _J = 150°C)	V _F V _F V _F	— — —	1.95 2.60 2.30	3.20 3.80 3.50	Volts Volts Volts
Reverse Recovery Time (I _F = 50A, di/dt = 25A/μsec, R _{B1E} = 0.25Ω)		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 _{θJC}	—	—	1.0	°C/Watt

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

2

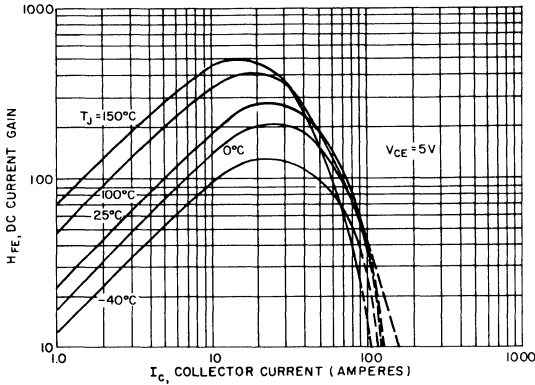


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 5V$)

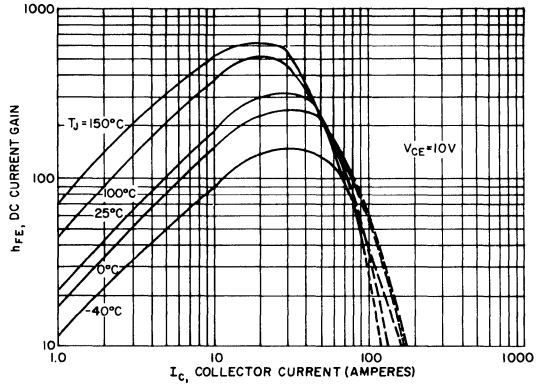


FIGURE 2. DC CURRENT GAIN ($V_{CE} = 10V$)

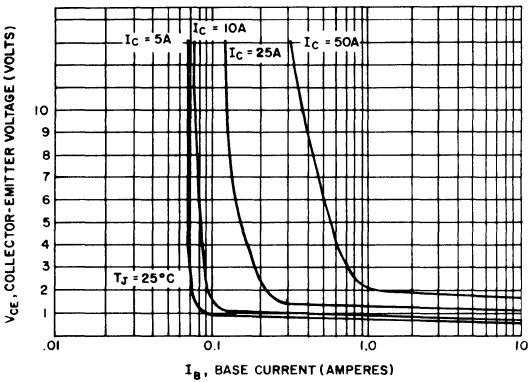


FIGURE 3. COLLECTOR SATURATION REGION

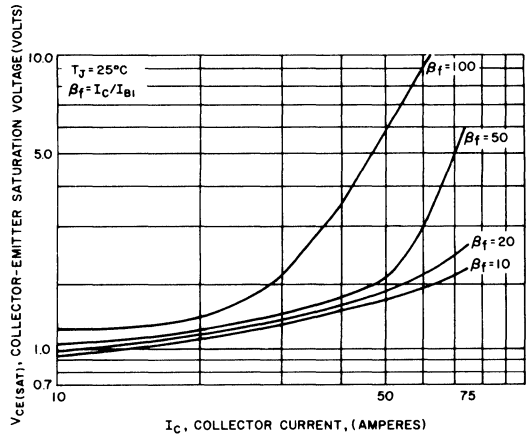


FIGURE 4. $V_{CE} (SAT)$ VS I_C , $T_J = 25^\circ C$

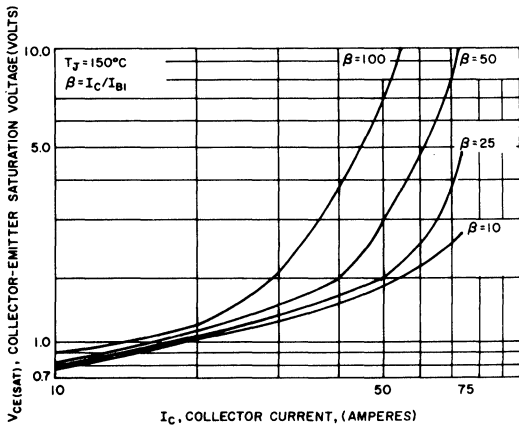


FIGURE 5. $V_{CE} (SAT)$ VS I_C , $T_J = 150^\circ C$

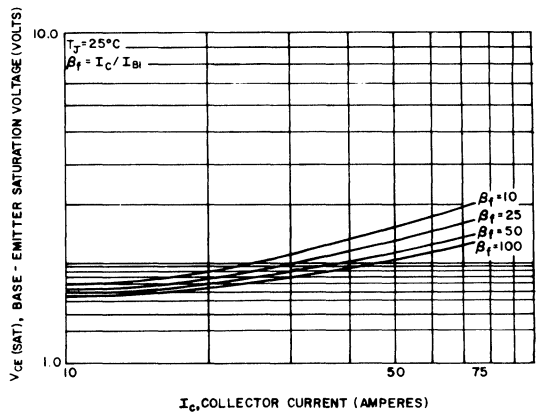


FIGURE 6. $V_{BE} (SAT)$ VS I_C , $T_J = 25^\circ C$

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

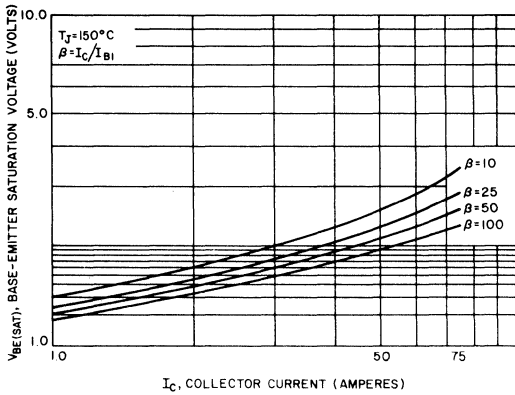


FIGURE 7. $V_{BE(SAT)}$ VS I_C , $T_J = 150^\circ\text{C}$

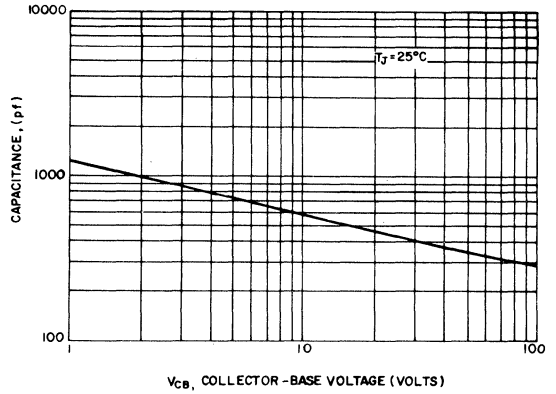


FIGURE 8. CAPACITANCE (C_{CB0})

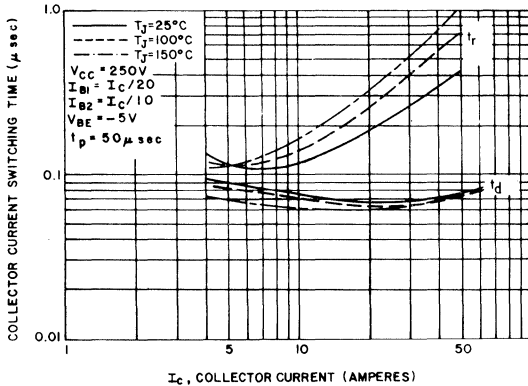


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD) (D64DV ONLY)

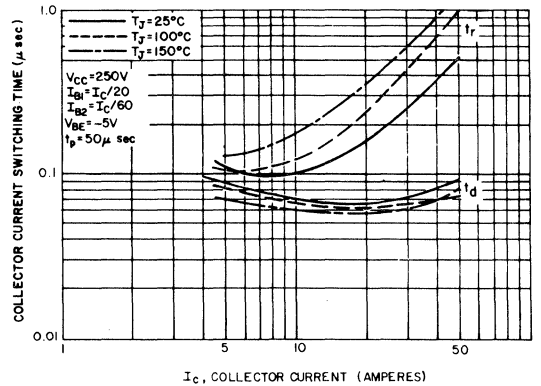


FIGURE 10. TURN-ON TIME (RESISTIVE LOAD) (D64EV ONLY)

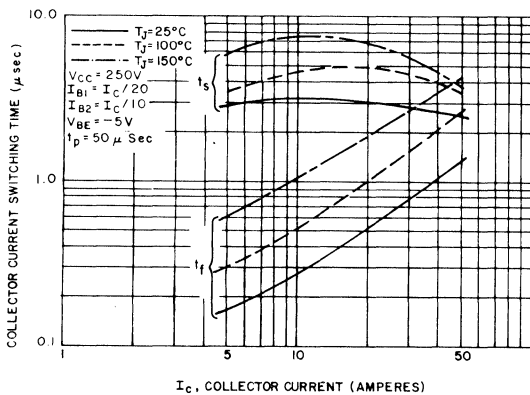


FIGURE 11. TURN-OFF TIME (RESISTIVE LOAD) (D64DV ONLY)

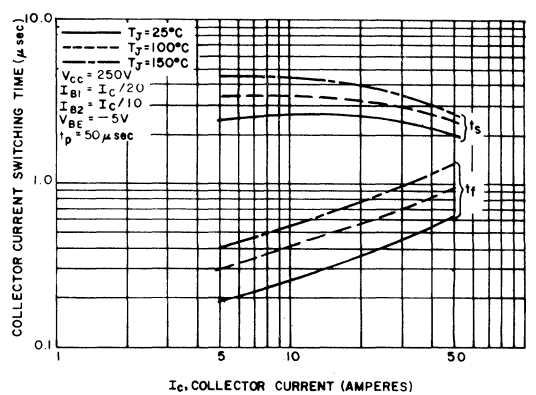


FIGURE 12. TURN-OFF TIME (RESISTIVE LOAD) (D64EV ONLY)

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

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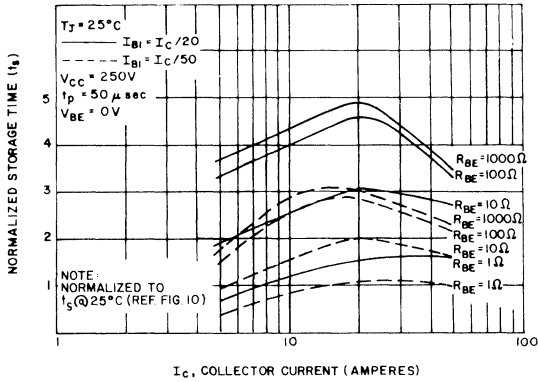


FIGURE 13. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS COLLECTOR CURRENT (D64DV ONLY)

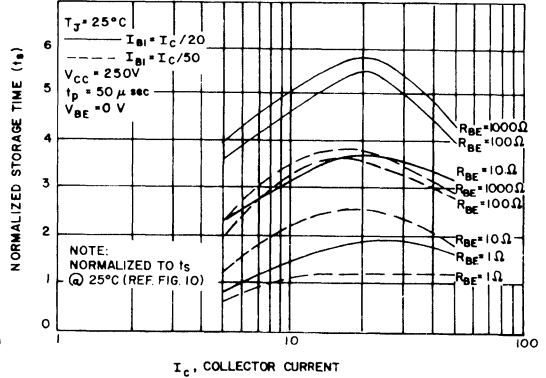


FIGURE 14. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS COLLECTOR CURRENT (D64EV ONLY)

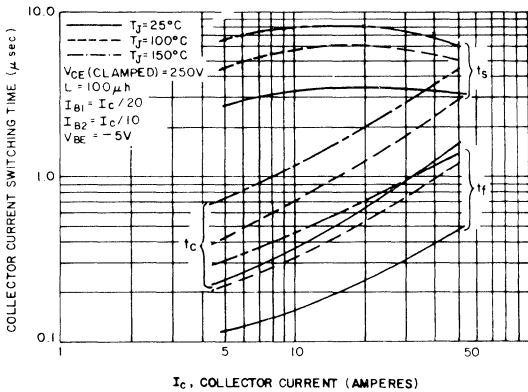


FIGURE 15. CLAMPING INDUCTIVE TURN-OFF TIME (D64DV ONLY)

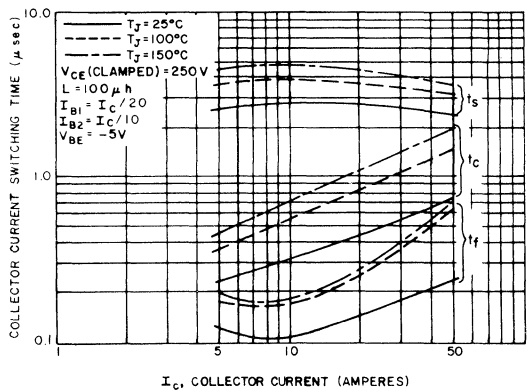


FIGURE 16. CLAMPING INDUCTIVE TURN-OFF TIME (D64EV ONLY)

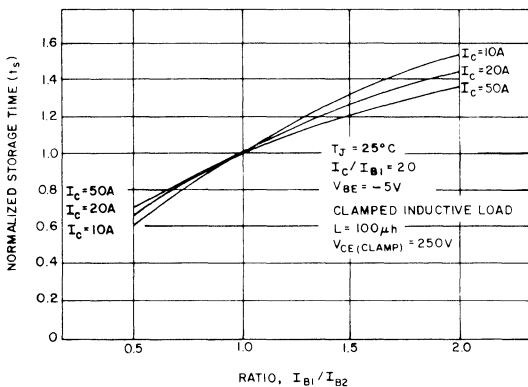


FIGURE 17. STORAGE TIME VARIATION WITH I_{B2} (D64DV ONLY)

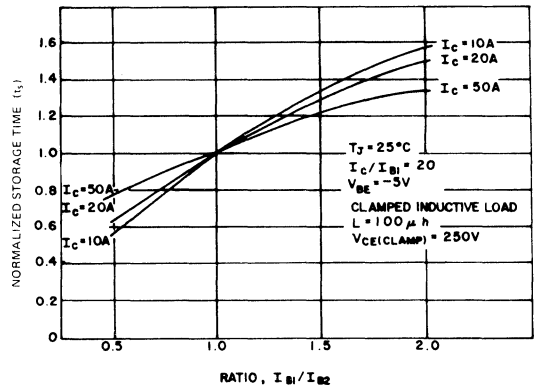


FIGURE 18. STORAGE TIME VARIATION WITH I_{B2} (D64EV ONLY)

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

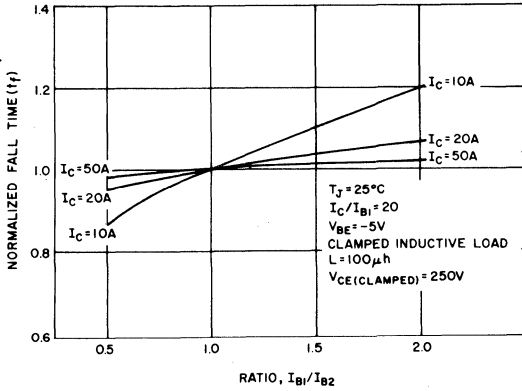


FIGURE 19. FALL TIME VARIATION WITH I_{B2} (D64DV ONLY)

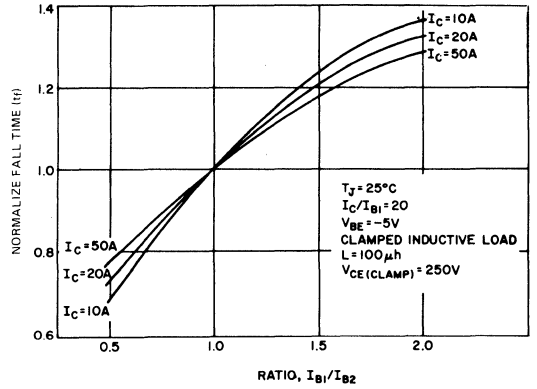


FIGURE 20. FALL TIME VARIATION WITH I_{B2} (D64EV ONLY)

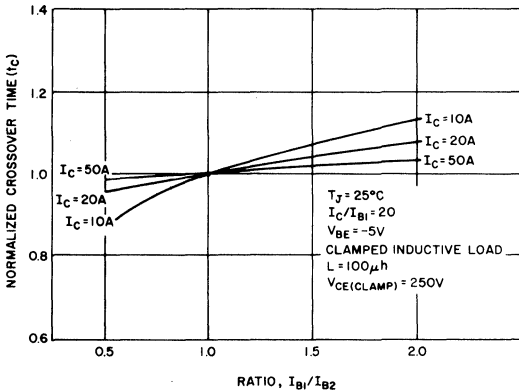


FIGURE 21. CROSSOVER TIME VARIATION WITH I_{B2} (D64DV ONLY)

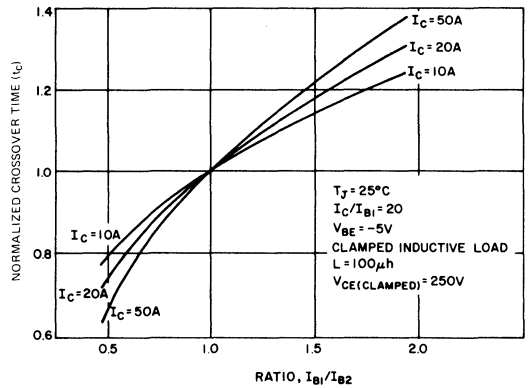


FIGURE 22. CROSSOVER TIME VARIATION WITH I_{B2} (D64EV ONLY)

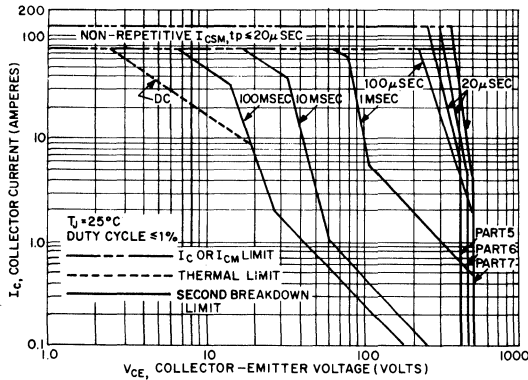


FIGURE 23. FORWARD BIAS SAFE OPERATING AREA

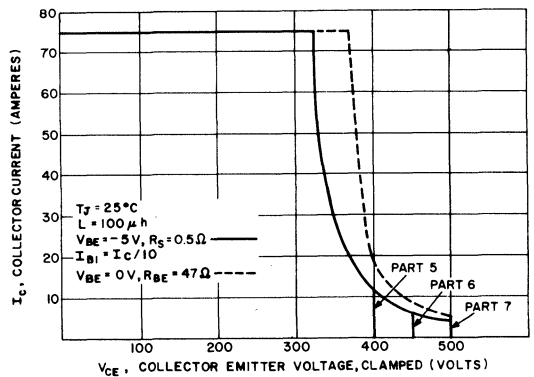


FIGURE 24. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

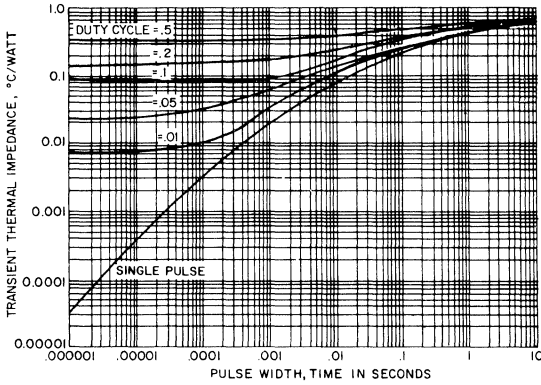


FIGURE 25. TRANSIENT THERMAL RESPONSE

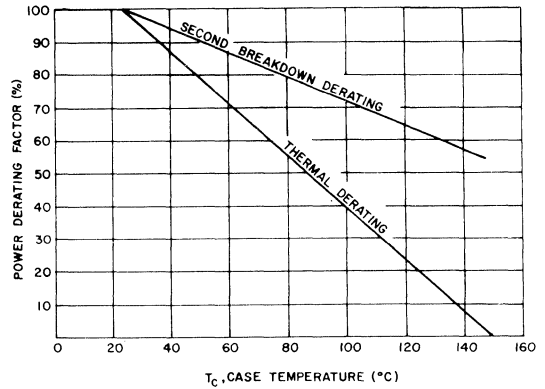


FIGURE 26. POWER DERATING

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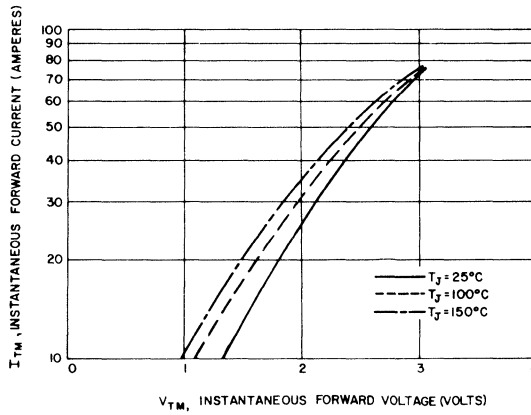


FIGURE 27. FORWARD CHARACTERISTICS

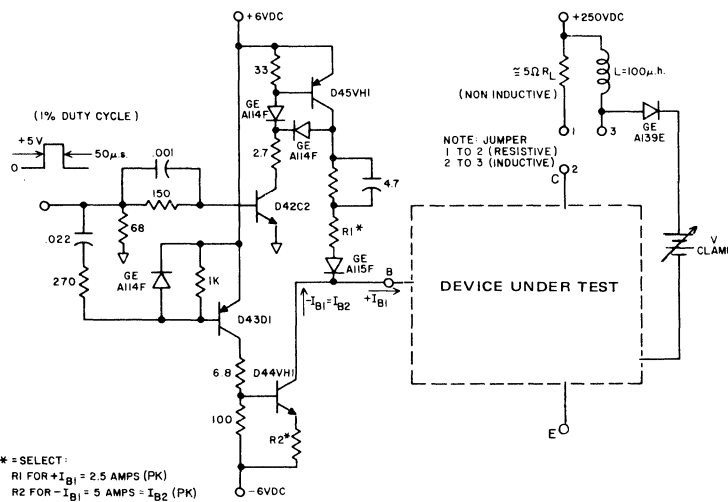


FIGURE 28. SWITCHING TIME TEST CIRCUIT

15-Ampere N-P-N Power Transistors

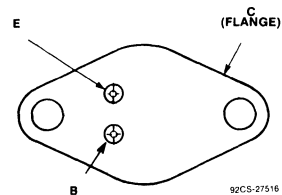
High-Voltage N-P-N Types for Off-Line Power Supplies
and Other High-Voltage Switching Applications

Features:

- 100°C maximum limits specified for:
 - Switching times
 - Saturation voltages
 - Leakage currents
- Very fast turn-off, $t_f < 100$ nsec (typ.)
@ 15A - inductive load

The D64VS series of silicon n-p-n power transistors are 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). They are ideally suited for off-line switching power supplies, inverter/converter circuits, and pulse width modulated regulators.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

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	I_C	15	15	15	A
Peak ⁽¹⁾	I_{CM}	30	30	30	
Base Current — Continuous	I_B	5	5	5	A
Peak ⁽¹⁾	I_{BM}	10	10	10	
Emitter Current — Continuous	I_E	20	20	20	A
Peak ⁽¹⁾	I_{EM}	35	35	35	
Total Power Dissipation @ $T_c = 25^\circ\text{C}$	P_D	195	195	195	Watts
@ $T_c = 100^\circ\text{C}$		111	111	111	
Derate above 25°C		1.11	1.11	1.11	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: 1/8" from Case for 5 Seconds	T_L	235	235	235	°C

(1) Pulse condition, $t_p \leq 5$ msec.

D64VS3,4,5**ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)**

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ⁽¹⁾ ($I_C = 100\text{mA}$)	D64VS3 D64VS4 D64VS5	$V_{CEO(sus)}$	300 350 400	— — —	Volts
Collector-Emitter Voltage ($I_C = 15\text{A}$, $I_{B1} = 2.5\text{A}$, $I_{B2} = -3.0\text{A}$) ($V_{BE(OFF)} = -6\text{V}$, $L = 200\ \mu\text{h}$)	D64VS3 D64VS4 D64VS5	V_{CEX}	300 350 400	— — —	Volts
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(OFF)} = -1.5\text{V}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(OFF)} = -1.5\text{V}$, $T_C = 100^\circ\text{C}$)		I_{CEV}	— —	0.1 1.0	mA
Emitter Cutoff Current ($V_{EB} = 7\text{V}$)		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 ($I_C = 10\text{A}$, $V_{CE} = 2\text{V}$) ($I_C = 15\text{A}$, $V_{CE} = 2\text{V}$)	h_{FE}	10 8	— —	—
Collector-Emitter Saturation Voltage ($I_C = 10\text{A}$, $I_B = 1.67\text{A}$) ($I_C = 15\text{A}$, $I_B = 2.5\text{A}$) ($I_C = 15\text{A}$, $I_B = 2.5\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(SAT)}$	— — —	0.7 1.0 1.5	Volts
Base-Emitter Saturation Voltage ($I_C = 15\text{A}$, $I_B = 2.5\text{A}$) ($I_C = 15\text{A}$, $I_B = 2.5\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(SAT)}$	— —	1.5 1.5	Volts

DYNAMIC CHARACTERISTICS

Current Gain — Bandwidth Product ($I_C = 1.0\text{A}$, $V_{CE} = 10\text{V}$, $f_{test} = 1.0\text{ MHz}$)	f_T	15	50	MHz
Output Capacitance ($V_{CB} = 10\text{V}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{OB}	150	360	pF

SWITCHING CHARACTERISTICS

		MAXIMUM			
		T_C	25°C	100°C	
Resistive Load (See Figure 17 for Test Circuit)					
Delay Time	$V_{CC} = 250\text{V}$, $I_C = 15\text{A}$ $I_{B1} = 2.5$, $I_{B2} = -3.0\text{A}$, $t_p = 50\ \mu\text{sec}$	t_d	0.1	0.2	μs
Rise Time		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	$I_C = 15\text{A}$, $V_{CLAMP} = 250\text{V}$ $I_{B1} = 2.5\text{A}$, $I_{B2} = -3.0\text{A}$, $V_{BE(OFF)} = -6\text{V}$ $L = 200\ \mu\text{h}$, $t_p = 25\ \mu\text{sec}$	t_s	3.0	3.5	μs
Fall Time		t_f	0.3	0.6	μsec
TYPICAL					
Storage Time		t_s	1.8	2.5	μsec
Fall Time	t_f	0.085	0.13	μsec	

(1) Pulse Duration = 300 μs , Duty Factor $\leq 2\%$. Do not measure on a curve tracer.

D64VS3,4,5

TYPICAL DC CHARACTERISTICS

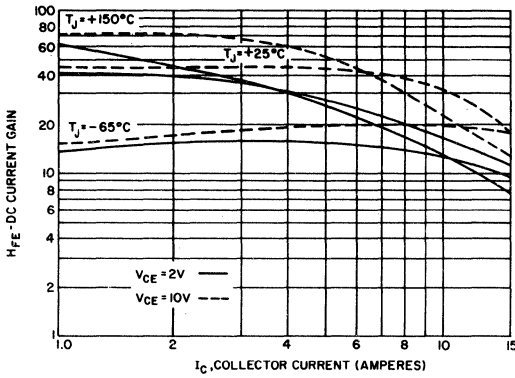


FIGURE 1. DC CURRENT GAIN

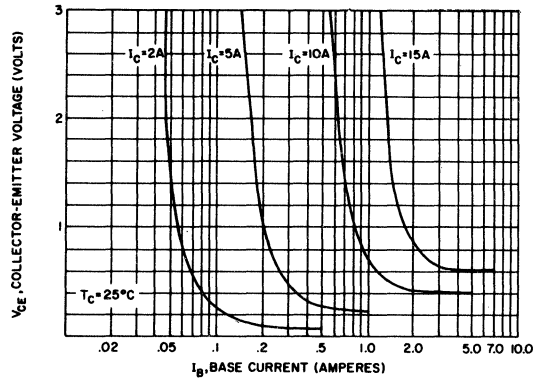


FIGURE 2. COLLECTOR SATURATION REGION

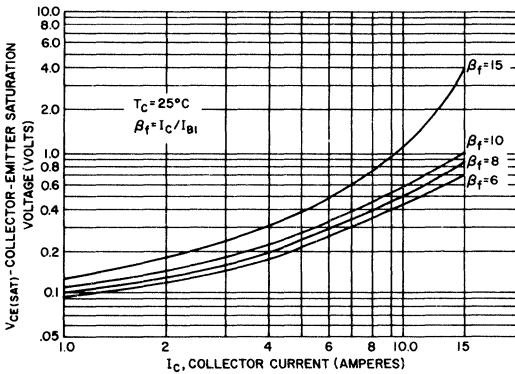


FIGURE 3. $V_{CE(sat)}$ vs I_C , $T_C = 25^\circ C$

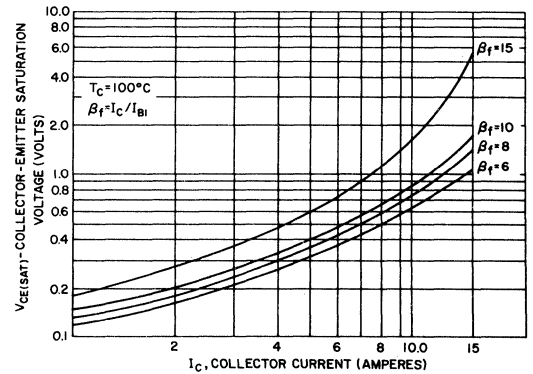


FIGURE 4. $V_{CE(sat)}$ vs I_C , $T_C = 100^\circ C$

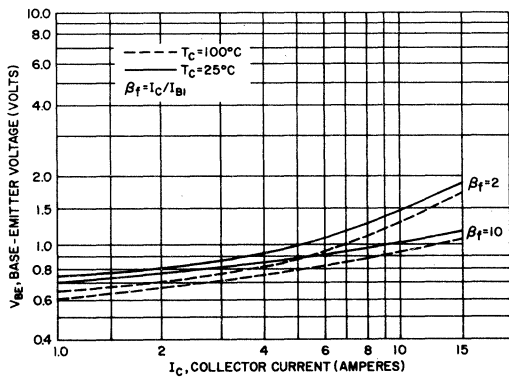


FIGURE 5. $V_{BE(sat)}$ vs I_C

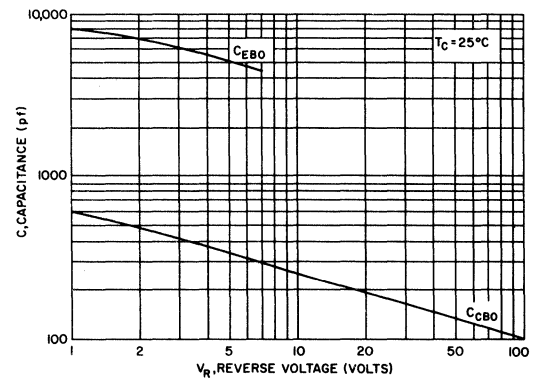


FIGURE 6. CAPACITANCE

D64VS3,4,5

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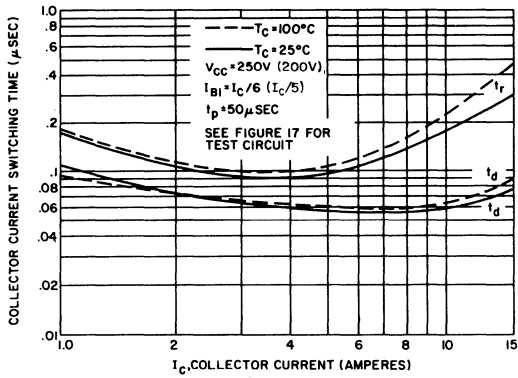


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

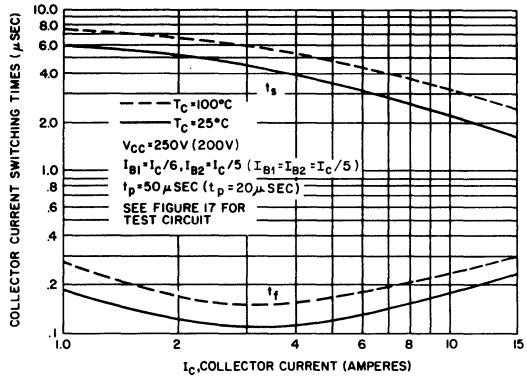


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

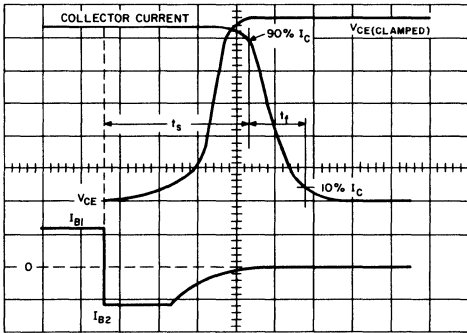


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

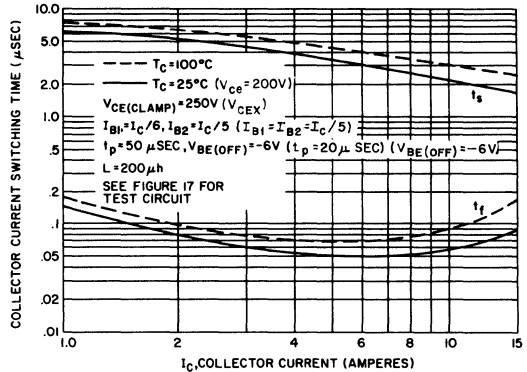


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

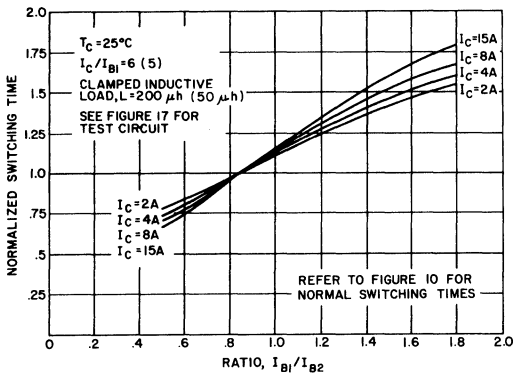


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

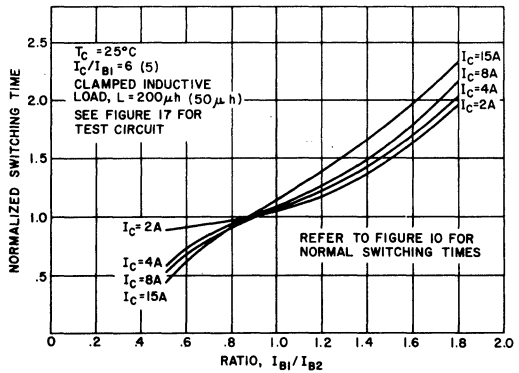


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D64VS3,4,5

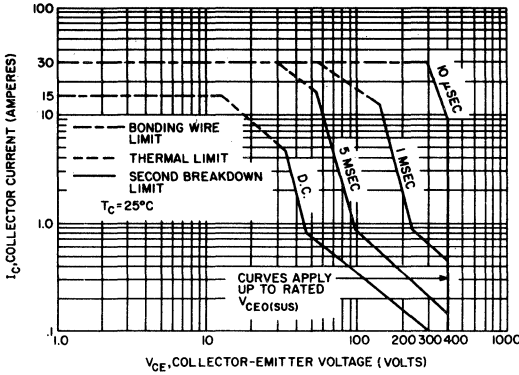


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

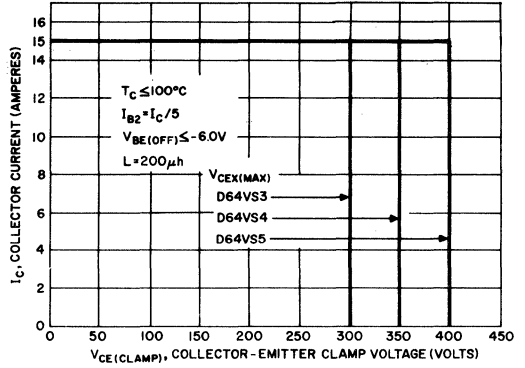


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

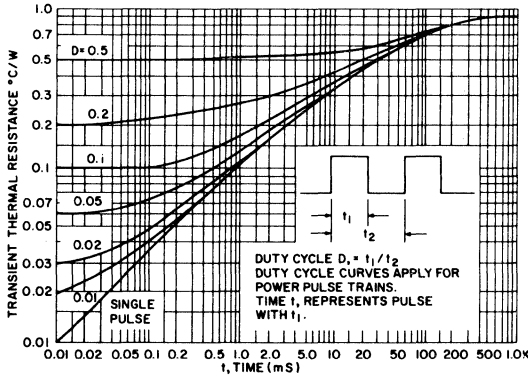


FIGURE 15. TRANSIENT THERMAL RESPONSE

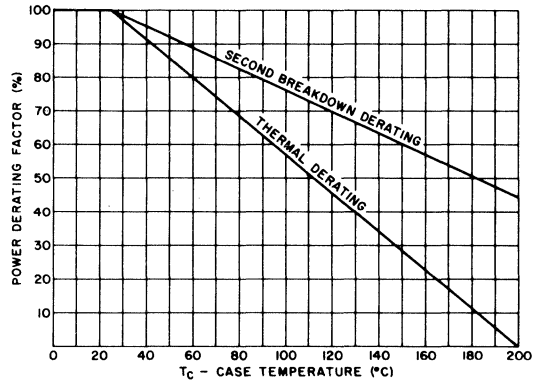


FIGURE 16. POWER DERATING

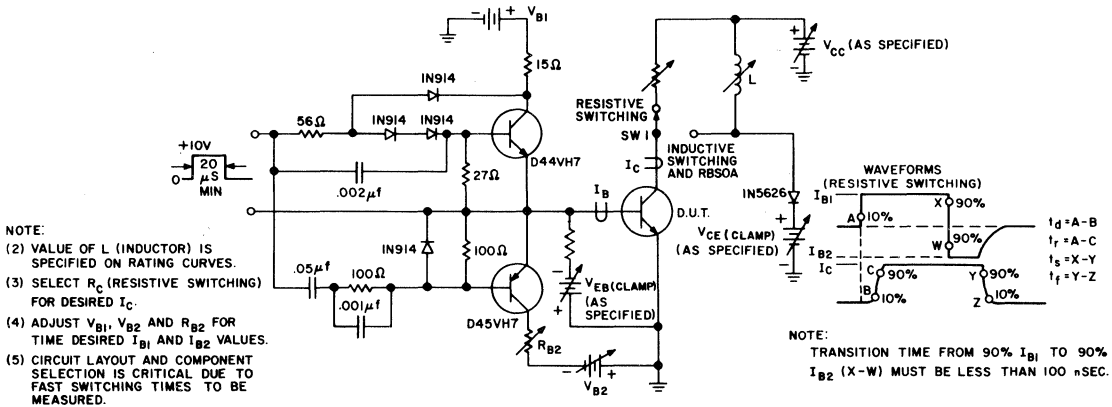


FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

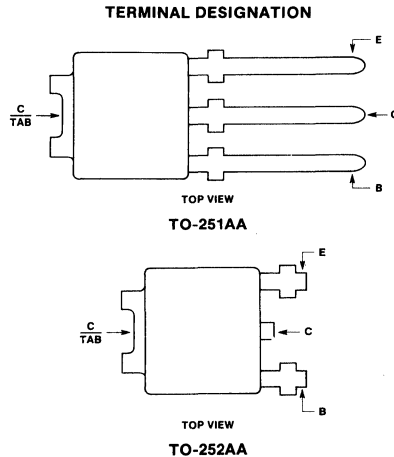
5-Ampere Silicon N-P-N Power Transistors

Features:

- Low $V_{CE(sat)}$
- Fast switching speed
- Complementary to D73F5T1,2

The D72F5T1 and D72F5T2 silicon n-p-n power transistors are designed for high current switching applications. They are intended for use in circuits such as converters, inverters, and pulse-width-modulated regulators.

The D72F5T1 is supplied in the JEDEC TO-251 package and the D72F5T2 is supplied in the JEDEC TO-252 surface-mount package.



2

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1.0 20	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS ⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	260	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D72F5T1, D72F5T2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	50	—	—	Volts
Collector Cut-off Current ($V_{CB} = 50\text{V}$, $I_E = 0$)	I_{CBO}	—	—	1	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$, $I_C = 0$)	I_{EBO}	—	—	1	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			
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ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{A}$, $V_{CE} = 1\text{V}$) ($I_C = 3\text{A}$, $V_{CE} = 1\text{V}$)	h_{FE}	70	—	240	—
	h_{FE}	30	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 3\text{A}$, $I_B = 0.15\text{A}$)	$V_{CE(sat)}$	—	0.2	0.4	V
Base-Emitter Saturation Voltage ($I_C = 3\text{A}$, $I_B = 0.15\text{A}$)	$V_{BE(sat)}$	—	0.9	1.2	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = 30\text{V}$ $I_{B1} = -I_{B2} = 0.15\text{A}$ Duty Cycle $\leq 1\%$	t_{on}	—	0.1	—	μs
Storage Time		t_{stg}	—	1.0	—	
Fall Time		t_f	—	0.1	—	

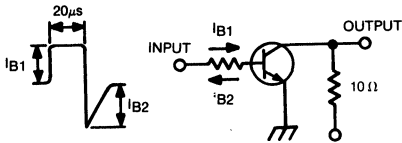


FIG. 1 SWITCHING TIME TEST CIRCUIT

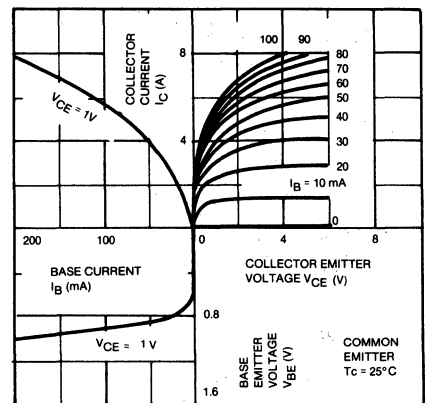


FIG. 2 STATIC CHARACTERISTICS

D72F5T1, D72F5T2

2

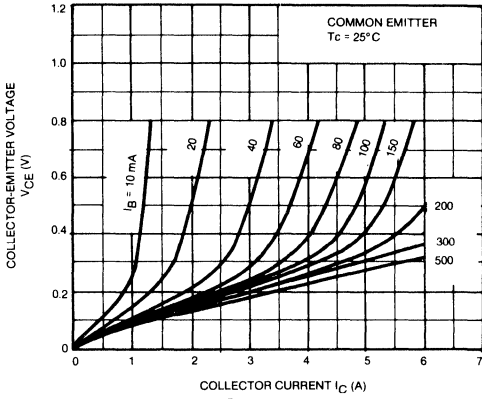


FIG. 3 $V_{CE} - I_C$

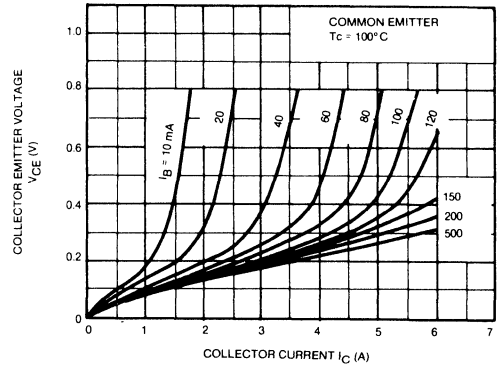


FIG. 4 $V_{CE} - I_C$

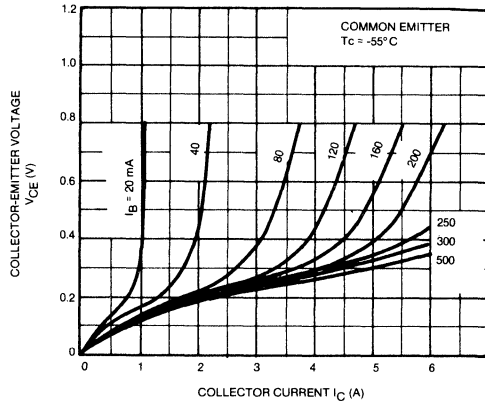


FIG. 5 $V_{CE} - I_C$

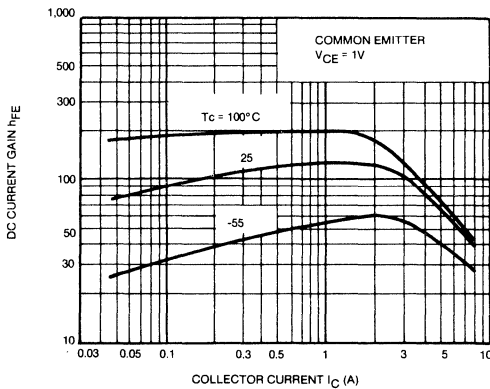


FIG. 6 $h_{FE} - I_C$

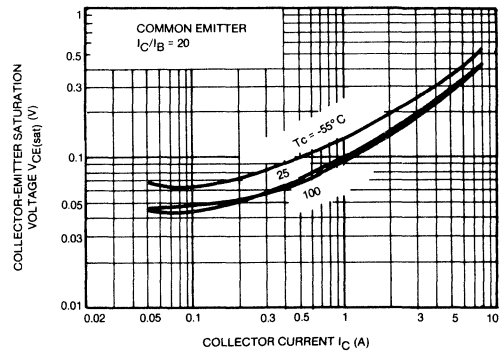


FIG. 7 $V_{CE(sat)} - I_C$

D72F5T1, D72F5T2

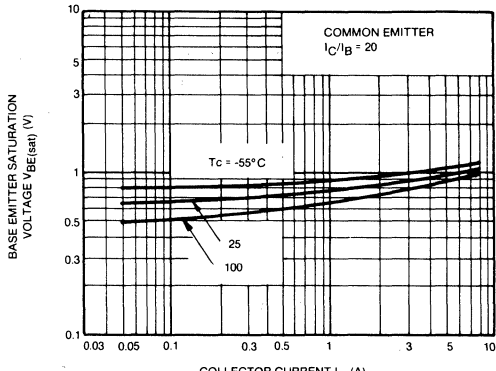


FIG. 8 $V_{BE(sat)} - I_C$

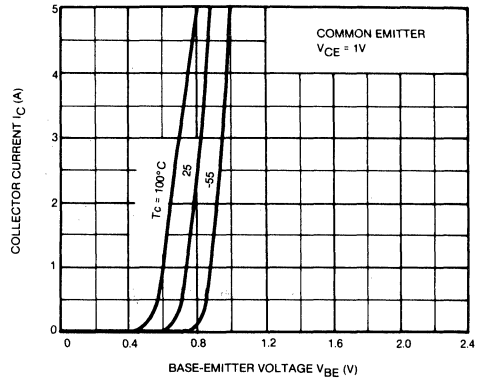


FIG. 9 $I_C - V_{BE}$

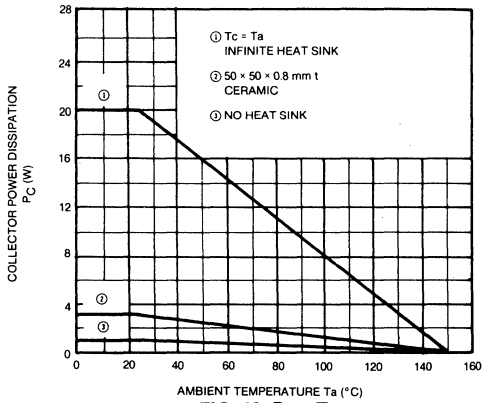


FIG. 10 $P_C - T_a$

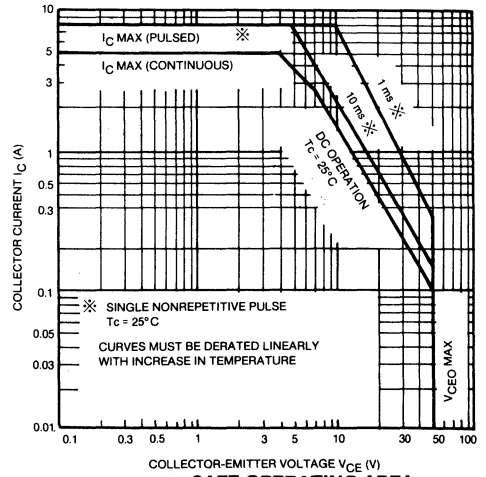


FIG. 11 SAFE OPERATING AREA

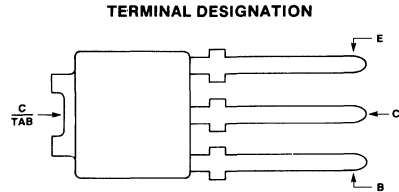
4-Ampere N-P-N Power Darlington Transistors

Features:

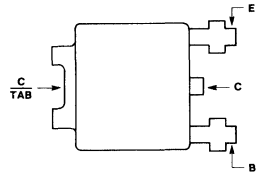
- Operates from IC without predriver
- h_{FE} Min. = 2000
- Complementary to D73FY4D1,2

The D72FY4D1 and D72FY4D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D72FY4D1 is supplied in the JEDEC TO-251 package and the D72FY4D2 is supplied in the JEDEC TO-252 surface-mount package.

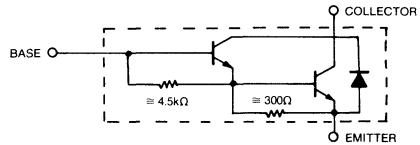


TOP VIEW
TO-251AA



TOP VIEW
TO-252AA

92CS-43478



Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1,0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS ⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D72FY4D1, D72FY4D2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	80	—	—	Volts
Collector Cutoff Current ($V_{CB} = 100\text{V}$, $I_E = 0$)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$, $I_C = 0$)	I_{EBO}	—	—	-2.5	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
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ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{A}$, $V_{CE} = 2\text{V}$) ($I_C = 3\text{A}$, $V_{CE} = 2\text{V}$)	h_{FE}	2000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 3\text{A}$, $I_B = 6\text{mA}$)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage ($I_C = 3\text{A}$, $I_B = 6\text{mA}$)	$V_{BE(sat)}$	—	—	2.0	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = 30\text{V}$	t_{on}	—	0.2	—	μs
Storage Time	$I_{B1} = -I_{B2} = 6\text{mA}$	t_{stg}	—	1.5	—	
Fall Time	Duty Cycle $\leq 1\%$	t_f	—	0.6	—	

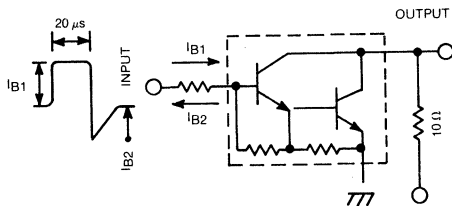


FIG. 1 SWITCHING TIME TEST CIRCUIT

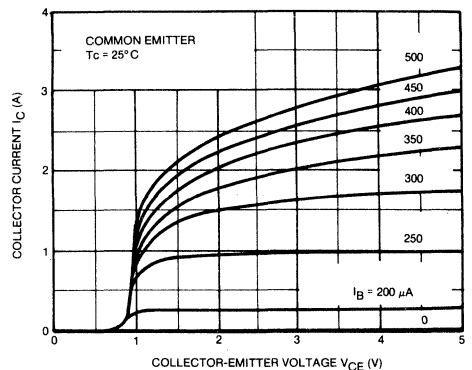


FIG. 2 $I_C - V_{CE}$

D72FY4D1, D72FY4D2

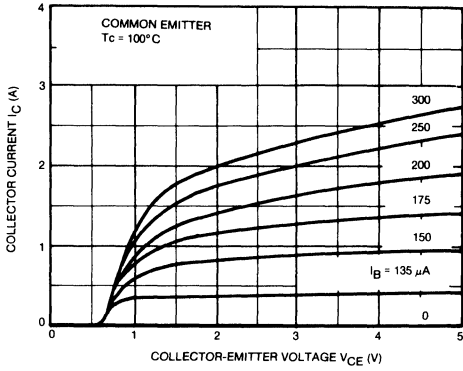


FIG. 3 $I_C - V_{CE}$

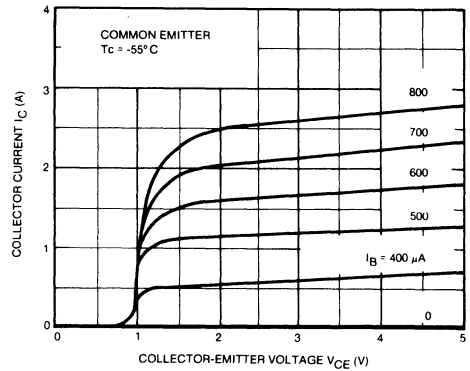


FIG. 4 $I_C - V_{CE}$

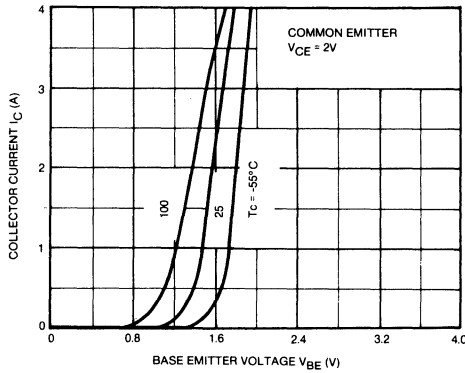


FIG. 5 $I_C - V_{BE}$

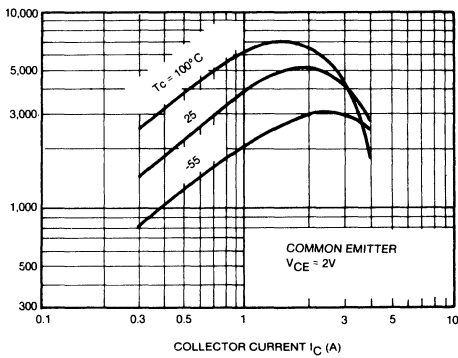


FIG. 6 $h_{FE} - I_C$

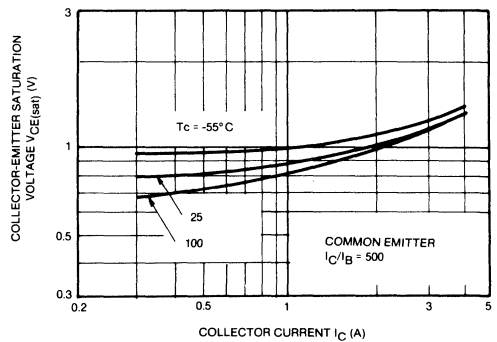


FIG. 7 $V_{CE(sat)} - I_C$

D72FY4D1, D72FY4D2

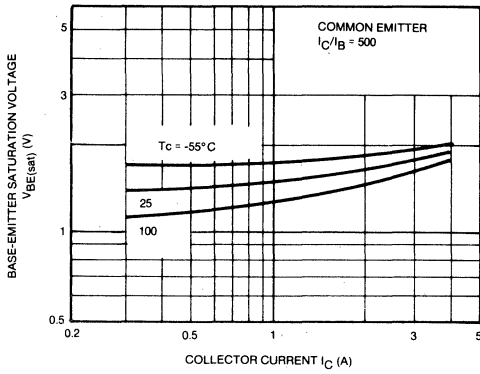


FIG. 8 $V_{BE(sat)} - I_C$

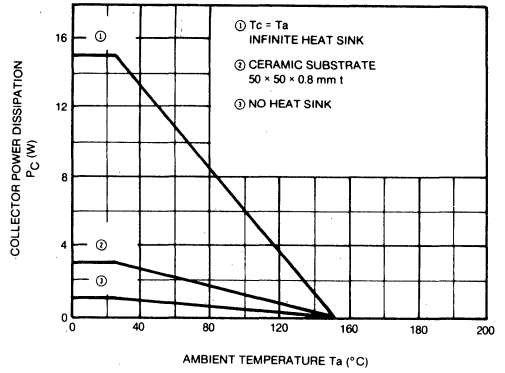


FIG. 9 $P_C - T_a$

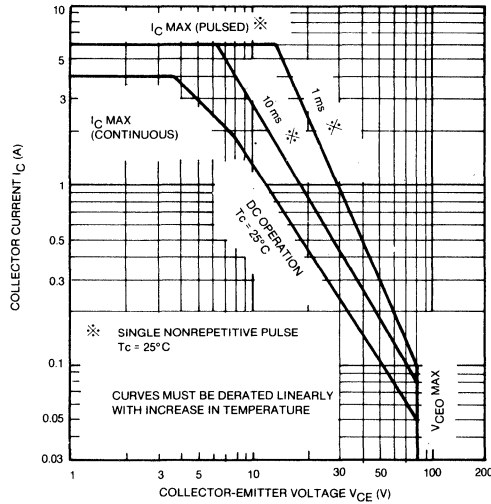


FIG. 10 SAFE OPERATING AREA

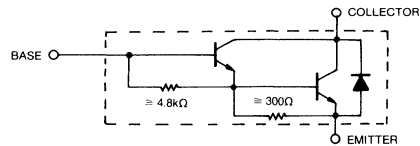
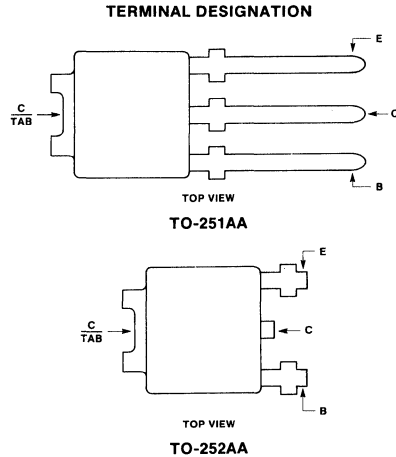
3-Ampere N-P-N Power Darlington Transistors

Features:

- Operates from IC without predriver
- h_{FE} Min. = 2000
- Complementary to D73K3D1,2

The D72K3D1 and D72K3D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D72K3D1 is supplied in the JEDEC TO-251 package and the D72K3D2 is supplied in the JEDEC TO-252 surface-mount package.



Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS ⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: $\frac{1}{16}$ " from Case for 5 Seconds	T_L	235	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D72K3D1, D72K3D2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Volts
Collector Cutoff Current ($V_{CB} = 60\text{V}$, $I_E = 0$)	I_{CBO}	—	—	20	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$, $I_C = 0$)	I_{EBO}	—	—	2.5	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
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ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{A}$, $V_{CE} = 2\text{V}$) ($I_C = 3\text{A}$, $V_{CE} = 2\text{V}$)	h_{FE}	2000	—	—	—
	h_{FE}	1000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 2\text{A}$, $I_B = 4\text{mA}$)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage ($I_C = 2\text{A}$, $I_B = 4\text{mA}$)	$V_{BE(sat)}$	—	—	2.0	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = 30\text{V}$ $I_{B1} = -I_{B2} = 6\text{mA}$ Duty Cycle $\leq 1\%$	t_{on}	—	0.1	—	μs
Storage Time		t_{stg}	—	1.0	—	
Fall Time		t_f	—	0.2	—	

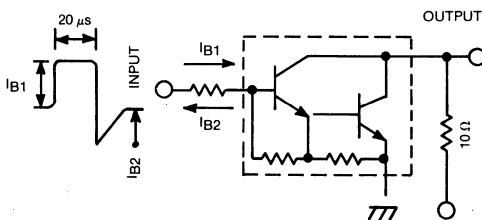


FIG. 1 SWITCHING TIME TEST CIRCUIT

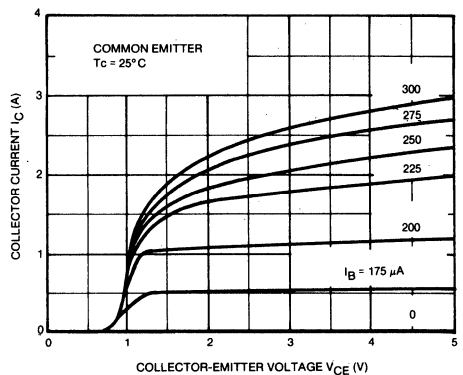


FIG. 2 $I_C - V_{CE}$

D72K3D1, D72K3D2

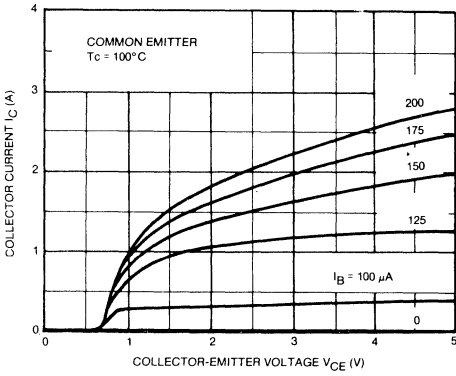


FIG. 3 I_C - V_{CE}

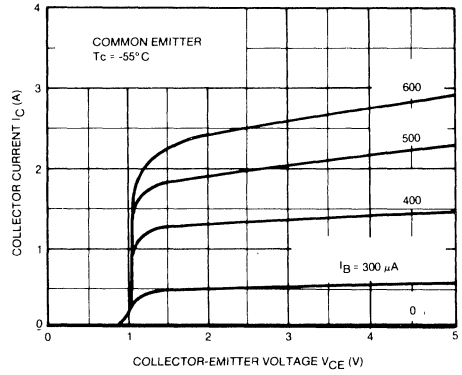


FIG. 4 I_C - V_{CE}

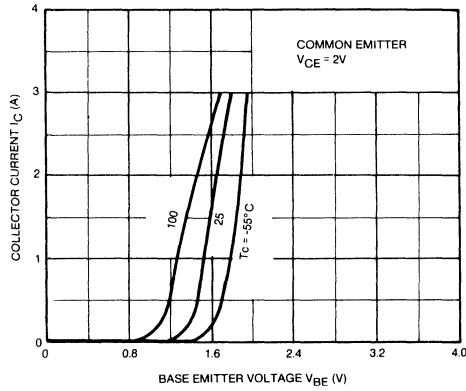


FIG. 5 I_C - V_{BE}

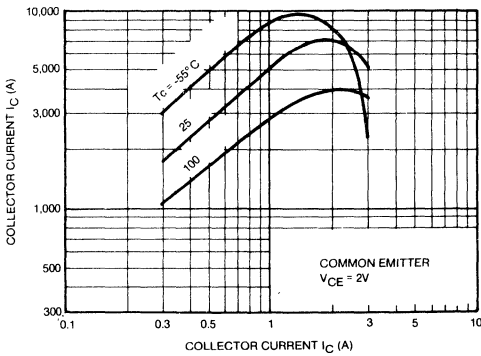


FIG. 6 h_{FE} - I_C

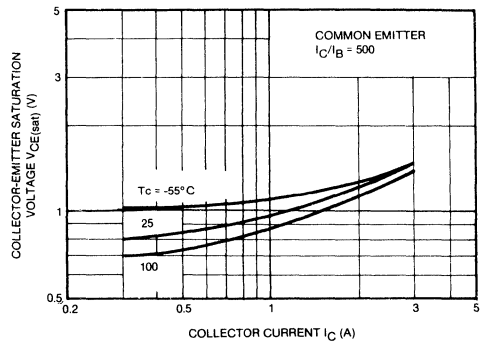


FIG. 7 V_{CE(sat)} - I_C

D72K3D1, D72K3D2

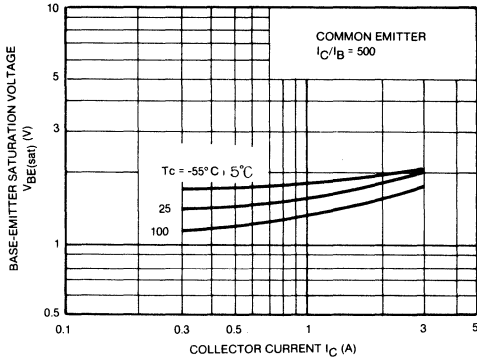


FIG. 8 $V_{BE(sat)} - I_C$

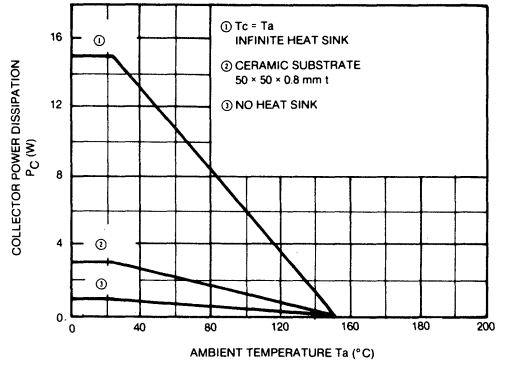


FIG. 9 $P_C - T_a$

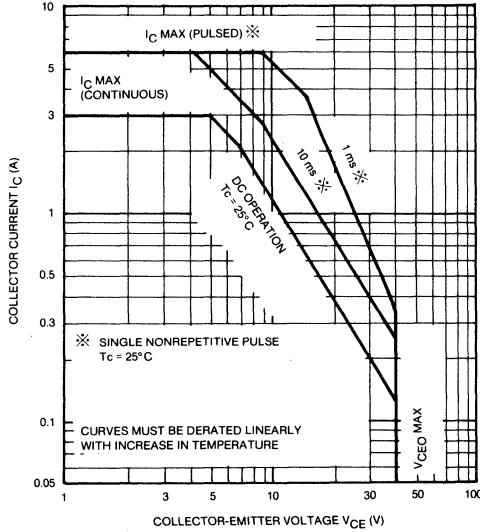


FIG. 10 SAFE OPERATING AREA

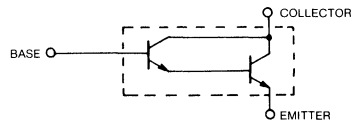
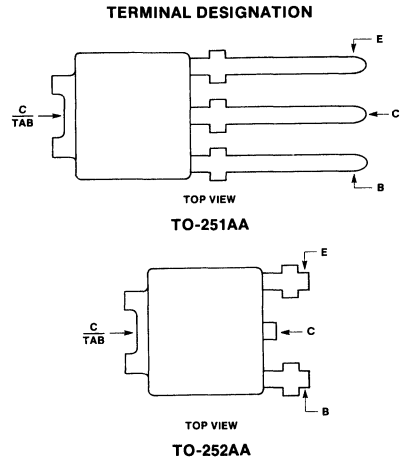
1.5-Ampere N-P-N Darlington Power Transistors

Features:

- Operates from IC without predriver
- h_{FE} Min. = 4000

The D72Y1.5D1 and D72Y1.5D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance gain characteristics.

The D72Y1.5D1 is supplied in the JEDEC TO-251 package and the D72Y1.5D2 is supplied in the JEDEC TO-252 surface-mount package.



Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1.0 10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS ⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	235	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D72Y1.5D1, D72Y1.5D2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Volts
Collector Cutoff Current ($V_{CB} = 30\text{V}$, $I_E = 0$)	I_{CBO}	—	—	10	μA
Emitter Cutoff Current ($V_{EB} = 10\text{V}$, $I_C = 0$)	I_{EBO}	—	—	-10	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
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ON CHARACTERISTICS

DC Current Gain ($I_C = 150\text{mA}$, $V_{CE} = 2\text{V}$)	h_{FE}	4000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 1\text{A}$, $I_B = 1\text{mA}$)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage ($I_C = 1\text{A}$, $I_B = 1\text{mA}$)	$V_{BE(sat)}$	—	—	2.2	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = 15\text{V}$	t_{on}	—	0.18	—	μs
Storage Time	$I_{B1} = -I_{B2} = 1\text{mA}$	t_{stg}	—	0.6	—	
Fall Time	Duty Cycle $\leq 1\%$	t_f	—	0.3	—	

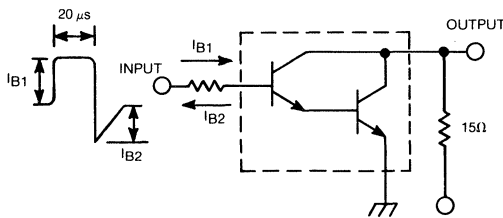


FIG. 1 SWITCHING TIME TEST CIRCUIT

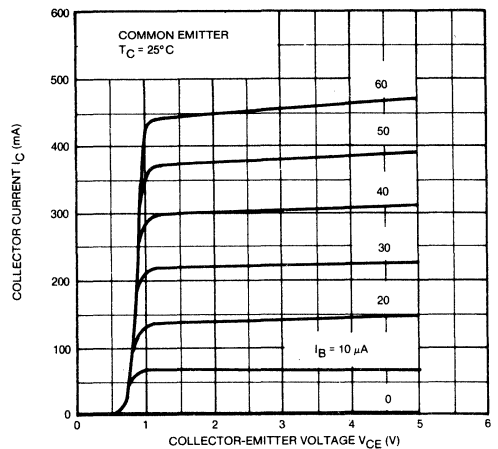


FIG. 2 $I_C - V_{CE}$

D72Y1.5D1, D72Y1.5D2

2

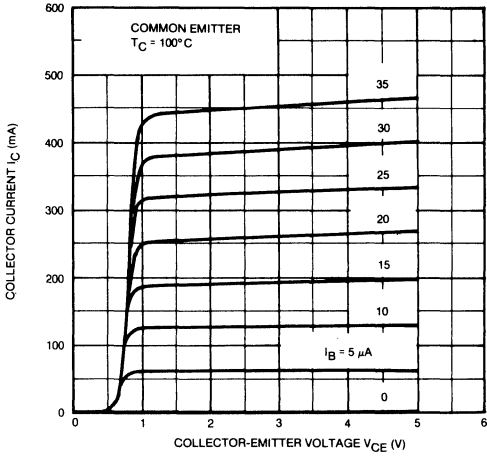


FIG. 3 $I_C - V_{CE}$

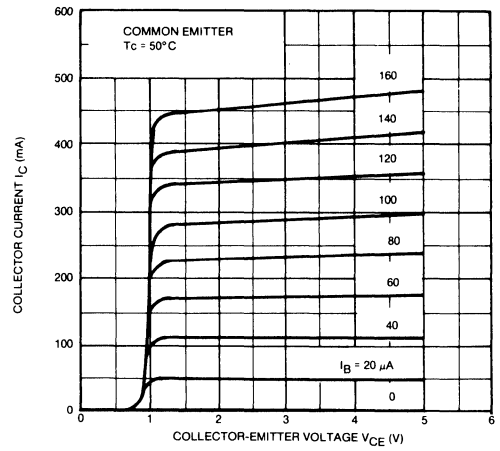


FIG. 4 $I_C - V_{CE}$

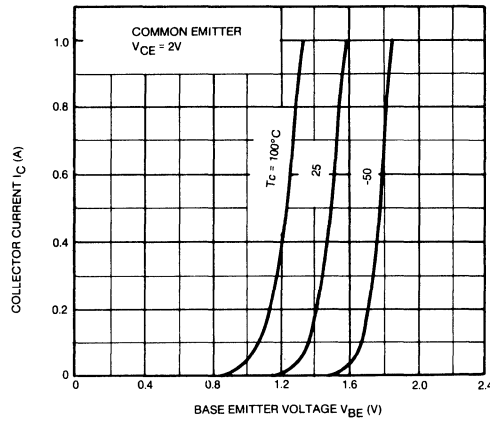


FIG. 5 $I_C - V_{BE}$

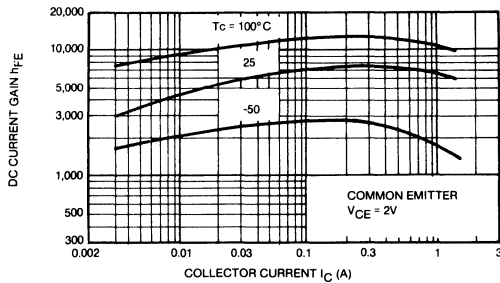


FIG. 6 $h_{FE} - I_C$

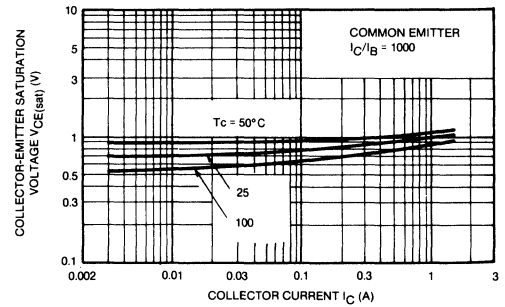


FIG. 7 $V_{CE(sat)} - I_C$

D72Y1.5D1, D72Y1.5D2

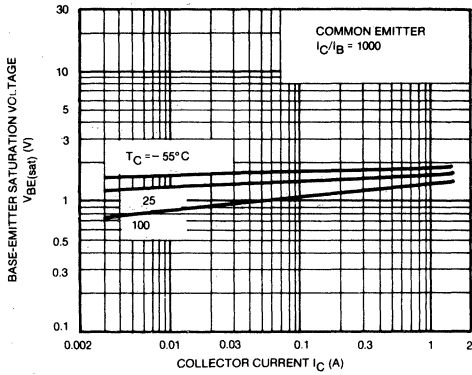


FIG. 8 $V_{BE(sat)} - I_C$

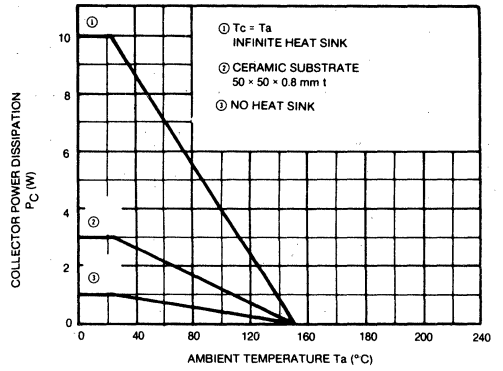


FIG. 9 $P_C - T_a$

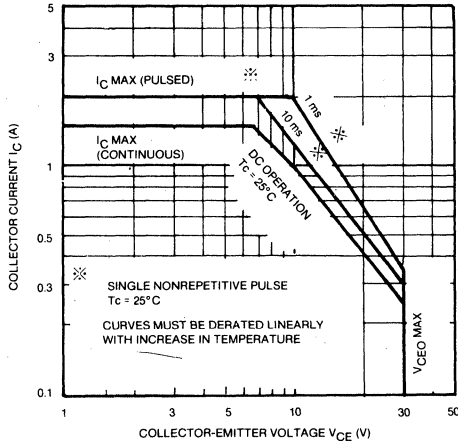


FIG. 10 SAFE OPERATING AREA

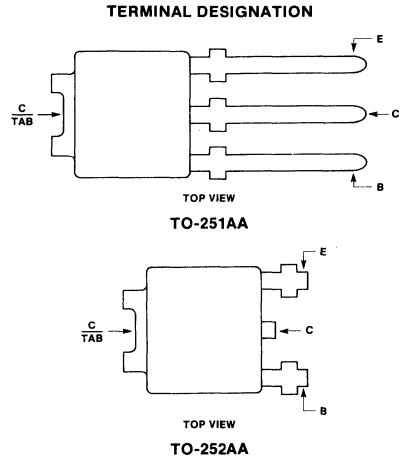
5-Ampere Silicon P-N-P Power Transistors

Features:

- Low $V_{CE(sat)}$
- Fast switching speed
- Complementary to D72F5T1,2

The D73F5T1 and D73F5T2 silicon p-n-p power transistors are designed for high current switching applications. They are intended for use in circuits such as converters, inverters, and pulse-width-modulated regulators.

The D73F5T1 is supplied in the JEDEC TO-251 package and the D73F5T2 is supplied in the JEDEC TO-252 surface-mount package.



2

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_C = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1.0 20	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS ⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	235	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D73F5T1, D73F5T2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	-50	—	—	Volts
Collector Cutoff Current ($V_{CB} = 50\text{V}$, $I_E = 0$)	I_{CBO}	—	—	-1	μA
Emitter Cutoff Current ($V_{EB} = 5\text{V}$, $I_C = 0$)	I_{EBO}	—	—	-1	μA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			
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ON CHARACTERISTICS

DC Current Gain ($I_C = -1\text{A}$, $V_{CE} = -1\text{V}$) ($I_C = -3\text{A}$, $V_{CE} = -1\text{V}$)	h_{FE}	70	—	240	—
	h_{FE}	30	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -3\text{A}$, $I_B = -0.15\text{A}$)	$V_{CE(sat)}$	—	-0.2	-0.4	V
Base-Emitter Saturation Voltage ($I_C = -3\text{A}$, $I_B = -0.15\text{A}$)	$V_{BE(sat)}$	—	-0.9	-1.2	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = -30\text{V}$ $-I_{B1} = I_{B2} = 0.15\text{A}$ Duty Cycle $\leq 1\%$	t_{on}	—	0.1	—	μs
Storage Time		t_{stg}	—	1.0	—	
Fall Time		t_f	—	0.1	—	

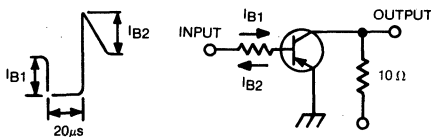


FIG. 1 SWITCHING TIME TEST CIRCUIT

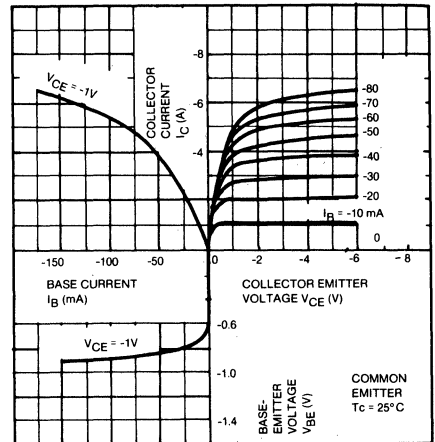


FIG. 2 STATIC CHARACTERISTICS

D73F5T1, D73F5T2

2

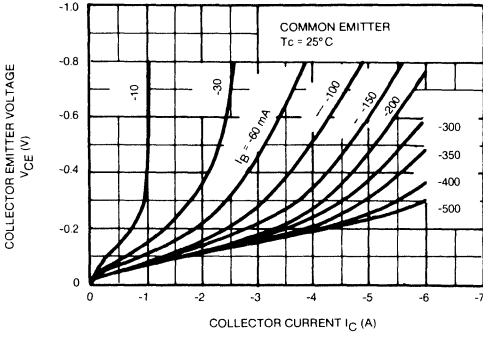


FIG. 3 VCE - IC

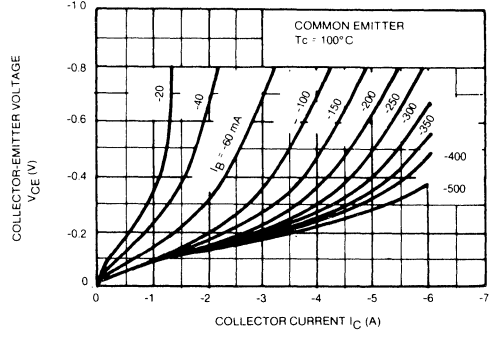


FIG. 4 VCE - IC

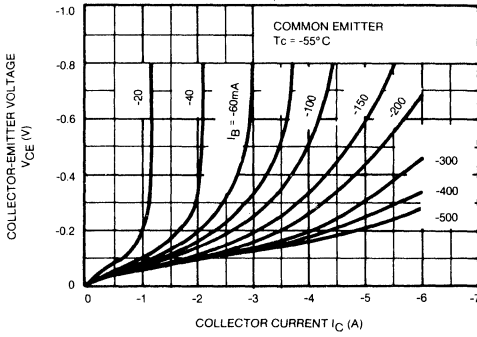


FIG. 5 VCE - IC

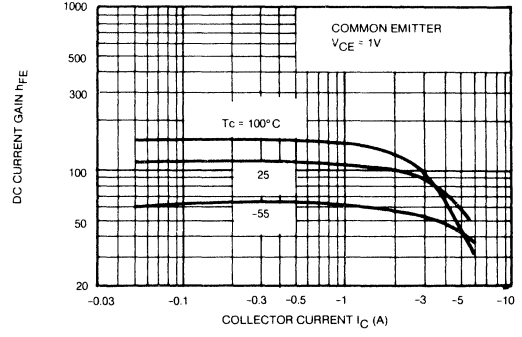


FIG. 6 hFE - IC

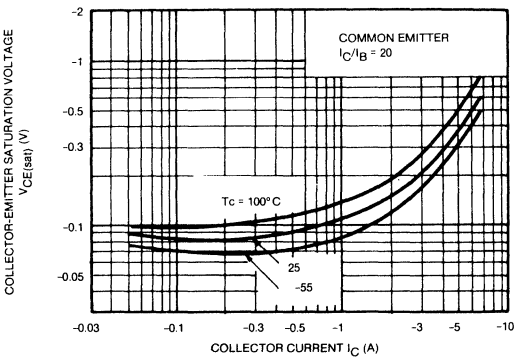


FIG. 7 VCE(sat) - IC

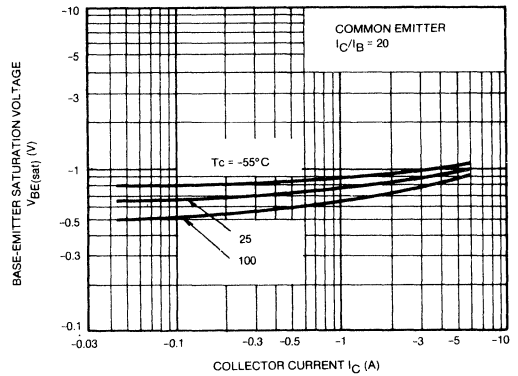


FIG. 8 VBE(sat) - IC

D73F5T1, D73F5T2

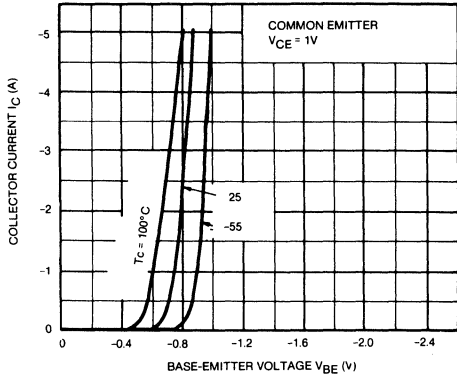


FIG. 9 $I_C - V_{BE}$

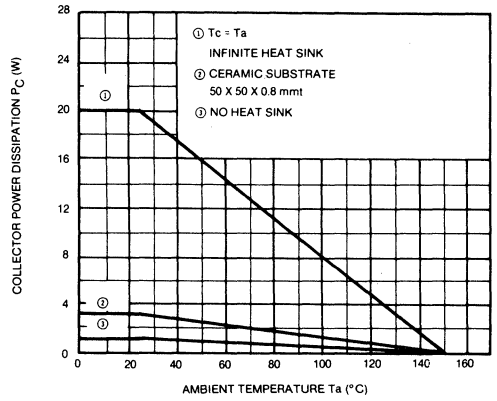


FIG. 10 $P_C - T_a$

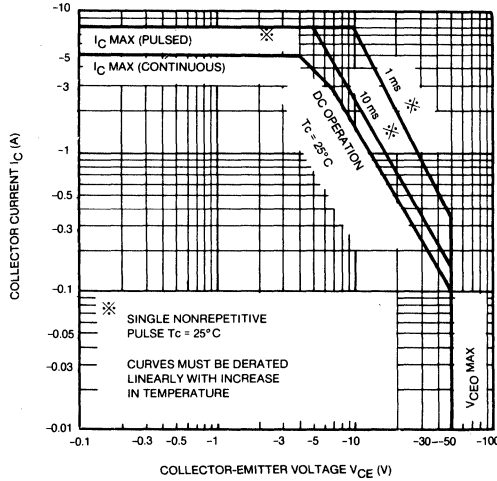


FIG. 11 SAFE OPERATING AREA

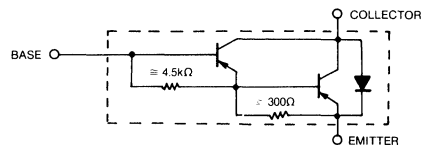
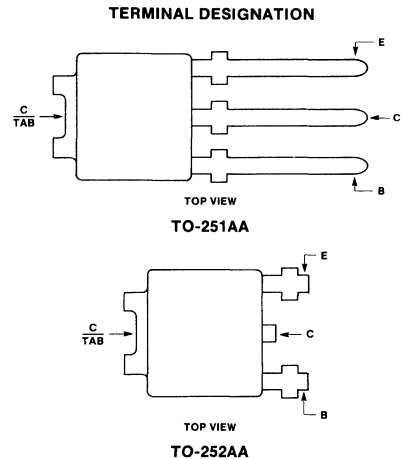
4-Ampere P-N-P Power Darlington Transistors

Features:

- Operates from IC without predriver
- h_{FE} Min. = 2000
- Complementary to D72FY4D1,2

The D73FY4D1 and D73FY4D2 silicon p-n-p power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D73FY4D1 is supplied in the JEDEC TO-251 package and the D73FY4D2 is supplied in the JEDEC TO-252 surface-mount package.



Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS ⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	235	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D73FY4D1, D73FY4D2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = -10\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	-80	—	—	Volts
Collector Cutoff Current ($V_{CB} = -100\text{V}$, $I_E = 0$)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$, $I_C = 0$)	I_{EBO}	—	—	-2.5	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9			
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ON CHARACTERISTICS

DC Current Gain ($I_C = -1\text{A}$, $V_{CE} = -2\text{V}$) ($I_C = -3\text{A}$, $V_{CE} = -2\text{V}$)	h_{FE}	2000	—	—	—
	h_{FE}	1000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -3\text{A}$, $I_B = -6\text{mA}$)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Saturation Voltage ($I_C = -3\text{A}$, $I_B = -6\text{mA}$)	$V_{BE(sat)}$	—	—	-2.0	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = -30\text{V}$ $-I_{B1} = I_{B2} = 6\text{mA}$ Duty Cycle $\leq 1\%$	t_{on}	—	0.15	—	μs
Storage Time		t_{stg}	—	0.80	—	
Fall Time		t_f	—	0.40	—	

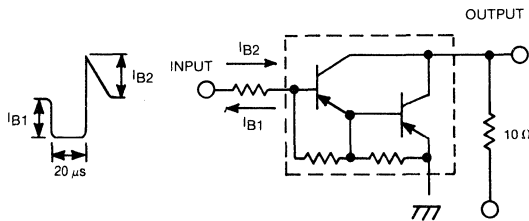


FIG. 1 SWITCHING TIME TEST CIRCUIT

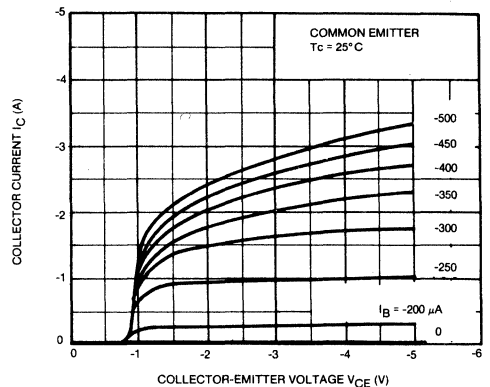


FIG. 2 $I_C - V_{CE}$

D73FY4D1, D73FY4D2

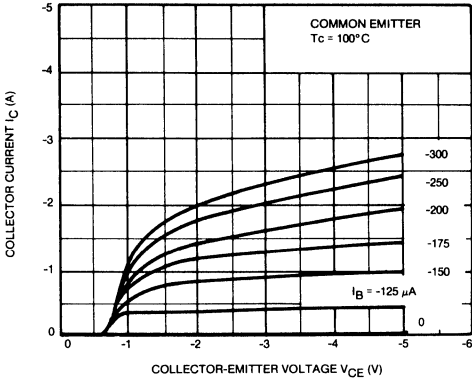


FIG. 3 $I_C - V_{CE}$

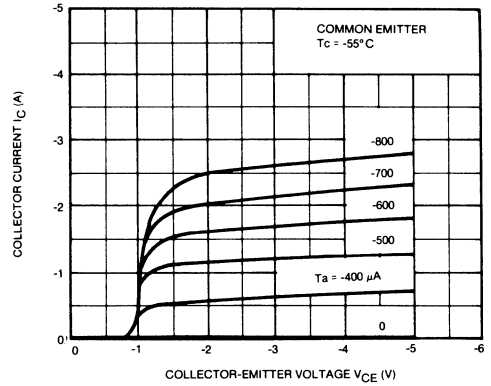


FIG. 4 $I_C - V_{CE}$

2

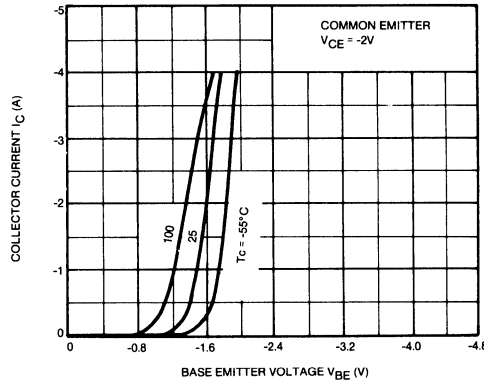


FIG. 5 $I_C - V_{BE}$

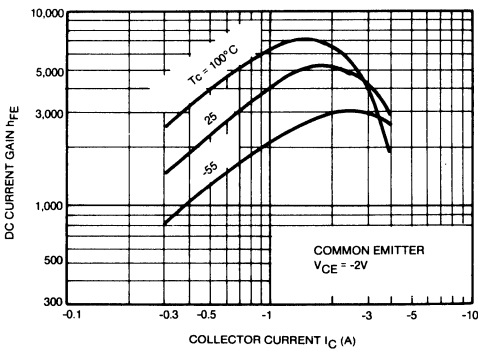


FIG. 6 $h_{FE} - I_C$

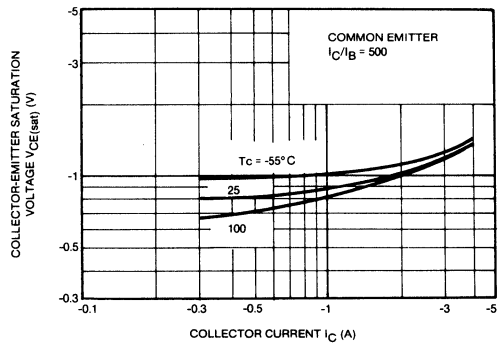


FIG. 7 $V_{CE(sat)} - I_C$

D73FY4D1, D73FY4D2

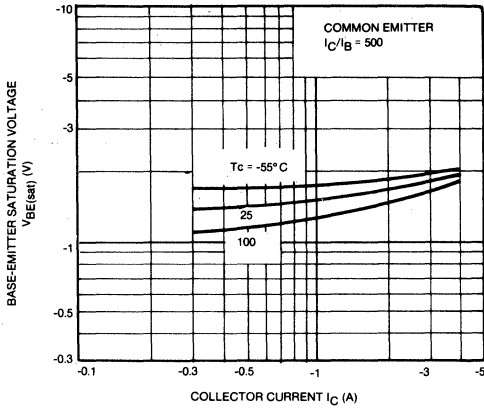


FIG. 8 $V_{BE(sat)} - I_C$

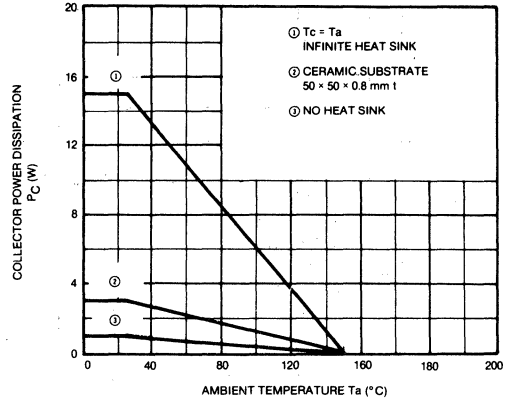


FIG. 9 $P_C - T_a$

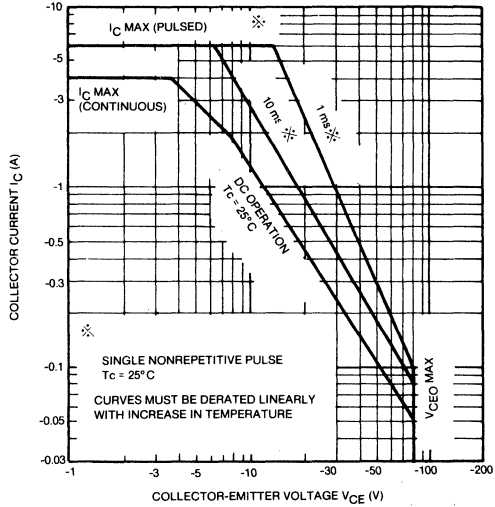


FIG. 10 SAFE OPERATING AREA

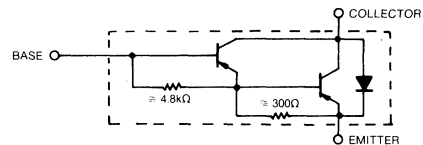
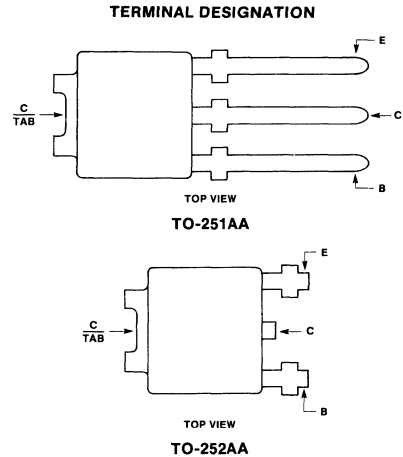
3-Ampere P-N-P Power Darlington Transistors

Features:

- Operates from IC without predriver
- h_{FE} Min. = 2000
- Complementary to D72K3D1,2

The D73K3D1 and D73K3D2 silicon p-n-p power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D73K3D1 is supplied in the JEDEC TO-251 package and the D73K3D2 is supplied in the JEDEC TO-252 surface-mount package.



Schematic diagram for all types.

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (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 @ $T_A = 25^\circ\text{C}$ @ $T_C = 25^\circ\text{C}$	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS⁽¹⁾

Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	$^\circ\text{C}$
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(1) See page 7-16 for thermal considerations.

D73K3D1, D73K3D2

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = -25\text{mA}$, $I_B = 0$)	$V_{(BR)CEO}$	-40	—	—	Volts
Collector Cutoff Current ($V_{CB} = -60\text{V}$, $I_E = 0$)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current ($V_{EB} = -5\text{V}$, $I_C = 0$)	I_{EBO}	—	—	-2.5	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
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ON CHARACTERISTICS

DC Current Gain ($I_C = -1\text{A}$, $V_{CE} = -2\text{V}$) ($I_C = -3\text{A}$, $V_{CE} = -2\text{V}$)	h_{FE}	2000	—	—	—
	h_{FE}	1000	—	—	—
Collector-Emitter Saturation Voltage ($I_C = -2\text{A}$, $I_B = -4\text{mA}$)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Saturation Voltage ($I_C = -2\text{A}$, $I_B = -4\text{mA}$)	$V_{BE(sat)}$	—	—	-2.0	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	$V_{CC} = -30\text{V}$ $-I_{B1} = I_{B2} = 6\text{mA}$ Duty Cycle $\leq 1\%$	t_{on}	—	0.30	—	μs
Storage Time		t_{stg}	—	0.60	—	
Fall Time		t_f	—	0.25	—	

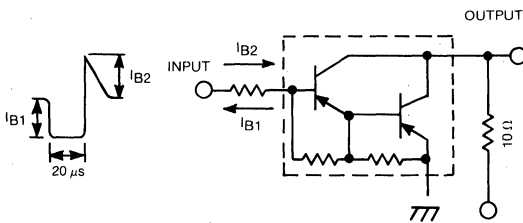


FIG. 1 SWITCHING TIME TEST CIRCUIT

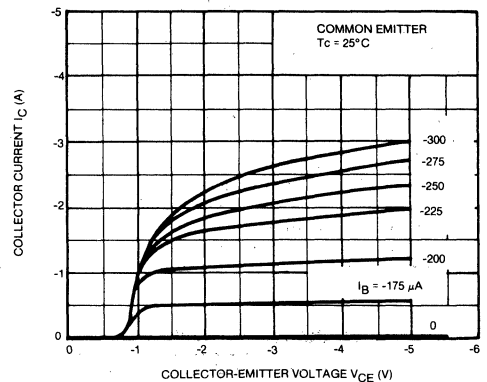


FIG. 2 $I_C - V_{CE}$

D73K3D1, D73K3D2

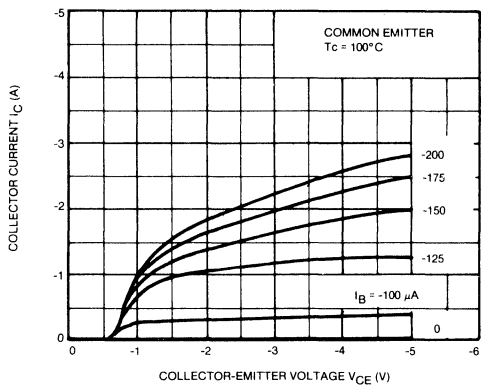


FIG. 3 $I_C - V_{CE}$

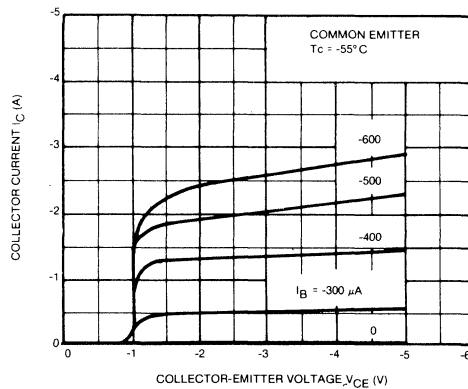


FIG. 4 $I_C - V_{CE}$

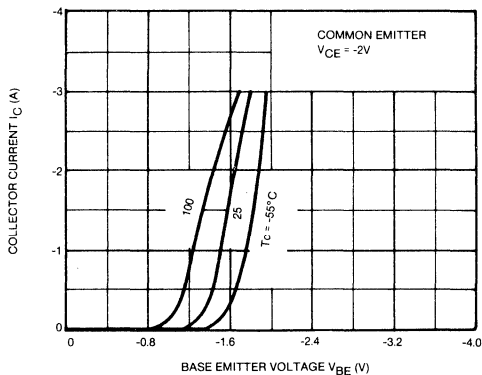


FIG. 5 $I_C - V_{BE}$

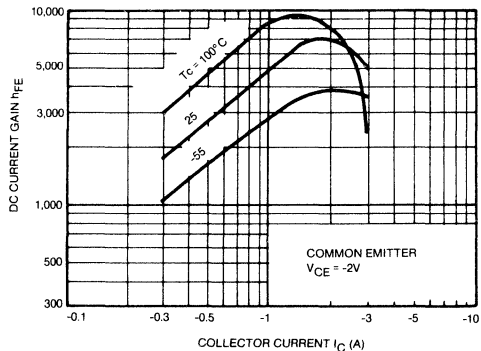


FIG. 6 $h_{FE} - I_C$

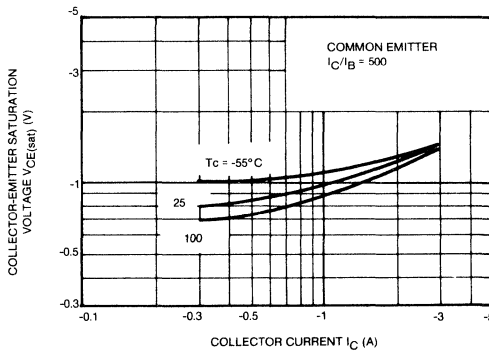


FIG. 7 $V_{CE(sat)} - I_C$

2

D73K3D1, D73K3D2

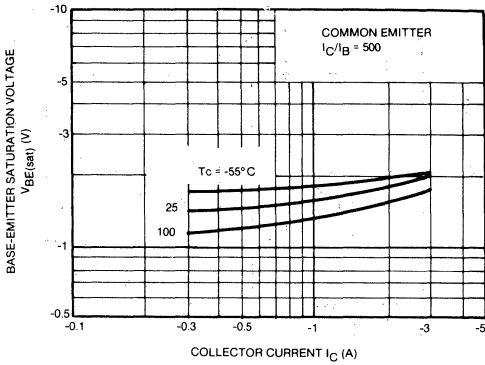


FIG. 8 $V_{BE(sat)} - I_C$

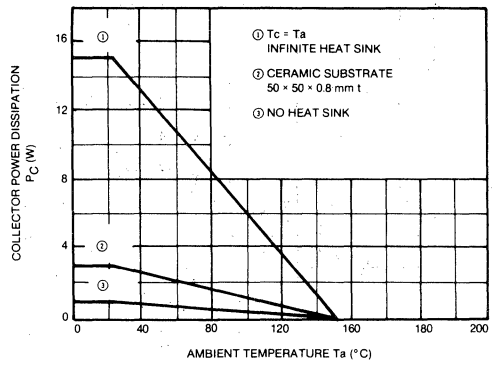


FIG. 9 $P_C - T_a$

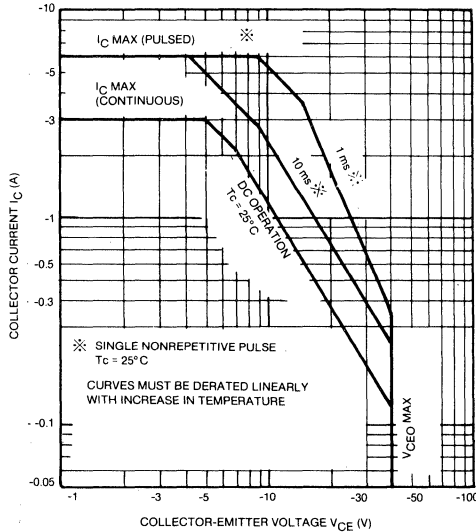


FIG. 10 SAFE OPERATING AREA

File Number **15.84****GE5060, GE5061, GE5062**

20-Ampere N-P-N Darlington Power Transistors

Features:

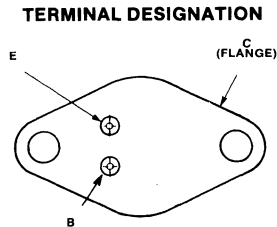
- High-voltage operation: 350, 400, 450 volts
- Gain of 100 at 10A

Applications:

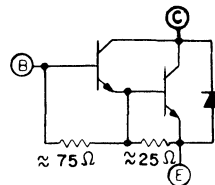
- Series/shunt regulators
- Automotive ignition
- Power switching
- Solenoid driver

The GE5060, GE5061, and GE5062 silicon n-p-n Darlington power transistors are designed for use in high-speed switching applications, such as: off-line power supplies, AC and DC motor control, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.



JEDEC TO-204AA



DEVICE CIRCUIT

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

RATING	SYMBOL	GE5060	GE5061	GE5062	UNITS
Collector-Base Voltage	V_{CB0}	400	450	500	Volts
Collector-Emitter Voltage	V_{CE0}	350	400	450	Volts
Emitter Base Voltage	V_{EBO}	8	8	8	Volts
Collector Current — Continuous	I_C	20	20	20	A
Peak (Repetitive)	I_{CM}	25	25	25	
Peak (Non-Repetitive)	I_{CSM}	42.5	42.5	42.5	
Base Current — Continuous	I_B	4	4	4	A
Peak (Non-Repetitive)	I_{BM}	6	6	6	
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	300	300	300	$^\circ\text{C}$

GE5060, GE5061, GE5062**ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 0.5\text{mA}$) ($V_{\text{clamp}} = V_{\text{CEO}}$ Rated)	GE5060 GE5061 GE5062	$V_{\text{CEO(sus)}}$	350 400 450	— — —	— — —	Volts
Collector-Base Voltage ($I_C = 0.25\text{mA}$)	GE5060 GE5061 GE5062	V_{CBO}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current ($V_{\text{CB}} = V_{\text{CBO}}$ Rated)		I_{CBO}	—	—	0.25	mA
Emitter Cutoff Current ($V_{\text{EB}} = 4.5\text{V}$, $I_C = 0$)		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 17

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 10\text{A}$, $V_{\text{CE}} = 5\text{V}$) ($I_C = 15\text{A}$, $V_{\text{CE}} = 5\text{V}$) ($I_C = 20\text{A}$, $V_{\text{CE}} = 5\text{V}$)	h_{FE}	100 40 15	160 115 65	— — —	—
Collector-Emitter Saturation Voltage ($I_C = 10\text{A}$, $I_B = 1\text{A}$) ($I_C = 10\text{A}$, $I_B = 2\text{A}$) ($I_C = 20\text{A}$, $I_B = 2\text{A}$)	$V_{\text{CE(sat)}}$	— — —	1.2 1.15 1.6	1.5 1.4 2	V
Base-Emitter Voltage ($I_C = 10\text{A}$, $I_B = 1\text{A}$) ($I_C = 20\text{A}$, $I_B = 2\text{A}$)	$V_{\text{BE(sat)}}$	— —	1.95 2.3	2.5 3.5	V

SWITCHING CHARACTERISTICS

Resistive Load						
Rise Time	$I_C = 15\text{A}$, $I_{B1} = 0.75\text{A}$, $I_{B2} = -1.5\text{A}$ $V_{\text{CC}} = 300\text{V}$, $t_p = 50 \mu\text{sec}$	t_r	—	0.3	—	μs
Storage Time		t_s	—	2.7	—	
Fall Time		t_f	—	1.15	—	
Inductive Load, Clamped						
Storage Time	$V_{\text{CC}} = 300\text{V}$, $L = 100 \mu\text{H}$ $I_C = 15\text{A}$, $I_{B1} = 0.75\text{A}$, $I_{B2} = -1.5\text{A}$	t_s	—	3.3	—	μs
Crossover Time		t_c	—	1.7	—	
Fall Time		t_f	—	0.4	—	

EMITTER-COLLECTOR DIODE CHARACTERISTICS

Forward Voltage $I_F = 10\text{A}$ $I_F = 25\text{A}$	V_F	— —	1.9 2.8	— —	Volts
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GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

2

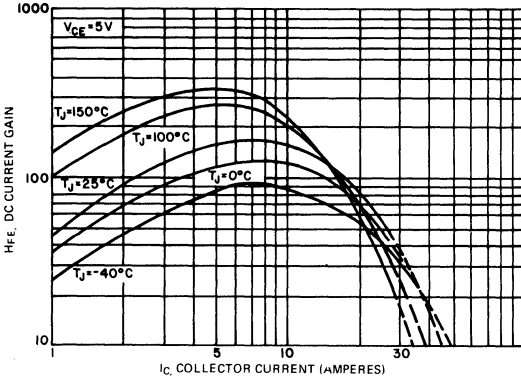


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 2V$)

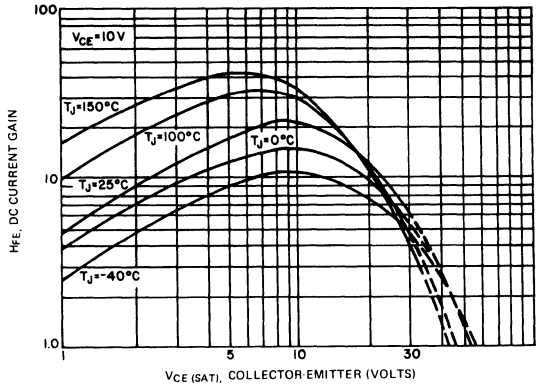


FIGURE 2. DC CURRENT GAIN ($V_{CE} = 10V$)

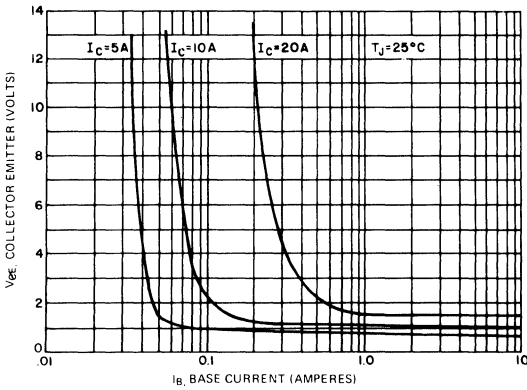


FIGURE 3. COLLECTOR SATURATION REGION

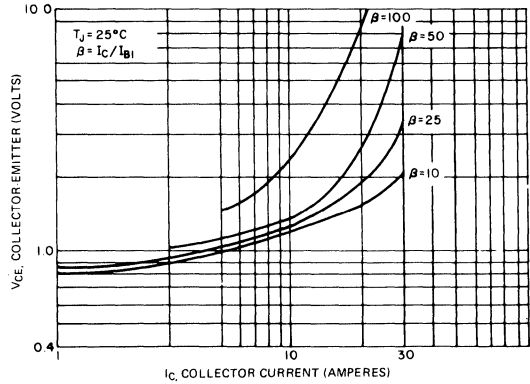


FIGURE 4. $V_{CE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

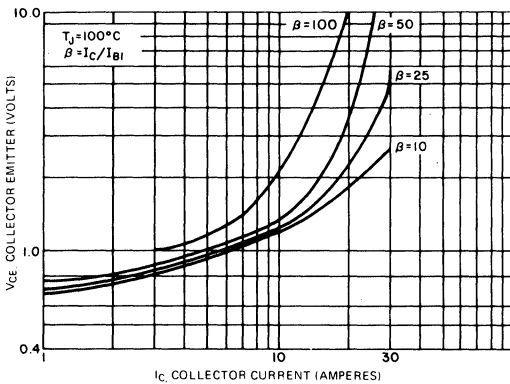


FIGURE 5. $V_{CE(SAT)}$ VS. I_C , $T_J = 100^\circ C$

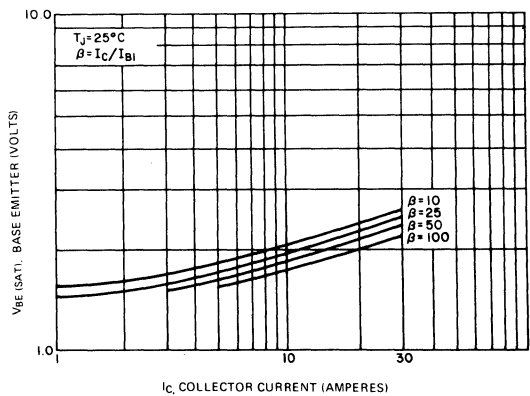


FIGURE 6. $V_{BE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

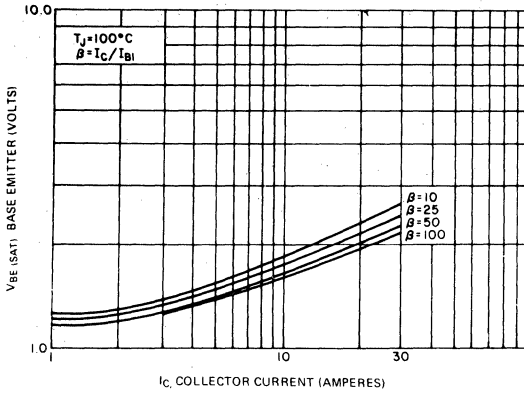


FIGURE 7. $V_{BE(SAT)}$ VS. I_C , $T_J = 100^\circ\text{C}$

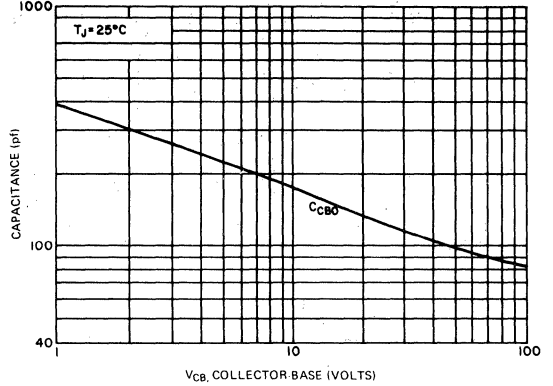


FIGURE 8. CAPACITANCE (C_{CB0})

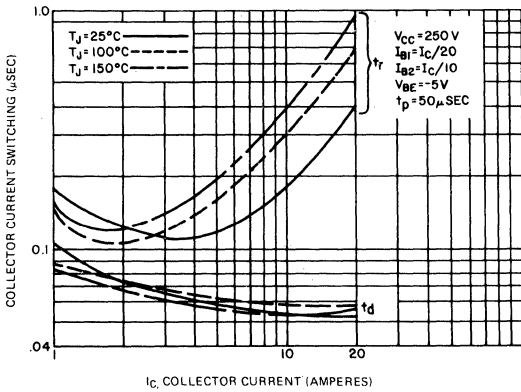


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD)

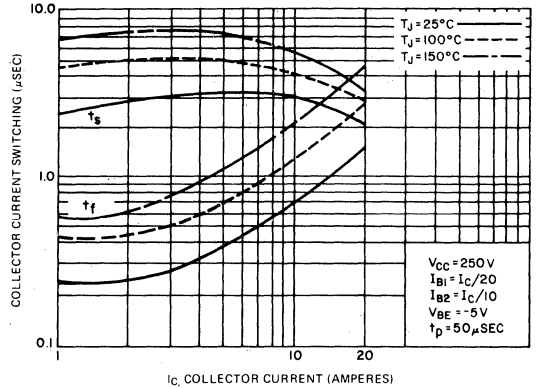


FIGURE 10. TURN-OFF TIME (RESISTIVE)

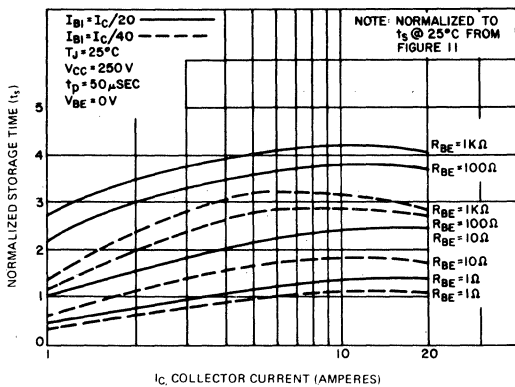


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

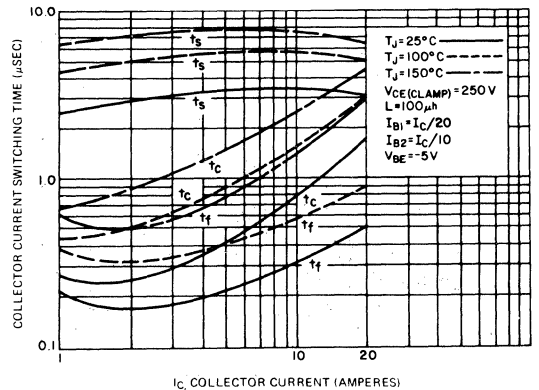


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

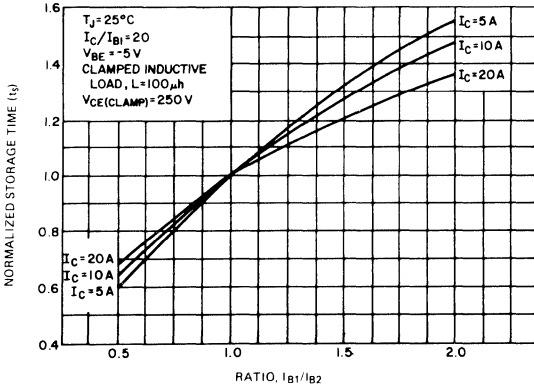


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

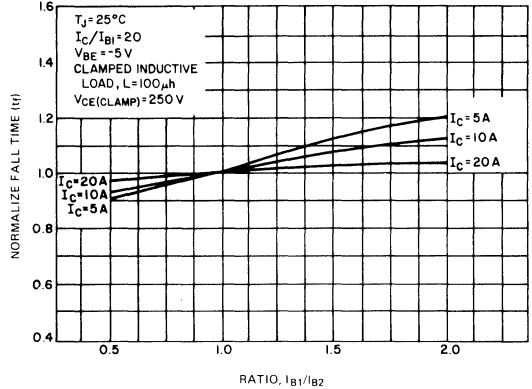


FIGURE 14. FALL TIME VARIATION WITH I_{B2}

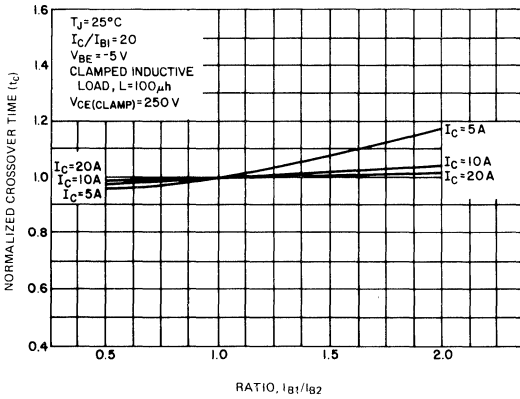


FIGURE 15. CROSS-OVER TIME VARIATION WITH I_{B2}

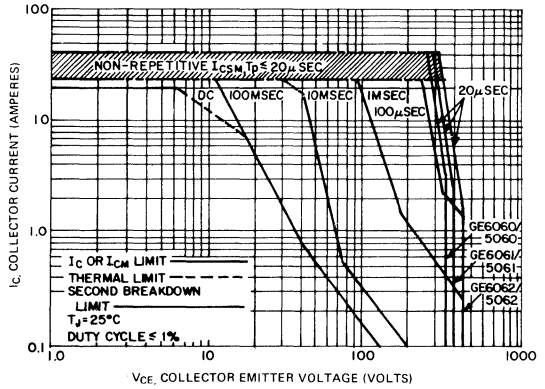


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

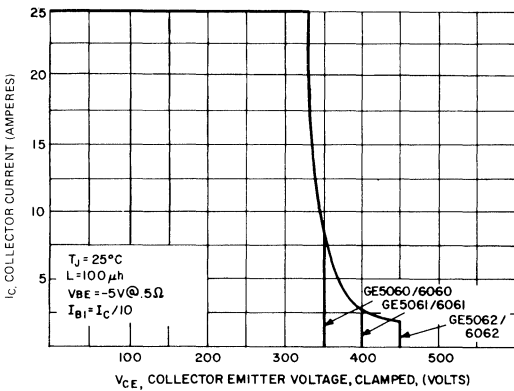


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

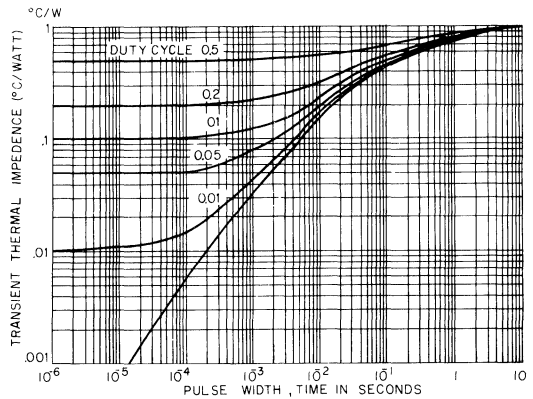


FIGURE 18. TRANSIENT THERMAL RESPONSE

GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

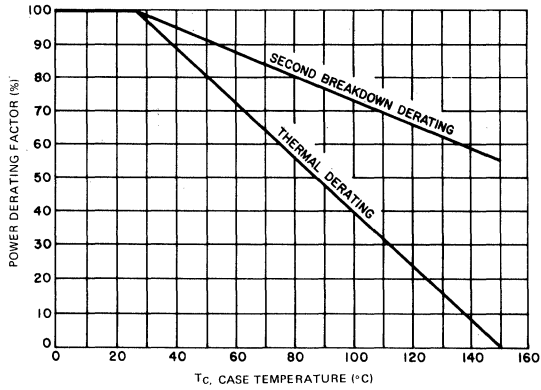


FIGURE 19. POWER DERATING

DIODE CHARACTERISTICS

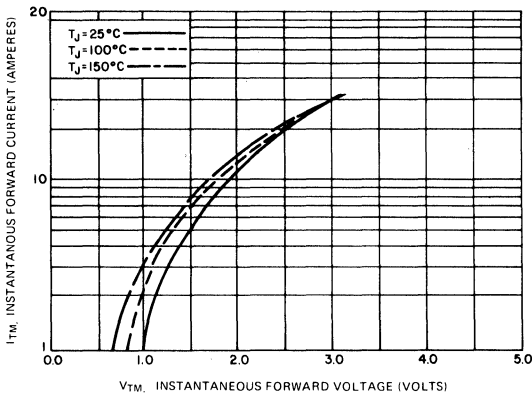


FIGURE 20. FORWARD CHARACTERISTICS

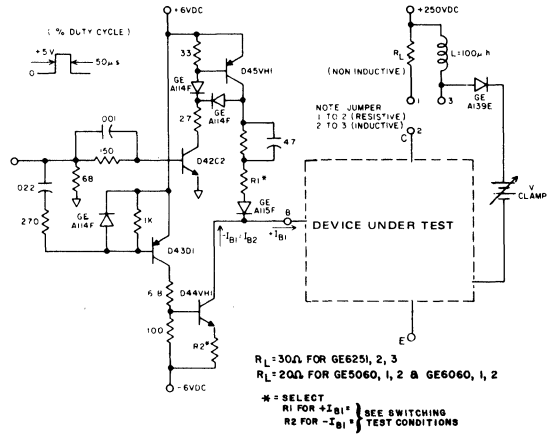


FIGURE 21. SWITCHING TIME TEST CIRCUIT

20-Ampere N-P-N Darlington Power Transistors

Features:

- High-voltage operation: 350, 400, 450 volts
- Gain of 40 at 10A

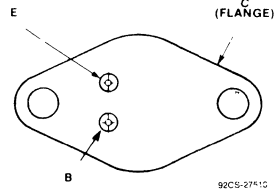
Applications:

- Series/shunt regulators
- Automotive ignition
- Power switching
- Solenoid driver

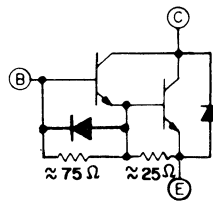
The GE6060, GE6061, and GE6062 silicon n-p-n Darlington power transistors are designed for use in high-speed switching applications, such as: off-line power supplies, AC and DC motor control, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

TERMINAL DESIGNATION



JEDEC TO-204AA



DEVICE CIRCUIT

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

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	I_C	20	20	20	A
Peak (Repetitive)	I_{CM}	25	25	25	
Peak (Non-Repetitive)	I_{CSM}	42.5	42.5	42.5	
Base Current — Continuous	I_B	4	4	4	A
Peak (Non-Repetitive)	I_{BM}	6	6	6	
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	300	300	300	$^\circ\text{C}$

GE6060, GE6061, GE6062ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 0.5\text{mA}$) ($V_{\text{clamp}} = V_{\text{CEO}}$ Rated)	GE6060 GE6061 GE6062	$V_{\text{CEO(sus)}}$	350 400 450	— — —	— — —	Volts
Collector-Base Voltage ($I_C = 0.25\text{mA}$)	GE6060 GE6061 GE6062	V_{CBO}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current ($V_{\text{CB}} = V_{\text{CBO}}$ Rated)		I_{CBO}	—	—	0.25	mA
Emitter Cutoff Current ($V_{\text{EB}} = 1.5\text{V}$, $I_C = 0$)		I_{EBO}	—	—	200	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 14
Clamped Inductive SOA with Base Reversed Biased	RBSOA	SEE FIGURE 17

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 10\text{A}$, $V_{\text{CE}} = 5\text{V}$) ($I_C = 15\text{A}$, $V_{\text{CE}} = 5\text{V}$) ($I_C = 20\text{A}$, $V_{\text{CE}} = 5\text{V}$)	h_{FE}	40 30 10	160 115 65	— — —	—
Collector-Emitter Saturation Voltage ($I_C = 10\text{A}$, $I_B = 1\text{A}$) ($I_C = 10\text{A}$, $I_B = 2\text{A}$) ($I_C = 20\text{A}$, $I_B = 2\text{A}$)	$V_{\text{CE(sat)}}$	— — —	1.2 1.15 1.6	1.5 1.4 2	V
Base-Emitter Voltage ($I_C = 5\text{A}$, $I_B = 0.5\text{A}$) ($I_C = 20\text{A}$, $I_B = 2\text{A}$)	$V_{\text{BE(sat)}}$	— —	1.95 2.3	2.5 3.5	V

SWITCHING CHARACTERISTICS

Resistive Load					
Rise Time	$V_{\text{CC}} = 300\text{V}$, $t_p = 50 \mu\text{s}$ $I_C = 15\text{A}$, $I_{B1} = 1.5\text{A}$, $I_{B2} = -2.25\text{A}$	t_r	—	0.3	0.4
Storage Time		t_s	—	2.3	2.5
Fall Time		t_f	—	0.5	1
Inductive Load, Clamped					
Storage Time	$V_{\text{CC}} = 300\text{V}$, $L = 100 \mu\text{H}$ $I_C = 15\text{A}$, $I_{B1} = 1.5\text{A}$, $I_{B2} = -2.25\text{A}$	t_s	—	2.6	—
Crossover Time		t_c	—	0.5	—
Fall Time		t_f	—	0.12	—

EMITTER-COLLECTOR DIODE CHARACTERISTICS

Forward Voltage $I_F = 10\text{A}$ $I_F = 25\text{A}$	V_F	— —	1.9 2.8	— —	Volts
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GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

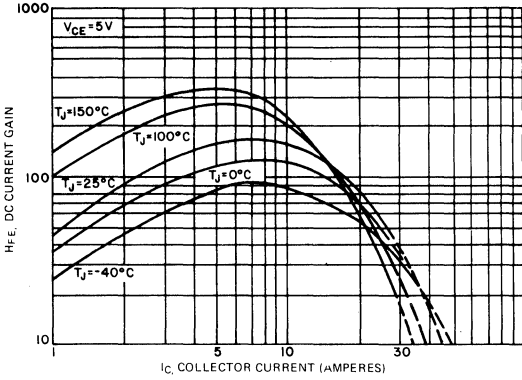


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 2V$)

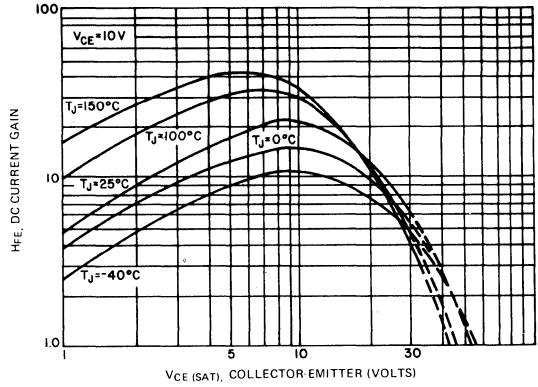


FIGURE 2. DC CURRENT GAIN ($V_{CE} = 10V$)

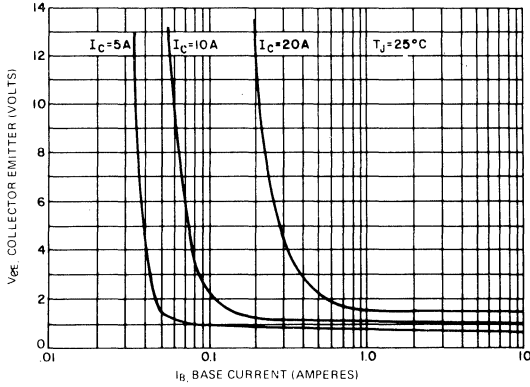


FIGURE 3. COLLECTOR SATURATION REGION

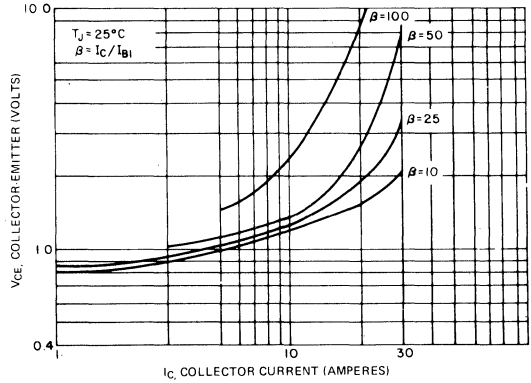


FIGURE 4. $V_{CE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

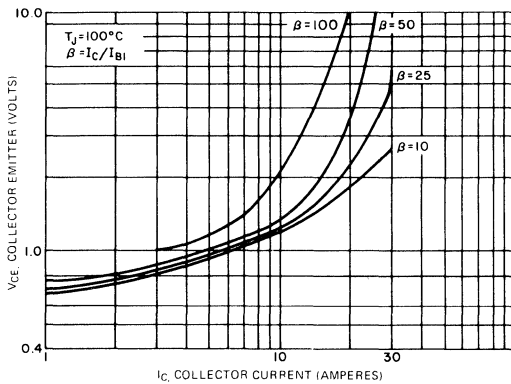


FIGURE 5. $V_{CE(SAT)}$ VS. I_C , $T_J = 100^\circ C$

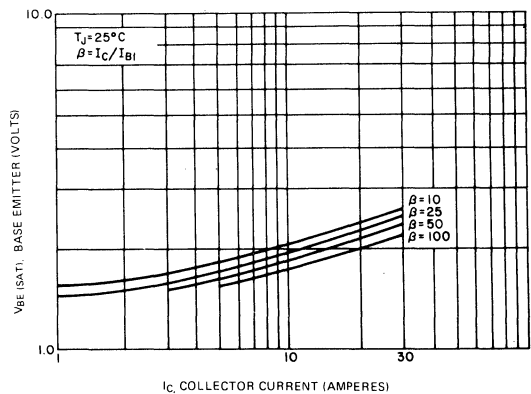


FIGURE 6. $V_{BE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

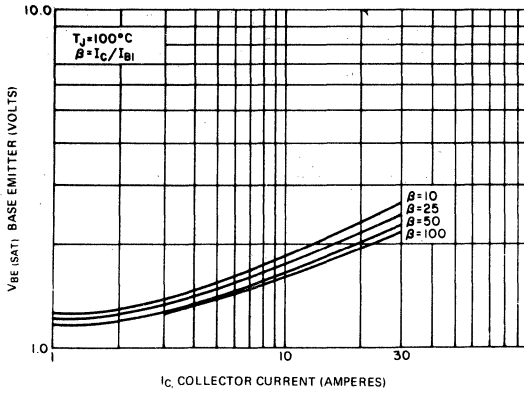


FIGURE 7. $V_{BE(SAT)}$ VS. I_C , $T_J = 100^\circ C$

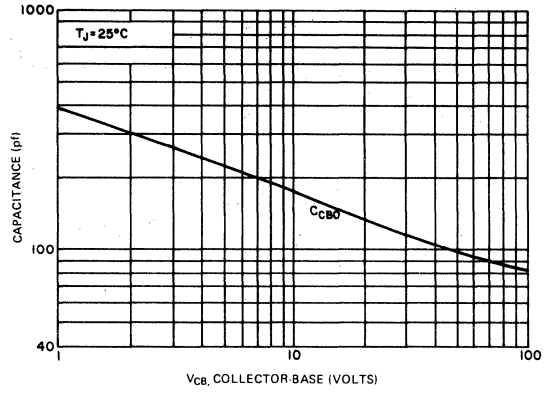


FIGURE 8. CAPACITANCE (C_{CB0})

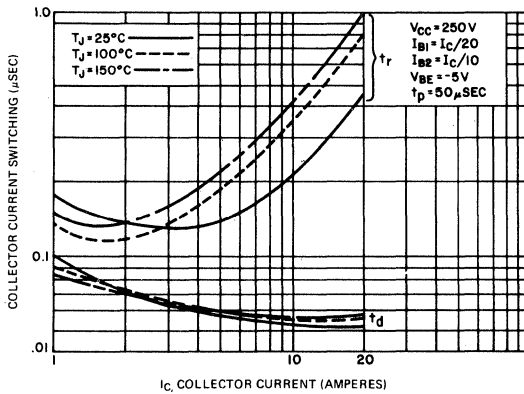


FIGURE 9. TURN-ON TIME (RESISTIVE)

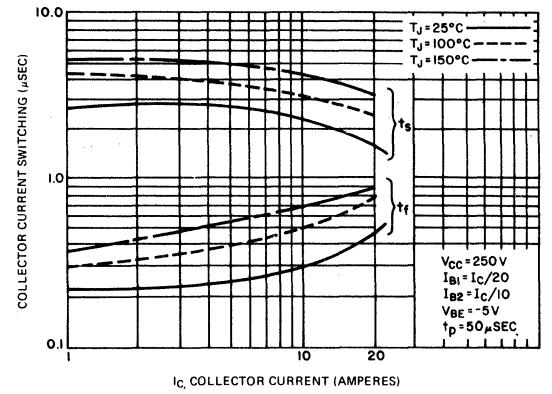


FIGURE 10. TURN-OFF TIME (RESISTIVE)

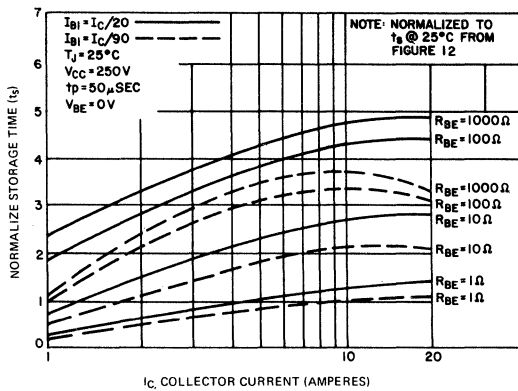


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

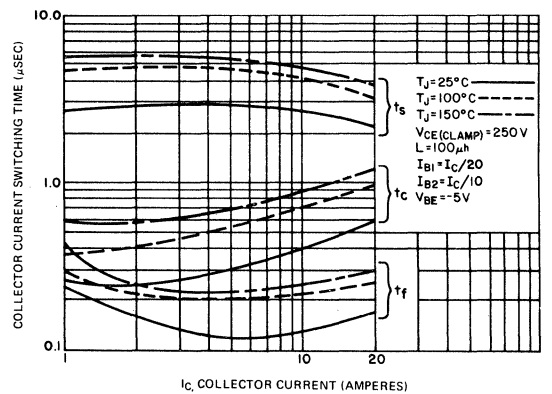


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

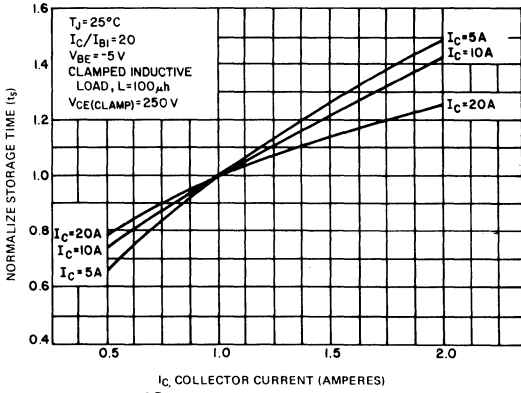


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

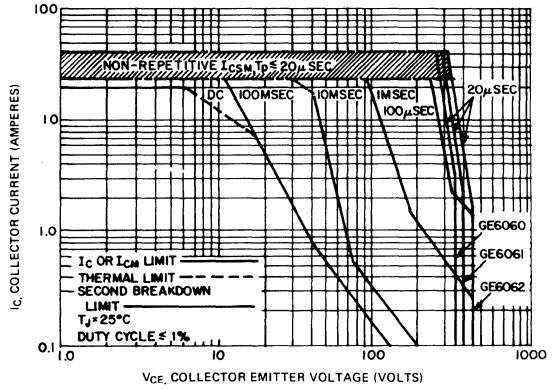


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

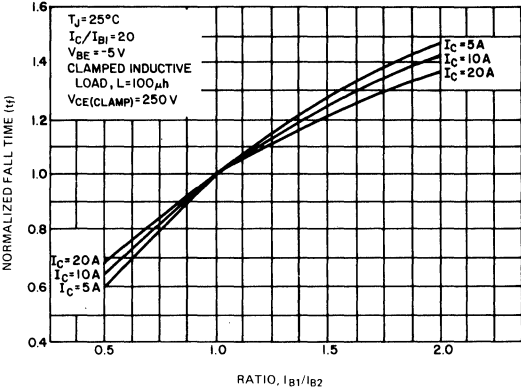


FIGURE 15. FALL TIME VARIATION WITH I_{B2}

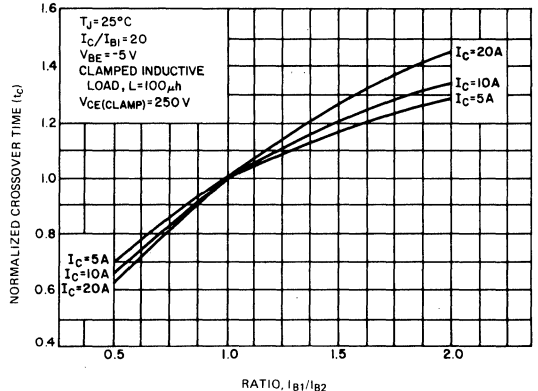


FIGURE 16. CROSS-OVER TIME VARIATION WITH I_{B2}

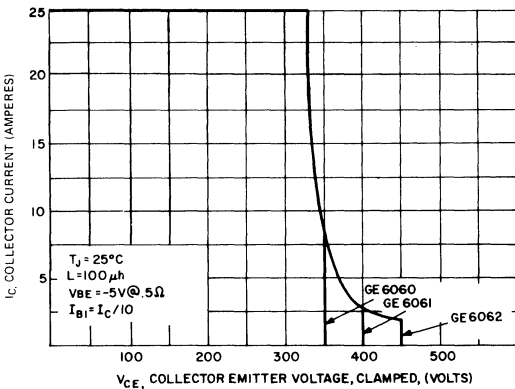


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

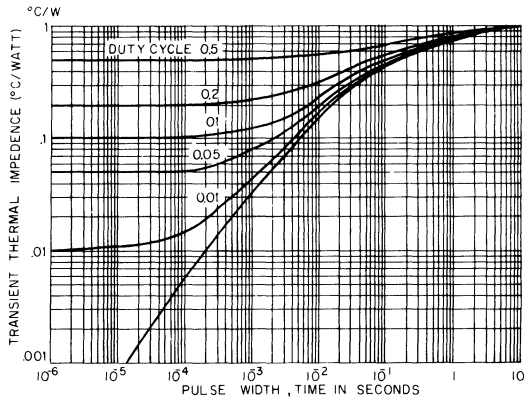


FIGURE 18. TRANSIENT THERMAL RESPONSE

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

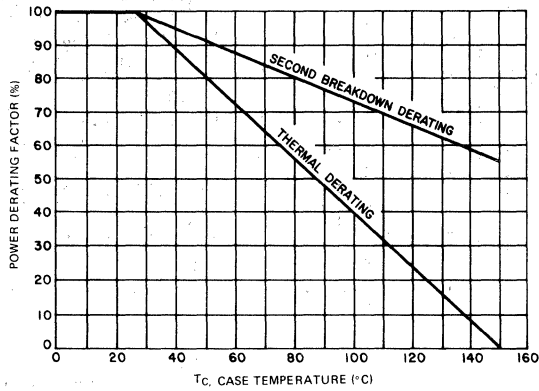


FIGURE 19. POWER DERATING

DIODE CHARACTERISTICS

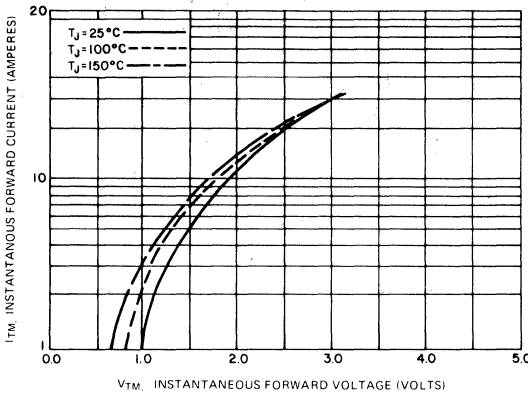


FIGURE 20. FORWARD CHARACTERISTICS

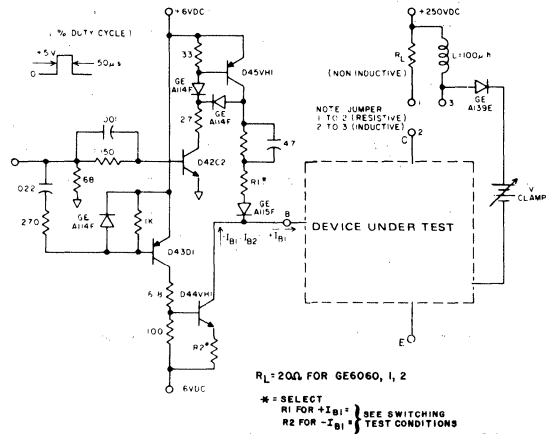


FIGURE 21. SWITCHING TIME TEST CIRCUIT

10-Ampere N-P-N Darlington Power Transistors

Features:

- High-voltage operation: 400, 450, 500 volts
- Gain of 60 at 3A

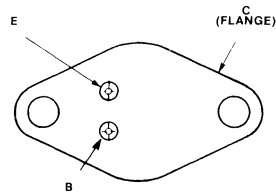
Applications:

- Series/shunt regulators
- Automotive ignition
- Power switching
- Solenoid driver

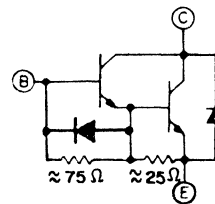
The GE6251, GE6252, and GE6253 silicon n-p-n Darlington power transistors are designed for use in high-speed switching applications, such as: off-line power supplies, AC and DC motor control, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

TERMINAL DESIGNATION



JEDEC TO-204AA



DEVICE CIRCUIT

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

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	I_C	10	10	10	A
Peak (Repetitive)	I_{CM}	15	15	15	
Peak (Non-Repetitive)	I_{CSM}	25	25	25	
Base Current — Continuous	I_B	3	3	3	A
Peak (Non-Repetitive)	I_{BM}	5	5	5	
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	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	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1		1	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: $\frac{1}{8}$ " from Case for 5 Seconds	T_L	300	300	300	$^\circ\text{C}$

GE6251, GE6252, GE6253**ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 0.5\text{A}$) ($V_{\text{clamp}} = V_{\text{CEO}}$ Rated)	GE6251	$V_{\text{CEO(sus)}}$	400	—	—	Volts
	GE6252		450	—	—	
	GE6253		500	—	—	
Collector-Base Voltage ($I_C = 1\text{mA}$)	GE6251	V_{CBO}	450	—	—	Volts
	GE6252		500	—	—	
	GE6253		550	—	—	
Collector Cutoff Current ($V_{\text{CB}} = V_{\text{CBO}}$ Rated)		I_{CBO}	—	—	1	mA
Emitter Cutoff Current ($V_{\text{EB}} = 1.5\text{V}$, $I_C = 0$)		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⁽¹⁾

DC Current Gain ($I_C = 3\text{A}$, $V_{\text{CE}} = 5\text{V}$) ($I_C = 5\text{A}$, $V_{\text{CE}} = 5\text{V}$) ($I_C = 10\text{A}$, $V_{\text{CE}} = 5\text{V}$)	h_{FE}	60	125	—	—
		50	170	—	—
		30	160	—	—
Collector-Emitter Saturation Voltage ($I_C = 5\text{A}$, $I_B = 0.5\text{A}$) ($I_C = 10\text{A}$, $I_B = 2\text{A}$)	$V_{\text{CE(sat)}}$	—	1	1.5	V
		—	1.15	2.0	
Base-Emitter Voltage ($I_C = 5\text{A}$, $I_B = 0.5\text{A}$)	$V_{\text{BE(sat)}}$	—	1.75	2.5	V

SWITCHING CHARACTERISTICS

Resistive Load						
Rise Time	$V_{\text{CC}} = 300\text{V}$, $t_p = 50\ \mu\text{sec}$ $I_C = 10\text{A}$, $I_{B1} = 1\text{A}$, $I_{B2} = -2\text{A}$	t_r	—	0.2	0.25	μs
Storage Time		t_s	—	2.1	2.5	
Fall Time		t_f	—	0.2	1.0	
Inductive Load, Clamped						
Storage Time	$V_{\text{CC}} = 300\text{V}$, $L = 100\ \mu\text{H}$ $I_C = 10\text{A}$, $I_{B1} = 1\text{A}$, $I_{B2} = -2\text{A}$	t_s	—	2.35	—	μs
Crossover Time		t_c	—	0.28	—	
Fall Time		t_f	—	0.09	—	

EMITTER-COLLECTOR DIODE CHARACTERISTICS

Forward Voltage $I_F = 10\text{A}$	V_F	—	1.9	—	Volts
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GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

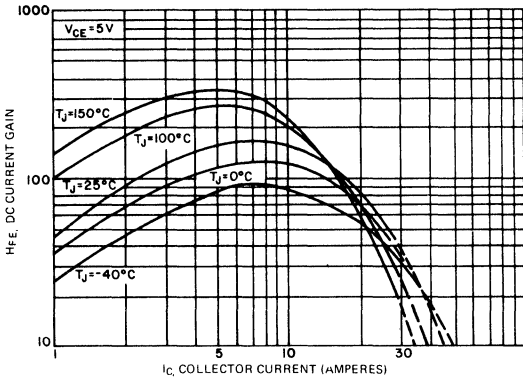


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 2V$)

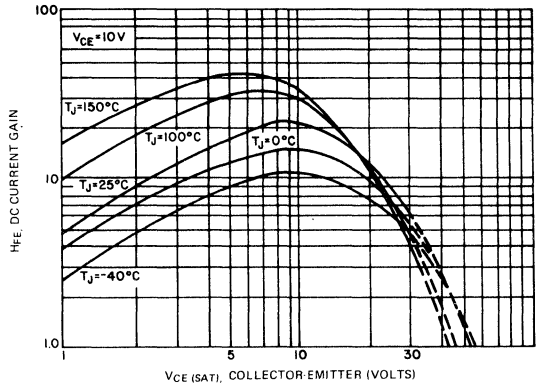


FIGURE 2. DC CURRENT GAIN ($V_{CE} = 10V$)

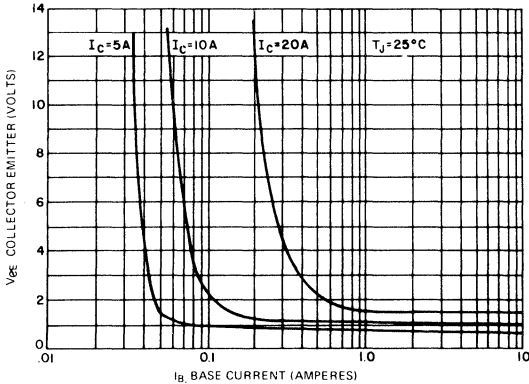


FIGURE 3. COLLECTOR SATURATION REGION

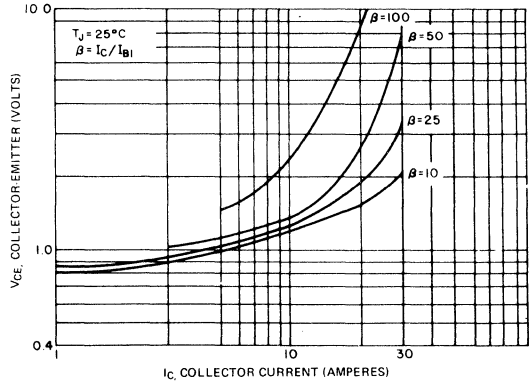


FIGURE 4. $V_{CE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

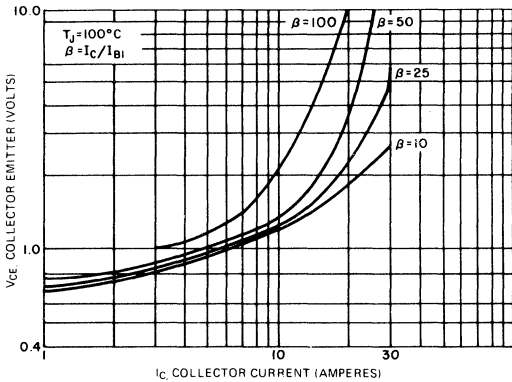


FIGURE 5. $V_{CE(SAT)}$ VS. I_C , $T_J = 100^\circ C$

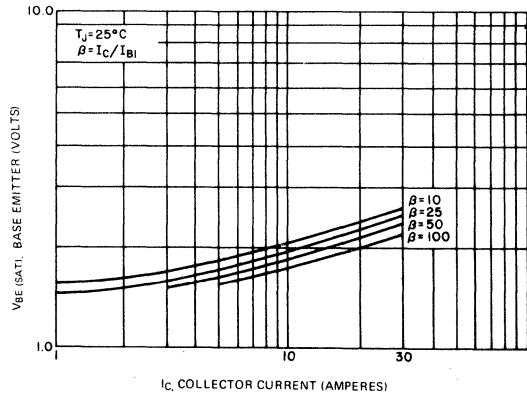


FIGURE 6. $V_{BE(SAT)}$ VS. I_C , $T_J = 25^\circ C$

2

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

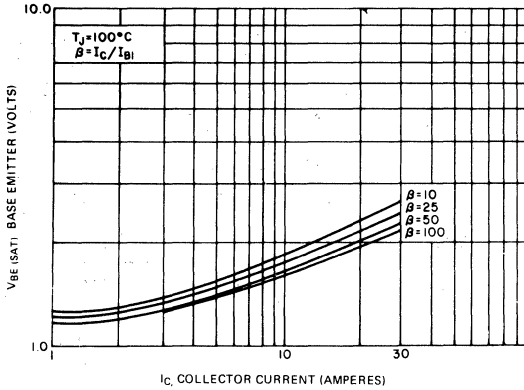


FIGURE 7. $V_{BE(SAT)}$ VS. I_C , $T_J = 100^\circ C$

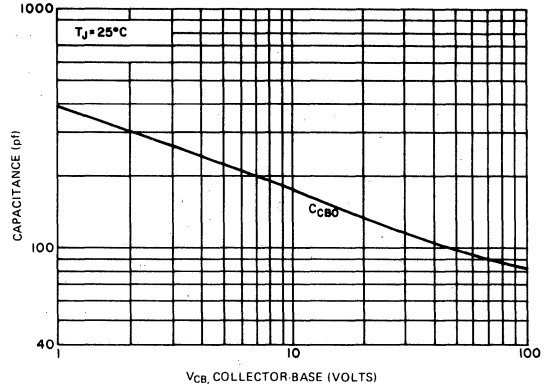


FIGURE 8. CAPACITANCE (C_{CB0})

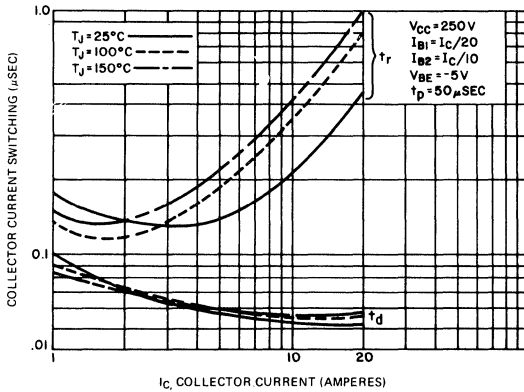


FIGURE 9. TURN-ON TIME (RESISTIVE)

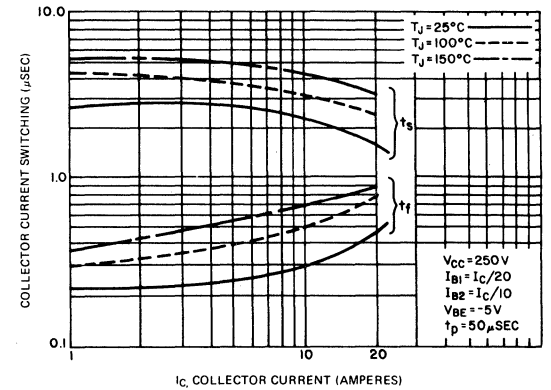


FIGURE 10. TURN-OFF TIME (RESISTIVE)

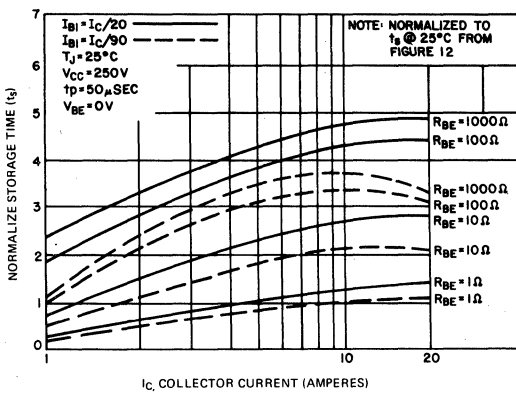


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

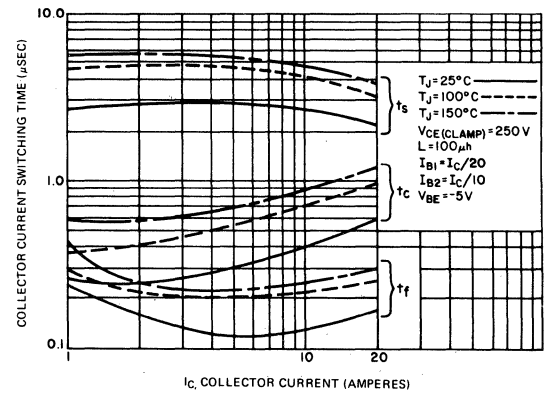


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

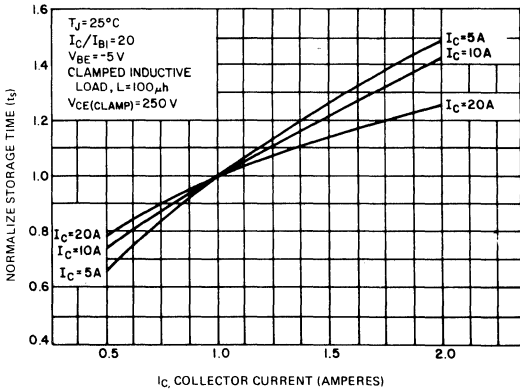


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

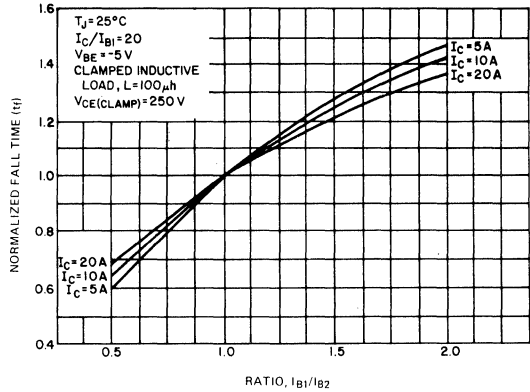


FIGURE 14. FALL TIME VARIATION WITH I_{B2}

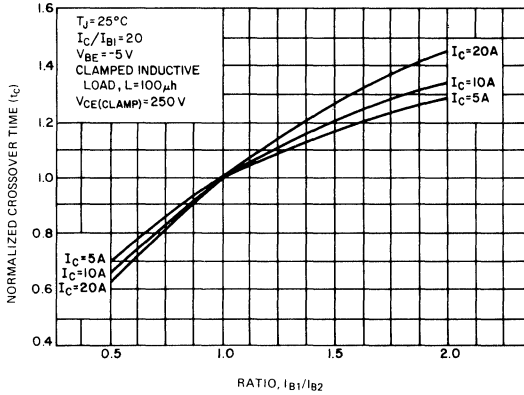


FIGURE 15. CROSS-OVER TIME VARIATION WITH I_{B2}

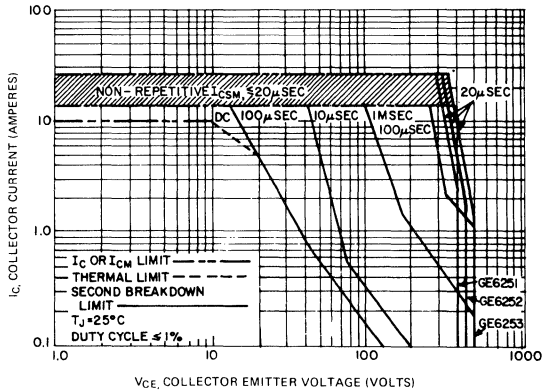


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

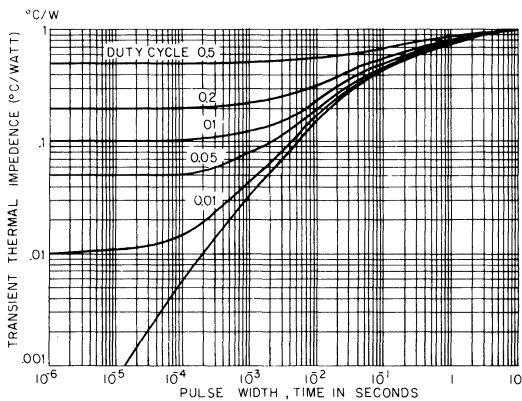


FIGURE 17. TRANSIENT THERMAL RESPONSE

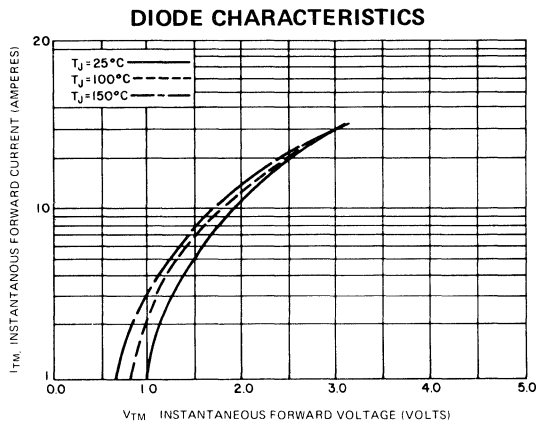


FIGURE 18 FORWARD CHARACTERISTICS

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

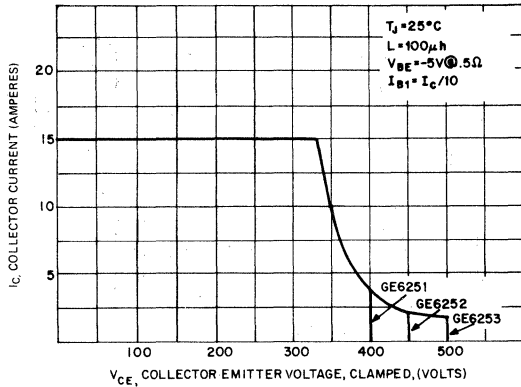


FIGURE 19. REVERSE BIAS SAFE OPERATING AREA

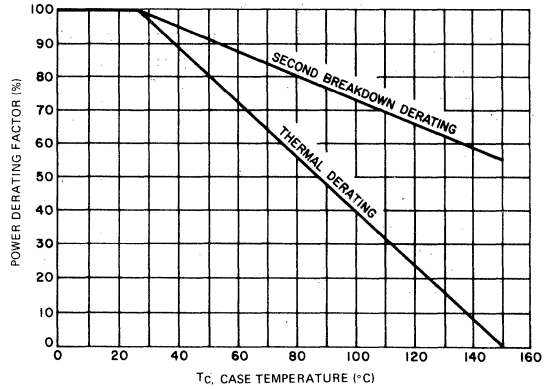


FIGURE 20. POWER DERATING

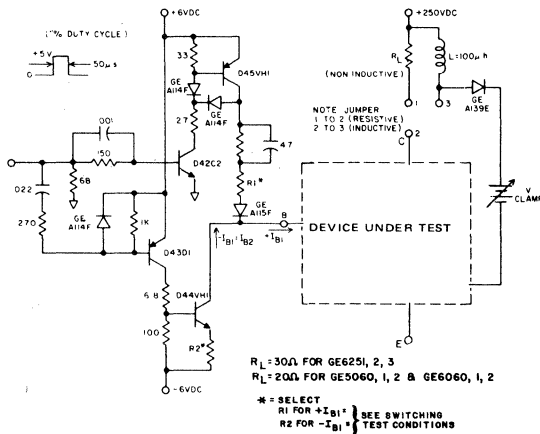
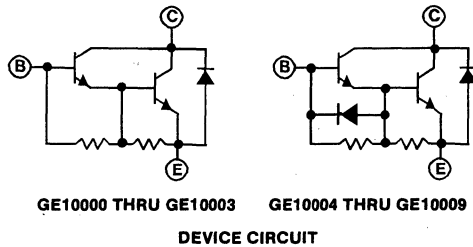
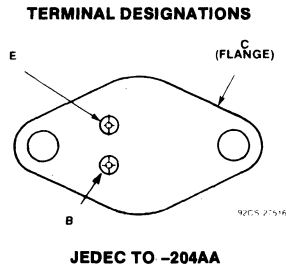


FIGURE 21. SWITCHING TIME TEST CIRCUIT

Silicon N-P-N Darlington Power Transistors

The GE10000 thru GE10009 series of silicon n-p-n power Darlington transistors are designed for power switching applications requiring high-voltage capability and fast switching speeds. They are ideally suited for off-line switching power supplies, ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA hermetic steel package.



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} , ($T_C = 100^\circ C$)	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

$P_D(T_C = 25^\circ C)$	175	175	150	150	175	175	150	150	175	175	Watts
$P_D(T_C = 100^\circ C)$	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.

GE1000-GE1009

DEVICE ELECTRICAL CHARACTERISTICS

(Test conditions on next page, $T_C = 25^\circ\text{C}$ except as noted)

STATIC		GE 10000	GE 10001	GE 10002	GE 10003	GE 10004	GE 10005	GE 10006	GE 10007	GE 10008	GE 10009	Units
(1) $V_{CE0(SUS)}$	Min.	350	400	350	400	350	400	350	400	450	500	Volts
(2) $V_{CEX(SUS)}$, ($T_C = 100^\circ\text{C}$)	Min.	400	450	400	450	400	450	400	450	450	500	Volts
(3) $V_{CEX(SUS)}$, ($T_C = 100^\circ\text{C}$)	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} , ($T_C = 150^\circ\text{C}$)	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} , ($T_C = 100^\circ\text{C}$)	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) $V_{CE(SAT)}$, ($T_C = 100^\circ\text{C}$)	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
$V_{BE(SAT)}$, ($T_C = 100^\circ\text{C}$)	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 ($V_{CB} = 10\text{V}$, $I_E = 0$, $f_{TEST} = 1\text{MHz}$)	Typ. Max.	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	pF pF
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SWITCHING

(1) Resistive	t_d	Typ.	.045	.045	.045	.045	.045	.045	.045	.04	.04	μs	
		Max.	.200	.200	.200	.200	.200	.200	.200	.25	.25	μs	
	t_r	Typ.	.23	.23	.14	.14	.22	.22	.11	.11	.18	.18	μs
Max.		.60	.60	.40	.40	.60	.60	.40	.40	1.0	1.0	μs	
	t_s	Typ.	1.7	1.7	1.5	1.5	1.2	1.2	1.3	1.3	1.2	1.2	μs
		Max.	3.5	3.5	3.0	3.0	1.5	1.5	1.5	1.5	2.0	2.0	μs
	t_f	Typ.	.85	.85	.40	.40	.25	.25	.15	.15	.20	.20	μs
		Max.	2.4	2.4	1.5	1.5	.50	.50	.50	.50	.60	.60	μs
(2) Inductive ($T_C = 100^\circ\text{C}$)	t_s	Typ.	4.4	4.4	4.2	4.2	2.9	2.9	3.2	3.2	3.0	3.0	μs
		Max.	6.5	6.5	6.0	6.0	4.0	4.0	4.0	4.0	4.0	4.0	μs
	t_f	Typ.	.54	.54	.39	.39	.19	.19	.18	.18	.20	.20	μs
Max.		1.5	1.5	1.5	1.5	1.0	1.0	1.0	1.0	1.0	1.0	μs	
	t_c	Typ.	1.7	1.7	1.0	1.0	.62	.62	.46	.46	.60	.60	μs
		Max.	3.0	3.0	2.5	2.5	1.5	1.5	1.5	1.5	1.5	1.5	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
		Max.	3.0	3.0	2.5	2.5	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

GE10000-GE10009

STATIC TEST CONDITIONS

(1) $V_{CEX(SUS)}$ a) $I_C = 250\text{mA}$, $I_B = 0$, $V_{CLAMP} = V_{CEO}$ Rated b) $I_C = 100\text{mA}$, $I_B = 0$, $V_{CLAMP} = V_{CEO}$ Rated	APPLIES TO GE10000 Thru GE10007 GE10008, 9
(2) $V_{CEX(SUS)}$ a) $I_C = 2\text{A}$, $V_{CLAMP} = V_{CEX}$ Rated b) $I_C = 1\text{A}$, $V_{CLAMP} = V_{CEX}$ Rated	APPLIES TO GE10000, 1, 4, 5, 8, 9 GE10002, 3, 6, 7
(3) $V_{CEX(SUS)}$ a) $I_C = 10\text{A}$, $V_{CLAMP} = V_{CEX}$ Rated b) $I_C = 5\text{A}$, $V_{CLAMP} = V_{CEX}$ Rated	APPLIES TO GE10000, 1, 4, 5, 8, 9 GE10002, 3, 6, 7
(4) I_{CEV} $V_{CEV} =$ Rated Valve, $V_{BE} = 1.5\text{V}$	APPLIES TO All
(5) I_{CER} $V_{CE} =$ Rated Valve, $R_{BE} = 50\Omega$	APPLIES TO All
(6) I_{EBO} $V_{EB} = 8\text{V}$, $I_C = 0$ $V_{EB} = 2\text{V}$, $I_C = 0$	APPLIES TO GE10000, 1, 2, 3 GE10004, 5, 6, 7, 8, 9
(7) $I_{S/b}$ SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE	
(8) h_{FE} (a) $I_C = 5\text{A}$, $V_{CE} = 5\text{V}$ (b) $I_C = 2.5\text{A}$, $V_{CE} = 5\text{V}$	APPLIES TO GE10000, 1, 4, 5, 8, 9 GE10002, 3, 6, 7
(9) h_{FE} $I_C = 10\text{A}$, $V_{CE} = 5\text{V}$ $I_C = 5\text{A}$, $V_{CE} = 5\text{V}$	APPLIES TO GE10000, 4, 5, 8, 9 GE10002, 3, 6, 7
(10) $V_{CE(SAT)}$ a) $I_C = 10\text{A}$, $I_B = .4\text{A}$ b) $I_C = 5\text{A}$, $I_B = .25\text{A}$ c) $I_C = 5\text{A}$, $I_B = .5\text{A}$	APPLIES TO GE10000, 1, 4, 5 GE10002, 3, 6, 7 GE10008, 9
(11) $V_{CE(SAT)}$ a) $I_C = 20\text{A}$, $I_B = 1\text{A}$ b) $I_C = 10\text{A}$, $I_B = 1\text{A}$ c) $I_C = 20\text{A}$, $I_B = 2\text{A}$	APPLIES TO GE10000, 1, 4, 5 GE10002, 3, 6, 7 GE10008, 9
(12) $V_{CE(SAT)}$ SAME AS (10) BUT $T_C = 100^\circ\text{C}$	
(13) $V_{BE(SAT)}$ a) $I_C = 10\text{A}$, $I_B = .4\text{A}$ b) $I_C = 5\text{A}$, $I_B = .25\text{A}$ c) $I_C = 10\text{A}$, $I_B = .5\text{A}$	APPLIES TO GE10000, 1, 4, 5 GE10002, 3, 6, 7 GE10008, 9
(14) DIODE V_F a) $I_F = 10\text{A}$ b) $I_F = 5\text{A}$	APPLIES TO GE10000, 4, 5, 8, 9 GE10002, 3, 6, 7

SWITCHING TEST CONDITIONS

(1) RESISTIVE $V_{CC} = 250\text{V}$, $t_p = 50\mu\text{s}$, Duty $\leq 2\%$ a) $I_C = 10\text{A}$, $I_{B1} = .4\text{A}$, $I_{B2} = 1.6\text{A}$ b) $I_C = 5\text{A}$, $I_{B1} = .25\text{A}$, $I_{B2} = 1\text{A}$ c) $I_C = 10\text{A}$, $I_{B1} = .5\text{A}$, $I_{B2} = 2\text{A}$	APPLIES TO GE10000, 1, 4, 5 GE10002, 3, 6, 7 GE10008, 9
(2) INDUCTIVE $V_{CLAMP} = 250\text{V}$, $L = 100\mu\text{H}$, $T_C = 100^\circ\text{C}$ a) $I_C = 10\text{A}$, $I_{B1} = .4\text{A}$, $I_{B2} = 1.6\text{A}$ b) $I_C = 5\text{A}$, $I_B = .25\text{A}$, $I_{B2} = 1\text{A}$ c) $I_C = 10\text{A}$, $I_B = .5\text{A}$, $I_{B2} = 2\text{A}$	APPLIES TO GE10000, 1, 4, 5 GE10002, 3, 6, 7 GE10008, 9
(3) INDUCTIVE Same as (2), but $T_C = 25^\circ\text{C}$	

Note: See FIGURE 24 for Switching Time Test Circuit.

GE10000-GE10009

TYPICAL CHARACTERISTICS

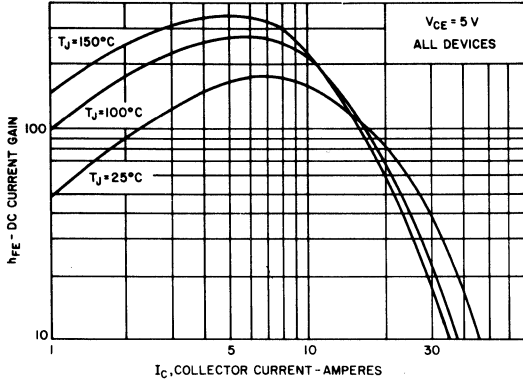


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 5V$)

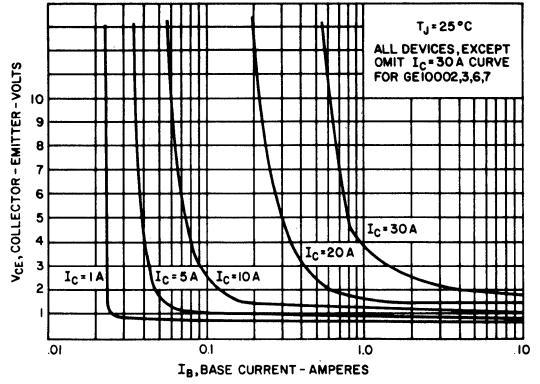


FIGURE 2. COLLECTOR SATURATION REGION

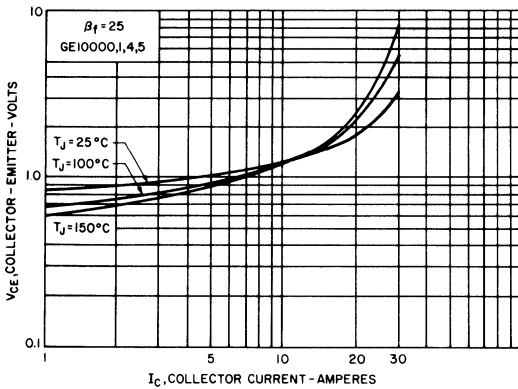


FIGURE 3. $V_{CE} (SAT)$ VS I_C

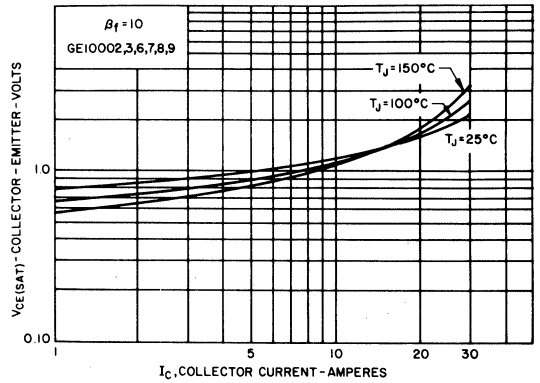


FIGURE 4. I_C COLLECTOR CURRENT (AMPERES)

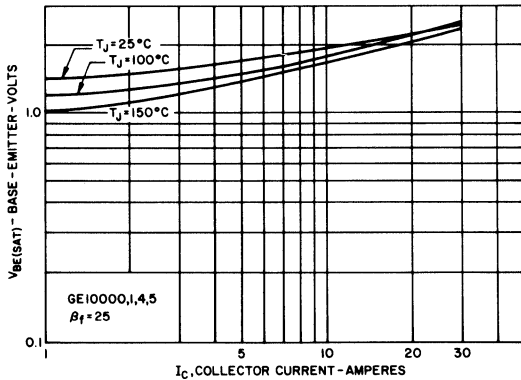


FIGURE 5. $V_{BE} (SAT)$ VS I_C

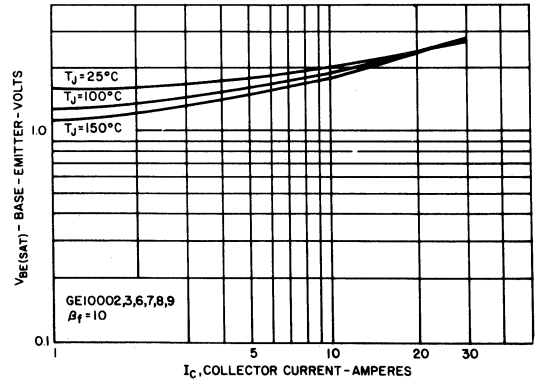


FIGURE 6. $V_{BE} (SAT)$ VS I_C

GE10000-GE10009

TYPICAL CHARACTERISTICS

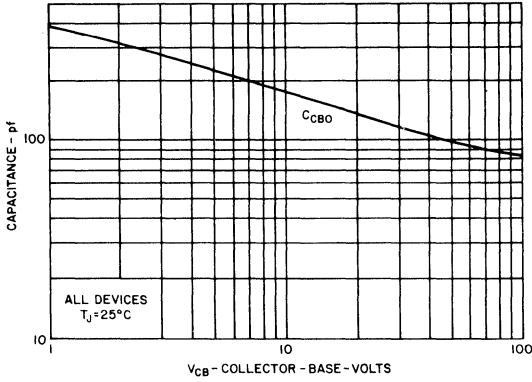


FIGURE 7. CAPACITANCE (C_{CBO})

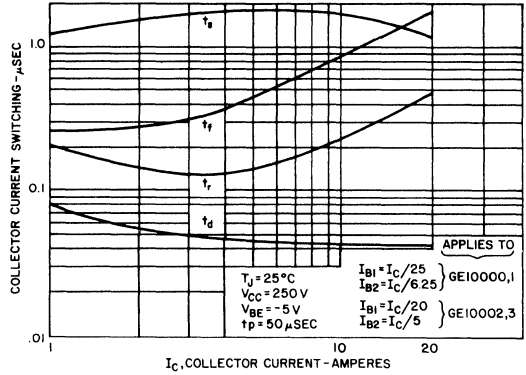


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

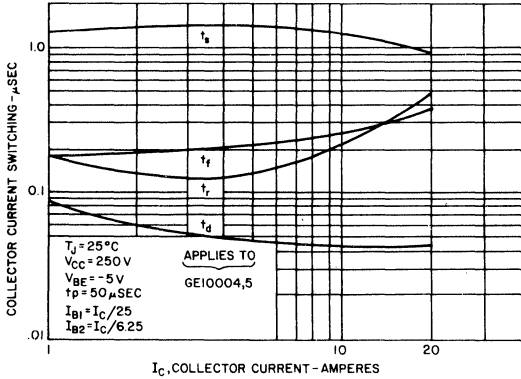


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

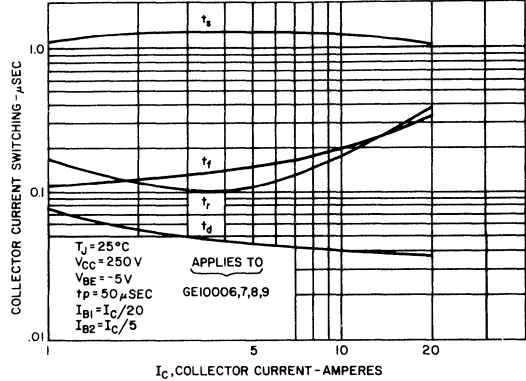


FIGURE 10. RESISTIVE SWITCHING PERFORMANCE

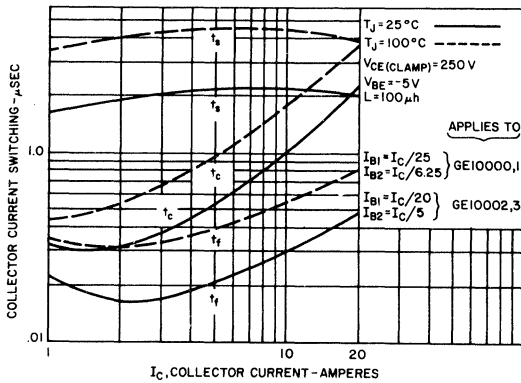


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

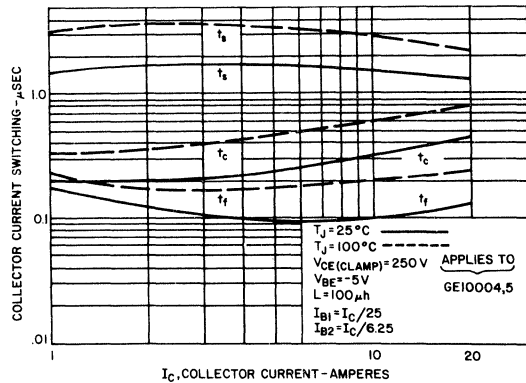


FIGURE 12. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

GE10000-GE10009

TYPICAL CHARACTERISTICS

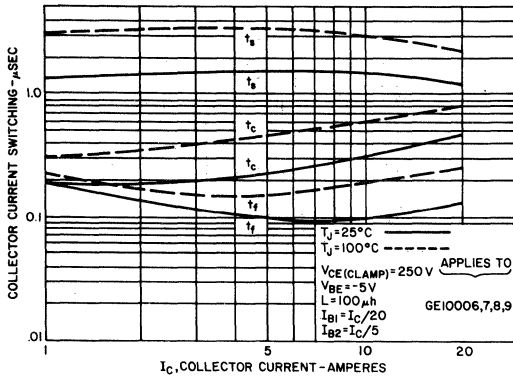


FIGURE 13. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

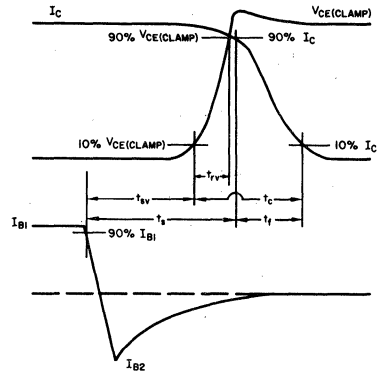


FIGURE 14. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

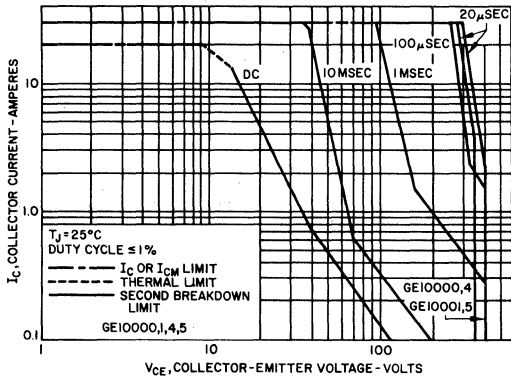


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

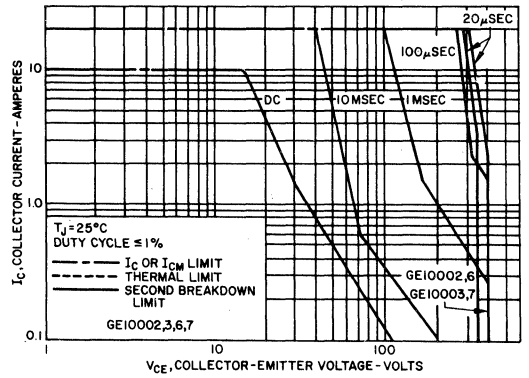


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

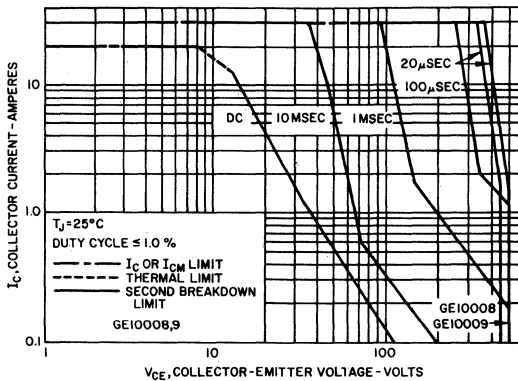


FIGURE 17. FORWARD BIAS SAFE OPERATING AREA

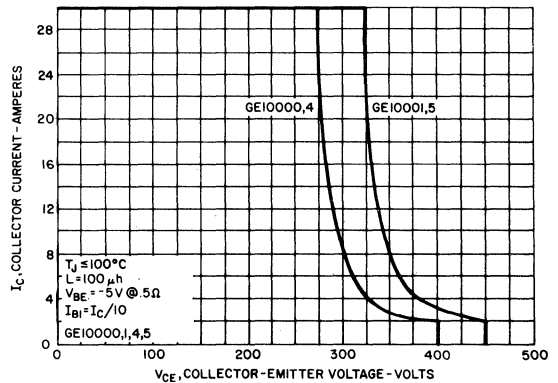


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

GE1000-GE1009

TYPICAL CHARACTERISTICS

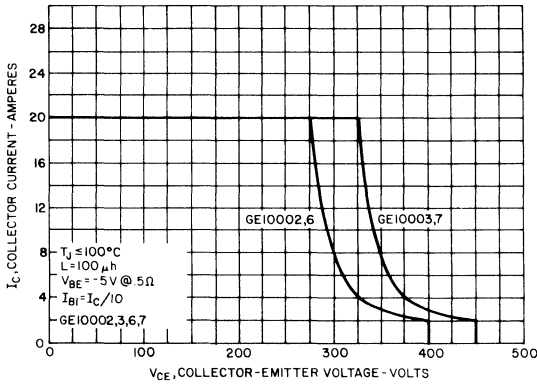


FIGURE 19. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

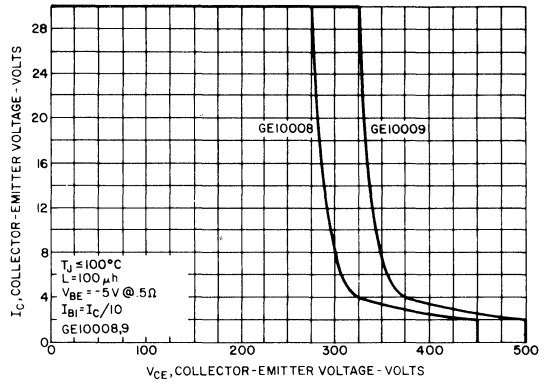


FIGURE 20. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

2

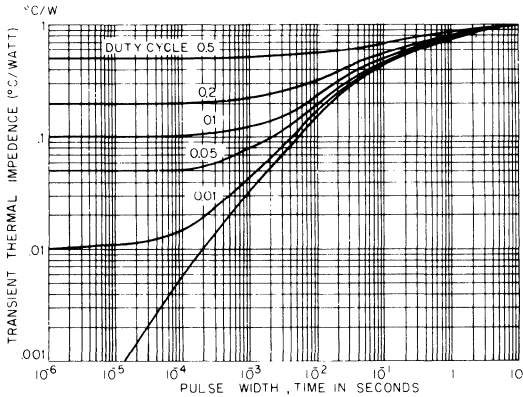


FIGURE 21. TRANSIENT THERMAL RESPONSE

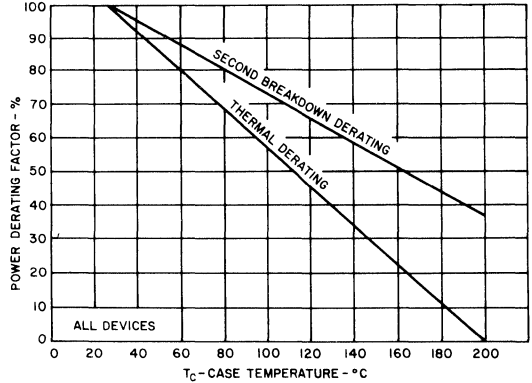


FIGURE 22. POWER DERATING

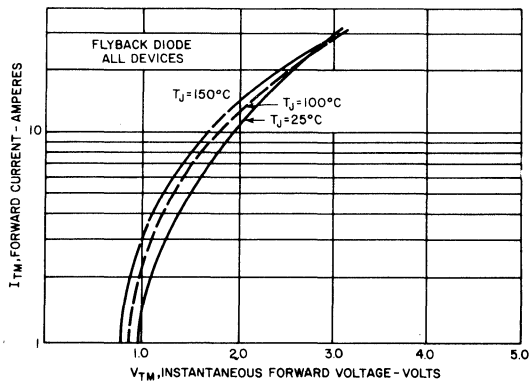


FIGURE 23. FORWARD CHARACTERISTICS

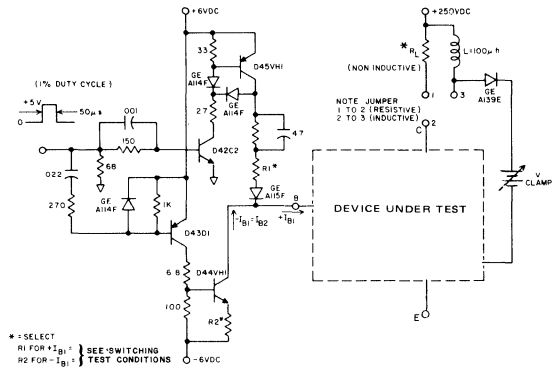


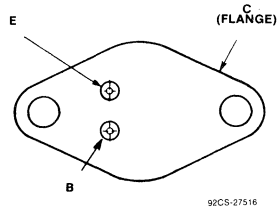
FIGURE 24. SWITCHING TIME TEST CIRCUIT

Silicon N-P-N Darlington Power Transistors

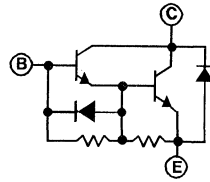
The GE10015, GE10016 and GE10020 thru GE10023 series of silicon n-p-n power Darlington transistors are designed for use in power switching applications requiring high-voltage capability and fast switching speeds. They are ideally suited for off-line switching power supplies, ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

TERMINAL DESIGNATIONS



JEDEC TO-204AE



DEVICE CIRCUIT

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	$P_D(T_C = 25^\circ C)$	250	250	250	250	250	250	Watts
Power Dissipation	$P_D(T_C = 100^\circ C)$	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.

GE10015,16,20,21,22,23

DEVICE ELECTRICAL CHARACTERISTICS

(Test conditions on next page, $T_C = 25^\circ\text{C}$ except as noted)

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} $I_{CEV} (T_C = 150^\circ\text{C})$	Max.	.25	.25	.25	.25	.25	.25	mA
		5.00	5.00	5.00	5.00	5.00	5.00	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.	25	25	75	75	50	50	
	Max.	—	—	1000	1000	600	600	
(6) h_{FE}	Min.	10	10	—	—	—	—	
	Max.	—	—	—	—	—	—	
(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) $V_{BE(SAT)}$, ($T_C = 100^\circ\text{C}$)	Max.	—	—	3.5	3.5	2.5	2.5	Volts
(12) DIODE V_F	Typ.	1.9	1.9	2.1	2.1	1.9	1.9	Volts
	Max.	5.0	5.0	5.0	5.0	5.0	5.0	Volts

DYNAMIC

OUTPUT CAPACITANCE ($V_{CB} = 10\text{V}$, $I_E = 0$, $f_{TEST} = 1\text{MHz}$)		Typ.	580	580	580	580	580	580	pF
	Max.		750	750	750	750	750	750	pF

SWITCHING

(1) Resistive	t_d	Typ.	.09	.09	.095	.095	.09	.09	μs
		Max.	.30	.30	.20	.20	.25	.25	μs
	t_r	Typ.	.20	.20	.32	.32	.20	.20	μs
		Max.	1.00	1.00	1.00	1.00	1.00	1.00	μs
	t_s	Typ.	1.45	1.45	1.50	1.50	1.45	1.45	μs
		Max.	2.5	2.5	3.5	3.5	2.5	2.5	μs
	t_f	Typ.	.25	.25	.30	.30	.25	.25	μs
		Max.	1.0	1.0	.50	.50	.90	.90	μs
(2) Inductive ($T_C = 100^\circ\text{C}$)	t_s	Typ.	2.8	2.8	2.7	2.7	2.8	2.8	μs
		Max.	—	—	4.5	4.5	5.0	5.0	μs
	t_f	Typ.	.21	.21	.30	.30	.21	.21	μs
		Max.	—	—	1.0	1.0	1.0	1.0	μs
	t_c	Typ.	.68	.68	.85	.85	.68	.68	μs
		Max.	—	—	2.0	2.0	2.0	2.0	μs
(3) Inductive ($T_C = 25^\circ\text{C}$)	t_s	Typ.	1.6	1.6	1.8	1.8	1.6	1.6	μs
		Max.	3.0	3.0	—	—	—	—	μs
	t_f	Typ.	.10	.10	.12	.12	.10	.10	μs
		Max.	.50	.50	—	—	—	—	μs
	t_c	Typ.	.30	.30	.40	.40	.30	.30	μs
		Max.	1.0	1.0	—	—	—	—	μs

GE10015,16,20,21,22,23

TEST CONDITIONS

STATIC

(1) $V_{CEO(SUS)}$ $I_C = 100mA$, $V_{CLAMP} = V_{CEO \text{ Rated}}$	APPLIES TO All
(2) I_{CEV} $V_{CEV} = \text{Rated Valve}$, $V_{BE} = -1.5V$	APPLIES TO All
(3) I_{EBO} $I_{EB} = 2.0 \text{ Volts}$	APPLIES TO All
(4) $I_{s/b}$ SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE	
(5) h_{FE} (a) $I_C = 10A$, $V_{CE} = 5V$ (b) $I_C = 15A$, $V_{CE} = 5V$ (c) $I_C = 20A$, $V_{CE} = 5V$	APPLIES TO GE10022, 23 GE10020, 21 GE10015, 16
(6) h_{FE} $I_C = 40A$, $V_{CE} = 5V$	APPLIES TO GE10015, 16
(7) $V_{CE(SAT)}$ a) $I_C = 20A$, $I_B = 1A$ b) $I_C = 30A$, $I_B = 1.2A$	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(8) $V_{CE(SAT)}$ (a) $I_C = 40A$, $V_{CE} = 5V$ (b) $I_C = 50A$, $V_{CE} = 10V$ (c) $I_C = 60A$, $V_{CE} = 5V$	APPLIES TO GE10022, 23 GE10015, 16 GE10020, 21
(9) $V_{CE(SAT)}$ (a) $I_C = 20A$, $I_B = 1A$ (b) $I_C = 30A$, $I_B = 1.2A$	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(10) $V_{BE(SAT)}$ (a) $I_C = 20A$, $I_B = 1A$ (b) $I_C = 30A$, $I_B = 1.2A$	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(11) $V_{BE(SAT)}$ SAME AS (10) BUT $T_C = 100^\circ C$	
(12) DIODE V_F a) $I_F = 20A$ b) $I_F = 30A$	APPLIES TO GE10015, 16, 22, 23 GE10020, 21

SWITCHING

(1) RESISTIVE $t_p = 50\mu s$, Duty Cycle $\leq 2\%$ a) $V_{CC} = 250V$, $I_C = 20A$, $I_{B1} = 1A$, $I_{B2} = 4A$ b) $V_{CC} = 175V$, $I_C = 30A$, $I_{B1} = 1A$, $I_{B2} = 4A$	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(2) INDUCTIVE $L = 100\mu h$, $I_{B1} = 1A$, $I_{B2} = 4A$, $T_C = 100^\circ C$ a) $I_C = 20A$, $V_{CLAMP} = 250V$ b) $I_C = 30A$, $V_{CLAMP} = 175V$	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(3) INDUCTIVE SAME AS (2), BUT $T_C = 25^\circ C$	

NOTE: See FIGURE 22 for Switching Time
Test Circuit.

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

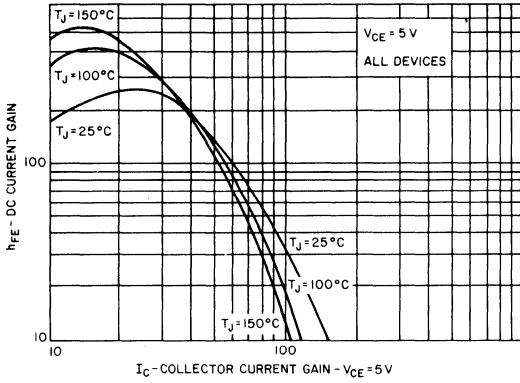


FIGURE 1. DC CURRENT GAIN ($V_{CE} = 5V$)

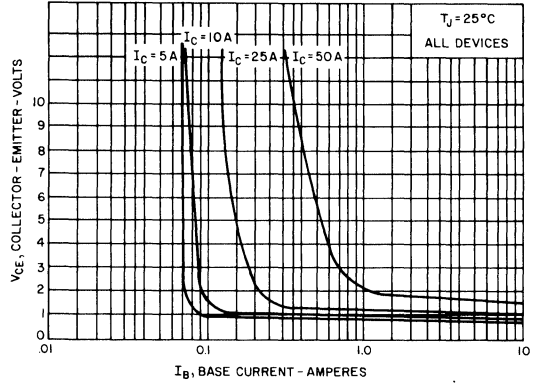


FIGURE 2. COLLECTOR SATURATION REGION

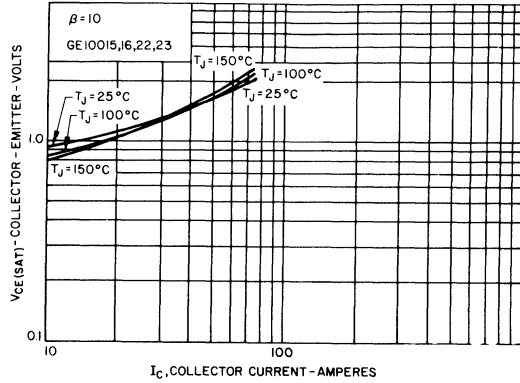


FIGURE 3. $V_{CE(SAT)}$ VS I_C

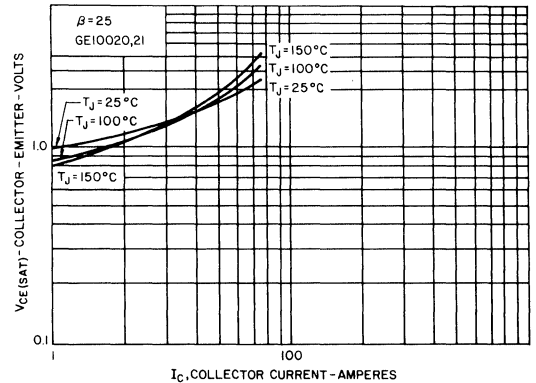


FIGURE 4. $V_{CE(SAT)}$ VS I_C

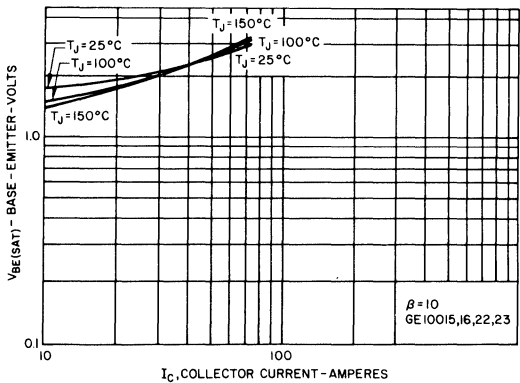


FIGURE 5. $V_{BE(SAT)}$ VS I_C

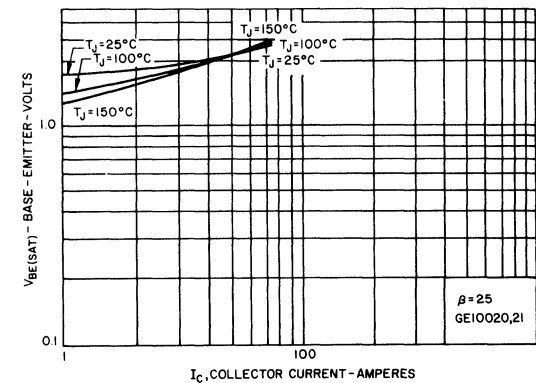


FIGURE 6. $V_{BE(SAT)}$ VS I_C

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

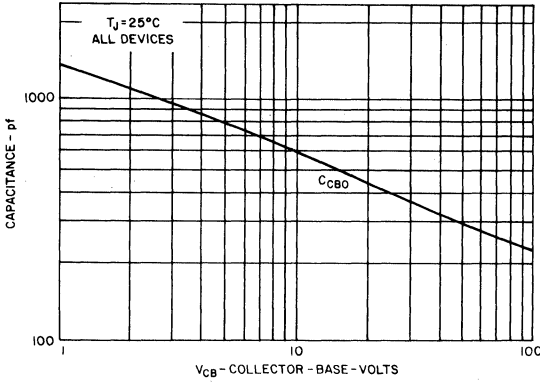


FIGURE 7. CAPACITANCE (C_{CBO})

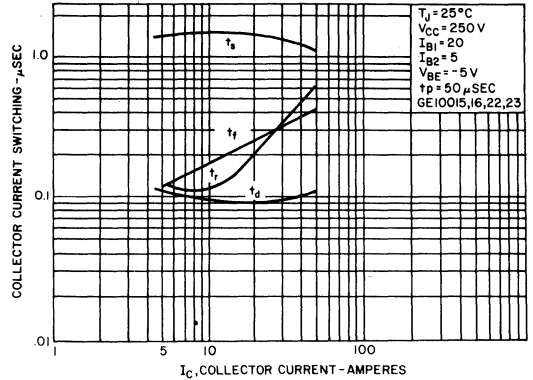


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

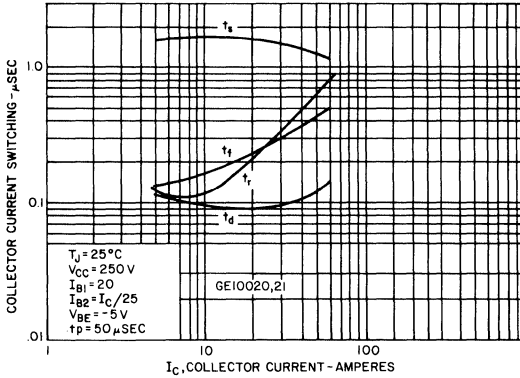


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

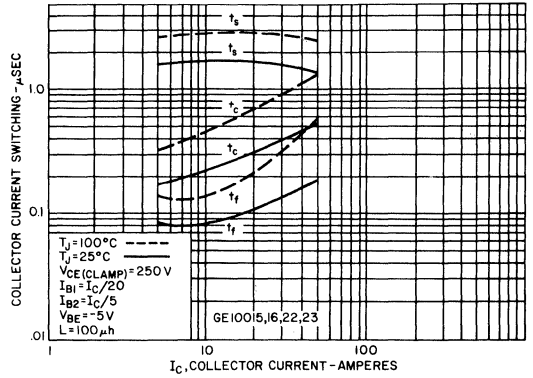


FIGURE 10. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

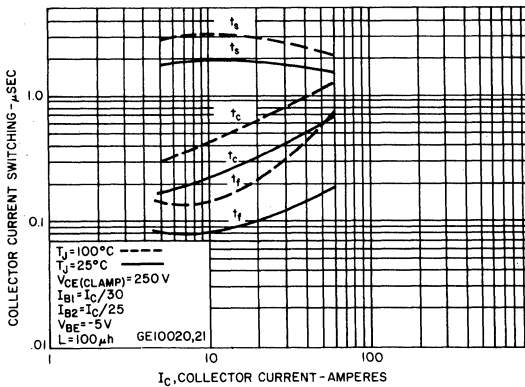


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

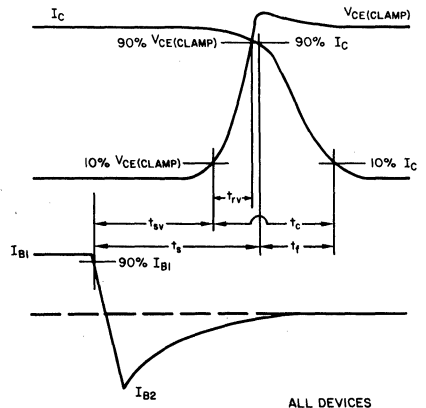


FIGURE 12. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

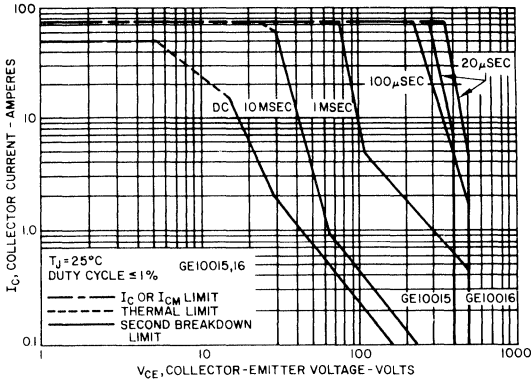


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

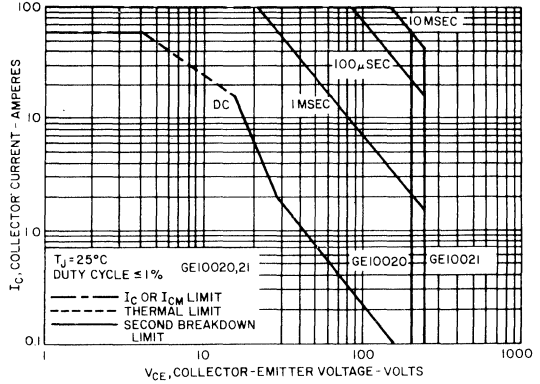


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

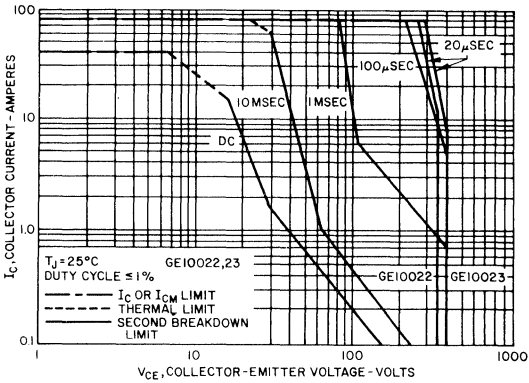


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

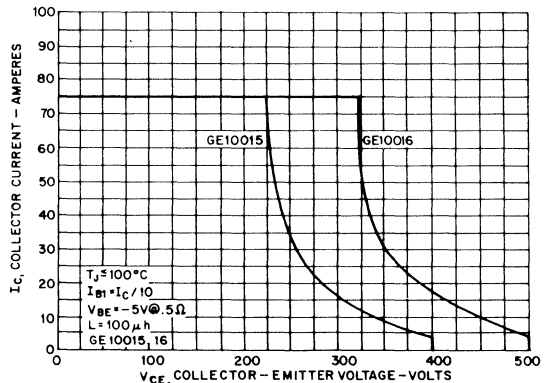


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA (CLAMPED)

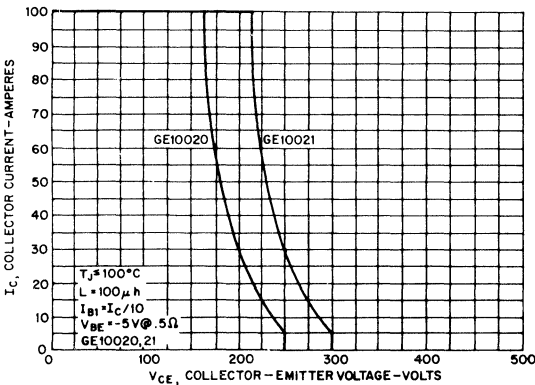


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

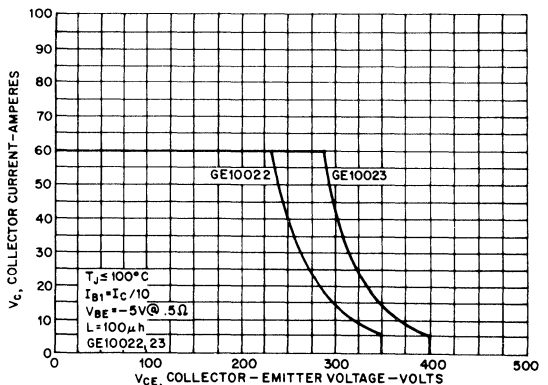


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA

GE10015, 16, 20, 21, 22, 23

TYPICAL CHARACTERISTICS

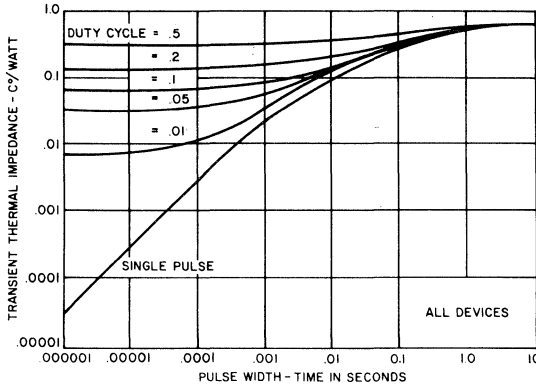


FIGURE 19. TRANSIENT THERMAL RESPONSE

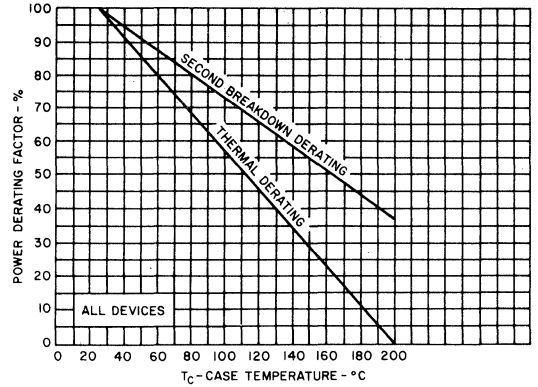


FIGURE 20. POWER DERATING

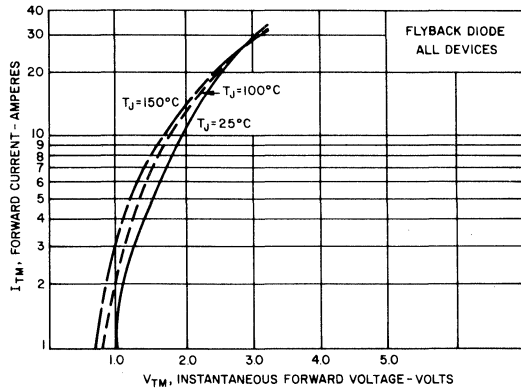


FIGURE 21. FORWARD CHARACTERISTICS

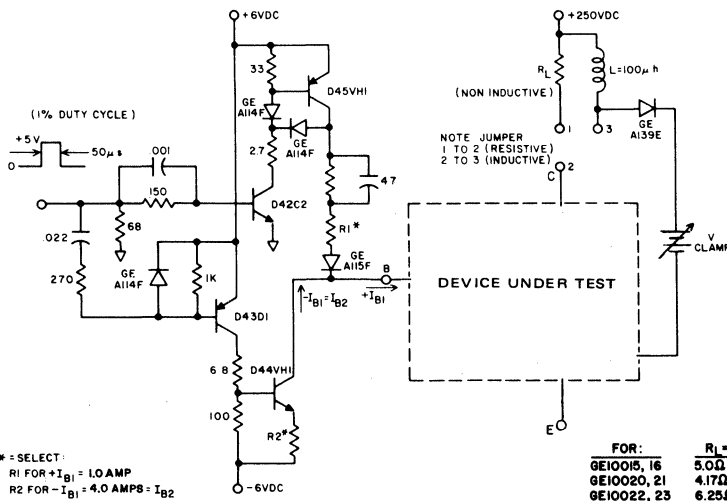


FIGURE 22. SWITCHING TIME TEST CIRCUIT

High-Speed Silicon N-P-N Power Transistors

Devices for Switching Applications

2

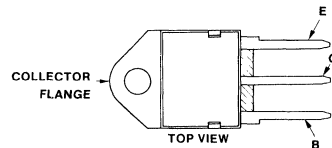
Features:

- **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

The GE13070P and GE13071P silicon n-p-n transistors are designed for high-voltage, high-speed switching applications in inductive circuits where fall time is critical. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage currents, and saturation voltages are specified at 25° C and 100° C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-218AC plastic package.

TERMINAL DESIGNATION



92CS-40257

JEDEC TO-218AC

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	I _C	5	5	A
Peak (Repetitive) ⁽¹⁾	I _{CM}	8	8	
Base Current — Continuous	I _B	2	2	A
Peak (Non-Repetitive) ⁽¹⁾	I _{BM}	4	4	
Total Power Dissipation @ T _c = 25° C	P _D	100	100	Watts
@ T _c = 100° C		40	40	
Derate above 25° C		0.8	0.8	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 _{θJC}	1.25	1.25	°C/W
Maximum Lead Temperature for Soldering Purpose: 1/8" from Case for 5 Seconds	T _L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

GE13070P, GE13071P**ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 100\text{mA}$, $I_B = 0$)	GE13070P GE13071P	$V_{CE(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = -1.5\text{V}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = -1.5\text{V}$, $T_C = 100^\circ\text{C}$)		I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEV}$, $R_{BE} = 50\Omega$, $T_C = 100^\circ\text{C}$)		I_{CER}	—	—	3	mA
Emitter Cutoff Current ($V_{EB} = 6\text{V}$, $I_C = 0$)		I_{EBO}	—	—	1	mA

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 3\text{A}$, $V_{CE} = 5\text{V}$)		h_{FE}	8	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 3\text{A}$, $I_B = 0.6\text{A}$) ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 3\text{A}$, $I_B = 0.6\text{A}$, $T_C = 100^\circ\text{C}$)		$V_{CE(sat)}$	— — —	— — —	1 3 2	V
Base-Emitter Saturation Voltage ($I_C = 3\text{A}$, $I_B = 0.6\text{A}$) ($I_C = 3\text{A}$, $I_B = 0.6\text{A}$, $T_C = 100^\circ\text{C}$)		$V_{BE(sat)}$	— —	— —	1.5 1.5	V

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	$(V_{CC} = 250\text{V}$, $I_C = 3\text{A}$ $I_{B1} = 0.4\text{A}$, $t_p = 30\ \mu\text{s}$ Duty Cycle $< 2\%$, $V_{BE(OFF)} = -5\text{V}$)	t_d	—	0.03	0.05	μs
Rise Time		t_r	—	0.1	0.4	
Storage Time		t_s	—	0.4	1.5	
Fall Time		t_f	—	0.175	0.5	
Inductive Load, Clamped						
Storage Time	$I_C(pk) = 3\text{A}$ $I_{B1} = 0.4\text{A}$	$(T_J = 100^\circ\text{C})$	t_{sv}	—	0.7	μs
Crossover Time			t_c	—	0.28		0.5
Fall Time	$V_{BE(off)} = -5\text{V}$ $V_{CE(pk)} = 250\text{V}$	$(T_J = 25^\circ\text{C})$	t_{fi}	—	0.15	0.3
Storage Time			t_{sv}	—	0.4	—
Crossover Time			t_c	—	0.15	—
Fall Time			t_{fi}	—	0.1	—

(1) Pulse Test: Pulse Width - $300\ \mu\text{s}$ Duty Cycle $\leq 2\%$.

15-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

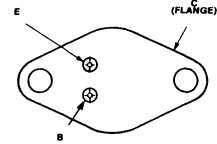
Features:

- Fast switching speed
- High-voltage ratings:
V_{CEV} = 650 V to 750 V
- Low V_{CE(sat)} at I_C = 15 A

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA MJ13090 and MJ13091 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for para-

meters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are specified at 100° C to provide information necessary for worst-case design.

The MJ13090 and MJ13091 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MJ13090	MJ13091	
V _{CEV}			
V _{BE} = -1.5 V	650	750	V
V _{CEO}	400	450	V
V _{EB0}	6		V
I _C	15		A
I _{CM}	20		A
I _B	5		A
I _{BM}	10		A
P _T			
@ T _C = 25° C	175		W
@ T _C = 100° C	100		W
T _C above 25° C, derate linearly	1		W/° C
T _{stg} , T _J	-65 to +200		° C
T _L			
At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.	275		° C
R _{θJC}	1		° C/W

MJ13090, MJ13091

ELECTRICAL CHARACTERISTICS at $T_C = 25^\circ\text{C}$ unless otherwise noted

CHARACTERISTIC			LIMITS			UNITS	
			Min.	Typ.	Max.		
OFF CHARACTERISTICS¹							
Collector-Emitter Sustaining Voltage	MJ13090	$V_{CE0(SUS)}$	400	—	—	V dc	
$I_C = 100\text{ mA}, I_B = 0$	MJ13091		450	—	—		
Collector Cutoff Current		I_{CEV}	—	—	0.5	mA dc	
$V_{CEV} = \text{Rated Value}, V_{BE(off)} = 1.5\text{ V dc}$ $V_{CEV} = \text{Rated Value}, V_{BE(off)} = 1.5\text{ V dc}, T_C = 100^\circ\text{C}$			—	—	2.5		
Collector Cutoff Current		I_{CER}	—	—	3	mA dc	
$V_{CE} = \text{Rated } V_{CEV}, R_{BE} = 50\ \Omega, T_C = 100^\circ\text{C}$							
Emitter Cutoff Current		I_{EBO}	—	—	1	mA dc	
$V_{EB} = 6\text{ V dc}, I_C = 0$							
SECOND BREAKDOWN							
Second Breakdown Collector Current with Base Forward Biased		$I_{S/B}$	See Fig. 1				
Clamped Inductive SOA with Base Reverse Biased		RBSOA	See Fig. 2				
ON CHARACTERISTICS¹							
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	—	—	1	V dc	
$I_C = 10\text{ A dc}, I_B = 2\text{ A dc}$			—	—	3		
$I_C = 15\text{ A dc}, I_B = 3\text{ A dc}$			—	—	2		
$I_C = 10\text{ A dc}, I_B = 2\text{ A dc}, T_C = 100^\circ\text{C}$			—	—			
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	—	—	1.5	V dc	
$I_C = 10\text{ A dc}, I_B = 2\text{ A dc}$			—	—	1.5		
$I_C = 10\text{ A dc}, I_B = 2\text{ A dc}, T_C = 100^\circ\text{C}$							
DC Current Gain		h_{FE}	8	—	—		
$I_C = 10\text{ A dc}, V_{CE} = 3\text{ V dc}$							
DYNAMIC CHARACTERISTICS							
Output Capacitance		C_{ob}	—	—	350	pF	
$V_{CB} = 10\text{ V dc}, I_E = 0, f_{test} = 1\text{ kHz}$							
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	$V_{CC} = 250\text{ V dc}, I_C = 10\text{ A dc},$ $I_{B1} = 1.25\text{ A dc}, t_p = 30\ \mu\text{s},$ Duty Cycle $\leq 2\%, V_{BE(off)} = 5\text{ V dc}$	t_d	—	0.03	0.05	μs	
Rise Time		t_r	—	0.13	0.5		
Storage Time		t_s	—	0.55	2.5		
Fall Time		t_f	—	0.1	0.5		
Inductive Load, Clamped							
Storage Time	$I_{C(pk)} = 10\text{ A},$ $I_{B1} = 1.25\text{ A dc},$ $V_{BE(off)} = 5\text{ V dc},$ $V_{CE(pk)} = 250\text{ V}$	$T_J = 100^\circ\text{C}$	t_{sv}	—	0.8	3	μs
Fall Time			t_{fl}	—	0.15	0.3	
Crossover Time			t_c	—	0.175	0.4	
Storage Time		$T_J = 25^\circ\text{C}$	t_{sv}	—	0.5	—	
Fall Time			t_{fl}	—	0.1	—	
Crossover Time			t_c	—	0.15	—	

¹Pulse Test: Pulse Width = 300 μs , Duty Cycle $\leq 2\%$.

MJ13090, MJ13091

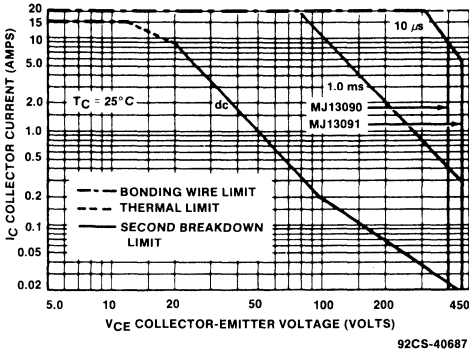


Fig. 1 - Maximum forward-bias safe-operating-areas for both types.

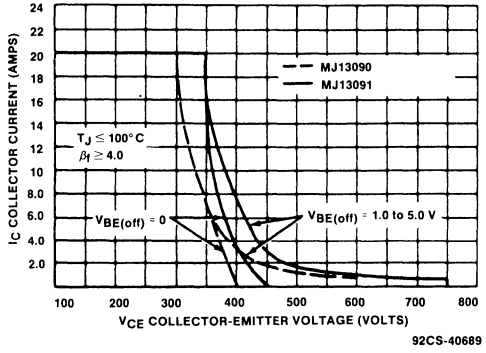


Fig. 2 - Maximum reverse-bias safe-operating-areas for both types.

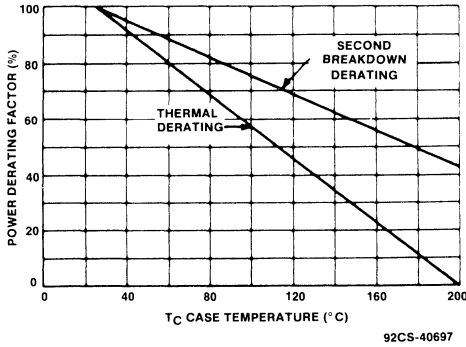


Fig. 3 - Dissipation and $I_{s,b}$ derating curves for both types.

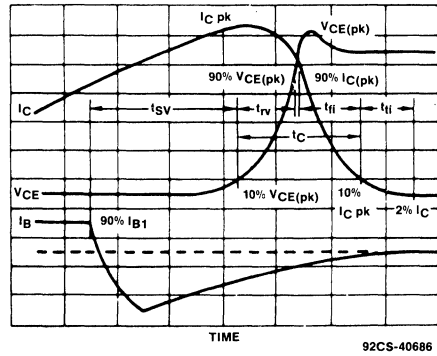


Fig. 4 - Inductive switching measurements display.

Complementary N-P-N/P-N-P Silicon Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

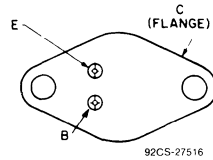
Features:

- High-dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- $f_T = 2$ MHz
- High gain at high current

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-MJ15001 and MJ15002 are ballasted epitaxial-base silicon transistors featuring high gain at high current.

The MJ15001 n-p-n transistor complements the MJ15002 p-n-p transistor. These types are supplied in the JEDEC TO-204AA packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MJ15001	MJ15002	
V_{CBO}	140	-140	V
V_{CEO}	140	-140	V
V_{EBO}	5	-5	V
I_C	15	-15	A
I_B	5	-5	A
I_E	20	-20	A
P_T			
At $T_C \leq 25^\circ C$	200	200	W
At $T_C > 25^\circ C$	1.14		W/ $^\circ C$
T_{stg}, T_J	-65 to +200		$^\circ C$
T_L			
At distance $\leq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	230		$^\circ C$

MJ15001, MJ15002

ELECTRICAL CHARACTERISTICS, at Case Temperature
(T_C) = 25°C Unless Otherwise Specified

CHARACTERISTICS	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		MJ15001		MJ15002		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEX}	140	1.5			-	1	-	-1	mA
$T_C = 150^\circ\text{C}$	140	1.5			-	2	-	-2	
I_{CEO}	140			0	-	2.5	-	-2.5	mA
I_{EBO}		5	0		-	1	-	-1	mA
$V_{CEO(sus)}^a$			2	0	140	-	-140	-	V
h_{FE}^a	2		4		25	150	25	150	
V_{BE}	2		4		-	2	-	-2	V
$V_{CE(sat)}$			4	0.4	-	1	-	-1	V
f_T $f = 0.5$ MHz	10		0.5		2	-	2	-	MHz
$I_{S/b}$ $tp \cdot 1s$	40				5	-	-5	-	A
	100				0.5	-	-0.5	-	
C_{ob} $V_{CB} = 10$ V $f = 1$ MHz					-	1000	-	1000	pF
$R_{\theta JC}$					-	0.875	-	0.875	°C/W

^a CAUTION: Sustaining voltage, $V_{CEO(sus)}$, *MUST NOT* be measured on a curve tracer. See Figs. 11 & 12.

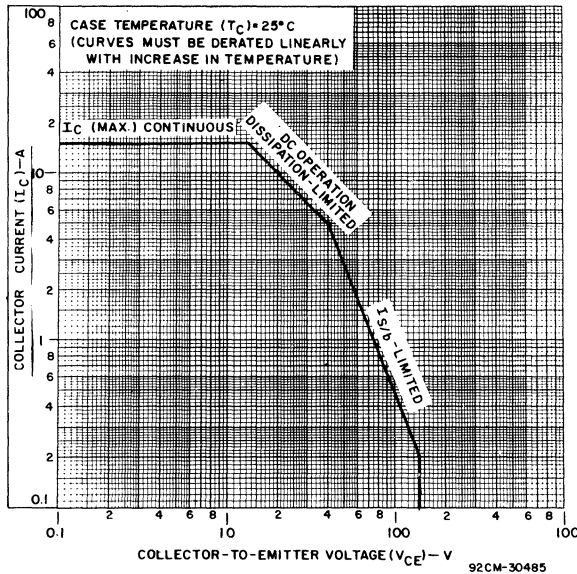


Fig. 1 - Maximum operating area for both types.

2

MJ15001, MJ15002

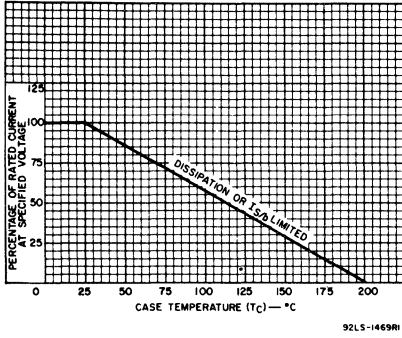


Fig. 2 - Current derating curve for both types.

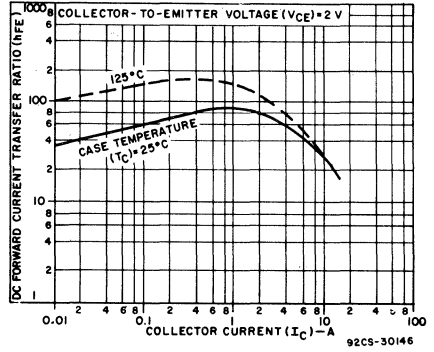


Fig. 3 - Typical dc beta characteristics as a function of collector current for MJ15001.

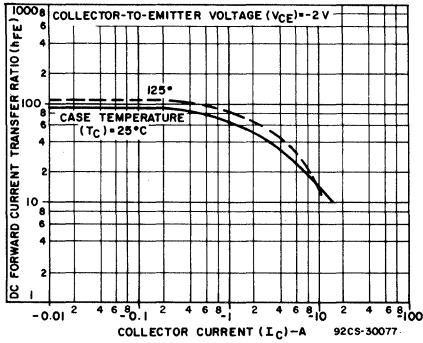


Fig. 4 - Typical dc beta characteristics as a function of collector current for MJ15002.

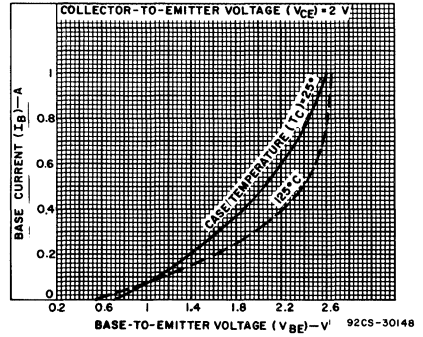


Fig. 5 - Typical input characteristics for MJ15001.

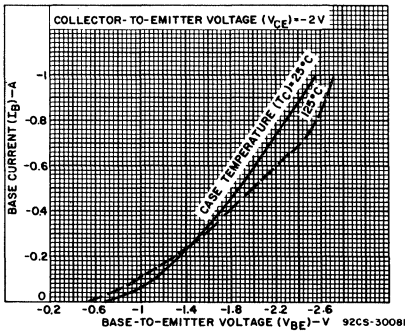


Fig. 6 - Typical input characteristics for MJ15002.

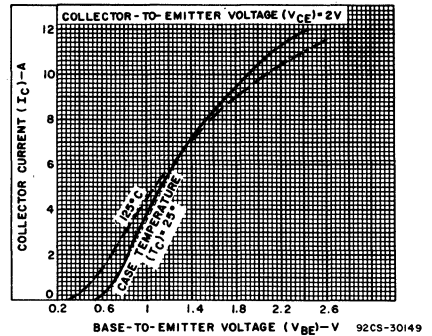


Fig. 7 - Typical transfer characteristics for MJ15001.

MJ15001, MJ15002

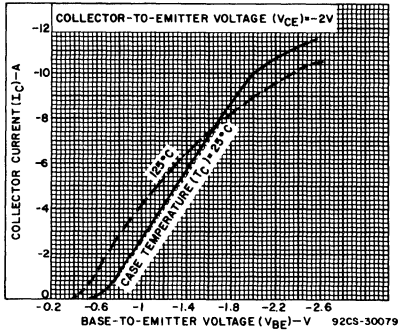


Fig. 8 - Typical transfer characteristics for MJ15002.

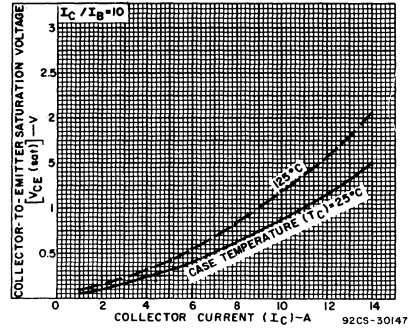


Fig. 9 - Typical saturation voltage characteristics for MJ15001.

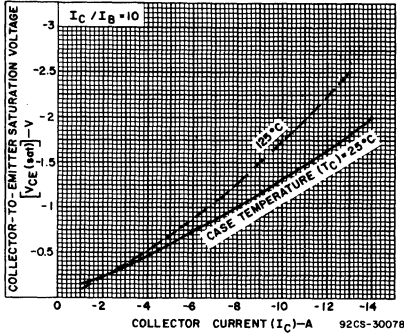


Fig. 10 - Typical saturation voltage characteristics for MJ15002.

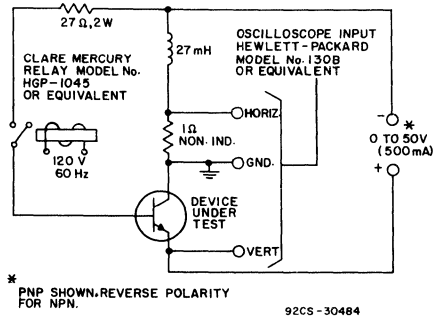
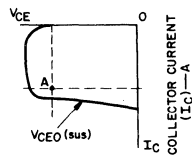


Fig. 11 - Circuit used to measure sustaining voltages $V_{CE0(sus)}$.

COLLECTOR-TO-EMITTER VOLTAGE (V_{CE})—V



NOTE: The sustaining voltage $V_{CE0(sus)}$ is acceptable when the trace falls to the left and below point "A". (For values of current and voltage, see Electrical Characteristics.)

92CS-30484

Fig. 12 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 11).

5-A *SwitchMax* II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

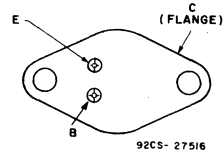
Features:

- Fast switching speed
- High-voltage ratings:
 $V_{CEV} = 850\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 10\text{ A}$

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

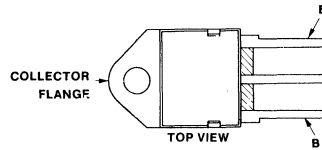
TERMINAL DESIGNATIONS



MJ16010
MJ16012

JEDEC TO-204AA

(200 mil diameter pin isolation)



MJH16010
MJH16012

JEDEC TO-218AC

92CS-40257

The MJ16010, MJ16012, MJH16010, and MJH16012 SwitchMax II series of silicon n-p-n power transistors feature high voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including

inductive turn-off time, and saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The MJ16010 and MJ16012 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The MJH16010 and MJH16012 transistors are supplied in JEDEC TO-218AC plastic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MJ16010 MJ16012	MJH16010 MJH16012	
V_{CEV}	850		V
$V_{BE} = -1.5\text{ V}$	450		V
V_{CEO}	6		V
V_{EBO}	10		A
$I_C(\text{sat})$	15		A
I_C	20		A
I_{CM}	10		A
I_B	15		A
I_{BM}			A
P_T			W
@ $T_C = 25^\circ\text{C}$	175	135	W
@ $T_C = 100^\circ\text{C}$	100	53.8	W
T_C above 25°C , derate linearly	1	1.08	W/°C
T_{stg}, T_J	-65 to 200	-65 to 150	°C
T_L			°C
At distance $\geq 1/8"$ in. (3.17 mm) from seating plane for 10 s max		235	°C
T_L			°C
At distance $\geq 1/16"$ in. (1.58 mm) from seating plane for 10 s max	235		°C
$R_{\theta JC}$	1	0.93	°C/W

MJ16010, MJ16012, MJH16010, MJH16012

MJ16010, MJH16010

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{CE(sus)}$	450	—	—	Vdc
Collector Cutoff Current ($V_{CEV} = 850\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$) ($V_{CEV} = 850\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	0.25 1.5	mAdc
Collector Cutoff Current ($V_{CE} = 850\text{ Vdc}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current ($V_{EB} = 6.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	1.0	mAdc

SECOND BREAKDOWN

Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Figure 1			
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Figure 2			

ON CHARACTERISTICS (1)

Collector-Emitter Saturation Voltage ($I_C = 5.0\text{ Adc}$, $I_B = 0.7\text{ Adc}$) ($I_C = 10\text{ Adc}$, $I_B = 1.3\text{ Adc}$) ($I_C = 10\text{ Adc}$, $I_B = 1.3\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — —	0.5 1.0 —	2.5 3.0 3.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 10\text{ Adc}$, $I_B = 1.3\text{ Adc}$) ($I_C = 10\text{ Adc}$, $I_B = 1.3\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— —	1.0 —	1.5 1.5	Vdc
DC Current Gain ($I_C = 15\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f_{test} = 1.0\text{ kHz}$)	C_{ob}	—	—	400	pF
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SWITCHING CHARACTERISTICS

Resistive Load							
Delay Time	$(I_C = 10\text{ Adc}$, $V_{CC} = 250\text{ Vdc}$, $I_{B1} = 1.3\text{ Adc}$, $PW = 30\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$)	$(I_{B2} = 2.6\text{ Adc}$, $R_B = 1.6\ \Omega)$	t_d	—	40	—	ns
Rise Time			t_r	—	100	—	
Storage Time			t_s	—	1400	—	
Fall Time		t_f	—	140	—		
Storage Time		$(V_{BE(off)} = 5.0\text{ Vdc})$	t_s	—	600	—	
Fall Time			t_f	—	100	—	
Inductive Load							
Storage Time	$(I_C = 10\text{ Adc}$, $I_{B1} = 1.3\text{ Adc}$, $V_{BE(off)} = 5.0\text{ Vdc}$, $V_{CE(pk)} = 400\text{ Vdc}$)	$(T_C = 100^\circ\text{C})$	t_{sv}	—	800	1800	ns
Fall Time			t_{fi}	—	50	200	
Crossover Time			t_c	—	100	250	
Storage Time	$(T_C = 150^\circ\text{C})$	t_{sv}	—	860	—	ns	
Fall Time		t_{fi}	—	40	—		
Crossover Time		t_c	—	80	—		

(1) Pulse Test: Pulse Width = $300\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$.

MJ16010, MJ16012, MJH16010, MJH16012

MJ16012, MJH16012

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current ($V_{CEV} = 850\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$) ($V_{CEV} = 850\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	0.25 1.5	mAdc
Collector Cutoff Current ($V_{CE} = 850\text{ Vdc}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current ($V_{EB} = 6.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	1.0	mAdc

SECOND BREAKDOWN

Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Figure 1			
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Figure 2			

ON CHARACTERISTICS (1)

Collector-Emitter Saturation Voltage ($I_C = 5.0\text{ Adc}$, $I_B = 0.5\text{ Adc}$) ($I_C = 10\text{ Adc}$, $I_B = 1.0\text{ Adc}$) ($I_C = 10\text{ Adc}$, $I_B = 1.0\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — —	— — —	2.5 3.0 3.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 10\text{ Adc}$, $I_B = 1.0\text{ Adc}$) ($I_C = 10\text{ Adc}$, $I_B = 1.0\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— —	— —	1.5 1.5	Vdc
DC Current Gain ($I_C = 15\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	7.0	—	—	—

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f_{test} = 1.0\text{ kHz}$)	C_{ob}	—	—	400	pF
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SWITCHING CHARACTERISTICS

Resistive Load							
Delay Time	$(I_C = 10\text{ Adc}$, $V_{CC} = 250\text{ Vdc}$, $I_{B1} = 1.0\text{ Adc}$, $PW = 30\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$)	$(I_{B2} = 2.0\text{ Adc}$, $R_B = 1.6\ \Omega)$	t_d	—	40	—	ns
Rise Time			t_r	—	100	—	
Storage Time			t_s	—	1400	—	
Fall Time		t_f	—	140	—		
Storage Time		$(V_{BE(off)} = 5.0\text{ Vdc})$	t_s	—	600	—	
Fall Time			t_f	—	100	—	
Inductive Load							
Storage Time	$(I_C = 10\text{ Adc}$, $I_{B1} = 1.0\text{ Adc}$, $V_{BE(off)} = 5.0\text{ Vdc}$, $V_{CE(pk)} = 400\text{ Vdc}$)	$(T_C = 100^\circ\text{C})$	t_{sv}	—	800	1500	ns
Fall Time			t_{fi}	—	50	150	
Crossover Time		t_c	—	100	200	—	
Storage Time		$(T_C = 150^\circ\text{C})$	t_{sv}	—	860	—	
Fall Time	t_{fi}		—	40	—		
Crossover Time	t_c		—	80	—		

(1) Pulse Test: Pulse Width = $300\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$.

MJ16010, MJ16012, MJH16010, MJH16012

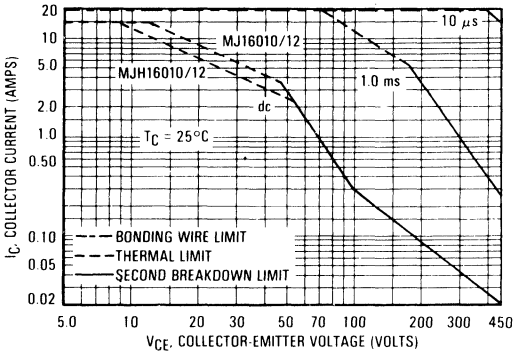


Fig. 1 — Maximum forward-bias safe-operating-areas for all types.

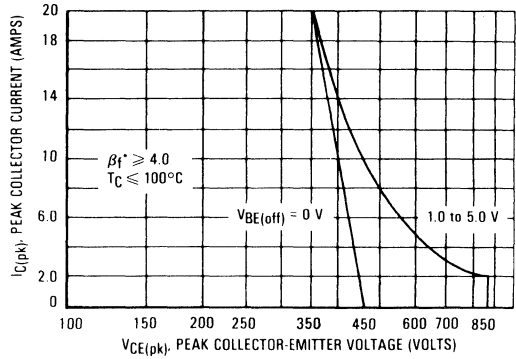


Fig. 2 — Maximum reverse-bias safe-operating-areas for all types.

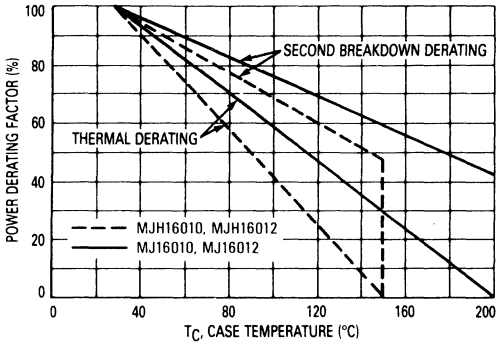


Fig. 3 — Dissipation and I_{S_b} derating curves for all types.

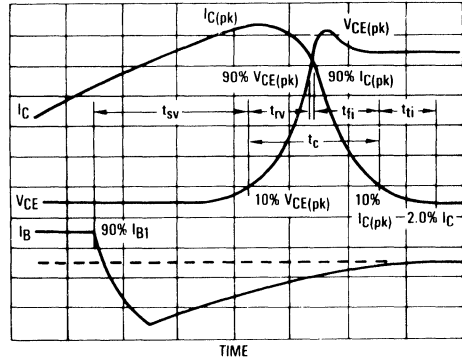


Fig. 4 — Inductive switching measurements display.

MJ16014, MJ16016

File Number **1871**

20-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

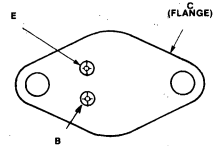
Features:

- Fast switching speed
- High-voltage ratings:
 $V_{CEV} = 850\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 10\text{ A}$

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AE

The RCA MJ16014 and MJ16016 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for para-

meters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The MJ16014 and MJ16016 transistors are supplied in steel modified JEDEC TO-204AE hermetic packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MJ16014 MJ16016	
V_{CEV}	850	V
$V_{BE} = -1.5\text{ V}$	450	V
V_{CEO}	6	V
V_{EBO}	20	A
I_C	30	A
I_{CM}	10	A
I_B	20	A
I_{BM}	250	W
P_T	143	W
@ $T_C = 25^\circ\text{ C}$	1.43	W/ $^\circ\text{ C}$
@ $T_C = 100^\circ\text{ C}$	-65 to +200	$^\circ\text{ C}$
T_C above 25° C , derate linearly		
T_{stg}, T_J	275	$^\circ\text{ C}$
T_L	0.7	$^\circ\text{ C/W}$
At distance $\geq \frac{1}{8}$ in. (3.17 mm) from seating plane for 10 s max.		
$R_{\theta jc}$		

MJ16014, MJ16016

MJ16014

ELECTRICAL CHARACTERISTICS at $T_C = 25^\circ\text{C}$ unless otherwise noted

CHARACTERISTIC	LIMITS			UNITS			
	Min.	Typ.	Max.				
OFF CHARACTERISTICS¹							
Collector-Emitter Sustaining Voltage $I_C = 100\text{ mA}$, $I_B = 0$	$V_{CE0(SUS)}$	450	—	—	V dc		
Collector Cutoff Current $V_{CEV} = 850\text{ V dc}$, $V_{BE(off)} = 1.5\text{ V dc}$ $V_{CEV} = 850\text{ V dc}$, $V_{BE(off)} = 1.5\text{ V dc}$, $T_C = 100^\circ\text{C}$	I_{CEV}	—	—	0.25 1.5	mA dc		
Collector Cutoff Current $V_{CE} = 850\text{ V dc}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$	I_{CER}	—	—	2.5	mA dc		
Emitter Cutoff Current $V_{EB} = 6\text{ V dc}$, $I_C = 0$	I_{EBO}	—	—	1	mA dc		
SECOND BREAKDOWN							
Second Breakdown Collector Current with Base Forward Biased	$I_{S,B}$	See Fig. 1					
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Fig. 2					
ON CHARACTERISTICS¹							
Collector-Emitter Saturation Voltage $I_C = 10\text{ A dc}$, $I_B = 1.3\text{ A dc}$ $I_C = 15\text{ A dc}$, $I_B = 2\text{ A dc}$ $I_C = 15\text{ A dc}$, $I_B = 2\text{ A dc}$, $T_C = 100^\circ\text{C}$	$V_{CE(sat)}$	— — —	— — —	2.5 3 3	V dc		
Base-Emitter Saturation Voltage $I_C = 15\text{ A dc}$, $I_B = 2\text{ A dc}$ $I_C = 15\text{ A dc}$, $I_B = 2\text{ A dc}$, $T_C = 100^\circ\text{C}$	$V_{BE(sat)}$	— —	— —	1.5 1.5	V dc		
DC Current Gain $I_C = 20\text{ A dc}$, $V_{CE} = 5\text{ V dc}$	h_{FE}	5	—	—			
DYNAMIC CHARACTERISTICS							
Output Capacitance $V_{CB} = 10\text{ V dc}$, $I_E = 0$, $f_{test} = 1\text{ kHz}$	C_{ob}	—	—	500	pF		
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	$I_C = 15\text{ A dc}$,	$I_{B2} = 4\text{ A dc}$, $R_B = 1.6\ \Omega$ $V_{BE(off)} = 5\text{ V dc}$	t_d	—	20	50	ns
Rise Time	$V_{CC} = 250\text{ V dc}$,		t_r	—	200	500	
Storage Time	$I_{B1} = 2\text{ A dc}$,		t_s	—	1200	2700	
Fall Time	$PW = 30\ \mu\text{s}$,		t_f	—	200	350	
Storage Time	Duty Cycle $\leq 2\%$		t_s	—	650	—	
Fall Time			t_f	—	80	—	
Inductive Load							
Storage Time	$I_C = 15\text{ A dc}$, $I_{B1} = 2\text{ A dc}$, $V_{BE(off)} = 5\text{ V dc}$, $V_{CE(pk)} = 400\text{ V dc}$	$T_C = 100^\circ\text{C}$	t_{sv}	—	800	2700	ns
Fall Time			t_{fi}	—	50	200	
Crossover Time			t_c	—	90	250	
Storage Time		$T_C = 150^\circ\text{C}$	t_{sv}	—	1050	—	
Fall Time			t_{fi}	—	70	—	
Crossover Time			t_c	—	120	—	

¹Pulse Test: Pulse Width = $300\ \mu\text{s}$, Duty Cycle $\leq 2\%$.

MJ16014, MJ16016

MJ16016

ELECTRICAL CHARACTERISTICS at $T_C = 25^\circ\text{C}$ unless otherwise noted

CHARACTERISTIC		LIMITS			UNITS		
		Min.	Typ.	Max.			
OFF CHARACTERISTICS¹							
Collector-Emitter Sustaining Voltage $I_C = 100\text{ mA}, I_B = 0$	$V_{CE(SUS)}$	450	—	—	V dc		
Collector Cutoff Current $V_{CEV} = 850\text{ V dc}, V_{BE(off)} = 1.5\text{ V dc}$ $V_{CEV} = 850\text{ V dc}, V_{BE(off)} = 1.5\text{ V dc}, T_C = 100^\circ\text{C}$	I_{CEV}	—	—	0.25 1.5	mA dc		
Collector Cutoff Current $V_{CE} = 850\text{ V dc}, R_{BE} = 50\ \Omega, T_C = 100^\circ\text{C}$	I_{CER}	—	—	2.5	mA dc		
Emitter Cutoff Current $V_{EB} = 6\text{ V dc}, I_C = 0$	I_{EBO}	—	—	1	mA dc		
SECOND BREAKDOWN							
Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Fig. 1					
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Fig. 2					
ON CHARACTERISTICS¹							
Collector-Emitter Saturation Voltage $I_C = 10\text{ A dc}, I_B = 1\text{ A dc}$ $I_C = 15\text{ A dc}, I_B = 1.5\text{ A dc}$ $I_C = 15\text{ A dc}, I_B = 1.5\text{ A dc}, T_C = 100^\circ\text{C}$	$V_{CE(sat)}$	— — —	— — —	2.5 3 3	V dc		
Base-Emitter Saturation Voltage $I_C = 15\text{ A dc}, I_B = 1.5\text{ A dc}$ $I_C = 15\text{ A dc}, I_B = 1.5\text{ A dc}, T_C = 100^\circ\text{C}$	$V_{BE(sat)}$	— —	— —	1.5 1.5	V dc		
DC Current Gain $I_C = 20\text{ A dc}, V_{CE} = 5\text{ V dc}$	h_{FE}	7	—	—			
DYNAMIC CHARACTERISTICS							
Output Capacitance $V_{CB} = 10\text{ V dc}, I_E = 0, f_{test} = 1\text{ kHz}$	C_{ob}	—	—	500	pF		
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	$I_C = 15\text{ A dc},$ $V_{CC} = 250\text{ V dc},$ $I_{B1} = 1.5\text{ A dc},$ $PW = 30\ \mu\text{s},$ Duty Cycle $\leq 2\%$	$I_{B2} = 3\text{ A dc},$ $R_B = 1.6\ \Omega$ $V_{BE(off)} = 5\text{ V dc}$	t_d	—	20	50	ns
Rise Time			t_r	—	200	500	
Storage Time			t_s	—	900	2200	
Fall Time			t_f	—	100	250	
Storage Time			t_s	—	500	—	
Fall Time			t_f	—	40	—	
Inductive Load							
Storage Time	$I_C = 15\text{ A dc},$ $I_{B1} = 1.5\text{ A dc},$ $V_{BE(off)} = 5\text{ V dc},$ $V_{CE(pk)} = 400\text{ V dc}$	$T_C = 100^\circ\text{C}$ $T_C = 150^\circ\text{C}$	t_{sv}	—	750	2500	ns
Fall Time			t_{fl}	—	30	150	
Crossover Time			t_c	—	50	200	
Storage Time			t_{sv}	—	900	—	
Fall Time			t_{fl}	—	30	—	
Crossover Time			t_c	—	70	—	

¹Pulse Test: Pulse Width = $300\ \mu\text{s}$, Duty Cycle $\leq 2\%$.

MJ16014, MJ16016

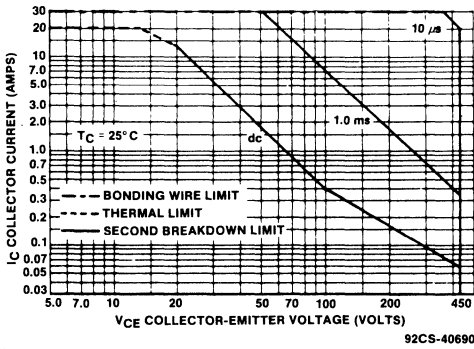


Fig. 1 - Maximum forward-bias safe-operating-areas for both types.

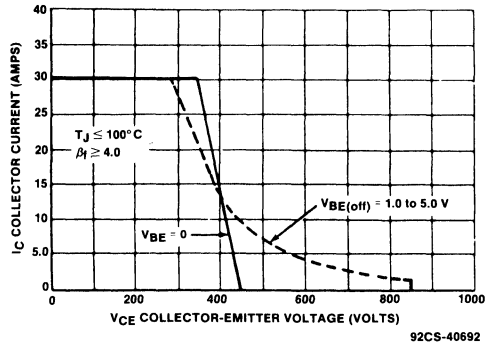


Fig. 2 - Maximum reverse-bias safe-operating-areas for both types.

2

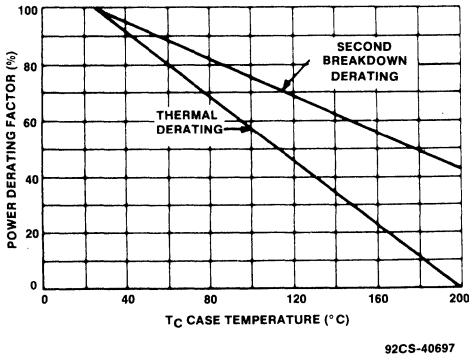


Fig. 3 - Dissipation and $I_{S,dc}$ derating curves for both types.

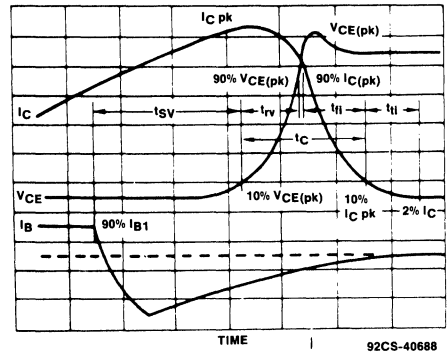


Fig. 4 - Inductive switching measurements display.

4-A *SwitchMax* II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

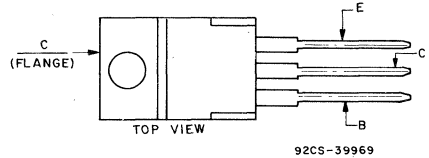
Features:

- Fast switching speed
- High-voltage ratings:
 $V_{CEV} = 600\text{ V to }700\text{ V}$
- Low $V_{CE(sat)}$ at $I_c = 4\text{ A}$

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The MJE13004 and MJE13005 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters

that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, saturation voltages are specified at 100°C to provide information necessary for worst-case design.

These transistors are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

V_{CEV}	
$V_{BE} = -1.5\text{ V}$	.....
V_{CEO}	.....
V_{EBO}	.....
$I_c(\text{sat})$	.....
I_c	.....
I_{CM}	.....
I_B	.....
I_{BM}	.....
P_T	.....
@ $T_c = 25^\circ\text{C}$	.....
@ $T_c = 100^\circ\text{C}$	.....
T_c above 25°C , derate linearly	.....
T_{stg} , T_J	.....
TL	.....
At distance $\geq 1/8"$ in. (3.17 mm) from seating plane for 10 s max	.....
$R_{\theta JC}$	.....

MJE13004

MJE13005

600	700	V
300	400	V
_____	9 _____	V
_____	4 _____	A
_____	4 _____	A
_____	8 _____	A
_____	2 _____	A
_____	4 _____	A
_____	75 _____	W
_____	45 _____	W
_____	0.6 _____	W/°C
_____	-65 to +150 _____	°C
_____	235 _____	°C
_____	1.67 _____	°C/W

MJE13004, MJE13005

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
*OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	MJE13004 MJE13005 $V_{CE(sus)}$	300 400	— —	— —	Vdc
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 1.5\text{ Vdc}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 1.5\text{ Vdc}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	— —	— —	1 5	mAdc
Emitter Cutoff Current ($V_{EB} = 9\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	1	mAdc

SECOND BREAKDOWN

Second Breakdown Collector Current with base forward biased	$I_{S/b}$			See Figure 1	
Clamped Inductive SOA with Base Reverse Biased	RBSOA			See Figure 2	

*ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$) ($I_C = 2\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	10 8	— —	60 40	—
Collector-Emitter Saturation Voltage ($I_C = 1\text{ Adc}$, $I_B = 0.2\text{ Adc}$) ($I_C = 2\text{ Adc}$, $I_B = 0.5\text{ Adc}$) ($I_C = 4\text{ Adc}$, $I_B = 1\text{ Adc}$) ($I_C = 2\text{ Adc}$, $I_B = 0.5\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — — —	0.2 0.3 0.7 —	0.5 0.6 1 1	Vdc
Base-Emitter Saturation Voltage ($I_C = 1\text{ Adc}$, $I_B = 0.2\text{ Adc}$) ($I_C = 2\text{ Adc}$, $I_B = 0.5\text{ Adc}$) ($I_C = 2\text{ Adc}$, $I_B = 0.5\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— — —	0.90 0.95 —	1.2 1.6 1.5	Vdc

DYNAMIC CHARACTERISTICS

Current-Gain – Bandwidth Product ($I_C = 500\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1\text{ MHz}$)	f_T	4	—	—	MHz
Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{ob}	—	200	—	pF

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	$(V_{CC} = 125\text{ Vdc}$, $I_C = 2\text{ A}$, $I_{B1} = I_{B2} = 0.4\text{ A}$, $t_p = 25\text{ }\mu\text{s}$, Duty Cycle $\leq 1\%$)	t_d	—	0.02	0.1	μs
Rise Time		t_r	—	0.08	0.7	μs
Storage Time		t_s	—	1.90	4	μs
Fall Time		t_f	—	0.16	0.9	μs
Inductive Load, Clamped						
Voltage Storage Time	$(I_C = 2\text{ A}$, $V_{clamp} = 300\text{ Vdc}$, $I_{B1} = 0.4\text{ A}$, $V_{BE(off)} = 5\text{ Vdc}$, $T_C = 100^\circ\text{C}$)	t_{sv}	—	1.60	4	μs
Crossover Time		t_c	—	0.15	0.9	μs
Fall Time		t_{fi}	—	0.05	—	μs

*Pulse Test: Pulse Width = 300 μs , Duty Cycle = 2%.

MJE13004, MJE13005

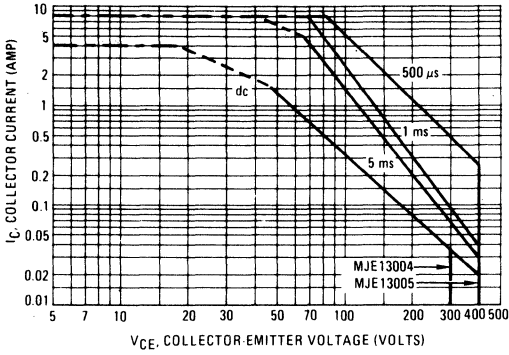


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

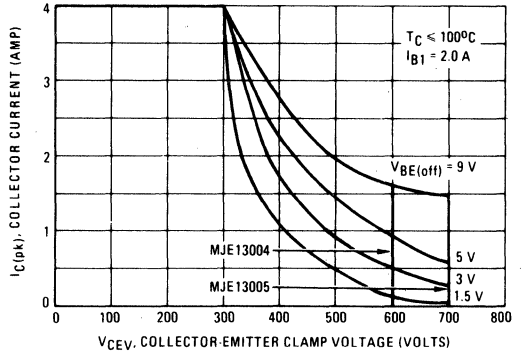


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

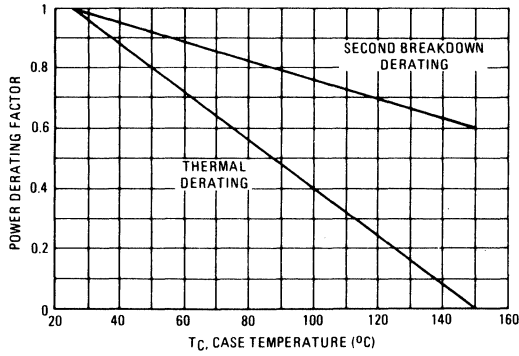


Fig. 3 — Dissipation and $I_{s b}$ derating curves for both types.

High-Speed Silicon N-P-N Power Transistors

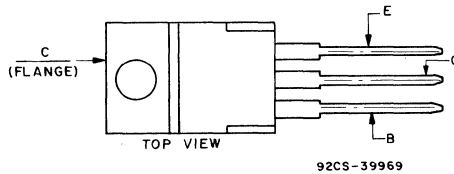
Features:

- $V_{CEO[sus]} = 300V$ (Min.)
- $V_{CEV} = 600V$ blocking capability
- Excellent switching time: $t_r = 1.5 \mu s$ (Max.),
 $t_f = 0.7 \mu s$ (Max.)

The MJE13006 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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		I_C	8	A
Pulse		I_{CP}	16	
Base Current — Continuous		I_B	4	A
Pulse		I_{BP}	8	
Emitter Current — Continuous		I_E	12	A
Pulse		I_{EP}	24	
Collector Power Dissipation	$T_A = 25^\circ C$	P_C	2	Watts
Derate above 25°C			16	mW/°C
Collector Power Dissipation	$T_C = 25^\circ C$	P_C	80	Watts
Derate above 25°C			640	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: 1/8" from Case for 5 Seconds	T_L	275	°C

MJE13006**ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)**

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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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 = 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 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	—	—	μs
Rise Time		t _r	—	—	
Storage Time		t _s	—	—	
Fall Time		t _f	—	—	
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}	—	—	μs
Crossover Time		t _c	—	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

MJE13006

2

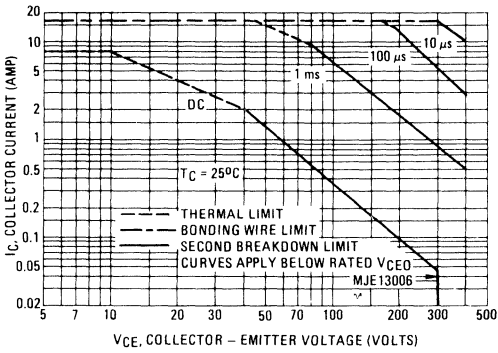


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

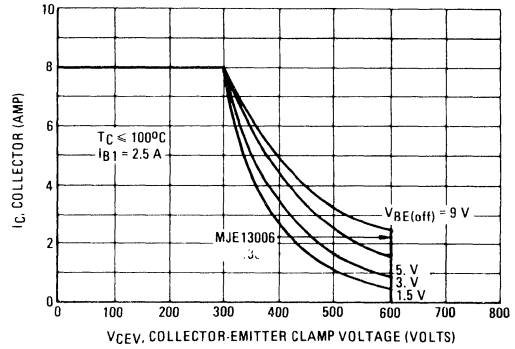


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

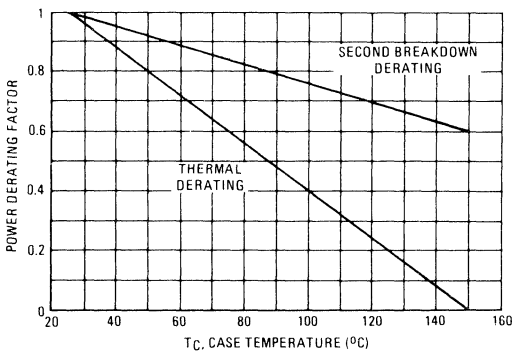


FIGURE 3 – FORWARD BIAS POWER DERATING

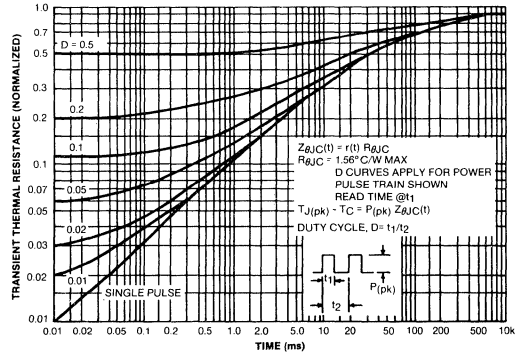


FIGURE 4 TYPICAL THERMAL RESPONSE [$Z_{\theta JC}(t)$]

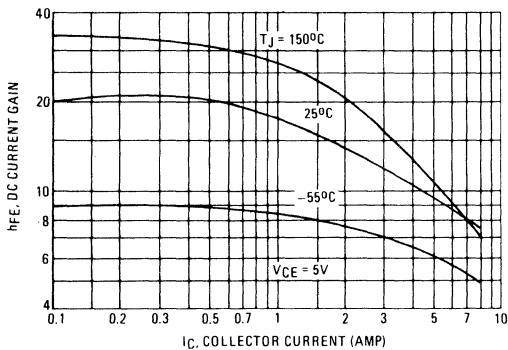


FIGURE 5 – DC CURRENT GAIN

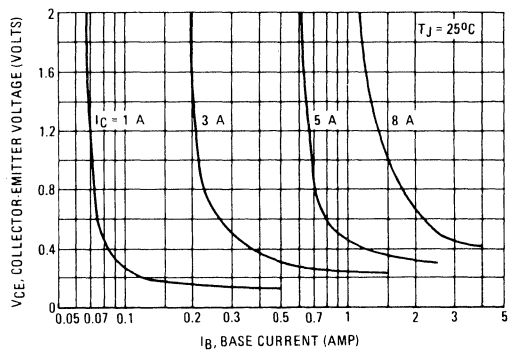


FIGURE 6 – COLLECTOR SATURATION REGION

MJE13006

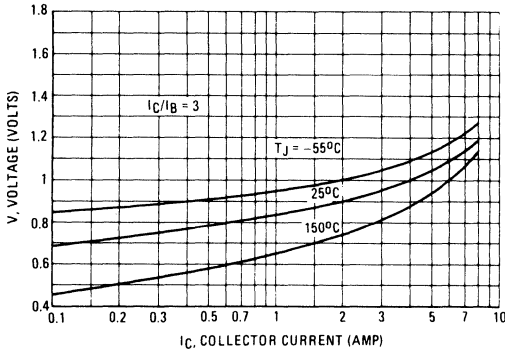


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

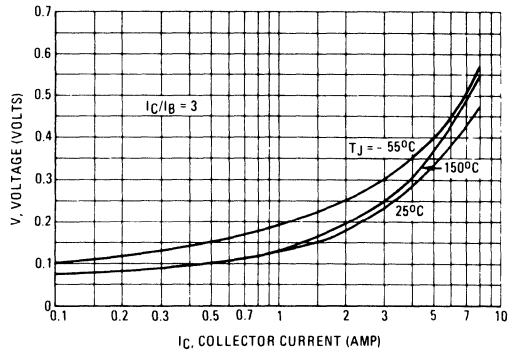


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

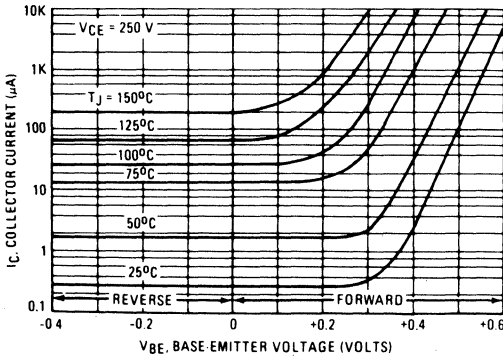


FIGURE 9 – COLLECTOR CUTOFF REGION

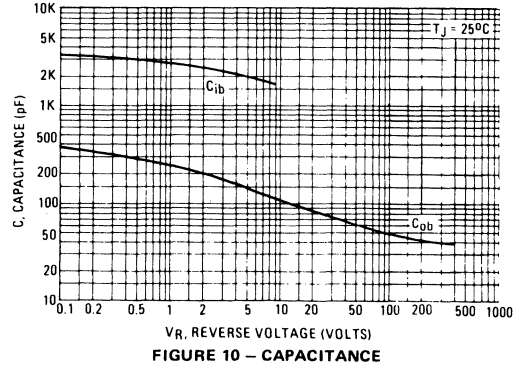


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

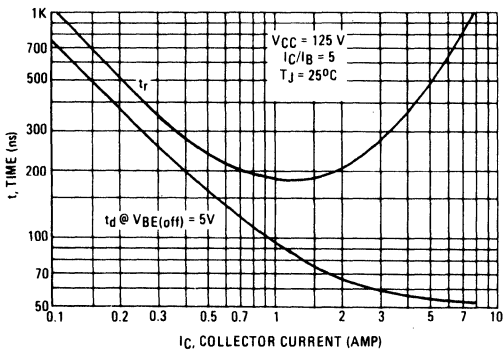


FIGURE 11 – TURN-ON TIME

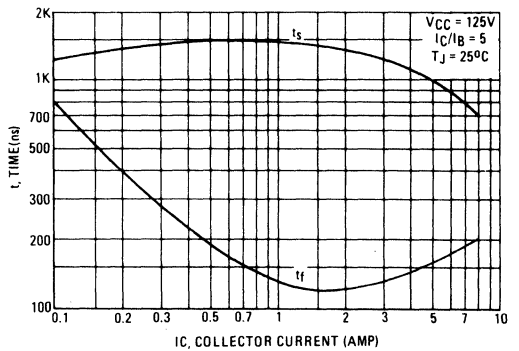


FIGURE 12 – TURN-OFF TIME

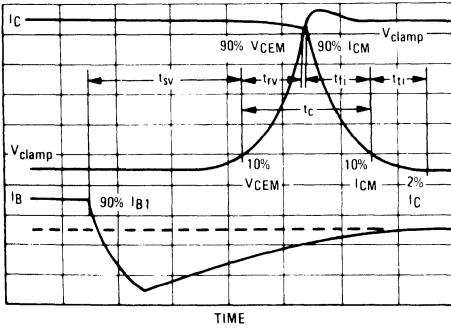


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

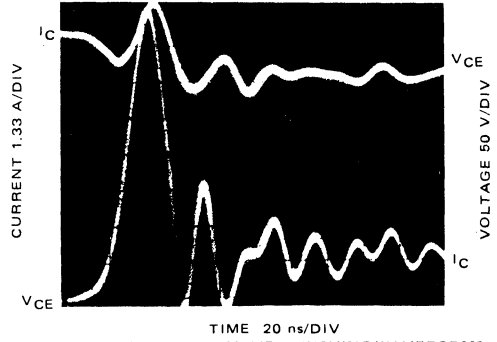


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS
(at 300 V and 8A with $I_{B1} = 1.6A$ and $V_{BE(off)} = 5V$)

2

High-Speed Silicon N-P-N Power Transistors

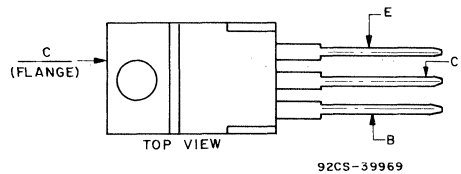
Features:

- $V_{CEO[sus]} = 400V$ (Min.)
- $V_{CEV} = 700V$ blocking capability
- Excellent switching time: $t_r = 1.5 \mu s$ (Max.),
 $t_f = 0.7 \mu s$ (Max.)

The MJE13007 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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	I_C	8	A
Pulse	I_{CP}	16	
Base Current — Continuous	I_B	4	A
Pulse	I_{BP}	8	
Emitter Current — Continuous	I_E	12	A
Pulse	I_{EP}	24	
Collector Power Dissipation Derate above 25°C	$T_A = 25^\circ C$ P_C	2 16	Watts mW/°C
Collector Power Dissipation Derate above 25°C	$T_C = 25^\circ C$ 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: 1/8" from Case for 5 Seconds	T_L	275	°C

MJE13007

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{CE0(sus)}$	400	—	—	Volts
Collector Cutoff Current ($V_{CE} = 700\text{V}$, $V_{BE} = -1.5\text{V}$) ($V_{CE} = 700\text{V}$, $V_{BE} = -1.5\text{V}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	1 5	mA
Emitter Cutoff Current ($V_{EB} = 9\text{V}$, $I_C = 0$)	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			

2

ON CHARACTERISTICS⁽¹⁾

DC Current Gain ($I_C = 2\text{A}$, $V_{CE} = 5\text{V}$) ($I_C = 5\text{A}$, $V_{CE} = 5\text{V}$)	h_{FE}	8 5	— —	60 30	—
Collector-Emitter Saturation Voltage ($I_C = 2\text{A}$, $I_B = 0.4\text{A}$) ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 8\text{A}$, $I_B = 2\text{A}$) ($I_C = 5\text{A}$, $I_B = 1\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — — —	— — — —	1 2 3 3	V
Base-Emitter Saturation Voltage ($I_C = 2\text{A}$, $I_B = 0.4\text{A}$) ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 5\text{A}$, $I_B = 1\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{V}$, $I_E = 0$, $f = 0.1\text{MHz}$)	C_{ob}	—	90	—	pF
Current Gain — Bandwidth Product ($I_C = 500\text{mA}$, $V_{CE} = 10\text{V}$, $f_{test} = 1\text{MHz}$)	f_T	4	—	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	$(V_{CC} = 125\text{V}$, $I_C = 2\text{A}$ $I_{B1} = -I_{B2} = 0.4\text{A}$, $t_p = 25\ \mu\text{s}$ 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 ($I_C = 5\text{A}$, $V_{clamp} = 300\text{V}$, $I_{B1} = 1\text{A}$, $V_{BE(off)} = -5\text{V}$, $T_C = 100^\circ\text{C}$)	t_{sv}	—	—	2.3	μs
Crossover Time		t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - $300\ \mu\text{s}$ Duty Cycle $\leq 2\%$.

MJE13007

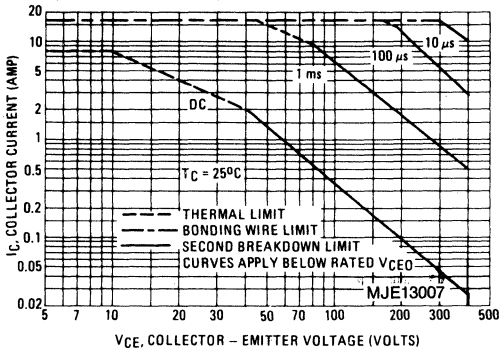


FIGURE 1 - FORWARD BIAS SAFE OPERATING AREA

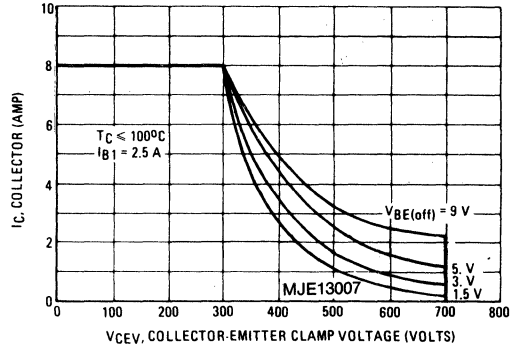


FIGURE 2 - REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

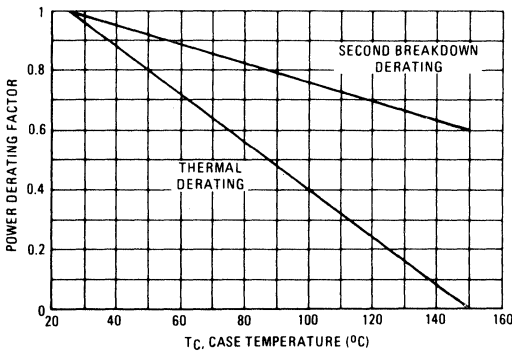


FIGURE 3 - FORWARD BIAS POWER DERATING

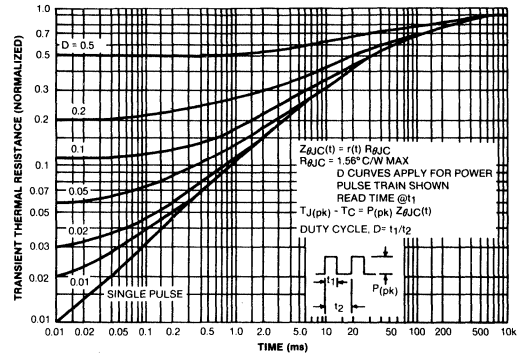


FIGURE 4 TYPICAL THERMAL RESPONSE [(Z_{θJC}(t))]

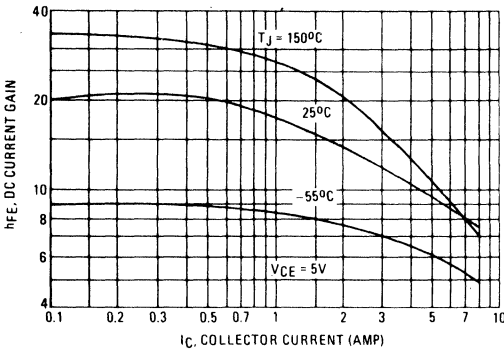


FIGURE 5 - DC CURRENT GAIN

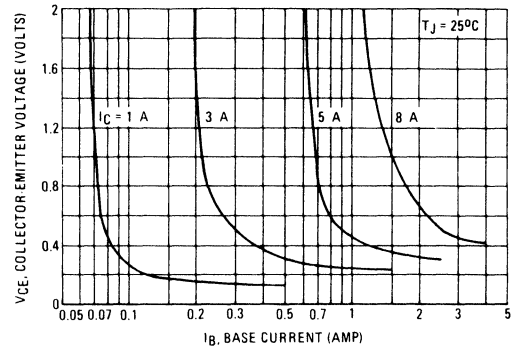


FIGURE 6 - COLLECTOR SATURATION REGION

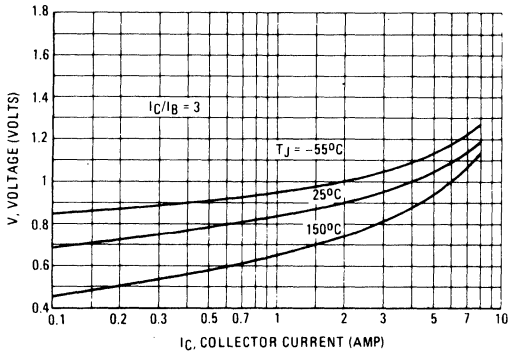


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

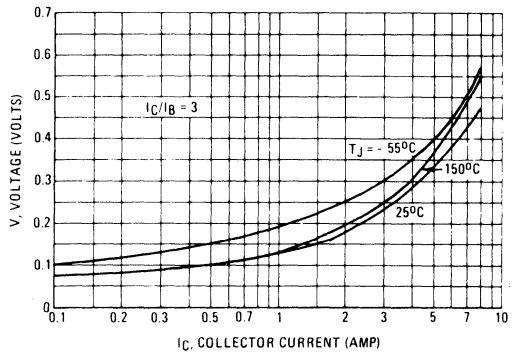


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

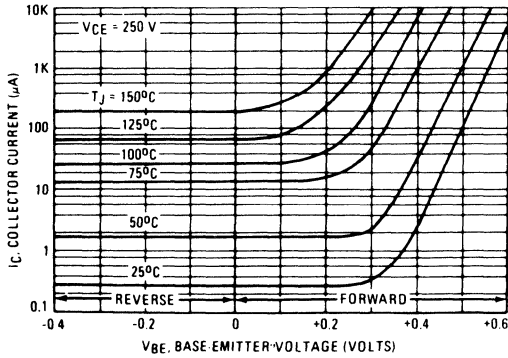


FIGURE 9 – COLLECTOR CUTOFF REGION

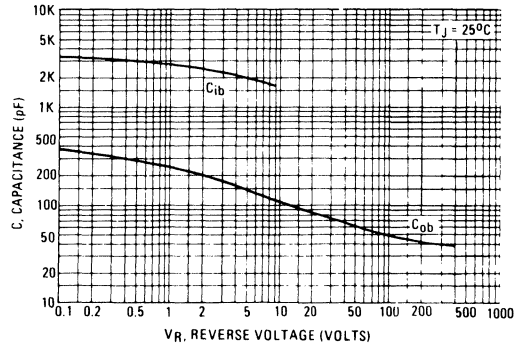


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

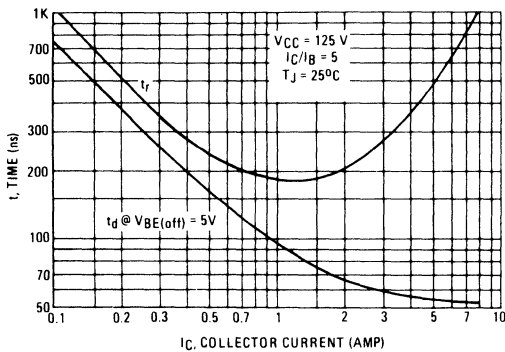


FIGURE 11 – TURN-ON TIME

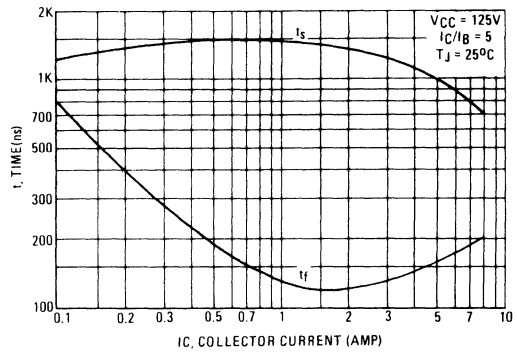


FIGURE 12 – TURN-OFF TIME

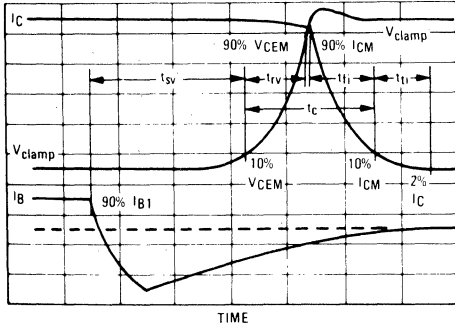


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

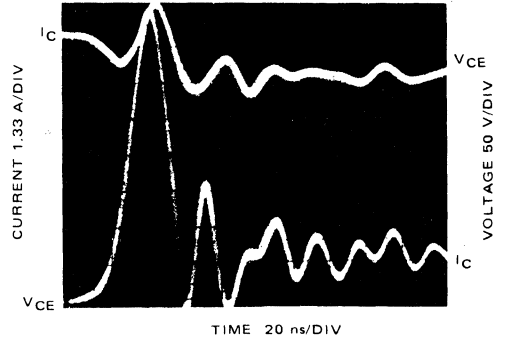


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS
(at 300 V and 8A with $I_{B1} = 1.6A$ and $V_{BE(off)} = 5 V$)

High-Speed Silicon N-P-N Power Transistors

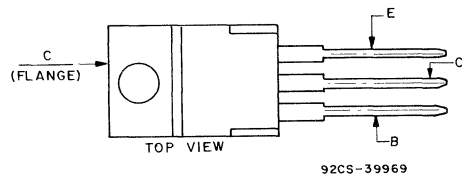
Features:

- $V_{CE0[sus]} = 300V$ (Min.)
- $V_{CEV} = 600V$ blocking capability
- Excellent switching time: $t_r = 1 \mu s$ (Max.),
 $t_f = 0.7 \mu s$ (Max.)

The MJE13008 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (unless otherwise specified)

RATING	SYMBOL	MJE13008	UNITS
Collector-Emitter Voltage	V_{CE0}	300	Volts
Collector-Emitter Voltage	V_{CEV}	600	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous	I_C	12	A
Pulse	I_{CP}	24	
Base Current — Continuous	I_B	6	A
Pulse	I_{BP}	12	
Emitter Current — Continuous	I_E	18	A
Pulse	I_{EP}	36	
Collector Power Dissipation Derate above 25°C	$T_A = 25^\circ C$ P_C	2 16	Watts mW/°C
Collector Power Dissipation Derate above 25°C	$T_C = 25^\circ C$ 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: 1/8" from Case for 5 Seconds	T_L	275	°C

MJE13008**ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)**

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{CE(sus)}$	300	—	—	Volts
Collector Cutoff Current ($V_{CE} = 600\text{V}$, $V_{BE} = -1.5\text{V}$) ($V_{CE} = 600\text{V}$, $V_{BE} = -1.5\text{V}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	1 5	mA
Emitter Cutoff Current ($V_{EB} = 9\text{V}$, $I_C = 0$)	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 ($I_C = 5\text{A}$, $V_{CE} = 5\text{V}$) ($I_C = 8\text{A}$, $V_{CE} = 5\text{V}$)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$) ($I_C = 12\text{A}$, $I_B = 3\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — — —	— — — —	1 1.5 3 2	V
Base-Emitter Saturation Voltage ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{V}$, $I_E = 0$, $f = 0.1\text{MHz}$)	C_{ob}	—	130	—	pF
Current Gain — Bandwidth Product ($I_C = 500\text{mA}$, $V_{CE} = 10\text{V}$, $f_{test} = 1\text{MHz}$)	f_T	4	—	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load					
Delay Time	$(V_{CC} = 125\text{V}$, $I_C = 8\text{A}$ $I_{B1} = -I_{B2} = 1.6\text{A}$, $t_p = 25\ \mu\text{s}$ 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	$(I_C = 8\text{A}$, $V_{clamp} = 300\text{V}$ $I_{B1} = 1.6\text{A}$, $V_{BE(off)} = -5\text{V}$, $T_C = 100^\circ\text{C}$)	t_{sv}	—	2.3	μs
Crossover Time		t_c	—	0.7	

(1) Pulse Test: Pulse Width - $300\ \mu\text{s}$ Duty Cycle $\leq 2\%$.

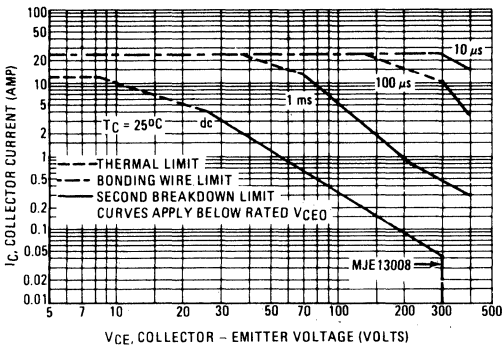


FIGURE 1 - FORWARD BIAS SAFE OPERATING AREA

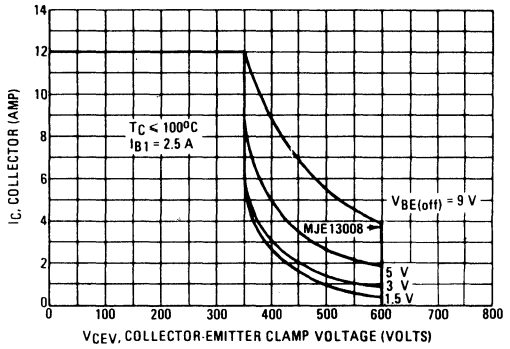


FIGURE 2 - REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

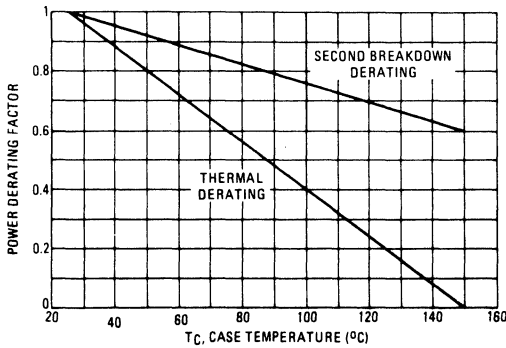


FIGURE 3 - FORWARD BIAS POWER DERATING

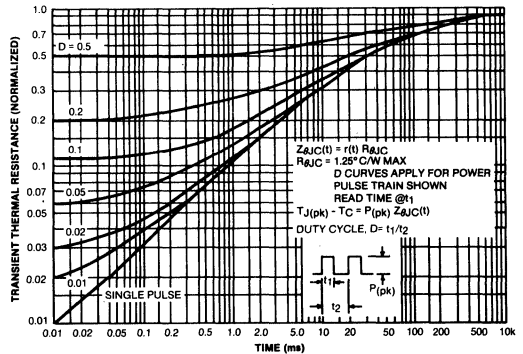


FIGURE 4 TYPICAL THERMAL RESPONSE [(Z_{θJC}(t))]

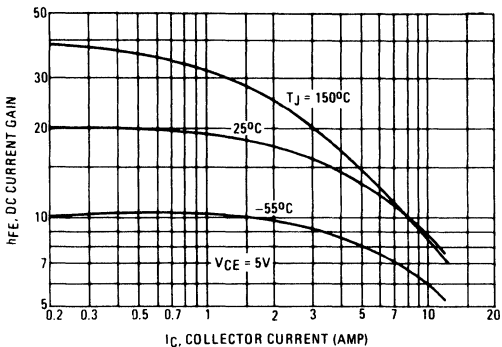


FIGURE 5 - DC CURRENT GAIN

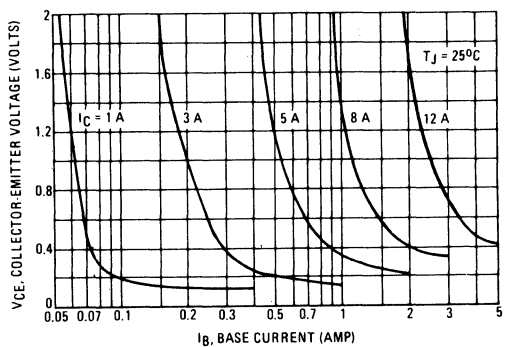


FIGURE 6 - COLLECTOR SATURATION REGION

MJE13008

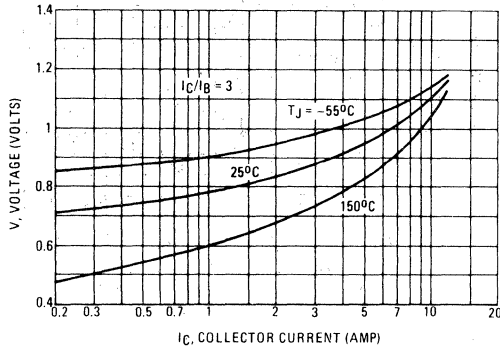


FIGURE 7 - BASE-EMITTER SATURATION VOLTAGE

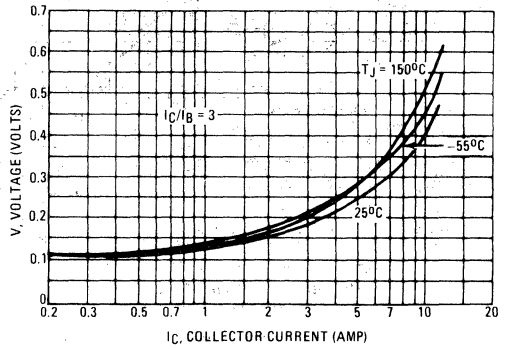


FIGURE 8 - COLLECTOR-EMITTER SATURATION VOLTAGE

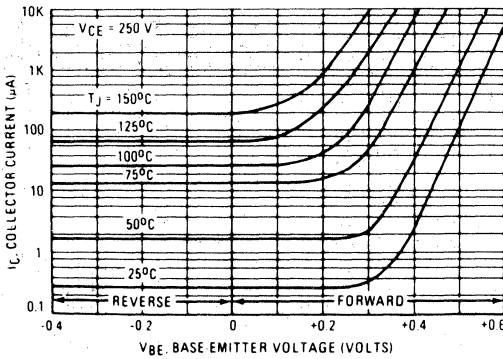


FIGURE 9 - COLLECTOR CUTOFF REGION

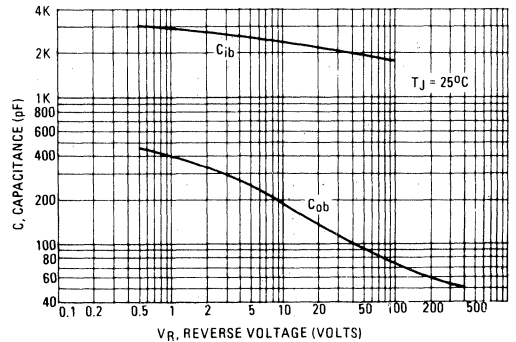


FIGURE 10 - CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

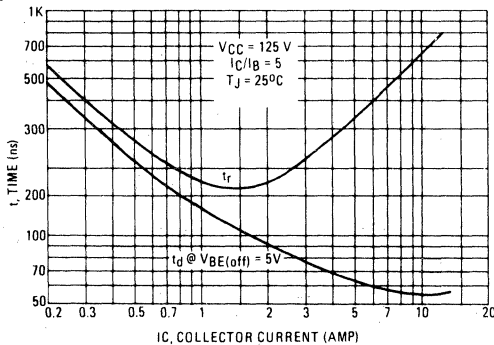


FIGURE 11 - TURN-ON TIME

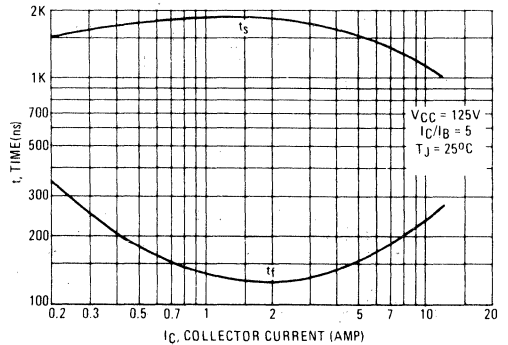


FIGURE 12 - TURN-OFF TIME

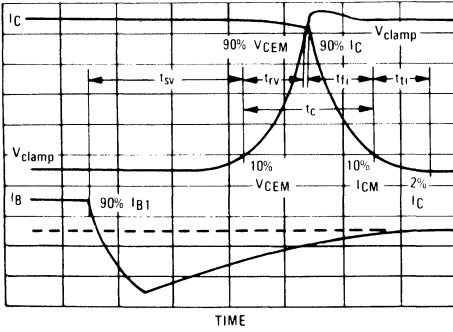


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

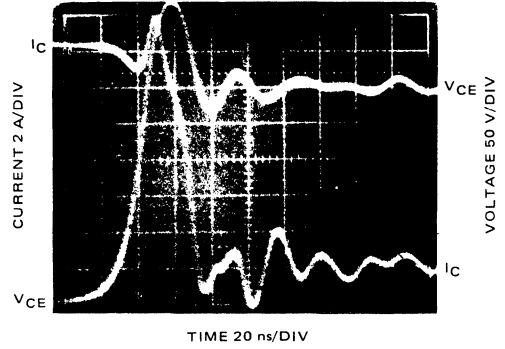


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS
(at 300 V and 12 A with $I_{B1} = 2.4$ A and $V_{BE(off)} = 5$ V)

High-Speed Silicon N-P-N Power Transistors

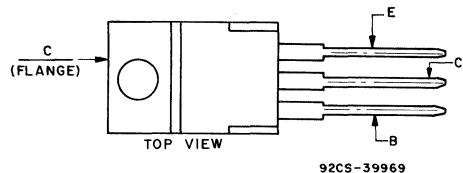
Features:

- $V_{CEO[sus]} = 400V$ (Min.)
- $V_{CEV} = 700V$ blocking capability
- Excellent switching time: $t_r = 1 \mu s$ (Max.),
 $t_f = 0.7 \mu s$ (Max.)

The MJE13009 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS ($T_A = 25^\circ C$) (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	12	A
		I_{CP}	24	
Base Current — Continuous Pulse		I_B	6	A
		I_{BP}	12	
Emitter Current — Continuous Pulse		I_E	18	A
		I_{EP}	36	
Collector Power Dissipation Derate above 25°C	$T_A = 25^\circ C$	P_C	2	Watts
			16	mW/°C
Collector Power Dissipation Derate above 25°C	$T_C = 25^\circ C$	P_C	100	Watts
			800	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: 1/8" from Case for 5 Seconds	T_L	275	°C

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Voltage ($I_C = 10\text{mA}$, $I_B = 0$)	$V_{CE0(sus)}$	400	—	—	Volts
Collector Cutoff Current ($V_{CE} = 700\text{V}$, $V_{BE} = -1.5\text{V}$) ($V_{CE} = 700\text{V}$, $V_{BE} = -1.5\text{V}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	1 5	mA
Emitter Cutoff Current ($V_{EB} = 9\text{V}$, $I_C = 0$)	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 ($I_C = 5\text{A}$, $V_{CE} = 5\text{V}$) ($I_C = 8\text{A}$, $V_{CE} = 5\text{V}$)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$) ($I_C = 12\text{A}$, $I_B = 3\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — — —	— — — —	1 1.5 3 2	V
Base-Emitter Saturation Voltage ($I_C = 5\text{A}$, $I_B = 1\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$) ($I_C = 8\text{A}$, $I_B = 1.6\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{V}$, $I_E = 0$, $f = 0.1\text{MHz}$)	C_{ob}	—	130	—	pF
Current Gain — Bandwidth Product ($I_C = 500\text{mA}$, $V_{CE} = 10\text{V}$, $f_{test} = 1\text{MHz}$)	f_T	4	—	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load					
Delay Time	$(V_{CC} = 125\text{V}$, $I_C = 8\text{A}$ $I_{B1} = -I_{B2} = 1.6\text{A}$, $t_p = 25\ \mu\text{s}$ Duty Cycle < 1%)	t_d	—	0.1	μs
Rise Time		t_r	—	1	μs
Storage Time		t_s	—	3	
Fall Time		t_f	—	0.7	
Inductive Load, Clamped					
Storage Time	$(I_C = 8\text{A}$, $V_{clamp} = 300\text{V}$ $I_{B1} = 1.6\text{A}$, $V_{BE(off)} = 5\text{V}$, $T_C = 100^\circ\text{C}$)	t_{sv}	—	2.3	μs
Crossover Time		t_c	—	0.7	

(1) Pulse Test: Pulse Width - 300 μs Duty Cycle $\leq 2\%$.

MJE13009

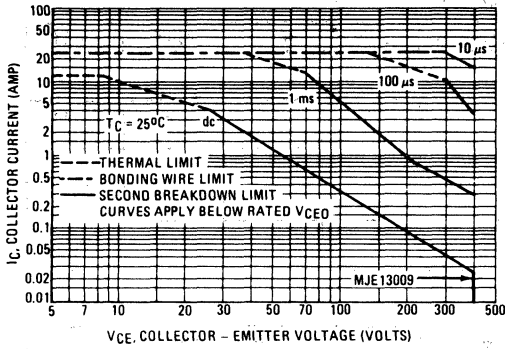


FIGURE 1 - FORWARD BIAS SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

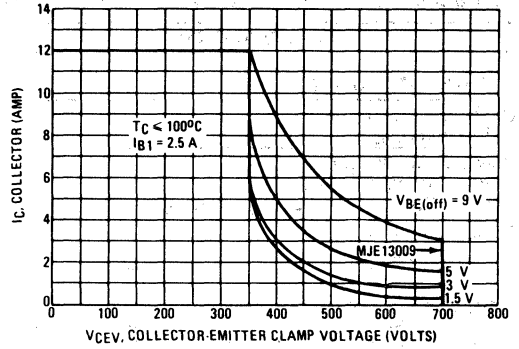


FIGURE 2 - REVERSE BIAS SWITCHING SAFE OPERATING AREA

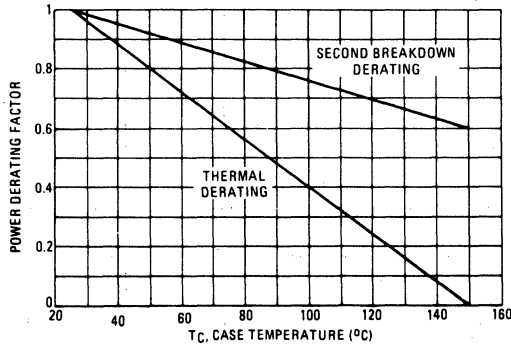


FIGURE 3 - FORWARD BIAS POWER DERATING

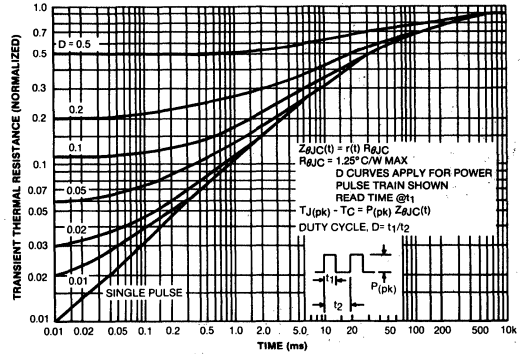


FIGURE 4 - TYPICAL THERMAL RESPONSE [$Z_{\theta JC}(t)$]

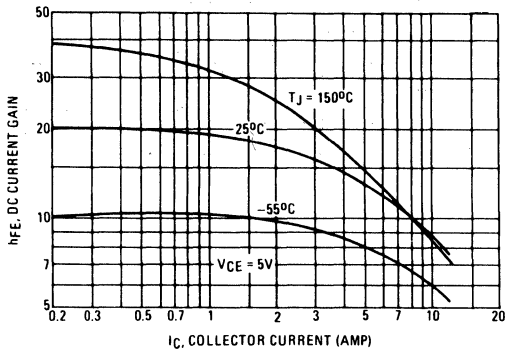


FIGURE 5 - DC CURRENT GAIN

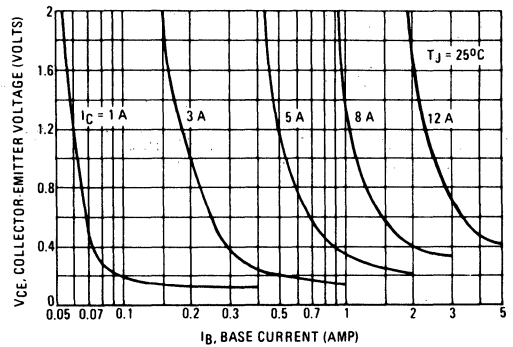


FIGURE 6 - COLLECTOR SATURATION REGION

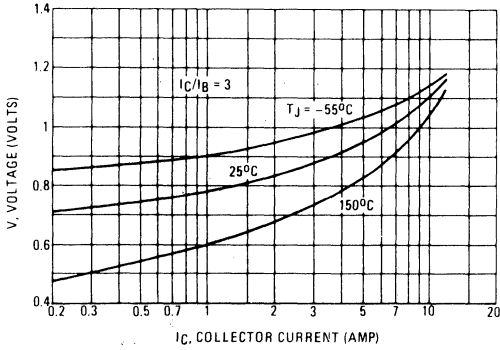


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

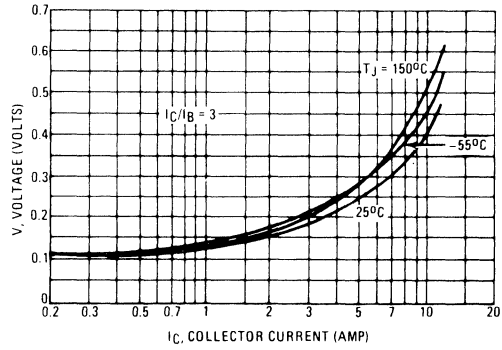


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

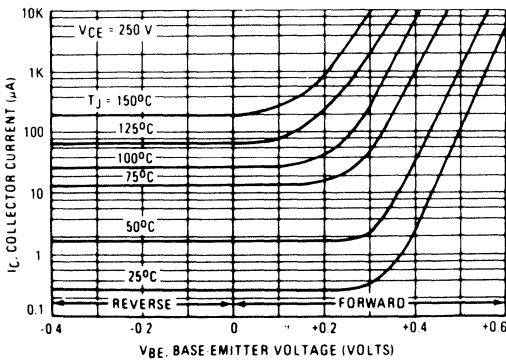


FIGURE 9 – COLLECTOR CUTOFF REGION

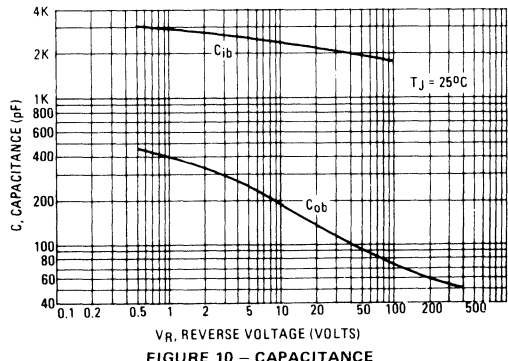


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

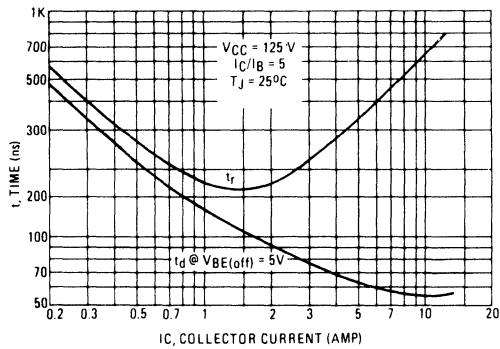


FIGURE 11 – TURN-ON TIME

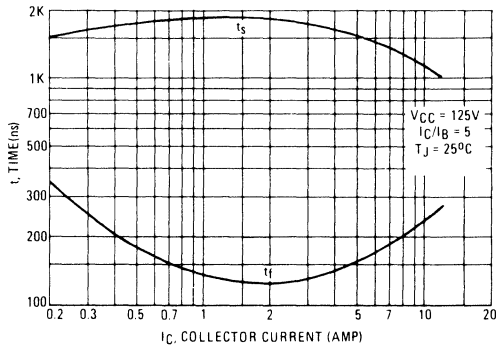


FIGURE 12 – TURN-OFF TIME

MJE13009

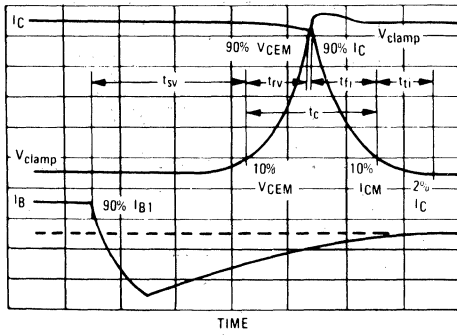


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

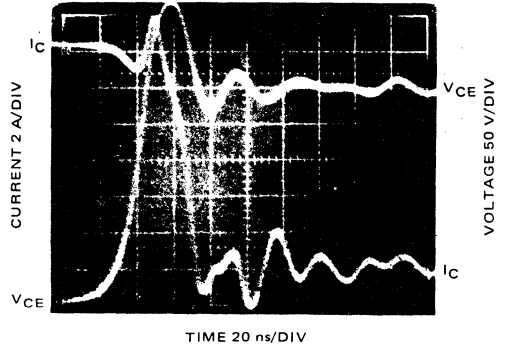


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS
(at 300 V and 12 A with $I_{B1} = 2.4$ A and $V_{BE(off)} = 5$ V)

5-A *SwitchMax* II Power Transistors

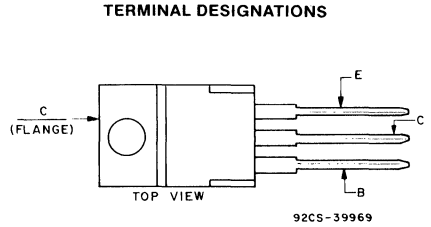
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- Fast switching speed
- High-voltage ratings:
 $V_{CEV} = 650\text{ V to }750\text{ V}$
- Low $V_{CE(sat)}$ at $I_c = 5\text{ A}$

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators



JEDEC TO-220AB

2

The MJE13070 and MJE13071 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters

that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, saturation voltages are specified at 100°C to provide information necessary for worst-case design.

These transistors are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

V_{CEV}	.....	650	750	V
$V_{BE} = -1.5\text{ V}$	.....	400	450	V
V_{CEO}	.....	_____	6 _____	V
V_{EBO}	.....	_____	5 _____	A
$I_C(sat)$	.....	_____	5 _____	A
I_C	.....	_____	8 _____	A
I_{CM}	.....	_____	2 _____	A
I_B	.....	_____	4 _____	A
I_{BM}	.....	_____	_____	_____
P_T	.....	_____	80 _____	W
@ $T_C = 25^\circ\text{C}$	.....	_____	32 _____	W
@ $T_C = 100^\circ\text{C}$	.....	_____	0.64 _____	W/°C
T_C above 25°C , derate linearly	.....	_____	-65 to +150 _____	°C
T_{stg}, T_J	.....	_____	_____	_____
TL	.....	_____	235 _____	°C
At distance $\geq 1/8"$ in. (3.17 mm) from seating plane for 10 s max	.....	_____	1.56 _____	°C/W
$R_{\theta JC}$	.....	_____	_____	_____

	MJE13070	MJE13071	
	650	750	V
	400	450	V
	_____	6 _____	V
	_____	5 _____	A
	_____	5 _____	A
	_____	8 _____	A
	_____	2 _____	A
	_____	4 _____	A
	_____	80 _____	W
	_____	32 _____	W
	_____	0.64 _____	W/°C
	_____	-65 to +150 _____	°C
	_____	235 _____	°C
	_____	1.56 _____	°C/W

MJE13070, MJE13071

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	MJE13070 MJE13071 $V_{CE0(sus)}$	400 450	—	—	Vdc
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 1.5\text{ Vdc}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(off)} = 1.5\text{ Vdc}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	0.5 2.5	mAdc
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEV}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	—	3.0	mAdc
Emitter Cutoff Current ($V_{EB} = 6.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	1.0	mAdc

SECOND BREAKDOWN

Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Figure 1			
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Figure 2			

ON CHARACTERISTICS (1)

DC Current Gain ($I_C = 3.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	8.0	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 3.0\text{ Adc}$, $I_B = 0.6\text{ Adc}$) ($I_C = 5.0\text{ Adc}$, $I_B = 1.0\text{ Adc}$) ($I_C = 3.0\text{ Adc}$, $I_B = 0.6\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	—	0.6 2.0	1.0 3.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 3.0\text{ Adc}$, $I_B = 0.6\text{ Adc}$) ($I_C = 3.0\text{ Adc}$, $I_B = 0.6\text{ Adc}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	—	1.0	1.5 1.5	Vdc

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f_{test} = 1.0\text{ kHz}$)	C_{ob}	—	—	250	pF
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SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	$(V_{CC} = 250\text{ Vdc}$, $I_C = 3.0\text{ Adc}$, $I_{B1} = 0.4\text{ Adc}$, $t_p = 30\ \mu\text{s}$, Duty Cycle $\leq 2\%$, $V_{BE(off)} = 5.0\text{ Vdc}$)	t_d	—	0.03	0.05	μs
Rise Time		t_r	—	0.08	0.40	
Storage Time		t_s	—	0.33	1.50	
Fall Time		t_f	—	0.10	0.50	

Inductive Load, Clamped *

Storage Time	$(I_{C(pk)} = 3.0\text{ A}$, $I_{B1} = 0.4\text{ Adc}$, $V_{BE(off)} = 5.0\text{ Vdc}$, $V_{CE(pk)} = 250\text{ V}$)	$(T_J = 100^\circ\text{C})$	t_{sv}	—	0.70	2.0	μs
Crossover Time			t_c	—	0.08	0.50	
Fall Time			t_{fi}	—	0.05	0.30	
Storage Time		$(T_J = 25^\circ\text{C})$	t_{sv}	—	0.40	—	
Crossover Time			t_c	—	0.05	—	
Fall Time			t_{fi}	—	0.03	—	

(1) Pulse Test PW = 300 μs , Duty Cycle $\leq 2\%$

MJE13070, MJE13071

2

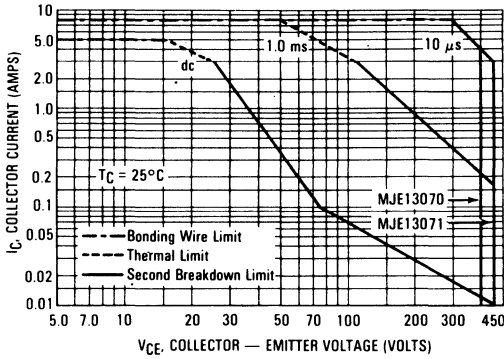


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

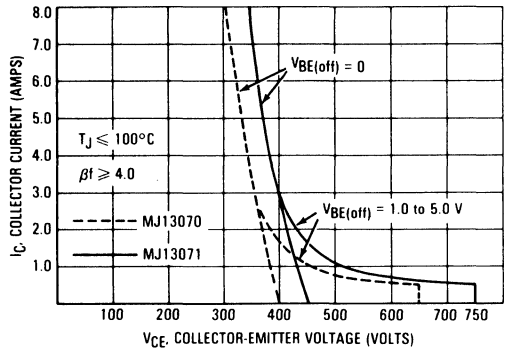


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

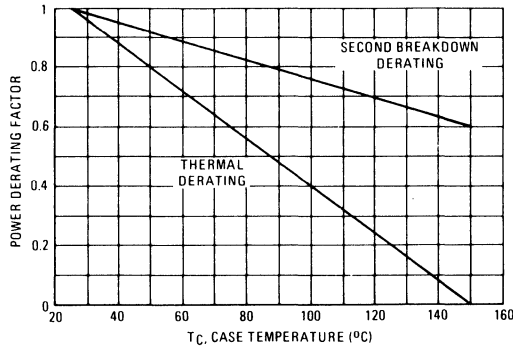


Fig. 3 — Dissipation and $I_{s/D}$ derating curves for both types.

5-A *SwitchMax* II Power Transistors

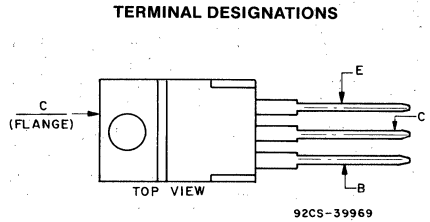
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- Fast switching speed
- High-voltage ratings:
 $V_{CEV} = 850\text{ V}$
- Low $V_{CE(sat)}$ at $I_C = 3\text{ A}$

Applications:

- Off-line power supplies
- High-voltage inverters
- Switching regulators



JEDEC TO-220AB

The MJE16002 and MJE16004 *SwitchMax* II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters

that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, saturation voltages are specified at 100°C to provide information necessary for worst-case design.

These transistors are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MJE16002	MJE16004	
V_{CEV}	850		V
$V_{BE} = -1.5\text{ V}$			V
V_{CEO}	450		V
V_{EBO}	6		V
$I_C(sat)$	3		A
I_C	5		A
I_{CM}	10		A
I_B	4		A
I_{BM}	8		A
P_T			
@ $T_C = 25^\circ\text{C}$	80		W
@ $T_C = 100^\circ\text{C}$	32		W
T_C above 25°C , derate linearly	0.64		W/ $^\circ\text{C}$
T_{stg} , T_J	-65 to +150		$^\circ\text{C}$
TL			
At distance $\geq 1/8"$ in. (3.17 mm) from seating plane for 10 s max	235		$^\circ\text{C}$
$R_{\theta JC}$	1.56		$^\circ\text{C/W}$

MJE16002, MJE16004

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current ($V_{CEV} = 850\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$) ($V_{CEV} = 850\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$, $T_C = 100^\circ\text{C}$)	I_{CEV}	—	—	0.25 1.5	mAdc
Collector Cutoff Current ($V_{CE} = 850\text{ Vdc}$, $R_{BE} = 50\ \Omega$, $T_C = 100^\circ\text{C}$)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current ($V_{EB} = 6.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	1.0	mAdc

SECOND BREAKDOWN

Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$		See Figure 1		
Clamped Inductive SOA with Base Reverse Biased	RBSOA		See Figure 2		

ON CHARACTERISTICS (1)

Collector-Emitter Saturation Voltage ($I_C = 1.5\text{ Adc}$, $I_B = 0.2\text{ Adc}$) MJE16002 ($I_C = 1.5\text{ Adc}$, $I_B = 0.15\text{ Adc}$) MJE16004 ($I_C = 3.0\text{ Adc}$, $I_B = 0.4\text{ Adc}$) MJE16002 ($I_C = 3.0\text{ Adc}$, $I_B = 0.3\text{ Adc}$) MJE16004 ($I_C = 3.0\text{ Adc}$, $I_B = 0.4\text{ Adc}$, $T_C = 100^\circ\text{C}$) MJE16002 ($I_C = 3.0\text{ Adc}$, $I_B = 0.3\text{ Adc}$, $T_C = 100^\circ\text{C}$) MJE16004	$V_{CE(sat)}$	—	0.5 0.5 1.2 1.2 — —	1.0 1.0 2.5 2.5 2.5 2.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 3.0\text{ Adc}$, $I_B = 0.4\text{ Adc}$) MJE16002 ($I_C = 3.0\text{ Adc}$, $I_B = 0.3\text{ Adc}$) MJE16004 ($I_C = 3.0\text{ Adc}$, $I_B = 0.4\text{ Adc}$, $T_C = 100^\circ\text{C}$) MJE16002 ($I_C = 3.0\text{ Adc}$, $I_B = 0.3\text{ Adc}$, $T_C = 100^\circ\text{C}$) MJE16004	$V_{BE(sat)}$	—	1.0 1.0 — —	1.5 1.5 1.5 1.5	Vdc
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$) MJE16002 MJE16004	h_{FE}	5.0 7.0	— —	— —	—

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f_{test} = 1.0\text{ kHz}$)	C_{ob}	—	—	200	pF
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SWITCHING CHARACTERISTICS

Resistive Load		MJE16002						
Delay Time	$(I_C = 3.0\text{ Adc}$, $V_{CC} = 250\text{ Vdc}$, $I_{B1} = 0.4\text{ Adc}$, $PW = 30\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$)	$(I_{B2} = 0.8\text{ Adc}$, $R_{B2} = 8.0\ \Omega$)	t_d	—	40	100	ns	
Rise Time			t_r	—	80	300		
Storage Time			t_s	—	900	3000		
Fall Time			t_f	—	20	300		
Storage Time			$(V_{BE(off)} = 5.0\text{ Vdc})$	t_s	—	330		—
Fall Time				t_f	—	100		—
Resistive Load		MJE16004						
Delay Time	$(I_C = 3.0\text{ Adc}$, $V_{CC} = 250\text{ Vdc}$, $I_{B1} = 0.3\text{ Adc}$, $PW = 30\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$)	$(I_{B2} = 0.6\text{ Adc}$, $R_{B2} = 8.0\ \Omega$)	t_d	—	40	100	ns	
Rise Time			t_r	—	110	300		
Storage Time			t_s	—	750	2700		
Fall Time			t_f	—	150	350		
Storage Time			$(V_{BE(off)} = 5.0\text{ Vdc})$	t_s	—	270		—
Fall Time				t_f	—	90		—

(1) Pulse Test: $PW = 300\ \mu\text{s}$, Duty Cycle $\leq 2\%$.

MJE16002, MJE16004

SWITCHING CHARACTERISTICS (continued)

Characteristics		Symbol	Min	Typ	Max	Unit
Inductive Load MJE16002						
Storage Time	$I_C = 3.0 \text{ Adc}$, $I_{B1} = 0.4 \text{ Adc}$	$(T_J = 100^\circ\text{C})$	t_{sv}	—	660	ns
Fall Time			t_{fi}	—	50	
Crossover Time			t_c	—	80	
Storage Time	$V_{BE(off)} = 5.0 \text{ Vdc}$, $V_{CE(pk)} = 400 \text{ Vdc}$	$(T_J = 150^\circ\text{C})$	t_{sv}	—	690	—
Fall Time			t_{fi}	—	50	
Crossover Time			t_c	—	90	
Inductive Load MJE16004						
Storage Time	$I_C = 3.0 \text{ Adc}$, $I_{B1} = 0.3 \text{ Adc}$	$(T_J = 100^\circ\text{C})$	t_{sv}	—	530	ns
Fall Time			t_{fi}	—	40	
Crossover Time			t_c	—	80	
Storage Time	$V_{BE(off)} = 5.0 \text{ Vdc}$, $V_{CE(pk)} = 400 \text{ Vdc}$	$(T_J = 150^\circ\text{C})$	t_{sv}	—	600	—
Fall Time			t_{fi}	—	40	
Crossover Time			t_c	—	80	

(1) Pulse Test: PW - 300 μs , Duty Cycle $\leq 2\%$.

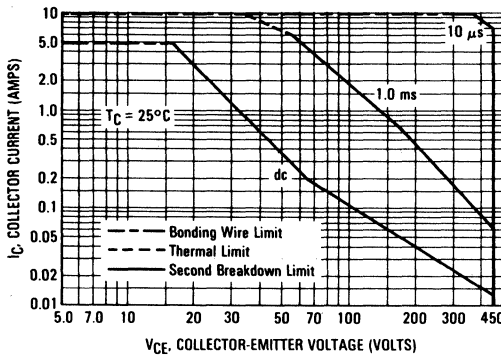


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

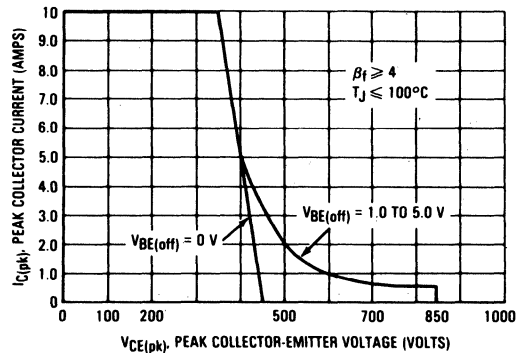


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

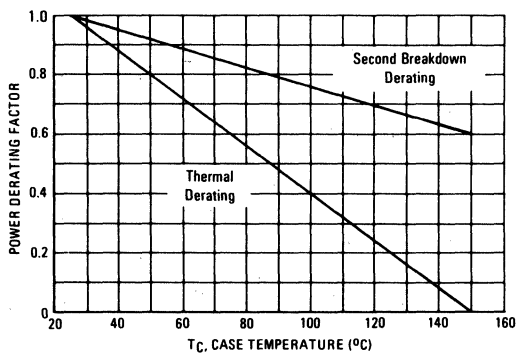


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

High-Speed Silicon N-P-N Power Transistors

Features:

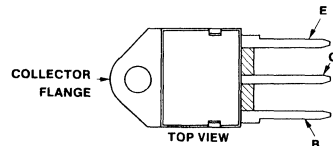
100° C Performance Specified for:

- Reverse-Biased SOA with inductive loads
- Switching times with inductive loads
- Saturation voltages
- Leakage currents

The MJH13090 and MJH13091 silicon n-p-n power transistors are designed for high-voltage, high-speed switching applications in inductive circuits where fall time is critical. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25° C and 100° C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-218AC plastic package.

TERMINAL DESIGNATION



92CS-40257

JEDEC TO-218AC

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$) (unless otherwise specified)

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	I_C	15	15	A
Peak (Repetitive) ⁽¹⁾	I_{CM}	20	20	
Base Current — Continuous	I_B	5	5	A
Peak (Non-Repetitive) ⁽¹⁾	I_{BM}	10	10	
Total Power Dissipation @ $T_c = 25^\circ\text{C}$	P_D	125	125	Watts
@ $T_c = 100^\circ\text{C}$		50	50	
Derate above 25° C		1	1	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: 1/8" from Case for 5 Seconds	T_L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle \leq 10%.

MJH13090, MJH13091**ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
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OFF CHARACTERISTICS⁽¹⁾

Collector-Emitter Sustaining Voltage ($I_C = 100\text{mA}$, $I_B = 0$)	MJH13090 MJH13091	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current ($V_{CEV} = \text{Rated Value}$, $V_{BE(OFF)} = -1.5\text{V}$) ($V_{CEV} = \text{Rated Value}$, $V_{BE(OFF)} = -1.5\text{V}$, $T_C = 100^\circ\text{C}$)		I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEV}$, $R_{BE} = 50\Omega$, $T_C = 100^\circ\text{C}$)		I_{CER}	—	—	3	mA
Emitter Cutoff Current ($V_{EB} = 6\text{V}$, $I_C = 0$)		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⁽¹⁾

DC Current Gain ($I_C = 10\text{A}$, $V_{CE} = 3\text{V}$)	h_{FE}	8	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 10\text{A}$, $I_B = 2\text{A}$) ($I_C = 15\text{A}$, $I_B = 3\text{A}$) ($I_C = 10\text{A}$, $I_B = 2\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{CE(sat)}$	— — —	— — —	1 3 2	V
Base-Emitter Saturation Voltage ($I_C = 10\text{A}$, $I_B = 2\text{A}$) ($I_C = 10\text{A}$, $I_B = 2\text{A}$, $T_C = 100^\circ\text{C}$)	$V_{BE(sat)}$	— —	— —	1.5 1.5	V

SWITCHING CHARACTERISTICS

Resistive Load							
Delay Time	$V_{CC} = 250\text{V}$, $I_C = 10\text{A}$ $I_{B1} = -I_{B2} = 1.25\text{A}$, $t_p = 30\ \mu\text{sec}$		t_d	—	0.03	0.05	μs
Rise Time			t_r	—	0.13	0.5	
Storage Time			t_s	—	0.55	2.5	
Fall Time			t_f	—	0.1	0.5	
Inductive Load, Clamped							
Storage Time	$I_{CC(PK)} = 10\text{A}$ $I_{B1} = 1.25\text{A}$	$(T_J = 100^\circ\text{C})$	t_{sv}	—	0.8	3	μs
Crossover Time			t_c	—	0.175	0.4	
Fall Time	$V_{BE(OFF)} = -5\text{V}$ $V_{CE(PK)} = 250\text{V}$	$(T_J = 25^\circ\text{C})$	t_{fi}	—	0.15	0.3	
Storage Time			t_{sv}	—	0.5	—	
Crossover Time			t_c	—	0.15	—	
Fall Time			t_{fi}	—	0.1	—	

(1) Pulse Test: Pulse Width - $300\ \mu\text{s}$ Duty Cycle $\leq 2\%$

TYPICAL ELECTRICAL CHARACTERISTICS

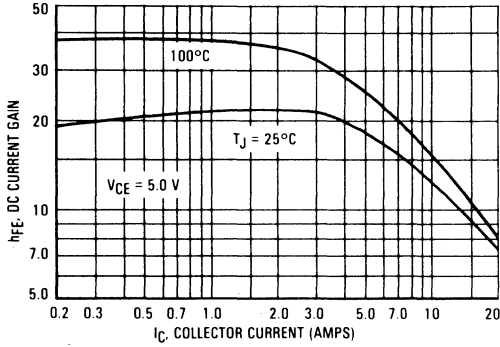


FIGURE 1 — DC CURRENT GAIN

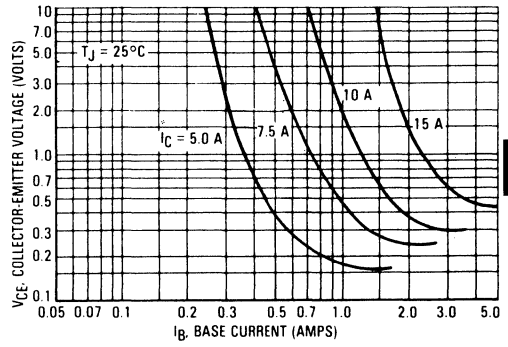


FIGURE 2 — COLLECTOR SATURATION REGION

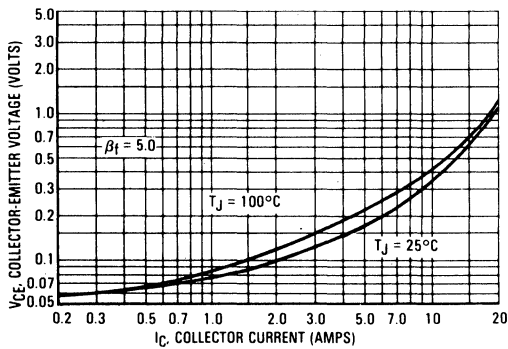


FIGURE 3 — COLLECTOR-EMITTER SATURATION VOLTAGE

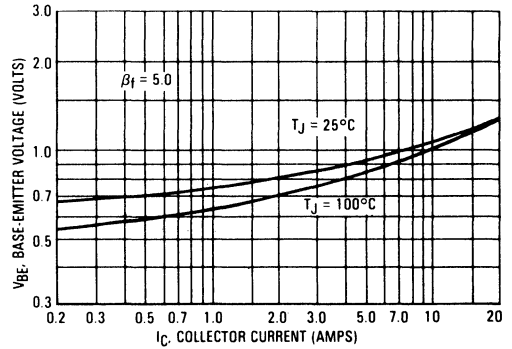


FIGURE 4 — BASE-EMITTER VOLTAGE

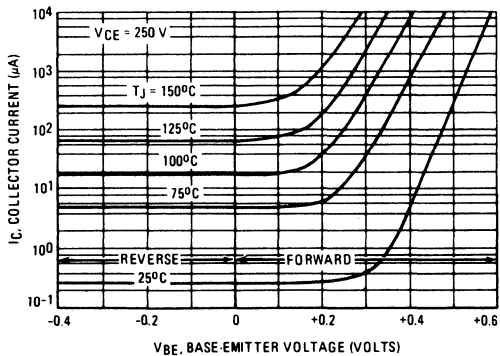


FIGURE 5 — COLLECTOR CUTOFF REGION

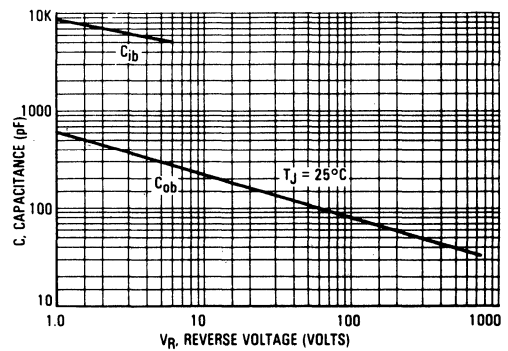


FIGURE 6 — CAPACITANCE

MJH13090, MJH13091

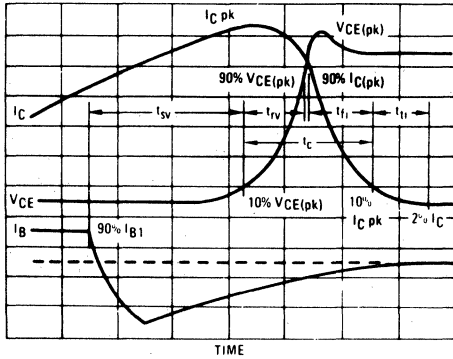


FIGURE 7 — INDUCTIVE SWITCHING MEASUREMENTS

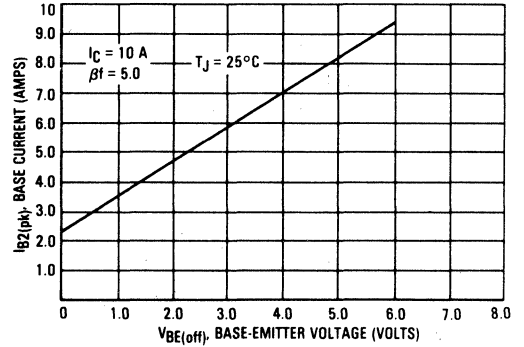


FIGURE 8 — PEAK REVERSE CURRENT

INDUCTIVE SWITCHING

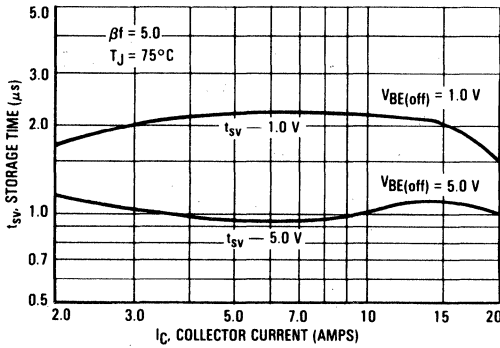


FIGURE 9 — STORAGE TIME

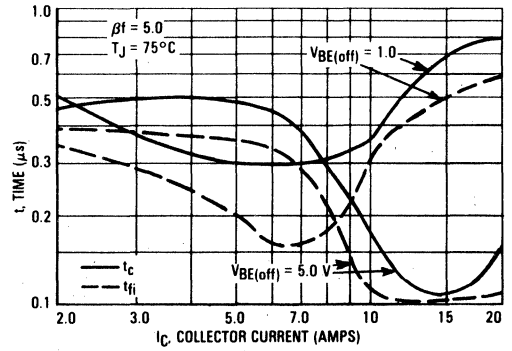


FIGURE 10 — CROSSOVER AND FALL TIMES

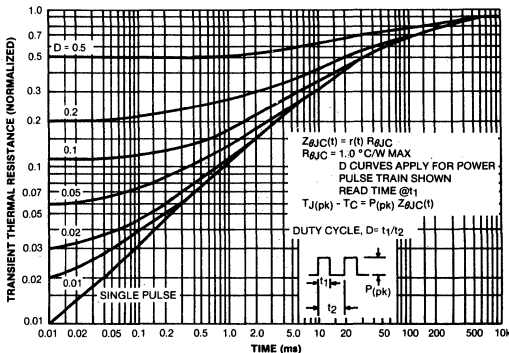


FIGURE 11 TYPICAL THERMAL RESPONSE [(Z_{thetaJC}(t))]

The Safe Operating Area figures shown in Figures 12 and 13 are specified for these devices under the test conditions shown.

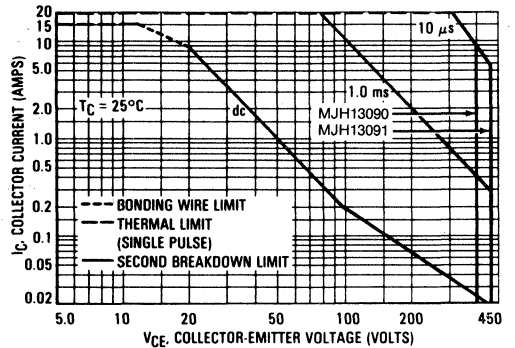


FIGURE 12 — FORWARD BIAS SAFE OPERATING AREA

MJH13090, MJH13091

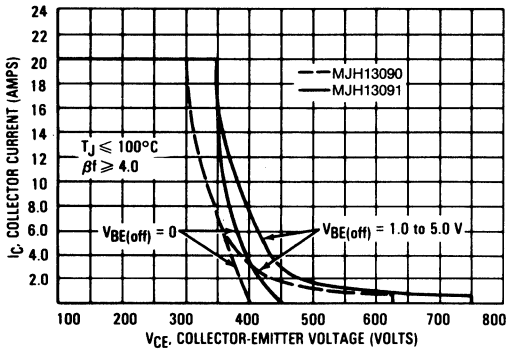


FIGURE 13 — REVERSE BIAS SAFE OPERATING AREA

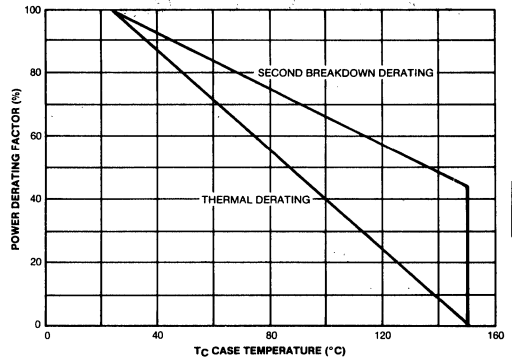


FIGURE 14 — POWER DERATING

8-Ampere Silicon N-P-N Darlington Power Transistors

For Use as Output Devices in General-Purpose
Switching and Amplifier Applications

Features:

- High dc current gain:
 $h_{FE} = 1000$ min. at $I_C = 3$ A
- Monolithic construction

RCA1000 and 1001 are monolithic silicon n-p-n Darlington transistors intended for medium-power applications as output devices. The construction of these units provides good forward-bias second-breakdown capability. Their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-204AA hermetic steel package.

TERMINAL DESIGNATIONS

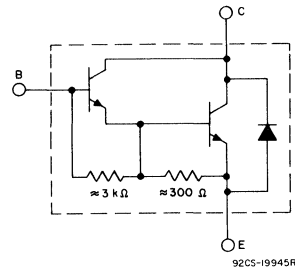
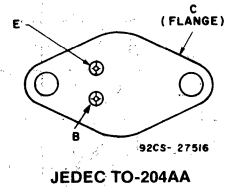


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA-1000	RCA-1001	
COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CB0}	60	80 V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CE0}	60	80 V
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EB0}	5	5 V
COLLECTOR CURRENT:			
Continuous	I_C	8	8 A
Pulsed		15	15 A
BASE CURRENT (Continuous)	I_B	0.1	0.1 A
TRANSISTOR DISSIPATION:			
At case temperatures up to 25°C	P_T	90	90 W
At case temperatures above 25°C, derate linearly at		0.515	W/°C
TEMPERATURE RANGE:			
Storage & Operating (Junction)		-55 to +200	°C
LEAD TEMPERATURE (During Soldering):			
At distance \geq 1/8 in. (3.17 mm) from case to 10 s max.		235	°C

RCA1000, RCA1001

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		DC VOLTAGE (V)			DC CURRENT (A)		RCA 1000		RCA 1001		
		V _{CB}	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I _{CEO}		30 40			0 0	— —	500 —	— —	— 500	μA
With external base-to-emitter resistance (R _{BE}) = 1 kΩ At T _C = 150°C	I _{CER}	60 80					— —	1 —	— —	— 1	mA
		60 80					— —	5 —	— —	— 5	
Emitter Cutoff Current	I _{EBO}			5	0		—	2	—	2	mA
Collector-to-Emitter Breakdown Voltage	V _{(BR)CEO}				0.1 ^a 0.1 ^a	0 0	60 —	— —	— 80	— —	V
DC Forward Current Transfer Ratio	h _{FE}		3 3		3 4		1000 750	— —	1000 750	— —	
Base-to-Emitter Voltage	V _{BE}		3		3 ^a		—	2.5	—	2.5	V
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}				3 ^a 8 ^a	0.012 0.04	— —	2 4	— —	2 4	V
Thermal Resistance (Junction-to-Case)	R _{θJC}						—	1.94	—	1.94	°C/W

^a Pulsed: Pulse duration ≤ 300 μs, duty factor ≤ 2%.

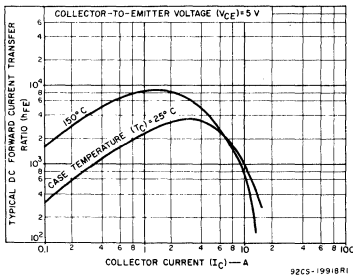


Fig. 2 — Typical dc beta characteristics for both types.

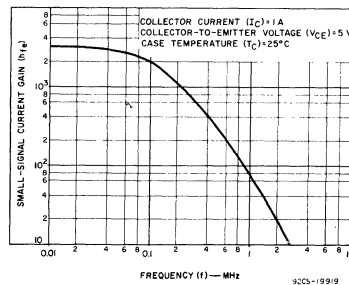


Fig. 3 — Typical small-signal gain for both types.

RCA1000, RCA1001

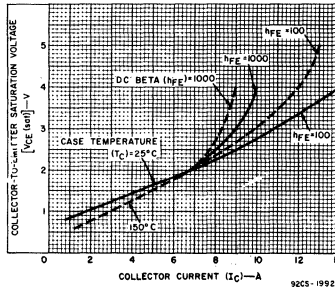


Fig. 4 — Typical saturation characteristics for both types.

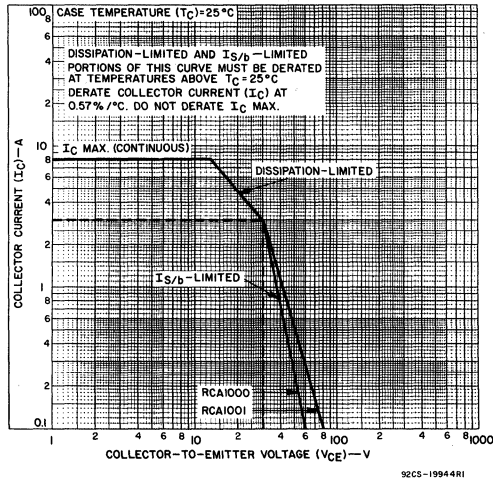
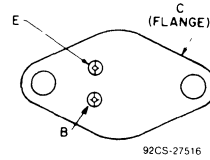


Fig. 5 — DC safe-area-of-operation for both types.

Silicon Transistors for Audio-Amplifier Applications

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA1B04 and RCA1B05 are silicon n-p-n transistors in a JEDEC TO-204AA package. They are especially suitable for applications in audio-amplifier circuits, in which they may be used as either driver or output unit.

These devices, together with a variety of other transistors that serve as input devices, V_{BE} amplifiers for biasing, current sources, load-line limiters (for overload protection), and predrivers, may be used to develop several hundred watts of audio output power in quasi-complementary-symmetry audio-amplifier configurations that employ parallel output transistors.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA1B04	RCA1B05	
V_{CBO}	225	275	V
V_{CEO}	200	250	V
$V_{CER} R_{BE} = 100 \Omega$	225	275	V
V_{EBO}	_____	5 _____	V
I_C	_____	7 _____	V
I_B	_____	2 _____	A
P_T	_____	150 _____	W
At $T_C \leq 25^\circ C$	_____	See Fig. 1	$^\circ C$
At $T_C > 25^\circ C$	_____	-65 to 150 _____	$^\circ C$
T_{stg}, T_J	_____	_____	$^\circ C$
T_L	_____	230 _____	$^\circ C$
At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	_____	_____	$^\circ C$

RCA1B04, RCA1B05

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS	LIMITS						UNITS
		RCA1B04▲		RCA1B05*		RCA1B09**		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER}	$V_{CE} = 120\text{ V}, R_{BE} = 100\ \Omega$ $V_{CE} = 200\text{ V}, R_{BE} = 100\ \Omega$	—	1	—	—	—	—	mA
I_{EBO}	$V_{EB} = 5\text{ V}, I_C = 0$	—	1	—	1	—	1	mA
V_{CEO}	$I_C = 0.2\text{ A}, I_B = 0$	200	—	250	—	250	—	V
V_{CER}	$I_C = 0.2\text{ A}, R_{BE} = 100\ \Omega$	225	—	275	—	275	—	V
f_T	$I_C = 0.2\text{ A}, V_{CE} = 10\text{ V}$ $I_C = 1\text{ A}, V_{CE} = 15\text{ V}$	5	—	5	—	—	5	MHz
h_{FE}	$I_C = 2\text{ A}, V_{CE} = 5\text{ V}$	15	75	15	75	40	—	
$V_{CE(sat)}$	$I_C = 2\text{ A}, I_B = 0.255\text{ A}$ $I_C = 2\text{ A}, I_B = 0.2\text{ A}$	—	2	—	2	—	1	V
V_{BE}	$I_C = 2\text{ A}, V_{CE} = 5\text{ V}$	0.75	1.75	0.75	1.75	—	1	V
$I_{S/b}$	$V_{CE} = 120\text{ V}, t = 1\text{ s}$ $V_{CE} = 140\text{ V}, t = 1\text{ s}$ $V_{CE} = 80\text{ V}, t = 1\text{ s}$	1.25	—	—	—	—	—	A

- ▲ For characteristics curves and test conditions, refer to published data for prototype 2N5239 (File 321).
- * For characteristics curves and test conditions, refer to published data for prototype 2N5240 (File 321).
- ** For characteristics curves and test conditions, refer to published data for prototype 2N6510 (File 848).

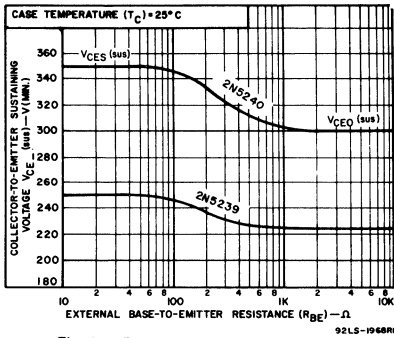


Fig. 1 — Derating curves for all types.

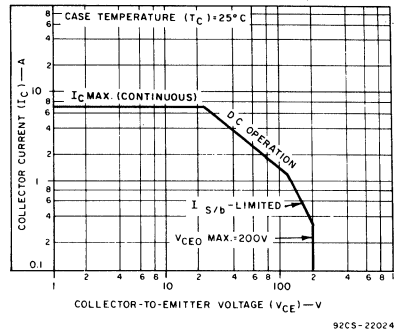


Fig. 2 — Maximum operating areas for RCA1B04.

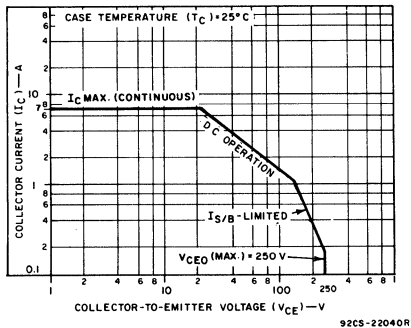


Fig. 3 — Maximum operating areas for RCA1B05.

Silicon N-P-N VERSAWATT Transistors

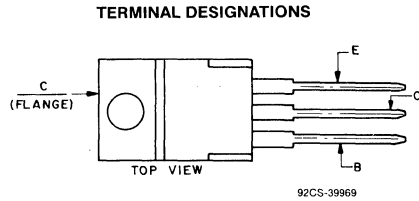
Designed for Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

Features:

- Maximum safe-area-of-operation curves
- Low saturation voltages
- High dissipation ratings

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits



RCA3054 and RCA3055 are silicon n-p-n transistors intended for a wide variety of high-current applications. The construction of these devices renders them highly resistant to second breakdown over a wide range of operating conditions.

The VERSAWATT case has a proven thermal-cycle capability. This capability is assured by real-time quality controls in our manufacturing locations. The RCA3054 and RCA3055 are supplied in the JEDEC TO-220AB straight-lead version of the package. They are also available on special order in a variety of lead-form configurations.

MAXIMUM RATINGS, Absolute-Maximum Values:

		RCA3054	RCA3055	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	90	100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	60	70	V
With base open	$V_{CEO}(sus)$	55	60	V
With base reverse-biased $V_{BE} = -1.5$ V	$V_{CEV}(sus)$	90	90	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	15	A
CONTINUOUS BASE CURRENT	I_B	2	4	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		36	75	W
At case temperatures above 25°C			See Fig.3	
TEMPERATURE RANGE:				
Storage and Operating (Junction)		-65 to +150		°C
PIN TEMPERATURE (During Soldering):				
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.		235		°C

RCA3054, RCA3055ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS	
		VOLTAGE V dc			CURRENT A dc		RCA3054		RCA3055			
		V _{CE}	V _{EB}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.		
Collector-Cutoff Current: With base open	I _{CEO}	30				0	—	0.5	—	0.7	mA	
With base-emitter junction reverse-biased	I _{CEX}	90 100		—1.5 —1.5			— —	1 —	— —	— 5		
At T _C = 150°C	I _{CEX}	90 100		—1.5 —1.5			— —	6 —	— —	— 30		
Emitter-Cutoff Current	I _{EBO}		7			0	—	1.0	—	5	mA	
Collector-to-Emitter Sustaining Voltage: With base open	V _{CEO(sus)}					0.1 ^a 0.2 ^a	0 0	55 —	— —	60 —	V	
With external base-to- emitter resistance (R _{BE}) = 100 Ω	V _{CER(sus)}					0.1 ^a 0.2 ^a		60 —	— —	70 —		
With base-emitter junction reverse-biased	V _{CEV(sus)}			—1.5		0.1 ^a		90 —	— —	90 —		
DC Forward-Current Transfer Ratio	h _{FE}	4 4 4 4				3 ^a 10 ^a 0.5 ^a 4 ^a		5 — 25 —	— — 100 —	— 5 — 20	— — 70	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}					0.5 ^a 4 ^a	0.05 ^a 0.4 ^a	— —	1.0 —	— —	— 1.1	V
Base-to-Emitter Voltage	V _{BE}	4 4				0.5 ^a 4 ^a		— —	1.7 —	— —	— 1.8	V
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio Cutoff Frequency	f _{hfe}	4 4				0.1 1		30 —	— —	— 10	— —	kHz
Magnitude of Common- Emitter, Small-Signal Short-Circuit Forward Current Transfer Ratio (f = 0.4 MHz)	|h _{fe}|	4 4				0.1 1		2 —	— —	8 —	— —	
Common-Emitter, Small-Signal, Short- Circuit Forward Current Transfer Ratio (f = 1 kHz)	h _{fe}	4 4				0.1 1		25 —	— —	— 15	— 120	
Forward-Bias Second Breakdown Collector Current ^b (t ≥ 1 s)	I _{S/b}	55 60						0.65 —	— —	— 1.2	— —	A
Thermal Resistance: Junction-to-Case	R _{θJC}							—	3.5	—	1.67	°C/W
Junction-to-Ambient	R _{θJA}							—	70	—	70	

^a Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.^b Pulsed: 1-second non-repetitive pulse.

RCA3054, RCA3055

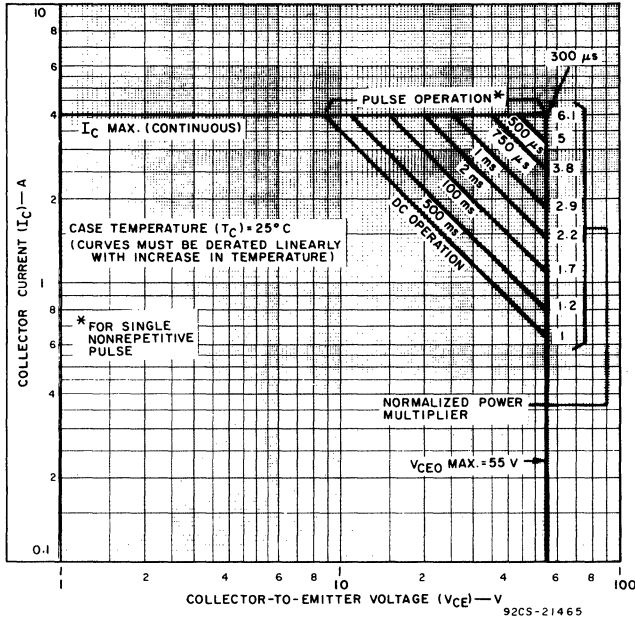


Fig. 1 — Maximum operating areas for RCA3054.

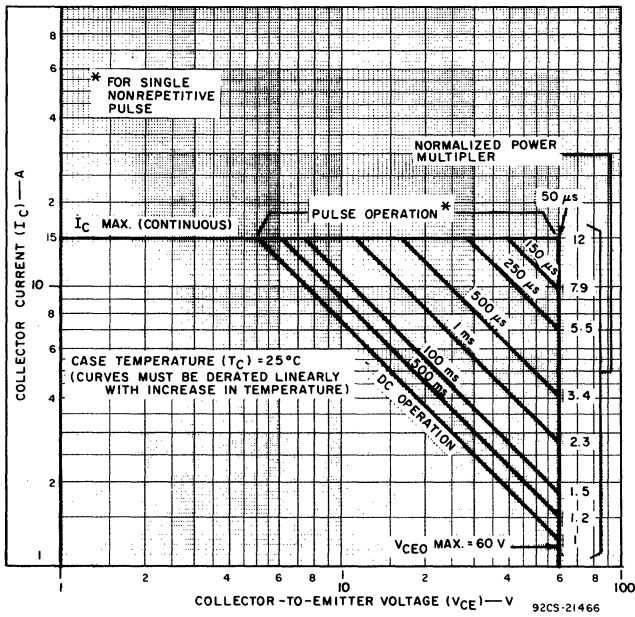


Fig. 2 — Maximum operating areas for RCA3055.

RCA3054, RCA3055

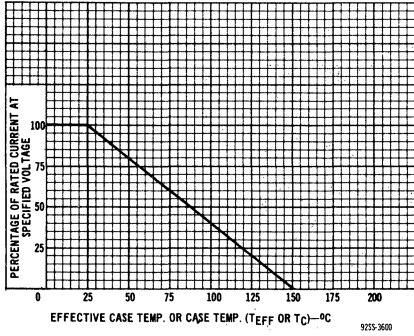


Fig. 3 — Derating curve for both types.

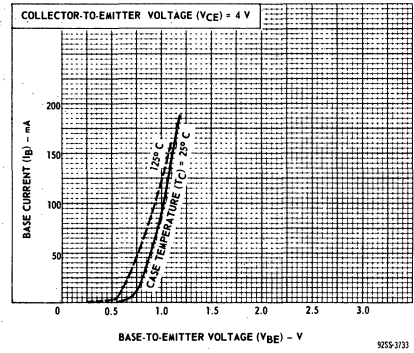


Fig. 4 — Typical input characteristics for RCA3054.

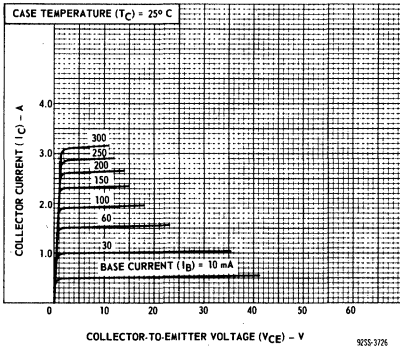


Fig. 5 — Typical output characteristics for RCA3054.

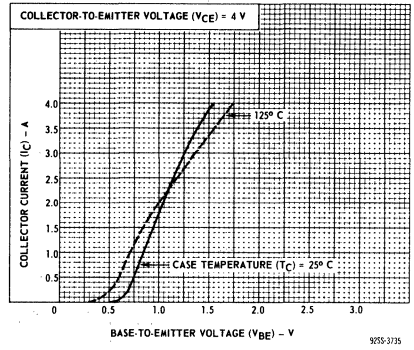


Fig. 6 — Typical transfer characteristics for RCA3054.

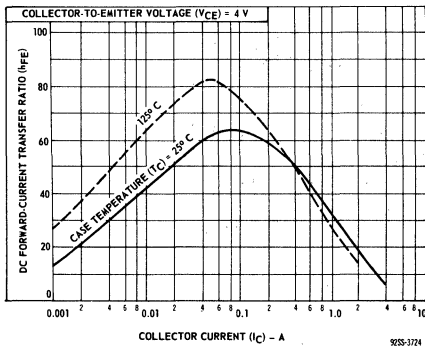


Fig. 7 — Typical dc beta characteristics for RCA3054.

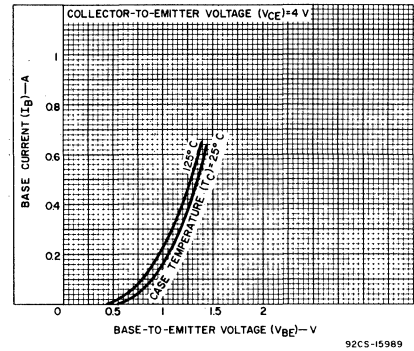


Fig. 8 — Typical input characteristics for RCA3055.

RCA3054, RCA3055

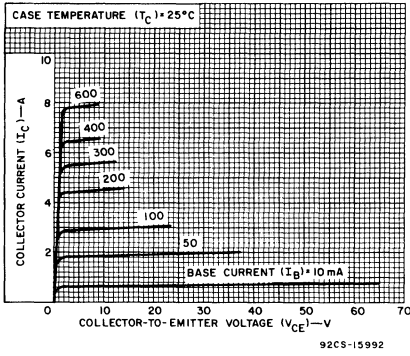


Fig. 9 — Typical output characteristics for RCA3055.

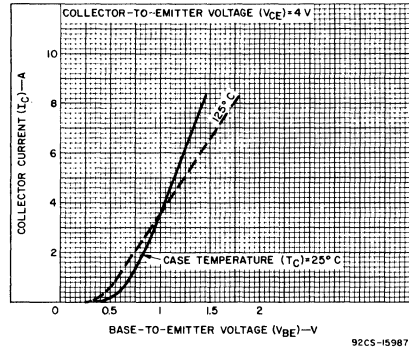


Fig. 10 — Typical transfer characteristics for RCA3055.

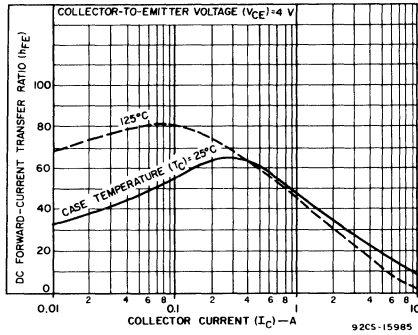


Fig. 11 — Typical dc beta characteristics for RCA3055.

Silicon N-P-N Epitaxial-Base High Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

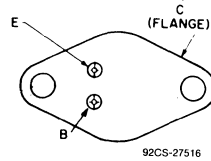
Features:

- High-dissipation capability
- Low saturation voltages
- Maximum safe-area-of-operation curves
- $f_T = 2$ MHz
- High gain at high current

Applications:

- Series and shunt regulators
- High-fidelity amplifiers
- Power-switching circuits
- Solenoid drivers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA3773, MJ15003, RCA8638C, RCA8638D, and RCA8638E are ballasted epitaxial-base silicon n-p-n transistors featuring high gain at high current. They may be used as complements to the p-n-p types 2N6609, MJ15004, RCA9116C, RCA9116D, and RCA9116E, respectively.

They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the steel JEDEC TO-204AA packages.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA3773	MJ15003	RCA8638C	RCA8638D	RCA8638E	
V_{CBO}	160	140	140	120	100	V
$V_{CEX(SUS)}$ $V_{BE} = -1.5$ V; $R_{BE} = 100 \Omega$	160	—	—	—	—	V
$V_{CER(SUS)}$ $R_{BE} = 100 \Omega$	150	150	150	130	110	V
$V_{CEO(SUS)}$	140	140	140	120	100	V
V_{EBO}	7	—	—	5	—	V
I_C	—	—	20	—	—	A
I_B	—	—	5	—	—	A
P_T At $T_C \leq 25^\circ\text{C}$	150	250	200	200	200	W
At $T_C > 25^\circ\text{C}$ Derate Linearly.....	0.857	1.43	—	1.14	—	W/ $^\circ\text{C}$
T_{stg}, T_J	—	—	-65 to +200	—	—	$^\circ\text{C}$
T_L At distance $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.	—	—	230	—	—	$^\circ\text{C}$

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS			LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc	RCA3773		MJ15003		
	V _{CE}	V _{BE}		Min.	Max.	Min.	Max.	
I _{CBO}	160 ^a 140 ^a			–	4 2	–	– 1	mA
I _{CEX}	140	–1.5		–	1	–	0.1	
I _{CEX} T _C = 150°C	140	–1.5		–	5	–	2	
I _{CEO} I _B = 0	140 120			–	– 1	–	0.25 –	
I _{EBO}	– –	7 5		–	1	–	– 0.1	
h _{FE}	4 4 2 2		8 ^c 16 ^c 5 ^c 10 ^c	15 5 – –	60 – – –	– – 25 10	– – 150 –	V
V _{CEX(sus)} ^b R _{BE} = 100Ω		–1.5	0.2	160	–	–	–	
V _{CER(sus)} ^b R _{BE} ≤ 100Ω			0.2	150	–	150	–	
V _{CEO(sus)} ^b			0.2	140	–	140	–	
V _{EBO} I _E = 1 mA			0	7	–	5 ^d	–	
V _{BE}	4 2		8 ^c 5 ^c	– –	2.2 –	– –	– 2	
V _{CE(sat)} I _B = 3.2A = 0.8A = 0.5A			16 ^c 8 ^c 5 ^c	– – –	4 1.4 –	– – –	– – 1	
I _{S/b} t _p = 1 s nonrep.	100 50			1.5 –	– –	1 5	– –	A
|h _{fe}| f = 0.5 MHz	10		0.5	4	–	4	–	
f _T				2	–	2	–	MHz
h _{fe} f = 1 kHz	4		1	40	–	–	–	
C _{ob} f = 0.1 MHz	10 ^a			–	500	–	500	pF
R _{θJC}	10		10	–	1.17	–	0.7	°C/W

See page 3 for footnotes.

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) = 25°C
Unless Otherwise Specified (Cont'd)

CHARAC- TERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE V dc		CUR- RENT A dc	RCA8638C		RCA8638D		RCA8638E		
	V _{CE}	V _{BE}	I _C	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CBO}	140 ^a			—	1	—	—	—	—	mA
	120 ^a			—	—	—	1	—	—	
	100 ^a			—	—	—	—	—	1	
I _{CEX}	140	1.5		—	1	—	—	—	—	mA
	120	1.5		—	—	—	1	—	—	
I _{CEX} T _C = 150°C	140	1.5		—	5	—	—	—	—	mA
	120	1.5		—	—	—	5	—	—	
I _{CEO} I _B = 0	70			—	1	—	—	—	—	mA
	60			—	—	—	1	—	—	
I _{EBO}	—	5		—	1	—	1	—	1	
h _{FE}	2		5 ^c	25	150	25	150	—	—	V
	2		7.5 ^c	—	—	—	—	10	100	
	2		10 ^c	10	—	10	—	—	—	
V _{CER(sus)} ^b R _{BE} ≤ 100Ω			0.2	150	—	130	—	110	—	V
V _{CEO(sus)} ^b			0.2	140	—	120	—	100	—	
V _{EBO} I _E = 1 mA			0	5	—	5	—	5	—	
V _{BE}	2		7.5 ^c	—	—	—	—	—	3	V
	2		5 ^c	—	2	—	2	—	—	
V _{CE(sat)} I _B = 0.75A = 0.5A			7.5 ^c 5 ^c	— —	— 1	— —	— 1	— —	1.5 —	
I _{S/b} t _p = 1 s nonrep.	35			5.71	—	5.71	—	—	—	A
	25			—	—	—	—	8	—	
|h _{fe}| f = 0.5 MHz	10		0.5	4	—	4	—	4	—	
f _T				2	—	2	—	2	—	MHz
C _{ob} f = 0.1 MHz	10 ^a			—	500	—	500	—	500	pF
R _{θJC}	10		10	—	0.875	—	0.875	—	0.875	°C/W

^a V_{CB}

^b CAUTION: Sustaining voltages V_{CEX(sus)}, V_{CER(sus)}, and V_{CEO(sus)} **MUST NOT** be measured on a curve tracer. See Figs. 8 and 9.

^c Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

^d Measured at I_E = -0.1 mA.

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

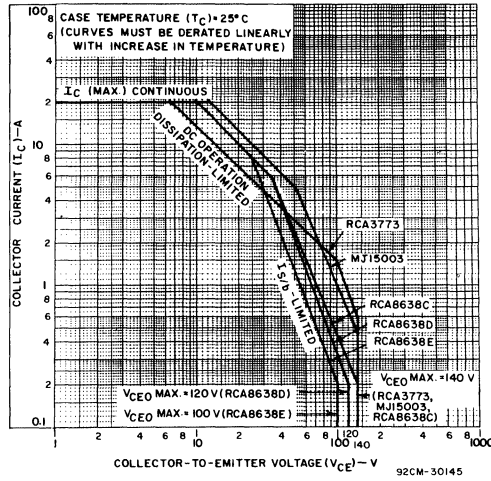


Fig. 1 - Maximum operating areas for all types.

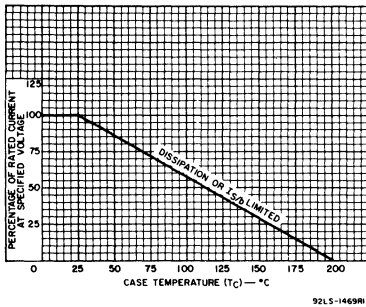


Fig. 2 - Current derating curve for all types.

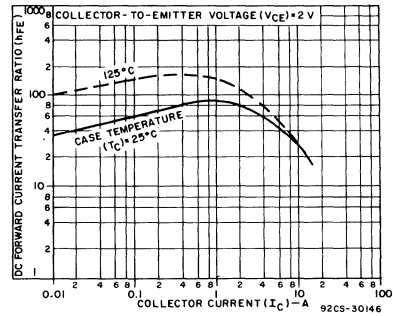


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

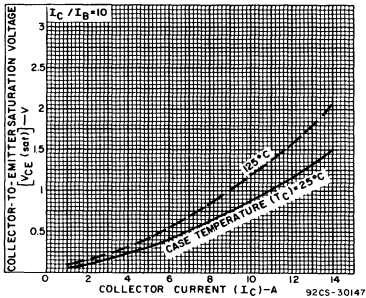


Fig. 4 - Typical saturation voltage characteristics for all types.

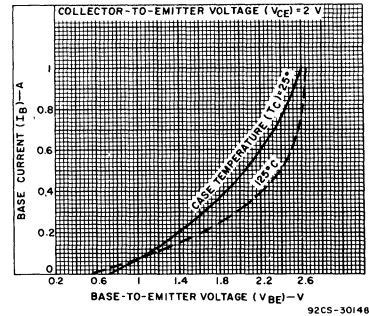


Fig. 5 - Typical input characteristics for all types.

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

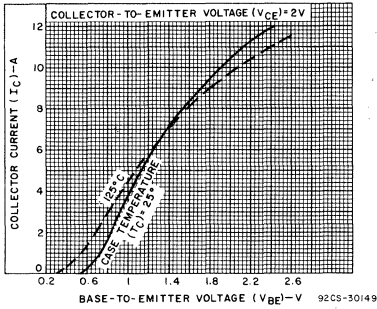


Fig. 6 - Typical transfer characteristics for all types.

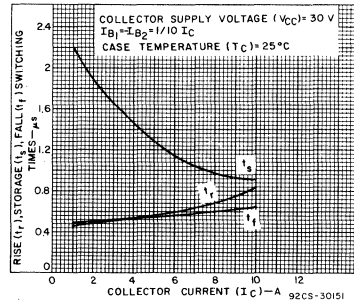


Fig. 7 - Typical saturated-switching times for all types.

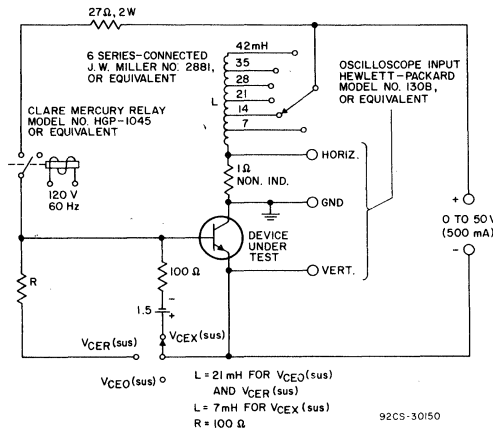
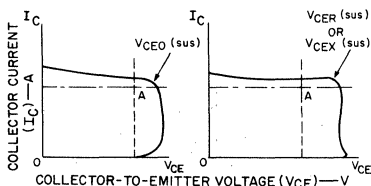


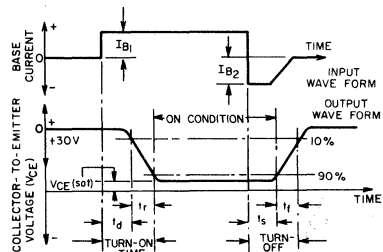
Fig. 8 - Circuit used to measure sustaining voltages $V_{CE0}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.



NOTE: The sustaining Voltages $V_{CE0}(sus)$, $V_{CER}(sus)$ or $V_{CEX}(sus)$ are acceptable when the trace falls to the right and above point "A". (For values of current and voltage, see Electrical Characteristics.)

92CS-15224R1

Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).



92CS-24797R1

Fig. 10 - Oscilloscope display for measurement of switching times for all types.

25-A Silicon N-P-N Power Transistors

N-P-N Types for Power Supplies and Other High Voltage Switching Applications

Features:

- *Fast switching speed*
- *Low $V_{CE(sat)}$*
- *Steel hermetic TO-204AA package*

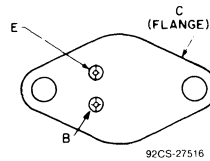
RCA6340 and RCA6341 silicon n-p-n power transistors which feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

These high-current, high-speed transistors are 100-percent tested for parameters that are essential to the design of high-power switching circuits.

The RCA6340 and RCA6341 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

These types are similar to the 2N6340 and 2N6341 except for the C_{ob0} , h_{FE} measured at I_C of 0.5A, and I_{B1} , I_{B2} conditions for switching times.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute Maximum Values:

	RCA6340	RCA6341	
V_{CB0}	160	180	V
V_{CE0}	140	150	V
V_{EB0}		3	V
I_C		25	A
I_{CM}		50	A
I_B		10	A
P_T			
T_C up to 25°C		200	W
T_C above 25°C, derate linearly		1.143	W/°C
T_{stg}, T_J		-65 to 200	°C
T_L			
At distance $\geq 1/16$ in. (1.58 mm) from seating plane for 10 s max.		235	°C

RCA6340, RCA6341

ELECTRICAL CHARACTERISTICS, at Case Temperature $T_c = 25^\circ\text{C}$ Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		RCA6340		RCA6341		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	
I _{CEV}	150	-1.5	—	—	—	10	—	—	μA
	150	-1.5	—	—	—	—	—	10	
T _C = 150°C	140	-1.5	—	—	—	1	—	—	mA
	150	-1.5	—	—	—	—	—	1	
I _{CBO}	160°C	—	—	—	—	10	—	—	μA
	180°C	—	—	—	—	—	—	10	
I _{EBO}	—	-6	0	—	—	100	—	100	
V _{CEO(sus)} ^b	—	—	0.05 ^a	0	140	—	150	—	V
h _{FE}	2	—	0.5 ^a	—	30	—	30	—	
	2	—	10 ^a	—	30	120	30	120	
	2	—	25 ^a	—	12	—	12	—	
V _{BE}	2	—	10 ^a	—	—	1.8	—	1.8	V
V _{BE(sat)}	—	—	10 ^a	1	—	1.8	—	1.8	
	—	—	25 ^a	2.5	—	2.5	—	2.5	
V _{CE(sat)}	—	—	10 ^a	1	—	1	—	1	
	—	—	25 ^a	2.5	—	1.8	—	1.8	
I _{s/b}	18	—	11.1	—	1	—	1	—	s
h _{fe} f = 5 MHz	10	—	1	—	8	—	8	—	
f _T	10	—	1	—	40	—	40	—	MHz
C _{obo} f = 0.1 MHz	10 ^c	—	—	—	—	600	—	600	pF
t _r ^d	—	-6	10	0.5	—	0.3	—	0.3	μs
t _s ^d	—	-6	10	0.5 ^e	—	2.0	—	2.0	
t _f ^d	—	-6	10	0.5 ^e	—	0.25	—	0.25	
R _{θJC}	10	—	5	—	—	0.875	—	0.875	°C/W

^a Pulsed; pulse duration = 300 μs , duty factory $\leq 2\%$.^b **CAUTION:** The sustaining voltage V_{CEO(sus)} MUST NOT be measured on a curve tracer.^c V_{CB} value.^d V_{CC} = 80 V, t_p = 10 μs .^e I_{B1} = -I_{B2}.

RCA6340, RCA6341

2

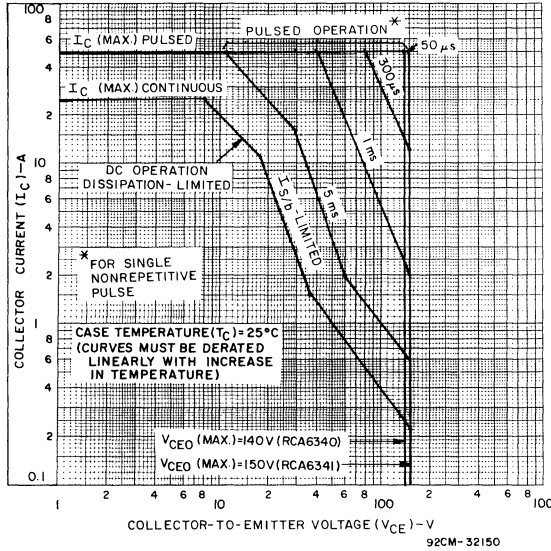


Fig. 1 - Maximum operating areas for both types.

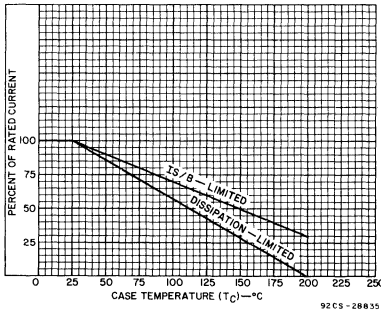


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for both types.

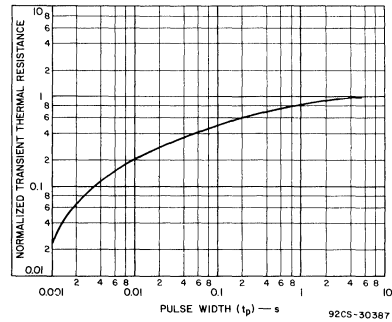


Fig. 3 - Typical thermal-response characteristic for both types.

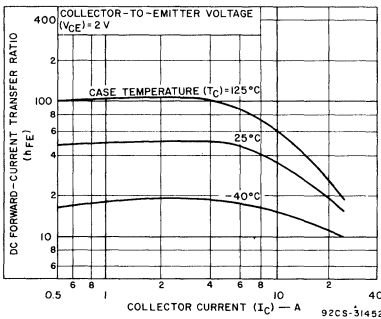


Fig. 4 - Typical dc beta characteristics for both types.

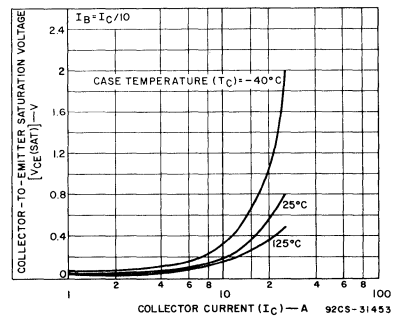


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for both types.

RCA6340, RCA6341

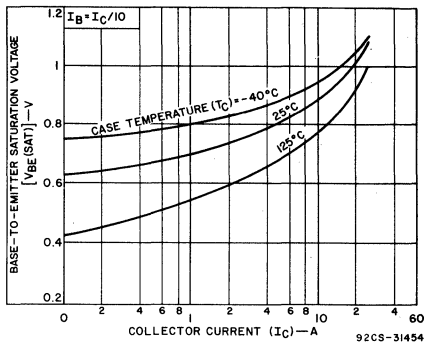


Fig. 6 - Typical base-to-emitter saturation voltage characteristic for both types.

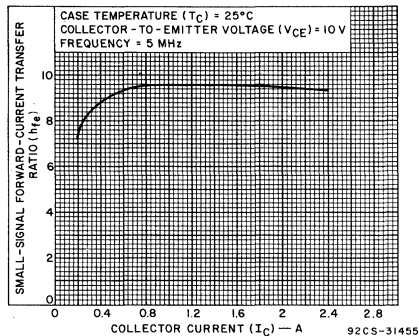


Fig. 7 - Typical small-signal forward-current transfer ratio characteristic for both types ($f = 5$ MHz).

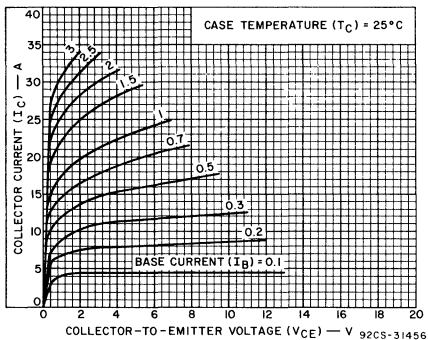


Fig. 8 - Typical output characteristics for both types.

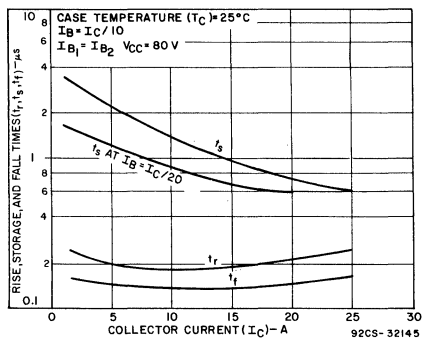


Fig. 9 - Typical saturated-switching-time characteristics as a function of collector current for both types.

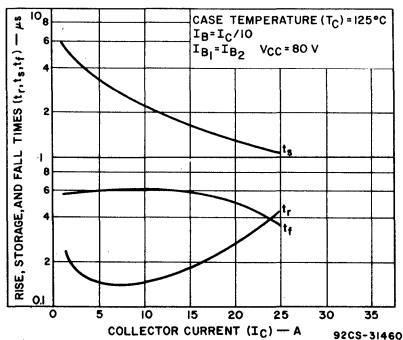


Fig. 10 - Typical saturated-switching-time characteristics at $T_C = 125^\circ C$ as a function of collector current for both types.

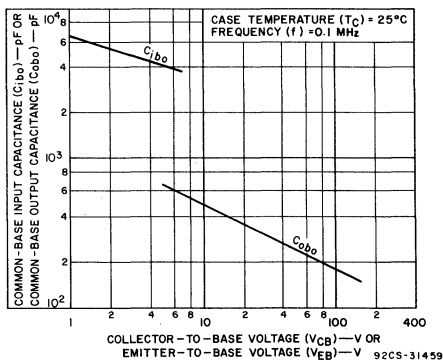


Fig. 11 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for both types.

RCA6340, RCA6341

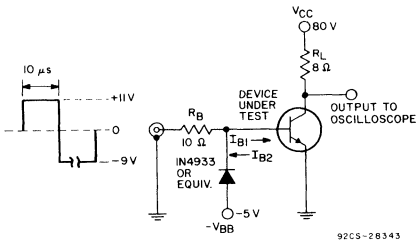


Fig. 12 - Switching-time test circuit.

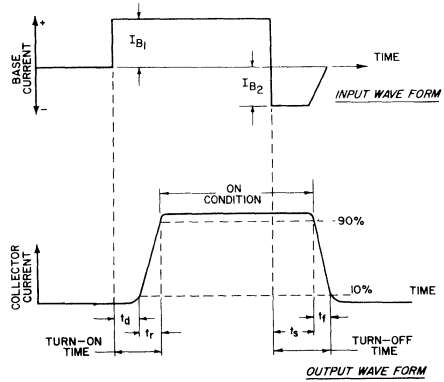


Fig. 13 - Phase relationship between input current and output current showing reference points for specification of switching times.

10-Ampere N-P-N Monolithic Darlington Power Transistors

350, 400, 450 Volts, 150 Watts

Gain of 100 at 4, 6A

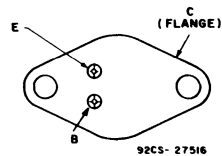
Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Automotive Ignition
- Solenoid drivers
- Series and shunt regulators

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 8766 Series* are monolithic n-p-n silicon Darlington transistors designed for automotive electronic power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

The devices in the series differ primarily in voltage ratings and in the current at which the dc gain is specified.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

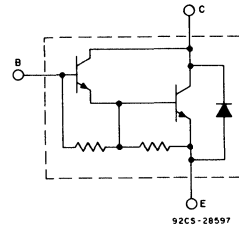


Fig. 1 - Schematic diagram for all types.

*Formerly RCA Dev. Nos. TA8766 Series.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA8766 RCA8766A	RCA8766B RCA8766C	RCA8766D RCA8766E	
V_{CBO}	350	400	450	V
$V_{CER(sus)}$ $R_{BE} = 50 \Omega$	350	400	450	V
$V_{CEO(sus)}$	350	400	450	V
V_{EBO}	5	5	5	V
I_C	10	10	10	A
I_{CM}	15	15	15	A
I_B	1	1	1	A
P_T				
$T_C \leq 25^\circ C$	150	150	150	W
$T_C > 25^\circ C$	See Fig. 2			
T_{stg}, T_J	-65 to +175			$^\circ C$
T_L	At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.			$^\circ C$
	235			

RCA8766 Series

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C) 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE	CURRENT		RCA8766		RCA8766B		RCA8766D		
	V dc	A dc		RCA8766A		RCA8766C		RCA8766E		
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER} $R_{BE} = 50 \Omega$	350			—	1	—	—	—	—	mA
	400			—	—	—	1	—	—	
	450			—	—	—	—	—	1	
$T_C = 150^\circ C$	350			—	10	—	—	—	—	
	400			—	—	—	10	—	—	
	450			—	—	—	—	—	10	
I_{EBO} $V_{BE} = -5 V$		0		—	60	—	60	—	60	mA
$V_{CEO(sus)}$		0.2 ^a	0	350	—	400	—	450	—	V
h_{FE}	RCA8766	3	6 ^a	100	—	—	—	—	—	
	RCA8766A	3	4 ^a	100	—	—	—	—	—	
	RCA8766B	3	6 ^a	—	—	100	—	—	—	
	RCA8766C	3	4 ^a	—	—	100	—	—	—	
	RCA8766D	3	6 ^a	—	—	—	—	100	—	
	RCA8766E	3	4 ^a	—	—	—	—	100	—	
V_{BE}	RCA8766	3	6 ^a	—	2.5	—	—	—	—	V
	RCA8766A	3	4 ^a	—	2.5	—	—	—	—	
	RCA8766B	3	6 ^a	—	—	—	2.5	—	—	
	RCA8766C	3	4 ^a	—	—	—	2.5	—	—	
	RCA8766D	3	6 ^a	—	—	—	—	—	2.5	
	RCA8766E	3	4 ^a	—	—	—	—	—	2.5	
$V_{CE(sat)}$	RCA8766		6 ^a	0.2 ^a	—	1.5	—	—	—	V
	RCA8766A		4 ^a	0.133 ^a	—	1.5	—	—	—	
	RCA8766B		6 ^a	0.2 ^a	—	—	—	1.5	—	
	RCA8766C		4 ^a	0.133 ^a	—	—	—	1.5	—	
	RCA8766D		6 ^a	0.2 ^a	—	—	—	—	1.5	
	RCA8766E		4 ^a	0.133 ^a	—	—	—	—	1.5	
	All Types		8 ^a	0.5 ^a	—	2.5	—	2.5	—		2.5
V_F		7 ^a		—	2	—	2	—	2	V
$|h_{fe}|$ $f = 1 \text{ MHz}$	5	1		10	—	10	—	10	—	
$I_{S/b}$ $t = 1 \text{ s, nonrep.}$	30			5	—	5	—	5	—	A
$R_{\theta JC}$				—	1	—	1	—	1	$^\circ C/W$

^a Pulsed: Pulse duration = 300 μs , duty factor = 1.8%.

RCA8766 Series

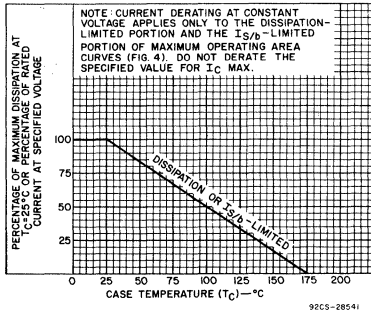


Fig. 2 — Derating curves for all types.

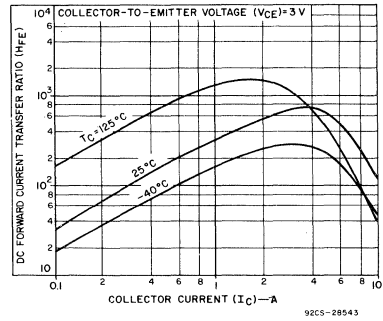


Fig. 3 — Typical DC beta characteristics for all types.

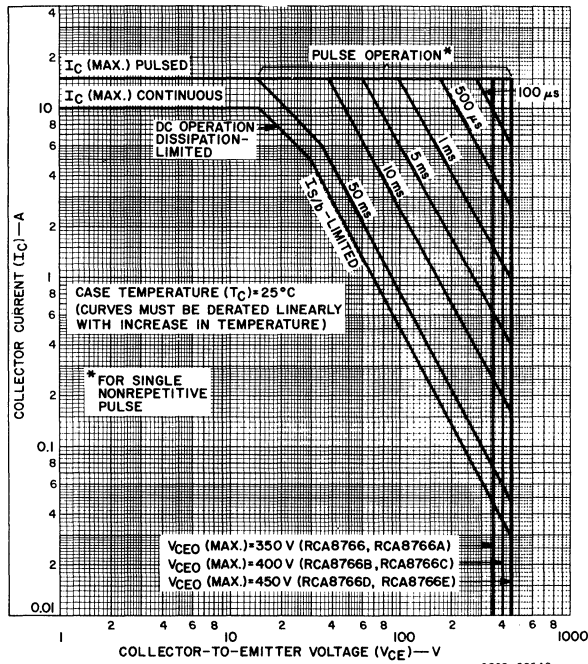


Fig. 4 — Maximum operating areas for all types.

RCA8766 Series

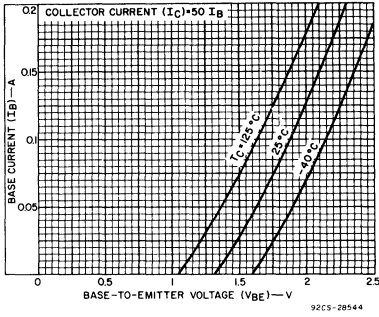


Fig. 5 — Typical input characteristics for all types.

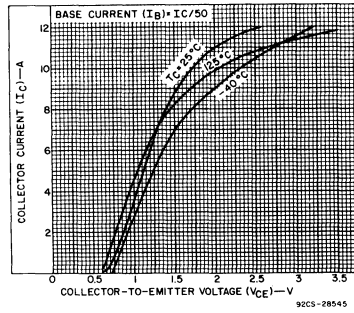


Fig. 6 — Typical output characteristics for all types.

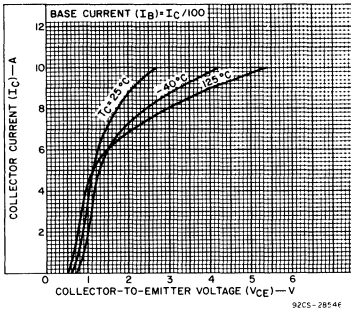


Fig. 7 — Typical output characteristics for all types.

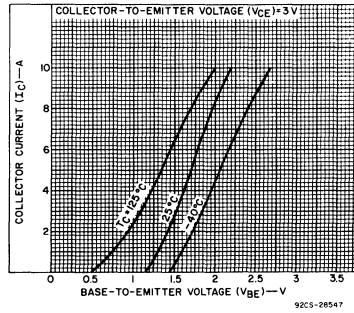


Fig. 8 — Typical transfer characteristics all types.

Silicon N-P-N Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commercial Use

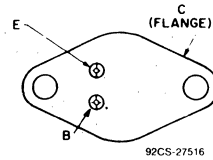
Features:

- High dissipation capability
- Maximum safe-area-of-operation curves
- High voltage
- High gain at high current

Applications:

- High-fidelity amplifiers
- Series and shunt regulators
- Linear/power amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA9166A*, RCA9166B*, MJ15022, and MJ15024 are ballasted multiple-epitaxial silicon n-p-n transistors featuring high gain at high current and high voltage. They differ from each other in voltage ratings, safe-operating-area (SOA) ratings, and the currents at which the parameters are controlled.

All these types are supplied in the JEDEC TO-204AA steel hermetic package.

*Formerly RCA Dev. Type Nos. TA9166A and TA9166B, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA9166A	RCA9166B	MJ15024	MJ15022	
V _{CB0}	—	—	400	350	V
V _{CER(SUS)} R _{BE} = 100 Ω	275	225	275	225	V
V _{CEO(SUS)}	250	200	250	200	V
V _{EBO}	—	5	—	—	V
I _C	—	16	—	—	A
I _{CM}	—	30	—	—	A
I _B	—	5	—	—	A
P _T	—	—	—	—	—
At T _C ≤ 25° C	—	250	—	—	W
At T _C > 25° C	—	1.43	—	—	W/° C
Derate linearly	—	—	—	—	—
T _{stg} , T _J	—	-65 to 200	—	—	° C
T _L	—	—	—	—	—
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	—	230	—	—	° C

RCA9166A, RCA9166B, MJ15022, MJ15024

ELECTRICAL CHARACTERISTICS, at Case Temperature (T_C)=25°C

Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS			LIMITS								UNITS
	VOLTAGE		CUR-RENT	RCA9166A		RCA9166B		MJ15024		MJ15022		
	V dc	V BE	I C A dc	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CBO}	400 ^a			—	—	—	—	—	1	—	—	mA
	350 ^a			—	—	—	—	—	—	—	1	
I _{CEO}	200			—	1	—	—	—	0.5	—	—	mA
	150			—	—	—	1	—	—	—	0.5	
I _{CEX}	400	-1.5		—	—	—	—	—	0.5	—	0.5	mA
	250	-1.5		—	—	—	—	—	0.25	—	—	
	200	-1.5		—	—	—	—	—	—	—	0.25	
I _{CER} R _{BE} =100 Ω, T _C =150°C	200			—	4	—	—	—	4	—	—	mA
	150			—	—	—	4	—	—	—	4	
h _{FE}	4		3 ^c	30	—	30	—	—	—	—	—	V
	4		5 ^c	20	—	20	—	—	—	—	—	
	4		8 ^c	—	—	—	—	15	60	15	60	
	4		16 ^c	3.2	—	3.2	—	5	—	5	—	
V _{CEO(sus)} ^b			0.1	250	—	200	—	250	—	200	—	V
V _{CER(sus)} ^b R _{BE} =100 Ω			0.1	275	—	225	—	275	—	225	—	
V _{EBO} I _E =1 mA I _E =0.5 mA				5	—	5	—	—	—	—	—	
V _{BE}	4 4		3 ^c 8 ^c	— —	2 —	— —	2 —	— —	— 2.2	— —	— 2.2	
V _{CE(sat)} I _B =0.3 A I _B =0.8 A I _B =3.2 A			3 ^c	—	1.0	—	1.0	—	—	—	—	V
			8 ^c	—	—	—	—	—	1.4	—	1.4	
			16 ^c	—	—	—	—	—	4	—	4	
I _{S/b} t _p =0.5 s nonrep.	80			3	—	3	—	2	—	2	—	A
	50			—	—	—	—	5	—	5	—	
|h _{fe}| f=1 MHz	10		1	4	20	4	20	4	20	4	20	
t _T	10		1	4	20	4	20	4	20	4	20	MHz
C _{ob}	10 ^a			—	500	—	500	—	500	—	500	pF
R _{θJC}	10		10	—	0.7	—	0.7	—	0.7	—	0.7	°C/W

^aV_{CB}.^bCAUTION: Sustaining voltages V_{CER(sus)} and V_{CEO(sus)} MUST NOT be measured on a curve tracer.^cPulsed; pulse duration=300 μs, duty factor=1.8%.

RCA9166A, RCA9166B, MJ15022, MJ15024

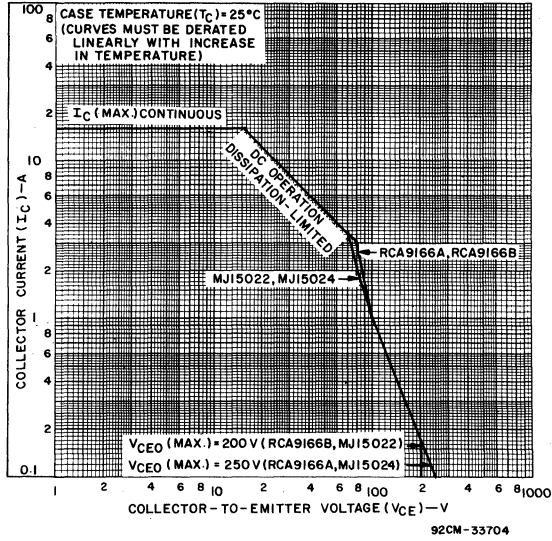


Fig. 1 - Maximum operating areas for all types.

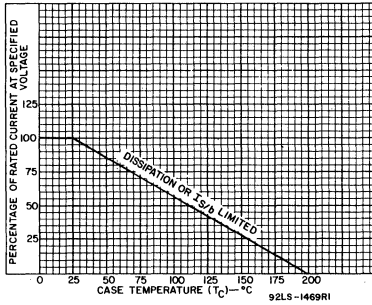


Fig. 2 - Current derating curve for all types.

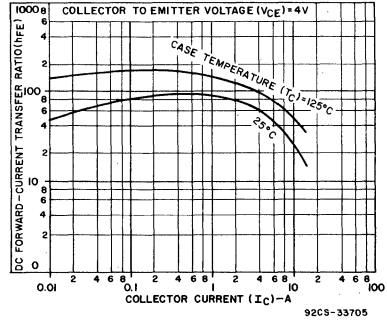


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

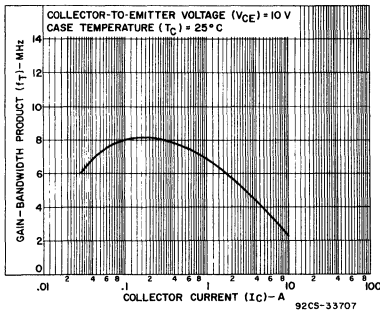


Fig. 4 - Typical gain-bandwidth product for all types.

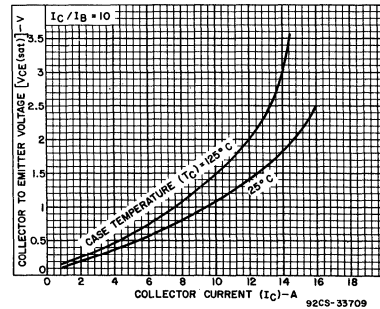


Fig. 5 - Typical saturation voltage characteristics for all types.

RCA9166A, RCA9166B, MJ15022, MJ15024

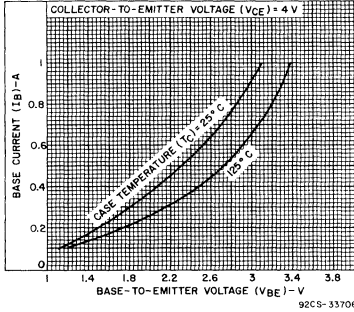


Fig. 6 - Typical input characteristics for all types.

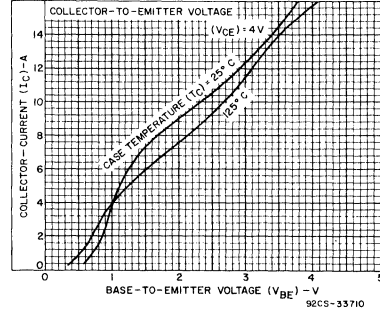


Fig. 7 - Typical transfer characteristics.

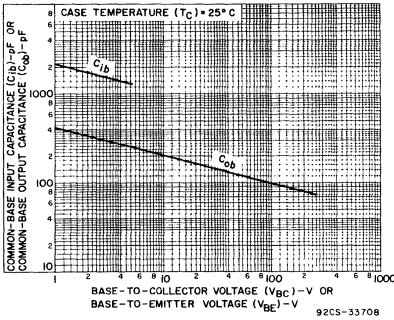


Fig. 8 - Typical common-base input or output capacitance characteristics as a function of reverse voltages for all types.

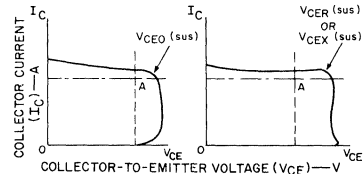


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 10).

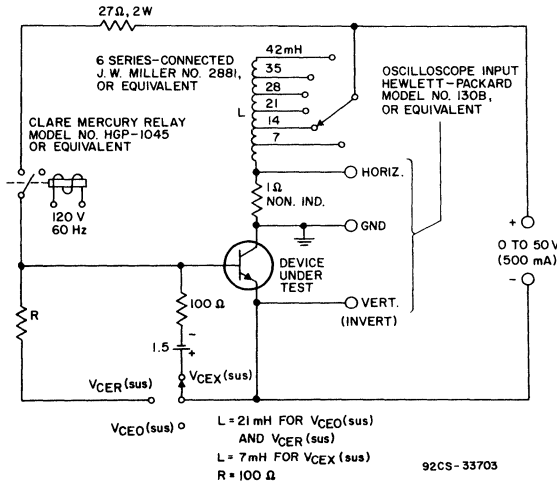


Fig. 10 - Circuit used to measure sustaining voltages $V_{CE0}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

RCA9202A, RCA9202B, RCA9202C

File Number 1414

4-Ampere N-P-N Darlington Power Transistors

300, 350 and 400 Volts, 65 Watts, Gain of 750 at 2A

Features

- Direct IC input without predriver
- Low leakage at high temperature
- Hard glass passivation
- Wire bonded construction

Applications

- General purpose
- Small engine ignition
- Voltage regulator

The RCA9202A, RCA9202B, and RCA9202C[•] are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) plastic package.

[•]Formerly RCA Dev. No. TA9202A, TA9202B and TA9202C, respectively.

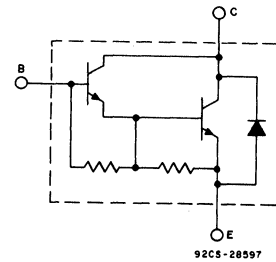
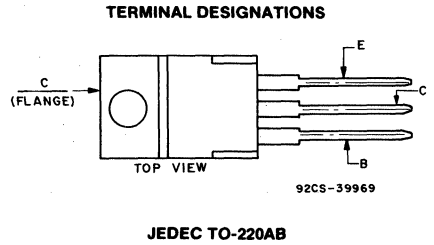


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA9202A	RCA9202B	RCA9202C	UNITS
V _{CB0}	300	350	400	V
V _{CEO(sus)}	300	350	400	V
V _{EB0}	5	5	5	V
I _C	4	4	4	A
I _{CM}	8	8	8	A
I _B	0.25	0.25	0.25	A
PT:				
T _c up to 25°C	65	65	65	W
T _c above 25°C	Derate linearly at			W/°C
T _{stg} , T _J	-65 to 150			°C
T _L				°C
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235			°C

RCA9202A, RCA9202B, RCA9202C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_c) = 25° C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		RCA9202A		RCA9202B		RCA9202C		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CB0} I _E = 0	300 ^a 350 ^a 400 ^a	— — —	— — —	— — —	— — —	0.2 — —	— — —	— 0.2 —	— — —	— — 0.2	mA
I _{CE0}	250 300 350	— — —	— — —	0 0 0	— — —	0.5 — —	— — —	— 0.5 —	— — 0.5		
I _{EBO}	—	-5	0	—	—	10	—	10	—	10		mA
V _{CE0(sus)} ^c	—	—	0.3 ^b	0	300	—	350	—	400	—	V
h _{FE}	3.0 3.0 3.0	— — —	2 ^b 3 ^b 4 ^b	— — —	750 — 500	— — —	750 — 500	— — —	750 500 250	— — —	
V _{BE}	3.0	—	4 ^b	—	—	2.5	—	2.5	—	2.5	V
V _{CE(sat)}	— — —	— — —	2 ^b 3 ^b 4 ^b	.1 .15 .2	— — —	1.5 1.5 1.5	— — —	1.5 1.5 1.5	— — —	1.5 1.5 1.5	V
C _{obo} V _{CB} = 10 V f = 1 MHz	—	—	—	—	100 Typ.		100 Typ.		100 Typ.		pF
I _{s/b} t = 0.5 s non- rep. pulse	50	—	—	—	1.3	—	1.3	—	1.3	—	A
R _{θJC}	—	—	—	—	—	1.92	—	1.92	—	1.92	°C/W

2

^aV_{CB} value.

^bPulsed, pulse duration = 300 μs, duty factor ≤ 2%.

^cCaution: Sustaining voltage, V_{CE0(sus)}, must not be measured on a curve tracer.

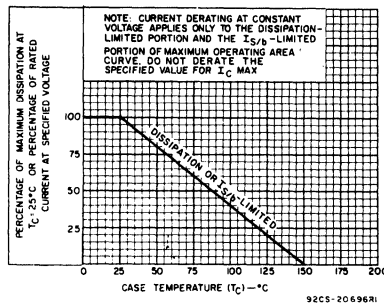


Fig. 2 - Derating curve for all types.

RCA9202A, RCA9202B, RCA9202C

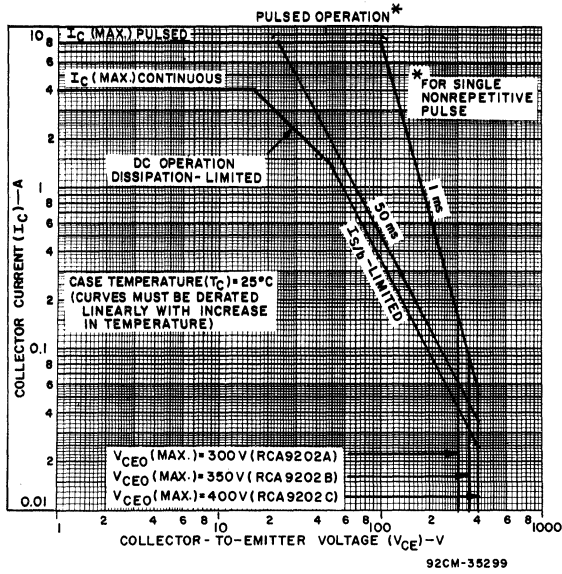


Fig. 3 - Maximum operating areas for all types.

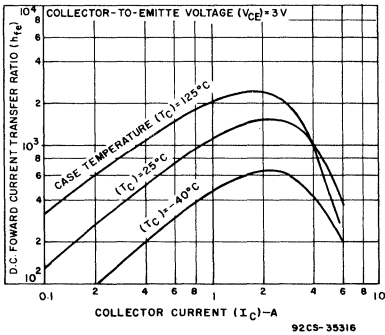


Fig. 4 - Typical dc beta characteristics for all types.

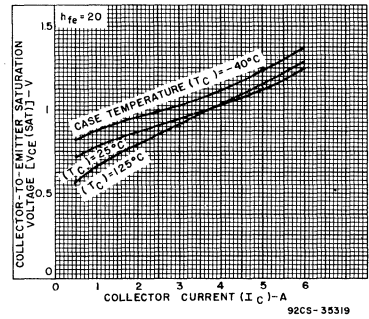


Fig. 5 - Typical saturation characteristics for all types.

RCA9202A, RCA9202B, RCA9202C

2

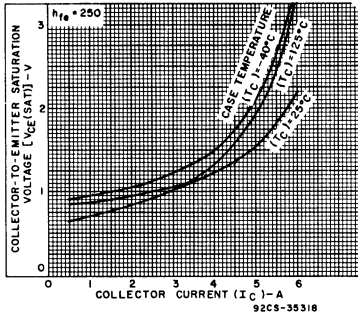


Fig. 6 - Typical saturation characteristics for all types.

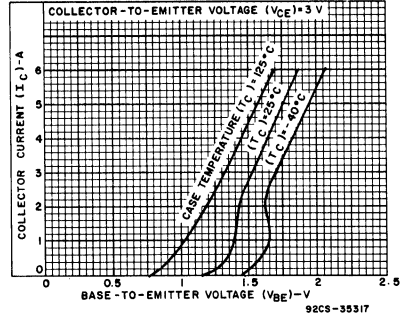


Fig. 7 - Typical transfer characteristics for all types.

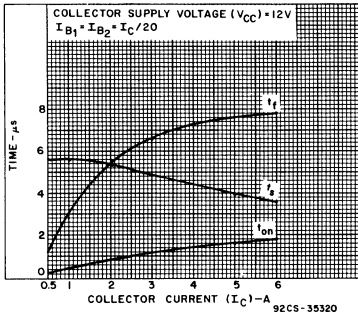


Fig. 8 - Typical saturated switching characteristics for all types.

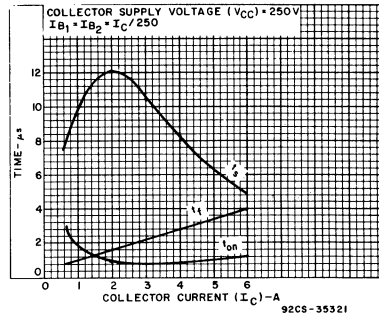


Fig. 9 - Typical saturated switching characteristics for all types.

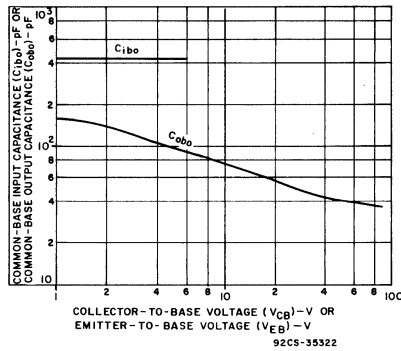


Fig. 10 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics (all types).

RCA9203A, RCA9203B

File Number 1413

4-Ampere N-P-N Darlington Power Transistors

250 and 300 Volts, 50 Watts
Gain of 500 at 2 A

Features

- Direct IC input without predriver
- No R₂, no anti-parallel diode
- Hard glass passivation
- Wire bonded construction

Applications

- General purpose
- Small engine ignition
- Voltage regulator

The RCA9203A, and RCA9203B are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

•Formerly RCA Dev. No. TA9203A, and TA9203B.

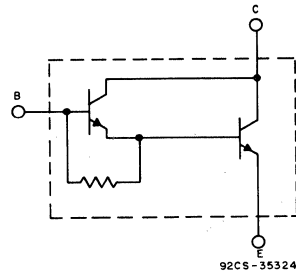
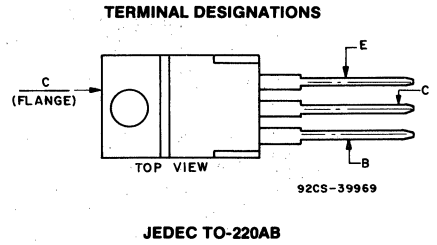


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA9203A	RCA9203B	UNITS
V _{CEO}	250	300	V
V _{CEO(SUS)}	250	300	V
V _{EB0}	9	9	V
I _C	4	4	A
I _{CM}	6	6	A
I _B	0.25	0.25	A
P _r			
T _c up to 25°C	50	50	W
T _c above 25°C	Derate linearly at _____ 0.4 _____		W/°C
T _{stg} , T _J	-65 to 150		°C
T _L			
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235		°C

RCA9203A, RCA9203B

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_c) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		RCA9203A		RCA9203B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	250 ^a 300 ^a	— —	— —	— —	— —	0.2 —	— —	— 0.2	mA
I_{CEO}	200 250	— —	— —	0 0	— —	0.5 —	— —	— 0.5	
I_{EBO}	—	-9	0	—	—	1	—	1	mA
$V_{CEO(sus)}^c$	—	—	.03 ^b	0	250	—	300	—	V
h_{FE}	3.0 3.0	— —	2 ^b 4 ^b	— —	500 100	— —	500 100	— —	
V_{BE}	3.0	—	4 ^b	—	—	2.5	—	2.5	V
$V_{CE(sat)}$	— —	— —	2 ^b 4 ^b	.1 .2	— —	1.5 2.0	— —	1.5 2.0	V
C_{obo} $V_{CB} = 10 V$ $f = 1 MHz$	—	—	—	—	100 Typ.		100 Typ.		pF
$I_{s/b}$ $t = 0.5 s$ non- rep. pulse	40	—	—	—	1.25	—	1.25	—	A
$R_{\theta JC}$	—	—	—	—	—	2.5	—	2.5	°C/W

2

^a V_{CB} value.
^bPulsed, pulse duration = 300 μs , duty factor $\leq 2\%$.
^cCaution: Sustaining voltage, $V_{CEO(sus)}$, must not be measured on a curve tracer.

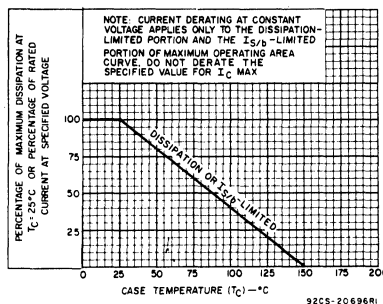


Fig. 2 - Derating curve for all types.

RCA9203A, RCA9203B

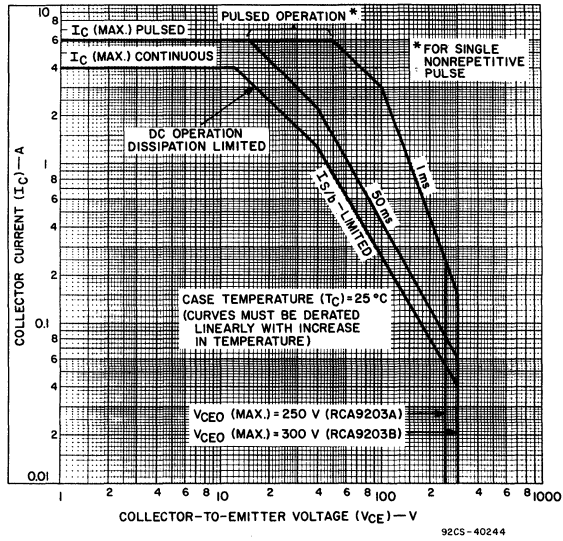


Fig. 3 - Maximum operating areas for all types.

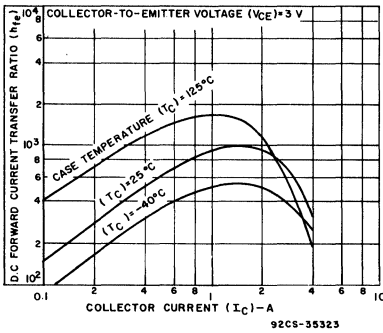


Fig. 4 - Typical dc beta characteristics for all types.

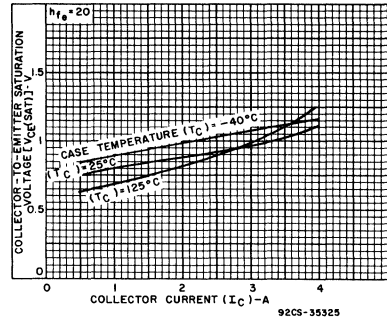


Fig. 5 - Typical saturation characteristics for all types.

RCA9203A, RCA9203B

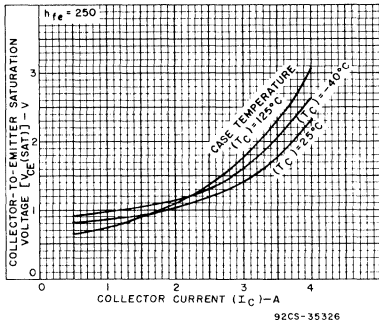


Fig. 6 - Typical saturation characteristics for all types.

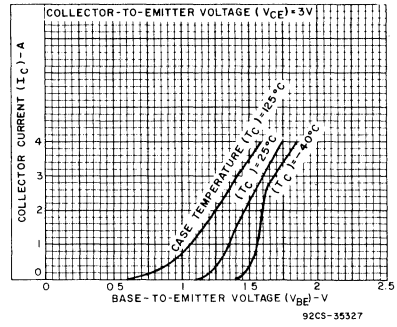


Fig. 7 - Typical transfer characteristics for all types.

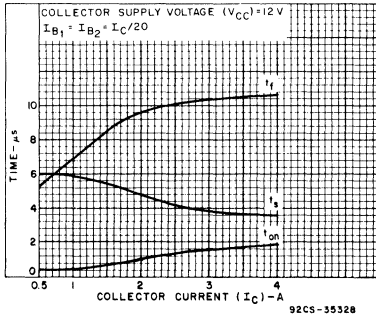


Fig. 8 - Typical saturated switching characteristics for all types.

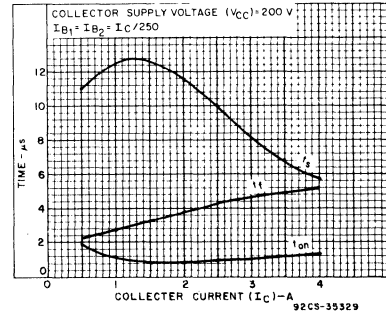


Fig. 9 - Typical saturated switching characteristics for all types.

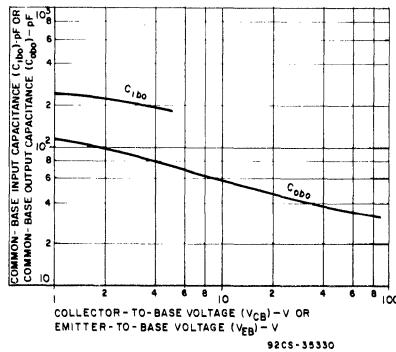


Fig. 10 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics (all types).

**RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D**

File Number **1448**

**50-A Complementary High-Current,
Medium-Voltage N-P-N and P-N-P Silicon
Darlington Power Transistors**

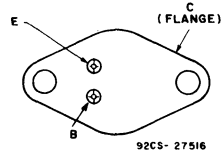
Features:

- 300 W at 25° C case temperature
- 50-A rated collector current
- Hard glass passivation
- Wire-bonded construction

Applications:

- General purpose
- Low-speed switching
- DC motor control

TERMINAL DESIGNATIONS



JEDEC TO-204AE

(141 mil diameter pin isolation)

The RCA9228A, RCA9228B, RCA9228C, RCA9228D and the RCA9229A*, RCA9229B*, RCA9229C*, RCA9229D* are complementary n-p-n and p-n-p silicon Darlington transistors designed for general-purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

*The RCA9228A, RCA9228B, RCA9228C, RCA9228D and RCA9229A, RCA9229B, RCA9229C, RCA9229D were formerly RCA developmental nos. TA9228 and TA9229, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	RCA9228A RCA9229A*	RCA9228B RCA9229B*	RCA9228C RCA9229C*	RCA9228D RCA9229D*	
V _{CEO}	60	80	100	120	V
V _{CEO(SUS)}	60	80	100	120	V
V _{ESD}	5				V
I _C	50				A
I _B	1				A
P _T					
T _C ≤ 25° C	300				W
T _C > 25° C	2.4				W/°C
T _{stg} , T _J	-65 to +150				°C
T _L					
At distances > 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

* For p-n-p devices, voltage and current values are negative.

RCA9228A, RCA9228B, RCA9228C, RCA9228D RCA9229A, RCA9229B, RCA9229C, RCA9229D

ELECTRICAL CHARACTERISTICS, Case Temperature (T_c) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		RCA9228A RCA9229A*		RCA9228B RCA9229B*		RCA9228C RCA9229C*		RCA9228D RCA9229D*		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	50 70 90 110				—	0.5	—	—	—	—	—	—	mA
I_{EBO}		-5			—	5	—	5	—	5	—	5	mA
$V_{CEO(sus)}$	a		0.1 b		60	—	80	—	100	—	120	—	V
h_{FE}	3 5		25 50		2000 400	—	2000 400	—	2000 400	—	2000 400	—	
$V_{BE(sat)}$			25 50	0.2 0.3	—	3 4.5	—	3 4.5	—	3 4.5	—	3 4.5	V
$V_{CE(sat)}$			25 50	0.25 0.5	—	2.5 3.5	—	2.5 3.5	—	2.5 3.5	—	2.5 3.5	V
$I_{S,b}$ $t = 0.5 \text{ sec.}$	30				10	—	10	—	10	—	10	—	A
C_{obo} $V_{CB} = 10 \text{ V}$ RCA9228A,B,C,D RCA9229A,B,C,D					Typ. 300 Typ. 600	—	Typ. 300 Typ. 600	—	Typ. 300 Typ. 600	—	Typ. 300 Typ. 600	—	pF
h_{fe} at $f = 1 \text{ MHz}$					Typ. 5	—	Typ. 5	—	Typ. 5	—	Typ. 5	—	
$R\theta_{JC}$					—	0.416	—	0.416	—	0.416	—	0.416	°C/W

2

• For p-n-p devices, voltage and current values are negative.

a CAUTION: Sustaining voltage $V_{CEO(sus)}$ MUST NOT be measured on a curve tracer.

b Pulsed: Pulse duration = 300 μs , duty factor < 2%.

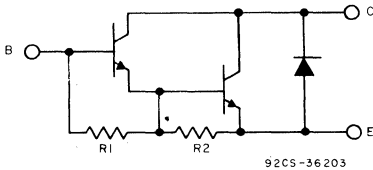


Fig. 1 - Schematic diagram for RCA9228A, RCA9228B, RCA9228C, RCA9228D.

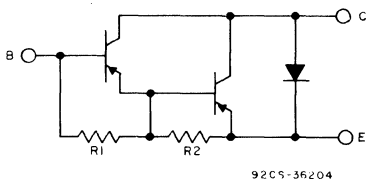
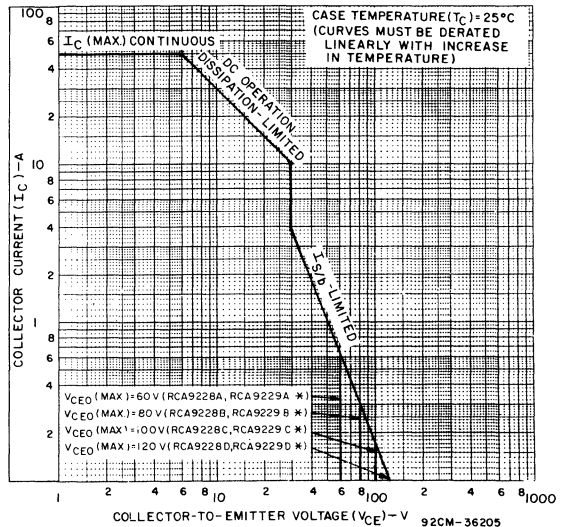


Fig. 2 - Schematic diagram for RCA9229A, RCA9229B, RCA9229C, RCA9229D.



*FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

Fig. 3 - Maximum operating areas for all types.

**RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D**

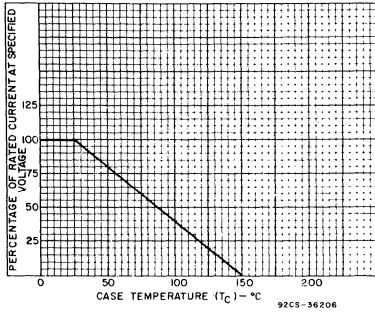


Fig. 4 - Current derating curve for all types.

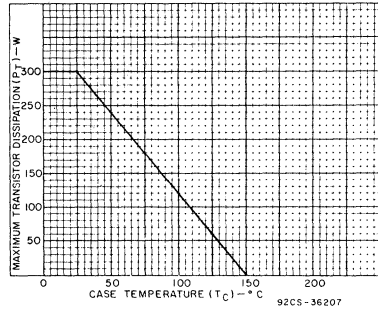


Fig. 5 - Power derating curve for all types.

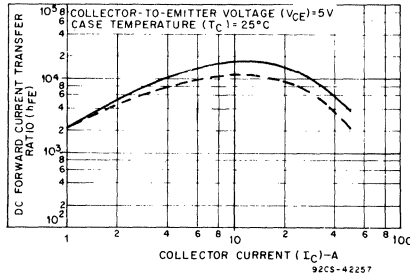


Fig. 6 - Typical dc beta characteristics for all types.

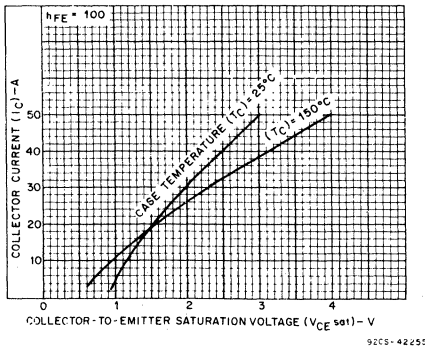


Fig. 7 - Typical collector-to-emitter saturation voltage characteristics for RCA9228A, RCA9228B, RCA9228C and RCA9228D.

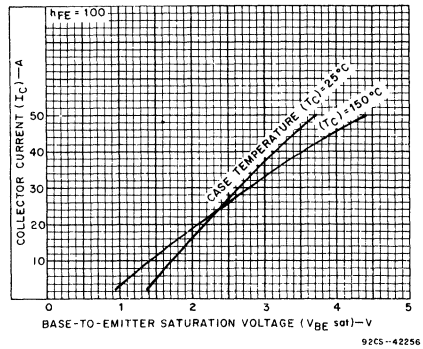


Fig. 8 - Typical base-to-emitter saturation voltage characteristics for RCA9228A, RCA9228B, RCA9228C and RCA9228D.

**RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D**

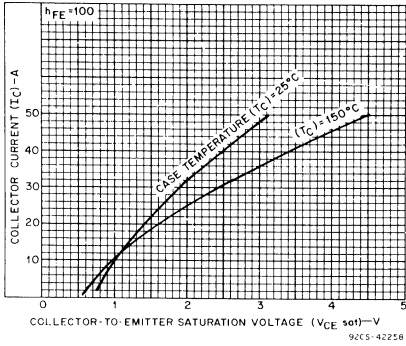


Fig. 9 - Typical collector-to-emitter saturation voltage characteristics for RCA9229A, RCA9229B, RCA9229C and RCA9229D.

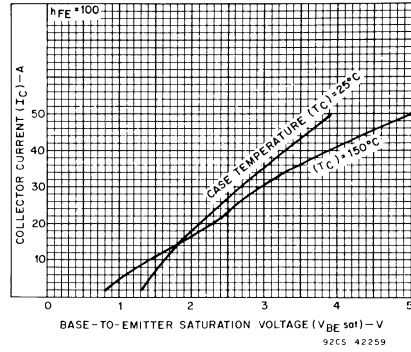


Fig. 10 - Typical base-to-emitter saturation voltage characteristics for RCA9229A, RCA9229B, RCA9229C and RCA9229D.

2

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

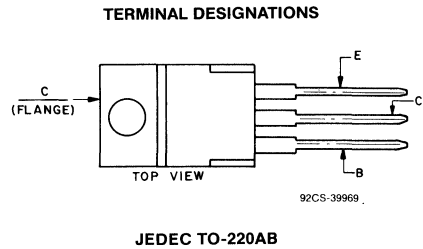
Features:

- 30 W at 25°C case temperature
- 3 A rated collector current
- Min. f_t of 3 MHz at 10 V, 200 mA
- Designed for complementary use with TIP30-series p-n-p types*

The RCA-TIP29, TIP29A, TIP29B, and TIP29C are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP30 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP30-series devices are given in RCA data bulletin File No. 988



MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP29	TIP29A	TIP29B	TIP29C	
V_{CB0}	40	60	80	100	V
V_{CE0}	40	60	80	100	V
V_{EB0}	5	5	5	5	V
I_C	3	3	3	3	A
I_B	1	1	1	1	A
P_T :					
At $T_C \leq 25^\circ\text{C}$	30	30	30	30	W
At $T_A \leq 25^\circ\text{C}$	2	2	2	2	W
At $T_C > 25^\circ\text{C}$	Derate linearly			0.24	W/°C
T_{stg}, T_J				-65 to 150	°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm)					
from case for 10 s max.				235	°C

TIP29, TIP29A, TIP29B, TIP29C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST COND.		LIMITS								Units		
	VOLT-AGE V dc	CUR-RENT A dc	TIP29		TIP29A		TIP29B		TIP29C				
	V _{CE}	I _C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.			
I _{CEO} I _B =0	30 60		-	0.3	-	0.3	-	-	0.3	-	0.3	mA	
I _{CES} V _{EB} =0	40 60 80 100		-	0.2	-	-	0.2	-	-	-	-		mA
I _{EBO} V _{BE} =-5V		0	-	1	-	1	-	1	-	1	1		
V _{CEO(sus)} I _B =0		0.03 ^a	40 ^b	-	60 ^b	-	80 ^b	-	100 ^b	-	-	V	
h _{FE}	4 4	0.2 ^a 1 ^a	40 15	- 150	40 15	- 150	40 15	- 150	40 15	- 150	-		
V _{BE}	4	1 ^a	-	1.3	-	1.3	-	1.3	-	1.3	-	V	
V _{CE(sat)} I _B = 0.125A		1 ^a	-	0.7	-	0.7	-	0.7	-	0.7	-	V	
h _{fe} f=1 kHz	10	0.2	20	-	20	-	20	-	20	-	-		
|h _{fe}|| f=1 MHz	10	0.2	3	-	3	-	3	-	3	-	-		
t _{ON} (t _d +t _r) V _{CC} = 30V R _L =30Ω I _{B1} =I _{B2} =0.1A		1	0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		μs		
t _{OFF} (t _s +t _f) V _{CC} = 30V R _L =30Ω I _{B1} =-I _{B2} =0.1A		1	1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)				
R _{θJC}			-	4.17	-	4.17	-	4.17	-	4.17	°C/W		
R _{θJA}			-	62.5	-	62.5	-	62.5	-	62.5			

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.^b CAUTION: Sustaining voltage, V_{CEO(sus)}, MUST NOT be measured on a curve tracer.

TIP29, TIP29A, TIP29B, TIP29C

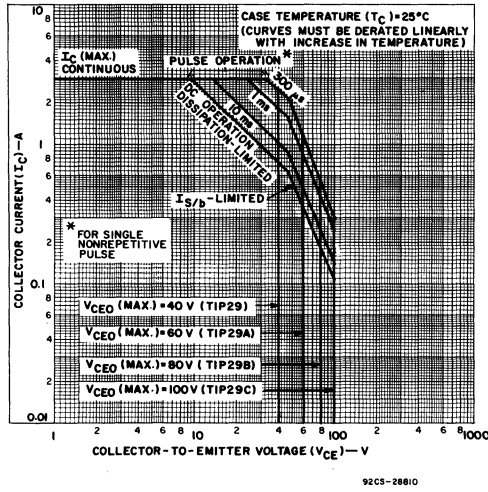


Fig. 1 — Maximum operating areas for all types.

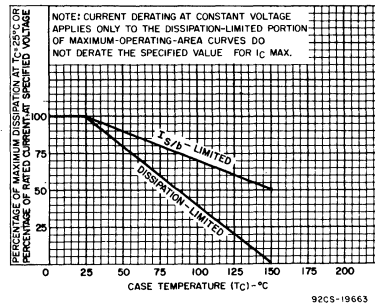


Fig. 2 — Derating curve for all types.

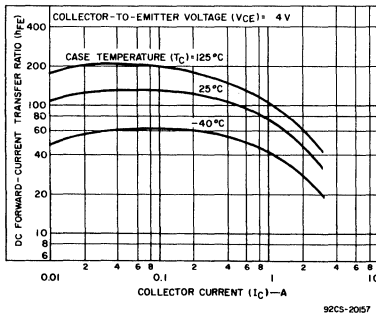


Fig. 3 — Typical dc beta characteristics for TIP29, TIP29A, and TIP29B.

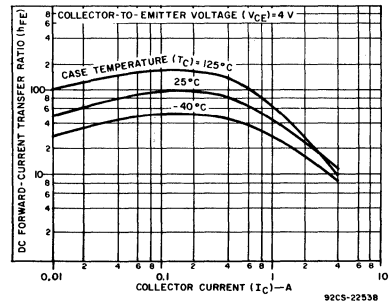


Fig. 4 — Typical dc beta characteristics for TIP29C.

TIP29, TIP29A, TIP29B, TIP29C

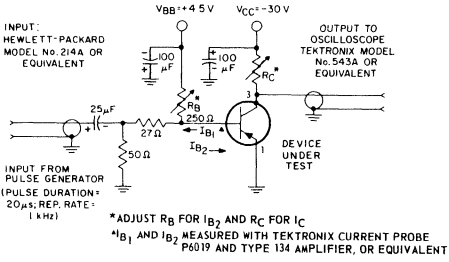


Fig. 5 — Circuit used to measure saturated switching times for all types.

92CS-24796

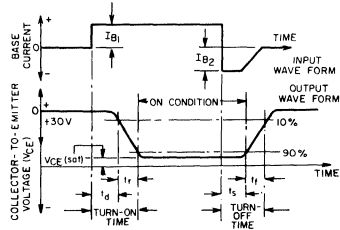


Fig. 6 — Oscilloscope display for measurement of switching times.

92CS-24797R1

TIP30, TIP30A, TIP30B, TIP30C

Epitaxial-Base, Silicon P-N-P
VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

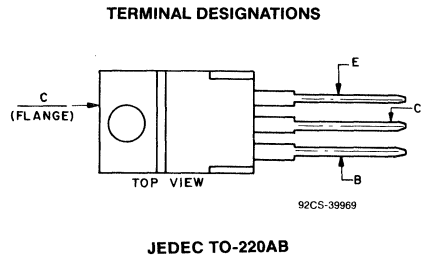
Features:

- 30 W at 25°C case temperature
- 3 A rated collector current
- Min. f_T of 3 MHz at -10 V, -200 mA
- Designed for complementary use with TIP29-series n-p-n types*

The RCA-TIP30, TIP30A, TIP30B, and TIP30C are epitaxial-base, silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP29 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP29-series devices are given in RCA data bulletin File No. 990



MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP30	TIP30A	TIP30B	TIP30C	
V_{CBO}	-40	-60	-80	-100	V
V_{CEO}	-40	-60	-80	-100	V
V_{EBO}	-5	-5	-5	-5	V
I_C	-3	-3	-3	-3	A
I_B	-1	-1	-1	-1	A
P_T :					
At $T_C \leq 25^\circ C$	30	30	30	30	W
At $T_A \leq 25^\circ C$	2	2	2	2	W
At $T_C > 25^\circ C$	Derate linearly			0.24	W/°C
T_{stg}, T_J				-65 to 150	°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm)					
from case for 10 s max.				235	°C

TIP30, TIP30A, TIP30B, TIP30C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST COND.		LIMITS								Units	
	VOLTAGE V dc	CURRENT A dc	TIP30		TIP30A		TIP30B		TIP30C			
	V _{CE}	I _C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
I _{CEO} I _B =0	-30 -60		-	-0.3	-	-0.3	-	-	-0.3	-	-	mA
I _{CES} V _{EB} =0	-40 -60 -80 -100		-	-0.2	-	-	-	-	-	-	-	mA
I _{EBO} V _{BE} =5V		0	-	-1	-	-1	-	-1	-	-1	-	mA
V _{CEO(sus)} I _B =0		-0.03 ^a	-40 ^b	-	-60 ^b	-	-80 ^b	-	-100 ^b	-	-	V
h _{FE}	-4 -4	-0.2 ^a -1 ^a	40 15	- 150	40 15	- 150	40 15	- 150	40 15	- 150	-	
V _{BE}	-4	-1 ^a	-	-1.3	-	-1.3	-	-1.3	-	-1.3	-	V
V _{CE(sat)} I _B = -0.125A		-1 ^a	-	-0.7	-	-0.7	-	-0.7	-	-0.7	-	V
h _{fe} f=1 kHz	-10	-0.2	20	-	20	-	20	-	20	-	-	
|h _{fe} l f=1 MHz	-10	-0.2	3	-	3	-	3	-	3	-	-	
t _{ON} (t _d +t _r) V _{CC} = -30V R _L =30Ω I _{B1} =-I _{B2} =-0.1A		-1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)			μs
t _{OFF} (t _s +t _f) V _{CC} = -30V R _L =30Ω I _{B1} =I _{B2} =-0.1A		-1	1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)			
R _{θJC}			-	4.17	-	4.17	-	4.17	-	4.17	-	°C/W
R _{θJA}			-	62.5	-	62.5	-	62.5	-	62.5	-	

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.^b CAUTION: Sustaining voltage, V_{CEO(sus)}, MUST NOT be measured on a curve tracer.

TIP30, TIP30A, TIP30B, TIP30C

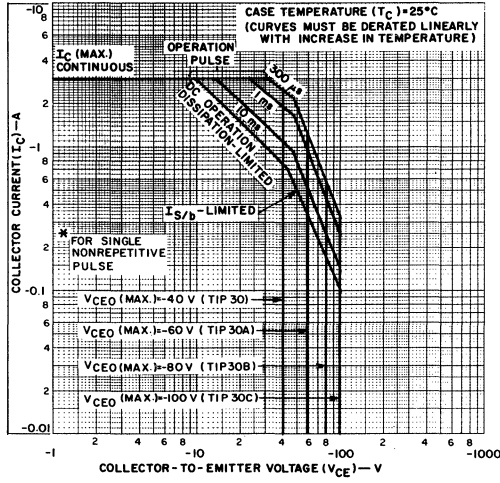


Fig. 1 - Maximum operating areas for all types.

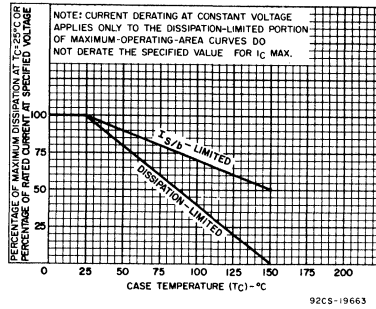


Fig. 2 - Derating curve for all types.

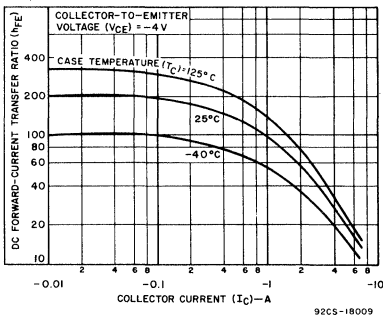


Fig. 3 - Typical dc beta characteristics for TIP30, TIP30A, and TIP30B.

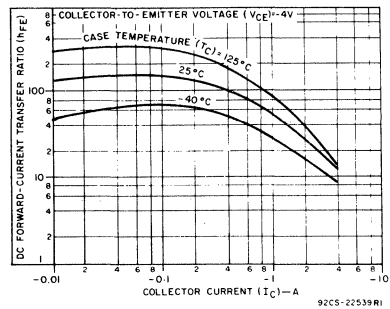
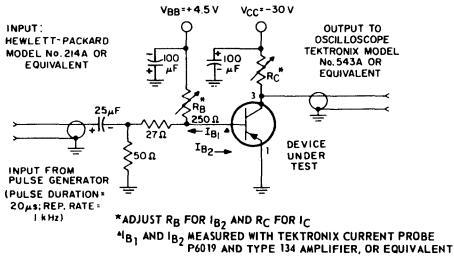


Fig. 4 - Typical dc beta characteristics for TIP30C.

TIP30, TIP30A, TIP30B, TIP30C



92CS-24796

Fig. 5 — Circuit used to measure saturated switching times for all types.

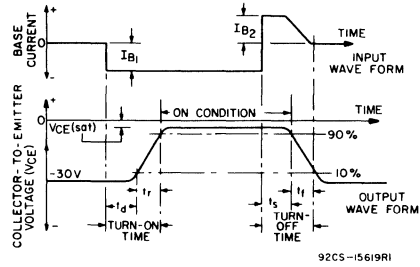


Fig. 6 — Oscilloscope display for measurement of switching times.

TIP31, TIP31A, TIP31B, TIP31C

**Epitaxial-Base, Silicon N-P-N
VERSAWATT Transistors**

For Power-Amplifier and High-Speed-Switching Applications

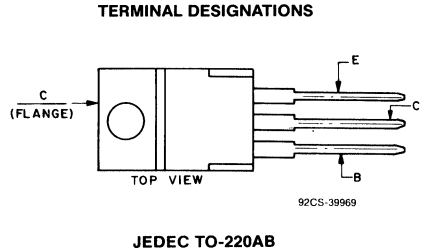
Features:

- 40 W at 25°C case temperature
- 5 A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Designed for complementary use with TIP32-series p-n-p types*

The RCA-TIP31, TIP31A, TIP31B, and TIP31C are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP32 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP32-series devices are given in RCA data bulletin File No. 987



MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP31	TIP31A	TIP31B	TIP31C	
V_{CBO}	40	60	80	100	V
V_{CEO}	40	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	5	5	5	5	A
I_B	1	1	1	1	A
P_T :					
At $T_C \leq 25^\circ\text{C}$	40	40	40	40	W
At $T_A \leq 25^\circ\text{C}$	2	2	2	2	W
At $T_C > 25^\circ\text{C}$	Derate linearly		0.32		W/°C
T_{stg}, T_J			-65 to 150		°C
T_C (During soldering):					
At distance 1/8 in. (3.17 mm)					
from case for 10 s max.			235		°C

TIP31, TIP31A, TIP31B, TIP31C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST COND.		LIMITS								Units
	VOLT-AGE V dc	CUR. RENT A dc	TIP31		TIP31A		TIP31B		TIP31C		
	VCE	IC	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CEO} I _B =0	30		–	0.3	–	0.3	–	–	–	–	mA
	60		–	–	–	–	–	0.3	–	0.3	
I _{CES} V _{EB} =0	40		–	0.2	–	–	–	–	–	–	mA
	60		–	–	–	0.2	–	–	–	–	
	80		–	–	–	–	–	0.2	–	–	
	100		–	–	–	–	–	–	–	0.2	
I _{EBO} V _{BE} =–5V		0	–	1	–	1	–	1	–	1	mA
V _{CEO(sus)} I _B =0		0.03 ^a	40 ^b	–	60 ^b	–	80 ^b	–	100 ^b	–	V
h _{FE}	4	1 ^a	25	–	25	–	25	–	25	–	
	4	3 ^a	10	50	10	50	10	50	10	50	
V _{BE}	4	3 ^a	–	1.8	–	1.8	–	1.8	–	1.8	V
V _{CE(sat)} I _B = 0.375A		3 ^a	–	1.2	–	1.2	–	1.2	–	1.2	V
h _{fe} f=1 kHz	10	0.5	20	–	20	–	20	–	20	–	
|h _{fe}| f=1 MHz	10	0.5	3	–	3	–	3	–	3	–	
t _{ON} (t _d +t _r) V _{CC} = 30V R _L =30Ω I _{B1} =I _{B2} =0.1A		1	0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		μs
t _{OFF} (t _s +t _f) V _{CC} = 30V R _L =30Ω I _{B1} =–I _{B2} =0.1A		1	1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		
R _{θJC}			–	3.125	–	3.125	–	3.125	–	3.125	°C/W
R _{θJA}			–	62.5	–	62.5	–	62.5	–	62.5	

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.^b CAUTION: Sustaining voltage, V_{CEO(sus)}, MUST NOT be measured on a curve tracer.

TIP31, TIP31A, TIP31B, TIP31C

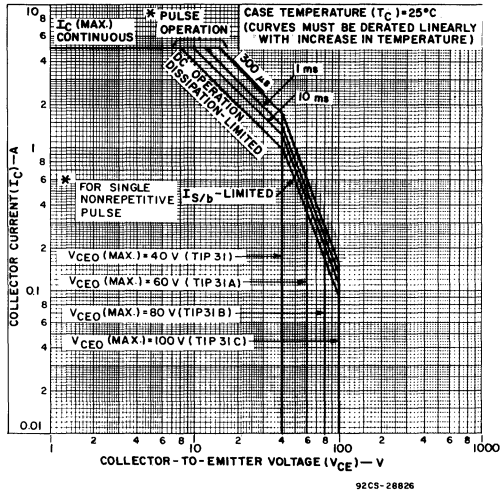


Fig.1 - Maximum operating areas for all types.

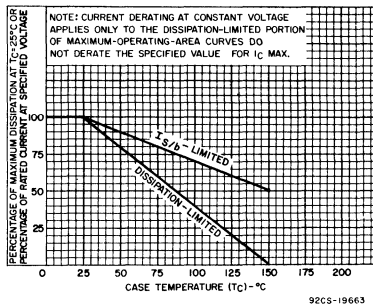


Fig.2 - Derating curve for all types.

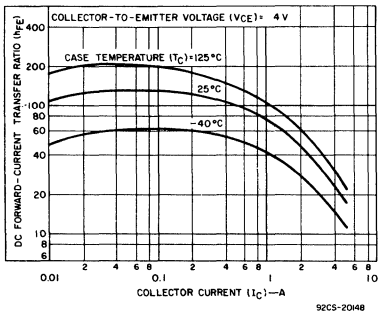


Fig. 3 - Typical dc beta characteristics for TIP31, TIP31A, and TIP31B.

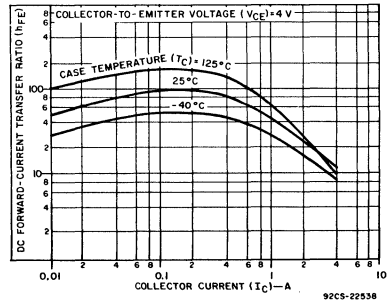


Fig. 4 - Typical dc beta characteristics for TIP31C.

TIP32, TIP32A, TIP32B, TIP32C

**Epitaxial-Base, Silicon P-N-P
VERSAWATT Transistors**

For Power-Amplifier and High-Speed-Switching Applications

Features:

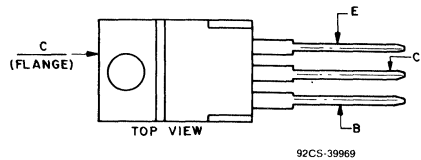
- 40 W at 25°C case temperature
- 5 A rated collector current
- Min. f_T of 3 MHz at -10 V, -500 mA
- Designed for complementary use with TIP31-series n-p-n types*

The RCA-TIP32, TIP32A, TIP32B, and TIP32C are epitaxial-base, silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP31 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP31-series devices are given in RCA data bulletin File No. 991

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP32	TIP32A	TIP32B	TIP32C	
V_{CBO}	-40	-60	-80	-100	V
V_{CEO}	-40	-60	-80	-100	V
V_{EBO}	-5	-5	-5	-5	V
I_C	-5	-5	-5	-5	A
I_B	-1	-1	-1	-1	A
P_T :					
At $T_C \leq 25^\circ\text{C}$	40	40	40	40	W
At $T_A \leq 25^\circ\text{C}$	2	2	2	2	W
At $T_C > 25^\circ\text{C}$	Derate linearly			0.32	W/°C
T_{stg}, T_J				-65 to 150	°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm)					
from case for 10 s max.				235	°C

TIP32, TIP32A, TIP32B, TIP32C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST COND.		LIMITS								Units	
	VOLT-AGE V dc	CUR-RENT A dc	TIP32		TIP32A		TIP32B		TIP32C			
	V _{CE}	I _C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
I _{CEO} I _B =0	-30 -60		-	-0.3	-	-0.3	-	-	-	-	-	mA
I _{CES} V _{EB} =0	-40 -60 -80 -100		-	-0.2	-	-0.2	-	-	-	-	-0.2	mA
I _{EBO} V _{BE} =5V		0	-	-1	-	-1	-	-1	-	-1	-	mA
V _{CEO(sus)} I _B =0		-0.03 ^a	-40 ^b	-	-60 ^b	-	-80 ^b	-	-100 ^b	-	-	V
h _{FE}	-4 -4	-1 ^a -3 ^a	25 10	- 50	25 10	- 50	25 10	- 50	25 10	- 50	-	
V _{BE}	-4	-3 ^a	-	-1.8	-	-1.8	-	-1.8	-	-1.8	-	V
V _{CE(sat)} I _B = -0.375A		-3 ^a	-	-1.2	-	-1.2	-	-1.2	-	-1.2	-	V
h _{fe} f=1 kHz	-10	-0.5	20	-	20	-	20	-	20	-	-	
|h _{fe} l f=1 MHz	-10	-0.5	3	-	3	-	3	-	3	-	-	
t _{ON} (t _d +t _r) V _{CC} = -30V R _L =30Ω I _{B1} =I _{B2} =-0.1A		-1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)			μs
t _{OFF} (t _s +t _f) V _{CC} = -30V R _L =30Ω I _{B1} =-I _{B2} =-0.1A		-1	1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)			
R _{θJC}			-	3.125	-	3.125	-	3.125	-	3.125	-	°C/W
R _{θJA}			-	62.5	-	62.5	-	62.5	-	62.5	-	

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.^b CAUTION: Sustaining voltage, V_{CEO(sus)}, MUST NOT be measured on a curve tracer.

TIP32, TIP32A, TIP32B, TIP32C

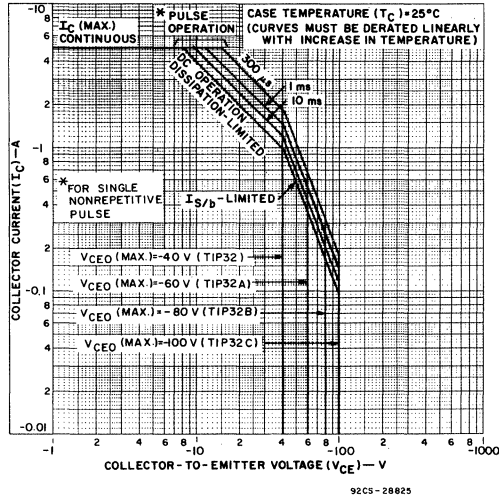


Fig.1 - Maximum operating areas for all types.

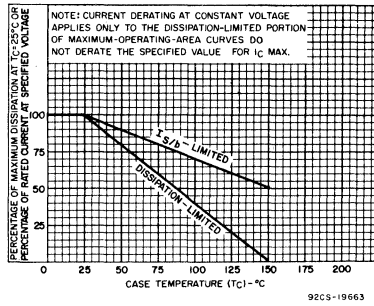


Fig.2 - Derating curve for all types.

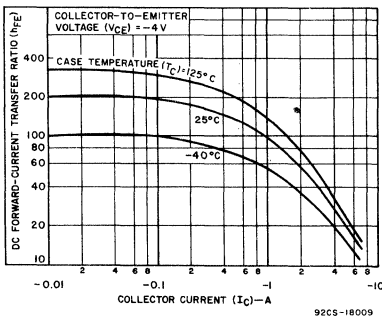


Fig. 3 - Typical dc beta characteristics for TIP32, TIP32A, and TIP32B.

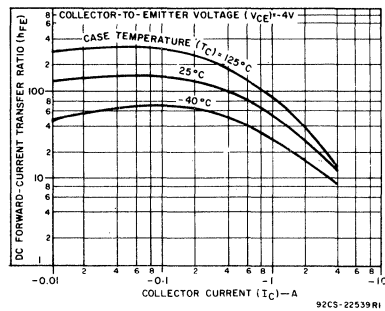


Fig. 4 - Typical dc beta characteristics for TIP32C.

TIP32, TIP32A, TIP32B, TIP32C

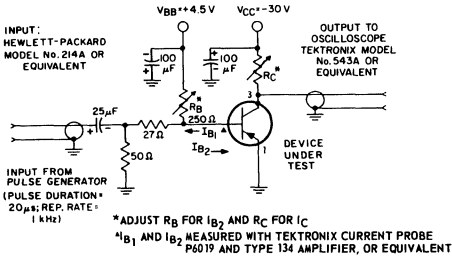


Fig. 5 — Circuit used to measure saturated switching times for all types.

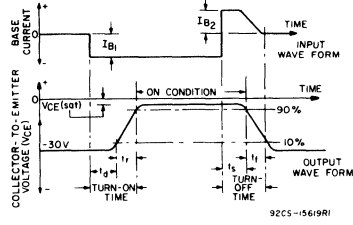


Fig. 6 — Oscilloscope display for measurement of switching times.

TIP41, TIP41A, TIP41B, TIP41C

**Epitaxial-Base, Silicon
N-P-N VERSAWATT Transistors**

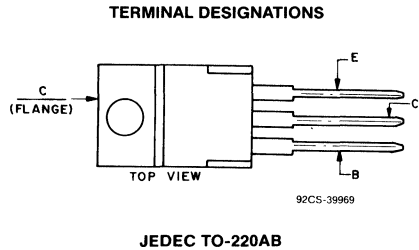
For Power-Amplifier and High-Speed-Switching Applications

Features:

- 65 W at 25°C case temperature
- 7 A rated collector current
- Min. f_T of 3 MHz at 10V, 500 mA
- Designed for complementary use with TIP42-series p-n-p types*

The RCA-TIP41, TIP41A, TIP41B, and TIP41C are epitaxial-base silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP42-series. They differ from each other in voltage ratings. They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP42-series devices are given in RCA data bulletin File No. 996



MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP41	TIP41A	TIP41B	TIP41C	
V_{CB0}	40	60	80	100	V
V_{CE0}	40	60	80	100	V
V_{EB0}	5	5	5	5	V
I_C	7	7	7	7	A
I_{CM}	10	10	10	10	A
I_B	3	3	3	3	A
P_T :					
At $T_C \leq 25^\circ C$	65	65	65	65	W
At $T_A \leq 25^\circ C$	2	2	2	2	W
At $T_C > 25^\circ C$	Derate linearly at			0.52	W/°C
T_{stg}, T_J				-65 to 150	W
T_L (During soldering):					
At distances 1/8 in. (3.17 mm)					
from case for 10 s max.	235				°C

TIP41, TIP41A, TIP41B, TIP41C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS		LIMITS								Units
	Voltage V dc	Current A dc	TIP41		TIP41A		TIP41B		TIP41C		
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} $I_B=0$	30		–	0.7	–	0.7	–	–	–	–	mA
	60		–	–	–	–	–	0.7	–	–	
I_{CES} $V_{BE}=0$	40		–	0.4	–	–	–	–	–	–	mA
	60		–	–	–	0.4	–	–	–	–	
	80		–	–	–	–	–	0.4	–	–	
	100		–	–	–	–	–	–	–	0.4	
I_{EBO} $V_{BE}=-5$ V		0	–	1	–	1	–	1	–	1	mA
$V_{CEO(sus)}$ $I_B=0$		0.03 ^a	40 ^b	–	60 ^b	–	80 ^b	–	100 ^b	–	V
h_{FE}	4	0.3 ^a	30	–	30	–	30	–	30	–	
	4	3 ^a	15	150	15	150	15	150	15	150	
V_{BE}	4	6 ^a	–	2.2	–	2.2	–	2.2	–	2.2	V
$V_{CE(sat)}$ $I_B=0.6$ A		6 ^a	–	2	–	2	–	2	–	2	V
h_{fe} $f=1$ kHz	10	0.5	20	–	20	–	20	–	20	–	
$|h_{fe}|$ $f=1$ MHz	10	0.5	3	–	3	–	3	–	3	–	
t_{ON} ($t_d + t_r$) $V_{CC}=30$ V, $R_L=5$ Ω , $I_{B1}=I_{B2}=0.6$ A		6	0.6 (typ.)		0.6 (typ.)		0.6 (typ.)		0.6 (typ.)		μ s
t_{OFF} ($t_s + t_f$) $V_{CC}=30$ V, $R_L=5$ Ω , $I_{B1}=I_{B2}=0.6$ A		6	1.4 (typ.)		1.4 (typ.)		1.4 (typ.)		1.4 (typ.)		
$R_{\theta JC}$			–	1.92	–	1.92	–	1.92	–	1.92	$^{\circ}$ C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	

^a Pulsed, pulse duration = 300 μ s, duty factor \leq 2%.^b CAUTION: Sustaining voltage, $V_{CEO(sus)}$, MUST NOT be measured on a curve tracer.

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

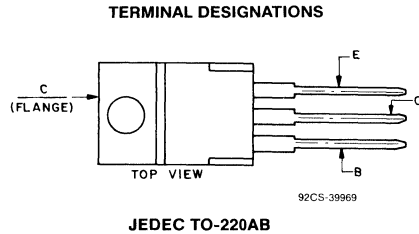
Features:

- 65 W at 25°C case temperature
- 7 A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Designed for complementary use with TIP41-series n-p-n types*

The RCA-TIP42, TIP42A, TIP42B, and TIP42C are epitaxial-base, silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP41 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP41-series devices are given in RCA data bulletin File No. 992



MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP42	TIP42A	TIP42B	TIP42C	
V_{CB0}	-40	-60	-80	-100	V
V_{CE0}	-40	-60	-80	-100	V
V_{EB0}	-5	-5	-5	-5	V
I_C	-7	-7	-7	-7	A
I_{CM}	-10	-10	-10	-10	A
I_B	-3	-3	-3	-3	A
P_T :					
At $T_C \leq 25^\circ\text{C}$	65	65	65	65	W
At $T_A \leq 25^\circ\text{C}$	2	2	2	2	W
At $T_C > 25^\circ\text{C}$	Derate linearly at _____ 0.52 _____				W/°C
T_{stg}, T_J	-65 to 150 _____				°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm)					
from case for 10 s max.	_____ 235 _____				°C

TIP42, TIP42A, TIP42B, TIP42C

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTICS	TEST COND.		LIMITS								UNITS		
	VOLTAGE V dc	CURRENT A dc	TIP42		TIP42A		TIP42B		TIP42C				
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.			
I_{CEO} $I_B = 0$	- 30 - 60		-	-0.7	-	-0.7	-	-	-	-0.7	-	-0.7	mA
I_{CES} $V_{EB} = 0$	- 40 - 60 - 80 -100		-	-0.4	-	-	-	-	-	-	-	-	mA
I_{EBO} $V_{BE} = -5$ V		0	-	-1	-	-1	-	-1	-	-1	-	-1	mA
$V_{CEO(sus)}$ $I_B = 0$		-0.03 ^a	-40 ^b	-	-60 ^b	-	-80 ^b	-	-100 ^b	-	-	-	V
h_{FE}	- 4 -4	-0.3 ^a -3 ^a	30 15	- 150	30 15	- 150	30 15	- 150	30 15	- 150	-	-	
V_{BE}	-4	-6 ^a	-	-2.2	-	-2.2	-	-2.2	-	-2.2	-	-2.2	V
$V_{CE(sat)}$ $I_B = -0.6$ A		-6 ^a	-	-2	-	-2	-	-2	-	-2	-	-2	V
h_{fe} f = 1 kHz	-10	-0.5	20	-	20	-	20	-	20	-	20	-	
$|h_{fe}|$ f = 1 MHz	-10	-0.5	3	-	3	-	3	-	3	-	3	-	
t_{ON} ($t_d + t_r$) $V_{CC} = -30$ V $R_L = 5 \Omega$ $I_{B1} = I_{B2} = -0.6$ A		-6	0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		μ s
t_{OFF} ($t_s + t_f$) $V_{CC} = -30$ V $R_L = 5 \Omega$ $I_{B1} = I_{B2} = -0.6$ A		-6	0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		
$R_{\theta JC}$			-	1.92	-	1.92	-	1.92	-	1.92	-	1.92	°C/W
$R_{\theta JA}$			-	62.5	-	62.5	-	62.5	-	62.5	-	62.5	

^a Pulsed, pulse duration = 300 μ s, duty factor \leq 2%.

^b CAUTION: Sustaining voltage, $V_{CEO(sus)}$, MUST NOT be measured on a curve tracer.

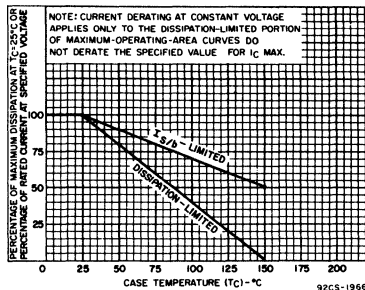


Fig. 1 - Derating curve for all types.

TIP42, TIP42A, TIP42B, TIP42C

2

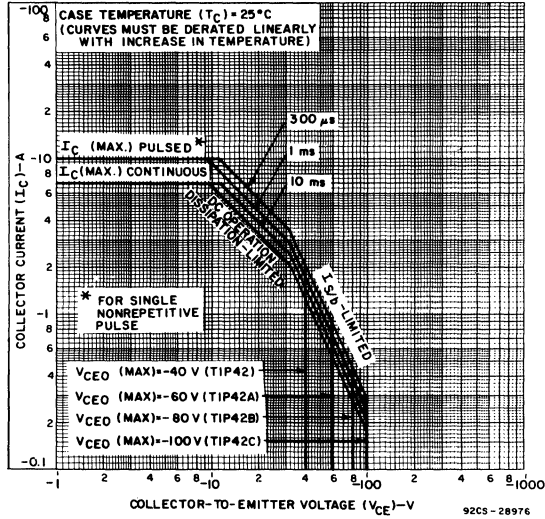


Fig. 2 — Maximum operating areas for all types.

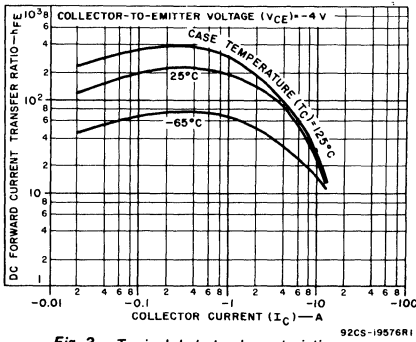


Fig. 3 — Typical dc beta characteristics for TIP42, TIP42A, and TIP42B.

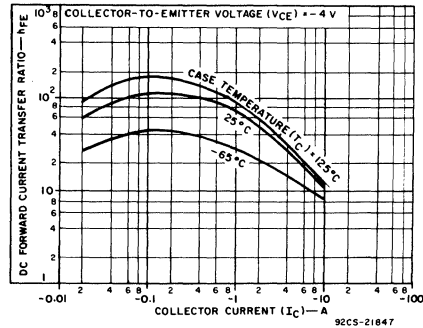
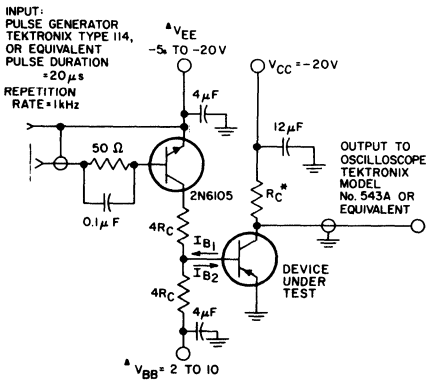


Fig. 4 — Typical dc beta characteristics for TIP42C.



* R_C IS CHOSEN FOR I_C
 ΔV_{EE} AND V_{BB} ARE MEASURED FOR I_{B1} AND I_{B2}
 I_{B1} AND I_{B2} ARE MEASURED WITH TEKTRONIX
 CURRENT PROBE P-6019
 AND TYPE 134 AMPLIFIER, OR EQUIVALENT

Fig. 5 — Circuit used to measure saturated switching times for all types.

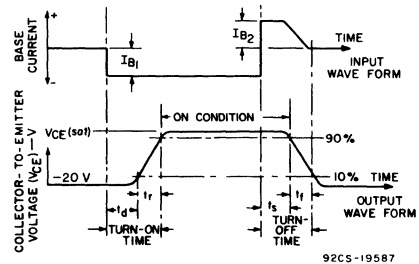


Fig. 6 — Oscilloscope display for measurement of switching times.

High-Voltage Silicon N-P-N Transistors

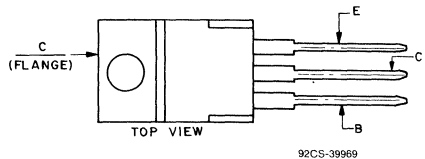
For High-Speed Switching and Linear-Amplifier Applications

Features:

- *VERSAWATT* package
- *Maximum safe-area-of-operation curves*

The TIP47, TIP48, TIP49, and TIP50 are silicon n-p-n transistors. Typical applications for these transistors include high-voltage switches, switching regulators, TV horizontal-deflection circuits, power supplies, and TV audio-output circuits. They are supplied in the JEDEC TO-220AB (*VERSAWATT*) plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP47	TIP48	TIP49	TIP50	
V_{CBO}	350	400	450	500	V
$V_{CEO(SUS)}$	250	300	350	400	V
V_{EBO}	5	5	5	5	V
I_C	1	1	1	1	A
I_{CM}	2	2	2	2	A
I_B	0.6	0.6	0.6	0.6	A
P_T :					
T_C up to 25°C	40	40	40	40	W
T_C above 25°C	Derate linearly				0.32 W/°C
T_A up to 25°C					1.8 W
T_{stg}, T_J					-65 to 150 °C
T_L :					
At distance $\geq 1/8$ in. (3.17 mm) from seating plane for 10 s max.					235 °C

TIP47, TIP48, TIP49, TIP50

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST COND.		LIMITS								UNITS
	VOLT- AGE V dc	CUR- RENT A dc	TIP47		TIP48		TIP49		TIP50		
	V _{CE}	I _C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CEO} I _B = 0	150		—	1	—	—	—	—	—	—	mA
	200		—	—	—	1	—	—	—	—	
	250		—	—	—	—	—	1	—	—	
	300		—	—	—	—	—	—	—	1	
I _{CES} V _{EB} = 0	350		—	1	—	—	—	—	—	—	mA
	400		—	—	—	1	—	—	—	—	
	450		—	—	—	—	—	1	—	—	
	500		—	—	—	—	—	—	—	1	
I _{EBO} V _{BE} = -5 V		0	—	1	—	1	—	1	—	1	mA
h _{FE}	10	1 ^a	10	—	10	—	10	—	10	—	
	10	0.3 ^a	30	150	30	150	30	150	30	150	
V _{CEO(sus)} I _B = 0		0.03 ^a	250 ^b	—	300 ^b	—	350 ^b	—	400 ^b	—	V
V _{BE}	10	1 ^a	—	1.5	—	1.5	—	1.5	—	1.5	V
V _{CE(sat)} I _B = 0.2 A		1 ^a	—	1	—	1	—	1	—	1	V
|h _{fe}| f = 1 MHz	10	0.2	10	—	10	—	10	—	10	—	
f _T f = 1 MHz	10	0.2	10	—	10	—	10	—	10	—	MHz
h _{fe} f = 1 kHz	10	0.2	25	—	25	—	25	—	25	—	
I _S /b t = 0.5 s	100	—	0.4	—	0.4	—	0.4	—	0.4	—	A
t _{ON} (t _d + t _r) ^{c,d} V _{CC} = 200 V		1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		μs
t _s ^{c,d} V _{CC} = 200 V		1	2 (typ.)		2 (typ.)		2 (typ.)		2 (typ.)		
t _r ^{c,d} V _{CC} = 200 V		1	0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		
R _{θJC}			—	3.12	—	3.12	—	3.12	—	3.12	
R _{θJA}			—	70	—	70	—	70	—	70	°C/W

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

^b CAUTION: Sustaining voltage, V_{CEO(sus)}, MUST NOT be measured on a curve tracer.

^c See Fig. 8.

^d I_{B1} = I_{B2} = 0.1 A.

TIP47, TIP48, TIP49, TIP50

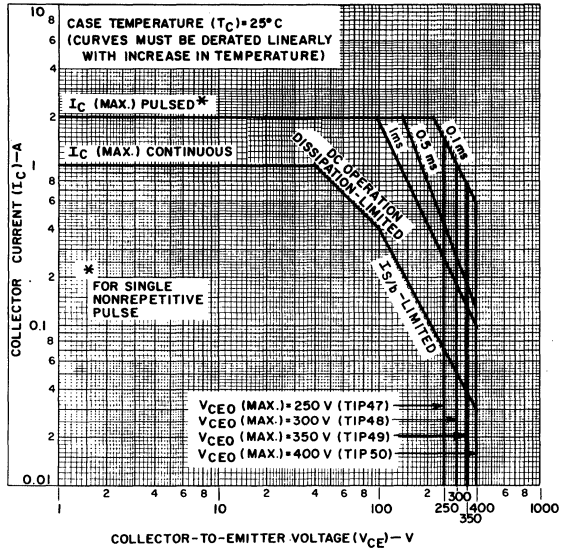


Fig.1 — Maximum operating areas for all types.

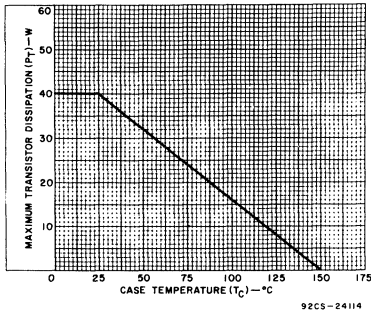


Fig.2 — Derating curve for all types.

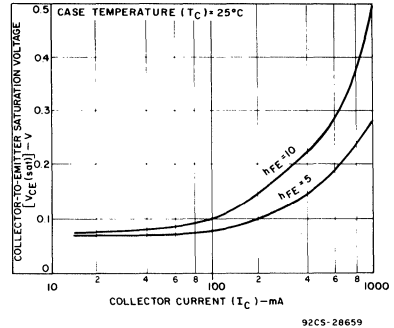


Fig.3 — Typical saturation-voltage characteristics for all types.

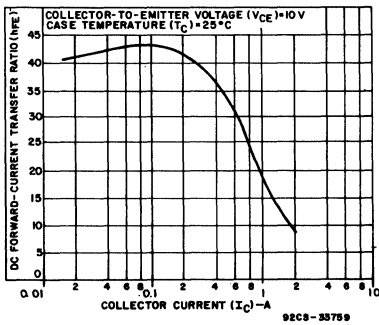


Fig.4 — Typical dc beta characteristics for all types.

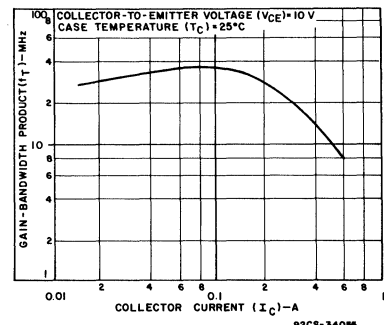


Fig.5 — Typical gain-bandwidth characteristics for all types.

TIP47, TIP48, TIP49, TIP50

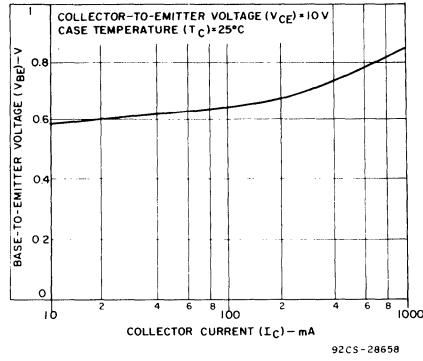


Fig. 6 - Typical base-to-emitter voltage vs. collector current.

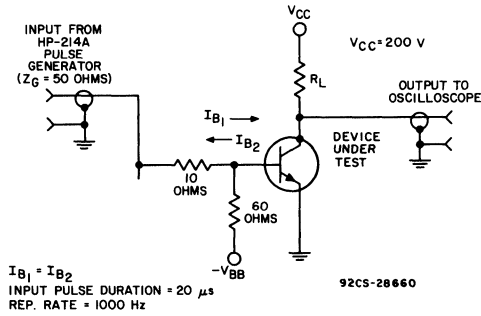


Fig. 7 - Circuit used to measure saturated switching times.

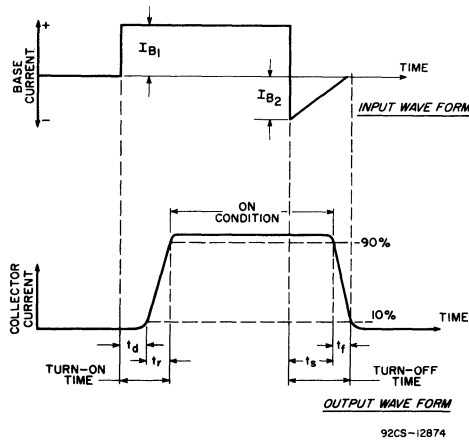


Fig. 8 - Phase relationship between input and output currents, showing reference points for specification of switching times.

TIP100, TIP101, TIP102

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 80 Watts
Gain of 1000 at 3 A

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Audio amplifiers
- Series and shunt regulators

The TIP100, TIP101 and TIP102 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) plastic package.

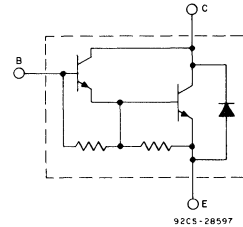
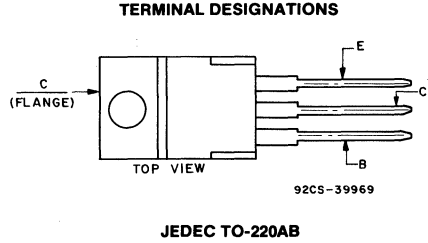


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP100	TIP101	TIP102	
V_{CBO}	60	80	100	V
$V_{CEO(sus)}$	60	80	100	V
V_{EBO}	5	5	5	V
I_C	8	8	8	A
I_{CM}	15	15	15	A
I_B	1	1	1	A
P_T				
T_C up to 25°C	80	80	80	W
T_C above 25°C	0.64	0.64	0.64	W/°C
Derate linearly at				
T_{stg}, T_J	-65 to 150	-65 to 150	-65 to 150	°C
T_L	235	235	235	°C
At distance $\geq 1/8$ in. (3.17 mm) from case for 10 s max.				

TIP100, TIP101, TIP102

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP100		TIP101		TIP102		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	60 80 100				—	50	—	—	—	—	μA
I_{CEO}	30 40 50			0 0 0	—	50	—	—	—	50	
I_{EBO}		-5	0		—	8	—	8	—	8	
$V_{CE(sus)}$			0.03 ^b	0	60	—	80	—	100	—	V
h_{FE}	4 4		3 ^b 8 ^b		1000 200	20,000 —	1000 200	20,000 —	1000 200	20,000 —	
V_{BE}	4		8 ^b		—	2.8	—	2.8	—	2.8	V
$V_{CE(sat)}$			3 ^b 8 ^b	0.006 0.08	— —	2 2.5	— —	2 2.5	— —	2 2.5	
V_F			-10		—	2.8	—	2.8	—	2.8	
t_d^c t_r^c t_s^c t_f^c			8 8 8 8	0.08 0.08 0.08 ^d 0.08 ^d	0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		μs
$I_{S/b}$ t=0.15 s non-rep. pulse	40				2	—	2	—	2	—	A
$R_{\theta JC}$					—	1.56	—	1.56	—	1.56	°C/W

^a V_{CB} value. ^b Pulsed: Pulse duration = 300 μs , duty factor $\leq 2\%$. ^c $V_{CC} = 40 V$ ^d $I_{B1} = -I_{B2}$.

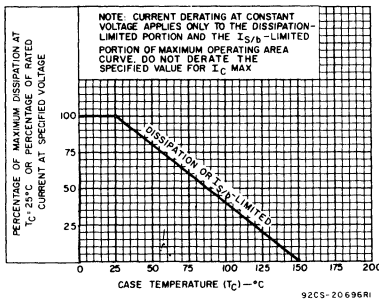


Fig. 2 - Derating curve for all types.

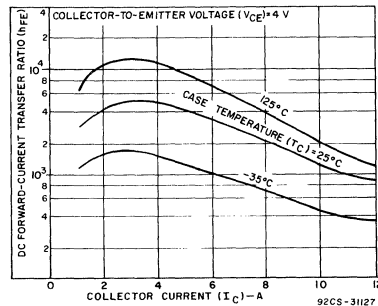
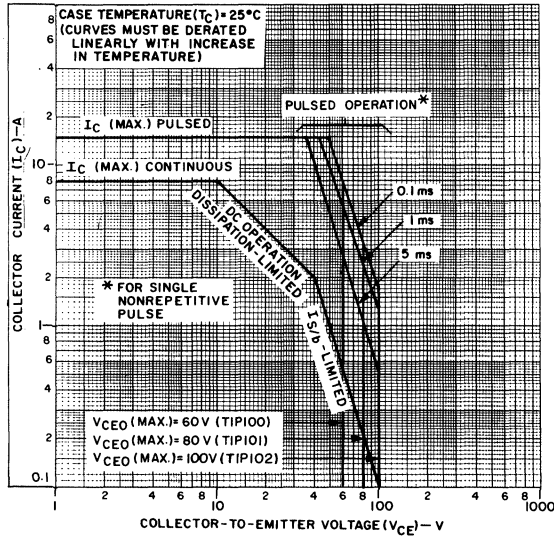


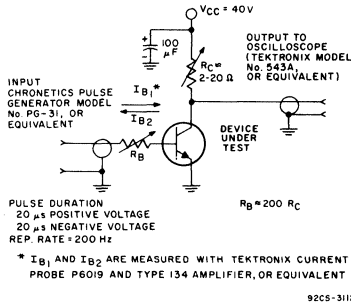
Fig. 3 - Typical dc-beta characteristics for all types.

TIP100, TIP101, TIP102



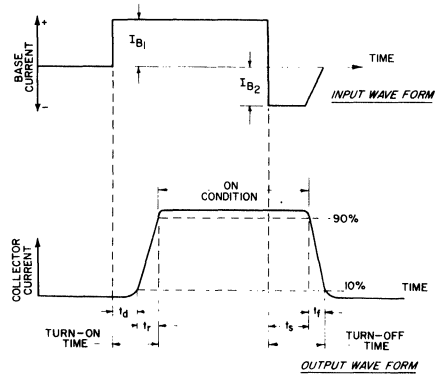
92CM-31125RI

Fig. 4 - Maximum operating areas for all types ($T_C = 25^\circ C$).



92CS-31126

Fig. 5 - Circuit used to measure saturated switching times.



92CS-3996-RI

Fig. 6 - Phase relationship between input current and output current showing reference points for specification of switching times.

2-Ampere N-P-N Darlington Power Transistors

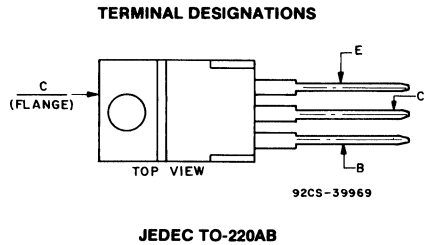
For Low and Medium Frequency Power Switching, Hammer Driver, Audio Amplifier, and Series and Shunt Regulator Applications

Features:

- Operates from IC without predriver
- Gain of 1000 at 1A
- Low leakage at high temperatures
- Designed for complementary use with TIP-115, 116, and 117
- Hard glass passivation
- Wire-bonded construction

The TIP110, TIP111 and TIP112 series monolithic n-p-n silicon Darlington transistors are designed for low and medium frequency power applications. The construction of these devices provides good forward-bias second-break-down capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.



2

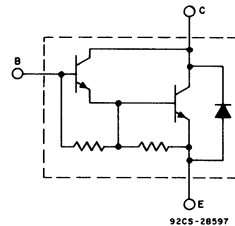


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute Maximum Values:

	TIP110	TIP111	TIP112	UNITS
V _{CB0}	60	80	100	V
V _{CEO(sus)}	60	80	100	V
V _{EBO}	5	5	5	V
I _C	2	2	2	A
I _{CM}	4	4	4	A
I _B	0.05	0.05	0.05	A
P _T :				
T _C up to 25°C	50	50	50	W
T _C above 25°C	0.4	0.4	0.4	W/°C
Derate linearly at				
T _{stg} , T _J	-65 to 150	-65 to 150	-65 to 150	°C
T _L				
At distance 1/8 in. (3.17 mm) from case for 10 s max.	260	260	260	°C

TIP110, TIP111, TIP112

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS	
	Voltage V dc		Current A dc		TIP110		TIP111		TIP112			
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
I _{CBO} I _E = 0	60 ^a 80 ^a 100 ^a	—	—	—	—	1	—	—	1	—	—	mA
I _{CEO}	30 40 50	—	—	0 0 0	—	2	—	—	2	—	—	
I _{EBO}	—	-5	0	—	—	2	—	2	—	2	—	mA
V _{CEO(sus)}	—	—	0.03 ^b	0	60	—	80	—	100	—	—	V
h _{FE}	4 4	—	1 ^b 2 ^b	—	1000 500	—	1000 500	—	1000 500	—	—	—
V _{BE}	4	—	2 ^b	—	—	2.8	—	2.8	—	2.8	—	V
V _{CE(sat)}	—	—	2 ^b	0.008	—	2.5	—	2.5	—	2.5	—	
C _{obo}	10 ^a	—	—	—	—	100	—	100	—	100	—	pf
|h _{fe} l f = 1.0 mHz	10	—	0.75	—	25 TYP.		25 TYP.		25 TYP.		—	—
I _{S/b} t = 0.5 s non-rep. pulse	40	—	—	—	1.25	—	1.25	—	1.25	—	—	A
R _{θJC}	—	—	—	—	—	2.5	—	2.5	—	2.5	—	°C/W
R _{θJA}	—	—	—	—	—	62.5	—	62.5	—	62.5	—	

^a V_{CB} value. ^b Pulsed: Pulsed duration = 300 μs, duty factor ≤ 2%.

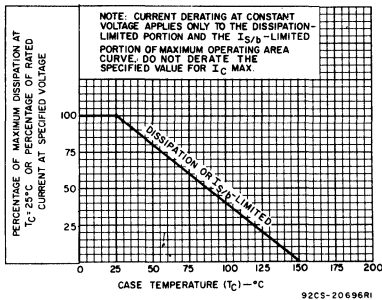


Fig. 2 - Derating curve for all types.

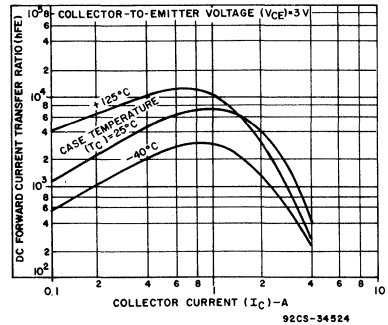


Fig. 3 - Typical dc-beta characteristics for all types.

TIP110, TIP111, TIP112

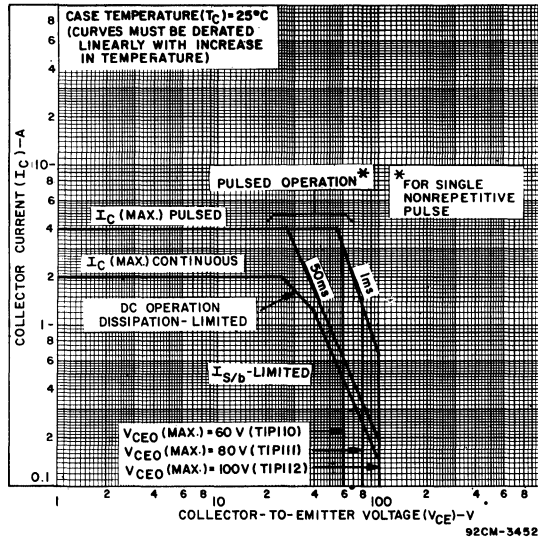


Fig. 4 - Maximum operating areas for all types ($T_C = 25^\circ C$).

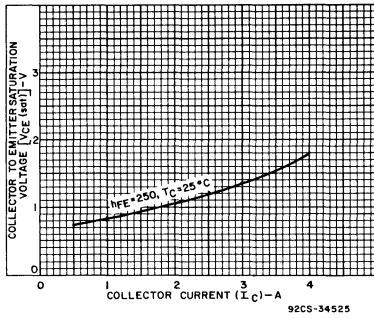


Fig. 5 - Typical saturation characteristics for all types.

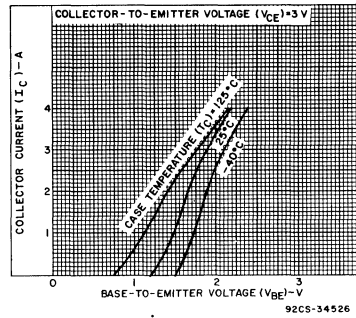


Fig. 6 - Typical transfer characteristics for all types.

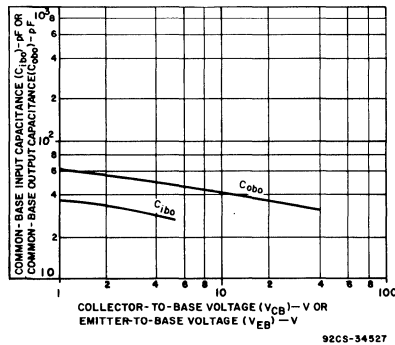


Fig. 7 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic (all types).

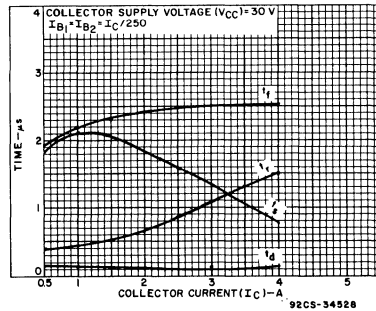


Fig. 8 - Typical saturated switching characteristics (all types).

TIP110, TIP111, TIP112

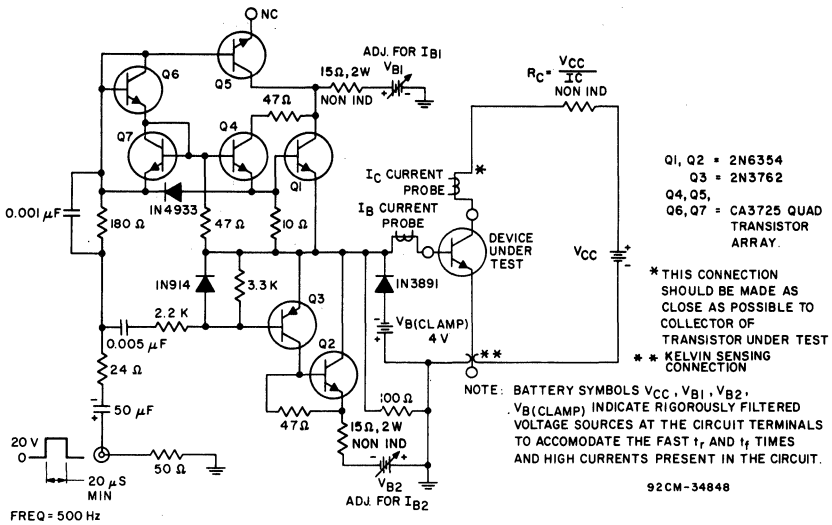


Fig. 9 - Circuit for measuring switching times.

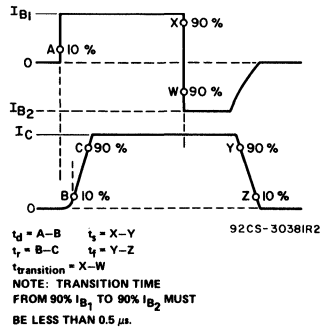


Fig. 10 - Phase relationship between input and output currents showing reference points for specification of switching times.

2-Ampere P-N-P Darlington Power Transistors

For Low and Medium Frequency Power Switching, Hammer Driver, Audio Amplifier, and Series and Shunt Regulator Applications

Features:

- Operates from IC without predriver
- Gain of 1000 at 1A
- Low leakage at high temperatures
- Designed for complementary use with TIP110, TIP111 and TIP112
- Hard glass passivation
- Wire-bonded construction

The TIP115, TIP116, and TIP117 series are monolithic p-n-p silicon Darlington transistors designed for low and medium frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) plastic package.

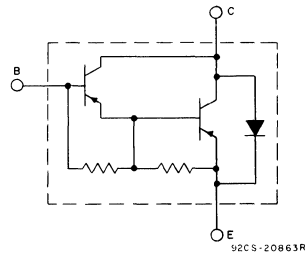
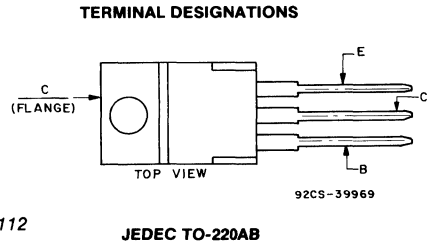


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute Maximum Values:

	TIP115	TIP116	TIP117	UNITS
V _{CB0}	60	80	100	V
V _{CEO(sus)}	60	80	100	V
V _{EB0}	5	5	5	V
I _C	2	2	2	A
I _{CM}	4	4	4	A
I _B	0.05	0.05	0.05	A
P _T :				
T _c up to 25°C	50	50	50	W
T _c above 25°C	0.4	0.4	0.4	W/°C
Derate linearly at				
T _{stg} , T _J	-65 to 150	-65 to 150	-65 to 150	°C
T _L				
At distance 1/8 in. (3.17 mm) from case for 10 s max.	260	260	260	°C

TIP115, TIP116, TIP117

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_c) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP115		TIP116		TIP117		
	V _{CE}	V _{BE}	I _C	I _B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I _{CBO} I _E = 0	-60 ^a -80 ^a -100 ^a	—	—	—	—	-1	—	—	—	—	mA
I _{CEO}	-30 -40 -50	—	—	0	—	-2	—	-2	—	—	
I _{EBO}	—	5	0	—	—	-2	—	-2	—	-2		mA
V _{CEO(sus)}	—	—	-0.03 ^b	0	-60	—	-80	—	-100	—	V
h _{FE}	-4 -4	—	-1 ^b -2 ^b	—	1000 500	—	1000 500	—	1000 500	—	—
V _{BE}	-4	—	-2 ^b	—	—	-2.8	—	-2.8	—	-2.8	V
V _{CE(sat)}	—	—	-2 ^b	-0.008	—	-2.5	—	-2.5	—	-2.5	
C _{obo}	-10 ^a	—	—	—	—	100	—	100	—	100	pF
h _{fe} f = 1.0 MHz	-10	—	-0.75	—	25 TYP.		25 TYP.		25 TYP.		—
I _{S/b} t ≅ 0, 5 s non-rep. pulse	-40	—	—	—	-1.25	—	-1.25	—	-1.25	—	A
R _{θJC}	—	—	—	—	—	2.5	—	2.5	—	2.5	°C/W
R _{θJA}	—	—	—	—	—	62.5	—	62.5	—	62.5	

^a V_{CB} value.

^b Pulsed: Pulsed duration = 300 μs, duty factor ≤ 2%.

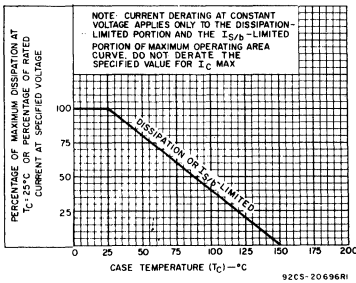


Fig. 2 - Derating curve for all types.

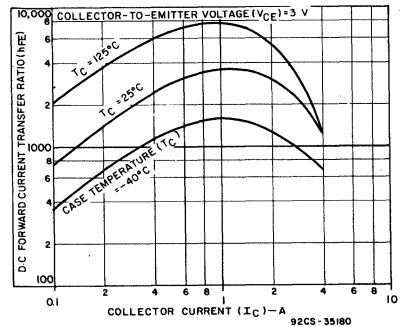


Fig. 3 - Typical dc-beta characteristics for all types.

TIP115, TIP116, TIP117

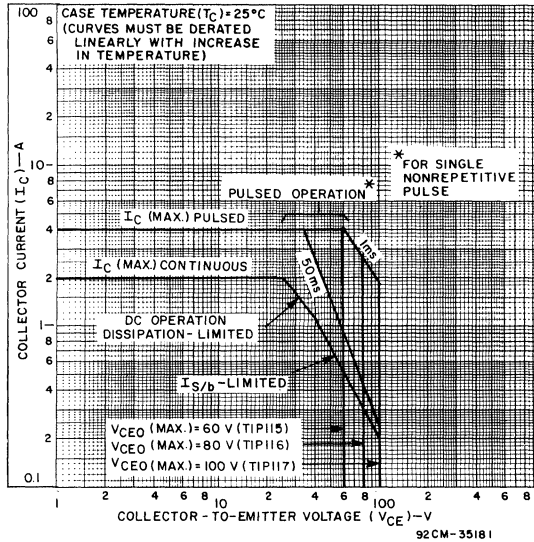


Fig. 4 - Maximum operating areas for all types ($T_c = 25^\circ C$).

2

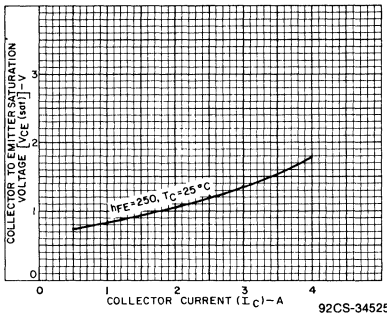


Fig. 5 - Typical saturation characteristics for all types.

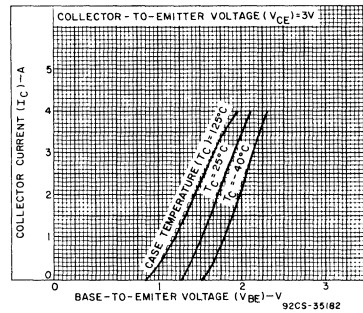


Fig. 6 - Typical transfer characteristics for all types.

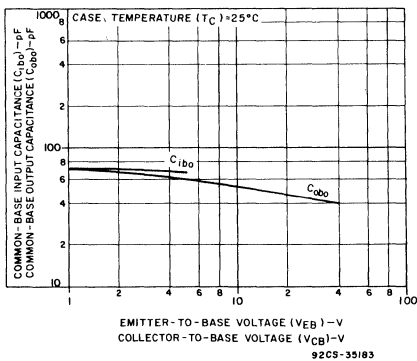


Fig. 7 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic (all types).

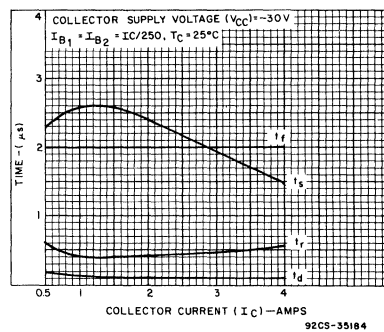


Fig. 8 - Typical saturated switching characteristics (all types).

TIP115, TIP116, TIP117

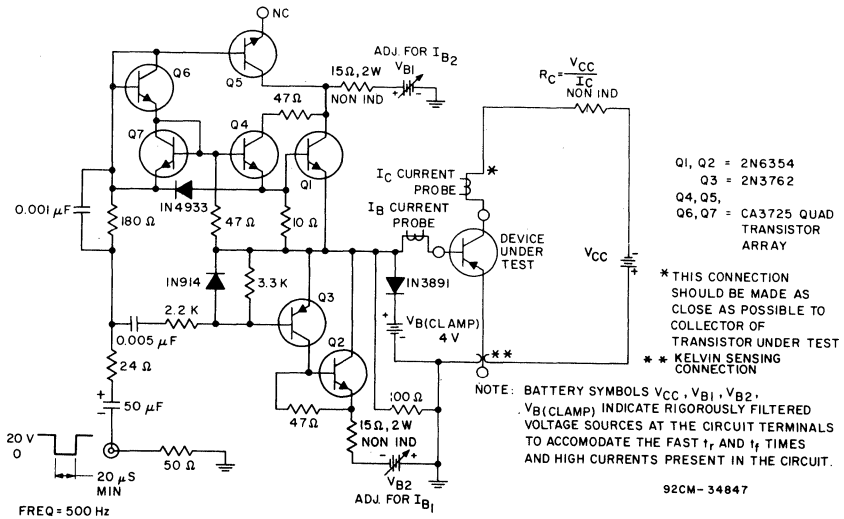


Fig. 9 - Circuit for measuring switching times.

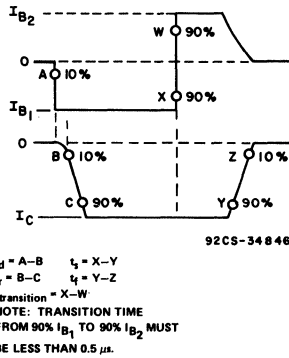


Fig. 10 - Phase relationship between input and output currents showing reference points for specification of switching times.

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 65 Watts
 Gain of 1000 at 0.5 A
 Gain of 1000 at 3 A

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

The TIP120, TIP121 and TIP122 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) plastic package.

The TIP120, TIP121 and TIP122 are n-p-n complements of the TIP125, TIP126 and TIP127 described in data bulletin File 997.

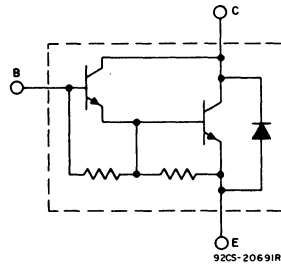
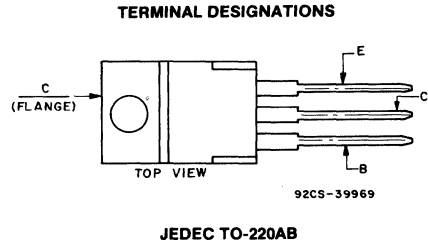


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP120	TIP121	TIP122	
V_{CBO}	60	80	100	V
$V_{CER(SUS)}$ $R_{RE} = 100 \Omega$	60	80	100	V
$V_{CEO(SUS)}$	60	80	100	V
$V_{CEV(SUS)}$ $V_{BE} = -1.5 V$	60	80	100	V
V_{EBO}	5	5	5	V
I_C	8	8	8	A
I_{CM}	10	10	10	A
I_B	0.25	0.25	0.25	A
P_T T_C up to 25°C	65	65	65	W
T_C above 25°C	Derate linearly at 0.52			W/°C
T_{stg} , T_J	-65 to 150			°C
T_L At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	235			°C

TIP120, TIP121, TIP122

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP120		TIP121		TIP122		
	V _{CE}	V _{BE}	I _C	I _B	Min.	Max.	Min.	Max.	Min.	Max.	
I _{CBO} I _E =0	60				—	0.2	—	—	—	—	mA
	80				—	—	—	0.2	—	—	
	100				—	—	—	—	—	0.2	
I _{CEO}	30			0	—	0.5	—	—	—	—	mA
	40			0	—	—	—	0.5	—	—	
	50			0	—	—	—	—	—	0.5	
I _{EBO}		-5	0		—	2	—	2	—	2	mA
V _{CEO} (sus)			0.2 ^a	0	60	—	80	—	100	—	V
h _{FE}	3		3 ^a		1000	—	1000	—	1000	—	
	3		0.5 ^a		1000	—	1000	—	1000	—	
V _{BE}	3		3 ^a		—	2.5	—	2.5	—	2.5	V
V _{CE} (sat)			3 ^a	0.012	—	2	—	2	—	2	V
			5 ^a	0.02	—	3	—	3	—	3	
h _{fe} f=1 kHz	5		1		1000	—	1000	—	1000	—	
|h _{fe}|| f=1 MHz	5		1		20	—	20	—	20	—	
C _{obo} V _{CB} =10 V f=1 MHz					—	200	—	200	—	200	pF
I _S /b t=0.5 s non-rep. pulse	25				2.6	—	2.6	—	2.6	—	A
R _θ JC					—	1.92	—	1.92	—	1.92	°C/W

^a Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

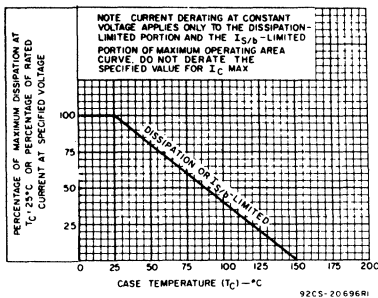


Fig. 2 — Derating curve for all types.

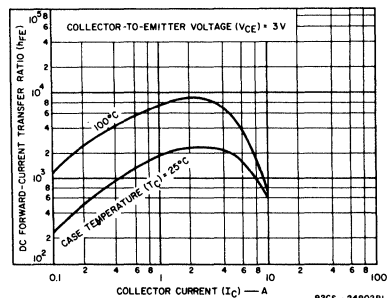


Fig. 3 — Typical dc beta characteristics for all types.

TIP120, TIP121, TIP122

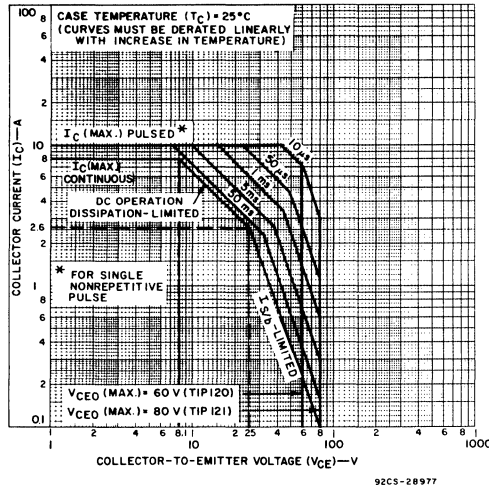


Fig. 4 — Maximum operating areas for TIP120 and TIP121.

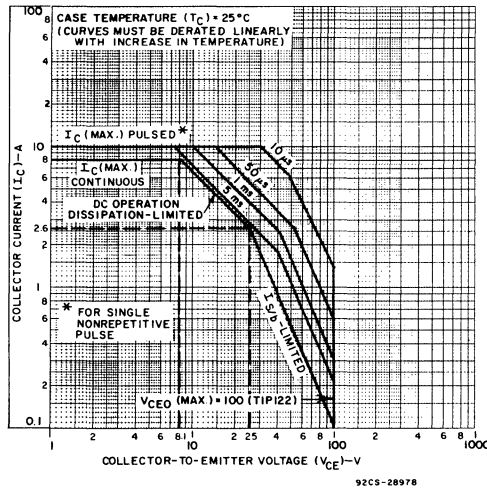


Fig. 5 — Maximum operating areas for TIP122.

TIP120, TIP121, TIP122

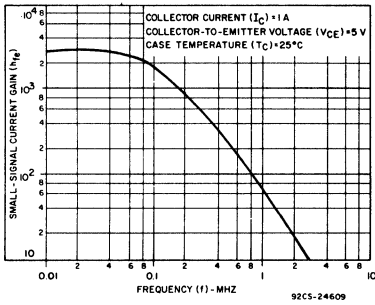


Fig. 6 — Typical small-signal current gain for all types.

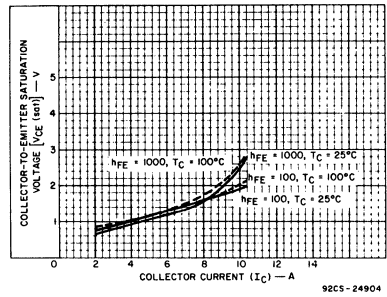


Fig. 7 — Typical saturation characteristics for all types.

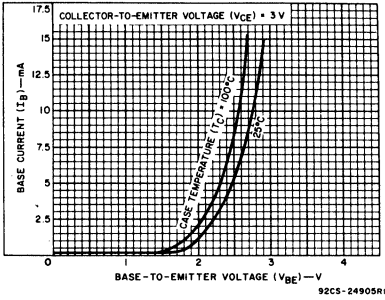


Fig. 8 — Typical input characteristics for all types.

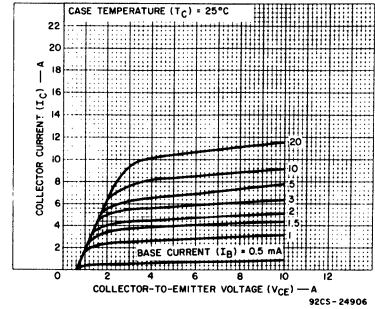


Fig. 9 — Typical output characteristics for all types.

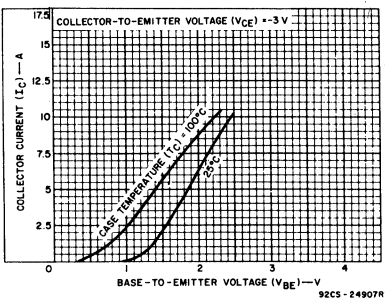


Fig. 10 — Typical transfer characteristics for all types.

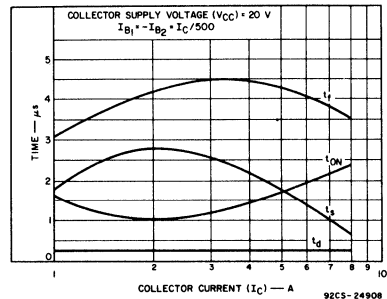


Fig. 11 — Typical saturated switching characteristics for all types.

File Number **997**

TIP125, TIP126, TIP127

8-Ampere P-N-P Darlington Power Transistors

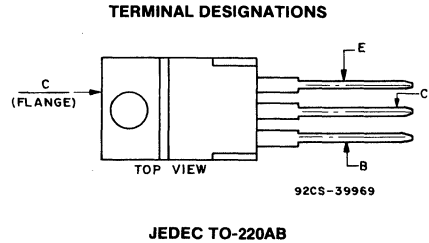
-60, -80, and -100 Volts, 65 Watts
 Gain of 1000 at -3 A
 Gain of 500 at -0.75 A

Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators



2

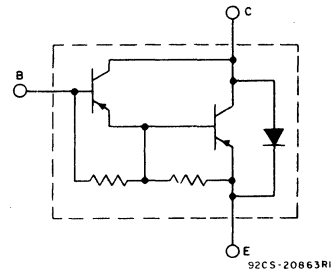


Fig. 1 - Schematic diagram for all types.

The TIP125, TIP126 and TIP127 are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VER-SAWATT) package.

The TIP125, TIP126 and TIP127 are p-n-p complements of the TIP120, TIP121 and TIP122 described in data bulletin File 998.

MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP125	TIP126	TIP127	
V_{CBO}	-60	-80	-100	V
$V_{CEO(SUS)}$	-60	-80	-100	V
V_{EBO}	-5	-5	-5	V
I_C	-8	-8	-8	A
I_{CM}	-15	-15	-15	A
I_B	-0.25	-0.25	-0.25	A
P_T				
$T_C \leq 25^\circ C$	65	65	65	W
$T_C > 25^\circ C$	0.52			W/°C
T_{stg} T_J	-65 to 150			°C
T_L				
At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.	235			°C

TIP125, TIP126, TIP127

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	Voltage V dc	Current A dc		TIP125		TIP126		TIP127		
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	-30 -40 -50		0 0 0	- - -	-0.5 - -	- - -	-0.5 - -	- - -0.5		mA
I_{EBO} $V_{BE}=5$ V		0		-	-10	-	-10	-	-10	mA
$V_{CEO(sus)}$		-0.03 ^a	0	-60	-	-80	-	-100	-	V
h_{FE}	-3 -3	-0.75 ^a -3 ^a		500 1000	-	500 1000	-	500 1000	-	
V_{BE}	-3	-3 ^a		-	-2.5	-	-2.5	-	-2.5	V
$V_{CE(sat)}$		-3 ^a -5 ^a	-0.012 -0.02	-	-2 -4	-	-2 -4	-	-2 -4	V
h_{fe} f=1 kHz	-5	-1		1000	-	1000	-	1000	-	
$|h_{fe}|$ f=1 MHz	-5	-1		20	-	20	-	20	-	
$I_{S/b}$ t=1-s nonrep. pulse	-20			-3.2	-	-3.2	-	-3.2	-	A
$R_{\theta JC}$				-	1.92	-	1.92	-	1.92	°C/W

^a Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

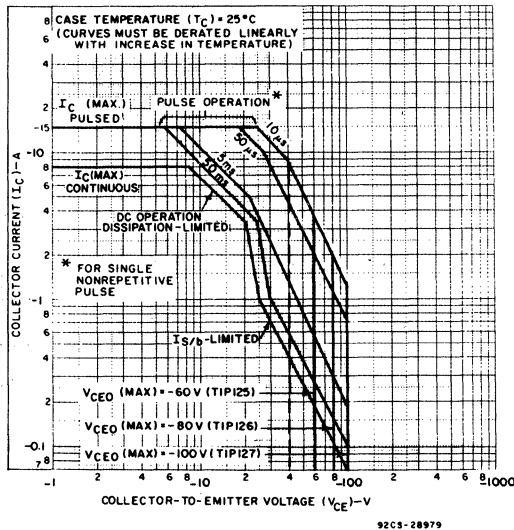


Fig. 2 — Maximum operating areas for all types.

TIP125, TIP126, TIP127

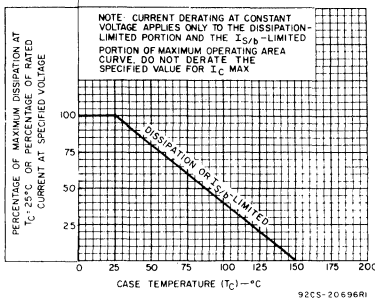


Fig. 3 — Dissipation derating curve for all types.

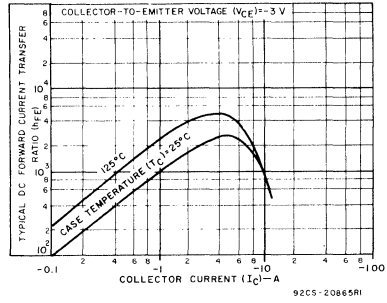


Fig. 4 — Typical dc beta characteristics for all types.

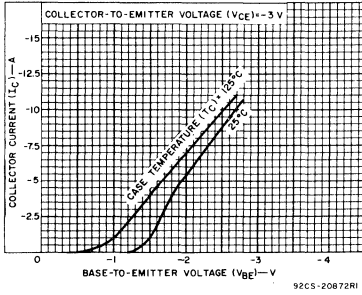


Fig. 5 — Typical transfer characteristics for all types.

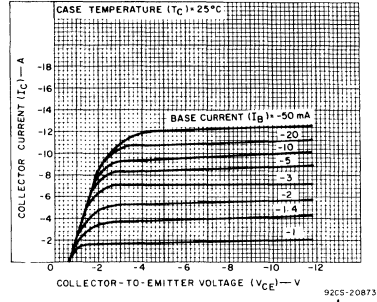


Fig. 6 — Typical output characteristics for all types.

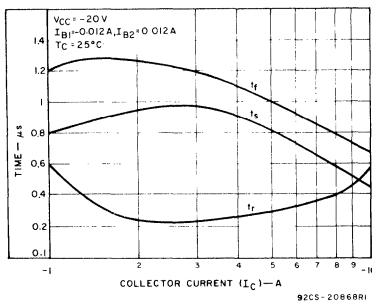


Fig. 7 — Typical saturated switching-time characteristics for all types.

TIP125, TIP126, TIP127

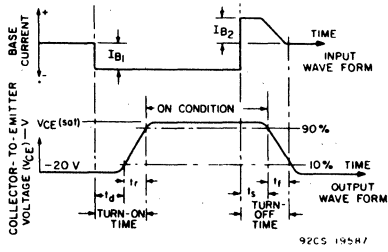
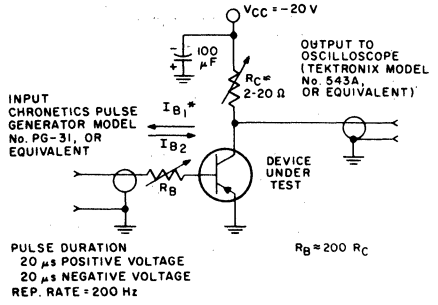


Fig. 8 — Phase relationship between input current and output voltage showing reference points for specification of switching-times.



PULSE DURATION
 20 μ s POSITIVE VOLTAGE
 20 μ s NEGATIVE VOLTAGE
 REP. RATE = 200 Hz

* I_{B1} AND I_{B2} ARE MEASURED WITH TEKTRONIX CURRENT PROBE P6019 AND TYPE 134 AMPLIFIER, OR EQUIVALENT

Fig. 9 — Circuit used to measure saturated switching-times.

Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

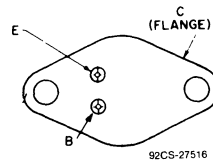
Features:

- V_{CE0} — 300 V and 400 V
- I_C — 10 A
- P_T — 100 W

The TIP562 and TIP563 silicon n-p-n power transistors feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power-switching circuits.

The TIP562 and TIP563 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	TIP562	TIP563	
V_{CB0}	300	400	V
$V_{CE0(SUS)}$	300	400	V
V_{EB0}	8		V
I_C	10		A
I_{CM}	15		A
I_B	2		A
P_T :			
At T_C up to 100 °C	100		W
T_J, T_{stg}	-65 to +200		°C
T_L :			
At distances $\geq 1/16$, in. (1.58 mm) from case for 10 s max.	200		°C

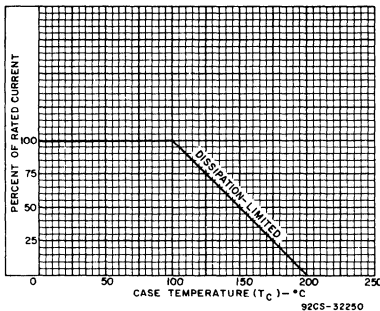


Fig. 1 - Dissipation derating curve.

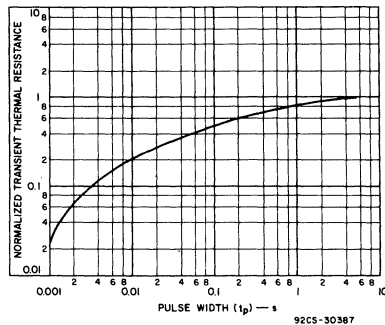


Fig. 2 - Typical thermal-response characteristic.

TIP562, TIP563

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		TIP562			TIP563			
	V _{CE}	V _{BE}	I _C	I _B	Min.	Typ.	Max.	Min.	Typ.	Max.	
I _{CEO}	270	—	—	0	—	—	1	—	—	—	mA
	360	—	—	0	—	—	—	—	—	1	
I _{CBO} , I _E = 0	300 ^b	—	—	—	—	—	100	—	—	—	μA
	400 ^b	—	—	—	—	—	—	—	—	100	
I _{EBO}	—	8	0	—	—	—	5	—	—	5	mA
V _{CEO(sus)} ^a	—	—	0.1	—	300	—	—	400	—	—	V
V _{BE(sat)} ^a	—	—	10	1.66	—	—	1.4	—	—	1.4	
V _{CE(sat)} ²	—	—	10	1.66	—	—	1.2	—	—	1.2	
h _{FE} ^a	—	—	15	5	—	—	2.0	—	—	2.0	
	4	—	1.0	—	20	—	—	20	—	—	
h _{FE} ^a	4	—	10	—	8	—	—	8	—	—	
	40	—	—	—	2.5	—	—	2.5	—	—	
I _S /b, t _p = 1 s, non-repetitive	40	—	—	—	2.5	—	—	2.5	—	—	A
t _d	V _{CC} = 180 V	-5.2	10	2	—	.05	—	—	.05	—	μs
t _r	V _{CC} = 180 V	-5.2	10	2	—	0.5	—	—	0.5	—	
t _s (I _{B1} = I _{B2})	V _{CC} = 180 V	-5.2	10	2	—	1.2	—	—	1.2	—	
t _f (I _{B1} = I _{B2})	V _{CC} = 180 V	-5.2	10	2	—	0.3	—	—	0.3	—	
t _c V _{CC} = 135 V L = 50 μH R _C = 13.5 Ω	—	-6	10	2	—	—	700	—	—	700	ns
R _{θJC}	—	—	—	—	—	—	—	—	—	1.0	°C/W

^aPulsed, pulse duration = 300 μs, duty factor < 2%.

^bV_{CB} value.

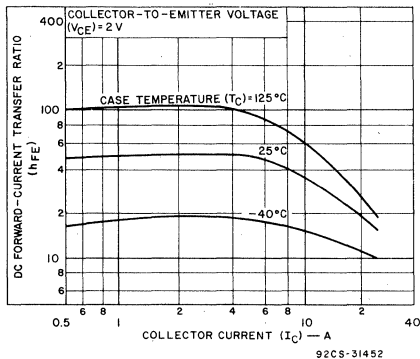


Fig. 3 - Typical dc beta characteristics for both types.

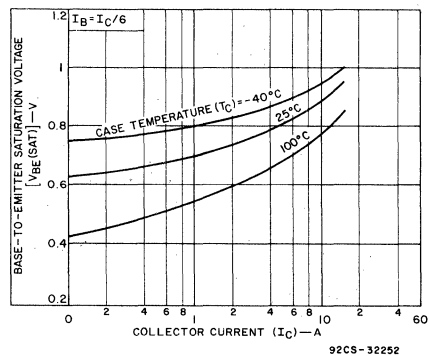


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for both types.

TIP562, TIP563

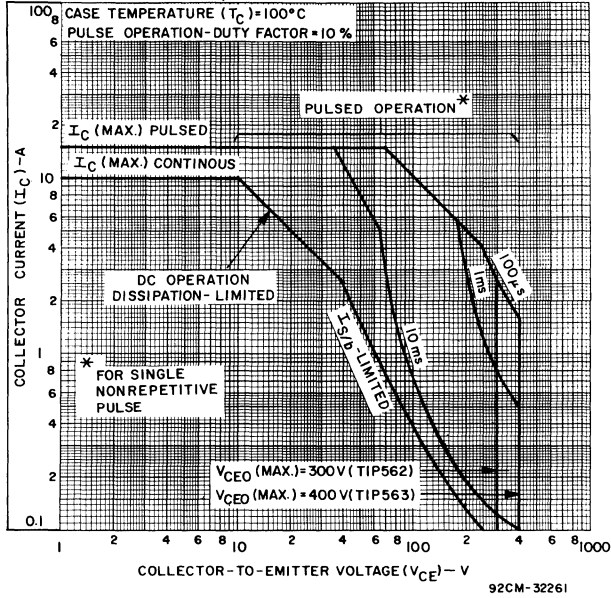


Fig. 5 - Maximum operating areas ($T_C = 100^\circ\text{C}$).

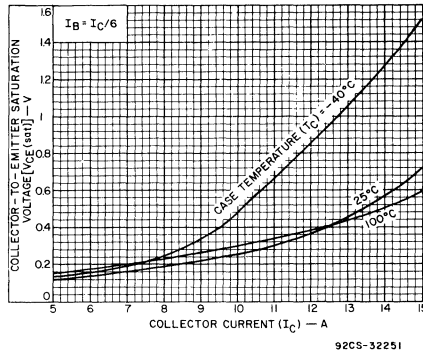


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for both types.

Power Hybrid Circuits

Technical Data

3

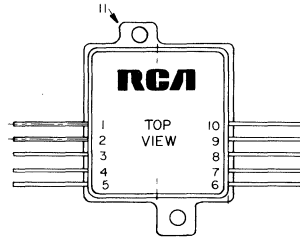
Multi-Purpose 7-Ampere Operational Amplifier

Linear Amplifiers for Applications in Industrial and Commercial Equipment

Features:

- Bandwidth: 30 kHz at 60 W
- High power output: up to 100 W(rms)
- Built-in load-line-limiting circuit
- Reactive-load fault protection
- Provision for feedback control

TERMINAL DESIGNATIONS



92CS-40377

The RCA-HC2000H is a complete solid-state hybrid operational amplifier in a metal hermetic package. The HC2000H is intended for military and critical industrial applications and can be supplied in accordance with applicable portions of MIL-STD.883.

The amplifier employs a quasi-complementary-symmetry class B output circuit with built-in load-fault protection.

Type HC2000H is recommended for the following applications: servo-amplifiers (ac, dc, PWM); deflection amplifiers; power operational amplifiers; audio amplifiers; voltage regulators; and driven inverters.

Additional information on hybrid power amplifiers is contained in RCA Application Notes AN-4483 and AN-4782.

MAXIMUM RATINGS, Absolute-Maximum Values:

V_S :		
Between leads 1 and 10		75 V
I_{OM}		7 A
P_T :		
Per Output Device	See Fig. 4 & 5	
T_{stg}		-55 to +125°C
T_J		-55 to +150°C
T_L (During Soldering):		
At distances $\geq 1/8$ in. (3.17 mm) from case for 10 s max.		235°C
ϕL (Min):		
At distance ≥ 0.075 (1.91 mm) from case	0.04 in. (1.02 mm)	

HC2000H

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	V_S -V	f -kHz	P_O -W	R_L - Ω	MIN.	TYP.	MAX.	
$\frac{V_{OUT}}{V_{IN}}$ Open-Loop	± 37.5	4	25	4	-	2000	-	
	Closed-Loop (See Fig. 3)	± 37.5	1	1	4	26	30	
Z_{IN} Measured between leads 7 & 8 (See Fig. 3)	-	-	-	-	16	18	-	k Ω
I_o	± 37.5	-	-	-	15	-	30	mA
V_{IO} Measured between leads 4 & 5 (See Fig. 3)	± 37.5	-	-	4	0	± 30	± 250	mV
V_{OUT}	± 37.5	1	100	4	28	32	-	V
f_H (See Figs. 3 & 8)	± 37.5	-	1	4	43	-	-	kHz
THD (See Figs. 3 & 9)	± 37.5	1	60	4	-	0.4	0.5	%
I_S (See Fig. 11)	± 37.5	1	-	0	± 2	-	± 3.85	A
S/N $Z_G = 600 \Omega$	± 37.5	-	-	-	-	78	-	dB
SR (Unity gain, $I_{OM} = 4A$)	± 37.5	1	100	4	5	-	-	V/ μs
$R_{\theta JC}$ Per Output Device (See Figs. 4 & 5)	-	-	-	-	-	-	2	$^{\circ}C/W$

3

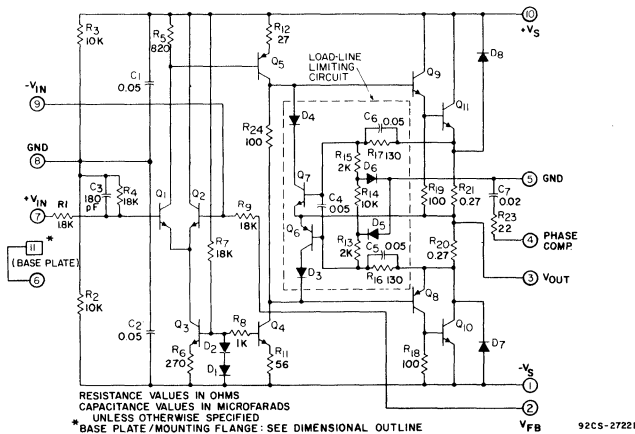
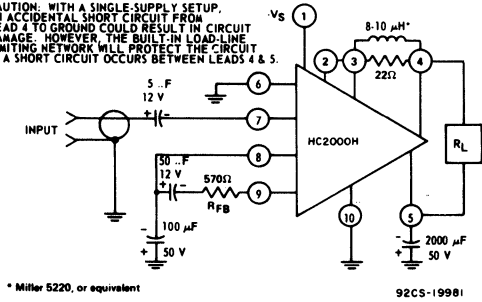


Fig. 1 - Schematic diagram of type HC2000H power hybrid circuit operational amplifier.

HC2000H

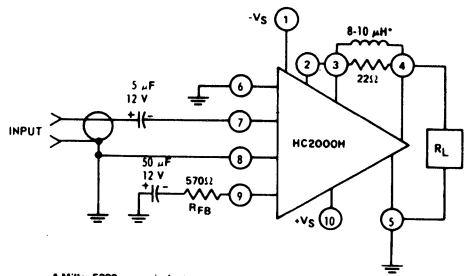
CAUTION: WITH A SINGLE-SUPPLY SETUP, AN ACCIDENTAL SHORT CIRCUIT FROM LEAD 4 TO GROUND COULD RESULT IN CIRCUIT DAMAGE. HOWEVER, THE BUILT-IN LOAD-LINE LIMITING NETWORK WILL PROTECT THE CIRCUIT IF A SHORT CIRCUIT OCCURS BETWEEN LEADS 4 & 5.



* Miller 5220, or equivalent

92CS-19981

Fig. 2 — Type HC2000H power hybrid circuit with external connections for operation with a single power supply.



* Miller 5220, or equivalent

92CS-19982

Fig. 3 — Type HC2000H power hybrid circuit with external connections (and split power supply) for measuring relative response and distortion; see Figs. 8 & 9.

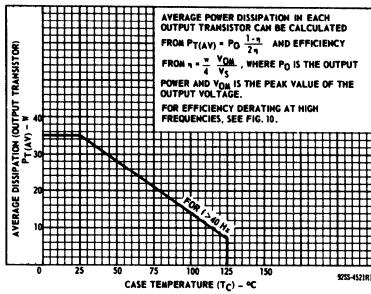


Fig. 4 — Dissipation (average) derating curve for each output transistor (for symmetrical waveforms with $f > 40$ Hz).

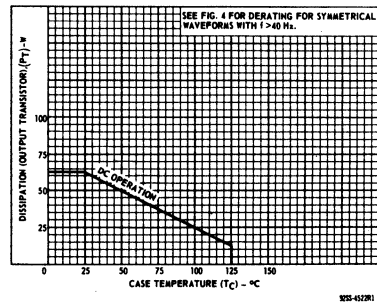


Fig. 5 — Dissipation (dc) derating curve for each output transistor.

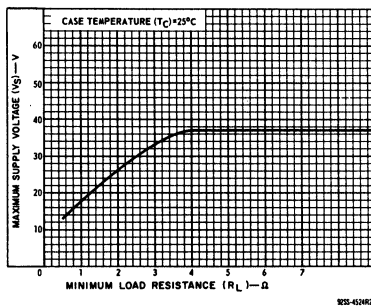


Fig. 6 — Maximum allowable supply voltage vs. load resistance.

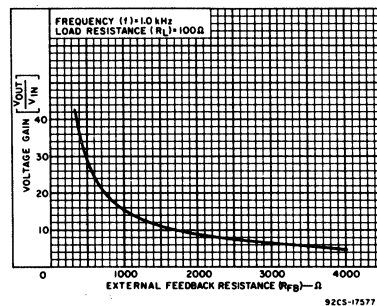


Fig. 7 — Closed-loop voltage gain vs. external feedback resistance.

HC2000H

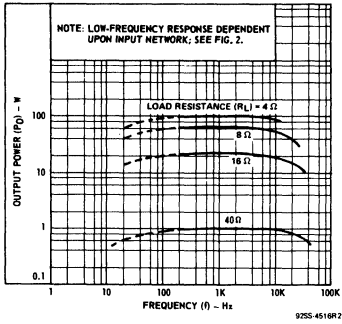


Fig. 8 - Output power vs. frequency.

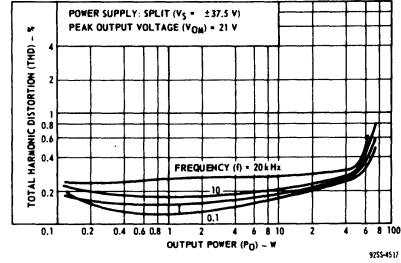


Fig. 9 - Total harmonic distortion with split power supply.

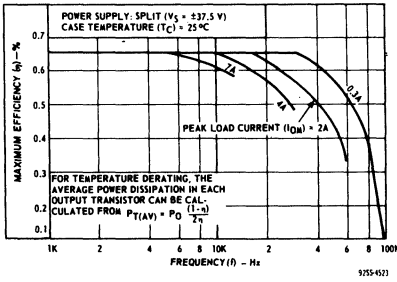


Fig. 10 - Maximum efficiency vs. frequency for several values of peak load current.

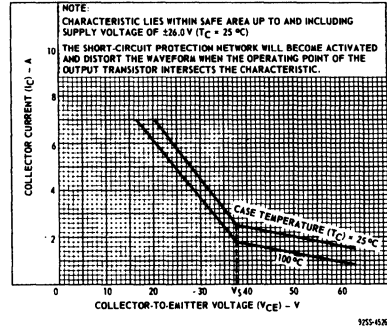


Fig. 11 - Characteristics of built-in load-line-limiting circuit.

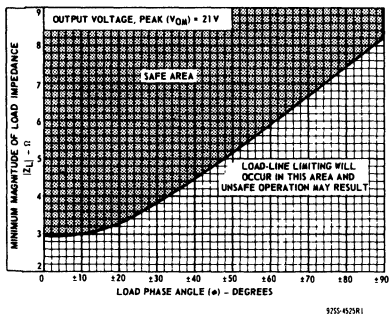


Fig. 12 - Minimum load impedance vs. load phase angle and safe area of operation.

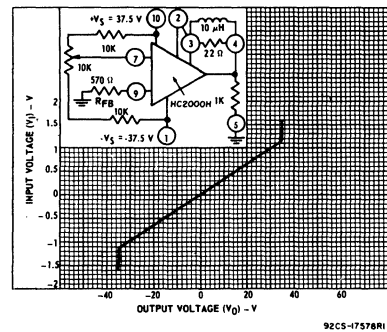


Fig. 13 - Gain linearity characteristic.

HC2000H

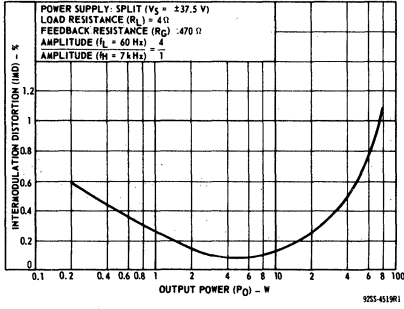


Fig. 14 – Intermodulation distortion with split supply and 4-ohm load.

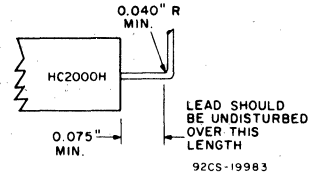


Fig. 15 – Recommended lead-bending specification.

Multi-Purpose, Low-Distortion 7-Ampere Operational Amplifier

Linear Amplifier for Applications in Industrial and Commercial Equipment

Features:

- Bandwidth: 30 kHz at 60 W
- High power output: up to 100 W(rms)
- Adjustable idling current

RCA type HC2500* is a complete solid-state hybrid amplifier in a compact hermetic package. It employs a quasi-complementary-symmetry output circuit.

The HC2500 is a low-distortion, 100-watt linear amplifier. The output section can be externally biased class AB for low inter-modulation and total harmonic distortion. Terminals are available for external frequency compensation, external short-circuit protection, and inverting and non-inverting inputs.

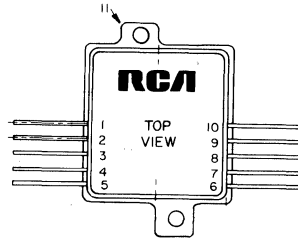
The HC2500 is recommended for the following applications; servo amplifiers (ac, dc, PWM), deflection amplifiers, power operational amplifiers, voltage regulators, driven inverters, hi-fi amplifiers, PA systems, and solenoid drivers.

*Derived from RCA Dev. No. TA8651A.

MAXIMUM RATINGS, Absolute-Maximum Values:

SUPPLY VOLTAGE:		
Between leads 1 and 10	75	V
OUTPUT CURRENT (Peak)	7	A
TOTAL DISSIPATION:		
Per output device	See Figs. 4 & 5	
TEMPERATURE RANGE:		
Storage	-55 to +125°C	
Output junction	-55 to +150°C	
LEAD TEMPERATURE (During Soldering):		
At distance ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235°C	

TERMINAL DESIGNATIONS



92CS-40377

3

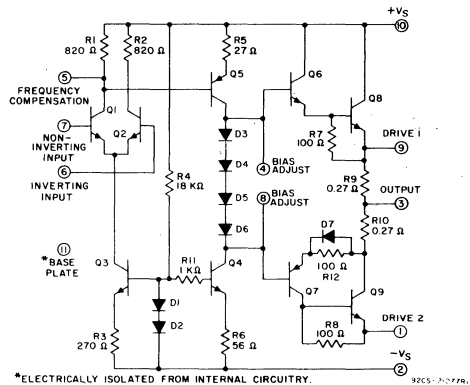


Fig. 1 - Schematic diagram of type HC2500 operational amplifier.

COMPARISON CHART

TYPE	IM DIST. @ 50 mW	OUTPUT PROTECTION NETWORK	OPERATING MODE	FREQUENCY COMPENSATION	COMMUTATING DIODES
HC2500	0.06%	NO	CLASS AB	CAPACITOR ON SIGNAL TERMINALS	NO
HC2000H	5.8%	YES	CLASS B	LC FILTER ON OUTPUT	YES

HC2500

ELECTRICAL CHARACTERISTICS, At Case Temperature (T_C) = 25°C and Supply Voltage (V_S) = ±37.5 V

CHARACTERISTIC	SYMBOL	REFER- ENCE FIG. NO.	TEST CONDITIONS				LIMITS			UNITS
			SPECIAL NOTES	FREQ. (f)—kHz	OUTPUT POWER (P_O)—W	LOAD RESIST. (R_L)— Ω	MIN.	TYP.	MAX.	
Offset Voltage	V_{offset}	3	Measured Pin 3 to Gnd	—	—	4	—	—	±250	mV
Quiescent Current	I_o	3	Idling Cur- rent < 1 mA	—	—	Open	—	—	±30	mA
Output Voltage Swing	V_{OUT}		Peak dc voltage	0	200	4	28	—	—	V
Closed-Loop Bandwidth	f_H	3		—	1	4	43	—	—	kHz
Total Harmonic Distortion	THD	15		1	60	4	—	0.3	0.5	%
Closed-Loop Voltage Gain	A_{CL}	3		1	1	4	31	32	—	
Thermal Resistance	$R_{\theta\text{JC}}$	5		—	—	—	—	—	2	°C/W

ELECTRICAL CHARACTERISTICS

Typical Values (for Design Guidance), At Case Temperature (T_C) = 25°C and Supply Voltage (V_S) = ±37.5 V

Open-Loop Voltage Gain	A_{OL}	8, 19	Idling cur- rent = 50 mA	1	25	4	—	70	—	dB
Input Offset Voltage	V_{IO}	20		—	0	Open	—	±10	—	mV
Input Offset Current	I_{IO}	20		—	0	Open	—	7	—	μA
Input Bias Current	I_{IB}	20		—	0	Open	—	20	—	μA
Common-Mode Input Impedance	R_{CM}	22		0.005	0	Open	—	1	—	M Ω
Common-Mode Input- Voltage Range	V_{ICR}			0.5	100	4	—	32	—	V
Common-Mode- Rejection Ratio	CMRR			0.005	0	Open	—	50	—	dB
Supply-Voltage Ripple- Rejection Ratio	V_{RR}			0.06	0	4	—	30	—	dB
Intermodulation Distortion	IMD	14	Idling cur- rent = 50 mA	—	0.05	4	—	0.06	—	%
Slew Rate	SR	18	$A_{\text{CL}} = 2$ $C_c = 100$ pF	0.5 Square Wave	—	4	—	4.3	—	V/ μs
Idling-Current Drift	ΔI_i	17	25°C to 100°C	—	—	4	—	1	—	mA/°C

HC2500

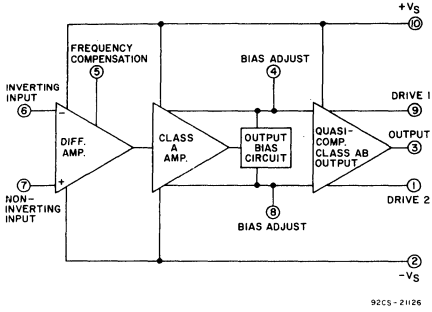


Fig. 2 — Block diagram of HC2500 100-watt class AB amplifier.

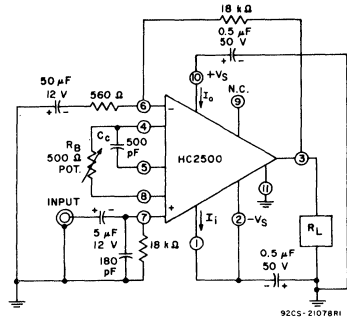


Fig. 3 — Typical test circuit with split supply for measuring A_{CL} , I_i , I_o , V_{offset} , f_H , THD, and IMD.

3

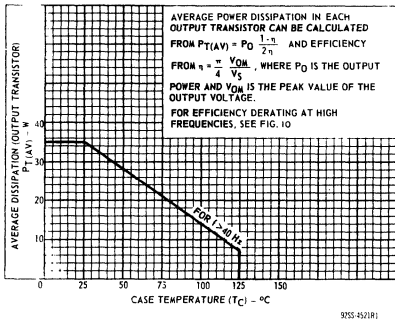


Fig. 4 — Dissipation (average) derating curve for each output transistor (for symmetrical waveforms with $f > 40$ Hz).

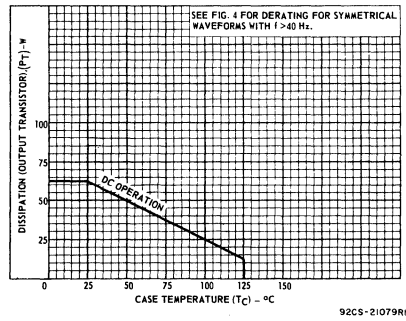


Fig. 5 — Dissipation derating curve for each output transistor.

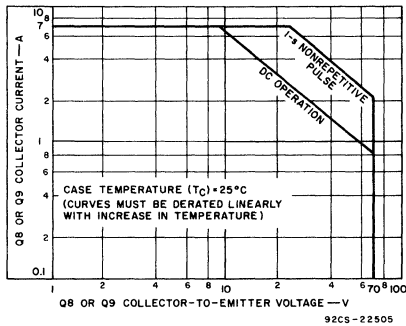


Fig. 6 — Maximum operating area for HC2500.

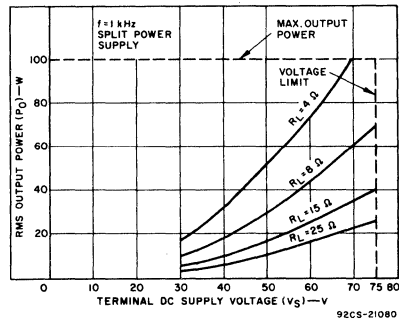


Fig. 7 — Output power as a function of supply voltage, with various values of load resistance, for symmetrical sine-wave operation.

HC2500

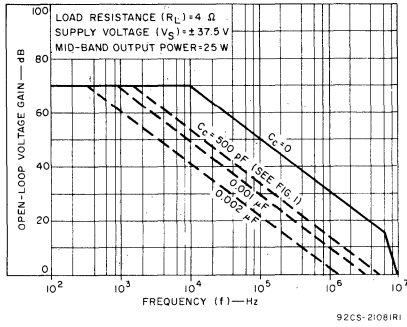


Fig. 8 - Typical open-loop voltage gain vs. frequency.

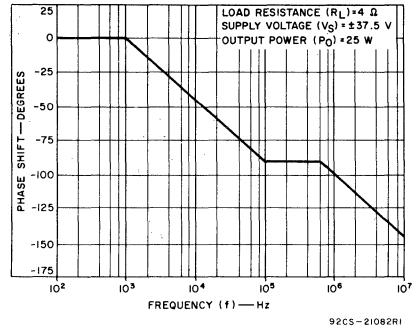


Fig. 9 - Typical open-loop phase shift vs. frequency.

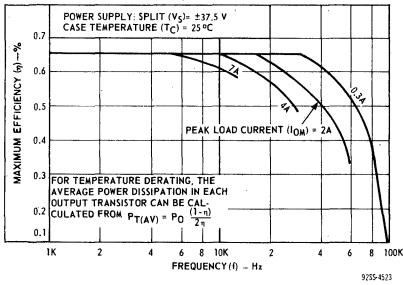


Fig. 10 - Maximum efficiency vs. frequency for several values of peak load current.

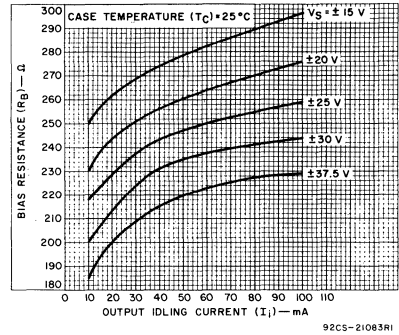


Fig. 11 - Bias resistor (R_B in Fig. 3) value vs. output idling current (I_I).

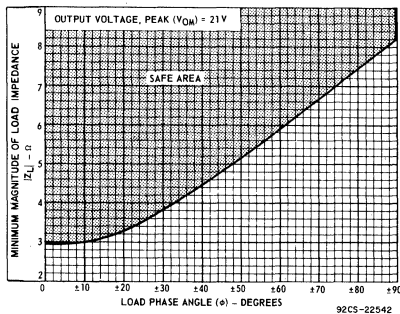


Fig. 12 - Minimum load impedance vs. load phase angle and safe area of operation.

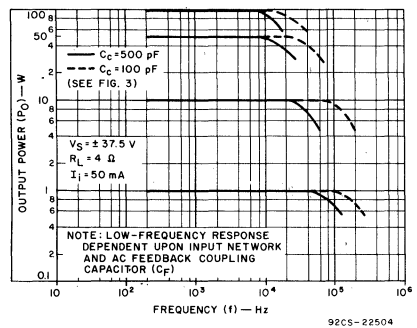


Fig. 13 - Output power vs. frequency.

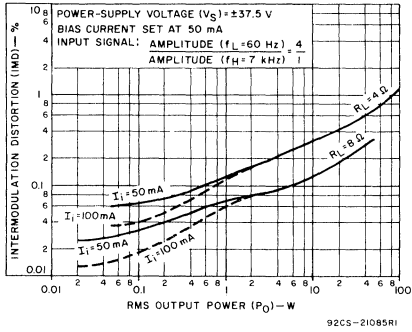


Fig. 14 — Typical intermodulation distortion vs. rms output power.

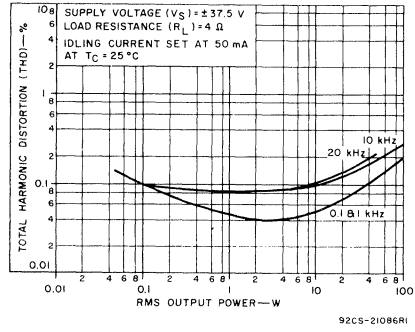


Fig. 15 — Typical total harmonic distortion vs. rms output power.

3

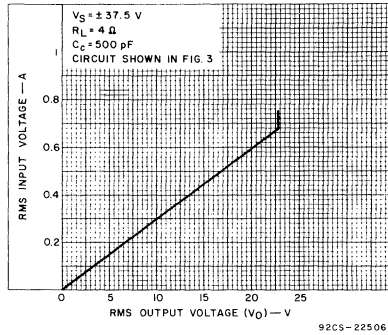


Fig. 16 — Input sensitivity.

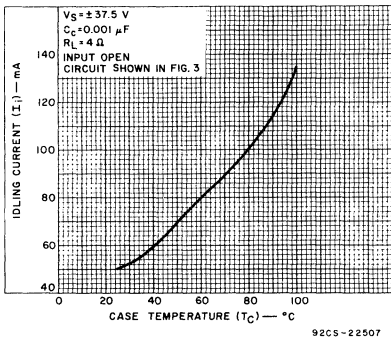


Fig. 17 — Typical idling-current drift.

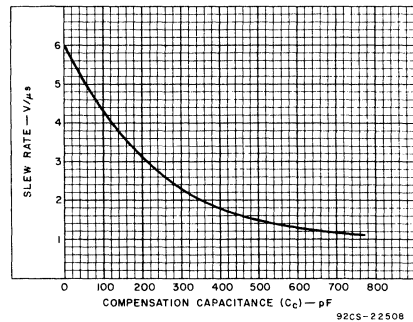


Fig. 18 — Typical slew rate vs. value of compensation capacitor, C_C (test circuit shown in Fig. 21).

HC2500

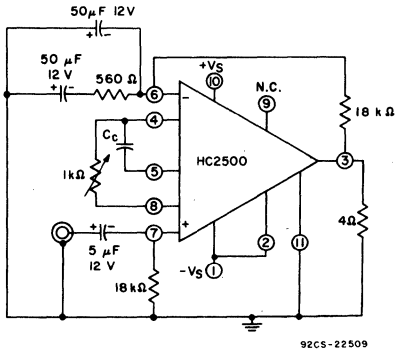
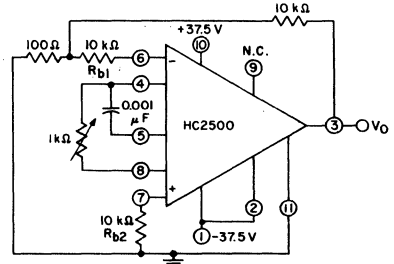


Fig. 19 – Test circuit for open-loop gain and phase response.



$$V_{IO} = -\frac{V_O}{100} \text{ with } R_{b1} \text{ and } R_{b2} \text{ shorted}$$

$$I_{IO} = -\frac{V_O}{100 R_{b2}}$$

$$I_{Ib} = \frac{V_O}{100 R_{b2}} \text{ with } R_{b1} \text{ shorted}$$

Fig. 20 – Test circuit for input offset voltage and current test.

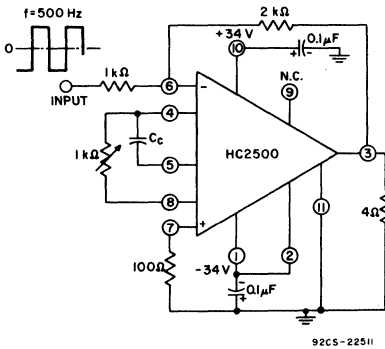
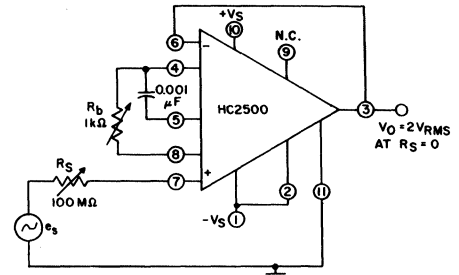


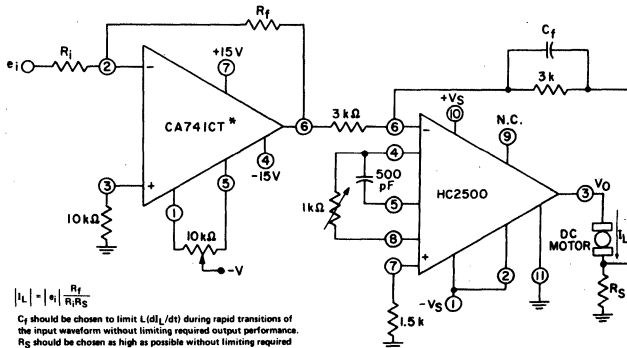
Fig. 21 – Circuit used to test slew rate.



$R_{CM} = 9 R_s$ with series resistance (R_s) increased from zero until output voltage (V_O) is reduced by 10%.

Fig. 22 – Test circuit for measuring common-mode input resistance.

TYPICAL APPLICATION CIRCUITS



$|A_v| = |A_v| \frac{R_f}{R_1 R_2}$
 C_f should be chosen to limit $L(dI/dt)$ during rapid transitions of the input waveform without limiting required output performance.
 R_s should be chosen as high as possible without limiting required output performance.
 *See Data Bulletin File 531.

Fig. 23 – Current-feedback motor-control circuit.

HC2500

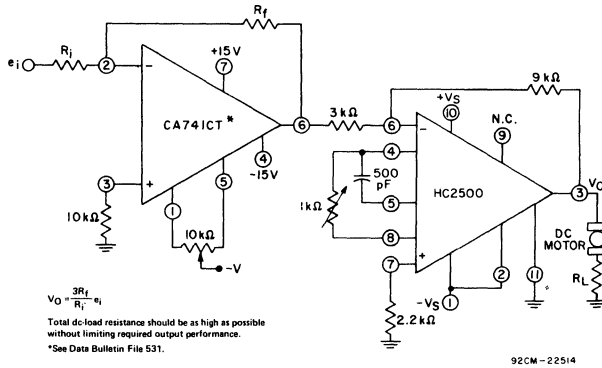


Fig. 24 - Voltage-feedback motor-control circuit.

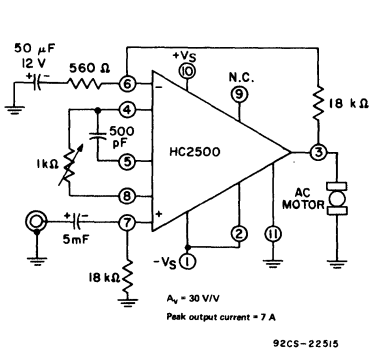


Fig. 25 - AC motor control.

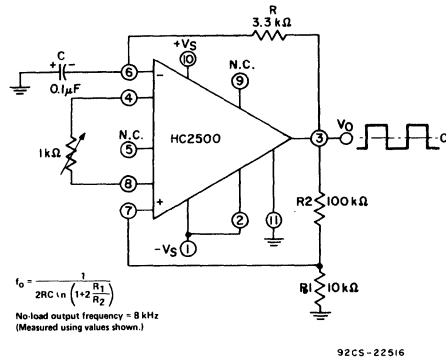


Fig. 26 - High-power astable multivibrator.

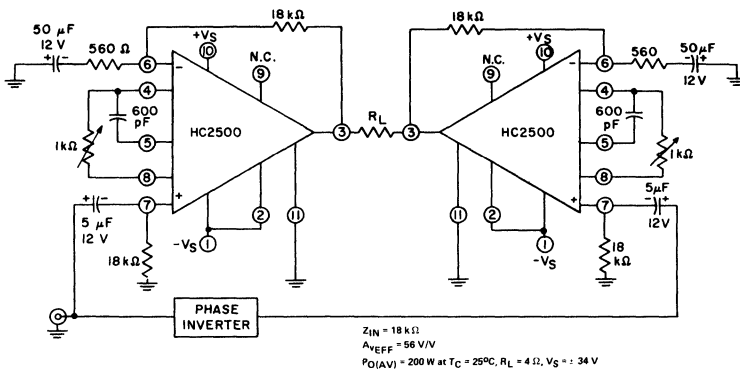
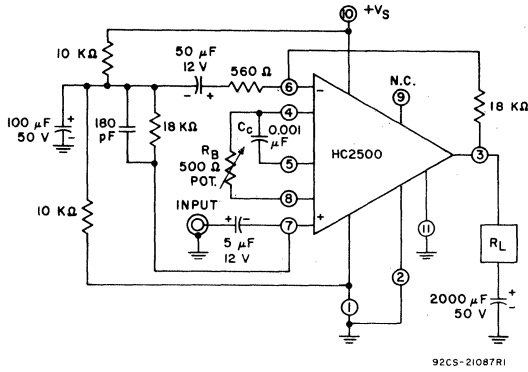


Fig. 27 - Bridge circuit for loads greater than 100 watts.

HC2500



V_S	54 V
P_{out}	60 W
Idling Current ($R_B = 168 \Omega$)	50 mA
THD	0.15%
IMD @ 50 mW	0.06%
V_{offset} Pin 3 To Gnd.	+ 100 mV
Efficiency	64%
R_L	4 ohms

Fig. 28 – Typical circuit connections for operation of HC2500 with single-ended supply, and performance data.

Silicon Rectifiers

Technical Data

4

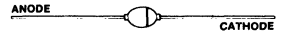
**1N4245, 1N4246, 1N4247
1N4248, 1N4249**

**1-A, Glass-Passivated Junction
Silicon Rectifiers**

Features:

- High-temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers
- Glass-passivated junction in DO-204AP package
- 1A operation at $T_A = 55^\circ\text{C}$ with no thermal runaway
- Typical reverse current less than $0.5\mu\text{A}$
- Exceeds environmental standard of MIL-STD-19500
- Hermetically sealed package
- High-temperature soldering guaranteed: $350^\circ\text{C}/10\text{ s}/0.375\text{ in.}$ (9.5 mm) lead length

TERMINAL DESIGNATIONS



DO-204AP

The GE/RCA 1N4245, 1N4246, 1N4247, 1N4248, and 1N4249 are glass-passivated "transient voltage protected", silicon rectifiers intended for general-purpose applications. These rectifiers will dissipate up to 1000 watts in reverse

direction without damage. Voltage transients generated by household or industrial power lines are dissipated. These rectifiers are supplied in a JEDEC DO-204AP package.

MAXIMUM RATINGS, Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:

	1N4245	1N4246	1N4247	1N4248	1N4249	
*MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, V_{RRM}	200	400	600	800	1000	V
*MAXIMUM RMS INPUT (SUPPLY) VOLTAGE: For resistive or inductive loads, V_{RMS}	140	280	420	560	700	V
*MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	200	400	600	800	1000	V
*MAXIMUM AVERAGE FORWARD CURRENT: For resistive or inductive loads, $T_A = 55^\circ\text{C}$ I_O	_____ 1 _____					A
*MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load, $T_A = 55^\circ\text{C}$... I_{FSM}	_____ 50 _____					A
*OPERATING TEMPERATURE RANGE T_{opr}	_____ -65 to +160 _____					$^\circ\text{C}$
*STORAGE TEMPERATURE RANGE T_{stg}	_____ -65 to +200 _____					$^\circ\text{C}$

* In accordance with JEDEC registration format.

1N4245, 1N4246, 1N4247
1N4248, 1N4249

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTIC		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop (at 1A)	V_F	—	—	1.2	V
Maximum Reverse Current:	I_R	—	—	1	μA
				At maximum dc reverse (blocking) voltage, $T_A = 25^\circ C$	
				$T_A = 125^\circ C$	
At average full-cycle, lead length = 0.375 in. (9.5 mm), $T_A = 55^\circ C$		—	—	50	
Junction Capacitance (at 1 MHz and applied reverse voltage = 4 V)	C_J	—	15	—	pF

* In accordance with JEDEC registration format.

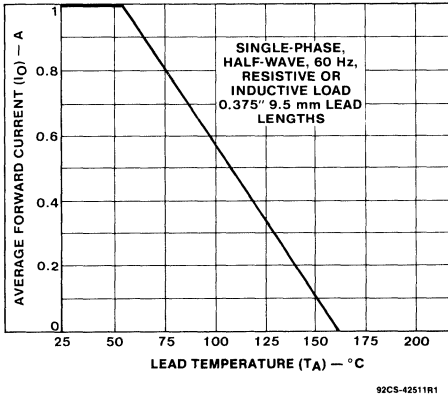


Fig. 1 - Maximum average forward output current characteristic.

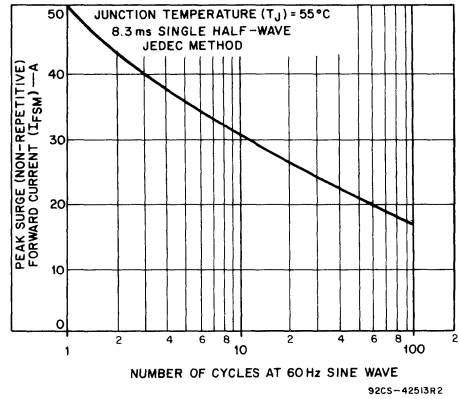


Fig. 2 - Maximum peak surge (non-repetitive) forward current characteristic.

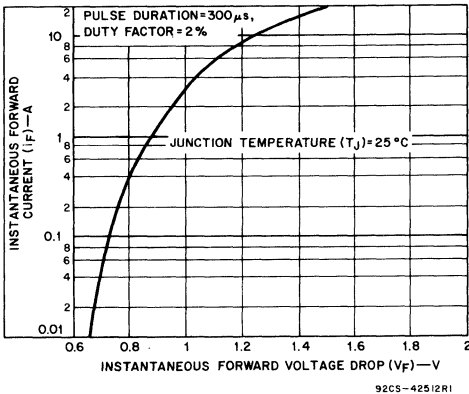


Fig. 3 - Typical instantaneous forward current characteristic.

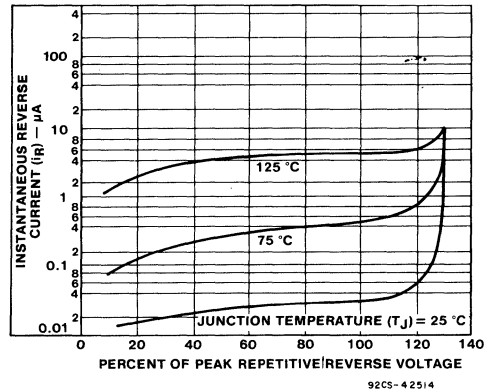


Fig. 4 - Typical reverse leakage current characteristics.

1N4245, 1N4246, 1N4247
1N4248, 1N4249

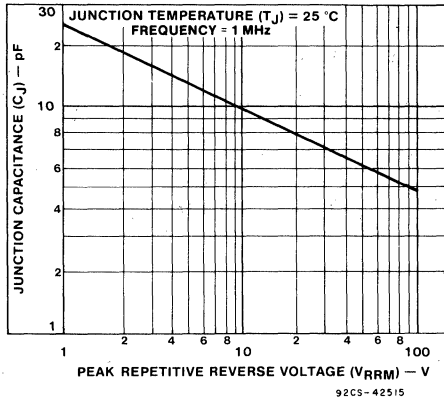


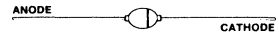
Fig. 5 - Typical junction capacitance characteristic.

1-A, Glass-Passivated Junction Silicon Rectifiers

Features:

- High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers
- Glass passivated junction
- 1A operation at $T_A = 100^\circ\text{C}$ with no thermal runaway
- Low reverse current
- Exceeds environmental standard of MIL-STD-19500
- Hermetically sealed package
- High temperature soldering: $350^\circ\text{C}/10\text{ S}/0.375\text{ in. (9.5mm)}$ lead length

TERMINAL DESIGNATIONS



DO-204AP

The GE/RCA 1N5059, 1N5060, 1N5061, and 1N5062 are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 800 watts in reverse

direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

4

MAXIMUM RATINGS, Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:

	1N5059	1N5060	1N5061	1N5062	
*MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, V_{RRM}	200	400	600	800	V
MAXIMUM RMS SUPPLY VOLTAGE:					
For resistive or inductive loads, V_{RMS}	140	280	420	560	V
*MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	200	400	600	800	V
*MAXIMUM AVERAGE FORWARD CURRENT:					
For resistive or inductive loads, $T_A = 75^\circ\text{C}$, I_o	_____			1	A
*MAXIMUM PEAK SURGE FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}	_____			50	A
OPERATING JUNCTION AND STORAGE					
TEMPERATURE RANGE, T_J, T_{stg}	_____			-65 to +175	$^\circ\text{C}$

*In accordance with JEDEC registration format.

1N5059, 1N5060, 1N5061, 1N5062

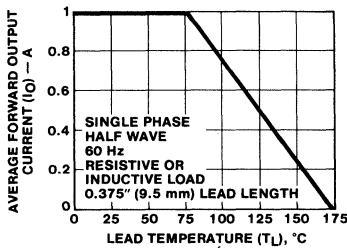
ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1A, $T_A = 75^\circ\text{C}$	V_F	—	—	1.2	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm)	I_R	—	—	$T_A = 25^\circ\text{C}$	μA
				$T_A = 175^\circ\text{C}$		150†
Maximum Reverse Current:*	I_R	—	—	$T_A = 25^\circ\text{C}$	μA
				$T_A = 175^\circ\text{C}$		300‡
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $t_{rr} = 0.25\text{A}$	t_{rr}	—	—	2	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	15	—	pF

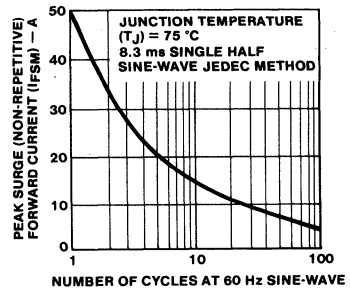
*In accordance with JEDEC registration format.

†100 μA for 1N5061 and 1N5062.

‡200 μA for 1N5061 and 1N5062.



92CS-43143

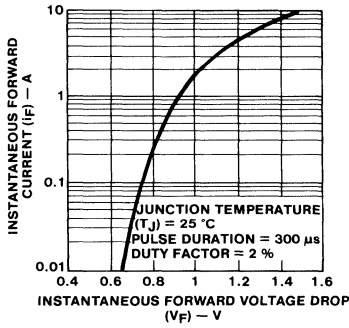


92CS-43144

Fig. 1 - Maximum average forward output current characteristic.

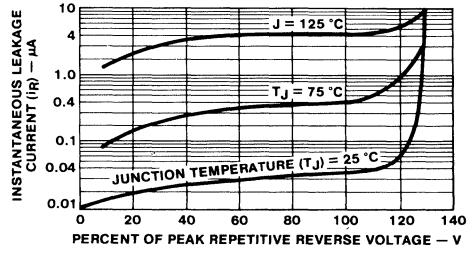
Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

1N5059, 1N5060, 1N5061, 1N5062



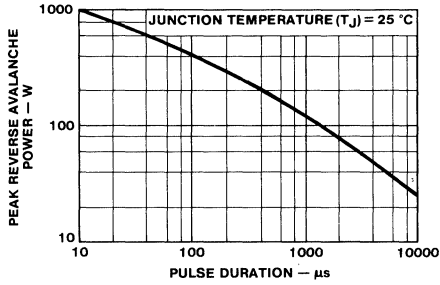
92CS-43145

Fig. 3 - Typical instantaneous forward current characteristic.



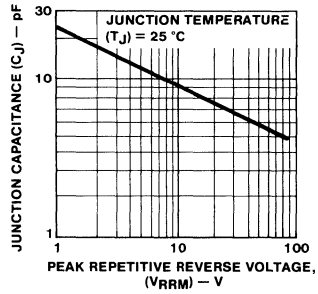
92CS-43146

Fig. 4 - Typical reverse leakage current characteristics.



92CS-43147

Fig. 5 - Maximum non-repetitive reverse avalanche power.



92CS-43148

Fig. 6 - Typical junction capacitance characteristic.

3-A, Glass-Passivated Junction Silicon Rectifiers

Features:

- High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers
- Glass passivated junction
- 3A operation at $T_A = 70^\circ\text{C}$ with no thermal runaway
- Low reverse leakage current
- Exceeds environmental standard of MIL-STD-19500
- Hermetically sealed package
- High temperature soldering: $350^\circ\text{C}/10\text{ s}/0.375\text{ in. (9.5mm)}$ lead length

TERMINAL DESIGNATIONS



GE-3

The GE/RCA 1N5624, 1N5625, 1N5626, and 1N5627 are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 800 watts in reverse

direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a GE-3 package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads†:

	1N5624	1N5625	1N5626	1N5627	
*MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	200	400	600	800	V
*MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	140	280	420	560	V
*MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	200	400	600	800	V
*MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_A = 70^\circ\text{C}$, I_o	3				A
*MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}	125				A
*OPERATING JUNCTION TEMPERATURE, T_j	-65 to +175				$^\circ\text{C}$
*STORAGE TEMPERATURE, T_{stg}	-65 to +200				$^\circ\text{C}$

*In accordance with JEDEC registration format.

†For capacitive load derate current by 20%.

1N5624, 1N5625, 1N5626, 1N5627

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 3A $T_A = 25^\circ\text{C}$	V_F	—	—	1	V
$T_A = 70^\circ\text{C}$	—	—	0.95		
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm), $T_A = 70^\circ\text{C}$	I_R	—	—	150‡	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25^\circ\text{C}$	I_R	—	—	5	
$T_A = 175^\circ\text{C}$		—	—	300†	
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	40	—	pF

*In accordance with JEDEC registration format.
 †200 μA for 1N5624 and 1N5625.
 ‡100 μA for 1N5626 and 1N5627.

4

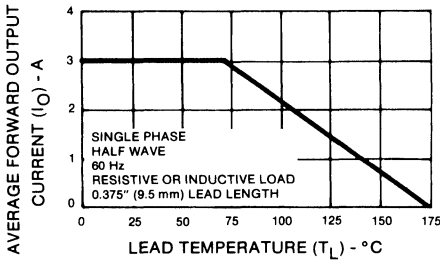


Fig. 1 - Maximum average forward output current characteristic.

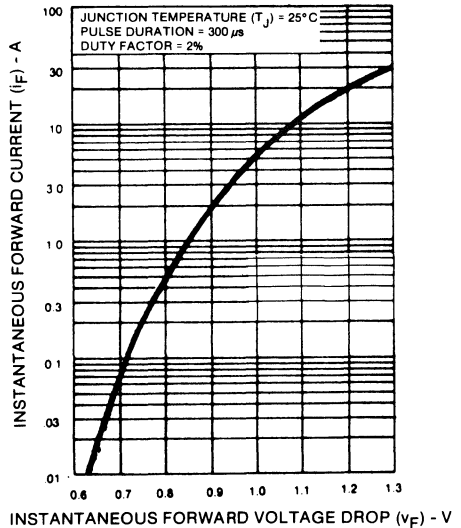


Fig. 3 - Typical instantaneous forward current characteristic.

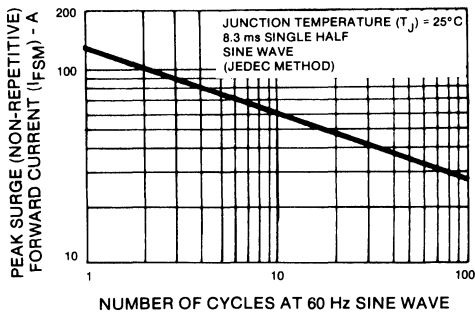


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

1N5624, 1N5625, 1N5626, 1N5627

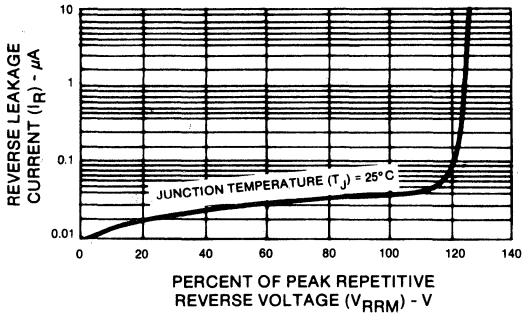


Fig. 4 - Typical reverse leakage current characteristics.

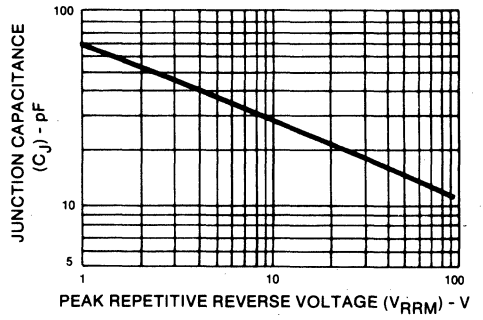


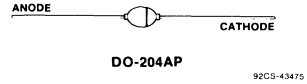
Fig. 5 - Typical junction capacitance characteristic.

1-A, Glass-Passivated Junction Silicon Rectifiers

Features:

- High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers
- Glass passivated junction
- 1A operation at $T_A = 100^\circ\text{C}$ with no thermal runaway
- Low reverse current
- Exceeds environmental standard of MIL-STD-19500
- Hermetically sealed package
- High temperature soldering: $350^\circ\text{C}/10 \text{ s}/0.375 \text{ in. (9.5mm)}$ lead length

TERMINAL DESIGNATIONS



The GE/RCA A14A, A14C, A14E, A14F, and A14P are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 1000 watts in reverse

direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

4

MAXIMUM RATINGS, Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:

	A14F	A14A	A14C	A14E	A14P	
MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, V_{RRM}	50	100	300	500	1000	V
MAXIMUM RMS (SUPPLY) VOLTAGE:						
For resistive or inductive loads, V_{RMS}	35	70	210	350	700	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	300	500	1000	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:						
For resistive or inductive loads, $T_A = 100^\circ\text{C}$			1			A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:						
For 8.3 ms half sine wave, superimposed on rated load,			50			A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ... T_j, T_{stg}			-65 to +175			$^\circ\text{C}$

A14A, A14C, A14E, A14F, A14P

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1A	V_F	—	—	1.2*	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) $T_A = 100^\circ\text{C}$	I_R	—	—	200	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage	I_R	—	—	2	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	2	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	15	—	pF

*1.1 V for A14C, A14E, and A14P.

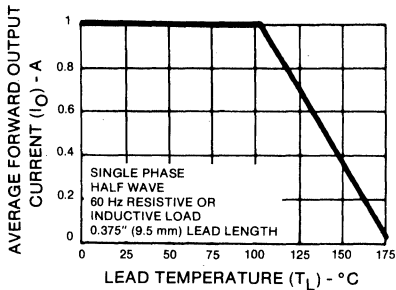


Fig. 1 - Maximum average forward output current characteristic.

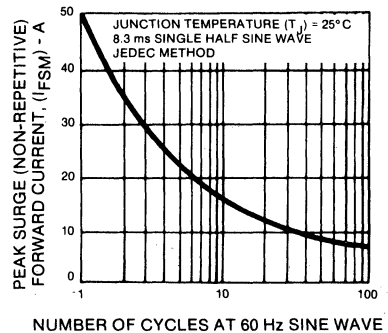


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

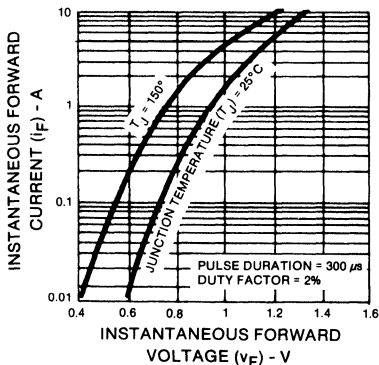


Fig. 3 - Typical instantaneous forward current characteristic.

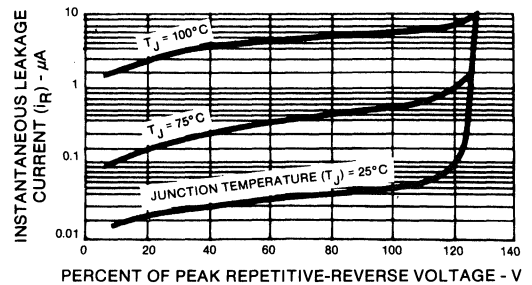


Fig. 4 - Typical reverse leakage current characteristics.

A14A, A14C, A14E, A14F, A14P

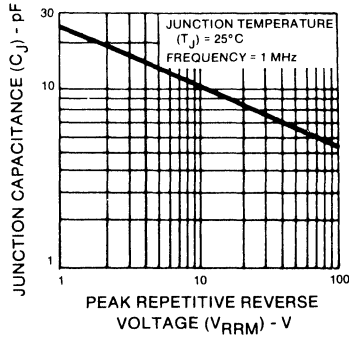


Fig. 5 - Typical junction capacitance characteristic.

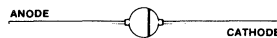
A15A, A15F

3-A, Glass-Passivated Junction Silicon Rectifiers

Features:

- High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers
- Glass passivated junction
- 3A operation at $T_A = 70^\circ\text{C}$ with no thermal runaway
- Low reverse current
- Exceeds environmental standard of MIL-STD-19500
- Hermetically sealed package
- High temperature soldering: $350^\circ\text{C}/10\text{ s}/0.375\text{ in. (9.5mm)}$ lead length

TERMINAL DESIGNATIONS



GE-3

The GE/RCA A15A and A15F are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 100 watts in reverse

direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a GE-3 package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:

	A15F	A15A	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, V_{RDCI}	50	100	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:			
Lead Length = 0.375 in. (9.5 mm); $T_A = 70^\circ\text{C}$, I_o		3	A
MAXIMUM PEAK SURGE (NON—REPETITIVE) FORWARD CURRENT:			
For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}		125	A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}		-65 to +175	$^\circ\text{C}$

*For capacitive load derate current by 20%.

A15A, A15F

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 3A	V_F	—	—	1.2	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm), $T_A = 70^\circ\text{C}$	I_R	—	—	200	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage	I_R	—	—	5	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $t_{rr} = 0.25\text{A}$	t_{rr}	—	—	3	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	40	—	pF

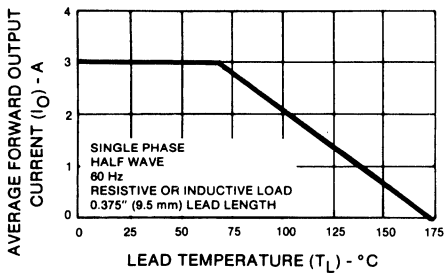


Fig. 1 - Maximum average forward output current characteristic.

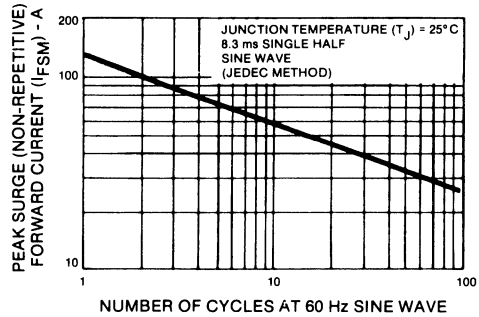


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

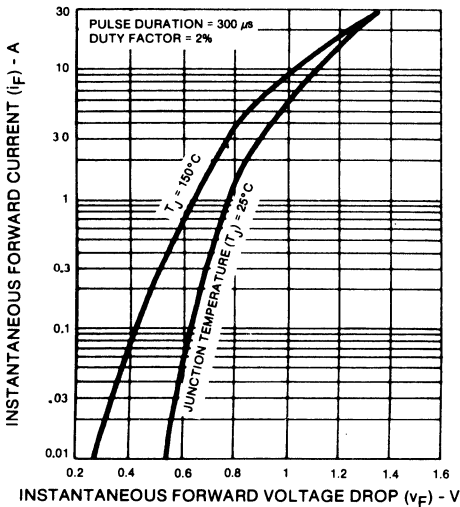


Fig. 3 - Typical instantaneous forward current characteristics.

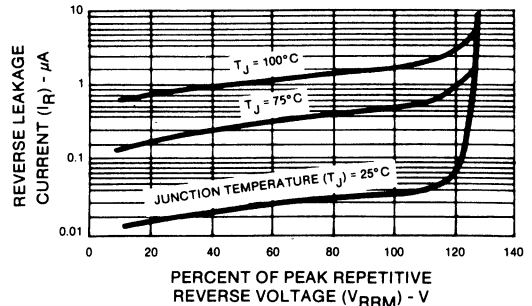


Fig. 4 - Typical reverse leakage current characteristics.

A15A, A15F

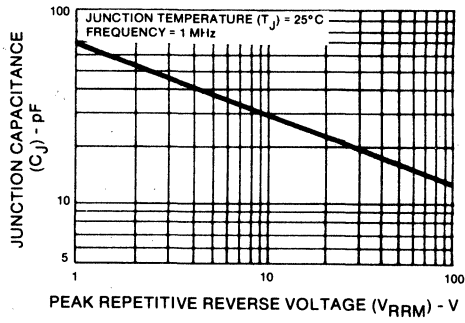


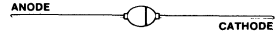
Fig. 5 - Typical junction capacitance characteristic.

1-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Fast recovery times
- Low forward voltage drop, high-current capability
- Low reverse current leakage
- High surge current capability

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

The GE/RCA A114A, A114B, A114C, A114D, A114E, A114F, and A114M are fast-recovery silicon rectifiers ($t_r = 200$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60-Hz, half-wave resistive or inductive loads*:

	A114F	A114A	A114B	A114C	A114D	A114E	A114M		
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	200	300	400	500	600	V	
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	140	210	280	350	420	V	
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	200	300	400	500	600	V	
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_A = 55^\circ\text{C}$, I_o	_____							1	A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}	_____							30	A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}	_____							-65 to +175	$^\circ\text{C}$

*For capacitive load derate current by 20%.

A114 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1A	V_F	—	—	1.3	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) $T_A = 25^\circ\text{C}$	I_R	—	—	1	μA
		—	—	100	
Maximum DC Reverse Current at Maximum DC Reverse (Blocking) Voltage	I_R	—	—	2	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	150*	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	10	—	pF

*200 ns for A115M.

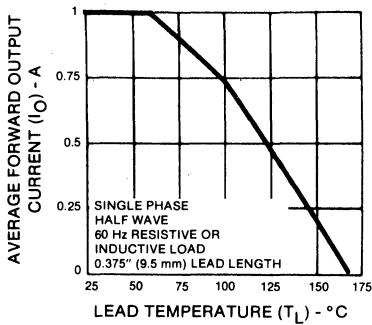


Fig. 1 - Maximum average forward output current characteristic.

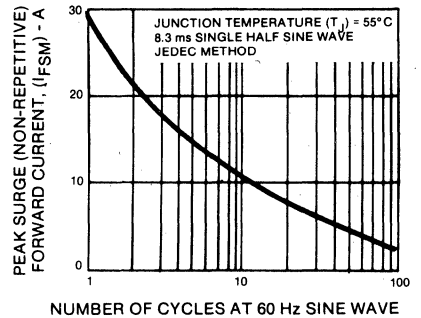


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A114 Series

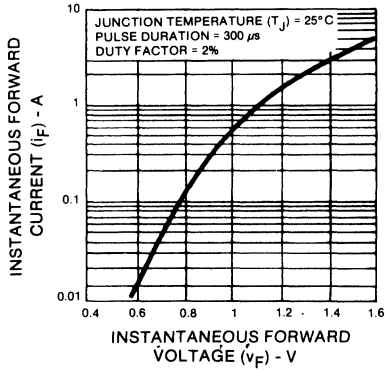


Fig. 3 - Typical instantaneous forward current characteristic.

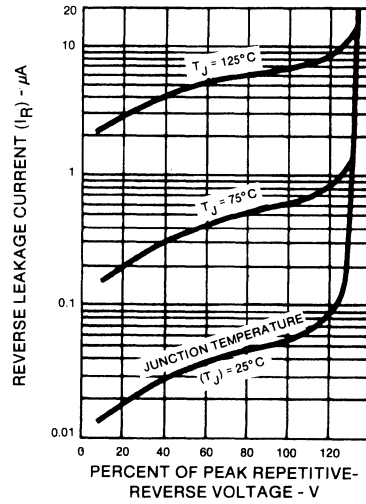


Fig. 4 - Typical reverse leakage current characteristics.

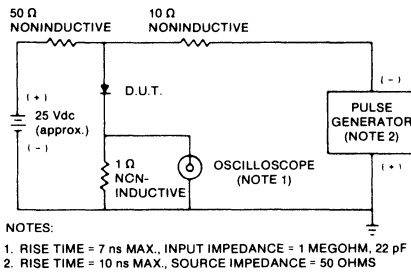


Fig. 5 - Reverse-recovery time test circuit.

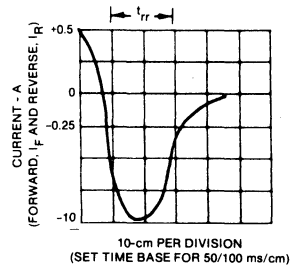


Fig. 6 - Reverse-recovery time waveform.

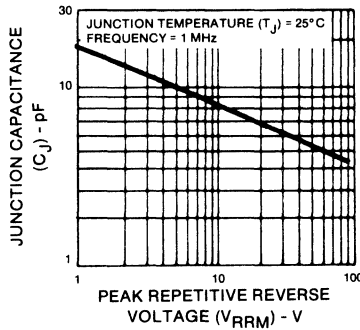


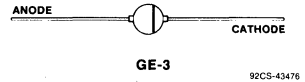
Fig. 7 - Typical junction capacitance characteristic.

3-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Fast recovery times
- Low forward voltage drop, high-current capability
- Low reverse current leakage
- High surge current capability

TERMINAL DESIGNATIONS



The GE/RCA A115A, A115B, A115C, A115D, A115E, A115F, and A115M are fast-recovery silicon rectifiers ($t_r = 250$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed GE-3 package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60-Hz, half-wave resistive or inductive loads*:

	A115F	A115A	A115B	A115C	A115D	A115E	A115M	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	200	300	400	500	600	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	140	210	280	350	420	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	200	300	400	500	600	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:								
Lead Length = 0.375 in. (9.5 mm); $T_A = 55^\circ\text{C}$, I_o				3				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:								
For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}				100				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}					-65 to +175			$^\circ\text{C}$

*For capacitive load derate current by 20%.

A115 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 3A	V_F	—	—	1.3	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) $T_A = 25^\circ\text{C}$	I_R	—	—	2	μA
		$T_A = 150^\circ\text{C}$	—	—		100
Maximum DC Reverse Current at Maximum DC Blocking Voltage	I_R	—	—	5	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	150*	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	40	—	pF

*250 ns for A115M.

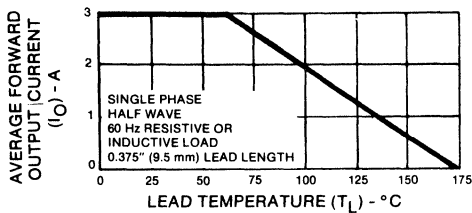


Fig. 1 - Maximum average forward output current characteristic.

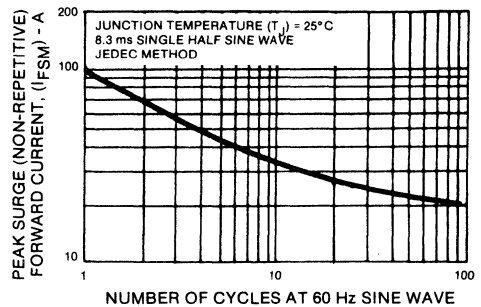


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A115 Series

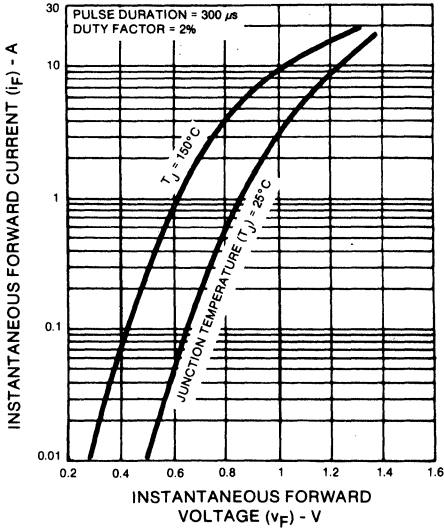


Fig. 3 - Typical instantaneous forward current characteristic.

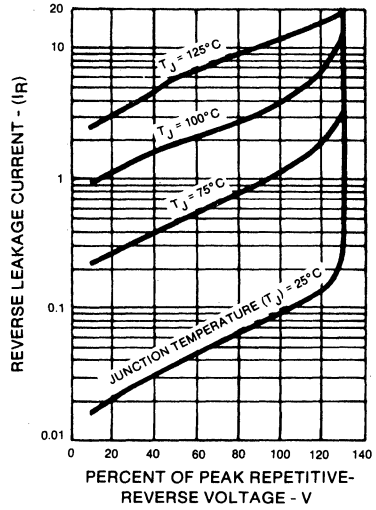


Fig. 4 - Typical reverse leakage current characteristics.

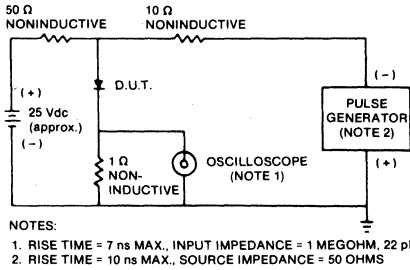


Fig. 5 - Reverse-recovery time test circuit.

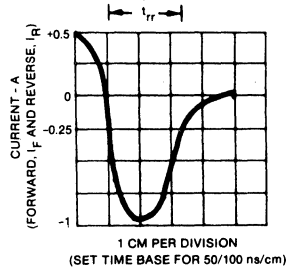


Fig. 6 - Reverse-recovery time waveform.

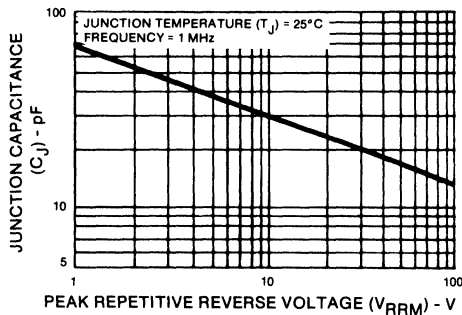


Fig. 7 - Typical junction capacitance characteristic.

2-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Ultra-fast recovery times
- Low forward voltage drop, high-current capability
- Low leakage current
- High surge current capability

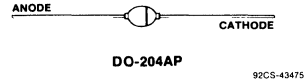
The GE/RCA A214A, A214B, A214F, and A214G are ultra-fast recovery silicon rectifiers ($t_r = 35$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

TERMINAL DESIGNATIONS



MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:

	A214F	A214A	A214G	A214B	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	105	105	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_A = 55^\circ\text{C}$, I_o				2	A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}				50	A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}				-65 to +175	$^\circ\text{C}$

*For capacitive load derate current by 20%.

A214 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 2A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25^\circ\text{C}$	I_R	—	—	2	μA
		—	—	50	
					$T_A = 150^\circ\text{C}$
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	45	—	pF
Thermal Resistance: Junction-to-Ambient at 0.375 in. (9.5 mm) lead length.	$R\theta_{JA}$	—	60	—	$^\circ\text{C/W}$

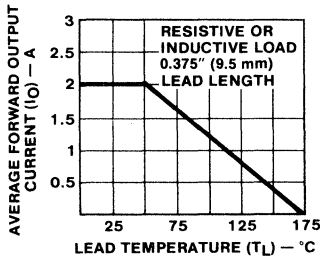


Fig. 1 - Maximum average forward output current characteristic.

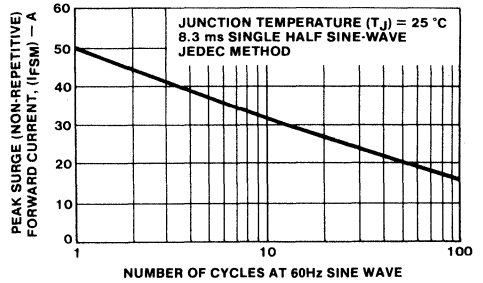


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A214 Series

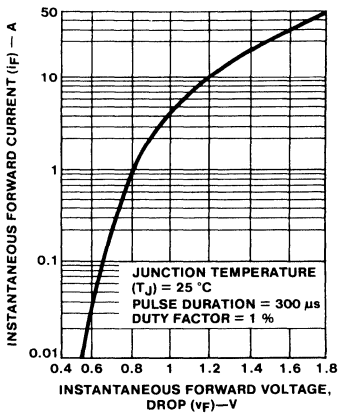


Fig. 3 - Typical instantaneous forward current characteristic.

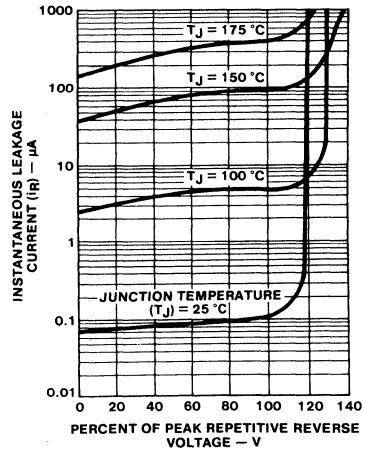


Fig. 4 - Typical reverse leakage current characteristics.

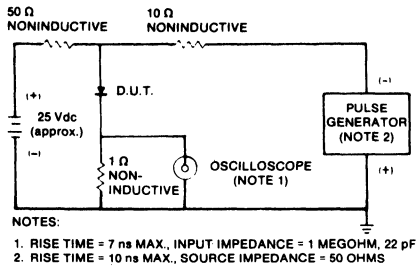


Fig. 5 - Reverse-recovery time test circuit.

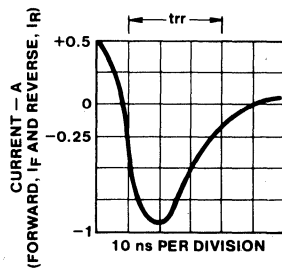


Fig. 6 - Reverse-recovery time waveform.

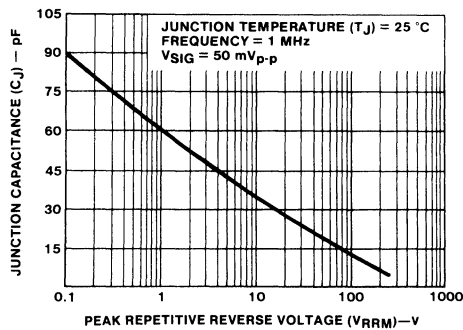


Fig. 7 - Typical junction capacitance characteristic.

A315 Series

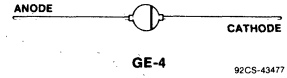
File Number **2163**

3-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Ultra-fast recovery times
- Low forward voltage drop, high-current capability
- Low leakage current
- High surge current capability

TERMINAL DESIGNATIONS



The GE/RCA A315A, A315B, A315F, and A315G are ultra-fast recovery silicon rectifiers ($t_{rr} = 35$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction. These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification. These types are supplied in unitized-glass hermetically-sealed GE-4 package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:

	A315F	A315A	A315G	A315B	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	105	105	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, V_{RDC}	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_L = 55^\circ\text{C}$, I_o			3		A
MAXIMUM PEAK SURGE (NON—REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load, $T_L = 55^\circ\text{C}$, ... I_{FSM}			135		A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}		-65 to +175			$^\circ\text{C}$

*For capacitive load derate current by 20%.

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 3A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25^\circ\text{C}$	I_R	—	—	3	μA
		—	—	50	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	100	—	pF

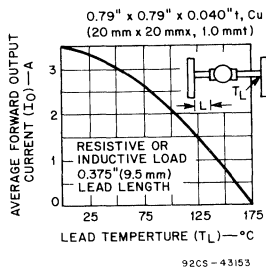


Fig. 1 - Maximum average forward output current characteristic.

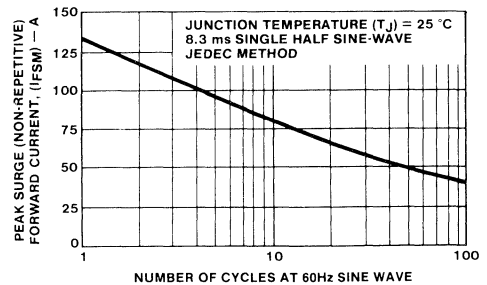


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A315 Series

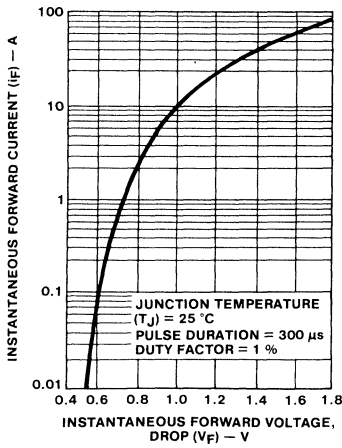


Fig. 3 - Typical instantaneous forward current characteristic.

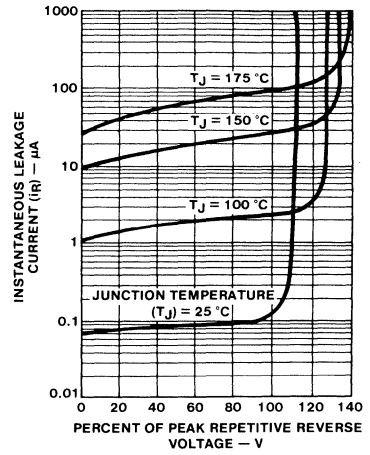


Fig. 4 - Typical reverse leakage current characteristics.

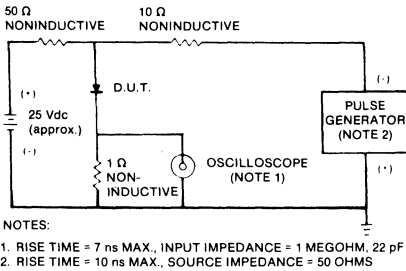


Fig. 5 - Reverse-recovery time test circuit.

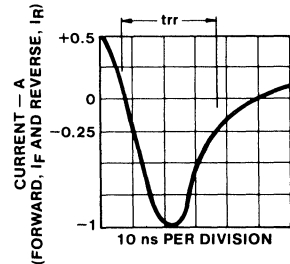


Fig. 6 - Reverse-recovery time waveform.

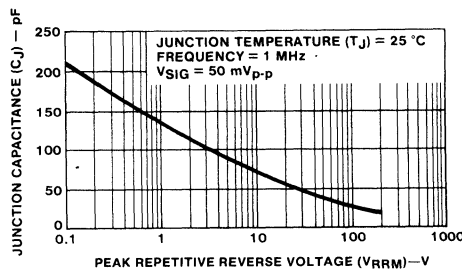


Fig. 7 - Typical junction capacitance characteristic.

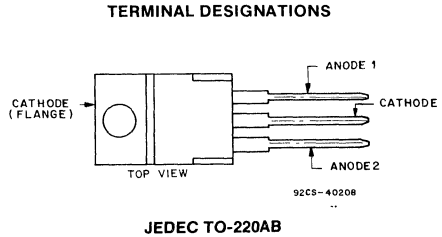
Dual 8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

Features:

- Ultra fast recovery time (< 35 ns)
- Low forward voltage
- Low thermal resistance
- Planar design
- Wire-bonded construction

Applications:

- General purpose
- Power switching circuits to 100 kHz
- Full-wave rectification



The BYW51 series devices are low forward voltage drop, ultra-fast-recovery rectifiers ($t_{rr} < 35$ ns). They use a planar ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and fly-wheel diodes in a variety of high-frequency pulse-width-modulated and switching regulators. Their low stored

charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AB plastic packages.

4

MAXIMUM RATINGS, Absolute-Maximum Values, per Junction:

	BYW 51-100	BYW 51-150	BYW 51-200	
V_{RRM}	100	150	200	V
V_{RSM}	110	165	220	V
I_{FRM} , $t_p < 10 \mu s$	100	100	100	A
I_F (RMS), total	20	20	20	A
I_F (Average), total	20	20	20	A
$T_C = 125^\circ C$, $\delta = 0.5$				
I_{FSM} (Surge)	100	100	100	A
$t_p = 10$ ms, sinusoidal				
P_D , $T_C = 125^\circ C$	20	20	20	W
T_J	-40 + 150	-40 + 150	-40 + 150	$^\circ C$
T_L (Lead temperature during soldering)				
At distance $> 1/8$ in. (3.17 mm) from case for 10 S max.	260	260	260	$^\circ C$

BYW51-100, BYW51-150, BYW51-200

ELECTRICAL CHARACTERISTICS, per junction

CHARACTERISTICS	TEST CONDITIONS			LIMITS						UNITS
	T _J °C	Voltage V _R V	Current I _F A	BYW51-100		BYW51-150		BYW51-200		
				Min.	Max.	Min.	Max.	Min.	Max.	
I _R	25	100		—	5	—	—	—	—	μA
		150		—	—	—	5	—	—	
		200		—	—	—	—	—	5	
	100	100		—	1	—	—	—	—	mA
		150		—	—	—	1	—	—	
		200		—	—	—	—	—	1	
V _F	25		8	—	0.95	—	0.95	—	0.95	V
	100		8	—	0.89	—	0.89	—	0.89	
t _{rr}	25		1(a)	—	35	—	35	—	35	ns
R _{θJC} , per leg				—	2.5	—	2.5	—	2.5	°C/W
R _{θJC} , total				—	1.3	—	1.3	—	1.3	
R _{θJA}				—	60	—	60	—	60	
C _J	25	10	0	All types (typ.) 40						pF

(a) diF/dt > 50A/μs, I_{RM}(rec) < 1A, I_{RR} = 0.25A

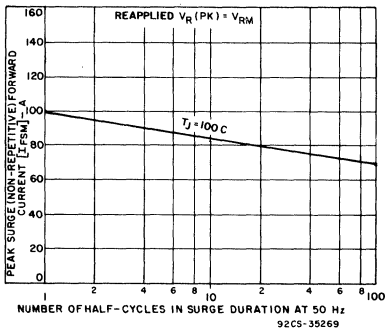


Fig. 1 - Peak surge forward current vs. surge duration.

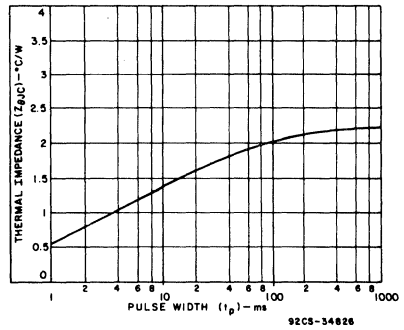


Fig. 2 - Thermal impedance vs. pulse width (per junction).

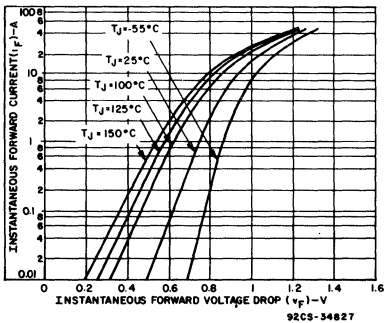


Fig. 3 - Typical forward current vs. forward-voltage drop.

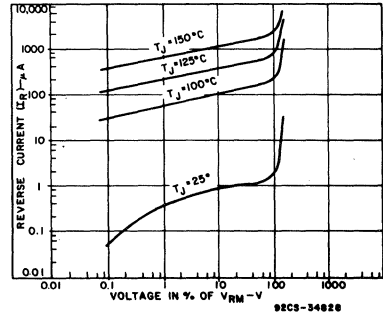


Fig. 4 - Typical reverse current vs. voltage.

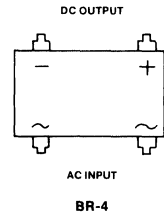
1-A, Single-Phase, Full-Wave Bridge Silicon Rectifiers

Miniaturized Package

Features:

- Glass passivated construction
- Surge ratings: 50 A
- Designed for PC board mounting
- UL recognized package material
- Exceeds environmental standards of MIL-S-19500

TERMINAL DESIGNATIONS



92CS-43474

The GE/RCA DB1 Series are full-wave bridge silicon rectifiers intended for low-power rectification.

These bridge rectifiers are supplied in BR-4 compact plastic package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:

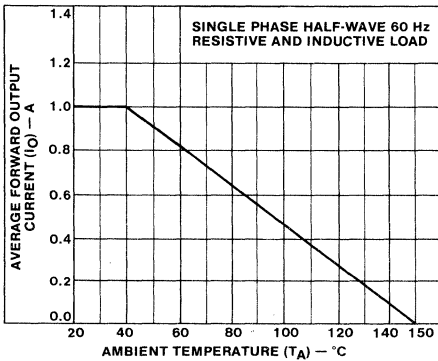
	DB1F	DB1A	DB1B	DB1D	DB1M	DB1N	DB1P	
MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE V_{RRM}	50	100	200	400	600	800	1000	V
MAXIMUM RMS BRIDGE INPUT (SUPPLY) VOLTAGE V_{RMS}	35	70	140	280	420	560	700	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE $V_R(DC)$	50	100	200	400	600	800	1000	V
MAXIMUM AVERAGE FORWARD CURRENT: For resistive or inductive loads, $T_A = 40^\circ C$ I_O	_____ 1 _____							A
MAXIMUM PEAK SURGE FORWARD CURRENT: For 8.3 ms half sine-wave, superimposed on rated load I_{FSM}	_____ 50 _____							A
FUSING CURRENT (For Bridge Rectifier Protection) $T_J = -55^\circ C, t = 1$ to 8.35 ms I^2t	_____ 10 _____							A ² s
OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE T_J, T_{stg}	_____ -55 to +150 _____							°C

*For capacitive load derate current by 20% or use conduction angle data (derating curve) Fig. 5.

DB1 Series

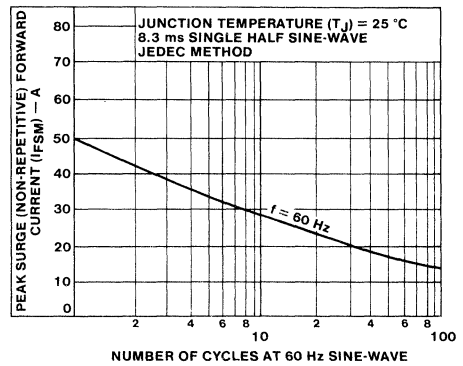
ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T) = 25°C Unless Otherwise Specified

CHARACTERISTICS	SYMBOL	LIMITS FOR ALL TYPES			UNITS
		MIN.	TYP.	MAX.	
		Maximum Instantaneous Forward Voltage Drop (per Bridge Element): At 1A	V_F	—		—	1.1	V
Maximum Reverse Current: At Maximum DC reverse (blocking) voltage, $T_J = 25^\circ\text{C}$	I_R	—	—	10	μA
$T_J = 125^\circ\text{C}$		—	—	0.5	mA
Typical Junction Capacitance (per Bridge Element): Measured at 2 MHz, applied reverse voltage = 4V	C_J	—	25	—	pF
Typical Thermal Resistance: Junction-to-Ambient, pc board mounted	$R_{\theta JA}$	—	80	—	$^\circ\text{C}/\text{W}$



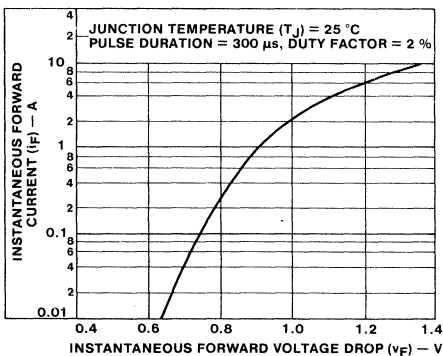
92CS-42517R1

Fig. 1 - Maximum forward (output) current characteristic.



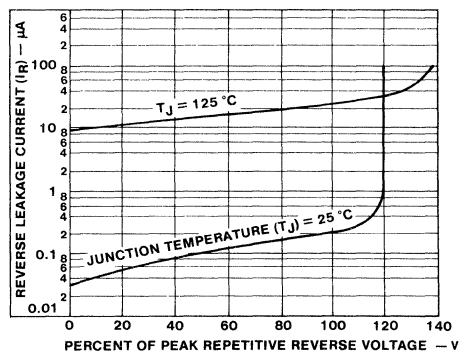
92CS-42519R1

Fig. 2 - Maximum peak (non-repetitive) surge forward current characteristic. (per bridge element)



92CS-42518R1

Fig. 3 - Typical instantaneous forward current characteristic.



92CS-42520R1

Fig. 4 - Typical reverse leakage current characteristic. (per bridge element)

DB1 Series

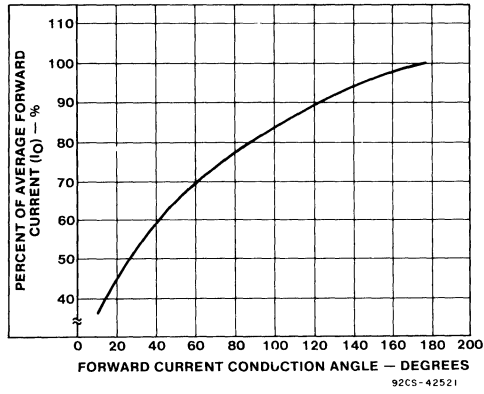


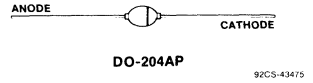
Fig. 5— Typical percent of average forward current characteristic. (de-rating curve for shortened conduction angle)

1-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Ultra-fast recovery times
- Low forward voltage drop, high-current capability
- Low reverse current leakage
- High surge current capability

TERMINAL DESIGNATIONS



The GE/RCA GE1001, GE1002, GE1003, and GE1004 are ultra-fast-recovery silicon rectifiers ($t_{rr} = 35$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60-Hz, half-wave resistive or inductive loads *:

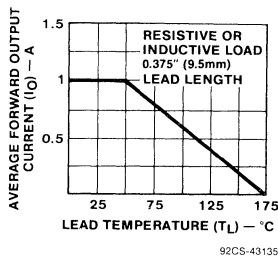
	GE1001	GE1002	GE1003	GE1004	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	105	140	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:					
Lead Length = 0.375 in. (9.5 mm); $T_A = 55^\circ\text{C}$, I_o			1		A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}			30		A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}			-65 to +175		$^\circ\text{C}$

* For capacitive load derate current by 20%.

GE1001, GE1002, GE1003, GE1004

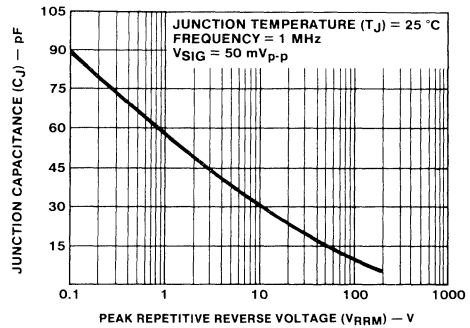
ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTIC		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1 A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum dc reverse (blocking) voltage,	I_R	—	—	2	μA
$T_A = 25^\circ C$ $T_A = 150^\circ C$		—	—	50	
Maximum Reverse Recovery Time: At $I_F = 0.5 A$, $I_R = 1 A$, $I_{rr} = 0.25 A$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4 V	C_J	—	45	—	pF
Thermal Resistance: Junction-to-Ambient (At lead lengths of 0.375 in. (9.5 mm))	$R_{\theta JA}$	—	—	65	$^\circ C/W$



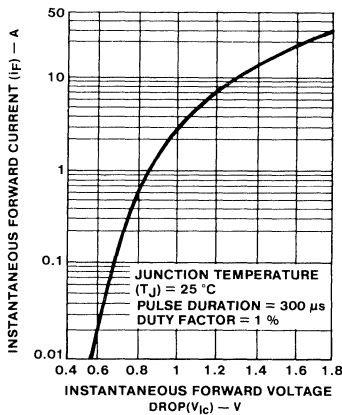
92CS-43135

Fig. 1 - Maximum average forward output current characteristic.



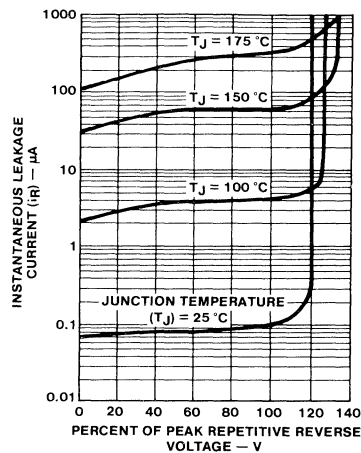
92CS-43138

Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.



92CS-43137

Fig. 3 - Typical instantaneous forward current characteristic.



92CS-43139

Fig. 4 - Typical reverse leakage current characteristics.

GE1001, GE1002, GE1003, GE1004

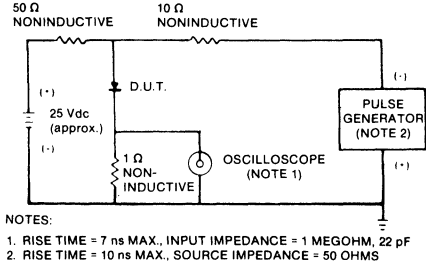


Fig. 5 - Reverse-recovery time test circuit.

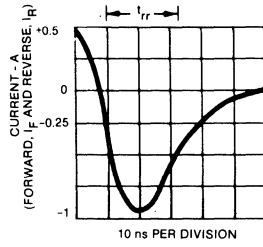
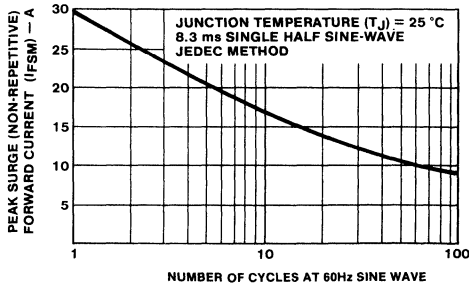


Fig. 6 - Reverse-recovery time waveform.



92CS-43136

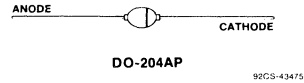
Fig. 7 - Typical junction capacitance characteristic.

2.5-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Ultra-fast recovery times
- Low forward voltage drop, high-current capability
- Low reverse leakage current
- High surge current capability

TERMINAL DESIGNATIONS



The GE/RCA GE1101, GE1102, GE1103, and GE1104 are ultra-fast recovery silicon rectifiers ($t_r = 35$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

4

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:

	GE1101	GE1102	GE1103	GE1104		
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE,	V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE,	V_{RMS}	35	70	105	140	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE,	$V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_A = 55^\circ\text{C}$,	I_o	2.5			A	
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load,	I_{FSM}	50			A	
OPERATING JUNCTION AND STORAGE TEMPERATURE,	T_j, T_{stg}	-65 to +175			$^\circ\text{C}$	

*For capacitive load derate current by 20%.

GE1101, GE1102, GE1103, GE1104

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 2A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25^\circ\text{C}$	I_R	—	—	2	μA
		—	—	50	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	45	—	pF
Thermal Resistance: Junction-to-Ambient at 0.375 in. (9.5 mm) lead length.	$R\theta_{JA}$	—	60	—	$^\circ\text{C/W}$

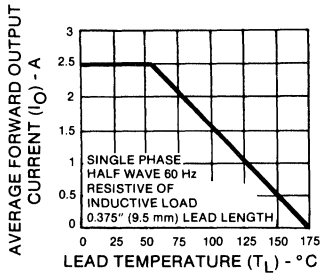


Fig. 1 - Maximum average forward output current characteristic.

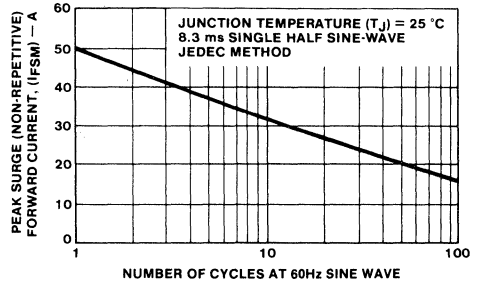


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

GE1101, GE1102, GE1103, GE1104

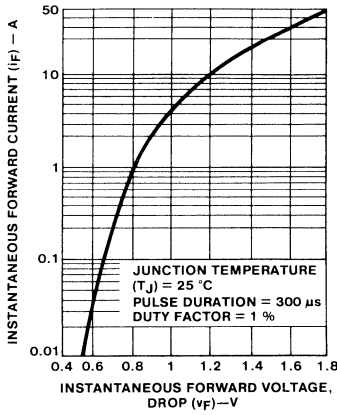


Fig. 3 - Typical instantaneous forward current characteristic.

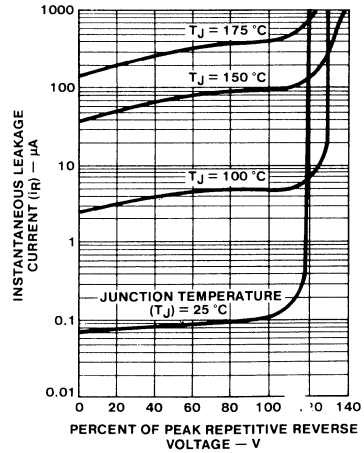


Fig. 4 - Typical reverse leakage current characteristics.

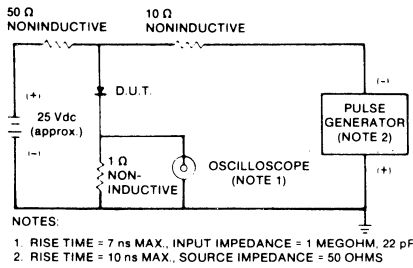


Fig. 5 - Reverse-recovery time test circuit.

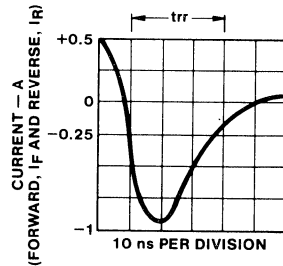


Fig. 6 - Reverse-recovery time waveform.

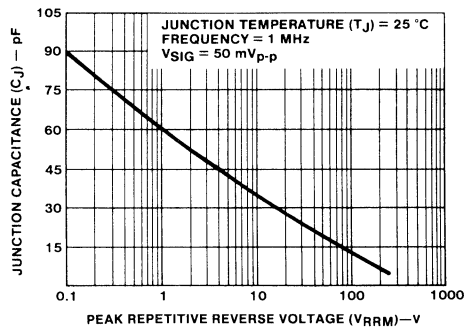
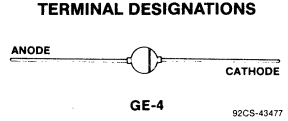


Fig. 7 - Typical junction capacitance characteristic.

6-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- Glass passivated junction
- Ultra-fast recovery times
- Low forward voltage drop, high-current capability
- Low leakage current
- High surge current capability



The GE/RCA GE1301, GE1302, GE1303, and GE1304 are ultra-fast recovery silicon rectifiers ($t_r = 35$ ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction. These rectifiers are intended for TV deflection, inverter,

high-frequency power supplies, energy recovery, and output rectification. These types are supplied in unitized-glass hermetically-sealed GE-4 package.

MAXIMUM RATINGS, Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:

	GE1301	GE1302	GE1303	GE1304	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, V_{RMS}	35	70	105	140	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_A = 55^\circ\text{C}$, I_o	_____ 6 _____				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}	_____ 150 _____				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, T_j, T_{stg}	_____ -65 to +175 _____				$^\circ\text{C}$

*For capacitive load derate current by 20%.

GE1301, GE1302, GE1303, GE1304

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 2A	V_F	—	—	0.975	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25^\circ\text{C}$	I_R	—	—	5	μA
		—	—	50	
					$T_A = 150^\circ\text{C}$
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	100	—	pF
Thermal Resistance: Junction- to- Lead at 0.375 in. (9.5 mm)	$R_{\theta_{JL}}$	—	16	—	$^\circ\text{C/W}$

4

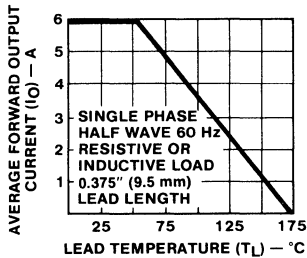


Fig. 1 - Maximum average forward output current characteristic.

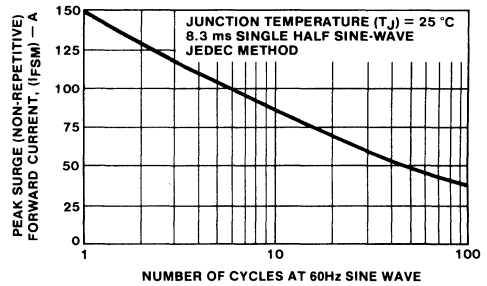


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

GE1301, GE1302, GE1303, GE1304

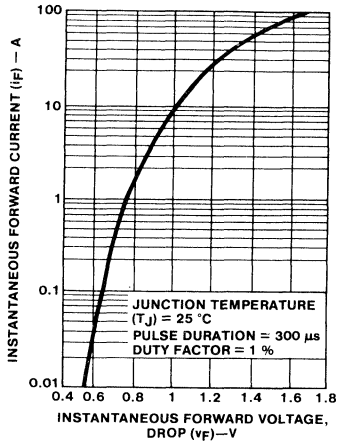


Fig. 3 - Typical instantaneous forward current characteristic.

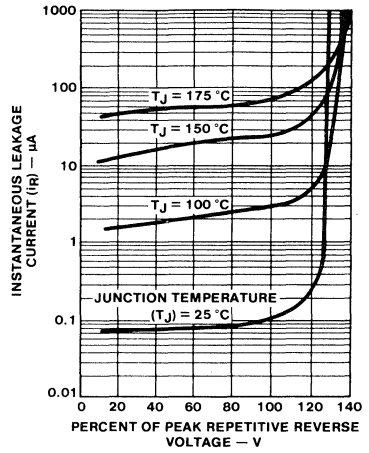


Fig. 4 - Typical reverse leakage current characteristics.

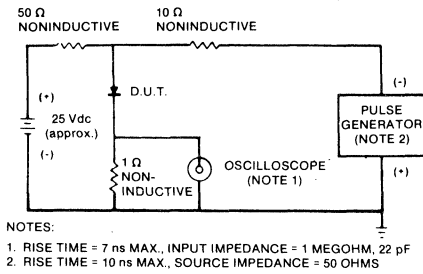


Fig. 5 - Reverse-recovery time test circuit.

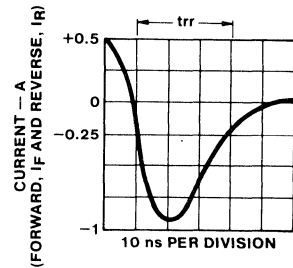


Fig. 6 - Reverse-recovery time waveform.

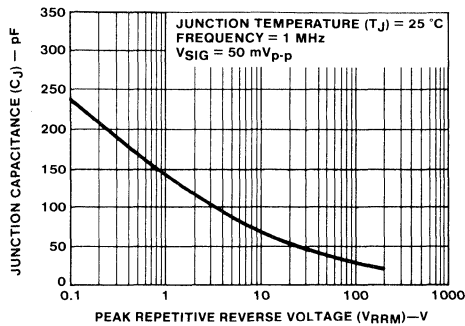


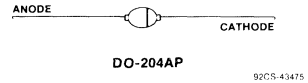
Fig. 7 - Typical junction capacitance characteristic.

1-A, Glass-Passivated Junction Silicon Rectifiers

Features:

- High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers
- Glass passivated junction
- 1A operation at $T_A = 100^\circ\text{C}$ with no thermal runaway
- Low reverse current
- Exceeds environmental standard of MIL-STD-19500
- Hermetically sealed package
- High temperature soldering: $350^\circ\text{C}/10\text{ s}/0.375\text{ in. (9.5mm)}$ lead length

TERMINAL DESIGNATIONS



The GE/RCA GER4001-GER4007 are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 1000 watts in reverse

direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

4

MAXIMUM RATINGS, Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:

	GER4001	GER4002	GER4003	GER4004	GER4005	GER4006	GER4007	
MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, V_{RRM}	50	100	200	400	600	800	1000	V
MAXIMUM RMS (SUPPLY) VOLTAGE:								
For resistive or inductive loads, V_{RMS}	35	70	140	280	420	560	700	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, $V_{R(DC)}$	50	100	200	400	600	800	1000	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:								
For resistive or inductive loads, $T_A = 100^\circ\text{C}$ I_o	_____							A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:								
For 8.3 ms half sine wave, superimposed on rated load, I_{FSM}	_____							A
OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE, T_j, T_{stg}	_____ -65 to +175 _____							$^\circ\text{C}$

GER4001-GER4007

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS			UNITS
		FOR ALL TYPES			
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1A	V_F	—	—	1.2*	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm), $T_A = 100^\circ\text{C}$	I_R	—	—	200	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage	I_R	—	—	2	
Maximum Reverse Recovery Time: At $I_F = 0.5\text{A}$, $I_R = 1\text{A}$, $I_{rr} = 0.25\text{A}$	t_{rr}	—	—	2	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	15	—	pF

*1.1 V for GER4003-GER4007.

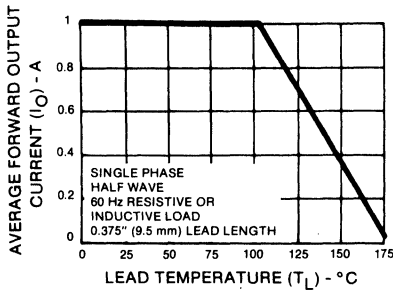


Fig. 1 - Maximum average forward output current characteristic.

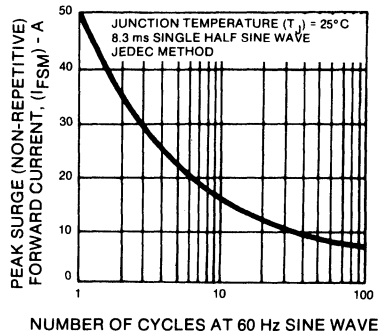


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

GER4001-GER4007

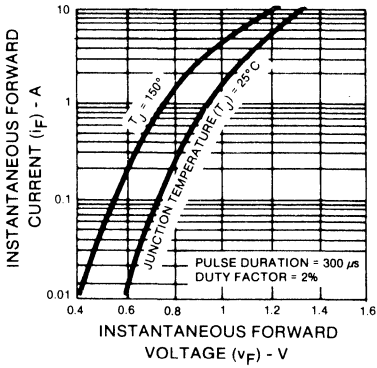


Fig. 3 - Typical instantaneous forward current characteristic.

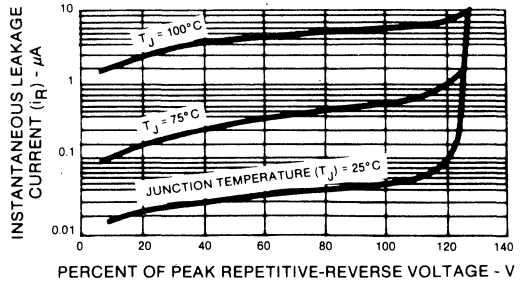


Fig. 4 - Typical reverse leakage current characteristics.

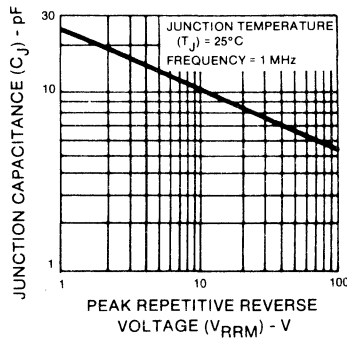


Fig. 5 - Typical junction capacitance characteristic.

MUR-810, MUR-815, MUR-820
RUR-810, RUR-815, RUR-820

File Number **1355**

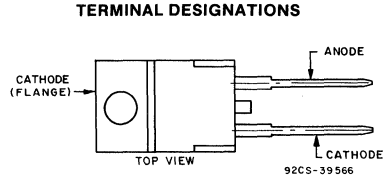
8-A, High-Speed, High Efficiency
Epitaxial Silicon Rectifiers

Features:

- Ultra fast recovery time (<35 ns)
- Low forward voltage
- Low thermal resistance
- Planar design
- Wire-bonded construction

Applications:

- General Purpose
- Power switching circuits to 100 kHz
- Output rectification in switching power supplies



JEDEC TO-220AC

The MUR-810, MUR-815, MUR-820, RUR-810, RUR-815, and RUR-820* are low forward voltage drop ultra-fast-recovery rectifiers (trr < 50 ns). They use a glass-passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and flywheel diodes in a variety of high-frequency pulse-width

modulated switching regulators. Their low stored charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AC plastic packages.

*Formerly RCA Dev. Nos. TA9223B, TA9223B, and TA9223C, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MUR-810	MUR-815	MUR-820	
	RUR-810	RUR-815	RUR-820	
VRM	100	150	200	V
IF (Average)				
T _A = 25°C (No Heat Sink)		3		A
T _A = 25°C (With Heat Sink) ^(a)		8		A
T _C = 150°C		8		A
IFSM (surge)				
8.3ms, 1/2 cycle, non-repetitive		100		A
Tstg, T _J		-65 to 175		°C
T _L (Lead temperature during soldering)				
At distance > 1/8in. (3.17mm) from case for 10 S max.		260		°C

(a) Wakefield type 295 heat sink with convection cooling

MUR-810, MUR-815, MUR-820
RUR-810, RUR-815, RUR-820

ELECTRICAL CHARACTERISTICS

CHARACTERISTICS	TEST CONDITIONS			LIMITS						UNITS
	T _J °C	Voltage V _R V	Current i _F A	MUR-810 RUR-810		MUR-815 RUR-815		MUR-820 RUR-820		
				Min.	Max.	Min.	Max.	Min.	Max.	
i _R	25	100		—	5	—	—	—	—	μA
		150		—	—	—	5	—	—	
		200		—	—	—	—	—	5	
	150	100		—	250	—	—	—	—	
		150		—	—	—	250	—	—	
		200		—	—	—	—	250	—	
V _F	25		8	—	0.975	—	0.975	—	1	V
	150		8	—	0.895	—	0.895	—	0.895	
t _{rr}	25		1 (a)	—	35	—	35	—	35	ns
R _{θJC}				—	3	—	3	—	2	°C/W
R _{θJA}				—	60	—	60	—	60	
C _J	25	10	0	40 Typ.		40 Typ.		40 Typ.		pF

(a) di_F/dt > 40A/μs, I_{RM} (reC) < 1A, I_{RR} = 0.25A

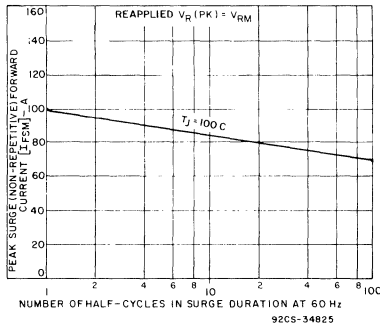


Fig. 1 - Peak surge forward current vs. surge duration.

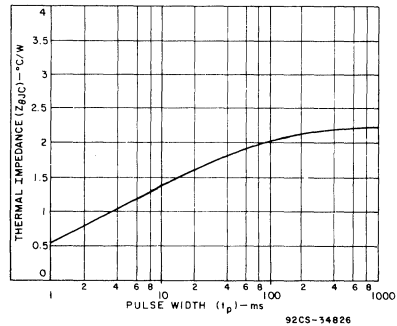


Fig. 2 - Thermal impedance vs. pulse width.

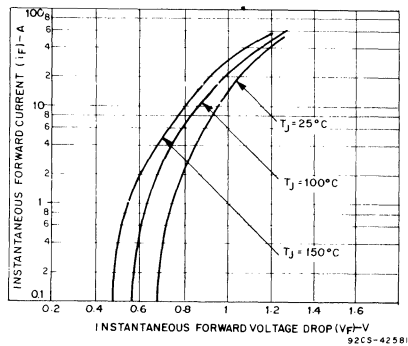


Fig. 3 - Typical forward current vs. forward-voltage drop.

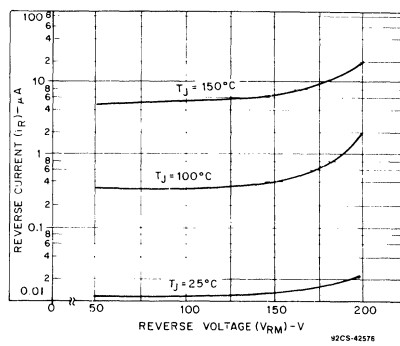


Fig. 4 - Typical reverse current vs. voltage.

MUR-840, MUR-850, MUR-860
RUR-840, RUR-850, RUR-860

8-A, High-Speed, High-Voltage, High Efficiency Epitaxial Silicon Rectifiers

Features:

- Ultra fast recovery time (< 50 ns)
- Low forward voltage
- Low thermal resistance
- Hard glass passivation
- Wire-bonded construction

Applications:

- General Purpose
- Power switching circuits to 100 kHz
- Output rectification in switching power supplies

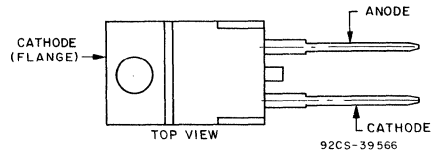
The MUR-840, MUR-850, MUR-860, RUR-840, RUR-850, and RUR-860* are low forward voltage drop ultra-fast-recovery rectifiers ($t_{rr} < 50$ ns). They use a glass-passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and flywheel diodes in a variety of high-frequency pulse-width modulated switching regulators. Their low stored charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

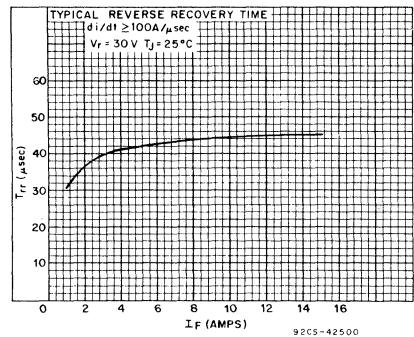
All are supplied in TO-220AC plastic packages.

*Formerly RCA Dev. No. TA9616.

TERMINAL DESIGNATIONS



JEDEC TO-220AC



Typical reverse recovery time - all types.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MUR-840 RUR-840	MUR-850 RUR-850	MUR-860 RUR-860	UNIT
Peak Repetitive Reverse Voltage, V_{RRM}	400	500	600	V
Working Peak Reverse Voltage, V_{RWM} DC Blocking Voltage, V_R				
Average Rectified Forward Current, I_{FAV}		8		A
Total Device, (Rated V_R), $T_C = 150^\circ C$				
Peak Repetitive Forward Current, I_{FM}		16		A
(Rated V_R , Square Wave, 20 kHz), $T_C = 150^\circ C$				
Nonrepetitive Peak Surge Current, I_{FSM}		100		A
(Surge applied at rated load conditions halfwave, single phase, 60 Hz)				
Operating Junction Temperature and Storage Temperature, T_J, T_{SIG}		-65 to + 175		$^\circ C$
Lead Temperature During Soldering, T_L At distance > 1/8 in. (3.17 mm) from case for 10 s max.		260		$^\circ C$

MUR-840, MUR-850, MUR-860 RUR-840, RUR-850, RUR-860

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	T _J °C	V _R V	I _F A	MUR-840 RUR-840		MUR-850 RUR-850		MUR-860 RUR-860		
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
i _R	25	400		—	10	—	—	—	—	μA
		500		—	—	—	10	—	—	
		600		—	—	—	—	—	10	
	150	400		—	500	—	—	—	—	
		500		—	—	—	500	—	—	
		600		—	—	—	—	—	500	
V _F	25		8	—	1.3	—	1.5	—	1.5	V
	150		8	—	1.0	—	1.2	—	1.2	
t _{rr}	25		1 *	—	60	—	60	—	60	ns
			0.5 **	—	50	—	50	—	50	
R _{θJC}				—	2	—	2	—	2	°C/W

* di/dt = 50 A/μs

** i_R = 1.0A, I_{REC} = 0.25 A

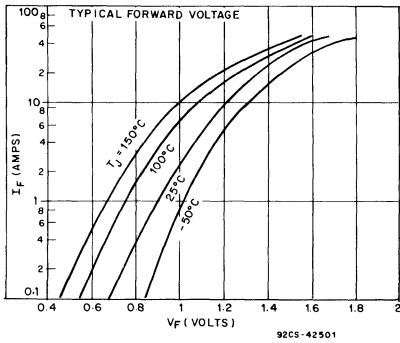


Fig. 1 - Typical forward voltage - MUR-840, RUR-840.

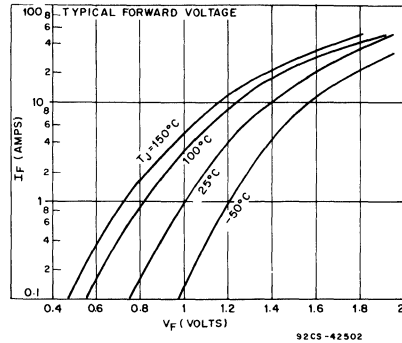


Fig. 2 - Typical forward voltage - MUR-850, MUR-860, RUR-850, and RUR-860.

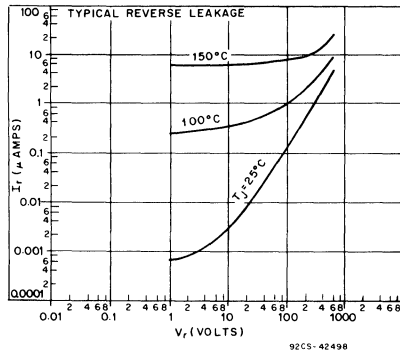


Fig. 3 - Typical reverse leakage - MUR-840, RUR-840.

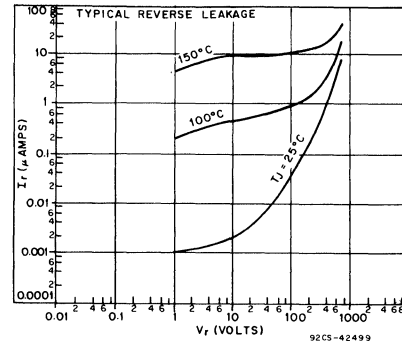


Fig. 4 - Typical reverse leakage - MUR-850, MUR-860, RUR-850, and RUR-860.

**MUR-1610CT, MUR-1615CT, MUR-1620CT
RUR-1610CT, RUR-1615CT, RUR-1620CT**

File Number **1885**

**Dual 8-A, High-Speed, High Efficiency
Epitaxial Silicon Rectifiers**

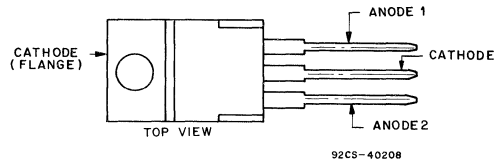
Features:

- Ultra-fast-recovery time (< 35 ns)
- Low forward voltage
- Low thermal resistance
- Hard glass passivation
- Wire-bonded construction

Applications:

- General Purpose
- Power switching circuits to 100 kHz
- Full-wave rectification

TERMINAL DESIGNATIONS



JEDEC TO-204AE

The MUR-1610CT, MUR-1615CT, MUR-1620CT, RUR-1610CT, RUR-1615CT, and RUR-1620CT* are low forward voltage drop ultra-fast-recovery rectifiers ($t_{rr} < 35$ ns). They use a glass-passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and flywheel diodes in a variety of high-frequency pulse-width modulated switching regulators. Their low stored charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AB plastic packages.

*Formerly RCA Dev. No. TA9224A.

MAXIMUM RATINGS, Absolute-Maximum Values:

	MUR-1610CT	MUR-1615CT	MUR-1620CT	Unit
	RUR-1610CT	RUR-1615CT	RUR-1620CT	
Peak Repetitive Reverse Voltage, V_{RRM}	100	150	200	V
Working Peak Reverse Voltage, V_{RWM}				
DC Blocking Voltage, V_R				
Average Rectified Forward Current - per leg, I_{FAV}		8		A
Total Device, (Rated V_R), $T_C = 150^\circ\text{C}$ - total device		16		A
Peak Repetitive Forward Current - per diode leg, I_{FM}		16		A
(Rated V_R , Square Wave, 20 kHz), $T_C = 150^\circ\text{C}$				
Nonrepetitive Peak Surge Current, I_{FSM}		100		A
(Surge applied at rated load conditions halfwave, single phase, 60 Hz)				
Operating Junction Temperature and				
Storage Temperature, T_J, T_{stg}		-65 to +175		$^\circ\text{C}$
(Lead temperature during soldering)				
At distance > 1/8 in. (3.17 mm) from case for 10 s max.		260		$^\circ\text{C}$

MUR-1610CT, MUR-1615CT, MUR-1620CT RUR-1610CT, RUR-1615CT, RUR-1620CT

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	T _J °C	Voltage V _R V	Current I _F A	MUR-1610CT RUR-1610CT		MUR-1615CT RUR-1615CT		MUR-1620CT RUR-1620CT		
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
i _R	25	100	—	—	5	—	—	—	—	μA
	25	150	—	—	—	—	5	—	—	
	25	200	—	—	—	—	—	—	5	
	150	100	—	—	250	—	—	—	—	
	150	150	—	—	—	—	250	—	—	
	150	200	—	—	—	—	—	—	250	
V _F	25	—	8	—	0.975	—	0.975	—	1	V
	150	—	8	—	0.895	—	0.895	—	0.895	
t _{rr}	25	—	1 *	—	35	—	35	—	35	ns
	25	—	0.5 **	—	25	—	25	—	25	
Rθ _{JC}	—	—	—	—	3	—	3	—	3	°C/W

* di/dt = 50 A/μs. ** i_R = 1.0 A, I_{REC} = 0.25 A.

MUR-1610CT, MUR-1615CT, RUR-1610CT, RUR-1615CT

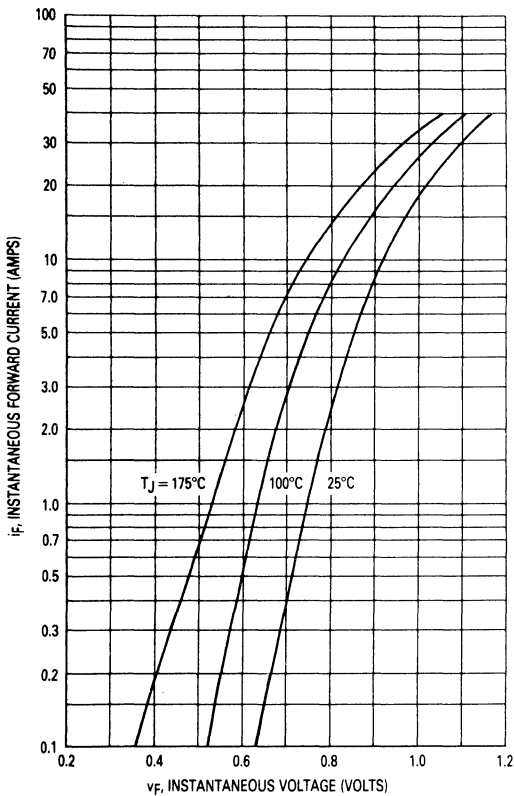


Fig. 1 - Typical forward voltage, per leg.

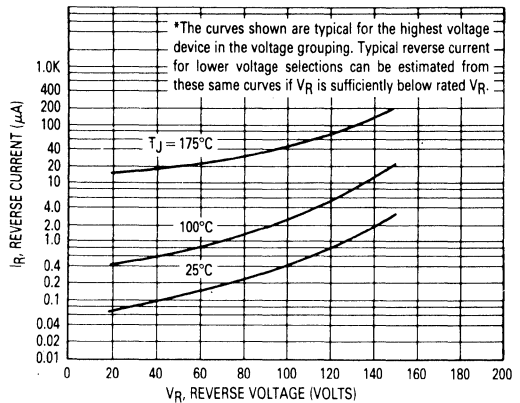


Fig. 2 - Typical reverse current, per leg *

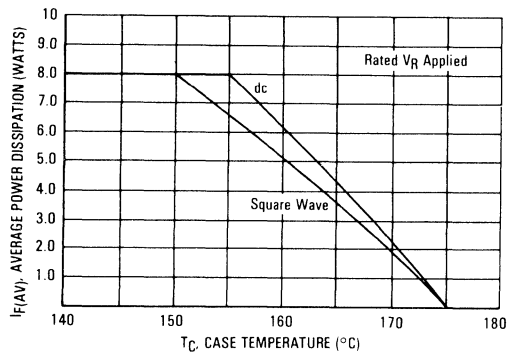


Fig. 3 - Current derating case, per leg.

**MUR-1610CT, MUR-1615CT, MUR-1620CT
RUR-1610CT, RUR-1615CT, RUR-1620CT**

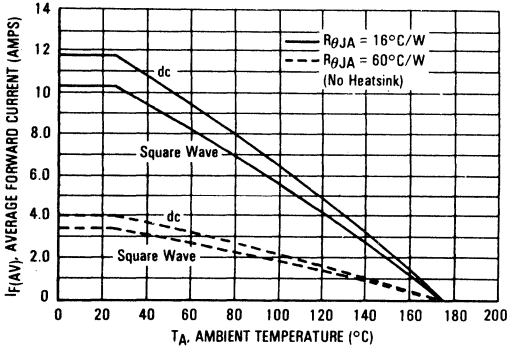


Fig. 4 - Current derating, ambient, per leg.

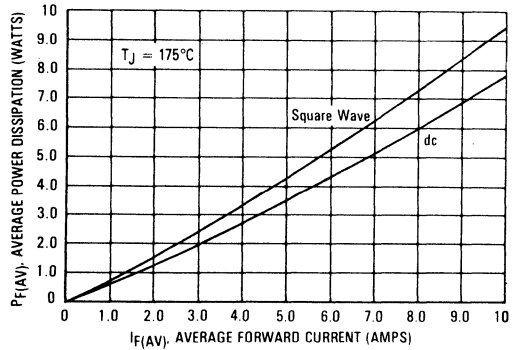


Fig. 5 - Power dissipation, per leg.

MUR-1620CT, RUR-1620CT

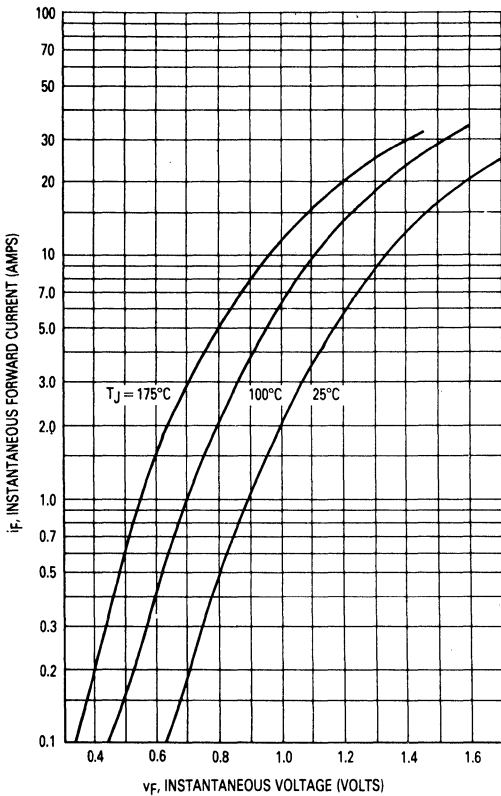


Fig. 6 - Typical forward voltage, per leg.

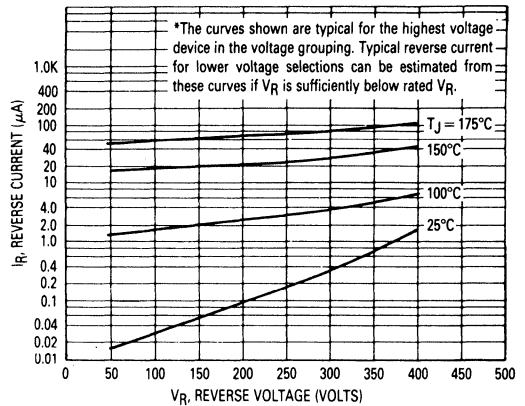


Fig. 7 - Typical reverse current, per leg *.

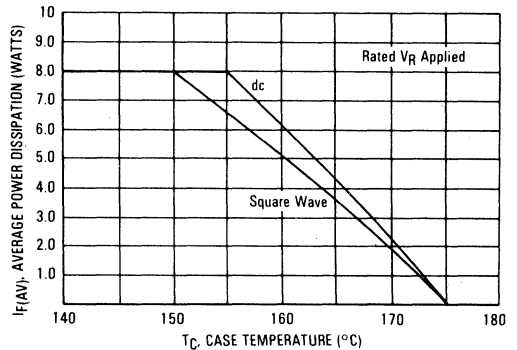


Fig. 8 - Current derating, case, per leg.

MUR-1610CT, MUR-1615CT, MUR-1620CT RUR-1610CT, RUR-1615CT, RUR-1620CT

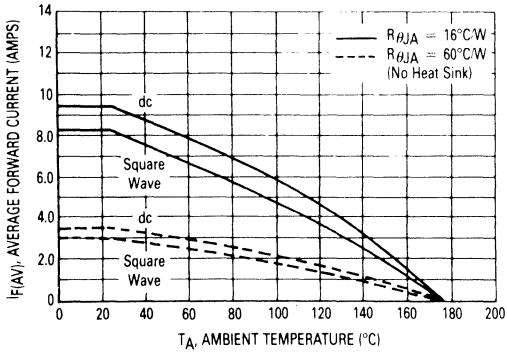


Fig. 9 - Current derating, ambient, per leg.

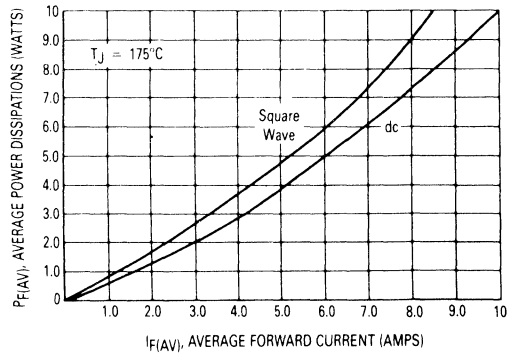


Fig. 10 - Power dissipation, per leg.

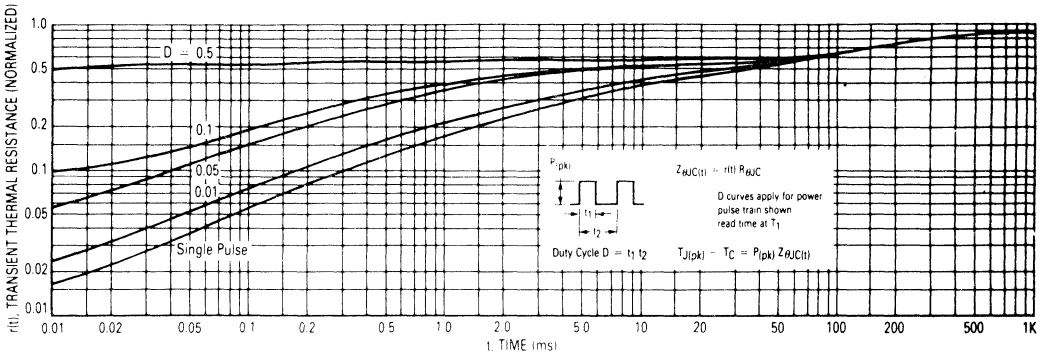


Fig. 11 - Thermal response.

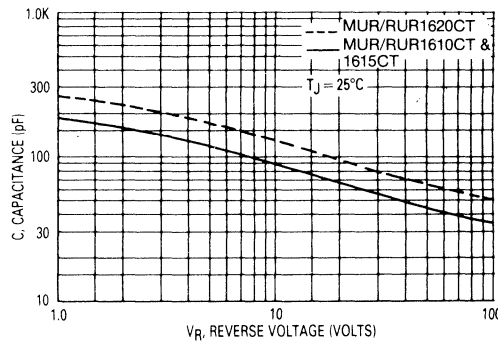


Fig. 12 - Typical capacitance, per leg.

Dual 8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

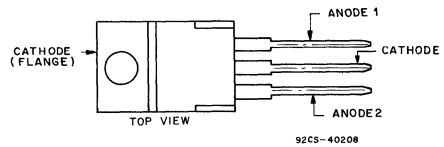
Features:

- Ultra fast recovery time [<35 ns]
- Low forward voltage
- Low thermal resistance
- Planar design
- Wire-bonded construction

Applications:

- General Purpose
- Power switching circuits to 100 kHz
- Full-wave rectification

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA RUR-D810, RUR-D815, and RUR-D820* are low forward voltage drop ultra fast-recovery rectifiers ($t_{rr} < 35$ ns). They use a glass passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and fly wheel diodes in a variety of high-frequency pulse-width modulated and switching regulators. Their low stored

charge and attendant fast reverse recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AB plastic packages.

*Formerly RCA Dev. No. TA9224A, TA9224B, and TA9224C, respectively.

MAXIMUM RATINGS, Absolute-Maximum Values, per Junction:

	RUR-D810	RUR-D815	RUR-D820	
VRM	100	150	200	V
IF (Average)				
$T_A = 25^\circ\text{C}$ (No Heat Sink)		3		A
$T_A = 25^\circ\text{C}$ (With Heat Sink) ^a		8		A
$T_C = 125^\circ\text{C}$		8		A
IFSM (surge)				
8.3ms, 1/2 cycle, non-repetitive		100		A
Tstg, T_J		-55 to 150		$^\circ\text{C}$
T_L (Lead temperature during soldering)				
At distance $> 1/8$ in. (3.17mm) from case for 10 S max.		260		$^\circ\text{C}$

(a) Wakefield type 295 heat sink with convection cooling

RUR-D810, RUR-D815, RUR-D820

ELECTRICAL CHARACTERISTICS, per junction

CHARACTERISTICS	TEST CONDITIONS			LIMITS						UNITS
	T _J °C	Voltage V _R V	Current i _F A	RUR-D810		RUR-D815		RUR-D820		
				Min.	Max.	Min.	Max.	Min.	Max.	
i _R	25	100		—	5	—	—	—	—	μA
		150		—	—	—	5	—	—	
		200		—	—	—	—	—	5	
	100	100		—	400	—	—	—	—	
		150		—	—	—	400	—	—	
		200		—	—	—	—	—	400	
V _F	25		8	—	0.95	—	0.95	—	1	V
	100		8	—	0.89	—	0.89	—	0.94	
t _{rr}	25		8(a)	—	35	—	35	—	35	ns
R _{θJC}				—	2.25	—	2.25	—	2.25	°C/W
R _{θJA}				—	60	—	60	—	60	°C/W
C _J	25	10	0	40 Typ.		40 Typ.		40 Typ.		pF

(a) di_F/dt > 40A/μs, I_{RM} (rec) < 1A, I_{RR} = 0.25A

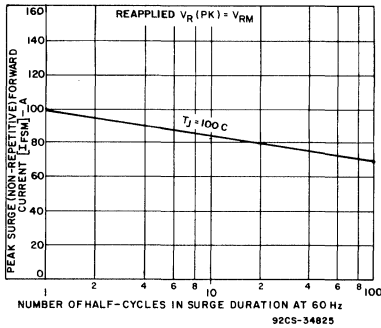


Fig. 1 — Peak surge forward current vs. surge duration.

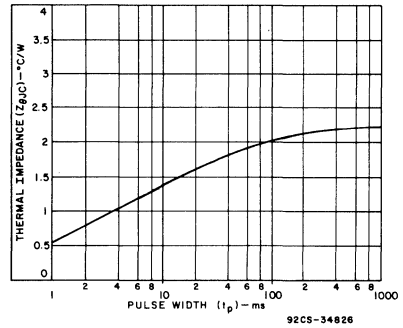


Fig. 2 — Thermal impedance vs. pulse width (per junction).

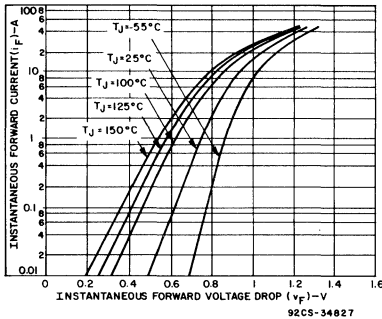


Fig. 3 — Typical forward current vs. forward-voltage drop.

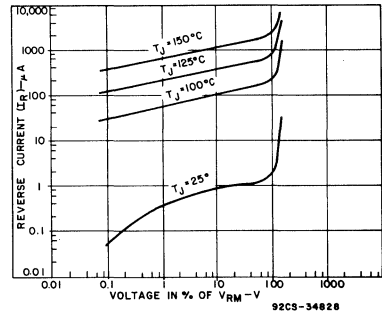


Fig. 4 — Typical reverse current vs. voltage.

Dual 16-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

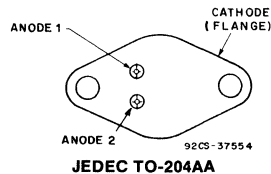
Features:

- Ultra fast recovery time (< 35 ns)
- Low forward voltage
- Low thermal resistance
- Planar design
- Wire-bonded construction

Applications:

- General purpose
- Power switching circuits to 100 kHz
- Full-wave rectification

TERMINAL DESIGNATIONS



The RCA RUR-D1610, RUR-D1615 and RUR-D1620 are low forward voltage drop, ultra fast-recovery rectifiers ($t_{rr} < 35$ ns). They use an ion-implanted planar epitaxial construction.

These devices are intended for use as output rectifiers and fly wheel diodes in a variety of high-frequency pulse-width modulated power supplies, amplifiers and switching regulators. Their low stored charge and attendant fast

reverse recovery behavior minimize electrical noise generation and, in many circuits, markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in steel JEDEC TO-204AA hermetic packages.

•Formerly RCA Developmental Nos. TA9226A, B and C respectively.

MAXIMUM RATINGS, Absolute-Maximum Values, per Junction:

	RUR-D1610	RUR-D1615	RUR-D1620	
V _{RM}	100	150	200	V
I _F (Average)				
T _A = 25°C (No Heat Sink)		6		A
T _A = 25°C (With Heat Sink) ■		16		A
T _C = 125°C		16		A
I _{FSM} (surge)				
8.3 ms, 1/2 cycle, non-repetitive		275		A
Thermal Resistance (J-C)		1.5		°C/W
Thermal Resistance (J-C) Total		1.2		°C/W
Thermal Resistance (J-A)		30		°C/W
T _{stg} , T _J		-55 to 150		°C
T _L (Lead temperature during soldering)				
At distance > 1/8 in. (3.17 mm) from case for 10 s max.		260		°C

■ Wakefield type 621 heat sink with convection cooling

RUR-D1610, RUR-D1615, RUR-D1620

ELECTRICAL CHARACTERISTICS, per junction

CHARACTERISTICS	TEST CONDITIONS			LIMITS						UNITS
	T _J °C	Voltage V _H V	Current I _i A	RUR-D1610		RUR-D1615		RUR-D1620		
				Min.	Max.	Min.	Max.	Min.	Max.	
i _r	25	100		—	15	—	—	—	—	μA
		150		—	—	—	15	—	—	
		200		—	—	—	—	—	15	
	100	100		—	1.5	—	—	—	—	mA
		150		—	—	—	1.5	—	—	
		200		—	—	—	—	—	1.5	
V _F	25		16	—	0.95	—	0.95	—	1	V
	125		16	—	0.83	—	0.83	—	0.88	
t _{rr}	25		4(a)	—	35	—	35	—	35	ns
R _{θJC}				—	1.5	—	1.5	—	1.5	°C/W
R _{θJA}				—	30	—	30	—	30	
C _J	25	10	0	80 Typ.		80 Typ.		80 Typ.		pF

(a) di_F/dt > 40A/μs, I_{RM}(rec) < 1A, I_{RR} = 0.25A

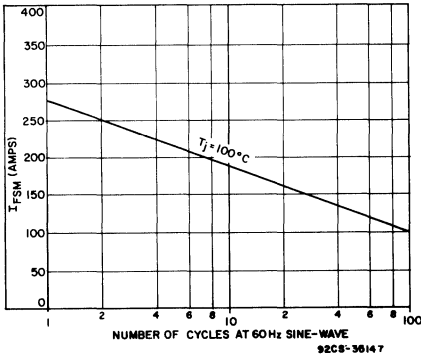


Fig. 1 - Peak surge forward current vs. surge duration.

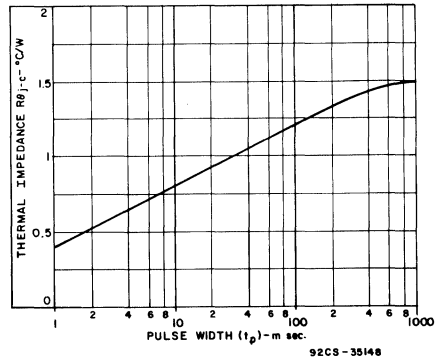


Fig. 2 - Thermal impedance vs. pulse width (per junction).

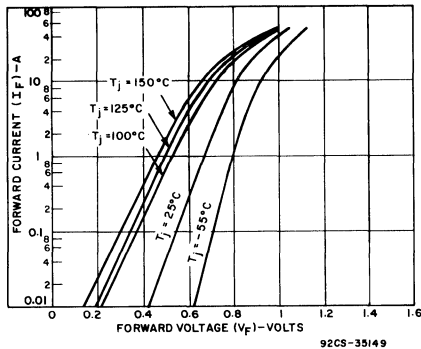


Fig. 3 - Typical forward current vs. forward-voltage drop.

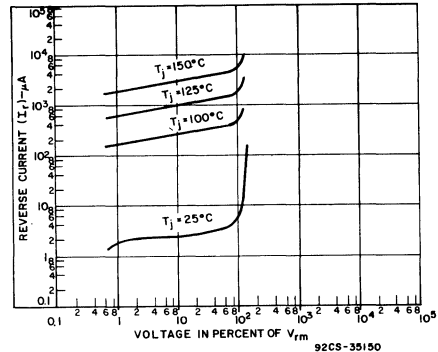


Fig. 4 - Typical reverse current vs. voltage.

Power Transistor Chips

Technical Data

Power Transistor Chips

Chip Type No.	V _{CE(SUS)} (V) min.	I _{CEO} (μA) max.	I _{CES} (μA) max.	I _{EB0} (mA) max.	V _{CE(SAT)} (V) max.	h _{FE} min.	File No.
PC44E	66	—	0.5	0.9†	—	1200	1932
PC44H	33	—	0.02	0.1	—	35	1933
PC45E•	-66	—	-0.4	-0.9	—	1200	1934
PC45H•	-33	—	-0.1	-0.1	—	40	1935
PC1482	60	—	—	0.01	1.4	35 - 100	1792
PC2102	60	5	—	0.005	1	40	1416
PC3439	—	20	—	0.015	1	40 - 150	1417
PC3442	140	200□	—	5	1	20 - 70	1793
PC3585	300	—	200	0.5	0.75	25	1794
PC3879	75	5□	—	10	1.2	20 - 80	1795
PC4036•	-60	-5	—	-5†	-1	40	1418
PC5038	90	20□	—	50	1	20 - 100	1796
PC5240	300	100	—	100†	2	20	1797
PC5303	80	100	—	50†	1	15	1395
PC5320	60	10	—	5†	1	30	1419
PC5322•	-60	-10	—	-5†	-1	30	1420
PC5415•	—	-25	—	-15†	-2	30 - 150	1421
PC5671	90	10□	—	10	0.75	20 - 100	1798
PC6079	350	—	0.5□	1	3	12	1799
PC6107•	-60	-20Δ	—	-20†	-2	50	1391
PC6213•	-225	—	-0.5□	-0.5	-1.6	10	1800
PC6247•	-80	-100Δ	—	-20†	-3.5	20 - 100	1801
PC6284	80	100	—	2	2	750-20K	1392
PC6287•	-80	-100	—	-2	-2	750 - 20K	1393
PC6292	80	20Δ	—	20†	—	20 - 150	1390
PC6354	120	20□	—	5	1	10 - 100	1802
PC6385	80	100Δ	—	2	2	2000	1803
PC6388	80	20Δ	—	2	4	—	1407
PC6476	80	20Δ	—	100†	0.5	20 - 150	1804
PC6478	140	2□	—	2	1	25 - 150	1805
PC6488	80	20Δ	—	10†	3.5	20	1806
PC6491•	40	20Δ	—	20†	1.2	20 - 110	1807
PC6650•	-80	-100Δ	—	-2	-1.5	2K - 20K	1808
PC6668•	-70	-20	—	-2	-1.5	—	1408
PC6673	400	—	100	2	1	10	1409
PC6678	400	—	100	1	1	8	1404
PC6688	180	—	50	100†	1.5	25	1403
PC6704	130	100	—	100†	0.7	20	1809
PC6754	400	—	100	2	1	8	1810
PC6773	350	—	100	2	1	10	1410
PC8638	125	100Δ	—	50†	1	25 - 125	1400
PC8766	—	100	—	10	1.8	220	1402
PC9116•	-120	-100Δ	—	-50†	-1	25	1401
PC9166	250	1□	—	1	1	30	1399
PC9202	300	500	—	10	1.5	250	1396
PC9203	250	500	—	1	2	100	1398
PC13005	400	—	100	1	1	8	2149
PC16010	400	—	100	1	1	8	2150
PC1IP110	80	20	—	2	2.5	500	1405
PCTIP115•	-60	-20	—	-2	-2.5	500	1406

• p-n-p † μA □ mA Δ I_{CEO}

High-Reliability Power Devices

High-Reliability Power Devices

Solid-state devices classified as high-reliability types have come to be primarily associated with military and aerospace applications. In many ways, this association is misleading because the commercial equipment market is probably the largest user of high-reliability products, but not necessarily by that label. Military and aerospace agencies, however, have been largely responsible for establishment of comprehensive published reliability specifications and standards which have been accepted by the solid-state industry. MIL standards dominate the procedures used to specify high-reliability solid-state devices and represent a common reference point frequently used by commercial users to define their requirements.

Military and aerospace requirements for high-reliability solid-state devices are extremely large and diverse, not only in terms of performance, operating conditions, and reliability, but also in terms of logistics and procurement. As a result of these requirements, the military services have jointly developed specifications and standards under which most military end-use solid-state devices are procured. To simplify procurement, logistics, and the development of reliability data, MIL specs are not issued for the full spectrum of devices manufactured: rather, they are restricted to those devices for which significant need is demonstrated and are specified so that the device can have as wide applicability as possible. Although the limits for operating conditions may exceed those required for some applications, they simplify procurement and assure a supply

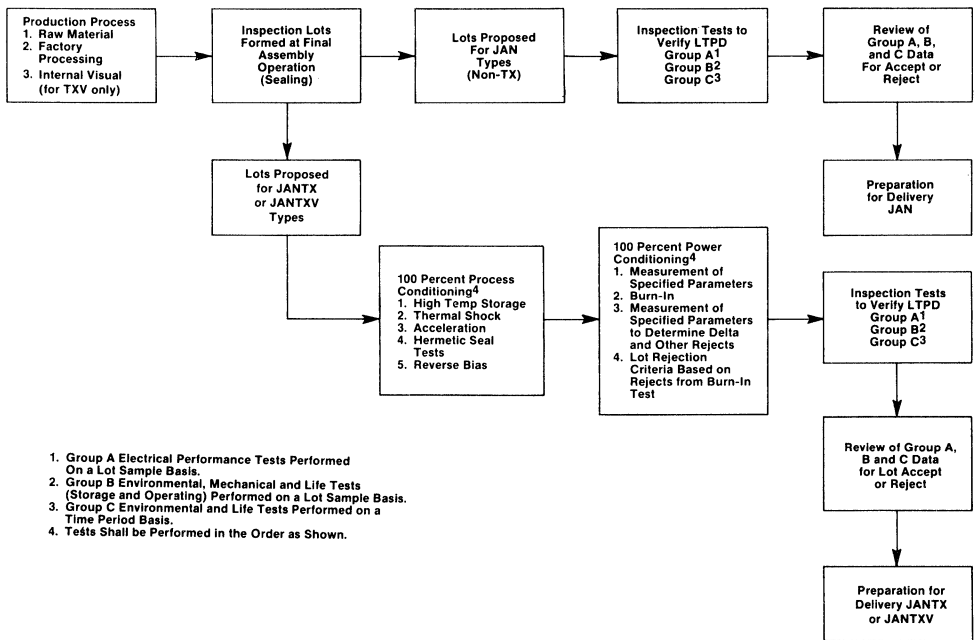
of devices for the majority of military equipment. These standards also cover a wide range of requirements for the manufacturer on such things as:

- (a) The procedure and requirements for a manufacturer to become certified to manufacture MIL-spec parts.
- (b) The requirements for qualifying parts.
- (c) Product-assurance provisions in such areas as quality control, inspection procedures, personnel training, cleanliness, failure analysis, and documentation.
- (d) Test methods and procedures.
- (e) Marking and identification of product.
- (f) Preservation and packing.

JAN, JANTX, and JANTXV Solid-State Power Devices

The major military specification used for the procurement of standard solid-state devices by the military is MIL-S-19500, which covers the devices such as discrete transistors, thyristors, and diodes.

MIL-S-19500 is the specification for the familiar "JAN" type solid state devices. Detailed electrical specifications are prepared as needed by the three military services and coordinated by the Defense Electronic Supply Center (DESC).



1. Group A Electrical Performance Tests Performed On a Lot Sample Basis.
2. Group B Environmental, Mechanical and Life Tests (Storage and Operating) Performed on a Lot Sample Basis.
3. Group C Environmental and Life Tests Performed on a Time Period Basis.
4. Tests Shall be Performed in the Order as Shown.

92CM - 25057RI

Order of procedure diagram for JAN, JANTX, and JANTXV solid-state devices.

JAN, JANTX, and JANTXV Devices

MIL-S-19500 is the specification for the familiar "JAN" type discrete solid state devices. Levels of reliability are defined by MIL-S-19500. JAN types receive Group A, Group B, and Group C lot sampling only, and are the least expensive. JANTX types receive 100 percent process conditioning, and power conditioning, and are subjected to lot rejection based on delta parameter criteria in addition to Group A, Group B, and Group C lot sampling. JANTXV

types are subjected to 100 percent (JTXV) internal visual inspection in addition to all of the JANTX tests in accordance with MIL-STD-750 test methods and MIL-S-19500.

DESC publishes "QPL-19500," a Qualified Products List of all types and suppliers approved to produce and brand devices in accordance with MIL-S-19500.

QPL Approved Types

Harris is presently qualified on the following devices. Prices and delivery quotations may be obtained from your local sales representative.

JAN and JANTX Bipolar Power Transistors

Types	MIL-S-19500/	Package	Polarity	P _T (W)	I _C (A)	V _{CEO} (V)	h _{FE}		f _T (MHz)
							Min.	I _C (A)	
2N3439, 2N3440	368	TO-205AD/TO-39	N-P-N	0.8	1	350	40	0.02	15
2N3584, 2N3585	384	TO-213AA/TO-66	N-P-N	35	2	300	25	1	15
2N3879	526	TO-213AA/TO-66	N-P-N	35	7	75	20	4	40
2N5038, 2N5039	439*	TO-204AA/TO-3	N-P-N	140	20	90	20	12	60
2N5302, 2N5303	456*	TO-204AA/TO-3	N-P-N	200	30	80	15	15	2
2N5415S, 2N5416S	485	TO-205AD/TO-39	P-N-P	0.75	-1	-300	30	-0.05	15
2N5671, 2N5672	488*	TO-204AA/TO-3	N-P-N	140	30	120	20	20	50
2N6032, 2N6033	528*	TO-204AE/TO-3	N-P-N	140	50	120	10	50	50
2N6211-2N6213	461	TO-213AA/TO-66	P-N-P	35	-2	-350	30	-1	20
2N6283, 2N6284	504*	TO-204AA/TO-3	N-P-N	175	20	100	1250	10	8
2N6286, 2N6287	505*	TO-204AA/TO-3	P-N-P	175	-20	-100	1250	-10	8
2N6306, 2N6308	498*	TO-204AA/TO-3	N-P-N	125	8	350	15	3	5
2N6383-2N6385	523*	TO-204AA/TO-3	N-P-N	100	10	80	1000	5	20
2N6546, 2N6547	525*	TO-204AA/TO-3	N-P-N	175	15	300	12	5	60
2N6648-2N6650	527*	TO-204AA/TO-3	P-N-P	85	-10	-80	1000	-5	20
2N6671, 2N6673	536*	TO-204AA/TO-3	N-P-N	150	10	400	10	5	15
2N6674, 2N6675	537*	TO-204AA/TO-3	N-P-N	175	20	400	8	10	15
2N6676, 2N6678	538*	TO-204AA/TO-3	N-P-N	175	20	400	8	10	15

*Available in **JANTXV** form.

Radiation-Resistant Power Transistors

The following Harris bipolar silicon power transistors are manufactured using special design and processing techniques to assure continued functional performance after exposure to specified dosages of neutron and gamma radiation.

The following types are recommended for those applications where radiation tolerance is a critical factor. Radiation tolerance is not covered by present slash (/) specifications. Device capabilities and system requirements are generally limited to a custom specification basis.

Harris Radiation-Hardened Bipolar Power Transistors

Types	Description	Package	Gamma Intensity (RAD(Si)/s)	Neutron Fluence (N/cm ²)
2N3879	75V/7A, N-P-N Hi-Speed	TO-213AA	1 x 10 ⁷	5 x 10 ¹³
2N5038	90V/20A, N-P-N Hi-Speed	TO-204AA	1 x 10 ⁷	5 x 10 ¹³
2N5320	75V/2A, N-P-N Small-Sig.	TO-205AD	1 x 10 ⁷	5 x 10 ¹³
2N5322	75V/2A, P-N-P Small-Sig.	TO-205AD	1 x 10 ⁷	5 x 10 ¹³
2N5672	120V/30A, N-P-N Hi-Speed	TO-204AA	1 x 10 ⁷	5 x 10 ¹³
2N6248	100V/10A, P-N-P EPI-Base	TO-204AA	1 x 10 ⁷	5 x 10 ¹³
2N6673	400V/8A, N-P-N Hi-Speed	TO-204AA	1 x 10 ⁷	5 x 10 ¹³
2N6688	200V/20A, N-P-N Hi-Speed	TO-204AA	1 x 10 ⁷	5 x 10 ¹³
2N7142*	60V/12A, N-P-N Hi-Speed	TO-204AA	1 x 10 ⁸	1 x 10 ¹⁴
2N7143*	80V/12A, N-P-N Hi-Speed	TO-204AA	1 x 10 ⁸	1 x 10 ¹⁴
2N7144*	60V/12A, N-P-N Hi-Speed	Radial	1 x 10 ⁸	1 x 10 ¹⁴
2N7145*	80V/12A, N-P-N Hi-Speed	Radial	1 x 10 ⁸	1 x 10 ¹⁴
2N7146*	60V/12A, N-P-N Hi-Speed	TO-257AA	1 x 10 ⁸	1 x 10 ¹⁴
2N7147*	80V/12A, N-P-N Hi-Speed	TO-257AA	1 x 10 ⁸	1 x 10 ¹⁴

*Formerly RCA Dev. type TA9107.

Neutron-Radiation Compensation

In Harris radiation-resistant bipolar power transistors, the base width is made as narrow as possible (consistent with other design objectives) to achieve a minimum base transit time so that a maximum number of minority carriers can complete the journey through the base. The narrower base width thus compensates for the major cause of failure in transistors exposed to neutron radiation, the reduction in minority-carrier lifetime and the corresponding decrease in transistor current gain. The voltage-supporting region in the collector is also made as narrow as feasible and is heavily doped. In this way, the series-resistance path is made as low as possible to compensate for the rise in collector series resistance and the resultant higher saturation voltage caused by exposure of the transistor to neutron radiation.

The problem of increased leakage currents is solved by use of epitaxial-planar transistors. The initial leakage in these transistors is so small that even the higher levels caused by neutron bombardment are unlikely to cause failure.

Because the narrower base width and reduced collector resistivity used to improve transistor radiation resistance

are contradictory to the design requirement for high-voltage, high-energy transistors, designers should adjust circuits to require the minimum possible emitter-to-collector voltage-breakdown capability. In addition, ratings for transistors should be specified in accordance with the way in which the devices are to be used. (i.e., V_{CE} or V_{CEV} , and never V_{CE0}). The circuit design should also provide high-energy protection for the transistor.

Gamma-Radiation Compensation

The gamma dose rate at which the onset of secondary photocurrent occurs depends strongly on the geometry of the transistor emitter. The secondary photocurrent is initiated when a portion of the emitter-base junction becomes forward-biased because of the voltage drop across the lateral base resistance under the emitter. In Harris radiation-resistant transistors, the distance from the base contact to the farthest point of the base under the emitter is reduced to the minimum possible value to achieve a substantial increase in the gamma threshold level at which the secondary photocurrent starts.

See Application Note AN-6320 for Data

Custom-Ordered Added Value Screening

Added Value Screening for Power Bipolar Transistors and Chips

Many solid-state devices not yet covered by military specifications, because they are too new, offer the most recent technological advances or have special performance characteristics which offer advantages to the designer of high-reliability equipment. Harris cooperates with the users of such devices in establishment of high-reliability specifications patterned after MIL standards, which allow these designs to be approved for use in military and aerospace systems, as well as commercial equipment.

Most procurements of solid-state devices for military systems are made by the equipment contractor from the MIL-STD parts list as awards are received for electronic equipment. Some military and aerospace programs, because of their size, duration, or special requirements (Minuteman and Peacekeeper are two examples), require that special specifications and process methods, or even special production lines, be established and tailored to the particular functional, reliability, and economic needs of the program. Harris has frequently used the resource of its laboratories, production facilities, and expert technical staff to contribute to the success of such programs.

All Harris high-reliability solid-state power devices are processed in accordance with provisions of MIL-S-19500. The desired screening test sequence can be chosen from the models shown in the screening table.

Class S devices provide wafer lot control traceability from wafer diffusion through screening.

Class S chips also provide wafer lot control traceability from wafer diffusion through screening. A sample of 22 devices taken from this lot is assembled in a suitable package. The assembled sample devices are subjected to the Class S screening sequence in the table below. Class S chips are released for shipment when the assembled sample devices successfully pass the screen.

Class V devices are screened for precap internal visual inspection plus burn-in and domestic assembly. Such devices are referred to as JANTXV. Class X devices are 100% burned-in and are referred to as JANTX.

Group B and Group C tests will be performed when requested in accordance with MIL-S-19500.

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
1. Internal Visual	2072	For transistors.	100%	100%	---
2. High Temp Life (LTPD) (stabilization bake)	1032	24 hrs min at max rated storage temp.	100%	100%	100%
3. Thermal shock (temp cycling)	1051	No dwell is required at 25° C. Test condition C, 20 cycles, t (extremes) > 10 min.	100%	100%	100%
4. Constant acceleration 1/	2006	Y ₁ direction at 20,000 G min except at 10,000 G min for devices with power rating of > 10 watts at T _c = 25° C. The 1 min hold time requirement shall not apply.	100%	100%	100%

Custom-Ordered Added Value Screening

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
5. Hermetic Seal Fine 1/	1071	Test condition G or H, max leak rate = 5×10^{-8} atm cc/s except 5×10^{-7} atm cc/s for devices with internal cavity > 0.3 cc.	Optional if done in screen 14.	100% 4/	100% 4/
Gross		Test condition A, C, D, E, or F.	Optional	100% 4/	100% 4/
6. Serialization		See 3.7.9.	100%		
7. Interim Electrical Parameters		As specified.	100% (Read and record)		
8. High Temp Reverse Bias (HTRB) Burn-in (for transistors)	1039	48 hrs min at $T_A = 150^\circ\text{C}$ (min) and minimum applied voltage as follows: Transistors - 80% (min) of rated V_{CB} (bipolar), $V_{GS(FET)}$, or $V_{DS(FET)}$ as applicable. Test condition A.	100%	100%	100%
9. Interim electrical and delta parameters		As specified but including all delta parameters as a minimum. Leakage current shall be measured on each device before any other test is made.	100% (Measure all specified parameters within 16 hrs after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 11.)	100% (Measure all specified parameters within 24 hrs after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 11.)	100% (Measure all specified parameters within 24 hrs after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 11.)

Custom-Ordered Added Value Screening

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
10. Power Burn-In		As specified.	100%	100%	100%
Burn-In (Transistors)		Transistors. Test condition B.	240 hrs (min)	160 hrs (min)	160 hrs (min)
Burn-In (Thyristors) 3/	1040	Thyristors.	240 hrs (min)	96 hrs (min)	96 hrs (min)
11. Final Electrical Test		As specified.	100%	100%	100%
Interim Electrical		All interim and delta parameter measurements must be completed within 96 hrs after removal from burn-in conditions.	Interim electrical and delta parameters as a minimum. (Read and record.)	Interim electrical and delta parameters as a minimum. (Read and record.)	Interim electrical and delta parameters as a minimum. (Read and record.)
Other Electrical Parameters			Group A, sub-groups 2 and 3.	Group A, sub-groups 2 and 3.	Group A, sub-groups 2 and 3.
12. Hermetic Seal	1071	(Same as 5 on previous page) 2/	100%	Optional 4/	Optional 4/
Fine 1/					
Gross					
13. Radiography	2076	2/	100%	—	—
14. External Visual Examination	2071	To be performed after complete marking.	100%	—	—

6

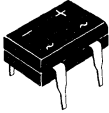
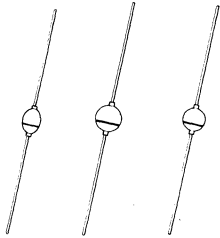
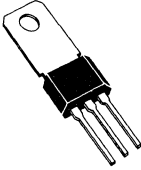
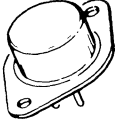
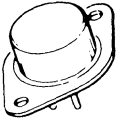
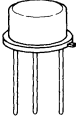
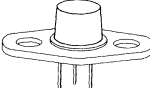
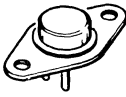
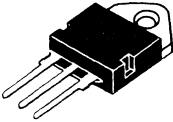
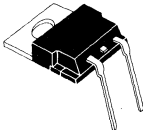
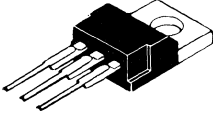
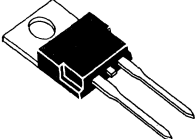
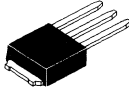

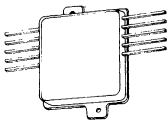

*1/ Omit fine leak seal test and constant acceleration test for double plug, non-internal cavity diode construction.

*2/ The radiographic and seal screens for JANS may be performed in any order following final electrical test. Glass diodes shall not be painted until after seal tests. When hermetic seal testing is performed in screen 5 it does not have to be performed again in screen 12 for double plug, non-internal cavity diode construction.

*3/ Reverse-blocking test shall replace power burn-in for power rectifiers at ≥ 10 amp rating at $T_c \geq 100^\circ\text{C}$ and all thyristors.

4/ Fine and gross seal leak test for JANTX and JANTXV shall be performed in either block 5 or block 12.

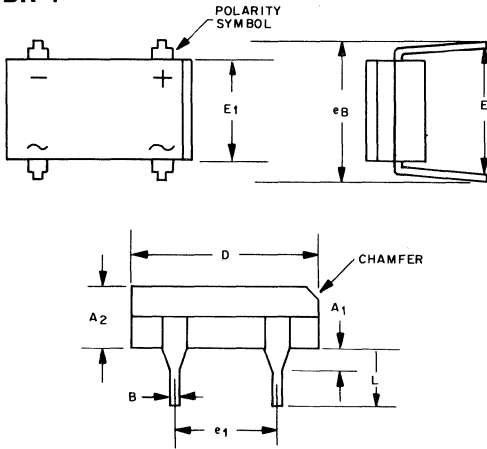
Package Designations

 <p>BR-4</p>	 <p>DO-204AP GE-3 GE-4 AXIAL LEAD</p>	 <p>TO-202AB</p>	 <p>TO-204AA</p>
 <p>(0.060 In.-Dia. Pins) TO-204AE</p>	 <p>TO-205AD</p>	 <p>TO-205AD w/Flange</p>	 <p>TO-213AA</p>
 <p>TO-218AC</p>	 <p>TO-220AA</p>	 <p>TO-220AB</p>	 <p>TO-220AC</p>
 <p>TO-251AA</p>	 <p>TO-252AA</p>	 <p>HYBRID CKT. PKG.</p>	 <p>RADIAL PKG.</p>

Package Information

Dimensional Outlines

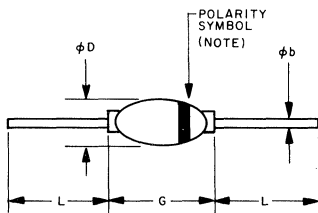
BR-4



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A ₁	0.060 TYP.		1.5 TYP.		
A ₂	0.125	0.135	3.2	3.4	
B	0.016	0.020	4.1	5.1	
D	0.355	0.365	9.0	9.3	
E	0.300	0.350	7.6	8.9	
E ₁	0.245	0.255	6.2	6.5	
e ₁	0.195	0.205	5.0	5.2	
e _B	0.290	0.310	7.4	7.9	
L	0.155	0.165	3.9	4.2	

92CS-42582

DO-204AP

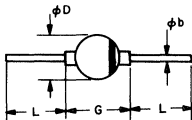


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
phi b	0.028	0.034	0.71	0.86	
phi D	0.100	0.150	2.5	3.8	
G	—	0.240	—	6.1	
L	1.000	—	25.4	—	

92CS-42583R1

NOTE:
COLOR BAND (POLARITY SYMBOL) INDICATES CATHODE CONNECTION.

GE-3

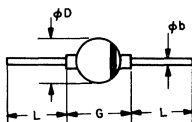


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
phi b	0.048	0.052	1.2	1.3	
phi D	0.170	0.250	4.3	6.3	
G	—	0.300	—	7.6	
L	1	—	25.4	—	

92CS-42648

NOTE:
COLOR BAND (POLARITY SYMBOL) INDICATES CATHODE CONNECTION.

GE-4



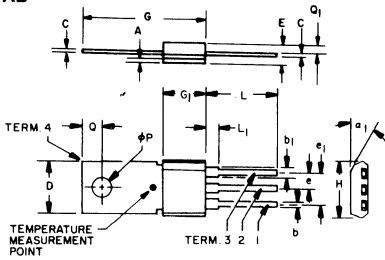
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
phi b	0.037	0.042	0.94	1.07	
phi D	0.115	0.180	2.9	4.6	
G	—	0.300	—	7.6	
L	1	—	25.4	—	

92CS-42647

NOTE:
COLOR BAND (POLARITY SYMBOL) INDICATES CATHODE CONNECTION.

Dimensional Outlines

TO-202AB VERSATAB

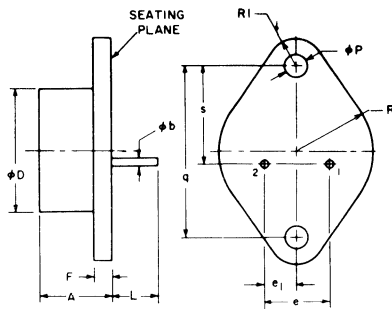


- Notes:
 1: Package contour optional within dimensions specified.
 2: Lead dimensions uncontrolled in this zone.
 3: Controlling dimensions: inch.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.05	—	1.270	1
b	0.023	0.029	0.584	0.736	1
b ₁	0.045	0.055	1.143	1.397	
c	0.018	0.026	0.457	0.660	
D	0.305	0.325	7.747	8.255	
E	0.130	0.150	3.302	3.810	
e	0.095	0.105	2.413	2.667	
e ₁	0.190	0.210	4.826	5.334	
G	0.760	0.840	19.31	21.33	
G ₁	0.230	0.250	5.842	6.350	
H	0.330	0.370	8.382	9.398	
L	0.400	0.450	10.16	11.43	
L ₁	0.050	0.100	1.27	2.54	1, 2
φP	0.123	0.127	3.124	3.225	
Q	0.120	0.130	3.048	3.302	
Q ₁	0.039	0.050	0.990	1.270	
α ₁	—	50°	—	50°	1

92CS-24062R6

TO-204AA

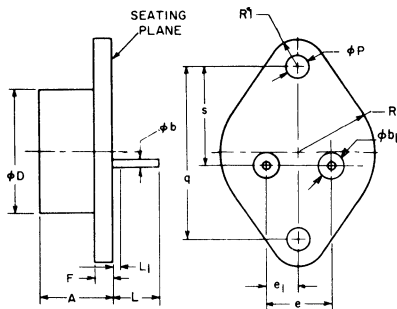


SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.4	11.4	
φb	0.038	0.043	0.966	1.092	
φD	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	
e ₁	0.205	0.225	5.21	5.71	
F	—	0.135	—	3.42	
L	0.312	—	7.93	—	
φP	0.151	0.161	3.84	4.08	
q	1.187 BSC		30.15 BSC		
R	—	0.525	—	13.33	
R ₁	—	0.188	—	4.77	
s	0.655	0.675	16.64	17.14	

92CS-37249R1

TO-204AA

200-mil diameter pin isolation



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.35	11.35	
φb	0.038	0.043	0.96	1.092	1
φb ₁	0.200 NOM.		5.08 NOM.		
φD	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	2
e ₁	0.205	0.225	5.21	5.71	2
F	0.060	0.135	1.53	3.42	
L	0.312	0.500	7.93	12.70	
L ₁	—	0.050	—	1.27	1
φP	0.151	0.161	3.836	4.089	
q	1.177	1.197	29.90	30.40	
R	0.495	0.525	12.58	13.33	
R ₁	0.131	0.188	3.33	4.77	
s	0.655	0.675	16.64	17.14	

92CS-32102

- Notes:
 1: φb applies between L₁ and L. Diameter is uncontrolled in L₁.

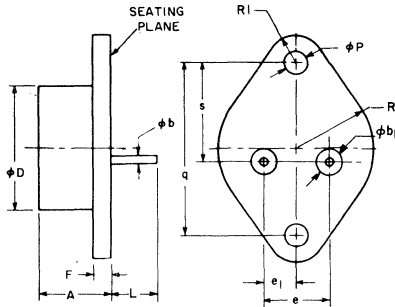
- 2: These dimensions should be measured at points 0.050 in. (1.270 mm) to 0.055 in. (1.397 mm) below seating plane. When gage is not used, measurement will be made at seating plane.

7

Dimensional Outlines

TO-204AE

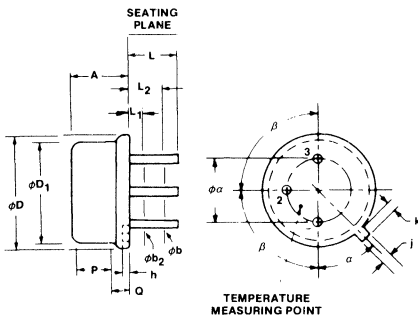
141-mil diameter pin isolation



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.4	11.4	
phi b	0.057	0.063	1.45	1.60	
phi b ₁	0.141 NOM.		3.58 NOM.		
phi D	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	
e ₁	0.205	0.225	5.21	5.71	
F	0.060	0.135	1.53	3.42	
L	0.440	0.480	11.18	12.19	
phi P	0.151	0.161	3.84	4.08	
q	1.187	BSC	30.15	BSC	
R	0.495	0.525	12.58	13.33	
R ₁	0.131	0.188	3.33	4.77	
s	0.655	0.675	16.64	17.14	

92CS-37523

TO-205AD



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
phi a	0.200 BSC		5.08 BSC		4
A	0.240	0.260	6.10	6.60	
phi b	0.016	0.021	0.41	0.53	5
phi b ₂	0.016	0.019	0.41	0.48	5
phi D	0.335	0.370	8.51	9.39	
phi D ₁	0.305	0.335	7.75	8.50	2
h	0.009	0.041	0.23	1.04	
j	0.028	0.034	0.72	0.86	
k	0.029	0.045	0.74	1.14	1
L	0.500	0.750	12.70	19.05	5
L ₁	—	0.050	—	1.27	5
L ₂	0.250	—	6.35	—	5
P	0.100	—	2.54	—	2
Q	—	0.050	—	1.27	3
alpha	45° NOMINAL				
beta	90° NOMINAL				

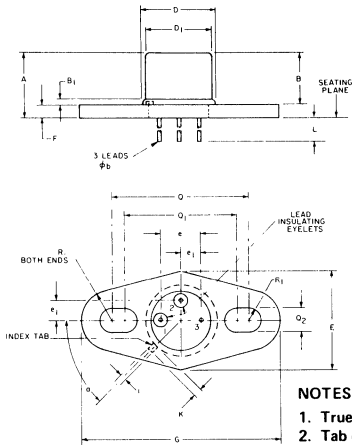
92CS-39772

Notes:

1. Dimension k measured from phi D maximum.
2. phi D₁ shall not vary more than 0.010 in Zone P. This zone controlled for automatic handling.
3. Details of outline in this zone optional.
4. Leads at gauge plane 0.054-0.055 below seating plane shall be within 0.007 radius of positional tolerance at MMC relative to tab at MMC. Device may be measured by direct methods or by gauge and gauging procedure described on JEDEC gauge drawing GS-1.
5. phi b₂ applies between L₁ and L₂. phi b applies between L₂ and L minimum. Diameter is uncontrolled in L₁ and beyond L minimum.

Dimensional Outlines

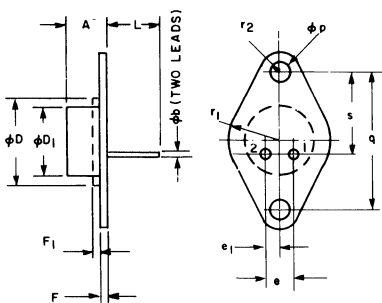
TO-205AD WITH FLANGE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.328	—	8.33	
B	0.240	0.260	6.10	6.60	
B ₁	0.009	0.125	0.229	3.18	
φ _b	0.016	0.019	0.406	0.483	
D	0.335	0.370	8.51	9.40	
D ₁	0.305	0.335	7.75	8.51	
E	0.495	0.505	12.57	12.83	
e	0.200 T.P.		5.08 T.P.		1
e ₁	0.100 T.P.		2.54 T.P.		1
F	0.062	0.068	1.57	1.74	
G	0.995	1.005	25.27	25.53	
i	0.028	0.034	0.711	0.864	
k	0.029	0.045	0.737	1.14	
L	0.430	—	10.92	—	
Q	0.685	0.691	17.40	17.55	
Q ₁	0.559	0.565	14.20	14.35	
Q ₂	0.128	0.132	3.25	3.35	
R	0.156 T.P.		3.96 T.P.		1
R ₁	0.064	0.066	1.63	1.67	
α	45° T.P.				1, 2

92CS-22333

TO-213AA



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.250	.340	6.35	8.63	
θ _b	.028	.034	.712	.863	
θD	—	.620	—	15.74	3
θD ₁	.470	.500	11.94	12.70	
e	.190	.210	4.83	5.33	
e ₁	.093	.107	2.37	2.71	
F	.050	.075	1.27	1.90	4
F ₁	—	.050	—	1.27	3
L	.360	—	9.15	—	
θP	.142	.162	3.61	4.08	
q	.950	.970	24.13	24.63	
r ₁	—	.350	—	8.89	
r ₂	—	.145	—	.368	
s	.570	.590	14.48	14.98	

92CS-39032

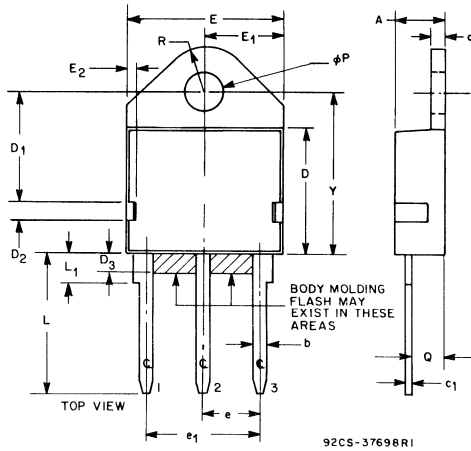
Notes:

1. Refer to applicable symbol list.
2. Dimensioning and tolerancing per ANSI Y14.5 - 1973.

3. Package contour optional within dimensions specified.
4. Dimension does not include sealing flanges.
5. Controlling dimensions: inch.

Dimensional Outlines

TO-218AC



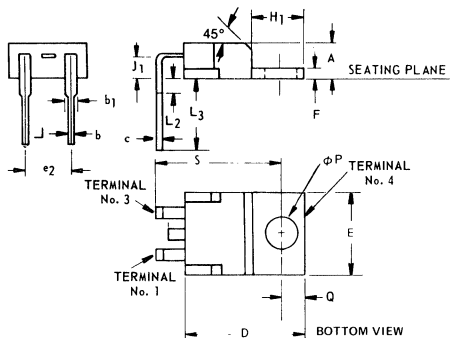
NOTES:

1. Tab outline optional within boundaries of dimensions E and R.
2. Lead dimensions uncontrolled in L₁.
3. Maximum radius of 0.050" on all body edges and corners.
4. Position of lead to be measured 0.185-0.190" from bottom of dimension D.
5. Controlling dimension: inch.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.165	0.200	4.191	5.080	
b	0.040	0.065	1.016	1.651	
c	0.053	0.065	1.346	1.651	
c ₁	0.015	0.030	0.381	0.762	
D	0.460	0.505	11.68	12.827	
D ₁	0.395	0.415	10.033	10.541	
D ₂	0.070	0.090	1.778	2.286	
D ₃	—	0.600	—	1.524	
E	0.610	0.640	15.494	16.256	1
E ₁	0.305	0.320	7.747	8.128	
E ₂	0.040	0.060	1.016	1.524	
e	0.205	0.225	5.207	5.715	4
e ₁	0.420	0.440	10.688	11.176	4
L	0.500	0.632	12.700	16.05	
L ₁	—	0.150	—	3.81	2
φP	0.157	0.167	3.988	4.241	
Q	0.093	0.126	2.36	3.200	
R	0.170	0.190	4.318	4.826	1
Y	0.600	0.650	15.24	16.51	

92CS-37698R2

TO-220AA VERSAWATT



NOTES:

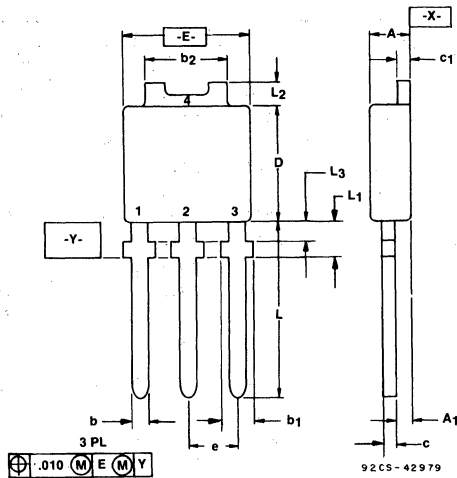
1. Tab contour optional within H₁ and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	—
b	0.020	0.045	0.51	1.14	—
b ₁	0.045	0.070	1.15	1.77	—
c	0.015	0.025	0.38	0.63	—
D	0.560	0.625	14.23	15.87	—
E	0.380	0.420	9.66	10.66	1
e ₂	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	—
H ₁	0.230	0.270	5.85	6.85	1
J ₁	0.080	0.115	2.04	2.92	—
L ₂	—	0.050	—	1.27	—
L ₃	0.360	0.422	9.15	10.71	—
φP	0.139	0.147	3.531	3.733	—
Q	0.100	0.120	2.54	3.04	—
S	0.580	0.610	14.74	15.49	—

92CS-37524R1

Dimensional Outlines

TO-251AA



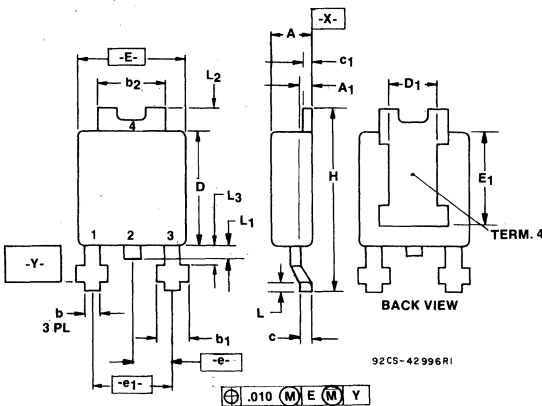
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.086	0.094	2.19	2.38	
A ₁	0.035	0.045	0.89	1.14	
b	0.025	0.035	0.64	0.89	2
b ₁	0.030	0.045	0.76	1.14	
b ₂	0.205	0.215	5.21	5.46	4
c	0.018	0.023	0.46	0.58	
c ₁	0.018	0.023	0.46	0.58	
D	0.235	0.245	5.97	6.22	
E	0.250	0.265	6.35	6.73	2
e	0.090 BSC		2.28 BSC		
L	0.350	0.380	8.89	9.65	
L ₁	0.075	0.090	1.91	2.28	
L ₂	0.035	0.050	0.89	1.27	4
L ₃	0.045	0.060	1.15	1.52	3

92CS-42862

NOTES:

1. **-X-** is datum surface. (seating plane)
2. **-E-** and **-Y-** are datums.
3. Lead dimension uncontrolled in L₃.
4. Tab contour optional within dimensions b₂ and L₂.
5. Controlling dimension: Inch.

TO-252AA



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.086	0.094	2.19	2.38	
A ₁	0.035	0.045	0.89	1.14	
b	0.025	0.035	0.64	0.88	2
b ₁	0.030	0.045	0.76	1.14	
b ₂	0.205	0.215	5.21	5.46	4
c	0.018	0.023	0.46	0.58	
c ₁	0.018	0.023	0.46	0.58	
D	0.235	0.245	5.97	6.22	
D ₁	0.170	—	4.32	—	1, 5
E	0.250	0.265	6.35	6.73	2
E ₁	0.170	—	4.32	—	1, 5
e	0.090 BSC		2.28 BSC		
e ₁	0.180 BSC		4.57 BSC		
H	0.370	0.410	9.40	10.42	
L	0.020	—	0.51	—	6
L ₁	0.025	0.040	0.64	1.02	
L ₂	0.035	0.050	0.88	1.27	4
L ₃	0.045	0.060	1.15	1.52	3

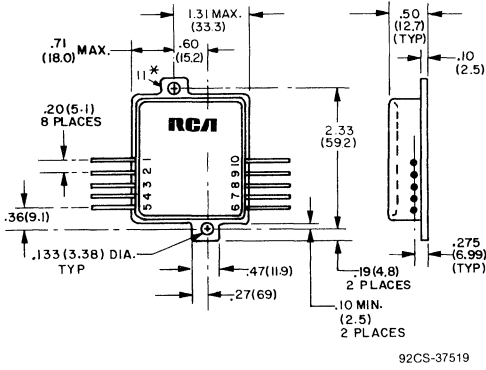
92CS-42863

NOTES:

1. **-X-** is datum surface. (seating plane)
2. **-E-** and **-Y-** are datums.
3. Lead dimension uncontrolled in L₃.
4. Tab contour optional within dimensions b₂ and L₂.
5. D₁ and E₁ establishes a minimum mounting surface for Terminal 4.
6. L is the terminal length for soldering.
7. Controlling dimension: Inch.

Dimensional Outlines

HYBRID-CIRCUIT PACKAGE

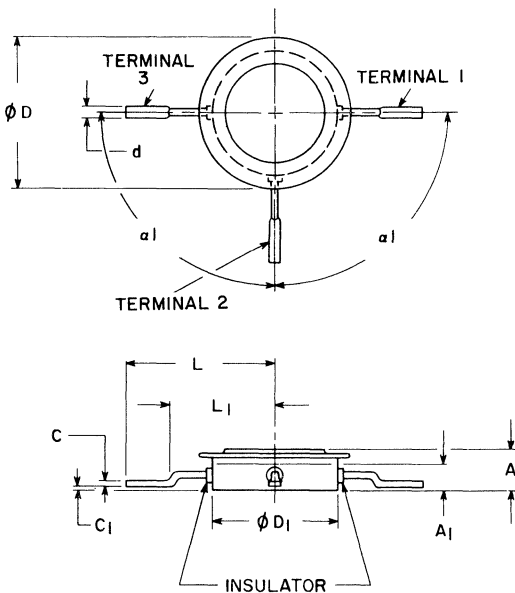


DIMENSIONS IN INCHES AND MILLIMETERS (VALUES IN PARENTHESES)

Typical lead length equals 0.75 (19.0).

*For HC2000H, Terminal 11 is internally connected to Terminal 6
For HC2500, Terminal 11 is electrically isolated from internal circuitry.

RADIAL PACKAGE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.200	—	5.08	
A ₁	—	0.125	—	3.17	1
C	0.015	0.019	0.38	0.48	
C ₁	—	0.015	—	0.38	
ϕD	—	0.710	—	18.03	
ϕD_1	0.615	0.690	15.62	17.52	1
d	0.042	0.046	1.06	1.16	
L	0.700	0.710	17.78	18.03	
L ₁	—	0.510	—	12.95	
α_1	90° ± 2°		90° ± 2°		

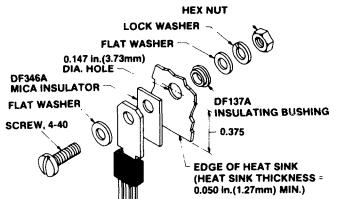
Note:

1. Controlled area of the diameter does not include the brazed area around the ceramic and terminal 2.

92CS-20224R1

Suggested Hardware and Mounting Arrangements

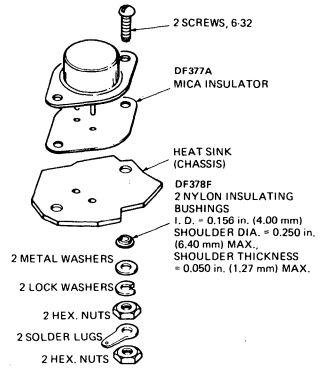
TO-202AB



NOTE: Maximum torque applied to mounting flange is 8 in.-lb. (0.09 kgf-m)

92CS-2777R1

TO-204AA

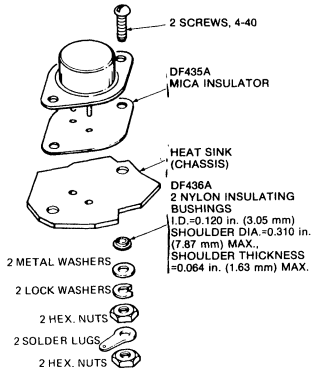


NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in. lbs. (0.14 kgf m).

92CS-22558R2

TO-204AA

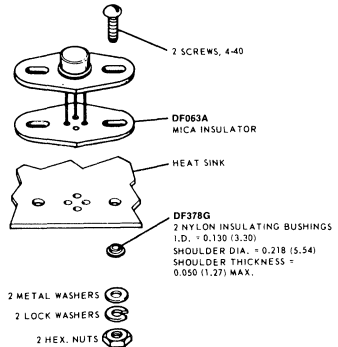
200-mil diameter pin isolation



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lb. (0.09 kgf m).

92CS-33203

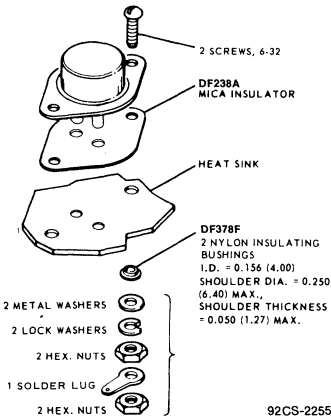
TO-205AD WITH FLANGE



Note: Maximum torque applied to mounting flange is 8 in.-lb. (0.09 kgfm).

92CS-22567E

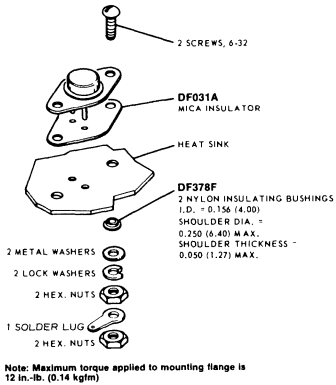
TO-204AE



92CS-22556R1

Suggested Hardware and Mounting Arrangements

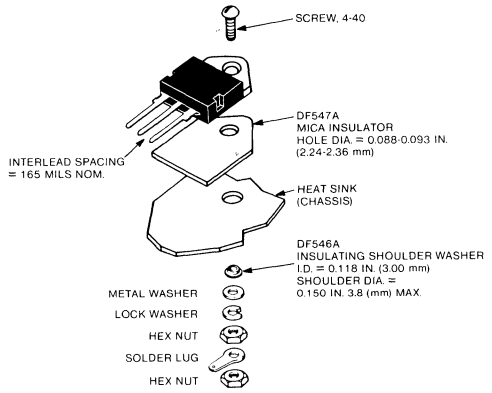
TO-213AA



Note: Maximum torque applied to mounting flange is 12 in.-lb. (0.14 kgm)

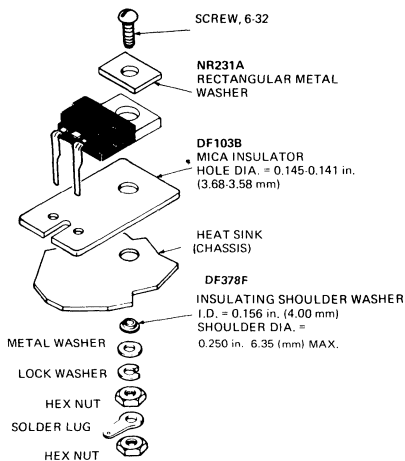
92CS-22560R5

TO-218AC



92CS-39588

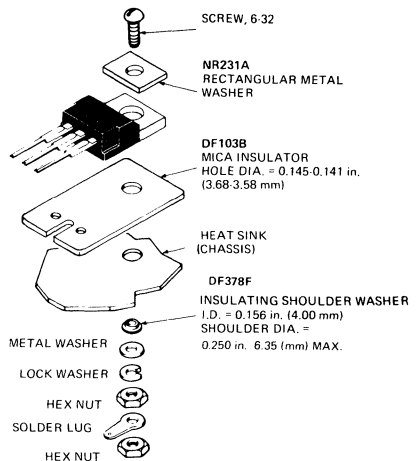
TO-220AA



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in. lb. (0.99 kgf m)

92CS-40181

TO-220AB

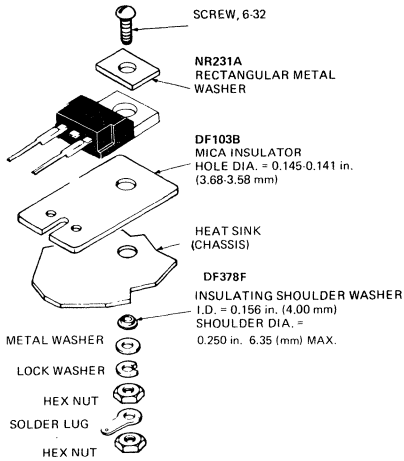


NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in. lb. (0.99 kgf m)

92CS-39586

Suggested Hardware and Mounting Arrangements

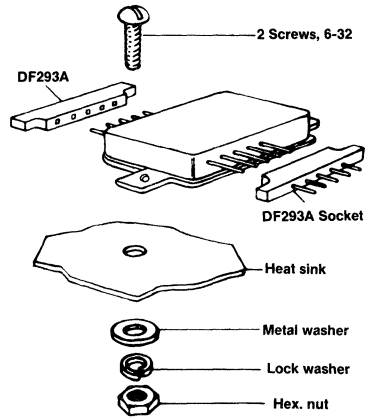
TO-220AC



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lb. (0.09 kgf-m)

92CS-39587

POWER HYBRID CIRCUIT PACKAGE



Note: Maximum torque applied to mounting flange is 24 in.-lb (0.3 kgf-m). DF293A is a socket to enable simple connection of this module.

92CS-27782R1

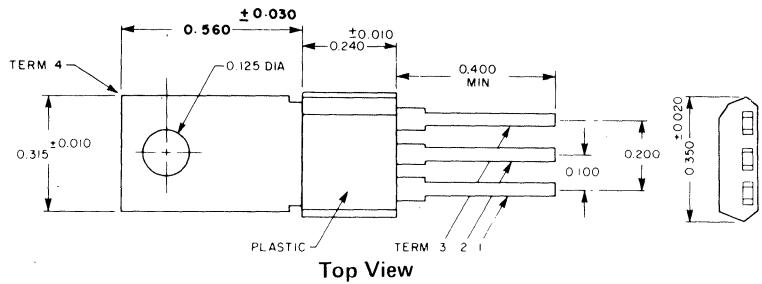
Lead Forms for Plastic Power Packages

TO-220

VERSAWATT (Cont'd)

Lead Form No.	Outline	Lead Form No.	Outline
6263		6265	
6264			

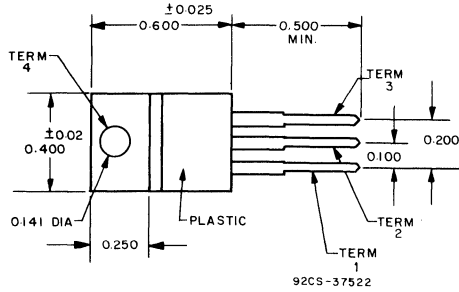
TO-202 VERSATAB



Lead Form No.	Outline	Lead Form No.	Outline
Type 1		Type 12	
Type 3			
Type 11		Type 32	

Surface-Mount Lead Forms

TO-220
 VERSAWATT



Lead Form No.	Outline	Lead Form No.	Outline
DR 6204	<p>92CS-43051</p>	DR 6269	<p>92CS-43052</p>
DR 6259	<p>92CS-43053</p>	DR 6274	<p>92CS-43054</p>
DR 6260	<p>92CS-43055</p>	DR 6280	<p>92CS-43056</p>

Surface-Mounted Devices Mounting and Handling Considerations

General — Since the external epoxy portions of the TO-251AA and TO-252AA 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.

Preheating — Both TO-251AA and TO-252AA "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 — Both TO-251AA and TO-252AA 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 1 and 2 show the relationship between soldering temperature and preheating time for various device mounting procedures.

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.

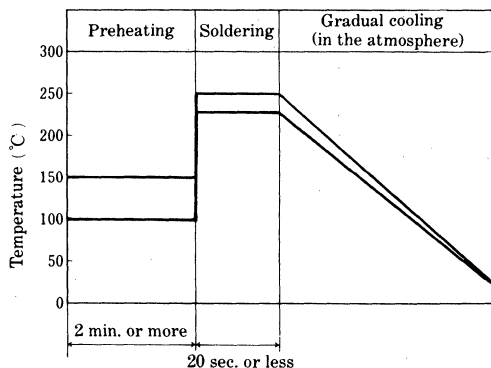


Fig. 1 — Solder dip method.

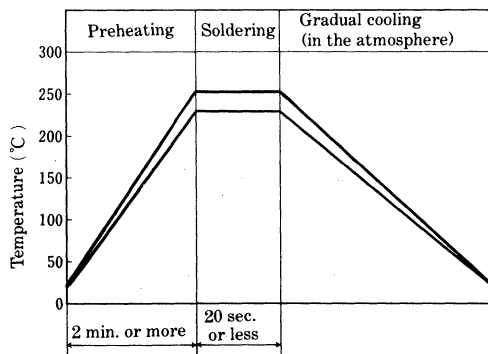


Fig. 2 — Reflow solder method.

Surface-Mounted Devices Power Dissipation Considerations

Maximum power dissipation for the TO-251AA is 1W; however, when the TO-252AA is mounted directly to a ceramic substrate, the power dissipation is increased to

2-3W. Figure 3 illustrates the maximum power dissipation for either the D72F5T1 or the D73F5T1 transistor mounted to a ceramic substrate.

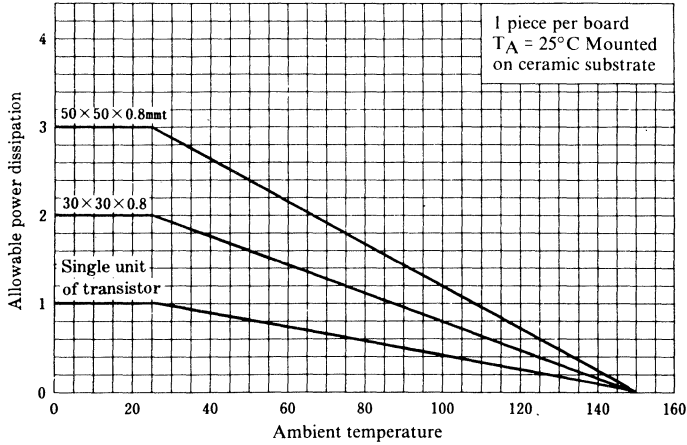


Fig. 3 — $P_{D(max)}$ vs. T_A characteristics of either the D72F5T1 or D73F5T1 transistor mounted on a ceramic substrate.

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 typical TO-251AA devices is shown in figure 4.

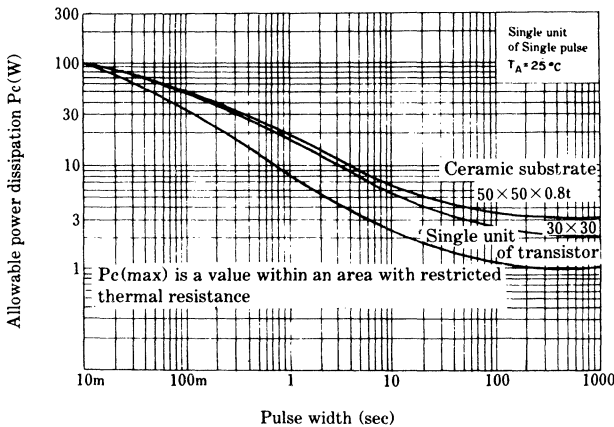


Fig. 4 — P_D vs. T_A characteristics of D72F5T1 and D73F5T1 under transient conditions.

Application Notes

Application Note Abstracts

Power Transistors

AN-4509 8 pages
Compact 5-Volt Power Supplies Using High-Voltage Power Transistors

The use of low-cost, industrial-type, high voltage power transistors and fast-recovery rectifiers to achieve size and weight reductions and efficiency improvements in 5-volt dc power supplies with output currents of 50 amperes or more are discussed. The supplies described, like those used in high-reliability aerospace applications, use switching rather than dissipating regulators to eliminate the need for a 60-Hz power transformer and heat sinks for the transistors. A complete switching-regulator power supply is described in detail.

AN-4573 6 pages
Testing for Forward-Bias Second Breakdown in Power Transistors

The design of a non-destructive forward-bias second-breakdown test facility that determines the forward-bias second-breakdown safe-operating locus for power transistors is described. Detailed schematic diagrams of test circuits that can be used to test devices with collector-current ratings up to 2.5 amperes and sustaining collector-to-emitter voltage [$V_{CEO(sus)}$] ratings up to 300 volts, or with ratings to 5 amperes and 100 volts, are given.

AN-4612 4 pages
Thermal-Cycling Rating System for Silicon Power Transistors

The basic causes of thermal fatigue in silicon power transistors are analyzed, and a rating chart that makes it possible for a circuit designer to avoid such failures during the operating life of his equipment is described. Examples are provided on the use of this chart to determine the transistor operating conditions required to assure a desired thermal-cycling capability and to determine whether the thermal-cycling capability is adequate for the requirements of a given application.

AN-6145 8 pages
A Test Set for Nondestructive Safe-Area Measurements Under High-Voltage, High-Current Conditions

The determination of the safe-operating area of power transistors at high volt/ampere products under pulsed and repetitive-pulsed conditions, nondestructively, is made possible by the test set described in this Note. System philosophy, design, construction, and operation are detailed.

AN-6163 12 pages
Quantitative Measurement of Thermal-Cycling Capability of Silicon Power Transistors

This Note discusses the methods used to test the thermal-cycling capability of power transistors. A brief description of thermal fatigue, application requirements, and rating charts is given. A detailed discussion of the practical design and construction of thermal-cycling racks is also included along with actual test conditions for various power transistor types. Acceleration factors, failure indicators, failure mechanisms, and real-time control of thermal-cycling capability of factory products are discussed. Some information is also given on hermetic versus plastic-package thermal-cycling reliability.

AN-6249 6 pages
Real-Time Controls of Silicon Power-Transistor Reliability

This Note compares the traditional, classical approach to the reliability-assurance testing of power transistors with a newer classification of testing: Real-Time Control, R.T.C. The classical approach is commonly referred to as Group B, and involves a series of mechanical, environmental, and life stress tests. RTC involves a continuous, systematic evaluation and control in "real time" of basic, potential failure mechanisms. It is an important supplement to a total program of reliability assurance.

AN-6281 6 pages
Accurate Measurement of Sustaining Voltage of Power Transistors — A Pulsed-Breakdown Test Set

Several techniques for the measurement of the primary (sustaining) breakdown voltage of power transistors are in common use today. The characteristics and limitations of these test methods frequently make rapid and accurate sustaining-voltage readings on power transistors difficult or impossible. The test set described in this Note fills the need for accurate, laboratory-type, sustaining-voltage measuring equipment, although circuitry used in the test set design may be adapted to high-speed testing equipment as well. A complete parts list and calibration sequence are given.

AN-6320 8 pages
Radiation-Hardness Capability of RCA Silicon Power Transistors

The types of radiation damage that might be experienced by a power device and the tests used to determine the design most effective in preventing these types of damage are described.

AN-6330 12 pages
A Safe-Area Rating System for Power Inverters Handling Capacitive and Inductive Loads

Although transistor power inverters have classically been evaluated with resistive loads, the reliability of practical inverters often depends on inductive and capacitive loads and associated starting transient considerations. This Note describes a safe-area rating system for transistors and relates this system to self-excited single-transformer, self-excited double transformer, and driven inverters operating into resistive, capacitive, and inductive loads under both steady-state and starting conditions.

AN-6423 8 pages
Thirty-Watt (RMS) True Complementary — Symmetry Audio Amplifier Using BDX33 and BDX34 Darlingtons Transistors

Monolithic-silicon Darlington transistors designed for low- and medium-frequency power applications are especially suitable for audio-output applications. This Note describes the design and performance of an audio amplifier that incorporates such devices.

AN-6425 8 pages
Automatic Analyzer for Determining Safe Operating Area of Power Transistors

The safe operating area is one of the most

important ratings of a power transistor, yet only a few methods exist to evaluate it. The method presented in this Note allows description of the safe operating area for both dc and pulse operation without subjecting the transistor to breakdown. Both n-p-n and p-n-p transistors in hermetic or plastic packages can be evaluated, and the complete safe-area curve can be automatically described in a short time.

AN-6605 16 pages
Application of RCA Power Devices in Off-Line High-Frequency Inverter/Converter Circuits

The current trend in power inverter/converter design is to use high-frequency switching techniques and direct operation off the available utility lines (i.e. 110 or 220 volts). The use of higher operating frequencies reduce the magnetic materials required and the size of the filter capacitors. This Note discusses the use of RCA power transistors and SCR's in selected high-frequency inverter/converter applications.

AN-6624 16 pages
Voltage Limitations of Power Transistors

This Note summarizes the primary factors that determine the voltage limitations of power transistors used in common-emitter circuits with typical base-to-emitter circuit terminations. The material presented defines terms and the various operating regions of the transistor as shown in typical volt-ampere characteristics, develops the analytic relations defining operation in each of the regions, and relates each of the operating regions to the physical actions taking place within the transistor structure.

AN-6679 32 pages
Theoretical Relationships in Capacitive Discharge Ignition Systems

There has been both confusion and exaggeration concerning the electrical performance of capacitive discharge, or CD, ignition systems. The theoretical relationships developed in this Note allow the analysis of the fundamentals of this type of ignition system and an evaluation of the maximum performance levels attainable. Three types of systems, the diode clamped system, the free-ringing system (no diode clamp) and the free-ringing single-cycle system are analyzed and compared.

AN-6688 20 pages
A Practical Approach to an Audio-Amplifier Design

This Note discusses general considerations, design requirements, and performance for a 20-watt, hi-fi amplifier.

AN-6741 8 pages
RCA 15-Ampere SwitchMax Power Transistors in a 340-Watt 20kHz Flyback Converter

This Note describes the use of the RCA 2N6676, a 15-ampere SwitchMax power transistor, as a driver pulse-width-modulated fly-back-converter stage, the final power-output stage, in a 20-kHz off-line power converter that provides 340 watts of output power. Adjunct circuitry, such as the driver stage, reverse-bias amplifier, and overvoltage and overcurrent protection circuits, are also discussed.

Application Note Abstracts

Power Transistors

- AN-6743 16 pages
90-Watt, Off-the-Line, Half-Bridge Converter Using Only Two 15-Ampere 'SwitchMax' High-Voltage Power Transistors
 To examine and demonstrate the capabilities of RCA's new series of 'SwitchMax' power transistors in a typical switching application, a 900-watt half-bridge converter was constructed and studied. The circuit switches at a 20-kilohertz rate and with minimal alterations can operate from either 120 or 40 volts. It was built using conventional circuitry but in a non-compact modular format so that it would be easily accessible for instrumentation connections and component or design alteration. The power switches used are the RCA-2N6678 'SwitchMax' 15-ampere V_{CE(sat)} 450-volt (V_{CEX}) high-speed transistors.
- AN-6744 6 pages
Low-Cost High-Power Audio Amplifiers Using the RCA 8638 and RCA 9116 Transistor Families
 This Note discusses the basic considerations and requirements for design of the output stage for class B audio amplifiers using devices selected from the RCA 8638 and RCA9116 families, depending on the output desired. Operation with load impedances other than eight ohms is also discussed for the various power categories.
- AN-6760 12 pages
230-Watt, 40-kHz, Off-Line Forward Converter Using One SwitchMax Transistor
 The increased availability of reliable high-current, high-voltage, fast switches, such as RCA's SwitchMax series devices, and the development of functional pulse-width-modulating integrated circuits have greatly reduced the cost of the off-line medium-power, high-frequency forward converters used in the production of precisely conditioned low-voltage power. This Note describes the possibilities of the forward-converter circuit and demonstrates the performance of the RCA 2N6673 SwitchMax transistor in a 230-watt 15-volt 15-ampere off-line converter operating at 40 kHz from a 120-volt 60-cycle line.
- AN-6800 6 pages
Test Set for Measuring h_{fe} and f_T as a Function of Collector Current
 This Application Note describes a technique and test circuit, the Swept- I_C Test Set, that measures the f_T characteristic of a power transistor at a fixed test frequency while the collector current, I_C , is "swept," varied, repetitively, at a linear rate, from zero to a predetermined maximum.
- AN-6819 8 pages
The SwitchMax Transistor
 The SwitchMax transistor families, designed for high-frequency off-line switching power supplies, converters, switching regulators and pulse-width-modulated amplifiers, are rated for 5, 10, 15, and 25-ampere operating currents. They have high safe-operating-area (SOA) ratings in both the forward-bias and inductive turn-off (clamped $E_{S(b)}$) modes. These capabilities are combined with V_{CE0} ratings of up to 400 volts, and V_{CEV} ratings to 1000 volts.

- AN-6820 8 pages
Typical Switching Speed Versus Temperature Data for SwitchMax Transistors Under Non-JEDEC Conditions

Since the introduction of the SwitchMax power-transistor line in 1978, a great amount of study of device behavior in special situations has resulted in the accumulation of a large volume of switching-speed data on hundreds of devices. This Note distills the data into a qualitative picture of SwitchMax-device performance at other than JEDEC-registered switching-test conditions.

- AN-6827 4 pages
40-Watt Automotive Audio-Power Booster

In recent years, there has been a growing demand for higher power-output capability in automotive tape and audio systems. One of the factors limiting output capability is the 12-volt automotive-system voltage. This Note describes the combination of a dc-to-dc regulated up-converter and a simple and economical output amplifier that will deliver 40 watts into a 4-ohm load.

- AN-6828 4 pages
In-Socket, High-Temperature, Dynamic Testing of Power Transistors

The measurement, at elevated temperatures, of dynamic parameters such as switching time, is a problem in in-chamber facilities because of the critical nature of lead length and dress. A solution to this problem, the approach described in this Note, involves the location of a source of heat at the socket of the device under test. This "hot-socket" method, in which controlled amounts of power are supplied to the socket heaters, is adaptable to curve-tracer measurements where IR drops are critical at high current. Kelvin connections are used at the collector and emitter terminals, mandating a five-terminal socket.

- AN-6857 4 pages
20-Ampere Monolithic-Darlington Power Transistors in a Sine-Wave-Inverter Output Stage

This Note describes the use of the type 2N6284 power transistor, a 20-ampere, p-n-p, monolithic darlington, and its complement, the type 2N6287 (p-n-p), as low-cost high-output-power single-ended power inverters. Either transistor can be used with equivalent performance results; the choice of type is dependent only upon the polarity of the dc voltage supply available.

- AN-6866 6 pages
Practical Aspects of Voltage-Breakdown Testing of Power Transistors and Darlington

In specifying voltage-breakdown requirements for power transistors and power darlington, a customer will choose a limit which he feels will protect his application. However, during the testing of the product to verify this limit, either the manufacturer or the customer may damage the device. This Note reviews the common methods of measurement of avalanche breakdown voltage. It points out why damage occurs to power transistors as a result of these measurements and suggests methods that may reduce the incidence of damage. The Note also points

out that avalanche breakdown testing is performed at voltages beyond the maximum ratings of the device and that such testing should only be undertaken after all necessary precautions have been taken, and with a complete understanding of the risks.

- AN-6896 8 pages
Safe Operating Area and the Design of Reliable Audio Power Amplifiers

The reliability of an audio power amplifier can depend on the designer's understanding of the Safe Operating Area, SOA, of the transistors employed, and his freedom to implement safeguards against the failure of those devices. The designer can overcome the limits placed by economics and other factors on this freedom, while assuring optimum reliability and performance from his designs, by working within the constraints imposed by the SOA ratings. This Note discusses the use of these ratings through example, and the protection circuits required in a proper design.

- AN-6904 12 pages
One-Hundred-Watt True-Complementary-Symmetry Audio Amplifier Using BD750 and BD751 Silicon Transistors

The BD750 and BD751 series of power transistors are complementary p-n-p and n-p-n series, respectively, selected from the ballasted epitaxial-base silicon transistor families, RCA8638 and RCA9116. They feature high-dissipation capability, low saturation voltage, maximum safe-operating area, a gain-bandwidth product (f_T) higher than 4 MHz, and high gain at high current levels. The transistors are especially suitable for use in the output stage of true-complementary high power audio amplifiers.

Power Hybrid Circuits

- AN-4483 6 pages
General Application Considerations for the RCA-HC2000H Hybrid Linear Power Amplifier

This Note briefly describes the RCA HC-2000H hybrid linear amplifier and discusses such operating considerations as dc and ac power dissipation, efficiency as a function of frequency, protection against excessive load variations and reactive loads, and heat-sink requirements.

- AN-4782 6 pages
General Application Considerations for the RCA-HC2000H Power Hybrid Operational Amplifier

The RCA-HC2000H is a power hybrid operational amplifier that can deliver 100 watts rms to a 4-ohm load at a maximum peak current of 7 amperes. It operates from a maximum power-supply voltage of 75 volts (single ended) or ± 37.5 volts (split). The low-profile package is light in weight and can be used with either printed-circuit-board connections or commercially available 0.110-inch quick-disconnect push-on terminals. This Note briefly describes the HC2000H and discusses some general application considerations for this amplifier.



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