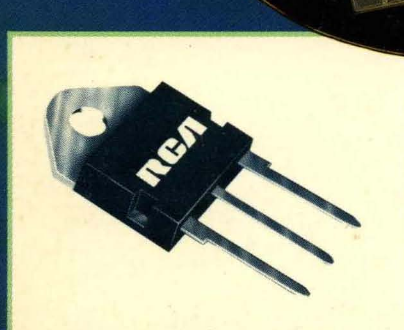
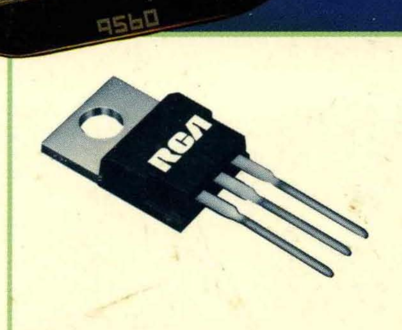
RCA Solid State

DATABOOK

Bipolar Power Devices

- Power Transistors
- Surge Suppression
- High Speed Rectifiers
- SCRs
- Triacs





RCA Solid State
Bipolar Power Devices

SSD-220D

RCA Bipolar Power Devices

Table of Contents

This DATABOOK contains detailed technical information on the full line of more than 750 RCA bipolar power devices consisting of: power transistors, SURGECTORs, ultra-fast-recovery rectifiers, power hybrid circuits, SCRs, and triacs. A complete index of these types is included on the following pages.

Eleven separate data sections provide definitive ratings and characteristics for each major product category of devices. Within each section, data pages for individual devices are included, as nearly as possible, in numerical-alphanumerical sequence. Because some devices are grouped together to show similarity of function or data, some individual type numbers may be out of sequence. If you don't find the type number that you are looking for where you expect it to be, check the Index to Devices.

The DATABOOK also contains general information on high-reliability power devices, package information covering dimensional outlines, mounting hardware, and lead forms for plastic packages, abstracts of RCA application notes, and listings of RCA sales offices, authorized distributors, and manufacturers' representatives.

RCA Solid State | Somerville, NJ • Brussels • Paris • London
Hamburg • Mexico City • Hong Kong

Information furnished by RCA is believed to be accurate and reliable. However, no responsibility is assumed by RCA for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of RCA.

When incorporating RCA Solid State Devices in equipment, it is recommended that the designer refer to "Operating Considerations for RCA Solid State Devices," Form No. 1CE-402, available on request from RCA Solid State Division, Box 3200, Somerville, NJ 08876.

Printed in USA/7-86

Index to Devices

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier
SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

Index to Devices

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier
SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

Index to Devices

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier
SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

Index to Devices

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier
SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

Index to Devices

Type No.	Page No.	Type of Device	Bulletin File No.
MJH16012	74	PWT	1839
RCA1B04	478	PWT	908
RCA1B05	478	PWT	908
RCA1000	310	PWT	594
RCA1001	310	PWT	594
RCA3054	480	PWT	618
RCA3055	480	PWT	618
RCA3773	485	PWT	1060
RCA6340	214	PWT	1205
RCA6341	214	PWT	1205
RCA8638C	485	PWT	1060
RCA8638D	485	PWT	1060
RCA8638E	485	PWT	1060
RCA8766	313	PWT	973
RCA8766A	313	PWT	973
RCA8766B	313	PWT	973
RCA8766C	313	PWT	973
RCA8766D	313	PWT	973
RCA8766E	313	PWT	973
RCA9116C	460	PWT	1061
RCA9116D	460	PWT	1061
RCA9116E	460	PWT	1061
RCA9166A	490	PWT	1293
RCA9166B	490	PWT	1293
RCA9202A	317	PWT	1414
RCA9202B	317	PWT	1414
RCA9202C	317	PWT	1414
RCA9203A	321	PWT	1413
RCA9203B	321	PWT	1413
RCA9228A	325	PWT	1448
RCA9228B	325	PWT	1448
RCA9228C	325	PWT	1448
RCA9228D	325	PWT	1448
RCA9229A	325	PWT	1448
RCA9229B	325	PWT	1448
RCA9229C	325	PWT	1448
RCA9229D	325	PWT	1448
RJH6674	20	PWT	1164
RJH6675	20	PWT	1164
RJH6676	26	PWT	1165
RJH6677	26	PWT	1165
RJH6678	26	PWT	1165
RUR-810	650	UFR	1355
RUR-815	650	UFR	1355
RUR-820	650	UFR	1355
RUR-D810	652	UFR	1356
RUR-D815	652	UFR	1356
RUR-D820	652	UFR	1356
RUR-D1610	654	UFR	1383
RUR-D1615	654	UFR	1383
RUR-D1620	654	UFR	1383
S2060A	719	SCR	654
S2060B	719	SCR	654
S2060C	719	SCR	654
S2060D	719	SCR	654
S2060E	719	SCR	654
S2060F	719	SCR	654
S2060M	719	SCR	654
S2060Q	719	SCR	654
S2060Y	719	SCR	654

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier

Type No.	Page No.	Type of Device	Bulletin File No.
S2061A	719	SCR	654
S2061B	719	SCR	654
S2061C	719	SCR	654
S2061D	719	SCR	654
S2061E	719	SCR	654
S2061F	719	SCR	654
S2061M	719	SCR	654
S2061Q	719	SCR	654
S2061Y	719	SCR	654
S2600B	724	SCR	1693
S2600D	724	SCR	1693
S2600M	724	SCR	1693
S2600N	724	SCR	1693
S2700D	727	SCR	1627
S2700M	727	SCR	1627
S2700N	727	SCR	1627
S2800A	730	SCR	890
S2800B	730	SCR	890
S2800C	730	SCR	890
S2800D	730	SCR	890
S2800E	730	SCR	890
S2800F	730	SCR	890
S2800M	730	SCR	890
S2800N	730	SCR	890
S2800S	730	SCR	890
S3700B	734	SCR	306
S3700D	734	SCR	306
S3700M	734	SCR	306
S4060A	737	SCR	1306
S4060B	737	SCR	1306
S4060C	737	SCR	1306
S4060D	737	SCR	1306
S4060E	737	SCR	1306
S4060F	737	SCR	1306
S4060M	737	SCR	1306
S4060N	737	SCR	1306
S4060S	737	SCR	1306
S4060U	737	SCR	1306
S5800B	741	SCR	1051
S5800C	741	SCR	1051
S5800D	741	SCR	1051
S5800E	741	SCR	1051
S5800M	741	SCR	1051
S5800N	741	SCR	1051
S5800S	741	SCR	1051
S6000D	745	SCR	1628
S6000M	745	SCR	1628
S6000N	745	SCR	1628
S6420A	694	SCR	578
S6420B	694	SCR	578
S6420D	694	SCR	578
S6420M	694	SCR	578
S6493M	748	SCR	247
S7410M	678	SCR	408
S7412M	684	SCR	724
SC141B	792	TRI	1167
SC141D	792	TRI	1167
SC141E	792	TRI	1167
SC141M	792	TRI	1167
SC141N	792	TRI	1167

SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

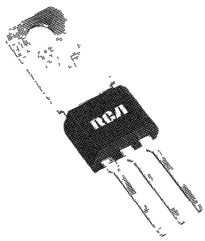
Index to Devices

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier

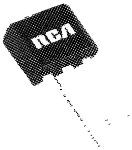
SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

PHC = Power Hybrid Circuit
PWT = Power Transistor
SCR = Silicon Controlled Rectifier
SUR = SURGECTOR
TRI = Triac
UFR = Ultra-Fast-Recovery Rectifier

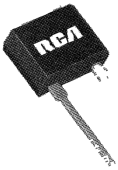
Package Designations



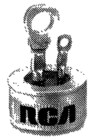
VERSATAB
JEDEC TO-202AB



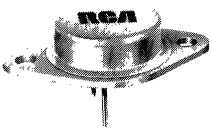
MODIFIED TO-202



MODIFIED TO-202

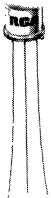


PRESS-FIT
JEDEC TO-203AA



JEDEC TO-204AA/TO-3

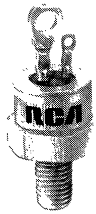
(0.060-In. Dia. Pins)
JEDEC TO-204AE/TO-3



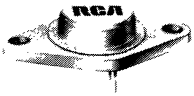
JEDEC TO-205AA/TO-5

JEDEC TO-205AD/TO-39

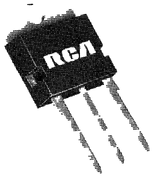
Low-Profile
JEDEC TO-205AF/TO-5



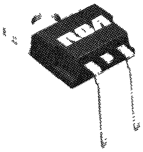
JEDEC TO-208AA/TO-48



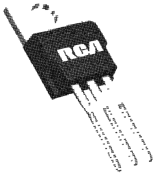
JEDEC TO-213AA/TO-66



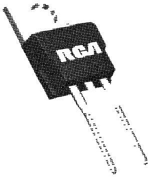
JEDEC TO-218AC



VERSAWATT
JEDEC TO-220AA



VERSAWATT
JEDEC TO-220AB



VERSAWATT
JEDEC TO-220AC

ISOLATED STUD

SwitchMax Power Transistors

Technical Data

Multiple Epitaxial, Double-Diffused Structure

SwitchMax transistors use a multiple epitaxial layer collector to achieve the necessary voltage field gradient control essential to good switching safe-operating area (SOA) without compromising either the switching speeds or saturation voltage V_{CE}(sat).

Two graded n-type layers, epitaxially grown on a heavily doped n+ substrate, provide the voltage capability for the switching SOA (clamped Es/b) requirement. A third n-type layer, carefully controlled to give the required breakdown-voltage ($V_{(BR)CBO}$) capability, is then grown over the second layer, completing the collector structure.

Ion implantation of the p- base dopant achieves the necessary precise control of resistivity and depth of the base layer diffusion. The fine geometry emitter is then deposited and diffused into the structure.

Optimized emitter geometries, wide base, controlled lifetimes, and graded multiple n- collector layers all enhance the ruggedness of SwitchMax transistors.

Clamped Reverse-Bias Safe Operating Area (Clamped Es/b)

Considerations of switching efficiency and power economy generally dictate that the normal operating load line of an inverter switch be resistive or capacitive. However, extremes of operation such as start up surges, overloads, short circuits, step load changes, can easily drive the load line inductive.

For this reason, clamped Es/b or inductive-load turn-off SOA is an important design parameter for a high voltage switch. In the RCA SwitchMax families, concern for this parameter was the main driving force for the multiple epitaxial collector design.

Forward-Bias Safe Operating Area

Forward-bias second breakdown ($I_{S/b}$) is an important limit parameter for all linear transistor applications. In switching applications it can become important whenever a significant excursion of the load line into the active area occurs. An example of such an excursion is the turn-on transients produced in the start up of some inverters with uncharged filter capacitors.

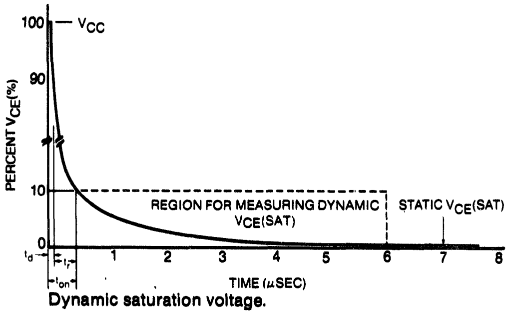
SwitchMax transistors have excellent $I_{S/b}$ capability due to the structural techniques already mentioned, particularly the sophisticated geometry permitted by the metal system and the wide base widths allowed by the ion implantation and controlled lifetime processes.

Dynamic Saturation Voltage

RCA SwitchMax power transistors offer lower dynamic saturation characteristics than other presently available high-speed transistors. The dynamic saturation voltage is the collector emitter voltage measured during the time interval between 10% of the supply voltage and the steady-state saturation voltage.

This measure of the instantaneous voltage provides a useful method to determine how rapidly the collector approaches V_{CE}(sat) after the transistor has reached it's classical turn-on time, which is the 10% V_{CE} point.

For power supplies operated at high collector supply voltages, a high dynamic saturation voltage can cause appreciable device dissipation. Thus, the improved performance capability exhibited by SwitchMax-series transistors permits greater operating efficiency over power supplies built with other high-speed transistors.



Dynamic saturation voltage.

Transistor Classification Chart

I_C(sat)		1A	5A	5A	6A	8A	10A	15A	25A
V_{CEV}	260 V	—	—	—	—	—	—	—	2N6686
	280 V	—	—	—	—	—	—	—	2N6687
	300 V	—	—	—	—	—	—	—	2N6688*
	450 V	2N6771Δ — —	2N6671■ 2N6738Δ BUW41Δ	— — —	— — —	— — —	2N6674■ RJH6674 —	2N6676■ RJH6676 —	— — —
	550 V	2N6772Δ — —	2N6672 2N6739Δ BUW41AΔ	— — —	— — —	— — —	— — —	2N6677 RJH6677 —	— — —
	650 V	2N6773Δ — —	2N6673■ 2N6740Δ BUW41BΔ	— — —	— — —	— — —	2N6675■ RJH6675 —	2N6678■ RJH6678 —	— — —
	800 V	— — —	— — —	2N6751 — —	BUX32 — —	BUX33 — —	— — —	— — —	— — —
	850 V	—	—	2N6752	—	—	—	—	—
	900 V	— — —	— — —	2N6753 — —	BUX32A — —	BUX33A — —	— — —	— — —	— — —
	1000 V	— — —	— — —	2N6754 — —	BUX32B — —	BUX33B — —	— — —	— — —	— — —
Characteristics	**Temp., T_C**				**Limits**				
I_{CEV} (max) at $V_{CE}=V_{CEV}$	25°C 100°C 125°C	0.1 mA — 1 mA	0.1 mA — 1 mA	0.1 mA 1 mA —	0.1 mA 1 mA —	0.1 mA 1 mA —	0.1 mA 2 mA —	0.1 mA 1 mA —	0.05 mA — 0.5 mA
V_{CE}(sat)(max) at I_C (sat)	25°C 100°C 125°C	1 V — 2 V	1 V — 2 V	1 V 1.5 V —	1 V 1.5 V —	1 V 1.5 V —	1 V 2 V —	1 V 2 V —	1.5 V — 1.5 V
t_r (max) at I_C (sat)	25°C 100°C 125°C	0.2 µs — 0.5 µs	0.5 µs — 0.8 µs	0.45 µs 0.6 µs —	0.45 µs 0.6 µs —	0.45 µs 0.6 µs —	0.6 µs 1 µs —	0.6 µs 1 µs —	0.6 µs — 0.8 µs
t_s (max) at I_C (sat)	25°C 100°C 125°C	2.5 µs — 4.5 µs	2.5 µs — 4 µs	3 µs 4 µs —	3 µs 4 µs —	3 µs 4 µs —	2.5 µs 4 µs —	2.5 µs 4 µs —	1.5 µs — 2.5 µs
t_f (max) at I_C (sat)	25°C 100°C 125°C	0.4 µs — 1.3 µs	0.4 µs — 0.8 µs	0.4 µs 0.7 µs —	0.4 µs 0.7 µs —	0.4 µs 0.7 µs —	0.5 µs 1 µs —	0.5 µs 1 µs —	0.25 µs — 0.8 µs
t_c (max) at I_C (sat)	25°C 100°C 125°C	0.4 µs — 1.3 µs	0.4 µs — 0.8 µs	0.4 µs 0.8 µs —	0.4 µs 0.8 µs —	0.4 µs 0.8 µs —	0.5 µs 0.8 µs —	0.5 µs 0.8 µs —	0.5 µs — 0.8 µs

All SwitchMax transistors are supplied in JEDEC TO-204AA/TO-3 packages, except as noted below:

ΔSupplied in JEDEC TO-220AB plastic package.

■MIL Approved:

MIL-S-19500/536 — 2N6671, 2N6673
MIL-S-19500/537 — 2N6674, 2N6675
MIL-S-19500/538 — 2N6676, 2N6678

*I_C (sat) = 20 A.

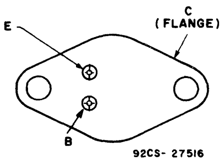
2N6671, 2N6672, 2N6673

File Number **1090**

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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 = 5 A*
- *Steel hermetic TO-204AA package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

The RCA-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 RCA-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}				
$V_{BE} = -1.5$ 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
$I_C(sat)$		5		A
* I_C		8		A
I_{CM}		10		A
* I_B		4		A
* P_T				
T_C up to 25°C		150		W
T_C above 25°C, derate linearly		0.86		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ⩾ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

* In accordance with JEDEC registration data.

ELECTRICAL CHARACTERISTICS

	CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6671 Min.	Max.	2N6672 Min.	Max.	2N6673 Min.	Max.	UNITS
	$T_C = 25^oC$											
*	I_{CEV}	450 550 650	−1.5 −1.5 −1.5			– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	mA
*	I_{EBO}		−8	0		–	2	–	2	–	2	mA
*	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] 8[a]	1 4	– –	1 2	– –	1 2	– –	1 2	V
*	V_{CEX}[b] (Clamped $E_{S/b}$) L=170 µH, R_{BB}=5 Ω		−5 −5	5 8	1[e] 3[e]	350 200	– –	400 250	– –	450 300	– –	V
*	$I_{S/b}$	25		6		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	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	µs
*	t_s[d]			5	1[e]	–	2.5	–	2.5	–	2.5	µs
*	t_f[d]			5	1[e]	–	0.4	–	0.4	–	0.4	µs
*	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	µs
	$T_C = 125^oC$											
*	I_{CEV}	450 550 650	−1.5 −1.5 −1.5			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
*	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	µs
*	t_f[d]			5	1[e]	–	0.8	–	0.8	–	0.8	µs
*	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	µs
*	$R_{\theta JC}$					–	1.17	–	1.17	–	1.17	°C/W

* In accordance with JEDEC registration data.
[a] Pulsed: pulse 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] V_{CB} value.
[d] V_{CC} = 125 V, t_p = 20 µs.
[e] $I_{B_1} = -I_{B_2}$.

2N6671, 2N6672, 2N6673

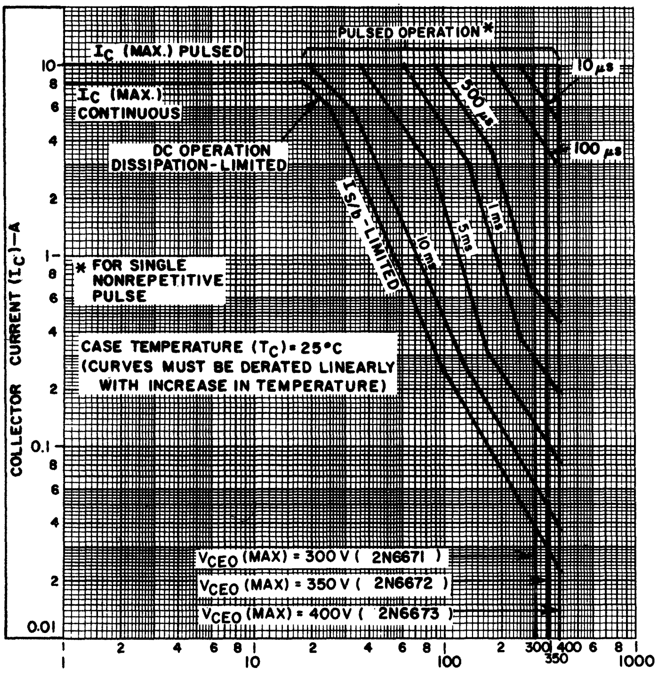


Fig. 1 — Maximum operating areas for all types (Tc = 25° C).

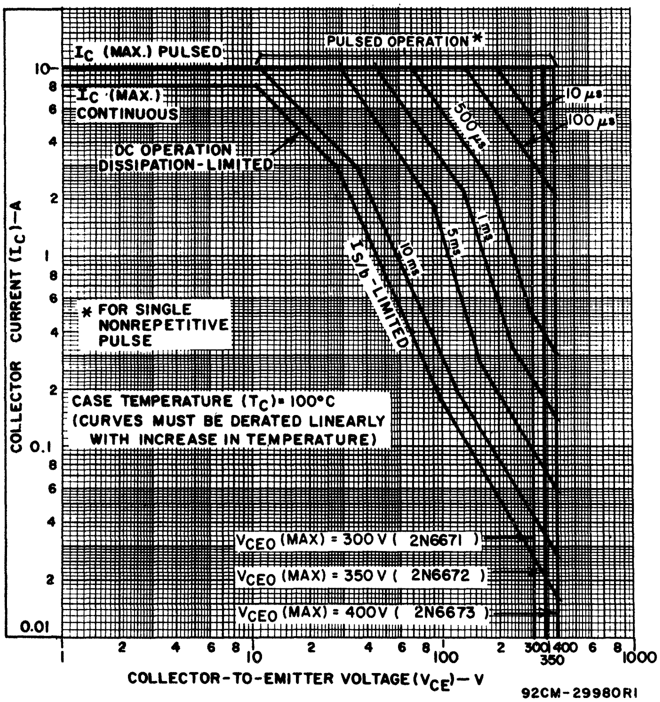


Fig. 2 — Maximum operating areas for all types (Tc =100° C).

2N6671, 2N6672, 2N6673

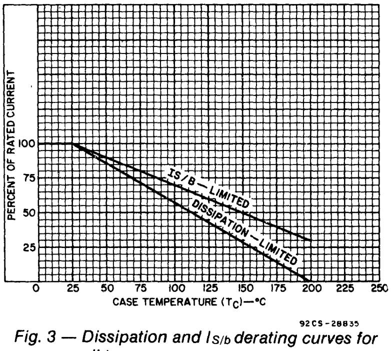


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

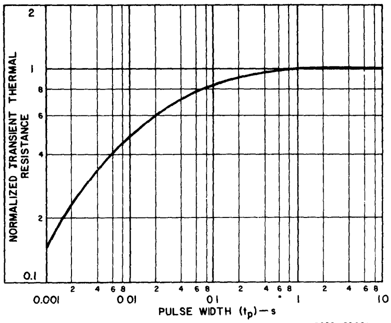


Fig. 4 — Typical thermal-response characteristic for all types.

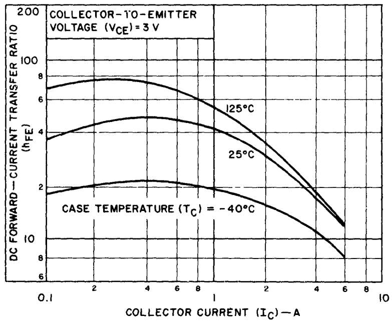


Fig. 5 — Typical dc beta characteristics for all types.

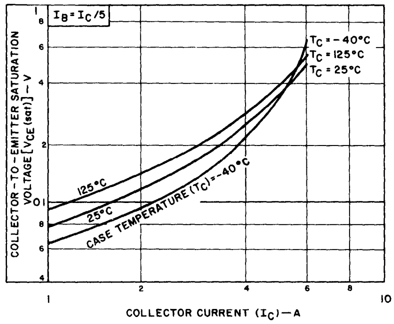


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

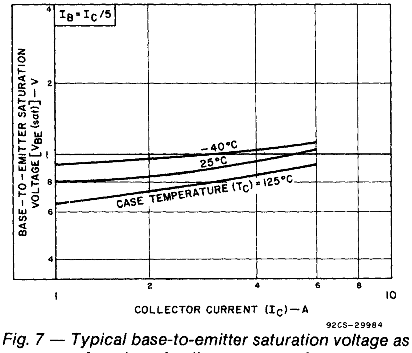


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

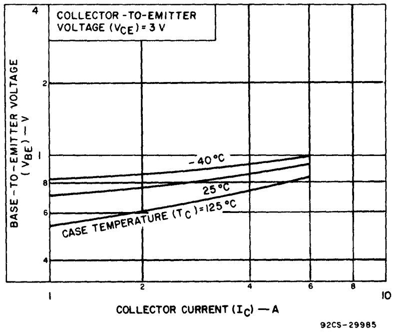


Fig. 8 — Typical base-to-emitter voltage as a function of collector current for all types.

2N6671, 2N6672, 2N6673

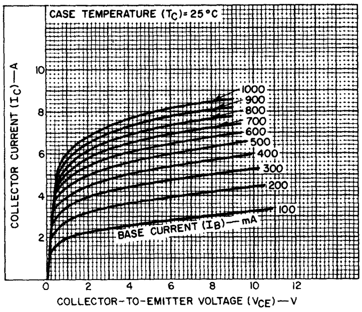


Fig. 9 — Typical output characteristics for all types.

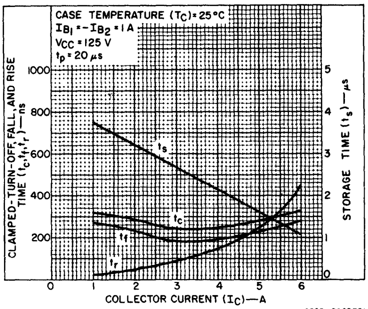


Fig. 10 — Typical saturated switching time characteristics for all types.

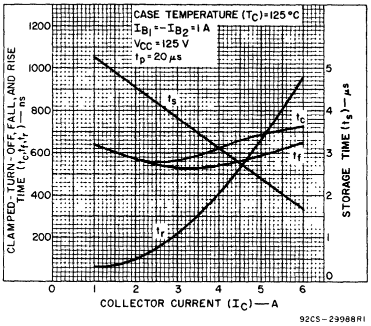


Fig. 11 — Typical saturated switching time characteristics for all types.

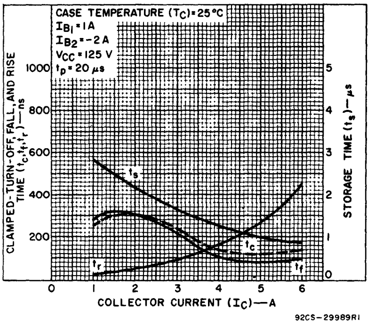


Fig. 12 — Typical saturated switching time characteristics for all types.

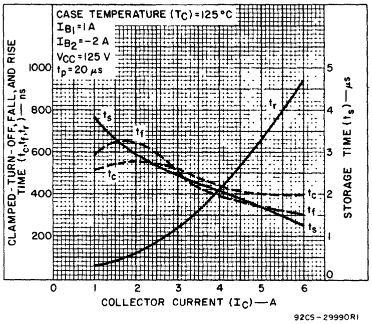


Fig. 13 — Typical saturated switching time characteristics for all types.

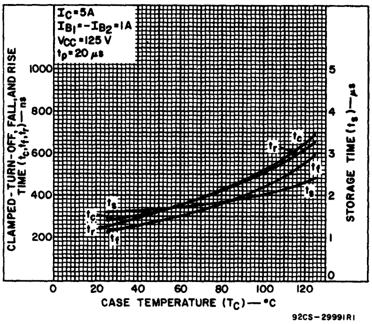


Fig. 14 — Typical saturated switching time characteristics as a function of

2N6671, 2N6672, 2N6673

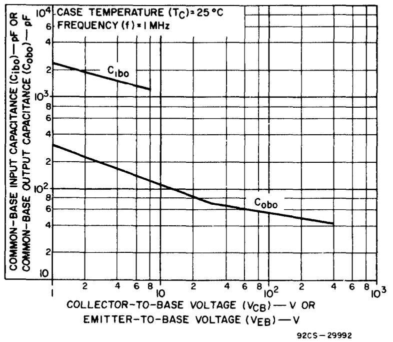


Fig. 15 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

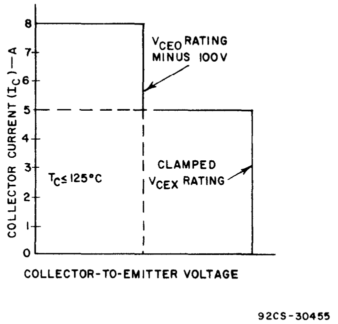


Fig. 16 — Maximum operating conditions for switching between saturation and cutoff.

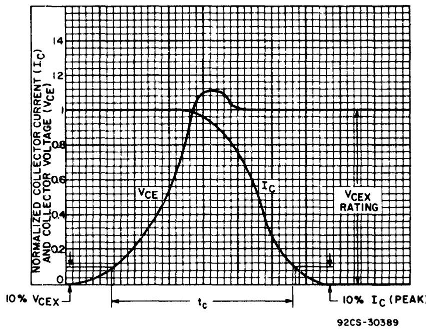


Fig. 17 — Oscilloscope display for measurement of clamped induction switching time (t_c).

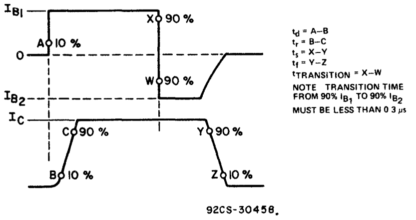


Fig. 18 — Phase relationship between input and output currents showing reference points for specification of switching times.

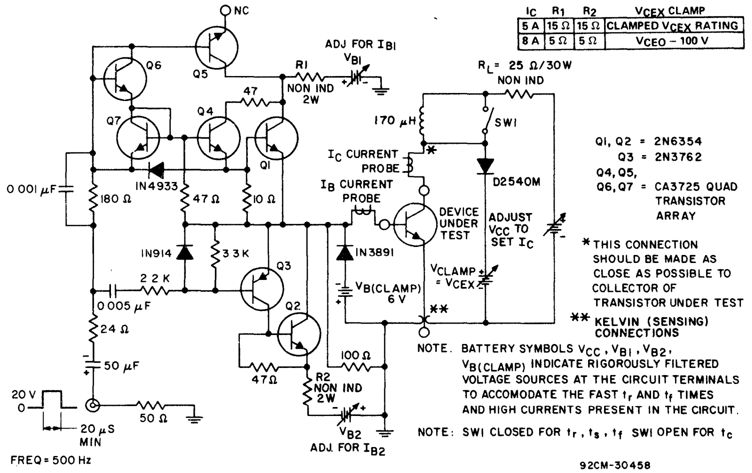


Fig. 19 — Circuit for measuring switching times.

2N6674, 2N6675, RJH6674, RJH6675

File Number **1164**

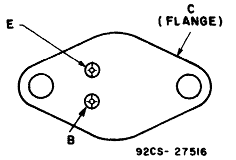
10-A SwitchMax Power Transistors

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*

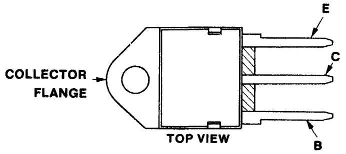
Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



2N6674
2N6675

JEDEC TO-204AA



RJH6674
RJH6675

JEDEC TO-218AC

92CS-40257

The RCA 2N6674, 2N6675, RJH6674, and RJH6675 Switch-Max 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: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N6674 RJH6674		2N6675 RJH6675		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
T_C=25° C									
* I_{CEV}	450	-1.5			—	0.1	—	—	mA
	650	-1.5			—	—	—	0.1	
* I_{EBO}		-7	0		—	2	—	2	
* V_{CEO}(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]	2	—	1	—	1	
			15[a]	5	—	5	—	5	
V_{CEX}[b] (Clamped $E_{S/b}$) L=50 μH, R_{BB}=2 Ω		-4	10	2	350	—	450	—	
$I_{S/b}$	30		5.9		1	—	1	—	s
	100		0.25		1	—	1	—	
* $\|h_{fe}\|$ f=5 MHz	10		1		3	10	3	10	
f_T	10		1		15	50	15	50	MHz
* C_{obo} 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, $R_C \leq$ 13.5 Ω, Collector clamped to V_{CEX}		-6	10	2[e]	—	0.5	—	0.5	
T_C=100° C									
* I_{CEV}	450	-1.5			—	1	—	—	mA
	650	-1.5			—	—	—	1	
* V_{CE}(sat)			10[a]	2	—	2	—	2	V
* t_r[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, $R_C \leq$ 13.5 Ω, Collector clamped to V_{CEX}		-6	10	2[e]	—	0.8	—	0.8	
* $R\theta_{JC}$ 2N6674, 2N6675	10		5		—	1	—	1	°C/W
$R\theta_{JC}$ RJH6674, RJH6675	10		5		—	0.71	—	0.71	°C/W

[a]Pulsed: pulse 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.
*In accordance with JEDEC registration data (2N6674, 2N6675 only).
[c]V_{CB} value.
[d]V_{CC}=135 V, t_p=20 μs.
[e]I_{B1}=$-I_{B2}$.

2N6674, 2N6675, RJH6674, RJH6675

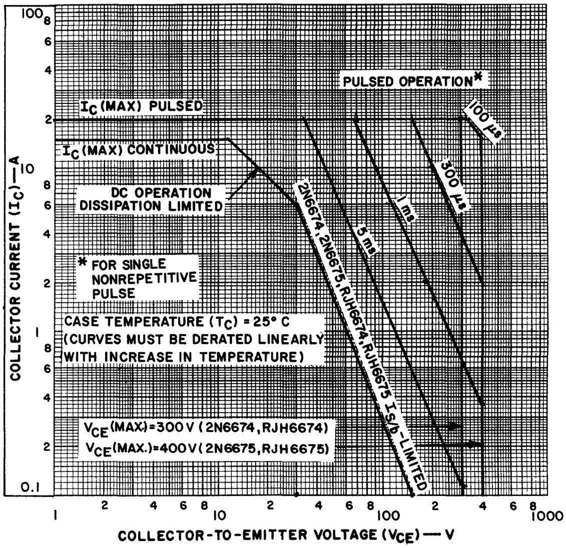


Fig. 1 - Maximum operating areas for all types (T_C=25° C).

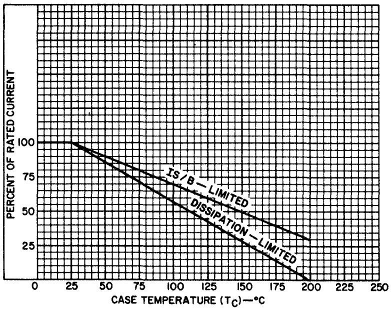


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for 2N6674 and 2N6675.

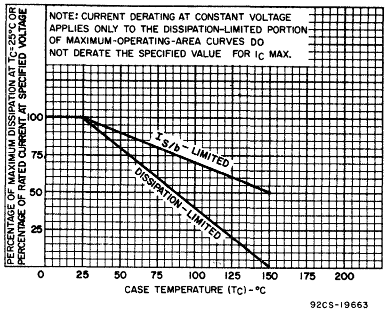


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for RJH6674 and RJH6675.

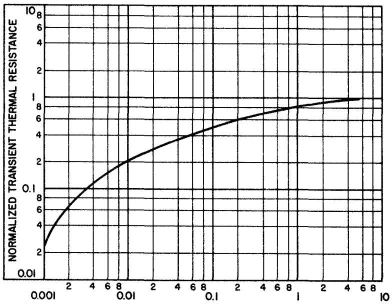


Fig. 4 - Typical thermal-response characteristic for all types.

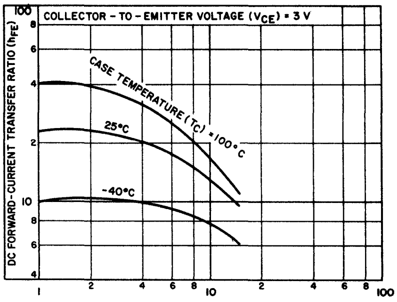
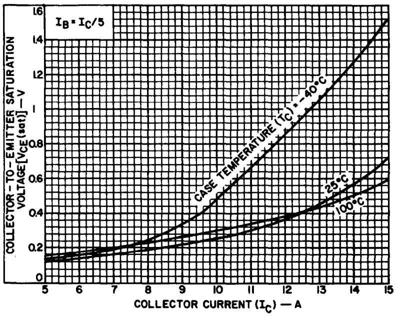


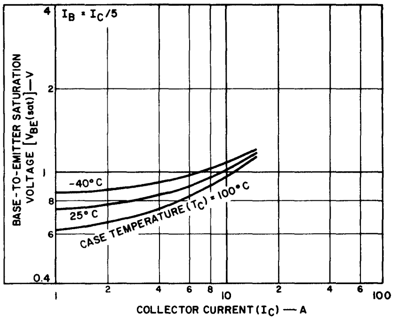
Fig. 5 - Typical dc beta characteristics for all types.

2N6674, 2N6675, RJH6674, RJH6675



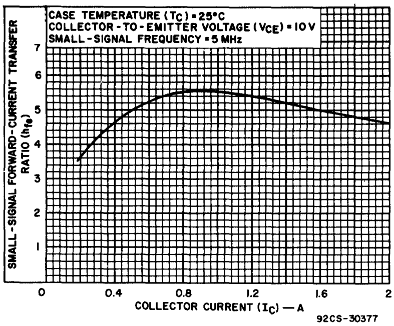
92CS-30386

Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.



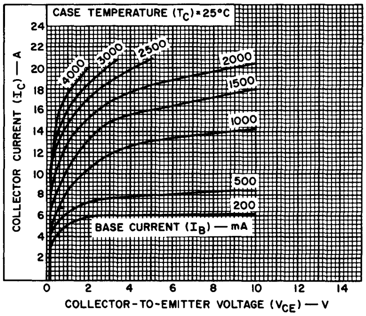
92CS-30376

Fig. 7 - Typical base-to-emitter saturation voltage characteristics for all types.



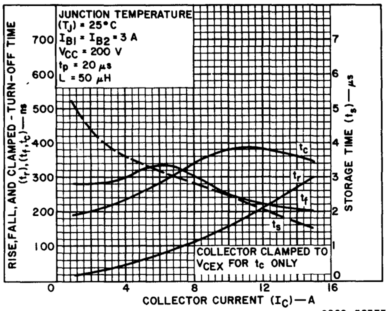
92CS-30377

Fig. 8 - Typical small-signal forward current transfer ratio characteristic for all types (f=5 MHz).



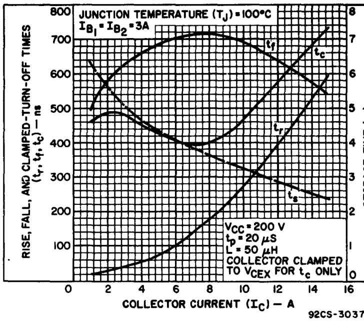
92CS-30374

Fig. 9 - Typical output characteristics for all types.



92CS-30373

Fig. 10 - Typical saturated-switching-time characteristics at T_J=25°C as a function of collector current for all types.



92CS-30379

Fig. 11 - Typical saturated-switching-time characteristics at T_J=100°C as a function of collector current for all types.

2N6674, 2N6675, RJH6674, RJH6675

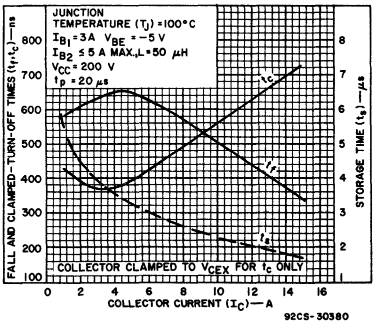


Fig. 12 - Typical saturated-switching-time characteristics at T_J=100° C as a function of collector current for all types.

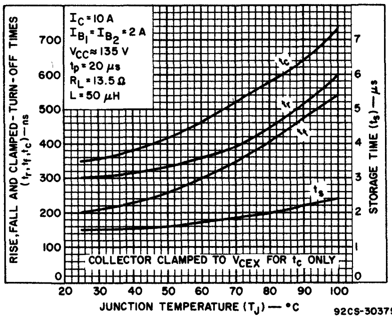


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

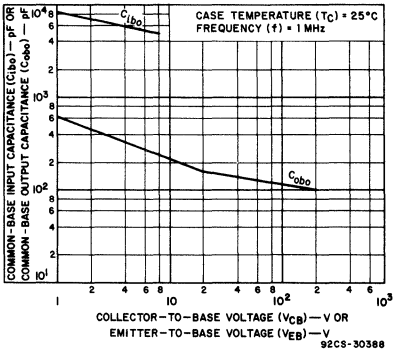


Fig. 14 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

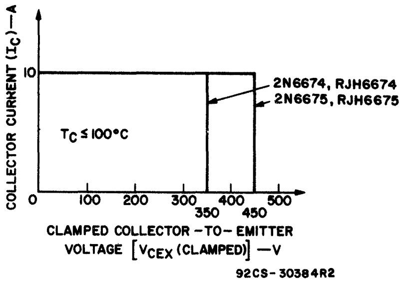


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

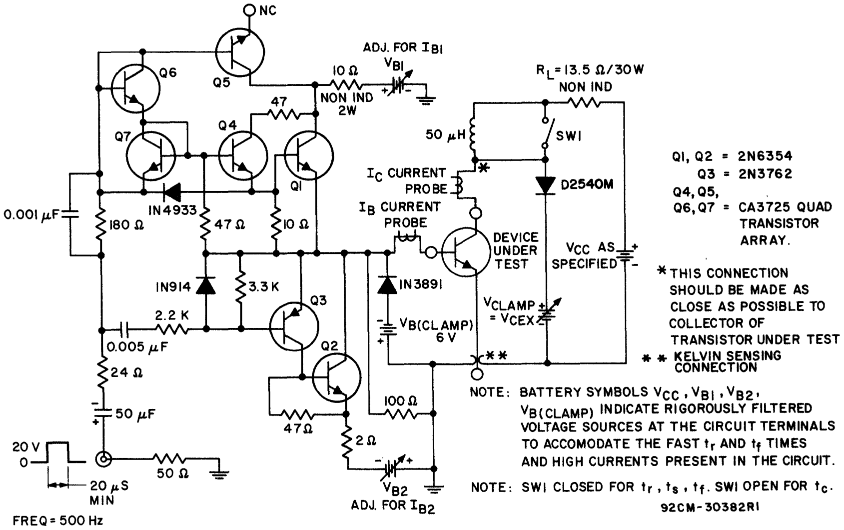


Fig. 16 - Circuit for measuring switching times.

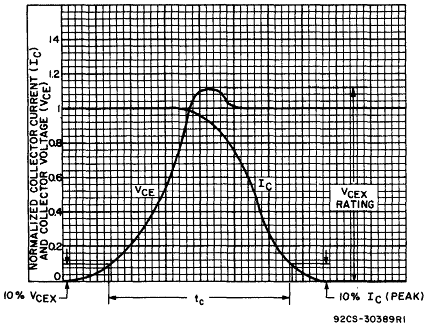


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

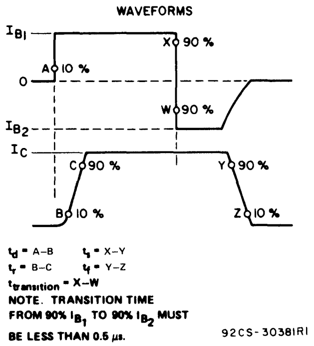


Fig. 18 - Phase relationship between input and output currents showing reference points for specification of switching times.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

File Number **1165**

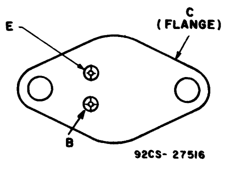
15-A SwitchMax Power Transistors

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 V to 450 V*
- *Low $V_{CE}(sat)$ at I_C = 15 A*

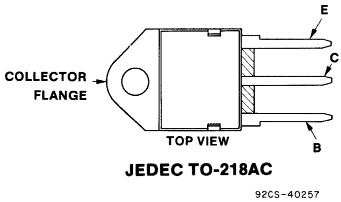
Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2N6676
2N6677
2N6678



JEDEC TO-218AC

92CS-40257

RJH6676
RJH6677
RJH6678

The RCA 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.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RJH6676	RJH6677	RJH6678	2N6676	2N6677	2N6678	
* V_{CEV}							
V_{BE} = -1.5 V	450	550	650	450	550	650	V
* V_{CEX} (Clamped)							
V_{BE} = -1.5 V	350	400	450	350	400	450	V
* V_{CEO}	300	350	400	300	350	400	V
* V_{EBO}	8						V
I_C(sat)	15						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 ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.				235			°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 (2N6676, 2N6677, 2N6678 only).

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6676 RJH6676		2N6677 RJH6677		2N6678 RJH6678		
	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_{EBO}		-8	0		—	2	—	2	—	2	
* V_{CEO}(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	V
* V_{CE}(sat)			15[a]	3	—	1	—	1	—	1	
			15[a]	3	—	1.5	—	1.5	—	1.5	
V_{CEX}[b] (Clamped $E_{S/b}$) L=50 μH, R_{BB}=2 Ω		-6	15	3	350	—	400	—	450	—	
$I_{S/b}$	30		5.9		1	—	1	—	1	—	s
	100		0.25		1	—	1	—	1	—	
* $\|h_{fe}\|$ f=5 MHz	10		1		3	10	3	10	3	10	
f_T	10		1		15	50	15	50	15	50	MHz
* C_{obo} 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	μs
* t_r[d]		-6	15	3	—	0.6	—	0.6	—	0.6	
* t_s[d]		-6	15	3[e]	—	2.5	—	2.5	—	2.5	
* t_f[d]		-6	15	3[e]	—	0.5	—	0.5	—	0.5	
* t_c[f] V_{CC}=200 V, L=50 μH, $R_C \leq$ 13.5 Ω		-6	15	3[e]	—	0.5	—	0.5	—	0.5	
T_C=100° C											
* I_{CEV}	450	-1.5			—	1	—	—	—	—	mA
	550	-1.5			—	—	—	1	—	—	
	650	-1.5			—	—	—	—	—	1	
* V_{CE}(sat)			15[a]	3	—	2	—	2	—	2	V
* t_r[d]		-6	15	3	—	1	—	1	—	1	μs
* t_s[d]		-6	15	3[e]	—	4	—	4	—	4	
* t_f[d]		-6	15	3[e]	—	1	—	1	—	1	
* t_c[f] V_{CC}=200 V, L=50 μH, $R_C \leq$ 13.5 Ω		-6	15	3[e]	—	0.8	—	0.8	—	0.8	
* $R\theta_{JC}$ 2N6676, 2N6677, 2N6678	10		5		—	1	—	1	—	1	°C/W
$R\theta_{JC}$ RJH6676, RJH6677, RJH6678	10		5		—	0.71	—	0.71	—	0.71	°C/W

[a]Pulsed: pulse 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.
*In accordance with JEDEC registration data (2N6676, 2N6677, 2N6678 only).
[c]V_{CB} value.
[d]V_{CC}=200 V, t_p=20 μs.
[e]I_{B1}=-I_{B2}.
[f]Collector clamped to V_{CEX}.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

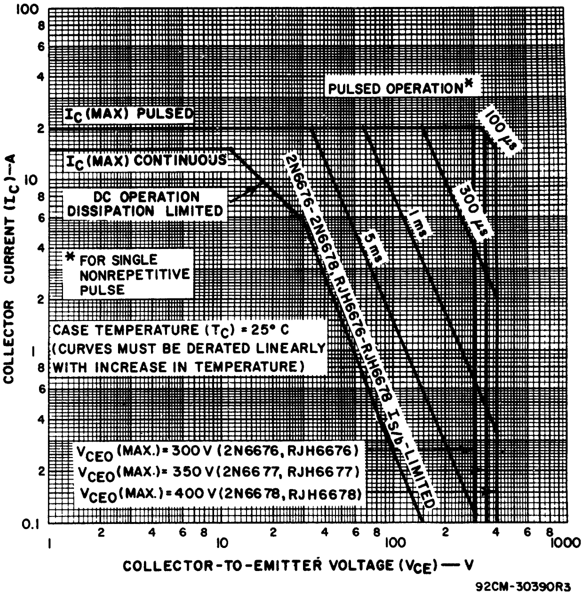


Fig. 1 - Maximum operating areas for all types (T_C = 25° C).

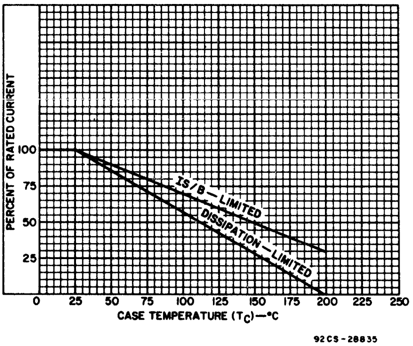


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for 2N6676, 2N6677, and 2N6678.

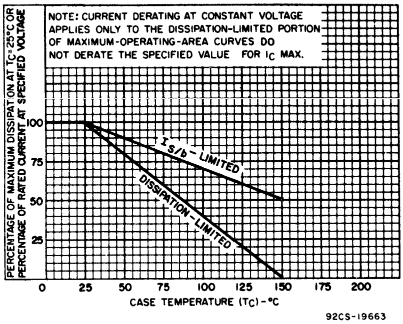


Fig. 3 - Dissipation and $I_{S/b}$ derating curves for RJH6676, RJH6677, and RJH6678.

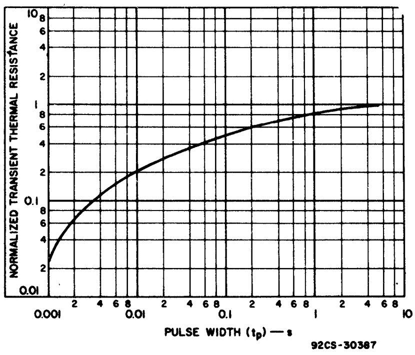


Fig. 4 - Typical thermal-response characteristic for all types.

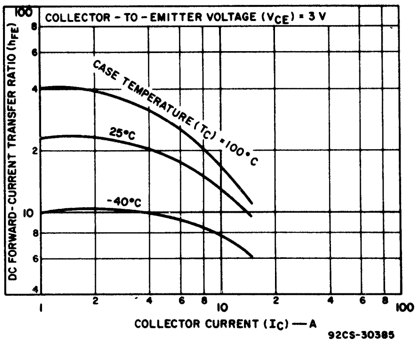


Fig. 5 - Typical dc beta characteristics for all types.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

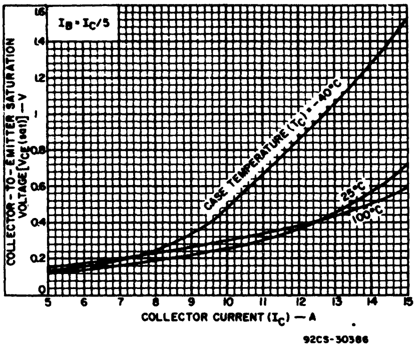


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

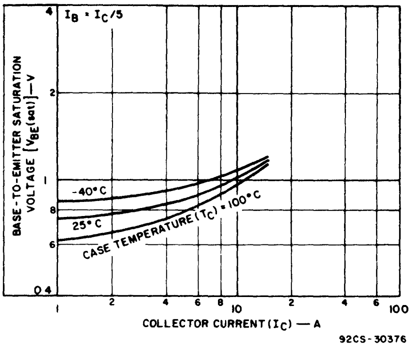


Fig. 7 - Typical base-to-emitter saturation voltage characteristics for all types.

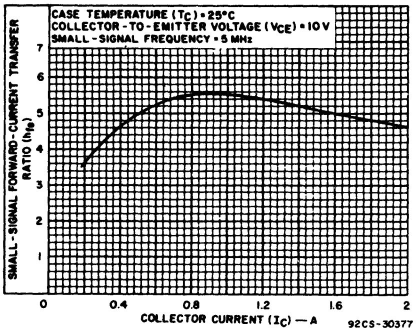


Fig. 8 - Typical small-signal forward current transfer ratio characteristic for all types (f = 5 MHz).

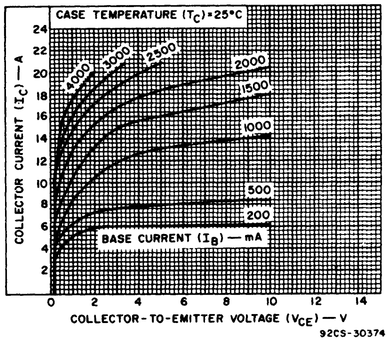


Fig. 9 - Typical output characteristics for all types.

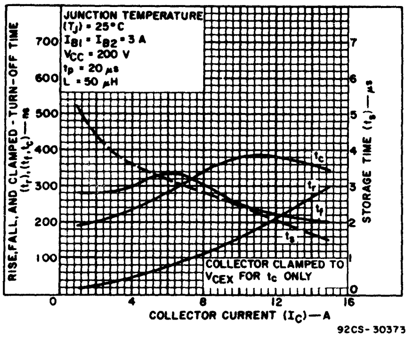


Fig. 10 - Typical saturated-switching-time characteristics at T_J = 25° C as a function of collector current for all types.

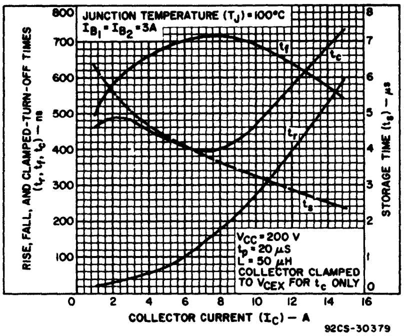


Fig. 11 - Typical saturated-switching-time characteristics at T_J = 100° C as a function of collector current for all types.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

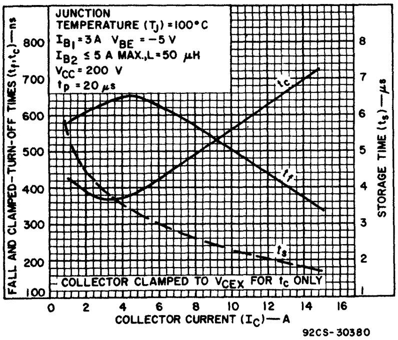


Fig. 12 - Typical saturated-switching-time characteristics at T_J = 100° C as a function of collector current for all types.

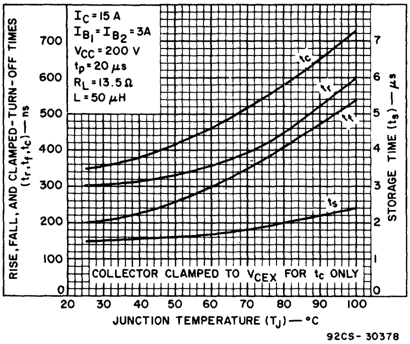


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

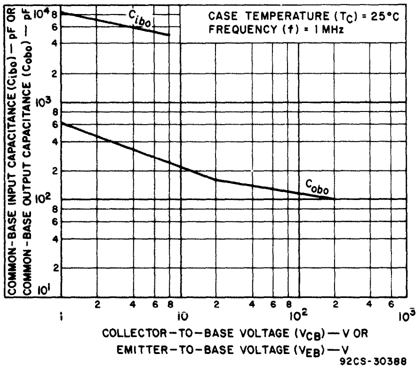


Fig. 14 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

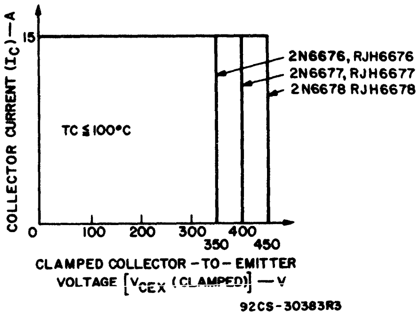


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

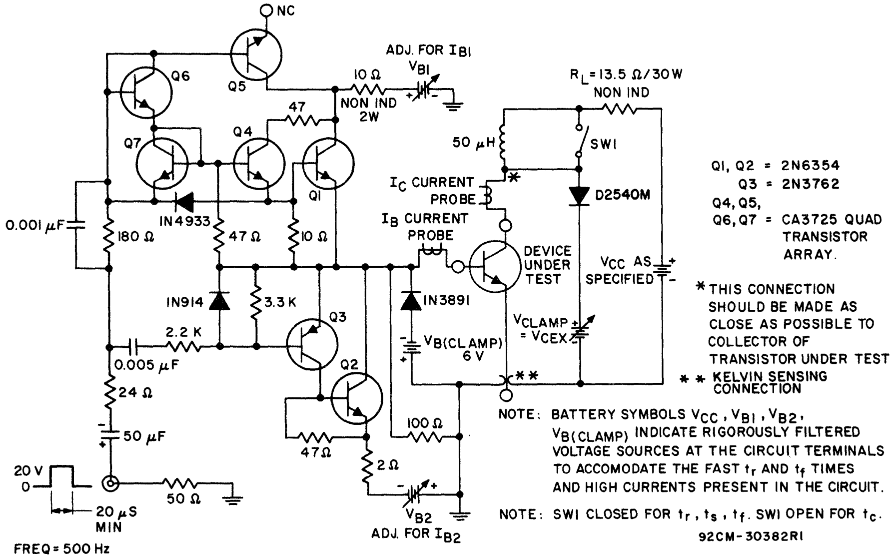


Fig. 16 - Circuit for measurement switching times.

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678

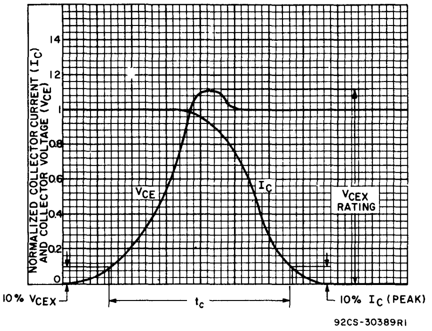


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

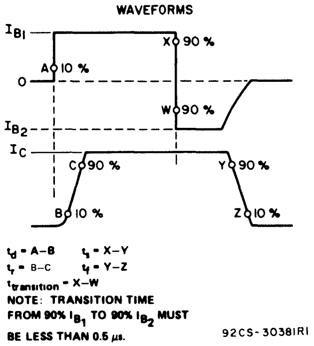


Fig. 18 - Phase relationship between input and output currents showing reference points for specification of switching times.

2N6686, 2N6687, 2N6688 File Number **1171**

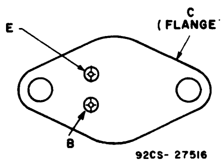
25-A *SwitchMax* Power Transistors

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)*
- *Steel hermetic TO-204AA Package*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-2N6686, 2N6687, and 2N6688• 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-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 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.

•Formerly RCA Dev. Type Nos. TA9119A, TA9119B, TA9119C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6686	2N6687	2N6688	
* V_{CEV}				
V_{BE} = −1.5 V	260	280	300	V
* V_{CEX}(Clamped)				
V_{BE} = −1.5 V	210	230	250	V
* V_{CEO}	160	180	200	V
* V_{EBO}		8		V
I_C(sat)	25	25	20	A
* I_C	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		1.14		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max		235		°C

* In accordance with JEDEC registration data.

2N6686, 2N6687, 2N6688

ELECTRICAL CHARACTERISTICS T_C = 25°C

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CEV}	260	-1.5	—	—	—	50	—	—	—	—	
		280	-1.5	—	—	—	—	—	50	—	—	µA
		300	-1.5	—	—	—	—	—	—	—	50	
*	I_{EBO}	—	-8	0	—	—	100	—	100	—	100	
*	$V_{CEO}(sus)$[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	—	—	—	
*	$V_{BE}(sat)$	—	—	20[a]	2	—	—	—	—	—	1.8	
		—	—	25[a]	2.5	—	1.8	—	1.8	—	—	
*	$V_{CE}(sat)$	—	—	20[a]	2	—	—	—	—	—	1.5	
		—	—	25[a]	2.5	—	1.5	—	1.5	—	—	V
*	V_{CEX}[b] (Clamped $E_{S/b}$) L = 25 µH, R_{BB} = 10 Ω	—	-4	25	3	210	—	230	—	250	—	
	$I_{S/b}$	18	—	11.1	—	1	—	1	—	1	—	s
*	$\|h_{fe}\|$ f = 5 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 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	
		—	-4	25	2.5[e]	—	1.50	—	1.50	—	—	µs
*	t_f[d]	—	-4	20	2[e]	—	—	—	—	—	0.25	
		—	-4	25	2.5[e]	—	0.25	—	0.25	—	—	
*	t_c V_{CC} = 80 V, L = 25 µH, $R_C \leq 4$ Ω, Collector clamped to V_{CEX}	—	-4	20	3[e]	—	—	—	—	—	0.5	
		—	-4	25	3[e]	—	0.5	—	0.5	—	—	

2N6686, 2N6687, 2N6688

ELECTRICAL CHARACTERISTICS (cont'd)

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6686		2N6687		2N6688		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 125°C											
* 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
			25	2.5	–	0.8	–	0.8	–	–	
* t_s[d]		−4	20	2	–	–	–	–	–	2.5	
			25	2.5[e]	–	2.5	–	2.5	–	–	
* t_f[d]		−4	20	2	–	–	–	–	–	0.8	
			25	2.5[e]	–	0.8	–	0.8	–	–	
* t_c V_{CC}=80 V, L=25 µH, $R_C \leqslant 4\,\Omega$, Collector Clamped to V_{CEX}		−4	20	3[e]	–	–	–	–	–	0.8	
		−4	25	3[e]	–	0.8	–	0.8	–	–	
* $R_{\theta JC}$	10		5		–	0.875	–	0.875	–	0.875	°C/W

* In accordance with JEDEC registration data.
[a] Pulsed: pulse 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] V_{CB} value.
[d] V_{CC} = 80 V, t_p = 20 µs
[e] $I_{B_1} = -I_{B_2}$

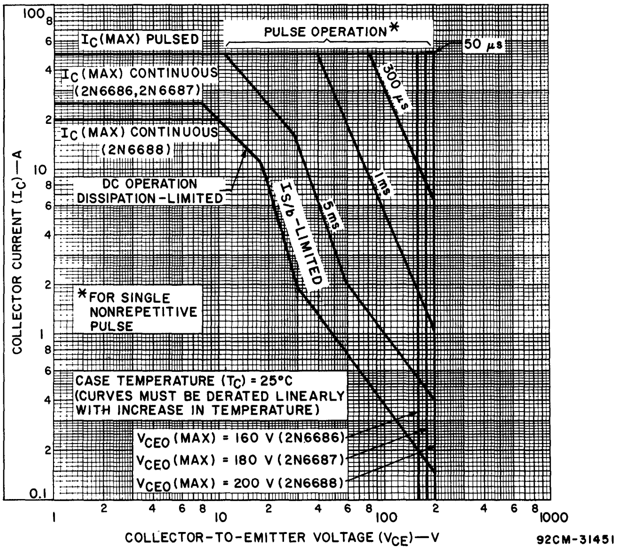


Fig. 1-Maximum operating areas for all types (T_C = 25°C).

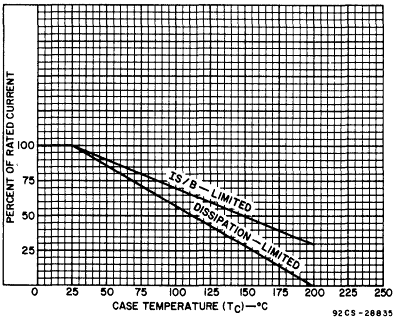


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for all types.

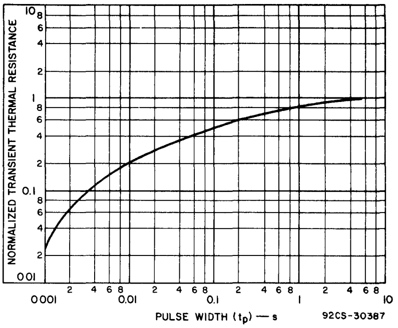


Fig. 3 — Typical thermal-response characteristic for all types.

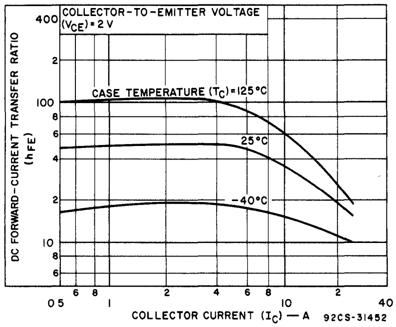


Fig. 4 — Typical dc beta characteristics for all types.

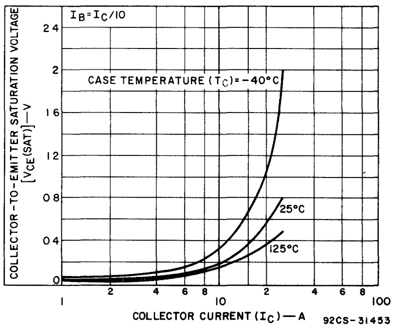


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics for all types.

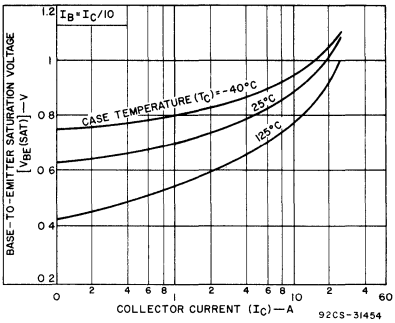


Fig. 6 — Typical base-to-emitter saturation voltage characteristic for all types.

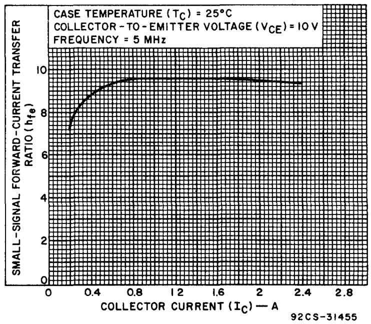


Fig. 7 — Typical small-signal forward-current transfer ratio characteristic for all ypes (f = 5 MHz).

2N6686, 2N6687, 2N6688

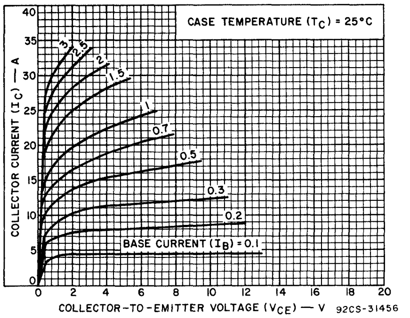


Fig. 8 — Typical output characteristics for all types.

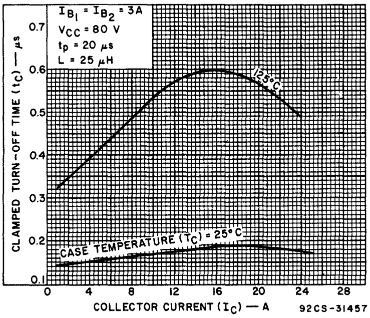


Fig. 9 — Typical clamped turn-off time characteristics for all types.

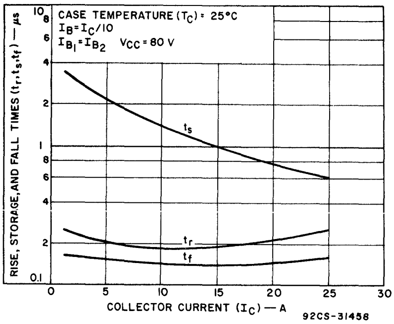


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

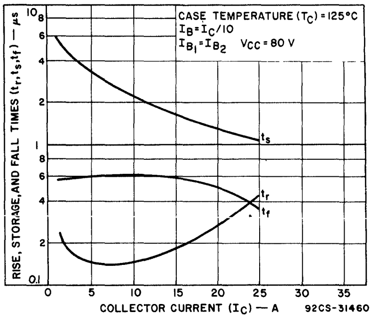


Fig. 11 — Typical saturated-switching-time characteristics at T_C = 125° C as a function of collector current for all types.

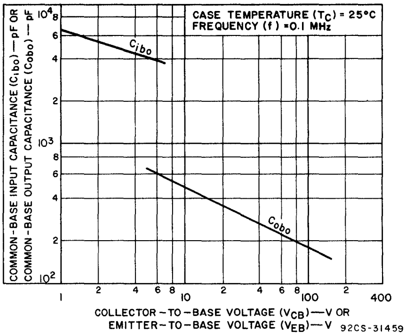


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

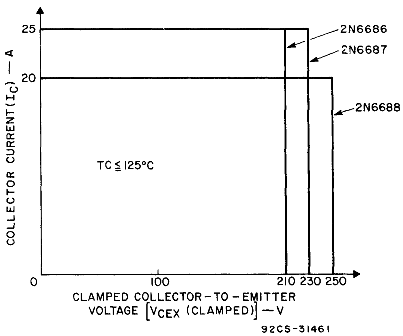


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff for all types.

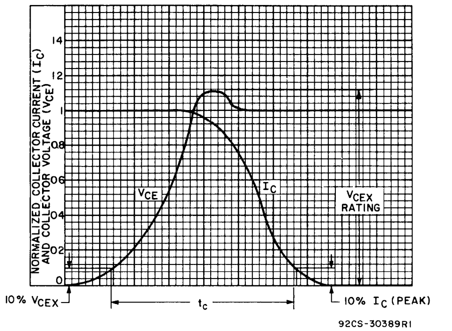


Fig. 14 — Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

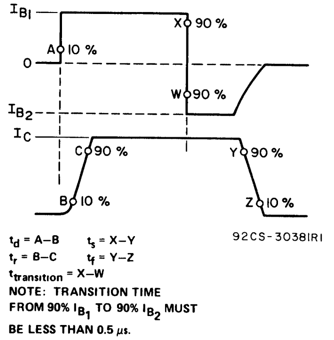


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times.

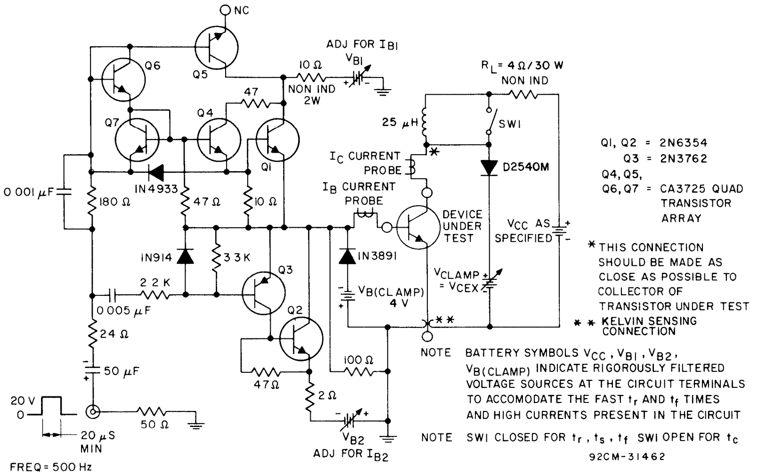


Fig. 16 — Circuit for measuring switching times.

2N6738, 2N6739, 2N6740

File Number **1291**

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

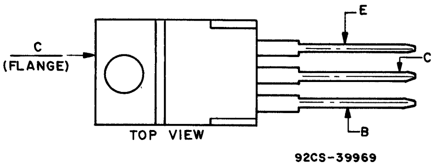
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 350 V to 450 V*
- *Low V_{CE} (sat) at I_C = 5 A*
- *VERSAWATT package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA 2N6738 and 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 RCA-2N6738, 2N6739, and 2N6740 series transistors are supplied in the JEDEC TO-220AB package.

•Formerly RCA Dev. Type Nos. TA9141A, TA9141B, and TA9141C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6738	2N6739	2N6740	
* 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)		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 ≥ 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 VOLTAGE V dc		CURRENT A dc		LIMITS 2N6738		2N6739		2N6740		UNITS
	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_{EBO}		−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	
* $V_{CE}(sat)$			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	
* 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	μs
* 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	
T_C=125° 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	
* 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	μs
* $R_{\theta JC}$	10		5		—	1.25	—	1.25	—	1.25	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

*In accordance with JEDEC registration data.

[a]Pulsed: pulse 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]V_{CB} value.

[d]V_{CC} = 125 V, t_p = 20 μs.

[e]$I_{B_1} = -I_{B_2}$.

2N6738, 2N6739, 2N6740

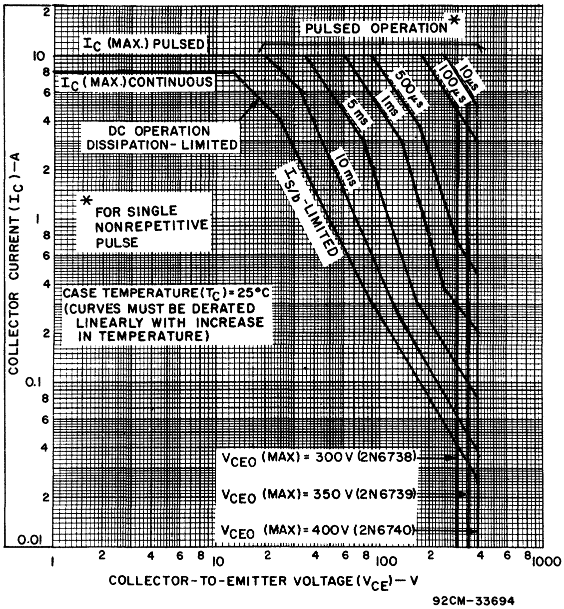


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

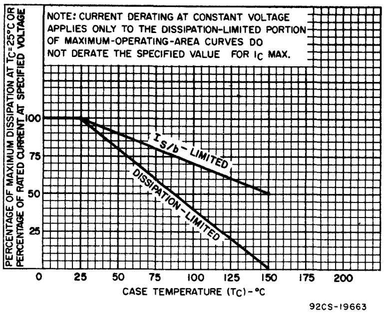


Fig. 2 — Dissipation and derating curve for all types.

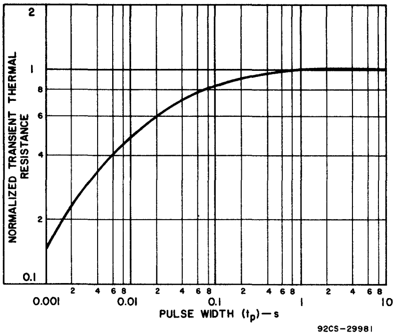


Fig. 3 — Typical thermal-response characteristic for all types.

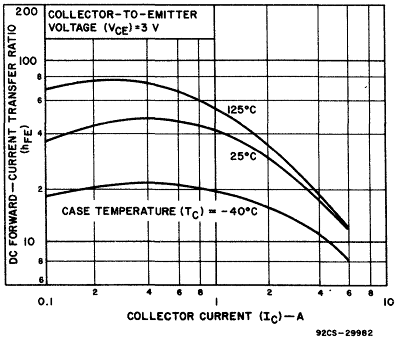


Fig. 4 — Typical dc beta characteristics for all types.

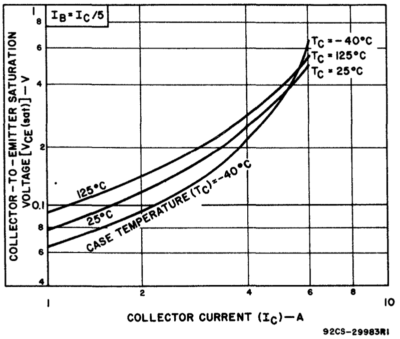


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

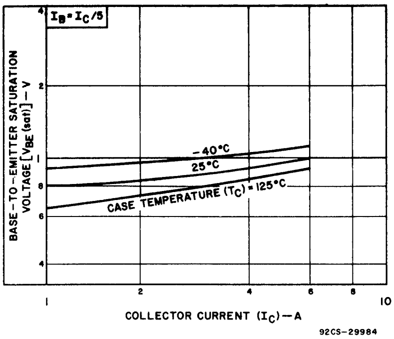


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

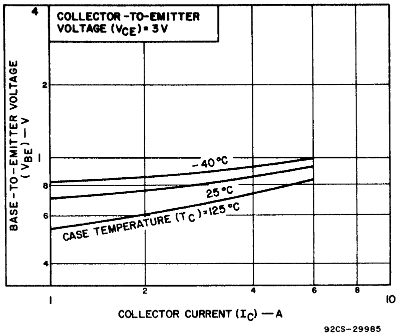


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

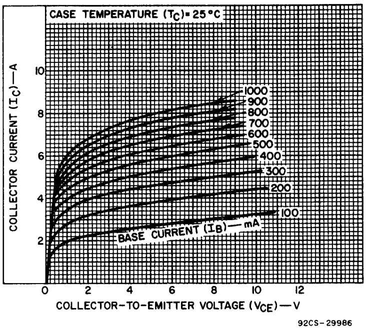


Fig. 8 — Typical output characteristics for all types.

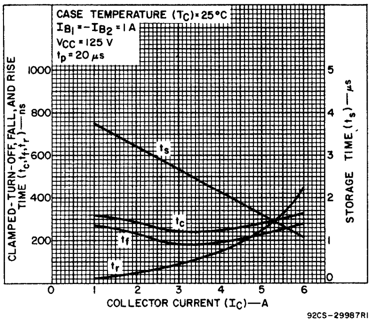


Fig. 9 — Typical saturated switching time characteristics for all types.

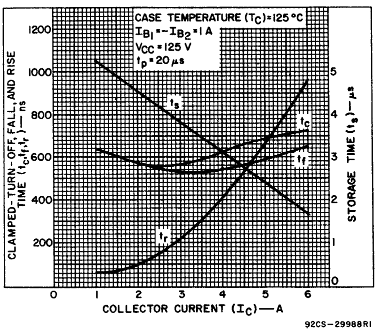


Fig. 10 — Typical saturated switching time characteristics for all types.

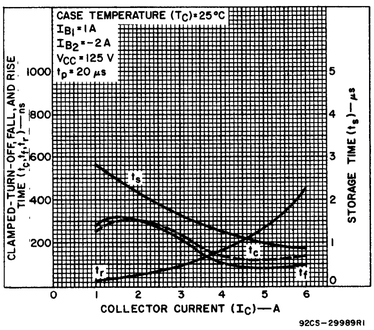


Fig. 11 — Typical saturated switching time characteristics for all types.

2N6738, 2N6739, 2N6740

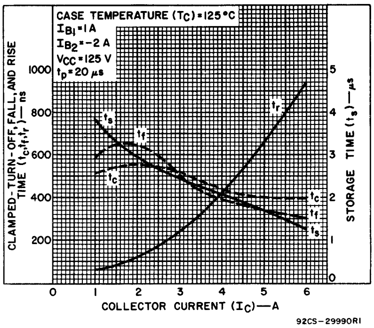


Fig. 12 — Typical saturated switching time characteristics for all types.

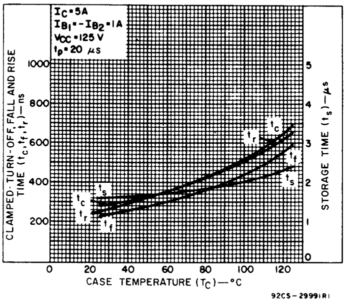


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

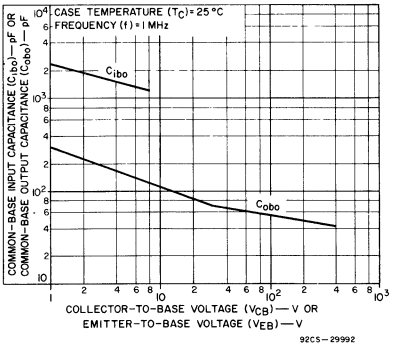


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

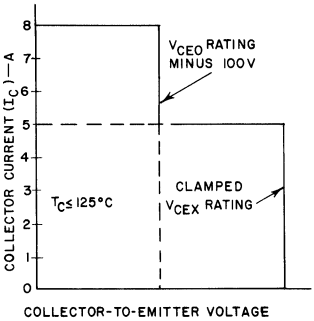


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

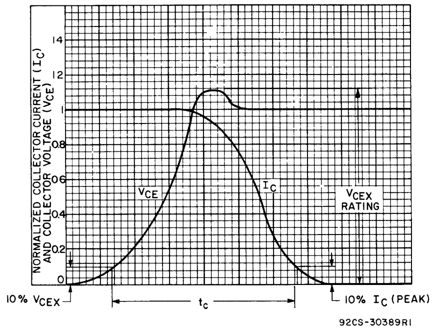


Fig. 16 — Oscilloscope display for measurement of clamped induction switching-time (t_c).

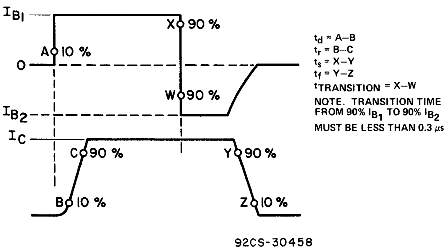
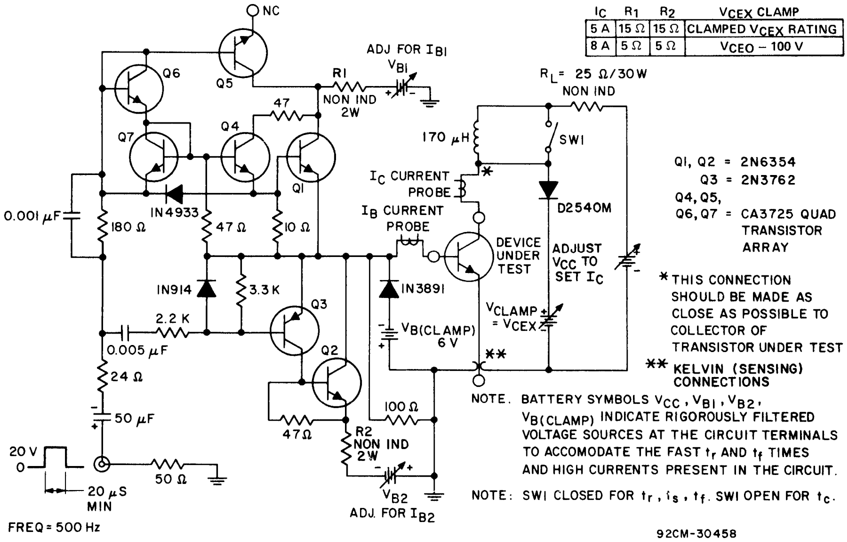


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N6738, 2N6739, 2N6740



I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING
8 A	5 Ω	5 Ω	V_{CEO} – 100 V

Fig. 18 — Circuit for measuring switching times.

2N6751, 2N6752, 2N6753, 2N6754

File Number **1244**

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

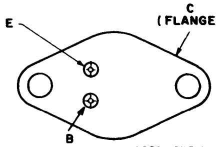
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 450 V — 550 V*
- *Low V_{CE} (sat) at I_C = 5 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 RCA-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 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 100°C to provide information necessary for worst-case design.

The 2N6751, 2N6752, 2N6753, and 2N6754 series 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 V	800	850	900	1000	V
* V_{CEX}(Clamped)					
V_{BE} = −1.5 V	450	500	550	550	V
* V_{CEO}	400	450	500	500	V
* V_{EBO}	8				V
I_C(sat)	5				A
* I_C	10				A
I_{CM}	10				A
* I_B	5				A
* P_T					
$T_C \leqslant$ 25°C	150				W
$T_C \geqslant$ 25°C, derate linearly	1				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

* In accordance with JEDEC registration data.

2N6751, 2N6752, 2N6753, 2N6754

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6751 Min.	2N6751 Max.	2N6752 Min.	2N6752 Max.	UNITS
$T_C = 25°C$									
* I_{CEV}	800 850	−1.5 −1.5			— —	0.1 —	— —	— 0.1	mA
* I_{EBO}		−8	0		—	2	—	2	mA
* $V_{CEO}(sus)$[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
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 μH		−6	5	1[c]	450	—	500	—	V
$I_{S/b}$	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	μs
* t_s[e]		−6	5	1[c]	—	3	—	3	μs
* t_f[e]		−6	5	1[c]	—	0.4	—	0.4	μs
* 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	μs
$T_C = 100°C$									
* I_{CEV}	800 850	−1.5 −1.5			— —	1 —	— —	— 1	mA
* $V_{CE}(sat)$			5[a]	1	—	1.5	—	1.5	V
* t_r[e]		−6	5	1	—	0.6	—	0.6	μs
* t_s[e]		−6	5	1[c]	—	5	—	5	μs
* t_f[e]		−6	5	1[c]	—	0.7	—	0.7	μs
* 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	μs
* $R_{\theta JC}$	10		5		—	1	—	1	°C/W

* 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] $I_{B_1} = -I_{B_2}$ [d] V_{CB} value [e] V_{CC} = 250 V, tp = 20 μs

2N6751, 2N6752, 2N6753, 2N6754

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6753		2N6754		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
$T_C = 25°C$									
* I_{CEV}	900	−1.5			—	0.1	—	—	mA
	1000	−1.5			—	—	—	0.1	mA
* I_{EBO}		−8	0		—	2	—	2	mA
* $V_{CEO}(sus)^b$			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]	1	—	1	—	1	V
			10[a]	3	—	3	—	3	V
V_{CEX}^b (Clamped $E_{S/b}$) L = 170 µH		−6	5	1[c]	550	—	550	—	V
$I_{S/b}$	30		5		1	—	1	—	s
* $\lvert h_{fe} \rvert$ 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	µs
* t_s^e		−6	5	1[c]	—	3	—	3	µs
* t_f^e		−6	5	1[c]	—	0.4	—	0.4	µs
* 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	µs
$T_C = 100°C$									
* I_{CEV}	900	−1.5			—	1	—	—	mA
	1000	−1.5			—	—	—	1	mA
* $V_{CE}(sat)$			5[a]	1	—	1.5	—	1.5	V
* t_r^e		−6	5	1	—	0.6	—	0.6	µs
* t_s^e		−6	5	1[c]	—	5	—	5	µs
* t_f^e		−6	5	1[c]	—	0.7	—	0.7	µs
* 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	µs
* $R_{\theta JC}$	10		5		—	1	—	1	°C/W

* 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] $I_{B_1} = -I_{B_2}$ [d] V_{CB} value [e] V_{CC} = 250 V, t_p = 20 µs

2N6751, 2N6752, 2N6753, 2N6754

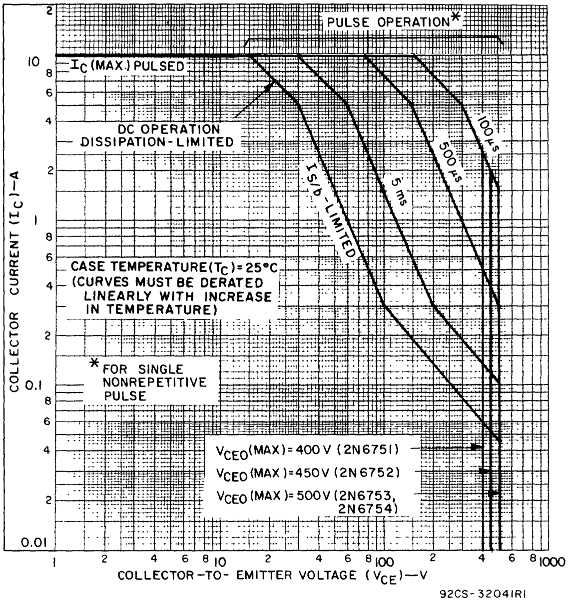


Fig. 1 — Maximum operating areas for all type (TcC).

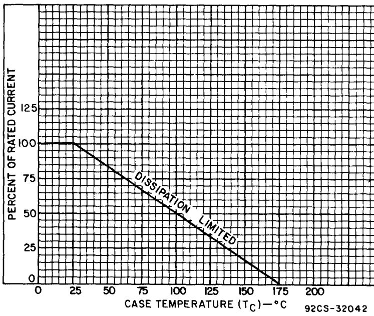


Fig. 2 — Dissipation derating curves for all types.

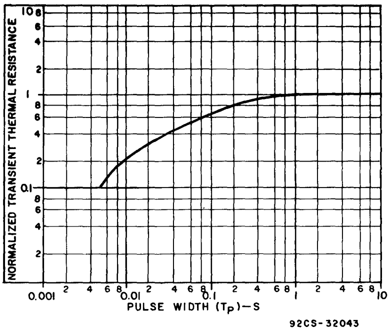


Fig. 3 — Typical thermal-response characteristic for all types.

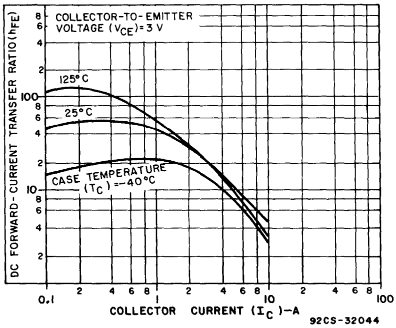


Fig. 4 — Typical dc beta characteristics for all types.

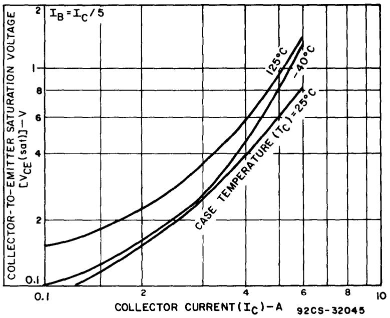


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6751, 2N6752, 2N6753, 2N6754

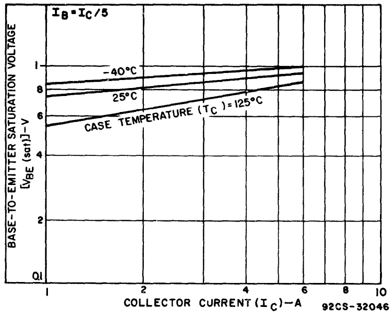


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

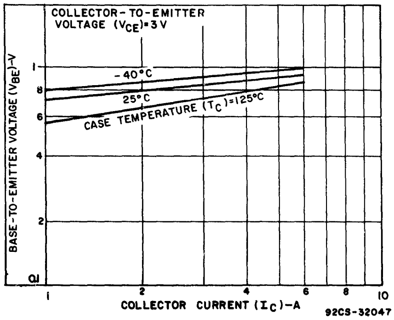


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

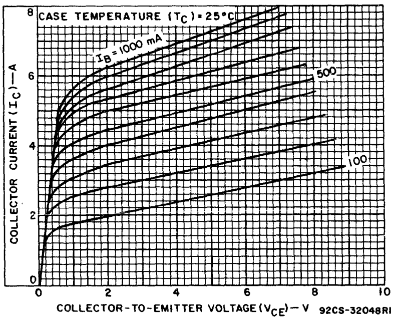


Fig. 8 — Typical output characteristics for all types.

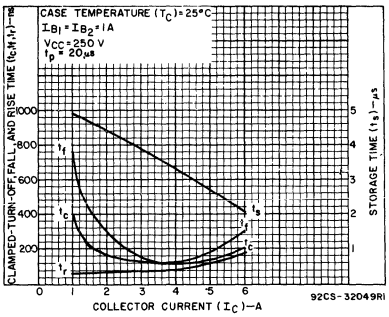


Fig. 9 — Typical saturated switching time characteristics for all types.

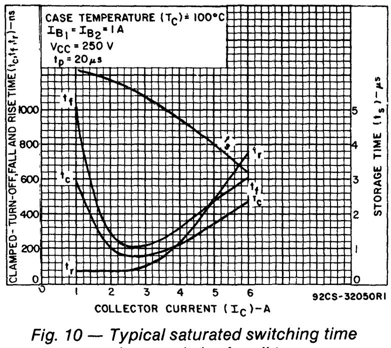


Fig. 10 — Typical saturated switching time characteristics for all types.

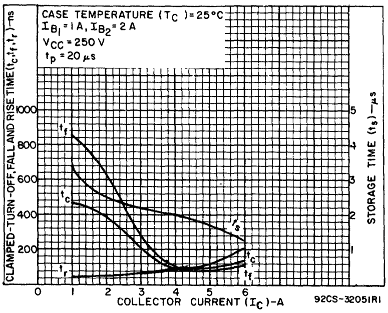


Fig. 11 — Typical saturated switching time characteristics for all types.

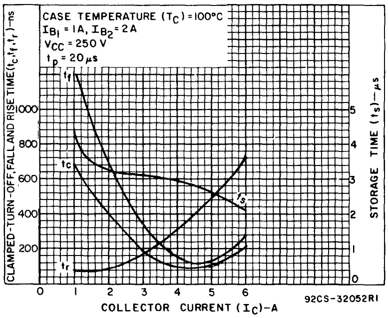


Fig. 12 — Typical saturated switching time characteristics for all types.

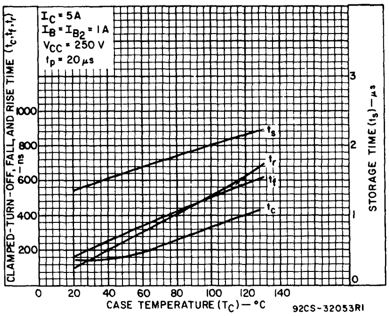


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

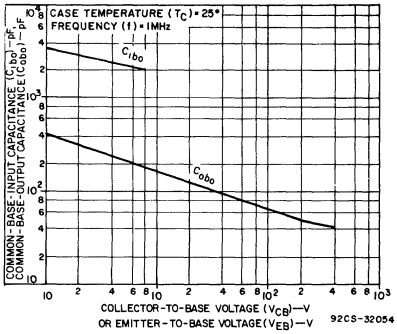


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

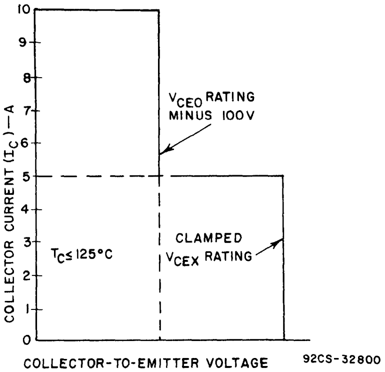


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

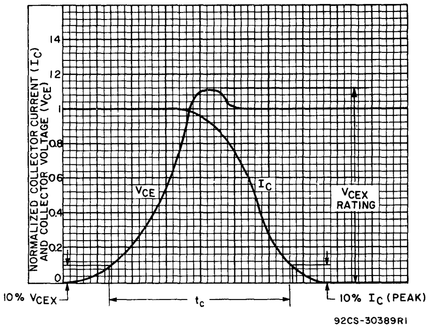


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_C).

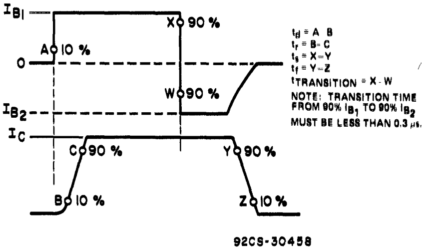


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N6751, 2N6752, 2N6753, 2N6754

I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING

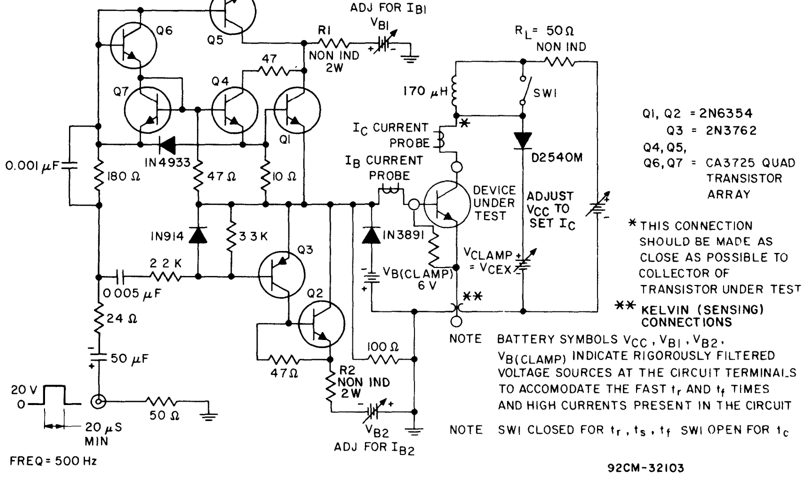


Fig. 18 — Circuit for measuring switching times.

File Number **1292**

2N6771, 2N6772, 2N6773

1-A SwitchMax VERSAWATT Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

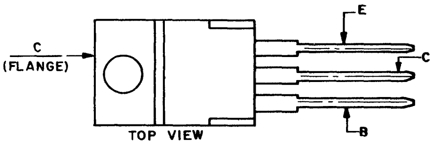
Features:

- *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*

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

The RCA-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 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 RCA-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: VOLTAGE V dc V_{CE}	TEST CONDITIONS: VOLTAGE V dc V_{BE}	TEST CONDITIONS: CURRENT A dc I_C	TEST CONDITIONS: CURRENT A dc I_B	LIMITS 2N6771 Min.	LIMITS 2N6771 Max.	LIMITS 2N6772 Min.	LIMITS 2N6772 Max.	LIMITS 2N6773 Min.	LIMITS 2N6773 Max.	UNITS
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	
* $R_{\theta JC}$	20		1		—	3.12	—	3.12	—	3.12	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

*In accordance with JEDEC registration data.
[a]Pulsed: pulse 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]V_{CB} value.
[d]V_{CC} = 200 V, t_p = 20 μs.
[e]$I_{B_1} = -I_{B_2}$.

2N6771, 2N6772, 2N6773

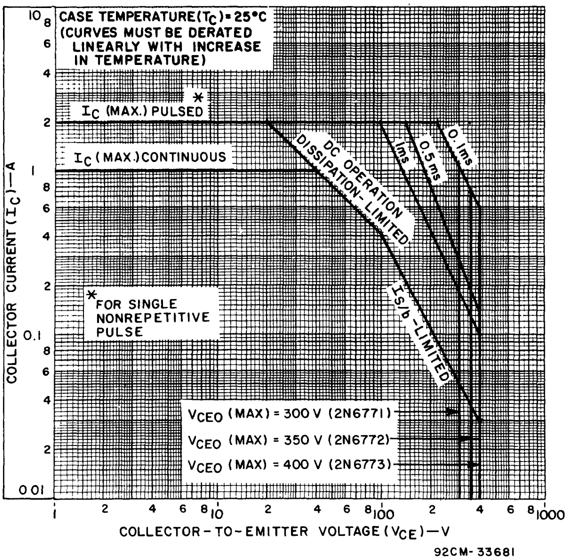


Fig. 1 — Maximum operating areas for all types.

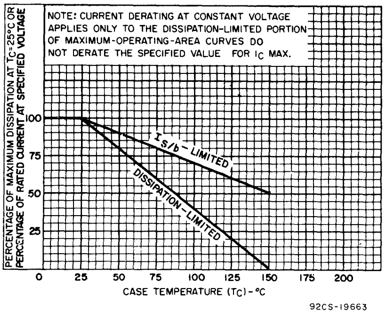


Fig. 2 — Derating curve for all types.

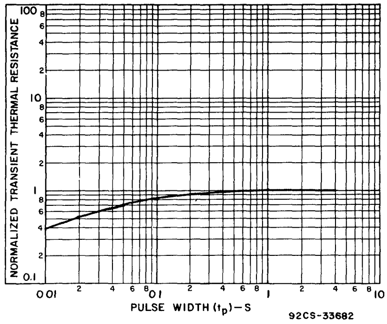


Fig. 3 — Typical thermal-response characteristics for all types.

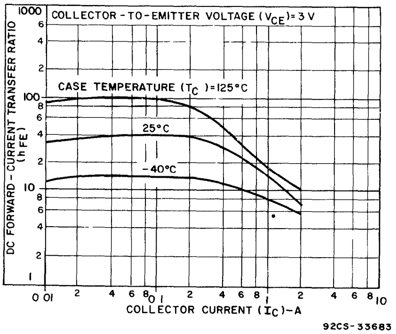


Fig. 4 — Typical dc beta characteristics for all types.

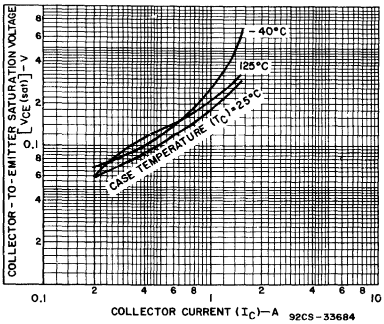


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6771, 2N6772, 2N6773

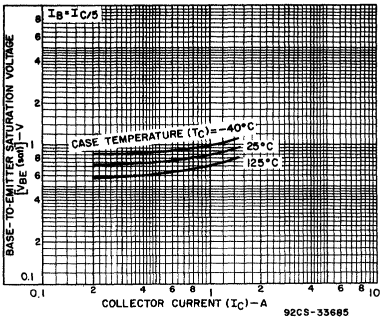


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

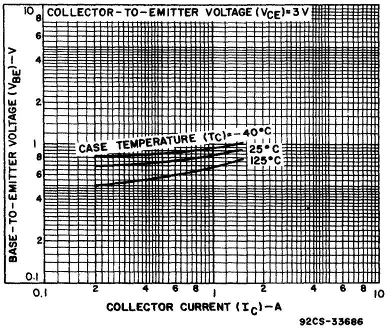


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

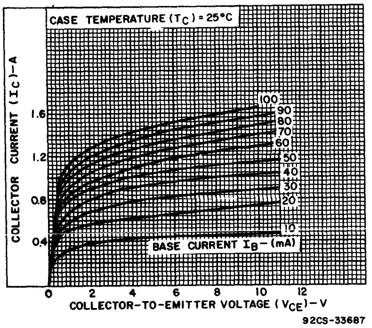


Fig. 8 — Typical output characteristics for all types.

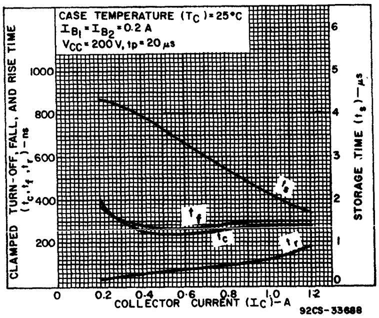


Fig. 9 — Typical saturated-switching-time characteristics for all types.

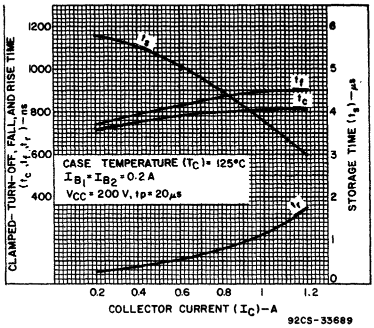


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

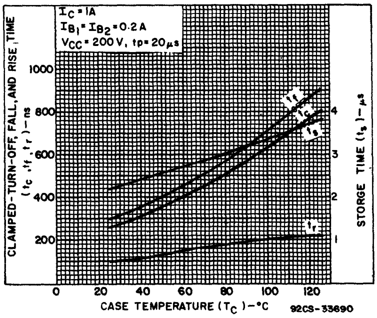


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

2N6771, 2N6772, 2N6773

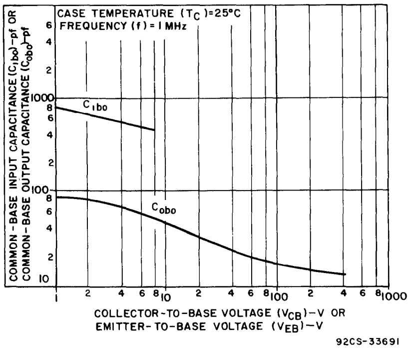


Fig. 12 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

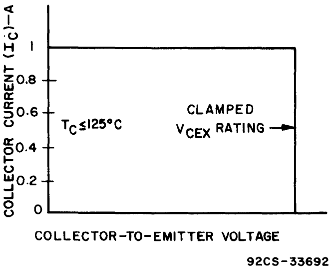


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff.

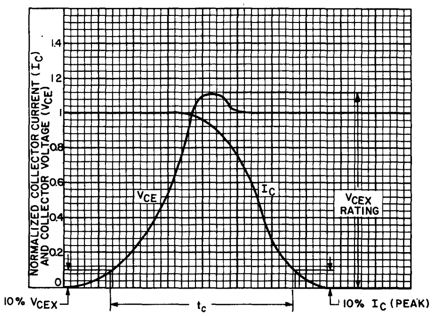


Fig. 14 — Oscilloscope display for measurement of clamped induction switching time (t_c).

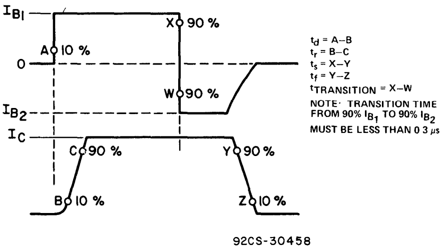


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times.

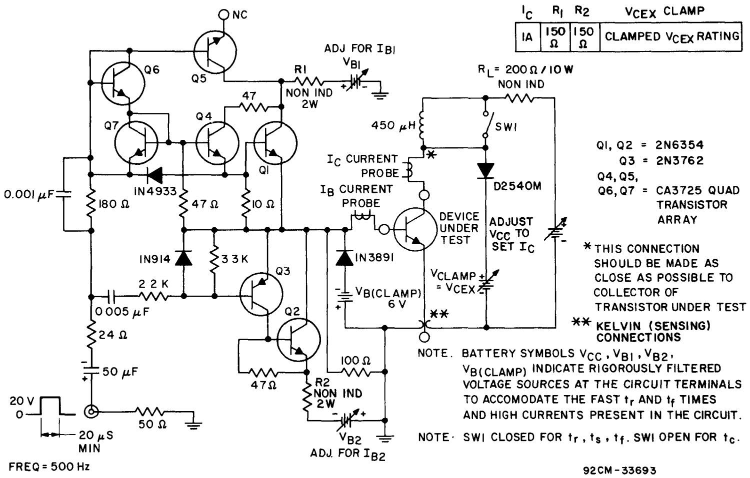


Fig. 16 — Circuit for measuring switching times.

BUW41, BUW41A, BUW41B

File Number **1275**

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

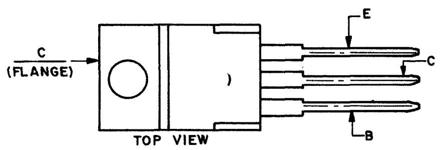
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 350 V to 450 V*
- *Low V_{CE} (sat) at I_C = 5 A*
- *VERSAWATT package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

The RCA-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 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 BUW41, BUW41A and BUW41B series transistors are supplied in JEDEC TO-204AB (RCA VERSAWATT) plastic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUW41	BUW41A	BUW41B	
V_{CER}, R_{BE} = 100Ω	350	400	450	V
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)		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 ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.		235		°C

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	—.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		—5	5	1[e]	350	—	400	—	450	—	
R_{BB} = 5 Ω		—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	

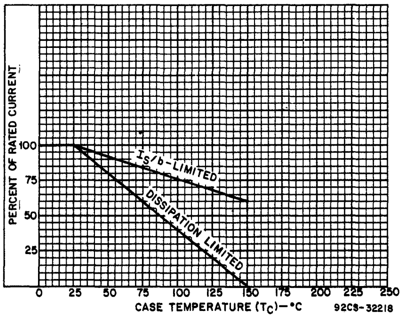


Fig. 1 — Dissipation and $I_{S/b}$ derating curves for all types.

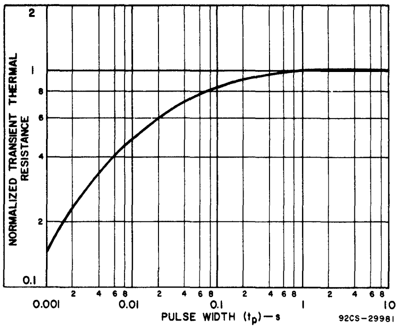


Fig. 2 — Typical thermal-response characteristics for all types.

BUW41, BUW41A, BUW41B

ELECTRICAL CHARACTERISTICS Continued

Characteristic	Test Conditions: Voltage V dc		Current A dc		Limits: BUW41		BUW41A		BUW41B		Units
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 125° C											
I_{CEV}	450	—1.5			—	1	—	—	—	—	mA
	550	—1.5			—	—	—	1	—	—	mA
	650	—1.5			—	—	—	—	—	1	mA
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	μs
t_f[d]			5	1[e]	—	0.8	—	0.8	—	0.8	μs
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	μs
$R_{\theta JC}$					—	1.25	—	1.25	—	1.25	° C/W
$R_{\theta JA}$					—	70	—	70	—	70	° C/W

[a]Pulsed: pulse 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]V_{CB}value.

[d]V_{CC}=125 V, t_p=20 μs.

[e]I_{B_1}= —I_{B_2}.

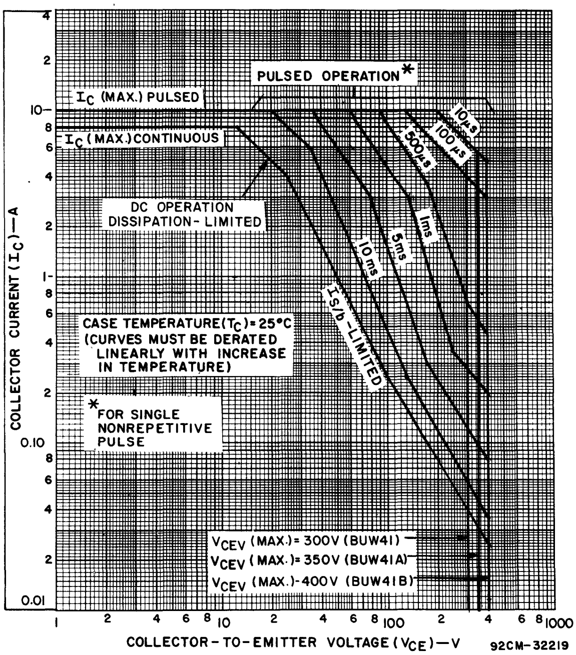


Fig. 3 — Maximum operating areas for all types [T_C = 25° C].

BUW41, BUW41A, BUW41B

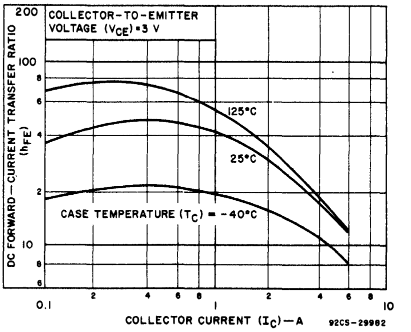


Fig. 4 — Typical dc beta characteristics for all types.

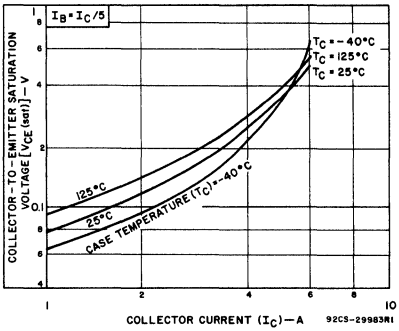


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

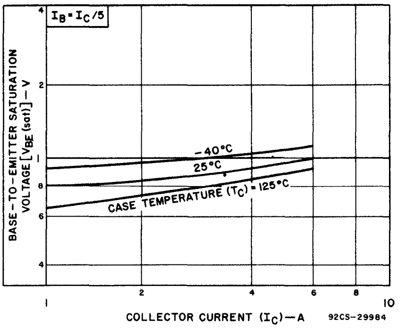


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

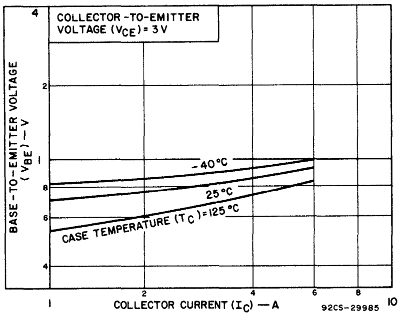


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

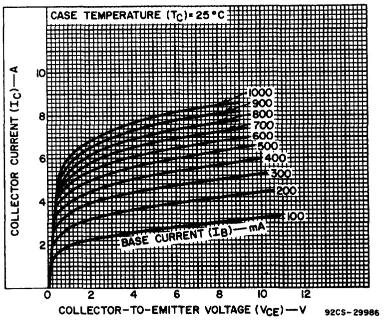


Fig. 8 — Typical output characteristics for all types.

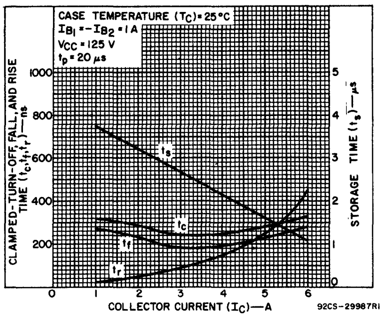


Fig. 9 — Typical saturated-switching-time characteristics for all types.

BUW41, BUW41A, BUW41B

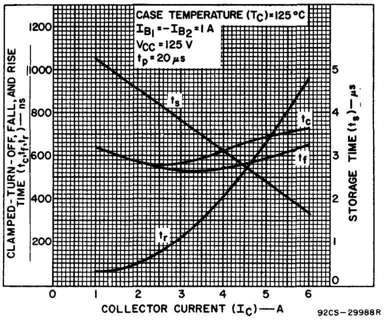


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

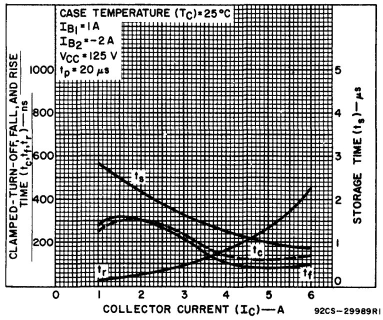


Fig. 11 — Typical saturated-switching-time characteristics for all types.

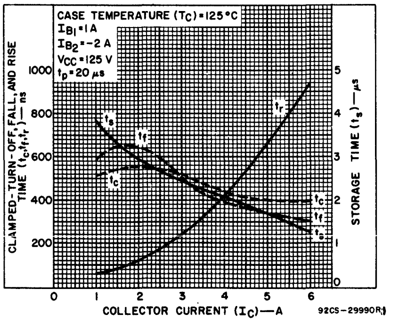


Fig. 12 — Typical saturated-switching-time characteristics for all types.

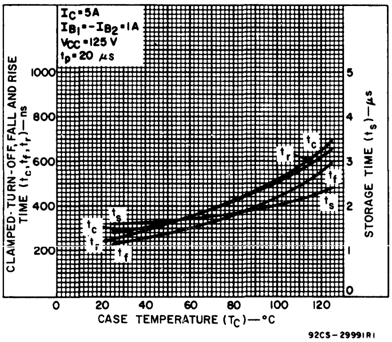


Fig. 13 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

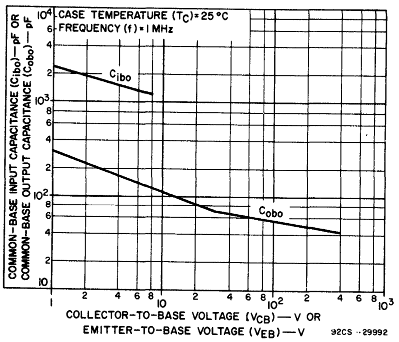


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

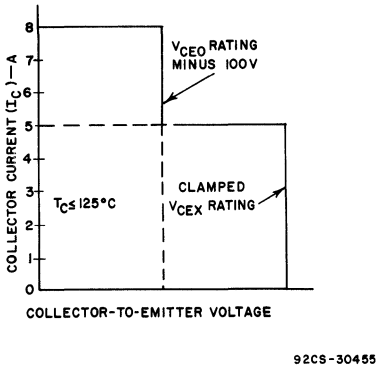


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

BUW41, BUW41A, BUW41B

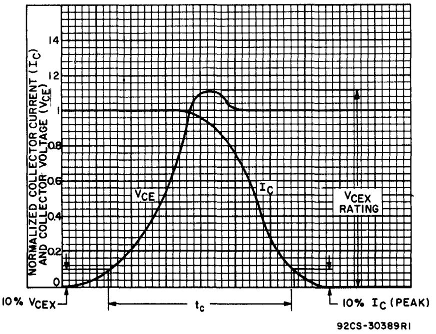


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

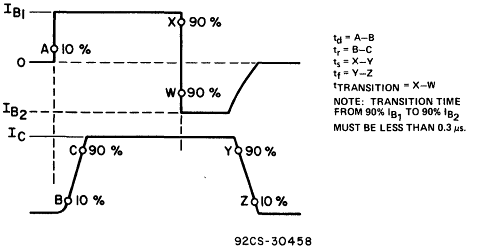


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

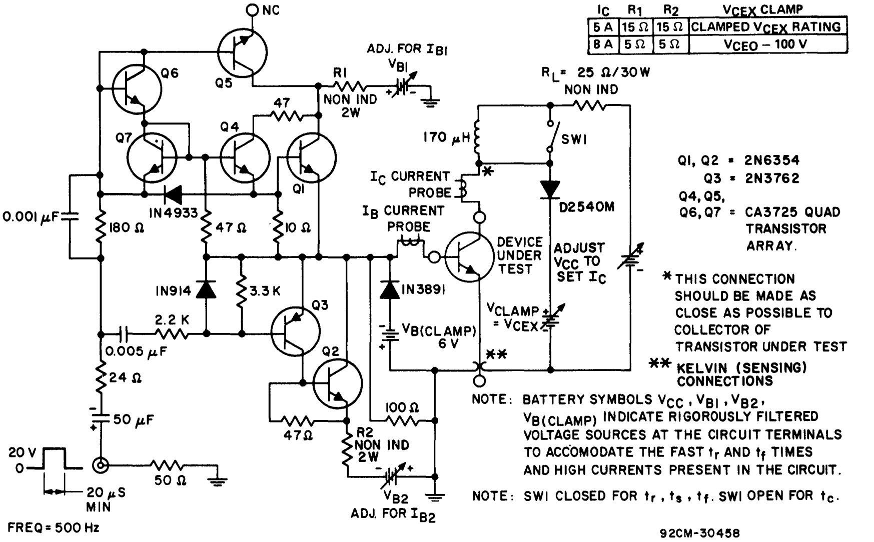


Fig. 18 — Circuit for measuring switching times.

BUX32, BUX32A, BUX32B

File Number **1285**

6-A SwitchMax Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

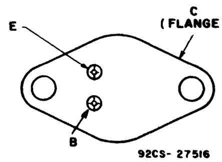
Features:

- *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)

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} $R_{BE} \leq 10\ \Omega$	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)		6		A
I_C		8		A
I_{CM}		10		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

BUX32, BUX32A, BUX32B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BUX32 Min.	BUX32 Max.	BUX32A Min.	BUX32A Max.	BUX32B Min.	BUX32B Max.	UNITS
T_C=25° C											
I_{CEV}	800	-1.5			—	0.1	—	—	—	—	mA
	900	-1.5			—	—	—	0.1	—	—	
	1000	-1.5			—	—	—	—	—	0.1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	0.2	—	—	—	—	
	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
$\lvert h_{fe} \rvert$ 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	
T_C=100° C											
I_{CEV}	800	-1.5			—	1	—	—	—	—	mA
	900	-1.5			—	—	—	1	—	—	
	1000	-1.5			—	—	—	—	—	1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	3	—	—	—	—	
	900				—	—	—	3	—	—	
	1000				—	—	—	—	—	3	
V_{CE}(sat)			6	1.2	—	1.5	—	1.5	—	1.5	V
t_j[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 V dc		CURRENT A dc		BUX32		BUX32A		BUX32B		
	V_{CE}	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

[a]Pulsed; pulse 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]V_{CB} value.
[d]V_{CC}=250 V, t_p=20 μs.
[e]$I_{B_1}=-I_{B_2}$.

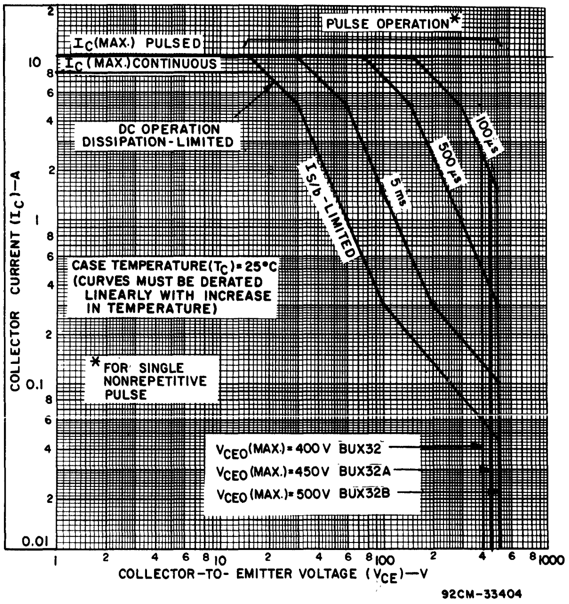


Fig. 1 — Maximum operating areas for all types (T_C).

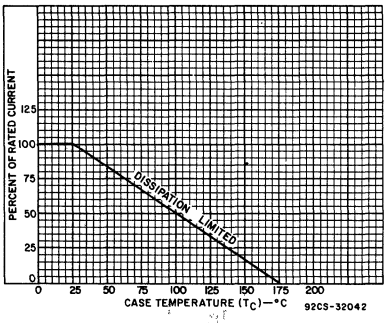


Fig. 2 — Dissipation derating curve for all types.

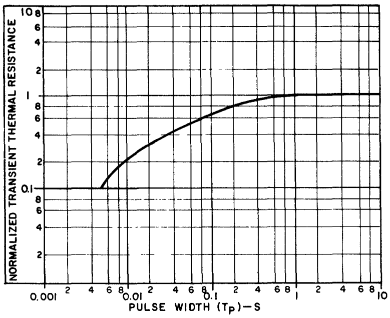


Fig. 3 — Typical thermal-response characteristic for all types.

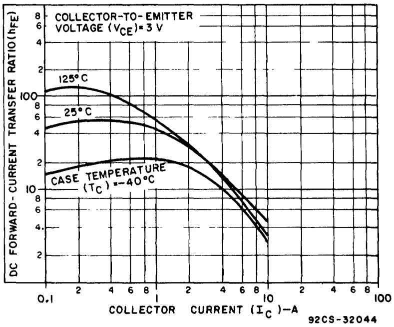


Fig. 4 — Typical dc beta characteristics for all types.

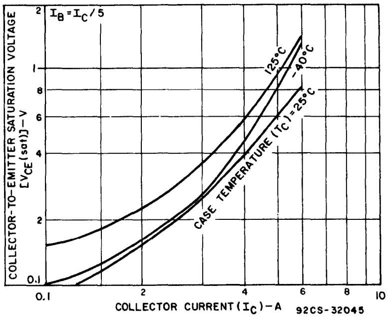


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

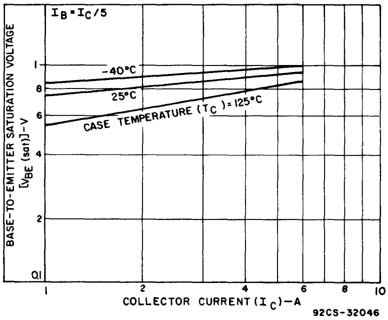


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

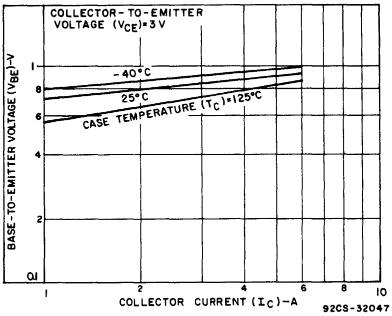


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

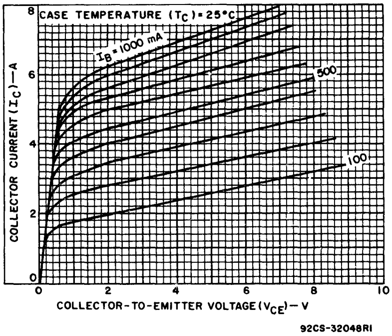


Fig. 8 — Typical output characteristics for all types.

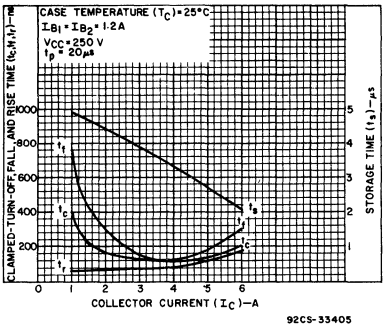


Fig. 9 — Typical saturated switching time characteristics for all types.

BUX32, BUX32A, BUX32B

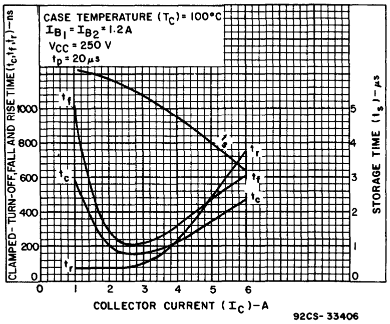


Fig. 10 — Typical saturated switching time characteristics for all types.

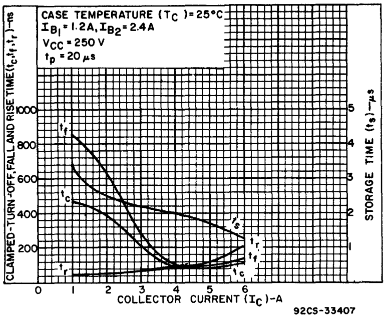


Fig. 11 — Typical saturated switching time characteristics for all types.

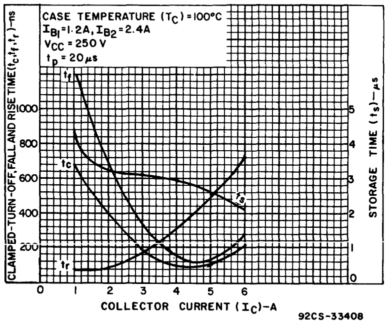


Fig. 12 — Typical saturated switching time characteristics for all types.

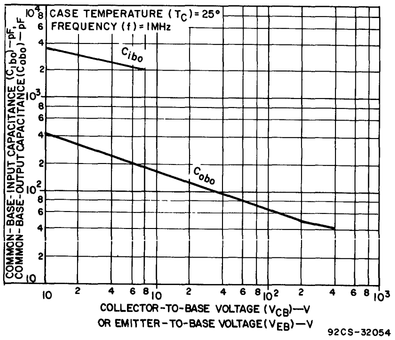


Fig. 13 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

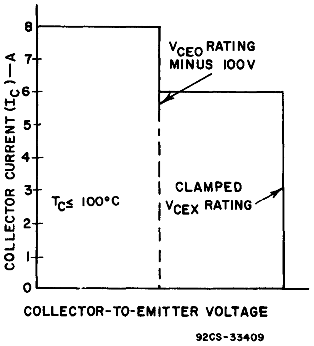


Fig. 14 — Maximum operating conditions for switching between saturation and cutoff.

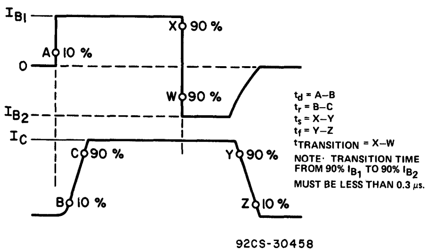


Fig. 15 — Phase relationship between input and output current showing reference points for specification of switching times.

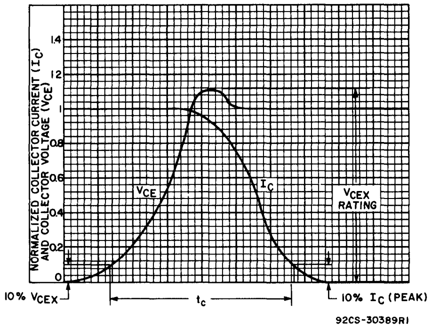


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

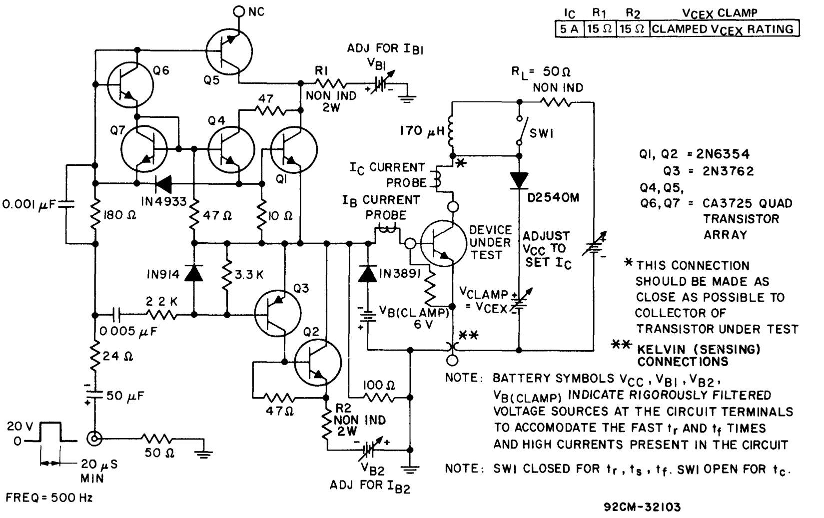


Fig. 17 — Circuit for measuring switching times.

BUX33, BUX33A, BUX33B

File Number **1354**

8-A SwitchMax Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

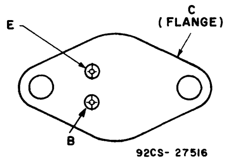
Features:

- *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)

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} $R_{BE} \leq 10\ \Omega$	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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BUX33 Min.	BUX33 Max.	BUX33A Min.	BUX33A Max.	BUX33B Min.	BUX33B Max.	UNITS
$T_C = 25°C$											
I_{CEV}	800	−1.5			—	0.1	—	—	—	—	mA
	900	−1.5			—	—	—	0.1	—	—	
	1000	−1.5			—	—	—	—	—	0.1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	0.2	—	—	—	—	
	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		8		6	40	6	40	6	40	
$V_{BE}(sat)$			8	2	—	1.3	—	1.3	—	1.3	
$V_{CE}(sat)$			8	2	—	1	—	1	—	1	V
			12	3	—	4	—	4	—	4	
V_{CEX}[b] (Clamped $E_{S/b}$) $L = 170\ \mu H$		−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	
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]			8	2	—	0.1	—	0.1	—	0.1	
t_r[d]			8	2	—	0.45	—	0.45	—	0.45	
t_s[d]			8	2[e]	—	3.0	—	3.0	—	3.0	
t_f[d]			8	2[e]	—	0.4	—	0.4	—	0.4	μs
t_c $V_{CC} = 240$ V, $L = 170\ \mu H$, $R_C = 30\ \Omega$ Collector clamped to V_{CEX}			8	2[e]	—	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} $R_{BE} \leq 10\ \Omega$	800				—	3	—	—	—	—	
	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	
t_s[d]			8	2[e]	—	4	—	4	—	4	
t_f[d]			8	2[e]	—	0.7	—	0.7	—	0.7	μs
t_c $V_{CC} = 240$ V, $L = 170\ \mu H$, $R_C = 30\ \Omega$ Collector clamped to V_{CEX}			8	2[e]	—	0.8	—	0.8	—	0.8	
$R\theta_{JC}$	10	5			—	1.0	—	1.0	—	1.0	°C/W

[a]Pulsed; pulse 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]V_{CB} value.
[d]$V_{CC} = 240$ V, $t_p = 20\ \mu s$.
[e]$I_{B1} = -I_{B2}$.

BUX33, BUX33A, BUX33B

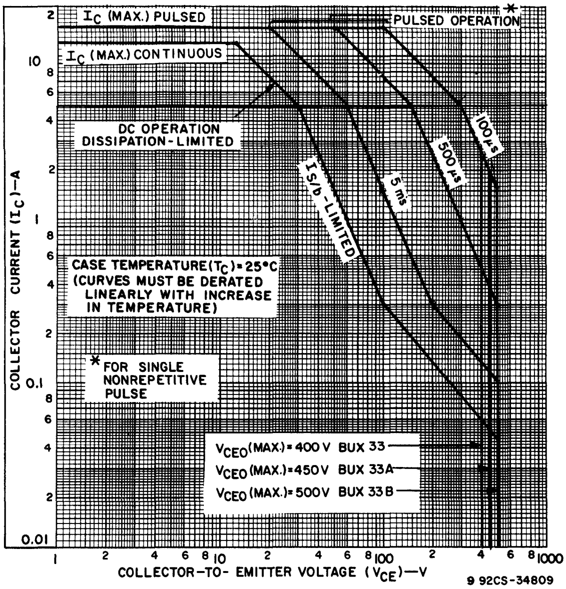


Fig. 1 — Maximum operating areas for all types (Tc).

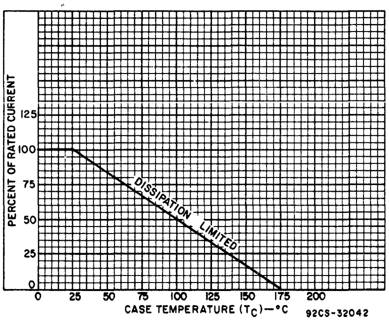


Fig. 2 — Dissipation derating curve for all types.

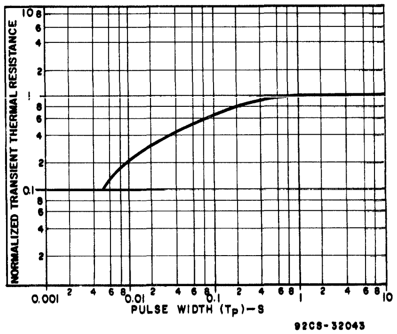


Fig. 3 — Typical thermal-response characteristic for all types.

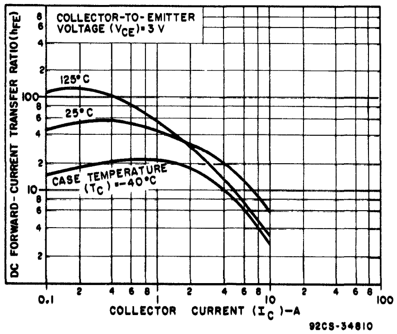


Fig. 4 — Typical dc beta characteristics for all types.

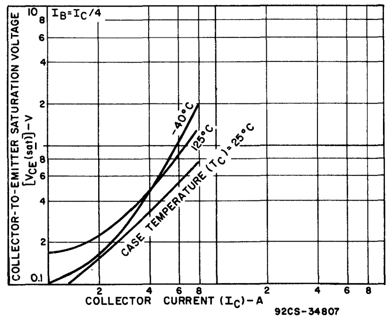


Fig. 5 — Typical collector-to-emitter saturation voltage for all types.

BUX33, BUX33A, BUX33B

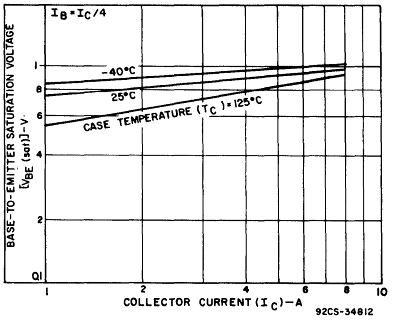


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

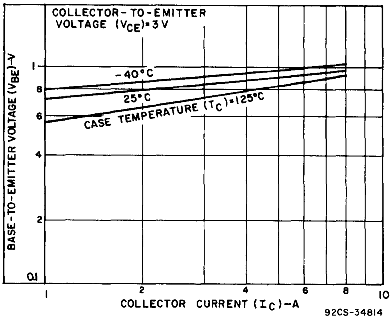


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

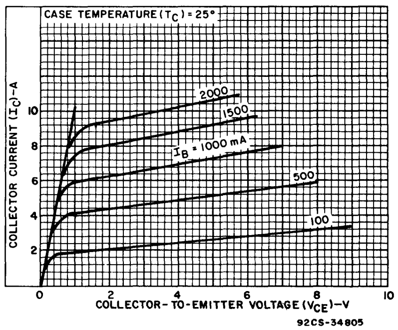


Fig. 8 — Typical output characteristics for all types.

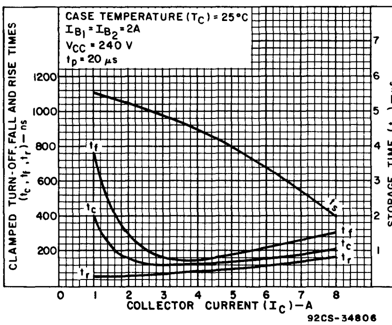


Fig. 9 — Typical saturated switching time characteristics for all types.

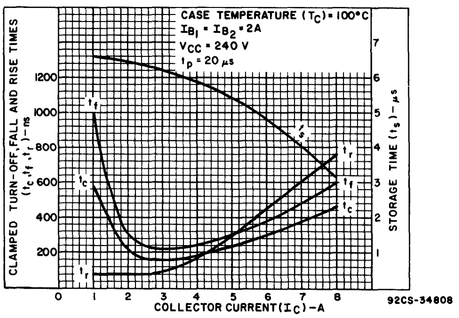


Fig. 10 — Typical saturated switching time characterics for all types.

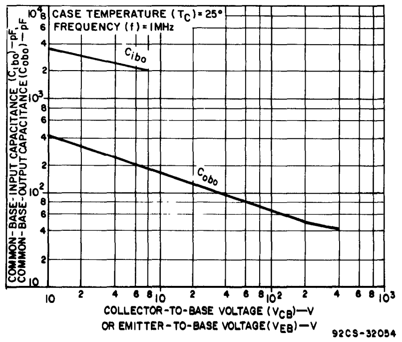


Fig. 11 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

BUX33, BUX33A, BUX33B

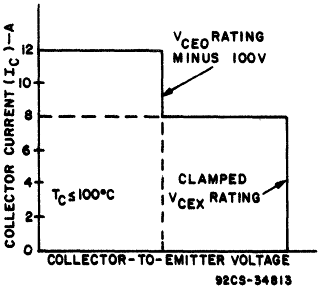


Fig. 12 — Maximum operating conditions for switching between saturation and cutoff.

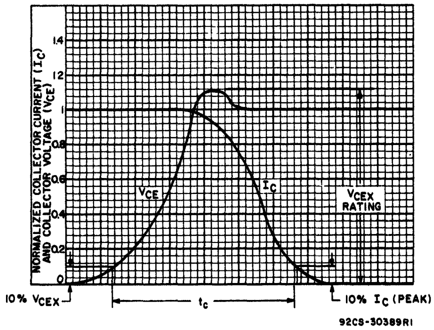


Fig. 13 — Oscilloscope display for measurement of clamped induction switching time (t_c).

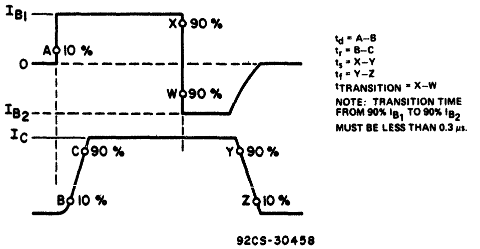


Fig. 14 — Phase relationship between input and output current showing reference points for specification of switching times.

BUX33, BUX33A, BUX33B

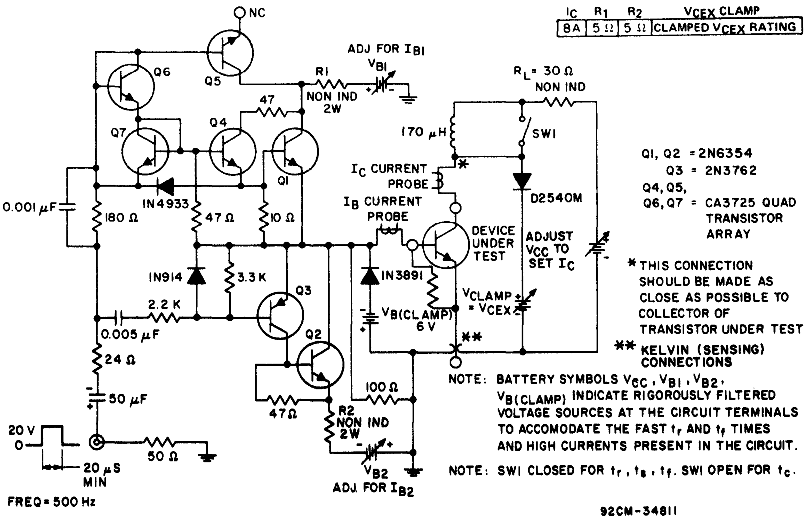


Fig. 15 — Circuit for measuring switching times.

MJ16010, MJ16012
MJH16010,MJH16012

File Number **1839**

5-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

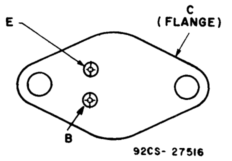
Features:

- *Fast switching speed*
- *High-voltage ratings:* V_{CEV} *= 850 V*
- *Low* $V_{CE}(sat)$ *at* I_c *= 10A*

Applications:

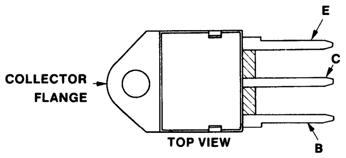
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



MJ16010
MJ16012

JEDEC TO-204AA
(200 mil diameter pin isolation)



MJH16010
MJH16012

JEDEC TO-218AC

92CS-40257

The RCA 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:*

<table>
<tr><th></th><th>MJ16010
MJ16012</th><th>MJH16010
MJH16012</th><th></th></tr>
<tr><td>V_{CEV}
V_{BE} = -1.5 V</td><td colspan="2">850</td><td>V</td></tr>
<tr><td>V_{CEO}</td><td colspan="2">450</td><td>V</td></tr>
<tr><td>V_{EBO}</td><td colspan="2">6</td><td>V</td></tr>
<tr><td>I_C(sat)</td><td colspan="2">10</td><td>A</td></tr>
<tr><td>I_C</td><td colspan="2">15</td><td>A</td></tr>
<tr><td>I_{CM}</td><td colspan="2">20</td><td>A</td></tr>
<tr><td>I_B</td><td colspan="2">10</td><td>A</td></tr>
<tr><td>I_{BM}</td><td colspan="2">15</td><td>A</td></tr>
<tr><td>P_T
@ T_C = 25°C</td><td>175</td><td>135</td><td>W</td></tr>
<tr><td>@ T_C = 100°C</td><td>100</td><td>53.8</td><td>W</td></tr>
<tr><td>T_C above 25°C, derate linearly</td><td>1</td><td>1.08</td><td>W/°C</td></tr>
<tr><td>T_{stg}, T_J</td><td>-65 to 200</td><td>-65 to 150</td><td>°C</td></tr>
<tr><td>TL
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max</td><td></td><td>235</td><td>°C</td></tr>
<tr><td>T_L
At distance ≥ 1/16" in. (1.58 mm) from seating plane for 10 s max.</td><td>235</td><td></td><td>°C</td></tr>
<tr><td>$R_{\theta JC}$</td><td>1</td><td>0.93</td><td>°C/W</td></tr>
</table>

MJ16010, MJ16012, MJH16010, MJH16012

MJ16010, MJH16010

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100 mA, I_B = 0)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current	I_{CEV}				mAdc
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc)		—	—	0.25	
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		—	—	1.5	
Collector Cutoff Current (V_{CE} = 850 Vdc, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current (V_{EB} = 6.0 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	$V_{CE(sat)}$				Vdc
(I_C = 5.0 Adc, I_B = 0.7 Adc)		—	0.5	2.5	
(I_C = 10 Adc, I_B = 1.3 Adc)		—	1.0	3.0	
(I_C = 10 Adc, I_B = 1.3 Adc, T_C = 100°C)		—	—	3.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 10 Adc, I_B = 1.3 Adc)		—	1.0	1.5	
(I_C = 10 Adc, I_B = 1.3 Adc, T_C = 100°C)		—	—	1.5	
DC Current Gain (I_C = 15 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)	C_{ob}	—	—	400	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Resistive Load							
Delay Time	(I_C = 10 Adc, V_{CC} = 250 Vdc, I_{B1} = 1.3 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 2.6 Adc, R_B = 1.6 Ω)	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 Vdc)	t_s	—	600	—	
Fall Time			t_f	—	100	—	
Inductive Load							
Storage Time	(I_C = 10 Adc, I_{B1} = 1.3 Adc, $V_{BE(off)}$ = 5.0 Vdc, $V_{CE(pk)}$ = 400 Vdc)	(T_C = 100°C)	t_{sv}	—	800	1800	ns
Fall Time			t_{fi}	—	50	200	
Crossover Time			t_c	—	100	250	
Storage Time		(T_C = 150°C)	t_{sv}	—	860	—	
Fall Time			t_{fi}	—	40	—	
Crossover Time			t_c	—	80	—	

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2.0%

MJ16010, MJ16012, MJH16010, MJH16012

MJ16012, MJH16012

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100 mA, I_B = 0)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current	I_{CEV}				mAdc
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc)		—	—	0.25	
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		—	—	1.5	
Collector Cutoff Current (V_{CE} = 850 Vdc, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current (V_{EB} = 6.0 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	$V_{CE(sat)}$				Vdc
(I_C = 5.0 Adc, I_B = 0.5 Adc)		—	—	2.5	
(I_C = 10 Adc, I_B = 1.0 Adc)		—	—	3.0	
(I_C = 10 Adc, I_B = 1.0 Adc, T_C = 100°C)		—	—	3.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 10 Adc, I_B = 1.0 Adc)		—	—	1.5	
(I_C = 10 Adc, I_B = 1.0 Adc, T_C = 100°C)		—	—	1.5	
DC Current Gain (I_C = 15 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	7.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)	C_{ob}	—	—	400	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Resistive Load							
Delay Time	(I_C = 10 Adc, V_{CC} = 250 Vdc, I_{B1} = 1.0 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 2.0 Adc, R_B = 1.6 Ω)	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 Vdc)	t_s	—	600	—	
Fall Time			t_f	—	100	—	
Inductive Load							
Storage Time	(I_C = 10 Adc, I_{B1} = 1.0 Adc, $V_{BE(off)}$ = 5.0 Vdc, $V_{CE(pk)}$ = 400 Vdc)	(T_C = 100°C)	t_{sv}	—	800	1500	ns
Fall Time			t_{fi}	—	50	150	
Crossover Time			t_c	—	100	200	
Storage Time		(T_C = 150°C)	t_{sv}	—	860	—	
Fall Time			t_{fi}	—	40	—	
Crossover Time			t_c	—	80	—	

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%

MJ16010, MJ16012, MJH16010, MJH16012

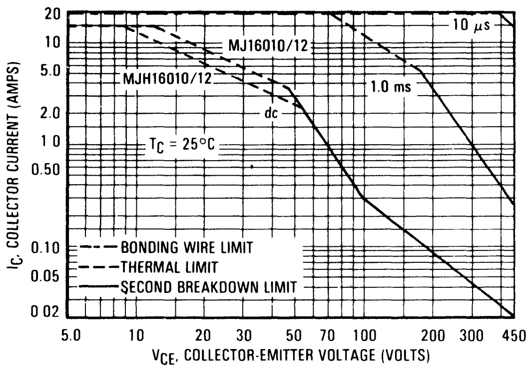


Fig. 1 — Maximum forward-bias safe-operating-areas for all types.

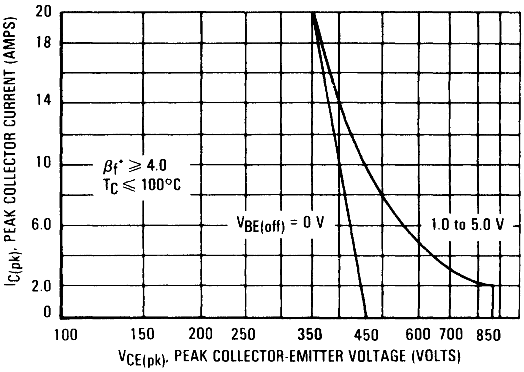


Fig. 2 — Maximum reverse-bias safe-operating-areas for all types.

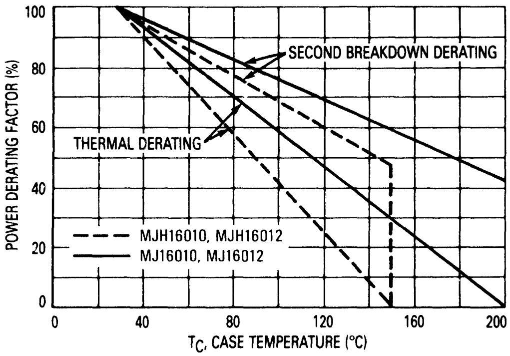


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for all types.

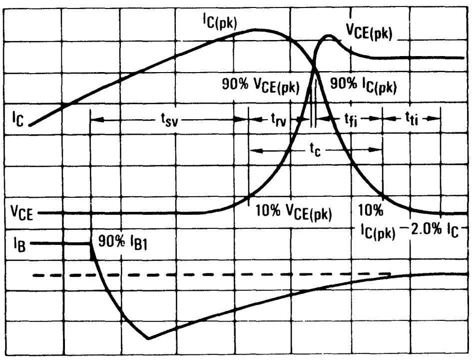


Fig. 4 — Inductive switching measurements display.

MJE13004, MJE13005

File Number **1840**

4-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

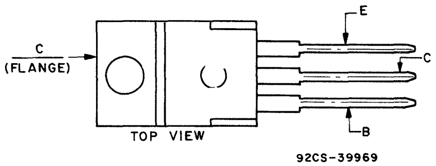
Features:

- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 600 V to 700 V*
- *Low $V_{CE}(sat)$ at I_c = 4A*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA 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:*

	MJE13004	MJE13005	
V_{CEV}			
V_{BE} = −1.5 V	600	700	V
V_{CEO}	300	400	V
V_{EBO}	9	9	V
I_C(sat)	4	4	A
I_C	4	4	A
I_{CM}	8	8	A
I_B	2	2	A
I_{BM}	4	4	A
P_T			
@ T_C = 25°C	75	75	W
@ T_C = 100°C	45	45	W
T_C above 25°C, derate linearly	0.6	0.6	W/°C
T_{stg}, T_J	−65 to +150	−65 to +150	°C
TL			
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max	235	235	°C
$R_{\theta JC}$	1.67	1.67	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**						
Collector-Emitter Sustaining Voltage (I_C = 10 mA, I_B = 0) MJE13004		$V_{CEO(sus)}$	300	–	–	Vdc
MJE13005			400	–	–	
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc)		I_{CEV}	–	–	1	mAdc
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)			–	–	5	
Emitter Cutoff Current (V_{EB} = 9 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 Adc, V_{CE} = 5 Vdc)		h_{FE}	10	–	60	–
(I_C = 2 Adc, V_{CE} = 5 Vdc)			8	–	40	
Collector-Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.2 Adc)		$V_{CE(sat)}$	–	0.2	0.5	Vdc
(I_C = 2 Adc, I_B = 0.5 Adc)			–	0.3	0.6	
(I_C = 4 Adc, I_B = 1 Adc)			–	0.7	1	
(I_C = 2 Adc, I_B = 0.5 Adc, T_C = 100°C)			–	–	1	
Base-Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.2 Adc)		$V_{BE(sat)}$	–	0.90	1.2	Vdc
(I_C = 2 Adc, I_B = 0.5 Adc)			–	0.95	1.6	
(I_C = 2 Adc, I_B = 0.5 Adc, T_C = 100°C)			–	–	1.5	
DYNAMIC CHARACTERISTICS						
Current-Gain – Bandwidth Product (I_C = 500 mAdc, V_{CE} = 10 Vdc, f = 1 MHz)		f_T	4	–	–	MHz
Output Capacitance (V_{CB} - 10 Vdc, I_E = 0, f = 0.1 MHz)		C_{ob}	–	200	–	pF
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time	(V_{CC} = 125 Vdc, I_C = 2 A,	t_d	–	0.02	0.1	μs
Rise Time	I_{B1} = I_{B2} = 0.4 A, t_p = 25 μs,	t_r	–	0.08	0.7	μs
Storage Time	Duty Cycle ≤ 1%)	t_s	–	1.90	4	μs
Fall Time		t_f	–	0.16	0.9	μs
Inductive Load, Clamped						
Voltage Storage Time	(I_C = 2 A, V_{clamp} = 300 Vdc,	t_{sv}	–	1.60	4	μs
Crossover Time	I_{B1} = 0.4 A, $V_{BE(off)}$ = 5 Vdc, T_C = 100°C)	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

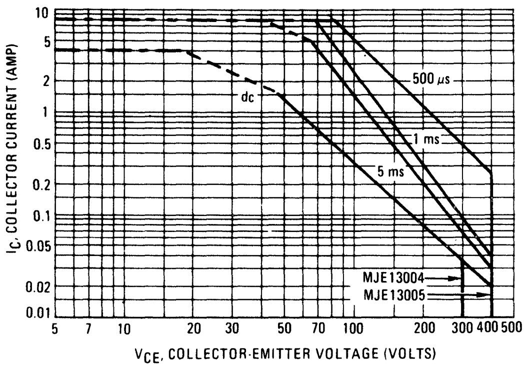


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

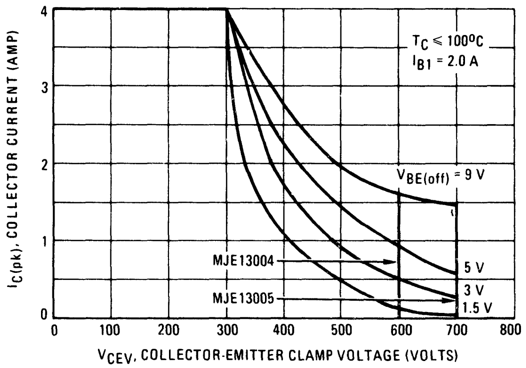


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

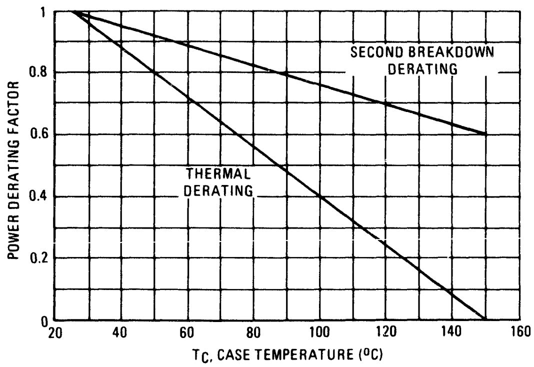


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

File Number **1841**

MJE13070, MJE13071

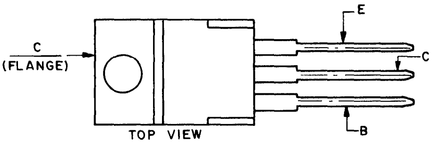
5-A SwitchMax II Power Transistors

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 V to 750 V*
- *Low $V_{CE}(sat)$ at I_c = 5A*

Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA 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:*

	MJE13070	MJE13071	
V_{CEV}			
V_{BE} = −1.5 V	650	750	V
V_{CEO}	400	450	V
V_{EBO}	6		V
$I_C(sat)$	5		A
I_C	5		A
I_{CM}	8		A
I_B	2		A
I_{BM}	4		A
P_T			
@ T_C = 25°C	80		W
@ T_C = 100°C	32		W
T_C above 25°C, derate linearly	0.64		W/°C
T_{stg}, T_J	−65 to +150		°C
TL			
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max	235		°C
$R_{\theta JC}$	1.56		°C/W

MJE13070, MJE13071

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100 mA, I_B = 0) MJE13070	$V_{CEO(sus)}$	400	—	—	Vdc
MJE13071		450	—	—	
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc)	I_{CEV}	—	—	0.5	mAdc
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		—	—	2.5	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	—	3.0	mAdc
Emitter Cutoff Current (V_{EB} = 6.0 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 Adc, V_{CE} = 5.0 Vdc	h_{FE}	8.0	—	—	—
Collector-Emitter Saturation Voltage (I_C = 3.0 Adc, I_B = 0.6 Adc)	$V_{CE(sat)}$	—	0.6	1.0	Vdc
(I_C = 5.0 Adc, I_B = 1.0 Adc)		—	2.0	3.0	
(I_C = 3.0 Adc, I_B = 0.6 Adc, T_C = 100°C)		—	—	2.0	
Base-Emitter Saturation Voltage (I_C = 3.0 Adc, I_B = 0.6 Adc)	$V_{BE(sat)}$	—	1.0	1.5	Vdc
(I_C = 3.0 Adc, I_B = 0.6 Adc, T_C = 100°C)		—	—	1.5	
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)	C_{ob}	—	—	250	pF

SWITCHING CHARACTERISTICS

Resistive Load

Characteristic	Conditions	Symbol	Min	Typ	Max	Unit
Delay Time	(V_{CC} = 250 Vdc, I_C = 3.0 Adc, I_{B1} = 0.4 Adc, t_p = 30 μs, Duty Cycle ≤2%, $V_{BE(off)}$ = 5.0 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

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Storage Time	($I_{C(pk)}$ = 3.0 A, I_{B1} = 0.4 Adc, $V_{BE(off)}$ = 5 0 Vdc, $V_{CE(pk)}$ = 250 V)	(T_J = 100°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°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 ≤2%

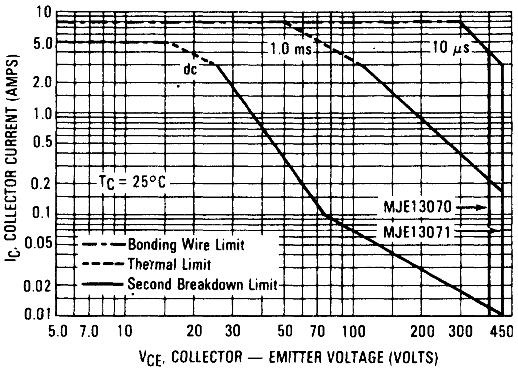


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

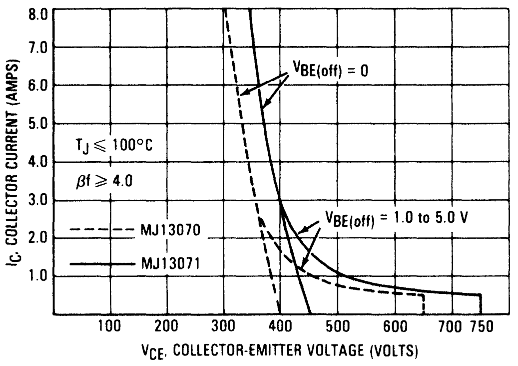


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

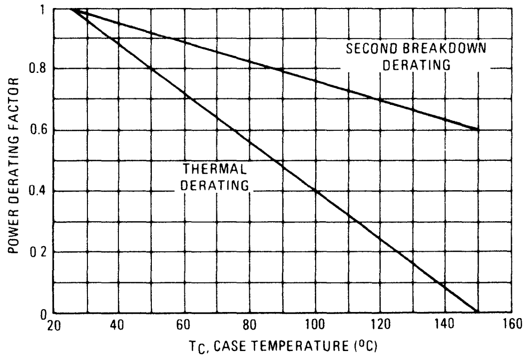


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

MJE16002, MJE16004

File Number **1842**

5-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

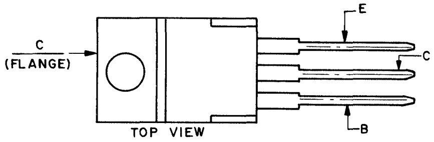
Features:

- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 850 V*
- *Low V_{CE}(sat) at I_c = 3A*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA 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}		
V_{BE} = -1.5 V	850	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°C	80	W
@ T_C = 100°C	32	W
T_C above 25°C, derate linearly	0.64	W/°C
T_{stg}, T_J	-65 to +150	°C
TL		
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max	235	°C
$R_{\theta JC}$	1.56	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100 mA, I_B = 0)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current	I_{CEV}				mAdc
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc)		—	—	0.25	
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		—	—	1.5	
Collector Cutoff Current (V_{CE} = 850 Vdc, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current (V_{EB} = 6.0 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	$V_{CE(sat)}$				Vdc
(I_C = 1.5 Adc, I_B = 0.2 Adc) MJE16002		—	0.5	1.0	
(I_C = 1.5 Adc, I_B = 0.15 Adc) MJE16004		—	0.5	1.0	
(I_C = 3.0 Adc, I_B = 0.4 Adc) MJE16002		—	1.2	2.5	
(I_C = 3.0 Adc, I_B = 0.3 Adc) MJE16004		—	1.2	2.5	
(I_C = 3.0 Adc, I_B = 0.4 Adc, T_C = 100°C) MJE16002		—	—	2.5	
(I_C = 3.0 Adc, I_B = 0.3 Adc, T_C = 100°C) MJE16004		—	—	2.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 3.0 Adc, I_B = 0.4 Adc) MJE16002		—	1.0	1.5	
(I_C = 3.0 Adc, I_B = 0.3 Adc) MJE16004		—	1.0	1.5	
(I_C = 3.0 Adc, I_B = 0.4 Adc, T_C = 100°C) MJE16002		—	—	1.5	
(I_C = 3.0 Adc, I_B = 0.3 Adc, T_C = 100°C) MJE16004		—	—	1.5	
DC Current Gain	h_{FE}				—
(I_C = 5.0 Adc, V_{CE} = 5.0 Vdc) MJE16002		5.0	—	—	
MJE16004		7.0	—	—	
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)	C_{ob}	—	—	200	pF

SWITCHING CHARACTERISTICS

Resistive Load	Conditions		Symbol	Min	Typ	Max	Unit
MJE16002							
Delay Time	(I_C = 3.0 Adc, V_{CC} = 250 Vdc, I_{B1} = 0.4 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 0.8 Adc, R_{B2} = 8.0 Ω)	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 Vdc)	t_s	—	330	—	
Fall Time			t_f	—	100	—	
MJE16004							
Delay Time	(I_C = 3.0 Adc, V_{CC} = 250 Vdc, I_{B1} = 0.3 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 0.6 Adc, R_{B2} = 8.0 Ω)	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 Vdc)	t_s	—	270	—	
Fall Time			t_f	—	90	—	

(1) Pulse Test: PW - 300 μs, Duty Cycle ≤2%.

MJE16002, MJE16004

SWITCHING CHARACTERISTICS (continued)

Characteristics			Symbol	Min	Typ	Max	Unit
Inductive Load	**MJE16002**						
Storage Time	(I_C = 3.0 Adc, I_{B1} = 0.4 Adc, $V_{BE(off)}$ = 5.0 Vdc, $V_{CE(pk)}$ = 400 Vdc)	(T_J = 100°C)	t_{sv}	—	660	1600	ns
Fall Time			t_{fi}	—	50	200	
Crossover Time			t_c	—	80	250	
Storage Time		(T_J = 150°C)	t_{sv}	—	690	—	
Fall Time			t_{fi}	—	50	—	
Crossover Time			t_c	—	90	—	
Inductive Load	**MJE16004**						
Storage Time	(I_C = 3.0 Adc, I_{B1} = 0.3 Adc, $V_{BE(off)}$ = 5.0 Vdc, $V_{CE(pk)}$ = 400 Vdc)	(T_J = 100°C)	t_{sv}	—	530	1300	ns
Fall Time			t_{fi}	—	40	150	
Crossover Time			t_c	—	80	200	
Storage Time		(T_J = 150°C)	t_{sv}	—	600	—	
Fall Time			t_{fi}	—	40	—	
Crossover Time			t_c	—	80	—	

(1) Pulse Test: PW - 300 μs, Duty Cycle ≤2%.

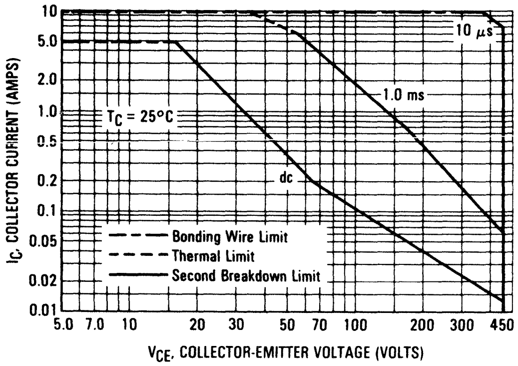


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

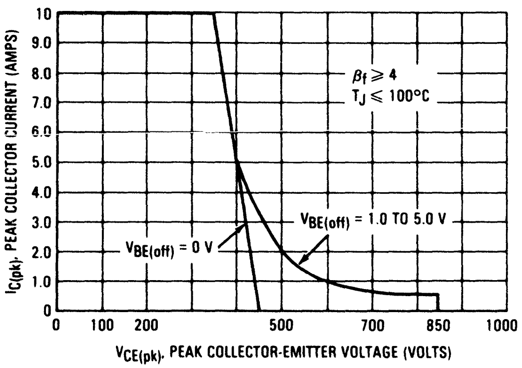


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

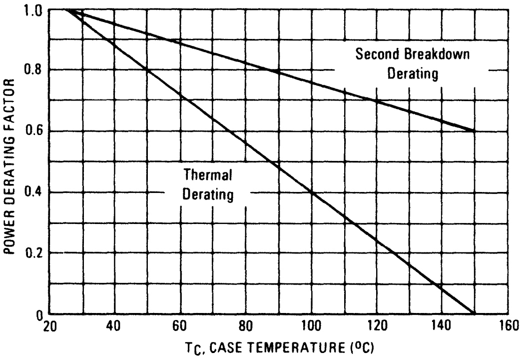


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

High-Speed Power Transistors
Technical Data

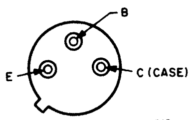
2N697 File Number **16**

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 RCA-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.

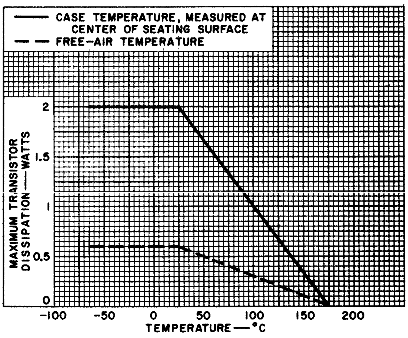


Fig. 1 - Current derating chart.

MAXIMUM RATINGS, *Absolute-Maximum Values*

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

* In accordance with JEDEC registration data.

2N697

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

	CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT mA dc			LIMITS			UNITS
		V_{CB}	V_{CE}	I_C	I_E	I_B	Min.	Typ.	Max.	
*	I_{CBO}	30			0		–	0.01	1	µA
	T_A = 150°C	30			0		–	1	100	µA
*	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
*	$V_{CER}(sus)$ 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.

2N1613, 2N2102

File Number **106**

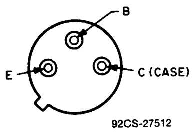
Medium-Power Silicon N-P-N Planar Transistors

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:* $V_{(BR)CBO}$ = 120 V min. at I_C = 0.1 mA
- *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
- *Beta (h_{FE}) controlled over 5 decades of I_C*

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The RCA-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 pulsed beta.

RCA-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
* $V_{CER}(sus)$			
R_{BE} = 10 Ω	80	50	V
* $V_{CEO}(sus)$	65	—	V
* V_{EBO}	7	7	V
I_C	1*	1	A
* P_T:			
At $T_C \leq 25°C$	5	3	W
At $T_A \leq 25°C$	1	0.8	W
At $T_C > 25°C$ ... Derate linearly	2.86	17.1	mW/°C
At $T_A > 25°C$ ... Derate linearly	5.7	4.57	mW/°C
* T_J, T_{stg}	-65 to +200		°C
* T_L (During soldering):			
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	300		°C

* In accordance with JEDEC registration data format.

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	μA
* 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}		5	1		30	100	30	100	
f=1 kHz		10	5		35	150	35	150	
$\|h_{fe}\|$ f=20 MHz		10	50		3	–	3	–	
* h_{ib}	5		1		24	34	24	34	Ω
f=1 kHz	10		5		4	8	4	8	Ω
* h_{rb}	5		1		–	$3x10^{-4}$	–	$3x10^{-4}$	
	10		1		–	$3x10^{-4}$	–	–	
f=1 kHz	10		5		–	–	–	$3x10^{-4}$	
* h_{ob}	5		1		0.05	0.5	0.01	0.5	μmho
f=1 kHz	10		5		0.05	0.5	0.01	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
$R_{\theta JC}$					–	58.3	–	35	°C/W
$R_{\theta JA}$					–	219	–	175	°C/W

* 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

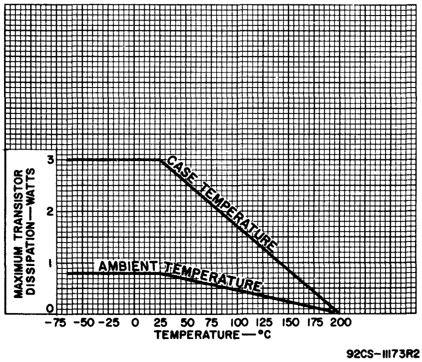


Fig. 1 — Rating chart for 2N1613.

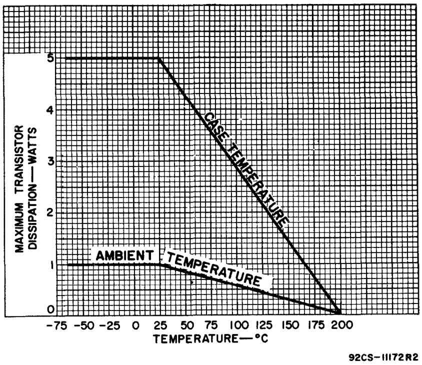


Fig. 2 — Rating chart for 2N2102.

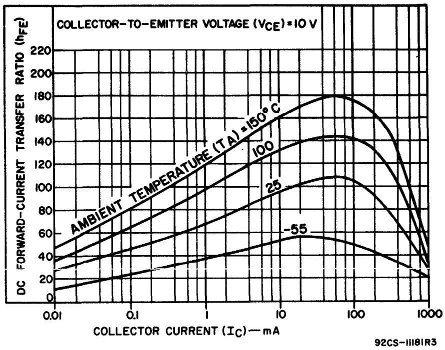


Fig. 3 — Typical dc beta characteristics for both types.

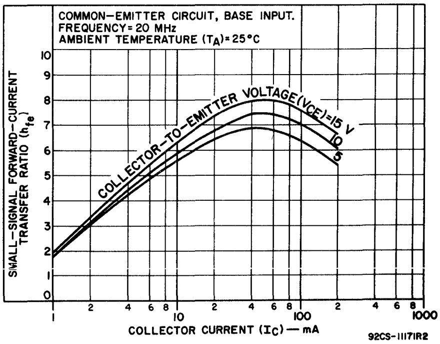


Fig. 4 — Typical small-signal beta characteristics for both types.

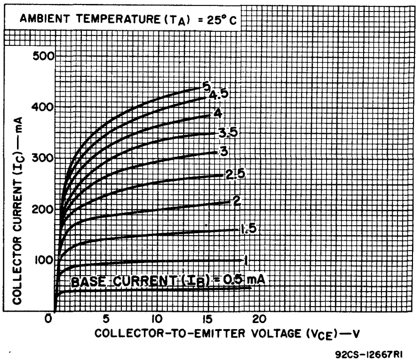


Fig. 5 — Typical output characteristics for both types.

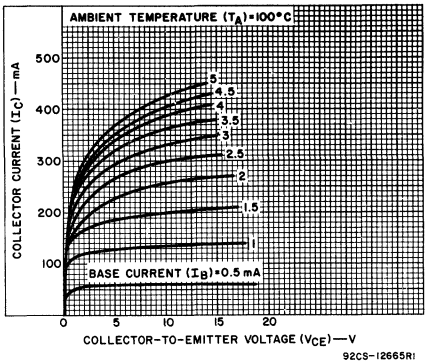


Fig. 6 — Typical output characteristics for both types at $T_A = 100^{o}C$.

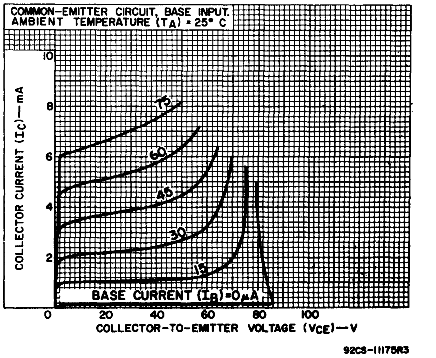


Fig. 7 — Typical high-current output characteristics for both types.

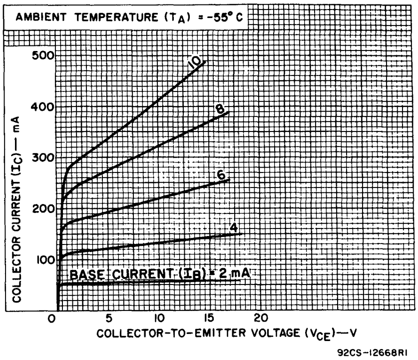


Fig. 8 — Typical output characteristics for both types at $T_A = -55^oC$.

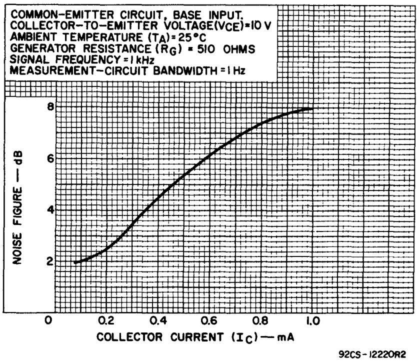


Fig. 9 — Typical noise figure characteristics for both types.

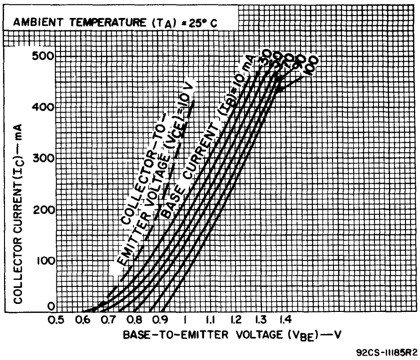


Fig. 10 — Typical transfer characteristics for both types.

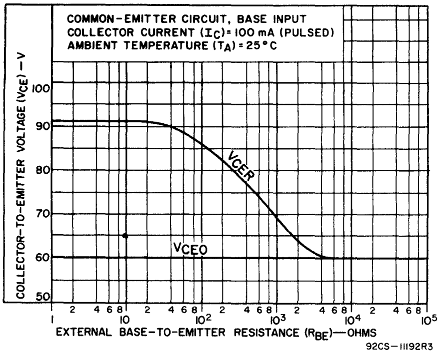


Fig. 11 — Typical sustaining voltage vs. base-to-emitter resistance for 2N1613.

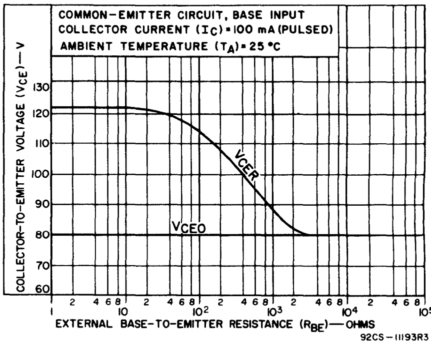


Fig. 12 — Typical sustaining voltage vs. base-to-emitter resistance for 2N2102.

2N1613, 2N2102

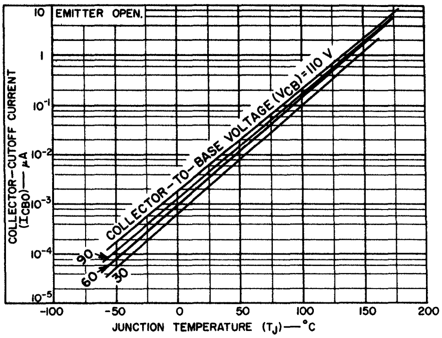


Fig. 13 — Typical leakage characteristics for both types.

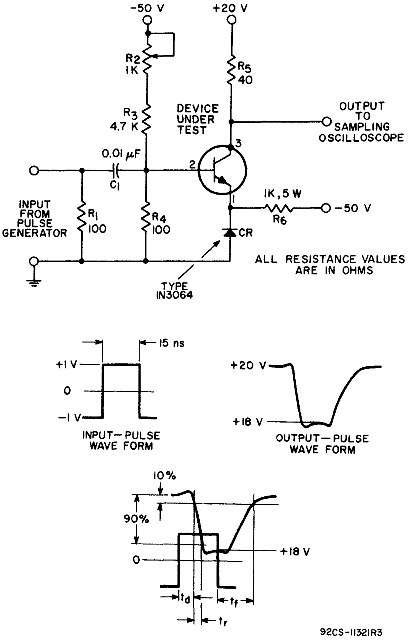


Fig. 14 — Circuit for measurement of switching time, and associated waveforms.

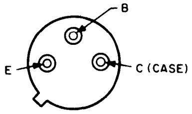
File Number **34**

2N1893, 2N2405

Medium-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications In Industrial and Commercial Equipment

TERMINAL DESIGNATIONS



92CS-27512

JEDEC TO-205AD

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

The RCA-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}).

RCA-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	V_{CBO}	120	120	V
* COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With external base-to-emitter resistance (R_{BE}) ≤ 10 Ω	V_{CER}	100	140	V
With base open	V_{CEO}	80	90	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
* COLLECTOR CURRENT	I_C	0.5	1	A
* TRANSISTOR DISSIPATION:	P_T			
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)	T_{stg}, T_J	-65 to +200		°C
* LEAD TEMPERATURE (During soldering): At distance from seating plane for 10 s max. ≥ 1/16 in. (1.58 mm) for 2N1893 and ≥ 1/32 in. (0.8 mm) for 2N2405	T_L	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}	90			0		–	0.01	–	0.01	μA
T_C = 150°C	90			0		–	15	–	10	
* I_{EBO} V_{BE} = –5 V			0			–	0.01	–	0.01	μA
* $V_{CEO}(sus)$			100[a]		0	–	–	90	–	V
			30[a]		0	80	–	90	–	
* $V_{CER}(sus)$ R_{BE} = 10 Ω			100[a]			100	–	140	–	V
R_{BE} = 500 Ω			100[a]			–	–	120	–	
* $V_{(BR)CBO}$			0.1	0		120	–	120	–	V
* $V_{(BR)EBO}$			0	0.1		7	–	7	–	V
* $V_{CE}(sat)$			150[a]		15	–	5	–	0.5	V
			50[a]		5	–	1.5	–	0.2	
* $V_{BE}(sat)$			150[a]		15	–	1.3	–	1.1	V
			50[a]		5	–	0.9	–	0.9	
* h_{FE}		10	150[a]			40	120	60	200	
*		10	10[a]			35	–	35	–	
*		10	0.1			20	–	–	–	
* T_C = 55°C		10	10			20	–	20	–	
h_{fe}										
* f = 1 kHz		5	1			30	100	–	–	
* 1 kHz		5	5			–	–	50	275	
* 1 kHz		10	5			45	–	–	–	
* 20 MHz		10	50			2.5	–	6	–	
* h_{ib}	5		1			20	30	24	34	Ω
f = 1 kHz	10		5			4	8	4	8	
* h_{rb}	5		1			–	1.25×10^{-4}	–	3×10^{-4}	
f = 1 kHz	10		5			–	1.5×10^{-4}	–	3×10^{-4}	
* h_{ob}	5		1			–	0.5	–	0.5	μmho
f = 1 kHz	10		5			–	0.5	–	0.5	
* 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 kHz	10		0.3			–	–	–	6	dB
* $R_{\theta J\text{-}C}$						–	58.3	–	35	°C/W
$R_{\theta J\text{-}A}$						–	219	–	175	

[a] Pulsed. Pulse duration = 300 μsec max.; duty factor ⩽2%.

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

2N1893, 2N2405

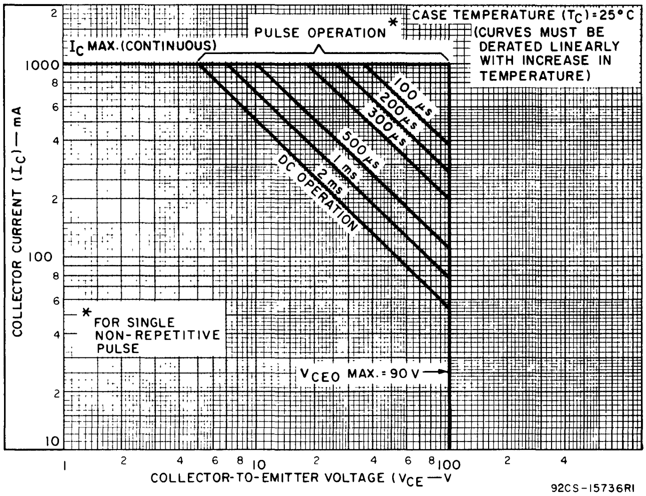


Fig. 1 — Maximum operating areas for type 2N2405.

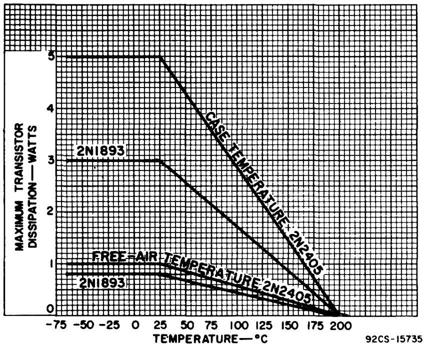


Fig. 2 — Dissipation derating curves for types 2N1893, and 2N2405.

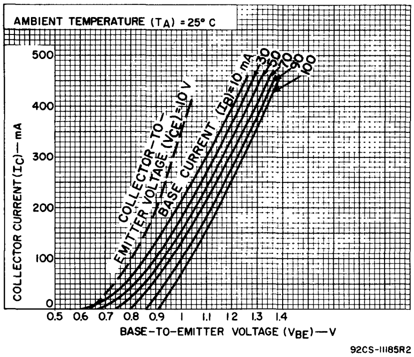


Fig. 3 — Typical transfer characteristics for types 2N1893 and 2N2405.

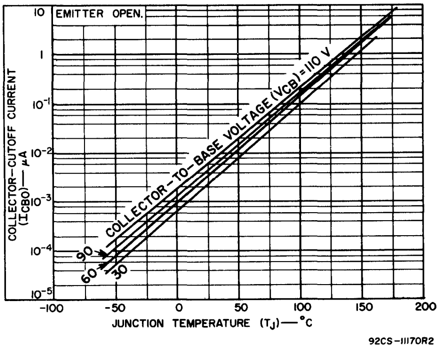


Fig. 4 — Typical cutoff characteristics for types 2N1893 and 2N2405.

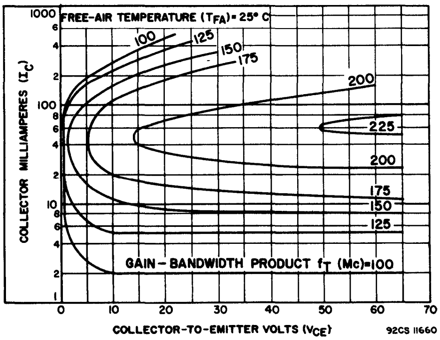


Fig. 5 — Typical gain bandwidth product characteristics for types 2N1893 and 2N2405.

2N1893, 2N2405

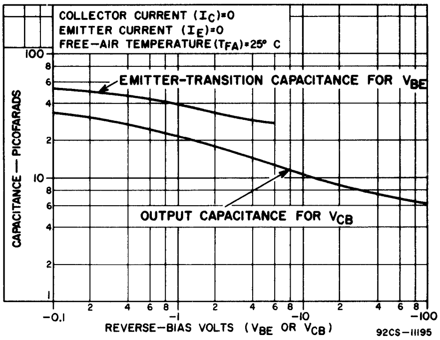


Fig. 6 — Typical capacitance characteristics for types 2N1893 and 2N2405.

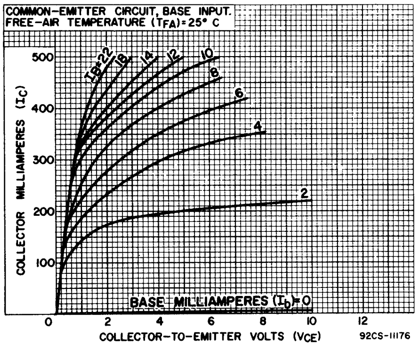


Fig. 7 — Typical collector characteristics at 25°C for type 2N2405.

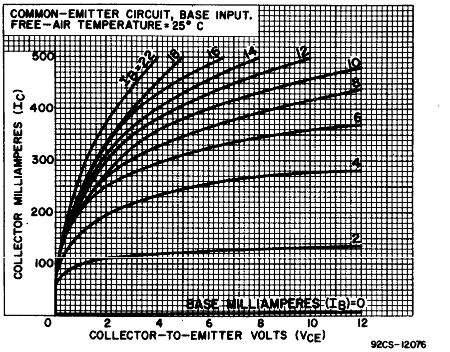


Fig. 8 — Typical collector characteristics at 25°C for type 2N1893.

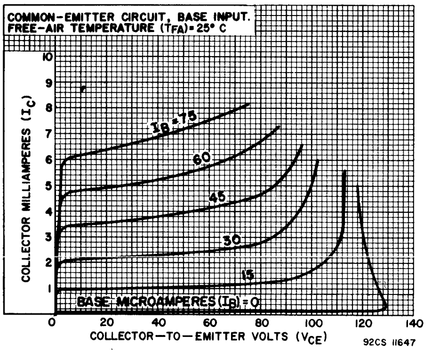


Fig. 9 — Typical collector characteristics at 25°C for type 2N2405.

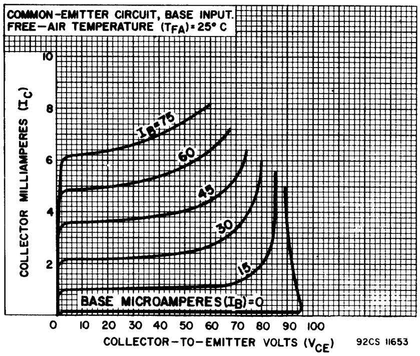


Fig. 10 — Typical collector characteristics at 25°C for type 2N1893.

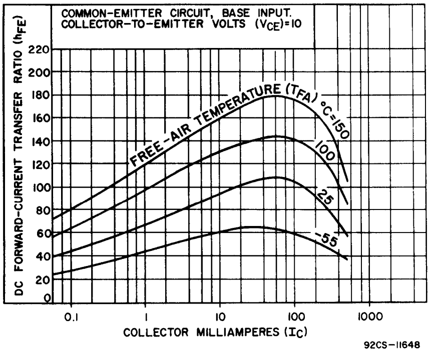


Fig. 11 — Typical dc-beta characteristics for types 2N1893 and 2N2405.

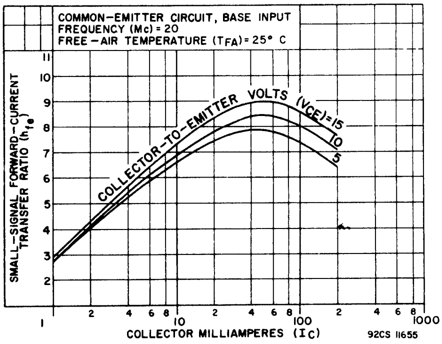


Fig. 12 — Typical small-signal beta characteristics for types 2N1893 and 2N2405.

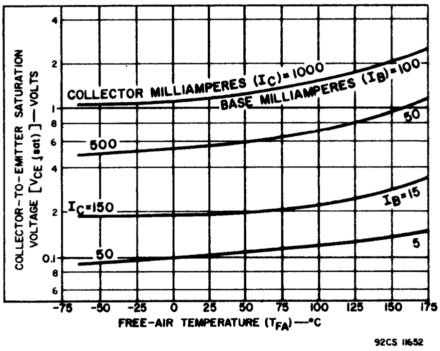


Fig. 13 — Typical saturation characteristics for types 2N1893 and 2N2405.

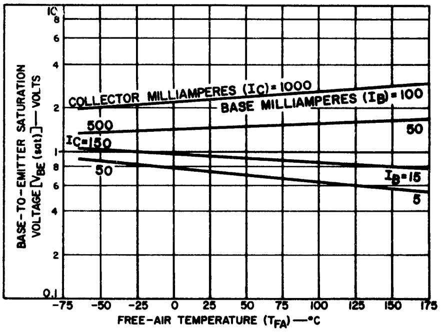


Fig. 14 — Typical saturation characteristics for types 2N2405 and 2N1893.

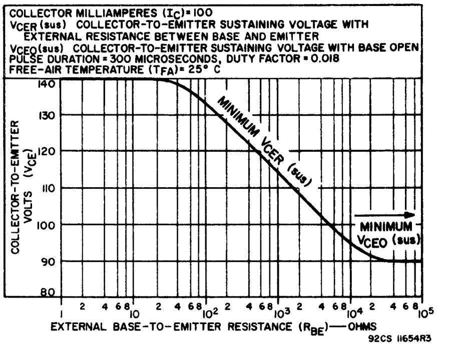


Fig. 15 — Sustaining voltage characteristic for type 2N2405.

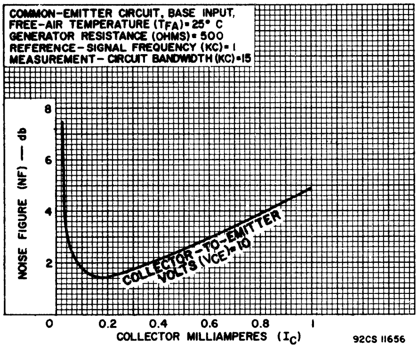


Fig. 16 — Typical wide-band noise characteristic for type 2N2405.

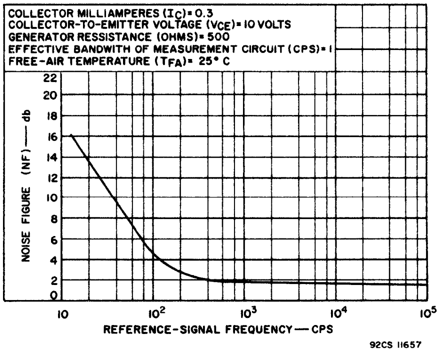


Fig. 17 — Typical narrow-band noise characteristic for type 2N2405.

2N2270

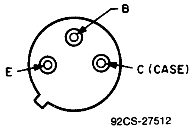
File Number **24**

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 RCA-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}) ≤ 10 Ω	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 ≥ 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).

2N2270

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}	60					–	0.05	μA
T_C = 150°C	60					–	50	
* 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		150[b]		50	200	
		10		1		30	–	
* 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
* $R_{\theta JC}$						–	35	°C/W
* $R_{\theta JA}$						–	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

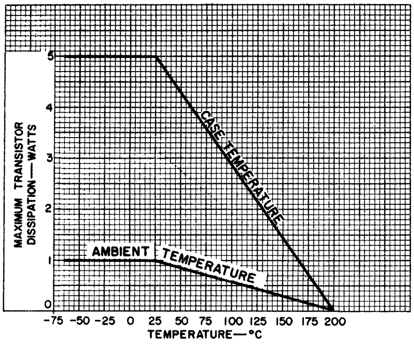


Fig. 1 – Rating Chart.

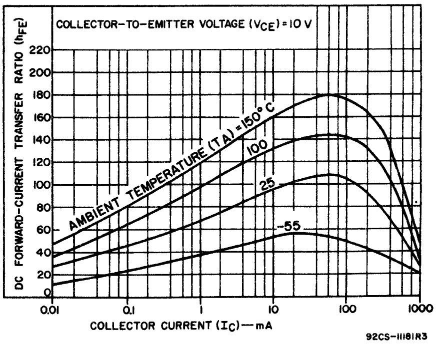


Fig. 2 – Typical dc forward-current transfer ratio characteristics.

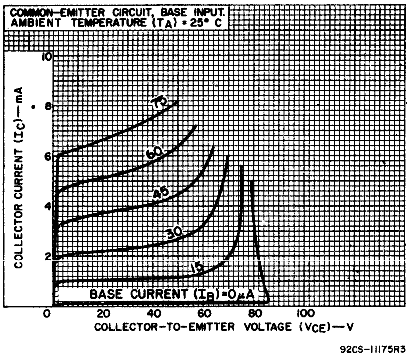


Fig. 3 – Typical collector characteristics.

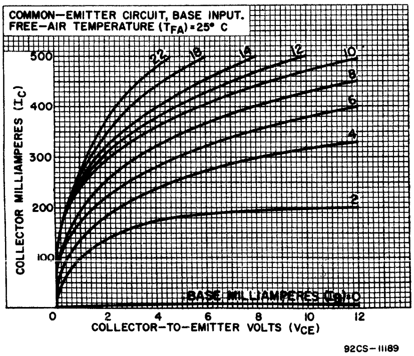


Fig. 4 – Typical collector characteristics.

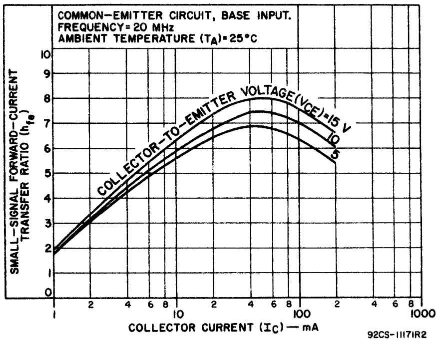


Fig. 5 – Typical small-signal forward-current ratio characteristics.

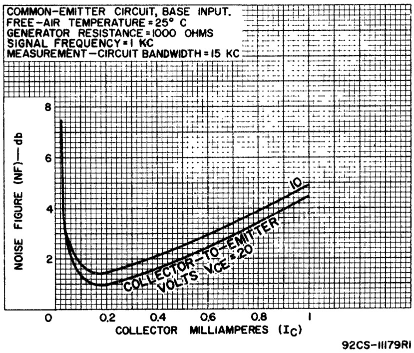


Fig. 6 – Typical af noise-figure characteristics.

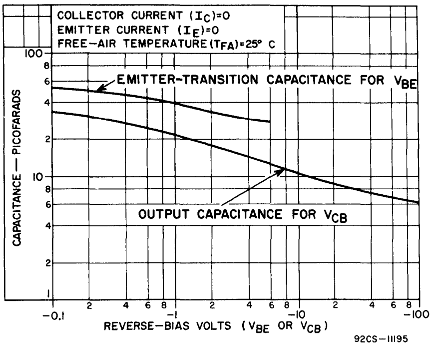


Fig. 7 — Typical emitter-transition-capacitance and output-capacitance characteristics.

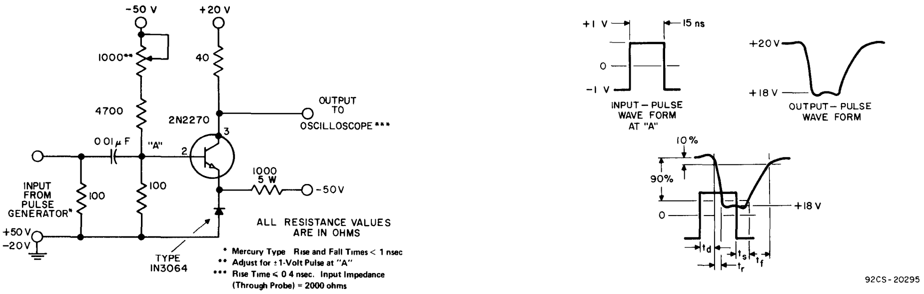


Fig. 8 — Test circuit for measurement of saturated switching time and associated waveforms.

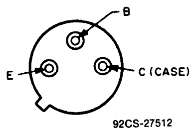
2N3053, 2N3053A

File Number **960**

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

For Small-Signal Applications

TERMINAL DESIGNATIONS



JEDEC TO-205AD

Features:

- *Maximum safe-area-of-operation curve*
- *High gain-bandwidth product f_T = 100 MHz*
- *Low leakage current*

Applications:

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

The RCA-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 Ω	50	70	V
* $V_{CEO}(sus)$	40	60	V
$V_{CEV}(sus)$			
V_{BE} = -1.5 V	60	80	V
* V_{EBO}	5	5	V
* I_C	0.7	0.7	A
* P_T			
$T_C \leq$ 25°C	5	5	W
$T_A \leq$ 25°C	1	1	W
$T_C >$ 25°C	Derate linearly 0.0286		W/°C
* T_{stg}, T_J	-65 to +200		°C
* T_L			
At distance 1/16 ± 1/32 in. (1.58 mm ± 0.8 mm) from seating plane for 10 s max.	235		°C

* In accordance with JEDEC registration data.

2N3053, 2N3053A

ELECTRICAL 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}	IC	IB	Min.	Max.	Min.	Max.	
* I_{CEV}	30	—	-1.5	—	—	—	0.25	—	—	μA
	60	—	-1.5	—	—	—	—	—	0.25	
* I_{BEV}	—	60	-1.5	—	—	—	—	—	0.25	μA
* I_{EBO}	—	—	-4	0	—	—	0.25	—	0.25	μA
* h_{FE}	—	2.5	—	150	—	25	—	25	—	
	—	10	—	150[a]	—	50	250	50	250	
* $V_{(BR)CBO}$	—	—	—	0.1	—	60	—	80	—	V
* $V_{(BR)EBO}$ 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 Ω	—	—	—	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
* hfe 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%.

2N3053, 2N3053A

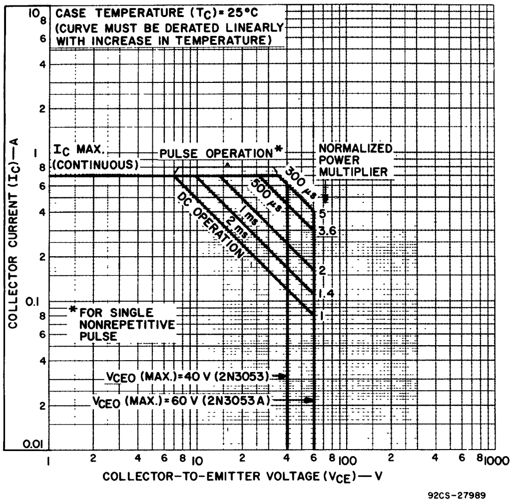


Fig. 1 - Maximum operating areas for 2N3053, 2N3053A.

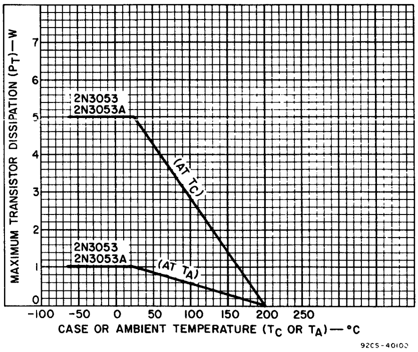


Fig. 2 - Dissipation derating curves for all types.

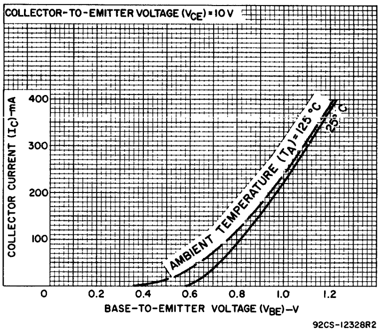


Fig. 3 - Typical transfer characteristics for all types.

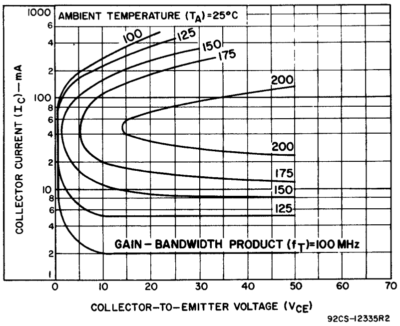


Fig. 4 - Typical dc beta characteristics for all types.

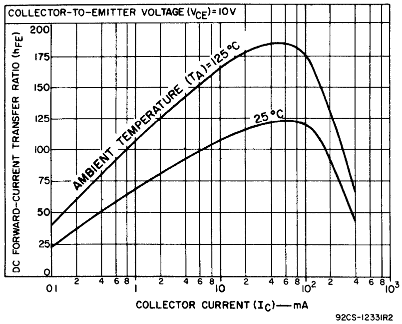


Fig. 5 - Typical variation of gain-bandwidth product with Ic and VCE for all types.

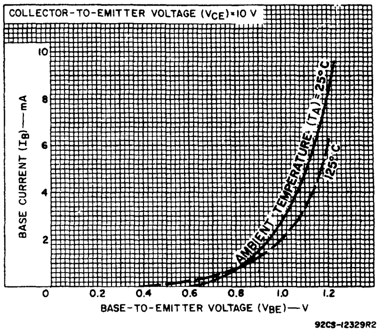


Fig. 6 - Typical input characteristics for all types.

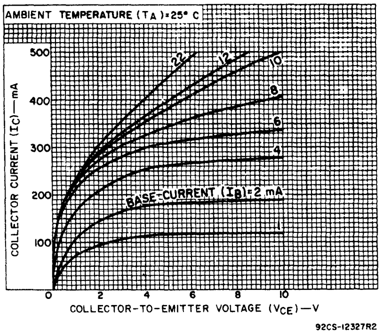


Fig. 7 - Typical output characteristics for all types.

2N3878, 2N3879, 2N5202, 2N6500

File Number **766**

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

For High-Speed Switching and Linear-Amplifier Applications

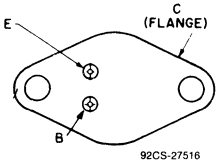
Features:
- *Maximum-area-of-operation curves for dc and pulse operation*
- *High substaining voltage*
- *Total saturated transition time less than 1 μs for 2N3879, 2N5202, and 2N6500*

RCA-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_{CBO}	120	120	100	120	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 50 Ω	V_{CER}(sus)	65	90	75*	110*	V
With base open	V_{CEO}(sus)	50*	75*	50	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					
At case temperature (T_C) = 25°C		35	35	35	35	W
At case temperatures above 25°C		Derate linearly at 0.2 W/°C				
For other conditions		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 VOLTAGE V dc		CURRENT A dc		LIMITS 2N3878		2N3879		2N5202		2N6500		UNITS
		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	
		120	−1.5			–	25	–	25	–	–	–	–	
* With base-emitter junction reverse-biased and T_C = 150°C		100	−1.5			–	4	–	4	–	10	–	–	
		110	0			–	–	–	–	–	–	–	10	
With base open	I_{CEO}	40			0	–	5*	–	5	–	–	–	–	mA
		70			0	–	–	–	–	–	–	–	5	
* Emitter Cutoff Current	I_{EBO}		−6			–	–	–	–	–	10	–	–	mA
			−7			–	10	–	10	–	–	–	25	
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]		
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]	0.3	–	–	–	–	–	–	–	1.5	V
				4[b]	0.4	–	2	–	1.2	–	1.2	–	–	
* Base-to-Emitter Voltage	V_{BE}	2		4b	–	–	2.5	–	–	–	–	–	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			3[b]	0.3	–	–	–	–	–	–	–	2.5	V
				4[b]	0.4	–	–	–	2	–	2	–	–	
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-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	$R_{\theta JC}$					–	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

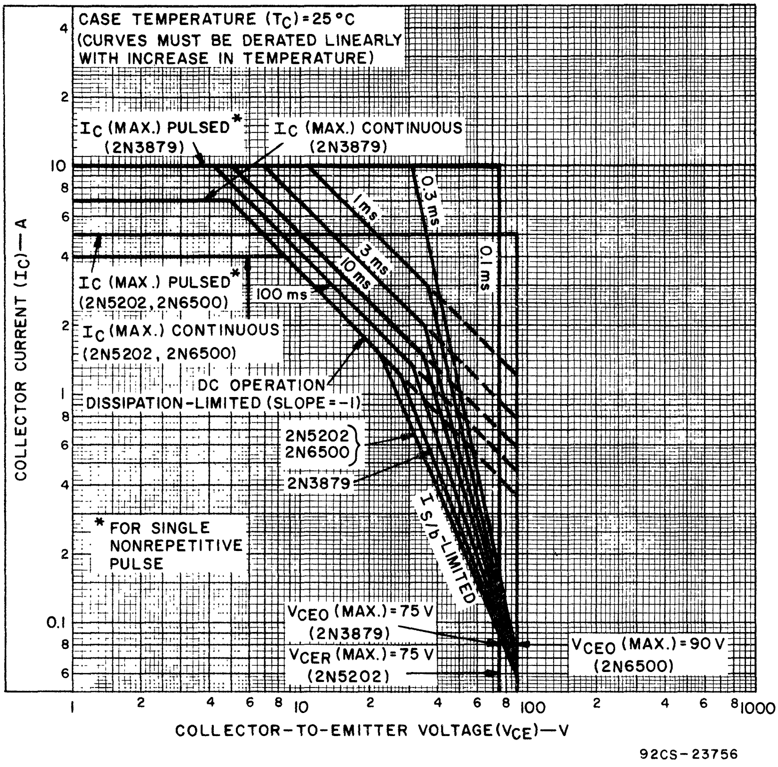


Fig. 1 – Maximum operating areas for 2N3879, 2N5202, and 2N6500.

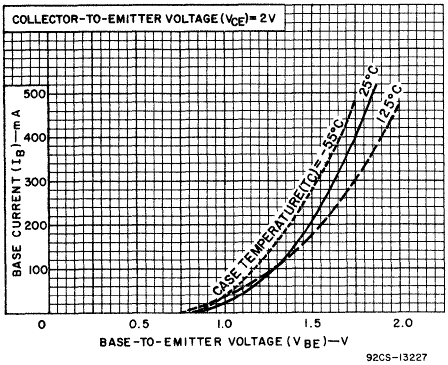


Fig. 2 – Typical input characteristics for all types.

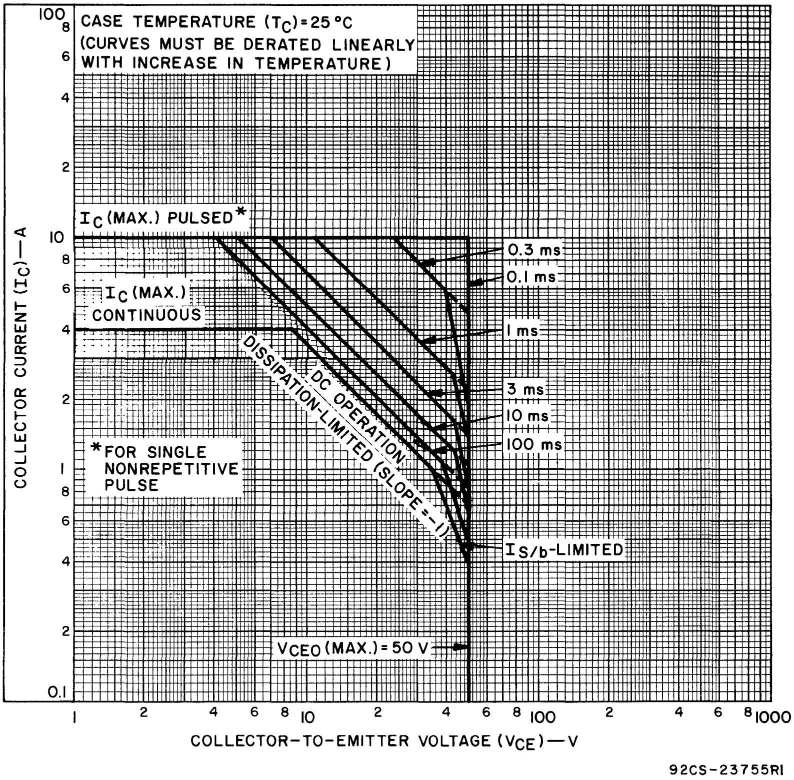


Fig. 3 – Maximum operating areas for 2N3878.

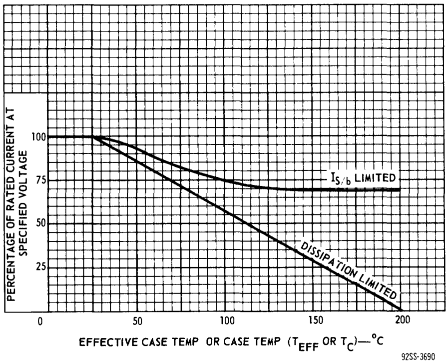


Fig. 4 – Dissipation derating for all types.

2N3878, 2N3879, 2N5202, 2N6500

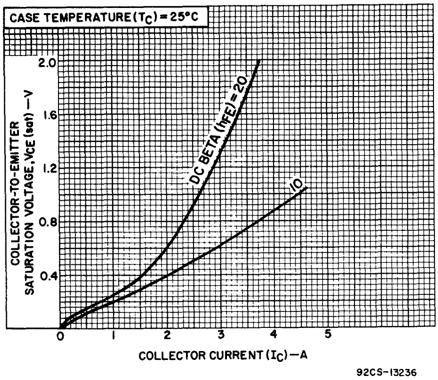


Fig. 5 – Typical saturation-voltage characteristics for 2N3878, and 2N3879.

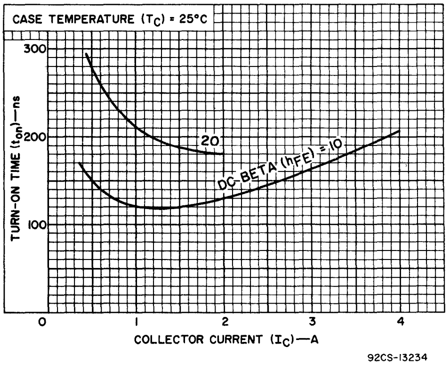


Fig. 6 – Typical turn-on time for 2N3879, 2N5202, and 2N6500.

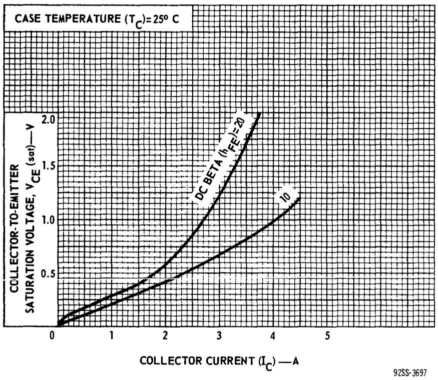


Fig. 7 – Typical saturation-voltage characteristics for 2N5202.

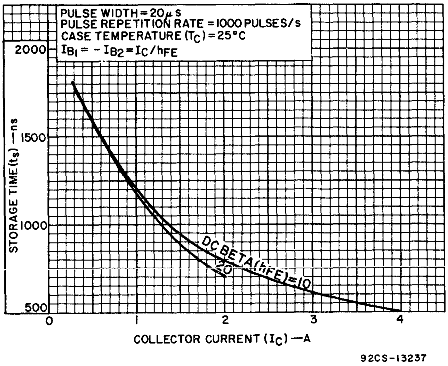


Fig. 8 – Typical storage time for 2N3879, 2N5202, and 2N6500.

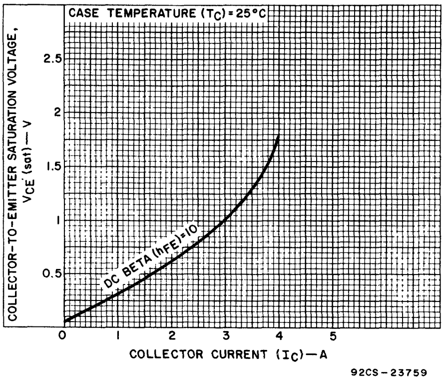


Fig. 9 – Typical saturation-voltage characteristics for 2N6500.

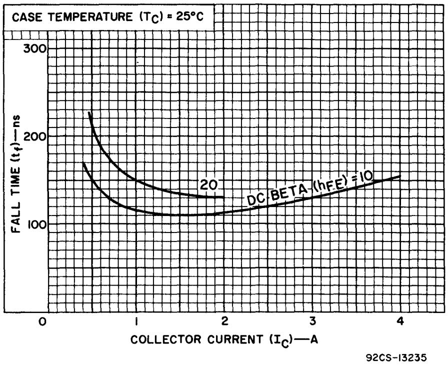


Fig. 10 – Typical fall time for 2N3879, 2N5202, and 2N6500.

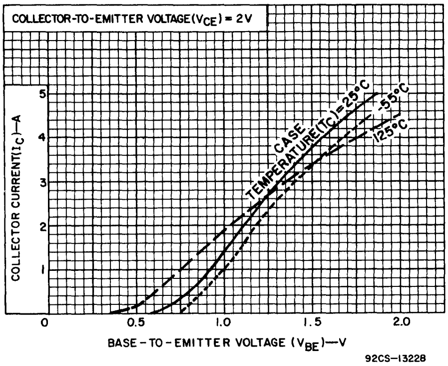


Fig. 11 – Typical transfer characteristics for all types.

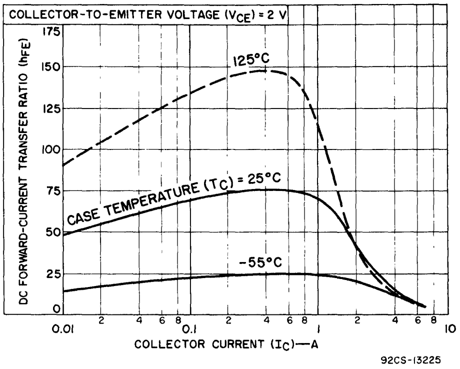


Fig. 12 – Typical dc beta characteristics for ***2N3878 and 2N3879.***

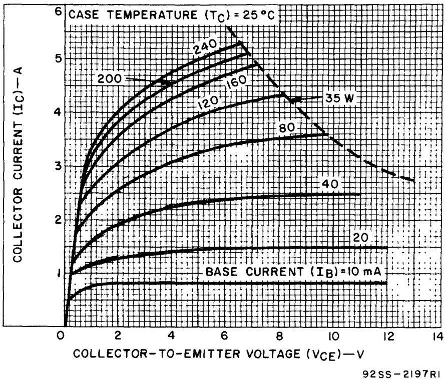


Fig. 13 – Typical output characteristics for ***2N3878, 2N3879 and 2N5202.***

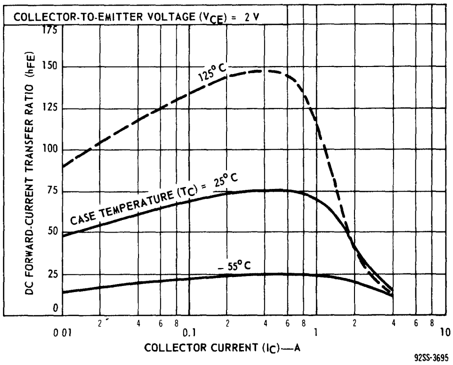


Fig. 14 – Typical dc beta characteristics for 2N5202.

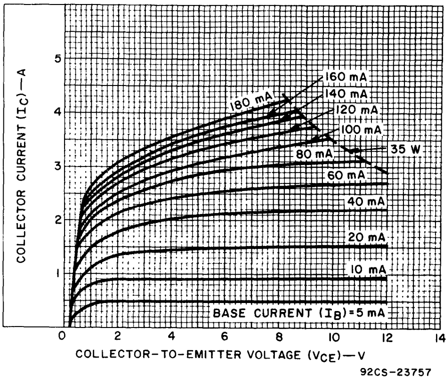


Fig. 15 – Typical output characteristics for 2N6500.

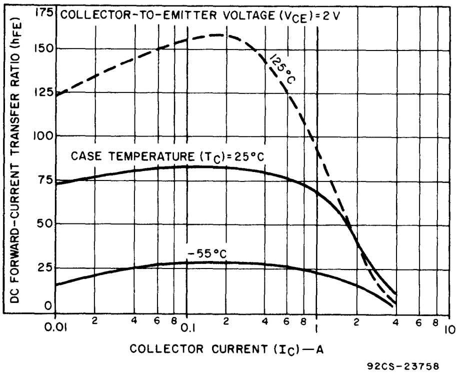


Fig. 16 – Typical dc beta characteristics for 2N6500.

2N3878, 2N3879, 2N5202, 2N6500

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc	TEST CONDITIONS: CURRENT A dc		LIMITS: 2N3879		LIMITS: 2N5202		LIMITS: 2N6500		UNITS
		V_{CC}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
Saturated Switching Time: Delay time	t_d	30	3	0.3[a]	–	–	–	–	–	40	ns
		30	4	0.4[a]	–	40	–	–	–	–	
		30	4	0.8[a]	–	–	–	40	–	–	
* Rise time	t_r	30	3	0.3[a]	–	–	–	–	–	400	
		30	4	0.4[a]	–	400	–	–	–	–	
		30	4	0.8[a]	–	–	–	400	–	–	
* Storage time	t_s	30	3	0.3[a]	–	–	–	–	–	1000	
		30	4	0.4[a]	–	800	–	–	–	–	
		30	4	0.8[a]	–	–	–	1200	–	–	
* Fall time	t_f	30	3	0.3[a]	–	–	–	–	–	500	
		30	4	0.4[a]	–	400	–	–	–	–	
		30	4	0.8[a]	–	–	–	400	–	–	

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

[a] $I_{B_1} = I_{B_2}$

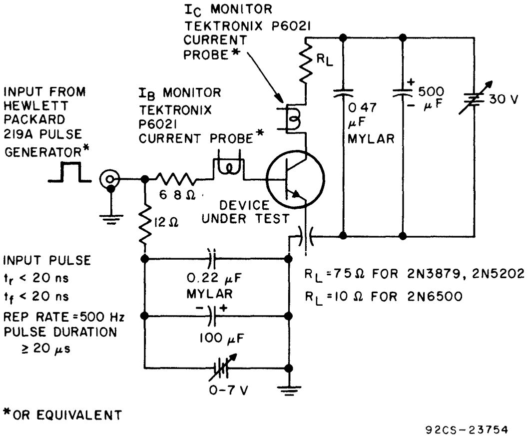


Fig. 17 - Circuit used to measure switching times for 2N3879, 2N5202, and 2N6500.

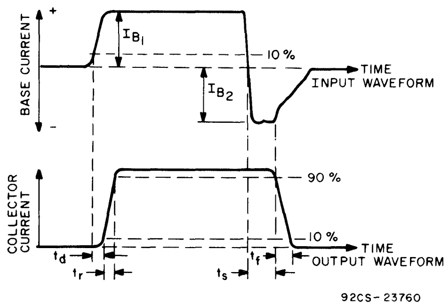


Fig. 18 - Oscilloscope display for measurement of switching times. (Circuit shown in Fig. 1).

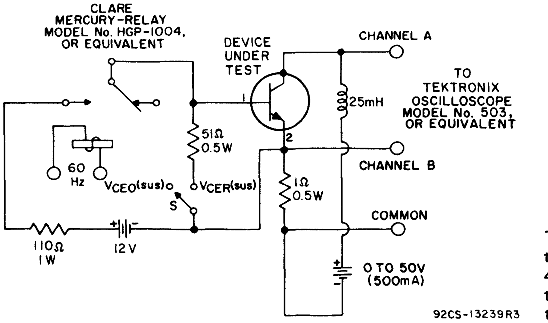
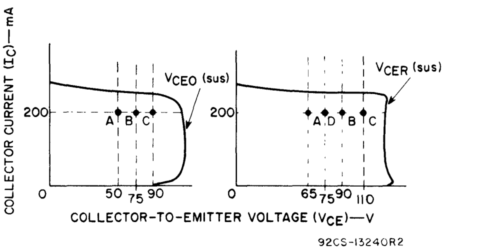


Fig. 19 - Circuit used to measure sustaining voltages, V_{CEO}(sus) and V_{CER}(sus) for all types.



The sustaining voltages V_{CEO}(sus) and V_{CER}(sus) are acceptable when the traces fall to the right and above point "A" for 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.

File Number **216**

2N4036, 2N4037, 2N4314

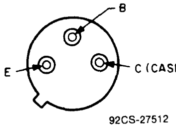
Medium-Power Silicon P-N-P Planar Transistors

General-Purpose Types for Industrial and Commerical 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*

TERMINAL DESIGNATIONS



JEDEC TO-205AD

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.

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: $T_C \leq 25°C$	7	7	7	W
	—	1	—	W
T_C, $T_A > 25°C$		See Fig. 2		°C
Pulsed		See Fig. 1		°C
*T_{stg}, T_J		-65 to 200		°C
*T_L (During soldering): At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max		230		°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 VOLTAGE V dc		CURRENT mA dc		LIMITS 2N4036		2N4037		2N4314		UNITS
	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*	μA
I_{CEO}	-30			0	–	-0.5*	–	-5*	–	-5*	μA
I_{CEX}	-85	1.5			–	-100*	–	–	–	–	mA
T_C = 150°C	-30	1.5			–	-0.1*	–	–	–	–	
I_{EBO}		7	0		–	-0.1*	–	–	–	–	mA
		5	0		–	-0.02	–	-1*	–	-1*	μA
$V_{(BR)CBO}$ $I_E = 0$			-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) $R_{BE} \leqslant 200\ \Omega$			-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	–	–	–	–	ns
* t_s	-30		-150	-15	–	600	–	–	–	–	ns
* t_f	-30		-150	-15	–	100	–	–	–	–	ns
* t_{ON}	-30		-150	-15	–	110	–	–	–	–	ns
* t_{OFF}	-30		-150	-15	–	700	–	–	–	–	ns
$R_{\theta JC}$					–	25*	–	25	–	25	°C/W
$R_{\theta JA}$					–	165	–	165	–	165	°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 μs, 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').

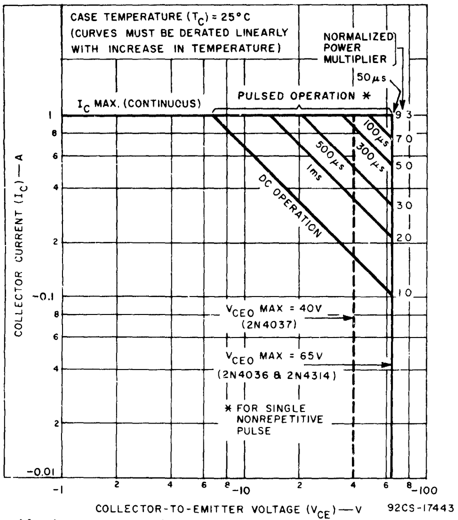


Fig. 1 - Maximum operating areas for 2N4036, 2N4037, and 2N4314.

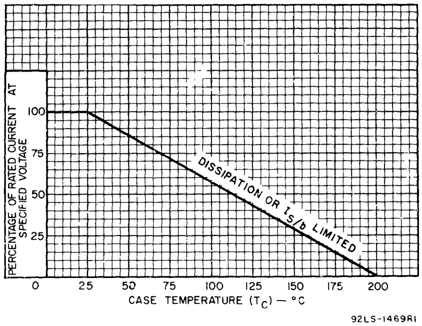


Fig. 2 - Dissipation derating curve for 2N4036, 2N4037, and 2N4314.

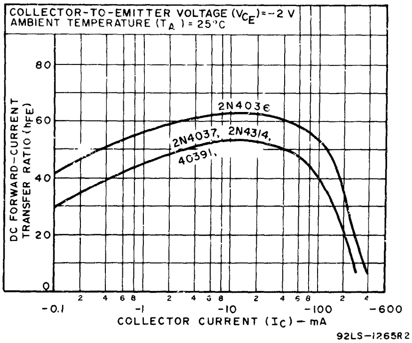


Fig. 3 - Typical dc beta characteristics for all types.

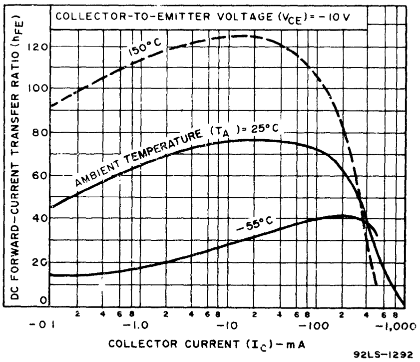
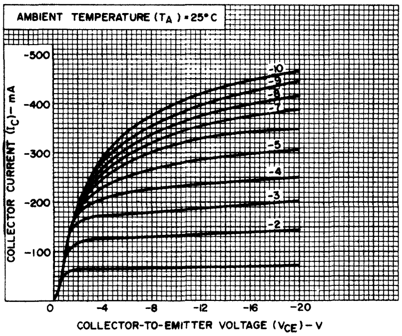


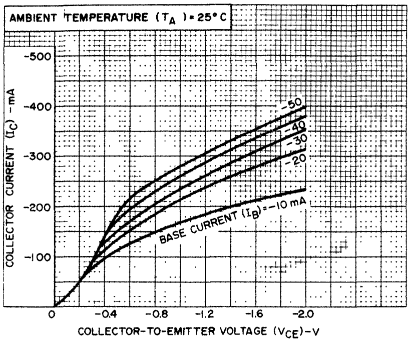
Fig. 4 - Typical dc beta characteristics for 2N4037 and 2N4314.

2N4036, 2N4037, 2N4314



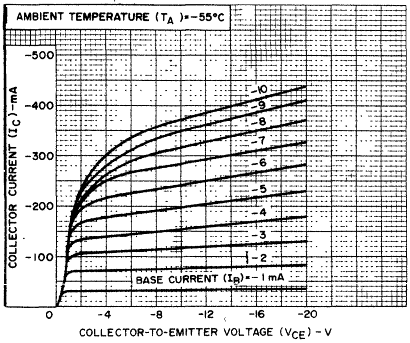
92LS-1291R1

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



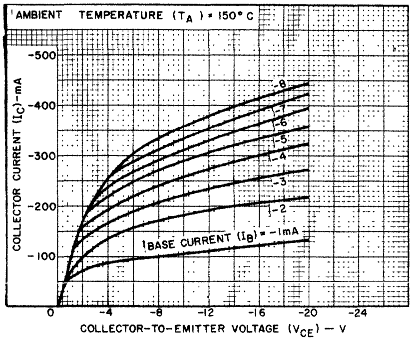
92LS-1287R1

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



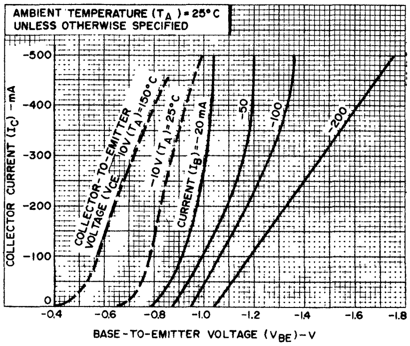
92LS-1282R1

Fig. 7 - Typical output characteristics at T_A=—55° C for 2N4037 and 2N4314.



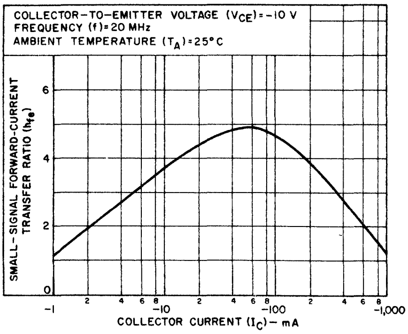
92LS-1289R1

Fig. 8 - Typical output characteristics at T_A=150° C for 2N4037 and 2N4314.



92LS-1295R2

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



92LS-1257R1

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

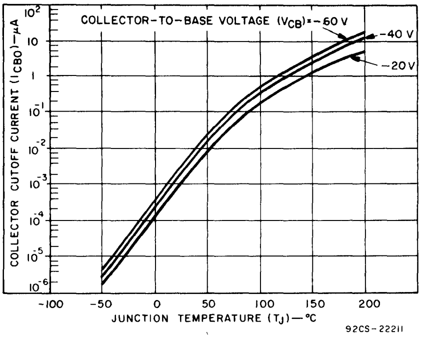


Fig. 11 - Typical collector cutoff current vs. junction temperature for 2N4036.

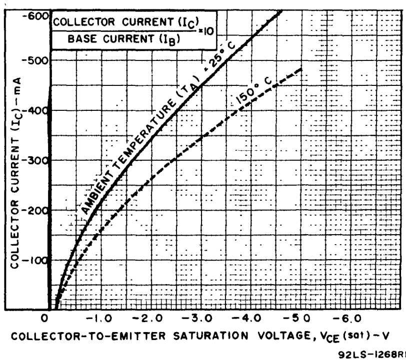


Fig. 12 - Typical saturation-voltage characteristics for 2N4036.

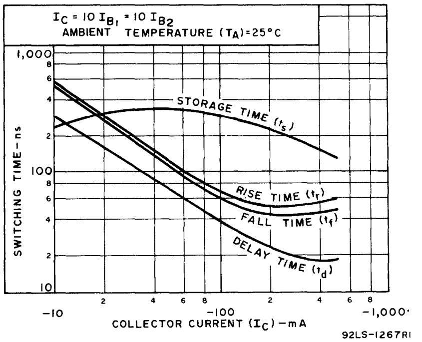


Fig. 13 - Typical saturated switching times for type 2N4036.

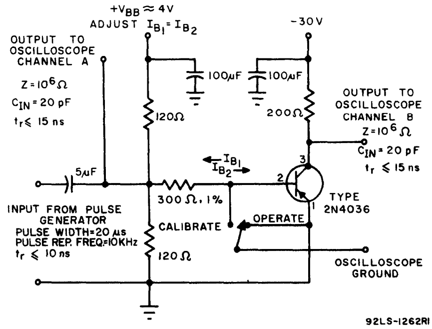


Fig. 14 - Circuit used to measure switching times for type 2N4036.

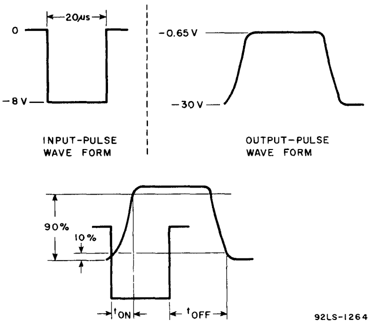


Fig. 15 - Oscilloscope display for measurement of switching times.

2N5038, 2N5039, 2N6496

File Number **698**

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

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

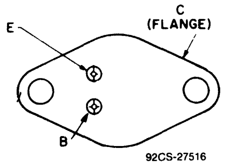
Features:

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

RCA-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 $R_{BE} \leqslant 50\ \Omega$	$V_{CER}(sus)$	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 ⩾ 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: VOLTAGE V dc: V_{CB}	V_{CE}	V_{EB}	V_{BE}	CURRENT A dc: I_C	I_E	I_B	LIMITS 2N5038 Min.	2N5038 Max.	2N5039 Min.	2N5039 Max.	2N6496 Min.	2N6496 Max.	UNITS
Collector Cutoff Current: With base open	I_{CEO}		55					0	–	–	–	20	–	–	
			70					0	–	20	–	–	–	–	
* With base-emitter junction reverse-biased	I_{CEV}		110		−1.5				–	–	–	50	–	–	
			140		−1.5				–	50	–	–	–	–	
			130		0				–	–	–	–	–	20	mA
* At T_C = 150°C			85		−1.5				–	–	–	10	–	–	
			100		−1.5				–	10	–	–	–	–	
			130		0				–	–	–	–	–	25	
* Emitter Cutoff Current	I_{EBO}			5		0			–	5	–	15	–	–	mA
				7		0			–	50	–	50	–	50	
DC Forward-Current Transfer Ratio	h_{FE}		5			2[a]			50	200	30	150	–	–	
*			5			10[a]			–	–	20	100	–	–	
*			5			12[a]			20	100	–	–	–	–	
*			2			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 $R_{BE} \leqslant 50\ \Omega$	$V_{CER}(sus)$[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			10[a]			–	–	–	1.8	–	–	
			5			12[a]			–	1.8	–	–	–		V
			2			8[a]			–	–	–	–	–	1.6	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					10[a]		1.0	–	–	–	1.0	–	–	
						12[a]		1.2	–	1.0	–	–	–	–	
*						20[a]		5	–	2.5	–	2.5	–	–	V
*						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					0		–	400	–	400	–	400	pF
Second-Breakdown Collector Current[e] (With base forward biased)	$I_{S/b}$[d]		28						5.0	–	5.0	–	5.0	–	A
			45						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	12			13	–	13	–	–	–	mJ
					−4	8			–	–	–	–	5.7	–	
* Sat. Switching Rise Time	t_r	V_{CC} = 30 V				10		1.0[c]	–	–	–	0.5	–	–	
						12		1.2[c]	–	0.5	–	–	–	–	
						8		0.8[c]	–	–	–	–	–	0.5	
* Sat. Switching Storage Time	t_s	V_{CC} = 30 V				10		1.0[c]	–	–	–	1.5	–	–	
						12		1.2[c]	–	1.5	–	–	–	–	μs
						8		0.8[c]	–	–	–	–	–	1.5	
* Sat. Switching Fall Time	t_f	V_{CC} = 30 V				10		1.0[c]	–	–	–	0.5	–	–	
						12		1.2[c]	–	0.5	–	–	–	–	
						8		0.8[c]	–	–	–	–	–	0.5	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$		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] $I_{S/b}$ 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. $E_{S/b} = \frac{1}{2}LI^2$ 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, RDF-1)

2N5038, 2N5039, 2N6496

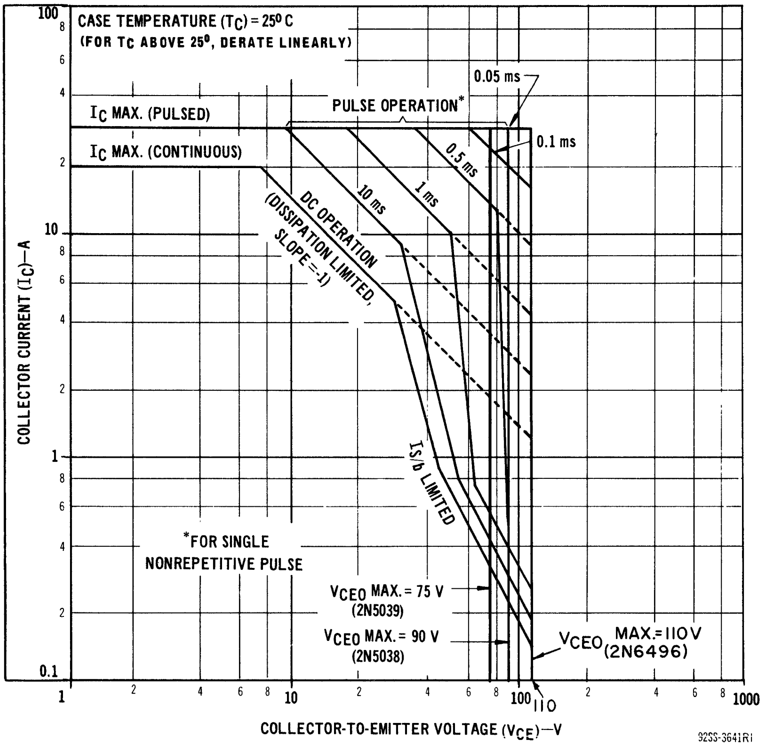


Fig. 1 — Maximum operating areas for all types.

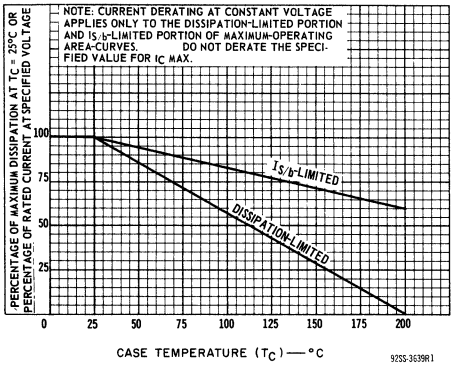


Fig. 2 — Dissipation derating curves for all types.

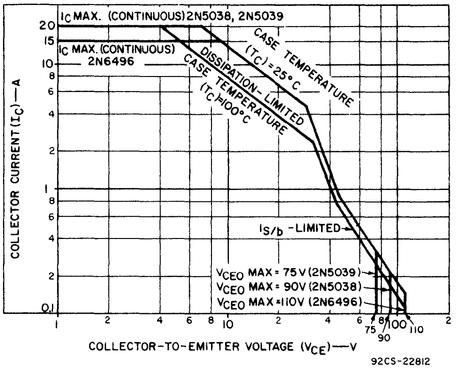


Fig. 3 - Maximum operating areas for all types.

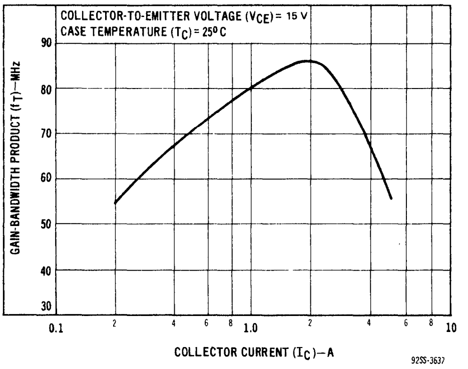


Fig. 4 - Typical gain-bandwidth product for all types.

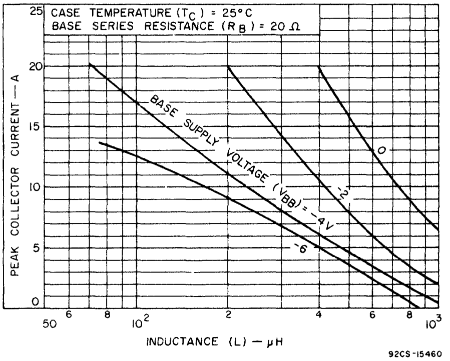


Fig. 5 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

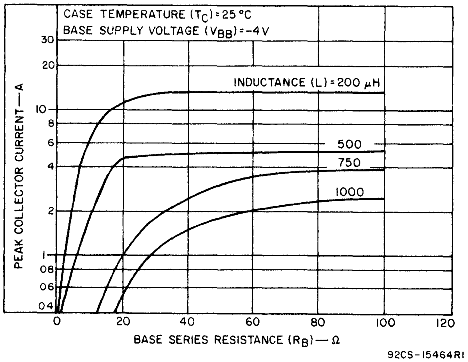


Fig. 6 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

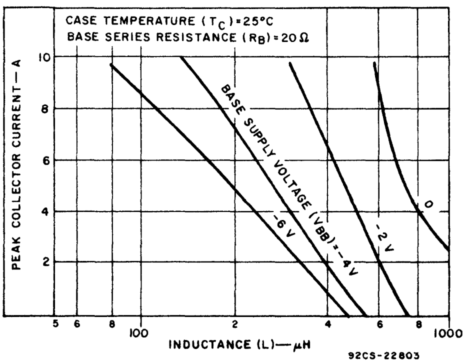


Fig. 7 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

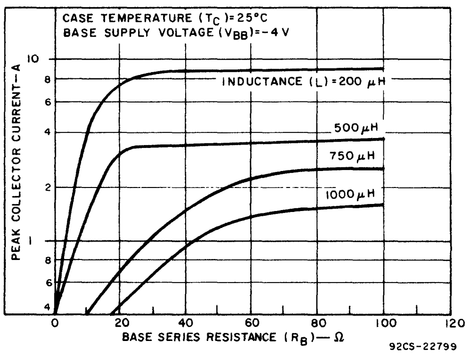


Fig. 8 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

2N5038, 2N5039, 2N6496

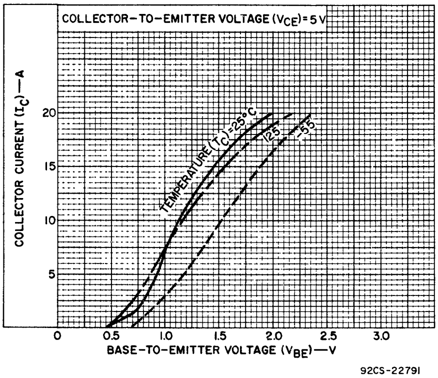


Fig. 9 - Typical transfer characteristics for 2N5038.

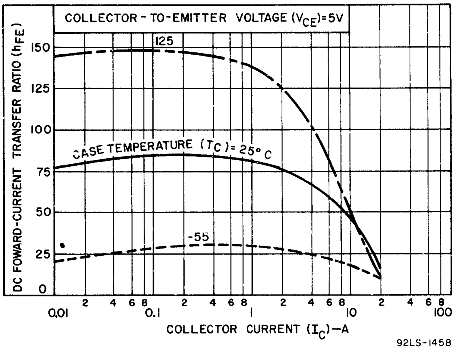


Fig. 10 - Typical dc beta characteristics for 2N5038.

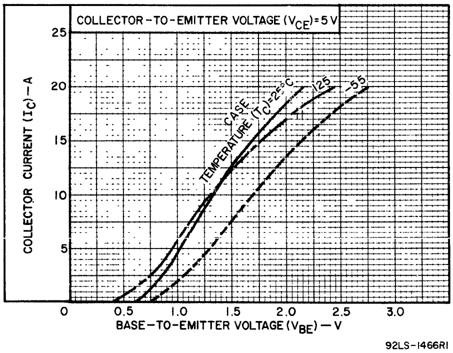


Fig. 11 - Typical transfer characteristics for 2N5039.

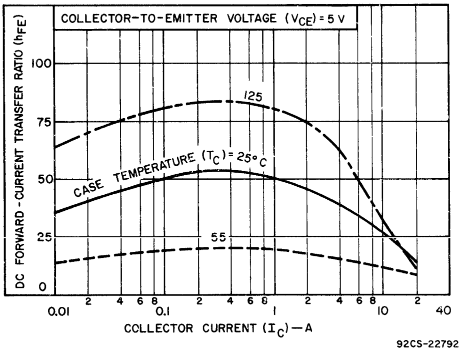


Fig. 12 -Typical dc beta characteristics for 2N5039.

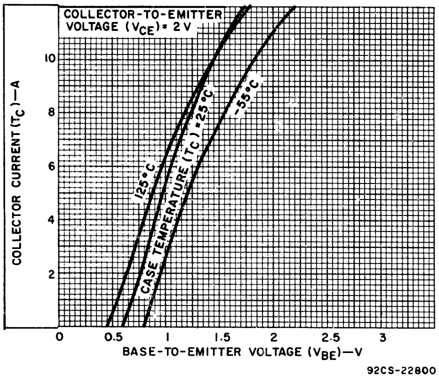


Fig. 13 - Typical transfer characteristics for 2N6496.

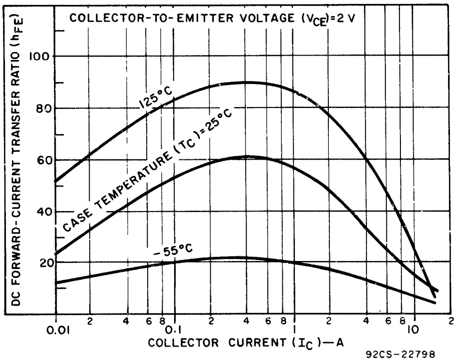


Fig. 14 - Typical dc beta characteristics for 2N6496.

2N5038, 2N5039, 2N6496

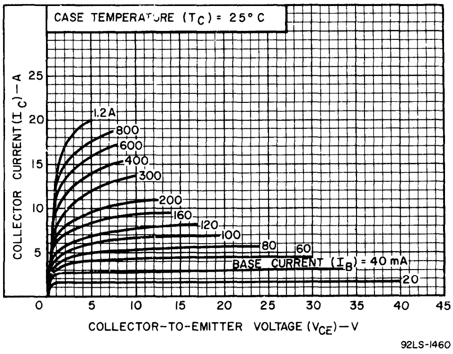


Fig. 15 - Typical output characteristics for 2N5038.

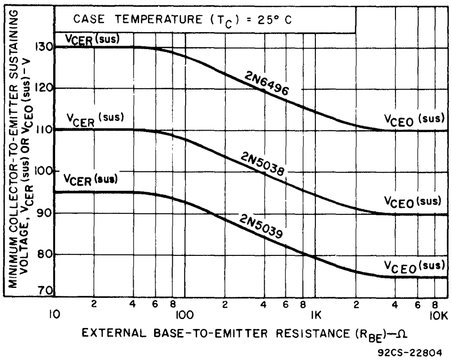


Fig. 16 - Collector-to-emitter sustaining voltage characteristic for all types.

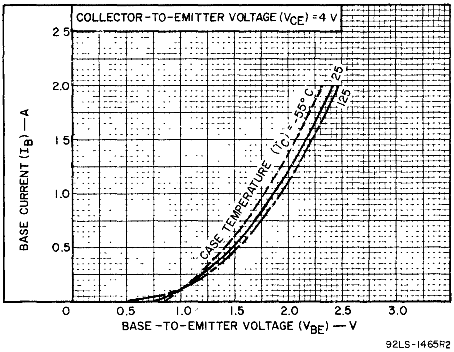


Fig. 17 - Typical output characteristics for 2N5039.

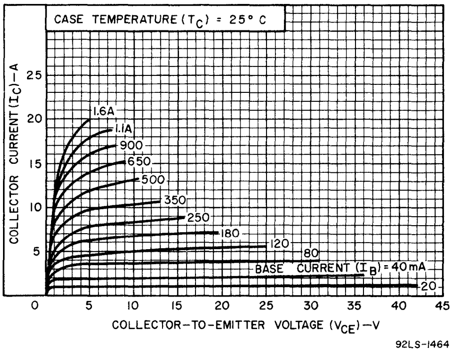


Fig. 18 - Typical input characteristics for 2N5038 and 2N5039.

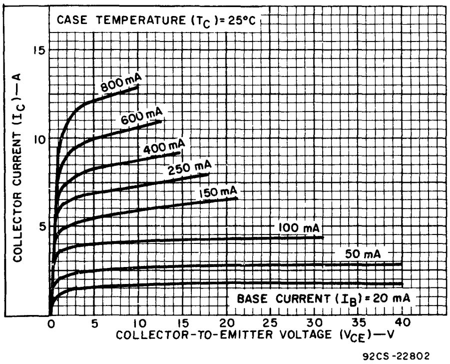


Fig. 19 - Typical output characteristics for 2N6496.

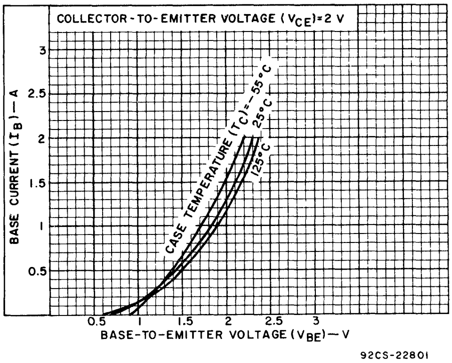


Fig. 20 - Typical input characteristics for 2N6496.

2N5038, 2N5039, 2N6496

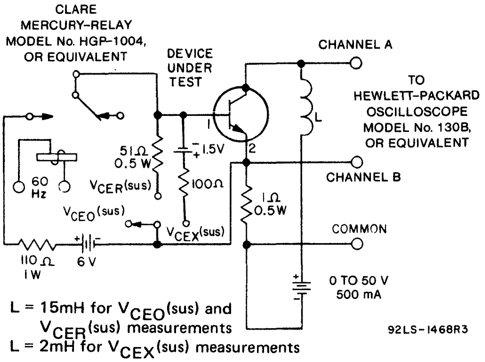
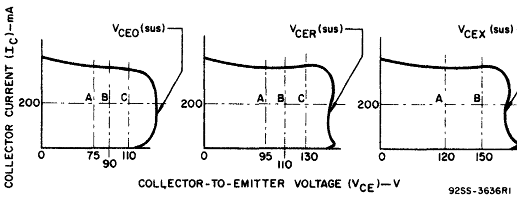


Fig. 21 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$.



The sustaining voltages ($V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$) 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 $V_{CEX}(sus)$.)

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

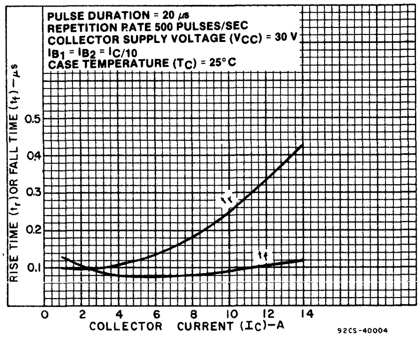


Fig. 23 - Typical rise-time and fall-time characteristics for all types.

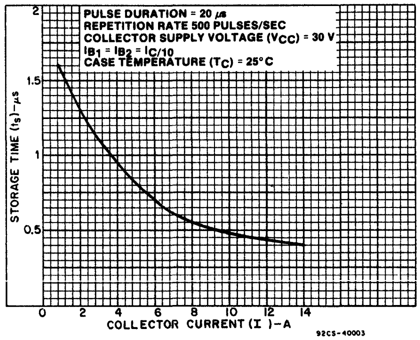


Fig. 24 - Typical storage time characteristic for all types.

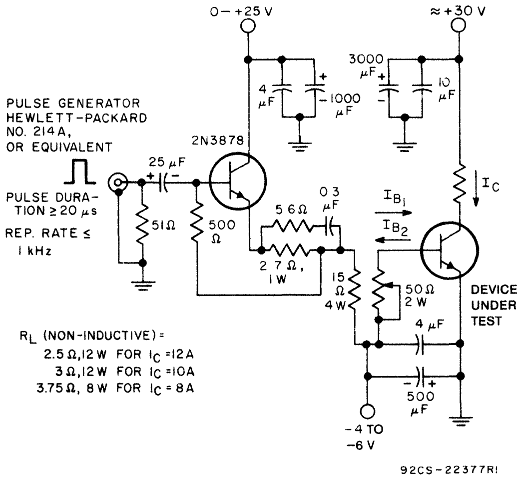


Fig. 25 - Circuit used to measure switching times for all types.

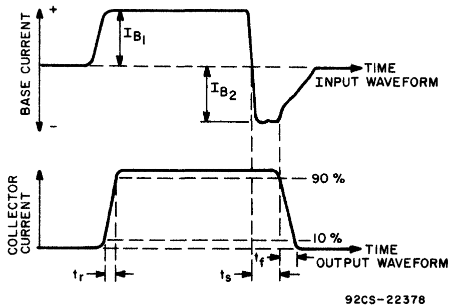


Fig. 26 — Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 26).

File Number **325**

2N5320, 2N5321, 2N5322, 2N5323

Complementary N-P-N & P-N-P Silicon Power Transistors

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

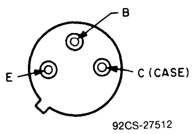
Features:

- 2N5322, 2N5323 — *P-N-P Complements of:* 2N5320, 2N5321
- *Maximum safe-area-of-operation curves*
- *Planar construction for low-noise and low leakage characteristics*
- *Low saturation voltage*
- *High beta at high collector current*

The RCA-2N5320, 2N5321, 2N5322 and 2N5323 are doubled-diffused epitaxial-planar silicon power transistors intended for small-signal medium-power applications. The 2N5320 and 2N5321 n-p-n types are actually high-current, high-dissipation versions of the 2N2102 with all of the salient features of that device. The 2N5322 and 2N5323, p-n-p complements of the 2N5320 and 2N5321, are actually high-current, high-power versions of the 2N4036 with all of its additional outstanding features.

The 2N5320, 2N5321, 2N5322, and 2N5323 are supplied in the TO-205AD package.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5321	2N5323	2N5320	2N5322	
*V_{CBO}	75	-75	100	-100	V
V_{CEV}					
V_{BE} = -1.5 V	75	-75	100	-100	V
V_{CER}					
R_{BE} = 100 Ω	65	-65	90	-90	V
*V_{CEO}	50	-50	75	-75	V
*V_{EBO}	5	-5	7	-7	V
*I_C	2	-2	2	-2	A
*I_B	1	-1	1	-1	A
*P_T					
$T_C \leq 25°C$	10	10	10	10	W
$T_C > 25°C$	Derate linearly at 0.057 W/°C				
*T_{stg}, T_J	-65 to +200				°C
*T_L					
At distance > 1/16 in. (1.58 mm) from seating plane for 10 s max.	230				°C

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

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 — — —	— — — —	— 5 — —	— — — —	— — −0.5 —	— — — —	— — — −5	µA
* I_{CEX}	100 75 −100 −75	−1.5 −1.5 1.5 1.5			— — — —	0.1 — — —	— — — —	— 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 —	— — — —	— — — −5	mA
* I_{EBO}		−7 −5 7 5	0 0 0 0		— — — —	0.1 — — —	— — — —	— 0.1 — —	— — — —	— — −0.1 —	— — — —	— — — −0.1	mA
		−5 −4 5 4	0 0 0 0		— — — —	0.1 — — —	— — — —	— 0.5 — —	— — — —	— — −0.1 —	— — — —	— — — −0.5	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	— —	— −1.2	V
* V_{BE}	4 −4		500[b] −500[b]		— —	1.1 —	— —	1.4 —	— —	— −1.1	— —	— −1.4	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	— —	
$I_{S/b}$[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
* $R_{\theta JC}$					—	17.5	—	17.5	—	17.5	—	17.5	°C/W
$R_{\theta JA}$					—	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

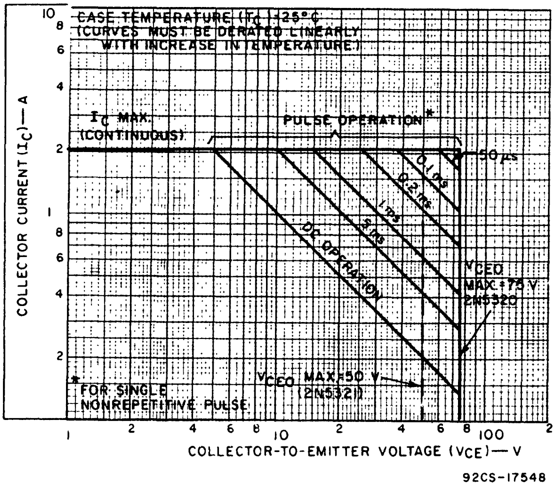


Fig. 1 — Maximum operating areas for types 2N5320 and 2N5321.

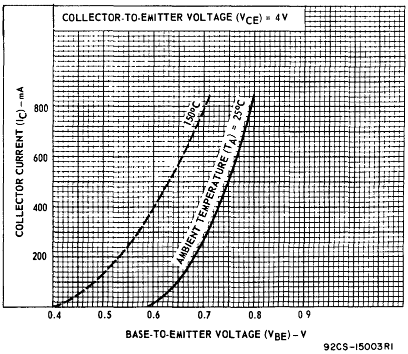


Fig.2 — Typical static beta characteristics for types 2N5320 and 2N5321.

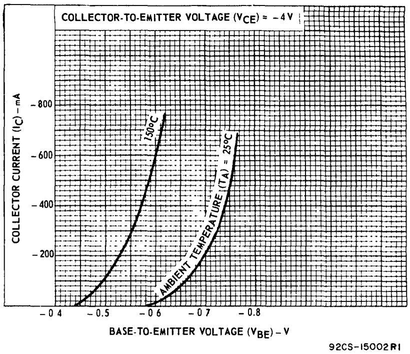


Fig.3 — Typical static beta characteristics for types 2N5322 and 2N5323.

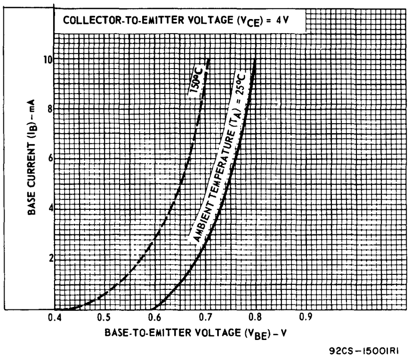


Fig.4 — Typical output characteristics for types 2N5320 and 2N5321.

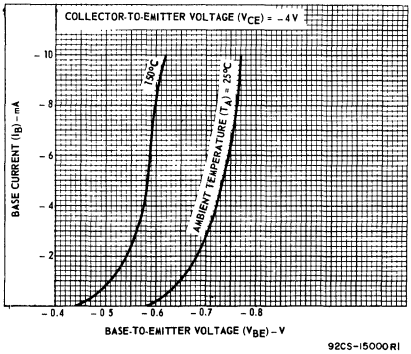


Fig.5 – Typical output characterisitcs for types 2N5322 and 2N5323.

2N5320, 2N5321, 2N5322, 2N5323

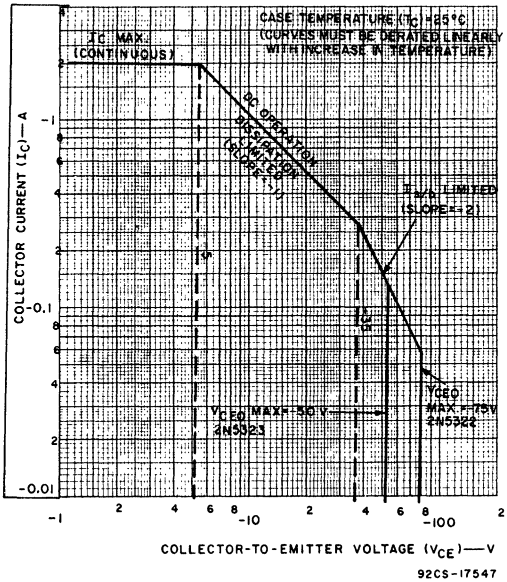


Fig.6 – Maximum operating areas for types 2N5322 and 2N5323.

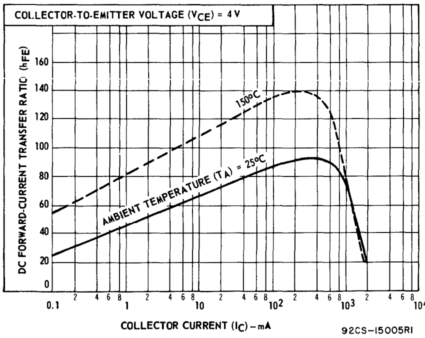


Fig.7 – Typical transfer characteristics for types 2N5320 and 2N5321.

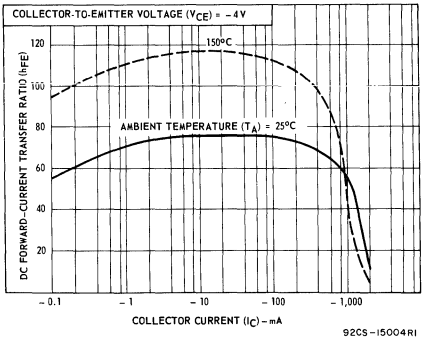


Fig.8 – Typical transfer characteristics for types 2N5322 and 2N5323.

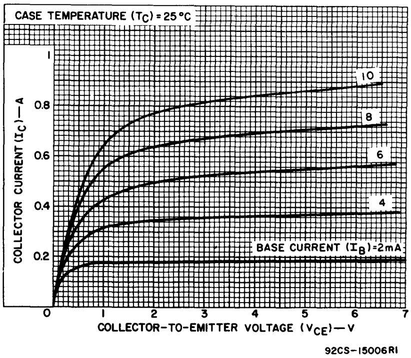


Fig.9 – Typical input characteristics for types 2N5320 and 2N5321.

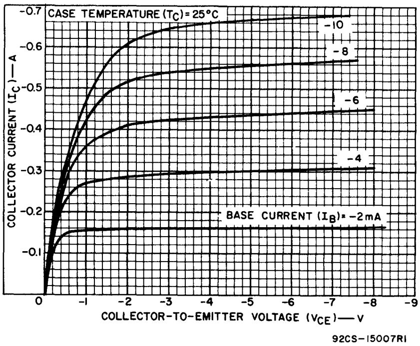
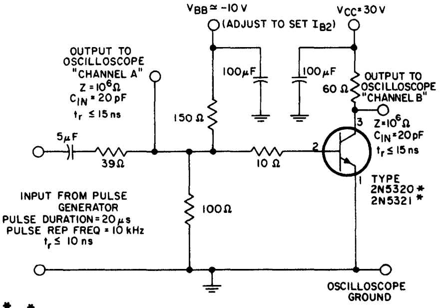


Fig.10 – Typical input characteristics for types 2N5322 and 2N5323.

2N5320, 2N5321, 2N5322, 2N5323



* For 2N5322 or 2N5323, reverse direction of I_{B1} and I_{B2} and reverse polarity of V_{BB} and V_{CC}.

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

2N5671, 2N5672

File Number **383**

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

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

Features:

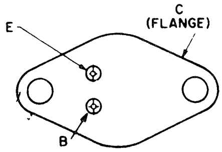
- *Maximum Safe-Area-of-Operation Curves - $I_{S/b}$ limit line beginning at 24 V*
- *Fast Turn-On Time - t_{ON} = 0.5 μs max. at I_C = 15 A*

RCA 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_{CEO}(sus)	90	120	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω, V_{CER}(sus)	110	140	V
With external base-to-emitter resistance (R_{BE}) ≤ 50 Ω & V_{BE}=−1.5, V_{CEX}(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 ≥ 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: DC Collector Voltage (V) V_{CB}	DC Collector Voltage (V) V_{CE}	DC Emitter or Base Voltage (V) V_{EB}	DC Emitter or Base Voltage (V) V_{BE}	DC Current (A) I_C	DC Current (A) I_E	DC Current (A) I_B	LIMITS: Type 2N5671 Min.	Type 2N5671 Max.	Type 2N5672 Min.	Type 2N5672 Max.	UNITS
Collector-Cutoff Current	I_{CEO}	–	80	–	–	–	–	0	–	10	–	10	mA
* Collector-Cutoff Current	I_{CEV}	–	110	–	−1.5	–	–	–	–	12	–	–	mA
* Collector-Cutoff Current	I_{CEV}		135	–	−1.5	–	–	–	–	–	–	10	mA
Collector-Cutoff Current	I_{CEV} (T_C=150° C)	–	100	–	−1.5	–	–	–	–	15	–	10	mA
* Emitter-Cutoff Current	I_{EBO}	–	–	7	–	0	–	–	–	10	–	10	mA
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$	–	–	–	–	0.2	–	0	90[a]	–	120[a]	–	V
With external base-to-emitter resistance (R_{BE}) ≤50 Ω	$V_{CER}(sus)$	–	–	–	–	0.2	–	0	110[a]	–	140[a]	–	V
With base-emitter junction reverse biased & R_{BE} ≤ 50 Ω	$V_{CEX}(sus)$	–	–	–	−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	[illegible]	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 Ω, L = 180 μH	$E_{S/b}$[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 V	–	–	–	15	–	I_{B1}= I_{B2}= 1.2	–	0.5	–	0.5	μs
* Saturated Switching Storage Time	t_s	V_{CC}= 30 V	–	–	–	15	–	I_{B1}= I_{B2}= 1.2	–	1.5	–	1.5	μs
* Saturated Switching Fall Time	t_f	V_{CC}= 30 V	–	–	–	15	–	I_{B1}= I_{B2}= 1.2	–	0.5	–	0.5	μs
Thermal Resistance (Junction-to-Case)	$\theta_{J\text{-}C}$	–	40	–	–	0.5	–	–	–	1.25	–	1.25	°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

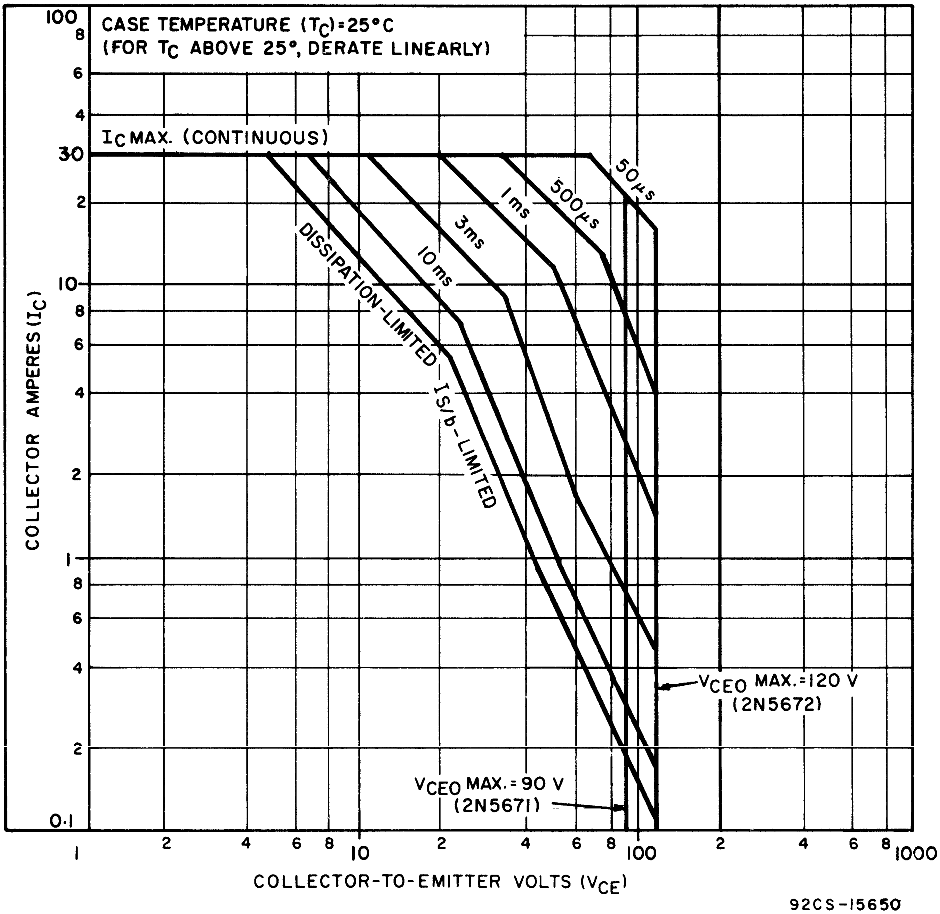


Fig. 1 - Maximum operating areas for types 2N5671 & 2N5672.

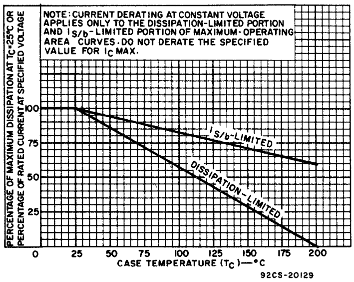


Fig. 2 - Dissipation derating curves for types 2N5671 & 2N5672.

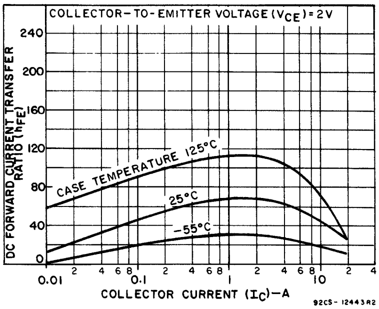


Fig. 3 - Typical dc beta characteristics for types 2N5671 & 2N5672.

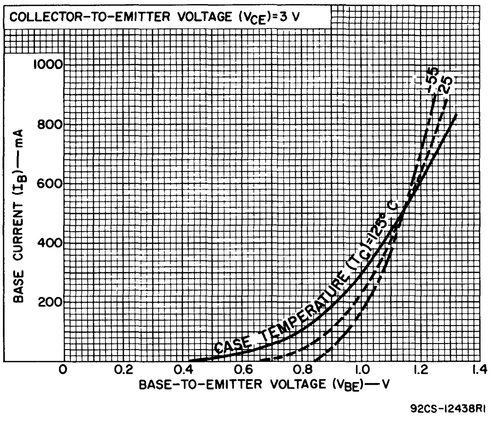


Fig. 4 - Typical input characteristics for types 2N5671 & 2N5672.

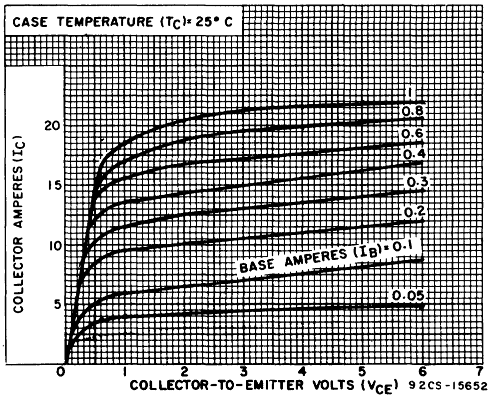


Fig. 5 - Typical output characteristics for types 2N5671 & 2N5672.

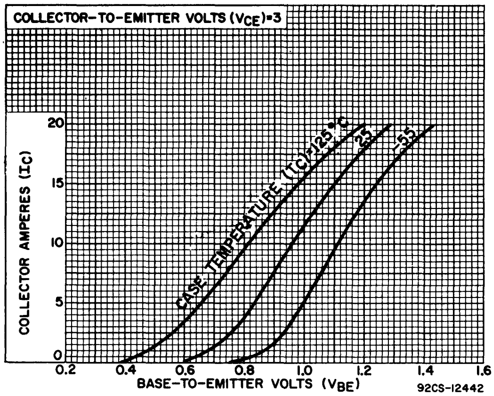


Fig. 6 - Typical transfer characteristics for types 2N5671 & 2N5672.

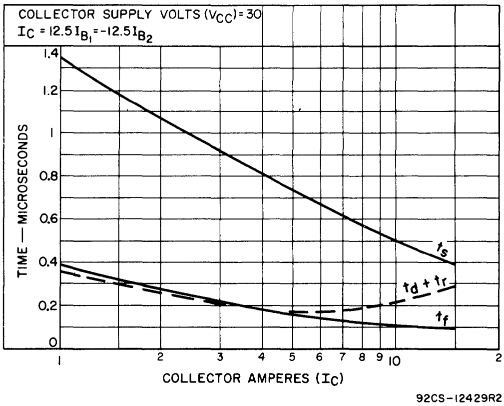


Fig. 7 - Typical saturated switching characteristics for types 2N5671 & 2N5672.

2N6032, 2N6033

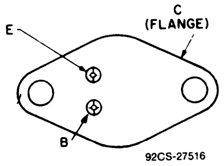
File Number **462**

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 V max. at 40 A, 1.3 V max. at 50 A*
- *Maximum safe-area-of-operation curves $I_{S/b}$ limit line beginning at 24 V*
- *Fast storage time: t_s=1.5μs max. at I_C=40 A (2N6033), 50 A (2N6032)*

TERMINAL DESIGNATIONS



JEDEC TO-204AE

The RCA-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.

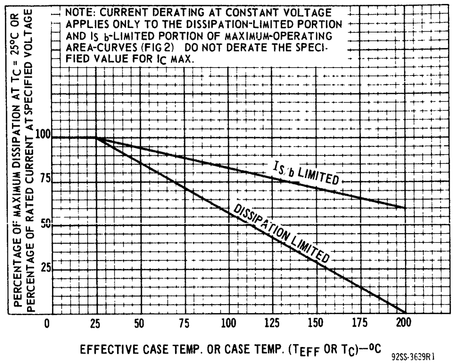


Fig. 1 - Derating curves for both types.

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})≤50 Ω, $V_{CER}(sus)$	110	140	V
* With external base-to-emitter resistance (R_{BE})≤50 Ω & V_{BE}=−1.5 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 ≥ 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: DC Collector Voltage (V)		DC Emitter or Base Voltage (V)		DC Current (A)			LIMITS: Type 2N6032		Type 2N6033		UNITS
		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	I_{CEV}	– –	110 135	– –	-1.5 -1.5	– –	– –	– –	– –	12 –	– –	– 10	mA
(T_C = 150°C)	I_{CEV}	–	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}) ≤ 50 Ω	$V_{CER}(sus)$	–	–	–	–	0.2	–	0	110[a]	–	140[a]	–	V
With base-emitter junction reverse biased & R_{BE} ≤ 50 Ω	$V_{CEX}(sus)$	–	–	–	-1.5	0.2	–	0	120[a]	–	150[a]	–	V
* Base-to-Emitter Saturation Voltage[c]	$V_{BE}(sat)$	– –	– –	– –	– –	50 40	– –	5 4	– –	2 –	– –	– 2	V
Base-to-Emitter Voltage	V_{BE}	– –	2 2	– –	– –	50 40	– –	– –	– –	2 –	– –	– 2	V
* Collector-to-Emitter Saturation Voltage[c]	$V_{CE}(sat)$	– –	– –	– –	– –	50 40	– –	5 4	– –	1.3 –	– –	– 1	V
* DC Forward-Current Transfer Ratio[c]	h_{FE}	– –	2.6 2	– –	– –	50 40	– –	– –	10 –	50 –	– 10	– 50	
Second-Breakdown Collector Current With base forward biased	$I_{S/b}$[b]	– –	24 40	– –	– –	– –	– –	– –	5.8[c] 0.9[c]	– –	5.8[c] 0.9[c]	– –	A
* Magnitude of common-emitter small-signal, short-circuit, forward-current transfer ratio (at 5 MHz)	$\|h_{fe}\|$		10			2			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 40	 –	5[e] 4[e]	– –	1 –	– –	– 1	µs
* Rise	t_r	V_{CC}= 30V	– –	– –	– –	50 40	– –	5[e] 4[e]	– –	1 –	– –	– 1	µs
* Storage	t_s	V_{CC}= 30V	– –	– –	– –	50 40	– –	5[e] 4[e]	– –	1.5 –	– –	– 1.5	µs
* Fall	t_f	V_{CC}= 30V	– –	– –	– –	50 40	– –	5[e] 4[e]	– –	0.5 –	– –	– 0.5	µs
Thermal Resistance (Junction-to-Case)	$\theta_{J\text{-}C}$	–	20	–	–	2.5	–	–	–	1.25	–	1.25	°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

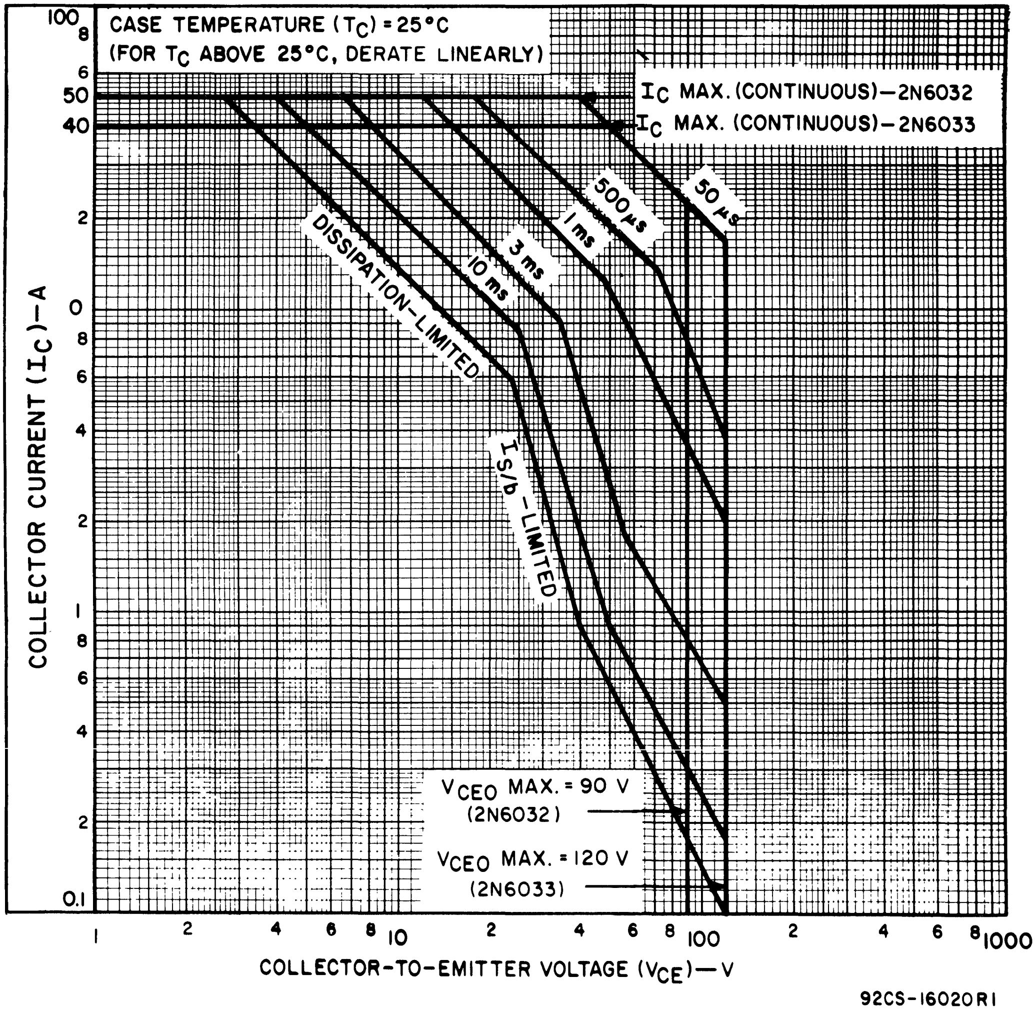


Fig. 2 - Maximum operating area for both types.

2N6032, 2N6033

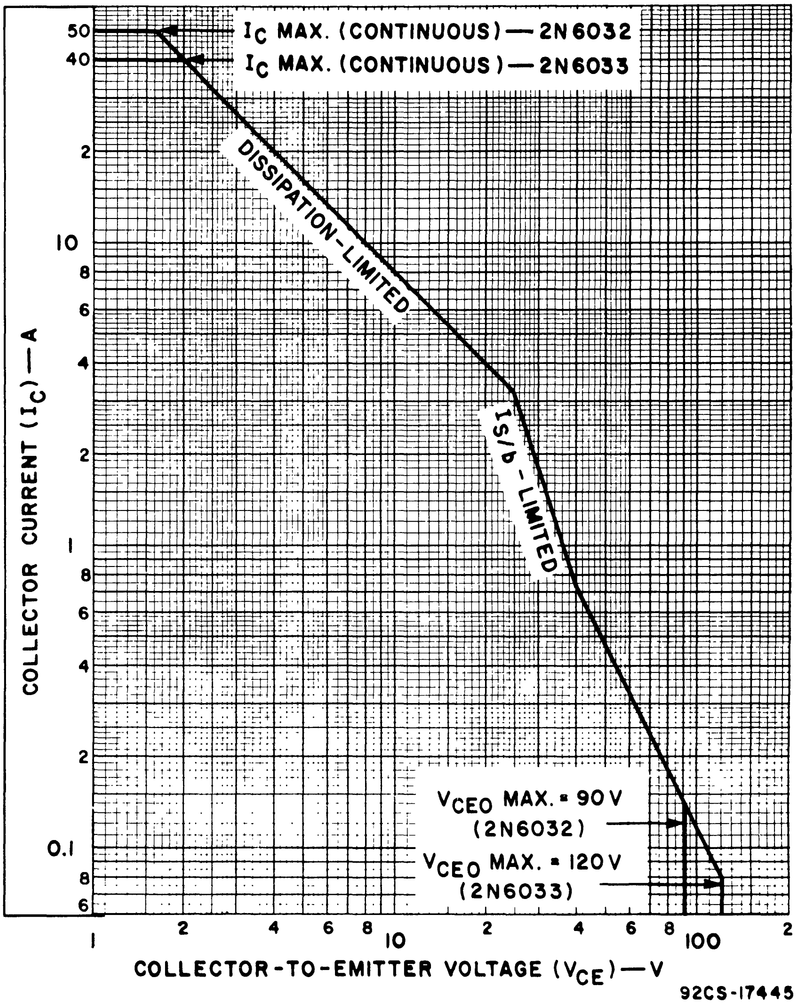


Fig. 3 - Maximum operating areas for both types at case temperature (T_C) = 100° C.

2N6032, 2N6033

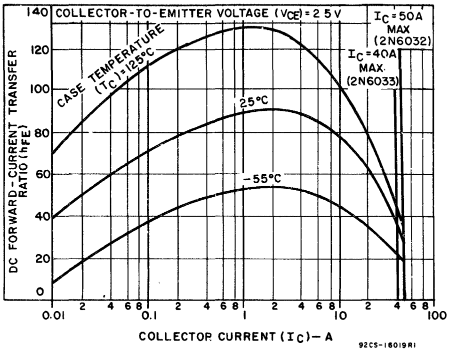


Fig. 4 - Typical dc-beta characteristics for both types.

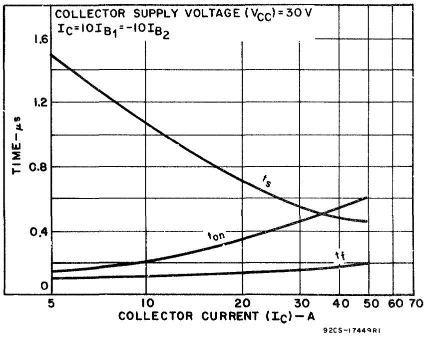


Fig. 5 - Typical saturated switching characteristics for both types.

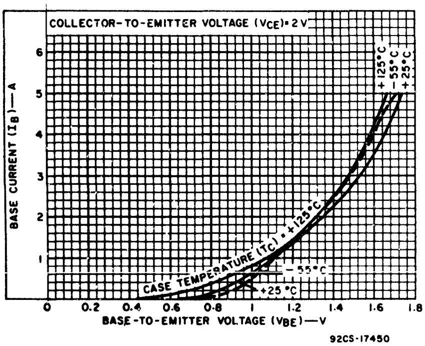


Fig. 6 - Typical input characteristics for both types.

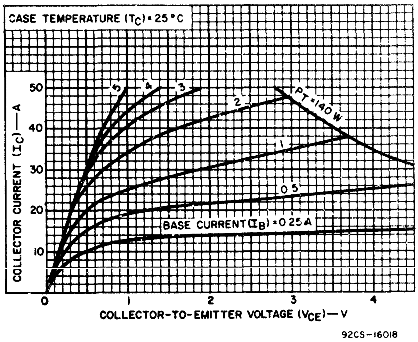


Fig. 7 - Typical collector characteristics for both types.

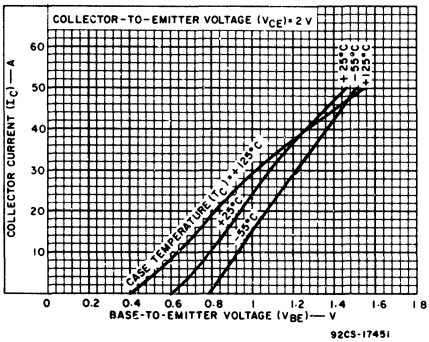


Fig. 8 - Typical transfer characteristics for both types.

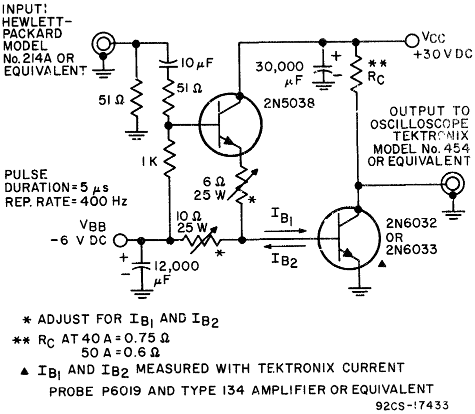


Fig. 9 - Switching-time test set.

File Number **582**

2N6354

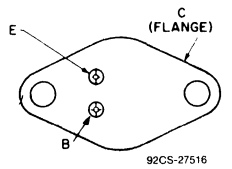
120-V, 10-A, 140-W Silicon N-P-N Planar Transistor

For Switching Applications in Military and Industrial Equipment

Features:

- *High $V_{CEO}(sus)$: 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

RCA 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_{CBO}	150 V
COLLECTOR-TO-EMITTER VOLTAGE:	
With base open, sustaining, $V_{CEO}(sus)$	120 V
* With external base-to-emitter resistance (R_{BE}) = 500 Ω, V_{CEX}	130 V
* EMITTER-TO-BASE VOLTAGE, V_{EBO}	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 ≥ 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_{CBO}		150					–	5	mA
With base open	I_{CEO}	100					0	–	20	mA
* With base-emitter junction reverse-biased	I_{CEV}	140			0			–	10	mA
* At T_C = 125°C	I_{CEV}	140			0			–	20	mA
* 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}) ≤ 100 Ω	$V_{CER(sus)}$[f]					0.2	0	130[b]	–	V
* 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	V
* 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 Ω, L = 25 µH)	$E_{S/b}$[g]			1		5		0.3	–	mJ
* Magnitude of Common Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 10 MHz)	$\|h_{fe}\|$	10				1		8	–	
* Saturated Switching Time: (See Figs. 11 & 12) Rise Time	t_r	V_{CC} = 30				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	µs
Storage Time (No Load)	t_{s2}					0.5	0.5[e]	–	2	µs
Fall Time	t_f					5 10	0.5[e] 1[e]	– –	0.2 0.2	µs
Output Capacitance (f = 1 MHz)	C_{obo}		10					–	300	pF
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	20				1		–	1.25	°C/W

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

[a]Pulsed: pulse duration ≤350 µs, duty factor = 2%.

[b]CAUTION: 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.

[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]Pulsed; 1-s non-repetitive pulse.

[e]$I_{B_1} = I_{B_2}$ = value shown.

[f]L = 15 mH

[g]$E_{S/b}$ 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.

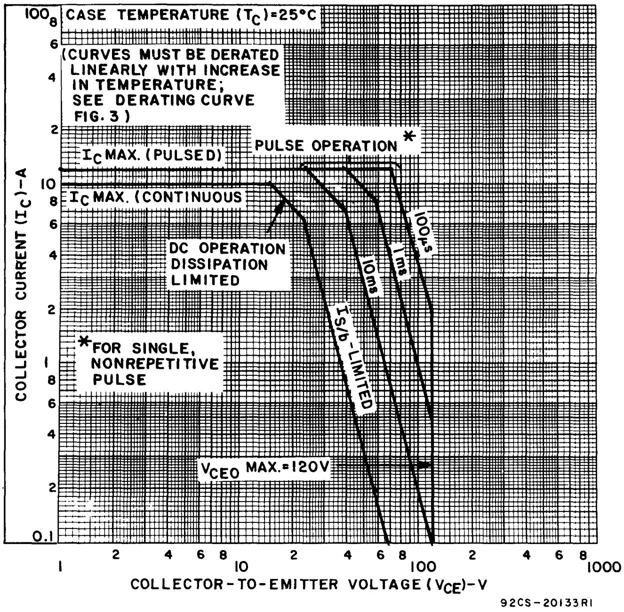


Fig. 1 - Maximum operating areas.

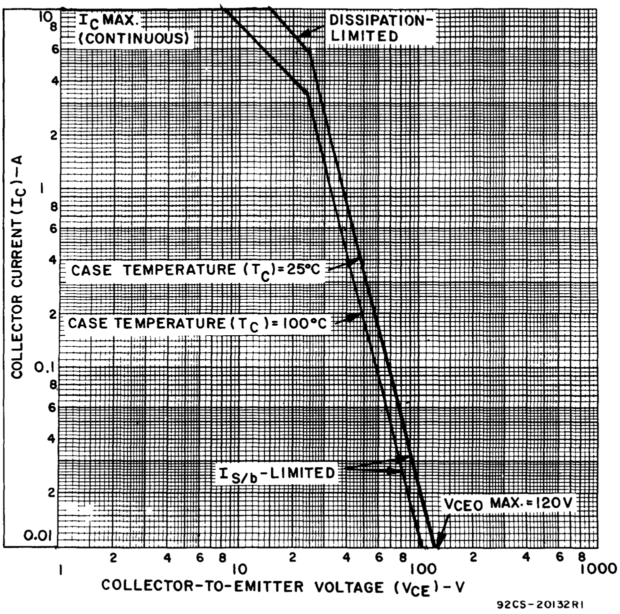


Fig. 2 - Maximum operating areas.

2N6354

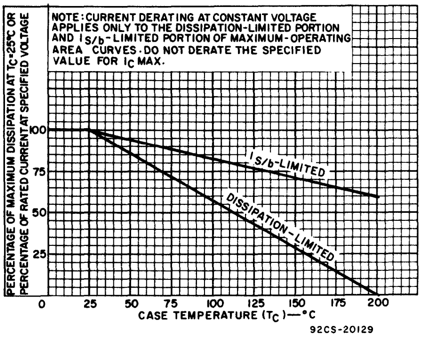


Fig. 3 - Derating curves.

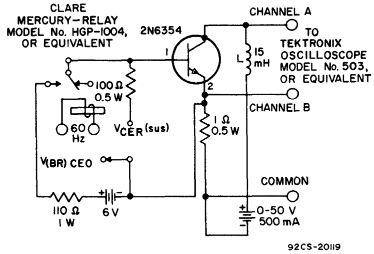
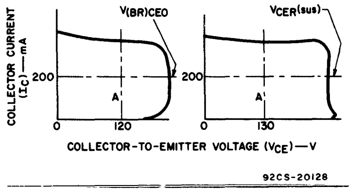


Fig. 4 - Circuit used to measure voltages $V_{(BR)CEO}$ and $V_{CER}(sus)$.



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).

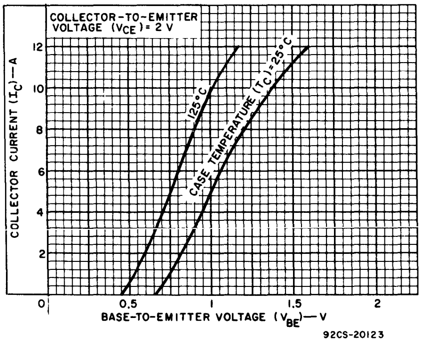


Fig. 6 - Typical transfer characteristics.

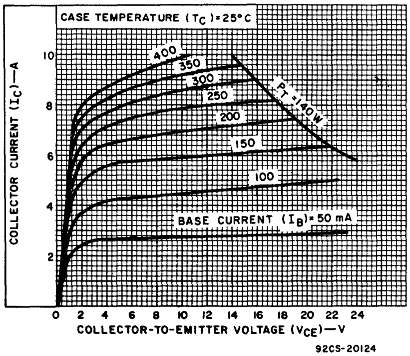


Fig. 7 - Typical output characteristics.

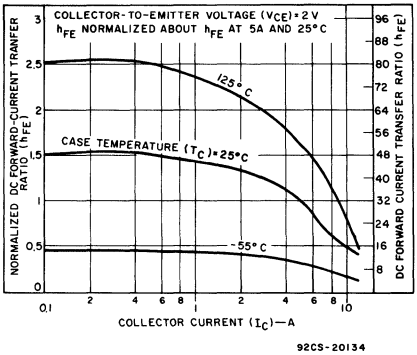


Fig. 8 - Typical normalized dc beta characteristics.

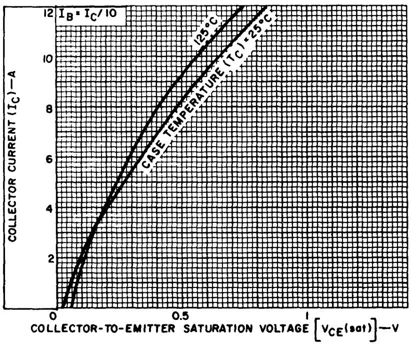


Fig. 9 - Typical saturation voltage characteristics.

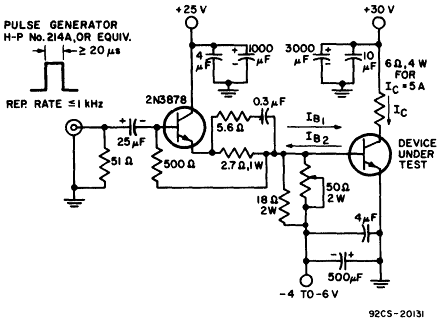


Fig. 10 - Circuit used to measure switching times.

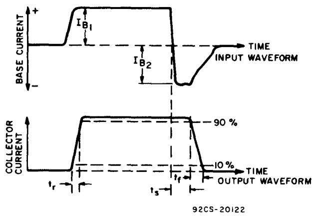


Fig. 11 - Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 11).

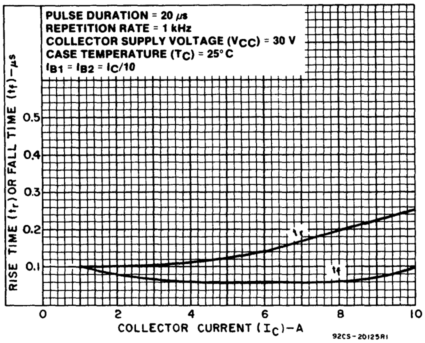


Fig. 12 - Typical rise-and fall-time characteristics.

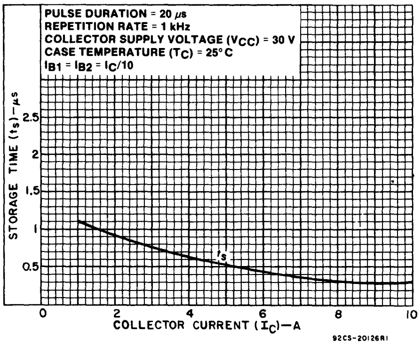


Fig. 13 - Typical storage-time characteristics.

2N6702, 2N6703, 2N6704

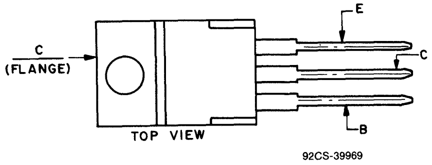
File Number **1187**

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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

RCA-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 ... Derate Linearly		0.4		W/°C
* T_{stg}, T_J		-65 to 150		°C
* T_L				
At distance ≥ 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°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	–	–	–	–	
	160	−1.5			–	–	–	100	–	–	µA
	180	−1.5			–	–	–	–	–	100	
T_C = 125°C	140	−1.5			–	1	–	–	–	–	
	160	−1.5			–	–	–	1	–	–	
	180	−1.5			–	–	–	–	–	1	mA
* 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	
			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	
			5	0.5	–	0.1	–	0.1	–	–	
* t_r[d]		−4	4	0.4	–	–	–	–	–	0.25	
			5	0.5	–	0.25	–	0.25	–	–	µs
* 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	°C/W

* In accordance with JEDEC registration data.
[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.
[c] V_{CB} value.
[d] V_{CC} = 70 V, t_p = 20 µs
[e] $I_{B_1} = -I_{B_2}$.

2N6702, 2N6703, 2N6704

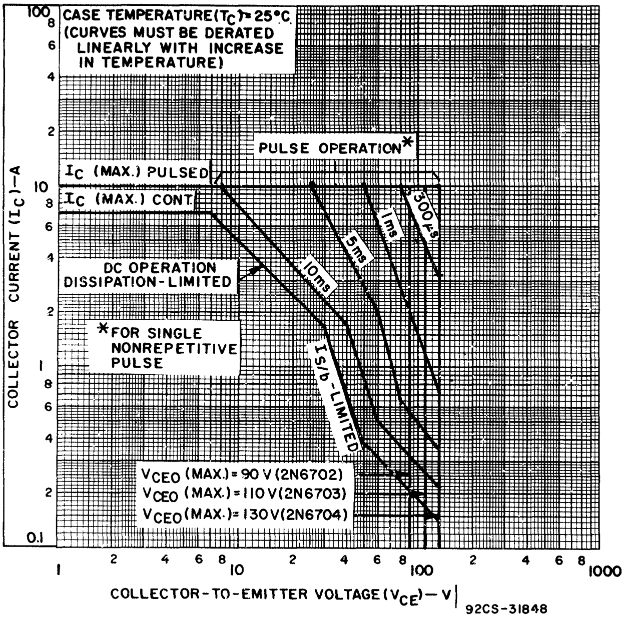


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

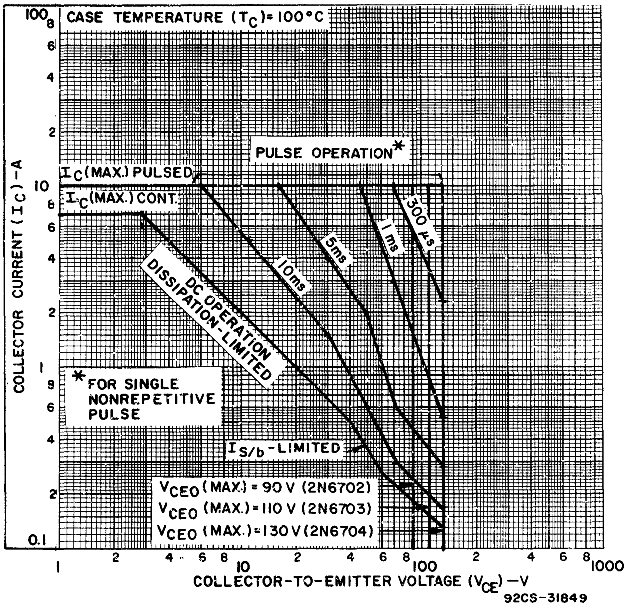


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

2N6702, 2N6703, 2N6704

[illegible]

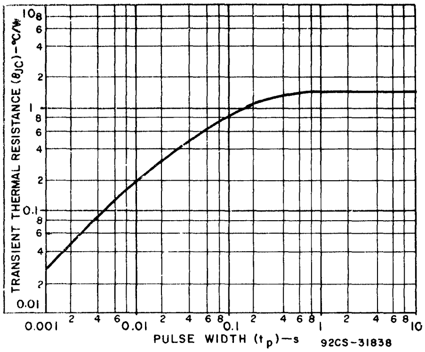


Fig. 4 — Typical thermal-response characteristic for all types.

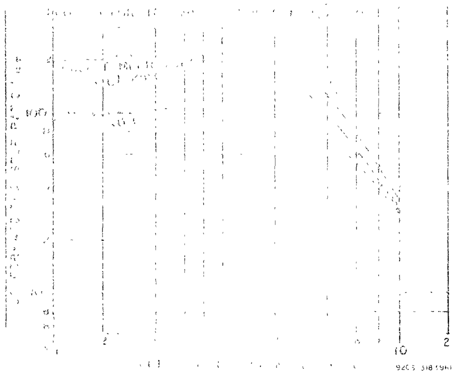


Fig. 5 – Typical [illegible] all types.

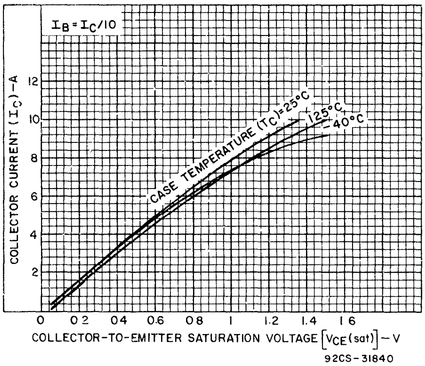


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

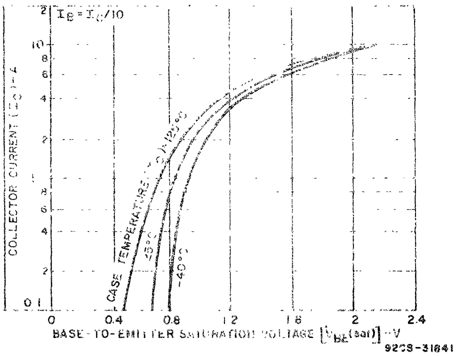


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

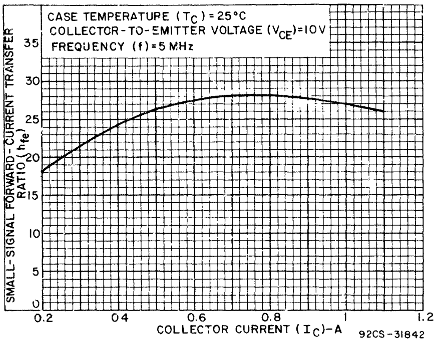


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

2N6702, 2N6703, 2N6704

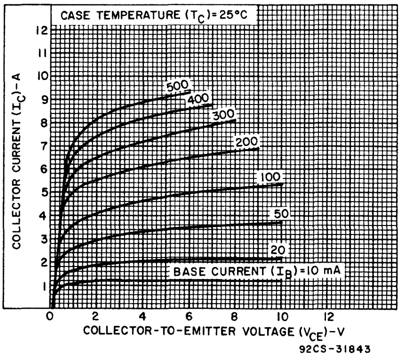


Fig. 9 — Typical output characteristics for all types.

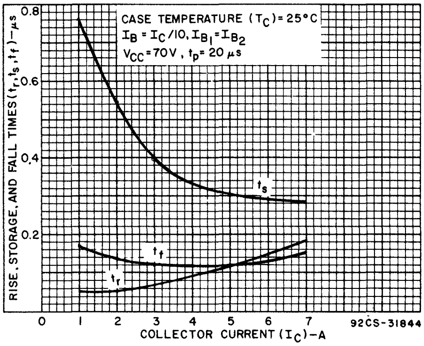


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

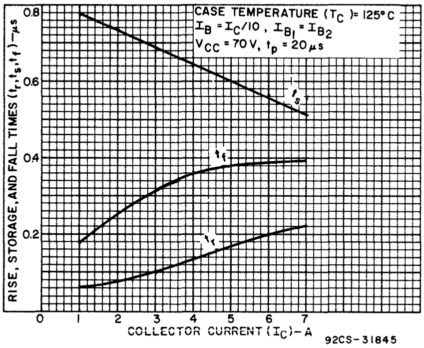


Fig. 11 — Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

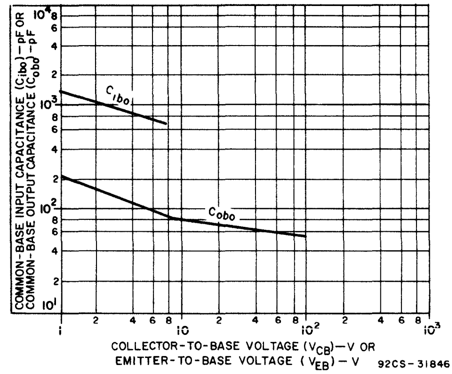


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

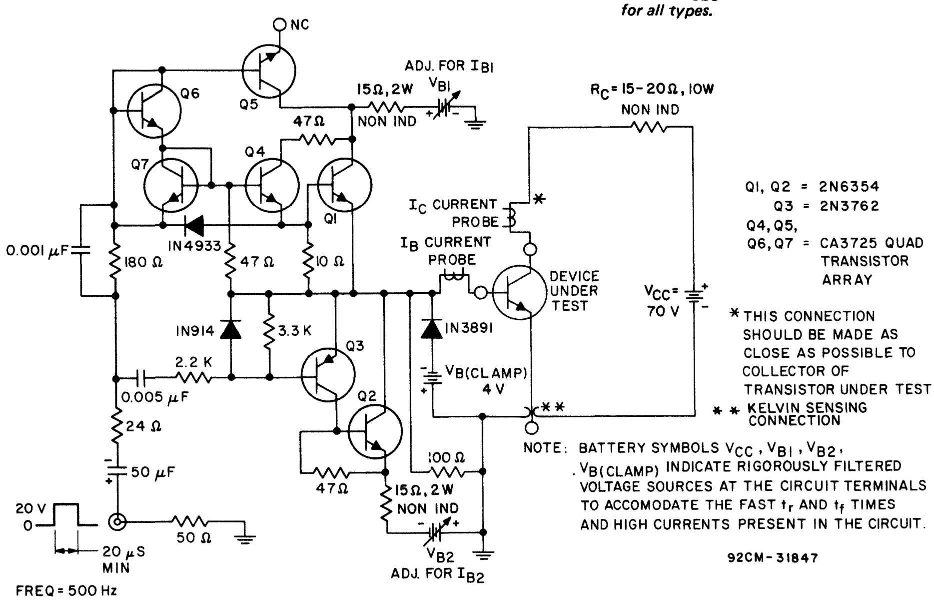
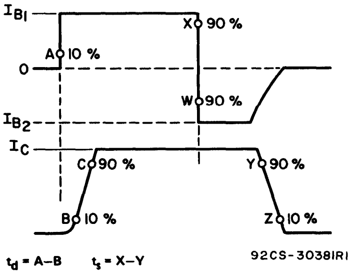


Fig. 13 — Circuit for measuring switching times.

2N6702, 2N6703, 2N6704



t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W
NOTE: TRANSITION TIME
FROM 90% I_{B_1} TO 90% I_{B_2} MUST
BE LESS THAN 0.5 μs.

Fig. 14 – Phase relationship between input and output currents showing reference points for specification of switching times.

TIP562, TIP563

File Number **1212**

Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

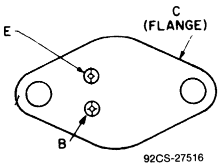
Features:

- V_{CEO} — 300 V and 400 V
- I_C — 10 A
- P_T — 100 W

The RCA-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 RCA-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_{CBO}	300	400	V
$V_{CEO(sus)}$	300	400	V
V_{EBO}	8	8	V
I_C	10	10	A
I_{CM}	15	15	A
I_B	2	2	A
P_T: At T_C up to 100°C	100	100	W
T_J, T_{stg}	-65 to +200	-65 to +200	°C
T_L: At distances ≥ 1/16 in. (1.58 mm) from case for 10 s max.	200	200	°C

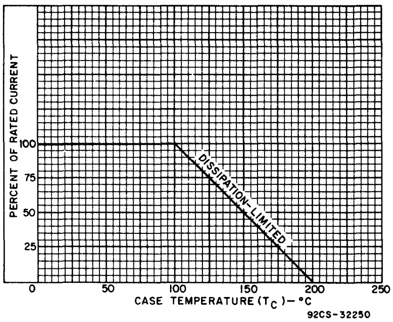


Fig. 1 - Dissipation derating curve.

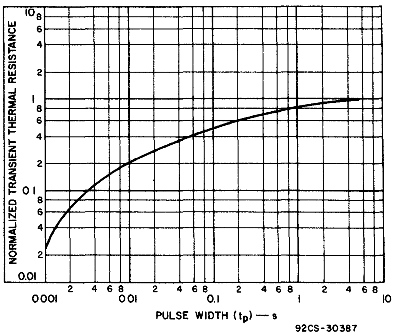


Fig. 2 - Typical thermal-response characteristic.

TIP562, TIP563

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS: TIP562			TIP563			UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{CEO}	270	—	—	0	—	—	1	—	—	—	mA
	360	—	—	0	—	—	—	—	—	1	mA
I_{CBO}, $I_E = 0$	300[b]	—	—	—	—	—	100	—	—	—	μA
	400[b]	—	—	—	—	—	—	—	—	100	μA
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
$V_{CE}(sat)$[2]	—	—	10	1.66	—	—	1.2	—	—	1.2	V
	—	—	15	5	—	—	2.0	—	—	2.0	V
h_{FE}[a]	4	—	1.0	—	20	—	—	20	—	—	
	4	—	10	—	8	—	—	8	—	—	
$I_{S/b}$, 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	—	μs
t_s ($I_{B1} = I_{B2}$)	V_{CC} = 180 V	−5.2	10	2	—	1.2	—	—	1.2	—	μs
t_f ($I_{B1} = I_{B2}$)	V_{CC} = 180 V	−5.2	10	2	—	0.3	—	—	0.3	—	μs
t_c, V_{CC} = 135 V, L = 50 μH, R_C = 13.5 Ω	—	−6	10	2	—	—	700	—	—	700	ns
$R_{\theta JC}$	—	—	—	—	—	—	1.0	—	—	1.0	°C/W

[a]Pulsed, pulse duration = 300 μs, duty factor ≤2%. [b]V_{CB} value.

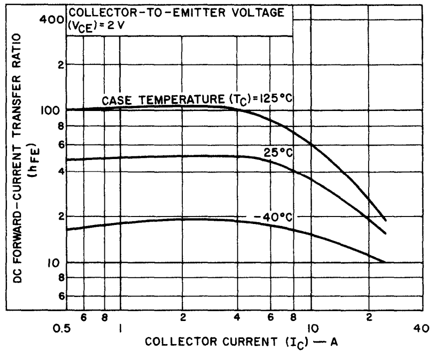


Fig. 3 - Typical dc beta characteristics for both types.

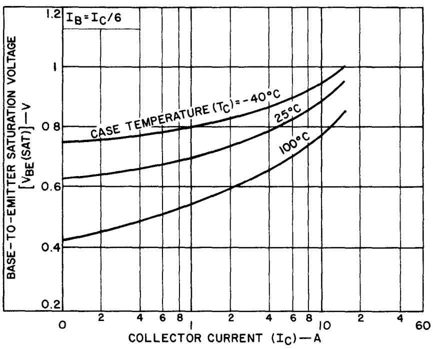


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for both types.

TIP562, TIP563

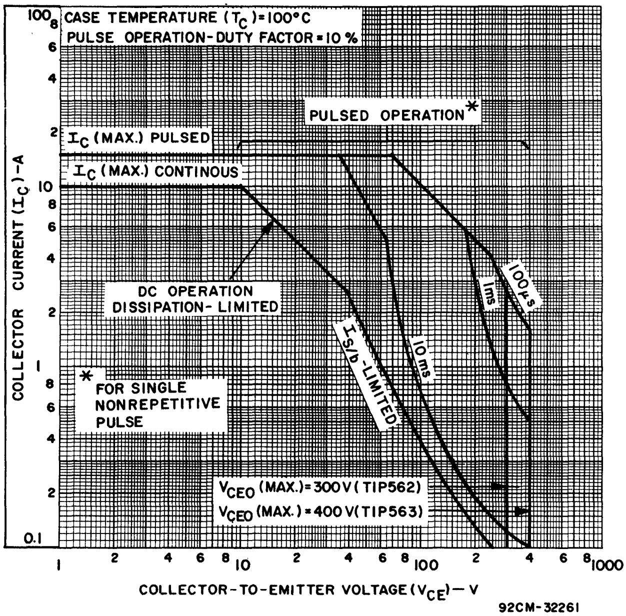


Fig. 5 - Maximum operating areas ($T_C = 100°C$).

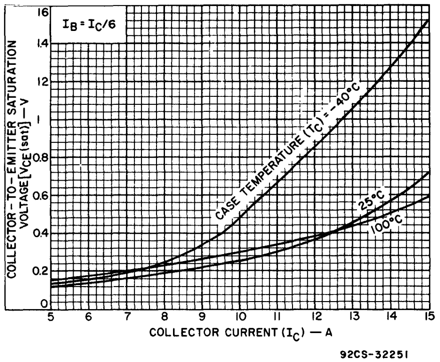


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for both types.

High-Voltage Power Transistors

Technical Data

2N3439, 2N3440, 2N4063, 2N4064

File Number 64

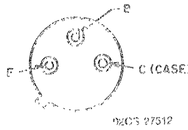
High-Voltage Silicon N-P-N Planar Transistors

For High-Speed Switching and Linear-Amplifier Applications

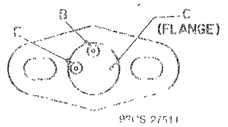
Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-205AD



JEDEC TO-205AD WITH FLANGE

RCA-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.

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
P_T:			
$T_C \leq 25°C$	10	10	W
* $T_A \leq 50°C$	1 (2N3439)	1 (2N3440)	W
$T_C > 50°C$ Derate linearly at	0.057		W/°C
* T_{stg}, T_J	65 to +200		°C
* T_L (During soldering) At distance 1/32 in. (0.8 mm) from case for 10 s max.	255		°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 VOLTAGE V dc		CURRENT mA dc		LIMITS 2N3439 2N4063		2N3440 2N4064		UNITS
	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
$R_{\theta JC}$					–	17.5	–	17.5	°C/W
$R_{\theta JA}$ 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

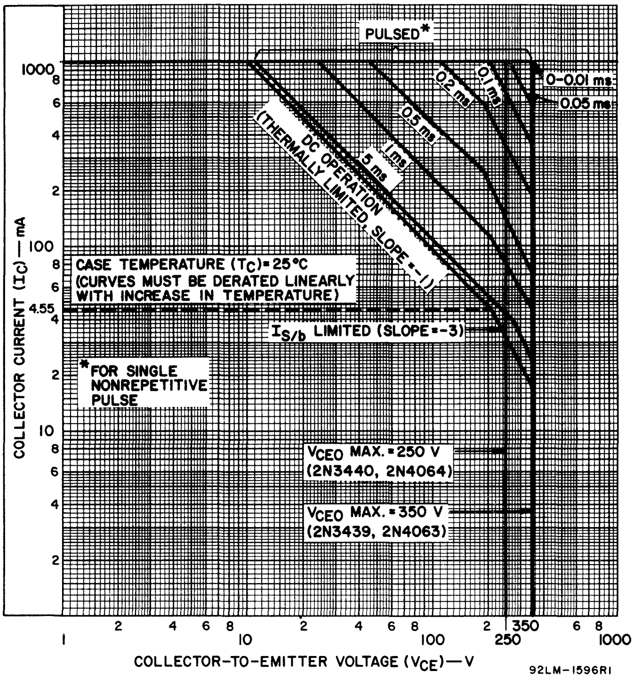


Fig. 1 – Maximum operating areas for 2N3439, 2N3440, 2N4063, and 2N4064.

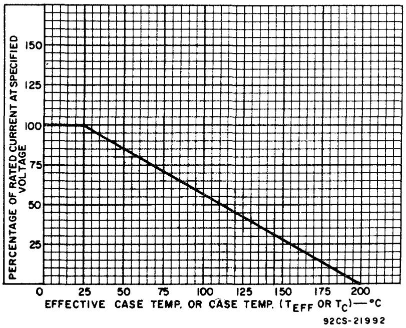


Fig. 2 – Current derating curve for all types.

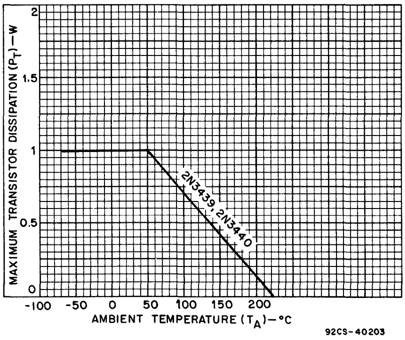


Fig. 3 - Dissipation derating curve for 2N3439 and 2N3440.

2N3439, 2N3440, 2N4063, 2N4064

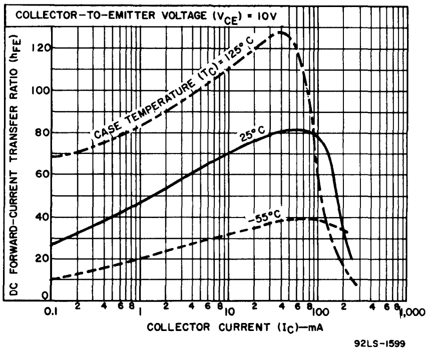


Fig. 4 – Typical dc beta characteristics for all types.

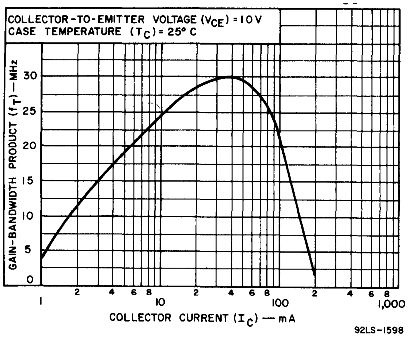


Fig. 5 – Typical gain bandwidth product for all types.

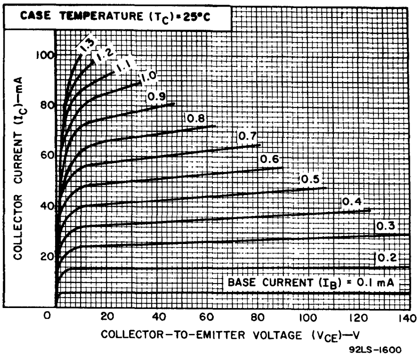


Fig. 6 – Typical output characteristics for all types.

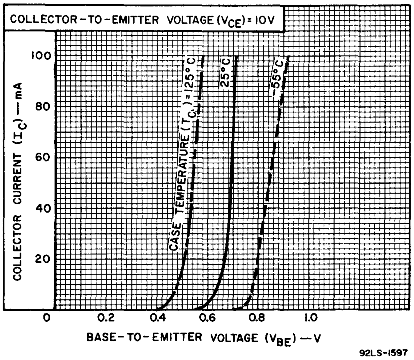


Fig. 7 – Typical transfer characteristics for all types.

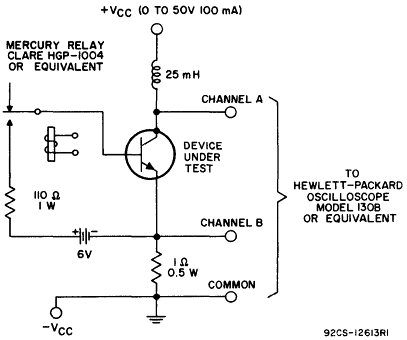
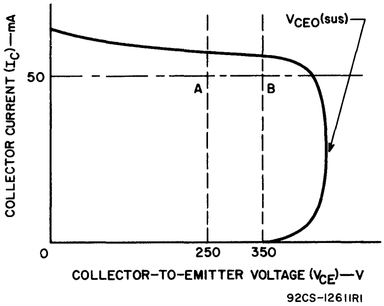


Fig. 8 – Circuit used to measure sustaining voltage $V_{CEO}(sus)$ for all types.



The sustaining voltage V_{CEO}(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.

2N3583-2N3585, 2N4240

File Number **138**

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*

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

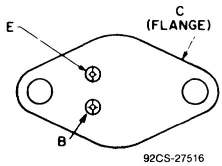
Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection and hi-fi amplifiers.

These transistors are also intended for a wide varitey 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 VOLTAGE V dc V_{CB}	V_{CE}	V_{EB}	V_{BE}	CURRENT mA dc I_C	I_E	I_B	LIMITS 2N3583 MIN.	2N3583 MAX.	2N3584 MIN.	2N3584 MAX.	2N3585 MIN.	2N3585 MAX.	2N4240 MIN.	2N4240 MAX.	UNITS
* 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	–	–	–	–	
			450		−1.5				–	–	–	–	–	1.0	–	2.0	
At T_C = 150°C	I_{CEX}		225		−1.5				–	3	–	–	–	–	–	–	mA
			300		−1.5				–	–	–	3	–	3	–	5.0	
* Emitter-Cutoff Current	I_{EBO}			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	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: * With base open	$V_{CEO}(sus)$					200		0	175•	–	250•	–	300•	–	300•	–	V
With external base-to-emitter resistance (R_{BE}) = 50Ω	I_{CER}		250						–	1.0	–	–	–	–	–	–	mA
			300						–	–	–	1.0	–	–	–	–	
			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	–	
* f = 1 kHz			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)	$I_{S/b}$		100						350	–	350	–	350	–	350	–	mA
* Saturated Switching Time (V_{CC} = 200 V): Rise Time	t_r	(V_{CC}) 200				1 A		100	–	–	–	3	–	3	–	–	μs
						750		75	–	–	–	–	–	–	–	0.5	
Storage Time	t_s	(V_{CC}) 200				1 A		100	–	–	–	4	–	4	–	–	
						750		75	–	–	–	–	–	–	–	6	
Fall Time	t_f	(V_{CC}) 200				750		75	–	–	–	–	–	–	–	3	
						1 A		100	–	–	–	3	–	3	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$								–	5	–	5	–	5	–	5	°C/W
Junction-to-Ambient	$R_{\theta JA}$								–	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

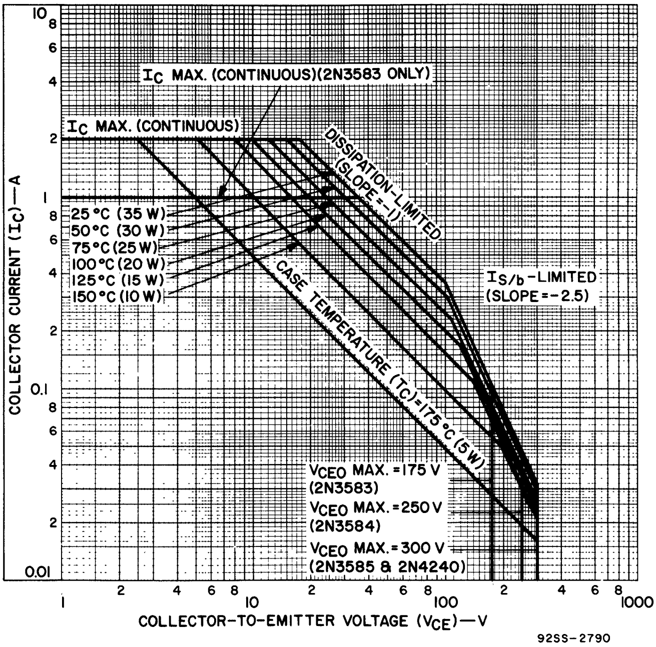


Fig. 1 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (dc conditions).

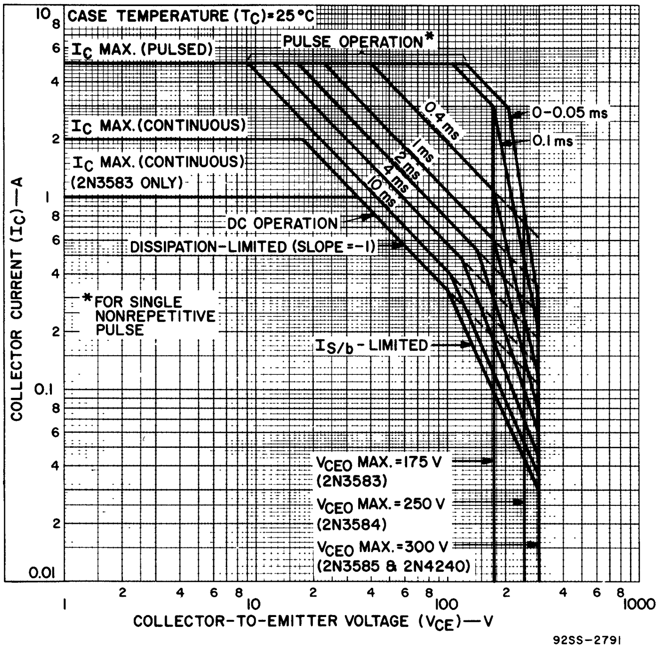


Fig. 2 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (pulse conditions).

2N3583-2N3585, 2N4240

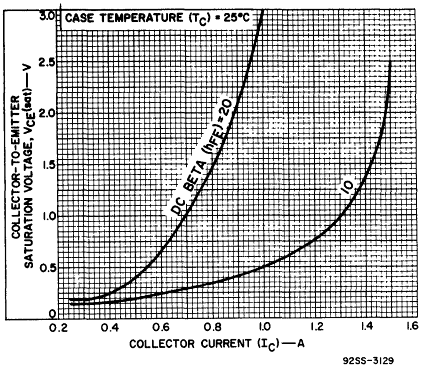


Fig. 3 - Typical collector-to-emitter saturation voltage vs. current for types 2N3584 and 2N3585.

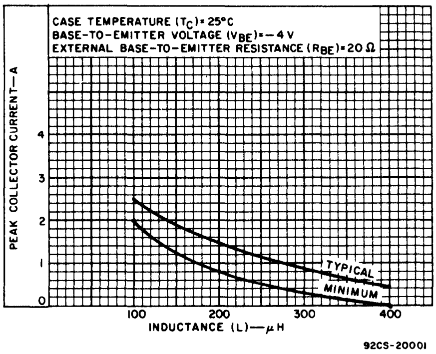


Fig. 4 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

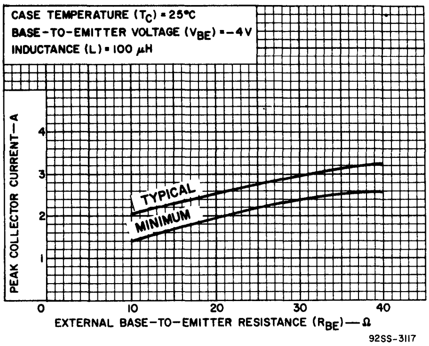


Fig. 5 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

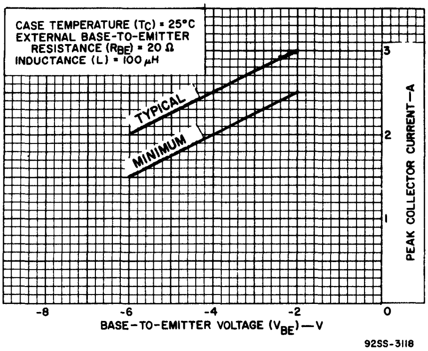


Fig. 6 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

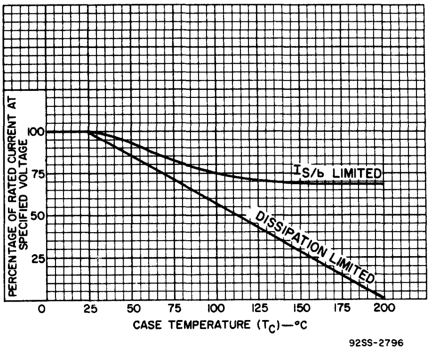


Fig. 7 - Dissipation derating curves for all types.

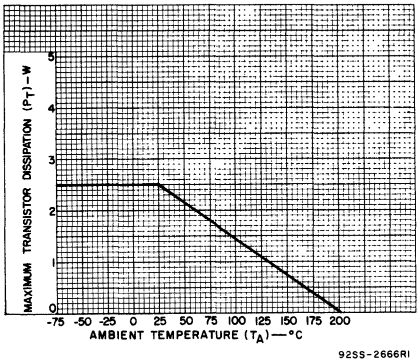


Fig. 8 - Dissipation derating curve for types 2N3583, 2N3584, 2N3585, and 2N4240.

2N3583-2N3585, 2N4240

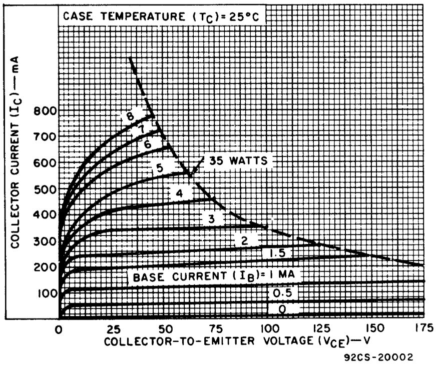


Fig. 9 - Typical output characteristics for type 2N3583.

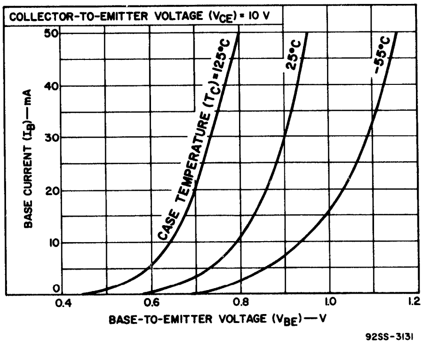


Fig. 10 - Typical input characteristics for all types.

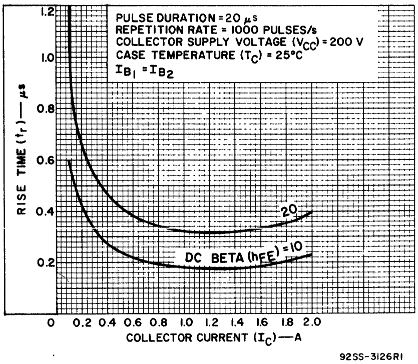


Fig. 11 - Typical rise time vs. collector current for types 2N3584 and 2N3585.

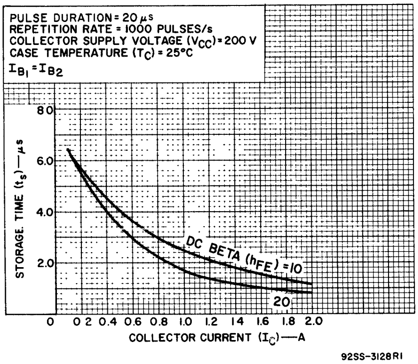


Fig. 12 - Typical storage time vs. collector current for types 2N3584 and 2N3585.

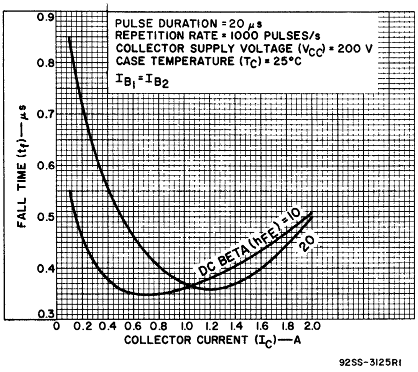


Fig. 13 - Typical fall time vs. collector current for types 2N3584 and 2N3585.

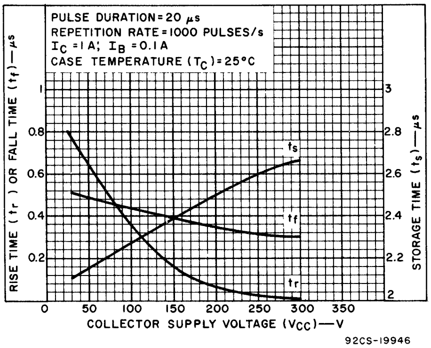


Fig. 14 - Typical rise time, fall time, and storage time vs. collector supply voltage for types 2N3584 and 2N3585.

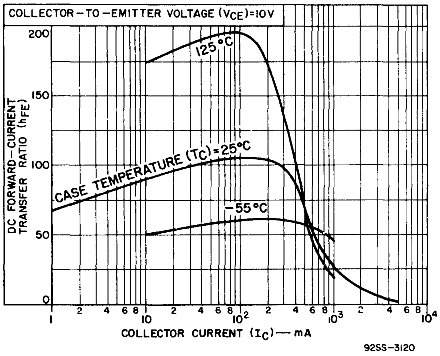


Fig. 15 - Typical dc beta vs. collector current for types 2N3583, and 2N4240.

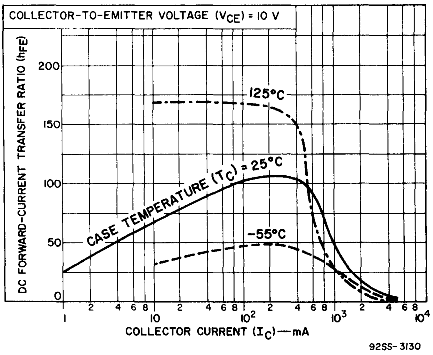


Fig. 16 - Typical dc beta vs. collector current for types 2N3584 and 2N3585.

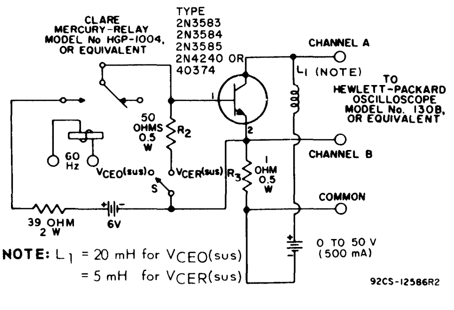
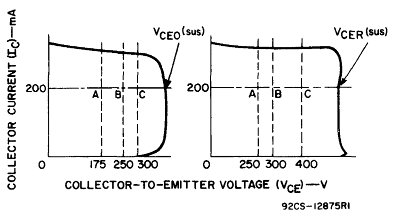


Fig. 17 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ for all types.



NOTE: The sustaining voltages $V_{CEO}(sus)$ 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.

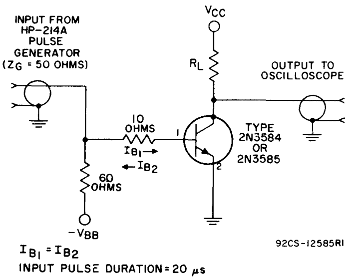


Fig. 19 - Circuit used to measure switching times for types 2N3584 and 2N3585.

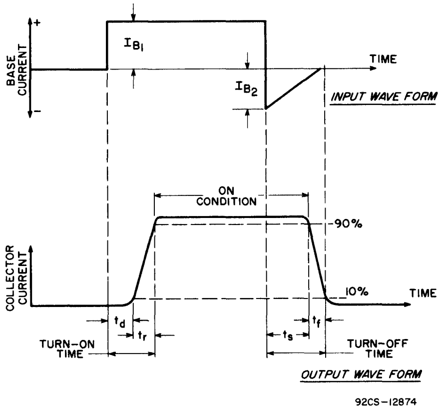


Fig. 20 - Phase relationship between input and output currents, showing reference points for specification of switching times.

2N5239, 2N5240 File Number **321**

High-Voltage, Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications in Industrial and Commerical 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:*
  $P_T = 100$ *W at* $V_{CE} = 125$ *V,* $T_C = 25°C$
- *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* $V_{CE} = 125$ *V*
- *Maximum area-of-operation curves for dc and pulse operation*

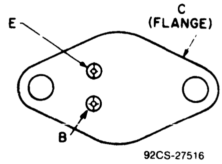
The RCA-2N5239 and 2N5240• are multi epitaxial silicon n-p-n power transistors.

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:*

<table>
<tr><th></th><th>2N5239</th><th>2N5240</th><th></th></tr>
<tr><td>*V_{CBO}</td><td>300</td><td>375</td><td>V</td></tr>
<tr><td>V_{CER}(sus)</td><td></td><td></td><td></td></tr>
<tr><td>$R_{BE} \leq 50\ \Omega$</td><td>250</td><td>350</td><td>V</td></tr>
<tr><td>*V_{CEO}(sus)</td><td>225</td><td>300</td><td>V</td></tr>
<tr><td>*V_{EBO}</td><td colspan="2">6</td><td>V</td></tr>
<tr><td>*I_C</td><td colspan="2">5</td><td>A</td></tr>
<tr><td>*I_B</td><td colspan="2">2</td><td>A</td></tr>
<tr><td>*P_T:</td><td></td><td></td><td></td></tr>
<tr><td>$T_C \leq 25°C$ and $V_{CE} \leq 125$ V</td><td colspan="2">100</td><td>W</td></tr>
<tr><td>$T_C \leq 25°C$ and $V_{CE} \leq 125$ V</td><td colspan="2">See Fig. 1</td><td></td></tr>
<tr><td>$T_C > 25°C$ and $V_{CE} > 125$ V</td><td colspan="2">See Fig. 1</td><td></td></tr>
<tr><td>*T_{stg}, T_J</td><td colspan="2">-65 to 200</td><td>°C</td></tr>
<tr><td>T_L</td><td></td><td></td><td></td></tr>
<tr><td>At distance ≥1/32 in. (0.8 mm) from seating plane for 10 s max.</td><td colspan="2">230</td><td>°C</td></tr>
</table>

* 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	—	—	mA
		375	-1.5			—	—	—	2	mA
	(T_C = 150° C)	300	-1.5			—	5	—	3	mA
	I_{EBO} (V_{EB} = 5 V)			0		—	5	—	1	mA
*	(V_{EB} = 6 V)			0		—	20	—	20	mA
	V_{EBO}				0.02	6	—	6	—	V
*	$V_{CEO}(sus)$[a]			0.2[b]		225	—	300	—	V
	$V_{CER}(sus)$[a] ($R_{BE} \leq 50\ \Omega$)			0.2[b]		250	—	350	—	V
	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	V
*				4.5[b]	1.125	—	5	—	5	V
*	$I_{S/b}$ (t = 1 s)	125				0.8	—	0.8	—	A
*	$\lvert h_{fe} \rvert$ (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
	$R_{\theta JC}$					—	1.75	—	1.75	°C/W

* 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 $\leq$ 350 μs, duty factory $\leq$ 2%.

[c] V_{CB} value.

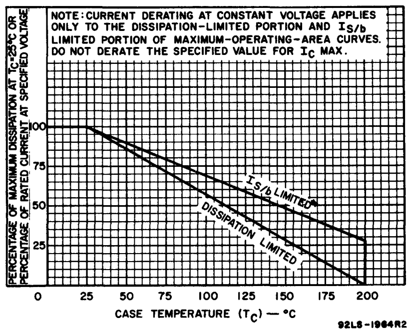


Fig. 1 - Derating curves for both types.

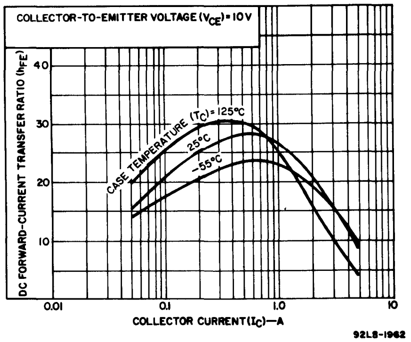


Fig. 2 — Typical dc beta characteristics for both types.

2N5239, 2N5240

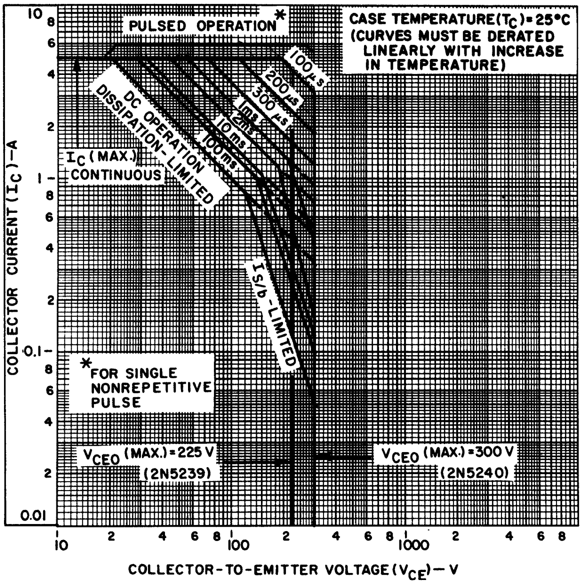


Fig. 3 - Maximum operating areas for both types.

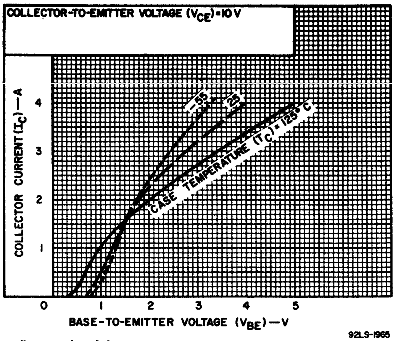


Fig. 4 — Typical transfer characteristics for both types.

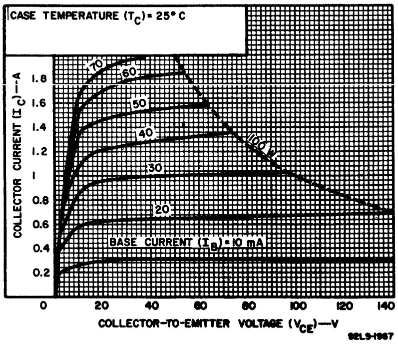


Fig. 5 — Typical output characteristics for both types.

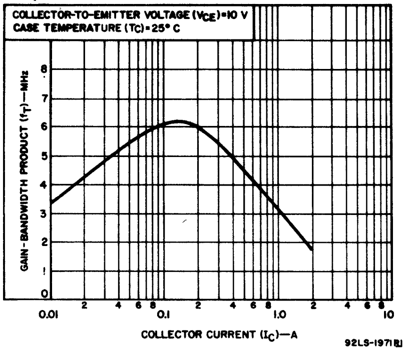


Fig. 6 — Typical gain-bandwidth product as a function of collector current for both types.

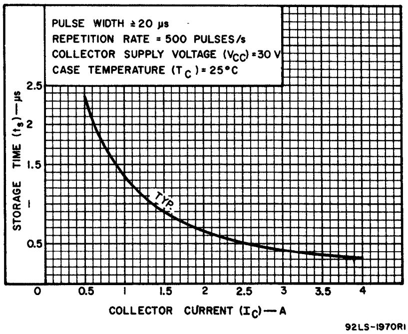


Fig. 7 — Typical saturated-switching time (storage) as a function of collector current for both types.

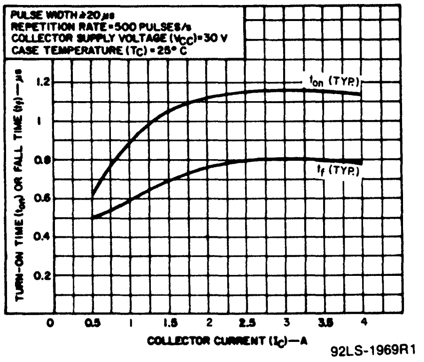


Fig. 8 — Typical saturated-time (turn-on or fall) as a function of collector current for both types.

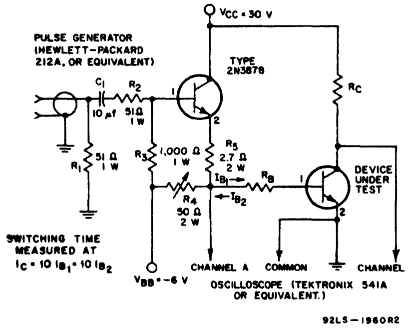


Fig. 9 — Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$ for both types.

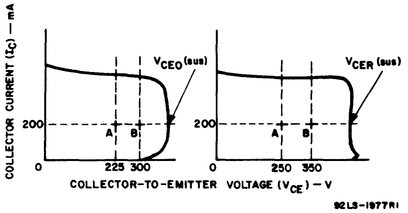


Fig. 10 — Oscilloscope display for $V_{CEO}(sus)$ and $V_{CER}(sus)$ measurement.

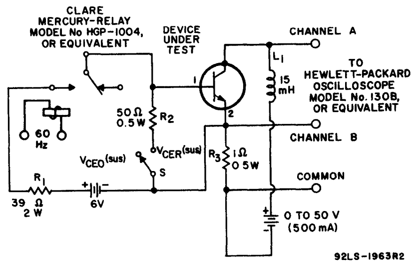


Fig. 11 — Circuit used to measure switching times for both types.

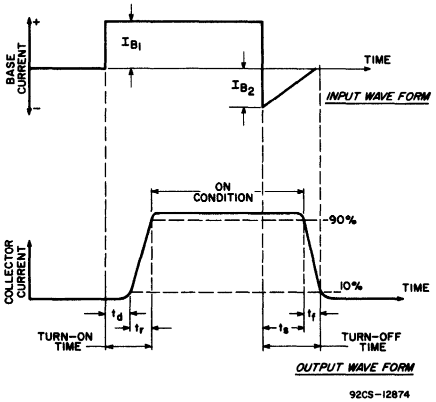


Fig. 12 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N5415, 2N5416

File Number **336**

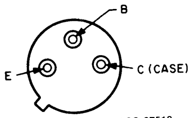
Silicon P-N-P High-Voltage Planar Transistors

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 RCA-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			
$T_C \leq 25°$ C	10	10	W
$T_C > 25°$ C	See Figs. 1 & 2		
$T_C \leq 50°$ C	1	1	W
$T_C > 50°$ C ... Derate linearly at	6.7	6.7	mW/°C
* 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.	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	– –	–50 –	µA
* I_{CBO} $I_E = 0$	–280 –175					– –	– –50	– –	–50 –	µA
I_{CEV}		–300 –200	1.5 1.5			– –	– –50	– –	–50 –	µA
* I_{EBO}			6 4	0 0		– –	– –20	– –	–20 –	µA
* h_{FE}		–10 –10		–50[b] –50[b]		– 30	– 150	30 –	120 –	
$V_{CEO}(sus)$				–50	0	–200[a]	–	–300[a]	–	V
$V_{CER}(sus)$ $R_{BE} = 50\ \Omega$				–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	–	
* $\lvert h_{fe} \rvert$ 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
$R_{\theta JC}$						–	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

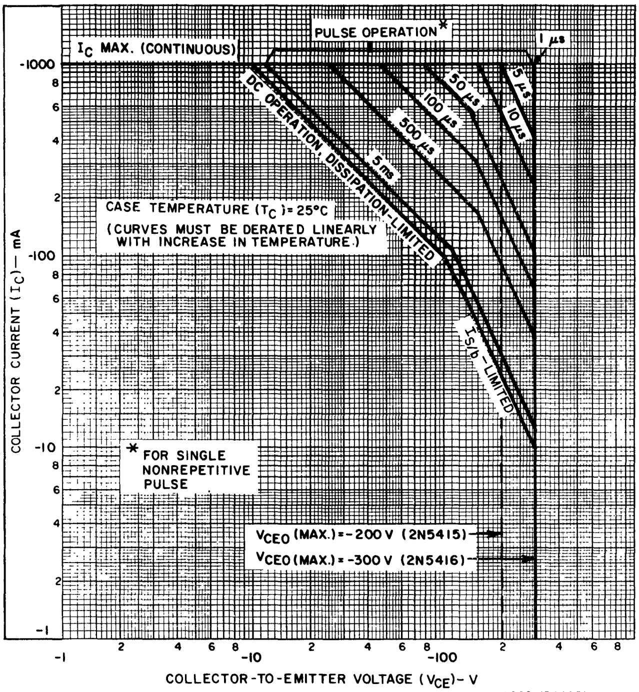


Fig. 1 — Maximum safe operating areas.

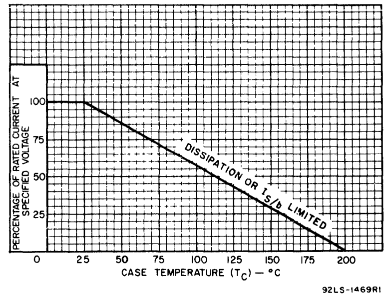


Fig. 2 — Dissipation derating curve.

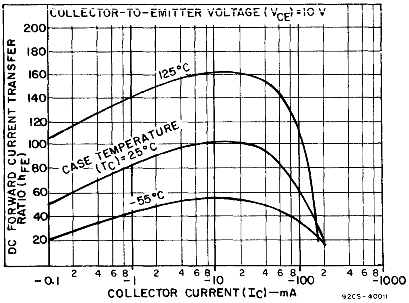


Fig. 3 — Typical dc beta characteristics for both types.

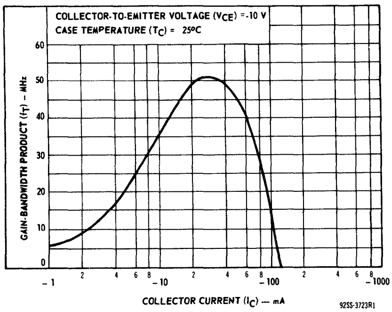


Fig. 4 — Typical gain-bandwidth product for both types.

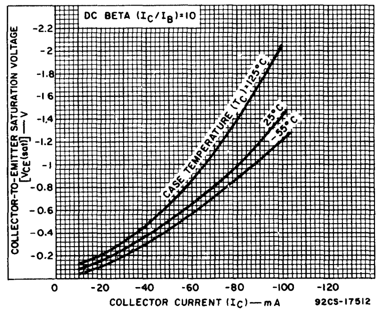


Fig. 5 — Typical collector-to-emitter saturation voltage for both types.

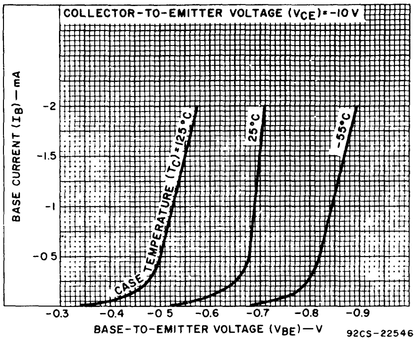


Fig. 6 — Typical input characteristics for both types.

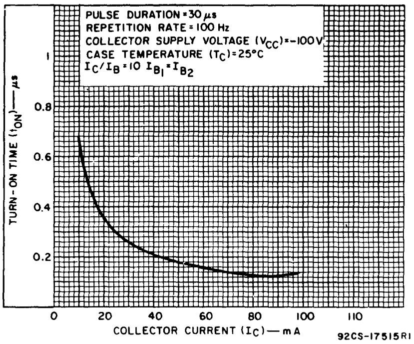


Fig. 7 — Typical turn-on time characteristic for both types.

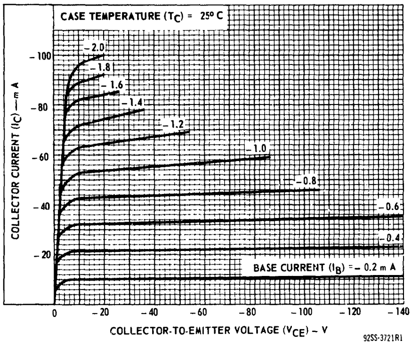


Fig. 8 — Typical output characteristics for both types.

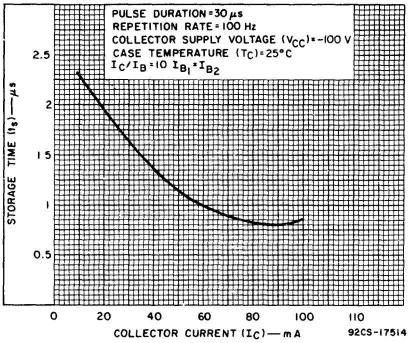


Fig. 9 — Typical storage-time characteristic for both types.

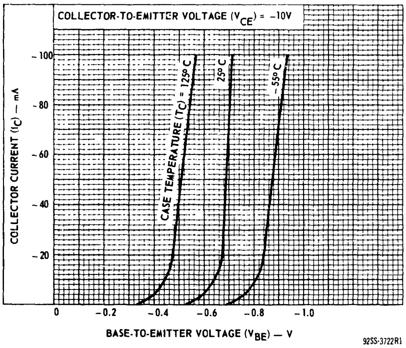


Fig. 10 — Typical transfer characteristics for both types.

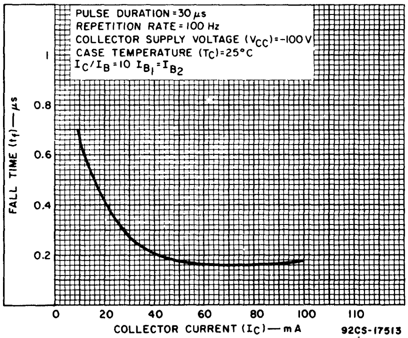


Fig. 11 — Typical fall-time characteristic for both types.

2N5838, 2N5839, 2N5840

File Number **410**

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

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

Features:

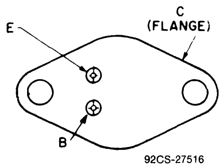
- *Maximum safe-area-of-operation curves*
- *Low saturation voltages*
- *High voltage ratings*
  V_{CER}[sus] = 375 V [2N5840]
  300 V [2N5839]
  275 V [2N5838]
- *High dissipation rating*
  P_T = 100 W

RCA-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 TA7420 respectively.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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_{CEO}(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}) ≤ 50 Ω, V_{CER}(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 ≥ 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_{CEX}(sus) in JEDEC Registration Data.

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}	200 250	.					- -	2 -	- -	- -	- 2	- -	- -	- 2	- -	mA
* With base-emitter junction reverse biased	I_{CEV}	265 290 360		-1.5 -1 5 -1 5				- - -	5 - -	- - -	- - -	- 2 -	- - -	- - -	- - 2	- - -	mA
* With base-emitter junction reverse biased	I_{CEV} T_C 100 °C	265 290 360		1 5 1 5 1 5				-	8			5	-	-	- - 5	- -	mA
* Emitter-Cutoff Current	I_{EBO}		-6						1	-	-	1	-		1	-	mA
* Collector-to-Emitter Sustaining Voltage (See Figs. 4, 5, & 6) With base open	$V_{CEO}(sus)^a$				0 2			250^b	-	-	275^b	-	-	350^b	-	-	V
* With base-emitter junction reversed biased	$V_{CEX}(sus)^a$			-1 5	0 1			275^b	-	-	300^b	-	-	375^b	-	-	V
With external base-to-emitter resistance (R_{BE}) - 50 Ω	$V_{CER}(sus)^a$				0 2			275^b	-	-	300^b	-	-	375^b	-	-	V
* Emitter-to-Base Voltage	V_{EBO}						0.02	6	-	-	6	-	-	6	-	-	V
* DC Forward-Current * Transfer Ratio	h_{FE}	5 3 2			0.5^b 2^b 3^b			20 - 8	- - 40	- - -	20 10 -	- 50 -	- - -	20 10 -	- 50 -	- - -	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				2 3	0 2 0 375		- -	2	-	- -	2 -	- -	- -	2 -	- -	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				2 3	0 2 0 375		-	1	- -		1 5	- -	- -	1 5	- -	V
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	$I_{S/b}{}^c$	40						2 5	-	-	2 5	-	-	2 5	-	-	A
Switching Times: Delay	t_d	VCC = 200			2 3	0.2^e 0.375^e		- -	- -	- 0.06	- -	- -	0.07 -	- -	- -	0.07 -	μs
* Rise	t_r	VCC = 200			2 3	0.2^e 0.375^e		-	- 1 5	- 0.8	- - .	1.5 -	0.6 -	- -	1.75 -	0.6 -	μs
* Storage	t_s	VCC - 200			2 3	0.2^e 0.375^e		- -	- 3 0	- 1 0	-	3.75 -	1.75 -	-	3.0 -	1.75 -	μs
* Fall	t_f	VCC - 200			2 3	0.2^e 0.375^e		- -	- 1.5	- 0.4	- -	1.5 -	0.35 -	- -	1.5 -	0.35 -	μs
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: Ths 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

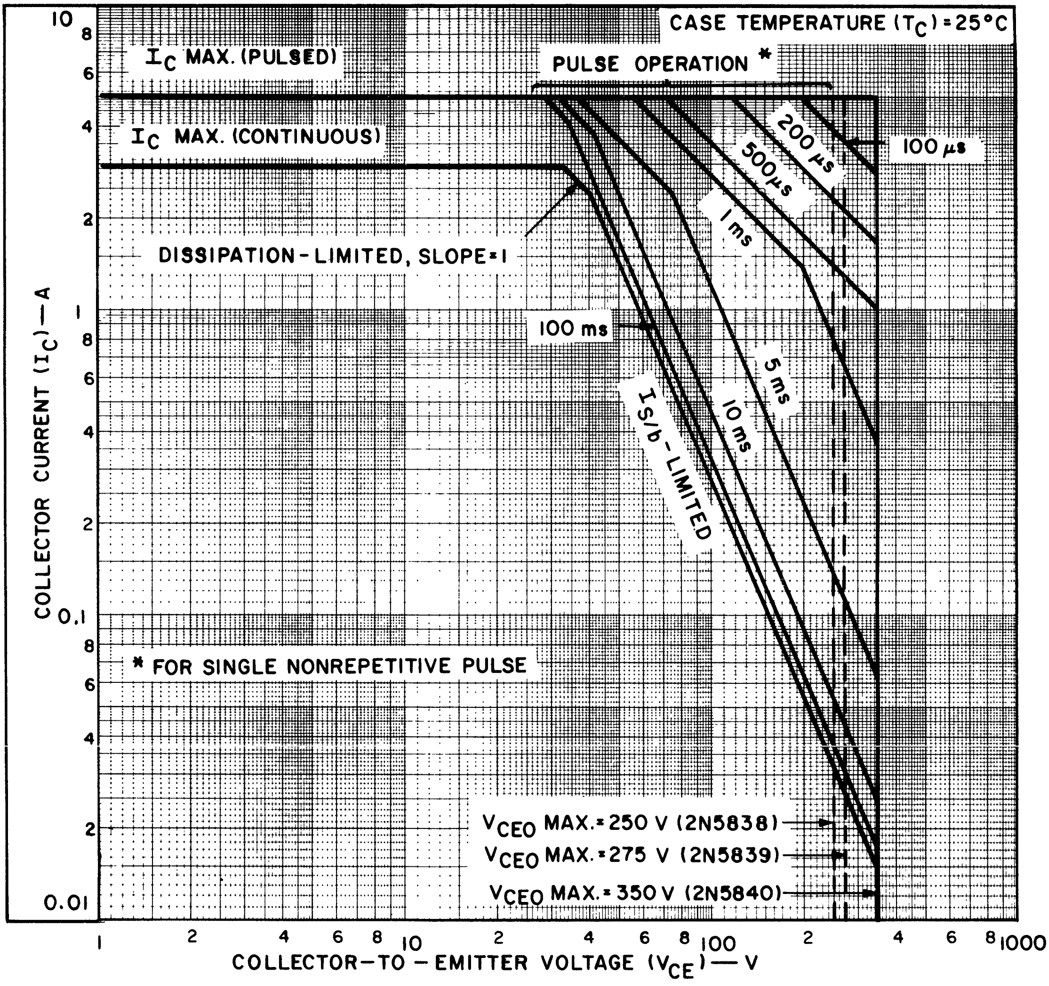


Fig. 1 — Maximum operating areas for all types.

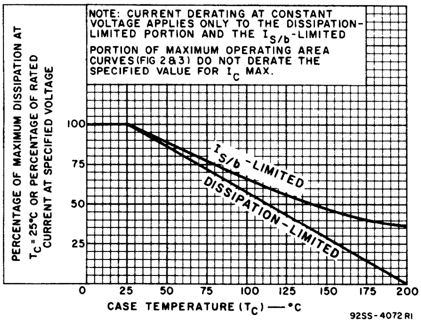


Fig. 2 — Derating curves for all types.

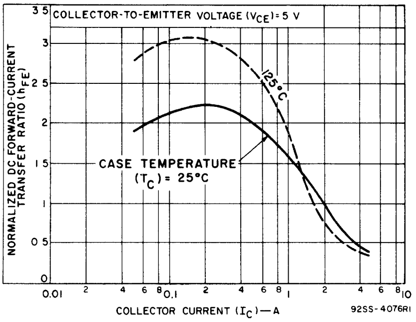


Fig. 3 — Typical normalized dc beta characteristics for all types.

2N5838, 2N5839, 2N5840

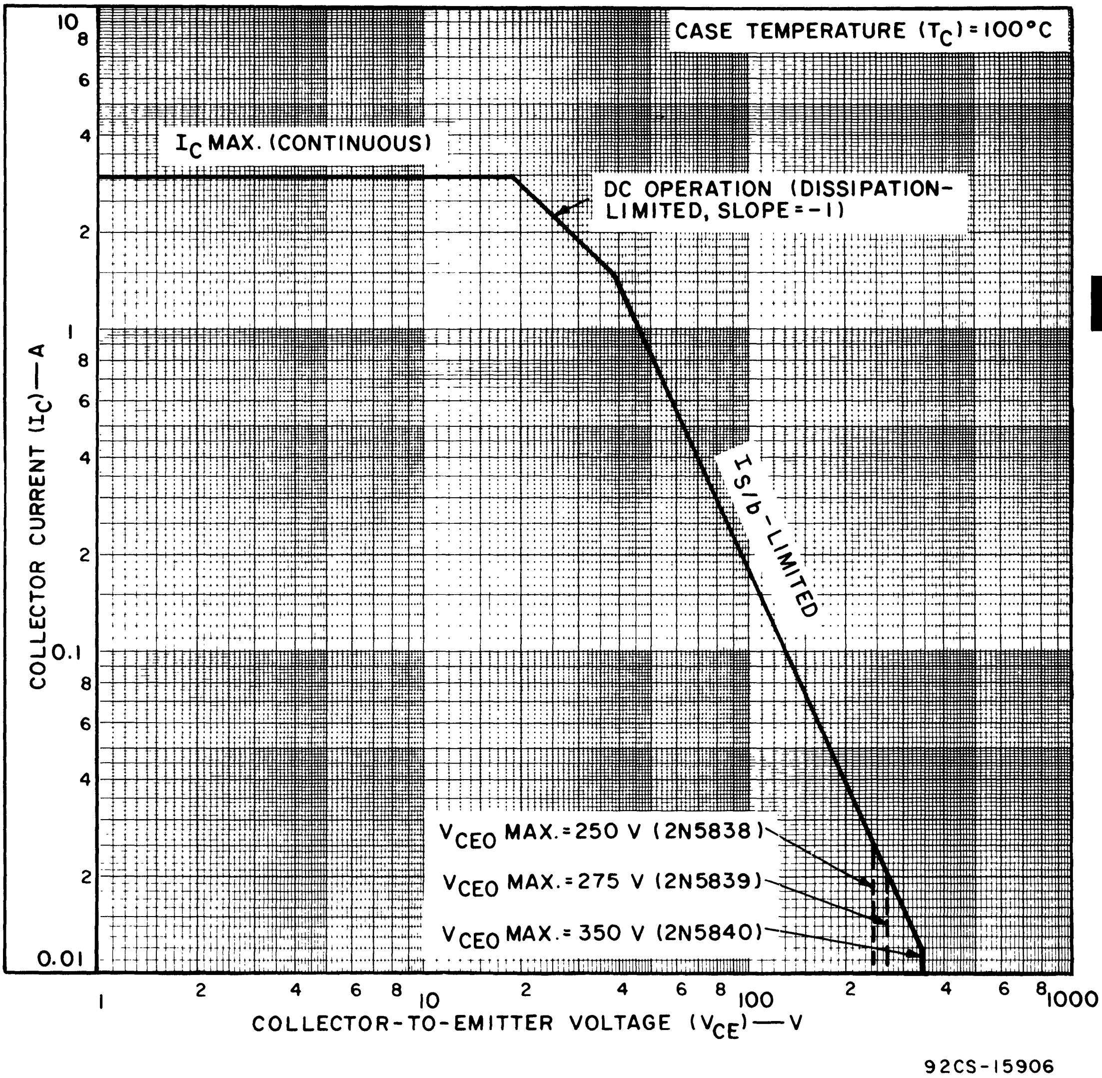


Fig. 4 — Maximum operating areas for all types.

2N5838, 2N5839, 2N5840

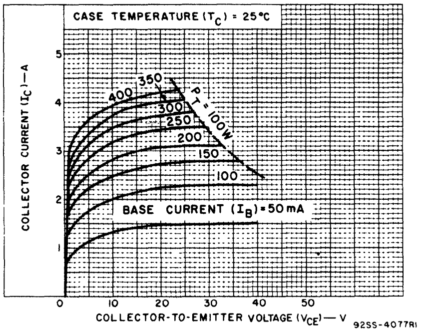


Fig. 5 — Typical output characteristics for all types.

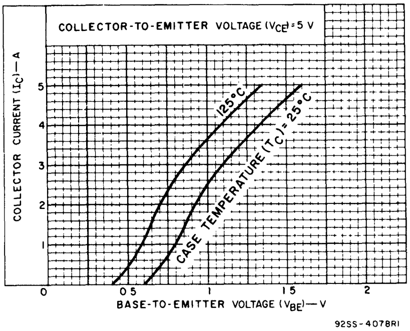


Fig. 6 — Typical transfer characteristics for all types.

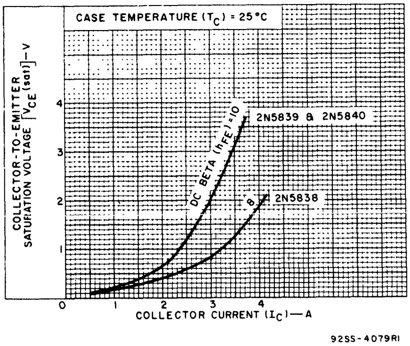


Fig. 7 — Typical saturation voltage characteristics for for all types.

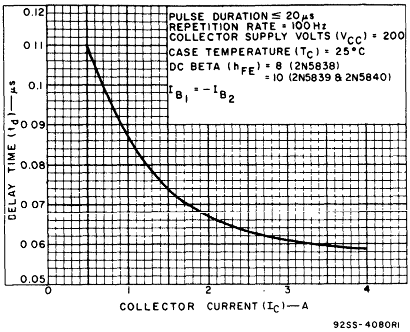


Fig. 8 — Typical delay-time characteristics for all types.

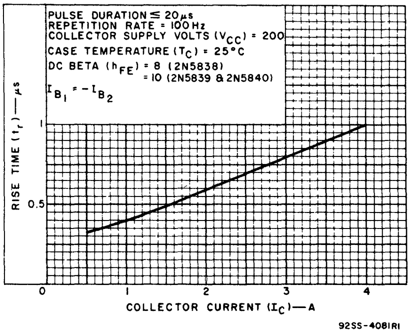


Fig. 9 — Typical rise-time characteristics for all types.

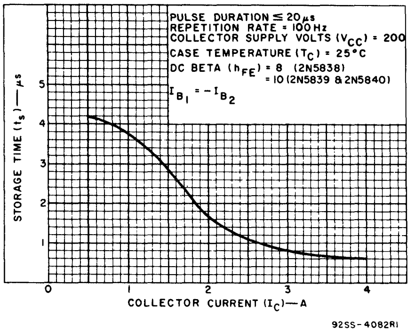


Fig. 10 — Typical storage-time characteristics for all types.

2N5838, 2N5839, 2N5840

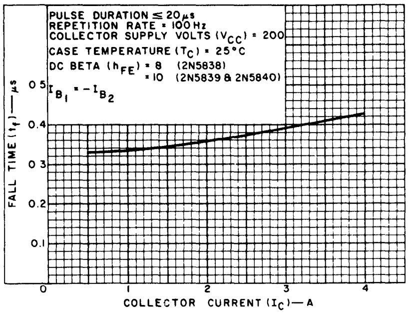


Fig. 11 — Typical fall-time characteristics for all types.

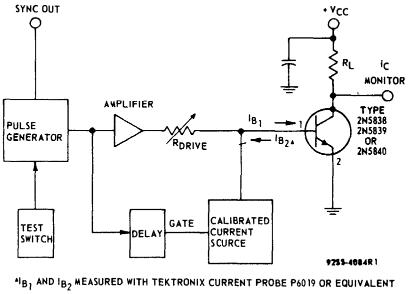


Fig. 12 — Circuit used to measure switching times for all types.

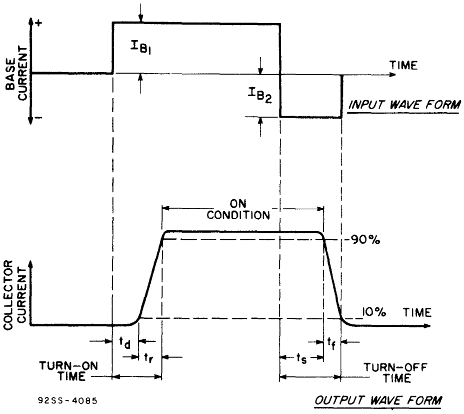


Fig. 13 — Phase relationship between input and output currents showing reference points for specification of switching times.

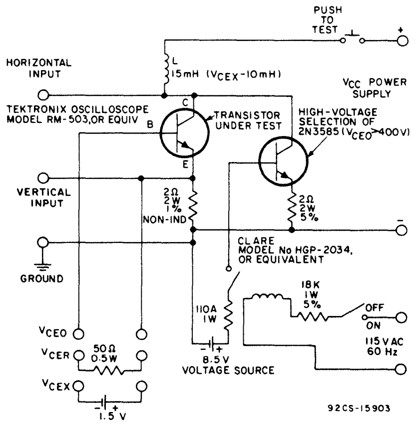
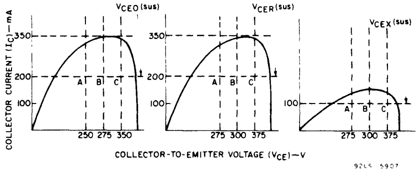


Fig. 14 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.



The sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, 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.

2N6077, 2N6078, 2N6079

File Number **492**

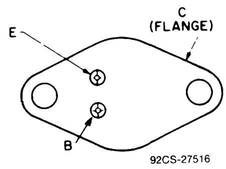
High-Voltage, High Power Silicon N-P-N Transistors

For Switching and Linear Applications

Features:

- *Maximum safe-area-of-operation curves*
- *Low saturation voltages*
- *High voltage ratings:*
  V_{CER}[sus] = 300 V [2N6077]
  = 275 V [2N6078]
  = 375 V [2N6079]
- *High dissipation ratings : P_T = 45 W*

TERMINAL DESIGNATIONS



JEDEC TO-213AA

RCA-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).

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}) ≤ 50Ω	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		°C
*PIN TEMPERATURE (During Soldering):					
At distances ≥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).

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°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]	–	–	
*Emitter-to-Base Voltage	V_{EBO}						0.001	6	–	–	6	–	–	9	–	–	V
*DC Forward-Current Transfer Ratio	h_{FE}	1			1.2			12	28	70	12	28	70	12	28	50	
*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 Ω, L = 100 μH	$E_{S/b}$[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[e]		–	0.02	–	–	0.02	–	–	0.02	–	μs
* Rise *(See Figs. 13, 17, & 18)*	t_r	V_{CC} = 250 V			1.2	0.2[e]		–	0.3	0.75	–	0.3	0.75	–	0.3	0.75	
* Storage *(See Figs. 11, 12, 17 & 18)*	t_s	V_{CC} = 250 V			1.2	0.2[e]		–	2.8	5	–	2.8	5	–	2.8	5	
* *(See Figs. 14, 17, & 18)*	t_f	V_{CC} = 250 V			1.2	0.2[e]		–	0.3	0.75	–	0.3	0.75	–	0.3	0.75	
Thermal Resistance (Junction-to-Case)	$\theta_{J\text{-}C}$	20			2.5			–	–	3.9	–	–	3.9	–	–	3.9	°C/W

[a] Pulsed; pulse duration ≤350 μs, 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] I_{B1} = I_{B2} = value shown.

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

2N6077, 2N6078, 2N6079

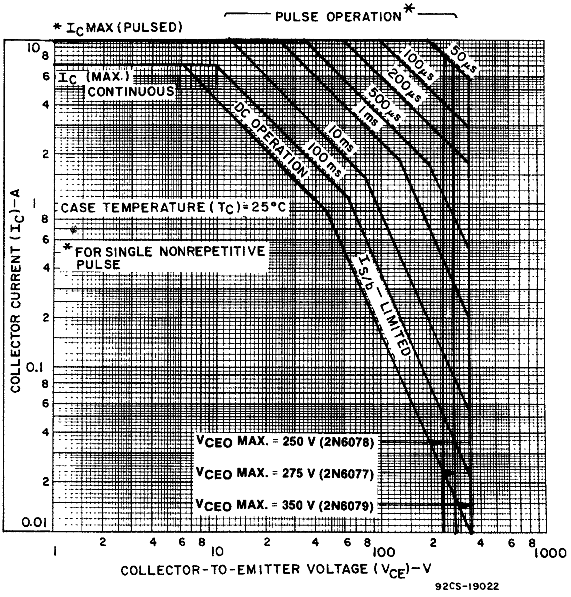


Fig. 1—Maximum operating areas for all types.

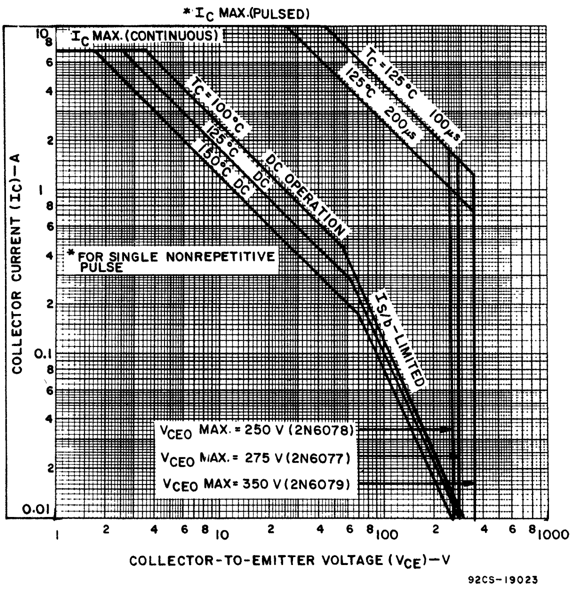


Fig. 2—Maximum operating areas for all types.

2N6077, 2N6078, 2N6079

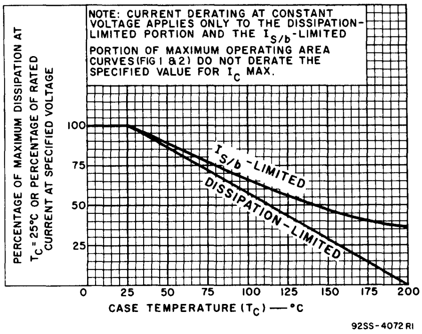


Fig.3—Derating curve for all types.

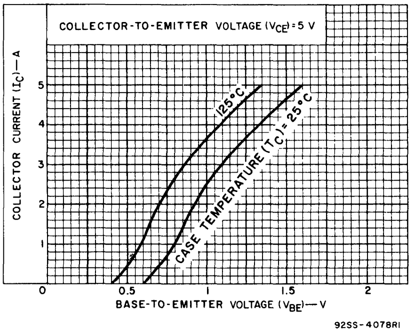


Fig.4—Typical transfer characteristics for all types.

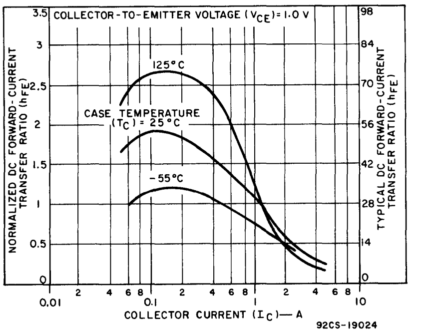


Fig.5—Typical normalized dc beta characteristics for all types.

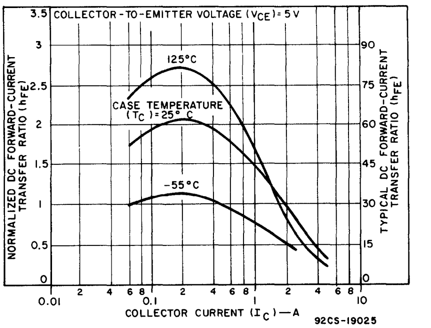


Fig.6—Typical normalized dc beta characteristics for all types.

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).

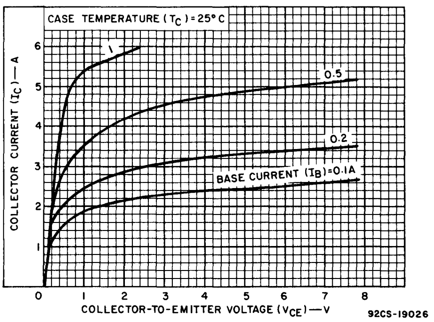


Fig.7—Typical output characteristics for all types.

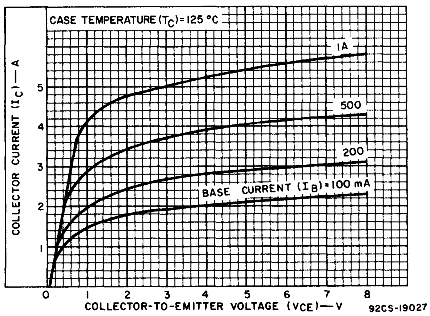


Fig.8—Typical output characteristics for all types.

2N6077, 2N6078, 2N6079

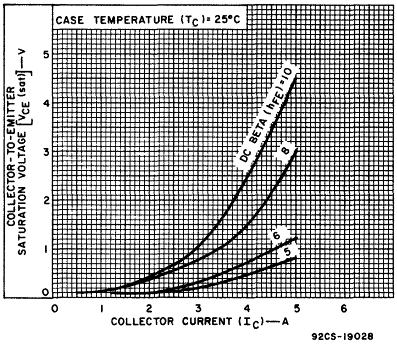


Fig.9—Typical saturation voltage characteristics for all types.

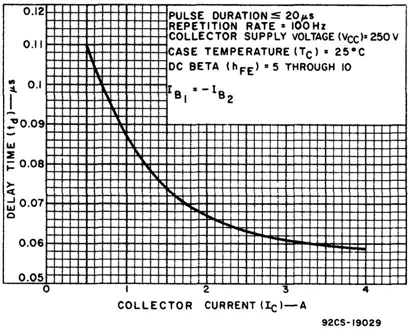


Fig.10—Typical delay-time characteristic for all types.

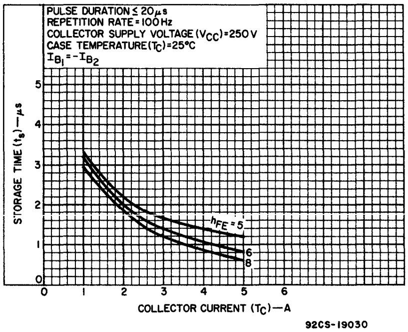


Fig.11—Typical storage-time characteristic for all types (with constant forced gain).

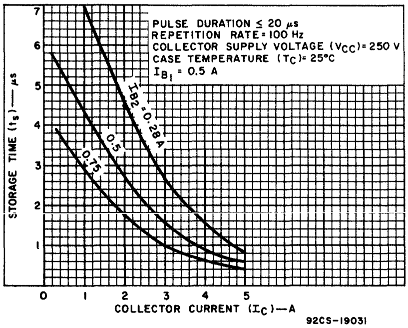


Fig.12—Typical storage-time characteristic for all types (with constant-base drives).

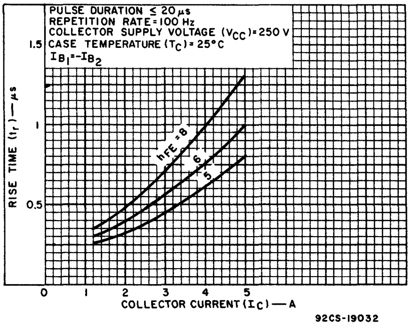


Fig.13—Typical rise-time characteristic for all types.

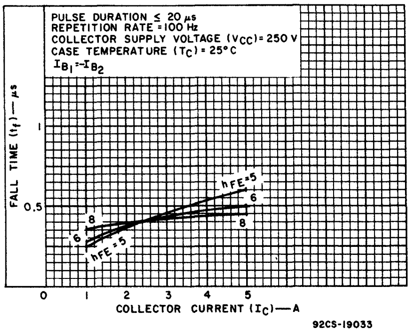


Fig.14—Typical fall-time characteristic for all types.

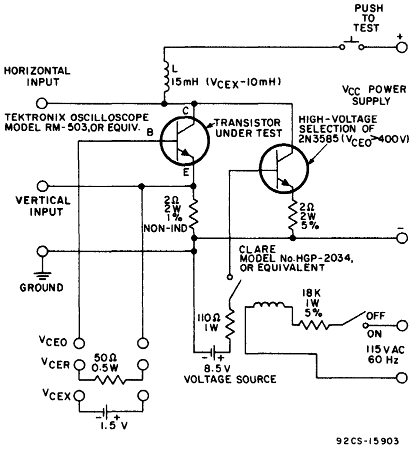
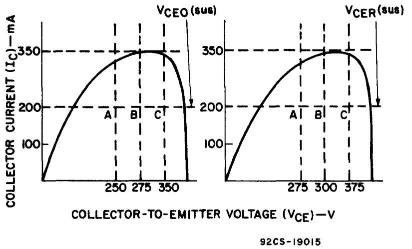
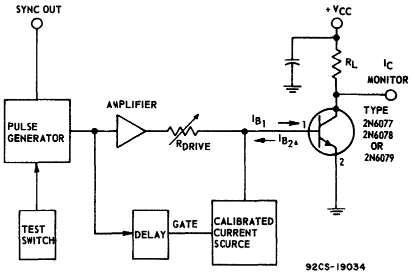


Fig.15–Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus) for all types.



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).



*I_{B1} AND I_{B2} MEASURED WITH TEKTRONIX CURRENT PROBE P6019 OR EQUIVALENT

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

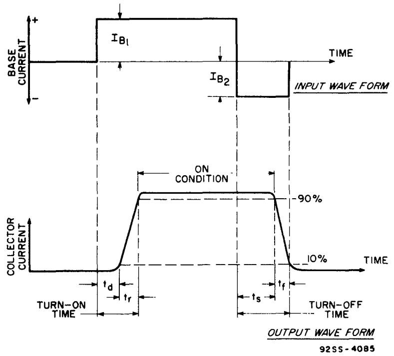


Fig.18–Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 17).

2N6211, 2N6212, 2N6213, 2N6214

File Number **507**

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

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

Features:

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

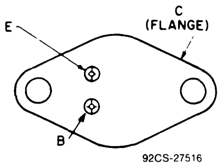
Applications:

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

RCA 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 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 ≥ 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: Voltage V dc V_{CE}	V_{BE}	Current A dc I_C	I_E	I_B	LIMITS: 2N6211 Min.	Max.	2N6212 Min.	Max.	2N6213 Min.	Max.	2N6214 Min.	Max.	UNITS
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	–	–	–	–	–	–	mA
		−315	1.5				–	–	–	−0.5	–	–	–	–	
		−360	1.5				–	–	–	–	–	−0.5	–	–	
		−410	1.5				–	–	–	–	–	–	–	−1	
* With base-emitter junction reverse biased and T_C = 100°C	I_{CEV}	−250	1.5				–	−5	–	–	–	–	–	–	mA
		−315	1.5				–	–	–	−5	–	–	–	–	
		−360	1.5				–	–	–	–	–	−5	–	–	
		−410	1.5				–	–	–	–	–	–	–	−10	
* 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	–	–	–	–	–	–	
		−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 Ω	$V_{CER}(sus)$			−0.2			−250	–	−325	–	−375	–	−425	–	V
With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CEX}(sus)$		1.5	−0.2			−275	–	−350	–	−400	–	−450	–	V
* Emitter-to-Base Voltage	V_{EBO}					0.5 mA	–	-	−6	–	−6	–	−6	–	V
						1 mA	−6				–	–	–	–	
* 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 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 MHz)	$\|h_{fe}\|$	−10		−0.2			4	–	4	–	4	–	4	–	
* Saturated Switching Times: Rise time	t_r	V_{CC} = −200 V		−1		I_{B1} & I_{B2} −0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Storage time	t_s	V_{CC} = −200 V		−1		I_{B1} & I_{B2} −0.125	–	2.5	–	2.5	–	2.5	–	2.5	μs
Fall time	t_f	V_{CC} = −200 V		−1		I_{B1} & I_{B2} −0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Thermal Resistance (Junction-to-case)	$R_{\theta JC}$	−10		−1			–	5	–	5	–	5	–	5	°C/W

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

[a] **Pulsed: Pulse duration = 300 μs; duty factor ≤2%.**

2N6211, 2N6212, 2N6213, 2N6214

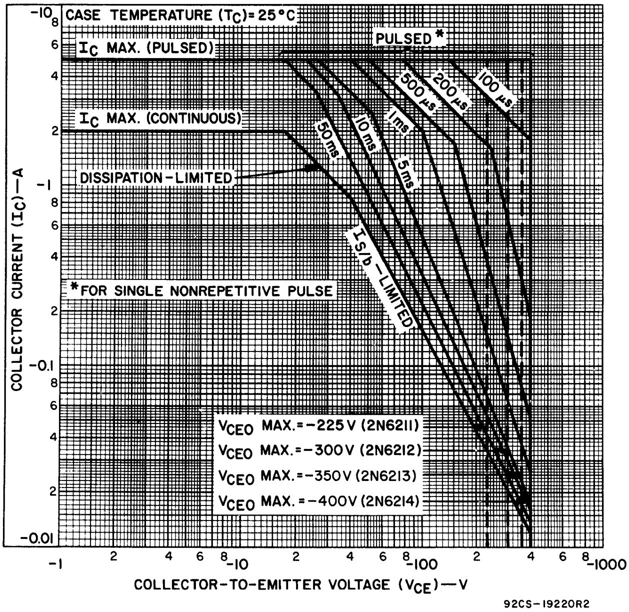


Fig. 1 - Maximum operating areas for all types.

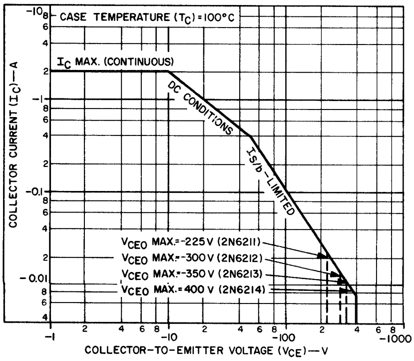


Fig. 2 - Maximum operating areas for all types.

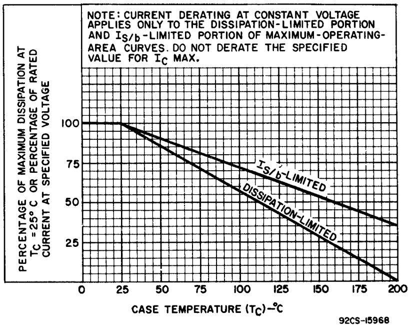


Fig. 3 - Derating curves for all types.

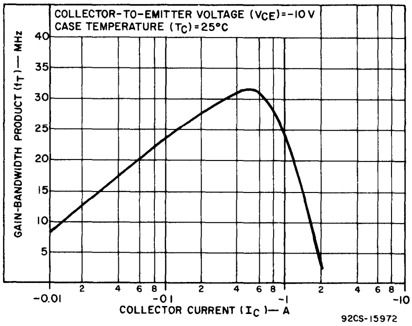


Fig. 4 - Typical gain-bandwidth product for all types.

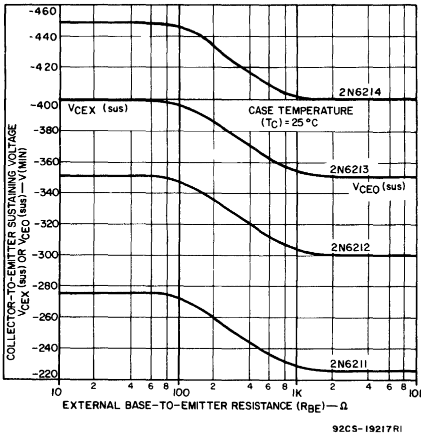


Fig. 5 - Collector-to-emitter sustaining-voltage characteristics for all types.

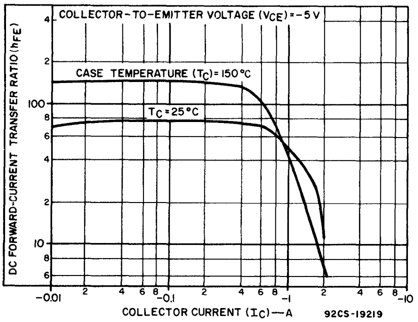


Fig. 6 - Typical dc beta characteristic for all types.

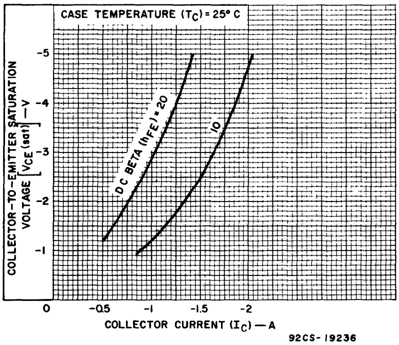


Fig. 7 - Typical saturation-voltage characteristics for all types.

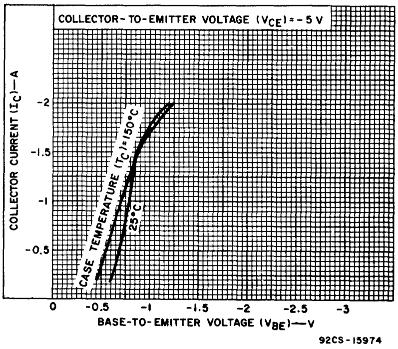


Fig. 8 - Typical transfer characteristics for all types.

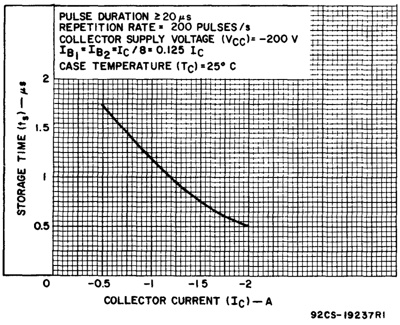


Fig. 9 - Typical storage-time characteristics for all types.

2N6211, 2N6212, 2N6213, 2N6214

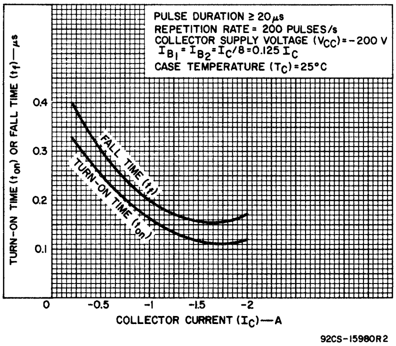


Fig. 10 - Typical turn-on time and fall-time characteristics for all types.

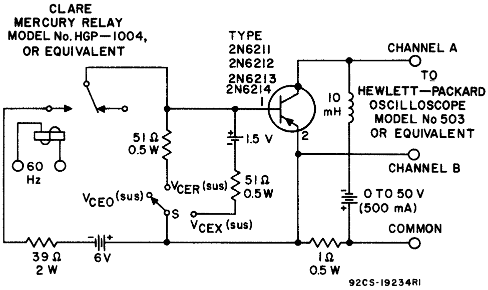


Fig. 11 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$ and $V_{CEX}(sus)$ for all types.

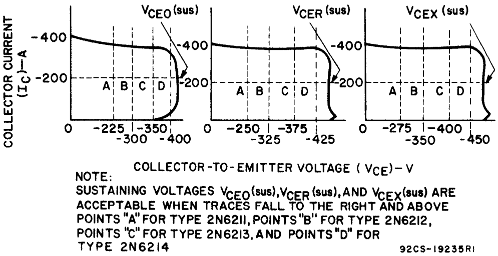


Fig. 12 - Oscilloscope display for measurement of sustaining voltages.

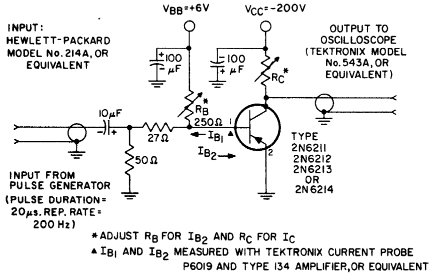


Fig. 13 - Circuit used to measure saturated switching times for all types.

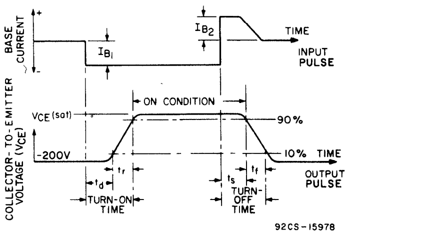


Fig. 14 - Phase relationship between input current and output voltage showing reference points for specification of switching times.

File Number **523**

2N6249, 2N6250, 2N6251

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 V (2N6251)
  375 V (2N6250)
  300 V (2N6249)
- *High dissipation rating:*
  P_T = 175 W
- *Low saturation voltages*
- *Maximum safe-area-of-operation curves*

RCA-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.

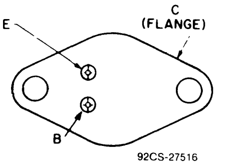
These devices use the popular JEDEC TO-204AA package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

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 V)	225	300	375	V
V_{CER}(sus) (R_{BE}) ≤ 50 Ω	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		°C/W
* T_J, T_{stg}		-65 to +200		°C
* T_L				
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max.		230		°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 DC VOLTAGE (V)	TEST CONDITIONS DC CURRENT (A)		LIMITS 2N6249			2N6250			2N6251			UNITS
	V_{CE}	I_C	I_B	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
I_{CEO}	150		0	–	–	5	–	–	–	–	–	–	
	225		0	–	–	–	–	–	5	–	–	–	
	300		0	–	–	–	–	–	–	–	–	5	
* I_{CEV} V_{BE} = −1.5	225			–	–	5	–	–	–	–	–	–	
	300			–	–	–	–	–	5	–	–	–	mA
	375			–	–	–	–	–	–	–	–	5	
* I_{CEV} V_{BE} = −1.5 T_C = 125°C	225			–	–	10	–	–	–	–	–	–	
	300			–	–	–	–	–	10	–	–	–	
	375			–	–	–	–	–	–	–	–	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 Ω		0.2		225[b]	–	–	300[b]	–	–	375[b]	–	–	V
* V_{EBO} I_E = 1 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]	1	–	–	2.25	–	–	–	–	–	–	
		10[a]	1.25	–	–	–	–	–	2.25	–	–	–	V
		10[a]	1.67	–	–	–	–	–	–	–	–	2.25	
* $V_{CE}(sat)$		10[a]	1	–	–	1.5	–	–	–	–	–	–	
		10[a]	1.25	–	–	–	–	–	1.5	–	–	–	V
		10[a]	1.67	–	–	–	–	–	–	–	–	1.5	
* $\|h_{fe}\|$ f = 1 MHz	10	1		2.5	8	–	2.5	8	–	2.5	8	–	
* $I_{S/b}$ t_p = 1s nonrep.	30			5.8	–	–	5.8	–	–	5.8	–	–	A
* $E_{S/b}$ V_{BE} = −4 R_B = 50 Ω, L = 50 μH		10[c]		2.5	–	–	2.5	–	–	2.5	–	–	mJ
* t_r V_{CC} = 200 V, I_{B1} = $-I_{B2}$		10	1	–	0.8	2	–	–	–	–	–	–	
		10	1.25	–	–	–	–	0.8	2	–	–	–	
		10	1.67	–	–	–	–	–	–	–	0.8	2	
* t_s V_{CC} = 200 V, I_{B1} = $-I_{B2}$		10	1	–	1.8	3.5	–	–	–	–	–	–	
		10	1.25	–	–	–	–	1.8	3.5	–	–	–	μs
		10	1.67	–	–	–	–	–	–	–	1.8	3.5	
* t_f V_{CC} = 200 V, I_{B1} = $-I_{B2}$		10	1	–	0.5	1	–	–	–	–	–	–	
		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 ≤300 μs, duty factor = 2%.

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

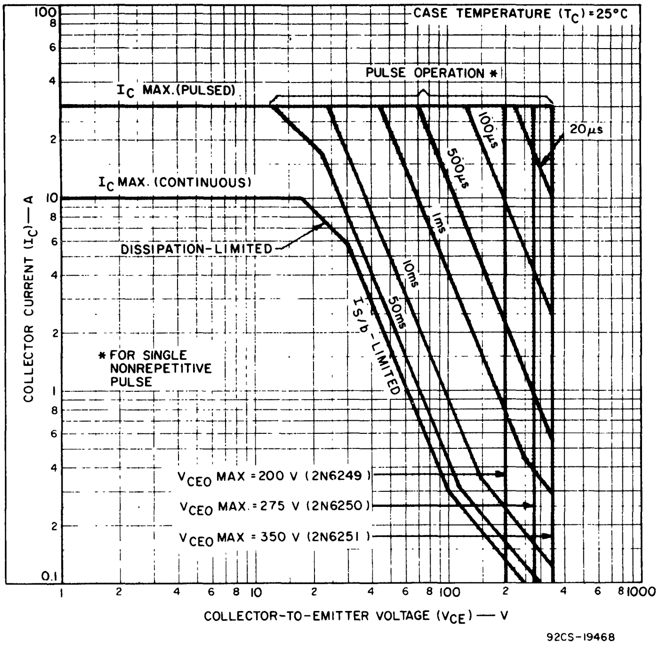


Fig. 1 - Maximum operating areas for all types at T_C = 25° C.

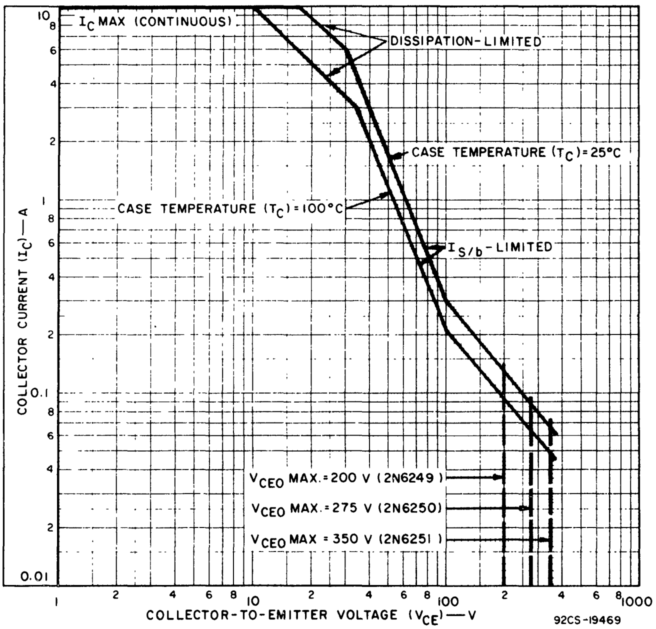


Fig. 2 - Maximum operating areas for all types at T_C = 100° C.

2N6249, 2N6250, 2N6251

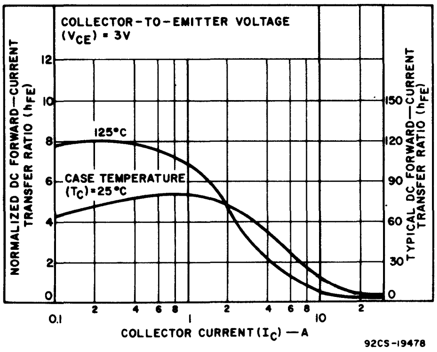


Fig. 3 - Typical normalized dc beta characteristics for all types.

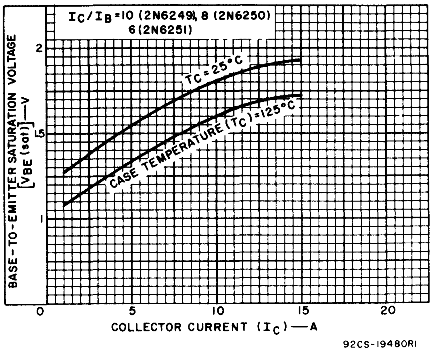


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for all types.

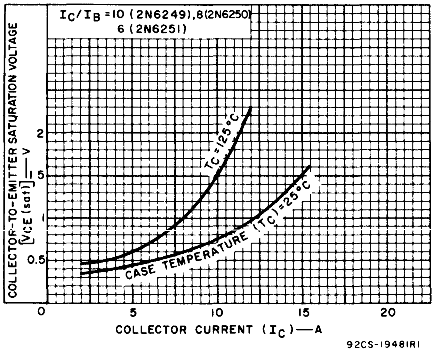


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

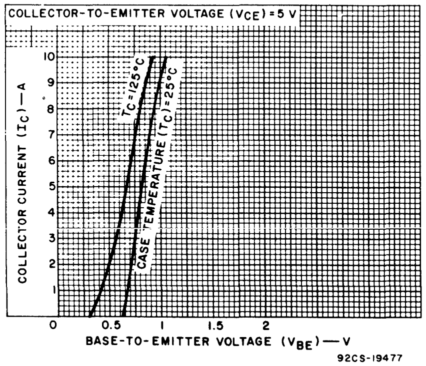


Fig. 6 - Typical transfer characteristics for all types.

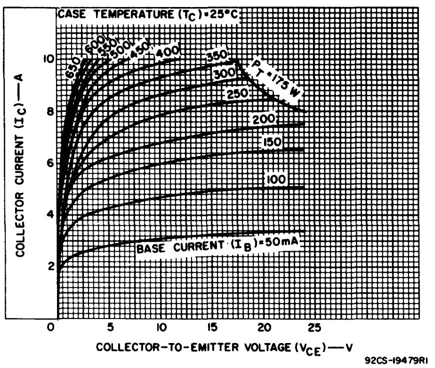


Fig. 7 - Typical output characteristics for all types.

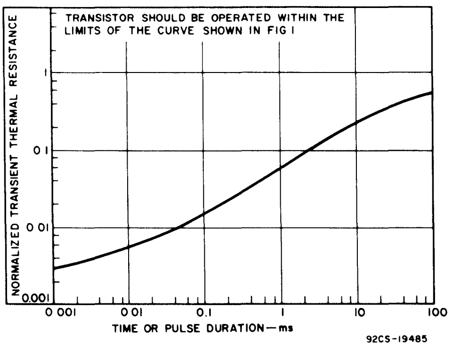


Fig. 8 - Typical thermal response characteristics for all types.

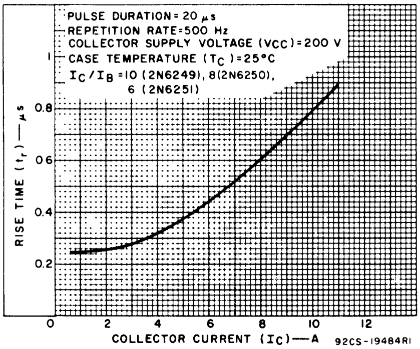


Fig. 9 - Typical rise-time characteristics for all types.

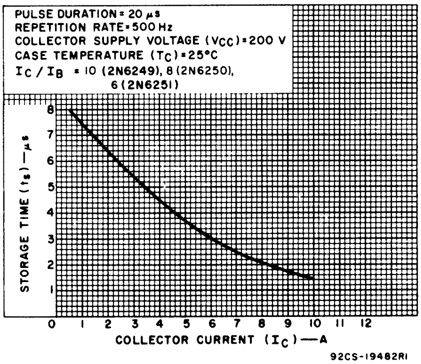


Fig. 10 - Typical storage-time characteristics for all types (with constant forced gain).

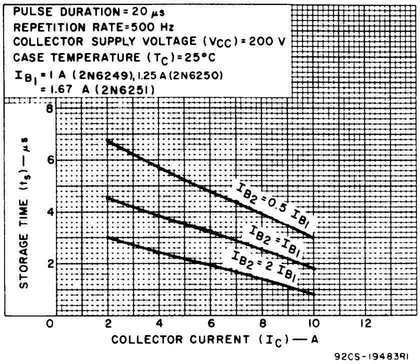


Fig. 11 - Typical storage-time characteristics for all types (with constant base drive).

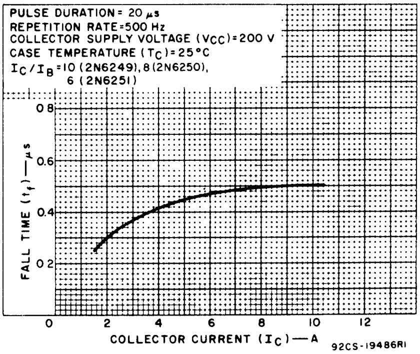


Fig. 12 - Typical fall-time characteristic for all types.

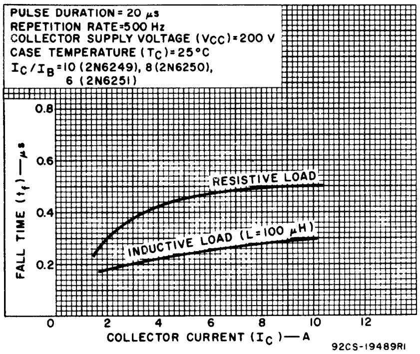


Fig. 13 - Typical inductive- and resistive-load fall-time characteristics for all types.

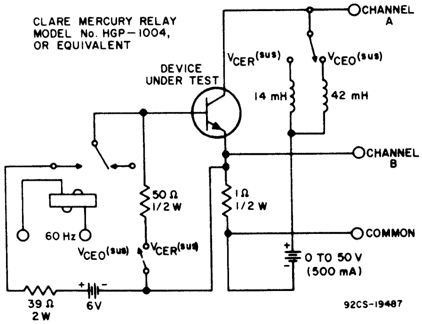
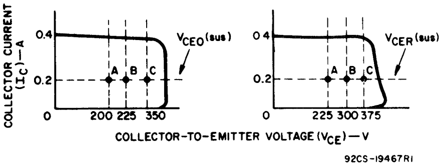


Fig. 14 - Circuit used to measure sustaining voltage $V_{CEO}(sus)$ and $V_{CER}(sus)$ for all types.

2N6249, 2N6250, 2N6251



The sustaining voltages V_{CEO}(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.

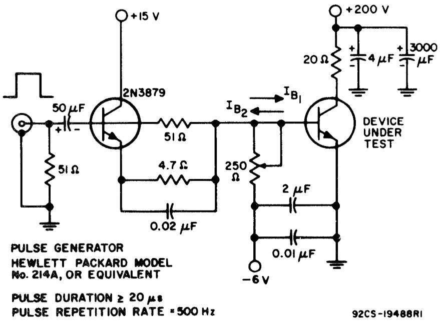


Fig. 16 - Circuit used to measure switching times for all types.

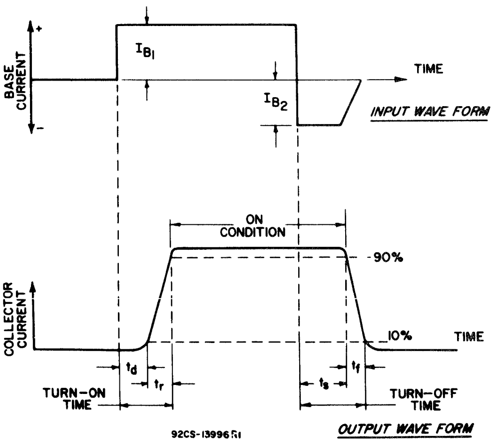


Fig. 17 - Phase relationship between input and output currents showing reference points for specifications of switching times.

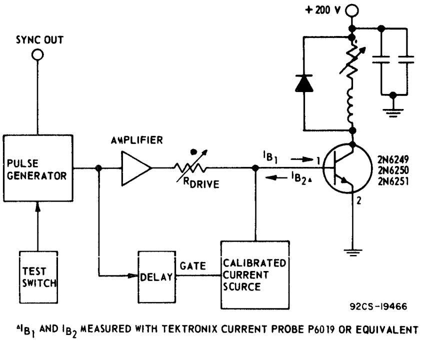


Fig. 18 - Circuit used to measure inductive-load switching times for all types.

File Number **1100**

2N6420, 2N6421, 2N6422, 2N6423

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

For High-Speed Switching and Linear-Amplifier Applications

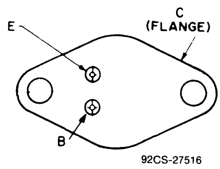
Features:

- *High voltage ratings:*
  V_{CEO}(sus) = *-175 V max. (2N6420)*
  = *-250 V max. (2N6421)*
  = *-300 V max. (2N6422)*
  = *-300 V max. (2N6423)*
- *Large safe-operating area*

The RCA 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_{CBO}	-250	-375	-550	-550	V
*V_{CEO}(sus)	-175	-250	-300	-300	V
*V_{EBO}	-6				V
*I_C	-1		-2		A
I_{CM}	-5				A
*I_B	-1				A
P_T					
$T_C \leq 100°C$, $V_{CE} \leq 50V$	20				W
* $T_C \leq 25°C$, $V_{CE} \leq 40V$	35				W
$T_C \leq 25°C$, $V_{CE} > 40V$	See Fig. 1				
$T_C < 25°C$, $V_{CE} > 40V$	See Figs. 1 & 3				
*T_{stg}, *T_J	-65 to +200				°C
*T_L					
At distances ≥ 1/32 in. (0.8 mm) from case for 10 s max	235				°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 VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6420 Min.	Max.	2N6421 2N6422 Min.	Max.	2N6423 Min.	Max.	Units
* I_{CEO}	−150				–	−10	–	−5	–	−5	mA
* I_{CEX}	−225	1.5			–	−1	–	–	–	–	mA
2N6421	−340	1.5			–	–	–	−1	–	–	mA
2N6422	−450	1.5			–	–	–	−1	–	–	mA
	−450	1.5			–	–	–	–	–	−2	mA
* I_{CEX}	−225	1.5			–	−3	–	–	–	–	mA
T_C=150°C	−300	1.5			–	–	–	−3	–	−5	mA
* I_{EBO}		6	0		–	−5	–	−0.5	–	−0.5	mA
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	–	V
			−1[a]	−0.1	–	−1.4	–	−1.4	–	–	V
V_{CE}(sat)			−0.75[a]	−0.075	–	–	–	–	–	−1	V
			−1[a]	−0.125	–	−5	–	−0.75	–	–	V
* V_{CEO}(sus)[b]			−0.05[a]	0	−175	–	–	–	−300	–	V
2N6421			−0.05[a]	0	–	–	−250	–	–	–	V
2N6422			−0.05[a]	0	–	–	−300	–	–	–	V
$I_{S/b}$	−100				−0.15	–	−0.15	–	−0.15	–	A
* $\|h_{fe}\|$ f = 5MHz	−10		−0.2		2	–	2	–	3	–	
* f = 1 kHz	−30		−0.1		25	350	–	–	–	–	
C_{obo} V_{CB}=10V f = 1 MHz			0		–	180	–	180	–	180	pF
* t_r[c]			−0.75	−0.075[d]	–	–	–	–	–	0.5	µs
			−1	−0.1[d]	–	–	–	3	–	–	µs
* t_s[c]			−0.75	−0.075[d]	–	–	–	–	–	6	µs
			−1	−0.1[d]	–	–	–	4	–	–	µs
* t_f[c]			−0.75	−0.075[d]	–	–	–	–	–	3	µs
			−1	−0.1[d]	–	–	–	3	–	–	µs
$R_{\theta JC}$	−10		−1		–	5	–	5	–	5	°C/W

* In accordance with JEDEC registration data.

[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.

[c] V_{CC} = −200 V, t_p = 20 µs

[d] $-I_{B_1} = I_{B_2}$

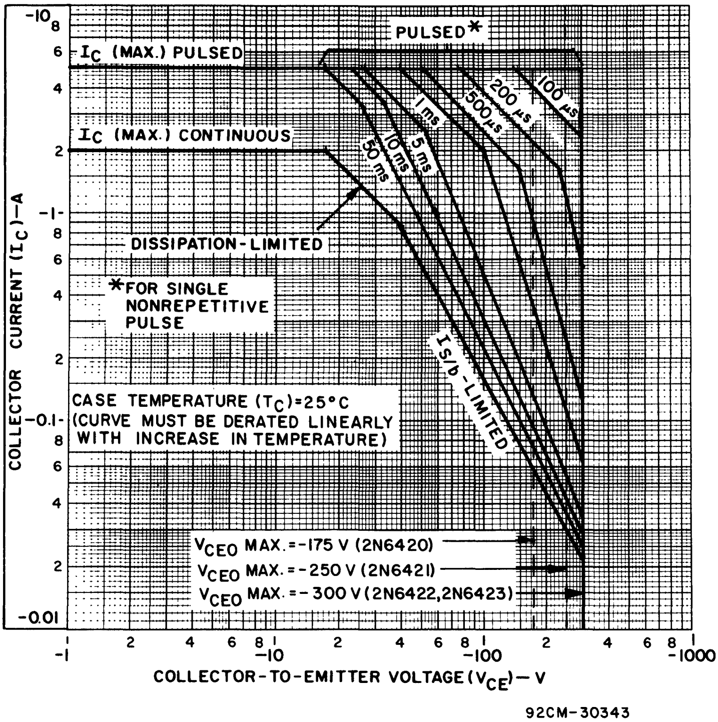


Fig. 1 — Maximum operating areas for all types.

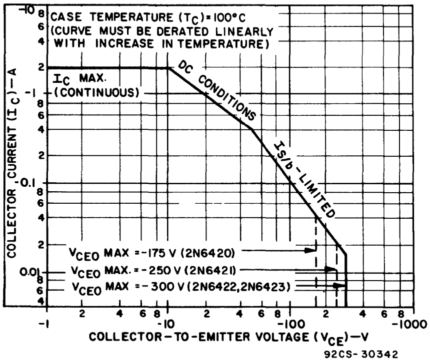


Fig. 2 — Maximum operating areas for all types.

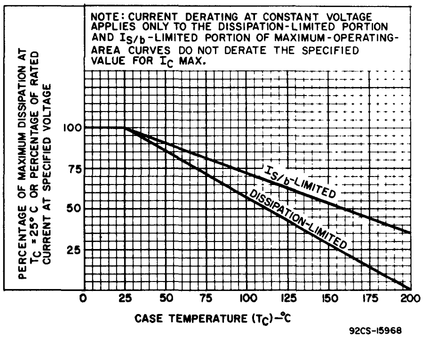


Fig. 3 — Derating curves for all types.

2N6420, 2N6421, 2N6422, 2N6423

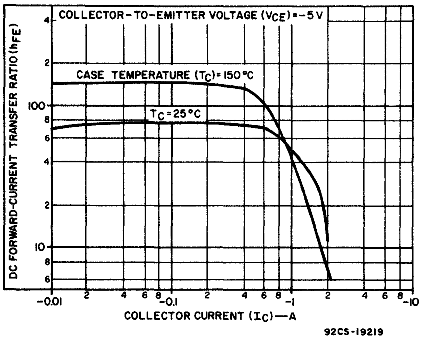


Fig. 4 — Typical dc beta characteristics for all types.

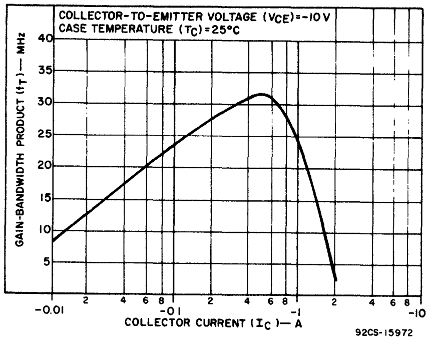


Fig. 5 — Typical gain-bandwidth product for all types.

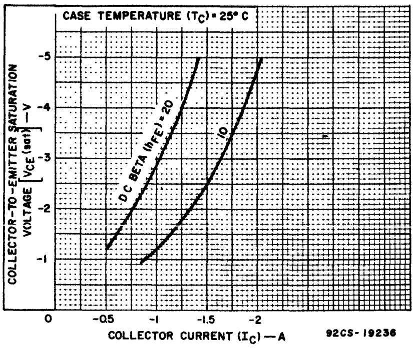


Fig. 6 — Typical saturation-voltage characteristics for all types.

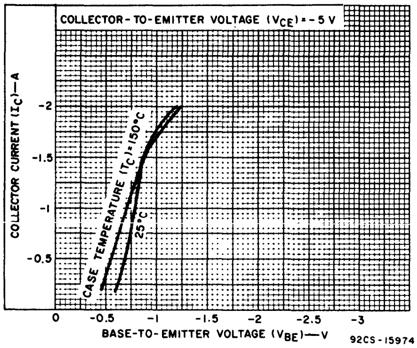


Fig. 7 — Typical transfer characteristics for all types.

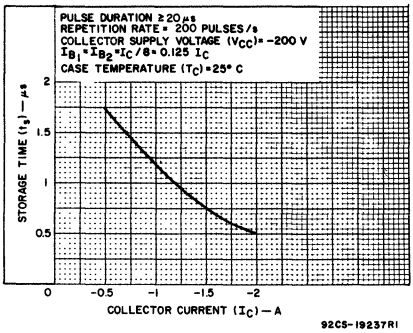


Fig. 8 — Typical storage time characteristic for all types.

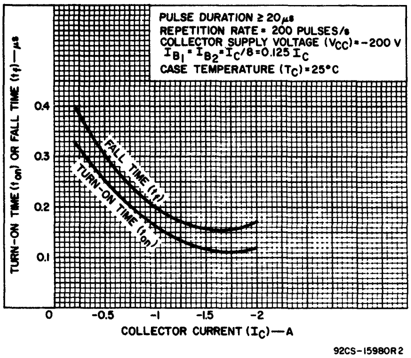


Fig. 9 — Typical turn-on time and fall-time characteristics for all types.

2N6420, 2N6421, 2N6422, 2N6423

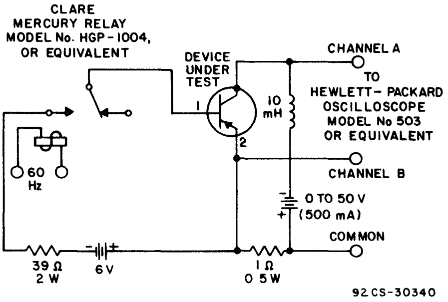
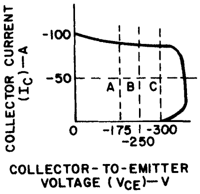


Fig. 10 — Circuit used to measure sustaining voltage V_{CEO} (sus) for all types.

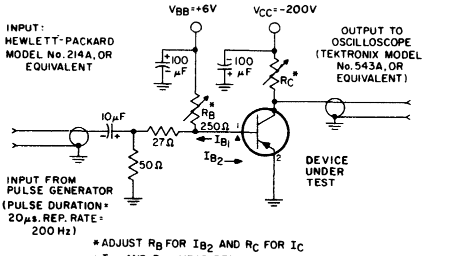


NOTE:

SUSTAINING VOLTAGES V_{CEO}(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.

92CS-30341

Fig. 11 — Oscilloscope display for measurement of sustaining voltages.



*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-15977R3

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

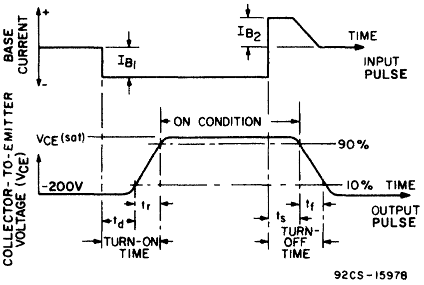


Fig. 13 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

2N6542, 2N6544, 2N6545, 2N6546

File Number **1096**

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 V
  = 450 V [2N6545]
- *Low V_{CE}[sat] at IC = 3-, 5-, and 10-A*

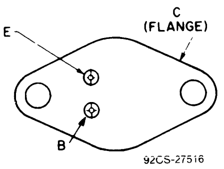
Applications:

- *Off-Line Power Supplies*
- *High Voltage Inverters*
- *Switching Regulators*

The RCA-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-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 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 V	650	650	850	650	V
*V_{CEX} (Clamped)					
V_{BE} = -1.5 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 ≥ 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 $T_C = 25°C$

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N6542		2N6544		2N6545		2N6546		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEV}	650	-1.5	—	—	—	0.5	—	0.5	—	—	—	1	
	850	-1.5	—	—	—	—	—	—	—	0.5	—	—	mA
* I_{EBO}	—	-8	0	—	—	1	—	1	—	1	—	1	
* $V_{CEO(sus)}$[b]	—	—	0.1[a]	—	300	—	300	—	400	—	300	—	V
* h_{FE}	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	
* $V_{BE(sat)}$	—	—	3[a]	0.6	—	1.4	—	—	—	—	—	—	
	—	—	5[a]	1	—	—	—	1.6	—	1.6	—	—	
	—	—	10[a]	2	—	—	—	—	—	—	—	1.6	
* $V_{CE(sat)}$	—	—	3[a]	0.6	—	1	—	—	—	—	—	—	
	—	—	5[a]	1	—	5	—	1.5	—	1.5	—	—	V
	—	—	8[a]	2	—	—	—	5	—	5	—	—	
	—	—	10[a]	2	—	—	—	—	—	—	—	1.5	
	—	—	15[a]	3	—	—	—	—	—	—	—	5	
* $I_{S/b}$ t = 1 s	100	—	—	—	0.2	—	0.2	—	0.2	—	0.2	—	A
f_T f = 1 MHz	10	—	0.2	—	6	28	—	—	—	—	—	—	
	10	—	0.3	—	—	—	6	28	6	28	—	—	MHz
	10	—	0.5	—	—	—	—	—	—	—	6	28	
* C_{obo} f = 1 MHz	10[d]	—	—	—	50	200	75	300	75	300	125	500	pF
* t_d[e,g]	—	—	3	0.6	—	0.05	—	—	—	—	—	—	
	—	—	5	1	—	—	—	0.05	—	0.05	—	—	
	—	—	10	2	—	—	—	—	—	—	—	0.05	
* t_r[e,g]	—	—	3	0.6	—	0.7	—	—	—	—	—	—	
	—	—	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	—	—	—	—	—	—	
	—	—	5	1	—	—	—	1	—	1	—	—	
	—	—	10	2	—	—	—	—	—	—	—	—	

* In accordance with JEDEC registration data.

2N6542, 2N6544, 2N6545, 2N6546

ELECTRICAL CHARACTERISTICS T_C = 100° C

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		2N6542		2N6544		2N6545		2N6546		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEV}	650	-1.5	—	—	—	2.5	—	2.5	—	—	—	4	mA
	850	-1.5	—	—	—	—	—	—	—	2.5	—	—	
* I_{CER} R_{BE} = 50 Ω	650	—	—	—	—	3	—	3	—	—	—	5	
	850	—	—	—	—	—	—	—	—	3	—	—	
* $V_{CEX(sus)}$ [b,c]													V
V_{CC} = 20 V	—	—	2.6[a]	—	350	—	—	—	—	—	—	—	
L = 180 μH,													
R_C = 0.05 Ω	—	—	4.5[a]	—	—	—	350	—	450	—	—	—	
V_{clamp} = Rated													
V_{CEX}	—	—	8[a]	—	—	—	—	—	—	—	350	—	
V_{clamp} = Rated													
V_{CEO} — 100 V	—	—	5[a]	—	200	—	—	—	—	—	—	—	
	—	—	8[a]	—	—	—	200	—	300	—	—	—	
	—	—	15[a]	—	—	—	—	—	—	—	200	—	
* $V_{BE(sat)}$	—	—	3[a]	0.6	—	1.4	—	—	—	—	—	—	V
	—	—	5[a]	1	—	—	—	1.6	—	1.6	—	—	
	—	—	10[a]	2	—	—	—	—	—	—	—	1.6	
* $V_{CE(sat)}$	—	—	3[a]	0.6	—	2	—	—	—	—	—	—	
	—	—	5[a]	1	—	—	—	2.5	—	2.5	—	—	
	—	—	10[a]	2	—	—	—	—	—	—	—	2.5	
* t_s [f,g]	—	-5	3	0.6	—	4	—	—	—	—	—	—	μS
	—	-5	5	1	—	—	—	4	—	4	—	—	
	—	-5	10	2	—	—	—	—	—	—	—	5	
* t_f [f,g]	—	-5	3	0.6	—	0.8	—	—	—	—	—	—	
	—	-5	5	1	—	—	—	0.9	—	0.9	—	—	
	—	-5	10	2	—	—	—	—	—	—	—	1.5	
* $R_{\theta JC}$	—	—	—	—	—	1.75	—	1.4	—	1.4	—	1	°C/W

* In accordance with JEDEC registration data.
[a] Pulsed: pulse duration = 300 μs, duty factory ≤ 2%.
[b] **CAUTION:** The sustaining voltage $V_{CEO(sus)}$ and $V_{CEX(sus)}$ *MUST NOT* be measured on a curve tracer.
[c] V_{CC} = 20 V, L = 180 μH, R_C = 0.05 Ω
[d] V_{CB} value
[e] Resistive load, V_{CC} = 250 V, t_p = 100 μs, I_{B1} = $-I_{B2}$
[f] Inductive load, V_{clamp} = Rated $V_{CEX(sus)}$, I_{B1} = $-I_C/5$, L = 180 μH, R_C = 0.05 Ω, V_{CC} = 20 V
[g] For switching speed test methods, see Application Note AN-6820.

2N6542, 2N6544, 2N6545, 2N6546

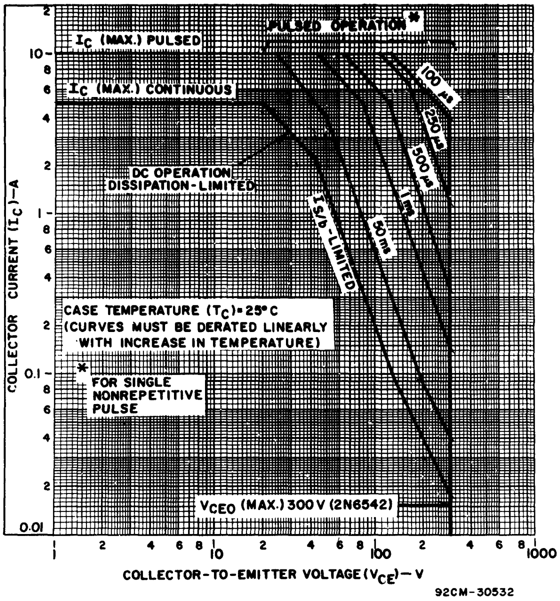


Fig. 1 - Maximum operating areas for type 2N6542 (Tc = 25°).

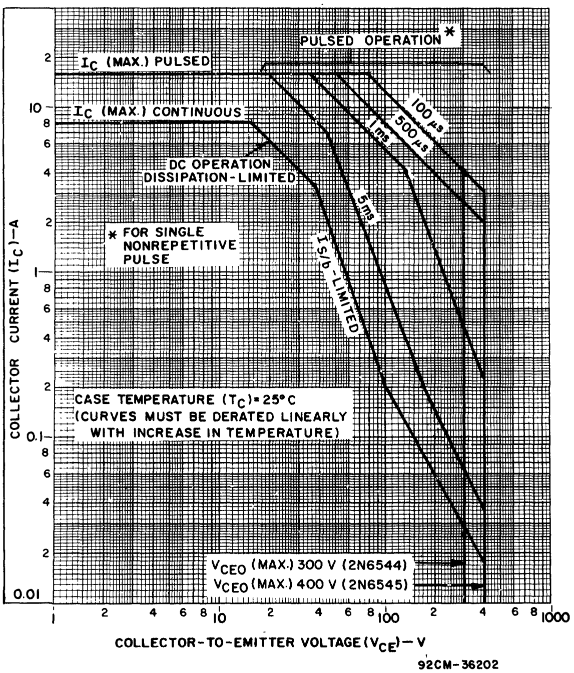


Fig. 2 - Maximum operating areas for type 2N6544 and 2N6545 (Tc = 25° C).

2N6542, 2N6544, 2N6545, 2N6546

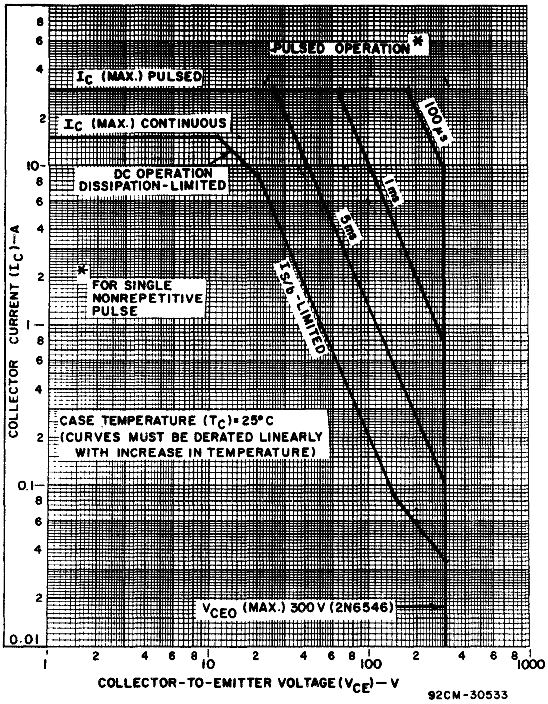


Fig. 3 - Maximum operating areas for type 2N6546 (Tc = 25°)

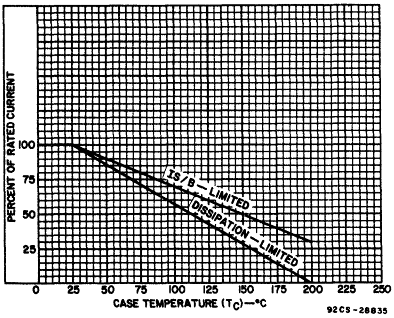


Fig. 4 - Dissipation and Is/b derating curves for all types.

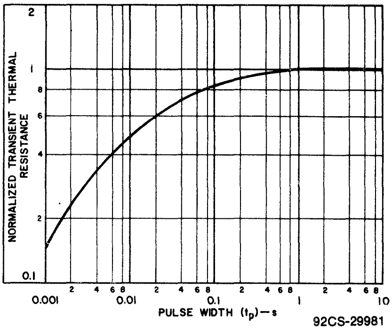


Fig. 5 — Typical thermal-response characteristics for types 2N6542, 2N6544 and 2N6545.

2N6542, 2N6544, 2N6545, 2N6546

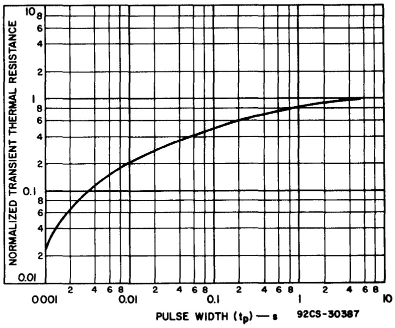


Fig. 6 — Typical thermal-response characteristics for type 2N6546.

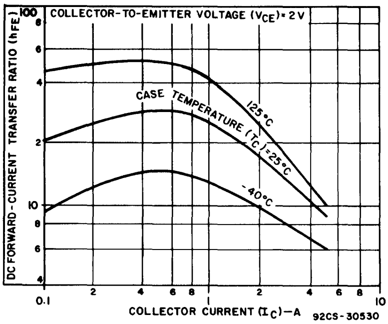


Fig. 7 — Typical dc beta characteristics for type 2N6542.

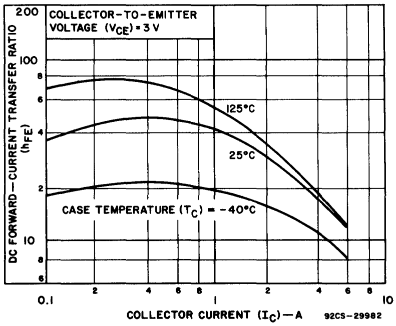


Fig. 8 — Typical dc beta characteristics for type 2N6544.

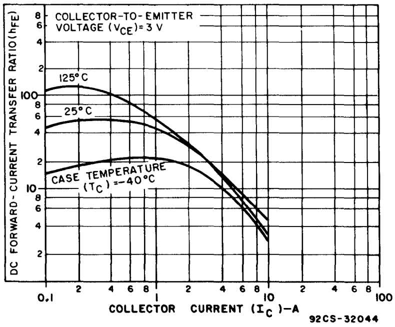


Fig. 9 — Typical dc beta characteristics for type 2N6545.

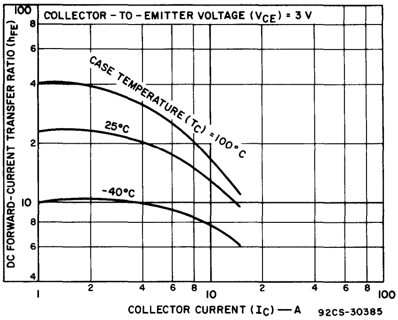


Fig. 10 — Typical dc beta characteristics for type 2N6546.

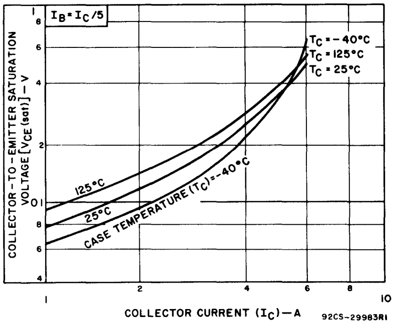


Fig. 11 — Typical collector-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

2N6542, 2N6544, 2N6545, 2N6546

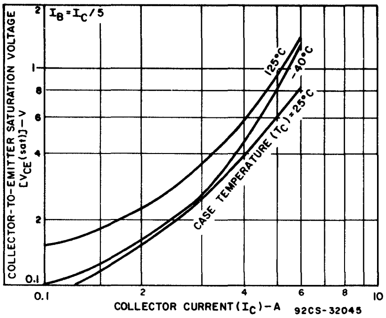


Fig. 12 — Typical collector-to-emitter saturation voltage as a function of collector current for type 2N6545.

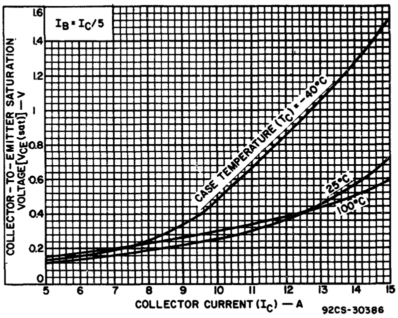


Fig. 13 — Typical collector-to-emitter saturation voltage characteristics for type 2N6546.

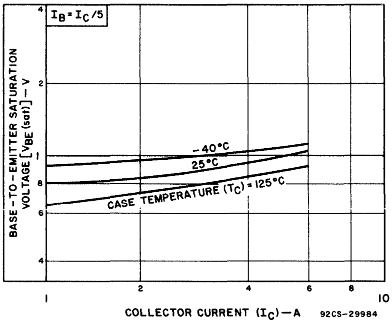


Fig. 14 — Typical base-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

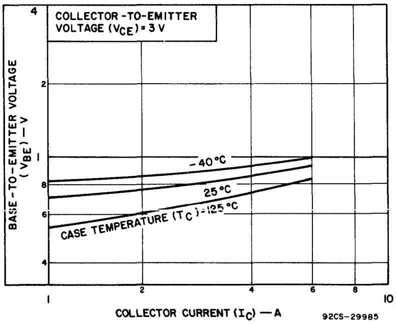


Fig. 15 — Typical base-to-emitter voltage as a function of collector current for types 2N6542 and 2N6544.

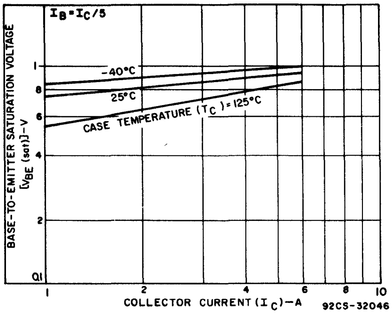


Fig. 16 — Typical base-to-emitter saturation voltage as a function of collector current for type 2N6545.

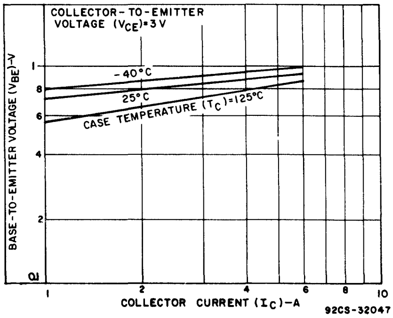


Fig. 17 — Typical base-to-emitter voltage as a function of collector current for type 2N6545.

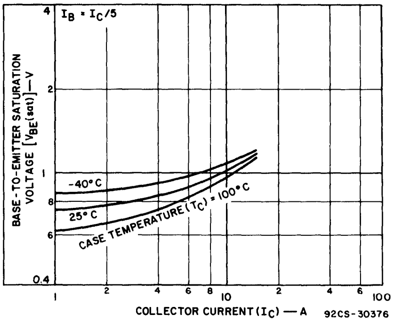


Fig. 18 — Typical base-to-emitter saturation voltage characteristics for type 2N6546.

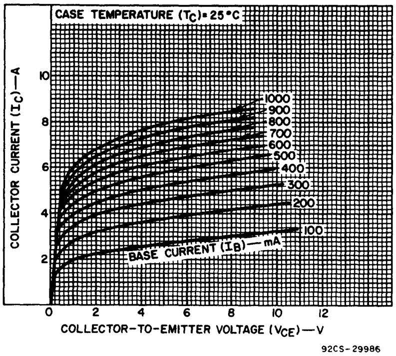


Fig. 19 — Typical output characteristics for types 2N6542 and 2N6544.

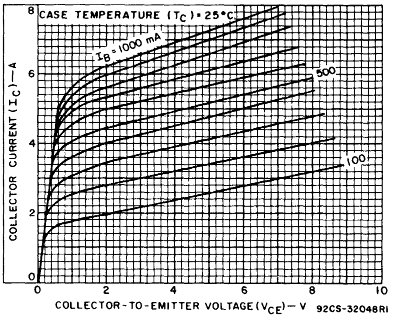


Fig. 20 — Typical output characteristics for type 2N6545.

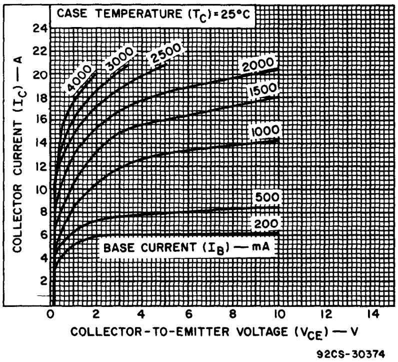


Fig. 21 — Typical output characteristics for type 2N6546.

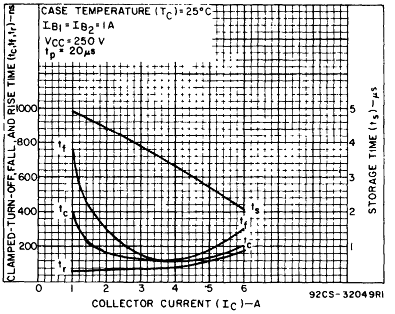


Fig. 22 — Typical saturated switching time characteristics for type 2N6545.

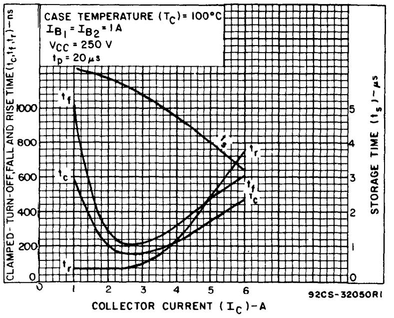


Fig. 23 — Typical saturated switching time characteristics for type 2N6545.

2N6542, 2N6544, 2N6545, 2N6546

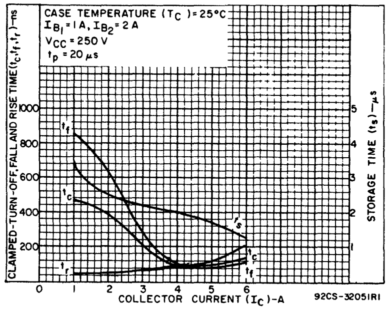


Fig. 24 — Typical saturated switching time characteristics for type 2N6545.

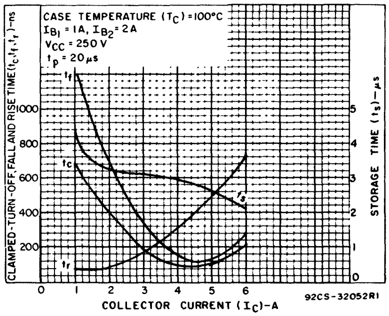


Fig. 25 — Typical saturated switching time characteristics for type 2N6545.

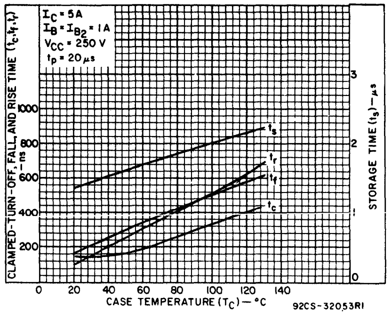


Fig. 26 — Typical saturated switching time characteristics as a function of case temperature for type 2N6545.

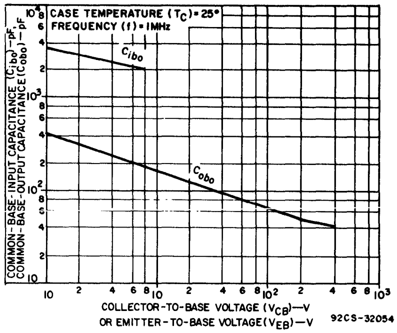


Fig. 27 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for type 2N6545.

File Number **211**

Medium-Power Silicon N-P-N Planar Transistors

For High-Voltage Switching and Linear-Amplifier Applications

Features:

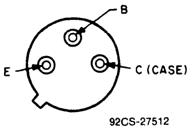
- *For operation at junction temperature up to 200° C*
- *Planar construction for low noise and low leakage*

RCA-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	
$V_{CER}(sus)$			
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			
$T_C \leq 25°C$	10	10	W
$T_A \leq 50°$	1	1	W
$T_A \leq 25°C$	—	—	W
At other temperatures	See Fig. 1		
T_{stg}, T_J	-65 to +200		°C
T_L			
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 V dc		CURRENT mA dc		40346		40412		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
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	150 200	−1.5 −1.5			– –	– 1	– –	2 –	mA
I_{EBO}		−4 −3	0 0		– –	5 –	– –	– 100	µA
h_{FE}	10 20		10 30		25 –	– –	– 40	– –	
V_{CER}(sus) R_{BE} = 1 kΩ			50		175[a]	–	–	–	V
R_{BE} = 10 kΩ			50		–	–	250[a]	–	V
V_{BE}	10		10		–	1	–	–	V
V_{CE}(sat)			10	1	–	0.5	–	–	V
$\|h_{fe}\|$ 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
$R_{\theta JC}$ 40346 40412					– –	15 –	– –	– 15	°C/W

[a] CAUTION: Sustaining voltage V_{CER}(sus), MUST NOT be measured on a curve tracer.

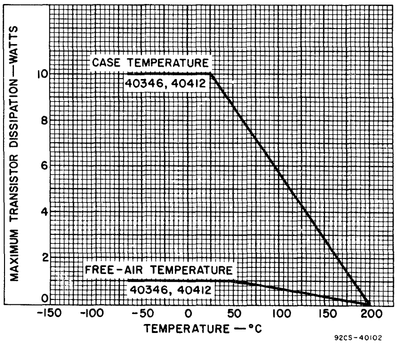


Fig. 1 - Dissipation derating curves.

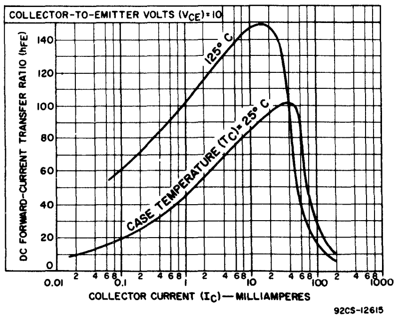


Fig. 2 - Typical dc beta characteristics for all types.

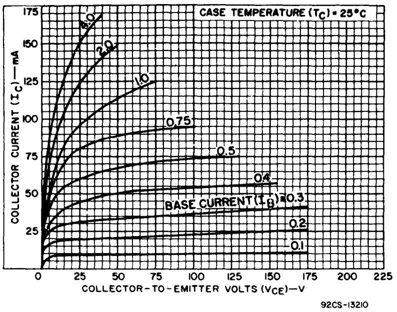


Fig. 3 - Typical output characteristics for all types.

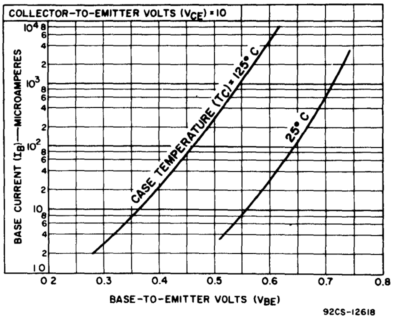


Fig. 4 - Typical input characteristics for all types.

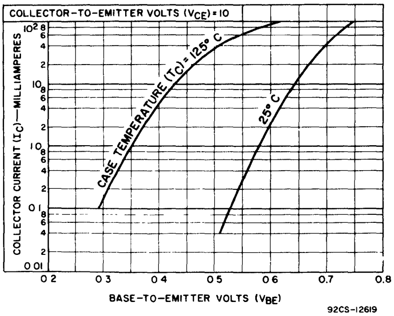


Fig. 5 - Typical transfer characteristics for all types.

RCA6340, RCA6341

File Number **1205**

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*

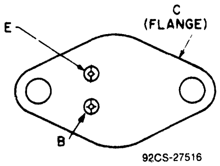
RCA6340 and RCA6341 silicon n-p-n power transistors which feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pusle-width-modulated regulators and a variety of power switching circuits.

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_{obo}, 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_{CBO}	160	180	V
V_{CEO}	140	150	V
V_{EBO}	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 ≥ 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° 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	
$R_{\theta JC}$	10	—	5	—	—	0.875	—	0.875	°C/W

[a] Pulsed; pulse duration = 300 µs, duty factory ≤ 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

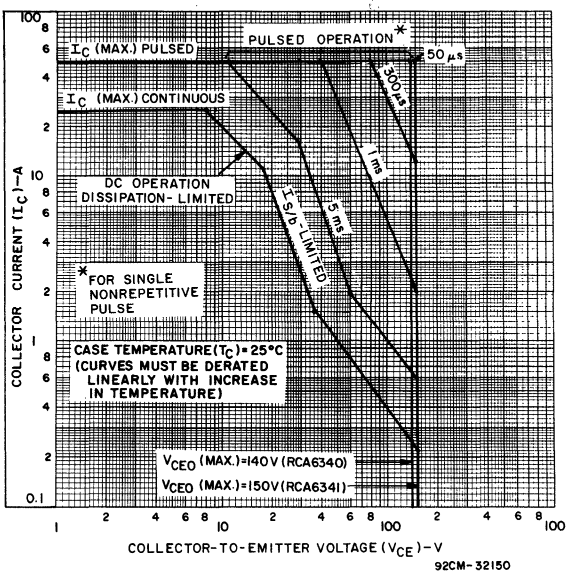


Fig. 1 - Maximum operating areas for both types.

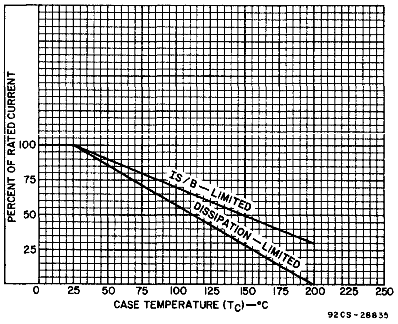


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for both types.

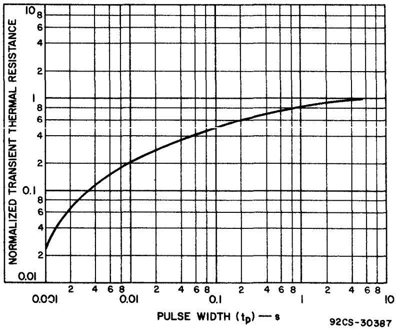


Fig. 3 - Typical thermal-response characteristic for both types.

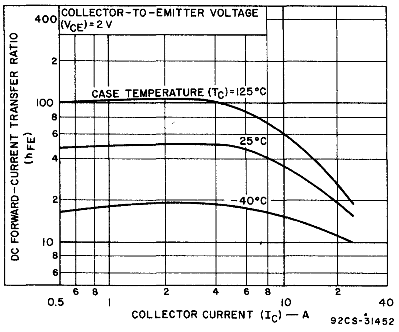


Fig. 4 - Typical dc beta characteristics for both types.

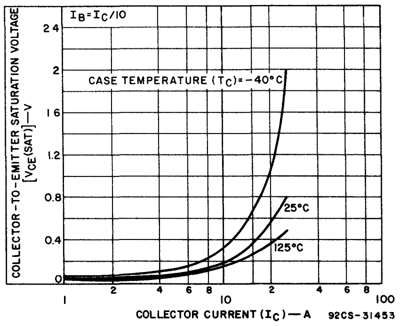


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for both types.

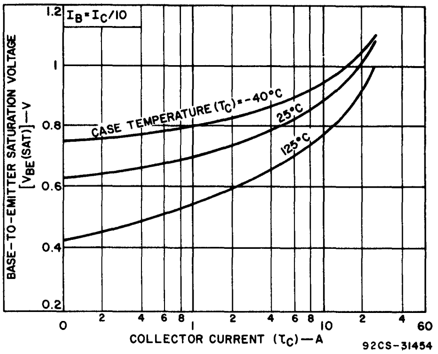


Fig. 6 - Typical base-to-emitter saturation voltage characteristic for both types.

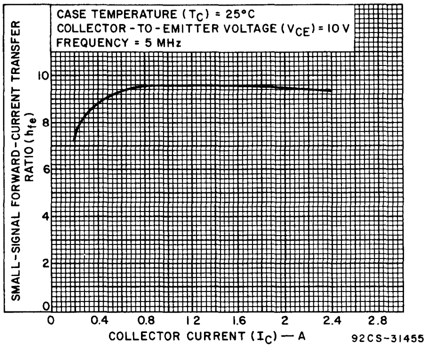


Fig. 7 - Typical small-signal forward-current transfer ratio characteristic for both types (f = 5 MHz).

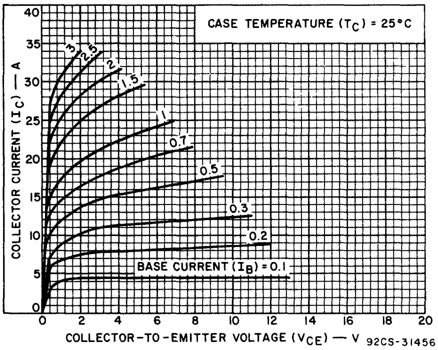


Fig. 8 - Typical output characteristics for both types.

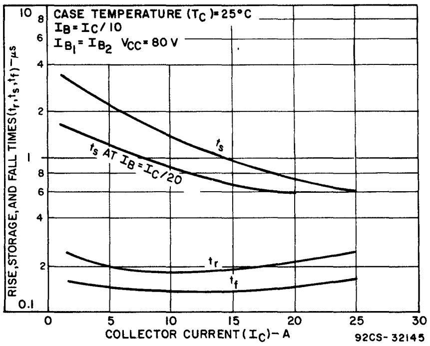


Fig. 9 - Typical saturated-switching-time characteristics as a function of collector current for both types.

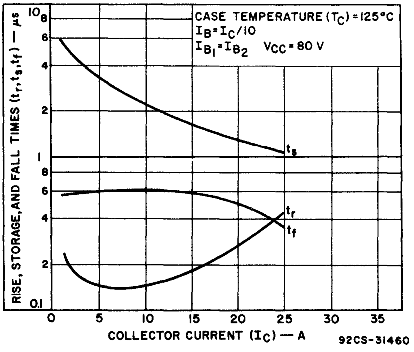


Fig. 10 - Typical saturated-switching-time characteristics at T_C = 125° C as a function of collector current for both types.

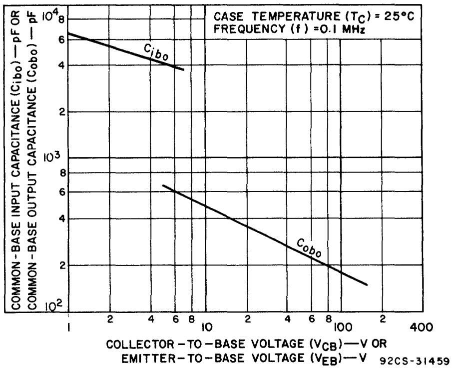


Fig. 11 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for both types.

RCA6340, RCA6341

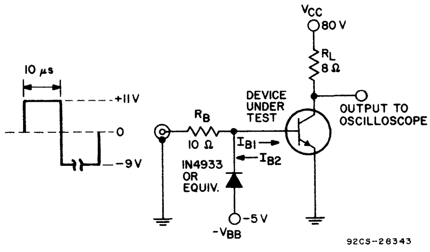


Fig. 12 - Switching-time test circuit.

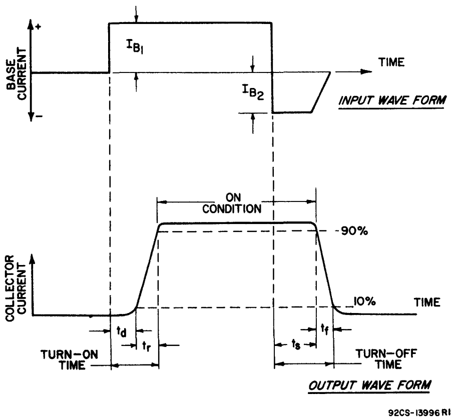


Fig. 13 - Phase relationship between input current and output current showing reference points for specification of switching times.

File Number **978**

TIP47, TIP48, TIP49, TIP50

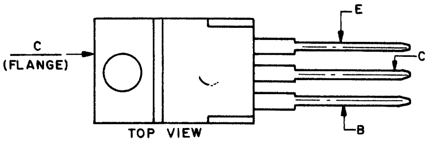
High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:
- *VERSAWATT package*
- *Maximum safe-area-of-operation curves*

The RCA-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 ≥ 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. VOLTAGE V dc	TEST COND. CURRENT A dc	LIMITS TIP47		LIMITS TIP48		LIMITS TIP49		LIMITS TIP50		UNITS
	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
$\lvert h_{fe} \rvert$, 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.)		µs
t_f[c,d], $V_{CC} = 200$ V		1	0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		µs
$R_{\theta JC}$			–	3.12	–	3.12	–	3.12	–	3.12	°C/W
$R_{\theta JA}$			–	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

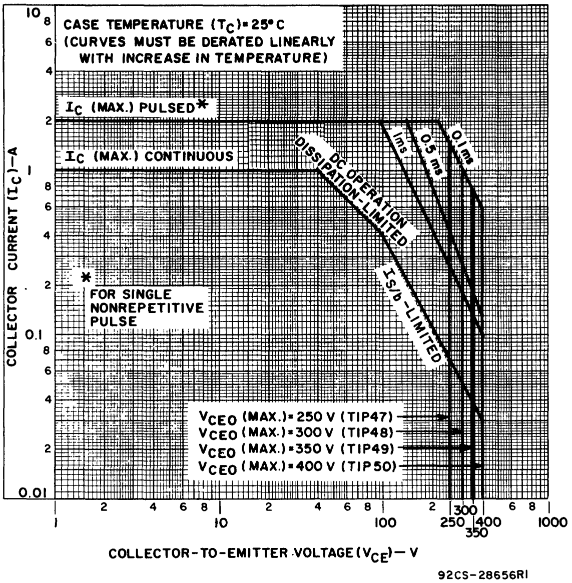


Fig. 1 — Maximum operating areas for all types.

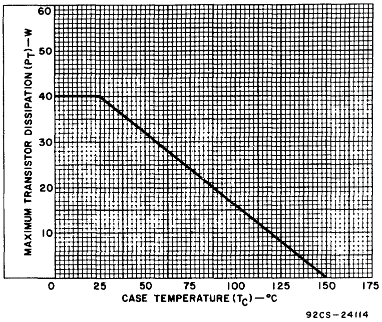


Fig.2 — Derating curve for all types.

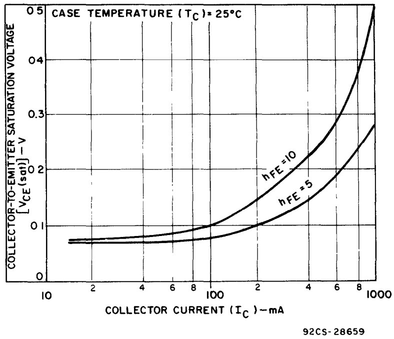


Fig. 3 — Typical saturation-voltage characteristics for all types.

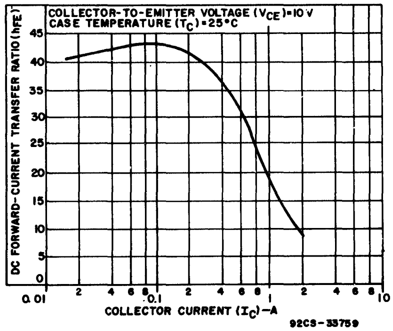


Fig.4 — Typical dc beta characteristics for all types.

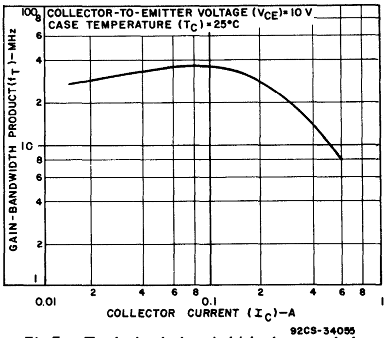


Fig.5 — Typical gain-bandwidth characteristics for all types.

TIP47, TIP48, TIP49, TIP50

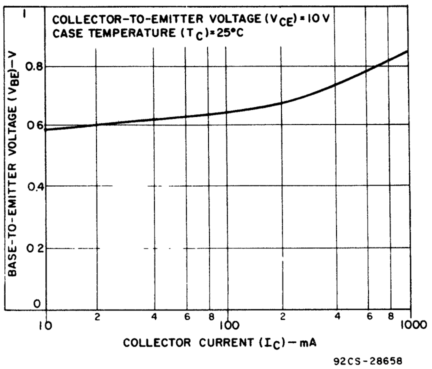


Fig.6 — Typical base-to-emitter voltage vs. collector current.

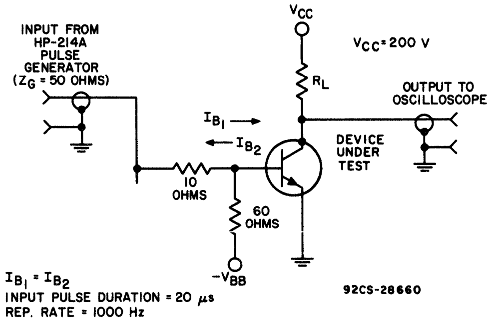


Fig. 7 — Circuit used to measure saturated switching times.

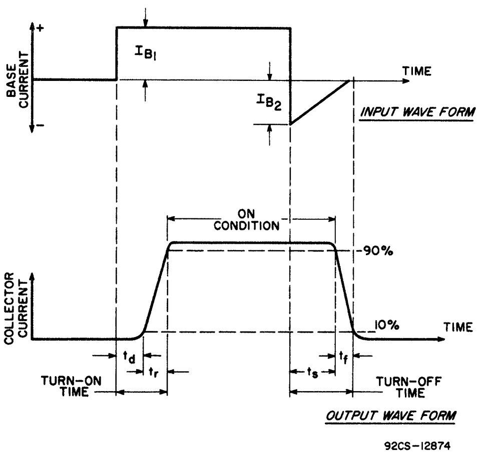
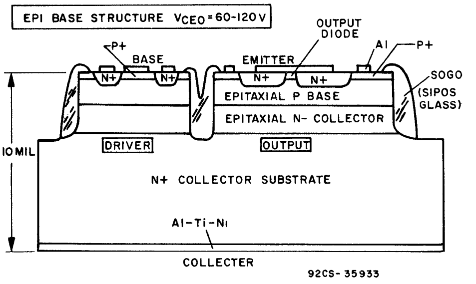


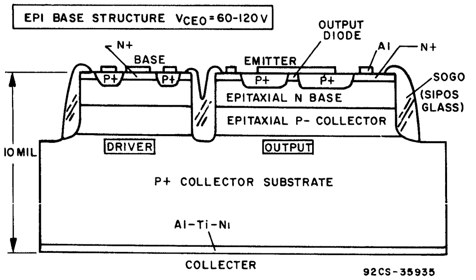
Fig. 8 — Phase relationship between input and output currents, showing reference points for specification of switching times.

Darlington Power Transistors
Technical Data

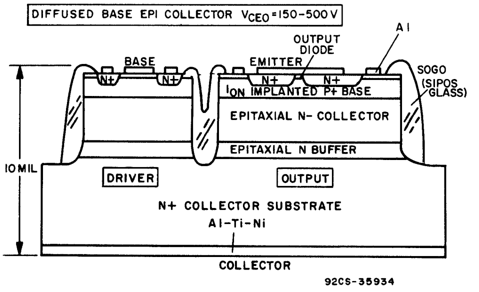
Darlington Power Transistors



Epitaxial Base n-p-n Darlington.



Epitaxial Base p-n-p Darlington.



Diffused Base Epitaxial Collector n-p-n Darlington.

Design Features

The latest state-of-the-art processing technology is employed in the manufacture of RCA n-p-n and p-n-p power Darlingtons.

- Epitaxial-base structures are used for low to medium-voltage n-p-n and p-n-p Darlingtons. The base region of an n-p-n device is created by the growth of a p-type epitaxial layer on an n-type epitaxial layer that has been grown onto a low-resistivity n+ substrate. The emitter is diffused using a phosphorous source. The p+ base contacts, resistors, and output diode are formed by ion-implanted boron and high-temperature diffusion.

  Similarly, the base region of a p-n-p Darlington is created by the growth of an n-type layer on a p-type epitaxial layer and a low-resistivity p+ substrate. The emitter is formed by ion-implanted boron and high-temperature diffusion. The n+ base contacts, resistors, and output diode are formed by ion-implanted phosphorus and high-temperature diffusion.

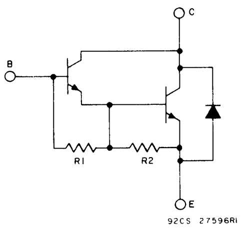
  A deep isolation diffusion, N+ for n-p-n and P+ for p-n-p devices, is used to define the planar collector-base junction. The planar junctions are passivated by a clean thermally grown silicon dioxide layer, supplemented by a deposited phosphor-silicate-glass overcoat.

- High-voltage n-p-n Darlingtons use diffused-base epitaxial-collector structures. The collector region is created by epitaxial n- and n layers grown on a low-resistivity n+ substrate. The base is formed by ion-implanted boron, and the emitter by phosphorous deposition, both driven in by high-temperature diffusion. The p+ base contacts, resistors, and output diode are formed by ion-implanted boron and high-temperature diffusion.
- Aluminum metallization on the emitter and base contacts provides for aluminum wire bonding. Trimetal (aluminum-titanium-nickel) evaporated onto the collector surface provides collector metallization for high-temperature solder mounting.
- Glass passivation is used over the collector-base junctions to assure reverse-bias stability, resistance to moisture penetration, and to provide mechanical protection during assembly.
- The output diode in all structures is located in the emitter bond-pad area.
- The RCA9203 Darlington features no output diode and no R2, and is used for special circuit applications.

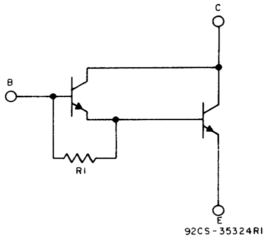
Hybrid Circuit Compatibility

RCA Darlingtons incorporate several construction features that are ideal for mounting the Darlington pellets in hybrid circuits as follows:

- The trimetal collector metallization is particularly suited for high-temperature solder mounting. (A eutectic solder bond formed with 95/5 lead-tin solder at a temperature of 320° C is recommended).
- The aluminum emitter and base metallization facilitates aluminum wire bonding.
- The glass-passivated structure assures excellent mechanical protection during processing.
- Large bonding surfaces are available on all types.



Conventional Darlington.



RCA9203 Darlington.

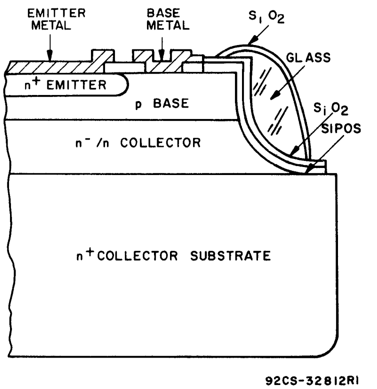
SIPOS-Oxide-Glass-Oxide (SOGO) Passivation System

In any high voltage device, fringing electric fields at the junction boundaries must be properly managed, insulated, and terminated. Otherwise mobile ionic contaminants can cause erratic device leakage, unstable voltage breakdown, and ultimate device failure.

RCA has developed a multilayer passivation system called SOGO to meet the performance requirements of high-voltage devices. The first layer is of Semi Insulating Polycrystalline Oxygen-doped Silicon (SIPOS). The resistivity of the SIPOS can be precisely controlled during deposition as required by the device design.

A silicon dioxide (SiO_2) layer is then deposited on top of the SIPOS to serve as buffer layer between the SIPOS and the lead alumino-silicate thick glass layer used to seal the junction and provide the actual mechanical protection with good thermal match to the silicon. A final layer of the SiO_2 over the glass protects the glass during subsequent processing.

The result of this passivation technique is typical V_{CBO} and V_{CEV} leakages of less than 1 μ at 25° C, less than 1 mA at 150° C and at rated voltages of up to 1000 volts, depending on device design.



SOGO passivation system.

Selection Matrix

Type	Ic (A)	VCEO (V)	hFE @	Ic (A)	VCE (V)	PT (W)	Pkg.	File No.
RCA8766 Family (n-p-n)								
RCA8766	10	350	100 min.	6	3	150	TO-204AA	973
RCA8766A	10	350	100 min.	4	3	150	TO-204AA	973
RCA8766B	10	400	100 min.	6	3	150	TO-204AA	973
RCA8766C	10	400	100 min.	4	3	150	TO-204AA	973
RCA8766D	10	450	100 min.	6	3	150	TO-204AA	973
RCA8766E	10	450	100 min.	4	3	150	TO-204AA	973
RCA 9421 (n-p-n) Complementary To RCA 9422 Family								
TIP110	2	60	1000 min.	1	4	50	TO-220AB	1336
TIP111	2	80	1000 min.	1	4	50	TO-220AB	1336
TIP112	2	100	1000 min.	1	4	50	TO-220AB	1336
RCA 9422 (p-n-p) Complementary To RCA 9421 Family								
TIP115	2	-60	1000 min.	-1	-4	50	TO-220AB	1387
TIP116	2	-80	1000 min.	-1	-4	50	TO-220AB	1387
TIP117	2	-100	1000 min.	-1	-4	50	TO-220AB	1387
RCA9202, RCA9203 (n-p-n)								
RCA9202A	4	300	750 min.	2	3	65	TO-220AB	1414
RCA9202B	4	350	750 min.	2	3	65	TO-220AB	1414
RCA9202C	4	400	750 min.	2	3	65	TO-220AB	1414
RCA9203A	4	250	500 min.	2	3	50	TO-220AB	1413
RCA9203B	4	300	500 min.	2	3	50	TO-220AB	1413
RCA9228 (n-p-n) Complementary To RCA9229 Family								
RCA9228A	50	60	2000 min.	25	3	300	TO-204AE	1437
RCA9228B	50	80	2000 min.	25	3	300	TO-204AE	1437
RCA9228C	50	100	2000 min.	25	3	300	TO-204AE	1437
RCA9229 (p-n-p) Complementary To RCA9228 Family								
RCA9229A	50	-60	2000 min.	-25	-3	300	TO-204AE	1438
RCA9229B	50	-80	2000 min.	-25	-3	300	TO-204AE	1438
RCA9229C	50	-100	2000 min.	-25	-3	300	TO-204AE	1438
2N6284 Family (n-p-n) Complementary To 2N6287 Family								
2N6057	12	60	750 min.	6	3	150	TO-204AA	1185
2N6282	20	60	750 min.	10	4	160	TO-204AA	1001
2N6058	12	80	750 min.	6	3	150	TO-204AA	1185
2N6283	20	80	750 min.	10	4	160	TO-204AA	1001
2N6059	12	100	750 min.	6	3	150	TO-204AA	1185
2N6284	20	100	750 min.	10	4	160	TO-204AA	1001
2N6287 Family (p-n-p) Complementary To 2N6284 Family								
2N6050	12	-60	750 min.	-6	-3	150	TO-204AA	1185
2N6285	20	-60	750 min.	-10	-4	160	TO-204AA	1001
2N6051	12	-80	750 min.	-6	-3	150	TO-204AA	1185
2N6286	20	-80	750 min.	-10	-4	160	TO-204AA	1001
2N6052	12	-100	750 min.	-6	-3	150	TO-204AA	1185
2N6287	20	-100	750 min.	-10	-4	160	TO-204AA	1001

Selection Matrix

Type	Ic (A)	VCEO (V)	hFE @	Ic (A)	VCE (V)	PT (W)	Pkg.	File No.
2N6385 Family (n-p-n) Complementary To 2N6650 Family								
2N6383	10	40	1000 min.	5	3	100	TO-204AA	609
BDX83	10	45	1000 min.	5	3	125	TO-204AA	955
2N6055	8	60	750 min.	4	3	100	TO-204AA	563
2N6384	10	60	1000 min.	5	3	100	TO-204AA	609
2N6576	15	60	2000 min.	4	3	120	TO-204AA	1152
BDX83A	10	60	1000 min.	5	3	125	TO-204AA	955
RCA1000	5	60	1000 min.	3	3	90	TO-204AA	594
2N6056	8	80	750 min.	4	3	100	TO-204AA	563
2N6385	10	80	1000 min.	5	3	100	TO-204AA	609
BDX83B	10	80	1000 min.	5	3	125	TO-204AA	563
RCA1001	5	80	1000 min.	3	3	90	TO-204AA	594
2N6577	15	90	2000 min.	4	3	120	TO-204AA	1152
BDX83C	10	100	1000 min.	5	3	125	TO-204AA	563
2N6578	15	120	2000 min.	4	3	120	TO-204AA	1152
2N6388 Family (n-p-n) Complementary To 2N6668 Family								
2N6386	8	40	1000 min.	3	3	65	TO-220AB	610
BDX33	10	45	750 min.	4	3	70	TO-220AB	693
2N6043	8	60	1000 min.	4	4	75	TO-220AB	1151
2N6387	10	60	1000 min.	5	3	65	TO-220AB	610
BDX33A	10	60	750 min.	4	3	70	TO-220AB	693
TIP100	8	60	1000 min.	3	4	80	TO-220AB	1152
TIP120	8	60	1000 min.	3	3	65	TO-220AB	998
2N6044	8	80	1000 min.	4	4	75	TO-220AB	1151
2N6388	10	80	1000 min.	5	3	65	TO-220AB	610
BDX33B	10	80	750 min.	3	3	70	TO-220AB	693
TIP101	8	80	1000 min.	3	4	80	TO-220AB	1153
TIP121	8	80	1000 min.	3	3	65	TO-220AB	998
2N6045	8	100	1000 min.	4	4	75	TO-220AB	1151
BDX33C	10	100	750 min.	3	3	70	TO-220AB	693
TIP102	8	100	1000 min.	3	4	80	TO-220AB	1153
BDX33D	10	120	750 min.	3	3	70	TO-220AB	693
TIP122	8	100	1000 min.	3	3	65	TO-220AB	998
2N6530 Family (n-p-n)								
2N6530	8	80	1000-10,000	5	3	65	TO-220AB	873
2N6531	8	100	500-10,000	3	3	65	TO-220AB	873
2N6532	8	100	1000-10,000	5	3	65	TO-220AB	873
2N6533	8	120	1000-10,000	3	3	65	TO-220AB	873
2N6650 Family (p-n-p) Complementary To 2N6385 Family								
2N6648	10	-40	1000-20,000	-5	-3	70	TO-204AA	1013
2N6649	10	-60	1000-20,000	-5	-3	70	TO-204AA	1013
2N6650	10	-80	1000-20,000	-5	-3	70	TO-204AA	1013
2N6668 Family (p-n-p) Complementary To 2N6388 Family								
2N6666	8	-40	1000 min.	-3	-3	65	TO-220AB	1069
BDX34	10	-45	750 min.	-4	-3	70	TO-220AB	694
BDX34A	10	-60	750 min.	-4	-3	70	TO-220AB	694
2N6667	10	-60	1000 min.	-5	-3	65	TO-220AB	1069
TIP125	8	-60	1000 min.	-3	-3	65	TO-220AB	997
BDX34B	10	-80	750 min.	-3	-3	70	TO-220AB	694
2N6668	10	-80	1000 min.	-5	-3	65	TO-220AB	1069
TIP126	8	-80	1000 min.	-3	-3	65	TO-220AB	997
BDX34C	10	-100	750 min.	-3	-3	70	TO-220AB	694
TIP127	8	-100	1000 min.	-3	-3	65	TO-220AB	997

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:

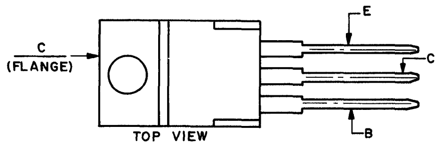
- *Operates from IC without predriver*

Applications:

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

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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

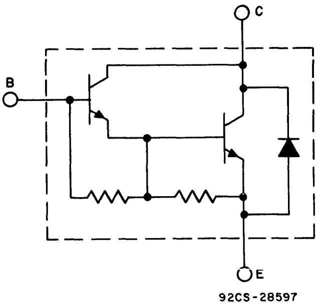


Fig. 1 — Schematic diagram for all types.

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
$*P_T$				
$T_C \geq 25°C$		75		W
$T_C > 25°C$		See Fig. 2		
$*T_{stg}, T_J$		-65 to 150		°C
$*T_L$				
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235		°C

*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			0	–	–	–	–	–	20	
	80			0	–	–	–	20	–	–	
	60			0	–	20	–	–	–	–	
* I_{CEV}	100	−1.5			–	–	–	–	–	20	
	80	−1.5			–	–	–	20	–	–	µA
	60	−1.5			–	20	–	–	–	–	
	100	−1.5			–	–	–	–	–	200	
T_C=125°C	80	−1.5			–	–	–	200	–	–	
	60	−1.5			–	200	–	–	–	–	
* I_{EBO}		5		0	–	2	–	2	–	2	mA
* V_{CEO}(sus)			0.1[a]	0	60	–	80	–	100	–	V
I_{CBO}	100[b]				–	–	–	–	–	20	
	80[b]				–	–	–	20	–	–	µA
	60[b]				–	20	–	–	–	–	
* h_{FE}	4		4		1000	20,000	1000	20,000	–	–	
	4		3		–	–	–	–	1000	20,000	
	4		8		100	–	100	–	100	–	
* V_{BE}	4		4		–	2.8	–	2.8	–	–	
	4		3		–	–	–	–	–	2.8	V
* V_{BE}(sat)			8	0.08	–	4.5	–	4.5	–	4.5	
* V_{CE}(sat)			4	0.016	–	2	–	2	–	–	
			3	0.012	–	–	–	–	–	2	V
			8	0.08	–	4	–	4	–	4	
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	°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

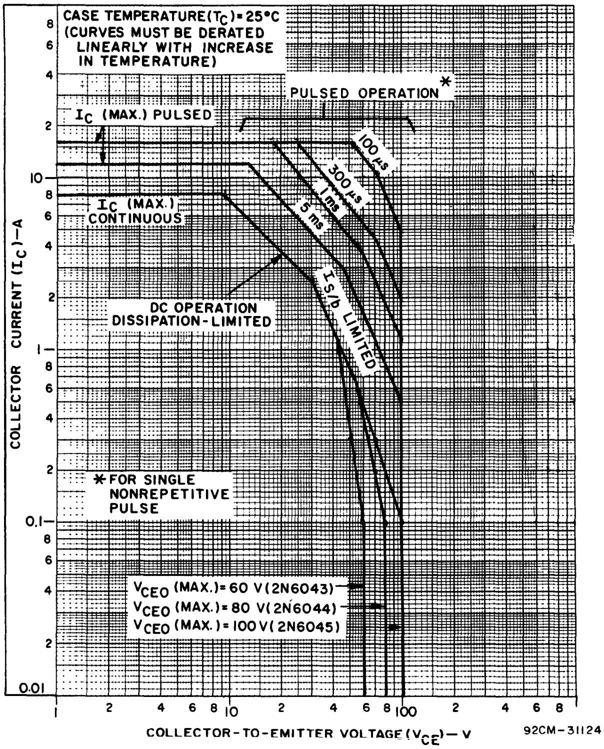


Fig. 2 — Maximum operating areas for all types (T_C = 25°C).

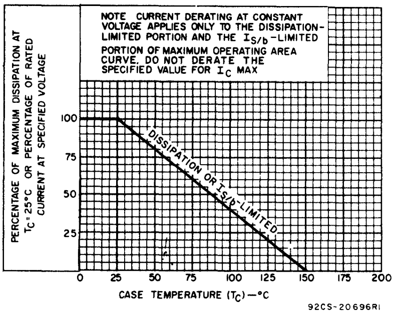


Fig. 3 — Derating curve for all types.

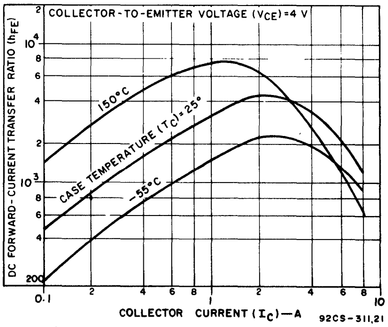


Fig. 4 — Typical dc beta characteristics for all types.

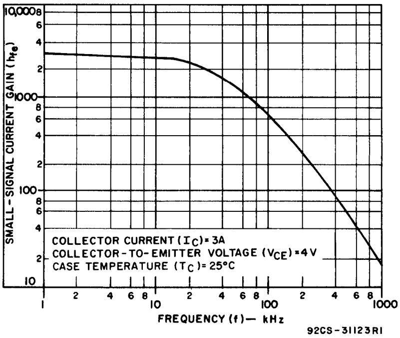


Fig. 5 — Typical small-signal gain for all types.

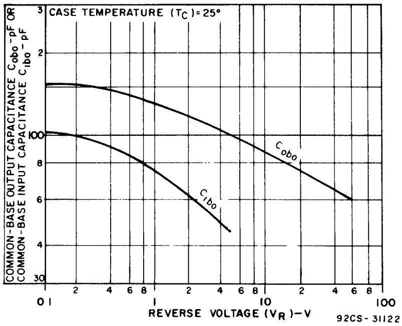


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of reverse voltage for all types.

2N6050, 2N6051, 2N6052, 2N6057, 2N6058, 2N6059 File Number **1185**

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

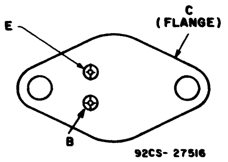
60-80-100 Volts, 150 Watts
Gain of 7000 (Typ.) at 5 A (2N6050, 2N6051, 2N6052)
Gain of 4000 (Typ.) at 5 A (2N6057, 2N6058, 2N6059)

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 RCA-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:

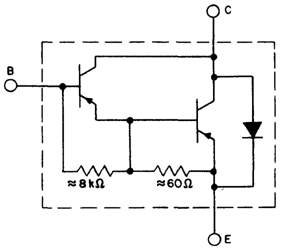
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

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				
$T_C \leq 25°C$		150		W
$T_C > 25°C$ Derate linearly		0.857		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distances ≥1/16 in. (1.58 mm) from case for 10 s max.		235		°C

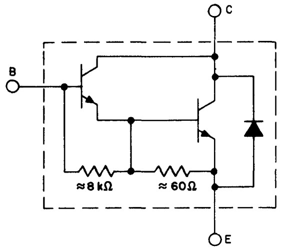
* In accordance with JEDEC registration data. ● For p-n-p devices, voltage and current values are negative.

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



92CS-29129

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



92CS-29128

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			0	–	1	–	–	–	–	mA
	40			0	–	–	–	1	–	–	
	50			0	–	–	–	–	–	1	
* I_{CEX}	60	−1.5			–	0.5	–	–	–	–	
	80	−1.5			–	–	–	0.5	–	–	
	100	−1.5			–	–	–	–	–	0.5	
T_C = 150°C	60	−1.5			–	5	–	–	–	–	
	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		12[a]		100	–	100	–	100	–	
	3		6[a]		750	18,000	750	18,000	750	18,000	
* $V_{CE}(sat)$			12[a]	0.12	–	3	–	3	–	3	V
			6[a]	0.024	–	2	–	2	–	2	
* V_{BE}	3		6[a]		–	2.8	–	2.8	–	2.8	V
* $V_{BE}(sat)$			12[a]	0.12	–	4	–	4	–	4	V
* h_{fe} f = 1 kHz	3		5		300	–	300	–	300	–	
* $\|h_{fe}\|$ f = 1 MHz	3		5		4	–	4	–	4	–	
* C_{ob} V_{CB} = 10 V, I_E 0, f = 0.1 MHz											
2N6050-52					–	500	–	500	–	500	pF
2N6057-59					–	300	–	300	–	300	
$I_{S/b}$ t = 1 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

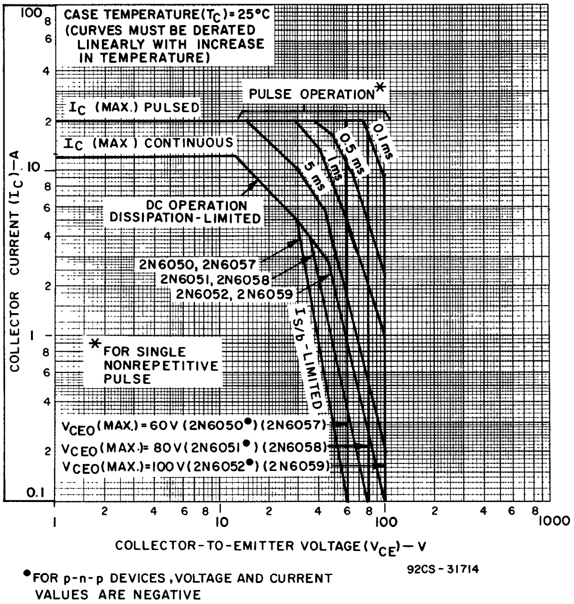


Fig. 3 — Maximum operating areas for all types.

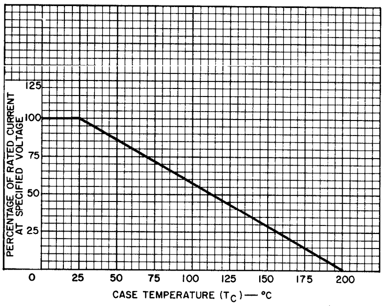


Fig. 4 — Current derating curve for all types.

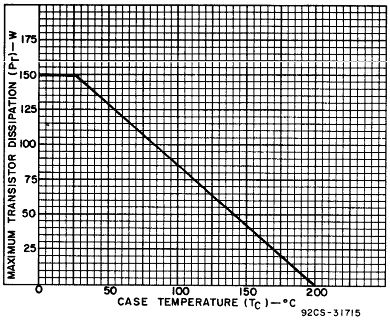


Fig. 5 — Power derating curve for all types.

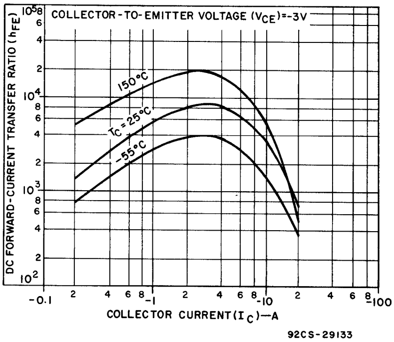


Fig. 6 — Typical dc beta characteristics for 2N6050, 2N6051, and 2N6052.

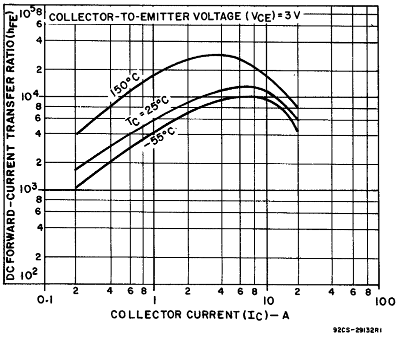


Fig. 7 — Typical dc beta characteristics for 2N6057, 2N6058, and 2N6059.

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

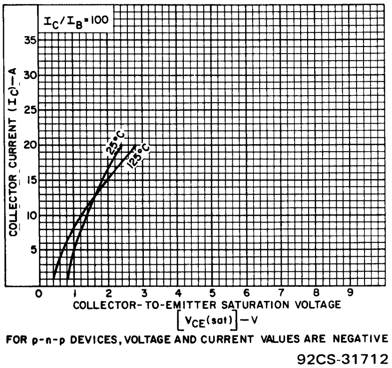


Fig. 8 — Typical saturation characteristics for all types.

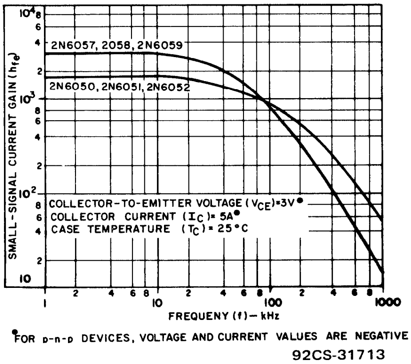


Fig. 9 — Typical small-signal current gain for all types.

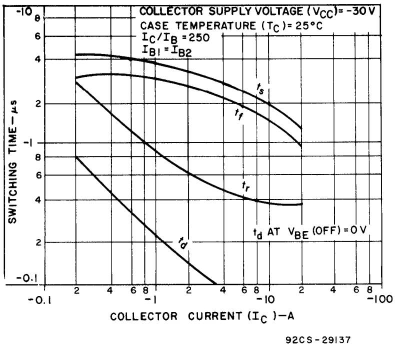


Fig. 10 — Typical switching times for 2N6050, 2N6051, and 2N6052.

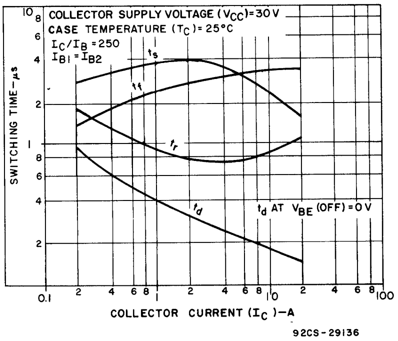


Fig. 11 — Typical switching times for 2N6057, 2N6058, and 2N6059.

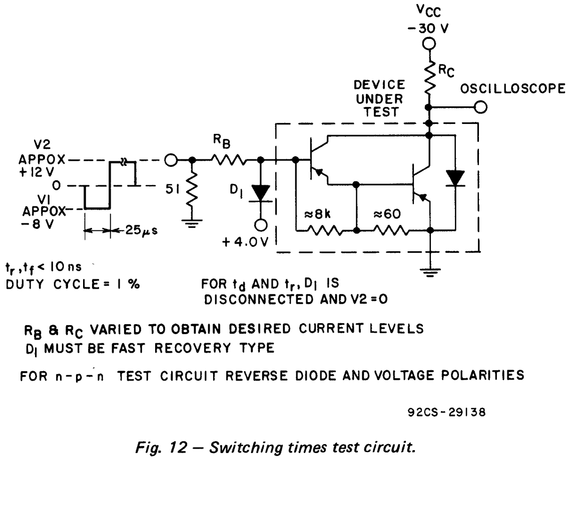


Fig. 12 — Switching times test circuit.

2N6055, 2N6056 File Number **563**

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

60- and 80-Volt, 100-Watt Types
With Gain of 750 at 4 Amperes

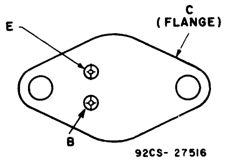
Features:

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

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-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.

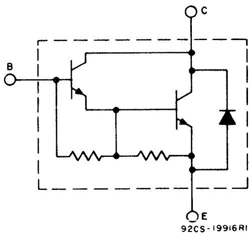


Fig.1 – Schematic diagram of 2N6055 and 2N6056 Darlington power transistors.

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			
$T_C \leq 25^oC$	100	100	W
$T_C > 25^oC$	— See Figs. 2 and 4 —		
* T_{stg}, T_J	—— −65 to +200 ——		^oC
* T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	—— 235 ——		^oC

* 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	
I_{CEX}	60 80		−1.5 −1.5				– –	0.5 –	– –	– 0.5	mA
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_{CER}(sus) R_{BE} = 100 Ω				0.1[a]			60[a]	–	80[a]	–	V
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
$R_{\theta JC}$							–	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

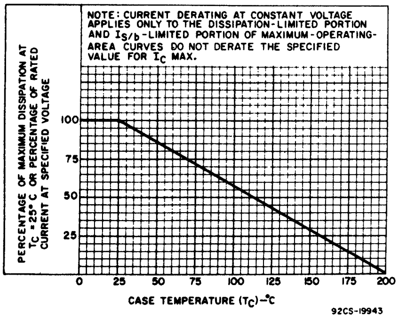


Fig.2 — Derating curve for both types.

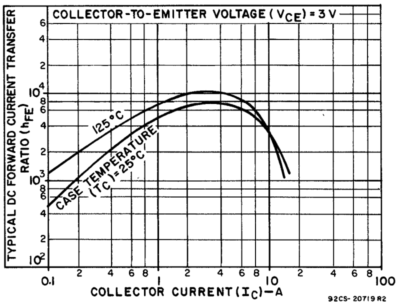


Fig.3 — Typical dc beta characteristics for both types.

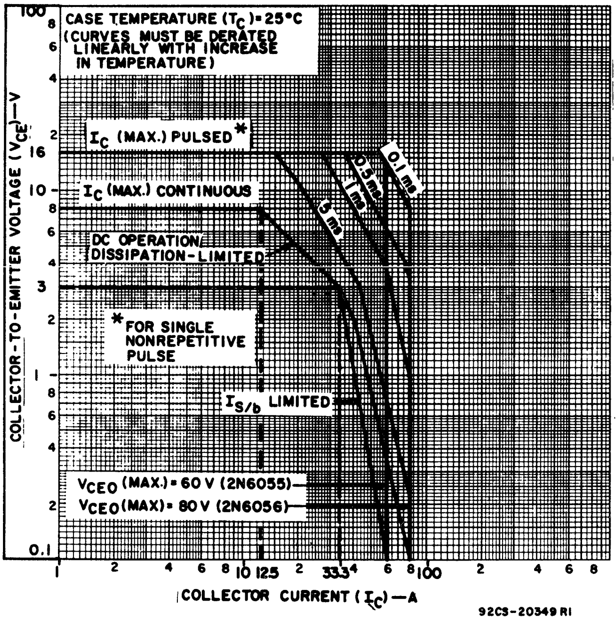


Fig.4 — Maximum operating areas for types 2N6055 and 2N6056.

2N6055, 2N6056

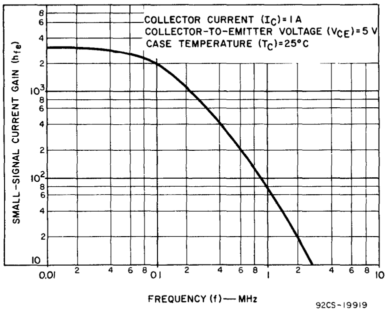


Fig. 5 — Typical small-signal gain for both types.

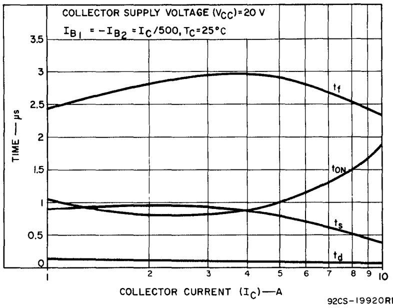


Fig. 6 — Typical saturated switching-time characteristics for both types.

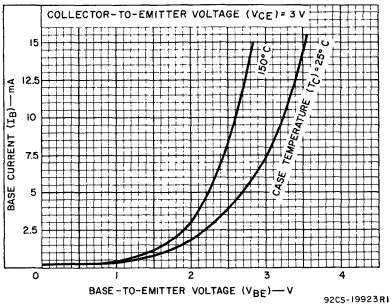


Fig. 7 — Typical input characteristics for both types.

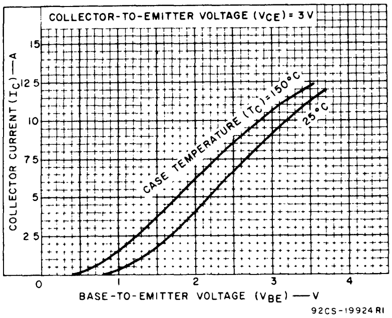


Fig. 8 — Typical transfer characteristics for both types.

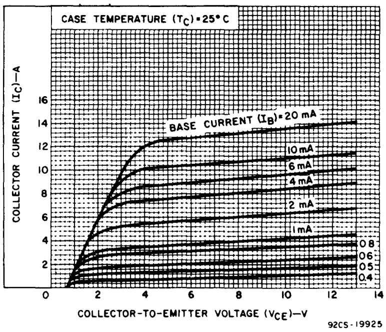


Fig. 9 — Typical output characteristics for both types.

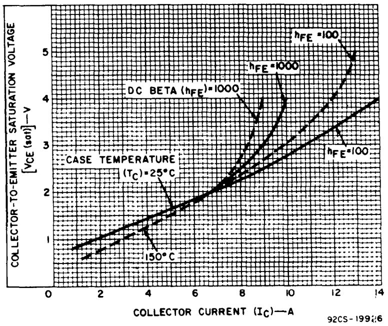


Fig. 10 — Typical saturation-voltage characteristics for both types.

2N6055, 2N6056

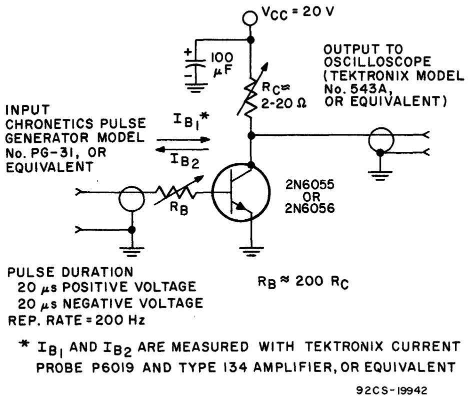


Fig. 11 — Circuit used to measure saturated switching times.

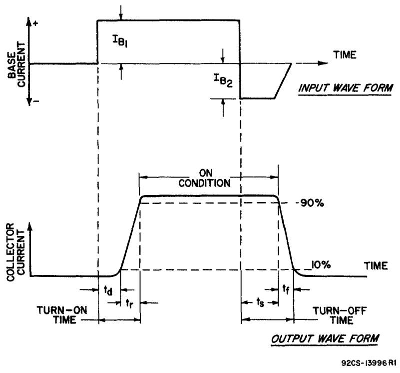


Fig. 12 — Phase relationship between input current and output current showing reference points for specification of switching times.

File Number **1001**

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287

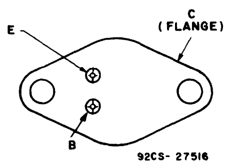
20-Ampere Complementary N-P-N and P-N-P Monolithic Darlington Power Transistors

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**

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-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.

- **High voltage ratings:**

  $V_{CEO}(sus)$ = 60 V Min. – 2N6282, 2N6285•
  = 80 V Min. – 2N6283, 2N6286•
  = 100 V Min. – 2N6284, 2N6287•

Applications:

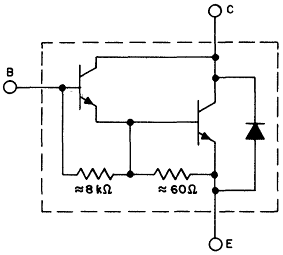
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

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				
$T_C \leq 25°C$	160	160	160	W
$T_C > 25°C$ Derate linearly		0.915		W/°C
* Tstg, TJ		−65 to 200		°C
* T_L				
At distances ≥1/16 in. (1.58 mm) from case for 10 s max.		235		°C

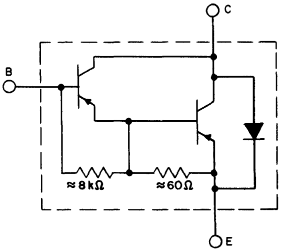
* In accordance with JEDEC registration data.
• For p-n-p devices, voltage and current values are negative.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287



92CS-29128

Fig. 1 – Schematic diagram for 2N6282, 2N6283, and 2N6284.



92CS-29129

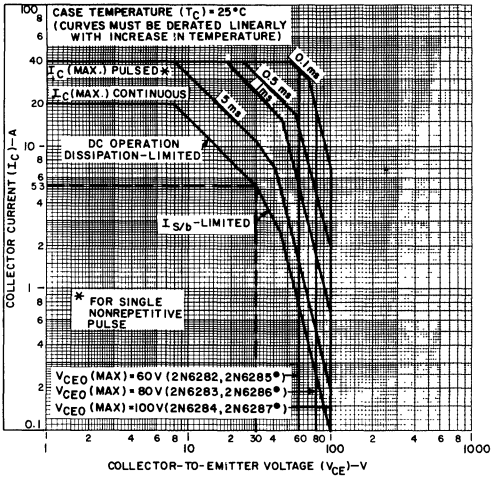
Fig. 2 – Schematic diagram for 2N6285, 2N6286, and 2N6287.

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	–	–	–	–	
	40			0	–	–	–	1	–	–	
	50			0	–	–	–	–	–	1	mA
* I_{CEX}	60	−1.5			–	0.5	–	–	–	–	
	80	−1.5			–	–	–	0.5	–	–	
	100	−1.5			–	–	–	–	–	0.5	
T_C = 150°C	60	−1.5			–	5	–	–	–	–	
	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]	0.2	–	3	–	3	–	3	V
			10[a]	0.04	–	2	–	2	–	2	
* 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 2N6282-84					–	400	–	400	–	400	pF
2N6285-87					–	600	–	600	–	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.

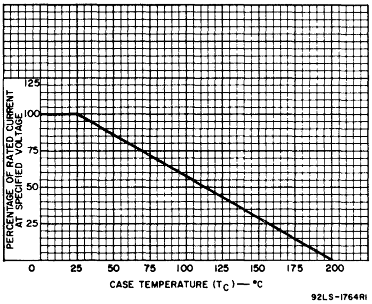


Fig. 4 — Current derating curve for all types.

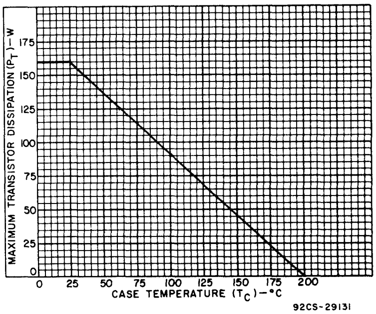


Fig. 5 — Power derating curve for all types.

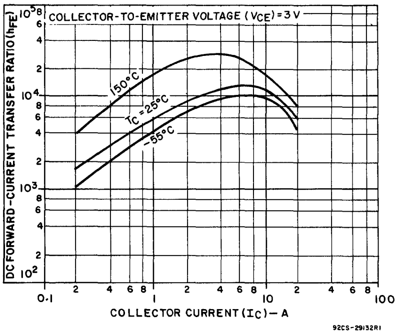


Fig. 6 — Typical dc beta characteristics for 2N6282, 2N6283, and 2N6284.

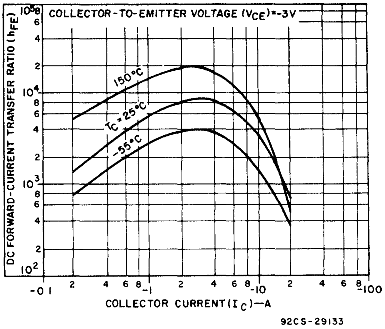


Fig. 7 — Typical dc beta characteristics for 2N6285, 2N6286, and 2N6287.

2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287

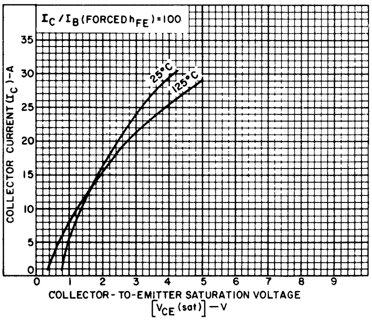


Fig. 8 — Typical saturation characteristics for all types.

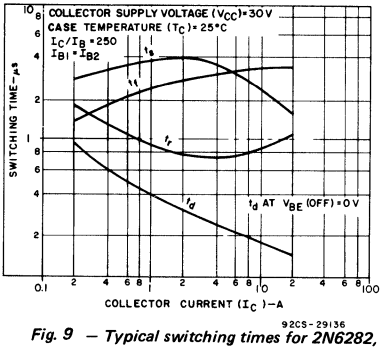


Fig. 9 — Typical switching times for 2N6282, 2N6283, and 2N6284.

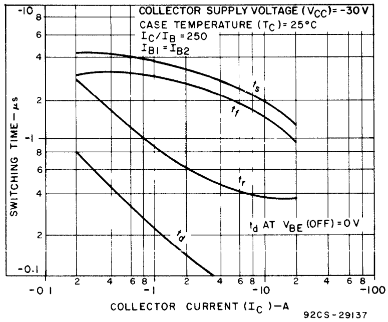
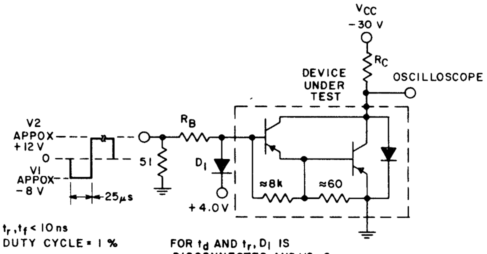


Fig. 10 — Typical switching times for 2N6285, 2N6286, and 2N6287.



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

FOR t_d AND t_r, D_1 IS DISCONNECTED AND V2 = 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. 11 - Switching times test circuit.

File Number **609**

2N6383, 2N6384, 2N6385

10-Ampere N-P-N Darlington Power Transistors

40-60-80 Volts, 100 Watts
Gain of 1000 at 5 A

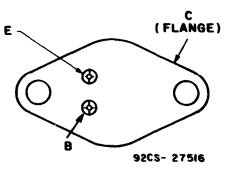
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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-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 steel hermetic package.

•Formerly RCA Dev. Nos. TA8349, TA8486, and TA8348.

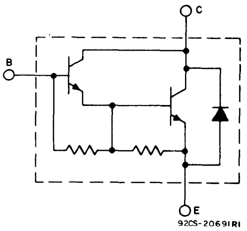


Fig.1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6385	2N6384	2N6383	
* V_{CBO}	80	60	40	V
$V_{CER}(sus)$				
$R_{BE} = 100\ \Omega$	80	60	40	V
* $V_{CEO}(sus)$	80	60	40	V
* V_{CEX}				
$V_{BE} = -1.5$ V, $R_{BB} = 100\ \Omega$	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				
$T_C \leqslant 25^oC$	100	100	100	W
$T_C > 25^oC$		See Fig.2		
* T_{stg}, T_J		−65 to +200		^oC
* T_L				
At distances ⩾ 1/32 in. (0.8mm) from seating plane for 10 s max.		235		^oC

* 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: VOLTAGE V dc			CURRENT A dc		LIMITS: 2N6385		2N6384		2N6383		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	80				0	–	1	–	–	–	–	mA
	60				0	–	–	–	1	–	–	
	40				0	–	–	–	–	–	1	
* I_{CEV}	80		−1.5			–	0.3	–	–	–	–	
	60		−1.5			–	–	–	0.3	–	–	
	40		−1.5			–	–	–	–	–	0.3	
T_C = 150°C	80		−1.5			–	3	–	–	–	–	
	60		−1.5			–	–	–	3	–	–	
	40		−1.5			–	–	–	–	–	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			5[a]		1000	20,000	1000	20,000	1000	20,000	
	3			10[a]		100	–	100	–	100	–	
* V_{BE}	3			5[a]		–	2.8	–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	–	4.5	
* $V_{CE}(sat)$				5[a]	0.01[a]	–	2	–	2	–	2	V
				10[a]	0.1[a]	–	3	–	3	–	3	
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					0.22	–	–	–	–	–	A
	55					–	–	0.55	–	–	–	
	30					3.33	–	3.33	–	3.33	–	
$R_{\theta JC}$						–	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.

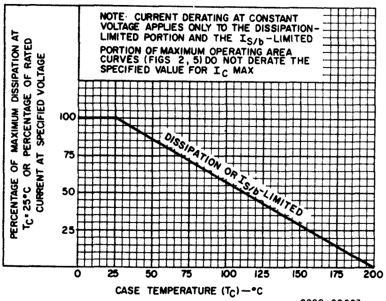


Fig.2 — Derating curves for all types.

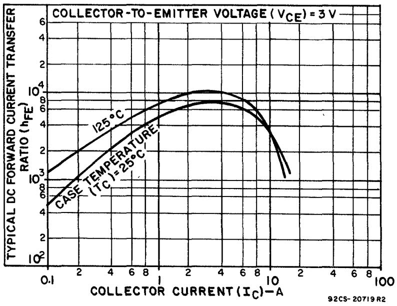


Fig. 3 — Typical dc-beta characteristics for all types.

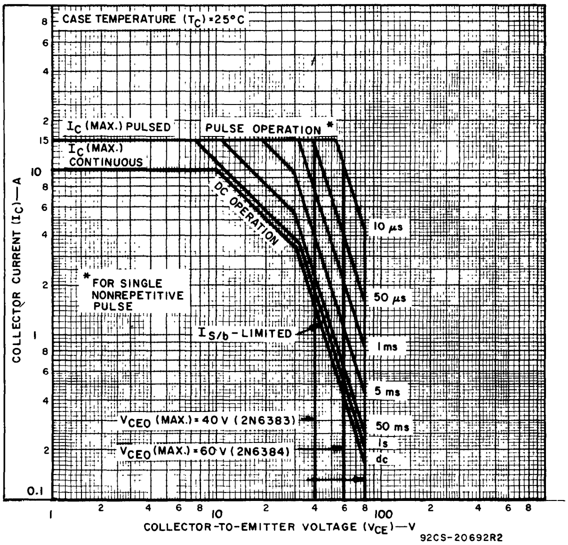


Fig.4 — Maximum operating area for all types.

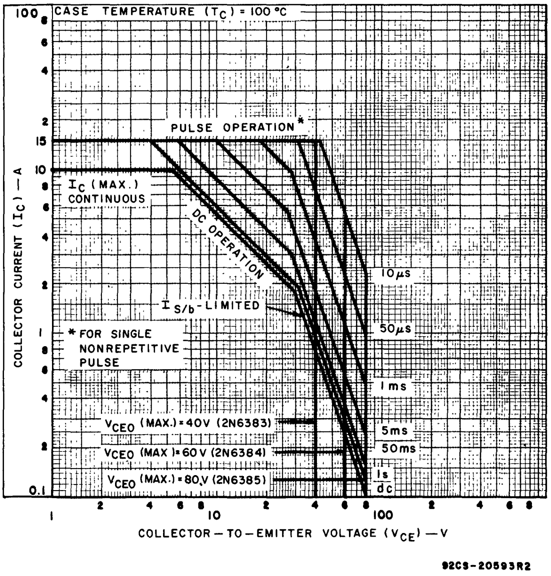


Fig.5 — Maximum operating area for all types.

2N6383, 2N6384, 2N6385

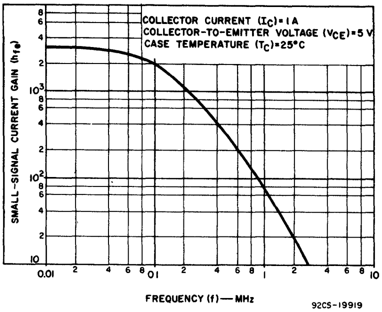


Fig. 6 — Typical small-signal gain for all types.

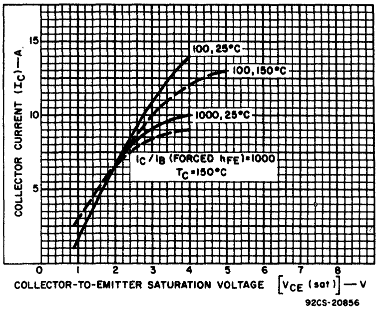


Fig. 7 — Typical saturation characteristics for all types.

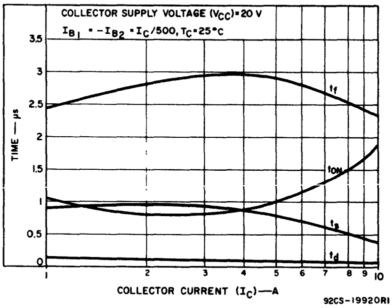


Fig. 8 — Typical saturated switching-time characteristics for all types.

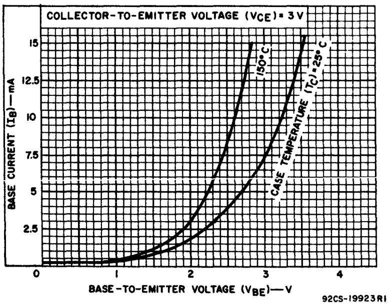


Fig. 9 — Typical input characteristics for all types.

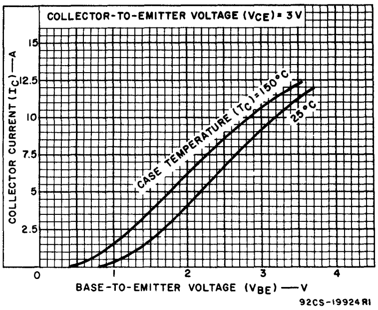


Fig. 10 — Typical transfer characteristics for all types.

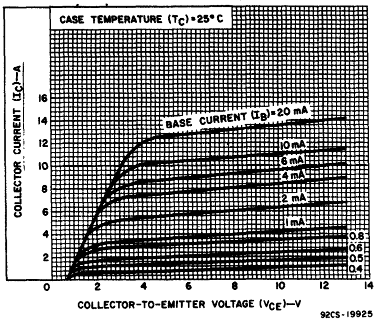


Fig. 11 — Typical output characteristics for all types.

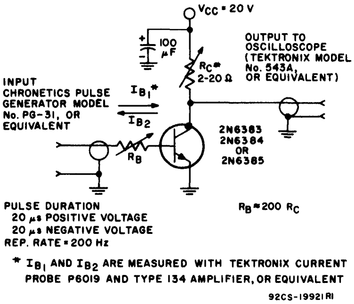


Fig. 12 — Circuit used to measure saturated-switching-times.

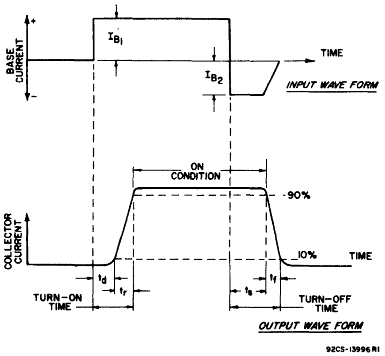


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times (test circuit shown in Fig. 14).

2N6386, 2N6387, 2N6388

File Number **610**

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)

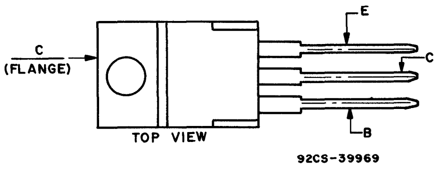
Features:

- **Operates from IC without predriver**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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.

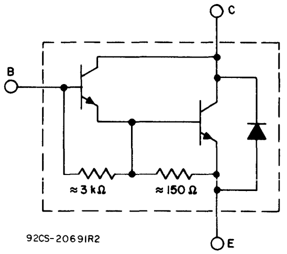


Fig.1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6386	2N6387	2N6388	
* V_{CBO}	40	60	80	V
V_{CER}(sus)				
R_{BE} = 100 Ω	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				
$T_C \leqslant 25^oC$	65	65	65	W
$T_C > 25^oC$		See Fig.2		
* T_{stg}, T_J		−65 to +150		^oC
* T_L At distances ⩾ 1/8 in. (3.17 mm) from case for 10 s max.		235		^oC

* 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 VOLTAGE V dc		CURRENT A dc		LIMITS 2N6386		2N6387		2N6388		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	80			0	–	–	–	–	–	1	mA
	60			0	–	–	–	1	–	–	
	40			0	–	1	–	–	–	–	
* I_{CEV}	80	−1.5			–	–	–	–	–	0.3	
	60	−1.5			–	–	–	0.3	–	–	
	40	−1.5			–	0.3	–	–	–	–	
T_C = 125°C	80	−1.5			–	–	–	–	–	3	
	60	−1.5			–	–	–	3	–	–	
	40	−1.5			–	3	–	–	–	–	
* I_{EBO}		5	0		–	5	–	5	–	5	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[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			−8[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
$R_{\theta JC}$					–	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.

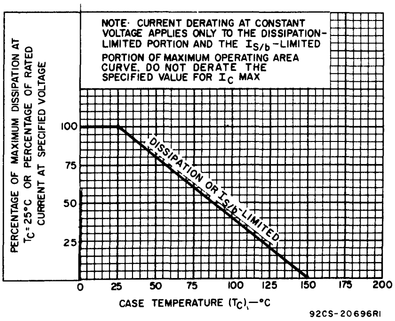


Fig.2 — Derating curve for all types.

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

2N6386, 2N6387, 2N6388

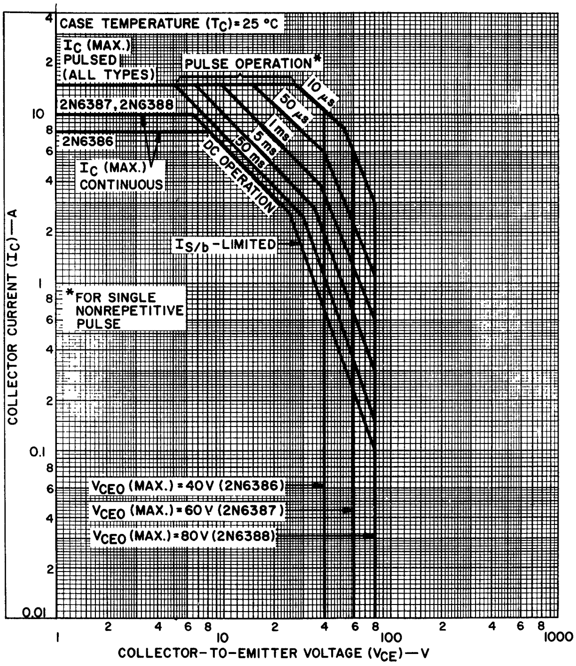


Fig. 4 — Maximum operating areas for all types.

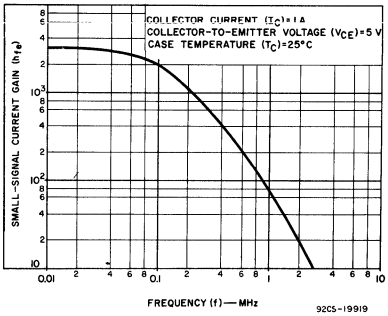


Fig. 5 — Typical small-signal gain for all types.

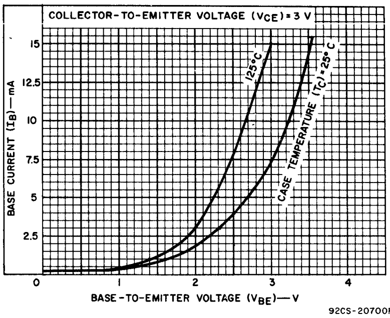


Fig. 6 — Typical input characteristics for all types.

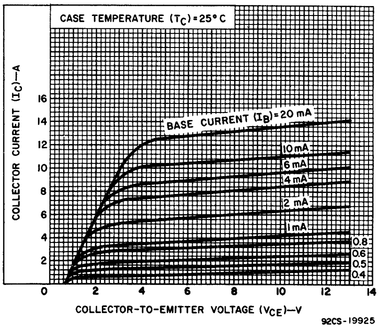


Fig. 7 — Typical output characteristics for all types.

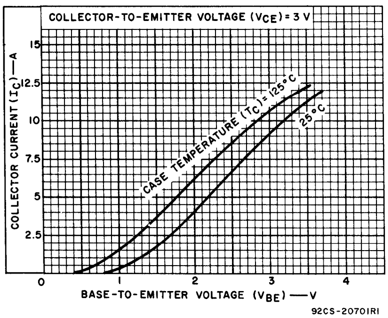


Fig. 8 — Typical transfer characteristics for all types.

2N6386, 2N6387, 2N6388

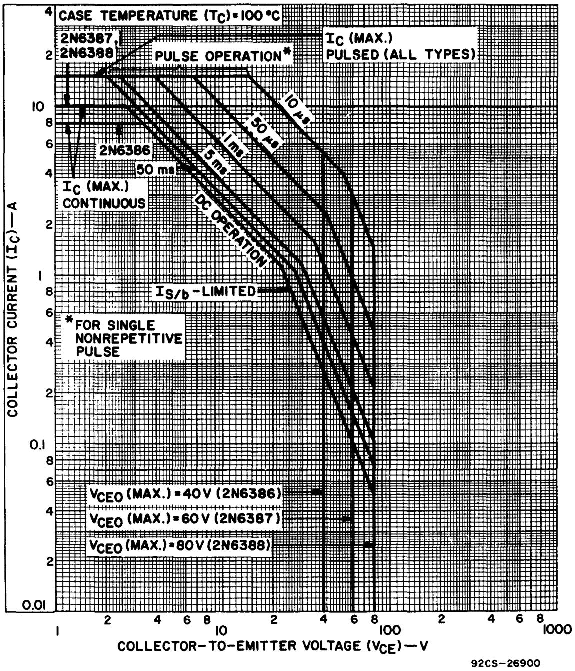


Fig. 9 — Maximum operating areas for all types at T_C = 100° C.

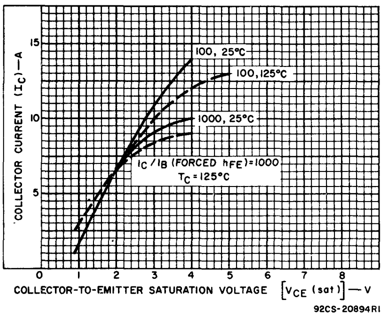


Fig. 10 — Typical saturation characteristics for all types.

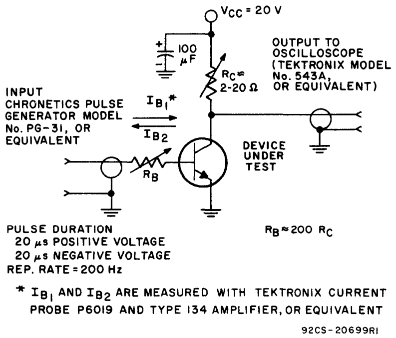


Fig. 11 — Circuit used to measure saturated switching-times.

2N6386, 2N6387, 2N6388

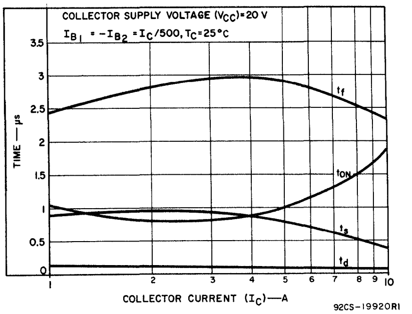


Fig. 12 — Typical saturated switching-time characteristics for all types.

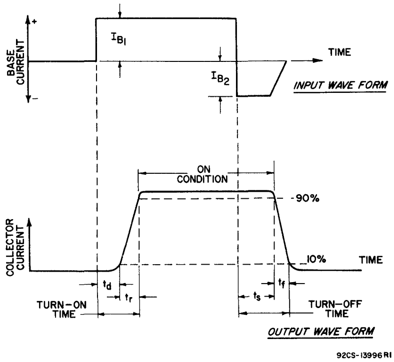


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times.

File Number **873**

2N6530, 2N6531, 2N6532, 2N6533

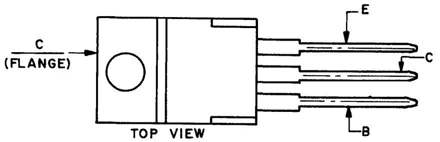
8-Ampere N-P-N Darlington Power Transistors

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:
- **Operate from IC without predriver**
- **Low leakage at high temperature**

Applications:
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

TERMINAL DESIGNATIONS

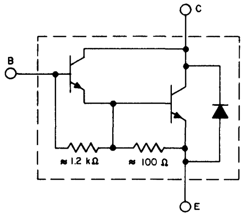


92CS-39969

JEDEC TO-220AB

The RCA-2N6530, 2N6531, 2N6532, and 2N6533• are monolithic n-p-n silicon Darlington transistors designed for power applications at low and medium frequencies. The construction of these devices provides good forward-bias second-breakdown characteristics. Their high gain allows them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.



92CS-24605

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: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N6530		2N6531		UNITS
	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	mA
* T_C = 125°C	80 100	−1.5 −1.5			– –	5 –	– –	– 5	mA
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 Ω			0.2		80[b]	–	100[b]	–	V
* V_{CEV}(sus)		−1.5	0.2		80[b]	–	100[b]	–	V
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] 8[a]		– –	– 5	– –	4 –	V
h_{fe} f = 1 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 0.5 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 ≤ 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 VOLTAGE V dc		CURRENT A dc		LIMITS 2N6532		2N6533		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	120 100			0 0	– –	– 1	– –	1 –	
* I_{CEV}	120 100	−1.5 −1.5			– –	– 0.5	– –	0.5 –	mA
* T_C = 125°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_{CER}(sus) R_{BE} = 100 Ω			0.2		100[b]	–	120[b]	–	V
* 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 kHz	5		1		1,000	–	1,000	–	
* $\|h_{fe}\|$ f = 1 MHz	5		1		20	–	20	–	
C_{obo} V_{CB} = 10 V f = 1 MHz					–	200	–	200	pF
* $I_{S/b}$ t = 0.5 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 ⩽ 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

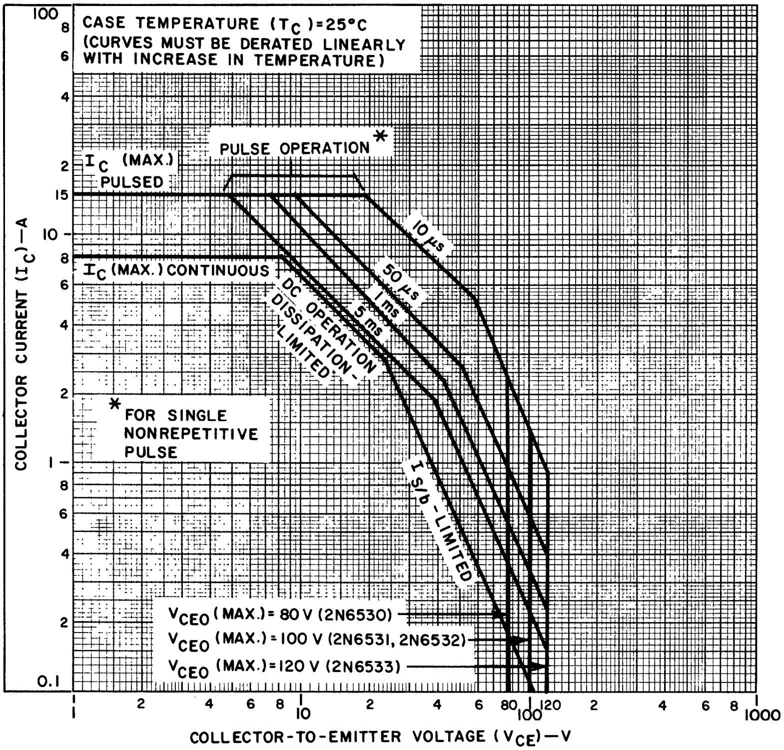


Fig. 2—Maximum operating areas for all types at case temperature of 25°C.

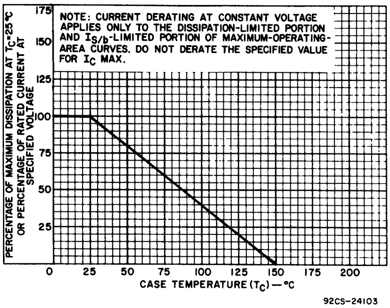


Fig. 3—Dissipation derating curve for all types.

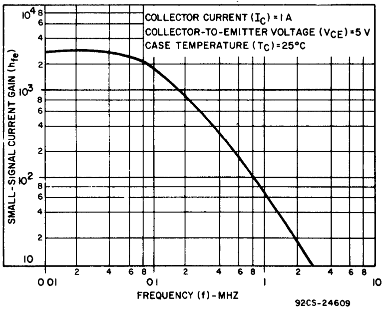


Fig. 4 — Typical small-signal current gain for all types.

2N6530, 2N6531, 2N6532, 2N6533

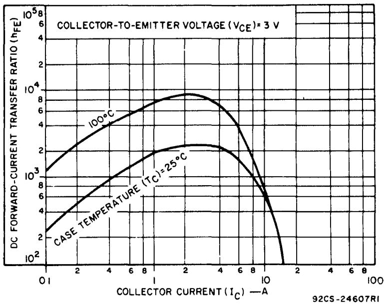


Fig. 5 — Typical dc beta characteristics for all types.

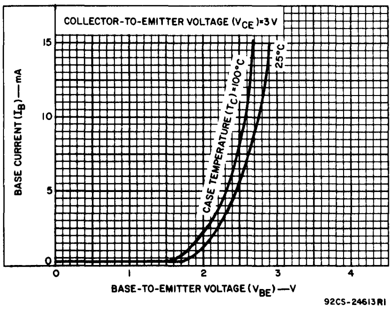


Fig. 6 — Typical input characteristics for all types.

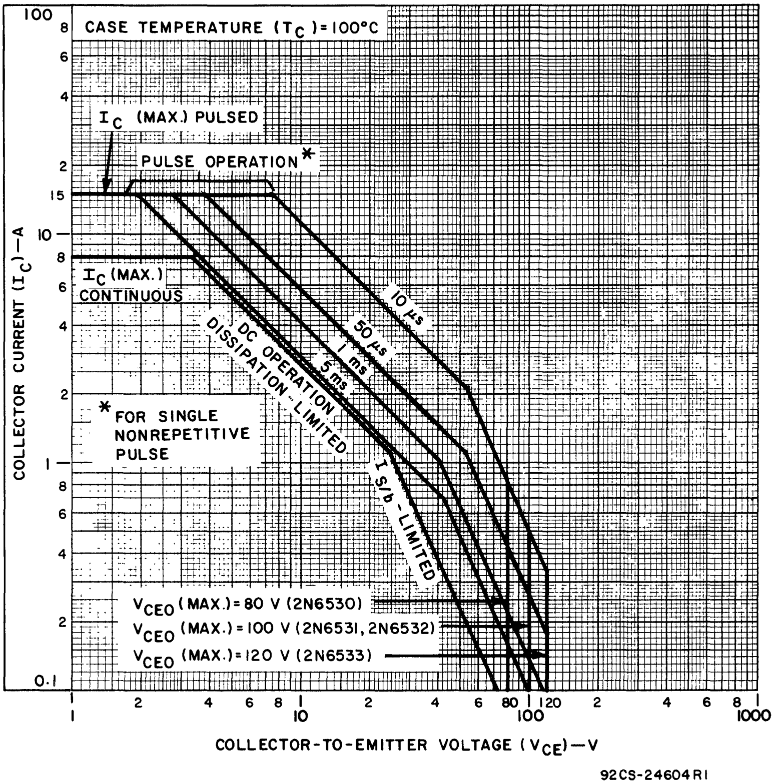


Fig. 7—Maximum operating areas for all types at case temperature of 100°C.

2N6530, 2N6531, 2N6532, 2N6533

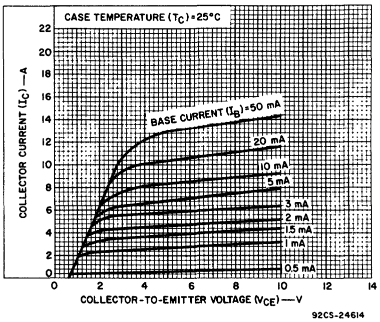


Fig. 8 — Typical output characteristics for all types.

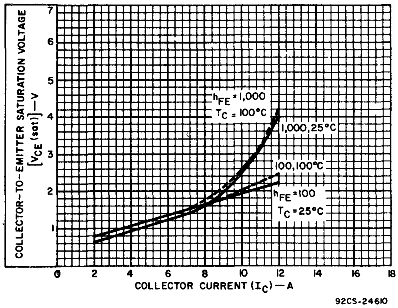


Fig. 9 — Typical saturation characteristics for all types.

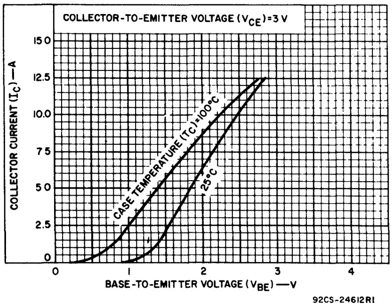


Fig. 10 — Typical transfer characteristics for all types.

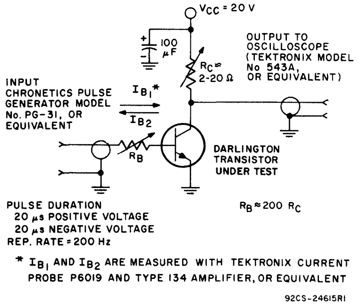


Fig. 11 — Circuit used to measure saturated switching-times.

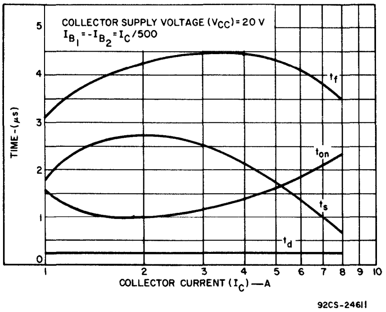


Fig. 12 — Typical saturated switching-time characterictics for all types.

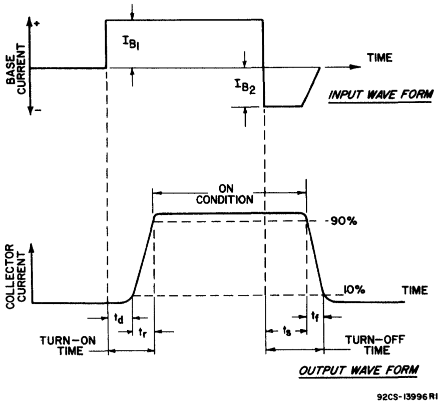


Fig. 13 — Phase relationship between input current and output current, showing reference points for specification of switching-times.

File Number **1152**

2N6576, 2N6577, 2N6578

15-Ampere N-P-N Darlington Power Transistors

60, 90, 120 Volts, 120 Watts
Gain of 2000 at 4 A

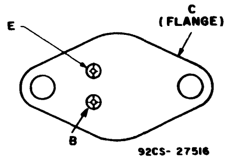
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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.

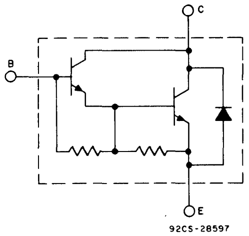


Fig. 1 – Schematic diagram for all types.

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				
$T_C \leqslant 25^oC$		120		W
$T_C > 25^oC$		See Fig. 2		
* T_{stg}, T_J		−65 to 200		^oC
* T_L				
At distances $\geqslant$ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235		^oC

* In accordance with JEDEC registration data.

2N6576, 2N6577, 2N6578

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

CHARAC-TERISTIC 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]					–	0.5	–	–	–	–	
	90[a]					–	–	–	0.5	–	–	
	120[a]					–	–	–	–	–	0.5	
* I_{CEO}	60				0	–	1	–	–	–	–	
	90				0	–	–	–	1	–	–	
	120				0	–	–	–	–	–	1	mA
I_{CER}	60					–	5	–	–	–	–	
R_{BE} = 10K	90					–	–	–	5	–	–	
* T_C=150°C	120					–	–	–	–	–	5	
I_{CEX}	60		–1.5			–	5	–	–	–	–	
T_C=175°C	90		–1.5			–	–	–	5	–	–	
	120		–1.5			–	–	–	–	–	5	
* I_{EBO}		7		0		–	7.5	–	7.5	–	7.5	mA
* V_{CEO}(sus)				0.2[b]	0	60	–	90	–	120	–	V
* h_{FE}	3			0.4[b]		200	–	200	–	200	–	
	3			4[b]		2000	20000	2000	20000	2000	20000	
	3			10[b]		500	5000	500	5000	500	5000	
	4			15[b]		100	–	100	–	100	–	
* V_{BE}(sat)			10	0.1[b]		–	3.5	–	3.5	–	3.5	V
			15	0.15[b]		–	4.5	–	4.5	–	4.5	
* V_{CE}(sat)				10[b]	0.1	–	2.8	–	2.8	–	2.8	
				15[b]	0.15	–	4	–	4	–	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	
* t_r[c]				10	0.1	–	1	–	1	–	1	μs
* 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
$R_{\theta JC}$						–	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] $I_{B_1} = -I_{B_2}$.

2N6576, 2N6577, 2N6578

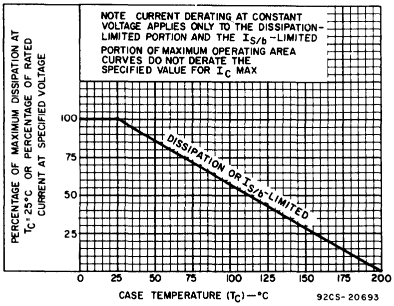


Fig. 2 — Derating curves for all types.

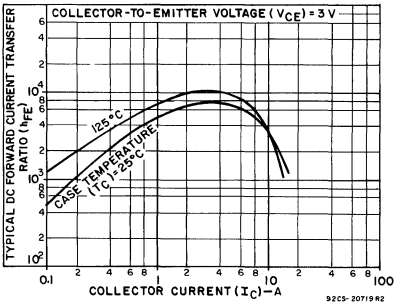


Fig. 3 — Typical dc-beta characteristics for all types.

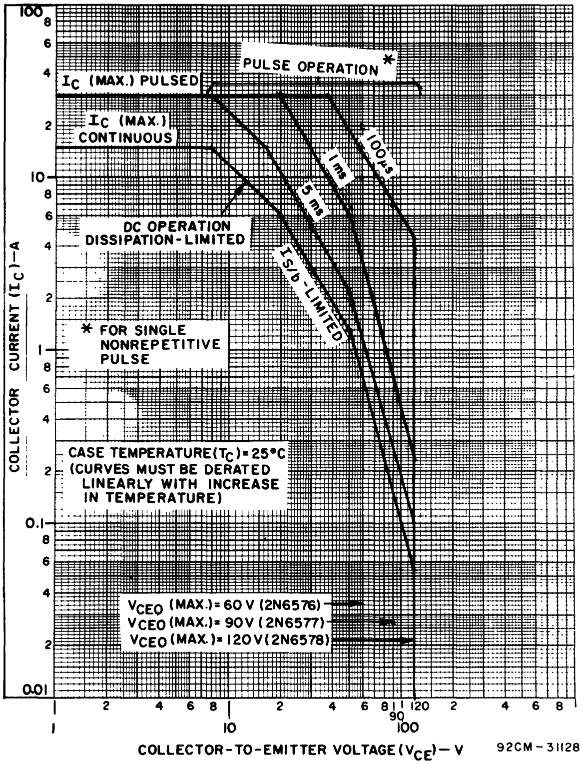


Fig. 4 — Maximum operating areas for all types.

2N6576, 2N6577, 2N6578

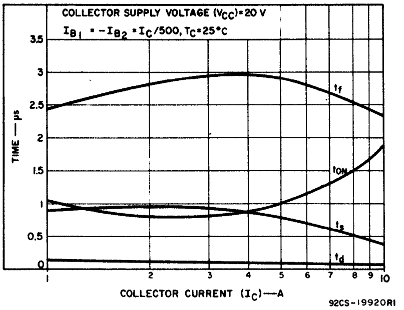


Fig. 5 — Typical saturated switching time characteristics for all types.

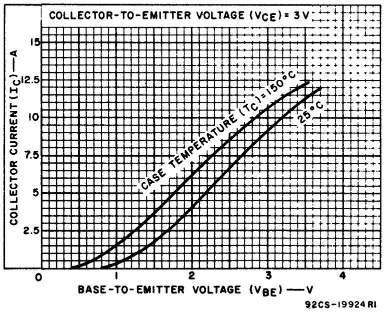


Fig. 6 — Typical transfer characteristics for all types.

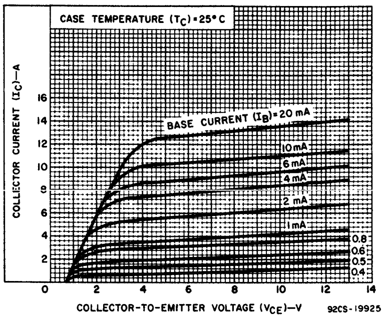


Fig. 7 — Typical output characteristics for all types.

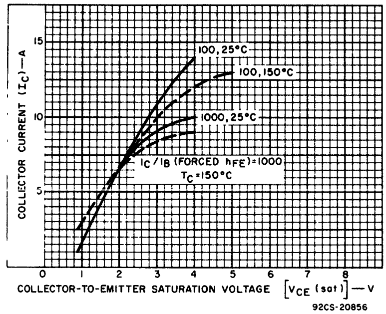


Fig. 8 — Typical saturation characteristics for all types.

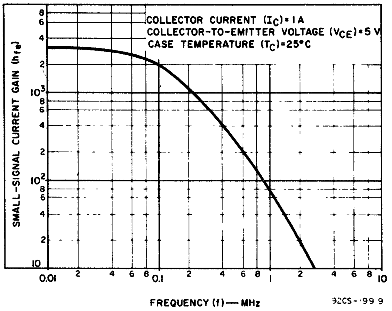


Fig. 9 — Typical small-signal gain for all types.

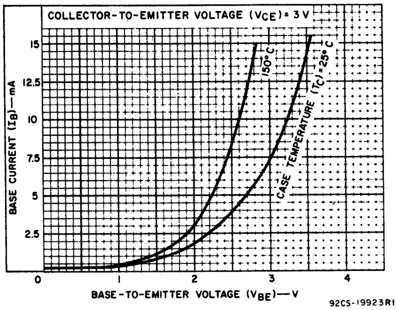


Fig. 10 — Typical input characteristics for all types.

2N6576, 2N6577, 2N6578

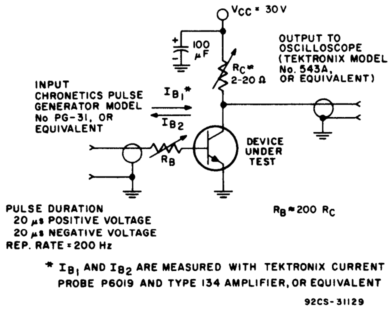
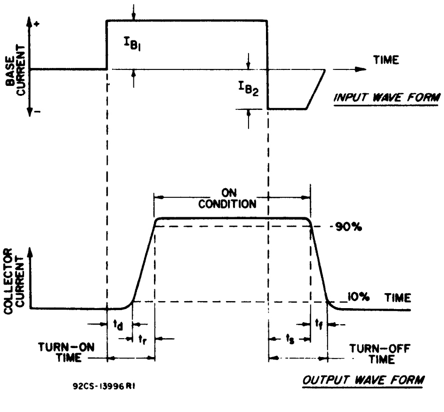


Fig. 11 — Circuit used to measure saturated-switching times.



2N6648. 2N6649, 2N6650

File Number **1013**

10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 70 Watts
Gain of 1000 at 5 A

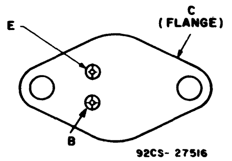
Features:

- **Operates from IC without predriver**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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.

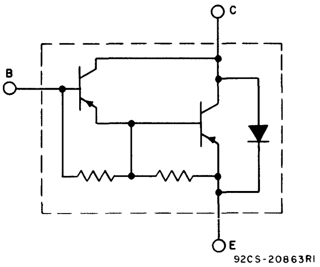


Fig.1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6648	2N6649	2N6650	
* V_{CBO}	–40	–60	–80	V
V_{CER}(sus) R_{BE} = 100 Ω	–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				
$T_C \leq 25^oC$	70	70	70	W
$T_C > 25^oC$ Derate linearly		0.56		W/°C
* T_{stg}, T_J		–65 to +150		°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-4)

2N6648, 2N6649, 2N6650

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6648		2N6649		2N6650		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	−40 −60 −80			0 0 0	– – –	−1 – –	– – –	– −1 –	– – –	– – −1	mA
* I_{CEV}	−40 −60 −80	1.5 1.5 1.5			– – –	−0.3 – –	– – –	– −0.3 –	– – –	– – −0.3	
T_C = 150°C	−40 −60 −80	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_{CER}(sus) R_{BE} = 100 Ω			−0.2[a]		−40	–	−60	–	−80	–	V
V_{CEV}(sus)		1.5	−0.2[a]		−40	–	−60	–	−80	–	
* 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[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.	−35 −25				−1 −2.8	– –	−1 −2.8	– –	−1 −2.8	– –	A
$R_{\theta JC}$					–	1.75	–	1.75	–	1.75	°C/W

* In accordance with JEDEC registration data format (JS-6 RDF-4).

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

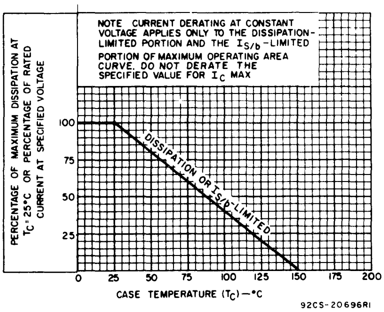


Fig.2 — Derating curve for all types.

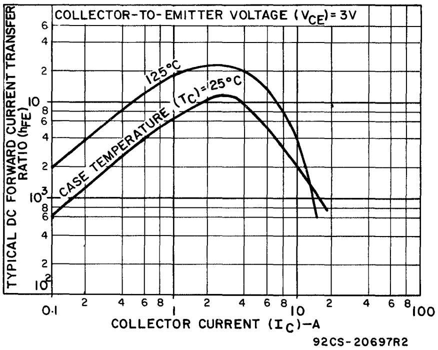


Fig. 3 — Typical dc beta characteristics for all types.

2N6648, 2N6649, 2N6650

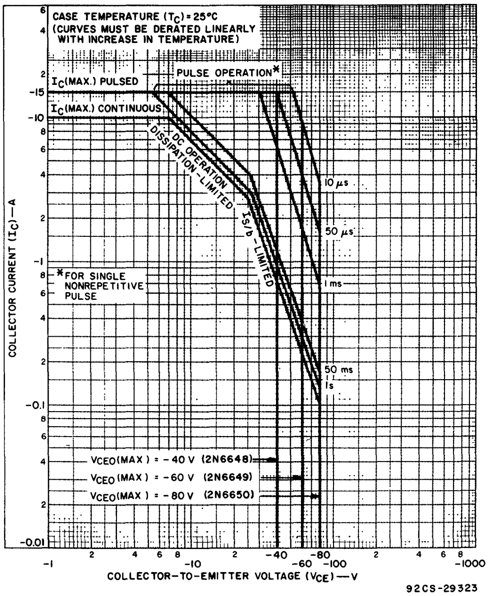


Fig. 4 — Maximum operating areas for all types.

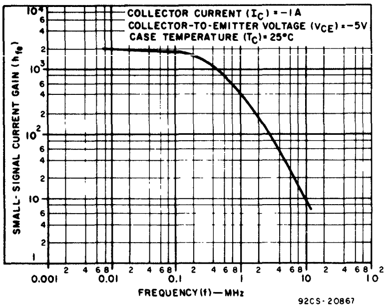


Fig. 5 — Typical small-signal gain for all types.

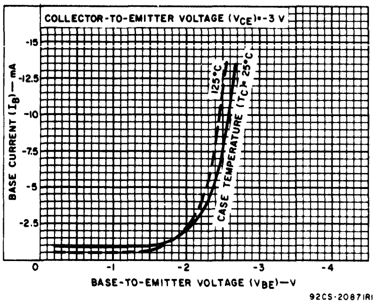


Fig. 6 — Typical input characteristics for all types.

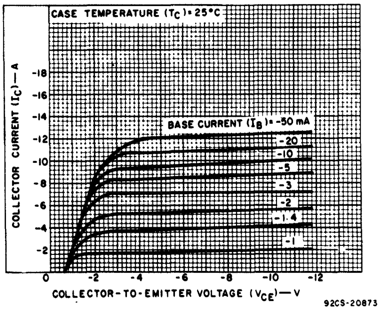


Fig. 7 — Typical output characteristics for all types.

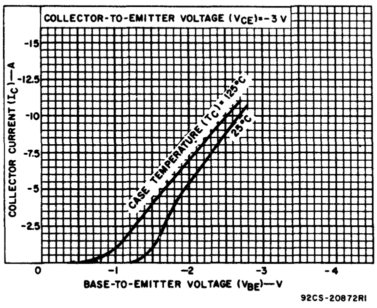


Fig. 8 — Typical transfer characteristics for all types.

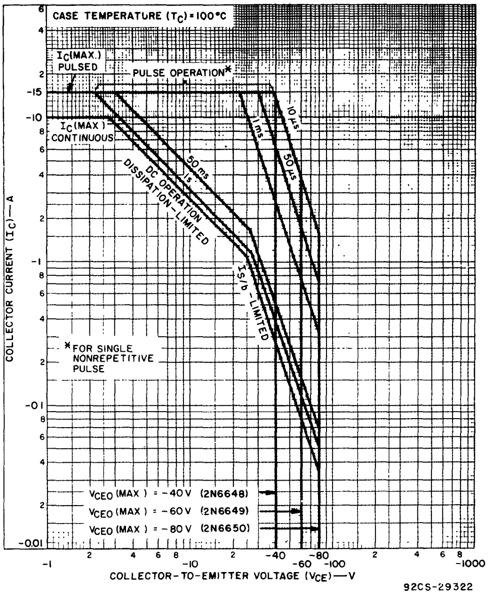


Fig. 9 — Maximum operating areas for all types at T_C = 100° C.

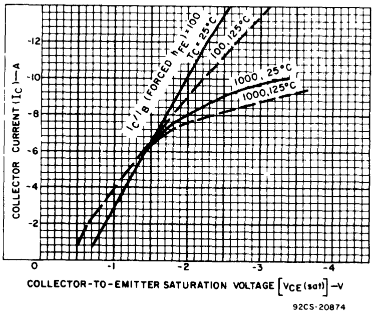


Fig. 10 — Typical saturation characteristics for all types.

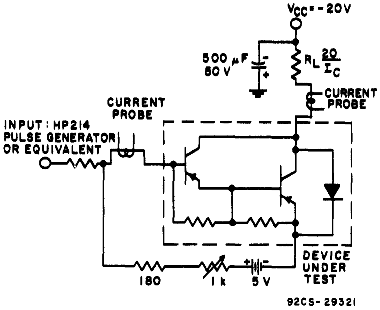


Fig. 11 — Circuit used to measure saturated switching times.

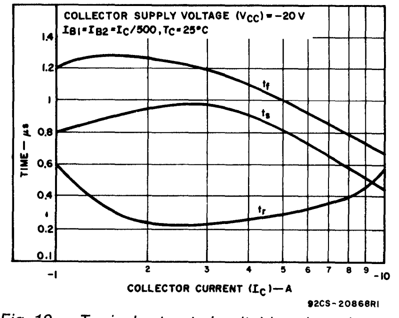


Fig. 12 — Typical saturated switching-time characteristics for all types.

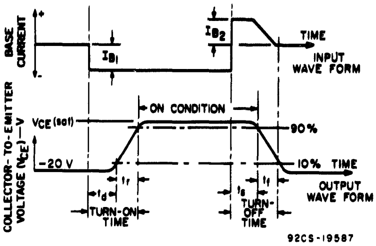


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching times.

2N6666, 2N6667, 2N6668

File Number **1069**

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)

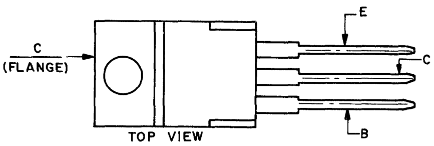
Features:

- **Operates from IC without predriver**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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 (VERSAWATT) plastic package.

●Formerly RCA Dev. Nos. TA8204, TA8487 and TA8203, respectively.
▲Technical data for 2N6386-2N6388 are given in RCA Bulletin File No. 610.

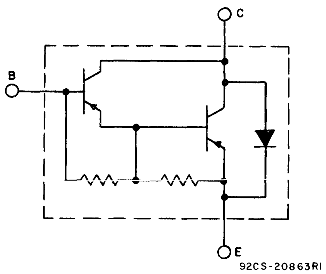


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6666	2N6667	2N6668	
* V_{CBO}	−40	−60	−80	V
$V_{CER}(sus)$				
R_{BE} = 100 Ω	−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				
$T_C \leqslant 25°C$	65	65	65	W
$T_C > 25°C$ derate linearly		0.52		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

*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 VOLTAGE V dc		CURRENT A dc		LIMITS 2N6666		2N6667		2N6668		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	−80			0	–	–	–	–	–	−1	mA
	−60			0	–	–	–	−1	–	–	
	−40			0	–	−1	–	–	–	–	
* I_{CEV}	−80	1.5			–	–	–	–	–	−0.3	
	−60	1.5			–	–	–	−0.3	–	–	
	−40	1.5			–	−0.3	–	–	–	–	
T_C = 125°C	−80	1.5			–	–	–	–	–	−3	
	−60	1.5			–	–	–	−3	–	–	
	−40	1.5			–	−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[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			8[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	–	
$I_{S/b}$ t = 1 s, nonrep.	−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%.
*In accordance with JEDEC registration data format (JS-6 RDF-4).

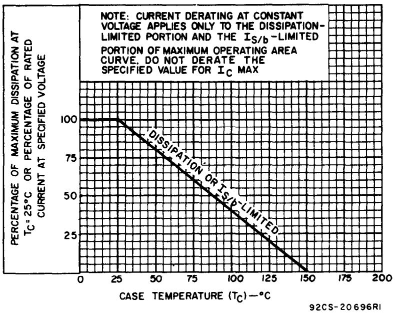


Fig. 2 — Derating curve for all types.

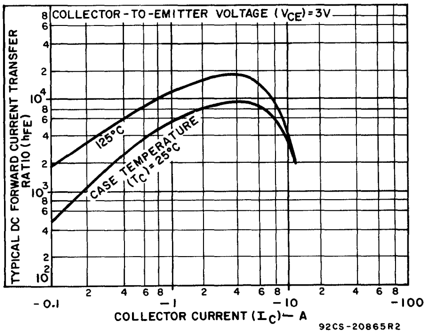


Fig. 3 — Typical dc beta characteristics for all types.

2N6666, 2N6667, 2N6668

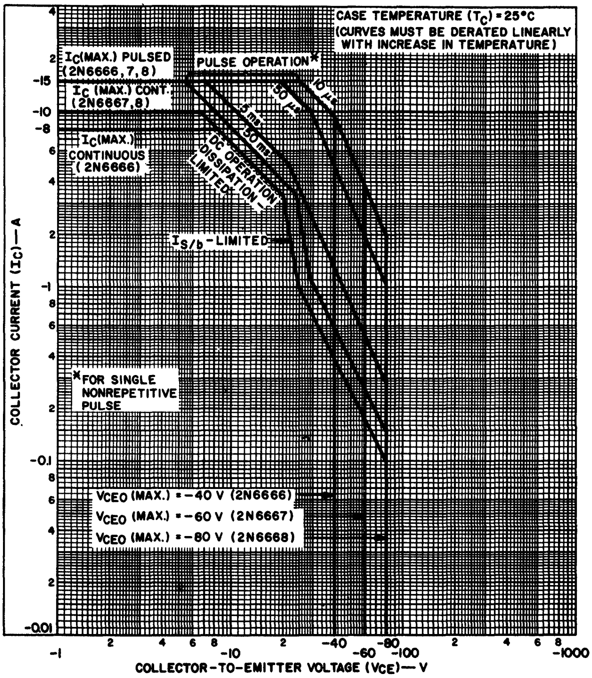


Fig. 4 — Maximum operating areas for all types at T_C = 25° C.

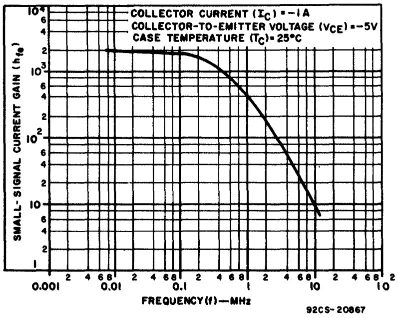


Fig. 5 — Typical small-signal gain for all types.

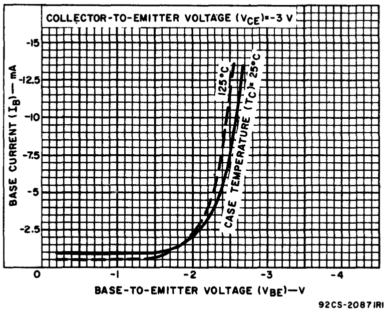


Fig. 6 — Typical input characteristics for all types.

2N6666, 2N6667, 2N6668

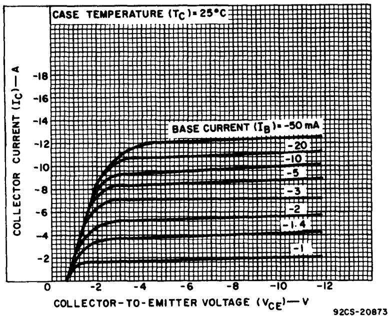


Fig. 7 — Typical output characteristics for all types.

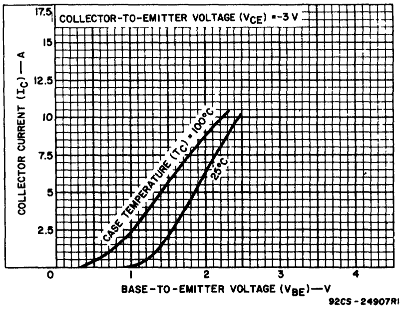


Fig. 8 — Typical transfer characteristics for all types.

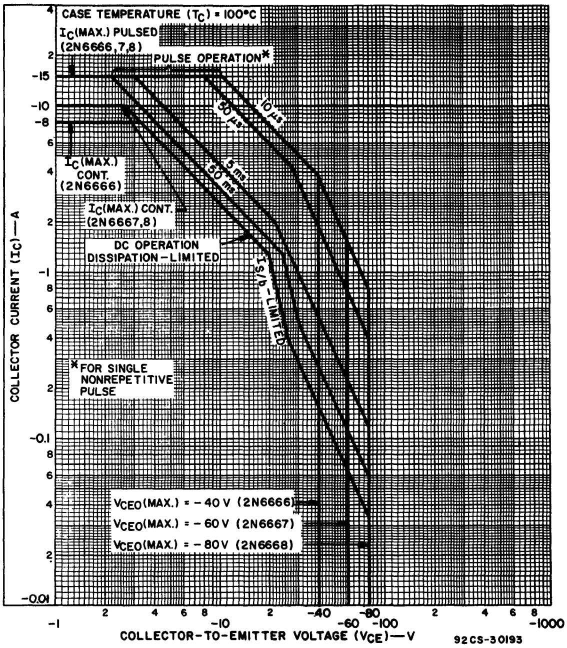


Fig. 9 — Maximum operating areas for all types T_C = 100° C.

2N6666, 2N6667, 2N6668

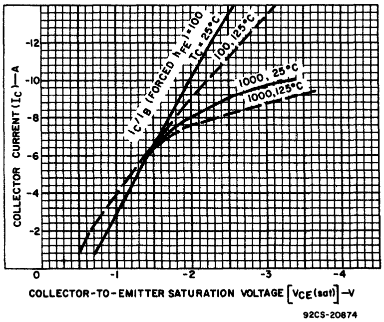


Fig. 10 — Typical saturation characteristics for all types.

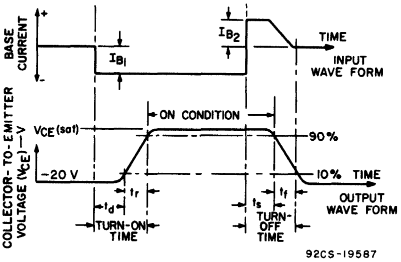


Fig. 11 — Phase relationship between input current and output current showing reference points for specification of switching times.

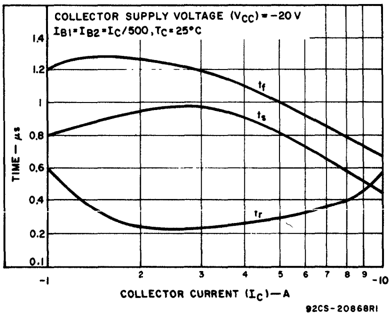


Fig. 12 — Typical saturated switching-time characteristics for all types.

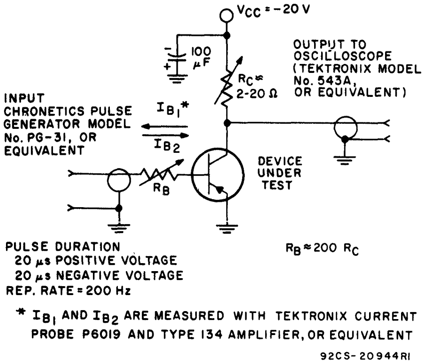


Fig. 13 — Circuit used to measure saturated switching times.

File Number **1241**

BD643, BD645, BD647, BD649

8-Ampere N-P-N Darlington Power Transistors

45-60-80 Volts, 70 Watts
Gain of 750 at 3A

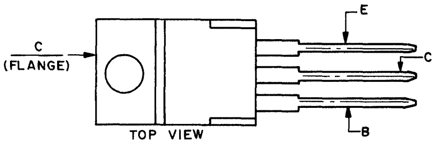
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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.

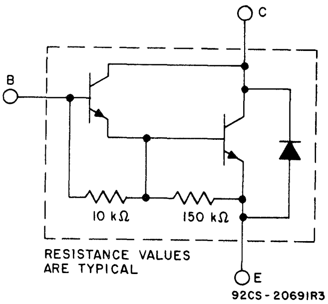


Fig. 1—Schematic diagram for all types.

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					
$T_C \leq 25°C$	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			CURRENT 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	mA
T_C = 100°C	45 60				— —	2 —	— —	— 2	mA
I_{EBO}			—5	0	—	2	—	2	mA
$V_{(BR)CEO}$				0.1[a]	45	—	60	—	V
$V_{(BR)CBO}$				0.005	45	—	60	—	V
$V_{(BR)EBO}$ I_E = 2 mA					5	—	5	—	V
h_{FE}		3 3 3		0.5[a] 3[a] 6[a]	1500[b] 750 750[b]	— — —	1500[b] 750 750[b]	— — —	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	V
f_T f = 1 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.

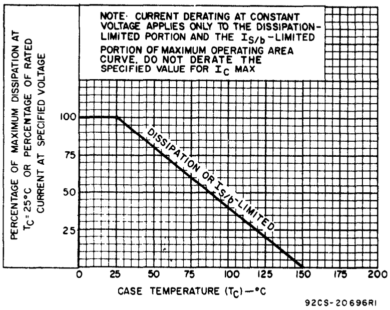


Fig. 2—Derating curve for all types.

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 —	— —	— 0.5	mA
I_{CBO}	80 100				— —	0.2 —	— —	— 0.2	mA
T_C = 100°C	80 100				— —	2 —	— —	— 2	mA
I_{EBO}			−5	0	—	2	—	2	mA
$V_{(BR)CEO}$				0.1[a]	80	—	100	—	V
$V_{(BR)CBO}$				0.005	80	—	100	—	V
$V_{(BR)EBO}$ I_E = 2 mA					5	—	5	—	V
h_{FE}		3 3 3		0.5[a] 3[a] 6[a]	1500[b] 750 750[b]	— — —	1500[b] 750 750[b]	— — —	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	V
f_T f = 1 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.

BD643, BD645, BD647, BD649

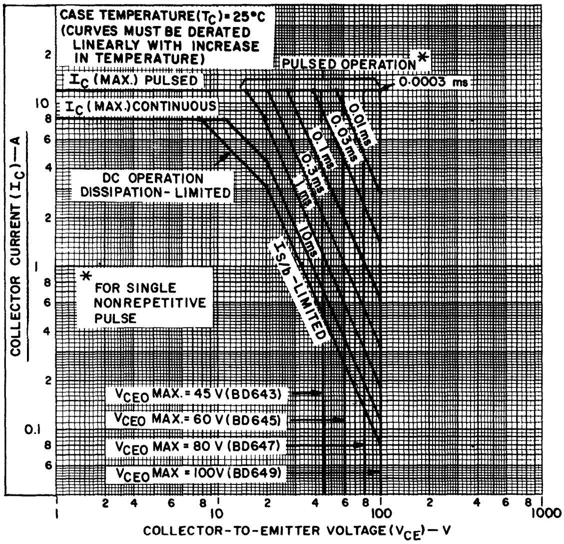


Fig. 3—Maximum operating area for all types.

File Number **1240** **BD895, BD895A, BD897, BD897A, BD899, BD899A, BD901**

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)

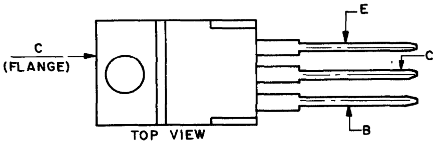
Features:

- **Operated from IC without predriver**
- **Low Leakage at high temperature**

Applications:

- **Power Switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

The RCA-BD895, 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.

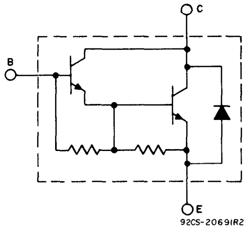


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD895 BD895A	BD897 BD897A	BD899 BD899A	BD901 —	
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	0.1				A
P_T					
$T_C \leq 25°C$	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°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			0	—	500	—	—	μA
		30			0	—	—	—	500	
I_{CBO}	45					—	0.2	—	—	mA
	60					—	—	—	0.2	
T_C = 100°C	45					—	2	—	—	
	60					—	—	—	2	
I_{EBO}			−5	0		—	2	—	2	
$V_{CEO}(sus)$				0.1[a]	0	45	—	60	—	V
h_{FE} BD895,BD897		3		3[a]		750	—	750	—	
BD895A,BD897A		3		4[a]		750	—	750	—	
V_{BE} BD895,BD897		3		3[a]		—	2.5	—	2.5	V
BD895A,BD897A		3		4[a]		—	2.5	—	2.5	
$V_{CE}(sat)$ BD895 BD897				3[a]	0.012	—	2.5	—	2.5	
BD895A,BD897A				4[a]	0.016	—	2.8	—	2.8	
h_{fe} f = 1 MHz		3		3		1	—	1	—	
$R_{\theta JC}$						—	1.78	—	1.78	°C/W

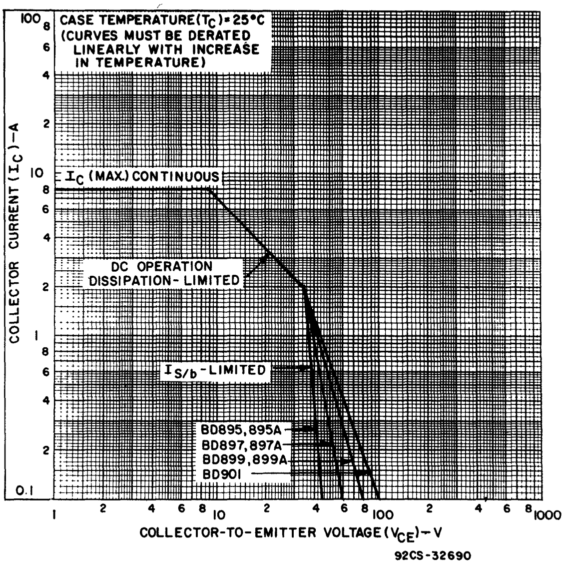


Fig. 2—Maximum operating areas for all types.

BD895, BD895A, BD897, BD897A, BD899, BD899A, BD901

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C = 25°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			0	—	500	—	—	μA
		50			0	—	—	—	500	
I_{CBO}	80					—	0.2	—	—	mA
	100					—	—	—	0.2	
T_C = 100°C	80					—	2	—	—	
	100					—	—	—	2	
I_{EBO}			−5	0		—	2	—	2	
V_{CEO}(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}(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	°C/W

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

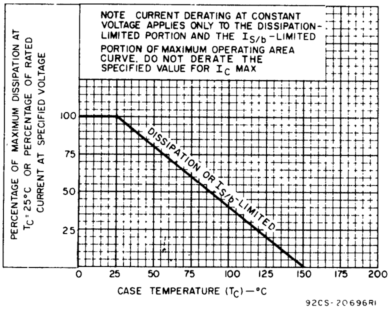


Fig. 3—Derating curve for all types.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D File Number **693**

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)

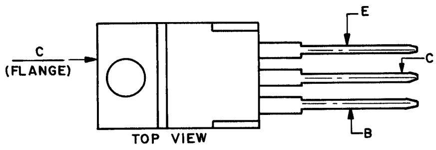
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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 (VERSAWATT) plastic package.

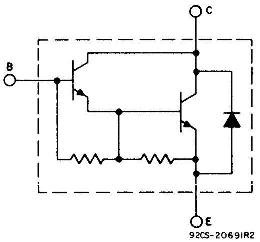


Fig. 1 – Schematic diagram for all types.

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 $T_C \leq 25°C$	70	70	70	70	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

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			CURRENT 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				3[a]	–	–	–	–	–	2.5	V
I_B = 0.008				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	–	
$R_{\theta JC}$					–	1.78	–	1.78	–	1.78	°C/W

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

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			CURRENT A dc		BDX33C		BDX33D		
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		60 50			0 0	– –	– 0.5	– –	0.5 –	mA
T_C = 100°C		60 50			0 0	– –	– 10	– –	10 –	mA
I_{CBO}	120 100					– –	– 1	– –	1 –	mA
T_C = 100°C	120 100					– –	– 5	– –	5 –	mA
I_{EBO}			–5	0		–	10	–	10	mA
$V_{CEO(sus)}$				0.1[a]	0	100	–	120	–	V
$V_{CER(sus)}$ (R_{BE}) = 100 Ω				0.1[a]		100	–	120	–	V
$V_{CEV(sus)}$			–1.5	0.1[a]		100	–	120	–	V
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 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.		25 36				2.8 1	– –	2.8 1	– –	A
$R_{\theta JC}$						–	1.78	–	1.78	°C/W

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

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

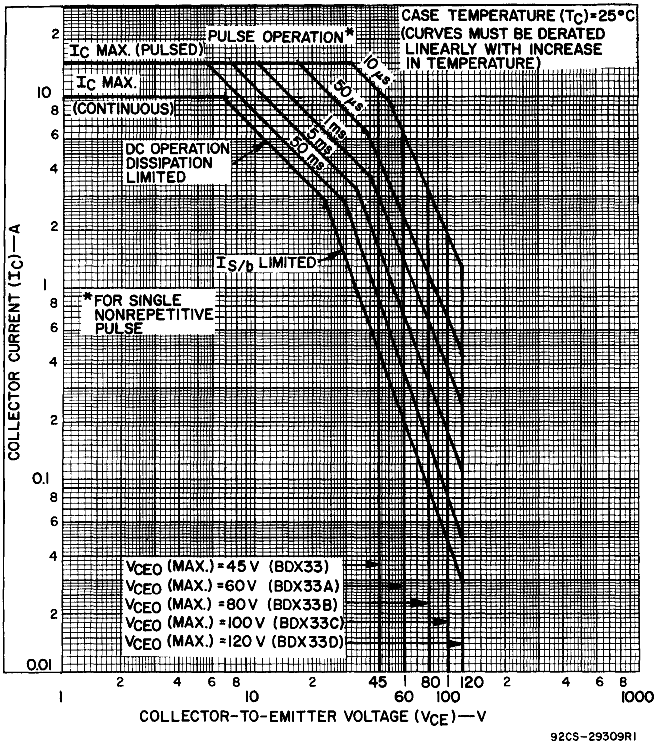


Fig. 2. — Maximum operating areas for BDX33-series types.

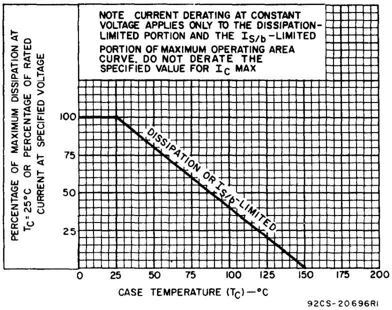


Fig. 3 — Derating curve for all types.

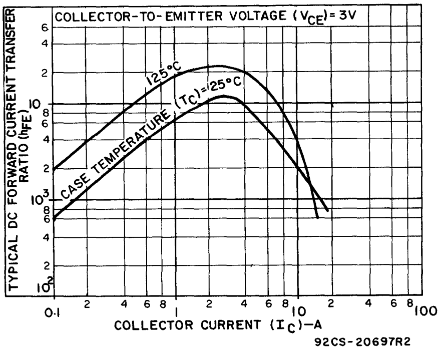


Fig. 4 — Typical dc-beta characteristics for all types.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

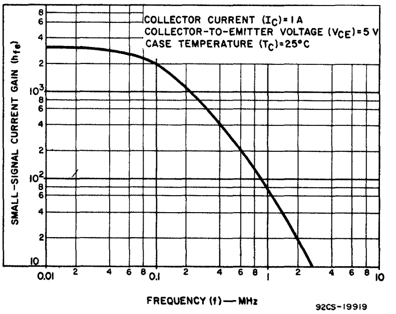


Fig. 5 — Typical small-signal gain for all types.

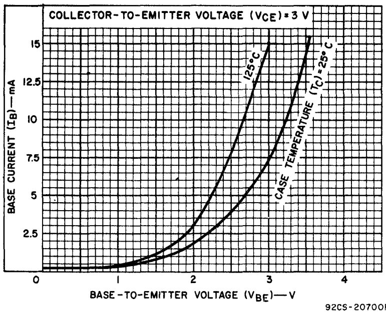


Fig. 6 — Typical Input characteristics for all types.

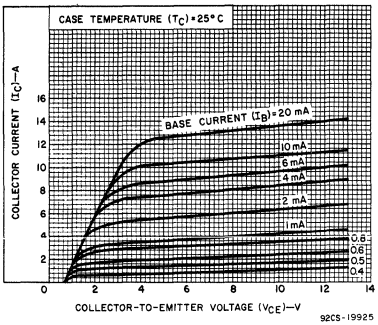


Fig. 7 — Typical output characteristics for all types.

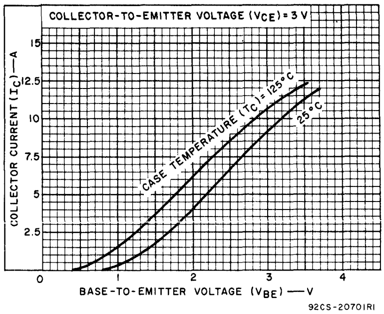


Fig. 8 — Typical transfer characteristics for all types.

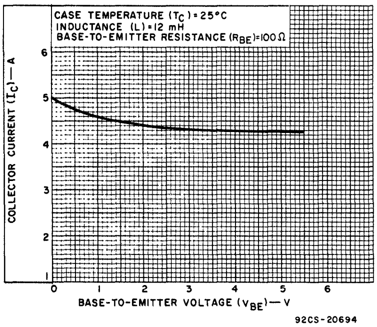


Fig. 9 — Typical saturation characteristics for all types.

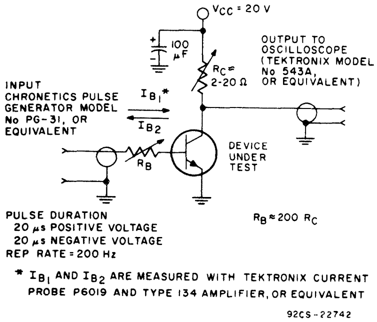


Fig. 10 — Circuit used to measure saturated switching times.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

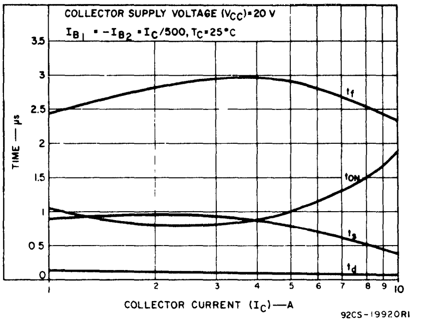


Fig. 11 — Typical saturated switching-time characteristics for all types.

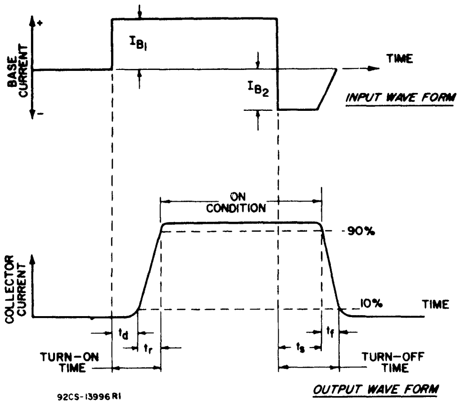


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching times (test circuit shown in Fig. 13).

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

File Number **694**

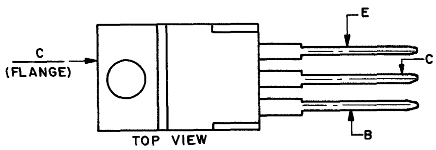
10-Ampere P-N-P Darlington Power Transistors

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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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 RCA Bulletin File No. 693.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

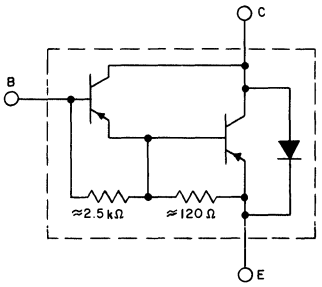


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX34	BDX34A	BDX34B	BDX34C	BDX34D	
V_{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			V
I_C			-10			A
I_B			-0.25			A
P_T $T_C \leq 25°C$			70			W
P_T $T_C > 25°C$			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*

CHARAC-TERISTIC	TEST CONDITIONS: VOLTAGE V dc			CURRENT A dc	LIMITS: BDX34		BDX34A		BDX34B		UNITS
	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	
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	-1.0[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 A				-3[a]	—	—	—	—	—	-2.5	
=-0.008 A				-4[a]	—	-2.5	—	-2.5	—	—	
V_F				-8	—	-4	—	-4	—	-4	
h_{fe} (f=1.0 kHz)		-5		-1	1000	—	1000	—	1000	—	
$\|h_{fe}\|$ (f=1.0 MHz)		-5		-1	20	—	20	—	20	—	
$I_{S/b}$		-20			-3.5	—	-3.5	—	-3.5	—	A
t_p=0.5s non-rep.		-33			-1	—	-1	—	-1	—	
$R_{\theta JC}$					—	1.78	—	1.78	—	1.78	°C/W

[a]Pulsed: 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: VOLTAGE V dc			TEST CONDITIONS: CURRENT A dc	LIMITS: BDX34C		LIMITS: BDX34D		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		-60			—	—	—	-0.5	mA
		-50			—	-0.5	—	—	
T_C=100° C		-60			—	—	—	-10	
		-50			—	-10	—	—	
I_{CBO}	-120				—	—	—	-1	
	-100				—	-1	—	—	
T_C=100° C	-120				—	—	—	-5	
	-100				—	-5	—	—	
I_{EBO}			5	0	—	-10	—	-10	
V_{CEO}(sus)				-0.1[a]	-100	—	-120	—	V
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_{BE}		-3		-3[a]	—	-2.5	—	-2.5	V
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			-3.5	—	-3.5	—	A
		-33			-1	—	-1	—	
$R_{\theta JC}$					—	1.78	—	1.78	°C/W

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

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

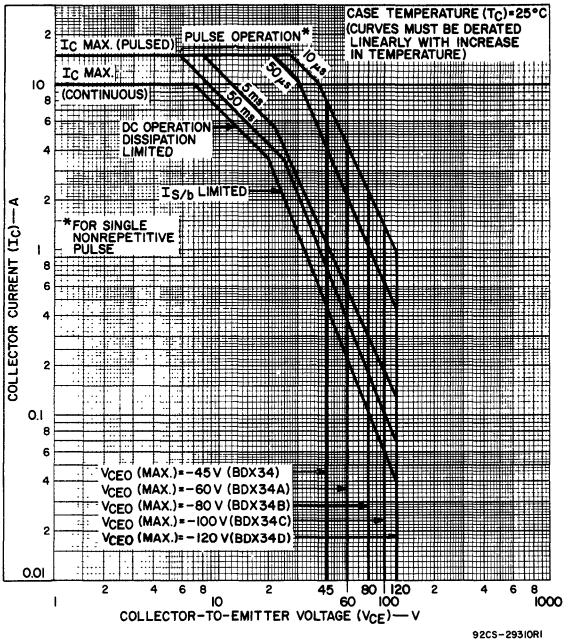


Fig. 2 - Maximum operating areas for BDX34-series types.

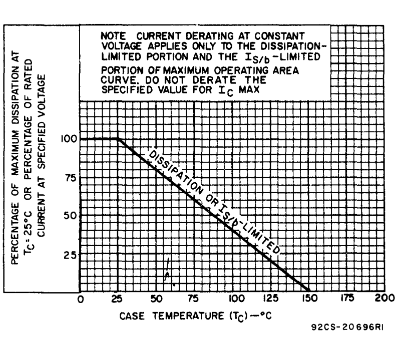


Fig. 3 - Current derating curve for all types.

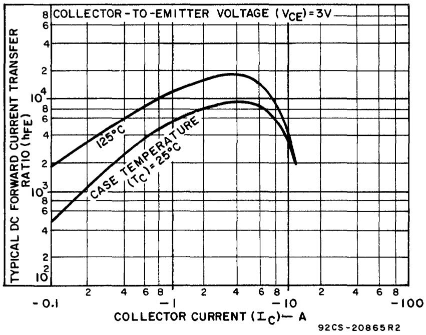


Fig. 4 - Typical dc beta characteristics for all types.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

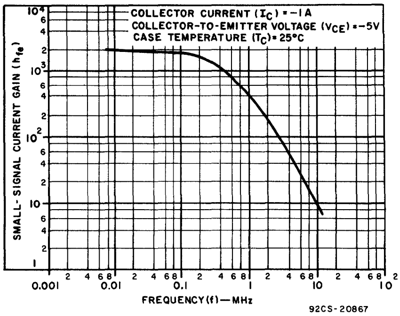


Fig. 5 — Typical small-signal gain for all types.

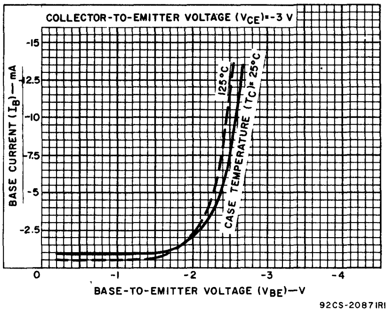


Fig. 6 — Typical input characteristics for all types.

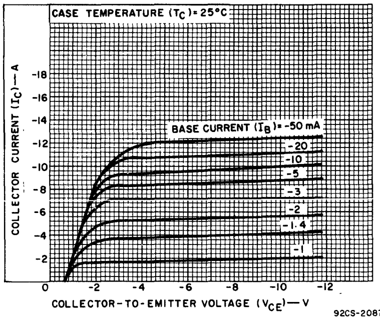


Fig. 7 — Typical output characteristics for all types.

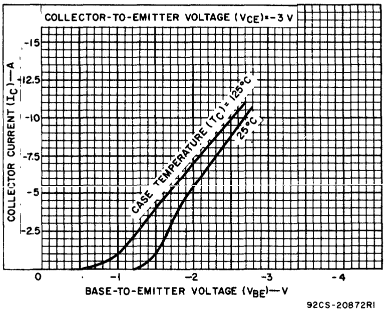


Fig. 8 — Typical transfer characteristics for all types.

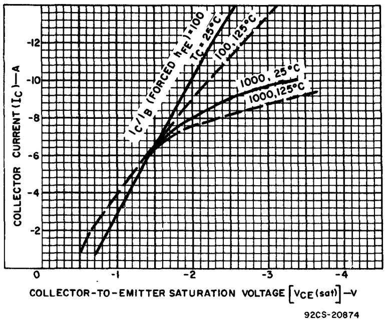


Fig. 9 — Typical saturation characteristics for all types.

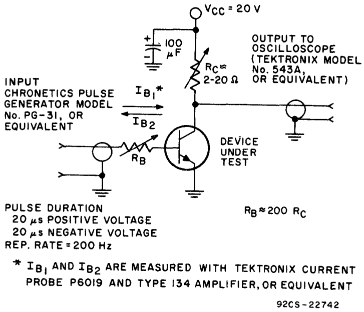


Fig. 10 — Circuit used to measure saturated switching times.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

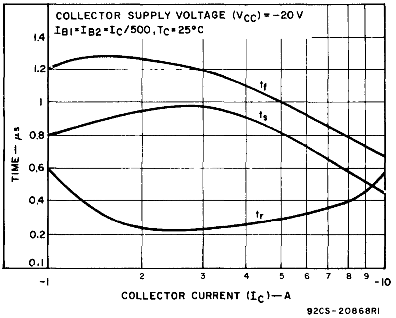


Fig. 11 — Typical saturated switching-time characteristics for all types.

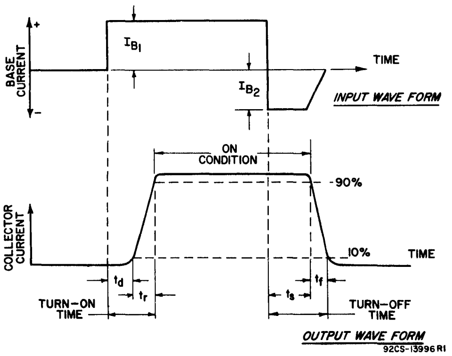


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching.

BDX53, BDX53A, BDX53B, BDX53C

File Number **1213**

8-Ampere N-P-N Darlington Power Transistors

45-60-80-100 Volts, 60 Watts
Gain of 750 at 3 A

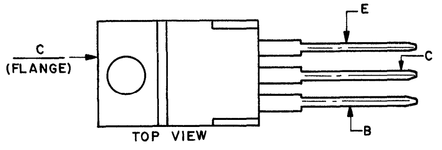
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-BDX53, BDX53A, BDX53B, and BDX53C monolithic silicon Darlington transistors are 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.

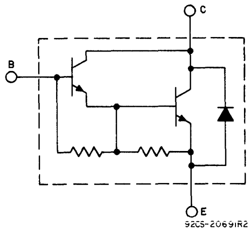


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX53	BDX53A	BDX53B	BDX53C	
V_{CBO}	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					
$T_C \leq 25°C$		60			W
$T_C > 25°C$		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*

CHARACTERSTIC	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			0	—	500	—	—	μA
		30			0	—	—	—	500	
I_{CBO}	45					—	200	—	—	
	60					—	—	—	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]		—	1.8	—	1.8	
				8[b]		2.5[c]	—	2.5[c]	—	
$R_{\theta JC}$						—	2.08	—	2.08	°C/W

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.5%. [b] I_F value. [c] Typical value.

ELECTRTICAL CHARACTERICS, *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			0	—	500	—	—	μA
		50			0	—	—	—	500	
I_{CBO}	80					—	200	—	—	
	100					—	—	—	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]		—	1.8	—	1.8	
				8[b]		2.5[c]	—	2.5[c]	—	
$R_{\theta JC}$						—	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

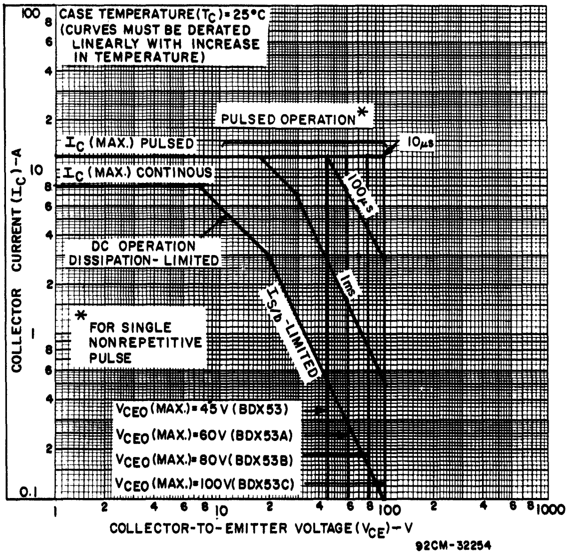


Fig. 2—Maximum operating areas for all types.

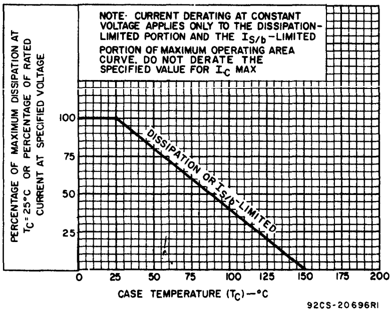


Fig. 3—Derating curve for all types.

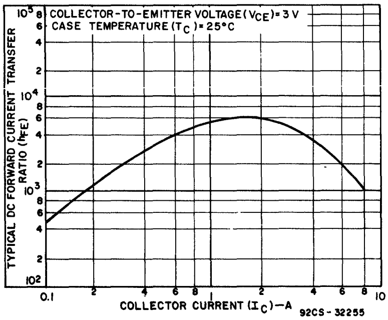


Fig. 4—Typical dc-beta characteristics for all types.

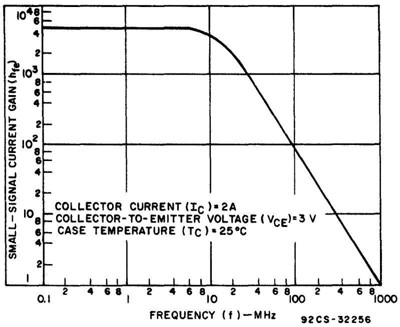


Fig. 5—Typical small-signal gain for all types.

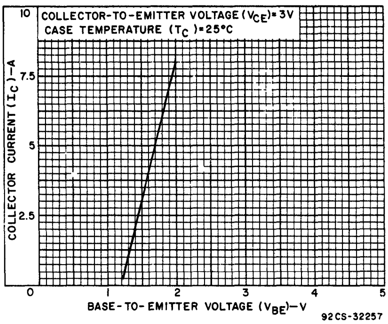


Fig. 6—Typical transfer characteristics for all types.

BDX53, BDX53A, BDX53B, BDX53C

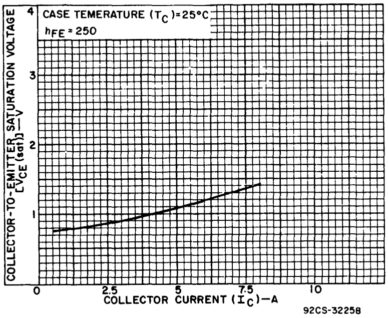


Fig. 7—Typical saturation characteristics for all types.

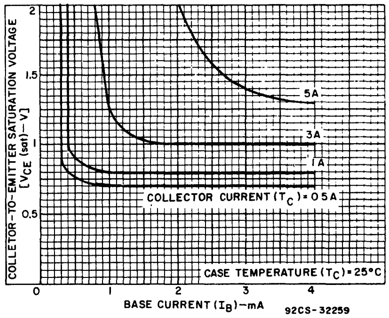


Fig. 8—Typical saturation characteristics for all types.

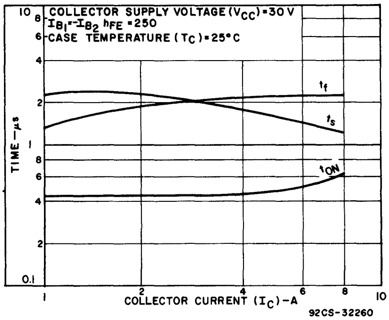


Fig. 9—Typical saturated switching-time characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C File Number **955**

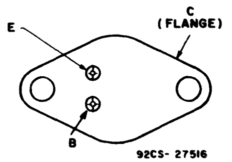
15-Ampere N-P-N Darlington Power Transistors

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



JEDEC TO-204AA

The RCA-BDX83, BDX83A, BDX83B, and BDX83C 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.

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

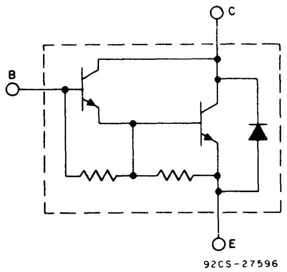


Fig. 1—Schematic diagram for all types.

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					
$T_C \leqslant 25^oC$	125	125	125	125	W
$T_C > 25^oC$	Derate linearly at 0.714 $W/^oC$				
T_{stg}, T_J	—65 to +200—				^oC
T_L					
At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	—235—				^oC

BDX83, BDX83A, BDX83B, BDX83C

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

CHARAC-TERISTIC SYMBOL	TEST CONDITIONS: VOLTAGE V dc			CURRENT A dc		LIMITS: BDX83		BDX83A		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	20				0	–	1	–	–	
	30				0	–	–	–	1	
I_{CEV}	45		–1.5			–	0.5	–	–	
	60		–1.5			–	–	–	0.5	mA
T_C = 150°C	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	
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	–	–	–	
	50					–	–	0.9	–	A
	30					4.16	–	4.16	–	
$R_{\theta JC}$						–	1.4	–	1.4	°C/W

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

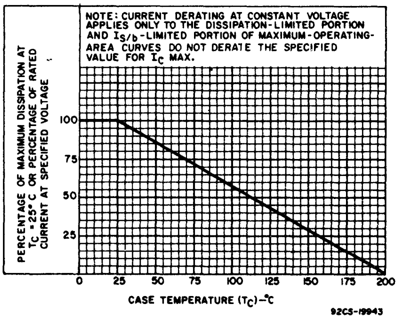


Fig. 2—Derating curves for all types.

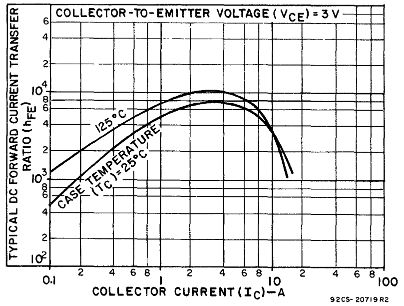


Fig. 3 — Typical dc-beta characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

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

CHARACTERISTIC SYMBOL	TEST CONDITIONS: VOLTAGE V dc			CURRENT A dc		LIMITS: BDX83B		BDX83C		UNITS
	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°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	
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

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

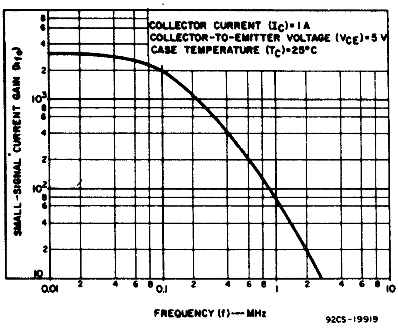


Fig. 4 — Typical small-signal gain for all types.

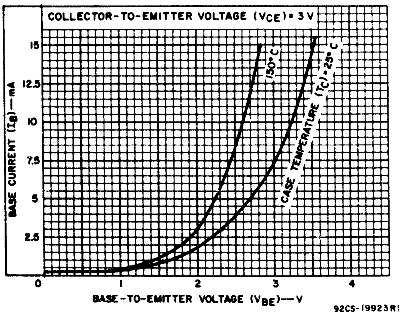


Fig. 5 — Typical input characteristic for all types.

BDX83, BDX83A, BDX83B, BDX83C

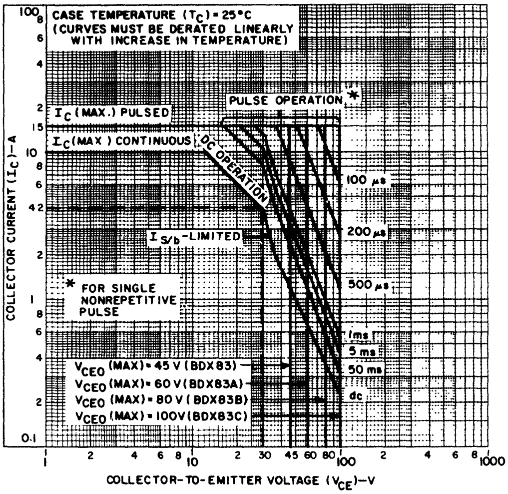


Fig. 6 — Maximum operating area for all types.

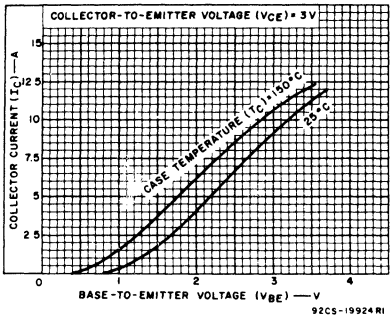


Fig. 7 — Typical transfer characteristics for all types.

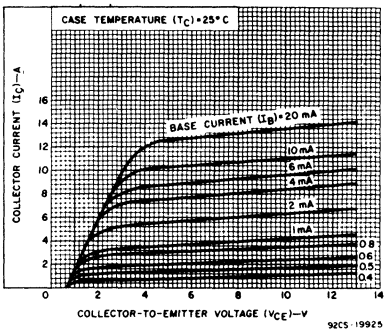


Fig. 8 — Typical output characteristics for all types.

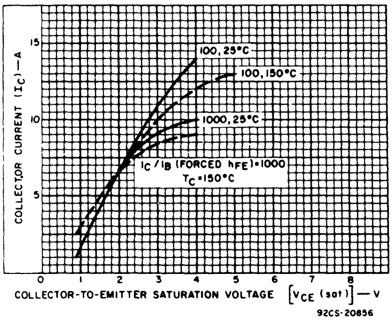


Fig. 9 — Typical saturation characteristics for all types.

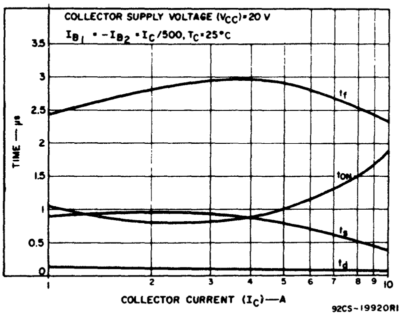


Fig. 10 — Typical saturated switching-time characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

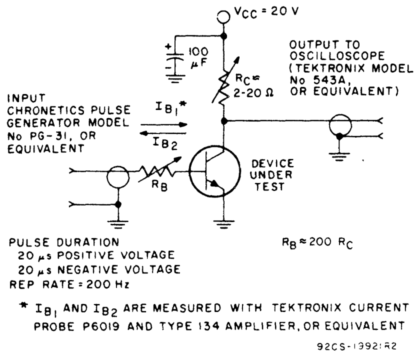


Fig. 11 — Circuit used to measure saturated-switching times.

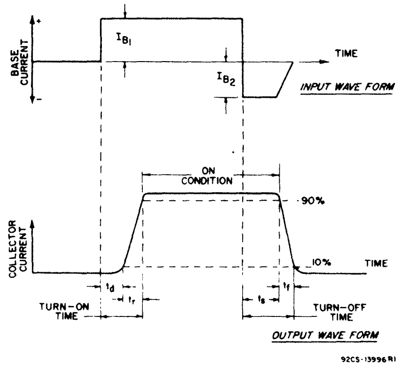


Fig. 12 — Phase relationship between input current and output current showing reference points for specification of switching times.

File Number **1312**

BU323, BU323A

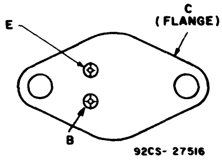
10-Ampere N-P-N Monolithic Darlington Power Transistors

350, 400 Volts, 175 Watts
Gain of 150 at 6 A

Features:
- *Operates from IC without predriver*
- *High voltage breakdown*
- *High reverse second-breakdown capability*

Applications:
- *Power switching*
- *Solenoid drivers*
- *Automotive ignition*
- *Series and shunt regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The BU323 and BU323A are monolithic n-p-n silicon Darlington transistors designed for automotive electronic power applications..

These dèvices provide good forward and reverse second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

The BU323 and BU323A are supplied in the JEDEC TO-204AA hermetic steel package.

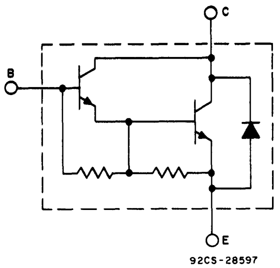


Fig. 1-Schematic diagram for both types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BU323	BU323A	
V_{CBO}	500	600	V
$V_{CER}(sus)$			
R_{BE}=100 Ω	400	475	V
$V_{CEO}(sus)$	350	400	V
V_{EBO}	8	8	V
I_C	10	10	A
I_{CM}	16	16	A
I_B	3	3	A
P_T			
$T_C \leq 25°C$	175	175	W
$T_C > 25°C$	See Fig. 2		
T_{stg}, T_J	-65 to +200		°C
T_L			
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235		°C

BU323, BU323A

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BU323		BU323A		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER}	400				—	1	—	—	mA
R_{BE}=100 Ω	475				—	—	—	1	
I_{EBO}		-6	0		—	40	—	40	
I_{CBO}	500[b]				—	1	—	—	
	600[b]				—	—	—	1	
V_{CER}(sus) R_{BE}=100 Ω L=500 μH			4		400	—	475	—	V
V_{CEO}(sus)			0.2[a]	0	350	—	400	—	
h_{FE}	6		3[a]		300	—	300	—	
	6		6[a]		150	2000	150	2000	
	6		10[a]		50	—	50	—	
V_{CE}(sat)			3[a]	0.06[a]	—	1.5	—	1.5	V
			6[a]	0.12[a]	—	1.7	—	1.7	
			10[a]	0.30[a]	—	2.7	—	2.7	
T_C=-40° C			6[a]	0.12[a]	—	2.0	—	2.0	
V_{BE}(sat)			6[a]	0.12	—	2.2	—	2.2	V
			10[a]	0.30	—	3	—	3	
T_C=-40° C			6[a]	0.12	—	2.4	—	2.4	
V_{BE}(On)	6		10[a]		—	2.5	—	2.5	
V_F			10[a]		—	3.5	—	3.5	
C_{ob} f=100 kHz	10[b]				—	350	—	350	pF
$I_C{}^2L/2$ (See Fig. 9)					550	—	550	—	mJ
t_s I_{B1}=I_{B2}	12[c]		6	0.3	—	15	—	15	μs
t_f I_{B1}=I_{B2}	12[c]		6	0.3	—	15	—	15	
$\|h_{fe}\|$ f=1 MHz	5		1		10	—	10	—	
$I_{S/b}$ t=1 s, nonrep.	50				3.5	—	3.5	—	A
$R_{\theta JC}$					—	1	—	1	°C/W

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

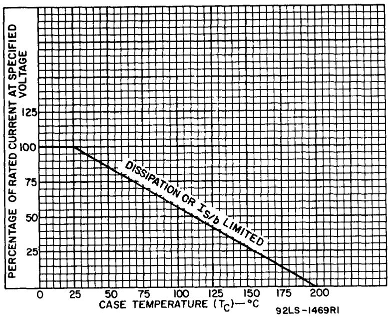


Fig. 2 — Dissipation derating curve for both types.

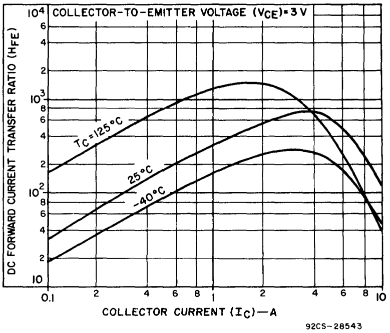


Fig. 3 — Typical DC beta characteristics for both types.

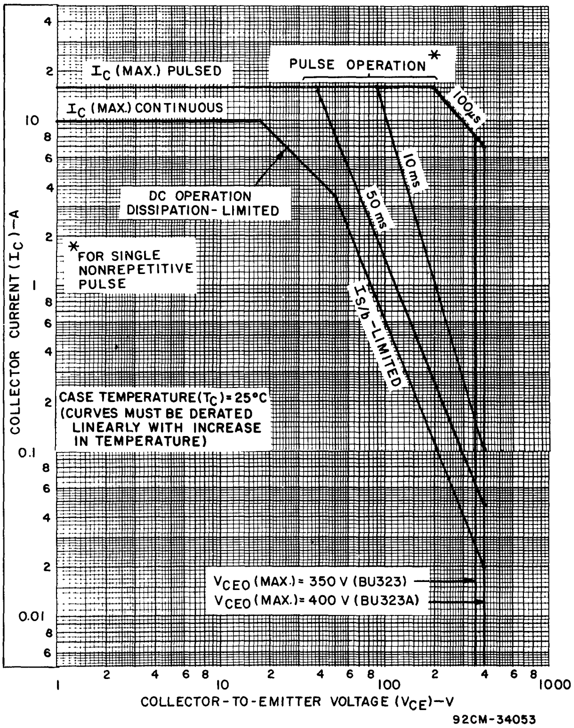


Fig. 4 — Maximum operating areas for both types.

BU323, BU323A

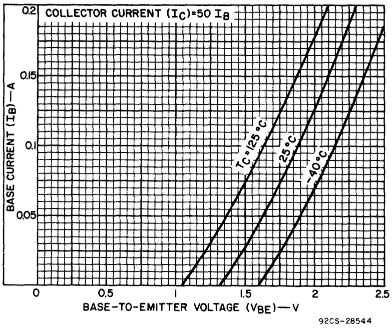


Fig. 5 — Typical input characteristics for both types.

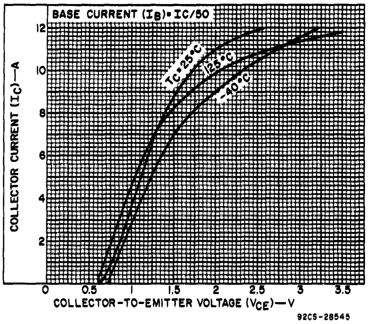


Fig. 6 — Typical output characteristics for both types.

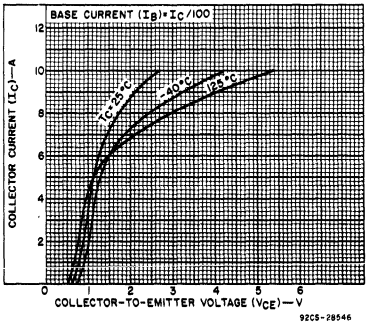


Fig. 7 — Typical output characteristics for both types.

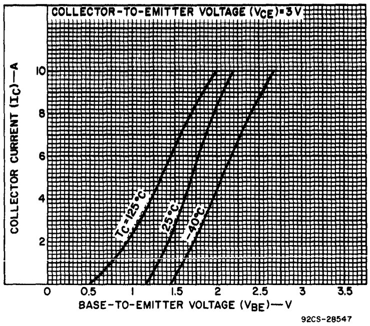


Fig. 8 — Typical transfer characteristics for both types.

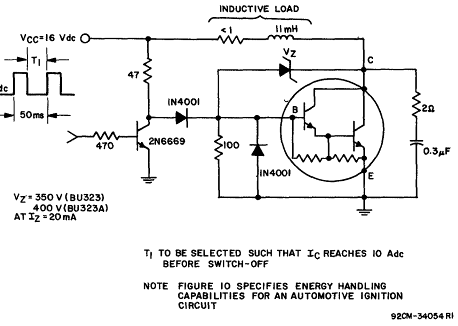


Fig. 9 — Ignition test circuit.

File Number **1243**

BUX37

15-Ampere N-P-N Monolithic Darlington Power Transistor

400 V , 35 W
Gain of 20 at 15A

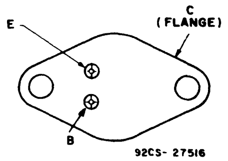
Features:

- *High voltage breakdown*

Applications:

- *Power switching*
- *Solenoid drivers*
- *Automotive Ignition*
- *Series and shunt regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-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 RCA-BUX37 is supplied in the steel JEDEC TO-204AA hermetic package.

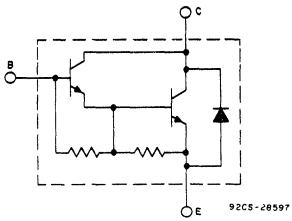


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

$V_{CEO}(sus)$	400	V
V_{EBO}	7	V
I_C	15	A
I_B	4	A
P_T		
$T_C \leq 100°C$	35	W
$T_C > 100°C$	Derate Linearly 0.7	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

BUX37

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	—	V
h_{FE}	5		15[a]		20	—	
$V_{BE}(sat)$			10[a]	0.15	—	2.7	V
T_C = −40°C			10[a]	0.15	—	3.5	V
$V_{CE}(sat)$			7[a]	0.07	—	1.5	V
			10[a]	0.15	—	2	V
T_C = −40°C			10[a]	0.15	—	2.9	V
$R_{\theta JC}$					—	1.5	°C/W

[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.

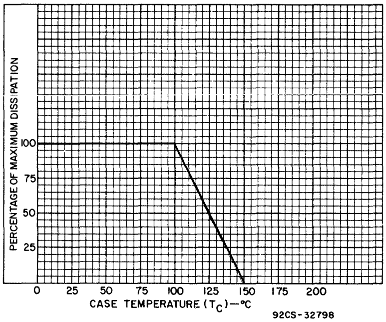


Fig. 2 — Derating curve.

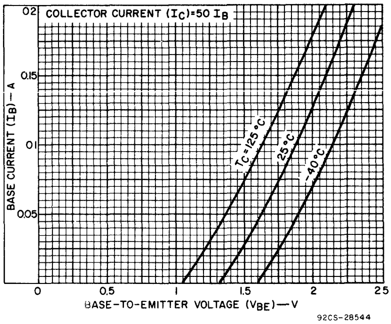


Fig. 3 — Typical input characteristics.

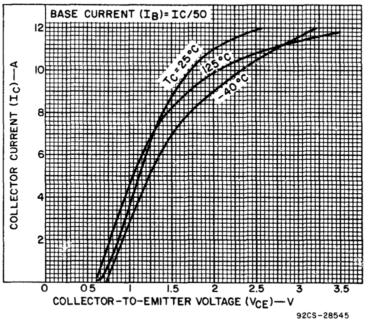


Fig. 4 — Typical output characteristics.

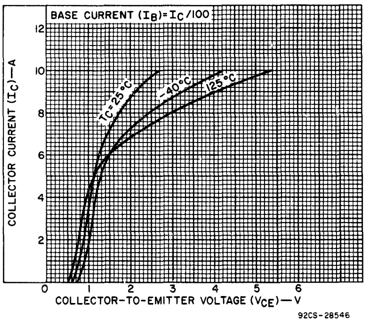


Fig. 5 — Typical output characteristics.

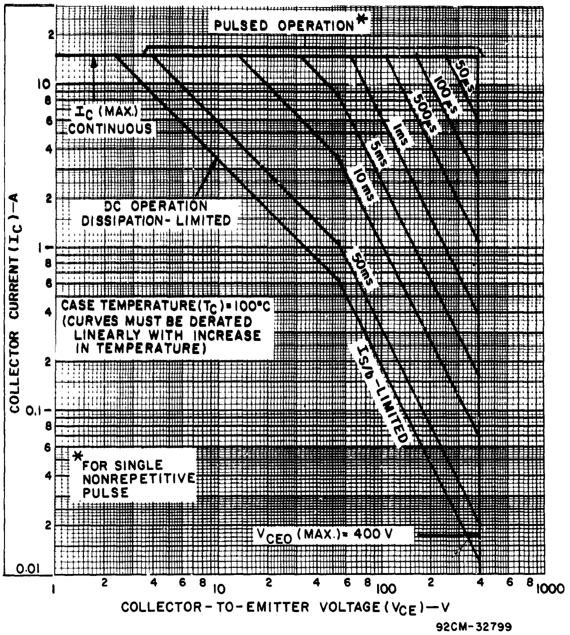


Fig. 6 — Maximum operating areas (T_C = 100° C).

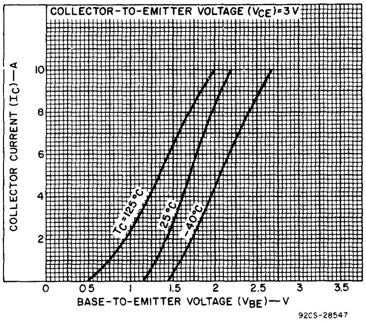


Fig. 7 — Typicai transfer characteristics.

RCA1000, RCA1001 File Number **594**

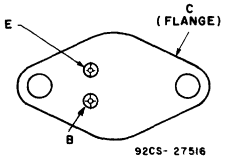
8-Ampere Silicon N-P-N Darlington Power Transistors

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**

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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.

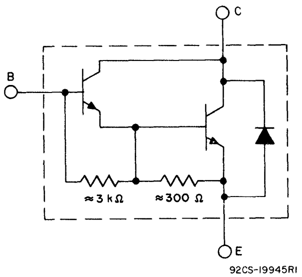


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		RCA-1000	RCA-1001	
COLLECTOR-TO-BASE VOLTAGE:				
With emitter open	V_{CBO}	60	80	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With base open	V_{CEO}	60	80	V
EMITTER-TO-BASE VOLTAGE:				
With collector open	V_{EBO}	5	5	V
COLLECTOR CURRENT:	I_C			
Continuous		8	8	A
Pulsed		15	15	A
BASE CURRENT (Continuous)	I_B	0.1	0.1	A
TRANSISTOR DISSIPATION:	P_T			
At case temperatures up to 25°C		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 ≥ 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: DC VOLTAGE (V) V_{CB}	V_{CE}	V_{BE}	DC CURRENT (A) I_C	I_B	LIMITS: RCA 1000 MIN.	RCA 1000 MAX.	RCA 1001 MIN.	RCA 1001 MAX.	UNITS
Collector Cutoff Current: With base open	I_{CEO}		30			0	–	500	–	–	μA
			40			0	–	–	–	500	
With external base-to-emitter resistance (R_{BE}) = 1 kΩ	I_{CER}	60					–	1	–	–	mA
		80					–	–	–	1	
At T_C = 150°C		60					–	5	–	–	
		80					–	–	–	5	
Emitter Cutoff Current	I_{EBO}			5	0		–	2	–	2	mA
Collector-to-Emitter Breakdown Voltage	$V_{(BR)CEO}$				0.1[a]	0	60	–	–	–	V
					0.1[a]	0	–	–	80	–	
DC Forward Current Transfer Ratio	h_{FE}		3		3		1000	–	1000	–	
			3		4		750	–	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]	0.012	–	2	–	2	V
					8[a]	0.04	–	4	–	4	
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	1.94	–	1.94	°C/W

[a] Pulsed: Pulse duration ≤ 300 μs, duty factor ≤ 2%.

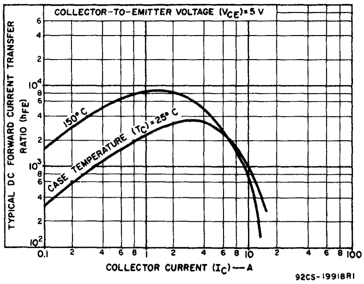


Fig. 2 — Typical dc beta characteristics for both types.

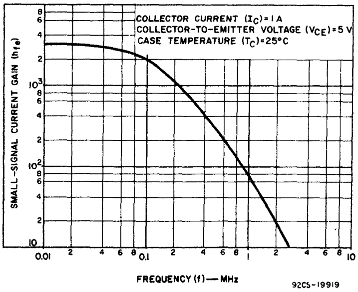


Fig. 3 — Typical small-signal gain for both types.

RCA1000, RCA1001

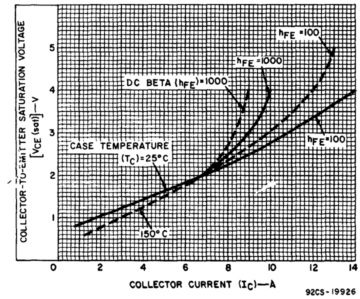


Fig. 4 — Typical saturation characteristics for both types.

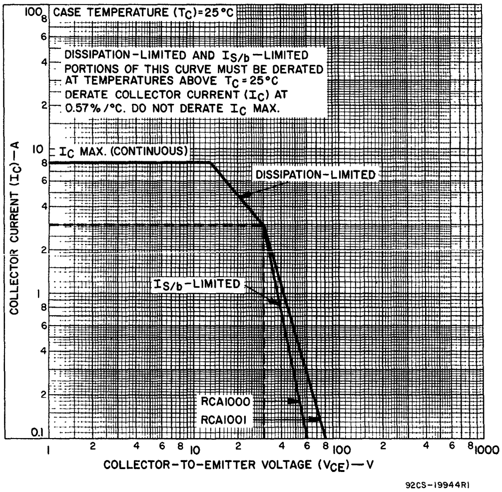


Fig. 5 — DC safe-area-of-operation for both types.

File Number **973**

RCA8766 Series

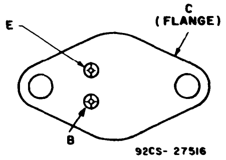
10-Ampere N-P-N Monolithic Darlington Power Transistors

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**
- **Solenoid drivers**
- **Automotive Ignition**
- **Series and shunt regulators**

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-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.

•Formerly RCA Dev. Nos. TA8766 Series.

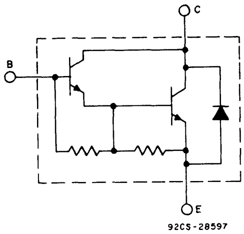


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA8766 RCA8766A	RCA8766B RCA8766C	RCA8766D RCA8766E	
V_{CBO}	350	400	450	V
$V_{CER}(sus)$				
R_{BE} = 50 Ω	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				
$T_C \leq 25°C$	150	150	150	W
$T_C > 25°C$		See Fig. 2		
T_{stg}, T_J		−65 to +175		°C
T_L				
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.		235		°C

RCA8766 Series

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

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE V dc	CURRENT A dc		RCA8766 RCA8766A		RCA8766B RCA8766C		RCA8766D RCA8766E		
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 50 Ω	350			–	1	–	–	–	–	mA
	400			–	–	–	1	–	–	
	450			–	–	–	–	–	1	
T_C = 150°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 MHz	5	1		10	–	10	–	10	–	
$I_{S/b}$ t = 1 s, nonrep.	30			5	–	5	–	5	–	A
$R_{\theta JC}$				–	1	–	1	–	1	°C/W

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

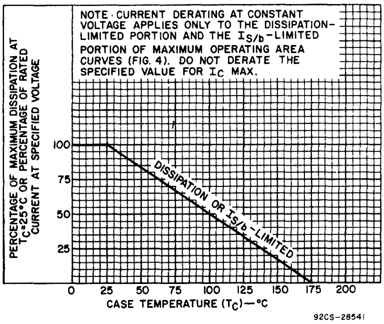


Fig. 2 — Derating curves for all types.

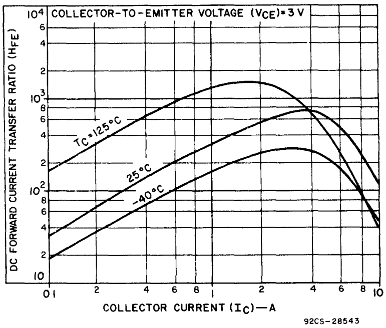


Fig. 3 — Typical DC beta characteristics for all types.

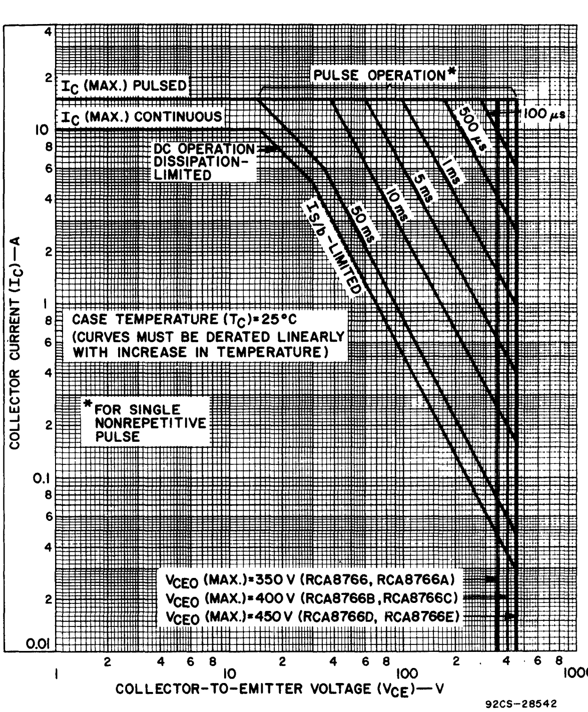


Fig. 4 — Maximum operating areas for all types.

RCA8766 Series

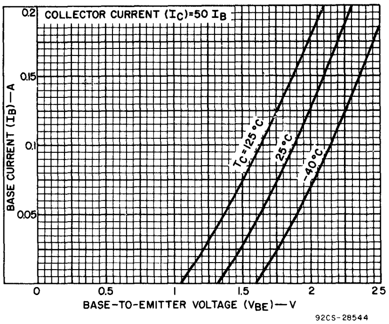


Fig. 5 — Typical input characteristics for all types.

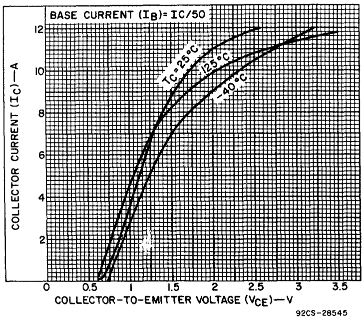


Fig. 6 — Typical output characteristics for all types.

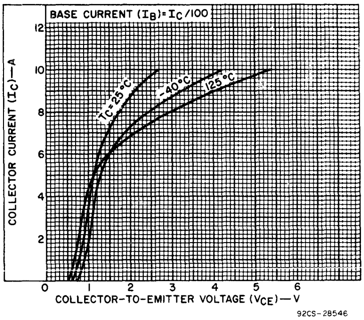


Fig. 7 — Typical output characteristics for all types.

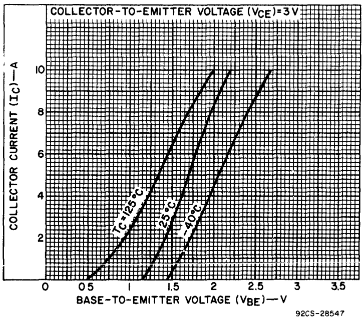


Fig. 8 — Typical transfer characteristics all types.

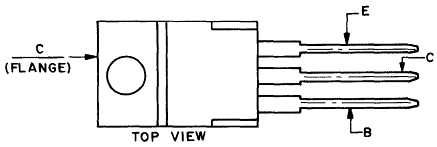
File Number **1414**

RCA9202A, RCA9202B, RCA9202C

4-Ampere N-P-N Darlington Power Transistors

300, 350 and 400 Volts, 65 Watts, Gain of 750 at 2A

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

Features

- *Direct IC input without predriver*
- *Low leakage at high temperature*
- *Hard glass passivation*
- *Wire bonded construction*

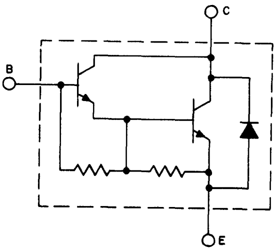
Applications

- *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 (VERSAWATT) plastic package.

●Formerly RCA Dev. No. TA9202A, TA9202B and TA9202C, respectively.



92CS-28597

Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA9202A	RCA9202B	RCA9202C	UNITS
V_{CBO}	300	350	400	V
$V_{CEO}(sus)$	300	350	400	V
V_{EBO}	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
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 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_{CBO} $I_E = 0$	300[a]	—	—	—	—	0.2	—	—	—	—	
	350[a]	—	—	—	—	—	—	0.2	—	—	
	400[a]	—	—	—	—	—	—	—	—	0.2	
I_{CEO}	250	—	—	0	—	0.5	—	—	—	—	mA
	300	—	—	0	—	—	—	0.5	—	—	
	350	—	—	0	—	—	—	—	—	0.5	
I_{EBO}	—	-5	0	—	—	10	—	10	—	10	mA
$V_{CEO}(sus)$[c]	—	—	.03[b]	0	300	—	350	—	400	—	V
h_{FE}	3.0	—	2[b]	—	750	—	750	—	750	—	
	3.0	—	3[b]	—	—	—	—	—	500	—	
	3.0	—	4[b]	—	500	—	500	—	250	—	
V_{BE}	3.0	—	4[b]	—	—	2.5	—	2.5	—	2.5	V
$V_{CE}(sat)$	—	—	2b	.1	—	1.5	—	1.5	—	1.5	V
	—	—	3b	.15	—	1.5	—	1.5	—	1.5	
	—	—	4b	.2	—	1.5	—	1.5	—	1.5	
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
$R_{\theta JC}$	—	—	—	—	—	1.92	—	1.92	—	1.92	°C/W

[a]V_{CB} value.
[b]Pulsed, pulse duration = 300 μs, duty factor $\leq$ 2%.
[c]Caution: Sustaining voltage, $V_{CEO}(sus)$, must not be measured on a curve tracer.

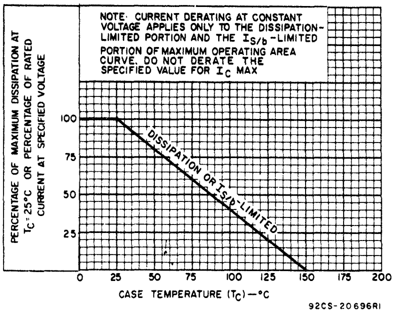


Fig. 2 - Derating curve for all types.

RCA9202A, RCA9202B, RCA9202C

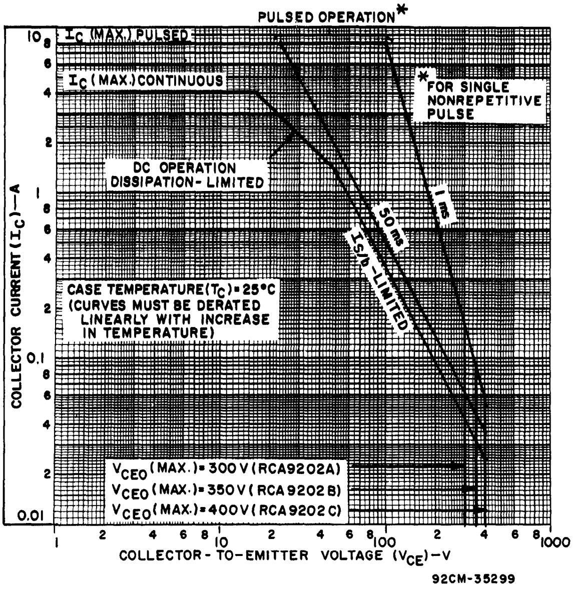


Fig. 3 - Maximum operating areas for all types.

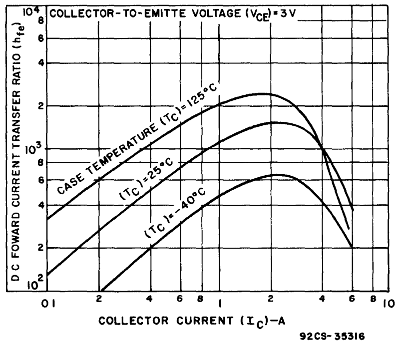


Fig. 4 - Typical dc beta characteristics for all types.

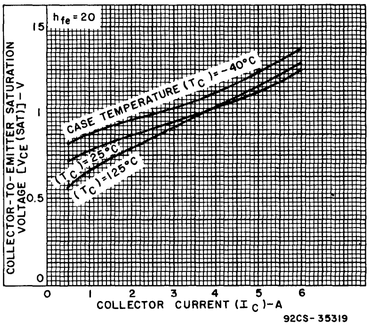


Fig. 5 - Typical saturation characteristics for all types.

RCA9202A, RCA9202B, RCA9202C

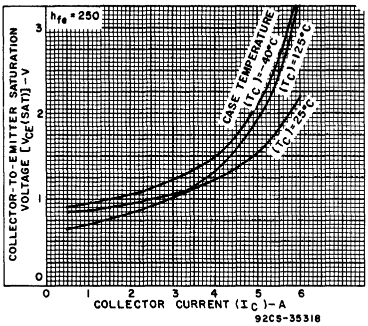


Fig. 6 - Typical saturation characteristics for all types.

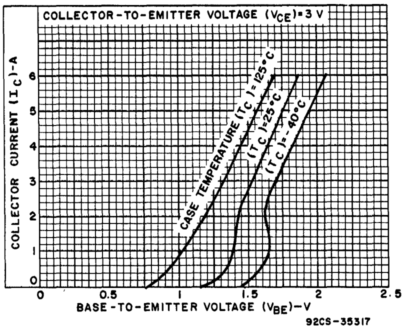


Fig. 7 - Typical transfer characteristics for all types.

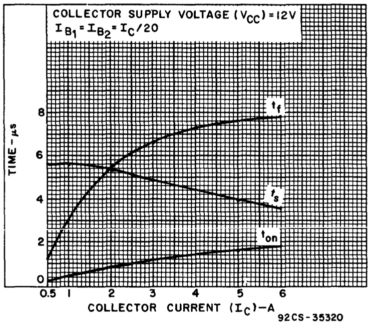


Fig. 8 - Typical saturated switching characteristics for all types.

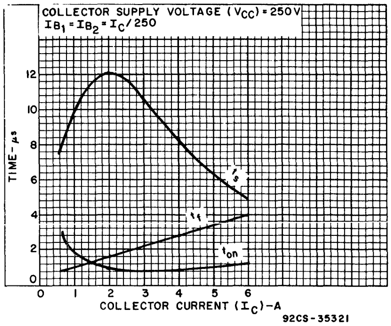


Fig. 9 - Typical saturated switching characteristics for all types.

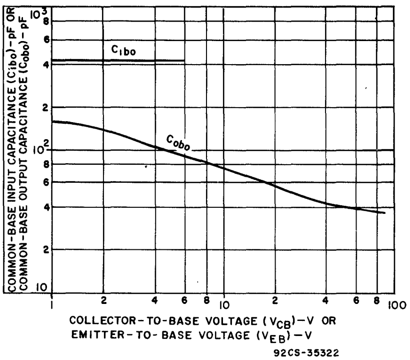


Fig. 10 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics (all types).

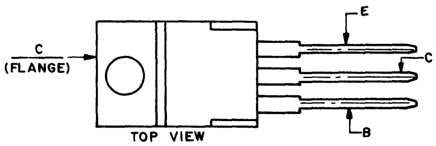
File Number **1413**

RCA9203A, RCA9203B

4-Ampere N-P-N Darlington Power Transistors

250 and 300 Volts, 50 Watts
Gain of 500 at 2 A

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

Features

- *Direct IC input without predriver*
- *No R_2, no anti-parallel diode*
- *Hard glass passivation*
- *Wire bonded construction*

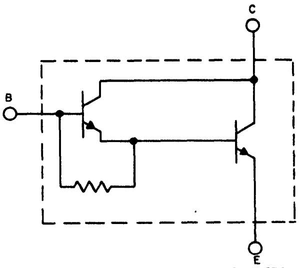
Applications

- *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.



92CS-35324

Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA9203A	RCA9203B	UNITS
V_{CBO}	250	300	V
V_{CEO}(sus)	250	300	V
V_{EBO}	9	9	V
I_C	4	4	A
I_{CM}	6	6	A
I_B	0.25	0.25	A
P_T:			
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}	250[a]	—	—	—	—	0.2	—	—	mA
$I_E = 0$	300[a]	—	—	—	—	—	—	0.2	
I_{CEO}	200	—	—	0	—	0.5	—	—	
	250	—	—	0	—	—	—	0.5	
I_{EBO}	—	-9	0	—	—	1	—	1	mA
$V_{CEO}(sus)$[c]	—	—	.03[b]	0	250	—	300	—	V
h_{FE}	3.0	—	2[b]	—	500	—	500	—	
	3.0	—	4[b]	—	100	—	100	—	
V_{BE}	3.0	—	4[b]	—	—	2.5	—	2.5	V
$V_{CE}(sat)$	—	—	2[b]	.1	—	1.5	—	1.5	V
	—	—	4[b]	.2	—	2.0	—	2.0	
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

[a]V_{CB} value.
[b]Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.
[c]Caution: Sustaining voltage, $V_{CEO}(sus)$, must not be measured on a curve tracer.

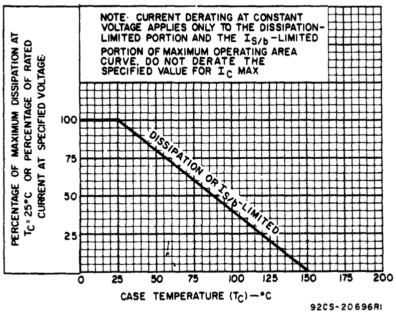


Fig. 2 - Derating curve for all types.

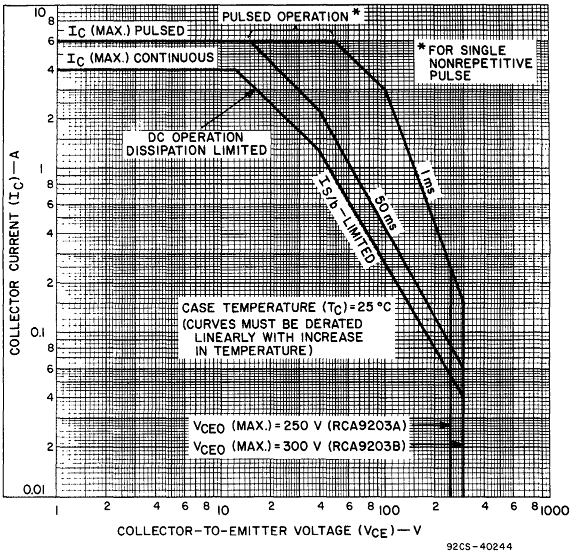


Fig. 3 - Maximum operating areas for all types.

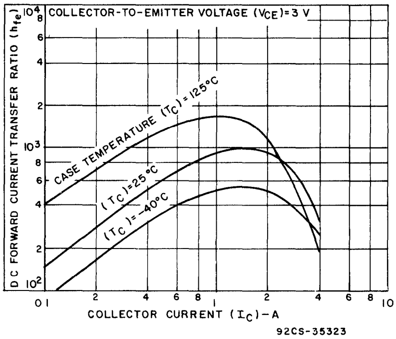


Fig. 4 - Typical dc beta characteristics for all types.

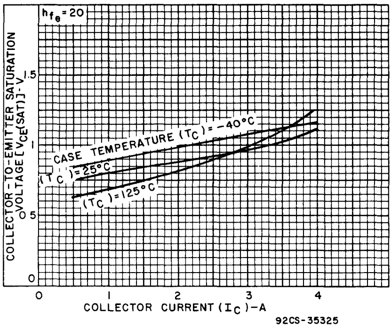


Fig. 5 - Typical saturation characteristics for all types.

RCA9203A, RCA9203B

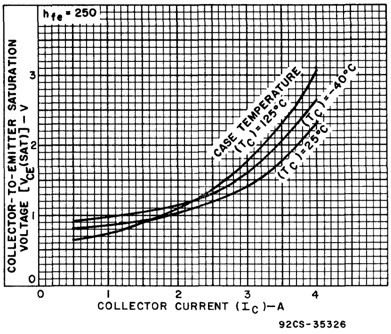


Fig. 6 - Typical saturation characteristics for all types.

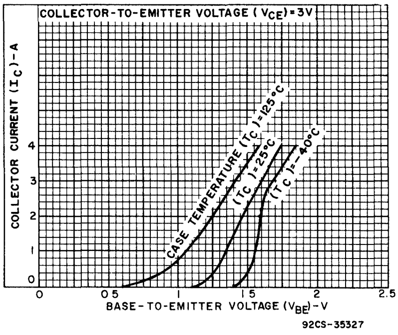


Fig. 7 - Typical transfer characteristics for all types.

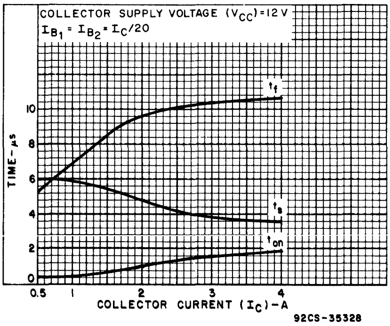


Fig. 8 - Typical saturated switching characteristics for all types.

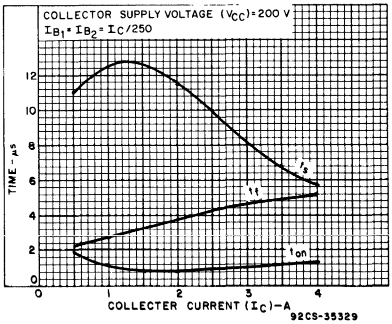


Fig. 9 - Typical saturated switching characteristics for all types.

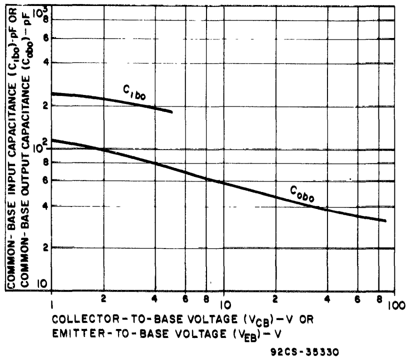


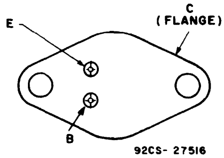
Fig. 10 - Typical common-base input (Cibo) or output (Cobo) capacitance characteristics (all types).

File Number **1448**

RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D

50-A Complementary High Current, Medium Voltage N-P-N and P-N-P Silicon Darlington Power Transistors

TERMINAL DESIGNATIONS



JEDEC TO-204AE
(141 mil diameter pin isolation)

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*

The RCA-9228 Series and the RCA-9229 Series* complementary n-p-n and p-n-p silicon Darlington transistors are 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 RCA9228 and RCA9229 Series were formerly RCA developmental numbers TA9228 and TA9229, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA9228A RCA9229A•	RCA9228B RCA9229B•	RCA9228C RCA9229C•	RCA9228D RCA9229D•	
V_{CBO}	60	80	100	120	V
$V_{CEO}(sus)$	60	80	100	120	V
V_{EBO}	5				V
I_C	50				A
I_B	1				A
P_T					
$T_C \leq 25°C$	300				W
$T_C > 25°C$ ... Derate linearly	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

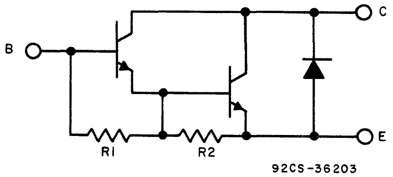


Fig. 1 - Schematic diagram for RCA9228 Series.

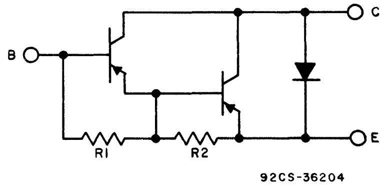


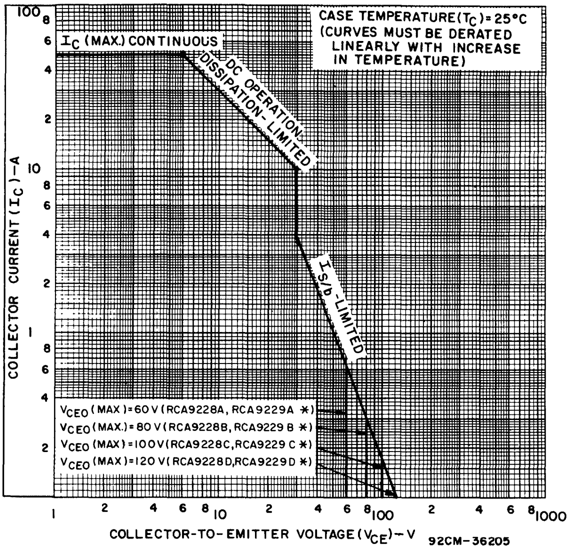
Fig. 2 - Schematic diagram for RCA9229 Series.

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

CHARAC-TERISTIC	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				—	0.5	—	—	—	—	—	—	mA
	70				—	—	—	0.5	—	—	—	—	
	90				—	—	—	—	—	0.5	—	—	
	110				—	—	—	—	—	—	—	0.5	
I_{EBO}		-5			—	5	—	5	—	5	—	5	mA
V_{CEO}	(a)		0.1(b)		60	—	80	—	100	—	120	—	V
h_{FE}	3		25		2000	—	2000	—	2000	—	2000	—	
	3		50		400	—	400	—	400	—	400	—	
V_{BE}(sat)			25	0.1	—	2.5	—	2.5	—	2.5	—	2.5	V
			50	0.2	—	3.5	—	3.5	—	3.5	—	3.5	
V_{CE}(sat)			25	0.1	—	2	—	2	—	2	—	2	V
			50	0.2	—	3	—	3	—	3	—	3	
$I_{S/b}$ t = 0.5 sec.	30				10	—	10	—	10	—	10	—	A
$R_{\theta JC}$					—	0.416	—	0.416	—	0.416	—	0.416	°C/W
Typical Values													
C_{ob}													
V_{CB} = 10 V													
RCA9228 Series					Typ.	300	Typ.	300	Typ.	300	Typ.	300	pF
RCA9229 Series					Typ.	600	Typ.	600	Typ.	600	Typ.	600	
h_{fe} 1 MHz	3		10		Typ.	5	Typ.	5	Typ.	5	Typ.	5	

(a) CAUTION: Sustaining voltage V_{CEO}(sus) MUST NOT be measured on a curve tracer.
(b) Pulsed: Pulse duration = 300 μs, duty factor < 2%.
• For p-n-p devices, voltage and current values are negative.

RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D



*FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

Fig. 3 - Maximum operating areas for all types.

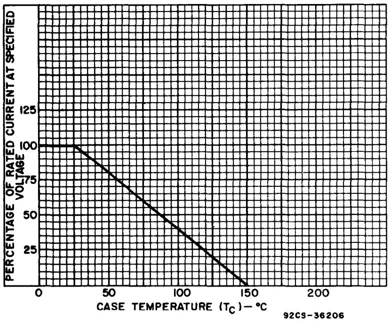


Fig. 4 - Current derating curve for all types.

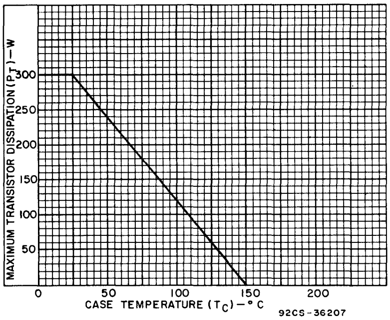


Fig. 5 - Power derating curve for all types.

RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D

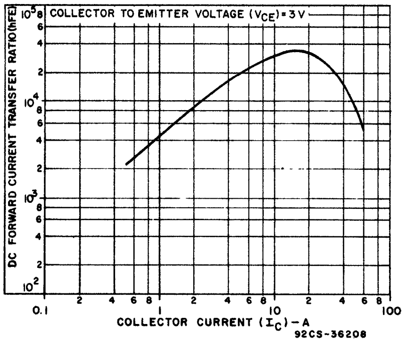


Fig. 6 - Typical dc beta characteristics for RCA9228 Series.

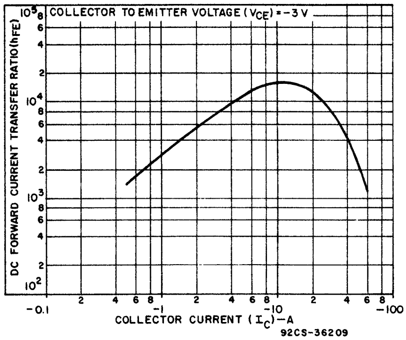


Fig. 7 - Typical dc beta characteristics for RCA9229 Series.

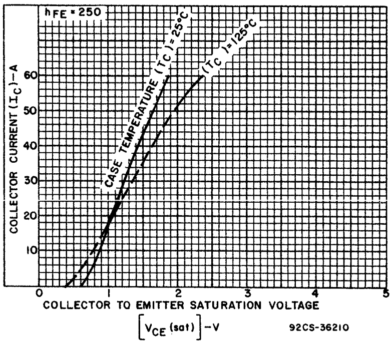


Fig. 8 - Typical saturation characteristics for RCA9228 Series.

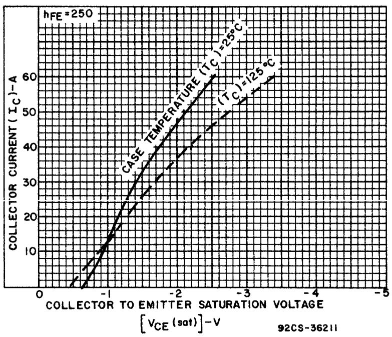


Fig. 9 - Typical saturation characteristics for RCA9229 Series.

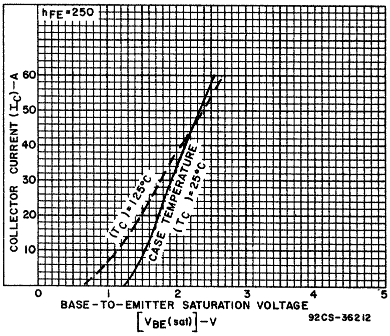


Fig. 10 - Typical saturation characteristics for RCA9228 Series.

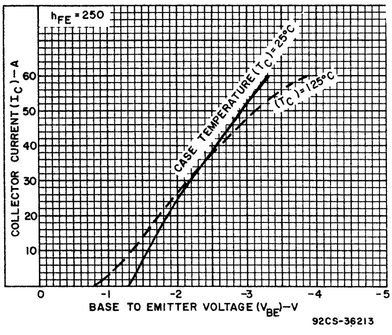


Fig. 11 - Typical saturation characteristics for RCA9229 Series.

File Number **1153**

TIP100, TIP101, TIP102

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 80 Watts
Gain of 1000 at 3 A

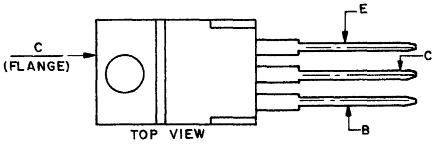
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

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

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

The RCA-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 (VERSAWATT) plastic package.

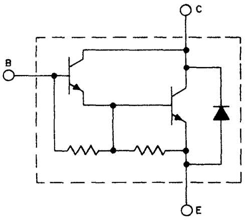


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP100	TIP101	TIP102	
V_{CBO}	60	80	100	V
$V_{CEO}(sus)$	60	80	100	V
V_{EBO}		5		V
I_C		8		A
I_{CM}		15		A
I_B		1		A
P_T:				
T_C up to 25°C		80		W
T_C above 25°C . . . Derate linearly at		0.64		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

TIP100, TIP101, TIP102

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

CHARAC-TERISTIC	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 – –	– – –	– 50 –	– – –	– – 50	μA
I_{CEO}	30 40 50			0 0 0	– – –	50 – –	– – –	– 50 –	– – –	– – 50	
I_{EBO}		–5	0		–	8	–	8	–	8	mA
$V_{CEO}(sus)$			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 ≤2%. [c] V_{CC} = 40 V [d] $I_{B_1} = -I_{B_2}$.

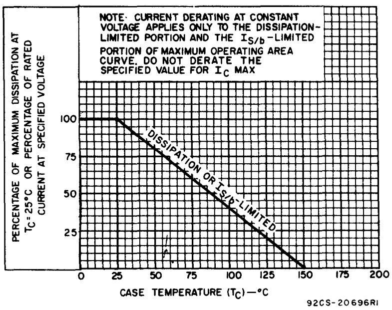


Fig. 2 — Derating curve for all types.

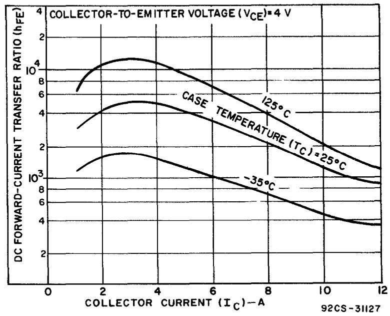


Fig. 3 — Typical dc-beta characteristics for all types.

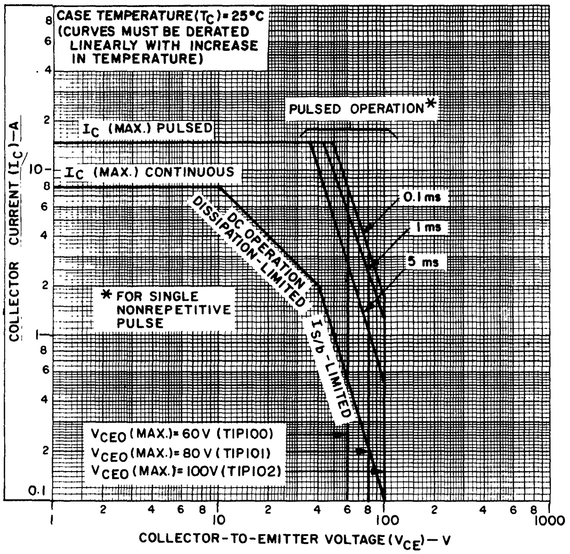


Fig. 4 — Maximum operating areas for all types (T_C = 25°C).

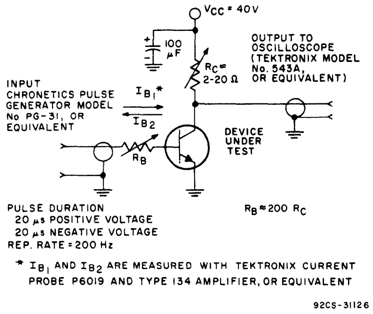


Fig. 5 — Circuit used to measure saturated switching times.

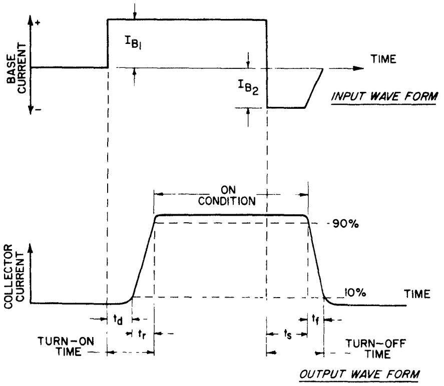


Fig. 6 — Phase relationship between input current and output current showing reference points for specification of switching times.

TIP110, TIP111, TIP112

File Number **1336**

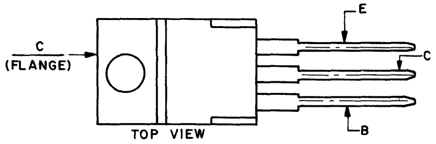
2-Ampere N-P-N Darlington Power Transistors

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 completementary use with TIP-115, 116, and 117*
- *Hard glass passivation*
- *Wire-bonded construction*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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-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.

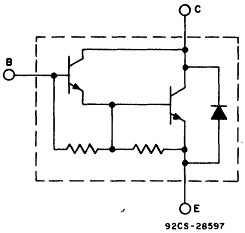


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute Maximum Values:*

	TIP110	TIP111	TIP112	UNITS
V_{CBO}	60	80	100	V
$V_{CEO}(sus)$	60	80	100	V
V_{EBO}		5		V
I_C		2		A
I_{CM}		4		A
I_B		0.05		A
P_T:				
T_C up to 25°C		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.		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]	—	—	—	—	1	—	—	—	—	mA
	80[a]	—	—	—	—	—	—	1	—	—	
	100[a]	—	—	—	—	—	—	—	—	1	
I_{CEO}	30	—	—	0	—	2	—	—	—	—	
	40	—	—	0	—	—	—	2	—	—	
	50	—	—	0	—	—	—	—	—	2	
I_{EBO}	—	-5	0	—	—	2	—	2	—	2	mA
V_{CEO}(sus)	—	—	0.03[b]	0	60	—	80	—	100	—	V
h_{FE}	4	—	1[b]	—	1000	—	1000	—	1000	—	—
	4	—	2[b]	—	500	—	500	—	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
$R_{\theta JC}$	—	—	—	—	—	2.5	—	2.5	—	2.5	°C/W
$R_{\theta JA}$	—	—	—	—	—	62.5	—	62.5	—	62.5	

[a] V_{CB} value. [b] Pulsed: Pulsed duration = 300 μs, duty factor $\leq$2%.

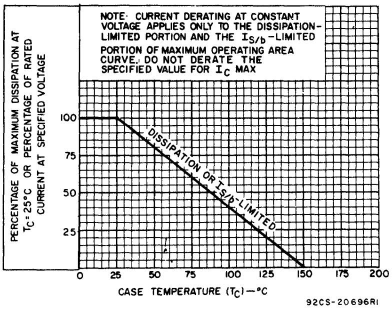


Fig. 2 - Derating curve for all types.

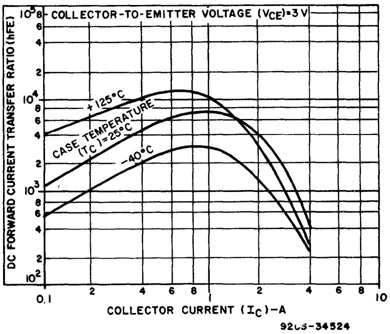


Fig. 3 - Typical dc-beta characteristics for all types.

TIP110, TIP111, TIP112

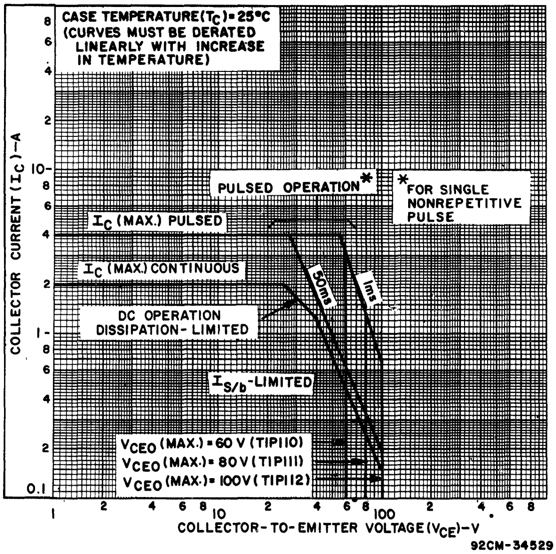


Fig. 4 - Maximum operating areas for all types (T_C = 25° C).

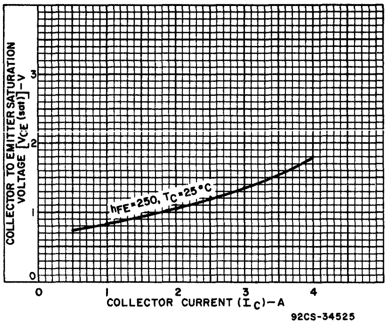


Fig. 5 - Typical saturation characteristics for all types.

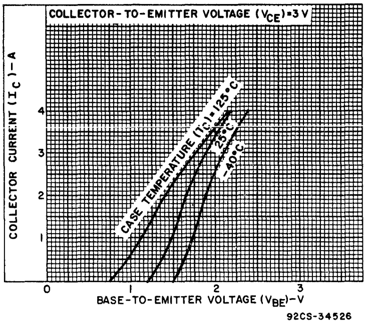


Fig. 6 - Typical transfer characteristics for all types.

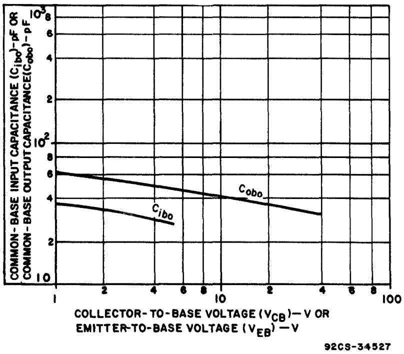


Fig. 7 - Typical common-base input (C_{ibo}) or output (C_{obo}) capaciatance characteristic (all types).

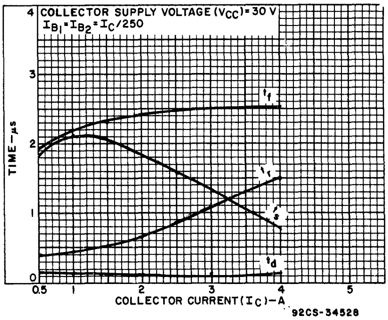


Fig. 8 - Typical saturated switching characteristics (all types).

TIP110, TIP111, TIP112

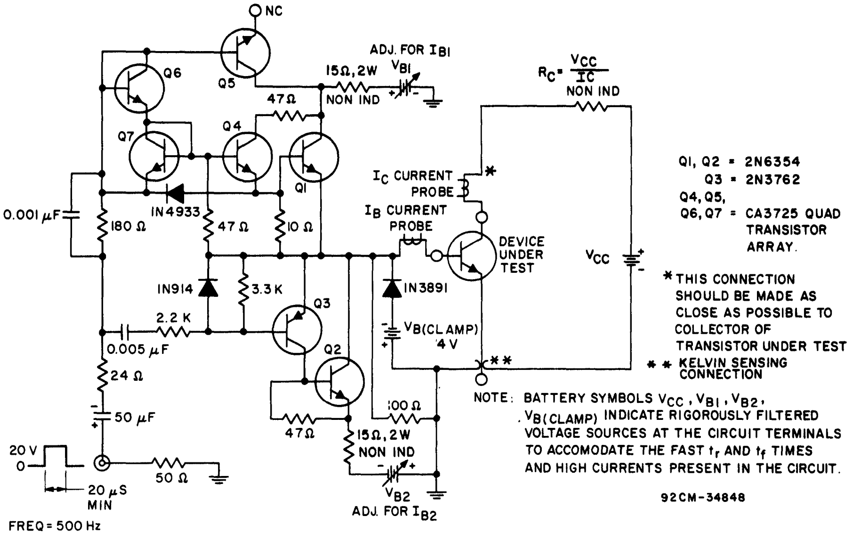
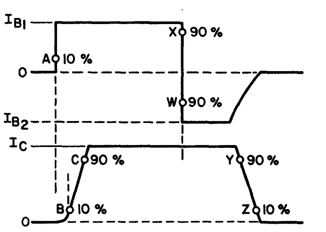


Fig. 9 - Circuit for measuring switching times.



t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W

NOTE: TRANSITION TIME FROM 90% I_{B_1} TO 90% I_{B_2} MUST BE LESS THAN 0.5 μs.

Fig. 10 - Phase relationship between input and output currents showing reference points for specification of switching times.

TIP115, TIP116, TIP117

File Number **1387**

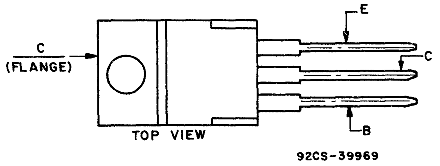
2-Ampere P-N-P Darlington Power Transistors

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 completementary use with TIP110, TIP111 and TIP112*
- *Hard glass passivation*
- *Wire-bonded construction*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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 foward-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.

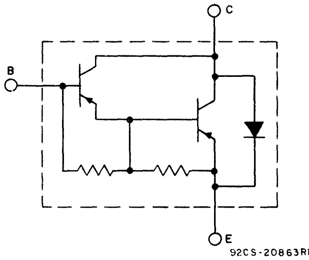


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute Maximum Values:*

	TIP115	TIP116	TIP117	UNITS
V_{CBO}	60	80	100	V
$V_{CEO}(sus)$	60	80	100	V
V_{EBO}		5		V
I_C		2		A
I_{CM}		4		A
I_B		0.05		A
P_T:				
T_C up to 25°C		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.		260		°C

TIP115, TIP116, TIP117

ELECTRICAL CHARACTERISTICS, At Case Temperature (Tc) = 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]	—	—	—	—	-1	—	—	—	—	mA
	-80[a]	—	—	—	—	—	—	-1	—	—	
	-100[a]	—	—	—	—	—	—	—	—	-1	
I_{CEO}	-30	—	—	0	—	-2	—	—	—	—	
	-40	—	—	0	—	—	—	-2	—	—	
	-50	—	—	0	—	—	—	—	—	-2	
I_{EBO}	—	5	0	—	—	-2	—	-2	—	-2	mA
$V_{CEO}(sus)$	—	—	-0.03[b]	0	-60	—	-80	—	-100	—	V
h_{FE}	-4	—	-1[b]	—	1000	—	1000	—	1000	—	—
	-4	—	-2[b]	—	500	—	500	—	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
$R_{\theta JC}$	—	—	—	—	—	2.5	—	2.5	—	2.5	°C/W
$R_{\theta JA}$	—	—	—	—	—	62.5	—	62.5	—	62.5	

[a] V_{CB} value.
[b] Pulsed: Pulsed duration = 300 μs, duty factor $\leq$ 2%.

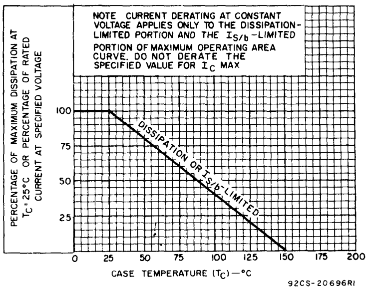


Fig. 2 - Derating curve for all types.

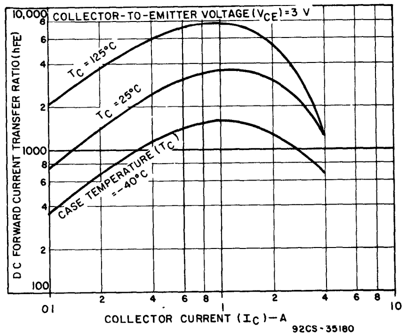


Fig. 3 - Typical dc-beta characteristics for all types.

TIP115, TIP116, TIP117

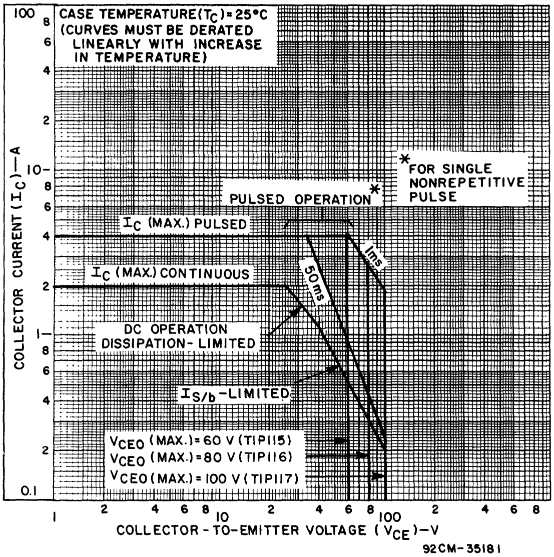


Fig. 4 - Maximum operating areas for all types (Tc = 25° C).

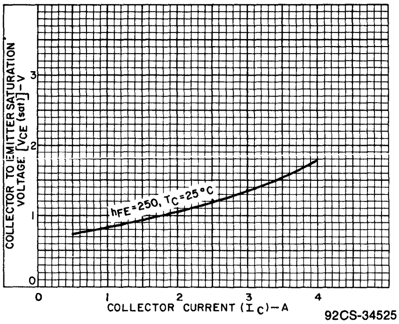


Fig. 5 - Typical saturation characteristics for all types.

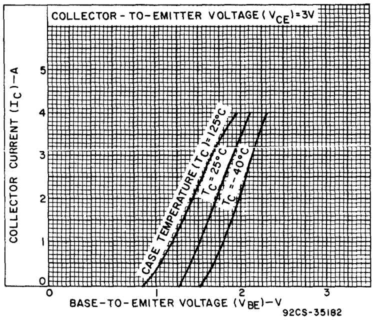


Fig. 6 - Typical transfer characteristics for all types.

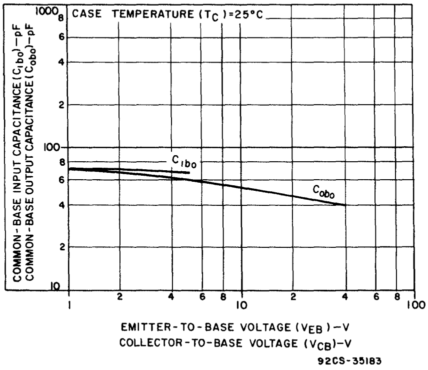


Fig. 7 - Typical common-base input (Cibo) or output (Cobo) capaciatance characteristic (all types).

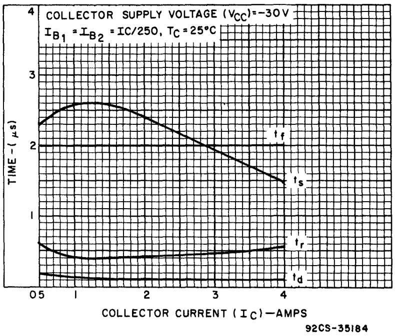


Fig. 8 - Typical saturated switching characteristics (all types).

TIP115, TIP116, TIP117

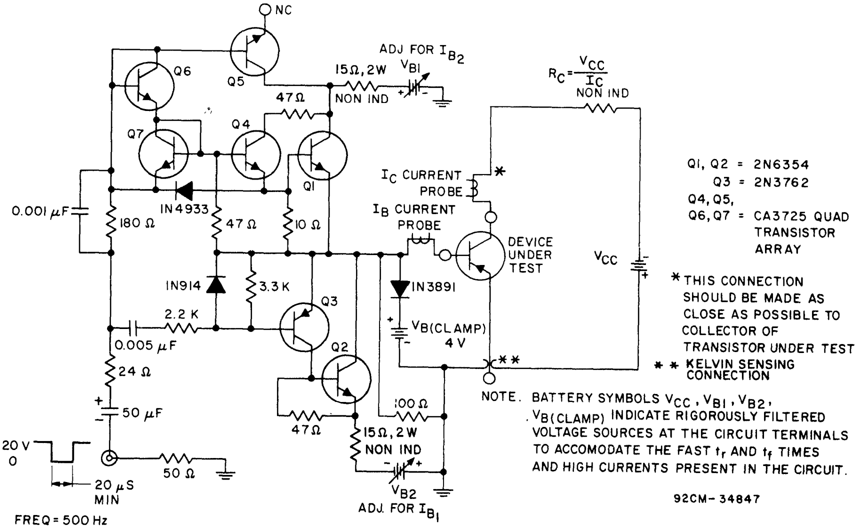
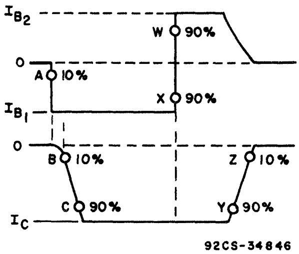


Fig. 9 - Circuit for measuring switching times.



t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W
NOTE: TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} MUST BE LESS THAN 0.5 μs.

Fig. 10 - Phase relationship between input and output currents showing reference points for specification of switching times.

TIP120, TIP121, TIP122

File Number **998**

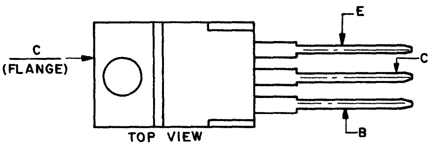
8-Ampere N-P-N Darlington Power Transistors

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**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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 (VERSAWATT) plastic package.

The TIP120, TIP121 and TIP122 are n-p-n complements of the TIP125, TIP126 and TIP127 described in RCA data bulletin File 997.

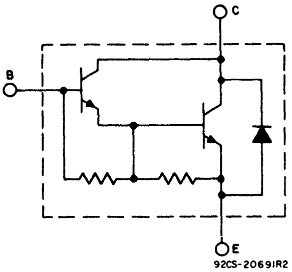


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP120	TIP121	TIP122	
V_{CBO}	60	80	100	V
$V_{CER}(sus)$ R_{RE} = 100 Ω	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 ≥ 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: Voltage V dc		Current A dc		LIMITS: TIP120		TIP121		TIP122		UNITS
	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	–	–	–	–	
	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
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽ 2%.

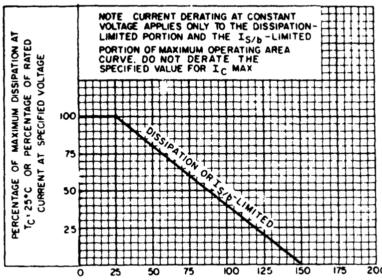


Fig. 2 — Derating curve for all types.

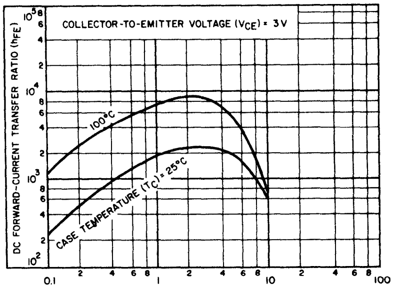


Fig. 3 — Typical dc beta characteristics for all types.

TIP120, TIP121, TIP122

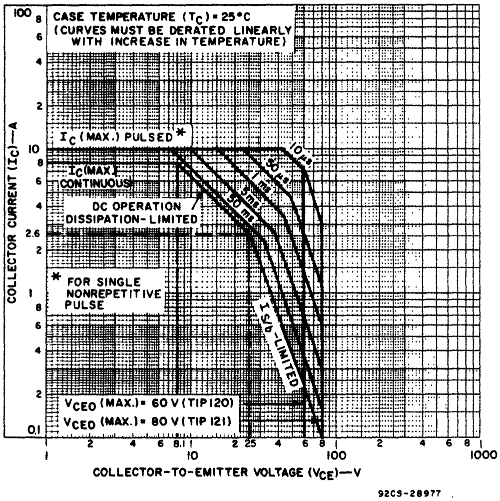


Fig. 4 — Maximum operating areas for TIP120 and TIP121.

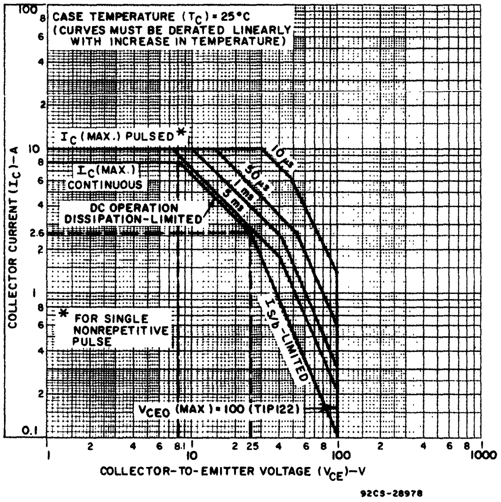


Fig. 5 — Maximum operating areas for TIP122.

TIP120, TIP121, TIP122

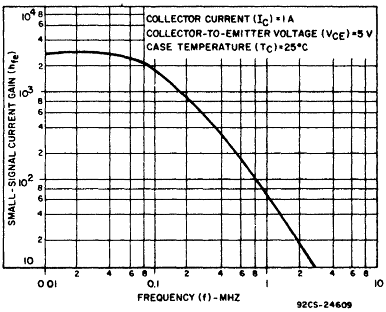


Fig. 6 — Typical small-signal current gain for all types.

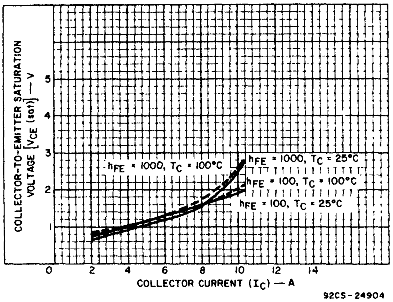


Fig. 7 — Typical saturation characteristics for all types.

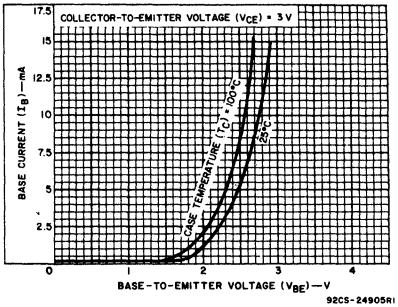


Fig. 8 — Typical input characteristics for all types.

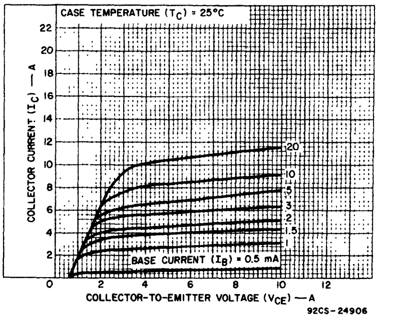


Fig. 9 — Typical output characteristics for all types.

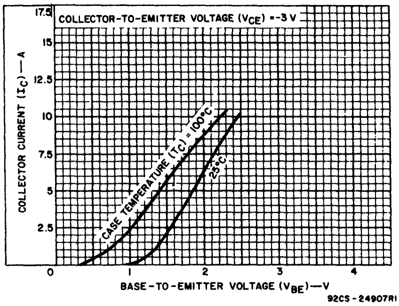


Fig. 10 — Typical transfer characteristics for all types.

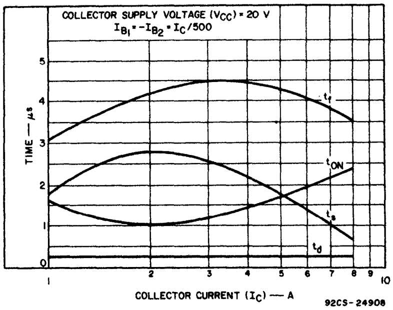


Fig. 11 — Typical saturated switching characteristics for all types.

TIP125, TIP126, TIP127

File Number **997**

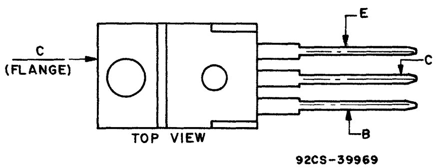
8-Ampere P-N-P Darlington Power Transistors

−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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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 (VERSAWATT) package.

The TIP125, TIP126 and TIP127 are p-n-p complements of the TIP120, TIP121 and TIP122 described in RCA data bulletin File 998.

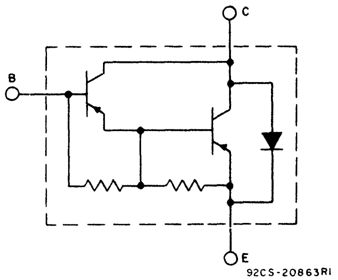


Fig. 1 — Schematic diagram for all types.

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				
$T_C \leq 25°C$	65	65	65	W
$T_C > 25°C$		0.52		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

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%.

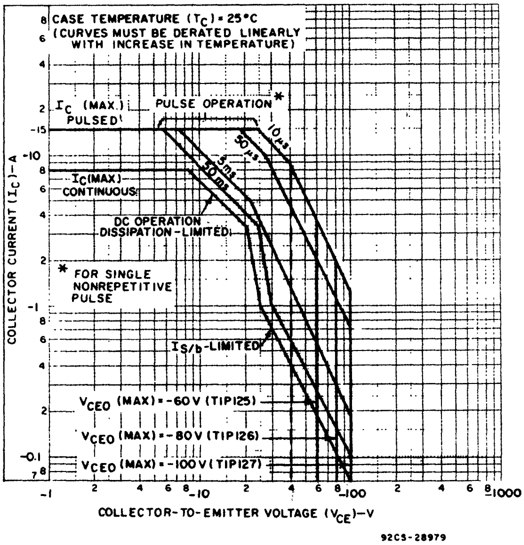


Fig. 2 — Maximum operating areas for all types.

TIP125, TIP126, TIP127

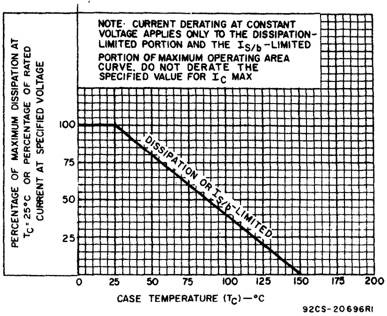


Fig. 3 — Dissipation derating curve for all types.

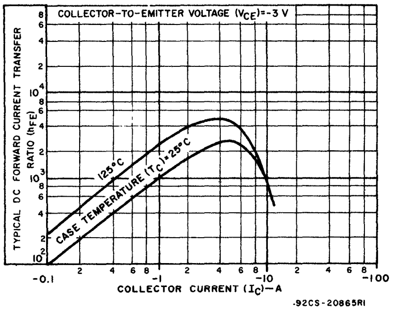


Fig. 4 — Typical dc beta characteristics for all types.

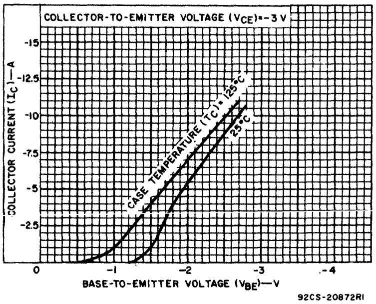


Fig. 5 — Typical transfer characteristics for all types.

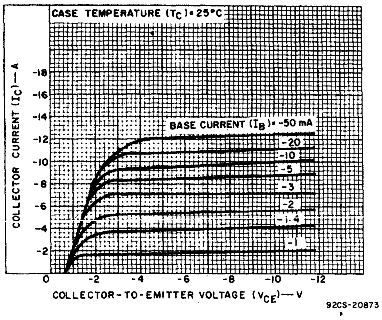


Fig. 6 — Typical output characteristics for all types.

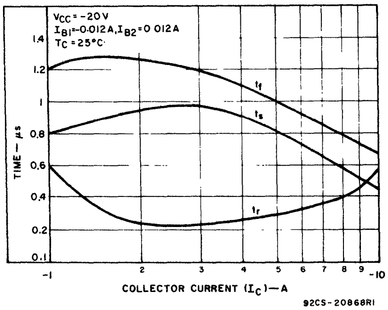


Fig. 7 — Typical saturated switching-time characteristics for all types.

TIP125, TIP126, TIP127

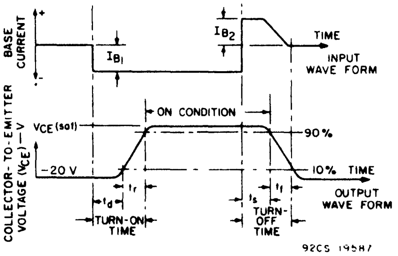


Fig. 8 — Phase relationship between input current and output voltage showing reference points for specification of switching-times.

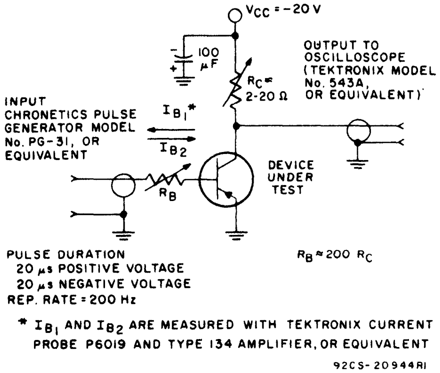


Fig. 9 — Circuit used to measure saturated switching-times.

General-Purpose Power Transistors

Technical Data

2N1479, 2N1480, 2N1481, 2N1482

File Number **135**

Silicon N-P-N Power Transistors

General-Purpose Types for Medium-Power Applications

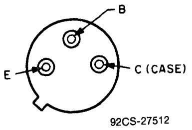
Features:
- *High-temperature characterization*
- *High dc beta at 200 mA*
- *Full switching-time characterization at 200 mA*

RCA-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

Maximum Ratings, *Absolute-Maximum Values:*		2N1479 2N1481	2N1480 2N1482	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	100	V
*COLLECTOR-TO-EMITTER VOLTAGE:				
With base open, sustaining	$V_{CEO}(sus)$	40	55	V
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: (See Rating Chart Fig. 1):	P_T			
At case temperature of 25° C		5	5	W
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:	I_{CBO}	30					0		10		10		10		10	μA
T_C = 150°C		30					0		500		500		500		500	
* Emitter Cutoff Current	I_{EBO}			12	0				10		10		10		10	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		
* 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	20			7		7					Ω
					200	10							7		7	
* 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_{α_b}	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.		μs
Storage Time	t_s•							0.6 Typ.		0.6 Typ.		0.6 Typ.		0.6 Typ.		μs
Fall Time	t_f•							1 Typ.		1 Typ.		1 Typ.		1 Typ.		μs
* Thermal Resistance: Junction-to-case	$R_{\theta JC}$								35		35		35		35	°C/W
Junction-to-free air	$R_{\theta JFA}$								200		200		200		200	°C/W

*In accordance with JEDEC registration data

•I_C = 200 mA, I_{B_1} = 20 mA, I_{B_2} = −8.5 mA; see Figs. 6 and 7.

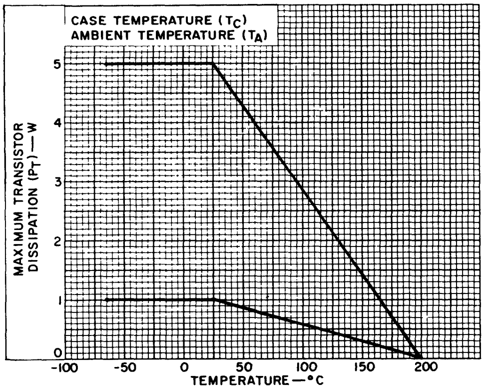


Fig. 1 — Derating chart for all types.

2N1479, 2N1480, 2N1481, 2N1482

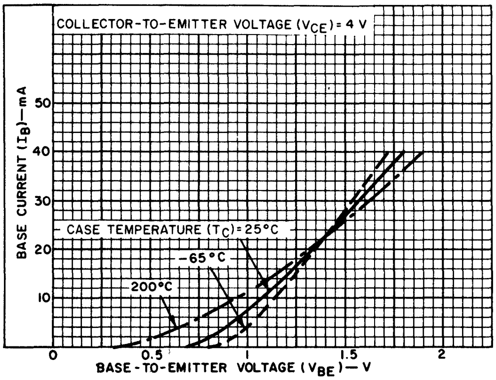


Fig.2 — Typical input characteristics for all types.

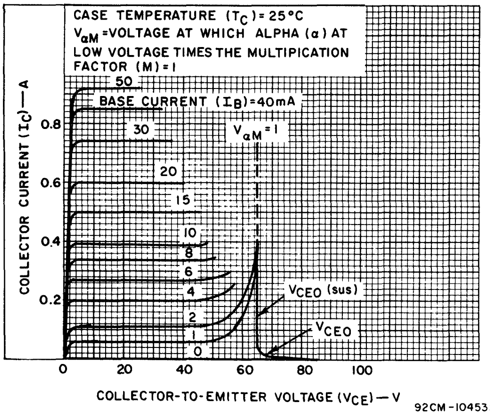


Fig.3 — Typical output characteristics for all types.

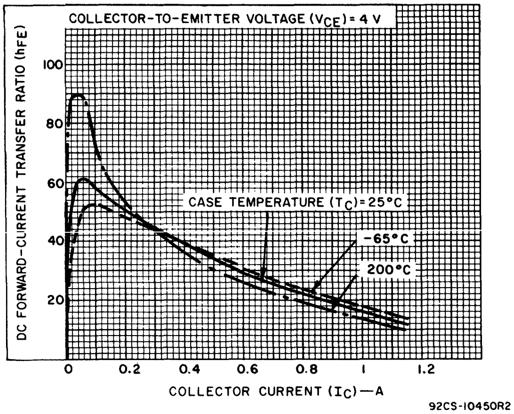


Fig.4 — Typical dc beta characteristics for all types.

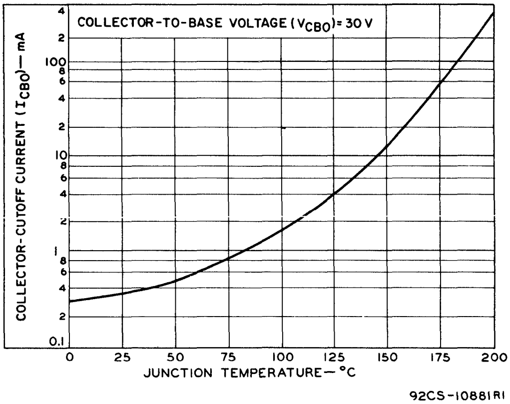


Fig.5 — Typical leakage characteristics for all types.

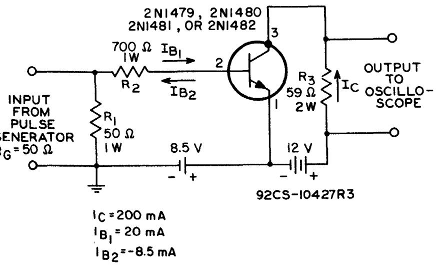


Fig.6 — Test circuit for measurement of saturated switching times.

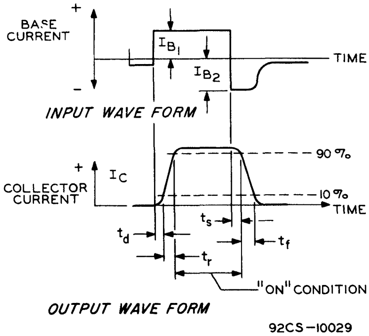


Fig. 7 — Oscilloscope display for measurement of switching times (test circuit in Fig. 6).

File Number **141**

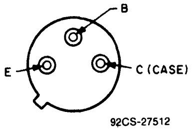
2N1700

Silicon N-P-N Power-Switching Transistor

For Switching Applications

Features:
- *Operation at high junction temperatures*

TERMINAL DESIGNATIONS



JEDEC TO-205AD

The RCA-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		
$T_C \leq 25°C$	5	W
$T_C > 25°C$ ... Derate linearly	0.029	°C/W
* T_{stg}, T_J	−65 to +200	°C
* T_L		
At distance ≥ 1/16 in. ± 1/32 in. (1.58 mm ± 0.8 mm) from seating plane for 10 s max.	255	°C

*In accordance with JEDEC registration data format.

2N1700

ELECTRICAL CHARACTERISTICS, *T_C=25° C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS 2N1700		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
* I_{CBO} V_{CB}=30 V					—	75	μA
V_{CB}=60 V					—	25	
* T_C=150° C, V_{CB}=30 V					—	1	mA
* I_{EBO}		-6	0		—	25	μA
* V_{CEO}(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}(sat)			0.1	0.01	—	10	Ω
* V_{CE}(sat)			1[a]	0.5	—	12	V
h_{fe} f=1 MHz	4		5		40	—	
* f_{hfb} V_{CB}=6 V				0.005	400	—	kHz
V_{CB}=28 V			0.0005		1.2 (typ.)		MHz
C_{obo} V_{CB}=40 V, f=1 MHz					150 (typ.)		pF
τ_l					10 (typ.)		ms
* $R_{\theta JC}$					—	35	°C/W
* $R_{\theta JA}$					—	200	°C/W

*In accordance with JEDEC registration data format.

[a]Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b]CAUTION: The sustaining voltages V_{CEO}(sus) and V_{CEX}(sus) MUST NOT be measured on a curve tracer.

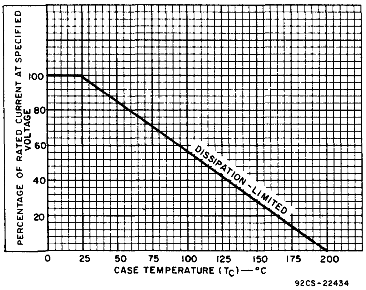


Fig. 1 - Derating curve.

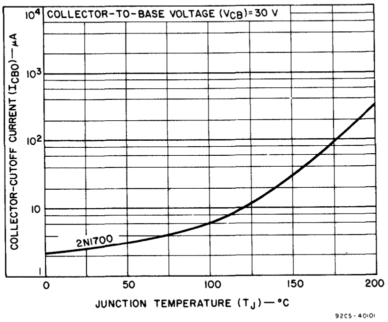


Fig. 2 - Typical collector-cutoff current characteristics.

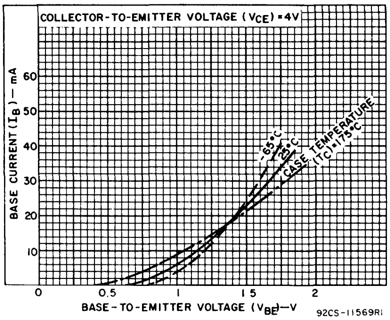


Fig. 3 - Typical input characteristics.

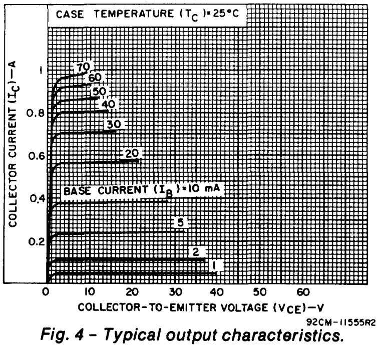


Fig. 4 - Typical output characteristics.

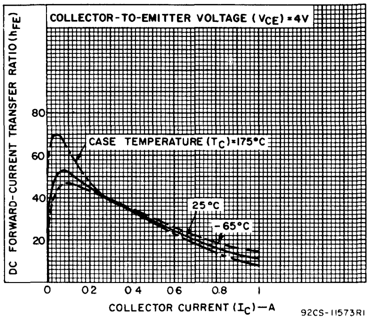
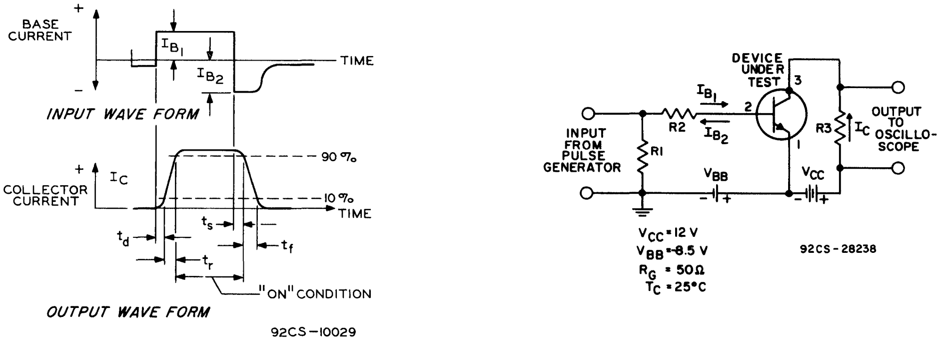


Fig. 5 - Typical dc beta characteristics.



		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.

2N3055 File Number **1699**

General-Purpose Power Transistor

Broadly Applicable Devices for
Industrial and Commercial Use

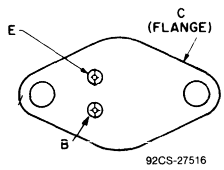
Features:
- *High gain at high current*
- *Low Saturation Voltage: $V_{CE}(sat) < 1.1$ V, @ I_C=4 A, I_B=0.4 A*
- *Excellent safe operating area*

The RCA-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 Ω)	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 (T_C=25° C)	115 W
Derate Linearly above 25° C	0.66 W/° C
*JUNCTION TEMPERATURE, T_j	200° C
*STORAGE TEMPERATURE, T_{stg}	-65 ~ 200° C

*In accordance with JEDEC registration data.

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

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

*In accordance with JEDEC registration data.
**The sustaining voltages V_{CER}(sus) and V_{CEO}(sus) MUST NOT be measured on a curve tracer.

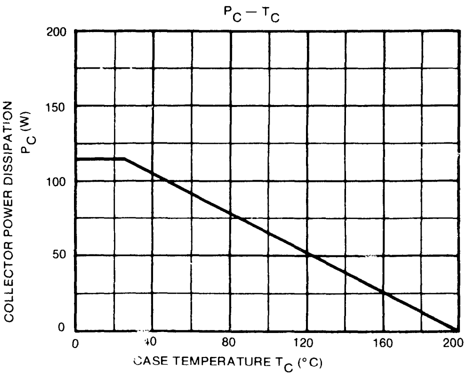


Fig. 1 - Power dissipation vs. temperature derating curve for 2N3055.

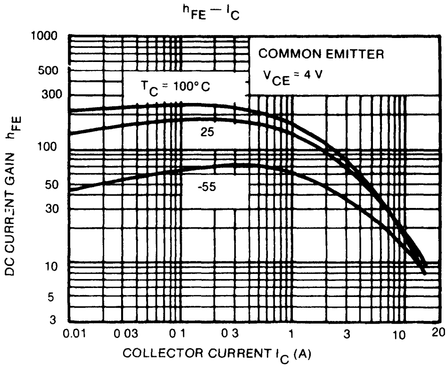


Fig. 2 - Typical dc-beta characteristics for 2N3055.

2N3055

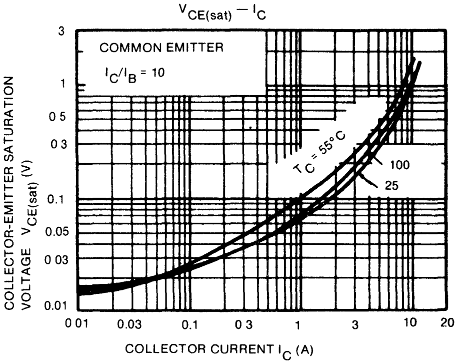


Fig. 3 - Typical collector-to-emitter saturation voltage characteristics for type 2N3055.

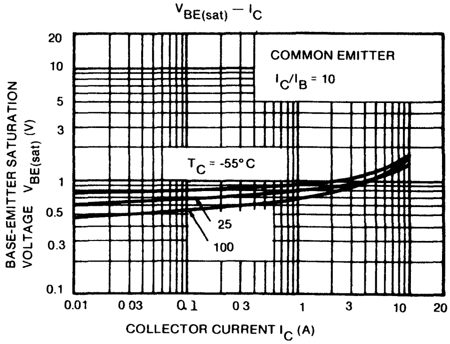


Fig. 4 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3055.

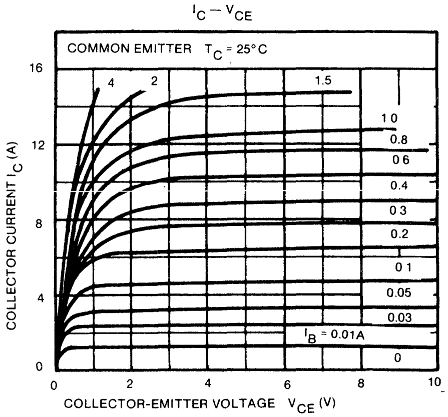


Fig. 5 - Typical output characteristics for 2N3055.

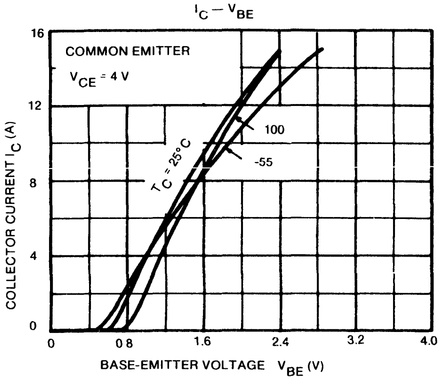


Fig. 6 - Typical transfer characteristics for 2N3055.

File Number **529**

2N3441, 2N6263, 2N6264

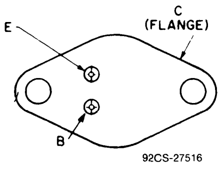
Medium-Power Silicon N-P-N Transistors

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

RCA 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	$V_{CEO}(sus)$	120	140	150	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$	130	150	160	V
With base reverse-biased (V_{BE} = -1.5 V)	$V_{CEV}(sus)$	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°C		20	25	50	W
* At temperatures above 25°C		See Figs. 2&4			
*TEMPERATURE RANGE:					
Storage & Operating (Junction)		-65 to 200			°C
*PIN TEMPERATURE (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 format JS-6 RDF-2

2N3441, 2N6263, 2N6264

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{EB}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6263 Min.	Max.	2N3441 Min.	Max.	2N6264 Min.	Max.	UNITS
Collector-Cutoff Current:													
		100				0	–	5	–	–	–	–	
* With base open	I_{CEO}	130				0	–	–	–	–	–	1	mA
		140				0	–	–	–	100	–	–	
Collector-Cutoff Current:													
		120		−1.5			–	2*	–	–	–	–	
	I_{CEX}	140		−1.5			–	–	–	5*	–	–	
		140		−1.5			–	–	–	1	–	–	
With base-emitter		150		−1.5			–	–	–	–	–	0.05*	
junction reversed													mA
biased		120		−1.5			–	10*	–	–	–	–	
	I_{CEX}	140		−1.5			–	–	–	6*	–	–	
	(T_C = 150°C)	140		−1.5			–	–	–	5	–	–	
		150		−1.5			–	–	–	–	–	1*	
* Emitter-Cutoff Current	I_{EBO}		5				–	2	–	–	–	–	mA
			7				–	–	–	1	–	0.2	
Collector-to-Emitter Sustaining Voltage:[a]	$V_{CEO}(sus)$												
* With base open					0.1	0	120	–	140	–	150	–	
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.1		130	–	150	–	160	–	V
With base-emitter junction reversed biased	$V_{CEV}(sus)$			−1.5	0.1		140	–	160	–	170	–	
		2			1		–	–	–	–	20	60	
* DC Forward-Current	h_{FE}	2			3		3	–	–	–	5	–	
Transfer Ratio		4			0.5		20	100	25	100	–	–	
		4			2.7		–	–	5	–	–	–	
					0.5	0.05	–	1.2*	–	1	–	–	
Collector-to-Emitter	$V_{CE}(sat)$				1	0.1	–	–	–	–	–	0.5*	V
Saturating Voltage					2.7	0.9	–	–	–	6*	–	–	
		2			1		–	–	–	–	–	1.5*	
Base-to-Emitter Voltage	V_{BE}	4			0.5		–	2*	–	1.7	–	–	V
		4			2.7		–	–	–	6*	–	–	
* 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	h_{fe}	4			0.1		25	–	–	–	25	–	
Forward Current Transfer Ratio (f = 1 kHz)		4			0.5		–	–	15	75	–	–	
Forward-Bias Second Breakdown Collector		120					0.167	–	–	–	–	–	
Current, Pulse Duration	$I_{S/b}$	120					–	–	–	–	0.417	–	A
(non-repetitive) = 1 s		120					–	–	0.21	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						—	8.75	—	7	—	3.5	°C/W

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

[a]**CAUTION:** The sustaining voltage $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ MUST NOT be measured on a curve tracer.

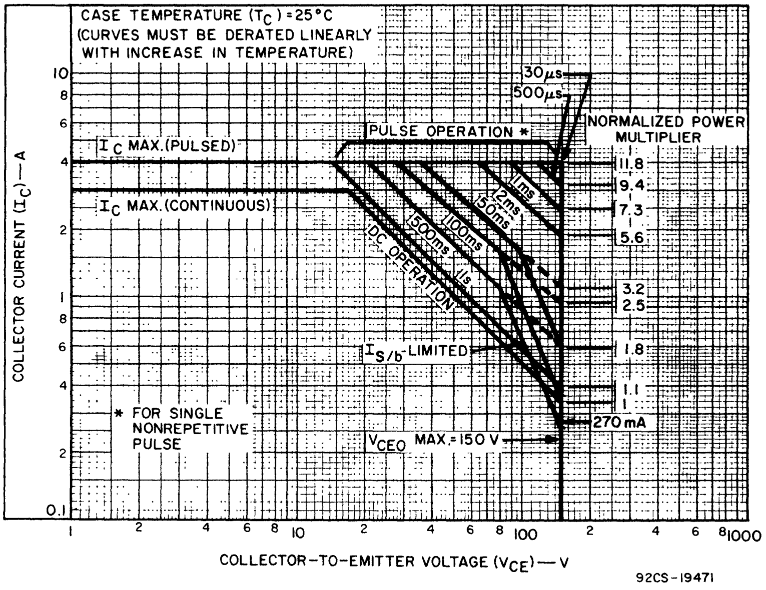


Fig. 1 — Maximum operating areas for type 2N6264.

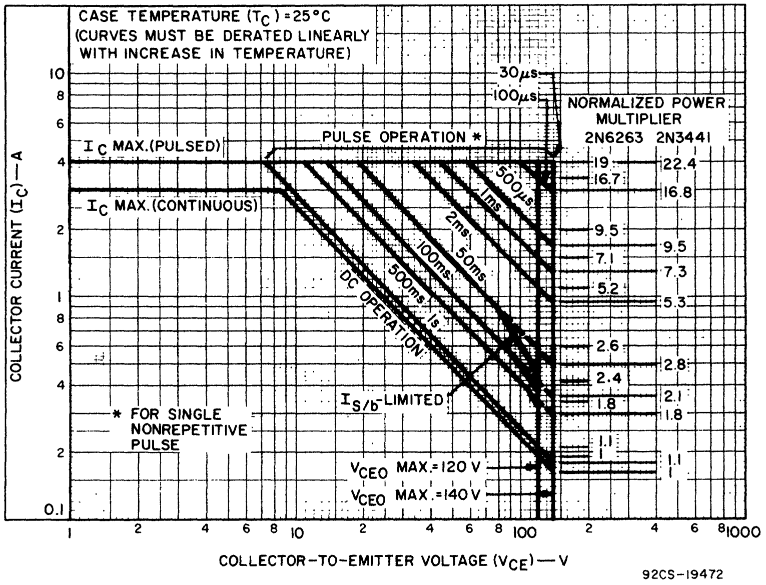


Fig. 2 — Maximum operating areas for types 2N6263 and 2N3441.

2N3441, 2N6263, 2N6264

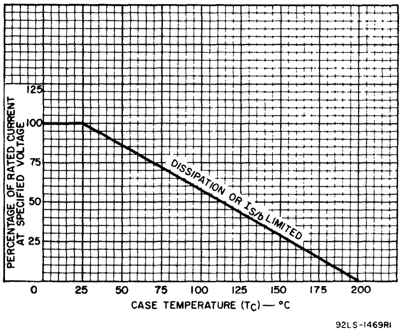


Fig. 3 — Current derating curve for all types.

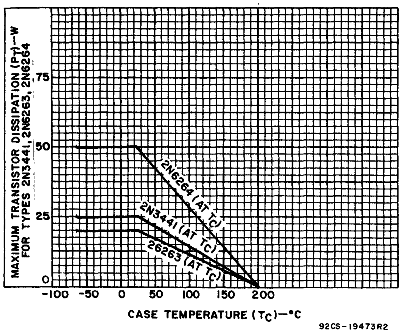


Fig. 4 — Dissipation derating curves for all types.

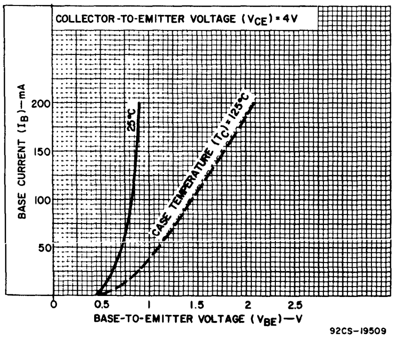


Fig 5 — Typical input characteristics for type 2N6264.

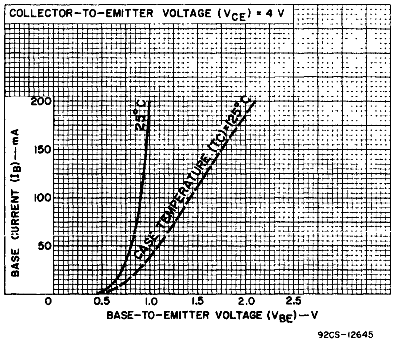


Fig. 6 — Typical input characteristics for type 2N3441.

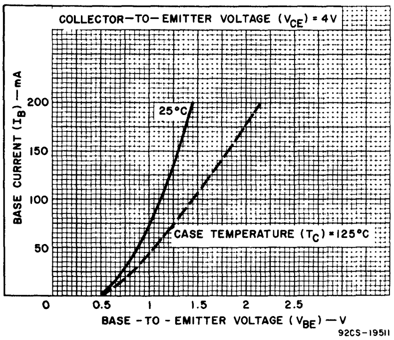


Fig. 7 — Typical input characteristics for type 2N6263.

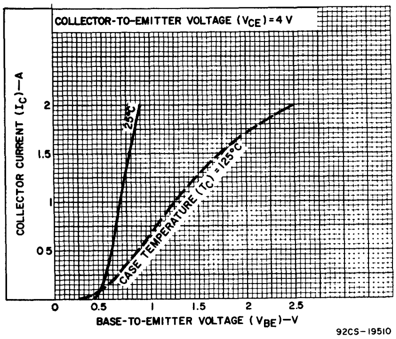


Fig. 8 — Typical transfer characteristics for type 2N6264.

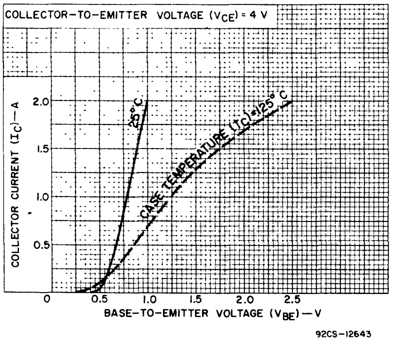


Fig. 9 — Typical transfer characteristics for type 2N3441.

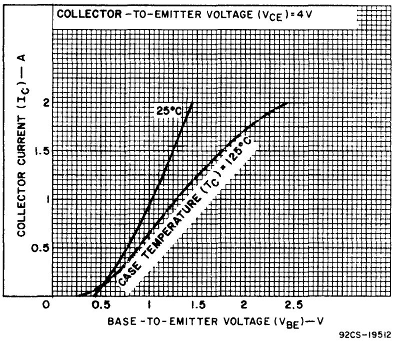


Fig. 10 — Typical transfer characteristics for type 2N6263.

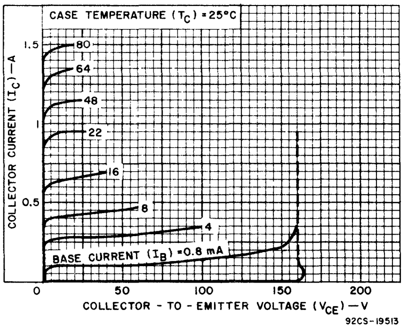


Fig. 11 — Typical output characteristics for type 2N6264.

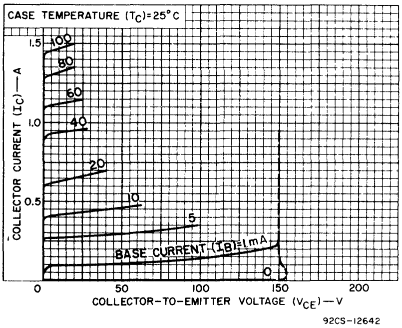


Fig. 12 — Typical output characteristics for type 2N3441.

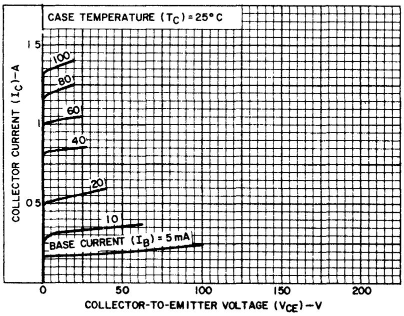


Fig. 13 — Typical output characteristics for type 2N6263.

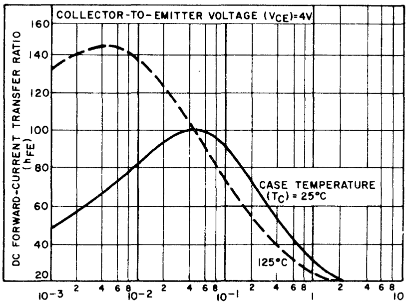


Fig. 14 — Typical dc beta characteristics for type 2N6264.

2N3441, 2N6263, 2N6264

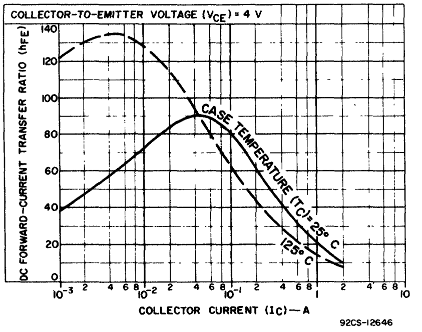


Fig. 15 — Typical dc beta characteristics for type 2N3441.

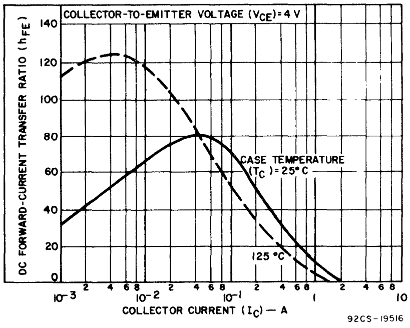


Fig. 16 — Typical dc beta characteristics for type 2N6263.

File Number **528**

2N3442, 2N4347, 2N6262

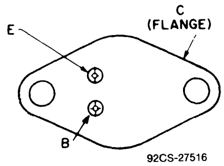
High-Voltage Silicon N-P-N Transistors

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

RCA-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_{CBO}	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	−1.5			–	2	–	–	–	–	mA
	140	−1.5			–	–	–	5	–	–	
	140	−1.5			–	–	–	1	–	–	
	150	−1.5			–	–	–	–	–	0.1	
* T_C = 150°C	125	−1.5			–	10	–	–	–	–	mA
	140	−1.5			–	–	–	30	–	–	
	140	−1.5			–	–	–	10	–	–	
	150	−1.5			–	–	–	–	–	2	
* I_{CEO}	100				–	200	–	–	–	–	mA
	110				–	–	–	–	–	1	
	140				–	–	–	200	–	–	
* I_{EBO}		−7	0		–	5	–	5	–	0.2	mA
* h_{FE}	2		3[a]		–	–	–	–	20	70	
	2		10[a]		–	–	–	–	5	–	
	4		2[a]		15	60	–	–	–	–	
	4		3[a]		–	–	20	70	–	–	
	4		5[a]		10	–	–	–	–	–	
	4		10[a]		–	–	4	–	–	–	
$V_{CEV}(sus)$		−1.5	0.1		140	–	160	–	–	–	V
		−1.5	0.2		–	–	–	–	170	–	
$V_{CER}(sus)$ (R_{BE}) = 100Ω			0.1		130	–	–	–	–	–	V
			0.2		–	–	150	–	160	–	
* $V_{CEO}(sus)$			0.2[a]	0	120	–	140	–	–	–	V
			0.2[a]	0	–	–	–	–	150	–	
* V_{BE}	2		3[a]		–	–	–	–	–	1	V
	4		3[a]		–	–	–	1.7	–	–	
	4		2[a]		–	2	–	–	–	–	
	4		5[a]		–	3	–	–	–	–	
	4		10[a]		–	–	–	5.7	–	–	
* $V_{CE}(sat)$			2[a]	0.2	–	1	–	–	–	–	V
			3[a]	0.3	–	–	–	1	–	0.5	
			5[a]	0.63	–	2	–	–	–	–	
			10[a]	2	–	–	–	5	–	–	
$I_{s/b}$	67		1.5		1	–	–	–	–	–	s
	78		1.5		–	–	1	–	–	–	
	100		1.5		–	–	–	–	1	–	
* $\|h_{fe}\|$ f = 50 kHz	4		0.5		4	–	–	–	–	–	
f = 40 kHz	4		1		–	–	–	–	2	–	
	4		2		–	–	2	–	–	–	
* h_{fe} f = 1 kHz	4		0.5		40	–	–	–	–	–	
	4		1		–	–	–	–	10	–	
	4		2		–	–	12	72	–	–	
$R_{\theta JC}$					–	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

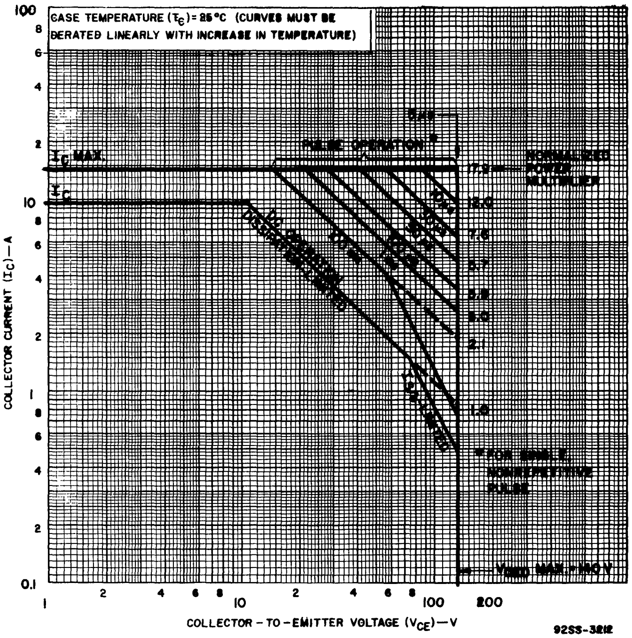


Fig. 1 — Maximum operating areas for type 2N3442.

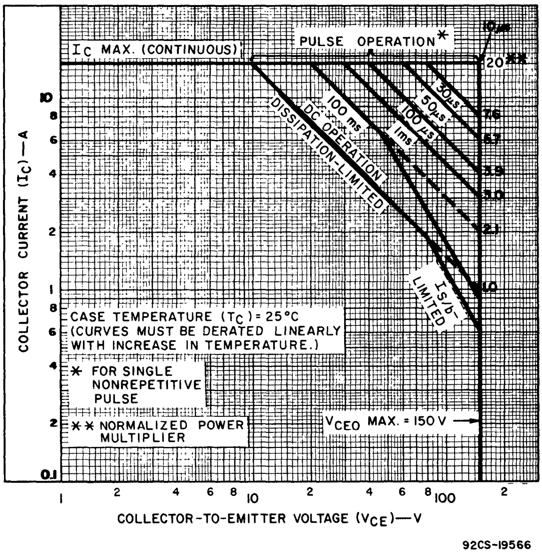


Fig. 2 — Maximum operating areas for type 2N6262.

2N3442, 2N4347, 2N6262

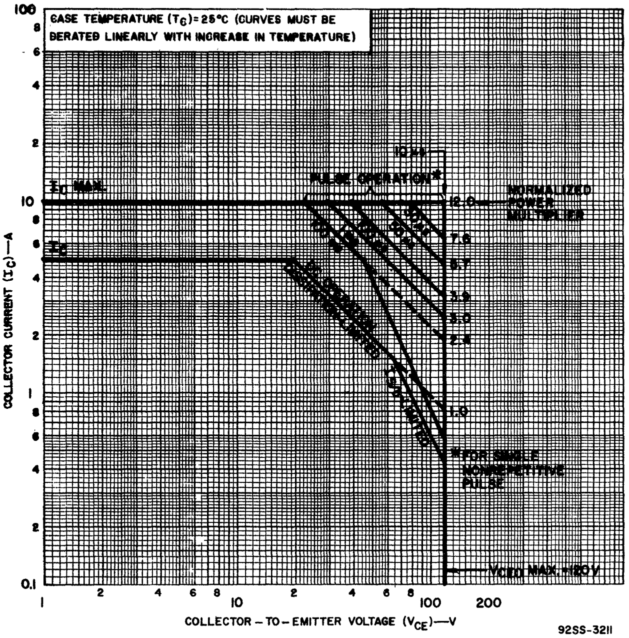


Fig. 3 — Maximum operating areas for type 2N4347.

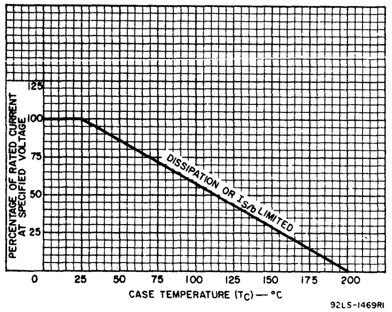


Fig. 4 — Current derating curve for all types.

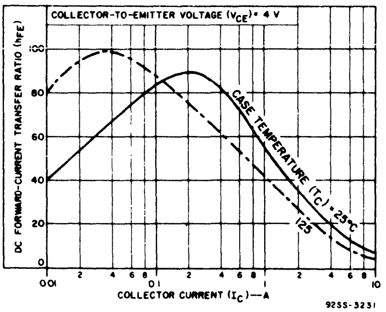


Fig. 5 — Typical dc beta characteristics for type 2N3442.

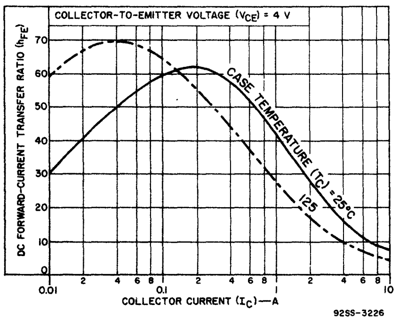


Fig. 6 — Typical dc beta characteristics for type 2N4347.

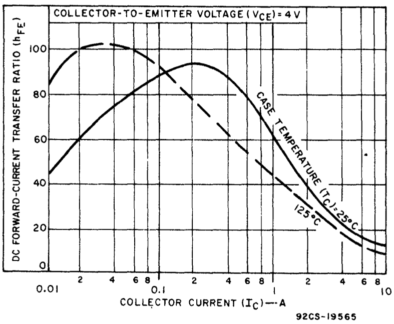


Fig. 7 — Typical dc beta characteristics for type 2N6262.

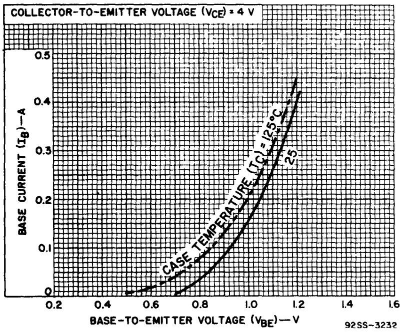


Fig. 8 — Typical input characteristics for type 2N3442.

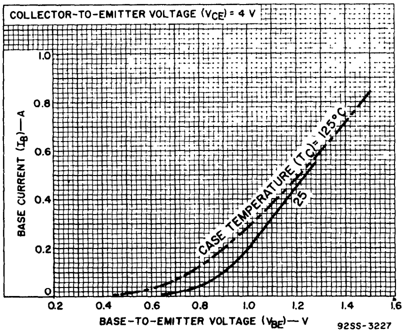


Fig. 9 — Typical input characteristics for type 2N4347.

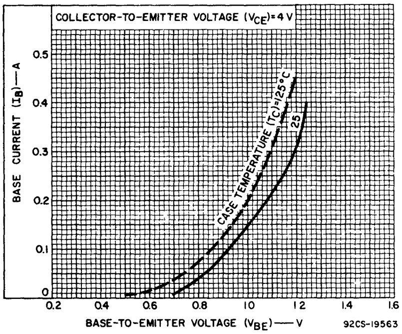


Fig. 10 — Typical input characteristics for type 2N6262.

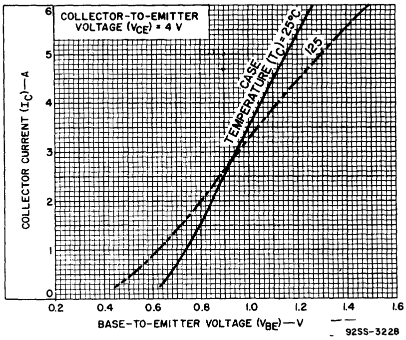


Fig. 11 — Typical transfer characteristics for type 2N3442 and 2N4347.

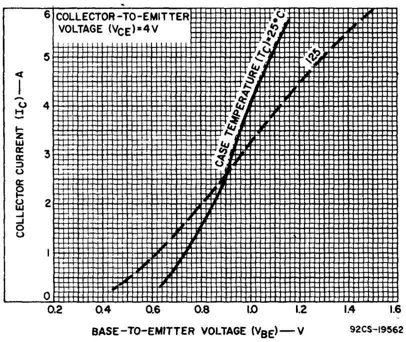


Fig. 12 — Typical transfer characteristics for type 2N6262.

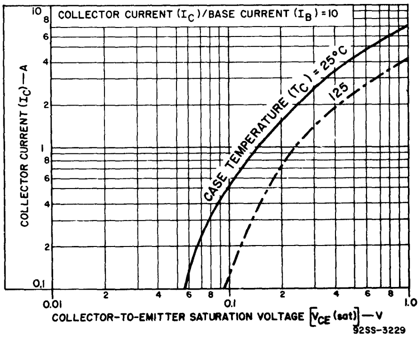


Fig. 13 — Typical saturation-voltage characteristics for all types.

2N3771, 2N3772

File Number **974**

High-Current Power Transistors

Broadly Applicable Devices for Industrial and Commercial Use

Features:

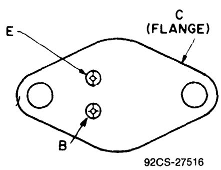
- *High collector dissipation: P_C=150 W (T_C=25° C)*
- *High collector current:*
  2N3771 I_C=30 A (dc)
  2N3772 I_C=20 A (dc)

The RCA-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 V, R_{BE}=100 Ω), 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 (T_C=25° C)	150	150	W
Derate Linearly above 25° C	0.855	0.855	W/° C
*JUNCTION TEMPERATURE, T_j	200	200	° C
*STORAGE TEMPERATURE, T_{stg}	−65 ~ 200	−65 ~ 200	° C

*In accordance with JEDEC registration data.

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	—	—	—	mA
		100					0		—	—	—	—	—	5	
*	I_{CEX}		50		1.5				—	—	2	—	—	—	
			100		1.5				—	—	—	—	—	5	
*	I_{CEX}, T_C=150° 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	
*	$V_{(BR)CEO}$					0.2		0	40	—	—	—	—	—	V
						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	—	—	—	V
			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	—	—	—	—	—	MHz
			4			1			—	—	—	0.2	—	—	
*	$\|h_{fe}\|$, f=1 kHz		4			1			40	—	—	—	—	—	
			4			1			—	—	—	40	—	—	
	$I_{S/b}$, t=1 s (non-repetitive)		40						3.75	—	—	—	—	—	A
			60						—	—	—	2.5	—	—	

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

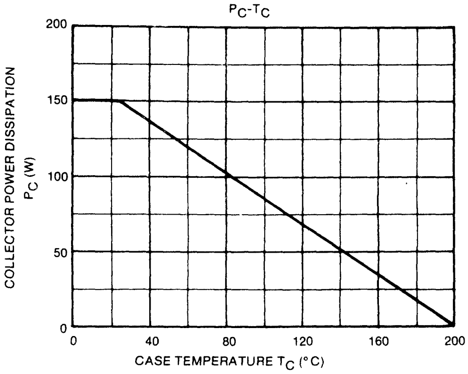


Fig. 1 - Power dissipation vs. temperature derating curve for both types.

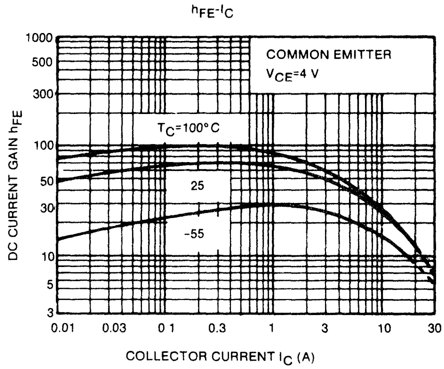


Fig. 2 - Typical dc-beta characteristics for 2N3771.

2N3771, 2N3772

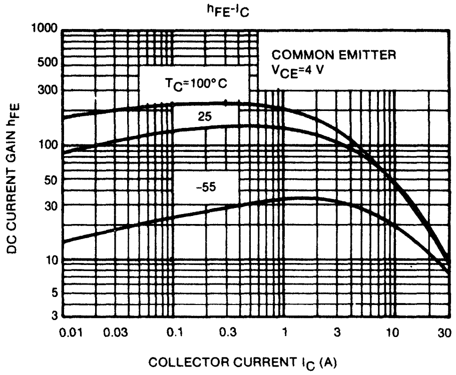


Fig. 3 - Typical dc-beta characteristics for 2N3772.

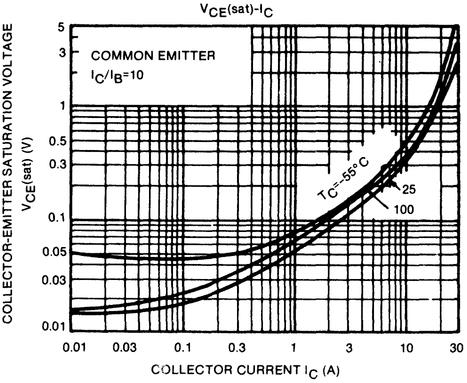


Fig. 4 - Typical collector-to-emitter saturation voltage characteristics for type 2N3771.

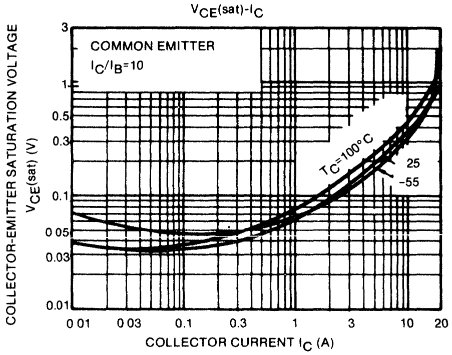


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for type 2N3772.

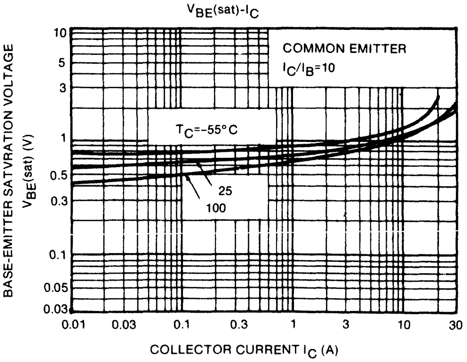


Fig. 6 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3771.

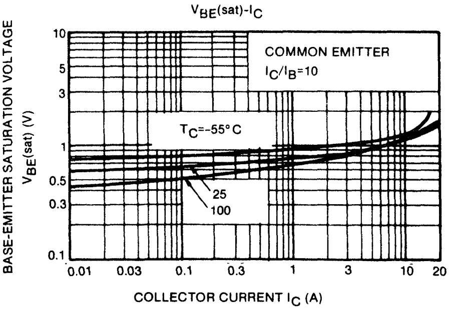


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3772.

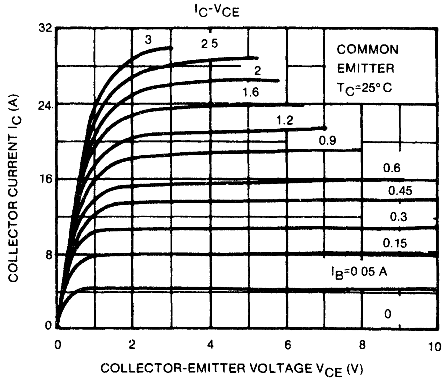


Fig. 8 - Typical output characteristics for 2N3771.

2N3771, 2N3772

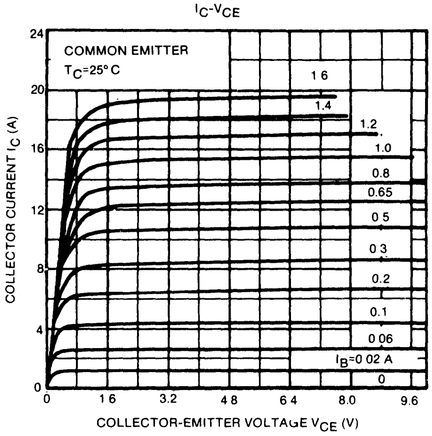


Fig. 9 - Typical output characteristics for 2N3772.

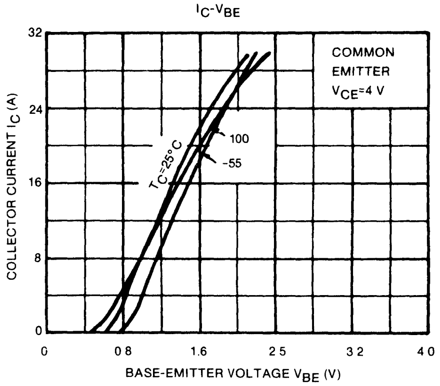


Fig. 10 - Typical transfer characteristics for 2N3771.

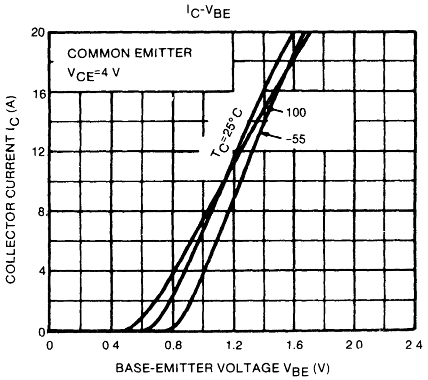


Fig. 11 - Typical transfer characteristics for 2N3772.

2N3773, 2N4348, 2N6259

File Number **526**

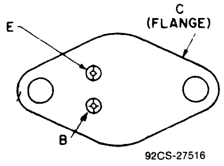
High-Voltage, High-Current Power Transistors

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 RCA-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 (T_c = 25°C)	120	150	250	W
Derate Linearly above 25°C	0.686	0.857	1.43	W/°C
*JUNCTION TEMPERATURE, T_J		200		°C
*STORAGE TEMPERATURE, T_{stg}		-65 to +200		°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: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N4348 Min.	2N4348 Max.	2N3773 Min.	2N3773 Max.	2N6259 Min.	2N6259 Max.	UNITS
* Collector-Cutoff Current: With emitter open, V_{CB}=140 V	I_{CBO}					–	–	–	2	–	–	mA
With base-emitter junction reverse-biased	I_{CEX}	120	−1.5			–	2	–	–	–	–	mA
		140	−1.5			–	–	–	2	–	–	
		150	−1.5			–	–	–	–	–	0.2	
With base-emitter junction reverse-biased and T_C = 150°C	I_{CEX}	120	−1.5			–	10	–	–	–	–	mA
		140	−1.5			–	–	–	10	–	–	
		150	−1.5			–	–	–	–	–	4	
With base open	I_{CEO}	100				–	200	–	–	–	–	mA
		120				–	–	–	10	–	2	
* 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:** With base-emitter junction reverse-biased (R_{BE} = 100Ω)	V_{CEX}(sus)		−1.5	0.1		140	–	160	–	170	–	V
With external base-to-emitter resistance (R_{BE}) = 100Ω	V_{CER}(sus)			0.2[a]		140	–	150	–	160	–	V
* With base open	V_{CEO}(sus)			0.2[a]	0	120	–	140	–	150	–	V
* Base-to-Emitter Voltage	V_{BE}	4		5[a]		–	2	–	–	–	–	V
		4		8[a]		–	–	–	2.2	–	–	
		2		8[a]		–	–	–	–	–	2	
		4		10[a]		–	3	–	–	–	–	
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			5[a]	0.5	–	1	–	–	–	–	V
				8[a]	0.8	–	–	–	1.4	–	1	
				10[a]	1.25	–	2	–	–	–	–	
				16[a]	3.2	–	–	–	4	–	2.5	
Second-Breakdown Collector Current With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$	80				1.5	–	–	–	–	–	A
		100				–	–	1.5	–	2.5	–	
* 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	$R_{\theta JC}$					–	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.

[a]Pulsed; pulse duration = 300μs, rep. rate = 60 Hz, duty factor ≤ 2.%.

2N3773, 2N4348, 2N6259

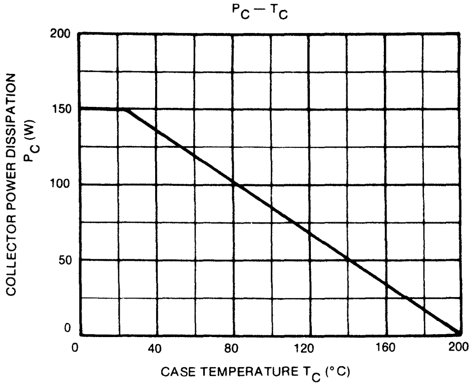


Fig. 1 — Dissipation derating curve for all types.

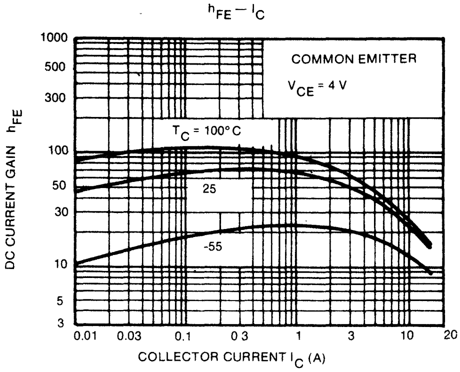


Fig. 2 — Typical dc-beta characteristics for all types.

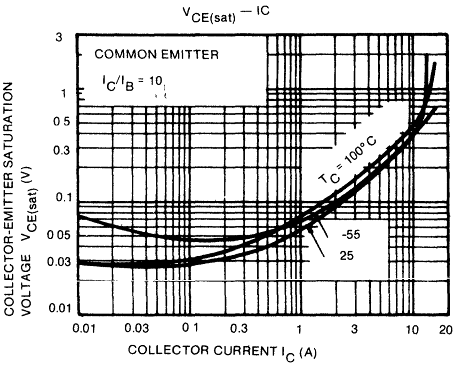


Fig. 3 — Typical collector-to-emitter saturation voltage characteristics for all types.

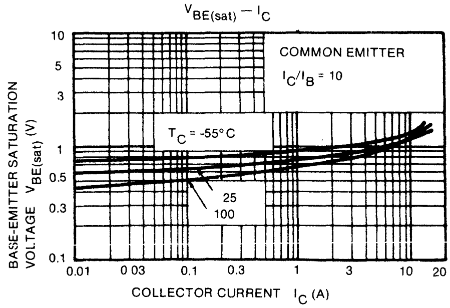


Fig. 4 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

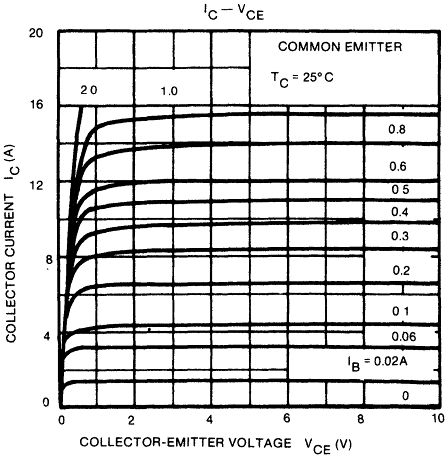


Fig. 5 — Typical output characteristics for all types.

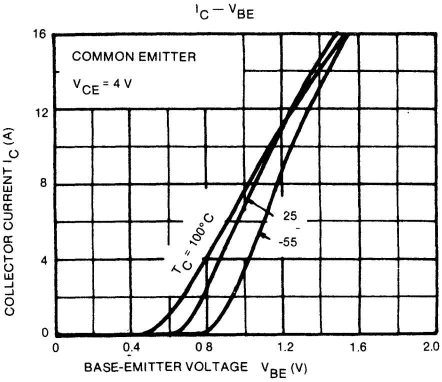


Fig. 6 — Typical transfer characteristics for 2N3773 and 2N4348.

File Number **1059**

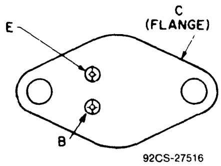
2N3791, 2N3792

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

The RCA-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_{CBO}	-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 $T_C \leq 25°C$	150	150	W
At $T_C > 25°C$ derate linearly	0.86		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	1.5	–	--	–	−1	–	–	mA
		−80	1.5	–	–	–	–	–	−1	
	T_C = 150°C	−60	1.5	–	–	–	−5	–	–	
		−80	1.5	–	–	–	–	–	−5	
*	I_{CEO}	−30		–	–	–	−10	–	−10	mA
		−40		–	–	–	−10	–	−10	
*	I_{EBO}		7	–	–	–	−5	–	−5	mA
*	$V_{CEO}(sus)$[b]			−0.2	0	−60	–	−80	–	V
*	h_{FE}[a]	−2		−1	–	50	150	50	150	
		−2		−3	–	30	–	30	–	
		−4		−10	–	4	–	4	–	
*	V_{BE}	−2		−5	–	–	−1.8	–	−1.8	V
		−4		−10	–	–	−4.0	–	−4.0	
*	$V_{BE}(sat)$[a]			−5	−0.5	–	−1.5	–	−1.5	V
*	$V_{CE}(sat)$[a]			−5	−0.5	–	−1	–	−1	V
				−10	−2.0	–	−4	–	−4	
*	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 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.

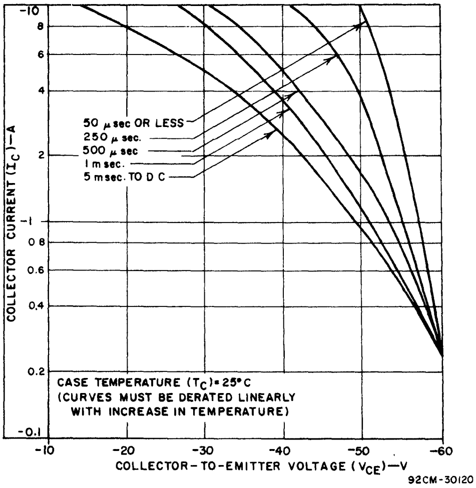


Fig. 1 — Maximum operating areas for 2N3791.

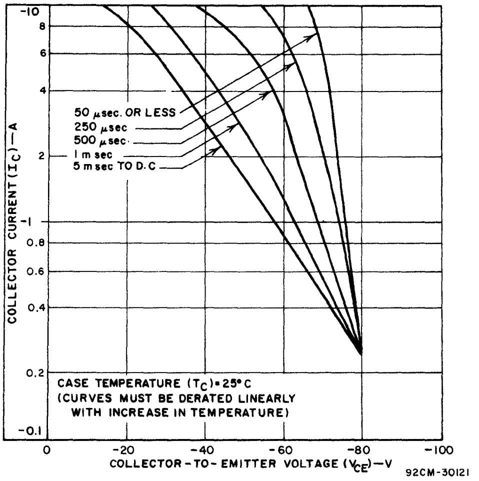


Fig. 2 — Maximum operating areas for 2N3792.

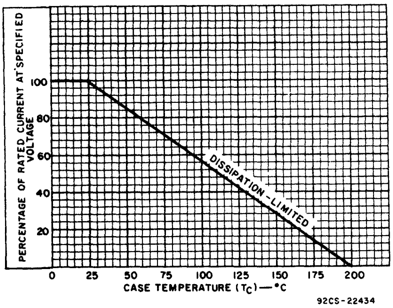


Fig. 3 — Derating curve.

2N3791, 2N3792

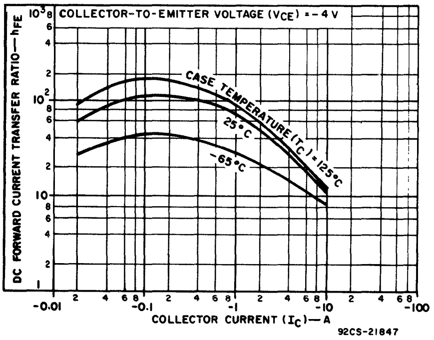


Fig. 4 – Typical dc beta characteristics for both types.

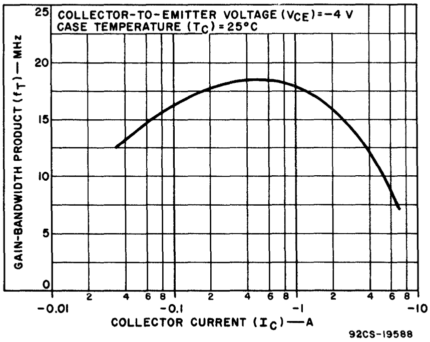


Fig. 5 – Typical gain-bandwidth product for both types.

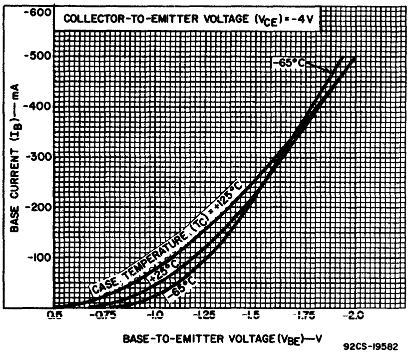


Fig. 6 – Typical input characteristics for both types.

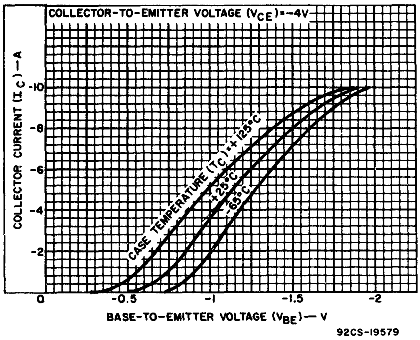


Fig. 7 – Typical transfer characteristics for both types.

File Number **1150**

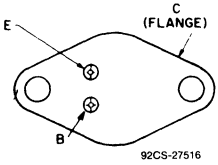
2N4898, 2N4899, 2N4900

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 RCA-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_{CBO}	40	60	80	V
* V_{CEX}(sus)				
V_{BE} = −1.5 V, R_{BE} = 100 Ω	40	60	80	V
V_{CEO}(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 ≥ 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: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N4898		2N4899		2N4900		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CBO}	40[a]				–	100	–	–	–	–	μA
	60[a]				–	–	–	100	–	–	
	80[a]				–	–	–	–	–	100	
* I_{CEX} R_{BE} = 100 Ω	40	–1.5			–	100	–	–	–	–	μA
	60	–1.5			–	–	–	100	–	–	
	80	–1.5			–	–	–	–	–	100	
* R_{BE} = 100 Ω, T_C = 150°C	40	–1.5			–	1	–	–	–	–	mA
	60	–1.5			–	–	–	1	–	–	
	80	–1.5			–	–	–	–	–	1	
* I_{CEO}	20				–	0.5	–	–	–	–	mA
	30				–	–	–	0.5	–	–	
	40				–	–	–	–	–	0.5	
* I_{EBO}		–5			–	1	–	1	–	1	mA
* h_{FE}	1		0.5[b]		20	100	20	100	20	100	
	1		0.05[b]		40	–	40	–	40	–	
	1		1[b]		10	–	10	–	10	–	
* $V_{CEO}(sus)$[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
$R_{\theta JC}$					–	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.)

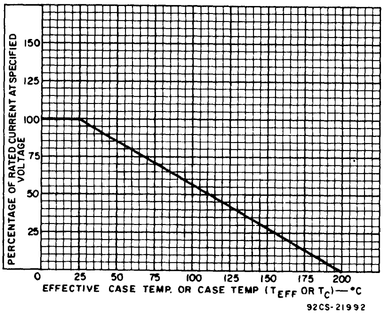


Fig. 1 — Current derating chart for all types.

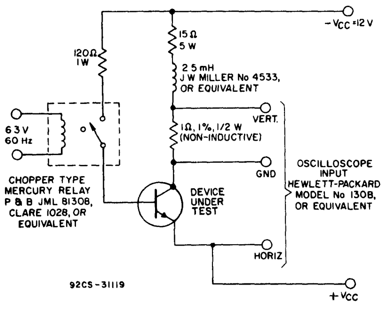


Fig. 2 — Circuit used to measure sustaining voltage, $V_{CEO}(sus)$.

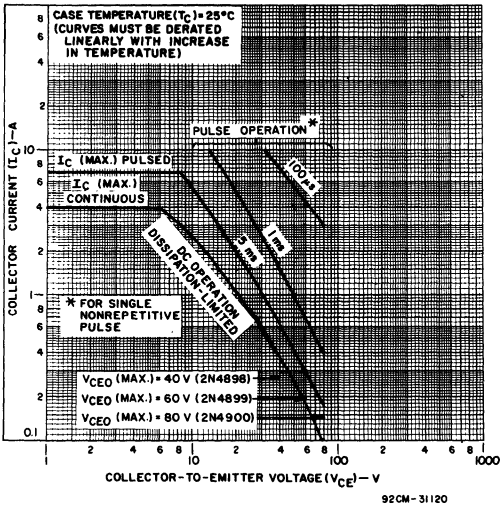
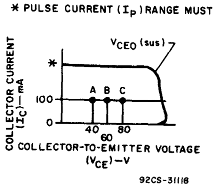


Fig. 3 — Maximum operating areas for all types. (T_C = 25°C).



The sustaining voltage, $V_{CEO}(sus)$, 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.

2N5294, 2N5296, 2N5298

File Number **322**

Silicon N-P-N Transistors

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

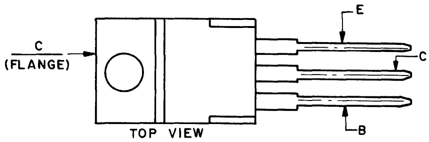
Features:
- *Low saturation voltage -*
  $V_{CE}(sat)$ = 1 V max. at I_C = 0.5 A (2N5294)
  = 1 V max. at I_C = 1 A (2N5296)
  = 1 V max. at I_C = 1.5 A (2N5298)
- *Maximum safe-area-of-operation curves specified for DC and pulse service*

RCA-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	V_{CBO}	80	60	80	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With -1.5 volts (V_{BE}) of reverse bias	V_{CEV}(sus)	80	60	80	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}(sus)	75	50	70	V
With base open	*V_{CEO}(sus)	70	40	60	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	5	5	V
*COLLECTOR CURRENT	I_C	4	4	4	A
*BASE CURRENT	I_B	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 ≥ 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: DC Collector Voltage (V) V_{CE}	DC Emitter or Base Voltage (V) V_{EB}	DC Emitter or Base Voltage (V) V_{BE}	DC Current (A) I_C	DC Current (A) I_B	LIMITS 2N5294 Min.	2N5294 Max.	2N5296 Min.	2N5296 Max.	2N5298 Min.	2N5298 Max.	Units
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}	65 35		-1.5 -1.5			– –	0.5 –	– –	– 2	– –	0.5 –	mA
	I_{CEV} (T_C = 150°C)	65 35		-1.5 -1.5			– –	3 –	– –	– 5	– –	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°C)	50					–	2	–	–	–	2	mA
* Emitter-Cutoff Current	I_{EBO}		7 5				– –	1 –	– –	– 1	– –	– 1	mA
* DC Forward-Current Transfer Ratio	h_{FE}[c]	4 4 4			0.5 1 1.5		30 – –	120 – –	– 30 –	– 120 –	– – 20	– – 80	
* Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$[c]				0.1 0.1 0.1	0 0 0	70 – –	– – –	– 40 –	– – –	– – 60	– – –	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$[c]				0.1 0.1 0.1		75 – –	– – –	– 50 –	– – –	– – 70	– – –	V
With base-emitter junction reverse biased	$V_{CEV}(sus)$[c]			-1.5 -1.5 -1.5	0.1 0.1 0.1		80 – –	– – –	– 60 –	– – –	– – 80	– – –	V
* Base-to-Emitter Voltage	V_{BE}[c]	4 4 4			0.5 1 1.5		– – –	1.1 – –	– – –	– 1.3 –	– – –	– – 1.5	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[c]				0.5 1 1.5	0.05 0.1 0.15	– – –	1 – –	– – –	– 1 –	– – –	– – 1	V
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 1 1.5	0.05[a] 0.1[a] 0.15[a]	– – –	5 – –	– – –	– 5 –	– – –	– – 5	μs
Turn-Off (See Figs. 22 - 24)	t_{off}	V_{CC} = 30			0.5 1 1.5	-0.05[a] -0.1[b] -0.15[b]	– – –	15 – –	– – –	– 15 –	– – –	– – 15	μs
Thermal Resistance (Junction-to-Case)	$\theta_{J\text{-}C}$						–	3.5	–	3.5	–	3.5	°C/W
(Junction-to-Ambient)	$\theta_{J\text{-}A}$						–	70	–	70	–	70	°C/W

[a] I_{B_1} value (turn-on base current). [b] I_{B_2} value (turn-off base current). [c] Pulsed, pulse duration = 300 μs, duty factor = .018.

*In accordance with JEDEC registration data.

2N5294, 2N5296, 2N5298

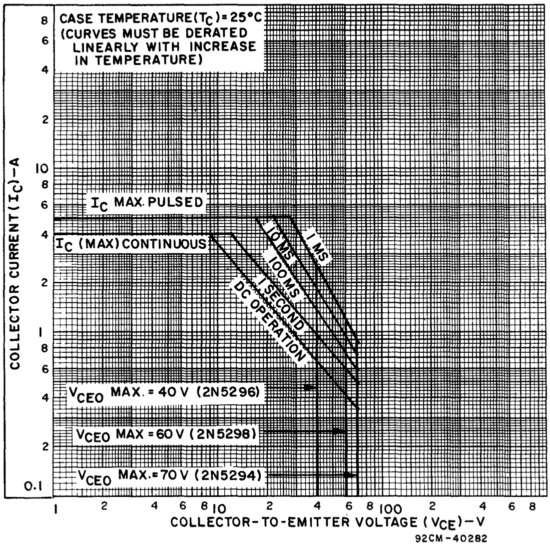


Fig. 1 - Maximum operating areas for all types.

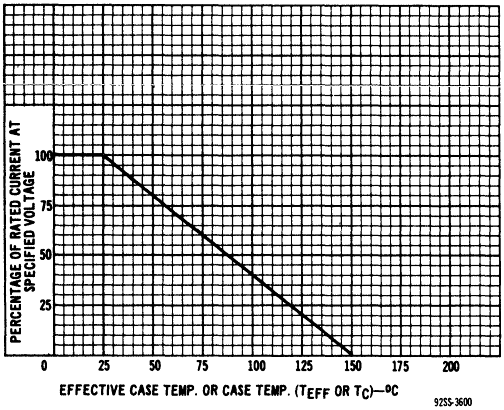


Fig. 2 - Derating curve for all types.

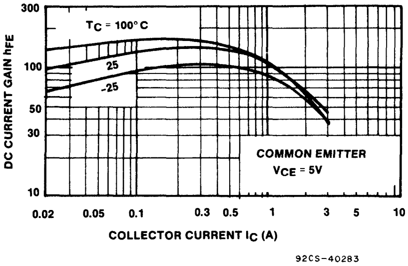


Fig. 3 - Typical DC beta characteristics for all types.

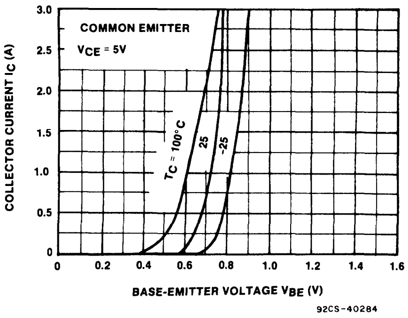


Fig. 4 - Typical input characteristics for all types.

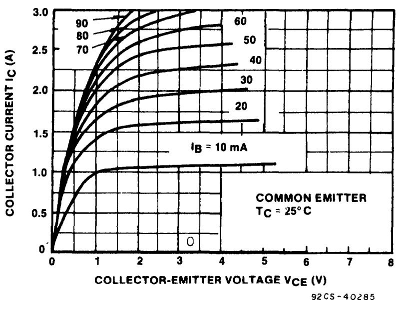


Fig. 5 - Typical output characteristics for all types.

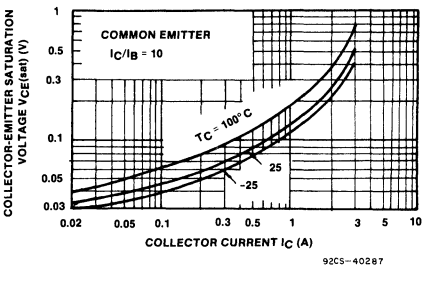


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

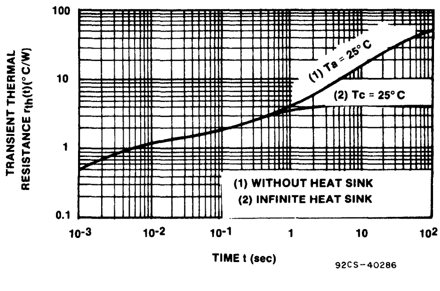


Fig. 7 - Transient thermal resistance characteristics for all types.

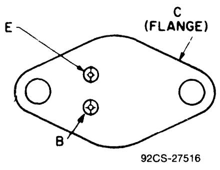
2N5301, 2N5302, 2N5303

File Number **1029**

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

The RCA-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 $T_C \leq 25°C$	—	200	—	W
At $T_C > 25°C$ ... derate linearly	—	1.15 *See Figs.1 & 2*	—	W/°C
* T_J, T_{stg}	—	-65 to 200	—	°C
T_L				
At distance ≥ 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.

2N5301, 2N5302, 2N5303

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

CHARAC-TERISTIC	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]				–	1	–	–	–	–	
	60[a]				–	–	–	1	–	–	
	80[a]				–	–	–	–	–	1	
* I_{CEX}	40	−1.5			–	1	–	–	–	–	
	60	−1.5			–	–	–	1	–	–	
	80	−1.5			–	--	–	–	–	1	
* I_{CEX} T_C = 150°C	40	−1.5			–	10	–	–	–	–	mA
	60	−1.5			–	–	–	10	–	–	
	80	−1.5			–	–	–	–	–	10	
* I_{CEO}	40				–	5	–	–	–	–	
	60				–	–	–	5	–	–	
	80				–	–	–	–	–	5	
* I_{EBO}		−5			–	5	–	5	–	5	
* h_{FE}	2		1[b]		40	–	40	–	40	–	
	2		10[b]		–	–	–	–	15	60	
	3		15[b]		15	60	15	60	–	–	
	2		20[b]		–	–	–	–	5	–	
	3		30[b]		5	–	5	–	–	–	
* V_{CEO}(sus)			0.2		40	–	60	–	80	–	
* V_{BE}	2		10[b]		–	–	–	–	–	1.5	
	2		15[b]		–	1.7	–	1.7	–	–	
	4		20[b]		–	–	–	–	–	2.5	
	4		30[b]		–	3	–	3	–	–	
* V_{BE}(sat)			10[b]	1	–	1.7	–	1.7	–	1.7	V
			15[b]	1.5	–	1.8	–	1.8	–	2	
			20[b]	2	–	2.5	–	2.5	–	–	
			20[b]	4	–	–	–	–	–	2.5	
* V_{CE}(sat)			10[b]	1	–	0.75	–	0.75	–	1	
			15[b]	1.5	–	–	–	–	–	1.5	
			20[b]	2	–	2	–	2	–	–	
			20[b]	4	–	–	–	–	–	2	
			30[b]	6	–	3	–	3	–	–	
$I_{S/b}$ tp = 1 s nonrep.	20				10	–	10	–	10	–	A
* $\lvert h_{fe} \rvert$ 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	
* t_s	30		10	1[c]	–	2	–	2	–	2	µs
* t_f			10	1[c]	–	1	–	1	–	1	
$R_{\theta JC}$	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] $I_{B_1} = -I_{B_2}$

2N5301, 2N5302, 2N5303

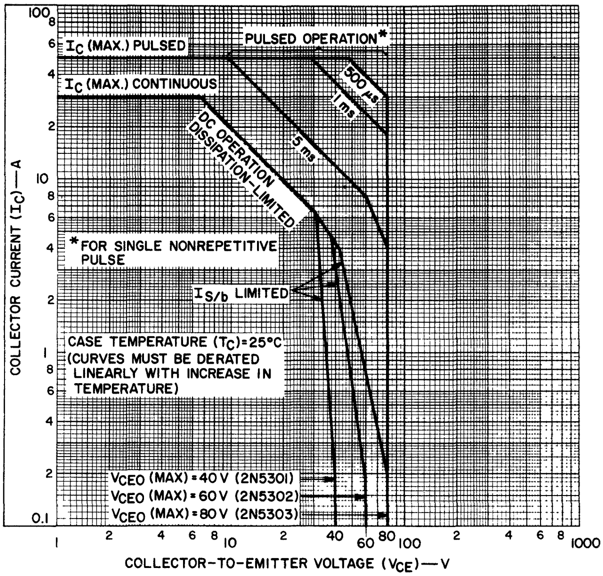


Fig. 1 — Maximum operating areas for 2N5301, 2N5302, and 2N5303.

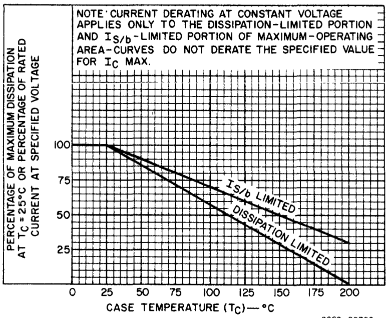


Fig. 2 — Derating curves for 2N5301, 2N5302, and 2N5303.

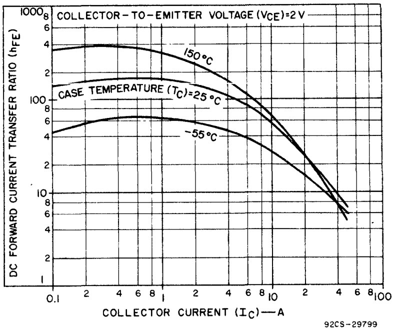


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

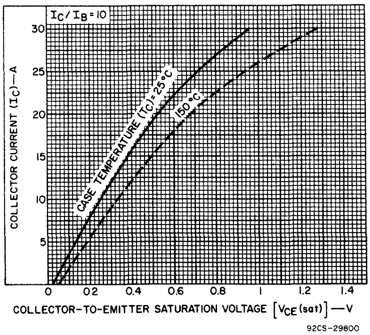


Fig. 4 — Typical saturation voltage characteristics for 2N5301, 2N5302, and 2N5303.

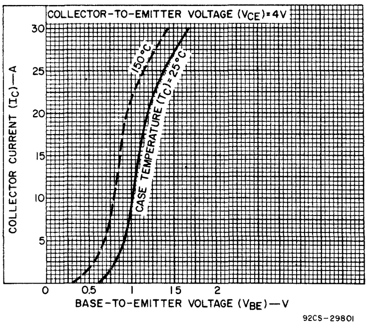


Fig. 5 — Typical transfer characreristics for 2N5301, 2N5302, and 2N5303.

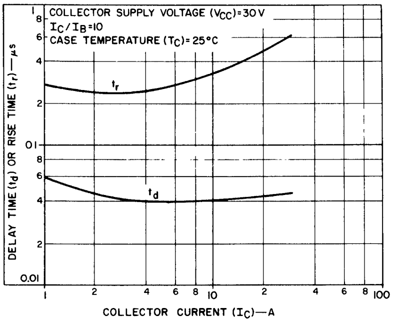


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

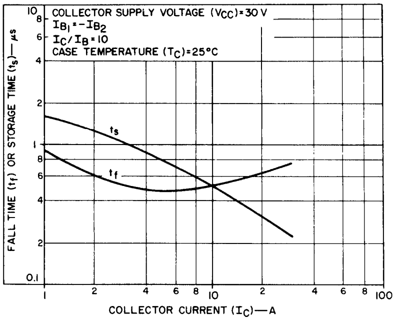


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

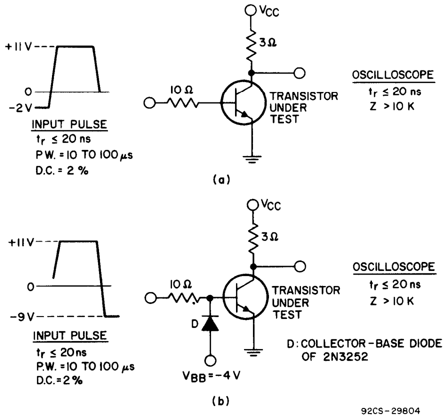


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5301, 2N5302, and 2N5303.

2N5490-2N5497

File Number **353**

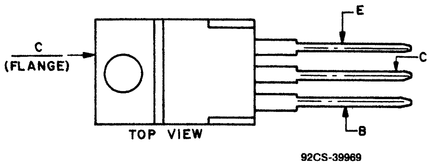
Silicon N-P-N VERSAWATT Transistors

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

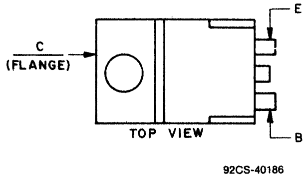
Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB



JEDEC TO-220AA

RCA-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.

Maximum Ratings, *Absolute-Maximum Values:*

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

2N5490-2N5497

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

Characteristic	Symbol	TEST CONDITIONS: DC Voltage (V) V_{CE}	V_{BE}	DC Current (A) I_C	I_B	LIMITS: Types 2N5496 2N5497 Min.	Max.	Types 2N5494 2N5495 Min.	Max.	Types 2N5492 2N5493 Min.	Max.	Types 2N5490 2N5491 Min.	Max.	Units
Collector-Cutoff Current With base-emitter junction reverse biased	I_{CEV}	85 55 70	-1.5 -1.5 -1.5			- - -	1 - -	- - -	- 1 -	- - -	- - 1	- - -	- - -	mA
	I_{CEV} (T_C = 150°C)	85 55 70	-1.5 -1.5 -1.5			- - -	5 - -	- - -	- 5 -	- - -	- - 5	- - -	- - -	mA
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	70 40 55				- - -	0.5 - -	- - -	- 0.5 -	- - -	- - 0.5	- - -	- 2 -	mA
	I_{CER} (T_C = 150°C)	70 40 55				- - -	3.5 - -	- - -	- 3.5 -	- - -	- - 3.5	- - -	- 5 -	mA
Emitter-Cutoff Current	I_{EBO}		-5			-	1	-	1	-	1	-	1	mA
DC Forward-Current Transfer Ratio	h_{FE}[c]	4 4 4 4		3.5 3 2.5 2		20 - - -	100 - - -	- 20 - -	- 100 - -	- - 20 -	- - 100 -	- - - 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 4 4 4		3.5 3 2.5 2		- - - -	1.7 - - -	- - - -	- 1.5 - -	- - - -	- - 1.3 -	- - - -	- - - 1.1	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[c]			3.5 3 2.5 2	0.35 0.3 0.25 0.2	- - - -	1 - - -	- - - -	- 1 - -	- - - -	- - 1 -	- - - -	- - - 1	V
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 3 2.5 2	0.35[a] 0.3[a] 0.25[a] 0.2	- - - -	5 - - -	- - - -	- 5 - -	- - - -	- - 5 -	- - - -	- - - 5	μs
Turn-Off	t_{off}	V_{CC} = 30		3.5 3 2.5 2	0.35[b] 0.3[b] 0.25[b] 0.2	- - - -	15 - - -	- - - -	- 15 - -	- - - -	- - 15 -	- - - -	- - - 15	μs

[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	$\theta_{J\text{-}C}$					-	2.5	-	2.5	-	2.5	-	2.5	°C/W
Junction-to-Ambient	$\theta_{J\text{-}A}$					-	70	-	70	-	70	-	70	°C/W

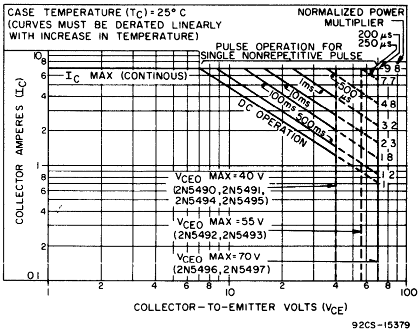


Fig. 1 — Maximum operating areas for types 2N5490 through 2N5497 inclusive.

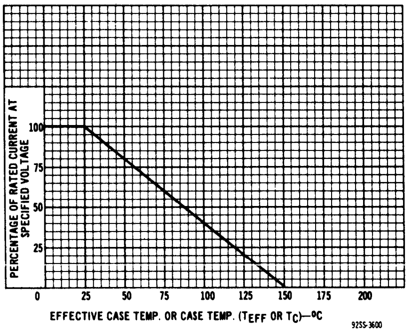


Fig. 2 — Derating curve for all types.

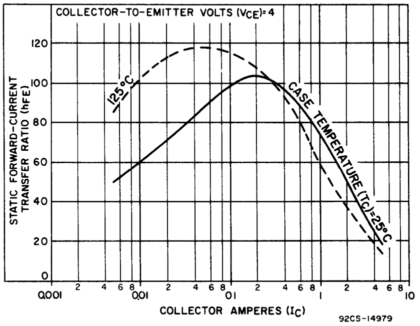


Fig. 3 — Typical static beta characteristics for types 2N5496 and 2N5497.

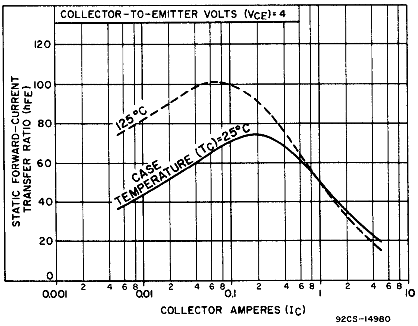


Fig. 4 — Typical static beta characteristics for types 2N5494 and 2N5495.

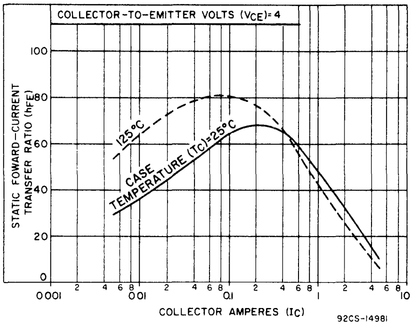


Fig. 5 — Typical static beta characteristics for types 2N5490 through 2N5493 inclusive.

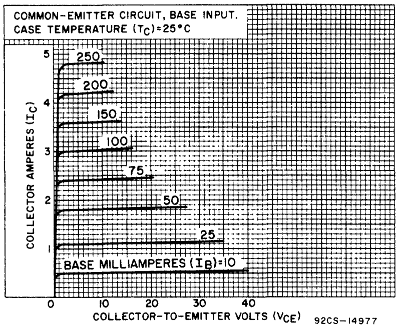


Fig.6 — Typical output characteristics for types 2N5494 through 2N5497 inclusive.

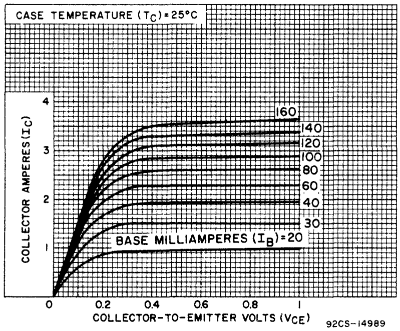


Fig. 7 — Typical output characteristics for types 2N5494 and 2N5495.

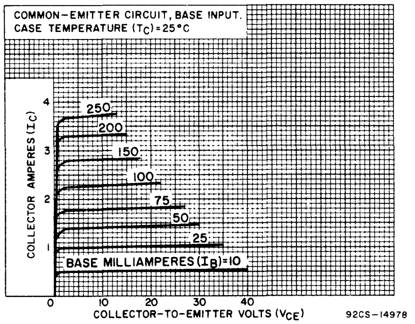


Fig. 8 — Typical output characteristics for types 2N5490 through 2N5493 inclusive.

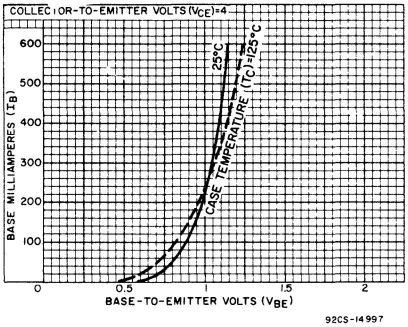


Fig. 9 — Typical input characteristics for types 2N5494 through 2N5497 inclusive.

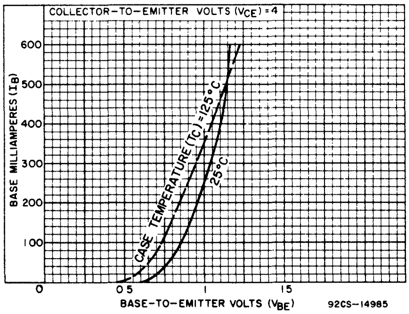


Fig. 10 — Typical input characteristics for types 2N5490 through 2N5493 inclusive.

2N5490-2N5497

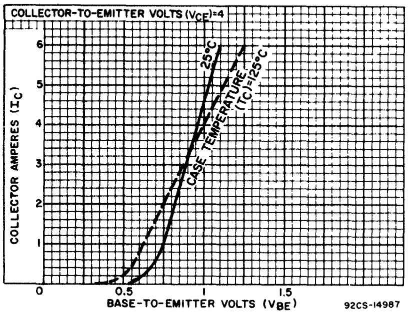


Fig. 11 — Typical transfer characteristics for types 2N5494 through 2N5497 inclusive.

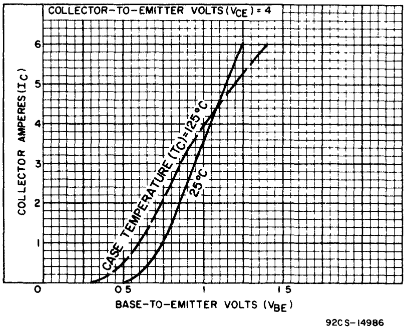


Fig. 12 — Typical transfer characteristics for types 2N5490 through 2N5493 inclusive.

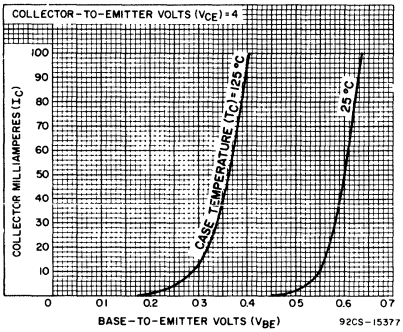


Fig. 13 — Typical transfer characteristics for types 2N5490 through 2N5497 inclusive.

File Number **1141**

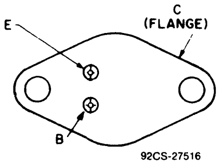
2N5629, 2N5630, 2N5631

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 RCA-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.

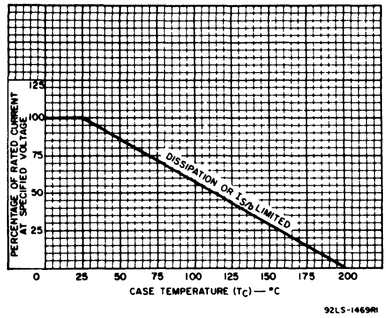


Fig. 1 — Current derating curve for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5629	2N5630	2N5631	
* V_{CEO}	100	120	140	V
* V_{CBO}	100	120	140	V
* V_{EBO}		7		V
* I_C		16		A
* I_{CM}		20		A
* I_B		5		A
* P_T				
At $T_C \leq 25°C$		200		W
At $T_C > 25°C$ derate linearly		1.14		W/°C
* 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°C Unless Otherwise Specified

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N5629		2N5630		2N5631		UNITS
	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°C	100	−1.5	–	–	–	5	–	–	–	–	
	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 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 MHz	20	–	1	–	1	–	1	–	1	–	MHz
* h_{fe} f = 1 kHz	10	–	4	–	15	–	15	–	15	–	
$I_{S/b}$ t_p = 1 s nonrep.	30	–	–	–	6.67	–	6.67	–	6.67	–	A
$R_{\theta JC}$	10	–	10	–	–	0.875	–	0.875	–	0.875	°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 ≤300 μs. Duty factor ≤2%.

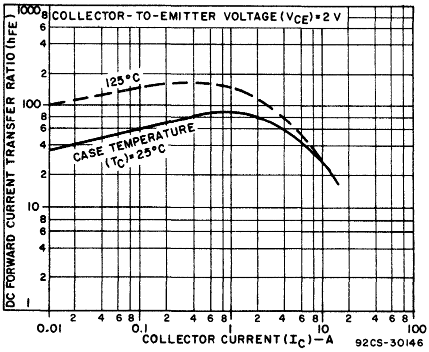


Fig. 2 – Typical dc beta characteristics as a function of collector current for all types.

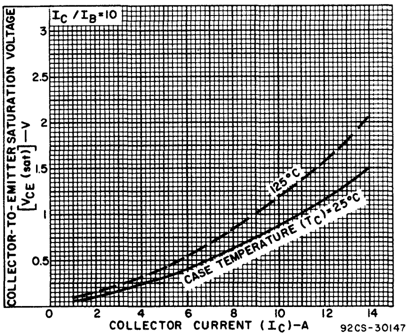


Fig. 3 – Typical saturation voltage characteristics for all types.

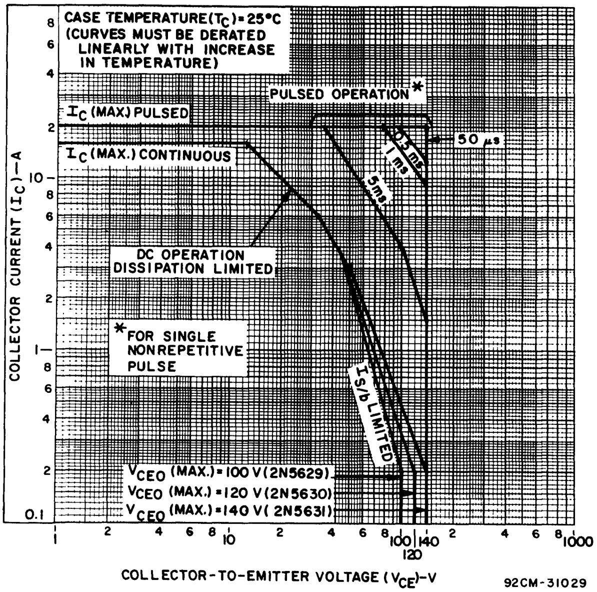


Fig. 4 — Maximum operating areas for all types ($T_C = 25°C$).

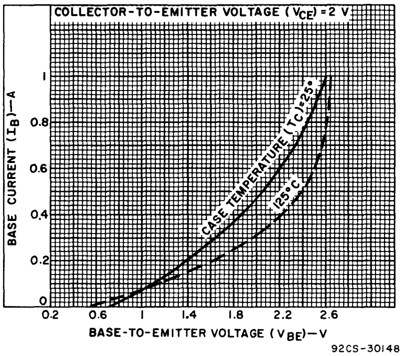


Fig. 5 — Typical input characteristics for all types.

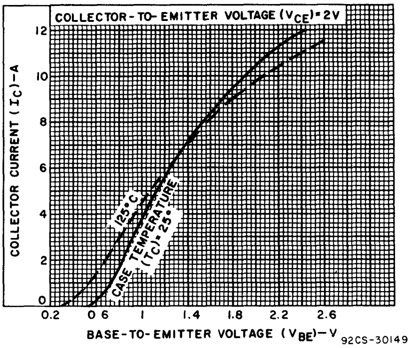


Fig. 6 — Typical transfer characteristics for all types.

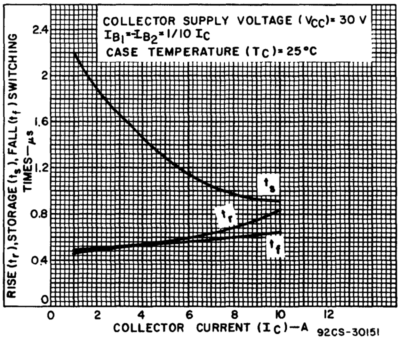


Fig. 7 — Typical saturated-switching times for all types.

2N5781, 2N5782, 2N5783, 2N5784, 2N5785, 2N5786 File Number **413**

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*

RCA-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.

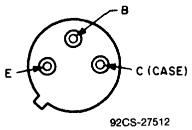
The three types in each family differ primarily in voltage ratings and saturation characteristics.

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



92CS-27512

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:						
Storage and operating (Junction)				−65 to +200		°C
*LEAD TEMPERATURE (During soldering):						
At distance ≥ 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♦ VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc I_B	LIMITS 2N5781 p-n-p Min.	LIMITS 2N5781 p-n-p Max.	LIMITS 2N5784 n-p-n Min.	LIMITS 2N5784 n-p-n Max.	UNITS
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	65				–	−10	–	10	μA
At T_C = 150°C	I_{CER}	65				–	−1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	−75 75	1.5 −1.5			– –	−10 –	– –	– 10	μA
* At T_C = 150°C	I_{CEX}	−75 75	1.5 −1.5			– –	−1 –	– –	– 1	mA
* 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 2		1[a] 3.2[a]		20 4	100 –	20 4	100 –	
* 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]	–	V
* 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	$\lvert h_{fe}\rvert$	−2		−0.1		2	15	–	–	
f = 200 kHz	$\lvert h_{fe}\rvert$	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 1	-0.1 0.1	– –	0.5 –	– –	– 5	μs
Turn-off ($t_s + t_f$)	t_{OFF}			−1 1	-0.1 0.1	– –	2.5 –	– –	– 15	μs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$					–	17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	°C/W

* 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%

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

[c] Lead resistance is critical in this test.

[d] Measured at a frequency where $\lvert h_{fe}\rvert$ 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♦ VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc I_B	LIMITS 2N5782 p-n-p Min.	LIMITS 2N5782 p-n-p Max.	LIMITS 2N5785 n-p-n Min.	LIMITS 2N5785 n-p-n Max.	UNITS
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	50				–	–10	–	10	µA
At T_C = 150°C	I_{CER}	50				–	–1	–	1	mA
* With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CEX}	–60 60	1.5 –1.5			– –	–10 –	– –	– 10	µA
* At T_C = 150°C	I_{CEX}	–60 60	1.5 –1.5			– –	–1 –	– –	– 1	mA
* 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 2		1.2[a] 3.2[a]		20 4	100 –	20 4	100 –	
* 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]	–	V
* 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] 3.2[a]	0.12 0.8	– –	–0.75 –2	– –	0.75 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	$\|h_{fe}\|$	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 1	–0.1 0.1	– –	0.5 –	– –	– 5	µs
Turn-off ($t_s + t_f$)	t_{OFF}			–1 1	–0.1 0.1	– –	2.5 –	– –	– 15	µs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	°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.*

♦ 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♦ VOLTAGE V dc		TEST CONDITIONS♦ CURRENT A dc		LIMITS 2N5783 p-n-p		LIMITS 2N5786 n-p-n		UNITS
		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	I_{CER}	40				–	–10	–	10	μA
At T_C = 150°C	I_{CER}	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	–	–	μA
		45	–1.5			–	–	–	10	μA
* At T_C = 150°C	I_{CEX}	–45	1.5			–	–1	–	–	mA
		45	–1.5			–	–	–	1	mA
* With base open	I_{CEO}	25			0	–	–100	–	100	μA
* Emitter Cutoff Current	I_{EBO}		–3.5	0		–	–10	–	10	μA
* 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	$\|h_{fe}\|$	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	μs
Turn-off ($t_s + t_f$)	t_{OFF}			–1	–0.1	–	2.5	–	–	μs
				1	0.1	–	–	–	15	μs
Thermal Resistance: Junction-to-case	$R_{\theta JC}$						17.5	–	17.5	°C/W
Junction-to-ambient	$R_{\theta JA}$					–	175	–	175	°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.*

♦ 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

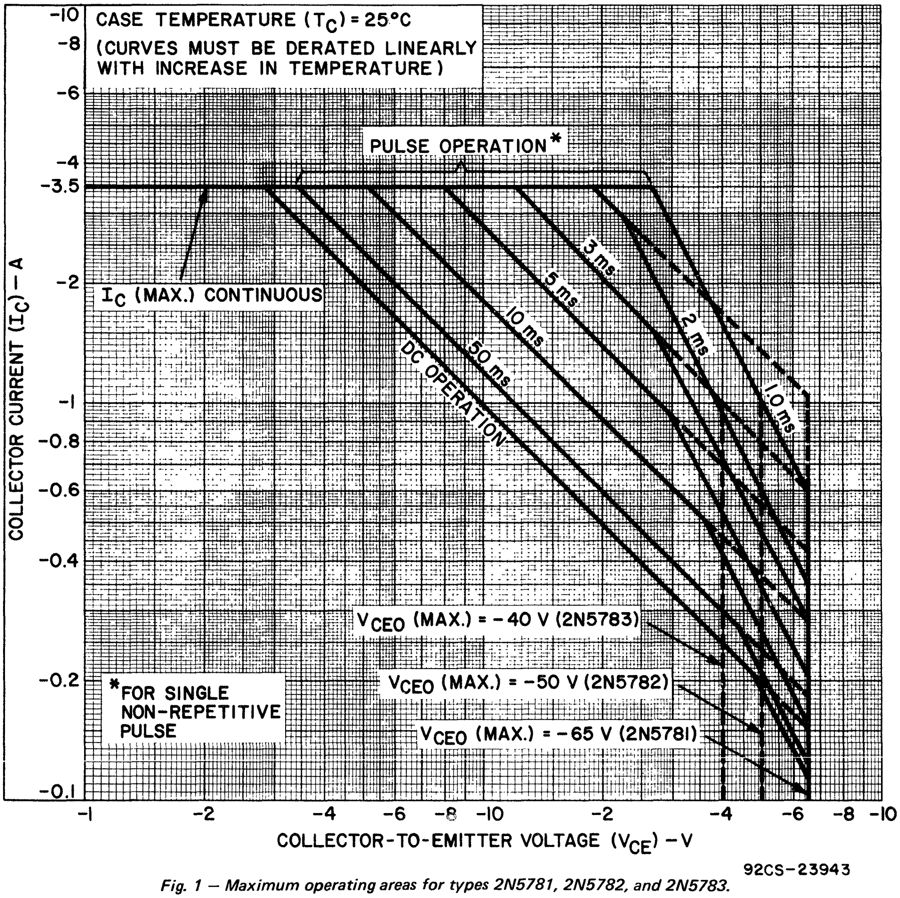


Fig. 1 – Maximum operating areas for types 2N5781, 2N5782, and 2N5783.

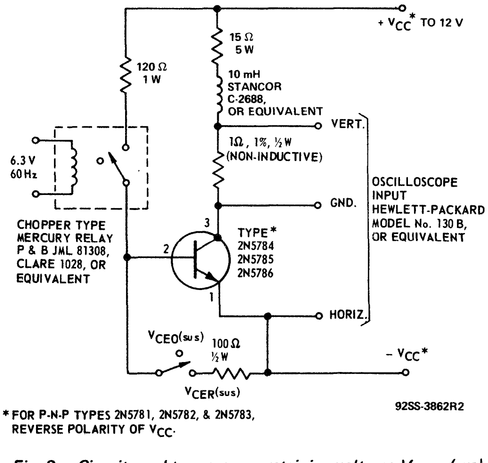
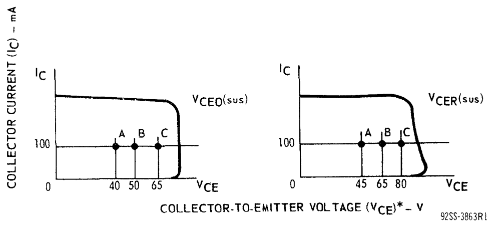


Fig. 2 – Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$.



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

The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ are acceptable when the trace falls 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

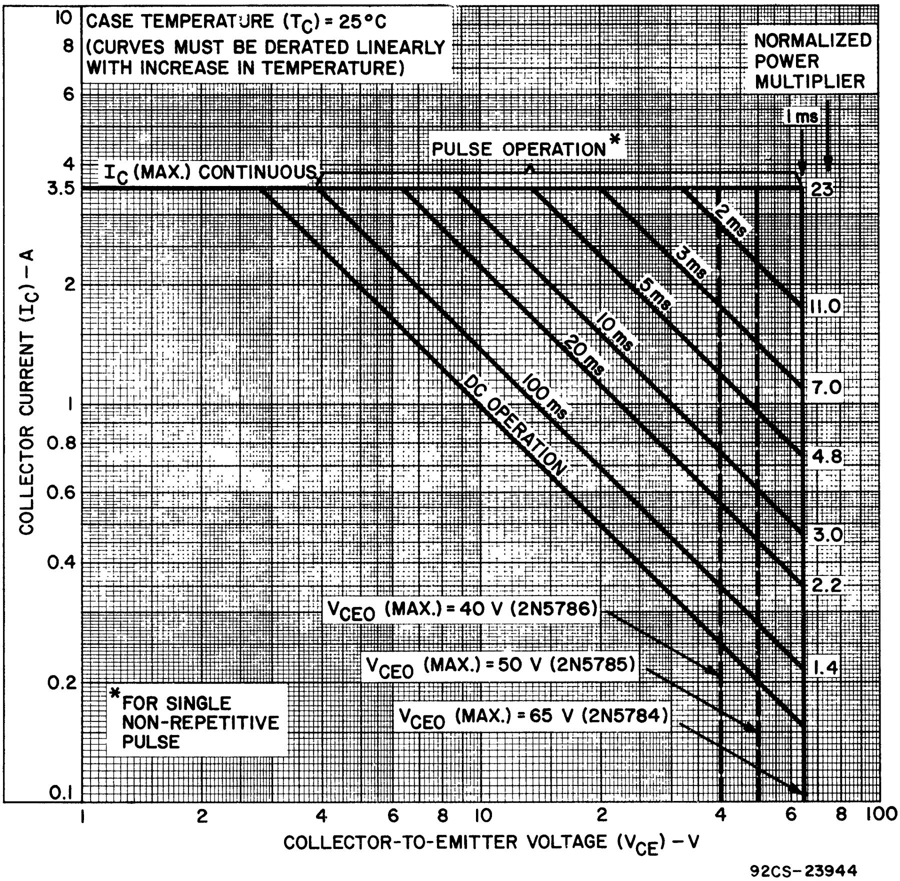


Fig. 4 – Maximum operating areas for types 2N5784, 2N5785, and 2N5786.

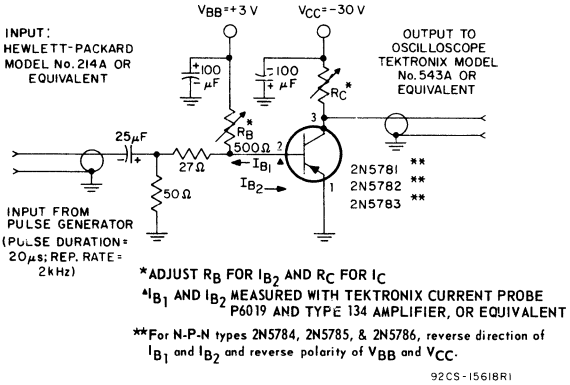


Fig. 5 – Circuit used to measure saturated switching times.

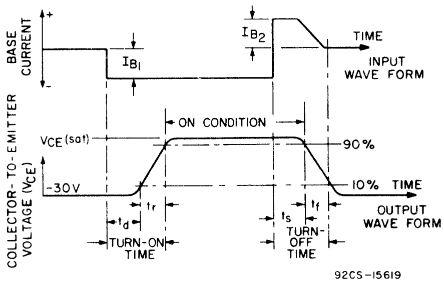


Fig. 6 – Oscilloscope display for measurement of switching times. (Test circuit shown in Fig. 5).

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

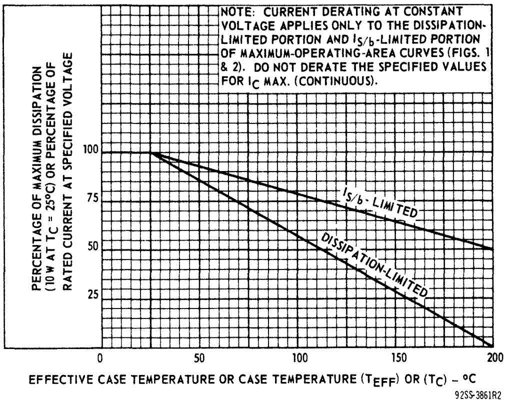


Fig. 7 — Dissipation derating curve for all types.

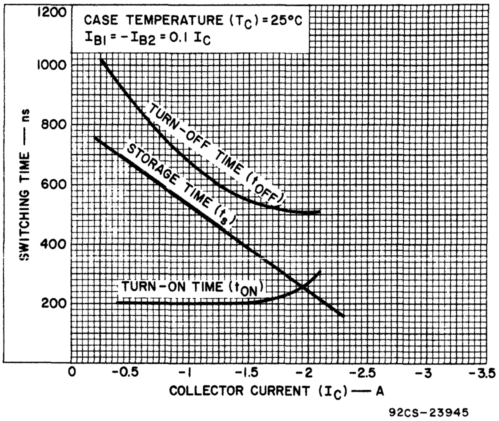


Fig. 8 — Typical saturated switching characteristics for types 2N5781, 2N5782, and 2N5783.

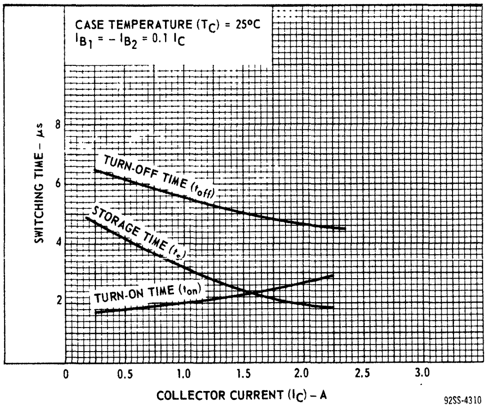


Fig. 9 — Typical saturated switching characteristics for types 2N5784, 2N5785, and 2N5786.

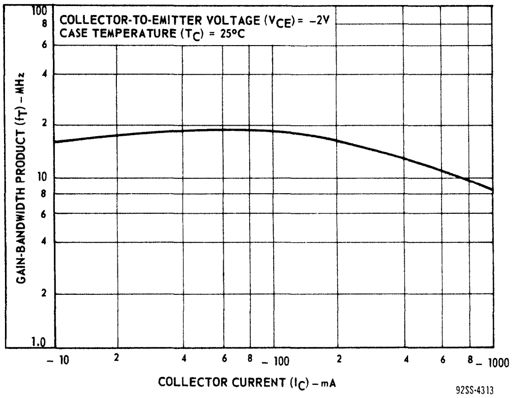


Fig. 10 — Typical gain-bandwidth product for types 2N5781, 2N5782, and 2N5783.

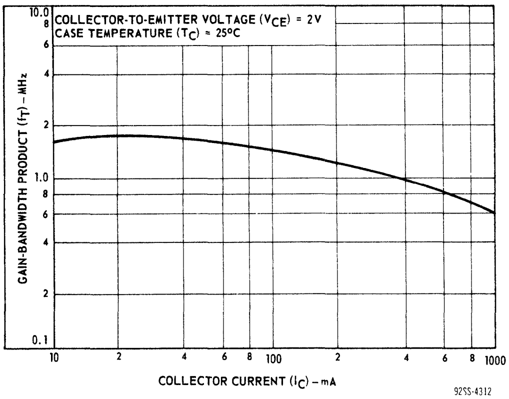


Fig. 11 — Typical gain-bandwidth product for types 2N5784, 2N5785, and 2N5786.

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

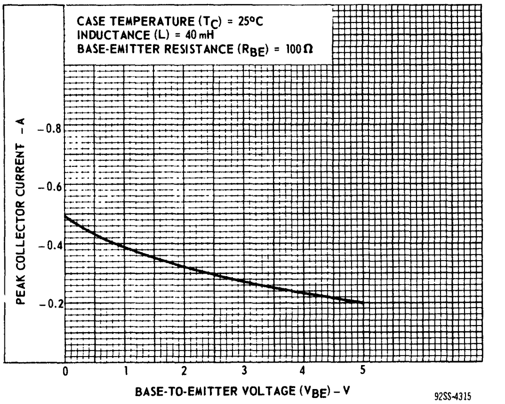


Fig. 12 — Reverse-bias second-breakdown characteristics for types 2N5781, 2N5782, and 2N5783.

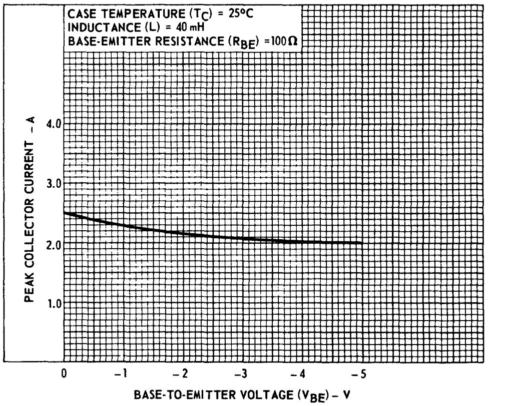


Fig. 13 — Reverse-bias second-breakdown characteristics for types 2N5784, 2N5785, and 2N5786.

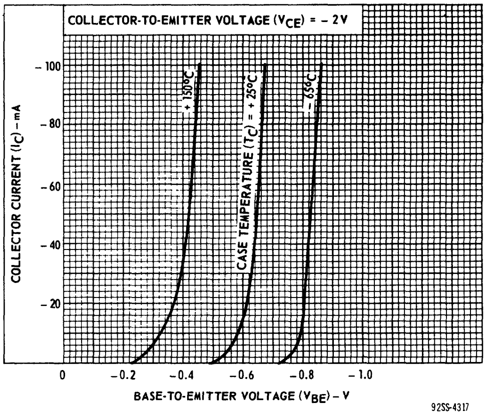


Fig. 14 — Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

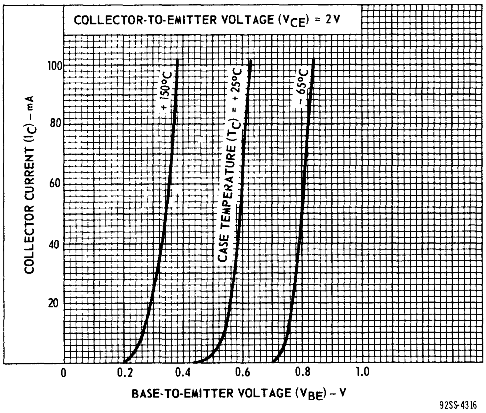


Fig. 15 — Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

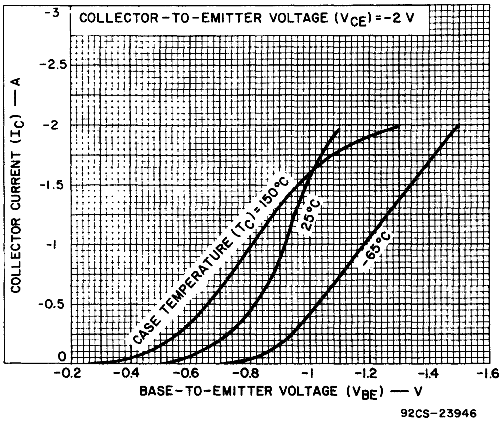


Fig. 16 — Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

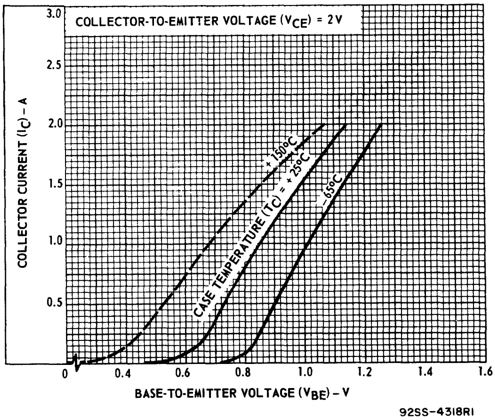


Fig. 17 — Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

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

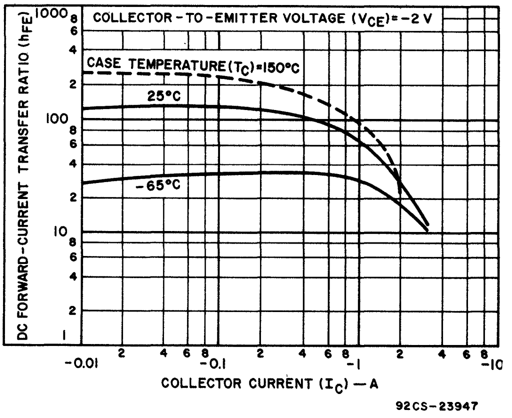


Fig. 18 — Typical dc beta characteristics for type 2N5781.

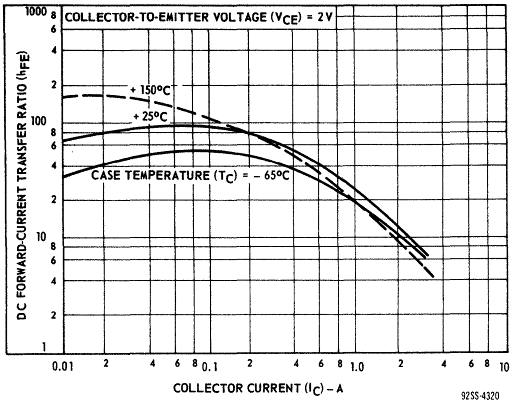


Fig. 19 — Typical dc beta characteristics for type 2N5784.

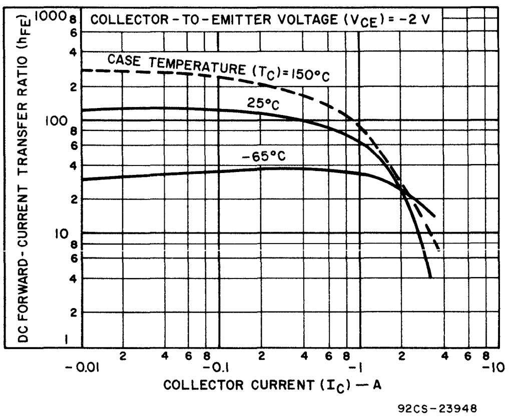


Fig. 20 — Typical dc beta characteristics for type 2N5782.

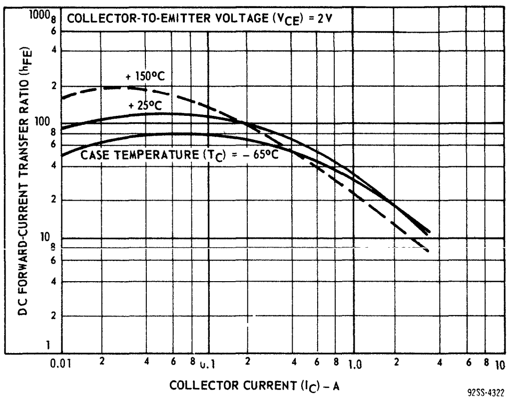


Fig. 21 — Typical dc beta characteristics for type 2N5785.

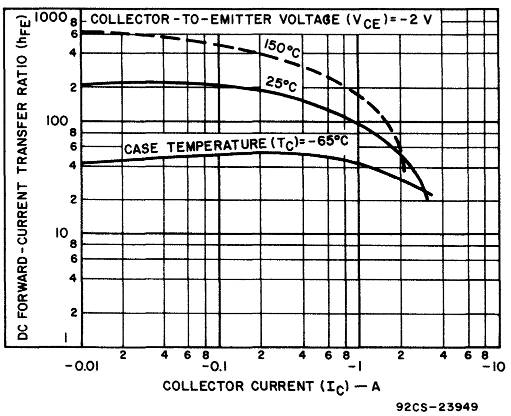


Fig. 22 — Typical dc beta characteristics for type 2N5783.

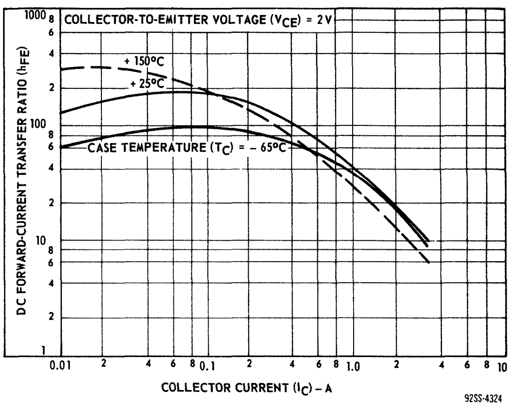


Fig. 23 — Typical dc beta characteristics for type 2N5786.

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

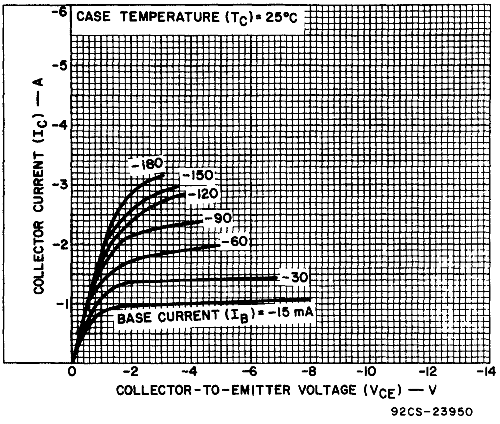


Fig. 24 — Typical output characteristics for type 2N5781.

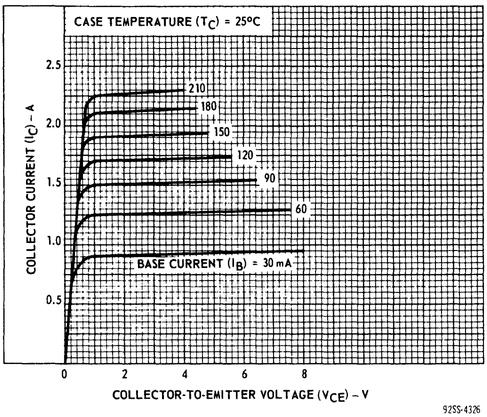


Fig. 25 — Typical output characteristics for type 2N5784.

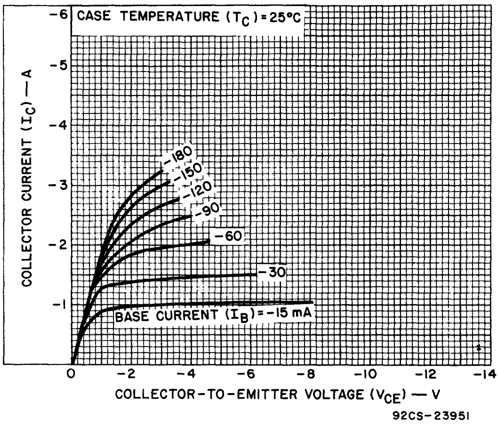


Fig. 26 — Typical output characteristics for type 2N5782.

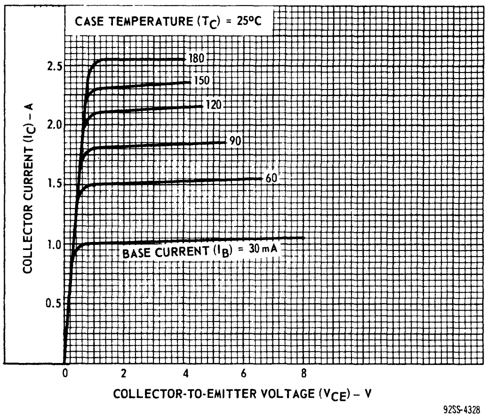


Fig. 27 — Typical output characteristics for type 2N5785.

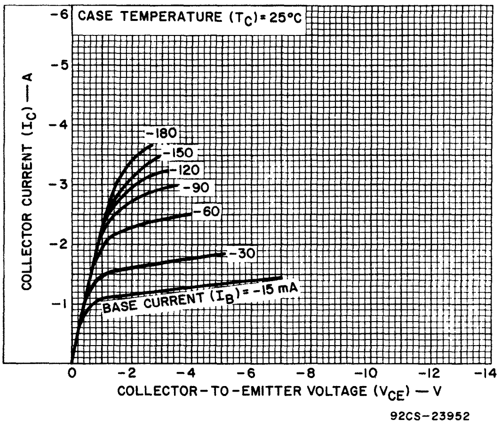


Fig. 28 — Typical output characteristics for type 2N5783.

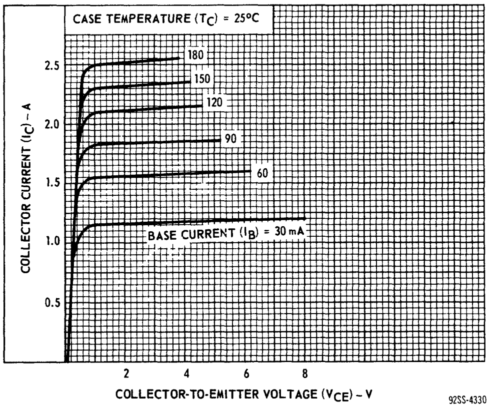
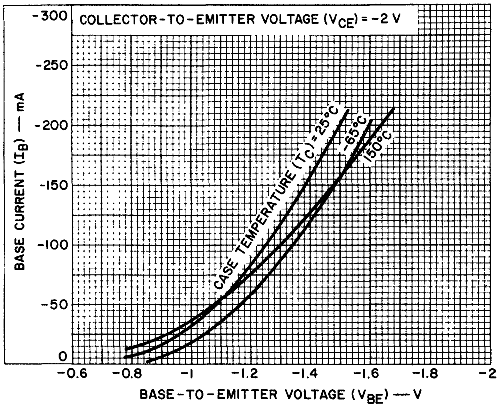


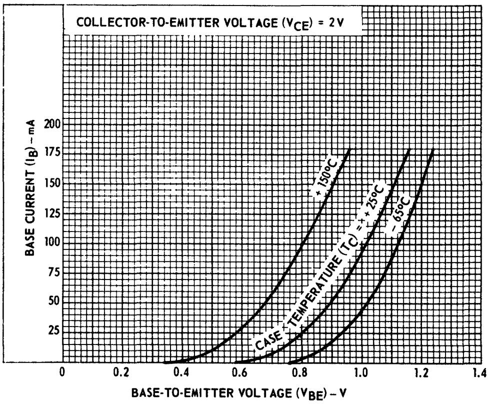
Fig. 29 — Typical output characteristics for type 2N5786.

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



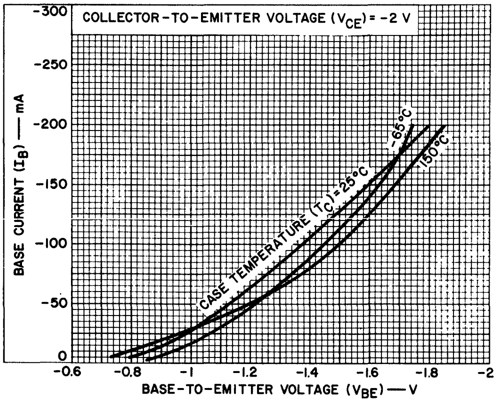
92CS-23953

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



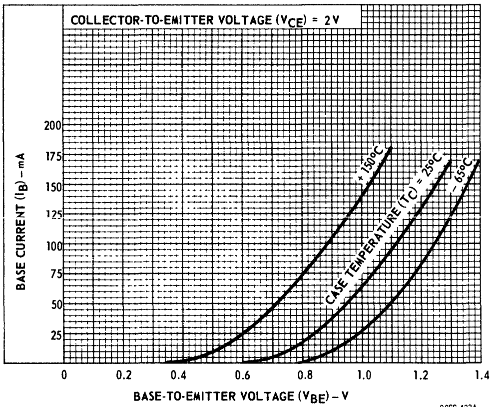
92SS-4332

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



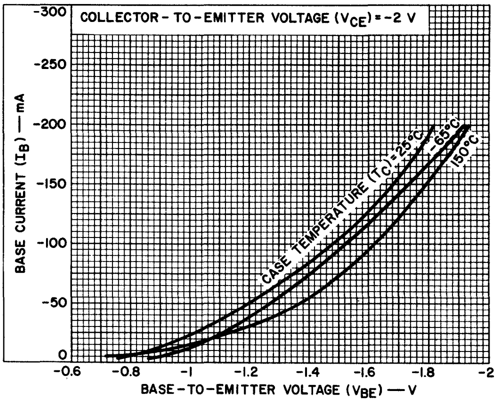
92CS-23954

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



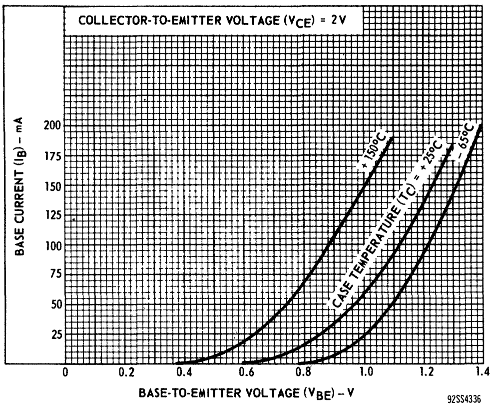
92SS-4334

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



92CS-23955

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



92SS4336

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

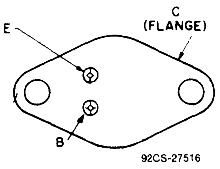
File Number **1041**

2N5885, 2N5886

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 $f_T = 4$ MHz [min.] at 1 A*
- *Low saturation voltage with high beta*
- *High dissipation capability*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-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		V
*I_C	25		A
*I_{CM}	50		A
*I_B	7.5		A
I_{BM}	15		A
*P_T:			
At $T_C \leq 25°C$	200		W
At $T_C > 25°C$ ... Derate linearly	1.15		W/°C
	See Figs. 1 and 2		
*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

*** 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 VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5885 Min.	Max.	2N5886 Min.	Max.	UNITS
* I_{CBO}	60[a] 80[a]				– –	1 –	– –	– 1	mA
* I_{CEX}	60 80	−1.5 −1.5			– –	1 –	– –	– 1	mA
* I_{CEX} T_C = 150°C	60 80	−1.5 −1.5			– –	10 –	– –	– 10	mA
* I_{CEO}	30 40				– –	2 –	– –	– 2	mA
* I_{EBO}		−5			–	1	–	1	mA
* 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
* V_{BE}	4		10		–	1.5	–	1.5	V
* V_{BE}(sat)			25[b]	6.25	–	2.5	–	2.5	V
* V_{CE}(sat)			15[b] 25[b]	1.5 6.25	– –	1 4	– –	1 4	V
$I_{S/b}$ 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) * t_s * t_f	V_{CC} = 30		10 10 10	1 1[c] 1[c]	– – –	0.7 1 0.8	– – –	0.7 1 0.8	μs
$R_{\theta JC}$	20		5		–	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] $I_{B_1} = -I_{B_2}$.

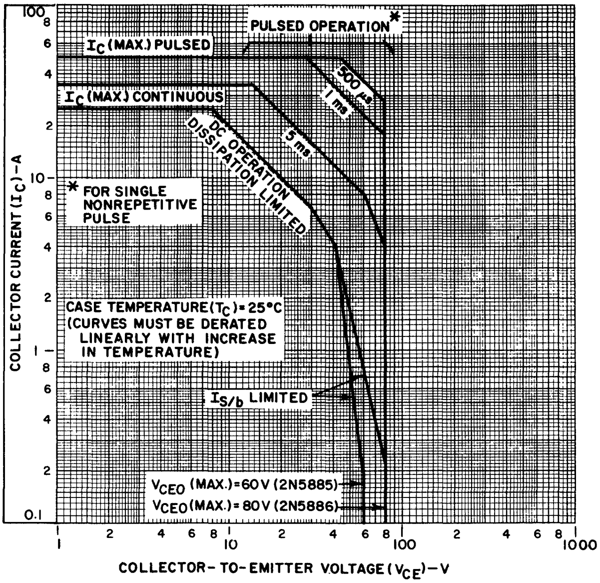


Fig. 1 — Maximum operating areas for 2N5885 and 2N5886.

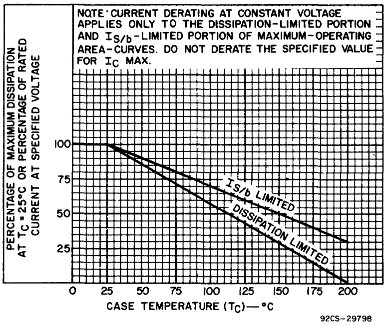


Fig. 2 — Derating curves for 2N5885 and 2N5886.

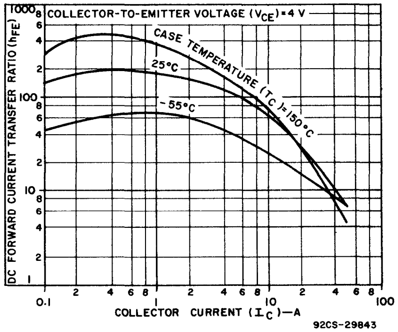


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5885 and 2N5886.

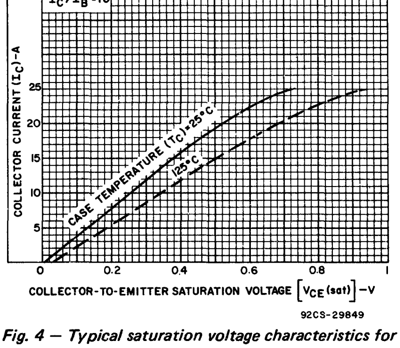


Fig. 4 — Typical saturation voltage characteristics for 2N5885 and 2N5886.

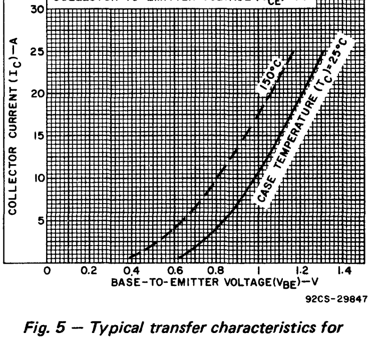


Fig. 5 — Typical transfer characteristics for 2N5885 and 2N5886.

2N5885, 2N5886

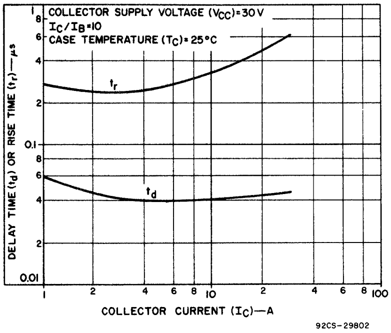


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5885 and 2N5886.

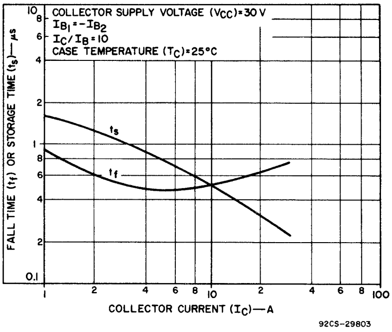


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5885 and 2N5886.

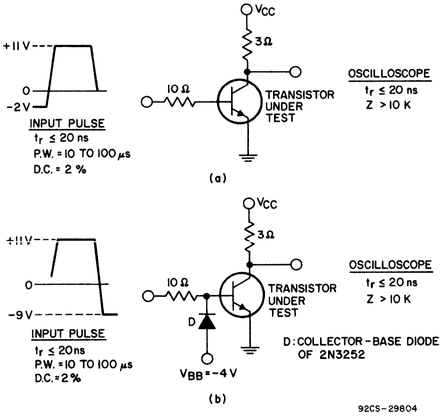


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5885 and 2N5886.

File Number **675**

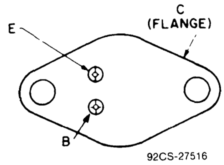
2N5954, 2N5955, 2N5956

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

RCA-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_{CBO}	-90	-70	-50	V
* $V_{CEX}(sus)$				
V_{BE} = 1.5 V, R_{BE} = 100 Ω	-90	-70	-50	V
$V_{CER}(sus)$				
R_{BE} = 100 Ω	-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 ≥ 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}	-35	—	—	—	—	-100	—	—	—	—	
R_{BE} = 100 Ω	-55	—	—	—	—	—	—	-100	—	—	μA
	-75	—	—	—	—	—	—	—	—	-100	
* I_{CEX}	-45	1.5	—	—	—	-100	—	—	—	—	
R_{BE} = 100 Ω	-65	1.5	—	—	—	—	—	-100	—	—	μA
	-85	1.5	—	—	—	—	—	—	—	-100	
* R_{BE} = 100 Ω,	-45	1.5	—	—	—	-2	—	—	—	—	
T_C = 150° C	-65	1.5	—	—	—	—	—	-2	—	—	mA
	-85	1.5	—	—	—	—	—	—	—	-2	
* I_{CEO}	-25	—	—	—	—	-1	—	—	—	—	
	-45	—	—	—	—	—	—	-1	—	—	mA
	-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]	—	
$V_{CER}(sus)$ R_{BE} = 100 Ω	—	—	-0.1[a]	—	-45[b]	—	-65[b]	—	-85[b]	—	V
$V_{CEX}(sus)$ R_{BE} = 100 Ω	—	1.5	-0.1[a]	—	-50[b]	—	-70[b]	—	-90[b]	—	
* V_{BE}	-4	—	-3[a]	—	—	-2	—	—	—	—	
	-4	—	-2.5[a]	—	—	—	—	-2	—	—	V
	-4	—	-2[a]	—	—	—	—	—	—	-2	
* $V_{CE}(sat)$	—	—	-3[a]	-0.3	—	-1	—	—	—	—	
	—	—	-2.5[a]	-0.25	—	—	—	-1	—	—	V
	—	—	-2[a]	-0.2	—	—	—	—	—	-1	
* $\|h_{fe}\|$ f = 1 MHz	-4	—	-1	—	5	—	5	—	5	—	
* h_{fe} f = 1 kHz	-4	—	-0.5	—	25	—	25	—	25	—	
$R\theta_{JC}$	—	—	—	—	—	4.3	—	4.3	—	4.3	° 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 voltage $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ MUST NOT be measured on a curve tracer.

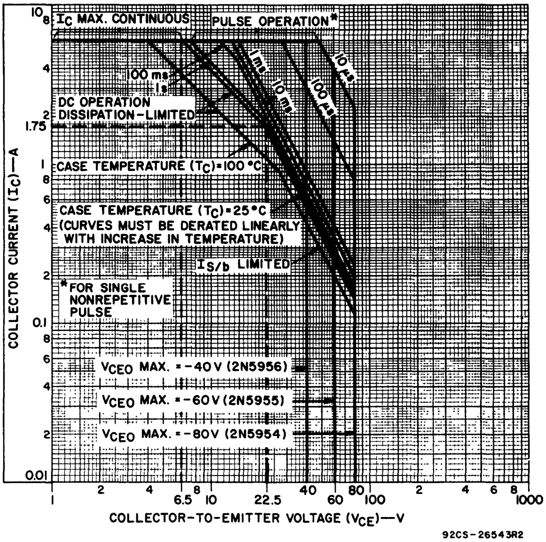


Fig. 1 - Maximum operating areas for all types.

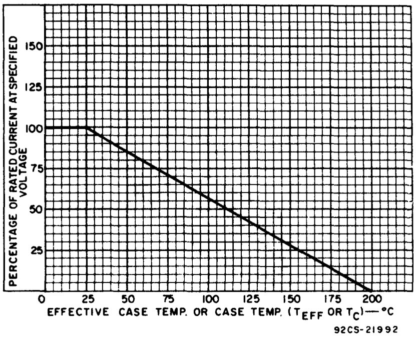


Fig. 2 - Current derating chart for all types.

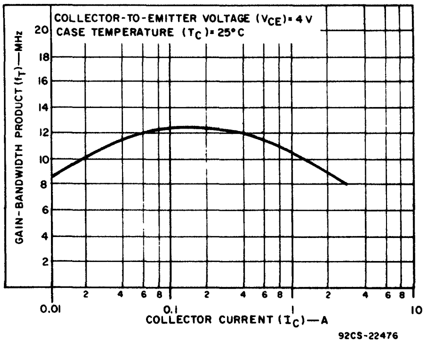


Fig. 3 - Typical gain-bandwidth product for all types.

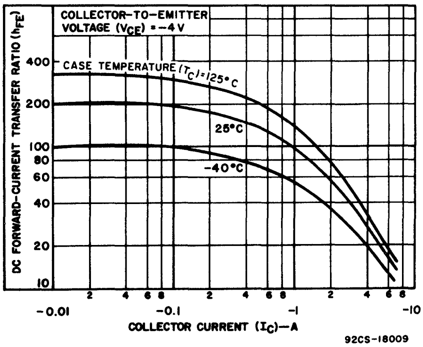


Fig. 4 - Typical dc beta characteristics for 2N5954-2N5956.

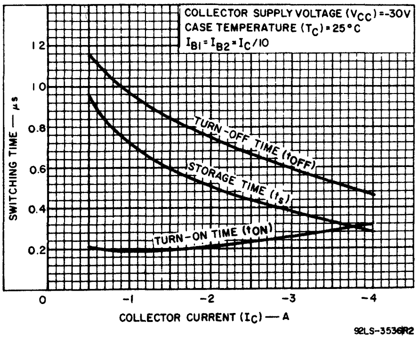


Fig. 5 - Typical saturated switching characteristics for 2N5954-2N5956.

2N5954, 2N5955, 2N5956

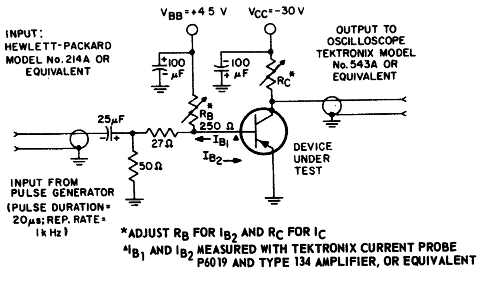


Fig. 6 - Circuit used to measure saturated switching times for 2N5954-2N5956.

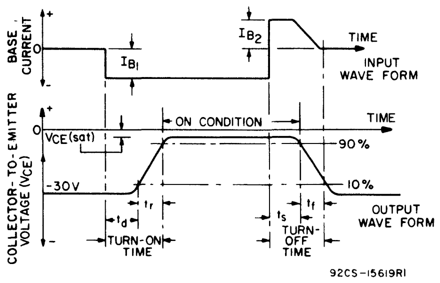


Fig. 7 - Oscilloscope display for measurement of switching times for 2N5954-2N5956.

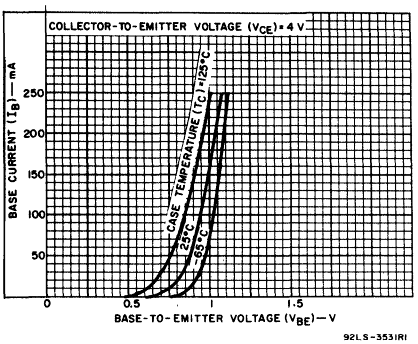


Fig. 8 - Typical input characteristics for all types.

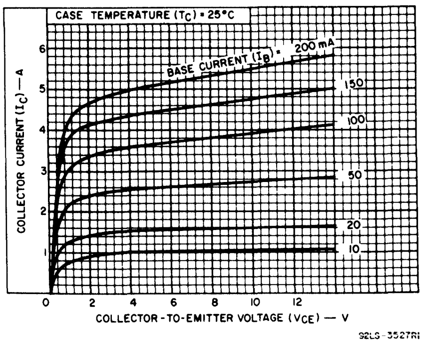


Fig. 9 - Typical output characteristics for all types.

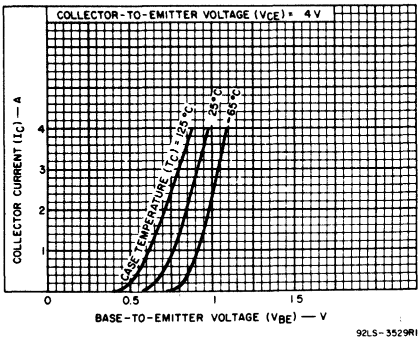


Fig. 10 - Typical transfer characteristics for all types.

File Number **676**

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

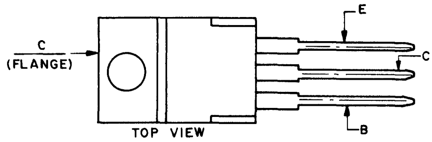
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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

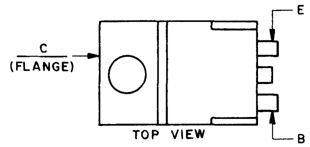
Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB



JEDEC TO-220AA

The RCA-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:*

N-P-N	2N6288 2N6289	2N6290 2N6291	2N6292 2N6293	2N6473	2N6474	
P-N-P	2N6110‡ 2N6111‡	2N6108‡ 2N6109‡	2N6106‡ 2N6107‡	2N6475‡	2N6476‡	
* V_{CBO}	40	60	80	110	130	V
* $V_{CEX}(sus)$						
R_{BB} = 100 Ω, 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°C)		7		4		A
* I_B ($T_C \leq$ 130°C)		3		2		A
P_T						
* $T_C \leq$ 25°C			40			W
$T_C >$ 25°C $\leq$ 100°C			16			W
$T_C >$ 25°C			Derate linearly 0.32			W/°C
$T_A \leq$ 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						
At distances ≥ 1/8 in. (3.17 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.

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

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

CHARACTERISTIC	TEST CONDITIONS♦ VOLTAGE V dc		CURRENT A dc		LIMITS 2N6292, 2N6293, 2N6106♦, 2N6107♦		2N6290, 2N6291, 2N6108♦, 2N6109♦		2N6288, 2N6289, 2N6110♦, 2N6111♦		UNITS
	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} = 100Ω, 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	–	–	–	–	V
	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	–	MHz
2N6106-11	–4		–0.5		10	–	10	–	10	–	
* C_{obo} (f = 1 MHz)	10[c]		0		–	250	–	250	–	250	pF
$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$					–	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 Ω)	120				–	0.1	–	–	mA
	100				–	–	–	0.1	
(R_{BE} = 100 Ω T_C = 100°C)	120				–	2	–	–	
	100				–	–	–	2	
* I_{CEX} (R_{BE} = 100 Ω)	120	−1.5			–	0.1	–	–	
	100	−1.5			–	–	–	0.1	
(R_{BE} = 100 Ω, T_C = 100°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 Ω)			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	–	
f_T 2N6473-74	4		0.5		4	–	4	–	MHz
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

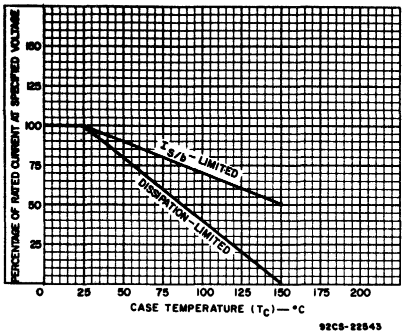


Fig. 1 — Current derating curves for all types.

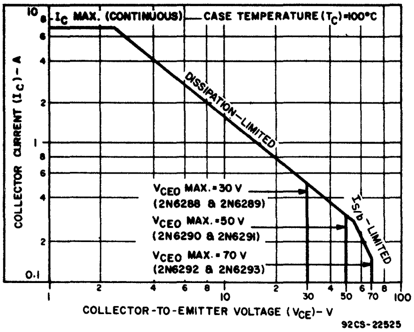


Fig. 2 - Maximum operating areas for 2N6288 — 2N6293 (T_C = 100°C).

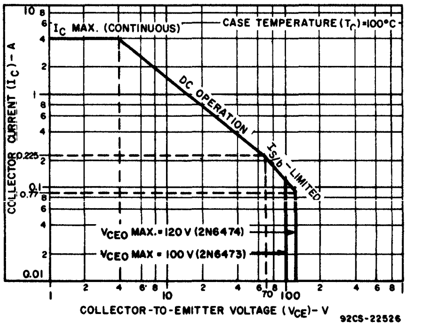


Fig. 3 - Maximum operating areas for 2N6473 — 2N6474 (T_C = 100°C).

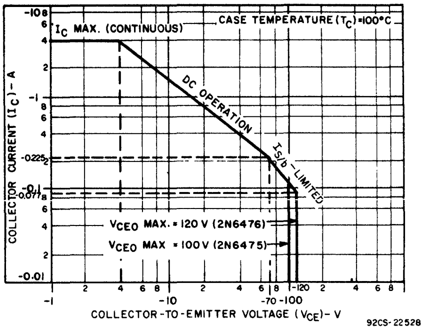


Fig. 4 - Maximum operating areas for 2N6475 and 2N6476 (T_C = 100°C).

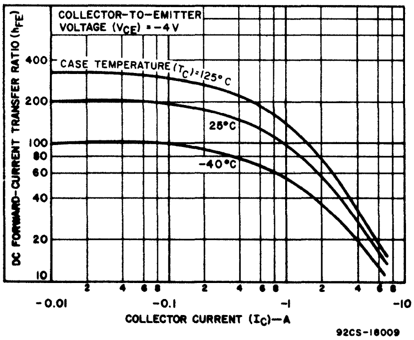


Fig. 5 - Typical dc beta characteristics for 2N6106 — 2N6111.

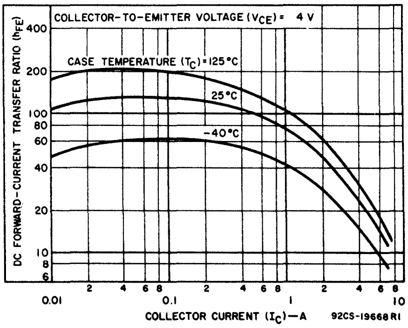


Fig. 6 - Typical dc beta characteristics for 2N6288 — 2N6293.

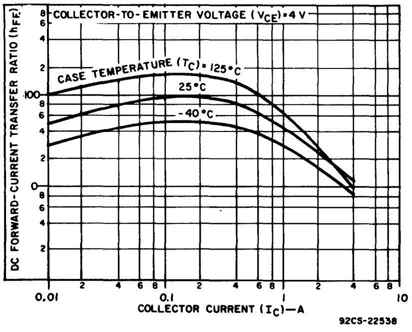


Fig. 7 - Typical dc beta characteristics for 2N6473 and 2N6474.

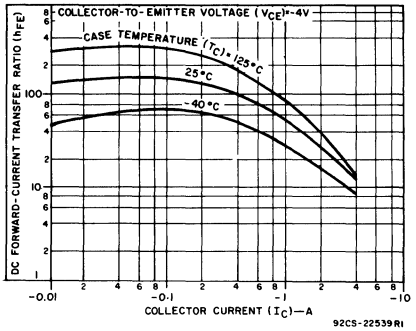


Fig. 8 - Typical dc beta characteristics for 2N6475 and 2N6476.

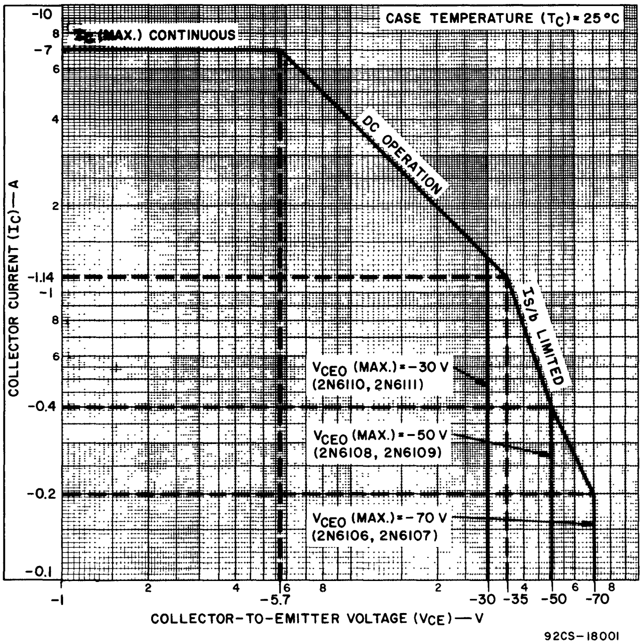


Fig. 9 - Maximum operating areas for 2N6106 – 2N6111 (T_C = 25°C).

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

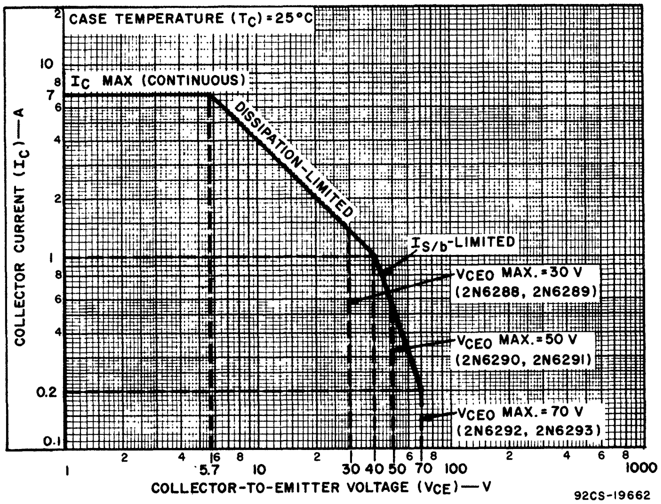


Fig. 10 - Maximum operating areas for 2N6288—2N6293 (T_C = 25°C).

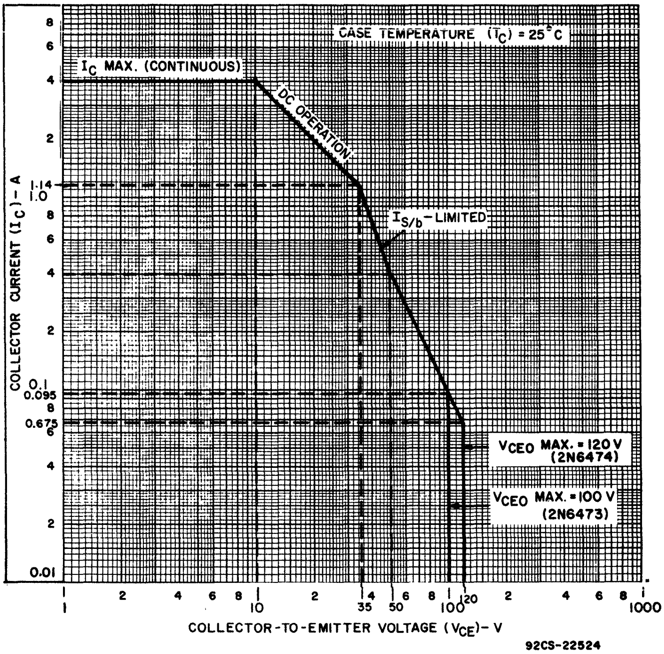


Fig. 11 - Maximum operating areas for 2N6473 and 2N6474 (T_C = 25°C).

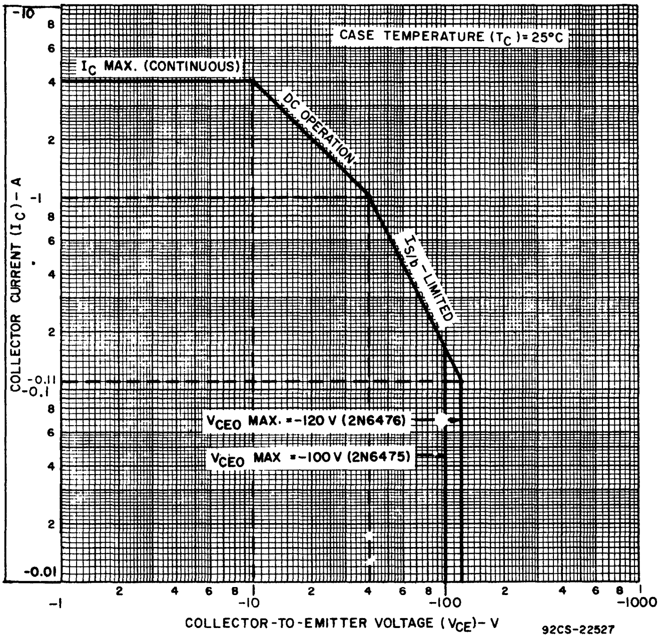


Fig. 12 - Maximum operating areas for 2N6475 – 2N6476 (T_C = 25°C).

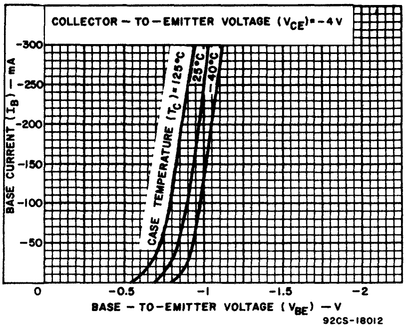


Fig. 13 - Typical input characteristics for 2N6106 – 2N6111, 2N6475, and 2N6476.

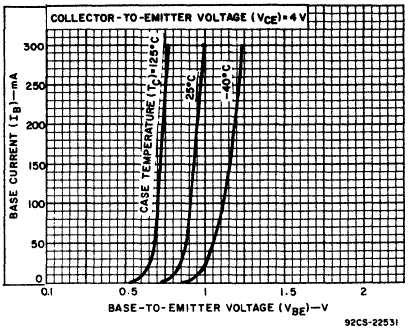


Fig. 14 - Typical input characteristics for 2N6288 – 2N6293.

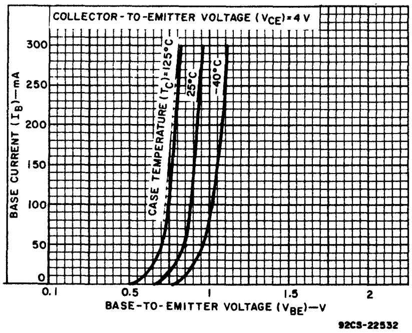


Fig. 15 - Typical input characteristics for 2N6473 2N6474.

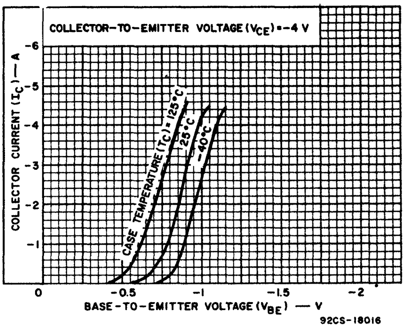


Fig. 16 - Typical transfer characteristics for 2N6106 – 2N6111.

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

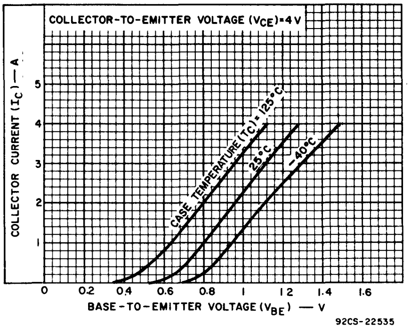


Fig. 17 - Typical transfer characteristics for 2N6288 – 2N6293.

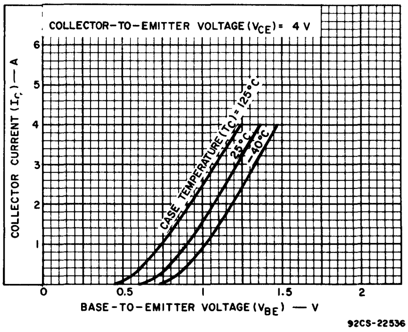


Fig. 18 - Typical transfer characteristics for 2N6473 and 2N6474.

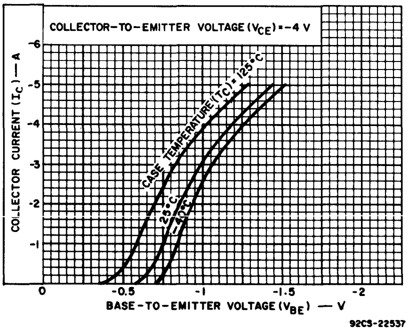


Fig. 19 - Typical transfer characteristics for 2N6475 and 2N6476.

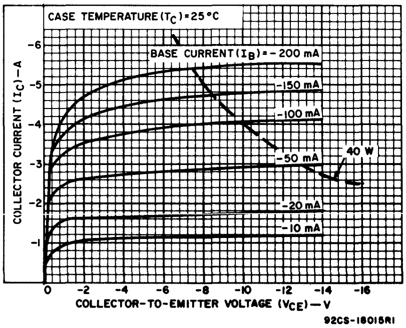


Fig. 20 - Typical output characteristics for 2N6106 – 2N6111.

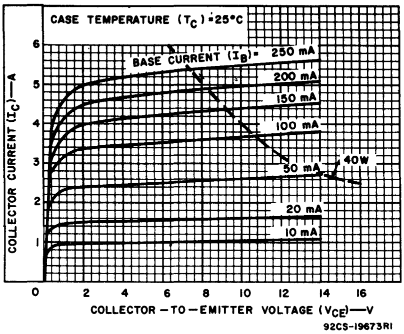


Fig. 21 - Typical output characteristics for 2N6288 – 2N6293.

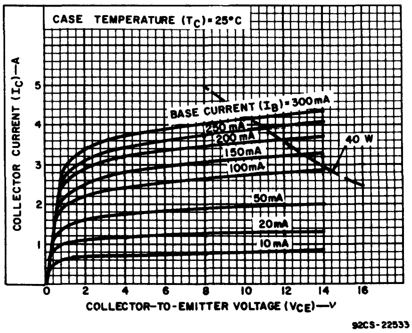


Fig. 22 - Typical output characteristics for 2N6473 and 2N6474.

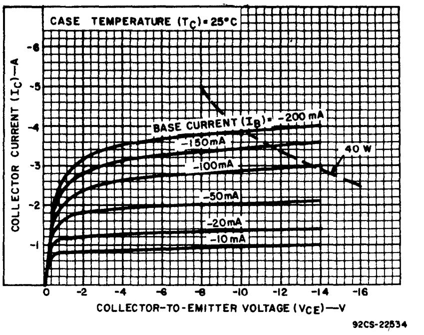


Fig. 23 - Typical output characteristics for 2N6475 and 2N6476.

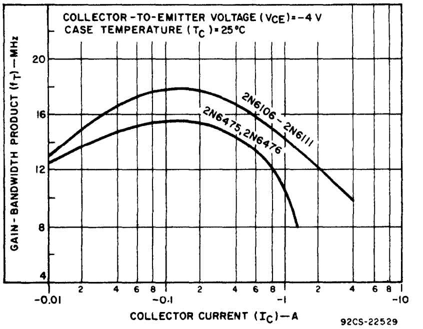


Fig. 24 - Typical gain-bandwidth product 2N6106 – 2N6111, 2N6475, and 2N6476.

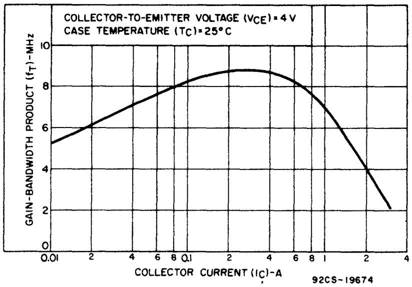


Fig. 25 - Typical gain-bandwidth product for 2N6288 – 2N6293.

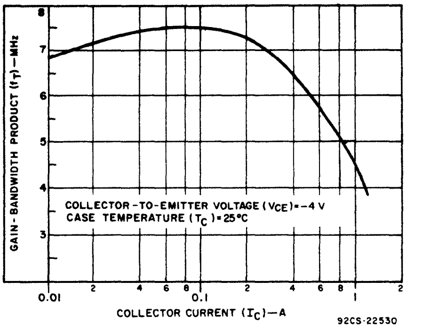


Fig. 26 - Typical gain-bandwidth product for 2N6473 and 2N6474.

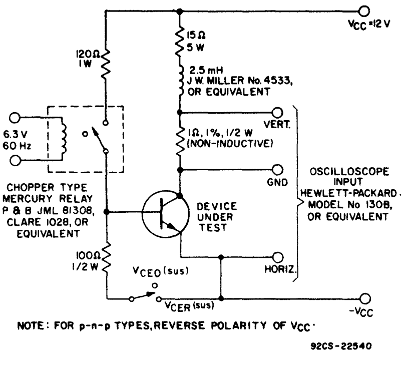
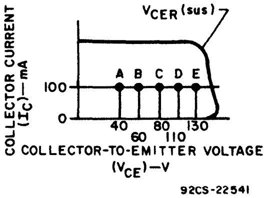


Fig. 27 - Circuit used to measure sustaining voltage V_{CER}(sus) for all types.



Note: Curve will be inverted and polarity reversed for p-n-p types. The sustaining voltage, V_{CER}(sus), is accepatble 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

File Number **1149**

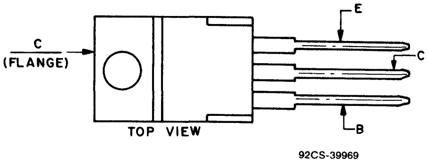
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-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	2N6123	
	P-N-P	2N6124	2N6125	2N6126	
*V_{CBO}		45	60	80	V
*$V_{CEO}(sus)$		45	60	80	V
*V_{EBO}			5		V
*I_C			4		A
*I_B			1		A
P_T					
*$T_C \geq 25°C$			40		W
$T_C > 25°C \leq 100°C$			16		W
$T_C > 25°C$			Derate linearly 0.32		W/°C
$T_A \leq 25°C$			1.8		W
$T_A > 25°C$			Derate linearly 0.0144		W/°C
*T_{stg}, T_J			-65 to 150		°C
T_L At distances $\geq$ 1/8 in. (3.17 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.

2N6121-2N6123, 2N6124-2N6126

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

CHARACTERISTIC	TEST CONDITIONS♦ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6121 2N6124♦ MIN.	MAX.	2N6122 2N6125♦ MIN.	MAX.	2N6123 2N6126♦ MIN.	MAX.	UNITS
I_{CBO}	45[a] 60[a] 80[a]				– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	mA
* I_{CEX}	45 60 80	−1.5 −1.5 −1.5			– – –	0.1 – –	– – –	– 0.1 –	– – –	– – 0.1	mA
T_C = 125°C	45 60 80	−1.5 −1.5 −1.5			– – –	2 – –	– – –	– 2 –	– – –	– – 2	mA
* I_{CEO}	45 60 80			0 0 0	– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* I_{EBO}		−5	0		–	1	–	1	–	1	mA
* 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_{BE}	2		1.5[c]		–	1.2	–	1.2	–	1.2	V
V_{CE}(sat)			1.5[c] 4[c]	0.15 1	– –	0.6 1.4	- –	0.6 1.4	– –	0.6 1.4	V
* $\|h_{fe}\|$ (f=1 MHz)	4		1		2.5	–	2.5	–	2.5	–	
* h_{fe} (f=1 kHz)	2		0.1		25	–	25	–	25	–	
$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	°C/W

* 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.

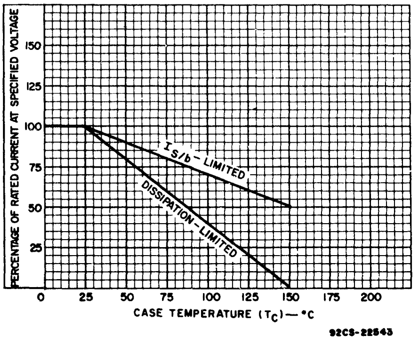


Fig. 1 — Current derating curves for all types.

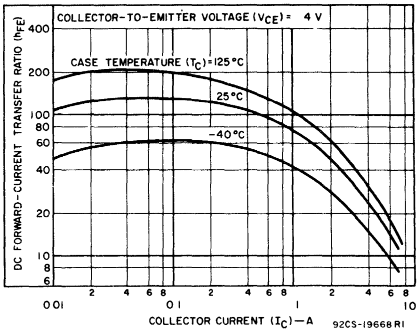


Fig. 2 — Typical dc beta characteristics for all types.

2N6121-2N6123, 2N6124-2N6126

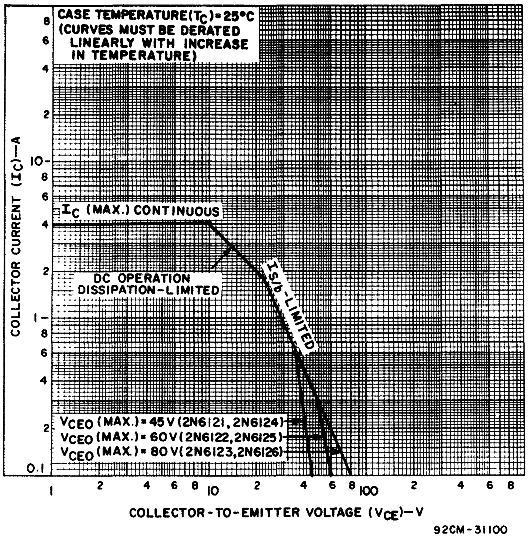


Fig. 3 — Maximum operating areas for all types.

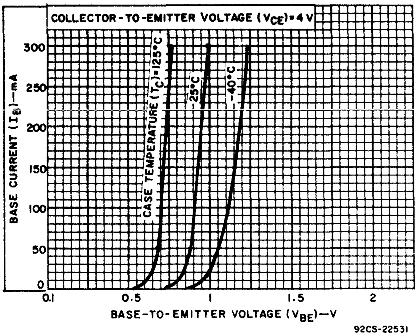


Fig. 4 — Typical input characteristics for all types.

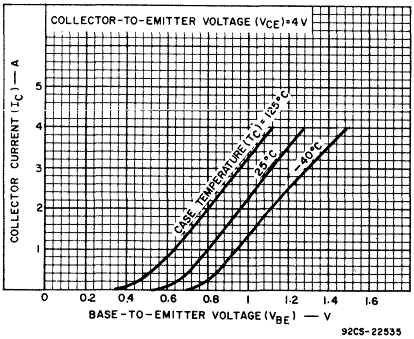


Fig. 5 — Typical transfer characteristics for all types.

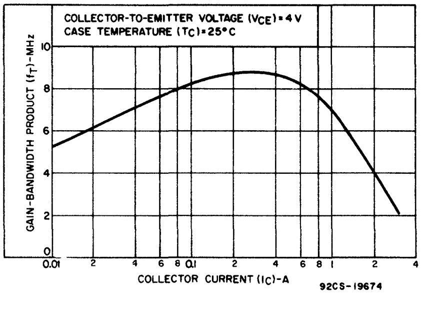


Fig. 6 — Typical gain-bandwidth product.

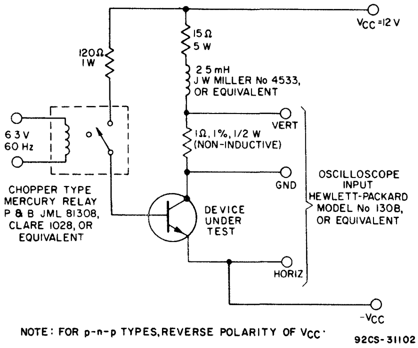


Fig. 7 — Circuit used to measure sustaining voltage V_{CEO}(sus) for all types.

File Number **677**

2N6246, 2N6247, 2N6248, 2N6469

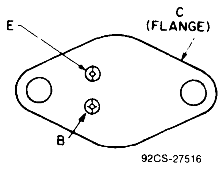
Silicon P-N-P Epitaxial-Base, High-Power Transistors

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

RCA-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	V_{CBO}	-50	-70	-90	-110	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	-50	-70	-90	-110	V
With base open	V_{CEO}	-40	-60	-80	-100	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	-5	-5	-5	-5	V
*CONTINUOUS COLLECTOR CURRENT	I_C	-15	-15	-15	-10	A
*CONTINUOUS BASE CURRENT	I_B	-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:						
Storage & Operating (Junction)		← −65 to +200 →				°C
*PIN TEMPERATURE (During Soldering):						
At distances ≥ 1/32" (0.8 mm) from seating plane for 10 s max.		← +235 →				°C

* 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°C	I_{CEX}	–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	°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 –	– –	– −200	μA
*	With base-emitter junction reverse-biased	I_{CEX}	−85 −100	1.5 1.5			– –	−200 –	– –	– −200	μA
*	With reverse bias, at T_C = 150°C	I_{CEX}	−70 −90	1.5 1.5			– –	−5 –	– –	– −5	mA
*	With base open	I_{CEO}	−40 −50			0 0	– –	−1 –	– –	– −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 – 5	– 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	–	V
*	Base-to-Emitter Voltage	V_{BE}	−4 −4		-6^a -5^a		– –	−1.8 –	– –	– −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 −3.5 –	– – – –	−1.3 – – −3.5	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	°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

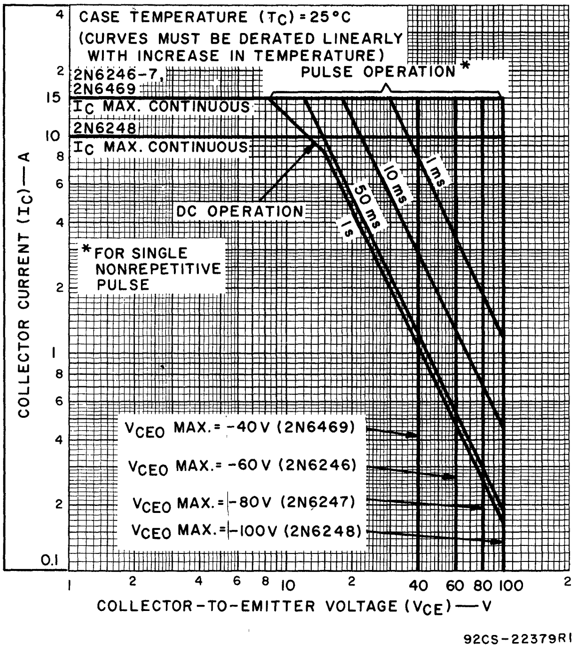


Fig. 1 — Maximum operating areas for all types.

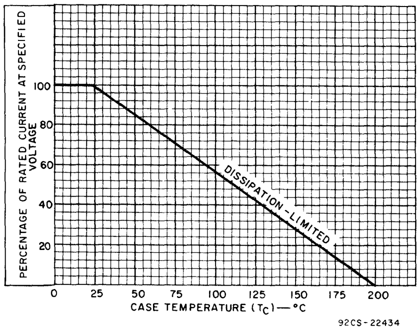


Fig. 2 — Current derating for all types.

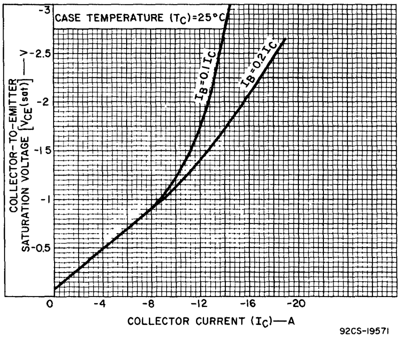


Fig. 3 — Typical collector-to-emitter saturation-voltage characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

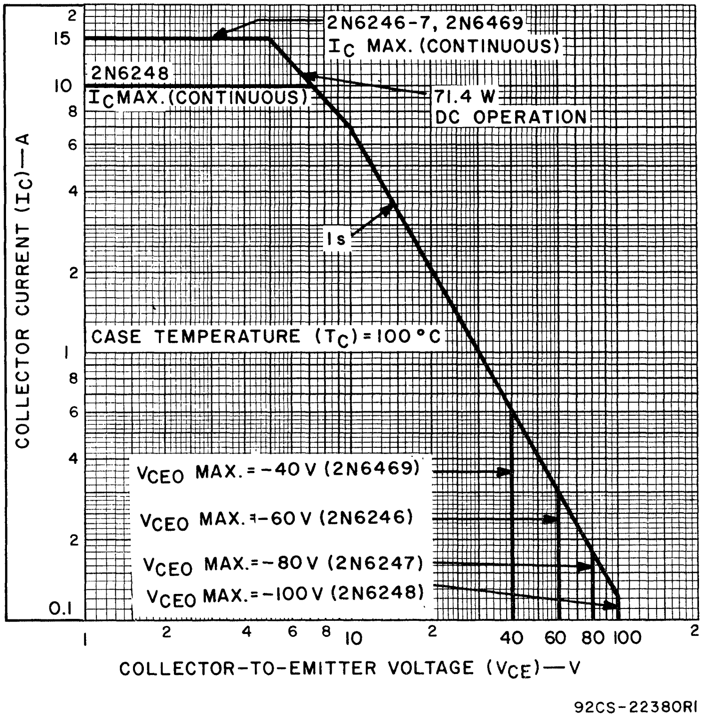


Fig. 4 — Maximum operating areas for all types.

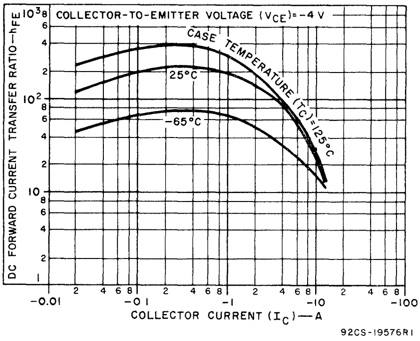


Fig. 5 — Typical dc beta characteristics for 2N6246, 2N6247, and 2N6469.

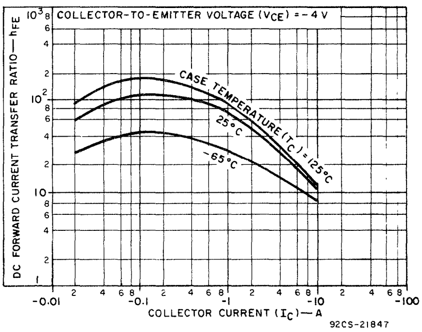


Fig. 6 — Typical dc beta characteristics for 2N6248.

2N6246, 2N6247, 2N6248, 2N6469

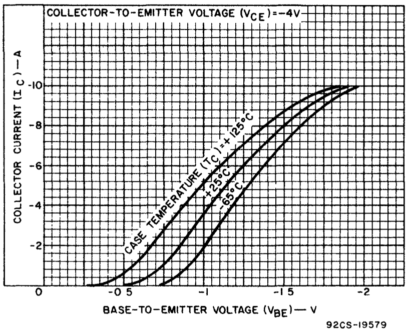


Fig. 7 — Typical transfer characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

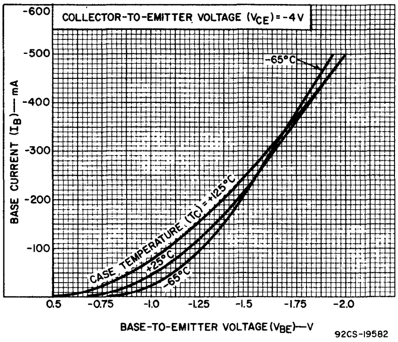


Fig. 8 — Typical input characteristics for 2N6246, 2N6247, and 2N6469.

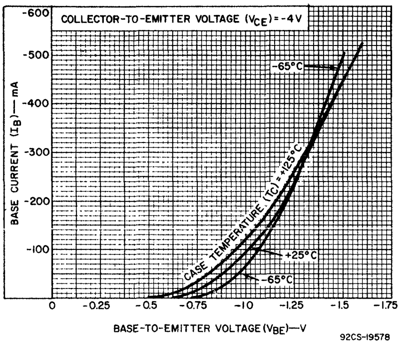


Fig. 9 — Typical input characteristics for 2N6248.

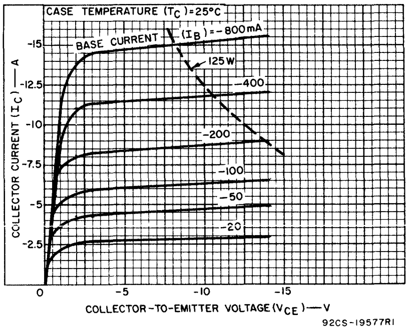


Fig. 10 — Typical output characteristics for 2N6246, 2N6247, and 2N6469.

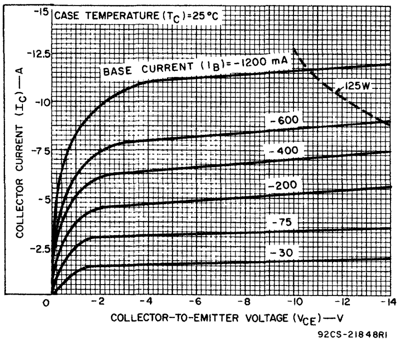


Fig. 11 — Typical output characteristics for 2N6248.

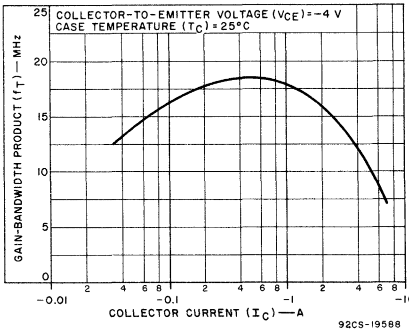


Fig. 12 — Typical gain-bandwidth product vs. collector current for 2N6246, 2N6247, 2N6248, and 2N6469.

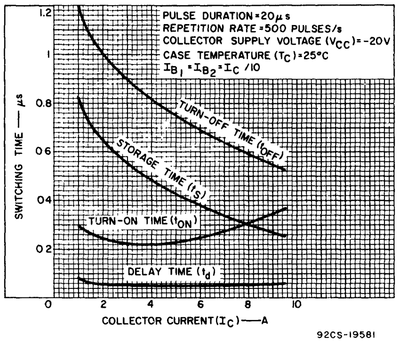


Fig. 13 — Typical saturated switching characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

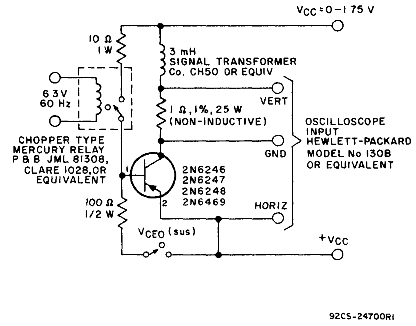


Fig. 14 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ for all types.

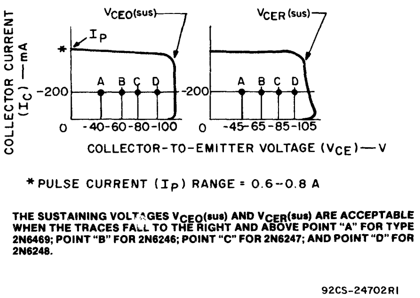


Fig. 15 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 14).

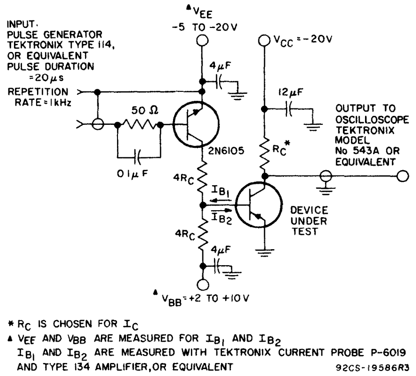


Fig. 16 — Circuit used to measure switching times for 2N6246, 2N6247, 2N6248, and 2N6469.

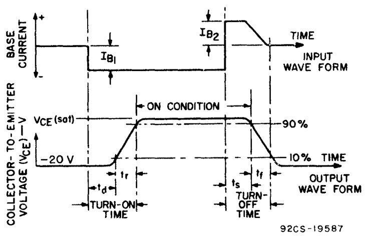


Fig. 17 — Oscilloscope display for measurement of switching times.

2N6253, 2N6254, 2N6371

File Number **1077**

High-Power Silicon N-P-N Transistors

For Industrial and Commercial Use

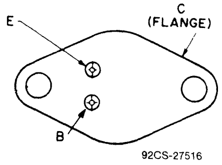
Features:

- *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

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_{CBO}	55	100	50	V
* $V_{CER}(sus)$				
R_{BE} = 100 Ω	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:				
≤ 25° C	115	150	117	W
> 25° 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° 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° C	40	-1.5	—	—	—	—	—	—	—	10	
	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_{CER}(sus) R_{BE} = 100 Ω	—	—	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_{fe} f = 1 kHz	4	—	1	—	10	—	10	—	10	—	
f_T	4	—	1	—	—	—	—	—	800	—	kHz
* $\|h_{fe}\|$ f = 0.4 MHz	4	—	1	—	2	—	2	—	2	—	
* f_{hfe}	4	—	1	—	10	—	10	—	—	—	kHz
$I_{S/b}$	40	—	—	—	—	—	—	—	2.9	—	A
t_p = 1 s	45	—	—	—	2.55	—	—	—	—	—	
nonrep.	80	—	—	—	—	—	1.87	—	—	—	
$R\theta_{JC}$	—	—	—	—	—	1.5	—	1.17	—	1.5	°C/W

* In accordance with JEDEC registration data formats JS-6 RDF-2; 2N6253, 2N6254, 2N6371.

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

2N6253, 2N6254, 2N6371

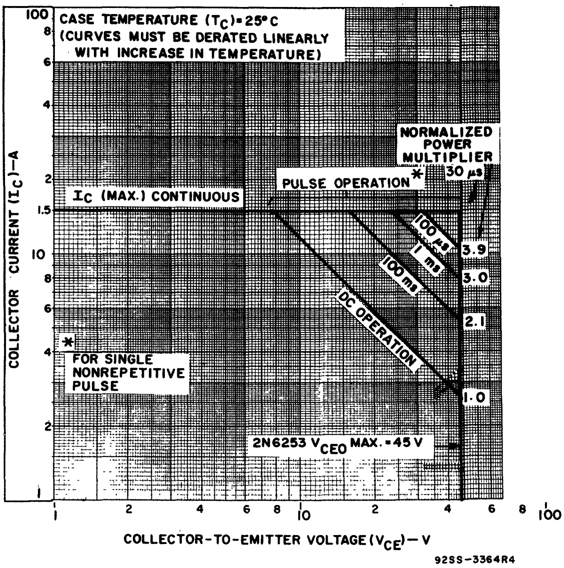


Fig. 1 - Maximum operating areas for 2N6253.

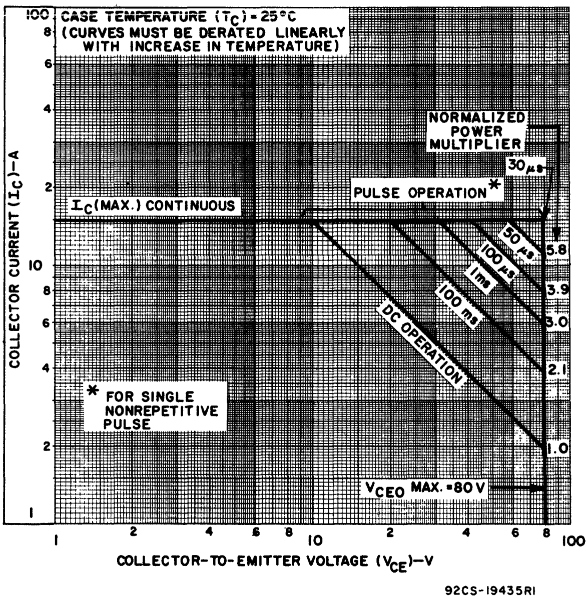


Fig. 2 - Maximum operating areas for 2N6254.

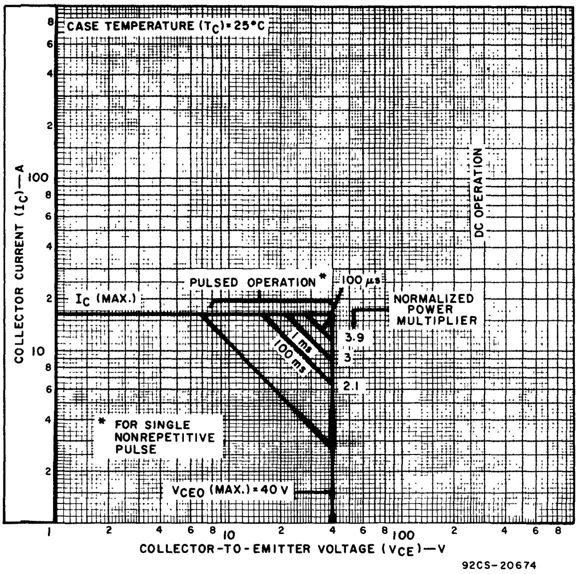


Fig. 3 - Maximum safe-area-of-operation at case temperature of 25° C for 2N6371.

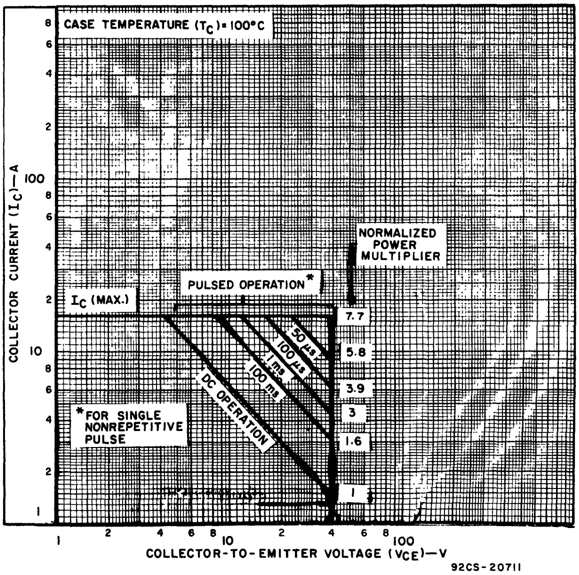


Fig. 4 - Maximum safe-area-of-operation at case temperature of 100° C for 2N6371.

2N6253, 2N6254, 2N6371

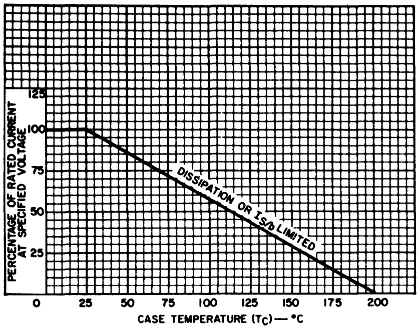


Fig. 5 - Current derating curve for all types.

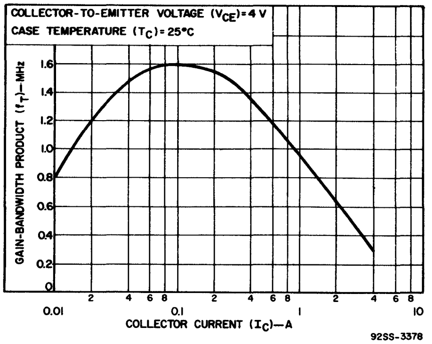


Fig. 6 - Typical gain-bandwidth product for all types.

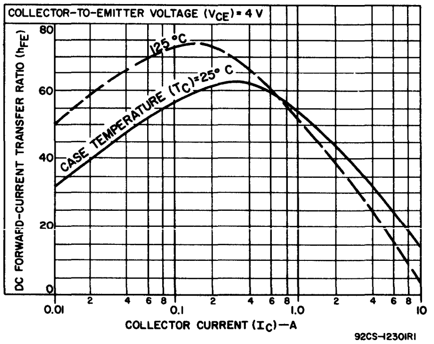


Fig. 7 - Typical dc-beta characteristics for 2N6371.

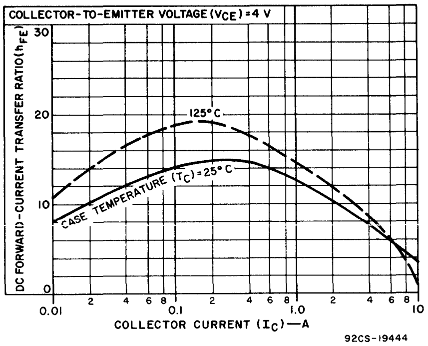


Fig. 8 - Typical dc-beta characteristics for 2N6253.

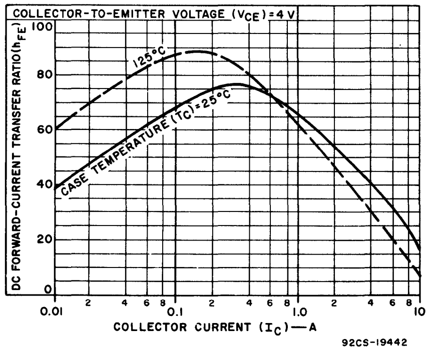


Fig. 9 - Typical dc-beta characteristics for 2N6254.

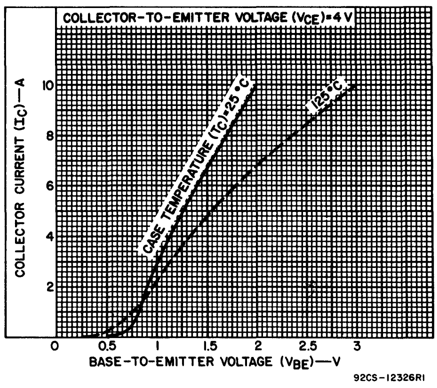


Fig. 10 - Typical transfer characteristics for 2N6253.

2N6253, 2N6254, 2N6371

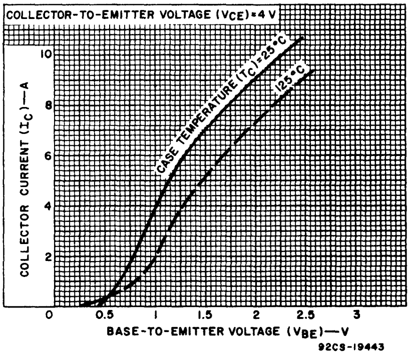


Fig. 11 - Typical transfer characteristics for 2N6254.

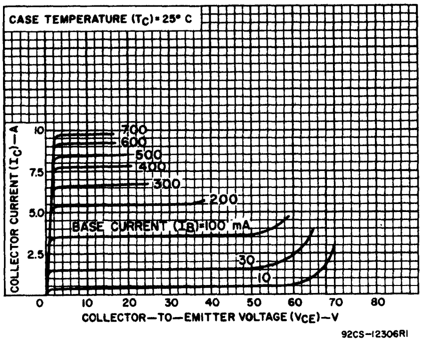


Fig. 12 - Typical output characteristics for 2N6371.

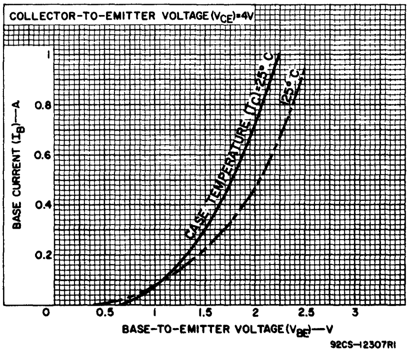


Fig. 13 - Typical input characteristics for 2N6371.

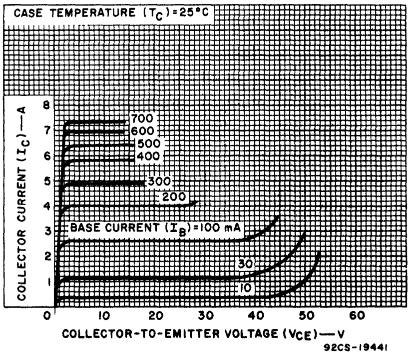


Fig. 14 - Typical output characteristics for 2N6253.

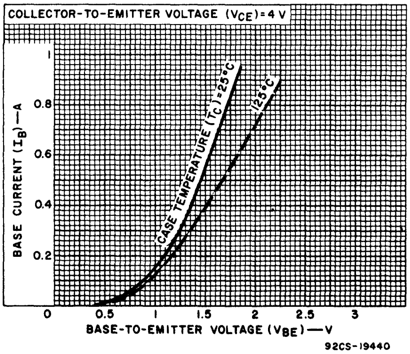


Fig. 15 - Typical input characteristics for 2N6253.

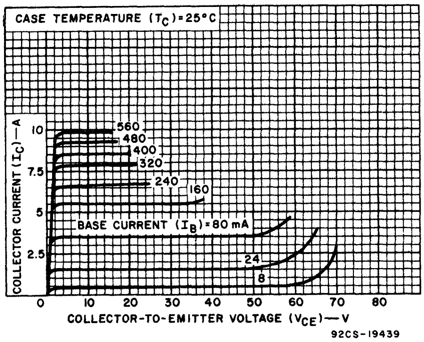


Fig. 16 - Typical output characteristics for 2N6254.

2N6253, 2N6254, 2N6371

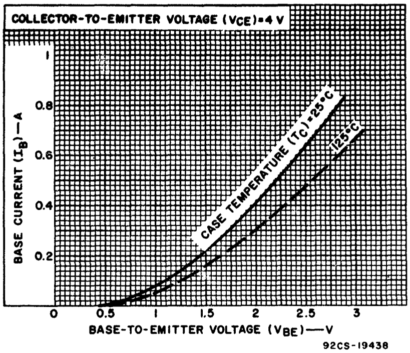


Fig. 17 - Typical input cnaracteristics for 2N6254.

File Number **888**

2N6467, 2N6468

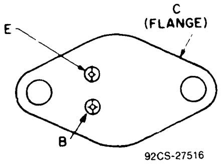
Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Application

Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-213AA

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.

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: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N6467		2N6468		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 100 Ω	-95 -100				— —	-100 —	— —	— -100	μA
*I_{CEX} R_{BE} = 100 Ω	-100 -120	1.5 1.5			— —	-100 —	— —	— -100	μA
R_{BE} = 100 Ω T_C = 150°C	-100 -120	1.5 1.5			— —	-2 —	— —	— -2	mA
*I_{CEO}	-50 -60				— —	-1 —	— —	— -1	mA
*I_{EBO}		5			—	-0.1	—	-.01	mA
*h_{FE}	-4 -4		-1.5[a] -4[a]		15 5	150 —	15 5	150 —	
*V_{CEO}(sus)			-0.1[a]		-100[b]	—	-120[b]	—	V
V_{CER}(sus) R_{BE} = 100 Ω			-0.1[a]		-105[b]	—	-125[b]	—	V
*V_{CEX}(sus) R_{BE} = 100 Ω		1.5	-0.1[a]		-110[b]	—	-130[b]	—	V
*V_{BE}	-4 -4		-1.5[a] -4[a]		— —	-2 -3.5	— —	-2 -3.5	V
V_{CE}(sat)			-1.5[a] -4[a]	-0.15 -0.8	— —	-1.2 -4*	— —	-1.2 -4*	V
*$\|h_{fe}\|$ f = 1 MHz	-4		1		5	—	5	—	
*h_{fe} f = 1 kHz	-4		0.5		25	—	25	—	
$R_{\theta JC}$					—	4.3	—	4.3	°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.*

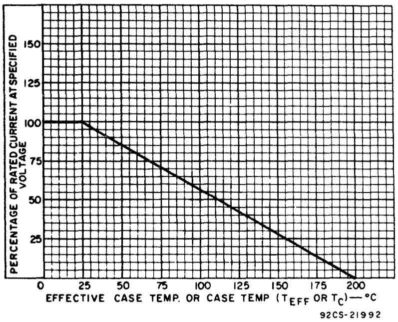


Fig. 1 — Current derating curve for all types.

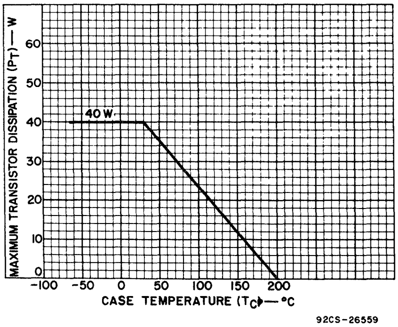


Fig. 2 — Dissipation derating curve for all types.

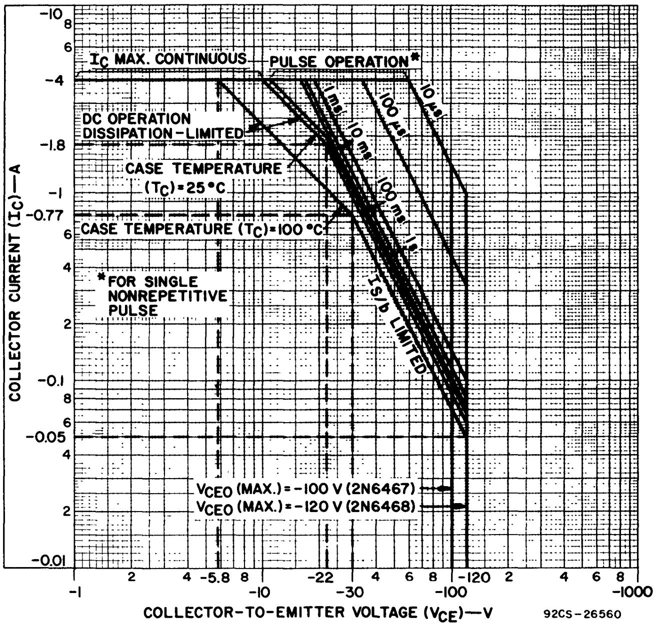


Fig. 3 — Maximum operating areas for 2N6467 and 2N6468.

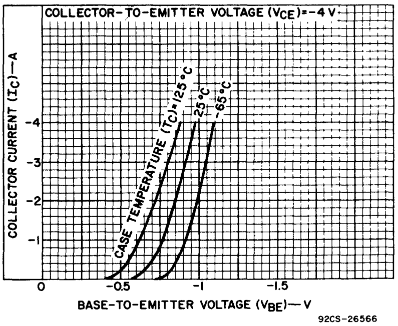


Fig. 4 — Typical transfer characteristics for 2N6467 and 2N6468.

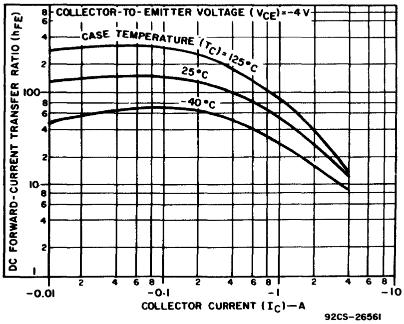


Fig. 5 — Typical dc beta characteristics for 2N6467 and 2N6468.

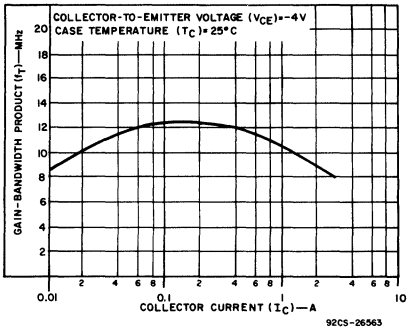


Fig. 6 — Typical gain-bandwidth product by 2N6467 and 2N6468.

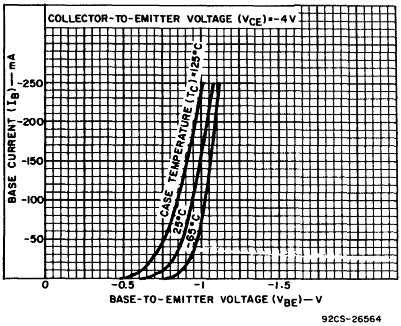


Fig. 7 — Typical input characteristics for 2N6467 and 2N6468.

2N6467, 2N6468

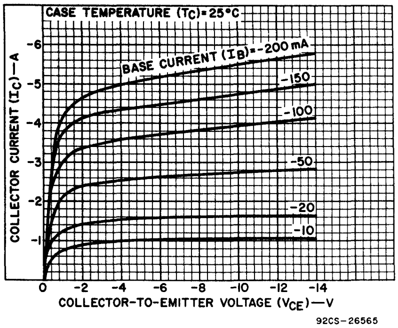


Fig. 8 — Typical output characteristics for 2N6467 and 2N6468.

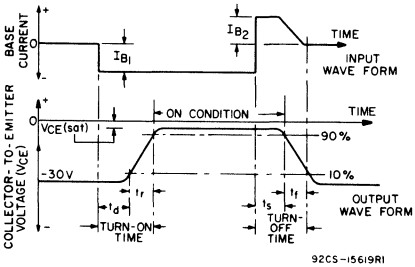


Fig. 9 — Oscilloscope display for measurement of switching times for 2N6467 and 2N6468.

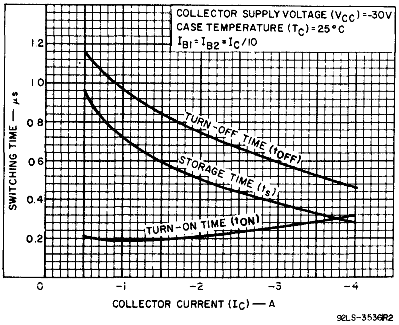


Fig. 10 — Typical saturated switching characteristics for 2N6467 and 2N6468.

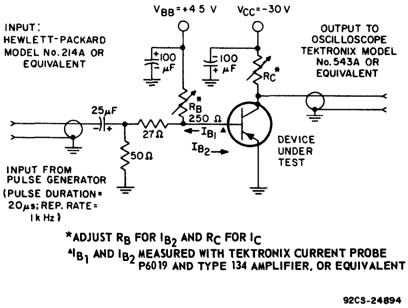


Fig. 11 — Circuit used to measure saturated switching times for 2N6467 and 2N6468.

File Number **680**

2N6477, 2N6478

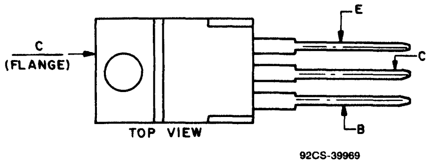
Medium-Power Silicon N-P-N Transistors

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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

RCA 2N6477 and 2N6478Δ 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 ⩾ 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 VOLTAGE V dc			CURRENT A dc		LIMITS 2N6477		2N6478		UNITS
		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	mA
At T_C = 150°C	I_{CEV}	120 140		−1.5 −1.5			– –	10 –	– –	– 10	mA
* 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	–	V
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			−1.5	0.1[a]		140	–	160	–	V
* 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	– –	1 2	– –	1 2	V
* Base-to-Emitter Voltage	V_{BE}	4 4			1[a] 2.5[a]		– –	1.8 3	– –	1.8 3	V
* 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	–	kHz
* 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	$R_{\theta JC}$						–	2.5	–	2.5	°C/W
Junction-to-Ambient	$R_{\theta JC}$						–	70	–	70	°C/W

* 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.

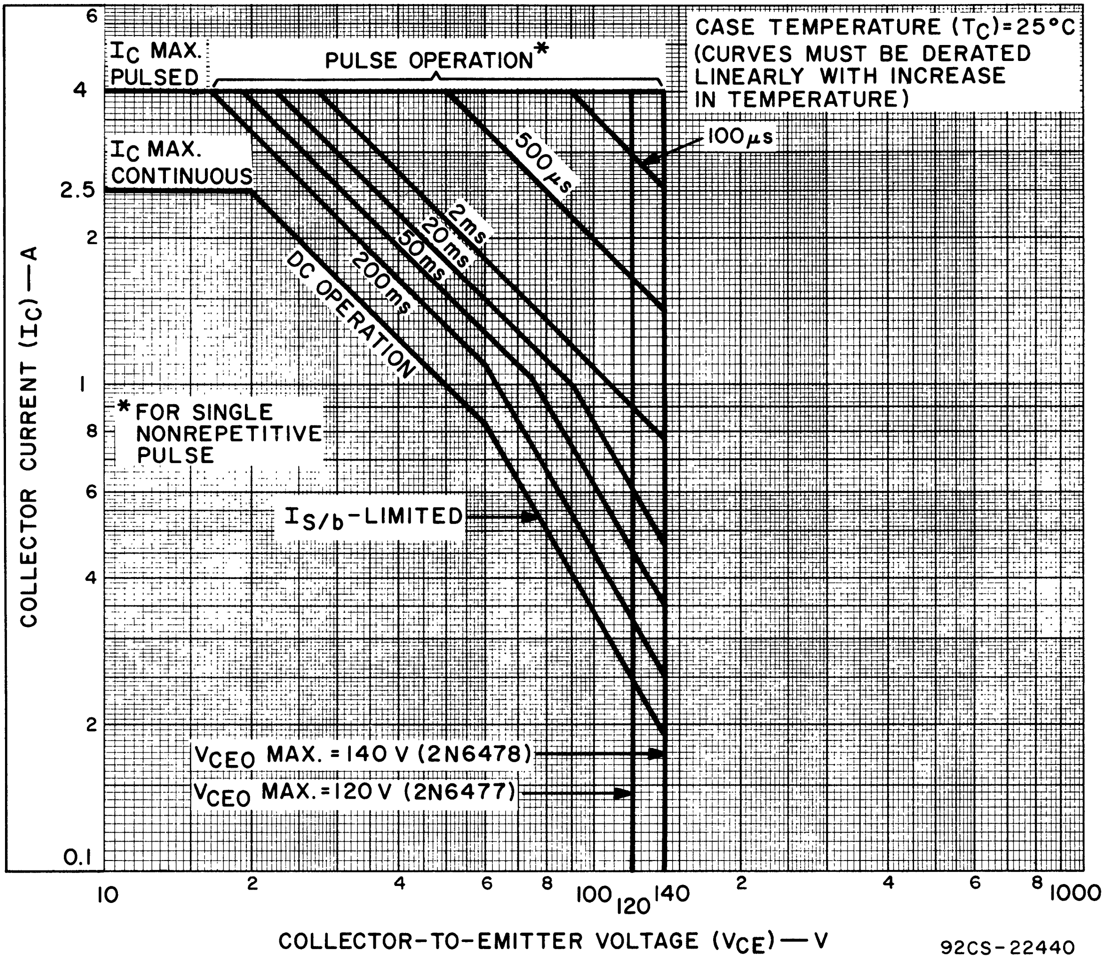


Fig. 1 — Maximum operating areas for both types.

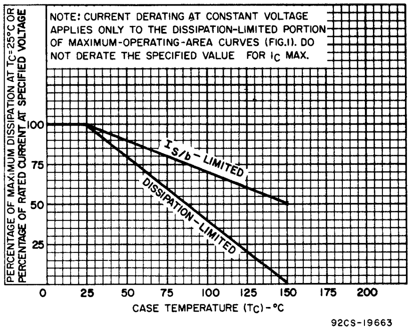


Fig. 2 — Current derating curve for both types.

2N6477, 2N6478

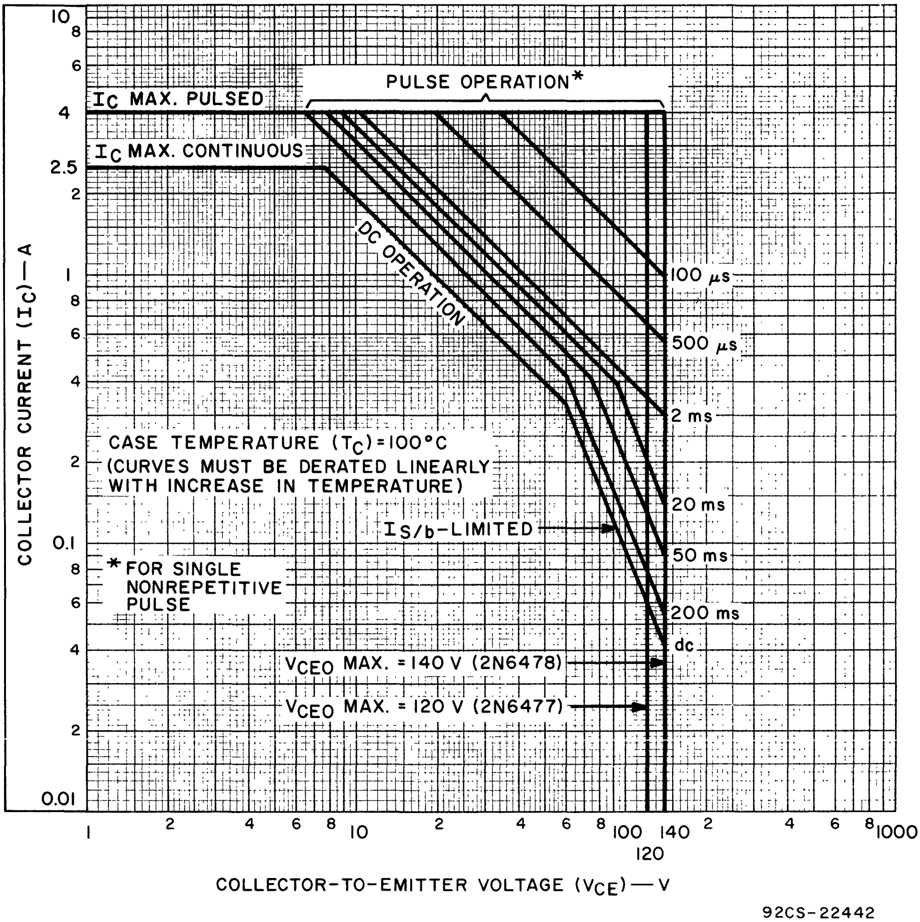


Fig. 3 — Maximum operating areas for both types.

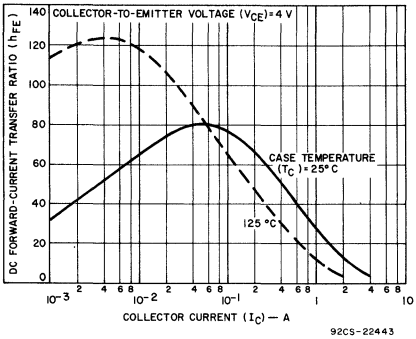


Fig. 4 — Typical dc beta characteristics for 2N6477.

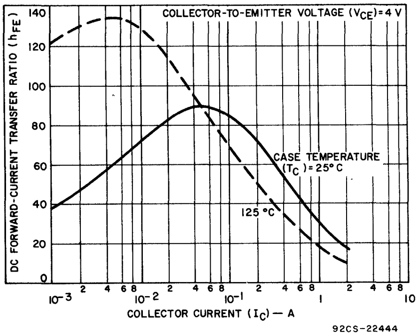


Fig. 5 — Typical dc beta characteristics for 2N6478.

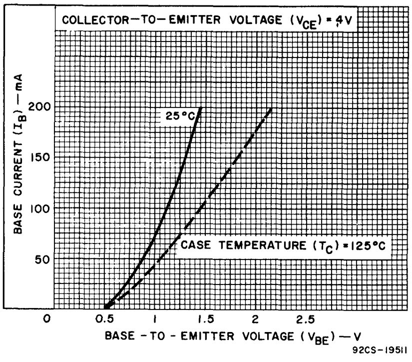


Fig. 6 — Typical input characteristics for 2N6477.

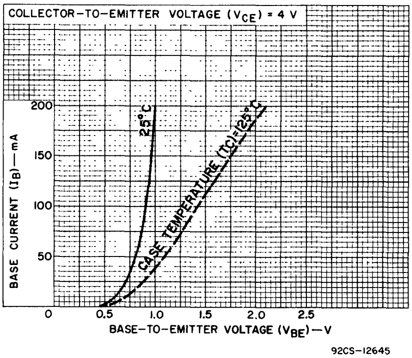


Fig. 7 — Typical input characteristics for 2N6478.

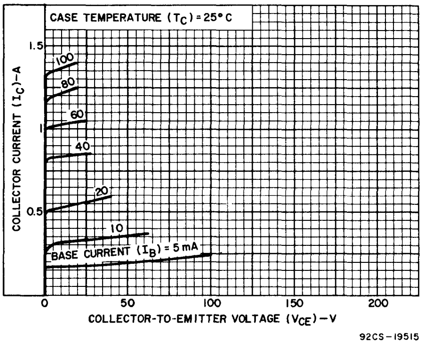


Fig. 8 — Typical output characteristics for 2N6477.

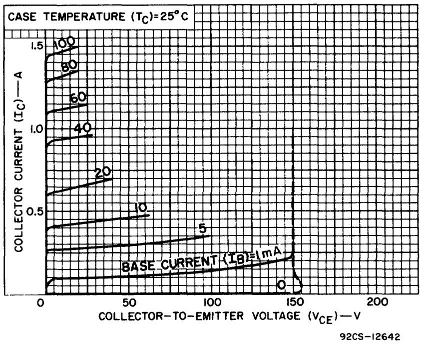


Fig. 9 — Typical output characteristics for 2N6478.

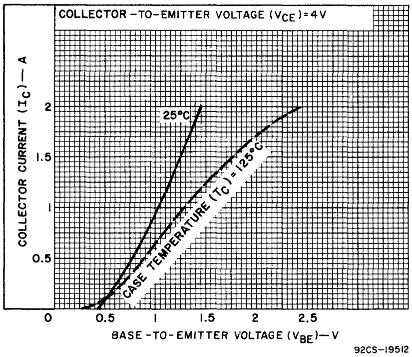


Fig. 10 — Typical transfer characteristics for 2N6477.

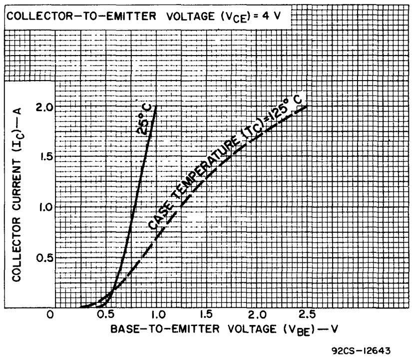


Fig. 11 — Typical transfer characteristics for 2N6478.

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

File Number **678**

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:

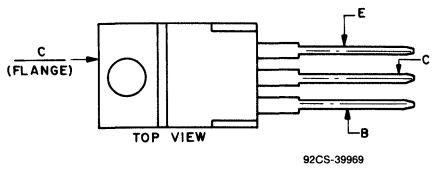
- *Maximum safe-area-of-operation curves*

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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		N-P-N / P-N-P	2N6486 / 2N6489†	2N6487 / 2N6490†	2N6488 / 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 (RBE) = 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 ≥ 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: VOLTAGE V dc		CURR. A dc	LIMITS: 2N6486 2N6489♦		2N6487 2N6490♦		2N6488 2N6491♦		UNITS
		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 – –	– – –	– 500 –	– – –	– – 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 – –	– – –	– 500 –	– – –	– – 500	μA
* At T_C = 150°C	I_{CEX}	40 60 80	−1.5 −1.5 −1.5		– – –	5 – –	– – –	– 5 –	– – –	– – 5	mA
* With base open	I_{CEO}	20 30 40			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* 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]	–	V
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]	–	V
* 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 — I_B = 0.5 A I_B = 5 A	$V_{CE}(sat)$			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 MHz	$\|h_{fe}\|$	4		1	5	–	5	–	5	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 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	°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.*

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

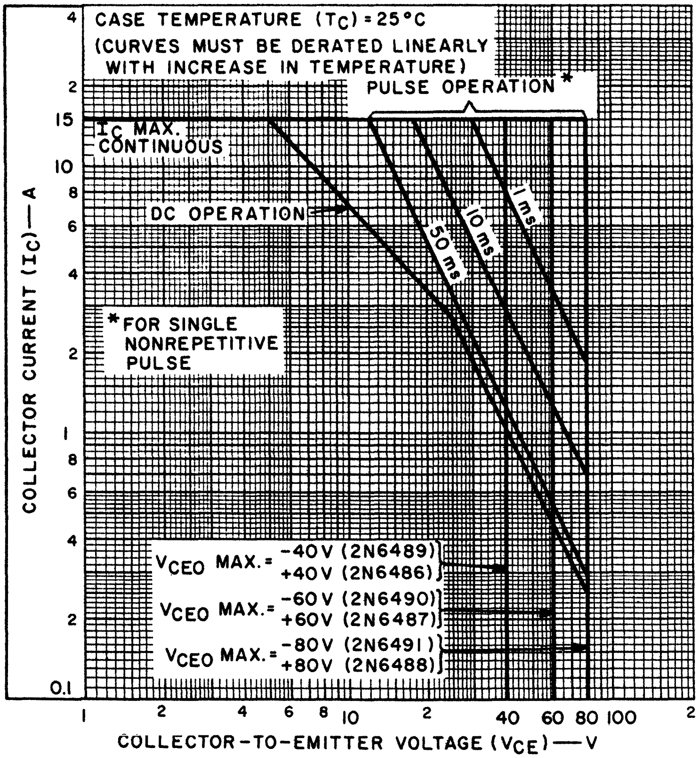


Fig. 1 — Maximum operating areas for all types†.

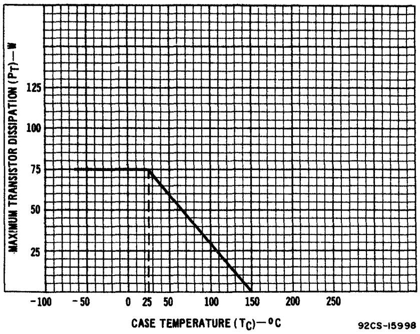


Fig. 2 — Derating chart for all types

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

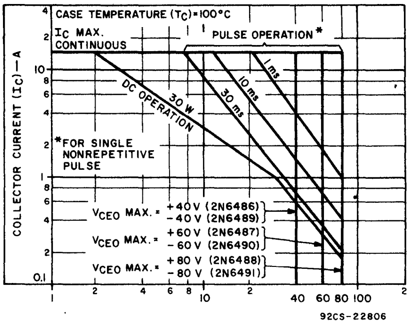


Fig. 3 — Maximum operating areas for all types†.

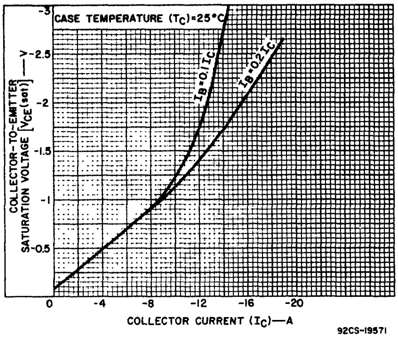


Fig. 4 — Typical collector-to-emitter saturation-voltage characteristics for all types.

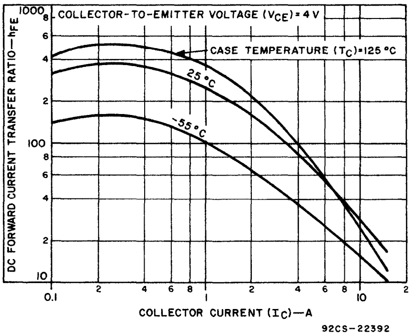


Fig. 5 — Typical dc beta characteristics for 2N6486, 2N6487, and 2N6488.

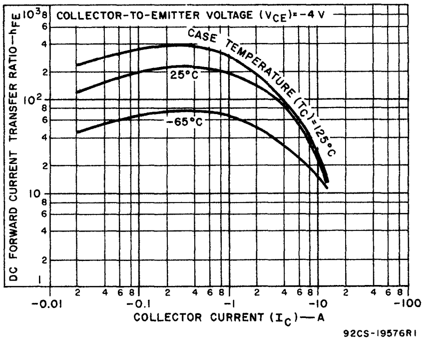


Fig. 6 — Typical dc beta characteristics for 2N6489, 2N6490, and 2N6491.

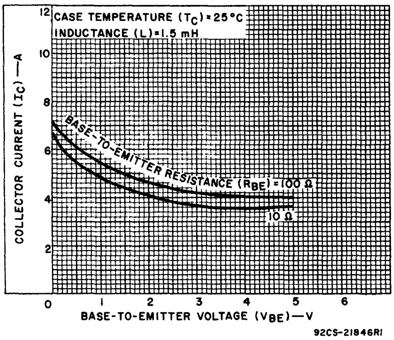


Fig. 7 — Minimum reverse-bias second-breakdown characteristics for all types†.

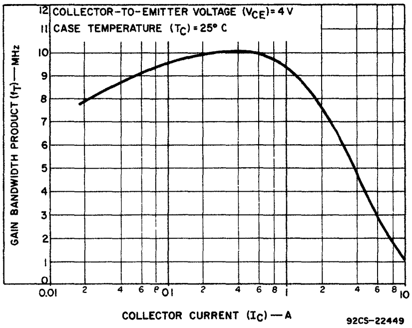


Fig. 8 — Typical gain-bandwidth product vs. collector current for all types†.

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

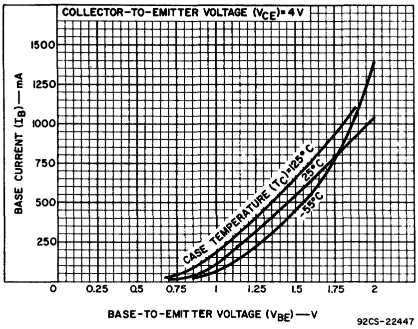


Fig. 9 — Typical input characteristics for all types†.

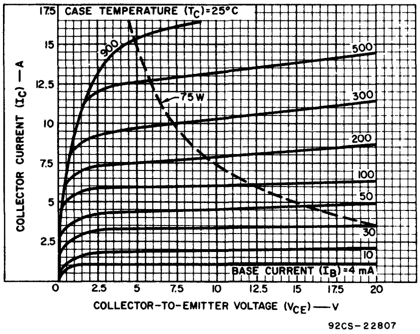


Fig. 10 — Typical output characteristics for all types†.

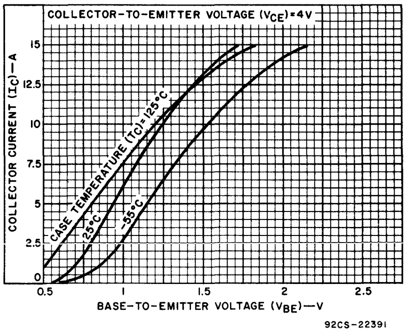


Fig. 11 — Typical transfer characteristics for all types†.

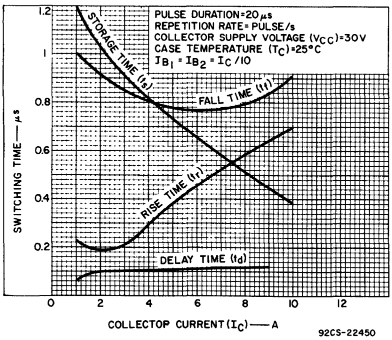


Fig. 12 — Typical saturated switching characteristics for 2N6486, 2N6487, and 2N6488.

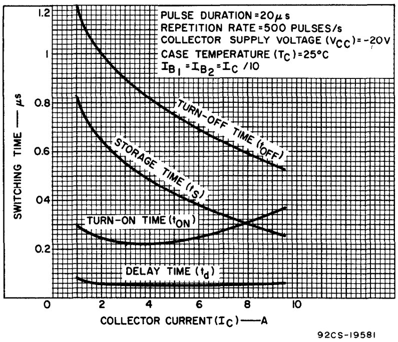


Fig. 13 — Typical saturated switching characteristics for 2N6489, 2N6490, and 2N6491.

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

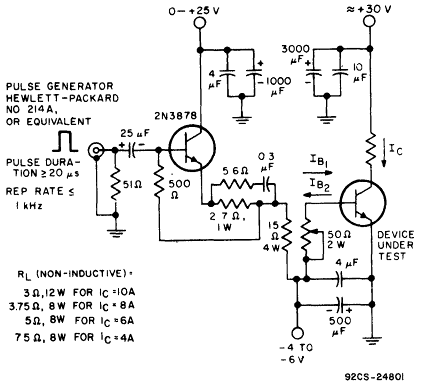


Fig. 14 — Circuit used to measure switching times for 2N6486, 2N6487, and 2N6488.

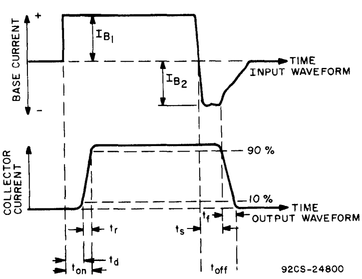


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 14).

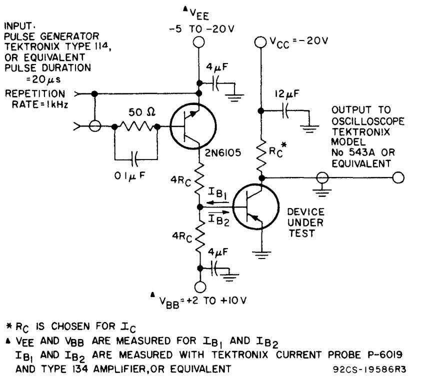


Fig. 16 — Circuit used to measure switching times for 2N6489, 2N6490, and 2N6491.

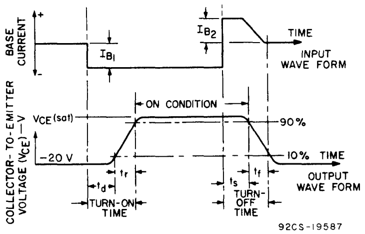


Fig. 17 — Oscilloscope display for measurement for switching times (test circuit shown in Fig. 16).

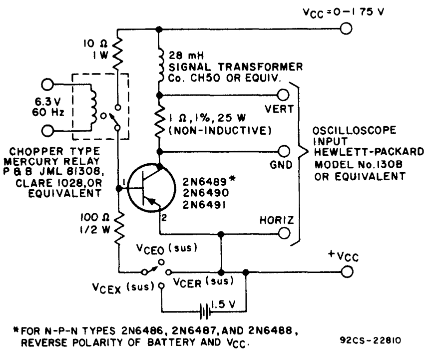


Fig. 18 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

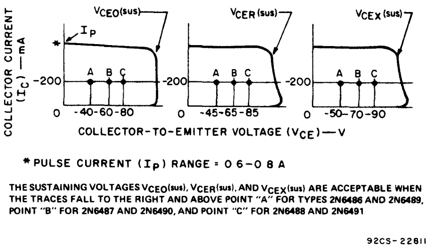


Fig. 19 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 18).

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

File Number **1061**

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

Rugged Devices, Broadly Applicable For Industrial and Commerical Use

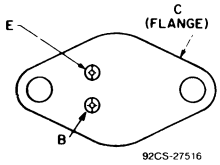
Features:

- *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 RCA2N6609, 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 Ω	-160	—	—	—	—	V
V_{CER}(sus) R_{BE} = 100 Ω	-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 $T_C \leq 25°C$	150	250	200	200	200	W
At $T_C > 25°C$ Derate Linearly	0.857	1.43		1.14		W/°C
* 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.	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		CURRENT 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	mA
	I_{CEX} T_C = 150°C	−140	1.5		–	–	–	−2	mA
*	I_{CEV}	−140	1.5		–	−2	–	–	mA
*	I_{CEV} T_C = 150°C	−140	1.5		–	−10	–	–	mA
 *	I_{CEO} I_B = 0	−140 −120			– –	– −10	– –	−0.25 –	mA
* 	I_{EBO}		−7 −5		– –	−5 –	– –	– −0.1	mA
* * 	h_{FE}	−4 −4 −2 −2		−8[c] −16[c] −5[c] −10[c]	15 5 – –	60 – – –	– – 25 10	– – 150 –	
	$V_{CEX}(sus)$[b] R_{BE} = 100Ω		1.5	−0.2	−160	–	–	–	V
	$V_{CER}(sus)$[b] R_{BE} ≤ 100Ω			−0.2	−150	–	−150	–	V
*	$V_{CEO}(sus)$[b]			−0.2	−140	–	−140	–	V
	V_{EBO} I_E = −1 mA			0	−7	–	−5[d]	–	V
	V_{BE}	−4 −2		−8[c] −5[c]	– –	−2.2 –	– –	– −2	V
 * * 	$V_{CE}(sat)$ I_B = −3.2A = −0.8A = −0.5A			 −16[c] −8[c] −5[c]	 – – –	 −4 −1.4 –	 – – –	 – – −1	V
	$I_{S/b}$ 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	 – –	
	f_T				2	–	2	–	MHz
*	h_{fe} f = 1 kHz	−4		−1	40	–	–	–	
	C_{ob} f = 0.1 MHz	−10[a]			–	1000	–	1000	pF
	$R_{\theta JC}$	−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)*

CHARAC-TERISTIC	TEST CONDITIONS: VOLTAGE V dc		CUR-RENT A dc	LIMITS: RCA9116C		RCA9116D		RCA9116E		UNITS
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	−140[a] −120[a] −100[a]			– – –	−1 – –	– – –	– −1 –	– – –	– – −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	– –	– –	mA
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] $R_{BE} \leq 100\Omega$			−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
$R_{\theta JC}$	−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

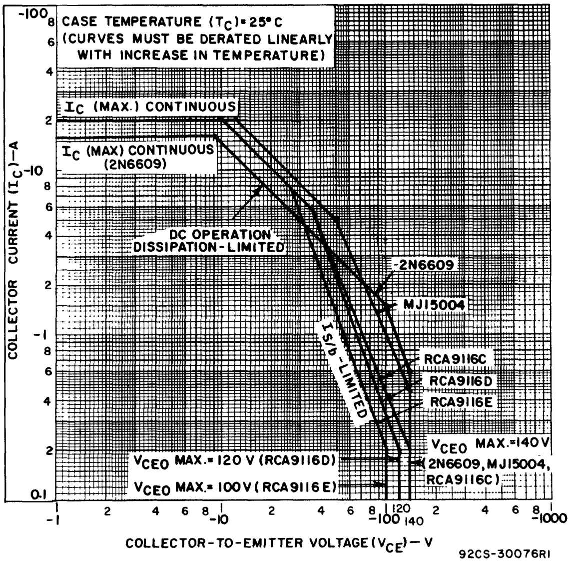


Fig. 1 - Maximum operating areas for all types.

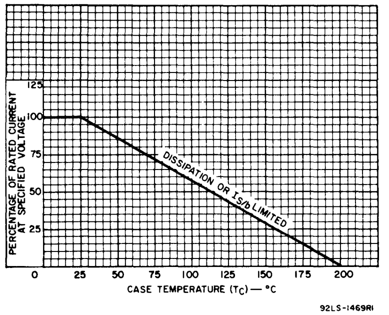


Fig. 2 - Current derating curve for all types.

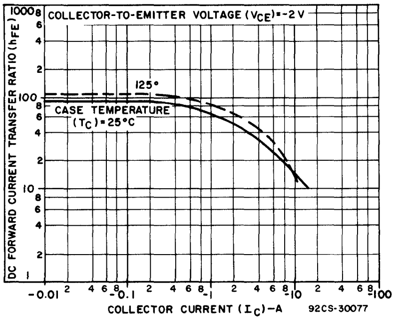


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

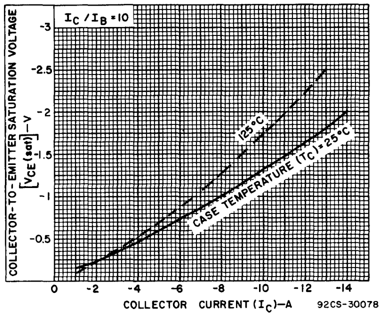


Fig. 4 - Typical saturation voltage characteristics for all types.

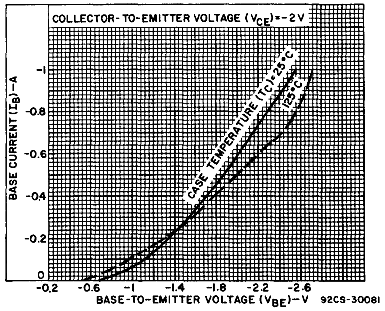


Fig. 5 - Typical input characteristics for all types.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

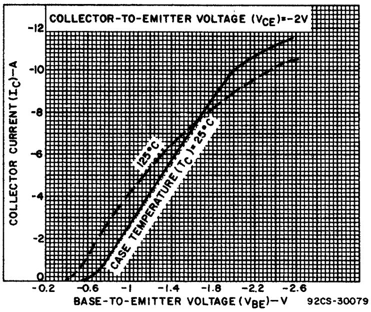


Fig. 6 - Typical transfer characteristics for all types.

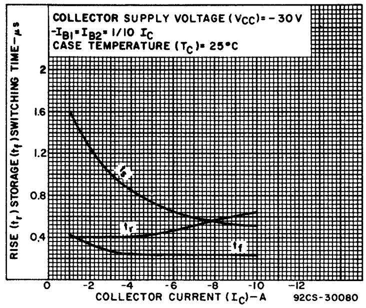


Fig. 7 - Typical saturated-switching times for all types.

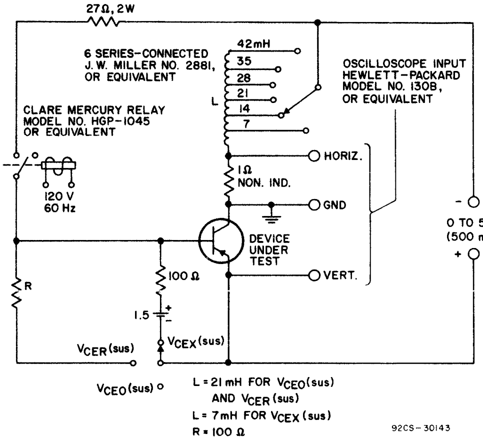


Fig. 8 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) for all types.

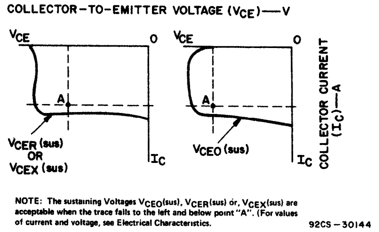


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

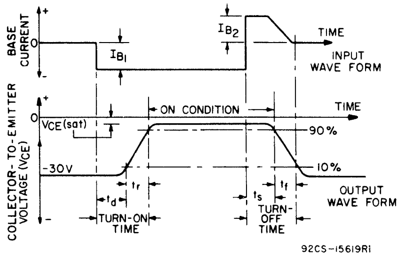


Fig. 10 - Oscilloscope display for measurement of switching times for all types.

File Number **88**

40347, 40348

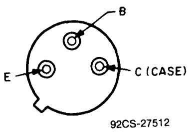
Silicon N-P-N Medium- and High-Voltage Transistors

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

RCA-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 ≥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 kΩ	I_{CER}	30					–	1	–	–	μA
		60					–	–	–	1	
		90					–	–	–	–	
With R_{BE} = 1 kΩ and T_C = 150°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: With base-emitter junction reverse biased	$V_{CEV}(sus)$			−1.5	0.050		60	–	90	–	V
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 Breakdown Collector Current (1-s non-repetitive pulse)	$I_{S/b}$	38					345	–	–	–	mA
		63					–	–	208	–	
		138					–	–	–	–	
Thermal Resistance Junction-to-Case	$R_{\theta JC}$						—	20	—	20	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor ⩽ 2%.

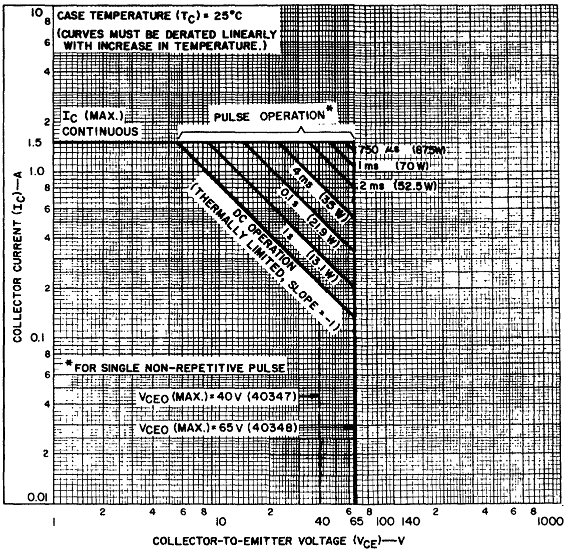


Fig. 1 — Maximum operating areas for types 40347 and 40348.

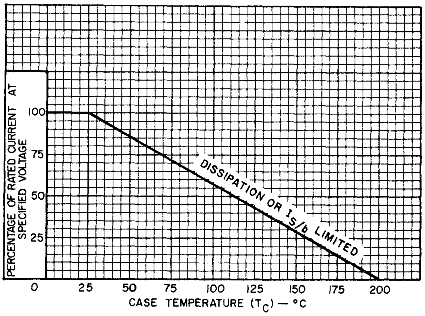


Fig. 2 — Dissipation derating curve for types 40347 and 40348.

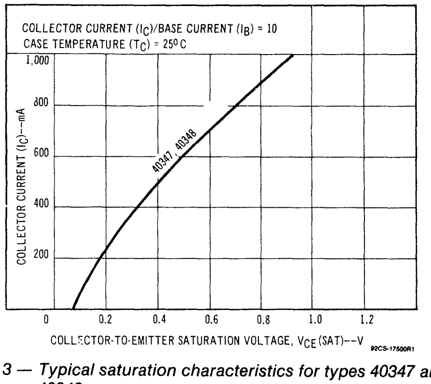


Fig. 3 — Typical saturation characteristics for types 40347 and 40348.

40347, 40348

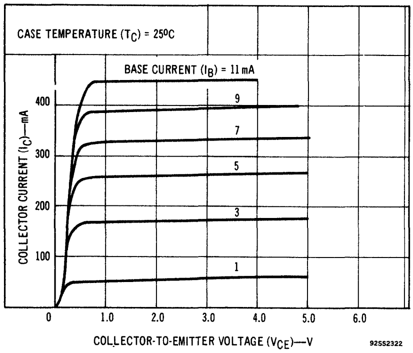


Fig. 4 — Typical output characteristics for type 40347.

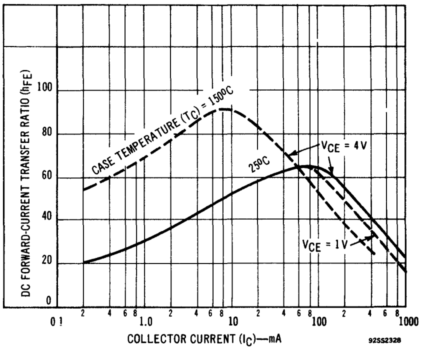


Fig. 5 — Typical dc-beta characteristics for type 40347.

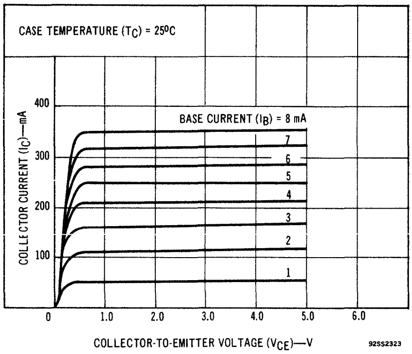


Fig. 6 — Typical output characteristics for type 40348.

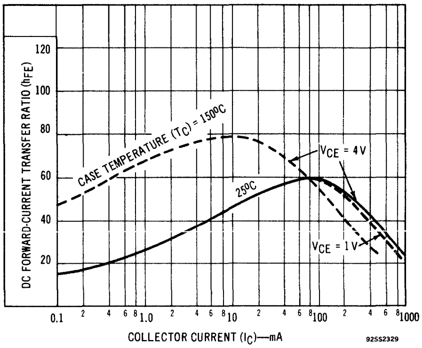


Fig. 7 — Typical dc-beta characteristics for type 40348.

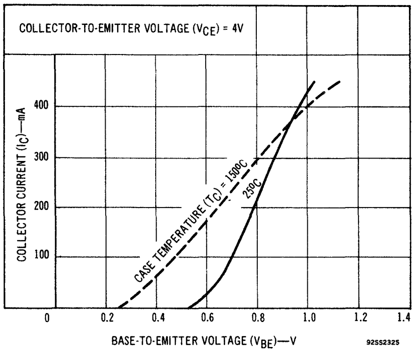


Fig. 8 — Typical transfer characteristics for type 40347.

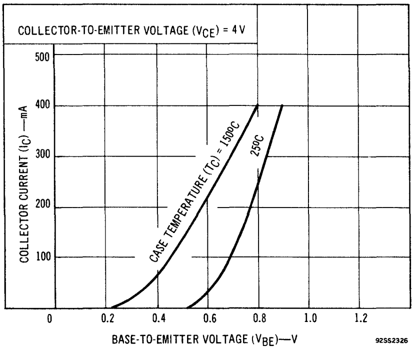


Fig. 9 — Typical transfer characteristics for type 40348.

File Number **219**

40406, 40407, 40408, 40411

Silicon N-P-N and P-N-P Power Transistors

For Audio-Amplifier Applications

Features:

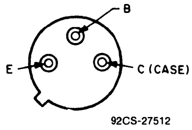
40406 & 40407
- $V_{CEO}(sus)$ = -50 V max. (40406)
- $V_{CEO}(sus)$ = 50 V max. (40407)
- *40406 is p-n-p complement of 40407*
- *1 W dissipation rating*

40408
- $V_{CEO}(sus)$ = 90 V max.
- *1 W dissipation rating*

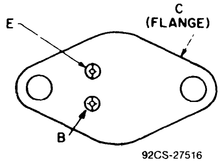
40411
- $V_{CER}(sus)$ = 90 max.
- *150 W dissipation rating*

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40406	40407	40408	40411	
$V_{CEO}(sus)$	-50	50	90	—	V
$V_{CER}(sus)$					
R_{BE} = 100 Ω	—	—	—	90	V
V_{EBO}	-4	4	4	4	V
I_C	-0.7	0.7	0.7	30	A
I_B	-0.2	0.2	0.2	15	A
P_T:					
$T_A \leq 25°C$	1	1	1	—	W
$T_C \leq 25°C$	—	—	—	150	W
T_J	-65 to +200				°C

40406, 40407, 40408, 40411

ELECTRICAL CHARACTERISTICS, $T_C = 25°$ *Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	CURRENT A dc I_C	I_B	LIMITS 40406# 40407 Min.	Max.	40408 Min.	Max.	40411 Min.	Max.	UNITS
I_{CBO} $I_E = 0$	10•			–	0.25♦	–	–	–	–	μA
I_{CEO}	40			–	1	–	–	–	–	μA
	80			–	–	–	1	–	–	μA
$T_C = 150°$ C 40406	40			–	0.01	–	–	–	–	mA
40407	40			–	0.1	–	–	–	–	mA
40408	80			–	–	–	0.25	–	–	mA
I_{CER} $R_{BE} = 100\ \Omega$	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) $R_{BE} = 100\ \Omega$		0.1			–	–	–	–	–	V
		0.2			–	–	–	90	–	V
V_{BE}	10	0.001[a]		–	0.8[c]	–	–	–	–	V
	4	0.01[a]		–	–	–	1	–	–	V
	4	0.15[a]		–	–	–	–	–	–	V
	4	4[a]		–	–	–	–	–	1.2	V
V_{CE}(sat)		0.15[a]	0.015	–	–	–	1.4	–	–	V
		4[a]	0.4	–	–	–	–	–	0.8	V
h_{FE} 40406	10	0.1 mA[a]		30	200	–	–	–	–	
40407	10	0.001[a]		40	200	–	–	–	–	
40408	4	0.01[a]		–	–	40	200	–	–	
40411	4	4[a]		–	–	–	–	35	100	
h_{fe} f = 20 MHz	10	0.05		6♦	–	–	–	–	–	
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♦	–	–	–	–	–	pF
$I_{S/b}$ t = 1s nonrep	30			–	–	–	–	5	–	A
$R_{\theta JC}$				–	35	–	35	–	1.17	°C/W
$R_{\theta JA}$				–	175	–	175	–	–	°C/W

\# 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

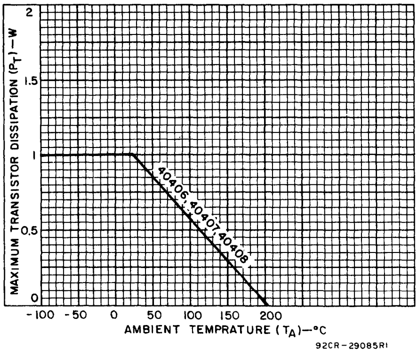


Fig. 1 - Dissipation derating curves for 40406, 40407, and 40408.

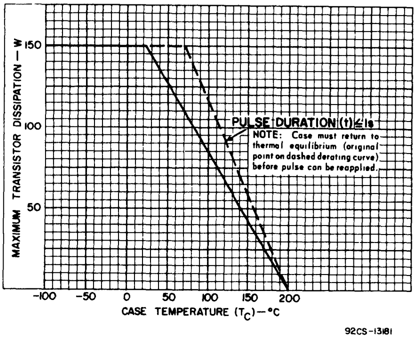


Fig. 2 - Dissipation derating curve for 40411.

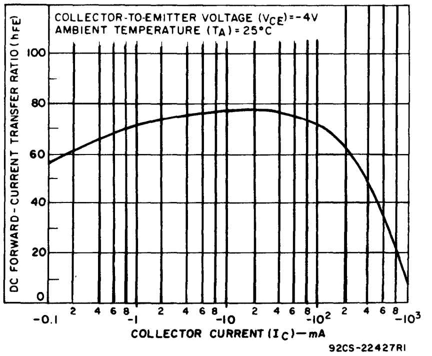


Fig. 3 - Typical dc beta characteristic for 40406.

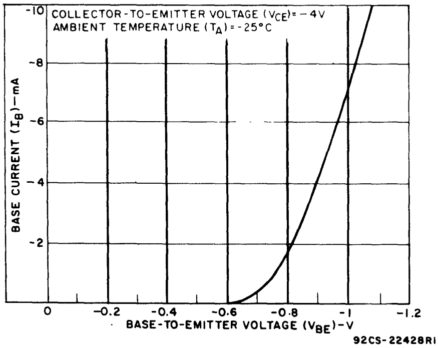


Fig. 4 - Typical input characteristic for 40406.

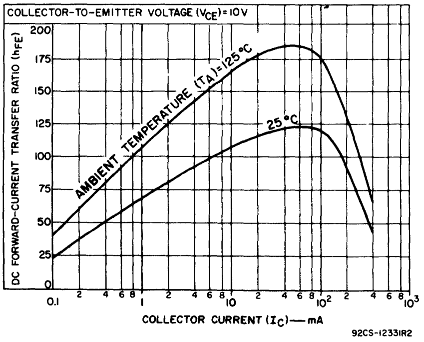


Fig. 5 - Typical dc beta characteristics for 40407 and 40408.

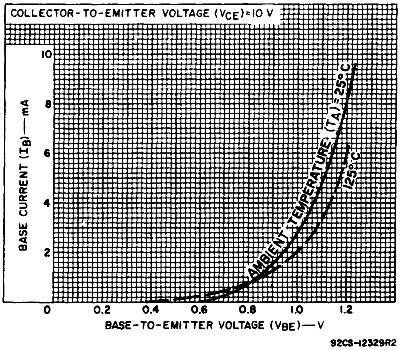


Fig. 6 - Typical input characteristics for 40407 and 40408.

40406, 40407, 40408, 40411

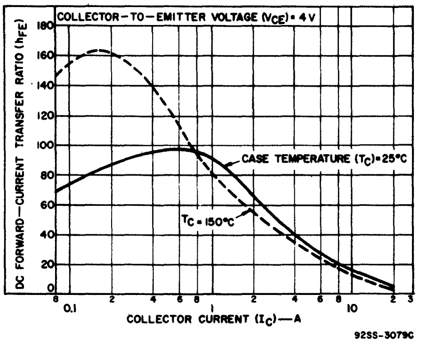


Fig. 7 - Typical dc beta characteristics for 40411.

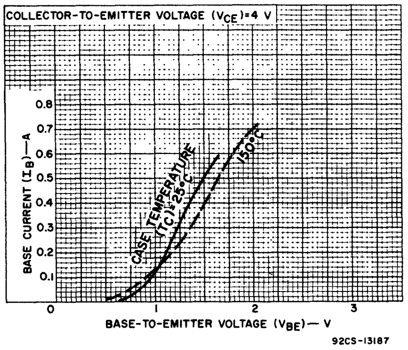


Fig. 8 - Typical input characteristics for 40411.

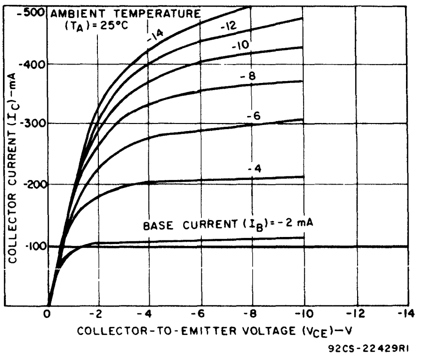


Fig. 9 - Typical output characteristics for 40406.

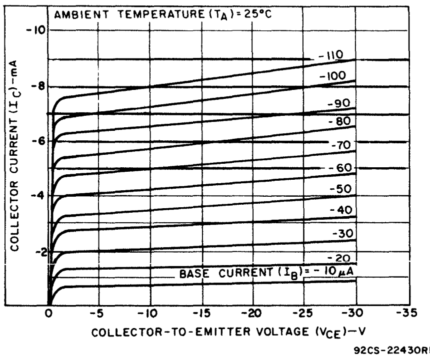


Fig. 10 - Typical large-signal output characteristics for 40406.

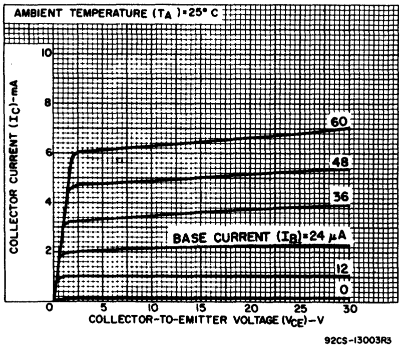


Fig. 11 - Typical output characteristics for 40407 and 40408.

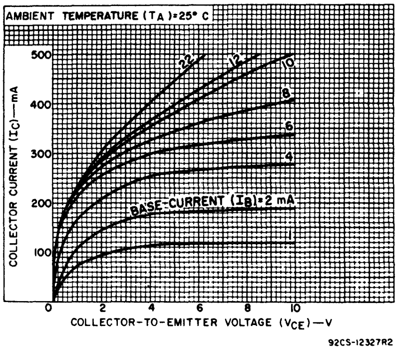


Fig. 12 - Typical large-signal output characteristics for 40407 and 40408.

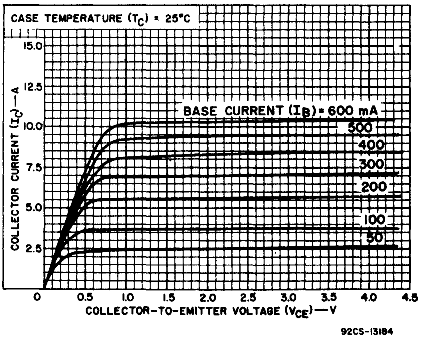


Fig. 13 - Typical output characterstics for 40411.

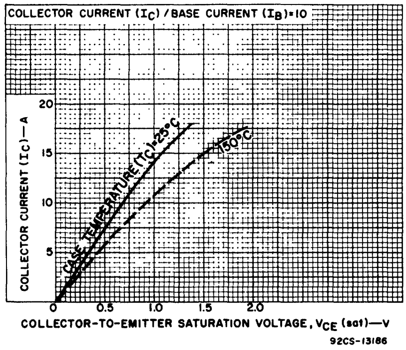


Fig. 14 - Typical saturation-voltage characteristics for 40411.

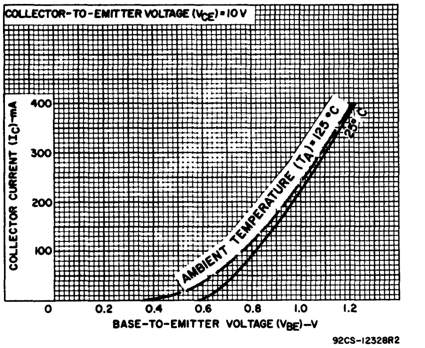


Fig. 15 - Typical transfer characteristics for 40407 and 40408.

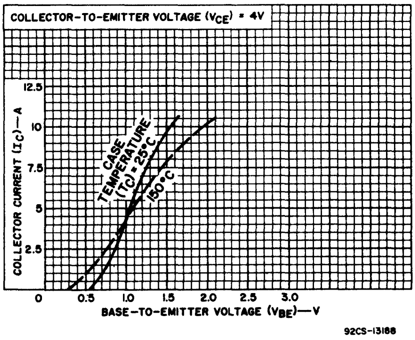


Fig. 16 - Typical transfer characterstics for 40411.

MJ15001, MJ15002

File Number **1093**

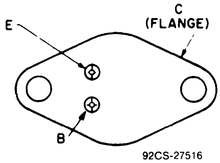
Complementary N-P-N/P-N-P Silicon Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commerical 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 $T_C \leq 25°C$	200	200	W
At $T_C > 25°C$	1.14		W/°C
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

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°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 - 1s	40 100				5 0.5	– –	–5 –0.5	– –	A
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.

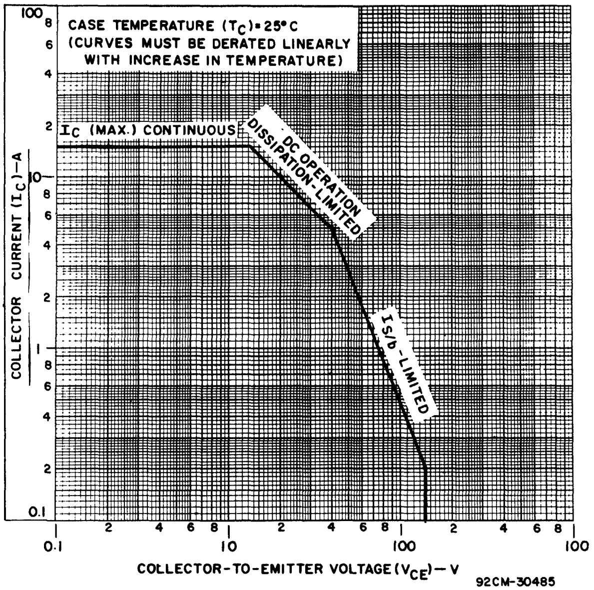


Fig. 1 - Maximum operating area for both types.

MJ15001, MJ15002

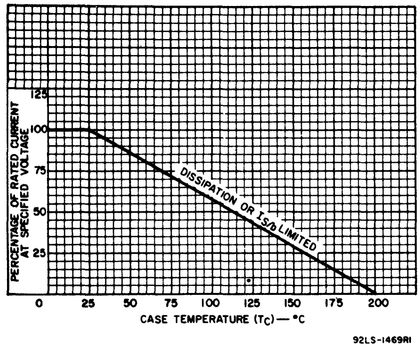


Fig. 2 - Current derating curve for both types.

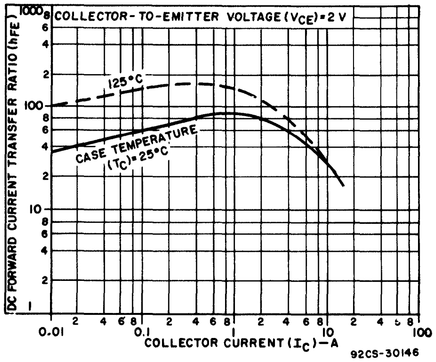


Fig. 3 - Typical dc beta characteristics as a function of collector current for MJ15001.

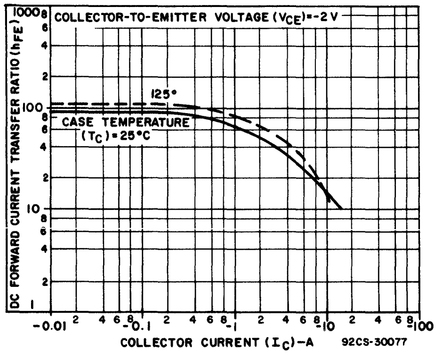


Fig. 4 - Typical dc beta characteristics as a function of collector current for MJ15002.

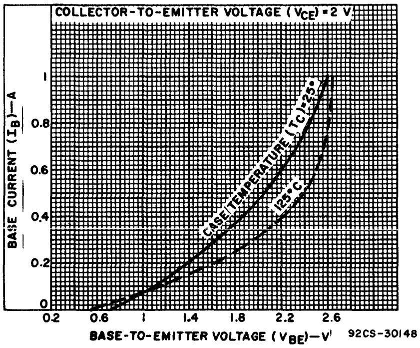


Fig. 5 - Typical input characteristics for MJ15001.

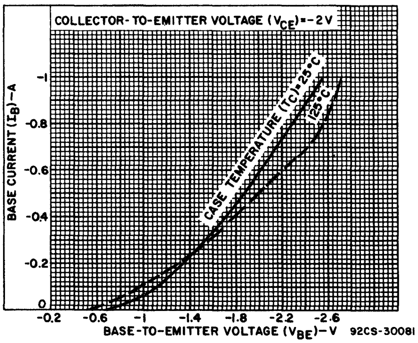


Fig. 6 - Typical input characteristics for MJ15002.

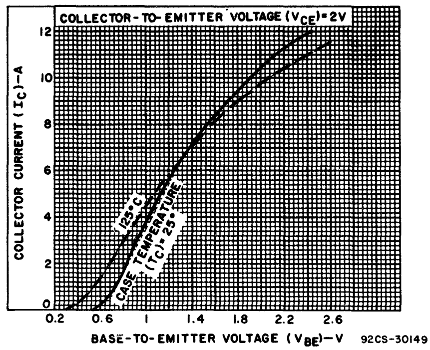


Fig. 7 - Typical transfer characteristics for MJ15001.

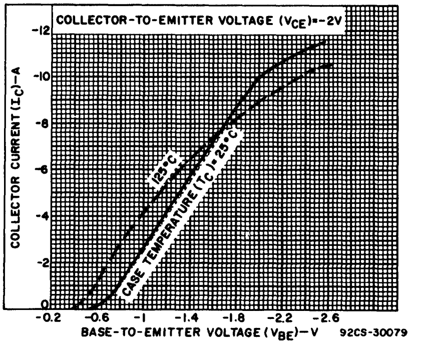


Fig. 8 - Typical transfer characteristics for MJ15002.

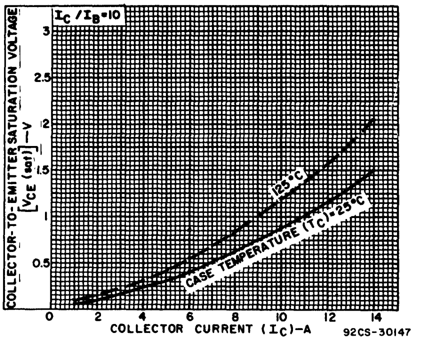


Fig. 9 - Typical saturation voltage characteristics for MJ15001.

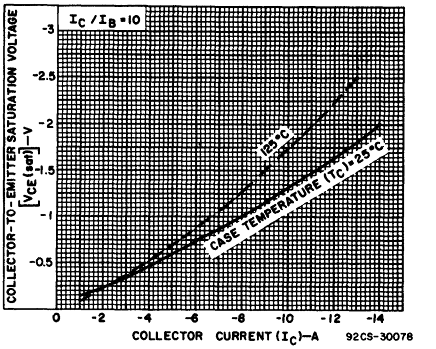


Fig. 10 - Typical saturation voltage characteristics for MJ15002.

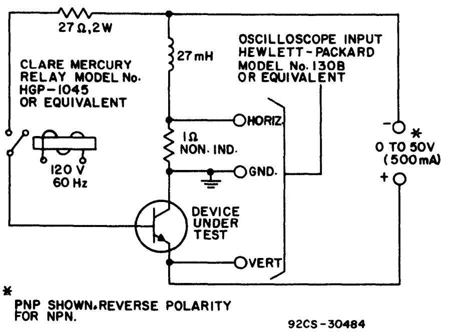
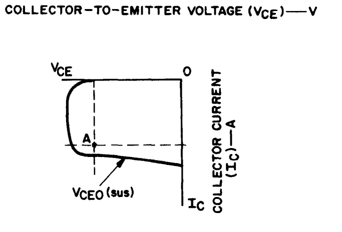


Fig. 11 - Circuit used to measure sustaining voltages V_{CEO}(sus).



NOTE: The sustaining Voltages V_{CEO}(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

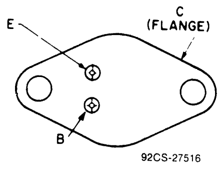
Fig. 12 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 11).

RCA1B04, RCA1B05

File Number **908**

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 Ω	225	275	V
V_{EBO}	5		V
I_C	7		V
I_B	2		A
P_T			
At $T_C \leq 25°C$	150		W
At $T_C > 25°C$	See Fig. 1		°C
T_{stg}, T_J	-65 to 150		°C
T_L At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

RCA1B04, RCA1B05

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

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS						UNITS
		RCA1B04▲		RCA1B05*		RCA1B09**		
		Min.	Max.	Min.	Max.	Min.	Max.	
I_{CER}	V_{CE} = 120 V, R_{BE} = 100 Ω	–	1	–	–	–	–	mA
	V_{CE} = 200 V, R_{BE} = 100 Ω	–	–	–	1	–	1	
I_{EBO}	V_{EB} = 5 V, I_C = 0	–	1	–	1	–	1	mA
V_{CEO}	I_C = 0.2 A, I_B = 0	200	–	250	–	250	–	V
V_{CER}	I_C = 0.2 A, R_{BE} = 100 Ω	225	–	275	–	275	–	V
f_T	I_C = 0.2 A, V_{CE} = 10 V	5	–	5	–	–	–	MHz
	I_C = 1 A, V_{CE} = 15 V	–	–	–	–	5	–	
h_{FE}	I_C = 2 A, V_{CE} = 5 V	15	75	15	75	40	–	
$V_{CE}(sat)$	I_C = 2 A, I_B = 0.255 A	–	2	–	2	–	–	V
	I_C = 2 A, I_B = 0.2 A	–	–	–	–	–	1	
V_{BE}	I_C = 2 A, V_{CE} = 5 V	0.75	1.75	0.75	1.75	–	1	V
$I_{S/b}$	V_{CE} = 120 V, t = 1 s	1.25	–	–	–	–	–	A
	V_{CE} = 140 V, t = 1 s	–	–	1.07	–	–	–	
	V_{CE} = 80 V, t = 1 s	–	–	–	–	1.875	–	

▲ For characteristics curves and test conditions, refer to published data for prototype 2N5239 (File 321).
* For characteristics curves and test conditons, refer to published data for prototype 2N5240 (File 321).
** For characteristics curves and test conditions, refer to published data for prototype 2N6510 (File 848).

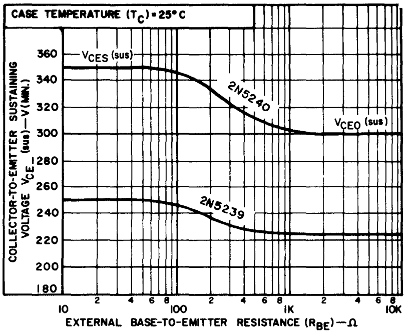


Fig. 1 — Derating curves for all types.

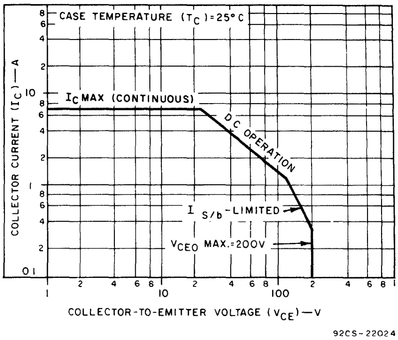


Fig. 2 — Maximum operating areas for RCA1B04.

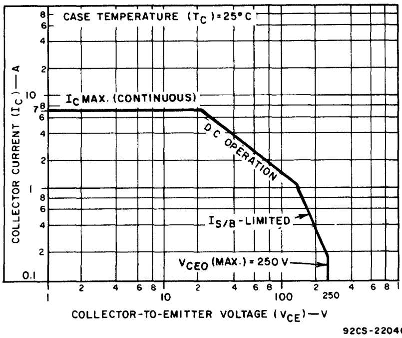


Fig. 3 — Maximum operating areas for RCA1B05.

RCA3054, RCA3055

File Number **618**

Silicon N-P-N VERSAWATT Transistors

Designed for Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

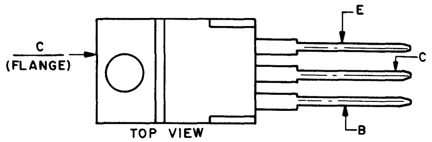
Features:

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

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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 ≥ 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		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	$R_{\theta JC}$						–	3.5	–	1.67	°C/W
Junction-to-Ambient	$R_{\theta JA}$						–	70	–	70	

[a] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.
[b] Pulsed: 1-second non-repetitive pulse.

RCA3054. RCA3055

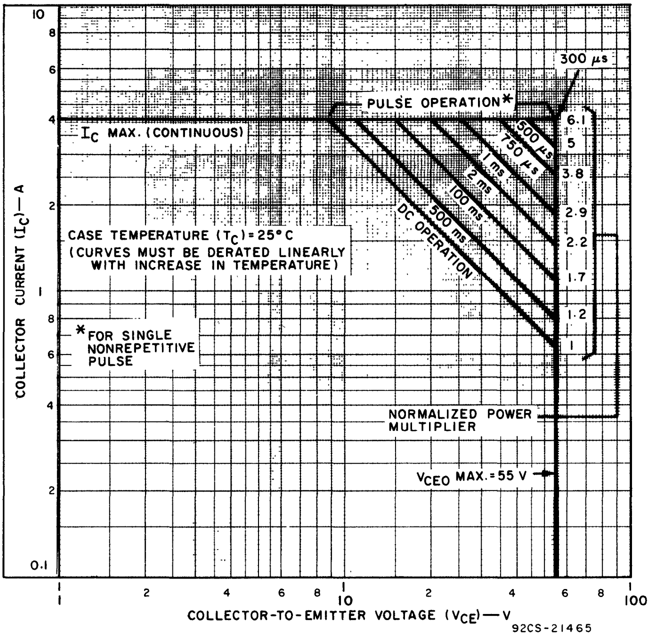


Fig. 1 — Maximum operating areas for RCA3054.

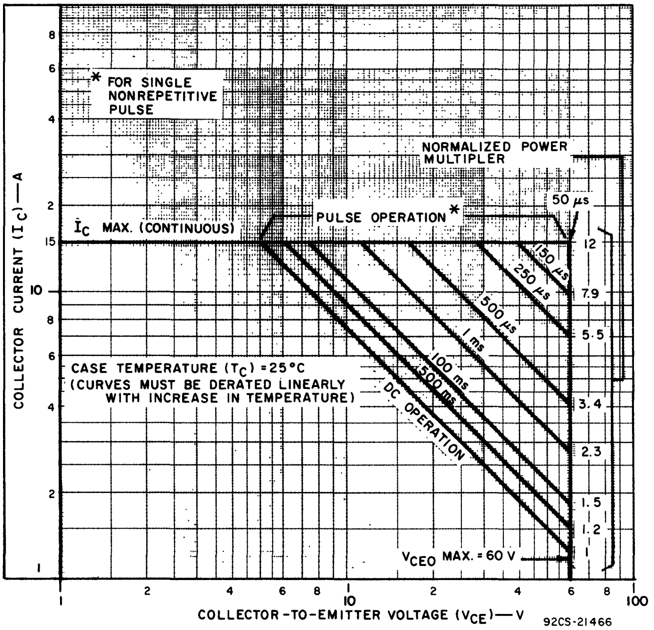


Fig. 2 — Maximum operating areas for RCA3055.

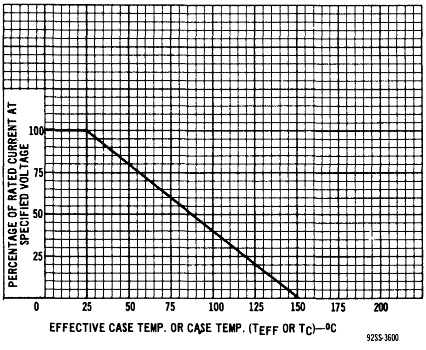


Fig. 3 — Derating curve for both types.

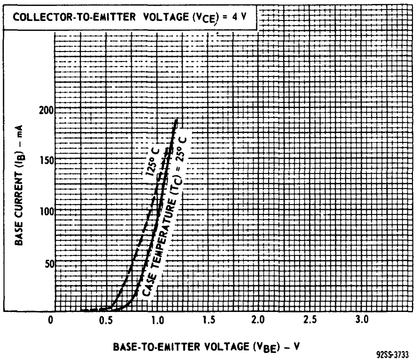


Fig. 4 — Typical input characteristics for RCA3054.

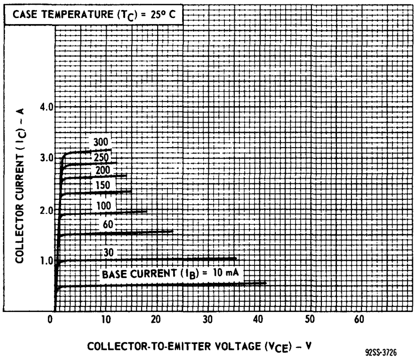


Fig. 5 — Typical output characteristics for RCA3054.

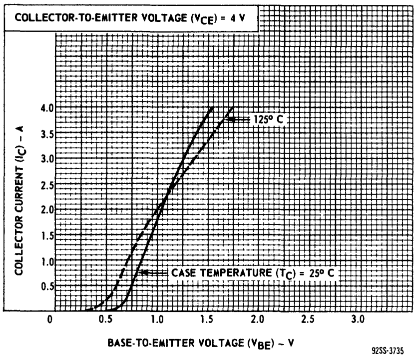


Fig. 6 — Typical transfer characteristics for RCA3054.

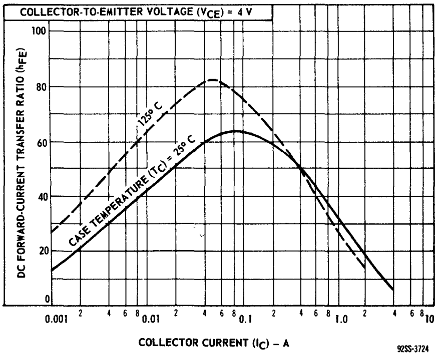


Fig. 7 — Typical dc beta characteristics for RCA3054.

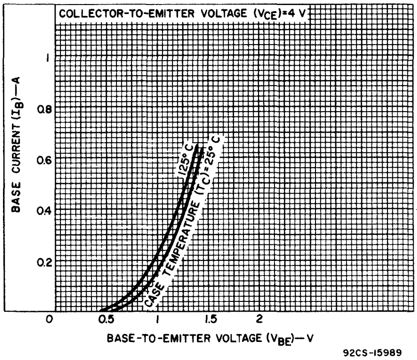


Fig. 8 — Typical input characteristics for RCA3055.

RCA3054, RCA3055

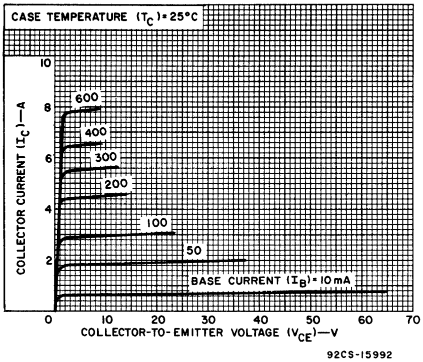


Fig. 9 — Typical output characteristics for RCA3055.

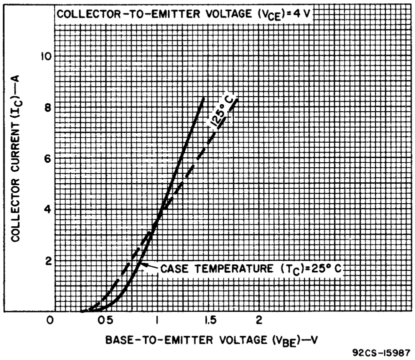


Fig. 10 — Typical transfer characteristics for RCA3055.

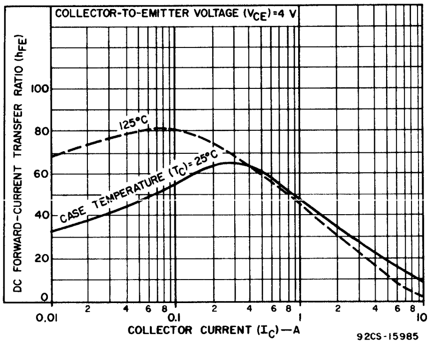


Fig. 11 — Typical dc beta characteristics for RCA3055.

File Number **1060** **RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E**

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

Rugged Devices, Broadly Applicable For Industrial and Commerical Use

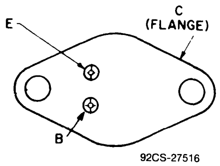
Features:

- *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 Ω	160	—	—	—	—	V
V_{CER}(sus)						
R_{BE} = 100 Ω	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 $T_C \leq 25°C$	150	250	200	200	200	W
At $T_C > 25°C$ Derate Linearly	0.857	1.43	1.14			W/°C
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

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}	I_C	Min.	Max.	Min.	Max.	
I_{CBO}	160[a]			–	4	–	–	mA
	140[a]			–	2	–	1	
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			–	–	–	0.25	
	120			–	1	–	–	
I_{EBO}	–	7		–	1	–	–	
	–	5		–	–	–	0.1	
h_{FE}	4		8[c]	15	60	–	–	
	4		16[c]	5	–	–	–	
	2		5[c]	–	–	25	150	
	2		10[c]	–	–	10	–	
V_{CEX}(sus)[b] R_{BE} = 100Ω		−1.5	0.2	160	–	–	–	V
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		8[c]	–	2.2	–	–	
	2		5[c]	–	–	–	2	
V_{CE}(sat) I_B = 3.2A			16[c]	–	4	–	–	
= 0.8A			8[c]	–	1.4	–	–	
= 0.5A			5[c]	–	–	–	1	
$I_{S/b}$ t_p = 1 s nonrep.	100			1.5	–	1	–	A
	50			–	–	5	–	
$\|h_{fe}\|$ 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
$R_{\theta JC}$	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)*

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc	LIMITS						UNITS
				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	–	–	–	–	
	120	1.5		–	–	–	1	–	–	
I_{CEX} T_C = 150°C	140	1.5		–	5	–	–	–	–	
	120	1.5		–	–	–	5	–	–	
I_{CEO} I_B = 0	70			–	1	–	–	–	–	
	60			–	–	–	1	–	–	
I_{EBO}	–	5		–	1	–	1	–	1	
h_{FE}	2		5[c]	25	150	25	150	–	–	
	2		7.5[c]	–	–	–	–	10	100	
	2		10[c]	10	–	10	–	–	–	
$V_{CER}(sus)$[b] $R_{BE} \leq 100\Omega$			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	
	2		5[c]	–	2	–	2	–	–	
$V_{CE}(sat)$ I_B = 0.75A			7.5[c]	–	–	–	–	–	1.5	
= 0.5A			5[c]	–	1	–	1	–	–	
$I_{S/b}$ 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
$R_{\theta JC}$	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

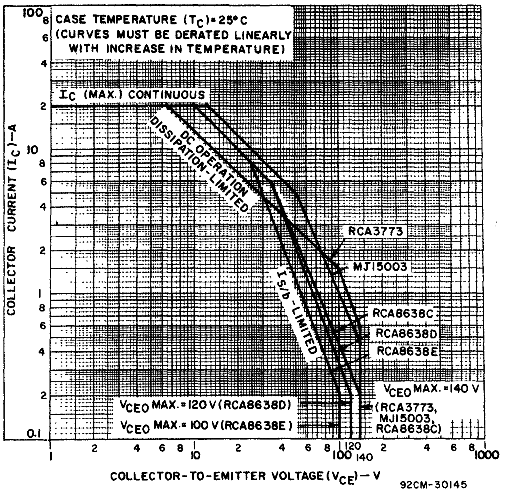


Fig. 1 - Maximum operating areas for all types.

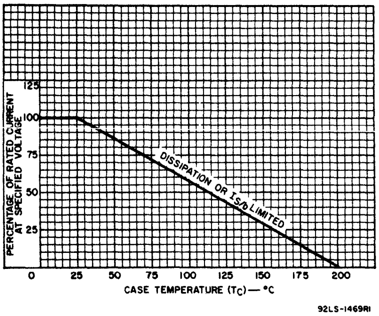


Fig. 2 - Current derating curve for all types.

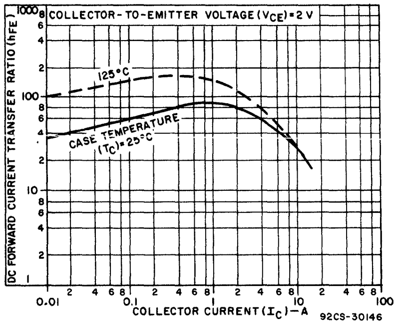


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

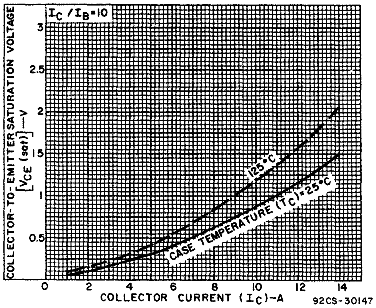


Fig. 4 - Typical saturation voltage characteristics for all types.

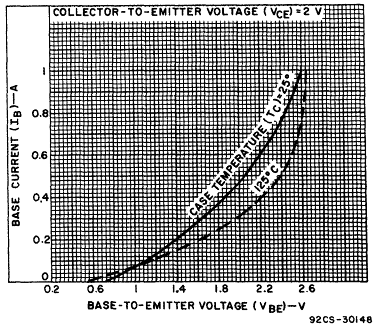


Fig. 5 - Typical input characteristics for all types.

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

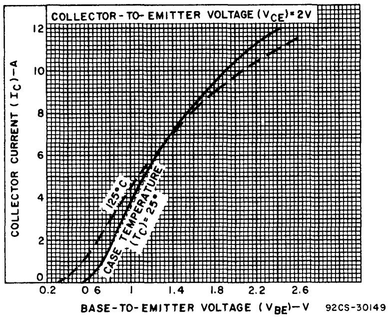


Fig. 6 - Typical transfer characteristics for all types.

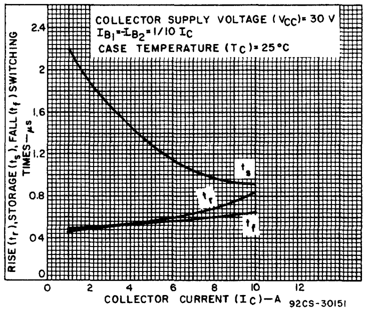


Fig. 7 - Typical saturated-switching times for all types.

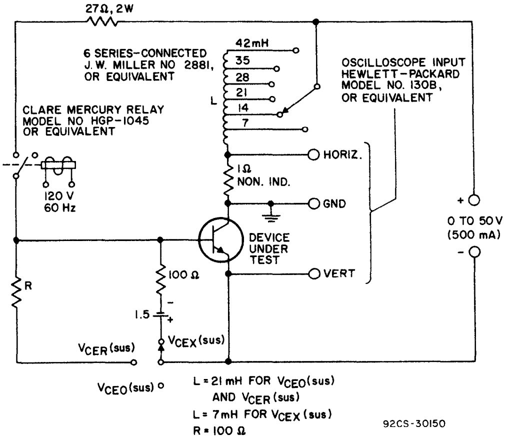


Fig. 8 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

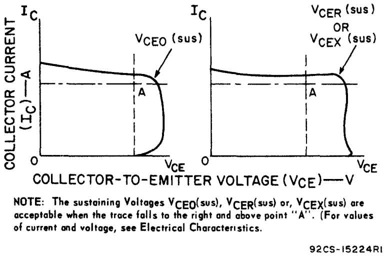


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

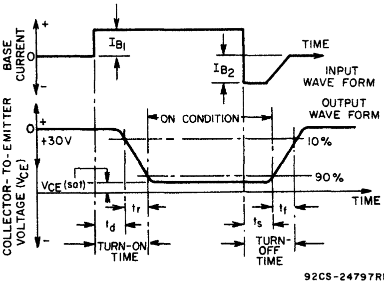


Fig. 10 - Oscilloscope display for measurement of switching times for all types.

RCA9166A, RCA9166B, MJ15022, MJ15024

File Number **1293**

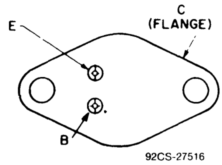
Silicon N-P-N Epitaxial-Base High-Power Transistors

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:*

<table>
<tr><th></th><th>RCA9166A</th><th>RCA9166B</th><th>MJ15024</th><th>MJ15022</th><th></th></tr>
<tr><td>V_{CBO}</td><td>—</td><td>—</td><td>400</td><td>350</td><td>V</td></tr>
<tr><td>$V_{CER}(sus)$ R_{BE} = 100 Ω</td><td>275</td><td>225</td><td>275</td><td>225</td><td>V</td></tr>
<tr><td>$V_{CEO}(sus)$</td><td>250</td><td>200</td><td>250</td><td>200</td><td>V</td></tr>
<tr><td>V_{EBO}</td><td colspan="4">5</td><td>V</td></tr>
<tr><td>I_C</td><td colspan="4">16</td><td>A</td></tr>
<tr><td>I_{CM}</td><td colspan="4">30</td><td>A</td></tr>
<tr><td>I_B</td><td colspan="4">5</td><td>A</td></tr>
<tr><td>P_T</td><td colspan="4"></td><td></td></tr>
<tr><td>At $T_C \leq 25°C$</td><td colspan="4">250</td><td>W</td></tr>
<tr><td>At $T_C > 25°C$ ... Derate linearly</td><td colspan="4">1.43</td><td>W/°C</td></tr>
<tr><td>T_{stg}, T_J</td><td colspan="4">-65 to 200</td><td>°C</td></tr>
<tr><td>T_L</td><td colspan="4"></td><td></td></tr>
<tr><td>At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.</td><td colspan="4">230</td><td>°C</td></tr>
</table>

RCA9166A, RCA9166B, MJ15022, MJ15024

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

CHARAC-TERISTIC	TEST CONDITIONS: VOLTAGE V dc		CUR-RENT A dc	LIMITS: RCA9166A		RCA9166B		MJ15024		MJ15022		UNITS
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	400[a]			—	—	—	—	—	1	—	—	mA
	350[a]			—	—	—	—	—	—	—	1	
I_{CEO}	200			—	1	—	—	—	0.5	—	—	
	150			—	—	—	1	—	—	—	0.5	
I_{CEX}	400	−1.5		—	—	—	—	—	0.5	—	0.5	
	250	−1.5		—	—	—	—	—	0.25	—	—	
	200	−1.5		—	—	—	—	—	—	—	0.25	
I_{CER} R_{BE}=100 Ω,	200			—	4	—	—	—	4	—	—	
T_C=150° C	150			—	—	—	4	—	—	—	4	
h_{FE}	4		3[c]	30	—	30	—	—	—	—	—	
	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				5	—	5	—	—	—	—	—	
I_E=0.5 mA				—	—	—	—	5	—	5	—	
V_{BE}	4		3[c]	—	2	—	2	—	—	—	—	
	4		8[c]	—	—	—	—	—	2.2	—	2.2	
V_{CE}(sat) I_B=0.3 A			3[c]	—	1.0	—	1.0	—	—	—	—	
I_B=0.8 A			8[c]	—	—	—	—	—	1.4	—	1.4	
I_B=3.2 A			16[c]	—	—	—	—	—	4	—	4	
$I_{S/b}$ t_p=0.5 s	80			3	—	3	—	2	—	2	—	A
nonrep.	50			—	—	—	—	5	—	5	—	
$\|h_{fe}\|$ f=1 MHz	10		1	4	20	4	20	4	20	4	20	
f_T	10		1	4	20	4	20	4	20	4	20	MHz
C_{ob}	10[a]			—	500	—	500	—	500	—	500	pF
$R_{\theta JC}$	10		10	—	0.7	—	0.7	—	0.7	—	0.7	°C/W

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

[c] Pulsed; pulse duration=300 μs, duty factor=1.8%.

RCA9166A, RCA9166B, MJ15022, MJ15024

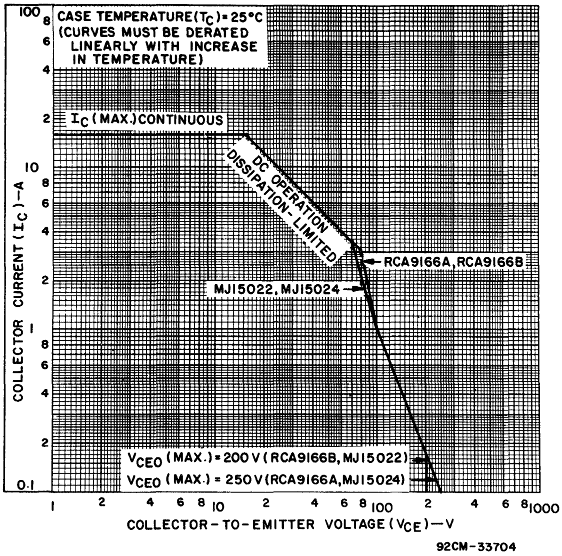


Fig. 1 - Maximum operating areas for all types.

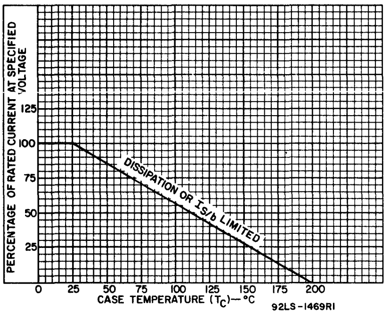


Fig. 2 - Current derating curve for all types.

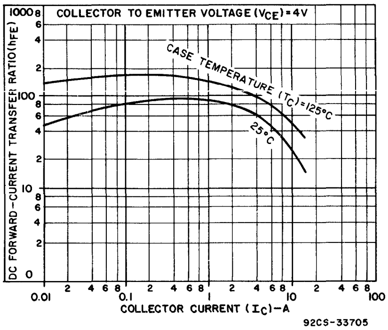


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

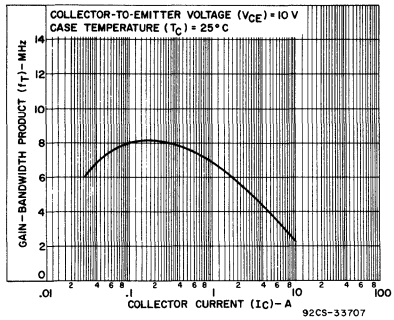


Fig. 4 - Typical gain-bandwidth product for all types.

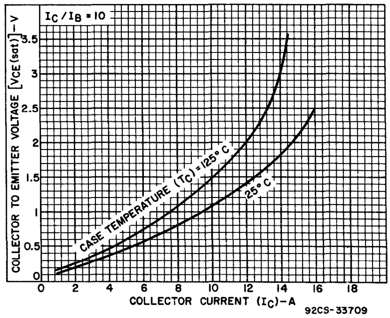


Fig. 5 - Typical saturation voltage characteristics for all types.

RCA9166A, RCA9166B, MJ15022, MJ15024

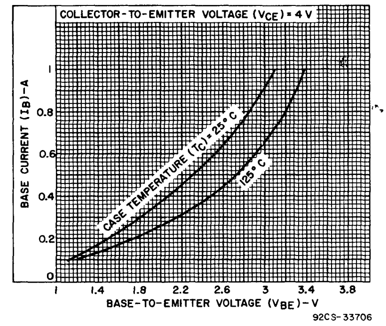


Fig. 6 - Typical input characteristics for all types.

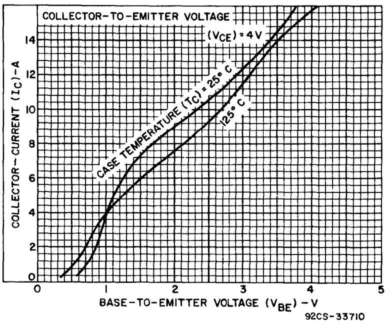


Fig. 7 - Typical transfer characteristics.

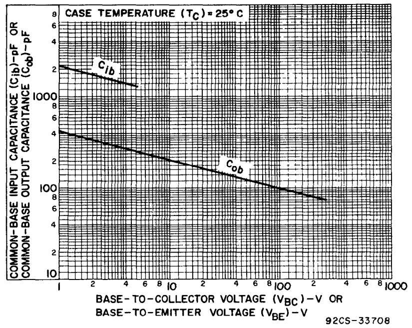


Fig. 8 - Typical common-base input or output capacitance characteristics as a function of reverse voltages for all types.

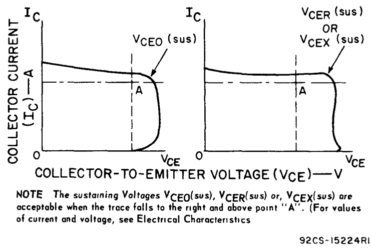


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 10).

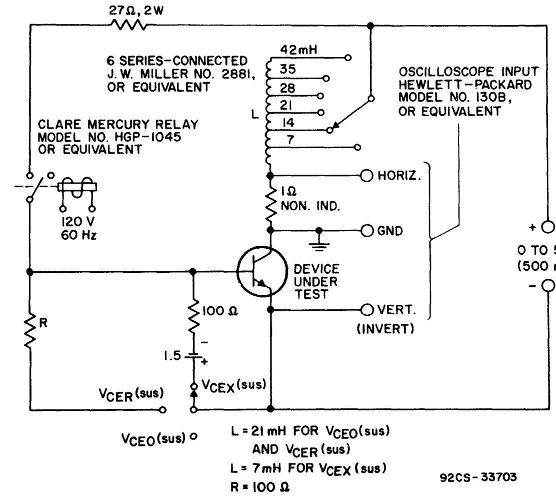


Fig. 10 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

TIP29, TIP29A, TIP29B, TIP29C

File Number **990**

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

For Power-Amplifier and High-Speed-Switching Applications

Features:

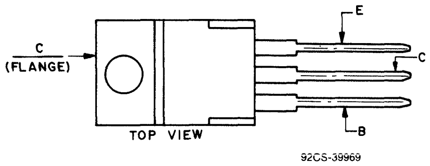
- *30 W at 25°C case temperature*
- *3 A rated collector current*
- *Min. f_T of 3 MHz at 10 V, 200 mA*
- *Designed for complementary use with TIP30-series p-n-p types**

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP29	TIP29A	TIP29B	TIP29C	
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 $T_C \leq 25°C$	30	30	30	30	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ ... 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
	VOLTAGE V dc	CURRENT A dc	TIP29		TIP29A		TIP29B		TIP29C		
	V_{CE}	I_C	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	0.2[a]	40	–	40	–	40	–	40	–	
	4	1[a]	15	150	15	150	15	150	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) $V_{CC}=30V$ $R_L=30\Omega$ $I_{B1}=I_{B2}=0.1A$		1	0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		0.4 (typ.)		μs
t_{OFF} (t_s+t_f) $V_{CC}=30V$ $R_L=30\Omega$ $I_{B1}=-I_{B2}=0.1A$		1	1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		1.2 (typ.)		μs
$R_{\theta JC}$			–	4.17	–	4.17	–	4.17	–	4.17	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	°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.

TIP29, TIP29A, TIP29B, TIP29C

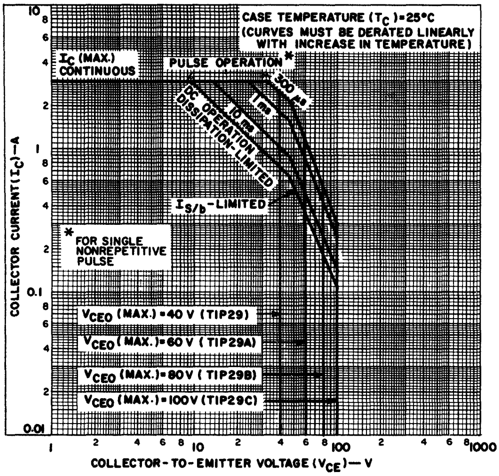


Fig. 1 — Maximum operating areas for all types.

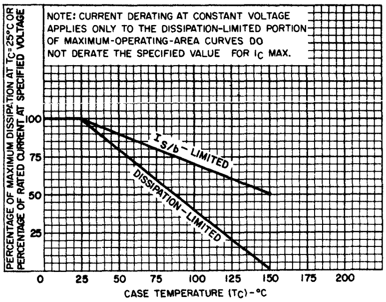


Fig. 2 — Derating curve for all types.

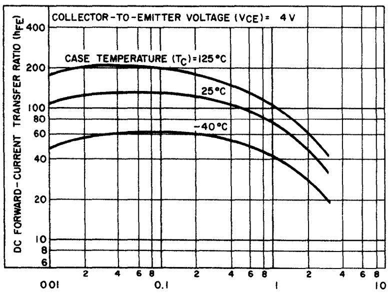


Fig. 3 — Typical dc beta characteristics for TIP29, TIP29A, and TIP29B.

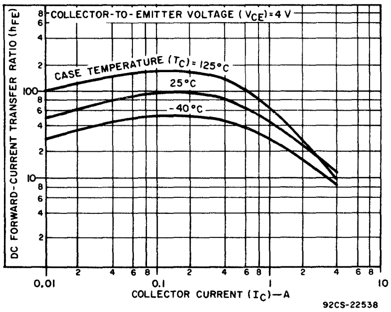
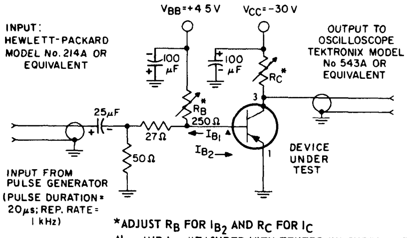


Fig. 4 — Typical dc beta characteristics for TIP29C.

TIP29, TIP29A, TIP29B, TIP29C

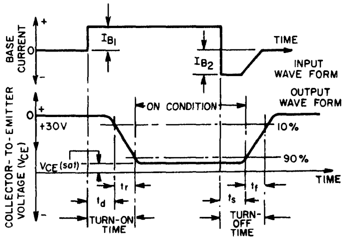


*ADJUST R_B FOR I_{B2} AND R_C FOR I_C

▲I_{B1} AND I_{B2} MEASURED WITH TEKTRONIX CURRENT PROBE P6019 AND TYPE 134 AMPLIFIER, OR EQUIVALENT

92CS-24796

Fig. 5 — Circuit used to measure saturated switching times for all types.



92CS-24797R1

Fig. 6 — Oscilloscope display for measurement of switching times.

TIP30, TIP30A, TIP30B, TIP30C

File Number **988**

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

For Power-Amplifier and High-Speed-Switching Applications

Features:

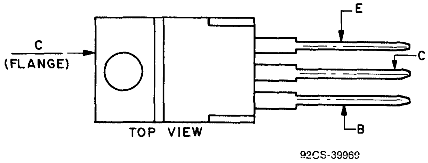
- *30 W at 25°C case temperature*
- *3 A rated collector current*
- *Min. f_T of 3 MHz at -10 V, -200 mA*
- *Designed for complementary use with TIP29-series n-p-n types**

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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 $T_C \leq 25°C$	30	30	30	30	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ ... 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. VOLTAGE V dc	TEST COND. CURRENT A dc	LIMITS TIP30		LIMITS TIP30A		LIMITS TIP30B		LIMITS TIP30C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} I_B=0	−30		–	−0.3	–	−0.3	–	–	–	–	
	−60		–	–	–	–	–	−0.3	–	−0.3	mA
I_{CES} V_{EB}=0	−40		–	−0.2	–	–	–	–	–	–	
	−60		–	–	–	−0.2	–	–	–	–	
	−80		–	–	–	–	–	−0.2	–	–	mA
	−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	−0.2[a]	40	–	40	–	40	–	40	–	
	−4	−1[a]	15	150	15	150	15	150	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	0.2 (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.)		µs
$R_{\theta JC}$			–	4.17	–	4.17	–	4.17	–	4.17	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	°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.

TIP30, TIP30A, TIP30B, TIP30C

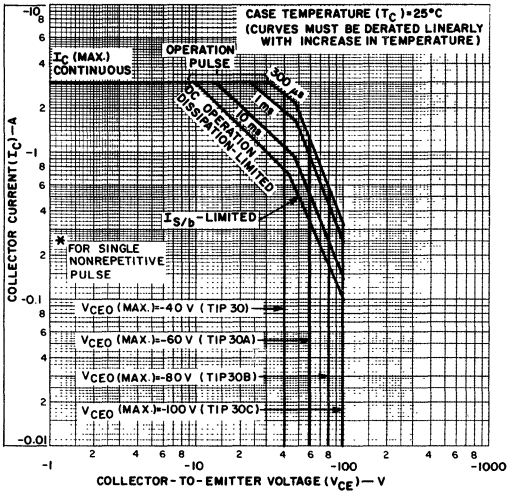


Fig.1 — Maximum operating areas for all types.

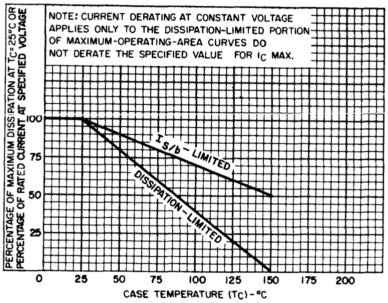


Fig.2 — Derating curve for all types.

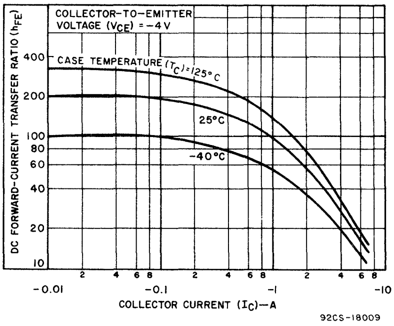


Fig. 3 — Typical dc beta characteristics for TIP30, TIP30A, and TIP30B.

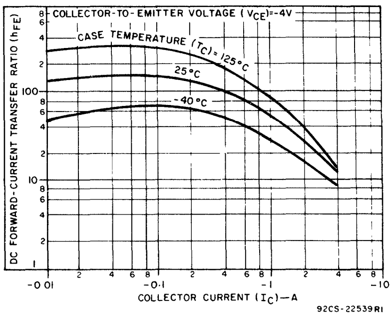


Fig. 4 — Typical dc beta characteristics for TIP30C.

TIP30, TIP30A, TIP30B, TIP30C

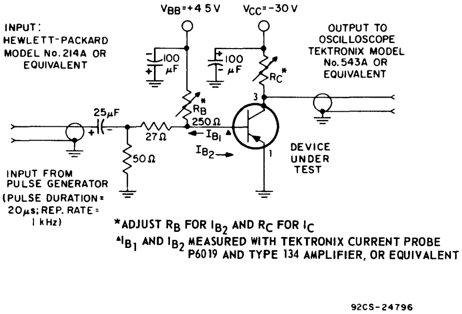


Fig. 5 — Circuit used to measure saturated switching times for all types.

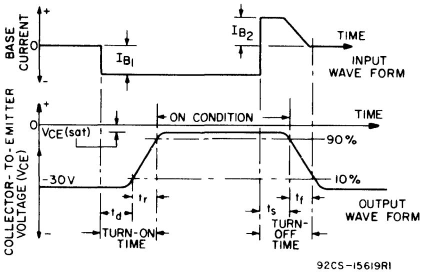


Fig. 6 — Oscilloscope display for measurement of switching times.

TIP31, TIP31A, TIP31B, TIP31C

File Number **991**

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

For Power-Amplifier and High-Speed-Switching Applications

Features:

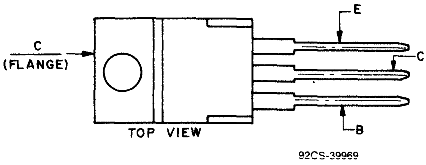
- *40 W at 25°C case temperature*
- *5 A rated collector current*
- *Min. f_T of 3 MH_Z at 10 V, 500 mA*
- *Designed for complementary use with TIP32-series p-n-p types**

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. Thev 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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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 $T_C \leq 25°C$	40	40	40	40	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ ... 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

TIP31, TIP31A, TIP31B, TIP31C

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

CHARACTERISTIC	TEST COND. VOLTAGE V dc	TEST COND. CURRENT A dc	LIMITS TIP31		TIP31A		TIP31B		TIP31C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	30		–	0.3	–	0.3	–	–	–	–	
I_B=0	60		–	–	–	–	–	0.3	–	0.3	mA
	40		–	0.2	–	–	–	–	–	–	
I_{CES}	60		–	–	–	0.2	–	–	–	–	
V_{EB}=0	80		–	–	–	–	–	0.2	–	–	mA
	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.)		µs
$R_{\theta JC}$			–	3.125	–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	°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.

TIP31, TIP31A, TIP31B, TIP31C

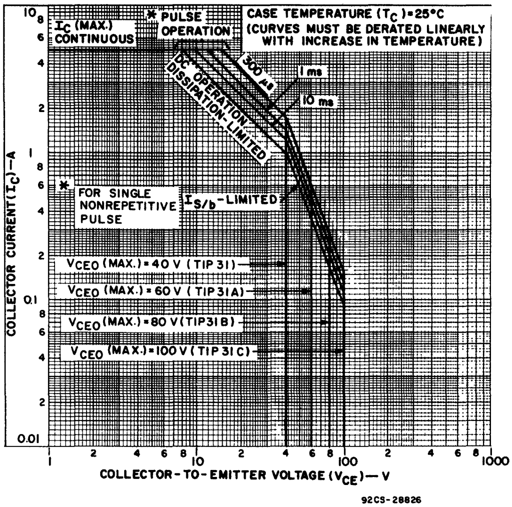


Fig.1 — Maximum operating areas for all types.

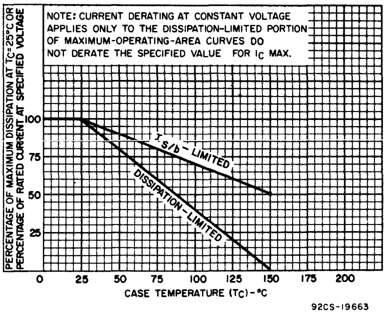


Fig.2 — Derating curve for all types.

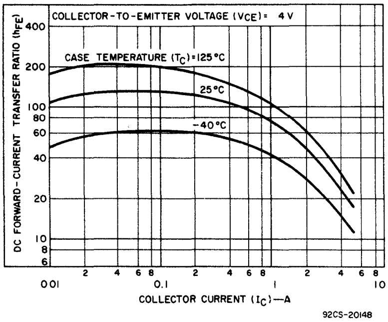


Fig. 3 — Typical dc beta characteristics for TIP31, TIP31A, and TIP31B.

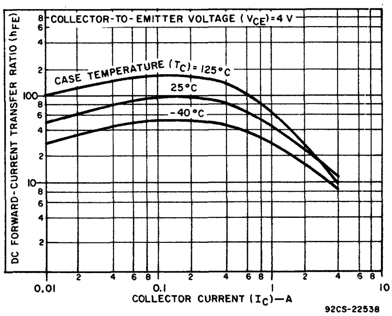


Fig. 4 — Typical dc beta characteristics for TIP31C.

TIP31, TIP31A, TIP31B, TIP31C

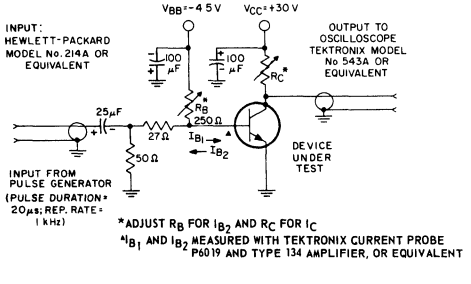


Fig. 5 — Circuit used to measure saturated switching times for all types.

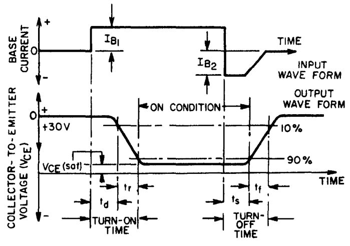


Fig. 6 — Oscilloscope display for measurement of switching times.

TIP32, TIP32A, TIP32B, TIP32C

File Number **987**

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

For Power-Amplifier and High-Speed-Switching Applications

Features:

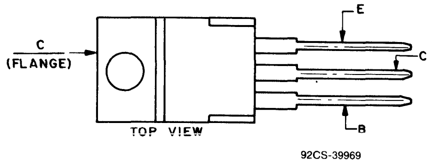
- *40 W at 25°C case temperature*
- *5 A rated collector current*
- *Min. f_T of 3 MHz at -10 V, -500 mA*
- *Designed for complementary use with TIP31-series n-p-n types**

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 $T_C \leq 25°C$	40	40	40	40	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ . . . 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. VOLTAGE V dc	TEST COND. CURRENT A dc	LIMITS TIP32		LIMITS TIP32A		LIMITS TIP32B		LIMITS TIP32C		Units
	V_{CE}	I_C	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) $V_{CC}=-30V$ $R_L=30\Omega$ $I_{B1}=I_{B2}=-0.1A$		−1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		µs
t_{OFF} (t_s+t_f) $V_{CC}=-30V$ $R_L=30\Omega$ $I_{B1}=-I_{B2}=-0.1A$		−1	1 (typ.)		1 (typ.)		1 (typ.)		1 (typ.)		µs
$R_{\theta JC}$			–	3.125	–	3.125	–	3.125	–	3.125	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	°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.

TIP32, TIP32A, TIP32B, TIP32C

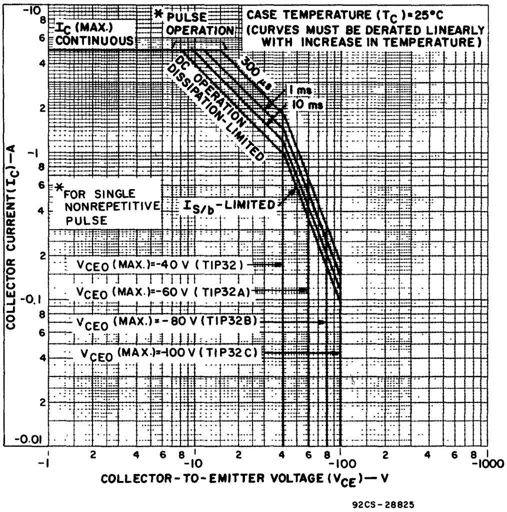


Fig. 1 — Maximum operating areas for all types.

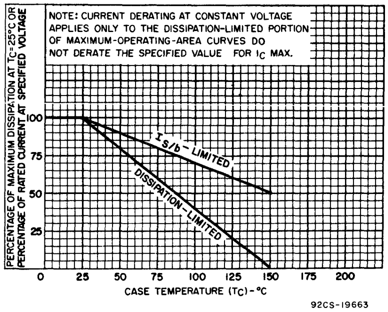


Fig.2 — Derating curve for all types.

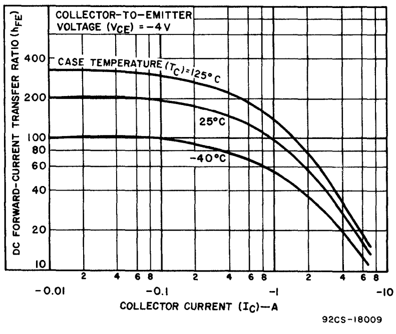


Fig. 3 — Typical dc beta characteristics for TIP32, TIP32A, and TIP32B.

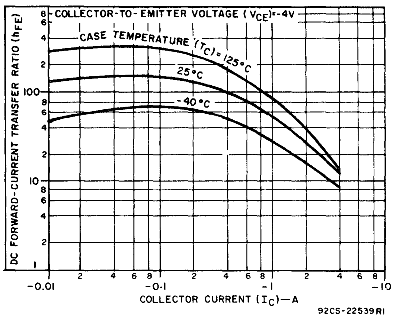


Fig. 4 — Typical dc beta characteristics for TIP32C.

TIP32, TIP32A, TIP32B, TIP32C

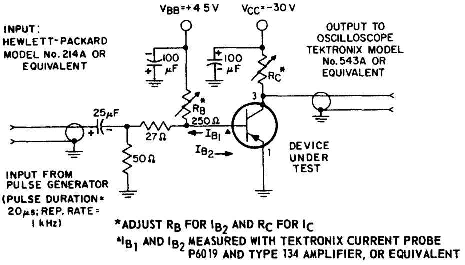


Fig. 5 — Circuit used to measure saturated switching times for all types.

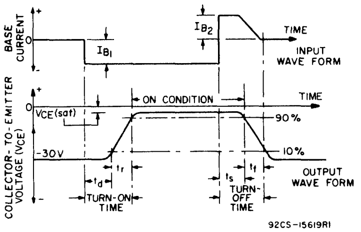


Fig. 6 — Oscilloscope display for measurement of switching times.

TIP41, TIP41A, TIP41B, TIP41C

File Number **992**

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

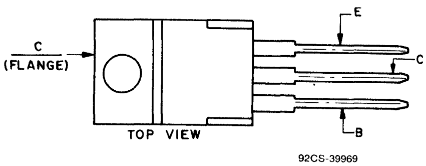
For Power-Amplifier and High-Speed-Switching Applications

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP41	TIP41A	TIP41B	TIP41C	
V_{CBO}	40	60	80	100	V
V_{CEO}	40	60	80	100	V
V_{EBO}	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 $T_C \leq 25°C$	65	65	65	65	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ ... 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 Voltage V dc V_{CE}	Current A dc I_C	TIP41 Min.	TIP41 Max.	TIP41A Min.	TIP41A Max.	TIP41B Min.	TIP41B Max.	TIP41C Min.	TIP41C Max.	Units
I_{CEO} I_B=0	30		–	0.7	–	0.7	–	–	–	–	mA
	60		–	–	–	–	–	0.7	–	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.)		μs
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.)		μs
$R_{\theta JC}$			–	1.92	–	1.92	–	1.92	–	1.92	°C/W
$R_{\theta JA}$			–	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.*

TIP41, TIP41A, TIP41B, TIP41C

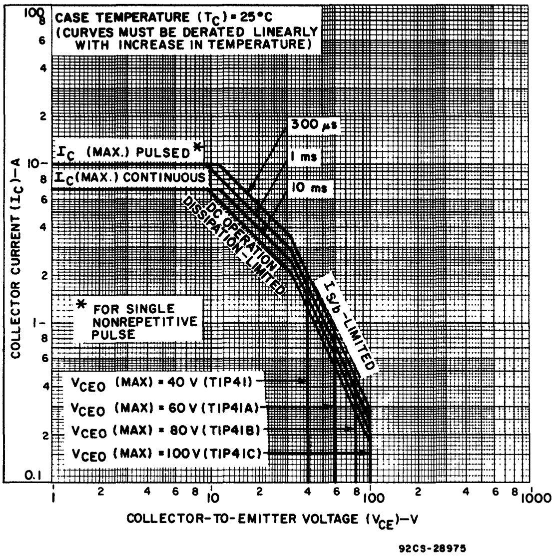


Fig. 1 — Maximum operating areas for all types.

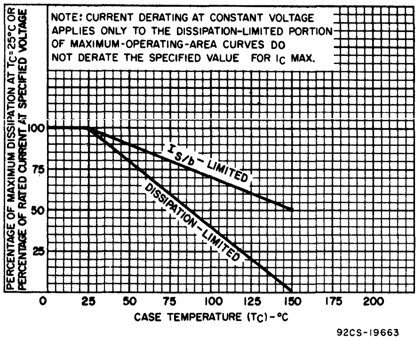


Fig. 2 — Derating curves for all types.

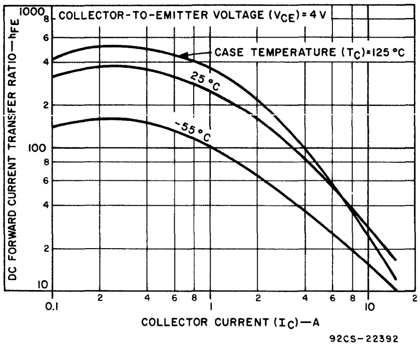


Fig. 3 — Typical dc beta characteristics for all types.

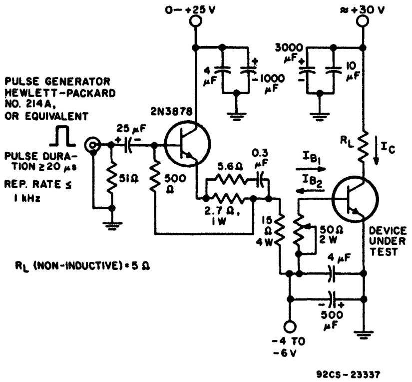


Fig. 4 — Circuit used to measure saturated switching times for all types.

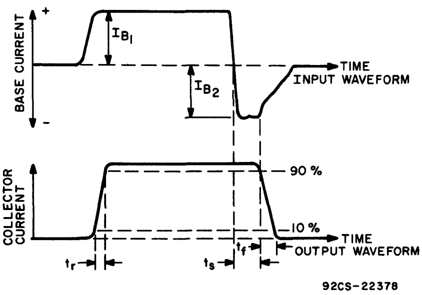


Fig. 5 — Oscilloscope display for measurement of switching times.

File Number **996**

TIP42, TIP42A, TIP42B, TIP42C

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

For Power-Amplifier and High-Speed-Switching Applications

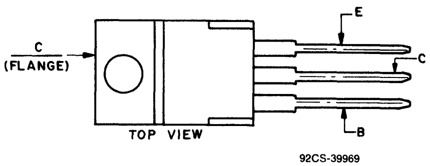
Features:
- *65 W at 25°C case temperature*
- *7 A rated collector current*
- *Min. f_T of 3 MHz at 10 V, 500 mA*
- *Designed for complementary use with TIP41-series n-p-n types**

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP42	TIP42A	TIP42B	TIP42C	
V_{CBO}	-40	-60	-80	-100	V
V_{CEO}	-40	-60	-80	-100	V
V_{EBO}	-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 $T_C \leq 25°C$	65	65	65	65	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ 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. VOLTAGE V dc V_{CE}	TEST COND. CURRENT A dc I_C	LIMITS TIP42 Min.	TIP42 Max.	TIP42A Min.	TIP42A Max.	TIP42B Min.	TIP42B Max.	TIP42C Min.	TIP42C Max.	UNITS
I_{CEO}	-30		–	-0.7	–	-0.7	–	–	–	–	
$I_B = 0$	-60		–	–	–	–	–	-0.7	–	-0.7	mA
I_{CES}	-40		–	-0.4	–	–	–	–	–	–	
$V_{EB} = 0$	-60		–	–	–	-0.4	–	–	–	–	
	-80		–	–	–	–	–	-0.4	–	–	mA
	-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 $R_L = 5\ \Omega$ $I_{B1} = I_{B2} = -0.6$ A		-6	0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		μs
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.)		μs
$R_{\theta JC}$			–	1.92	–	1.92	–	1.92	–	1.92	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	°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.

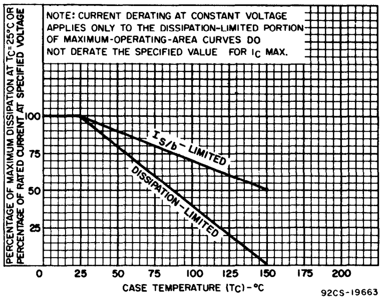


Fig. 1 — Derating curve for all types.

TIP42, TIP42A, TIP42B, TIP42C

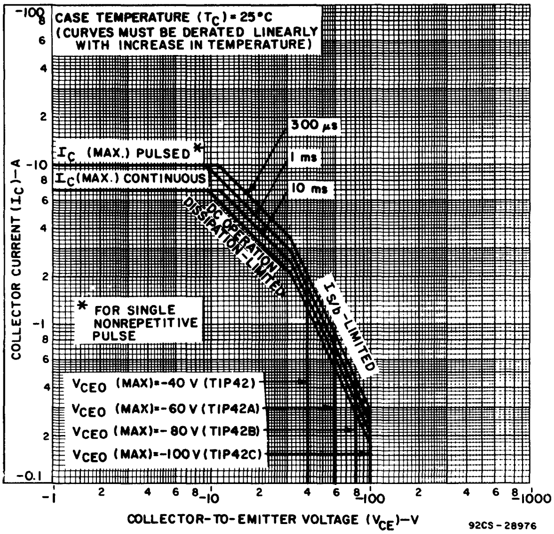


Fig. 2 — Maximum operating areas for all types.

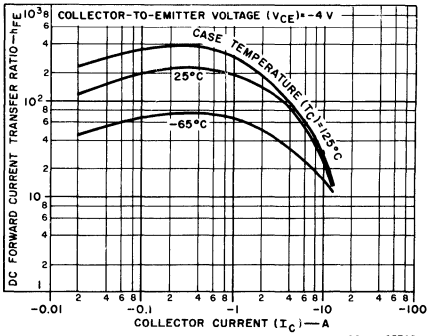


Fig. 3 — Typical dc beta characteristics for TIP42, TIP42A, and TIP42B.

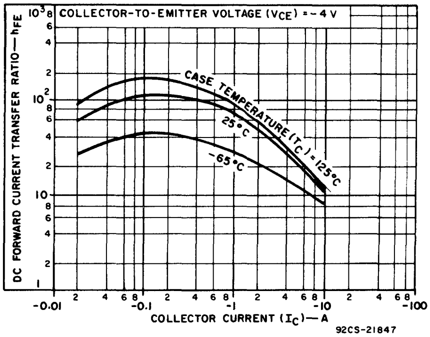
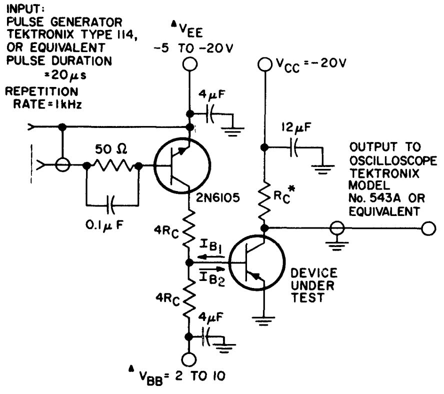


Fig. 4 — Typical dc beta characteristics for TIP42C.



* R_C IS CHOSEN FOR I_C
▲ V_{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 92CS-23338R1

Fig. 5 — Circuit used to measure saturated switching times for all types.

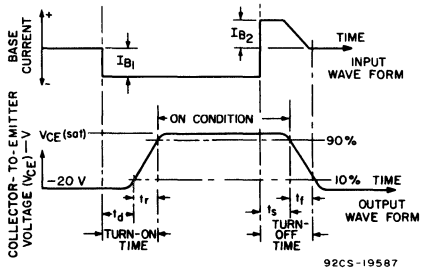


Fig. 6 — Oscilloscope display for measurement of switching times.

PRO ELECTRON Power Transistors
Technical Data

This section includes technical data for all PRO ELECTRON power transistors supplied by RCA with the exception of SwitchMax and power Darlington types. Technical data for RCA PRO ELECTRON SwitchMax and Darlington transistors are grouped with the data for other SwitchMax and Darlington types. These types, together with the DATABOOK page-number locations for them are listed below:

PRO ELECTRON SCR's, triacs, and rectifiers are covered in the data sections for these product categories.

BD142 File Number **701**

High-Power Silicon N-P-N Transistor

General-Purpose Device
For Commercial Use

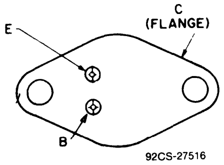
Features:

- *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 ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235	°C

BD142

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	–	V
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-Breakdown Collector Current (t ⩾ 1 s)	$I_{S/b}$	39					3	–	A
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$						–	1.5	°C/W

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

BD142

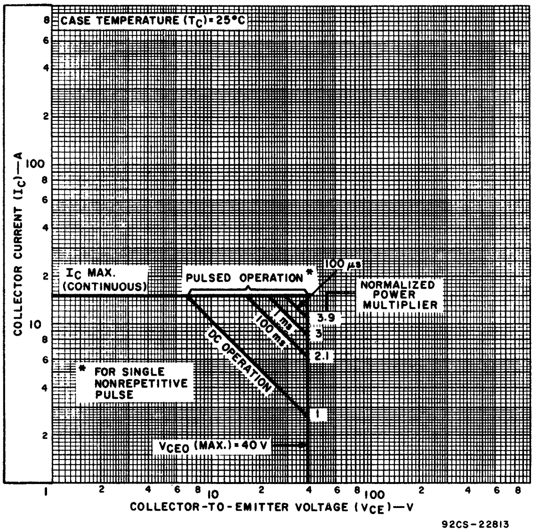


Fig. 1 — Maximum safe area of operation.

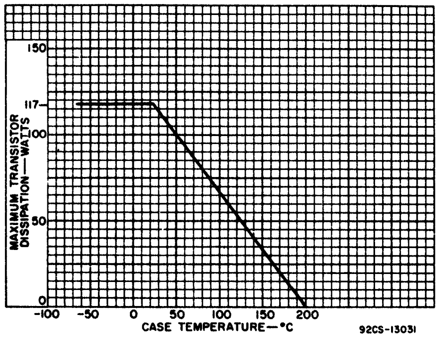


Fig. 2 — Dissipation derating curve.

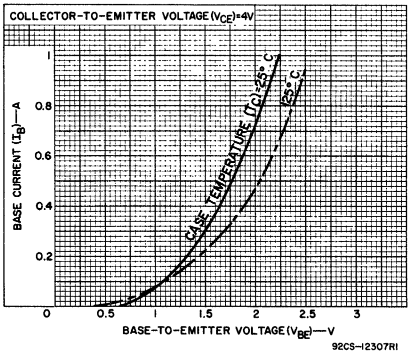


Fig. 3 — Typical input characteristics.

BD142

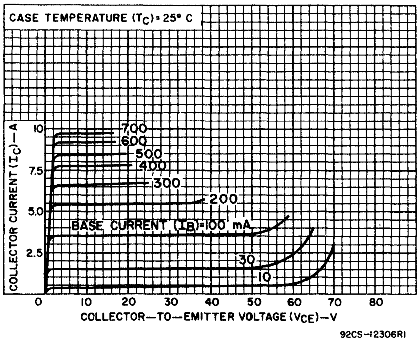


Fig. 4 — Typical output characteristics.

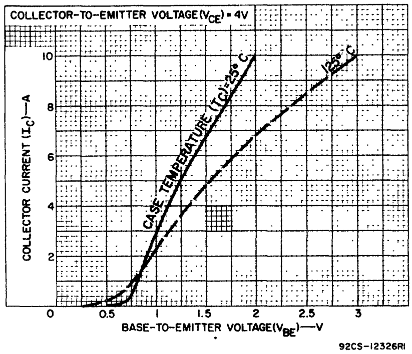


Fig. 5 — Typical transfer characteristics.

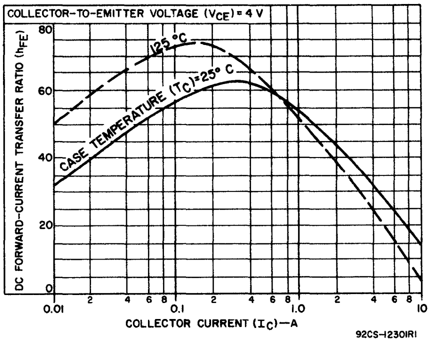


Fig. 6 — Typical dc-beta characteristics.

BD181, BD182, BD183 File Number **700**

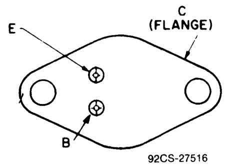
High-Power Silicon N-P-N Transistors

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 ≥ 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: VOLTAGE V dc				CURRENT A dc		LIMITS: BD181		BD182		BD183		UNITS
		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°C	I_{CBO}	45					0	–	2	–	–	–	–	
		60					0	–	–	–	5	–	–	
		80					0	–	–	–	–	–	5	
With base-emitter junction reverse-biased	I_{CEX}		45		−1.5				1	–	–	–	–	mA
			60		−1.5			–	–	–	1	–	–	
			80		−1.5			–	–	–	–	–	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	–	
With external base-to-emitter resistance (R_{BE})=100 Ω	$V_{CER}(sus)$					0.2[a]		55	–	70	–	85	–	V
DC Forward Current Transfer Ratio	h_{FE}		4			4[a]		–	–	20	70	–	–	
			4			3[a]		20	70	–	–	20	70	
Base-to-Emitter Voltage	V_{BE}		4			3[a]		–	1.5	–	–	–	1.5	V
			4			4[a]		–	–	–	1.5	–	–	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					4[a]	0.4[a]	–	–	–	1	–	–	V
						3[a]	0.3[a]	–	1	–	–	–	1	
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)	$R_{\theta JC}$							–	1.5	–	1.5	–	1.5	°C/W

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

BD181, BD182, BD183

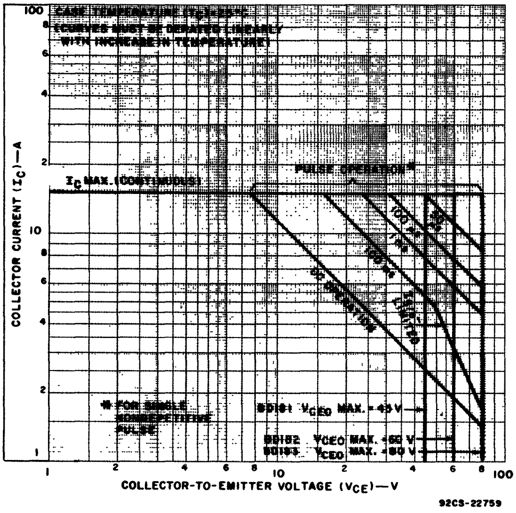


Fig. 1 — Maximum operating areas for all types.

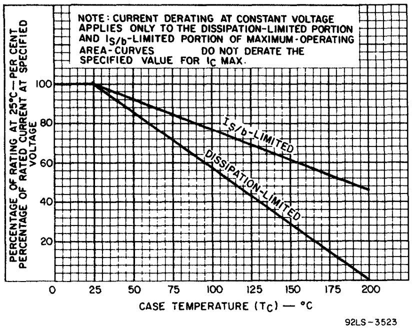


Fig. 2 — Dissipation and $I_{S/b}$ derating of all types.

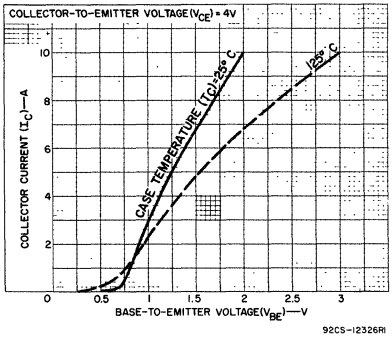


Fig. 3 — Typical transfer characteristics for all types.

BD181, BD182, BD183

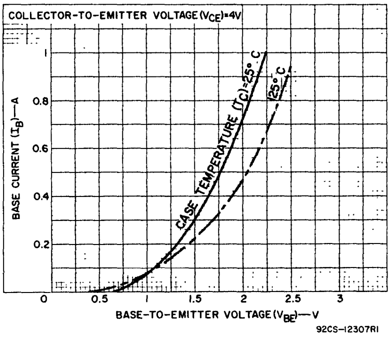


Fig. 4 — Typical input characteristics for BD182.

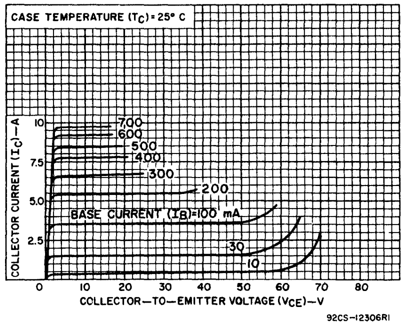


Fig. 5 — Typical output characteristics for BD182.

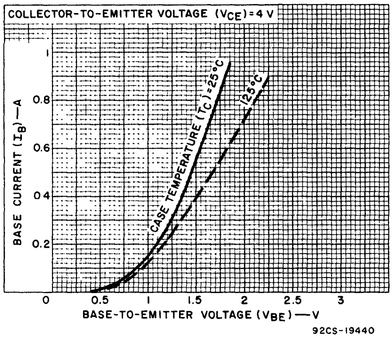


Fig. 6 — Typical input characteristics for BD181 and BD183.

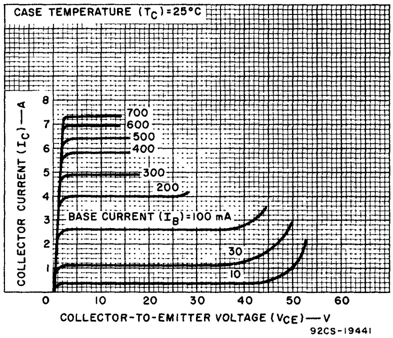


Fig. 7 — Typical output characteristics for BD181 and BD183.

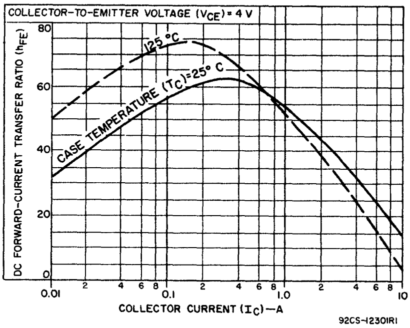


Fig. 8 — Typical dc-beta characteristics for BD182.

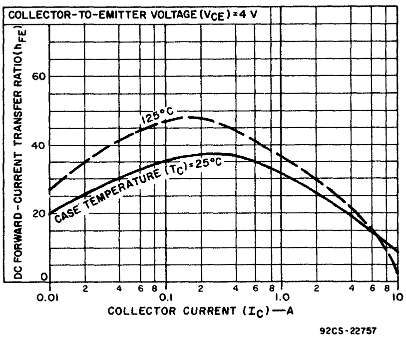


Fig. 9 — Typical dc-beta characteristics for BD181 and BD183.

BD201, BD202, BD203, BD204

File Number **1282**

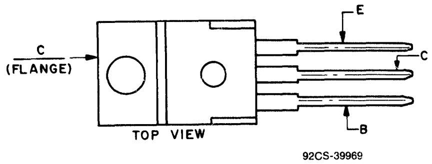
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-BD201 and BD203 n-p-n transistors and their complementary p-n-p types, BD202 and BD204 respectively, are epitaxial-base 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 amplifier.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N	BD201	BD203	
	P-N-P	BD202■	BD204■	
V_{CBO}		60	80	V
$V_{CEO}(sus)$		45	60	V
V_{EBO}		5		V
I_C		8		A
I_B		3		A
P_T				
$T_C \leq 25°C$		60		W
$T_C > 25°C$		Derate linearly 0.48		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.

BD201, BD202, BD203, BD204

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

CHARAC-TERISTIC	TEST CONDITIONS■ VOLTAGE V dc			CURRENT A dc		LIMITS BD201 BD202■		BD203 BD204■		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CBO}	40					—	1	—	1	mA
T_J=150°C	40					—	1	—	1	mA
I_{CEO}		30				—	1	—	1	mA
I_{EBO}			-5			—	5	—	5	mA
$V_{CEO}(sus)^a$				0.2^b		45	—	60	—	V
h_{FE}		2		1^b		30	—	30	—	
		2		2^b		—	—	30	—	
		2		3^b		30	—	—	—	
V_{BE}		2		3^b		—	1.5	—	1.5	V
$V_{CE}(sat)$				3^b	0.3	—	1	—	1	V
$I_{S/b}$		20		3		0.5	—	0.5	—	s
$\|h_{fe}\|$ (f=1 kHz)		3		0.3		3	—	3	—	
h_{fe} (f=1 kHz)		3		0.3		25	—	25	—	
$R_{\theta JC}$						—	2.08	—	2.08	°C/W
$R_{\theta JA}$						—	70	—	70	°C/W

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

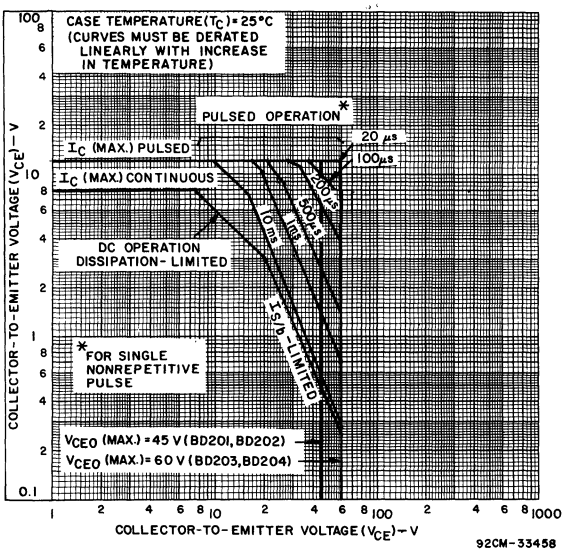


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

BD201, BD202, BD203, BD204

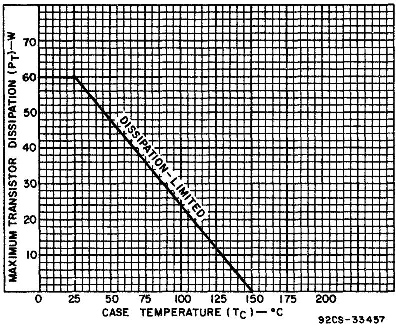


Fig. 2 - Derating curve for all types.

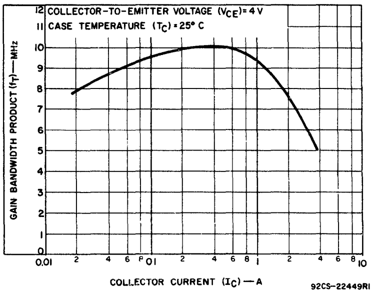


Fig. 3 - Typical gain-bandwidth product vs. collector current for all types.

File Number **669**

BD239, BD239A, BD239B, BD239C

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

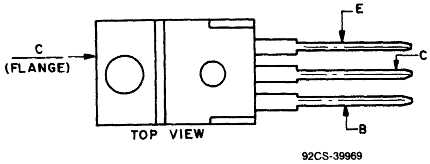
Features:

- **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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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

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	
With base-to-emitter junction short-circuited	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	$R_{\theta JC}$					–	4.17	–	4.17	–	4.17	–	4.17	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

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

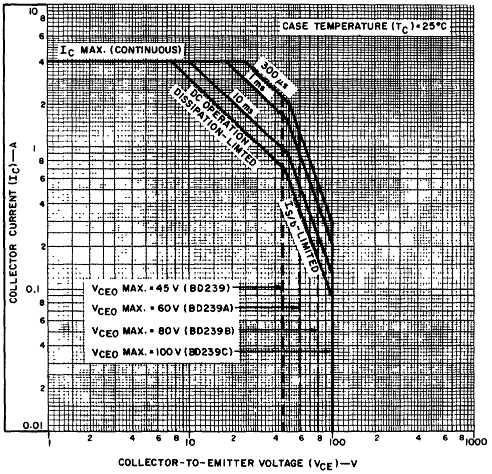


Fig. 1— Maximum safe operating areas for all types.

BD239, BD239A, BD239B, BD239C

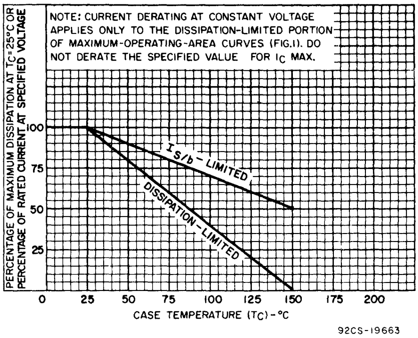


Fig. 2— Derating curves for all types.

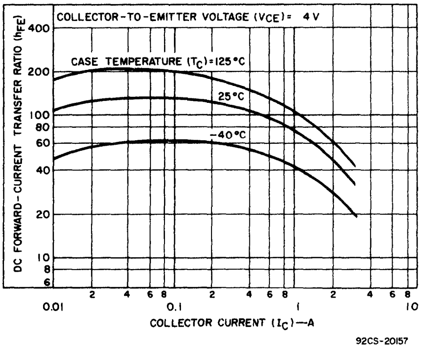


Fig. 3 — Typical dc beta characteristics for all types.

BD240, BD240A, BD240B, BD240C

File Number **670**

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

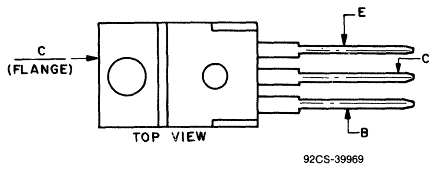
Features:

- **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:	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

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			0	–	−0.3	–	−0.3	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.3	–	−0.3	mA
With base-to-emitter junction short-circuited	I_{CES}	−45	0			–	−0.2	–	–	–	–	–	–	mA
		−60	0			–	–	–	−0.2	–	–	–	–	mA
		−80	0			–	–	–	–	–	−0.2	–	–	mA
		−100	0			–	–	–	–	–	–	–	−0.2	mA
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	$R_{\theta JC}$					–	4.17	–	4.17	–	4.17	–	4.17	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

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

BD240, BD240A, BD240B, BD240C

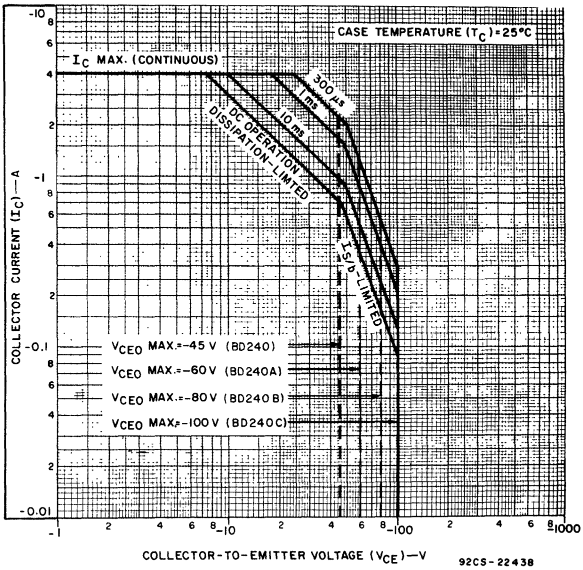


Fig. 1— Maximum safe operating areas for all types.

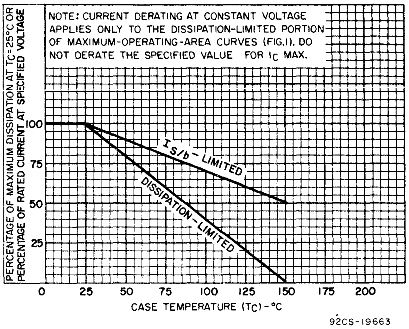


Fig. 2— Derating curves for all types.

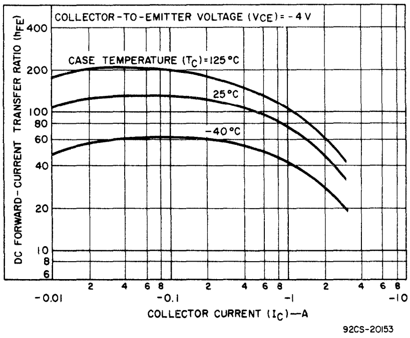


Fig. 3 — Typical dc beta characteristics for all types.

File Number **671**

BD241, BD241A, BD241B, BD241C

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

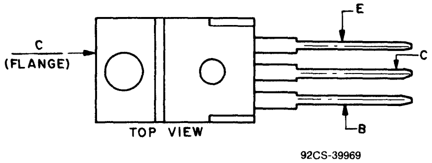
Features:

- **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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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:	P_T					
At case temperatures up to 25°C		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, BD241C

ELECTRICAL 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			0	–	0.3	–	0.3	–	–	–	–	mA
		60			0	–	–	–	–	–	0.3	–	0.3	
With base-to-emitter junction short-circuited	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		1[a]		25	–	25	–	25	–	25	–	
		4		3[a]		10	–	10	–	10	–	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	$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

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

BD241, BD241A, BD241B, BD241C

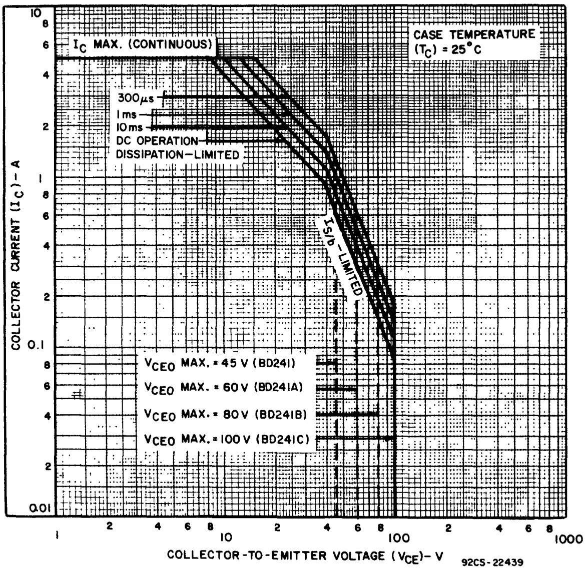


Fig. 1— Maximum safe operating areas for all types.

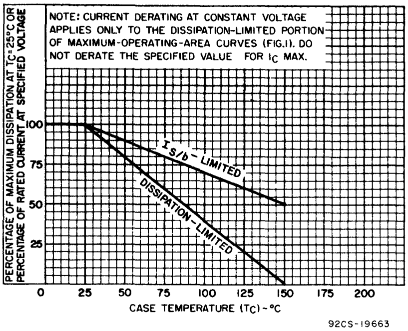


Fig. 2— Derating curves for all types.

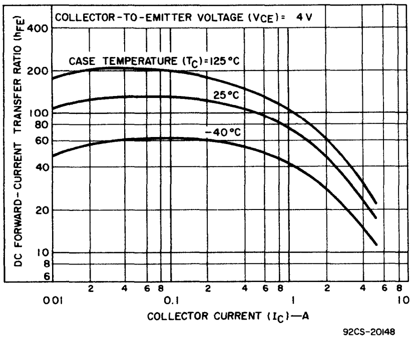


Fig. 3 — Typical dc beta characteristics for all types.

BD242, BD242A, BD242B, BD242C

File Number **672**

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

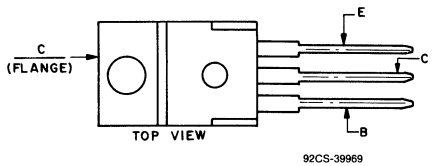
Features:

- **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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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:	P_T					
At case temperatures up to 25°C		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, BD242C

ELECTRICAL 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			0	–	−0.3	–	−0.3	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.3	–	−0.3	
With base-to-emitter junction short-circuited	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		−1[a]		25	–	25	–	25	–	25	–	
		−4		−3[a]		10	–	10	–	10	–	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	$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

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

BD242, BD242A, BD242B, BD242C

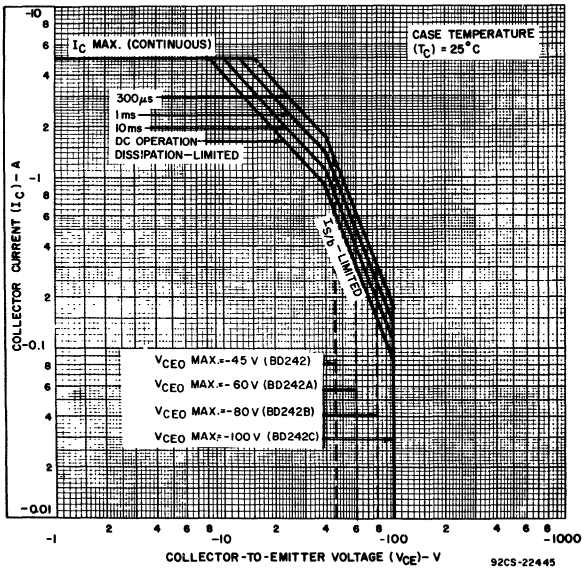


Fig. 1— Maximum safe operating areas for all types.

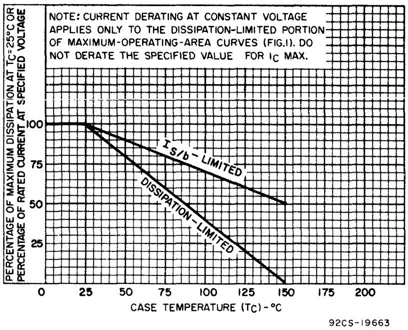


Fig. 2— Derating curves for all types.

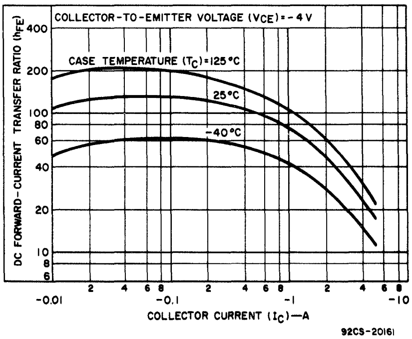


Fig. 3 — Typical dc beta characteristics for all types.

File Number **673**

BD243, BD243A, BD243B, BD243C

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

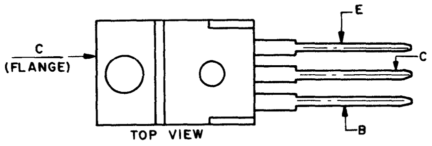
Features:

- **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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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:	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

BD243, BD243A, BD243B, BD243C

ELECTRICAL 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	–	0.7	mA
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.4	–	–	–	–	–	–	mA
		60	0			–	–	–	0.4	–	–	–	–	mA
		80	0			–	–	–	–	–	0.4	–	–	mA
		100	0			–	–	–	–	–	–	–	0.4	mA
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	$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

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

BD243, BD243A, BD243B, BD243C

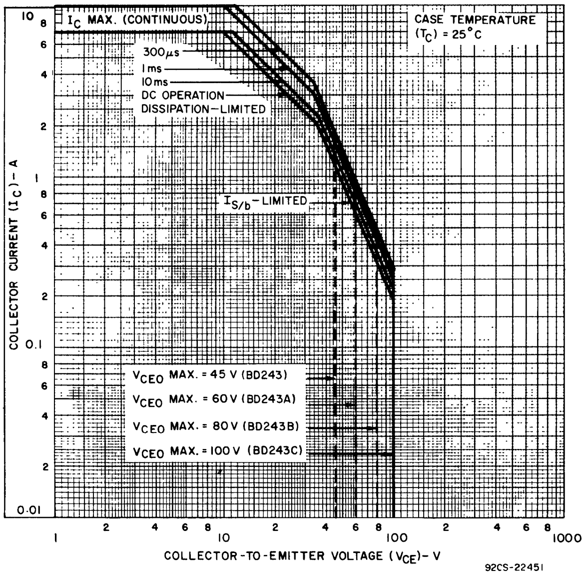


Fig. 1— Maximum safe operating areas for all types.

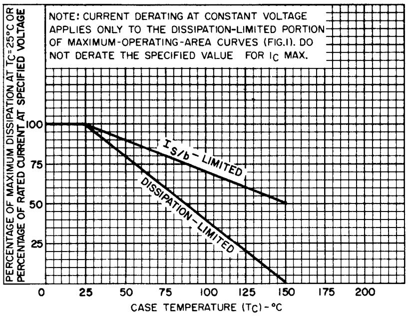


Fig. 2— Derating curves for all types.

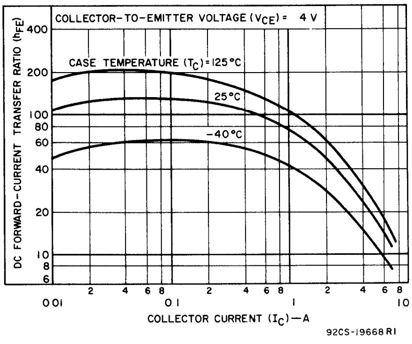


Fig. 3 — Typical dc beta characteristics for all types.

BD244, BD244B, BD244A, BD244C

File Number **674**

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

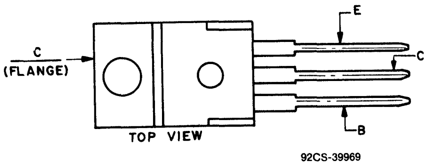
Features:

- **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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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, BD244B, BD244A, 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			0	–	−0.7	–	−0.7	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.7	–	−0.7	
With base-to-emitter junction short-circuited	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	$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

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

BD244, BD244B, BD244A, BD244C

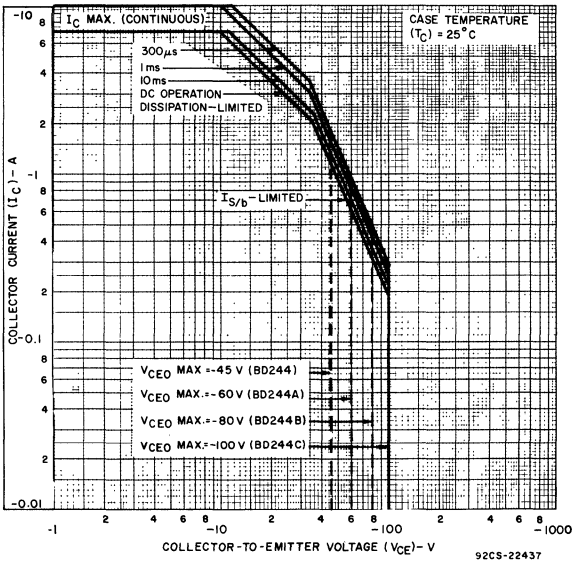


Fig. 1— Maximum safe operating areas for all types.

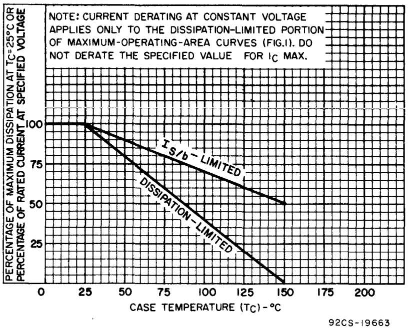


Fig. 2— Derating curves for all types.

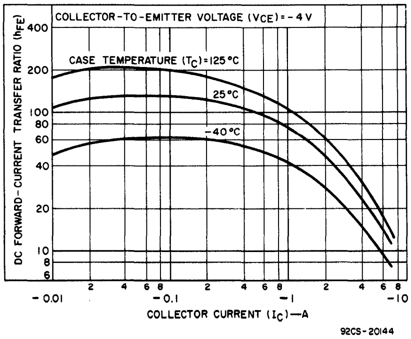


Fig. 3 — Typical dc beta characteristics for all types.

File Number **667**

BD277

7-A, 70-W, Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Applications in Series and Shunt Regulators

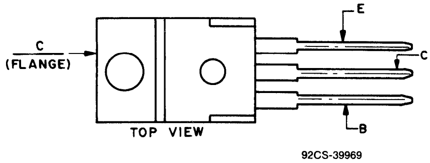
Features:

- *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.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE:			
With emitter open	V_{CBO}	–45	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With base open	V_{CEO}	–45	V
EMITTER-TO-BASE VOLTAGE:			
With collector open	V_{EBO}	–4	V
COLLECTOR CURRENT (Continuous)	I_C	–7	A
BASE CURRENT (Continuous)	I_B	–3	A
TRANSISTOR DISSIPATION:	P_T		
At case temperatures up to 25°C		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 ≥ 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 VOLTAGE V dc			CURRENT A dc			LIMITS		UNITS
		V_{CE}	V_{CB}	V_{EB}	I_C	I_B	I_E	MIN.	MAX.	
Collector Cutoff Current: With emitter open	I_{CBO}		−45				0	–	−0.1	mA
With emitter open and T_C = 150°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	$R_{\theta JC}$							–	1.78	°C/W
Junction-to-Ambient	$R_{\theta JA}$							–	70	

* Pulsed: Pulse duration = 300 μs, duty factor ≤ 2%.

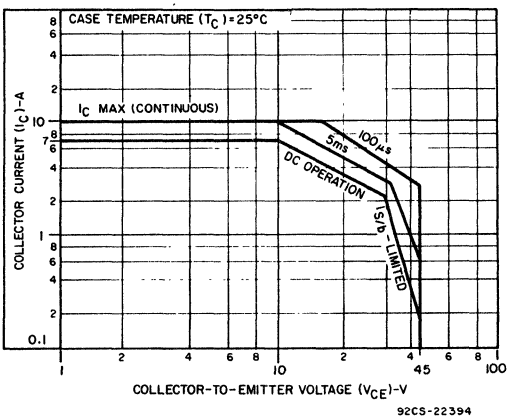


Fig.1 – Maximum operating area.

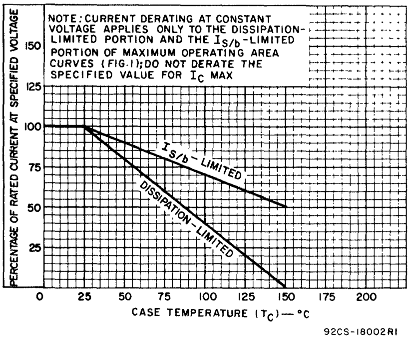


Fig. 2 — Derating curves.

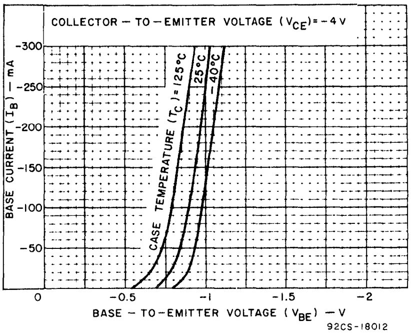


Fig. 3 — Typical input characteristics.

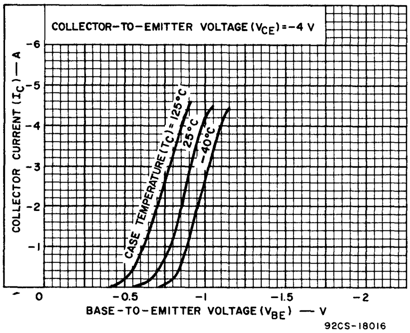


Fig. 4 — Typical transfer characteristics.

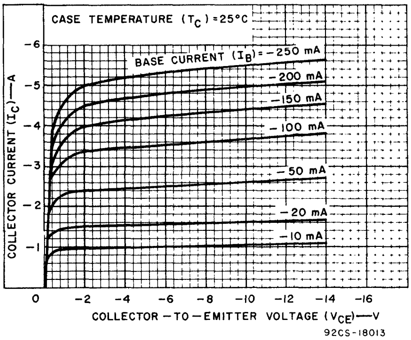


Fig. 5 — Typical output characteristics.

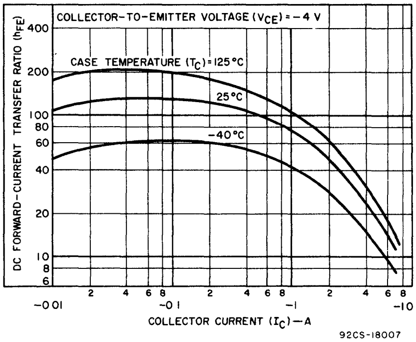


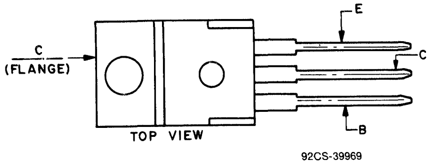
Fig. 6 — Typical dc beta characteristics.

BD500, BD500B, BD501B

File Number **1108**

Silicon Transistors for Full-Complementary-Symmetry Audio Amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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 $T_C \leq 25°C$	75		W
At $T_C > 25°C$	See Figs. 1 and 2		
T_{stg}, T_J	-65 to 150		°C
T_L At distances ≥ 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*

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS▲				UNITS
		BD500•		BD500B• BD5001B		
		Min.	Max.	Min.	Max.	
I_{CER}	V_{CE} = 45 V	—	1	—	—	mA
R_{BE} = 100 Ω	V_{CE} = 75 V	—	—	—	1	
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 Ω	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	15	90	—	—	—
	I_C = 3.5 A; V_{CE} = 4 V	—	—	20	120	
V_{CE}(sat)	I_C = 5 A; I_B = 0.5 A	—	1.2	—	—	V
	I_C = 3.5 A; I_B = 0.35 A	—	—	—	1	
V_{BE}	I_C = 5 A; V_{CE} = 4 V	—	1.8	—	—	V
	I_C = 3.5 A; V_{CE} = 4 V	—	—	—	1.5	
$I_{S/b}$	V_{CE} = 20 V; t = 0.5 s	3.75	—	—	—	A
	V_{CE} = 30 V; t = 0.5 s	—	—	2.5	—	

▲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.

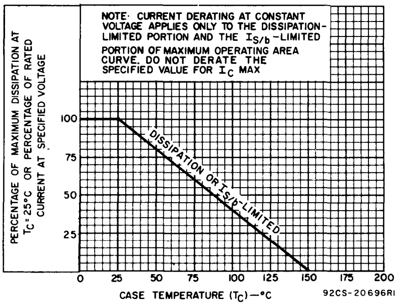


Fig. 1 — Derating curve for all types.

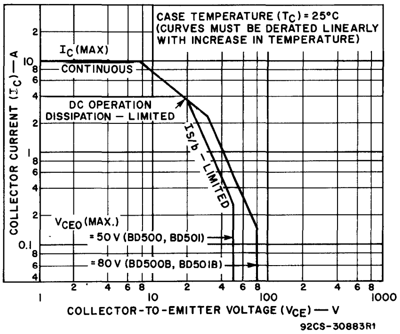


Fig. 2 — Maximum operating areas for all types.

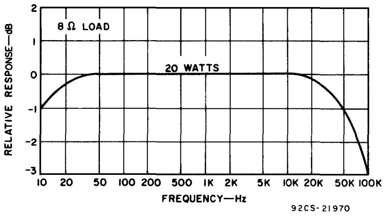


Fig. 3 — Typical frequency response.

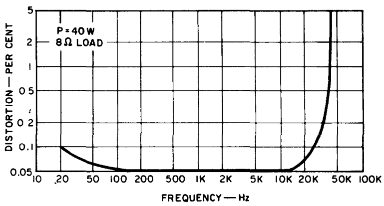


Fig. 4 — Typical total harmonic distortion as a function of frequency.

BD533, BD534, BD535, BD536, BD537, BD538

File Number **1236**

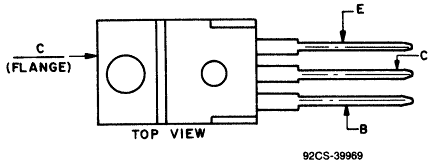
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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*

TERMINAL DESIGNATIONS



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:*

	N-P-N	BD533	BD535	BD537	
	P-N-P	BD534■	BD536■	BD538■	
V_{CBO}		45	60	80	V
$V_{CES}(sus)$		45	60	80	V
$V_{CEO}(sus)$		45	60	80	V
V_{EBO}			5		V
I_C			8		A
I_B			1		A
P_T					
$T_C \leq 25°C$			50		W
$T_C > 25°C$ derate linearly			0.4		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.

BD533, BD534, BD535, BD536, BD537, BD538

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

CHARACTERISTIC	TEST CONDITIONS▲ VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BD533 BD534▲ MIN.	MAX.	BD535 BD536▲ MIN	MAX.	BD537 BD538▲ MIN.	MAX.	UNITS
I_{CBO}	45⊕				—	100	—	—	—	—	μA
	60⊕				—	—	—	100	—	—	
	80⊕				—	—	—	—	—	100	
I_{CES}	45				—	100	—	—	—	—	
	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 (For BD533, BD534 only)	2		2*		60	150	—	—	—	—	
	2		3*		30	—	—	—	—	—	
V_{BE}	2		2*		—	1.5	—	1.5	—	1.5	V
V_{CE}(sat)			2*	0.2	—	0.8	—	0.8	—	0.8	
			6*	0.6	0.8●	—	0.8●	—	0.8●	—	
f_T	1		0.5		3	12●	3	12●	3	12●	MHz
$R_{\theta JC}$					—	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.

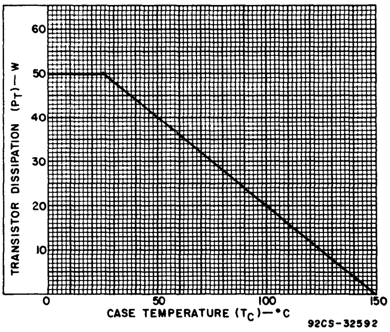


Fig. 1—Derating curve for all types.

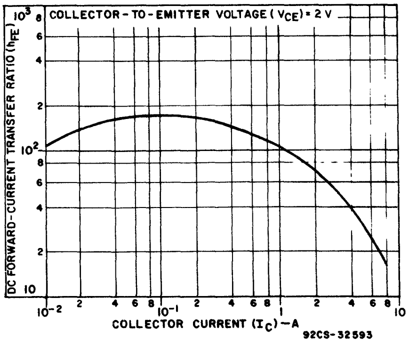


Fig. 2—Typical dc beta characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

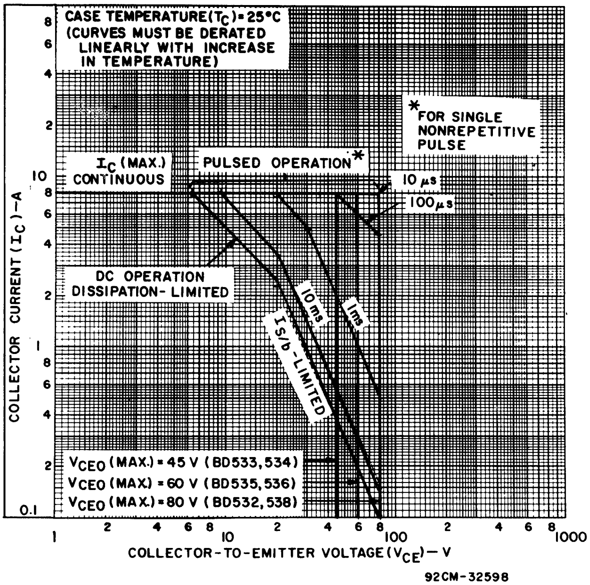


Fig. 3—Maximum safe-operating areas for all types.

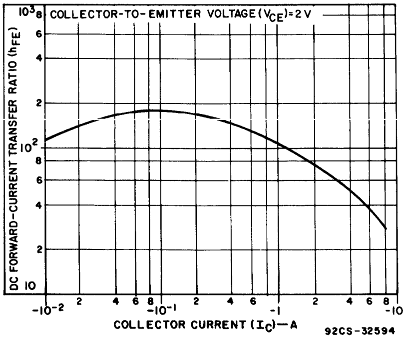


Fig. 4—Typical dc beta characteristic for BD534, BD536, and BD538 types.

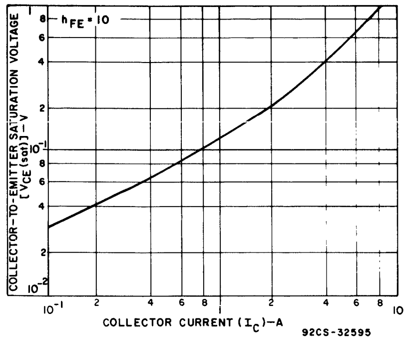


Fig. 5—Typical collector to-emitter saturation voltage characteristic for BD533, BD535, and BD537 types.

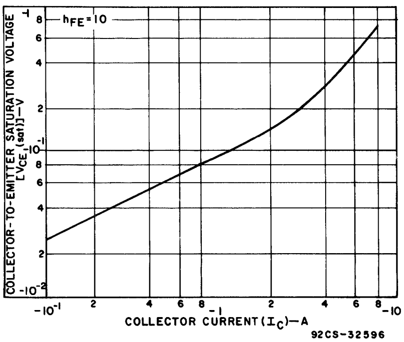


Fig. 6—Typical collector-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

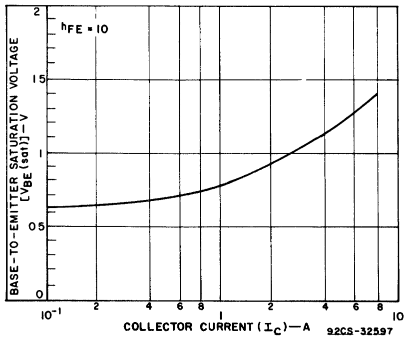


Fig. 7—Typical base-to-emitter saturation voltage characteristic for BD533 BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

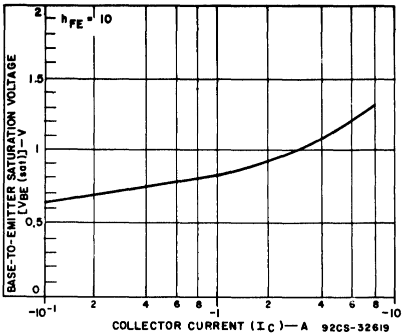


Fig. 8—Typical base-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

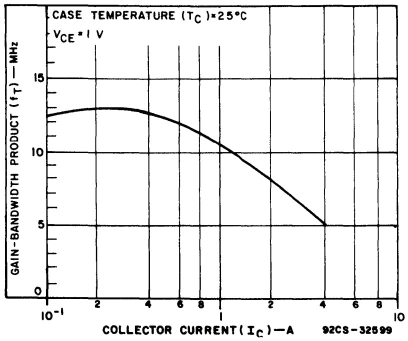


Fig. 9—Typical gain-bandwidth product characteristic for BD533, BD535, and BD537 types.

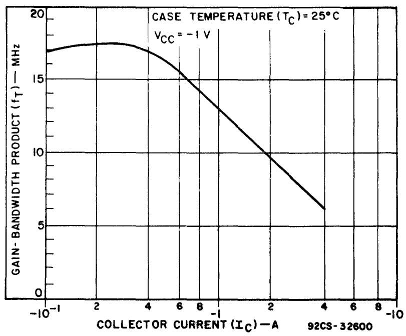


Fig. 10—Typical gain-bandwidth product characteristic for BD534, BD536, and BD538 types.

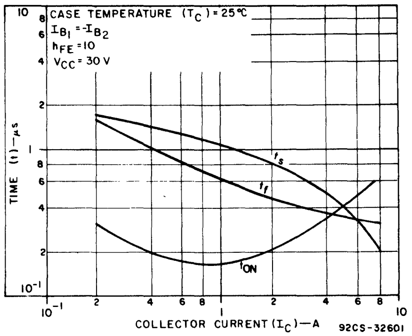


Fig. 11—Typical saturated-switching time characteristics for BD533, BD535, and BD537 types.

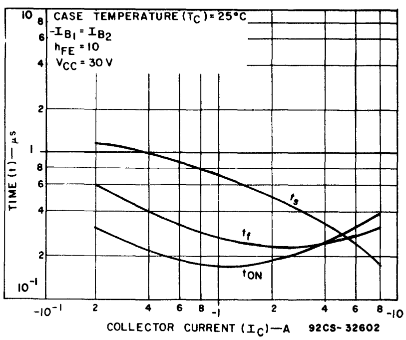


Fig. 12—Typical saturated switching time characteristics for BD534, BD536, and BD538 types.

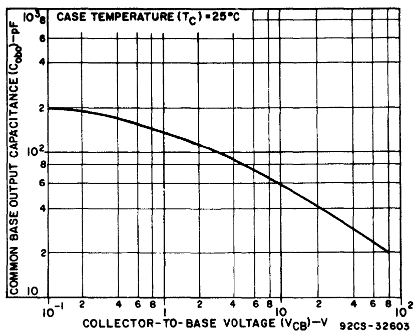


Fig. 13—Typical common-base output capacitance characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

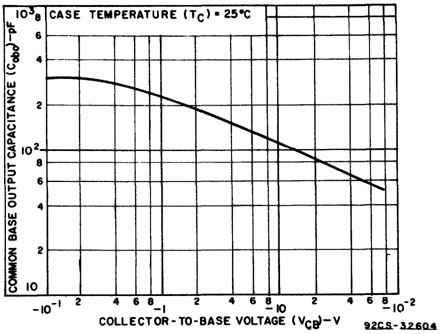


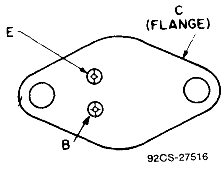
Fig. 14—Typical common-base output capacitance characteristic for BD534, BD536, and BD538 types.

File Number **1109**

BD550, BD550B

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		V
I_C	7		A
I_B	2		A
P_T			
At $T_C \leq 25°C$	150		W
At $T_C > 25°C$	See Fig. 1		W/°C
T_{stg}, T_J	-65 to 200		°C
T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

BD550, BD550B

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

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS				UNITS
		BD550		BD550B•		
		Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 100 Ω	V_{CE} = 110 V V_{CE} = 250 V	— —	1 —	— —	— 1	mA
I_{CEO}	V_{CE} = 95 V V_{CE} = 200 V	— —	5 —	— —	— 5	mA
I_{EBO}	V_{EB} = 5 V	—	1	—	1	mA
V_{CEO}	I_C = 0.2 A	110	—	250	—	V
V_{CER}	I_C = 0.2 A; R_{BE} = 100 Ω	130	—	275	—	V
f_T	I_C = 0.2 A; V_{CE} = 10 V	5 typ.		5 typ.		MHz
h_{FE}	I_C = 4 A; V_{CE} = 4 V I_C = 2A; V_{CE} = 4 V	15 —	75 —	— 10	— 50	
V_{CE}(sat)	I_C = 4 A; I_B = 0.5 A I_C = 2A; I_B = 0.25 A	— —	2 —	— —	— 2	V
V_{BE}	I_C = 4 A; V_{CE} = 4 V I_C = 2 A; V_{CE} = 4 V	0.75 —	1.75 —	— 1	— 2	V
$I_{S/b}$	V_{CE} = 80 V; t = 1 S V_{CE} = 140 V; t = 1 S	1.87 —	— —	— 1.07	— —	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).

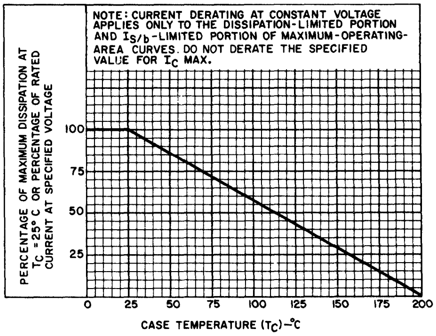


Fig. 1 — Derating curve for all types.

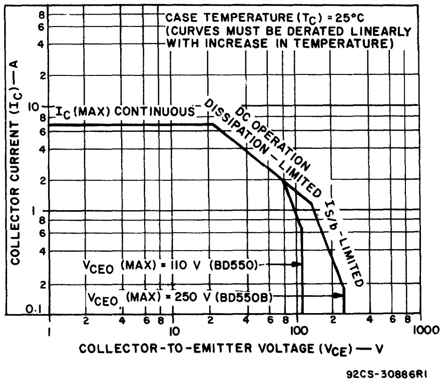


Fig. 2 — Maximum operating areas for all types.

File Number **1242**

BD795, BD796, BD797, BD798, BD799, BD800, BD801, BD802

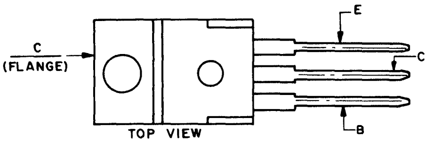
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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*

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB

The RCA-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 P-N-P	BD795 BD796•	BD797 BD798•	BD799 BD800•	BD801 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						
$T_C \leq 25°C$		65				W
$T_C > 25°C$		Derate Linearly 0.522				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

•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					—	0.1	—	—	mA
	60					—	—	—	0.1	mA
I_{EBO}			−5	0		—	1	—	1	mA
V_{CEO}[b]				0.1[a]	0	45	—	60	—	V
h_{FE}		2		1[a]		40	—	40	—	
		2		3[a]		25	—	25	—	
V_{BE}(ON)		2		3[a]		—	1.6	—	1.6	V
V_{CE}(sat)				3[a]	0.3	—	1	—	1	V
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_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

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

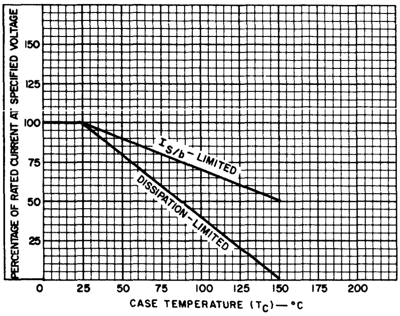


Fig. 1—Current derating curves for all types.

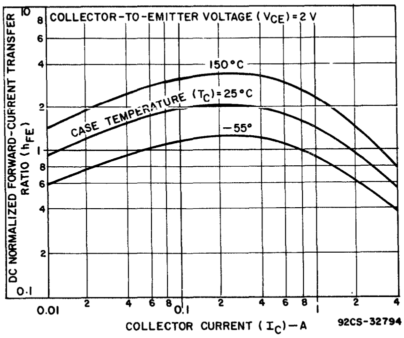


Fig. 2—Normalized dc-beta characteristics for all types.

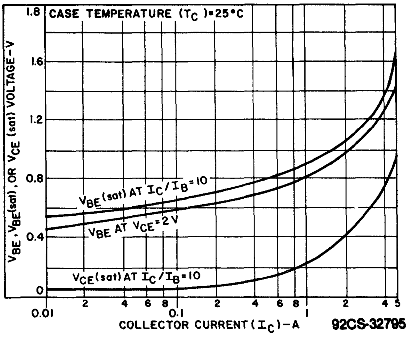


Fig. 3—Typical "on" voltage characteristics for all types.

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					—	0.1	—	—	mA
	100					—	—	—	0.1	
I_{EBO}			−5	0		—	1	—	1	
V_{CEO}[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_{CEO}(sus) *MUST NOT* be measured on a curve tracer.

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

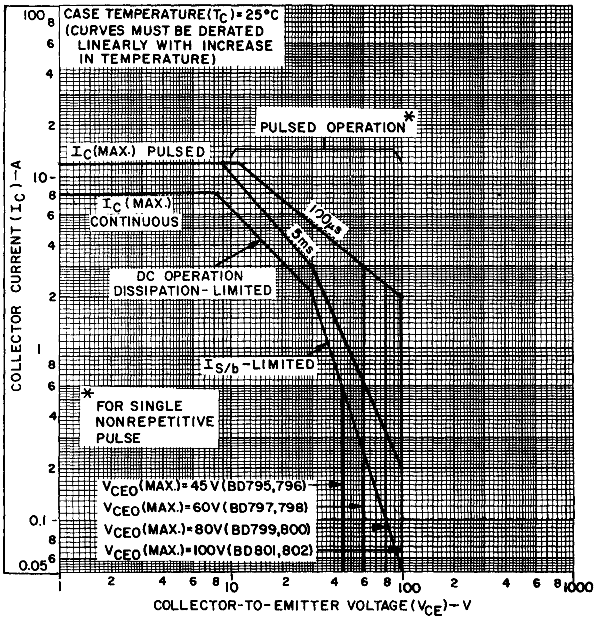


Fig. 4 — Maximum operating areas for all types.

BDX18, MJ2955

File Number **994**

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

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

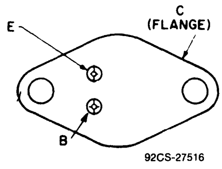
Features:

- *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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX18 MJ2955	
V_{CBO}	-100	V
$V_{CER}(sus)$ $R_{BE} = 100\ \Omega$	-70	V
$V_{CEO}(sus)$	-60	V
V_{EBO}	-7	V
I_C	-15	A
I_B	-7	A
P_T At $T_C \leq 25°C$	150 (MJ2955) 115 (BDX18)	W
At $T_C > 25°C$ Derate linearly	0.86 (MJ2955) 0.66 (BDX18)	W/°C
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° 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}(sus)		—	—	-0.2	—	-60^b	—	V
V_{CER}(sus) R_{BE} = 100 Ω		—	—	-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}(sat)	BDX18, MJ2955	—	—	-4^a	-0.4	—	-1.1	V
	MJ2955 only	—	—	-10^a	-3.3	—	-3	
f_{hfe} 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	

[a]Pulsed; pulse duration = 300μs, duty factor = 1.8%.
[b]**CAUTION:** Sustaining voltages V_{CEO}(sus) and V_{CER}(sus) *MUST NOT* be measured on a curve tracer.

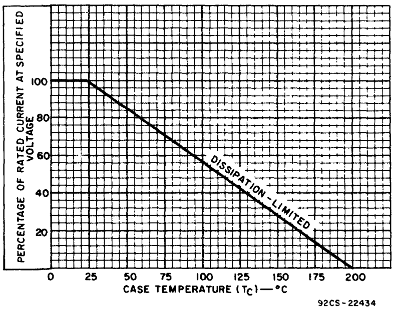


Fig. 1 — Derating curve.

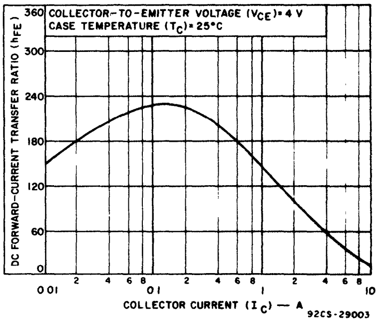


Fig. 2 — Typical dc beta characteristics.

BDX18, MJ2955

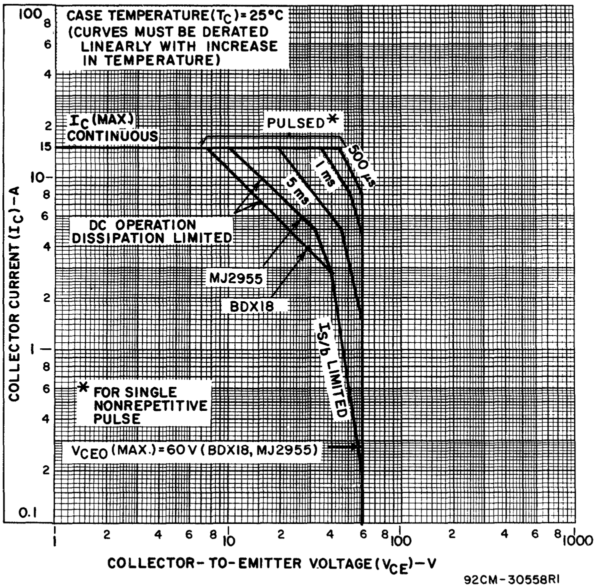


Fig. 3 — Maximum operating areas for BDX18 and MJ2955.

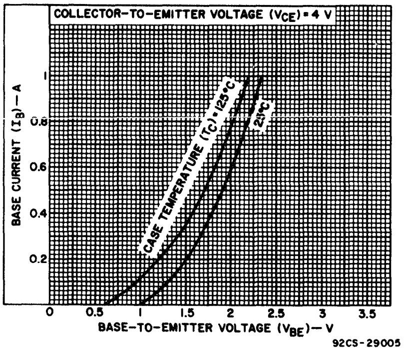


Fig. 4 — Typical input characteristics.

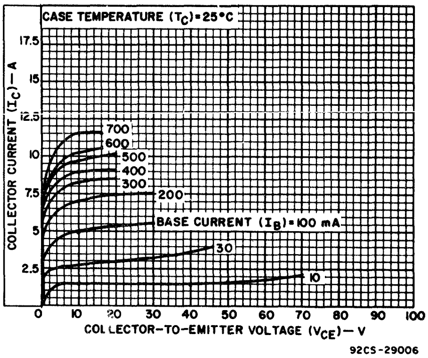


Fig. 5 — Typical output characteristics.

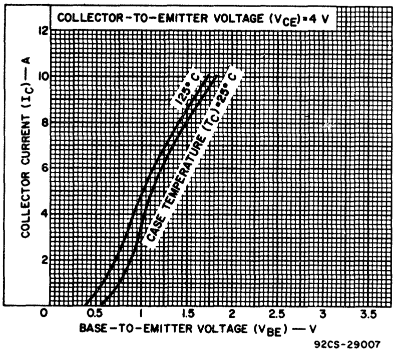


Fig. 6 — Typical transfer characteristics.

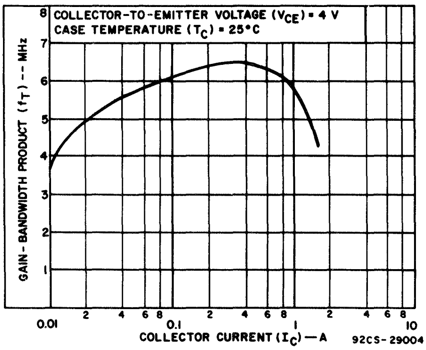


Fig. 7 — Typical gain-bandwidth product.

File Number **819**

BDY29

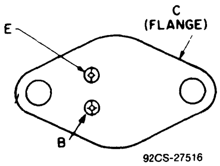
High-Power High-Current Transistor

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 V (V_{BE}) & R_{BE} = 100 Ω	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	°C
PIN TEMPERATURE (During soldering):			
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230	°C

BDY29

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc			TEST CONDITIONS CURRENT A dc		LIMITS BDY29		UNITS
		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-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	$\lvert h_{fe} \rvert$		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	$R_{\theta JC}$						–	0.8	°C/W

[a]Pulsed; pulse duration = 300 μs, rep. rate = 60 Hz; duty factor ⩽ 2%.

[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.

BDY29

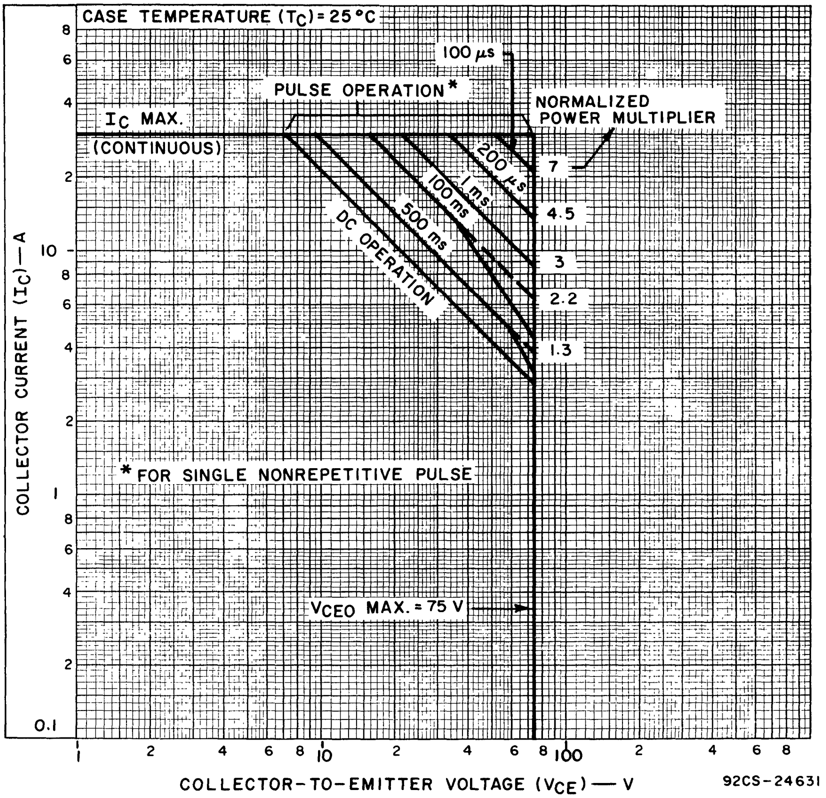


Fig. 1 — Maximum operating areas.

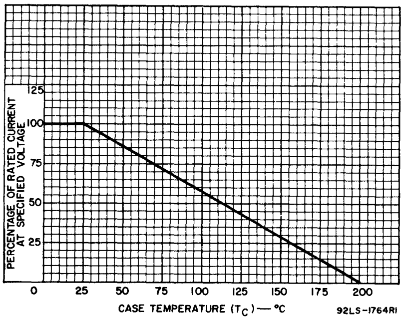


Fig. 2 — Dissipation derating curve.

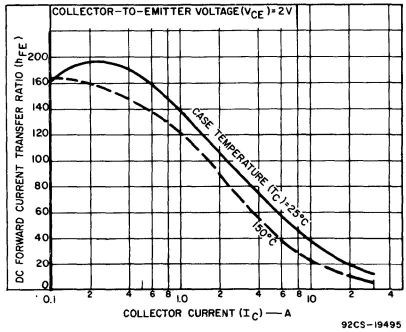


Fig. 3 — Typical dc beta characteristics.

BDY29

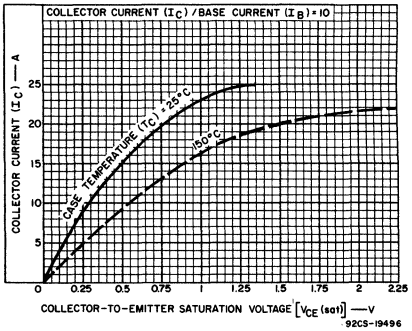


Fig. 4 — Typical saturation-voltage characteristics.

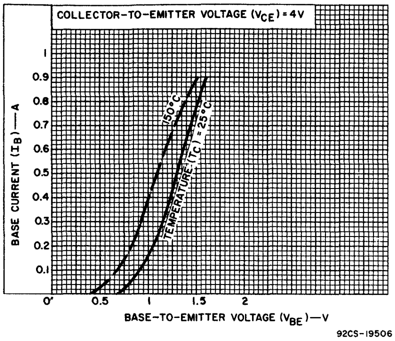


Fig. 5 — Typical input characteristics.

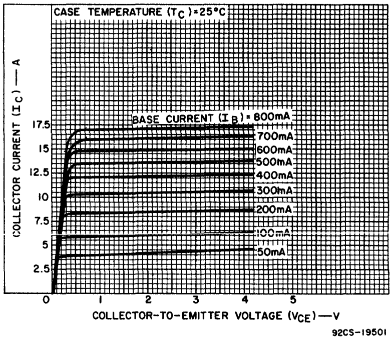


Fig. 6 — Typical output characteristics.

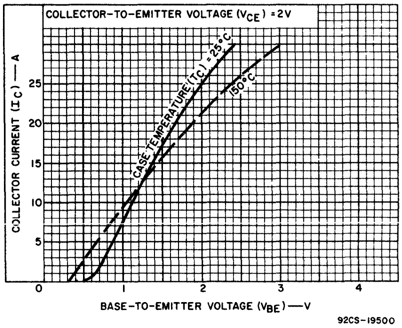


Fig. 7 — Typical transfer characteristics.

File Number **1215**

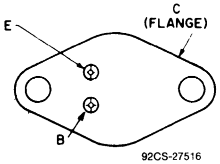
BDY55, BDY56

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*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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.

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			
$T_C = 25°C$	117		W
T_{stg}, T_J	-65 to +200		°C
T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230		°C

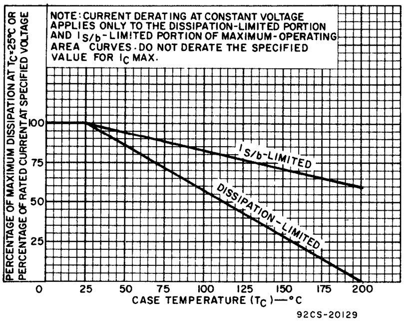


Fig. 1 - Dissipation derating curves for both types.

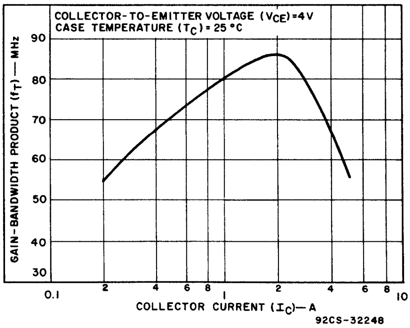


Fig. 2 - Typical gain-bandwidth product for both types.

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	mA
At T_C = 150 °C	100 150		−1.5 −1.5			— —	30 —	— —	— 30	mA
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
V_{CE}(sat)				4 10	4 3.3	— —	1.1 2.5	— —	1.1 2.5	V
t_{ON} V_{CC} = 50 V				5	1.0	—	0.5	—	0.5	μS
t_{OFF} V_{CC} = 50 V				5	I_{B1} = 1 A I_{B2} = −0.5 A	—	2	—	2	μS
$R_{\theta JC}$	10			10		—	1.5	—	1.5	°C/W

a Pulsed; pulse duration ⩽ 350 μs, 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.

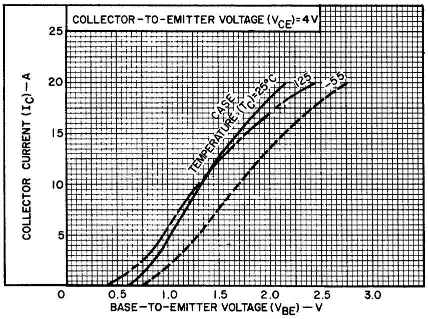


Fig. 3 - Typical transfer characteristics for both types.

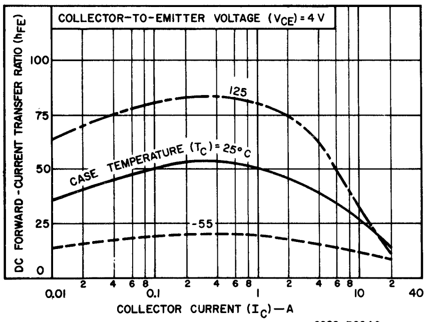


Fig. 4 - Typical dc beta characteristics for both types.

BDY55, BDY56

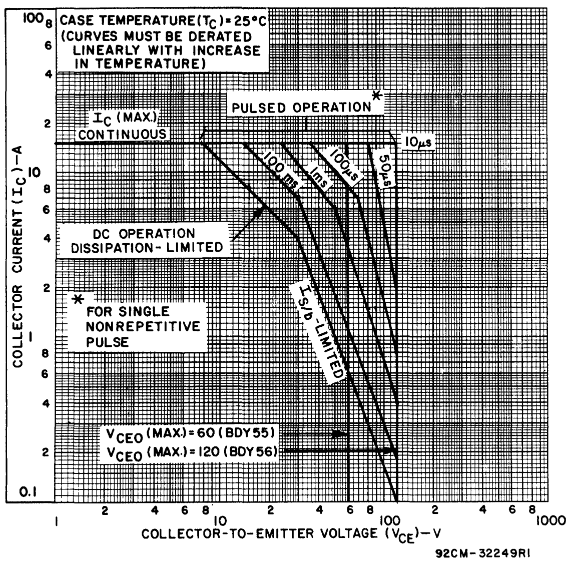


Fig. 5 - Maximum operating areas for both types.

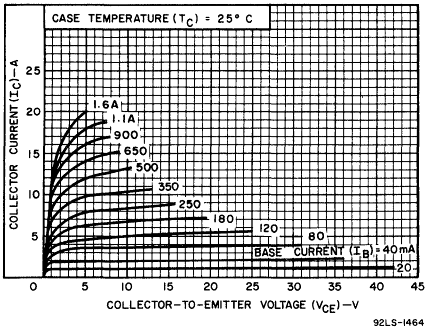


Fig. 6 - Typical output characterstics for both types.

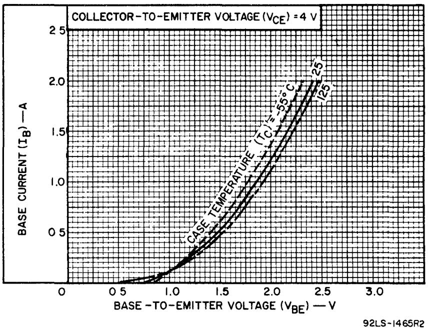


Fig. 7 - Typical input characterstics for both types.

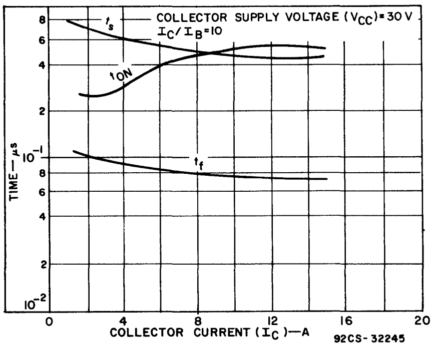


Fig. 8 - Switching-time characterstics as a function of collector current for both types.

BDY58R File Number **1206**

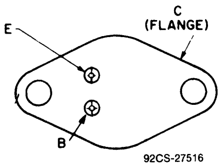
Silicon N-P-N Switching Transistors

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 25°	175 W
T_J, T_{stg}	-65 to + 200°C
T_L:	
At distances ≥ 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 VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS BDY58R			UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CBO}	V_{CB} = 200	—	—	0	—	0.1	1	mA
I_{CER} R_{BE} = 10 Ω, T_C = 100 °C	180	—	—	—	—	—	10	mA
I_{EBO}	—	−5	0	—	—	0.1	0.5	mA
$V_{CEO}(sus)$[b]	—	—	0.2[a]	—	160[a]	—	—	V
$V_{(BR)EBO}$ I_E = 0.05 A	—	—	0	—	8	—	—	V
$V_{BE}(sat)$	—	—	10[a]	1	—	0.9	2	V
$V_{CE}(sat)$	—	—	10[a]	1	—	0.2	1.4	V
h_{FE}	4	—	10[a]	—	20	—	60	
	4	—	20[a]	—	—	20	—	
T_C = −30 °C	4	—	10[a]	—	10	—	—	
f_T	15	—	1	—	10	48	—	MHz
t_{on}	V_{CC} = 75 V	—	15	1.5	—	0.3	1	µs
t_{off} (I_{B1} = I_{B2})	V_{CC} = 75 V	—	15	1.5	—	1.2	2	µs
$R_{\theta JC}$	—	—	—	—	—	—	1	°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.

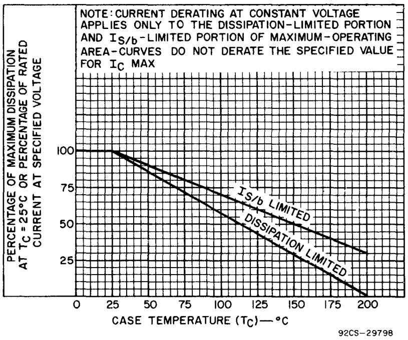


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

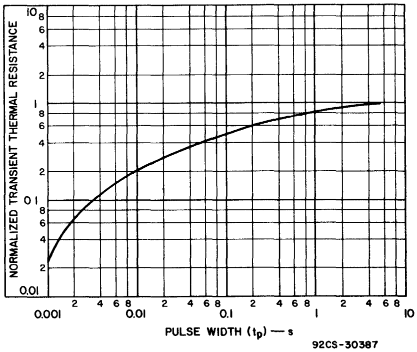


Fig. 2 — Typical thermal-response characteristic.

BDY58R

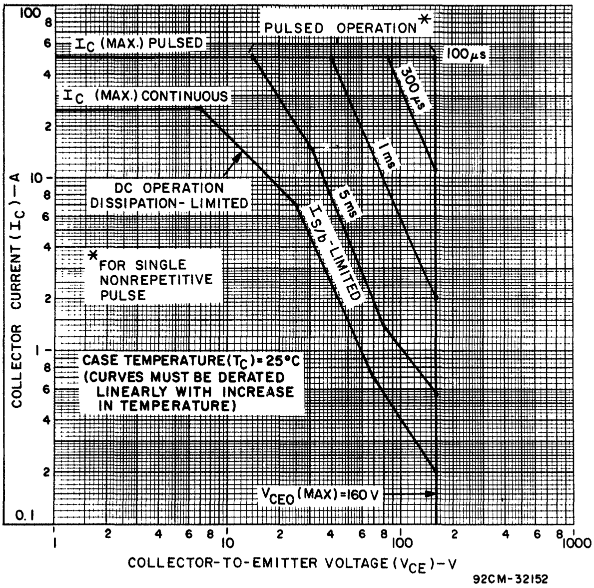


Fig. 3 — Maximum safe-operating areas (T_C = 25° C).

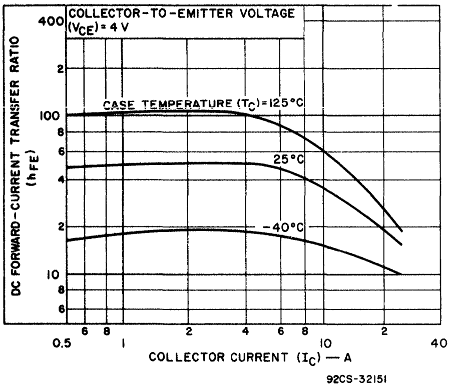


Fig. 4 — Typical dc beta characteristics.

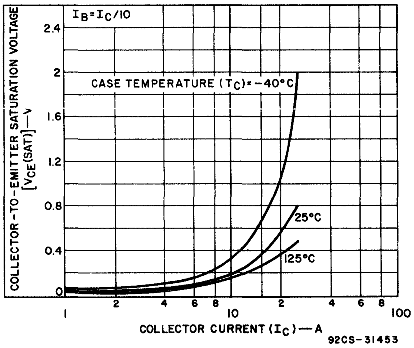


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

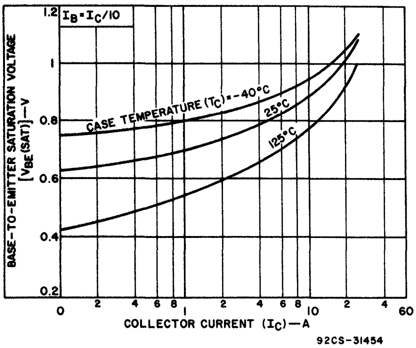


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

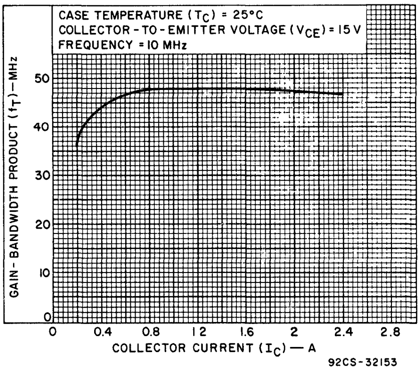


Fig. 7 — Typical gain-bandwidth product.

BDY58R

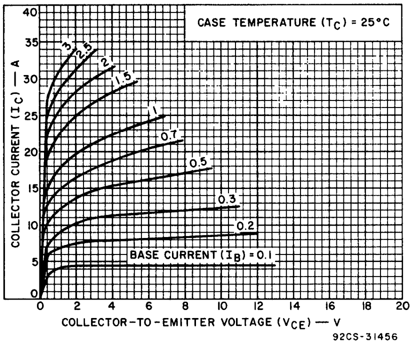


Fig. 8 — Typical output characteristics.

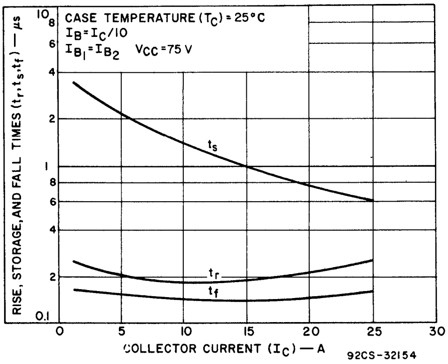


Fig. 9 — Typical saturated-switching-time characteristics as a function of collector current.

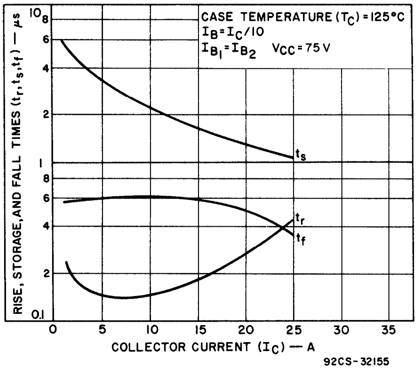


Fig. 10 — Typical switching-time characteristics at T_C = 125° C as a function of collector current.

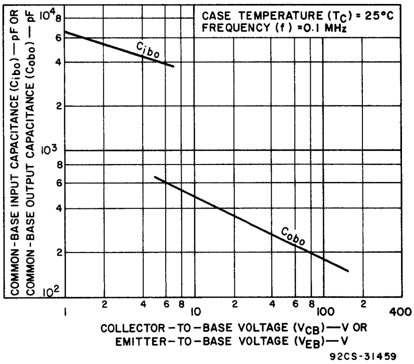


Fig. 11 — Typical common-base input (C_{ibo}) of output (C_{obo}) capacitance characteristics.

BDY90, BDY91, BDY92

File Number **1289**

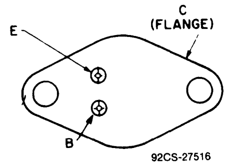
High-Speed Silicon N-P-N Planar Transistors

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.

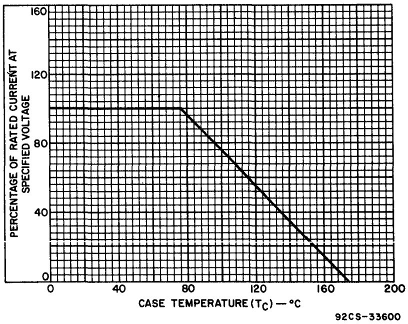


Fig. 1 - Dissipation derating curves for all types.

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_{CEO}(sus)	100	80	60	V
V_{EBO}		6		V
I_C		10		A
I_{CM}		15		A
I_B		2		A
P_T				
$T_C \leq 75°C$		40		W
$T_C \leq 25°C$, $V_{CE} > 28$ 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
V_{EBO} I_E = 0.05 A			0		6	—	6	—	6	—	V
$V_{CE}(sat)$			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	µs
t_f V_{CC} = 30 V			5	0.5[c]	—	0.2	—	0.2	—	0.2	µs
$R_{\theta JC}$	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.

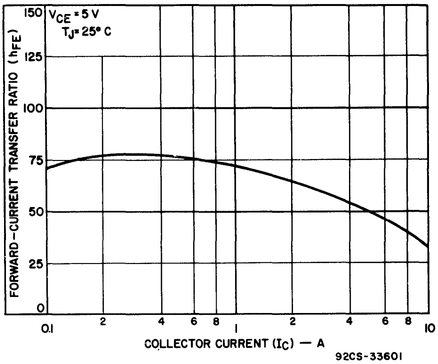


Fig.2 - Typical dc beta characteristics for all types.

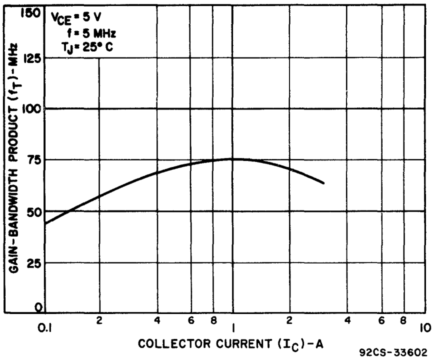


Fig.3 - Typical gain-bandwidth product for all types.

BDY90, BDY91, BDY92

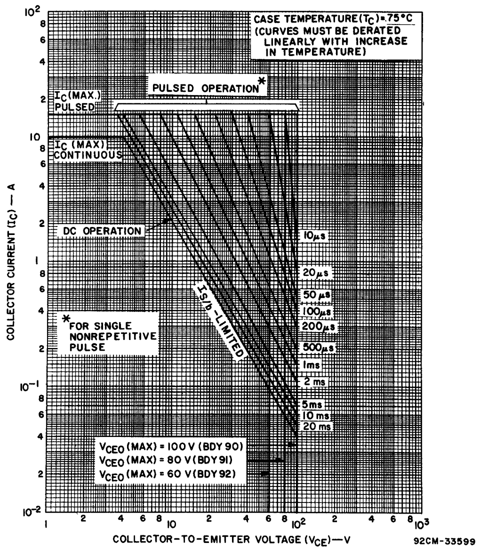


Fig.4 - Maximum operating areas for all types.

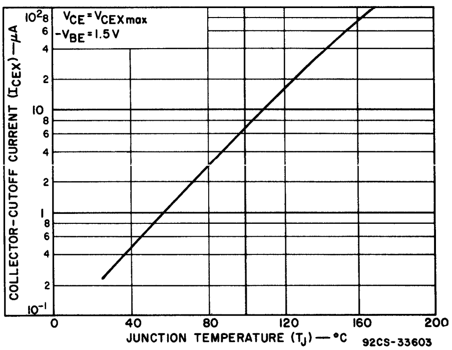


Fig.5 - Typical collector leakage current vs. junction temperature for all types.

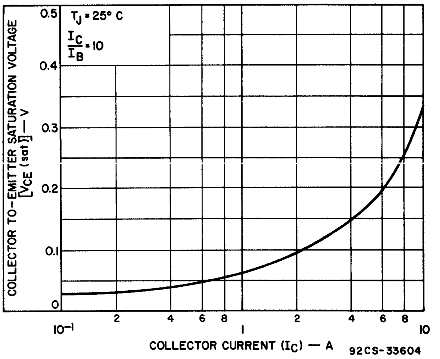


Fig.6 - Typical collector-to-emitter saturation voltage characteristics as a function of collector current for all types.

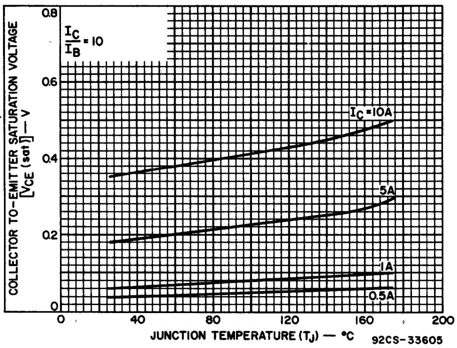


Fig.7 - Typical collector-to-emitter saturation voltage characteristics as a function of junction temperature for all types.

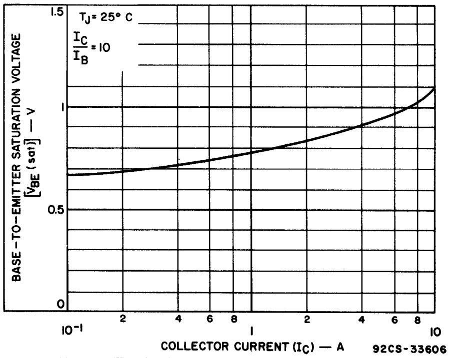


Fig.8 - Typical base-to-emitter saturation voltage characteristics as a function of collector current for all types.

BDY90, BDY91, BDY92

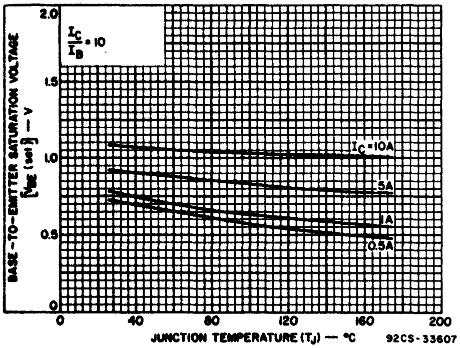


Fig.9 - Typical base-to-emitter saturation voltage characteristics as a function of junction temperature.

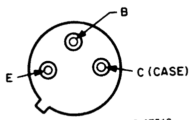
BFT19, BFT19A, BFT19B File Number **683**

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)

TERMINAL DESIGNATIONS



92CS-27512

JEDEC TO-205AD

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.

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 ⩾ 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 –	– – –	– – −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	– – –	
Collector-to-Emitter Sustaining Voltage (*See Figs. 2 and 3*): With base open	$V_{CEO}(sus)$				−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	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				−10 −30		−1 −3	– –	−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	–	
Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (at 5 MHz)	$\|h_{fe}\|$		−10		−30			5	–	5	–	5	–	
Common-Base, Short-Circuit, Input Capacitance (at 1 MHz)	C_{ib}			−5	0			–	75	–	75	–	75	pF
Output Capacitance (at 1 MHz)	C_{ob}	−10				0		–	15	–	15	–	15	pF
Second-Breakdown[b] Collector Current: With base forward biased[c]	$I_{S/b}$[d]	−100						−50	–	−50	–	−50	–	mA
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$							–	35	–	35	–	35	°C/W

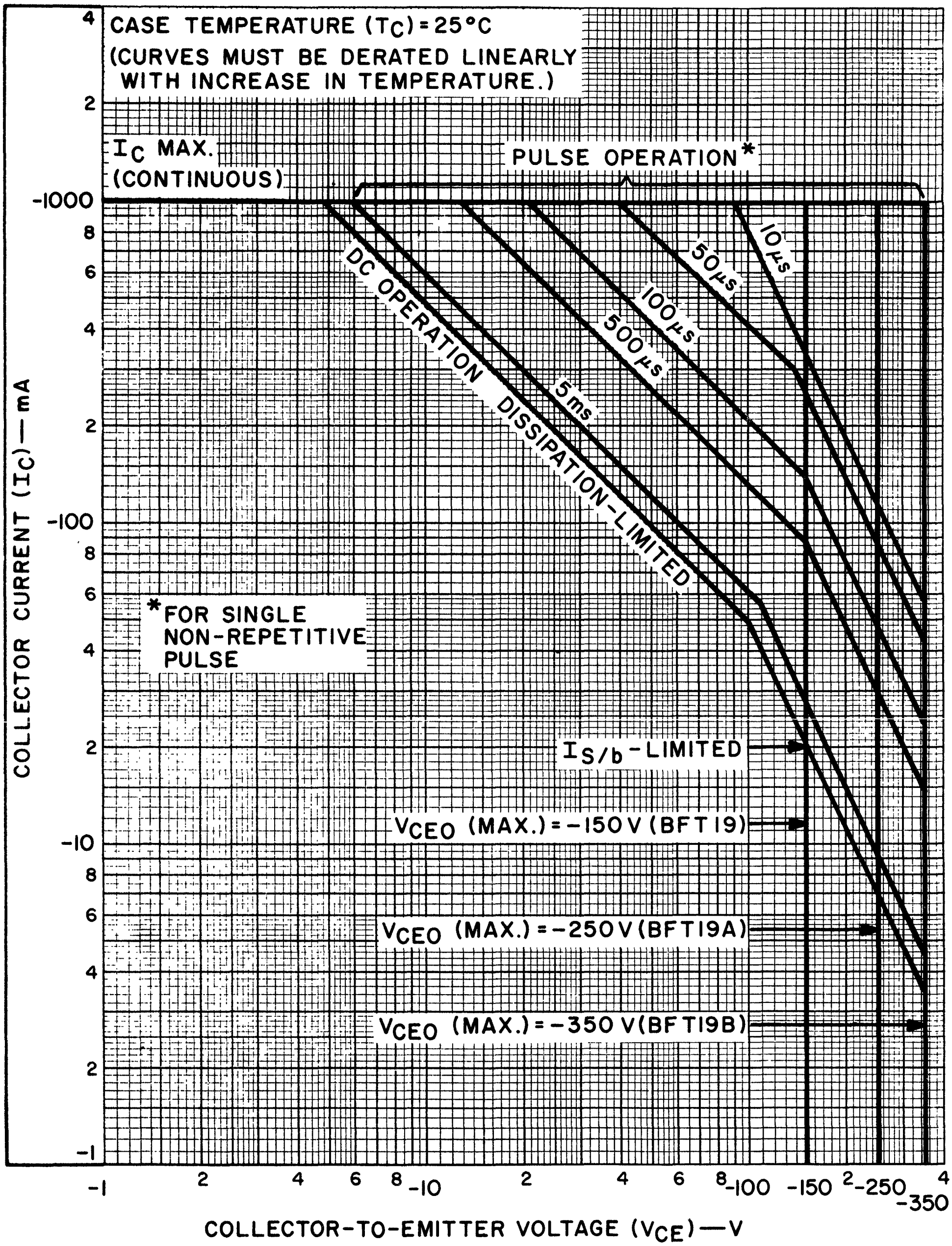
[a] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. The sustaining voltage should be measured by means of the test circuit shown in Fig. 2.

[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

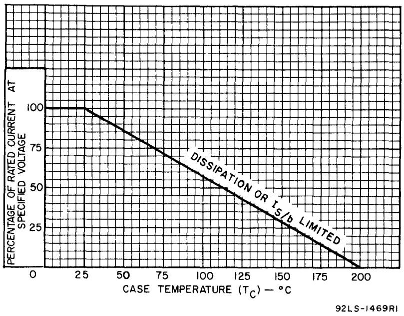


Fig. 2 — Dissipation derating curve.

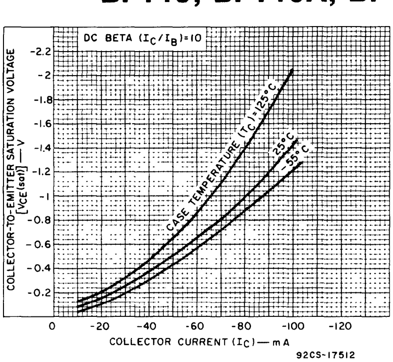


Fig. 3 — Typical collector-to-emitter saturation voltage.

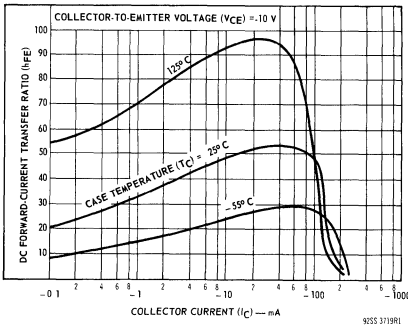


Fig. 4 — Typical dc-beta characteristics.

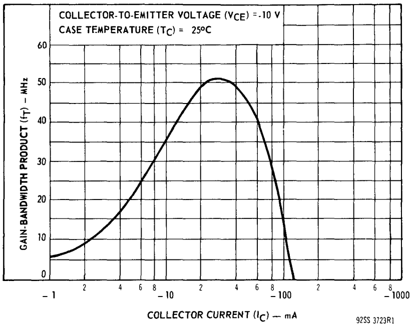


Fig. 5 — Typical gain-bandwidth product.

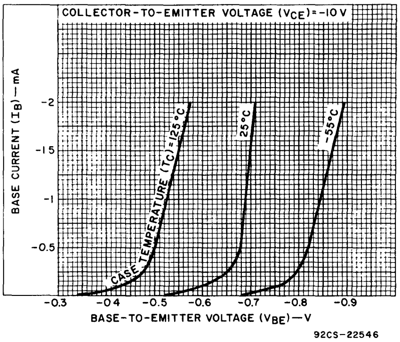


Fig. 6 — Typical input characteristics.

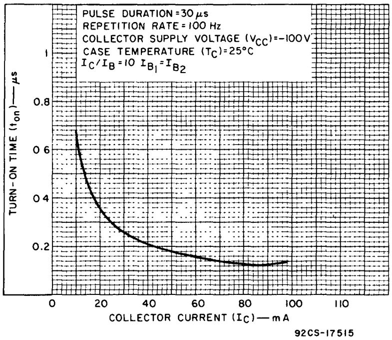


Fig. 7 — Typical turn-on time characteristic.

BFT19, BFT19A, BFT19B

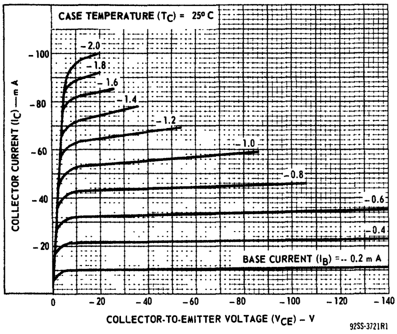


Fig. 8 — Typical output characteristics.

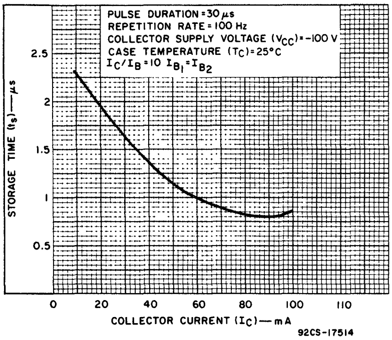


Fig. 9 — Typical storage-time characteristic.

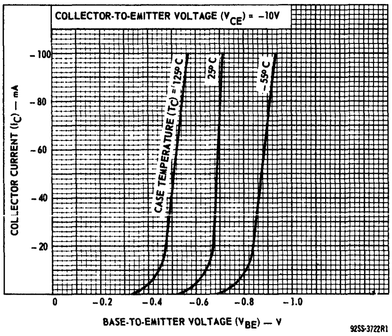


Fig. 10 — Typical transfer characteristics.

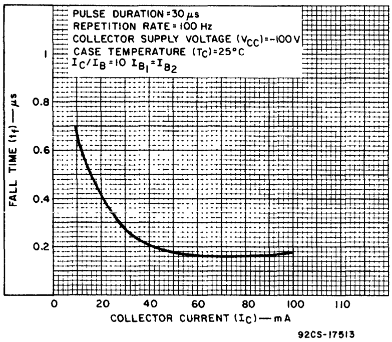


Fig. 11 — Typical fall-time characteristic.

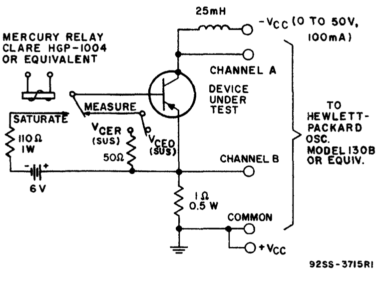
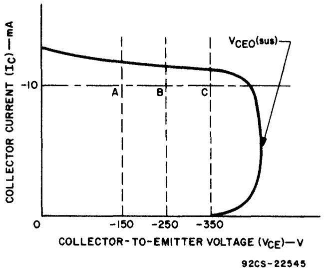


Fig. 12 — Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$.



The sustaining voltage $V_{CEO}(sus)$ is acceptable when the trace falls to the right and above point "A" for type 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.

File Number **815**

BFT28, BFT28A, BFT28B, BFT28C

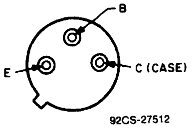
Silicon P-N-P High-Voltage Transistors

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.

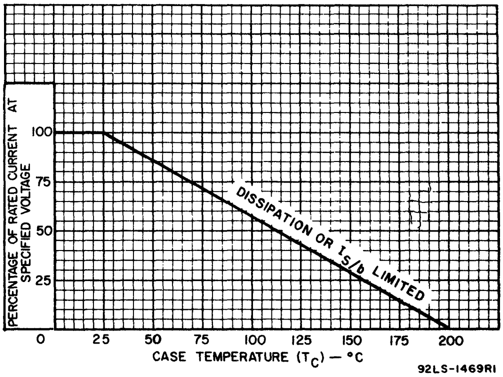


Fig. 1 — Dissipation derating curve.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BFT28	BFT28A	BFT28B	BFT28C	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−150	−200	−250	−300	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	−150	−200	−250	−300	V
With base open	$V_{CEO}(sus)$	−100	−150	−200	−250	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	−4	−4	−4	−4	V
COLLECTOR CURRENT	I_C	−1	−1	−1	−1	A
BASE CURRENT	I_B	−0.5	−0.5	−0.5	−0.5	A
TRANSISTOR DISSIPATION:						
At case temperatures up to 25°C		5	5	5	5	W
At case temperatures above 25°C		See Figs. 1 and 2				
At ambient temperatures up to 50°C		1	1	1	1	W
At ambient temperatures above 50°C ..... Derate linearly at		5.7	5.7	5.7	5.7	mW/°C
TEMPERATURE RANGE:						
Storage and Operating (Junction)		−65 to +200				°C
LEAD TEMPERATURE (During soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		255				°C

BFT28, BFT28A, BFT28B, BFT28C

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc			TEST CONDITIONS CURRENT mA dc		LIMITS BFT28		LIMITS BFT28A		UNITS
		V_{CB}	V_{CE}	V_{EB}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With emitter open	I_{CBO}	–50					–	–1	–	–	μA
		–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	$R_{\theta JC}$						–	35	–	35	°C/W

[a]CAUTION: 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.

[b]$I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

[c]Pulsed, 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}) = 100 Ω	$V_{CER}(sus)$				–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-s non-repetitive pulse	$I_{S/b}$[b]		–80				–62.5	–	–62.5	–	mA
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	35	–	35	°C/W

[a]CAUTION: 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.

[b]$I_{S/b}$ is defined as the current at which second breakdown occurs at a specified collector voltage.

[c]Pulsed, pulse duration = 300 μs; duty factor ≤ 2%.

BFT28, BFT28A, BFT28B, BFT28C

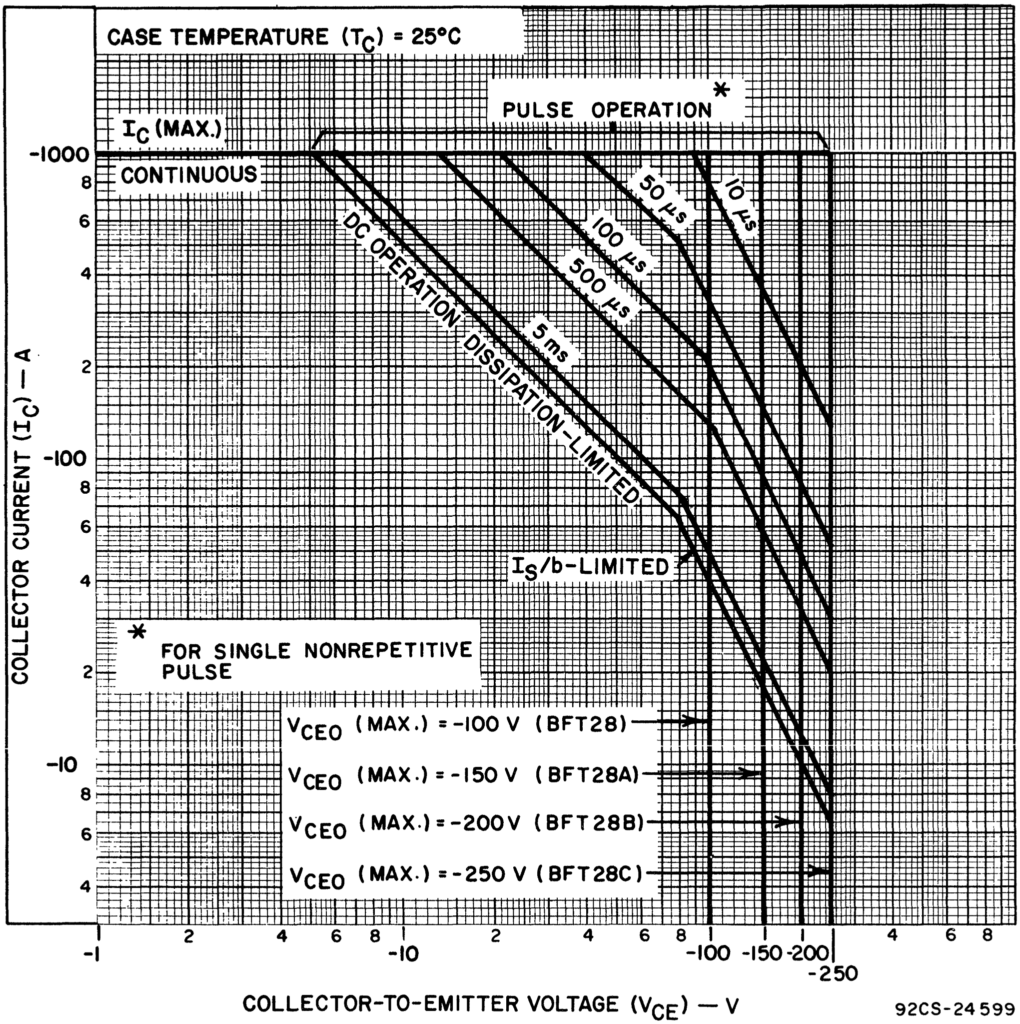


Fig. 2 — Maximum safe operating areas.

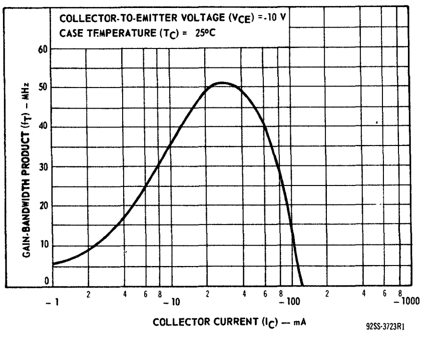


Fig. 3 — Typical gain-bandwidth product for all types.

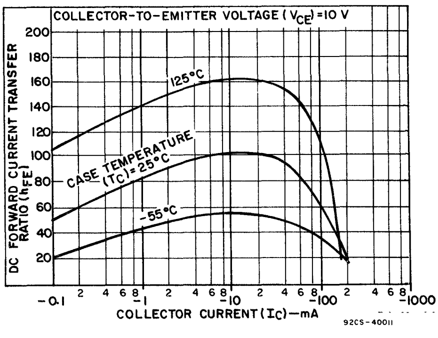


Fig. 4 — Typical dc beta characteristics for all types.

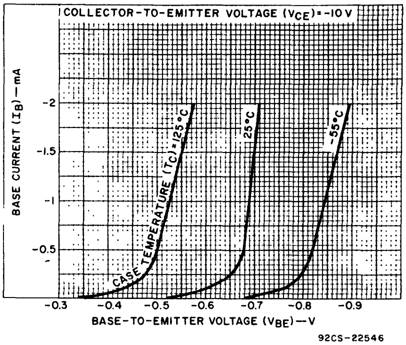


Fig. 5 — Typical input characteristics for all types.

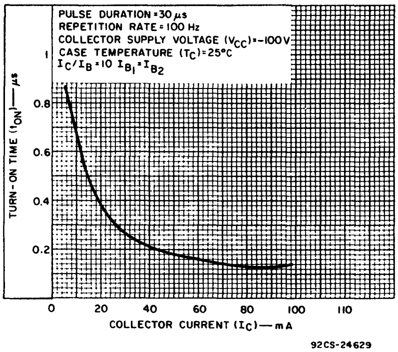


Fig. 6 — Typical turn-on time characteristic for all types.

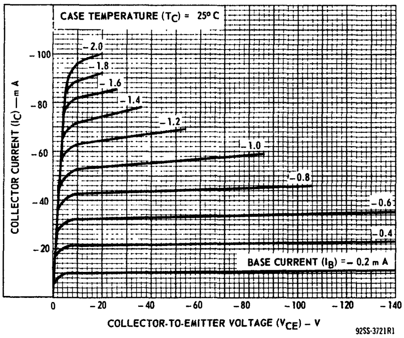


Fig. 7 — Typical output characteristics for all types.

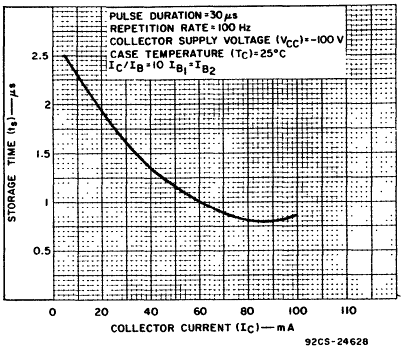


Fig. 8 — Typical storage-time characteristic for all types.

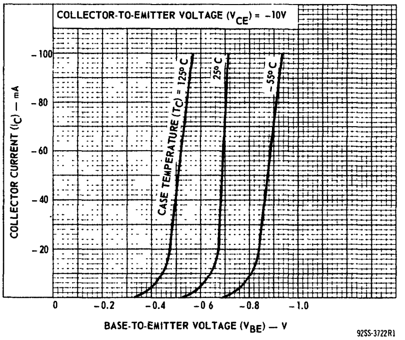


Fig. 9 — Typical transfer characteristics for all types.

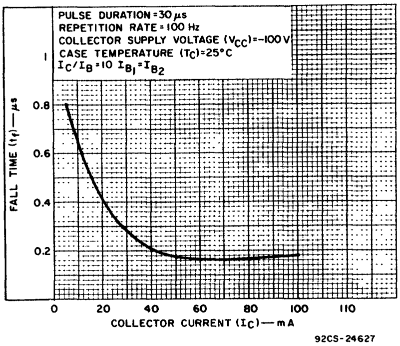


Fig. 10 — Typical fall-time characteristic for all types.

BFT28, BFT28A, BFT28B, BFT28C

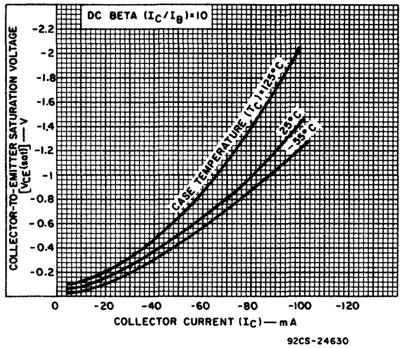


Fig. 11 – Typical collector-to-emitter saturation voltage for all types.

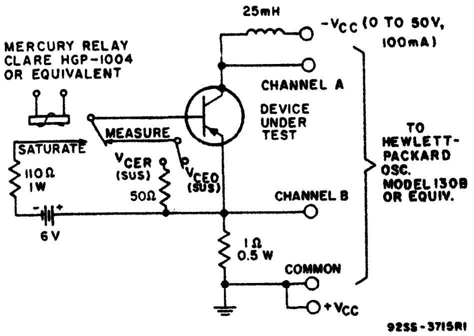
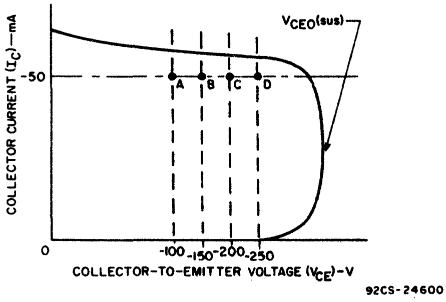


Fig. 12 – Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$.



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).

File Number **1199**

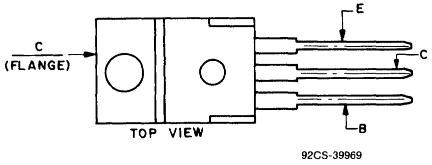
BUW64A, BUW64B, BUW64C

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*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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}				
$V_{BE} = -1.5$ 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 ... Derate Linearly		0.4		W/°C
T_{stg}, T_J		-65 to 150		°C
T_L				
At distance ≥ 1/8 in. (3.16 mm) from seating plane for 10 s max.		235		°C

BUW64A, BUW64B, BUW64C

ELECTRICAL CHARACTERISTICS, at Case Temperature T_C = 25°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°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	
			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	
			5	0.5[e]	–	0.5	–	0.5	–	–	
$R_{\theta JC}$	4		5		–	2.5	–	2.5	–	2.5	°C/W

[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.

[c] V_{CB} value.

[d] V_{CC} = 70 V, t_p = 20 µs

[e] $I_{B_1} = -I_{B_2}$.

BUW64A, BUW64B, BUW64C

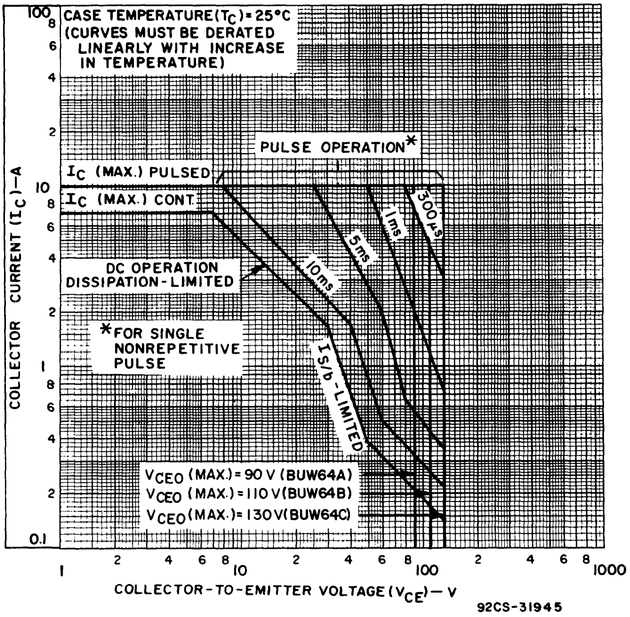


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

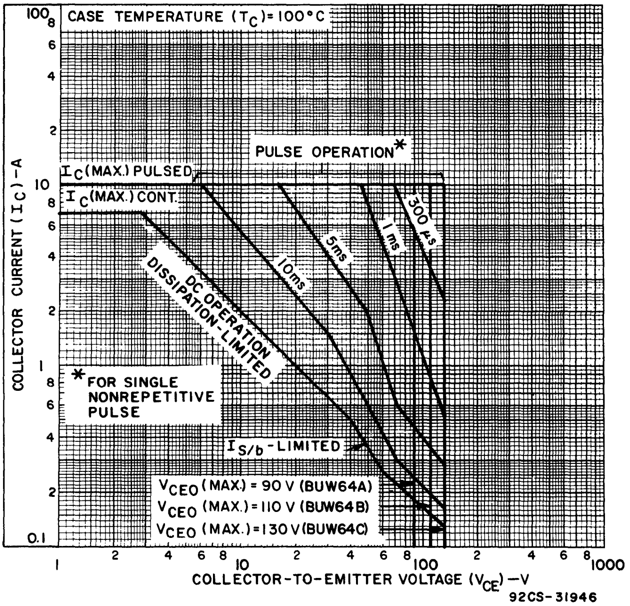


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

BUW64A, BUW64B, BUW64C

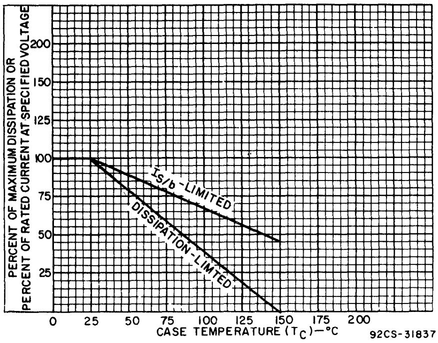


Fig. 3 – Dissipation and $I_{S/b}$ derating curves for all types.

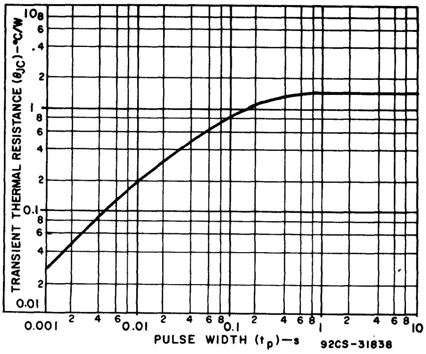


Fig. 4 – Typical thermal-response characteristic for all types.

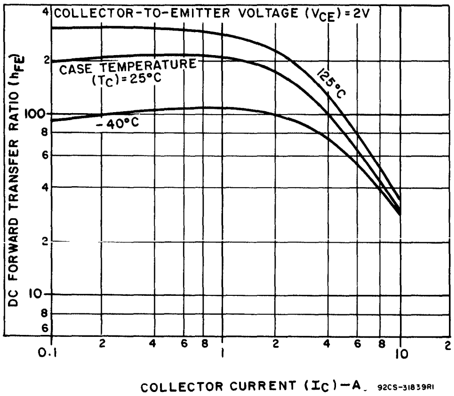


Fig. 5 – Typical dc beta characteristics for all types.

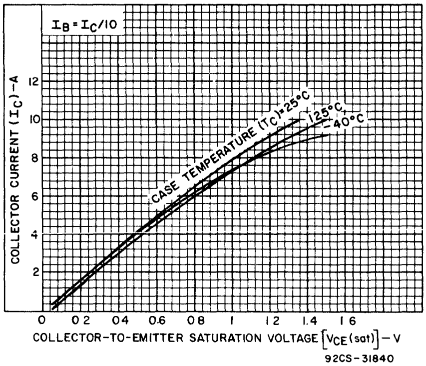


Fig. 6 – Typical collector-to-emitter saturation voltage characteristics for all types.

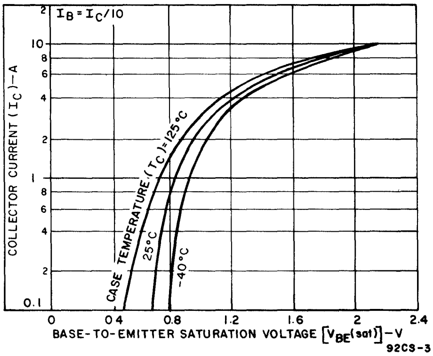


Fig. 7 – Typical base-to-emitter saturation voltage characteristic for all types.

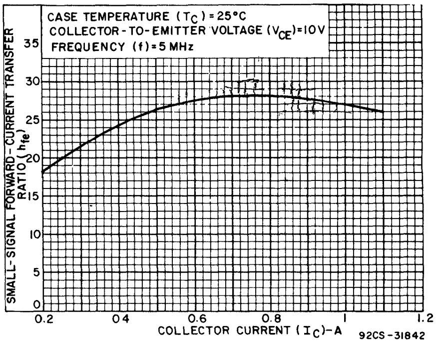


Fig. 8 – Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

BUW64A, BUW64B, BUW64C

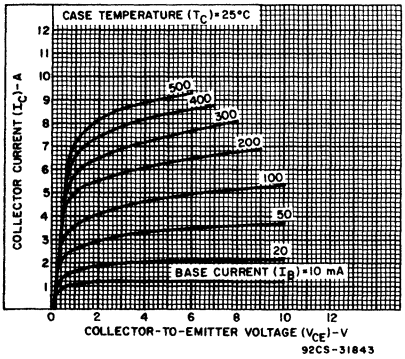


Fig. 9 – Typical output characteristics for all types.

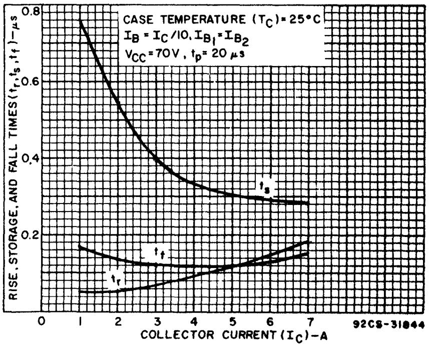


Fig. 10 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

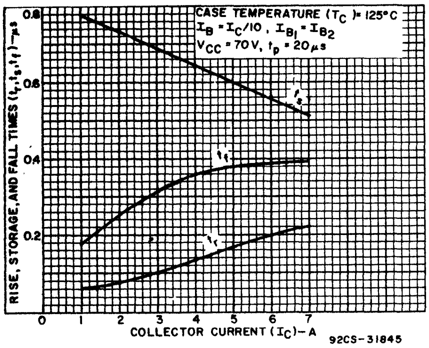


Fig. 11 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

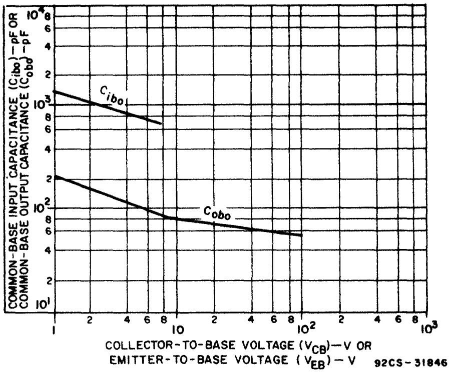


Fig. 12 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

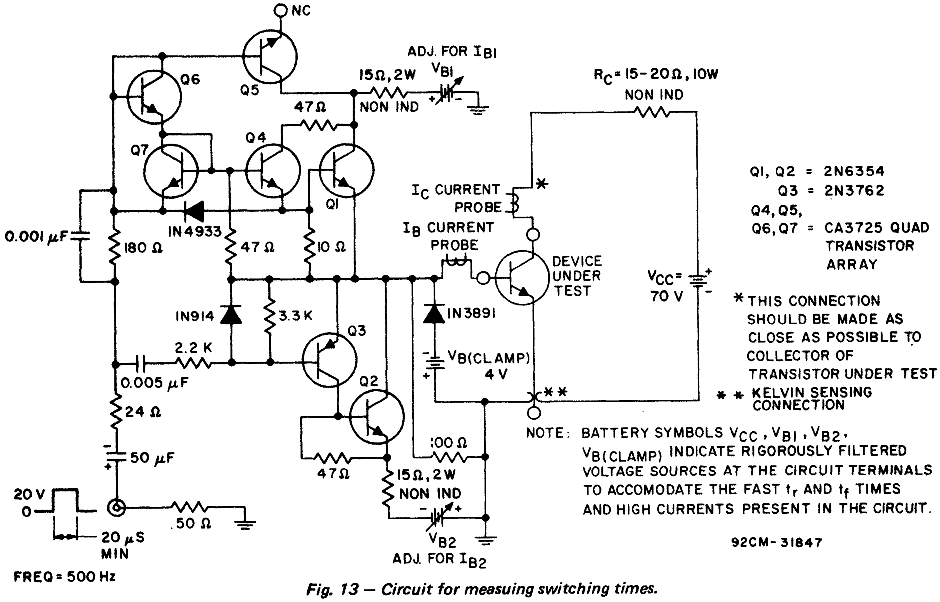
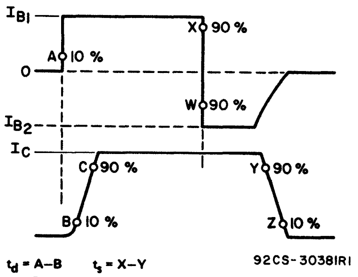


Fig. 13 – Circuit for measuing switching times.

BUW64A, BUW64B, BUW64C



t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W
NOTE: TRANSITION TIME FROM 90% I_{B_1} TO 90% I_{B_2} MUST BE LESS THAN 0.5 μs.

Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

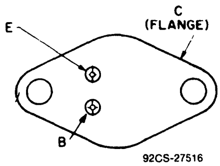
File Number **1216**

BUX10A

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

Features:
- V_{CEO} — 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.

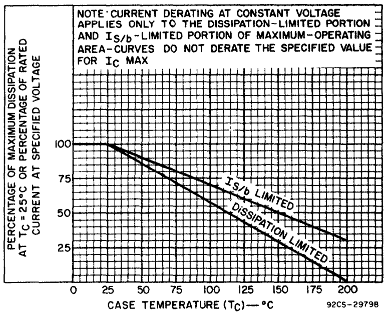


Fig. 1—Derating curves for $I_{S/b}$ and dissipation.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX10A	
V_{CBO}	170	V
V_{CER}		
R_{BE} = 100 Ω	160	V
V_{CEO}	125	V
V_{CEX}		
V_{BE} = -1.5 V	170	V
V_{EBO}	7	V
I_C	25	A
I_{CM}	30	A
I_B	5	A
P_T		
$T_C \leq 25°C$	150	W
$T_C > 25°C$ ... Derate linearly	0.86	W/°C
T_{stg}, T_J	-65 to +200	°C
T_L		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

BUX10A

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX10A			
	V_{CE}	V_{BE}	I_C	I_B	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 Ω			0.2[a]		160	—	—	V
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	V
f_T f = 10 MHz	10		2		50	—	—	MHz
$I_{S/b}$ t = 1s, nonrepetitive	25				6	—	—	A
t_{ON}	V_{CE} = 30 V		20	2	—	1	1.5	μs
t_s $I_{B1} = I_{B2}$	V_{CE} = 30 V		20	2	—	0.6	1.2	μs
t_f $I_{B1} = I_{B2}$	V_{CE} = 30 V		20	2	—	0.15	0.2	μs
$R_{\theta JC}$					—	—	1.17	°C/W

[a] Pulsed; pulse duration = 300 μs, duty factor < 2%.
[b] **CAUTION:** The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ *MUST NOT* be measured on a curve tracer.

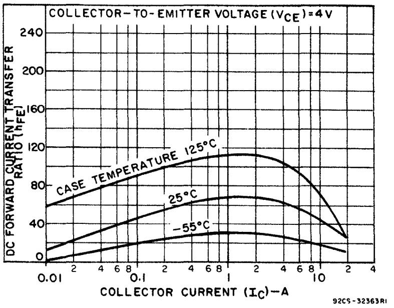


Fig. 2—Typical dc beta characteristics.

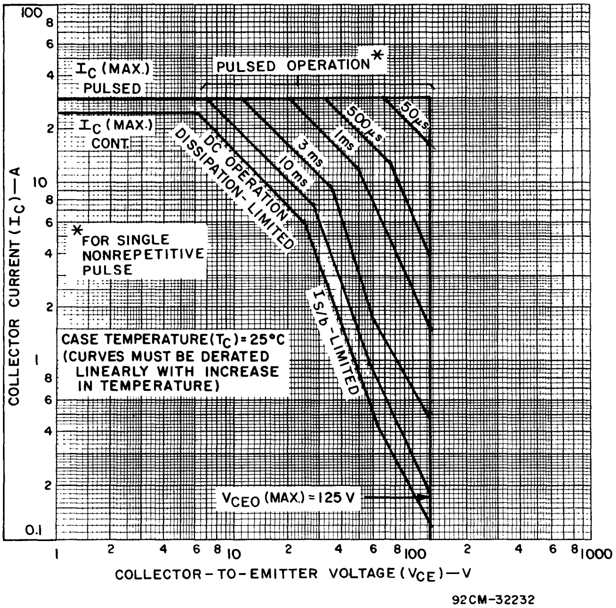


Fig. 3—Maximum safe-operating areas (T_C = 25°C).

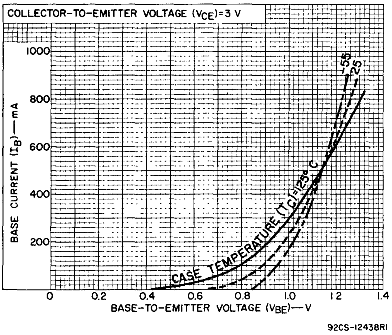


Fig. 4—Typical input characteristics.

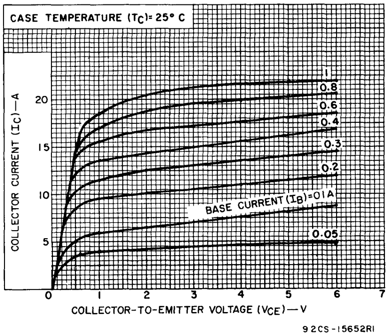


Fig. 5—Typical output characteristics.

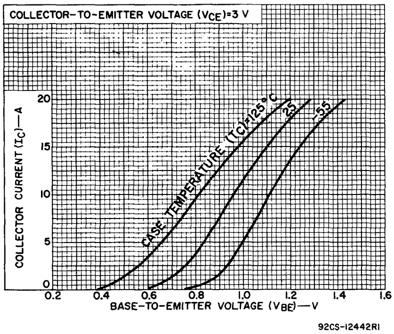


Fig. 6—Typical transfer characteristics.

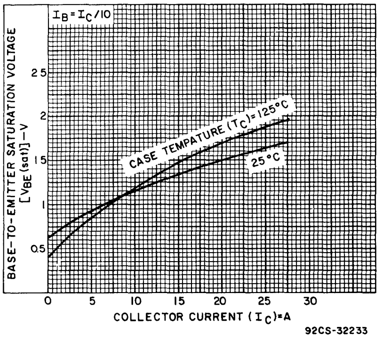


Fig. 7—Typical base-to-emitter saturation voltage characteristics.

BUX10A

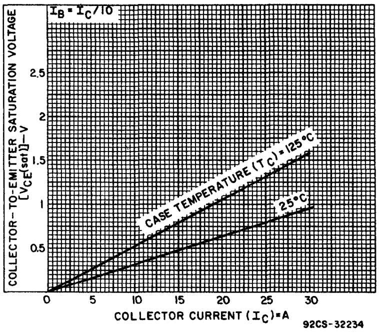


Fig. 8—Typical collector-to-emitter saturation voltage characteristics.

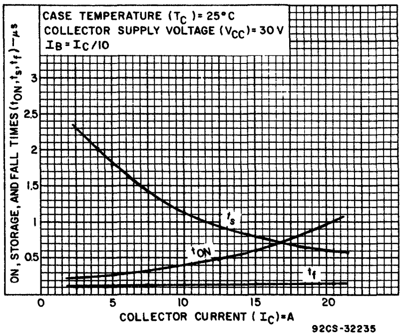


Fig. 9—Typical switching time characteristics.

File Number **1353**

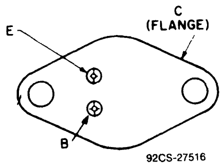
BUX11A

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

Features:

- V_{CEO} - 190 V
- I_C - 20 A
- P_T - 200 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}		
$V_{BE} = -1.5$ V	250	V
V_{EBO}	7	V
I_C	20	A
I_{CM}	25	A
I_B	4	A
P_T		
$T_C \leq 25°C$	200	W
$T_C > 25°C$ derate linearly	1.14	W/°C
T_{stg}, T_J	−65 to + 200	°C
T_L		
At distances ≧ 1/32 in. (0.8 mm) from seating plane for 10 s max	235	°C

BUX11A

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		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	mA
I_{CEX} T_C = 125° C	250	-1.5			—	6	mA
I_{EBO}		-5			—	1	mA
$V_{CEO}(sus)$[a]			0.2[b]		190	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	V
h_{FE}	2		8[b]		20	60	
	4		15[b]		10	—	
$V_{BE}(sat)$			15[b]	1.88	—	1.8	V
$V_{CE}(sat)$			8[b]	0.8	—	0.6	V
			15[b]	1.88	—	1.5	V
$I_{S/b}$	140				0.15	—	A
t_p = 1s nonrep.	18				11.1	—	A
f_T	15		1	—	8	—	MHz
t_{ON}	150[c]		15	1.88	—	1	µs
t_s $I_{B1} = I_{B2}$	150[c]		15	1.88	—	1.5	µs
t_f $I_{B1} = I_{B2}$	150[c]		15	1.88	—	0.4	µs
$R\theta_{JC}$					—	0.875	° C/W

[a]CAUTION: The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.
[b]Pulsed; pulse duration = 300 µs, duty factor ≤ 2%.
[c]V_{CC}.

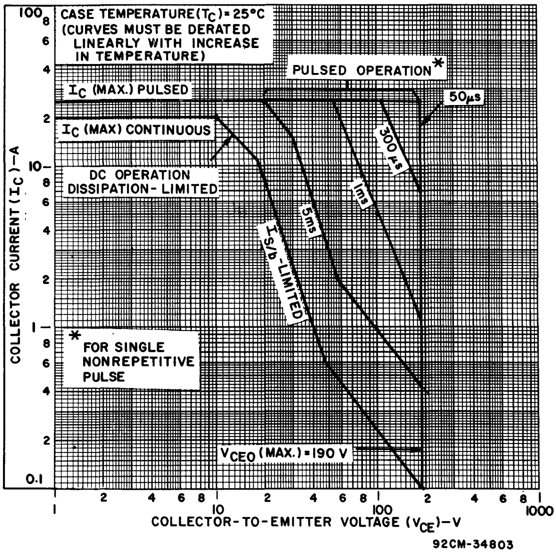


Fig. 1 — Maximum safe-operating areas for BUX11A (T_c = 25° C).

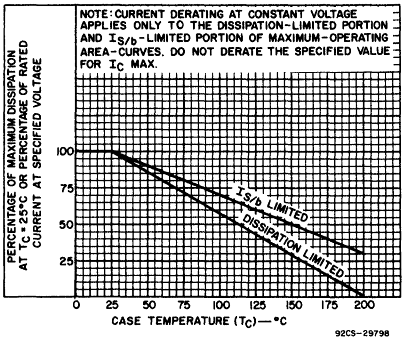


Fig. 2 — Derating curves for $I_{S/b}$ and dissipation.

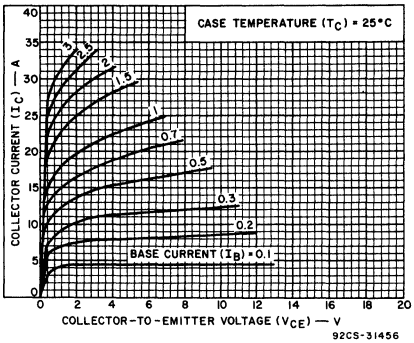


Fig. 3 — Typical output characteristics.

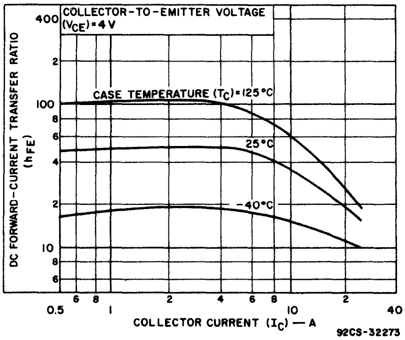


Fig. 4 — Typical dc beta characteristics.

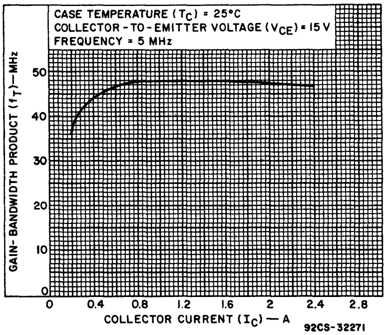


Fig. 5 — Typical gain-bandwidth product.

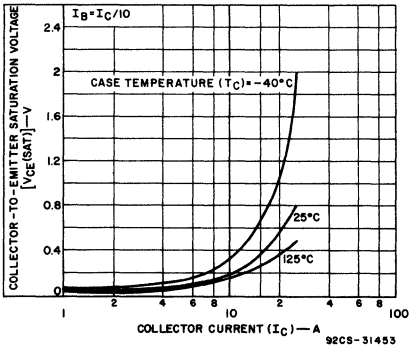


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics.

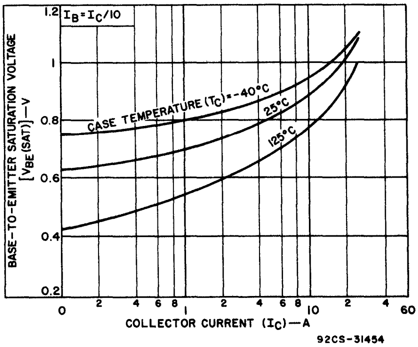


Fig. 7 — Typical base-to-emitter saturation voltage characteristics.

BUX11A

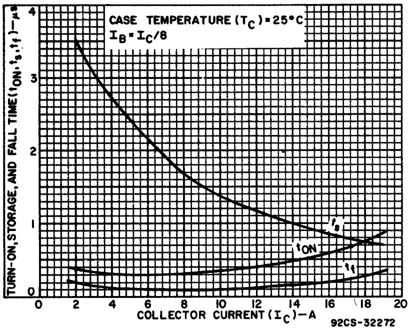


Fig. 8 — Typical saturated-switching times as a function of collector current.

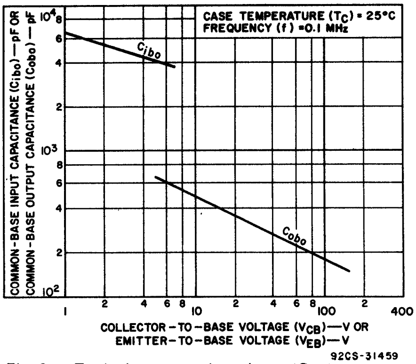


Fig. 9 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic.

File Number **1203**

BUX14

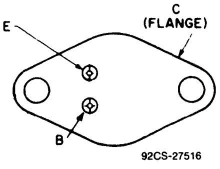
Silicon N-P-N Switching Transistor

For High-Voltage Switching and Amplifier Applications in Industrial and Commercial Equipment

Features:

- V_{CEO} — 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 Ω	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_J, T_{stg}	-65 to +200 °C
T_L	
At distances ≥ 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°C	450	−1.5	—	—	—	—	6	
I_{EBO}	—	−5	0	—	—	—	1	
$V_{CEO}(sus)$[b]	—	—	0.2[a]	0	400[a]	—	—	V
$V_{(BR)EBO}$ I_E = 0.05 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	—	—	
$I_{S/b}$	140	—	—	—	0.15	—	—	A
t = 1 s, nonrepetitive	30	—	—	—	5	—	—	
f_T	15	—	1	—	8	—	—	MHz
t_{on}	V_{CC}	—	6	1.2	—	0.5	1.4	μs
t_s	=	—	6	1.2[c]	—	1	3	
t_f	30 V	—	6	1.2[c]	—	0.3	1.2	
$R_{\theta JC}$	—	—	—	—	—	—	1.17	°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]$I_{B1} = I_{B2}$.

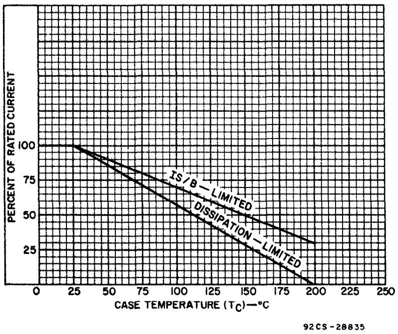


Fig. 1 — Dissipation and $I_{S/b}$ derating curves.

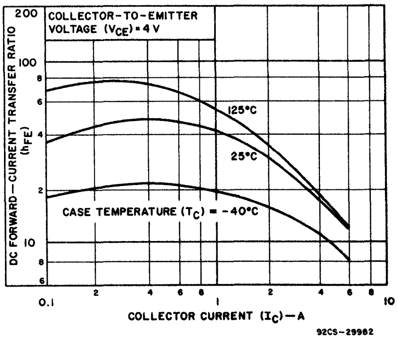


Fig. 2 — Typical dc beta characteristics.

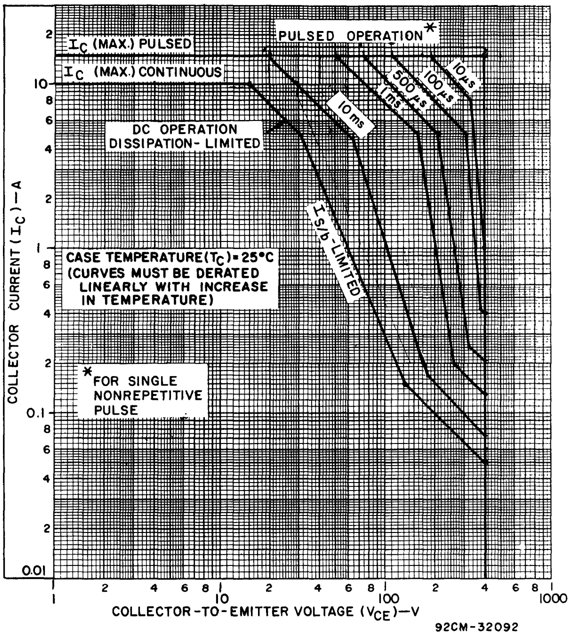


Fig. 3 — Maximum safe-operating areas (T_C = 25° C).

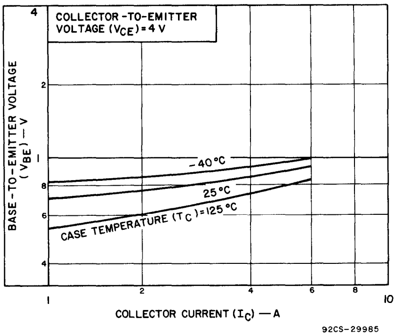


Fig. 4 — Typical base-to-emitter voltage as a function of collector current.

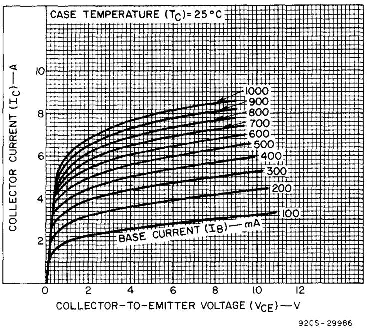


Fig. 5 — Typical output characteristics.

BUX14

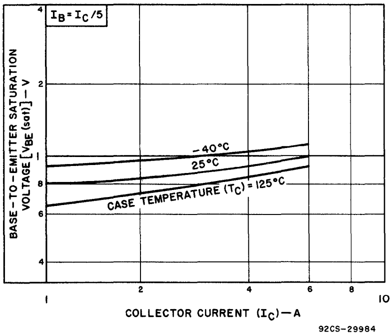


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

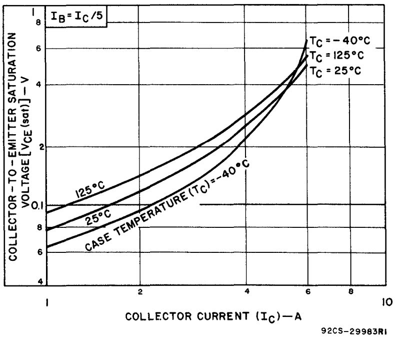


Fig. 7 — Typical collector-to-emitter saturation voltage as a function of collector current.

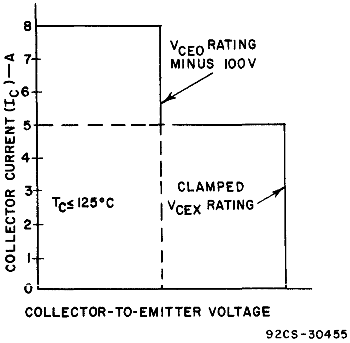


Fig. 8 — Maximum operating conditions for switching between saturation and cutoff.

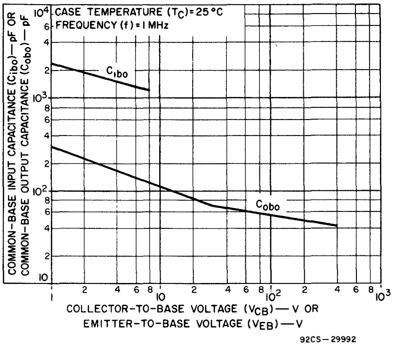


Fig. 9 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

File Number **800**

BUX16, BUX16A, BUX16B, BUX16C

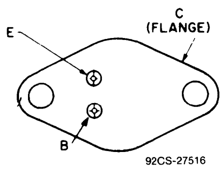
High-Voltage, High-Power Silicon N-P-N Power Transistor

For Switching and Linear Applications in Industrial, and Commercial Equipment

Features:

- **High voltage ratings: V_{CER}(sus) up to 400 V, $R_{BE} \leqslant 50\ \Omega$**
  V_{CEO}(sus) up to 350 V
- **High power dissipation rating: P_T = 100 W at V_{CE} = 135 V, T_C = 25°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}) ⩽50 Ω	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				°C
PIN TEMPERATURE (During soldering):						
At distance ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	230				°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	mA
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	mA
Collector-to-Emitter Sustaining Voltage[a] With base open	$V_{CEO}(sus)$	–	–	0.2	0	200	–	250	–	300	–	350	–	V
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	–	V
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	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$	–	–	2[b]	0.25	–	2.5	–	2.5	–	2.5	–	2.5	V
		–	–	4.5[b]	1.125	–	5	–	5	–	5	–	5	
Gain-Bandwidth Product	f_T	10	–	0.2	–	5	–	5	–	5	–	5		MHz
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	pF
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	–	A
Thermal Resistance: Junction-to-case	$R_{\theta JC}$	–	–	–	–	–	1.75	–	1.75	–	1.75	–	1.75	°C/W

[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

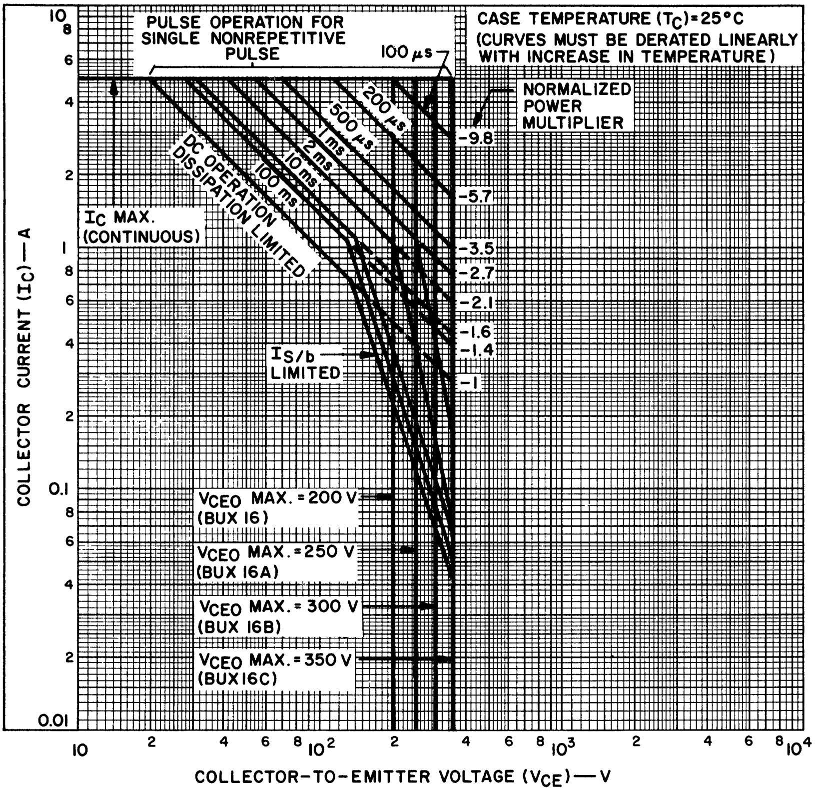


Fig. 1 — Maximum operating areas for all types.

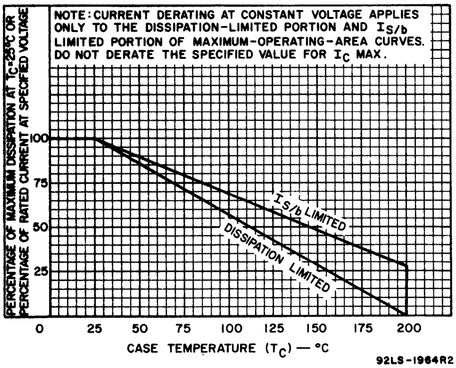


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for all types.

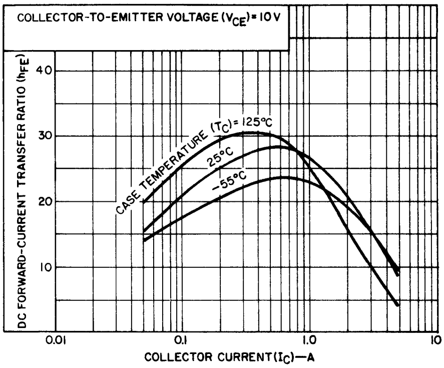


Fig. 3 — Typical DC beta vs. collector for current for all types.

BUX16, BUX16A, BUX16B, BUX16C

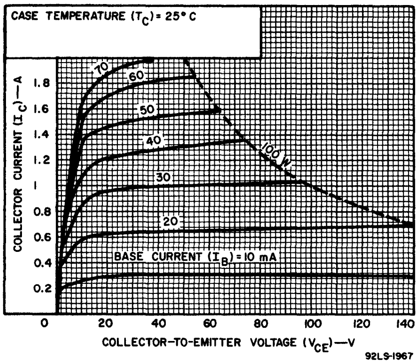


Fig. 4 — Typical output characteristics for all types.

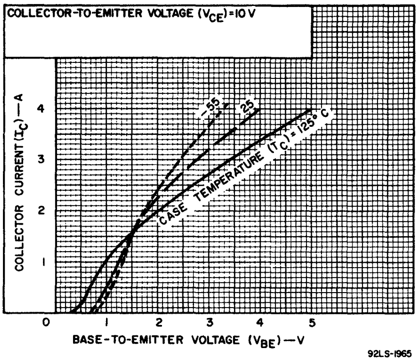


Fig. 5 — Typical transfer characteristics for all types.

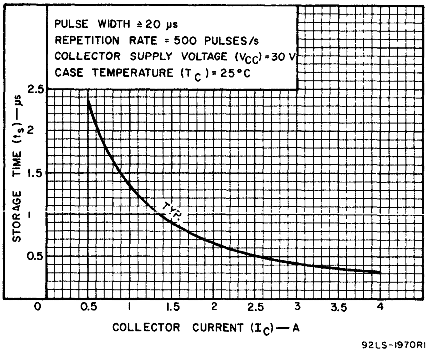


Fig. 6 — Saturated switching time (storage) vs. collector current for all types.

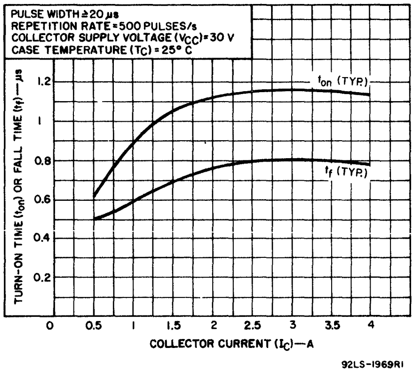


Fig. 7 — Saturated switching-times (turn-on and fall) vs. collector current for all types.

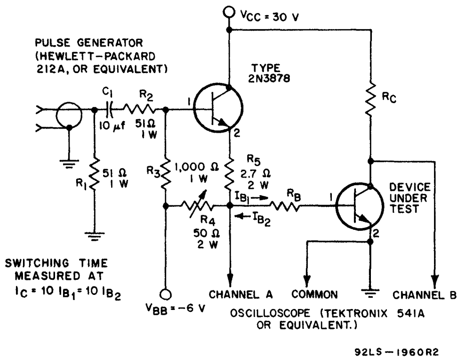


Fig. 8 — Circuit used to measure switching times for all types.

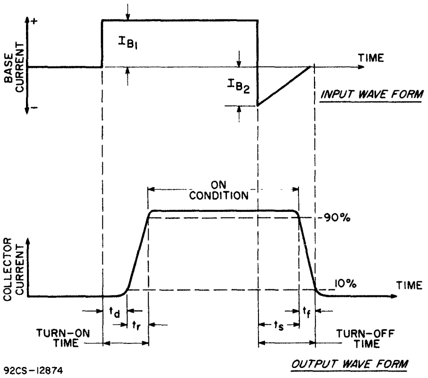


Fig. 9 — Oscilloscope display of switching times (test circuit shown in Fig. 8).

File Number **1172**

BUX21

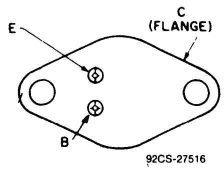
Silicon N-P-N Switching Transistor

For Switching Applications in Industrial and Commercial Equipment

Features:

- V_{CEO} — 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_{CEO}(sus)	200	V
V_{CEX}(sus)		
V_{BE} = -1.5V	250	V
V_{CER}(sus)		
R_{BE} = 100 Ω	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°C and V_{CE} up to 20 V	250	W
T_J, T_{stg}	-65 to +200	°C
T_L		
At distances ≥ 1/16 in. (1.58 mm) from case for 10 s max.	200	°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	mA
T_C = 125°C	250	−1.5	–	–	–	–	12	mA
I_{EBO}	–	−5	0	–	–	–	1	mA
$V_{CEO}(sus)$[b]	–	–	0.2[a]	–	200[a]	–	–	V
$V_{(BR)EBO}$ I_E = 0.05 A	–	–	0	–	7	–	–	V
$V_{BE}(sat)$	–	–	25[a]	3	–	1.2	1.5	V
$V_{CE}(sat)$	– –	– –	12[a] 25[a]	1.2 3	– –	0.2 0.7	0.6 1.5	V
h_{FE}	2 4	– –	12[a] 25[a]	– –	20 10	– –	60 –	
$I_{S/b}$ t = 1s, nonrepetitive	140 20	– –	– –	– –	0.15 12.5	– –	– –	A
f_T f = 10 MHz	15	–	2	–	8	–	–	MHz
t_{on}	V_{CC} = 100 V	–	25	3	–	0.3	1.2	μs
t_s ($I_{B_1} = I_{B_2}$)	V_{CC} = 100 V	–	25	3	–	1.0	1.8	μs
t_f ($I_{B_1} = I_{B_2}$)	V_{CC} = 100 V	–	25	3	–	0.2	0.4	μs
$R_{\theta JC}$	–	–	–	–	–	–	0.7	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** Sustaining Voltages $V_{CEO}(sus)$ *MUST NOT* be measured on a curver tracer.

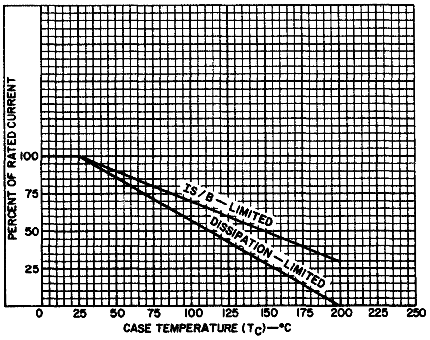


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

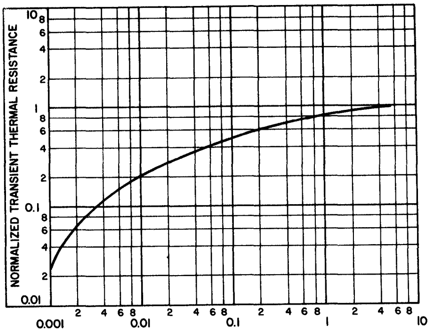


Fig. 2 — Typical thermal-response characteristic.

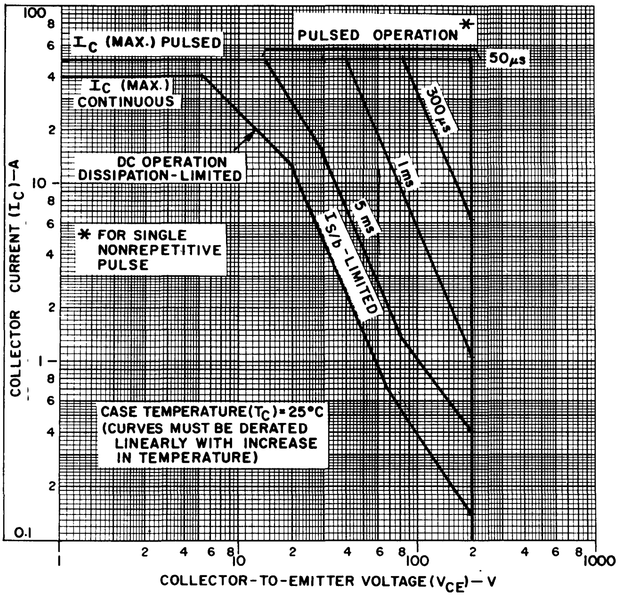


Fig. 3 — Maximum operating areas (T_C = 25° C).

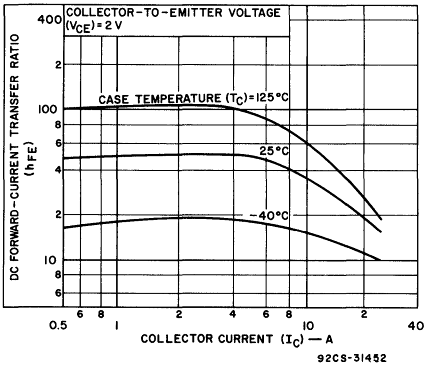


Fig. 4 — Typical dc beta characteristics.

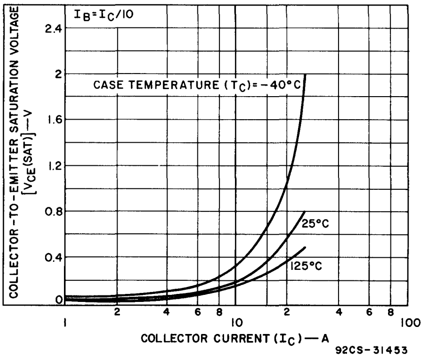


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

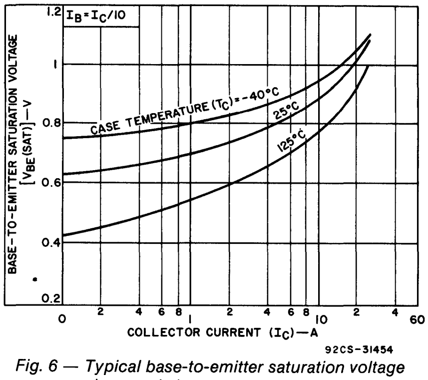


Fig. 6 — Typical base-to-emitter saturation voltage characteristics.

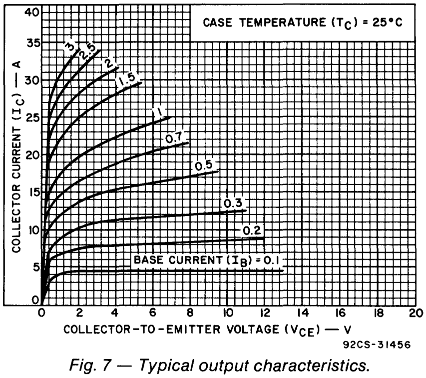


Fig. 7 — Typical output characteristics.

BUX21

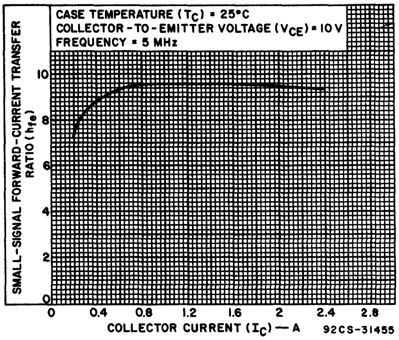


Fig. 8 — Typical small-signal forward-current transfer ratio characteristics.

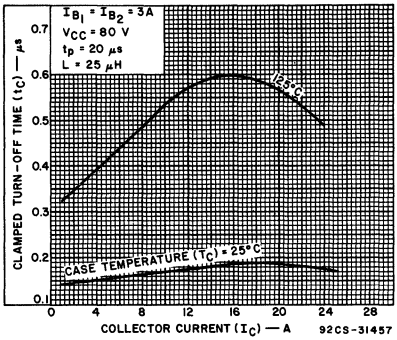


Fig. 9 — Typical clamped turn-off time characteristics.

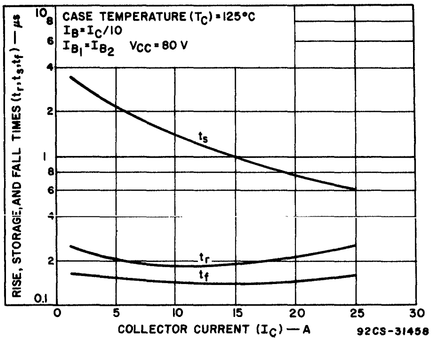


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current.

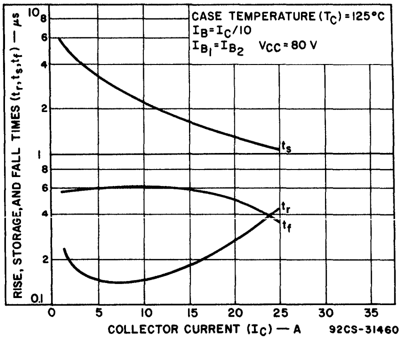


Fig. 11 — Typical-switching-time characteristics at T_C = 125° C as a function of collector current.

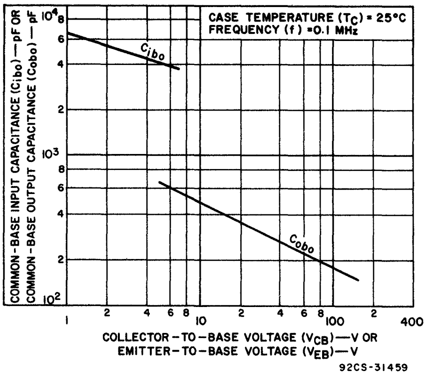


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

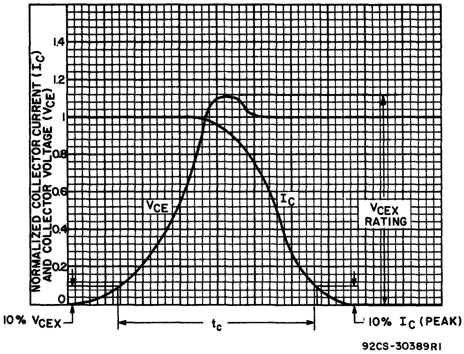


Fig. 13 — Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

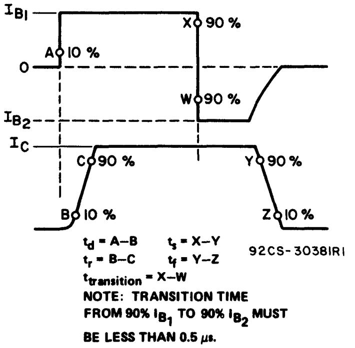


Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

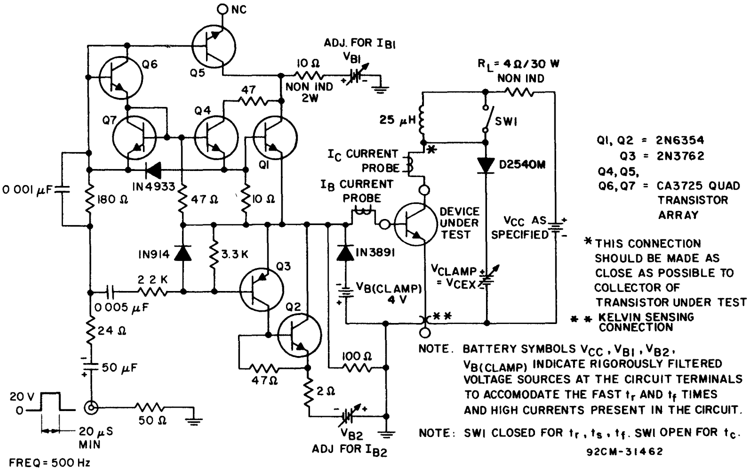


Fig. 15 — Circuit for measuring switching times.

BUX39 File Number **1211**

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

For Switching and Amplifier Applications in Industrial and Commercial Service

Features:

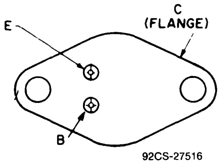
- *Maximum area-of-operation curves for dc and pulse operation - $I_{S/b}$ limit begins at 25 V*
- *Fast turn-on time - 1 μs at I_C = 15 A*
- *High-current capability - h_{FE}, $V_{CE}(sat)$, $V_{BE}(sat)$ measured at I_C = 10 A*

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 Ω	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	
$T_C \leq 25°C$	120 W
$T_C \geq 25°C$, derate linearly	0.68 W/°C
T_{stg}, T_J	-65 to 100°C
T_L	
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230°C

BUX39

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS			UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	70				—	—	1	mA
I_{CEX}	120	−1.5			—	—	1	mA
T_C = 125 °C	120	−1.5			—	—	5	mA
I_{EBO}		−5	0		—	—	1	mA
$V_{CEO}(sus)^a$ L = 25 mH			0.2^b	0	90	—	—	V
$V_{(BR)EBO}$ 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	V
$I_{S/b}$ 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	μS
t_f			20	2.5^c		0.15	0.3	μS
$R_{\theta JC}$					—	—	1.46	°C/W

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

b Pulsed; pulse duration ≤ 300 μS, duty factor ≤ 2%.

c $I_{B_1} = -I_{B_2}$.

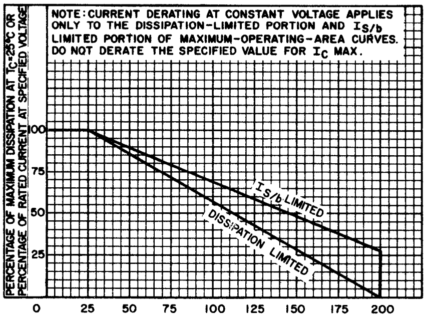


Fig. 1 - Derating curves.

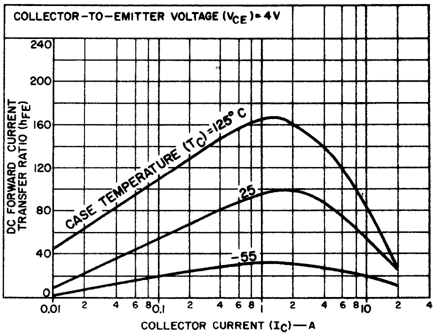


Fig. 2 - Typical DC beta characteristics.

BUX39

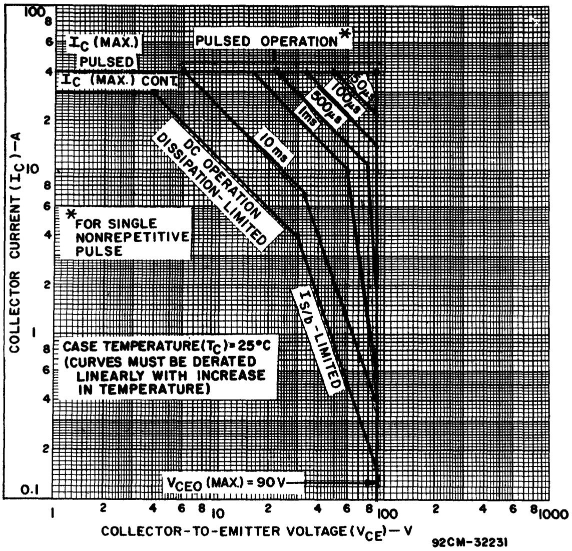


Fig. 3 - Maximum operating areas.

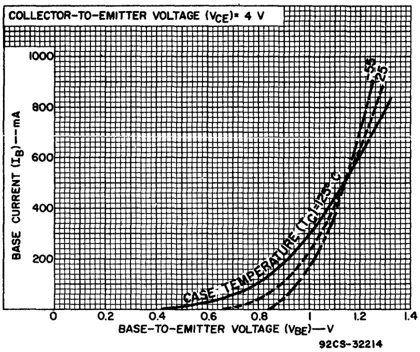


Fig. 4 - Typical input characteristics.

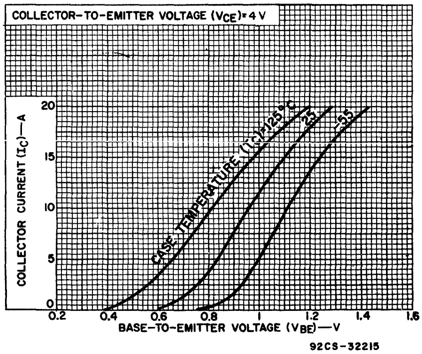


Fig. 5 - Typical transfer characteristics.

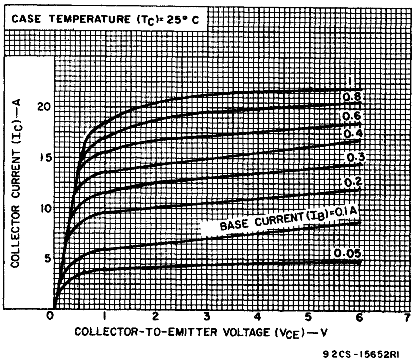


Fig. 6 - Typical output characteristics.

File Number **1231**

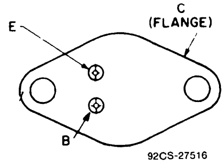
BUX45

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

Features:

- V_{CEO} — 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_{CEO}	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		
$I_C \leq 25°C$	120	W
$T_C > 25°C$ derate linearly	0.69	W/°C
T_{stg}, T_J	-65 to +200	°C
T_L		
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°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°C	500	−1.5			—	—	5	
I_{EBO}		−5	0		—	—	1	
$V_{CEO}(sus)$[b]			0.2[a]	0	500	—	—	V
$V_{(BR)EBO}$ I_E = 50 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
$I_{S/b}$	135				0.15	—	—	A
t = 1s, nonrepetitive	30				4	—	—	
t_{ON}	V_{CC}		2	0.4	—	0.4	1	µs
t_s I_{B1} = I_{B2}	=		2	0.4	—	3.5	5	
t_f I_{B1} = I_{B2}	100 V		2	0.4	—	0.6	1.2	
$R_{\theta JC}$					—	—	1.46	°C/W

[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.

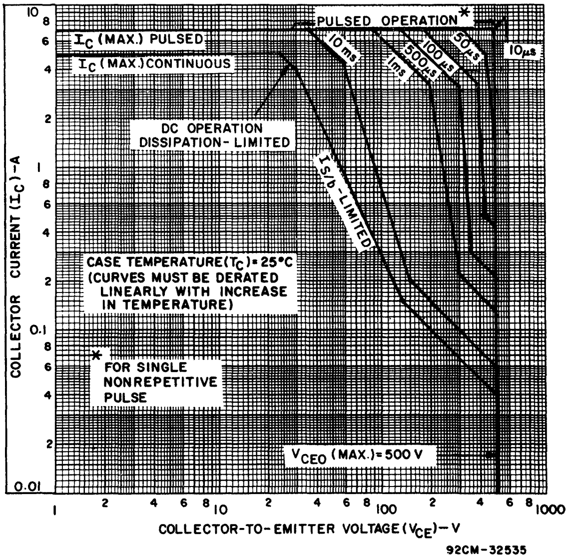


Fig. 1 — Maximum safe-operating areas (T_C=25° C).

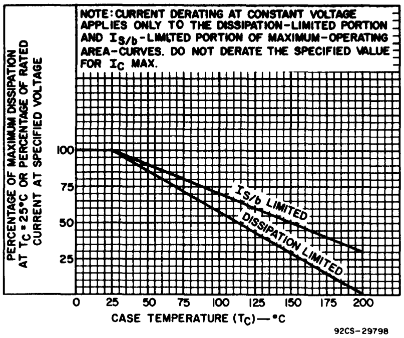


Fig. 2 — Derating curves for $I_{S/b}$ and dissipation.

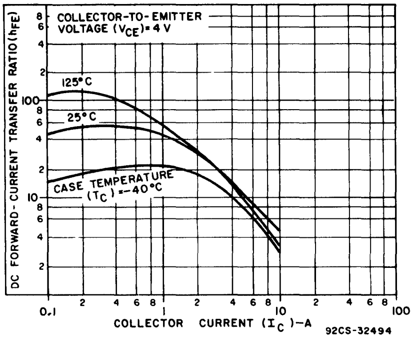


Fig. 3 — Typical dc beta characteristics.

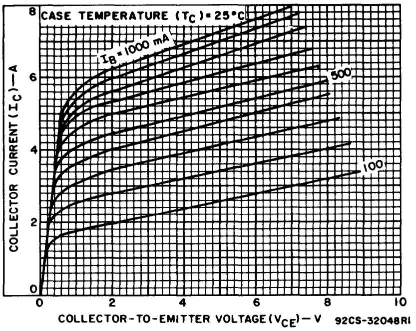


Fig. 4 — Typical output characteristics.

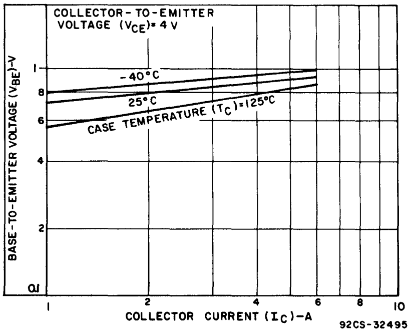


Fig. 5 — Typical base-to-emitter voltage as a function of collector current.

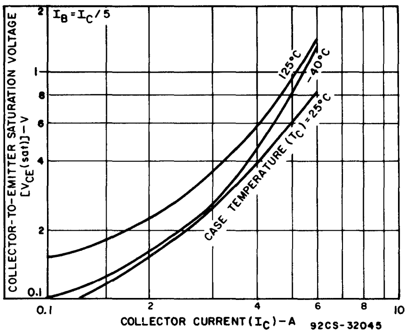


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current.

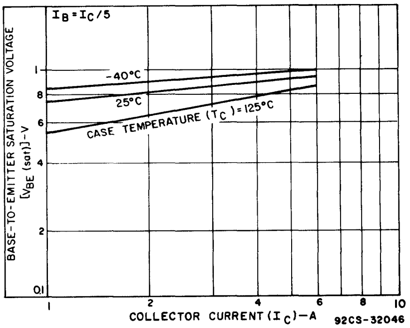


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current.

BUX45

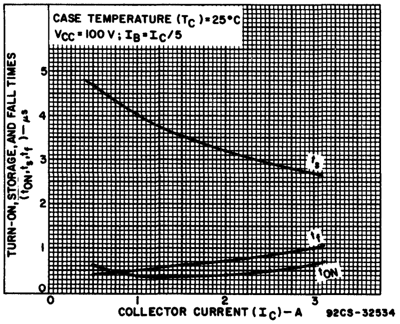


Fig. 8 — *Typical saturated-switching times as a function of collector current.*

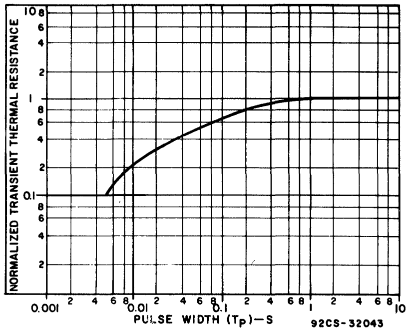


Fig. 9 — *Typical thermal-response characteristic.*

File Number **870**

BUX66, BUX66A, BUX66B, BUX66C

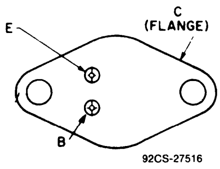
High Voltage Silicon P-N-P Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:

- *High voltage ratings:*
  V_{CEO}(sus) = -150 V max. (BUX66)
  = -250 V max. (BUX66A)
  = -300 V max. (BUX66B)
  = -350 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 V	—200	—300	—350	—400	V
V_{CER}(sus)					
R_{BE} = 100Ω	—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	–	–	mA
	−300	1.5			–	–	–	−8	mA
T_C = 100°C	−200	1.5			–	−10	–	–	mA
	−300	1.5			–	–	–	−10	mA
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
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	μs
t_f V_{CC} = −200 V			−1	−0.10[b]	–	0.6	–	0.6	μs
$R_{\theta JC}$					–	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.

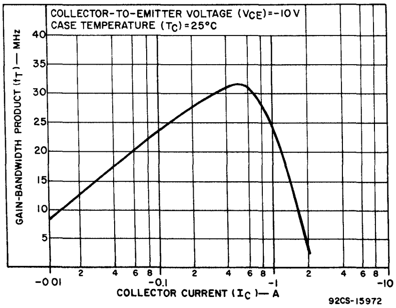


Fig.1 – Typical gain-bandwidth product for all types.

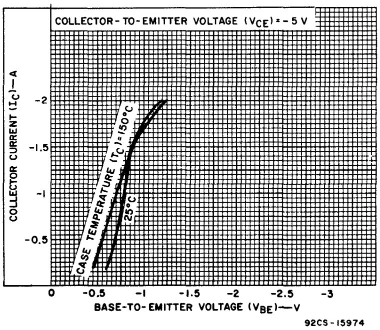


Fig.2 – Typical transfer characteristics for all types.

BUX66, BUX66A, BUX66B, BUX66C

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

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BUX66B Min.	Max.	BUX66C Min.	Max.	UNITS
I_{CEO}	–150			0	–	–5	–	–5	
I_{CEX}	–350	1.5			–	–8	–	–	
	–400	1.5			–	–	–	–8	mA
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
$\lvert h_{fe} \rvert$ f = 5 MHz	–10		–0.2		4	–	4	–	
t_r V_{CC} = –200 V			–1	–0.10[b]	–	0.6	–	0.6	
t_s V_{CC} = –200 V			–1	–0.10[b]	–	2.5	–	2.5	μs
t_f V_{CC} = –200 V			–1	–0.10[b]	–	0.6	–	0.6	
$R_{\theta JC}$					–	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.

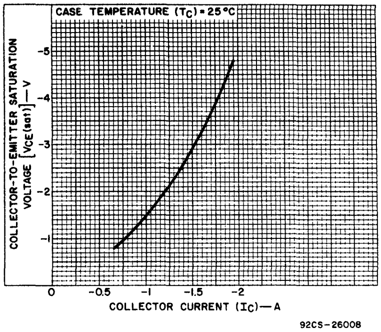


Fig.3 — Typical saturation-voltage characteristic for all types.

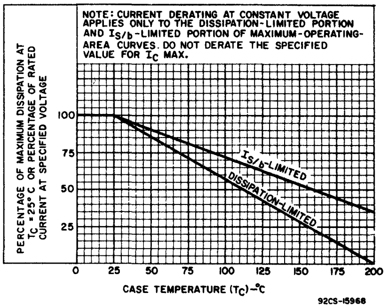


Fig. 4 — Derating curve for all types.

BUX66, BUX66A, BUX66B, BUX66C

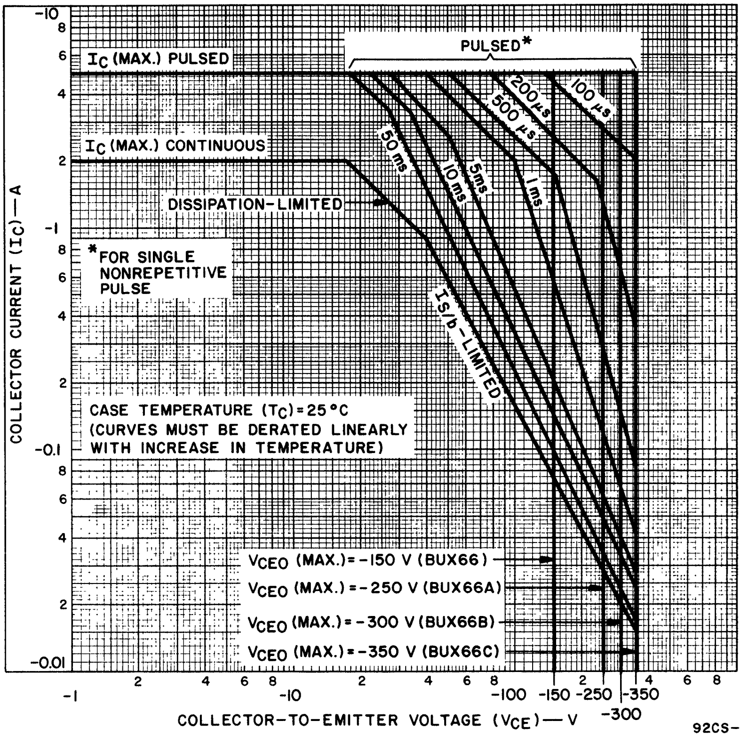


Fig.5 — Maximum operating areas for all types.

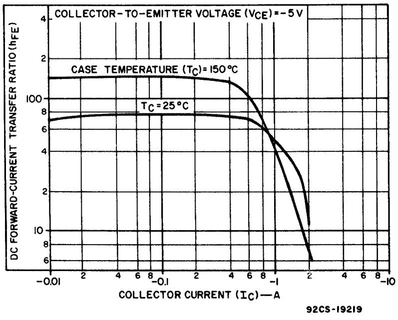


Fig. 6 — Typical dc beta characteristics for all types.

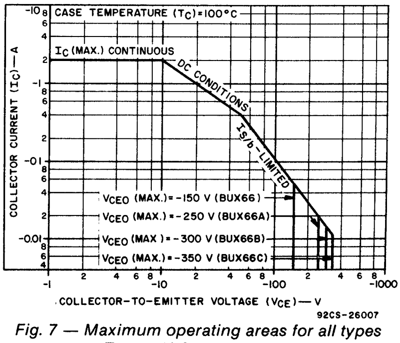


Fig. 7 — Maximum operating areas for all types at T_C = 100° C.

BUX66, BUX66A, BUX66B, BUX66C

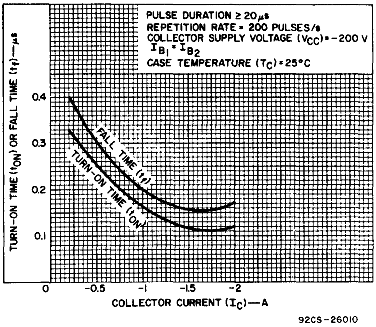


Fig. 8 — Typical turn-on time and fall-time characteristics for all types.

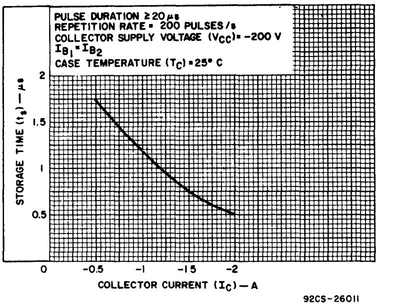


Fig. 9 — Typical storage-time characteristic for all types.

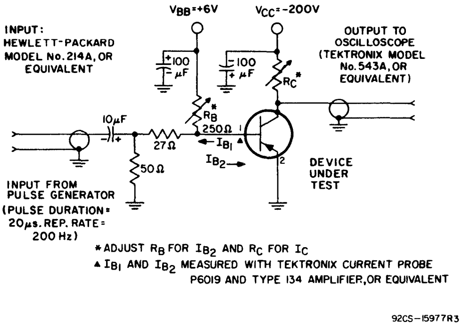


Fig. 10 — Circuit used to measure saturated switching times for all types.

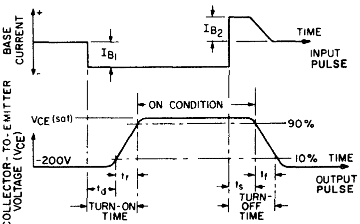


Fig. 11 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

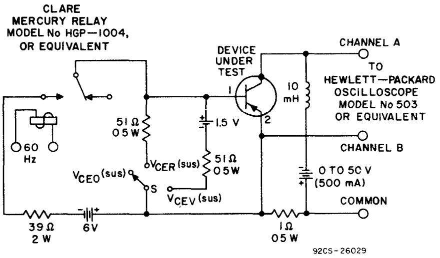
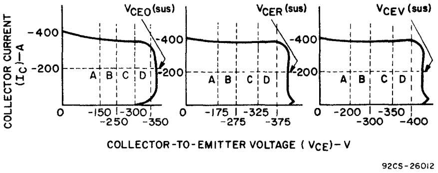


Fig. 12 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ for all types.



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.

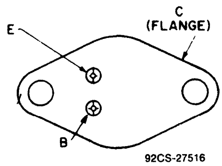
Fig. 13 — Oscilloscope display for measurement of sustaining voltages.

File Number **1288**

BUX97, BUX97A, BUX97B

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

Features:

- *Fast switching speeds*
- *High voltage ratings: V_{CES} = 750-800 V*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*

The RCA-BUX97 series are epitaxial-base silicon n-p-n transistors having 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.

The BUX97-series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX97	BUX97A	BUX97B	
V_{CES}	750	800	800V	V
V_{CEO}	350	400	450	v
V_{EBO}		7		V
I_C		6		A
$I_{CM}(t_p = 500\ \mu s)$		8		A
I_B		3		A
P_T				
$T_C = 75°C$		60		W
T_J		175		°C
T_{stg}		-65 to 175		°C
T_L				
At distance ¼ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

BUX97, BUX97A, BUX97B

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

Charac-teristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUX97		BUX97A		BUX97B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CES}	750[d]	0			—	1	—	—	—	—	mA
	800[d]	0			—	—	—	1	—	1	
I_{CES} T_C=150° C	750[d]	0			—	3	—	—	—	—	
	800[d]	0			—	—	—	3	—	3	
I_{EBO}		−7	0		—	1	—	1	—	1	mA
V_{CEO}(sus)[b]			0.1[a]	0	350	—	400	—	450	—	V
h_{FE}	5		1.0[a]		10	70	10	70	10	70	
V_{BE}(sat)			1[a]	0.2	—	1.3	—	1.3	—	1.3	V
			4[a]	1.25	—	1.8	—	1.8	—	1.8	
V_{CE} (sat)			1[a]	0.2	—	1	—	1	—	1	V
			4[a]	1.25	—	3	—	3	—	3	
f_T	10		0.5		20 (Typ.)		20 (Typ.)		20 (Typ.)		MHz
t_{ON} V_{CC}=100V			4	1.25[c]	0.6 (Typ.)		0.6 (Typ.)		0.6 (Typ.)		μs
t_s V_{CC}=100 V			4	1.25[c]	3.5 (Typ.)		3.5 (Typ.)		3.5 (Typ.)		
t_f V_{CC}=100 V			4	1.25[c]	0.5 (Typ.)		0.5 (Typ.)		0.5 (Typ.)		
$R_{\theta JC}$	10		5		—	1.67	—	1.67	—	1.67	°C/W

[a] Pulsed: pulse duration = 300 μs, duty factor ≈ 1.8%

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

[c] I_{B1} = $-I_{B2}$ [d] V_{CE} = V_{CES} max.

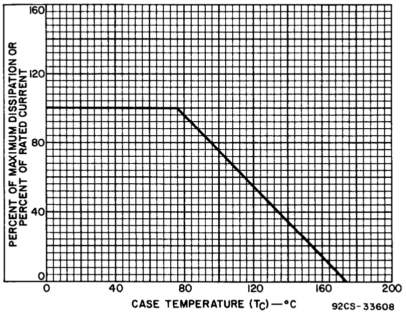


Fig. 1 — Dissipation derating curves for all types.

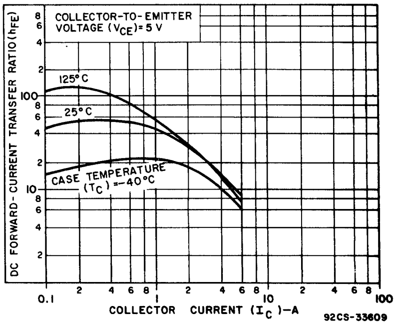


Fig. 2 — Typical dc-beta characteristics for all types.

BUX97, BUX97A, BUX97B

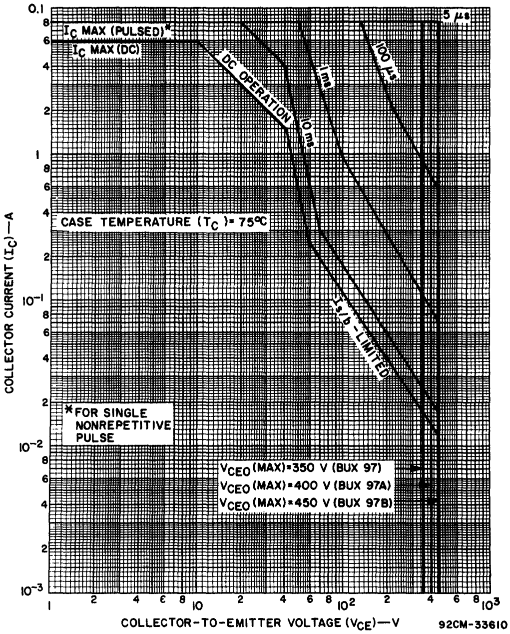


Fig. 3 — Maximum safe-operating areas for all types.

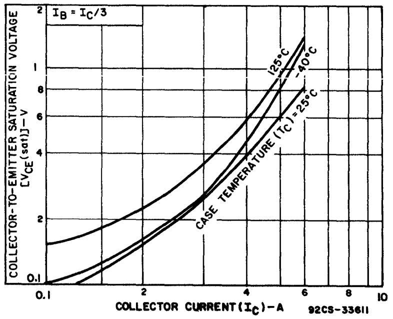


Fig. 4 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

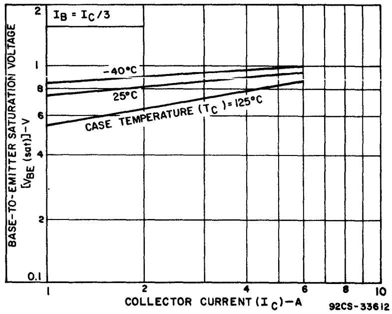


Fig. 5 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

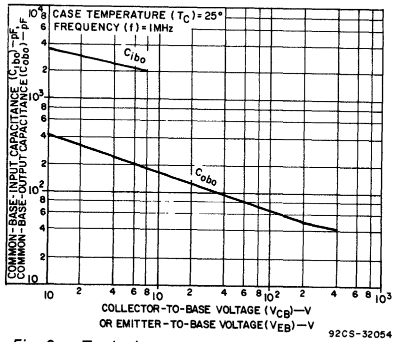


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

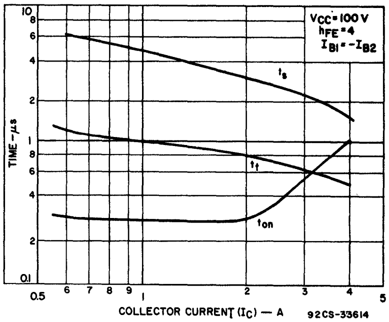


Fig. 7 — Typical switching-time characteristics as a function of collector current for all types.

File Number **1237**

BUY69A, BUY69B, BUY69C

High Voltage Silicon N-P-N Power Transistors

For Horizontal-Deflection Circuits and Other High-Voltage Switching Applications

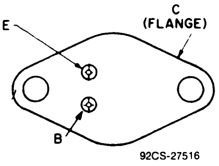
Features:

- *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 μs)		15		A
I_B		3		A
P_T				
T_C = 25°C		100		W
T_J		200		°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

BUY69A, BUY69B, BUY69C

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS BUY69A		BUY69B		BUY69C		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEX}	1000	−2			—	0.1	—	—	—	—	mA
	800	−2			—	—	—	0.1	—	—	
	500	−2			—	—	—	—	—	0.1	
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 = 1s	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
$R_{\theta JC}$					—	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.

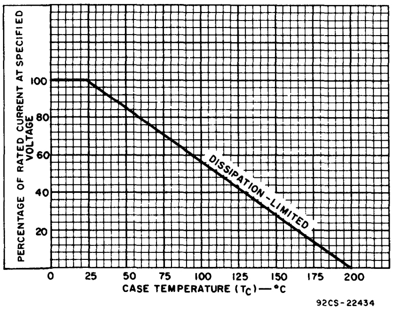


Fig. 1 — Dissipation derating curve for all types.

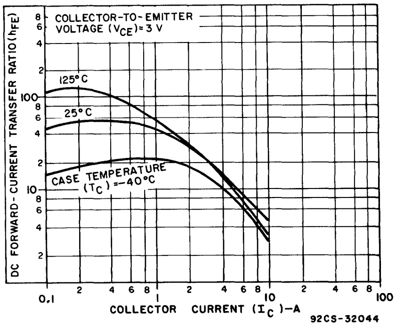


Fig. 2 — Typical dc beta characteristics for all types.

BUY69A, BUY69B, BUY69C

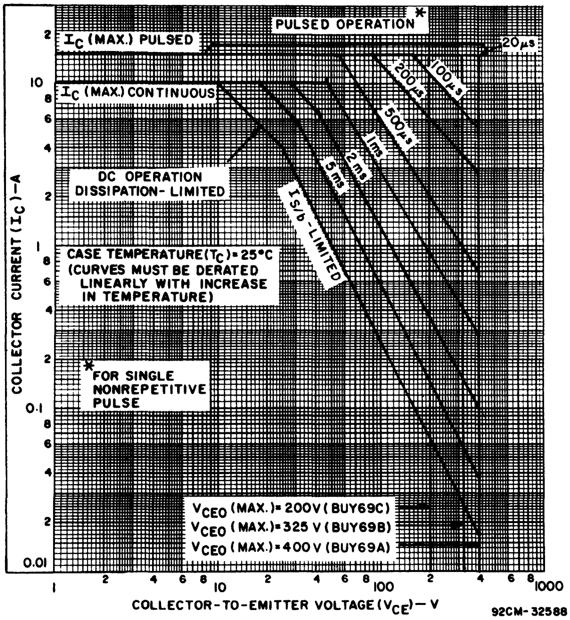


Fig. 3 — Maximum operating areas for all types (T_C =25° C).

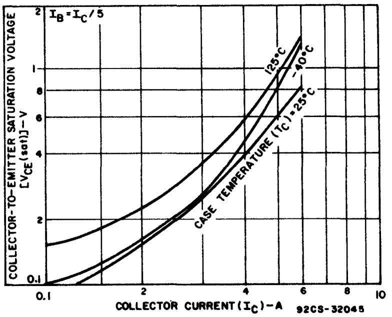


Fig. 5 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

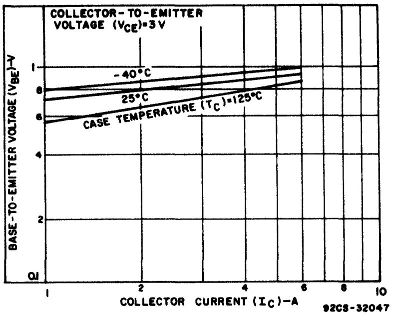


Fig. 6 — Typical base-to-emitter voltage as a function of collector current for all types.

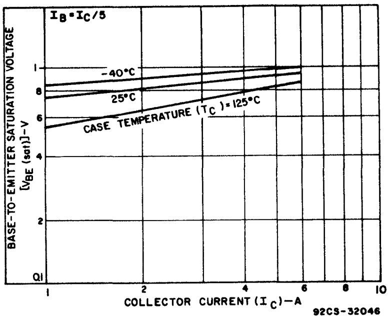


Fig. 4 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

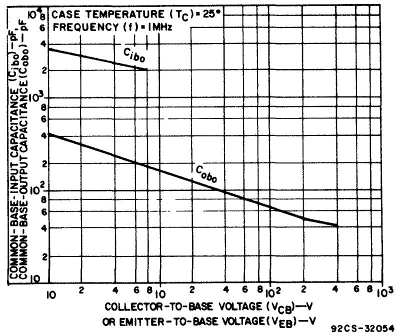


Fig. 7 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

BUY69A, BUY69B, BUY69C

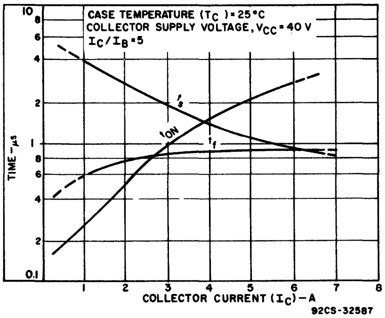


Fig. 8 — Typical switching-time characteristics as a function of collector current.

SURGECTORs
Transient Surge Suppressors
Technical Data

RCA SURGECTORS provide excellent protection against transient surges

A SURGECTOR is a solid state device designed to protect telecommunications equipment from damage due to transient surges. A telephone system is susceptible at any point to disturbances caused by, but not limited to, contact with power lines (line crosses), direct lightning strikes, induced voltages due to magnetic or electric fields, and static discharges. The increasing use of solid state electronics has increased equipment sensitivity to damage from these sources of transients.

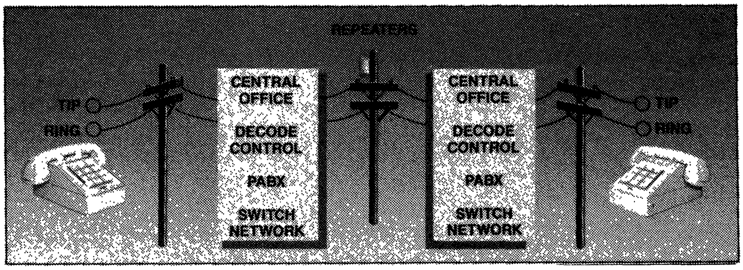
Protection is provided by diverting the surge current through a low-impedance path around the vulnerable components. The four-layer (PNPN) thyristor (or SCR) structure provides the best low-impedance path compared to other available semiconductor devices because of its high-current-handling capability. Advances in semiconductor processing now make it feasible to construct an SCR with precisely-controlled anode voltage turn-on ability, resulting in the creation of the SURGECTOR.

The SURGECTOR is a monolithic compound structure consisting of a thyristor whose gate region contains a special diffused zener diode. This zener permits anode voltage turn-on of the structure. Initial clamping by the zener and fast turn-on by the thyristor provide excellent voltage limiting on very fast rise-time transients. The thyristor also features very high holding current allowing the SURGECTOR to recover to its high impedance off-state after the transient. The SURGECTOR's normal off-state condition in the forward blocking mode is a high impedance, low leakage state that prevents loading of the telecomunications line.

RCA SURGECTORS are designed to protect telecommunication equipment, data links, alarm systems, power supplies and other sensitive electrical circuits from damage that could be caused by switching transients, lightning strikes, load changes, commutation spikes, and line crosses.

RCA SURGECTORS

Type No.	Description	Features
SGT10S10	Unidirectional, gate-controlled surge suppressor	• 100V Forward Blocking Voltage • 300A Peak Transient Surge Current • 100 mA Minimum Holding Current • Subnanosecond Clamping Action • Low On-State Voltage
SGT03U13, SGT06U13, SGT23U13	Unidirectional surge suppressors	• Clamping voltages—33V, 60V, or 230V • 300A peak transient surge current • 130 mA minimum holding current • Subnanosecond clamping action • Low on-state voltage



SURGECTORS provide Transient Protection for:

- Central Office Equipment
- Supervisory Equipment
- Switchgear Equipment
- Data Transmission
- Repeaters
- Line Concentrators
- Receivers
- Handsets
- Headsets
- Modem
- PCM
- EPABX, PABX, PBX
- TDM
- SDM
- PAM
- FSK

File Number **1692**

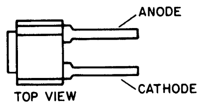
SGT03U13, SGT06U13, SGT23U13

Unidirectional Transient Surge Suppressors

Features:
- *Clamping voltages - 33V, 60V, or 230V*
- *300A peak transient surge current*
- *130 mA minimum holding current*
- *Subnanosecond clamping action*
- *Low on-state voltage*

Applications:
- *Telecommunications equipment*
- *Data and voice lines*
- *Computer modems*
- *Alarm systems*

TERMINAL DESIGNATIONS



92CS-40367

MODIFIED TO-202

RCA SURGECTORs are designed to protect telecommunication equipment, data links, alarm systems, power supplies and other sensitive electrical circuits from damage that could be caused by switching transients, lightning strikes, load changes, commutation spikes, and line crosses.

These RCA SURGECTORs are monolithic compound structures consisting of a thyristor whose gate region contains a special diffused section which acts as a zener diode. This zener diode section permits anode voltage turn-on of the structure. Initial clamping by the zener diode section and fast turn-on by the thyristor provide excellent voltage limiting even on very fast rise-time transients. The thyristor also features very high holding current allowing the SURGECTOR to recover to it's high impedance off-state after the transient. The SURGECTOR's normal off-state condition in the forward blocking mode is a high-impedance, low-leakage state that prevents loading of the telecommunication line.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		SGT03U13	SGT06U13	SGT23U13	
Continuous Off-State Voltage	V_{DM}	30	58	225	V
	V_{RM}	1	1	1	V
Transient Peak Surge Current	I_{TSM}				
1μs x 2μs*			300		A
6μs x 400μs			125		A
10μs x 560μs			90		A
10μs x 1000μs			75		A
One Half Cycle, 50-60 Hz**			60		A
One Second, 50-60 Hz, Halfwave			30		A
Operating Temperature	T_A		-40 to +85		°C
Storage Temperature	T_{stg}		-40 to +150		°C

*Unit designed not to fail open below 450A.
**One every 30 seconds maximum.

SGT03U13, SGT06U13, SGT23U13

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

CHARACTERISTIC		LIMITS			UNITS
		MIN.	TYP.	MAX.	
Off-State Current At Maximum Rated V_{DM}	I_{DM}				
T_A = 25°C		—	—	50	nA
T_A = 85°C		—	—	10	μA
Reverse Current V_{RM} = 1 V	I_{RM}				
T_A = 25°C		—	—	1	mA
T_A = 85°C		—	—	10	mA
Clamping Voltage, I_Z = 100 μA	V_Z				
SGT03U13		33	—	—	V
SGT06U13		60	—	—	V
SGT23U13		230	—	—	V
Breakover Voltage, D_V/D_T = 100V/μs	V_{BO}				
SGT03U13		—	—	50	V
SGT06U13		—	—	85	V
SGT23U13		—	—	275	V
Holding Current	I_H	130	—	—	mA
On-State Voltage, I_T = 10A	V_T	—	—	2	V
Main Terminal Capacitance	C_O	—	90	—	pF

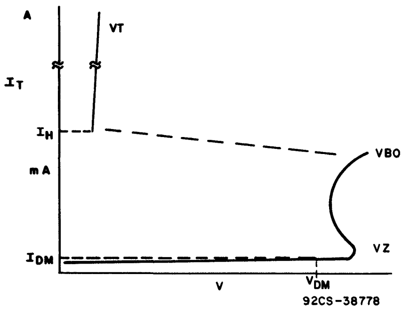


Fig. 1 - Typical volt-ampere characteristics.

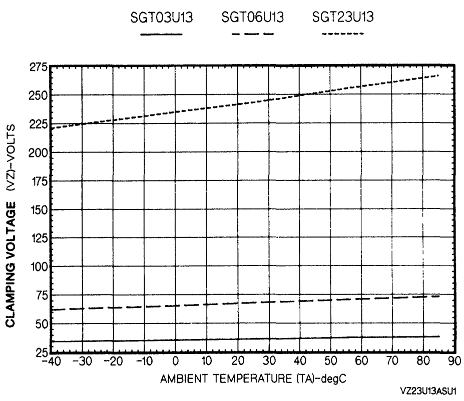


Fig. 2 - Typical clamping voltage vs. temperature.

SGT03U13, SGT06U13, SGT23U13

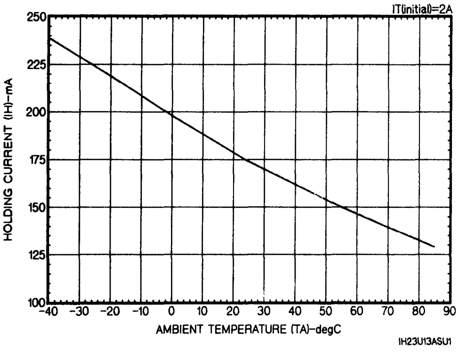


Fig. 3 - Typical holding current vs. temperature.

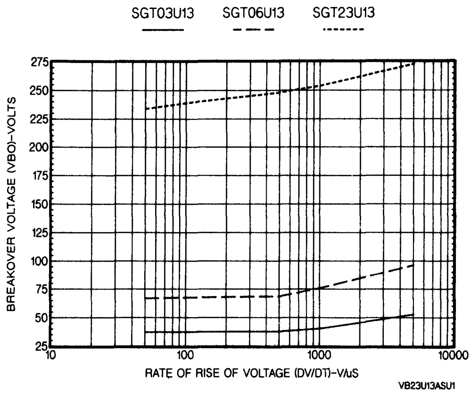


Fig. 4 - Typical V_{BO} vs. D_V/D_T.

SGT10S10

File Number **1691**

Gate-Controlled Unidirectional Transient Surge Suppressor

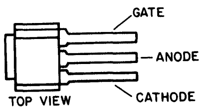
Features:

- 100V Forward Blocking Voltage
- 300A Peak Transient Surge Current
- 100 mA Minimum Holding Current
- Subnanosecond Clamping Action
- Low On-State Voltage

Applications:

- Telecommunications Equipment
- Data and Voice Lines
- Computer Modems
- Alarm Systems

TERMINAL DESIGNATIONS



MODIFIED TO-202

RCA SURGECTORS are designed to protect telecommunication equipment, data links, alarm systems, power supplies and other sensitive electrical circuits from damage that could be caused by switching transients, lightning strikes, load changes, commutation spikes, and line crosses.

This RCA SURGECTOR is a fast turn-on, high-holding-current thyristor. When coupled with a user-supplied voltage level detector it provides excellent voltage limiting even on very fast rise time transients. The high holding current allows the SURGECTOR to return to it's high impedance state following a transient. The SURGECTOR'S normal "off" condition high-forward impedance prevents loading of the line.

MAXIMUM RATINGS, *Absolute-Maximum Values ($T_C = 25°C$):*

Continuous Off-State Voltage	*VDM*	*100V*
	VRM	*1V*
Transient Peak Surge Current	*ITSM*	
1μs x 2μs*		300A
6μs x 400μs		125A
10μs x 560μs		90A
10μs x 1000μs		75A
One half Cycle, 50-60 Hz, 1 Every 30 Sec. Max.		50A
One Second, 50-60Hz, Halfwave		30A
Operating Temperature	*TA*	*-40 to* +85°C
Storage Temperature	*Tstg*	-40 to +150°C

*Unit designed not to fail open below 450A.

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

CHARACTERISTIC	SYMBOL	LIMITS Min.	Typ.	Max.	Units
Off-State Current					
VDM = 100V, TA = 25°C	IDM	—	—	50	nA
TA = 85°C		—	—	10	μA
VRM = 1V, TA = 25°C	IRM	—	—	1	mA
TA = 85°C		—	—	10	mA
*Breakover Voltage, DV/DT = 100V/μs	VBO			100	V
Holding Current	IH	100	—	—	mA
On-State Voltage, IT = 10A	VT	—	—	2	V
Gate Trigger Current	IGT	—	—	150	mA
Main Terminal Capacitance, VD = 0	CO	—	90	—	pF

*External 60V Zener Diode from Anode to Gate.

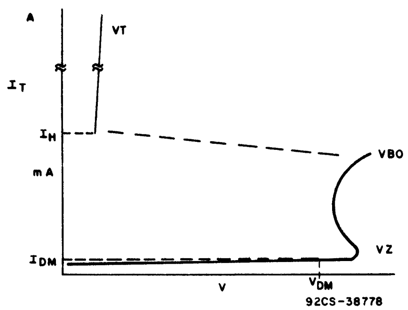


Fig. 1 — Typical Volt-Ampere Characteristics

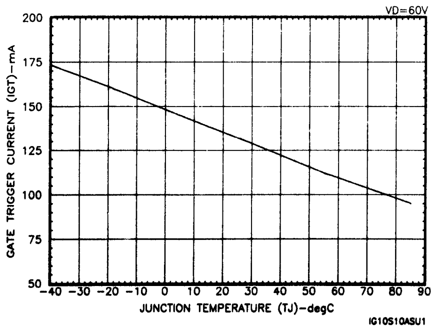


Fig. 2 — Typical Gate Trigger Current vs. Temperature

SGT10S10

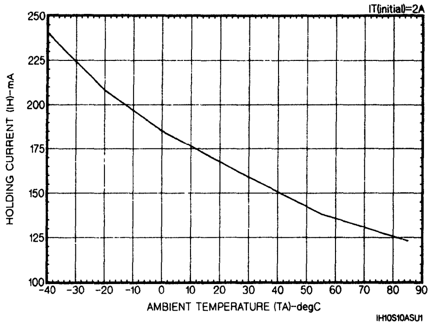


Fig. 3 — Typical Holding Current vs. Temperature

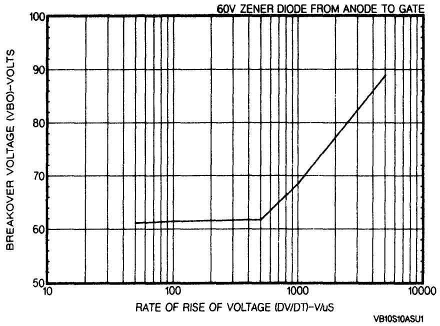


Fig. 4 — Typical VBO vs. DV/DT

Ultra-Fast-Recovery Rectifiers
Technical Data

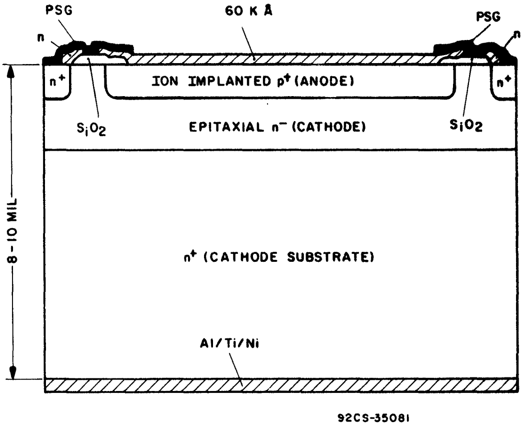
Ultra-Fast-Recovery Rectifiers

Basic Design Features

The latest state-of-the-art processing technology is employed in the manufacture of the new series of RCA ultra-fast-recovery (35-ns) rectifiers. The cathode region is created by the growth of an n^- epitaxial layer onto a low-resistivity n^+ substrate. The anode region is formed by ion implantation and high-temperature diffusion. Aluminum metal on the anode provides for aluminum wire bonding. Trimetal (aluminum-titanium-nickel) evaporated onto the cathode surface provides cathode metallization for high-temperature solder mounting.

Modern planar technology is used to form the edges of the rectifier structure. The structure features an n^+ "channel stopper," an evaporated metal field shield, and an ion trap to assure reverse-bias stability. The p-n junction is insulated by a silicon-dioxide (SiO_2) layer. A phosphorous-doped silicon-glass overcoat provides mechanical protection during assembly.

The resultant structure features low forward voltage drops, excellent bias stability, low dissipation, and very short reverse-recovery times (less than 35 ns).

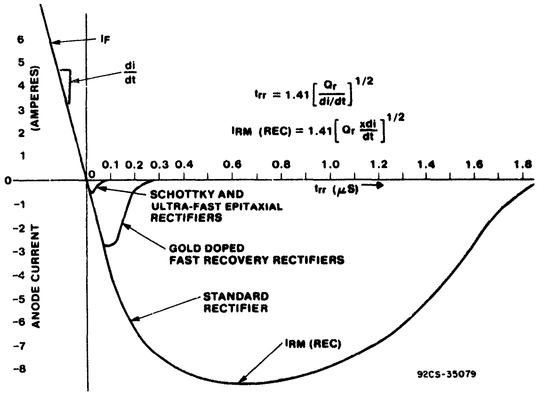


Planar, high-speed, glass-passivated pellet structure used in RCA ultra-fast-recovery rectifiers.

Circuit Benefits

RCA ultra-fast-recovery rectifiers offer several important benefits for use in high-speed power-switching circuits. These benefits include:

- Decrease in the short-circuit energy that impinges on the power switches
- Less RFI generation in the rectifier filter system
- Reduction in, or elimination of, the RC damping networks frequently required with Schottky and ordinary fast-recovery rectifiers
- Dissipations that are 20 to 30 percent less than those in ordinary fast-recovery rectifiers
- Breakdown voltages three to five times greater than those of Schottky rectifiers



Relative reverse-recovery-time (t_{rr}) characteristics of various rectifier structures. Curves show the excellent recovery behavior of the RCA ultra-fast epitaxial structure.

Special Attributes

The RUR series of ultra-fast-recovery rectifiers feature a passivated epitaxial structure that combines the advantages of fast switching speed, low forward-voltage drop, good breakdown capability, and wide operating temperature range. The low stored charge and attendant fast reverse-recovery behavior of these rectifiers minimize electrical noise generation and, in many circuits, markedly reduce the turn-on dissipation of associated power switching transistors. These attributes make RUR-series types excellent choices for use in switching power supplies.

Fast Switching Speeds

Thin anode and cathode regions in the RUR series of RCA ultra-fast-recovery rectifiers limit the build up of excess charge during forward conduction. Gold doping causes this minimal charge to be dissipated quickly during the recovery period so that the recovery time of RUR-series rectifiers is comparable to that of Schottky rectifiers.

Low Forward-Voltage Drop

Precise manufacturing control of the anode and cathode vertical structure makes possible low forward-voltage drops — typically less than 0.9 volt at the rated current — significantly lower than those of conventional high-voltage fast-recovery rectifiers.

Temperature Capability

The low forward voltage drop of the ultra-fast-recovery rectifiers permit safe operation of these devices at case temperatures of 125°C at the rated average forward current. At this case temperature, the RUR-810 series rectifiers can operate safely at average currents up to 8 amperes or at peak currents up to 16 amperes in an output circuit with a 50 per cent duty cycle.

Breakdown-Voltage Tradeoff

The vertical structure used in RCA ultra-fast rectifiers is optimized for high-speed switching capability, achieved as a tradeoff against reverse-voltage breakdown capability. As a result, the ultra-fast-recovery series are suitable for use as output rectifiers in 100-kHz switching power supplies that provide outputs of 5 to 48 volts. Despite the trade-off for switching speed, the RUR-series rectifiers have a breakdown capability three to five times greater than that of Schottky rectifiers with similar recovery times.

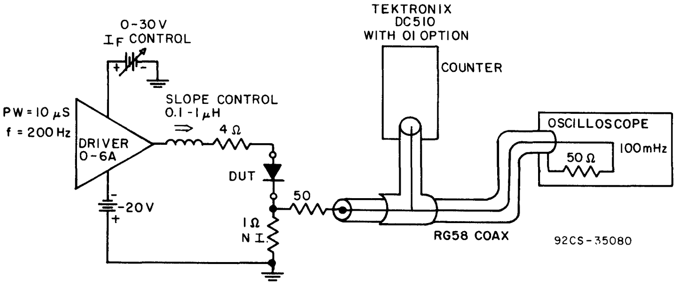
Hybrid-Circuit Compatibility

RCA ultra-fast-recovery rectifiers incorporate several construction features that are ideal for mounting the rectifier pellets in hybrid circuits, as follows:

- The trimetal cathode metallization is particularly suited for high-temperature solder mounting. (A eutectic solder bond formed with 95/5 lead-tin solder at a temperature of 320°C is recommended.)
- The aluminum anode metallization facilitates aluminum wire bonding.
- The glass-passivated planar structure assures excellent mechanical protection during processing.
- Large bonding surfaces (3600 mils^2 on 8-ampere types, 10,000 mils^2 on 15-ampere types) are available.

Recovery-Time Measurement Method

Reverse-recovery-time (t_{rr}) measurements are, to some extent, dependent upon the circuit configuration in which the measurement is made and the level of current from which the device must recover. The test-circuit configuration and the test method used in the recovery measurements on the RCA ultra-fast-recovery rectifiers assures realistic current levels and various rates of change of current (-di/dt).



Test circuit used for reverse-recovery-time measurements.

BYW51-100, BYW51-150, BYW51-200

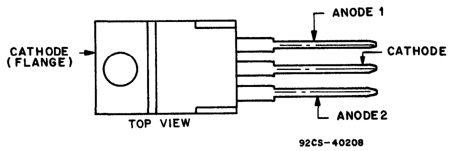
File Number **1412**

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 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.

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 T_C = 125°C, δ = 0.5	20	20	20	A
I_{FSM}(Surge) t_p = 10 ms, sinusoidal	100	100	100	A
P_D, T_C = 125°C	20	20	20	W
T_j	-40 + 150	-40 + 150	-40 + 150	°C
T_L (Lead temperature during soldering) At distance > 1/8 in. (3.17 mm) from case for 10 S max.	260	260	260	°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 Min.	BYW51-100 Max.	BYW51-150 Min.	BYW51-150 Max.	BYW51-200 Min.	BYW51-200 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
$R_{\theta JC}$, per leg				—	2.5		2.5	—	2.5	°C/W
$R_{\theta JC}$, total				—	1.3	—	1.3	—	1.3	
$R_{\theta JA}$				—	60	—	60	—	60	
C_J	25	10	0	All types (typ.) 40						pF

(a) $di_F/dt > 50A/\mu s$, $I_{RM}(rec) < 1A$, $I_{RR} = 0.25A$

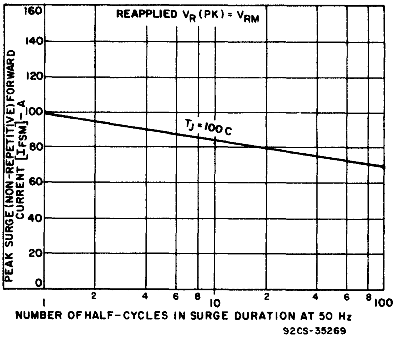


Fig. 1 - Peak surge forward current vs. surge duration.

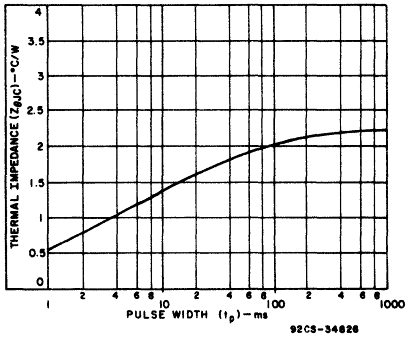


Fig. 2 - Thermal impedance vs. pulse width (per junction).

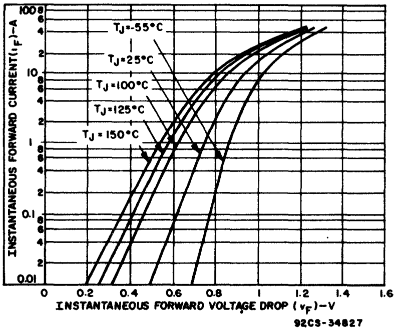


Fig. 3 - Typical forward current vs. forward-voltage drop.

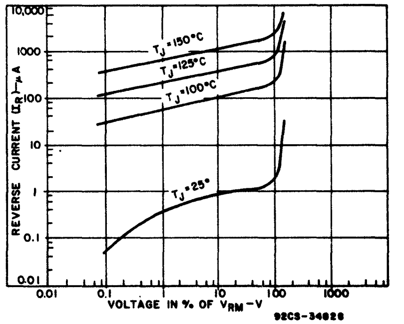


Fig. 4 - Typical reverse current vs. voltage.

RUR-810, RUR-815, RUR-820

File Number **1355**

8-A, High Speed, High Efficiency Epitaxial Silicon Rectifiers

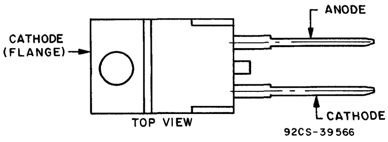
Features:

- *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*

TERMINAL DESIGNATIONS



JEDEC TO-220AC

The RCA RUR-810, RUR-815, and RUR-820* are low forward voltage drop ultra fast-recovery rectifiers (trr <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-220AC plastic packages.

*Formerly RCA Dev. No. TA9223A, TA9223B, and TA9223C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	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 = 125°C		8		A
IFSM (surge)				
8.3ms, 1/2 cycle, non-repetitive		100		A
Tstg, T_J		−55 to 150		°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

RUR-810, RUR-815, RUR-820

ELECTRICAL CHARACTERISTICS

CHARAC-TERISTICS	TEST CONDITIONS			LIMITS						UNITS
	T_J °C	Voltage V_R V	Current i_F A	RUR-810 Min.	RUR-810 Max.	RUR-815 Min.	RUR-815 Max.	RUR-820 Min.	RUR-820 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		2(a)	—	35	—	35	—	35	ns
$R_{\theta JC}$				—	2.25	—	2.25	—	2.25	°C/W
$R_{\theta JA}$				—	60	—	60	—	60	
C_J	25	10	0	40 Typ.		40 Typ.		40 Typ.		pF

(a) $di_F/dt > 40A/\mu s$, I_{RM} (rec) $< 1A$, $I_{RR} = 0.25A$

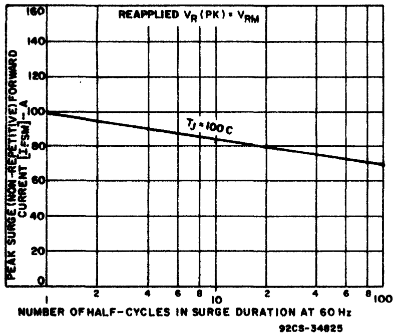


Fig. 1 — Peak surge forward current vs. surge duration.

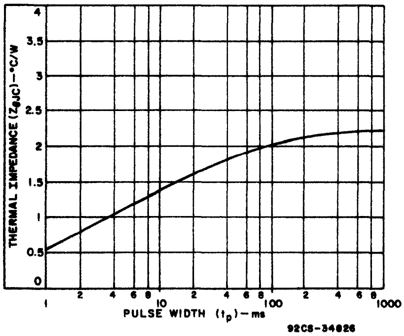


Fig. 2 — Thermal impedance vs. pulse width.

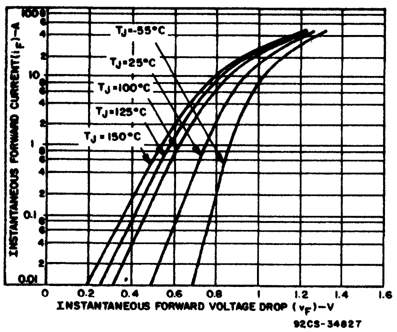


Fig. 3 — Typical forward current vs. forward-voltage drop.

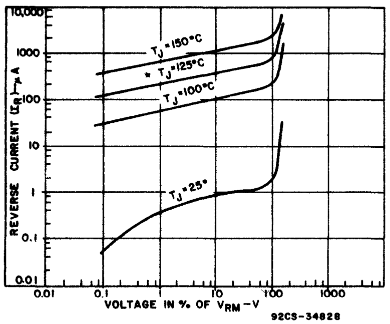


Fig. 4 — Typical reverse current vs. voltage.

RUR-D810, RUR-D815, RUR-D820

File Number **1356**

Dual 8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

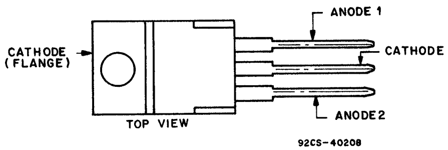
Features:

- *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 (trr <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°C (No Heat Sink)		3		A
T_A = 25°C (With Heat Sink)[a]		8		A
T_C = 125°C		8		A
IFSM (surge)				
8.3ms, 1/2 cycle, non-repetitive		100		A
Tstg, T_J		−55 to 150		°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

RUR-D810, RUR-D815, RUR-D820

ELECTRICAL CHARACTERISTICS, per junction

CHARACTERISTICS	TEST CONDITIONS T_J °C	Voltage V_R V	Current I_F A	LIMITS RUR-D810 Min.	RUR-D810 Max.	RUR-D815 Min.	RUR-D815 Max.	RUR-D820 Min.	RUR-D820 Max.	UNITS
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
$R_{\theta JC}$				—	2.25	—	2.25	—	2.25	°C/W
$R_{\theta JA}$				—	60	—	60	—	60	
C_J	25	10	0	40 Typ.		40 Typ.		40 Typ.		pF

(a) $di_F/dt > 40A/\mu s$, I_{RM} (rec) $< 1A$, $I_{RR} = 0.25A$

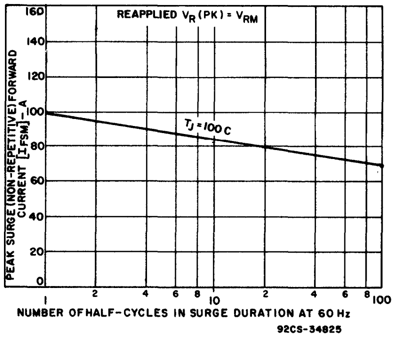


Fig. 1 — Peak surge foward current vs. surge duration.

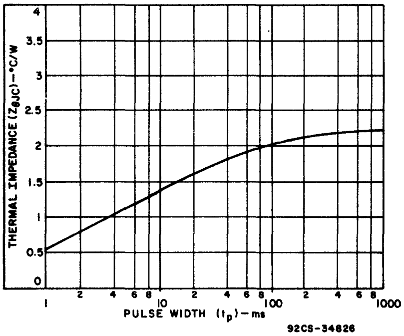


Fig. 2 - Thermal impedance vs. pulse width (per junction).

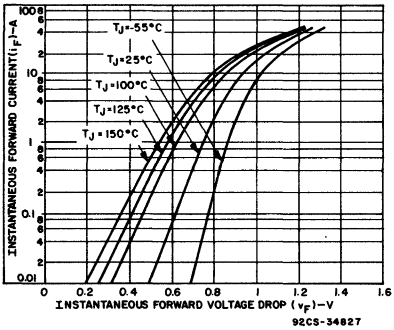


Fig. 3 — Typical forward current vs. forward-voltage drop.

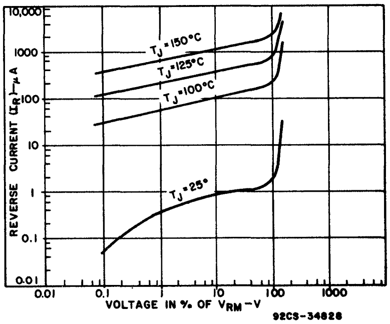


Fig. 4 — Typical reverse current vs. voltage.

RUR-D1610, RUR-D1615, RUR-D1620

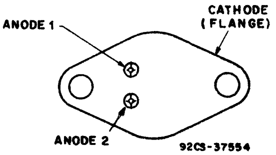
File Number **1383**

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



JEDEC TO-204AA

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_R V	Current I_F A	RUR-D1610 Min.	RUR-D1610 Max.	RUR-D1615 Min.	RUR-D1615 Max.	RUR-D1620 Min.	RUR-D1620 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
$R\theta JC$				—	1.5	—	1.5	—	1.5	°C/W
$R\theta JA$				—	30	—	30	—	30	
C_J	25	10	0	80 Typ.		80 Typ.		80 Typ.		pF

(a) $di_F/dt > 40A/\mu s$, $I_{RM}(rec) < 1A$, $I_{RR} = 0.25A$

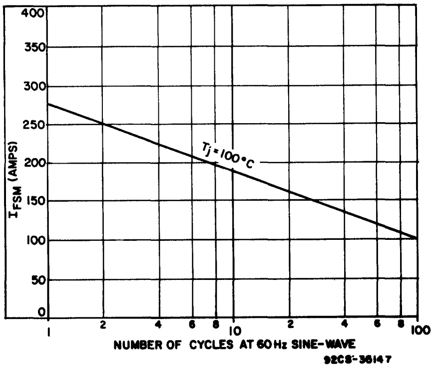


Fig. 1 - Peak surge forward current vs. surge duration.

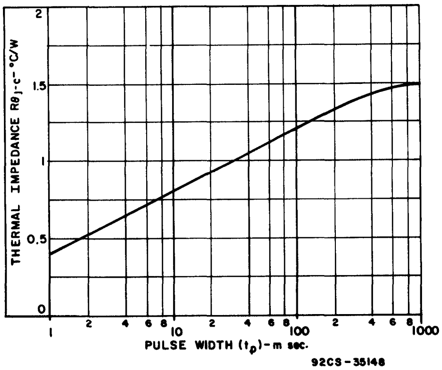


Fig. 2 - Thermal impedance vs. pulse width (per junction).

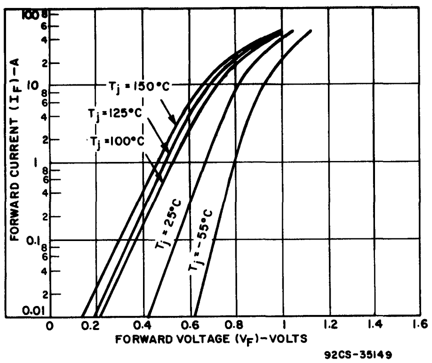


Fig. 3 - Typical forward current vs. forward-voltage drop.

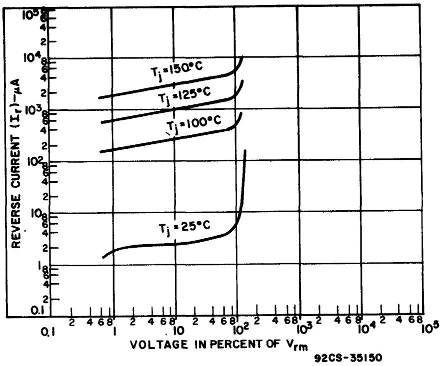


Fig. 4 - Typical reverse current vs. voltage.

Power Hybrid Circuits
Technical Data

HC2000H

File Number **566**

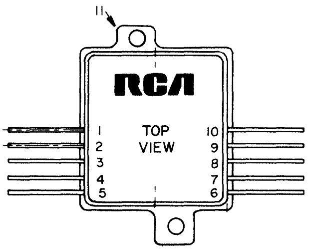
Multi-Purpose 7-Ampere Operational Amplifier

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. Single copies of these publications are available upon request from RCA Solid State Division, Box 3200, Somerville, N.J. 08876.

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 ≥ 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)

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	–	kΩ
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 Ω	±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	°C/W

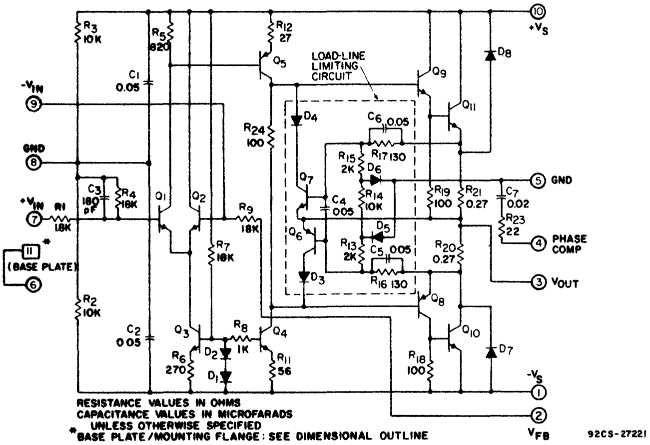


Fig. 1 – Schematic diagram of type HC2000H power hybrid circuit operational amplifier.

HC2000H

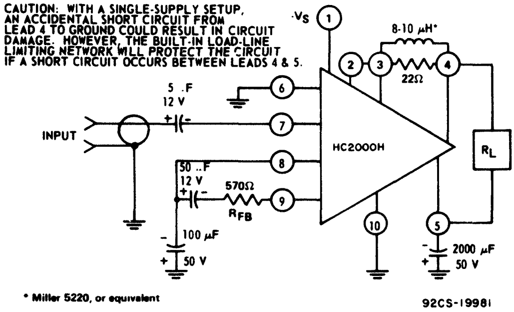


Fig. 2 – Type HC2000H power hybrid circuit with external connections for operation with a single power supply.

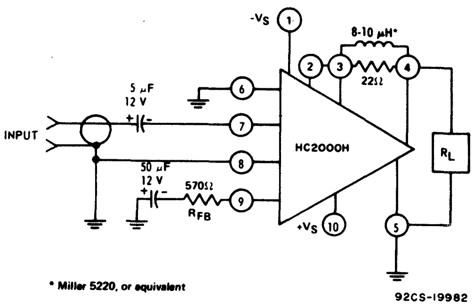


Fig. 3 – Type HC2000H power hybrid circuit with external connections (and split power supply) for measuring relative response and distortion; see Figs. 8 & 9.

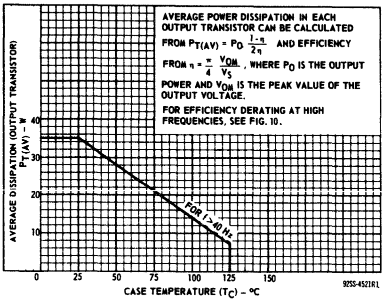


Fig. 4 – Dissipation (average) derating curve for each output transistor (for symmetrical waveforms with f > 40 Hz).

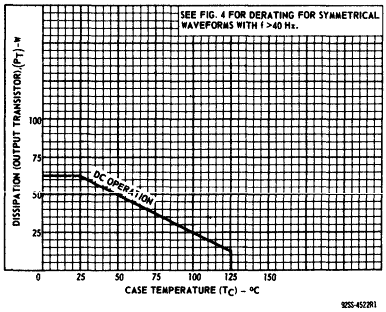


Fig. 5 – Dissipation (dc) derating curve for each output transistor.

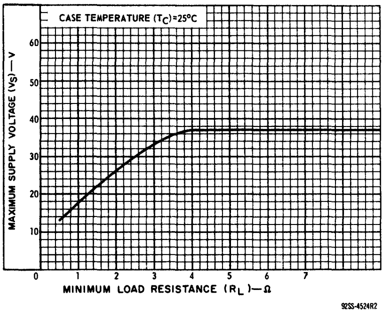


Fig. 6 – Maximum allowable supply voltage vs. load resistance.

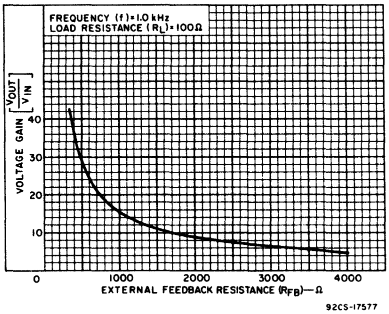


Fig. 7 – Closed-loop voltage gain vs. external feedback resistance.

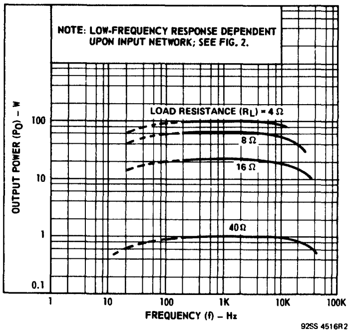


Fig. 8 — Output power vs. frequency.

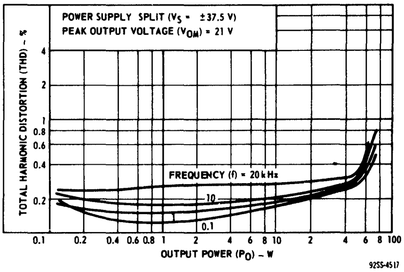


Fig. 9 — Total harmonic distortion with split power supply.

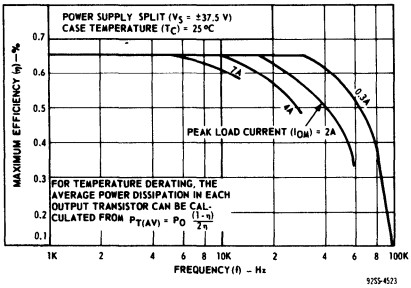


Fig. 10 — Maximum efficiency vs. frequency for several values of peak load current.

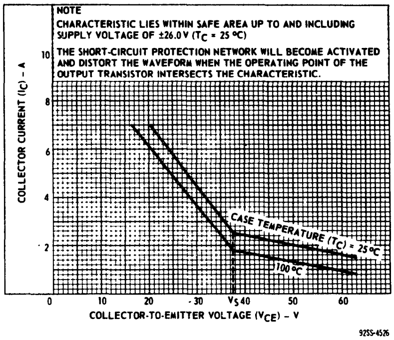


Fig. 11 — Characteristics of built-in load-line-limiting circuit.

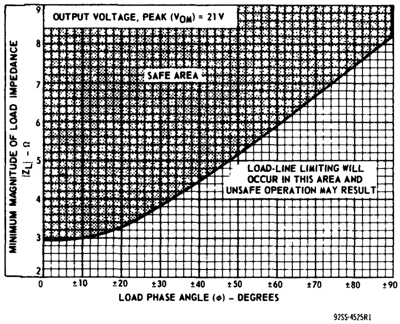


Fig. 12 — Minimum load impedance vs. load phase angle and safe area of operation.

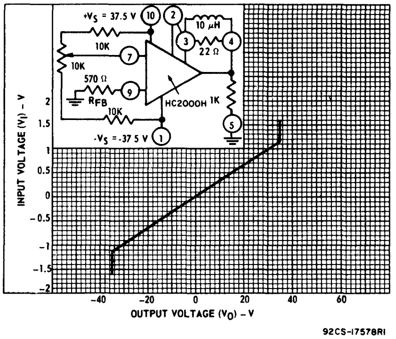


Fig. 13 — Gain linearity characteristic.

HC2000H

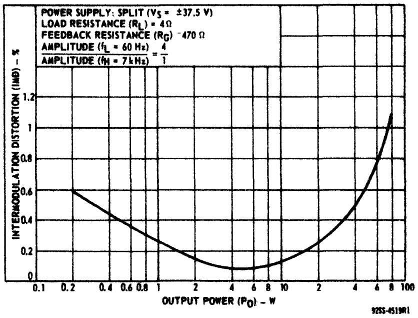


Fig. 14 – Intermodulation distortion with split supply and 4-ohm load.

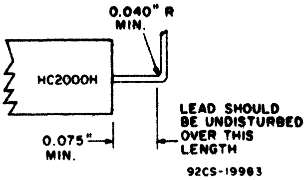


Fig. 15 – Recommended lead-bending specification.

File Number **681**

HC2500

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*

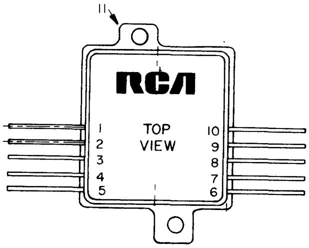
RCA type HC2500• is a complete solid-state hybrid amplifier in a compact hermetic package. It employs a quasi-complementary-symmetry output circuit.

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.

TERMINAL DESIGNATIONS



92CS-40377

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	

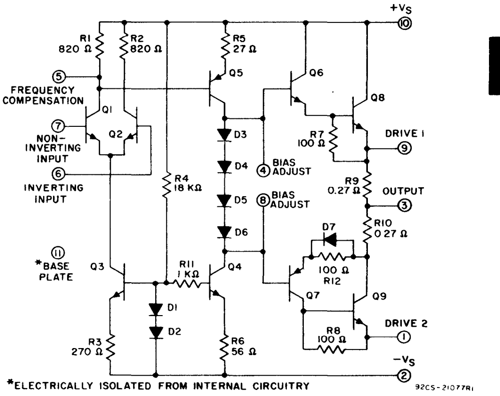


Fig.1 — Schematic diagram of type HC2500 operational amplifier.

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	REFERENCE FIG. NO.	TEST CONDITIONS: SPECIAL NOTES	TEST CONDITIONS: FREQ. (f)–kHz	TEST CONDITIONS: OUTPUT POWER (P_O)–W	TEST CONDITIONS: LOAD RESIST. (R_L)–Ω	LIMITS: MIN.	LIMITS: TYP.	LIMITS: MAX.	UNITS
Offset Voltage	V_{offset}	3	Measured Pin 3 to Gnd	–	–	4	–	–	±250	mV
Quiescent Current	I_o	3	Idling Current < 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	$R_{\theta JC}$	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*

CHARACTERISTIC	SYMBOL	REFERENCE FIG. NO.	SPECIAL NOTES	FREQ. (f)–kHz	OUTPUT POWER (P_O)–W	LOAD RESIST. (R_L)–Ω	MIN.	TYP.	MAX.	UNITS
Open-Loop Voltage Gain	A_{OL}	8, 19	Idling current = 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	–	MΩ
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 current = 50 mA	–	0.05	4	–	0.06	–	%
Slew Rate	SR	18	A_{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

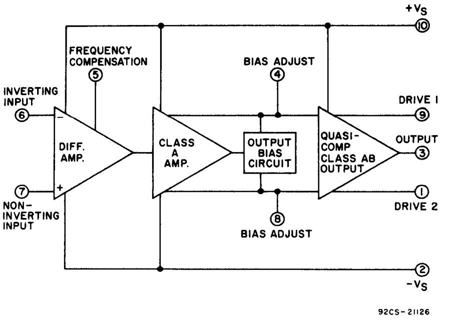


Fig. 2 — Block diagram of HC2500 100-watt class AB amplifier.

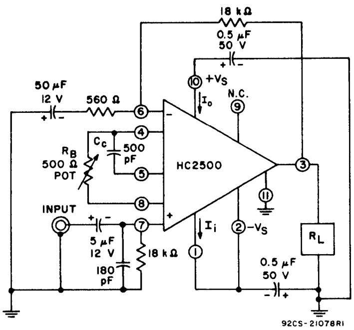


Fig. 3 — Typical test circuit with split supply for measuring A_{CL}, I_i, I_o, V_{offset}, f_H, THD, and IMD.

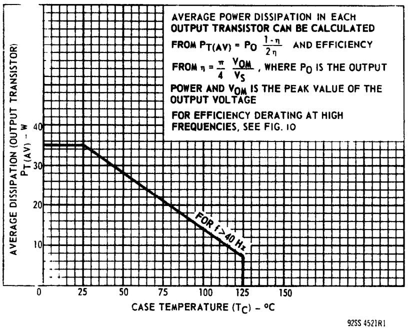


Fig. 4 — Dissipation (average) derating curve for each output transistor (for symmetrical waveforms with f >40 Hz).

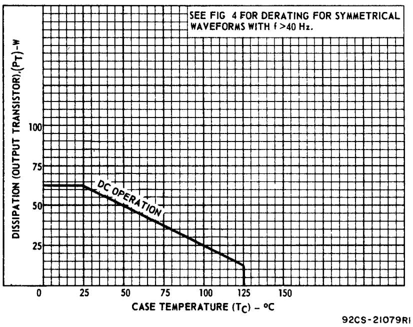


Fig. 5 — Dissipation derating curve for each output transistor.

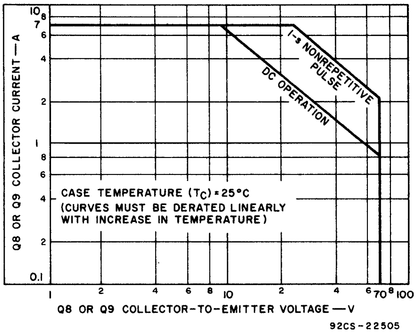


Fig. 6 — Maximum operating area for HC2500.

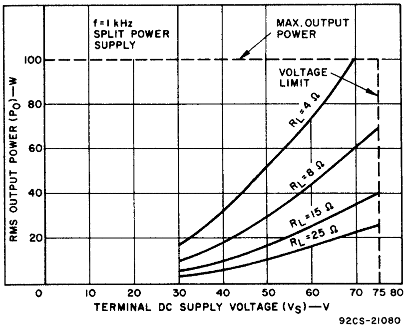


Fig. 7 — Output power as a function of supply voltage, with various values of load resistance, for symmetrical sine-wave operation.

HC2500

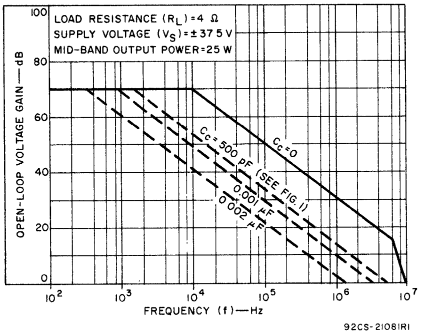


Fig. 8 – Typical open-loop voltage gain vs. frequency.

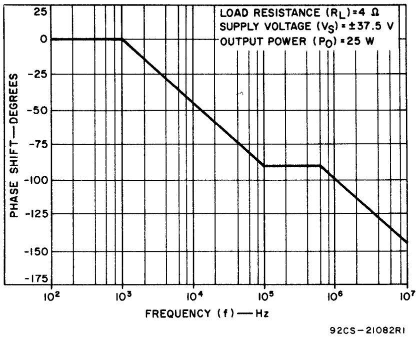


Fig. 9 – Typical open-loop phase shift vs. frequency.

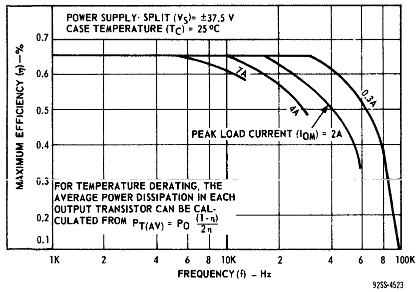


Fig. 10 – Maximum efficiency vs. frequency for several values of peak load current.

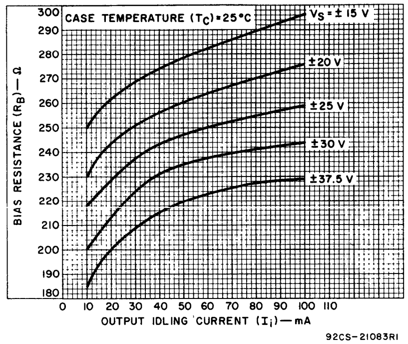


Fig. 11 – Bias resistor (R_B in Fig. 3) value vs. output idling current (I_i).

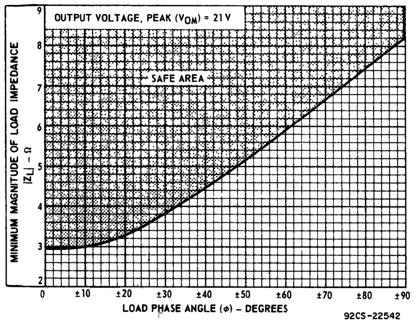


Fig. 12 – Minimum load impedance vs. load phase angle and safe area of operation.

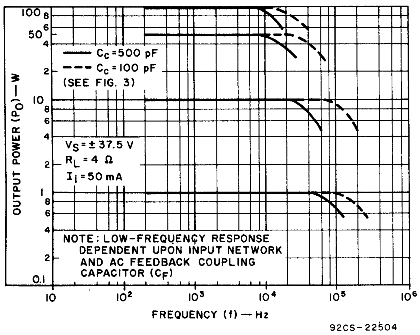


Fig. 13 – Output power vs. frequency.

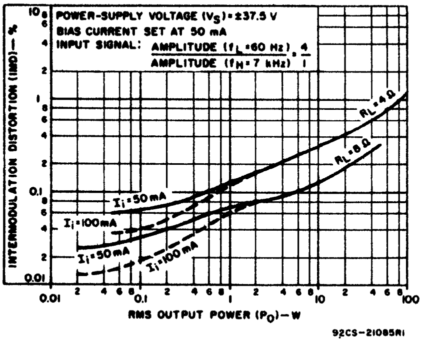


Fig. 14 – Typical intermodulation distortion vs. rms output power.

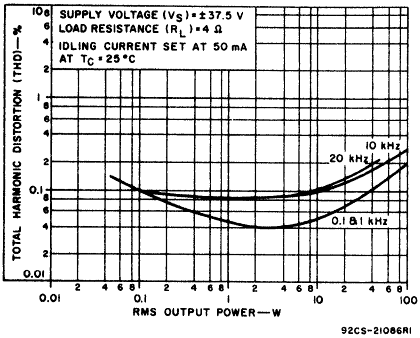


Fig. 15 – Typical total harmonic distortion vs. rms output power.

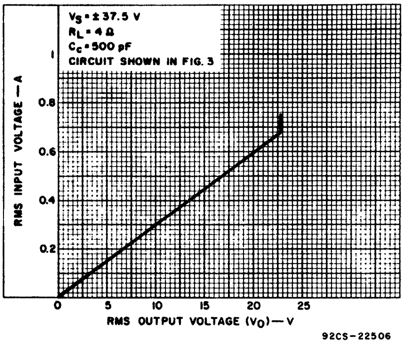


Fig. 16 – Input sensitivity.

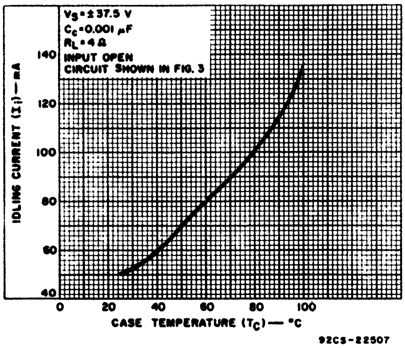


Fig. 17 – Typical idling-current dirft.

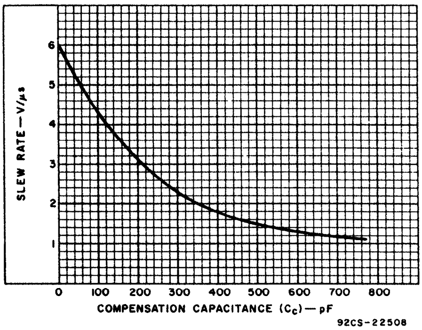
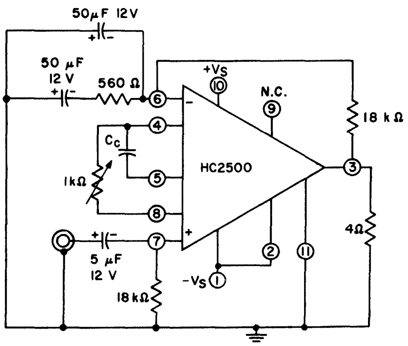


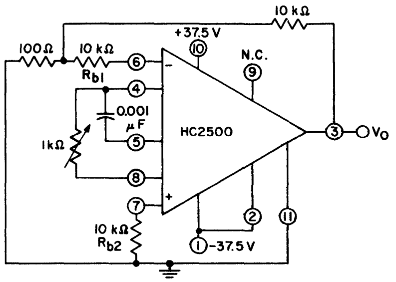
Fig. 18 – Typical slew rate vs. value of compensation capacitor, C_C (test circuit shown in Fig. 21).

HC2500



92CS-22509

Fig. 19 – Test circuit for open-loop gain and phase response.



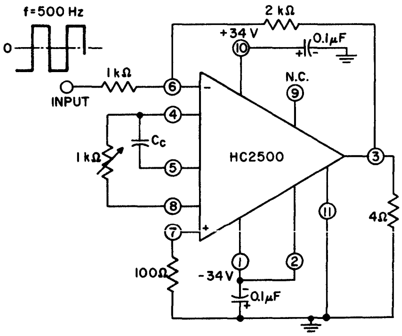
$V_{IO} = -\frac{V_O}{100}$ with R_{b1} and R_{b2} shorted

$I_{IO} = -\frac{V_O}{100\,R_{b2}}$

$I_{Ib} = \frac{\pm V_O}{100\,R_{b2}}$ with R_{b1} shorted

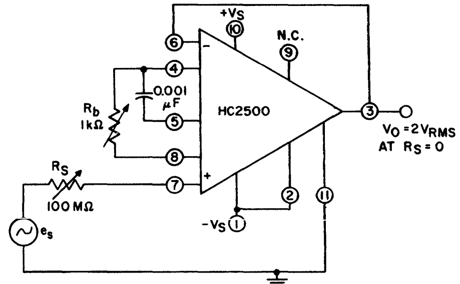
92CS-22510

Fig. 20 – Test circuit for input offset voltage and current test.



92CS-22511

Fig. 21 – Circuit used to test slew rate.

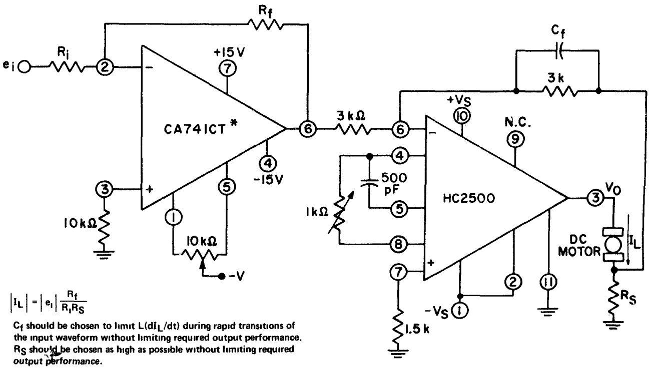


$R_{CM} = 9\ R_S$ with series resistance (R_S) increased from zero until output voltage (V_O) is reduced by 10%

92CS-22512

Fig. 22 – Test circuit for measuring common-mode input resistance.

TYPICAL APPLICATION CIRCUITS



$|I_L| = |e_i| \frac{R_f}{R_i R_S}$

C_f should be chosen to limit $L(dI_L/dt)$ 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.

92CM-22513

Fig. 23 – Current-feedback motor-control circuit.

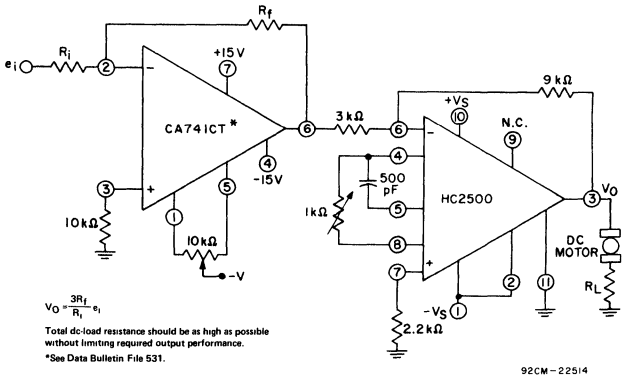


Fig. 24 — Voltage-feedback motor-control circuit.

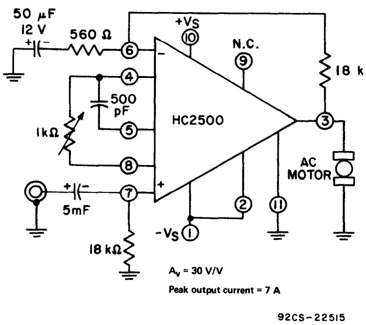


Fig. 25 — AC motor control.

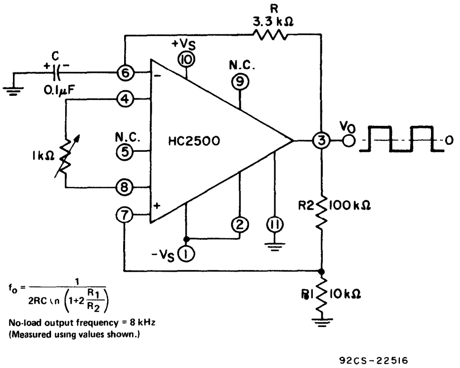


Fig. 26 — High-power astable multivibrator.

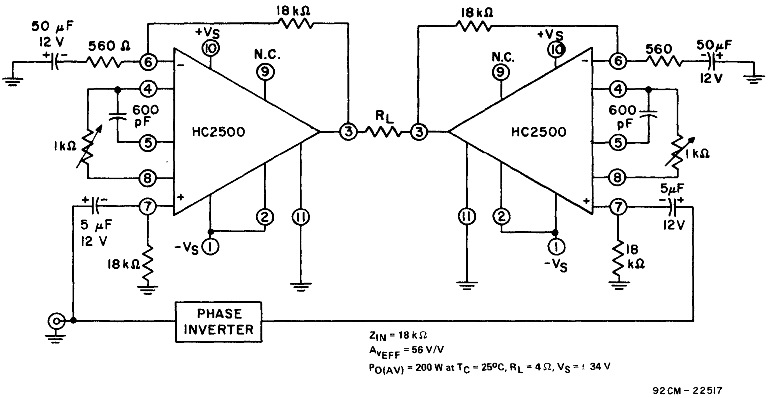
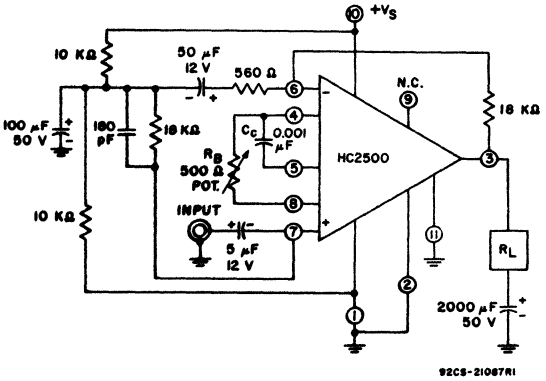


Fig. 27 — Bridge circuit for loads greater than 100 watts.

HC2500



V_S	54 V
P_{out}	60 W
Idling Current (R_B = 168 Ω	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 Controlled Rectifiers (SCRs)
Technical Data

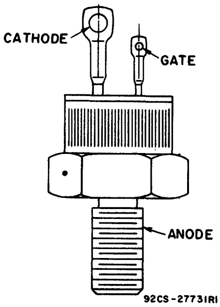
2N681-2N692 File Number **96**

25-A Silicon Controlled Rectifiers

For Power-Control and Power-Switching Application

Features:
- *High di/dt capability*
- *Low on-state voltage at high current levels*
- *Low thermal resistance*

TERMINAL DESIGNATIONS



JEDEC TO-208AA

The RCA2N681-2N692 are all-diffused silicon controlled rectifiers (reverse-blocking triode thrysistors) designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state.
These SCR's employ a hermetic JEDEC TO-208AA package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N681	2N682	2N683	2N684	2N685	2N686	2N687	2N688	2N689	2N690	2N691	2N692	
V_{RSOM}▲	35	75	150	225	300	350	400	500	600	720	840	960	V
*V_{RROM}▲	25	50	100	150	200	250	300	400	500	600	700	800	V
*V_{DROM}▲	25	50	100	150	200	250	300	400	500	600	700	800	V
$I_{T(RMS)}$ ($\theta = 180°$): $T_C = 65°$ C	25												A
*$I_{T(AV)}$ ($\theta = 180°$): $T_C = 65°$ C	16												
I_{STM}: For one full cycle of applied principal voltage													
* 60Hz♦	150												A
50Hz♦	140												A
For more than one full cycle of applied principal voltage	See Fig. 2												
di/dt: $V_D = V_{DROM}$, $I_{GT} = 200$ mA, $t_r = 0.5$ µs	200												A/µs
I^2t [*at* T_C shown for $I_{T(RMS)}$]: t = 10 ms	100												A^2s
= 1 ms	46												A^2s
*P_{GM}•:	5												W
*$P_{G(AV)}$•	0.5												W
*I_{GM}	2												A
*V_{GM}	10												V
*V_{GRM}	5												V
*T_{stg} ■	-65 to 150												°C
*T_C■	-65 to 125												°C
T_T During soldering for 10 s maximum (terminal and case)	225												°C
τ_s: Recommended	35												in-lb
	0.4												kgf-m
Maximum (DO NOT EXCEED)	50												in-lb
	0.57												kgf-m

*In accordance with JEDEC registration data.
∆These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
♦At $I_{T(RMS)} = 25$ A and $T_C = 65°$C
•Any product gate current and gate voltage which results in gate power less than the maximum is permitted.
■For temperature measurement reference point, see Dimensional Outline.

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)*

CHARACTERISTIC	LIMITS 2N681-2N690			UNITS
	MIN.	TYP.	MAX.	
*I_{DROM} or I_{RROM} $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 125°C$:				mA
2N681, 2N682, 2N683, 2N684	—	—	6.5	
2N685	—	—	6	
2N686	—	—	5.5	
2N687	—	—	5	
2N688	—	—	4	
2N689	—	—	3	
2N690	—	—	2.5	
2N691	—	—	2.25	
2N692	—	—	2	
*v_T: i_T = 50 A (peak), T_C = 25°C	—	—	2	V
$v_T(AV)$: $I_T = I_T$ (RMS) = T_C = 65°C	—	—	0.86	V
i_{HO}: T_C = 125°C	—	15	—	mA
I_{GT}: T_C = 125°	—	—	25	mA
V_D = 12 V (dc), R_L = 50Ω, T_C = -65°C	—	—	80*	
V_{GT}: V_D = 12 V (dc), R_L = 50Ω, T_C = -65 to 125°C	—	—	3	V
= 125°	0.25	—	—	
$R_{\theta JC}$	—	—	2	°C/W

*In accordance with JEDEC registration data.

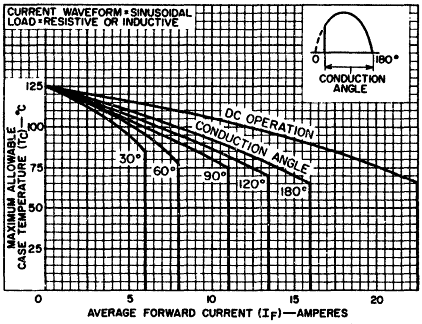


Fig. 1 — Maximum allowable case temperature vs. on-state current for 2N681-2N692.

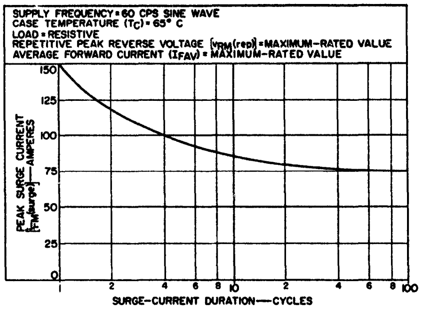


Fig. 2 — Peak surge on-state current vs. surge duration for 2N681-2N692.

2N681-2N692

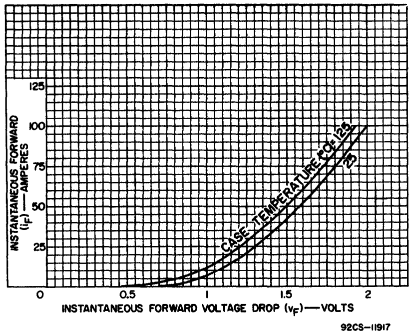


Fig. 3 — Typical on-state current vs. instantaneous on-state voltage for 2N681-2N692.

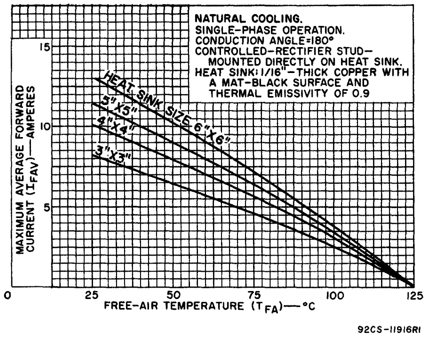


Fig. 4 — Average on-state forward current vs. ambient temperature for 2N681-2N692.

File Number **114**

2N3228, 2N3525, 2N4101

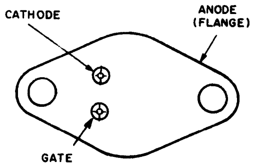
5-A Silicon Controlled Rectifiers

For Low-Cost Power-Control and Power-Switching Applications

Features

- *High di/dt and dv/dt capabilities*
- *Low leakage currents, both forward and reverse*
- *Low forward voltage drop at high current levels*
- *Low thermal resistance*

TERMINAL DESIGNATIONS



JEDEC TO-213AA

RCA 2N3228*, 2N3525*, and 2N4101* are all-diffused, three-junction, silicon controlled rectifiers (SCR's) intended for use in power-control and power-switching applications.

Types 2N3228, 2N3525, and 2N4101 use the JEDEC TO-66 package and have a blocking voltage capability of up to 600 volts and a forward current rating of 5 amperes (rms value) at a case temperature of 75° C.

**Formerly Dev. Types TA1222, TA1225, and TA2773, respectively.*

ABSOLUTE-MAXIMUM RATINGS, *for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load.*

	2N3228	2N3525	2N4101	
Transient Peak Reverse Voltage (Non-Repetitive), v_{RM} (non-rep)	330	660	700	V
Peak Reverse Voltage (Repetitive), v_{RM} (rep)	200	400	600	V
Peak Forward Blocking Voltage (Repetitive), v_{FBOM} (rep)	200	400	600	V
Forward Current: For case temperature (T_C) of + 75° C, and unit mounted on heat sink				
Average DC value at a conduction angle of 180°, I_{FAV}	3.2	3.2	3.2	A
RMS value, I_{FRMS}	5.0	5.0	5.0	A
For free-air temperature (T_{FA}) of 25° C, and with no heat sink employed—				
Average DC value at a conduction angle of 180°, I_{FAV}	1.7	1.7	1.7	A
For other conditions, See Fig. 2				
Peak Surge Current, i_{FM} (surge): For one cycle of applied principal voltage.				
60 Hz (sinusoidal), T_C = 75° C		60		A
50 Hz (sinusoidal), T_C = 75° C		50		A
For more than one cycle of applied voltage, See Fig. 5				
Fusing Current (for SCR protection):				
T_J = -40 to 100° C, t = 1 to 8.3 ns, I^2t		15		A^2s
Rate of Change of Forward Current, di/dt		200		A/μs
I_{GT} = 200 mA, 0.5 μs rise time				
Gate Power*: Peak, Forward or Reverse, for 10 μs duration, P_{GM}		13		W
Average, P_{GAV}		0.5		W
Temperature:				
Storage, T_{stg}		-40 to +125		°C
Operating (Case), T_C		-40 to +100		°C

*Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.

2N3228, 2N3525, 2N4101

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES									UNITS
	2N3228			2N3525			2N4101			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Breakover Voltage, v_{BOO}: At T_C = +100°C	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at T_C = +100°C: Forward, I_{FBOM} (V_{FBO}' = v_{BOO} (min. value))	—	0.10	1.5	—	0.20	3.0	—	0.40	4.0	mA
Reverse, I_{RBOM} (V_{RBOI} = v_{RM}(rep) value)	—	0.05	0.75	—	0.10	1.5	—	0.20	2.0	mA
Forward Voltage Drop, v_F At a Forward Current of 30 amperes and a T_C = +25°C	—	2.15	2.8	—	2.15	2.8	—	2.15	2.8	volts
DC Gate-Trigger Current, I_{GT} At T_C = +25°C	—	8	15	—	8	15	—	8	15	mA(dc)
Gate-Trigger Voltage, V_{GT} At T_C = +25°C	—	1.2	2.0	—	1.2	2.0	—	1.2	2.0	volts(dc)
Holding Current, i_{HOO} At T_C = +25°C	—	10	20	—	10	20	—	10	20	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt (V_{FB} = v_{BOO}(min. value), exponential rise, T_C = +100°C)	10	200	—	10	200	—	10	200	—	volts/ microsecond
Turn-On Time, t_{on}, (Delay Time + Rise Time) (V_{FB} = v_{BOO}(min. value), i_F = 4.5amperes, I_{GT} = 200mA, 0.1μs rise time, T_C = +25°C)	0.75	1.5	—	0.75	1.5	—	0.75	1.5	—	microseconds
Turn-Off Time, t_{off} (i_F = 2 amperes, 50μs pulse width, dv_{FB}/dt = 20v/μs, di_r/dt = 30A/μs, I_{GT} = 200mA, T_C = +75°C)	—	15	50	—	15	50	—	15	50	microseconds
Thermal Resistance: Junction-to-case	—	—	4	—	—	4	—	—	4	
Junction-to-ambient	—	—	40	—	—	40	—	—	40	°C/W

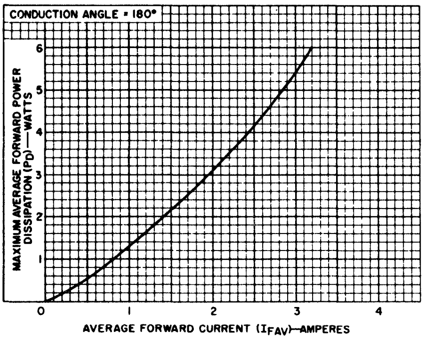


Fig. 1 — Power dissipation chart for all types.

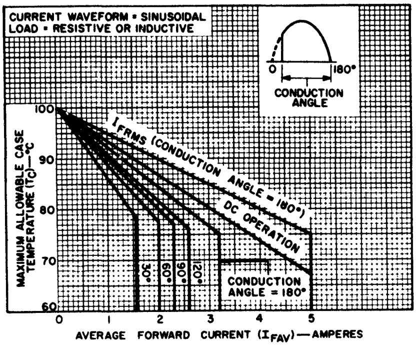


Fig. 2 — Rating chart (case temperature).

2N3228, 2N3525, 2N4101

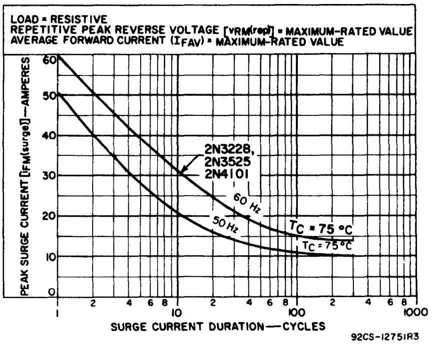


Fig. 3 — Surge-current rating chart.

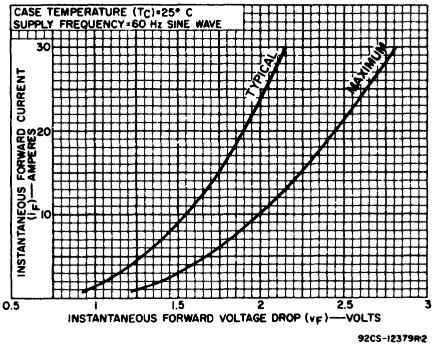


Fig. 4 — Forward characteristics for all types.

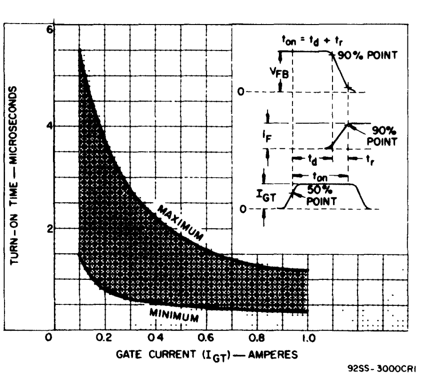


Fig. 5 — Turn-on time characteristics.

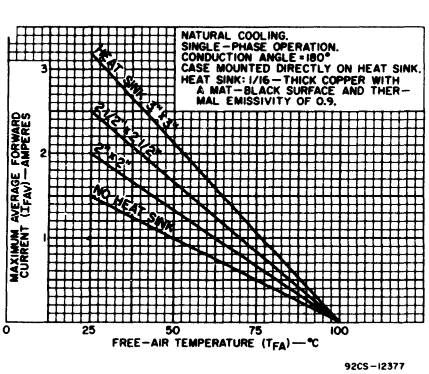


Fig. 6 — Operation guidance chart for types 2N3228, 2N3525, and 2N4101.

2N3650, 2N3651, 2N3652, 2N3653, S7410M

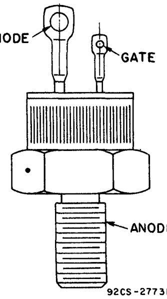
File Number **408**

35-A Silicon Controlled Rectifiers

For Inverter Applications

Features
- *Fast turn-off time — 15 µs max.*
- *High di/dt and dv/dt capabilities*
- *Low thermal resistance*

TERMINAL DESIGNATIONS



JEDEC TO-208AA

RCA-2N3650 to 2N3653, inclusive, and the S7410M* are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

The 2N3650 to 2N3653 have forward and reverse off-state voltage ratings of 100, 200, 300, and 400 volts, respectively. Type S7410M has a forward and reverse off-state voltage rating of 600 volts.

These SCR's employ a hermetic JEDEC TO-208AA package.

*Formerly RCA Type No. S7430M.

MAXIMUM RATINGS, *Absolute-Maximum Values*

	2N3650	2N3651	2N3652	2N3653	S7410M	
$^{*}V_{RSOM}$▲	150	300	400	500	700	V
V_{DSOM}▲	150	300	400	500	700	V
$^{*}V_{RROM}$▲	100	200	300	400	600	V
$^{*}V_{DROM}$▲	100	200	300	400	600	V
$I_{T(RMS)}$ ($T_C = 40°C$, $\theta = 180°$)			35			A
$^{*}I_{T(AV)}$ ($T_C + 40°C$, $\theta = 180°$)			25			A
I_{TSM}: For one full cycle of applied principal voltage 60-Hz (Rectangular wave-pw = 5 ms, $t_r = 50$ µs), $T_C = 40°C$			180			A
*di/dt: $V_D = V_{DROM}$, I_{GT} = 200 mA, $t_r = 0.1$ µs (See Fig. 13)			400			A/µs
I^2t: T_J = -65 to 120°C, T = 1 to 8.3 ms			165			A^2s
$^{*}P_{GM}$•: Peak (forward or reverse) for 10 µs maximum			40			W
$^{*}P_{G(AV)}$•: Averaging time = 10 ms maximum			1			W
$^{*}T_{stg}$■			-65 to 150			°C
T_C■			-65 to 120			°C
T_T: During soldering for 10 s maximum (terminal and case)			225			°C
T_S: Recommended			35			in-lbf
			0.4			kgf-m
Maximum (DO NOT EXCEED)			50			in-lbf
			0.57			kgf-m

* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.

▲ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

• Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

■ For temperature measurement reference point, see Dimensional Outline.

2N3650, 2N3651, 2N3652, 2N3653, S7410M

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

	CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
		MIN.	TYP.	MAX.	
	I_{DOM} or I_{ROM}:				
	$V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 120°C$				
	2N3650, 2N3651	–	2	6*	mA
	2N3652	–	2	5.5*	
	2N3653	–	2	4*	
	S7410M	–	–	3	
	v_T:				
	i_T = 25 A (peak), T_C = 25°C	–	1.5	2.05*	V
	i_{HO}:				
	T_C = 25°C	–	75	150	mA
	T_C = −65°C	–	150	350*	
*	dv/dt:				
	$V_D = V_{DROM}$, exponential voltage rise, T_C = 120°C (See Fig 14)	200	—	—	V/μs
	I_{GT}:				
	V_D = 6 V (dc), R_L = 4 Ω, T_C = 25°C	–	80	180	mA
	V_D = 6 V (dc), R_L = 2 Ω, T_C = −65°C	–	150	500*	
	V_{GT}:				
	V_D = 6 V (dc), R_L = 4 Ω, T_C = 25°C	–	1.5	3	V
*	V_D = 6 V (dc), R_L = 200 Ω, T_C = 120°C	0.25	–	–	
	V_D = 6 V (dc), R_L = 2 Ω, T_C = −65°C	–	2	4.5*	
*	tq:				
	Rectangular Pulse				
	$V_{DX} = V_{DROM}$, i_T = 10 A, pulse duration = 50 μs, dv/dt = 200 V/μs, −di/dt = 5 A/μs, I_{GT} = 200 mA at turn-on, V_{RX} = 15 V minimum, V_{GK} = 0 V at turn-off, T_C = 120°C (See Figs. 15 & 16)	–	–	15	μs
	Sinusoidal Pulse				
	$V_{DX} = V_{DROM}$, i_T = 100 A, pulse duration = 2 μs, dv/dt = 200 V/μs, V_{RX} = 30 V minimum, V_{GK} = 0 at turn-off, T_C = 115°C (See Figs. 17 & 18)	–	–	15	
	$R_{\theta JC}$	–	0.85	1.7*	°C/W

2N3650, 2N3651, 2N3652, 2N3653, S7410M

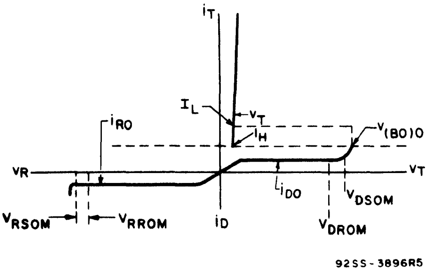


Fig. 1 — Principal voltage-current characteristic.

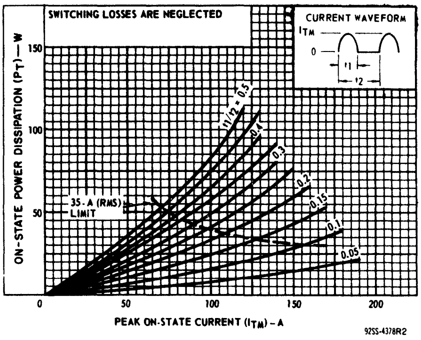


Fig. 2 — Power dissipation vs. peak on-state current.

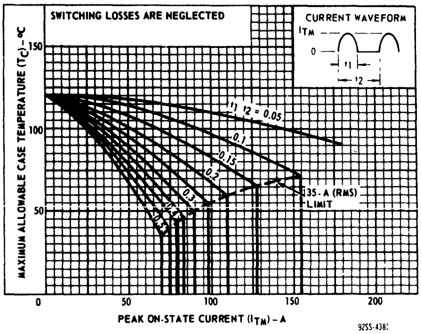


Fig. 3 — Maximum allowable case-temperature vs. peak on-state current.

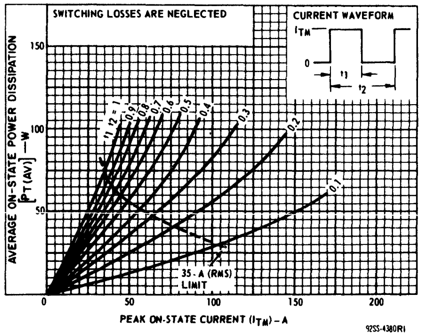


Fig. 4 — Power dissipation vs. peak on-state current.

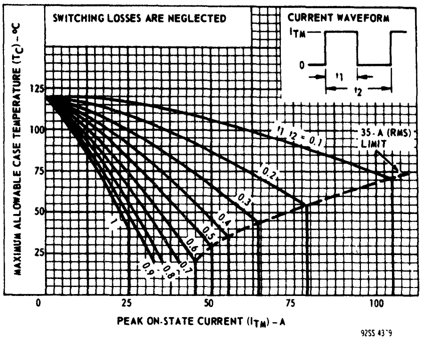


Fig. 5 — Maximum allowable case-temperature vs. peak on-state current.

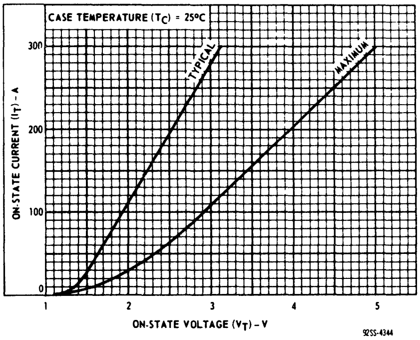


Fig. 6 — Variation of on-state with on-state voltage.

2N3650, 2N3651, 2N3652, 2N3653, S7410M

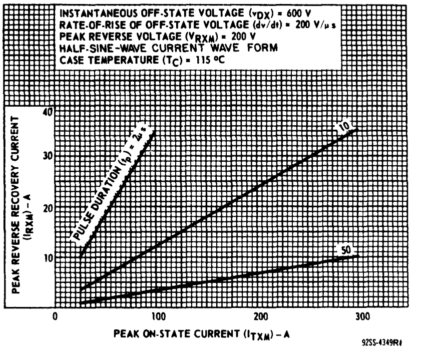


Fig. 7 — Typical variation of peak reverse-recovery current with peak on-state current (half-sine-wave pulse).

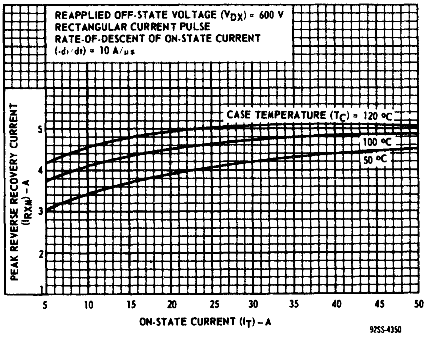


Fig. 8 — Typical variation of peak reverse-recovery current with on-state current (rectangular pulse).

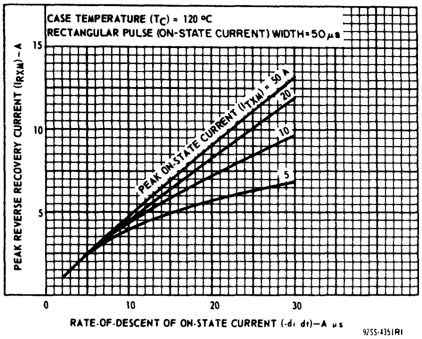


Fig. 9 — Typical variation of peak reverse-recovery current with rate-of-descent of on-state current (rectangular pulse).

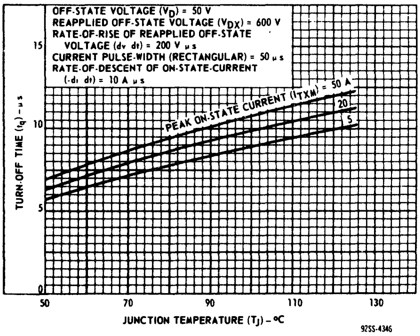


Fig. 10 — Typical variation of turn-off time with junction temperature (rectangular pulse).

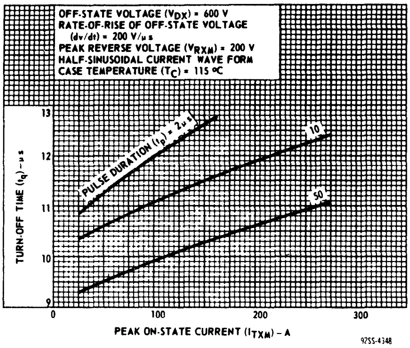


Fig. 11 — Typical variation of turn-off time with peak on-state current (half-sine-wave pulse).

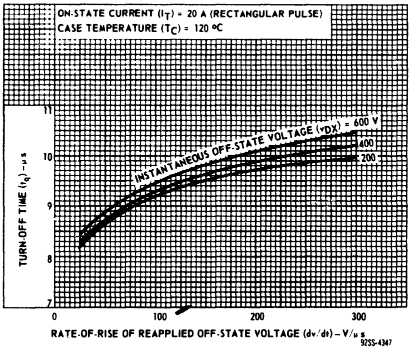


Fig. 12 — Typical variation of tune-off time with rate-of-rise of reapplied off-state voltage (rectangular pulse).

2N3650, 2N3651, 2N3652, 2N3653, S7410M

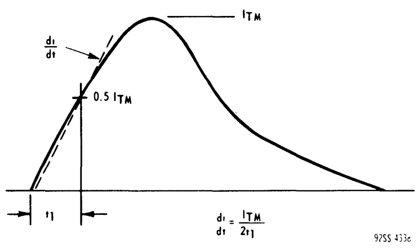


Fig. 13 — Rate-of-change of on-state current with time (defining di/dt).

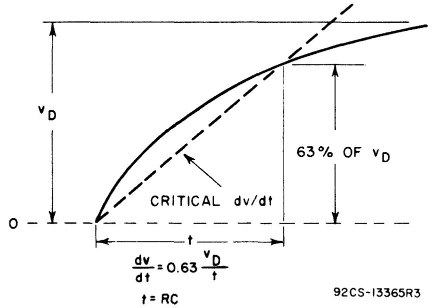


Fig. 14 — Rate-of-rise of off-state voltage with time (defining dv/dt).

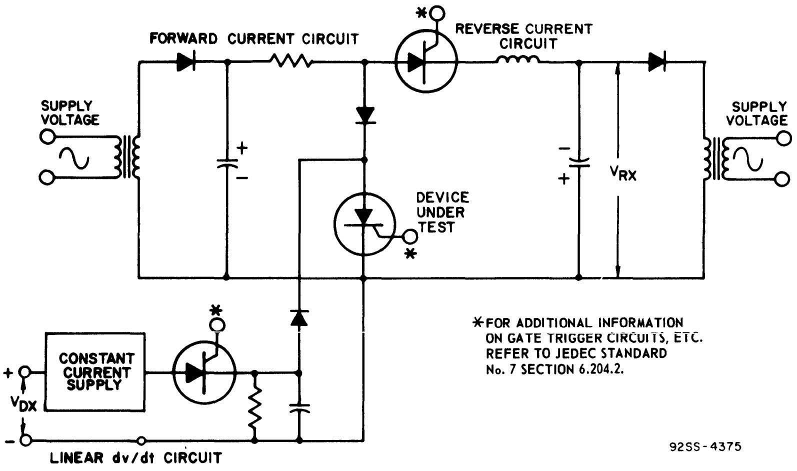


Fig. 15 — Circuit used to measure turn-off time (t_q), rectangular pulse.

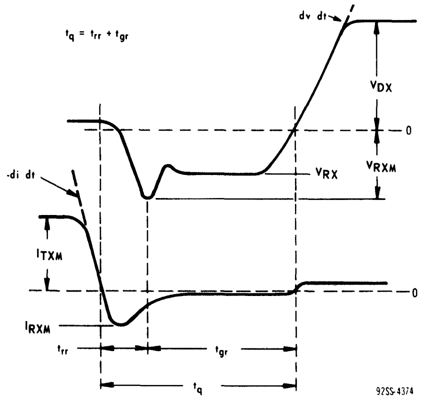


Fig. 16 — Relationship between off-state voltage, reverse voltge, on-state current, and reverse current showing reference points defining turn-off time (t_q), rectangular pulse.

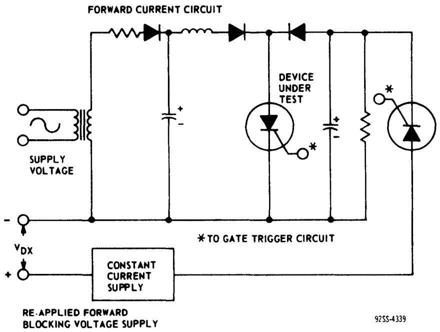


Fig. 17 — Circuit used to measure turn-off time (t_q) half-sine-wave pulse.

2N3650, 2N3651, 2N3652, 2N3653, S7410M

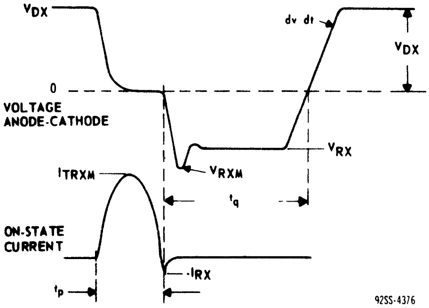


Fig. 18 — Relationship between off-state voltage, reverse voltage, on state current, and reverse current showing reference points for specification of turn-off time (t_q), half-sine-wave pulse.

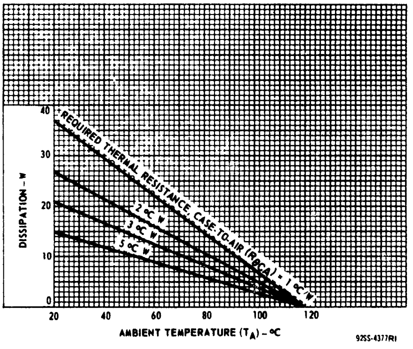


Fig. 19 — Heat sink guidance.

2N3654, 2N3655, 2N3656, 2N3657, 2N3658, S7412M

File Number **724**

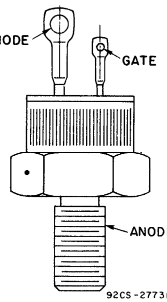
35-A Silicon Controlled Rectifiers

For Inverter Applications

Features:

- *Fast turn-off time — 10 µs max.*
- *High di/dt and dv/dt capability*
- *Low thermal resistance*

TERMINAL DESIGNATIONS



JEDEC TO-208AA

RCA-2N3654 to 2N3658, inclusive, and the S7412M* are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

The 2N3654 to 2N3658 have forward and reverse off-state voltage ratings of 50, 100, 200, 300, and 400 volts, respectively. Type S7412M has a forward and reverse off-state voltage rating of 600 volts.

These SCR's employ a hermetic JEDEC TO-208AA package.

*Formerly RCA Type No. S7432M.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N3654	2N3655	2N3656	2N3657	2N3658	S7412M	
*V_{RSOM}†	75	150	300	400	500	700	V
V_{DSOM}†	75	150	300	400	500	700	V
*V_{RROM}†	50	100	200	300	400	600	V
*V_{DROM}†	50	100	200	300	400	600	V
$I_{T(RMS)}$ (T_C = 40°C, θ = 180°)			35				A
*$I_{T(AV)}$ (T_C = 40°C, θ = 180°)			25				A
*I_{TSM}: For one full cycle of applied principal voltage 60-Hz (Rectangular wave-pw = 5 ms, t_r = 50 µs), T_C = 40°C			180				A
*di/dt: V_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 µs (See Fig. 15)			400				A/µs
I^2t: T_J = -65 to 120°C, t = 1 to 8.3 ms			165				A2s
*P_{GM}■: Peak (forward or reverse) for 10µs maximum, See Fig. 7)			40				W
*$P_{G(AV)}$■: Averaging time = 10 ms maximum			1				W
*T_{stg}•			-65 to 150				°C
*T_C•			-65 to 120				°C
T_T: During soldering for 10 s maximum (terminal and case)			225				°C
τ_S: Recommended			35				in-lbf
			0.4				kgf-m
Maximum (DO NOT EXCEED)			50				in-lbf
			0.57				kgf-m

* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.
† These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
■ Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
• For temperature measurement reference point, see Dimensional Outline.

2N3654, 2N3655, 2N3656, 2N3657, 2N3658, S7412M

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 120°C$				
2N3654, 2N3655, 2N3656, S7412M	–	2	6*	mA
2N3657	–	2	5.5*	mA
2N3658	–	2	4*	mA
v_T: $i_T = 25$ A (peak), $T_C = 25°C$	–	1.5	2.05*	V
i_{HO}:				
$T_C = 25°C$	–	75	150	mA
$T_C = -65°C$	–	150	350*	mA
* dv/dt: $V_D = V_{DROM}$, exponential voltage rise, $T_C = 120°C$ (See Fig. 16)	200	–	–	V/μs
I_{GT}:				
$V_D = 6$ V (dc), $R_L = 4\ \Omega$, $T_C = 25°C$	–	80	180	mA
$V_D = 6$ V (dc), $R_L = 2\ \Omega$, $T_C = -65°C$	–	150	500*	mA
V_{GT}:				
$V_D = 6$ V (dc), $R_L = 4\ \Omega$, $T_C = 25°C$	–	1.5	3	V
* $V_D = 6$ V (dc), $R_L = 200\ \Omega$, $T_C = 120°C$	0.25	–	–	V
$V_D = 6$ V (dc), $R_L = 2\ \Omega$, $T_C = -65°C$	–	2	4.5*	V
* tq:				
Rectangular Pulse: $V_{DX} = V_{DROM}$, $i_T = 10$ A, pulse duration = 50 μs, dv/dt = 200 V/μs, −di/dt = 5 A/μs, $I_{GT} = 200$ mA at turn-on, $V_{RX} = 15$ V minimum, $V_{GK} = 0$ V at turn-off, $T_C = 120°C$ (See Figs. 17 & 18)	–	–	10	μs
Sinusoidal Pulse: $V_{DX} = V_{DROM}$, $i_T = 100$ A, pulse duration = 2 μs, dv/dt = 200 V/μs, $V_{RX} = 30$ V minimum, $V_{GK} = 0$ at turn-off, $T_C = 115°C$ (See Figs. 19 & 20)	–	–	10	μs
$R_{\theta JC}$	–	0.85	1.7*	°C/W

* In accordance with JEDEC registration data format (JS-14, RDF-1) filed for the JEDEC (2N series) types.

2N3654, 2N3655, 2N3656, 2N3657, 2N3658, S7412M

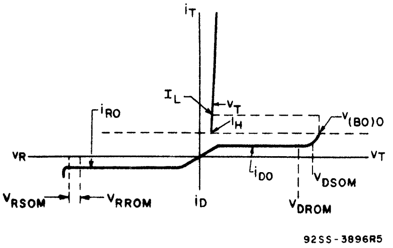


Fig. 1 — Principal voltage-current characteristic.

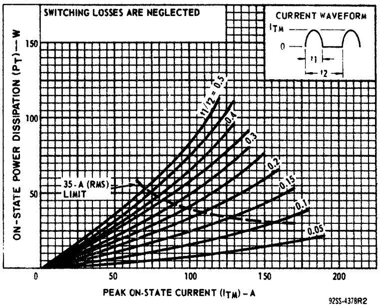


Fig. 2 — Power dissipation vs. peak on-state current.

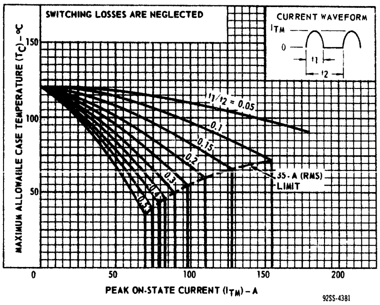


Fig. 3 — Maximum allowable case-temperature vs. peak on-state current.

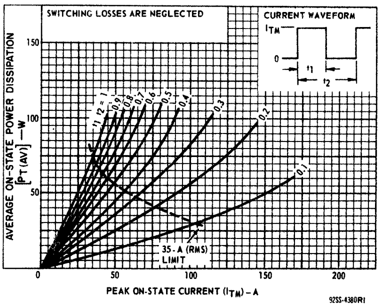


Fig. 4 — Power dissipation vs. peak on-state current.

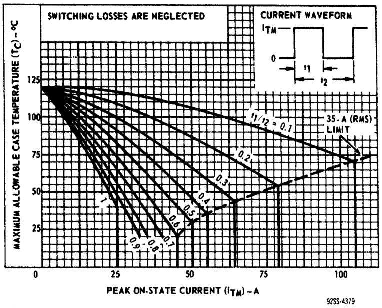


Fig. 5 — Maximum allowable case-temperature vs. peak on-state current.

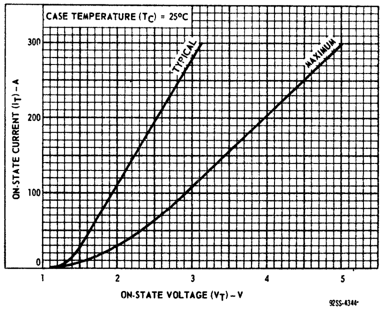


Fig. 6 — Variation of on-state with on-state voltage.

2N3654, 2N3655, 2N3656, 2N3657, 2N3658, S7412M

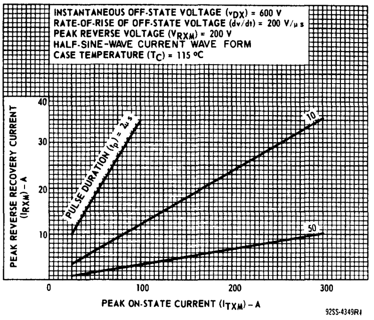


Fig. 7 — Typical variation of peak reverse-recovery current with peak on-state current (half-sine-wave pulse).

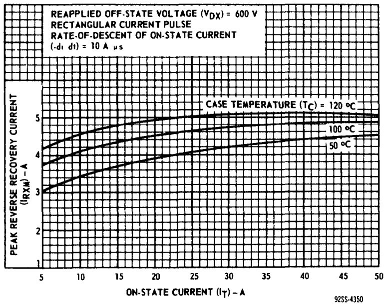


Fig. 8 — Typical variation of peak reverse-recovery current with on-state current (rectangular pulse).

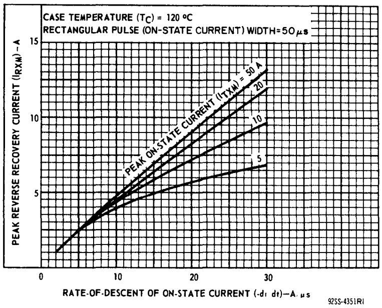


Fig. 9 — Typical variation of peak reverse-recovery current with rate-of-descent of on-state current (rectangular pulse).

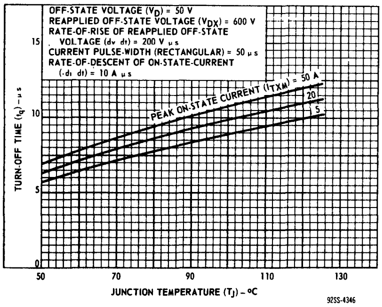


Fig. 10 — Typical variation of turn-off time with junction temperature (rectangular pulse).

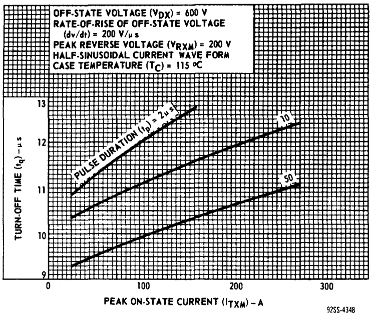


Fig. 11 — Typical variation of turn-off time with peak on-state current (half-sine-wave pulse).

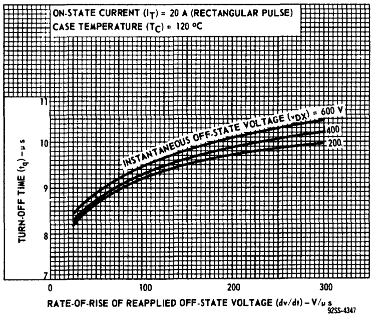


Fig. 12 — Typical variation of turn-off time with rate-of-rise of reapplied off-state voltage (rectangular pulse).

2N3654, 2N3655, 2N3656, 2N3657, 2N3658, S7412M

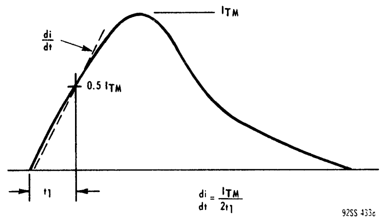


Fig. 13 — Rate-of-change of on-state current with time (defining di/dt).

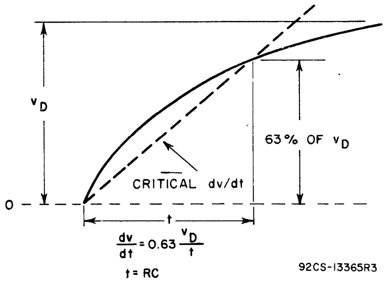


Fig. 14 — Rate-of-rise of off-state voltage with time (defining dv/dt).

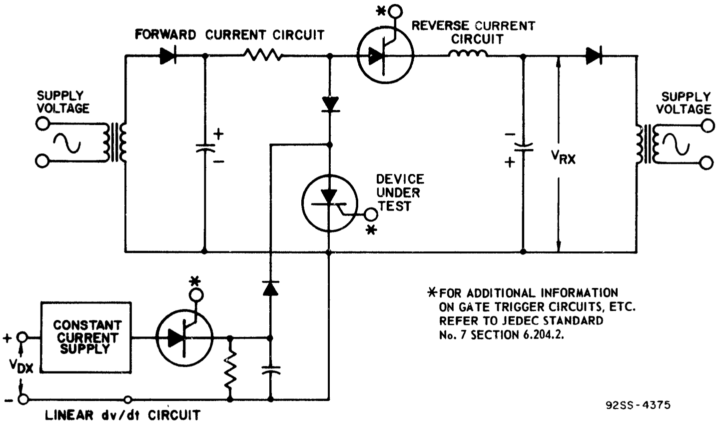


Fig. 15 — Circuit used to measure turn-off time (t_q), rectangular pulse.

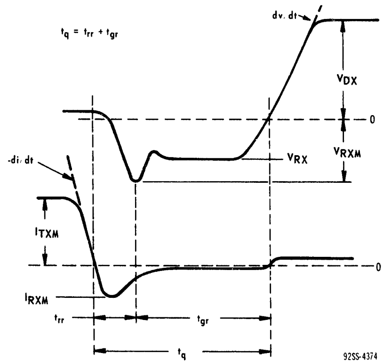


Fig. 16 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points defining turn-off time (t_q), rectangular pulse.

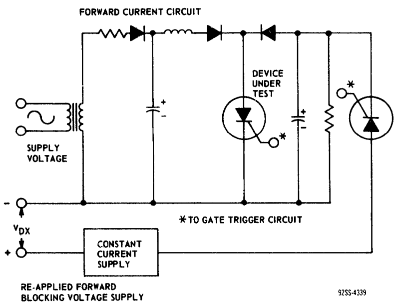


Fig. 17 — Circuit used to measure turn-off time (t_q), half-sine-wave pulse.

2N3654, 2N3655, 2N3656, 2N3657, 2N3658, S7412M

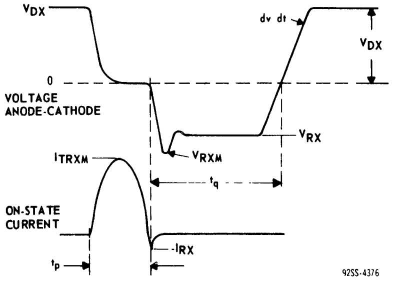


Fig. 18 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points for specification of turn-off (t_q), half-sine-wave pulse.

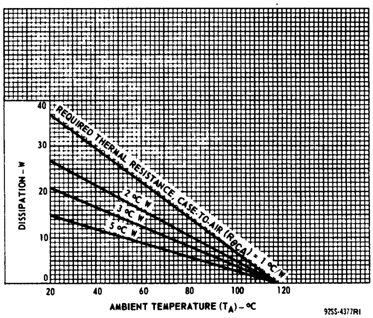


Fig. 19 — Heat sink guidance.

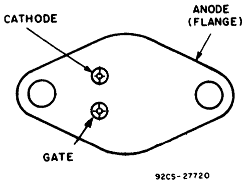
12.5-A Silicon Controlled Rectifiers

For Low-Cost Power-Control and Power-Switching Applications

Features:

- *Low switching losses*
- *High di/dt and dv/dt capabilities*
- *Low leakage currents, both forward and reverse*
- *Low forward voltage drop at high current levels*
- *Low thermal resistance*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

RCA 2N3668*, 2N3669*, 2N3670*, and 2N4103* are all-diffused, three-junction, silicon controlled-rectifiers (SCR's). They are intended for use in power-control and power-switching applications requiring a blocking voltage capability of up to 600 volts and a forward-current capability of 12.5 amperes (rms value) or 8 amperes (average value) at a case temperature of 80°C.

The 2N3668 is designed for low-voltage power supplies, the 2N3669 for direct operation from 120-volt line supplies, the 2N3670 for direct operation from 240-volt line supplies, and the 2N4103 for high-voltage power supplies.

The 2N3668, 2N3669, 2N3670 and 2N4103 SCR's employ the hermetic JEDEC TO-204AA package.

*Formerly Dev. Types TA2621, TA2598, TA2618, and TA2775, respectively.

Absolute-Maximum Ratings, for Operation with Sinusoidal AC Supply Voltage at a Frequency between 50 and 400 Hz, and with Resistive or Inductive Load

RATINGS	CONTROLLED-RECTIFIER TYPES				UNITS
	2N3668	2N3669	2N3670	2N4103	
Transient Peak Reverse Voltage					
(Non-Repetitive), v_{RM}(non-rep)	150	330	660	700	volts
Peak Reverse Voltage (Repetitive), v_{RM} (rep)	100	200	400	600	volts
Peak Forward Blocking Voltage (Repetitive), v_{FBOM}(rep)	100	200	400	600	volts
Forward Current:					
For case temperature (T_C) of +80°C					
Average DC value at a conduction angle of 180°, I_{FAV}	8	8	8	8	amperes
RMS value, I_{FRMS}	12.5	12.5	12.5	12.5	amperes
For other conditions, (See Fig. 4)					
Peak Surge Current, i_{FM} (surge):					
For one cycle of applied voltage	200	200	200	200	amperes
For one cycle of applied principal voltage					
60 Hz (sinusoidal), T_C = 80°C	200	200	200	200	amperes
50 Hz (sinusoidal), T_C = 80°C	170	170	170	170	amperes
For more than one cycle of applied voltage	See Fig. 1	See Fig. 1	See Fig. 1	See Fig. 1	
Fusing Current (for SCR protection):					
T_J = -40 to 100°C, t = 1 to 8.3 ms, I^2t	170	170	170	170	ampere^2 second
Rate of Change of Forward Current, di/dt	200	200	200	200	amperes/ microsecond
$V_{FB} = V_{BOO}$ (min. value)					
I_{GT} = 200 mA, 0.5 ns rise time					
Gate Power*:					
Peak, Forward or Reverse, for 10 ns duration, P_{GM} (See Figs. 7 and 9)	40	40	40	40	watts
Average, P_{GAV}	0.5	0.5	0.5	0.5	watt
Temperature:					
Storage, T_{stg}•	-40 to +125	-40 to +125	-40 to +125	-40 to +125	°C
Operating (Case), T_C	-40 to +100	-40 to +100	-40 to +100	-40 to +100	°C

*Any values of peak gate current or peak gate voltage to give the maximum gate power is permissible.
•Temperature reference point is within 1/8 in. (3.17 mm) of the center of the underside of unit.

ELECTRICAL CHARACTERISTICS

Characteristics at Maximum Ratings (unless otherwise specified), and at Indicated Case Temperature (T_C)

CHARACTERISTICS	CONTROLLED-RECTIFIER TYPES												UNITS
	2N3668			2N3669			2N3670			2N4103			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Repetitive Blocking Voltage, V_{DROM} At $T_C = +100°C$	100	—	—	200	—	—	400	—	—	600	—	—	volts
Peak Blocking Current, at $T_C = +100°C$: Forward, I_{DOM} $V_D = V_{DROM}$	—	0.2	2	—	0.25	2.5	—	0.3	3	—	0.35	4	mA
Reverse, I_{ROM} $V_R = V_{RROM}$	—	0.05	1	—	0.1	1.25	—	0.2	1.5	—	0.3	3	mA
Forward Voltage Drop, v_F At a Forward Current of 25 amperes and a $T_C = +25°C$ (See Fig. 2)	—	1.5	1.8	—	1.5	1.8	—	1.5	1.8	—	1.5	1.8	volts
DC Gate-Trigger Current, I_{GT}: At $T_C = +25°C$ (See Fig. 9)	1	20	40	1	20	40	1	20	40	1	20	40	mA (dc)
Gate-Trigger Voltage, V_{GT}: At $T_C = +25°C$ (See Fig. 9)	—	1.5	2	—	1.5	2	—	1.5	2	—	1.5	2	volts (dc)
Holding Current, i_{HO}: At $T_C = +25°C$	0.5	25	50	0.5	25	50	0.5	25	50	0.5	25	50	mA
Critical Rate of Applied Forward Voltage, Critical dv/dt $V_{FB}=V_{BOO}$(min. value), exponential rise, $T_C = +100°C$	10	100	—	10	100	—	10	100	—	10	100	—	volts/ micro-second
Turn-On Time, t_{on} (Delay Time + Rise Time) $V_D = V_{DROM}$ $i_T = 8$ amperes, $I_G = 200$ mA, 0.1 μs rise time, $T_C = +25°C$	—	1.25	—	—	1.25	—	—	1.25	—	—	1.25	—	micro-seconds
Turn-Off Time, t_{off}, (Reverse Recovery Time + Gate Recovery Time) $i_F = 8$ amperes, 50 ns pulse width, $dv_{FB}/dt = 20$ v/μs, $di_r/dt = 30$ A/μs, $I_{GT} = 200$ mA, $T_C = +80°C$	—	20	50	—	20	50	—	20	50	—	20	50	micro-seconds
Thermal Resistance, Junction-to-Case	—	—	1.7	—	—	1.7	—	—	1.7	—	—	1.7	°C/W

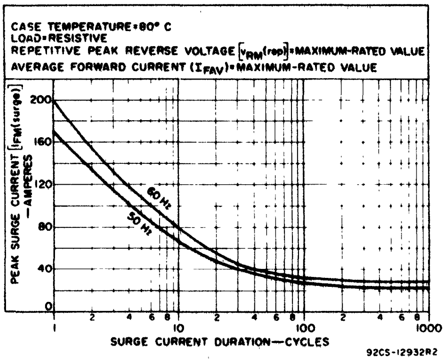


Fig. 1 — Peak surge current vs. surge current duration.

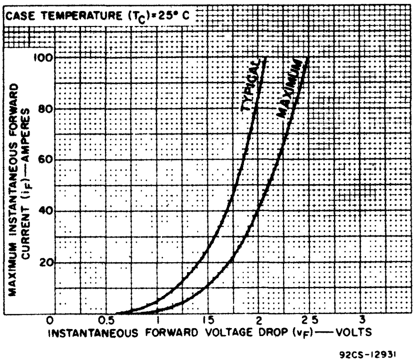


Fig. 2 — Instantaneous forward current vs. instantaneous forward voltage drop.

2N3668-2N3670, 2N4103

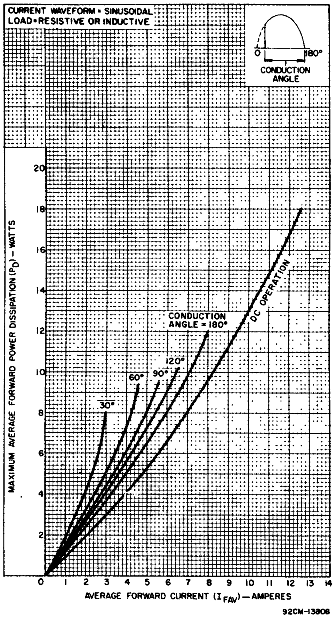


Fig. 3 — Power dissipation vs. forward current.

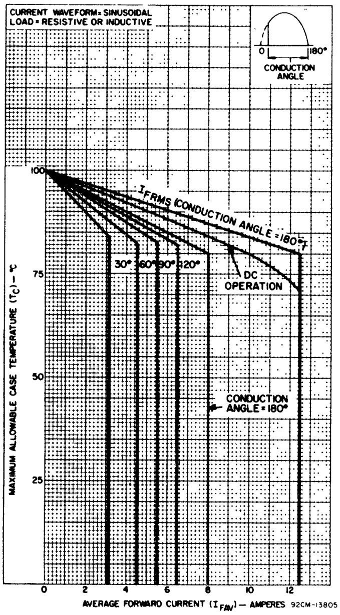


Fig. 4 — Maximum allowable case temperature vs. average forward current.

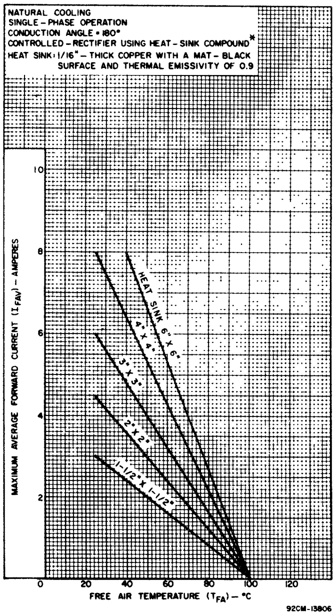


Fig. 5 — Natural-cooling operation guidance chart.

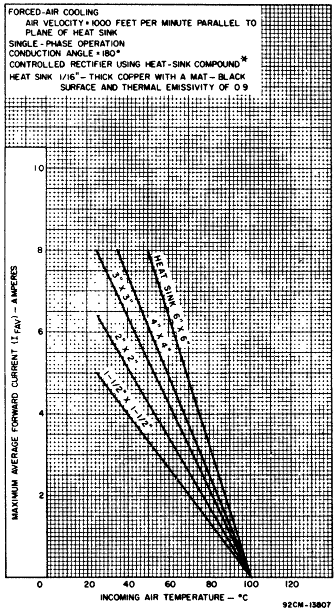


Fig. 6 — Forced-air cooling operation guidance chart.

*Dow Corning 340 Silicon Heat Sink Compound, or Equivalent.

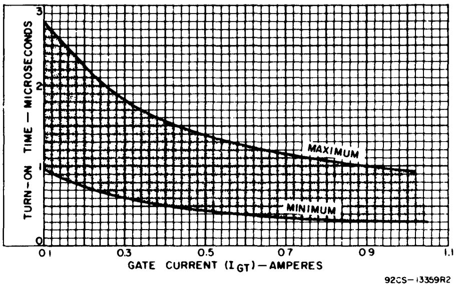


Fig. 7 — Turn-on time vs. gate current.

2N3870-2N3873, 2N3896-2N3899, S6420 Series

File Number **578**

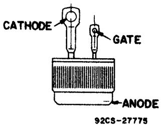
35-A Silicon Controlled Rectifiers

Features:

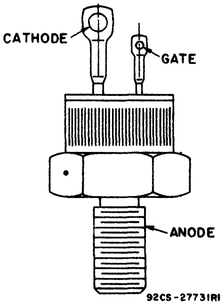
- *High di/dt and dv/dt capabilities*
- *Low on-state voltage at high current levels*
- *Low thermal resistance*

Voltage Package	100 V Types	200 V Types	400 V Types	600 V Types
Press-Fit	2N3870	2N3871	2N3872	2N3873
Stud	2N3896	2N3897	2N3898	2N3899
Isolated-Stud	S6420A	S6420B	S6420D	S6420M

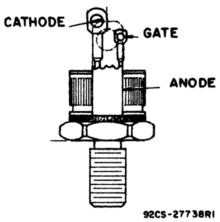
TERMINAL DESIGNATIONS



2N3870-73



2N3896-99



S6420 Series

These RCA types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for power switching, power control, and voltage regulator applications and for heating, lighting, and motor speed-control circuits.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3870 2N3896 S6420A	2N3871 2N3897 S6420B	2N3872 2N3898 S6420D	2N3873 22N3899 S6420M	
*NON-REPETITIVE PEAK REVERSE VOLTAGE‡ Gate Open	V_{RSOM}	150	330	660	700	V
*REPETITIVE PEAK REVERSE VOLTAGE‡ Gate Open	V_{RROM}	100	200	400	600	V
*REPETITIVE PEAK OFF-STATE VOLTAGE‡ Gate Open	V_{DROM}	100	200	400	600	V
ON-STATE CURRENT: T_C = 65°C†, conduction angle = 180°:						
RMS	$I_{T(RMS)}$	35				A
*Average	$I_{T(AV)}$	22				A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT: For one full cycle of applied principal voltage	I_{TSM}					
*60 Hz (sinusoidal)		350				A
50 Hz (sinusoidal)		300				A
RATE OF CHANGE OF ON-STATE CURRENT V_D=V_{DROM}, I_{GT}=200 mA, t_r = 0.5 μs	di/dt	200				A/μs
FUSING CURRENT (for SCR protection): T_J = -40 to 100°C, t = 1 to 8.3 ms	I^2t	300				A^2s
GATE POWER DISSIPATION•:						
Peak Forward (for 10 μs max., See Fig. 7)	P_{GM}	40				W
Peak Reverse	P_{RGM}	See Fig. 8				
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	0.5				W
*TEMPERATURE RANGE#:						
Storage	T_{stg}	-40 to 125				°C
Operating (Case)	T_C	-40 to 100				°C
TERMINAL TEMPERATURE (During soldering): For 10 s max. (terminals and case)	T_T	225				°C

*In accordance with JEDEC registration data filed for the JEDEC (2N-series) types.
‡These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
†T_C = 60° for isolated-stud package types.
• Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
Temperature measurement point is shown on the DIMENSIONAL OUTLINE.

2N3870-2N3873, 2N3896-2N3899, S6420 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES Unless Otherwise Specified MIN.	TYP.	MAX.	UNITS
Peak Off-State Current: (Gate open, T_C = 100°C) Forward Current (I_{DOM}) at $V_D = V_{DROM}$ Reverse Current (I_{ROM}) at $V_R = V_{RROM}$	I_{DOM} or I_{ROM}				mA
2N3870, 2N3896, S6420A		–	0.2	2*	mA
2N3871, 2N3897, S6420B		–	0.25	2.5*	mA
2N3872, 2N3898, S6420D		–	0.3	3*	mA
2N3873, 2N3899, S6420M,					
Instantaneous On-State Voltage: i_T = 69 A (peak), T_C = 25°C	v_T	–	–	1.85*	V
i_T = 100 A (peak), T_C = 25°C		–	1.7	2.1	V
DC Gate Trigger Voltage: V_D = 12 V (dc), R_L = 30 Ω, T_C = -40°C	V_{GT}	–	1.5	3*	V
V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C		–	1.1	2	V
For other case temperatures			See Fig. 10		
DC Gate Trigger Current: V_D = 12 V (dc), R_L = 30 Ω, T_C = -40°C	I_{GT}	–	46	80*	mA
V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C		1	25	40	mA
For other case temperatures			See Fig. 9		
Instantaneous Holding Current: Gate open, T_C = 25°C	i_{HO}	0.5	30	70	mA
For other case temperatures			See. Fig. 6		
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For $V_D = V_{DROM}$, I_G = 200 mA, t_r = 0.1 μs, I_T = 30 A (peak), T_C = 25°C (See Fig. 11 & 13)	t_{gt}	–	1.25	2	μs
Circuit Commutated Turn-Off Time: $V_D = V_{DROM}$, i_T = 18 A, pulse duration = 50 μs, dv/dt = 20 V/μs, -di/dt = -30 A/μs, I_G = 200 mA, T_C = 80°C (See Fig. 14)	t_q	–	20	40	μs
Critical Rate of Rise of Off-State Voltage: $V_D = V_{DROM}$, exponential voltage rise, Gate open, T_C = 100°C (See Fig. 15)	dv/dt	10	100	–	V/μs
Thermal Resistance, Junction-to-Case: Steady-State Press-fit & stud types	$R_{\theta JC}$	–	–	0.9*	°C/W
Isolated-stud types		–	–	1	°C/W

*In accordance with JEDEC registration data filed for the JEDEC (2N-series) types.

2N3870-2N3873, 2N3896-2N3899, S6420 Series

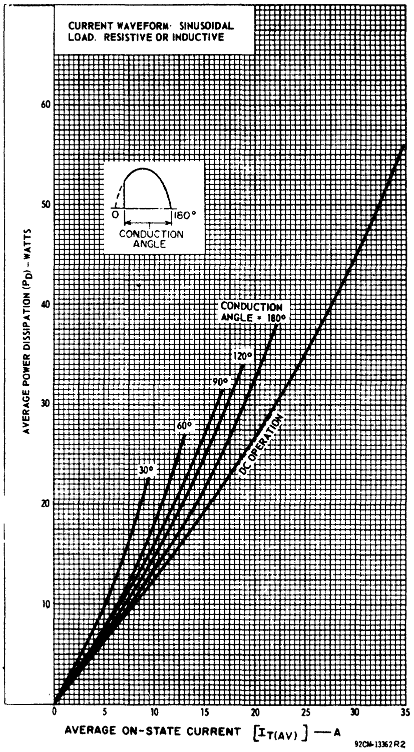


Fig. 1 — Power dissipation vs. on-state current.

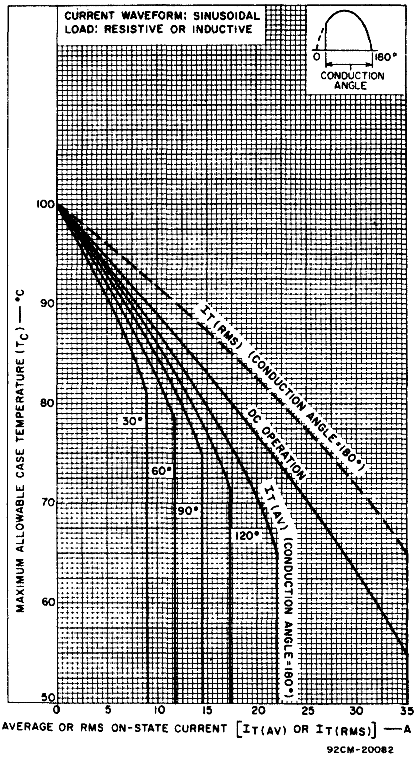


Fig. 2 — Maximum allowable case temperature vs. on-state current for press-fit and stud types.

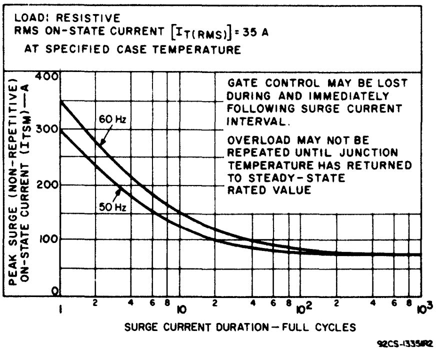


Fig. 3 — Peak surge on-state current vs. surge current duration.

2N3870-2N3873, 2N3896-2N3899, S6420 Series

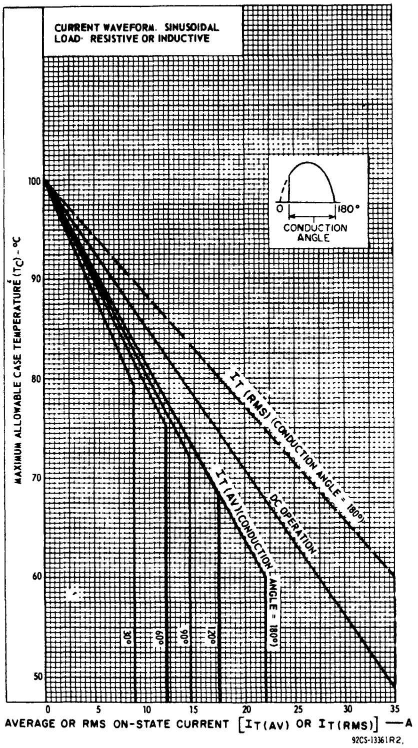


Fig. 4 — Maximum allowable case temperature vs. on-state current for isolated-stud types.

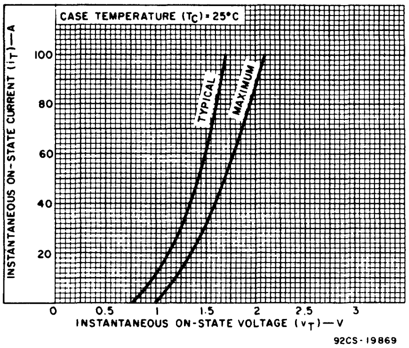


Fig. 5 — Instantaneous on-state current vs. on-state voltage.

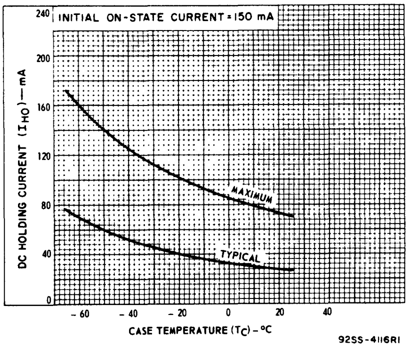


Fig. 6 — DC holding current vs. case temperature.

2N3870-2N3873, 2N3896-2N3899, S6420 Series

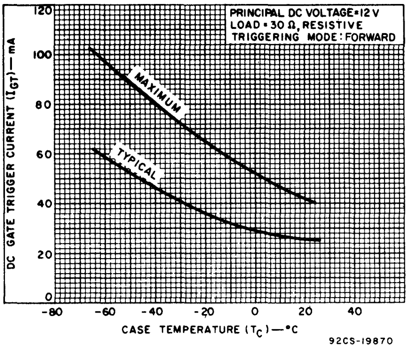


Fig. 7 — DC gate trigger current (forward) vs. case temperature.

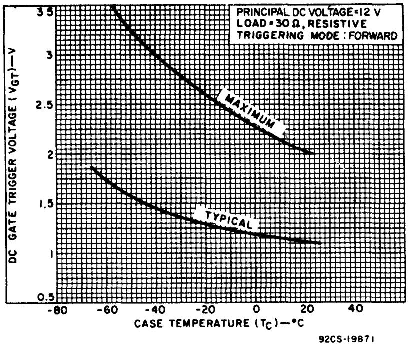


Fig. 8 — DC gate trigger voltage (forward) vs. case temperature.

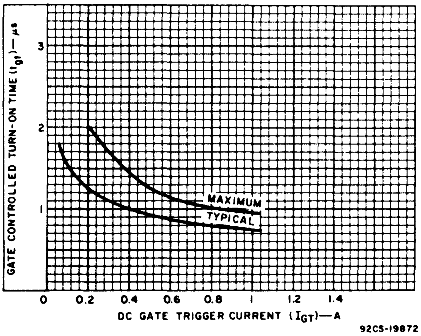


Fig. 9 — Gate-controlled turn-on time vs. gate trigger current.

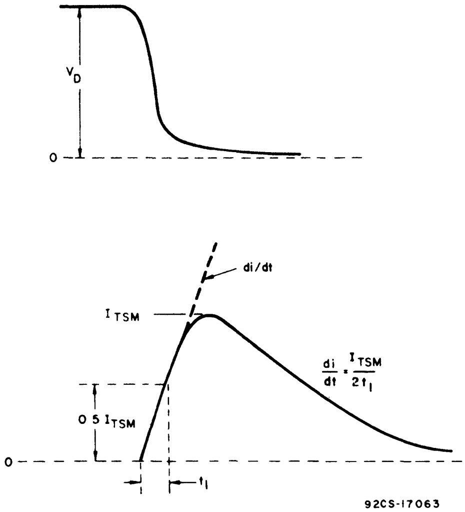


Fig. 10 — Rate of change of on-state current with time (defining di/dt).

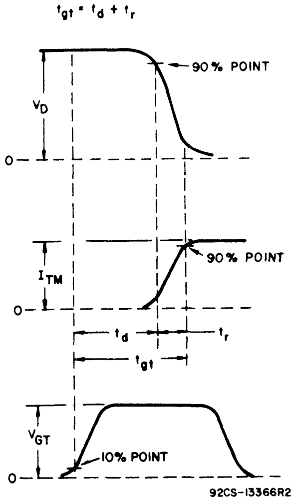


Fig. 11 — Relationship between off-state voltage, on-state current, and gate trigger voltage showing reference points for definition of turn-on time (t_{gt}).

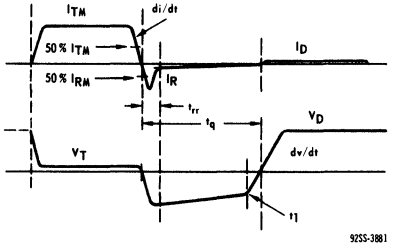


Fig. 12 — Relationship between instantaneous on-state current and voltage showing reference points for definition of circuit commutated turn-off time (t_q).

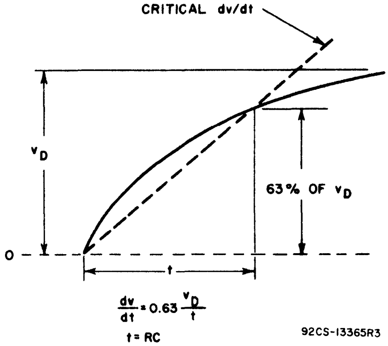


Fig. 13 — Rate of rise of off-state voltage with time (defining-critical dv/dt).

2N6394—2N6398

File Number **891**

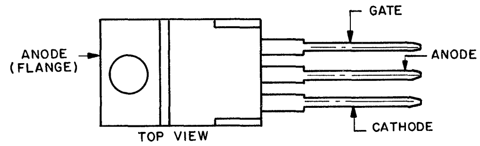
12-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

Features:

- *High dv/dt capability*
- *Low thermal resistance*
- *Low on-state voltage at high current levels*

TERMINAL DESIGNATIONS



92CS-39968

JEDEC TO-220AB

The RCA-2N6394 to 2N6398, inclusive, are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) designed for switching ac and dc currents.

The TO-220AB package provides easy package mounting and low thermal resistance allowing operation at high case temperatures and permitting reduced heat-sink size.

MAXIMUM RATINGS, *Absolute-Maximum Values:*	**2N6394**	**2N6395**	**2N6396**	**2N6397**	**2N6398**	
*V_{RSOM}†	75	125	250	450	650	V
V_{DSOM}†	75	125	250	450	650	V
*V_{RROM}†	50	100	200	400	600	V
*V_{DROM}†	50	100	200	400	600	V
$I_{T(RMS)}$ (T_C = 90°C, θ = 180°)			12			A
I_{TSM}: For one full cycle of applied principal voltage 60-Hz‡			125•			A
50-Hz‡			105			A
For more than one full cycle of applied principal voltage			See Fig. 4			
di/dt: V_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.1 μs (See Fig. 13)			100			A/μs
I^2t: T_J = -40 to 125°C, t = 1 to 8.3 ms			65			A2s
P_{GM}■: Peak forward for 10μs max.			16#			W
Peak reverse			See Fig. 7			
*$P_{G(AV)}$■: Averaging time = 8 ms maximum			0.5			W
I_{GM}: (forward)			2			A
*T_{stg}			-40 to 150			°C
*T_C			-40 to 125			°C
T_T: During soldering for 10 s maximum (terminal and case)			250			°C

* In accordance with JEDEC registration data format (JS-22, RDF-1) filed for the JEDEC (2N series) types.
† These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
‡ At $I_{T(RMS)}$ = 12 A and T_C = 90°C.
• JEDEC registration value is 100 A at T_C = 90°C.
■ Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.
JEDEC registered value is 10 W.

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 125^oC$	–	0.1	2*	mA
v_T: i_T = 24 A (peak), $T_C = 25^oC$ (See Fig. 5)	–	1.7	2.2*	V
i_{HO}: (See Fig. 10) $T_C = 25^oC$	–	10	35	mA
$T_C = -40^oC$	–	–	60*	mA
dv/dt: $V_D = V_{DROM}$, exponential voltage rise, $T_C = 125^oC$ (See Fig. 15)	50	–	–	V/μs
I_{GT} (See Fig. 8) V_D = 12 V (dc), R_L = 50 Ω, $T_C = 25^oC$	–	8	30	mA
V_D = 12 V (dc), R_L = 50 Ω, $T_C = -40^oC$	–	–	60*	mA
V_{GT}: (See Fig. 9) V_D = 12 V (dc), R_L = 50 Ω, $T_C = 25^oC$	–	0.7	1.5	V
V_D = 12 V (dc), R_L = 50 Ω, $T_C = -40^oC$	–	–	2.5*	V
V_{GRD}: $V_D = V_{DROM}$, $T_C = 125^oC$	0.2	–	–	V
t_{gt}: $V_D = V_{DROM}$, i_T = 24 A (peak), I_{GT} = 200 mA, t_r = 0.02 μs, $T_C = 25^oC$ (See Figs. 12 & 14)	–	–	2*	μs
t_q: Rectangular Pulse $V_D = V_{DROM}$, i_T = 12 A, pulse duration = 50 μs, dv/dt = 50 V/μs, –di/dt = –10 A/μs, I_{GT} = 80 mA at turn-on, V_R = 20 V minimum, V_{GK} = 0 V at turn-off, $T_C = 75^oC$ (See Fig. 16)	–	35	75	μs
$R_{\theta JC}$	–	–	2*	$^oC/W$
$R_{\theta JA}$	–	–	50*	$^oC/W$

* In accordance with JEDEC registration data format (JS-22, RDF-1) filed for the JEDEC (2N series) types.

2N6394—2N6398

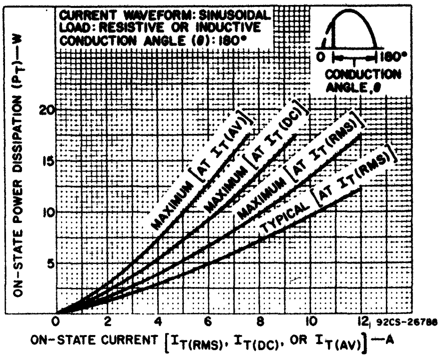


Fig. 1 — On-state power dissipation vs. on-state current.

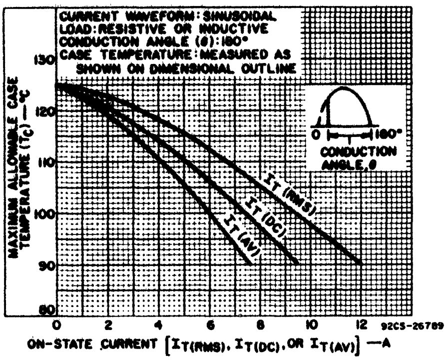


Fig. 2 — Maximum allowable case temperature vs. on-state current.

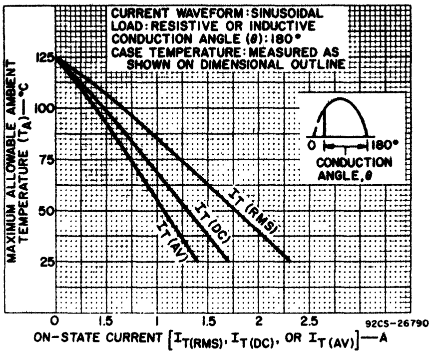


Fig. 3 — Maximum allowable ambient temperature vs. on-state current — no heat sinking.

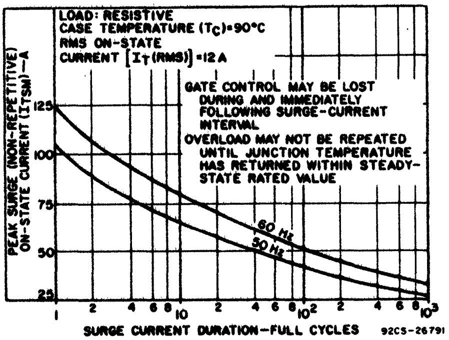


Fig. 4 — Allowable peak surge on-state current vs. surge duration.

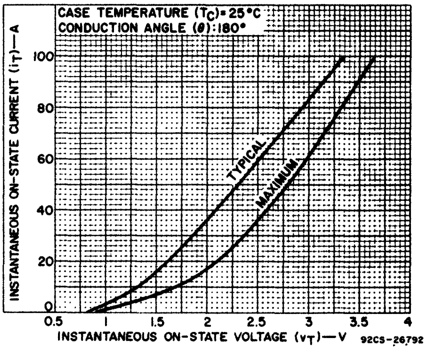


Fig. 5 — Instantaneous on-state current vs. instantaneous on-state voltage.

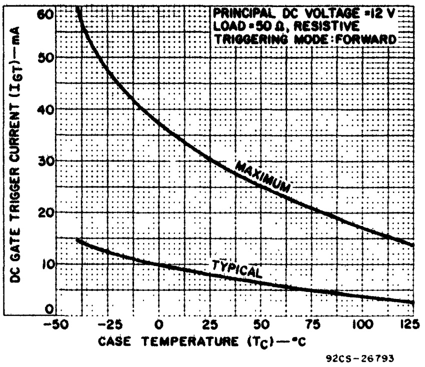


Fig. 6 — DC Gate trigger current vs. case temperature.

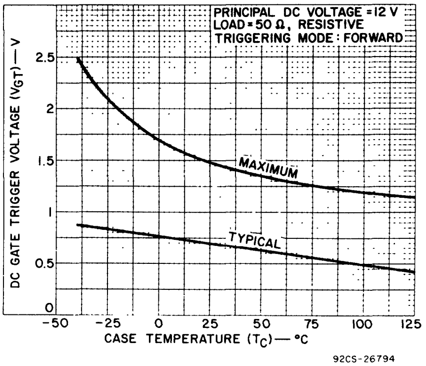


Fig. 7 — *DC Gate trigger voltage vs. case temperature.*

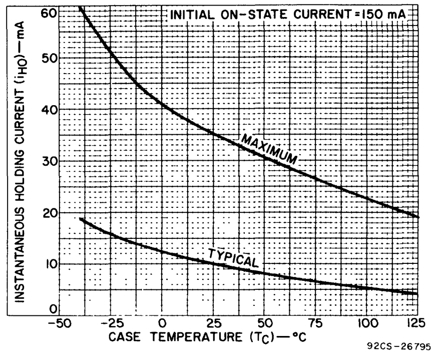


Fig. 8 — *Instantaneous holding current vs. case temperature.*

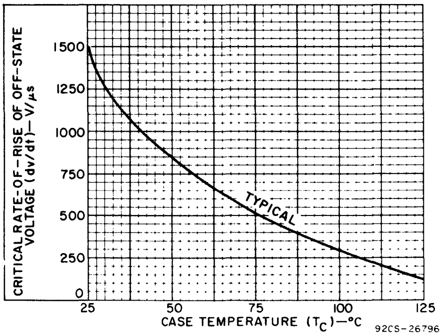


Fig. 9 — *Critical of rise of off-state voltage vs. case temperature.*

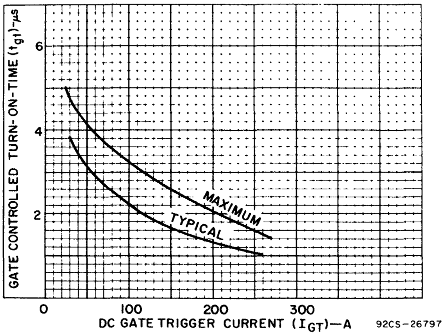


Fig. 10 — *Typical gate-controlled turn-on time vs. gate trigger current.*

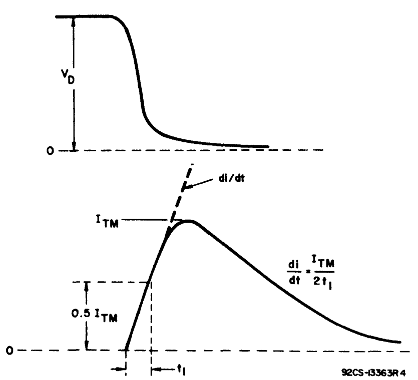


Fig. 11 — *Rate of change on-state current with time (defining di/dt).*

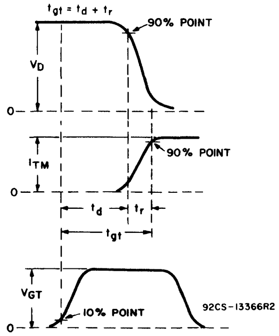


Fig. 12 — *Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).*

2N6394—2N6398

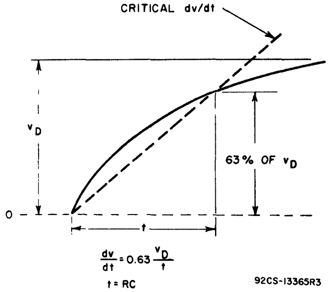


Fig. 13 — Rate of rise of off-state voltage with time (defining critical dv/dt).

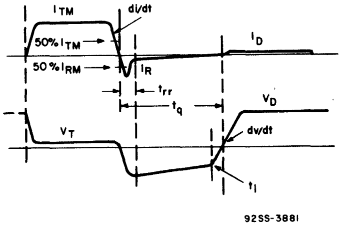


Fig. 14 — Relationship between instantaneous on-state current and voltage, showing reference points for definition of circuit-commutated turn-off time (t_{qt}).

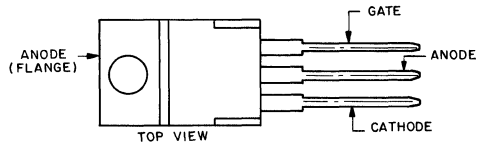
File Number **892**

2N6400—2N6404

16-A Silicon Controlled Rectifiers

For Power Switching, Power Control, and Ignition Applications

TERMINAL DESIGNATIONS



JEDEC TO-220AB

Features:

- *High dv/dt capability*
- *Low thermal resistance*
- *Low on-state voltage at high current levels*

The RCA-2N6400 to 2N6404, inclusive, are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) designed for switching ac and dc currents.

The TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heat-sink size.

MAXIMUM RATINGS, *Absolute-Maximum Values:*	**2N6400**	**2N6401**	**2N6402**	**2N6403**	**2N6404**	
*V_{RSOM}†	75	125	250	450	650	V
V_{DSOM}†	75	125	250	450	650	V
*V_{RROM}†	50	100	200	400	600	V
*V_{DROM}†	50	100	200	400	600	V
$I_{T(RMS)}$ (T_C = 100°C, θ = 180°)			16			A
I_{TSM}: For one full cycle of applied principal						
*voltage 60-Hz‡			160			A
50-Hz‡			135			A
For more than one full cycle of applied principal voltage			See Fig. 4			
di/dt:						
V_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.1 μs (See Fig. 13)			100			A/μs
I^2t:						
T_J = -40 to 125°C, t = 1 to 8.3 ms			100			A2s
P_{GM}■:						
Peak forward for 10μs max.			16#			W
Peak reverse			See Fig. 7			
*$P_{G(AV)}$■:						
Averaging time = 8 ms maximum			0.5			W
I_{GM}: (forward)			2			A
*T_{stg}			-40 to 150			°C
*T_C			-40 to 125			°C
T_T:						
During soldering for 10 s maximum (terminal and case)			250			°C

* In accordance with JEDEC registration data format (JS-22, RDF-1) filed for the JEDEC (2N series) types.

† These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

‡ At $I_{T(RMS)}$ = 16 A and T_C = 100°C.

■ Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

JEDEC registered value is 10 W.

2N6400—2N6404

ELECTRICAL CHARACTERISTICS

As Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 125^oC$	–	0.1	2*	mA
v_T: i_T = 32 A (peak), $T_C = 25^oC$ (See Fig. 5)	–	1.4	1.7*	V
i_{HO}: (See Fig. 10)				
$T_C = 25^oC$	–	10	35	mA
$T_C = -40^oC$	–	–	60*	mA
dv/dt: $V_D = V_{DROM}$, exponential voltage rise, $T_C = 125^oC$ (See Fig. 13)	50	–	–	V/μs
I_{GT}: (See Fig. 8)				
V_D = 12 V (dc), R_L = 50 Ω, $T_C = 25^oC$	–	8	30	mA
V_D = 12 V (dc), R_L = 50 Ω, $T_C = -40^oC$	–	–	60*	mA
V_{GT}: (See Fig. 9)				
V_D = 12 V (dc), R_L = 50 Ω, $T_C = 25^oC$	–	0.7	1.5	V
V_D = 12 V (dc), R_L = 50 Ω, $T_C = -40^oC$	–	–	2.5*	V
V_{GRD}: $V_D = V_{DROM}$, $T_C = 125^oC$	0.2	–	–	V
t_{gt}: $V_D = V_{DROM}$, i_T = 32 A (peak), I_{GT} = 200 mA, t_r = 0.02 μs, $T_C = 25^oC$ (See Figs. 13 & 14)	–	–	2*	μs
tq: Rectangular Pulse $V_D = V_{DROM}$, i_T = 16 A, pulse duration = 50 μs, dv/dt = 50 V/μs, –di/dt = –10A/μs, I_{GT} = 80 mA at turn-on, V_R = 20 V minimum, V_{GK} = 0 V at turn-off, $T_C = 75^oC$ (See Fig. 16)..............	–	35	75	μs
$R_{\theta JC}$	–	–	1.5*	$^oC/W$
$R_{\theta JA}$	–	–	50*	$^oC/W$

* In accordance with JEDEC registration data format (JS-22, RDF-1) filed for the JEDEC (2N series) types.

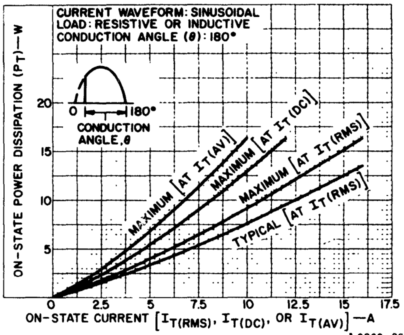


Fig. 1 — On-state power dissipation vs. on-state current.

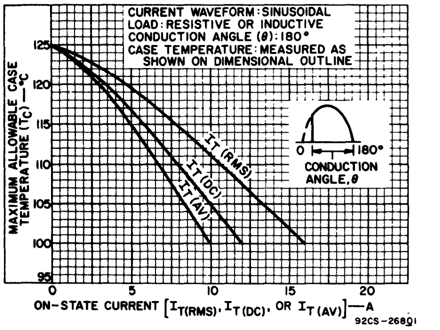


Fig. 2 — Maximum allowable case temperature vs. on-state current.

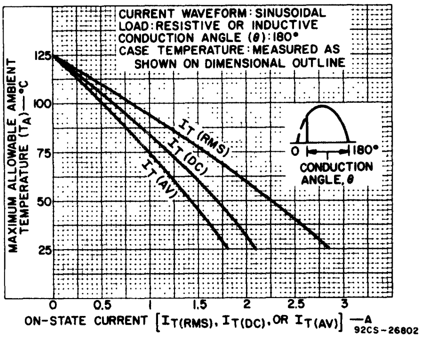


Fig. 3 — Maximum allowable ambient temperature vs. on-state current — no heat sinking.

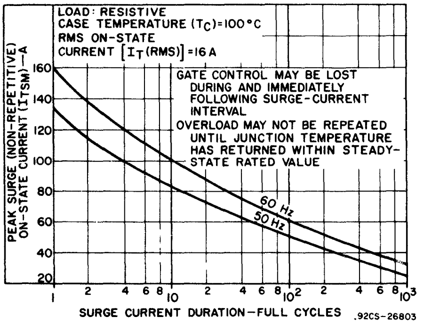


Fig. 4 — Allowable peak surge on-state current vs. surge duration.

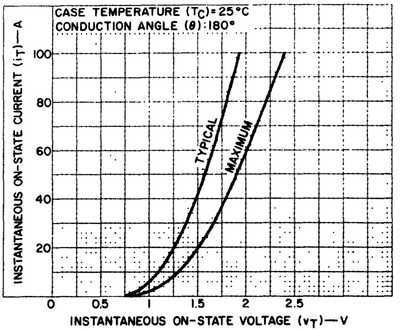


Fig. 5 — Instantaneous on-state current vs. instantaneous on-state voltage.

2N6400—2N6404

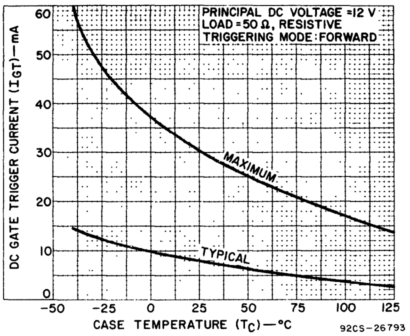


Fig. 6 — DC gate trigger current vs. case temperature.

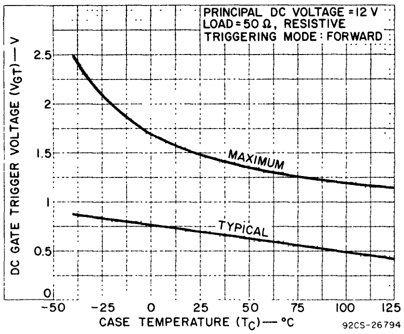


Fig. 7 — DC gate trigger voltage vs. case temperature.

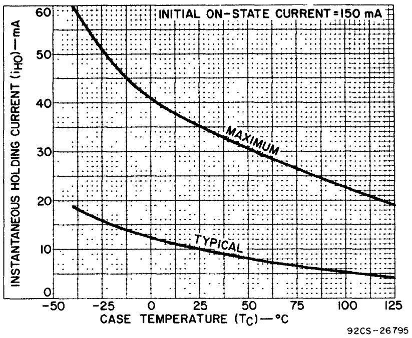


Fig. 8 — Instantaneous holding current vs. case temperature.

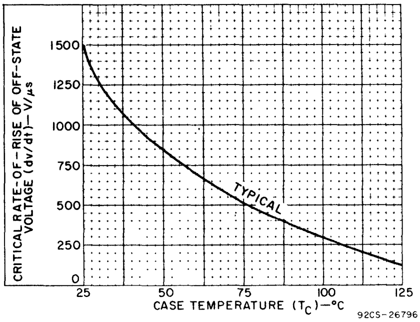


Fig. 9 — Critical rate of rise of off-state voltage vs. case temperature.

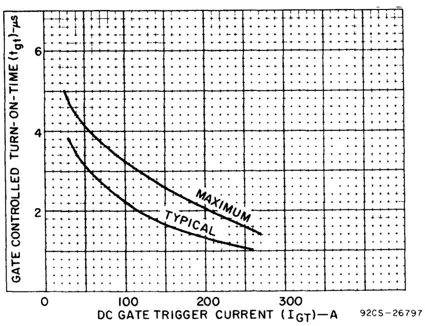


Fig. 10 — Typical gate-controlled turn-on time vs. gate trigger current.

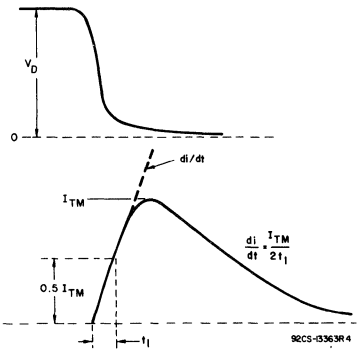


Fig. 11 — Rate of change of on-state current with time (defining di/dt).

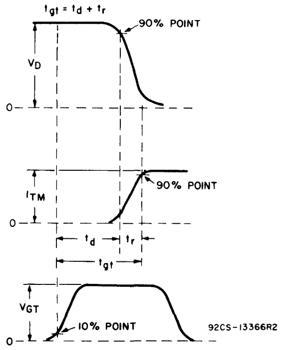


Fig. 12 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

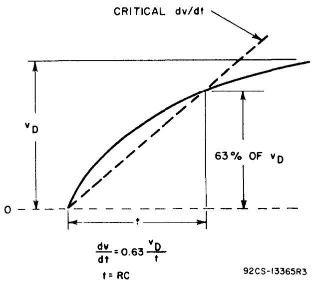


Fig. 13 — Rate of rise of off-state voltage with time (defining critical dv/dt).

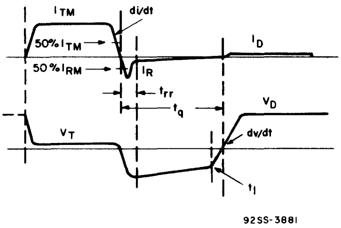


Fig. 14 — Relationship between instantaneous on-state current and voltage, showing reference points for definition of circuit-commutated turn-off time (t_q).

C106 Series

File Number **1005**

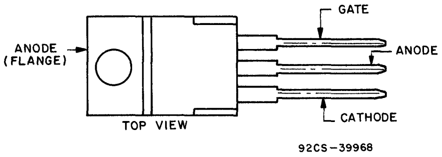
4-A Sensitive-Gate Silicon Controlled Rectifiers

For Power-Switching and Control Application

Features:

- *3.5-A(rms) on-state current ratings*
- *20-A peak surge capability*
- *Glass-passivated chip for stability*
- *Formed-lead options available*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-C106 series of sensitive-gate silicon controlled rectifiers are designed for switching ac and dc currents. The types within the series differ in their voltage ratings; the voltage ratings are identified by suffix letters in type designations.

These SCR's have microampere gate-current requirements which permit operation with low-level logic circuits. They can be used for lighting, power-switching, and motor-speed controls, and for gate-current amplification for driving large SCR's.

All types in the series utilize the JEDEC-TO-202AB (RCA VERSATAB) plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	C106F	C106A	C106B	C106C	C106D	C106E	C106M	C106S	C106N	
V_{RRM}: R_{GK} = 1000 Ω, T_C = -40 to 110°C; V_{DRM}: R_{GK} = 1000 Ω, T_C = -40 to 110°C	50	100	200	300	400	500	600	700	800	V

	All types	
$I_{T(AV)}$ (T_C = 45°C)	2.2	A
$I_{T(RMS)}$ (T_C = 45°C)	3.5	A
$I_{T(DC)}$ (T_C = 70°C)	2.6	A
I_{TSM}: For one cycle of applied principal voltage, T_C = 45°C		
60 Hz (sinusoidal)	20	A
50 Hz (sinusoidal)	18.5	A
I_{GM} (t = 10 μs)	0.2	A
V_{GRM}	6	V
di/dt:		
V_{DM} = V_{DRM}, I_G = 1 mA, t_r = 0.5 μs, T_C = 110°C	100	A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:		
t = 10 ms	1.77	A^2s
8.33 ms	1.67	A^2s
1 ms	0.82	A^2s
P_{GM} (For 10 μs max.)	0.5	W
$P_{G(AV)}$ (Averaging time = 10 ms max.)	0.1	W
T_{stg}	-40 to +150	°C
T_C	-40 to +110	°C
T_T (During soldering for 10 s max.)	250	°C

C106 Series

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	LIMITS — FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
	Min.	Typ.	Max.	
I_{DROM} or I_{RROM}: $V_D = V_{DRM}$ or $V_R = V_{RRM}$, $R_{GK} = 1000\ \Omega$ $T_C = 25°C$ ..... $T_C = 110°C$	— —	0.1 10	10 100	μA
v_T: For $i_T = 4$ A and $T_C = 25°C$ (See Fig. 7)	—	1.25	2.2	V
i_H: $R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $I_{T(INITIAL)} = 50$ mA, $T_C = 25°C$:	—	1.7	3	mA
I_{LX}: $R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $T_C = 25°C$: ($I_{GT} = 200\ \mu A$)	—	1.8	4	mA
dv/dt: $V_D = V_{DRM}$, $R_{GK} = 1000\ \Omega$, Exponential rise, $T_C = 110°C$	—	8	—	V/μs
I_{GT}: $V_D = 12$ V dc, $R_L = 30\ \Omega$, $T_C = 25°C$: For other case temperatures	—	30 (See Fig. 12)	200	μA
V_{GT}: $V_D = 12$ V dc, $R_L = 30\ \Omega$, $T_C = 25°C$ ..... For other case temperatures	—	0.5 (See Fig. 13)	0.8	V
t_{gt}: $V_D = V_{DRM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, $I_G = 1$ mA, Rise Time = 0.1 μs, $T_C = 25°C$	—	1.7	—	μs
t_q: $V_D = V_{DRM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, Pulse Duration = 50 μs, dv/dt = 5 V/μs, di/dt = -10 A/μs, $I_{GT} = 1$ mA at turn-on, $T_C = 110°C$ ...	—	65	—	μs
$R_{\theta JC}$ ..... $R_{\theta JA}$	— —	— —	8 60	°C/W

C106 Series

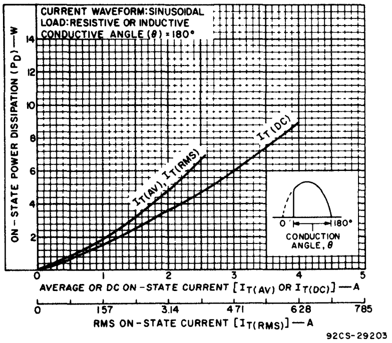


Fig. 1 — Power dissipation as a function of average dc, or rms on-state current.

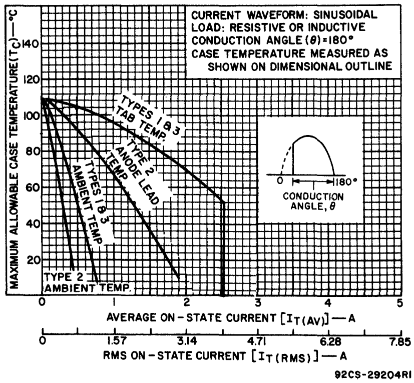


Fig. 2 — Maximum allowable case temperature as a function of average or rms on-state current.

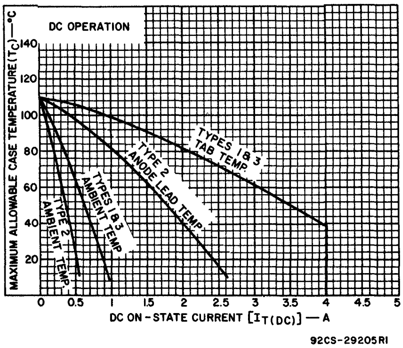


Fig. 3 — Maximum allowable case temperature as a function of dc on-state current for C106 series.

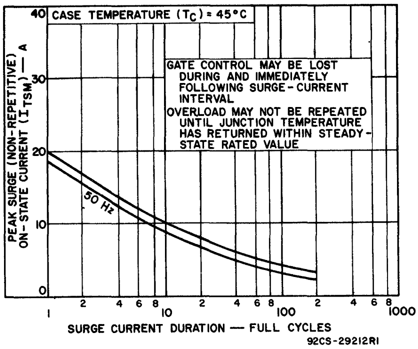


Fig. 4 — Peak surge on-state current as a function of surge current duration.

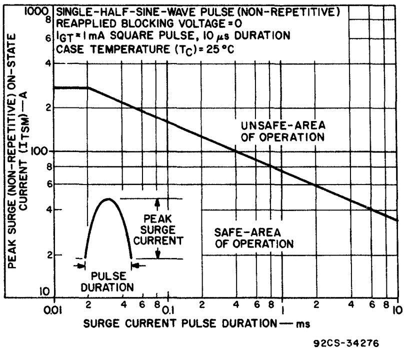


Fig. 5 — Surge capability without reapplied blocking voltage for all series.

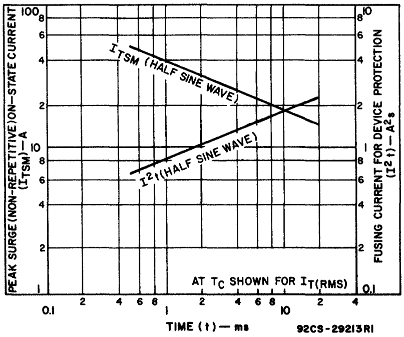


Fig. 6 Peak surge on-state current and fusing current as a function of time.

C106 Series

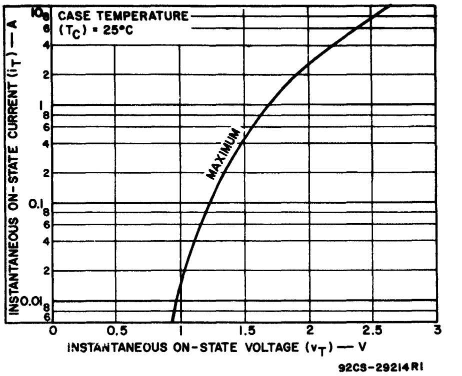


Fig. 7 — Maximum instantaneous on-state current as a function of on-state voltage.

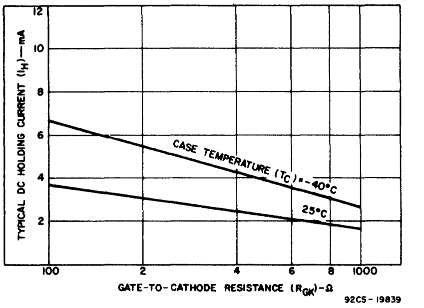


Fig. 8 — DC holding current as a function of gate-cathode resistance for the C106 series.

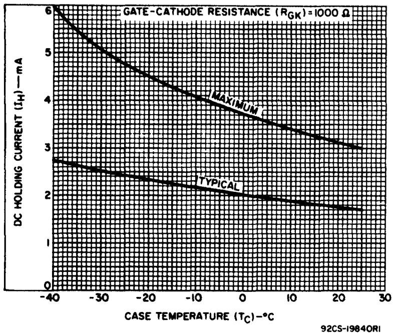


Fig. 9 — DC holding current as a function of case temperature.

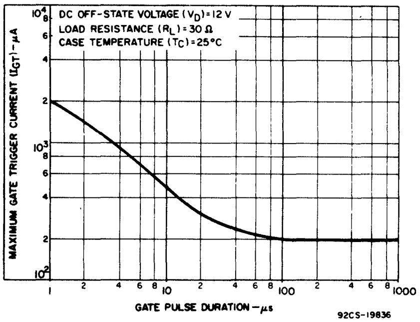


Fig. 10 — Maximum gate trigger current as a function of pulse duration for types in the C106 series.

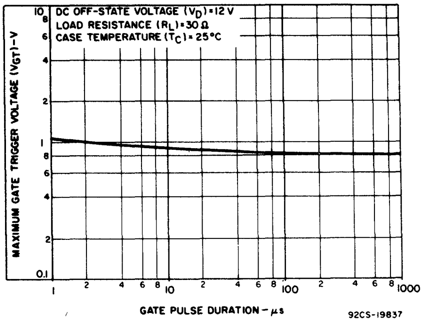


Fig. 11 — Maximum gate trigger voltage as a function of gate pulse duration for types in the C106 series.

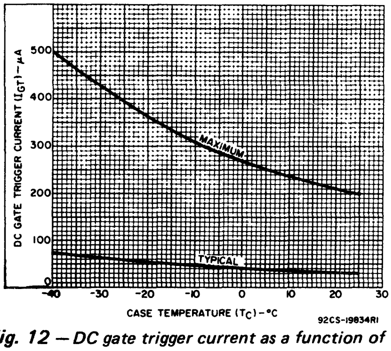


Fig. 12 — DC gate trigger current as a function of case temperature for C106 series.

C106 Series

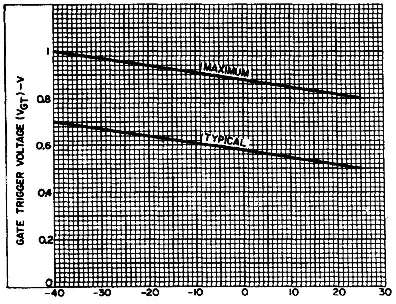


Fig. 13 — Gate trigger voltage as a function of case temperature.

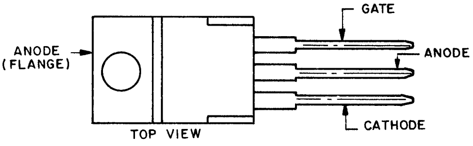
8-A Silicon Controlled Rectifiers

For Power Switching, Power Control

Features:

- *High dv/dt capability*
- *Glass-passivated chip*
- *Shorted-emitter gate-cathode construction*
- *Low thermal resistance*

TERMINAL DESIGNATIONS



92CS-39968

JEDEC TO-220AB

The RCA-C122 series types are medium-power silicon controlled rectifiers designed for switching ac and dc currents. These devices can switch from the off-state to the on-state when both the anode and gate voltages are positive. Negative anode voltages make these devices revert to the blocking state regardless of gate-voltage polarity.

The TO-220AB package provides easy package mounting and low thermal resistance, allowing operation at high case temperatures and permitting reduced heat-sink size. These SCR's can be used in lighting and motorspeed controls and power-switching systems.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	C122F	C122A	C122B	C122C	C122D	C122E	C122M	
V_{RROM}^Δ, V_{DROM}^Δ	50	100	200	300	400	500	600	V
$I_{T(RMS)}$ (T_C = 75° C, θ = 180°)				8				A
I_{TSM}								
For one full cycle of applied principal voltage 400-Hz				200				A
60-Hz				100				A
50-Hz				85				A
For more than one full cycle of applied principal voltage				See Fig. 3				
di/dt								
$V_D = V_{DROM}$								
I_{GT} = 80 mA, t_r = 0.5 μs				100				A/μs
I^2t								
T_J = -65 to 100° C, t = 1 to 8.3 ms				40				A^2s
P_{GM}• (for 10 μs max.)				16				W
$P_{G(AV)}$• (averaging time = 10 ms max.)				0.5				W
T_{stg}				-65 to +150				°C
T_C				-65 to +100				°C
T_T								
During soldering for 10 s maximum (terminal and case)				250				°C

ΔThese values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
•Any values of peak gate current or peak gate voltage which result in equal or lower power are permissible.

C122 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DOM} or I_{ROM} $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = +100^oC$	–	0.1	0.5	mA
v_T $i_T = 16$ A, $T_C = +25^oC$ For other values of i_T	– ←	1.45 See Fig. 5	1.83 →	V
I_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25^oC$ .... For other case temperatures	– ←	10 See Fig. 6	15 →	mA
V_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25^oC$ .... For other case temperatures	– ←	1.0 See Fig. 7	1.5 →	V
i_{HO} $T_C = +25^oC$ .... For other case temperatures	– ←	20 See Fig. 8	30 →	mA
dv/dt $V_D = V_{DROM}$ Exponential voltage rise $T_C = +100^oC$ (See Fig. 12)	10	100	–	V/μs
t_{gt} $V_D = V_{DROM}$, $i_T = 4.5$ A, $i_T = 2$ A $I_{GT} = 80$ mA, 0.1 μs rise time $T_C = +25^oC$ (See Fig. 10)	–	1.6	2.5	μs
t_q $V_D = V_{DROM}$, $i_T = 2$ A, $t_p = 50\ \mu$s dv/dt = 200 V/μs, di/dt = –10 A/μs $I_{GT} = 200$ mA at t_{ON}, $T_C = +75^oC$ (See Fig. 13)	–	10	35	μs
$R_{\theta JC}$	–	–	1.8	$^oC/W$
$R_{\theta JA}$	–	–	75	

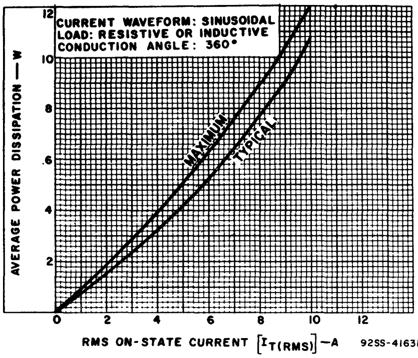


Fig. 1 — Power dissipation vs. on-state current.

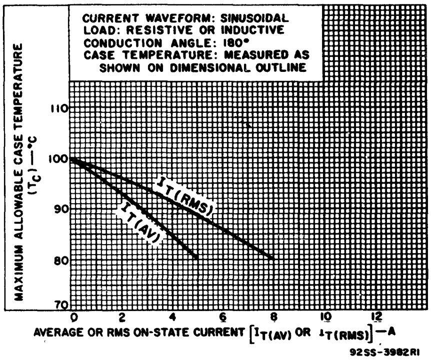


Fig. 2 — Maximum allowable case temperature vs. on-state current.

C122 Series

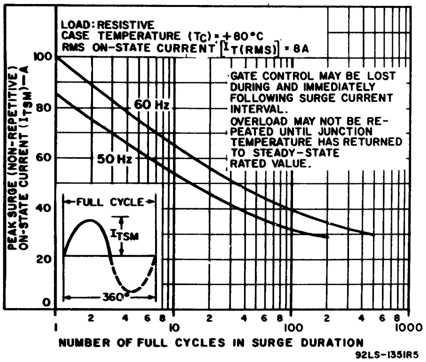


Fig. 3 — Allowable peak surge on-state current vs. surge duration.

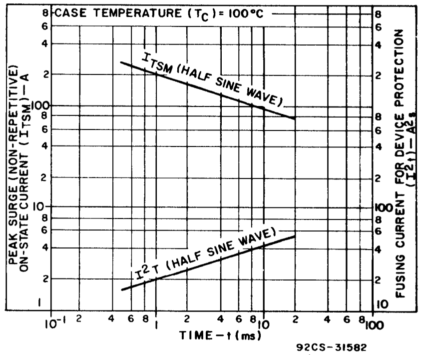


Fig. 4 — Peak surge on-state current and fusing current as a function of time.

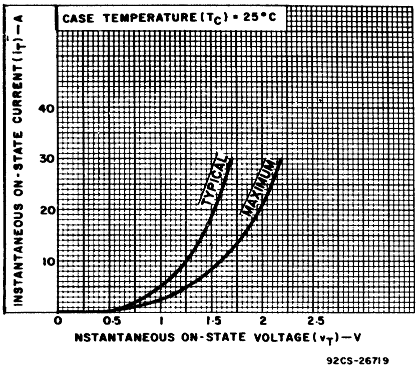


Fig. 5 — Instantaneous on-state current vs. on-state voltage.

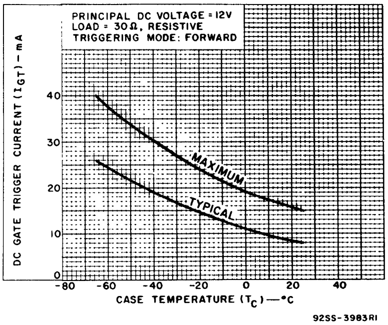


Fig. 6 — DC gate-trigger current vs. case temperature.

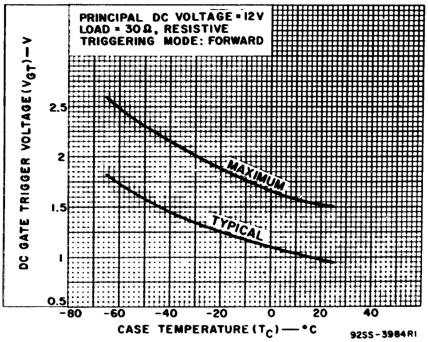


Fig. 7 — DC gate-trigger voltage vs. case temperature.

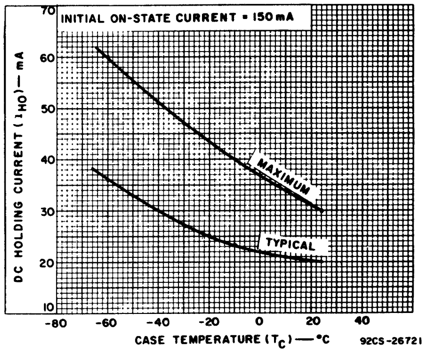


Fig. 8 — Holding current vs. case temperature.

C122 Series

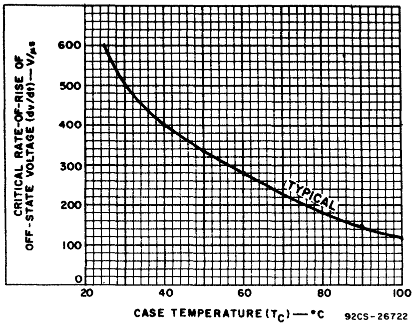


Fig. 9 — Critical rate of rise of off-state voltage vs. case temperature.

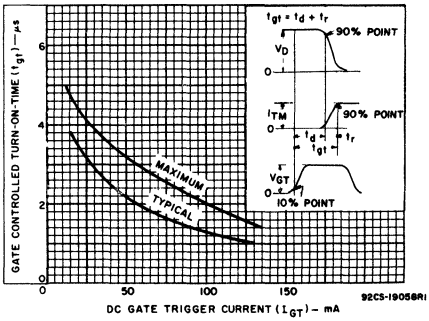


Fig. 10 — Gate-controlled turn-on time vs. gate trigger current.

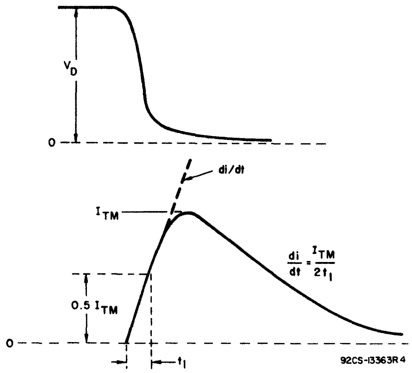


Fig. 11 — Rate of change of on-state current with time (defining di/dt).

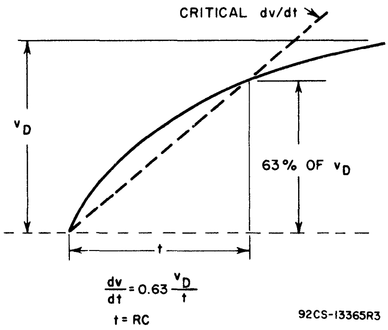


Fig. 12 — Rate of rise of off-state voltage with time (defining critical dv/dt).

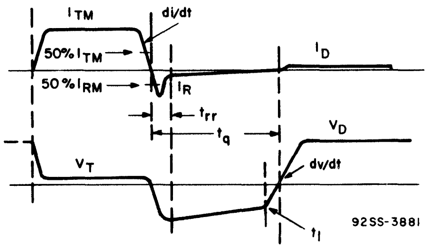


Fig. 13 — Relationship between instantaneous on-state current and voltage, showing reference points for measurement of circuit-commutated turn-off time (t_q).

File Number **654**

S2060, S2061 Series

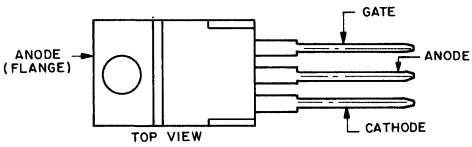
4-Ampere Sensitive-Gate Silicon Controlled Rectifiers

For Power Switching and Control Applications

Features:

- *Microampere gate sensitivity*
- *600-V capability*
- *35-A peak surge capability*
- *Low thermal resistances*
- *Surge capability curve*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The S2060 and S2061 series are sensitive-gate silicon controlled rectifiers designed for switching ac and dc currents. The SCR's are divided into two different series according to gate sensitivity. The types within each series differ in their voltage ratings; the voltage ratings are identified by suffix letters in the type designations.

These thyristors have microampere gate-current requirements which permit operation with low-level logic circuits.

All types in each series utilize the JEDEC TO-220AB package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		S2060Q S2061Q	S2060Y S2061Y	S2060F S2061F	S2060A S2061A	S2060B S2061B	S2060C S2061C	S2060D S2061D	S2060E S2061E	S2060M S2061M	
NON-REPETITIVE PEAK REVERSE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 125°C	V_{RSXM}	25	50	75	125	250	400	500	600	700	V
NON-REPETITIVE PEAK OFF-STATE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 125°C	V_{DSXM}										
REPETITIVE PEAK REVERSE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 125°C	V_{RRXM}	15	30	50	100	200	300	400	500	600	V
REPETITIVE PEAK OFF-STATE VOLTAGE R_{GK} = 1000 Ω, T_C = -40 to 125°C	V_{DRXM}										
ON-STATE CURRENT: Conduction angle = 180°, T_C = 100°C											
Average ac value	$I_{T(AV)}$	2.5									A
RMS value	$I_{T(RMS)}$	4									A
DC operation	$I_{T(DC)}$	2.75									A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT For one cycle of applied principal voltage 60 Hz (sinusoidal)	I_{TSM}	35									A
For more than one cycle of applied principal voltage	I_{GFM}	See Fig. 5									
PEAK GATE CURRENT (t = 10 μsec)	I_{GFM}	0.2									A
PEAK GATE REVERSE VOLTAGE	V_{GRM}	6									V
RATE OF CHANGE OF ON-STATE CURRENT: V_{DM} = V_{DROM}, I_{GT} = 1 mA, t_r = 0.5 μs, T_C = 110°C	di/dt	100									A/μs
GATE POWER DISSIPATION: PEAK FORWARD (for 10 μs max.)	P_{GM}	0.5									W
AVERAGE (averaging time = 10 ms max.)	$P_{G(AV)}$	0.1									W
TEMPERATURE RANGE: Storage	T_{stg}	-40 to +150									°C
Operating (case)	T_C	-40 to +110									°C
TERMINAL TEMPERATURE (During soldering): For 10 s max.	T_T	250									°C

S2060, S2061 Series

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
		MIN.	TYP.	MAX.	
PEAK OFF-STATE CURRENT:					
Forward, $V_D = V_{DRXM}$, R_{GK} = 1000 Ω	I_{DRXM}				µA
T_C = 25°C		–	0.1	10	
T_C = 125°C		–	10	100	
Reverse, $V_R = V_{RRXM}$, R_{GK} = 1000 Ω	I_{RRXM}				
T_C = 25°C		–	0.1	10	
T_C = 125°C		–	10	100	
INSTANTANEOUS ON-STATE VOLTAGE: For i_T = 4 A and T_C = 25°C (See Fig. 14)	v_T	–	1.25	2.2	V
DC GATE TRIGGER CURRENT: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C:	I_{GT}				µA
S2060 Series		–	–	200	
S2061 Series		–	–	500	
			–		
For other case temperatures		See Figs. 9 & 10			
DC GATE TRIGGER VOLTAGE: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	V_{GT}	–	0.5	0.8	V
For other case temperatures		See Fig. 12			
INSTANTANEOUS HOLDING CURRENT: R_{GK} = 1000 Ω, V_D = 12 V, $I_{T\,(INITIAL)}$ = 50 mA, T_C = 25°C:	i_H				mA
S2060 Series		–	1.7	3	
S2061 Series		–	3.9	6	
		–			
LATCHING CURRENT: R_{GK} = 1000 Ω, V_D = 12 V, T_C = 25°C:	i_L				mA
S2060 Series (I_{GT} = 200 µA)		–	1.8	4	
S2061 Series (I_{GT} = 500 µA)		–	2.5	8	
		–			
CRITICAL RATE OF RISE OF OFF-STATE VOLTAGE: $V_D = V_{DRXM}$, R_{GK} = 1000 Ω, Exponential rise, T_C = 125°C	dv/dt	5	8	–	V/µs
GATE-CONTROLLED TURN-ON TIME: $V_D = V_{DRXM}$, i_T = 1 A, R_{GK} = 1000 Ω, I_{GT} = 1 mA, rise time = 0.1 µs, T_C = 25°C	t_{gt}	–	1.7	2.5	µs
CIRCUIT COMMUTATED TURN-OFF TIME: $V_D = V_{DRXM}$, i_T = 1 A, R_{GK} = 1000 Ω, Pulse Duration = 50 µs, dv/dt = 5 V/µs, di/dt = –10 A/µs, I_{GT} = 1 mA at turn on, T_C = 125°C	t_q	–	30	100	µs
THERMAL RESISTANCE:					
Junction-to-Case*	$R_{\theta JC}$	–	–	3.5	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	–	60	

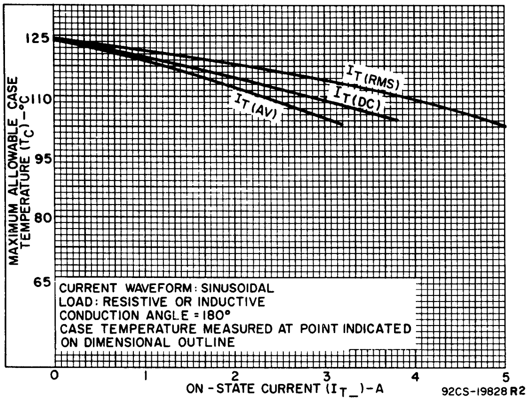


Fig. 1 — Maximum allowable case temperature vs. on-state-current for both series.

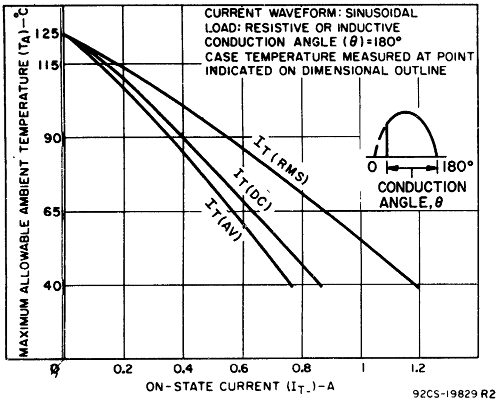


Fig. 2 — Maximum allowable ambient temperature vs. on-state current for both series.

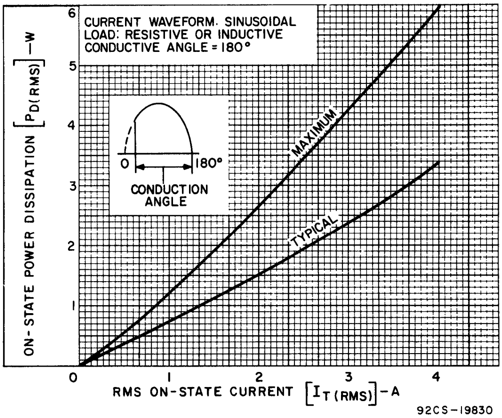


Fig. 3 — Power dissipation vs. rms-on-state current for both series.

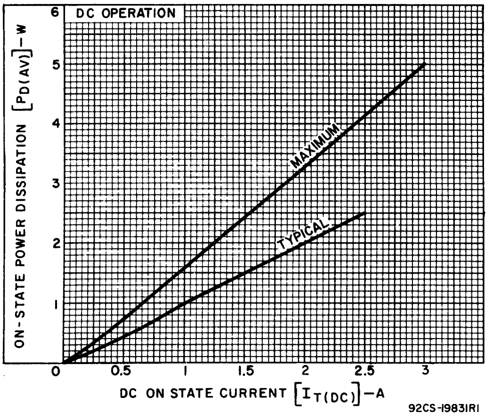


Fig. 4 — Power dissipation vs. dc on-state current for both series.

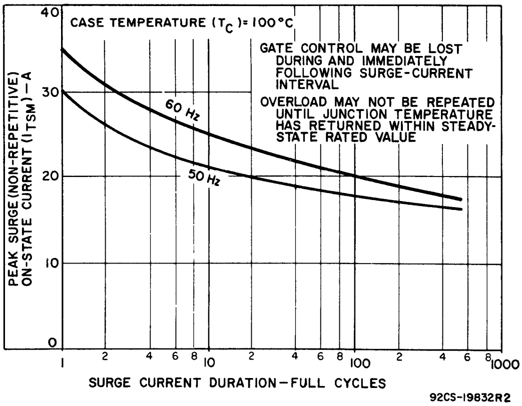


Fig. 5 — Peak surge on-state current vs. surge-current duration for both series.

S2060, S2061 Series

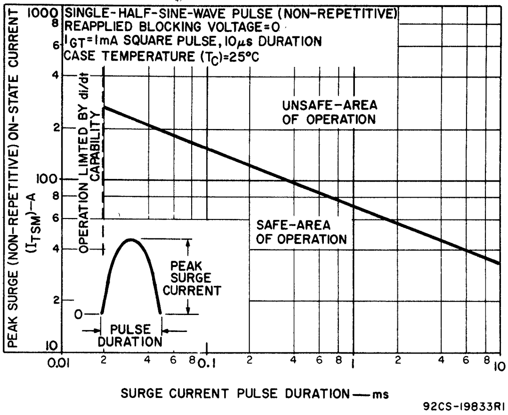


Fig. 6 — Surge capability without reapplied blocking voltage for both series.

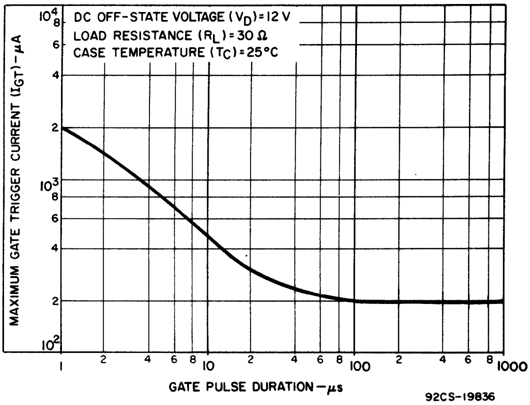


Fig. 7 — Maximum gate trigger current vs. gate pulse duration for types in the S2060 series.

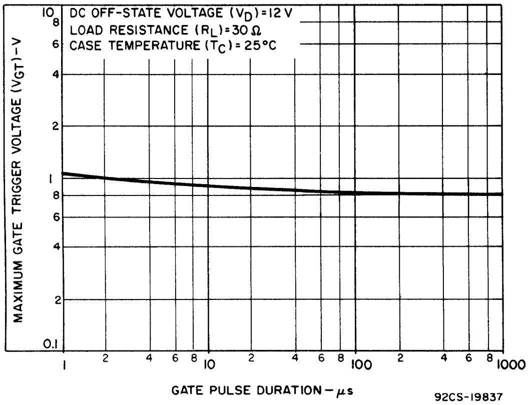


Fig. 8 — Maximum gate trigger voltage vs. gate pulse duration for types in the S2060 series.

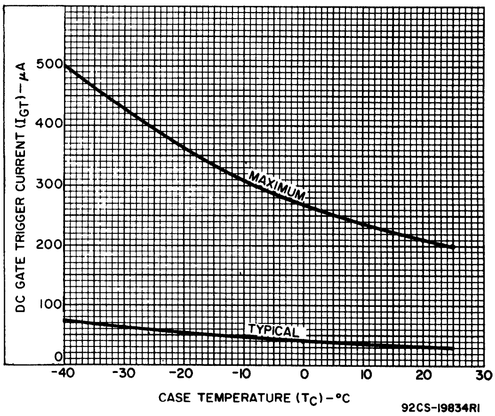


Fig. 9 — DC gate trigger current vs. case temperature for S2060 series.

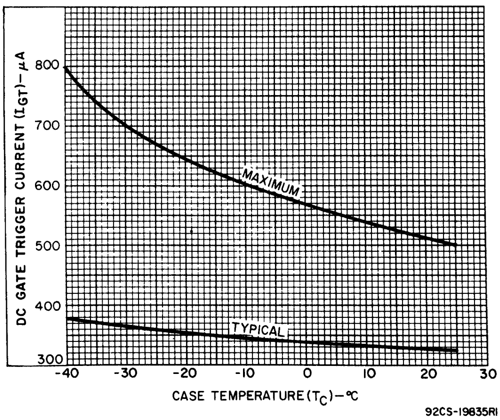


Fig. 10 — DC gate trigger current vs. case temperature for S2061 series.

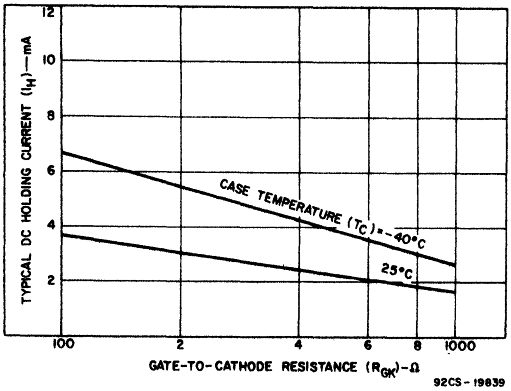


Fig. 11 — DC holding current vs. gate-cathode resistance for the S2060 series.

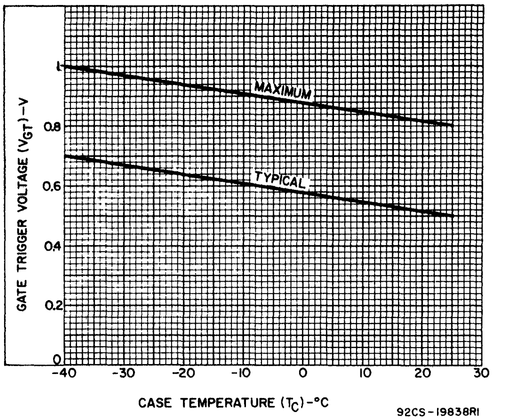


Fig. 12 — Gate trigger voltage vs. case temperature for all series.

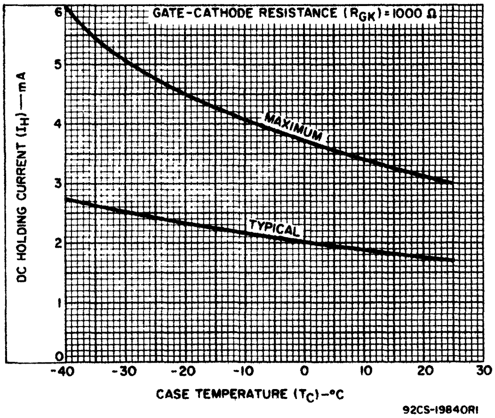


Fig. 13 — DC holding current vs. case temperature for the S2060 series.

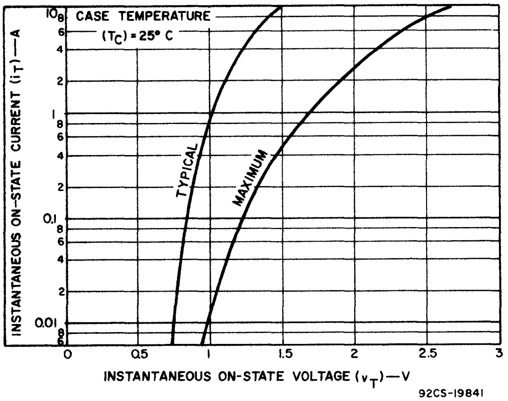


Fig. 14 — Instantaneous on-state current vs. on-state voltage for both series.

S2600B, S2600D, S2600M, S2600N

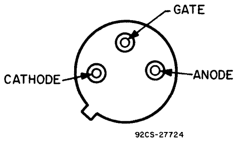
File Number **1693**

High Voltage, Medium Current Silicon Controlled Rectifiers

For Power Switching, Power Control and Ignition Applications

Features:
- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



Low-Profile TO-205

The S2600 series are high voltage, medium current silicon controlled rectifiers designed for switching AC and DC currents. The types within the series differ in their voltage ratings: the voltage ratings are identified by suffix letters in the type designations.

All types utilize the low-profile TO-205 package.

These Thyristors feature an advanced unisurface construction with a multilayer glass passivation system for improved reliability performance at high junction operating temperatures. Their dv/dt, di/dt capability and low switching losses make them suitable for applications such as lighting, power-switching, motor speed control and crowbars.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S2600B	S2600D	S2600M	S2600N	
VDRM	200	400	600	800	V
VRRM	200	400	600	800	V
IT (RMS) ($T_C = 65°C$)			7		A
IT (av) ($T_C = 65°C$, $\theta = 180$ Deg.)			4.5		A
ITSM (for 1 full cycle)			100		A
di/dt			200		A/μs
I^2T (at 8.3 ms)			40		A^2s
(at 1.5 ms)			30		A^2s
PGM (for 10μs max.)			15		W
PG (av) (Averaging time 10ms max.)			0.5		W
T Storage			-65 to 150		°C
TJ			-65 to 125		°C

S2600B, S2600D, S2600M, S2600N

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

CHARACTERISTIC	SYMBOL	LIMITS S2600 FAMILY MIN.	TYP.	MAX.	UNITS
Repetitive Peak Forward and Reverse Blocking Current Rated VDRM and VRRM, Gate Open at TC = 125°C	 IDROM IRROM	 — —	 — —	 50 2	 μA mA
Forward "On State" Voltage ITM = 30A	VTM	—	1.8	2.6	V
Gate Trigger Current (dc) VD = 12 Vdc RL = 30 Ohms	IGT	—	10	15	mA
Gate Trigger Voltage (dc) VD = 12 Vdc, RL = 30 Ohms VD = VDRM, RL = 500 Ohms, TC = 125°C	VGT	 — 0.2	 1 —	 1.5 —	V
Holding Current VD = 12 Vdc, IT (initial) = 200mA	IH	—	15	—	mA
Critical Rate of Rise of Off-State Voltage (Exponential Waveform) TC = 125° C, Gate Open, VD = VDRM S2600B, S2600D S2600M S2600N	dv/dt	 — — — —	 — 150 125 75	 — — — —	V/μS
Turn-On Time IT = 2A, VD = VDRM IG = 80mA	tgt	—	1.2	—	μS
Turn-Off Time VD = VDRM, TC = 75°C, dv/dt = 20V/μS IT = 2A for 50 μS, di/dt = 10A/μS IG = 80mA at Turn-On	tq	—	65	—	μS
Thermal Resistance Junction to Case Junction to Ambient	 RθJC RθJA	 — —	 — —	 7 150	°C/W

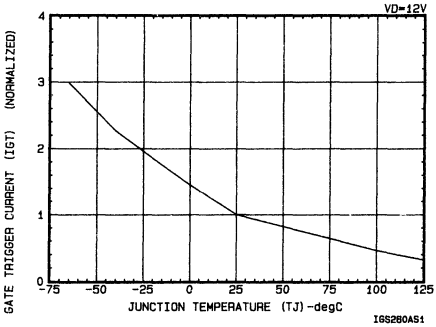


Fig. 1 - Typical Gate Trigger Current Vs. Temperature

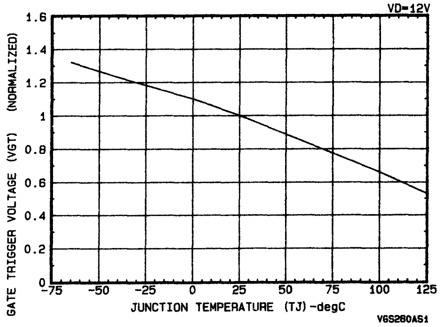


Fig. 2 - Typical Gate Trigger Voltage Vs. Temperature

S2600B, S2600D, S2600M, S2600N

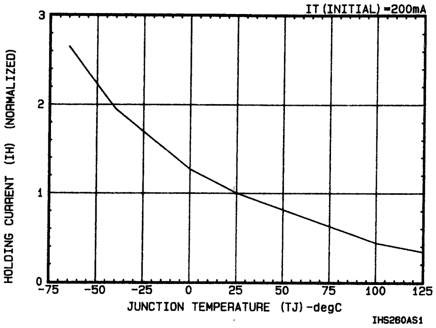


Fig. 3 - Typical Holding Current Vs. Temperature

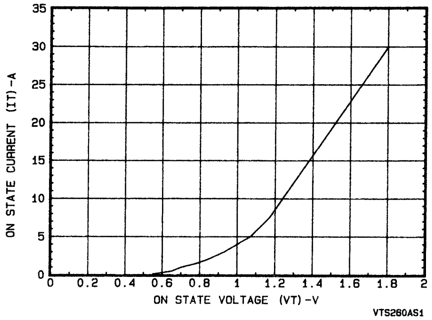


Fig. 4 - Typical On State Voltage Vs. Current

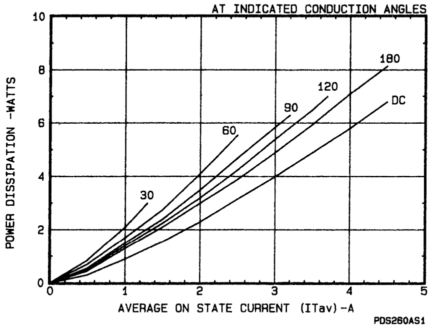


Fig. 5 - Maximum Power Dissipation Vs. Average Current

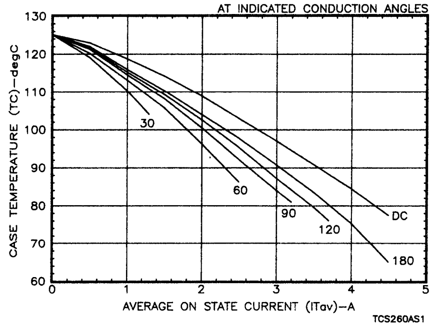


Fig. 6 - Maximum Case Temperature Vs. Average Current

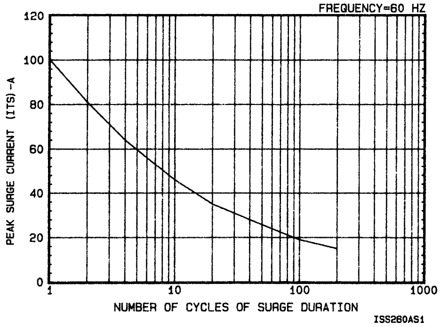


Fig. 7 - Peak Surge Current Vs. Duration

File Number **1627**

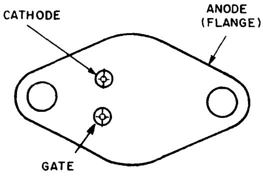
S2700D, S2700M, S2700N

High Voltage, Medium Current Silicon Controlled Rectifiers

For Power Switching, Power Control

Features:
- 800V, 125 deg. C T_J Operating
- High dv/dt and di/dt Capability
- Low Switching Losses
- High Pulse Current Capability
- Low Forward and Reverse Leakage
- Sipos Oxide Glass Multilayer Passivation System
- Advanced Unisurface Construction
- Precise Ion Implanted Diffusion Source

TERMINAL DESIGNATIONS



JEDEC TO-213AA

The S2700, series are high voltage, medium current silicon controlled rectifiers designed for switching AC and DC currents. The types within the series differ in their voltage ratings: the voltage ratings are identified by suffix letters in the type designations.

All types utilize the JEDEC TO-213AA/TO-66 package.

These Thyristors feature an advanced unisurface construction with a multilayer glass passavation system for improved reliability performance at high junction operating temperatures. Their dv/dt, di/dt capability and low switching losses make them suitable for applications such as lighting, power-switching, motor speed control and crowbars.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S2700D	S2700M	S2700N	
VDRM	400	600	800	V
VRRM	400	600	800	V
IT (RMS) (Tc=95°C)		5		A
IT (av) (Tc=95°C, θ=180 Deg.)		3.2		A
ITSM (for 1 full cycle)		100		A
di/dt		200		A/µs
I^2T (at 8.3ms)		40		A^2S
(at 1.5ms)		30		A^2S
PGM (for 10µs max.)		15		W
PG(av) (Averaging time 10ms max.)		0.5		W
T STORAGE		-65 TO 150		°C
TJ		-65 TO 125		°C

S2700D, S2700M, S2700N

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

CHARACTERISTIC	SYMBOL	LIMITS S2700 FAMILY Min.	Typ.	Max.	UNITS
Repetitive Peak Forward and Reverse Blocking Current Rated VDRM and VRRM, Gate Open at TC = 125°C	 IDROM IRROM	 — —	 — —	 50 2	 µA mA
Forward "On State" Voltage ITM = 30A	VTM	—	2	2.8	V
Gate Trigger Current (dc) VD = 12Vdc RL = 30 Ohms	IGT	—	10	15	mA
Gate Trigger Voltage (dc) VD = 12Vdc, RL =30 Ohms VD = VDRM, RL =500 Ohms, TC = 125°C	VGT	 — 0.2	 1 —	 1.5 —	V
Holding Current VD = 12 Vdc, IT (initial) = 200 mA	IH	—	15	—	mA
Critical Rate of Rise of Off-State Voltage (Exponential Waveform) TC = 125°C, Gate Open, VD = VDRM S2700D S2700M S2700N	dv/dt	 — — — —	 — 175 150 100	 — — — —	Vµs
Turn-On Time IT = 2A, VD = VDRM IG = 80mA	tgt	—	1.2	—	µs
Turn-Off Time VD = VDRM, TC = 75°C, dv/dt = 20V/µs IT = 2A for 50µs, di/dt = 10A/µs IG = 80mA at Turn-On	tq	—	65	—	µs
Thermal Resistance Junction to Case Junction to Ambient	 RθJC RθJA	 — —	 — —	 5 40	°C/W

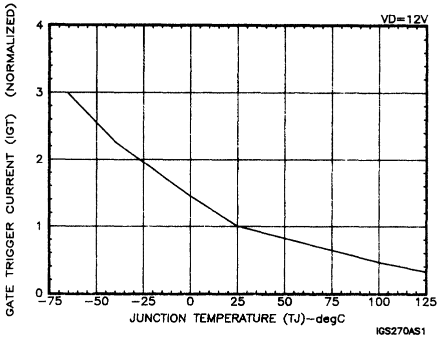


Fig. 1 — Typical Gate Trigger Current vs. Temperature

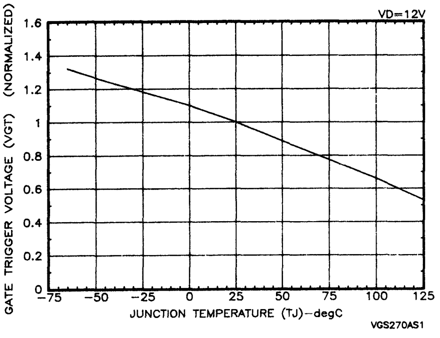


Fig. 2 — Typical Gate Trigger Voltage vs. Temperature

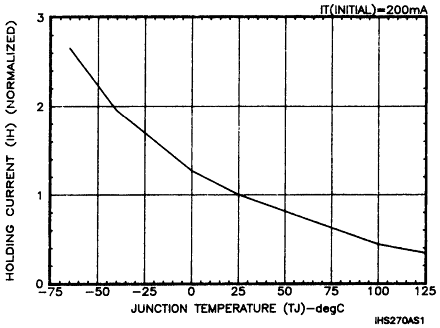


Fig. 3 — Typical Holding Current vs. Temperature

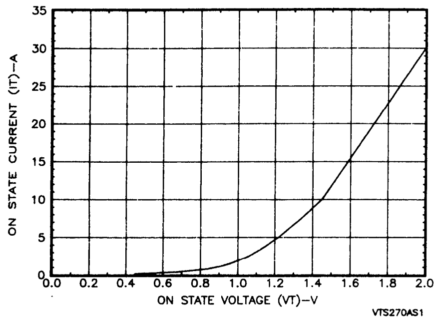


Fig. 4 — Typical On State Voltage vs. Current

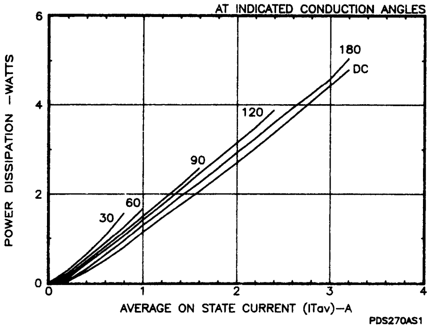


Fig. 5 — Maximum Power Dissipation vs. Average Current

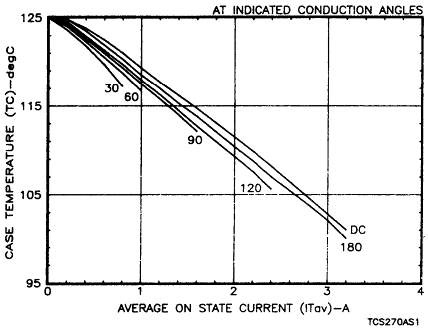


Fig. 6 — Maximum Case Temperature vs. Average Current

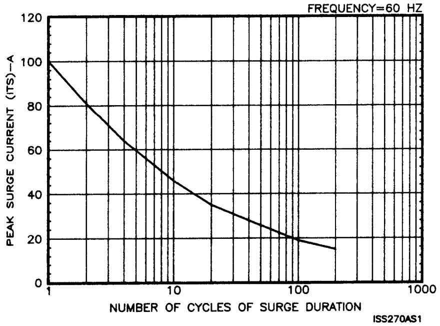


Fig. 7 — Peak Surge Current vs. Duration

S2800 Series

File Number **890**

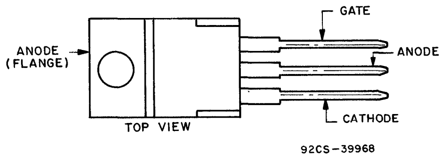
10-A Silicon Controlled Rectifiers

For Power Switching, Power Control

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The S2800 series are high voltage, medium current silicon controlled rectifiers designed for switching AC and DC currents. The types within the series differ in their voltage ratings: the voltage ratings are identified by suffix letters in the type designations.

All types utilize the JEDEC TO-220AB package.

These Thyristors feature an advanced unisurface construction with a multilayer glass passavation system for improved reliability performance at high junction operating temperatures. Their dv/dt, di/dt capability and low switching losses make them suitable for applications such as lighting, power-switching, motor speed control and crow-bars.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S2800F	S2800A	S2800B	S2800C	S2800D	S2800E	S2800M	S2800S	S2800N	
V_{DRM}, V_{RRM}	50	100	200	300	400	500	600	700	800	V
$I_{T(RMS)}$ (T_C=100° C, θ = 180°)					10					A
I_{TSM} (for 1 full cycle)					100					A
di/dt					100					A/μs
I^2T (at 8.3 ms)					40					A^2s
P_{GM} (for 10μs max.)					16					W
$P_{G(AV)}$ (Averaging time 10ms max.)					0.5					W
T Storage					-65 to +150					°C
T_J					-65 to +125					°C
T_T (During soldering): For 10 s max. terminals and case)					250					°C

S2800 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified, and at Indicated Case Temperatures (T_C)

CHARACTERISTIC	LIMITS — For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM} or I_{ROM} $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = +125°C$	—	0.1	2	mA
V_T $i_T = 30$ A, $T_C = +25°C$	—	1.7	2	V
For other values of i_T	←	See Fig. 4	→	
I_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25°C$	—	8	15	mA
For other case temperatures	←	See Fig. 5	→	
V_{GT} $V_D = 12$ V (DC), $R_L = 30\ \Omega$ $T_C = +25°C$	—	0.9	1.5	V
For other case temperatures	←	See Fig. 6	→	
I_{HO} $T_C = +25°C$	—	10	20	mA
For other case temperatures	←	See Fig. 7	→	
dv/dt $v_D = V_{DROM}$, Exponential voltage rise $T_C = +125°C$ (See Fig. 11)				V/μs
S2800F	100	—	—	V/μs
S2800A	75	—	—	V/μs
S2800B	50	—	—	V/μs
S2800C	40	—	—	V/μs
S2800D	30	—	—	V/μs
S2800E	25	—	—	V/μs
S2800M	20	—	—	V/μs
S2800S	15	—	—	V/μs
S2800N	15	—	—	V/μs
t_{gt} $v_D = V_{DROM}$, $i_T = 2$ A $I_{GT} = 80$ mA, 0.1 μs rise time $T_C = +25°C$ (See Fig. 9)	—	1.6	2.5	μs
t_q $V_D = V_{DROM}$, $i_T = 2$ A, $t_p = 50\ \mu$s dv/dt = 200 V/μs, di/dt = −10 A/μs I_{GT} = 200 mA at t_{ON}, $T_C = +75°C$ (See Fig. 12)	—	10	35	μs
$R_{\theta JC}$	—	—	2	°C/W
$R_{\theta JA}$	—	—	60	°C/W

S2800 Series

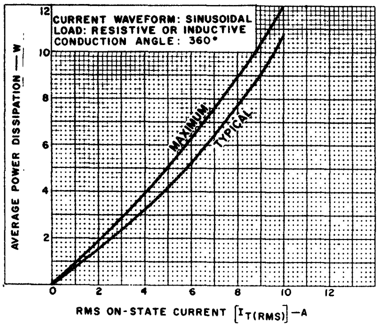


Fig. 1 — Power dissipation vs. on-state current.

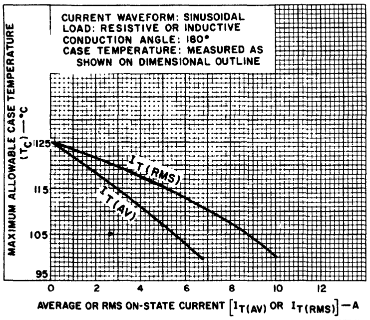


Fig. 2 — Maximum allowable case temperature vs. on-state current.

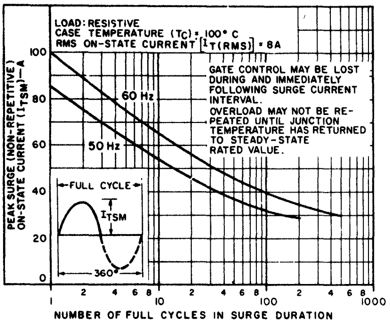


Fig. 3 — Allowable peak surge on-state current vs. surge duration.

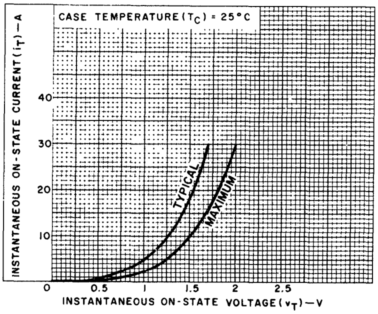


Fig. 4 — Instantaneous on-state current vs. on-state voltage.

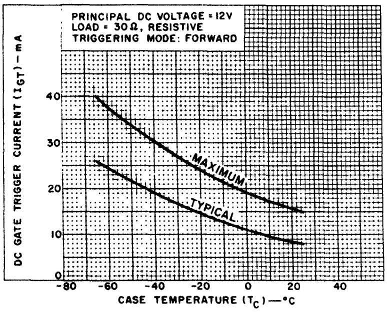


Fig. 5 — DC gate-trigger current vs. case temperature.

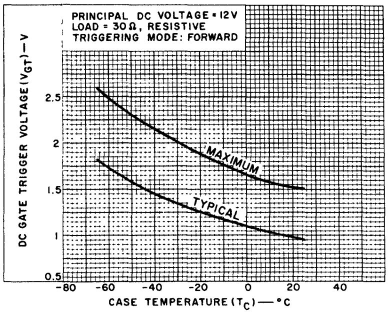


Fig. 6 — DC gate-trigger voltage vs. case temperature.

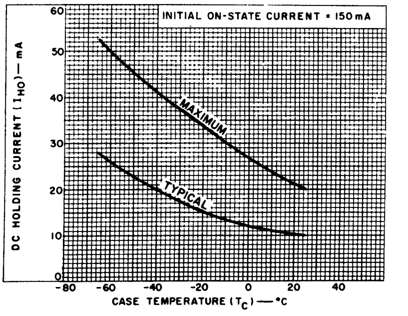


Fig. 7 — Holding current vs. case temperature.

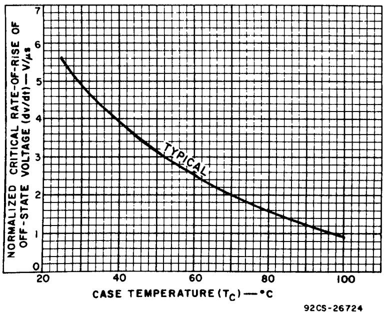


Fig. 8 — Normalized critical rate of rise of off-state voltage vs. case temperature.

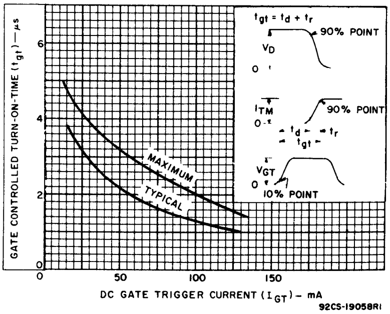


Fig. 9 — Gate-controlled turn-on time vs. gate trigger current.

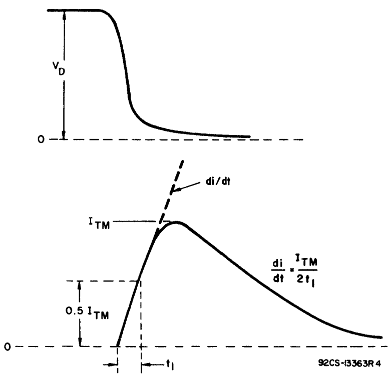


Fig. 10 — Rate of change of on-state current with time (defining di/dt).

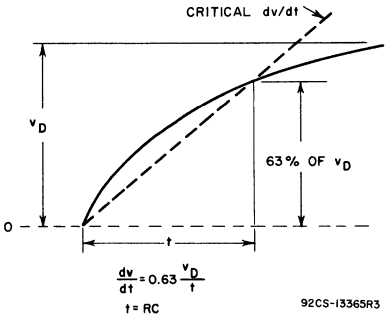


Fig. 11 — Rate of rise of off-state voltage with time (defining critical dv/dt).

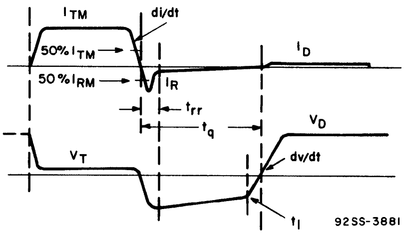


Fig. 12 — Relationship between instantaneous on-state current and voltage, showing reference points for measurement of circuit-commutated turn-off time (t_q).

S3700 Series

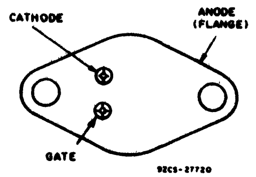
File Number **306**

5-A Silicon Controlled Rectifiers

For Inverter Applications

Features:
- *600V, 125°C T_J operating*
- *High dv/dt and di/dt capability*
- *Low switching losses*
- *High pulse-current capability*
- *Low forward and reverse leakage*
- *SIPOS oxide glass multilayer passivation system*
- *Advanced unisurface construction*
- *Precise ion-implanted diffusion source*

TERMINAL DESIGNATIONS



JEDEC TO-213AA

The RCA-S3700-series types are all-diffused, silicon controlled rectifiers (reverse-blocking triode thyristors) designed for inverter applications such as ultrasonics, choppers, regulated power supplies; induction heaters, and fluorescent lighting. These types may be used at frequencies up to 25 kHz.

The S3700 series employ a hermetic JEDEC TO-213AA package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		S3700B	S3700D	S3700M	
Non-repetitive peak reverse voltage:■					
Gate Open	V_{RSOM}	300	500	700	V
Non-repetitive peak off-state voltage:■					
Gate Open	V_{DSOM}	300	500	700	V
Repetitive peak reverse voltage:■					
Gate Open	V_{RROM}	200	400	600	V
Repetitive peak off-state voltage:■					
Gate Open	V_{DROM}	200	400	600	V
On-state current:					
T_C = 85° C, conduction angle = 180°:					
RMS	$I_{T(RMS)}$		5		A
Average	$I_{T(AV)}$		3.2		A
For other conditions			See Figs. 3 & 4		
Peak surge (non-repetitive) on-state current:	I_{TSM}				
For one full cycle of applied principal voltage, T_C = 85° C					
60 Hz (sinusoidal)			80		A
50 Hz (sinusoidal)			65		A
For more than one full cycle of applied principal voltage			See Fig. 5		
Rate of change of on-state current					
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 µs	di/dt		200		A/µs
Fusing current (for SCR protection):					
T_J = -40 to 100°C, t = 1 to 8.3 ms	I^2t		25		A
Gate power dissipation:•					
Peak Forward (for 10 µs max., See Fig. 7)	P_{GM}		13		W
Peak Reverse (for 10 µs max., See Fig. 8)	P_{RGM}		13		W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$		0.5		W
Temperature Range:†					
Storage	T_{stg}		-40 to 150		°C
Operating (Case)	T_C		-40 to 125		°C
Pin Temperature (During soldering):					
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P		225		°C

■ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

• Any product of gate current and gate voltage which results in a gate power less then the maximum is permitted.

† For temperature measurement reference point, *see Dimensional Outline.*

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES Except as Specified			UNITS
		MIN.	TYP.	MAX.	
Peak Off-State Current: (Gate open, T_C = 125°C)					
Forward Current (I_{DOM}) at V_D = V_{DROM}	I_{DOM}	–	0.5	3	mA
Reverse Current (I_{ROM}) at V_R = V_{RROM}	I_{ROM}	–	0.3	1.5	mA
Instantaneous On-State Voltage: i_T = 30 A (peak), T_C = 25°C	v_T	–	2.2	3	V
For other conditions			See Fig. 6		
Instantaneous Holding Current: Gate open, T_C = 25°C	I_{HO}	–	20	50	mA
Critical Rate of Rise of Off-State Voltage: V_D = V_{DROM}, exponential voltage rise, Gate open, T_C = 125°C	dv/dt	100	250	–	V/μs
DC Gate Trigger Current: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	I_{GT}	–	15	40	mA
For other conditions			See Fig. 7		
DC Gate Trigger Voltage: V_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	V_{GT}	–	1.8	3.5	V
For other conditions			See Fig. 7		
Gate Controlled Turn-On Time: (Delay Time + Rise Time) For V_{DX} = V_{DROM}, I_{GT} = 300 mA, t_r = 0.1 μs, I_T = 2 A (peak), T_C = 25°C (See Fig. 10)	t_{gt}	–	0.7	–	μs
Circuit Commutated Turn-Off Time: V_{DX} = V_{DROM}, i_T = 2 A, pulse duration = 50 μs, dv/dt = 100 V/μs, –di/dt = –10 A/μs, I_{GT} = 100 mA, V_{GT} = 0 V (at turn-off), T_C = 80°C (See Fig. 13)	t_q		4	6	μs
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	–	4	8	°C/W
Junction-to-Ambient	$R_{\theta JA}$	–	–	40	°C/W

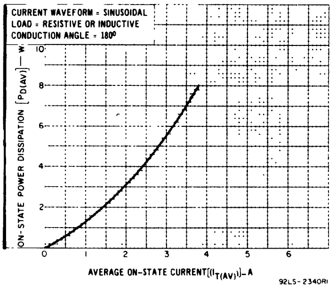


Fig. 1—Power dissipation vs. average on-state current.

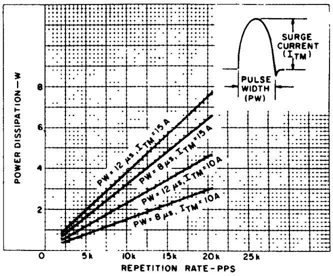


Fig. 2—Dissipation vs. repetition rate.

S3700 Series

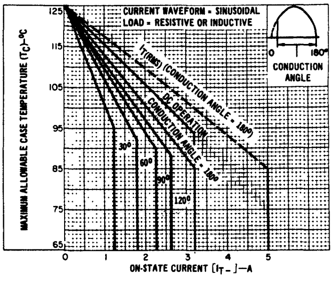


Fig. 3—Maximum allowable case temperature vs. on-state current.

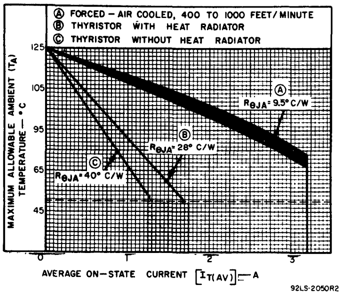


Fig. 4—Maximum allowable ambient temperature vs. average on-state current.

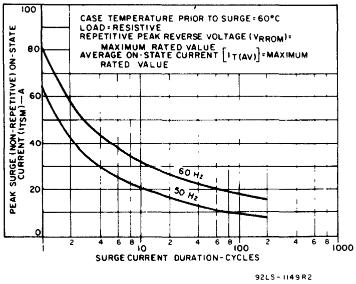


Fig. 5—Peak surge on-state current vs. surge-current duration.

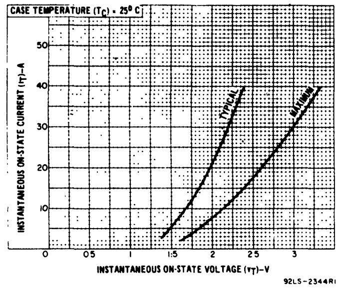


Fig. 6—Instantaneous on-state current vs. on-state voltage.

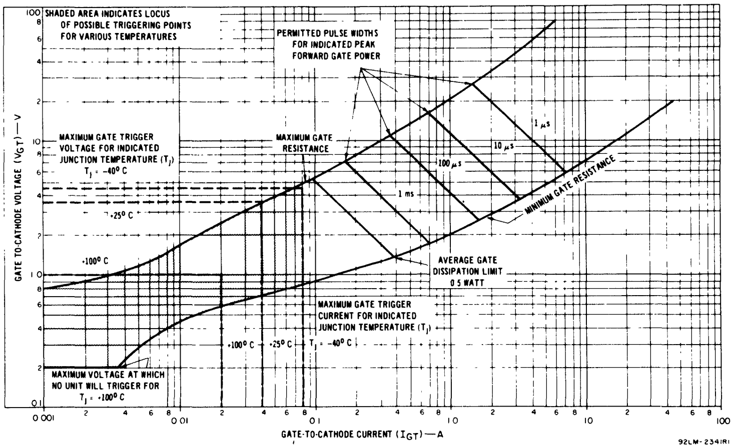


Fig. 7—Gate-trigger characteristics and limiting conditions for determination of permissible gate-trigger pulses.

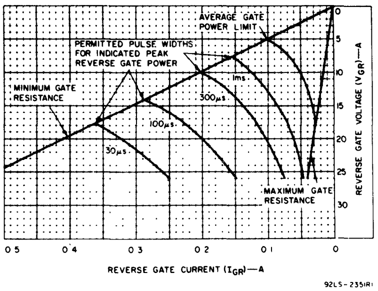


Fig. 8—Reverse-gate voltage vs. reverse-gate current.

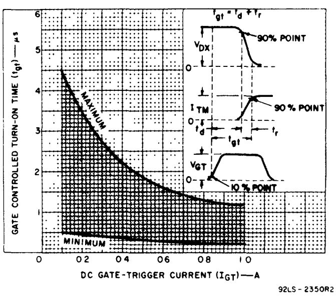


Fig. 9—Turn-on time vs. gate-trigger current.

File Number **1306**

S4060 Series

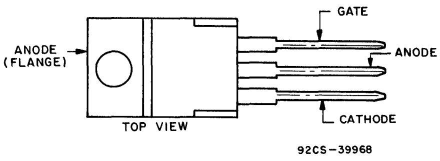
10-Ampere Sensitive-Gate Silicon Controlled Rectifiers

For Power Switching and Control Applications

Features:

- *Microampere gate sensitivity*
- *800-V capability*
- *10-A (rms) on-state current ratings*
- *120-A peak surge capability*
- *Low thermal resistances*
- *Surge capability curve*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The S4060 series* are sensitive-gate silicon controlled rectifiers designed for switching ac and dc currents. The types within the series differ in their voltage ratings; the voltage råtings are identified by suffix letters in the type designations.

All types utilize the JEDEC TO-220AB package.

These thyristors have microampere gate-current requirements which permit operation with low-level logic circuits. They can be used for lighting, power-switching, and motor-speed controls, and for gate-current amplification for driving larger SCR's.

*Formerly the RCA Dev. No. TAS4060 series.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S4060U	S4060F	S4060A	S4060B	S4060C	S4060D	S4060E	S4060M	S4060S	S4060N	
V_{RRXM} $R_{GK} = 1000\ \Omega$, $T_C = -40$ to 125°C .. V_{DRXM} $R_{GK} = 1000\ \Omega$, $T_C = -40$ to 125°C ..	25	50	100	200	300	400	500	600	700	800	V

	All types	
$I_{T(RMS)}$ Conduction angle = 180°, $T_C = 103°C$	10	A
I_{TSM} For one cycle of applied principal voltage 60 Hz (sinusoidal)	120	A
For more than one cycle of applied principal voltage	See Figs. 5, 6	
I_{GFM} ($t = 10\ \mu sec$)	0.2	A
V_{GRM}	6	V
di/dt $V_{DM} = V_{DROM}$, $I_{GT} = 1$ mA, $t_r = 0.5\ \mu$, $T_C = 110°C$	100	A/μs
P_{GM} (for 10 μs max.)	0.5	W
$P_{G(AV)}$ (averaging time = 10 ms max.)	0.1	W
T_{stg}	-40 to +150	°C
T_C	-40 to +125	°C
T_T For 10 s max.	250	°C

S4060 Series

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED			UNITS
	MIN.	TYP.	MAX.	
I_{DRXM}, $V_D = V_{DRXM}$, $R_{GK} = 1000\ \Omega$				
$T_C = 25°\ C$	—	0.4	50	μA
$T_C = 125°C$	—	50	500	μA
I_{RRXM}, $V_R = V_{RRXM}$, $R_{GK} = 1000\ \Omega$				
$T_C = 25°\ C$	—	0.4	50	μA
$T_C = 125°C$	—	50	500	μA
v_T For $i_T = 30$ A and $T_C = 25°$ C (See Fig. 4)	—	1.55	2.3	V
I_{GT} $V_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25°$ C:	—	—	200	μA
For other case temperatures	See Fig. 8			
V_{GT} $V_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25°$ C	—	0.58	1.5	V
For other case temperatures	See Fig. 7			
i_H $R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $I_{T\ (INITIAL)} = 150$ mA, $T_C = 25°$ C: (See Fig. 9)	—	3.5	—	mA
i_L $R_{GK} = 1000\ \Omega$, $V_D = 12$ V, $T_C = 25°$ C: ($I_{GT} = 200\ \mu A$)	—	1.8	—	mA
dv/dt $V_D = V_{DRXM}$, $R_{GK} = 1000\ \Omega$, Exponential rise, $T_C = 125°C$ (See Fig. 10)	—	4.0	—	V/μs
t_{gt} $V_D = V_{DRXM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, $I_{GT} = 1$ mA, rise time = 0.1 μs, $T_C = 25°$ C	—	1.7	—	μs
t_q $V_D = V_{DRXM}$, $i_T = 1$ A, $R_{GK} = 1000\ \Omega$, Pulse Duration = 50 μs, dv/dt = 2 V/μs, di/dt = — 10 A/μs, $I_{GT} = 1$ mA at turn on, $T_C = 125°C$	—	50	—	μs
$R_{\theta JC}$	—	—	2.0	°C/W
$R_{\theta JA}$	—	—	60	°C/W

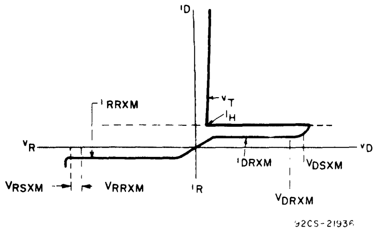


Fig. 1 - Typical volt-ampere characteristics.

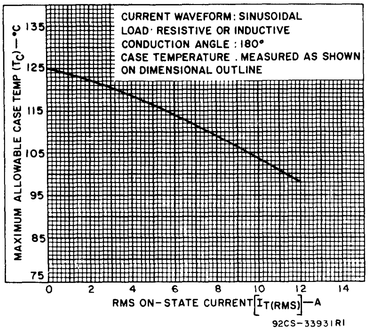


Fig. 3 - Maximum allowable case temp. vs. RMS on-state current.

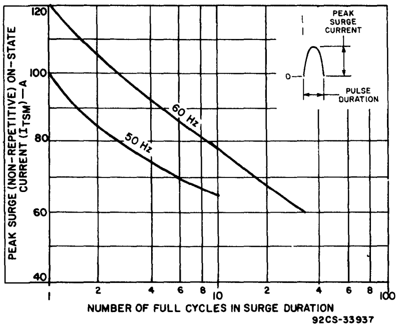


Fig. 5 - Allowable peak surge on-state current vs. surge duration.

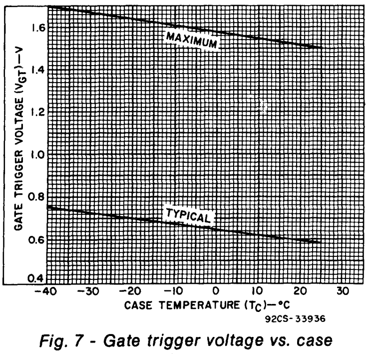


Fig. 7 - Gate trigger voltage vs. case temperature.

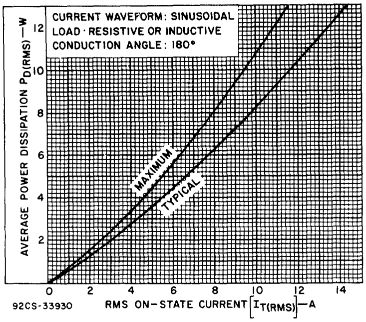


Fig. 2 - Power dissipation vs. rms on-state current.

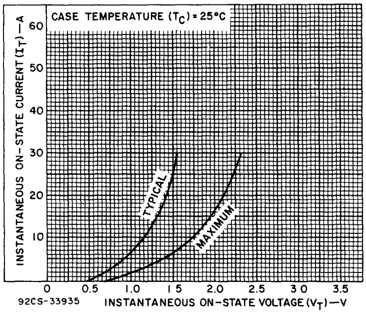


Fig. 4 - Instantaneous on-state current vs. on-state voltage.

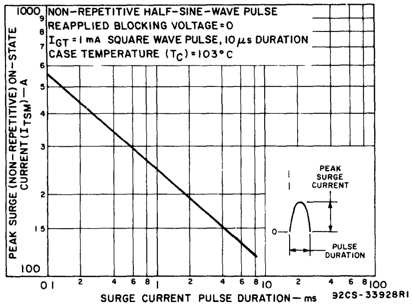


Fig. 6 - Surge capability without reapplied blocking voltage.

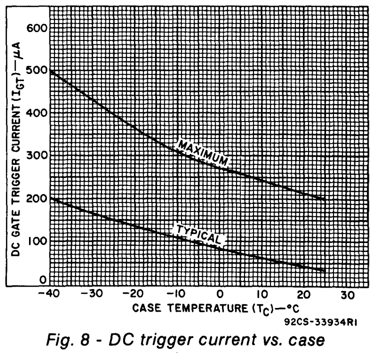


Fig. 8 - DC trigger current vs. case temperature.

S4060 Series

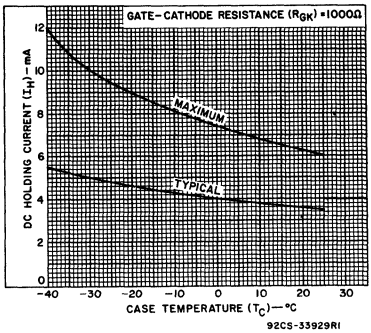


Fig. 9 - DC holding current vs. case temperature.

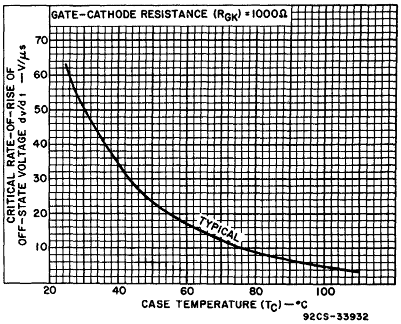


Fig. 10 - Critical rate-of-rise of off-state voltage vs. case temperature.

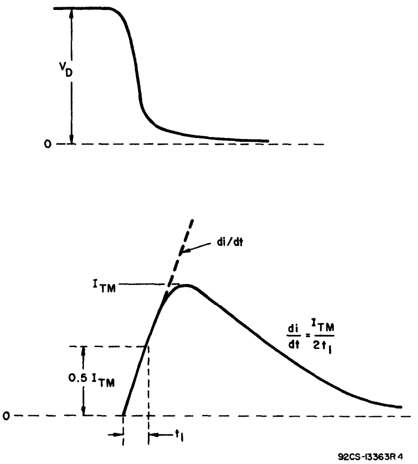


Fig. 11 - Rate of change of on-state current with time (defining di/dt).

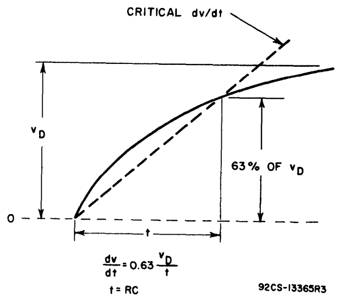


Fig. 12 - Rate of rise of off-state voltage with time (defining critical dv/dt).

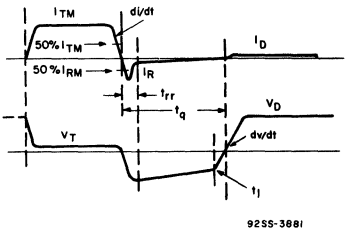


Fig. 13 - Relationship between instantaneous on-state current and voltage, showing reference points for measurement of circuit-commutated turn-off time [t_q].

File Number **1051**

S5800

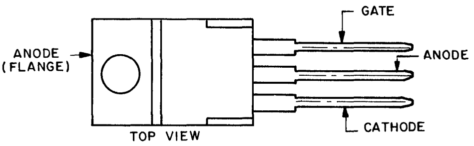
5-A Silicon Controlled Rectifiers

For Inverter/Regulator Applications

Features:

- *800V, 125 deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



92CS-39968

JEDEC TO-220AB

The RCA-S5800 series are all-diffused silicon controlled rectifiers (reverse-blocking triode thyristors) intended for high-speed switching applications such as power inverters, switching regulators, and high-current pulse applications. They feature fast turn-off, high dv/dt, and high di/dt characteristics and may be used at frequencies up to 25 kHz.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S5800B	S5800C	S5800D	S5800E	S5800M	S5800S	S5800N	
V_{RROM}▲	200	300	400	500	600	700	800	V
V_{DROM}▲	200	300	400	500	600	700	800	V
$I_{T(RMS)}$ ($T_C = 85°C$, $t_1/t_2 = 0.5$)	5							A
$I_{T(AV)}$ ($T_C = 85°C$, $t_1/t_2 = 0.5$)	3.2							A
I_{TSM}: (For one full cycle of applied principal voltage)								
60-Hz (sinusoidal)	80							A
50-Hz (sinusoidal)	75							A
For more than one cycle of applied principal voltage	See Fig. 3							
di/dt: (See Fig. 8) $V_{DM} = V_{DROM}$, $I_{GT} = 500$ mA,	200							A/µs
I^2T [At T_C shown for I_T(RMS)]:								
t = 10 ms	28							A^2s
8.3 ms	26							A^2s
1 ms	13							A^2s
For other time values	See Fig. 4							
P_{GM}: Peak forward for 10 µs max.	13							W
P_{RGM}: Peak reverse for 10 µs max.	13							W
$P_{G(AV)}$: Averaging time = 10 ms max.	0.5							W
T_{stg}	-40 to 150							°C
T_C	-40 to 125							°C
T_T (During soldering for 10 s maximum, terminals and case).	225							°C

▲These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.

S5800

ELECTRICAL CHARACTERISTICS

As Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Min.	Typ.	Max.	UNITS
I_{DROM}: $V_D = V_{DROM}$, $T_C = 125°C$	–	0.5	3	mA
I_{RROM}: $V_R = V_{RROM}$, $T_C = 125°C$	–	0.3	1.5	mA
V_T: I_{TM} = 30 A (peak), $T_C = 25°C$: (See Fig. 5)	–	2.3	4	V
i_{HO}: $T_C = 25°C$	–	20	–	mA
dv/dt: (Linear) (See Fig. 9) $V_D = V_{DROM}$, $T_C = 80°C$	–	250	–	V/μs
I_{GT}: V_D = 12 V dc, R_L = 30 Ω, $T_C = 25°C$	–	–	40	mA
V_{GT}: V_D = 12 V dc, R_L = 30 Ω, $T_C = 25°C$	–	1.2	2.5	V
t_{gt}: (See Fig. 10) $V_D = V_{DROM}$, i_T = 8 A (peak), I_{GT} = 300 mA, t_r = 0.1 μs, $T_C = 25°C$	–	0.7	–	μs
t_q: (See Figs. 7, 11, 12) ½ Sine Wave $V_D = V_{DROM}$, pulse duration = 50 μs, dv/dt = 100 V/μs, –di/dt = –10 A/μs, I_{GT} = 100 mA at turn on, V_{GK} = 0 V at turn off, $T_C = 100°C$: i_T = 4A	–	4.4	–	μs
i_T = 8A	–	4.7	6	μs
$R_{\theta JC}$	–	–	2.2	°C/W

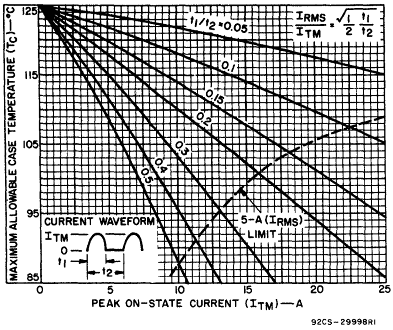


Fig. 1 — Maximum allowable case temperature as a function of peak on-state current.

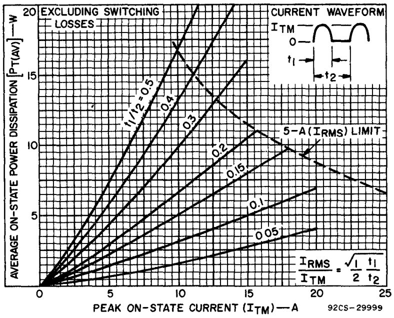


Fig. 2 — Average on-state power dissipation as a function of peak on-state current.

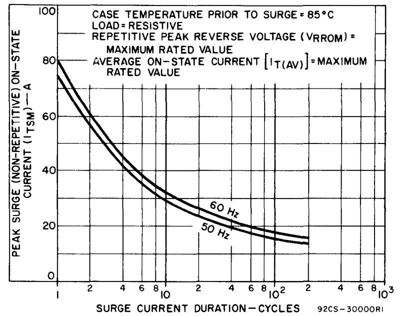


Fig. 3 — Peak surge on-state current as a function of surge duration.

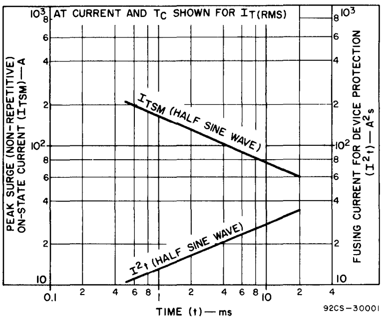


Fig. 4 — Peak surge on-state current and fusing current as a function of time.

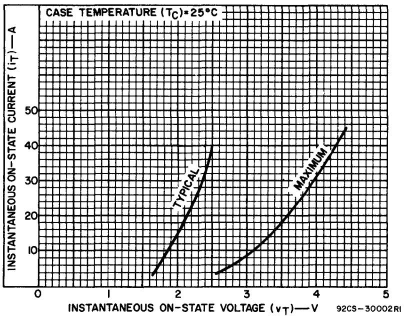


Fig. 5 — Instantaneous on-state current as a function of instantaneous on-state voltage.

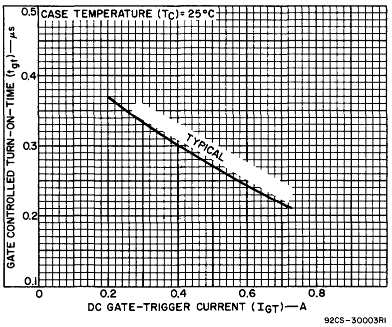


Fig. 6 — Gate-controlled turn-on-time as a function of gate current.

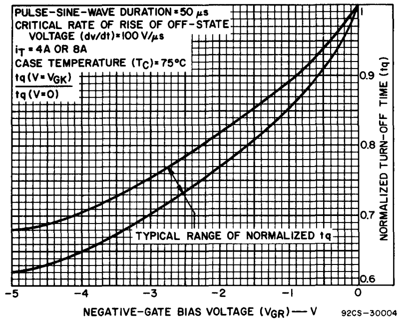


Fig. 7 — Normalized turn-off time as a function of negative-gate bias voltage.

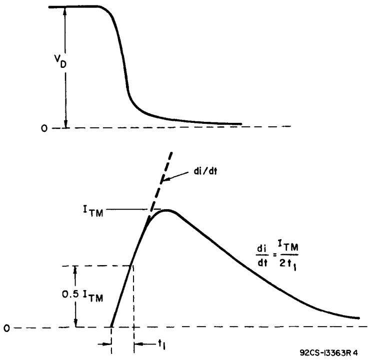


Fig. 8 — Rate of change on-state current with time (defining di/dt).

S5800

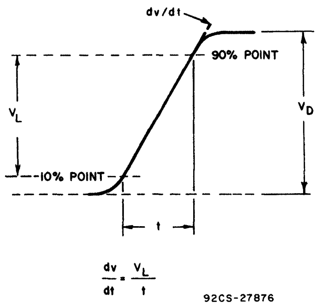


Fig. 9 — Linear rate of rise of off-state voltage with time (defining dv/dt).

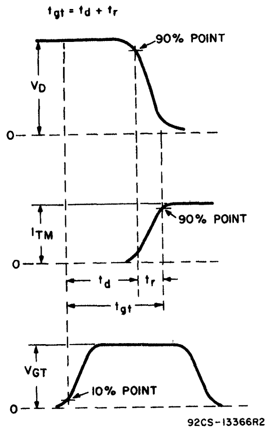


Fig. 10 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

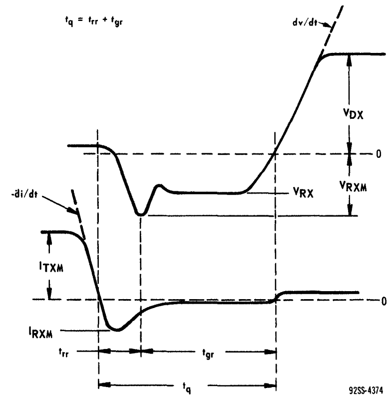


Fig. 11 — Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points defining turn-off time (t_q).

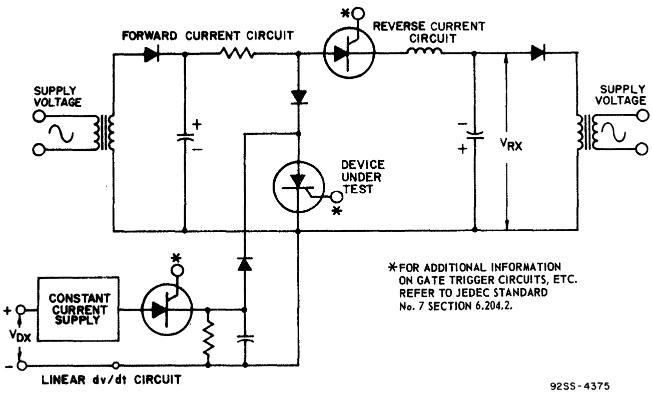


Fig. 12 — Circuit used to measure turn-off time (t_q).

File Number **1628**

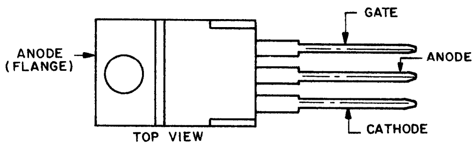
S6000D, S6000M, S6000N

High Voltage, Medium Current Silicon Controlled Rectifiers

For Power Switching, Power Control, and Motor Speed Control

Features:
- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The S6000 series are high voltage, medium current silicon controlled rectifiers designed for switching AC and DC currents. The types within the series differ in their voltage ratings: the voltage ratings are identified by suffix letters in the type designations.

All types utilize the JEDEC TO-220AB package.

These Thyristors feature an advanced unisurface construction with a multilayer glass passivation system for improved reliability performance at high junction operating temperatures. Their dv/dt, di/dt capability and low switching losses make them suitable for applications such as lighting, power-switching, motor speed control and crowbars.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	S6000D	S6000M	S6000N	
VDRM	400	600	800	V
VRRM	400	600	800	V
IT (RMS) (T_C = 90°C)		16		A
IT (av) (T_C = 90°C, θ = 180 Deg.)		10		A
ITSM (for 1 full cycle)		160		A
di/dt		200		A/μs
I^2T (at 8.3 ms)		100		A^2s
(at 1.5 ms)		75		A^2s
PGM (for 10μs max.)		16		W
PG (av) (Averaging time 10ms max.)		0.5		W
T Storage		-65 to 150		°C
TJ		-65 to 125		°C

S6000D, S6000M, S6000N

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

CHARACTERISTIC	SYMBOL	LIMITS S6000 FAMILY MIN.	TYP.	MAX.	UNITS
Repetitive Peak Forward and Reverse Blocking Current Rated VDRM and VRRM, Gate Open at TC = 125°C	IDROM IRROM	— —	— —	50 2	μA mA
Forward "On State" Voltage ITM = 100A	VTM	—	2	2.4	V
Gate Trigger Current (dc) VD = 12 Vdc RL = 30 Ohms	IGT	—	20	30	mA
Gate Trigger Voltage (dc) VD = 12 Vdc, RL = 30 Ohms VD = VDRM, RL = 500 Ohms, TC = 125°C	VGT	— 0.2	1 —	1.5 —	V
Holding Current VD = 12 Vdc, IT (initial) = 300mA	IH	—	30	—	mA
Critical Rate of Rise of Off-State Voltage (Exponential Waveform) TC = 125°C, Gate Open, VD = VDRM S6000D S6000M S6000N	dv/dt	— — — —	— 175 150 100	— — — —	V/μS
Turn-On Time IT = 10A, VD = VDRM IG = 100mA	tgt	—	1.5	—	μS
Turn-Off Time VD = VDRM, TC = 75°C, dv/dt = 20V/μS IT = 2A for 50 μS, di/dt = 10A/μS IG = 80mA at Turn-On	tq	—	65	—	μS
Thermal Resistance Junction to Case Junction to Ambient	RθJC RθJA	— —	— —	2.2 60	°C/W

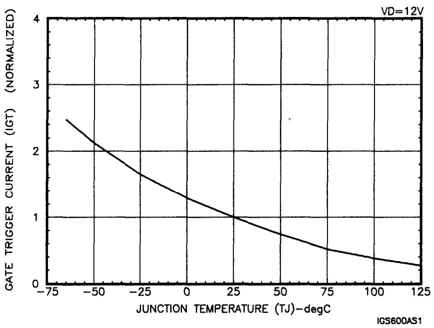


Fig. 1 - Typical Gate Trigger Current Vs. Temperature

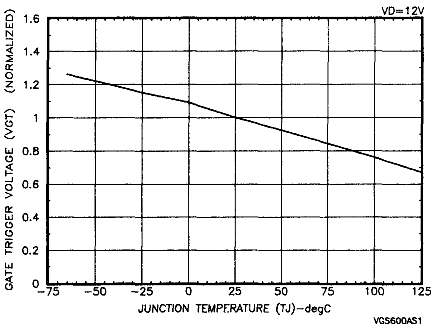


Fig. 2 - Typical Gate Trigger Voltage Vs. Temperature

S6000D, S6000M, S6000N

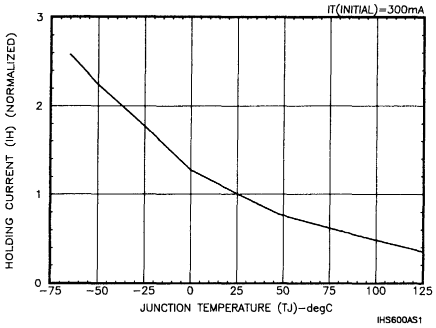


Fig. 3 - Typical Holding Current Vs. Temperature

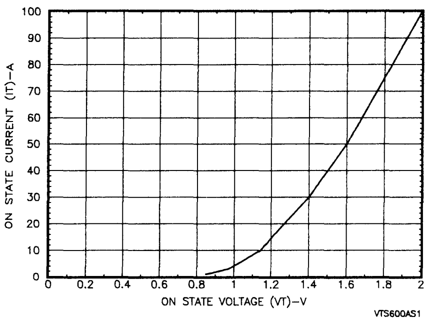


Fig. 4 - Typical On State Voltage Vs. Current

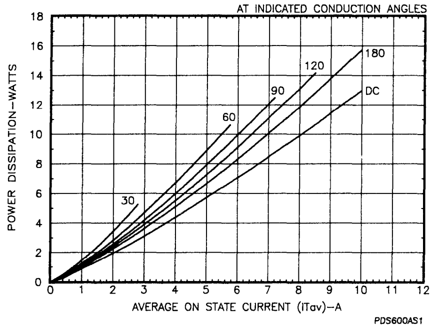


Fig. 5 - Maximum Power Dissipation Vs. Average Current

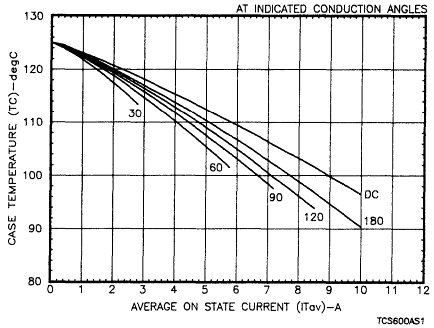


Fig. 6 - Maximum Case Temperature Vs. Average Current

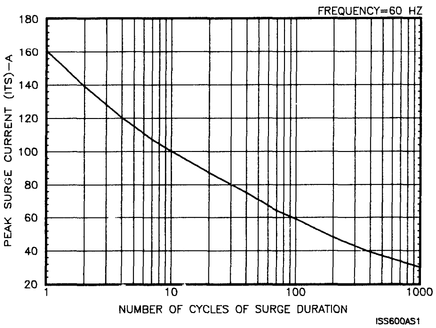


Fig. 7 - Peak Surge Current Vs. Duration

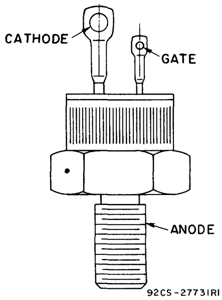
S6493M

File Number **247**

Silicon Controlled Rectifier For High-Current Pulse Applications

Features:
- *Up to 900 A peak pulse on-state current*
- *300 W maximum average dissipation*
- *On-state current of 35 A (rms value)*

TERMINAL DESIGNATIONS



JEDEC TO-208AA

The RCA-S6493M* is an all-diffused silicon controlled rectifier (reverse-blocking triode thyristor) designed especially for use in radar pulse modulators, inverters, switching regulators, and other applications requiring a large ratio of peak to average current.

It is especially constructed for rapid spread of forward current over the full junction area to achieve a high rate of change of forward current (di/dt) capability and low switching dissipation.

* Formerly RCA Type No. S6431M.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{RSOM} Δ	700	V
V_{DSOM} Δ	700	V
V_{RROM} Δ	600	V
V_{DROM} Δ	600	V
$I_{T(RMS)}$ (T_C = 65°C, θ = 180°C)	35	A
I_{TM} (pulse)		
T_C = 65°C, See Figs. 1 and 2	900	A
I^2t		
T_J = -65 to 125°C, t = 1 to 8.3 ms	2000	A^2s
$P_{D(AV)}$ (T_C = 65°C, See Fig. 3)	30	W
P_{GM} •		
Peak (forward or reverse) for 10 μs maximum	40	W
$P_{G(AV)}$ •		
Averaging time = 10 ms maximum	1	W
T_{stg}	-65 to 150	°C
T_C	-65 to 125	°C
T_T		
During soldering for 10 s maximum (terminals and case)	225	°C
T_s		
Recommended	35 0.4	in-lbf kgf-m
Maximum (DO NOT EXCEED)	50 0.57	in-lbf kgf-m

Δ These values do not apply if there is a positive gate signal. Gate must be open or negatively biased.
• Any product of gate current and gate voltage which results in a gate power less than the maximum is permitted.

S6493M

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS			UNITS
	MIN.	TYP.	MAX.	
I_{DOM} or I_{ROM}: $V_D = V_{DROM}$ or $V_R = V_{RROM}$, $T_C = 125°C$	–	2	10	mA
$V_{T(I)}$ $I_{TM(pulse)}$ = 600 A, t = 2 μs, T_C = 65°C (See Fig. 4)	–	–	19	V
i_{HO}: T_C = 25°C	0.5	20	70	mA
dv/dt: $V_D = V_{DROM}$, exponential voltage rise, T_C = 125°C (See Fig. 8)	20	50	–	V/μs
I_{GT} (T_C = 25°C)	1	25	80	mA
V_{GT} (T_C = 25°C)	–	1.1	2	V
t_{gt}: $V_D = V_{DROM}$, i_T = 30 A (peak), I_{GT} = 200 mA, t_r = 0.1 μs, T_C = 25°C (See Figs. 5 and 9)	–	1.25	–	μs
t_q: Rectangular Pulse $V_{DX} = V_{DROM}$, i_T 18 A, pulse duration = 50 μs, dv/dt = 20 V/μs, – di/dt = –30 A/μs, I_{GT} = 200 mA at turn-on, T_C = 80°C (See Figs. 10 and 11)	–	20	40	μs
$R_{\theta JC}$	–	–	2	°C/W

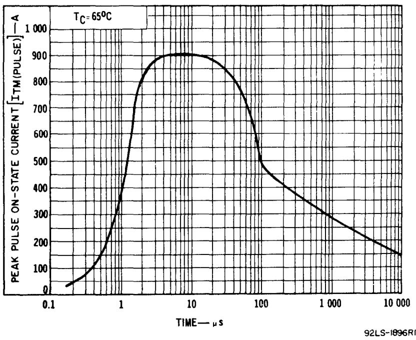


Fig. 1 - Peak pulse on-state current vs. time.

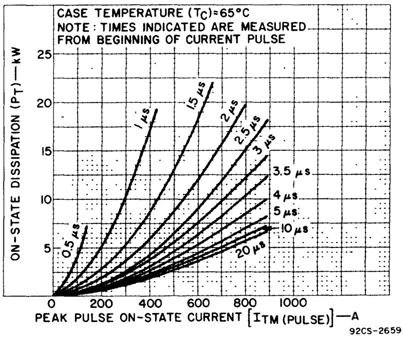


Fig. 2 - On-state dissipation vs. peak pulse on-state current and time.

S6493M

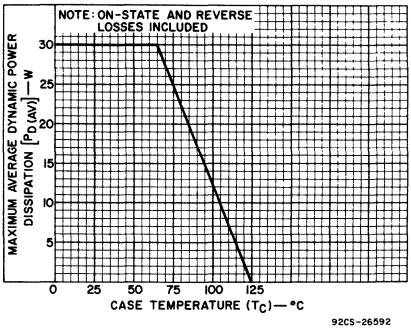


Fig. 3 - Dissipation derating curve.

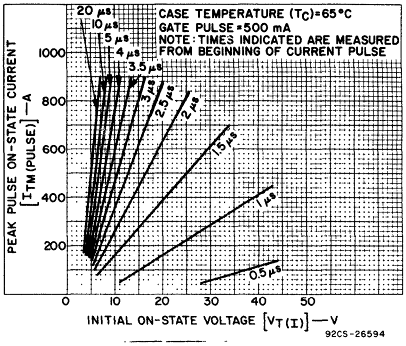


Fig. 4 - Initial on-state voltage characteristics.

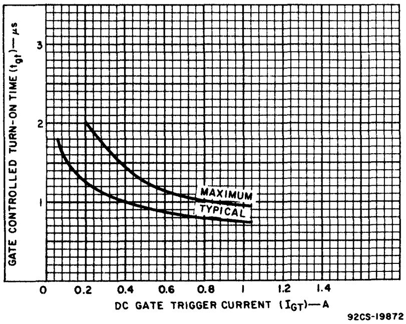


Fig. 5 - Gate-controlled turn-on time vs. gate trigger current.

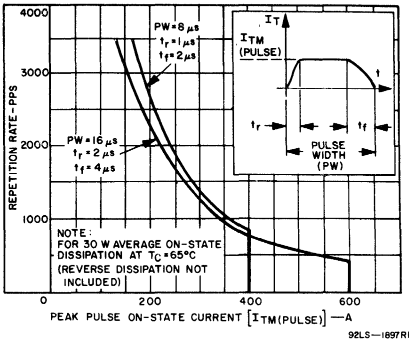


Fig. 6 - Peak pulse on-state current as a function of repetition rate, rectangular pulse.

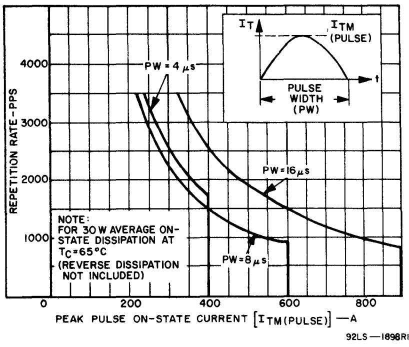


Fig. 7 - Peak pulse on-state current as a function of repetition rate, half sine wave pulse.

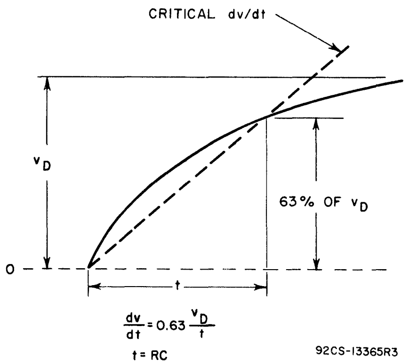


Fig. 8 - Rate-of-rise off-state voltage with time (defining dv/dt).

S6493M

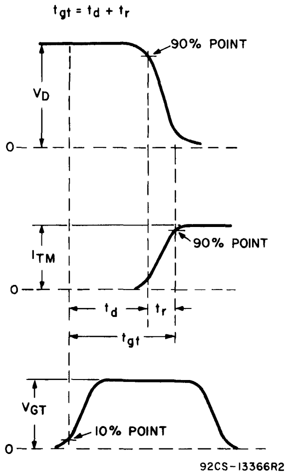


Fig. 9 - Relationship between off-state voltage, on-state current, and gate trigger voltage showing reference points for definition of turn-on time (t_{gt}).

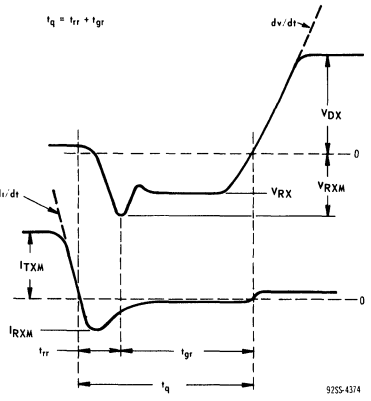


Fig. 10 - Relationship between off-state voltage, reverse voltage, on-state current, and reverse current showing reference points defining turn-off time (t_q), rectangular pulse.

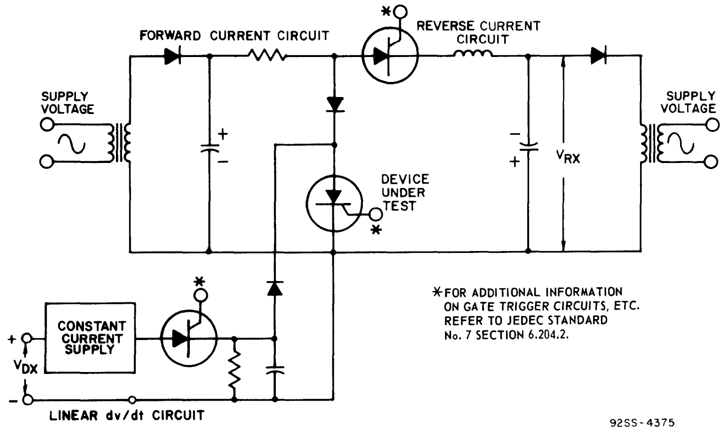


Fig. 11 - Circuit used to measure turn off-time (t_q), rectangular pulse.

Triacs
Technical Data

2N5441-2N5446, T6420 Series

File Number **593**

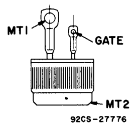
40-A Silicon Triacs

Features:
- *di/dt capability = 100 A/μs*
- *Low switching losses*
- *Low on-state voltage at high current levels*
- *Low thermal resistance*

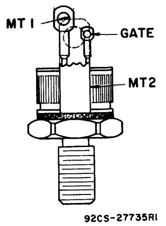
Package \ Voltage	200 V Types	400 V Types	600 V Types
Press-Fit	2N5441	2N5442	2N5443
Stud	2N5444	2N5445	2N5446
Isolated-Stud	T6420B	T6420D	T6420M

RCA triacs are gate-controlled, full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages.

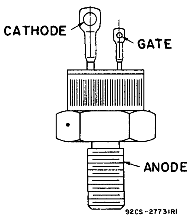
TERMINAL DESIGNATIONS



2N5441-43



T6420 Series



2N5444-46

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For Operation with Sinusoidal Supply Voltage at Frequencies up to 50/60 Hz and with resistive or Inductive Load

	2N5441 2N5444 T6420B	2N5442 2N5445 T6420D	2N5443 2N5446 T6420M	
* REPETITIVE PEAK OFF-STATE VOLTAGE •, V_{DROM}				
Gate Open, T_J = -65 to 100°C	200	400	600	V
RMS ON-STATE CURRENT (Conduction angle = 360°C), $I_{T(RMS)}$				
Case temperature				
* T_C = 70°C (Press-fit types)		40		A
* T_C = 65°C (Stud types)		40		A
T_C = 60°C (Isolated-stud types)		40		A
For other conditions		See Fig. 3		
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT, I_{TSM}				
For one cycle of applied principal voltage				
* 60 Hz (sinusoidal)		300		A
50 Hz (sinusoidal)		265		A
For more than one cycle of applied principal voltage		See Fig. 4		
RATE OF CHANGE OF ON-STATE CURRENT, di/dt				
$V_{DM} = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs (See Fig. 12)		100		A/μs
FUSING CURRENT (for Triac Protection), I^2t				
T_J = -65 to 110°C, t = 1.25 to 10 ms		450		A^2s
* PEAK GATE-TRIGGER CURRENT ■, I_{GTM}				
For 1 μs max.		12		A
* GATE POWER DISSIPATION				
Peak (For 10 μs max., $I_{GTM} \leq$ 4 A, P_{GM}		40		W
Average, $P_{G(AV)}$		0.75		W
* TEMPERATURE RANGE Δ				
Storage, T_{stg}		-65 to 150		°C
Operating (Case), T_C		-65 to 110		°C
* TERMINAL TEMPERATURE (During Soldering), T_T				
For 10 s max. (terminals and case)		225		°C
STUD TORQUE, τ_S				
Recommended		35		in-lb
Maximum (DO NOT EXCEED)		50		in-lb

* In accordance with JEDEC registration data format (JS-14, RDF2) filed for the JEDEC (2N-Series) types.
• For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■ For either polarity of gate voltage (V_G) with reference to main terminal 1.
Δ For temperature measurement reference point, see Dimensional Outline

2N5441-2N5446, T6420 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	SYMBOL	LIMITS FOR ALL TYPES UNLESS OTHERWISE SPECIFIED MIN.	TYP.	MAX.	UNITS
Peak Off-State Current:♠					
Gate open, T_J = 110°C, V_{DROM} = Max. rated value	I_{DROM}	–	0.2	4*	mA
Maximum On-State Voltage:♠					
For i_T = 100 A (peak), T_C = 25°C	V_{TM}	–	1.7	2	V
For i_T = 56 A (peak), T_C = 25°C		–	1.5	1.85*	
DC Holding Current:♠					
Gate open, Initial principal current = 500 mA (dc), v_D = 12V:					
T_C = 25°C	I_{HO}	–	25	60	mA
T_C = -65°C		–	–	100*	
For other case temperatures		See Fig. 6			
Critical Rate of Rise of Commutation Voltage:♠					
For v_D = V_{DROM}, $I_{T(RMS)}$ = 40 A, commutating di/dt = 22 A/ms, gate unenergized, (See Fig. 13):					
T_C = 70°C (Press-fit types)	dv/dt	5*	30	–	v/μs
= 65°C (Stud types)		5*	30	–	
= 60°C (Isolated-stud types)		5	30	–	
Critical Rate of Rise of Off-State Voltage:♠					
For v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 110°C:					
2N5441, 2N5444, T6420B	dv/dt	50*	200	–	V/μs
2N5442, 2N5445, T6420D		30*	150	–	
2N5443, 2N5446, T6420M		20*	100	–	
DC Gate-Trigger Current:♠◆ (Mode / V_{MT2} / V_G)					
For v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C: Mode I+, V_{MT2} positive, V_G positive	I_{GT}	–	15	50	mA
Mode III−, negative, negative		–	20	50	
Mode I−, positive, negative		–	30	80	
Mode III+, negative, positive		–	40	80	
For v_D = 12 V (dc), R_L = 30 Ω, T_C = -65°C: Mode I+, V_{MT2} positive, V_G positive		–	–	125*	
Mode III−, negative, negative		–	–	125*	
Mode I−, positive, negative		–	–	240*	
Mode III+, negative, positive		–	–	240*	
For other case temperatures		See Figs. 7 & 8			
DC Gate-Trigger Voltage:♠◆					
For v_D = 12 V (dc), R_L = 30 Ω,					
T_C = 25°C	V_{GT}	–	1.35	2.5	V
= -65°C		–	1.8	3.4*	
For other case temperatures		See Fig. 9			
For v_D = V_{DROM}, R_L = 125 Ω, T_C = 110°C		0.2	–	–	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs, i_T = 60 A (peak), T_C = 25°C (See Figs. 10 & 14)	t_{gt}	–	1.7	3	μs
Thermal Resistance, Junction-to-Case:					
Steady-State					
Press-fit types	$R_{\theta JC}$	–	–	0.8*	°C/W
Stud types		–	–	0.9*	
Isolated-stud types		–	–	1	
Transient (Press-fit & stud types)		See Fig. 11			

* In accordance with JEDEC registration data format (JS-14, RDF 2) filed for the JEDEC (2N-Series) types.
♠ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
◆ For either polarity of gate voltage (V_G) with reference to main terminal 1.

2N5441-2N5446, T6420 Series

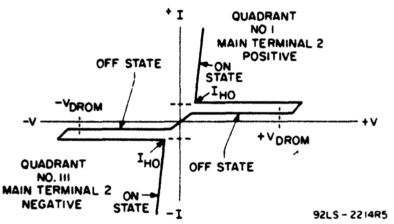


Fig. 1 - Principal voltage-current characteristic.

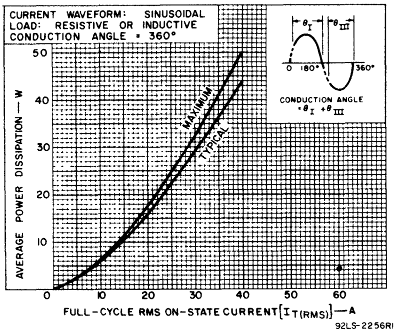


Fig. 2 - Power dissipation vs. on-state current.

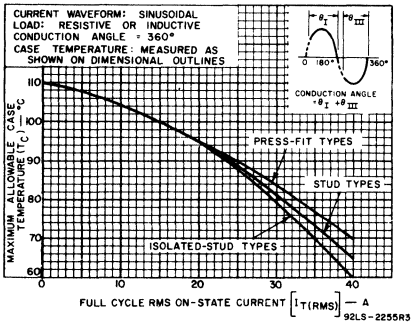


Fig. 3 - Maximum allowable case temperature vs. on-state current.

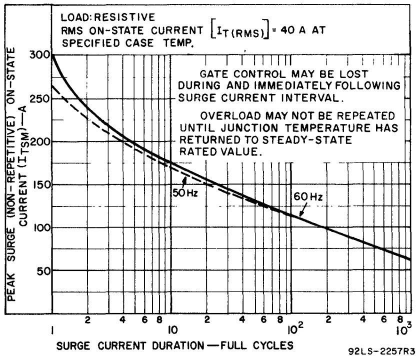


Fig. 4 - Peak surge on-state current vs. surge current duration.

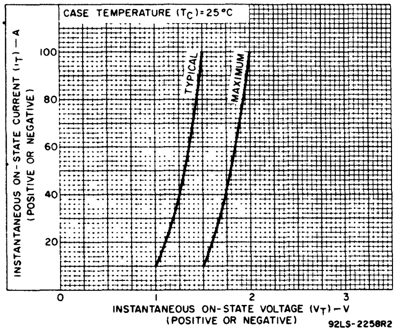


Fig. 5 - On-state current vs. on-stage voltage.

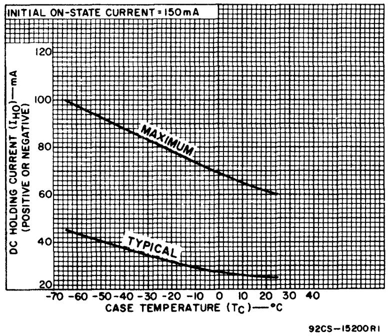


Fig. 6 - DC holding current vs. case temperature.

2N5441-2N5446, T6420 Series

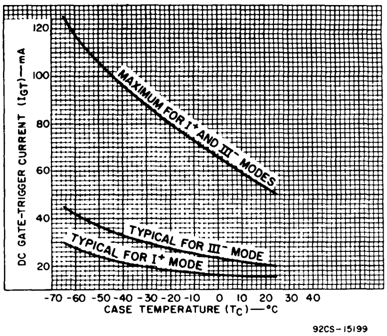


Fig. 7 - DC gate-trigger current vs. case temperature (I^+ & III^- modes).

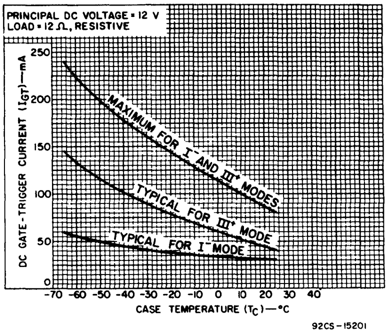


Fig. 8 - DC gate-trigger current vs. case temperature (I^- & III^- modes).

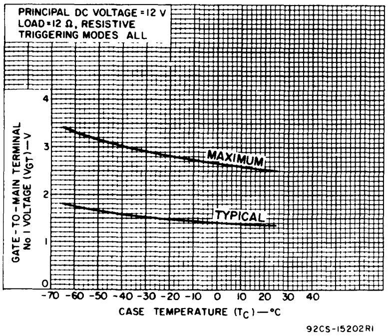


Fig. 9 - DC gate trigger voltage vs. case temperature.

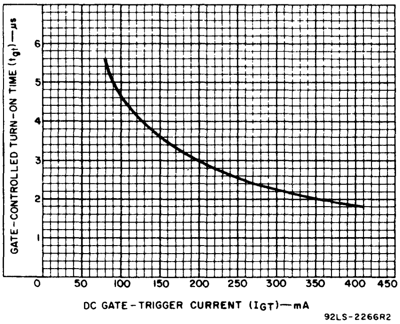


Fig. 10 - Turn-on time vs. gate-trigger current.

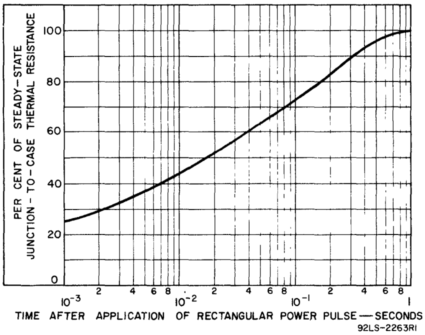


Fig. 11 - Transient junction-to-case thermal reistance vs. time for press-fit and stud types.

2N5441-2N5446, T6420 Series

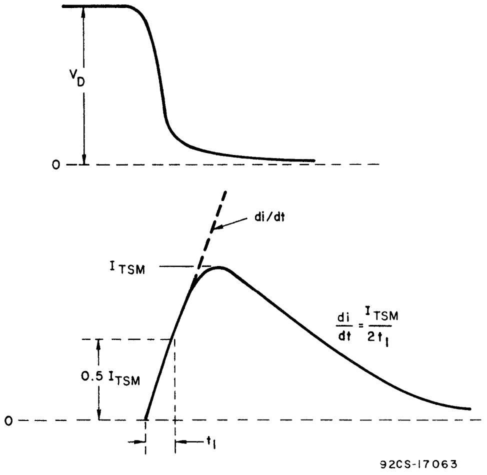


Fig. 12 - Rate of change of on-state current with time (defining di/dt).

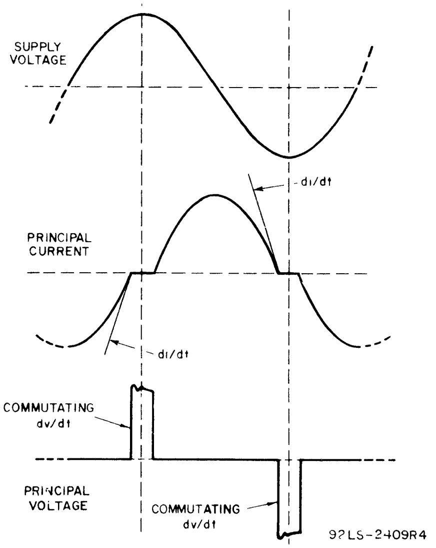


Fig. 13 - Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

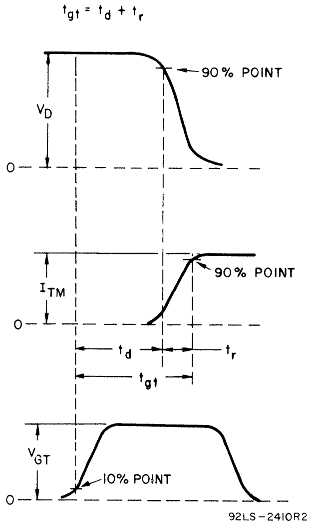


Fig. 14 - Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

File Number **414**

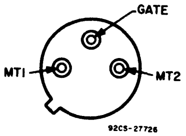
2N5754-2N5757

2.5-A Silicon Triacs

Features:
- *Gate sensitivity - 25 mA*
- *di/dt capability - 100 A/µs*
- *Low switching losses*
- *Low-on-state voltage at high current levels*

Package \ Voltage	100 V Types	200 V Types	400 V Types	600 V Types
Modified TO-205	2N5754	2N5755	2N5756	2N5757

TERMINAL DESIGNATIONS



MODIFIED TO-205

These RCA triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

The gate sensitivity of these triacs permits the use of economical transistorized control circuits and enhances their use in low-power phase control and load-switching applications.

MAXIMUM RATINGS, *Absolute-Maximum Values:*
For operation with sinusoidal supply voltage at frequencies up to 50/60 Hz and with resistive or inductive load

	2N5754	2N5755	2N5756	2N5757	
* V_{DROM} Δ					
Gate open, T_J = -65 to 100°C	100	200	400	600	V
$I_{T(RMS)}$ (θ = 360°C)					
T_C = 70°C	2.5				A
For other conditions	See Figs. 2, 3, 4				
I_{TSM}					
For one cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$					
* 60 Hz (sinusoidal)	25				A
50 Hz (sinusoidal)	21				A
For more than one cycle of applied principal voltage	See Figs. 5, 6				
di/dt					
$V_D = V_{DROM}$, I_{GT} = 50 mA, t_r = 0.1 µs	100				A/µs
I^2t [At T_C shown for $I_{T(RMS)}$]					
t = 20 ms	4.3				A^2s
t = 2.5 ms	2				A^2s
t = 0.5 ms	1				A^2s
For other time values	See Fig. 6				
* I_{GTM} •					
For 1 µs max.	1				A
P_{GM}					
Peak (For 1 µs max., $I_{GT} \leq$ 1 A (peak)	10				W
* $P_{G(AV)}$ - T_C = 70°C	0.15				W
T_A = 25°C	0.05				W
* T_{stg}	-65 to 150				°C
* T_C	-65 to 100				°C
T_T					
During soldering for 10 s maximum at distance ≥ 1/16 in. (1.58 mm) from seating plane	225				°C

For Notes See Electrical Characteristic Chart

2N5754-2N5757

ELECTRICAL CHARACTERISTICS, At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

	CHARACTERISTICS	LIMITS ALL TYPES MIN.	TYP.	MAX.	UNITS
*	I_{DROM} Δ				
	Gate open, T_J = 100°C, V_{DROM} = Max. rated value	—	0.2	0.75	mA
*	V_{TM} Δ (See Fig. 7)				
	i_T = 10 A (peak), T_C = 25°C	—	2.2	2.6	V
	i_T = 3.5 A (peak), T_C = 25°C	—	—	1.8	
	I_{HO} Δ (See Fig. 8)				
	Gate open, Initial principal current = 150 mA (dc), V_D=12 V				
	T_C = 25°C	—	6	35	mA
	T_C = -65°C	—	20	82 *	
*	dv/dt (Commutating) Δ				
	V_D = V_{DROM}, $I_{T(RMS)}$ = 2.5A commutating di/dt = 1.33 A/ms, gate unenergized, T_C = 70°C	0.5	—	—	V/μs
	dv/dt (Off-State) Δ				
	V_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C	10	100	—	V/μs
	I_{GT} Δ •				
	V_D = 12 V dc, R_L = 30 Ω, T_C = 25°C				
	Mode / V_{MT2} / V_G				
	I+ positive positive	—	5	25	
	III- negative negative	—	5	25	
	I- positive negative	—	10	40	
	III+ negative positive	—	10	40	mA
	V_D = 12 V dc, R_L = 30 Ω, T_C = -65°C				
	Mode / V_{MT2} / V_G				
	I+ positive positive	—	30	60 *	
	III- negative negative	—	30	60 *	
	I- positive negative	—	40	100 *	
	III+ negative positive	—	40	100 *	
	V_{GT} Δ • (See Fig. 10)				
	V_D = 12 V dc, R_L = 30 Ω, T_C = 25°C	—	0.9	2.2	
	V_D = 12 V dc, R_L = 30 Ω, T_C = -65°C	—	1.5	3 *	V
	V_D = V_{DROM}, R_L = 125 Ω, T_C = 100°C	0.2	—	—	
	t_{gt}				
	V_D = V_{DROM}, I_G = 60 mA, t_r = 0.1 μs, i_T = 10 A (peak) T_C = 25°C	—	1.8	2.5	μs
*	$R\theta_{JC}$				
	Steady-State	—	—	8.5	°C/W
	$R\theta_{JA}$				
	Steady-State	—	—	150	

* In accordance with JEDEC registration data format JS-14, RDF-2 - filed for the JEDEC (2N-Series) types.
Δ For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
• For either polarity of gate voltage (V_G) with reference to main terminal 1.

2N5754-2N5757

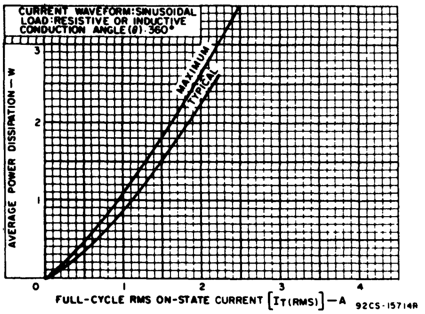


Fig. 1 - Power dissipation vs. on-state current.

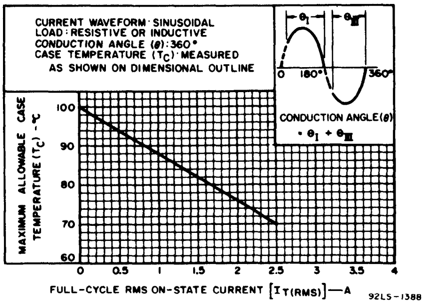


Fig. 2 - Maximum allowable case temperature vs. on-state current.

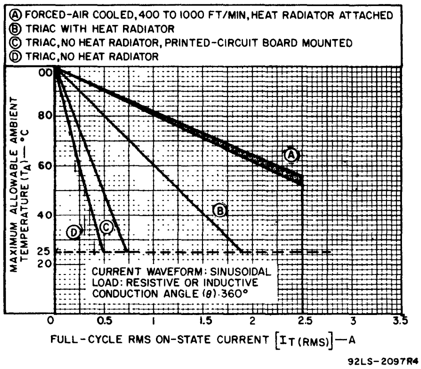


Fig. 3 - Maximum allowable ambient temperature vs. on-state current.

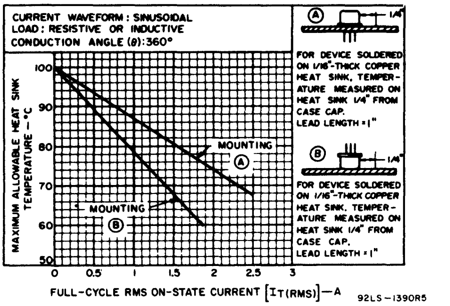


Fig. 4 - Maximum allowable heat-sink temperature vs. on-state current.

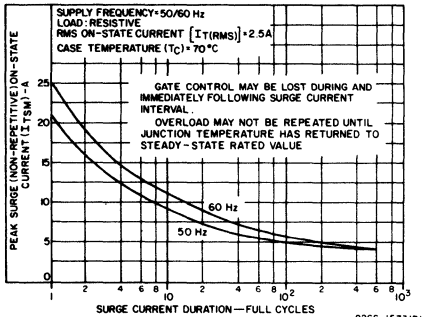


Fig. 5 - Peak surge on-state current vs. surge-current duration.

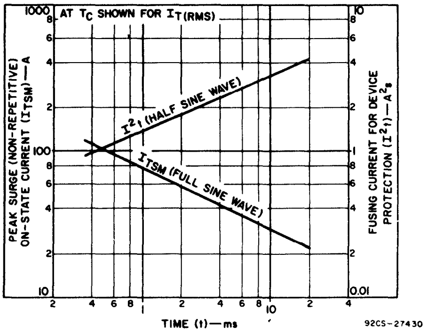


Fig. 6 - Peak surge on-state current and fusing current vs. time.

2N5754-2N5757

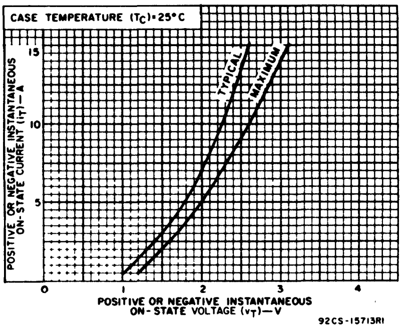


Fig. 7 - On-state current vs. on-state voltage.

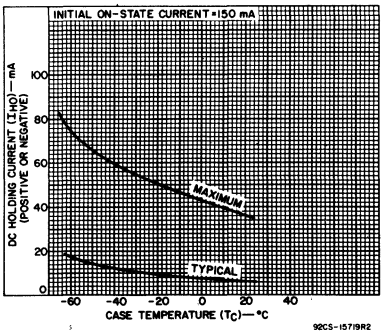


Fig. 8 - DC holding current (positive or negative) vs. case temperature.

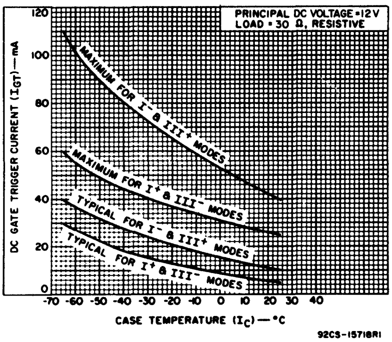


Fig. 9 - DC gate-trigger current vs. case temperature.

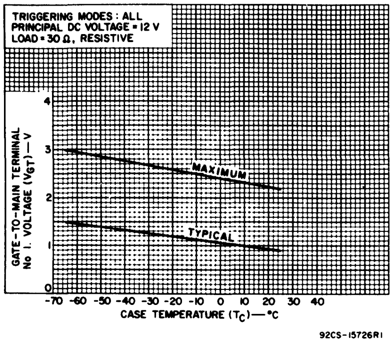


Fig. 10 - DC gate-trigger voltage vs. case temperature.

File Number **1084**

2N6342A-2N6349A Series

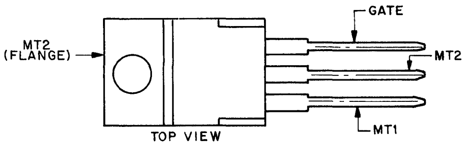
12-A Silicon Triacs

For Power Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



92CS-39970

JEDEC TO-220AB

The 2N6342A-2N6349A series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 12 amperes at a T_C of 80°C and repetitive off-state voltage ratings of 200, 400, 600, and 800 volts. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6342A 2N6346A	2N6343A 2N6347A	2N6344A 2N6348A	2N6345A 2N6349A	
*V_{DROM}• T_J = -40 to 110°C	200	400	600	800	V
$I_{T(RMS)}$ T_C = 80°C, θ 360°	12				A
For other conditions	See Figs. 5				
I_{TSM}					
For one cycle of applied principal voltage					
* 60 Hz (sinusoidal), T_C = 80°C	120				A
50 Hz (sinusoidal), T_C = 80°C	113				A
For more than one cycle of applied principal voltage	See Fig. 6				
di/dt					
$v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs	100				A/μs
I^2t [At T_C shown for $I_{T(RMS)}$, half-sine wave]:					
t = 10 ms	64				A^2s
= 2.5 ms	40				A^2s
= 0.5 ms	23				A^2s
* = 1 to 8.3 ms	40				A^2s
*I_{GTM}■					
For 1 μs max.	4				A
*P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A	20				W
*$P_{G(AV)}$	0.5				W
*T_{stg}	-40 to 150				°C
*T_C	-40 to 110				°C
*T_T During soldering for 10 s max.	230				°C

*In accordance with JEDEC registration data format JC-22 RDF-2.

•For either polarity to main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity to gate voltge (V_G) with reference to main terminal 1.

2N6342A-2N6349A Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS: For All Types Except as Specified — Min.	Typ.	Max.	UNITS
* I_{DROM}● T_J = 110°C, V_{DROM} = Max, rated value	—	—	2	mA
* v_{TM}● i_T = 17A (peak), T_C = 25°C	—	1.3	1.75	V
I_{HO}●				
Gate open, Initial principal current = 200 mA				
v_D = 12V, T_C = 25°C	—	6	40	mA
* = -40°C	—	—	75	
dv/dt● (Commutating)				
v_D = V_{DROM}, I_{TM} = 17A, di/dt = 6.5A/ms.				
T_C = 80°C	—	5	—	
dv/dt● (Off-State)				V/μs
v_D = V_{DROM}, T_C = 100°C				
2N6342A, 2N6346A	100	300	—	
2N6343A, 2N6347A	75	250	—	
2N6344A, 2N6348A	60	200	—	
2N6345A, 2N6349A	30	70	—	
I_{GT}●■ v_D = 12V (dc), R_L = 100 Ω				
Mode / V_{MT2} / V_G	—			
T_C = 25°C 1+ + +	—	6	50	
111- − −	—	10	50	
1− + − (2N6346A-49A only)	—	6	75	
111+ − + (2N6346A-49A only)	—	25	75	mA
* T_C = -40°C 1+ + +	—	—	100	
* 111- − −	—	—	100	
* 1− + − (2N6346A-49A only)	—	—	125	
* 111+ − + (2N6346A-49A only)	—	—	125	
V_{GT}●■ v_D = 12V (dc), R_L = 100 Ω				
Mode / V_{MT2} / V_G				
T_C = 25°C 1+ + +	—	0.9	2	
111- − −	—	1.1	2	
1− + − (2N6346A-48A only)	—	0.9	2.5	
111+ − + (2N6346A-48A only)	—	1.4	2.5	
* T_C = -40°C 1+ + +	—	—	2.5	
* 111- − −	—	—	2.5	
* 1− + − (2N6346A-49A only)	—	—	3	V
* 111+ − + (2N6346A-49A only)	—	—	3	
v_D = V_{DROM}, R_L = 10 K Ω				
T_J = 110°C 1+ + +	0.2	—	—	
111- − −	0.2	—	—	
1− + − (2N6346A-49A only)	0.2	—	—	
111+ 1− + (2N6346A-49A only)	0.2	—	—	
* t_{gt}				
V_D = V_{DROM}, I_{GT} = 120mA, t_r = 0.1 μs, i_T = 17A (peak),				
T_C = 25°C	—	1.5	2	μs
* $R_{\theta JC}$	—	—	2	°C/W

*In accordance with JEDEC registration data format JC-22 RDF2.

●For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■For either polarity of gate voltage (V_G) with reference to main terminal 1.

2N6342A-2N6349A Series

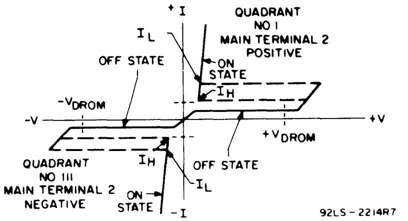


Fig. 1 — Principal voltage-current characteristic.

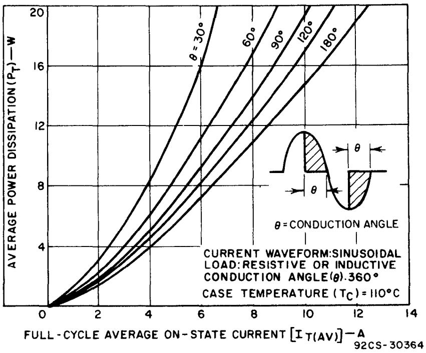


Fig. 2 — Power dissipation as a function of average on-state current.

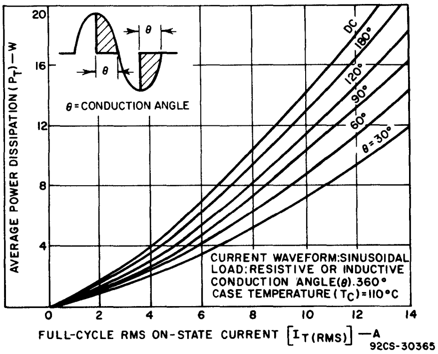


Fig. 3 — Power dissipation as a function of rms on-state current.

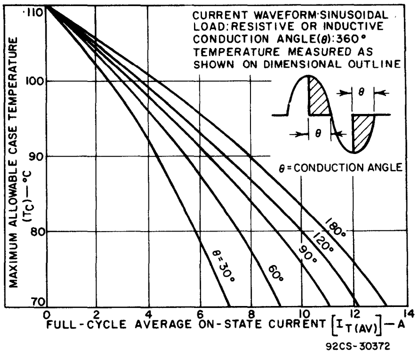


Fig. 4 — Maximum allowable case-temperature as a function of average on-state current.

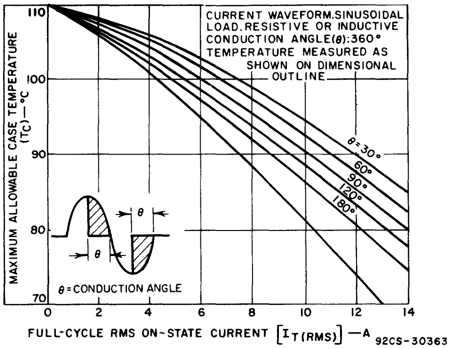


Fig. 5 — Maximum allowable case-temperature as a function of rms on-state current.

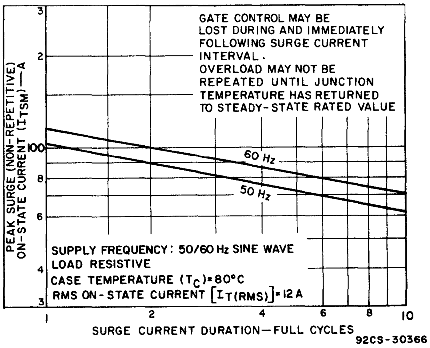


Fig. 6 — Peak surge on-state current as a function of surge current duration.

2N6342A-2N6349A Series

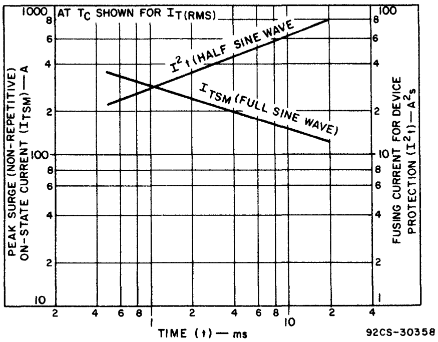


Fig. 7 — Peak surge on-state current and fusing current as a function of time.

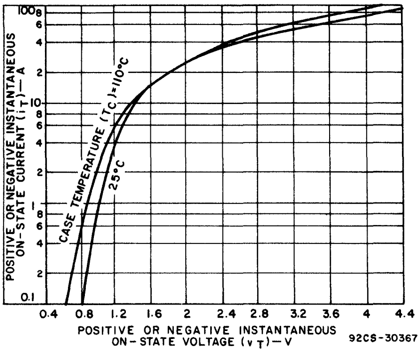


Fig. 8 — On-state current as a function of on-state voltage.

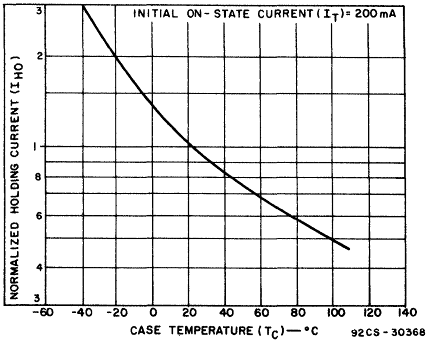


Fig. 9 — Normalized holding current as a function of case temperature.

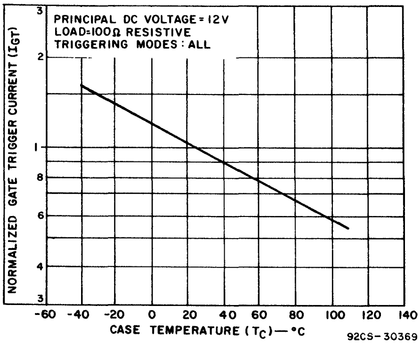


Fig. 10 — Normalized gate trigger current as a function of case temperature.

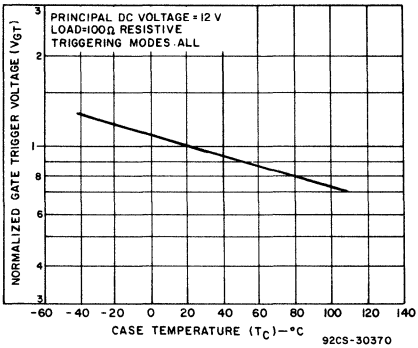


Fig. 11 — Normalized gate trigger voltage as a function of case temperature.

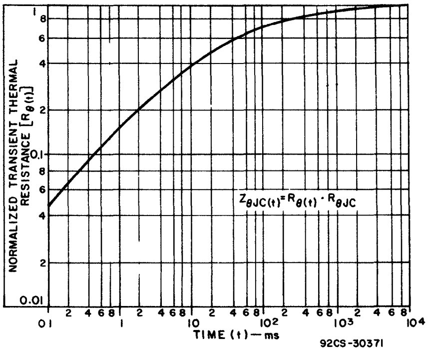


Fig. 12 — Normalized transient thermal resistance as a function of time.

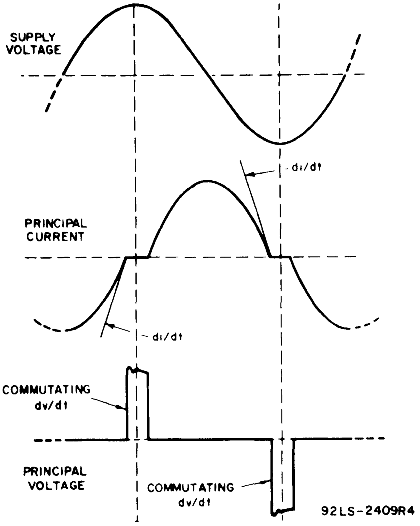


Fig. 13 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

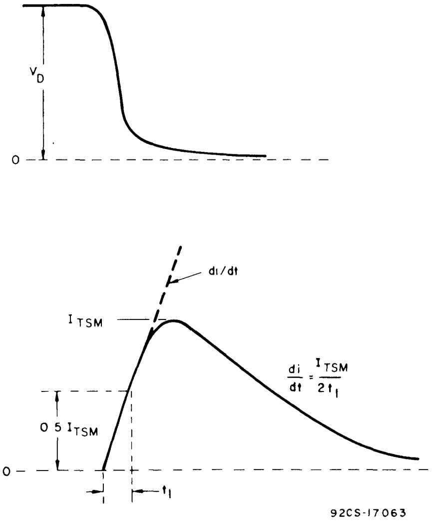


Fig. 14 — Rate-of-change of on-state current with time (defining di/dt).

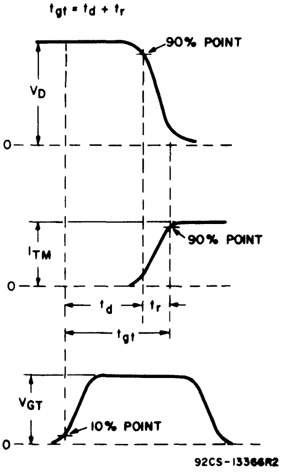


Fig. 15 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

BTA20 Series

File Number **1298**

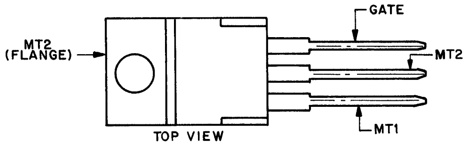
6-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA BTA20-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 10 amperes at a T_C of 75°C and repetitive off-state voltage ratings of 200, 300, 400, 500, 600, and 800 volts.

These devices are characterized I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BTA20C	BTA20D	BTA20E	BTA20M	BTA20N	
V_{DROM}•, Gate open, T_J = -65 to 125°C	300	400	500	600	800	V
$I_{T(RMS)}$, T_C = 75°C, θ = 360°			6			A
I_{TSM} (for 1 full cycle) 60 Hz (sinusoidal)			80			A
50 Hz (sinusoidal)			75			A
di/dt						
$V_D = V_{DROM}$, I_G = 200 mA, t_r = 0.1 μs						
(See Fig. 11)			70			A/μs
I^2t (See Fig. 10)						
t = 20 ms			40			A^2s
t = 2.5 ms			20			A^2s
t = 0.5 ms			11			A^2s
I_{GTM}■						
For 1 μs max.			4			A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A			16			W
$P_{G(AV)}$			0.35			W
T_{stg}†			-65 to 150			°C
T_C†			-65 to 125			°C
T_T (During Soldering):						
For 10 s max. (terminals and case)			225			°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity to gate voltage (V_G) with reference to main terminal 1.
†For temperature measurement reference point, see Dimensional Outline.

BTA20 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	LIMITS For All Types Unless Otherwise Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}• Gate open, T_J = 125° C, V_{DROM} = Max. rated value	—	0.1	2	mA
V_{TM}• i_T = 30 A (peak), T_C = 25° C (See Fig. 6)	—	2	3	V
I_{HO}• Gate open, Initial principal current = 150 mA (dc) v_D = 12 V, T_C = 25° C	—	100	—	mA
For other case temperatures		See Fig. 7		
dv/dt (Commutating)• v_D = V_{DROM}, $I_{T(RMS)}$ = 6 A, commutating di/dt = 3.2 A/ms, gate unenergized, T_C = 80° C (See Fig. 11)	2	10	—	V/μs
dv/dt• v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100° C: BTA20C	40	275	—	V/μs
BTA20D	30	250	—	V/μs
BTA20E	20	225	—	V/μs
BTA20M	15	150	—	V/μs
BTA20N	10	50	—	V/μs
I_{GT}•■ Mode I^+, V_{MT2} positive, V_G positive; v_D = 12 V (dc), R_L = 30 Ω, T_C = 25° C	—	25	80	mA
Mode III^-, V_{MT2} negative, V_G negative	—	25	80	mA
For other case temperatures		See Fig. 9		mA
V_{GT}•■ v_D = 12 V (dc), R_L = 30 Ω, T_C = 25° C	—	1.5	4	V
For other case temperatures		See Fig. 5		V
v_D = V_{DROM}, R_L = 125 Ω, T_C = 100° C	0.2	—	—	V
t_{gt} For v_D = V_{DROM}, I_G = 80 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25° C (See Fig. 13)	—	1.6	2.5	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	°C/W

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

BTA20 Series

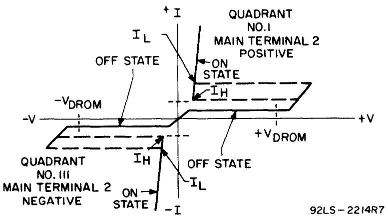


Fig. 1 — Principal voltage-current characteristic.

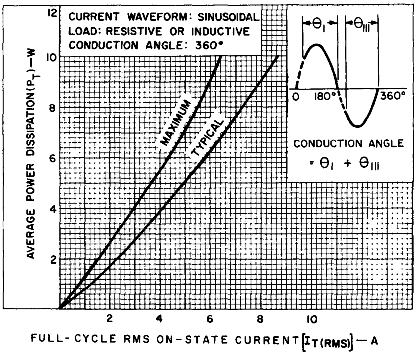


Fig. 2 — Power dissipation vs. on-state current.

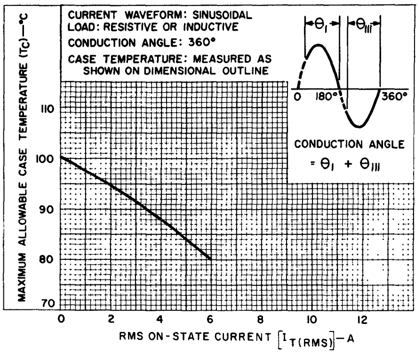


Fig. 3 - Allowable case temperature vs. on-state current.

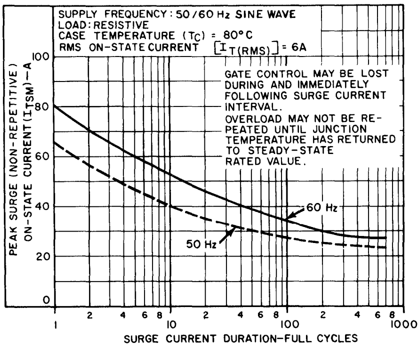


Fig. 4 — Peak surge on-state current vs. surge current duration.

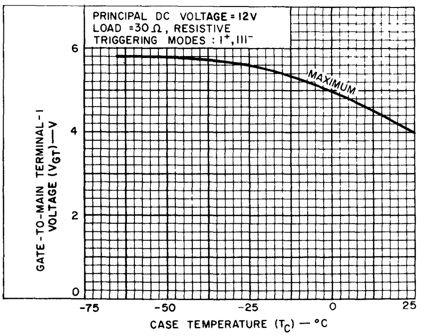


Fig. 5 — DC gate-trigger voltage vs. case temperature.

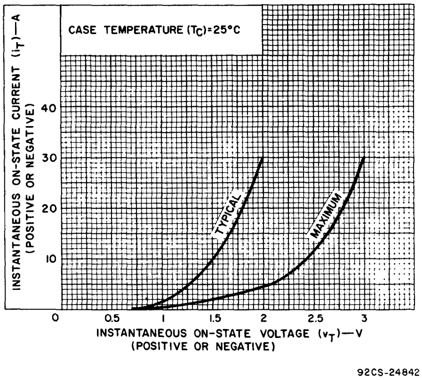


Fig. 6 — On-state current vs. on-state voltage.

BTA20 Series

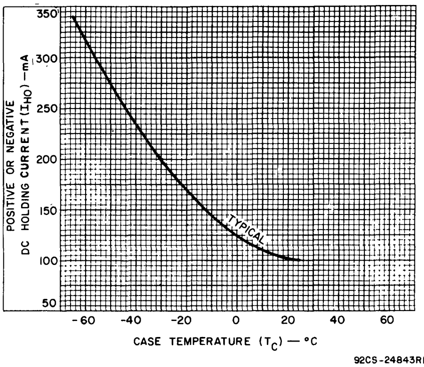


Fig. 7 — DC holding current vs. case temperature.

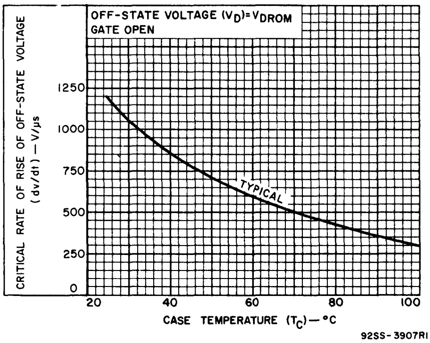


Fig. 8 — Critical rate-of-rise of off-state voltage vs. case temperature.

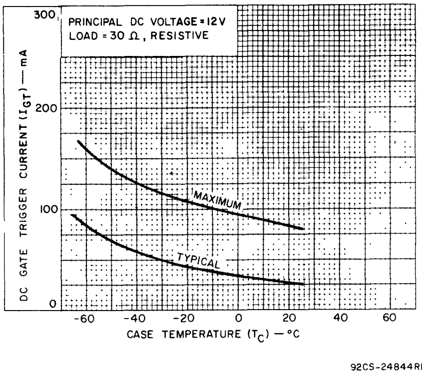


Fig. 9 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

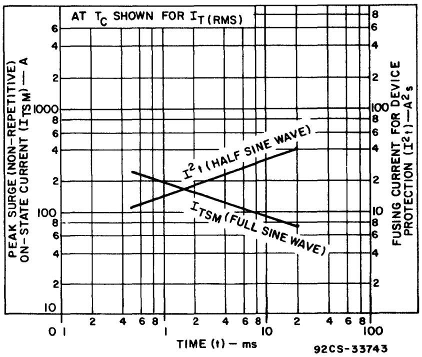
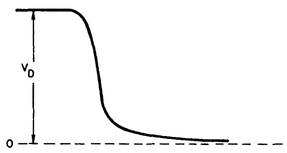


Fig. 10 — Peak surge on-state current and fusing current vs. time.



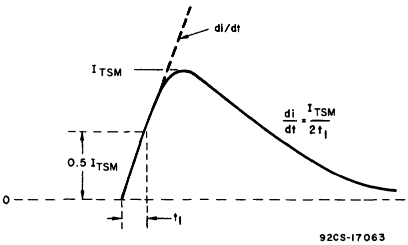


Fig. 11 — Rate of change of on-state current with time (defining di/dt).

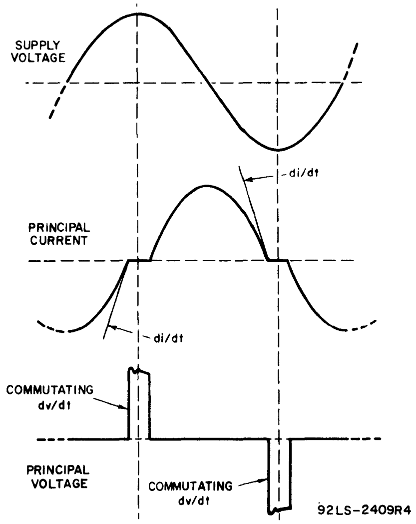


Fig. 12 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

BTA20 Series

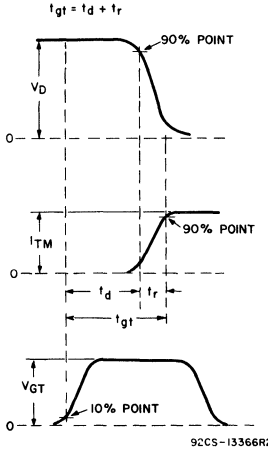
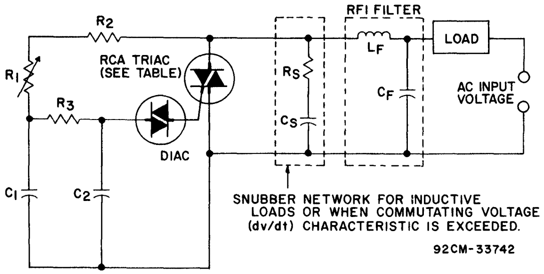


Fig. 13 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).



AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C1		0.1 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
C2		0.1 µF 100 V	0.1 µF 100 V	0.1 µF 100 V
R1		100 kΩ ½ W	200 kΩ ½ W	250 kΩ ½ W
R2		2.2 kΩ ½ W	3.3 kΩ ½ W	3.3 kΩ ½ W
R3		15 kΩ ½ W	15 kΩ ½ W	15 kΩ ½ W
SNUBBER NETWORK FOR 6 A (RMS)• INDUCTIVE LOAD	CS	0.068 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
	RS	1.2 kΩ ½ W	1 kΩ ½ W	1 kΩ ½ W
RFI FILTER	CF•	0.1 µF 200 V	0.1 µF 400 V	0.1 µF 400 V
	LF•	100 µH	200 µH	200 µH
RCA TRIACS		BTA20C	BTA20D BTA20E	BTA20D BTA20E

•For other RMS current values refer to RCA Application Note AN-4745.

•Typical values for lamp dimming circuits.

Fig. 14 — Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

File Number **1299**

BTA21 Series

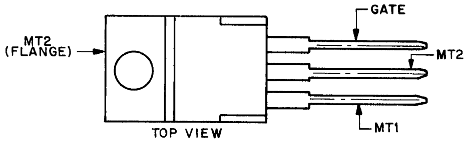
8-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



92CS-39970

JEDEC TO-220AB

The RCA BTA21-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 10 amperes at a T_C of 75°C and repetitive off-state voltage ratings of 200, 300, 400, 500, 600, and 800 volts.

These devices are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BTA21C	BTA21D	BTA21E	BTA21M	BTA21N	
V_{DROM}•, Gate open, T_J = -65 to 125°C	300	400	500	600	800	V
$I_{T(RMS)}$, T_C = 75°C, θ = 360°			8			A
I_{TSM} (for 1 full cycle) 60 Hz (sinusoidal)			100			A
50 Hz (sinusoidal)			94			A
di/dt						
$V_D = V_{DROM}$, I_G = 200 mA, t_r = 0.1 μs (See Fig. 10)			70			A/μs
I^2t (See Fig. 9)						
t = 20 ms			55			A^2s
t = 2.5 ms			27			A^2s
t = 0.5 ms			16			A^2s
I_{GTM}■						
For 1 μs max.			4			A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A			16			W
$P_{G(AV)}$			0.35			W
T_{stg}†			-65 to 150			°C
T_C†			-65 to 125			°C
T_T (During Soldering):						
For 10 s max. (terminals and case)			225			°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity to gate voltage (V_G) with reference to main terminal 1.
†For temperature measurement reference point, see Dimensional Outline.

BTA21 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	LIMITS For All Types Unless Otherwise Specified Min.	Typ.	Max.	UNITS
I_{DROM}• Gate open, T_J = 125°C, V_{DROM} = Max. rated value	—	0.1	2	mA
V_{TM}• i_T = 30 A (peak), T_C = 25°C (See Fig. 6)	—	1.7	2	V
I_{HO}• Gate open, Initial principal current = 150 mA (dc) v_D = 12 V, T_C = 25°C	—	100	—	mA
For other case temperatures		See Fig. 6		
dv/dt (Commutating)• v_D = V_{DROM}, $I_{T(RMS)}$ = 10 A, commutating di/dt = 4.44 A/ms, gate unenergized, T_C = 75°C (See Fig. 11)	2	10	—	V/μs
dv/dt• v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C: BTA22C	40	275	—	V/μs
BTA22D	30	250	—	V/μs
BTA22E	20	225	—	V/μs
BTA21M	15	150	—	V/μs
BTA21N	10	50	—	V/μs
I_{GT}•■ v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C — Mode I^+, V_{MT2} positive, V_G positive	—	—	35	mA
Mode III^-, V_{MT2} negative, V_G negative	—	—	35	mA
For other case temperatures		See Fig. 8		
V_{GT}•■ v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	—	1.25	2.5	V
For other case temperatures		See Fig. 5		
v_D = V_{DROM}, R_L = 125 Ω, T_C = 100°C	0.2	—	—	V
t_{gt} For v_D = V_{DROM}, I_G = 80 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25°C (See Fig. 12)	—	2.2	—	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	°C/W

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

BTA21 Series

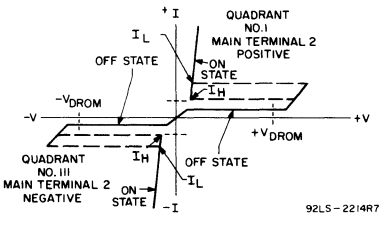


Fig. 1 — Principal voltage-current characteristic.

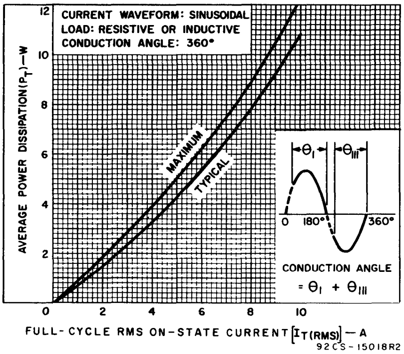


Fig. 2 — Power dissipation vs. on-state current.

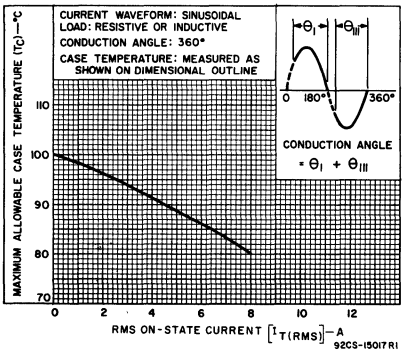


Fig. 3 - Maximum allowable case temperature vs. on-state current.

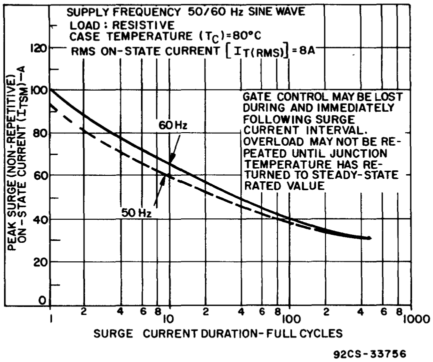


Fig. 4 — Peak surge on-state current vs. surge current duration.

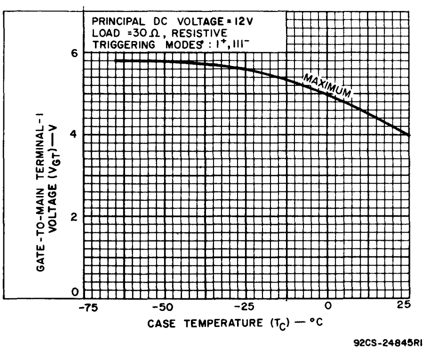


Fig. 5 — DC gate-trigger voltage vs. case temperature.

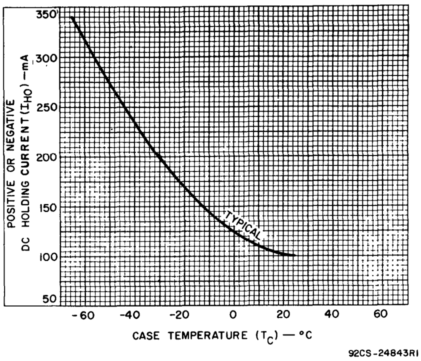


Fig. 6 — DC holding current vs. case temperature.

BTA21 Series

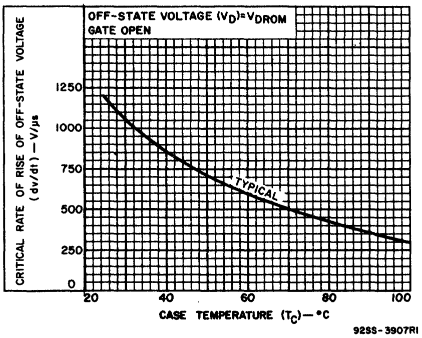


Fig. 7 — Critical rate-of-rise of off-state voltage vs. case temperature.

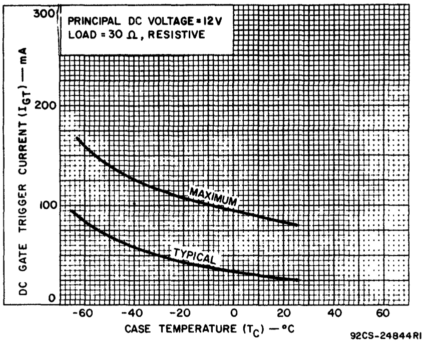


Fig. 8 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

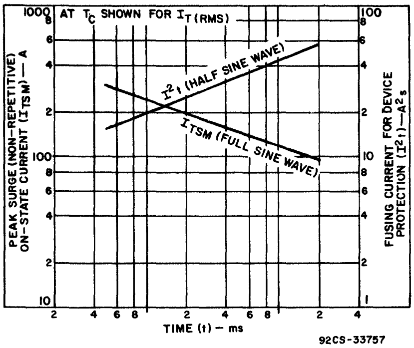


Fig. 9 — Peak surge on-state current and fusing current as a function of time.

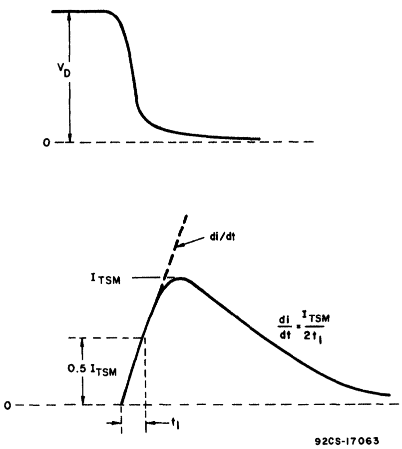


Fig. 10 — Rate of change of on-state current with time (defining di/dt).

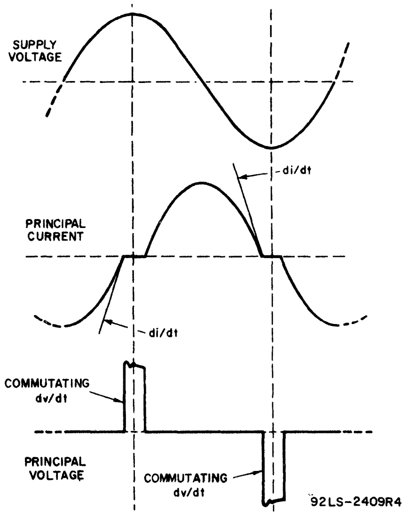


Fig. 11 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

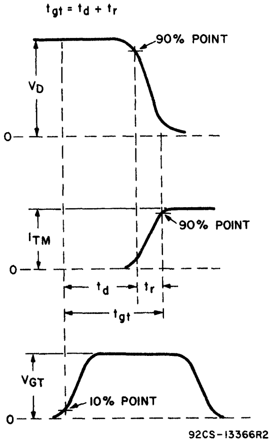
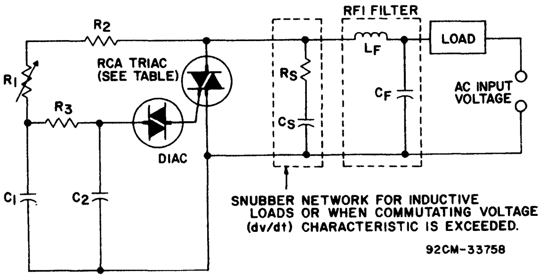


Fig. 12 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

BTA21 Series



AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C_1		0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
C_2		0.1 μF 100 V	0.1 μF 100 V	0.1 μF 100 V
R_1		100 kΩ ½ W	200 kΩ ½ W	250 kΩ ½ W
R_2		2.2 kΩ ½ W	3.3 kΩ ½ W	3.3 kΩ ½ W
R_3		15 kΩ ½ W	15 kΩ ½ W	15 kΩ ½ W
SNUBBER NETWORK FOR 8 A (RMS)* IN-DUCTIVE LOAD	C_S	0.068 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	R_S	1.2 kΩ ½ W	1 kΩ ½ W	1 kΩ ½ W
RFI FILTER	C_F*	0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	L_F*	100 μH	200 μH	200 μH
RCA TRIACS		BTA21C	BTA21D BTA21E	BTA21D BTA21E

*For other RMS current values refer to RCA Application Note AN-4745.

*Typical values for lamp dimming circuits.

Fig. 13 — Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

BTA22 Series

File Number **1300**

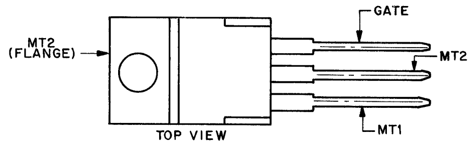
10-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



92CS-39970

JEDEC TO-220AB

The RCA BTA22-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 10 amperes at a T_C of 75°C and repetitive off-state voltage ratings of 200, 300, 400, 500, 600, and 800 volts.

These devices are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BTA22B	BTA22C	BTA22D	BTA22E	BTA22M	BTA22N	
V_{DROM}•, Gate open, T_J = -65 to 125°C	200	300	400	500	600	800	V
$I_{T(RMS)}$, T_C = 75°C, θ = 360°				10			A
I_{TSM} (for 1 full cycle) 60 Hz (sinusoidal)				110			A
50 Hz (sinusoidal)				103			A
di/dt							
$V_D = V_{DROM}$, I_G = 200 mA, t_r = 0.1 μs (See Fig. 13)				70			A/μs
I^2t (See Fig. 11)							
t = 20 ms				66			A^2s
t = 2.5 ms				33			A^2s
t = 0.5 ms				19			A^2s
I_{GTM}■							
For 1 μs max.				4			A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A				16			W
$P_{G(AV)}$				0.35			W
T_{stg}†				-65 to 150			°C
T_C†				-65 to 125			°C
T_T (During Soldering):							
For 10 s max. (terminals and case)				225			°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity to gate voltage (V_G) with reference to main terminal 1.
†For temperature measurement reference point, see Dimensional Outline.

BTA22 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	LIMITS For All Types Unless Otherwise Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}•				
Gate open, $T_J = 125°C$, V_{DROM} = Max. rated value	—	0.1	2	mA
V_{TM}•				
$i_T = 30$ A (peak), $T_C = 25°C$ (See Fig. 6)	—	—	1.7	V
I_{HO}•				
Gate open, Initial principal current = 150 mA (dc)				
$v_D = 12$ V, $T_C = 25°C$	—	15	—	mA
For other case temperatures	See Fig. 7			
dv/dt (Commutating)•				
$v_D = V_{DROM}$, $I_{T(RMS)} = 10$ A, commutating di/dt = 4.44 A/ms, gate unenergized, $T_C = 75°C$ (See Fig. 14)	4	10	—	V/μs
dv/dt•				
$v_D = V_{DROM}$, exponential voltage rise, gate open, $T_C = 100°C$:				
BTA22B	100	300	—	V/μs
BTA22C	85	275	—	V/μs
BTA22D	75	250	—	V/μs
BTA22E	65	225	—	V/μs
BTA22M	60	200	—	V/μs
BTA22N	10	50	—	V/μs
I_{GT}•■ — Mode / V_{MT2} / V_G				
$v_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25°C$ — I^+ / positive / positive	—	10	25	mA
III^- / negative / negative	—	20	30	mA
I^- / positive / negative	—	20	60	mA
III^+ / negative / positive	—	30	60	mA
For other case temperatures	See Figs. 9 & 10			
V_{GT}•■				
$v_D = 12$ V (dc), $R_L = 30\ \Omega$, $T_C = 25°C$	—	1.25	2.5	V
For other case temperatures	See Fig. 12			
$v_D = V_{DROM}$, $R_L = 125\ \Omega$, $T_C = 100°C$	0.2	—	—	V
t_{gt}				
For $v_D = V_{DROM}$, $I_G = 80$ mA, $t_r = 0.1$ μs, $i_T = 10$ A (peak), $T_C = 25°C$ (See Fig. 5)	—	1.6	—	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	°C/W

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

BTA22 Series

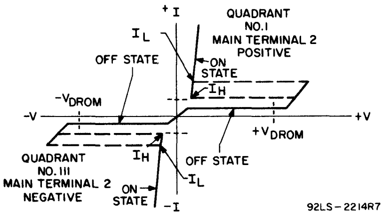


Fig. 1 — Principal voltage-current characteristic.

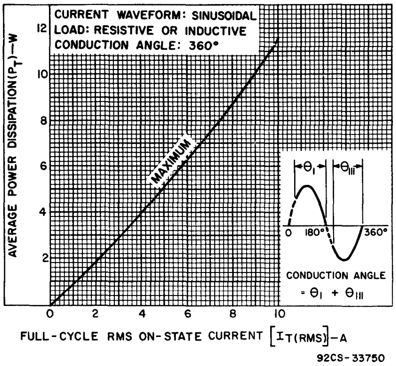


Fig. 2 — Power dissipation vs. on-state current.

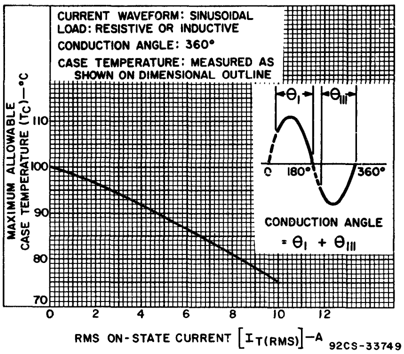


Fig. 3 - Maximum allowable case temperature vs. on-state current.

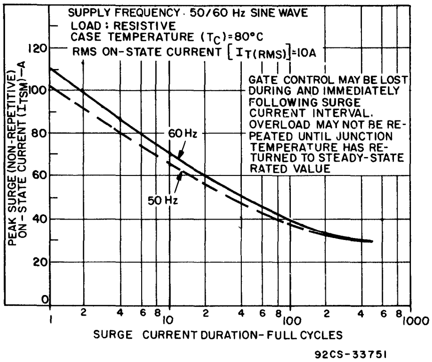


Fig. 4 — Peak surge on-state current vs. surge current duration.

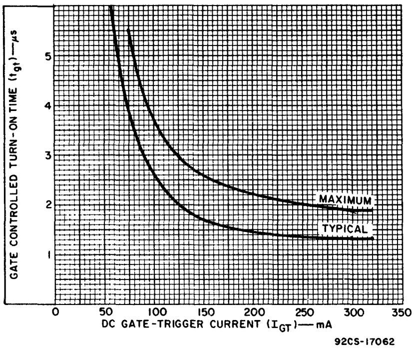


Fig. 5 — Turn-on time vs. gate-trigger current.

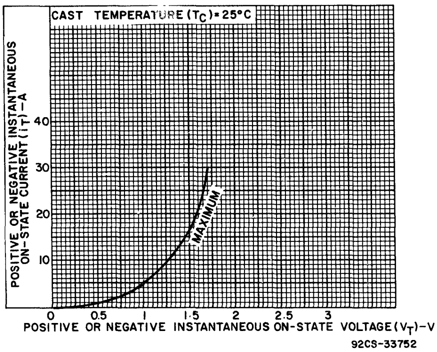


Fig. 6 — On-state current vs. on-state voltage.

BTA22 Series

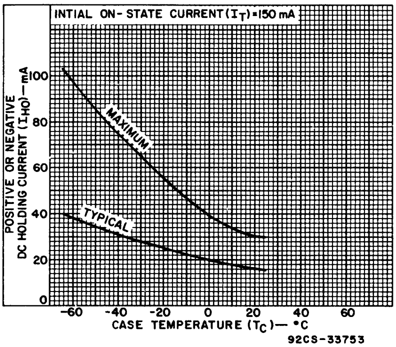


Fig. 7 — DC holding current vs. case temperature.

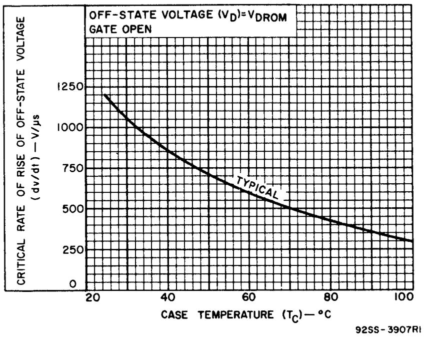


Fig. 8 — Critical rate-of-rise of off-state voltage vs. case temperature.

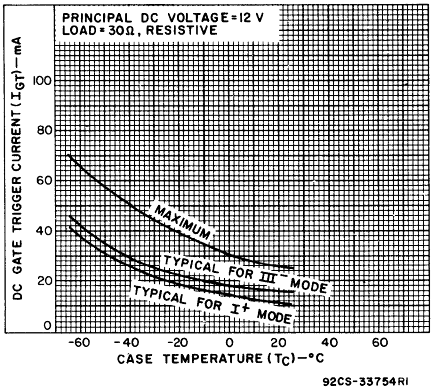


Fig. 9 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

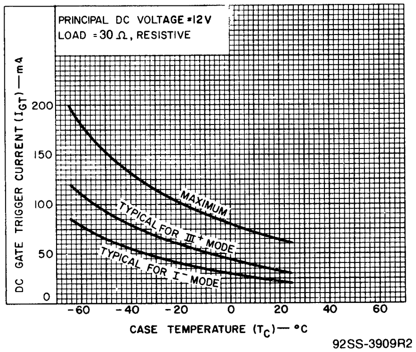


Fig. 10 — DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature.

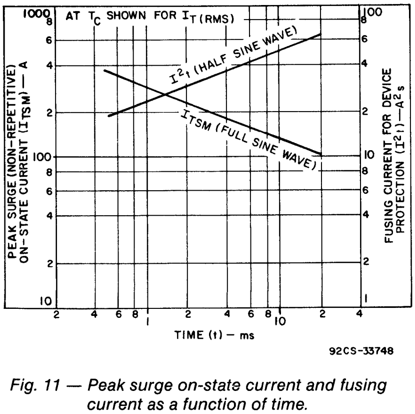


Fig. 11 — Peak surge on-state current and fusing current as a function of time.

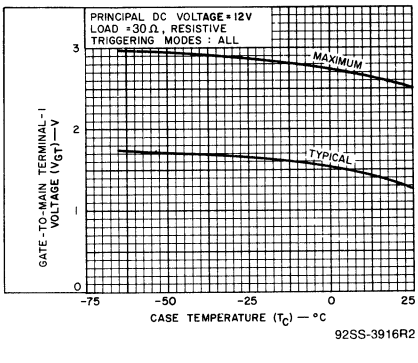


Fig. 12 — DC gate-trigger voltage vs. case temperature.

BTA22 Series

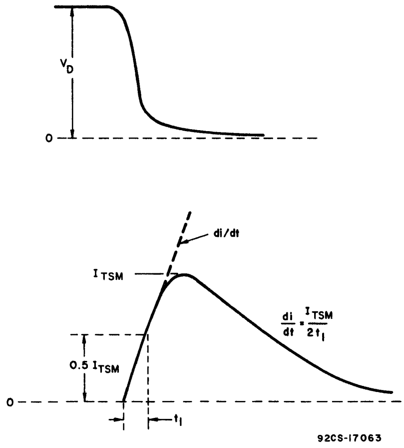


Fig. 13 — Rate-of-change of on-state current with time (defining di/dt).

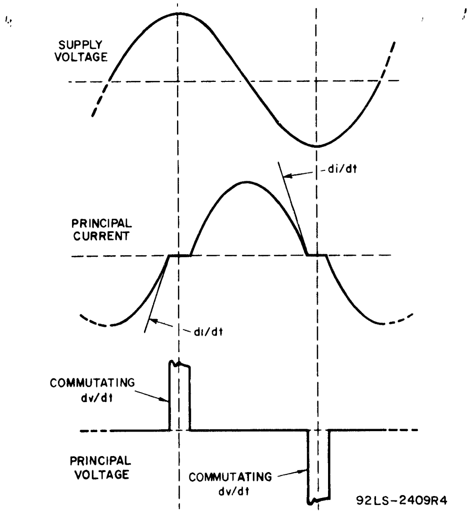


Fig. 14 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

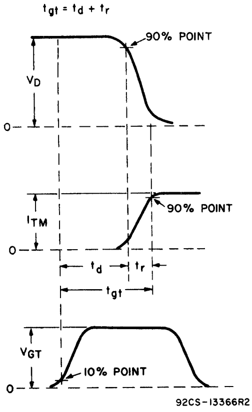
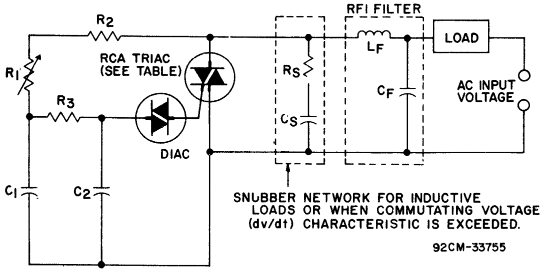


Fig. 15 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).



AC INPUT VOLTAGE		120 V 60 Hz	240 V 60 Hz	240 V 50 Hz
C1		0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
C2		0.1 μF 100 V	0.1 μF 100 V	0.1 μF 100 V
R1		100 kΩ ½ W	200 kΩ ½ W	250 kΩ ½ W
R2		2.2 kΩ ½ W	3.3 kΩ ½ W	3.3 kΩ ½ W
R3		15 kΩ ½ W	15 kΩ ½ W	15 kΩ ½ W
SNUBBER NETWORK FOR 10 A (RMS)* INDUCTIVE LOAD	CS	0.068 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	RS	1.2 kΩ ½ W	1 kΩ ½ W	1 kΩ ½ W
RFI FILTER	CF•	0.1 μF 200 V	0.1 μF 400 V	0.1 μF 400 V
	LF•	100 μH	200 μH	200 μH
RCA TRIACS		BTA22B BTA22C	BTA22D BTA22E	BTA22D BTA22E

*For other RMS current values refer to RCA Application Note AN-4745.
•Typical values for lamp dimming circuits.

Fig. 16 — Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

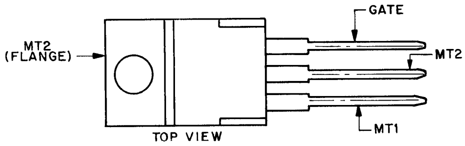
12-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



92CS-39970

JEDEC TO-2203AB

The RCA BTA23-series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages. They have an on-state current rating of 10 amperes at a T_C of 75°C and repetitive off-state voltage ratings of 200, 300, 400, 500, 600, and 800 volts.

These devices are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BTA23B	BTA23C	BTA23D	BTA23E	BTA23M	BTA23N	
V_{DROM}•, Gate open, T_J = -65 to 125°C	200	300	400	500	600	800	V
$I_{T(RMS)}$, T_C = 70°C, θ = 360°	12						A
I_{TSM} (for 1 full cycle) 60 Hz (sinusoidal)	115						A
50 Hz (sinusoidal)	108						A
di/dt							
$V_D = V_{DROM}$, I_G = 200 mA, t_r = 0.1 μs	70						A/μs
I^2t (See Fig. 14)							
t = 20 ms	73						A^2s
t = 2.5 ms	36						A^2s
t = 0.5 ms	20						A^2s
I_{GTM}■							
For 1 μs max.	4						A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A	16						W
$P_{G(AV)}$	0.2						W
T_{stg}†	-65 to 150						°C
T_C†	-65 to 125						°C
T_T (During Soldering):							
For 10 s max. (terminals and case)	225						°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity to gate voltage (V_G) with reference to main terminal 1.
†For temperature measurement reference point, see Dimensional Outline.

BTA23 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	LIMITS For All Types Unless Otherwise Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}•				
Gate open, T_J = 125°C, V_{DROM} = Max. rated value	—	0.1	2	mA
V_{TM}•				
i_T = 30 A (peak), T_C = 25°C (See Fig. 6)	—	—	1.6	V
I_{HO}•				
Gate open, Initial principal current = 150 mA (dc)				
v_D = 12 V, T_C = 25°C	—	15	—	mA
For other case temperatures		See Fig. 7		
dv/dt (Commutating)•				
v_D = V_{DROM}, $I_{T(RMS)}$ = 10 A, commutating di/dt = 4.44 A/ms, gate unenergized, T_C = 75°C (See Fig. 15)	4	10	—	V/μs
dv/dt•				
v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 100°C:				
BTA23B	100	300	—	V/μs
BTA23C	85	275	—	V/μs
BTA23D	75	250	—	V/μs
BTA23E	65	225	—	V/μs
BTA23M	60	200	—	V/μs
BTA23N	30	70	—	V/μs
I_{GT}•■ Mode / V_{MT2} / V_G				
v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C — I^+ positive positive	—	10	25	mA
III^- negative negative	—	20	30	mA
For other case temperatures				
I^- positive negative	—	20	60	mA
III^+ negative positive	—	30	60	mA
For other case temperatures		See Figs. 10 & 11		
V_{GT}•■				
v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	—	1.25	2.5	V
For other case temperatures		See Fig. 12		
v_D = V_{DROM}, R_L = 125 Ω, T_C = 100°C	0.2	—	—	V
t_{gt}				
For v_D = V_{DROM}, I_G = 80 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25°C (See Fig. 13)	—	1.6	—	μs
$R_{\theta JC}$	—	—	2.2	°C/W
$R_{\theta JA}$	—	—	60	°C/W

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

BTA23 Series

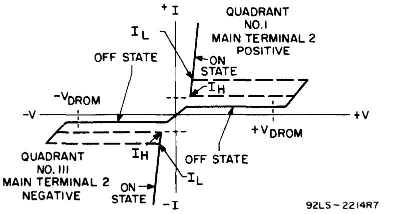


Fig. 1 — Principal voltage-current characteristic.

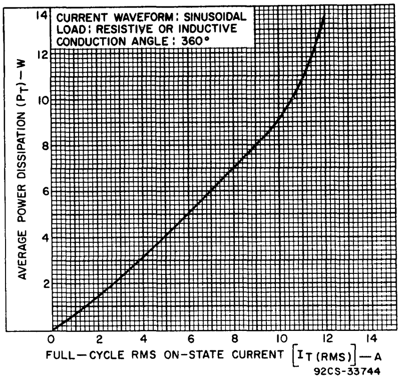


Fig. 2 — Power dissipation as a function of on-state current.

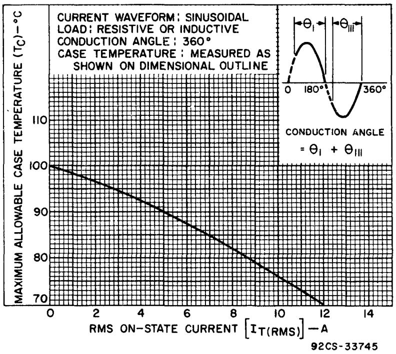


Fig. 3 - Allowable case temperature as a function of on-state current.

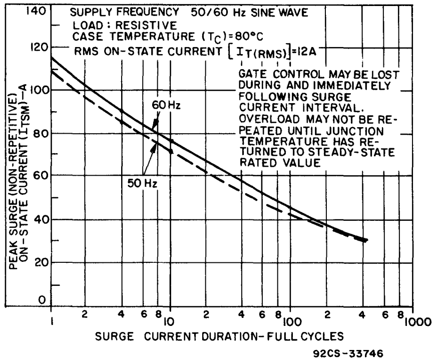


Fig. 4 — Peak surge on-state current as a function of surge current duration.

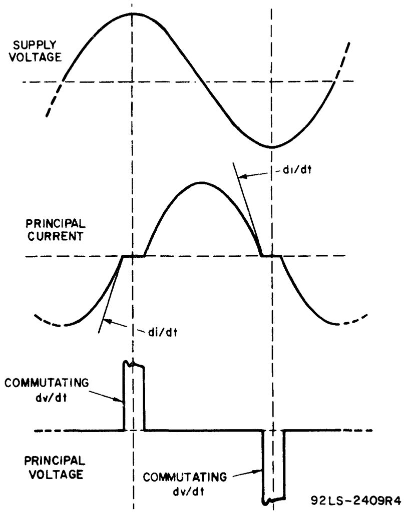


Fig. 5 — Oscilloscope display of commutating dv/dt.

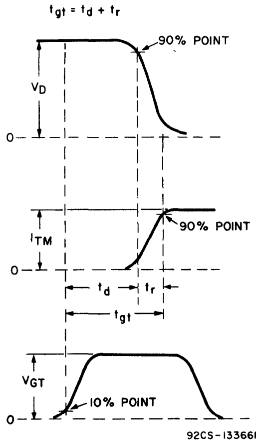


Fig. 6 — Oscilloscope display for measurement of gate-controlled turn-on time (t_{gt}).

BTA23 Series

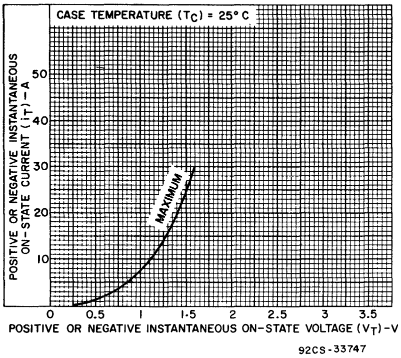


Fig. 7 — On-state current vs. on-state voltage.

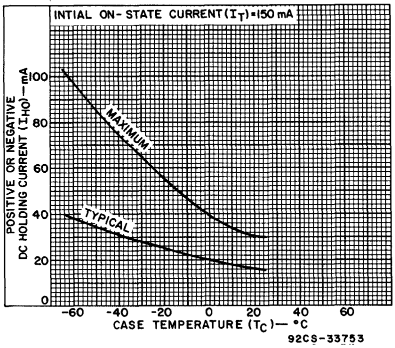


Fig. 8 — DC holding current for either direction of on-state current vs. case temperature.

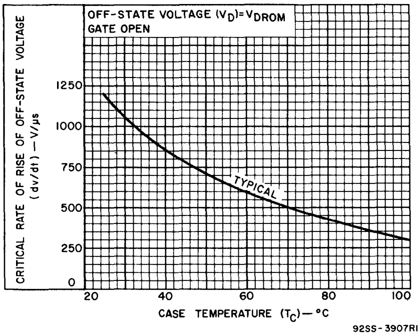


Fig. 9 — Critical rate-of-rise of off-state voltage as a function of case temperature.

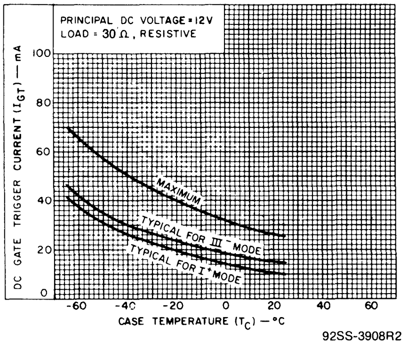


Fig. 10 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

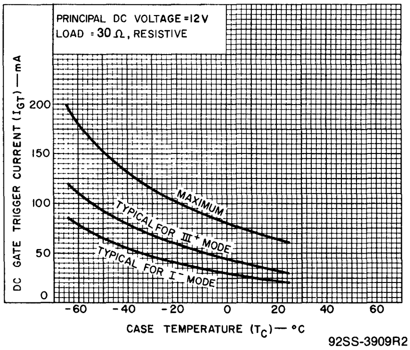


Fig. 11 — DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature.

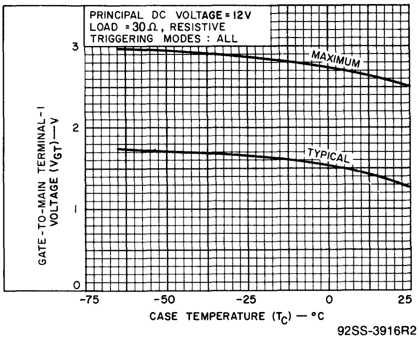


Fig. 12 — DC gate-trigger voltage vs. case temperature.

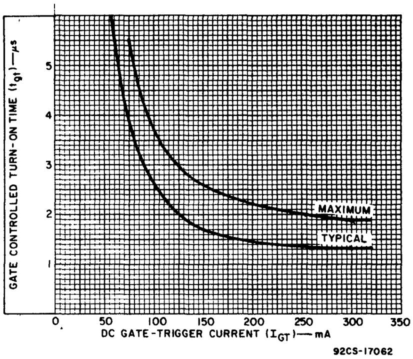


Fig. 13 — Turn-on time vs. gate-trigger current.

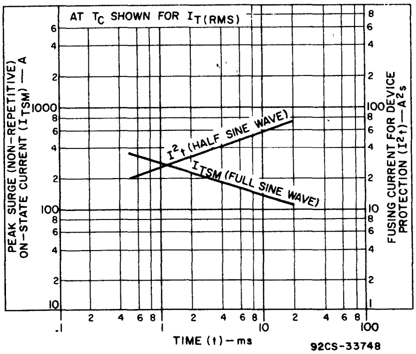
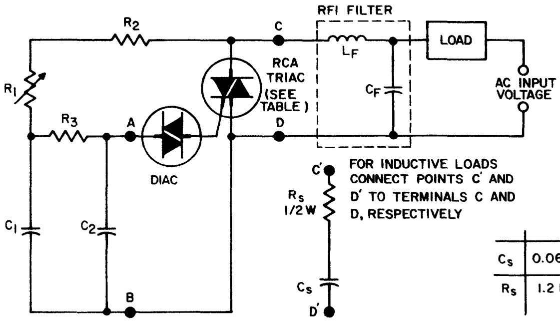


Fig. 14 — Peak surge on-state current and fusing current as a function of time.



	120V	240 V
C_s	0.068 μF/200V	0.1μF/400V
R_s	1.2 KΩ	1 KΩ

AC INPUT VOLTAGE	C_1	C_2	R_1	R_2	R_3	RFI FILTER L_F* (typ.)	RFI FILTER C_F* (typ.)	RCA TYPES
120 V 60 Hz	0.1 μF 200 V	0.1 μF 100 V	100 KΩ ½ W	2.2 KΩ ½ W	15 KΩ ½ W	100 μH	0.1 μF 200V	BTA23B,C
240 V 50 Hz	0.1 μF 400 V	0.1 μF 100 V	250 KΩ 1 W	3.3 KΩ ½ W	15 KΩ ½ W	200 μH	0.1 μF 400 V	BTA23D,E
240 V 60 Hz	0.1 μF 400 V	0.1 μF 100 V	200 KΩ 1 W	3.3 KΩ ½ W	15 KΩ ½ W	200 μH	0.1 μF 400 V	BTA23D,E

*Typical values for lamp-dimming circuits.

92CS-33761

Fig. 15 — Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

MAC15, MAC15A Series

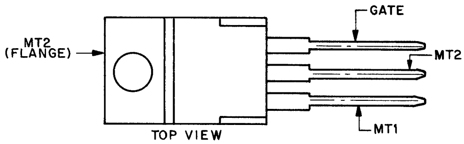
File Number **1086**

15-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Features:
- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-MAC15 and MAC15A series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 12-A at T_C = 95°C and 15-A at T_C = 80°C and repetitive off-state voltage ratings, of 200, 400, 600, and 800 volts.

The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MAC15-4 MAC15A-4	MAC15-6 MAC15A-6	MAC15-8 MAC15A-8	MAC15-10 MAC15A-10	
V_{DROM}• T_J = -40 to 125°C	200	400	600	800	V
$I_{T(RMS)}$ θ = 360°:					
T_C = 95°C	12				A
= 80°C	15				A
For other conditions	See Fig. 3				
I_{TSM}:					
For more than one full cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:					
60 Hz (sinusoidal)	150				A
50 Hz (sinusoidal)	140				A
For more than one cycle of applied principal voltage	See Fig. 4				
di/dt:					
$V_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs	100				A/μs
I_{GTM}▪					
For 1 μs max.	2				A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A)	20				W
$P_{G(AV)}$	0.5				W
T_{stg}	-40 to 150				°C
T_C	-40 to 125				°C
T_T (During soldering for 10 s max.)	230				°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
▪For either polarity of gate voltage (V_G) with reference to main terminal 1.

MAC15, MAC15A Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}●				
V_{DROM} = Max. rated value, T_C = 125°C	–	–	2	mA
v_{TM}●				
T_C = 25°C, i_T = 21A (peak)	–	1.3	1.6	V
I_{HO}●				
Gate open, Initial principal current = 200 mA (dc)				
v_D = 12 V, T_C = 25°C	–	6	40	mA
dv/dt● (Commutating)				
v_D = V_{DROM}, i_T = 21A (peak)				
di/dt = 8 A/ms, T_C = 80°C	–	5	–	V/μs
I_{GT}●■ v_D = 12 V (dc), R_L = 100 Ω				
T_C = 25°C Mode V_{MT2} V_G				
I+ + +	–	–	50	mA
III– – –	–	–	50	
I– + – MAC15A series only	–	–	75	
III+ – + MAC15A series only	–	–	75	
V_{GT}●■ v_D = 12 V (dc), R_L = 100 Ω				
T_C = 25°C Mode V_{MT2} VG				
I+ + +	–	0.9	2	
III– – –	–	1.1	2	
I– + – MAC15A series only	–	0.9	2.5	
III+ – + MAC15A series only	–	1.4	2.5	V
T_C = 110°C v_D = V_{DROM}, R_L = 10 kΩ				
I+ + +	0.2	–	–	
III– – –	0.2	–	–	
I– + – MAC15A series only	0.2	–	–	
III+ – + MAC15A series only	0.2	–	–	
t_{gt}				
v_D = V_{DROM}, I_{GT} = 120 mA, t_r = 0.1 μs, i_T = 17A (peak),				
T_C = 25°C	–	1.5	2	μs
$R_{\theta JC}$	–	–	2	°C/W

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

MAC15, MAC15A Series

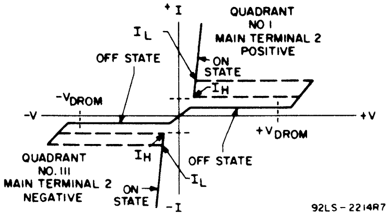


Fig. 1 — Principal voltage-current characteristic.

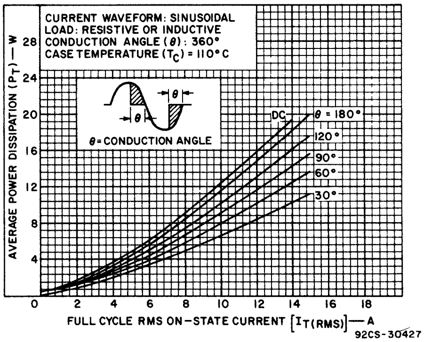


Fig. 2 — Power dissipation as a function of on-state current.

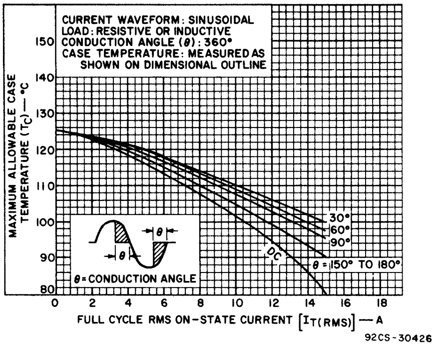


Fig. 3 — Maximum allowable case-temperature as a function of on-state current.

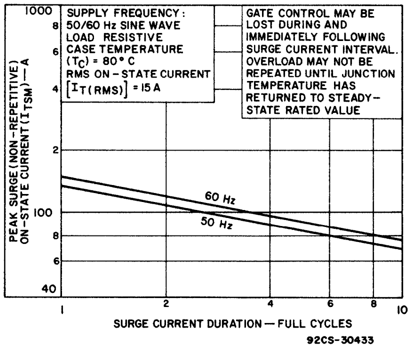


Fig. 4 — Peak surge on-state current as a function of surge current duration.

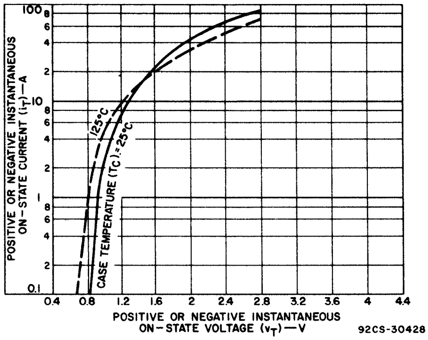


Fig. 5 — On-state current as a function of on-state voltage.

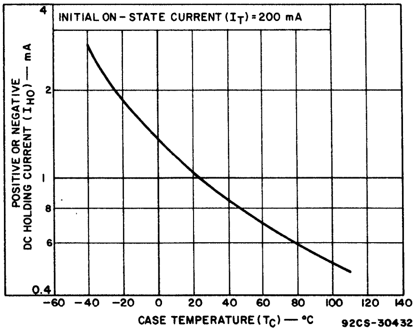


Fig. 6 — DC holding current as a function of case temperature.

MAC15, MAC15A Series

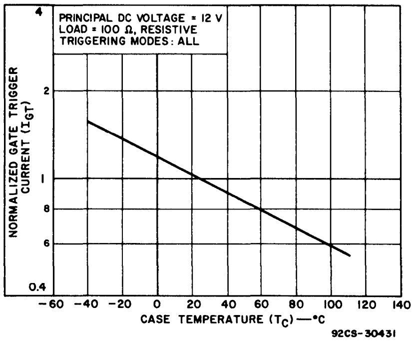


Fig. 7 — Normalized gate trigger current as a function of case temperature.

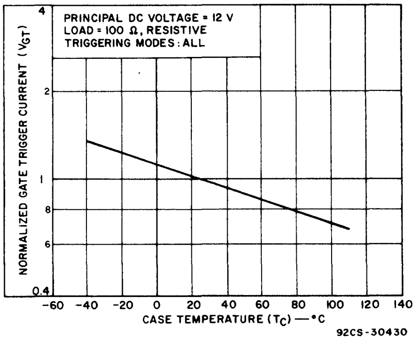


Fig. 8 — Normalized gate trigger voltage as a function of case temperature.

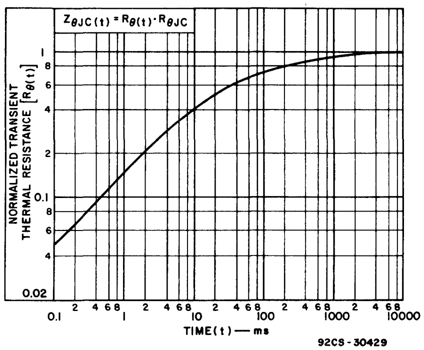


Fig. 9 — Normalized transient thermal resistance as a function of time.

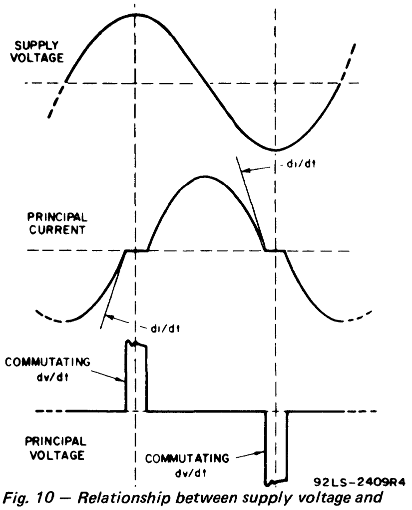
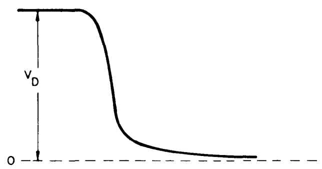


Fig. 10 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).



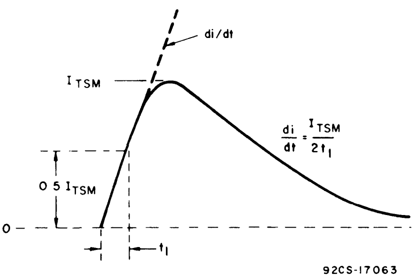


Fig. 11 — Rate-of-change of on-state current with time (defining di/dt).

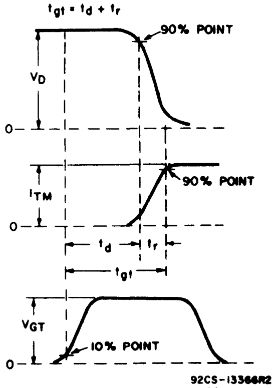


Fig. 12 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

SC141, SC146 Series

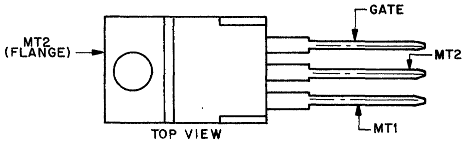
File Number **1167**

6-A and 10-A Silicon Triacs

Three-Lead Plastic Types for Power-Control and Power-Switching Applications

Features:
- *800 V, 125 Deg. C T_J operating*
- *High dv/dt and di/dt capability*
- *Low switching losses*
- *High pulse current capability*
- *Low forward and reverse leakage*
- *Sipos oxide glass multilayer passivation system*
- *Advanced unisurface construction*
- *Precise Ion implanted diffusion source*

TERMINAL DESIGNATIONS



92CS-39970

JEDEC TO-220AB

The RCA-SC141 and SC146 series triacs are gate-controlled full-wave silicon switches.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 6-A at T_C = 75°C (SC141 series) and 10-A at T_C = 80° (SC146 series) and repetitive off-state voltage ratings, of 200, 400, 500, 600, and 800 volts.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	SC141B SC146B	SC141D SC146D	SC141E SC146E	SC141M SC146M	SC141N SC146N	
V_{DROM}• T_J = -40 to 125°C	200	400	500	600	800	V
$I_{T(RMS)}$ θ = 360°:						
For SC141 series, T_C = 75°C			6			A
For SC146 series, T_C = 80°C			10			A
For other conditions			See Fig. 4			
I_{TSM}:						
For one full cycle of applied principal voltage, at current and temperature shown above for $I_{T(RMS)}$:	SC141 Series			SC146 Series		
60 Hz (sinusoidal)	80			120		A
50 Hz (sinusoidal)	75			110		A
For more than one cycle of applied principal voltage			See Fig. 5			
di/dt:						
$V_D = V_{DROM}$, I_G = 200 mA, t_r = 0.1 μs			70			A/μs
I^2t [At T_C shown for $I_{T(RMS)}$, half-sine wave]:	SC141 Series			SC146 Series		
t = 10 ms	25			70		A^2s
2.5 ms	17			45		A^2s
0.5 ms	10			25		A^2s
I_{GTM}▪						
For 1 μs max.			4			A
P_{GM} (For 1 μs max., $I_{GTM} \leq$ 4 A)			10			W
$P_{G(AV)}$			0.5			W
T_{stg}			-40 to 125			°C
T_C			-40 to 125			
T_T (During soldering for 10 s max.)			230			°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
▪For either polarity of gate voltage (V_G) with reference to main terminal 1.

SC141, SC146 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}●				
V_{DROM} = Max. rated value, T_C = 25°C	–	–	0.1	mA
= 125°C	–	–	0.5	
V_{TM}●				
T_C = 25°C, i_T = 8.5 A (peak SC141 series	–	–	1.83	V
= 14 A (peak) SC146 series	–	–	1.65	
I_{HO}●				
Gate open, initial principal current = 500 mA (dc)				
v_D = 12 V, T_C = 25°C	–	–	50	
= –40°C	–	–	100	
I_L●				mA
R_{GK} = 100 Ω, t_W = 50 μs, $t_r = t_f$ = 5 μs, f = 1 kHz,				
T_C = 25°C Mode V_{MT2} V_G				
1+ + +	–	–	100	
111– – –	–	–	100	
1– + –	–	–	200	
T_C = –40°C 1+ + +	–	–	200	
111– – –	–	–	200	
1– + –	–	–	400	
dv/dt● (Commutating)				
$v_D = V_{DROM}$, $I_{T(RMS)}$ = Max. rated value,				
di/dt = 3.2 A/ms, T_C = 80°C SC141 series	4	–	–	
di/dt = 5.4 A/ms, T_C = 80°C SC146 series	4	–	–	V/μs
dv/dt● (Off-State)				
$v_D = V_{DROM}$, T_C = 100°C, Exponential voltage rise				
SC141 series	30	100	–	
SC146 series	100	250	–	
I_{GT}●■ v_D = 12 V (dc)				
T_C = 25°C R_L–Ω Mode V_{MT2} V_G				
100 1+ + +	–	–	50	
100 111– – –	–	–	50	mA
50 1– + –	–	–	50	
T_C = –40°C 50 1+ + +	–	–	80	
50 111– – –	–	–	80	
25 1– + –	–	–	80	
V_{GT}●■ v_D = 12 V (dc)				
T_C = 25°C R_L–Ω Mode V_{MT2} V_G				
100 1+ + +	–	–	2.5	
100 111– – –	–	–	2.5	
50 1– + –	–	–	2.5	V
T_C = –40°C 50 1+ + +	–	–	3.5	
50 111– – –	–	–	3.5	
25 1– + –	–	–	3.5	

SC141, SC146 Series

ELECTRICAL CHARACTERISTICS (Cont'd)

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified			UNITS
	Min.	Typ.	Max.	
V_{GD}● $v_D = V_{DROM}$, $R_L = 1k\Omega$, $T_C = 100°C$ (For all triggering modes)	0.2	–	–	V
t_{gt} $v_D = V_{DROM}$, I_G = 80 mA, $t_r = 0.1$ μs, $i_T = 25$ A (peak), $T_C = 25°C$	–	1.6	2.5	μs

Thermal Characteristics

Characteristic		Min.	Typ.	Max.	Units
$R_{\theta JC}$	SC141 series	–	–	3.0	°C/W
	SC146 series			2.2	°C/W
$R_{\theta JA}$		–	–	75	°C/W
$R_{\theta JC (ac)}$* During ac current conduction	SC141 series	–	–	2.22	°C/W
	SC146 series	–	–	1.5	°C/W

● For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

■ For either polarity of gate voltage (V_G) with reference to main terminal 1.

* This characteristic is useful in the calculation of junction-temperature rise above T_C for ac current conduction and applies for a 50 or 60 Hz full sine wave of current. It can be calculated with the following formula:

$$\text{Apparent thermal resistance} = \frac{T_{J(max.)} - T_C}{P_{T(AV)}}$$

where: $T_{J(max.)}$ = maximum junction temperature
T_C = case temperature
$P_{T(AV)}$ = average on-state power

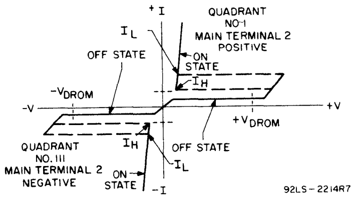


Fig. 1 – Principal voltage-current characteristic.

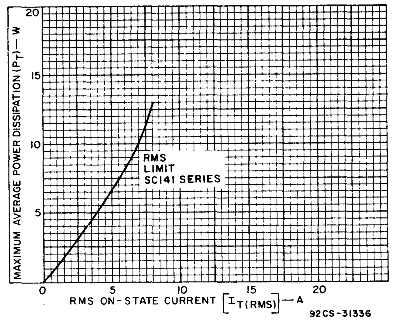


Fig. 2 – Power dissipation as a function of on-state current for SC141 series.

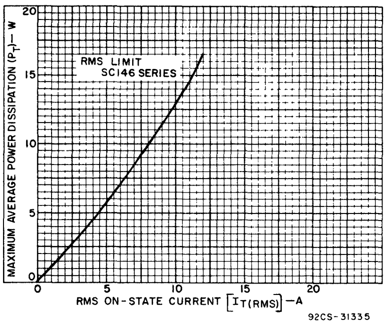


Fig. 3 – Power dissipation as a function of on-state current for SC146 series.

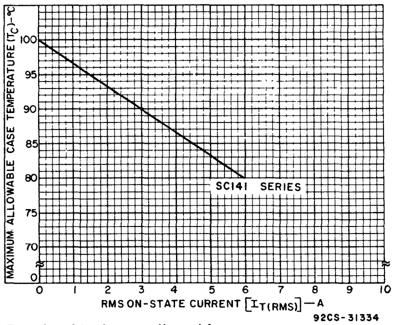


Fig. 4 – Maximum allowable case-temperature as a function of on-state current for SC141 series.

SC141, SC146 Series

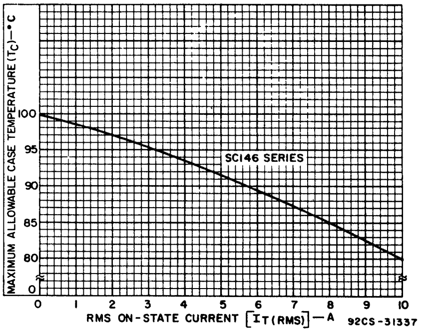


Fig. 5 — Maximum allowable case-temperature as a function of on-state current for SC146 series.

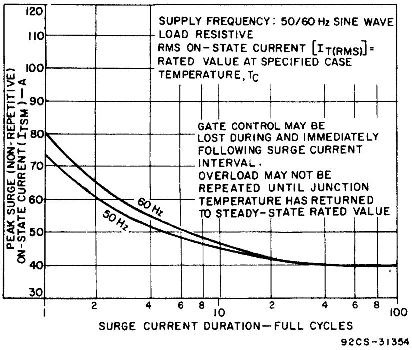


Fig. 6 — Peak surge on-state current as a function of surge current duration for SC141 series.

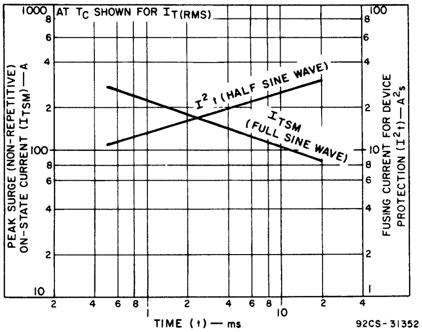


Fig. 7 — Peak surge on-state current and fusing current as a function of time for SC141 series.

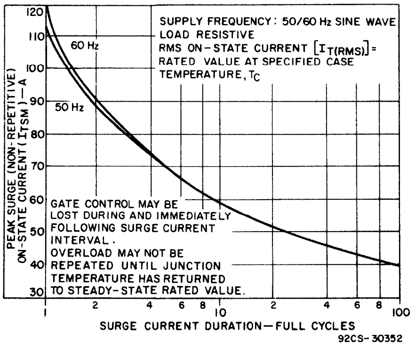


Fig. 8 — Peak surge on-state current as a function of surge current duration for SC146 series.

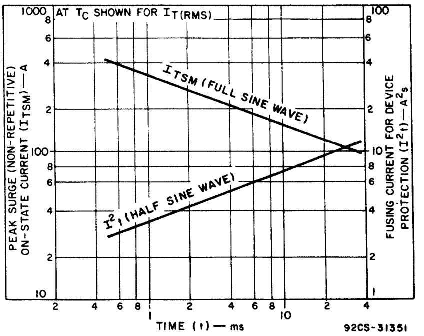


Fig. 9 — Peak surge on-state current and fusing current as a function of time for SC146 series.

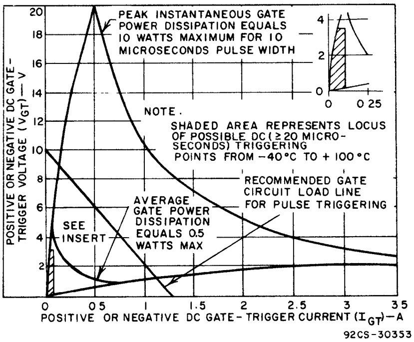


Fig. 10 — Gate pulse characteristics for all triggering modes.

SC141, SC146 Series

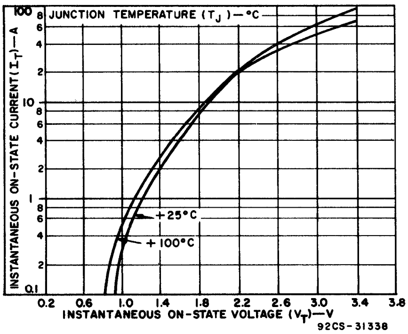


Fig. 11 — On-state current as a function of on-state voltage for SC141 series.

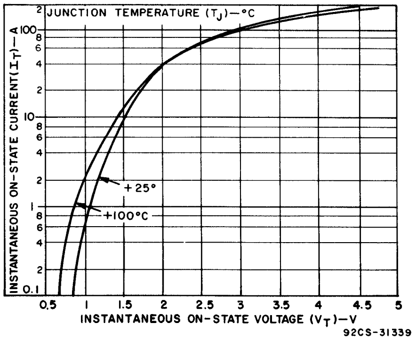


Fig. 12 — On-state current as a function of on-state voltage for SC146 series.

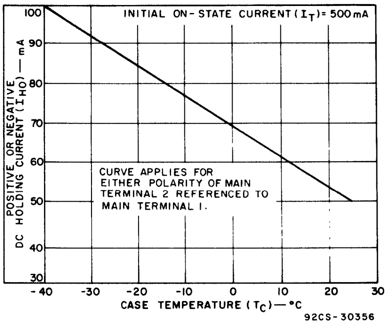


Fig. 13 — DC holding current as a function of case temperature.

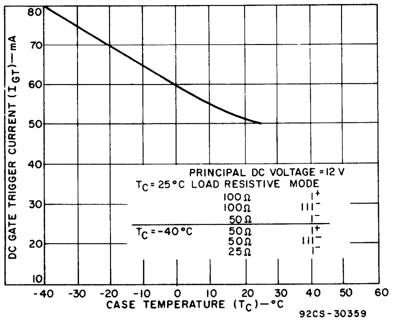


Fig. 14 — DC gate trigger current as a function of case temperature.

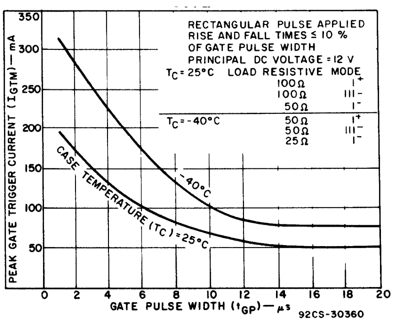


Fig. 15 — Peak gate trigger current as a function of gate pulse width.

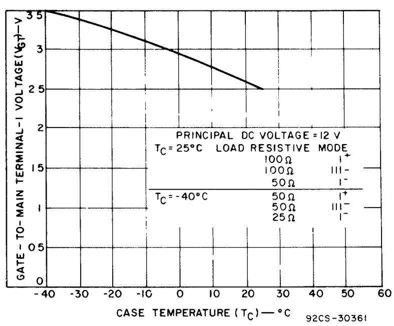


Fig. 16 — DC gate-trigger voltage as a function of case temperature.

SC141, SC146 Series

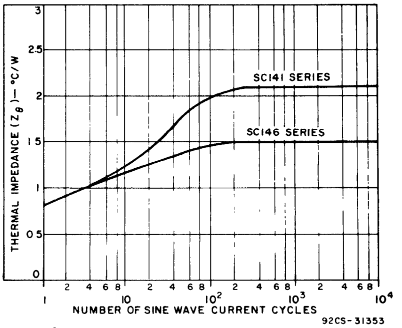


Fig. 17 — Thermal impedance as a function of sine-wave current cycles.

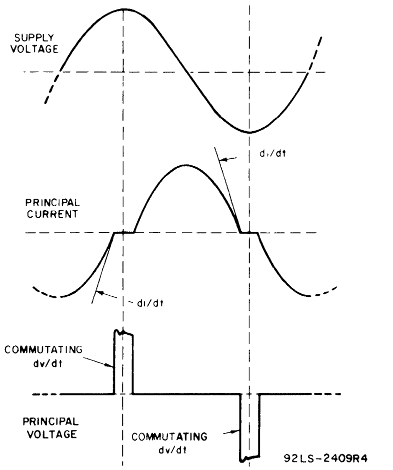
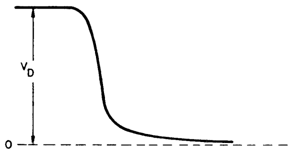


Fig. 18 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).



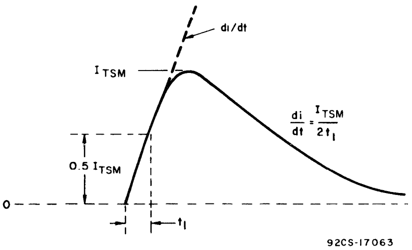


Fig. 19 — Rate-of-change of on-state current with time (defining di/dt).

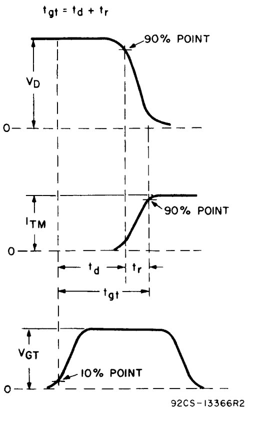


Fig. 20 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

T2300, T2301, T2302 Series

File Number **911**

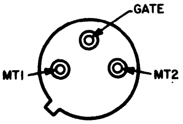
2.5-A Sensitive-Gate Silicon Triacs

Modified TO-205 Package for AC Power Switching

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



92CS-27726

Modified TO-205

The RCA-T2300, T2301, T2302, series triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

The gate sensitivity of these triacs permits the use of economical transistorized control circuits and enhances their use in low-power phase-control and load-switching applications.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

3 mA Gate	**T2300F**	**T2300A**	**T2300B**	**T2300D**	**T2300M**	**T2300N**	
4 mA Gate	**T2301F**	**T2301A**	**T2301B**	**T2301D**	**T2301M**	**T2301N**	
10 mA Gate	**T2302F**	**T2302A**	**T2302B**	**T2302D**	**T2302M**	**T2302N**	
V_{DROM}▲: T_J = -40 to 125° C	50	100	200	400	600	800	V
$I_{T(RMS)}$: T_C = 95° C	2.5						A
For other conditions	See Figs. 3,4,5						
I_{TSM}: For one cycle of applied principal voltage							
60 Hz (sinusoidal)	25						A
50 Hz (sinusoidal)	21						A
More than one cycle of applied principal voltage	See Figs. 6,7						
di/dt: $V_D = V_{DROM}$, I_G = 50 mA, t_r = 0.1 μs	100						A/μs
I^2t [At T_C shown for $I_{T(RMS)}$]:							
t = 20 ms	4.3						A^2s
= 2.5 ms	2						A^2s
= 0.5 ms	1						A^2s
I_{GTM}•: For 1 μs max.	1						A
P_{GM}: Peak (For 1 μs max., $I_{GTM} \leq$ 1 A(peak)	10						W
$P_{G(AV)}$:							
T_C = 60° C	0.15						W
T_A = 25° C	0.05						W
T_{stg}■	-40 to 150						°C
T_C■	-40 to 125						°C
T_T■: During soldering for 10 s maximum at distance ≥ 1/16 in. (1.58 mm) from seating plane	225						°C

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
•For either polarity of gate voltage (V_G) with reference to main terminal 1.
■For temperature measurement reference point, see Dimensional Outlines.

T2300, T2301, T2302 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS FOR ALL TYPES Except as Specified			UNITS
	Min.	Typ.	Max.	
I_{DROM}▲: Gate open, T_J = 125°C, V_{DROM} = Max. rated value	–	0.2	0.75	mA
V_{TM}▲: i_T=10 A(peak), T_C=25°C	–	1.7	2.2	V
I_{HO}▲: *(See Figs. 9 & 10)* Gate open, Initial principal current=150 mA (dc), v_D=12 V, T_C=25°C				mA
(T2300, T2301 series)	–	2	5	
(T2302 series)	–	7	15	
dv/dt (Commutating)▲: *(See Fig. 14)* $v_D=V_{DROM}$, $I_{T(RMS)}$=2.5 A, commutating di/dt=1.33 A/ms, gate unenergized, T_C= 70°C	0.5	–	–	V/μs
dv/dt (Off-state)▲: $v_D=V_{DROM}$, exponential voltage rise, gate open,				V/μs
T_c = 115°C (T2300, T2301 series)	3	5	–	
T_c = 125°C (T2302 series)	6	10	–	
I_{GT}▲●: *(See Figs. 11 & 12)* v_D=12 V dc, R_L=30 Ω, T_C=25°C				mA
Mode / V_{MT2} / V_G				
I^+ positive positive				
T2300 series	–	1	3	
T2301 series	–	1	4	
T2302 series	–	3.5	10	
III^- negative negative				
T2300 series	–	1	3	
T2301 series	–	1	4	
T2302 series	–	3.5	10	
I^- positive negative				
T2300 series	–	2	3	
T2301 series	–	2	4	
T2302 series	–	7	10	
III^+ negative positive				
T2300 series	–	2	3	
T2301 series	–	2	4	
T2302 series	–	7	10	
V_{GT}▲●: *(See Fig. 13)*				V
v_D=12 V dc, R_L=30 Ω, T_C=25°C	–	1	2.2	
$v_D=V_{DROM}$, R_L=125 Ω, T_c = 125°C	0.15	–	–	
t_{gt}: *(See Fig. 16)* $v_D=V_{DROM}$, I_{GT}=60 mA, t_r=0.1 μs, i_T=10 A(peak), T_C=25°C	–	1.8	2.5	μs
$R_{\theta JC}$: Steady-state	–	–	8.5	°C/W
$R_{\theta JA}$: (T2300 Series)	–	–	150	°C/W

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.

●For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2300, T2301, T2302 Series

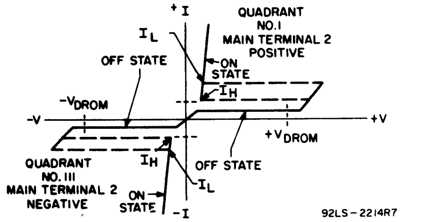


Fig. 1—Principal voltage-current characteristic.

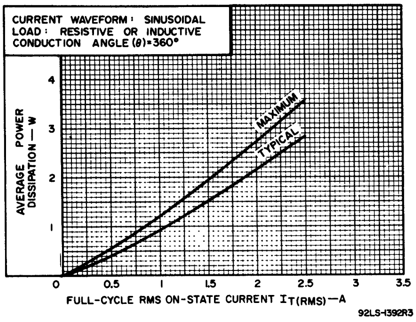


Fig. 2—Power dissipation vs. on-state current.

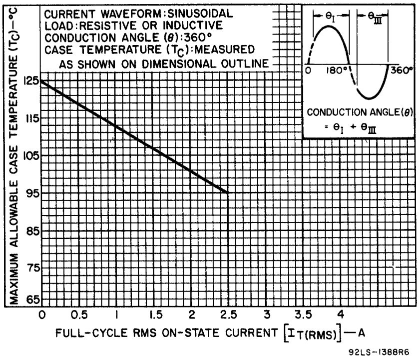


Fig. 3—Maximum allowable case temperature vs. on-state current.

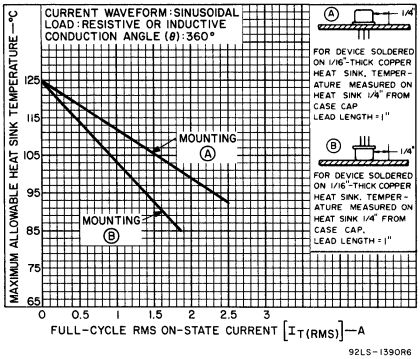


Fig. 4–Maximum allowable heat-sink temperature vs. on-state current for T2300, T2301, T2302 series.

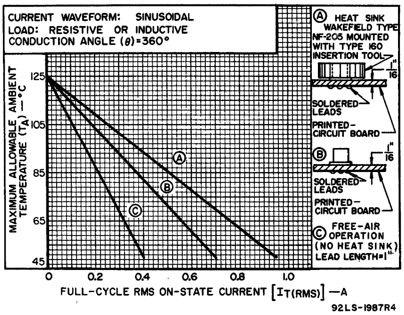


Fig. 5–Maximum allowable ambient temperature vs. on-state current for T2302 series.

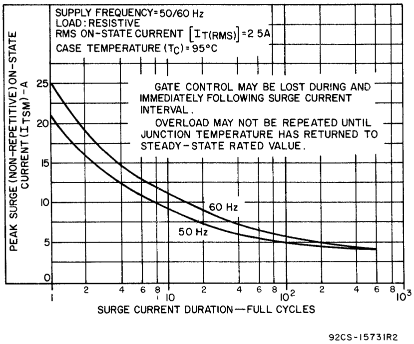


Fig. 6–Peak surge on-state current vs. surge-current duration.

T2300, T2301, T2302 Series

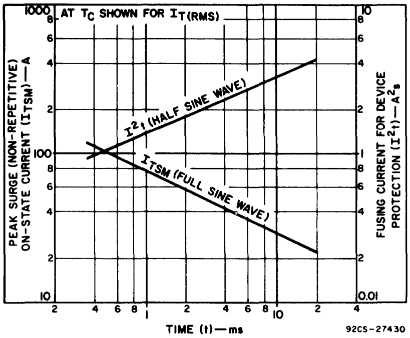


Fig. 7- Peak surge on-state current and fusing current vs. time.

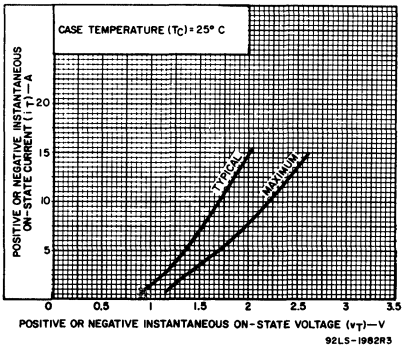


Fig. 8- On-state current vs. on-state voltage for all series.

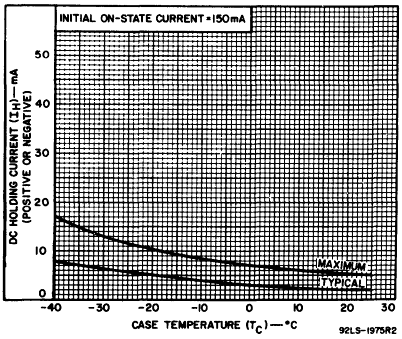


Fig. 9- DC holding current (positive or negative) vs. case temperature for T2300, T2301 series.

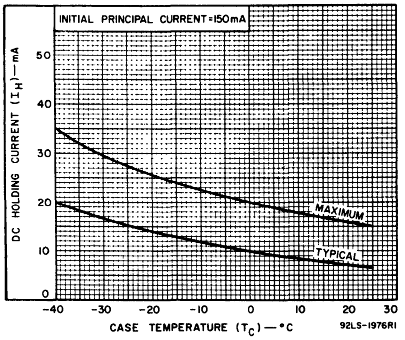


Fig. 10- DC holding current (positive or negative) vs. case temperature for T2302 series.

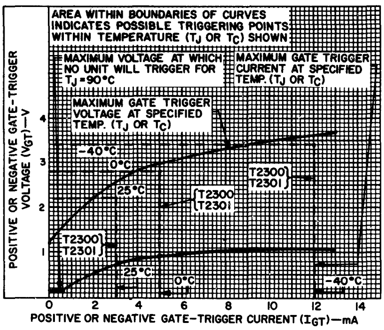


Fig. 11-Gate-trigger current vs. case temperature for T2300, T2301 Series.

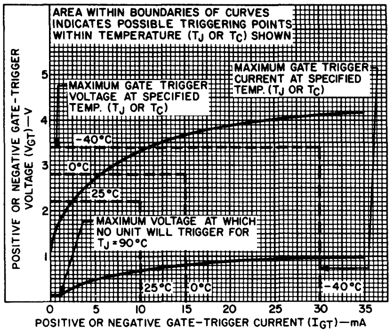


Fig. 12-Gate-trigger current vs. case temperature for T2302 series.

T2300, T2301, T2302 Series

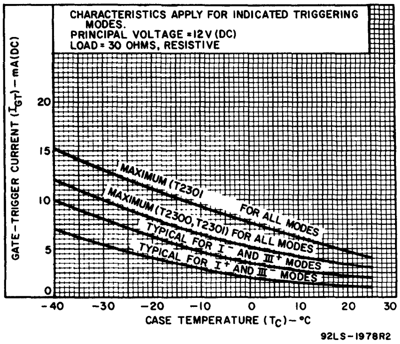


Fig. 13-Gate-trigger voltage vs. case temperature.

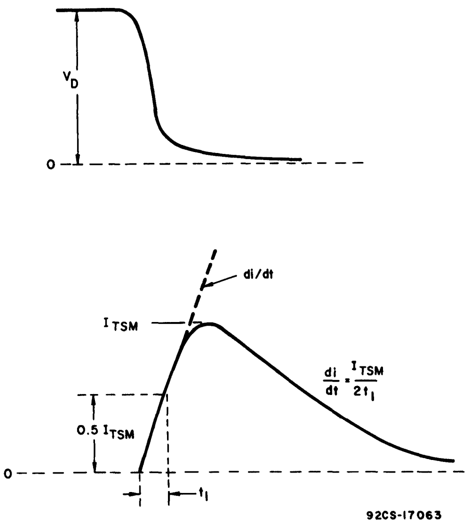


Fig. 14-Rate-of-change of on-state current with time (defining di/dt).

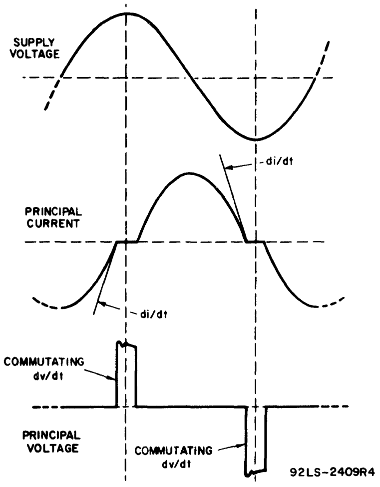


Fig. 15-Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

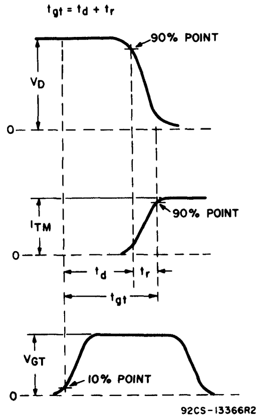


Fig. 16-Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

File Number **1042**

T2320, T2322, T2323, T2327 Series

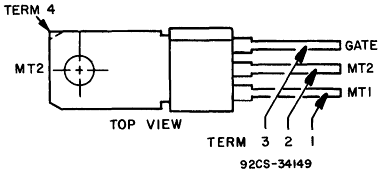
2.5-A Sensitive-Gate Silicon Triacs

For AC Power Switching

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-202AB

The RCA-T2320, T2322, T2323 and T2327, series triacs are gate-controlled full-wave silicon ac switches that are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. The gate sensitivity of these triacs permits the use of economical transistorized or integrated circuit control circuits and enhances their use in low-power phase-control and load-switching applications.

All types in each series utilize the JEDEC-TO-202AB (VERSATAB) plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

3mA Gate	**T2320A**	**T2320B**	**T2320D**	**T2320E**	**T2320M**	**T2320N**	
10 mA Gate	**T2322A**	**T2322B**	**T2322D**	**T2322E**	**T2322M**	**T2322N**	
25 mA Gate	**T2323A**	**T2323B**	**T2323D**	**T2323E**	**T2323M**	**T2323N**	
5 mA Gate	**T2327A**	**T2327B**	**T2327D**	**T2327E**	**T2327M**	**T2327N**	
V_{DROM}▲ (Gate Open, T_J = -40 to 125° C)	100	200	400	500	600	800	

$I_{T(RMS)}$ (T_C = 95° C)	2.5	A
$I_{T(RMS)}$ (T_A = 25° C)	1	A
I_{TSM} (for 1 full cycle)	25	A
di/dt:	100	A/μs
I^2t [At T_C shown for $I_{T(RMS)}$] (Half-sine wave):		
t = 20 ms	3.4	A^2s
= 2.5 ms	1.7	A^2s
= 0.5 ms	1	A^2s
For other time values	See Fig. 5	
I_{GTM}• (For 1 μs max.)	1	A
P_{GM} (for 1 μs max.)	10	W
$P_{G(AV)}$ (Averaging time 10ms max.)	0.1	W
T Storage	-40 to 150	°C
T_J	-40 to 125	°C
T_T■:		
During soldering for 10 s maximum at distance ≥ 1/16 in. (1.58 mm) from seating plane	225	°C

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
•For either polarity of gate voltage (V_G) with reference to main terminal 1.
■For temperature measurement reference point, *see Dimensional Outlines.*

T2320, T2322, T2323, T2327 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Case Temperature (T_C)

CHARACTERISTIC	LIMITS For All Types Except as Specified Min.	Typ.	Max.	UNITS
I_{DROM}▲:				
Gate open, T_J= 125° C, V_{DROM} = Max. rated value	—	0.2	0.75	mA
v_{TM}▲:				
i_T = 10 A (peak), T_C = 25° C T2322, T2322, T2327 series	—	1.7	2.2	V
i_T = 10 A (peak), T_C = 25° C T2323 series	—	1.7	2.6	
I_{HO}▲:				
Gate open, Initial principal current = 150 mA (dc), v_D = 12 V, T_C = 25° C	—	15	30	mA
dv/dt (Commutating) ▲:				
v_D = V_{DROM}, $I_{T(RMS)}$ = 2.5 A, commutating di/dt = 1.33 A/ms, gate unenergized, T_C = 95° C	1	4	—	V/μs
dv/dt (Off-state) ▲:				
v_D = V_{DROM}, exponential voltage rise, gate open, T_C = 125° C	10	100	—	V/μs
I_{GT}▲●: (See Fig. 7)				
v_D = 12 V dc, R_L = 30 Ω, T_C = 25° C				
Mode V_{MT2} V_G				
I+ positive positive				
T2320 series	—	—	3	mA
T2322 series	—	—	10	mA
T2323 series	—	—	25	mA
T2327 series	—	—	5	mA
III− negative negative				
T2320 series	—	—	3	mA
T2322 series	—	—	10	mA
T2323 series	—	—	25	mA
T2327 series	—	—	5	mA
I− positive negative				
T2320 series	—	—	3	mA
T2322 series	—	—	10	mA
T2323 series	—	—	40	mA
T2327 series	—	—	5	mA
III+ negative positive				
T2320 series	—	—	3	mA
T2322 series	—	—	10	mA
T2323 series	—	—	40	mA
T2327 series	—	—	5	mA
V_{GT}▲●: (See Fig. 8)				
v_D = 12 V dc, R_L = 30 Ω, T_C = 25° C	—	1	2.2	V
v_D = V_{DROM}, R_L = 125 Ω, T_C = 125° C	0.15	—	—	V
t_{gt}: (See Fig. 11)				
v_D = V_{DROM}, I_G = 60 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25° C	—	1.8	2.5	μs
$R_{θJC}$	—	—	8	°C/W
$R_{θJA}$	—	—	80	°C/W

▲For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
●For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2320, T2322, T2323, T2327 Series

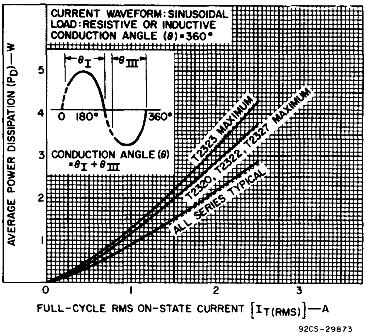


Fig. 1 — Power dissipation as a function of on-state current.

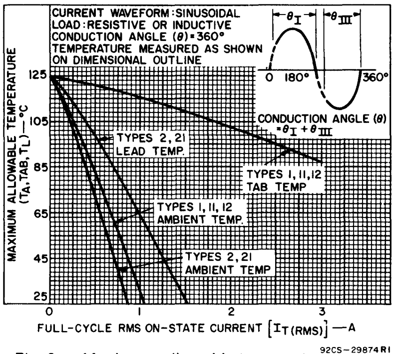


Fig. 2 — Maximum allowable temperature as a function of on-state current for T2320, T2322, and T2327.

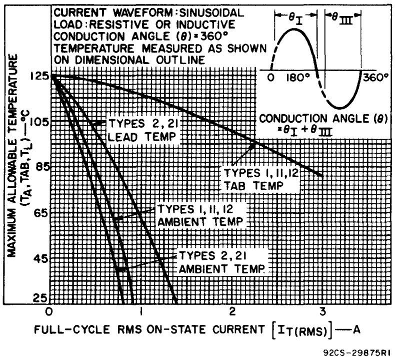


Fig. 3 — Maximum allowable temperature as as function of on-state current for T2323.

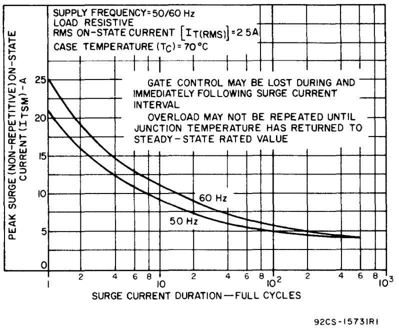


Fig. 4 — Peak surge on-state current as a function of surge-current duration.

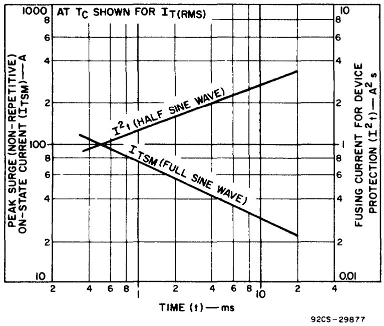


Fig. 5 — Peak surge on-state current and fusing current as a function of time.

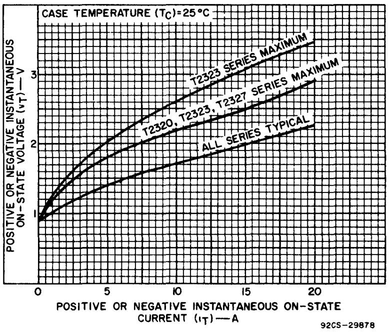


Fig. 6 — On-state current vs. on-state voltage.

T2320, T2322, T2323, T2327 Series

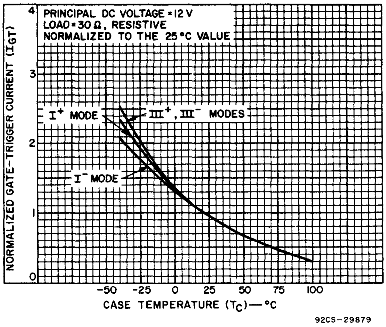


Fig. 7 — Gate-trigger current vs. case temperature.

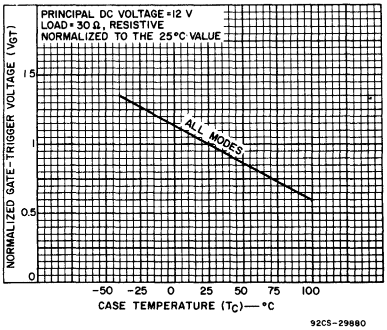


Fig. 8 — Gate-trigger voltage vs. case temperature.

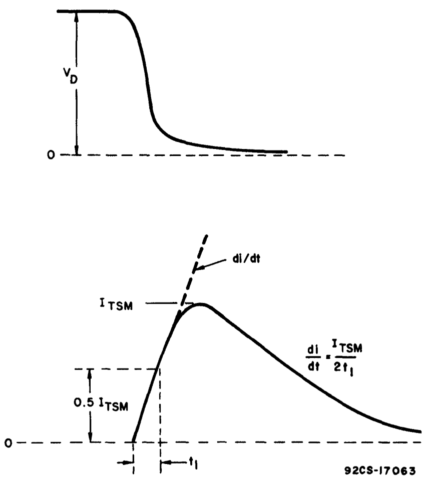


Fig. 9 — Rate-of-change of on-state current with time (defining di/dt).

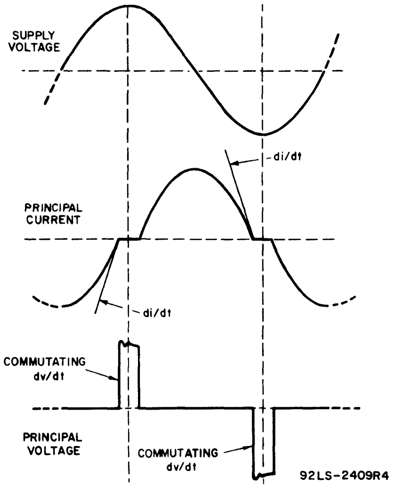


Fig. 10 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

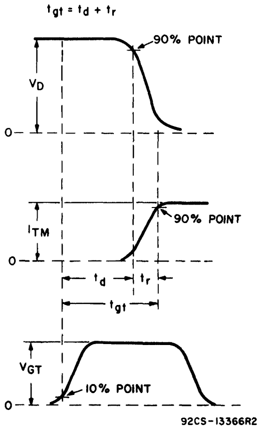


Fig. 11 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

File Number **615**

T2500 Series

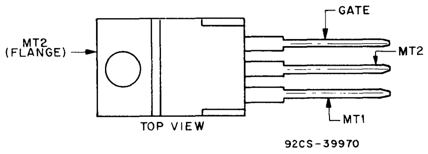
High Voltage, 6-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The T2500-series are gate-controlled full-wave silicon triacs utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, heating controls, relay replacement, solenoid drivers, static switching, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage and with positive or negative gate triggering voltages. They have an on-state current rating of 6 amperes at a T_C of 80°C.

All types utilize the JEDEC TO-220AB package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	T2500B	T2500D	T2500M	T2500N	
V_{DRM}•	200	400	600	800	V
$I_{T(RMS)}$ (T_C = 105°C)	6				A
I_{TSM} (for 1 full cycle) 60 Hz	60				A
di/dt	70				A/µs
I^2T (at 8.3 ms)	18				A^2s
I_{GTM}■	4				A
P_{GM} (for 10µs max.)	16				W
$P_{G(AV)}$ (Averaging time 10ms max.)	0.2				W
T Storage▲	-65 to 150				°C
T_C	-65 to 125				°C
T_T (During soldering): For 10 s max. (terminals and case)	225				°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲For temperature measurement reference point, *see Dimensional Outline.*

T2500 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS For All Types Unless Otherwise Specified			UNITS
		Min.	Typ.	Max.	
Peak Off-State Current:* Gate open, T_J = 125°C, V_{DROM} = Max. rated value	I_{DROM}	—	0.1	2	mA
Maximum On-State Voltage:* For i_T = 30 A (peak), T_C = 25°C	v_{TM}	—	1.7	2	V
DC Holding Current:* Gate open, Initial principal current = 150 mA (DC), v_D = 12V: T_C = 25°C	I_{HO}	—	15	—	mA
For other case temperatures		See Fig. 5			
Critical Rate-of-Rise of Commutation Voltage:* For v_D = V_{DROM}, $I_{T(RMS)}$ = 6 A, Commutating di/dt = 3.2 A/ms, and gate unenergized At T_C = 80°C	dv/dt	—	10	—	V/µs
Critical Rate of Rise of Off-State Voltage:* For v_D = V_{DROM}, exponential voltage rise, and gate open At T_C = 125°C	dv/dt				V/µs
T2500B		100	300	—	
T2500D		75	250	—	
T2500M		60	200	—	
T2500N		40	100	—	
For other case temperatures		See Fig. 6			
DC Gate-Trigger Current:* † For v_D = 12 V (dc), R_L = 30 Ω T_C = 25°C, and specified triggering mode:	I_{GT}				mA
I^+ Mode: V_{MT2} positive, V_G positive		—	10	25	
III^- Mode: V_{MT2} negative, V_G negative		—	20	30	
I^- Mode: V_{MT2} positive, V_G negative		—	20	60	
III^+ Mode: V_{MT2} negative, V_G positive		—	30	60	
For other case temperatures		See Figs. 7 & 8			
DC Gate-Trigger Voltage:* † For v_D = 12 V (DC) and R_L = 30 Ω T_C = 25°C	V_{GT}	—	1.25	2.5	V
For other case temperatures		See Fig. 9			
For v_D = V_{DROM}, R_L = 125 Ω, T_C = 125°C		0.2	—	—	
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_G = 160 mA, t_r = 0.1 µs, i_T = 10 A (peak), T_C = 25°C (See Fig. 15)	t_{gt}	—	1.6	—	µs
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	—	—	2.7	°C/W
Thermal Resitance: Junction-to-Ambient	$R_{\theta JA}$	—	—	60	°C/W

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
†For either polarity of gate voltage (V_G) with reference to main terminal 1.

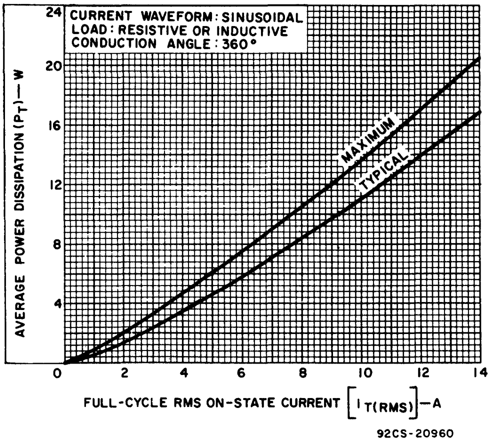


Fig. 1 — Power dissipation vs. on-state current.

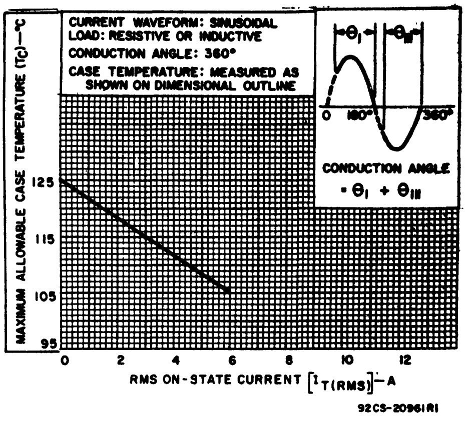


Fig. 2 — Allowable case temperature vs. on-state current.

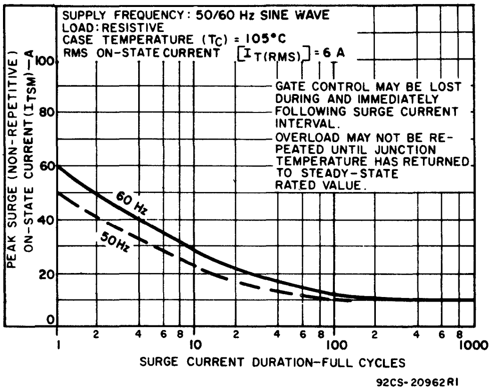


Fig. 3 — Peak surge on-state current vs. surge current duration.

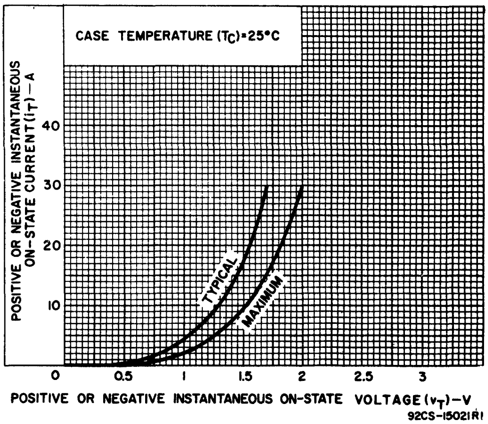


Fig. 4 — On-state current vs. on-state voltage.

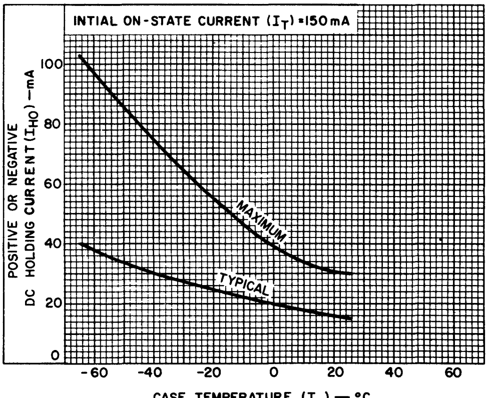


Fig. 5 — DC holding current for either direction of on-state current vs. case temperature.

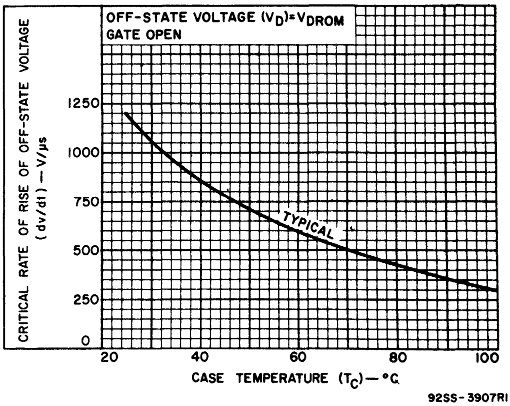


Fig. 6 — Critical rate of rise of off-state voltage vs. case temperature.

T2500 Series

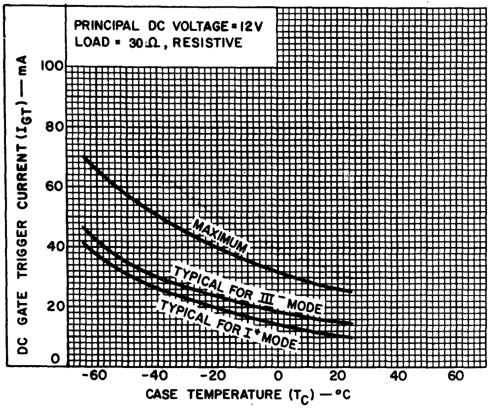


Fig. 7 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

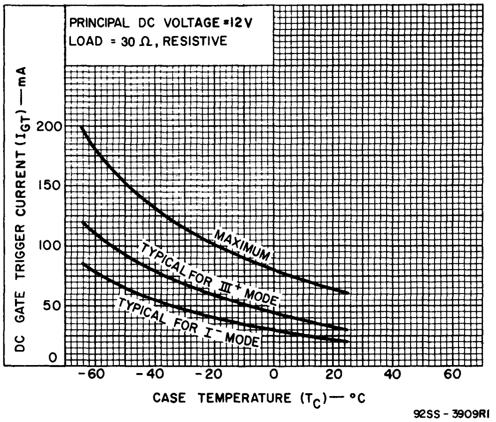


Fig. 8 — DC gate-trigger current (for I^- and III^+ triggering modes) vs. temperature.

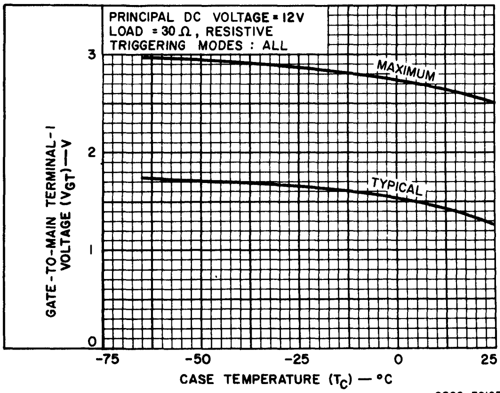


Fig. 9 — DC gate-trigger voltage vs. case temperature.

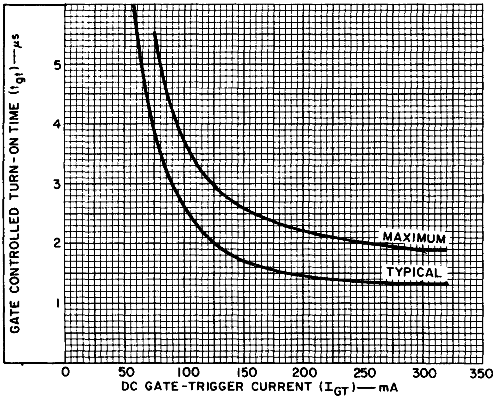


Fig. 10 — Typical turn-on time vs. gate-trigger current.

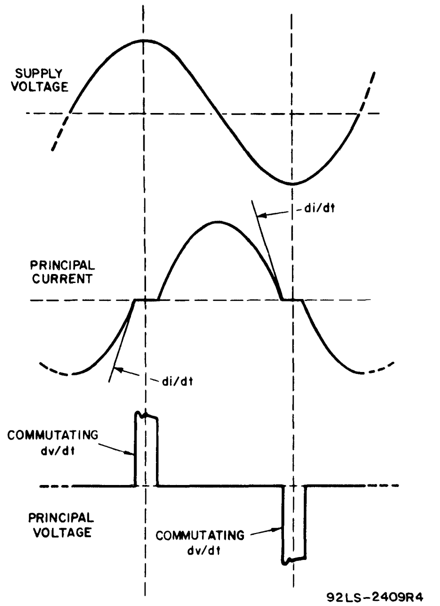


Fig. 11 — Oscilloscope display of commutating dv/dt.

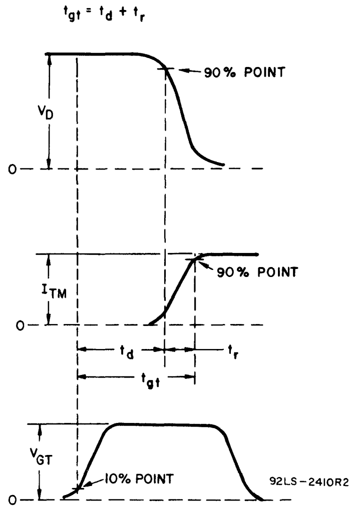


Fig. 12 — Oscilloscope display for measurement of gate-controlled turn-on time (t_{gt}).

T2700 Series

File Number **351**

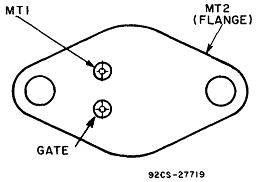
High Voltage, 6-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-213AA

RCA T2700-series devices are gate controlled full-wave silicon triacs. They are intended for the control of ac loads in applications such as heating controls, motor controls, light dimmers, and power-switching systems.

These triacs are designed to switch from an off-state to an on-state condition for either polarity of applied voltage with positive or negative triggering voltages to the gate.

The T2700B, D, M, and N are hermetically sealed types having an on-state current rating of 6 amperes at a case temperature of +75° C and repetitive off-state voltage ratings of 200, 400, 600, and 800 volts, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	T2700B	T2700D	T2700M	T2700N	
V_{DRM}•	200	400	600	800	V
$I_{T(RMS)}$ (T_C = 100°C)			6		A
I_{TSM} (for 1 full cycle) 60 Hz			100		A
di/dt			100		A/µs
I^2T (at 1.25 to 10 ms)			50		A^2s
I_{GTM}■			4		A
P_{GM} (for 1 µs max.)			16		W
$P_{G(AV)}$ (Averaging time 10ms max.)			0.2		W
T Storage▲			-65 to 150		°C
T_C			-65 to 125		°C
T_T (During soldering): For 10 s max. (terminals and case)			225		°C

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲For temperature measurement reference point, *see Dimensional Outline.*

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS For All Types Unless Otherwise Specified			UNITS
		Min.	Typ.	Max.	
Peak Off-State Current:* Gate open, T_J = 125°C, V_{DROM} = Max. rated value	I_{DROM}	—	0.1	4	mA
Maximum On-State Voltage:* For i_T = 30A (peak), T_C = 25°C	v_{TM}	—	1.8	2.25	V
DC Holding Current:* Gate open, Initial principal current = 150 mA (DC), v_D = 12V: T_C = 25°C	I_{HO}	—	15	30	mA
For other case temperatures			See Fig. 5		
Critical Rate-of-Rise of Commutation Voltage:* For v_D = V_{DROM}, $I_{T(RMS)}$ = 6 A, Commutating di/dt = 3.2 A/ms, and gate unenergized At T_C = +100°C	dv/dt	3	10	—	V/μs
Critical Rate of Rise of Off-State Voltage:* For v_D = V_{DROM}, exponential voltage rise, and gate open At T_C = 125°C					
T2500B	dv/dt	30	150	—	V/μs
T2500D	dv/dt	20	100	—	V/μs
T2500M	dv/dt	15	70	—	V/μs
T2500N	dv/dt	10	50	—	V/μs
DC Gate-Trigger Current:*† For v_D = 12 volts (dc), R_L = 30 Ω, T_C = +25°C, and Specified Triggering Mode:					
I⁺ Mode: V_{MT2} positive, V_G positive	I_{GT}	—	15	25	mA
III⁻ Mode: V_{MT2} negative, V_G negative	I_{GT}	—	20	30	mA
I⁻ Mode: V_{MT2} positive, V_G negative	I_{GT}	—	25	40	mA
III⁺ Mode: V_{MT2} negative, V_G positive	I_{GT}	—	25	40	mA
For other case temperatures			See Figs. 7 & 8		
DC Gate-Trigger Voltage:*† For v_D = 12 V(DC), R_L = 30 Ω T_C = 25°C	V_{GT}	—	1	2.2	V
For other case temperatures	V_{GT}		See Fig. 9		V
For v_D = V_{DROM}, R_L = 125 Ω, T_C = 125°C	V_{GT}	0.2	—	—	V
Gate-Controlled Turn-On Time: (Delay Time + Rise Time) For v_D = V_{DROM}, I_G = 160 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25°C (See Fig. 15)	t_{gt}	—	2.2	—	μs
Thermal Resistance: Junction-to-Case (Steady-State)	$R_{\theta JA}$	—	—	4	°C/W
Junction-to-Case (Transient)			See Fig. 10		

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
†For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2700 Series

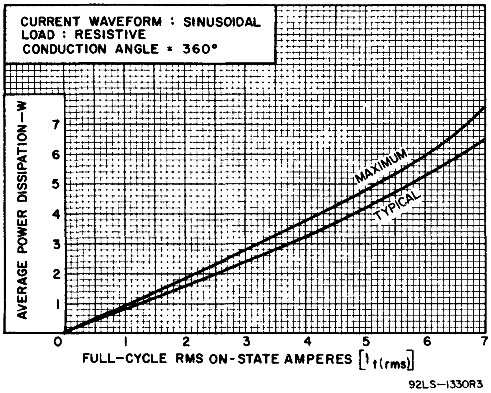


Fig. 1 — Power dissipation vs. on-state current.

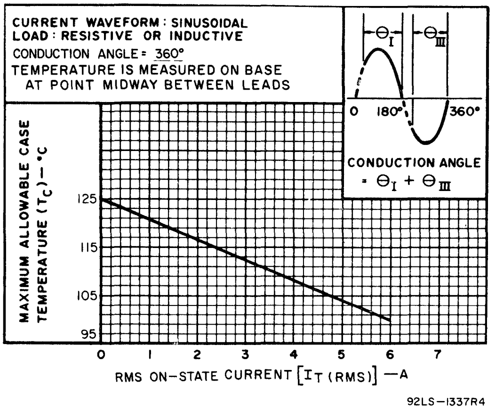


Fig. 2 — Allowable case temperature vs. on-state current.

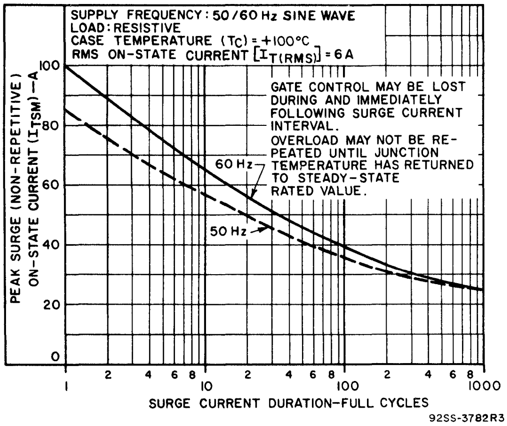


Fig. 3 — Peak surge on-state current vs. surge current duration.

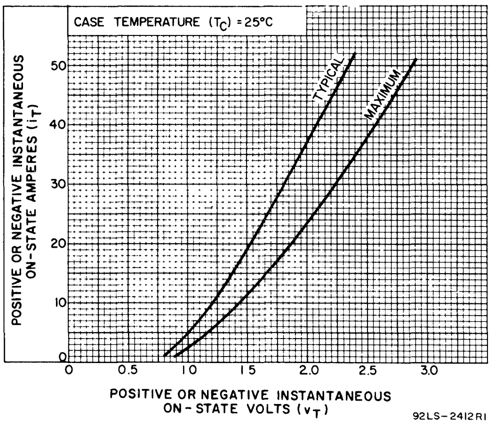


Fig. 4 — On-state current vs. on-state voltage.

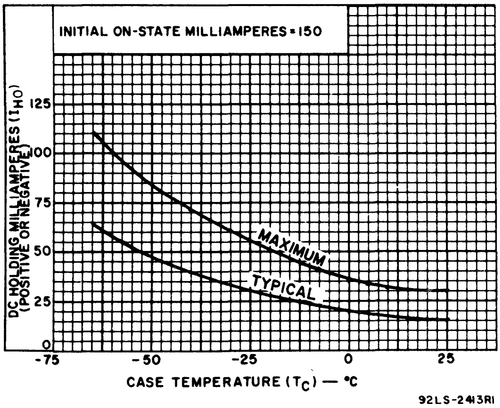


Fig. 5 — DC holding current for either direction of on-state current vs. case temperature.

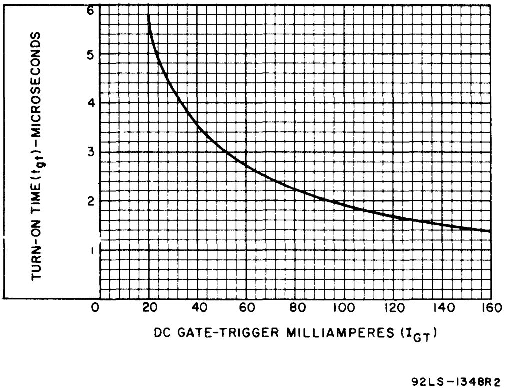


Fig. 6 — Typical turn-on time vs. gate-trigger current.

T2700 Series

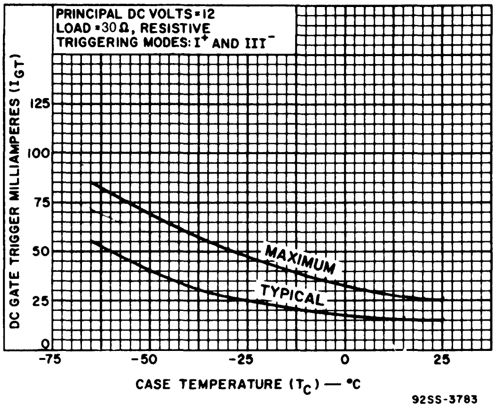


Fig. 7 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

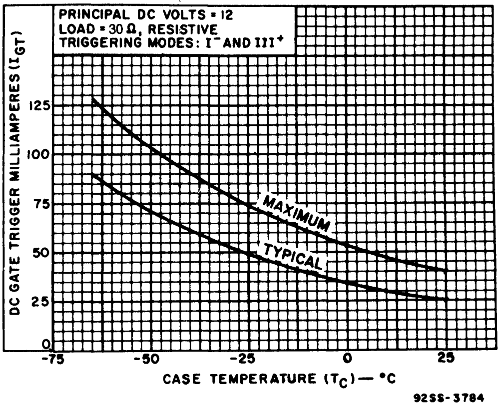


Fig. 8 — DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature.

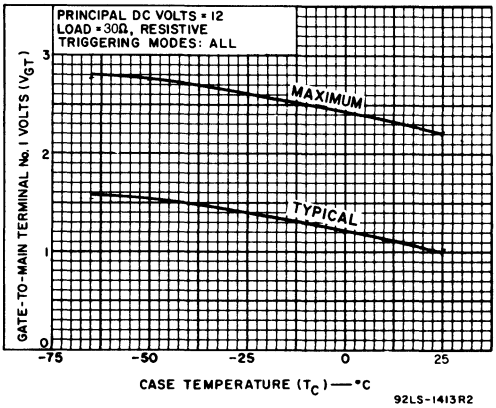


Fig. 9 — DC gate-trigger voltage vs. case temperature.

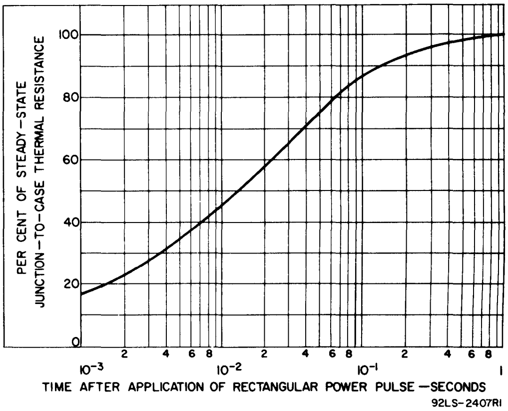


Fig. 10 — Transient thermal resistance (junction-to-case vs. time).

T2700 Series

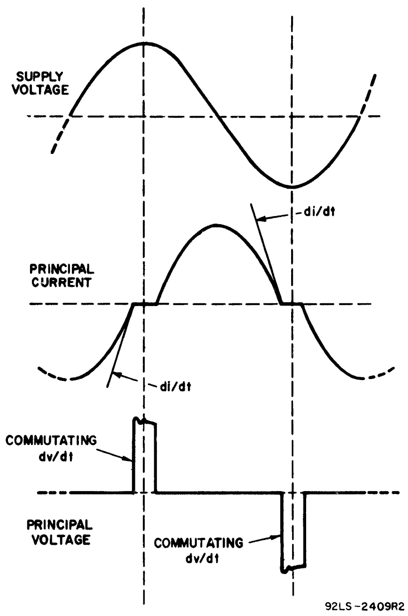


Fig. 11 — Oscilloscope display of commutating dv/dt.

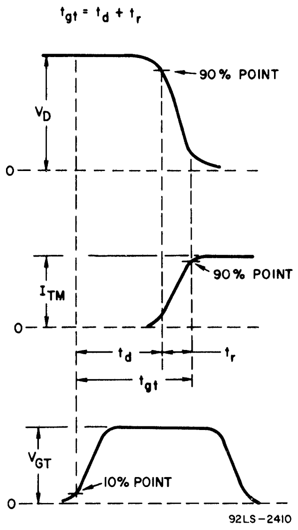


Fig. 12 — Oscilloscope display for measurement of gate-controlled turn-on time (t_{gt}).

File Number **1314**

T2800, T2802 Series

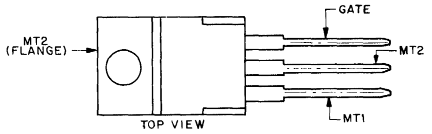
High Voltage, 8-A Silicon Triacs

For Power-Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

These RCA triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed-circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems.

These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate-triggering voltages.

The T2802 series triacs are characterized for I^+, III^- gate-triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering.

All series employ the plastic JEDEC TO-220AB package. The plastic package design provides not only ease of mounting but also low thermal impedance, which allows operation at high case temperatures and permits reduced heat-sink size.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	T2800A T2802A	T2800B T2802B	T2800C T2802C	T2800D T2802D	T2800E T2802E	T2800M T2802M	T2800N T2802N	
V_{DROM}* (Gate Open, T_J = -65 to 125° C)	100	200	300	400	500	600	800	V
$I_{T(RMS)}$: T_C = 105° C				8				A
I_{TSM} (For one cycle of applied principal voltage):								
60 Hz (sinusoidal), T_c = 105° C				100				A
50 Hz (sinusoidal), T_c = 105° C				85				A
For more than one cycle				See Figs. 2				
di/dt: V_D = V_{DROM}, I_G = 200 mA, t_r = 0.1 μs				70				A/μs
I^2t (At T_C shown for $I_{T(RMS)}$):								
t = 20 ms				55				A^2s
= 2.5 ms				28				A^2s
= 0.5 ms				16				A^2s
I_{GTM}†				4				A
P_{GM}: (for 1 μs max., $I_{GTM} \leq$ 4 A)				16				W
$P_{G(AV)}$				0.35				W
T_{stg}				-65 to 150				°C
T_C				-65 to 125				°C
T_T During soldering for 10 s max. (terminals and case)				225				°C

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
†For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2800, T2802 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature

CHARACTERISTIC	SYMBOL	LIMITS — For All Types Unless Otherwise Specified: Min.	Typ.	Max.	UNITS
Peak Off-State Current:*					
Gate open, T_J = 125°C, V_{DROM} = Max. rated value	I_{DROM}	—	0.1	2	mA
Maximum On-State Voltage:* (See Fig. 4)					
For i_T = 30 A (peak), T_C = 25°C	v_{TM}	—	1.7	2	V
DC Holding Current:*					
Gate open, Initial principal current = 150 mA (dc),					
v_D = 12 V, T_C = 25°C, T2800 series	I_{HO}	—	15	30	mA
T2802 series	I_{HO}	—	20	60	mA
For other case temperatures			See Fig. 5		
Critical Rate-of-Rise of Commutation Voltage:*†					
For V_D = V_{DROM}, $I_{T(RMS)}$ = 8 A, commutating di/dt = 4.3 A/ms, gate unenergized, T_C = 105°C	dv/dt	4	10	—	V/μs
Critical Rate-of-Rise of Off-State Voltage:*					
For v_D = V_{DROM}, exponential voltage rise, and gate open, T_C = 125°C					
T2800B, T2802B	dv/dt	100	300	—	V/μs
T2800C, T2802C	dv/dt	85	275	—	V/μs
T2800D, T2802D	dv/dt	75	250	—	V/μs
T2800E, T2802E	dv/dt	65	225	—	V/μs
T2800M, T2802M	dv/dt	60	200	—	V/μs
T2800N, T2802N	dv/dt	40	100	—	V/μs
DC Gate-Trigger Current:* ‡					
For v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C					
Mode — V_{MT2} — V_G					
I+ positive positive T2800 series	I_{GT}	—	10	25	mA
T2802 series	I_{GT}	—	25	50	mA
III− negative negative T2800 series	I_{GT}	—	15	25	mA
T2802 series	I_{GT}	—	25	50	mA
I− positive negative T2800 series only	I_{GT}	—	20	60	mA
III+ negative positive T2800 series only	I_{GT}	—	30	60	mA
For other case temperatures			See Figs. 6 & 7		
DC Gate-Trigger Voltage:* ‡					
For v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C	V_{GT}	—	1.25	2.5	V
For other case temperatures			See Fig. 8 & 9		
For v_D = V_{DROM}, R_L = 125 Ω, T_C = 125°C	V_{GT}	0.2	—	—	V
Gate-Controlled Turn-On Time:					
For v_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.1 μs, i_T = 10 A (peak), T_C = 25°C	t_{gt}	—	1.6	2.5	μs
Thermal Resistance:					
Junction-to-Case	$R_{\theta JC}$	—	—	2.2	°C/W
Junction-to-Ambient	$R_{\theta JA}$	—	—	60	°C/W

*For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
†Variants of these devices having dv/dt characteristics selected specifically for inductive leads are available on special order; for additional information, contact your RCA Representative or your RCA Distributor.
‡For either polarity of gate voltage (V_G) with reference to main terminal 1.

T2800, T2802 Series

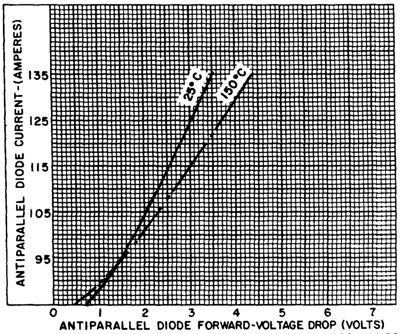


Fig. 1 — Maximum allowable case temperature vs. on-state current.

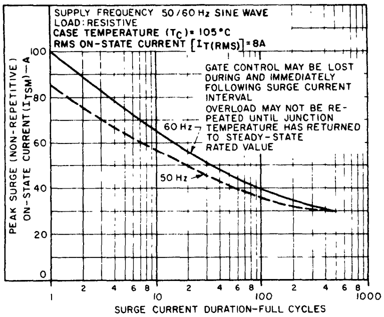


Fig. 2 — Peak surge on-state current vs. surge current duration for T2800, T2802 series.

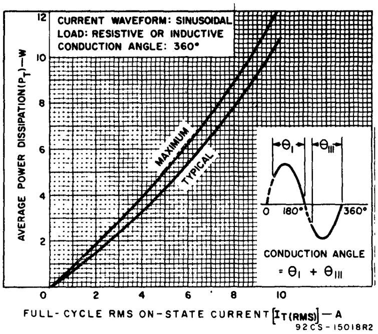


Fig. 3 — Power dissipation vs. on-state current for T2800, T2802 series.

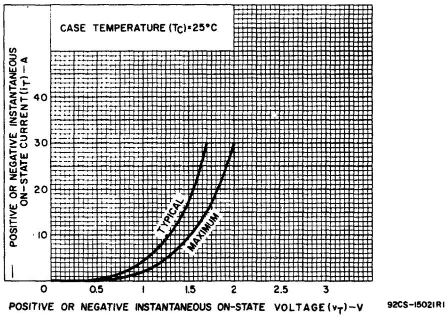


Fig. 4 — On-state current vs. on-state voltage for T2800, T2802 series.

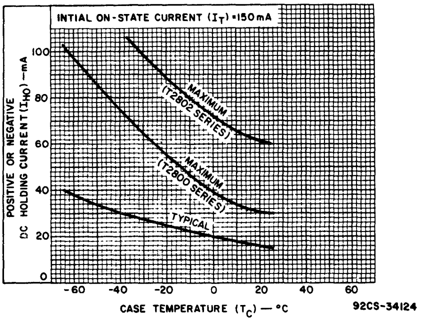


Fig. 5 — DC holding current vs. case temperature for T2800, T2802.

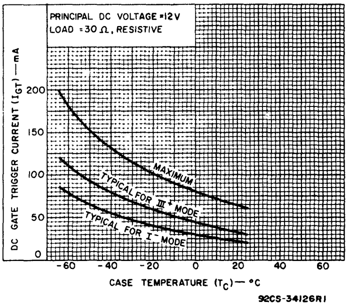


Fig. 6 — DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature for T2800, T2802 series.

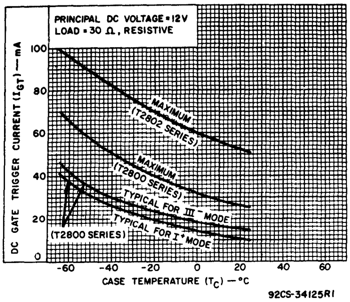


Fig. 7 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature for T2800, T2802 series.

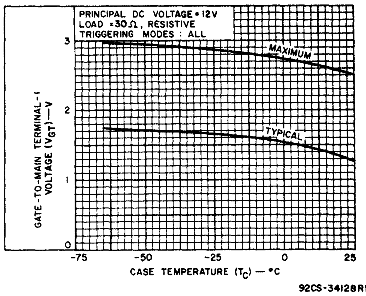


Fig. 8 — DC gate-trigger voltage vs. case temperature for T2800, T2802 series.

T2800, T2802 Series

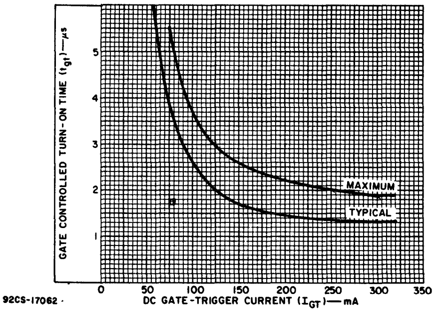


Fig. 9 — Turn-on time vs. gate-trigger current for T2800, T2802 series.

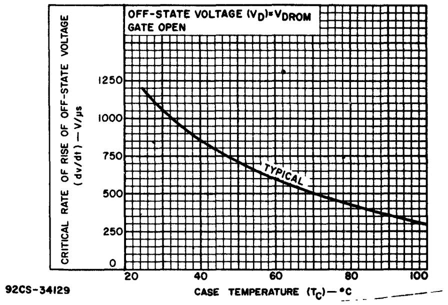


Fig. 10 — Typical critical rate-of-rise of off-state voltage vs. case temperature for all series.

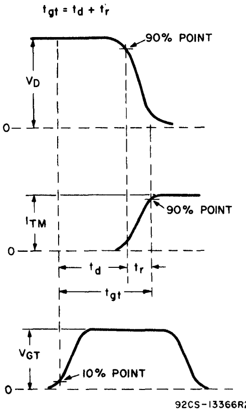


Fig. 11 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

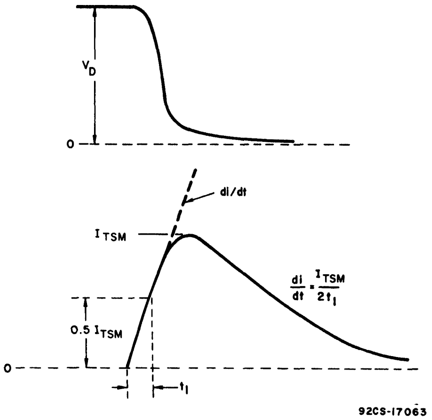


Fig. 12 — Rate-of-change of on-state current with time (defining di/dt.).

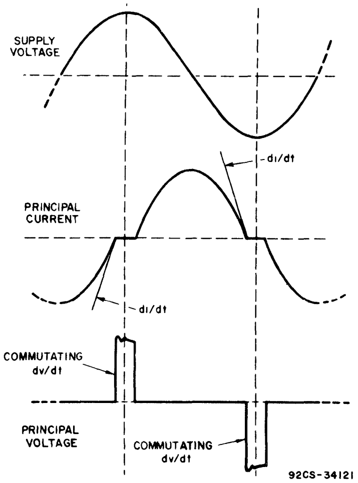


Fig. 13 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage [dv/dt].

NOTES

1. Curve defines temperature rise of either junction above case temperature for equal-amplitude symmetrical sine wave current at 50 and 80 Hz.
2. Curve considers junction temperature measured immediately after the final cycle of current.
3. Gate will regain control if temperature is maintained below rated value and load current is reduced or maintained at RMS value.
4. For more than 100 cycles of current the case temperature rise must be observed and used in calculating the total junction temperature.
5. Junction temperature rise above case is defined as apparent transient thermal impedance times average conduction power dissipated during full cycle conduction.
6. Apparent steady-state value is not the same as JEDEC value listed as steady-state in characteristics table.

File Number **300**

T4700 Series

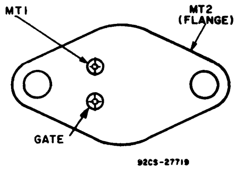
15-Ampere Silicon Triacs

For Phase-Control and Load-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-213AA

The RCA T4700 Series are gate-controlled full-wave ac silicon switches. They are designed to switch from an off-state to a conducting state for either polarity of applied voltage with positive or negative gate triggering.

These devices are intended for the control of ac loads in applications such as space heater, oven and furnace controls, motor controls, and lamp loads.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		T4700B	T4700D	T4700M	T4700N	
REPETITIVE PEAK OFF-STATE VOLTAGE:■						
Gate Open	V_{DROM}	200	400	600	800	V
RMS ON-STATE CURRENT:						
T_C = 95° C, conduction angle = 360°	$I_{T(RMS)}$	15				A
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}					
For one full cycle of applied principal voltage 60 Hz (sinusoidal)		100				A
For one full cycle of applied principal voltage (50-Hz, sinusoidal)		85				A
For more than one full cycle of applied voltage		See Fig. 3				
PEAK GATE-TRIGGER CURRENT:						
For 1 μs max.	I_{GTM}	4				A
FUSING CURRENT (for triac protection):						
T_J = -40 to 100° C, t = 1.25 to 10 ms	I^2t	50				A^2s
GATE POWER DISSIPATION:						
Peak• (for 1 μs max. and I_{GTM} = ≤ 4 A)	P_{GM}	16				W
Average (averaging time = 10 ms max.)	$P_{G(AV)}$	0.45				W
TEMPERATURE RANGE:▲						
Storage	T_{stg}	-40 to 150				°C
Operating (Case)	T_C	-40 to 125				°C
PIN TEMPERATURE (During soldering):						
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	T_P	225				°C

■For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
•For either polarity of gate voltage (V_G) with reference to main terminal 1.
▲For temperature measurement reference point, *see Dimensional Outline.*

T4700 Series

ELECTRICAL CHARACTERISTICS
At Maximum Ratings and at Indicated Case Temperature (T_C) Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	LIMITS For All Types Unless Otherwise Specified			UNITS
		Min.	Typ.	Max.	
Peak Off-State Current♠ Gate open, T_J = 125°C, V_{DROM} = Max. rated value	I_{DROM}	—	0.2	4	mA
Instantaneous On-State Voltage♠ For i_T = 30A (peak), T_C 25°C	v_T	—	1.6	2.0	V
DC Holding Current♠ Gate open, Initial principal current = 150 mA (DC), v_D = 12V: T_C = 25°C For other case temperatures	I_{HO}	—	15 See Fig. 5	60	mA
Critical Rate of Applied Commutating Voltage♠ For v_D = V_{DROM}, $I_{T(RMS)}$ = 15 A, commutating di/dt = 8 A/ms, and gate unenergized At T_C = +95°C	dv/dt	2	10	—	V/μs
Critical Rate of Rise of Off-State Voltage♠ For v_D = V_{DROM}, exponential voltage rise, and gate open At T_C = 125°C T4700B T4700D T4700M T4700N	dv/dt	30 20 15 10	150 100 75 50	— — — —	V/μs
DC Gate-Trigger Current♠ ■ For v_D = 6 volts (dc), R_L = 12 ohms, T_C = +25°, and Specified Triggering Mode: I^+ Mode: V_{T2} is positive, V_G is positive I^- Mode: V_{T2} is positive, V_G is negative III^+ Mode: V_{T2} is negative, V_G is positive III^- Mode: V_{T2} is negative, V_G is negative For other case temperatures	I_{GT}	— — — —	15 35 35 15 See Figs. 7 & 9	30 80 80 30	mA
DC Gate-Trigger Voltage♠ ■ For v_D = 6 volts (dc) and R_L = 12 ohms At T_C = +25° For other case temperatures For v_D = V_{DROM}, R_L = 125 Ω, T_C = 125°C	V_{GT}	— 0.2	1 See Fig. 11 —	2.5 —	V
Gate-Controlled Turn-On Time (Delay Time + Rise Time) For v_D = V_{DROM}, I_G = 160 mA, t_r = 0.1 μs, i_T = 25 A (peak), T_C = 25°C	t_{gt}	—	1.6	2.5	μs
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	—	—	1.3	°C/W

♠For either polarity of main terminal 2 voltage (V_{T2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

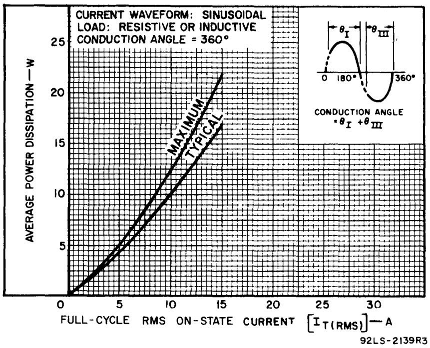


Fig. 1 — Power dissipation curve.

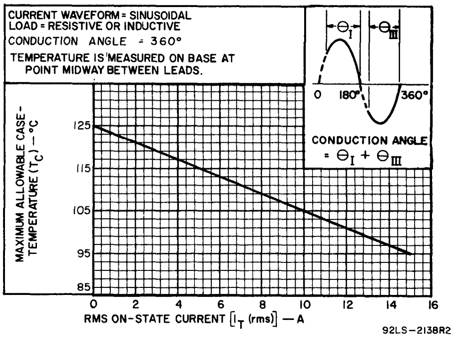


Fig. 2 — Conduction rating chart (case temperature).

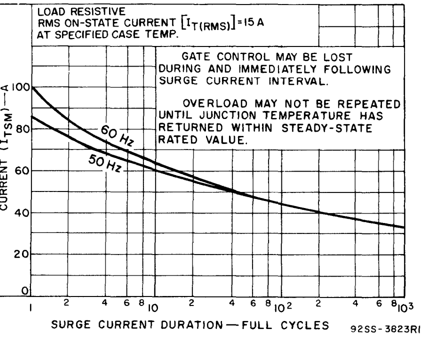


Fig. 3 — Surge current rating chart.

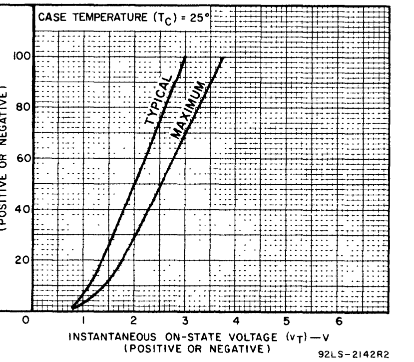


Fig. 4 — On-state characteristics for either direction of principal current.

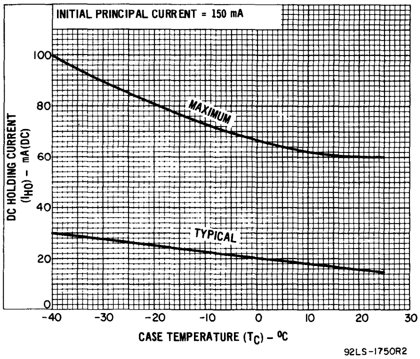


Fig. 5 — DC holding current characteristics for either direction of principal current.

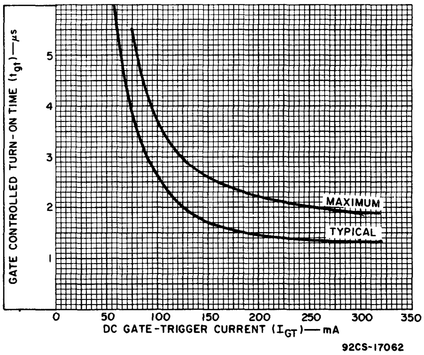


Fig. 6 — Turn-on time vs. gate trigger current.

T4700 Series

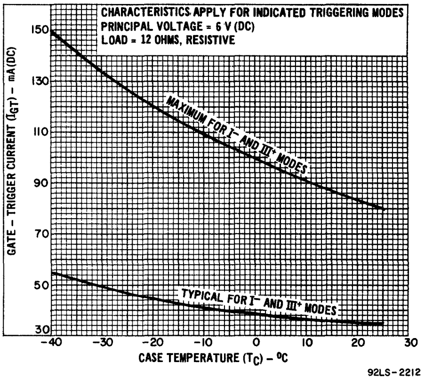


Fig. 7 — DC gate-trigger current characteristics for I- and III+ modes.

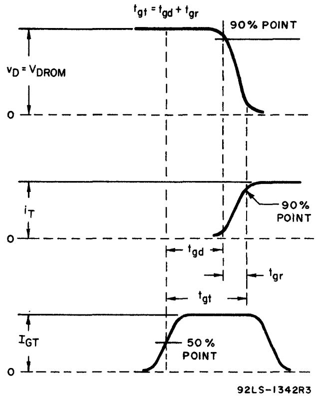


Fig. 8 — Waveshapes of t_{gt} characteristics test.

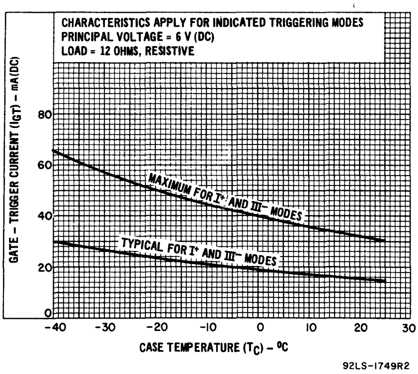


Fig. 9 — DC gate-trigger current characteristics for I^+ and III^- modes.

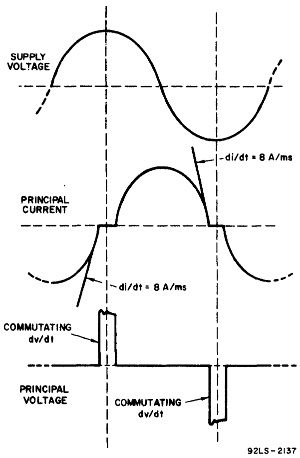


Fig. 10 — Waveshapes of commutating dv/dt characteristics.

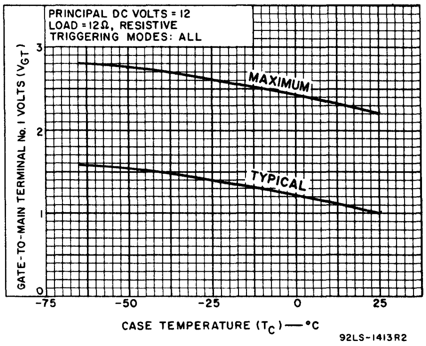


Fig. 11 — DC gate-trigger voltage characteristics.

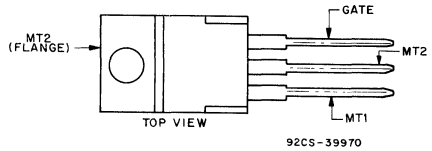
16-A Silicon Triacs

For Power Control and Power-Switching Applications

Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-T6000, T6001 and T6006 series triacs are gate-controlled full-wave silicon switches utilizing a plastic case with three leads to facilitate mounting on printed circuit boards. They are intended for the control of ac loads in such applications as motor controls, light dimmers, heating controls, and power-switching systems. These devices are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages. They have an on-state current rating of 16 amperes at a T_C of 95° C.

The T6001-series triacs are characterized for I^+, III^- gate triggering modes only and should suit a wide range of applications that employ diac or anode on/off triggering. The T6006-series triacs are characterized for I^+ and III^+ gate-triggering modes only. They are intended for power-control applications in which integrated-circuit zero-crossing switches, such as the RCA-CA3059 series, are used as the triac-triggering circuits. The T6006-series triacs have gate characteristics which assure tht a CA3059-series integrated circuit can supply sufficient gate current to trigger them over their full operating temperature range.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

<table>
<tr><th></th><th>T6000B
T6001B
T6006B</th><th>T6000D
T6001D
T6006D</th><th>T6000M
T6001M
T6006M</th><th>T6000N
T6001N
T6006N</th><th></th></tr>
<tr><td>V_{DROM}•: T_J = -65 to 125° C</td><td>200</td><td>400</td><td>600</td><td>800V</td><td></td></tr>
<tr><td>$I_{T(RMS)}$: T_C = 95° C, θ 360°</td><td colspan="4">16</td><td>A</td></tr>
<tr><td>I_{TSM}: For one cycle of applied principal voltage</td><td colspan="4"></td><td></td></tr>
<tr><td>60 Hz (sinusoidal), T_C = 80° C</td><td colspan="4">150</td><td>A</td></tr>
<tr><td>50 Hz (sinusoidal), T_C = 80° C</td><td colspan="4">140</td><td>A</td></tr>
<tr><td>di/dt: $v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs</td><td colspan="4">100</td><td>A/μs</td></tr>
<tr><td>I^2t [At T_C shown for $I_{T(RMS)}$]:</td><td colspan="4"></td><td></td></tr>
<tr><td>t = 10 ms</td><td colspan="4">100</td><td>A^2s</td></tr>
<tr><td>= 4.25 ms</td><td colspan="4">49</td><td>A^2s</td></tr>
<tr><td>I_{GTM}■</td><td colspan="4"></td><td></td></tr>
<tr><td>For 1 μs max.</td><td colspan="4">4</td><td>A</td></tr>
<tr><td>P_{GM} (For 1 μs max., $I_{GTM} \leq 4$ A</td><td colspan="4">16</td><td>W</td></tr>
<tr><td>$P_{G(AV)}$:</td><td colspan="4">0.5</td><td>W</td></tr>
<tr><td>T_{stg}</td><td colspan="4">-65 to 150</td><td>°C</td></tr>
<tr><td>T_C</td><td colspan="4">-65 to 125</td><td>°C</td></tr>
<tr><td>T_T (During soldering for 10 s max.)</td><td colspan="4">225</td><td>°C</td></tr>
</table>

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity to gate voltge (V_G) with reference to main terminal 1.

T6000, T6001, T6006 Series

ELECTRICAL CHARACTERISTICS

At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperatures

CHARACTERISTIC	LIMITS For All Types Except as Specified Min.	Typ.	Max.	UNITS
I_{DROM}● T_J=125°C, V_{DROM} = Max. rated value	—	0.1	1.2	mA
v_{TM}● i_T = 30 A (peak), T_C = 25°C — T6000, T6006 Series	—	1.4	1.75	V
T6001 Series	—	1.8	2.0	V
I_{HO}● v_D = 12 V, T_C = 25°C — T6000 Series	—	15	35	mA
T6001 Series	—	20	—	mA
For other case temperatures		See Fig. 6		
dv/dt● v_D = V_{DROM}, $I_{T(RMS)}$ = 16 A, di/dt = 8.5A/ms, T_C = 95°C	4	10	—	V/μs
dv/dt● v_D = V_{DROM}, T_C = 125°C — T6000B, T6001B, T6006B	100	300	—	V/μs
T6000D, T6001D, T6006D	75	250	—	V/μs
T6000M, T6001M, T6006M	60	200	—	V/μs
T6000N, T6001M, T6006M	30	70	—	V/μs
I_{GT}●■ Mode / V_{MT2} / V_G; v_D = 12 V (dc), R_L = 30 Ω, T_C = 25°C — 1+ positive positive T6000 series	—	25	50	mA
T6001 series	—	—	80	mA
T6006 series	—	—	45	mA
III− negative negative T6000 series	—	25	50	mA
T6001 series	—	—	80	mA
I− positive negative T6000 series only	—	45	80	mA
III+ negative positive T6000 series only	—	45	80	mA
T6006	—	—	45	mA
For other case temperatures		See Figs. 7 & 8		
V_{GT}● v_D = 12 v (dc), R_L = 30 Ω, T_C = 25°C — T6001 I+ III−	—	1.25	3.0	V
T6006 I+ III+	—	1.25	1.5	V
T6000 all models	—	1.25	2.5	V
v_D = V_{DROM}, R_L 125 Ω, T_C = 125°C	0.2	—	—	V
For other case temperatures		See Fig. 9		
t_{gt} v_D = V_{DROM}, I_{GT} = 80 mA, t_r = 0.1 μs, i_T = 25 A (peak), T_C = 25°C	—	1.6	—	μs
$R_{θJC}$	—	—	1.5	°C/W
$R_{θJA}$	—	—	50	°C/W

●For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

T6000, T6001, T6006 Series

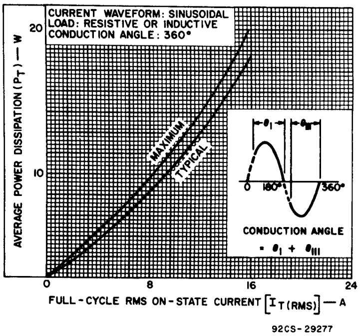


Fig. 1 — Power dissipation vs. on-state current.

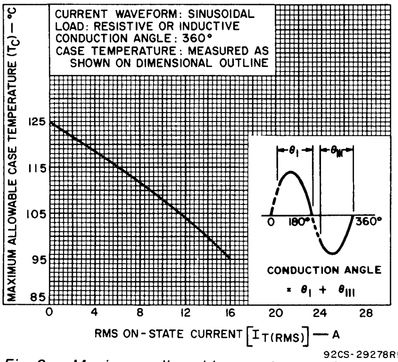


Fig. 2 — Maximum allowable case-temperature vs. on-state current.

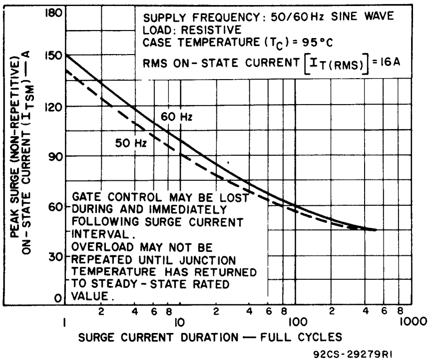


Fig. 3 — Peak surge on-state current vs. surge current duration.

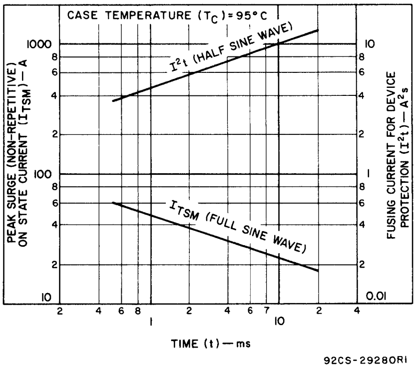


Fig. 4 — Peak surge on-state current and fusing-current vs. time.

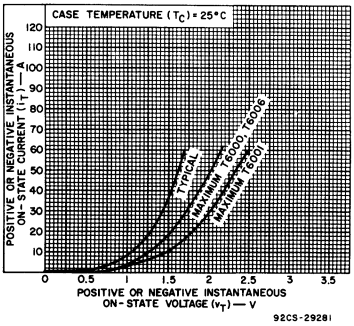


Fig. 5 — On-state current vs. on-state voltage.

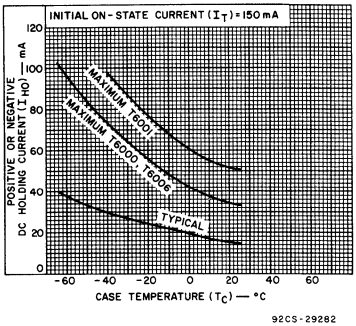


Fig. 6 — DC holding current vs. case temperature.

T6000, T6001, T6006 Series

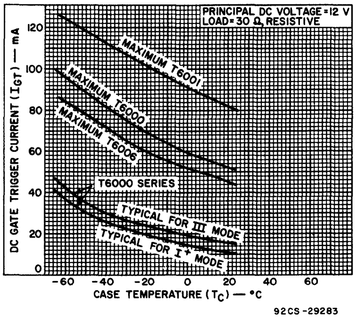


Fig. 7 — DC gate-trigger current (for I^+ and III^- triggering modes) vs. case temperature.

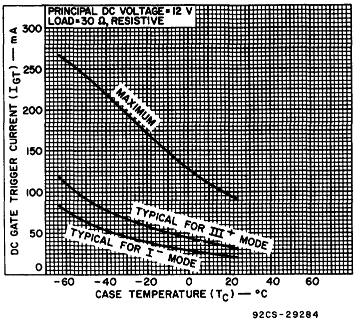


Fig. 8 — DC gate-trigger current (for I^- and III^+ triggering modes) vs. case temperature for T6000-series only.

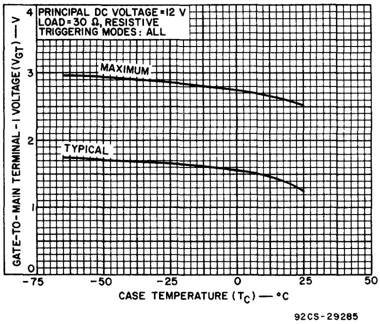


Fig. 9 — DC gate-trigger voltage vs. case temperature for T6000 series only.

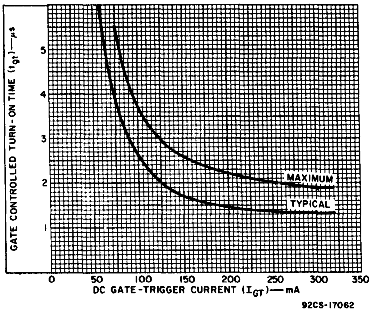


Fig. 10 — Turn-on time vs. gate-trigger current.

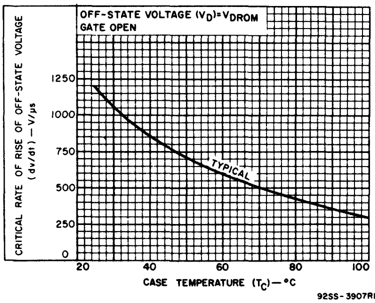


Fig. 11 — Typical critical rate-of-rise of off-state voltage vs. case temperature.

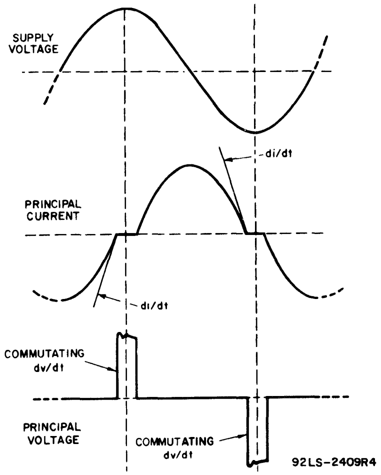


Fig. 12 — Relationship between supply voltage and principal current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

T6000, T6001, T6006 Series

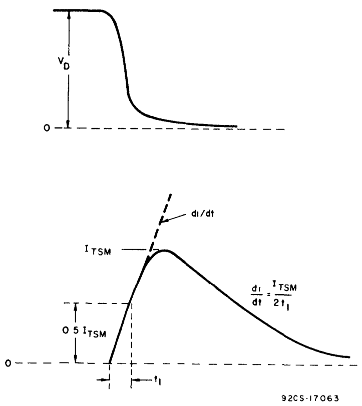


Fig. 13 — Rate-of-change of on-state current with time (defining di/dt).

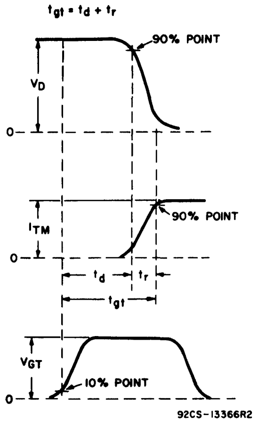


Fig. 14 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

T6401, T6411, T6421 Series

File Number **459**

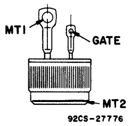
30-A Silicon Triacs

For Power-Switching and Power Control

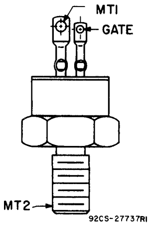
Features:

- *800V, 125 Deg. C T_J Operating*
- *High dv/dt and di/dt Capability*
- *Low Switching Losses*
- *High Pulse Current Capability*
- *Low Forward and Reverse Leakage*
- *Sipos Oxide Glass Multilayer Passivation System*
- *Advanced Unisurface Construction*
- *Precise Ion Implanted Diffusion Source*

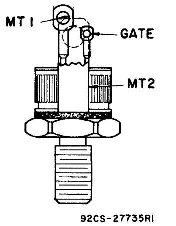
TERMINAL DESIGNATIONS



PRESS-FIT TYPES
T6401 SERIES



STUD TYPES
T6411 SERIES



ISOLATED-STUD TYPES
T6421 SERIES

These RCA triacs are gate-controlled full-wave silicon ac switches. They are designed to switch from an off-state to an on-state for either polarity of applied voltage with positive or negative gate triggering voltages.

These triacs are intended for control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, and power switching systems. They can also be used in air-conditioning and photocopying equipment.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		T6401B T6411B T6421B	T6401D T6411D T6421D	T6401M T6411M T6421M	T6401N T6411N —	
REPETITIVE PEAK OFF-STATE VOLTAGE:•						
Gate open, T_J = -50 to 125° C	V_{DROM}	200	400	600	800	V
RMS ON-STATE CURRENT (Conduction angle = 360°):						
Case temperature	$I_{T(RMS)}$					
T_C = 90° C (Press-fit types)		30				A
= 85° C (Stud types)		30				A
= 80° C (Isolated-stud types)		30				A
For other conditions		See Fig. 3				
PEAK SURGE (NON-REPETITIVE) ON-STATE CURRENT:	I_{TSM}					
For one cycle of applied principal voltage						
60 Hz (sinusoidal)		300				A
50 Hz (sinusoidal)		265				A
For more than one cycle of applied principal voltage		See Fig. 4				
RATE-OF-CHANGE OF ON-STATE CURRENT:	di/dt					
V_{DM} = V_{DROM}, I_{GT} = 200 mA, t_r = 0.1 μs (See Fig. 13)		100				A/μs
FUSING CURRENT (for triac protection):						
T_J = -40 to 100° C, t = 1.25 to 10 ms	I^2t	450				A^2s
PEAK GATE-TRIGGER CURRENT:■	I_{GTM}					
For 1 μs max., See Fig. 7		12				A
GATE POWER DISSIPATION:						
PEAK (For 1 μs max., $I_{GTM} \leq$ 4 A, See Fig. 7)	P_{GM}	40				W
AVERAGE	$P_{G(AV)}$	0.75				W
TEMPERATURE RANGE:▲						
Storage	T_{stg}	-65 to 150				°C
Operating (Case)	T_C	-65 to 100				°C
TERMINAL TEMPERATURE (During soldering):	T_T					
For 10 s max. (terminals and case)		225				°C
STUD TORQUE:						
Recommended		35				in-lb
Maximum (DO NOT EXCEED)		50				in-lb

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity to gate voltage (V_G) with reference to main terminal 1.
▲For temperature measurement reference point, see Dimensional Outline.

T6401, T6411, T6421 Series

ELECTRICAL CHARACTERISTICS, *At Maximum Ratings Unless Otherwise Specified, and at Indicated Temperature*

CHARACTERISTIC	SYMBOL	LIMITS For All Types Unless Otherwise Specified			UNITS
		Min.	Typ.	Max.	
Peak Off-State Current:•					
Gate open, $T_J = 125°C$, V_{DROM} = Max. rated value	I_{DROM}	—	0.2	4	mA
Maximum On-State Voltage:•					
For i_T = 100 A (peak), $T_C = 25°C$	V_{TM}	—	2.1	2.5	V
DC Holding Current:•					
Gate open, Initial principal current = 150 mA (DC), v_D = 12V:					
$T_C = 25°C$	I_{HO}	—	25	60	mA
For other case temperatures			See Fig. 6		
Critical Rate-of-Rise of Commutation Voltage:•					
For $v_D = V_{DROM}$, $I_{T(RMS)}$ = 30 A, commutating di/dt = 16 A/ms, gate unenergized (See Fig. 14):					
$T_C = 90°C$ (Press-fit types)	dv/dt	3	20	—	V/μs
= 85°C (Stud types)	dv/dt	3	20	—	V/μs
= 80°C (Isolated-stud types)	dv/dt	3	20	—	V/μs
Critical Rate-of-Rise of Off-State Voltage:•					
For $v_D = V_{DROM}$, exponential voltage rise, gate open, $T_C = 125°C$:					
T6401B, T6411B, T6421B	dv/dt	40	200	—	V/μs
T6401D, T6411D, T6421D	dv/dt	25	150	—	V/μs
T6401M, T6411M, T6421M	dv/dt	20	100	—	V/μs
T6401N, T6411N	dv/dt	10	50		V/μs
DC Gate-Trigger Current:•■ Mode / V_{MT2} / V_G					
For v_D = 12 V (DC), $R_L = 30\ \Omega$, $T_C = 25°C$: I^+ positive positive	I_{GT}	—	15	50	mA
III^- negative negative	I_{GT}	—	20	50	mA
I^- positive negative	I_{GT}	—	30	80	mA
III^+ negative positive	I_{GT}	—	40	80	mA
For other case temperatures			See Figs. 8 & 9		
DC Gate-Trigger Voltage:•■					
For v_D = 12 V(DC), $R_L = 30\ \Omega$,					
$T_C = 25°C$	V_{GT}	—	1.35	2.5	V
For other case temperatures	V_{GT}		See Fig. 10		V
For $v_D = V_{DROM}$, $R_L = 125\ \Omega$, $T_C = 100°C$	V_{GT}	0.2	—	—	V
Gate-Controlled Turn-On Time:					
(Delay Time = Rise Time) For $v_D = V_{DROM}$, I_{GT} = 200 mA, t_r = 0.1 μs, i_T = 45 A (peak), $T_C = 25°C$ (See Figs. 7 & 12)	t_{gt}	—	1.7	3	μs
Thermal Resistance, Junction-to-Case:					
Steady-State					
Press-fit types	$R_{\theta JC}$	—	—	0.8	°C/W
Stud	$R_{\theta JC}$	—	—	0.9	°C/W
Transient (Press-fit & stud types)			See Fig. 2		°C/W
Thermal Resistance, Junction-to-Hex (Stud, See Dim. Outline):					
Steady-State (Isolated-stud types)	$R_{\theta JIH}$	—	—	1	°C/W

•For either polarity of main terminal 2 voltage (V_{MT2}) with reference to main terminal 1.
■For either polarity of gate voltage (V_G) with reference to main terminal 1.

T6401, T6411, T6421 Series

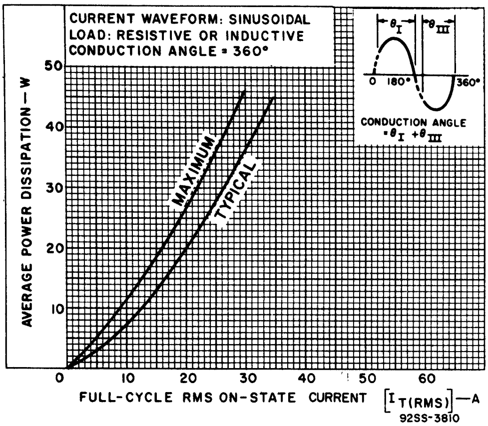


Fig. 1 — Power dissipation vs. on-state current.

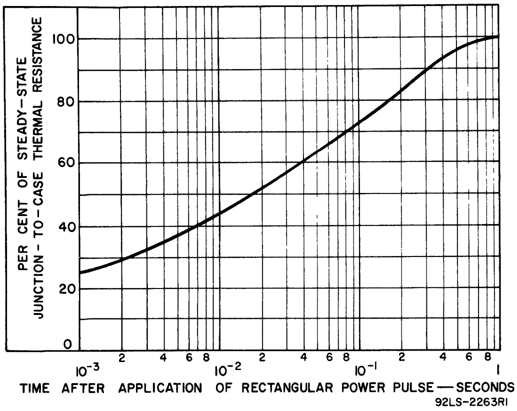


Fig. 2 — Transient junction-to-case thermal resistance vs. time.

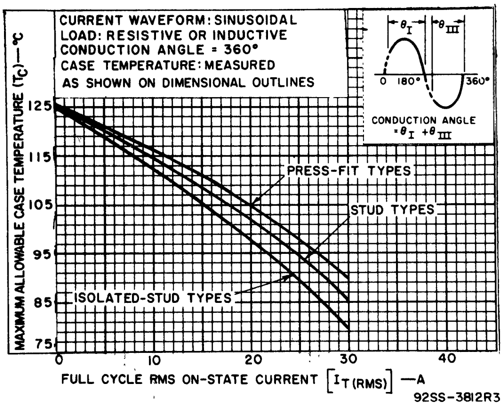


Fig. 3 — Maximum allowable case temperature vs. on-state current.

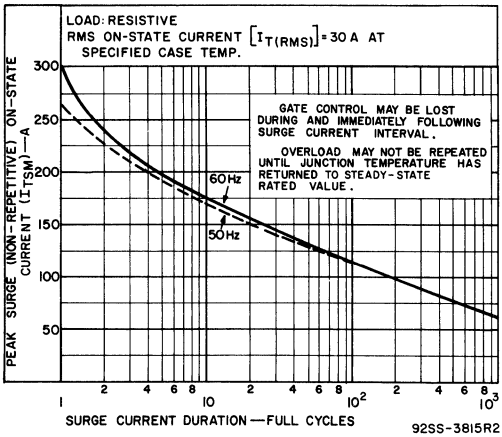


Fig. 4 — Peak surge on-state current vs. surge current duration.

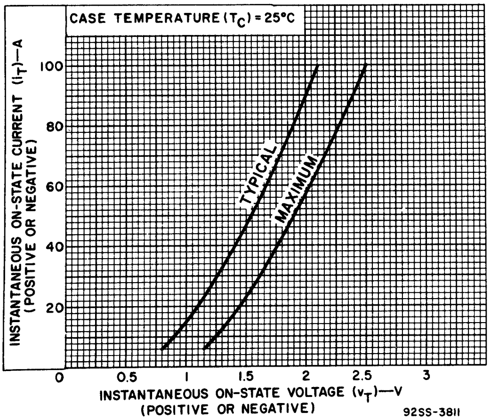


Fig. 5 — On-state current vs. on-state voltage.

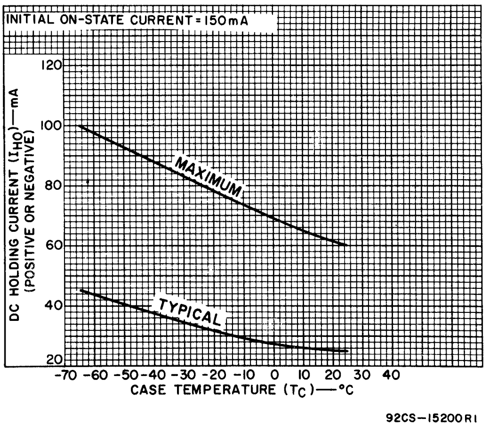


Fig. 6 — DC holding current vs. case temperature.

T6401, T6411, T6421 Series

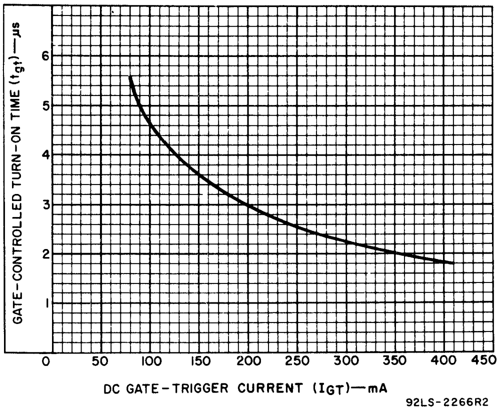


Fig. 7 — Turn-on time vs. gate trigger current.

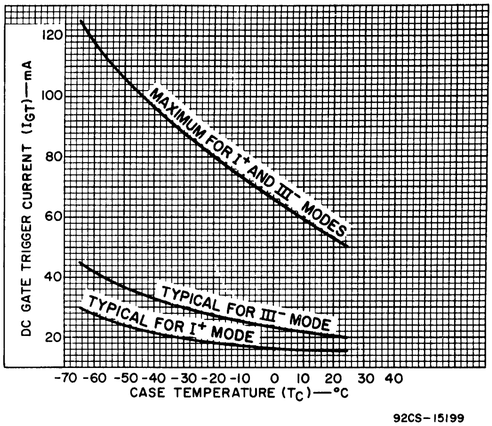


Fig. 8 — DC gate-trigger current vs. case temperature (I^+ and III^- modes).

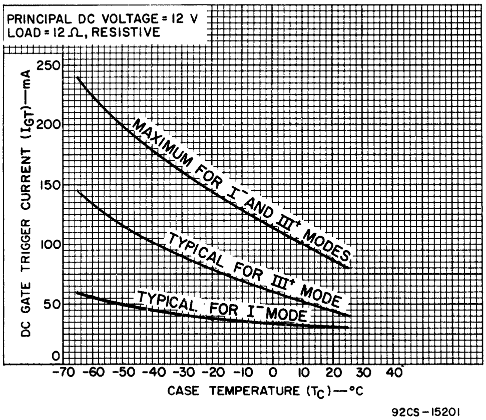


Fig. 9 — DC gate-trigger current vs. case temperature (I^- and III^+ modes).

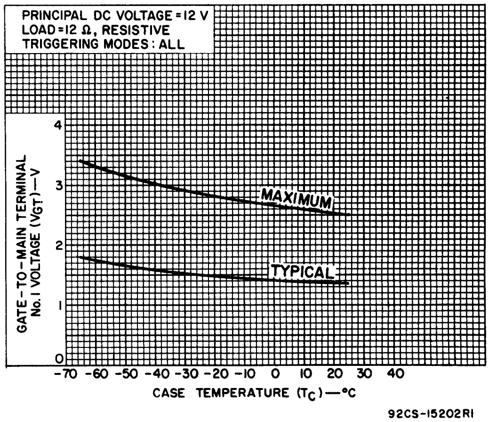


Fig. 10 — DC gate-trigger voltage vs. case temperature.

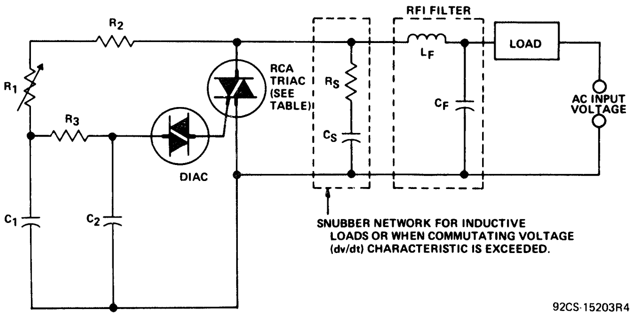


Fig. 11 — Typical phase-control circuit for lamp dimming, heat control, and universal-motor speed control.

AC INPUT VOLTAGE		120V 60Hz	240V 60Hz	240V 50Hz
C_1		0.1μF 200V	0.1μF 400V	0.1μF 400V
C_2		0.1μF 100V	0.1μF 100V	0.1μF 100V
R_1		100KΩ 1/2W	200KΩ 1W	250KΩ 1W
R_2		2.2KΩ 1/2W	3.3KΩ 1/2W	3.3KΩ 1/2W
R_3		15KΩ 1/2W	15KΩ 1/2W	15KΩ 1/2W
SNUBBER NETWORK	C_S	0.1μF 200V	0.1μF 400V	0.1μF 400V
	R_S	100Ω 1/2W	100Ω 1/2W	100Ω 1/2W
RFI FILTER	C_F*	0.1μF 200V	0.1μF 400V	0.1μF 400V
	L_F*	100μH	200μH	200μH
RCA TRIACS		T6401B T6411B T6421B	T6401D T6411D T6421D	T6401D T6411D T6421D

*Typical values for lamp dimming circuits.

T6401, T6411, T6421 Series

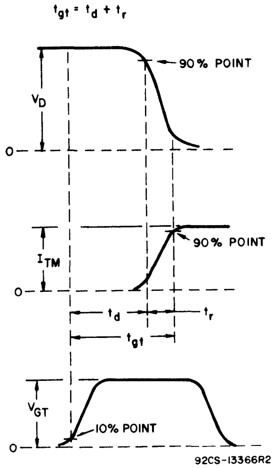


Fig. 12 — Relationship between off-state voltage, on-state current, and gate-trigger voltage showing reference points for definition of turn-on time (t_{gt}).

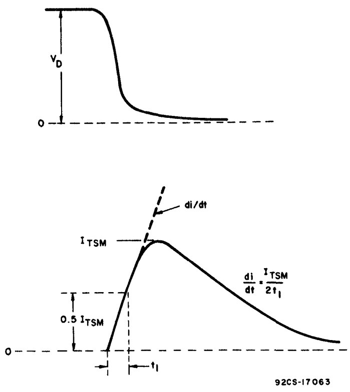


Fig. 13 — Rate of change of on-state current with time (defining di/dt).

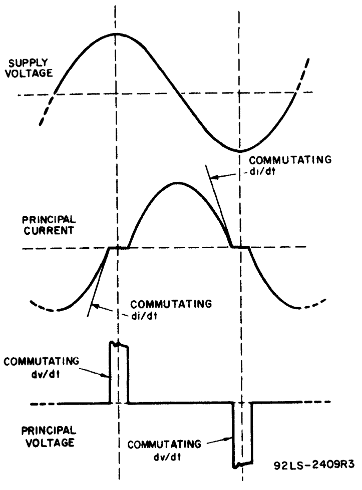


Fig. 14 — Relationship between supply voltage and principle current (inductive load) showing reference points for definition of commutating voltage (dv/dt).

MOUNTING CONSIDERATIONS

Mounting of press-fit package types depends upon an interference fit between the thyristor case and the heat sink. As the thyristor is forced into the heat-sink hole, metal from the heat sink flows into the knurl voids of the thyristor case. The resultant close contact between the heat sink and the thyristor case assures low thermal and electrical resistances.

A recommended mounting method shows press-fit knurl and heat-sink hole dimensions. If these dimensions are maintained, a "worst-case" condition of 0.0085 in. (0.2159 mm) interference fit will allow press-fit insertion below the maximum allowable insertion force of 800 pounds. A slight chamfer in the heat-sink hole will help center and guide the press-fit package properly into the heat sink. The insertion tool should be a hollow shaft having an inner diameter of 0.380 ± 0.010 in. (9.65 ± 0.254 mm) and an outer diameter of 0.500 in. (12.70 mm). These dimensions provide sufficient clearance for the leads and assure that no direct force will be applied to the glass seal of the thyristor.

The press-fit package is not restricted to a single mounting arrangement; direct soldering and the use of epoxy adhesives have been successfully employed. The press-fit case is tin-plated to facilitate direct soldering to the heat sink. A 60-40 solder should be used and heat should be applied only long enough to allow the solder to flow freely.

File Number **406**

Zero-Voltage-Switched Types

6-40 A, 200-600 V Silicon Triacs For Use With IC Zero-Voltage Switches

For Power-Control and Switching Applications at 50-60 Hz with RCA-CA3059 or CA3079 IC as Trigger Circuits

The triacs listed below are gate-controlled full-wave ac switches intended for load-control applications. They are especially useful in ac circuits for heating controls (proportional or on-off), lamp switching, motor switching, and a wide variety of other power-control applications.

These devices have gate characteristics which assure that an RCA-CA3059 or CA3079 integrated circuit can supply sufficient drive current to trigger them over their full operating-temperature range (-40°C to +85°C).

The RCA-CA3059 and CA3079 are monolithic silicon integrated-circuit zero-voltage switches which can operate directly from the ac line. They are designed to drive the triac gate directly and provide the gating signal at zero-voltage crossings for minimum radio-frequency interference.

These triacs have rms on-state current ratings that range from 6 to 40 amperes, and repetitive off-state voltage ratings from 200 to 600 volts. They are supplied in a variety of packages.

RATINGS AND CHARACTERISTICS

All types, at case temperature (T_C) = 25° C, I+ and III+ triggering modes, Δ I_{GT} = 45 mA max., V_{GT} = 1.5 V max.

Type No.	Rep. Peak Off-State Voltage V_{DROM} (V)	RMS On-State Current I_T(RMS) at Case Temp. (A)	(°C)	Typical DC Holding Current at 25° C, I_{HO} (mA)	Package	Additional Data Shown in Bulletin File No.*
T2506B	200	6	105	15	TO-220AB	615
T2506D	400	6	105	15		615
T2506M	600	6	105	15		615
T2506N	800	6	105	15		615
T2706B	200	6	100	15	TO-213AA	351
T2706D	400	6	100	15		351
T2706M	600	6	100	15		351
T2706N	800	6	100	15		351
T2806B	200	8	105	15	TO-220AB	1314
T2806C	300	8	105	15		1314
T2806D	400	8	105	15		1314
T2806M	600	8	105	15		1314
T2806N	800	8	105	15		1314

Zero-Voltage-Switched Types

RATINGS AND CHARACTERISTICS, Cont'd

All types, at case temperature (T_C) = 25° C, I+ and III+ triggering modes, Δ I_{GT} = 45 mA max., V_{GT} = 1.5 V max.

Type No.	Rep. Peak Off-State Voltage V_{DROM} (V)	RMS On-State Current I_T(RMS) at Case Temp. (A)	(°C)	Typical DC Holding Current at 25° C, I_{HO} (mA)	Package	Additional Data Shown in Bulletin File No.*
T4706B	200	15	95	15	TO-213AA	300
T4706D	400	15	95	15		300
T4706M	600	15	95	15		300
T4706N	800	15	95	15		300
T6406B	200	40	95	45	Press-fit	593
T6406D	400	40	95	45		593
T6406M	600	40	95	45		593
T6407B	200	30	90	25	Press-fit	459
T6407D	400	30	90	25		459
T6407M	600	30	90	25		459
T6407N	800	30	90	25		459
T6416B	200	40	90	25	Stud	593
T6416D	400	40	90	25		593
T6416M	600	40	90	25		593
T6417B	200	30	85	25	Stud	459
T6417D	400	30	85	25		459
T6417M	600	30	85	25		459
T6417N	800	30	85	25		459
T6426B	200	40	85	25	Isolated Stud	593
T6426D	400	40	85	25		593
T6426M	600	40	85	25		593
T6427B	200	30	80	25	Isolated Stud	459
T6427D	400	30	80	25		459
T6427M	600	30	80	25		459

ΔA triac driven directly from the output terminal of the CA3059 or CA3079 should be characterized for operation in the I+ or III+ triggering mode, i.e., with positive gate current (current flows into the gate for both polarities of the applied ac voltage).

*Except for gate characteristics, data in these bulletins also apply to the types listed in this chart.

Technical information on RCA-CA3059 and CA3079 is contained in bulletin File No. 490.

For detailed application information, see Application Note ICAN-6182, "Features and Application of RCA Integrated Circuit Zero-Voltage Switches."

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 commerical 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 commerical users to define their requirements.

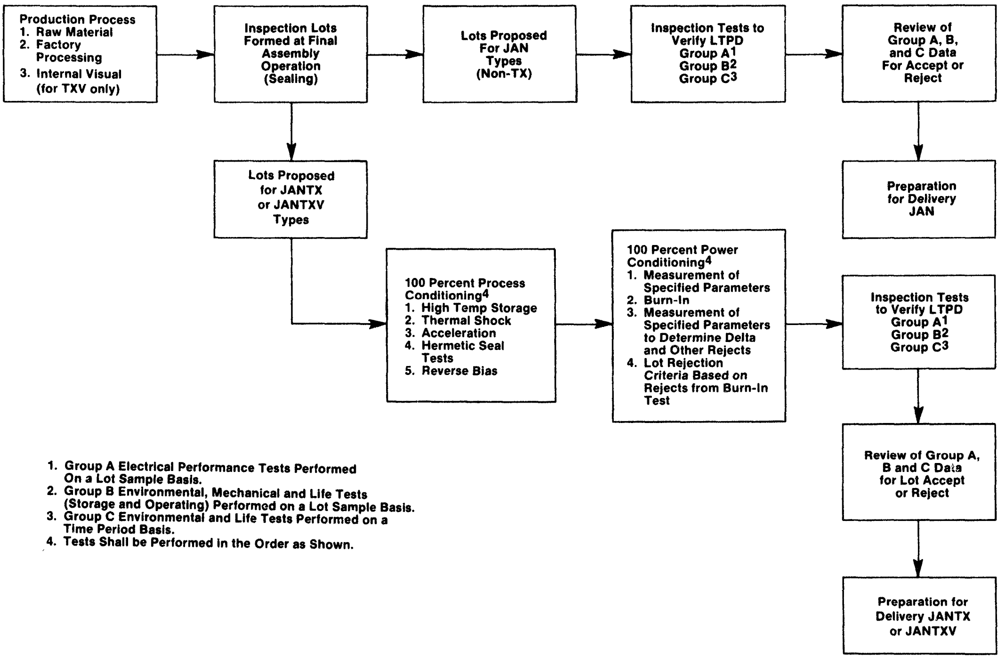
Military and aerospace requirements for high-reliability solid-state devices are extremely large and diverse, not only in terms of performance, operating conditions, and reliability, but also in terms of logistics and procurement. As a result of these requirements, the military services have jointly 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).



Order of procedure diagram for JAN, JANTX, and JANTXV solid-state devices.

JAN, JANTX, and JANTXV 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.

The following tables list approved "QPL" types and types that are in the process of testing preliminary to QPL approval by DESC, respectively.

Custom high-reliability selections of RCA Power devices can also be supplied with similar process and power conditioning tests and delta criteria.

QPL Approved Types

RCA is presently qualified on the following devices. Prices and delivery quotations may be obtained from your local sales representative.

Bipolar Power Transistors

Types	MIL-S 19500/	Package	Polarity	P_T (W)	I_C (A)	V_{CEO} (V)	h_{FE} Min.	h_{FE} I_C (A)	f_T (MHz)
2N3439, 2N3440	368	TO-39	N-P-N	0.8	1	350	40	0.02	15
2N3584, 2N3585	384	TO-66	N-P-N	35	2	300	25	1	15
2N3879	526	TO-66	N-P-N	35	7	75	20	4	40
2N5038, 2N5039	439	TO-3	N-P-N	140	20	90	20	12	60
2N5302, 2N5303	456	TO-3	N-P-N	200	30	80	15	15	2
2N5415S, 2N5416S	485	TO-39	P-N-P	0.75	1	300	30	0.05	15
2N5671, 2N5672	488	TO-3	N-P-N	140	30	120	20	20	50
2N6032, 2N6033	528	TO-3	N-P-N	140	50	120	10	50	50
2N6211-2N6213	461	TO-66	P-N-P	35	2	350	30	1	20
2N6283, 2N6284	504	TO-3	N-P-N	175	20	100	1250	10	8
2N6306, 2N6308	498	TO-3	N-P-N	125	8	350	15	3	5
2N6383-2N6385	523	TO-3	N-P-N	100	10	80	1000	5	20
2N6546, 2N6547	525	TO-3	N-P-N	175	15	300	12	5	60
2N6648-2N6650	527	TO-3	P-N-P	85	10	80	1000	5	20
2N6671, 2N6673	536	TO-3	N-P-N	150	10	400	10	5	15
2N6674, 2N6675	537	TO-3	N-P-N	175	20	400	8	10	15
2N6676, 2N6678	538	TO-3	N-P-N	175	20	400	8	10	15

SCR's

Types	MIL-S 19500/	Package	V_{DRM} (V)	$I_{T(RMS)}$ (A)	V_{GT} (V)	I_{GT} (mA)	dv/dt (V/μs)
2N682	108	TO-48	50	25	3	35	20
2N683	108	TO-48	100	25	3	35	20
2N685	108	TO-48	200	25	3	35	20
2N686	108	TO-48	250	25	3	35	20
2N687	108	TO-48	300	25	3	35	20
2N688	108	TO-48	400	25	3	35	20
2N690	108	TO-48	600	25	3	35	20

JANTXV Types Now Available

The following bipolar types are now available in JANTXV form:

2N6546TXV	2N6649TXV	2N6676TXV	2N5671TXV
2N6547TXV	2N6650TXV	2N6678TXV	2N5672TXV
2N6383TXV	2N6671TXV	2N5038TXV	2N6283TXV
2N6384TXV	2N6673TXV	2N5039TXV	2N6284TXV
2N6385TXV	2N6674TXV	2N5302TXV	2N6306TXV
2N6648TXV	2N6675TXV	2N5303TXV	2N6308TXV

Added Value Screening

RCA Added Value Screening

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. RCA 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. RCA Solid State Division has frequently used the resources of its laboratories, production, facilities, and expert technical staff to contribute to the success of such programs.

All RCA 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 Table III.

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.

Group B and Group C tests will be performed when requested in accordance with MIL-S-19500.

ADDED VALUE HIGH-RELIABILITY SCREENING

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%

Added Value Screening

ADDED VALUE HIGH-RELIABILITY SCREENING (Continued)

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 = $5x10^{-8}$ atm cc/s except $5x10^{-7}$ 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)		48 hrs min at T_A = 150° C (min) and minimum applied voltage as follows:			
Burn-in (for transistors)	1039	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.)

Added Value Screening

ADDED VALUE HIGH-RELIABILITY SCREENING (Continued)

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-roups 2 and 3.
12. Hermetic Seal Fine 1/ Gross	1071	(Same as 5 on previous page) 2/	100%	Optional 4/	Optional 4/
13. Radiography	2076	2/	100%	—	—
14. External Visual Examination	2071	To be performed after complete marking.	100%	—	—

*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 $T_C \geq 100°C$ and all thyristors.
4/ Fine and gross seal leak test for JANTX and JANTXV shall be performed in either block 5 or block 12.

Radiation-Resistant Power Transistors

RCA offers a variety of bipolar silicon power transistors in which special design and processing techniques are used 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.

Types	Package	Polarity	P_T (W)	h_{FE}		V_{CEO} (V)
				Min.	I_C(A)	
2N3879	TO-66	N-P-N	35	20	4	75
2N5038	TO-204AA	N-P-N	140	20	12	90
2N5320	TO-39	N-P-N	10	10	1	75
2N5322	TO-39	P-N-P	10	10	1	75
2N5672	TO-204AA	N-P-N	140	20	20	120
2N6248	TO-204AA	P-N-P	125	5	10	100
2N6480	Radial	N-P-N	87	20	12	100
2N6673	TO-204AA	N-P-N	150	10	5	400
2N6688	TO-204AA	N-P-N	200	15	20	200
TA9107 (Dev. Type)	Radial	N-P-N	87	50	8	80

For all types except TA9107,
Gamma Intensity (RAD(Si/s) = 1×10^7
Neutron Fluence (N/cm^2) = 5×10^{13}

For TA9107,
Gamma Intensity (RAD(Si)/s) = 1×10^8
Neutron Fluence (N/cm^2) = 1×10^{14}

See Application Note AN-6320 for Data

Neutron-Radiation Compensation

In RCA radiation-resistant 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 resulting 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_{CEO}). 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 RCA 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.

Design Example

The RCA developmental transistor TA9107 is an excellent example of the radiation-resistance capability that can be achieved through the use of effective design techniques. This transistor can operate satisfactorily after exposure to neutron fluence levels of 1×10^{14} neutrons/cm^2 and can withstand a gamma dose rate of 1×10^8 rads (Si)/second before the onset of secondary photocurrent.

The TA9107 has a collector-to-emitter voltage rating V_{CER} of 100 volts and a post-radiation current capability of 10 amperes. The width of the collector-to-base depletion region is only 0.7 mil, the doping concentration in the collector is 1×10^{15} atoms/cm^2, and the width of the base is only about 8000 angstroms. The TA9107 employs a unique emitter design in which 32 emitter sites are interconnected by an expanded metallization system so that the maximum distance from the base contact to the center of the emitter is only 2 mils.

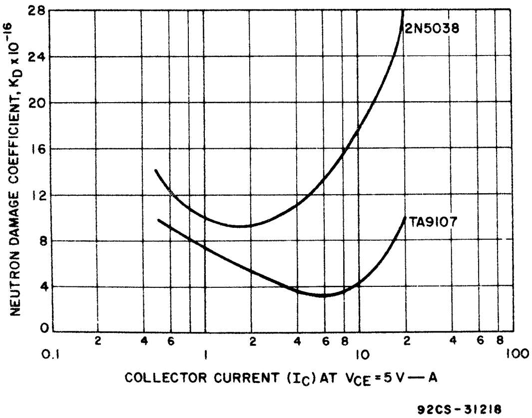
Aluminum metallization 50,000 angstroms thick is used in the TA9107 to assure uniform current distribution in the emitter. A gold eutectic bond is used for collector mounting.

Radiation-Resistant Power Transistors

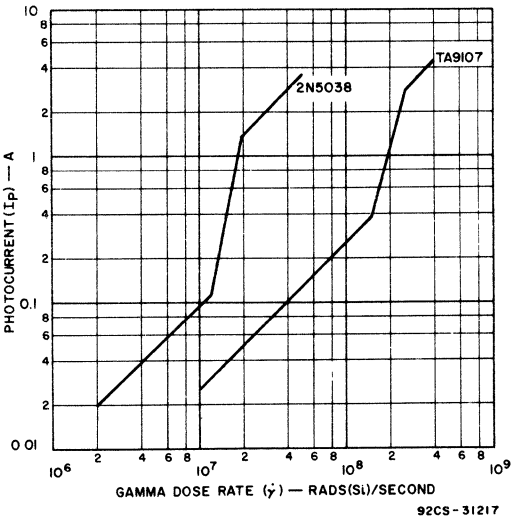
TA9107 Capability

CHARACTERISTIC	PRE-RADIATION	POST-RADIATION (5×10^{13} N/cm^2)
V_{CEO}	80 V	80 V
V_{CBO}	100 V	100 V
V_{EBO}	5.5 V	5.5 V
h_{FE} at I_C = 5 A, V_{CE} = 2 V	80	10
V_{CE}(sat) at I_C = 8 A, h_{FE} = 5	0.5 V	2 V
V_{BE}(sat) at I_C = 8 A, h_{FE} = 5	1.35 V	1.5 V
$I_{S/b}$ at 75 V for 100 μs	60 W	60 W
$E_{S/b}$ L = 125 μH	0.3 mJ	0.3 mJ

Primary Photocurrent = 250 mA typ. at 1×10^8 rad (Si)/second.
Onset of Secondary Photocurrent occurs typically at 1.5×10^8 rad (Si)/second.



Neutron damage coefficient (at 1 mev) as a function of collector current for the TA9107 and 2N5038 radiation-hardened power transistors.



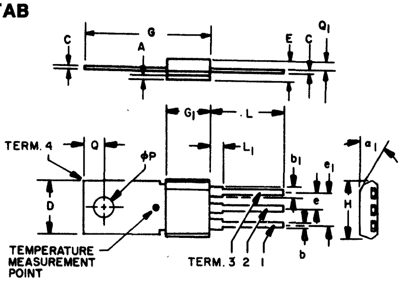
Photocurrent as a function of gamma dose rate for the TA9107 and 2N5038 radiation-hardened power transistors.

Package Information

Dimensional Outlines

TO-202AB

VERSATAB



TEMPERATURE MEASUREMENT:
1/16 in. (1.58 mm) from plastic encapsulation on either mounting flange (terminal No. 4) or anode lead (terminal No. 2)

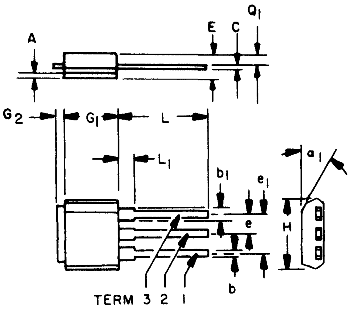
Notes:
1: Package contour optional within dimensions specified.
2: Lead dimensions uncontrolled in this zone.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.05	—	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
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

3: Controlling dimensions: inch.

TO-202 MODIFIED

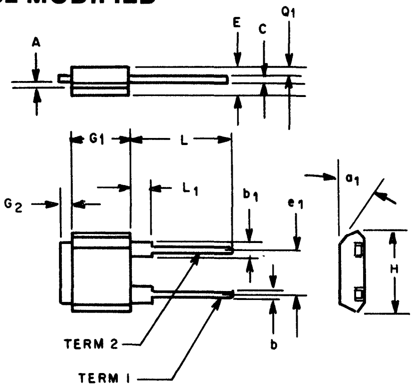


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.05	—	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
c	0.018	0.026	0.457	0.660	
E	0.130	0.150	3.302	3.810	
e	0.095	0.105	2.413	2.667	
e_1	0.190	0.210	4.826	5.334	
G_1	0.220	0.260	5.588	6.624	
G_2	—	0.09	—	2.285	
H	0.330	0.380	8.382	9.652	
L	0.390	0.450	9.906	11.43	
L_1	—	0.110	—	2.794	1, 2
Q_1	0.039	0.050	0.990	1.270	
α_1	—	50°	—	50°C	1

92CS-39028R1

Note:
1: Package contour optional within dimensions specified.
2: Lead dimensions uncontrolled in this zone.

TO-202 MODIFIED



Notes:
1. Package contour optional within dimensions specified.
2. Lead dimensions uncontrolled in this zone.

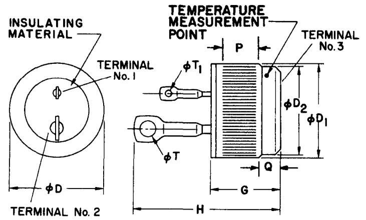
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.05	—	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
c	0.018	0.026	0.457	0.660	
E	0.130	0.150	3.302	3.810	
e_1	0.190	0.210	4.826	5.334	
G_1	0.220	0.260	5.588	6.624	
G_2	—	0.09	—	2.285	
H	0.330	0.380	8.382	9.652	
L	0.390	0.450	9.906	11.43	
L_1	—	0.110	—	2.794	1, 2
Q_1	0.039	0.050	0.990	1.270	
α_1	—	50°	—	50°	1

92CS-39011R1

Dimensional Outlines

TO-203AA

PRESS-FIT 6-, 10-, AND 15-A TRIACS: 20- AND 35-A SCRs



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕD	—	0.510	—	12.95	1
ϕD_1	0.501	0.505	12.726	12.827	2
ϕD_2	0.465	0.475	11.82	12.06	
G	0.330	0.380	8.39	9.65	
H	—	0.800	—	20.32	
P	0.100	—	2.54	—	2
Q	0.080	0.097	2.04	2.46	
ϕT	0.065	0.090	1.66	2.28	3, 4
ϕT_1	0.035	0.068	0.89	1.72	

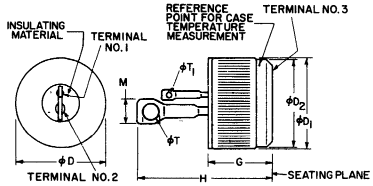
92CS-23134R1

Notes:

1: Outline contour is optional within zone defined by ϕ D and G min. and H max.
2: Straight knurl surface.
3: Elongated hole in terminal is optional
4: Contour and orientation of terminal 1 and terminal 2 are not defined.
5: Terminal 1 to be shorter than terminal 2 for identification.

PRESS-FIT

25-, 30-, AND 40-A TRIACS



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
G	—	0.380	—	9.65	
ϕD	0.501	0.510	12.73	12.95	
ϕD_1	—	0.505	—	12.83	1
ϕD_2	0.465	0.475	11.81	12.07	
H	0.825	1.000	20.95	25.40	
M	0.215	0.225	5.46	5.71	
ϕT_1	0.058	0.068	1.47	1.73	
ϕT	0.138	0.148	3.51	3.75	

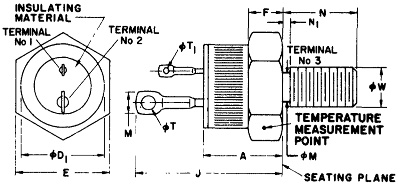
Note:

92CS-15207R4

1: Outer diameter of knurled surface.

STUD

6-, 10-, AND 15-A TRIACS; 20- AND 35-A SCRs

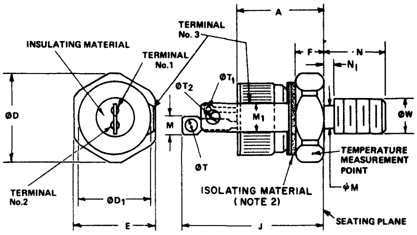


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	8.40	12.80	
ϕD_1	—	0.544	—	13.81	
E	0.544	0.562	13.82	14.28	
F	0.113	0.200	2.87	5.08	
J	—	0.950	—	24.13	
ϕM	0.220	0.249	5.59	6.32	
M	—	0.155	—	3.94	
N	0.422	0.453	10.72	11.50	
N_1	—	0.090	—	2.28	
ϕT_1	0.058	0.068	1.47	1.73	
ϕT	0.080	0.090	2.03	2.29	
ϕW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

92CS-23135R2

ISOLATED-STUD

25-, 30-, AND 40-A TRIACS



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.673	—	17.09	
ϕD	0.604	0.614	15.34	15.59	
ϕD_1	0.501	0.505	12.72	12.82	
E	0.551	0.557	13.99	14.14	
F	0.100	0.185	2.50	4.69	
J	—	1.298	—	32.96	
ϕM	0.220	0.249	5.59	6.32	
M	0.210	0.230	5.33	5.84	
M_1	0.200	0.210	5.08	5.33	
N	0.422	0.452	10.72	11.48	
N_1	—	0.090	—	2.28	
ϕT_1	0.058	0.068	1.47	1.73	
ϕT	0.138	0.148	3.50	3.75	
ϕT_2	0.138	0.148	3.50	3.75	
ϕW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

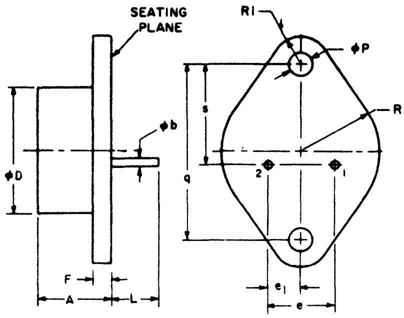
92CS-29311R3

Note:

1: ϕW is pitch diameter of coated threads.
REF: Screw-Thread Standards for Federal Services, Handbook H28, Part 1. Recommended Torque: 36 in.lbf (0.4 kgf-m). Maximum Torque: 50 in.lbf (0.57 kgf-m).

Dimensional Outlines

TO-204AA/TO-3

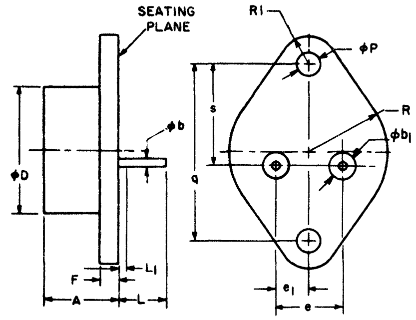


SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.4	11.4	
ϕb	0.038	0.043	0.966	1.092	
ϕD	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	
e_1	0.205	0.225	5.21	5.71	
F	—	0.135	—	3.42	
L	0.312	—	7.93	—	
ϕP	0.151	0.161	3.84	4.08	
q	1.187 BSC		30.15 BSC		
R	—	0.525	—	13.33	
R_1	—	0.188	—	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

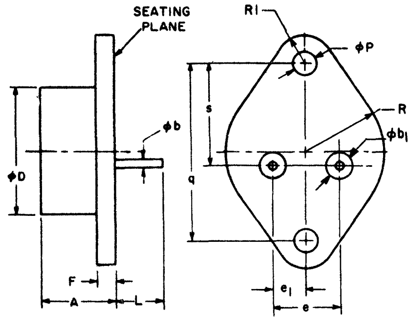
Notes:

1: ϕb applies between L_1 and L. Diameter is uncontrolled in L_1.

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.

TO-204AE

141-mil diameter pin isolation

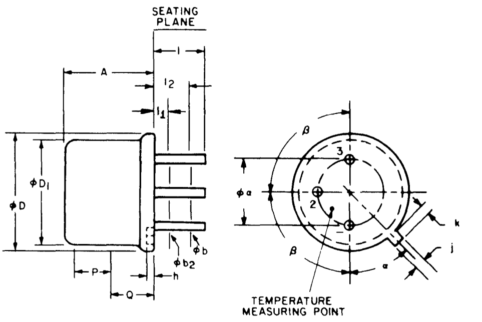


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.4	11.4	
ϕb	0.057	0.063	1.45	1.60	
$ϕb_1$	0.141 NOM.		3.58 NOM.		
ϕD	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	
e_1	0.205	0.225	5.21	5.71	
F	0.060	0.135	1.53	3.42	
L	0.440	0.480	11.18	12.19	
ϕP	0.151	0.161	3.84	4.08	
q	1.187	BSC	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

Dimensional Outlines

TO-205AA/TO-5
TO-205AD/TO-39



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	0.190	0.210	4.83	5.33	
A	0.240	0.260	6.10	6.60	
ϕb	0.016	0.021	0.406	0.533	2
ϕb_2	0.016	0.019	0.406	0.483	2
ϕD	0.350	0.370	8.89	9.40	
ϕD_1	0.305	0.335	8.00	8.51	
h	0.009	0.041	0.229	1.04	
j	0.028	0.034	0.711	0.864	
k	0.029	0.040	0.737	1.02	3
L (TO-5)	1.500	1.750	38.10	44.45	2
L (TO-39)	0.500	0.750	12.70	19.05	2
l_1	—	0.0 50	—	1.27	2
l_2	0.250	—	6.35	—	2
P	0.100	—	2.54	—	1
Q					4
α	45° NOMINAL		—	—	
β	90° NOMINAL		—	—	

92CS-37723

Notes:

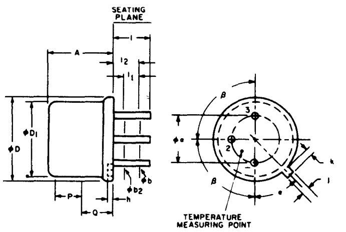
1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed 0.010 in. (0.254 mm).

2: (Three leads) ϕb_2 applies between l_1 and l_2. ϕb applies between l_2 and l. Diameter is uncontrolled in l_1.

3: Measured from maximum diameter of the actual device.

4: Details of outline in this zone optional.

"MOD. TO-205"

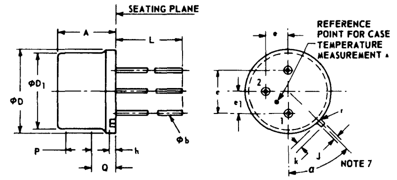


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	.190	.210	4.83	5.33	
A	.240	.260	6.10	6.60	
ϕb	.017	.021	.44	.53	
ϕD	.335	.366	8.51	9.30	
ϕD_1	—	.330	8.13	8.38	
h	.015	.035	.38	.89	
j	.028	.035	.71	.89	
k	.029	.045	.74	1.14	
l	.975	1.025	24.76	26.03	
P	.100	—	2.54	—	
Q	—	—	—	—	1
α	45° NOMINAL				
β	50° NOMINAL				

92CS-37697

Note 1: Details of outline in this zone optional.

"LOW-PROFILE TO-205"



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.160	.180	4.06	4.57	
ϕb	.017	.021	.432	.533	2
ϕD	.335	.366	9.017	9.296	
ϕD_1	.323	.335	8.204	8.51	
e	.190	.210	4.83	5.33	
e_1	.100 TRUE POSITION		2.54 TRUE POSITION		4, 5
h	.015	.035	.381	.889	
j	.028	.035	.711	.889	5
k	.029	.045	.737	1.14	3, 5
L	.985	1.015	25.02	25.78	2
P	.100	—	2.54	—	1
Q	—	—	—	—	6
r	—	.007	—	.179	
α	42°	48°	—	—	5, 7

92CS-34150

Notes

1: This zone is controlled for automatic handling. The variation in actual diameter within the zone shall not exceed .012 in. (.279 mm).

2: (Three leads) ϕb applies between seating plane and 1.015 in. (25.78 mm)

3: Measured from maximum diameter of the actual device.

4: Leads having maximum diameter .021 in. (.533 mm) measured at the seating plane of the device shall be within .007 in. (.178 mm) of their true positions relative to the maximum-width tab.

5: The device may be measured by direct methods or by the gage and gaging procedure described on gage drawing GS-1 of JEDEC publication 12E, May 1964.

6: Details of outline in this zone optional.

7: Tab centerline.

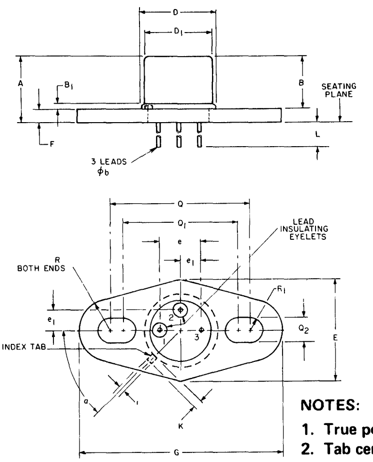
▲CASE TEMPERATURE MEASUREMENT

The specified temperature-reference point should be used when making temperature measurements. A low-mass temperature probe or thermocouple having wire no larger than AWG No. 26 should be attached at the temperature reference point.

Dimensional Outlines

TO-205AD/TO-39

WITH FLANGE



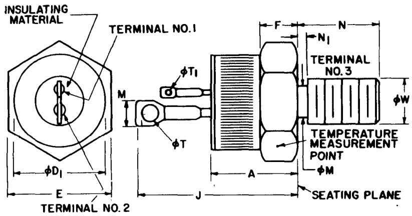
NOTES:
1. True position.
2. Tab centerline.

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	
ϕb	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	
a	45° T.P.				1, 2

92CS-22333

TO-208AA/TO-48

25-, 30-, AND 40-A TRIACS



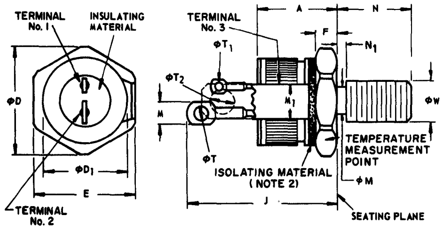
Note:
1: φW is pitch diameter of coated threads.
REF: Screw-thread Standards for Federal Services, Handbook H28, Part I. Recommended Torque: 35 in.lbf (0.4 kgf-m). Maximum Torque: 50 in-lbf (0.57 kgf-m).

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.330	0.505	9.4	12.8	
ϕD_1	—	0.544	—	13.81	
E	0.544	0.562	13.82	14.28	
F	0.113	0.200	2.87	5.08	
J	0.950	1.100	24.13	27.94	
ϕM	0.220	0.249	5.59	6.32	
M	0.215	0.225	5.46	5.71	
N	0.422	0.453	10.72	11.50	
N_1	—	0.090	—	2.28	
ϕT_1	0.058	0.068	1.47	1.73	
ϕT	0.138	0.148	3.50	3.75	
ϕW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

92CS-15208R5

ISOLATED STUD

6-, 10-, AND 15-A TRIACS; 20- AND 35-A SCRs



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.673	—	17.09	
ϕD	0.604	0.614	15.34	15.50	
ϕD_1	0.501	0.505	12.72	12.82	
E	0.551	0.557	13.99	14.14	
F	0.100	0.185	2.50	4.69	
J	—	1.055	—	26.79	
ϕM	0.220	0.249	5.59	6.32	
M	—	0.155	—	3.94	
M_1	0.200	0.210	5.08	5.33	
N	0.422	0.452	10.72	11.48	
N_1	—	0.090	—	2.28	
ϕT_1	0.058	0.068	1.47	1.73	
ϕT	0.080	0.090	2.03	2.29	
ϕT_2	0.138	0.148	3.50	3.75	
ϕW	1/4-28	UNF-2A	1/4-28	UNF-2A	1

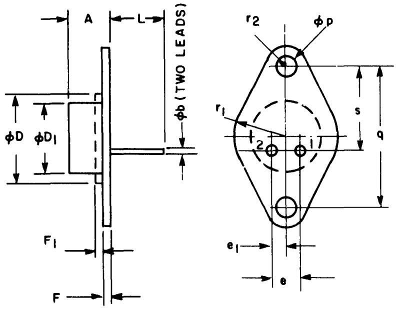
92CS-23133R4

WARNING: The ceramic used in these packages contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

Notes:
1: φW is pitch diameter of coated threads.
REF: Screw-Thread Standards for Federal Services, Handbook H28, Part I. Recommended Torque: 35 in.lbf (0.4 kgf-m). Maximum Torque: 50 in-lbf (0.57 kgf-m).

Dimensional Outlines

TO-213AA/TO-66

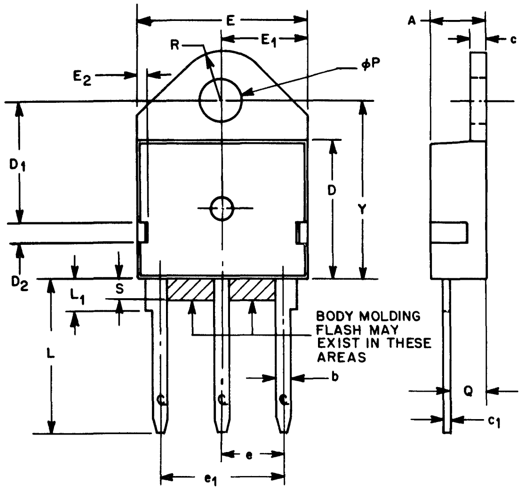


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.250	.340	6.35	8.63	
θ_b	.028	.034	.712	.863	
θD	—	.620	—	15.74	3
θD_1	.470	.500	11.94	12.70	
e	.190	.210	4.83	5.33	
e_1	.093	.107	2.37	2.71	
F	.050	.075	1.27	1.90	4
F_1	—	.050	—	1.27	3
L	.360	—	9.15	—	
θP	.142	.162	3.61	4.08	
q	.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.

TO-218AC



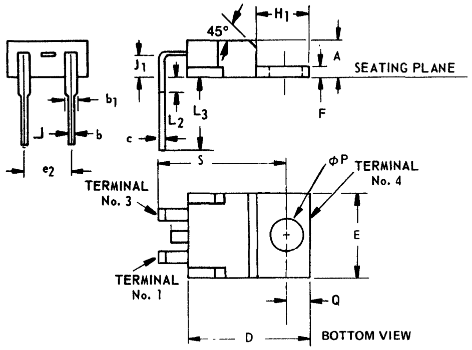
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.165	.200	4.191	5.080	
b	.040	.063	1.016	1.600	
c	.053	.065	1.346	1.651	
c_1	.018	.030	.457	.762	
D	.485	.505	12.319	12.827	
D_1	.395	.415	10.033	10.541	
D_2	.070	.090	1.778	2.286	
E	.610	.640	15.494	16.256	1
E_1	.305	.320	7.747	8.128	
E_2	.040	.060	1.016	1.524	
e	.205	.225	5.207	5.715	
e_1	.420	.440	10.688	11.176	
L	.500	.610	12.700	15.494	
L_1	—	.125	—	3.175	2
ϕP	.157	.167	3.988	4.241	
Q	.094	.126	2.388	3.200	
R	.170	.190	4.318	4.826	
S	—	0.60	—	1.524	
Y	.626	.670	15.900	17.018	

92CS-37698R1

Notes:
1: Tab outline optional within boundaries of dimensions E and R.
2: Lead dimensions uncontrolled in L_1.
3: Controlling dimensions: inch.

Dimensional Outlines

TO-220AA
VERSAWATT

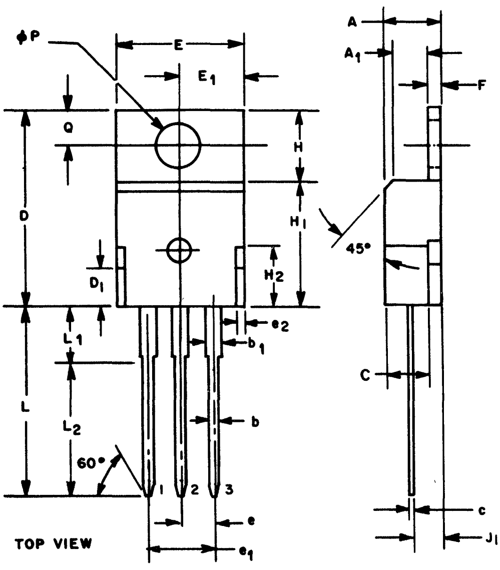


NOTES:
1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

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

TO-220AB
VERSAWATT



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.140	0.190	3.56	4.82
A_1	0.080	0.085	2.03	2.16
b	0.020	0.045	0.51	1.14
b_1	0.045	0.070	1.14	1.77
C	–	0.125	–	3.18
c	0.015	0.025	0.38	0.63
D	0.560	0.625	14.23	15.87
D_1	–	0.100	–	2.54
E	0.380	0.420	9.66	10.66
e	0.090	0.110	2.29	2.79
e_1	0.190	0.210	4.83	5.33
e_2	–	0.030	–	0.76
F	0.045	0.055	1.14	1.39
H	0.230	0.270	5.85	6.85
H_1	0.355	0.370	9.02	9.40
H_2	–	0.160	–	4.06
J_1	0.080	0.115	2.04	2.92
L	0.500	0.562	12.70	14.27
L_1	–	0.250	–	6.35
L_2	0.400	0.410	10.16	10.41
ϕP	0.139	0.161	3.531	4.089
Q	0.100	0.120	2.54	3.04

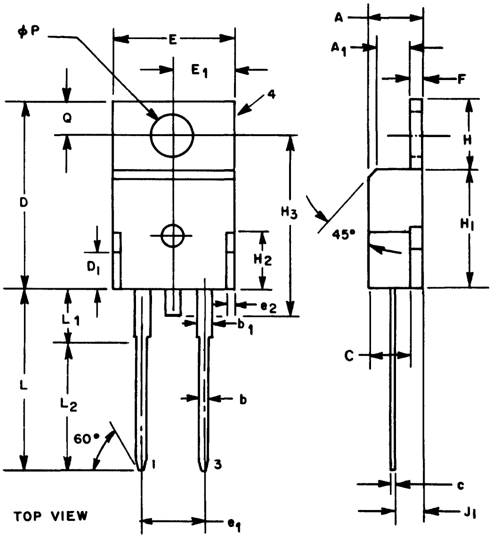
NOTES:

1. Position of lead to be measured 0.250-0.255 in. (6.350-6.477 mm) from case.

92CS-34697R1

Dimensional Outlines

TO-220AC
VERSAWATT



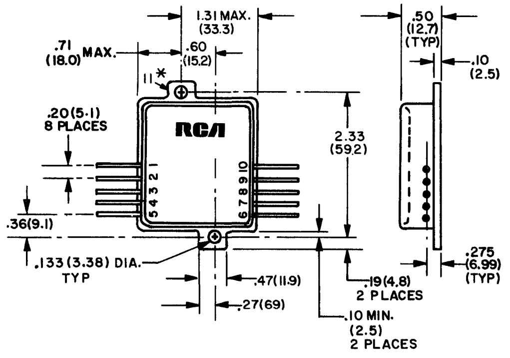
SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.140	0.190	3.56	4.82
A_1	0.080	0.085	2.03	2.16
b	0.020	0.045	0.51	1.14
b_1	0.045	0.070	1.14	1.77
C	—	0.125	—	3.18
c	0.015	0.025	0.38	0.63
D	0.560	0.625	14.23	15.87
D_1	—	0.100	—	2.54
E	0.380	0.420	9.66	10.66
e_1	0.190	0.210	4.83	5.33
e_2	—	0.030	—	0.76
F	0.045	0.055	1.14	1.39
H	0.230	0.270	5.85	6.85
H_1	0.355	0.370	9.02	9.40
H_2	—	0.160	—	4.06
H_3	—	0.600	—	15.24
J_1	0.080	0.115	2.04	2.92
L	0.500	0.562	12.70	14.27
L_1	—	0.250	—	6.35
L_2	0.400	0.410	10.16	10.41
ϕP	0.139	0.161	3.531	4.089
Q	0.100	0.120	2.54	3.04

92CS-34830R1

NOTES:

1. **Position of lead to be measured 0.250-0.255 in. (6.350-6.477 mm) from case.**

HYBRID-CIRCUIT PACKAGE



92CS-37519

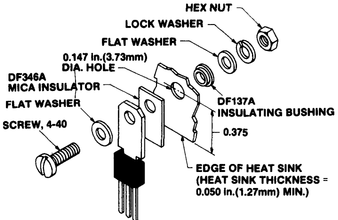
DIMENSIONS IN INCHES AND MILLIMETERS (VALUES IN PARENTHESES)

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.

Suggested Hardware and Mounting Arrangements

TO-202AB

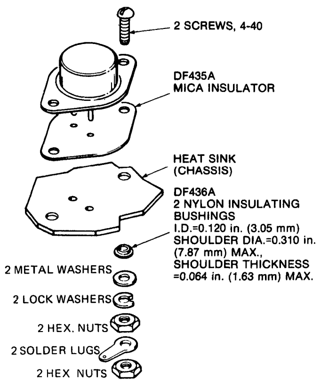


NOTE: Maximum torque applied to mounting flange is 8 in.-lb (0.09 kgf-m)

92CS-27777R1

TO-204AA

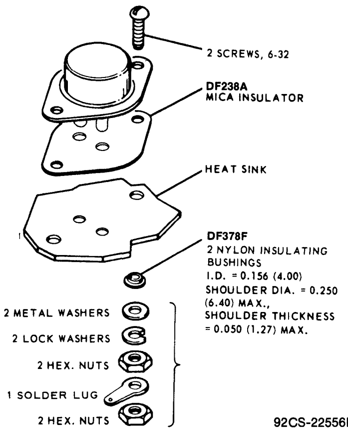
200-mil diameter pin isolation



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lbs (0.09 kgf m)

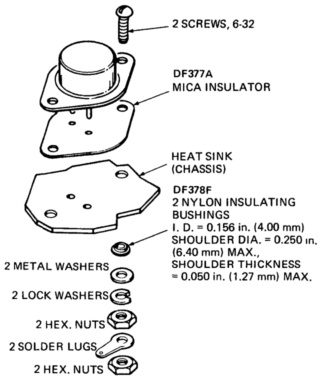
92CS-33203

TO-204AE



92CS-22556R1

TO-204AA

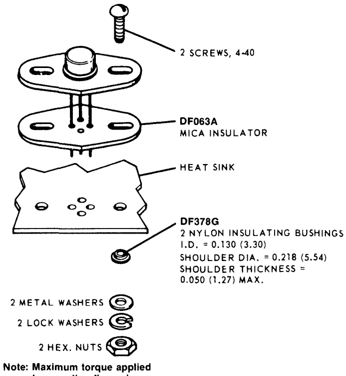


NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in lbs (0 14 kgf m)

92CS-22558R2

TO-205MA/TO-5 TO-205MD/TO-39

WITH FLANGE

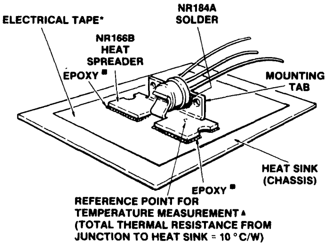


Note: Maximum torque applied to mounting flange is 8 in.-lb. (0.09 kgfm).

92CS-22567E

Suggested Hardware and Mounting Arrangements

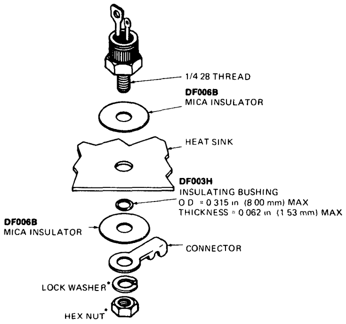
"LOW-PROFILE TO-205"
WITH HEAT SPREADER



* Scotch brand electrical tape No. 27 (thermo setting one side), Minnesota Mining & Mfg. Co., St. Paul, Minnesota, or equivalent.
■ An epoxy such as Hysol Epoxy Patch Kit 6C, Hysol Corporation, Olean, N.Y. 14761, or equivalent.
▲ For heat-sink temperature measurement, the thermocouple (wire no larger than AWG No. 26) should be inserted in a small, shallow hole drilled in (but not through) the heat sink at the indicated temperature reference point.

92CS-37671

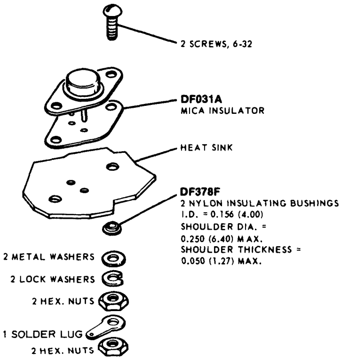
TO-208AA/TO-48
Including Stud and Isolated-Stud Triacs and SCRs



Maximum torque 50 in.-lb (0.58 kgf-m)
*Only hardware required for Isolated-Stud package

92CS-22566R1

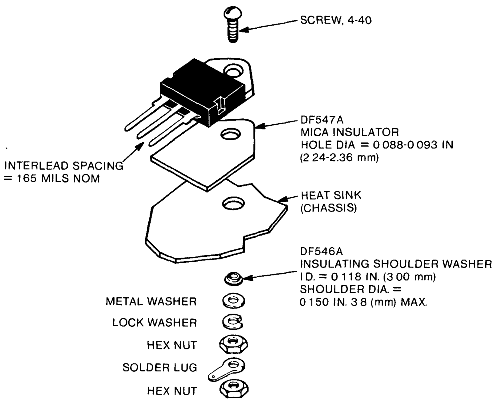
TO-213AA/TO-66



Note: Maximum torque applied to mounting flange is 12 in.-lb. (0.14 kgfm)

92CS-22560R5

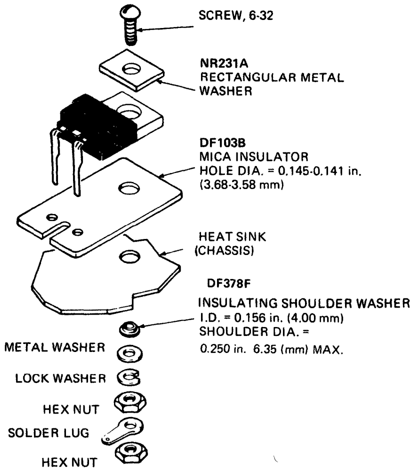
TO-218AC



92CS-39588

Suggested Hardware and Mounting Arrangements

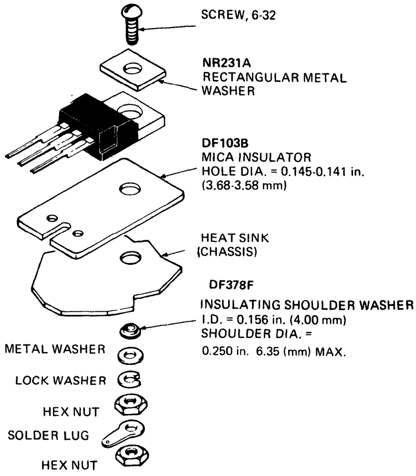
TO-220AA



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lb. (0.09 kgf-m)

92CS-40181

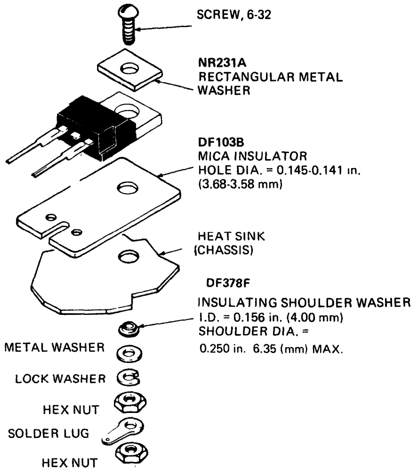
TO-220AB



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lb. (0.09 kgf m)

92CS-39586

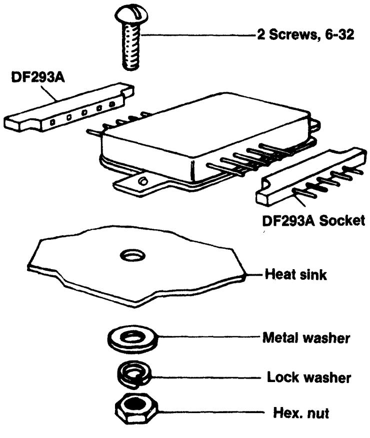
TO-220AC



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lb (0 09 kgf m)

92CS-39587

POWER HYBRID CIRCUIT PACKAGE



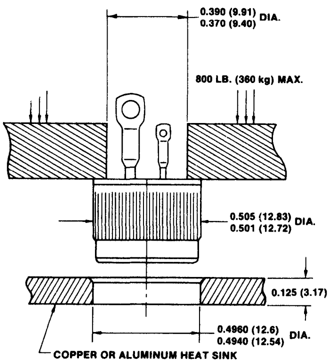
Note: Maximum torque applied to mounting flange is 24 in-lb (0.3 kgf-m).
DF293A is a socket to enable simple connection of this module.

92CS-27782R1

Suggested Hardware and Mounting Arrangements

TO-203AA

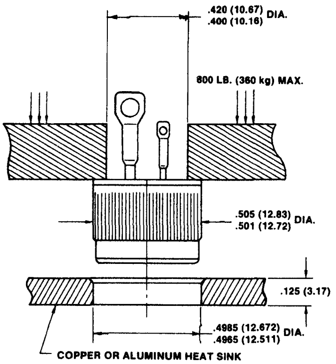
6-, 10-, AND 15-A TRIACS, 20- AND 35-A SCRs



92CS-37672

PRESS-FIT

25-, 30-, AND 40-A TRIACS



92CS-37073

PRESS-FIT TRIACS AND SCRs

MOUNTING CONSIDERATIONS

Mounting of press-fit package types depends upon an interference fit between the thyristor case and the heat sink. As the thyristor is forced into the heat-sink hole, metal from the heat sink flows into the knurl voids of the thyristor case. The resulting close contact between the heat sink and the thyristor case assures low thermal and electrical resistances.

A recommended mounting method, Press-Fit (TO-203AA) or Press-Fit (25-, 30-, and 40-A triacs) shows press-fit knurl and heat-sink hole dimensions. If these dimensions are maintained, a "worst-case" condition of 0.0085 in. (0.2159 mm) interference fit will allow press-fit insertion below the maximum allowable insertion force of 800 pounds. A slight chamfer in the heat-sink hole will help center and guide the press-fit package properly into the heat sink. The insertion tool should be a hollow shaft having an inner diameter of 0.380 ± 0.010 in. (9.65 ± 0.254 mm) for PF-1 package, and 0.410 ± 0.010 in. (10.41 ± 0.254 mm) for PF-2 package and an outer diameter of 0.500 in (12.70 mm). These dimensions provide sufficient clearance for the leads and assure that no direct force will be applied to the glass seal of the thyristor.

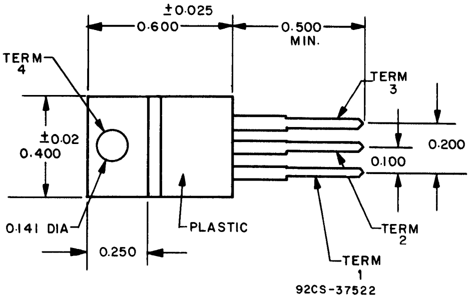
The press-fit package is not restricted to a single mounting arrangement; direct soldering and the use of epoxy adhesives have been successfully employed. The press-fit case is tin-plated to facilitate direct soldering to the heat sink. A 60-40 solder should be used and heat should be applied only long enough to allow the solder to flow freely.

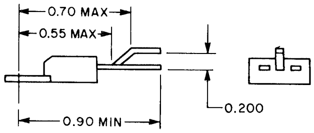
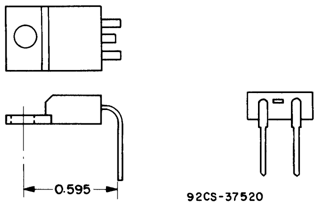
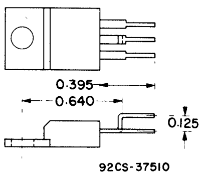
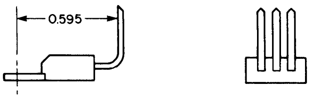
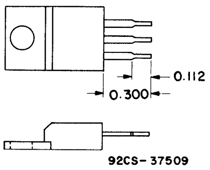
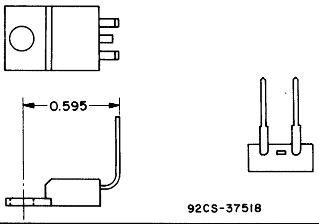
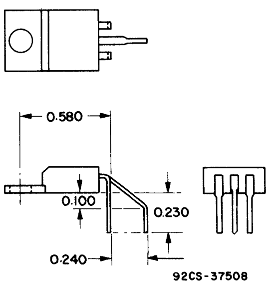
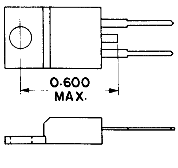
CASE-TO-HEAT SINK THERMAL RESISTANCE FOR DIFFERENT MOUNTING ARRANGEMENTS-TRIACS AND SCRs

Package	Type of Mounting Employed	Thermal Resistance-°C/W
Stud & Isolated-Stud	Directly mounted on heat sink with or without the use of heat-sink compound.	0.6
Stud	Mounted on heat sink with a 0.004 to 0.006 in. (0.102 to 0.152 mm) thick mica insulating washer used between unit and heat sink. Without heat sink compound	2.5
	With heat sink compound	1.5
Press-Fit	Press-fitted into heat sink. Minimum required thickness of heat sink = 1/8 in. (3.17 mm).	0.5
	Soldered directly to heat sink, (60-40 solder which has a melting point of 188°C should be used. Heating time should be sufficient to cause solder to flow freely).	0.1 to 0.35

Lead Forms for RCA Plastic Power Packages

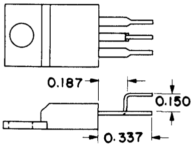
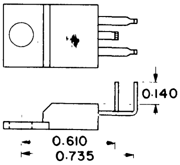
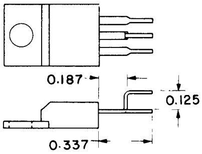
TO-220
VERSAWATT



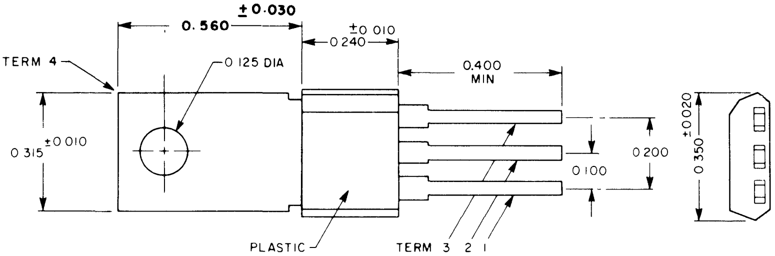
Lead Form No.	Outline	Lead Form No.	Outline
6200		6226	
6201		6255	
6203		6258	
6204		6261	
6206			

Lead Forms for RCA Plastic Power Packages

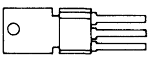
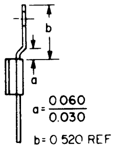
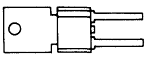
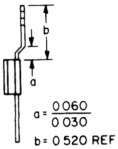
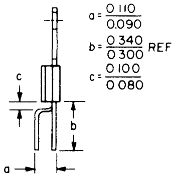
TO-220
VERSAWATT (Cont'd)

Lead Form No.	Outline	Lead Form No.	Outline
6263	 92CS-37505	6265	 92CS-37506
6264	 92CS-37507		

TO-202
VERSATAB



Top View

Lead Form No.	Outline	Lead Form No.	Outline
Type 1		Type 12	
Type 3		Type 32	
Type 11			

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, RTC. 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 Darlington 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 f methods exist to evaluate it. The method presented this Note allows description of the safe operating ar for both dc and pulse operation without subjecti the transistor to breakdown. Both n-p-n and p-n transistors in hermetic or plastic packages can l evaluated, and the complete safe-area curve can l automatically described in a short time.

AN-6605 .... 16 pa
Application of RCA Power Devices in Off-Lin High-Frequency Inverter/Converter Circuits
The current trend in power inverter/convert design is to use high-frequency switching techniqu and direct operation off the available utility lines (i. 110 or 220 volts). The use of higher operating fr quencies reduce the magnetic materials required ar the size of the filter capacitors. This Note discuss the use of RCA power transistors and SCR's i selected high-frequency inverter/converter application

AN-6624 .... 16 pag
Voltage Limitations of Power Transistors
This Note summarizes the primary factors tha determine the voltage limitations of power transistor used in common-emitter circuits with typical base-to emitter circuit terminations. The material presente defines terms and the various operating regions of th transistor as shown in typical volt-ampere charac teristics, develops the analytic relations definin operation in each of the regions, and relates each o 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 driven 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

ver Transistors

-6743 .... 16 pages
-Watt, Off-the-Line, Half-Bridge Converter ng Only Two 15-Ampere 'SwitchMax' High-tage Power Transistors
'o examine and demonstrate the capabilities of A's new series of 'SwitchMax' power transistors ı typical switching application, a 900-watt half-ıge converter was constructed and studied. The cuit switches at a 20-kilohertz rate and with nimal alterations can operate from either 120 or 0 volts. It was built using conventional circuitry but a non-compact modular format so that it would be sily accessible for instrumentation connections and mponent or design alteration. The power switches ed are the RCA-2N6678 'SwitchMax' 15-ampere $CE(sat)$] 450-volt (V_{CEX}) high-speed transistors.

N-6744 .... 6 pages
ow-Cost High-Power Audio Amplifiers Using ıe RCA 8638 and RCA 9116 Transistor Families
This Note discusses the basic considerations and ;quirements for design of the output stage for class ıB audio amplifiers using devices selected from the ;CA 8638 and RCA9116 families, depending on the utput desired. Operation with load impedances ıther than eight ohms is also discussed for the various ıower categories.

ıN-6760 .... 12 pages
ı 230-Watt, 40-kHz, Off-Line Forward Converter Jsing 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
A 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 h_{fe} characteristic of a power transistor at a fixed test frequency while the collector current, I_C, is "swept," or 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-widthmodulated 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_{CEO} ratings of up to 500 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, n-p-n, 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 Darlingtons
In specifying voltage-breakdown requirements for power transistors and power darlingtons, 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 reilability 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.

Application Note Abstracts

Thyristors (SCR's and Triacs)

AN-3697 ....8 pages
Triac Power-Control Applications
This Note describes triac operating characteristics and provides guidance in the use of triacs in specific applications: incandescent lamp controls, light-activated controls, motor controls, heat controls, and a proportional integral-cycle control.

AN-4242 ....16 pages
A Review of Thyristor Characteristics and Applications
This Note describes the operation, ratings, characteristics and typical applications of thyristors. The basic operation of a thyristor is explained by use of a two-transistor analogy. The significance of voltage and temperature ratings is pointed out. Thyristor gate characteristics, switching behavior, and triggering techniques are described. Use of thyristors in typical power-control applications is discussed.

AN-4745 ....6 pages
Analysis and Design of Snubber Networks for dv/dt Suppression in Thyristor Circuits
When a triac is used to control an inductive load, voltages with high rates of change (dv/dt) can be generated that can cause a non-gated turn-on of the triac. The result is a loss of control of power to the load. The simplest method of suppressing this dv/dt stress is to place a series RC network across the main terminals of the triac. The design of this network, commonly called a snubber network, must take into account the peak voltage that can be allowed in the circuit and the maximum dv/dt stress that the device can withstand. This Note analyzes the RC network design and contains graphs that allow a designer to select a snubber to fit a given application.

AN-6054 ....6 pages
Triac Power Controls for Three-Phase Systems
The growing demand for solid-state switching of ac power in heating controls and other industrial applications has resulted in the increasing use of triac circuits in the control of three-phase power. This Note explains a basic approach to the design of triac control circuits for use in the switching of three-phase power. The basic design rules employed in this approach are outlined, an integrated-circuit zero-voltage switch specifically intended for use in triac triggering is briefly described, and the necessity for, and methods of isolation of, the dc logic circuitry in power controls for three-phase systems are pointed out. Recommended configurations are then shown for power-control circuits intended for use with both inductive and resistive balanced three-phase loads, and the specific design requirements for each type of loading condition are discussed.

AN-6096 ....8 pages
Solid-State Approaches to Cooking-Range Control
As a result of decreasing semiconductor costs, advanced system-cost analysis by appliance manufacturers, and increased consumer consciousness, various solid-state range-control designs can be applied in today's appliance market. This Note presents various solid-state design approaches available to the range-control designer.

AN-6141 ....6 pages
Power Switching Using Solid-State Relays
Solid-state relays make use of a semiconductor device for control of ac or dc power. Since, in most ac applications, the semiconductor element chosen for power control is the triac, this Note describes the triac as a power-switching element. Advantages and disadvantages of the active element over the electromechanical relay are discussed in general terms. Basic parameters, such as surge in-rush capability, transient-voltage ratings, suppression network, turn-off consideration and the different modes of triac gating are also discussed. AC power control is covered by various circuit designs for ON/OFF control, zero-voltage switching, and line-voltage isolation.

ICAN-6182 ....28 pages
Features and Applications of RCA Integrated-Circuit Zero - Voltage Switches (CA3058, CA3059 and CA3079)
RCA-CA3058, CA3059 and CA3079 zero-voltage switches are monolithic integrated circuits designed primarily for use as trigger circuits for thyristors in ac power-control and power-switching applications.

These integrated-circuit switches operate from ac input voltages of 24, 120, 208 to 230, or 277 volts at 50, 60, or 400 Hz. Zero-voltage switches trigger the thyristors at zero-voltage points in the supply-voltage cycle. Consequently, transient load-current surges and radio-frequency interference are substantially reduced. Zero-voltage switches also reduce the rate of change of on-state current (di/dt) in the thyristor being triggered and can be adapted for use in a variety of control functions by use of an internal differential comparator to detect the difference between two externally developed voltages.

AN-6286 ....8 pages
Latching, Gate-Trigger Circuits Using Thyristors for Machine Control Applications
This Note describes a variety of approaches to the development of a solid-state, latching gate drive for the control of ac loads; the solid-state device used is the thyristor. The solid-state circuits described have fewer undesirable characteristics than electro-mechanical devices and are smaller and lighter.

AN-6288 ....2 pages
Thyristors in Capacitive Discharge (CD) Ignition Systems
This Note describes the requirements of small-engine ignition systems (those deriving electrical energy from a flywheel alternator system), automotive or battery-powered systems, and the ac line-operated igniters. The merits of both capacitive and inductive systems are compared. Both systems are described in terms of performance and limitations. Practical circuits are shown.

AN-6438 ....24 pages
Surge Capability of SCR's, Triacs, and Rectifiers
This Note provides the designer with an easy way to derive, from the published sinusoidal capability of any semiconductor, its triangular surge capability for stress durations between 0.5 and 20 milliseconds, and thereby helps him select the most suitable fuse to protect the semiconductor of interest.

AN-6452 16
A New Practical Fuse-Thyristor Coordin Method
This Note describes the possibilities of protect semiconductor by fusing—when and how a fus be used and how much protection is afforded. C for which fuse protection is not possible, or for w only partial protection is feasible are also discu Fuse selection methods are described.

AN-6687 ....6 p
Latching Voltage and Current in Thyristors
Triacs are normally used for the switching o load current in on-off applications and for pl control of power to a load. Their design pen gating signals of positive or negative polarity w respect to main terminal one to initiate turn-o load currents of either polarity. However, the g triggering sensitivity and turn-on requirements each of the four modes are normally not equal, a there may be preferred modes of operation
The purpose of this Note is to describe the sensi ity levels of each mode relative to turn on, and relate preferred modes of operation of RCA triacs circuit applications.

AN-6689 ....12 pa
Circuit-Commutated Turn-Off Time Thyristors
Thyristor turn-off is one of the most difficult sen conductor parameters to determine because of strong dependency on many variables, such as jun tion temperature, gate bias, and anode-voltage a anode-current waveforms. Because of this stro dependency, it makes no sense to specify the turn-o time of a thyristor without specifying precisely th conditions under which that time was determine But it is impossible to choose a set of conditions th will match the interests of all present or potenti purchasers of the device. Therefore, the need for new concept for measuring the circuit commutate turn-off time of thyristors.
The turn-off-time measurement method describe in this Note is very different from the conventional complex turn-off-time specification mentioned above it is a very basic method intended to measure th turn-off time as a simple parameter under conditions that are not critical for measurement precision and that can be easily reproduced by any thyristor user Data are provided to assure correct interpretation o the new measurement, inherent turn-off-time, T_{Qi}

AN-6936 ....8 pages
Triac Gate Characteristics and Drive Considerations
This Note provides information concerning more reliable pulsed triggering of RCA triacs. It describes triac gate triggering and employs equivalent circuits to illustrate the gate trigger process. Gate characteristics of the triac are discussed and the critical turn-on period is defined. Data is presented showing the time dependence of gate drive, the relationship between gate sensitivity and main-terminal voltage, and the dependence of latching current on gate drive current Finally, recommendations are given for safe, reliable pulse firing.

Operating Considerations for RCA Solid-State Devices

This Note summarizes important operating recommendations and precautions which should be followed in the interest of maintaining the high standards of performance of solid-state devices.

The ratings included in RCA Solid-State Devices data bulletins are based on the Absolute-Maximum Rating System, which is defined by the following Industry Standard (JEDEC) statement:

> Absolute-Maximum Ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

It is recommended that equipment manufacturers consult RCA whenever device applications involve unusual electrical, mechanical or environmental operating conditions.

GENERAL CONSIDERATIONS

The design flexibility provided by these devices makes possible their use in a broad range of applications and under many different operating conditions. When incorporating these devices in equipment, therefore, designers should anticipate the rare possibility of device failure and make certain that no safety hazard would result from such an occurrence.

The small size of most solid-state products provides obvious advantages to the designers of electronic equipment. However, it should be recognized that these compact devices usually provide only relatively small insulation area between adjacent leads and the device package. When these devices are used in moist or contaminated atmospheres, therefore, supplemental protection must be provided to prevent the development of electrical conductive paths across the relatively small insulating surfaces. For specific information on voltage creepage, the user should consult references such as the JEDEC Standard No. 7 "Suggested Standard on Thyristors," and JEDEC Standard RS282 "Standards for Silicon Rectifier Diodes and Stacks".

The metal shells of some solid-state devices operate at the collector voltage and for some rectifiers and thyristors at the anode voltage. Similarly, the TO-5-style package often used for integrated circuits usually has the substrate or most negative supply voltage connected to the case. Therefore, consideration should be given to the possibility of shock hazard if the shells are to operate at voltages appreciably above or below ground potential. In general, in any application in which devices are operated at voltages which may be dangerous to personnel, suitable precautionary measures should be taken to prevent direct contact with these devices.

Devices should not be connected into or disconnected from circuits with the power on because high transient voltages may cause permanent damage to the devices.

TESTING PRECAUTIONS

In common with many electronic components, solid-state devices should be operated and tested in circuits which have reasonable values of current limiting resistance, or other forms of effective current overload protection. Failure to observe these precautions can cause excessive internal heating of the device and result in destruction and/or possible shattering of the enclosure.

TRANSISTORS AND THYRISTORS WITH MOUNTING FLANGES

The mounting flanges of JEDEC-type packages such as the TO-3 or TO-66 often serve as the collector or anode terminal. In such cases, for the electrical connection, but more importantly for conduction of the heat generated, it is essential that the mounting flange be securely fastened to the heat sink, which may be the equipment chassis. Soldering is the preferred method for mounting. The package may be soldered to the heat sink by use of lead-tin solder, however a solder with a lower melting point than the 95/5 lead/tin solder used for assembly should be used. The soldering process should be carefully controlled to prevent permanent damage to the device. Devices which cannot be soldered can be installed in commercially available sockets. Electrical connections may also be made by soldering directly to the terminal pins. Such connections may be soldered to the pins close to the pin seals provided care is taken to conduct excessive heat away from the seals; otherwise the heat of the soldering operation could crack the pin seals and damage the device.

During operation, the mounting-flange temperature is higher than the ambient temperature by an amount which depends on the heat sink used. The heat sink must have sufficient thermal capacity to assure that the heat dissipated in the heat sink itself does not raise the device mounting-flange temperature above the rated value. The heat sink or chassis may be connected to either the positive or negative supply.

In many applications the chassis is connected to the voltage-supply terminal. If the recommended mounting hardware shown in the data bulletin for the specific solid-state device is not available, it is necessary to use either an anodized aluminum insulator having high thermal conductivity or a mica insulator between the mounting-flange and the chassis. If an insulating aluminum washer is required, it should be drilled or punched to provide the two mounting holes for the terminal pins. The burrs should then be removed from the washer and the washer anodized. To insure that the anodized insulating layer is not destroyed during mounting, it is necessary to remove the burrs from the holes in the chassis.

It is also important that an insulating bushing, such as glass-filled nylon, be used between each mounting bolt and the chassis to prevent a short circuit. However, the insulating bushing should not exhibit shrinkage or softening under the operating temperatures encountered. Otherwise the thermal resistance at the interface between device and heat sink may increase as a result of decreasing pressure.

PLASTIC POWER TRANSISTORS AND THYRISTORS

RCA power transistors and thyristors (SCRs and triacs) in molded-epoxy-plastic packages are available in a wide range of power-dissipation ratings and a variety of package configurations. The following paragraphs provide guidelines for handling and mounting of these plastic-package devices, recommend forming of leads to meet specific mounting requirements, and describe various mounting arrangements, thermal considerations, and cleaning methods. This information is intended to augment the data on electrical characteristics, safe operating area, and performance capabilities in the technical bulletin for each type of plastic-package transistor or thyristor.

Lead-Forming Techniques

The leads of the RCA VERSAWATT and VERSATAB in-line plastic packages can be formed to a custom shape, provided they are not indiscriminately twisted or bent. Although these leads can be formed, they are not flexible in the general sense, nor are they sufficiently rigid for unrestrained wire wrapping.

Before an attempt is made to form the leads of an in-line package to meet the requirements of a specific application, the desired lead configuration should be determined, and a lead-bending fixture should be designed and constructed. When the use of a properly designed fixture is not practical, a pair of long-nosed pliers may be used. The pliers should hold the lead firmly between the bending point and the case, but should not touch the case.

When the leads of an in-line plastic package are to be formed, whether by use of long-nosed pliers or a special bending fixture, the following precautions must be observed to avoid internal damage to the device:

1. Restrain the lead between the bending point and the plastic case to prevent relative movement between the lead and the case.
2. When the bend is made in the plane of the lead (spreading), bend only the narrow part of the lead.
3. When the bend is made in the plane perpendicular to that of the leads, make the bend at least ⅛ inch from the plastic case.
4. Do not use a lead-bend radius of less than 1/16 inch.
5. Avoid repeated bending of leads.

The leads of the TO-220AB VERSAWATT and TO-202 VERSATAB in-line packages are not designed to withstand excessive axial pull. Force in this direction greater than 4 pounds may result in permanent damage to the device. If the mounting arrangement tends to impose axial stress on the leads, some method of strain relief should be devised.

Wire wrapping of the leads is permissible, provided that the lead is restrained between the plastic case and the point of the wrapping. Soldering to the leads is also allowed. The maximum soldering temperature, however, must not exceed 235° C. The soldering instrument must be at least 1/8 inch from the device and must not be applied for more than 10 seconds. When wires are used for connections, care should be exercised to assure that movement of the wire does not cause movement of the lead at the lead-to-plastic junctions.

The leads of RCA molded-plastic packages are not designed to be reshaped. However, simple bending of the leads is permitted to change them from a standard vertical to a standard horizontal configuration, or conversely. Bending of the leads in this manner is restricted to three 90-degree bends; repeated bendings should be avoided.

Mounting

TO-220. Recommended mounting arrangements and suggested hardware for the VERSAWATT package are given in the data bulletins for specific devices and in RCA Application Note AN-4124. When the package is fastened to a heat sink, a rectangular washer (RCA Part No. NR231A) is recommended to minimize distortion of the mounting flange. Excessive distortion of the flange could cause damage to the package. The washer is particularly important when the size of the mounting hole exceeds 0.140 inch (6-32 clearance). Larger holes are needed to accommodate insulating bushings; however, the holes should not be larger than necessary to provide hardware clearance and, in any case, should not exceed a diameter of 0.250 inch.

Flange distortion is also possible if excessive torque is used during mounting. A maximum torque of 8 inch-pounds is specified. Care should be exercised to assure that the tool used to drive the mounting screw never comes in contact with the plastic body during the driving operation. Such contact can result in damage to the plastic body and internal device connections. An excellent method of avoiding this problem is to use a spacer or combination spacer-isolating bushing which raises the screw head or nut above the top surface of the plastic body. The material used for such a spacer or spacer-isolating bushing should, of course, be carefully selected to avoid "cold flow" and consequent reduction in mounting force. Suggested materials for these bushings are diallphthalate, fiberglass-filled nylon, or fiberglass-filled polycarbonate. Unfilled nylon should be avoided. Damage to the device can also result from the use of a non-flat mounting surface. This surface should be flat within 0.002 inch from the mounting hole to either side of the TO-220 device.

Modification of the flange can also result in flange distortion and should not be attempted. The package may be soldered to the heat sink by use of lead-tin solder, however this solder should have a lower melting point than the 95/5 lead/tin solder used for assembly. The soldering process should be carefully controlled to prevent permanent damage to the device.

The TO-220AA plastic package can be mounted in commercially available TO-66 sockets, such as UID Electronics Corp. Socket No. PTD-4 or equivalent. For testing purposes, the TO-220AB in-line package can be mounted in a Jetron Socket No. DC74-104 or equivalent. Regardless of the mounting method, the following precautions should be taken:

1. Use appropriate hardware.

2. Always fasten the package to the heat sink before the leads are soldered to fixed terminals.
3. Never allow the mounting tool to come in contact with the plastic case.
4. Never exceed a torque of 8 inch-pounds.
5. Avoid oversize mounting holes.
6. Provide strain relief if there is any probability that axial stress will be applied to the leads.
7. Use insulating bushings to prevent hot-creep problems. Such bushings should be made of diallphthalate, fiber-glass-filled nylon, or fiberglass-filled polycarbonate.

TO-3. The high power-handling capability of the TO-3 package requires the use of very large silicon die. Large die are susceptible to damage when the TO-3 package is fastened to a non-flat surface, or when unequal torque is applied during mounting.

When mounting a TO-3 device, the following precautions must be observed to avoid internal damage to the device:

1. The mounting surface should be flat within 0.007 inch.
2. **Both** mounting screws should be tightened lightly to 2 inch-pounds **first**, and then to no more than 12 inch-pounds.
3. The use of impact wrenches is not recommended.
4. Care should be exercised with thermal greases to avoid an increase in viscosity and the formation of lumps as a result of excessive exposure to air prior to application. These conditions will place additional stress on the device during mounting.

Thermal Considerations

The maximum allowable power dissipation in a solid-state device is limited by the junction temperature. An important factor in assuring that the junction temperature remains below the specified maximum value is the ability of the associated thermal circuit to conduct heat away from the device.

When a solid-state device is operated in free air, without a heat sink, the steady-state thermal circuit is defined by the junction-to-free-air thermal resistance given in the published data for the device. Thermal considerations require that a free flow of air around the device is always present and that the power dissipation be maintained below the level which would cause the junction temperature to rise above the maximum rating. However, when the device is mounted on a heat sink, care must be taken to assure that all portions of the thermal circuit are considered.

To assure efficient heat transfer from case to heat sink when mounting RCA molded-plastic solid-state power devices, the following special precautions should be observed:

1. Mounting torque should be between 4 and 8 inch-pounds.
2. The mounting holes should be kept as small as possible.
3. Holes should be drilled or punched clean with no burrs or ridges, and chamfered to a maximum radius of 0.010 inch.
4. The mounting surface should be flat within 0.002 inch/inch.
5. Thermal grease (Dow Corning 340 or equivalent) should always be used on both sides of the insulating washer if one is employed.
   Note: Silicone-oil fluids that come into direct physical contact with silicone-molded transistors may react chemically with and cause damage to the packages. These silicone oils are commonly formulated into thermal-grease heat-transfer compounds. Selection of these greases is therefore critical and based on the bleed rate of the oil from the grease. For example, in mounting arrangements that employ an insulating washer, a thermal-grease heat-sink compound, such as Dow Corning No. 340 or equivalent, for which the bleed rate does not exceed 0.5 per cent after 24 hours of 200° C is recommended for use on both sides of the insulating washer.
6. Thin insulating washers should be used. (Thickness of factory-supplied mica washers ranges from 2 to 4 mils).
7. A lock washer or torque washer, made of material having sufficient creep strength, should be used to prevent degradation of heat sink efficiency during life.

Cleaning After Mounting

A wide variety of chemicals and solvents is available for fluxing, degreasing, and flux removal. Care must be exercised in the selection of materials, such that from a reliability standpoint, there is no adverse effect on component life. A major contributor, effecting device reliability, is the chemical reaction of chloride with the aluminum metallization of the die. Eventually this etching process will result in electrical open circuits. The mechanism is defined as Electrolytic Metal Attack (EMA) and is accelerated in a moisture environment. Cleaning and fluxing compounds free of chloride will therefore maximize device life. Chloride is defined as the dissociated ion, which is soluble in water, as contrasted to the water insoluble organic chlorine of compounds such as perchloroethylene and trichloroethane. It is, of course, impractical to evaluate the long-term effect on semiconductor life of all chemicals which are marketed under a variety of brand names.

The choice of fluxes for electronic applications should be restricted to rosin types, R, RMA and RA and water soluble organic acid, OA, formulations. Inorganic acid fluxes should not be used as they can attack the internal metallization of the semiconductor. As stated above, it is further recommended, where applicable, that non-halide type fluxes be used for improved device reliability. Some examples of acceptable fluxes are:

A. Rosin Types (RA)
   Alpha 711
   Alpha 809 foam flux
   Alpha 811 foam flux
   Alpha 815 foam flux
   Alpha TL33M halide free
B. Water soluble organic acid (OA) types, halide free
   Blackstone 1452
   Kenco 183
   Alpha 260HF and 265HF

Since circuit boards can fall into several categories, such as single sided, double sided with plated-through holes and densely populated multilayer types, it must be stressed that the manufacturer's recommendation be considered when choosing the proper flux for the process being used.

Flux cleaning and/or degreasing is necessary to assure that the final soldered assembly is free of contaminating soils. The choice of the cleaning system is relative to the soil being removed. Water-based cleaners are generally used to remove polar soils, such as rosin activators, organic acid residues, and finger salts. Solvent cleaners are chosen for removal of organic (non-polar) contaminants, which include rosins, oils, and greases. Cleaning methods can incorporate immersion (with or without ultrasonics), brushing, and spraying. The choice of cleaner should be based on affinity for the contaminant, ability to thoroughly wet the parts, and compatibility with components. It should also be safe to use. use.

Solvent cleaners are generally divided into two classes: chlorinated and fluorinated. These can be used for cleaning rosin-activated (RA) fluxes. The chlorinated solvents are more aggressive and care must be taken to assure there is no damage to components or substrate. This type solvent should not be used with silicone-encapsulated transistors as the solvent will tend to dissolve the plastic. The use of chlorinated solvents must be closely monitored because of a breakdown to form acid components in the presence of moisture. The solvent should be checked regularly and discarded when acid levels exceed manufacturer's guidelines. Fluorinated solvents are normally blends of trifluorotrichloroethane with other solvents, such as: methanol, ethanol, isopropanol, acetone, methylene chloride, or chloroform. These solvents can be purchased under trade names as Freon TE, TE35, TP35, Frigen 113 TR-M, Haltron 113 MOM, and Flugene 113 MA. Fluorinated systems are milder acting and are used in vapor degreasing systems at the boiling point of the solvent mixture.

The solvents may be used for a maximum of 4 hours at 25° C or for a maximum of 1 hour at 50° C.

Rosin fluxes can be removed by either solvent or aqueous cleaners. The water systems contain an additive that reacts with the rosin acids to convert the acids to a water-soluble biodegradable soap. Water-soluble organic-acid fluxes may require the use of a neutralizer to accelerate the solubility of the acid residues and neutralize any residues that may remain. Alcohols are acceptable solvents for rosin-based flux removal; but because of flammability concerns, the fluorinated alcohol blends are preferred. Examples of suitable alcohols are methanol, isopropanol, and special denatured ethyl alcohols, such as SDA1, SDA30, SDA34, and SDA44.

If the completed assembly is to be encapsulated, the effect on the molded-plastic transistor must be studied from both a chemical and physical standpoint.

RECTIFIERS AND THYRISTORS

A surge-limiting impedance should always be used in series with silicon rectifiers and thyristors. The impedance value must be sufficient to limit the surge current to the value specified under the maximum ratings. This impedance may be provided by the power transformer winding, or by an external resistor or choke.

A very efficient method for mounting thyristors utilizing the TO-205AF package is to provide intimate contact between the heat sink and at least one half of the base of the device opposite the leads. This package can be mounted to the heat sink mechanically with glue or an epoxy adhesive, or by soldering, the most efficient method.

The use of a "self-jigging" arrangement and a solder preform is recommended. If each unit is soldered individually, the heat source should be held on the heat sink and the solder on the unit. Heat should be applied only long enough to permit solder to flow freely. For more detailed thyristor mounting considerations, refer to Application Note AN-3822, "Thermal Considerations in Mounting of RCA Thyristors".

MOS FIELD-EFFECT TRANSISTORS

Small-Signal and Power MOSFETs

Insulated-Gate Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs), like bipolar high-frequency transistors, are susceptible to gate insulation damage by the electrostatic discharge of energy through the devices. Electrostatic discharges can occur in a MOSFET if a type with an unprotected gate is picked up and the static charge on the handler's body allowed to discharge through the device. With proper handling and applications procedures, however, MOS transistors are currently being extensively used in production by numerous equipment manufacturers in military, industrial, and consumer applications, with virtually no problems of damage due to electrostatic discharge.

In some MOSFETs, diodes are electrically connected between each insulated gate and the transistor's source. These diodes offer protection against static discharge and in-circuit transients without the need for external shorting mechanisms. MOSFETs which do not include gate-protection diodes can be handled safely if the following basic precautions are taken:

1. Prior to assembly into a circuit, all leads should be kept shorted together either by the use of metal shorting springs attached to the device by the vendor, or by the insertion into conductive material such as "ECCOSORB• LD26" or equivalent.
   (NOTE: Polystyrene *insulating* "SNOW" is not sufficiently conductive and should not be used.)
2. When devices are removed by hand from their carriers, the hand being used should be grounded by any suitable means, for example, with a metallic wristband.
3. Tips of soldering irons should be grounded.
4. Devices should never be inserted into or removed from circuits with power on.

Power MOSFETs

In addition to the above basic precautions, the following precautions should be taken for safe handling of Power MOSFETs:

1. Gate Voltage Rating — Never exceed the gate-voltage rating of ±20 V.* Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.
2. Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.
3. Gate Protection — These devices do not have an internal monolithic zener diodes connected from gate to source. If gate protection is required an external zener is recommended.

INTEGRATED CIRCUITS

Mounting

Integrated circuits are normally supplied with tin-lead dipped leads to facilitate soldering into circuit boards.

When integrated circuits are welded onto printed-circuit boards or equipment, the presence of moisture between the closely spaced terminals can result in conductive paths that may impair device performance in high-impedance applications. It is therefore recommended that conformal coatings or potting be provided as an added measure of protection against moisture penetration.

In any method of mounting integrated circuits which involves bending or forming of the device leads, it is extremely important that the lead be supported and clamped between the bend and the package seal, and that bending be done with care to avoid damage to lead plating. In no case should the radius of the bend be less than the diameter of the lead, or in the case of rectangular leads, such as those used in RCA 14-lead and 16-lead flat-packages, less than the lead thickness. When solder-dipped leads are formed, they must be reflowed or redipped within 40 mils of the package body. It is also extremely important that the ends of the bent leads be straight to assure proper insertion through the holes in the printed-circuit board.

•Trade Name: Emerson and Cumming, Inc.
*±10 V for logic-level MOSFETs.

CMOS INTEGRATED CIRCUITS

Handling

All CMOS gate inputs have a diode or resistor/diode gate protection network. All transmission gate inputs and all outputs have diode protection provided by inherent p-n junction diodes. These diode networks at input and output interfaces protect CMOS devices from gate-oxide failure in handling environments where static discharge is not excessive. In low-temperature, low-humidity environments, improper handling may result in device damage. It is recommended that ionizers be used in the handling and assembly areas to minimize damage from electrostatic discharge (ESD). See ICAN-6525, "Handling and Operating Considerations for MOS Integrated Circuits", for proper handling procedures.

Operating

Unused Inputs

All unused input leads must be connected to either the low rail (V_{SS}, V_{EE}, or GND) or the high rail (V_{CC} or V_{DD}), whichever is appropriate for the logic circuit involved. A floating input on a high-current type such as the CD4049 or CD4050, operating at a supply voltage above 5 V, not only can result in faulty logic operation, but can cause the maximum-rated power dissipation to be exceeded and may result in damage to the device. Inputs to these types, which are mounted on printed-circuit boards that may temporarily become unterminated, should have a pull-up resistor to the high or low voltage supply rails. A useful range of values for such resistors is from 10 kilohms to 1 megohm. Pins that are I/O must have a terminating resistor.

Input Signals

Signals shall not be applied to the inputs while the device power supply is off unless the input current is limited to a steady-state value of less than the absolute-maximum rating. This value is either 10 mA or 20 mA depending on device family. Input currents of less than the maximum rating prevent device damage; however, proper operation may be impaired as a result of current flow through structural diode junctions.

Output Short Circuits

Shorting of outputs to the high or low supply rail can damage many of the higher-output-current CMOS types, such as the CD4007, CD4041, CD4049, and CD4050. In general, these types can all be safely shorted for supplies up to 5 volts, but will be damaged (depending on type) at higher power-supply voltages. For the QMOS HC/HCT/HCU types, outputs may be shorted to V_{CC} (5 V $\pm$ 10%) for 1 second maximum and only one output at a time. For cases in which a short-circuit load, such as the base of a p-n-p or an n-p-n bipolar transistor, is directly driven, the device output characteristics given in the published data should be consulted to determine the requirements for a safe operation below the device maximum-rated output power.

For detailed CMOS IC operating and handling considerations, refer to Application Note ICAN-6525 "Handling and Operating Considerations for MOS Integrated Circuits".

CMOS Power-Supply Distribution and Decoupling

Power distribution should be a prime consideration in all CMOS designs. Although DC power dissipation is very low, dynamic power (due to switching transients) can be high. High-voltage and/or low-temperature operation increase dynamic current transients.

A low-impedance power source and supply-to-ground capacitance bypass placed near each device will significantly reduce noise generation on signal and power lines; system reliability is greatly changed.

Decoupling

Higher speeds, faster edges and higher output-drive currents cause higher-frequency current transients to be imposed on ground and V_{CC} rails of an IC. For LSI, HC, and HCT families, consideration of power-supply distribution and decoupling become important. Before decoupling can be utilized for noise reduction, there must first be a good power-supply distribution network. A good ground connection system and capacitive decoupling must be employed. For details refer to Application Note ICAN-7329, "Power-Supply Distribution and Decoupling for QMOS High-Speed-Logic ICs".

LINEAR INTEGRATED CIRCUITS

BIMOS, BIPOLAR AND CMOS

In linear integrated circuits that employ diode-isolation techniques, there are numerous parasitic devices associated with the primary circuit components. These devices may be activated or turned on by driving inputs and/or outputs beyond the supply-voltage range of the integrated circuit. For example, externally driving the collector terminal of a transistor array below the isolation or substrate potential will forward bias the parasitic isolation diode shown in Fig. 1. Since the collector region and substrate form a comparatively large-area diode, high currents will be sustained, often at levels sufficiently high to melt the metallization to these devices.

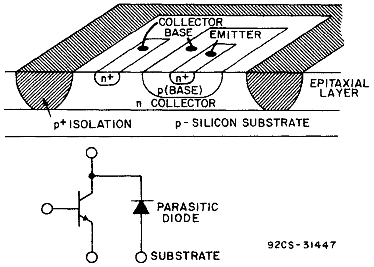


Fig. 1 - Sectional view of conventional "vertical" n-p-n transistor commonly used on IC chip. Also shown is the equivalent circuit and associated parasitic diode.

Operational amplifiers like the 741, and other similar structures, can be damaged by driving a positive-going signal into the input device with power off. The signal will forward bias the collector-to-base junction of the input transistor and, if the positive supply impedance is low enough, drive current back into the supply. Current above the maximum rating may result in damage to the amplifier.

Supply transients are another possible source of damage. They can activate or trigger parasitic SCR devices which can cause an integrated circuit to draw extremely high current. If the supply impedance is sufficiently high, the SCR gate drive in the latched condition is removed by the limiting action of the supply. If the supply impedance is too low, the device will continue to demand high currents until the metallization of either the device or the printed-circuit board fuses open.

1CE-402

Although device manufacturers take precautions to keep the number of these parasitic devices at a minimum, normal device process variations occasionally make the formation of parasitic devices inevitable. It is essential, therefore, that the user take precautions to insure that an integrated circuit is never operated beyond its maximum ratings, even under momentary transient conditions.

SOLID-STATE CHIPS

Solid-state chips, unlike packaged devices, are non-hermetic devices, normally fragile and small in physical size, and therefore, require special-handling considerations as follows:

1. Chips must be stored under proper conditions to insure that they are not subjected to a moist and/or contaminated atmosphere that could alter their electrical, physical, or mechanical characteristics. After the shipping container is opened, the chip must be stored under the following conditions:
   A. Storage temperature, 40° C
   B. Relative humidity, 50% max.
   C. Clean, dust-free environment
2. The user must exercise proper care when handling chips to prevent even the slightest physical damage to the chip.
3. MOS chips that are ESD-sensitive should be handled in an environment where ionizers are employed.
4. During mounting and lead bonding of chips, the user must use proper assembly techniques to obtain proper electrical, thermal, and mechanical performance.
5. After the chip has been mounted and bonded, any necessary procedure must be followed by the user to insure that these non-hermetic chips are not subjected to moist or contaminated atmospheres which might cause the development of electrical conductive paths across the relatively small insulating surfaces. In addition, proper consideration must be given to the protection of these devices from other harmful environments which could conceivably adversely affect their proper performance.

RCA Sales Offices, Authorized Distributors and Manufacturers' Representatives

Sales Offices

UNITED STATES

Alabama
RCA
Park Plaza
303 Williams Avenue
Suite 133
Huntsville, AL 35801-6001
Tel: (205) 533-5200
TACNET: 8-721-1110

Arizona
RCA
6900 E. Camelback Road
Suite 460
Scottsdale, AZ 85251-2441
Tel: (602) 947-7235

California
RCA
3150 De La Cruz Blvd.
Bldg. D, Suite 206
Santa Clara, CA95054-2486
Tel: (408) 748-0933
TACNET: 8-528-1605

RCA
Suite 420
4827 No. Sepulveda Blvd.
Sherman Oaks, CA 91403-1993
Tel: (818) 783-3955
TACNET: 8-522-4200

RCA
17731 Irvine Blvd., Suite 104
Magnolia Plaza Bldg.
Tustin, CA 92680-3235
Tel: (714) 832-5302
TACNET: 8-542-1120

Colorado
RCA Corp.
6767 So. Spruce Street
Englewood, CO 80112-1284
Tel: (303) 740-8441

Florida
RCA
P.O. Box 12247
Lake Park, FL 33403-0247
Tel: (305) 626-6350
TACNET: 8-722-1291

Georgia
RCA
Suite 304
2872 Woodcock Blvd.
Atlanta, GA 30341-4002
Tel: (404) 452-2355
TACNET: 8-727-2344

Illinois
RCA
One Pierce Place
Suite 325, West Tower
Itasca, IL 60143-2681
Tel: (312) 250-0070
TACNET: 8-439-6160

Indiana
RCA
Mark I - Suite 660
11611 N. Meridian Street
Carmel, IN 46032-9487
Tel: (317) 267-6375
TACNET: 8-422-6375

Kansas
RCA
Suite 208
8575 West 110th Street
Overland Park, KS 66210-2620
Tel: (913) 345-2224
TACNET: 8-422-6371

Massachusetts
RCA
Suite 101
One Newton Exec. Park
Newton, MA 02162-1435
Tel: (617) 969-0141
TACNET: 8-341-1210

Michigan
RCA
30400 Telegraph Road
Birmingham, MI 48010-3095
Tel: (313) 644-1151
TACNET: 8-438-1281

Minnesota
RCA
3600 West 80th Street
Suite 515
Minneapolis, MN 55431-1070
Tel: (612) 835-2004

New Jersey
RCA
485B Route 1, South
Iselin, NJ 08830-3013
Tel: (201) 750-9000
TACNET: 8-325-6090

RCA
700 E. Gate Drive
Mt. Laurel, NJ 08054
Tel: (609) 338-5042
TACNET: 8-222-4473

New York
RCA
160 Perinton Hill Office Park
Fairport, NY 14450-3665
Tel: (716) 223-5240

North Carolina
RCA
2000 Regency Parkway
Suite 150
Cary, NC 27511-8506
Tel: (919) 481-4221

Ohio
RCA
3700 Corporate Drive
Suite 101
Columbus, OH 43229-1739
Tel: (614) 899-9009
TACNET: 8-448-1210

Texas
RCA
Waterloo Executive Suites
12710 Research Blvd., Suite 240
Austin, TX 78759
Tel: (512) 335-1602

RCA
17000 Dallas Parkway
Suite 100
Dallas, TX 75248-1921
Tel: (214) 733-0800
TACNET: 8-639-1260

Virginia
RCA
1901 N. Moore Street
Arlington, VA 22209-1766
Tel: (703) 558-4161
TACNET: 8-232-4162

CANADA

Ontario
RCA Inc.
411 Roosevelt Avenue
Suite 203A
Ottawa, Ontario K2A 3X9
Tel: (613) 728-0031

ASIA PACIFIC

Hong Kong
RCA International, Ltd.
13th Floor, Fourseas Bldg.
208-212 Nathan Road
Tsimshatsui, Kowloon
Tel: 3-7236339

Singapore
RCA International, Ltd.
24-15 International Plaza
10 Anson Road
Singapore 0207
Tel: 2224156

Taiwan
RCA SSD
Room 1103, No. 600
Ming Chuan East Road
Taipei
Tel: (02) 7169310

LATIN AMERICA

Argentina
Ramiro E. Podetti Reps.
Casilla de Correo 4622
1000 Buenos Aires
Tel: (01) 393-3919

Mexico
RCA S.A. de C.V./SSD
Avenida Cuitlahuac 2519
Apartado Postal 17-570
Mexico City, D.F. 11410
Tel: (905) 396-8934

EUROPE

Belgium
RCA, s.a.
Mercure Centre
Rue de la Fusee 100
1130 Brussels
Tel: 02/720.89.80

France
RCA, s.a.
2-4, Avenue de L'Europe
78140 Velizy
Tel: 33-1-39.46.56.56

Germany
RCA GmbH
Ridlerstrasse 35A
8000 Munchen 2
West Germany
Tel: 089/5026014

RCA GmbH
Justus-von-Liebig-Ring 10
2085 Quickborn
West Germany
Tel: 04106/613-0

RCA GmbH
Zeppelinstrasse 35
7302 Ostfildern 4
West Germany
Tel: 0711/454001

Italy
RCA SpA
Viale Milanofiori L1
20089 Rozzano (MI)
Tel: (02) 8242006

Spain
RCA S.A.
Monte Esquinza 28
28010 Madrid 4
Tel: 01/442 11 00

Sweden
RCA International Ltd
P.O. Box 3047
Hagalundsgatan 8
17103 Solna 3
Tel: 08/83 42 25

U.K.
RCA Ltd
Lincoln Way, Windmill Road
Sunbury-on-Thames
Middlesex TW16 7HW
Tel: 093 27 85511

RCA Authorized Distributors

U.S. and Canada

ALABAMA

Hamilton Avnet Electronics
4940 Research Drive
Huntsville, AL 35805
Tel: (205)837-7210

ARIZONA

Hamilton Avnet Electronics
505 South Madison Drive
Tempe, AZ 85281
Tel: (602)231-5100

Kierulff Electronics, Inc.
4134 East Wood Street
Phoenix, AZ 85040
Tel: (602)243-4101

Schweber Electronics Corp.
11049 N. 23rd Drive, Suite 1100
Phoenix, AZ 85029
Tel: (602)997-4874

Sterling Electronics, Inc.
3501 E. Broadway Road
Phoenix, AZ 85040
Tel: (602)268-2121

Wyle Electronics Marketing Group
17855 N. Black Canyon Highway
Phoenix, AZ 85023
Tel: (602)249-2232

CALIFORNIA

Arrow Electronics, Inc.
19748 Dearborn Street
North Ridge Business Center
Chatsworth, CA 91311
Tel: (213)701-7500

Arrow Electronics, Inc.
1502 Crocker Avenue
Hayward, CA 94544
Tel: (415)487-4600

Arrow Electronics, Inc.
9511 Ridge Haven Court
San Diego, CA 92123
Tel: (619)741-3411

Arrow Electronics, Inc.
521 Weddell Drive
Sunnyvale, CA 94086
Tel: (408)745-6600

Arrow Electronics, Inc.
2961 Dow Avenue
Tustin, CA 92680
Tel: (714)838-5422

Avnet Electronics
20501 Plummer Street
Chatsworth, CA 91311
Tel: (818)700-2600

Avnet Electronics
350 McCormick Avenue
Costa Mesa, CA 92626
Tel: (714)754-6051

Hamilton Avnet Electronics
1361-B W. 190th Street
Gardena, CA 90248
Tel: (213)615-3900

Hamilton Avnet Electronics
3002 E.G. Street
Ontario, CA 91764
Tel: (714)989-4602

Hamilton Avnet Electronics
4103 Northgate Boulevard
Sacramento, CA 95834
Tel: (916)920-3150

Hamilton Avnet Electronics
4545 Viewridge Avenue
San Diego, CA 92123
Tel: (714)571-7510

Hamilton Avnet Electronics
1175 Bordeaux Drive
Sunnyvale, CA 94086
Tel: (408)743-3300

Hamilton Electro Sales
9650 Desoto Avenue
Chatsworth, CA 91311
Tel: (818)700-1222

Hamilton Electro Sales
3170 Pullman Street
Costa Mesa, CA 92626
Tel: (714)641-4107

Hamilton Electro Sales
10912 W. Washington Boulevard
Culver City, CA 90230
Tel: (213)558-2121

Kierulff Electronics, Inc.
10824 Hope Street
Cypress, CA 90630
Tel: (714)220-6300

Kierulff Electronics, Inc.
5650 Jillson Street
Los Angeles, CA 90040
Tel: (213)725-0325

Kierulff Electronics, Inc.
8797 Balboa Avenue
San Diego, CA 92123
Tel: (714)278-2112

Kierulff Electronics, Inc.
1180 Murphy Avenue
San Jose, CA 95131
Tel: (408)971-2600

Kierulff Electronics, Inc.
14101 Franklin Avenue
Tustin, CA 92680
Tel: (714)731-5711

Schweber Electronics Corp.
21139 Victory Boulevard
Canoga Park, CA 91303
Tel: (818)999-4702

Schweber Electronics Corp.
17822 Gillette Avenue
Irvine, CA 92714
Tel: (714)863-0200

Schweber Electronics Corp.
6730 Nancyridge Drive
San Diego, CA 92121
Tel: (619)450-0454

Schweber Electronics Corp.
90 East Tasman Drive
San Jose, CA 95134
Tel: (408)946-7171

Wyle Electronics Marketing Group
26677 Agoura Road
Calabasas, CA 91302
Tel: (818)880-9001

Wyle Electronics Marketing Group
124 Maryland Avenue
El Segundo, CA 90245
Tel: (213)322-8100

Wyle Electronics Marketing Group
17872 Cowan Avenue
Irvine, CA 92714
Tel: (714)863-9953

Wyle Electronics Marketing Group
1151 Sun Center Drive
Rancho Cordova, CA 95670
Tel: (916)638-5282

Wyle Electronics Marketing Group
9525 Chesapeake Drive
San Diego, CA 92123
Tel: (714)565-9171

Wyle Electronics Marketing Group
3000 Bowers Avenue
Santa Clara, CA 95052
Tel: (408)727-2500

COLORADO

Arrow Electronics Inc.
1390 So. Potomac Street
Suite 136
Aurora, CO 80012
Tel: (303)696-1111

Hamilton Avnet Electronics
8765 E. Orchard Road
Suite 708, Englewood, CO 80111
Tel: (303)740-1000

Kierulff Electronics, Inc.
7060 So. Tucson Way
Englewood, CO 80112
Tel: (303)790-4444

Schweber Electronics Corp.
8955 E. Nichols Avenue
Englewood, CO 80112
Tel: (303)799-0258

Wyle Electronics Marketing Group
451 East 124th Avenue
Thornton, CO 80241
Tel: (303)457-9953

CONNECTICUT

Arrow Electronics, Inc.
12 Beaumont Road
Wallingford, CT 06492
Tel: (203)265-7741

Hamilton Avnet Electronics
Commerce Drive
Commerce Industrial Park
Danbury, CT 06810
Tel: (203)797-2800

Kierulff Electronics, Inc.
10 Capital Drive
Wallingford, CT 06492
Tel: (203)265-1115

Milgray Electronics, Inc.
378 Boston Post Road
Orange, CT 06477
Tel: (203)795-0711

Schweber Electronics Corp.
Finance Drive
Commerce Industrial Park
Danbury, CT 06810
Tel: (203)748-7080

FLORIDA

Arrow Electronics, Inc.
350 Fairway Drive
Deerfield, FL 33441
Tel: (305)429-8200

Arrow Electronics, Inc.
1530 Bottlebush Drive
Palm Bay, FL 32905
Tel: (305)725-1480

***Chip Supply**
7725 No. Orange Blossom Trail
Orlando, FL 32810
Tel: (305)298-7100

*Chip distributor only.

RCA Authorized Distributors

U.S. and Canada (Cont'd)

FLORIDA

Hamilton Avnet Electronics
6801 NW 15th Way
Ft. Lauderdale, FL 33309
Tel: (305)971-2900

Hamilton Avnet Electronics
3197 Tech Drive, No.
St. Petersburg, FL 33702
Tel: (813)576-3930

Hamilton Avnet Electronics
6947 University Boulevard
Winter Park, FL 32792
Tel: (305)628-3888

Kierulff Electronics, Inc.
5410 N.W. 33rd Avenue
Ft. Lauderdale, FL 33309-6316
Tel: (305)486-4004

Kierulff Electronics, Inc.
3247 Tech Drive
St. Petersburg, FL 33702
Tel: (813)576-1966

Milgray Electronics, Inc.
1850 Lee World Center
Suite 104
Winter Park, FL 32789
Tel: (305)647-5747

Schweber Electronics Corp.
2830 North 28th Terrace
Hollywood, FL 33020
Tel: (305)927-0511

GEORGIA

Arrow Electronics, Inc.
3155 Northwood Parkway
Suite A
Norcross, GA 30071
Tel: (404)449-8252

Hamilton Avnet Electronics
5825D Peachtree Corners
Norcross, GA 30092
Tel: (404)447-7503

Kierulff Electronics, Inc.
5824 Peachtree Corners East
Norcross, GA 30092
Tel: (404)447-5252

Schweber Electronics Corp.
303 Research Drive
Suite 210
Norcross, GA 30092
Tel: (404)449-9170

ILLINOIS

Arrow Electronics, Inc.
2000 Algonquis Road
Schaumburg, IL 60193
Tel: (312)397-3440

Hamilton Avnet Electronics
1130 Thorndale Avenue
Bensenville, IL 60106
Tel: (312)860-7700

Kierulff Electronics, Inc.
1140 West Thorndale
Itasca, IL 60143
Tel: (312)640-0200

Newark Electronics
4801 N. Ravenswood
Chicago, IL 60640-4496
Tel: (312)784-5100

Schweber Electronics Corp.
904 Cambridge Drive
Elk Grove Village, IL 60007
Tel: (312)364-3750

INDIANA

Arrow Electronics, Inc.
2495 Directors Row, Suite H
Indianapolis, IN 46241
Tel: (317)243-9353

Graham Electronics Supply, Inc.
133 S. Pennsylvania Street
Indianapolis, IN 46204
Tel: (317)634-8202

Hamilton Avnet Electronics, Inc.
485 Gradle Drive
Carmel, IN 46032
Tel: (317)844-9333

IOWA

Hamilton/Avnet Electronics
915 33rd Avenue, S.W.
Cedar Rapids, IA 52404
Tel: (319)362-4757

KANSAS

Hamilton Avnet Electronics
9219 Quivira Road
Overland Park, KS 66215
Tel: (913)888-8900

Milgray Electronics, Inc.
6901 W. 63rd Street
Overland Park, KS 66202
Tel: (913)236-8800

MARYLAND

Arrow Electronics, Inc.
8300 Guildford Road
Columbus, MD 21046
Tel: (301)995-0003

Hamilton Avnet Electronics
6822 Oakhill Lane
Columbia, MD 21045
Tel: (301)995-3500

Kierulff Electronics, Inc.
825D Hammons Ferry Road
Linthicum, MD 21090
Tel: (301)636-5800

Schweber Electronics Corp.
9330 Gaithers Road
Gaithersburg, MD 20877
Tel: (301)840-5900

MASSACHUSETTS

Arrow Electronics, Inc.
Arrow Drive
Woburn, MA 01801
Tel: (617)933-8130

Hamilton Avnet Electronics
10D Centennial Drive
Peabody, MA 01960
Tel: (617)531-7430

***Hybrid Components Inc.**
72 Cherry Hill Drive
Beverly, MA 01915
Tel: (617)927-5820

Kierulff Electronics, Inc.
13 Fortune Drive
Billerica, MA 01821
Tel: (617)667-8331

A. W. Mayer Co.
34 Linnell Circle
Billerica, MA 01821
Tel: (617)229-2255

Schweber Electronics Corp.
25 Wiggins Avenue
Bedford, MA 01710
Tel: (617)275-5100

***SerTech**
10B Centennial Drive
Peabody, MA 01960
Tel: (617)531-8673

Sterling Electronics, Inc.
15D Constitution Way
Woburn, MA 01801
Tel: (617)938-6200

MICHIGAN

Arrow Electronics, Inc.
755 Phoenix Drive
Ann Arbor, MI 48104
Tel: (313)971-8220

Hamilton Avnet Electronics
2215 29th Street
Grand Rapids, MI 49503
Tel: (616)243-8805

Hamilton Avnet Electronics
32487 Schoolcraft Road
Livonia, MI 48150
Tel: (313)522-4700

Schweber Electronics Corp.
12060 Hubbard Avenue
Livonia, MI 48150
Tel: (313)525-8100

MINNESOTA

Arrow Electronics, Inc.
5230 West 73rd Street
Edina, MN 55435
Tel: (612)830-1800

Hamilton Avnet Electronics
10300 Bren Road, East
Minnetonka, MN 55343
Tel: (612)932-0600

Kierulff Electronics, Inc.
7667 Cahill Road
Edina, MN 55435
Tel: (612)941-7500

Schweber Electronics Corp.
7424 W. 78th Street
Edina, MN 55435
Tel: (612)941-5280

MISSOURI

Arrow Electronics, Inc.
2380 Schultz Road
St. Louis, MO 63141
Tel: (314)567-6888

Hamilton Avnet Electronics
13743 Shoreline Court East
Earth City, MO 63045
Tel: (314)344-1200

Kierulff Electronics, Inc.
2608 Metro Park Boulevard
Maryland Heights, MO 63043
Tel: (314)739-0855

NEW HAMPSHIRE

Arrow Electronics, Inc.
One Perimeter Drive
Manchester, NH 03103
Tel: (603)668-6968

Hamilton Avnet Electronics
444 E. Industrial Park Drive
Manchester, NH 03103
Tel: (603)624-9400

*Chip distributor only.

RCA Authorized Distributors

U.S. and Canada (Cont'd)

NEW JERSEY

Arrow Electronics, Inc.
6000 Lincoln Drive East
Marlton, NJ 08053
Tel: (609)596-8000

Arrow Electronics, Inc.
Two Industrial Road
Fairfield, NJ 07006
Tel: (201)575-5300

Hamilton Avnet Electronics
Ten Industrial Road
Fairfield, NJ 07006
Tel: (201)575-3390

Hamilton Avnet Electronics
One Keystone Avenue
Cherry Hill, NJ 08003
Tel: (609)424-0110

Kieruiff Electronics, Inc.
37 Kulick Road
Fairfield, NJ 07006
Tel: (201)575-6750

Kieruiff Electronics, Inc.
520 Fellowship Road
Mt. Laurel, NJ 08054
Tel: (609)235-1444

Schweber Electronics Corp.
18 Madison Road
Fairfield, NJ 07006
Tel: (201)227-7880

NEW MEXICO

Arrow Electronics, Inc.
2460 Alamo, SE
Albuquerque, NM 87106
Tel: (505)243-4566

Hamilton Avnet Electronics
2524 Baylor S.E.
Albuquerque, NM 87106
Tel: (505)765-1500

Sterling Electronics, Inc.
3540 Pan American
Freeway, N.E.
Albuquerque, NM 87107
Tel: (505)884-1900

NEW YORK

Arrow Electronics, Inc.
20 Oser Avenue
Hauppauge, L.I., NY 11788
Tel: (516)231-1000

Arrow Electronics, Inc.
7705 Maltlage Drive
Liverpool, NY 13088
Tel: (315)652-1000

Arrow Electronics, Inc.
25 Hub Drive
Melville, L.I., NY 11747
Tel: (516)391-1300

Arrow Electronics, Inc.
3375 Brighton Henrietta Towline Rd.
Rochester, NY 14623
Tel: (716)427-0300

Hamilton Avnet Electronics
933 Motor Parkway
Hauppauge, L.I., NY 11788
Tel: (516)231-9800

Hamilton Avnet Electronics
333 Metro Park
Rochester, NY 14623
Tel: (716)475-9130

Hamilton Avnet Electronics
103 Twin Oaks Drive
Syracuse, NY 13206-1200
Tel: (315)437-2641

Milgray Electronics, Inc.
77 Schmitt Boulevard
Farmingdale, L.I., NY 11735
Tel: (516)420-9800

Schweber Electronics Corp.
Two Townline Circle
Rochester, NY 14623
Tel: (716)424-2222

Schweber Electronics Corp.
Jericho Turnpike
Westbury, L.I., NY 11590
Tel: (516)334-7474

Summit Distributors, Inc.
916 Main Street
Buffalo, NY 14202
Tel: (716)884-3450

NORTH CAROLINA

Arrow Electronics, Inc.
5240 Greensdairy Road
Raleigh, NC 27604
Tel: (919)876-3132

Hamilton Avnet Electronics
3510 Spring Forest Road
Raleigh, NC 27604
Tel: (919)878-0810

Kieruiff Electronics Inc.
One North Commerce Center
5249 North Boulevard
Raleigh, NC 27604
Tel: (919)872-8410

Schweber Electronics Corp.
5285 North Boulevard
Raleigh, NC 27604
Tel: (919)876-0000

OHIO

Arrow Electronics, Inc.
7620 McEwen Road
Centerville, OH 45459
Tel: (513)435-5563

Arrow Electronics, Inc.
6238 Cochran Road
Solon, OH 44139
Tel: (216)248-3990

Hamilton Avnet Electronics
4588 Emery Industrial Parkway
Warrensville Hts., OH 44128
Tel: (216)831-3500

Hamilton Avnet Electronics
954 Senate Drive
Dayton, OH 45459
Tel: (513)433-0610

Hamilton Avnet Electronics
777 Brooksedge Boulevard
Westerville, OH 43081
Tel: (614)882-7004

Hughes-Peters, Inc.
481 East Eleventh Avenue
Columbus, OH 43211
Tel: (614)294-5351

Kieruiff Electronics, Inc.
23060 Miles Road
Cleveland, OH 44128
Tel: (216)587-6558

Milgray Electronics, Inc.
6155 Rockside Road
Cleveland, OH 44131
Tel: (216)447-1520

Schweber Electronics Corp.
23880 Commerce Park Road
Beachwood, OH 44122
Tel: (216)464-2970

OKLAHOMA

Kieruiff Electronics, Inc.
Metro Park 12318 East 60th
Tulsa, OK 74145
Tel: (918)252-7537

Sterling Electronics, Inc.
5119 So. 10th E. Avenue
Tulsa, OK 74146
Tel: (918)663-2410

OREGON

Arrow Electronics, Inc.
10260 S.W. Nimbus Ave., Suite M-3
Portland, OR 97223
Tel: (503)684-1690

Hamilton Avnet Electronics
6024 S.W. Jean Road
Bldg. C, Suite 10
Lake Oswego, OR 97034
Tel: (503)635-8157

Wyle Electronics Marketing Group
5289 N.E. Ezram Young Parkway
Hillsboro, OR 97123
Tel: (503)640-6000

PENNSYLVANIA

Arrow Electronics, Inc.
650 Seco Road
Monroeville, PA 15146
Tel: (412)856-7000

Hamilton Avnet Electronics
2800 Liberty Avenue, Bldg. E
Pittsburgh, PA 15222
Tel: (412)281-4150

Herbach & Rademan, Inc.
401 East Erie Avenue
Philadelphia, PA 19134
Tel: (215)426-1700

Schweber Electronics Corp.
231 Gibralter Road
Horsham, PA 19044
Tel: (215)441-0600

TEXAS

Arrow Electronics, Inc.
22227 West Breaker Lane
Austin, TX 78758
Tel: (512)835-4180

Arrow Electronics, Inc.
3220 Commander Drive
Carrollton, TX 75006
Tel: (214)380-6464

Arrow Electronics, Inc.
10899 Kinghurst Dr., Suite 100
Houston, TX 77099
Tel: (713)530-4700

Hamilton Avnet Electronics
1807A W. Braker Lane, #A
Austin, TX 78758-3605
Tel: (512)837-8911

Hamilton Avnet Electronics
2111 West Walnut Hill Lane
Irving, TX 75060
Tel: (214)659-4111

RCA Authorized Distributors

U.S. and Canada (Cont'd)

TEXAS

Hamilton Avnet Electronics
4850 Wright Road, Suite 190
Stafford, TX 77477
Tel: (713)240-7898

Kierulff Electronics, Inc.
3007 Longhorn Blvd., Suite 105
Austin, TX 78758
Tel: (512)835-2090

Kierulff Electronics, Inc.
9610 Skillman Avenue
Dallas, TX 75243
Tel: (214)343-2400

Kierulff Electronics, Inc.
10415 Landsbury Drive, Suite 210
Houston, TX 77099
Tel: (713)530-7030

Schweber Electronics Corp.
4202 Beltway
Dallas, TX 75234
Tel: (214)661-5010

Schweber Electronics Corp.
10625 Richmond Ste. 100
Houston, TX 77042
Tel: (713)784-3600

Sterling Electronics, Inc.
2335A Kramer Lane, Suite A
Austin, TX 78758
Tel: (512)836-1341

Sterling Electronics, Inc.
11090 Stemmons Freeway
Stemmons at Southwell
Dallas, TX 75229
Tel: (214)243-1600

Sterling Electronics, Inc.
4201 Southwest Freeway
Houston, TX 77027
Tel: (713)627-9800

Wyle Electronics Marketing Group
1840 Greenville Avenue
Richardson, TX 75081
Tel: (214)235-9953

UTAH

Hamilton Avnet Electronics
1585 West 2100 South
Salt Lake City, UT 84119
Tel: (801)972-2800

Kierulff Electronics, Inc.
2121 S. 3600 West Street
Salt Lake City, UT 84119
Tel: (801)973-6913

Wyle Electronics Marketing Group
1959 South 4130 West Unit B
Salt Lake City, UT 84104
Tel: (801)974-9953

WASHINGTON

Arrow Electronics, Inc.
14320 N.E. 21st Street
Bellevue, WA 98005
Tel: (206)643-4800

Hamilton Avnet Electronics
14212 N.E. 21st Street
Bellevue, WA 98005
Tel: (206)453-5874

Kierulff Electronics, Inc.
19450 68th Avenue
South Kent, WA 98032
Tel: (206)575-4420

Priebe Electronics, Inc.
12908 N.E. 125th Way
Kirkland, WA 98034
Tel: (206)821-4695

Wyle Electronics Marketing Group
1750 132nd Avenue, N.E.
Bellevue, WA 98005
Tel: (206)453-8300

WISCONSIN

Arrow Electronics, Inc.
200 No. Patrick Boulevard
Brookfield, WI 53005
Tel: (414)792-0150

Hamilton Avnet Electronics
2975 South Moorland Road
New Berlin, WI 53151
Tel: (414)784-4510

Kierulff Electronics, Inc.
2238 E.W. Bluemound Road
Waukesha, WI 53186-2916
Tel: (414)784-8160

Taylor Electric Company
1000 W. Donges Bay Road
Mequon, WI 53092
Tel: (414)241-4321

Canada

ALBERTA

Hamilton/Avnet (Canada) Ltd.
2816 21st St. N.E.
Calgary, Alberta T2E 6Z2
Tel: (403)230-3586

L. A. Varah, Ltd.
6420 6A Street SE
Calgary, Alberta T2H ZB7
Tel: (403)255-9550

BRITISH COLUMBIA

L. A. Varah, Ltd.
2077 Alberta Street
Vancouver, B.C. V5Y 1C4
Tel: (604)873-3211

R.A.E. Industrial Electronics, Ltd.
3455 Gardner Court
Burnaby, B.C. V5G 4J7
Tel: (604)291-8866

MANITOBA

L. A. Varah, Ltd.
#12 1832 King Edward Street
Winnipeg, Manitoba R2R 0N1
Tel: (204)633-6190

ONTARIO

Arrow/Cesco
24 Martin Ross Road
Downsview, Ontario M3J 2K9
Tel: (416)661-0220

Arrow/Cesco
148 Colonnade Road
Nepean, Ontario K2E 7J5

Hamilton Avnet (Canada) Ltd.
6845 Rexwood Drive
Units 3,4,5
Mississauga, Ontario L4V 1M5
Tel: (416)677-7432

Hamilton Avnet (Canada) Ltd.
210 Colonnade Street
Nepean, Ontario K2E 7L5
Tel: (613)226-1700

L. A. Varah, Ltd.
504A Iroquois Shore Drive
Ontario L6H 3K4
Tel: (416)561-9311

QUEBEC

Arrow/Cesco
4050 Jean Talon Street, West
Montreal, Quebec H4P 1W1
Tel: (514)735-5511

Hamilton Avnet (Canada) Ltd.
2670 Sabourin Street
St. Laurent, Quebec H4S 1M2
Tel: (514)331-6443

Europe, Middle East, and Africa

AUSTRIA
TVG
Transistor Vertriebsgesellschaft mbH & Co KG
Auhofstrasse 41A
1130 Vienna
Tel: 0222/8294510

BELGIUM

Inelco Belgium S.A.
Avenue des Croix de Guerre 94
1120 Brussels
Tel: 02/216 01 60

DENMARK

Tage Olsen A/S
P.O. Box 225
2750 Ballerup
Tel: 02/65 81 11

EGYPT

Sakrco Enterprises
P.O. Box 1133
37 Kasr El Nil Street, Apt. 5
Cairo
Tel: 744440

ETHIOPIA

General Trading Agency
P.O. Box 1684
Addis Ababa
Tel: 132718-137275

FINLAND

Telercas OY
P.O. Box 33
04201 Kerava
Tel: 0/248.055

FRANCE

Almex
48, rue de l'Aubepine
92160 Antony
Tel: (1)46.66.21.12

***Hybritech**
Route de Bua
ZAC des Godets
91370 Verrieres-Le-Buisson
Tel: (1)69.20.22.10

Radio Equipements Antares S.A.
9, rue Ernest Cognacq
92301 Levallois Perret
Tel: (1)47.58.11.11

Radio Television Francais
9, rue D'Arcueil
94250 Gentilly
Tel: (1)46.64.11.01

*Chip Distributor only.

RCA Authorized Distributors

Europe, Middle East, and Africa (Cont'd)

FRANCE

Tekelec Airtronic S.A.
Cite des Bruyeres
Rue Carle Vernet
92310 Sevres
Tel: (1)45.34.75.35

GERMANY

Alfred Neye Enatechnik GmbH
Schillerstrasse 14
2085 Quickborn
West Germany
Tel: 04106/6120

▪**Asternetics GmbH**
Lindenring 3
8021 Taufkirchen
Tel: 089/61 21007

ECS Hilmar Frehsdorf GmbH
Electronic Components Service
Carl-Zeiss-Strasse 3
2085 Quickborn
West Germany
Tel: 04106/70 050

ELECTRONIC 2000
Stahlgruberring 12
8000 Munchen 82
Tel: 089/42 001-0

Elkose GmbH
Bahnhofstrasse 44
7141 Moeglingen
West Germany
Tel: 07141/487-1

Sasco GmbH
Hermann-Oberth-Strasse 16
8011 Putzbrunn bei Munchen
West Germany
Tel: 089/46111

Spoerle Electronic KG
Max-Planck-Strasse 1-3
6072 Dreieich bei Frankfurt
West Germany
Tel: 06103/3041

GREECE

Semicon Co.
104 Aeolou Str.
TT 131 Athens
Tel: 3253626

HUNGARY

Hungagent
P.O. Box 542
1374 Budapest
Tel: 01/669-385

ICELAND

Georg Amundason
P.O. Box 698, Reykjavik
Tel: 81180

ISRAEL

Aviv Electronics
Kehilat Venezia Street 12
69010 Tel-Aviv
Tel: 03-494450

ITALY

Eledra SpA
Via G. Watt, 37
20143 Milano
Tel: (02)818221

▪High-Rel Specialist

IDAC Elettronica SpA
Via Verona 8
35010 Busa di Vigonza
Tel: (049)72.56.99

LASI Elettronica SpA
Viale Fulvio Testi 126
20092 Cinisello Balsamo (MI)
Tel: (02)24 40 012

Silverstar Ltd.
Via dei Gracchi 20
20146 Milano
Tel: (02)49 96

KUWAIT

Morad Yousuf Behbehani
P.O. Box 146
Kuwait

MOROCCO

Societe d'Equipement Mecanique et Electrique SA (S.E.M.E.)
rue Ibn Batouta 29
Casablanca
Tel: (212)22.08.65

THE NETHERLANDS

Koning en Hartman Elektrotechniek BV
Postbus 125
2600 AC Delft
Tel: (15)60 99 06

Vekano BV
Postbus 6115
5600 HC Eindhoven
Tel: (40)82 98 98

NORWAY

National Elektro A/S
P.O. Box 53, Ulvenveien 75
Okern, Oslo 5
Tel: (472)64 49 70

PORTUGAL

Cristalonica Componentes de Radio e Televisao, Lda
Rua Bernardim Ribeiro, 25
1100 Lisbon
Tel: (019)53 46 31

SOUTH AFRICA

Allied Electronic Components (PTY) Ltd.
P.O. Box 6387
Dunswart 1508
Tel: (011)528-661

SPAIN

Diode Espana S.A.
Edifico Iberia Mart
Avda. de Brasil, 5, 1
28020 Madrid
Tel: 1/455 36 86

Kontron S.A.
Salvatierra 4
Madrid 34
Tel: 1/729.11.55

SWEDEN

Ferner Electronics AB
Snormakarvagen 35
P.O. Box 125
16126 Bromma Stockholm
Tel: 08/80 25 40

Nordisk Elektronik AB
P.O. Box 1409
17127 Solna
Tel: 08/734 97 70

SWITZERLAND

Baerlocher AG
Forrlibuckstrasse 110
8005 Zurich
Tel: (01)42.99.00

TURKEY

Zer Kollektif Sti
Guniz Sokak 17
Kavaklidere
Ankara
Tel: (41)67.08.39

U.K.

ACCESS Electronic Components Ltd.
Jubilee House, Jubilee Road
Letchworth, Hertfordshire SG6 1QH
Tel: Letchworth (0462)68 2333

Gothic Crellon Electronics Ltd.
3 The Business Centre
Molly Millars Lane
Wokingham, Berkshire RG11 2EY
Tel: (0734)78 7848

Jermyn Distribution
Vestry Industrial Estate
Otford Road
Sevenoaks, Kent TN14 5EU
Tel: Sevenoaks (0732)450144

Macro Marketing Ltd.
Burnham Lane
Slough, Berkshire SL1 6LN
Tel: Burnham (06286)4422

Micromark Electronics, Ltd.
Boyn Valley Road
Maidenhead, Berks SL6 4DT
Tel: (0628)76 176

STC Electronics Services
Edinburgh Way
Harlow, Essex, CM20 2DF
Tel: Harlow (0279)26777

VSI Electronics Ltd.
Roydonbury Industrial Park
Horsecroft Road
Harlow, Essex CM19 5BY
Tel: Harlow (0279)29666

YUGOSLAVIA

Avtotehna
P.O. Box 593, Celovska 175
61000 Ljubljana
Tel: (061)552 341

ZAMBIA

African Technical Associates Ltd.
Stand 5196 Luanshya Road
Lusaka

ZIMBABWE

BAK Electrical Holdings (Pvt) Ltd.
30 Pioneer Street
Harare

RCA Authorized Distributors

Asia Pacific

AUSTRALIA

AWA (Aust.) Ltd.
North Ryde Division
Corner Lane Cove & Talavera Roads
Macquarie Park
North Ryde, N.S.W. 2113

Amtron Tyree Pty. Ltd.
176 Cope Street
Waterloo, N.S.W. 2017

BANGLADESH

Electronic Engineers & Consultants Ltd.
103 Elephant Road, 1st Floor
Dacca 5

HONG KONG

Gibb Livingston & Co., Ltd.
13/F., Tai Yau Building
181 Johnston Road
Wanchai

Hong Kong Electronic Components Co.
Flat A Yun Kai Bldg. 1/F1
466-472 Nathan Road
Kowloon

INDIA

Photophone Ltd.
179-5 Second Cross Road
Lower Palace Orchards
Bangalore 560 003

INDONESIA

NVPD Soedarpo Corp.
Samudera Indonesia Building
JL Letten, Jen. S
Parman No. 35 Slipi
Jakarta Barat

JAPAN

Okura & Company Ltd.
3-6 Ginza, Nichome, Chuo-Ku
Tokyo 104

KOREA

Panwest Company, Ltd.
Room 1202 Sam Heung Bldg.
32 Eulchi-ro 1-ka, Chung-Ku
Seoul, Republic of South Korea

Shin-A Trading Company
Room 406, Koryo Bldg.
88-7 Nonhyon-Dong
Kangnam-ku
Seoul, Republic of South Korea

NEPAL

Continental Commercial Distributors
Phohara Durbar
Durbarmarga
Kathmandu

NEW ZEALAND

AWA NZ Ltd.
N.Z. P.O. Box 50-248
Porirua

PHILIPPINES

Philippine Electronics Inc.
P.O. Box 498
3rd Floor, Rose
Industrial Bldg., 11 Pioneer St.
Pasig, Metro Manila

Semitronics Philippines
P.O. Box 445 Greenhills
San Juan 3113
Metro Manila

SINGAPORE

Device Electronics Pte. Ltd.
101 Kitchener Road No. 02-04
Singapore 0820

Microtronics Assoc. Pte. Ltd.
8 Lorong Bakar Batu, No. 03-01
Kolam Ayer Industrial Park
Singapore 1334

SRI LANKA

C.W. Mackie & Co. Ltd.
36 D.R. Wijewardena Mawatha
Colombo 10

TAIWAN

Delta Engineering Ltd.
No. 42 Hsu Chang Street
8th Floor, Taipei

Sertek International Inc.
No. 315, Fu Shin North Road
Taipei 104

Teco Enterprise Co. Ltd.
2nd Floor, No. 120, Sec. 2
Chung Hsiao East Road
Taipei

THAILAND

Better Pro Co. Ltd.
71 Chakkawat Road
Wat Tuk, Bangkok

Latin America

ARGENTINA

Eneka S.A.I.C.F.I.
Tucuman 299
1049 Buenos Aires
Tel: 31-3363

Radiocom S.A.
Conesa 1003
1426 Buenos Aires
Tel: 551-2780

Tecnos S.R.L.
Independencia 1861
1225 Buenos Aires
Tel: 37-0239

BRAZIL

Commercial Bezerra Ltda.
Rua Costa Azevedo, 139
CEP-69.000 Manaus/AM
Tel: 322-5363

CHILE

Industria de Radio y Television S.A. (IRT)
Vic. MacKenna 3333
Casilla 170-D, Santiago
Tel: 510081

COLOMBIA

Electronica Moderna
Carrera 9A, NRO 19-52
Apartado Aereo 5361
Bogota, D.E.1
Tel: 282286

ECUADOR

Elecom, S.A.
Junin 618 y Boyaca
P.O. Box 9611, Guayaquil
Tel: 307786

MEXICO

Dicopel, S.A.
Tochtli No. 368 Fracc.
San Antonio Azcapotzalco
02760 Mexico, D.F.

Electronica Remberg, S.A. de C.V.
Rep. Del Salvador No. 30-101
Mexico City 1, D.F.
Tel: 510-47-49

PERU

Arven S.A.
PSJ Adan Mejia 103, OF. 33
Lima 11
Tel: 716229

URUGUAY

American Products S.A. (APSA)
Casilla de Correo 1438
Canelones 1133
Montevideo
Tel: 902735

VENEZUELA

P. Benavides, P., S.R.L.
Residencies Camarat, Local 7
La Candelaria, Caracas
MAIL ADDRESS: Apartado Postal 20.249
San Martin, Caracas
Tel: 571-21-46

RCA Manufacturers' Representatives

United States

ALABAMA

Electronic Sales, Inc. (ESI)
303 Williams Avenue
Suite 422
Huntsville, AL 35801
Tel: (205)533-1735

CALIFORNIA

CK Associates
8333 Clairemont Mesa Blvd.
Suite 102
San Diego, CA 92111
Tel: (619)279-0420

Pinnacle Sales
275 Saratoga Avenue
Suite 200
Santa Clara, CA 95050
Tel: (408)249-7400

CONNECTICUT

COM-SALE, Inc.
5 Shire Drive
P.O. Box 946
Wallingford, CT 06492
Tel: (203)269-7964

FLORIDA

G.F. Bohman Assoc., Inc.
130 N. Park Avenue
Apopka, FL 32703
Tel: (305)886-1882

G.F. Bohman Assoc., Inc.
2020 W. McNab Road
Ft. Lauderdale, FL 33309
Tel: (305)979-0008

GEORGIA

Electronic Sales, Inc. (ESI)
3103A Medlock Bridge Road
Norcross, GA 30071
Tel: (404)448-6554

INDIANA

Electronic Mktg. Consultants, Inc. (EMCI)
5259 No. Tacoma Avenue
Suite 8
Indianapolis, IN 46220
Tel: (317)253-1668

IOWA

REP Associates Corp.
4905 Lakeside Drive, NE
Cedar Rapids, IA 52402
Tel: (319)373-0152

KANSAS

Electri-Rep Inc.
7050 W. 107th Street
Suite 210
Overland Park, KS 66212
Tel: (913)649-2168

MASSACHUSETTS

COM-SALE, Inc.
105 Chestnut Street
Needham, MA 02192
Tel: (617)444-8071

MICHIGAN

Rathsburg Assocs., Inc.
16621 E. Warren Avenue
Detroit, MI 48224
Tel: (313)882-1717

MINNESOTA

Comprehensive Technical Sales (COM-TEK)
8053 Bloomington Freeway
Suite 138
Minneapolis, MN 55420
Tel: (612)888-7011

MISSOURI

Electri-Rep Inc.
2300 Westport Plaza Drive
Suite 303
St. Louis, MO 63146
Tel: (314)878-8209

NEW HAMPSHIRE

COM-SALE, Inc.
101 High Street
Exeter, NH 03833
Tel: (603)772-3300

NEW JERSEY

Astrorep, Inc.
717 Convery Boulevard
Perth Amboy, NJ 08861
Tel: (201)826-8050

Tritek Sales, Inc.
21 East Euclid Avenue
Haddonfield, NJ 08033
Tel: (609)429-1551

NEW YORK

Astrorep, Inc.
103 Cooper Street
Babylon, L.I., NY 11702
Tel: (516)422-2500

Foster & Wager, Inc.
2507 Browncraft Blvd.
Rochester, NY 14625
Tel: (716)385-7744

NORTH CAROLINA

Electronic Sales, Inc. (ESI)
315 No. Academy Street
Suite 206
Cary, NC 27511
Tel: (919)467-8486

OHIO

Lyons Corporation
4812 Frederick Road
Suite 101
Dayton, OH 45414
Tel: (513)278-0714

Lyons Corporation
4615 W. Streetsboro Road
Richfield, OH 44286
Tel: (216)659-9224

OREGON

Vantage Corp.
7100 S.W. Hampton Street
Suite 205
Tigard, OR 97223
Tel: (503)620-3280

UTAH

Simpson Assocs.
7324 So. 1300 E.
Suite 350
Midvale, UT 84047
Tel: (801)566-3691

WASHINGTON

Vantage Corp.
300 120th Avenue N.E.
Bldg. 7, Suite 207
Bellevue, WA 98005
Tel: (206)455-3460

Canada

ALBERTA

Hi-Tech Sales, Ltd.
Box 115
339-10 Avenue, S.E.
Calgary, Alberta T2G 0W2
Tel: (403)229-6990

BRITISH COLUMBIA

Hi-Tech Sales, Ltd.
7510B Kingsway
Burnaby, B.C. V3N 3C2
Tel: (604)524-2131

MANITOBA

Hi-Tech Sales, Ltd.
102-902 St. James Street
Winnepeg, Manitoba R3G 3J7
Tel: (204)786-3343

ONTARIO

Bytewide Marketing, Inc.
7528 Bath Road
Mississauga, Ontario L4T 4C1
Tel: (416)675-1868

QUEBEC

Bytewide Marketing, Inc.
5020 Fairway Avenue
Suite 226
Lachine, Quebec H8T 1B8
Tel: (514)636-4121

RCA Solid State

DATABOOK