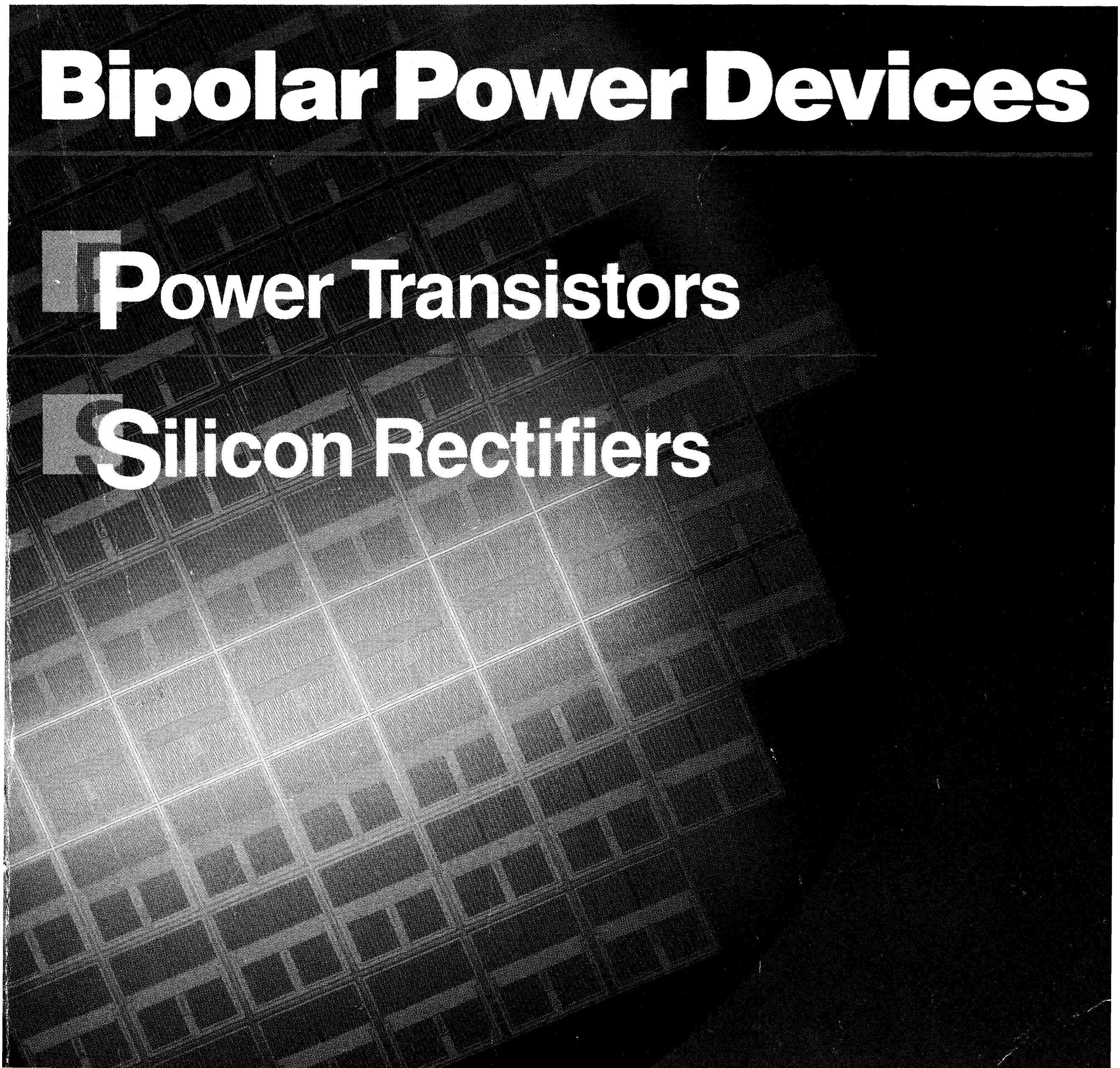
HARRIS
SEMICONDUCTOR

DATA BOOK

Bipolar Power Devices

Power Transistors

Silicon Rectifiers



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

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

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

Commercial Products Group

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

Military and Aerospace Division

- Standard Products
- Custom Products
- Microwave Products

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

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What your vision of the future demands. Today.

Printed in USA/3-89

Bipolar Power Devices

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

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

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

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Index to Devices

POWER TRANSISTORS

*JAN-type versions available

POWER TRANSISTORS

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POWER TRANSISTORS

POWER TRANSISTORS

POWER TRANSISTORS

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Power Transistors 2
Technical Data

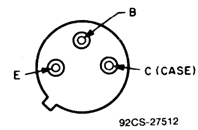
2N697 File Number **16**

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 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.

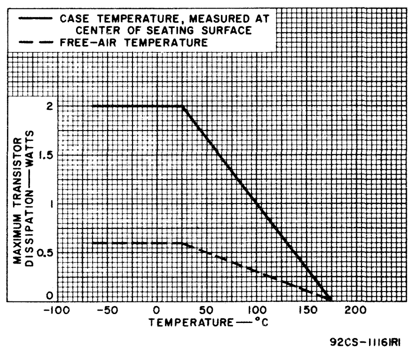


Fig. 1 - Current derating chart.

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 V_{CB}	V_{CE}	CURRENT mA dc I_C	I_E	I_B	LIMITS Min.	Typ.	Max.	UNITS
*	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.

2

2N1479, 2N1480, 2N1481, 2N1482

File Number **135**

Silicon N-P-N Power Transistors

General-Purpose Types for Medium-Power Applications

Features:

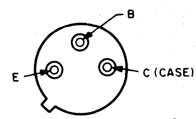
- *High-temperature characterization*
- *High dc beta at 200 mA*
- *Full switching-time characterization at 200 mA*

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-205AD

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: VOLTAGE V dc: V_{CB}	V_{CE}	V_{EB}	CURRENT mA dc: I_C	I_B	I_E	LIMITS 2N1479 Min.	2N1479 Max.	2N1480 Min.	2N1480 Max.	2N1481 Min.	2N1481 Max.	2N1482 Min.	2N1482 Max.	UNITS
* 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				200 200	20 10			7 		7 		 7		 7	Ω
* Collector-To-Base Capacitance	C_{ob}	40						150 Typ.		150 Typ.		150 Typ.		150 Typ.		pF
* Thermal Time Constant	τ_1							10 Typ.		10 Typ.		10 Typ.		10 Typ.		ms
* Alpha-Cutoff Frequency	$f_{\alpha b}$	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	

*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.

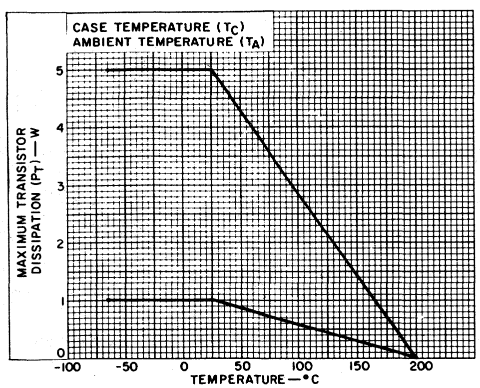


Fig. 1 — Derating chart for all types.

2N1479, 2N1480, 2N1481, 2N1482

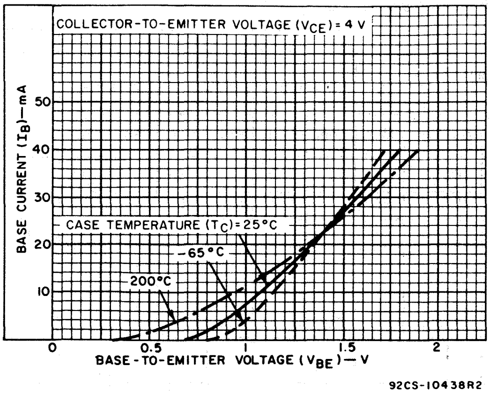


Fig.2 — Typical input characteristics for all types.

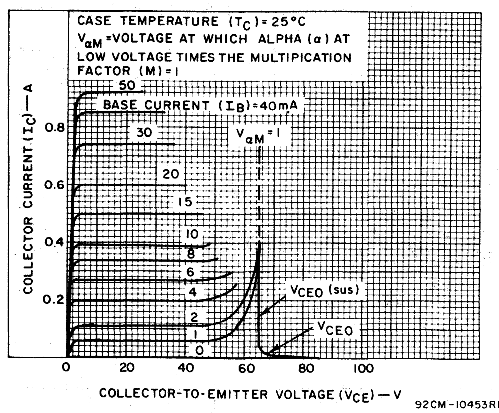


Fig.3 — Typical output characteristics for all types.

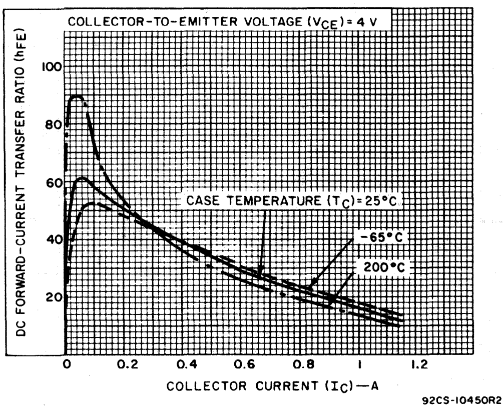


Fig.4 — Typical dc beta characteristics for all types.

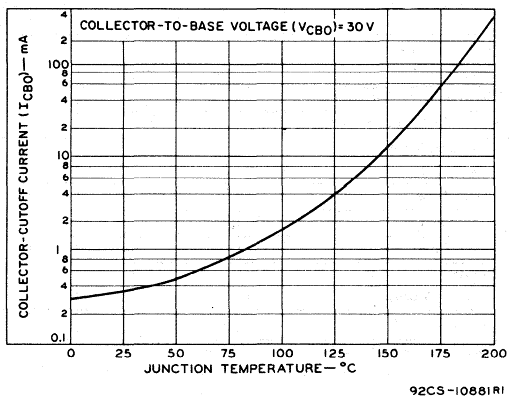


Fig.5 — Typical leakage characteristics for all types.

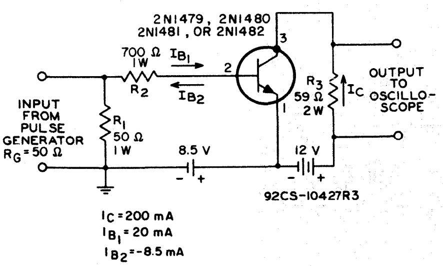


Fig.6 — Test circuit for measurement of saturated switching times.

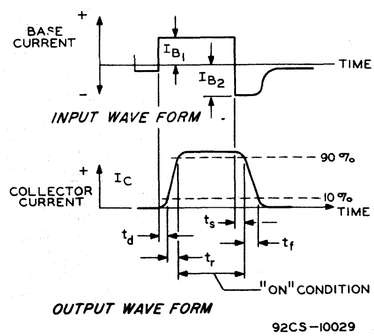


Fig. 7 — Oscilloscope display for measurement of switching times (test circuit in Fig. 6).

File Number **106**

2N1613, 2N2102

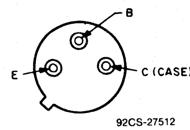
Medium-Power Silicon N-P-N Planar Transistors

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

2

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

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

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

Features for Both Types:

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N2102	2N1613	
* V_{CBO}	120	75	V
* $V_{CER}(sus)$			
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.

2N1613, 2N2102

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	Voltage V dc		Current mA dc		2N1613		2N2102		
	V_{CB}	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CBO}	60				–	0.01	–	0.002	μA
At T_C=150°C	60				–	10	–	2	
* I_{EBO} V_{EB}=5 V			0		–	0.01	–	0.002	μA
* h_{FE}		10	0.01		–	–	10	–	
		10	0.1		20	–	20	–	
		10	10[a]		35	–	35	–	
		10	150[a]		40	120	40	120	
		10	500[a]		20	–	25	–	
At T_C=–55°C		10	10[a]		20	–	20	–	
* V_{RT} V_{EB}=1.5 V, I_E=0					–	–	120	–	V
* $V_{(BR)CBO}$ I_E=0			0.1		75	–	120	–	V
* $V_{(BR)EBO}$ I_E=0.1 mA			0		7	–	7	–	V
* $V_{CEO}(sus)$			100[a]	0	–	–	65	–	V
* $V_{CER}(sus)$ R_{BE}=10 Ω			100[a]		50	–	80	–	V
* $V_{BE}(sat)$			150[a]	15	–	1.3	–	1.1	V
* $V_{CE}(sat)$			150[a]	15	–	1.5	–	0.5	V
* h_{fe}		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	
* h_{rb}	5		1		–	3×10^{-4}	–	3×10^{-4}	
	10		1		–	3×10^{-4}	–	–	
f=1 kHz	10		5		–	–	–	3×10^{-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	
* 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	

* 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

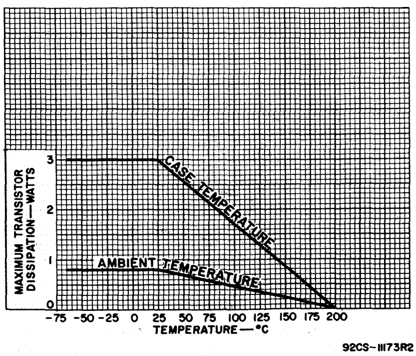


Fig. 1 — Rating chart for 2N1613.

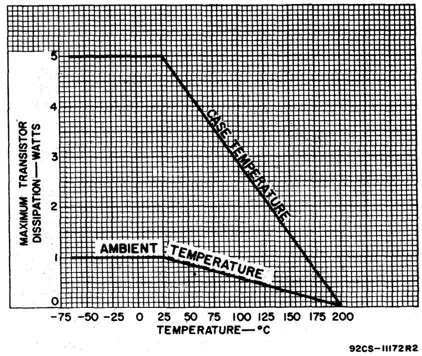


Fig. 2 — Rating chart for 2N2102.

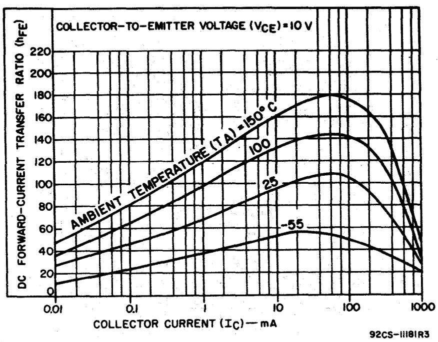


Fig. 3 — Typical dc beta characteristics for both types.

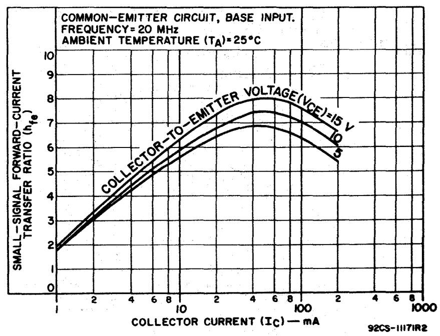


Fig. 4 — Typical small-signal beta characteristics for both types.

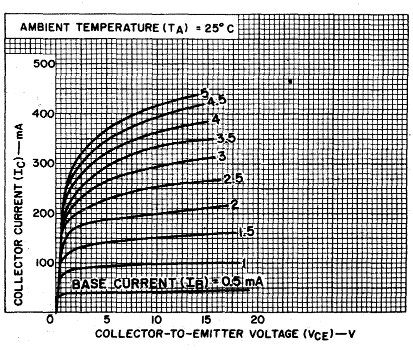


Fig. 5 — Typical output characteristics for both types.

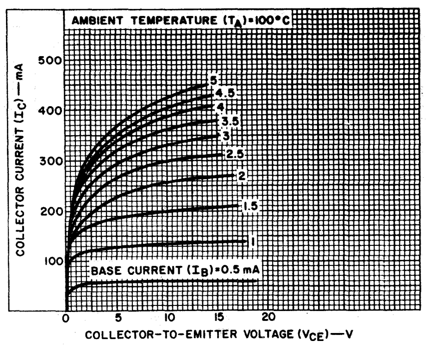


Fig. 6 — Typical output characteristics for both types at $T_A = 100^oC$.

2

2N1613, 2N2102

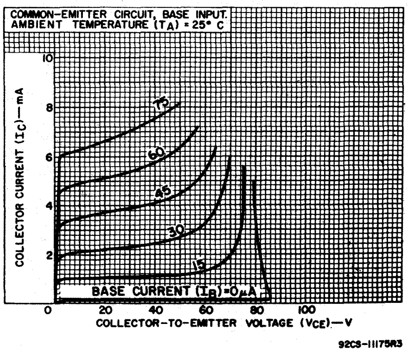


Fig. 7 — Typical high-current output characteristics for both types.

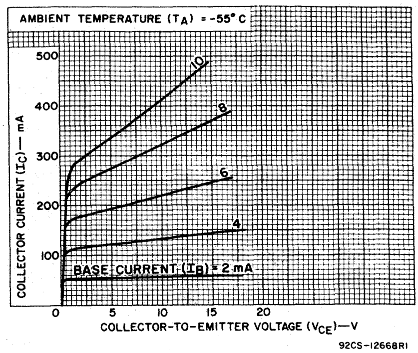


Fig. 8 — Typical output characteristics for both types at $T_A = -55^oC$.

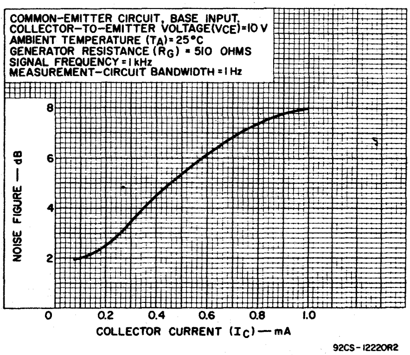


Fig. 9 — Typical noise figure characteristics for both types.

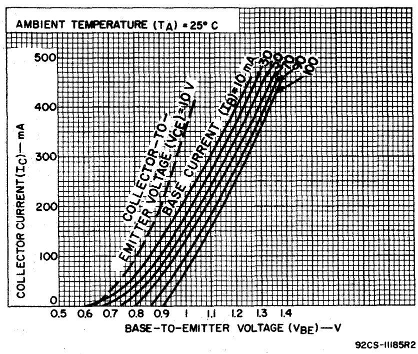


Fig. 10 — Typical transfer characteristics for both types.

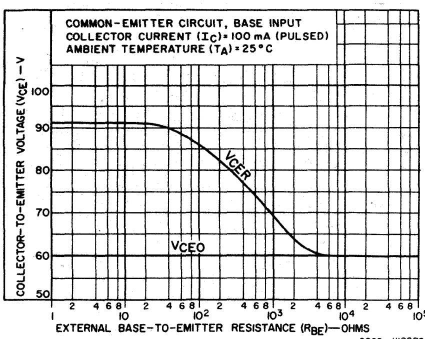


Fig. 11 — Typical sustaining voltage vs. base-to-emitter resistance for 2N1613.

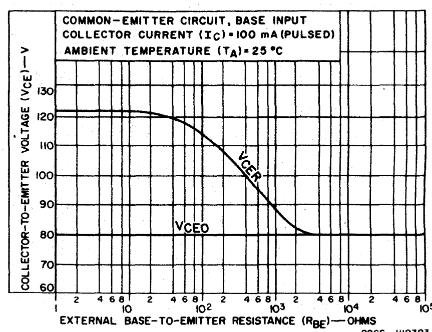


Fig. 12 — Typical sustaining voltage vs. base-to-emitter resistance for 2N2102.

2N1613, 2N2102

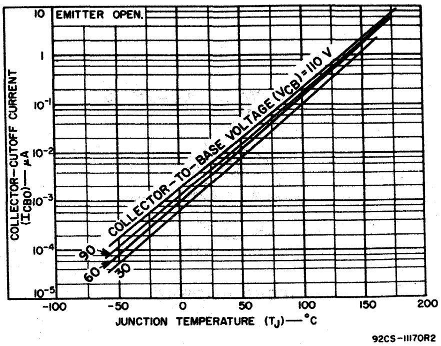


Fig. 13 — Typical leakage characteristics for both types.

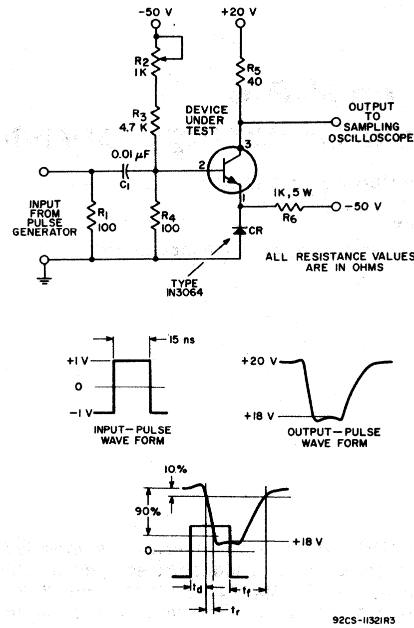


Fig. 14 — Circuit for measurement of switching time, and associated waveforms.

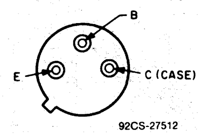
2N1700 File Number **141**

Silicon N-P-N Power-Switching Transistor

For Switching Applications

Features:
- *Operation at high junction temperatures*

TERMINAL DESIGNATIONS



JEDEC TO-205AD

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N1700	
* V_{CBO}	60	V
* V_{CEX}		
V_{BE} = −1.5 V	60	V
* V_{CEO}(sus)	40	V
* V_{EBO}	6	V
* I_C	1	A
* I_B	0.75	A
* P_T		
$T_C \leq 25°C$	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	
* 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	

*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.

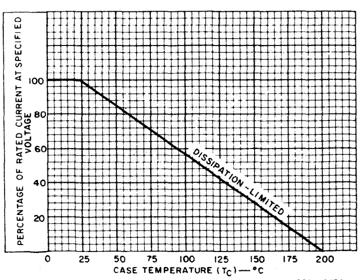


Fig. 1 - Derating curve.

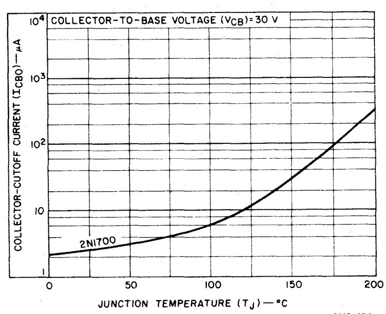


Fig. 2 - Typical collector-cutoff current characteristics.

2N1700

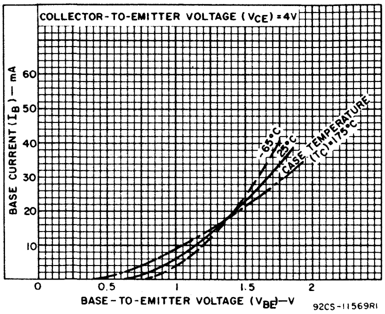


Fig. 3 - Typical input characteristics.

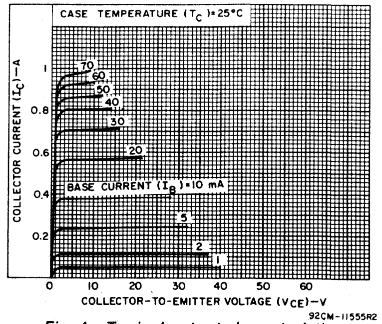


Fig. 4 - Typical output characteristics.

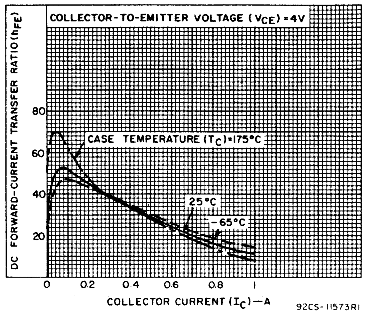
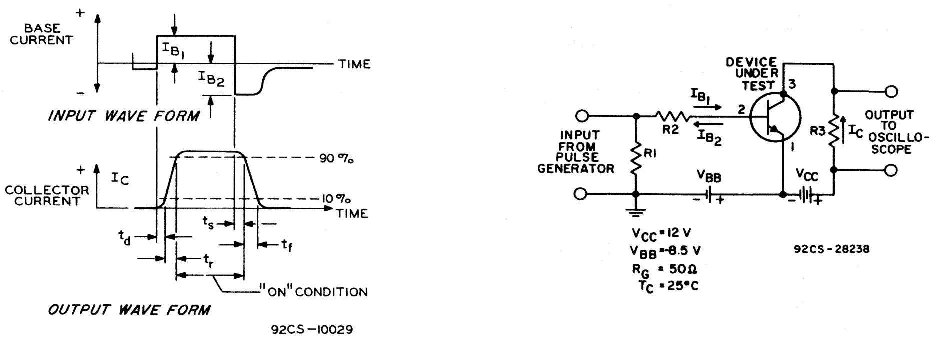


Fig. 5 - Typical dc beta characteristics.



		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.

File Number **34**

2N1893, 2N2405

Medium-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications In Industrial and Commercial Equipment

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

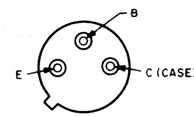
The 2N1893 and 2N2405* are silicon n-p-n planar transistors intended for a variety of small-signal and medium-power applications. They feature exceptionally high collector-to-emitter sustaining voltage, low leakage characteristics, high switching speeds, and high pulse beta (h_{FE}).

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

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

*Formerly Dev. Type TA2235A.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

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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	μA
*	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
*	V_{CER}(sus) R_{BE} = 10 Ω			100[a]			100	–	140	–	V
	R_{BE} = 500 Ω			100[a]			–	–	120	–	V
*	$V_{(BR)CBO}$			0.1	0		120	–	120	–	V
*	$V_{(BR)EBO}$			0	0.1		7	–	7	–	V
*	V_{CE}(sat)			150[a]		15	–	5	–	0.5	V
				50[a]		5	–	1.5	–	0.2	V
*	V_{BE}(sat)			150[a]		15	–	1.3	–	1.1	V
				50[a]		5	–	0.9	–	0.9	V
*	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} f = 1 kHz	5		1			20	30	24	34	Ω
		10		5			4	8	4	8	Ω
*	h_{rb} f = 1 kHz	5		1			–	1.25×10^{-4}	–	3×10^{-4}	
		10		5			–	1.5×10^{-4}	–	3×10^{-4}	
*	h_{ob} f = 1 kHz	5		1			–	0.5	–	0.5	μmho
		10		5			–	0.5	–	0.5	μmho
*	C_{obo}	10			0		–	15	–	15	pF
*	C_{ib} V_{BE} = −0.5 V			0			–	85	–	80	pF
	NF RG = 500 Ω BW = 15 kHz f = 1 kHz	10		0.3			–	–	–	6	dB
*	$R_{\theta J\text{-}C}$						–	58.3	–	35	°C/W
	$R_{\theta J\text{-}A}$						–	219	–	175	°C/W

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

2N1893, 2N2405

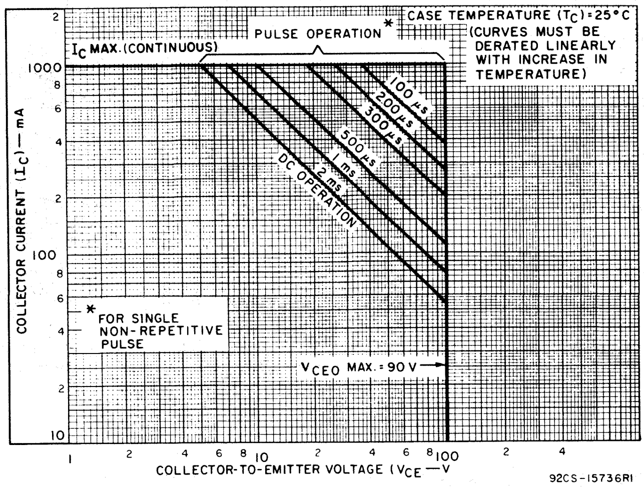

Fig. 1 — Maximum operating areas for type 2N2405.

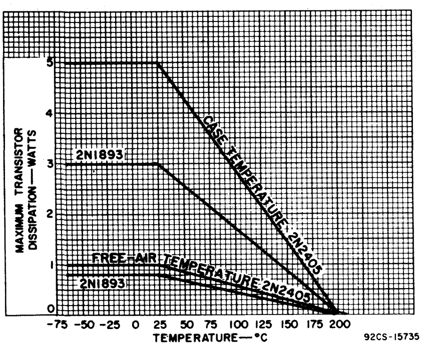

Fig. 2 — Dissipation derating curves for types 2N1893, and 2N2405.

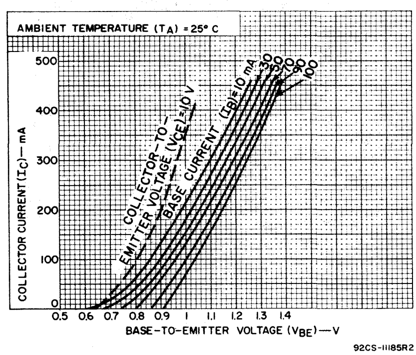

Fig. 3 — Typical transfer characteristics for types 2N1893 and 2N2405.

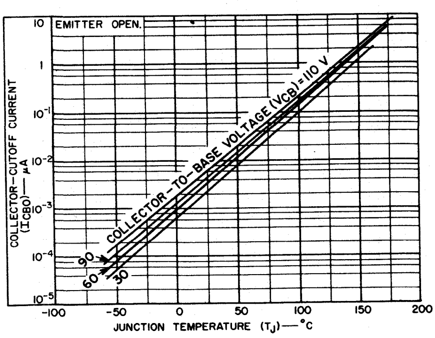

Fig. 4 — Typical cutoff characteristics for types 2N1893 and 2N2405.

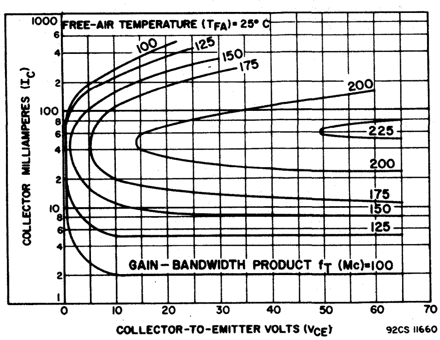

Fig. 5 — Typical gain bandwidth product characteristics for types 2N1893 and 2N2405.

2N1893, 2N2405

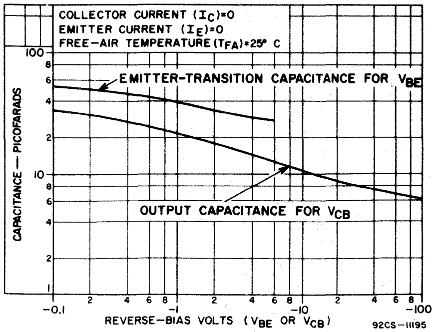

Fig. 6 — Typical capacitance characteristics for types 2N1893 and 2N2405.

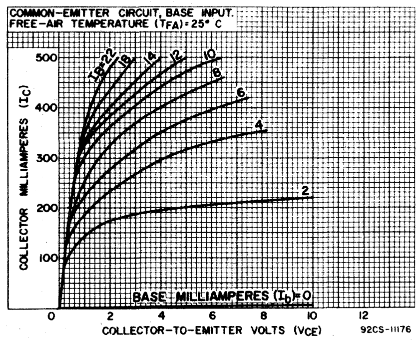

Fig. 7 — Typical collector characteristics at 25°C for type 2N2405.

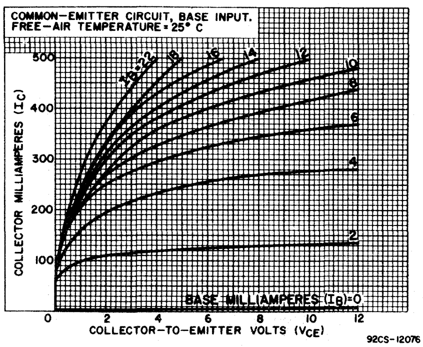

Fig. 8 — Typical collector characteristics at 25°C for type 2N1893.

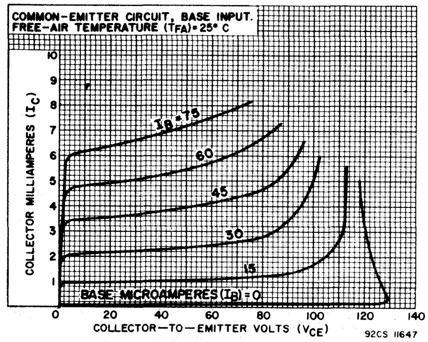

Fig. 9 — Typical collector characteristics at 25°C for type 2N2405.

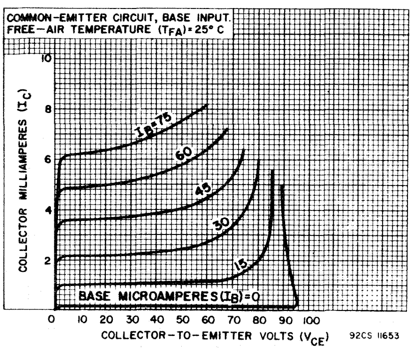

Fig. 10 — Typical collector characteristics at 25°C for type 2N1893.

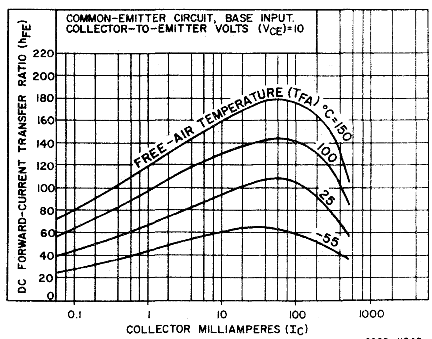

Fig. 11 — Typical dc-beta characteristics for types 2N1893 and 2N2405.

2N1893, 2N2405

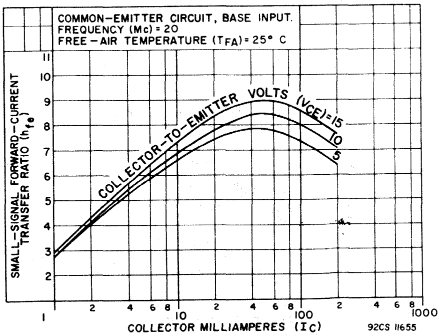

Fig. 12 – Typical small-signal beta characteristics for types 2N1893 and 2N2405.

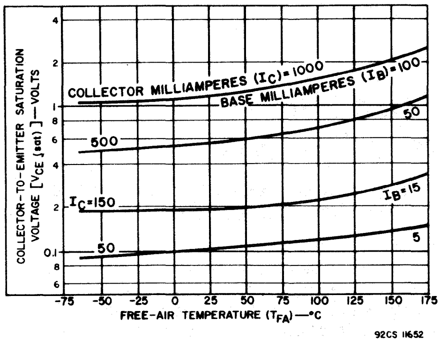

Fig. 13 – Typical saturation characteristics for types 2N1893 and 2N2405.

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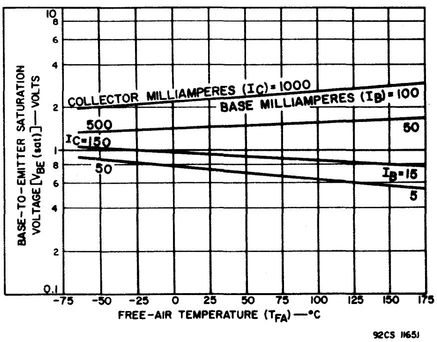


Fig. 14 – Typical saturation characteristics for types 2N2405 and 2N1893.

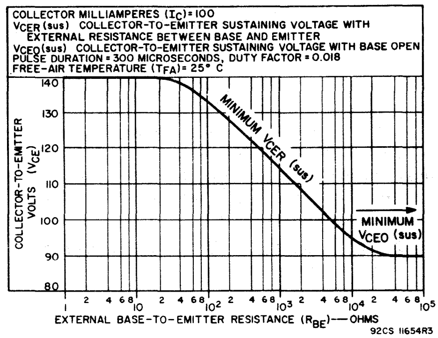


Fig. 15 – Sustaining voltage characteristic for type 2N2405.

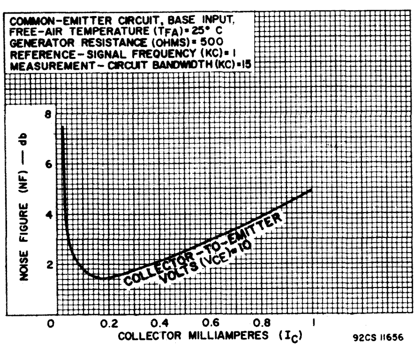


Fig. 16 – Typical wide-band noise characteristic for type 2N2405.

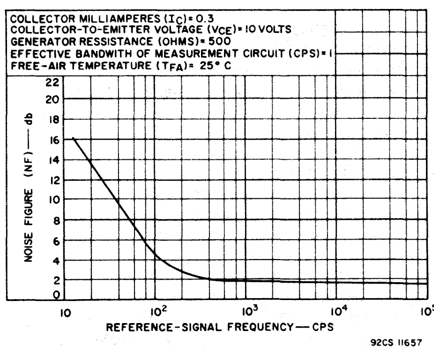


Fig. 17 – Typical narrow-band noise characteristic for type 2N2405.

2N2270

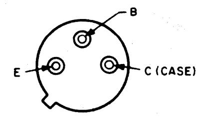
File Number **24**

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 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	μA
*	I_{EBO}			–5	0		–	0.1	μA
*	$V_{(BR)EBO}$ I_E = 0.1 mA				0		7	–	V
*	$V_{(BR)CBO}$				0.1		60	–	V
*	$V_{CER}(sus)$[a] R_{BE} = 10 Ω				100[b]		60	–	V
	$V_{CEO}(sus)$[a]				100[b]	0	45	–	V
*	$V_{CE}(sat)$				150[b]	15		0.9	
*	$V_{BE}(sat)$				150	15	–	1.2	V
*	h_{FE}		10		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	°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 ≤ 300 μs, duty factor ≤ 1.8%.

2

2N2270

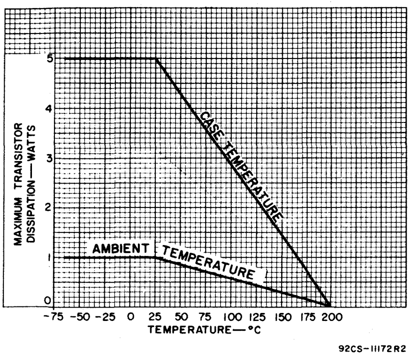


Fig. 1 — Rating Chart.

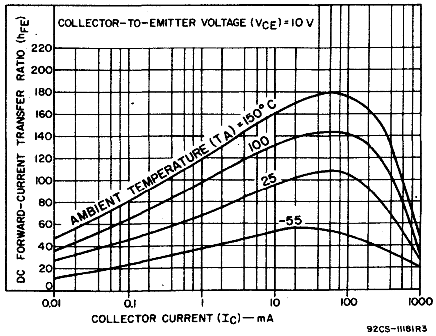


Fig. 2 — Typical dc forward-current transfer ratio characteristics.

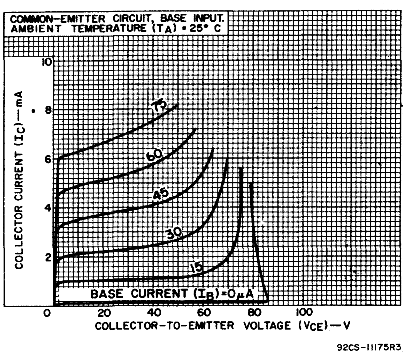


Fig. 3 — Typical collector characteristics.

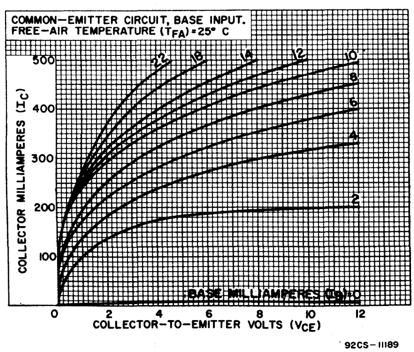


Fig. 4 — Typical collector characteristics.

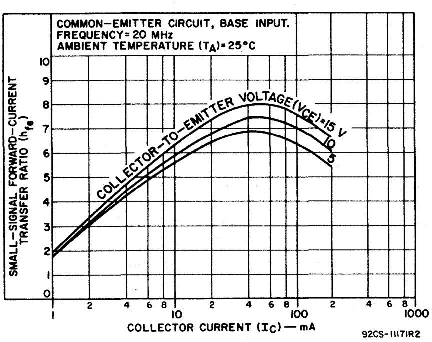


Fig. 5 — Typical small-signal forward-current ratio characteristics.

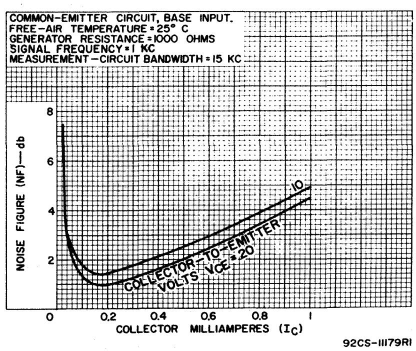


Fig. 6 — Typical af noise-figure characteristics.

2N2270

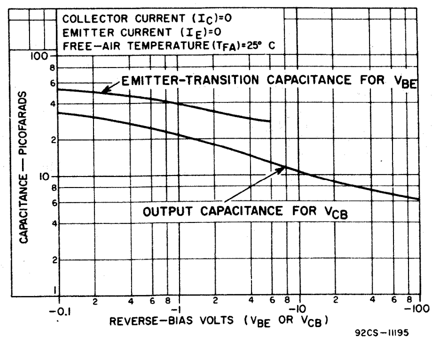


Fig. 7 — Typical emitter-transition-capacitance and output-capacitance characteristics.

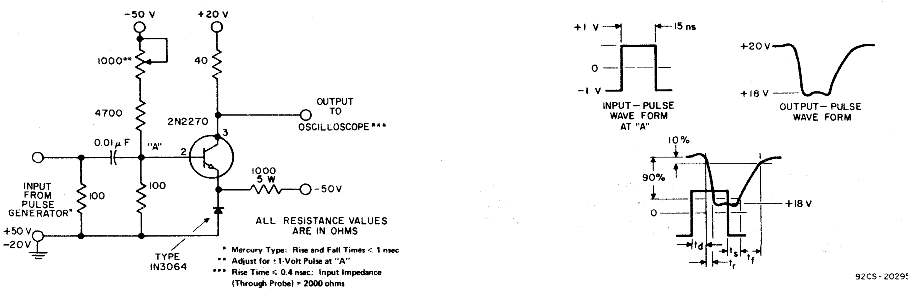


Fig. 8 — Test circuit for measurement of saturated switching time and associated waveforms.

2N3053, 2N3053A

File Number **960**

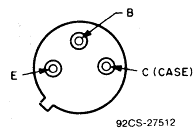
General-Purpose, Medium-Power Silicon N-P-N Planar Transistors

For Small-Signal Applications

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

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

TERMINAL DESIGNATIONS



JEDEC TO-205AD

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N3053	2N3053A	
* V_{CBO}	60	80	V
$V_{CER}(sus)$ R_{BE} = 10 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

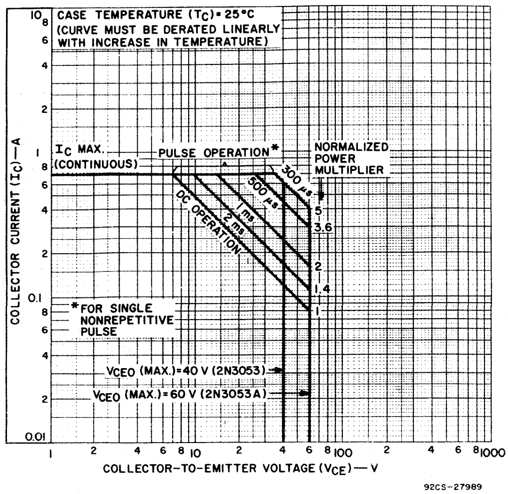


Fig. 1 - Maximum operating areas for 2N3053, 2N3053A.

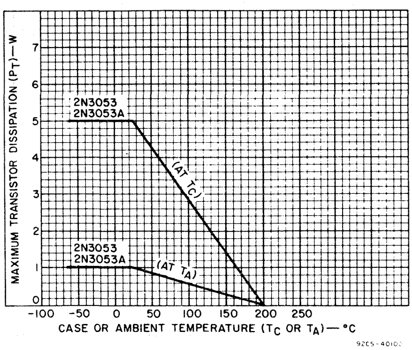


Fig. 2 - Dissipation derating curves for all types.

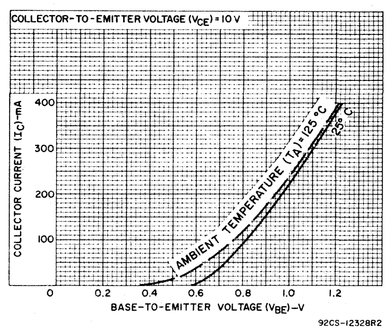


Fig. 3 - Typical transfer characteristics for all types.

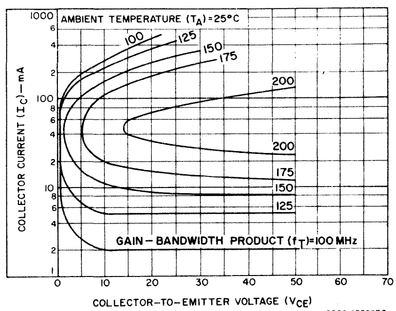


Fig. 4 - Typical dc beta characteristics for all types.

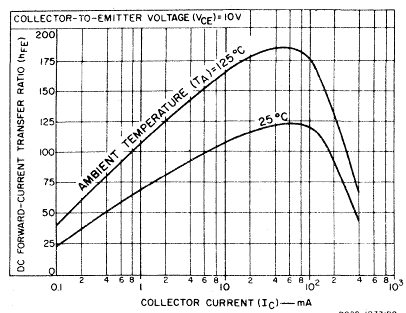


Fig. 5 - Typical variation of gain-bandwidth product with Ic and VCE for all types.

2N3053, 2N3053A

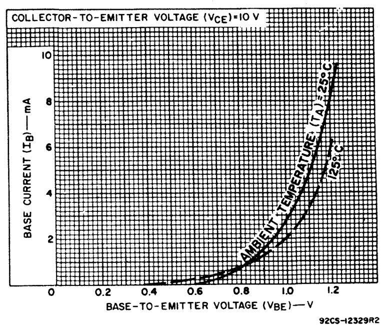


Fig. 6 - Typical input characteristics for all types.

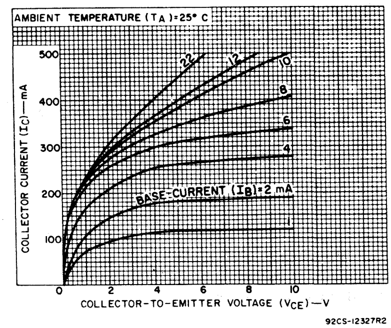


Fig. 7 - Typical output characteristics for all types.

2N3055 File Number **1699**

General-Purpose Power Transistor

Broadly Applicable Devices for Industrial and Commercial Use

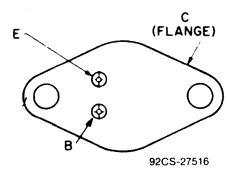
Features:
- *High gain at high current*
- *Low Saturation Voltage: $V_{CE}(sat) < 1.1$ V, @ I_C=4 A, I_B=0.4 A*
- *Excellent safe operating area*

The 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.

2N3055

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

	CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc			TEST CONDITIONS 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	
*	I_{CEO}	30					0	—	—	0.7	
*	I_{EBO}		7		0			—	—	5	
*	V_{CER}(sus)** R_{BE}=100 Ω				0.2			70	—	—	V
*	V_{CEO}(sus)**				0.2		0	60	—	—	
*	h_{FE}	4			4			20	—	70	
		4			10			5	—	—	
*	V_{BE}	4			4			—	—	1.8	V
*	V_{CE}(sat)				4		0.4	—	—	1.1	
					10		3.3	—	—	8	
*	f_{hfe}, f=10 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.

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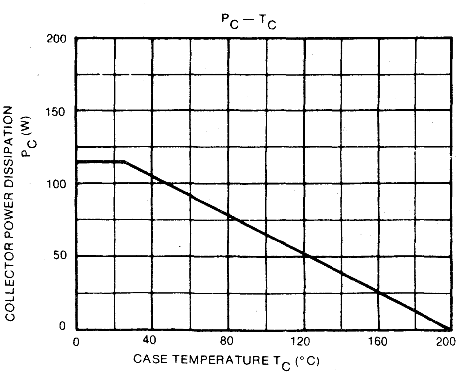


Fig. 1 - Power dissipation vs. temperature derating curve for 2N3055.

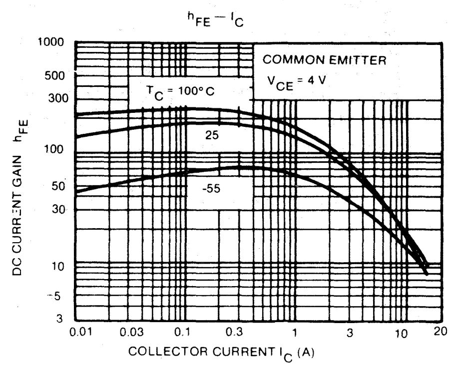


Fig. 2 - Typical dc-beta characteristics for 2N3055.

2N3055

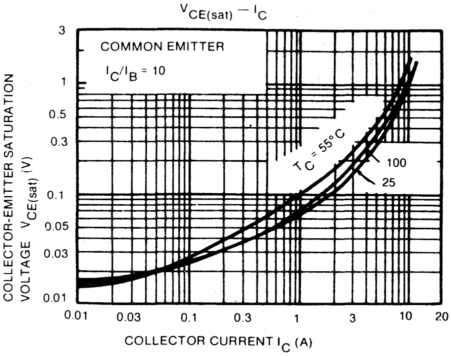


Fig. 3 - Typical collector-to-emitter saturation voltage characteristics for type 2N3055.

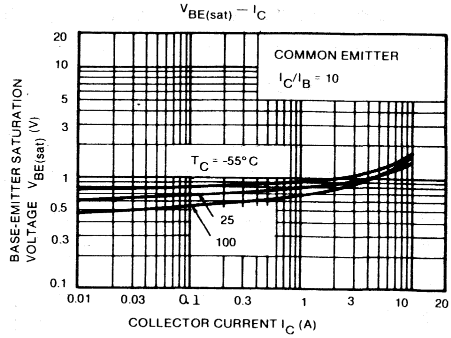


Fig. 4 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3055.

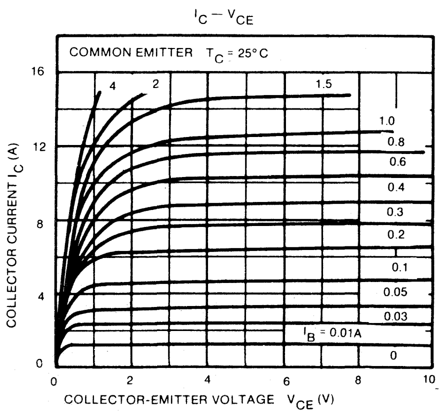


Fig. 5 - Typical output characteristics for 2N3055.

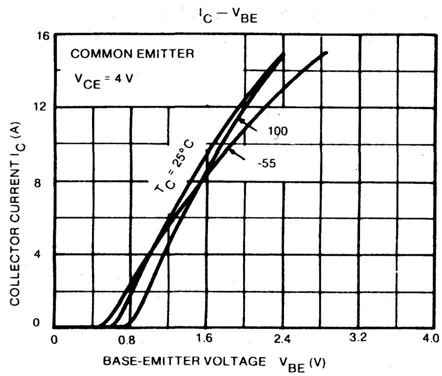


Fig. 6 - Typical transfer characteristics for 2N3055.

File Number **64**

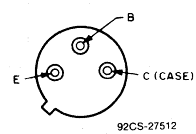
2N3439, 2N3440, 2N4063, 2N4064

High-Voltage Silicon N-P-N Planar Transistors

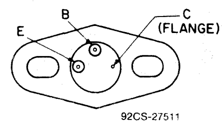
For High-Speed Switching and Linear-Amplifier Applications

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

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

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

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

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

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

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 V_{CE}	V_{BE}	CURRENT mA dc I_C	I_B	LIMITS 2N3439 2N4063 Min.	Max.	2N3440 2N4064 Min.	Max.	UNITS
*	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	°C/W

* 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

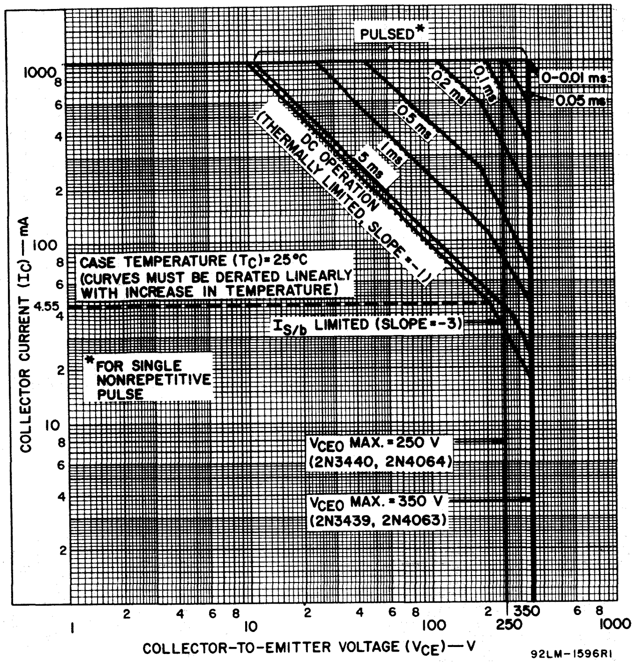


Fig. 1 – Maximum operating areas for 2N3439, 2N3440, 2N4063, and 2N4064.

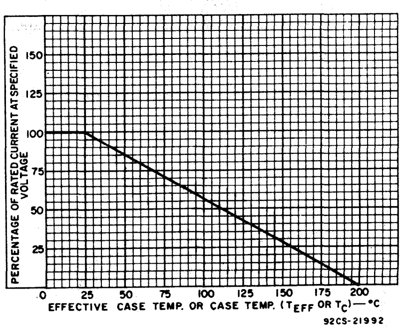


Fig. 2 – Current derating curve for all types.

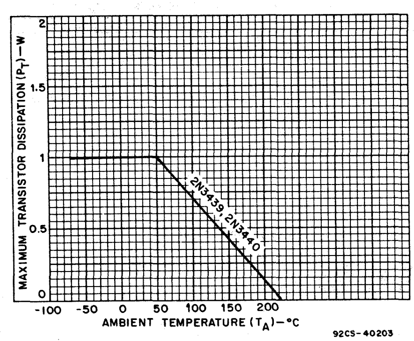


Fig. 3 - Dissipation derating curve for 2N3439 and 2N3440.

2N3439, 2N3440, 2N4063, 2N4064

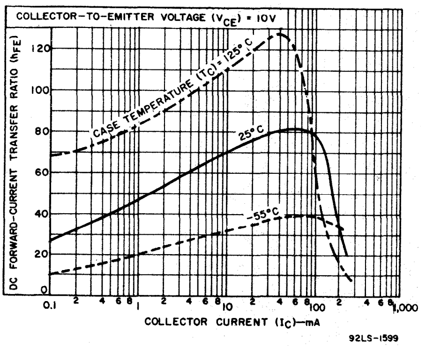


Fig. 4 – Typical dc beta characteristics for all types.

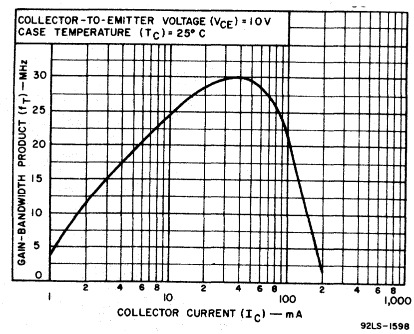


Fig. 5 – Typical gain bandwidth product for all types.

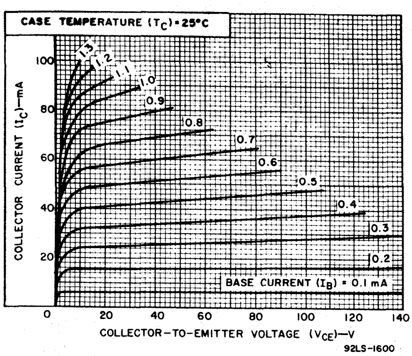


Fig. 6 – Typical output characteristics for all types.

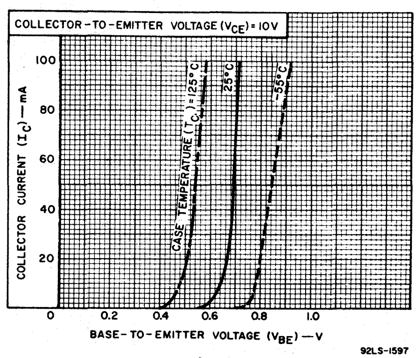


Fig. 7 – Typical transfer characteristics for all types.

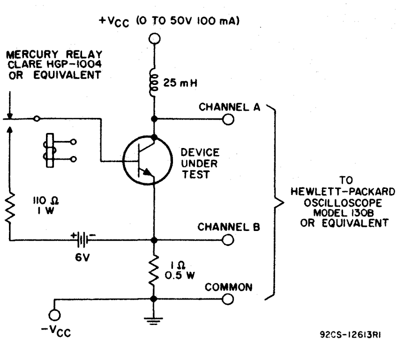
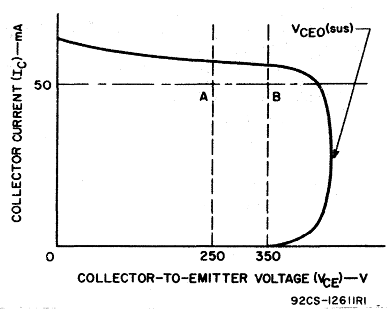


Fig. 8 – Circuit used to measure sustaining voltage $V_{CEO}(sus)$ for all types.



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.

File Number **529**

2N3441, 2N6263, 2N6264

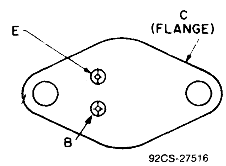
Medium-Power Silicon N-P-N Transistors

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

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6263	2N3441	2N6264	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	140	160	170	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
* With base open	$V_{CEO}(sus)$	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 Saturating Voltage	V_{CE}(sat)				1	0.1	–	–	–	–	–	0.5*	V
					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.

2N3441, 2N6263, 2N6264

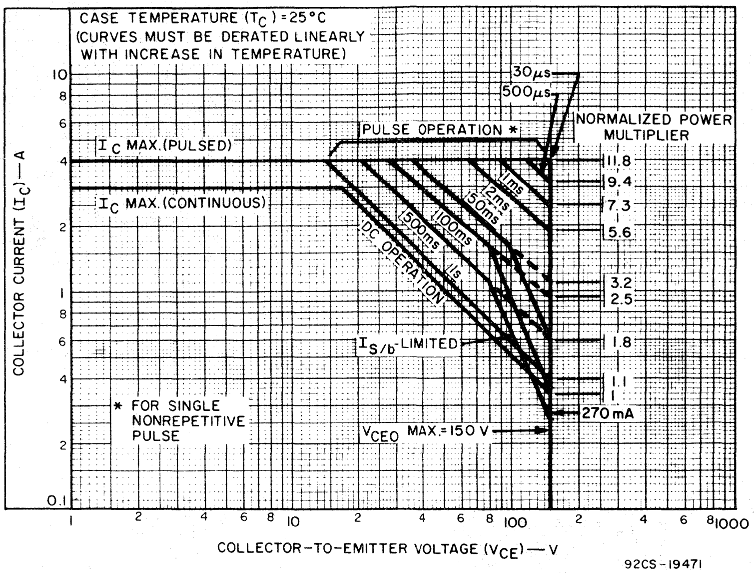


Fig. 1 — Maximum operating areas for type 2N6264.

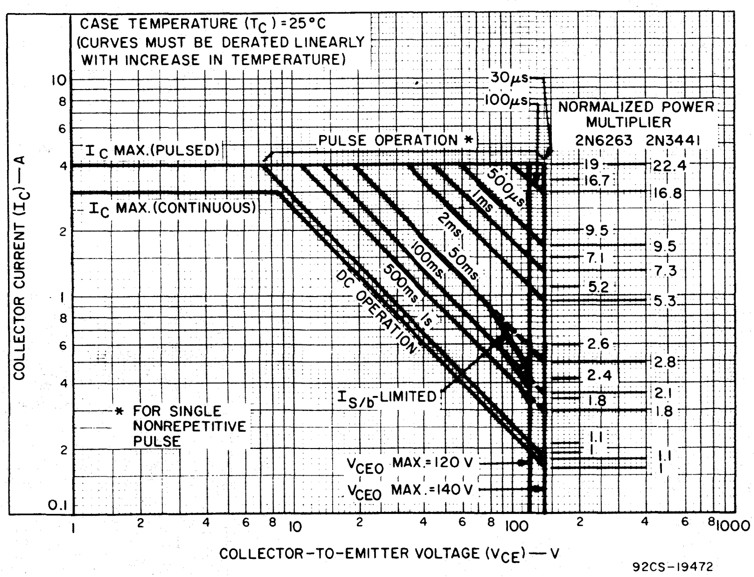


Fig. 2 — Maximum operating areas for types 2N6263 and 2N3441.

2

2N3441, 2N6263, 2N6264

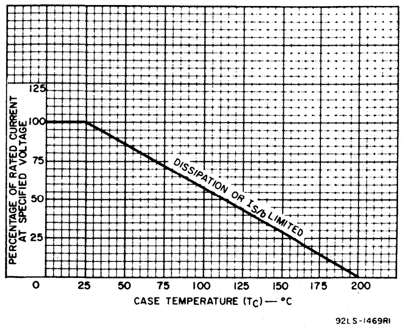


Fig. 3 — Current derating curve for all types.

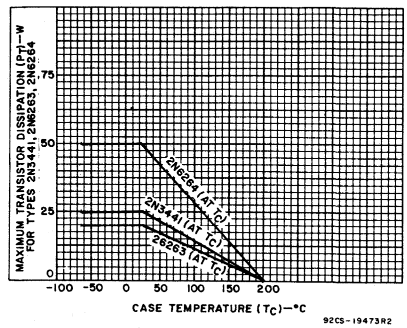


Fig. 4 — Dissipation derating curves for all types.

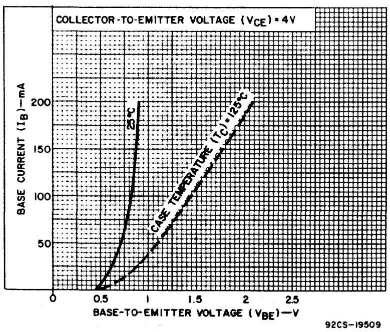


Fig 5 — Typical input characteristics for type 2N6264.

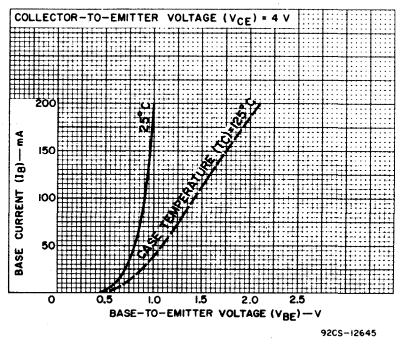


Fig. 6 — Typical input characteristics for type 2N3441.

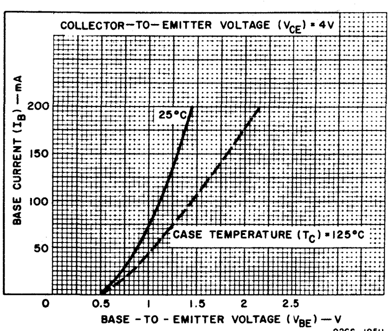


Fig. 7 — Typical input characteristics for type 2N6263.

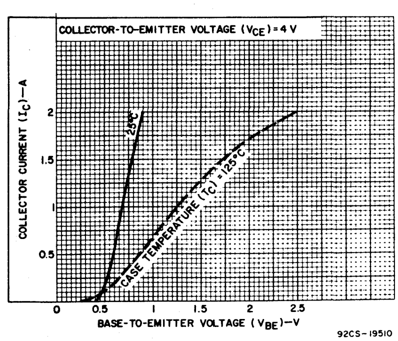


Fig. 8 — Typical transfer characteristics for type 2N6264.

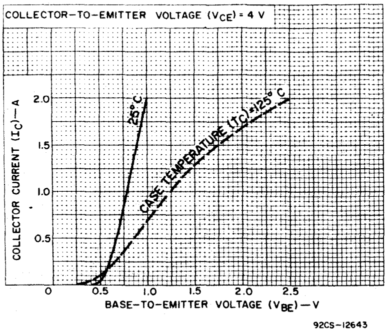


Fig. 9 — Typical transfer characteristics for type 2N3441.

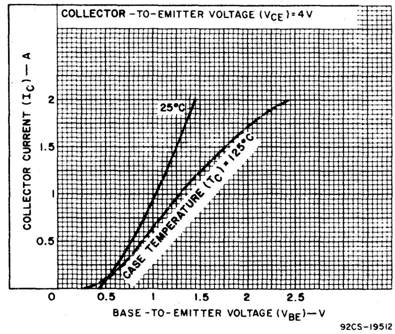


Fig. 10 — Typical transfer characteristics for type 2N6263.

2

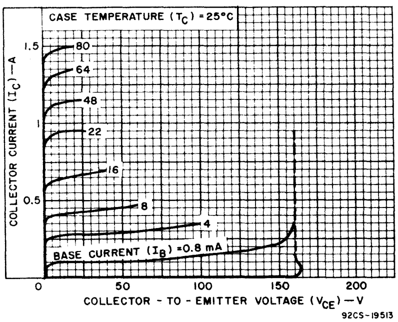


Fig. 11 — Typical output characteristics for type 2N6264.

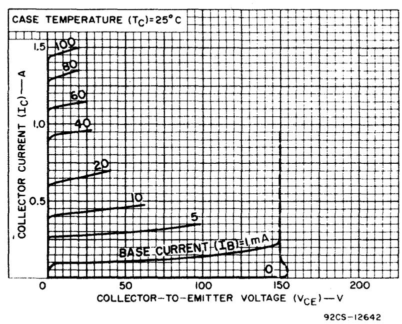


Fig. 12 — Typical output characteristics for type 2N3441.

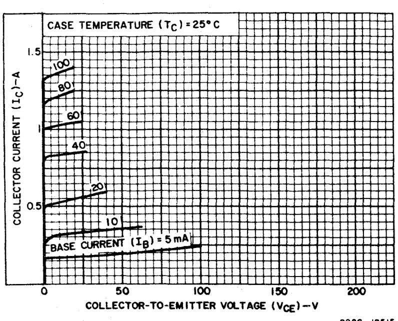


Fig. 13 — Typical output characteristics for type 2N6263.

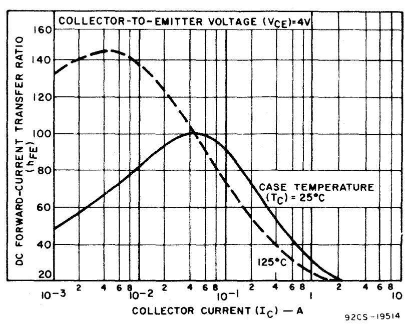


Fig. 14 — Typical dc beta characteristics for type 2N6264.

2N3441, 2N6263, 2N6264

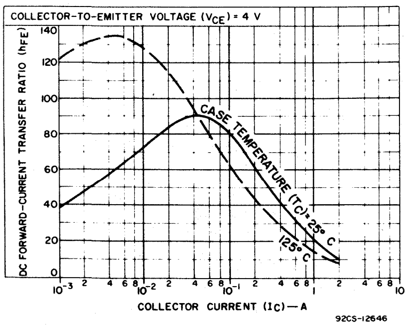


Fig. 15 — Typical dc beta characteristics for type 2N3441.

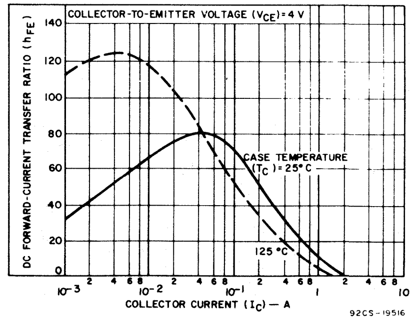


Fig. 16 — Typical dc beta characteristics for type 2N6263.

File Number **528**

2N3442, 2N4347, 2N6262

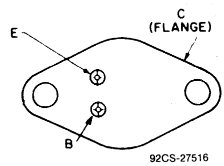
High-Voltage Silicon N-P-N Transistors

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

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N4347	2N3442	2N6262	
*V_{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: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N4347 Min.	2N4347 Max.	2N3442 Min.	2N3442 Max.	2N6262 Min.	2N6262 Max.	UNITS
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	–	
* $\lvert h_{fe} \rvert$ 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

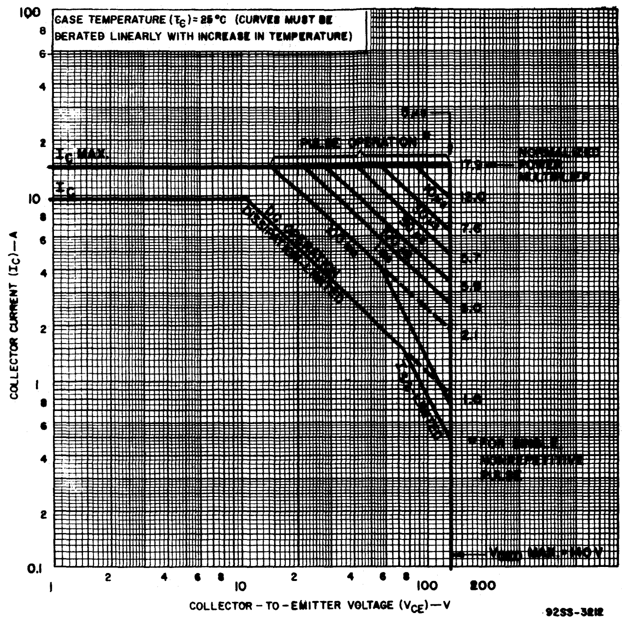


Fig. 1 — Maximum operating areas for type 2N3442.

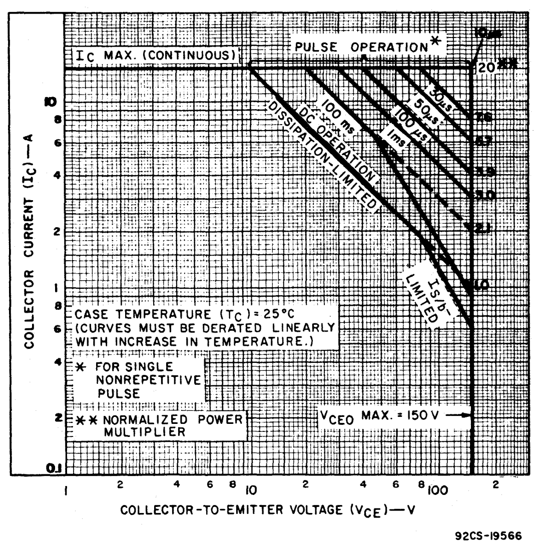


Fig. 2 — Maximum operating areas for type 2N6262.

2N3442, 2N4347, 2N6262

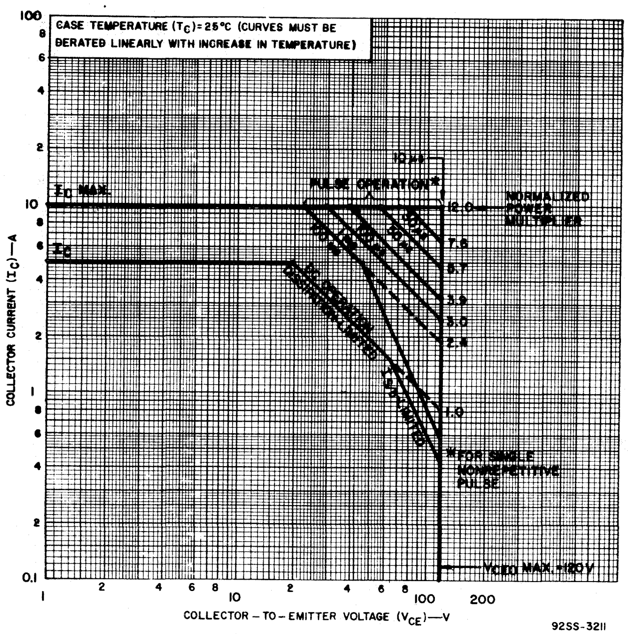


Fig. 3 — Maximum operating areas for type 2N4347.

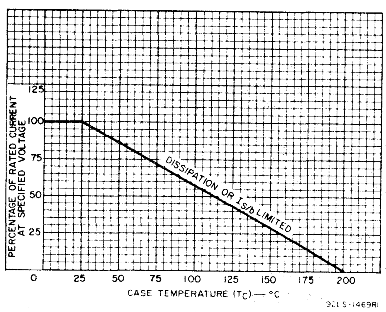


Fig. 4 — Current derating curve for all types.

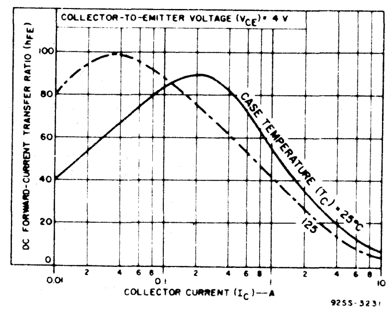


Fig. 5 — Typical dc beta characteristics for type 2N3442.

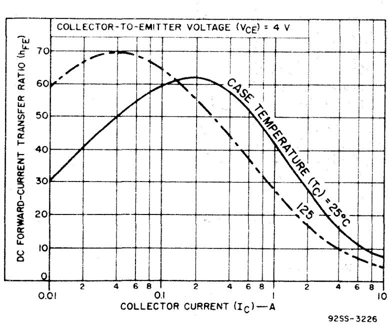


Fig. 6 — Typical dc beta characteristics for type 2N4347.

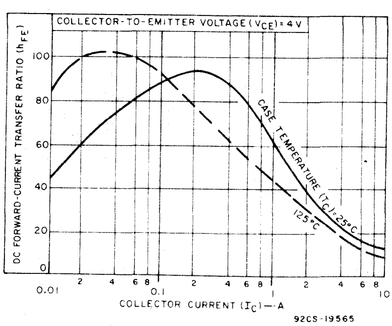


Fig. 7 — Typical dc beta characteristics for type 2N6262.

2N3442, 2N4347, 2N6262

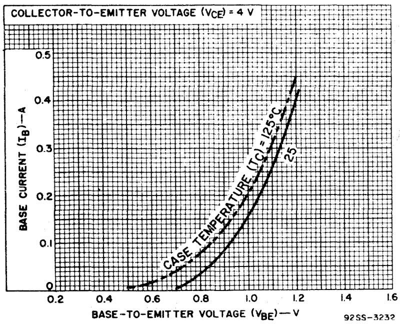


Fig. 8 — Typical input characteristics for type 2N3442.

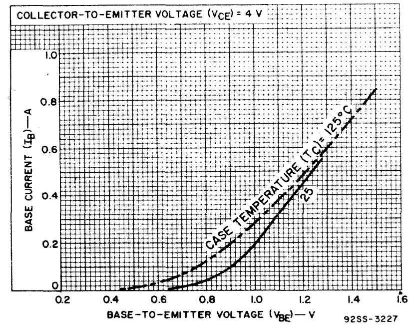


Fig. 9 — Typical input characteristics for type 2N4347.

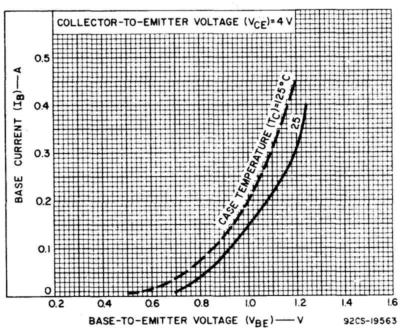


Fig. 10 — Typical input characteristics for type 2N6262.

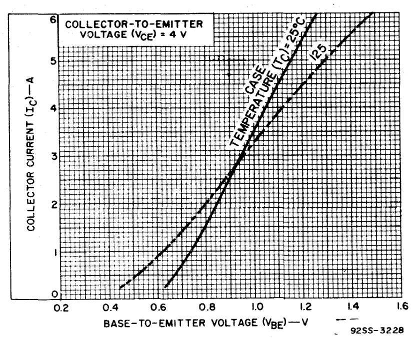


Fig. 11 — Typical transfer characteristics for type 2N3442 and 2N4347.

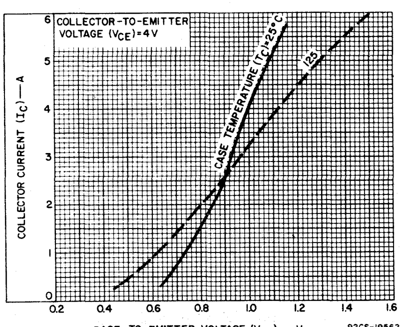


Fig. 12 — Typical transfer characteristics for type 2N6262.

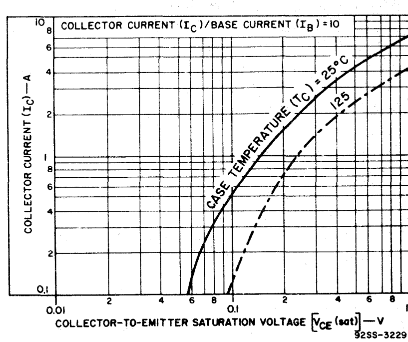


Fig. 13 — Typical saturation-voltage characteristics for all types.

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*

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

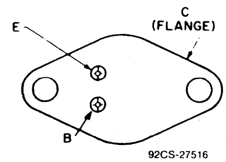
Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection and hi-fi amplifiers.

These transistors are also intended for a wide 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%.

2

2N3583-2N3585, 2N4240

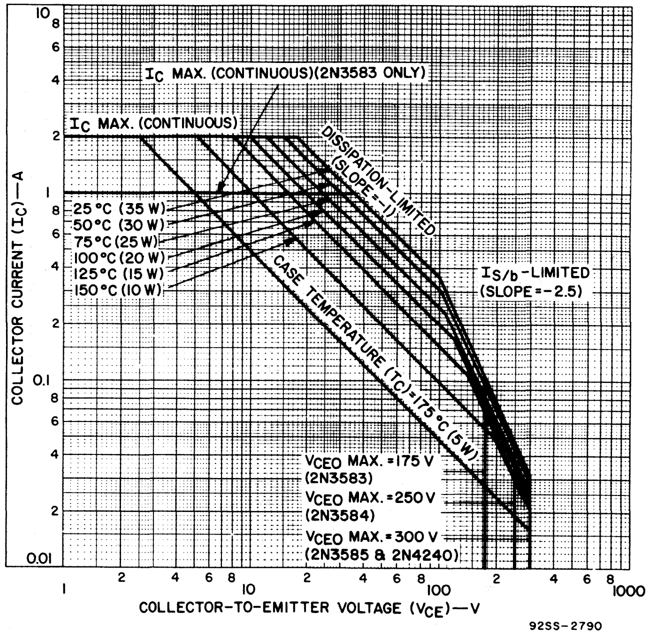


Fig. 1 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (dc conditions).

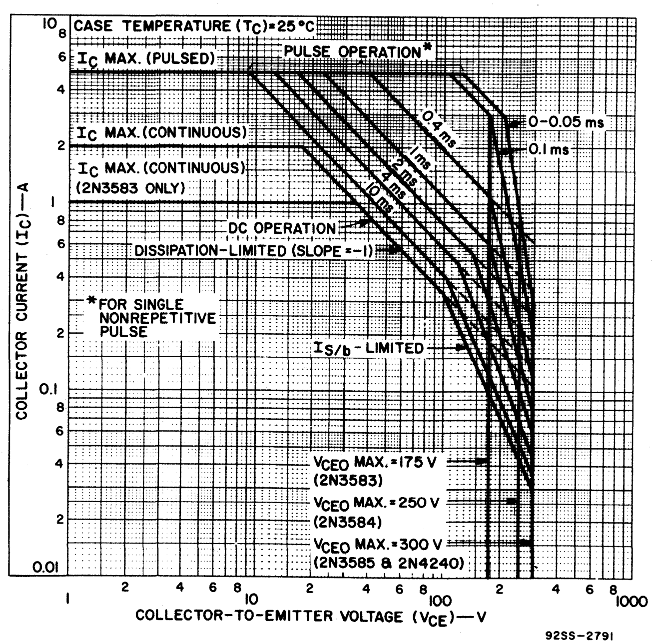


Fig. 2 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (pulse conditions).

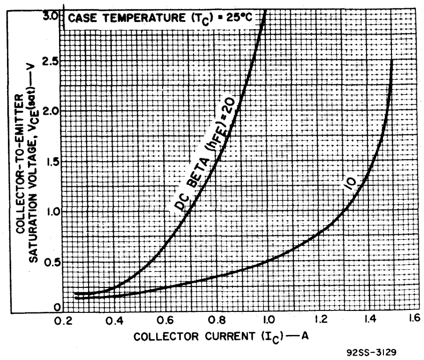


Fig. 3 - Typical collector-to-emitter saturation voltage vs. current for types 2N3584 and 2N3585.

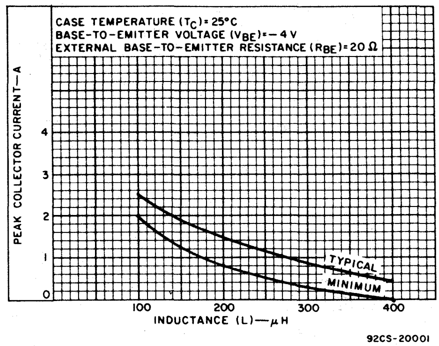


Fig. 4 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

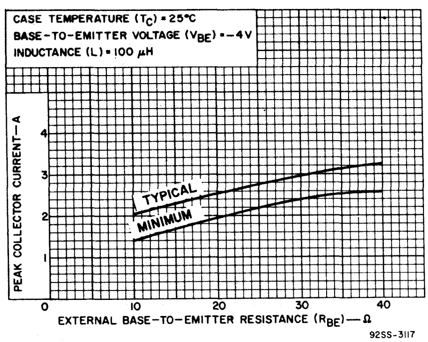


Fig. 5 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

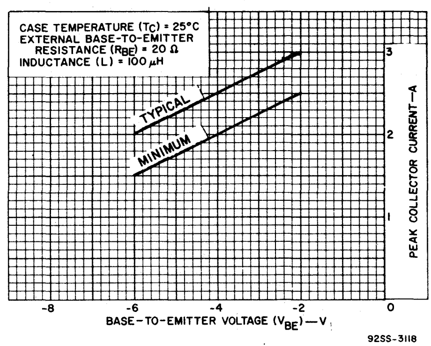


Fig. 6 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

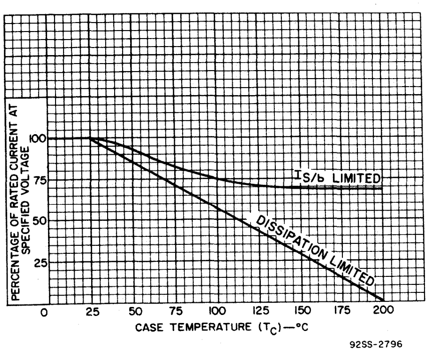


Fig. 7 - Dissipation derating curves for all types.

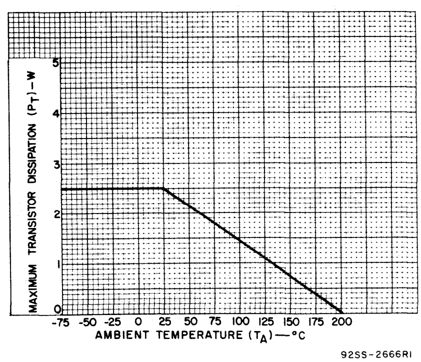


Fig. 8 - Dissipation derating curve for types 2N3583, 2N3584, 2N3585, and 2N4240.

2N3583-2N3585, 2N4240

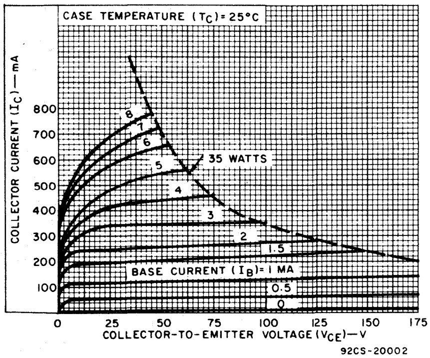


Fig. 9 - Typical output characteristics for type 2N3583.

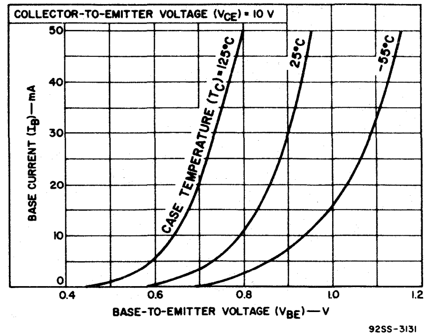


Fig. 10 - Typical input characteristics for all types.

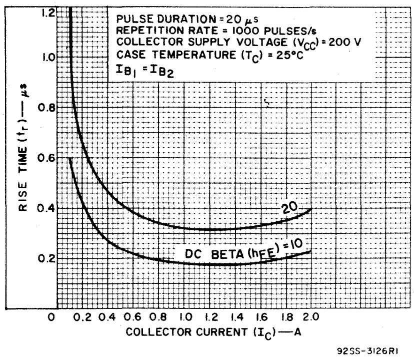


Fig. 11 - Typical rise time vs. collector current for types 2N3584 and 2N3585.

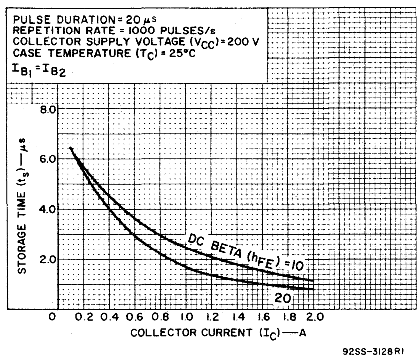


Fig. 12 - Typical storage time vs. collector current for types 2N3584 and 2N3585.

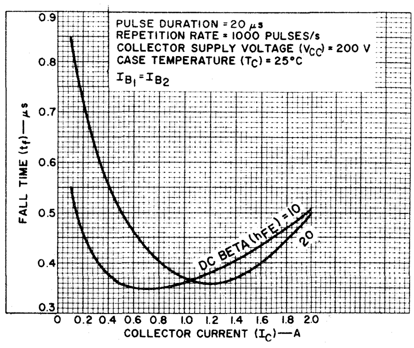


Fig. 13 - Typical fall time vs. collector current for types 2N3584 and 2N3585.

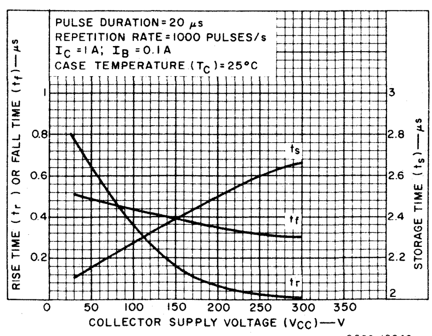


Fig. 14 - Typical rise time, fall time, and storage time vs. collector supply voltage for types 2N3584 and 2N3585.

2N3583-2N3585, 2N4240

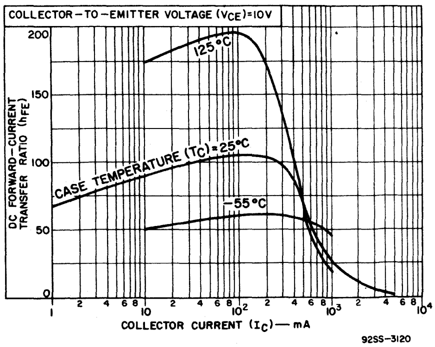


Fig. 15 - Typical dc beta vs. collector current for types 2N3583, and 2N4240.

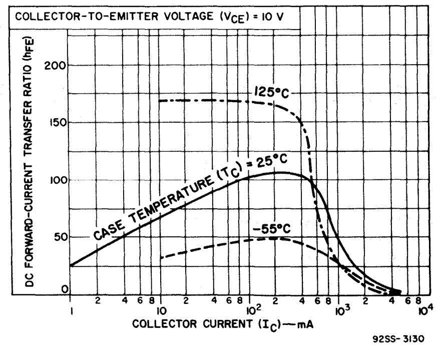


Fig. 16 - Typical dc beta vs. collector current for types 2N3584 and 2N3585.

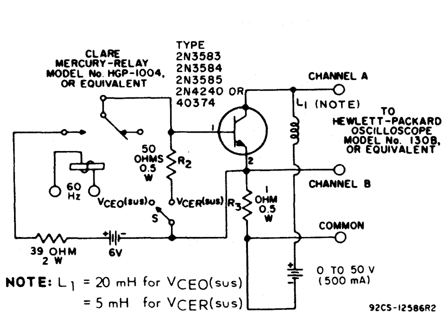
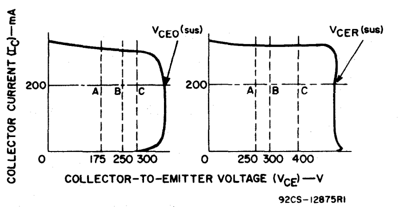


Fig. 17 - Circuit used to measure sustaining voltages V_{CEO}(sus) and V_{CER}(sus) for all types.



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.

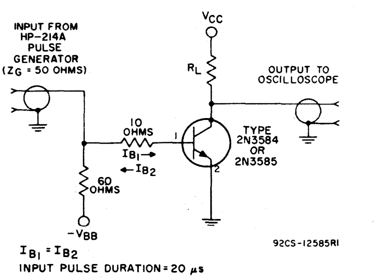


Fig. 19 - Circuit used to measure switching times for types 2N3584 and 2N3585.

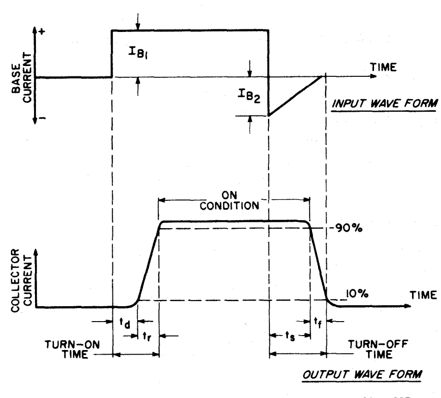


Fig. 20 - Phase relationship between input and output currents, showing reference points for specification of switching times.

2N3771, 2N3772

File Number **974**

High-Current Power Transistors

Broadly Applicable Devices for
Industrial and Commercial Use

Features:

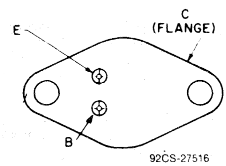
- *High collector dissipation: P_C=150 W (T_C=25° C)*
- *High collector current:*
  2N3771 I_C=30 A (dc)
  2N3772 I_C=20 A (dc)

The 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.

2N3771, 2N3772

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc				CURRENT A dc			LIMITS: 2N3771			2N3772			UNITS
	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	mA
* I_{CEX}		50		1.5				—	—	2	—	—	—	mA
		100		1.5				—	—	—	—	—	5	mA
* I_{CEX}, T_C=150° C		30		1.5				—	—	10	—	—	—	mA
		30		1.5				—	—	—	—	—	10	mA
* I_{CEO}		30					0	—	—	10	—	—	—	mA
		50					0	—	—	—	—	—	10	mA
* I_{EBO}			5		0			—	—	5	—	—	—	mA
			7		0			—	—	—	—	—	5	mA
* $V_{(BR)CEO}$					0.2		0	40	—	—	—	—	—	V
					0.2		0	—	—	—	60	—	—	V
* 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
* $V_{CE}(sat)$					15		1.5	—	—	2	—	—	—	V
					30		6	—	—	4	—	—	—	V
					10		1	—	—	—	—	0.3	1.4	V
					20		4	—	—	—	—	—	4	V
* f_T		4			1			0.2	—	—	—	—	—	MHz
		4			1			—	—	—	0.2	—	—	MHz
* $\|h_{fe}\|$, f=1 kHz		4			1			40	—	—	—	—	—	
		4			1			—	—	—	40	—	—	
$I_{S/b}$, t=1 s (non-repetitive)		40						3.75	—	—	—	—	—	A
		60						—	—	—	2.5	—	—	A

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

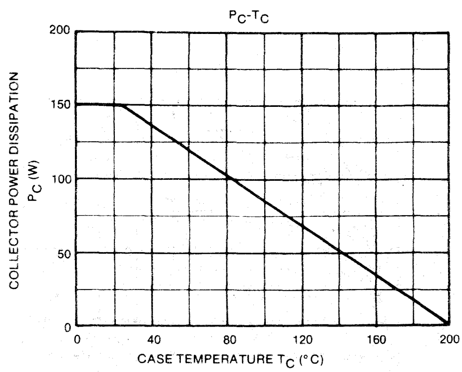


Fig. 1 - Power dissipation vs. temperature derating curve for both types.

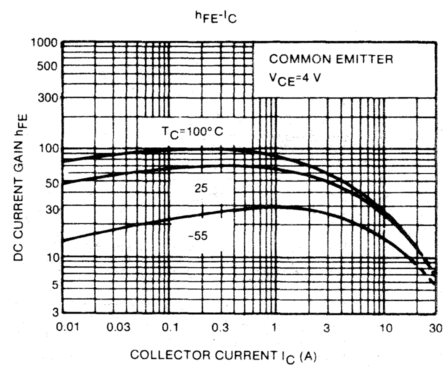


Fig. 2 - Typical dc-beta characteristics for 2N3771.

2N3771, 2N3772

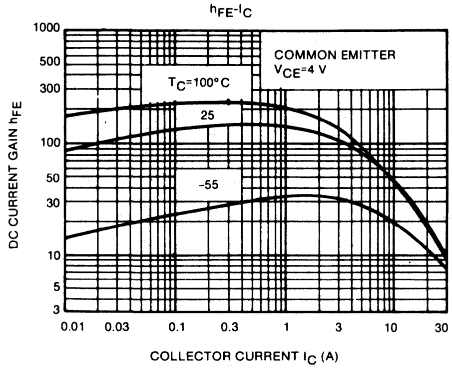


Fig. 3 - Typical dc-beta characteristics for 2N3772.

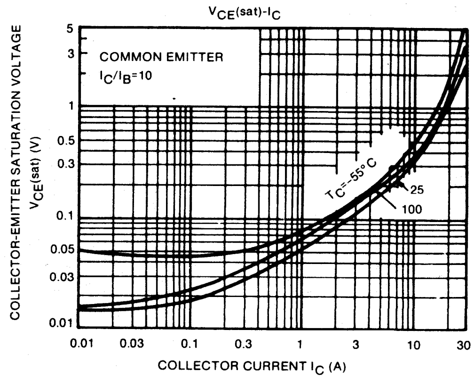


Fig. 4 - Typical collector-to-emitter saturation voltage characteristics for type 2N3771.

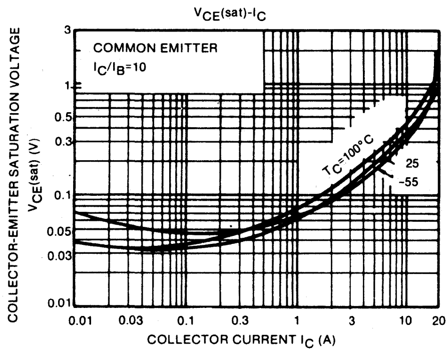


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for type 2N3772.

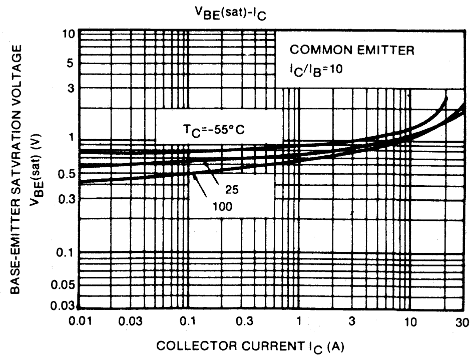


Fig. 6 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3771.

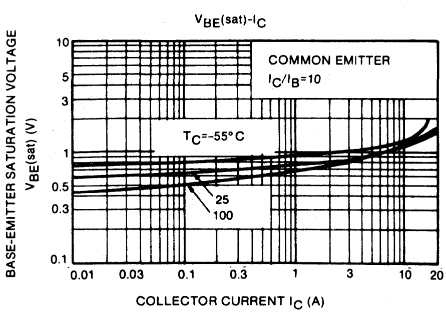


Fig. 7 - Typical base-to-emitter saturation voltage as a function of collector current for type 2N3772.

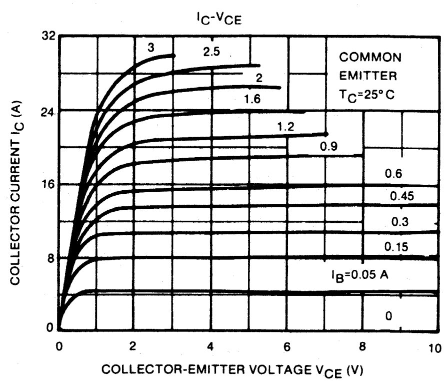


Fig. 8 - Typical output characteristics for 2N3771.

2N3771, 2N3772

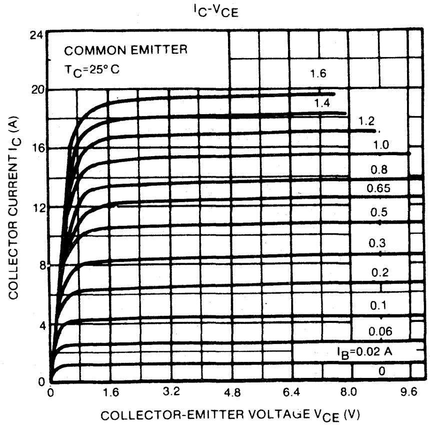


Fig. 9 - Typical output characteristics for 2N3772.

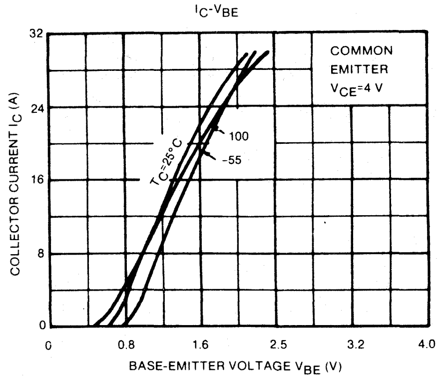


Fig. 10 - Typical transfer characteristics for 2N3771.

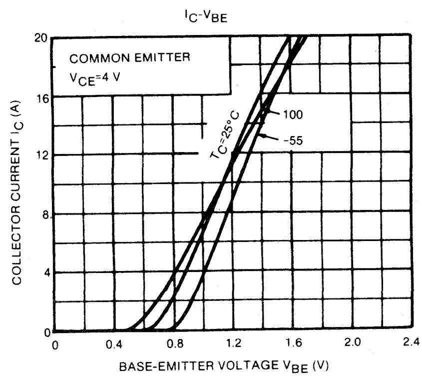


Fig. 11 - Typical transfer characteristics for 2N3772.

2N3773, 2N4348, 2N6259

File Number **526**

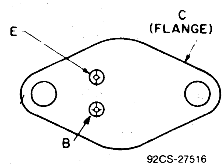
High-Voltage, High-Current Power Transistors

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 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.	Max.	2N3773 Min.	Max.	2N6259 Min.	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.%.

2

2N3773, 2N4348, 2N6259

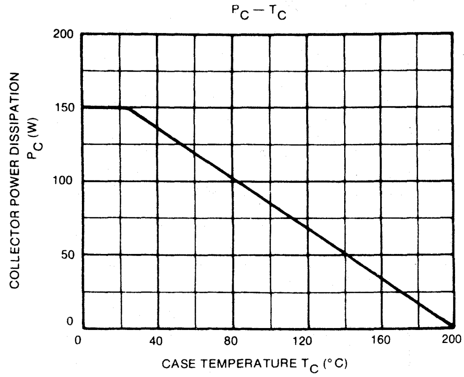


Fig. 1 — Dissipation derating curve for all types.

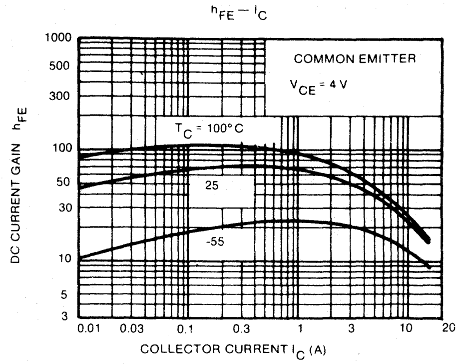


Fig. 2 — Typical dc-beta characteristics for all types.

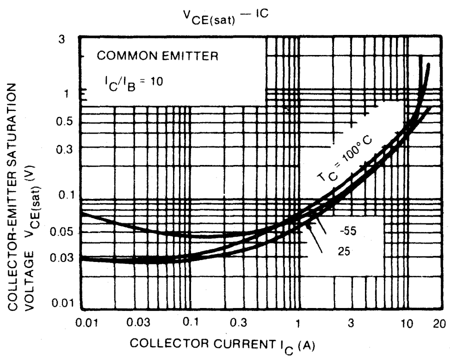


Fig. 3 — Typical collector-to-emitter saturation voltage characteristics for all types.

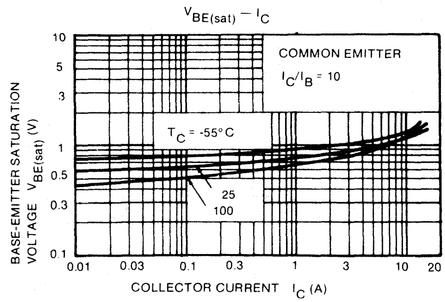


Fig. 4 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

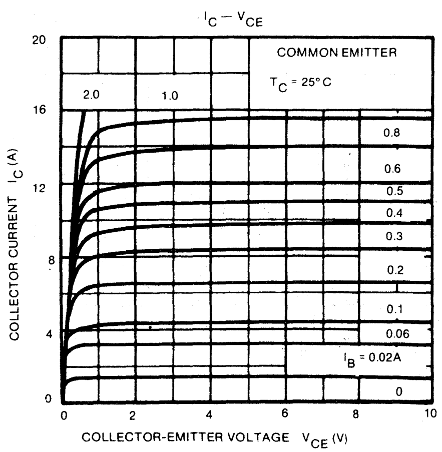


Fig. 5 — Typical output characteristics for all types.

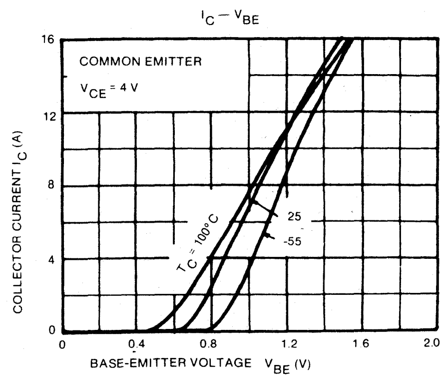


Fig. 6 — Typical transfer characteristics for 2N3773 and 2N4348.

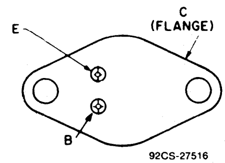
File Number **1059**

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

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N3791	2N3792	
* V_{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	0.86	W/°C
* T_J, T_{stg}	-65 to 200	-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.

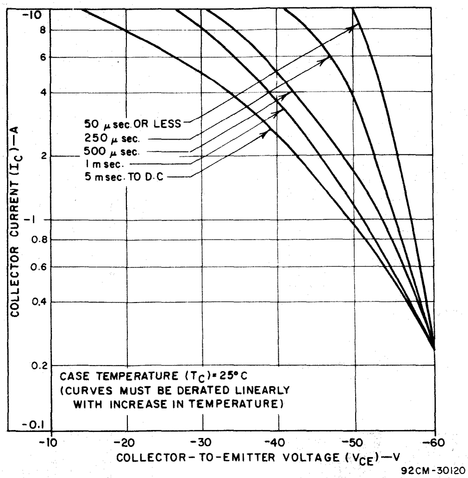


Fig. 1 — Maximum operating areas for 2N3791.

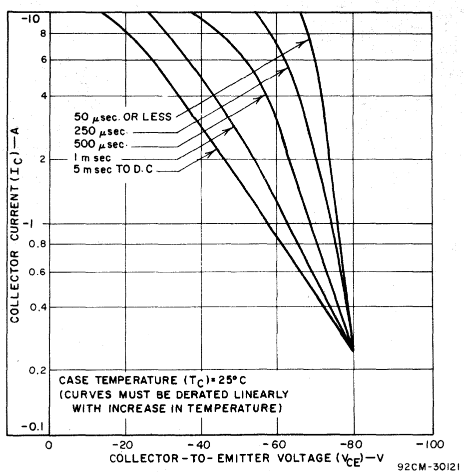


Fig. 2 — Maximum operating areas for 2N3792.

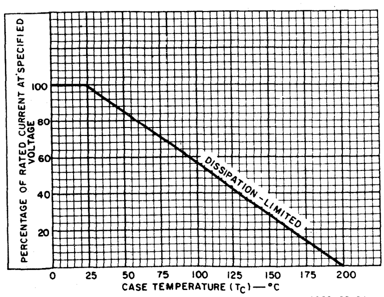


Fig. 3 — Derating curve.

2N3791, 2N3792

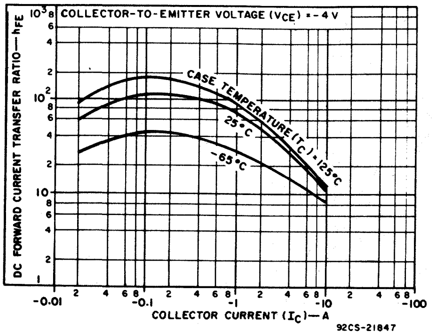


Fig. 4 — Typical dc beta characteristics for both types.

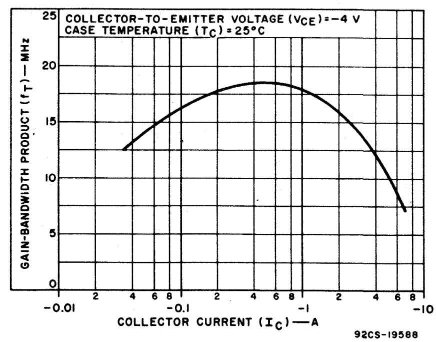


Fig. 5 — Typical gain-bandwidth product for both types.

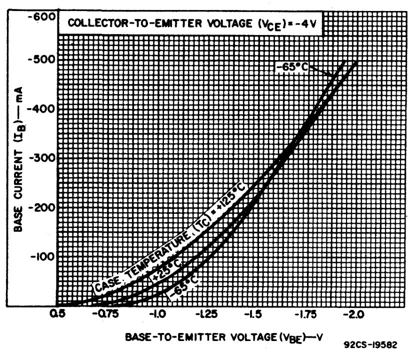


Fig. 6 — Typical input characteristics for both types.

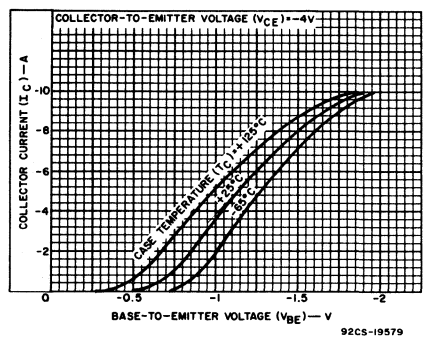


Fig. 7 — Typical transfer characteristics for both types.

File Number **766**

2N3878, 2N3879, 2N5202, 2N6500

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*

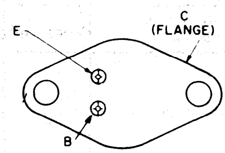
2

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

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

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

TERMINAL DESIGNATIONS



92CS-27516

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 V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	2N3878 Min.	2N3878 Max.	2N3879 Min.	2N3879 Max.	2N5202 Min.	2N5202 Max.	2N6500 Min.	2N6500 Max.	UNITS
Collector Cutoff Current: * With base-emitter junction reverse-biased	I_{CEV}	100 110 120	−1.5 0 −1.5			– – –	– – 25	– – –	– – 25	– – –	10 – –	– – –	– 5 –	mA
* With base-emitter junction reverse-biased and T_C = 150°C	I_{CEV}	100 110	−1.5 0			– –	4 –	– –	4 –	– –	10 –	– –	– 10	mA
With base open	I_{CEO}	40 70			0 0	– –	5* –	– –	5 –	– –	– –	– –	– 5	mA
* Emitter Cutoff Current	I_{EBO}		−6 −7			– –	– 10	– –	– 10	– –	10 –	– –	– 25	mA
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2	0	50*a	–	75*a	–	50a	–	90*a	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			0.2	0	65a	–	90a	–	75a	–	110a		V
DC Forward-Current Transfer Ratio	h_{FE}	1.2 2 2 2 5 5		4b 0.5b 3b 4b 4b 0.5b		– 40* – 8* 20* 50*	– 200* – – – 200*	– – – 12* 20 40	– – – 100* 80 –	10* – – – – –	100* – – – – –	– – 15* – – –	– – 60* – – –	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			3b 4b	0.3 0.4	– –	– 2	– –	– 1.2	– –	– 1.2	– –	1.5 –	V
* Base-to-Emitter Voltage	V_{BE}	2		4b	–	–	2.5	–	–	–	–	–	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			3b 4b	0.3 0.4	– –	– –	– –	– 2	– –	– 2	– –	2.5 –	V
Collector-to-Base Output Capacitance (f = 1 MHz, V_{CB} = 10 V)	C_{ob}					–	175*	–	175	–	175	–	175	pF
Second Breakdown Collector Current: With base forward-biased and 1-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)	$\lvert h_{fe} \rvert$	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

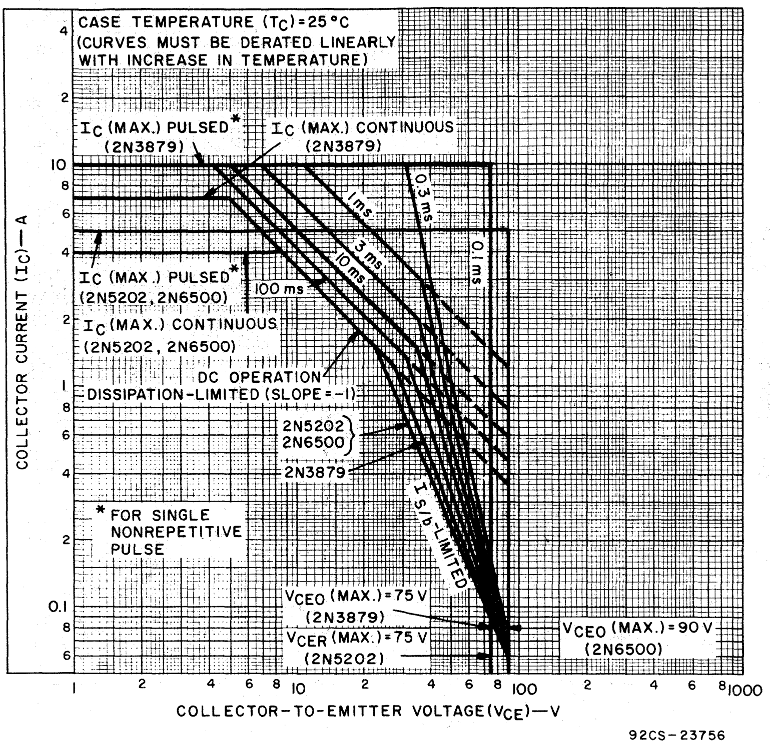


Fig. 1 – Maximum operating areas for 2N3879, 2N5202, and 2N6500.

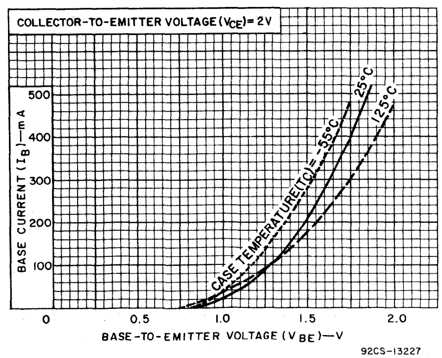


Fig. 2 – Typical input characteristics for all types.

2

2N3878, 2N3879, 2N5202, 2N6500

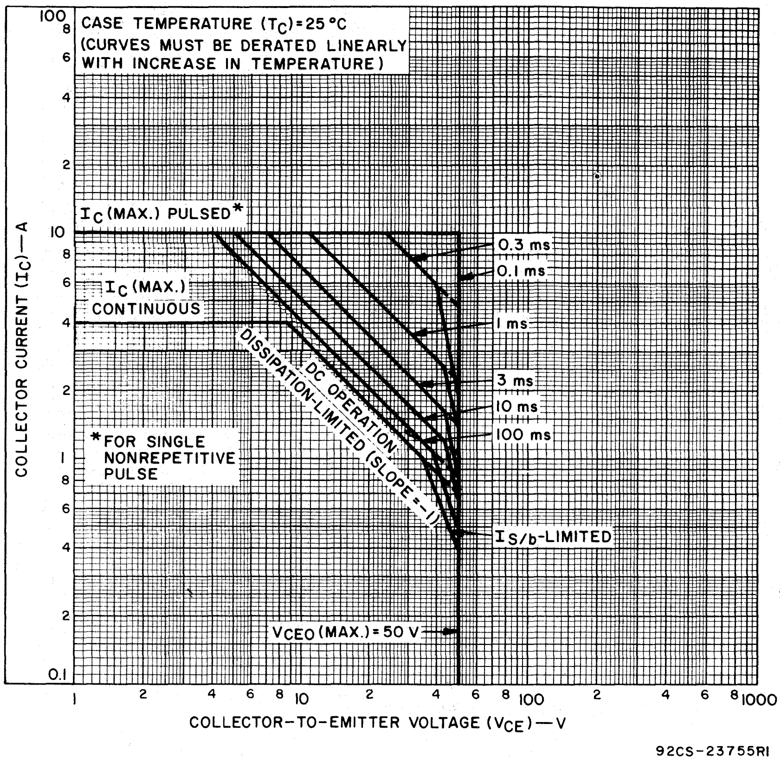


Fig. 3 – Maximum operating areas for 2N3878.

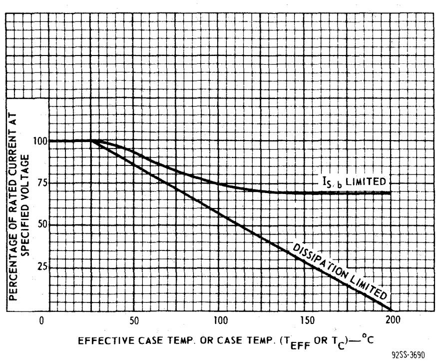
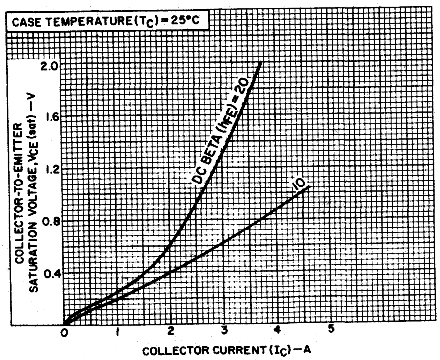
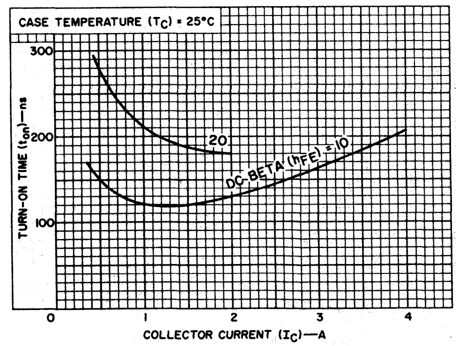


Fig. 4 – Dissipation derating for all types.



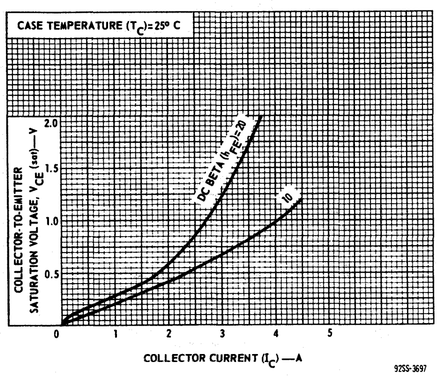
92CS-13236

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



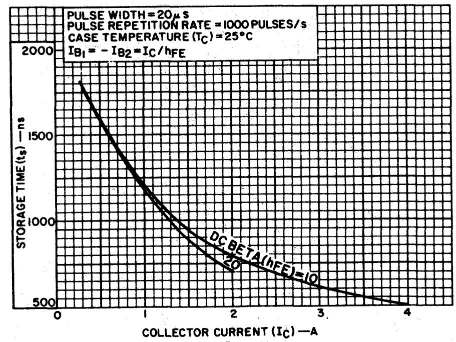
92CS-13234

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



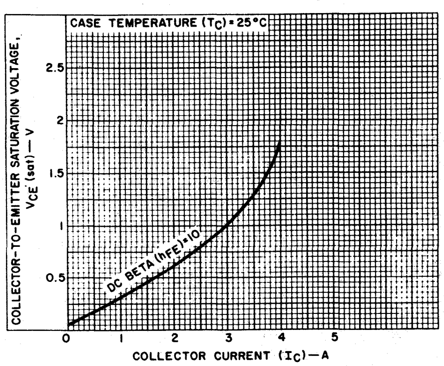
92SS-3697

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



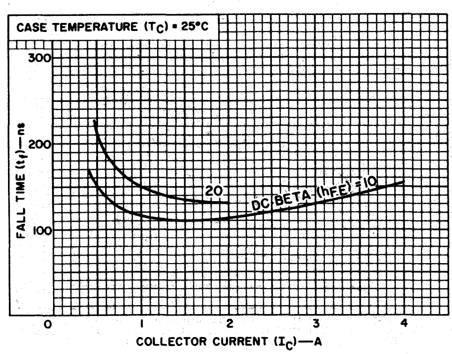
92CS-13237

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



92CS-23759

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



92CS-13235

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

2N3878, 2N3879, 2N5202, 2N6500

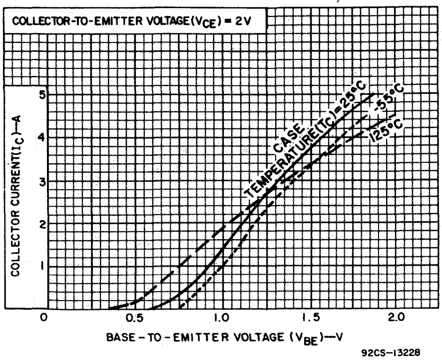


Fig. 11 — Typical transfer characteristics for all types.

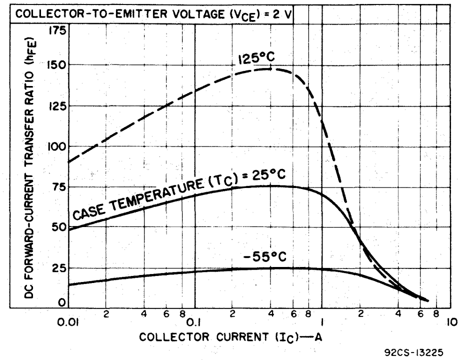


Fig. 12 — Typical dc beta characteristics for ***2N3878 and 2N3879.***

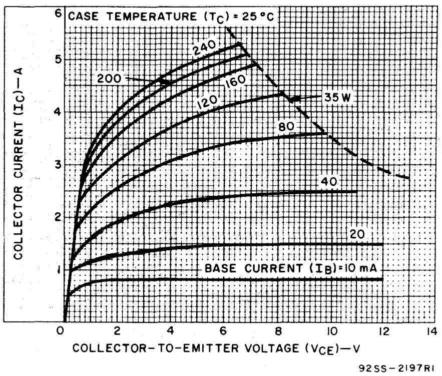


Fig. 13 — Typical output characteristics for ***2N3878, 2N3879 and 2N5202.***

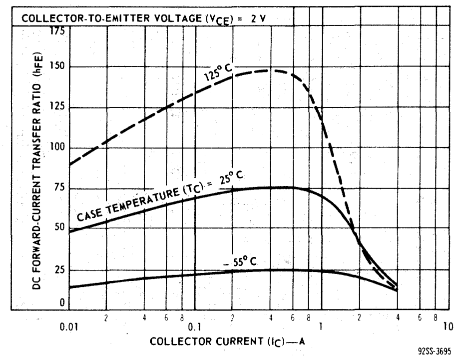


Fig. 14 — Typical dc beta characteristics for 2N5202.

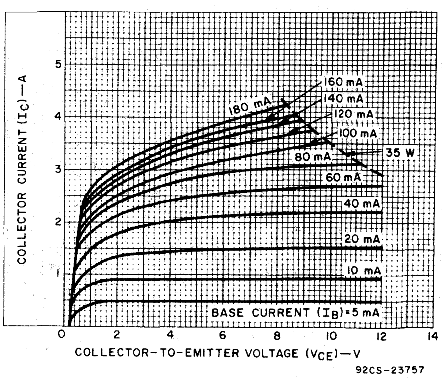


Fig. 15 — Typical output characteristics for 2N6500.

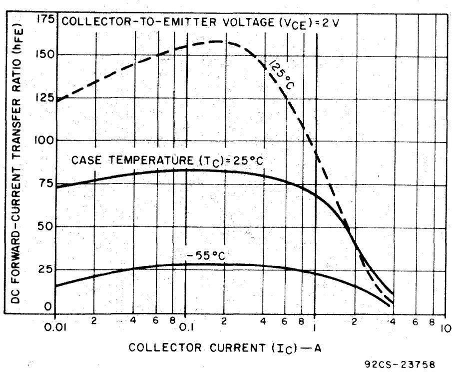


Fig. 16 — Typical dc beta characteristics for 2N6500.

2N3878, 2N3879, 2N5202, 2N6500

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

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

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

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

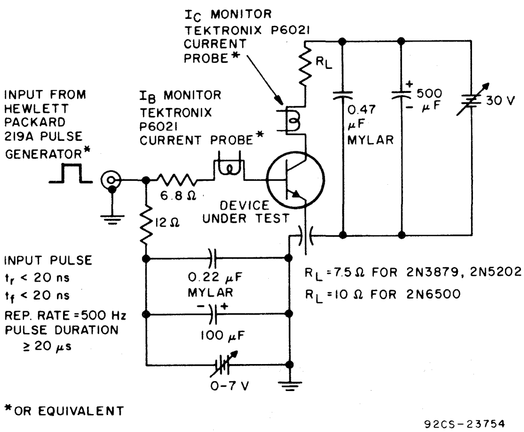


Fig. 17 – Circuit used to measure switching times for 2N3879, 2N5202, and 2N6500.

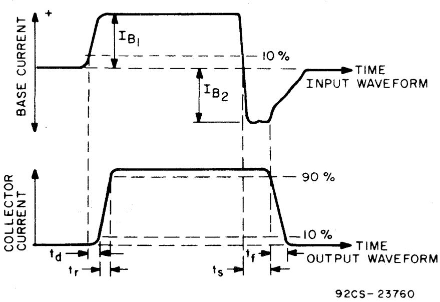


Fig. 18 – Oscilloscope display for measurement of switching times. (Circuit shown in Fig.1).

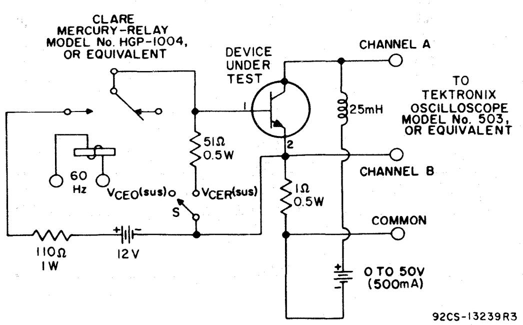
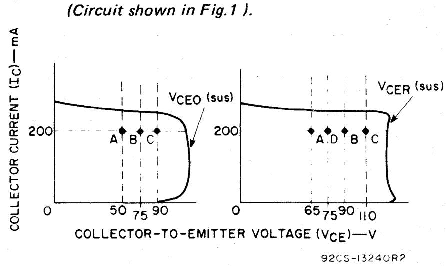


Fig. 19 – Circuit used to measure sustaining voltages, V_{CEO}(sus) and V_{CER}(sus) for all types.



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.

2N4036, 2N4037, 2N4314

File Number **216**

Medium-Power Silicon P-N-P Planar Transistors

General-Purpose Types for Industrial and Commerical Applications

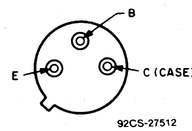
Features:

- *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*

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

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

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N4036	2N4037	2N4314	
*V_{CBO}	-90	-60	-90	V
$V_{CEV}(sus)$				
V_{BE} = +1.5 V	-85	-60	-85	V
$V_{CER}(sus)$				
$R_{BE} \leq 200\ \Omega$	-85	-60	-85	V
*$V_{CEO}(sus)$	-65	-40	-65	V
*V_{EBO}	-7	-7	-7	V
*I_C	-1.0	-1.0	-1.0	A
*I_B	-0.5	-0.5	-0.5	A
*P_T:				
$T_C \leq 25°C$	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}	-90●				–	-0.1*	–	–	–	–	mA
$I_E = 0$	-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*	–	–	–	–	mA
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
$V_{CER}(sus)$ $R_{BE} \leq 200\ \Omega$			-100		-85[b]	–	-60[b]	–	-85[b]	–	V
* $V_{CEO}(sus)$			-100	0	-65[b]	–	-40[b]	–	-65[b]	–	V
* $V_{CE}(sat)$			-150	-15	–	-0.65	–	-1.4	–	-1.4	V
V_{BE}	-10		-150		–	-1.1	–	-1.5*	–	-1.5*	V
* $V_{BE}(sat)$			-150	-15	–	-1.4	–	–	–	–	V
* h_{FE}	-2		-150		20	200	–	–	–	–	
	-10		-0.1		20	–	–	–	–	–	
	-10		-1.0		–	–	15	–	15	–	
	-10		-150[a]		40	140	50	250	50	250	
	-10		-500[a]		20	–	–	–	–	–	
* $\|h_{fe}\|$ f = 20 MHz	-10		-50		3	–	3	10	3	10	
C_{cb} $I_E = 0$, f = 1 MHz	-10●				–	30	–	30*	–	30*	pF
C_{ib}		0.5	0		–	90	–	90	–	90	pF
* t_r	-30		-150	-15	–	70	–	–	–	–	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').

2N4036, 2N4037, 2N4314

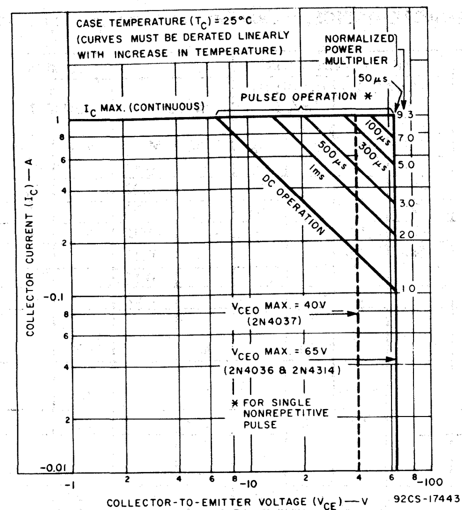


Fig. 1 - Maximum operating areas for 2N4036, 2N4037, and 2N4314.

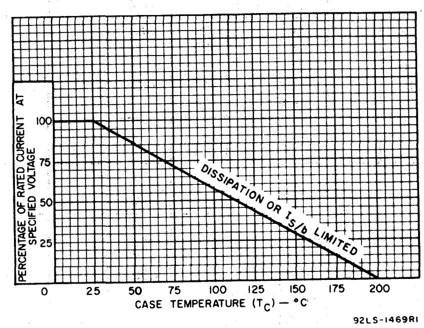


Fig. 2 - Dissipation derating curve for 2N4036, 2N4037, and 2N4314.

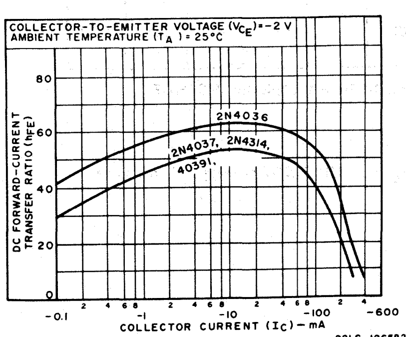


Fig. 3 - Typical dc beta characteristics for all types.

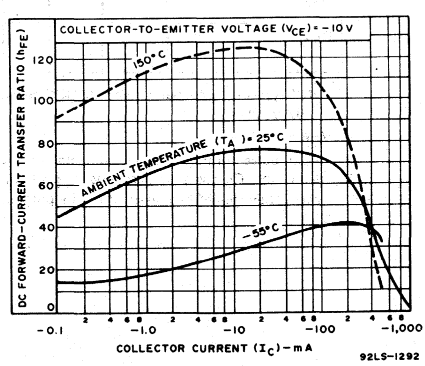


Fig. 4 - Typical dc beta characteristics for 2N4037 and 2N4314.

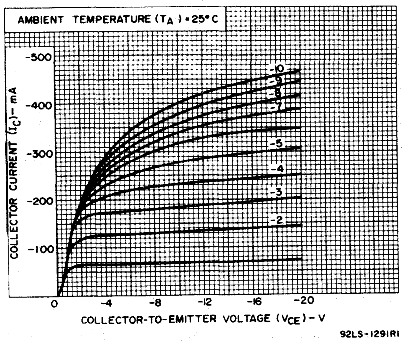


Fig. 5 - Typical large-signal output characteristics for 2N4037 and 2N4314.

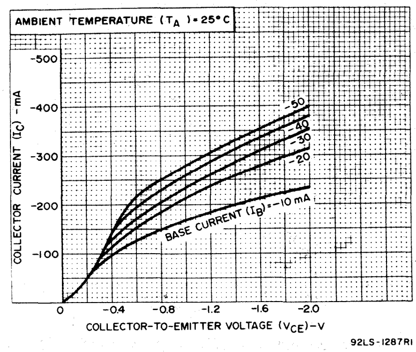


Fig. 6 - Typical small-signal output characteristics for 2N4037 and 2N4314.

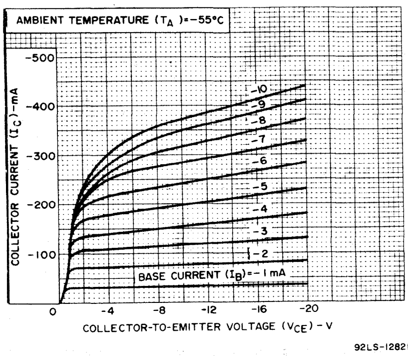


Fig. 7 - Typical output characteristics at $T_A = -55°C$ for 2N4037 and 2N4314.

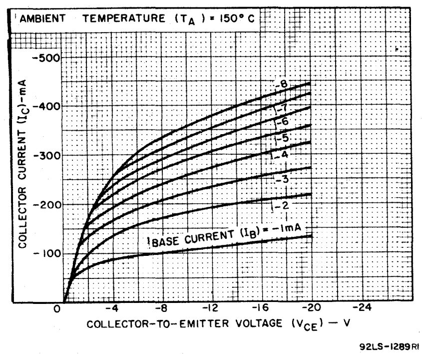


Fig. 8 - Typical output characteristics at $T_A = 150° C$ for 2N4037 and 2N4314.

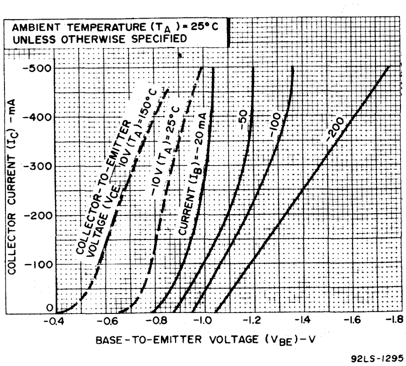


Fig. 9 - Typical transfer characteristics for 2N4037 and 2N4314.

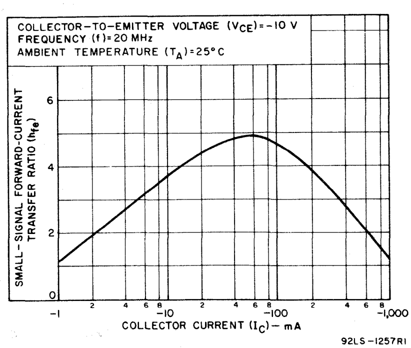


Fig. 10 - Typical small-signal beta characteristic for all types.

2N4036, 2N4037, 2N4314

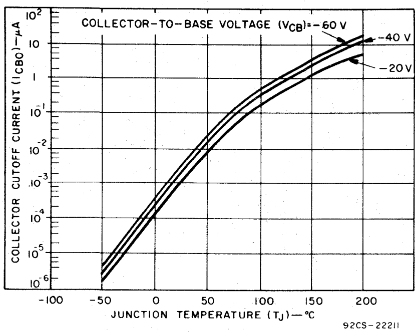


Fig. 11 - Typical collector cutoff current vs. junction temperature for 2N4036.

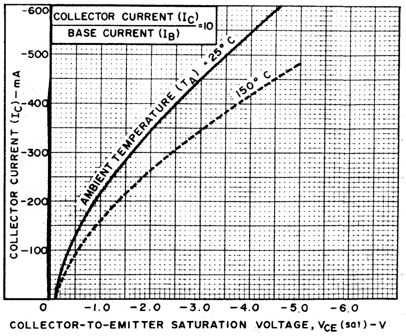


Fig. 12 - Typical saturation-voltage characteristics for 2N4036.

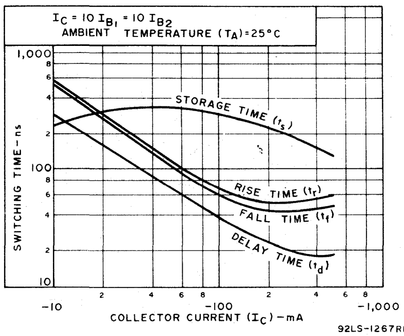


Fig. 13 - Typical saturated switching times for type 2N4036.

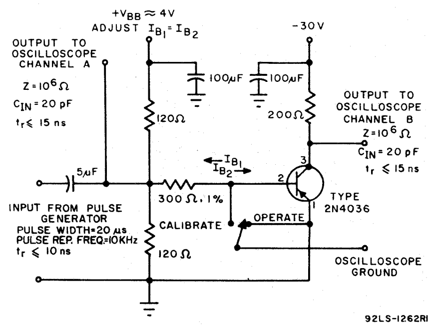


Fig. 14 - Circuit used to measure switching times for type 2N4036.

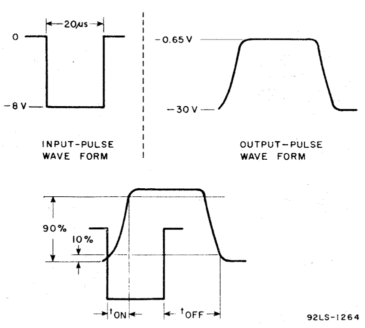


Fig. 15 - Oscilloscope display for measurement of switching times.

File Number **1150**

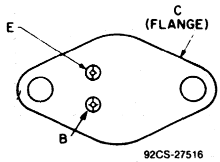
2N4898, 2N4899, 2N4900

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 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				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N4898		2N4899		2N4900		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{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.)

2N4898, 2N4899, 2N4900

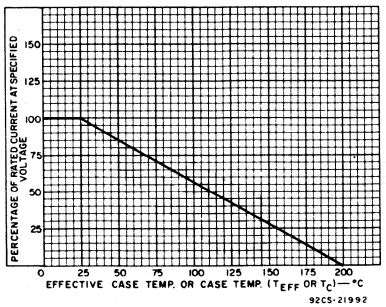


Fig. 1 — Current derating chart for all types.

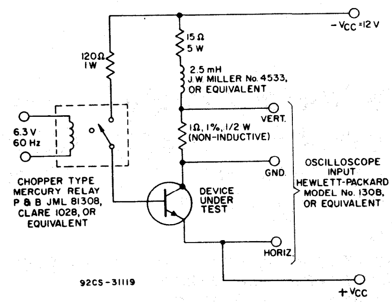


Fig. 2 — Circuit used to measure sustaining voltage, $V_{CEO}(sus)$.

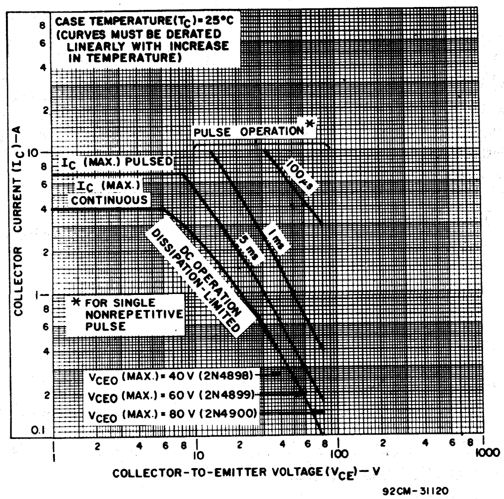
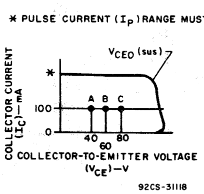


Fig. 3 — Maximum operating areas for all types. ($T_C = 25°C$).



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.

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

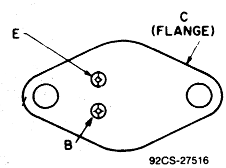
Features:

- *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*

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5038	2N5039	2N6496	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	150	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With − 1.5 volts (V_{BE}) of reverse bias and external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CEX}(sus)$	150	120	–	V
With $R_{BE} \leqslant 50\ \Omega$	$V_{CER}(sus)$	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 $R_{BE} \leq 50\ \Omega$	$V_{CER}(sus)$[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

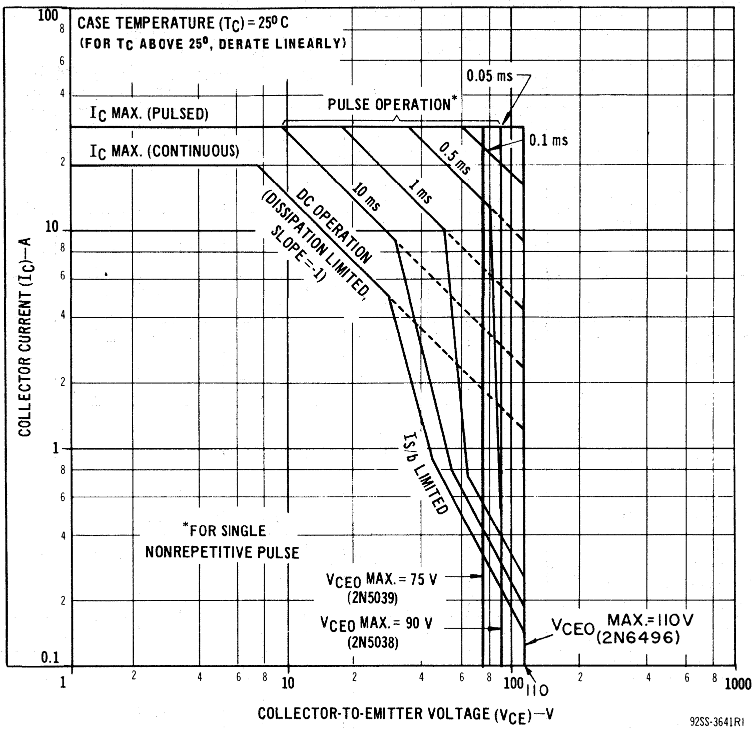


Fig. 1 — Maximum operating areas for all types.

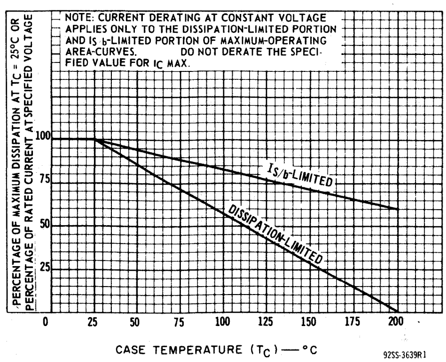


Fig. 2 — Dissipation derating curves for all types.

2N5038, 2N5039, 2N6496

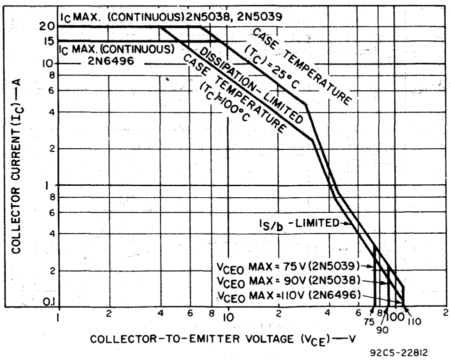


Fig. 3 – Maximum operating areas for all types.

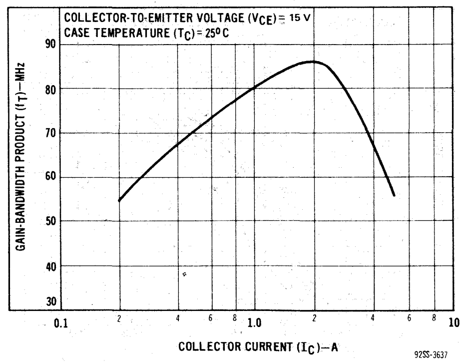


Fig. 4 – Typical gain-bandwidth product for all types.

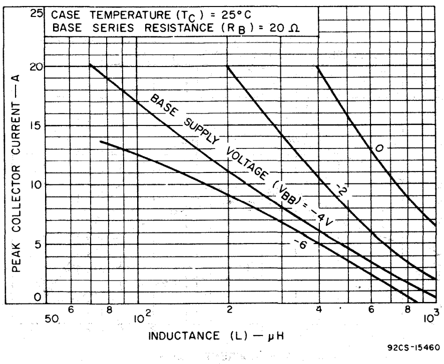


Fig. 5 – Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

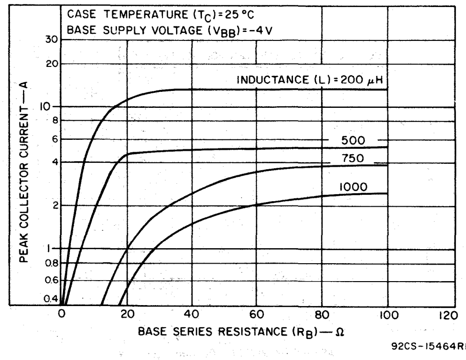


Fig. 6 – Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

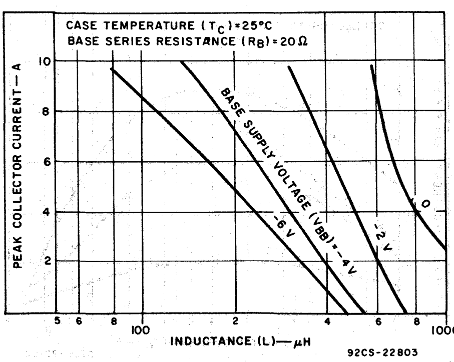


Fig. 7 – Maximum reverse-bias, second-breakdown characteristics for 2N6496.

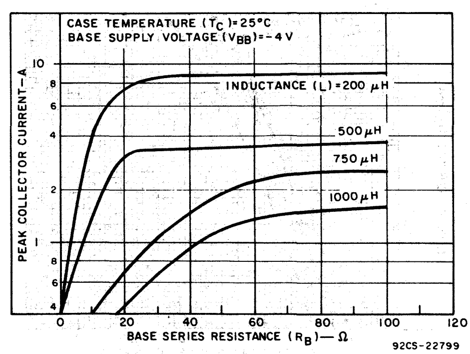


Fig. 8 – Maximum reverse-bias, second-breakdown characteristics for 2N6496.

2

2N5038, 2N5039, 2N6496

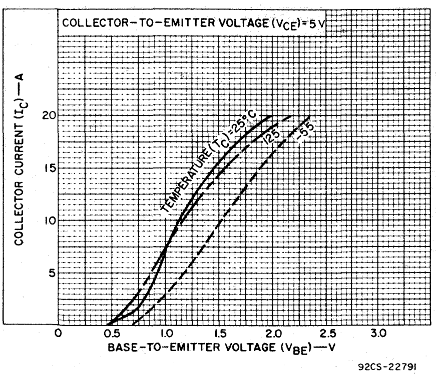


Fig. 9 - Typical transfer characteristics for 2N5038.

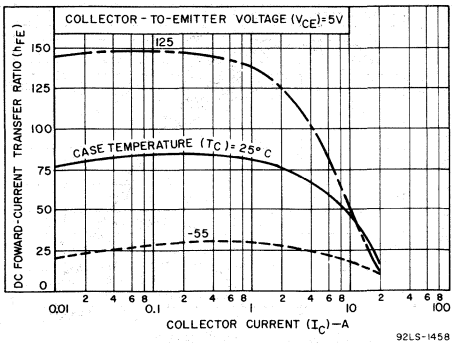


Fig. 10 - Typical dc beta characteristics for 2N5038.

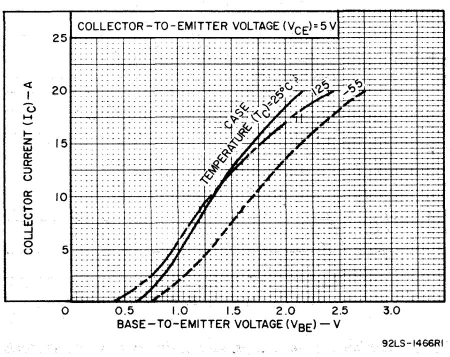


Fig. 11 - Typical transfer characteristics for 2N5039.

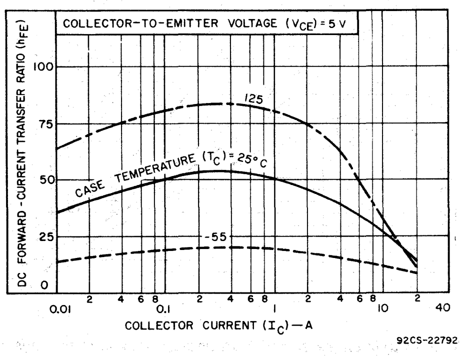


Fig. 12 -Typical dc beta characteristics for 2N5039.

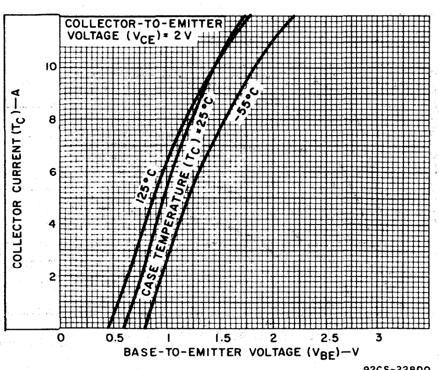


Fig. 13 - Typical transfer characteristics for 2N6496.

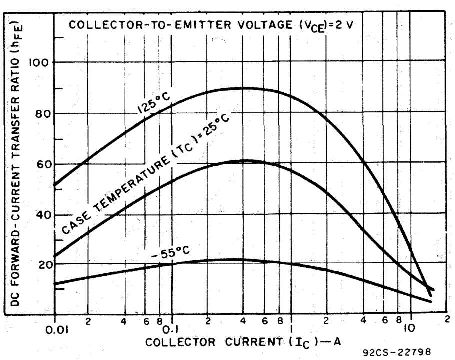


Fig. 14 - Typical dc beta characteristics for 2N6496.

2N5038, 2N5039, 2N6496

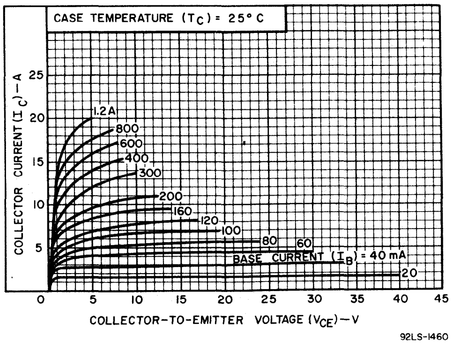


Fig. 15 – Typical output characteristics for 2N5038.

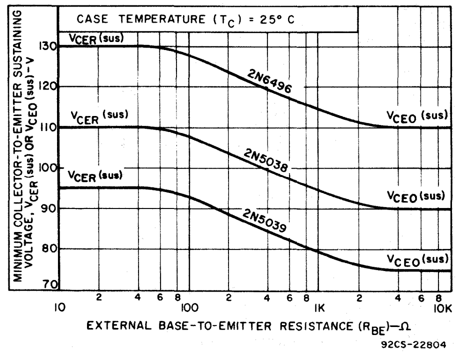


Fig. 16 – Collector-to-emitter sustaining voltage characteristic for all types.

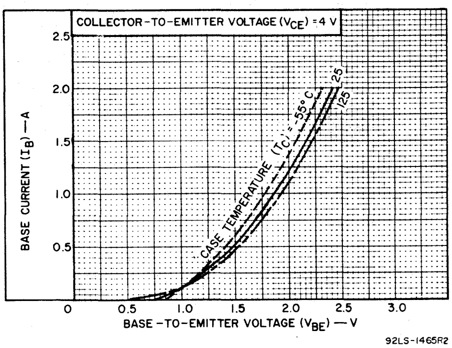


Fig. 17 – Typical output characteristics for 2N5039.

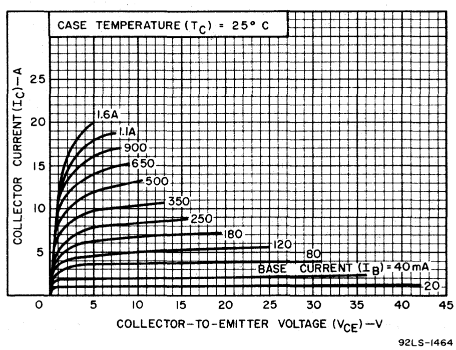


Fig. 18 – Typical input characteristics for 2N5038 and 2N5039.

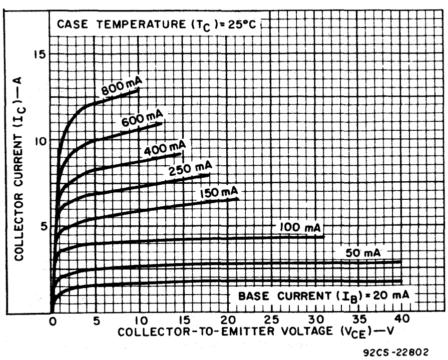


Fig. 19 – Typical output characteristics for 2N6496.

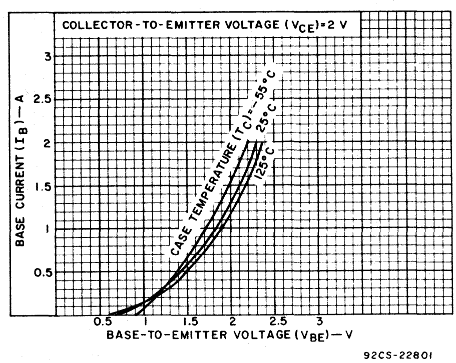


Fig. 20 – Typical input characteristics for 2N6496.

2N5038, 2N5039, 2N6496

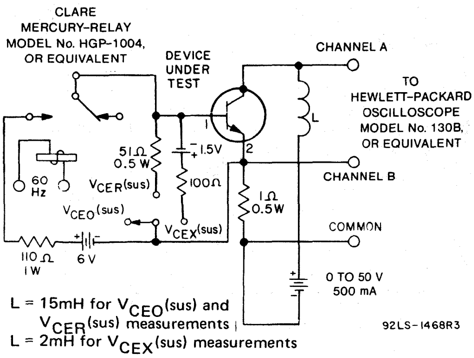
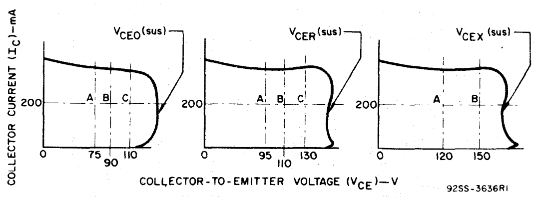


Fig. 21 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus).



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).

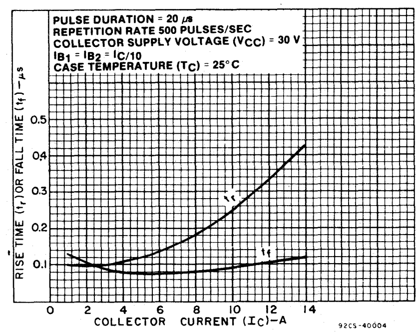


Fig. 23 - Typical rise-time and fall-time characteristics for all types.

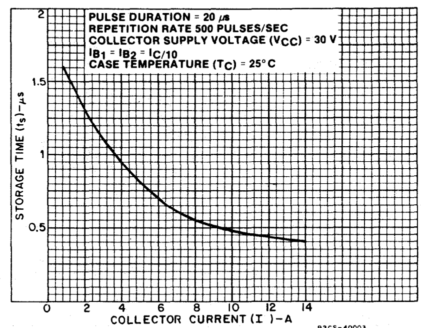


Fig. 24 - Typical storage time characteristic for all types.

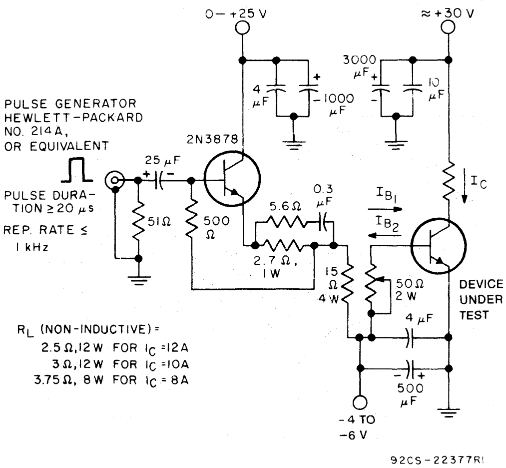


Fig. 25 - Circuit used to measure switching times for all types.

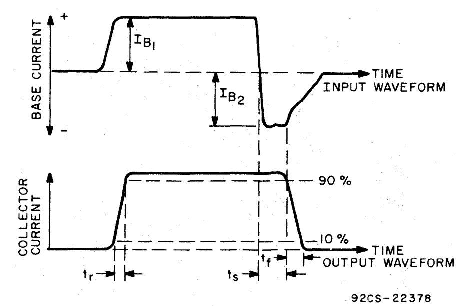


Fig. 26 — Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 26).

File Number **321**

2N5239, 2N5240

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*

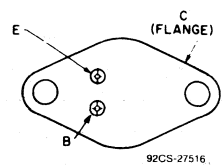
The 2N5239 and 2N5240• are multi epitaxial silicon n-p-n power transistors.

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5239	2N5240	
*V_{CBO}	300	375	V
V_{CER}(sus)			
$R_{BE} \leq 50\ \Omega$	250	350	V
*V_{CEO}(sus)	225	300	V
*V_{EBO}	6		V
*I_C	5		A
*I_B	2		A
*P_T:			
$T_C \leq 25°C$ and $V_{CE} \leq 125$ V	100		W
$T_C \leq 25°C$ and $V_{CE} \leq 125$ V	See Fig. 1		
$T_C > 25°C$ and $V_{CE} > 125$ V	See Fig. 1		
*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

2N5239, 2N5240

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N5239		2N5240		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CEO}	200			0	—	5	—	2	mA
* I_{CEV}	300	-1.5			—	4	—	—	
	375	-1.5			—	—	—	2	
(T_C = 150° C)	300	-1.5			—	5	—	3	
I_{EBO} (V_{EB} = 5 V)			0		—	5	—	1	
* (V_{EB} = 6 V)			0		—	20	—	20	
V_{EBO}				0.02	6	—	6	—	V
* V_{CEO}(sus)[a]			0.2[b]		225	—	300	—	
V_{CER}(sus)[a] ($R_{BE} \leq 50\ \Omega$)			0.2[b]		250	—	350	—	
h_{FE}	10		0.4[b]		20	80	20	80	
*	10		2[b]		20	80	20	80	
*	10		4.5[b]		5	—	5	—	
* V_{BE}	10		2[b]		—	3	—	3	V
V_{CE}(sat)			2[b]	0.25	—	2.5	—	2.5	
*			4.5[b]	1.125	—	5	—	5	
* $I_{S/b}$ (t = 1 s)	125				0.8	—	0.8	—	A
* $\|h_{fe}\|$(f = 1 MHz)	10		0.2		2	—	2	—	
* h_{fe} (f = 1 kHz)	10		4		20	—	20	—	
f_T	10		0.2		2	—	2	—	MHz
C_{obo} (f = 1 MHz)	10[c]		0		—	250	—	250	pF
$R_{\theta JC}$					—	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 ≤ 350 μs, duty factory ≤ 2%.

[c] V_{CB} value.

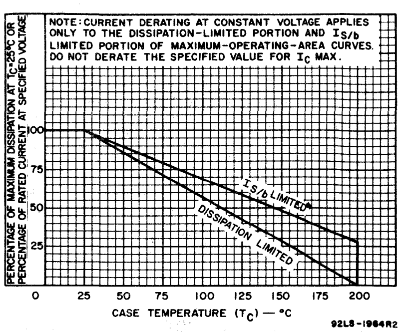


Fig. 1 - Derating curves for both types.

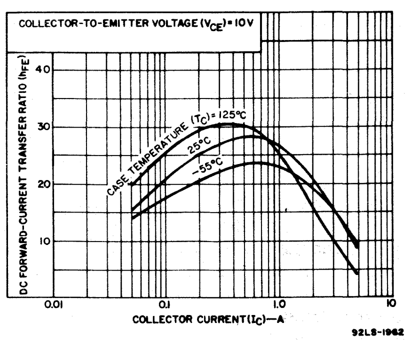


Fig. 2 — Typical dc beta characteristics for both types.

2N5239, 2N5240

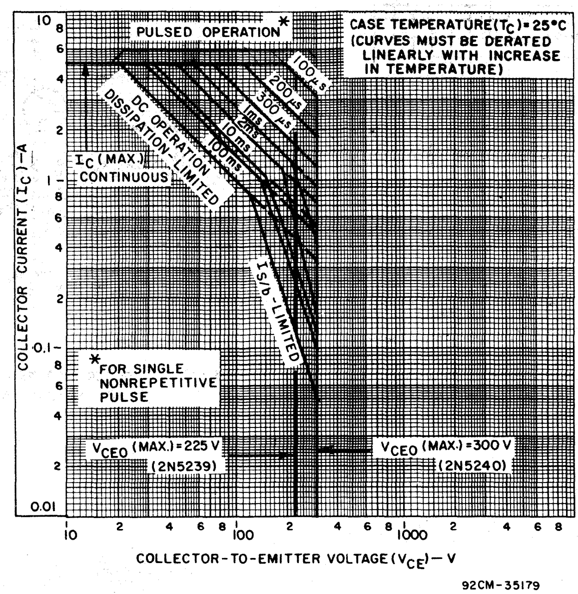


Fig. 3 - Maximum operating areas for both types.

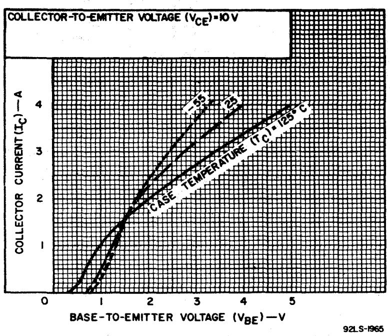


Fig. 4 — Typical transfer characteristics for both types.

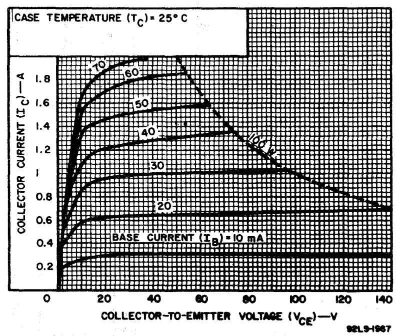


Fig. 5 — Typical output characteristics for both types.

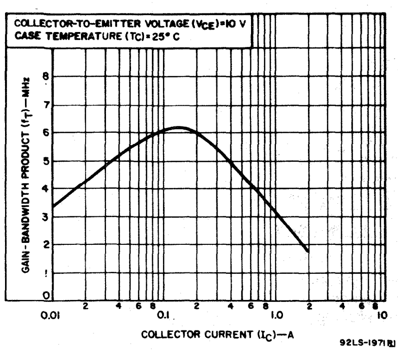


Fig. 6 — Typical gain-bandwidth product as a function of collector current for both types.

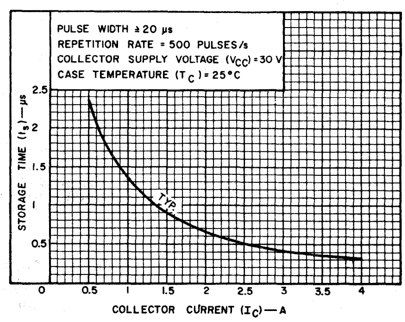


Fig. 7 — Typical saturated-switching time (storage) as a function of collector current for both types.

2N5239, 2N5240

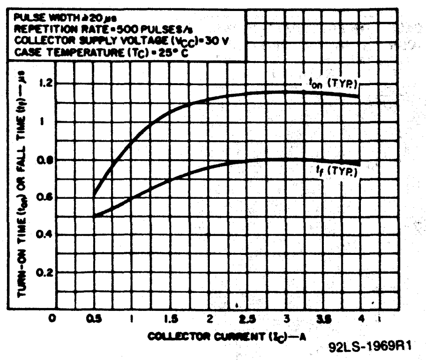


Fig. 8 — *Typical saturated-time (turn-on or fall) as a function of collector current for both types.*

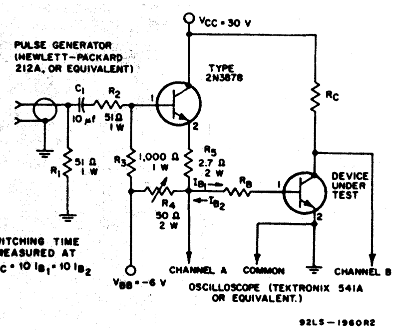


Fig. 9 — *Circuit used to measure sustaining voltages, V_{CEO}(sus) and V_{CER}(sus) for both types.*

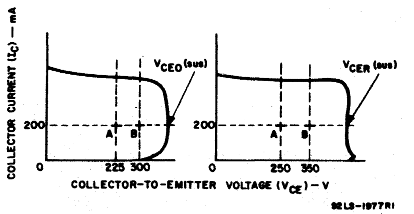


Fig. 10 — *Oscilloscope display for V_{CEO}(sus) and V_{CER}(sus) measurement.*

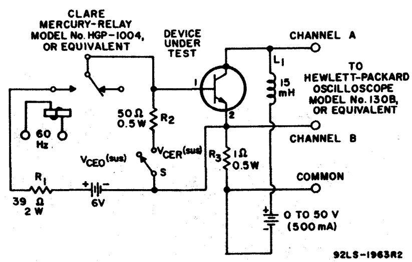


Fig. 11 — *Circuit used to measure switching times for both types.*

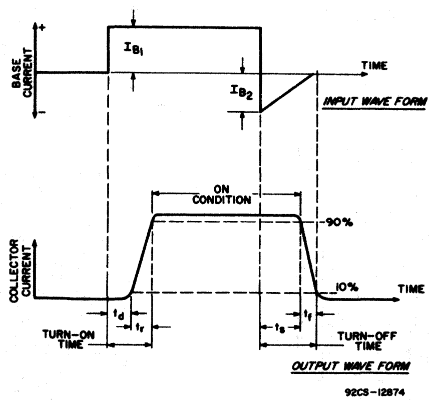


Fig. 12 — *Phase relationship between input and output currents showing reference points for specification of switching times.*

File Number **322**

2N5294, 2N5296, 2N5298

Silicon N-P-N Transistors

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

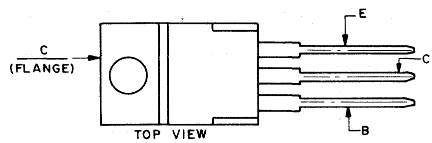
Features:
- *Low saturation voltage -*
  $V_{CE}(sat)$ = 1 V max. at I_C = 0.5 A (2N5294)
  = 1 V max. at I_C = 1 A (2N5296)
  = 1 V max. at I_C = 1.5 A (2N5298)
- *Maximum safe-area-of-operation curves specified for DC and pulse service*

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5294	2N5296	2N5298	
*COLLECTOR-TO-BASE VOLTAGE	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		-1.5			–	0.5	–	–	–	0.5	mA
		35		-1.5			–	–	–	2	–	–	
	I_{CEV} (T_C = 150°C)	65		-1.5			–	3	–	–	–	3	mA
		35		-1.5			–	–	–	5	–	–	
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				–	1	–	–	–	–	mA
			5				–	–	–	1	–	1	
* DC Forward-Current Transfer Ratio	h_{FE}[c]	4			0.5		30	120	–	–	–	–	
		4			1		–	–	30	120	–	–	
		4			1.5		–	–	–	–	20	80	
* Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$[c]				0.1	0	70	–	–	–	–	–	V
					0.1	0	–	–	40	–	–	–	
					0.1	0	–	–	–	–	60	–	
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$[c]				0.1		75	–	–	–	–	–	V
					0.1		–	–	50	–	–	–	
					0.1		–	–	–	–	70	–	
With base-emitter junction reverse biased	$V_{CEV}(sus)$[c]			-1.5	0.1		80	–	–	–	–	–	V
				-1.5	0.1		–	–	60	–	–	–	
				-1.5	0.1		–	–	–	–	80	–	
* Base-to-Emitter Voltage	V_{BE}[c]	4			0.5		–	1.1	–	–	–	–	V
		4			1		–	–	–	1.3	–	–	
		4			1.5		–	–	–	–	–	1.5	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[c]				0.5	0.05	–	1	–	–	–	–	V
					1	0.1	–	–	–	1	–	–	
					1.5	0.15	–	–	–	–	–	1	
Gain-Bandwidth Product	f_T	4			0.2		0.8	–	0.8	–	0.8	–	MHz
Sat. Switching Time Turn-On (See Figs. 22 - 24)	t_{on}	V_{CC} = 30			0.5	0.05[a]	–	5	–	–	–	–	μs
					1	0.1[a]	–	–	–	5	–	–	
					1.5	0.15[a]	–	–	–	–	–	5	
Turn-Off (See Figs. 22 - 24)	t_{off}	V_{CC} = 30			0.5	-0.05[a]	–	15	–	–	–	–	μs
					1	-0.1[b]	–	–	–	15	–	–	
					1.5	-0.15[b]	–	–	–	–	–	15	
Thermal Resistance (Junction-to-Case)	$\theta_{J\text{-}C}$						–	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.

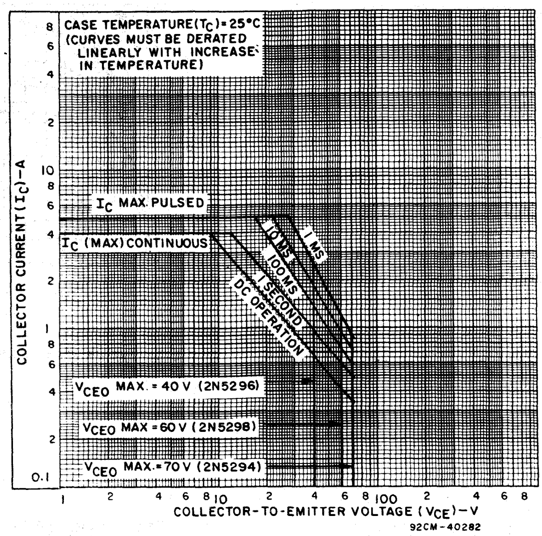


Fig. 1 - Maximum operating areas for all types.

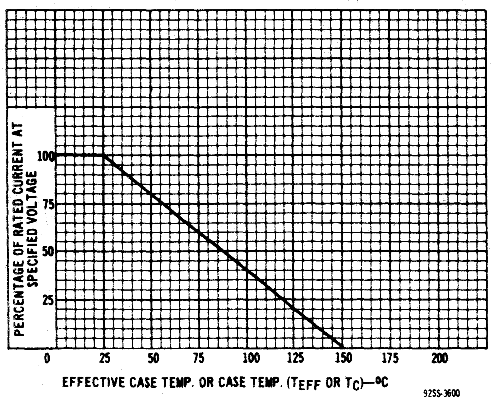


Fig. 2 - Derating curve for all types.

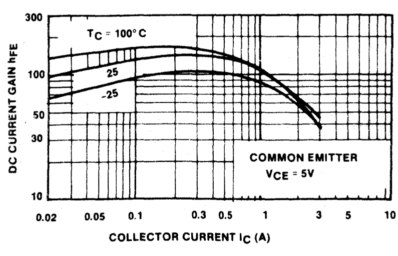


Fig. 3 - Typical DC beta characteristics for all types.

2N5294, 2N5296, 2N5298

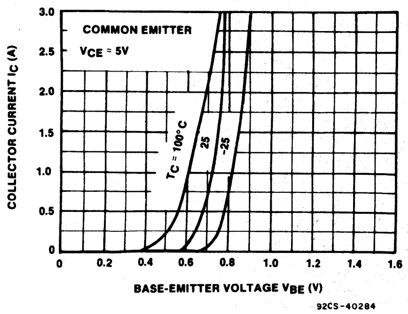


Fig. 4 - Typical input characteristics for all types.

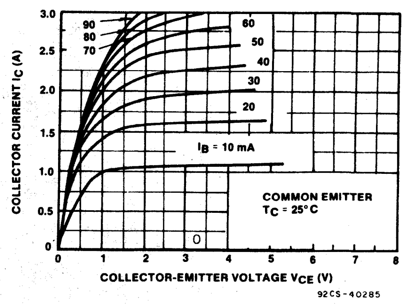


Fig. 5 - Typical output characteristics for all types.

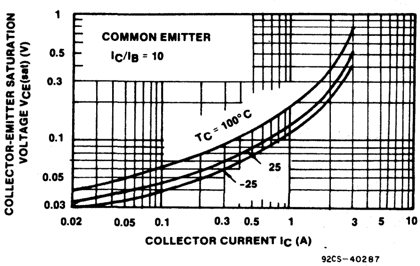


Fig. 6 - Typical collector-to-emitter saturation voltage as a function of collector current for all types.

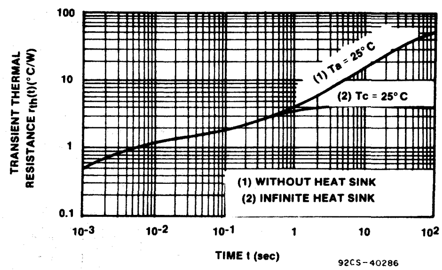


Fig. 7 - Transient thermal resistance characteristics for all types.

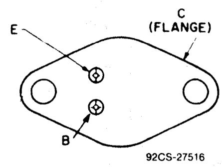
File Number **1029**

2N5301, 2N5302, 2N5303

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5301	2N5302	2N5303	
* V_{CBO}	40	60	80	V
* $V_{CEO}(sus)$	40	60	80	V
* V_{EBO}		5		V
* I_C		30		A
* I_{CM}		50		A
* I_B		7.5		A
I_{BM}		15		A
* P_T				
At $T_C \leq 25°C$		200		W
At $T_C > 25°C$ derate linearly		1.15		W/°C
		See Figs.1 & 2		
* 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*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5301 Min.	2N5301 Max.	2N5302 Min.	2N5302 Max.	2N5303 Min.	2N5303 Max.	UNITS
* I_{CBO}	40[a]				–	1	–	–	–	–	mA
	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	–	–	–	–	
	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
* 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	
			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	µs
* t_s	30		10	1[c]	–	2	–	2	–	2	
* 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

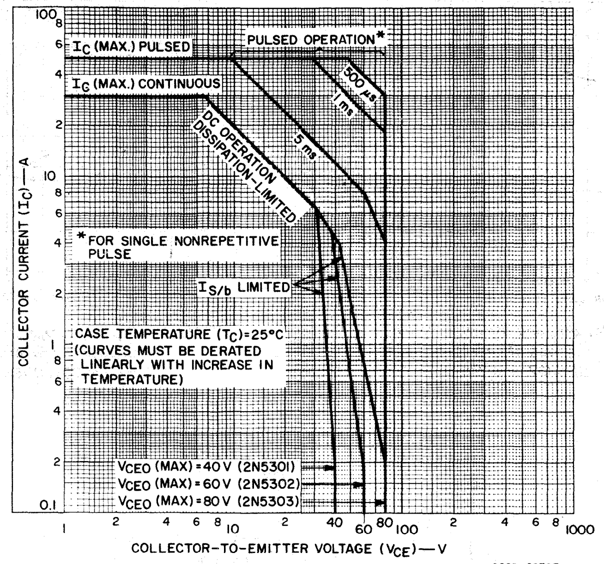


Fig. 1 — Maximum operating areas for 2N5301, 2N5302, and 2N5303.

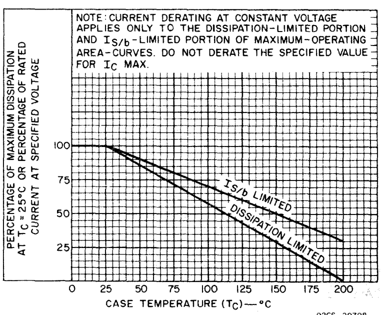


Fig. 2 — Derating curves for 2N5301, 2N5302, and 2N5303.

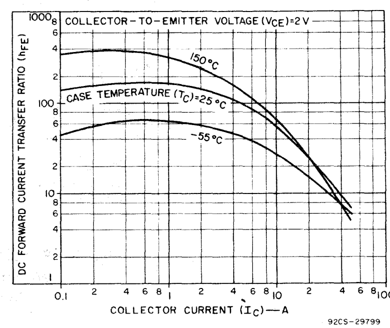


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

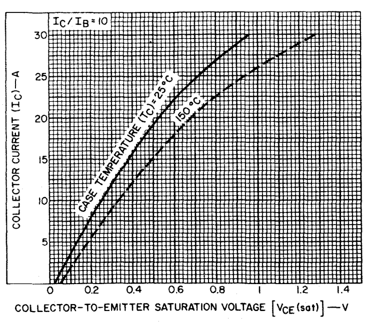


Fig. 4 — Typical saturation voltage characteristics for 2N5301, 2N5302, and 2N5303.

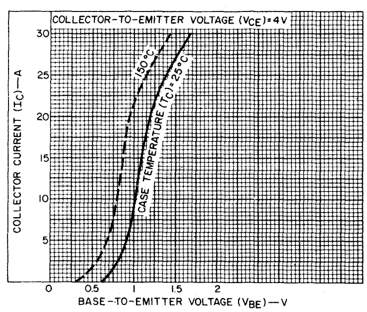


Fig. 5 — Typical transfer characreristics for 2N5301, 2N5302, and 2N5303.

2N5301, 2N5302, 2N5303

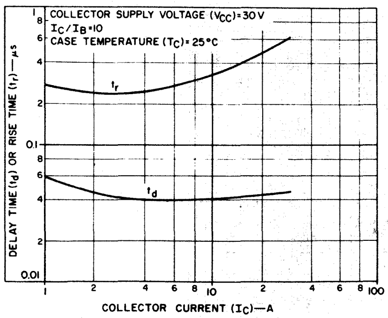


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

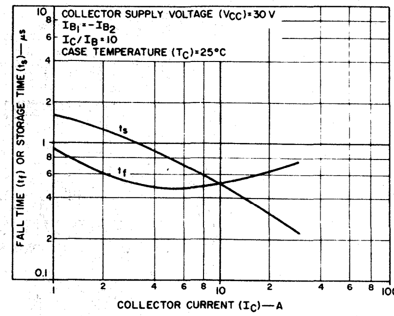


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

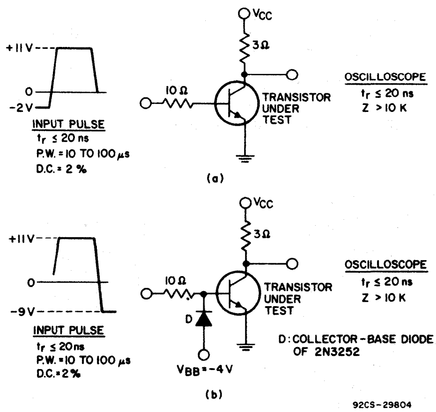


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5301, 2N5302, and 2N5303.

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

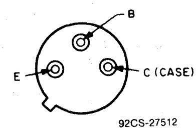
Features:
- *2N5322, 2N5323 P-N-P Complements of: 2N5320, 2N5321*
- *Maximum safe-area-of-operation curves*
- *Planar construction for low-noise and low leakage characteristics*
- *Low saturation voltage*
- *High beta at high collector current*

2

The 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▲				–	0.5	–	–	–	–	–	–	μA
	60▲				–	–	–	5	–	–	–	–	
	−80▲				–	–	–	–	–	−0.5	–	–	
	−60▲				–	–	–	–	–	–	–	−5	
* I_{CEX}	100	−1.5			–	0.1	–	–	–	–	–	–	mA
	75	−1.5			–	–	–	0.1	–	–	–	–	
	−100	1.5			–	–	–	–	–	−0.1	–	–	
	−75	1.5			–	–	–	–	–	–	–	−0.1	
T_C = 150°C	70	−1.5			–	5	–	–	–	–	–	–	mA
	45	−1.5			–	–	–	5	–	–	–	–	
	−70	1.5			–	–	–	–	–	−5	–	–	
	−45	1.5			–	–	–	–	–	–	–	−5	
* I_{EBO}		−7	0		–	0.1	–	–	–	–	–	–	mA
		−5	0		–	–	–	0.1	–	–	–	–	
		7	0		–	–	–	–	–	−0.1	–	–	
		5	0		–	–	–	–	–	–	–	−0.1	
		−5	0		–	0.1	–	–	–	–	–	–	μA
		−4	0		–	–	–	0.5	–	–	–	–	
		5	0		–	–	–	–	–	−0.1	–	–	
		4	0		–	–	–	–	–	–	–	−0.5	
$V_{(BR)CEV}$		−1.5	0.1		100	–	75	–	–	–	–	–	V
		1.5	−0.1		–	–	–	–	−100	–	−75	–	
$V_{CER}(sus)$[a] R_{BE} = 100Ω			100[b]		90	–	65	–	–	–	–	–	V
			−100[b]		–	–	–	–	−90	–	−65	–	
* $V_{CEO}(sus)$[a]			100[b]	0	75	–	50	–	–	–	–	–	V
			−100[b]	0	–	–	–	–	−75	–	−50	–	
* $V_{CE}(sat)$			500[b]	50	–	0.5	–	0.8	–	–	–	–	V
			−500[b]	−50	–	–	–	–	–	−0.7	–	−1.2	
* V_{BE}	4		500[b]		–	1.1	–	1.4	–	–	–	–	V
	−4		−500[b]		–	–	–	–	–	−1.1	–	−1.4	
* h_{FE}	4		500[b]		30	130	40	250	–	–	–	–	
	−4		−500[b]		–	–	–	–	30	130	40	250	
	2		1000[b]		10	–	–	–	–	–	–	–	
	−2		−1000[b]		–	–	–	–	10	–	–	–	
* $\|h_{fe}\|$ f = 10 MHz	4		50		5	–	5	–	–	–	–	–	
	−4		−50		–	–	–	–	5	–	5	–	
$I_{S/b}$[d]	50				200	–	200	–	–	–	–	–	mA
	−35				–	–	–	–	−285	–	−285	–	
* t_{ON}	30		500	50	–	80	–	80	–	–	–	–	ns
	−30		−500	−50	–	–	–	–	–	100	–	100	
* t_{OFF}	30		500	50	–	800	–	800	–	–	–	–	ns
	−30		−500	−50	–	–	–	–	–	1000	–	1000	
* $R_{\theta JC}$					–	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

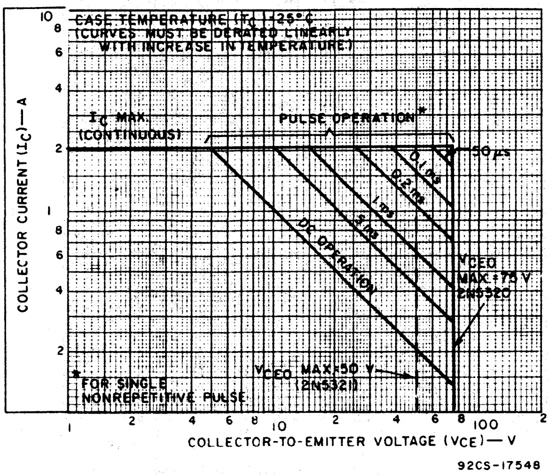


Fig.1 — Maximum operating areas for types 2N5320 and 2N5321.

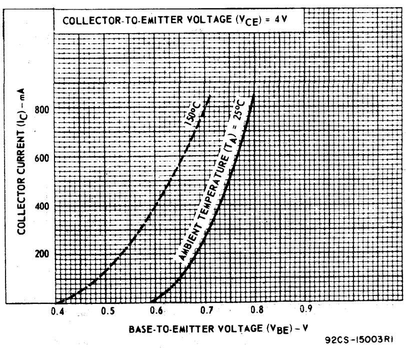


Fig.2 — Typical static beta characteristics for types 2N5320 and 2N5321.

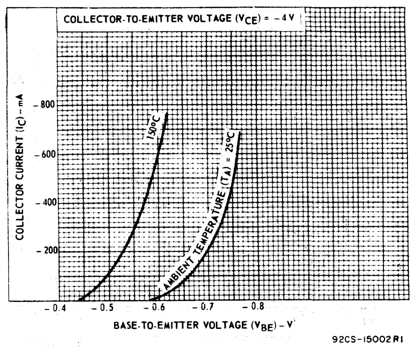


Fig.3 — Typical static beta characteristics for types 2N5322 and 2N5323.

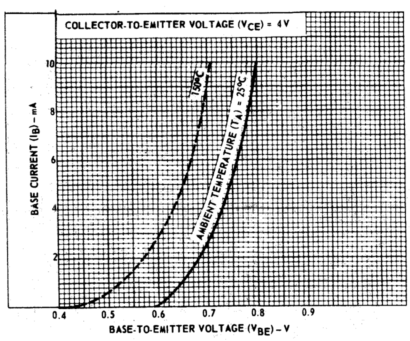


Fig.4 — Typical output characteristics for types 2N5320 and 2N5321.

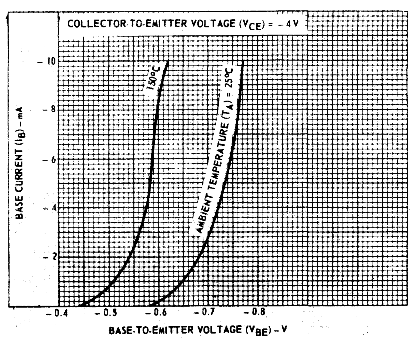


Fig.5 – Typical output characterisitcs for types 2N5322 and 2N5323.

2N5320, 2N5321, 2N5322, 2N5323

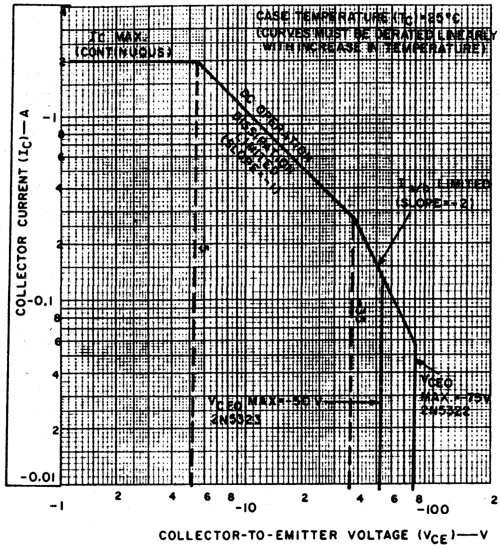


Fig.6 — Maximum operating areas for types 2N5322 and 2N5323.

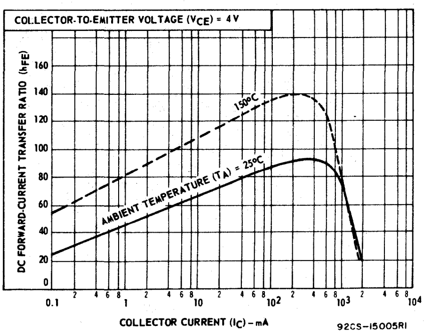


Fig.7 — Typical transfer characteristics for types 2N5320 and 2N5321.

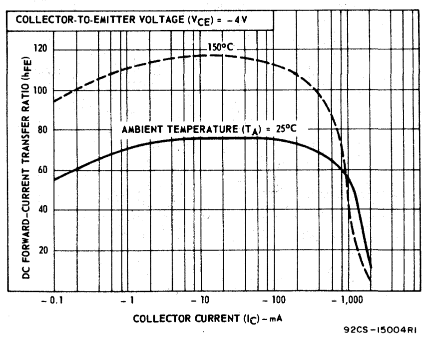


Fig.8 — Typical transfer characteristics for types 2N5322 and 2N5323.

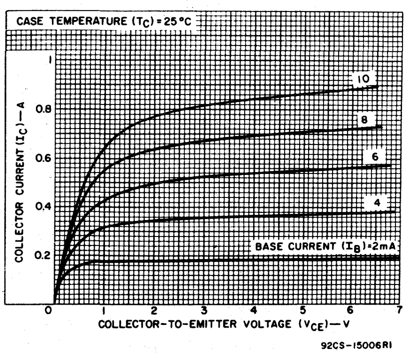


Fig.9 — Typical input characteristics for types 2N5320 and 2N5321.

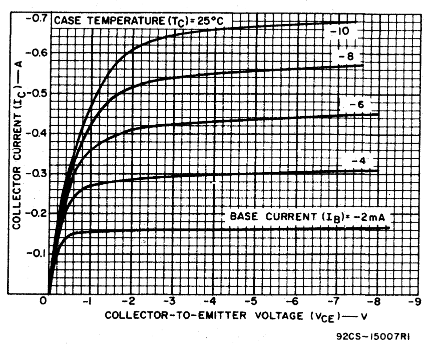
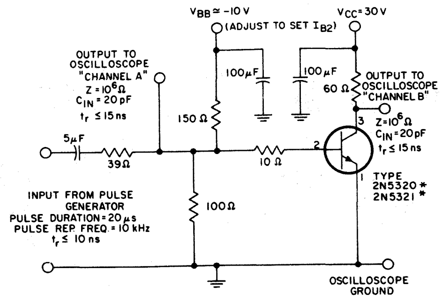


Fig.10 — Typical input characteristics for types 2N5322 and 2N5323.

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}.

92CS-17020

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

2

2N5415, 2N5416

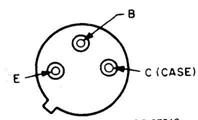
File Number **336**

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 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 Ω	—	-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			0	–	–	–	−50	µA
		−150			0	–	−50	–	–	
* I_{CBO} $I_E = 0$	−280					–	–	–	−50	µA
	−175					–	−50	–	–	
I_{CEV}		−300	1.5			–	–	–	−50	µA
		−200	1.5			–	−50	–	–	
* I_{EBO}			6	0		–	–	–	−20	µA
			4	0		–	−20	–	–	
* h_{FE}		−10		−50[b]		–	–	30	120	
		−10		−50[b]		30	150	–	–	
$V_{CEO}(sus)$				−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	–	
* $\|h_{fe}\|$ f = 5 MHz		−10		−10		3	–	3	–	
* $Re(h_{ie})$ f = 1 MHz		−10		−5		–	300	–	300	Ω
* C_{ib} f = 1 MHz			5	0		–	75	–	75	pF
* C_{ob} f = 1 MHz	−10					–	15	–	15	pF
$I_{S/b}$ $t_p = 0.4$ s nonrep.		−100				−100	–	−100	–	mA
$R_{\theta JC}$						–	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%.

2

2N5415, 2N5416

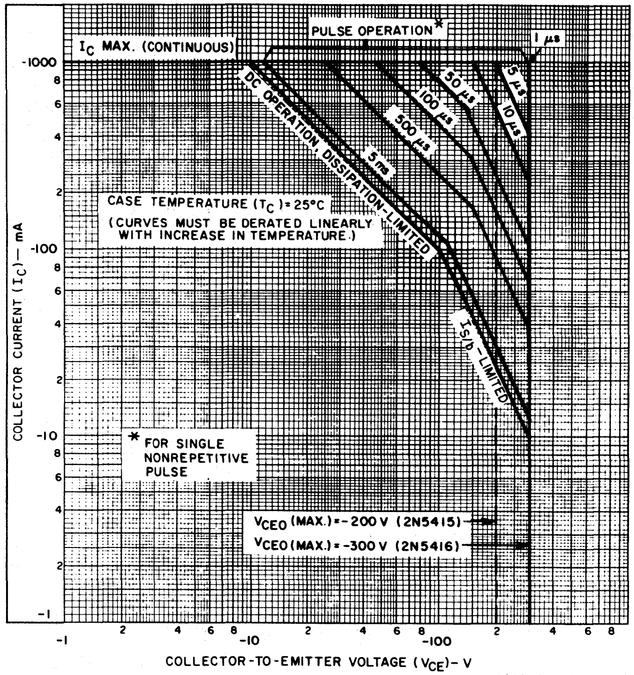


Fig. 1 — Maximum safe operating areas.

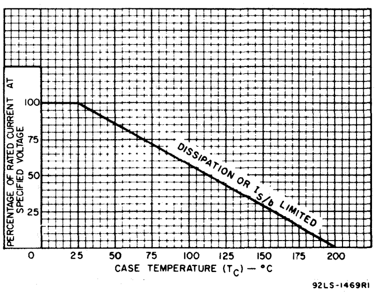


Fig. 2 — Dissipation derating curve.

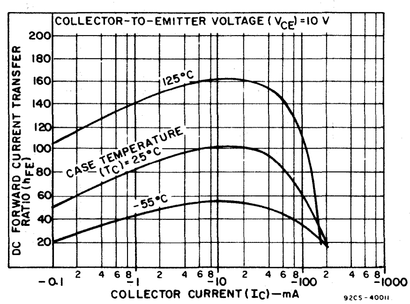


Fig. 3 — Typical dc beta characteristics for both types.

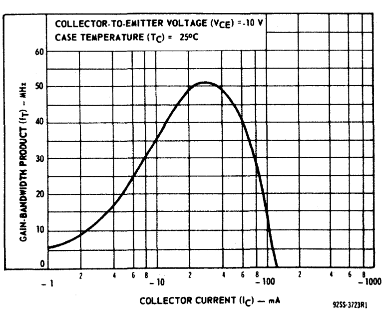


Fig. 4 — Typical gain-bandwidth product for both types.

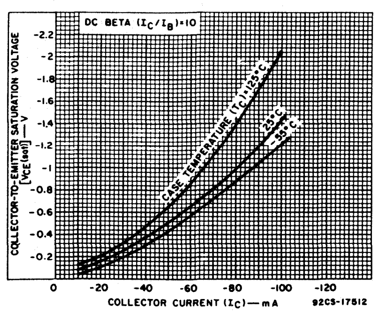


Fig. 5 — Typical collector-to-emitter saturation voltage for both types.

2N5415, 2N5416

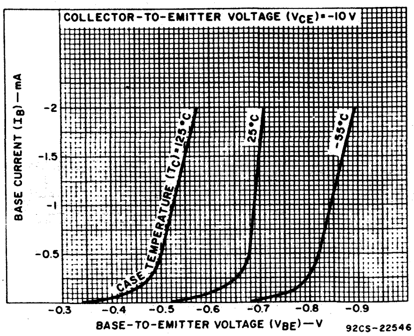


Fig. 6 – Typical input characteristics for both types.

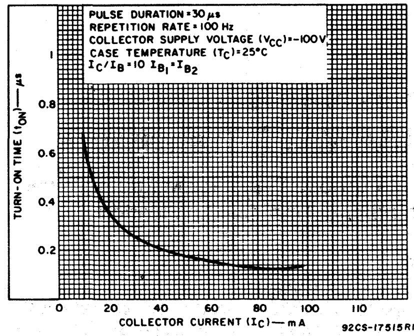


Fig. 7 – Typical turn-on time characteristic for both types.

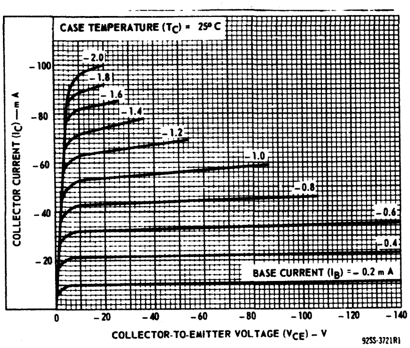


Fig. 8 – Typical output characteristics for both types.

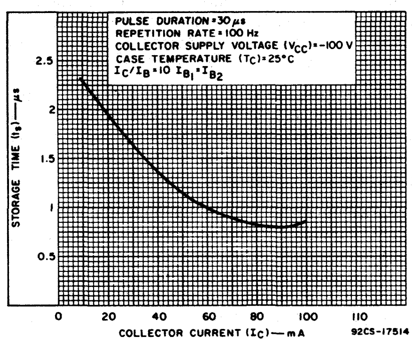


Fig. 9 – Typical storage-time characteristic for both types.

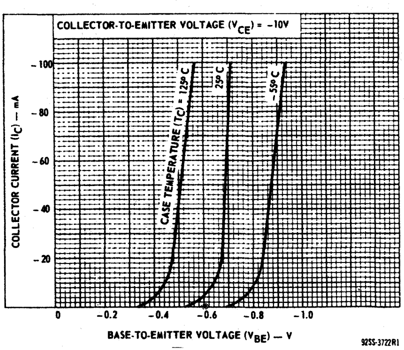


Fig. 10 – Typical transfer characteristics for both types.

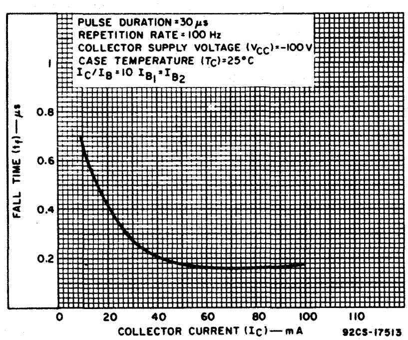


Fig. 11 – Typical fall-time characteristic for both types.

2N5490-2N5497

File Number **353**

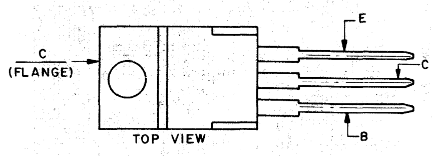
Silicon N-P-N VERSAWATT Transistors

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

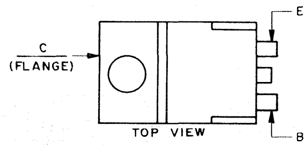
Features:

- *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

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

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

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

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

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}) = 100 Ω	$V_{CER}(sus)$	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	-1.5			-	1	-	-	-	-	-	-	mA
		55	-1.5			-	-	-	1	-	-	-	-	
		70	-1.5			-	-	-	-	-	1	-	-	
	I_{CEV} (T_C = 150°C)	85	-1.5			-	5	-	-	-	-	-	-	mA
		55	-1.5			-	-	-	5	-	-	-	-	
		70	-1.5			-	-	-	-	-	5	-	-	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 100 Ω	I_{CER}	70				-	0.5	-	-	-	-	-	-	mA
		40				-	-	-	0.5	-	-	-	2	
		55				-	-	-	-	-	0.5	-	-	
	I_{CER} (T_C = 150°C)	70				-	3.5	-	-	-	-	-	-	mA
		40				-	-	-	3.5	-	-	-	5	
		55				-	-	-	-	-	3.5	-	-	
Emitter-Cutoff Current	I_{EBO}		-5			-	1	-	1	-	1	-	1	mA
DC Forward-Current Transfer Ratio	h_{FE}[c]	4		3.5		20	100	-	-	-	-	-	-	
		4		3		-	-	20	100	-	-	-	-	
		4		2.5		-	-	-	-	20	100	-	-	
		4		2		-	-	-	-	-	-	20	100	
Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$[c]			0.1	0	70	-	40	-	55	-	40	-	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$[c]			0.1		80	-	50	-	65	-	50	-	V
With base-emitter junction reverse biased	$V_{CEV}(sus)$[c]		-1.5	0.1		90	-	60	-	75	-	60	-	V
Base-to-Emitter Voltage	V_{BE}[c]	4		3.5		-	1.7	-	-	-	-	-	-	V
		4		3		-	-	-	1.5	-	-	-	-	
		4		2.5		-	-	-	-	-	1.3	-	-	
		4		2		-	-	-	-	-	-	-	1.1	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$[c]			3.5	0.35	-	1	-	-	-	-	-	-	V
				3	0.3	-	-	-	1	-	-	-	-	
				2.5	0.25	-	-	-	-	-	1	-	-	
				2	0.2	-	-	-	-	-	-	-	1	
Gain-Bandwidth Product	f_T	4		0.5		0.8	-	0.8	-	0.8	-	0.8	-	MHz
Sat. Switching Time: Turn-On	t_{on}	V_{CC} = 30		3.5	0.35[a]	-	5	-	-	-	-	-	-	μs
				3	0.3[a]	-	-	-	5	-	-	-	-	
				2.5	0.25[a]	-	-	-	-	-	5	-	-	
				2	0.2	-	-	-	-	-	-	-	5	
Turn-Off	t_{off}	V_{CC} = 30		3.5	0.35[b]	-	15	-	-	-	-	-	-	μs
				3	0.3[b]	-	-	-	15	-	-	-	-	
				2.5	0.25[b]	-	-	-	-	-	15	-	-	
				2	0.2	-	-	-	-	-	-	-	15	

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

2N5490-2N5497

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

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

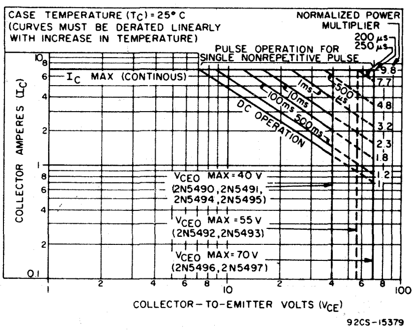


Fig. 1 — Maximum operating areas for types 2N5490 through 2N5497 inclusive.

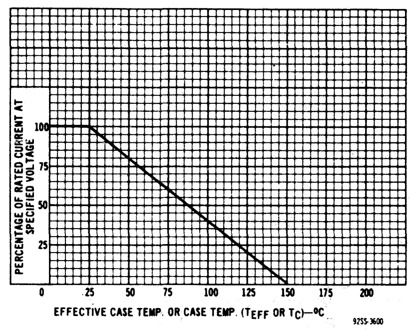


Fig. 2 — Derating curve for all types.

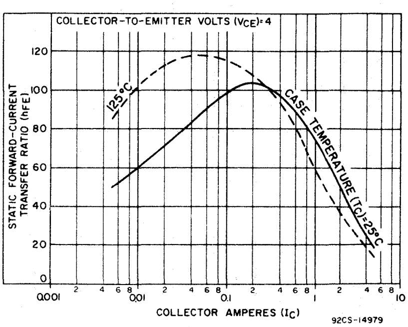


Fig. 3 — Typical static beta characteristics for types 2N5496 and 2N5497.

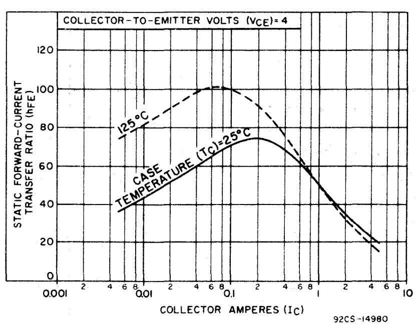


Fig. 4 — Typical static beta characteristics for types 2N5494 and 2N5495.

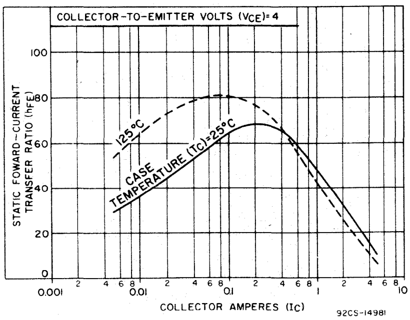


Fig. 5 — Typical static beta characteristics for types 2N5490 through 2N5493 inclusive.

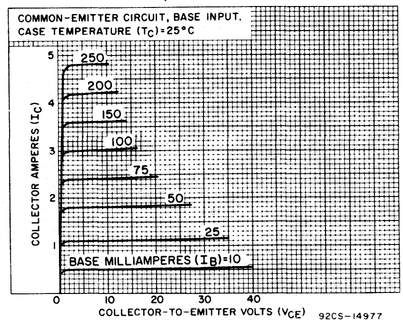


Fig.6 — Typical output characteristics for types 2N5494 through 2N5497 inclusive.

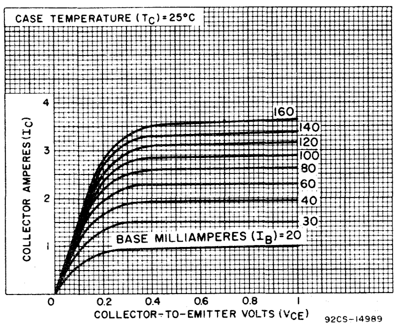


Fig. 7 — Typical output characteristics for types 2N5494 and 2N5495.

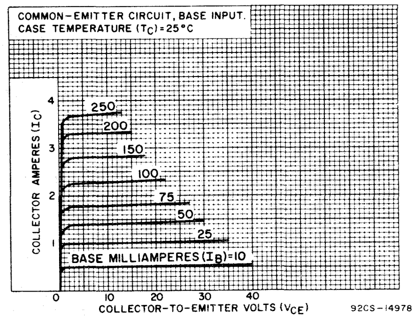


Fig. 8 — Typical output characteristics for types 2N5490 through 2N5493 inclusive.

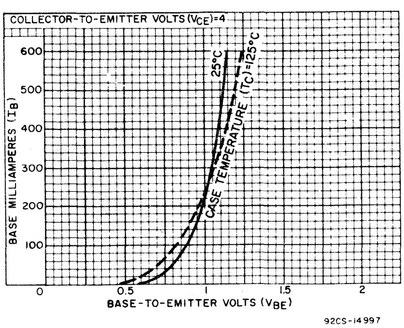


Fig. 9 — Typical input characteristics for types 2N5494 through 2N5497 inclusive.

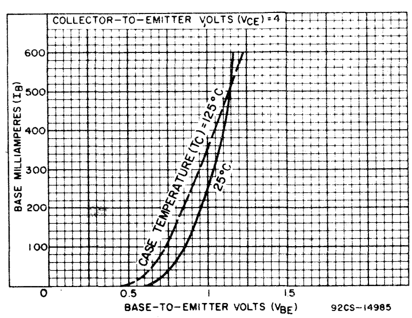


Fig. 10 — Typical input characteristics for types 2N5490 through 2N5493 inclusive.

2N5490-2N5497

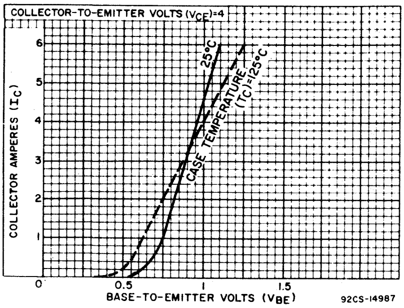


Fig. 11 — Typical transfer characteristics for types 2N5494 through 2N5497 inclusive.

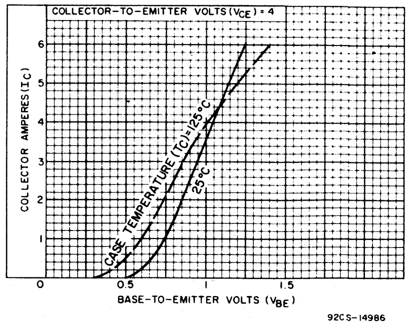


Fig. 12 — Typical transfer characteristics for types 2N5490 through 2N5493 inclusive.

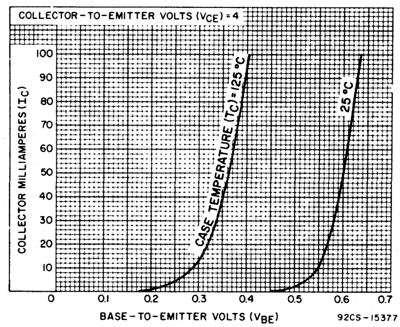


Fig. 13 — Typical transfer characteristics for types 2N5490 through 2N5497 inclusive.

File Number **1141**

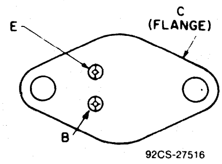
2N5629, 2N5630, 2N5631

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

2

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

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

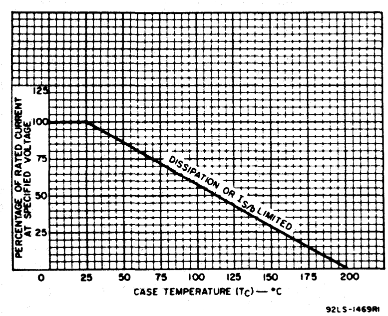


Fig. 1 — Current derating curve for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N5629	2N5630	2N5631	
* V_{CEO}		100	120	140	V
* V_{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 V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5629 Min.	Max.	2N5630 Min.	Max.	2N5631 Min.	Max.	UNITS
* 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%.

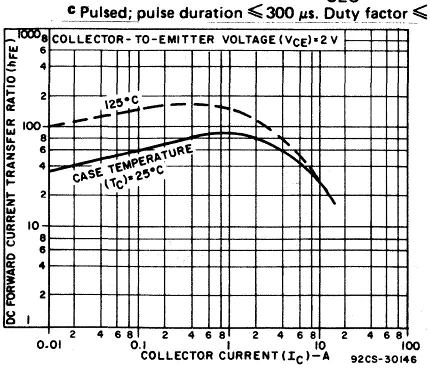


Fig. 2 — Typical dc beta characteristics as a function of collector current for all types.

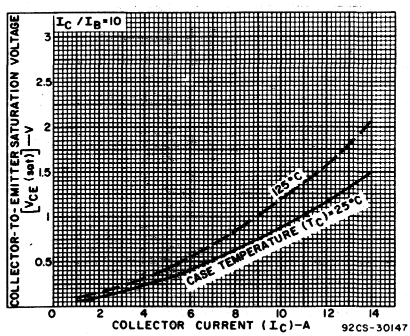


Fig. 3 — Typical saturation voltage characteristics for all types.

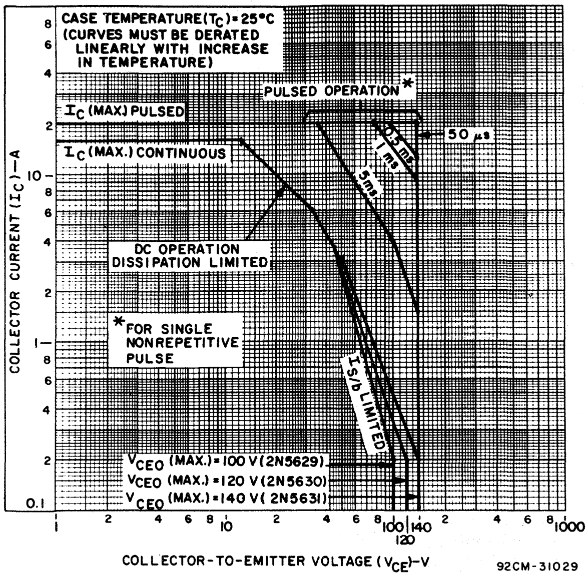


Fig. 4 — Maximum operating areas for all types (T_C = 25°C).

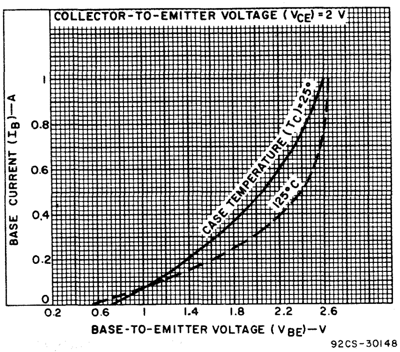


Fig. 5 — Typical input characteristics for all types.

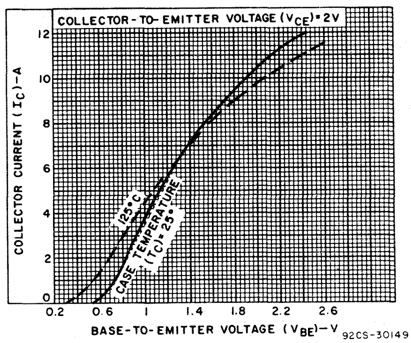


Fig. 6 — Typical transfer characteristics for all types.

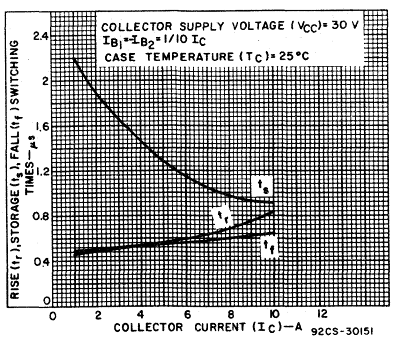


Fig. 7 — Typical saturated-switching times for all types.

2

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

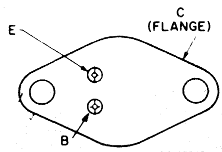
Features:
- *Maximum Safe-Area-of-Operation Curves - $I_{S/b}$ limit line beginning at 24 V*
- *Fast Turn-On Time - t_{ON} = 0.5 μs max. at I_C = 15 A*

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)		DC Emitter or Base Voltage (V)		DC Current (A)			LIMITS: Type 2N5671		Type 2N5672		UNITS
		V_{CB}	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	
* Collector-Cutoff Current	I_{CEO}	–	80	–	–	–	–	0	–	10	–	10	mA
	I_{CEV}	–	110	–	–1.5	–	–	–	–	12	–	–	mA
*			135	–	–1.5	–	–	–	–	–	–	10	mA
	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)	θ_{J-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)

2

2N5671, 2N5672

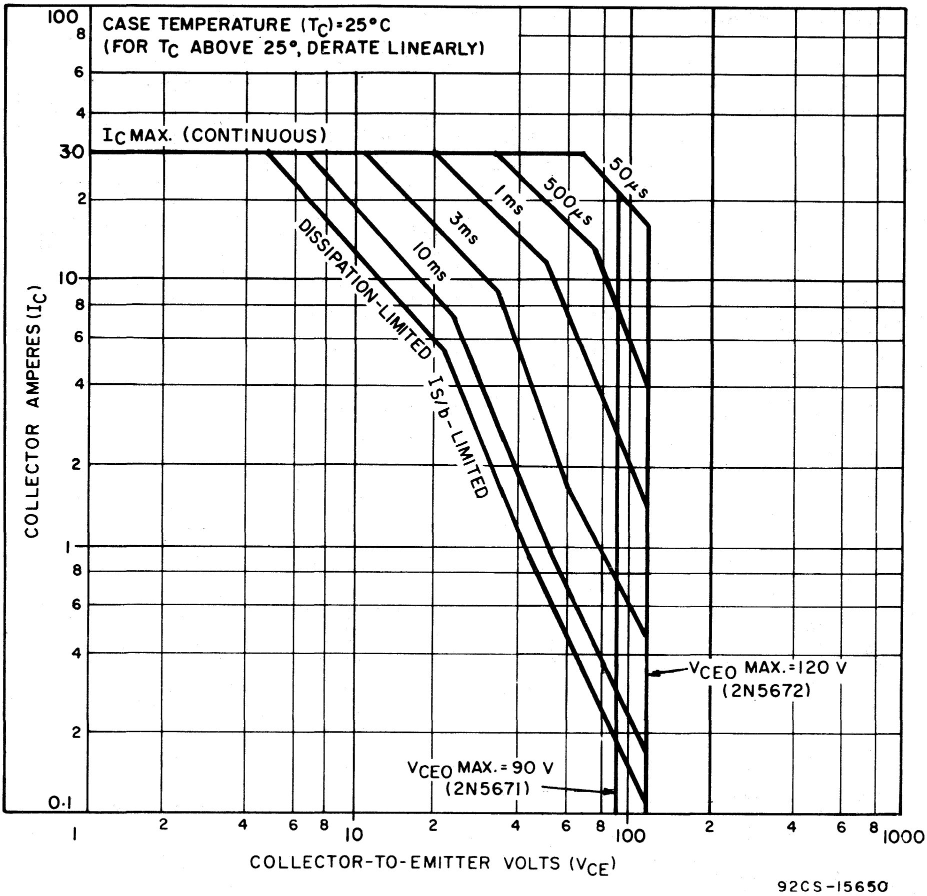


Fig. 1 - Maximum operating areas for types 2N5671 & 2N5672.

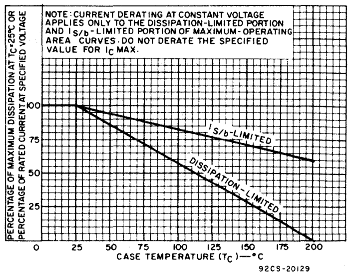


Fig. 2 - Dissipation derating curves for types 2N5671 & 2N5672.

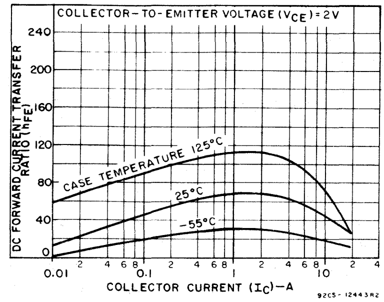


Fig. 3 - Typical dc beta characteristics for types 2N5671 & 2N5672.

2N5671, 2N5672

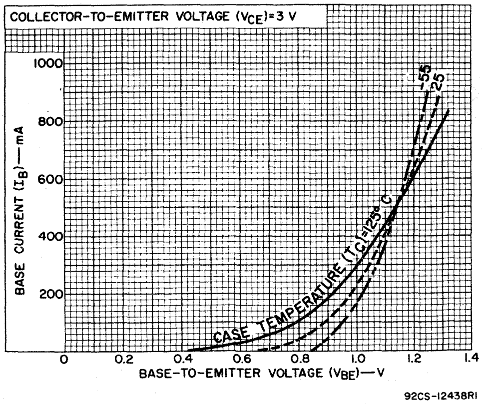


Fig. 4 - Typical input characteristics for types 2N5671 & 2N5672.

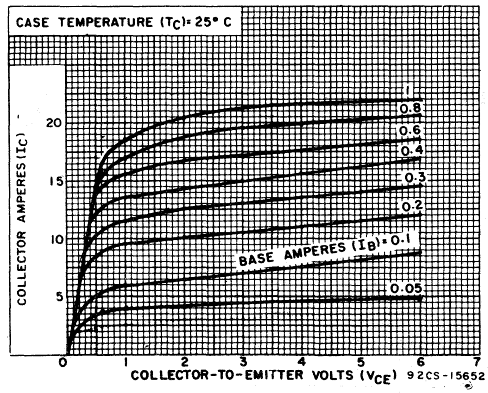


Fig. 5 - Typical output characteristics for types 2N5671 & 2N5672.

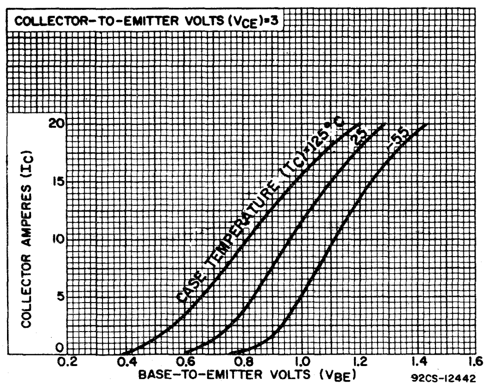


Fig. 6 - Typical transfer characteristics for types 2N5671 & 2N5672.

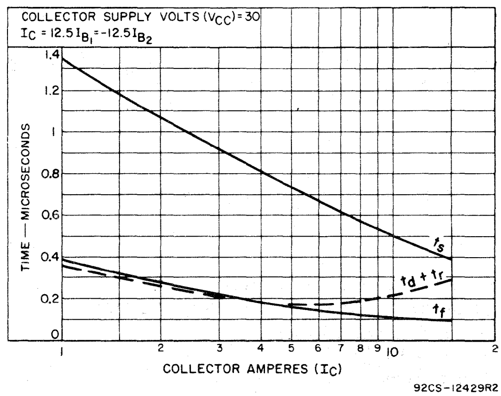


Fig. 7 - Typical saturated switching characteristics for types 2N5671 & 2N5672.

2

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*

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

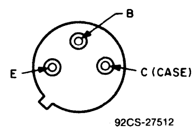
The three types in each family differ primarily in voltage ratings and saturation characteristics.

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		P-N-P	2N5781♦	2N5782♦	2N5783♦	
		N-P-N	2N5784	2N5785	2N5786	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}		80	65	45	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
* With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$		80	65	45	V
With base open	$V_{CEO}(sus)$		65	50	40	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}		5	5	3.5	V
*CONTINUOUS COLLECTOR CURRENT	I_C		3.5	3.5	3.5	A
*CONTINUOUS BASE CURRENT	I_B		1	1	1	A
*TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C			10	10	10	W
At ambient temperatures up to 25°C			1	1	1	W
At case temperatures above 25°C .... Derate linearly			0.057 W/°C, or see Fig. 7.			
At ambient temperatures above 25°C .... Derate linearly			0.0057			W/°C
*TEMPERATURE RANGE:						
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}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N5781 p-n-p Min.	Max.	2N5784 n-p-n Min.	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	$\|h_{fe}\|$	–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.

♦ 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 $|h_{fe}|$ is decreasing at approximately 6 dB per octave.

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

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS♦				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N5782 p-n-p		2N5785 n-p-n		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
Collector Cutoff Current: With external base-to-emitter resistance (R_{BE}) = 100 Ω	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 V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc I_B	LIMITS 2N5783 p-n-p Min.	LIMITS 2N5783 p-n-p Max.	LIMITS 2N5786 n-p-n Min.	LIMITS 2N5786 n-p-n Max.	UNITS
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		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

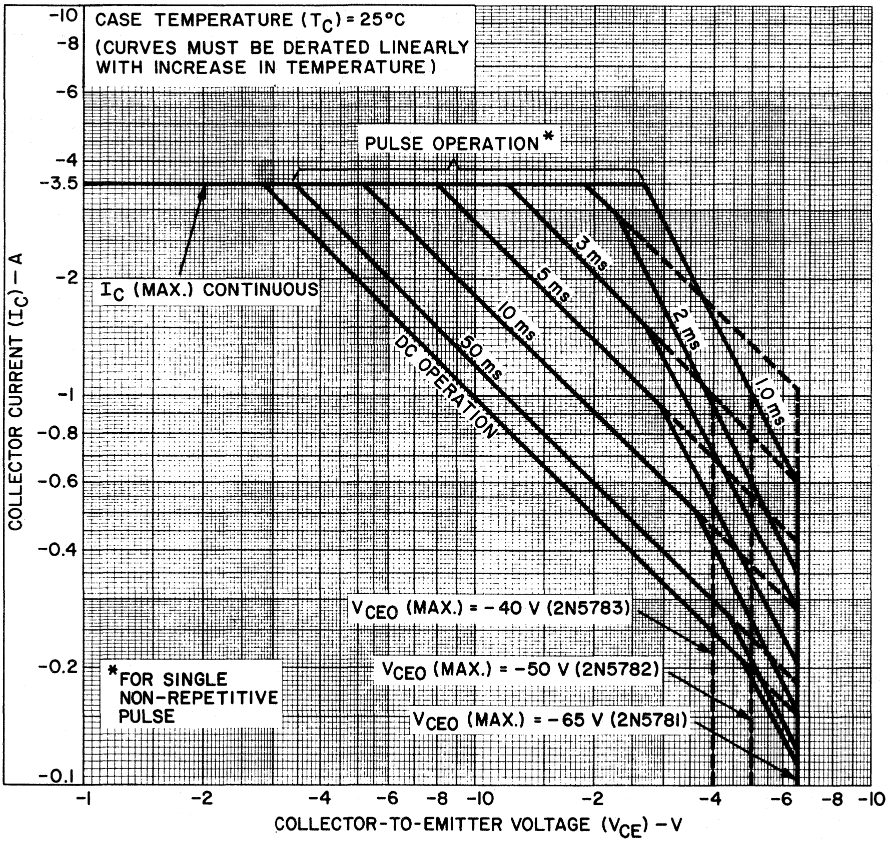


Fig. 1 — Maximum operating areas for types 2N5781, 2N5782, and 2N5783.

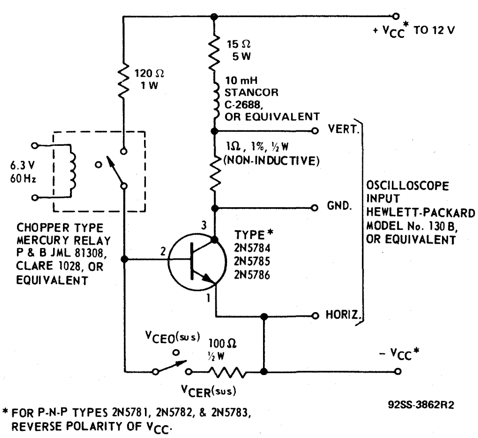
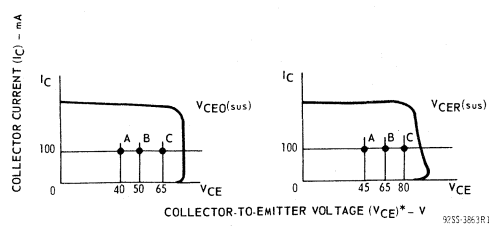


Fig. 2 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$.



*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 fails to the right and above point "A" (2N5783 & 2N5786), "B" (2N5782 & 2N5785), or "C" (2N5781 & 2N5784).

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

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

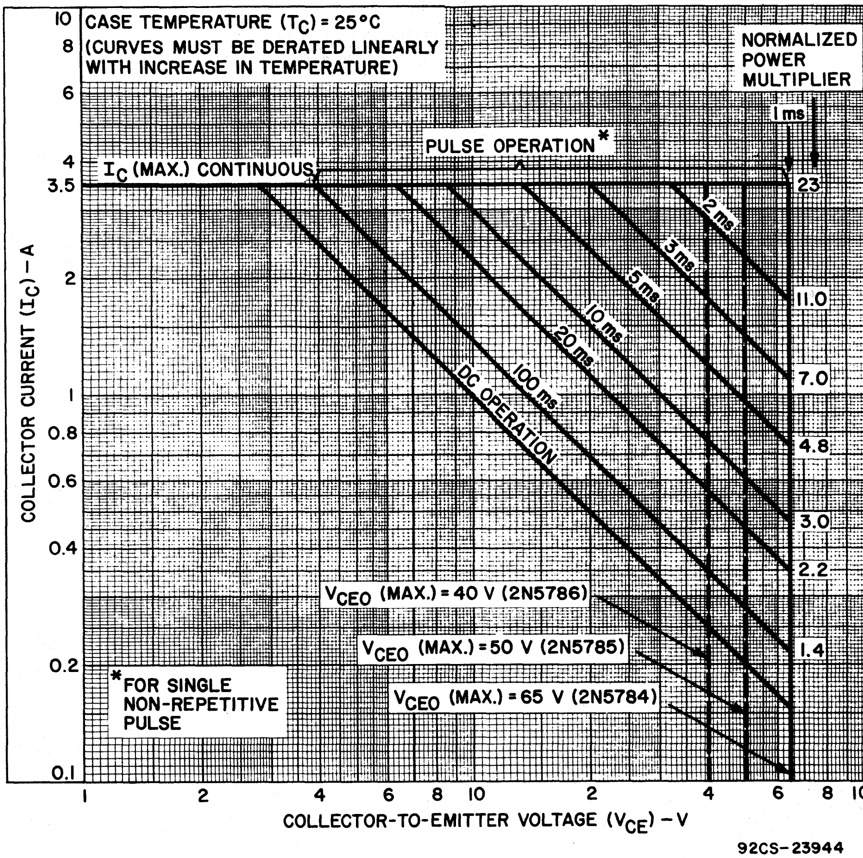


Fig. 4 — Maximum operating areas for types 2N5784, 2N5785, and 2N5786.

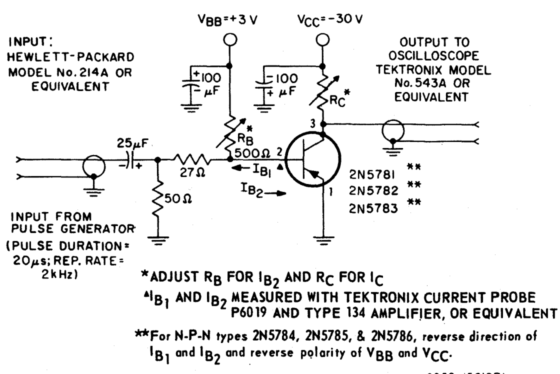


Fig. 5 — Circuit used to measure saturated switching times.

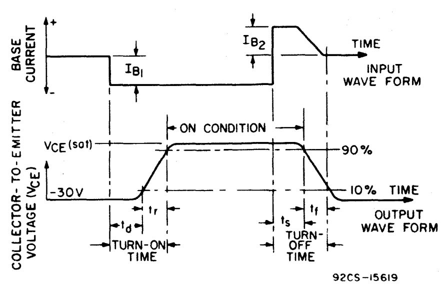


Fig. 6 — Oscilloscope display for measurement of switching times. (Test circuit shown in Fig. 5).

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

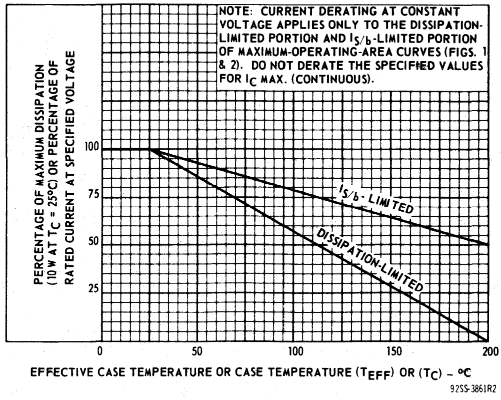


Fig. 7 – Dissipation derating curve for all types.

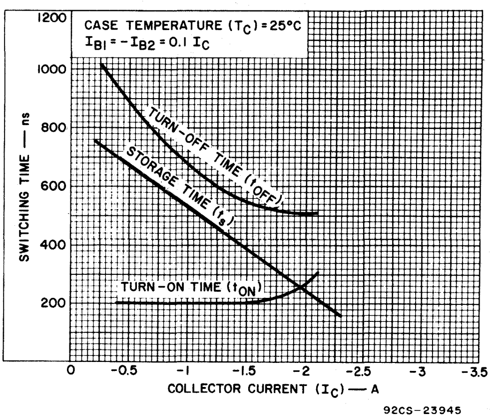


Fig. 8 – Typical saturated switching characteristics for types 2N5781, 2N5782, and 2N5783.

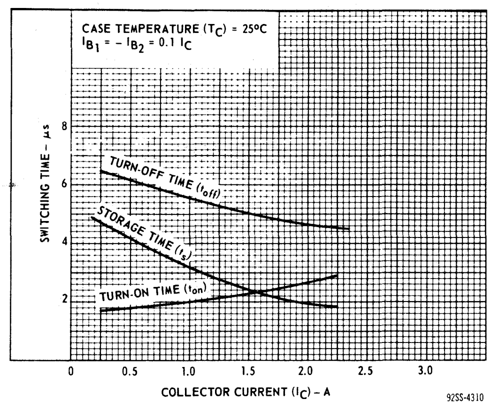


Fig. 9 – Typical saturated switching characteristics for types 2N5784, 2N5785, and 2N5786.

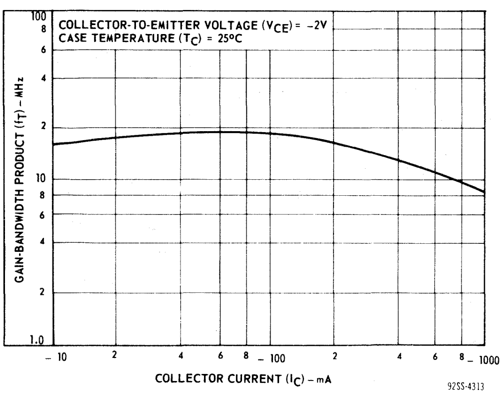


Fig. 10 – Typical gain-bandwidth product for types 2N5781, 2N5782, and 2N5783.

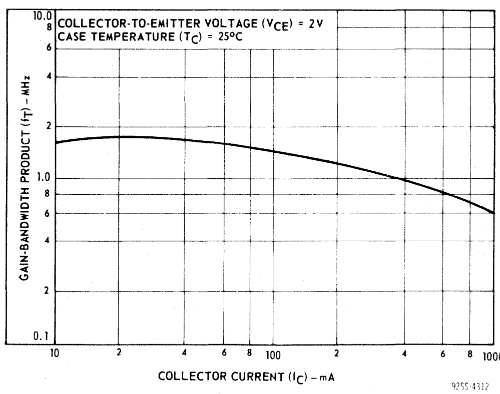


Fig. 11 – Typical gain-bandwidth product for types 2N5784, 2N5785, and 2N5786.

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

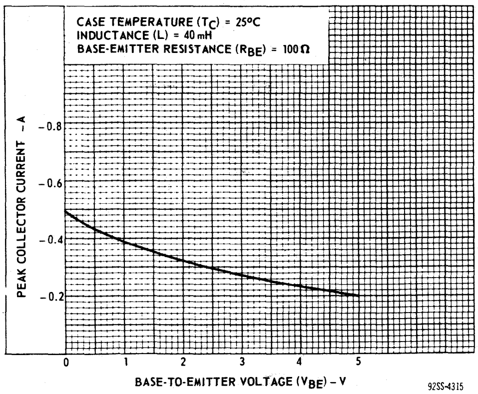


Fig. 12 – Reverse-bias second-breakdown characteristics for types 2N5781, 2N5782, and 2N5783.

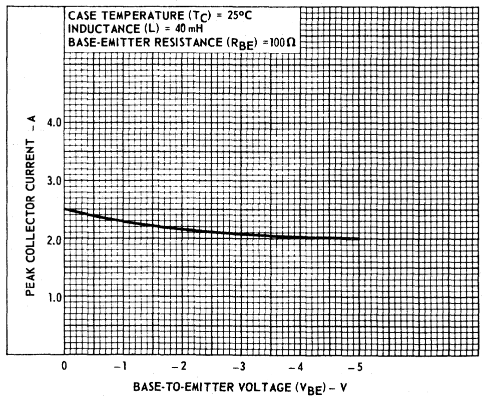


Fig. 13 – Reverse-bias second-breakdown characteristics for types 2N5784, 2N5785, and 2N5786.

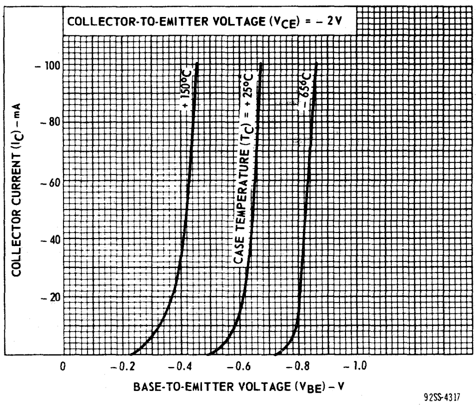


Fig. 14 – Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

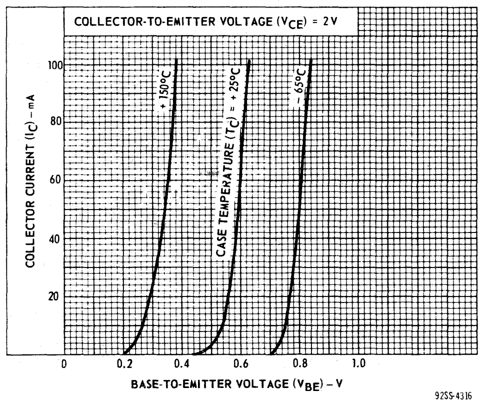


Fig. 15 – Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

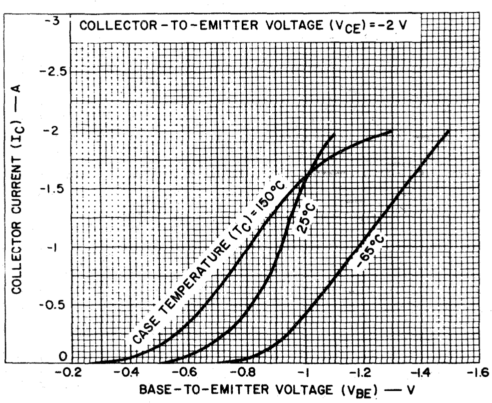


Fig. 16 – Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

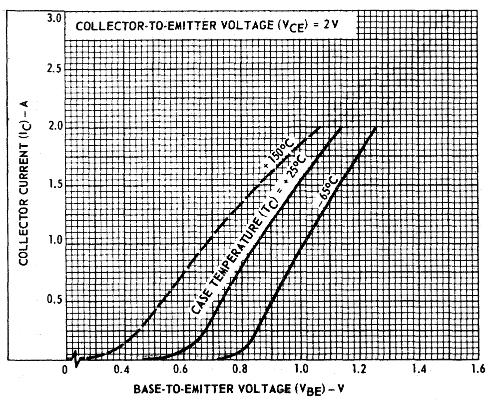


Fig. 17 – Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

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

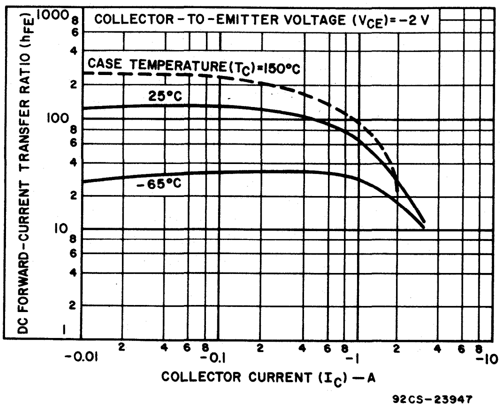


Fig. 18 — Typical dc beta characteristics for type 2N5781.

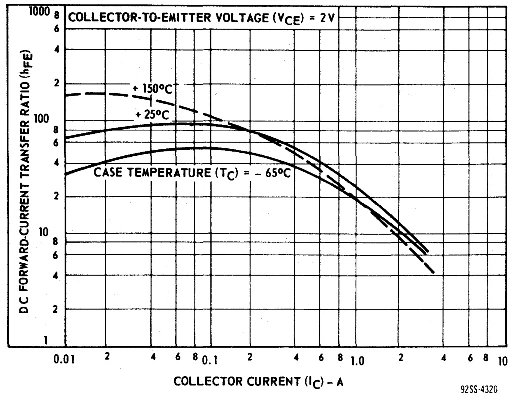


Fig. 19 — Typical dc beta characteristics for type 2N5784.

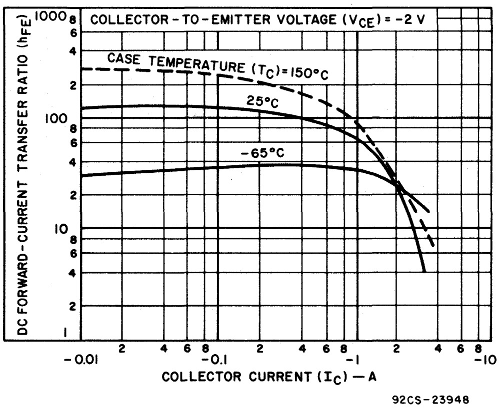


Fig. 20 — Typical dc beta characteristics for type 2N5782.

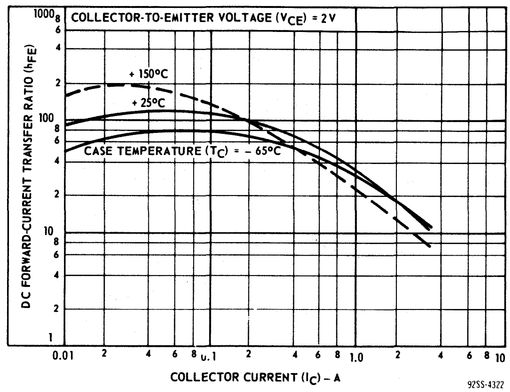


Fig. 21 — Typical dc beta characteristics for type 2N5785.

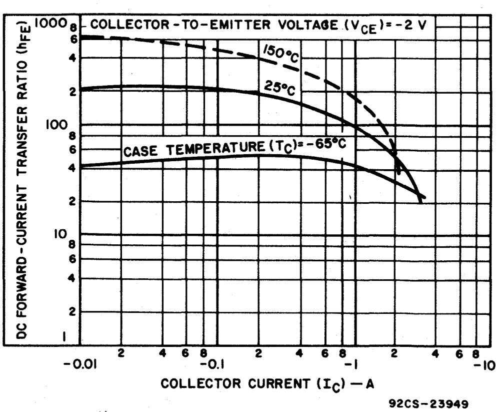


Fig. 22 — Typical dc beta characteristics for type 2N5783.

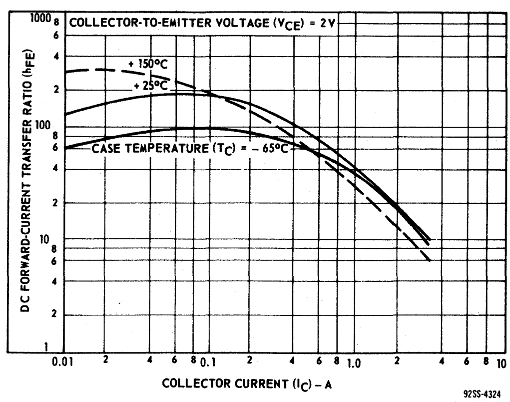


Fig. 23 — Typical dc beta characteristics for type 2N5786.

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

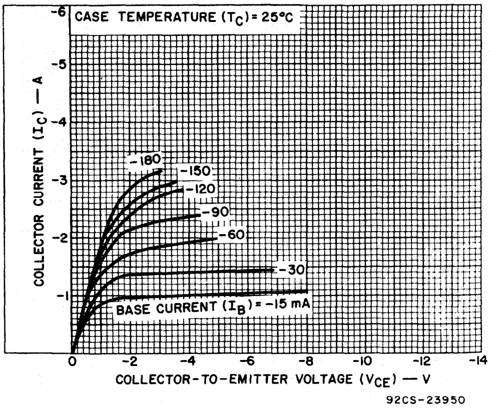


Fig. 24 — Typical output characteristics for type 2N5781.

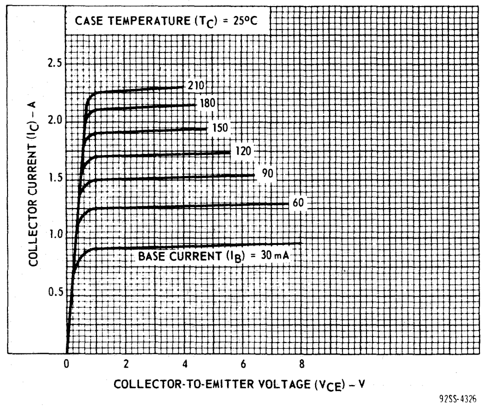


Fig. 25 — Typical output characteristics for type 2N5784.

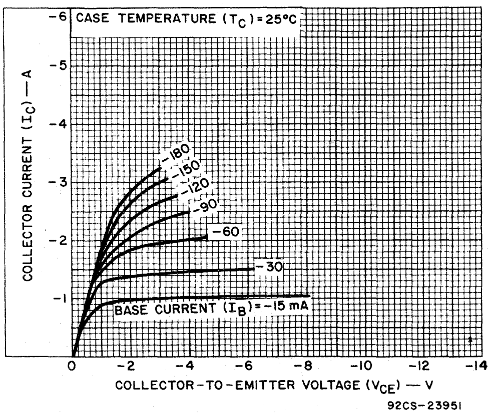


Fig. 26 — Typical output characteristics for type 2N5782.

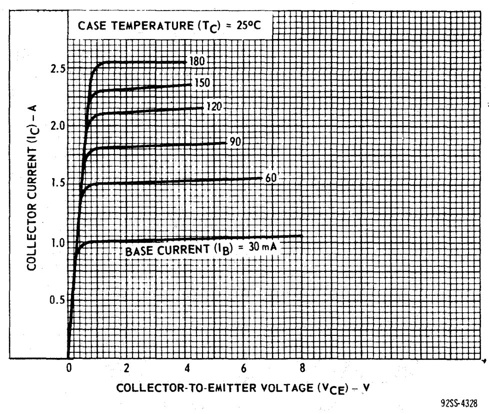


Fig. 27 — Typical output characteristics for type 2N5785.

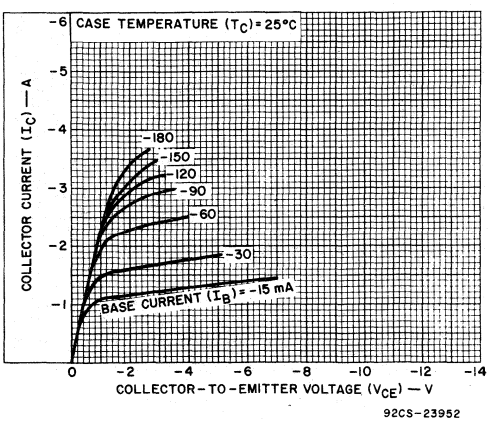


Fig. 28 — Typical output characteristics for type 2N5783.

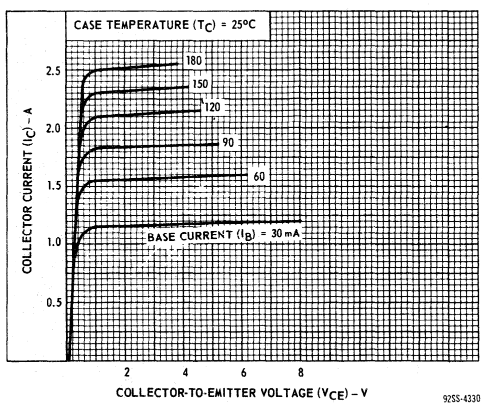


Fig. 29 — Typical output characteristics for type 2N5786.

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

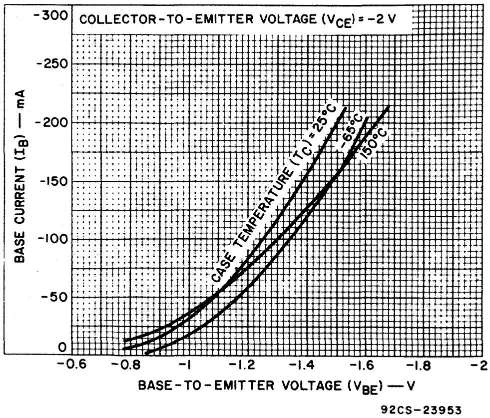


Fig. 30 — Typical input characteristics for type 2N5781.

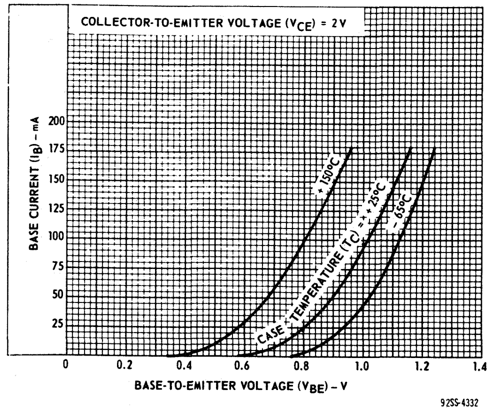


Fig. 31 — Typical input characteristics for type 2N5784.

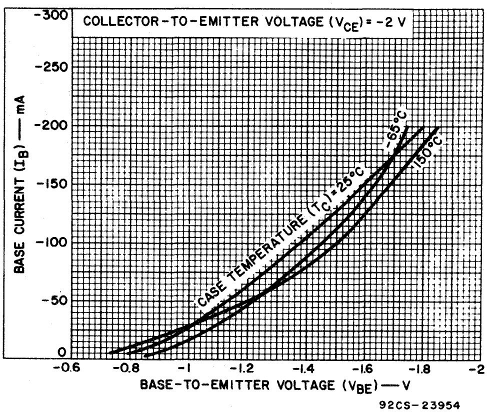


Fig. 32 — Typical input characteristics for type 2N5782.

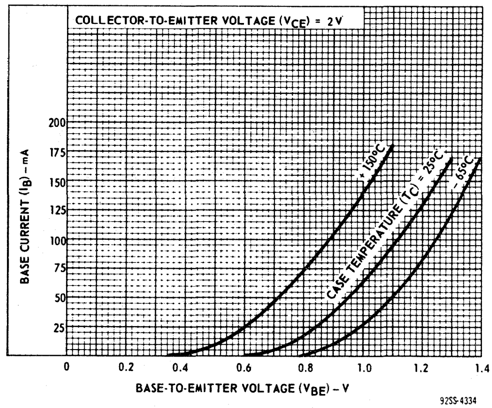


Fig. 33 — Typical input characteristics for type 2N5785.

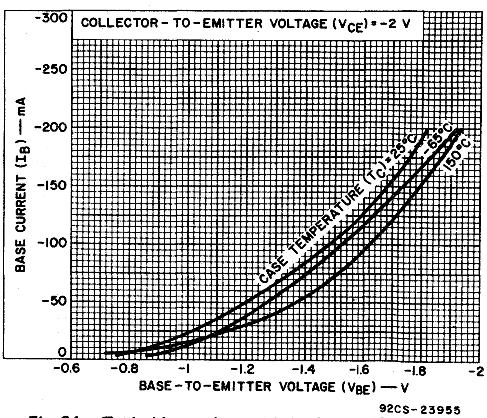


Fig. 34 — Typical input characteristics for type 2N5783.

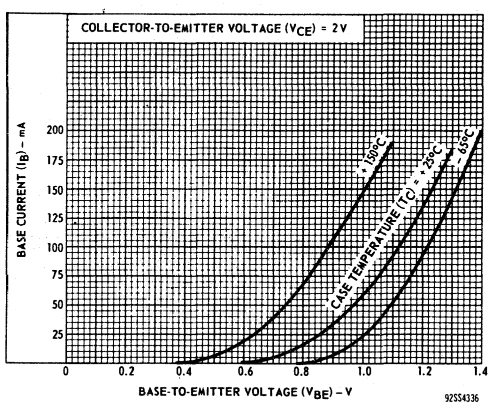


Fig. 35 — Typical input characteristics for type 2N5786.

File Number **410**

2N5838, 2N5839, 2N5840

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

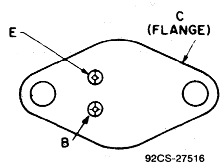
2

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

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

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

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: DC Collector Voltage (V)	Test Conditions: DC Emitter or Base Voltage (V)		Test Conditions: DC Current (A)			Limits: Type 2N5838			Limits: Type 2N5839			Limits: Type 2N5840			Units
		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	$I_{S/bC}$	40						2.5	-	-	2.5	-	-	2.5	-	-	A
Switching Times: Delay	t_d	V_{CC} = 200			2 3	0.2[e] 0.375[e]		- -	- -	- 0.06	- -	- -	0.07 -	- -	- -	0.07 -	μs
* Rise	t_r	V_{CC} = 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	V_{CC} = 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	V_{CC} = 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

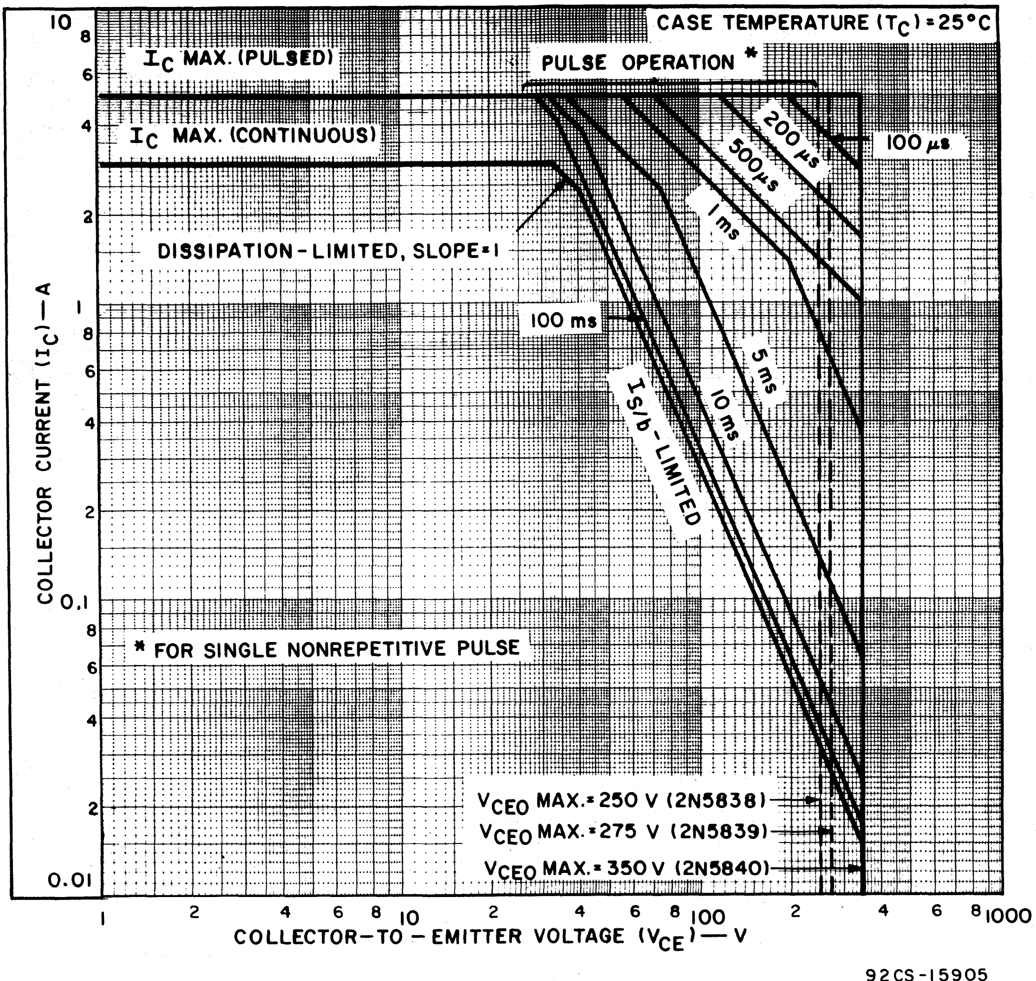


Fig. 1 — Maximum operating areas for all types.

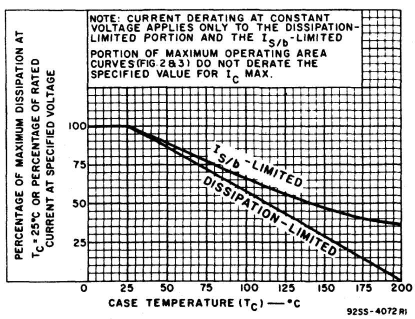


Fig. 2 — Derating curves for all types.

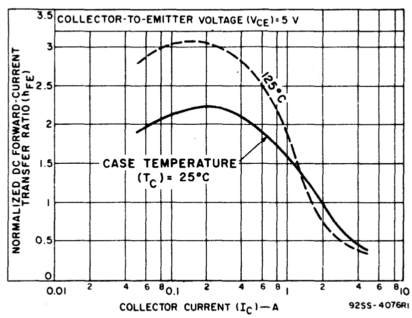


Fig. 3 — Typical normalized dc beta characteristics for all types.

2N5838, 2N5839, 2N5840

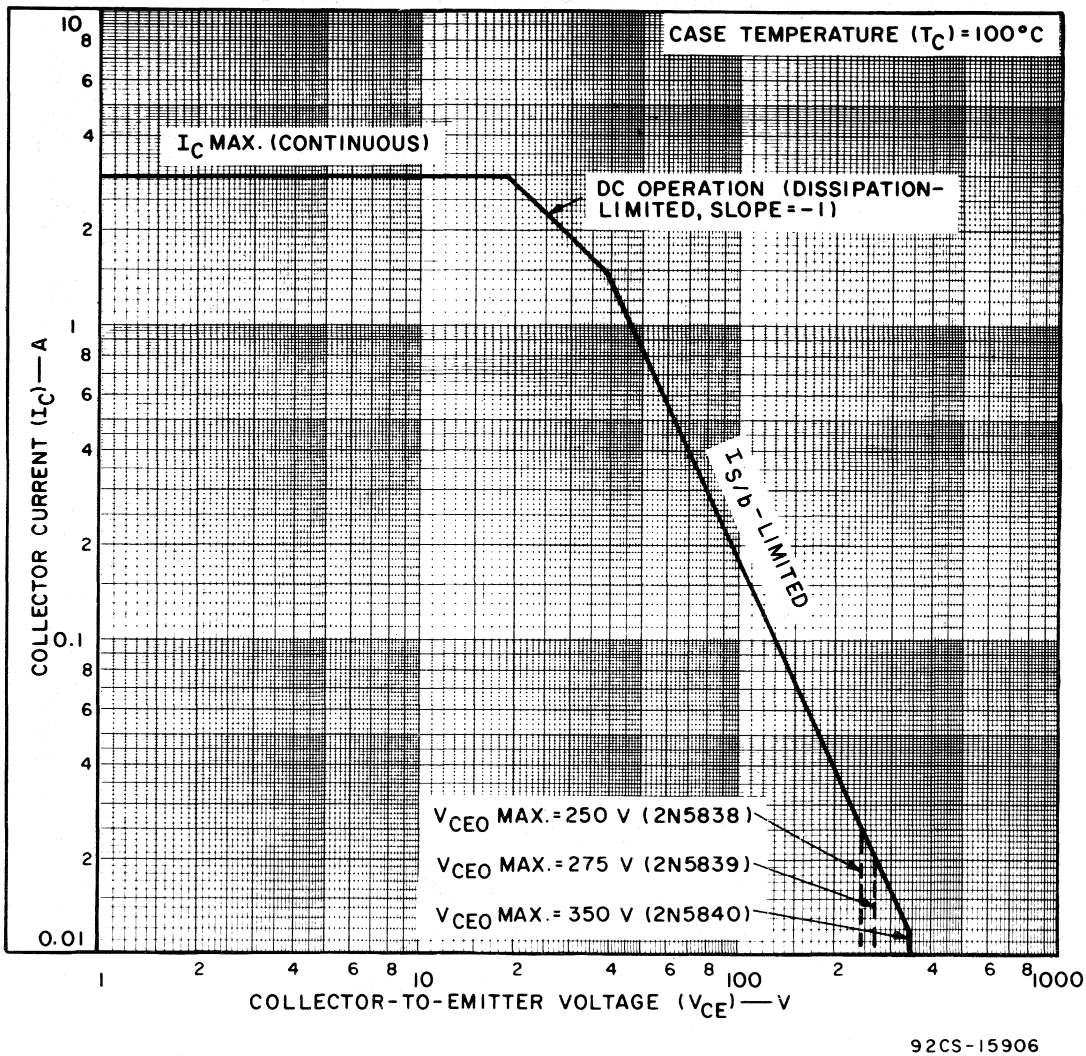


Fig. 4 — Maximum operating areas for all types.

2N5838, 2N5839, 2N5840

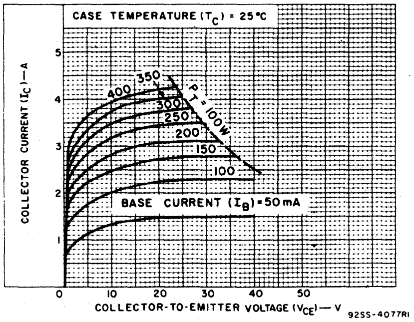


Fig. 5 — Typical output characteristics for all types.

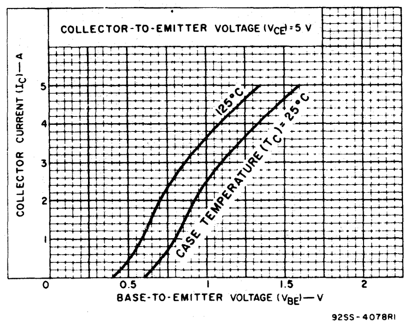


Fig. 6 — Typical transfer characteristics for all types.

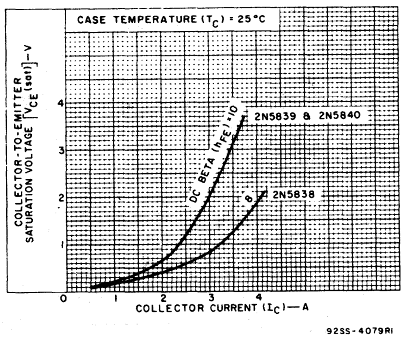


Fig. 7 — Typical saturation voltage characteristics for for all types.

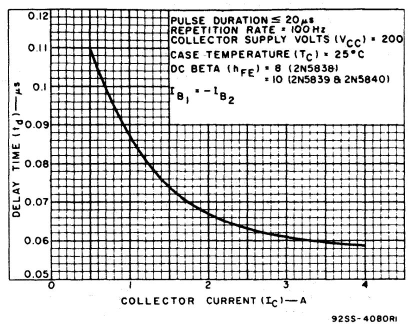


Fig. 8 — Typical delay-time characteristics for all types.

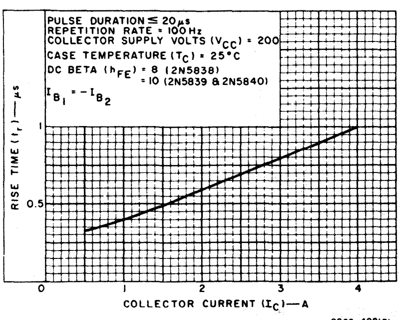


Fig. 9 — Typical rise-time characteristics for all types.

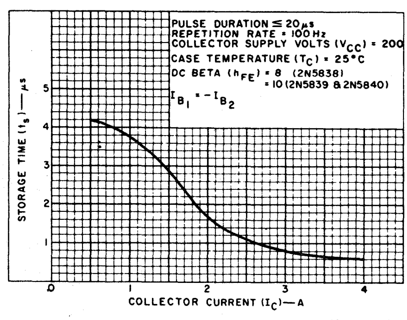


Fig. 10 — Typical storage-time characteristics for all types.

2N5838, 2N5839, 2N5840

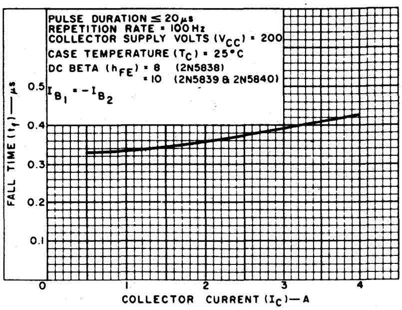


Fig. 11 — Typical fall-time characteristics for all types.

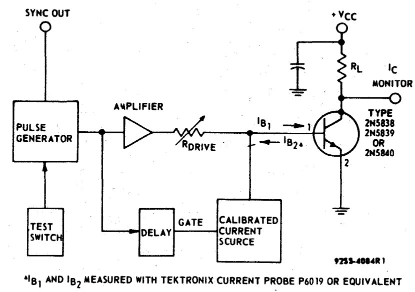


Fig. 12 — Circuit used to measure switching times for all types.

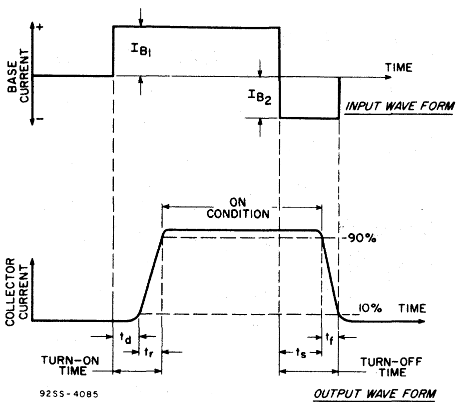


Fig. 13 — Phase relationship between input and output currents showing reference points for specification of switching times.

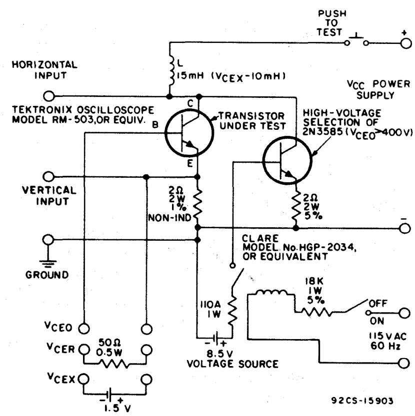
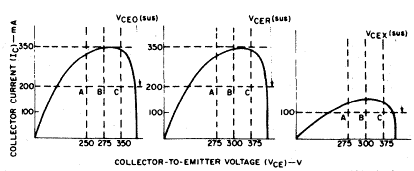


Fig. 14 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.



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.

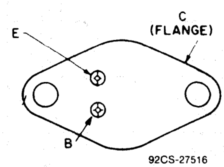
File Number **1041**

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 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		CURRENT A dc		LIMITS: 2N5885		2N5886		UNITS
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
*	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] $I_{B_1} = -I_{B_2}$.

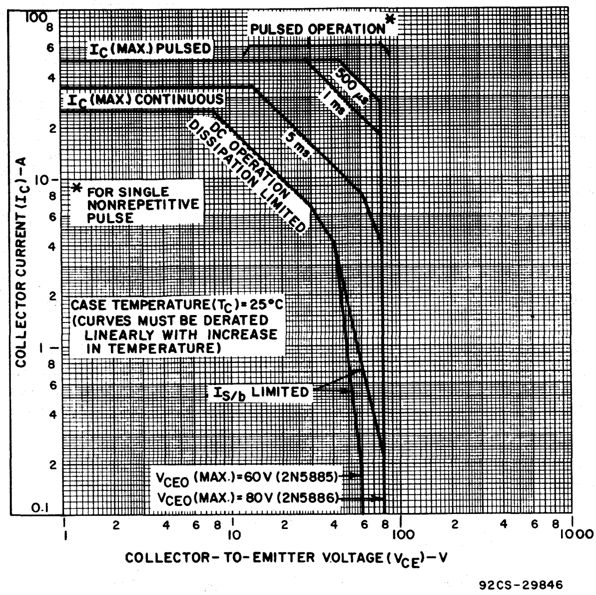


Fig. 1 — Maximum operating areas for 2N5885 and 2N5886.

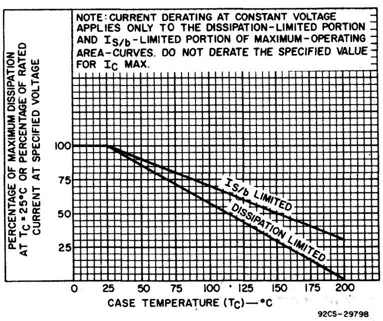


Fig. 2 — Derating curves for 2N5885 and 2N5886.

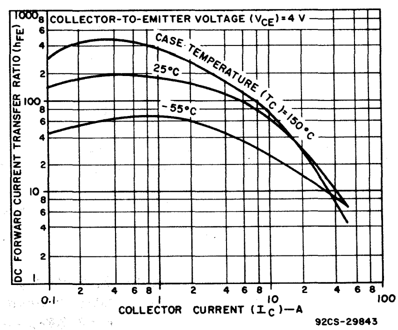


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5885 and 2N5886.

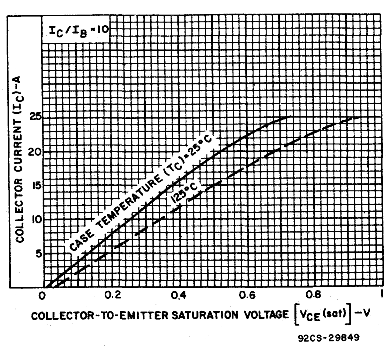


Fig. 4 — Typical saturation voltage characteristics for 2N5885 and 2N5886.

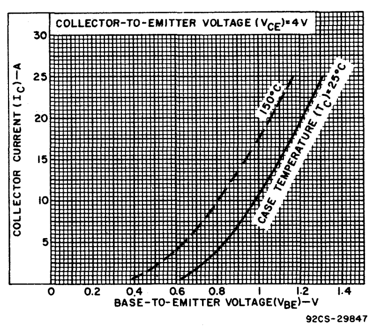


Fig. 5 — Typical transfer characteristics for 2N5885 and 2N5886.

2N5885, 2N5886

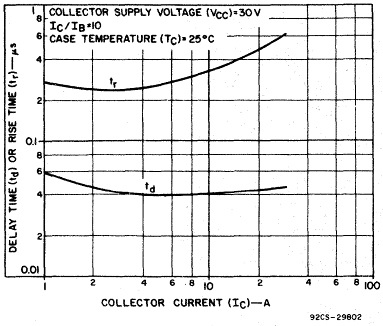


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5885 and 2N5886.

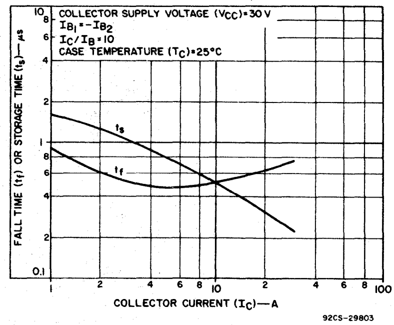


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5885 and 2N5886.

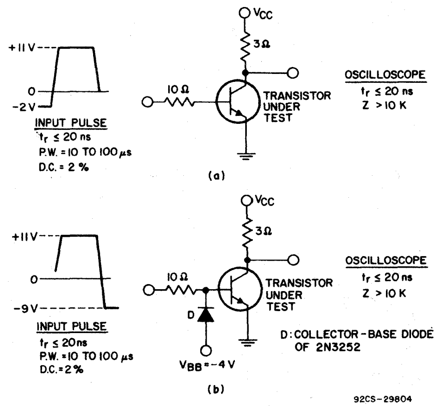


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5885 and 2N5886.

File Number **675**

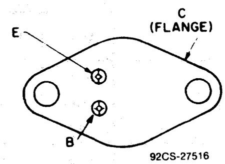
2N5954, 2N5955, 2N5956

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

2

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

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5954	2N5955	2N5956	
* V_{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.

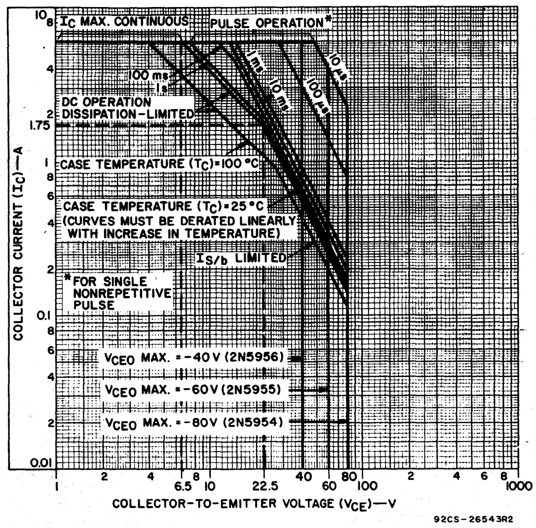


Fig. 1 - Maximum operating areas for all types.

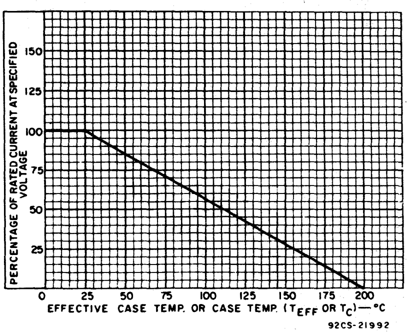


Fig. 2 - Current derating chart for all types.

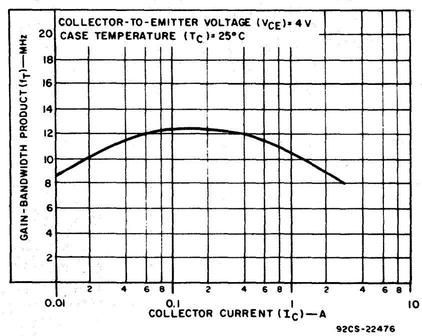


Fig. 3 - Typical gain-bandwidth product for all types.

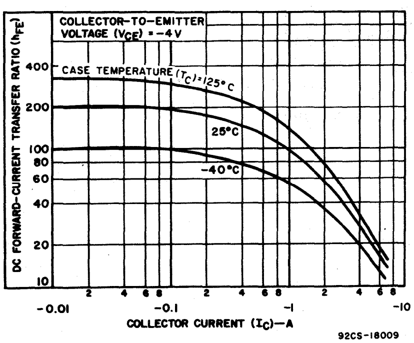


Fig. 4 - Typical dc beta characteristics for 2N5954-2N5956.

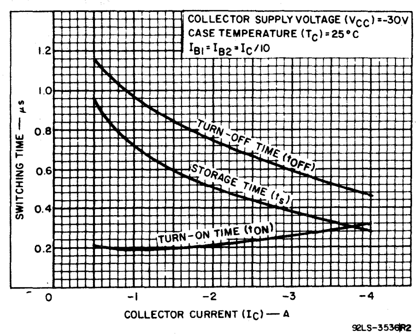


Fig. 5 - Typical saturated switching characteristics for 2N5954-2N5956.

2N5954, 2N5955, 2N5956

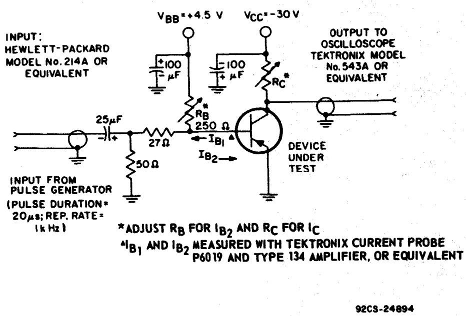


Fig. 6 - Circuit used to measure saturated switching times for 2N5954-2N5956.

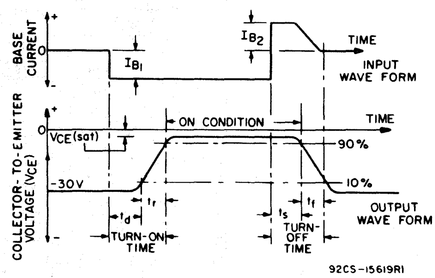


Fig. 7 - Oscilloscope display for measurement of switching times for 2N5954-2N5956.

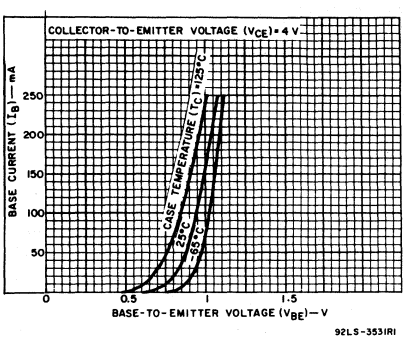


Fig. 8 - Typical input characteristics for all types.

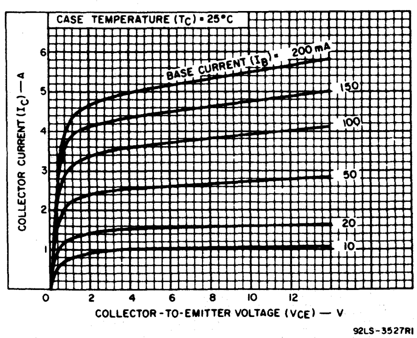


Fig. 9 - Typical output characteristics for all types.

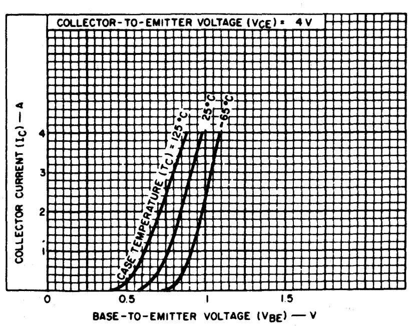


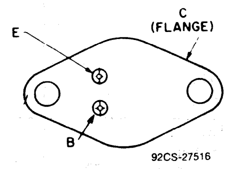
Fig. 10 - Typical transfer characteristics for all types.

File Number **462**

2N6032, 2N6033

High-Current, High-Speed High-Power Transistors

TERMINAL DESIGNATIONS



JEDEC TO-204AE

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)

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

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

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

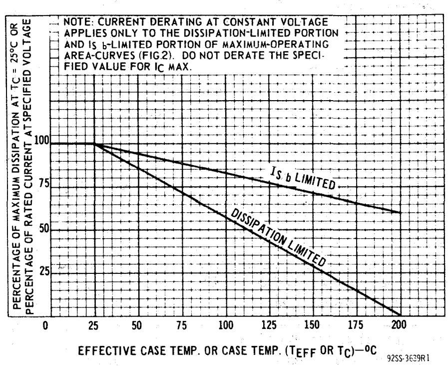


Fig. 1 - Derating curves for both types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6032	2N6033	
* COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	120	150	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:			
With base open, $V_{CEO}(sus)$	90	120	V
With external base-to-emitter resistance (R_{BE})≤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) V_{CB}	V_{CE}	DC Emitter or Base Voltage (V) V_{EB}	V_{BE}	DC Current (A) I_C	I_E	I_B	LIMITS: Type 2N6032 Min.	Max.	Type 2N6033 Min.	Max.	UNITS
Collector-Cutoff Current: With base open	I_{CEO}	–	80	–	–	–	–	0	–	10	–	10	mA
* With base-emitter junction reverse biased	I_{CEV}	–	110	–	-1.5	–	–	–	–	12	–	–	mA
		–	135	–	-1.5	–	–	–	–	–	–	10	
(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: *(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	–	5	–	2	–	–	V
		–	–	–	–	40	–	4	–	–	–	2	
Base-to-Emitter Voltage	V_{BE}	–	2	–	–	50	–	–	–	2	–	–	V
		–	2	–	–	40	–	–	–	–	–	2	
* Collector-to-Emitter Saturation Voltage[c]	$V_{CE}(sat)$	–	–	–	–	50	–	5	–	1.3	–	–	V
		–	–	–	–	40	–	4	–	–	–	1	
* DC Forward-Current Transfer Ratio[c]	h_{FE}	–	2.6	–	–	50	–	–	10	50	–	–	
		–	2	–	–	40	–	–	–	–	10	50	
Second-Breakdown Collector Current With base forward biased	$I_{S/b}$[b]	–	24	–	–	–	–	–	5.8[c]	–	5.8[c]	–	A
		–	40	–	–	–	–	–	0.9[c]	–	0.9[c]	–	
* 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	–	5[e]	–	1	–	–	µs
			–	–	–	40	–	4[e]	–	–	–	1	
* Rise	t_r	V_{CC}= 30V	–	–	–	50	–	5[e]	–	1	–	–	µs
			–	–	–	40	–	4[e]	–	–	–	1	
* Storage	t_s	V_{CC}= 30V	–	–	–	50	–	5[e]	–	1.5	–	–	µs
			–	–	–	40	–	4[e]	–	–	–	1.5	
* Fall	t_f	V_{CC}= 30V	–	–	–	50	–	5[e]	–	0.5	–	–	µs
			–	–	–	40	–	4[e]	–	–	–	0.5	
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] $I_{B_1} = I_{B_2}$ *In accordance with JEDEC registration format JS-6 RDF-1.

2N6032, 2N6033

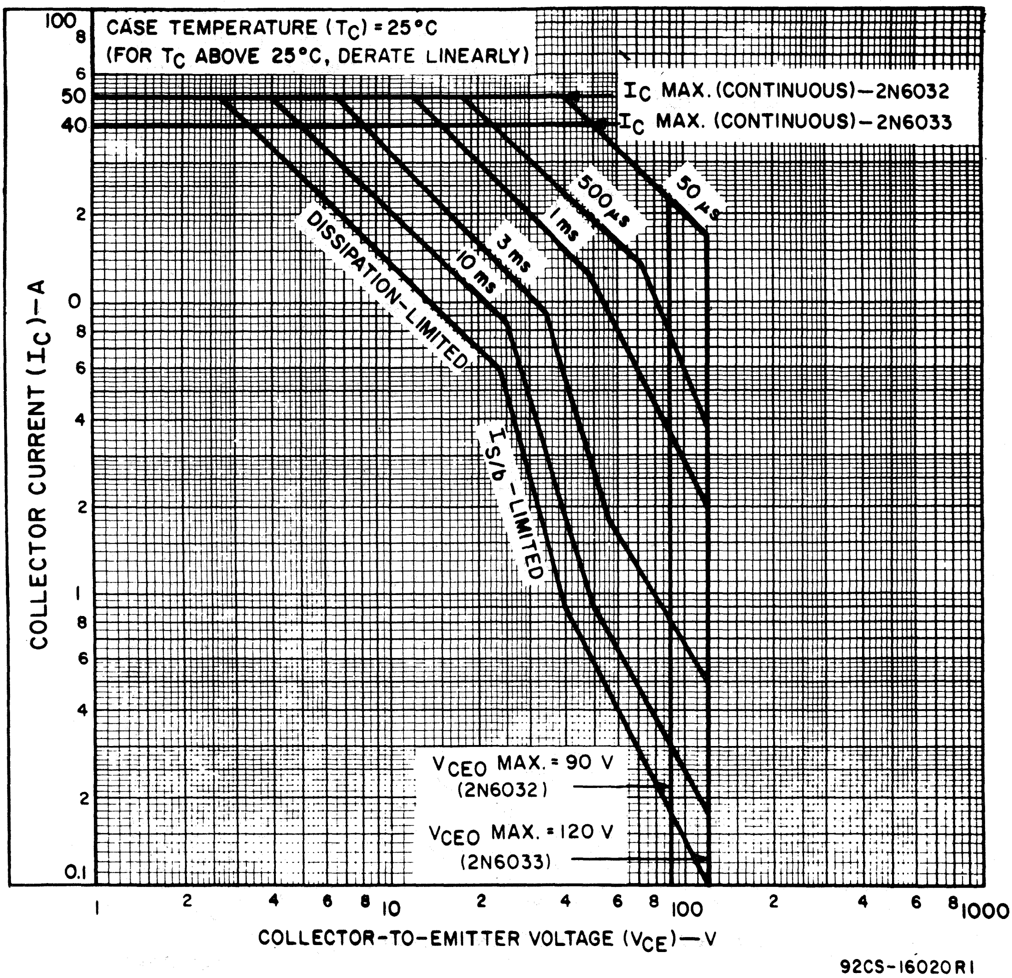


Fig. 2 - Maximum operating area for both types.

2N6032, 2N6033

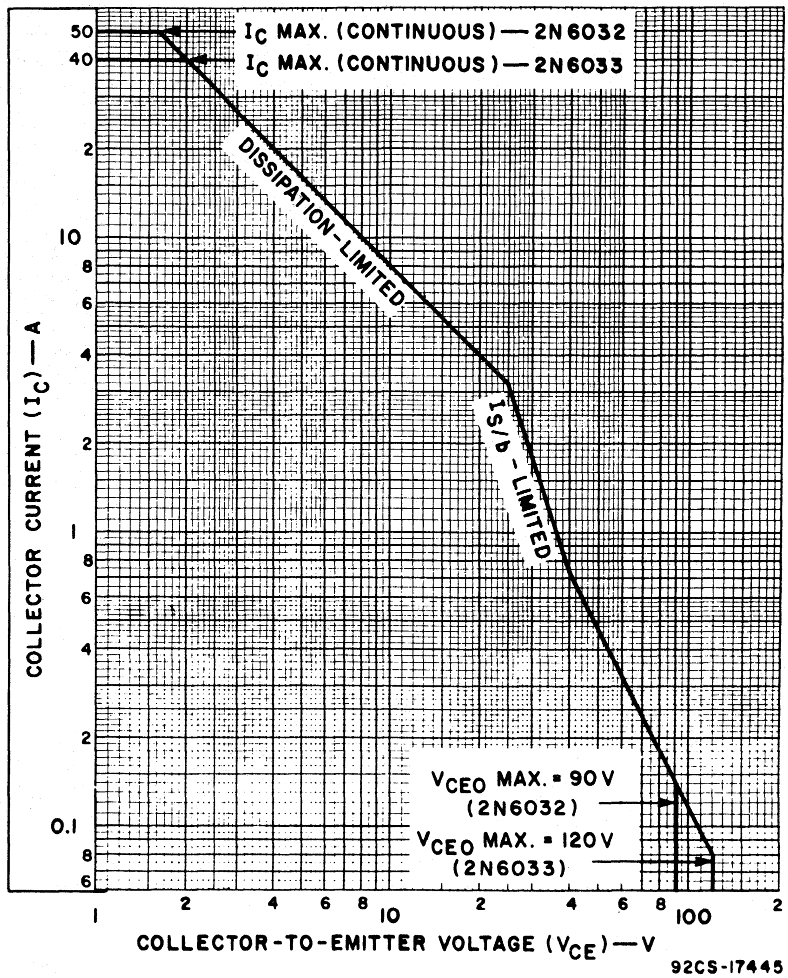


Fig. 3 - Maximum operating areas for both types at case temperature (T_C) = 100° C.

2N6032, 2N6033

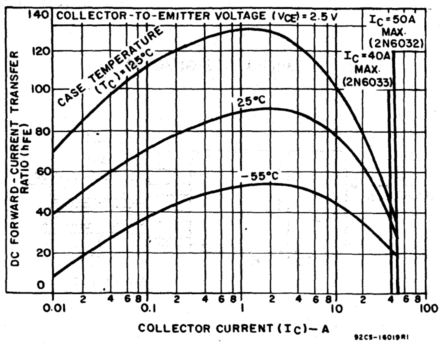


Fig. 4 - Typical dc-beta characteristics for both types.

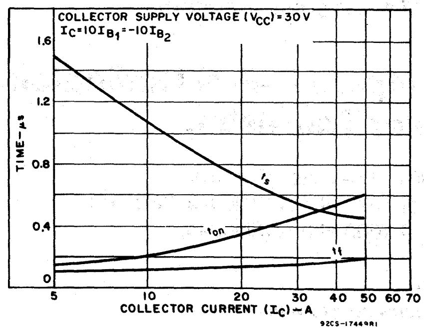


Fig. 5 - Typical saturated switching characteristics for both types.

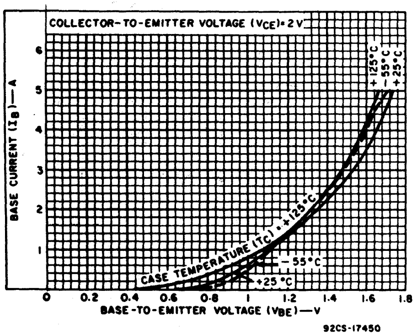


Fig. 6 - Typical input characteristics for both types.

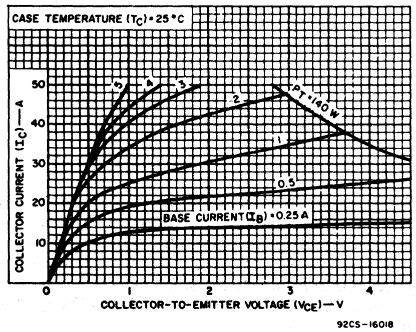


Fig. 7 - Typical collector characteristics for both types.

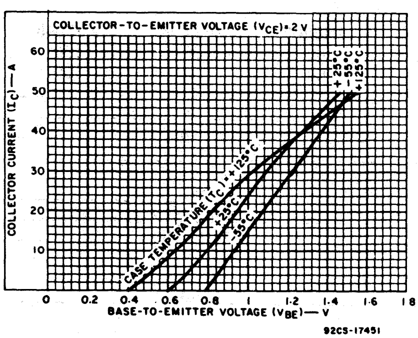


Fig. 8 - Typical transfer characteristics for both types.

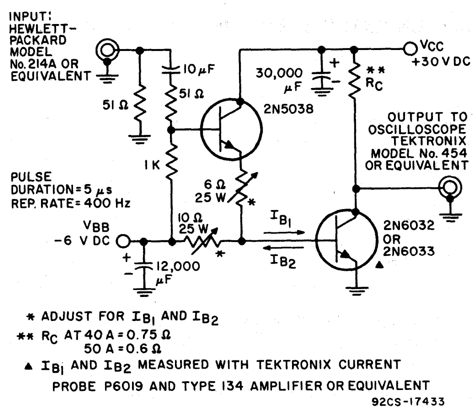


Fig. 9 - Switching-time test set.

2N6043, 2N6044, 2N6045

File Number **1151**

8-Ampere N-P-N Darlington Power Transistors

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

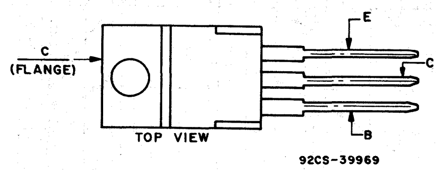
Features:

- *Operates from IC without predriver*

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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

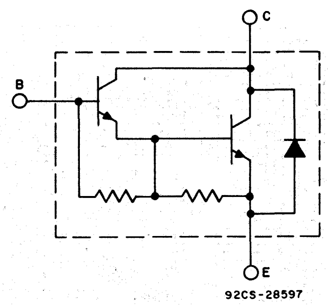


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6043	2N6044	2N6045	
*V_{CBO}	60	80	**100**	V
V_{CEO}(sus)	60	80	**100**	V
*V_{EBO}		5		V
*I_C		8		A
I_{CM}		16		A
*I_B		0.12		A
*P_T				
$T_C \geq 25°C$		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

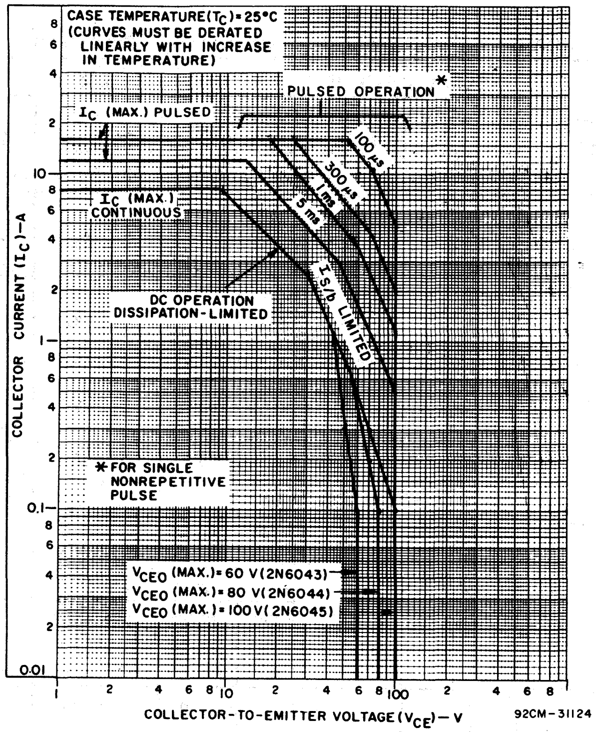


Fig. 2 — Maximum operating areas for all types (T_C = 25°C).

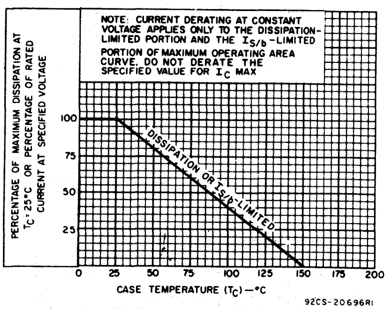


Fig. 3 — Derating curve for all types.

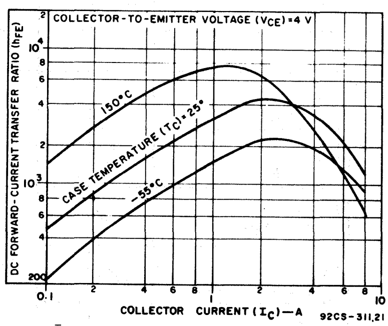


Fig. 4 — Typical dc beta characteristics for all types.

2N6043, 2N6044, 2N6045

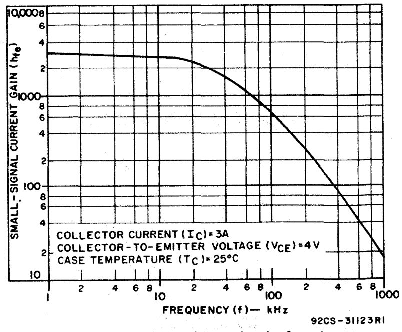


Fig. 5 — Typical small-signal gain for all types.

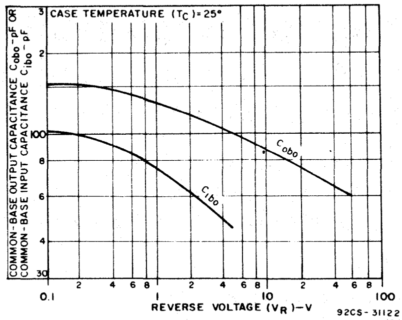


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of reverse voltage for all types.

2

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

File Number **1185**

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

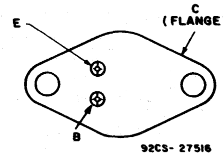
60-80-100 Volts, 150 Watts
Gain of 7000 (Typ.) at 5 A (2N6050, 2N6051, 2N6052)
Gain of 4000 (Typ.) at 5 A (2N6057, 2N6058, 2N6059)

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 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				
$T_C \leq 25^\circ C$		150		W
$T_C > 25^\circ C$ 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

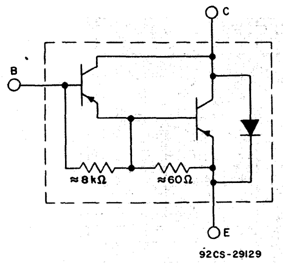


Fig. 1 – Schematic diagram for 2N6050, 2N6051, and 2N6052.

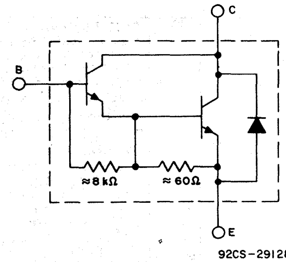


Fig. 2 – Schematic diagram for 2N6057, 2N6058, and 2N6059.

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS: 2N6050• 2N6057 MIN.	MAX.	2N6051• 2N6058 MIN.	MAX.	2N6052• 2N6059 MIN.	MAX.	UNITS
* 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

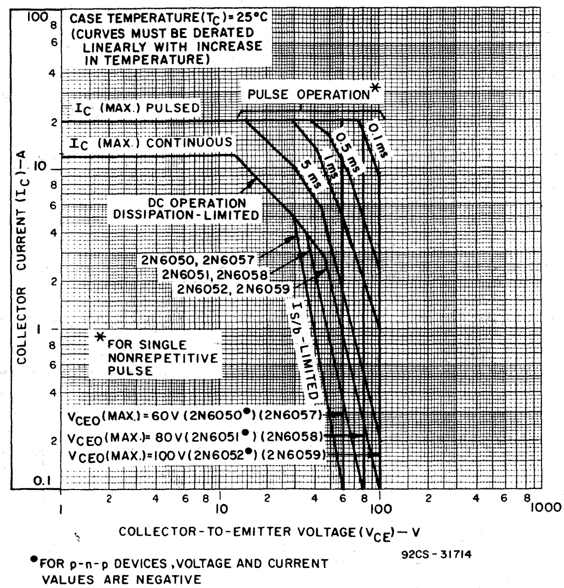


Fig. 3 — Maximum operating areas for all types.

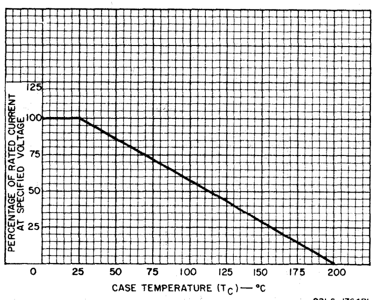


Fig. 4 — Current derating curve for all types.

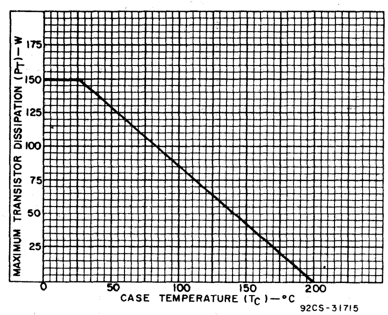


Fig. 5 — Power derating curve for all types.

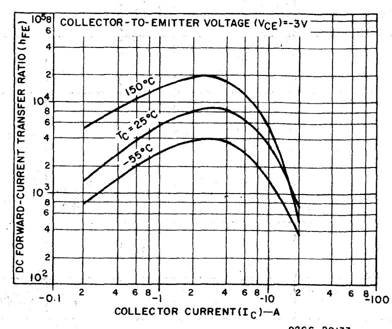


Fig. 6 — Typical dc beta characteristics for 2N6050, 2N6051, and 2N6052.

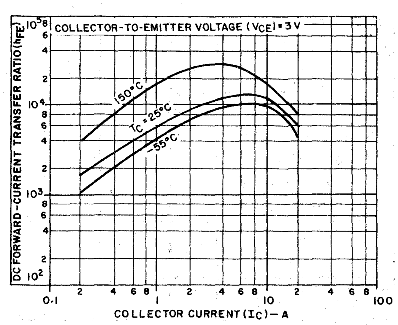
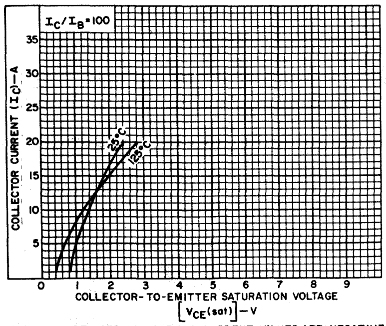


Fig. 7 — Typical dc beta characteristics for 2N6057, 2N6058, and 2N6059.

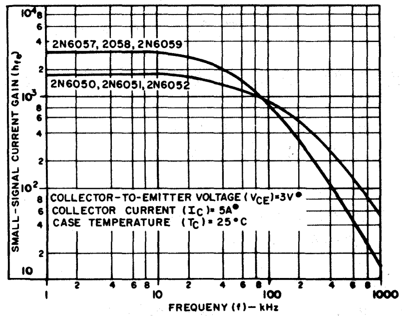
2N6050, 2N6051, 2N6052, 2N6057, 2N6058, 2N6059



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

92CS-31712

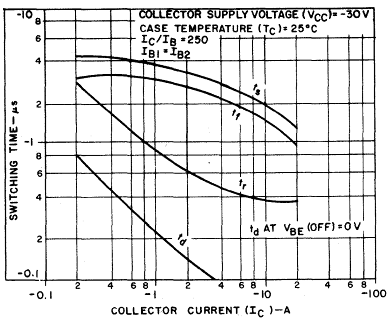
Fig. 8 — Typical saturation characteristics for all types.



•FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

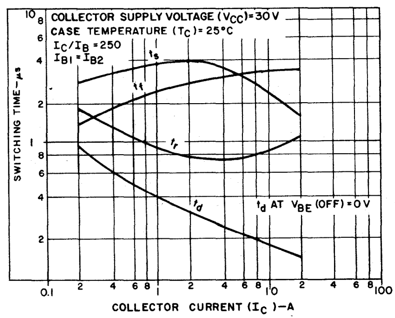
92CS-31713

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



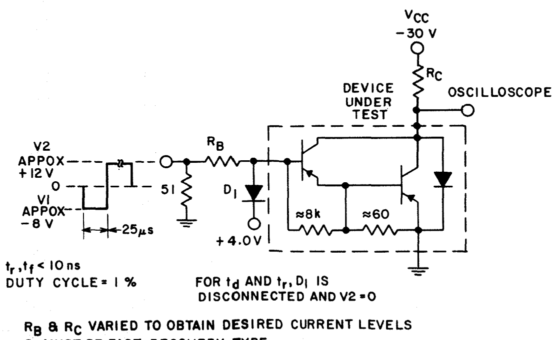
92CS-29137

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



92CS-29136

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



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

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

92CS-29138

Fig. 12 — Switching times test circuit.

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

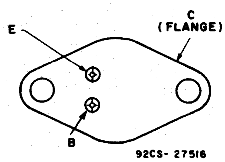
Features:

- **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 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.

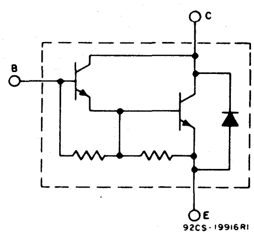


Fig. 1 – Schematic diagram of 2N6055 and 2N6056 Darlington power transistors.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6055	2N6056	
* V_{CBO}	60	80	V
$V_{CER}(sus)$			
R_{BE} = 100 Ω	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			
$T_C \leqslant 25^oC$	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	mA
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	mA
* I_{EBO}		5		0			–	2	–	2	mA
* h_{FE}	3 3			8[a] 4[a]			100 750	– 18,000	100 750	– 18,000	
V_{CEO}(sus)				0.1[a]			60[a]	–	80[a]	–	V
V_{CER}(sus) R_{BE} = 100 Ω				0.1[a]			60[a]	–	80[a]	–	V
V_{CEX}(sus)			−1.5	0.1[a]			60[a]	–	80[a]	–	V
* 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	V
* $\|h_{fe}\|$ 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

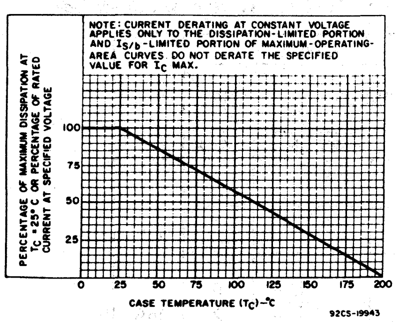


Fig.2 — Derating curve for both types.

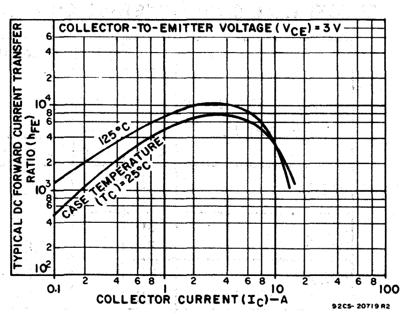


Fig.3 — Typical dc beta characteristics for both types.

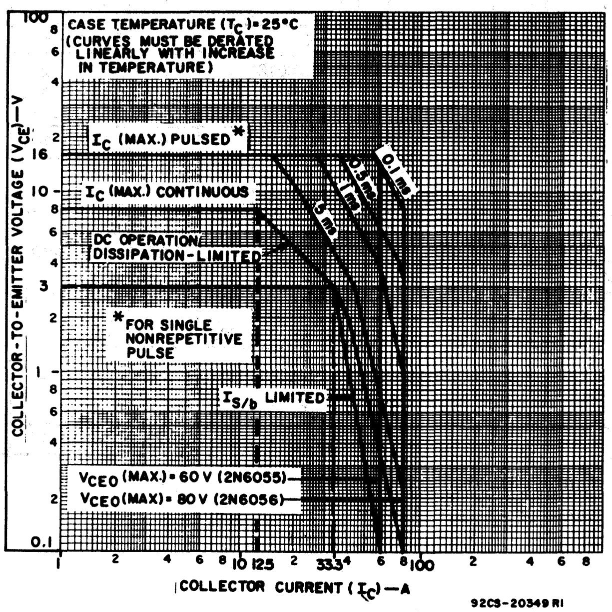


Fig.4 — Maximum operating areas for types 2N6055 and 2N6056.

2N6055, 2N6056

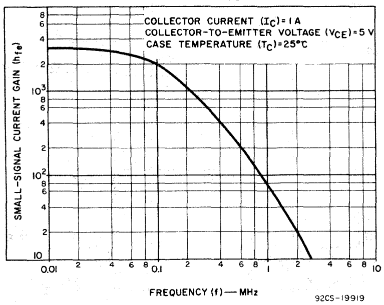


Fig. 5 — Typical small-signal gain for both types.

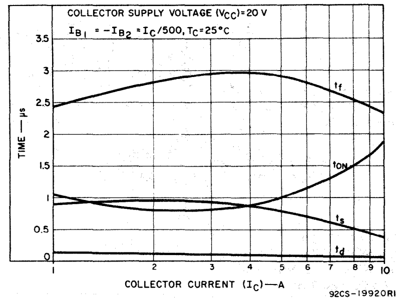


Fig. 6 — Typical saturated switching-time characteristics for both types.

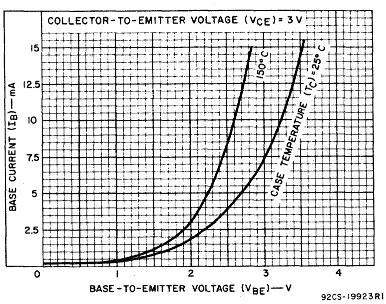


Fig. 7 — Typical input characteristics for both types.

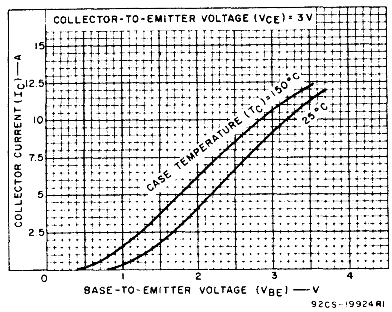


Fig. 8 — Typical transfer characteristics for both types.

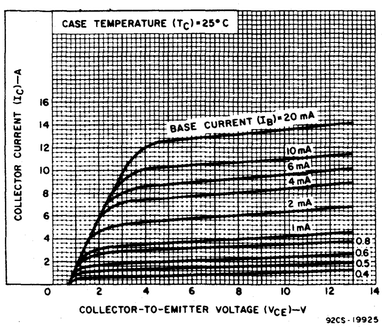


Fig. 9 — Typical output characteristics for both types.

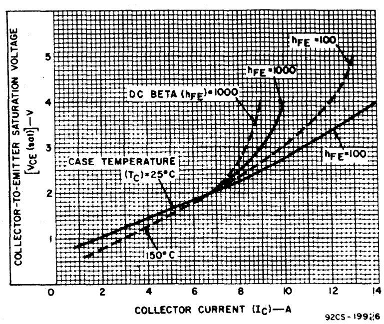


Fig. 10 — Typical saturation-voltage characteristics for both types.

2N6055, 2N6056

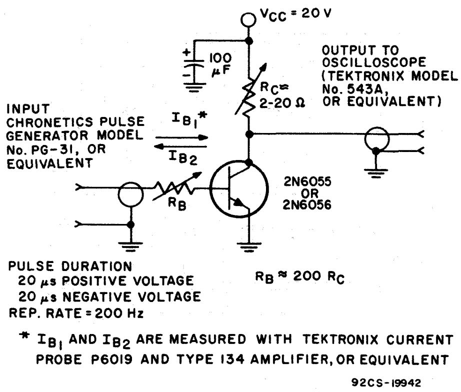


Fig. 11 — Circuit used to measure saturated switching times.

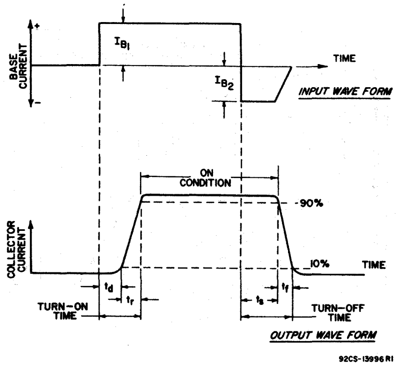


Fig. 12 — Phase relationship between input current and output current showing reference points for specification of switching times.

File Number **492**

2N6077, 2N6078, 2N6079

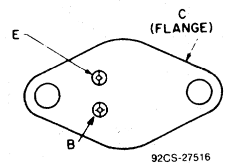
High-Voltage, High Power Silicon N-P-N Transistors

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

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

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

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

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

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

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: DC Collector Voltage (V)		DC Emitter Voltage (V)	DC Current (A)			Limits: Type 2N6077			Type 2N6078			Type 2N6079			Units
		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]	–	–	V
* 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	μs
* 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	μs
* (*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	μs
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

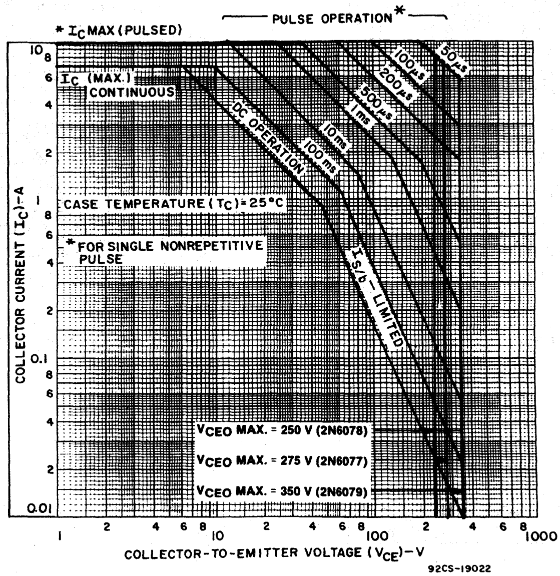


Fig. 1—Maximum operating areas for all types.

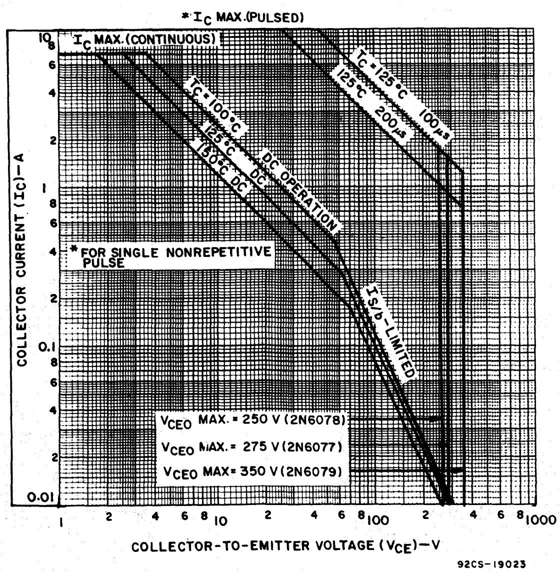


Fig. 2—Maximum operating areas for all types.

2

2N6077, 2N6078, 2N6079

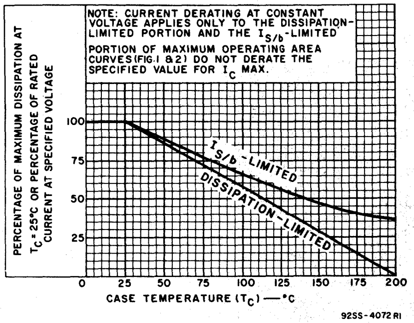


Fig.3—Derating curve for all types.

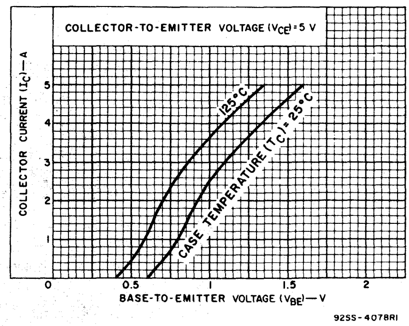


Fig.4—Typical transfer characteristics for all types.

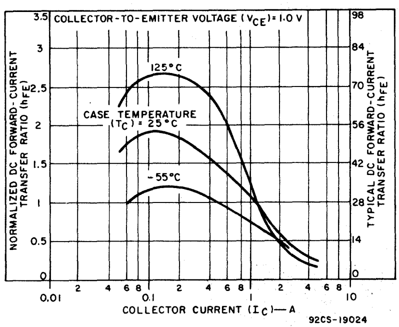


Fig.5—Typical normalized dc beta characteristics for all types.

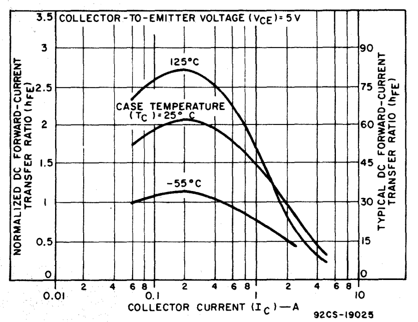


Fig.6—Typical normalized dc beta characteristics for all types.

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).

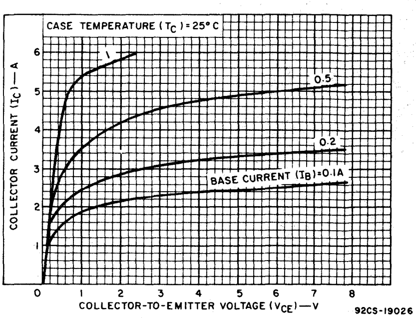


Fig.7—Typical output characteristics for all types.

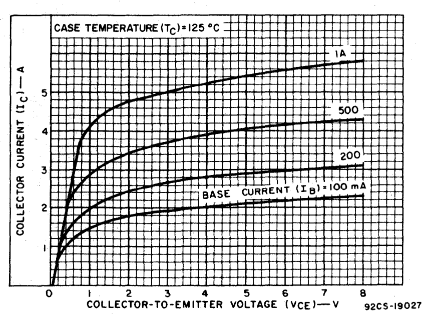


Fig.8—Typical output characteristics for all types.

2N6077, 2N6078, 2N6079

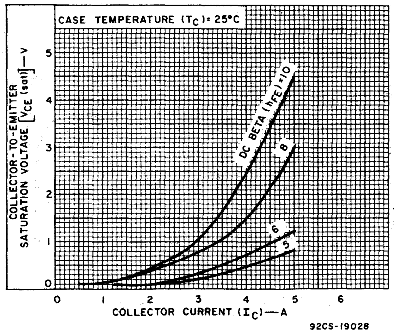


Fig.9—Typical saturation voltage characteristics for all types.

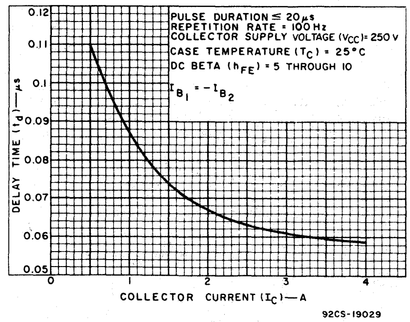


Fig.10—Typical delay-time characteristic for all types.

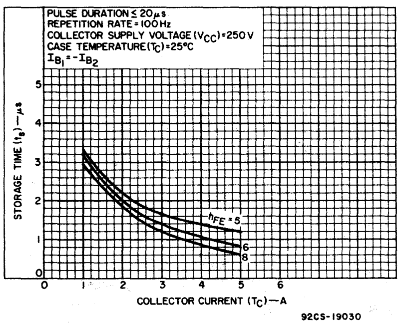


Fig.11—Typical storage-time characteristic for all types (with constant forced gain).

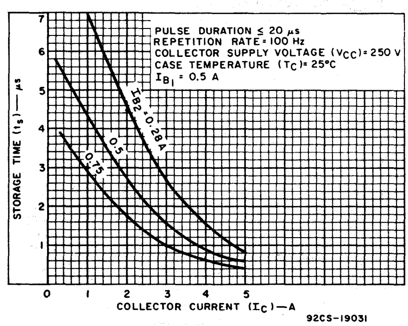


Fig.12—Typical storage-time characteristic for all types (with constant-base drives).

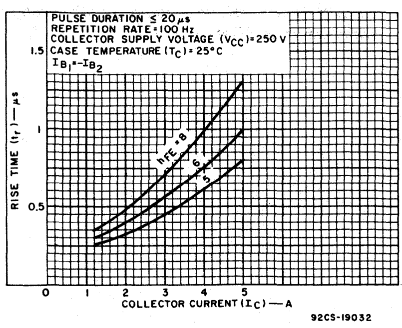


Fig.13—Typical rise-time characteristic for all types.

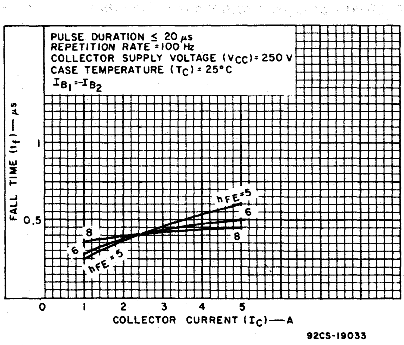


Fig.14—Typical fall-time characteristic for all types.

2N6077, 2N6078, 2N6079

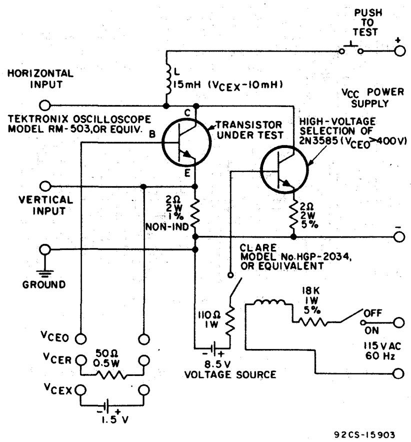
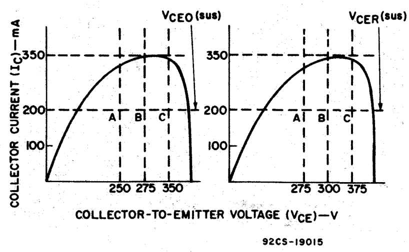
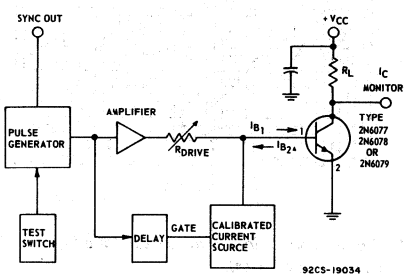


Fig. 15—Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus) for all types.



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

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



*I_{B_1} AND I_{B_2} MEASURED WITH TEKTRONIX CURRENT PROBE P6019 OR EQUIVALENT

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

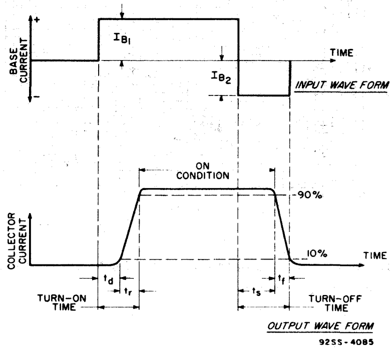


Fig. 18—Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 17).

File Number **676**

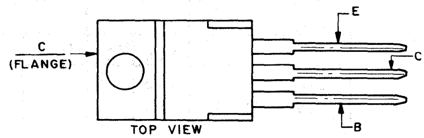
2N6106-2N6111, 2N6288-2N6293, 2N6473-2N6476

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

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

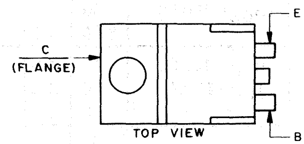
Features:
- *Low saturation voltages*
- *Complementary n-p-n and p-n-p types*
- *Maximum safe-area-of-operation curves specified for dc operation*

TERMINAL DESIGNATIONS



92CS-39969

JEDEC TO-220AB



92CS-40186

JEDEC TO-220AA

The 2N6106-2N6111, 2N6288-2N6293, and 2N6473-2N6476 are epitaxial-base silicon transistors supplied in a VERSAWATT package. The 2N6288-2N6293, 2N6473, and 2N6474• are n-p-n complements of p-n-p types 2N6106-2N6111, 2N6475, and 2N6476■, respectively. All these transistors are intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

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 V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6292, 2N6293, 2N6106♦, 2N6107♦ MIN.	MAX.	2N6290, 2N6291, 2N6108♦, 2N6109♦ MIN.	MAX.	2N6288, 2N6289, 2N6110♦, 2N6111♦ MIN.	MAX.	UNITS
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	mA
	(R_{BE} = 100 Ω T_C = 100°C)	120				–	2	–	–	mA
		100				–	–	–	2	mA
*	I_{CEX} (R_{BE} = 100 Ω)	120	−1.5			–	0.1	–	–	mA
		100	−1.5			–	–	–	0.1	mA
	(R_{BE} = 100 Ω, T_C = 100°C)	120	−1.5			–	2	–	–	mA
		100	−1.5			–	–	–	2	mA
*	I_{CEO}	60			0	–	1	–	–	mA
		50			0	–	–	–	1	mA
*	I_{EBO}		−5		0	–	1	–	1	mA
*	$V_{CEO}(sus)$[b]			0.1[a]	0	120	–	100	–	V
	$V_{CER}(sus)$[b] (R_{BE} = 100 Ω)			0.1[a]		130	–	110	–	V
*	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
*	$V_{CE}(sat)$			1.5[a]	0.15	–	1.2	–	1.2	V
				4[a]	2	–	2.5	–	2.5	V
*	$\lvert h_{fe} \rvert$ (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	–	MHz
*	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	°C/W

* 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.

2

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

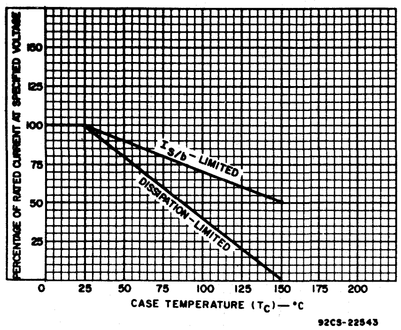


Fig. 1 – Current derating curves for all types.

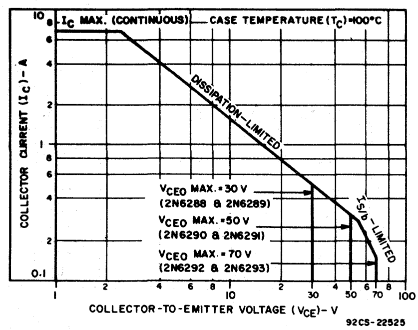


Fig. 2 - Maximum operating areas for 2N6288 – 2N6293 (T_C = 100°C).

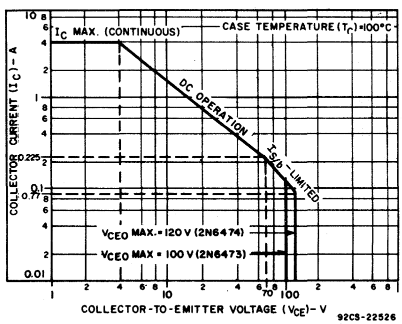


Fig. 3 - Maximum operating areas for 2N6473 – 2N6474 (T_C = 100°C).

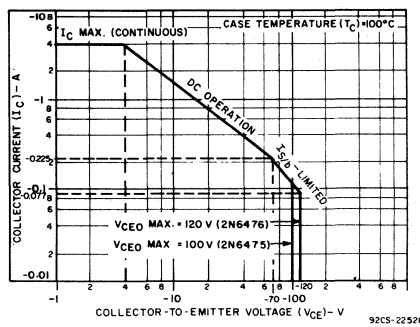


Fig. 4 - Maximum operating areas for 2N6475 and 2N6476 (T_C = 100°C).

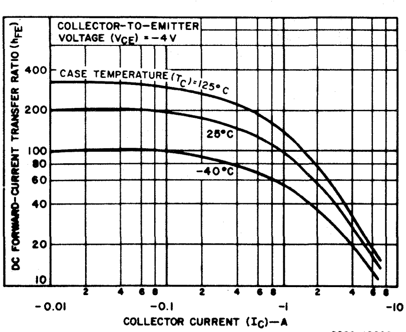


Fig. 5 - Typical dc beta characteristics for 2N6106 – 2N6111.

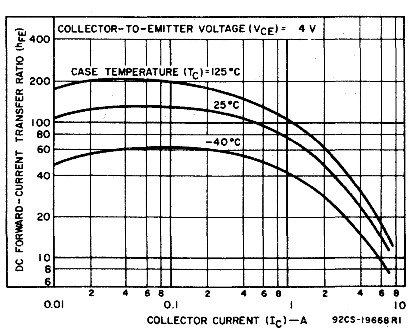


Fig. 6 - Typical dc beta characteristics for 2N6288 – 2N6293.

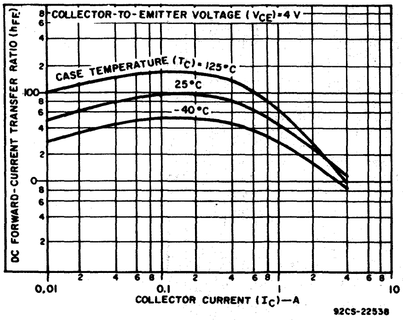


Fig. 7 - Typical dc beta characteristics for 2N6473 and 2N6474.

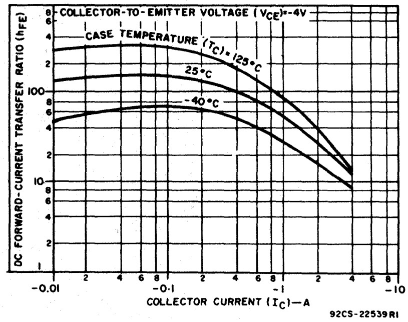


Fig. 8 - Typical dc beta characteristics for 2N6475 and 2N6476.

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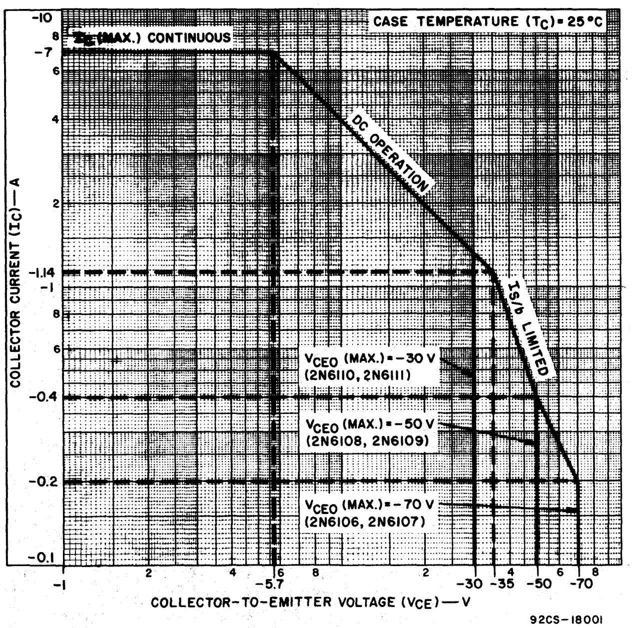

Fig. 9 - Maximum operating areas for 2N6106 – 2N6111 (T_C = 25°C).

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

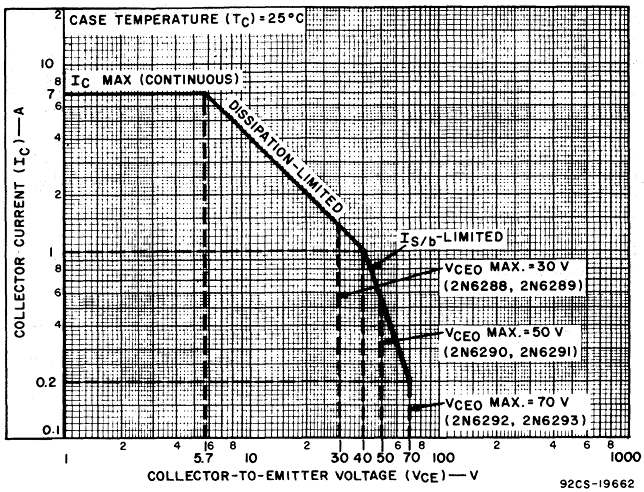

Fig. 10 - Maximum operating areas for 2N6288—2N6293 (T_C = 25°C).

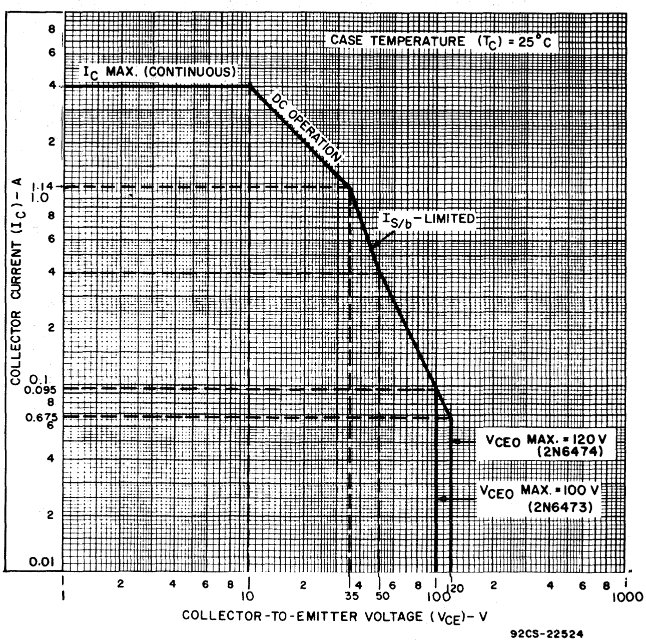

Fig. 11 - Maximum operating areas for 2N6473 and 2N6474 (T_C = 25°C).

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

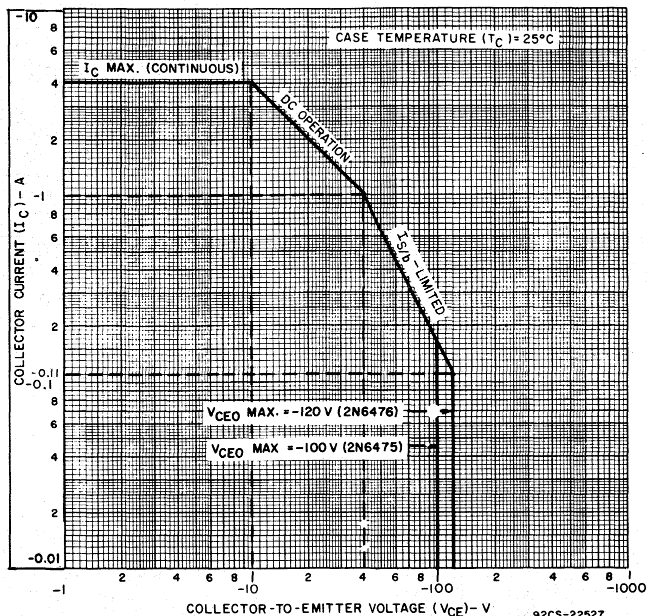

Fig. 12 - Maximum operating areas for 2N6475 – 2N6476 (T_C = 25°C).

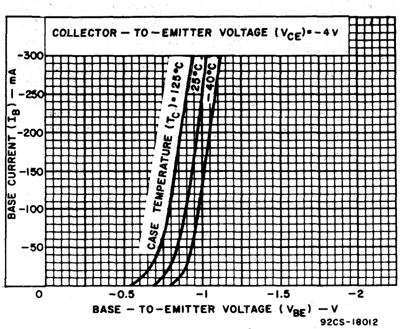

Fig. 13 - Typical input characteristics for 2N6106 – 2N6111, 2N6475, and 2N6476.

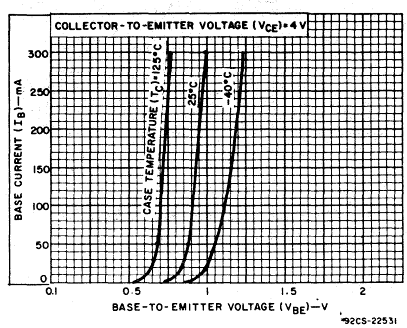

Fig. 14 - Typical input characteristics for 2N6288 – 2N6293.

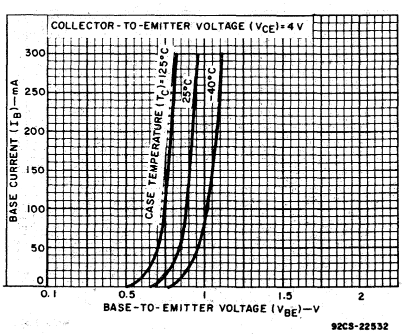

Fig. 15 - Typical input characteristics for 2N6473 2N6474.

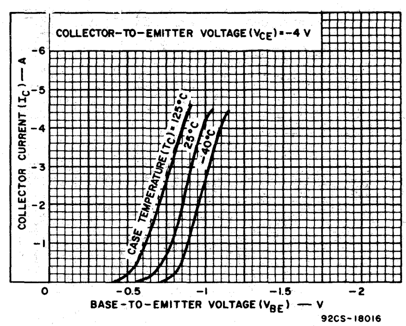

Fig. 16 - Typical transfer characteristics for 2N6106 – 2N6111.

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

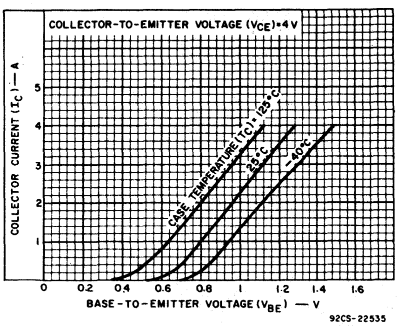


Fig. 17 - Typical transfer characteristics for 2N6288 – 2N6293.

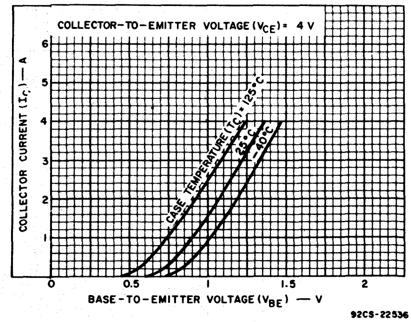


Fig. 18 - Typical transfer characteristics for 2N6473 and 2N6474.

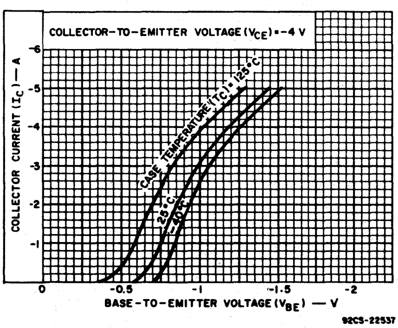


Fig. 19 - Typical transfer characteristics for 2N6475 and 2N6476.

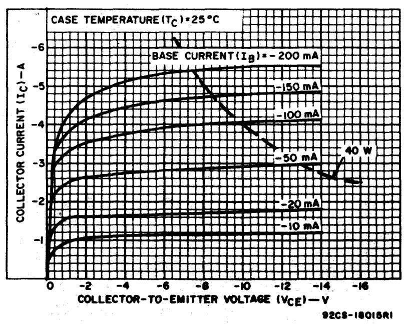


Fig. 20 - Typical output characteristics for 2N6106 – 2N6111.

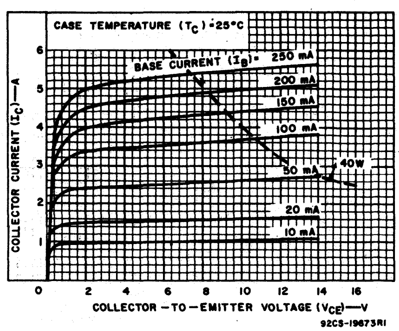


Fig. 21 - Typical output characteristics for 2N6288 – 2N6293.

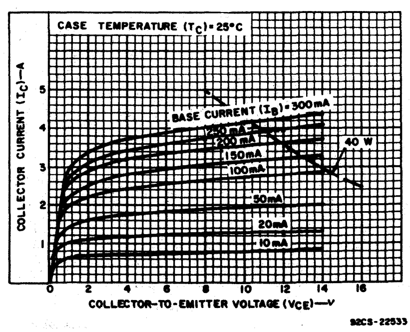


Fig. 22 - Typical output characteristics for 2N6473 and 2N6474.

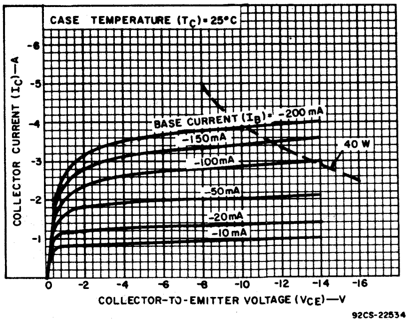


Fig. 23 - Typical output characteristics for 2N6475 and 2N6476.

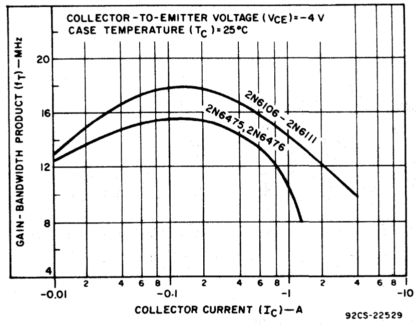


Fig. 24 - Typical gain-bandwidth product 2N6106 – 2N6111, 2N6475, and 2N6476.

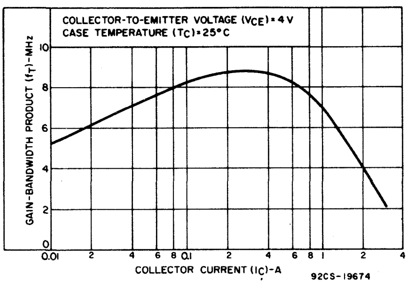


Fig. 25 - Typical gain-bandwidth product for 2N6288 – 2N6293.

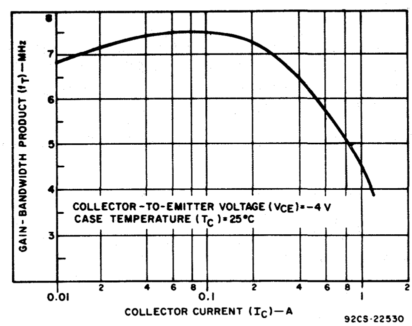


Fig. 26 - Typical gain-bandwidth product for 2N6473 and 2N6474.

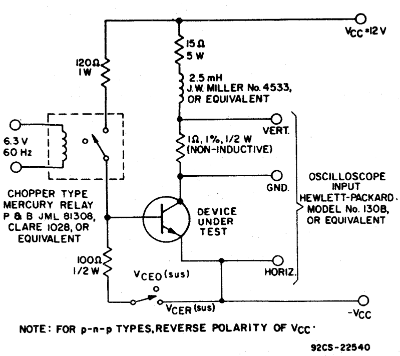
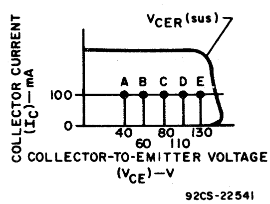


Fig. 27 - Circuit used to measure sustaining voltage V_{CER}(sus) for all types.



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**

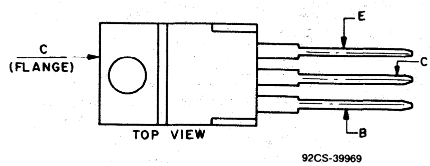
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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 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 P-N-P	2N6121 2N6124	2N6122 2N6125	2N6123 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 ≥ 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*

CHARAC-TERISTIC	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]				–	0.1	–	–	–	–	mA
	60[a]				–	–	–	0.1	–	–	
	80[a]				–	–	–	–	–	0.1	
* I_{CEX}	45	−1.5			–	0.1	–	–	–	–	
	60	−1.5			–	–	–	0.1	–	–	
	80	−1.5			–	–	–	–	–	0.1	
T_C = 125°C	45	−1.5			–	2	–	–	–	–	
	60	−1.5			–	–	–	2	–	–	
	80	−1.5			–	–	–	–	–	2	
* I_{CEO}	45			0	–	1	–	–	–	–	
	60			0	–	–	–	1	–	–	
	80			0	–	–	–	–	–	1	
* I_{EBO}		−5	0		–	1	–	1	–	1	
* V_{CEO}(sus)[b]			0.1[c]	0	45	–	60	–	80	–	V
* h_{FE}	2		1.5[c]		25	100	25	100	20	80	
	2		4[c]		10	–	10	–	7	–	
* V_{BE}	2		1.5[c]		–	1.2	–	1.2	–	1.2	V
V_{CE}(sat)			1.5[c]	0.15	–	0.6	–	0.6	–	0.6	
			4[c]	1	–	1.4	–	1.4	–	1.4	
* $\lvert h_{fe}\rvert$ (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.

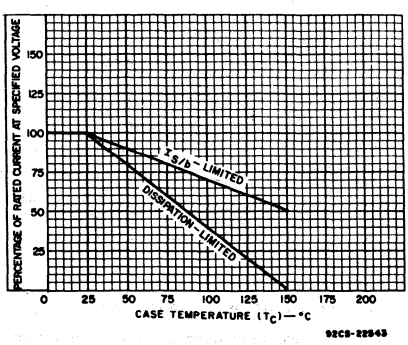


Fig. 1 — Current derating curves for all types.

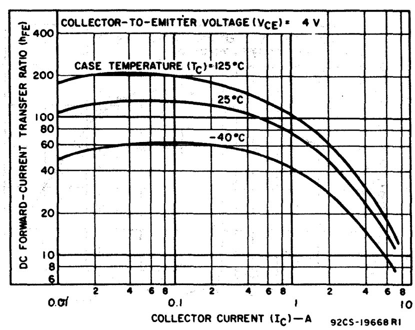


Fig. 2 — Typical dc beta characteristics for all types.

2N6121-2N6123, 2N6124-2N6126

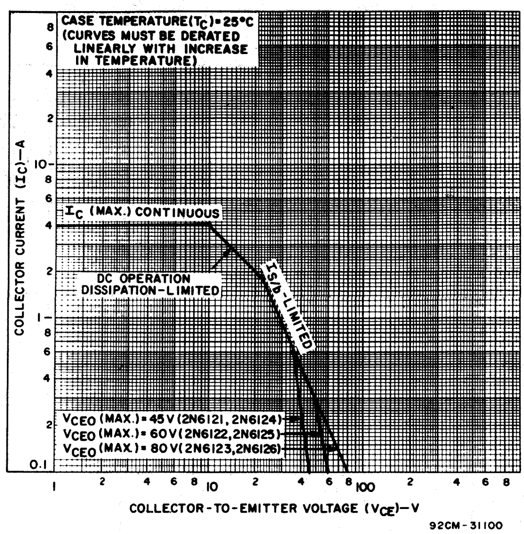


Fig. 3 — Maximum operating areas for all types.

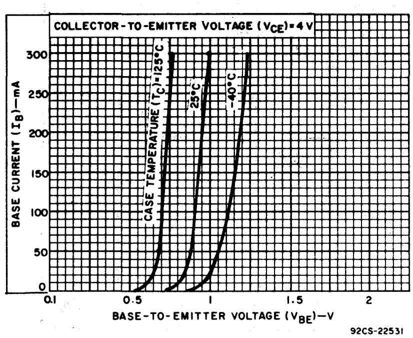


Fig. 4 — Typical input characteristics for all types.

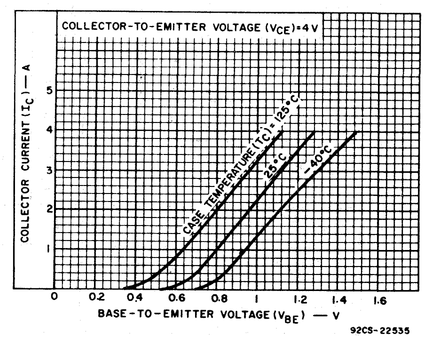


Fig. 5 — Typical transfer characteristics for all types.

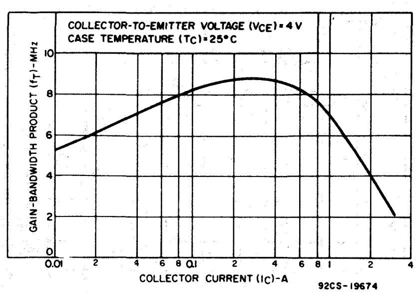


Fig. 6 — Typical gain-bandwidth product.

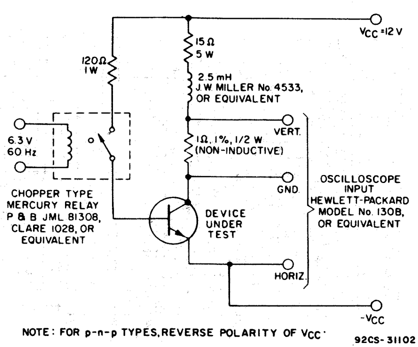


Fig. 7 — Circuit used to measure sustaining voltage $V_{CEO}(sus)$ for all types.

File Number **507**

2N6211, 2N6212, 2N6213, 2N6214

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)

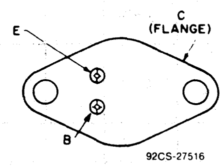
Applications:

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

The types 2N6211, 2N6212, 2N6213, and 2N6214• are epitaxial silicon p-n-p transistors with high breakdown voltage ratings and fast switching speeds. They are supplied in the popular JEDEC TO-213AA package; they differ in breakdown-voltage ratings and leakage current values.

•Formerly RCA Dev. Nos. TA7719, TA7410, TA8330, and TA8331, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6211	2N6212	2N6213	2N6214	
* COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	-275	-350	-400	-450	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open, V_{CEO}(sus)	-225	-300	-350	-400	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω, V_{CER}(sus)	-250	-325	-375	-425	V
* With base-emitter junction reverse-biased (V_{BE} = 1.5 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		Current A dc			LIMITS 2N6211		2N6212		2N6213		2N6214		UNITS
		V_{CE}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	−150				0	–	−5	–	−5	–	−5	–	−5	mA
* With base-emitter junction reverse-biased	I_{CEV}	−250 −315 −360 −410	1.5 1.5 1.5 1.5				– – – –	−0.5 – – –	– – – –	– −0.5 – –	– – – –	– – −0.5 –	– – – –	– – – −1	mA
* With base-emitter junction reverse biased and T_C = 100°C	I_{CEV}	−250 −315 −360 −410	1.5 1.5 1.5 1.5				– – – –	−5 – – –	– – – –	– −5 – –	– – – –	– – −5 –	– – – –	– – – −10	mA
* Emitter-Cutoff Current	I_{EBO}		6	0			–	−1	–	−0.5	–	−0.5	–	−0.5	mA
* DC Forward-Current Transfer Ratio	h_{FE}	−2.8 −3.2 −4 −5		−1 [a] −1 [a] −1 [a] −1 [a]			10 – – –	100 – – –	– 10 – –	– 100 – –	– – 10 –	– – 100 –	– – – 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 1 mA	 −6		−6 –	–	−6 –	– –	−6 –	– –	V
* Emitter-to-Base Saturation Voltage	$V_{BE}(sat)$			−1 [a]		−0.125		1.4	–	−1.4	–	−1.4	–	−1.4	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			−1 [a]		−0.125	–	1.4	–	−1.6	–	−2	–	−2.5	V
Output Capacitance (f = 1 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

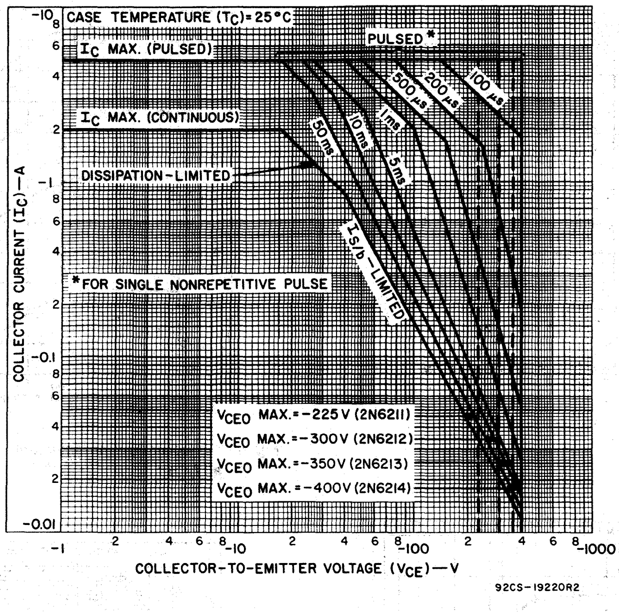


Fig. 1 - Maximum operating areas for all types.

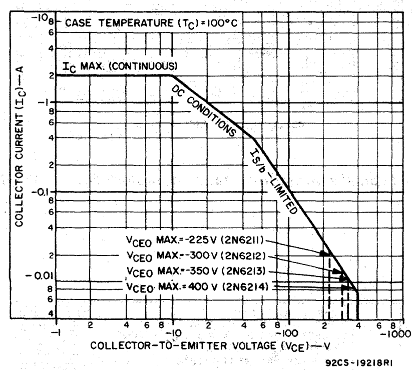


Fig. 2 - Maximum operating areas for all types.

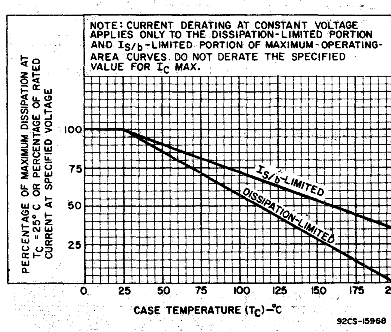


Fig. 3 - Derating curves for all types.

2N6211, 2N6212, 2N6213, 2N6214

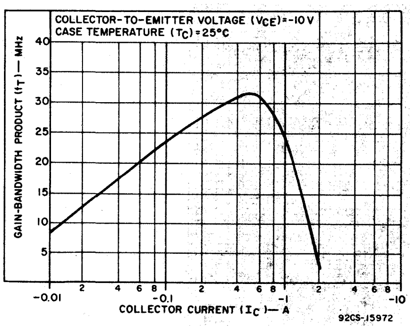


Fig. 4 - Typical gain-bandwidth product for all types.

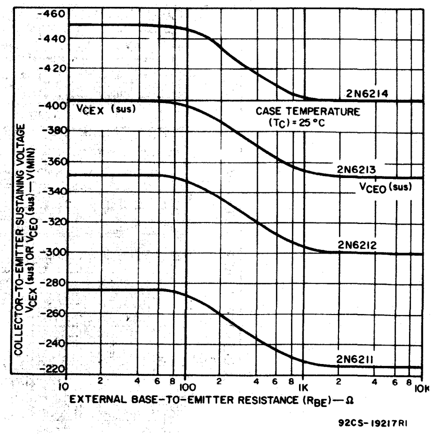


Fig. 5 - Collector-to-emitter sustaining-voltage characteristics for all types.

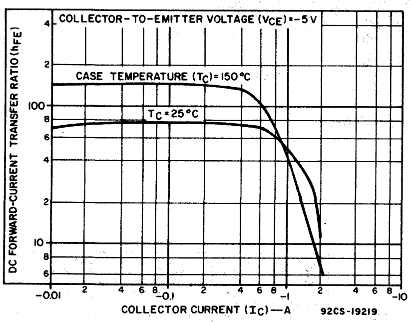


Fig. 6 - Typical dc beta characteristic for all types.

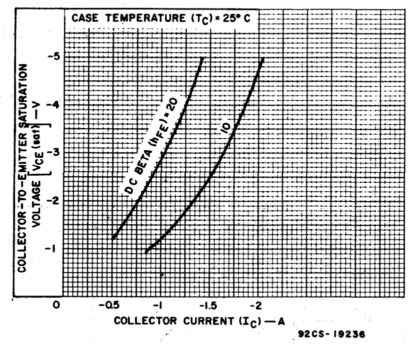


Fig. 7 - Typical saturation-voltage characteristics for all types.

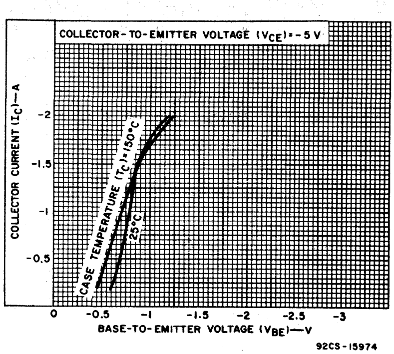


Fig. 8 - Typical transfer characteristics for all types.

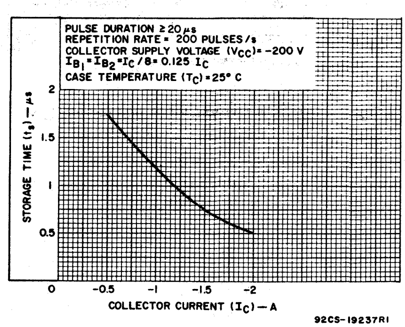


Fig. 9 - Typical storage-time characteristics for all types.

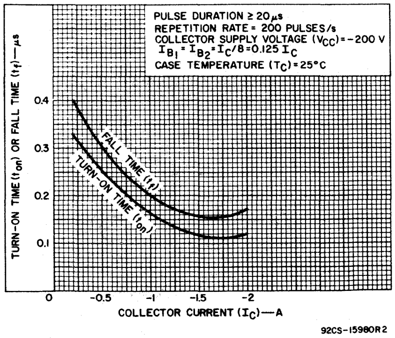


Fig. 10 - Typical turn-on time and fall-time characteristics for all types.

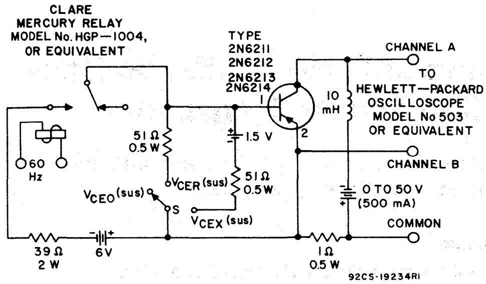


Fig. 11 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus) and V_{CEX}(sus) for all types.

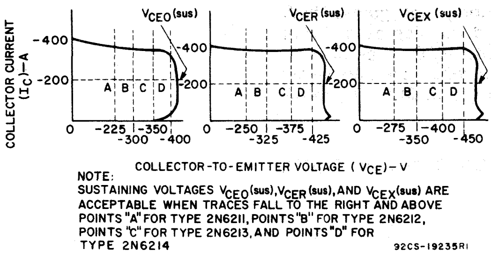


Fig. 12 - Oscilloscope display for measurement of sustaining voltages.

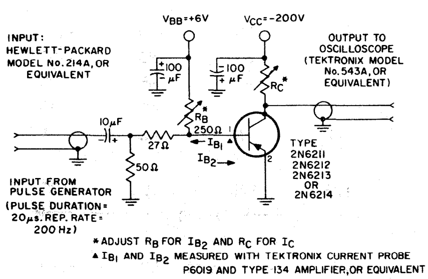


Fig. 13 - Circuit used to measure saturated switching times for all types.

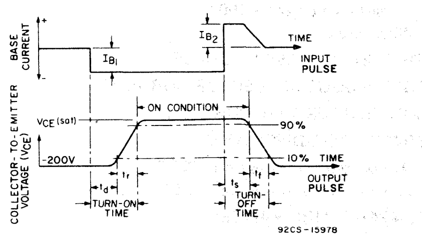


Fig. 14 - Phase relationship between input current and output voltage showing reference points for specification of switching times.

2N6246, 2N6247, 2N6248, 2N6469

File Number 677

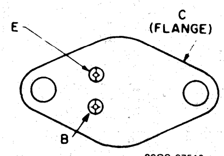
Silicon P-N-P Epitaxial-Base, High-Power Transistors

General-Purpose Types of Switching and Linear-Amplifier Applications

Features:

- *High dissipation capability: 125 W at 25° C*
- *Low saturation voltages*
- *Maximum safe-area-of-operation curves*
- *High gain at high current*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6246, 2N6247, 2N6248, and 2N6469 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. All of these devices have a dissipation capability of 125 watts at case temperatures up to 25°C. They differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the JEDEC TO-204AA package.

▲Formerly RCA Dev. Nos. TA7281, TA7280, TA7279, and TA8724, respectively.

Maximum Ratings, *Absolute-Maximum Values:*

		2N6469	2N6246	2N6247	2N6248	
*COLLECTOR-TO-BASE VOLTAGE	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.*

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 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 2N6247 Min.	LIMITS 2N6247 Max.	LIMITS 2N6248 Min.	LIMITS 2N6248 Max.	UNITS
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

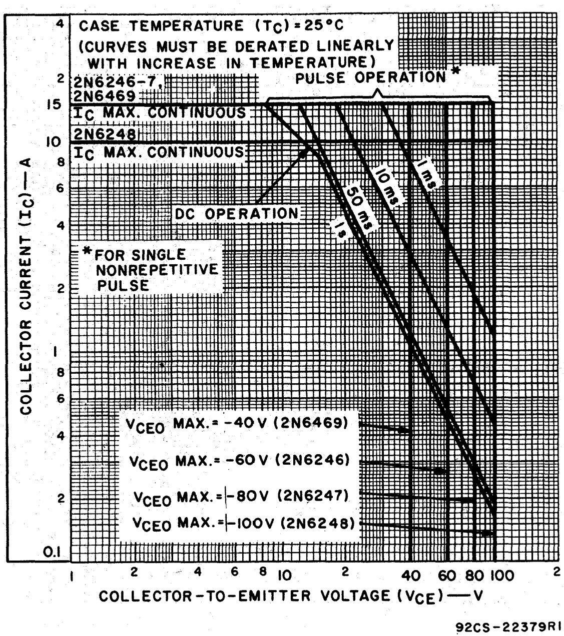


Fig. 1 — Maximum operating areas for all types.

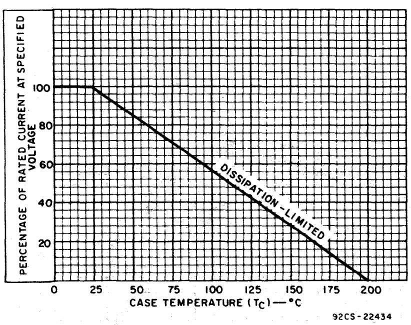


Fig. 2 — Current derating for all types.

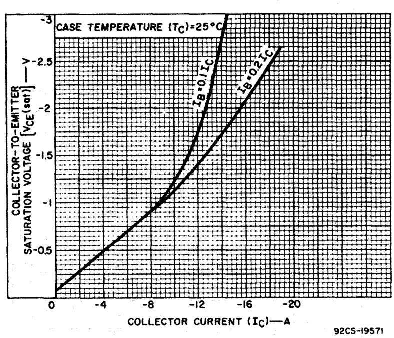


Fig. 3 — Typical collector-to-emitter saturation-voltage characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

2N6246, 2N6247, 2N6248, 2N6469

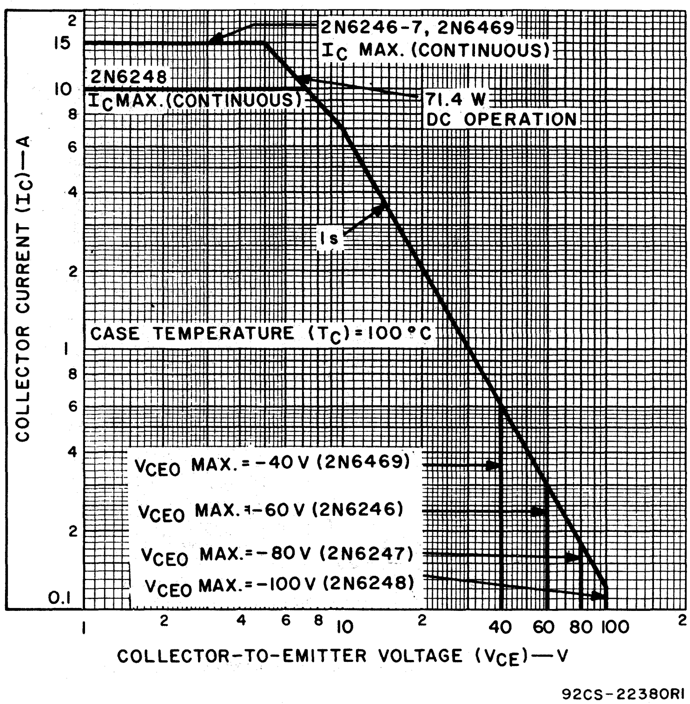


Fig. 4 — Maximum operating areas for all types.

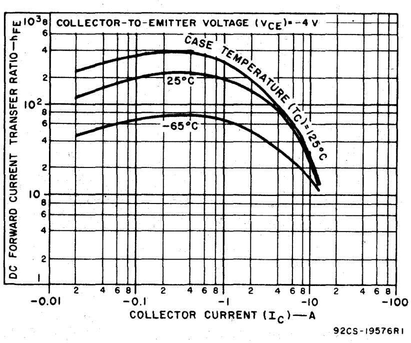


Fig. 5 — Typical dc beta characteristics for 2N6246, 2N6247, and 2N6469.

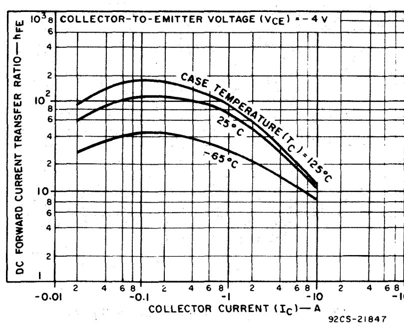


Fig. 6 — Typical dc beta characteristics for 2N6248.

2N6246, 2N6247, 2N6248, 2N6469

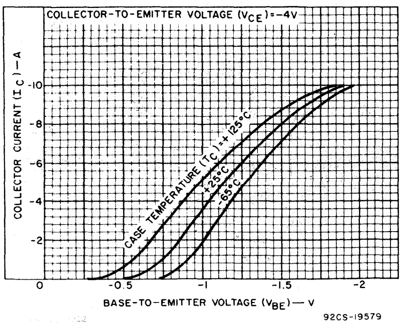


Fig. 7 — Typical transfer characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

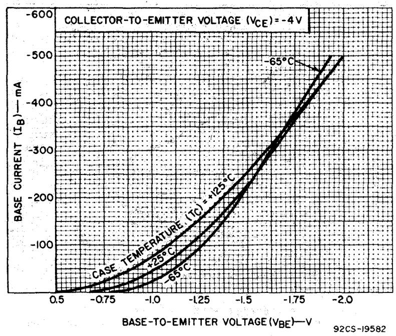


Fig. 8 — Typical input characteristics for 2N6246, 2N6247, and 2N6469.

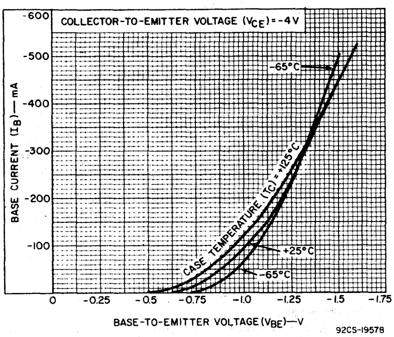


Fig. 9 — Typical input characteristics for 2N6248.

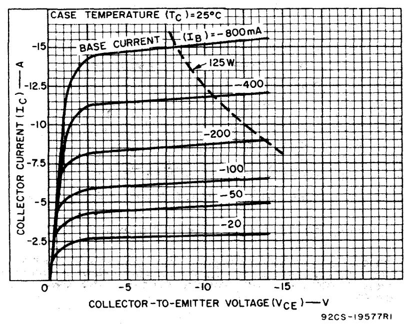


Fig. 10 — Typical output characteristics for 2N6246, 2N6247, and 2N6469.

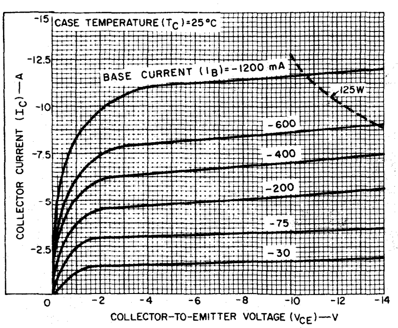


Fig. 11 — Typical output characteristics for 2N6248.

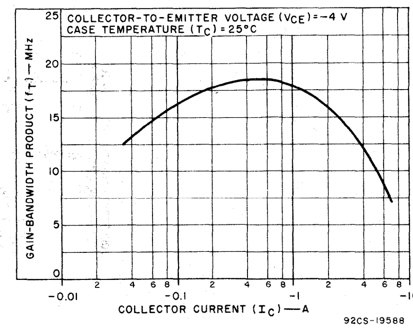


Fig. 12 — Typical gain-bandwidth product vs. collector current for 2N6246, 2N6247, 2N6248, and 2N6469.

2N6246, 2N6247, 2N6248, 2N6469

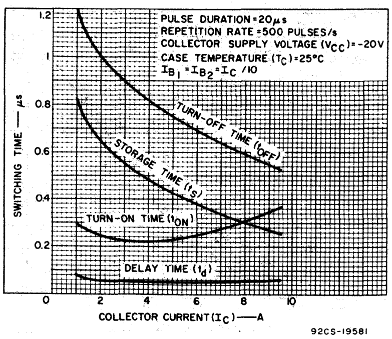


Fig. 13 — Typical saturated switching characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

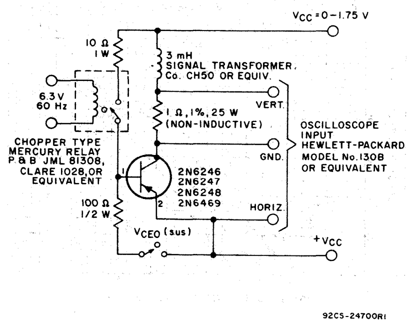


Fig. 14 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ for all types.

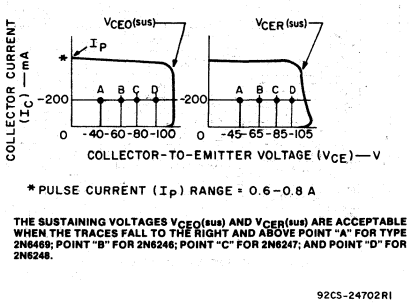


Fig. 15 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 14).

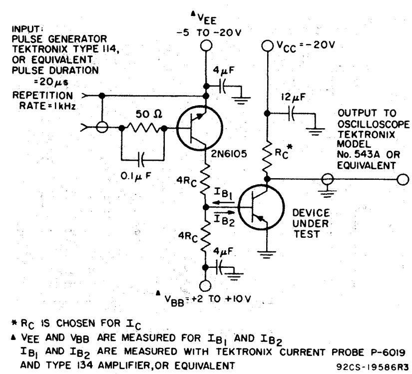


Fig. 16 — Circuit used to measure switching times for 2N6246, 2N6247, 2N6248, and 2N6469.

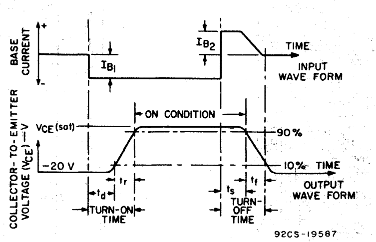


Fig. 17 — Oscilloscope display for measurement of switching times.

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*

2

The 2N6249, 2N6250 and 2N6251 are multiple epitaxial silicon n-p-n power transistors. Multiple-epitaxial construction maximizes the volt-ampere characteristic of the device and provides fast switching speeds.

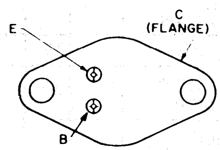
These devices use the popular JEDEC TO-204AA package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

The exceptional second-breakdown capabilities and high voltage-breakdown ratings make these transistors especially suitable for offline inverters, switching regulators motor controls, and deflection circuit applications.

The high gain and high $E_{S/b}$ energy-handling capability of the 2N6249 make it an excellent choice for motor-control applications in which large winding inductances are encountered and high surge currents are required to start the motor.

The high breakdown voltages, low saturation voltages, and fast-switching capability of the 2N6250 and 2N6251 make them especially suitable for inverter circuits operating directly off the rectified 115-V power line or a bridge configuration operating from the rectified 220-V line.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6249	2N6250	2N6251	
* V_{CBO}	300	375	450	V
V_{CEO}(sus)	200	275	350	V
* V_{CEX}(sus) (V_{BE} = 0 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) V_{CE}	DC CURRENT (A) I_C	DC CURRENT (A) I_B	LIMITS 2N6249 MIN.	2N6249 TYP.	2N6249 MAX.	2N6250 MIN.	2N6250 TYP.	2N6250 MAX.	2N6251 MIN.	2N6251 TYP.	2N6251 MAX.	UNITS
I_{CEO}	150		0	–	–	5	–	–	–	–	–	–	mA
	225		0	–	–	–	–	–	5	–	–	–	
	300		0	–	–	–	–	–	–	–	–	5	
* I_{CEV} V_{BE} = −1.5	225			–	–	5	–	–	–	–	–	–	
	300			–	–	–	–	–	5	–	–	–	
	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	–	–	–	–	–	–	V
		10[a]	1.25	–	–	–	–	–	2.25	–	–	–	
		10[a]	1.67	–	–	–	–	–	–	–	–	2.25	
* V_{CE}(sat)		10[a]	1	–	–	1.5	–	–	–	–	–	–	V
		10[a]	1.25	–	–	–	–	–	1.5	–	–	–	
		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	–	–	–	–	–	–	μs
		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	–	–	–	
		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.

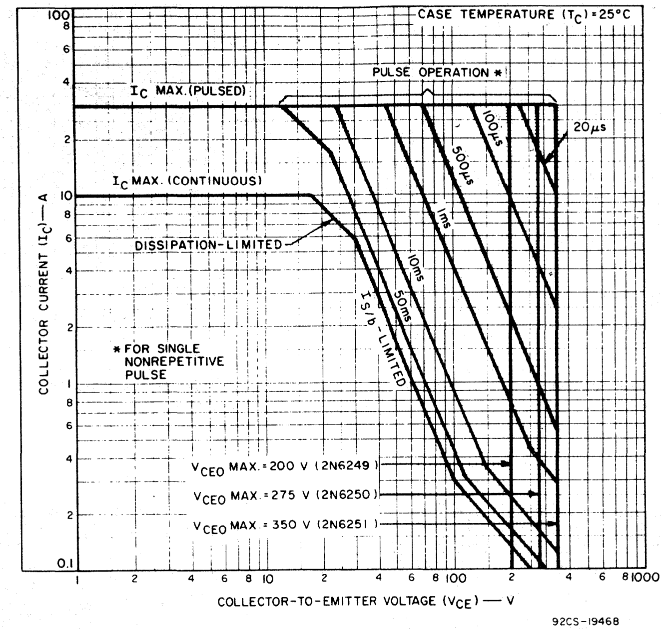


Fig. 1 - Maximum operating areas for all types at T_C = 25° C.

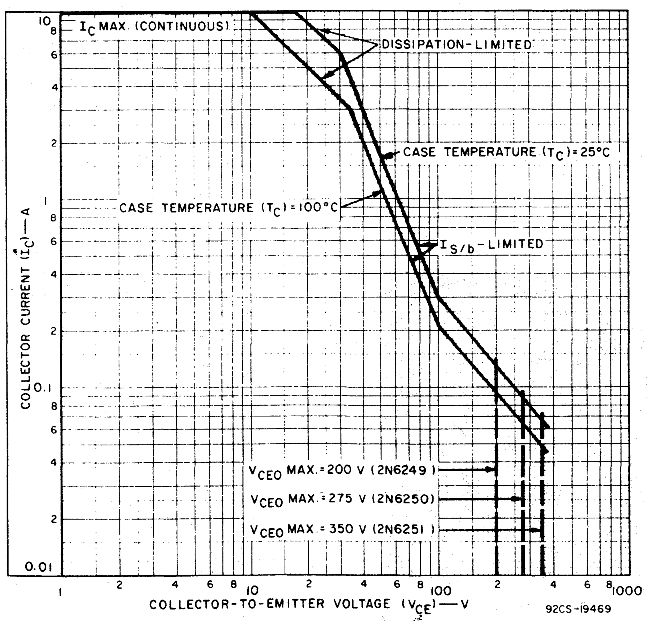


Fig. 2 - Maximum operating areas for all types at T_C = 100° C.

2

2N6249, 2N6250, 2N6251

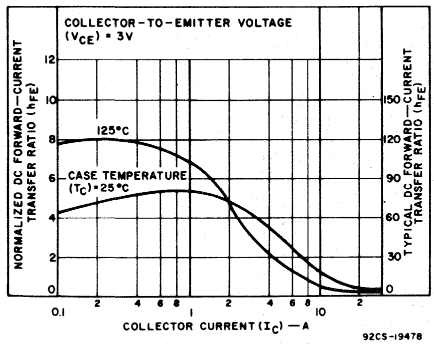


Fig. 3 - Typical normalized dc beta characteristics for all types.

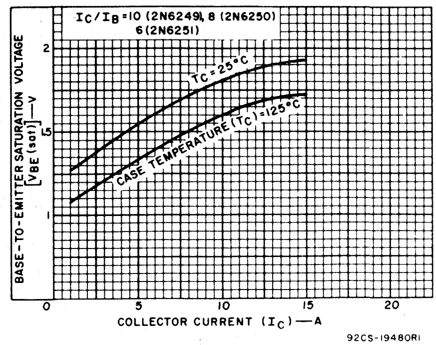


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for all types.

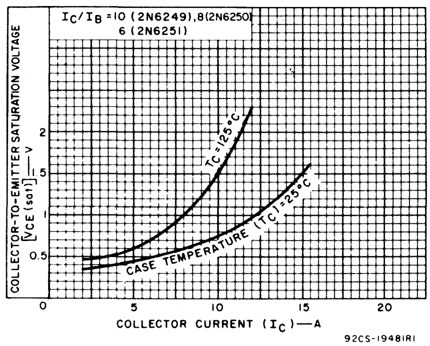


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

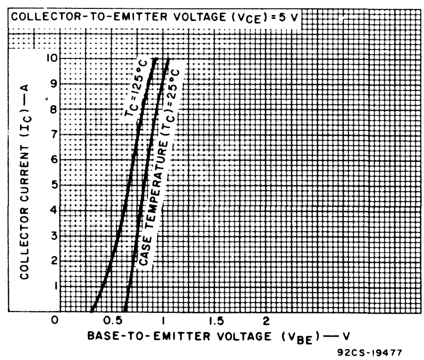


Fig. 6 - Typical transfer characteristics for all types.

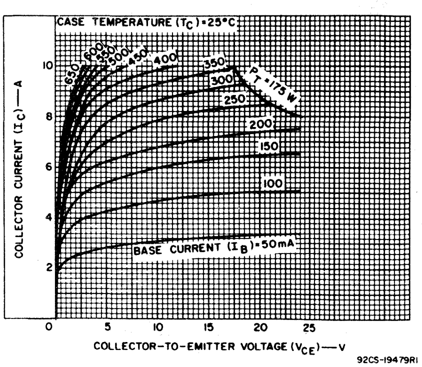


Fig. 7 - Typical output characteristics for all types.

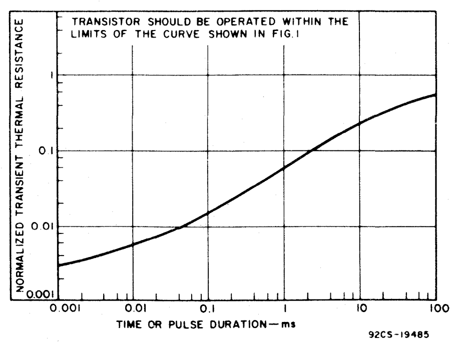


Fig. 8 - Typical thermal response characteristics for all types.

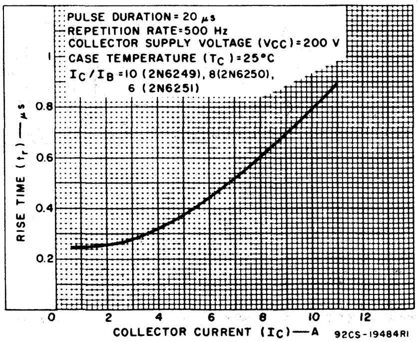


Fig. 9 - Typical rise-time characteristics for all types.

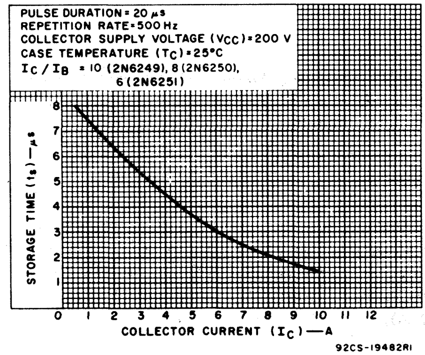


Fig. 10 - Typical storage-time characteristics for all types (with constant forced gain).

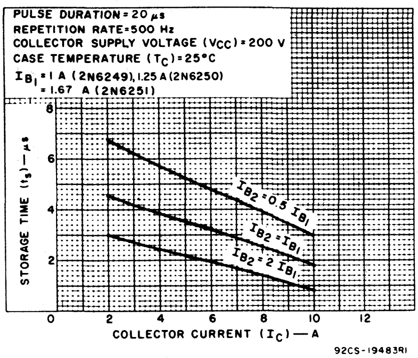


Fig. 11 - Typical storage-time characteristics for all types (with constant base drive).

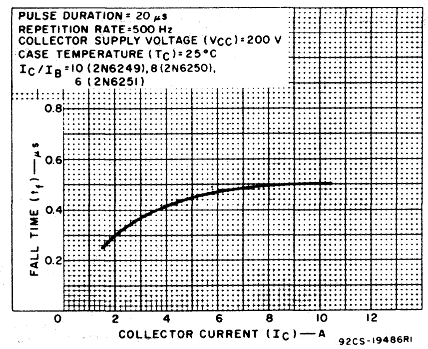


Fig. 12 - Typical fall-time characteristic for all types.

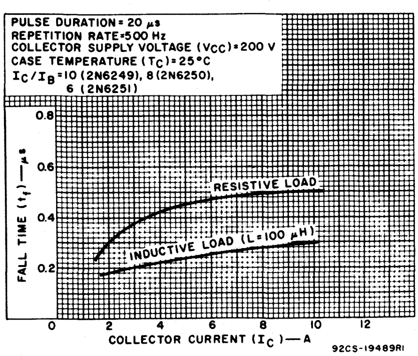


Fig. 13 - Typical inductive- and resistive-load fall-time characteristics for all types.

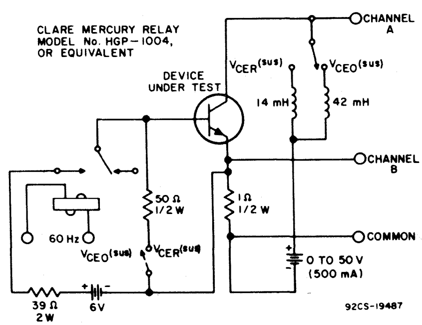
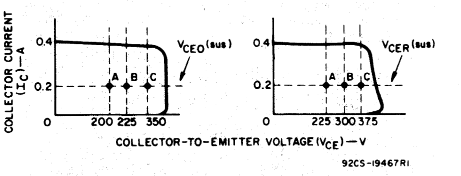


Fig. 14 - Circuit used to measure sustaining voltage $V_{CEO}(sus)$ and $V_{CER}(sus)$ for all types.

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.

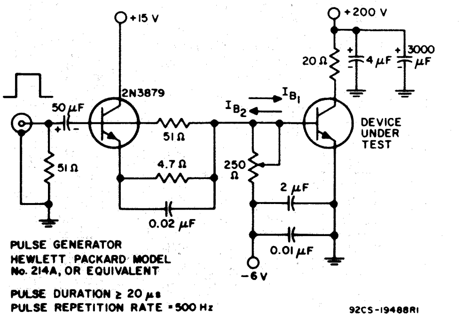


Fig. 16 - Circuit used to measure switching times for all types.

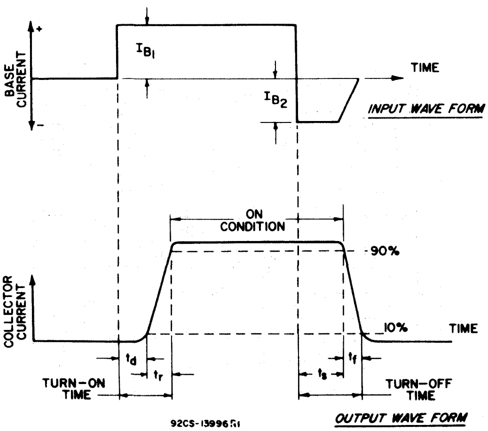


Fig. 17 - Phase relationship between input and output currents showing reference points for specifications of switching times.

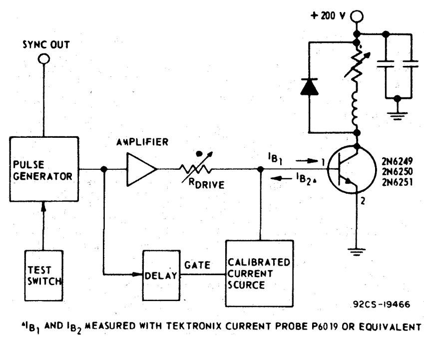


Fig. 18 - Circuit used to measure inductive-load switching times for all types.

File Number **1077**

2N6253, 2N6254, 2N6371

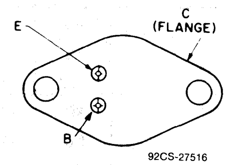
High-Power Silicon N-P-N Transistors

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
$I_{S/b}$ t_p = 1 s nonrep.	40	—	—	—	—	—	—	—	2.9	—	A
	45	—	—	—	2.55	—	—	—	—	—	
	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

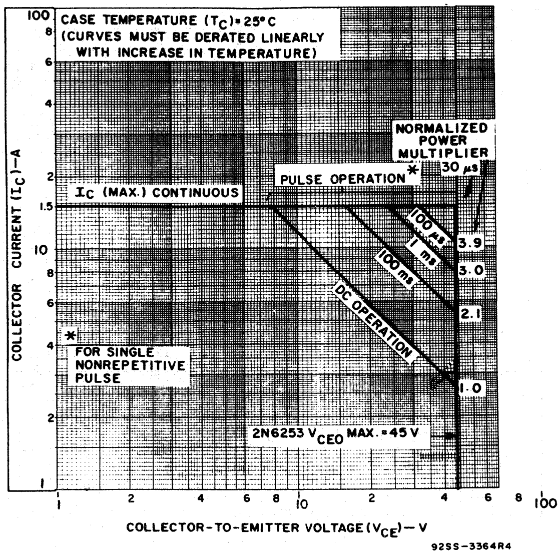


Fig. 1 - Maximum operating areas for 2N6253.

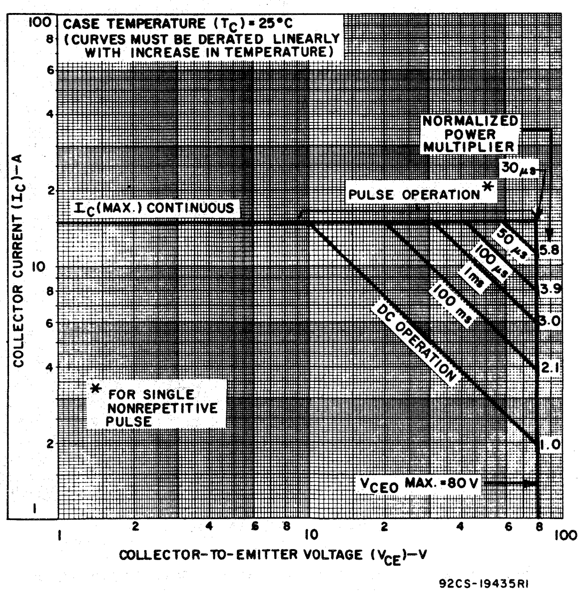


Fig. 2 - Maximum operating areas for 2N6254.

2N6253, 2N6254, 2N6371

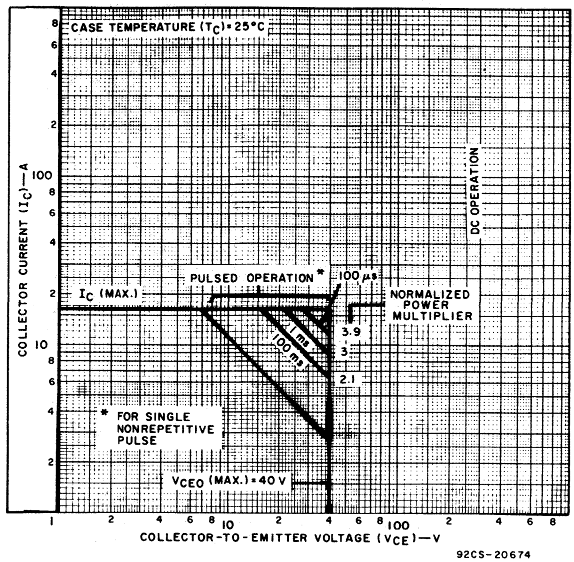


Fig. 3 - Maximum safe-area-of-operation at case temperature of 25° C for 2N6371.

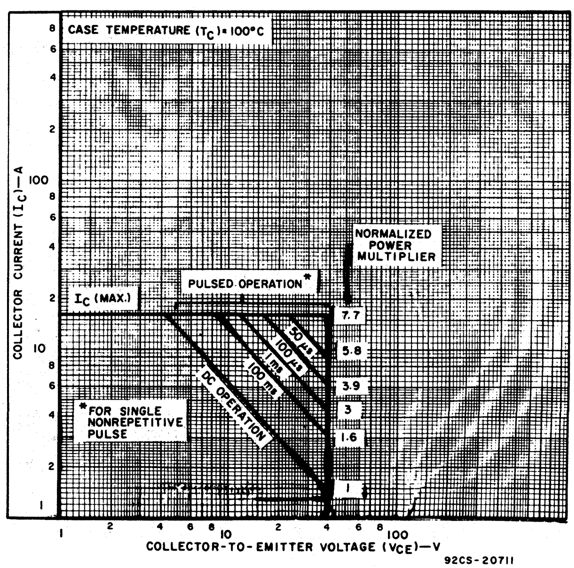


Fig. 4 - Maximum safe-area-of-operation at case temperature of 100° C for 2N6371.

2N6253, 2N6254, 2N6371

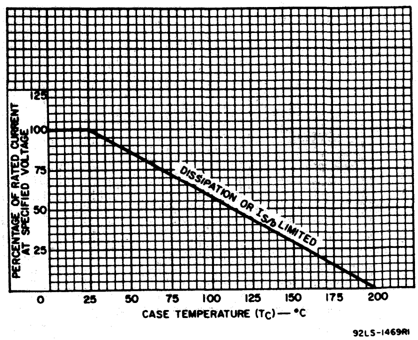


Fig. 5 - Current derating curve for all types.

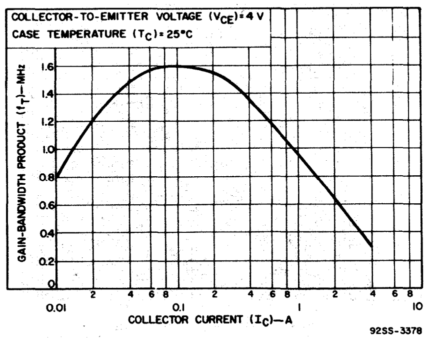


Fig. 6 - Typical gain-bandwidth product for all types.

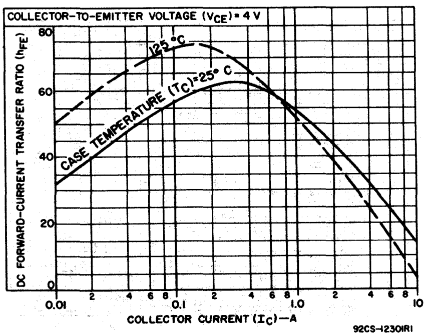


Fig. 7 - Typical dc-beta characteristics for 2N6371.

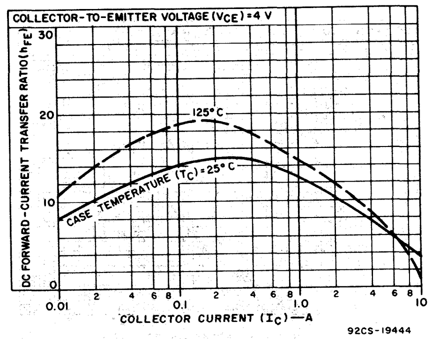


Fig. 8 - Typical dc-beta characteristics for 2N6253.

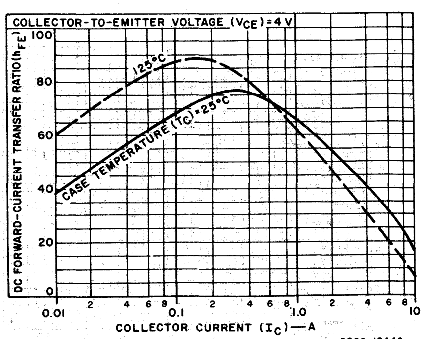


Fig. 9 - Typical dc-beta characteristics for 2N6254.

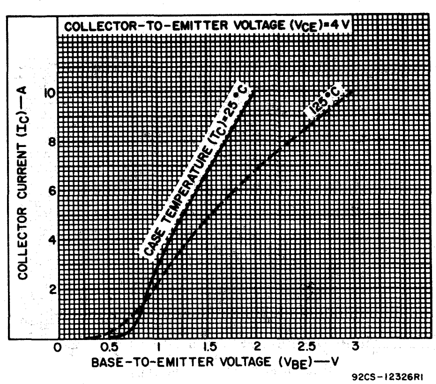


Fig. 10 - Typical transfer characteristics for 2N6253.

2N6253, 2N6254, 2N6371

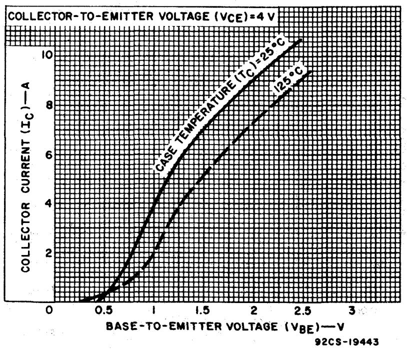


Fig. 11 - Typical transfer characteristics for 2N6254.

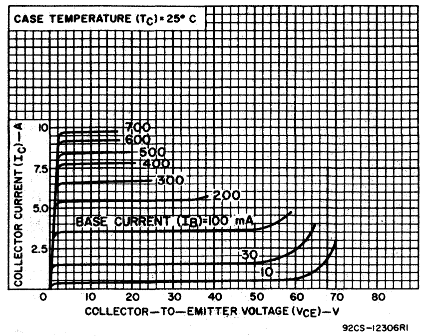


Fig. 12 - Typical output characteristics for 2N6371.

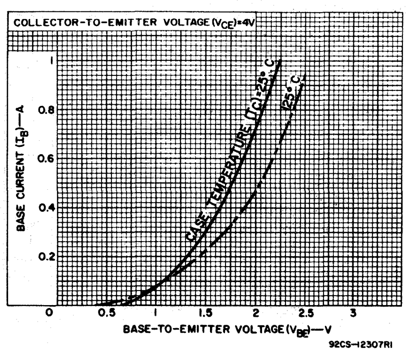


Fig. 13 - Typical input characteristics for 2N6371.

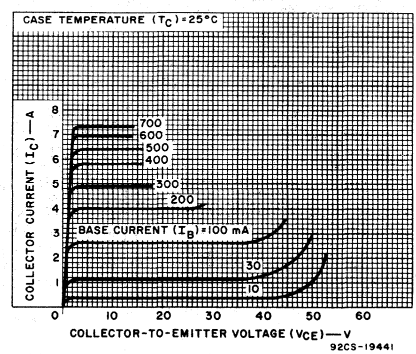


Fig. 14 - Typical output characteristics for 2N6253.

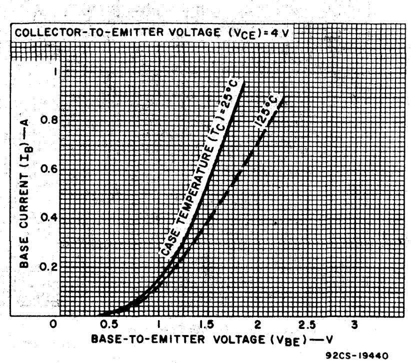


Fig. 15 - Typical input characteristics for 2N6253.

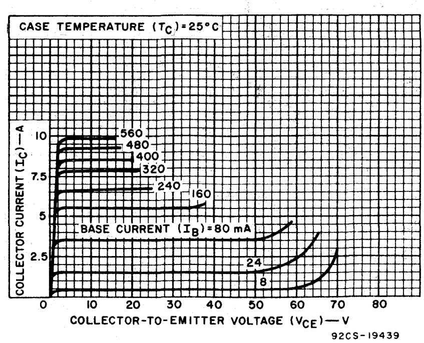


Fig. 16 - Typical output characteristics for 2N6254.

File Number **1001**

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

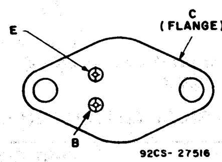
20-Ampere Complementary N-P-N and P-N-P Monolithic Darlington Power Transistors

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

2

The 2N6282, 2N6283, and 2N6284 and the 2N6285, 2N6286, and 2N6287 are complementary n-p-n and p-n-p monolithic silicon Darlington transistors designed for general purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

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

- **High voltage ratings:**
  $V_{CEO}(sus)$ = 60 V Min. – 2N6282, 2N6285●
  = 80 V Min. – 2N6283, 2N6286●
  = 100 V Min. – 2N6284, 2N6287●

Applications:

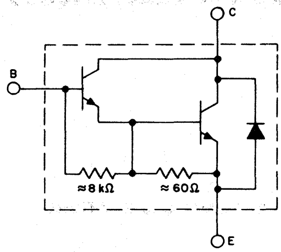
- **Power switching**
- **Hammer drivers**
- **Series and shunt regulators**
- **Audio amplifiers**

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

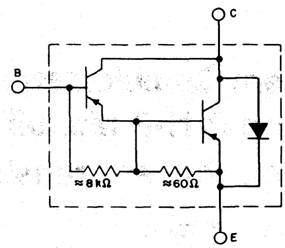
* In accordance with JEDEC registration data.
● For p-n-p devices, voltage and current values are negative.

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



92CS-29128

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



92CS-29129

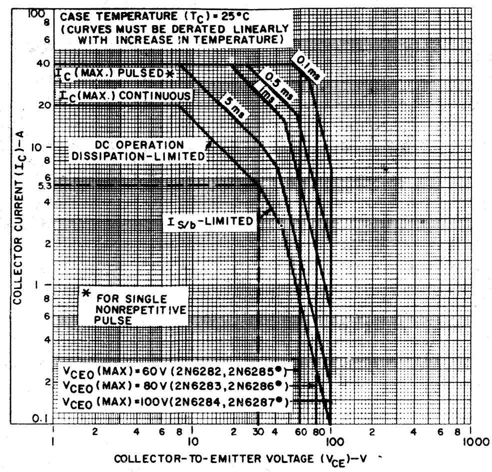
Fig. 2 – Schematic diagram for 2N6285, 2N6286, and 2N6287.

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6282 2N6285• MIN.	MAX.	2N6283 2N6286• MIN.	MAX.	2N6284 2N6287• MIN.	MAX.	UNITS
* 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		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.

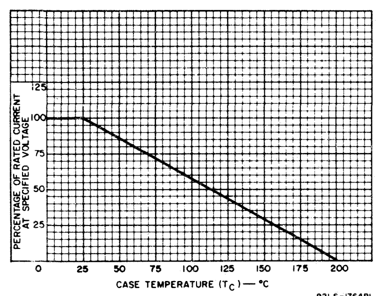


Fig. 4 — Current derating curve for all types.

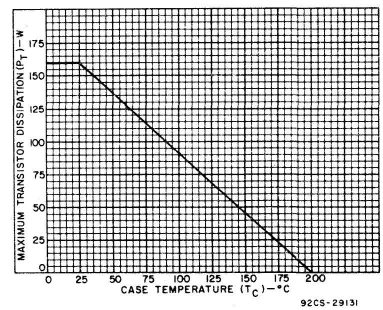


Fig. 5 — Power derating curve for all types.

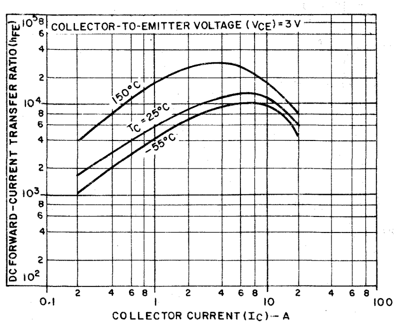


Fig. 6 — Typical dc beta characteristics for 2N6282, 2N6283, and 2N6284.

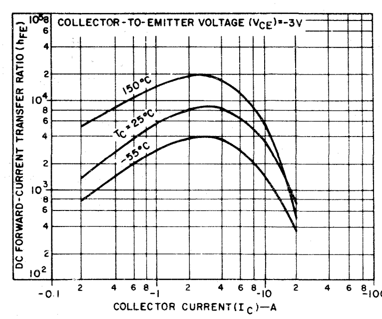
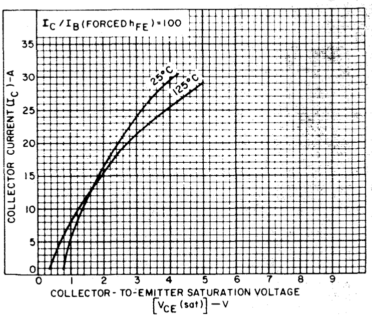


Fig. 7 — Typical dc beta characteristics for 2N6285, 2N6286, and 2N6287.

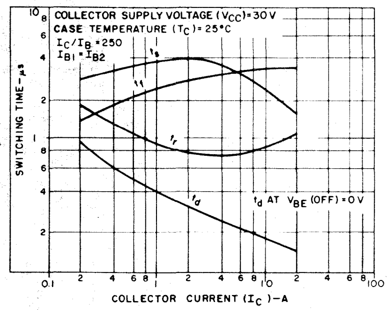
2N6282, 2N6283, 2N6284, 2N6285, 2N6286, 2N6287



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

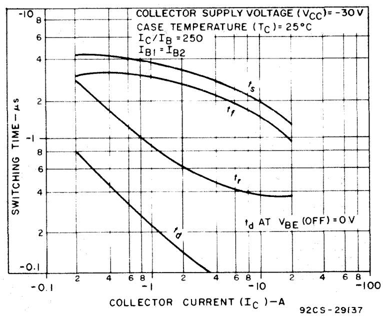
92CS-29135

Fig. 8 — Typical saturation characteristics for all types.



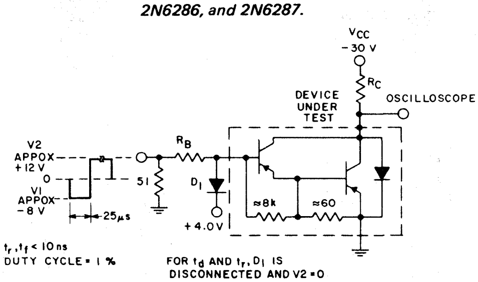
92CS-29136

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



92CS-29137

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



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 **582**

2N6354

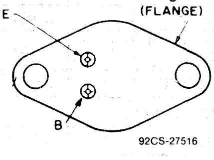
120-V, 10-A, 140-W Silicon N-P-N Planar Transistor

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

2

The type 2N6354• is an epitaxial silicon n-p-n planar transistor with a multiple-emitter-site structure. The device is supplied in the JEDEC TO-204AA package.

Typical high-speed switching applications for the 2N6354 include switching-control amplifiers operated from a 48-V (nominal) power supply, power gates, switching regulators, dc-dc converters, and power oscillators.

• Formerly RCA Dev. No. TA7534.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

* COLLECTOR-TO-BASE VOLTAGE, V_{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: DC VOLTAGE (V) V_{CE}	V_{CB}	V_{EB}	V_{BE}	DC CURRENT (A) I_C	I_B	LIMITS 2N6354 MIN.	MAX.	UNITS
* 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}	V_{CC} = 30				5 10	0.5[e] 1[e]	– –	1 0.6	µs
Storage Time (No Load)	t_{s2}	V_{CC} = 30				0.5	0.5[e]	–	2	µs
Fall Time	t_f	V_{CC} = 30				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.

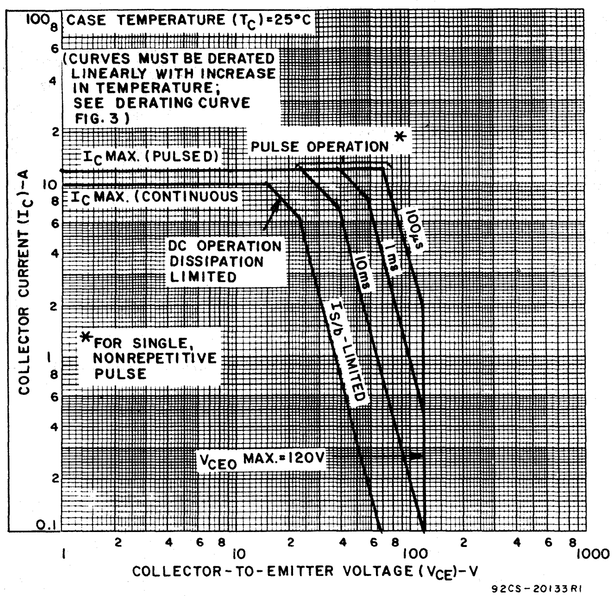


Fig. 1 - Maximum operating areas.

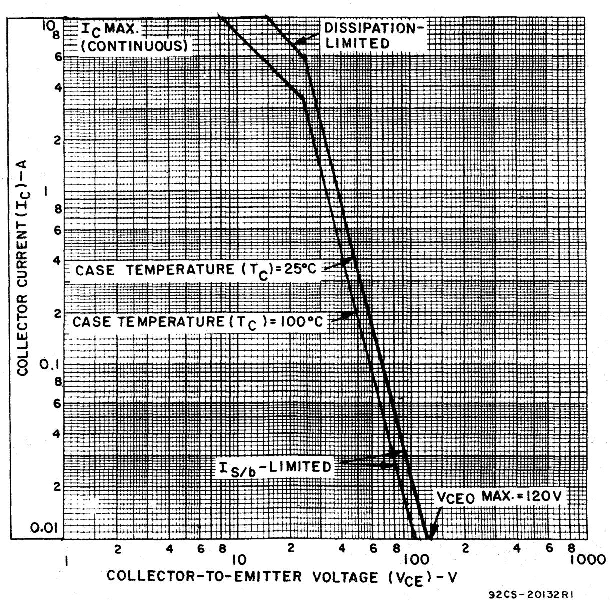


Fig. 2 - Maximum operating areas.

2N6354

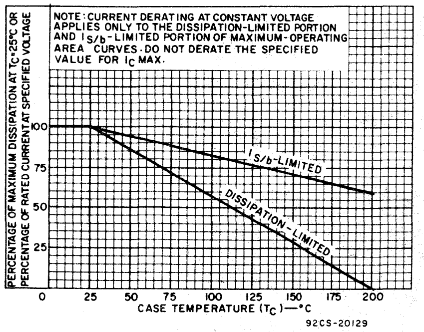


Fig. 3 - Derating curves.

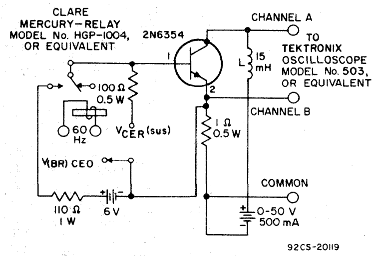


Fig. 4 - Circuit used to measure voltages $V_{(BR)CEO}$ and $V_{CER}(sus)$.

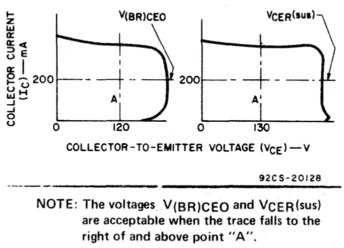


Fig. 5 - Oscilloscope display for $V_{(BR)CEO}$ and $V_{CER}(sus)$ measurement (test circuit shown in Fig. 5).

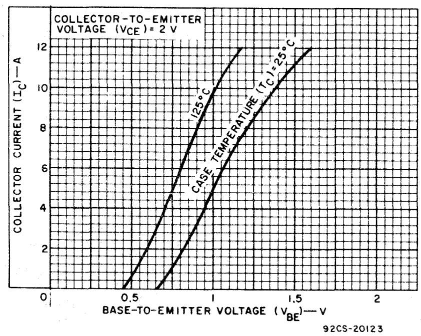


Fig. 6 - Typical transfer characteristics.

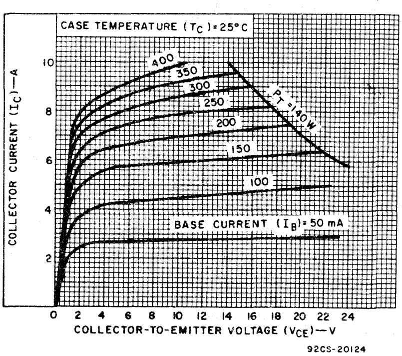


Fig. 7 - Typical output characteristics.

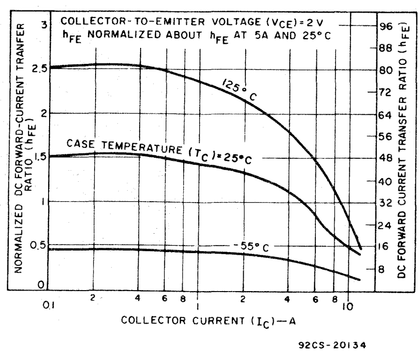


Fig. 8 - Typical normalized dc beta characteristics.

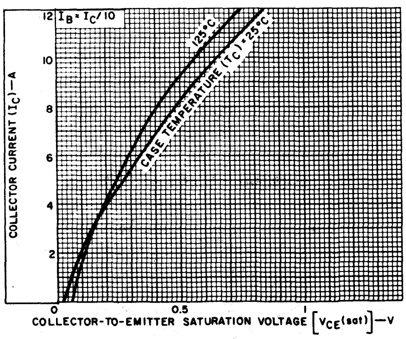


Fig. 9 - Typical saturation voltage characteristics.

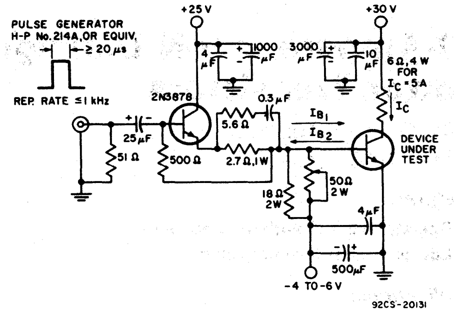


Fig. 10 - Circuit used to measure switching times.

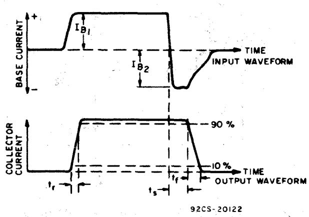


Fig. 11 - Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 11).

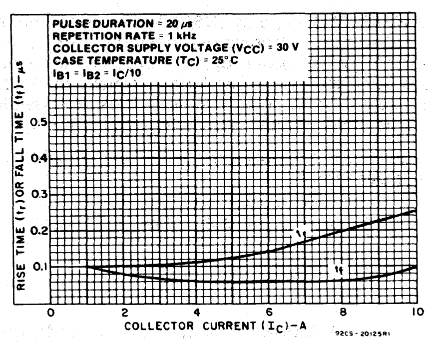


Fig. 12 - Typical rise-and fall-time characteristics.

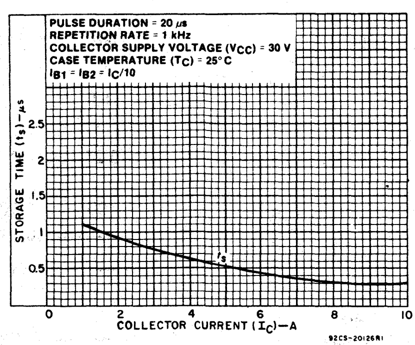


Fig. 13 - Typical storage-time characteristics.

2N6383, 2N6384, 2N6385

File Number **609**

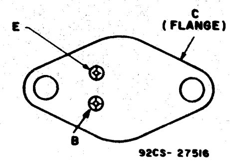
10-Ampere N-P-N Darlington Power Transistors

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.

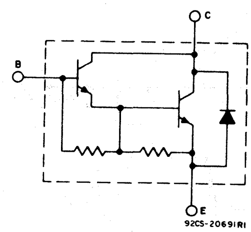


Fig.1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6385	2N6384	2N6383	
* V_{CBO}	80	60	40	V
V_{CER}(sus)				
R_{BE} = 100 Ω	80	60	40	V
* V_{CEO}(sus)	80	60	40	V
* V_{CEX}				
V_{BE} = −1.5 V, R_{BB} = 100 Ω	80	60	40	V
* V_{EBO}	5	5	5	V
* I_C	10	10	10	A
I_{CM}	15	15	15	A
* I_B	0.25	0.25	0.25	A
* P_T				
$T_C \leqslant 25^oC$	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 V_{CE}	V_{EB}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6385 MIN.	2N6385 MAX.	2N6384 MIN.	2N6384 MAX.	2N6383 MIN.	2N6383 MAX.	UNITS
* 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.

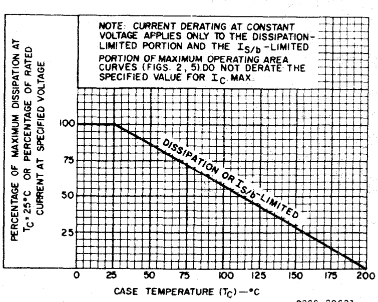


Fig.2 — Derating curves for all types.

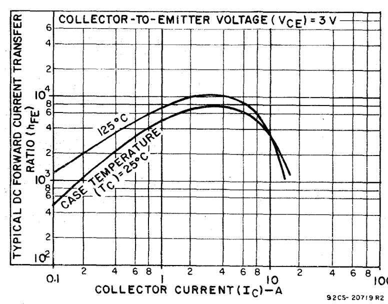


Fig. 3 — Typical dc-beta characteristics for all types.

2N6383, 2N6384, 2N6385

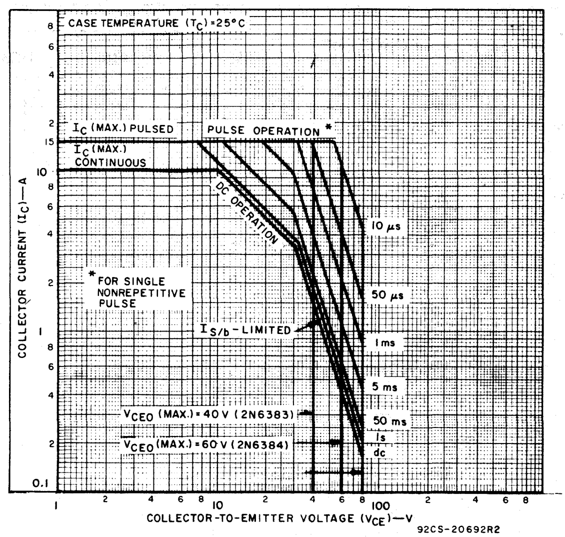


Fig.4 — Maximum operating area for all types.

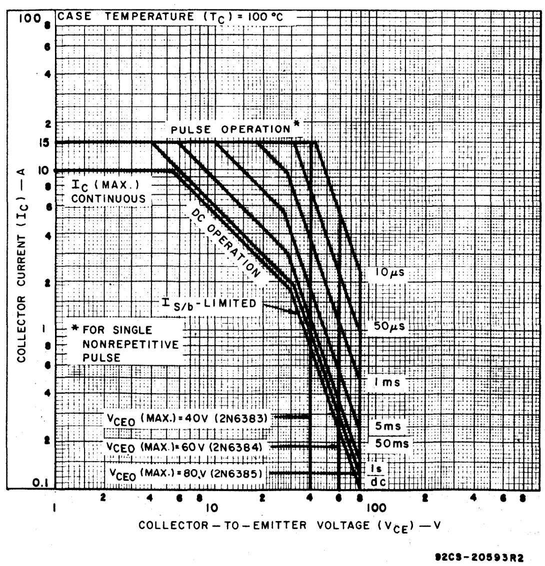


Fig.5 — Maximum operating area for all types.

2N6383, 2N6384, 2N6385

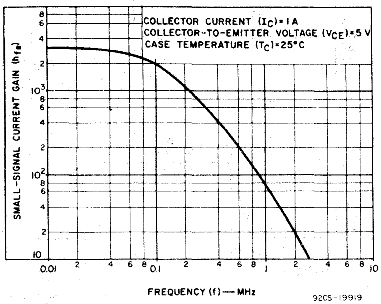


Fig. 6 — Typical small-signal gain for all types.

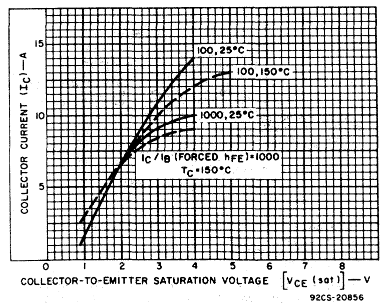


Fig. 7 — Typical saturation characteristics for all types.

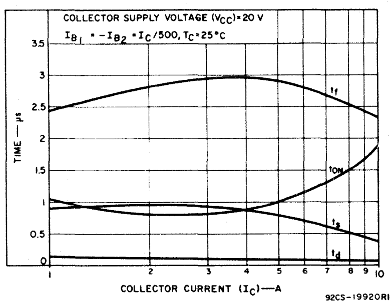


Fig. 8 — Typical saturated switching-time characteristics for all types.

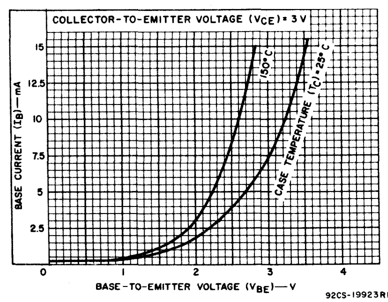


Fig. 9 — Typical input characteristics for all types.

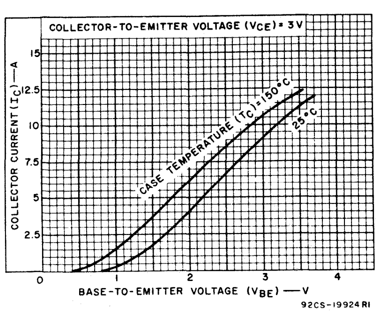


Fig. 10 — Typical transfer characteristics for all types.

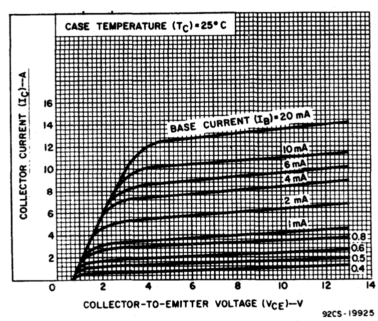


Fig. 11 — Typical output characteristics for all types.

2N6383, 2N6384, 2N6385

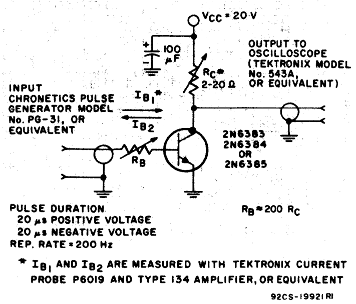


Fig. 12 — Circuit used to measure saturated-switching-times.

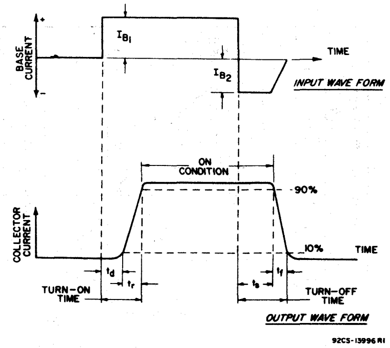


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times (test circuit shown in Fig. 14).

File Number **610**

2N6386, 2N6387, 2N6388

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)

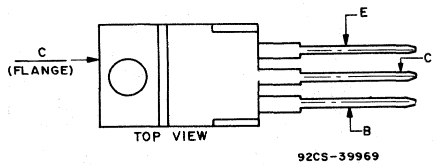
Features:

- **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.

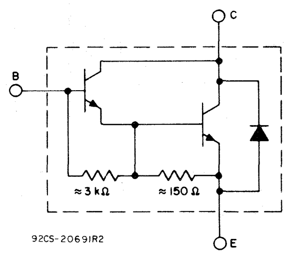


Fig.1 — Schematic diagram for all types.

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 $T_C \leq 25^oC$	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.

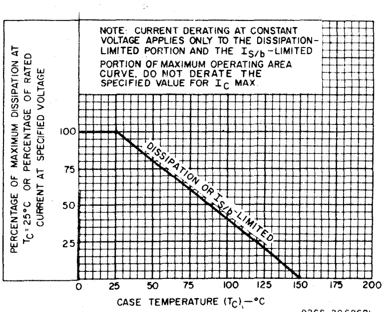


Fig.2 — Derating curve for all types.

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

2N6386, 2N6387, 2N6388

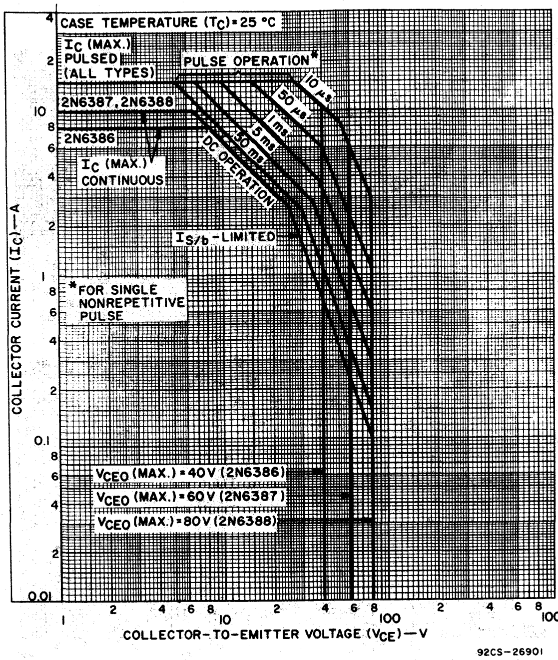


Fig. 4 — Maximum operating areas for all types.

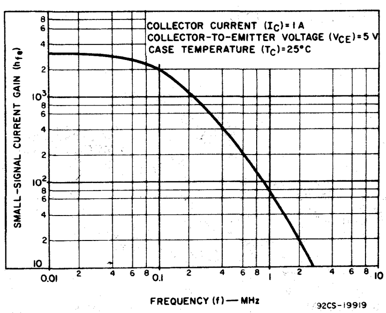


Fig. 5 — Typical small-signal gain for all types.

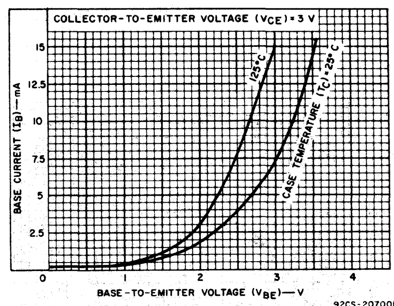


Fig. 6 — Typical input characteristics for all types.

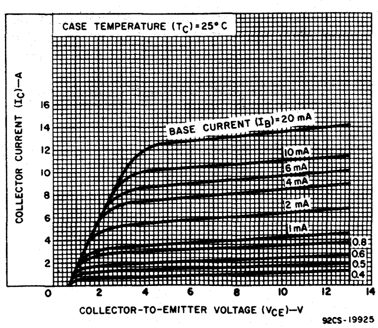


Fig. 7 — Typical output characteristics for all types.

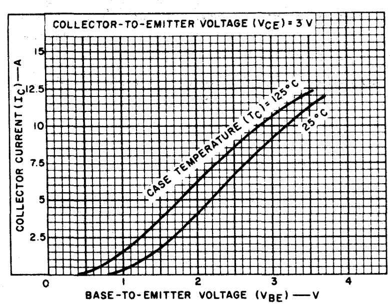


Fig. 8 — Typical transfer characteristics for all types.

2

2N6386, 2N6387, 2N6388

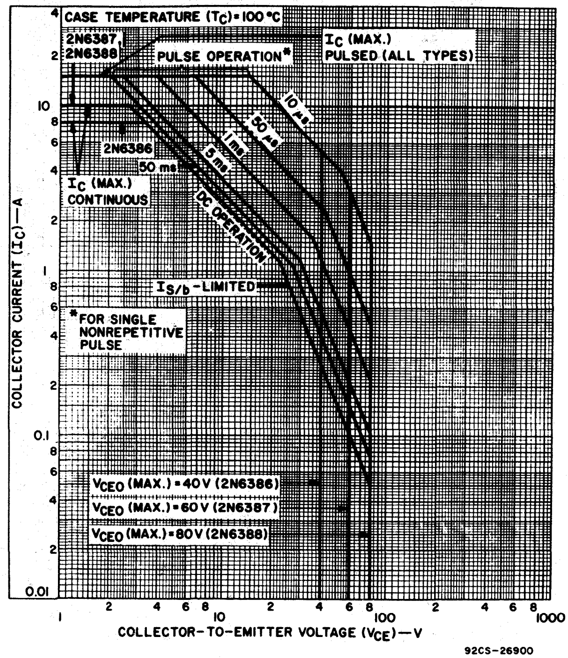


Fig. 9 — Maximum operating areas for all types at T_C = 100° C.

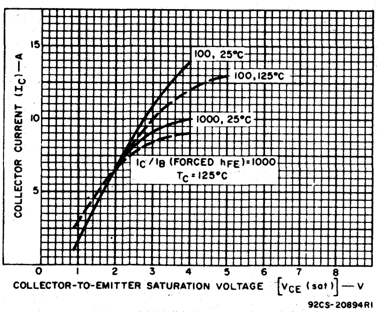


Fig. 10 — Typical saturation characteristics for all types.

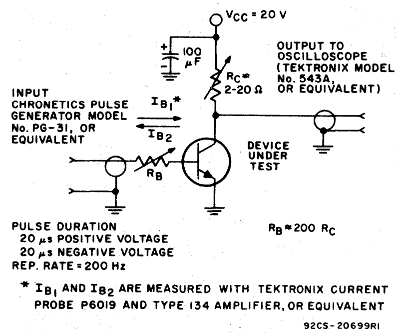


Fig. 11 — Circuit used to measure saturated switching-times.

2N6386, 2N6387, 2N6388

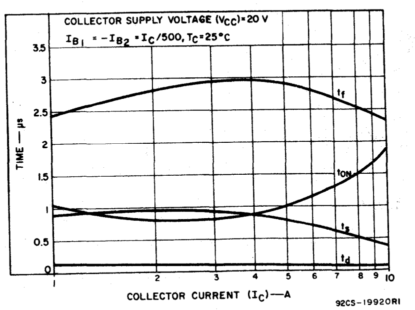


Fig. 12 — Typical saturated switching-time characteristics for all types.

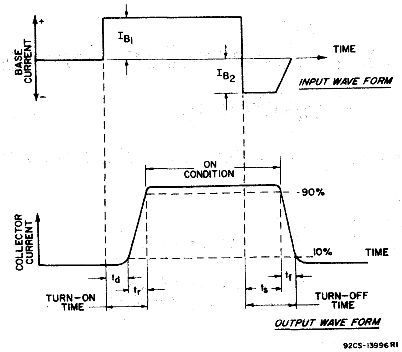


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times.

2

2N6420, 2N6421, 2N6422, 2N6423

File Number **1100**

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

For High-Speed Switching and Linear-Amplifier Applications

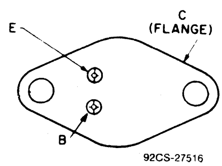
Features:

- *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 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.	2N6420 Max.	2N6421 2N6422 Min.	2N6421 2N6422 Max.	2N6423 Min.	2N6423 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] $-I_{B_1} = I_{B_2}$

2

2N6420, 2N6421, 2N6422, 2N6423

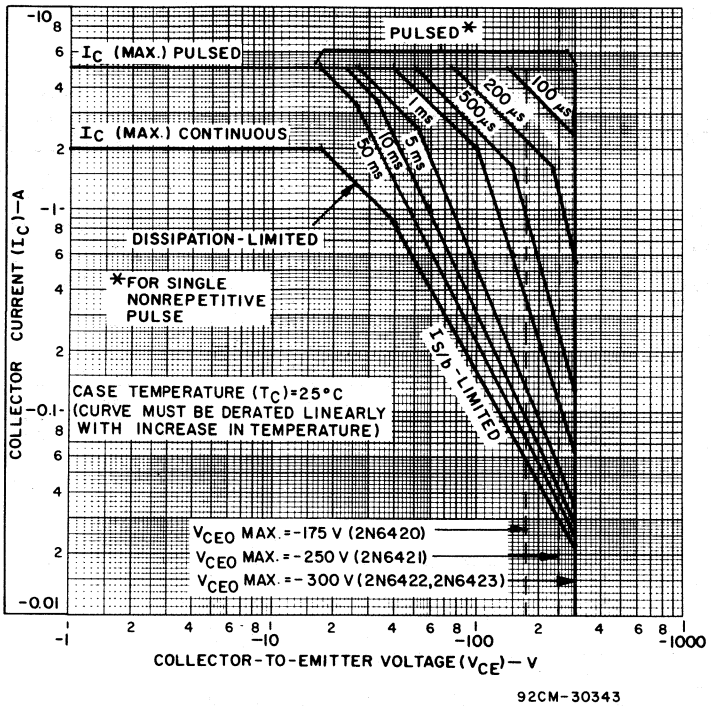


Fig. 1 — Maximum operating areas for all types.

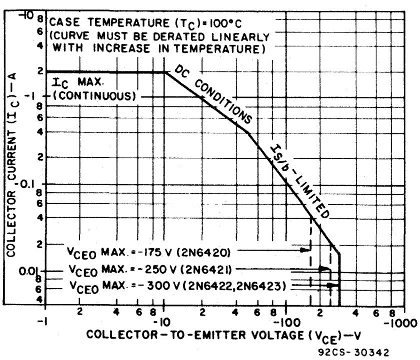


Fig. 2 — Maximum operating areas for all types.

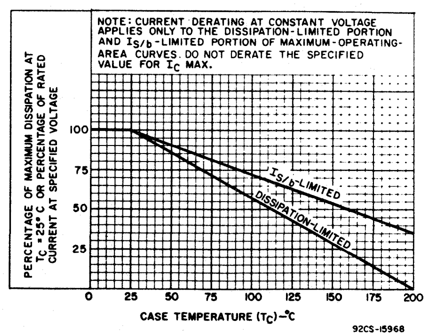


Fig. 3 — Derating curves for all types.

2N6420, 2N6421, 2N6422, 2N6423

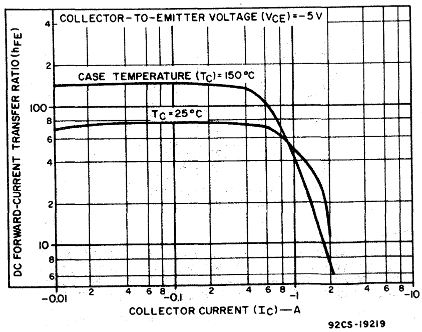


Fig. 4 — Typical dc beta characteristics for all types.

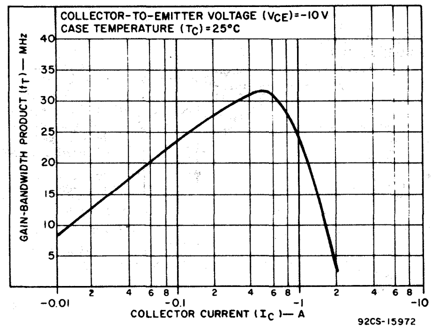


Fig. 5 — Typical gain-bandwidth product for all types.

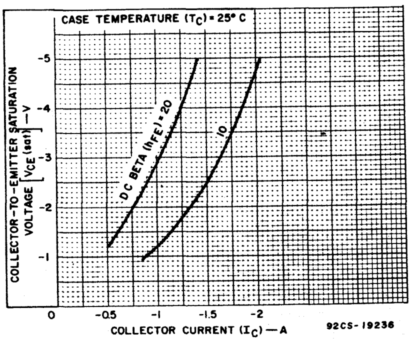


Fig. 6 — Typical saturation-voltage characteristics for all types.

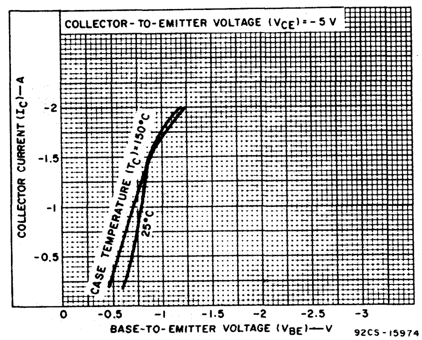


Fig. 7 — Typical transfer characteristics for all types.

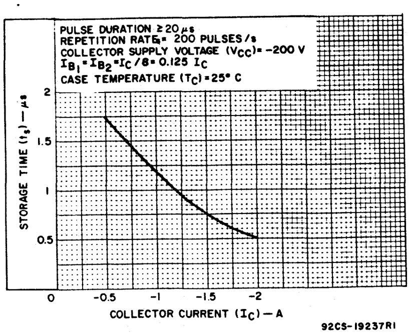


Fig. 8 — Typical storage time characteristic for all types.

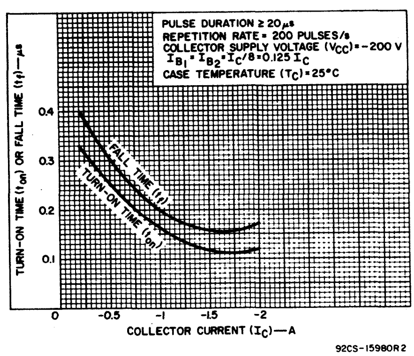


Fig. 9 — Typical turn-on time and fall-time characteristics for all types.

2N6420, 2N6421, 2N6422, 2N6423

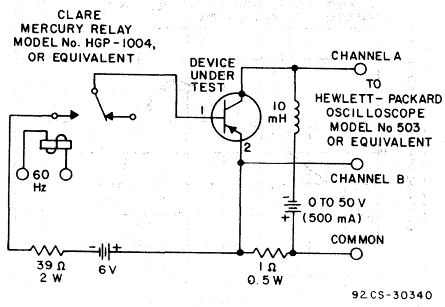


Fig. 10 — Circuit used to measure sustaining voltage V_{CEO} (sus) for all types.

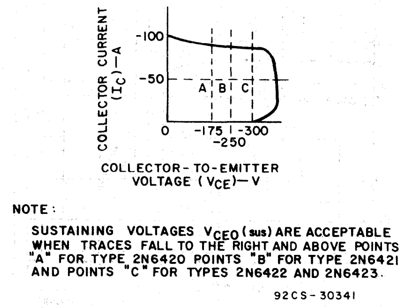


Fig. 11 — Oscilloscope display for measurement of sustaining voltages.

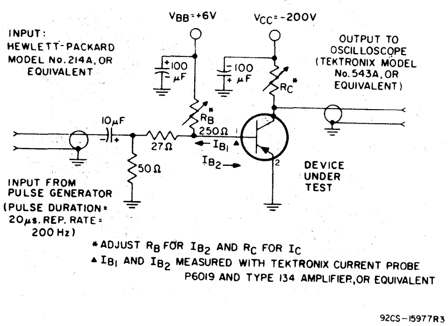


Fig. 12 — Circuit used to measure saturated switching times for all types.

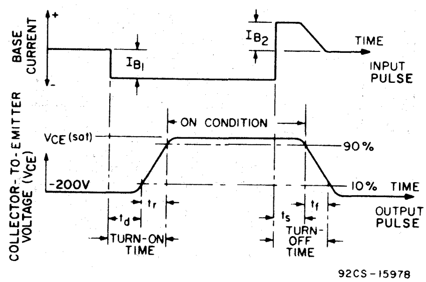


Fig. 13 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

File Number **888**

2N6467, 2N6468

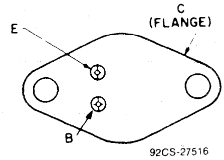
Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Application

Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-213AA

2

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				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6467		2N6468		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 100 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.*

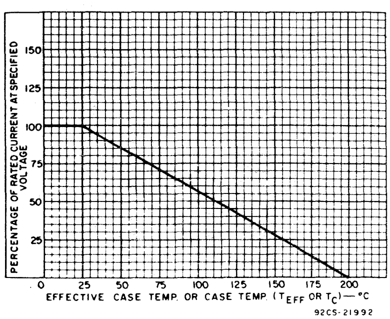


Fig. 1 — Current derating curve for all types.

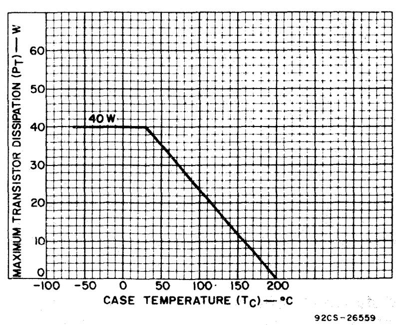


Fig. 2 — Dissipation derating curve for all types.

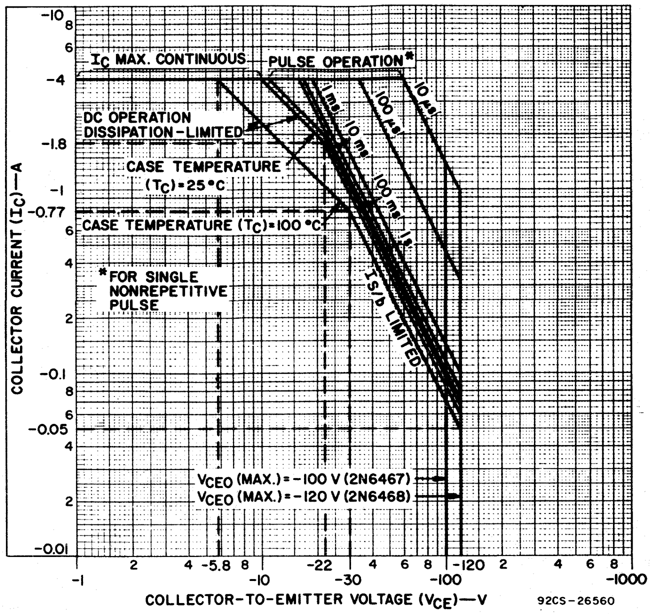


Fig. 3 — Maximum operating areas for 2N6467 and 2N6468.

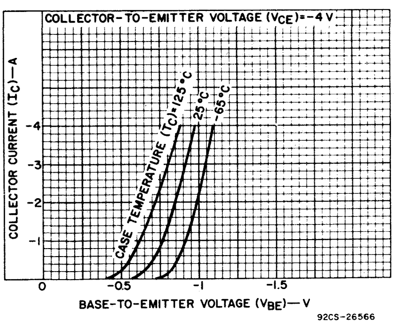


Fig. 4 — Typical transfer characteristics for 2N6467 and 2N6468.

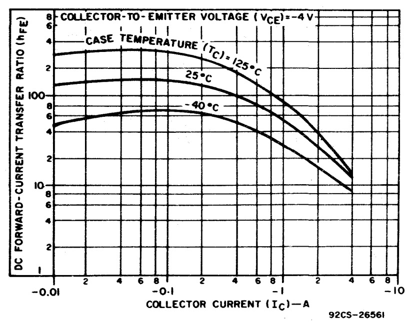


Fig. 5 — Typical dc beta characteristics for 2N6467 and 2N6468.

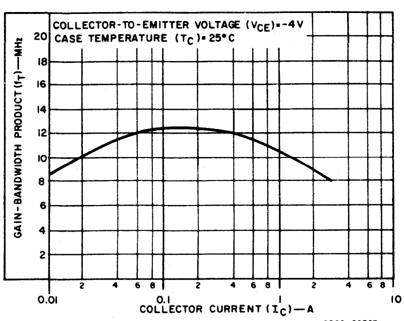


Fig. 6 — Typical gain-bandwidth product by 2N6467 and 2N6468.

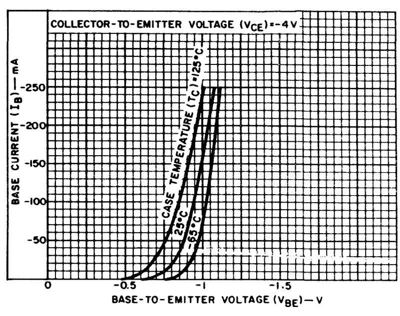


Fig. 7 — Typical input characteristics for 2N6467 and 2N6468.

2N6467, 2N6468

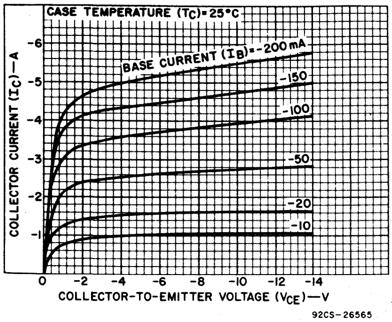


Fig. 8 — Typical output characteristics for 2N6467 and 2N6468.

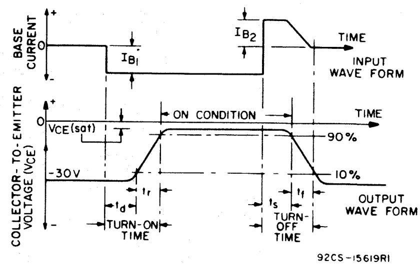


Fig. 9 — Oscilloscope display for measurement of switching times for 2N6467 and 2N6468.

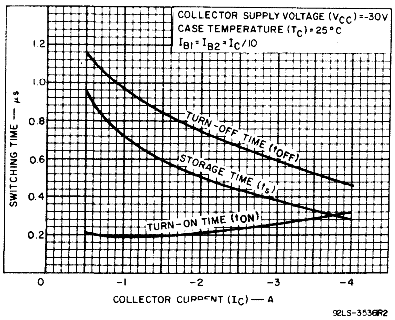


Fig. 10 — Typical saturated switching characteristics for 2N6467 and 2N6468.

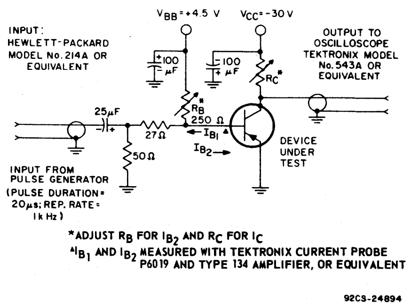


Fig. 11 — Circuit used to measure saturated switching times for 2N6467 and 2N6468.

File Number **680**

2N6477, 2N6478

Medium-Power Silicon N-P-N Transistors

For Intermediate Power Applications in Industrial and Commercial Equipment

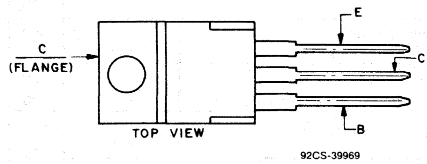
Features:

- *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 V_{CE}	V_{EB}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6477 MIN.	2N6477 MAX.	2N6478 MIN.	2N6478 MAX.	UNITS
* 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.

2N6477, 2N6478

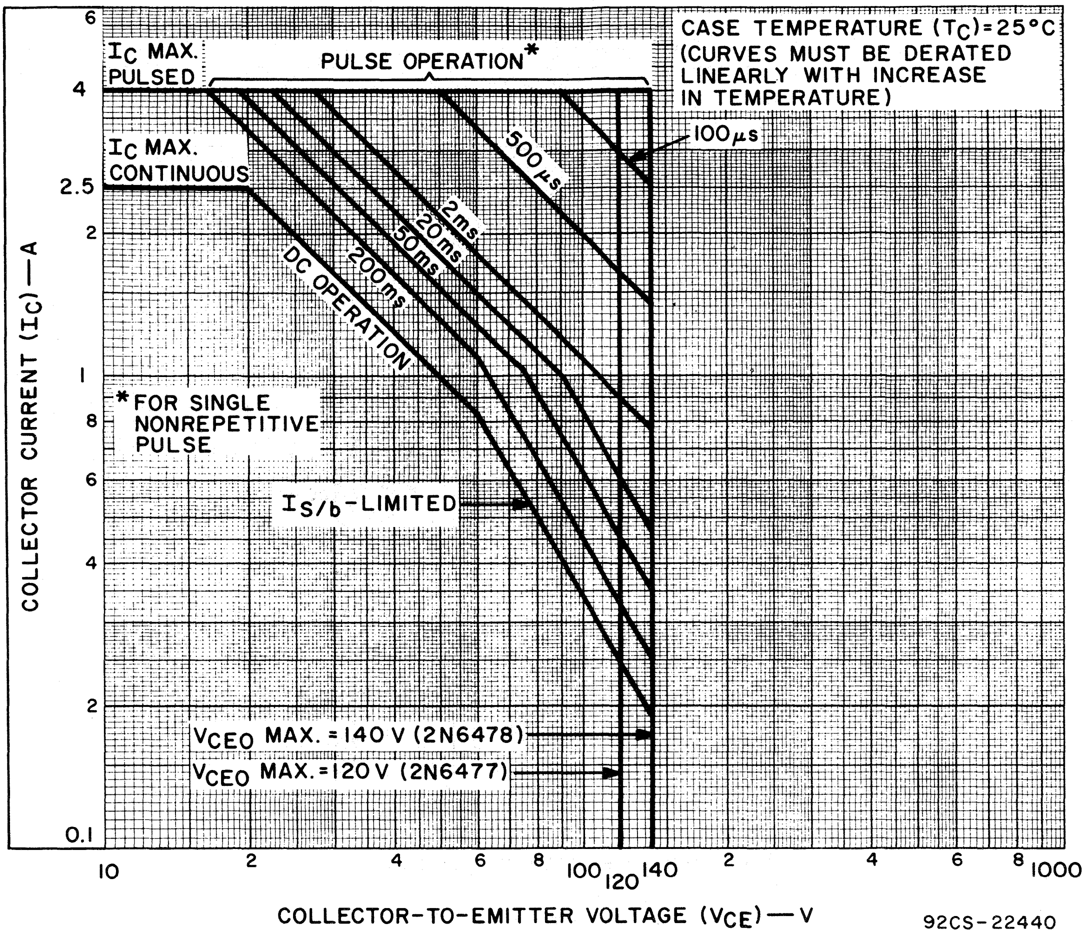


Fig. 1 — Maximum operating areas for both types.

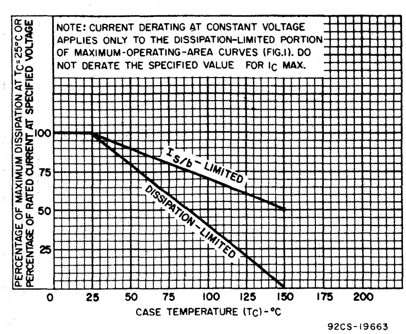


Fig. 2 — Current derating curve for both types.

2N6477, 2N6478

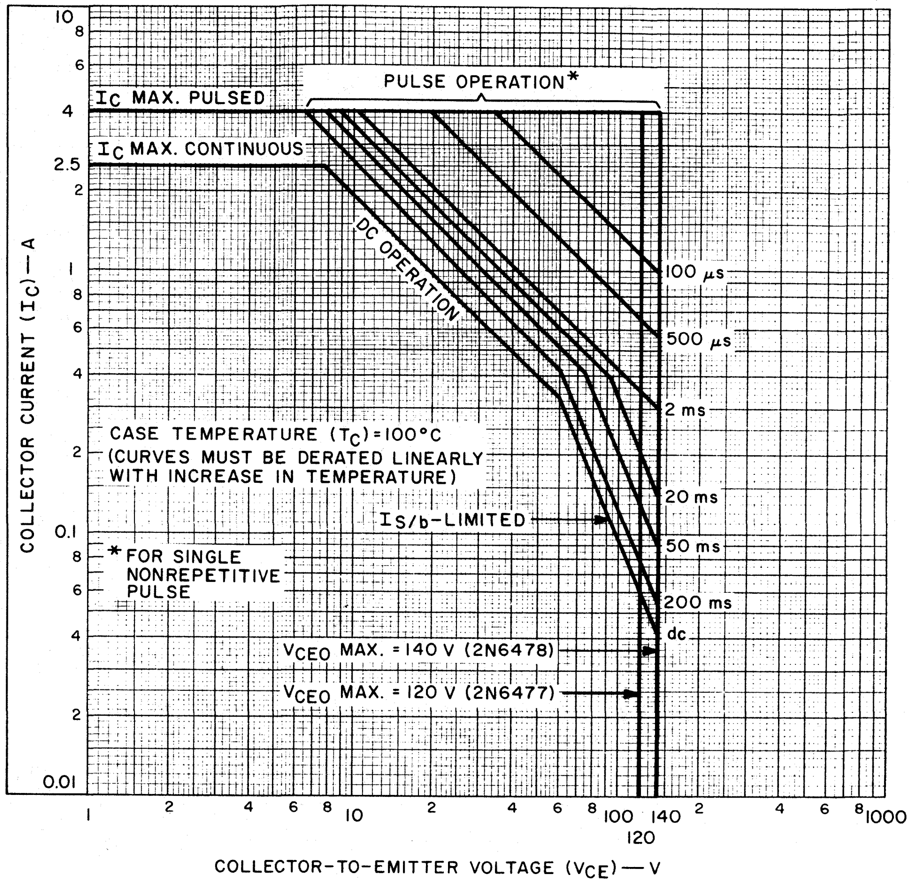


Fig. 3 — Maximum operating areas for both types.

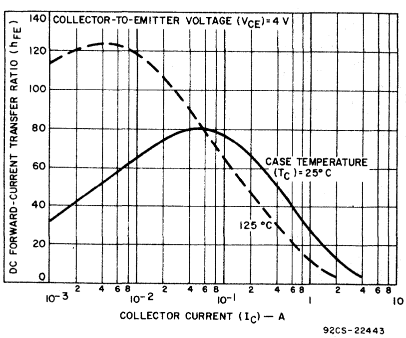


Fig. 4 — Typical dc beta characteristics for 2N6477.

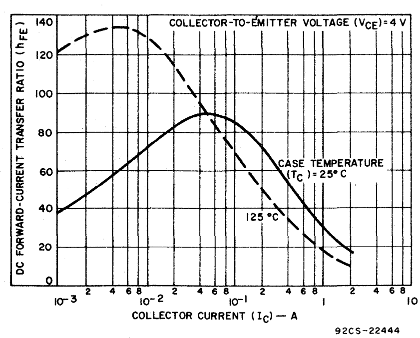


Fig. 5 — Typical dc beta characteristics for 2N6478.

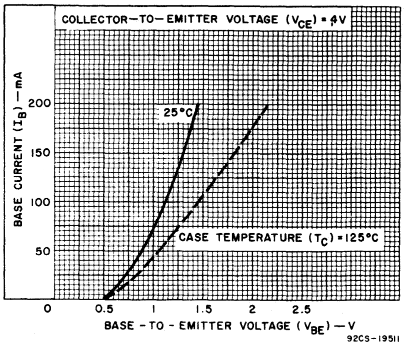


Fig. 6 — Typical input characteristics for 2N6477.

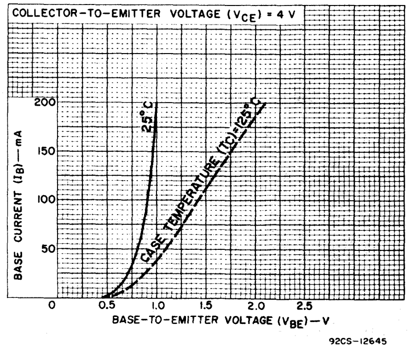


Fig. 7 — Typical input characteristics for 2N6478.

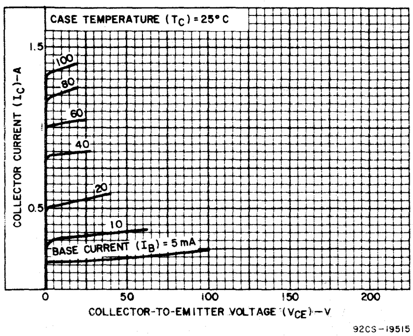


Fig. 8 — Typical output characteristics for 2N6477.

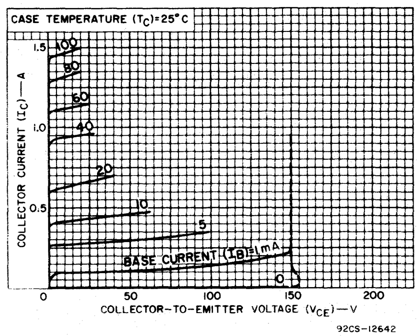


Fig. 9 — Typical output characteristics for 2N6478.

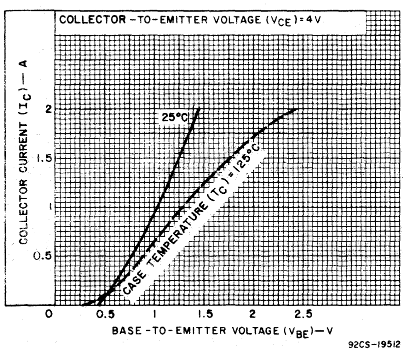


Fig. 10 — Typical transfer characteristics for 2N6477.

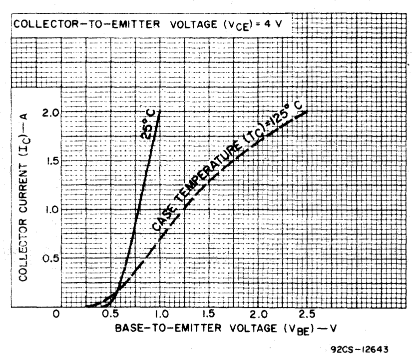


Fig. 11 — Typical transfer characteristics for 2N6478.

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:

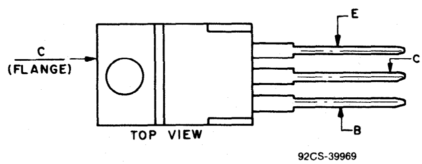
- *Maximum safe-area-of-operation curves*

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 V_{CE}	V_{BE}	CURR. A dc I_C	LIMITS 2N6486 2N6489♦ Min.	Max.	2N6487 2N6490♦ Min.	Max.	2N6488 2N6491♦ Min.	Max.	UNITS
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		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

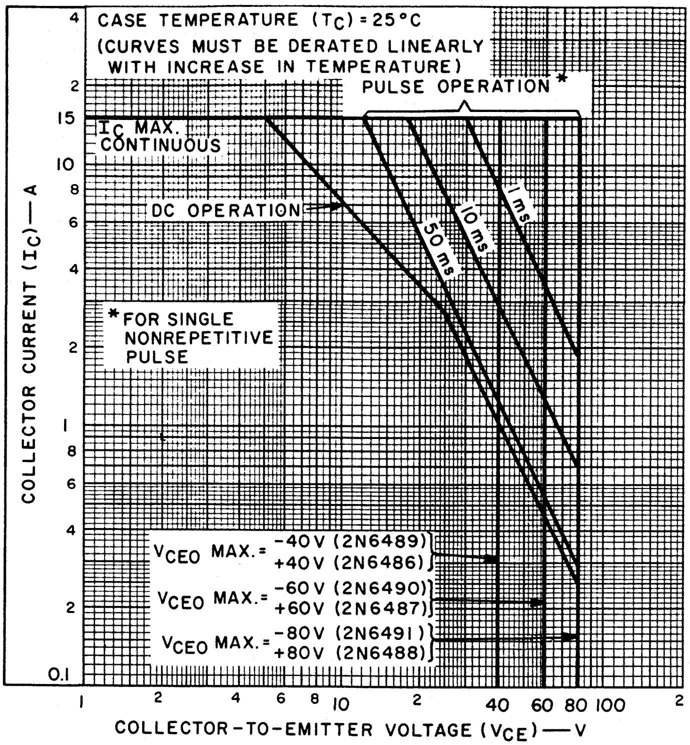


Fig. 1 — Maximum operating areas for all types†.

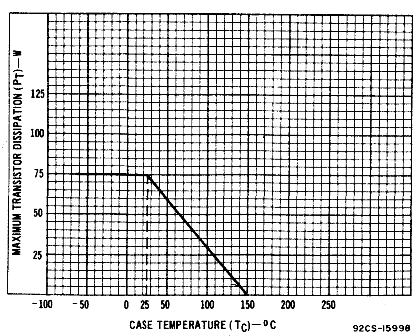


Fig. 2 — Derating chart for all types

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

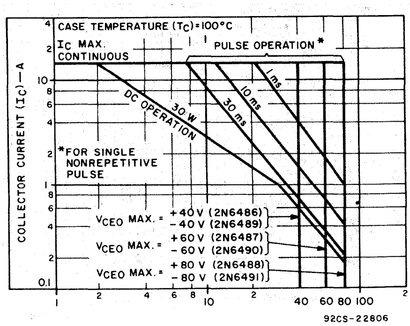


Fig. 3 — Maximum operating areas for all types†.

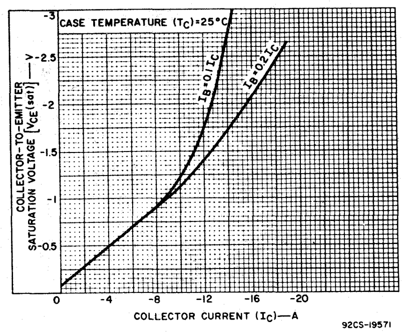


Fig. 4 — Typical collector-to-emitter saturation-voltage characteristics for all types.

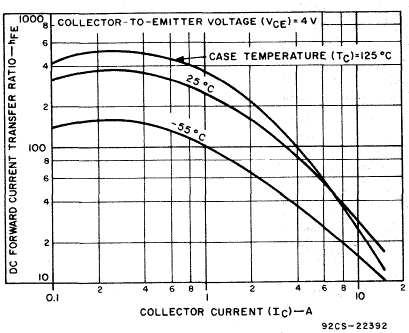


Fig. 5 — Typical dc beta characteristics for 2N6486, 2N6487, and 2N6488.

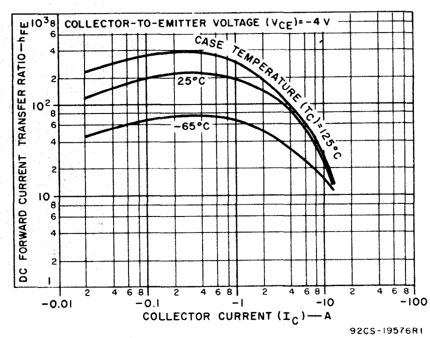


Fig. 6 — Typical dc beta characteristics for 2N6489, 2N6490, and 2N6491.

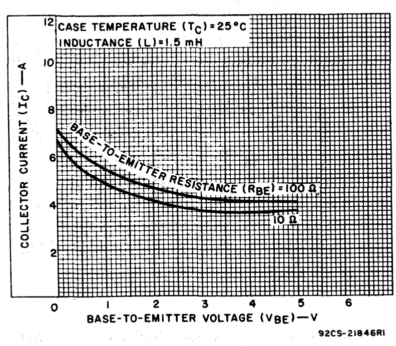


Fig. 7 — Minimum reverse-bias second-breakdown characteristics for all types†.

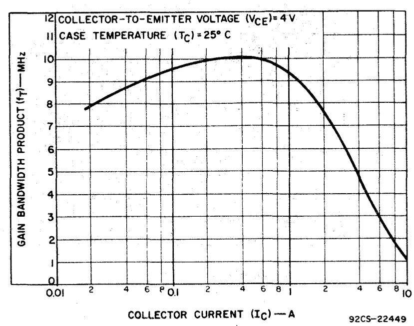


Fig. 8 — Typical gain-bandwidth product vs. collector current for all types†.

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

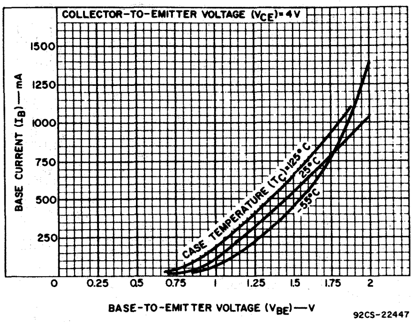


Fig. 9 — Typical input characteristics for all types†.

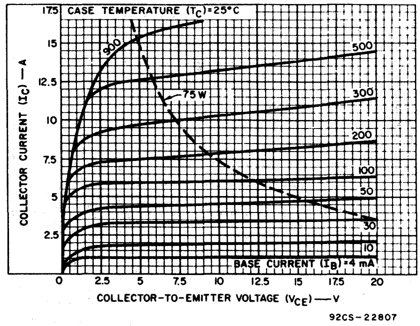


Fig. 10 — Typical output characteristics for all types†.

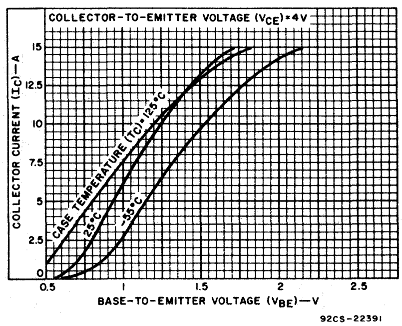


Fig. 11 — Typical transfer characteristics for all types†.

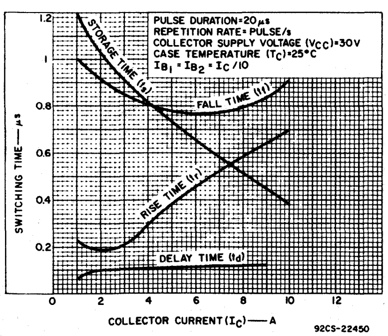


Fig. 12 — Typical saturated switching characteristics for 2N6486, 2N6487, and 2N6488.

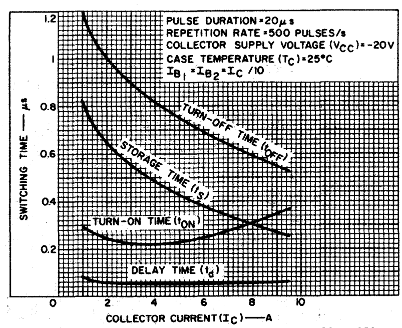


Fig. 13 — Typical saturated switching characteristics for 2N6489, 2N6490, and 2N6491.

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

2N6486, 2N6487, 2N6488, 2N6489, 2N6490, 2N6491

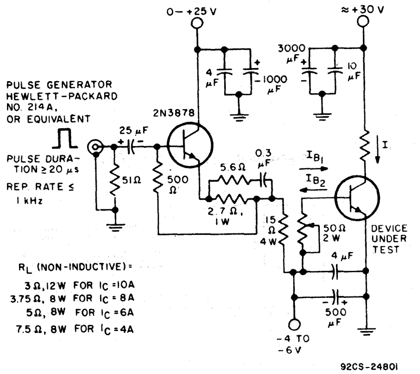


Fig. 14 — Circuit used to measure switching times for 2N6486, 2N6487, and 2N6488.

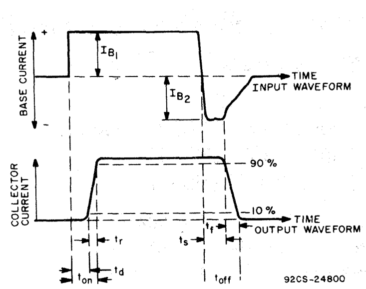


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 14).

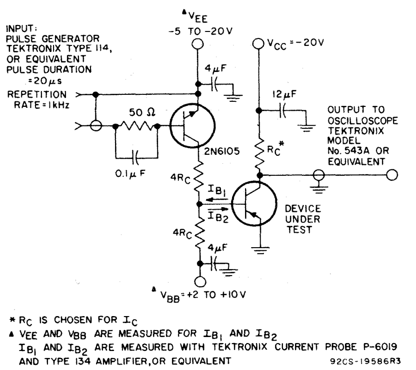


Fig. 16 — Circuit used to measure switching times for 2N6489, 2N6490, and 2N6491.

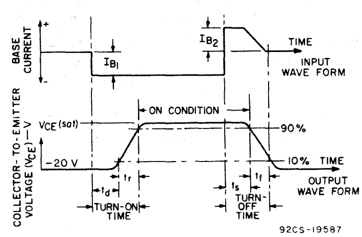


Fig. 17 — Oscilloscope display for measurement for switching times (test circuit shown in Fig. 16).

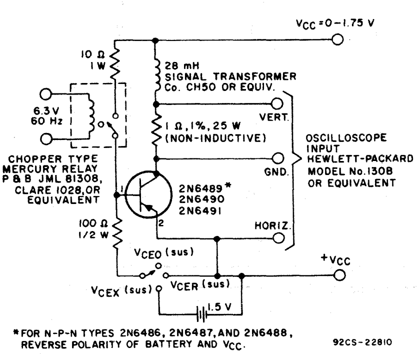


Fig. 18 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

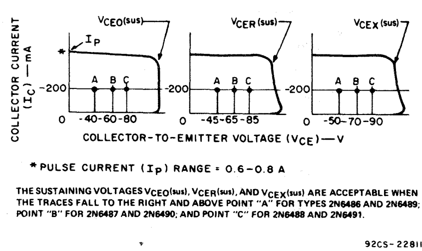


Fig. 19 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 18).

2N6530, 2N6531, 2N6532, 2N6533

File Number **873**

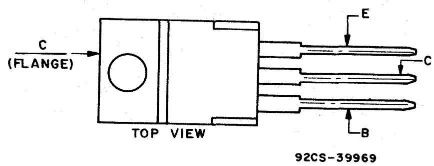
8-Ampere N-P-N Darlington Power Transistors

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



JEDEC TO-220AB

The 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.

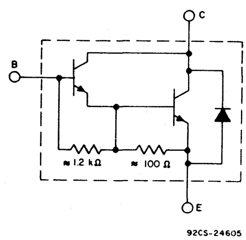


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6530	2N6531	2N6532	2N6533	
$*V_{CBO}$	80	100	100	120	V
$V_{CER}(sus)$					
$R_{BE} = 100\ \Omega$	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 –	mA
*	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 –	mA
	I_{EBO}		−5	0		–	5	–	5	mA
*	h_{FE}	3 3 3		3[a] 5[a] 8[a]		– 1,000 100	– 10,000 5,000	1,000 – 100	10,000 – 5,000	
	V_{CEO}(sus)			0.2	0	100[b]	–	120[b]	–	V
	V_{CER}(sus) R_{BE} = 100 Ω			0.2		100[b]	–	120[b]	–	V
*	V_{CEV}(sus)		−1.5	0.2		100[b]	–	120[b]	–	V
	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

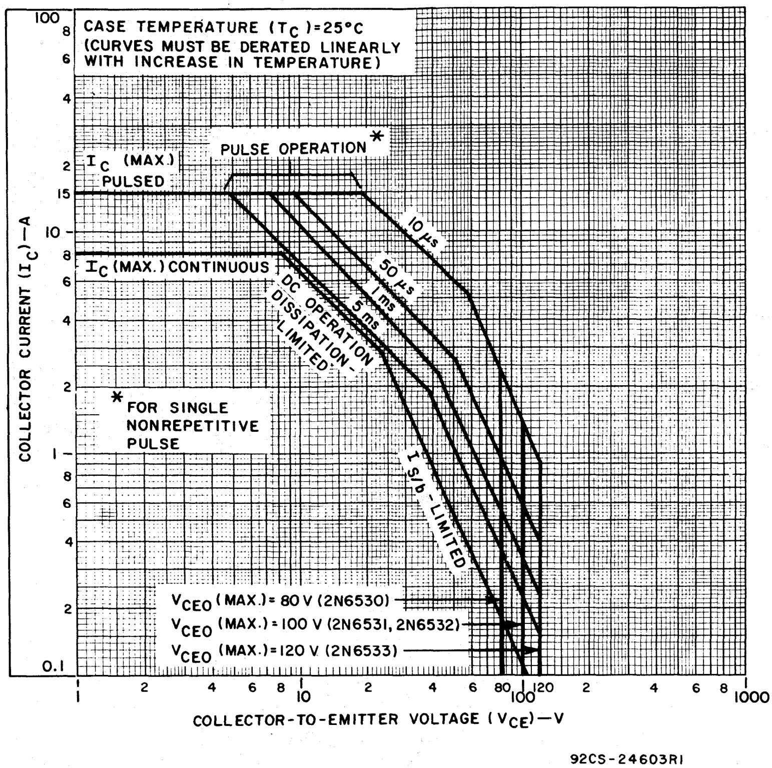


Fig. 2—Maximum operating areas for all types at case temperature of 25°C.

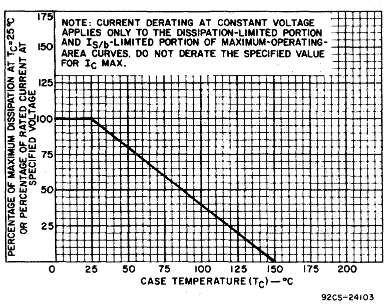


Fig. 3—Dissipation derating curve for all types.

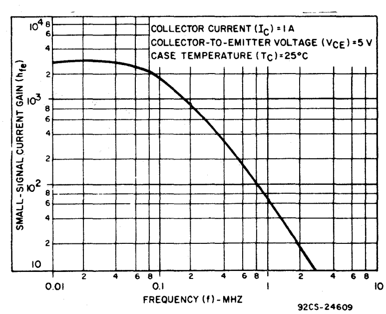


Fig. 4 — Typical small-signal current gain for all types.

2N6530, 2N6531, 2N6532, 2N6533

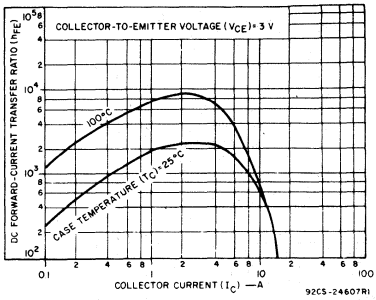


Fig. 5 — Typical dc beta characteristics for all types.

2N6530, 2N651, 2N6532, 2N6533

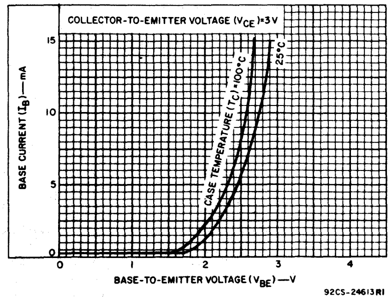


Fig. 6 — Typical input characteristics for all types.

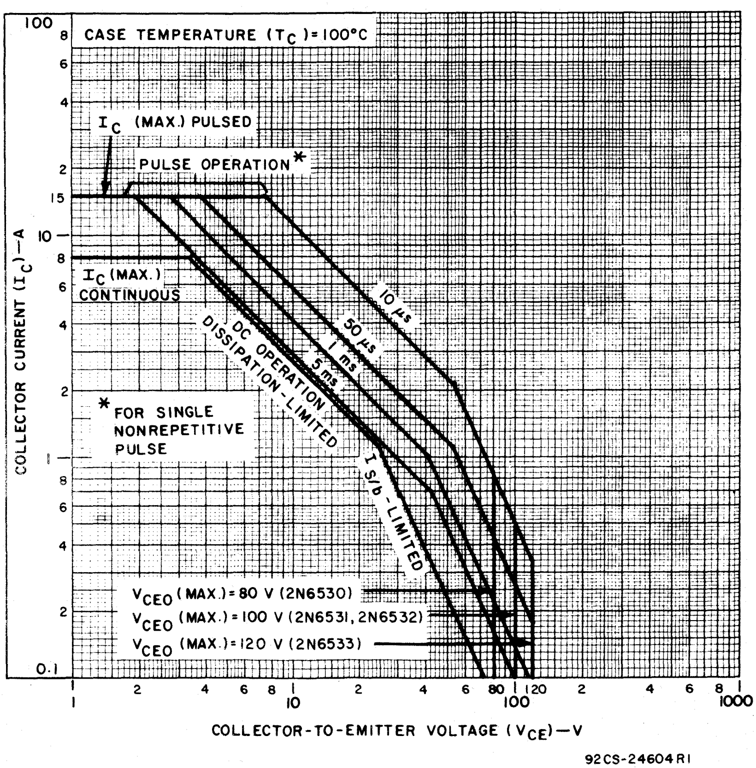


Fig. 7 — Maximum operating areas for all types at case temperature of 100°C.

2N6530, 2N6531, 2N6532, 2N6533

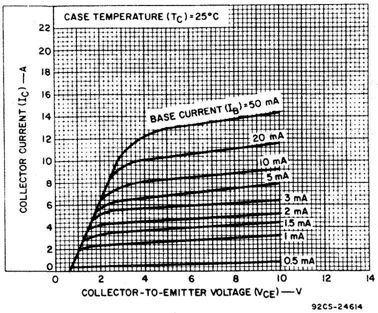


Fig. 8 — Typical output characteristics for all types.

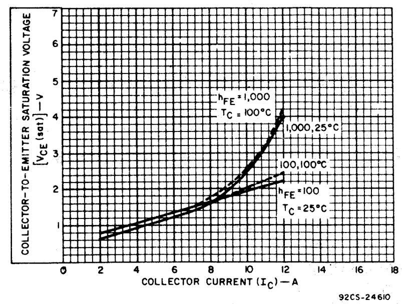


Fig. 9 — Typical saturation characteristics for all types.

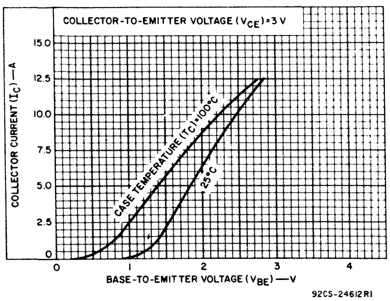


Fig. 10 — Typical transfer characteristics for all types.

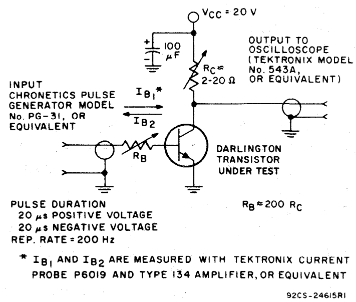


Fig. 11 — Circuit used to measure saturated switching-times.

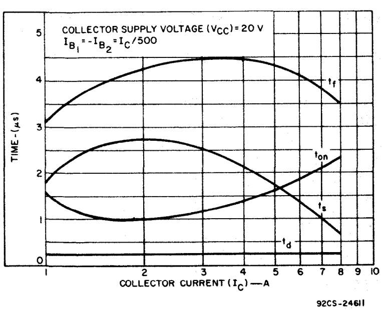


Fig. 12 — Typical saturated switching-time characterictics for all types.

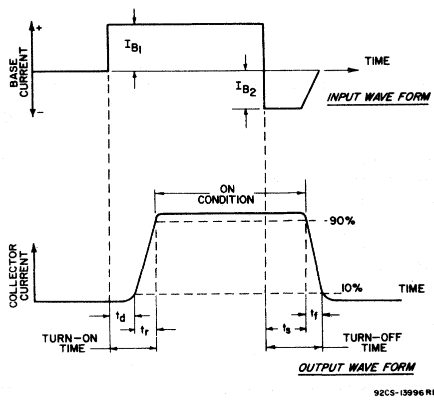


Fig. 13 — Phase relationship between input current and output current, showing reference points for specification of switching-times.

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 I_C = 3-, 5-, and 10-A*

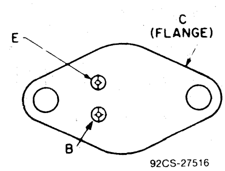
Applications:

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

The 2N6542, 2N6544, 2N6545, and 2N6546 series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are characterized at 100° C; as well as at 25° C, to provide information necessary for worst-case design.

The 2N6542, 2N6544, 2N6545, and 2N6546 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6542	2N6544	2N6545	2N6546	
*V_{CEV}					
V_{BE} = -1.5 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	—	—	—	—	—	—	V
	—	—	5[a]	1	—	5	—	1.5	—	1.5	—	—	
	—	—	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_{CC} = 20 V	—	—	2.6[a]	—	350	—	—	—	—	—	—	—	V
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

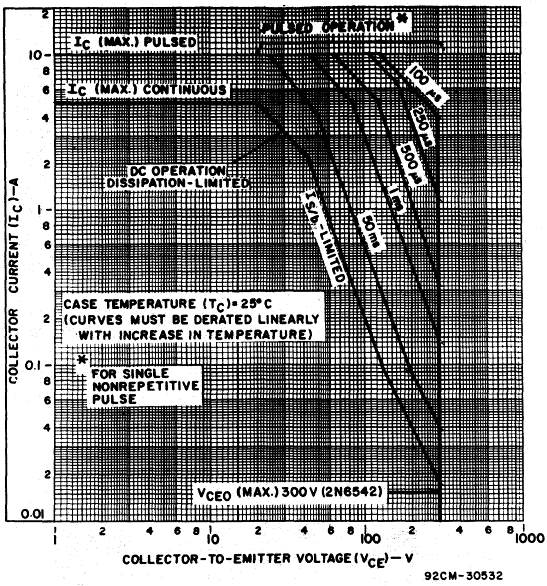


Fig. 1 - Maximum operating areas for type 2N6542 (Tc = 25°).

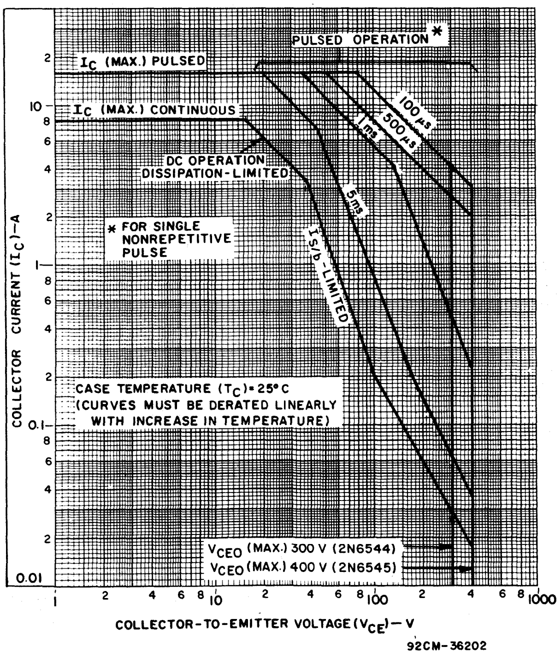


Fig. 2 - Maximum operating areas for type 2N6544 and 2N6545 (Tc = 25° C).

2N6542, 2N6544, 2N6545, 2N6546

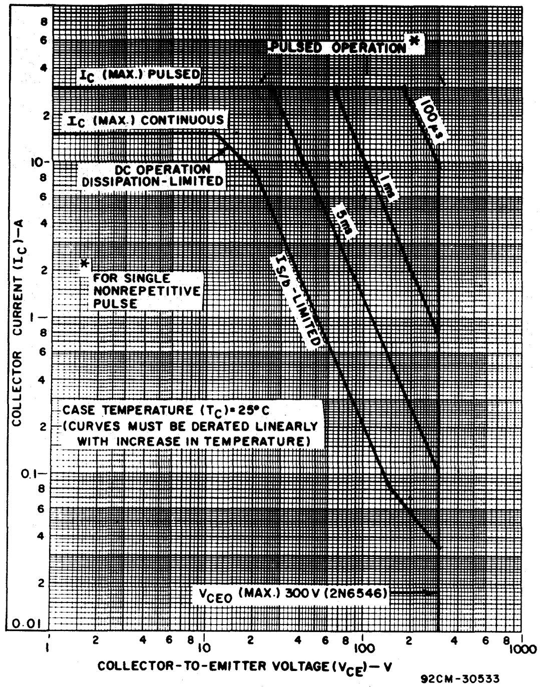


Fig. 3 - Maximum operating areas for type 2N6546 (Tc = 25°)

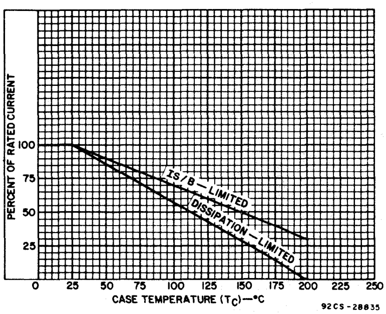


Fig. 4 - Dissipation and Is/b derating curves for all types.

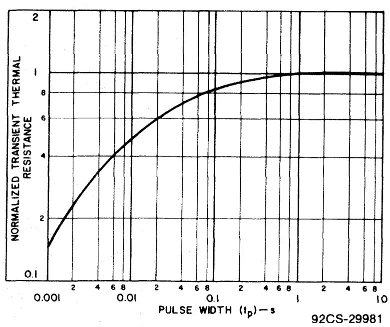


Fig. 5 — Typical thermal-response characteristics for types 2N6542, 2N6544 and 2N6545.

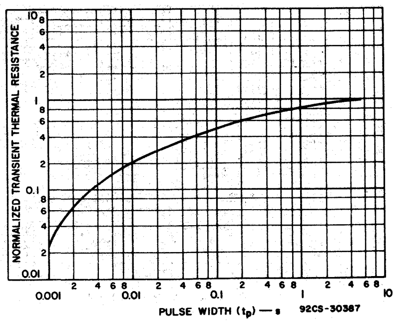


Fig. 6 — Typical thermal-response characteristics for type 2N6546.

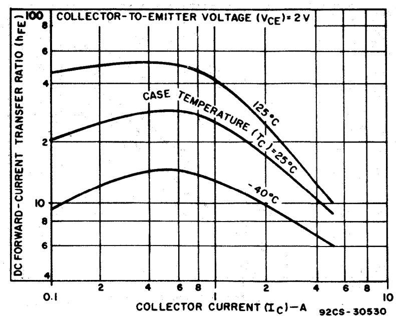


Fig. 7 — Typical dc beta characteristics for type 2N6542.

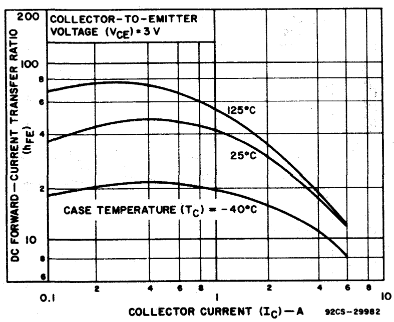


Fig. 8 — Typical dc beta characteristics for type 2N6544.

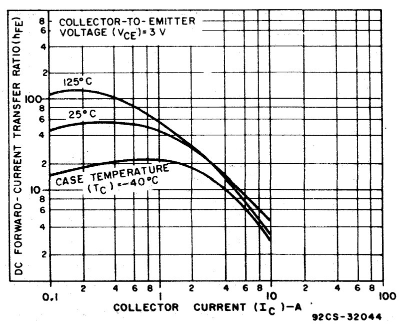


Fig. 9 — Typical dc beta characteristics for type 2N6545.

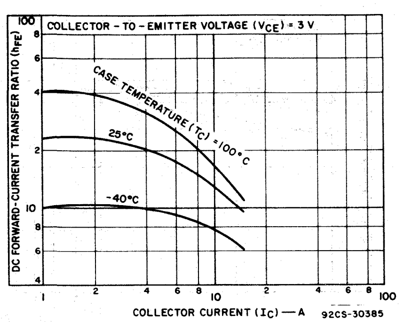


Fig. 10 — Typical dc beta characteristics for type 2N6546.

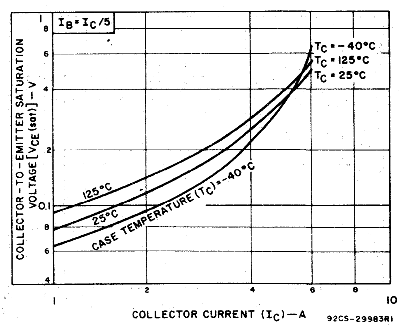


Fig. 11 — Typical collector-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

2N6542, 2N6544, 2N6545, 2N6546

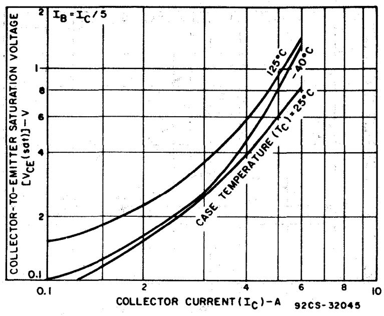


Fig. 12 — Typical collector-to-emitter saturation voltage as a function of collector current for type 2N6545.

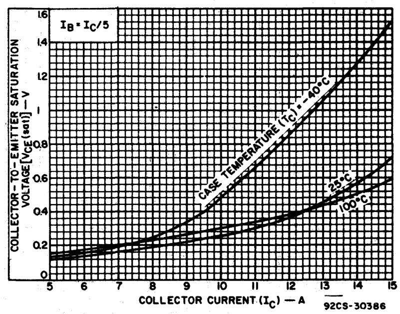


Fig. 13 — Typical collector-to-emitter saturation voltage characteristics for type 2N6546.

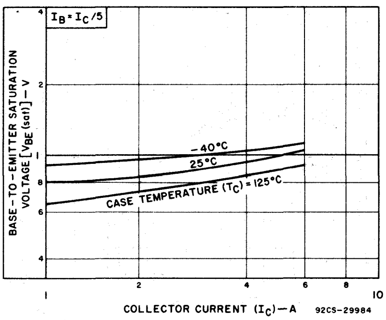


Fig. 14 — Typical base-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

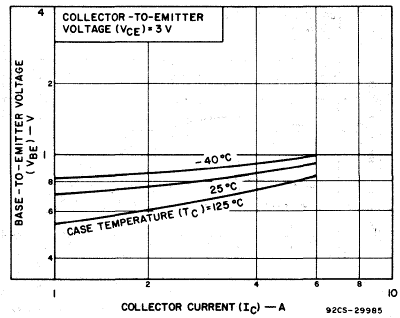


Fig. 15 — Typical base-to-emitter voltage as a function of collector current for types 2N6542 and 2N6544.

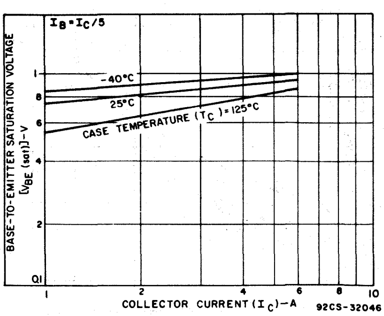


Fig. 16 — Typical base-to-emitter saturation voltage as a function of collector current for type 2N6545.

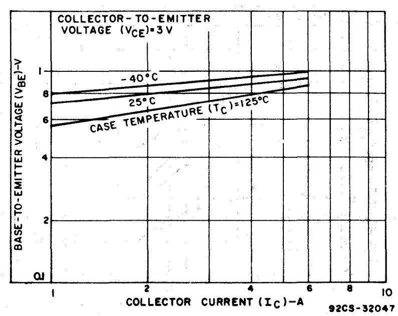


Fig. 17 — Typical base-to-emitter voltage as a function of collector current for type 2N6545.

2N6542, 2N6544, 2N6545, 2N6546

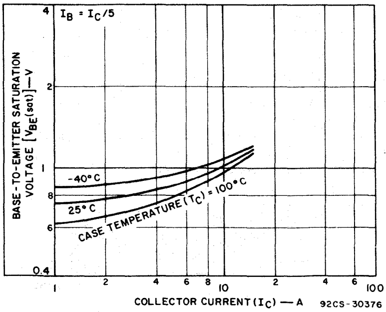


Fig. 18 — Typical base-to-emitter saturation voltage characteristics for type 2N6546.

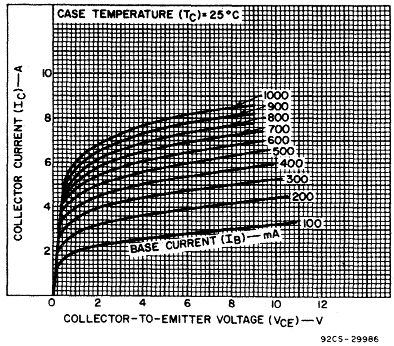


Fig. 19 — Typical output characteristics for types 2N6542 and 2N6544.

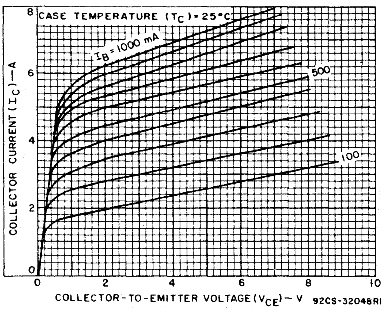


Fig. 20 — Typical output characteristics for type 2N6545.

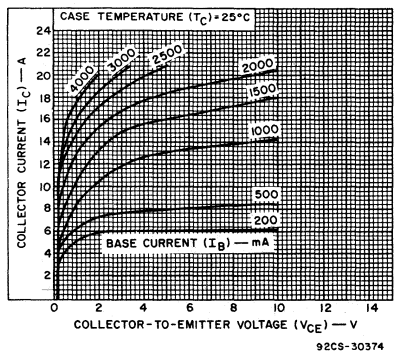


Fig. 21 — Typical output characteristics for type 2N6546.

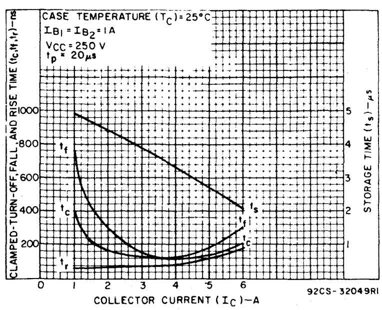


Fig. 22 — Typical saturated switching time characteristics for type 2N6545.

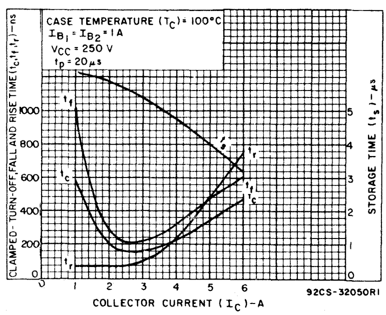


Fig. 23 — Typical saturated switching time characteristics for type 2N6545.

2N6542, 2N6544, 2N6545, 2N6546

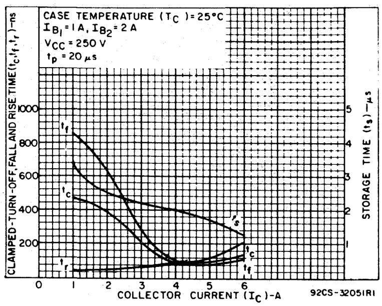


Fig. 24 — Typical saturated switching time characteristics for type 2N6545.

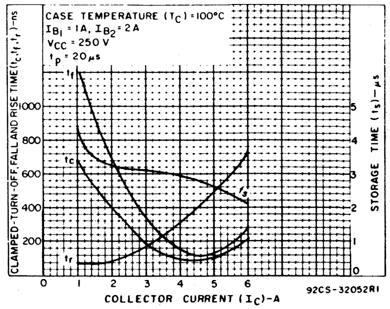


Fig. 25 — Typical saturated switching time characteristics for type 2N6545.

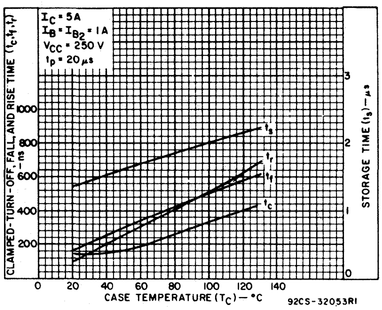


Fig. 26 — Typical saturated switching time characteristics as a function of case temperature for type 2N6545.

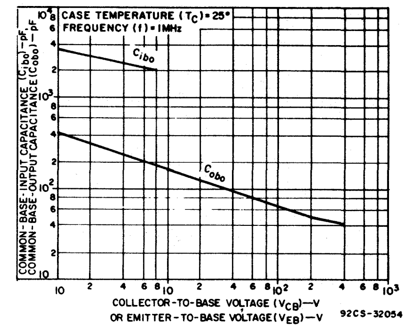


Fig. 27 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for type 2N6545.

File Number **15.109**

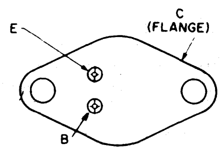
2N6547

15-Ampere Power-Switching Transistors

Features:
- *100% High temperature tested for 100°C parameters*
- *Fast switching speed*
- *High voltage rating V_{CEX} = 450V*
- *Low $V_{CE}(sat)$ at IC = 2- and 3- A*

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

TERMINAL DESIGNATION



JEDEC TO-204AA

The 2N6547 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits.

These devices are supplied in the JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	2N6547	UNITS
Collector-Emitter Voltage	V_{CEO}	400	Volts
Collector-Emitter Voltage •	V_{CEX}	450	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Peak	I_C I_{CM}	15 30	A
Base Current — Continuous Peak	I_B I_{BM}	10 20	A
Total Power Dissipation @ T_C = 100°C @ T_C = 25°C Derate above 25°C	P_D	100 175 1	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +200	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	275	°C

2N6547

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100mA)	$V_{CEO(sus)}$	400	—	—	Volts
Collector-Emitter Sustaining Voltage (I_C = 8.0mA, V_{clamp} = Rated V_{CEX}, T_C = 100°C) (I_C = 15A, V_{clamp} = Rated V_{CEO} - 100V, T_C = 100°C)	V_{CEX}	450 300	— —	— —	Volts Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = -1.5V) (V_{CEV} = Rated Value, $V_{BE(off)}$ = -1.5V, T_C = 100°C)	I_{CEV}	— —	— —	1 4	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100°C)	I_{CER}	—	—	5	mA
Emitter Cutoff Current (V_{EB} = 9.0V)	I_{EBO}	—	—	1	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 7			
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 8			
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 5A, V_{CE} = 2V) (I_C = 10A, V_{CE} = 2V)	h_{FE}	12 6	— —	60 30	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 2A) (I_C = 15A, I_B = 3A) (I_C = 10A, I_B = 2A, T_C = 100°C)	$V_{CE(sat)}$	— — —	— — —	1.5 5 2.5	V
Base-Emitter Saturation Voltage (I_C = 10A, I_B = 2.0A) (I_C = 10A, I_B = 2.0A, T_C = 100°C)	$V_{BE(sat)}$	— —	— —	1.6 1.6	V

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	V_{CC} = 250V, I_C = 10A	t_d	—	—	0.05	μs
Rise Time	I_{B1} = $-I_{B2}$ = 2A, t_p = 100μs	t_r	—	—	1	
Storage Time	Duty Cycle < 2.0%	t_s	—	—	4	
Fall Time		t_f	—	—	0.7	

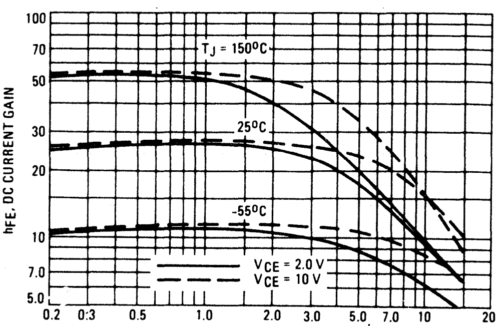


FIGURE 1 — DC CURRENT GAIN

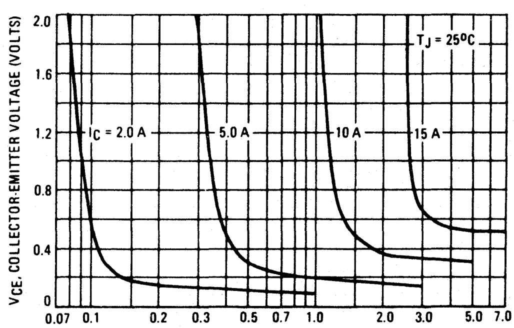


FIGURE 2 — COLLECTOR SATURATION REGION

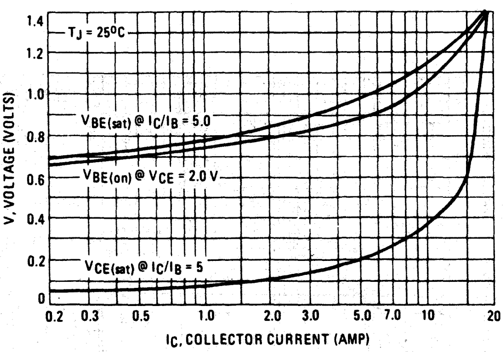


FIGURE 3 – "ON" VOLTAGE

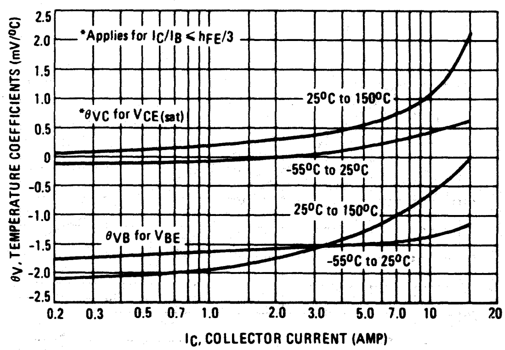


FIGURE 4 – TEMPERATURE COEFFICIENTS

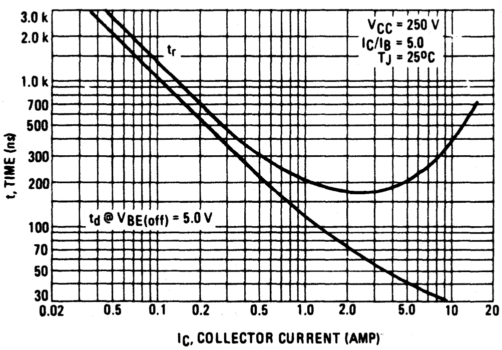


FIGURE 5 – TURN-ON TIME

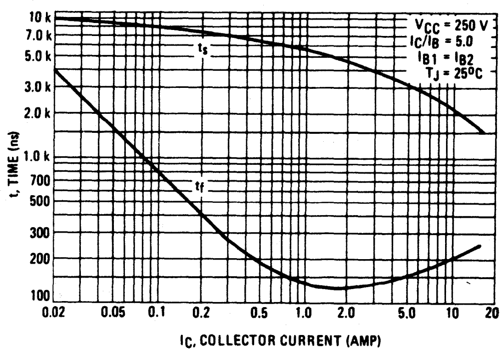


FIGURE 6 – TURN-OFF TIME

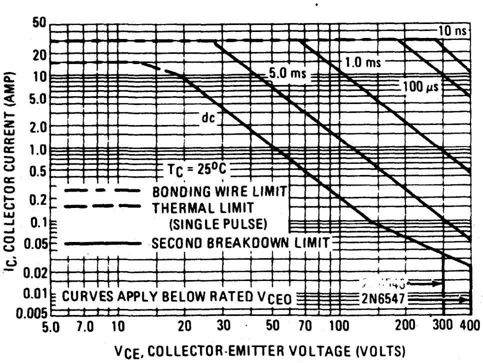


FIGURE 7 – FORWARD BIAS SAFE OPERATING AREA

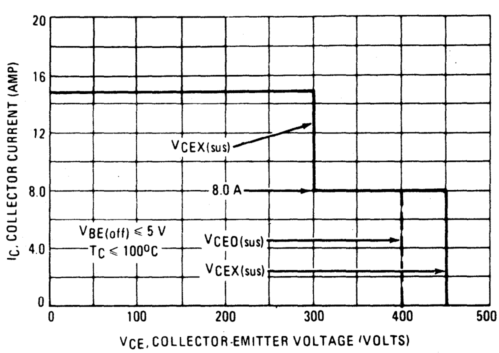


FIGURE 8 – REVERSE BIAS SAFE OPERATING AREA

2N6547

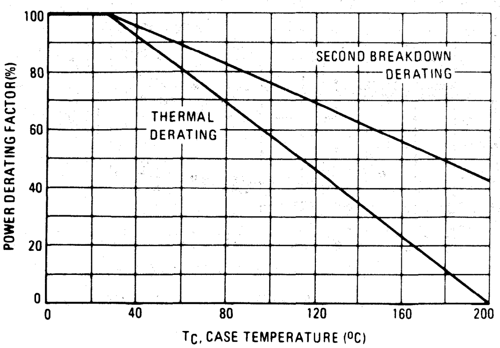


FIGURE 9 – POWER DERATING

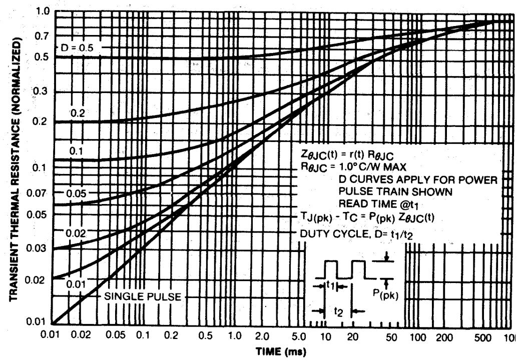


FIGURE 10 - THERMAL RESPONSE

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

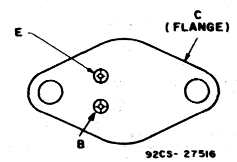
Features:

- **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

2

The 2N6576, 2N6577, and 2N6578 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

All types utilize the steel JEDEC TO-204AA/ TO-3 hermetic package.

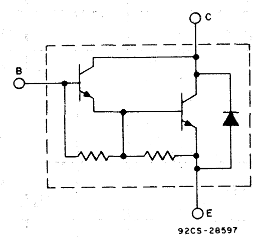


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6576	2N6577	2N6578	
*	V_{CBO}	60	90	120	V
*	$V_{CEO}(sus)$	60	90	120	V
*	V_{EBO}		7		V
*	I_C		15		A
	I_{CM}		30		A
*	I_B		0.25		A
*	P_T				
	$T_C \leqslant 25^oC$		120		W
	$T_C > 25^oC$		See Fig. 2		
*	T_{stg}, T_J		−65 to 200		^oC
*	T_L				
	At distances ⩾ 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	V
					15[b]	0.15	–	4	–	4	–	4	
	V_F				–15		–	4.5	–	4.5	–	4.5	
*	h_{fe} f=1 MHz	3			3		4	40	4	40	4	40	
*	t_d[c]				10	0.1	–	0.15	–	0.15	–	0.15	μs
*	t_r[c]				10	0.1	–	1	–	1	–	1	
*	t_s[c]				10	0.1[d]	–	2	–	2	–	2	
*	t_f[c]				10	0.1[d]	–	7	–	7	–	7	
	$I_{S/b}$ t=1 s, non rep.	20					6	–	6	–	6	–	A
	$R_{\theta JC}$						–	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

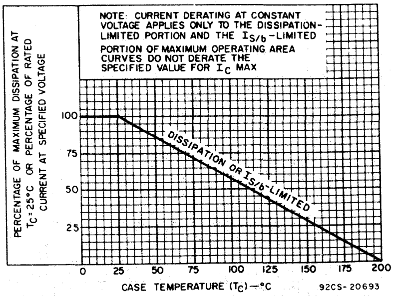


Fig. 2 — Derating curves for all types.

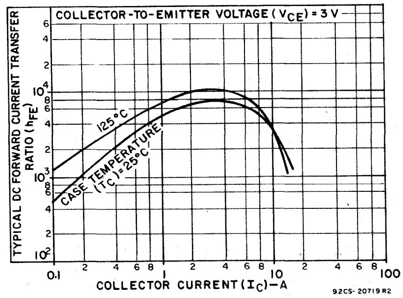


Fig. 3 — Typical dc-beta characteristics for all types.

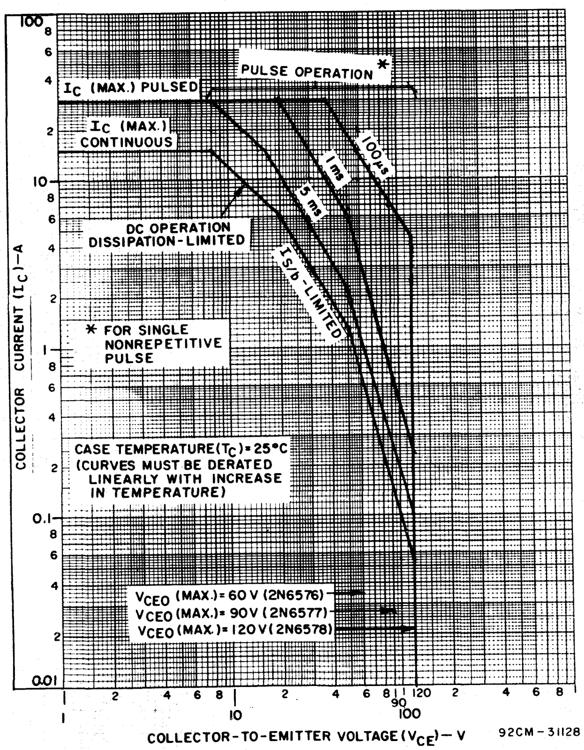


Fig. 4 — Maximum operating areas for all types.

2N6576, 2N6577, 2N6578

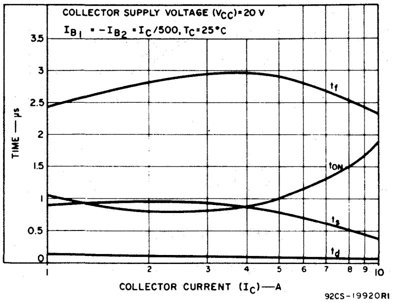


Fig. 5 — Typical saturated switching time characteristics for all types.

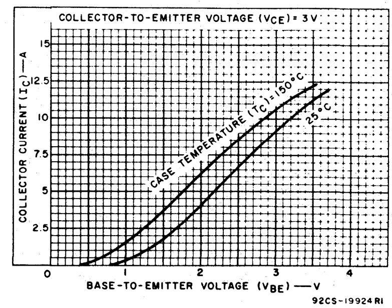


Fig. 6 — Typical transfer characteristics for all types.

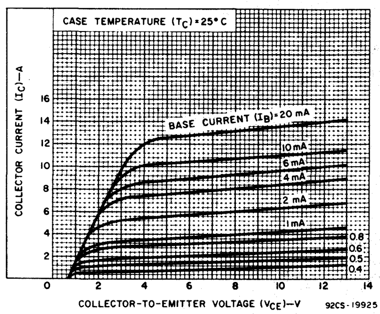


Fig. 7 — Typical output characteristics for all types.

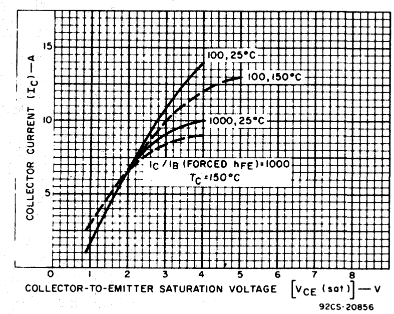


Fig. 8 — Typical saturation characteristics for all types.

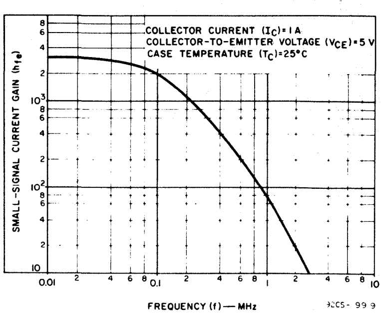


Fig. 9 — Typical small-signal gain for all types.

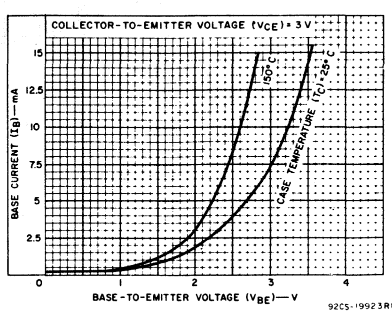


Fig. 10 — Typical input characteristics for all types.

2N6576, 2N6577, 2N6578

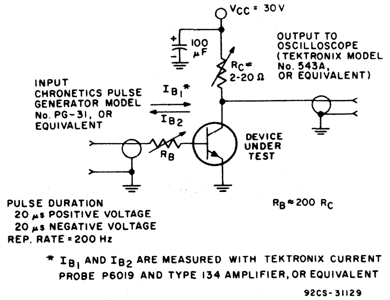
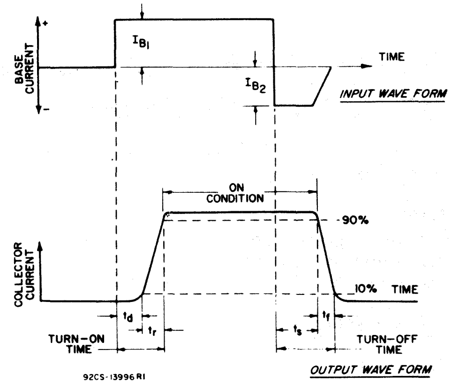


Fig. 11 – Circuit used to measure saturated-switching times.



2

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

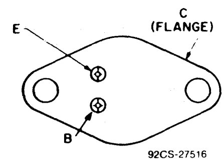
Features:

- *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 2N6609, MJ15004, RCA9116C, RCA9116D, and RCA9116E are ballasted epitaxial-base silicon p-n-p transistors featuring high gain at high current. They may be used as complements to the n-p-n types RCA3773. MJ15003, RCA8638C, RCA8638D, and RCA8638E, respectively.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6609	MJ15004	RCA9116C	RCA9116D	RCA9116E	
* V_{CBO}	-160	-140	-140	-120	-100	V
$V_{CEX}(sus)$ V_{BE} = -1.5 V; R_{BE} = 100 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 VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	LIMITS 2N6609 Min.	2N6609 Max.	MJ15004 Min.	MJ15004 Max.	UNITS
I_{CBO}	−160[a]			–	−4	–	–	mA
*	−140[a]			–	−2	–	−1	
I_{CEX}	−140	1.5		–	–	–	−0.1	
I_{CEX} T_C = 150°C	−140	1.5		–	–	–	−2	
* I_{CEV}	−140	1.5		–	−2	–	–	
* I_{CEV} T_C = 150°C	−140	1.5		–	−10	–	–	
I_{CEO} I_B = 0	−140			–	–	–	−0.25	
*	−120			–	−10	–	–	
* I_{EBO}		−7		–	−5	–	–	
		−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	–	
$\lvert h_{fe} \rvert$ * f = 0.05	−4		−1	4	–	–	–	
= 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]			–	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)*

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	LIMITS RCA9116C Min.	RCA9116C Max.	RCA9116D Min.	RCA9116D Max.	RCA9116E Min.	RCA9116E Max.	UNITS
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] $R_{BE} \leqslant 100\Omega$			−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

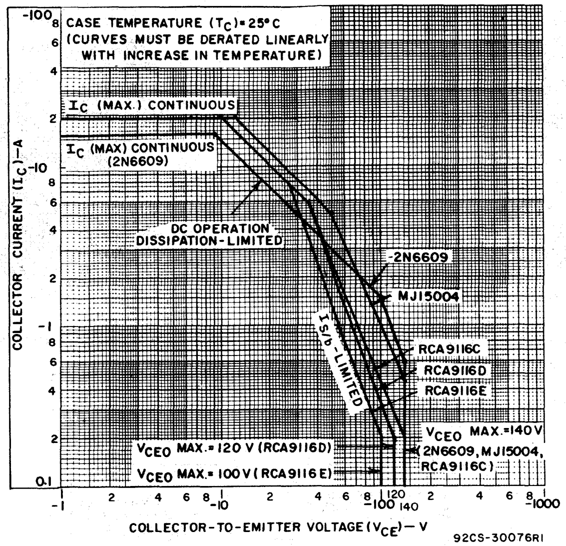


Fig. 1 - Maximum operating areas for all types.

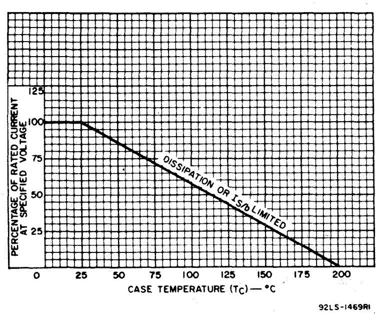


Fig. 2 - Current derating curve for all types.

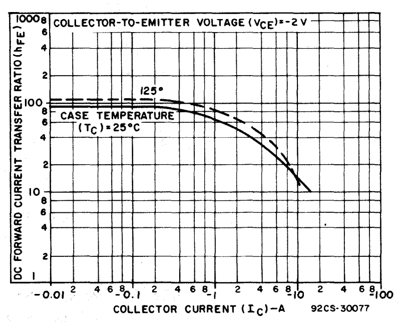


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

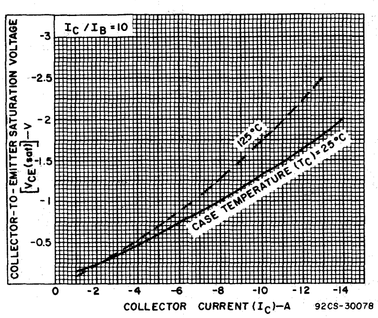


Fig. 4 - Typical saturation voltage characteristics for all types.

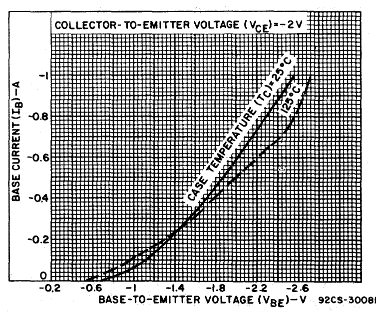


Fig. 5 - Typical input characteristics for all types.

2N6609, MJ15004, RCA9116C, RCA9116D, RCA9116E

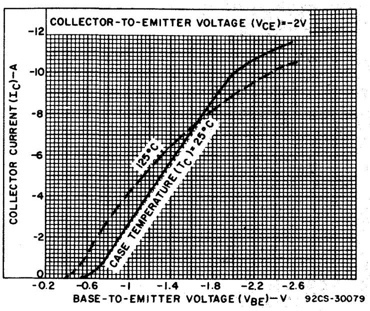


Fig. 6 - Typical transfer characteristics for all types.

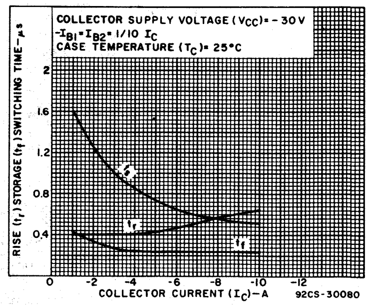


Fig. 7 - Typical saturated-switching times for all types.

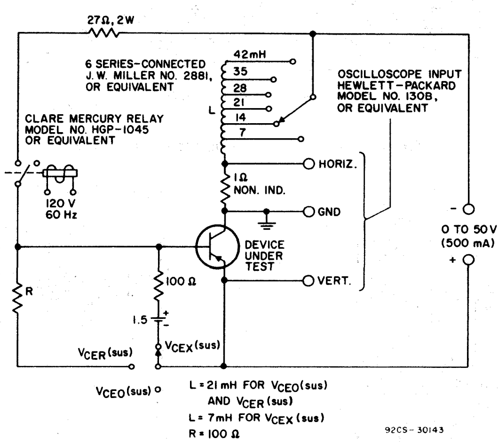


Fig. 8 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

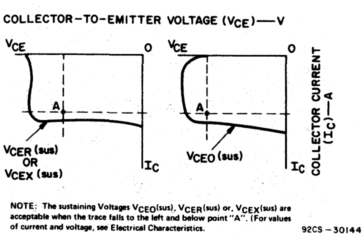


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

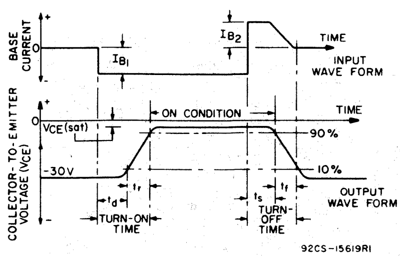


Fig. 10 - Oscilloscope display for measurement of switching times for all types.

File Number **1013**

2N6648, 2N6649, 2N6650

10-Ampere P-N-P Darlington Power Transistors

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

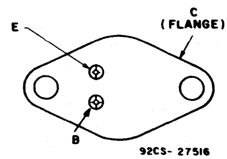
Features:

- **Operates from IC without predriver**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

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.

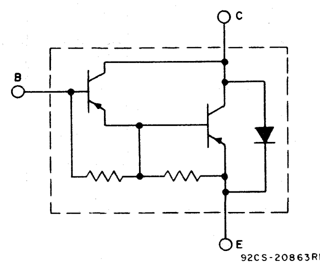


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6648	2N6649	2N6650	
*	V_{CBO}	−40	−60	−80	V
	$V_{CER}(sus)$ $R_{BE} = 100\ \Omega$	−40	−60	−80	V
*	$V_{CEO}(sus)$	−40	−60	−80	V
	$V_{CEV}(sus)$ $V_{BE} = -1.5$ V	−40	−60	−80	V
*	V_{EBO}	−5	−5	−5	V
*	I_C	−10	−10	−10	A
	I_{CM}	−15	−15	−15	A
*	I_B	−0.25	−0.25	−0.25	A
*	P_T				
	$T_C \leq 25°C$	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 ≥ 1/32 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 V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6648 MIN.	MAX.	2N6649 MIN.	MAX.	2N6650 MIN.	MAX.	UNITS
I_{CEO}	−40			0	–	−1	–	–	–	–	mA
	−60			0	–	–	–	−1	–	–	
	−80			0	–	–	–	–	–	−1	
* I_{CEV}	−40	1.5			–	−0.3	–	–	–	–	
	−60	1.5			–	–	–	−0.3	–	–	
	−80	1.5			–	–	–	–	–	−0.3	
T_C = 150°C	−40	1.5			–	−3	–	–	–	–	
	−60	1.5			–	–	–	−3	–	–	
	−80	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		−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	
	−3		−10[a]		–	−4.5*	–	−4.5*	–	−4.5*	V
V_{CE}(sat)			−5[a]	−0.01[a]	–	−2	–	−2	–	−2	
			−10[a]	−0.1[a]	–	−3*	–	−3*	–	−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				−1	–	−1	–	−1	–	
	−25				−2.8	–	−2.8	–	−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%.

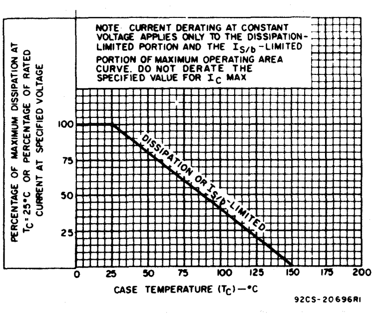


Fig.2 — Derating curve for all types.

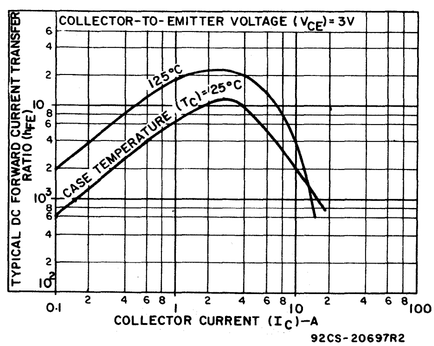


Fig. 3 — Typical dc beta characteristics for all types.

2N6648, 2N6649, 2N6650

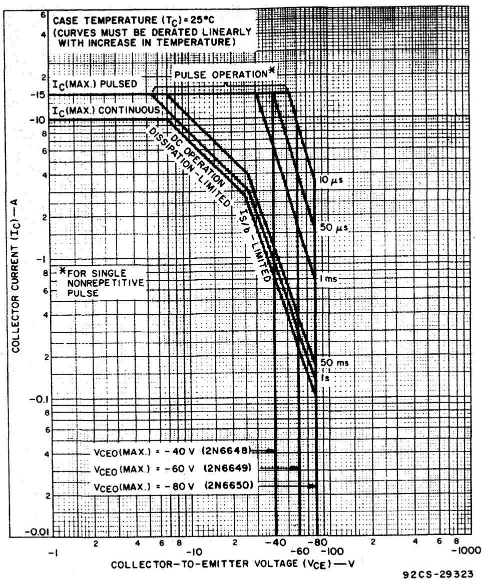


Fig. 4 — Maximum operating areas for all types.

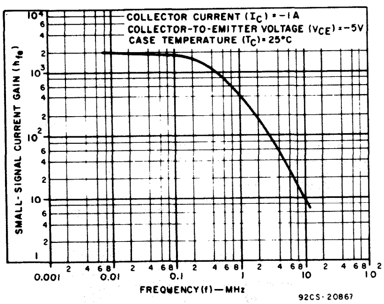


Fig. 5 — Typical small-signal gain for all types.

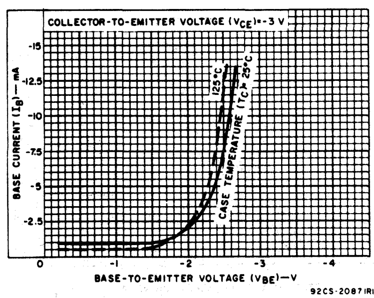


Fig. 6 — Typical input characteristics for all types.

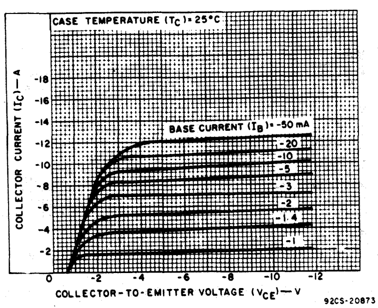


Fig. 7 — Typical output characteristics for all types.

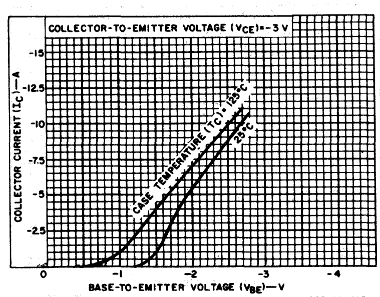


Fig. 8 — Typical transfer characteristics for all types.

2

2N6648, 2N6649, 2N6650

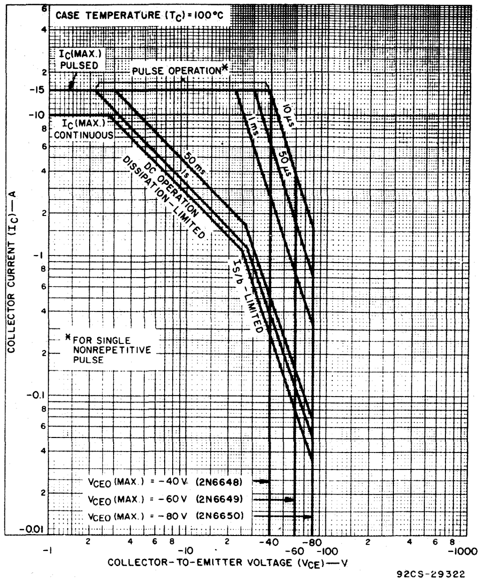


Fig. 9 — Maximum operating areas for all types at T_C = 100° C.

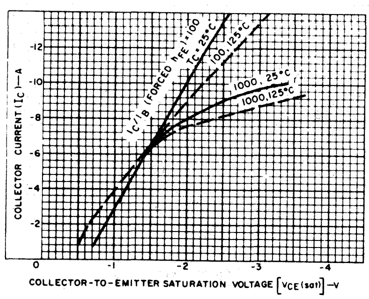


Fig. 10 — Typical saturation characteristics for all types.

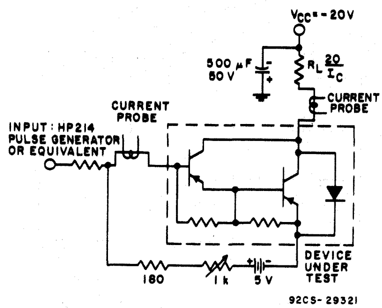


Fig. 11 — Circuit used to measure saturated switching times.

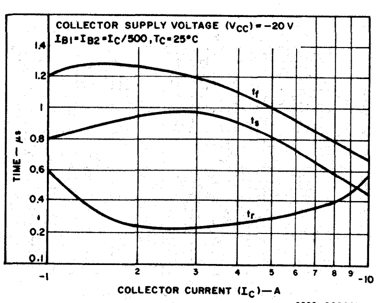


Fig. 12 — Typical saturated switching-time characteristics for all types.

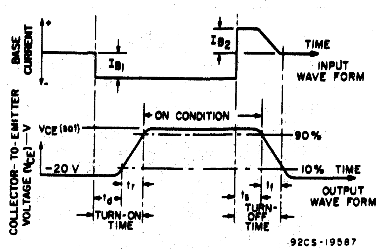


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching times.

File Number **1069**

2N6666, 2N6667, 2N6668

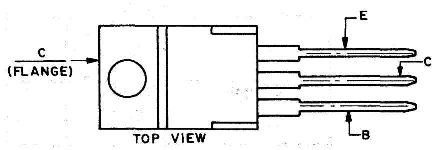
10-Ampere P-N-P Darlington Power Transistors

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.

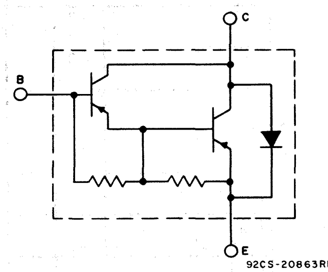


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6666	2N6667	2N6668	
*	V_{CBO}	−40	−60	−80	V
	$V_{CER}(sus)$ $R_{BE} = 100\ \Omega$	−40	−60	−80	V
	$V_{CEO}(sus)$	−40	−60	−80	V
	$V_{CEV}(sus)$ $V_{BE} = -1.5$ V	−40	−60	−80	V
*	V_{EBO}	−5	−5	−5	V
*	I_C	−8	−10	−10	A
	I_{CM}	−15	−15	−15	A
*	I_B	−0.25	−0.25	−0.25	A
*	P_T				
	$T_C \leq 25°C$	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	–	
* $\lvert h_{fe} \rvert$ 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).

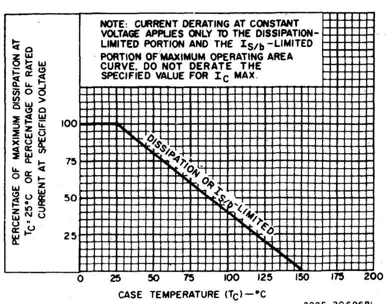


Fig. 2 — Derating curve for all types.

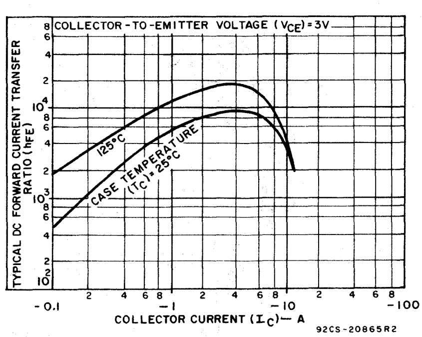


Fig. 3 — Typical dc beta characteristics for all types.

2N6666, 2N6667, 2N6668

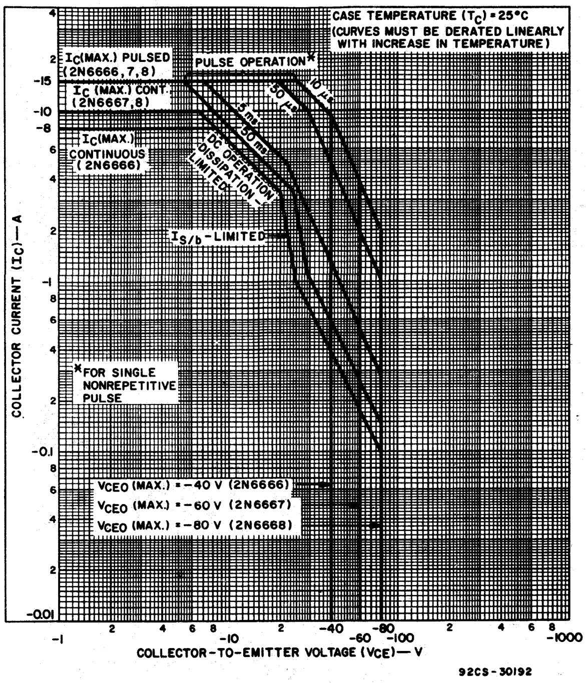


Fig. 4 — Maximum operating areas for all types at T_C = 25° C.

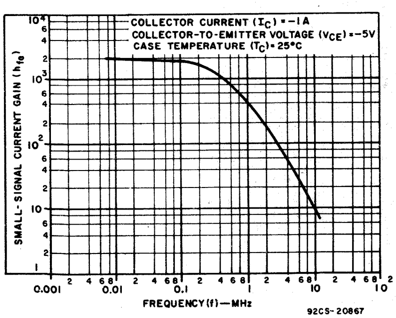


Fig. 5 — Typical small-signal gain for all types.

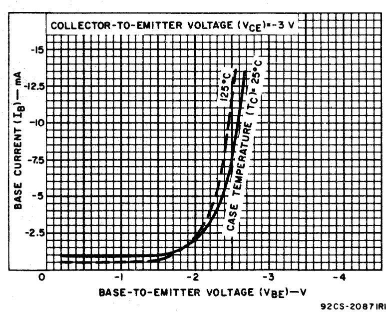


Fig. 6 — Typical input characteristics for all types.

2N6666, 2N6667, 2N6668

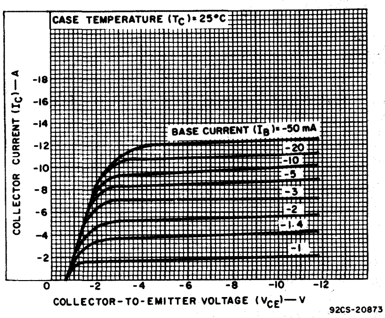


Fig. 7 — Typical output characteristics for all types.

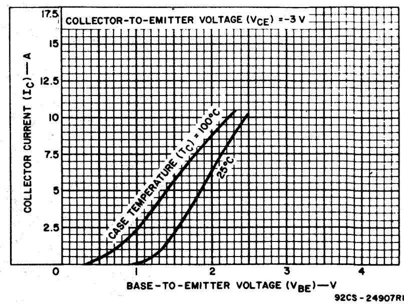


Fig. 8 — Typical transfer characteristics for all types.

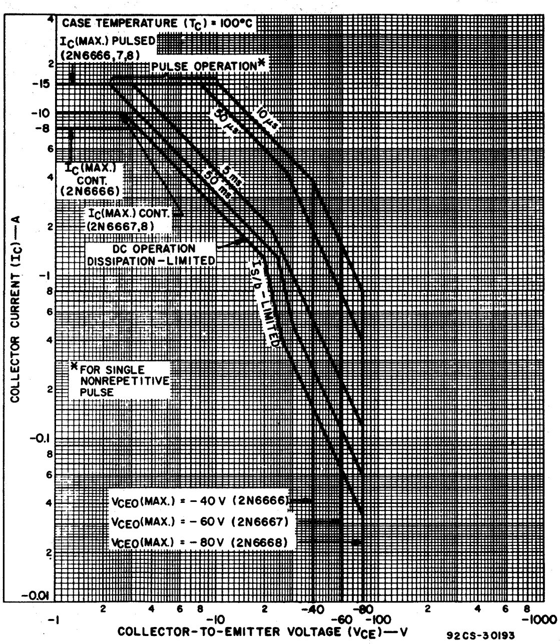


Fig. 9 — Maximum operating areas for all types $T_C = 100°C$.

2N6666, 2N6667, 2N6668

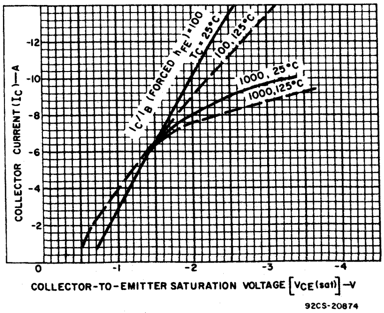


Fig. 10 — Typical saturation characteristics for all types.

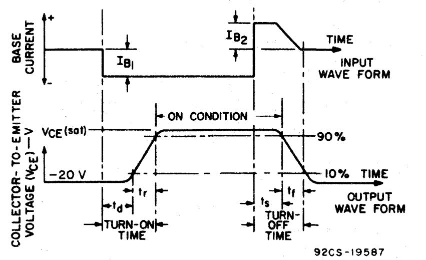


Fig. 11 — Phase relationship between input current and output current showing reference points for specification of switching times.

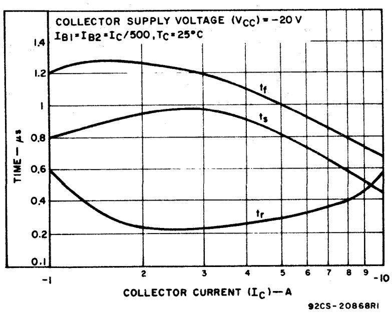


Fig. 12 — Typical saturated switching-time characteristics for all types.

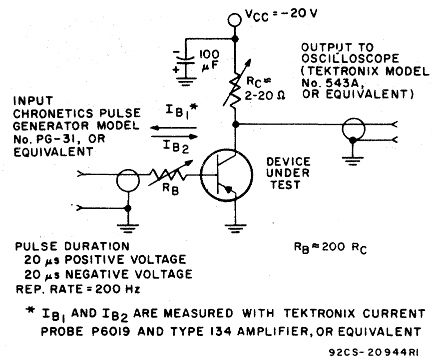


Fig. 13 — Circuit used to measure saturated switching times.

2

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

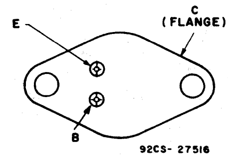
Features:

- *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*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6671, 2N6672, and 2N6673• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The 2N6671, 2N6672, and 2N6673 series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

•Formerly RCA8767, RCA8767A, and RCA8767B, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6671	2N6672	2N6673	
* V_{CEV}				
V_{BE} = −1.5 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.

2N6671, 2N6672, 2N6673

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6671 Min.	2N6671 Max.	2N6672 Min.	2N6672 Max.	2N6673 Min.	2N6673 Max.	UNITS
$T_C = 25^oC$											
* 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
* $V_{CE}(sat)$			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	–	
		−5	8	3[e]	200	–	250	–	300	–	
* $I_{S/b}$	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	
* 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	
$T_C = 125^oC$											
* I_{CEV}	450	−1.5			–	1	–	–	–	–	mA
	550	−1.5			–	–	–	1	–	–	
	650	−1.5			–	–	–	–	–	1	
* $V_{CE}(sat)$			5[a]	1	–	2	–	2	–	2	V
* t_r[d]			5	1	–	0.8	–	0.8	–	0.8	µs
* t_s[d]			5	1[e]	–	4	–	4	–	4	
* t_f[d]			5	1[e]	–	0.8	–	0.8	–	0.8	
* t_c V_{CC}=125 V, L=170 µH, R_C=25 Ω Collector clamped to V_{CEX}			5	1[e]	–	0.8	–	0.8	–	0.8	
* $R_{\theta JC}$					–	1.17	–	1.17	–	1.17	$^oC/W$

* 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] $I_{B_1} = -I_{B_2}$.

2

2N6671, 2N6672, 2N6673

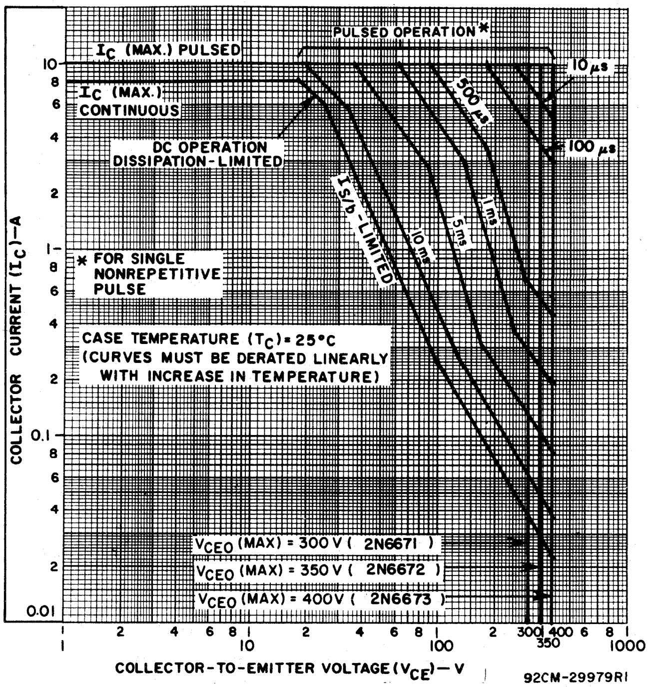


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

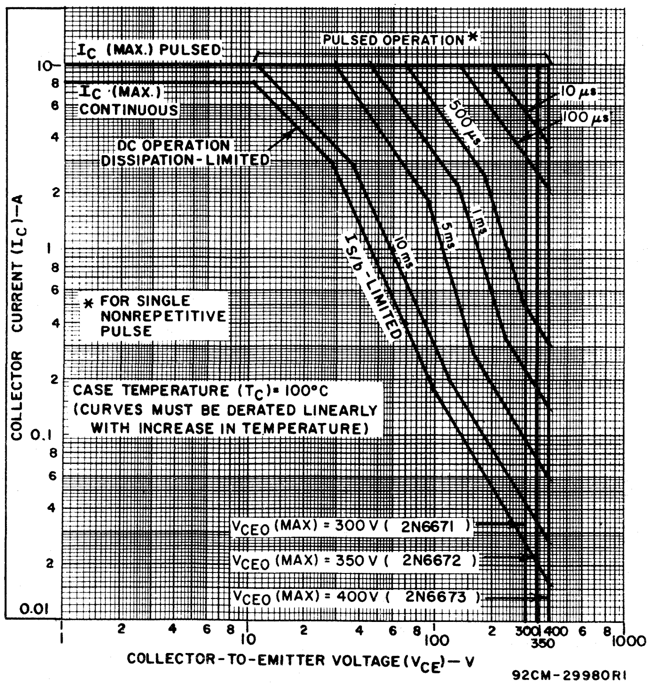


Fig. 2 — Maximum operating areas for all types (T_C =100° C).

2N6671, 2N6672, 2N6673

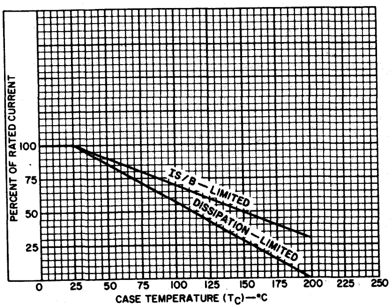


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

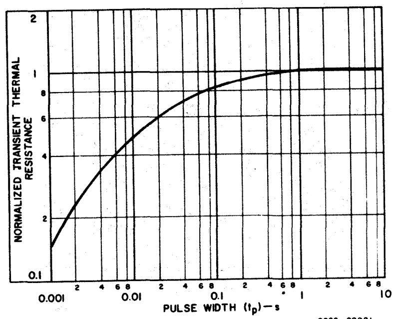


Fig. 4 — Typical thermal-response characteristic for all types.

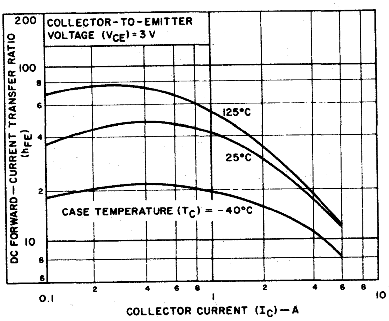


Fig. 5 — Typical dc beta characteristics for all types.

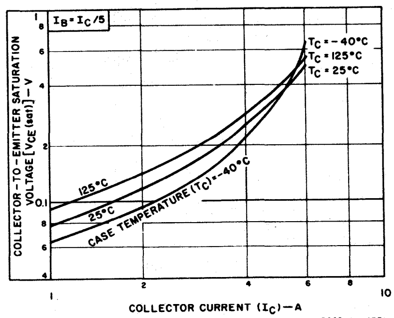


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

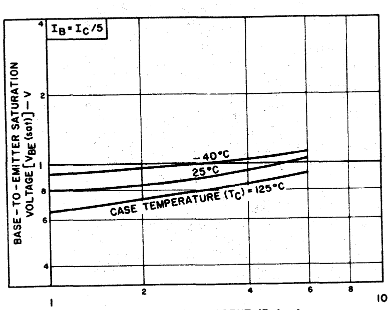


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

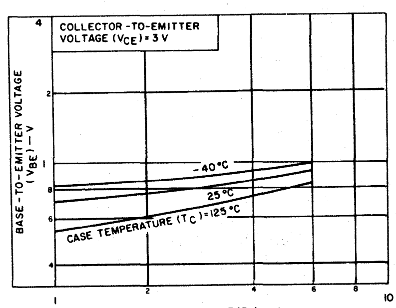


Fig. 8 — Typical base-to-emitter voltage as a function of collector current for all types.

2N6671, 2N6672, 2N6673

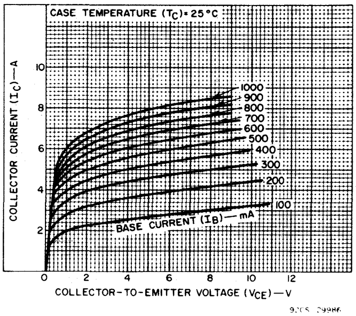


Fig. 9 — Typical output characteristics for all types.

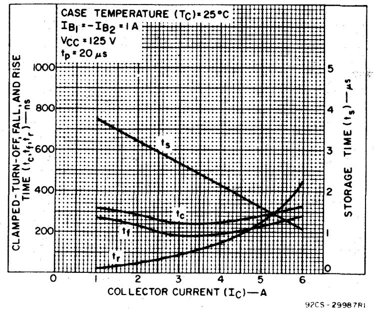


Fig. 10 — Typical saturated switching time characteristics for all types.

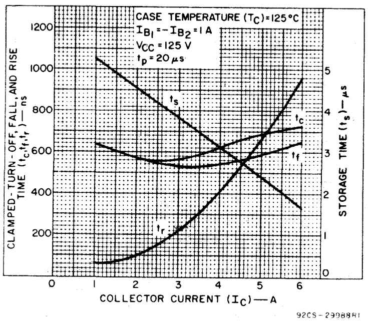


Fig. 11 — Typical saturated switching time characteristics for all types.

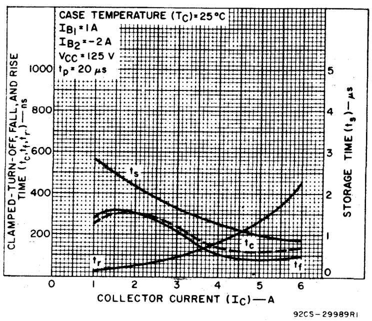


Fig. 12 — Typical saturated switching time characteristics for all types.

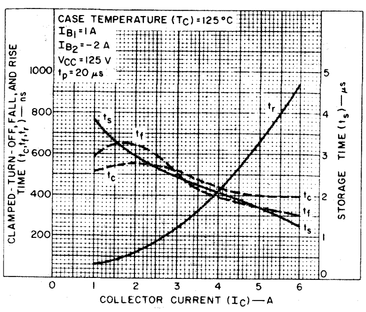


Fig. 13 — Typical saturated switching time characteristics for all types.

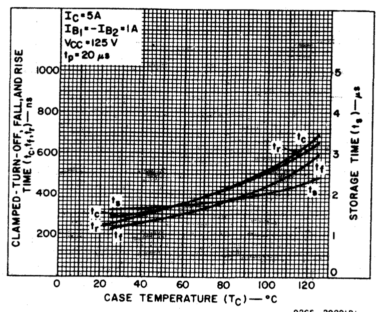


Fig. 14 — Typical saturated switching time characteristics as a function of

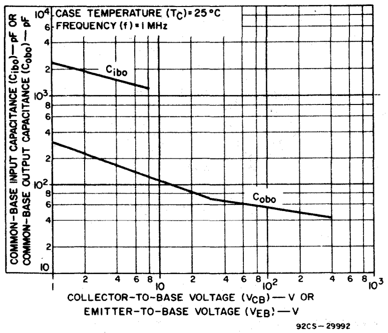


Fig. 15 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

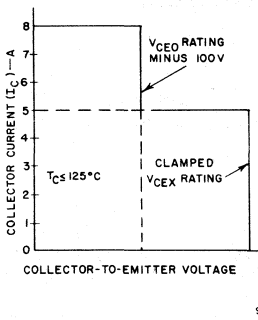


Fig. 16 — Maximum operating conditions for switching between saturation and cutoff.

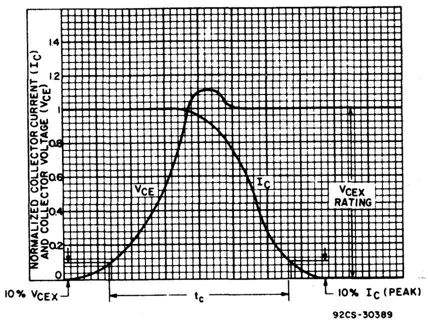


Fig. 17 — Oscilloscope display for measurement of clamped induction switching time (t_c).

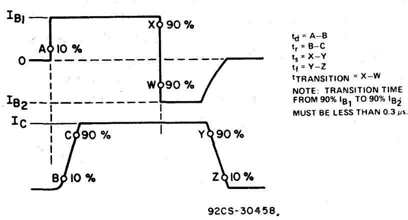


Fig. 18 — Phase relationship between input and output currents showing reference points for specification of switching times.

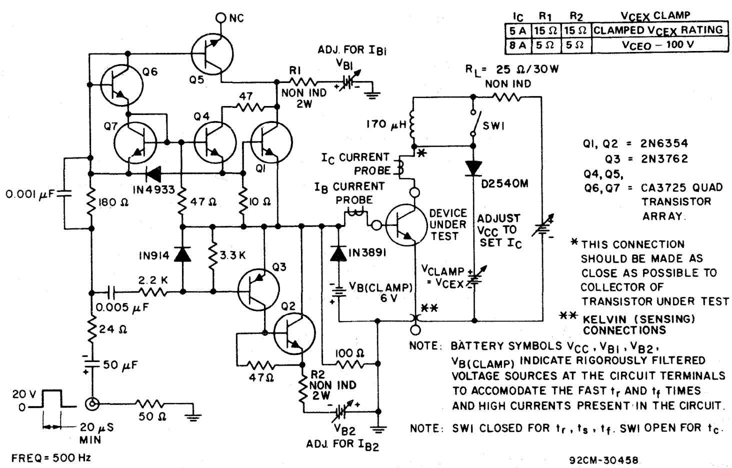


Fig. 19 — Circuit for measuring switching times.

2N6674, 2N6675, RJH6674, RJH6675

File Number **1164**

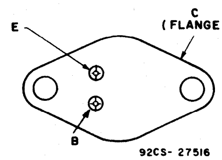
10-A *SwitchMax* Power Transistors

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

Features:
- *Fast switching speed*
- *High voltage ratings: V_{CEX}=350 V to 450 V*
- *Low $V_{CE}(sat)$ at I_C=10 A*

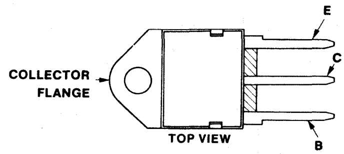
Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



2N6674
2N6675

JEDEC TO-204AA



RJH6674
RJH6675

JEDEC TO-218AC

92CS-40257

The 2N6674, 2N6675, RJH6674, and RJH6675 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The 2N6674 and 2N6675 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The RJH6674 and RJH6675 transistors are supplied in JEDEC TO-218AC plastic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RJH6674	RJH6675		2N6674	2N6675	
*V_{CEV}						
V_{BE}=-1.5 V	450	650		450	650	V
*V_{CEX}(Clamped)						
V_{BE}=-1.5 V	350	450		350	450	V
*V_{CEO}	300	400		300	400	V
*V_{EBO}			7			V
I_C(sat)			10			A
*I_C			15			A
I_{CM}			20			A
*I_B			5			A
*P_T						
T_C up to 25° C			175			W
T_C above 25°C, derate linearly	1.4	1.4		1	1	W/°C
*T_{stg}, T_J	-65 to 150			-65 to 200		°C
*T_L						
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max				235		°C
TL						
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max	235					°C

*In accordance with JEDEC registration data (2N6674, 2N6675 only).

2N6674, 2N6675, RJH6674, RJH6675

ELECTRICAL CHARACTERISTICS

	CHARACTERISTIC	TEST CONDITIONS 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}.

2

2N6674, 2N6675, RJH6674, RJH6675

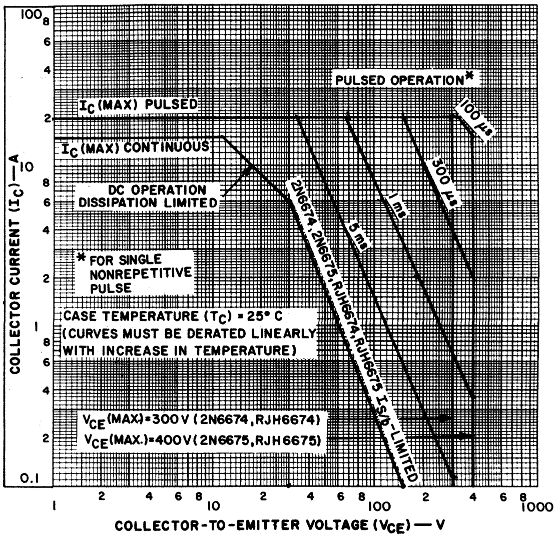


Fig. 1 - Maximum operating areas for all types (T_C=25° C).

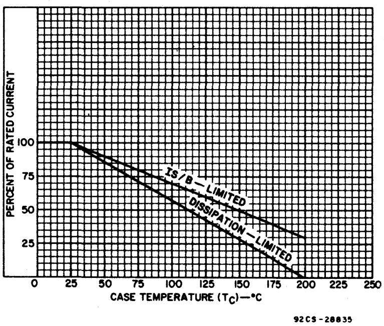


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for 2N6674 and 2N6675.

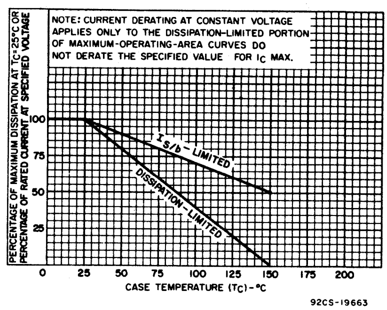


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for RJH6674 and RJH6675.

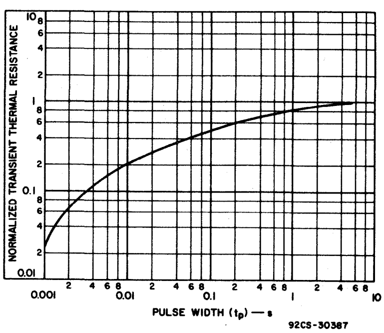


Fig. 4 - Typical thermal-response characteristic for all types.

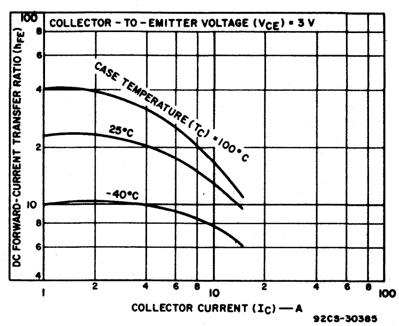


Fig. 5 - Typical dc beta characteristics for all types.

2N6674, 2N6675, RJH6674, RJH6675

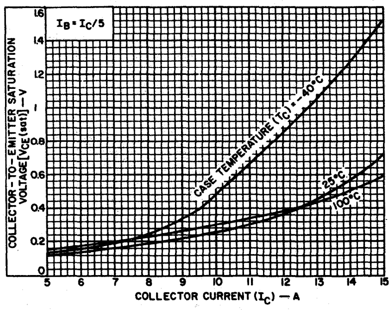


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

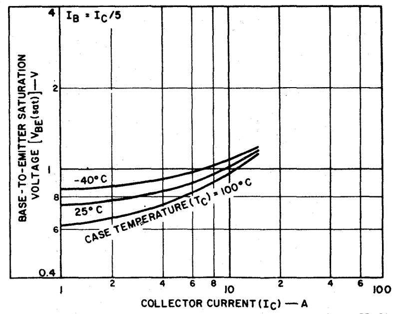


Fig. 7 - Typical base-to-emitter saturation voltage characteristics for all types.

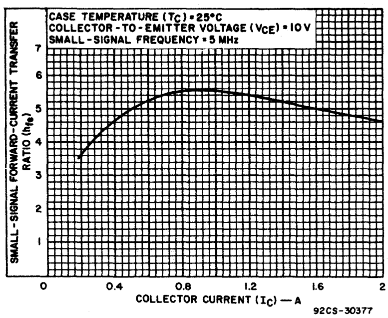


Fig. 8 - Typical small-signal forward current transfer ratio characteristic for all types (f=5 MHz).

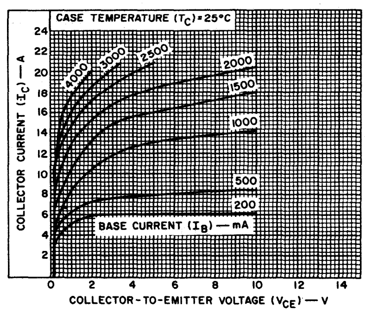


Fig. 9 - Typical output characteristics for all types.

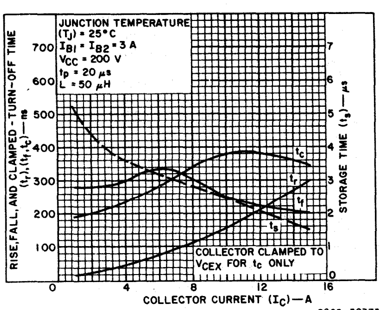


Fig. 10 - Typical saturated-switching-time characteristics at T_J=25° C as a function of collector current for all types.

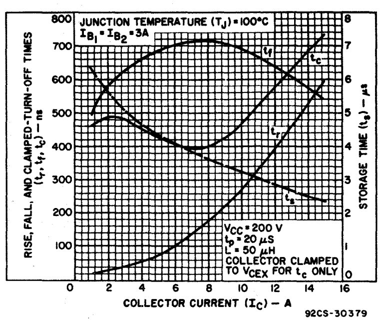


Fig. 11 - Typical saturated-switching-time characteristics at T_J=100° C as a function of collector current for all types.

2N6674, 2N6675, RJH6674, RJH6675

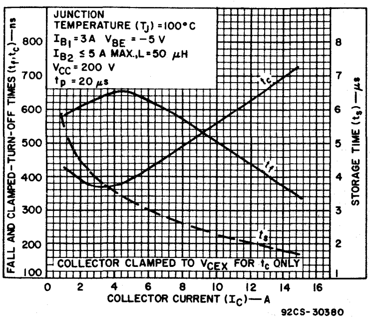


Fig. 12 - Typical saturated-switching-time characteristics at T_J=100°C as a function of collector current for all types.

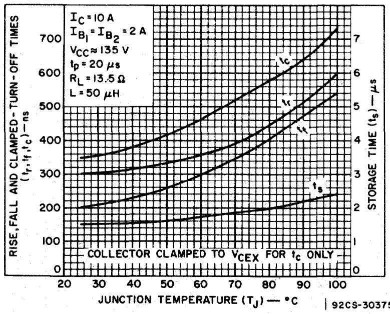


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

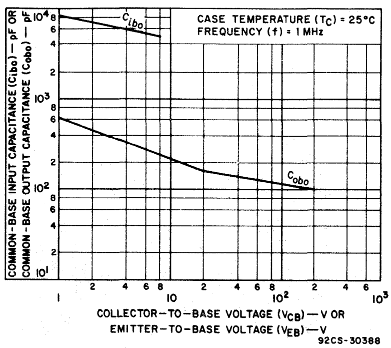


Fig. 14 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

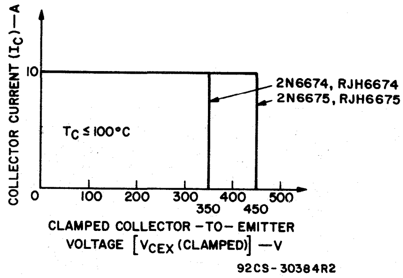


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

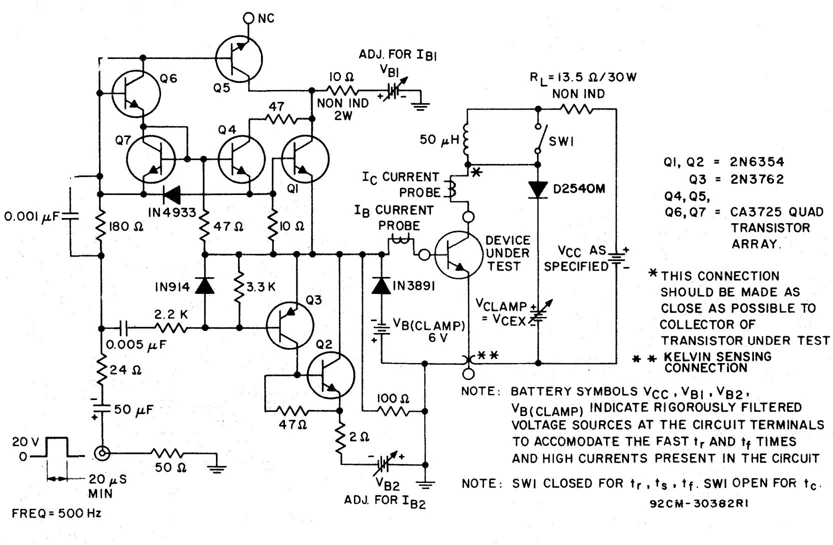


Fig. 16 - Circuit for measuring switching times.

2N6674, 2N6675, RJH6674, RJH6675

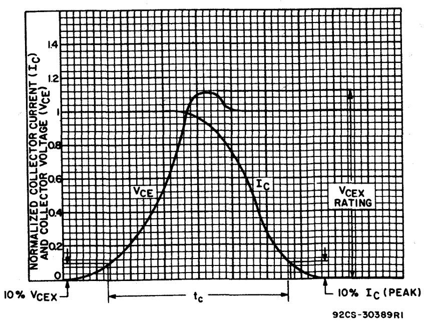


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

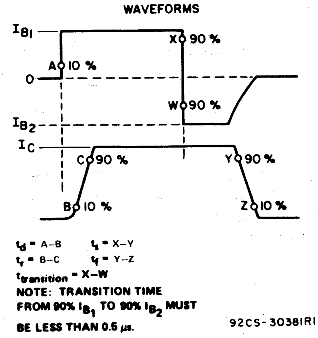


Fig. 18 - Phase relationship between input and output currents showing reference points for specification of switching times.

2

2N6676, 2N6677, 2N6678, RJH6676, RJH6677, RJH6678 File Number **1165**

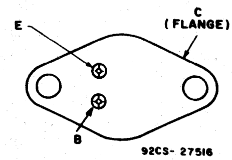
15-A *SwitchMax* Power Transistors

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*

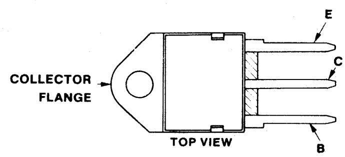
Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



2N6676
2N6677
2N6678

JEDEC TO-204AA



RJH6676
RJH6677
RJH6678

JEDEC TO-218AC

92CS-40257

The 2N6676, 2N6677 and 2N6678, RJH6676, RJH6677, and RJH6678 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The 2N6676, 2N6677, and 2N6678 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The RJH6676, RJH6677, and RJH6678 transistors are supplied in JEDEC TO-218AC plastic packages.

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 VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6676 RJH6676 Min.	Max.	2N6677 RJH6677 Min.	Max.	2N6678 RJH6678 Min.	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
* 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

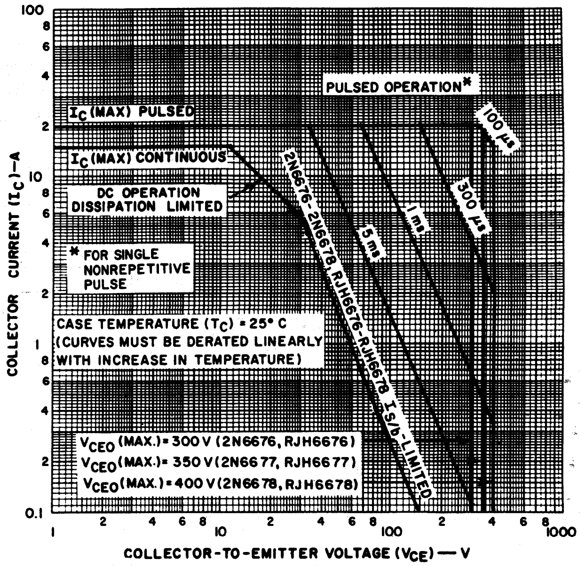


Fig. 1 - Maximum operating areas for all types (T_C = 25° C).

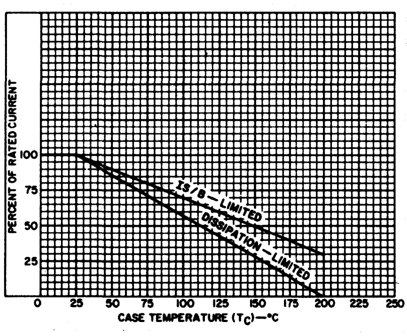


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for 2N6676, 2N6677, and 2N6678.

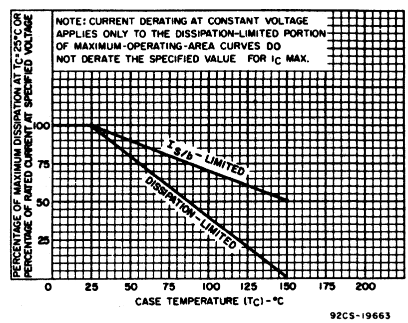


Fig. 3 - Dissipation and $I_{S/b}$ derating curves for RJH6676, RJH6677, and RJH6678.

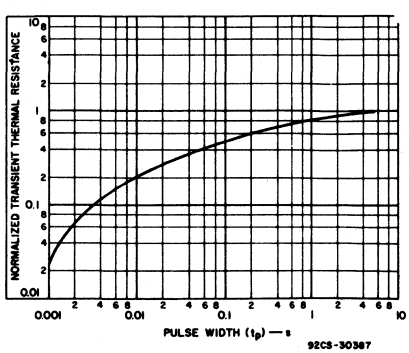


Fig. 4 - Typical thermal-response characteristic for all types.

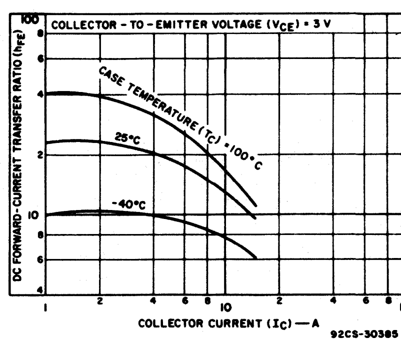


Fig. 5 - Typical dc beta characteristics for all types.

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

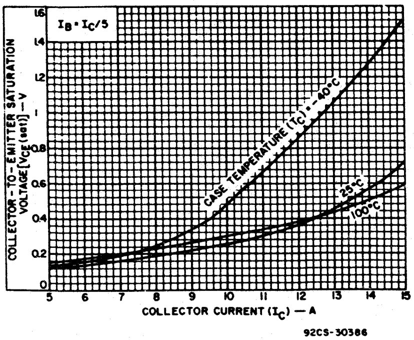


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

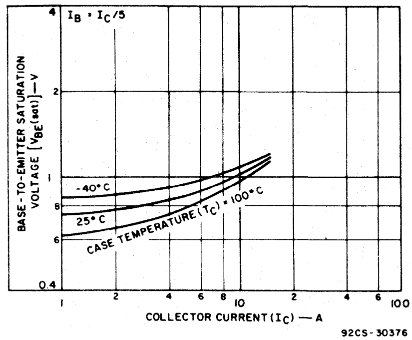


Fig. 7 - Typical base-to-emitter saturation voltage characteristics for all types.

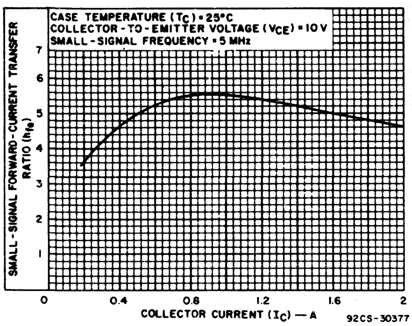


Fig. 8 - Typical small-signal forward current transfer ratio characteristic for all types (f = 5 MHz).

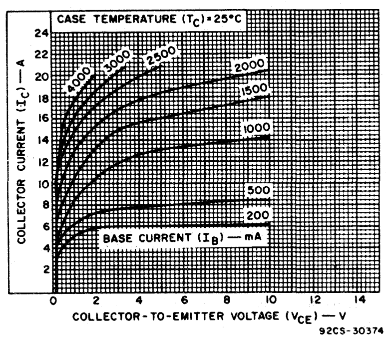


Fig. 9 - Typical output characteristics for all types.

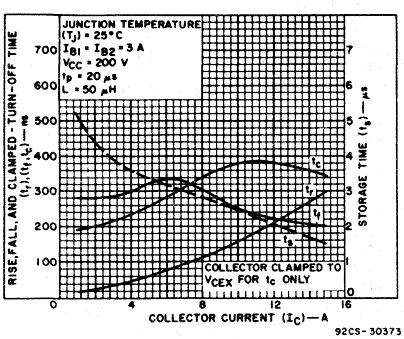


Fig. 10 - Typical saturated-switching-time characteristics at T_J = 25° C as a function of collector current for all types.

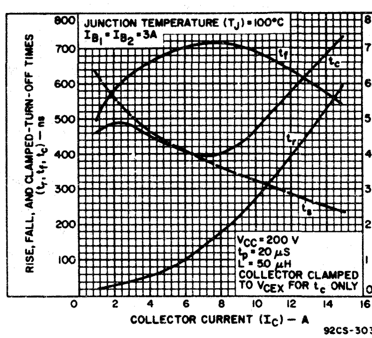


Fig. 11 - Typical saturated-switching-time characteristics at T_J = 100° C as a function of collector current for all types.

2

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

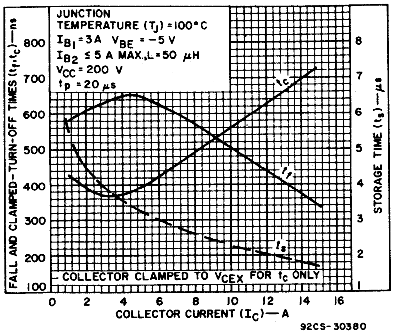


Fig. 12 - Typical saturated-switching-time characteristics at T_J = 100° C as a function of collector current for all types.

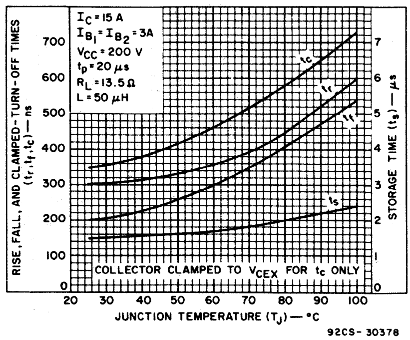


Fig. 13 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

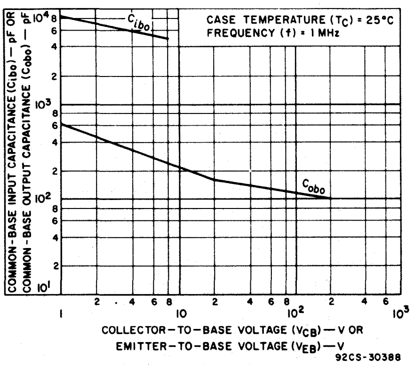


Fig. 14 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

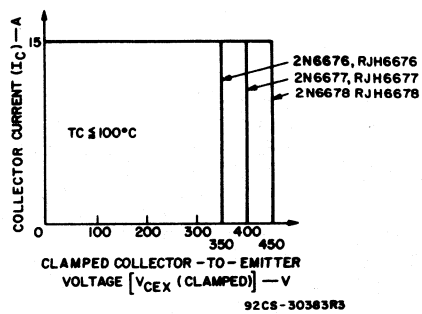


Fig. 15 - Maximum operating conditions for switching between saturation and cutoff for all types.

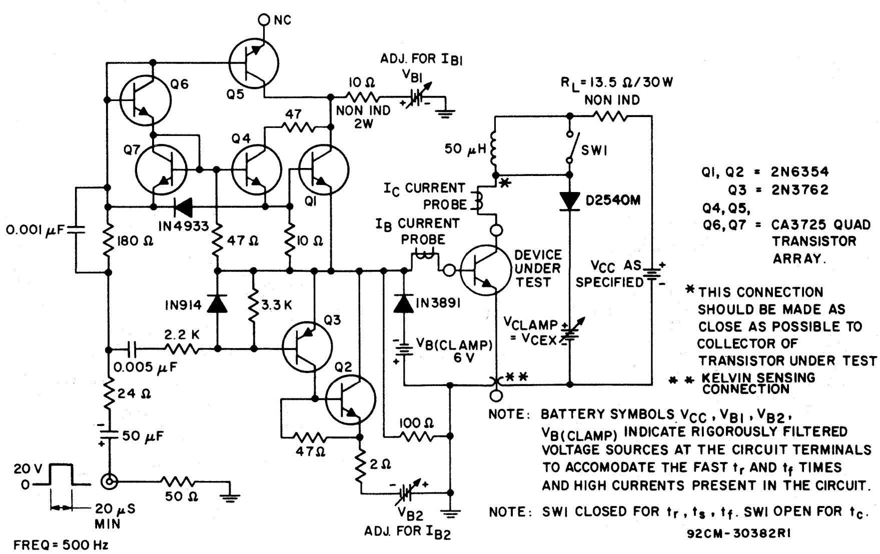


Fig. 16 - Circuit for measurement switching times.

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

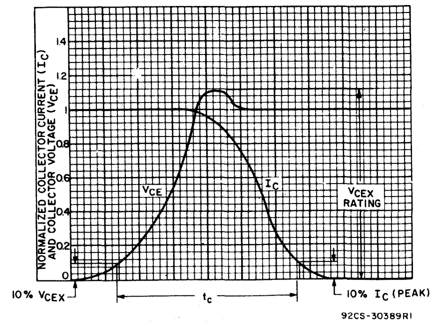


Fig. 17 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

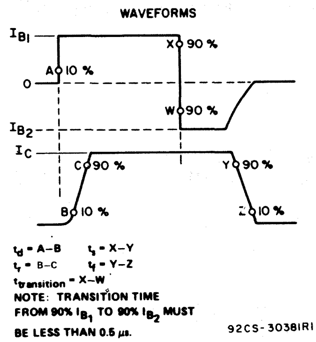


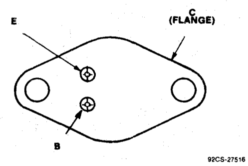
Fig. 18 - Phase relationship between input and output currents showing reference points for specification of switching times.

2

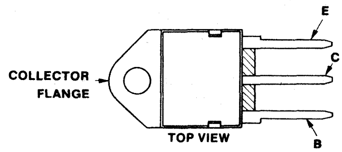
2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

File Number **1171**

TERMINAL DESIGNATIONS



JEDEC TO-204AA



JEDEC TO-218AC

92CS-40257

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 $V_{CE}(sat)$*

The RCA 2N6686, 2N6687 and 2N6688•, RJH6686, RJH6687, and RJH6688 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits. These high-current, high-speed transistors are 100-percent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C as well as at 25°C, to provide information necessary for worst-case design.

The 2N6686, 2N6687, and 2N6688 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The RJH6686, RJH6687, and RJH6688 transistors are supplied in JEDEC TO-218AC plastic packages.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

<table>
<tr><th></th><th>RJH6686</th><th>RJH6687</th><th>RJH6688</th><th>2N6686</th><th>2N6687</th><th>2N6688</th><th></th></tr>
<tr><td>* V_{CEV} V_{BE} = -1.5 V</td><td>260</td><td>280</td><td>300</td><td>260</td><td>280</td><td>300</td><td>V</td></tr>
<tr><td>* V_{CEX} (Clamped) V_{BE} = -1.5 V</td><td>210</td><td>230</td><td>250</td><td>210</td><td>230</td><td>250</td><td>V</td></tr>
<tr><td>* V_{CEO}</td><td>160</td><td>180</td><td>200</td><td>160</td><td>180</td><td>200</td><td>V</td></tr>
<tr><td>* V_{EBO}</td><td colspan="6">8</td><td>V</td></tr>
<tr><td>I_C(sat)</td><td>25</td><td>25</td><td>20</td><td>25</td><td>25</td><td>20</td><td>A</td></tr>
<tr><td>* I_C</td><td>25</td><td>25</td><td>20</td><td>25</td><td>25</td><td>20</td><td>A</td></tr>
<tr><td>I_{CM}</td><td colspan="6">50</td><td>A</td></tr>
<tr><td>* I_B</td><td colspan="6">8</td><td>A</td></tr>
<tr><td>* P_T T_C up to 25°C</td><td colspan="6">200</td><td>W</td></tr>
<tr><td>T_C above 25°C, derate linearly</td><td colspan="3">1.6</td><td colspan="3">1.14</td><td>W/°C</td></tr>
<tr><td>* T_{stg}, T_J</td><td colspan="3">-65 to 150</td><td colspan="3">-65 to 200</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></td><td></td><td></td><td colspan="3">235</td><td>°C</td></tr>
<tr><td>T_L At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.</td><td colspan="3">235</td><td></td><td></td><td></td><td>°C</td></tr>
</table>

* In accordance with JEDEC registration data (2N6686, 2N6687, 2N6688 only).

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

ELECTRICAL CHARACTERISTICS T_C = 25° C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686 RJH6686		2N6687 RJH6687		2N6688 RJH6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	260	-1.5	—	—	—	50	—	—	—	—	µA
	280	-1.5	—	—	—	—	—	50	—	—	µA
	300	-1.5	—	—	—	—	—	—	—	50	µA
* I_{EBO}	—	-8	0	—	—	100	—	100	—	100	µA
* 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	V
	—	—	25[a]	2.5	—	1.8	—	1.8	—	—	V
* V_{CE}(sat)	—	—	20[a]	2	—	—	—	—	—	1.5	V
	—	—	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	—	V
$I_{S/b}$ 2N6686, 2N6687, 2N6688	18	—	11.1	—	1	—	1	—	1	—	s
RJH6686, RJH6687, RJH6688	18	—	11.1	—	0.5	—	0.5	—	0.5	—	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	µs
	—	-4	25	2.5	—	0.1	—	0.1	—	—	µs
* t_r[d]	—	-4	20	2	—	—	—	—	—	0.60	µs
	—	-4	25	2.5	—	0.60	—	0.60	—	—	µs
* t_s[d]	—	-4	20	2[e]	—	—	—	—	—	1.50	µs
	—	-4	25	2.5[e]	—	1.50	—	1.50	—	—	µs
* t_f[d]	—	-4	20	2[e]	—	—	—	—	—	0.25	µs
	—	-4	25	2.5[e]	—	0.25	—	0.25	—	—	µs
* 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	µs
	—	-4	25	3[e]	—	0.5	—	0.5	—	—	µs

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

ELECTRICAL CHARACTERISTICS T_C = 25° C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686 RJH6686		2N6687 RJH6687		2N6688 RJH6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	260	-1.5	—	—	—	0.5	—	—	—	—	mA
	280	-1.5	—	—	—	—	—	0.5	—	—	mA
	300	-1.5	—	—	—	—	—	—	—	0.5	mA
$V_{CE}(sat)$	—	—	20[a]	2	—	—	—	—	—	1.5	V
	—	—	25a	2.5	—	1.5	—	1.5	—	—	V
t_r[d]	—	-4	20	2	—	—	—	—	—	0.8	μs
	—	-4	25	2.5	—	0.8	—	0.8	—	—	μs
t_s[d]	—	-4	20	2	—	—	—	—	—	2.5	μs
	—	-4	25	2.5[e]	—	2.5	—	2.5	—	—	μs
t_f[d]	—	-4	20	2	—	—	—	—	—	0.8	μs
	—	-4	25	2.5[e]	—	0.8	—	0.8	—	—	μs
t_c V_{CC} = 80 V, L = 25 μH, $R_C \leq 4\ \Omega$, Collector Clamped to V_{CEX}	—	-4	20	3[e]	—	—	—	—	—	0.8	μs
	—	-4	25	3[e]	—	0.8	—	0.8	—	—	μs
$R\theta_{JC}$ 2N6686, 2N6687, 2N6688	10	—	5	—	—	0.875	—	0.875	--	0.875	°C/W
$R\theta_{JC}$ RJH6686, RJH6687, RJH6688	10	—	5	—	—	0.625	—	0.625	—	0.625	°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 $I_{B_1} = -I_{B_2}$.

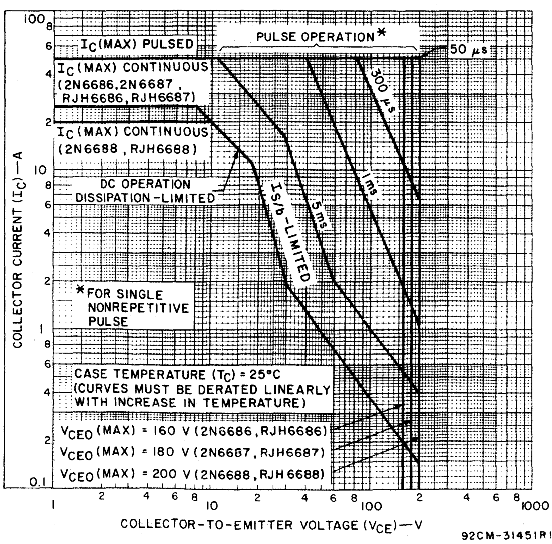


Fig. 1 - Maximum operation areas of all types. (T_C = 25°).

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

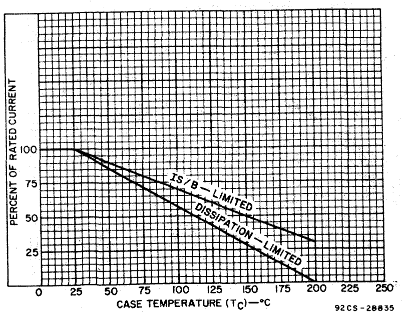


Fig. 2 - Dissipation and $I_{s/b}$ derating curves for 2N6686, 2N6687, and 2N6688.

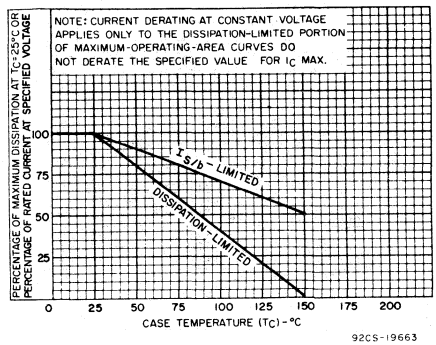


Fig. 3 - Dissipation and $I_{s/b}$ derating curves for RJH6686, RHJ6687, and RJH6688.

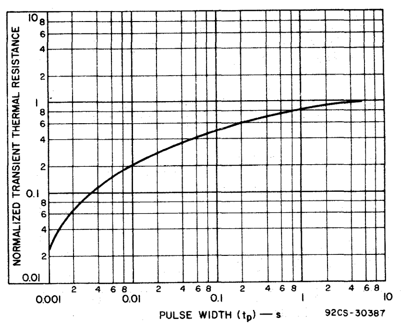


Fig. 4 - Typical thermal-response characteristic for all types.

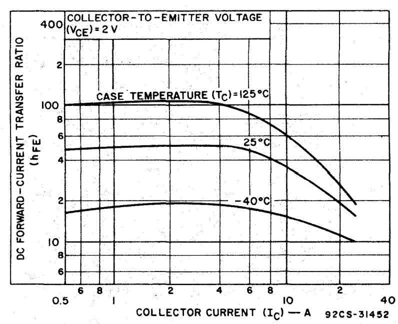


Fig. 5 - Typical dc beta characteristics for all types.

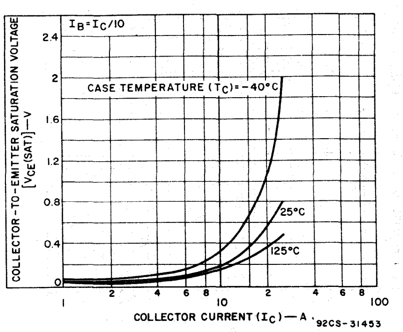


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for all types.

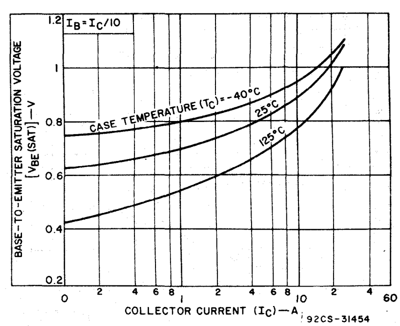


Fig. 7 - Typical base-to-emitter saturation voltage characteristic for all types.

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

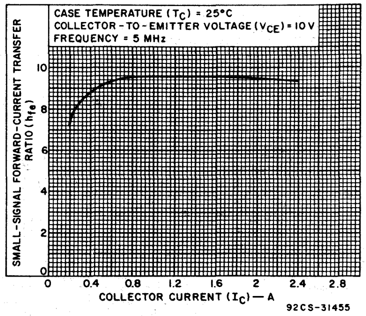


Fig. 8 - Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

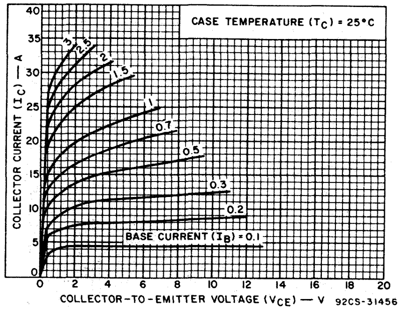


Fig. 9 - Typical output characteristics for all types.

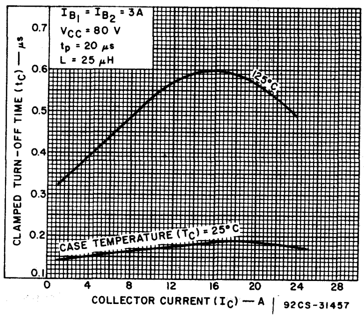


Fig. 10 - Typical clamped turn-off time characteristics for all types.

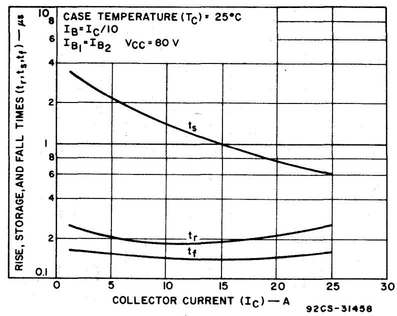


Fig. 11 - Typical saturated-switching-time characteristics as a function of collector current for all types.

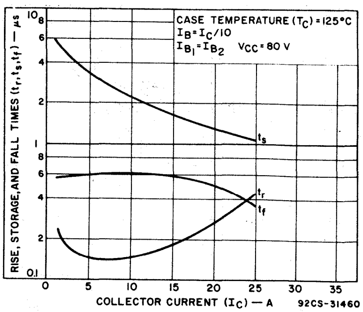


Fig. 12 - Typical saturated-switching-time characteristics at Tc = 125° C as a function of collector current for all types.

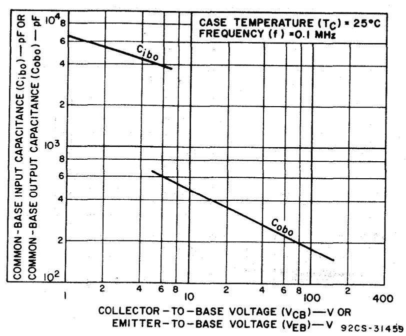


Fig. 13 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

2N6686, 2N6687, 2N6688
RJH6686, RJH6687, RJH6688

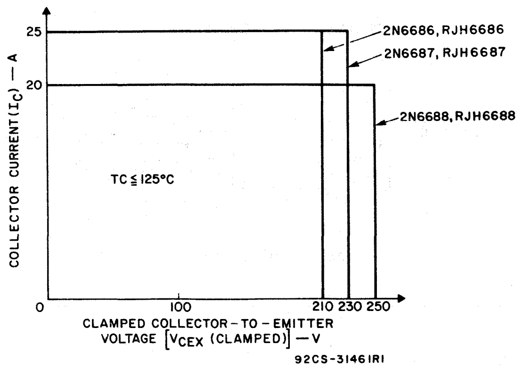


Fig. 14 - Maximum operating conditions for switching between saturation and cutoff for all types.

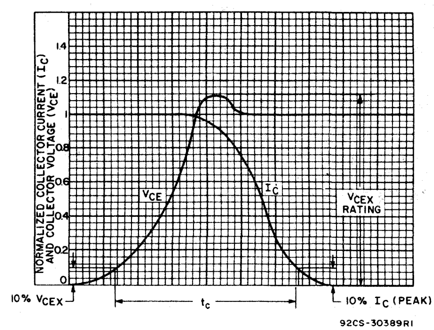


Fig. 15 - Oscilloscope display for normalized measurements of clamped inductive switching time (t_c).

2

2N6702, 2N6703, 2N6704

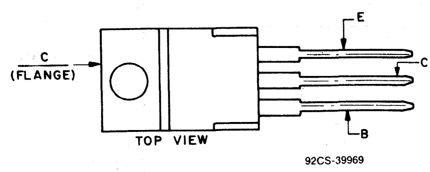
File Number **1187**

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

The 2N6702, 2N6703 and 2N6704• epitaxial-base silicon n-p-n power transistors which feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

The 2N6702, 2N6703, and 2N6704 transistors are supplied in the JEDEC TO-220AB (RCA VERSAWATT) plastic packages.

•Formerly RCA Dev. Type Nos. TA9164A, TA9164B, TA9164C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6702	2N6703	2N6704	
* V_{CEV}				
$V_{BE} = -1.5$ V	140	160	180	V
* V_{CEO}	90	110	130	V
* V_{EBO}		7		V
$I_C(sat)$	5	5	4	A
* I_C		7		A
I_{CM}		10		A
* I_B		5		A
* P_T				
T_C up to 25° C		50		W
T_C above 25° C ... 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: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6702 Min.	2N6702 Max.	2N6703 Min.	2N6703 Max.	2N6704 Min.	2N6704 Max.	UNITS
*	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
*	$V_{CE}(sat)$			4[a]	0.4	–	–	–	–	–	0.7	V
				5[a]	0.5	–	0.8	–	0.8	–	–	V
				7[a]	0.7	–	1.5	–	1.5	–	1.5	V
	$I_{S/b}$	20		2.5		1	–	1	–	1	–	s
*	$\lvert h_{fe} \rvert$ 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	–	–	µs
*	t_r[d]		−4	4	0.4	–	–	–	–	–	0.25	µs
				5	0.5	–	0.25	–	0.25	–	–	µs
*	t_s[d]		−4	4	0.4[e]	–	–	–	–	–	1	µs
				5	0.5[e]	–	1	–	1	–	–	µs
*	t_f[d]		−4	4	0.4[e]	–	–	–	–	–	0.5	µs
				5	0.5[e]	–	0.5	–	0.5	–	–	µs
*	$R_{\theta JC}$	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] $I_{B_1} = -I_{B_2}$.

2

2N6702, 2N6703, 2N6704

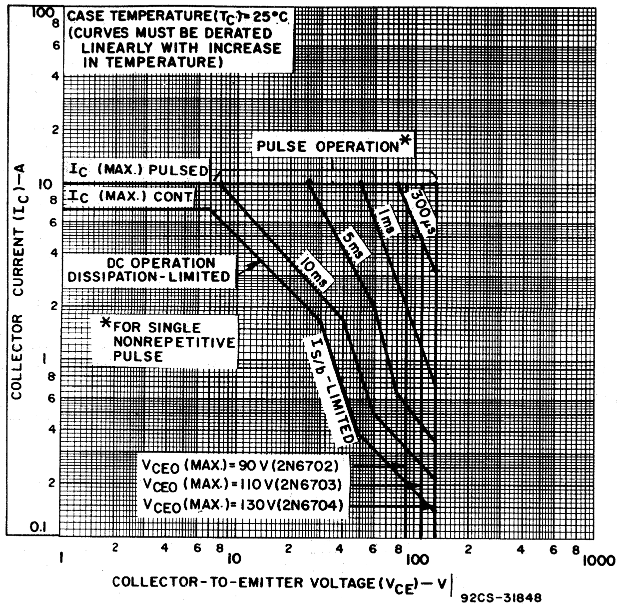


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

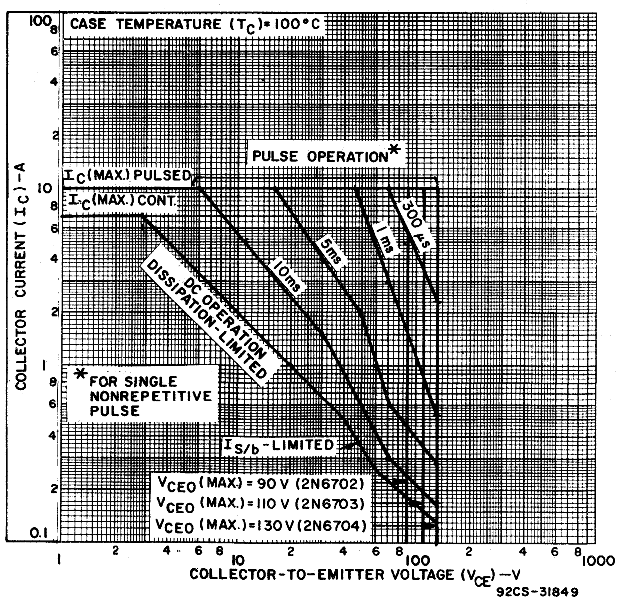


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

2N6702, 2N6703, 2N6704

2

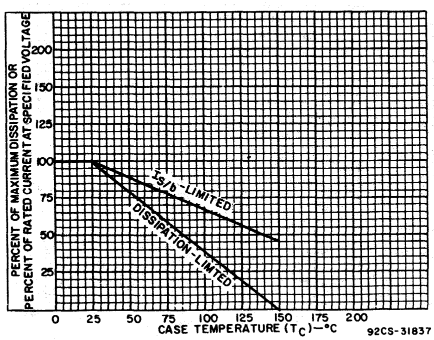


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

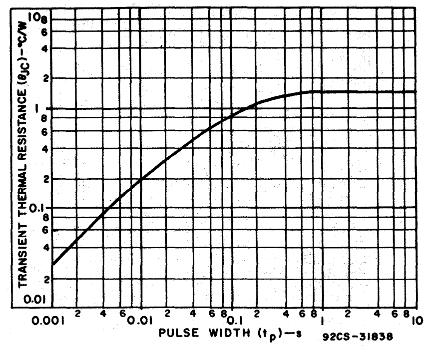


Fig. 4 — Typical thermal-response characteristic for all types.

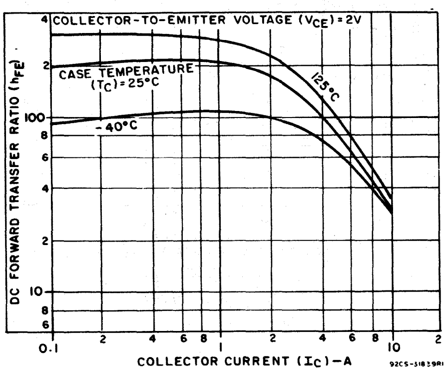


Fig. 5 — Typical dc beta characteristics for all types.

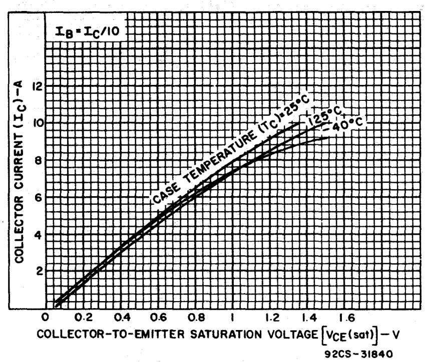


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

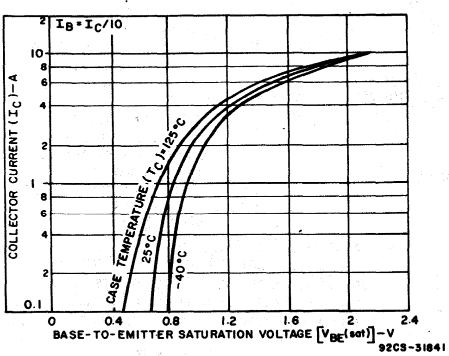


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

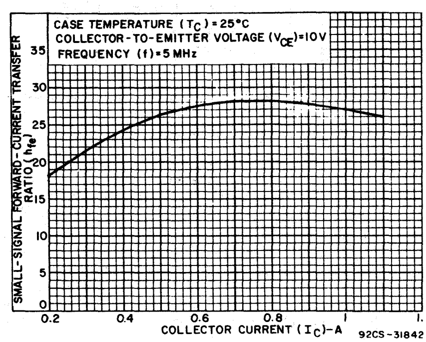


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

2N6702, 2N6703, 2N6704

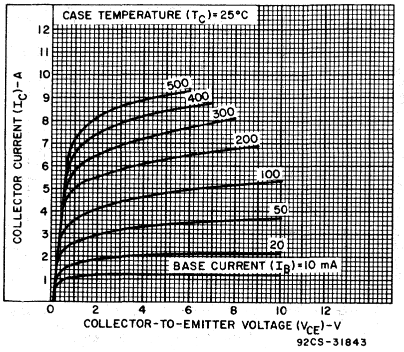


Fig. 9 — Typical output characteristics for all types.

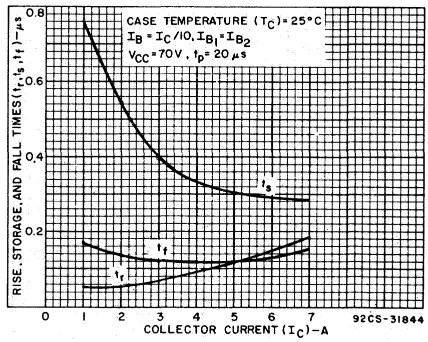


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types ($T_C = 25^\circ C$).

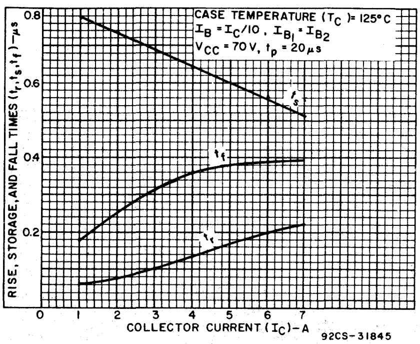


Fig. 11 — Typical saturated-switching-time characteristics as a function of collector current for all types ($T_C = 125^\circ C$).

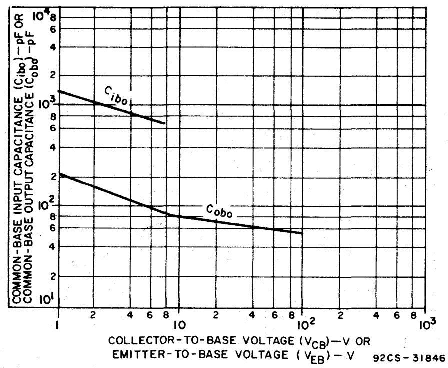


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

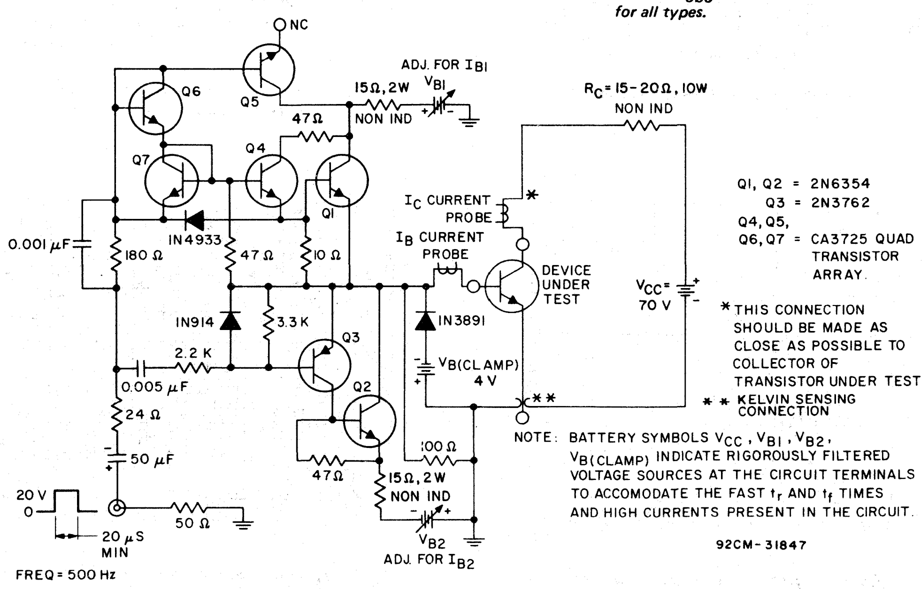
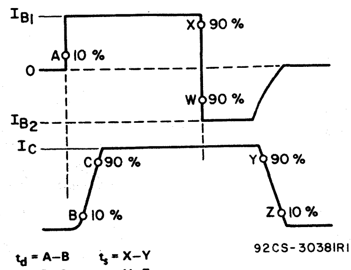


Fig. 13 — Circuit for measuring switching times.

2N6702, 2N6703, 2N6704



t_d = A–B t_s = X–Y
t_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.

2

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

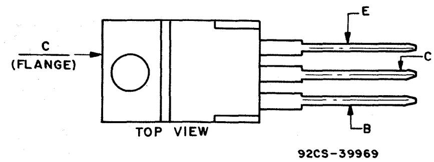
Features:

- *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 2N6738, 2N6739, and 2N6740• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

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

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6738	2N6739	2N6740	
* V_{CEV}				
$V_{BE}=-1.5$ 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

CHARAC-TERISTIC	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS 2N6738		LIMITS 2N6739		LIMITS 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
* $V_{CE}(sat)$			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	—	
		−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	
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	μs
* t_s[d]			5	1[e]	—	4	—	4	—	4	
* t_f[d]			5	1[e]	—	0.8	—	0.8	—	0.8	
* t_c V_{CC}=125 V, L=170 μH, R_C=25 Ω Collector clamped to V_{CEX}			5	1[e]	—	0.8	—	0.8	—	0.8	
* $R_{\theta JC}$	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

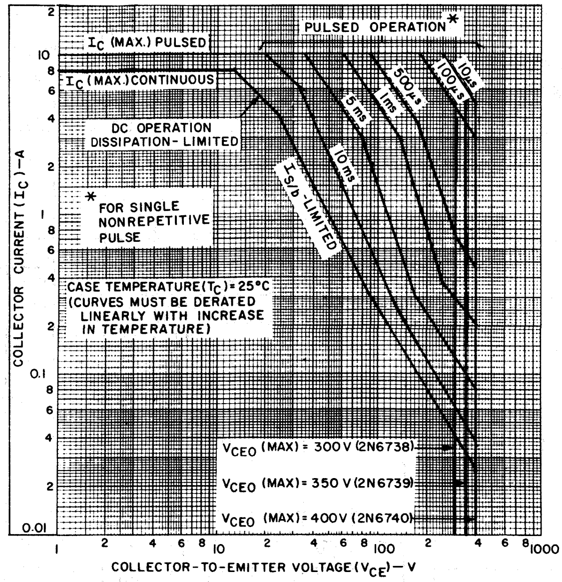


Fig. 1 — Maximum operating areas for all types (Tc = 25° C).

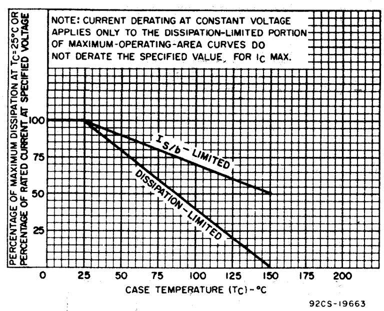


Fig. 2 — Dissipation and derating curve for all types.

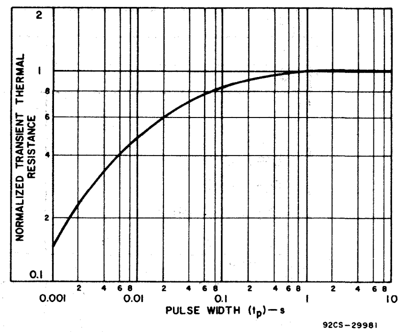


Fig. 3 — Typical thermal-response characteristic for all types.

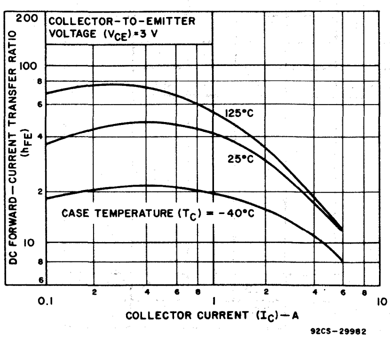


Fig. 4 — Typical dc beta characteristics for all types.

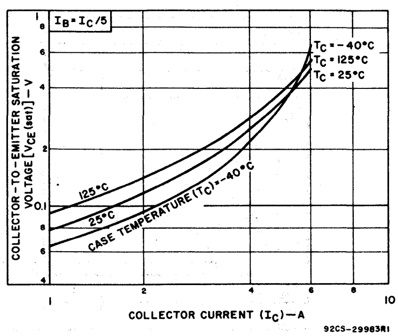


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6738, 2N6739, 2N6740

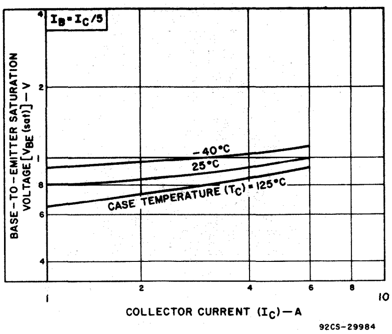


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

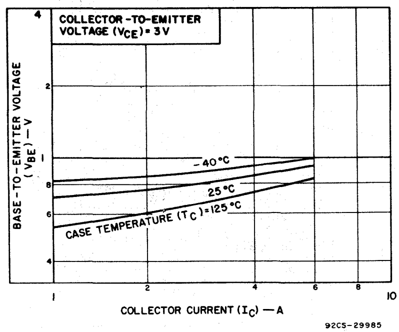


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

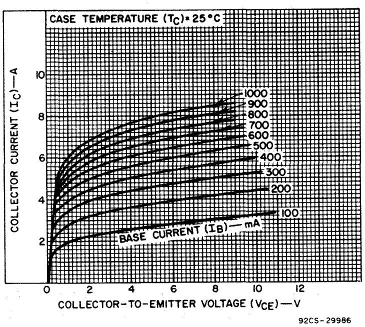


Fig. 8 — Typical output characteristics for all types.

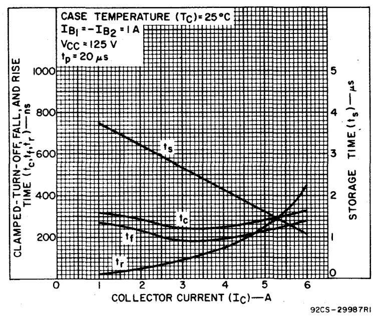


Fig. 9 — Typical saturated switching time characteristics for all types.

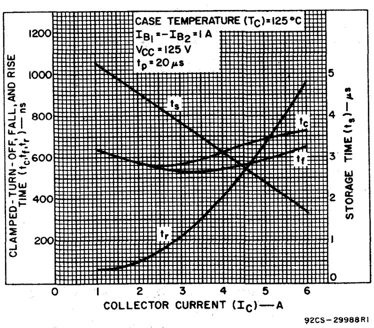


Fig. 10 — Typical saturated switching time characteristics for all types.

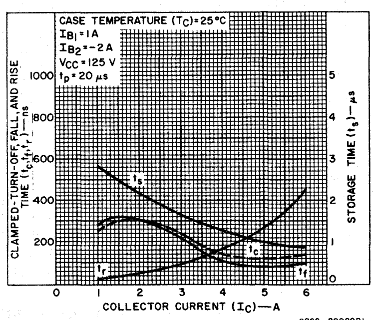


Fig. 11 — Typical saturated switching time characteristics for all types.

2

2N6738, 2N6739, 2N6740

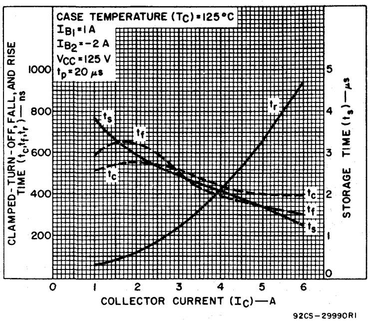


Fig. 12 — Typical saturated switching time characteristics for all types.

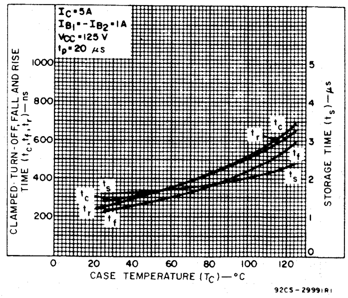


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

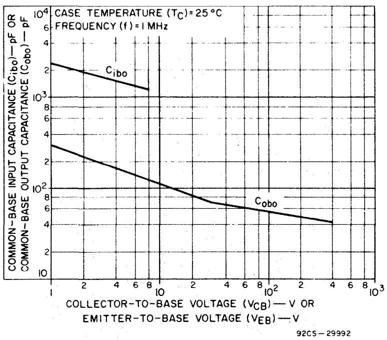


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

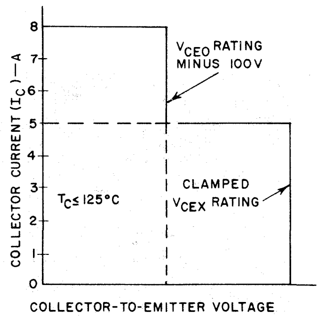


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

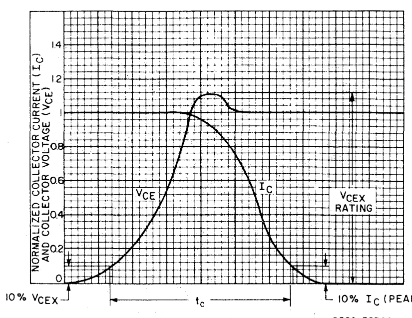


Fig. 16 — Oscilloscope display for measurement of clamped induction switching-time (t_c).

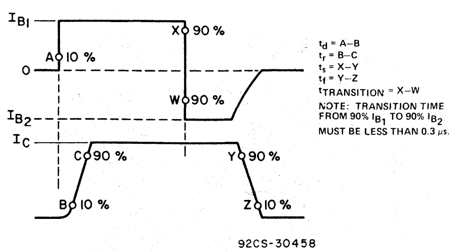
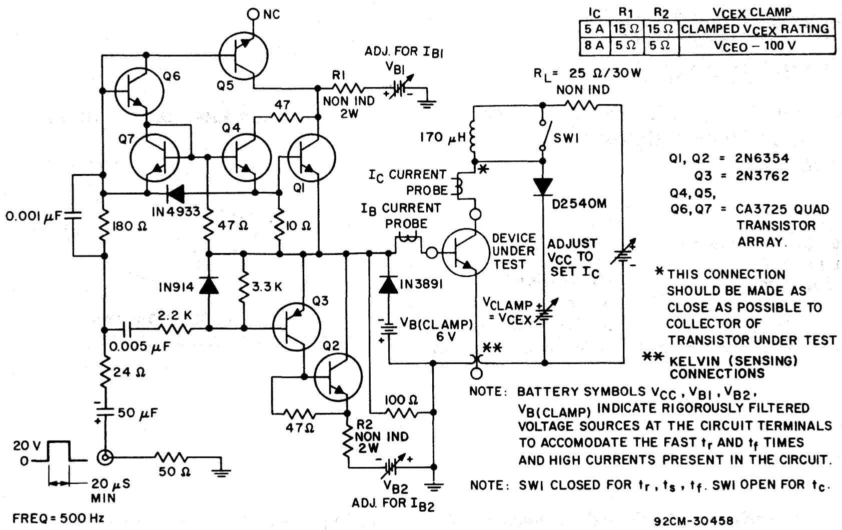


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

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

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

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

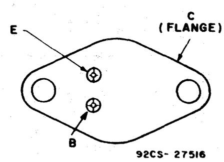
Features:

- *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 2N6751, 2N6752, 2N6753, and 2N6754 SwitchMax series• of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits.

Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The 2N6751, 2N6752, 2N6753, and 2N6754 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

•Formerly TA9153, TA9153A, TA9153B,

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6751	2N6752	2N6753	2N6754	
* V_{CEV}					
V_{BE} = −1.5 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					
$T_C \leq 25°C$	150				W
$T_C \geq 25°C$, 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.	Max.	2N6752 Min.	Max.	UNITS
T_C = 25°C									
* I_{CEV}	800	−1.5			—	0.1	—	—	
	850	−1.5			—	—	—	0.1	mA
* I_{EBO}		−8	0		—	2	—	2	
* $V_{CEO}(sus)$[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	
* $V_{CE}(sat)$			5[a]	1	—	1	—	1	
			10[a]	3	—	3	—	3	V
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 µH		−6	5	1[c]	450	—	500	—	
$I_{S/b}$	30		5		1	—	1	—	s
* $\|h_{fe}\|$ f = 5 MHz	10		0.2		3	12	3	12	
f_T	10		0.2		15	60	15	60	MHz
* C_{obo} f = 0.1 MHz	10[d]				50	250	50	250	pF
* t_d[e]		−6	5	1	—	0.1	—	0.1	
* t_r[e]		−6	5	1	—	0.4	—	0.4	
* t_s[e]		−6	5	1[c]	—	3	—	3	
* t_f[e]		−6	5	1[c]	—	0.4	—	0.4	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	
T_C = 100°C									
* I_{CEV}	800	−1.5			—	1	—	—	mA
	850	−1.5			—	—	—	1	
* $V_{CE}(sat)$			5[a]	1	—	1.5	—	1.5	V
* t_r[e]		−6	5	1	—	0.6	—	0.6	
* t_s[e]		−6	5	1[c]	—	5	—	5	
* 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	
* $R_{\theta JC}$	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

2

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
* $\|h_{fe}\|$ 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}	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

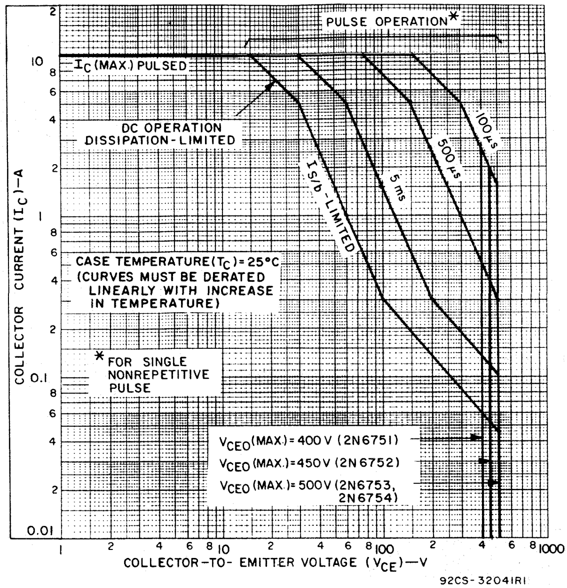


Fig. 1 — Maximum operating areas for all type ($T_C C$).

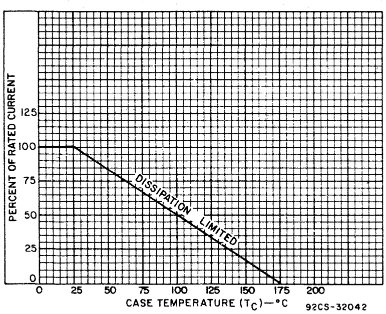


Fig. 2 — Dissipation derating curves for all types.

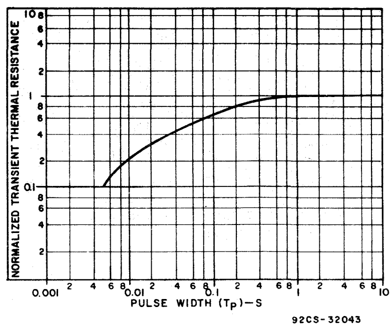


Fig. 3 — Typical thermal-response characteristic for all types.

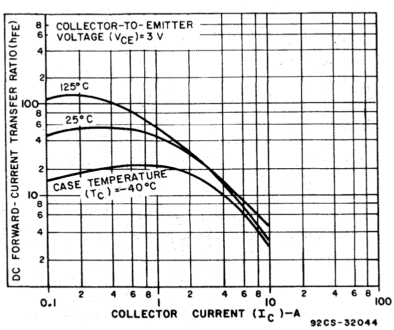


Fig. 4 — Typical dc beta characteristics for all types.

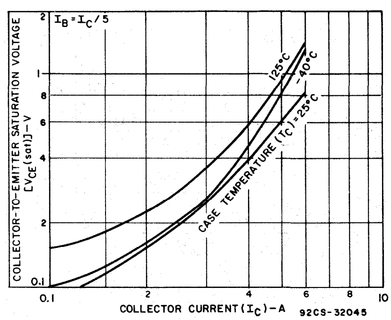


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6751, 2N6752, 2N6753, 2N6754

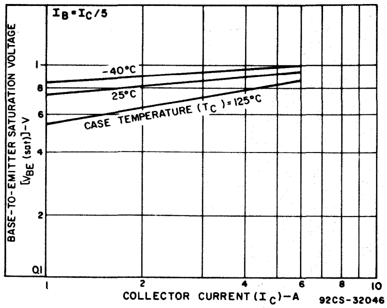


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

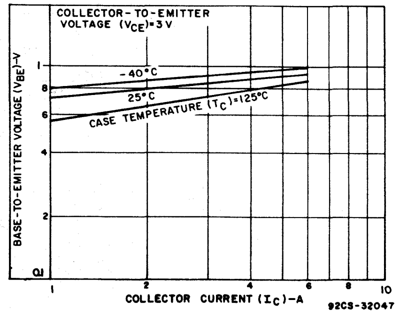


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

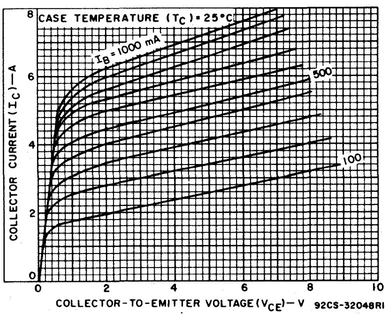


Fig. 8 — Typical output characteristics for all types.

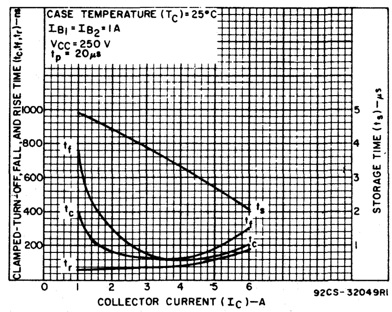


Fig. 9 — Typical saturated switching time characteristics for all types.

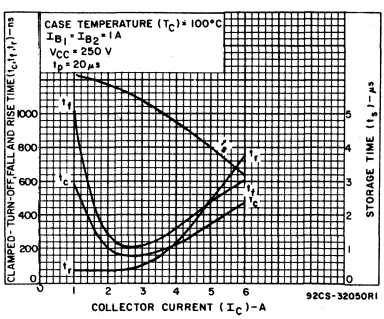


Fig. 10 — Typical saturated switching time characteristics for all types.

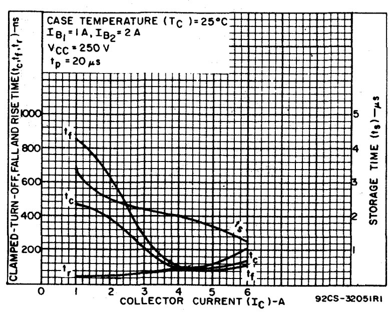
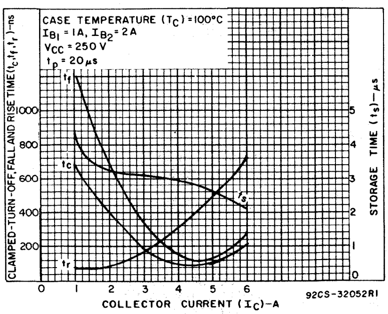


Fig. 11 — Typical saturated switching time characteristics for all types.

2N6751, 2N6752, 2N6753, 2N6754



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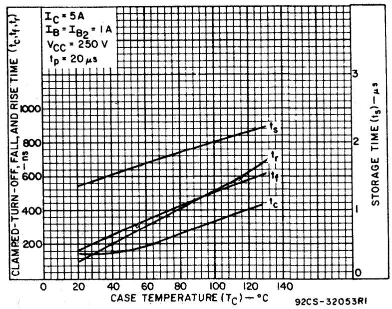
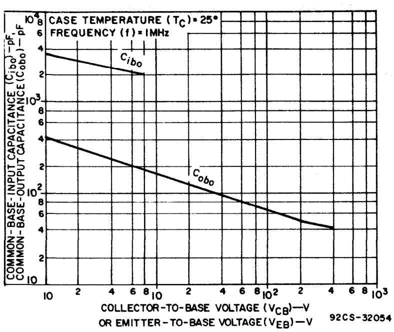


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.



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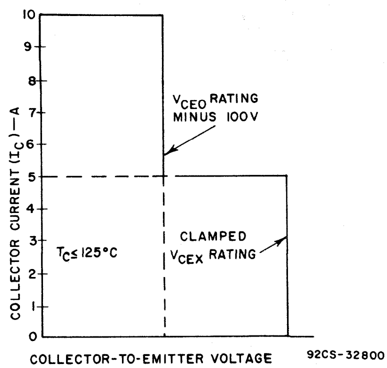


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

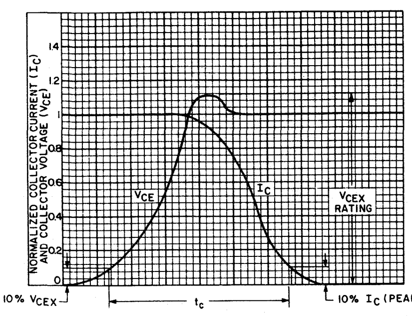


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

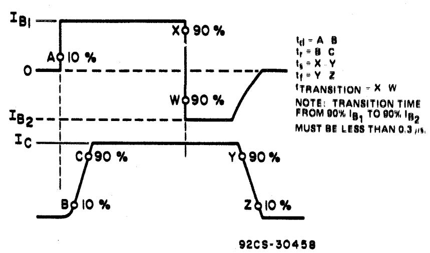


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N6751, 2N6752, 2N6753, 2N6754

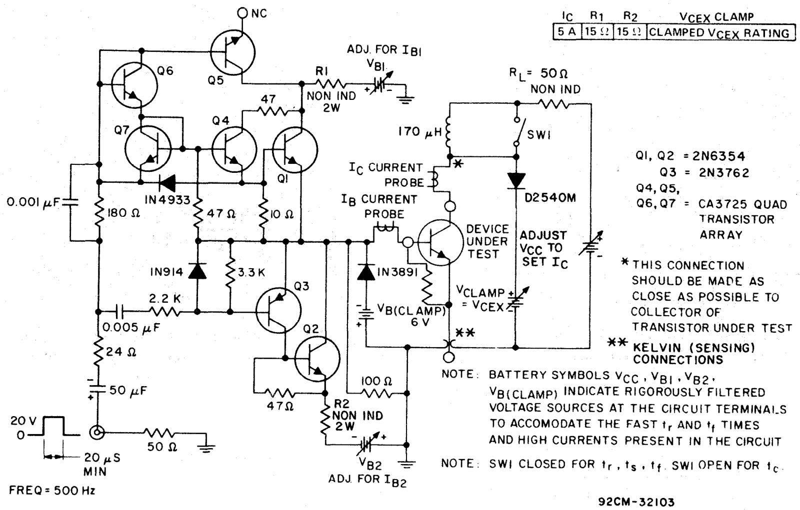


Fig. 18 — Circuit for measuring switching times.

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

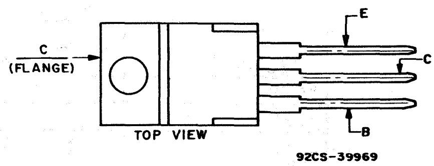
Features:

- *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



JEDEC TO-220AB

2

The 2N6771, 2N6772, and 2N6773• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125° C to provide information necessary for worst-case design.

The 2N6771, 2N6772, and 2N6773 series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic packages.

•Formerly RCA8863A, RCA8863B, and RCA8863C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6771	2N6772	2N6773	
* V_{CEV}				
V_{BE} = −1.5 V	450	550	650	V
* V_{CEX} (Clamped)				
V_{BE} = −1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}		8		V
I_C(sat)		1		A
* I_C		1		A
I_{CM}		2		A
* I_B		0.6		A
* P_T				
T_C up to 25°C		40		W
T_C above 25°C, derate linearly		0.32		W/°C
* T_{stg}, T_J		-65 to 150		°C
* T_L				
At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.		235		°C

*In accordance with JEDEC registration data.

2N6771, 2N6772, 2N6773

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc I_B	LIMITS 2N6771 Min.	2N6771 Max.	2N6772 Min.	2N6772 Max.	2N6773 Min.	2N6773 Max.	UNITS
T_C=25° C											
* I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	mA
	650	−1.5			—	—	—	—	—	0.1	mA
* I_{EBO}		−8	0		—	2	—	2	—	2	mA
* 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
* V_{BE}(sat)			1[a]	0.2	—	1.2	—	1.2	—	1.2	V
* 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	μs
* t_s[d]			1	0.2[e]	—	2.5	—	2.5	—	2.5	μs
* t_f[d]			1	0.2[e]	—	0.6	—	0.6	—	0.6	μs
* 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	μs
T_C=125° C											
* I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	mA
	650	−1.5			—	—	—	—	—	1	mA
* 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	μs
* t_f[d]			1	0.2[e]	—	1.5	—	1.5	—	1.5	μs
* t_c V_{CC}=200 V, L=450 μH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	1.5	—	1.5	—	1.5	μs
* $R_{\theta JC}$	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

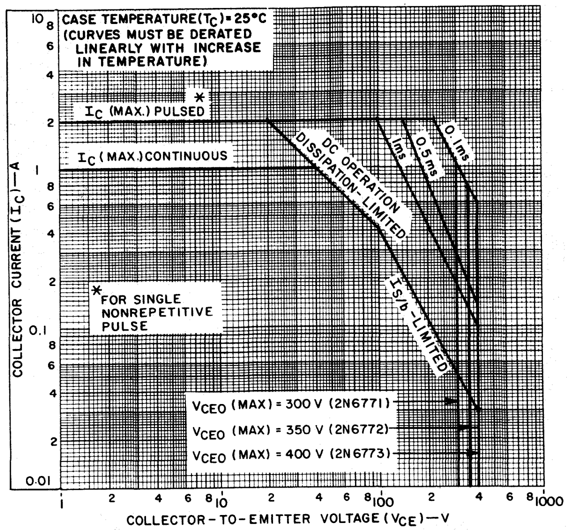


Fig. 1 — Maximum operating areas for all types.

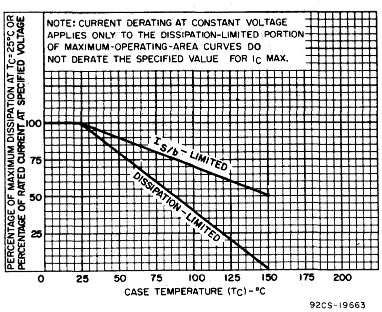


Fig. 2 — Derating curve for all types.

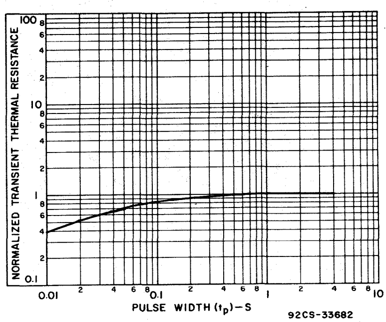


Fig. 3 — Typical thermal-response characteristics for all types.

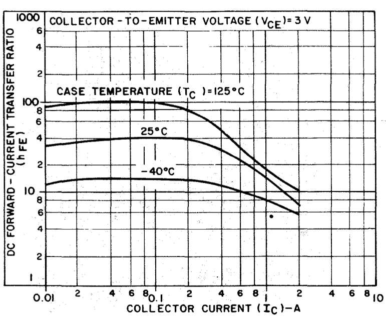


Fig. 4 — Typical dc beta characteristics for all types.

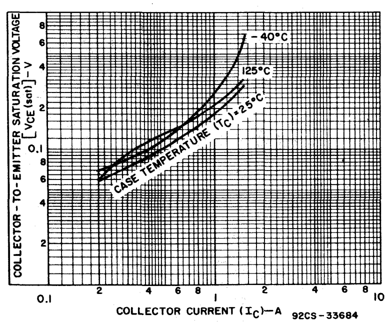


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6771, 2N6772, 2N6773

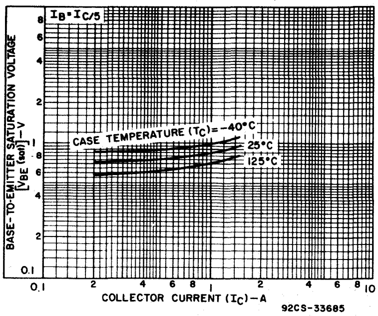


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

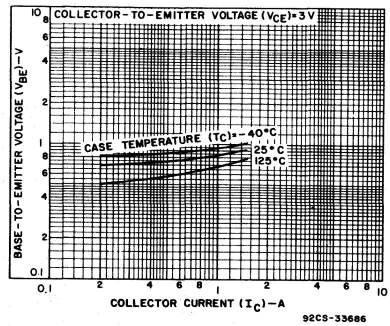


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

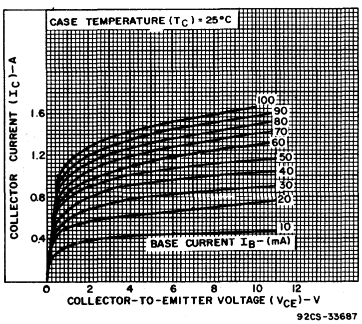


Fig. 8 — Typical output characteristics for all types.

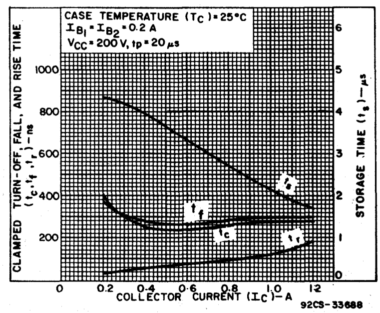


Fig. 9 — Typical saturated-switching-time characteristics for all types.

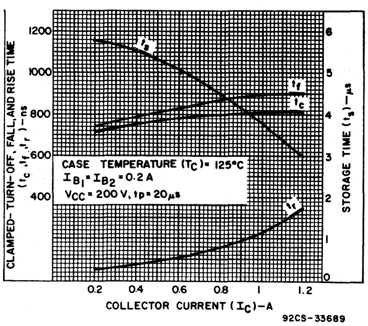


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

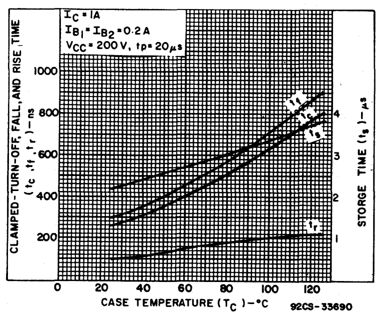


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

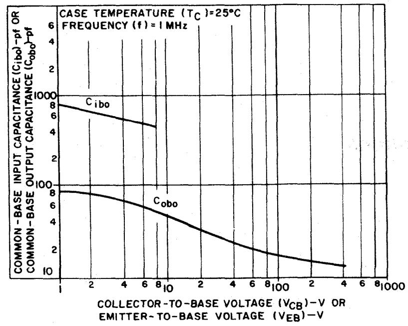


Fig. 12 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

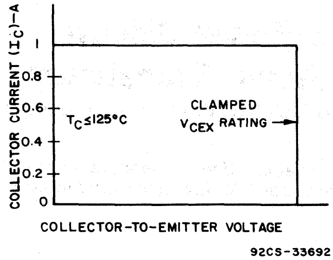


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff.

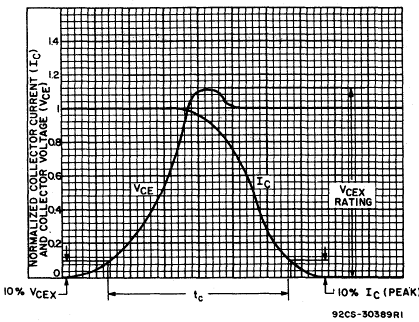


Fig. 14 — Oscilloscope display for measurement of clamped induction switching time (t_c).

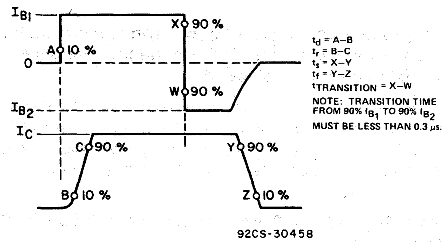


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times.

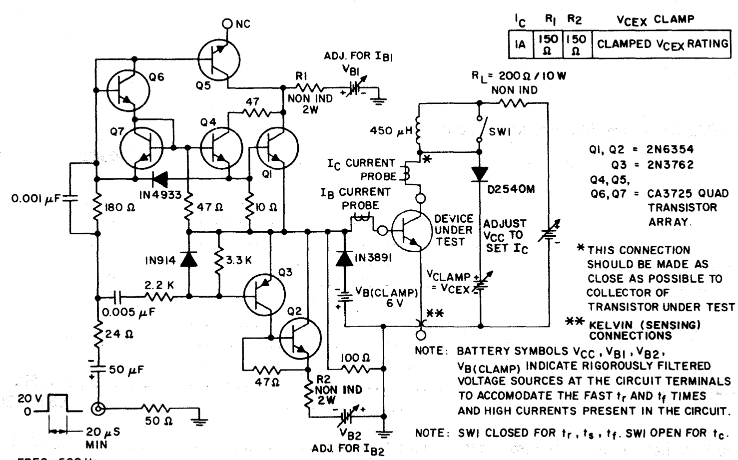


Fig. 16 — Circuit for measuring switching times.

40346, 40412

File Number **211**

Medium-Power Silicon N-P-N Planar Transistors

For High-Voltage Switching and Linear-Amplifier Applications

Features:

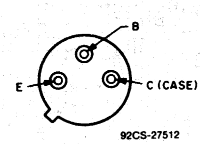
- *For operation at junction temperature up to 200° C*
- *Planar construction for low noise and low leakage*

The 40346 and 40412 are silicon n-p-n transistors having high breakdown voltages, high frequency-response capability, and fast switching speeds.

These transistors are intended for a wide variety of low- and medium-power, high-voltage applications. Type 40346 is especially useful in differential and operational amplifiers. Type 40412 is especially suited for class A ac/dc audio-amplifier service.

Types 40346 and 40412 are supplied in a JEDEC TO-205AD hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	40346	40412	
$V_{CER}(sus)$			
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

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	−1.5			–	–	–	2	mA
	200	−1.5			–	1	–	–	
I_{EBO}		−4	0		–	5	–	–	µA
		−3	0		–	–	–	100	
h_{FE}	10		10		25	–	–	–	
	20		30		–	–	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					–	15	–	–	°C/W
$R_{\theta JC}$ 40412					–	–	–	15	°C/W

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

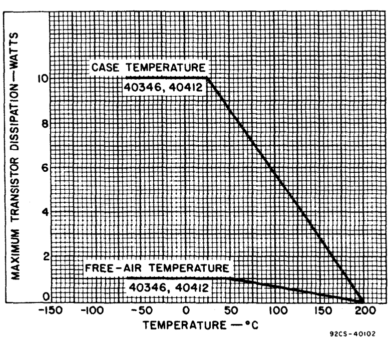


Fig. 1 - Dissipation derating curves.

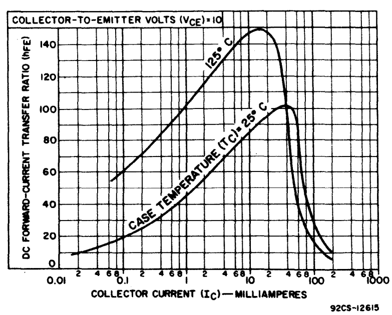


Fig. 2 - Typical dc beta characteristics for all types.

40346, 40412

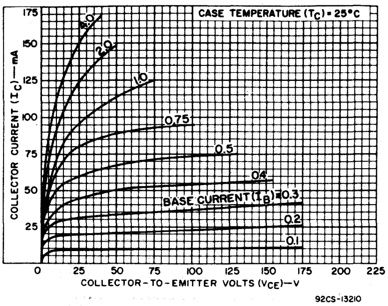


Fig. 3 - Typical output characteristics for all types.

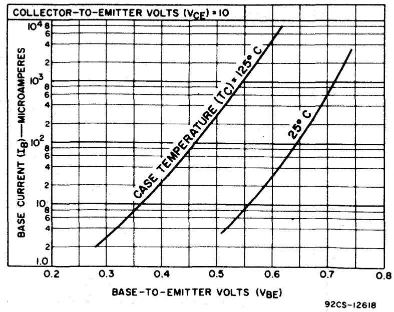


Fig. 4 - Typical input characteristics for all types.

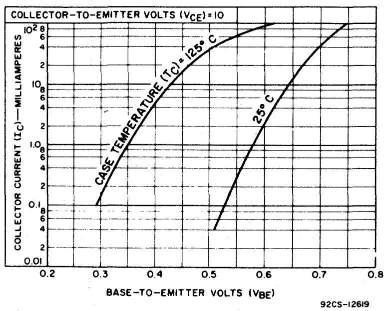


Fig. 5 - Typical transfer characteristics for all types.

File Number **88**

40347, 40348

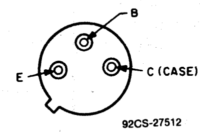
Silicon N-P-N Medium- and High-Voltage Transistors

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

2

The 40347 and 40348 are silicon n-p-n transistors intended for a wide variety of low- and medium-power applications requiring medium- and high-voltage power transistors. These devices differ primarily in their breakdown-voltage ratings.

Typical applications for these transistors include switching regulators, converters, inverters, relay controls, oscillators, pulse amplifiers, and audio amplifiers (in low-power driver and output stages). These transistors are especially suitable for use in low-cost ac/dc amplifier circuits.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		40347	40348	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	60	90	V
COLLECTOR-TO-EMITTER VOLTAGE:				
With -1.5 V (V_{BE}) of reverse bias	V_{CEV}	60	90	V
With base open	V_{CEO}	40	65	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	V
CONTINUOUS COLLECTOR CURRENT	I_C	1.5	1.5	A
PEAK COLLECTOR CURRENT	I_{CM}	3.0	3.0	A
CONTINUOUS BASE CURRENT	I_B	0.5	0.5	A
TRANSISTOR DISSIPATION	P_T			
At case temperature up to 25°C		8.75	8.75	W
At case temperature above 25°C		See Figs. 1 & 2		
At ambient temperature up to 25°C		1.0	1.0	W
TEMPERATURE RANGE:				
Storage and Operating (Junction)		-65 to 200		°C
LEAD TEMPERATURE (During soldering):				
At distances ≥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: Voltage V dc V_{CE}	V_{EB}	V_{BE}	Current A dc I_C	I_B	LIMITS 40347 Min.	40347 Max.	40348 Min.	40348 Max	Units
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%.

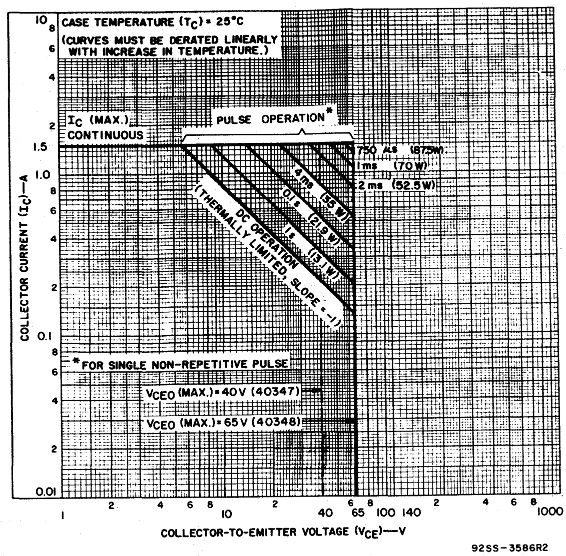


Fig. 1 — Maximum operating areas for types 40347 and 40348.

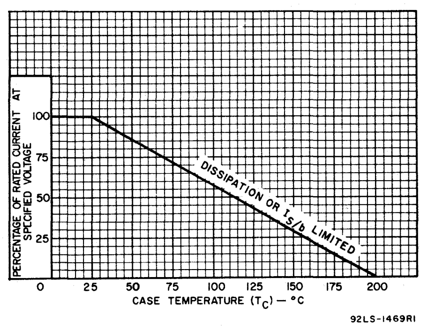


Fig. 2 — Dissipation derating curve for types 40347 and 40348.

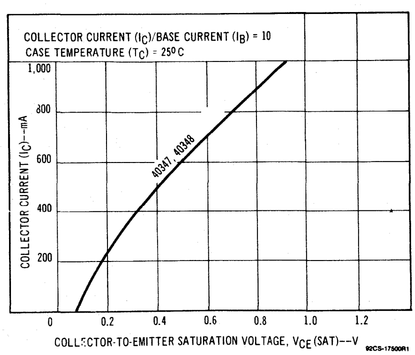


Fig. 3 — Typical saturation characteristics for types 40347 and 40348.

40347, 40348

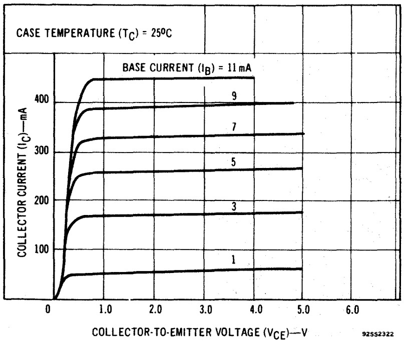


Fig. 4 — Typical output characteristics for type 40347.

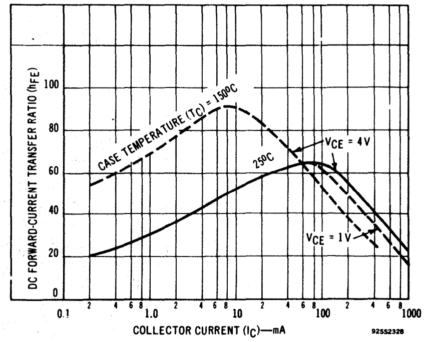


Fig. 5 — Typical dc-beta characteristics for type 40347.

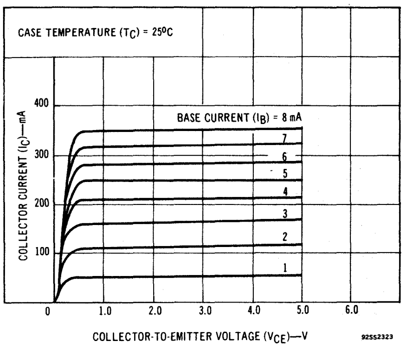


Fig. 6 — Typical output characteristics for type 40348.

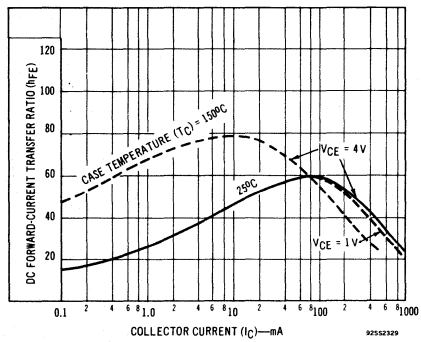


Fig. 7 — Typical dc-beta characteristics for type 40348.

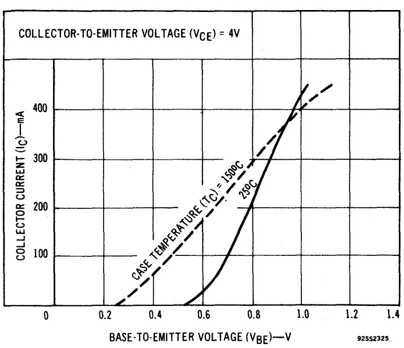


Fig. 8 — Typical transfer characteristics for type 40347.

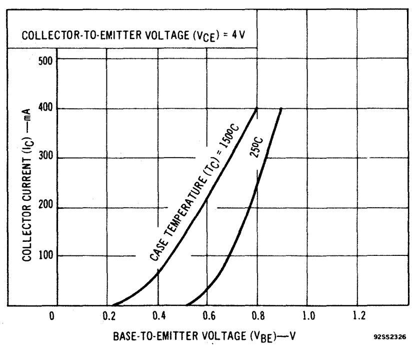


Fig. 9 — Typical transfer characteristics for type 40348.

File Number **219**

40406, 40407, 40408, 40411

Silicon N-P-N and P-N-P Power Transistors

For Audio-Amplifier Applications

Features:

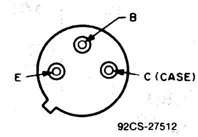
40406 & 40407
- $V_{CEO}(sus)$ = -50 V max. (40406)
- $V_{CEO}(sus)$ = 50 V max. (40407)
- *40406 is p-n-p complement of 40407*
- *1 W dissipation rating*

40408
- $V_{CEO}(sus)$ = 90 V max.
- *1 W dissipation rating*

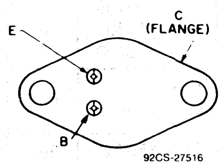
40411
- $V_{CER}(sus)$ = 90 max.
- *150 W dissipation rating*

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

2

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 80			– –	1 –	– –	– 1	– –	– –	μA
T_C = 150° C 40406 40407 40408	40 40 80			– – –	0.01 0.1 –	– – –	– – 0.25	– – –	– – –	mA
I_{CER} R_{BE} = 100 Ω	80			–	–	–	–	–	500	μA
T_C = 150° C	80			–	–	–	–	–	2	mA
I_{EBO} V_{BE} = −4 V		0		–	100	–	100	–	500	μA
V_{CEO}(sus)		0.1[a]	0	50[b]	–	90[b]	–	–	–	V
V_{CER}(sus) R_{BE} = 100 Ω		0.1 0.2			– –	– –	– –	– 90	– –	V
V_{BE}	10 4 4 4	0.001[a] 0.01[a] 0.15[a] 4[a]		– – – –	0.8[c] – – –	– – – –	– 1 – –	– – – –	– – – 1.2	V
V_{CE}(sat)		0.15[a] 4[a]	0.015 0.4	– –	– –	– –	1.4 –	– –	– 0.8	V
h_{FE} 40406 40407 40408 40411	10 10 4 4	0.1 mA[a] 0.001[a] 0.01[a] 4[a]		30 40 – –	200 200 – –	– – 40 –	– – 200 –	– – – 35	– – – 100	
h_{fe} f = 20 MHz	10	0.05		6♣	–	–	–	–	–	
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

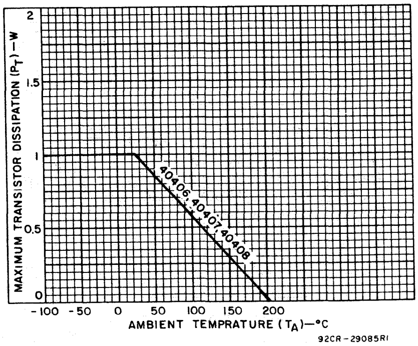


Fig. 1 - Dissipation derating curves for 40406, 40407, and 40408.

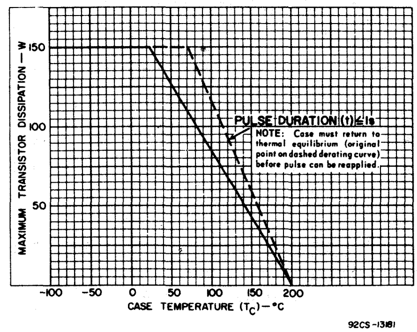


Fig. 2 - Dissipation derating curve for 40411.

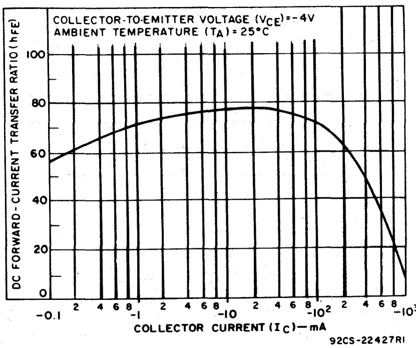


Fig. 3 - Typical dc beta characteristic for 40406.

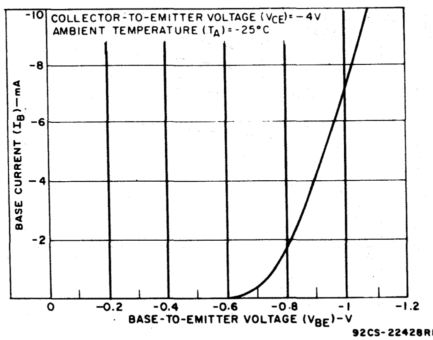


Fig. 4 - Typical input characteristic for 40406.

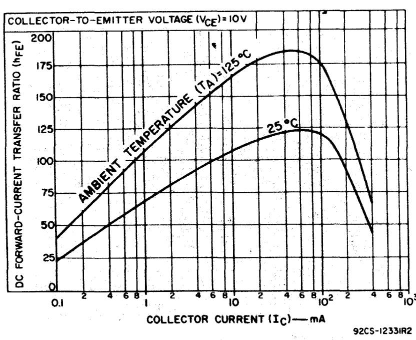


Fig. 5 - Typical dc beta characteristics for 40407 and 40408.

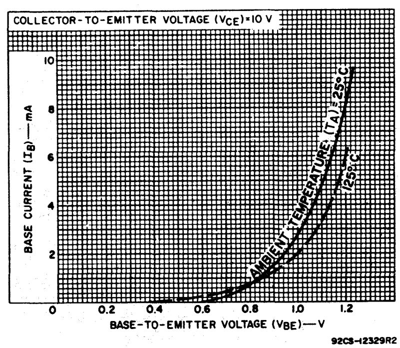


Fig. 6 - Typical input characteristics for 40407 and 40408.

40406, 40407, 40408, 40411

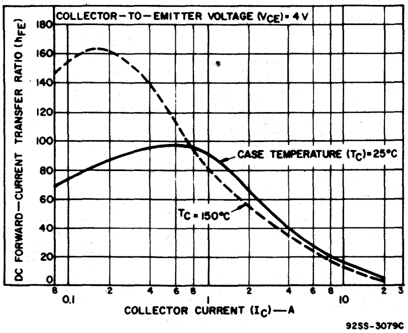


Fig. 7 - Typical dc beta characteristics for 40411.

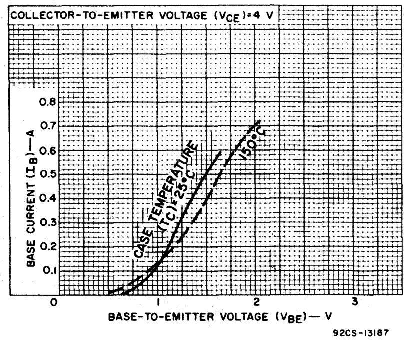


Fig. 8 - Typical input characteristics for 40411.

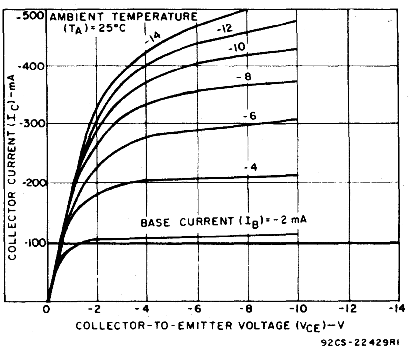


Fig. 9 - Typical output characteristics for 40406.

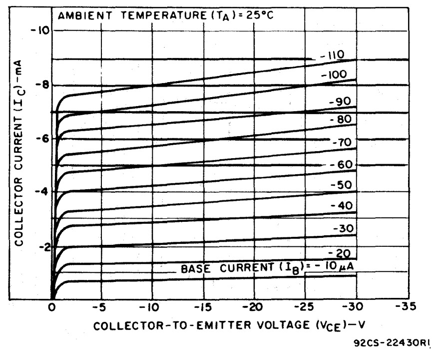


Fig. 10 - Typical large-signal output characteristics for 40406.

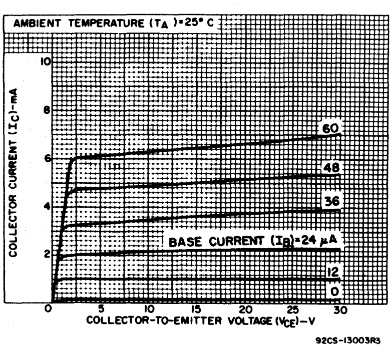


Fig. 11 - Typical output characteristics for 40407 and 40408.

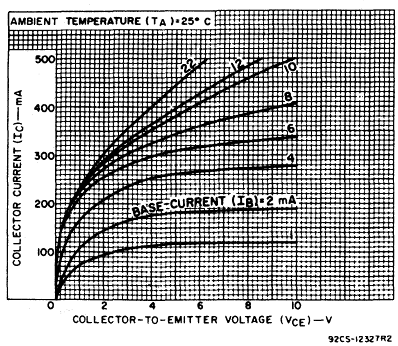


Fig. 12 - Typical large-signal output characteristics for 40407 and 40408.

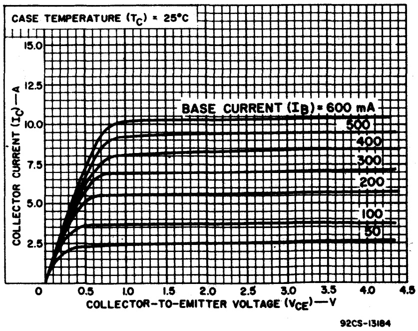


Fig. 13 - Typical output characterstics for 40411.

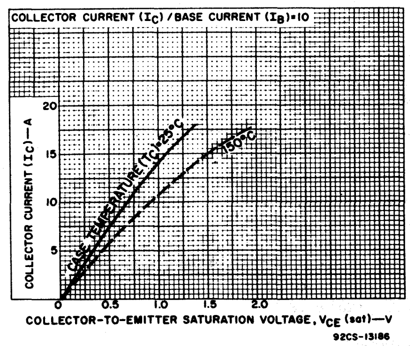


Fig. 14 - Typical saturation-voltage characteristics for 40411.

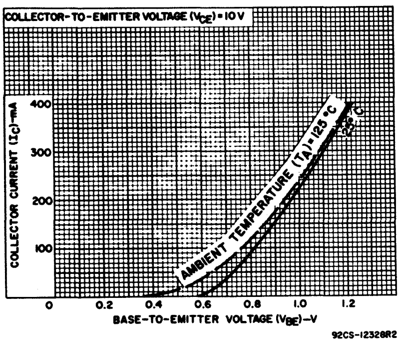


Fig. 15 - Typical transfer characteristics for 40407 and 40408.

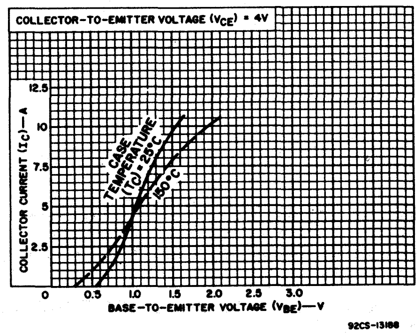


Fig. 16 - Typical transfer characterstics for 40411.

2

BD142

File Number **701**

High-Power Silicon N-P-N Transistor

General-Purpose Device
For Commercial Use

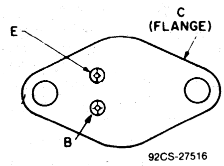
Features:

- *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: VOLTAGE V dc: V_{CE}	TEST CONDITIONS: VOLTAGE V dc: V_{EB}	TEST CONDITIONS: VOLTAGE V dc: V_{BE}	TEST CONDITIONS: CURRENT A dc: I_C	TEST CONDITIONS: CURRENT A dc: I_B	LIMITS: MIN.	LIMITS: MAX.	UNITS
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%.

2

BD142

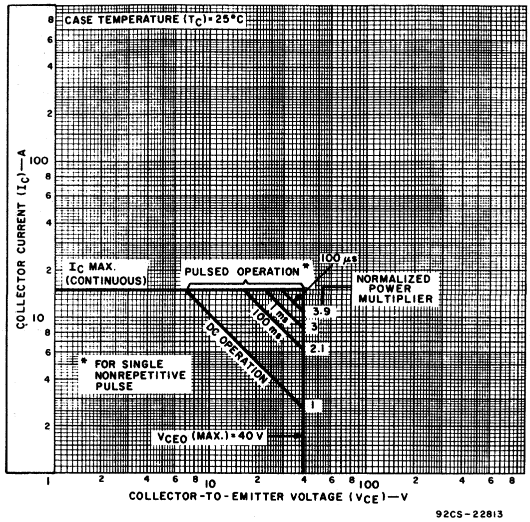


Fig. 1 — Maximum safe area of operation.

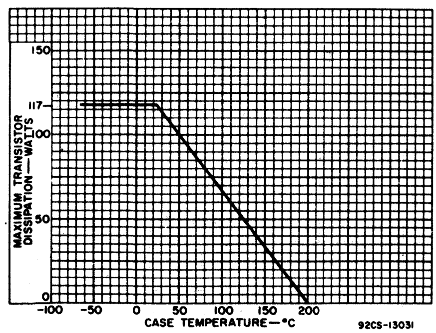


Fig. 2 — Dissipation derating curve.

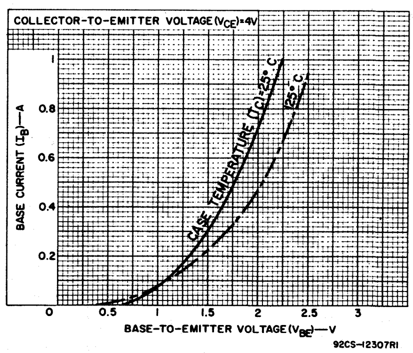


Fig. 3 — Typical input characteristics.

BD142

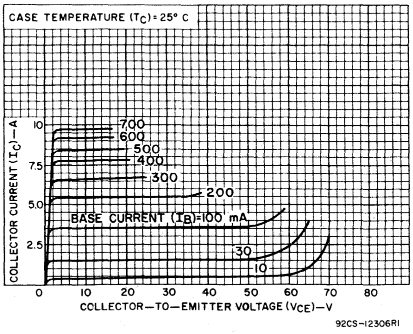


Fig. 4 — Typical output characteristics.

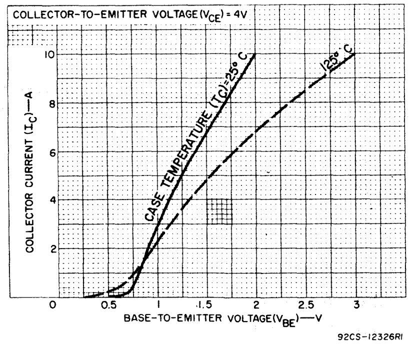


Fig. 5 — Typical transfer characteristics.

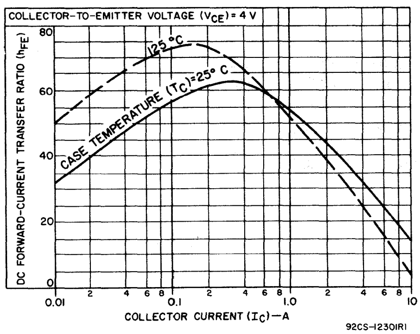


Fig. 6 — Typical dc-beta characteristics.

BD181, BD182, BD183

File Number **700**

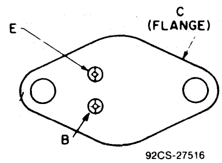
High-Power Silicon N-P-N Transistors

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	–	–	
						3[a]	0.3[a]	–	1	–	–	–	1	V
Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio (f = 0.4 MHz)	$\|h_{fe}\|$		4			1		2	–	2	–	2	–	
Gain-Bandwidth Product	f_T					1		800	–	800	–	800	–	kHz
Common-Emitter, Short-Circuit, Small-Signal, Forward Current Transfer Ratio Cutoff Frequency	f_{hfe}		4			0.3		15	–	15	–	15	–	kHz
Forward-Bias Second Breakdown Collector Current (t ⩾ 1 s)	$I_{S/b}$		30					3.95	–	3.95	–	3.95	–	A
Thermal Resistance (Junction-to-Case)	$R_{\theta JC}$							–	1.5	–	1.5	–	1.5	°C/W

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

2

BD181, BD182, BD183

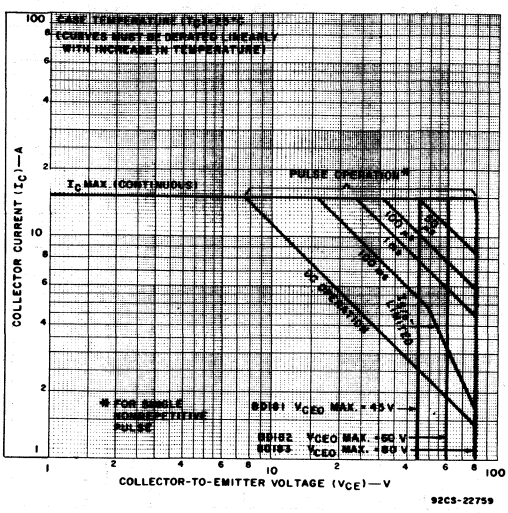


Fig. 1 — Maximum operating areas for all types.

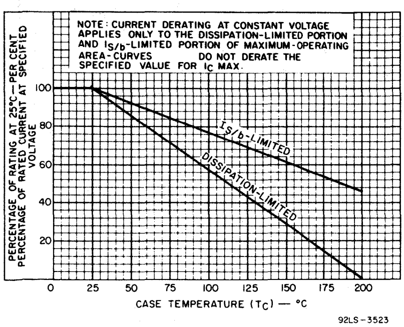


Fig. 2 — Dissipation and $I_{S/b}$ derating of all types.

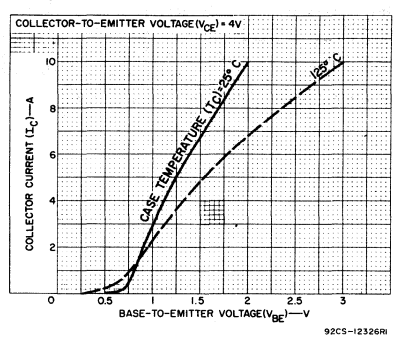


Fig. 3 — Typical transfer characteristics for all types.

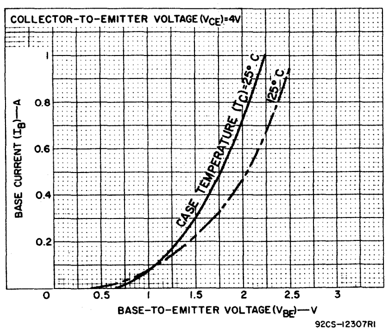


Fig. 4 — Typical input characteristics for BD182.

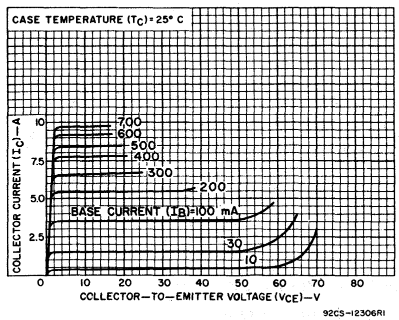


Fig. 5 — Typical output characteristics for BD182.

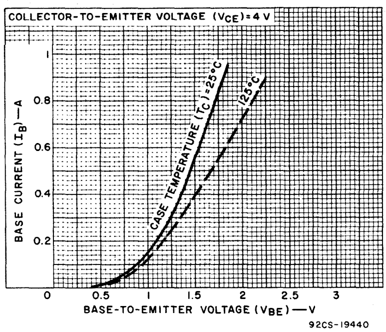


Fig. 6 — Typical input characteristics for BD181 and BD183.

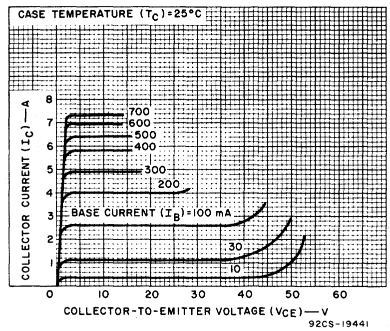


Fig. 7 — Typical output characteristics for BD181 and BD183.

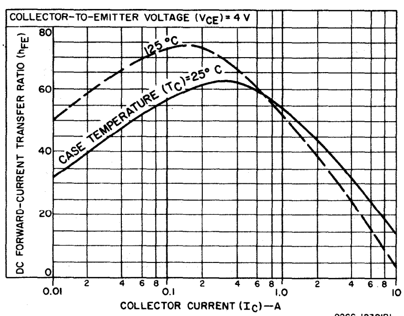


Fig. 8 — Typical dc-beta characteristics for BD182.

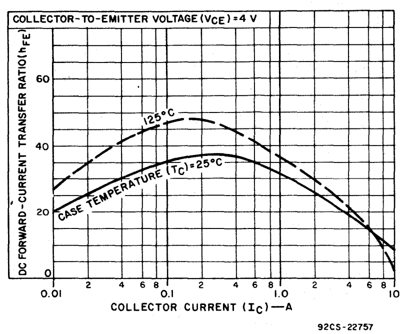


Fig. 9 — Typical dc-beta characteristics for BD181 and BD183.

BD239, BD239A, BD239B, BD239C

File Number **669**

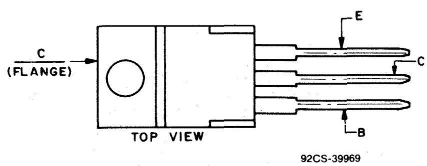
Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

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**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

Types BD239, BD239A, BD239B, and BD239C are epitaxial-base silicon n-p-n transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD239-series power transistors are complements of the devices in the BD240 series. (The BD240-series devices are described in File No. 670.)

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BD239	BD239A	BD239B	BD239C	
COLLECTOR-TO-EMITTER VOLTAGE:						
With external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CER}	55	70	90	115	V
With base open	V_{CEO}	45	60	80	100	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	5	5	5	5	V
CONTINUOUS COLLECTOR CURRENT	I_C	4	4	4	4	A
CONTINUOUS BASE CURRENT	I_B	1	1	1	1	A
TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		30	30	30	30	W
At ambient temperatures up to 25°C		2	2	2	2	W
At case temperatures above 25°C		← See Fig. 2 →				
TEMPERATURE RANGE:						
Storage & Operating (Junction)		← −65 to 150 →				°C
LEAD TEMPERATURE (During Soldering):						
At distance 1/8 in. (3.17 mm) from case for 10 s max.		← 235 →				°C

BD239, BD239A, BD239B, BD239C

ELECTRICAL CHARACTERISTICS *at Case Temperature* $(T_C) = 25^oC$

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS BD239		BD239A		BD239B		BD239C		UNITS
		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	$^oC/W$
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

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

2

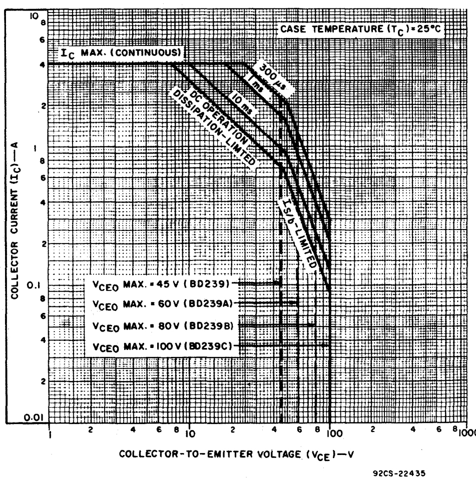


Fig. 1— Maximum safe operating areas for all types.

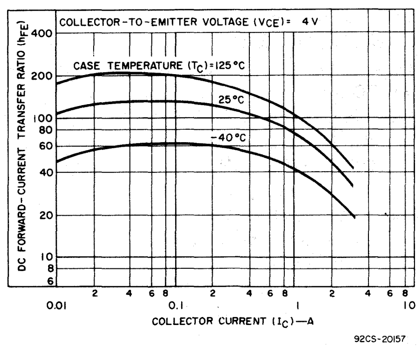


Fig. 2— Typical dc beta characteristics for all types.

BD240, BD240A, BD240B, BD240C

File Number **670**

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

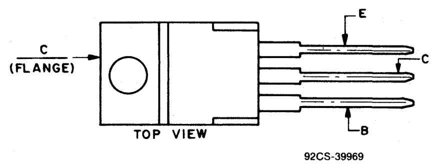
Features:

- **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 VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BD240 MIN.	BD240 MAX.	BD240A MIN.	BD240A MAX.	BD240B MIN.	BD240B MAX.	BD240C MIN.	BD240C MAX.	UNITS
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%.

2

BD240, BD240A, BD240B, BD240C

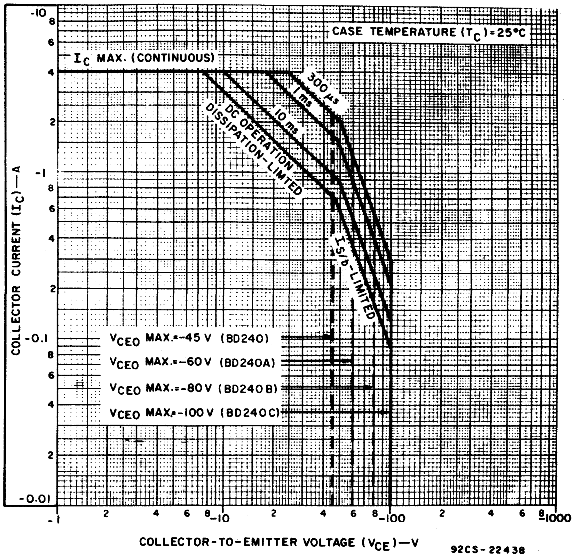


Fig. 1— Maximum safe operating areas for all types.

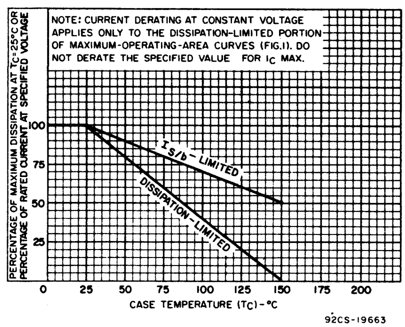


Fig. 2— Derating curves for all types.

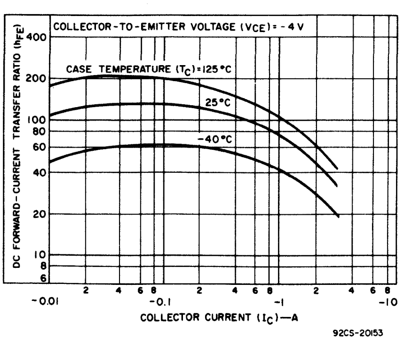


Fig. 3 — Typical dc beta characteristics for all types.

File Number **671**

BD241, BD241A, BD241B, BD241C

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

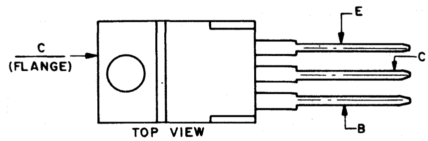
Features:

- **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	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		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	°C/W

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

BD241, BD241A, BD241B, BD241C

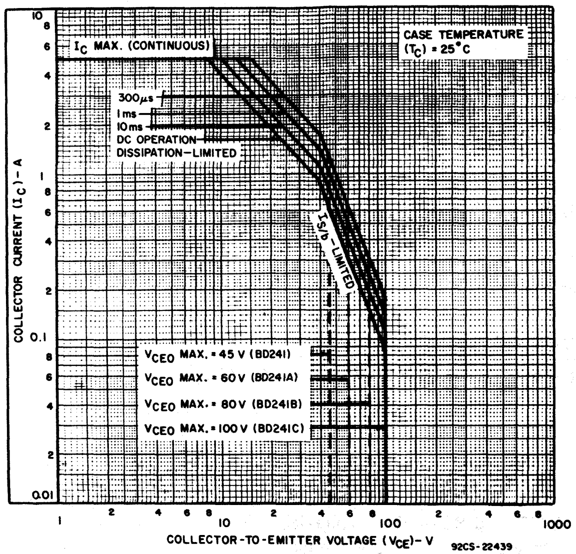


Fig. 1— Maximum safe operating areas for all types.

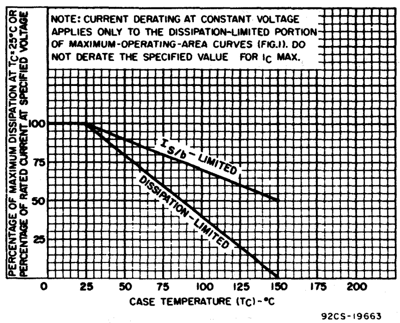


Fig. 2— Derating curves for all types.

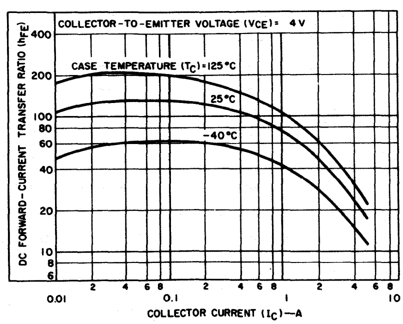


Fig. 3 — Typical dc beta characteristics for all types.

BD242, BD242A, BD242B, BD242C

File Number **672**

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

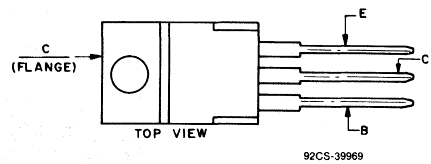
Features:

- **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 VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS BD242		BD242A		BD242B		BD242C		UNITS
		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		−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	°C/W

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

BD242, BD242A, BD242B, BD242C

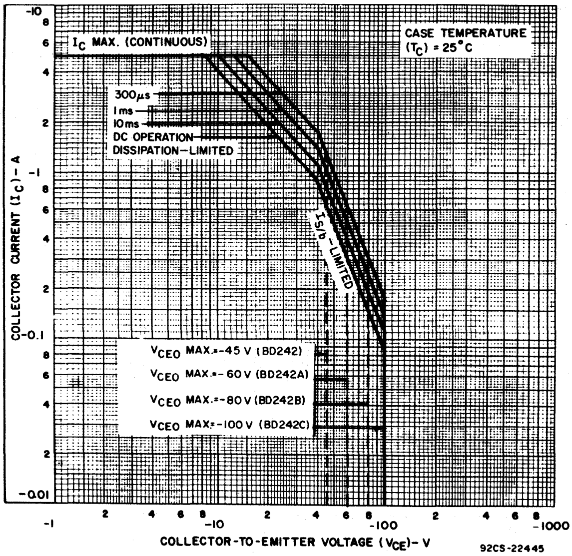


Fig. 1— Maximum safe operating areas for all types.

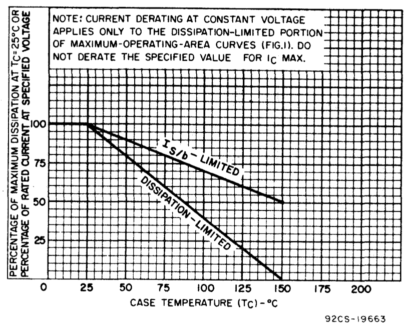


Fig. 2— Derating curves for all types.

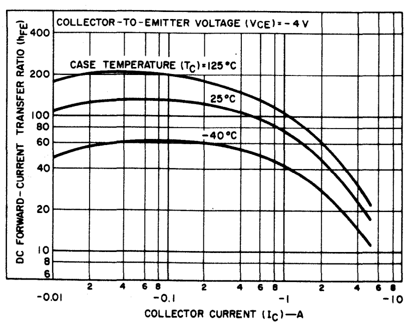


Fig. 3 — Typical dc beta characteristics for all types.

File Number **673**

BD243, BD243A, BD243B, BD243C

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

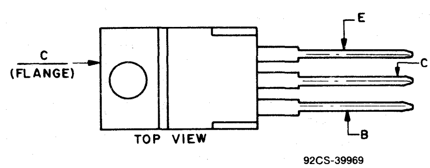
Features:

- **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	
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%.

BD243, BD243A, BD243B, BD243C

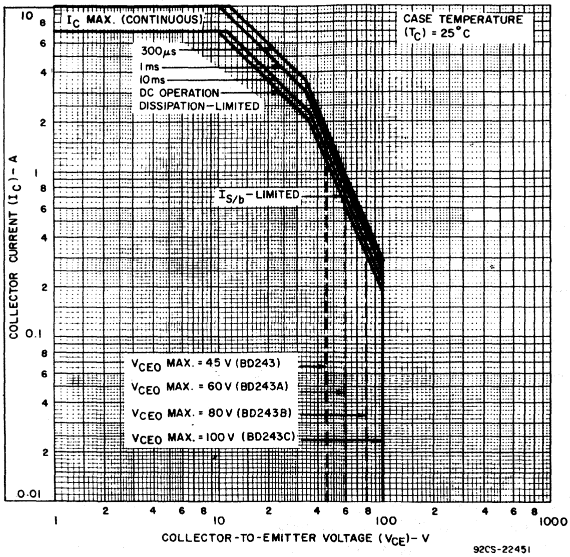


Fig. 1– Maximum safe operating areas for all types.

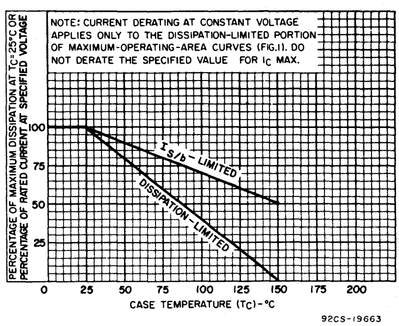


Fig. 2– Derating curves for all types.

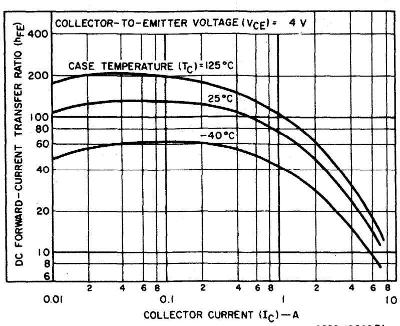


Fig. 3 — Typical dc beta characteristics for all types.

BD244, BD244A, BD244B, BD244C File Number **674**

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

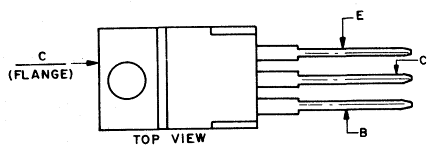
Features:

- **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, BD244A, BD244B, BD244C

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD244		BD244A		BD244B		BD244C		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	−30			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%.

2

BD244, BD244A, BD244B, BD244C

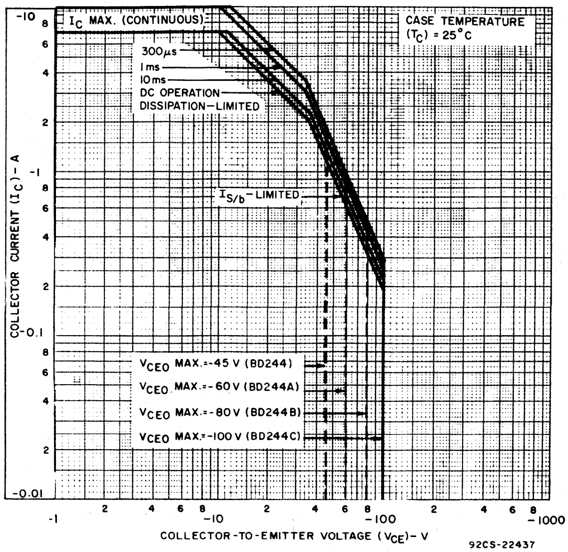


Fig. 1— Maximum safe operating areas for all types.

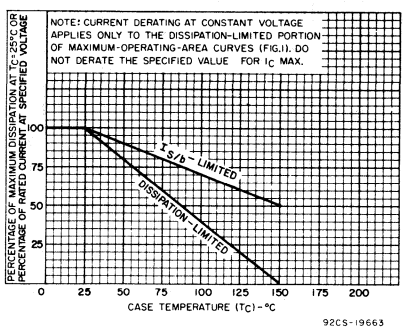


Fig. 2— Derating curves for all types.

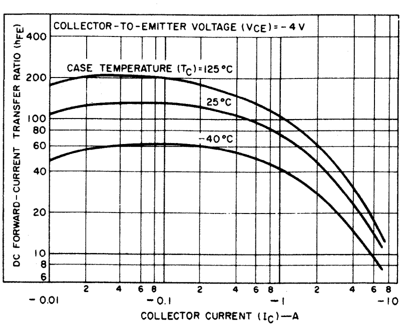


Fig. 3 — Typical dc beta characteristics for all types.

File Number **667**

BD277

7-A, 70-W, Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Applications in Series and Shunt Regulators

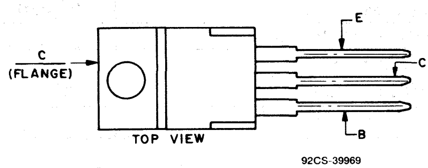
Features:

- *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 useтul 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 V_{CE}	V_{CB}	V_{EB}	CURRENT A dc I_C	I_B	I_E	LIMITS MIN.	MAX.	UNITS
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%.

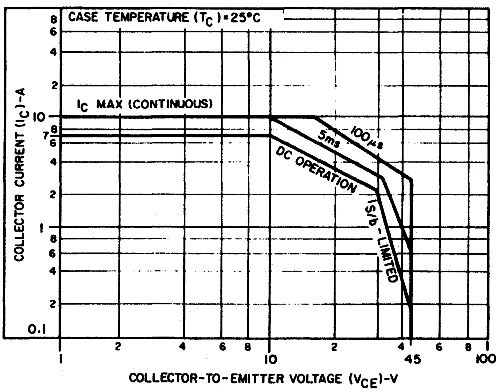


Fig.1 — Maximum operating area.

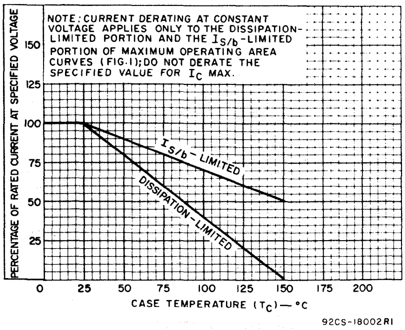


Fig. 2 — Derating curves.

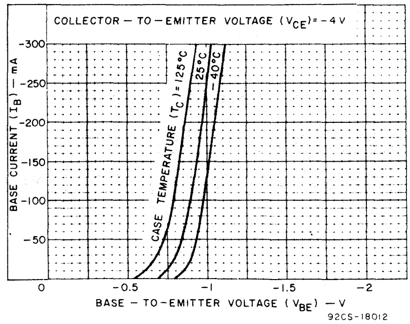


Fig. 3 — Typical input characteristics.

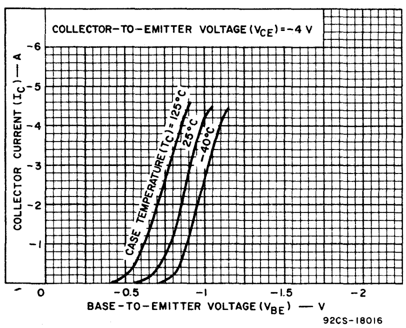


Fig. 4 — Typical transfer characteristics.

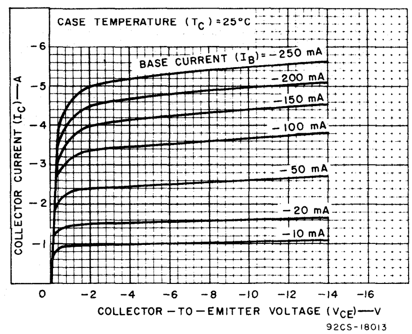


Fig. 5 — Typical output characteristics.

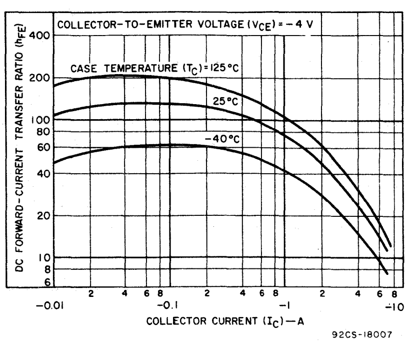


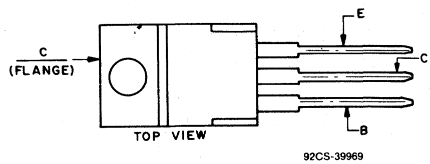
Fig. 6 — Typical dc beta characteristics.

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.

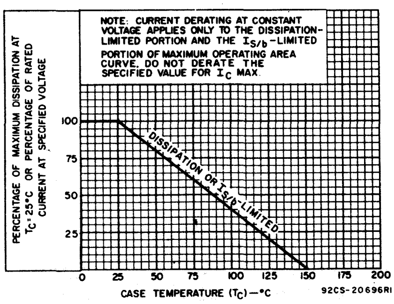


Fig. 1 — Derating curve for all types.

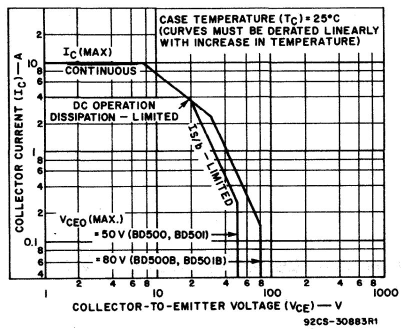


Fig. 2 — Maximum operating areas for all types.

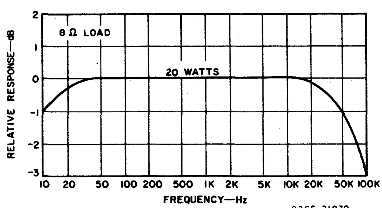


Fig. 3 — Typical frequency response.

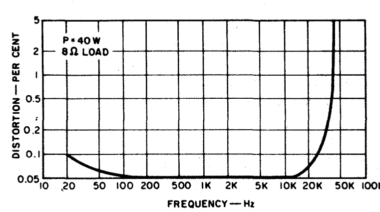


Fig. 4 — Typical total harmonic distortion as a function of frequency.

BD533, BD534, BD535, BD536, BD537, BD538

File Number **1236**

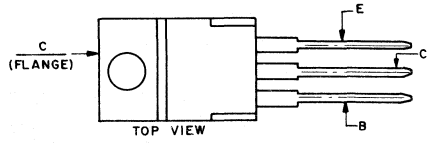
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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		CURRENT A dc		LIMITS BD533 BD534▲		BD535 BD536▲		BD537 BD538▲		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN	MAX.	MIN.	MAX.	
I_{CBO}	45⊕				—	100	—	—	—	—	µA
	60⊕				—	—	—	100	—	—	
	80⊕				—	—	—	—	—	100	
I_{CES}	45				—	100	—	—	—	—	
	60				—	—	—	100	—	—	
	80				—	—	—	—	—	100	
I_{EBO}		5			—	1	—	1	—	1	mA
V_{CEO}(sus)■			0.1*	0	45	—	60	—	80	—	V
h_{FE}	5		0.01*		20	—	20	—	15	—	
	2		0.5*		40	—	40	—	40	—	
	2		2*		25	—	25	—	15	—	
h_{FE} Groups J	2		2*		30	75	30	75	30	75	
	2		3*		15	—	15	—	15	—	
K	2		2*		40	100	40	100	40	100	
	2		3*		20	—	20	—	20	—	
L	2		2*		60	150	—	—	—	—	
(For BD533, BD534 only)	2		3*		30	—	—	—	—	—	
V_{BE}	2		2*		—	1.5	—	1.5	—	1.5	
V_{CE}(sat)			2*	0.2	—	0.8	—	0.8	—	0.8	V
			6*	0.6	0.8●	—	0.8●	—	0.8●	—	
f_T	1		0.5		3	12●	3	12●	3	12●	MHz
$R_{\theta JC}$					—	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.

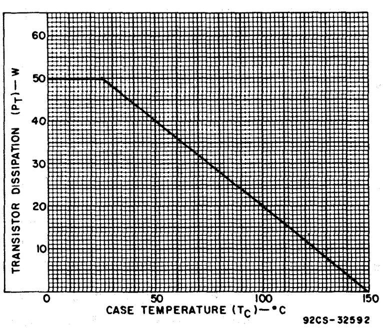


Fig. 1—Derating curve for all types.

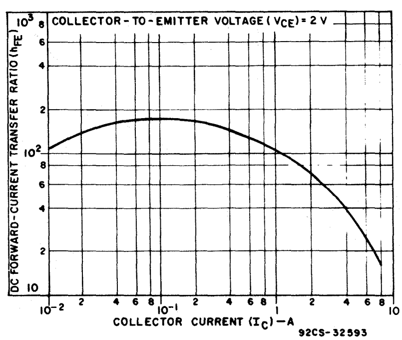
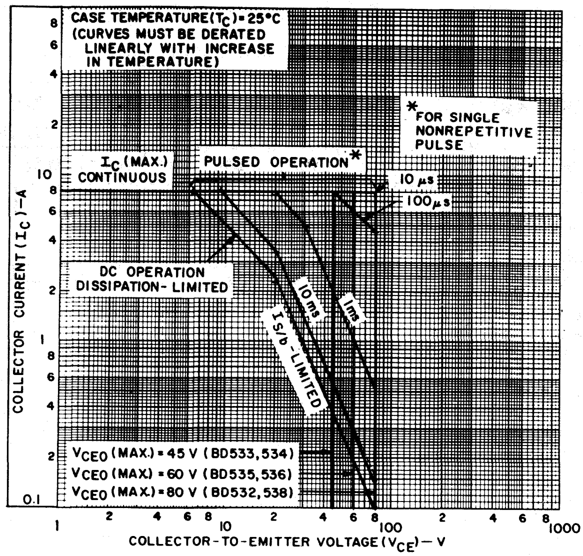


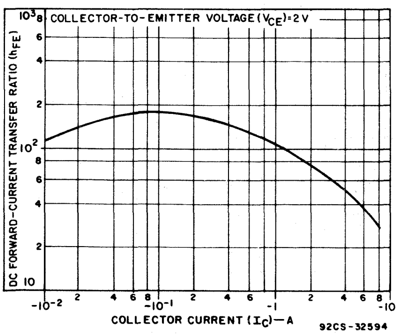
Fig. 2—Typical dc beta characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538



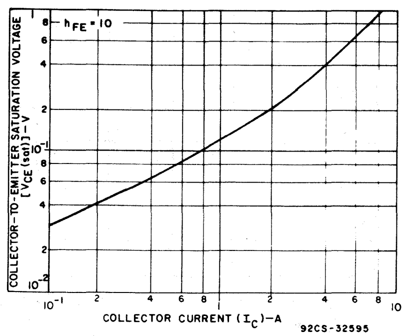
92CM-32598

Fig. 3—Maximum safe-operating areas for all types.



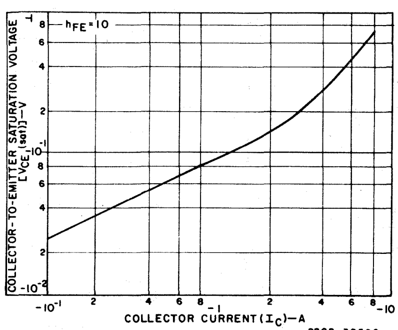
92CS-32594

Fig. 4—Typical dc beta characteristic for BD534, BD536, and BD538 types.



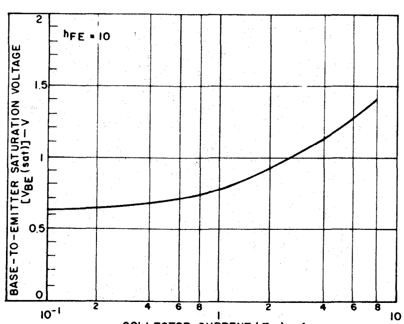
92CS-32595

Fig. 5—Typical collector to-emitter saturation voltage characteristic for BD533, BD535, and BD537 types.



92CS-32596

Fig. 6—Typical collector-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.



92CS-32597

Fig. 7—Typical base-to-emitter saturation voltage characteristic for BD533 BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

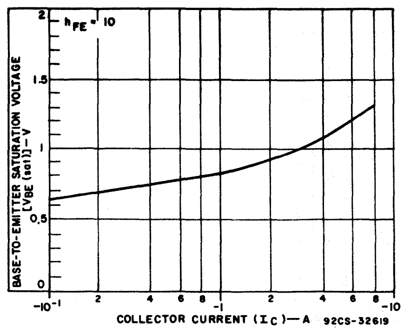


Fig. 8—Typical base-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

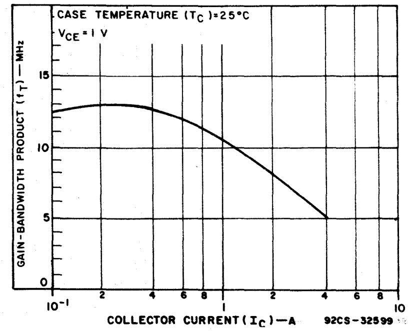


Fig. 9—Typical gain-bandwidth product characteristic for BD533, BD535, and BD537 types.

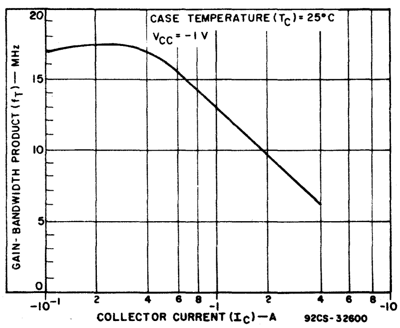


Fig. 10—Typical gain-bandwidth product characteristic for BD534, BD536, and BD538 types.

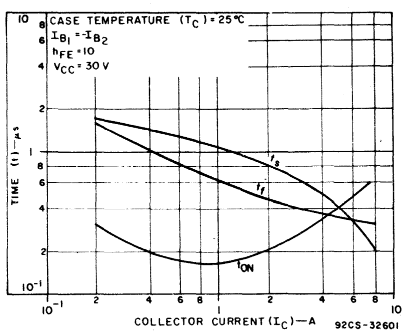


Fig. 11—Typical saturated-switching time characteristics for BD533, BD535, and BD537 types.

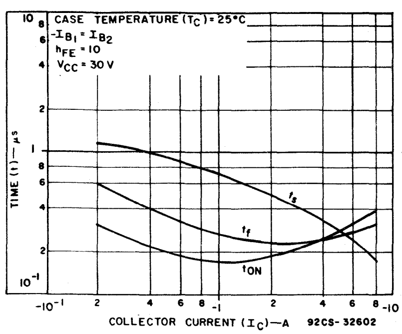


Fig. 12—Typical saturated switching time characteristics for BD534, BD536, and BD538 types.

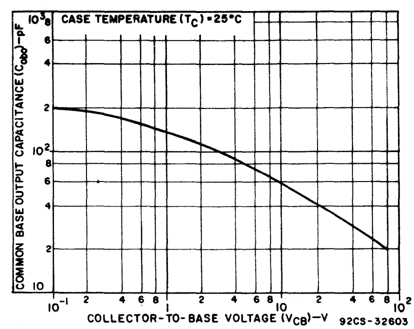


Fig. 13—Typical common-base output capacitance characteristic for BD533, BD535, and BD537 types.

BD533, BD534, BD535, BD536, BD537, BD538

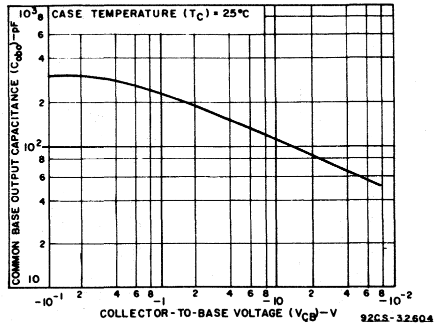


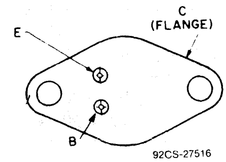
Fig. 14—Typical common-base output capacitance characteristic for BD534, BD536, and BD538 types.

File Number **1109**

BD550, BD550B

Silicon Transistors for Quasi-Complementary-Symmetry Audio Amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

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).

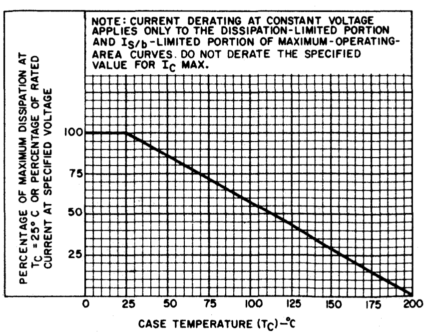


Fig. 1 — Derating curve for all types.

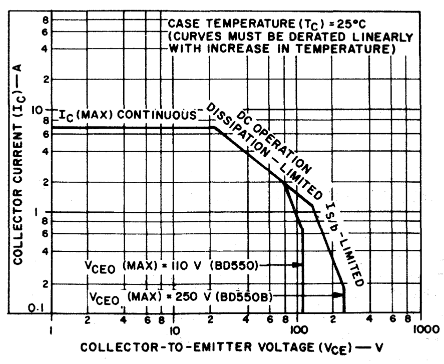


Fig. 2 — Maximum operating areas for all types.

File Number **1241**

BD643, BD645, BD647, BD649

8-Ampere N-P-N Darlington Power Transistors

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

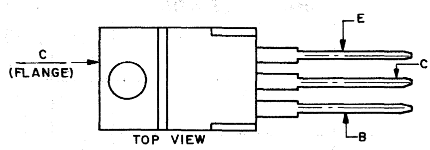
Features:

- **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 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.

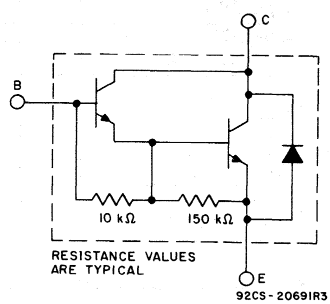


Fig. 1—Schematic diagram for all types.

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: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	LIMITS: BD643 Min.	BD643 Max.	BD645 Min.	BD645 Max.	UNITS
I_{CEO}		20			—	0.5	—	—	mA
		30			—	—	—	0.5	mA
I_{CBO}	45				—	0.2	—	—	mA
	60				—	—	—	0.2	mA
T_C = 100°C	45				—	2	—	—	mA
	60				—	—	—	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		0.5[a]	1500[b]	—	1500[b]	—	
		3		3[a]	750	—	750	—	
		3		6[a]	750[b]	—	750[b]	—	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	V
f_T f = 1 MHz		3		3	1	—	1	—	MHz
		3		3	10[b]	—	10[b]	—	MHz
$R_{\theta JC}$					—	2	—	2	°C/W

[a] Pulsed; pulse duration = 200 μs, duty factor = 1%.

[b] Typical value.

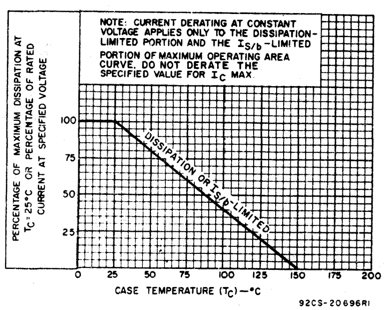


Fig. 2—Derating curve for all types.

BD643, BD645, BD647, BD649

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc			CURRENT A dc	LIMITS: BD647		BD649		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		40			—	0.5	—	—	mA
		50			—	—	—	0.5	mA
I_{CBO}	80				—	0.2	—	—	mA
	100				—	—	—	0.2	mA
T_C = 100°C	80				—	2	—	—	mA
	100				—	—	—	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		0.5[a]	1500[b]	—	1500[b]	—	
		3		3[a]	750	—	750	—	
		3		6[a]	750[b]	—	750[b]	—	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	V
f_T f = 1 MHz		3		3	1	—	1	—	MHz
		3		3	10[b]	—	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

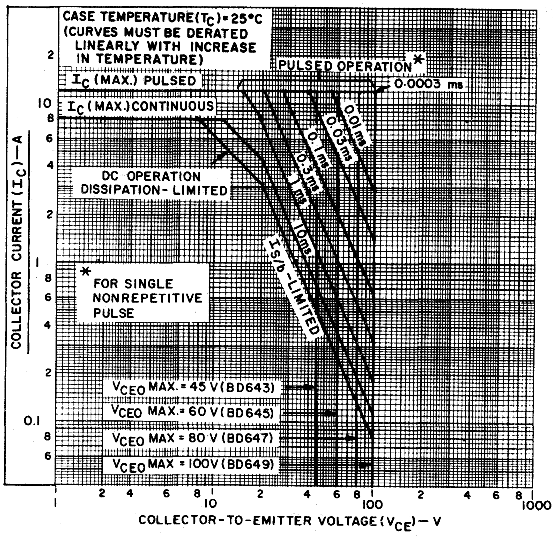


Fig. 3—Maximum operating area for all types.

File Number **1242**

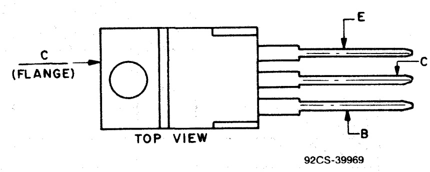
BD795, BD796, BD797, BD798, BD799, BD800, BD801, BD802

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



JEDEC TO-220AB

2

The BD795, BD797, BD799, and BD801 n-p-n transistors and their p-n-p complements BD796, BD798, BD800, and BD802, respectively, are epitaxial-base silicon types intended for a wide variety of medium-power switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	N-P-N	BD795	BD797	BD799	BD801	
	P-N-P	BD796•	BD798•	BD800•	BD802•	
V_{CBO}		45	60	80	100	V
$V_{CEO}(sus)$		45	60	80	100	V
V_{EBO}		5				V
I_C		8				A
I_B		3				A
P_T						
$T_C \leq 25°C$		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	
I_{EBO}			−5	0		—	1	—	1	
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	
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.**

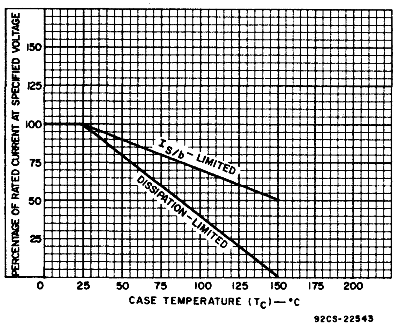


Fig. 1—Current derating curves for all types.

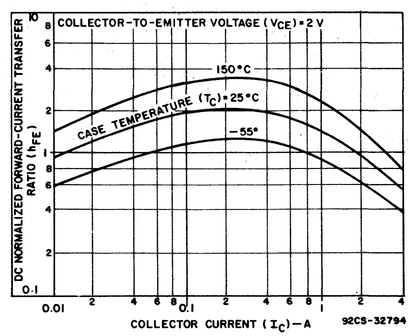


Fig. 2—Normalized dc-beta characteristics for all types.

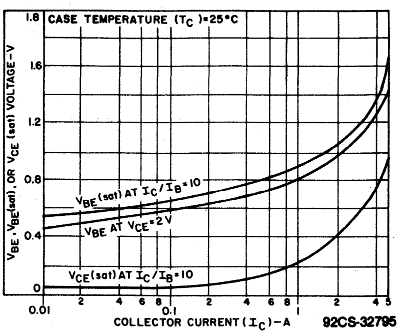


Fig. 3—Typical "on" voltage characteristics for all types.

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	mA
I_{EBO}			−5	0		—	1	—	1	mA
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	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.

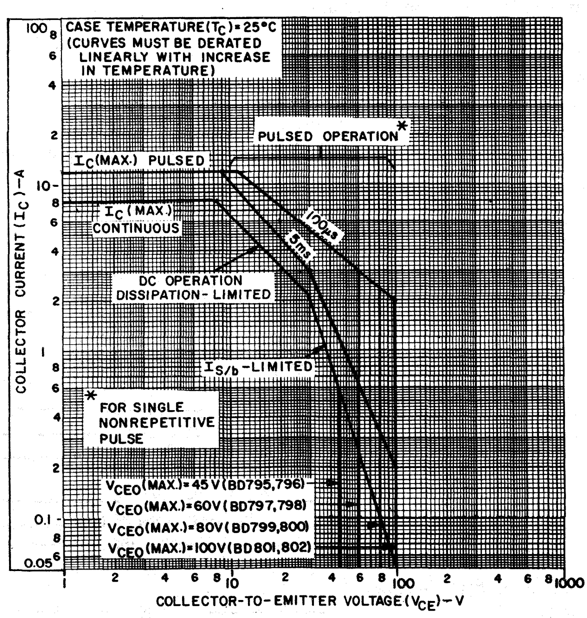


Fig. 4 — Maximum operating areas for all types.

BD895, BD895A, BD897, BD897A, BD899, BD899A, BD901

File Number **1240**

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)

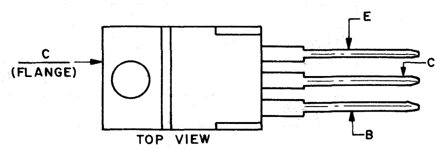
Features:

- **Operated from IC without predriver**
- **Low Leakage at high temperature**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The BD895, BD645, BD895A, BD897, BD897A, BD899, BD899A, and BD901 are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

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

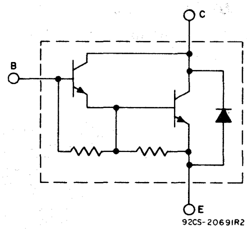


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD895 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: VOLTAGE V dc			CURRENT A dc		LIMITS: BD895 BD895A		BD897 BD897A		UNITS
	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

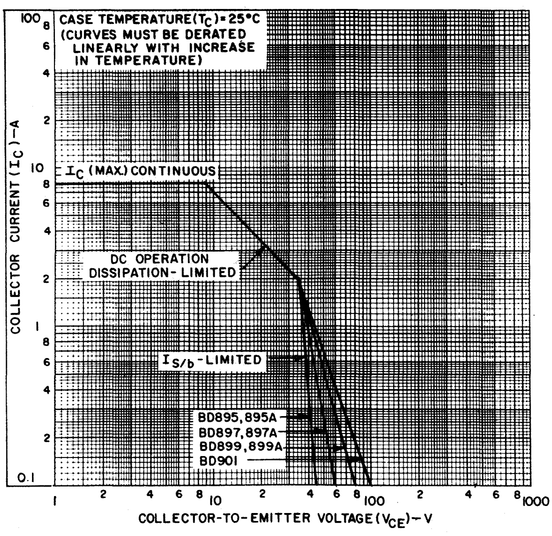


Fig. 2—Maximum operating areas for all types.

BD895, BD895A, BD897, BD897A, BD899, BD899A, BD901

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc			CURRENT A dc		LIMITS BD899 BD899A		BD901		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		40 50			0 0	— —	500 —	— —	— 500	μA
I_{CBO}	80 100					— —	0.2 —	— —	— 0.2	mA
T_C = 100°C	80 100					— —	2 —	— —	— 2	mA
I_{EBO}			−5	0		—	2	—	2	mA
$V_{CEO}(sus)$				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
$V_{CE}(sat)$ BD899 BD901				3[a]	0.012	—	2.5	—	2.5	V
BD899A only				4[a]	0.016	—	2.8	—	—	V
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%.

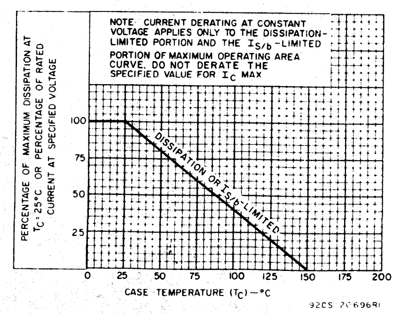


Fig. 3—Derating curve for all types.

File Number **994**

BDX18, MJ2955

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

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

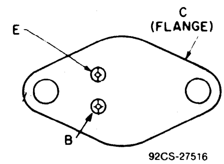
Features:

- *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-204AA

2

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 Ω	-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 ≥ 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	mA
I_{CEX}, T_C = 150° C	MJ2955	-100	1.5	—	—	—	-5	mA
	BDX18	-60	1.5	—	—	—	-10	mA
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	V
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	°C/W

[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.

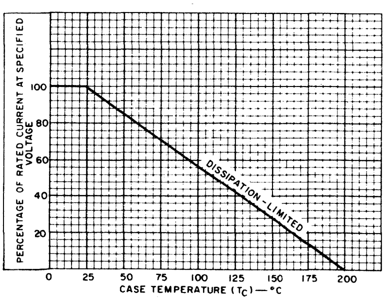


Fig. 1 — Derating curve.

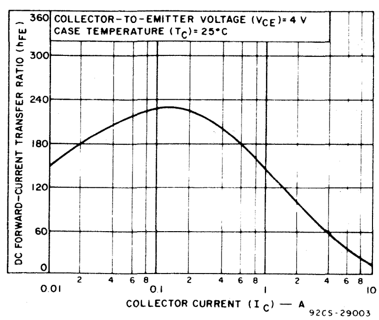


Fig. 2 — Typical dc beta characteristics.

BDX18, MJ2955

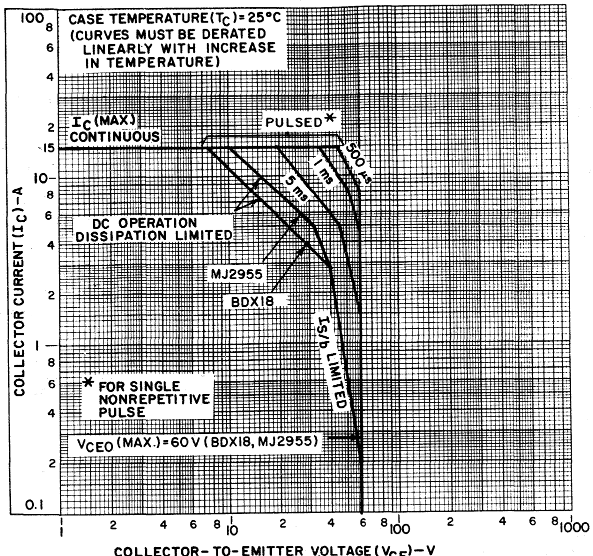


Fig. 3 — Maximum operating areas for BDX18 and MJ2955.

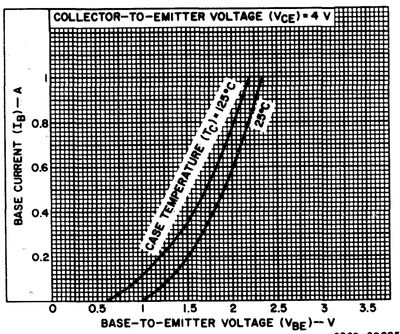


Fig. 4 — Typical input characteristics.

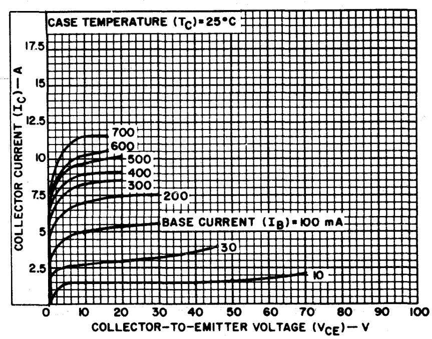


Fig. 5 — Typical output characteristics.

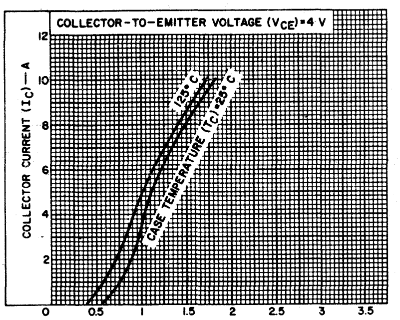


Fig. 6 — Typical transfer characteristics.

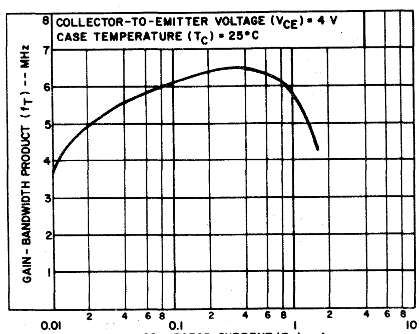


Fig. 7 — Typical gain-bandwidth product.

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)

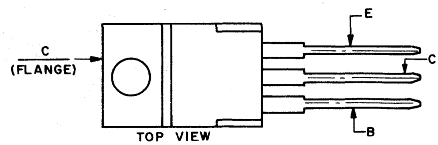
Features:

- **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 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.

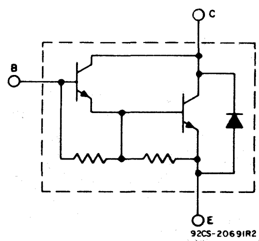


Fig. 1 – Schematic diagram for all types.

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: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	LIMITS: BDX33 Min.	BDX33 Max.	BDX33A Min.	BDX33A Max.	BDX33B Min.	BDX33B Max.	UNITS
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%.

2

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BDX33C Min.	BDX33C Max.	BDX33D Min.	BDX33D Max.	UNITS
I_{CEO}		60			0	–	–	–	0.5	mA
		50			0	–	0.5	–	–	mA
T_C = 100°C		60			0	–	–	–	10	mA
		50			0	–	10	–	–	mA
I_{CBO}	120					–	–	–	1	mA
	100					–	1	–	–	mA
T_C = 100°C	120					–	–	–	5	mA
	100					–	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				2.8	–	2.8	–	A
		36				1	–	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

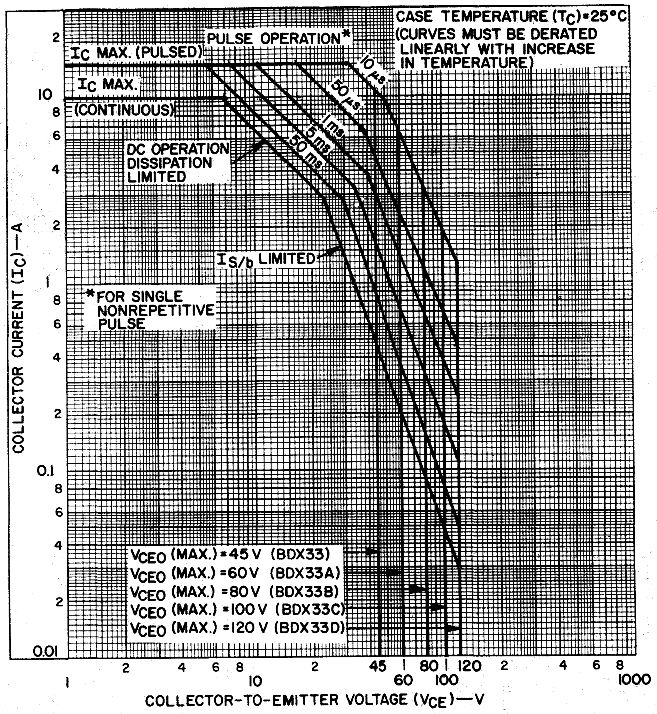


Fig. 2. — Maximum operating areas for BDX33-series types.

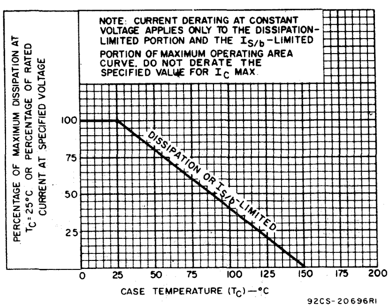


Fig. 3 — Derating curve for all types.

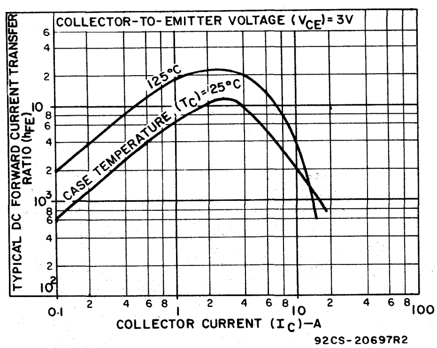


Fig. 4 — Typical dc-beta characteristics for all types.

2

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

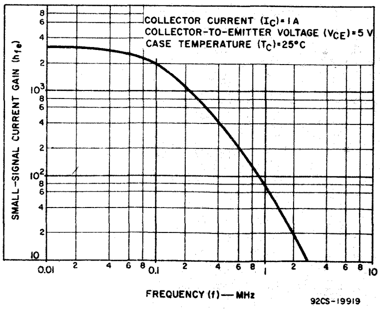


Fig. 5 — Typical small-signal gain for all types.

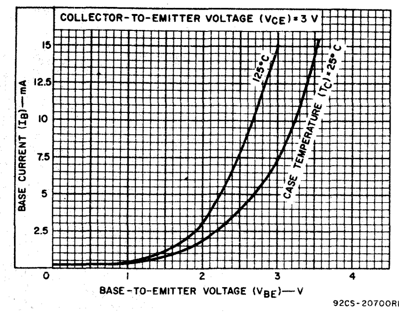


Fig. 6 — Typical Input characteristics for all types.

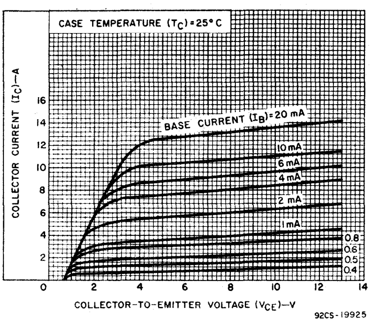


Fig. 7 — Typical output characteristics for all types.

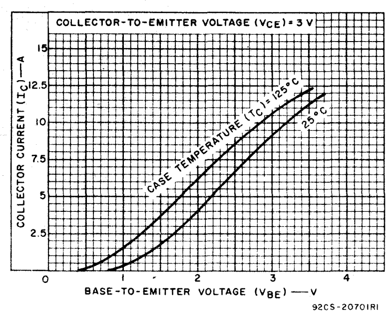


Fig. 8 — Typical transfer characteristics for all types.

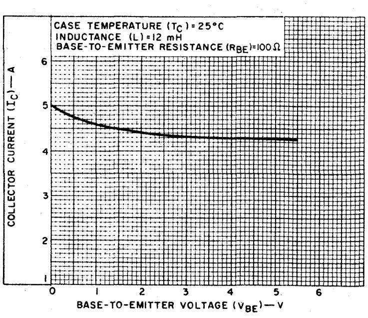


Fig. 9 — Typical saturation characteristics for all types.

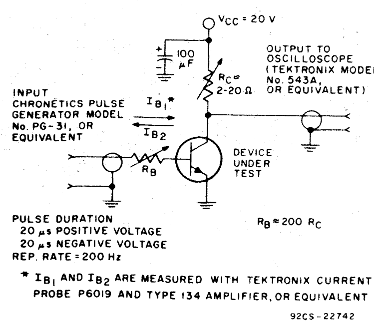


Fig. 10 — Circuit used to measure saturated switching times.

BDX33, BDX33A, BDX33B, BDX33C, BDX33D

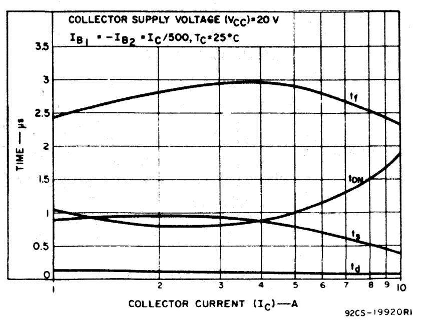


Fig. 11 — Typical saturated switching-time characteristics for all types.

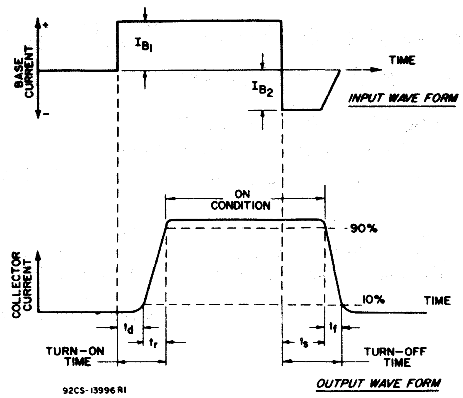


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching times (test circuit shown in Fig. 13).

2

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

File Number **694**

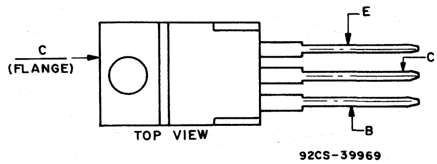
10-Ampere P-N-P Darlington Power Transistors

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, BDX43C, 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 complimentary to the BDX33, BDX33A, BDX33B, BDX33C, and BDX33D described in Data Sheet File No. 693.

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

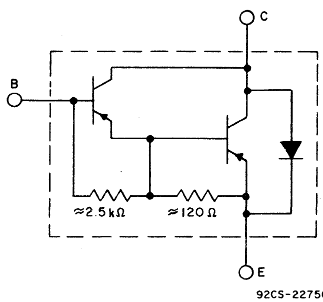


Fig. 1 - Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX34	BDX34A	BDX34B	BDX34C	BDX34D	
V_{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
$T_C > 25°C$			Derate linearly 0.56			W/°C
T_{stg}, T_J			-65 to +150			°C
T_L At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.			235			°C

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	LIMITS: BDX34 Min.	BDX34 Max.	BDX34A Min.	BDX34A Max.	BDX34B Min.	BDX34B Max.	UNITS
I_{CEO}		-40			—	—	—	—	—	-0.5	
		-30			—	—	—	-0.5	—	—	
		-20			—	-0.5	—	—	—	—	
T_C=100°C		-40			—	—	—	—	—	-10	
		-30			—	—	—	-10	—	—	
		-20			—	-10	—	—	—	—	
I_{CBO}	-80				—	—	—	—	—	-1	mA
	-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_{CER}(sus) (R_{BE})=100 Ω				-0.1[a]	-45	—	-60	—	-80	—	V
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	
		-3		-4[a]	—	-2.5	—	-2.5	—	—	
V_{CE}(sat) I_B=-0.006 A				-3[a]	—	—	—	—	—	-2.5	V
=-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			CURRENT A dc	LIMITS BDX34C		BDX34D		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		-60			—	—	—	-0.5	mA
		-50			—	-0.5	—	—	mA
T_C=100° C		-60			—	—	—	-10	mA
		-50			—	-10	—	—	mA
I_{CBO}	-120				—	—	—	-1	mA
	-100				—	-1	—	—	mA
T_C=100° C	-120				—	—	—	-5	mA
	-100				—	-5	—	—	mA
I_{EBO}			5	0	—	-10	—	-10	mA
V_{CEO}(sus)				-0.1[a]	-100	—	-120	—	V
V_{CER}(sus) (R_{BE})=100 Ω				-0.1[a]	-100	—	-120	—	V
V_{CEV}(sus)			1.5	-1.0[a]	-100	—	-120	—	V
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
V_F				-8	—	-4	—	-4	V
h_{fe} (f=1.0 kHz)		-5		-1	1000	—	1000	—	
$\|h_{fe}\|$ (f=1.0 MHz)		-5		-1	20	—	20	—	
$I_{S/b}$		-20			-3.5	—	-3.5	—	A
t_p=0.5 s non-rep.		-33			-1	—	-1	—	A
$R_{\theta JC}$					—	1.78	—	1.78	°C/W

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

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

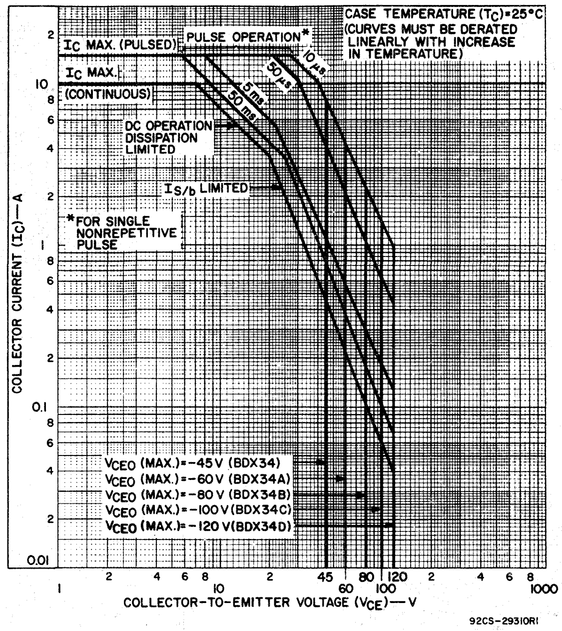


Fig. 2 - Maximum operating areas for BDX34-series types.

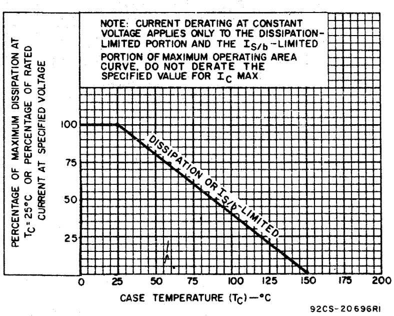


Fig. 3 - Current derating curve for all types.

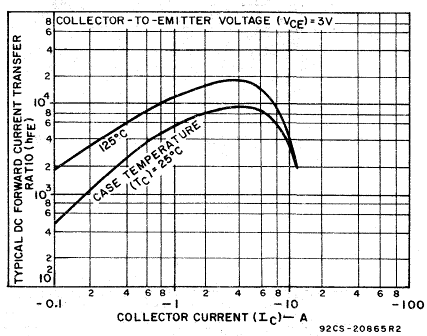


Fig. 4 - Typical dc beta characteristics for all types.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

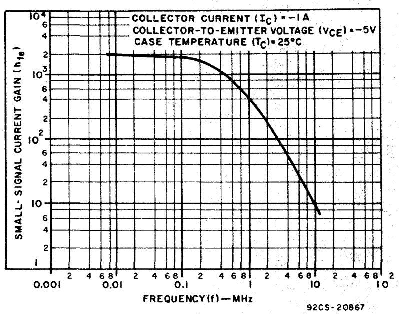


Fig. 5 — Typical small-signal gain for all types.

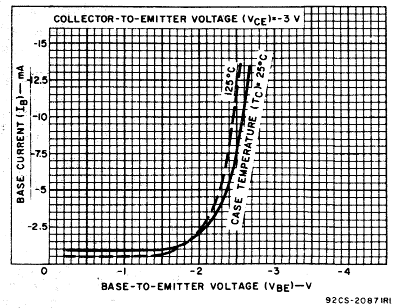


Fig. 6 — Typical input characteristics for all types.

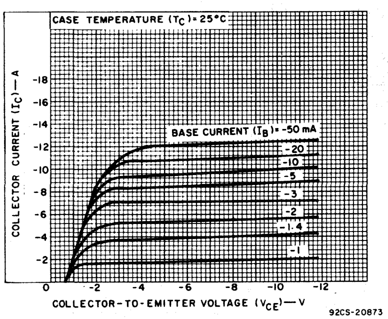


Fig. 7 — Typical output characteristics for all types.

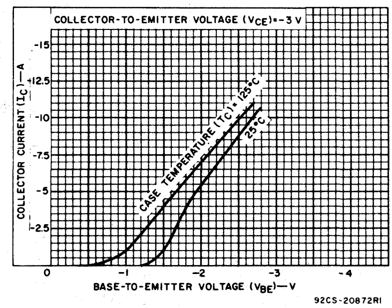


Fig. 8 — Typical transfer characteristics for all types.

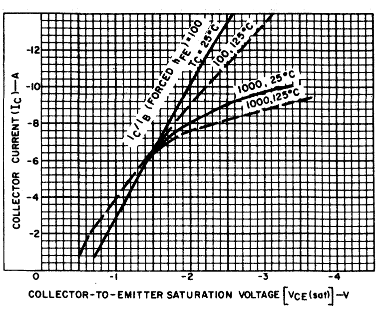


Fig. 9 — Typical saturation characteristics for all types.

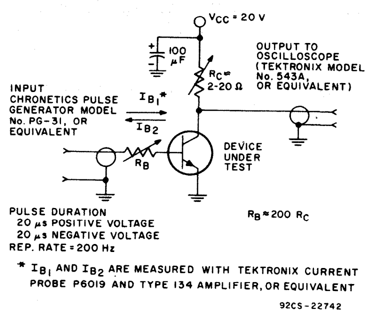


Fig. 10 — Circuit used to measure saturated switching times.

BDX34, BDX34A, BDX34B, BDX34C, BDX34D

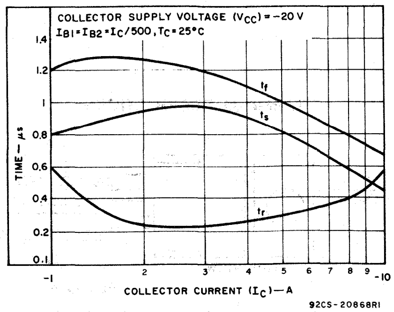


Fig. 11 — Typical saturated switching-time characteristics for all types.

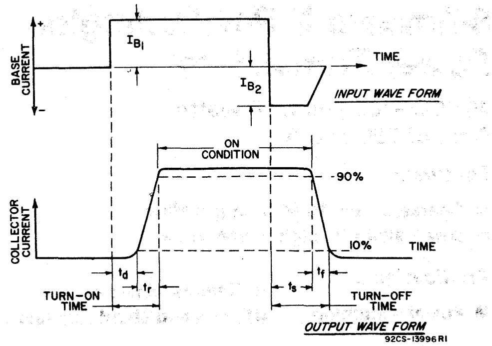


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching.

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

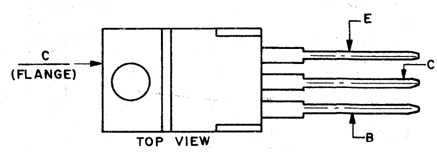
Features:

- **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 BDX53, BDX53A, BDX53B, and BDX53C are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

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

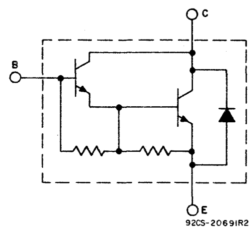


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX53	BDX53A	BDX53B	BDX53C	
V_{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

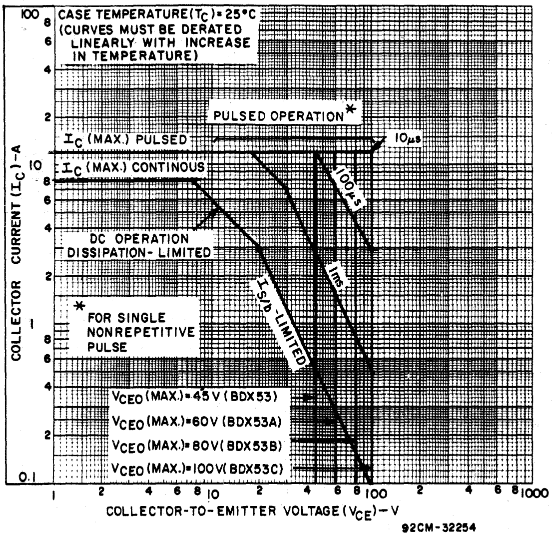


Fig. 2—Maximum operating areas for all types.

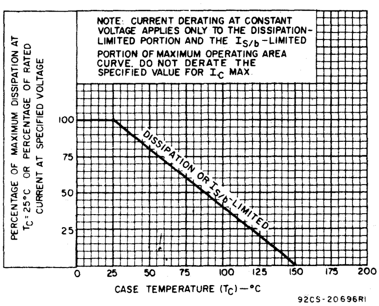


Fig. 3—Derating curve for all types.

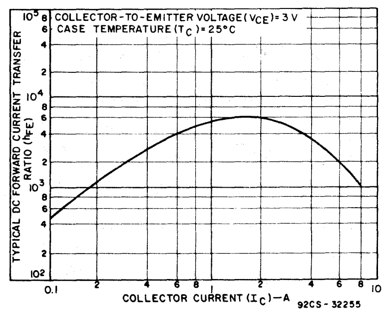


Fig. 4—Typical dc-beta characteristics for all types.

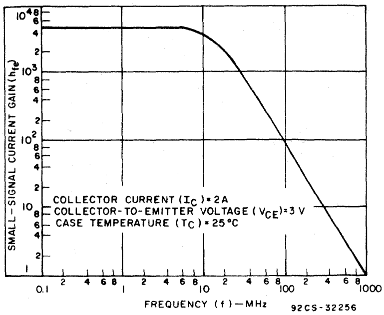


Fig. 5—Typical small-signal gain for all types.

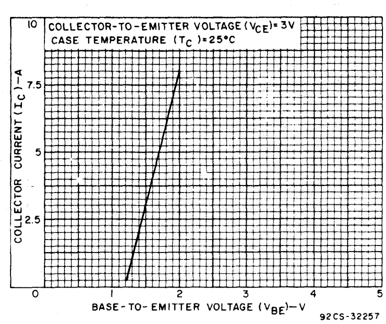


Fig. 6—Typical transfer characteristics for all types.

BDX53, BDX53A, BDX53B, BDX53C

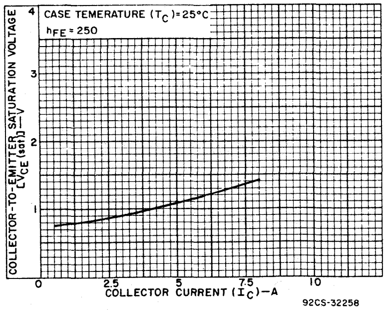


Fig. 7—Typical saturation characteristics for all types.

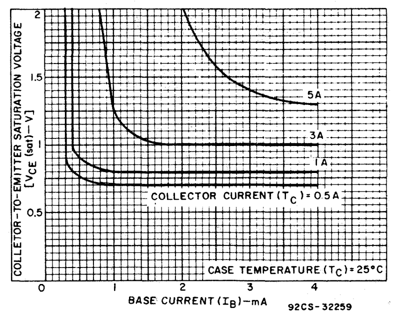


Fig. 8—Typical saturation characteristics for all types.

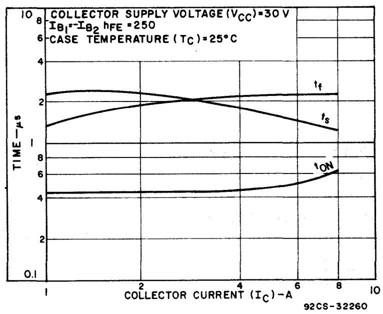


Fig. 9—Typical saturated switching-time characteristics for all types.

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

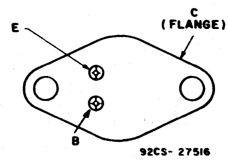
Features:

- 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 BDX83, BDX83A, BDX83B, and BDX83C are monolithic silicon n-p-n Darlington transistors designed for low and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO 220AA steel hermatic package.

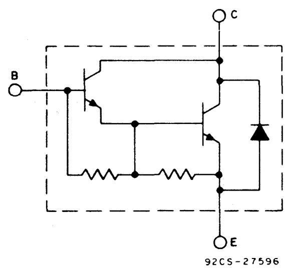


Fig. 1—Schematic diagram for all types.

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					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX83		BDX83A		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	20				0	–	1	–	–	mA
	30				0	–	–	–	1	
I_{CEV}	45		−1.5			–	0.5	–	–	
	60		−1.5			–	–	–	0.5	
T_C = 150°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	–	–	–	A
	50					–	–	0.9	–	
	30					4.16	–	4.16	–	
$R_{\theta JC}$						--	1.4	–	1.4	°C/W

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

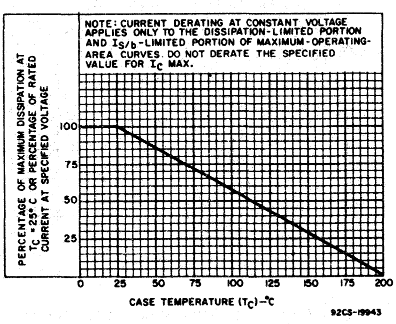


Fig. 2—Derating curves for all types.

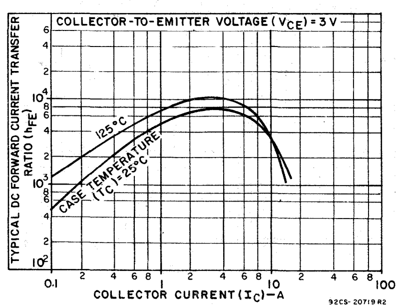


Fig. 3 — Typical dc-beta characteristics for all types.

BDX83, BDX83A, BDX83B, BDX83C

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

CHARAC-TERISTIC SYMBOL	TEST CONDITIONS					LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc		BDX83B		BDX83C		
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	40				0	–	1	–	–	mA
	50				0	–	–	–	1	
I_{CEV}	80		−1.5			–	0.5	–	–	
	100		−1.5			–	–	–	0.5	
T_C = 150°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%.

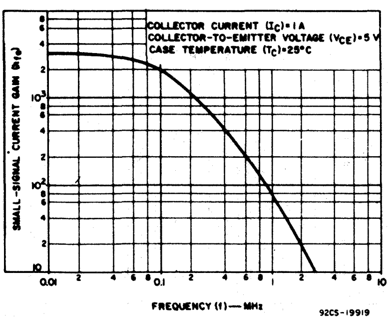


Fig. 4 — Typical small-signal gain for all types.

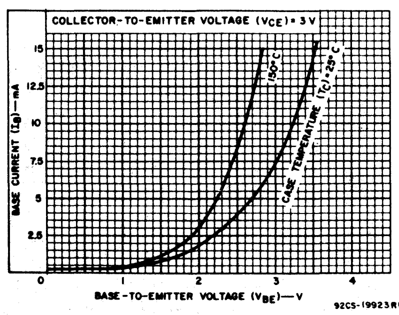


Fig. 5 — Typical input characteristic for all types.

BDX83, BDX83A, BDX83B, BDX83C

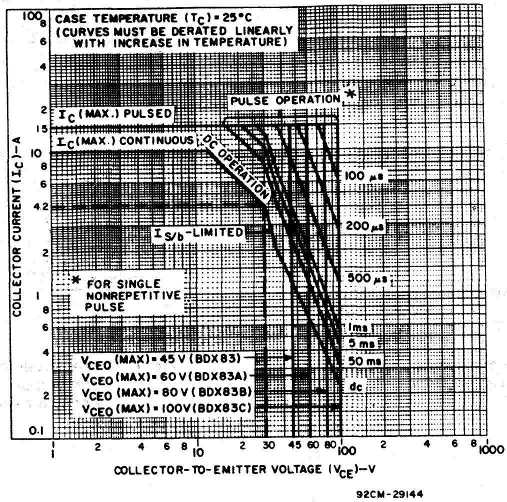


Fig. 6 — Maximum operating area for all types.

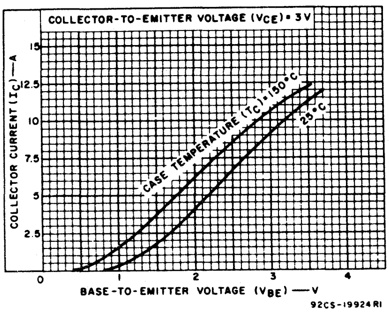


Fig. 7 — Typical transfer characteristics for all types.

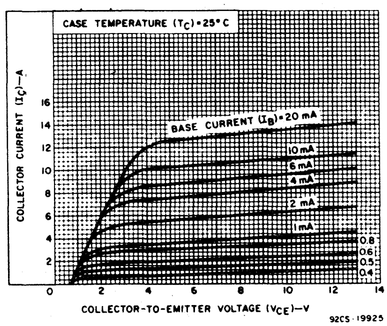


Fig. 8 — Typical output characteristics for all types.

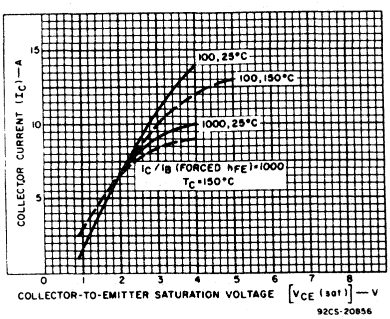


Fig. 9 — Typical saturation characteristics for all types.

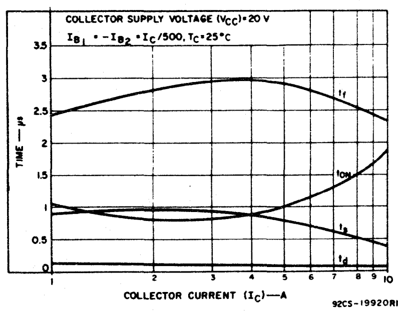


Fig. 10 — Typical saturated switching-time characteristics for all types.

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BDX83, BDX83A, BDX83B, BDX83C

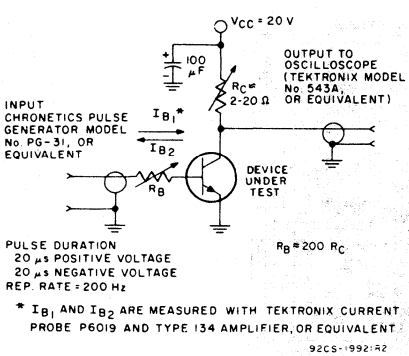


Fig. 11 — Circuit used to measure saturated-switching times.

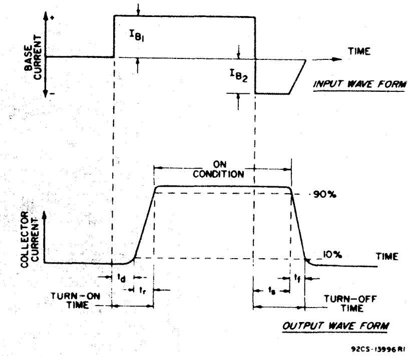


Fig. 12 — Phase relationship between input curren and output current showing reference points for specification of switching times.

File Number **819**

BDY29

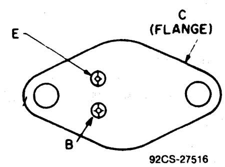
High-Power High-Current Transistor

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

2

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 V_{CB}	V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BDY29 Min.	Max.	UNITS
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	$\|h_{fe}\|$		4		1		4	16 (Typ.)	
Common-Emitter, Small-Signal, Short-Circuit, Forward Current Transfer Ratio: f = 1 kHz	h_{fe}		4		1		40	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	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

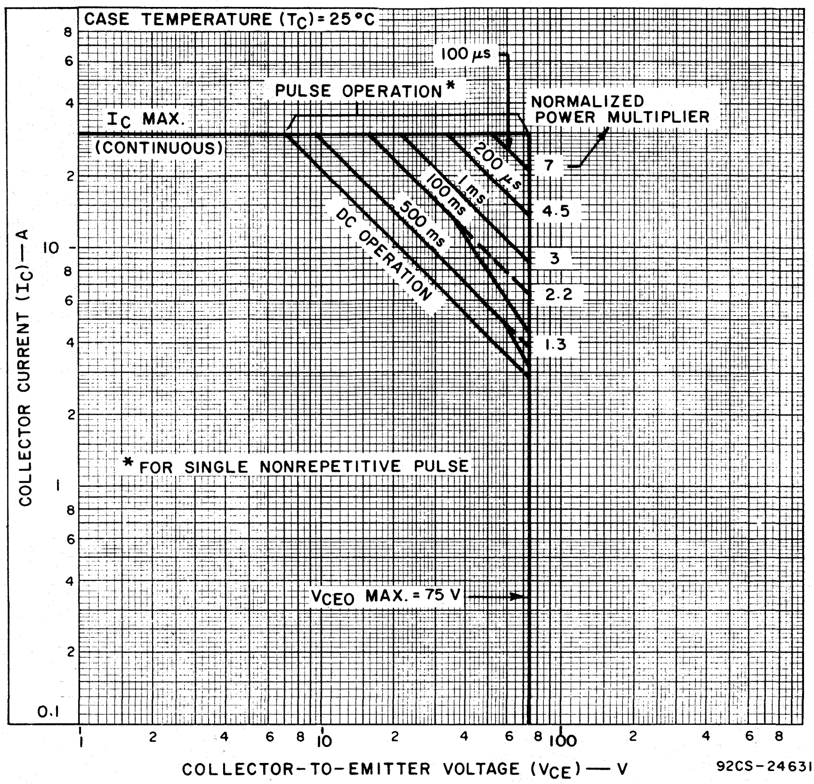


Fig. 1 — Maximum operating areas.

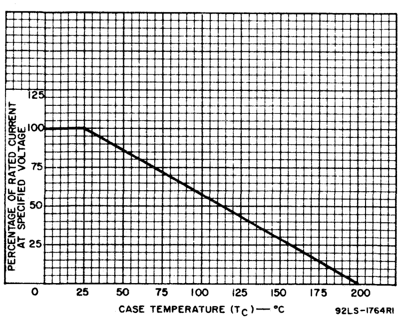


Fig. 2 — Dissipation derating curve.

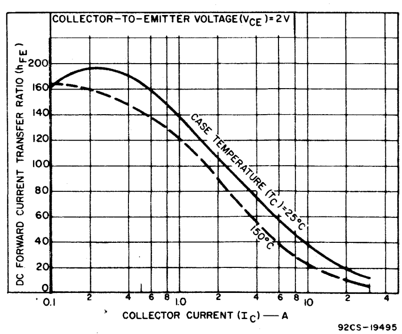


Fig. 3 — Typical dc beta characteristics.

BDY29

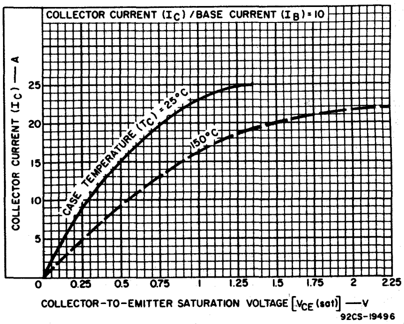


Fig. 4 — Typical saturation-voltage characteristics.

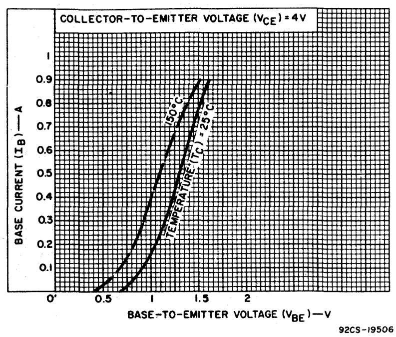


Fig. 5 — Typical input characteristics.

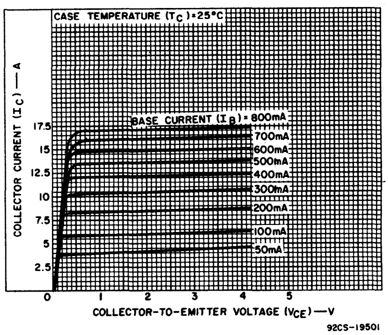


Fig. 6 — Typical output characteristics.

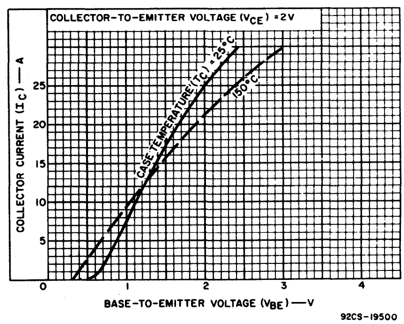


Fig. 7 — Typical transfer characteristics.

File Number **1215**

BDY55, BDY56

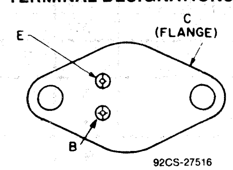
High-Current, High-Power, High-Speed Silicon N-P-N Planar Transistors

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

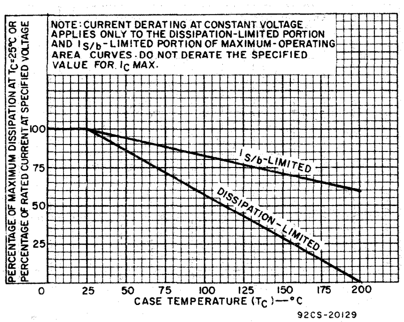


Fig. 1 - Dissipation derating curves for both types.

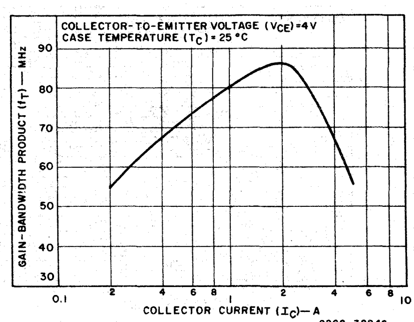


Fig. 2 - Typical gain-bandwidth product for both types.

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.

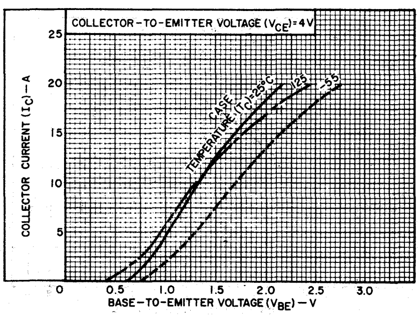


Fig. 3 - Typical transfer characteristics for both types.

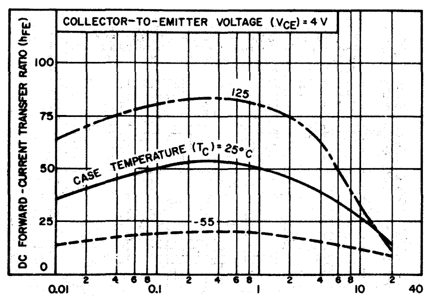


Fig. 4 - Typical dc beta characteristics for both types.

BDY55, BDY56

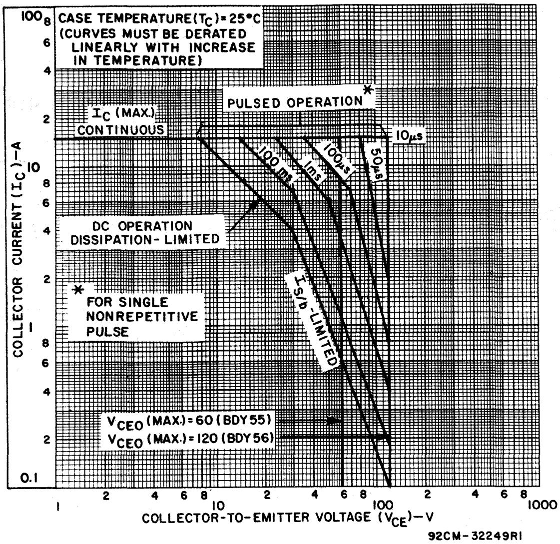


Fig. 5 - Maximum operating areas for both types.

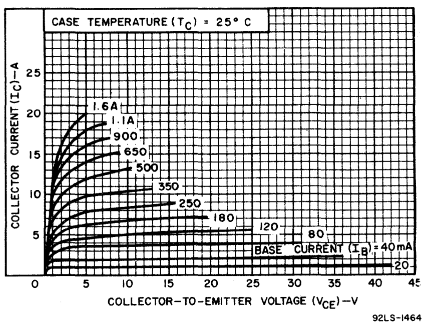


Fig. 6 - Typical output characterstics for both types.

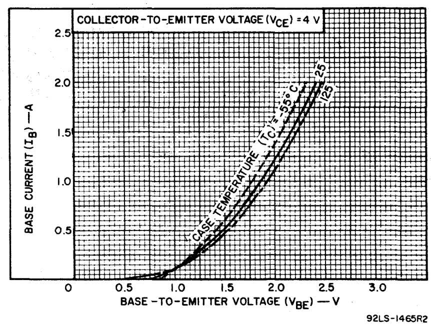


Fig. 7 - Typical input characterstics for both types.

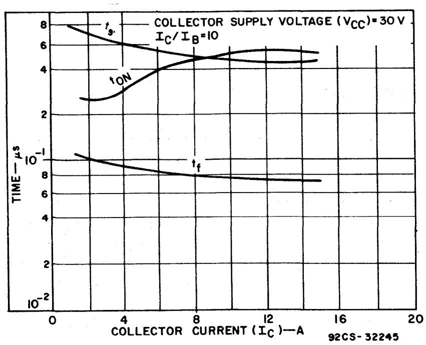


Fig. 8 - Switching-time characterstics as a function of collector current for both types.

BDY58R File Number **1206**

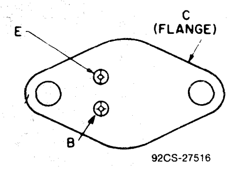
Silicon N-P-N Switching Transistors

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				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BDY58R			
	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.

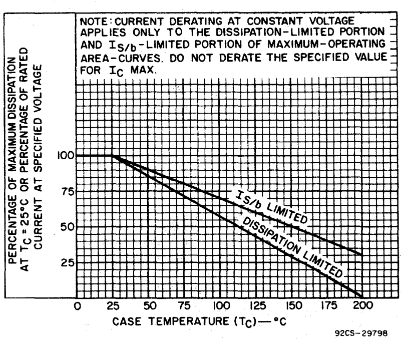


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

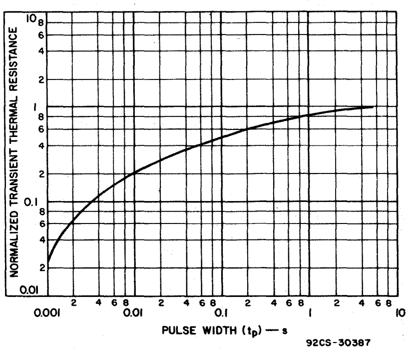


Fig. 2 — Typical thermal-response characteristic.

BDY58R

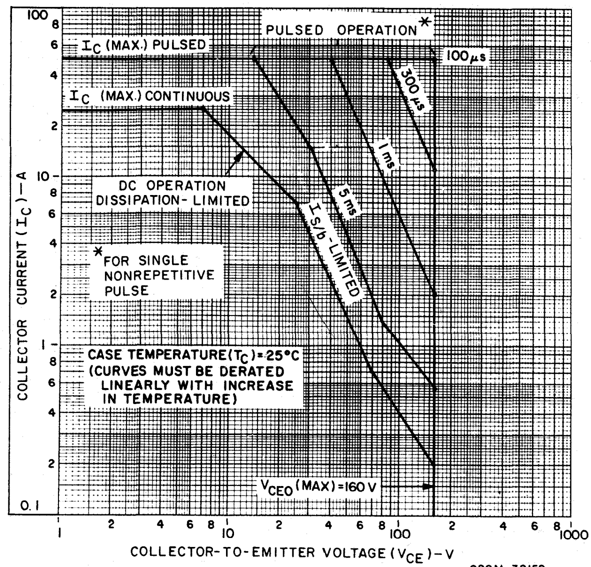


Fig. 3 — Maximum safe-operating areas (T_C = 25° C).

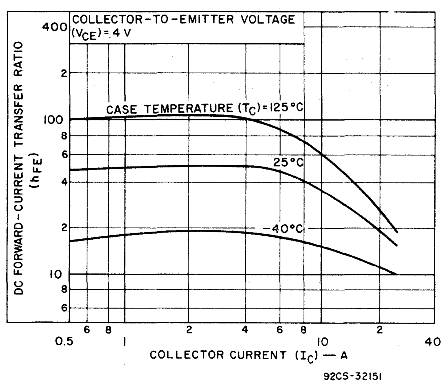


Fig. 4 — Typical dc beta characteristics.

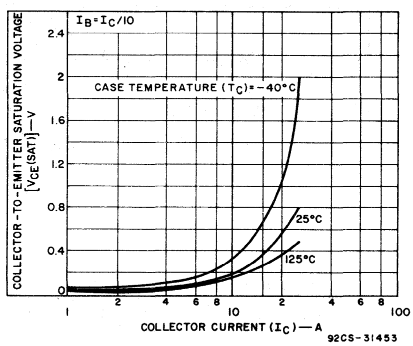


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

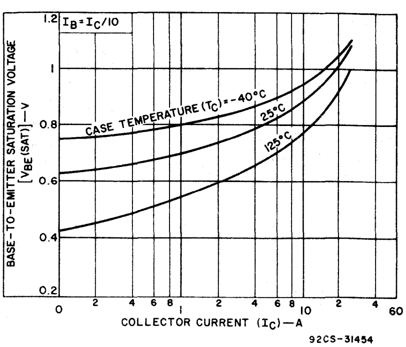


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

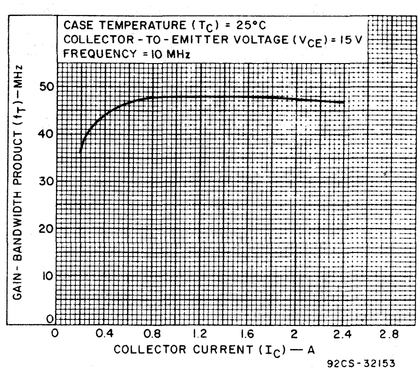


Fig. 7 — Typical gain-bandwidth product.

BDY58R

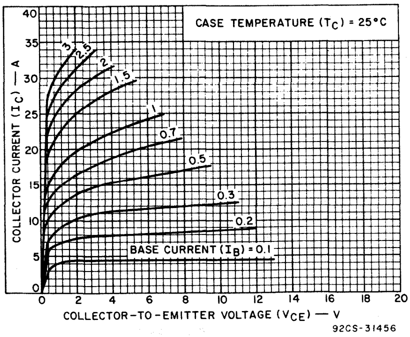


Fig. 8 — Typical output characteristics.

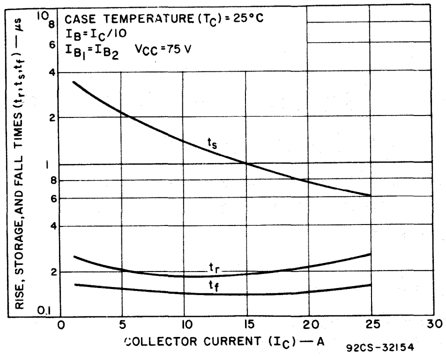


Fig. 9 — Typical saturated-switching-time characteristics as a function of collector current.

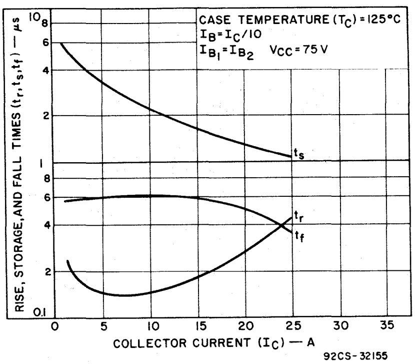


Fig. 10 — Typical switching-time characteristics at T_C = 125° C as a function of collector current.

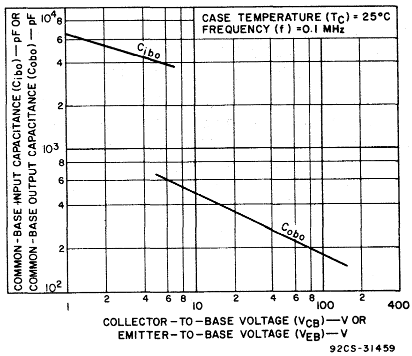


Fig. 11 — Typical common-base input (C_{ibo}) of output (C_{obo}) capacitance characteristics.

2

BDY90, BDY91, BDY92

File Number **1289**

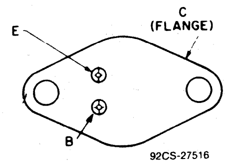
High-Speed Silicon N-P-N Planar Transistors

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.

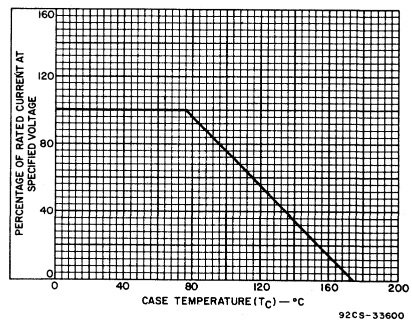


Fig. 1 - Dissipation derating curves for all types.

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: Voltage V dc		Current A dc		Limits: BDY90		BDY91		BDY92		Units
	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** $I_{B_1} = -I_{B_2}$

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

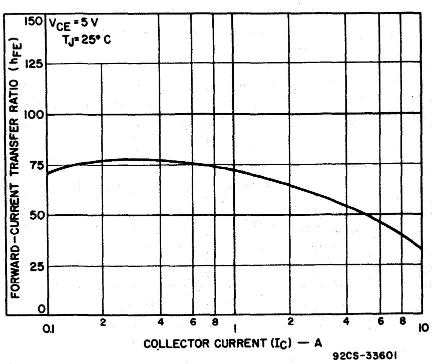


Fig.2 - Typical dc beta characteristics for all types.

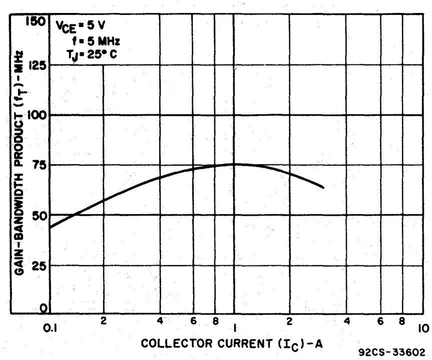


Fig.3 - Typical gain-bandwidth product for all types.

BDY90, BDY91, BDY92

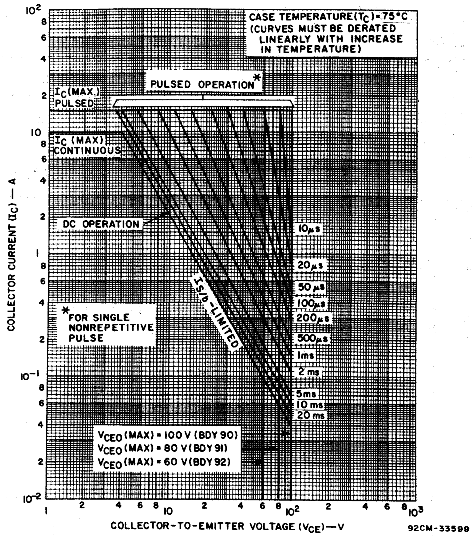


Fig.4 - Maximum operating areas for all types.

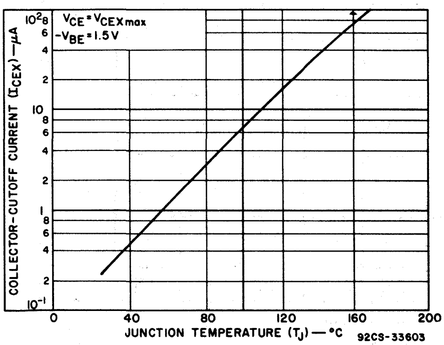


Fig.5 - Typical collector leakage current vs. junction temperature for all types.

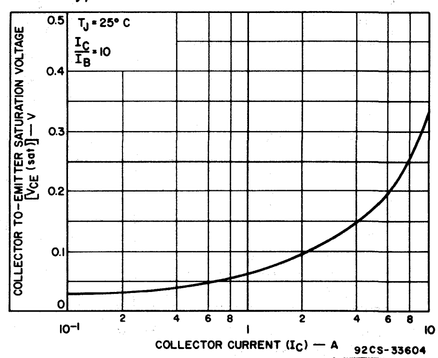


Fig.6 - Typical collector-to-emitter saturation voltage characteristics as a function of collector current for all types.

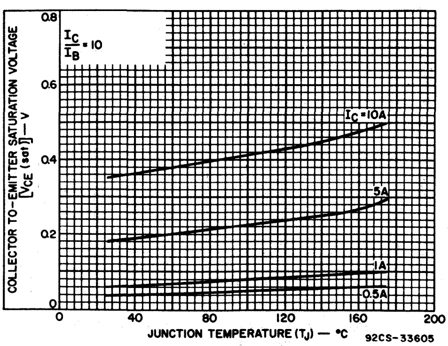


Fig.7 - Typical collector-to-emitter saturation voltage characteristics as a function of junction temperature for all types.

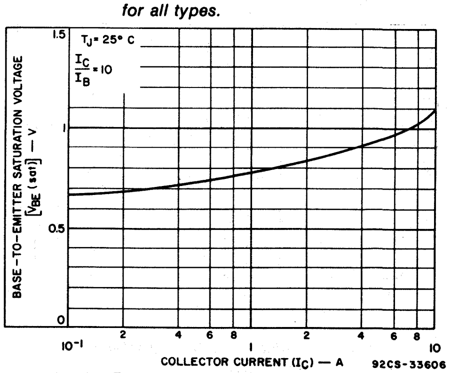


Fig.8 - Typical base-to-emitter saturation voltage characteristics as a function of collector current for all types.

BDY90, BDY91, BDY92

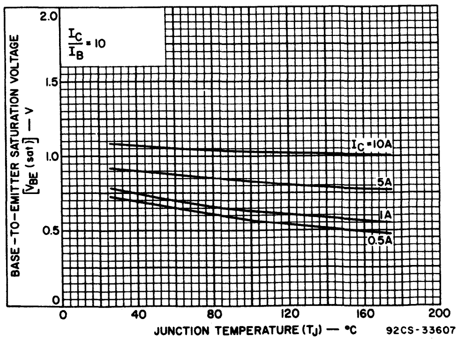


Fig.9 - Typical base-to-emitter saturation voltage characteristics as a function of junction temperature.

2

BFT19, BFT19A, BFT19B

File Number **683**

Silicon P-N-P High-Voltage Planar Transistors

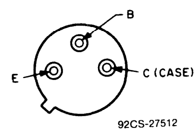
For High-Speed Switching and Linear-Amplifier Applications in Military, Industrial and Commercial Equipment

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)

RCA-BFT19, BFT19A, and BFT19B are silicon p-n-p transistors with high breakdown voltages, high frequency response, and fast switching speeds. These transistors differ in their voltage ratings.

Typical applications include high-voltage differential and operational amplifiers; high-voltage inverters, and high-voltage, low-current switching and series regulators.

TERMINAL DESIGNATIONS



JEDEC TO-205AD

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		BFT19	BFT19A	BFT19B	
COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	−200	−300	−400	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With base open	$V_{CEO}(sus)$	−150	−250	−350	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$	−200	−300	−400	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	−5	−5	−5	V
COLLECTOR CURRENT (Continuous)	I_C	−1	−1	−1	A
BASE CURRENT (Continuous)	I_B	−0.5	−0.5	−0.5	A
TRANSISTOR DISSIPATION:	P_T				
At case temperatures up to 25°C		5	5	5	W
At case temperatures above 25°C		See Figs. 1 & 4.			
At ambient temperatures up to 25°C		1	1	1	W
At ambient temperatures above 25°C		Derate linearly at 5.7 mW/°C			
TEMPERATURE RANGE:					
Storage and Operating (Junction)		← −65 to 200 →			°C
PIN TEMPERATURE (During Soldering):					
At distance ⩾ 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					0	–	−100	–	–	–	–	μA
		−200					0	–	–	–	−100	–	–	
		−300					0	–	–	–	–	–	−100	
Emitter-Cutoff Current	I_{EBO}			−5	0			–	−100	–	−100	–	−100	μA
DC Forward-Current Transfer Ratio	h_{FE}		−10		−10			20	–	20	–	20	–	
			−10		−30			25	–	25	–	25	–	
			−10		−50			20	–	20	–	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		−1	–	−1	–	−1	–	−1	V
					−30		−3	–	−2.5	–	−2.5	–	−2.5	
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.

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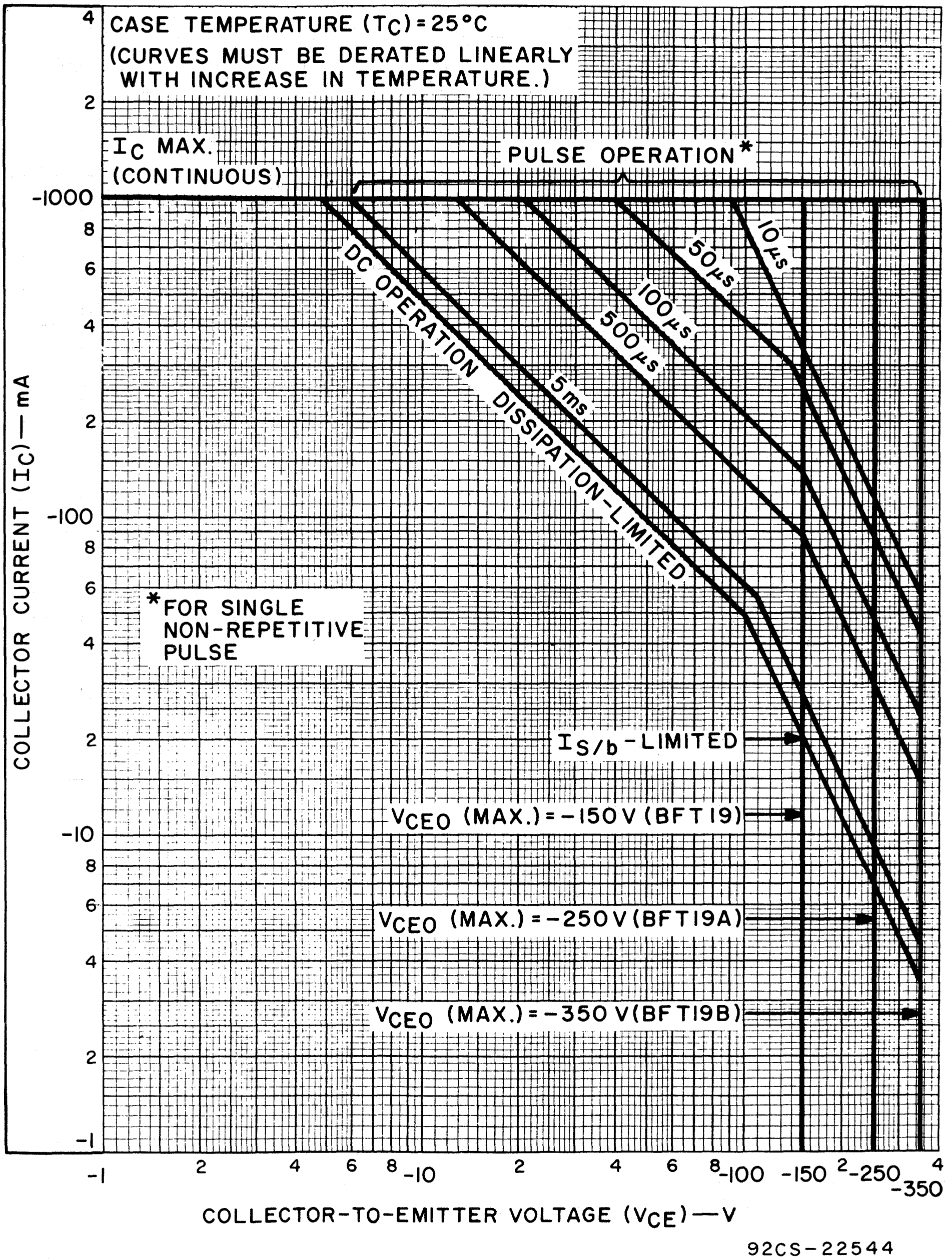
BFT19, BFT19A, BFT19B



BFT19, BFT19A, BFT19B

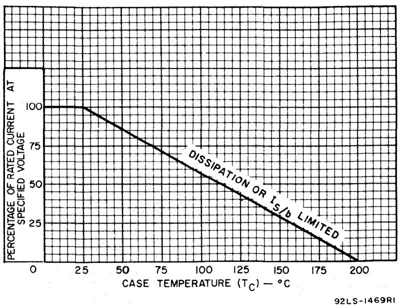


Fig. 2 — Dissipation derating curve.

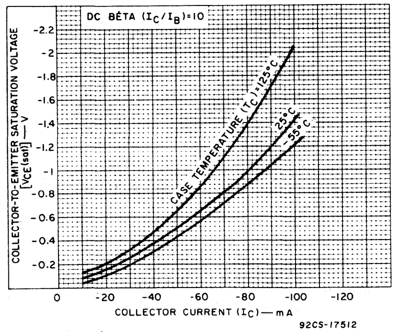


Fig. 3 — Typical collector-to-emitter saturation voltage.

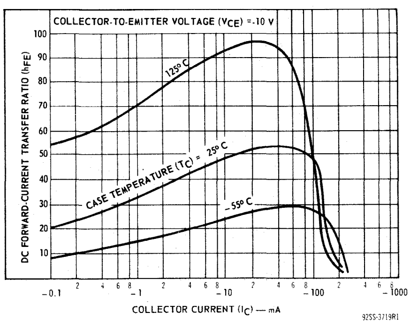


Fig. 4 — Typical dc-beta characteristics.

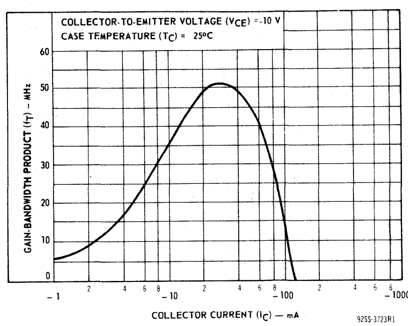


Fig. 5 — Typical gain-bandwidth product.

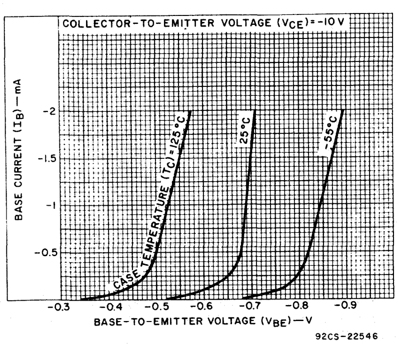


Fig. 6 — Typical input characteristics.

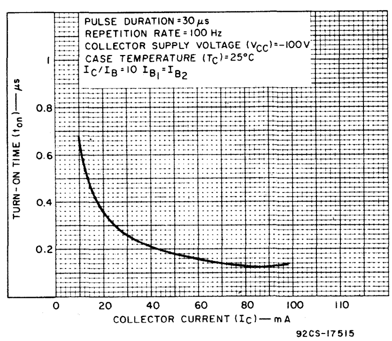


Fig. 7 — Typical turn-on time characteristic.

BFT19, BFT19A, BFT19B

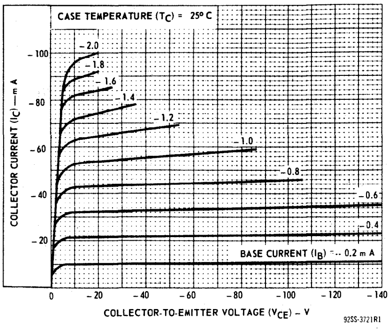


Fig. 8 — Typical output characteristics.

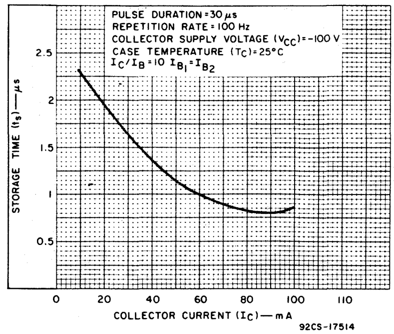


Fig. 9 — Typical storage-time characteristic.

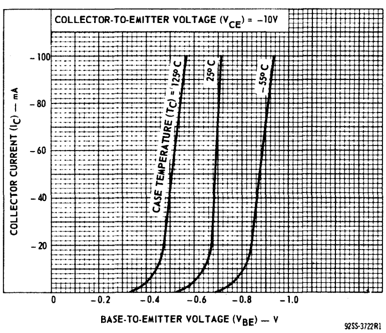


Fig. 10 — Typical transfer characteristics.

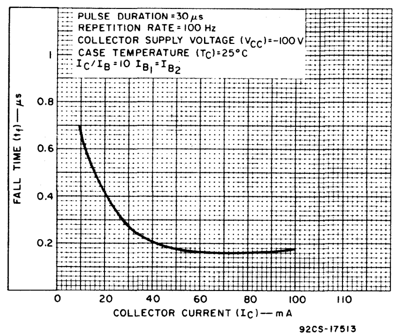


Fig. 11 — Typical fall-time characteristic.

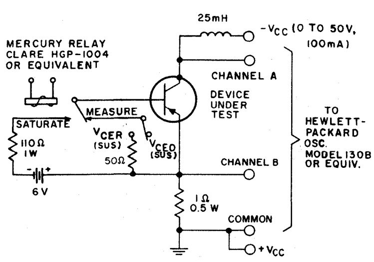
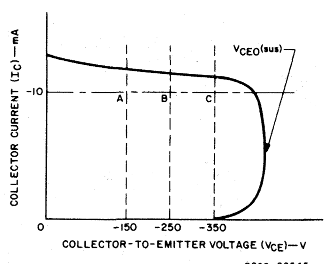


Fig. 12 — Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$.



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

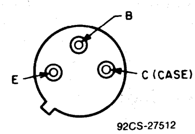
Silicon P-N-P High-Voltage Transistors

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

2

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.

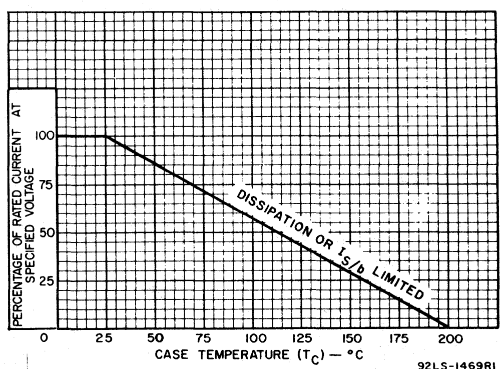


Fig. 1 — Dissipation derating curve.

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 –75					– –	–1 –	– –	– –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: VOLTAGE V dc V_{CB}	V_{CE}	V_{EB}	CURRENT mA dc I_C	I_B	LIMITS BFT28B Min.	BFT28B Max.	BFT28C Min.	BFT28C Max.	UNITS
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%.

2

BFT28, BFT28A, BFT28B, BFT28C

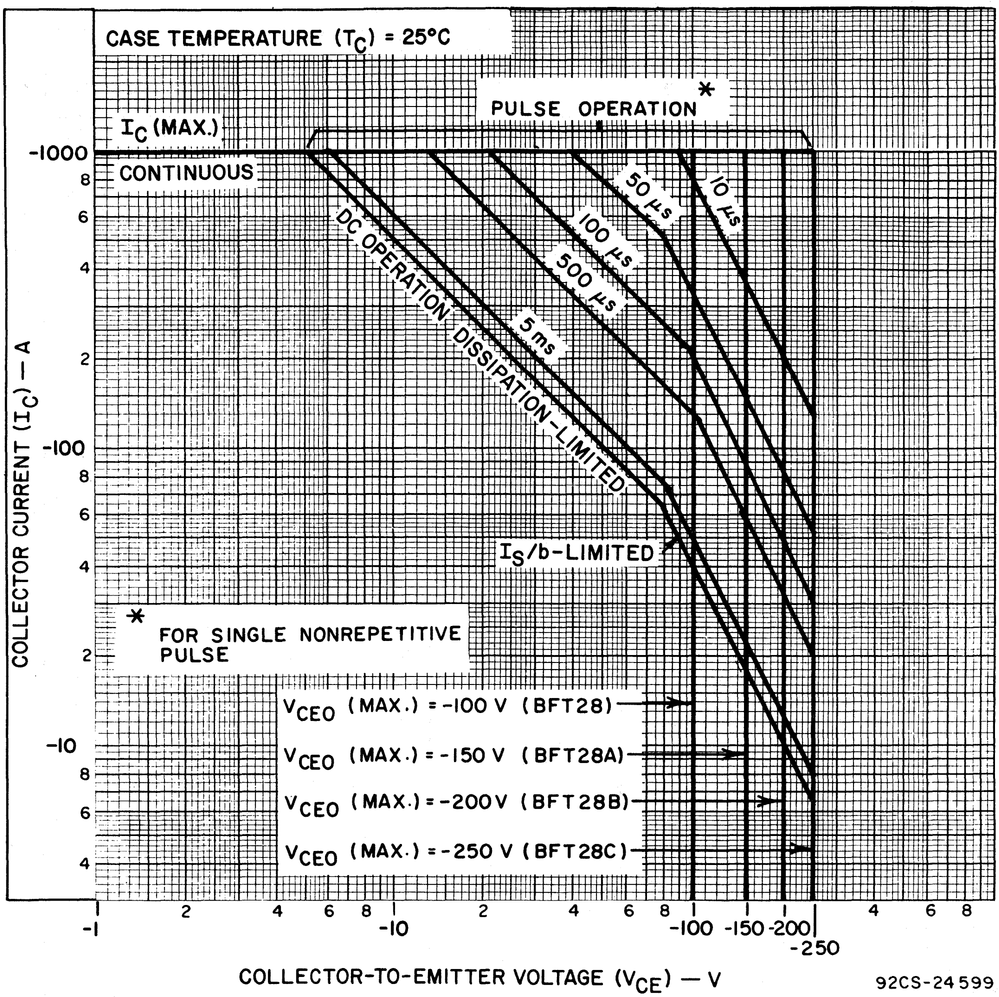


Fig. 2 — Maximum safe operating areas.

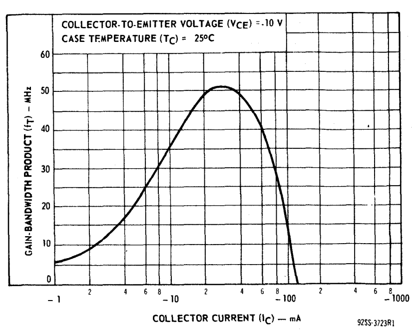


Fig. 3 — Typical gain-bandwidth product for all types.

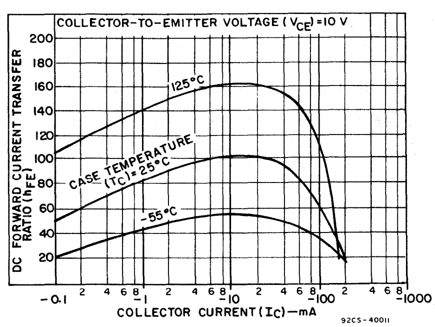


Fig. 4 — Typical dc beta characteristics for all types.

BFT28, BFT28A, BFT28B, BFT28C

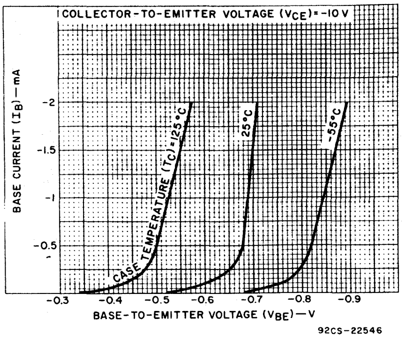


Fig. 5 — Typical input characteristics for all types.

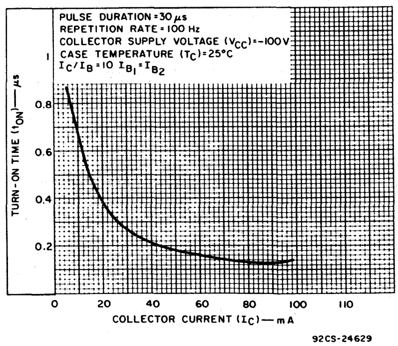


Fig. 6 — Typical turn-on time characteristic for all types.

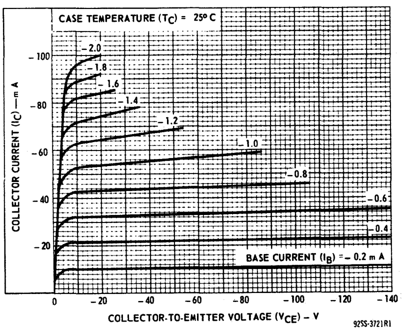


Fig. 7 — Typical output characteristics for all types.

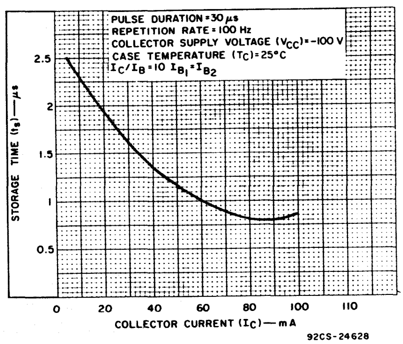


Fig. 8 — Typical storage-time characteristic for all types.

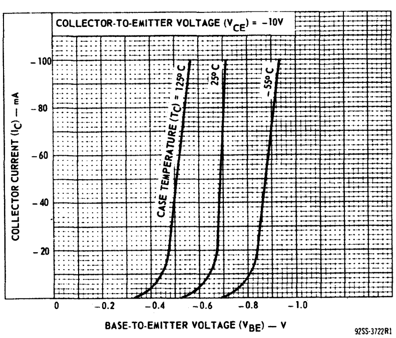


Fig. 9 — Typical transfer characteristics for all types.

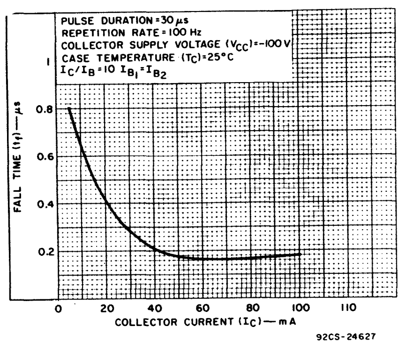


Fig. 10 — Typical fall-time characteristic for all types.

BFT28, BFT28A, BFT28B, BFT28C

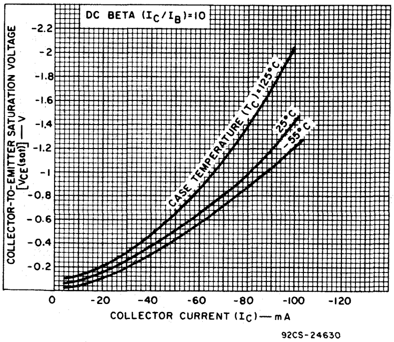


Fig. 11 – Typical collector-to-emitter saturation voltage for all types.

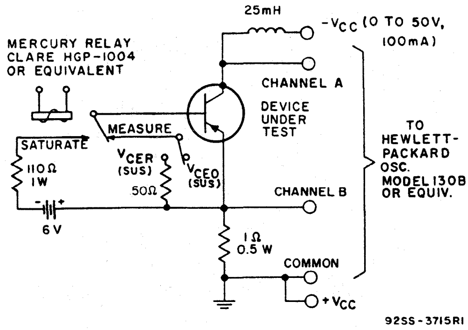
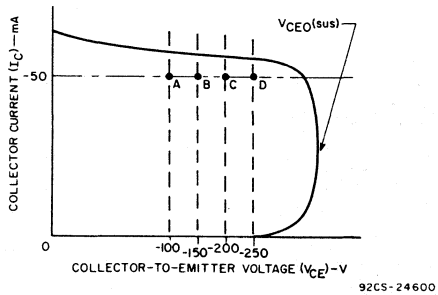


Fig. 12 – Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$.



The sustaining voltage V_{CEO}(sus) is acceptable when the trace falls to the right and above point "A" for type BFT28. The trace must fall to the right and above point "B" for BFT28A; point "C" for BFT28B; and point "D" for BFT28C.

Fig. 13 – Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 12).

File Number **1308**

BUW40, BUW40A, BUW40B

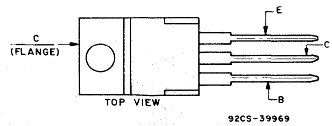
1-A *SwitchMax* VERSAWATT Transistors

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*

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

2

The RCA-BUW40, BUW40A, and BUW40B SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-percent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The RCA-BUW40, BUW40A, and BUW40B series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUW40	BUW40A	BUW40B	
V_{CER}, R_{BE} = 100 Ω	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
$I_{C(sat)}$		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

BUW40, BUW40A, BUW40B

ELECTRICAL CHARACTERISTICS

CHARAC-TERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS BUW40		BUW40A		BUW40B		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
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

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

BUW40, BUW40A, BUW40B

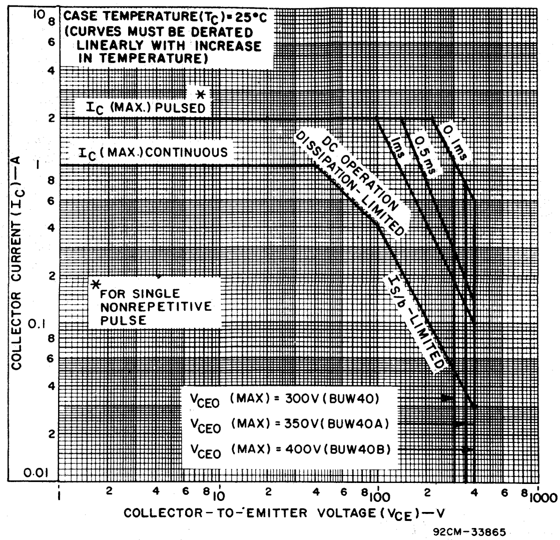


Fig. 1 — Maximum operating areas for all types.

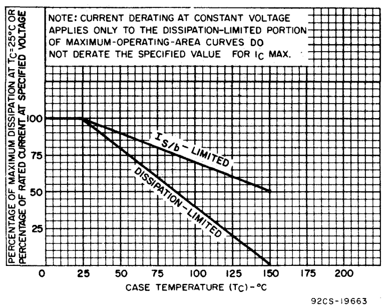


Fig. 2 — Derating curve for all types.

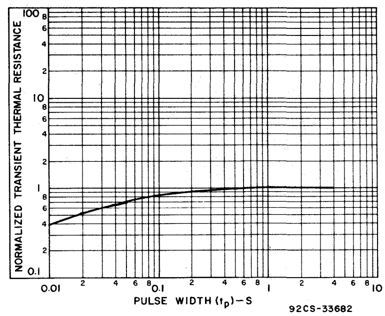


Fig. 3 — Typical thermal-response characteristics for all types.

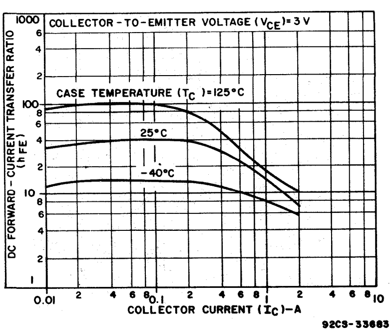


Fig. 4 — Typical dc beta characteristics for all types.

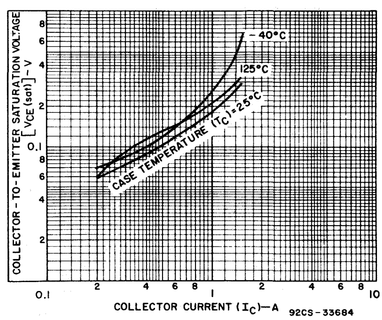


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

BUW40, BUW40A, BUW40B

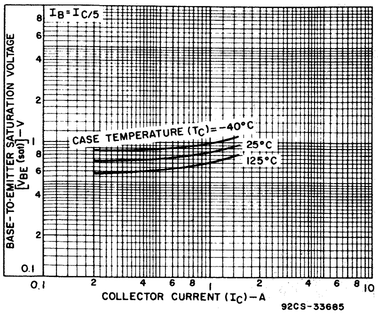


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

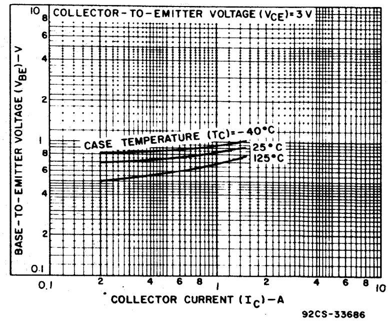


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

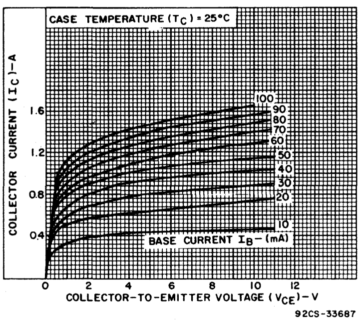


Fig. 8 — Typical output characteristics for all types.

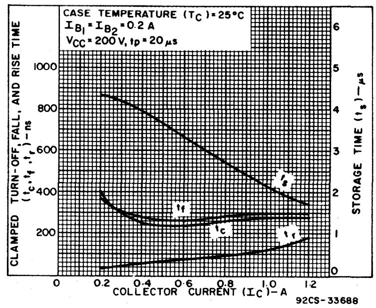


Fig. 9 — Typical saturated-switching-time characteristics for all types.

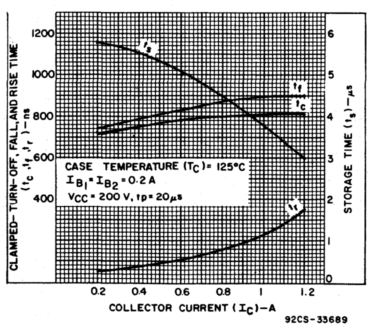


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

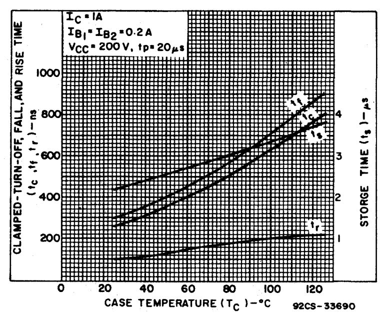


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

BUW40, BUW40A, BUW40B

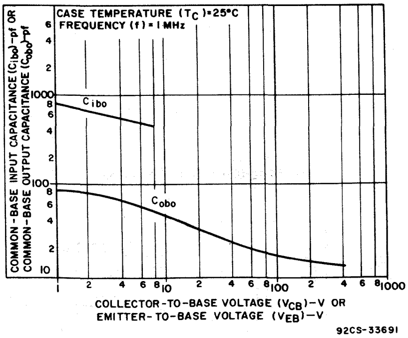


Fig. 12 — *Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.*

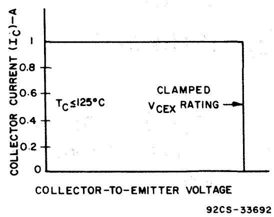


Fig. 13 — *Maximum operating conditions for switching between saturation and cutoff.*

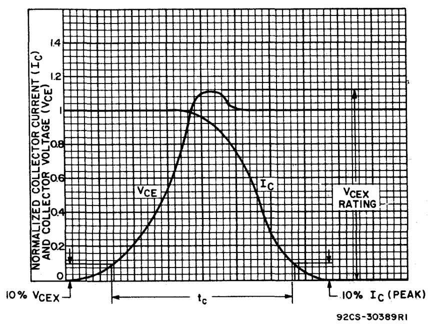


Fig. 14 — *Oscilloscope display for measurement of clamped induction switching time (t_c).*

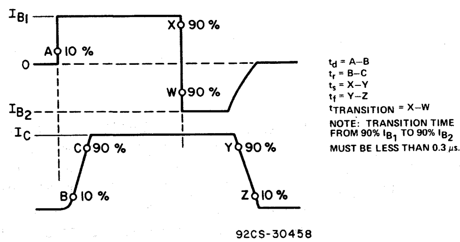


Fig. 15 — *Phase relationship between input and output currents showing reference points for specification of switching*

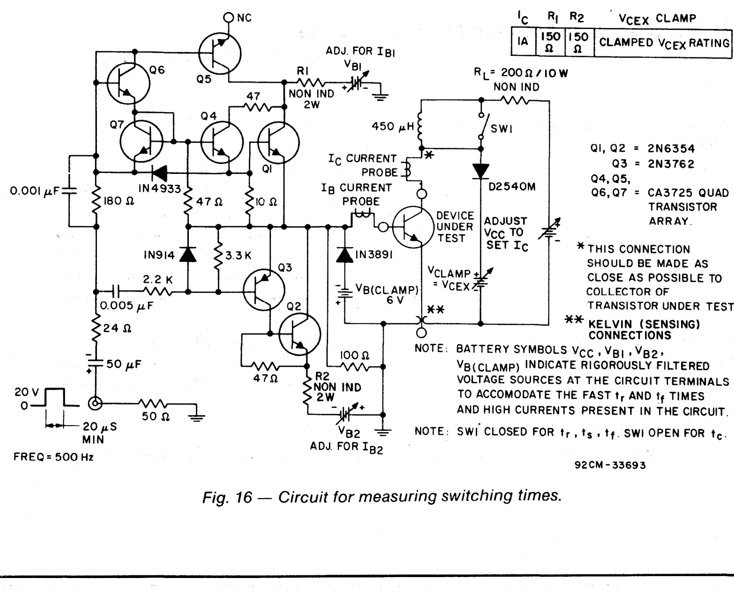


Fig. 16 — *Circuit for measuring switching times.*

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

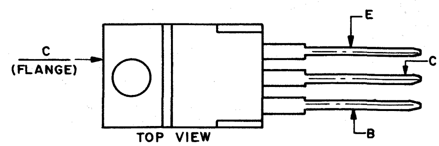
Features:

- *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



JEDEC TO-220AB

The BUW41, BUW41A, and BUW41B SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The BUW41, BUW41A and BUW41B series transistors are supplied in JEDEC TO-220AB (VERSAWATT) plastic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUW41	BUW41A	BUW41B	
V_{CER}, R_{BE} = 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

BUW41, BUW41A, BUW41B

ELECTRICAL CHARACTERISTICS

Characteristic	Test Conditions: Voltage V dc V_{CE}	Voltage V dc V_{BE}	Current A dc I_C	Current A dc I_B	BUW41 Min.	BUW41 Max.	BUW41A Min.	BUW41A Max.	BUW41B Min.	BUW41B Max.	Units
T_C = 25° C											
I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	mA
	650	−.5			—	—	—	—	—	0.1	mA
I_{IEBO}		−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]	1	—	1	—	1	—	1	V
			8[a]	4	—	2	—	2	—	2	V
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 µH		−5	5	1[e]	350	—	400	—	450	—	V
R_{BB} = 5 Ω		−5	8	3[e]	200	—	250	—	300	—	V
$I_{S/b}$	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	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

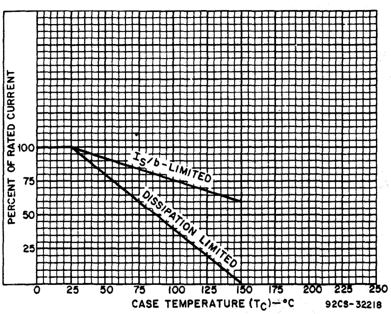


Fig. 1 — Dissipation and $I_{S/b}$ derating curves for all types.

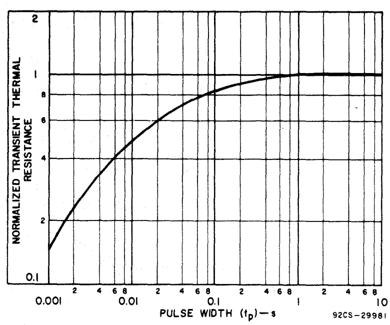


Fig. 2 — Typical thermal-response characteristics for all types.

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_{B1} = $-I_{B2}$.

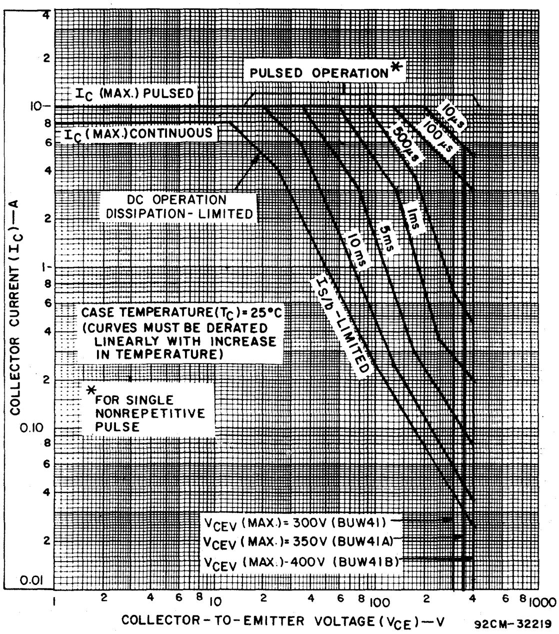


Fig. 3 — Maximum operating areas for all types [T_C = 25° C].

BUW41, BUW41A, BUW41B

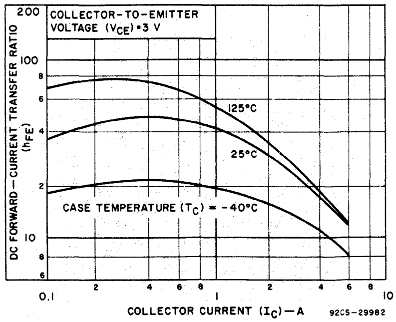


Fig. 4 — Typical dc beta characteristics for all types.

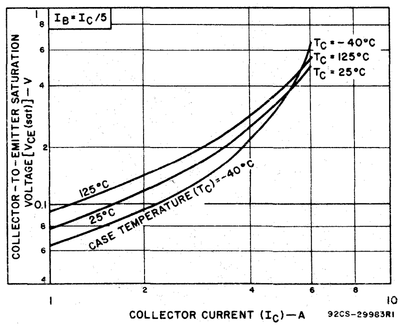


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

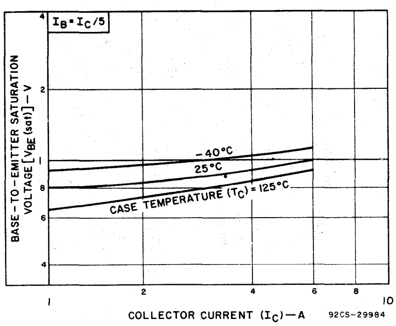


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

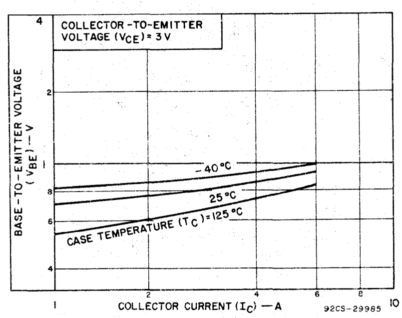


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

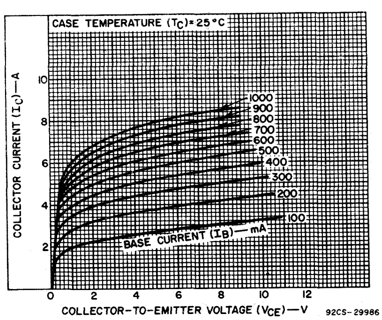


Fig. 8 — Typical output characteristics for all types.

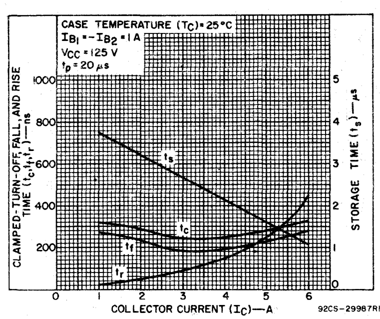


Fig. 9 — Typical saturated-switching-time characteristics for all types.

BUW41, BUW41A, BUW41B

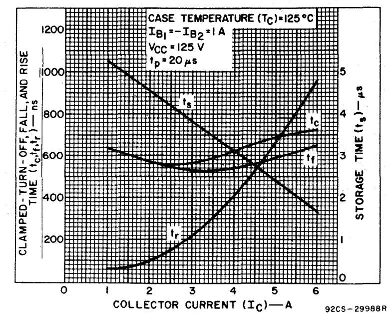


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

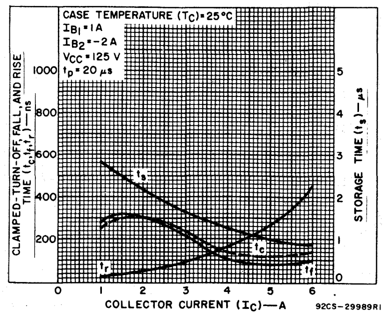


Fig. 11 — Typical saturated-switching-time characteristics for all types.

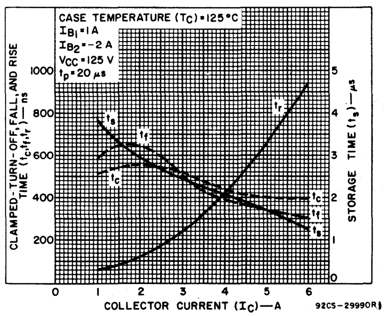


Fig. 12 — Typical saturated-switching-time characteristics for all types.

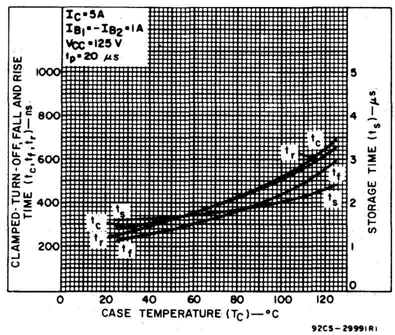


Fig. 13 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

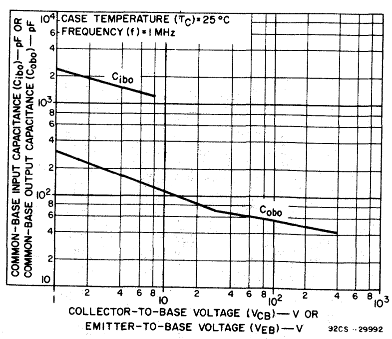


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

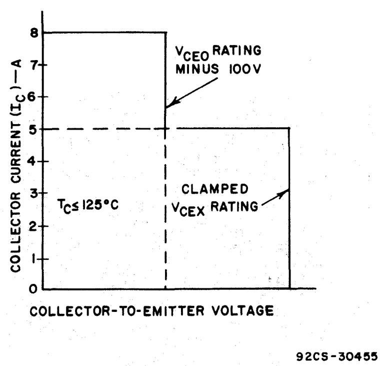


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

BUW41, BUW41A, BUW41B

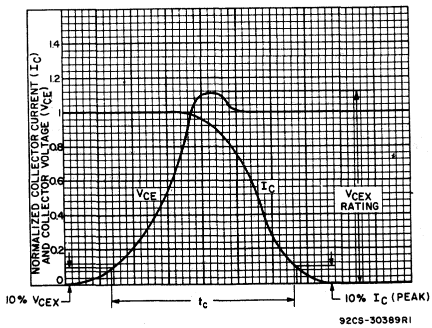


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

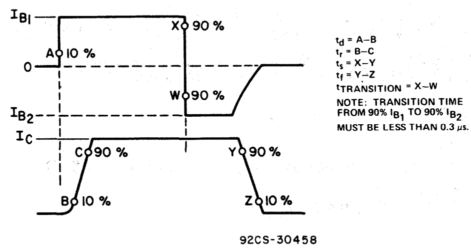


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

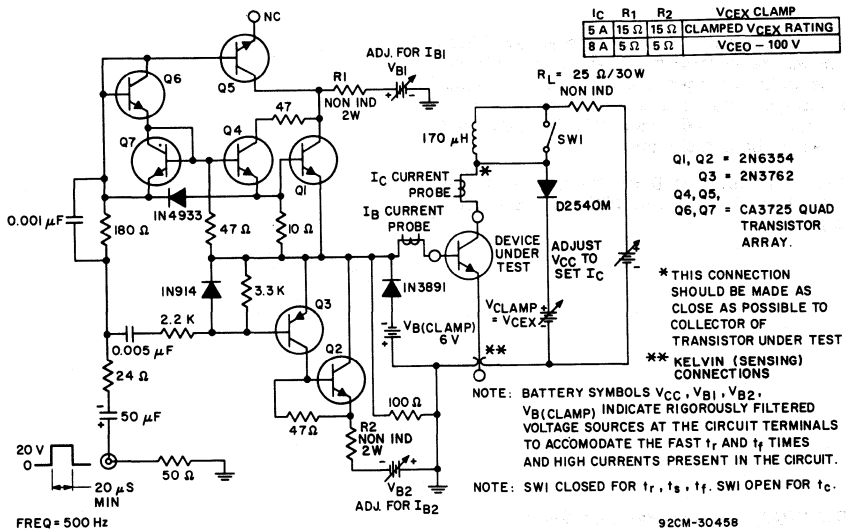


Fig. 18 — Circuit for measuring switching times.

BUW64A, BUW64B, BUW64C

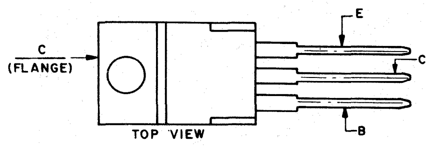
File Number **1199**

High-Current, Silicon N-P-N VERSAWATT Transistors

Switching Applications

Features:
- *Fast switching speed at temperatures up to 125° C*
- *Low $V_{CE}(sat)$*
- *VERSAWATT plastic package*

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

CHARAC-TERISTIC	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

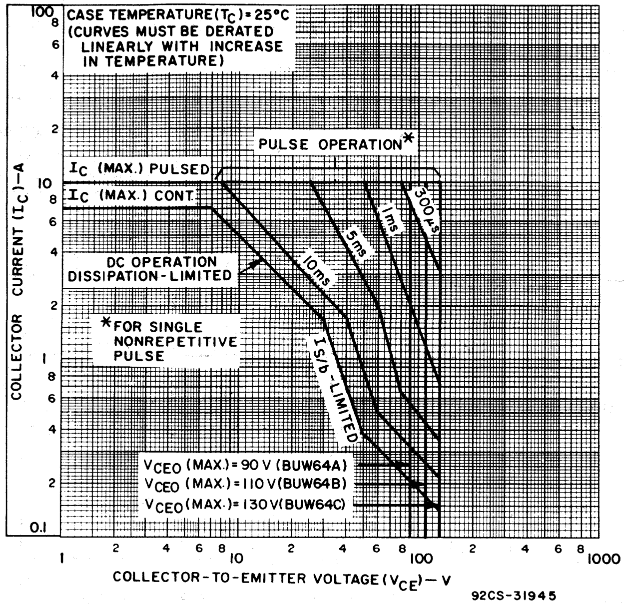


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

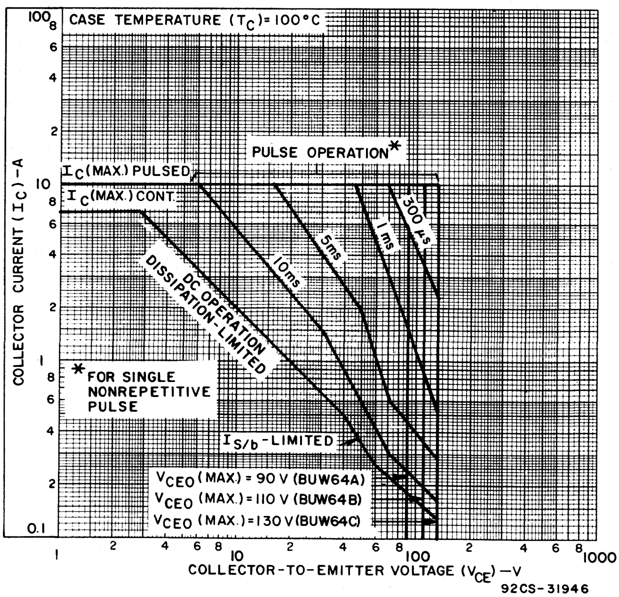


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

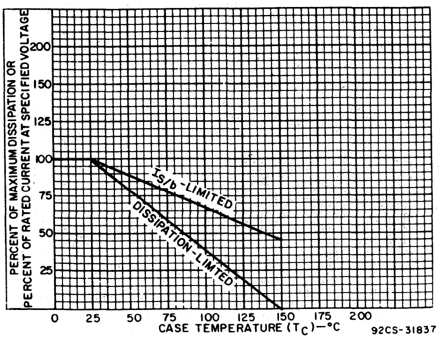


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

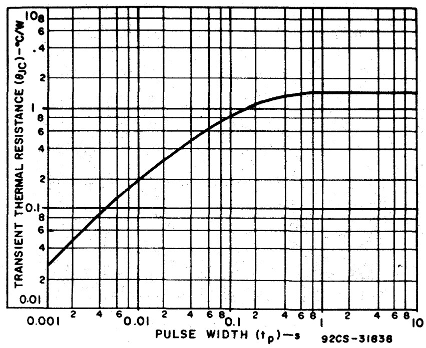


Fig. 4 — Typical thermal-response characteristic for all types.

2

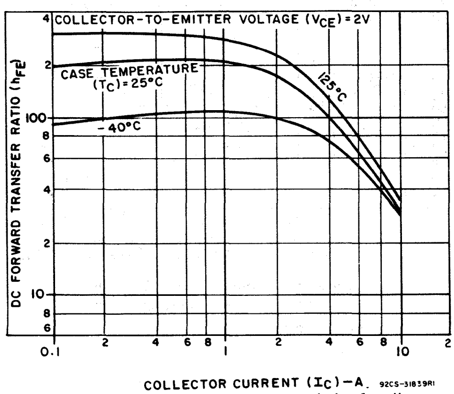


Fig. 5 — Typical dc beta characteristics for all types.

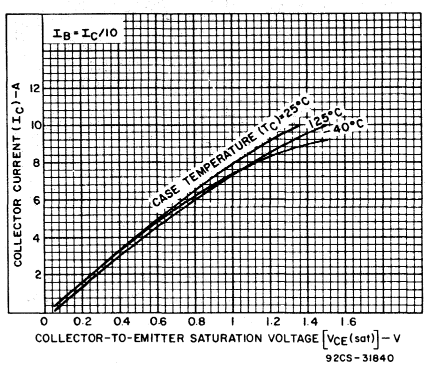


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

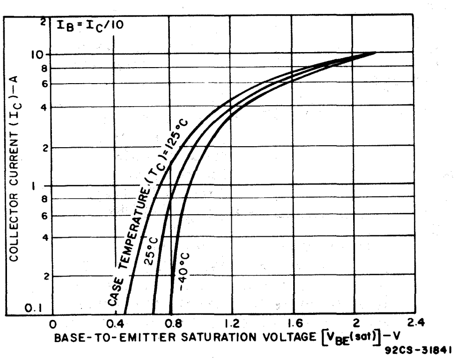


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

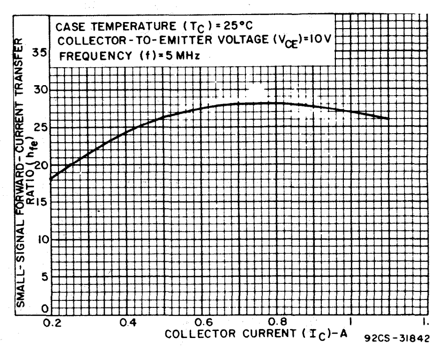


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

BUW64A, BUW64B, BUW64C

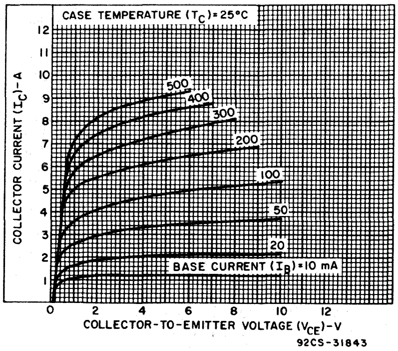


Fig. 9 – Typical output characteristics for all types.

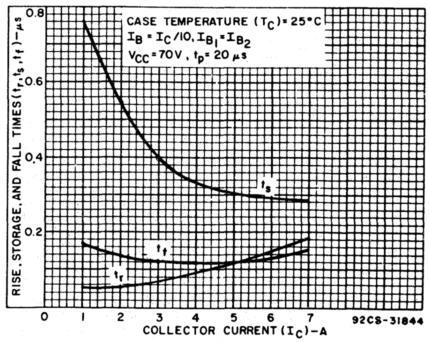


Fig. 10 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

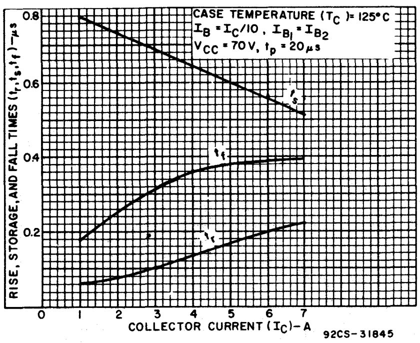


Fig. 11 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

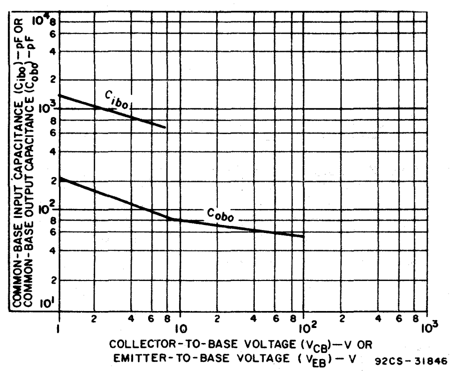


Fig. 12 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

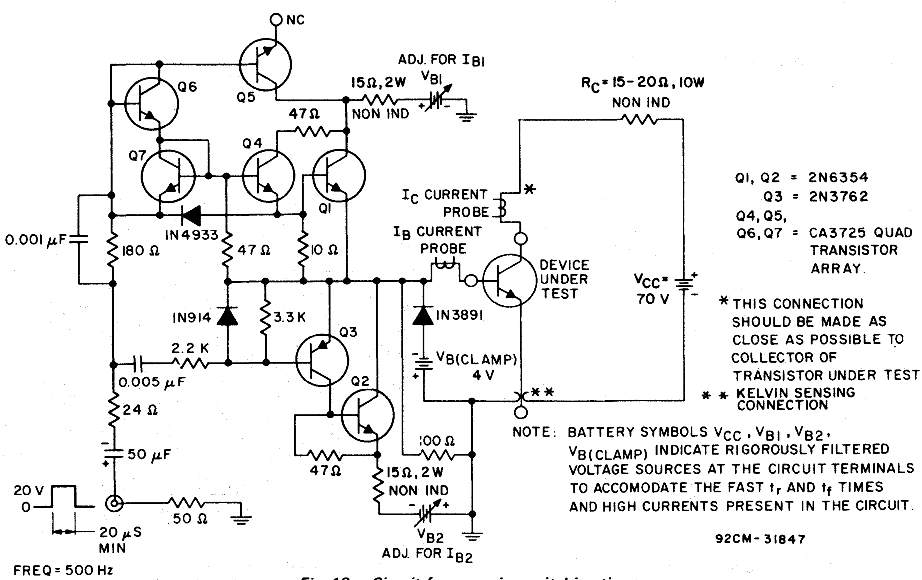
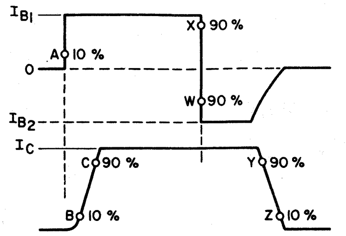


Fig. 13 – Circuit for measuing switching times.

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.

2

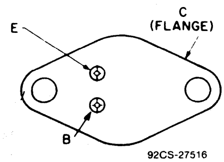
BUX10A

File Number **1216**

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.

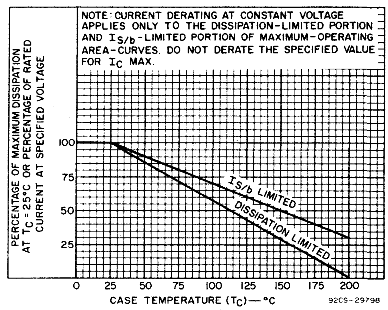


Fig. 1—Derating curves for $I_{S/b}$ and dissipation.

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

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 $I_{B1} = I_{B2}$			20	2	—	0.6	1.2	μs
t_f $I_{B1} = I_{B2}$			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.

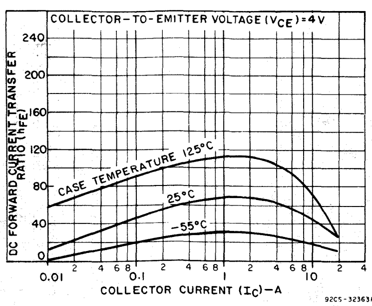


Fig. 2—Typical dc beta characteristics.

BUX10A

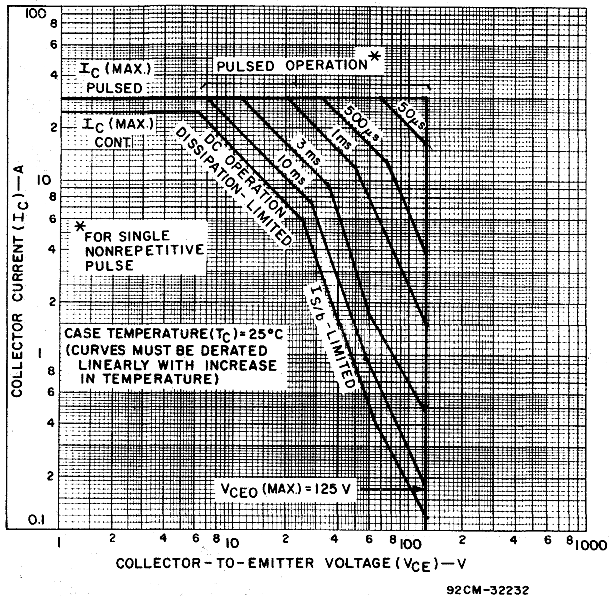


Fig. 3—Maximum safe-operating areas (T_C = 25°C).

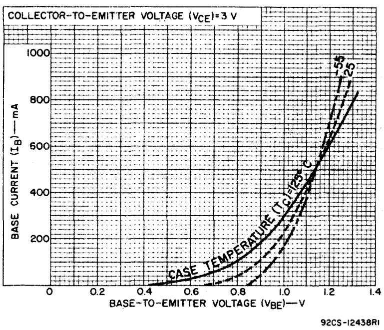


Fig. 4—Typical input characteristics.

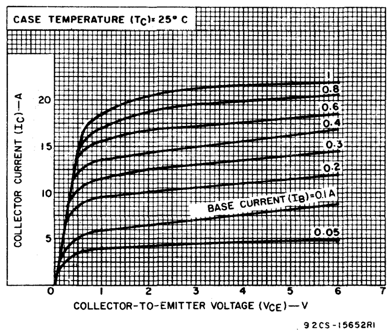


Fig. 5—Typical output characteristics.

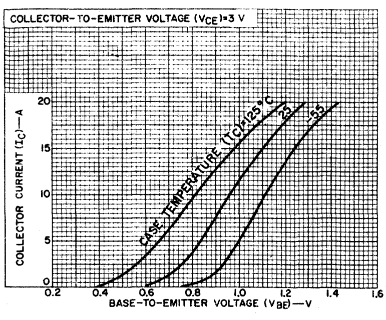


Fig. 6—Typical transfer characteristics.

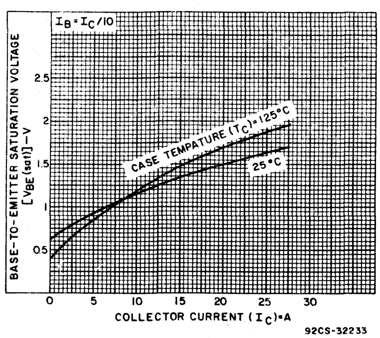


Fig. 7—Typical base-to-emitter saturation voltage characteristics.

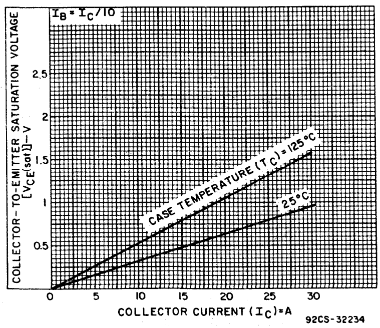


Fig. 8—Typical collector-to-emitter saturation voltage characteristics.

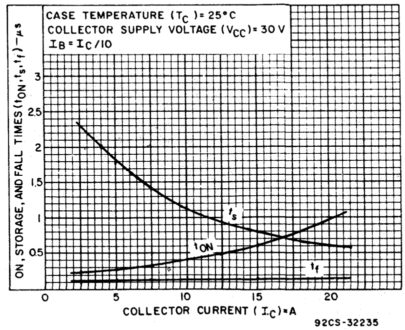


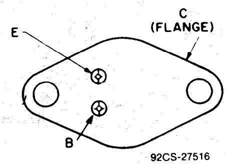
Fig. 9—Typical switching time characteristics.

2

BUX11A File Number **1353**

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

TERMINAL DESIGNATIONS



JEDEC TO-204AA

Features:

- V_{CEO} - 190 V
- I_C - 20 A
- P_T - 200 W

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 Ω	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

2

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 BUX11A Min.	Max.	UNITS
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 4		8^b 15^b		20 10	60 —	
$V_{BE}(sat)$			15^b	1.88	—	1.8	V
$V_{CE}(sat)$			8^b 15^b	0.8 1.88	— —	0.6 1.5	V
$I_{S/b}$ t_p = 1s nonrep.	140 18				0.15 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}.

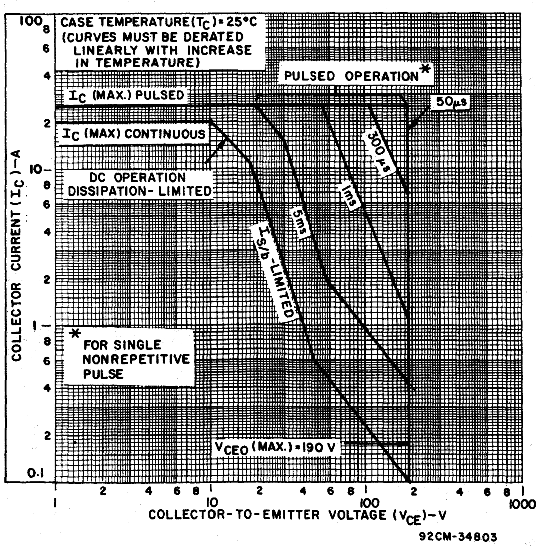


Fig. 1 — Maximum safe-operating areas for BUX11A (T_c = 25° C).

BUX11A

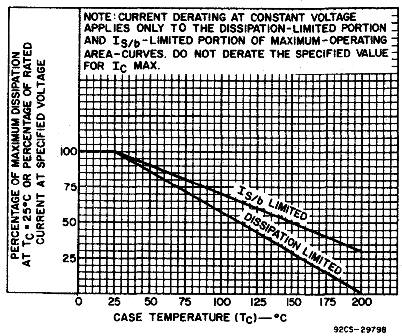


Fig. 2 — Derating curves for $I_{S/b}$ and dissipation.

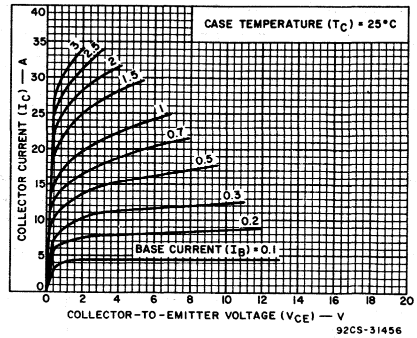


Fig. 3 — Typical output characteristics.

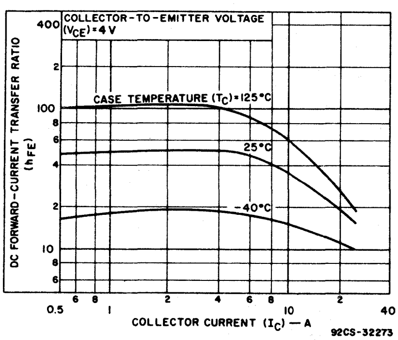


Fig. 4 — Typical dc beta characteristics.

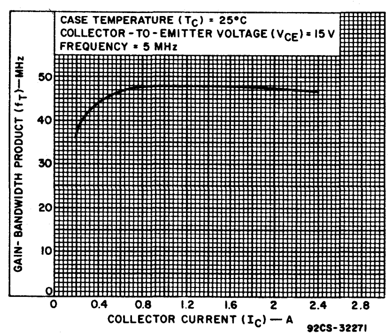


Fig. 5 — Typical gain-bandwidth product.

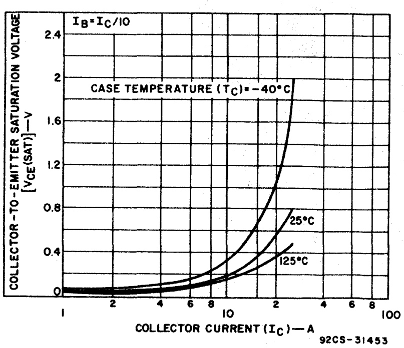


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics.

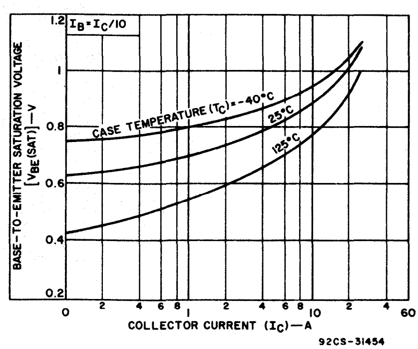


Fig. 7 — Typical base-to-emitter saturation voltage characteristics.

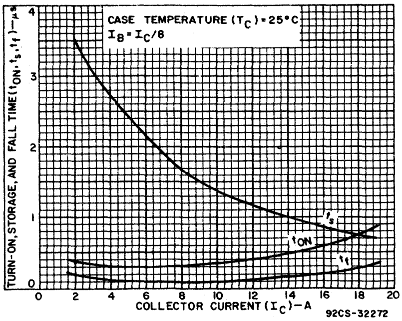


Fig. 8 — Typical saturated-switching times as a function of collector current.

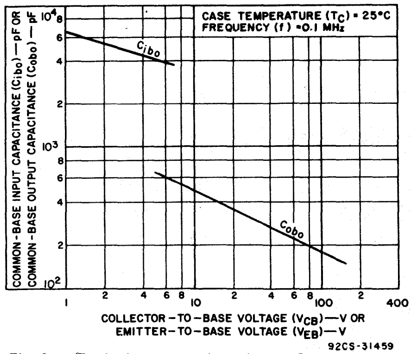


Fig. 9 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic.

2

BUX14

File Number **1203**

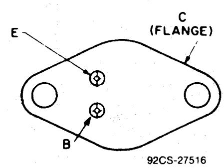
Silicon N-P-N Switching Transistor

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

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 BUX14 Min.	Typ.	Max.	UNITS
I_{CEO}	320	—	—	0	—	—	1.5	mA
I_{CEX}	450	−1.5	—	—	—	—	1.5	mA
T_C = 125°C	450	−1.5	—	—	—	—	6	mA
I_{EBO}	—	−5	0	—	—	—	1	mA
$V_{CEO}(sus)$[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
$V_{CE}(sat)$	—	—	3[a]	0.6	—	0.2	0.6	V
	—	—	6[a]	1.2	—	0.5	1.5	V
h_{FE}	4	—	3[a]	—	15	—	60	
	4	—	6[a]	—	8	—	—	
$I_{S/b}$	140	—	—	—	0.15	—	—	A
t = 1 s, nonrepetitive	30	—	—	—	5	—	—	A
f_T	15	—	1	—	8	—	—	MHz
t_{on}	V_{CC} = 30 V	—	6	1.2	—	0.5	1.4	μs
t_s	V_{CC} = 30 V	—	6	1.2[c]	—	1	3	μs
t_f	V_{CC} = 30 V	—	6	1.2[c]	—	0.3	1.2	μs
$R_{\theta JC}$	—	—	—	—	—	—	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]$I_{B1} = I_{B2}$.

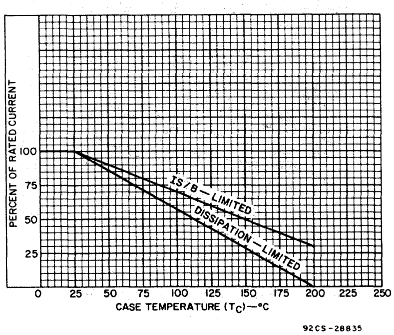


Fig. 1 — Dissipation and $I_{S/b}$ derating curves.

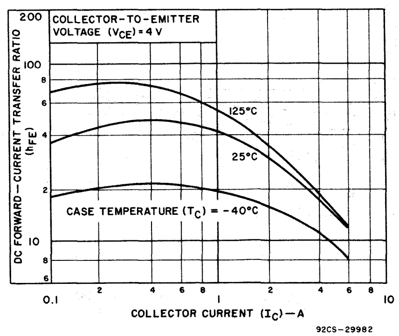


Fig. 2 — Typical dc beta characteristics.

BUX14

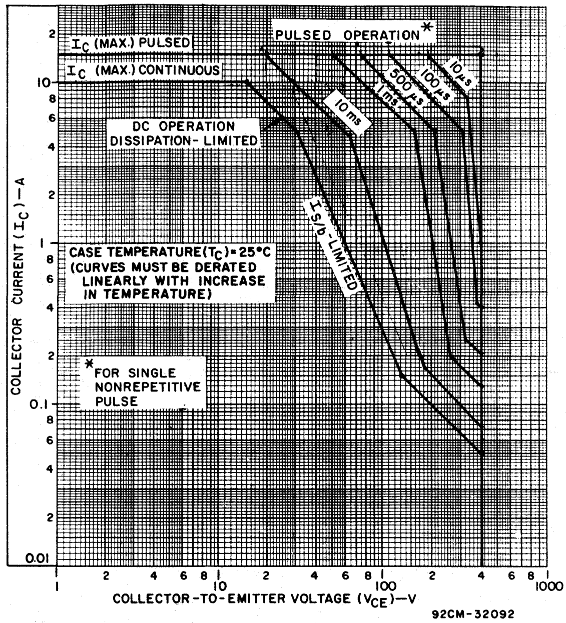


Fig. 3 — Maximum safe-operating areas (T_C = 25° C).

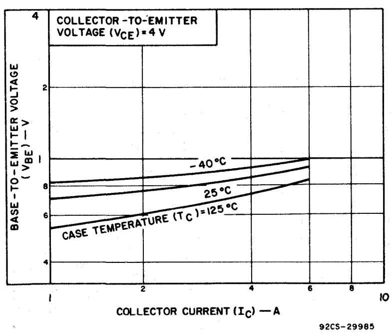


Fig. 4 — Typical base-to-emitter voltage as a function of collector current.

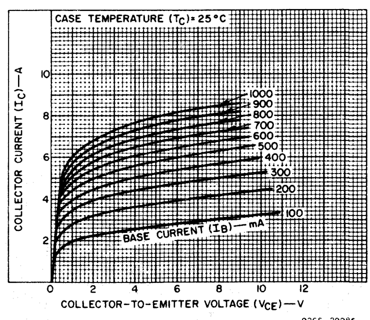


Fig. 5 — Typical output characteristics.

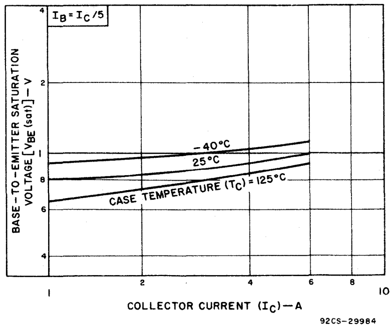


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

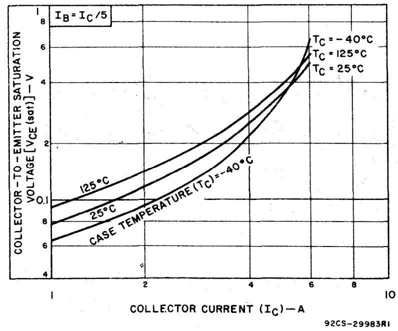


Fig. 7 — Typical collector-to-emitter saturation voltage as a function of collector current.

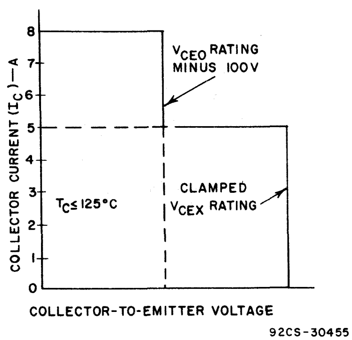


Fig. 8 — Maximum operating conditions for switching between saturation and cutoff.

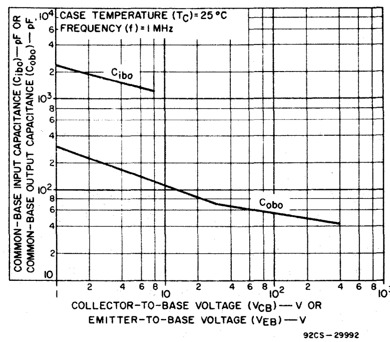


Fig. 9 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

BUX16, BUX16A, BUX16B, BUX16C

File Number **800**

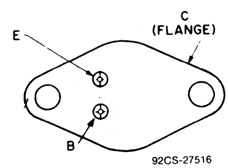
High-Voltage, High-Power Silicon N-P-N Power Transistor

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	–	–	–	–	–	–	mA
		325	−1.5	–	–	–	–	–	5	–	–	–	–	
		375	−1.5	–	–	–	–	–	–	–	2	–	–	
		425	−1.5	–	–	–	–	–	–	–	–	–	2	
With base reverse-biased T_C = 150°C	I_{CEV}	250	−1.5	–	–	–	8	–	8	–	3	–	3	
With base open	I_{CEO}	175	–	–	0	–	5	–	2	–	–	–	–	
		250	–	–	0	–	–	–	–	–	5	–	2	
Emitter Cutoff Current: V_{EB} = 5 V	I_{EBO}	–	–	0	–	–	5	–	5	–	2	–	2	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

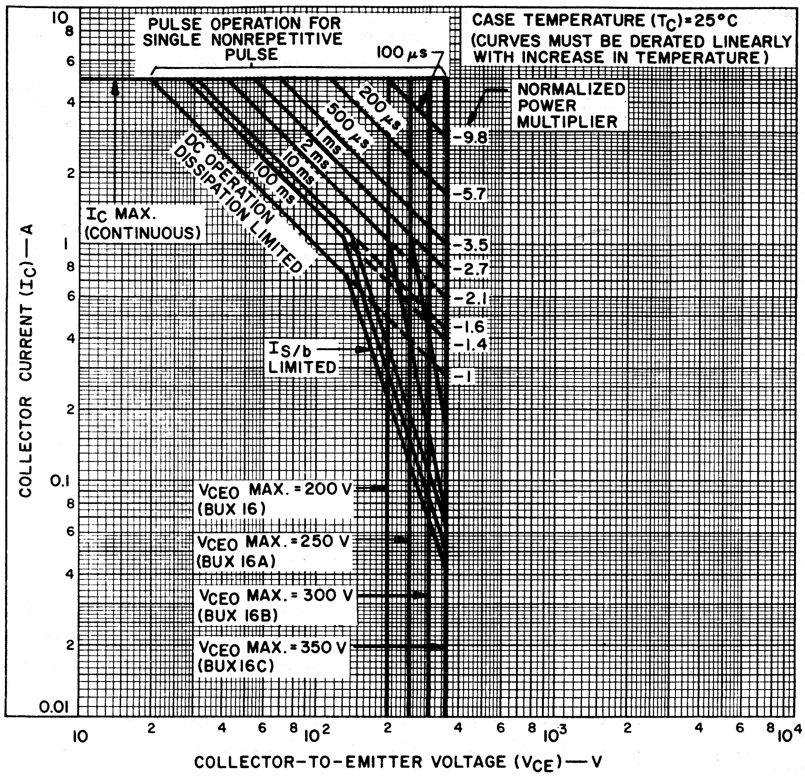


Fig. 1 — Maximum operating areas for all types.

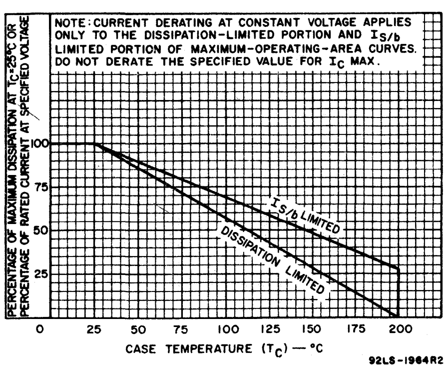


Fig. 2 — Dissipation and $I_{S\,b}$ derating curves for all types.

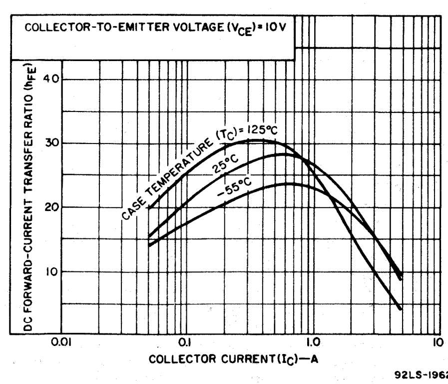


Fig. 3 — Typical DC beta vs. collector for current for all types.

BUX16, BUX16A, BUX16B, BUX16C

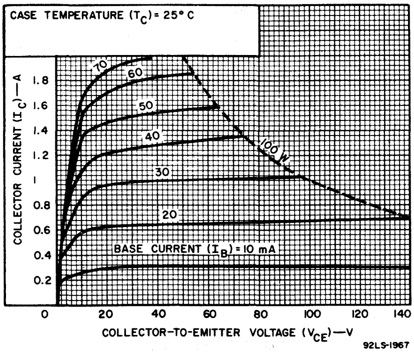


Fig. 4 — Typical output characteristics for all types.

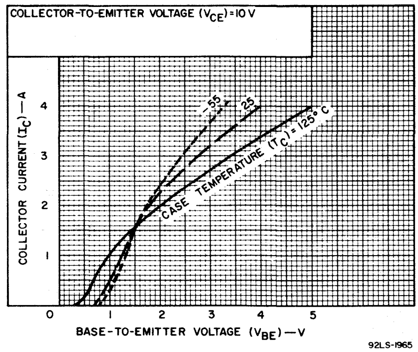


Fig. 5 — Typical transfer characteristics for all types.

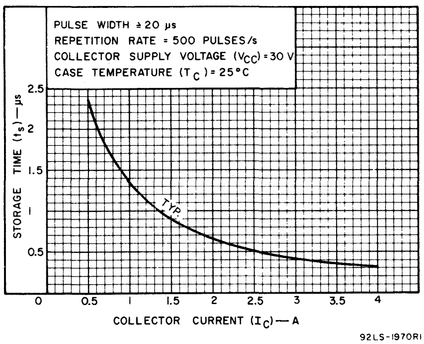


Fig. 6 — Saturated switching time (storage) vs. collector current for all types.

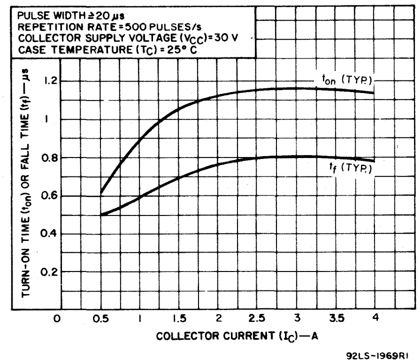


Fig. 7 — Saturated switching-times (turn-on and fall) vs. collector current for all types.

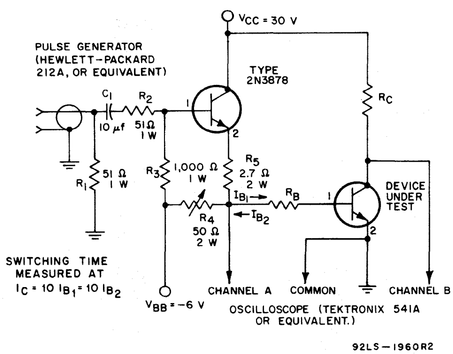


Fig. 8 — Circuit used to measure switching times for all types.

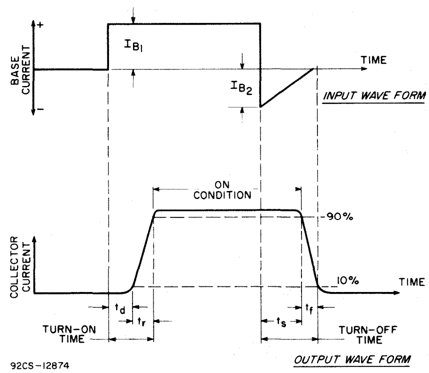


Fig. 9 — Oscilloscope display of switching times (test circuit shown in Fig. 8).

2

BUX21

File Number **1172**

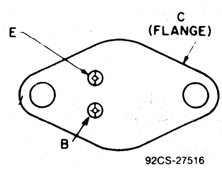
Silicon N-P-N Switching Transistor

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

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.

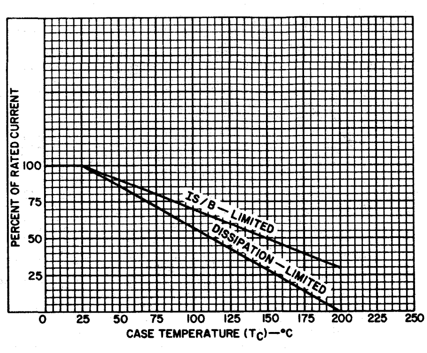


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

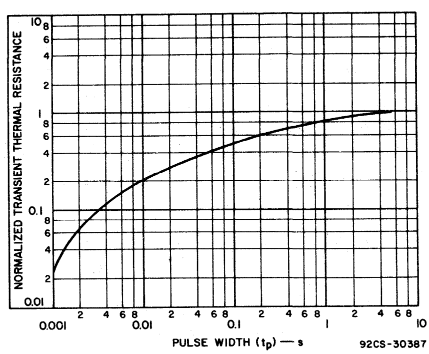


Fig. 2 — Typical thermal-response characteristic.

BUX21

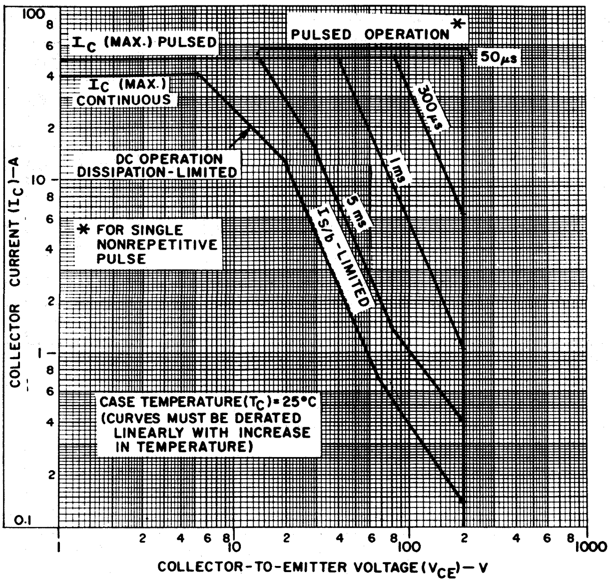


Fig. 3 — Maximum operating areas (T_C = 25° C).

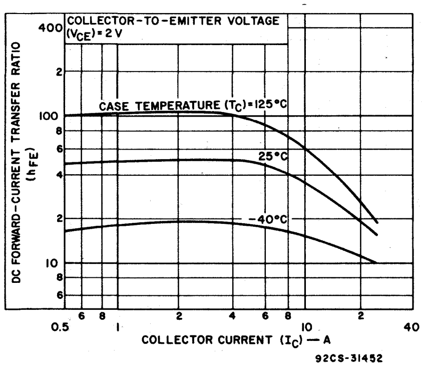


Fig. 4 — Typical dc beta characteristics.

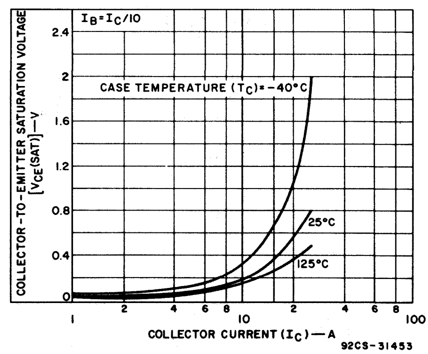


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

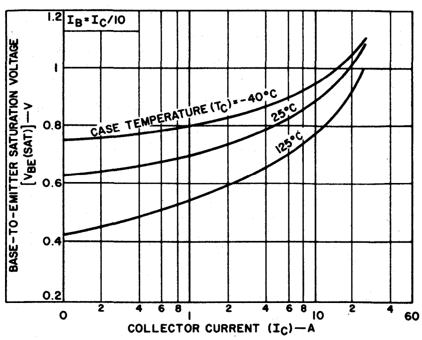


Fig. 6 — Typical base-to-emitter saturation voltage characteristics.

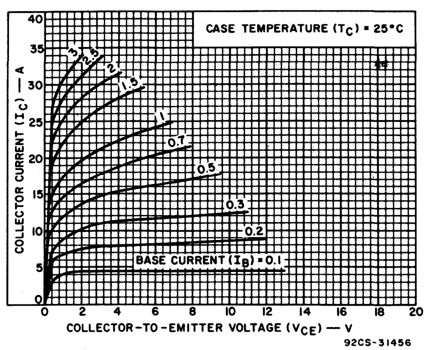


Fig. 7 — Typical output characteristics.

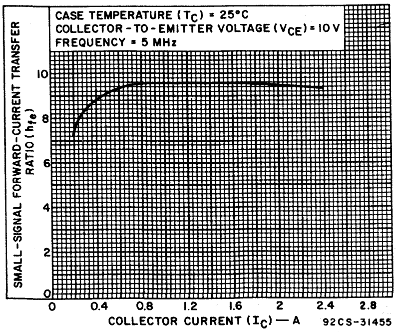


Fig. 8 — Typical small-signal forward-current transfer ratio characteristics.

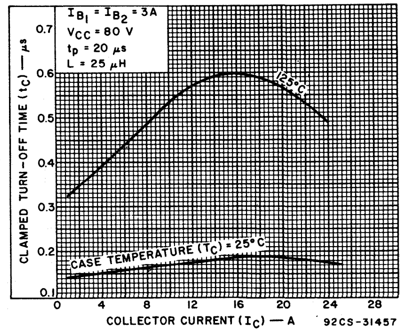


Fig. 9 — Typical clamped turn-off time characteristics.

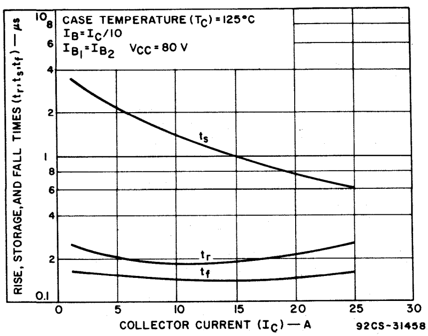


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current.

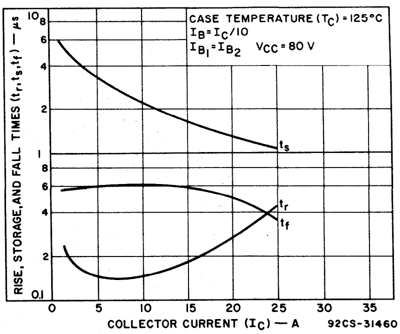


Fig. 11 — Typical-switching-time characteristics at T_C = 125° C as a function of collector current.

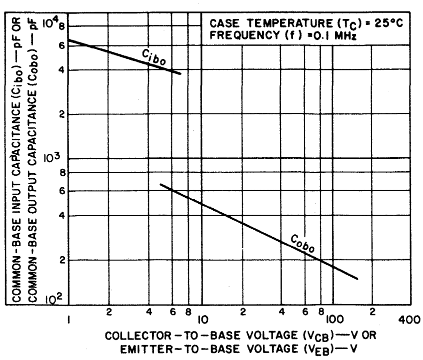


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

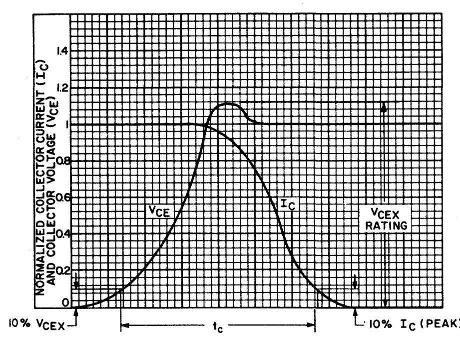


Fig. 13 — Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

BUX21

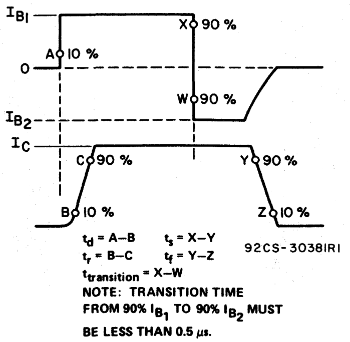


Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

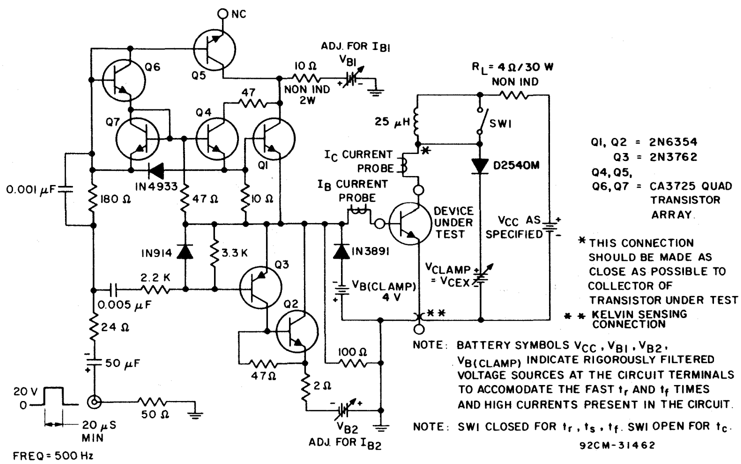


Fig. 15 — Circuit for measuring switching times.

File Number **1285**

BUX32, BUX32A, BUX32B

6-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

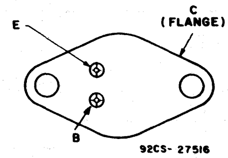
Features:

- *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} $R_{BE} \leqq 10\ \Omega$	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	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	—	—	mA
	1000	-1.5			—	—	—	—	—	0.1	mA
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	0.2	—	—	—	—	mA
	900				—	—	—	0.2	—	—	mA
	1000				—	—	—	—	—	0.2	mA
I_{EBO}		-8	0		—	2	—	2	—	2	mA
$V_{CEO}(sus)$[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	V
			8	2	—	2	—	2	—	2	V
V_{CEX}[b] (Clamped $E_{S/b}$) L=170 μH		-5	6	1.2[e]	450	—	500	—	550	—	V
$I_{S/b}$	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	μs
t_s[d]			6	1.2[e]	—	3.0	—	3.0	—	3.0	μs
t_f[d]			6	1.2[e]	—	0.4	—	0.4	—	0.4	μs
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	μs
T_C=100° C											
I_{CEV}	800	-1.5			—	1	—	—	—	—	mA
	900	-1.5			—	—	—	1	—	—	mA
	1000	-1.5			—	—	—	—	—	1	mA
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	3	—	—	—	—	mA
	900				—	—	—	3	—	—	mA
	1000				—	—	—	—	—	3	mA
$V_{CE}(sat)$			6	1.2	—	1.5	—	1.5	—	1.5	V
t_i[d]			6	1.2	—	0.6	—	0.6	—	0.6	μs
t_s[d]			6	1.2[e]	—	4	—	4	—	4	μs
t_f[d]			6	1.2[e]	—	0.7	—	0.7	—	0.7	μs
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	μs

BUX32, BUX32A, BUX32B

ELECTRICAL CHARACTERISTICS

CHARAC-TERISTIC	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}.

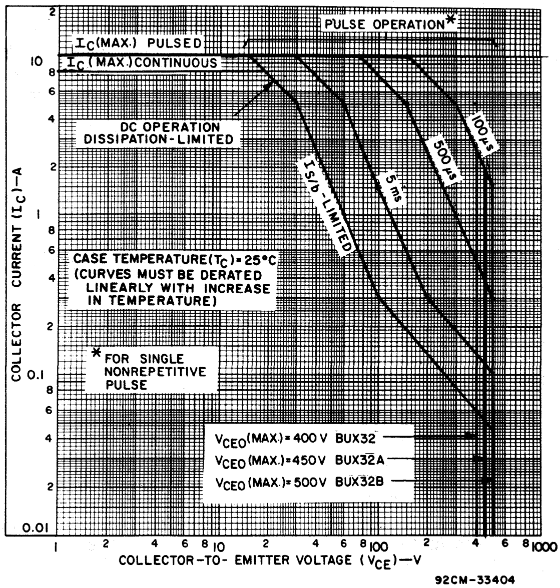


Fig. 1 — Maximum operating areas for all types (T_C).

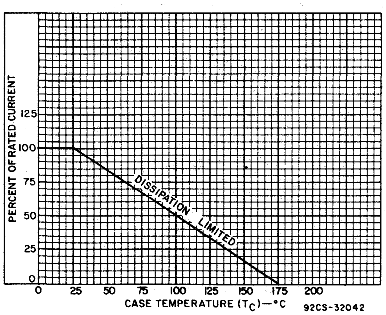


Fig. 2 — Dissipation derating curve for all types.

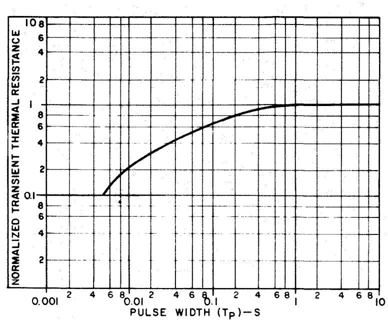


Fig. 3 — Typical thermal-response characteristic for all types.

BUX32, BUX32A, BUX32B

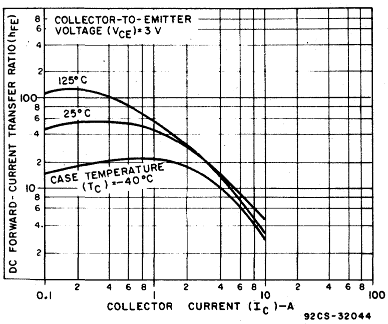


Fig. 4 — Typical dc beta characteristics for all types.

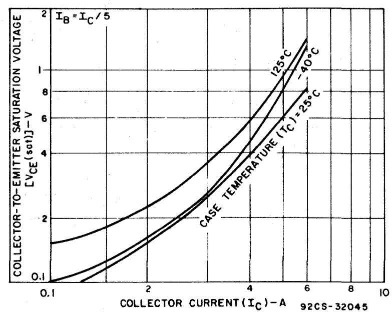


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

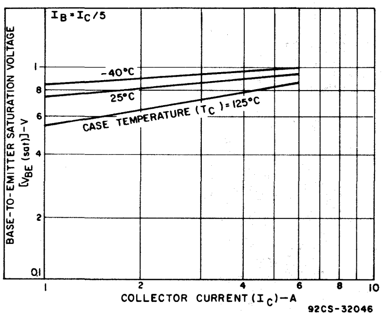


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

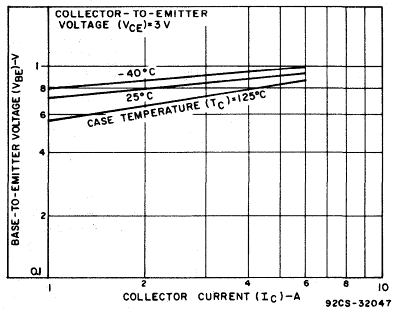


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

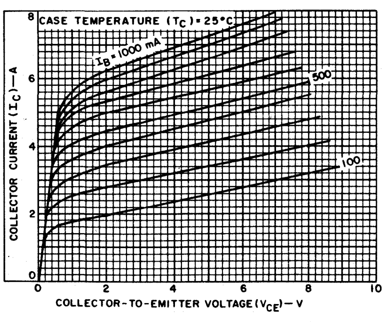


Fig. 8 — Typical output characteristics for all types.

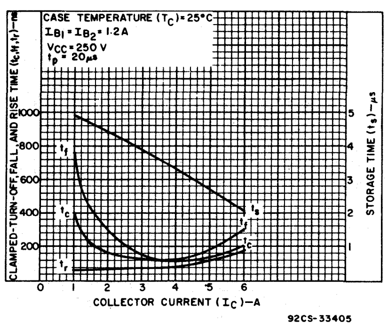


Fig. 9 — Typical saturated switching time characteristics for all types.

BUX32, BUX32A, BUX32B

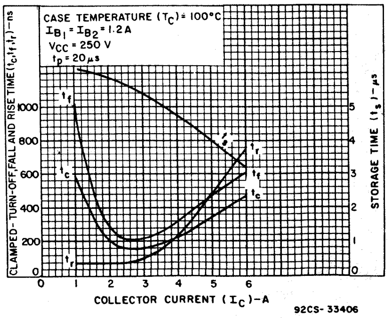


Fig. 10 — Typical saturated switching time characteristics for all types.

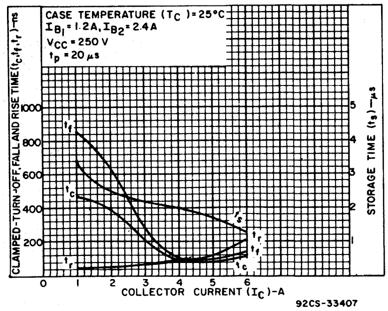


Fig. 11 — Typical saturated switching time characteristics for all types.

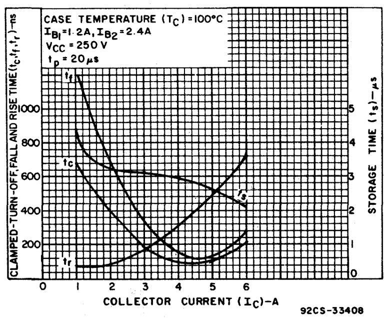


Fig. 12 — Typical saturated switching time characteristics for all types.

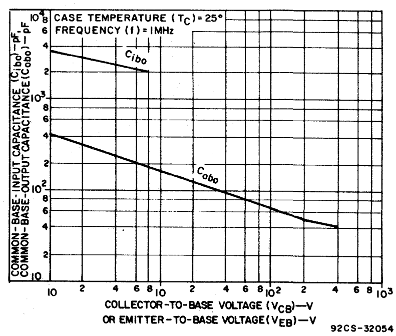


Fig. 13 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

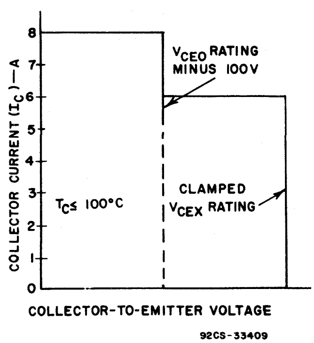


Fig. 14 — Maximum operating conditions for switching between saturation and cutoff.

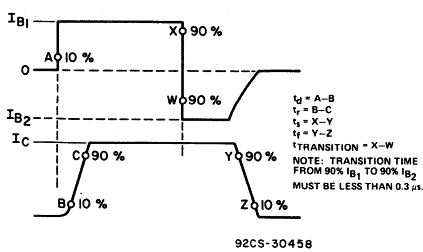


Fig. 15 — Phase relationship between input and output current showing reference points for specification of switching times.

BUX32, BUX32A, BUX32B

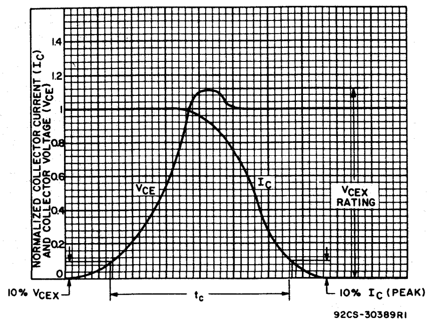


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

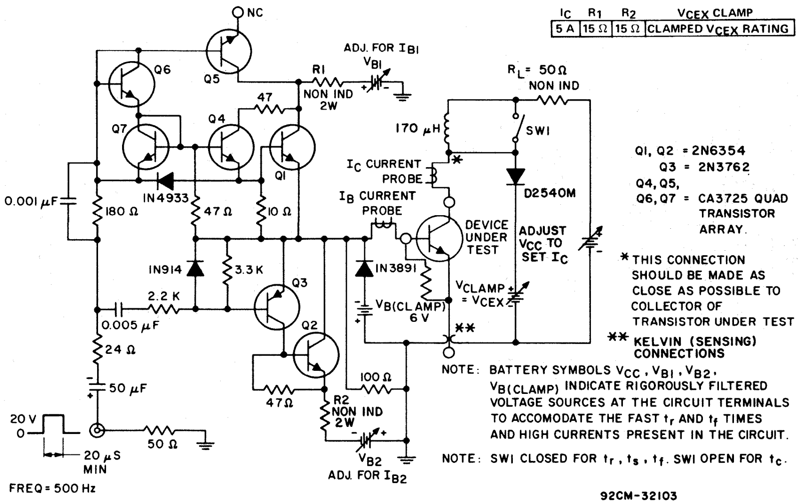


Fig. 17 — Circuit for measuring switching times.

File Number **1354**

BUX33, BUX33A, BUX33B

8-A *SwitchMax* Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

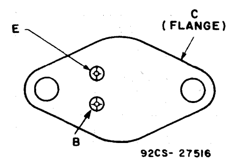
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 450 V — 550 V*
- *Low V_{CE} (sat) at I_C = 8 A*
- *Steel hermetic TO-204AA package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

(200 mil diameter pin isolation)

2

The BUX33 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a side range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The BUX33-series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX33	BUX33A	BUX33B	
V_{CEV}				
V_{BE} = 1.5 V	800	900	1000	V
V_{CER} $R_{BE} \leq 10\ \Omega$	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		CURRENT A dc		LIMITS BUX33		BUX33A		BUX33B		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 25° C											
I_{CEV}	800	−1.5			—	0.1	—	—	—	—	mA
	900	−1.5			—	—	—	0.1	—	—	
	1000	−1.5			—	—	—	—	—	0.1	
I_{CER} $R_{BE} \leq 10\ \Omega$	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
$V_{CE}(sat)$			8	2	—	1	—	1	—	1	
			12	3	—	4	—	4	—	4	
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 μH		−5	8	2	450	—	500	—	550	—	
$I_{S/b}$	30		5		1	—	1	—	1	—	s
$\lvert h_{fe} \rvert$ 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]			8	2	—	0.1	—	0.1	—	0.1	μs
t_r[d]			8	2	—	0.45	—	0.45	—	0.45	
t_s[d]			8	2[e]	—	3.0	—	3.0	—	3.0	
t_f[d]			8	2[e]	—	0.4	—	0.4	—	0.4	
t_c V_{CC}: = 240 V, L = 170 μH, R_C = 30 Ω Collector clamped to V_{CEX}			8	2[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	μs
t_s[d]			8	2[e]	—	4	—	4	—	4	
t_f[d]			8	2[e]	—	0.7	—	0.7	—	0.7	
t_c V_{CC} = 240 V. L = 170 μH, R_C = 30 Ω Collector clamped to V_{CEX}			8	2[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 μs.
[e]$I_{B1} = -I_{B2}$.

BUX33, BUX33A, BUX33B

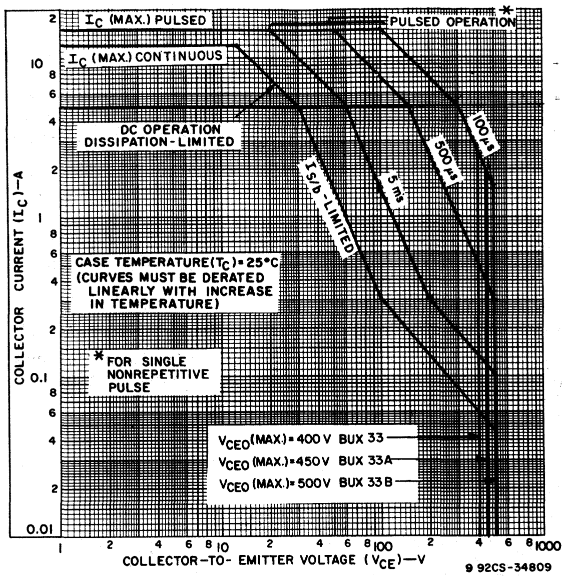


Fig. 1 — Maximum operating areas for all types (Tc).

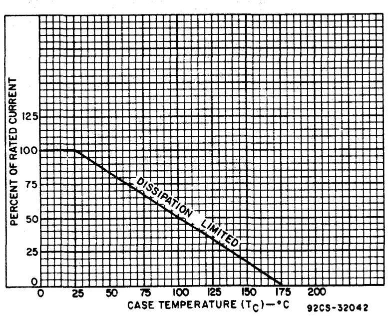


Fig. 2 — Dissipation derating curve for all types.

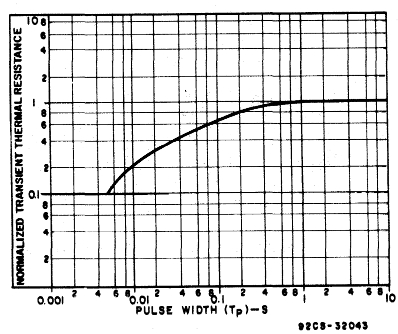


Fig. 3 — Typical thermal-response characteristic for all types.

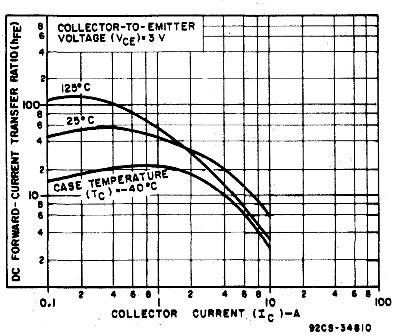


Fig. 4 — Typical dc beta characteristics for all types.

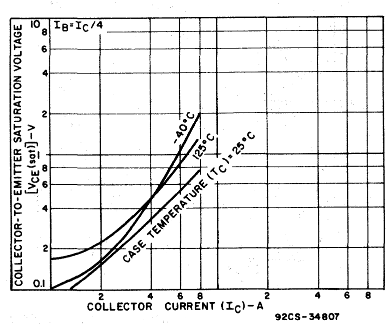


Fig. 5 — Typical collector-to-emitter saturation voltage for all types.

2

BUX33, BUX33A, BUX33B

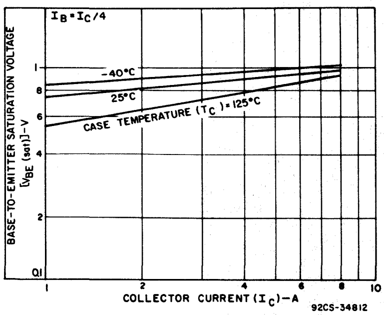


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

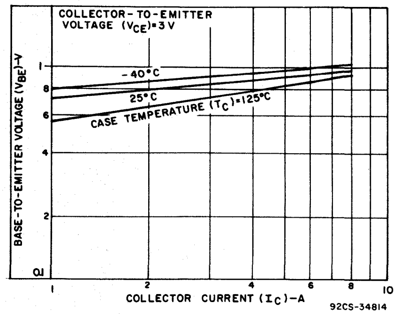


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

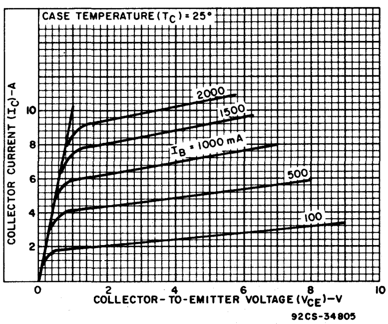


Fig. 8 — Typical output characteristics for all types.

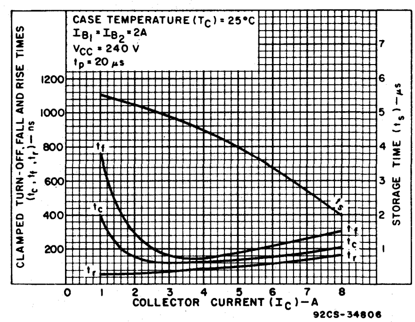


Fig. 9 — Typical saturated switching time characteristics for all types.

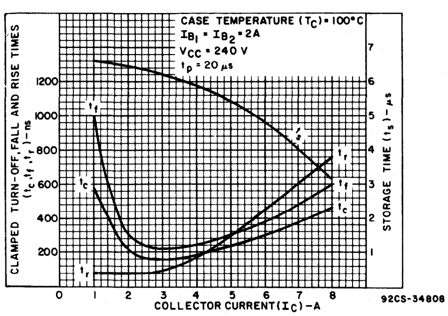


Fig. 10 — Typical saturated switching time characterics for all types.

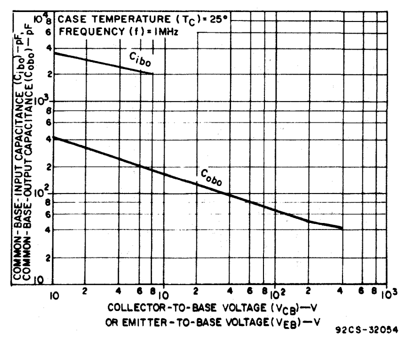


Fig. 11 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

BUX33, BUX33A, BUX33B

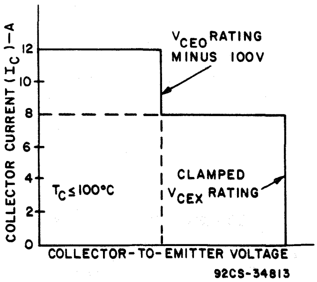


Fig. 12 — Maximum operating conditions for switching between saturation and cutoff.

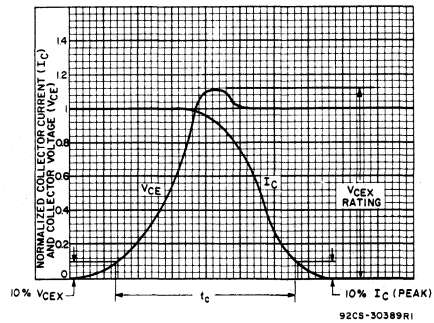


Fig. 13 — Oscilloscope display for measurement of clamped induction switching time (t_c).

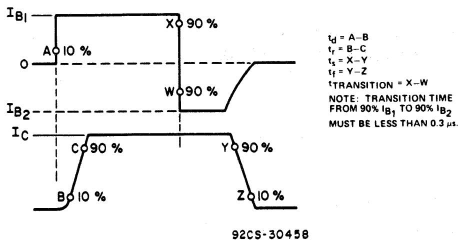


Fig. 14 — Phase relationship between input and output current showing reference points for specification of switching times.

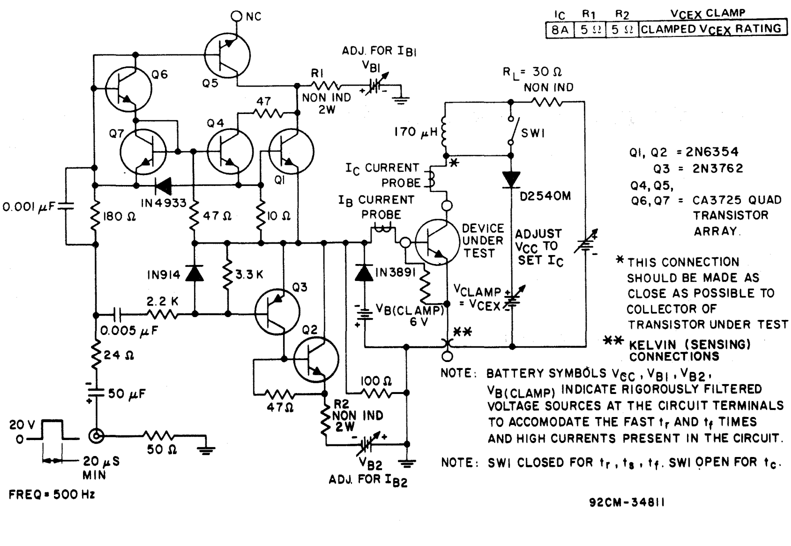


Fig. 15 — Circuit for measuring switching times.

BUX37

File Number **1243**

15-Ampere N-P-N Monolithic Darlington Power Transistor

400 V , 35 W
Gain of 20 at 15A

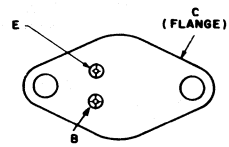
Features:

- *High voltage breakdown*

Applications:

- *Power switching*
- *Automotive Ignition*
- *Solenoid drivers*
- *Series and shunt regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The BUX37 is a monolithic n-p-n silicon Darlington transistor designed for automotive electronic power applications. The construction of this device provides good forward and reverse second-breakdown capability.

The BUX37 is supplied in the JEDEC TO-204AA steel hermetic package.

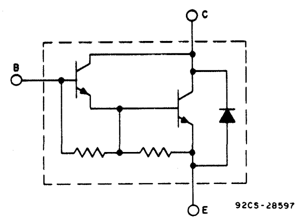


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

$V_{CEO}(sus)$	400	V
V_{EBO}	7	V
I_C	15	A
I_B	4	A
P_T		
$T_C \leqslant 100°C$	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

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS BUX37		UNITS
	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.

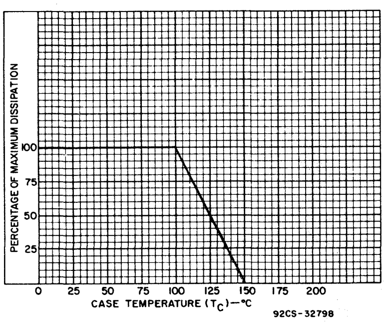


Fig. 2 — Derating curve.

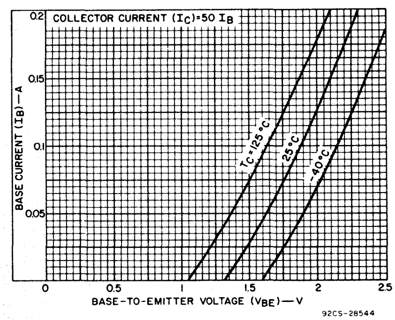


Fig. 3 — Typical input characteristics.

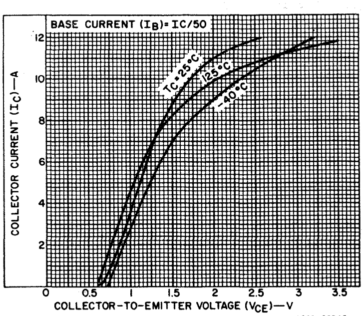


Fig. 4 — Typical output characteristics.

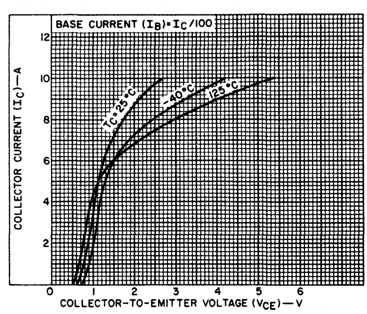


Fig. 5 — Typical output characteristics.

BUX37

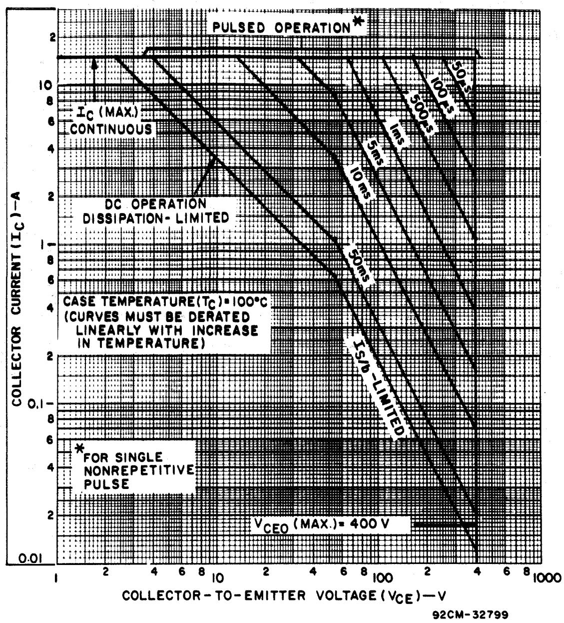


Fig. 6 — Maximum operating areas (T_C = 100° C).

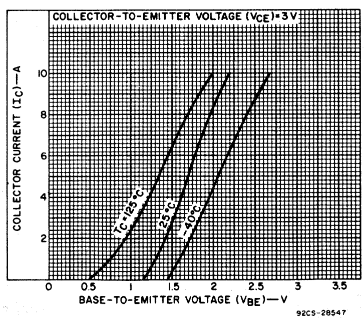


Fig. 7 — Typical transfer characteristics.

File Number **1211**

BUX39

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*

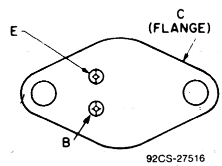
2

The RCA BUX39 is an epitaxial silicon n-p-n planar transistor that has high current and high power handling capability and fast switching speed.

This device is especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits converters, inverters, control circuits. Other recommended applications include dc-rf amplifiers, and power oscillators.

The BUX39 is supplied in a steel JEDEC TO-204AA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{CBO}	120 V
V_{CEX}	
V_{BE} = -1.5 V	120 V
V_{CER}	
R_{BE} = 100 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	
T_C = 125 °C	120	−1.5			—	—	5	
I_{EBO}		−5	0		—	—	1	
$V_{CEO}(sus)^a$ L = 25 mH			0.2^b	0	90	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	
h_{FE}	4 4		12^b 20^b		15 8	— —	45 —	
$V_{BE(sat)}$			20^b	2.5	—	2.1	2.5	V
$V_{CE(sat)}$			12^b 20^b	1.2 2.5	— —	0.7 1.25	1.2 1.6	
$I_{S/b}$ t = 1 s	45 30				1 4	— —	— —	A
f_T	15		1		8	—	—	MHz
t_{ON} $t_d + t_r$	V_{CC} = 30 V		20	2.5	—	0.8	1.5	µS
t_s			20	2.5^c	—	0.55	1	
t_f			20	2.5^c		0.15	0.3	
$R_{\theta JC}$					—	—	1.46	°C/W

A CAUTION: The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

b Pulsed; pulse duration $\leq$ 300 µS, duty factor $\leq$ 2%.

c $I_{B_1} = -I_{B_2}$.

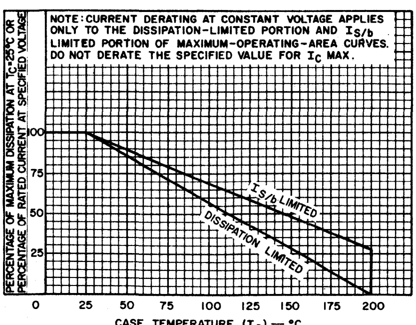


Fig. 1 - Derating curves.

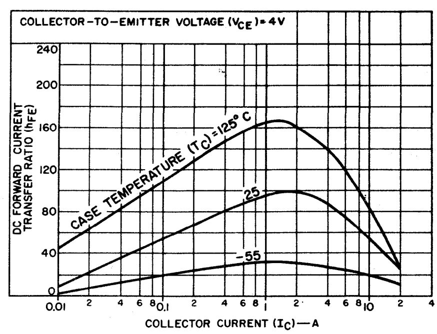


Fig. 2 - Typical DC beta characteristics.

BUX39

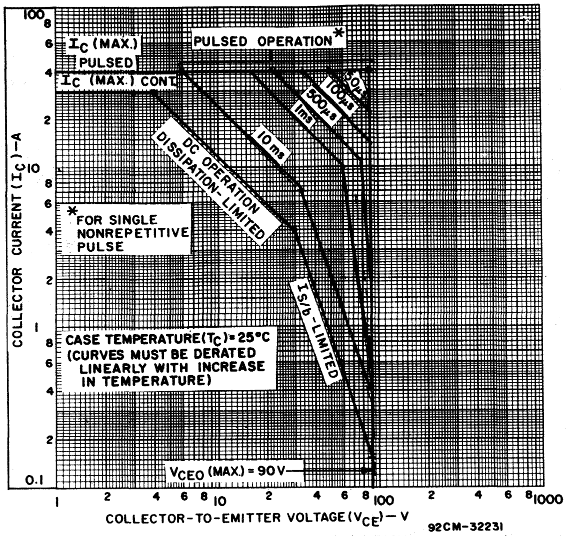


Fig. 3 - Maximum operating areas.

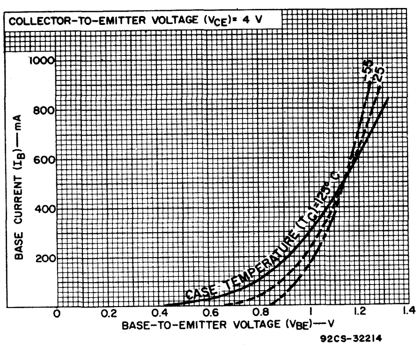


Fig. 4 - Typical input characteristics.

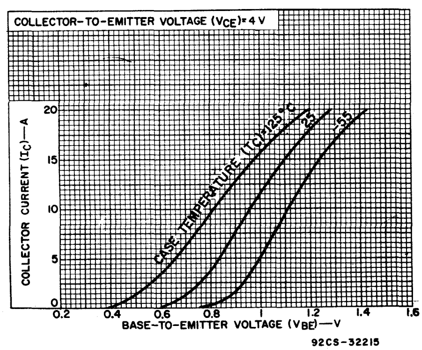


Fig. 5 - Typical transfer characteristics.

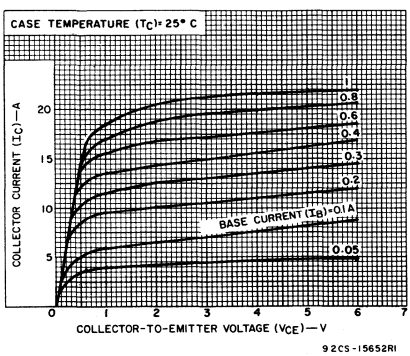


Fig. 6 - Typical output characteristics.

BUX45

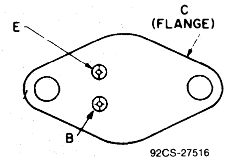
File Number **1231**

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} = 100Ω	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

ELECTRICAL CHARACTERISTICS, *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 BUX45 Min.	Typ.	Max.	UNITS
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} = 100 V		2	0.4	—	0.4	1	μs
t_s $I_{B1} = I_{B2}$			2	0.4	—	3.5	5	
t_f $I_{B1} = I_{B2}$			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.

2

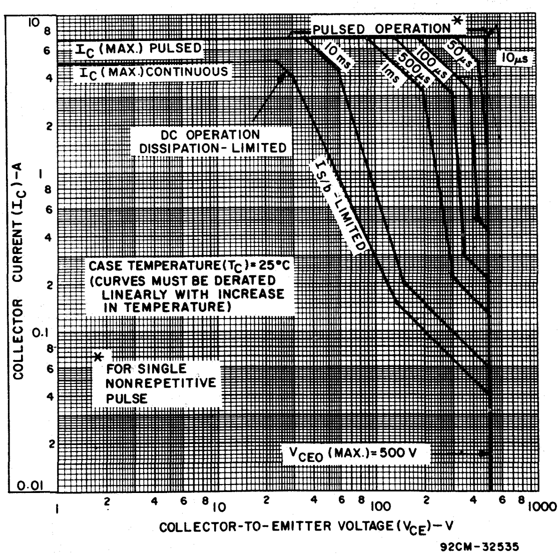


Fig. 1 — Maximum safe-operating areas (T_C=25° C).

BUX45

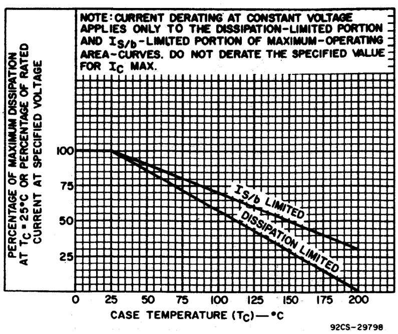


Fig. 2 — Derating curves for $I_{S/b}$ and dissipation.

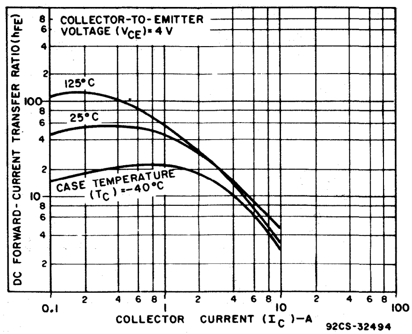


Fig. 3 — Typical dc beta characteristics.

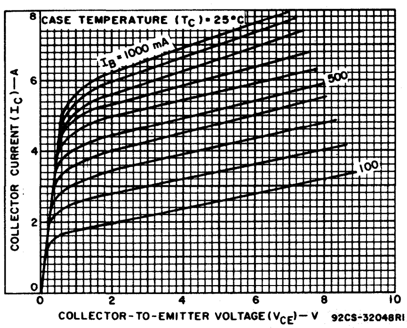


Fig. 4 — Typical output characteristics.

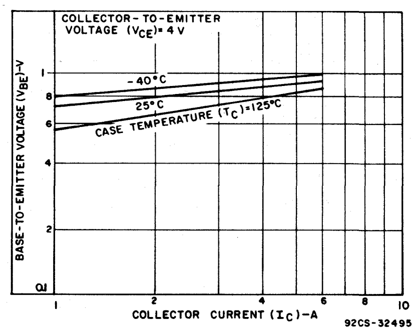


Fig. 5 — Typical base-to-emitter voltage as a function of collector current.

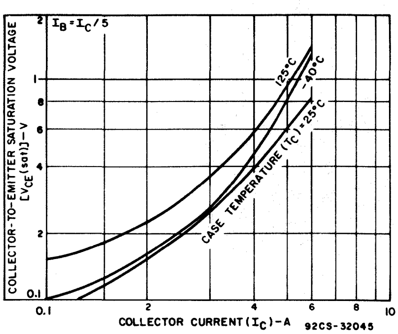


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current.

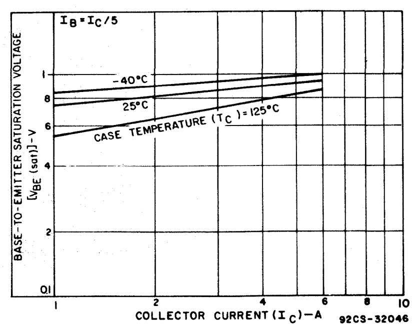


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current.

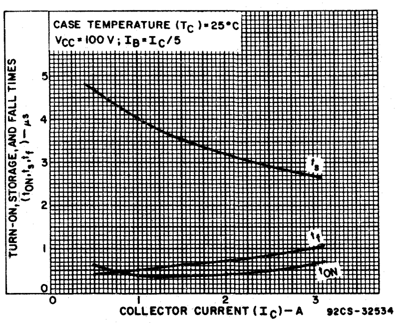


Fig. 8 — Typical saturated-switching times as a function of collector current.

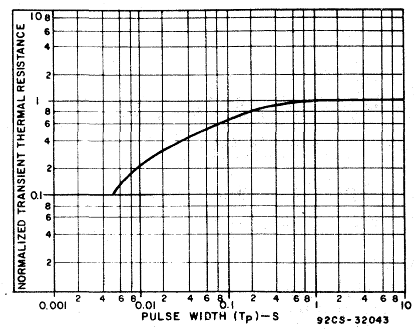


Fig. 9 — Typical thermal-response characteristic.

2

BUX66, BUX66A, BUX66B, BUX66C

File Number **870**

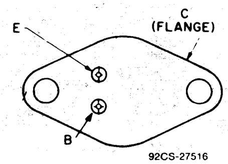
High Voltage Silicon P-N-P Transistors

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	
I_{CEX}	−200	1.5			–	−8	–	–	
	−300	1.5			–	–	–	−8	mA
T_C = 100°C	−200	1.5			–	−10	–	–	
	−300	1.5			–	–	–	−10	
I_{EBO}		6	0		–	−1	–	−1	mA
h_{FE}	−5		−1[a]		10	150	10	150	
V_{CEO}(sus)			−0.2[a]	0	−150[c]	–	−250[c]	–	
V_{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	
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.

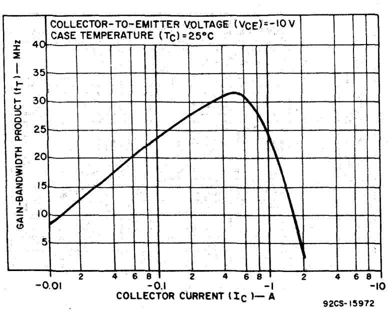


Fig.1 – Typical gain-bandwidth product for all types.

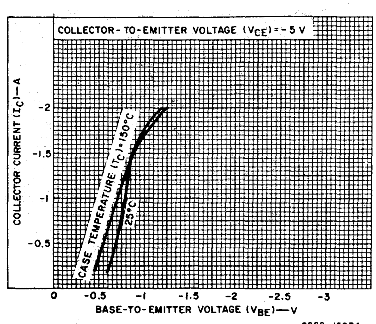


Fig.2 – Typical transfer characteristics for all types.

BUX66, BUX66A, BUX66B, BUX66C

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC SYMBOL	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS: BUX66B		BUX66C		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	–150			0	–	–5	–	–5	mA
I_{CEX}	–350	1.5			–	–8	–	–	mA
	–400	1.5			–	–	–	–8	mA
T_C = 100°C	–350	1.5			–	–10	–	–	mA
	–400	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	–300[c]	–	–350[c]	–	V
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	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.

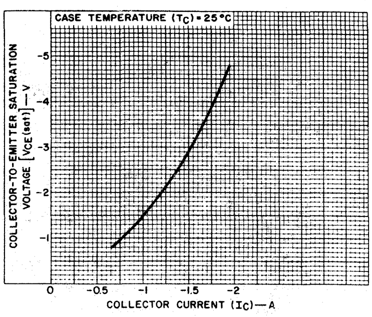


Fig.3 — Typical saturation-voltage characteristic for all types.

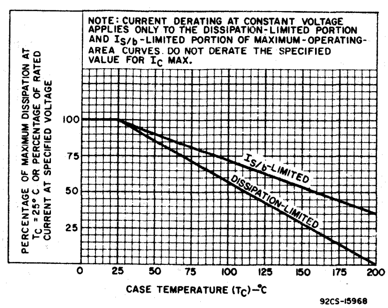


Fig. 4 — Derating curve for all types.

BUX66, BUX66A, BUX66B, BUX66C

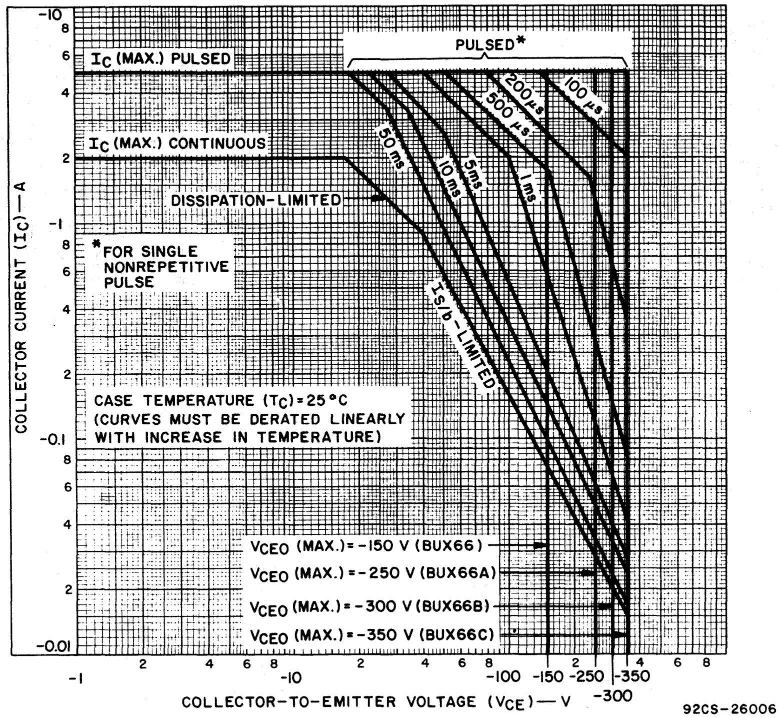


Fig.5 — Maximum operating areas for all types.

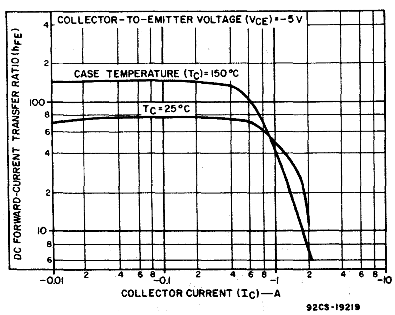


Fig. 6 — Typical dc beta characteristics for all types.

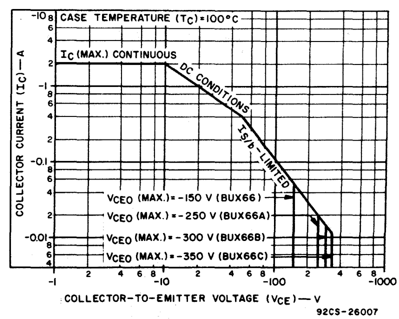


Fig. 7 — Maximum operating areas for all types at T_C = 100° C.

BUX66, BUX66A, BUX66B, BUX66C

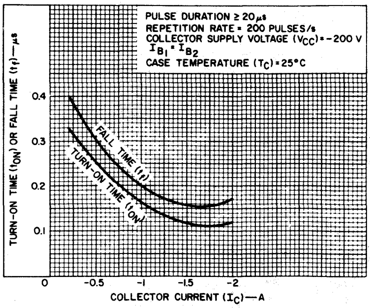


Fig. 8 — Typical turn-on time and fall-time characteristics for all types.

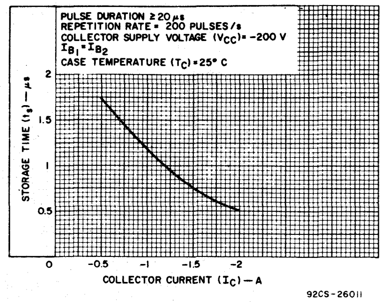


Fig. 9 — Typical storage-time characteristic for all types.

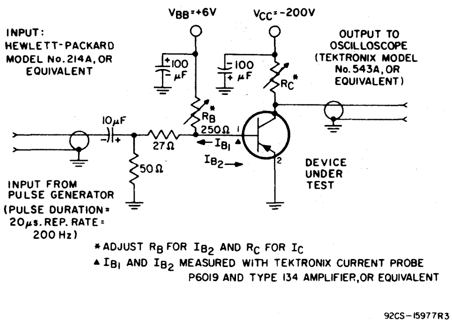


Fig. 10 — Circuit used to measure saturated switching times for all types.

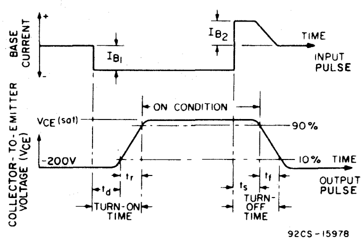


Fig. 11 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

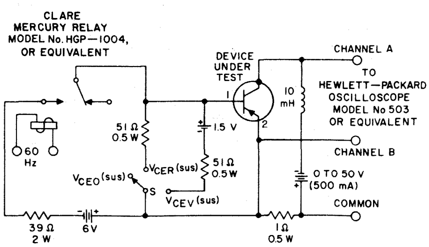
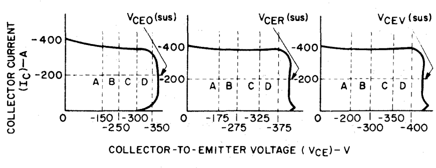


Fig. 12 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ for all types.



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 **1237**

BUY69A, BUY69B, BUY69C

High Voltage Silicon N-P-N Power Transistors

For Horizontal-Deflection Circuits and Other High-Voltage Switching Applications

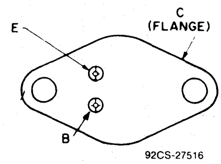
Features:

- *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

2

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 ana 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.

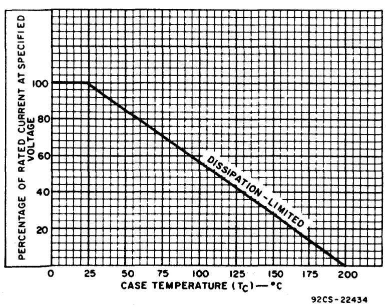


Fig. 1 — Dissipation derating curve for all types.

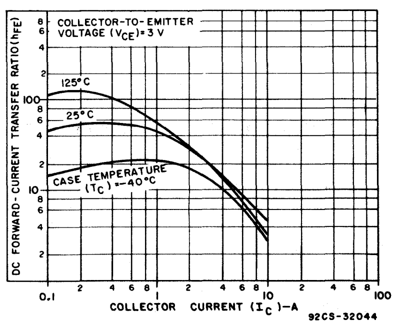


Fig. 2 — Typical dc beta characteristics for all types.

BUY69A, BUY69B, BUY69C

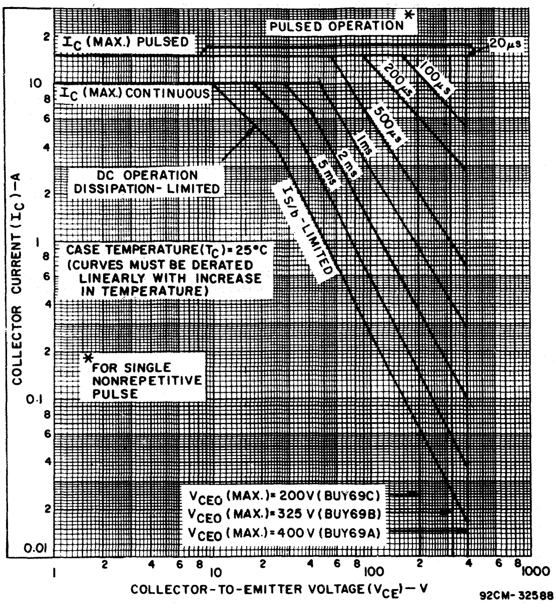


Fig. 3 — Maximum operating areas for all types (T_C =25° C).

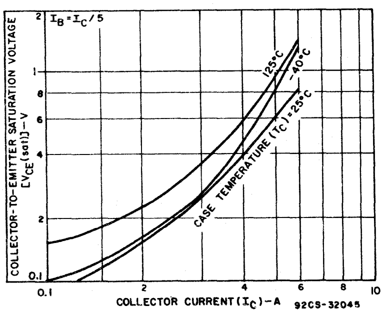


Fig. 5 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

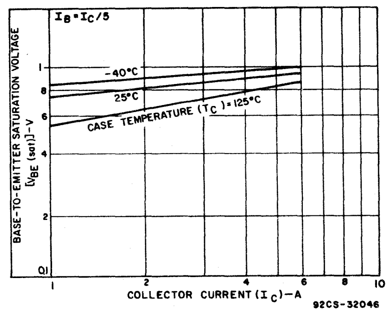


Fig. 4 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

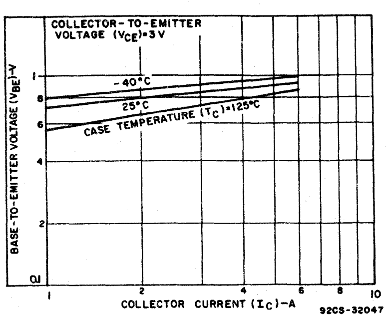


Fig. 6 — Typical base-to-emitter voltage as a function of collector current for all types.

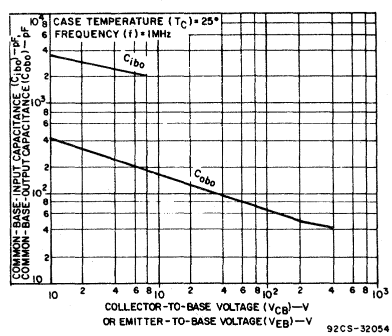


Fig. 7 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

2

BUY69A, BUY69B, BUY69C

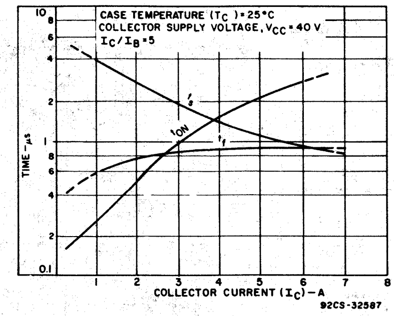


Fig. 8 — Typical switching-time characteristics as a function of collector current.

File Number **15.1**

D40C Series

0.5-Ampere N-P-N Darlington Power Transistors

h_{FE} Min. — 10,000
1.33 Watt power dissipation at T_A = 25°

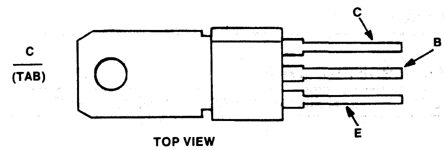
Features:
- *Operates from IC without predriver*

Application:
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*

The D40C-series silicon n-p-n Darlington power transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devies makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

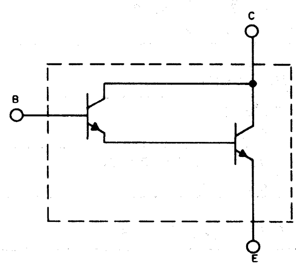
These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB



92CS-43150

Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40C1	D40C4	D40C7	UNITS
Collector-Emitter Voltage	V_{CEO}	30	40	50	Volts
Collector-Emitter Voltage	V_{CES}	30	40	50	Volts
Emitter Base Voltage	V_{EBO}	13	13	13	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	0.5 1.0	0.5 1.0	0.5 1.0	A
Base Current — Continuous	I_B	0.1	0.1	0.1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.33 6.25	1.33 6.25	1.33 6.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D40C Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Voltage (I_C = 10mA)	D40C1	V_{CEO}	30	—	—	Volts
	D40C4		40	—	—	
	D40C7		50	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})	(T_C = 25°C)	I_{CES}	—	—	0.5	μA
	(T_C = 150°C)	I_{CBO}	—	—	20	
Emitter Cutoff Current (V_{EB} = 13V)		I_{EBO}	—	—	0.1	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 2			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 200mA, V_{CE} = 5V)		h_{FE}	10K	—	60K	
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 0.5mA)		$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 500mA, I_B = 0.5mA)		$V_{BE(sat)}$	—	—	2.0	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	—	220	pF
Current Gain - Bandwidth Product (I_C = 20mA, V_{CE} = 5V)		f_T	—	75	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 1mA	$t_d + t_r$	—	100	—	ns
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	350	—	
Fall Time		t_f	—	800	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

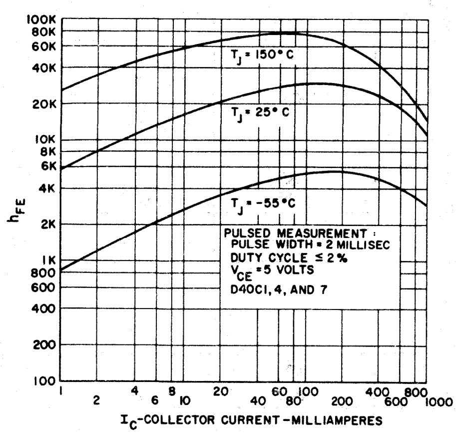


FIG 1. TYPICAL h_{FE} vs. I_C

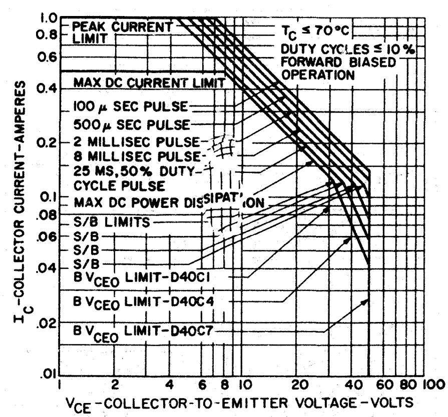


FIG. 2 SAFE REGION OF OPERATION

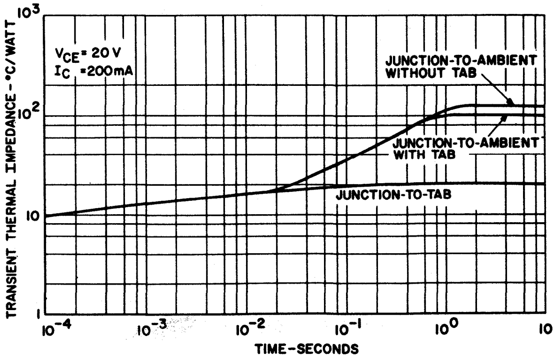


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

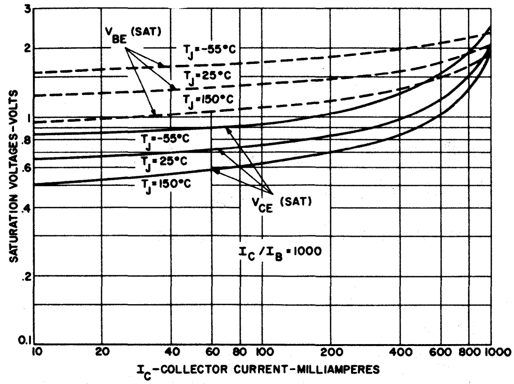


FIG. 4 TYPICAL SATURATION VOLTAGES

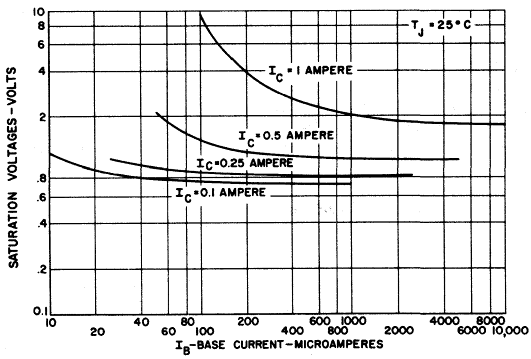


FIG. 5 TYPICAL SATURATION VOLTAGES

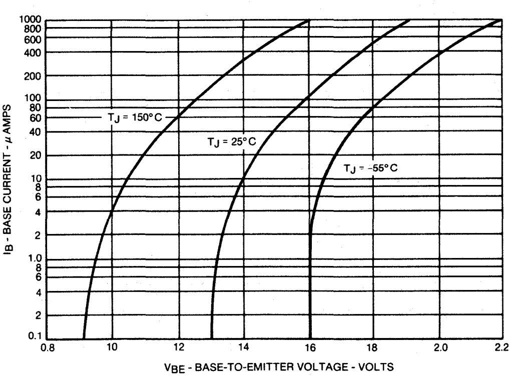


FIG. 6 TYPICAL INPUT CHARACTERISTICS

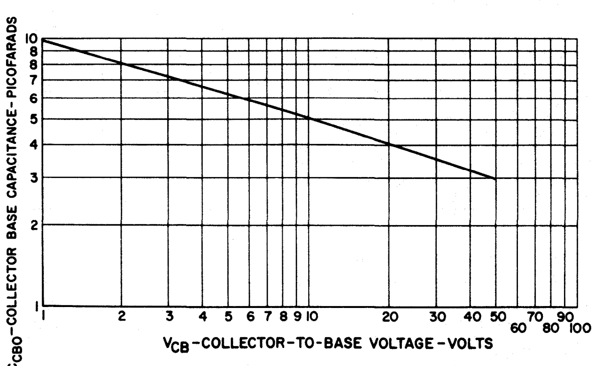


FIG. 7 TYPICAL C_{CBO} vs. VOLTAGE

D40D Series

File Number **15.2**

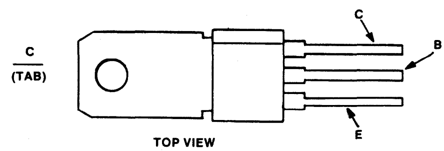
1-Ampere Silicon N-P-N Power Transistors

Complementary to the D41D Series

Features:

- High free-air power dissipation
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



JEDEC TO-202AB

The D40D-series of silicon n-p-n power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40D1, 2	D40D4, 5	D40D7, 8	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	Volts
Collector-Emitter Voltage	V_{CES}	45	60	75	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	1 1.5	1 1.5	1 1.5	A
Base Current — Continuous	I_B	0.5	0.5	0.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25C	P_D	1.67 6.25	1.67 6.25	1.67 6.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D40D Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 10mA)	D40D1, 2	$V_{CEO(sus)}$	30	—	—	Volts
	D40D4, 5		45	—	—	
	D40D7, 8		60	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CEO}) T_C = 25°C		I_{CES}	—	—	0.1	
(V_{CE} = Rated V_{CES}) T_C = 150°C			—	1.0	—	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	0.1	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 4			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 100mA, V_{CE} = 2V)	D40D1, 4, 7	h_{FE}	50	—	150	—
	D40D2, 5, 8		120	—	360	
(I_C = 1A, V_{CE} = 2V)	D40D1, 4, 7	h_{FE}	10	—	—	—
	D40D2		20	—	—	
	D40D5, 8		10	—	—	
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)	D40D1, 2, 4, 5	$V_{CE(sat)}$	—	—	0.5	Volts
	D40D7, 8		—	—	1.0	
Base-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)		$V_{BE(sat)}$	—	—	1.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	8	—	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 10V)		f_T	—	200	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A	$t_d + t_r$	—	25	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	200	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

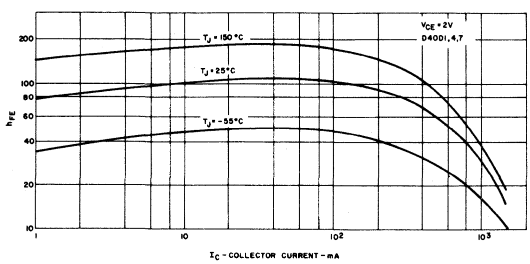


FIG. 1

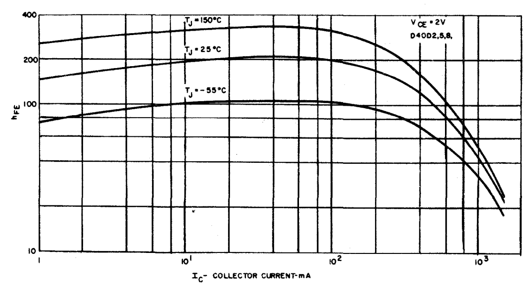


FIG. 2

TYPICAL H_{FE} VS I_C

D40D Series

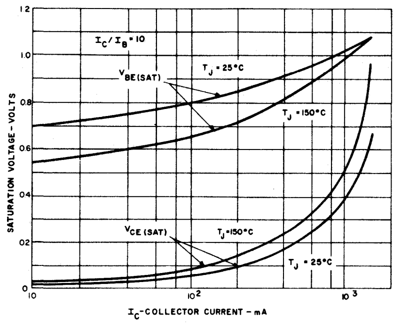


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

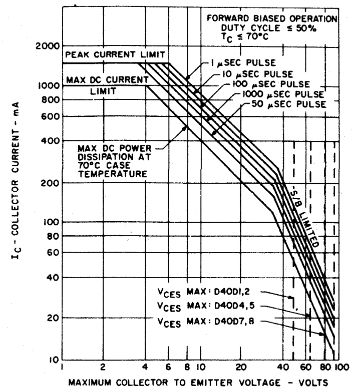


FIG. 4 SAFE REGION OF OPERATION

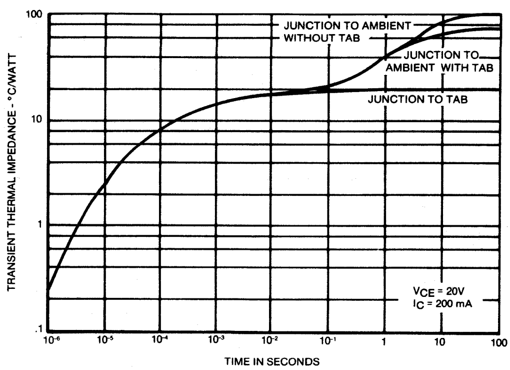


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

File Number **15.4**

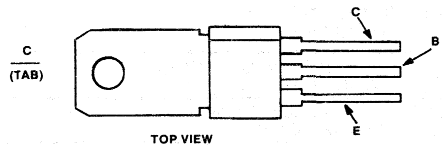
D40E Series

2-Ampere Silicon N-P-N Power Transistors

Complementary to the D41E Series

Features:
- High free-air power dissipation
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB

The D40E-series of silicon n-p-n power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40E1	D40E5	D40E7	UNITS
Collector-Emitter Voltage	V_{CEO}	30	60	80	Volts
Collector-Emitter Voltage	V_{CES}	45	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 3	2 3	2 3	A
Base Current — Continuous	I_B	1	1	1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.33 8	1.33 8	1.33 8	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D40E Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = 10mA)	D40E1 D40E5 D40E7	$V_{CEO(sus)}$	30 60 80	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	0.1	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	0.1	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 1			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 100mA, V_{CE} = 2V) (I_C = 1A, V_{CE} = 2V)		h_{FE} h_{FE}	50 10	— —	— —	— —
Collector-Emitter Saturation Voltage (I_C = 1.0A, I_B = 0.1A)		$V_{CE(sat)}$	—	—	1.0	Volts
Base-Emitter Saturation Voltage (I_C = 1.0mA, I_B = 0.1A)		$V_{BE(sat)}$	—	—	1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1M_{Hz})		C_{CBO}	—	9	—	pF
Current-Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V)		f_T	—	230	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A	$t_d + t_r$	—	130	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	400	—	
Fall Time		t_f	—	170	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

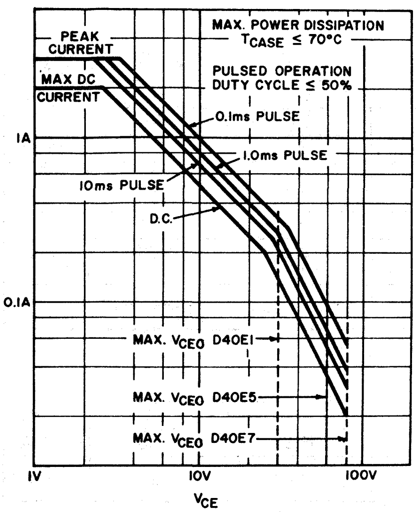


FIG. 1 SAFE REGION OF OPERATION

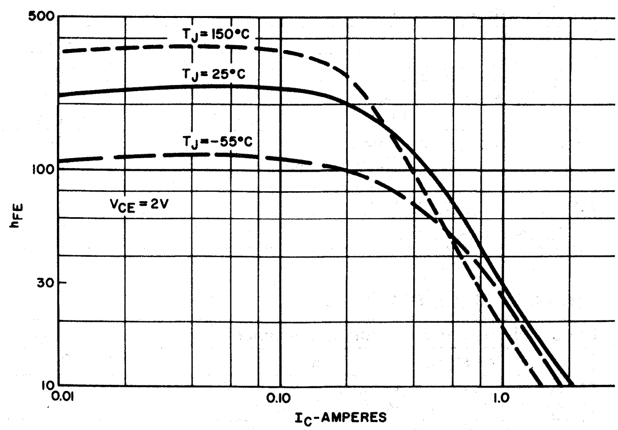


FIG. 2 TYPICAL H_{FE} VS I_C

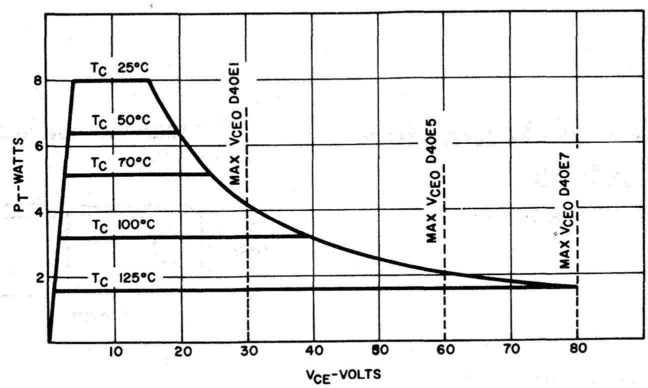


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

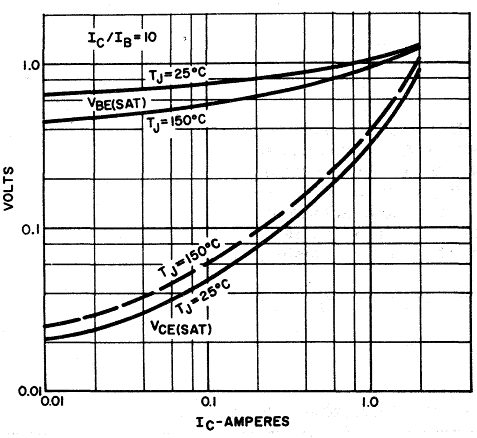


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

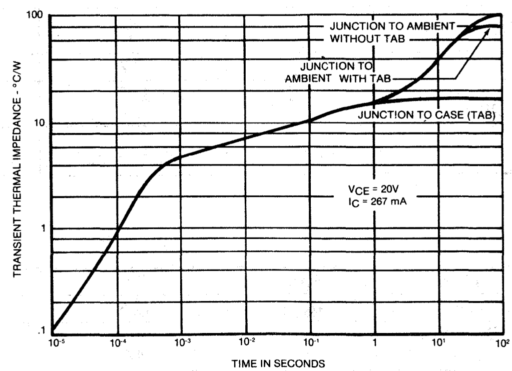


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

2

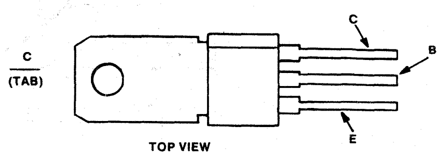
D40K Series

File Number **15.6**

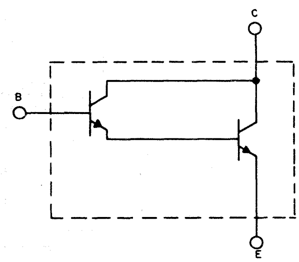
2-Ampere N-P-N Darlington Power Transistors

Complementary to the D41K Series

TERMINAL DESIGNATIONS



JEDEC TO-202AB



Schematic diagram for all types.

Features:

- Operates from IC without predriver

Applications:

- Switching regulator
- Lamp driver
- Touch switch
- Solenoid driver

The D40K-series of silicon n-p-n Darlington power transistors are designed for use in general purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40K1,3	D40K2,4	UNITS
Collector-Emitter Voltage	V_{CEO}	30	50	Volts
Collector-Emitter Voltage	V_{CES}	30	50	Volts
Emitter Base Voltage	V_{EBO}	13	13	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 3	2 3	A A
Base Current — Continuous	I_B	0.2	0.2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 10	1.67 10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	12.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D40K Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)					
Collector-Emitter Sustaining Voltage D40K1,3 (I_C = 10mA) D40K2,4	V_{CEO}	30 50	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES})	I_{CES}	—	—	.5	μA
Emitter Cutoff Current (V_{EB} = 13V)	I_{EBO}	—	—	.1	μA
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 200mA, V_{CE} = 5V)	h_{FE}	10K	—	—	—
(I_C = 1.5A, V_{CE} = 5V) D40K1,2 (I_C = 1A, V_{CE} = 5V) D40K3,4	h_{FE}	1K 1K	— —	— —	— —
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA) D40K1,2 (I_C = 1A, 1_B = 2mA) D40K3,4	$V_{CE(sat)}$	— —	— —	1.5 1.5	V V
Base-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA) D40K1,2 (I_C = 1A, I_B = 2mA) D40K3,4	$V_{BE(sat)}$	— —	— —	2.5 2.5	V
DYNAMIC CHARACTERISTICS					
Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	—	5	10	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 5V)	f_T	—	75	—	MHz

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

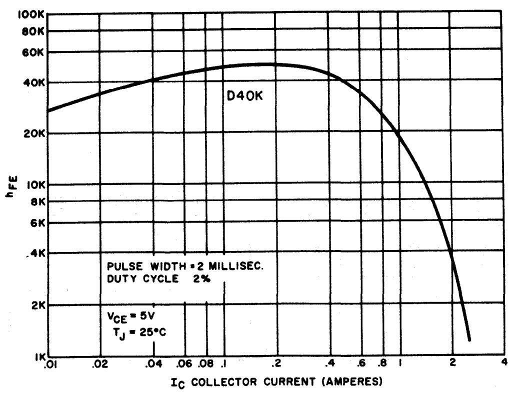


FIG. 1 TYPICAL h_{FE} vs. I_C

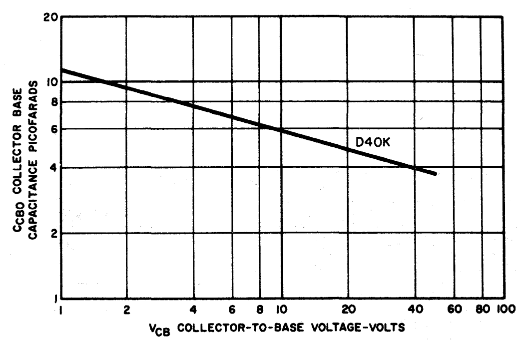
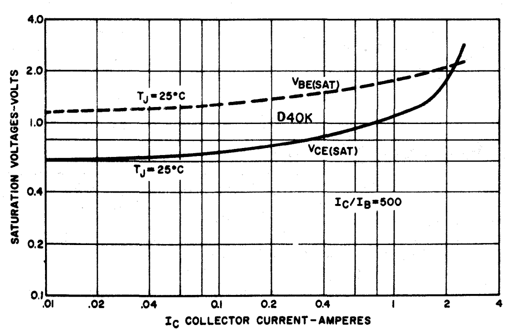


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

FIG. 3 TYPICAL SATURATION VOLTAGE



D40V Series

File Number **15.8**

Silicon N-P-N Power Transistors

General-Purpose Types for Medium-Power Switching and Amplifier Applications

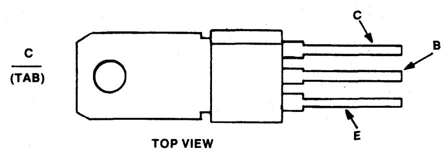
Features:

- Low C_{CB} (2 pF typical at V_{CB} =20V)
- Excellent linearity

The D40V-series of silicon n-p-n power transistors are designed for general-purpose high-voltage usage. Applications include: TV horizontal driver and output stage; audio output stage of portable TV sets; high-voltage regulators; and video display drivers.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-202AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D40V1,2	D40V3,4	D40V5,6	UNITS
Collector-Emitter Voltage	V_{CEO}	250	300	350	Volts
Collector-Emitter Voltage	V_{CES}	300	350	400	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous	I_C	0.1	0.1	0.1	A
Base Current — Continuous	I_B	0.1	0.1	0.1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.7 9	1.7 9	1.7 9	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	73.5	73.5	73.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	13.9	13.9	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

D40V Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Voltage (I_C = 5mA)	D40V1,2 D40V3,4 D40V5,6	V_{CEO}	250 300 350	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = 300V) (V_{CE} = 350V) (V_{CE} = 400V)	D40V1,2 D40V3,4 D40V5,6	I_{CES}	— — —	— — —	10 10 10	μA μA μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	10	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 6			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 5mA, V_{CE} = 10V) (I_C = 20mA, V_{CE} = 10V) (I_C = 40mA, V_{CE} = 10V)	D40V1,3,5	h_{FE}	20 30 20	— — —	— 90 —	—
(I_C = 5mA, V_{CE} = 10V) (I_C = 20mA, V_{CE} = 10V) (I_C = 40mA, V_{CE} = 10V)	D40V2,4,6	h_{FE}	30 60 30	— — —	— 180 —	
Collector-Emitter Saturation Voltage (I_C = 20mA, I_B = 2mA)		$V_{CE(sat)}$	—	—	1.0	V
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)		C_{CB}	—	2	3	pF
Current Gain Bandwidth Product (I_C = 100mA, V_{CE} = 10V, f_{test} = 1.0 MHz)		f_T	50	—	—	MHz

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

2

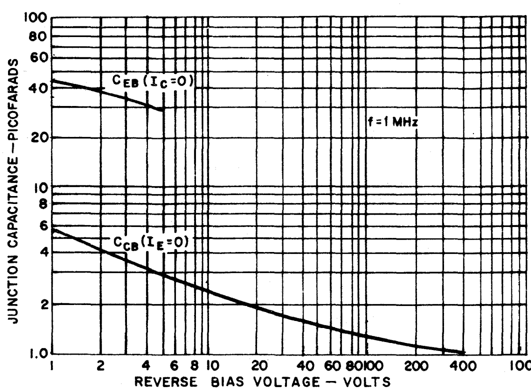


FIG. 1 JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

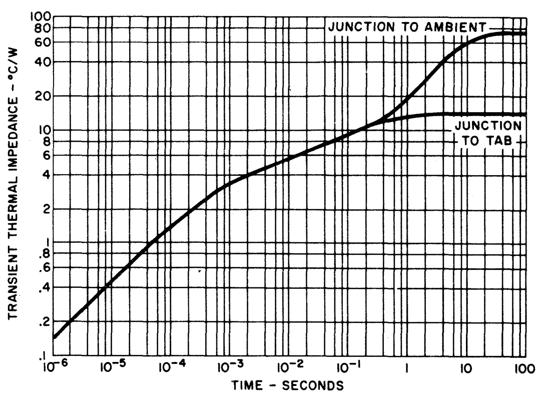


FIG. 2 MAXIMUM TRANSIENT THERMAL IMPEDANCE

D40V Series

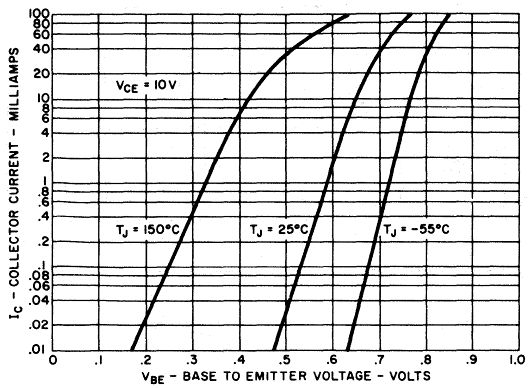


FIG. 3 TYPICAL TRANCONDUCTANCE CHARACTERISTICS

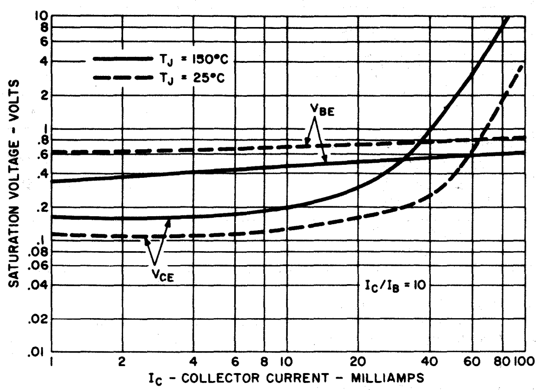


FIG. 4 TYPICAL SATURATION VOLTAGES

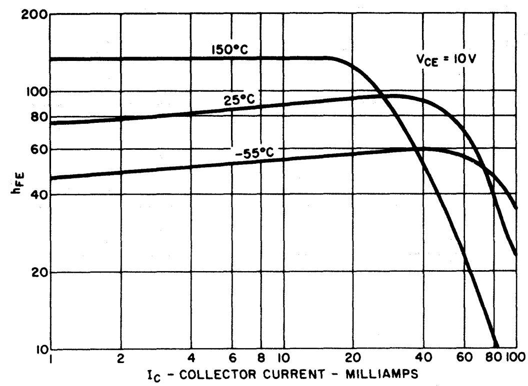


FIG. 5 TYPICAL h_{FE} VS. I_C

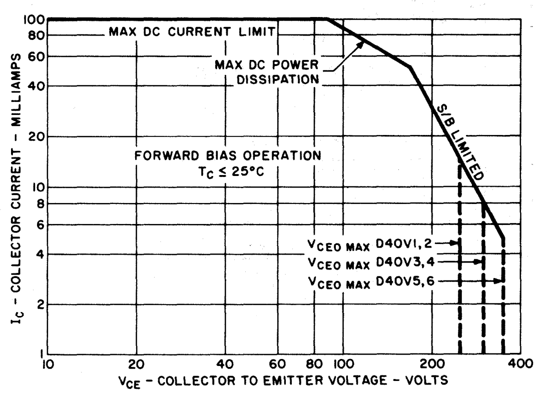


FIG. 6 SAFE REGION OF OPERATION

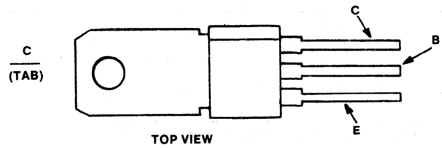
File Number **15.3**

D41D Series

1-Ampere Silicon P-N-P Power Transistors

Complementary to the D40D Series

TERMINAL DESIGNATIONS



JEDEC TO-202AB

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -1A I_C)
- Excellent linearity
- Fast switching

The D41D-series of silicon p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D41D1, 2	D41D4, 5	D41D7, 8	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	Volts
Collector-Emitter Voltage	V_{CES}	-45	-60	-75	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-1 -1.5	-1 -1.5	-1 -1.5	A
Base Current — Continuous	I_B	-0.5	-0.5	-0.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25C	P_D	1.67 6.25	1.67 6.25	1.67 6.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	20	20	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D41D Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = -10ma)	D41D1, 2 D41D4, 5 D41D7, 8	$V_{CEO(sus)}$	-30 -45 -60	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CEO}) T_C = 25°C (V_{CE} = Rated V_{CES}) T_C = 150°C		I_{CES}	— —	— -1	-0.1 —	μA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-0.1	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 7			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = -100mA, V_{CE} = - 2V)	D41D1, 4, 7 D41D2, 5, 8	h_{FE}	50 120	— —	150 360	—
(I_C = -1A, V_{CE} = -2V)	D41D1, 4, 7 D41D2 D41D5, 8	h_{FE}	10 20 10	— — —	— — —	—
Collector-Emitter Saturation Voltage (I_C = -500mA, I_B = -50mA)	D41D1, 2, 4, 5 D41D7, 8	$V_{CE(sat)}$	— —	— —	-0.5 -1.0	Volts
Base-Emitter Saturation Voltage (I_C = -500mA, I_B = -50mA)		$V_{BE(sat)}$	—	—	-1.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	10	—	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -10V)		f_T	—	150	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A	$t_d + t_r$	—	50	—	nS
Storage Time	V_{CC} = -30V, t_p = 25 μsec	t_s	—	75	—	
Fall Time		t_f	—	40	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

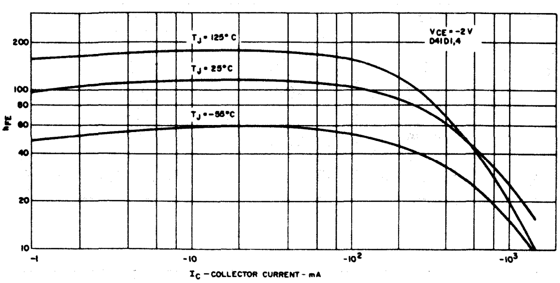


FIG. 1

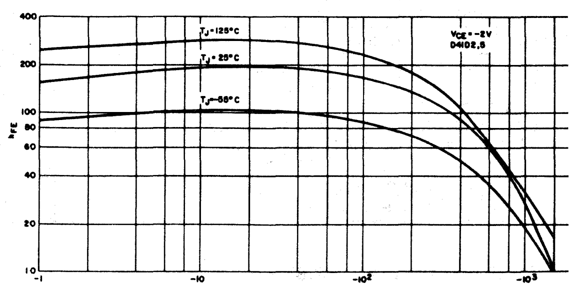


FIG. 2

TYPICAL h_{FE} VS. I_C

D41D Series

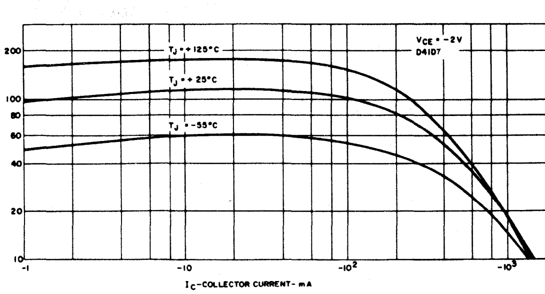


FIG. 3

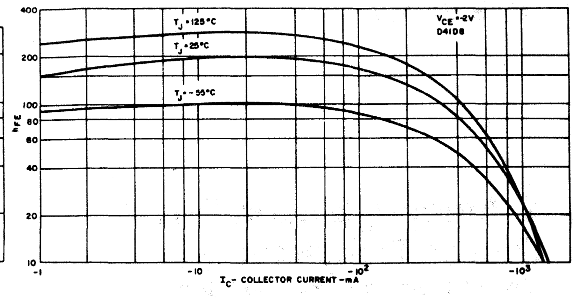


FIG. 4

TYPICAL h_{FE} VS. I_C

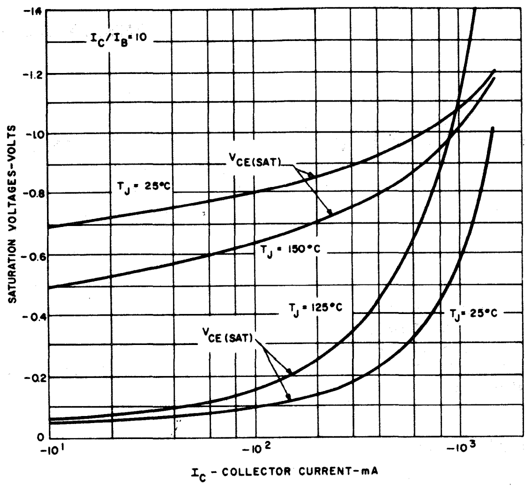


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

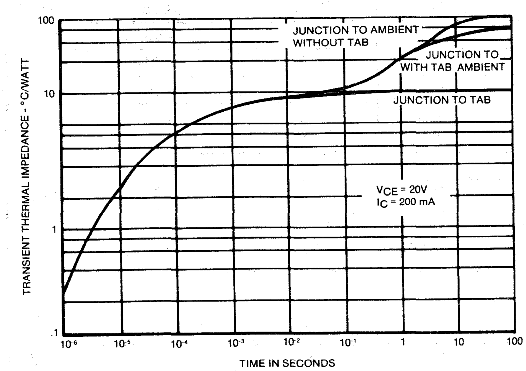


FIG. 6 MAXIMUM TRANSIENT THERMAL IMPEDANCE

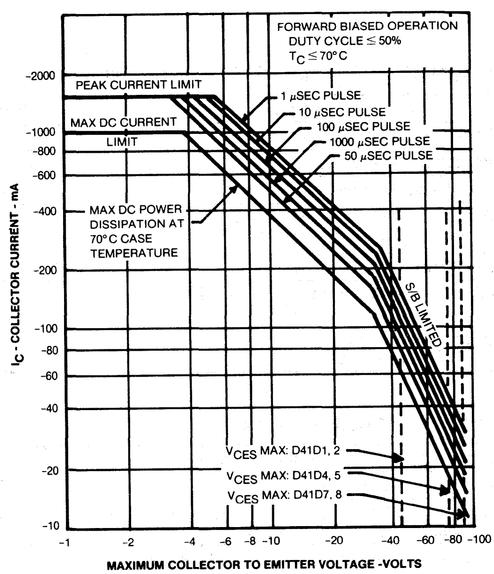


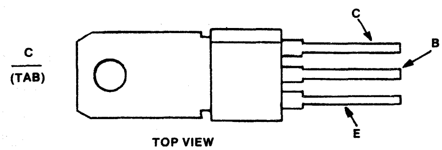
FIG. 7 SAFE REGION OF OPERATION

D41E Series File Number **15.5**

2-Ampere Silicon P-N-P Power Transistors

Complementary to the D40E Series

TERMINAL DESIGNATIONS



JEDEC TO-202AB

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -1A I_C)
- Excellent linearity
- Fast switching

The D41E-series of silicon p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D41E1	D41E5	D41E7	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-45	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-2 -3	-2 -3	-2 -3	A
Base Current — Continuous	I_B	-1	-1	-1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.33 8	1.33 8	1.33 8	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D41E Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT

OFF CHARACTERISTICS(1)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Sustaining Voltage (I_C = -10ma) D41E1	$V_{CEO(sus)}$	-30	—	—	Volts
D41E5		-60	—	—	
D41E7		-80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})	I_{CES}	—	—	-0.1	μA
Emitter Cutoff Current (V_{EB} = -5V)	I_{EBO}	—	—	-0.1	μA

SECOND BREAKDOWN

CHARACTERISTIC	SYMBOL				
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1			

ON CHARACTERISTICS(1)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = -100mA, V_{CE} = -2V)	h_{FE}	50	—	—	—
(I_C = -1A, V_{CE} = -2V)	h_{FE}	10	—	—	—
Collector-Emitter Saturation Voltage (I_C = -1.0A, I_B = -0.1A)	$V_{CE(sat)}$	—	—	-1.0	Volts
Base-Emitter Saturation Voltage (I_C = -1.0mA, I_B = 0.1A)	$V_{BE(sat)}$	—	—	-1.3	Volts

DYNAMIC CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector Capacitance (V_{CB} = 10V, f = 1M_{Hz})	C_{CBO}	—	13	—	pF
Current-Gain Bandwidth Product (I_C = -100mA, V_{CE} = -10V)	f_T	—	175	—	MHz

SWITCHING CHARACTERISTICS

CHARACTERISTIC	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A	$t_d + t_r$	—	180	—	nS
Storage Time	V_{CC} = -30V, t_p = 25 μsec	t_s	—	250	—	
Fall Time		t_f	—	110	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

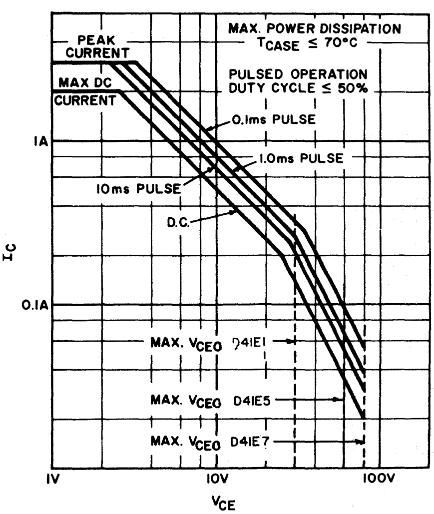


FIG. 1 SAFE REGION OF OPERATION

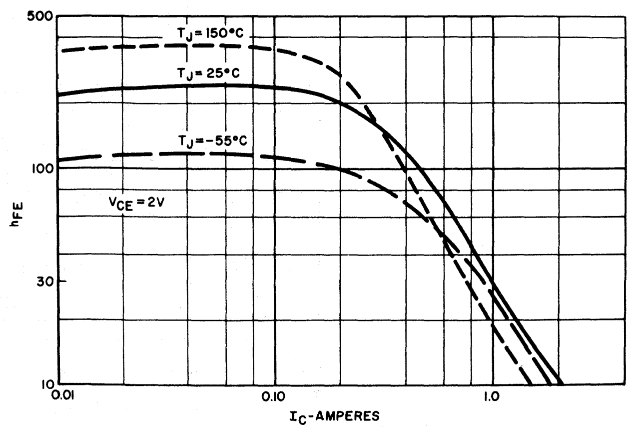


FIG. 2 TYPICAL H_{FE} VS I_C

D41E Series

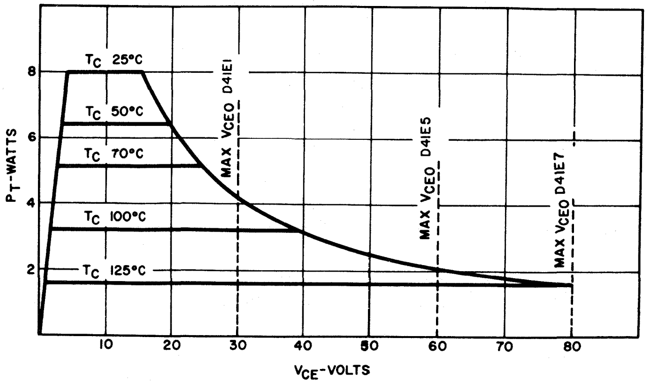


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

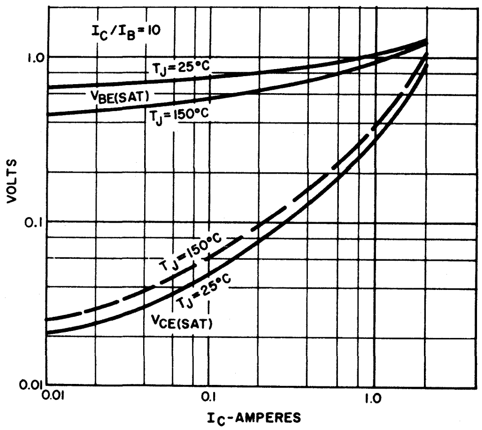


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

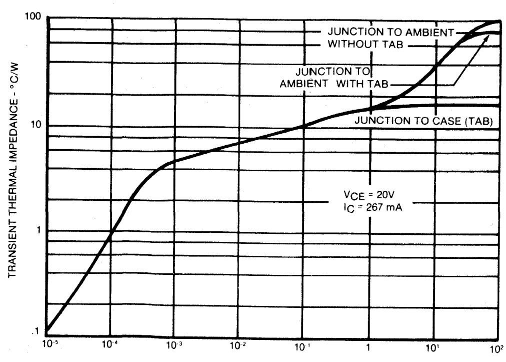


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

File Number **15.7**

D41K Series

2-Ampere Silicon P-N-P Power Transistors

Complementary to the D40K Series

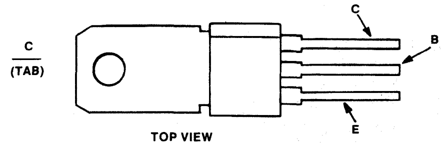
Features:
- Operates from IC without predriver

Applications:
- Switching regulator
- Lamp driver
- Touch switch
- Solenoid driver

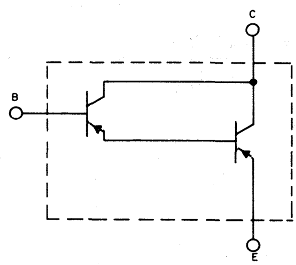
The D41K-series of silicon p-n-p Darlington power transistors are designed for general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-202AB



Schematic diagram for all types.

2

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D41K1,3	D41K2,4	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-50	Volts
Collector-Emitter Voltage	V_{CES}	-30	-50	Volts
Emitter Base Voltage	V_{EBO}	-13	-13	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-2 -3	-2 -3	A A
Base Current — Continuous	I_B	-0.2	-0.2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 10	1.67 10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	12.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D41K Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Voltage (I_C = -10ma)	D41K1,3 D41K2,4	V_{CEO}	-30 -50	— —	— —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-0.5	μA
Emitter Cutoff Current (V_{EB} = -13V)		I_{EBO}	—	—	-0.1	μA
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = -200mA, V_{CE} = -5V)		h_{FE}	10K	—	—	—
(I_C = -1.5A, V_{CE} = -5V) (I_C = -1A, V_{CE} = -5V)	D41K1,2 D41K3,4	h_{FE}	1K 1K	— —	— —	— —
Collector-Emitter Saturation Voltage (I_C = -1.5A, I_B = -3mA) (I_C = -1.0A, 1_B = -2mA)	D41K1,2 D41K3,4	$V_{CE(sat)}$	— —	— —	-1.5 -1.5	Volts
Base-Emitter Saturation Voltage (I_C = -1.5A, I_B = -3mA) (I_C = -1A, I_B = -2mA)	D41K1,2 D41K3,4	$V_{BE(sat)}$	— —	— —	-2.5 -2.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	9	15	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -5V)		f_T	—	100	—	MHz

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

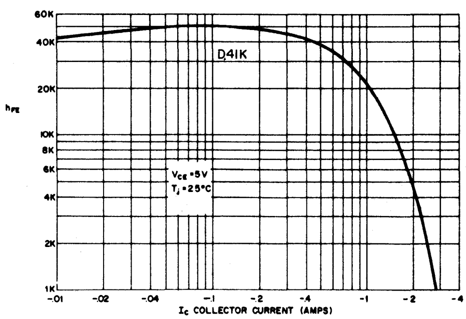


FIG. 1 TYPICAL h_{FE} vs. I_C

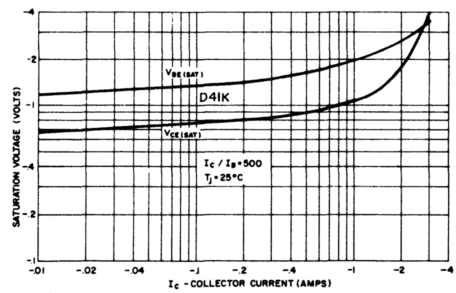


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

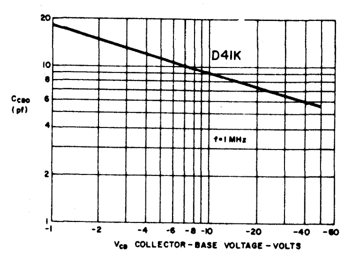


FIG. 3 TYPICAL SATURATION VOLTAGE

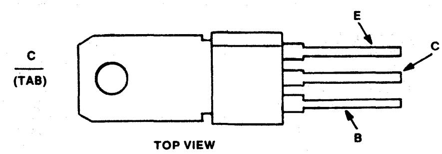
File Number **15.9**

D42C Series

3-Ampere Silicon N-P-N Power Transistors

Complementary to the D43C Series

TERMINAL DESIGNATIONS



92CS-43473

JEDEC TO-202AB

Features:

- High free-air power dissipation
- Low collector saturation voltage (0.5V typ. @ 3A I_C)
- Excellent linearity
- Fast switching

The D42C-series of silicon n-p-n power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D42C1, 2, 3	D42C4, 5, 6	D42C7, 8, 9	D42C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	80	Volts
Collector-Emitter Voltage	V_{CES}	40	55	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	3 5	3 5	3 5	3 5	A
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 12.5	2.1 12.5	2.1 12.5	2.1 12.5	Watts
Operating and Storage Junction Temperature Range	T_J,T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D42C Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 100mA)	D42C1, 2, 3	$V_{CEO(sus)}$	30	—	—	Volts
	D42C4, 5, 6		45	—	—	
	D42C7, 8, 9		60	—	—	
	D42C10, 11, 12		80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURES 3 & 4			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 200mA, V_{CE} = 1V)	D42C1, 4, 7, 10	h_{FE}	25	—	—	—
	D42C2, 5, 8, 11		100	—	220	
	D42C3, 6, 9, 12		40	—	120	
(I_C = 1A, V_{CE} = 1V)	D42C1, 4, 7, 10	h_{FE}	10	—	—	—
(I_C = 2A, V_{CE} = 1V)	D42C2, 5, 8, 11		20	—	—	
	D42C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 50mA)	D42C2, 5, 8, 11	$V_{CE(sat)}$	—	—	0.5	Volts
	D42C3, 6, 9, 12		—	—	0.5	
(I_C = 1A, I_B = 100mA)	D42C1, 4, 7, 10	$V_{CE(sat)}$	—	—	0.5	Volts
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 100mA)		$V_{BE(sat)}$	—	—	1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	—	100	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 4V)		f_T	—	50	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A,	$t_d + t_r$	—	100	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

D42C Series

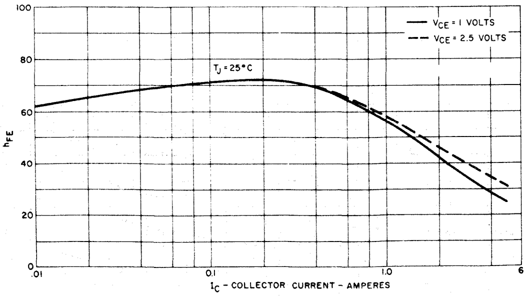


FIG. 1 TYPICAL h_{FE} VS. I_C

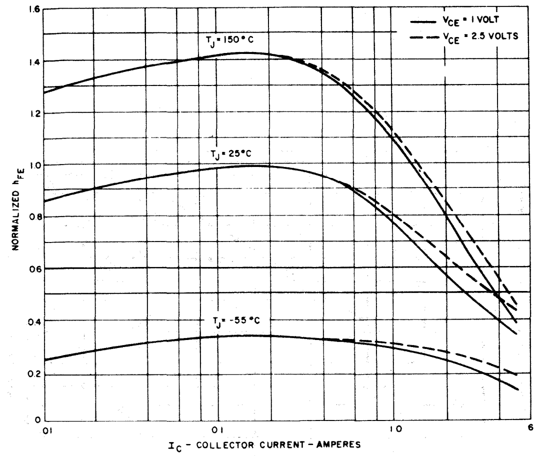


FIG. 2 TYPICAL NORMALIZED h_{FE} VS. I_C

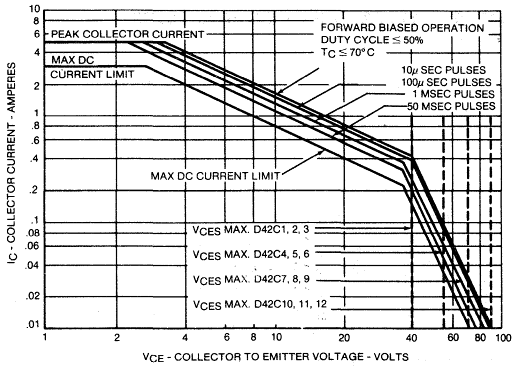


FIG. 3 SAFE REGION OF OPERATION

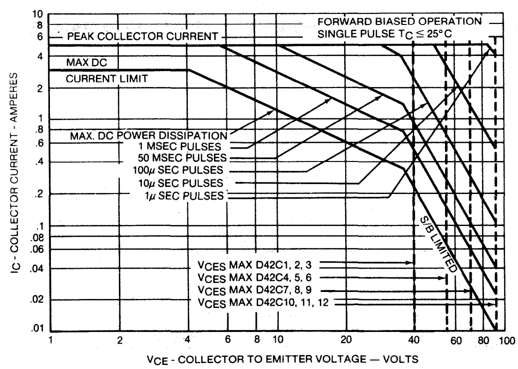


FIG. 4 SAFE REGION OF OPERATION

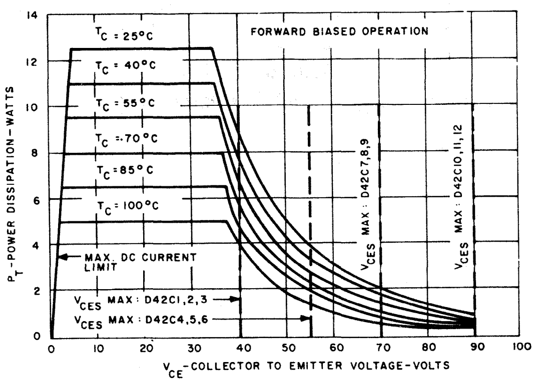


FIG. 5 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

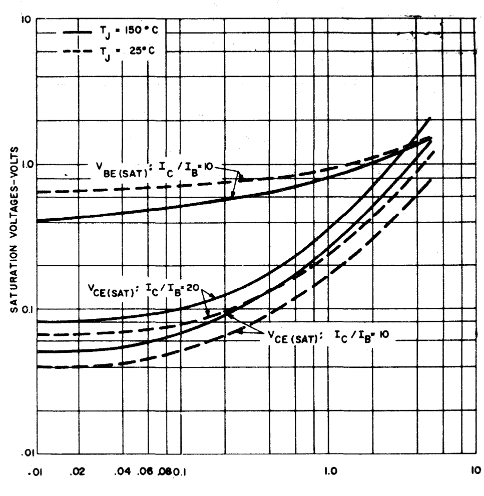


FIG. 6 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

2

D42C Series

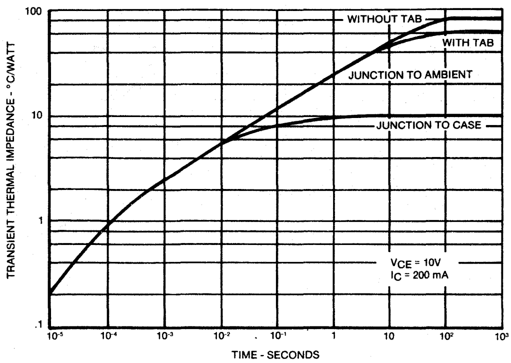


FIG. 7 MAXIMUM TRANSIENT THERMAL IMPEDANCE

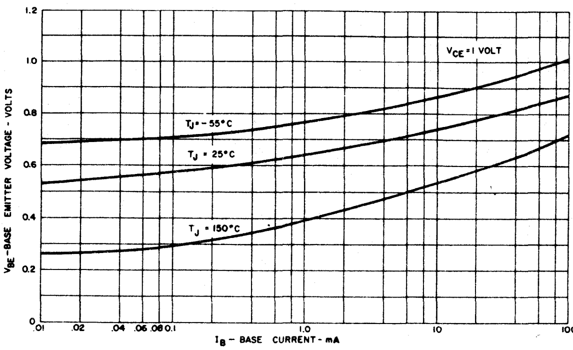


FIG. 8 TYPICAL INPUT CHARACTERISTICS

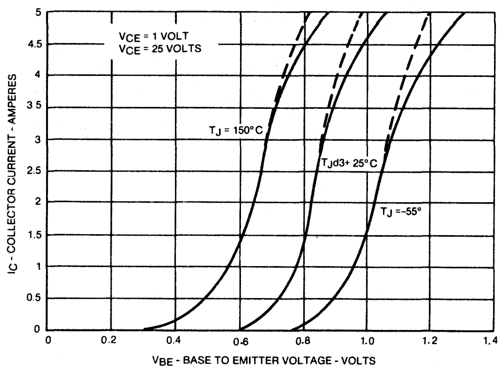


FIG. 9

TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

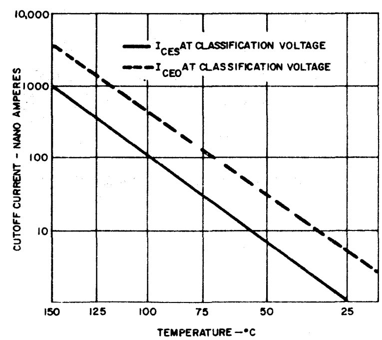


FIG. 10

TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

File Number **15.10**

D43C Series

3-Ampere Silicon P-N-P Power Transistors

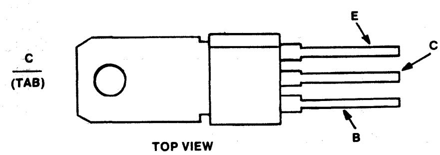
Complementary to the D42C Series

2

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -3A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



92CS-43473

JEDEC TO-202AB

The D43C-series of silicon p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D43C1, 2, 3	D43C4, 5, 6	D43C7, 8, 9	D43C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-40	-55	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-3 -5	-3 -5	-3 -5	-3 -5	A
Base Current — Continuous	I_B	-2	-2	-2	-2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 12.5	2.1 12.5	2.1 12.5	2.1 12.5	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D43C Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = -100ma)	D43C1, 2, 3	$V_{CEO(sus)}$	-30	—	—	Volts
	D43C4, 5, 6		-45	—	—	
	D43C7, 8, 9		-60	—	—	
	D43C10, 11, 12		-80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 3			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = -200mA, V_{CE} = -1V)	D43C1, 4, 7, 10	h_{FE}	25	—	—	—
	D43C2, 5, 8, 11		40	—	120	
	D43C3, 6, 9, 12		40	—	120	
(I_C = -1A, V_{CE} = -1V)	D43C1, 4, 7, 10	h_{FE}	10	—	—	—
	D43C2, 5, 8, 11		20	—	—	
(I_C = -2A, V_{CE} = -1V)	D43C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -50mA)	D43C2, 5, 8, 11	$V_{CE(sat)}$	—	—	-0.5	Volts
	D43C3, 6, 9, 12		—	—	-0.5	
(I_C = -1A, I_B = -100mA)	D43C1, 4, 7, 10	$V_{CE(sat)}$	—	—	-0.5	Volts
Base-Emitter Saturation Voltage (I_C = -1A, I_B = -100mA)		$V_{BE(sat)}$	—	—	-1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = $1M_{Hz}$)		C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -4V)		f_T	—	40	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A	$t_d + t_r$	—	50	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

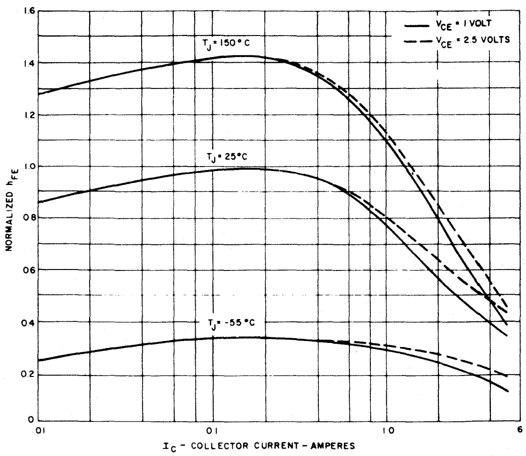


FIG. 1 TYPICAL NORMALIZED h_{FE} VS. I_C

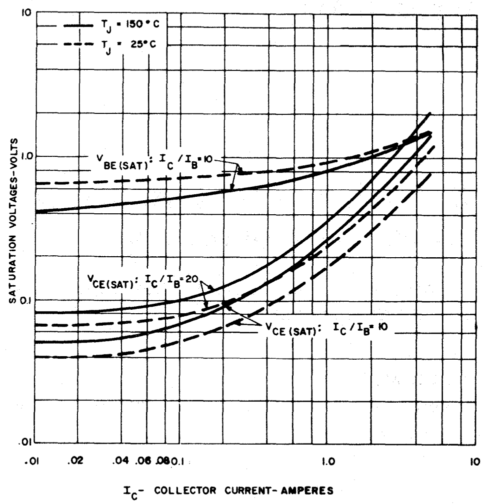


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

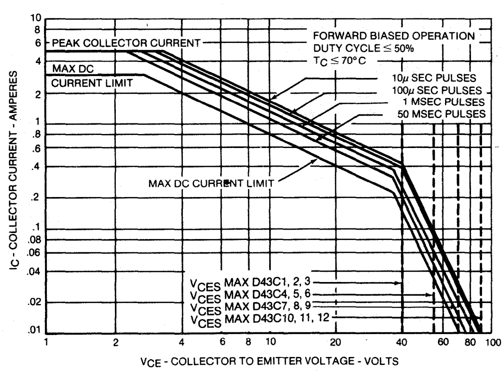


FIG. 3 SAFE REGION OF OPERATION

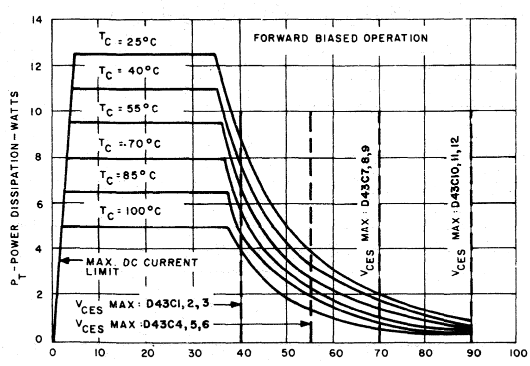


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

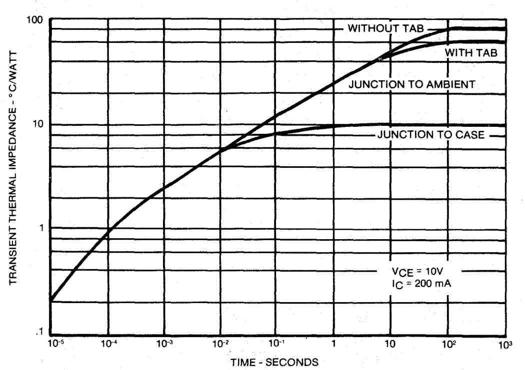


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

D44C Series

File Number **15.11**

Silicon N-P-N Transistors

Complementary to the D45C Series

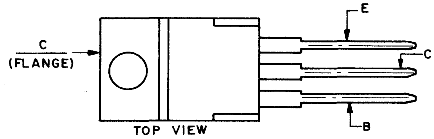
General-Purpose Types for Medium-Power Switching and Amplifier Applications

Features:

- *Very low collector saturation voltage* [0.5V typ. @ 3.0A I_C]
- *Excellent linearity*
- *Fast switching*

TERMINAL DESIGNATIONS

D44C-series n-p-n power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz, series, shunt and switching regulators, and low and high frequency inverters/converters.



92CS-39969

JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44C1, 2, 3	D44C4, 5, 6	D44C7, 8, 9	D44C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	80	Volts
Collector-Emitter Voltage	V_{CES}	40	55	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous	I_C	4	4	4	4	A
Peak(1)	I_{CM}	6	6	6	6	
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ T_A = 25°C	P_D	1.67	1.67	1.67	1.67	Watts
@ T_C = 25°C		30	30	30	30	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D44C Series

ELECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 100mA)	D44C1, 2, 3 D44C4, 5, 6 D44C7, 8, 9 D44C10, 11, 12	$V_{CEO(sus)}$	30 45 60 80	— — — —	— — — —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 3			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 0.2A, V_{CE} = 1V)	D44C1, 4, 7, 10 D44C2, 5, 8, 11 D44C3, 6, 9, 12	h_{FE}	25 100 40	— — —	— 220 120	—
(I_C = 1A, V_{CE} = 1V) (I_C = 2A, V_{CE} = 1V)	D44C1, 4, 7, 10 D44C2, 5, 8, 11 D44C3, 6, 9, 12	h_{FE}	10 20 20	— — —	— — —	—
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 50mA) (I_C = 1A, I_B = 100mA)	D44C2, 5, 8, 11 D44C3, 6, 9, 12 D44C1, 4, 7, 10	$V_{CE(sat)}$	— — —	— — —	0.5 0.5 0.5	Volts
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 100mA)		$V_{BE(sat)}$	—	—	1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	—	100	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 4V)		f_T	—	50	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A,	$t_d + t_r$	—	100	—	nS
Storage Time	V_{CC} = 30A, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

2

D44C Series

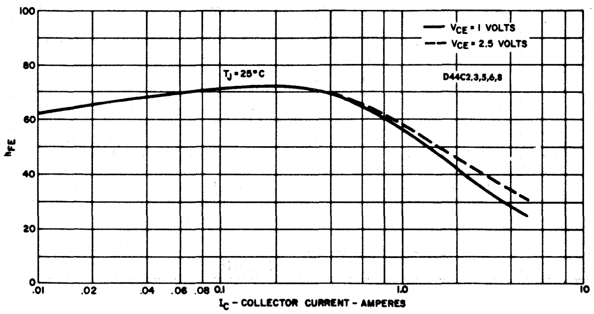


FIG. 1 TYPICAL h_{FE} VS. I_C

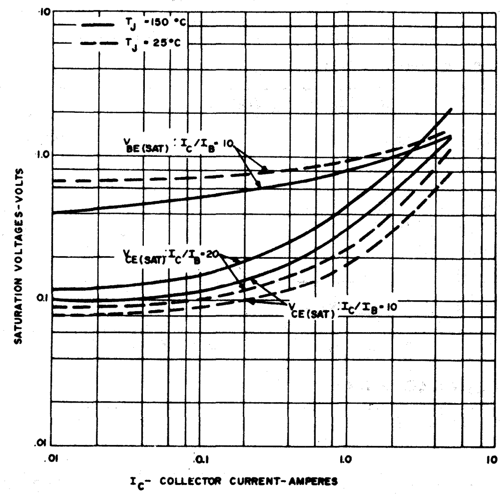


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

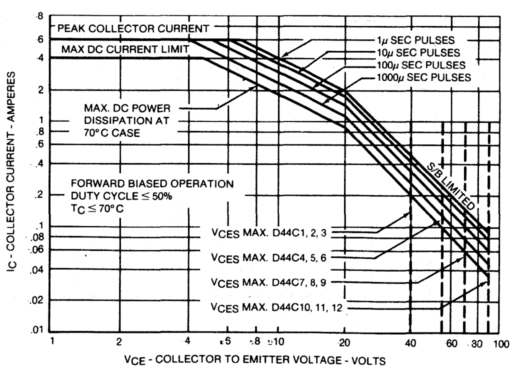


FIG. 3 SAFE REGION OF OPERATION

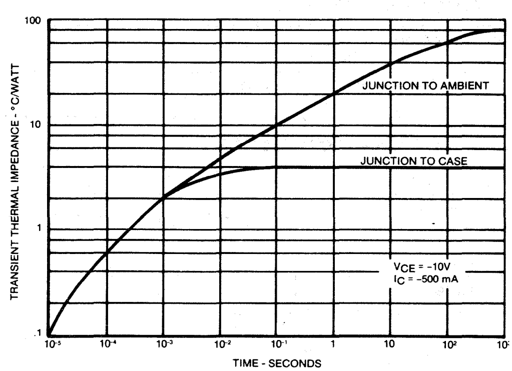


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

File Number **15.13**

D44D Series

6-Ampere N-P-N Darlington Power Transistors

Complementary to the D45D Series

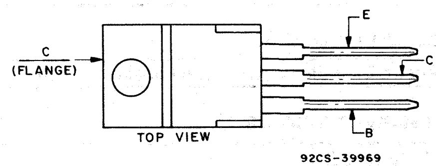
40, 60, and 80 Volts, 30 Watts
Gain of 2000 at 1 A

Features:
- *Operates from IC without predriver*

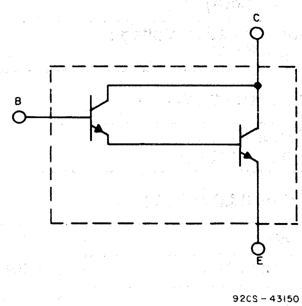
Applications:
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*
- *Inverter/Converter*

The D44D-series n-p-n Darlington power transitors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 2000.

TERMINAL DESIGNATIONS



JEDEC TO-220AB



Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44D1,2	D44D3,4	D44D5,6	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	Volts
Collector-Emitter Voltage	V_{CES}	50	70	90	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous	I_C	6	6	6	A
Base Current — Continuous	I_B	0.5	0.5	0.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 30	2.1 30	2.1 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

D44D Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Breakdown Voltage (I_C = 50mA)	D44D1,2	$V_{CEO(BR)}$	40	—	—	Volts
	D44D3,4		60	—	—	
	D44D5,6		80	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})	T_C = 25°C	I_{CES}	—	—	10	µA
(V_{CE} = Rated V_{CES}, V_{BE} = 0.4V)	T_C = 125°C	I_{CEV}	—	—	5	
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	10	µA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 5			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 1A, V_{CE} = 2V)		h_{FE}	2,000	5,000	—	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 3mA)		$V_{CE(sat)}$	—	—	1.5	V
(I_C = 5A, I_B = 5mA)	D44D2,4,6 only		—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 5mA)		$V_{BE(sat)}$	—	—	2.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	—	45	pF

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time + Rise Time	I_C = 3A, I_{B1} = I_{B2} = 3mA	$t_d + t_r$	—	0.5	—	µS
Storage Time	V_{CC} = 40V, t_p = 25 µsec	t_s	—	1.2	—	
Fall Time		t_f	—	0.8	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

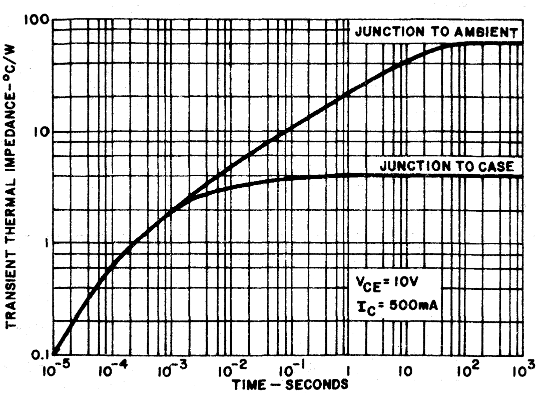


FIG. 1
MAXIMUM TRANSIENT THERMAL IMPEDANCE

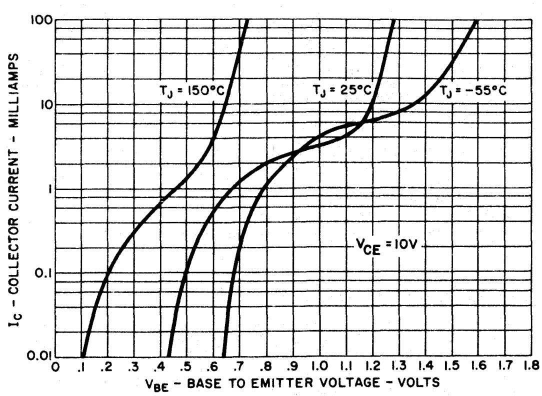


FIG. 2
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

D44D Series

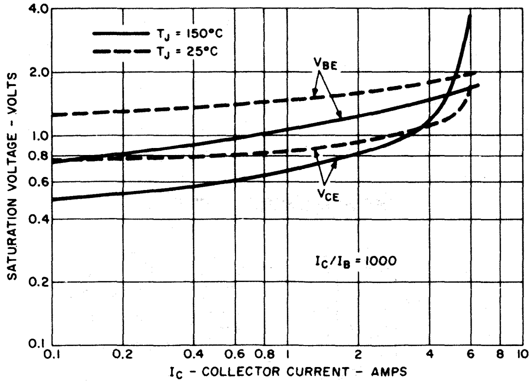


FIG. 3
TYPICAL SATURATION VOLTAGE CHARACTERISTICS

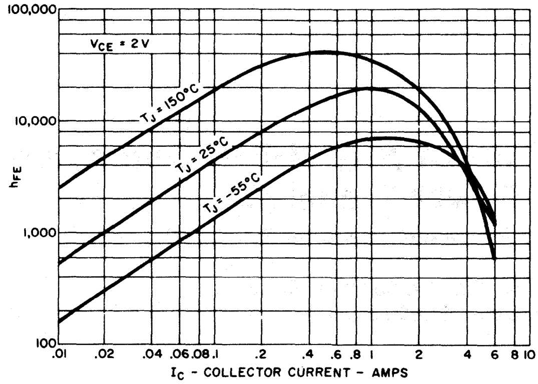


FIG. 4 TYPICAL h_{FE} VS. I_C

2

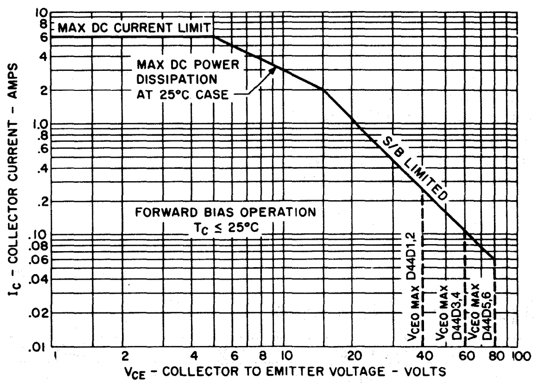


FIG. 5 SAFE REGION OF OPERATION

D44E Series

File Number **15.15**

10-Ampere N-P-N Darlington Power Transistors

Complementary to the D45E Series

40, 60, and 80 Volts, 50 Watts
Gain of 2000 at 5 A

Features:

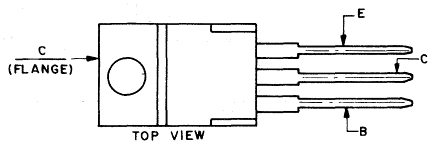
- *Operates from IC without predriver*

Applications:

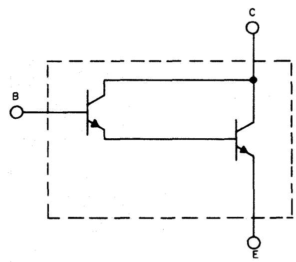
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*
- *Inverter/Converter*

The D44E-series n-p-n Darlington power transitors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 1000.

TERMINAL DESIGNATIONS



JEDEC TO-220AB



Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44E1	D44E2	D44E3	UNITS
Collector-Emitter Voltage	V_{CEO}	40	60	80	Volts
Collector-Emitter Voltage	V_{CES}	40	60	80	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	10 20	10 20	10 20	A
Base Current — Continuous	I_B	1	1	1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle ≤ 2%.

D44E Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Voltage (I_C = 100mA)	D44E1 D44E2 D44E3	V_{CEO}	40 60 80	— — —	— — —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 7V)		I_{EBO}	—	—	1.0	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 6			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 5A, V_{CE} = 5V)		h_{FE}	1,000	—	—	—
Collector-Emitter Saturation Voltage (I_C = 5.0A, I_B = 10mA) (I_C = 10.0A, 1_B = 20mA)		$V_{CE(sat)}$	— —	— —	1.5 2.0	V V
Base-Emitter Saturation Voltage (I_C = 5.0A, I_B = 10mA)		$V_{BE(sat)}$	—	—	2.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = −10V, f = 1MHz)		C_{CBO}	—	—	130	pF
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 10A, I_{B1} = I_{B2} = 20mA V_{CC} = 40V, t_p = 25 μsec	$t_d + t_r$	—	0.6	—	μS
Storage Time		t_s	—	2.0	—	
Fall Time		t_f	—	0.5	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

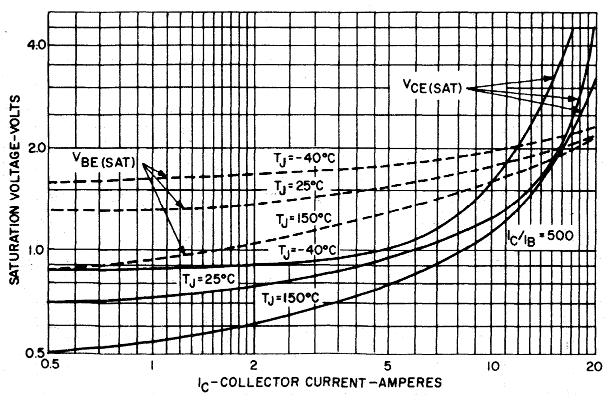


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

D44E Series

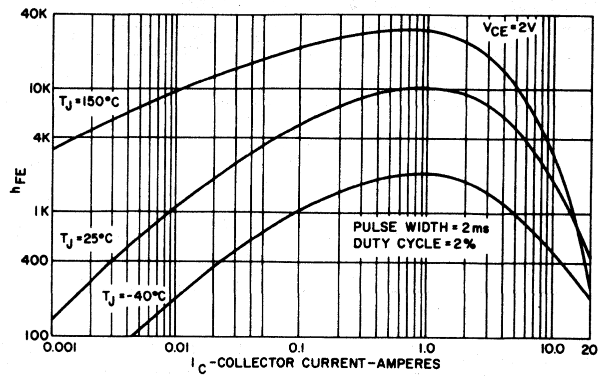


FIG. 2 TYPICAL GAIN CHARACTERISTIC

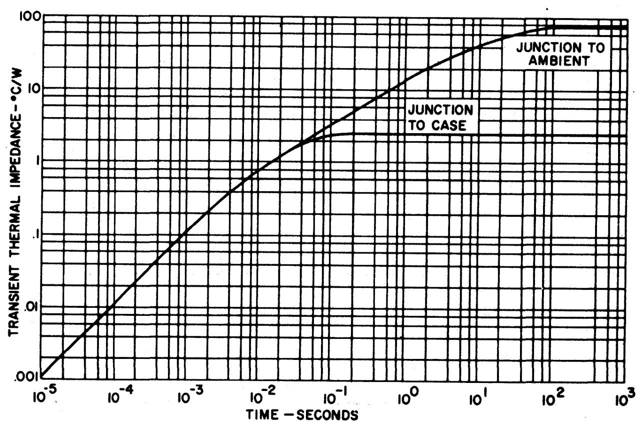


FIG. 3 TRANSIENT THERMAL IMPEDANCE

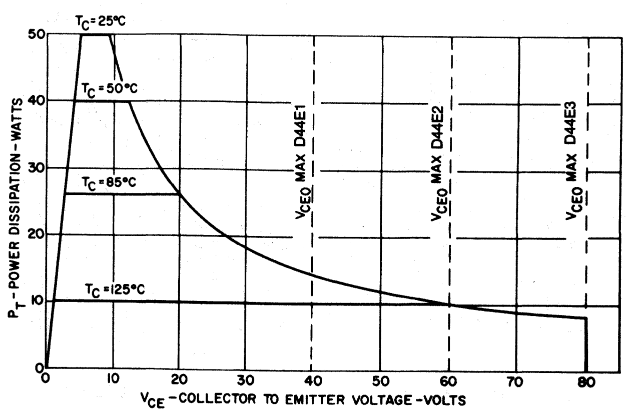


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

D44E Series

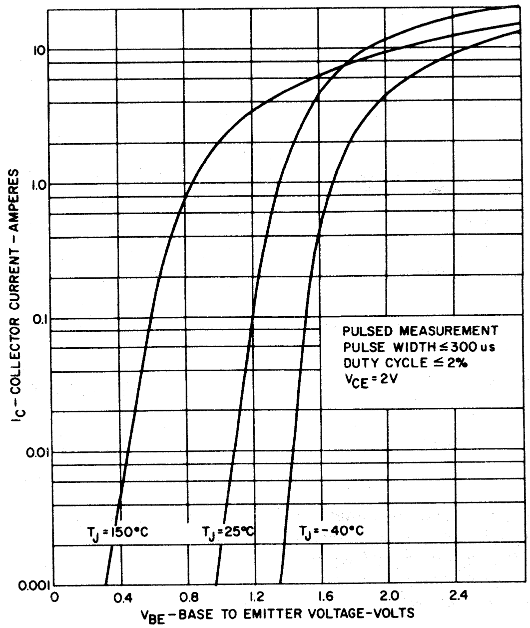


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

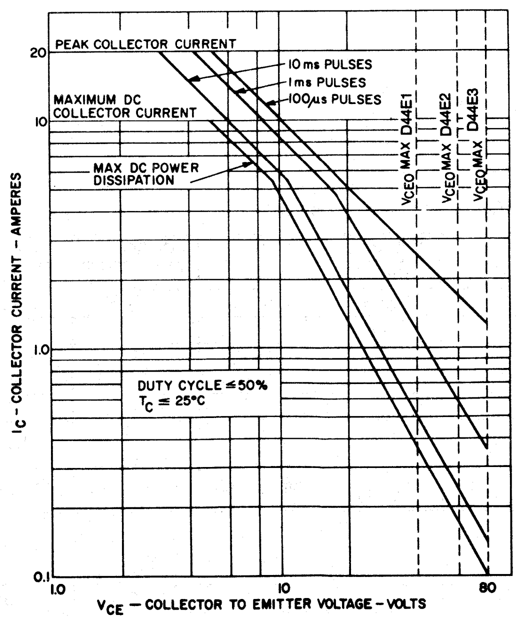


FIG. 6 SAFE REGION OF OPERATION

D44H Series

File Number **15.17**

Silicon N-P-N Transistors

Complementary to the D45H Series

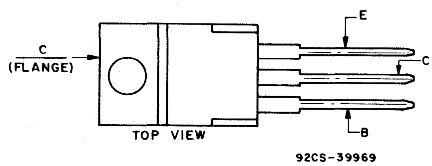
For Switching and Linear Applications

Features:

- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

D44H-series n-p-n power transistors are designed for various specific and general purpose applications, such as output and driver stages of amplifiers operating at frequencies fron DC to greater than 1.0 MHz, series, shunt and switching regulators, and low and high frequency inverters/ converters.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44H1, 2	D44H4, 5	D44H7, 8	D44H10, 11	UNITS
Collector-Emitter Voltage	V_{CEO}	30	45	60	80	Volts
Collector-Emitter Voltage	V_{CES}	30	45	60	80	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	10 20	10 20	10 20	10 20	A
Base Current — Continuous	I_B	5	5	5	5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D44H Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 100mA)	D44H1, 2 D44H4, 5 D44H7, 8 D44H10, 11	$V_{CEO(sus)}$	30 45 60 80	— — — —	— — — —	Volts
Collector Cutoff Current (V_{CB} = Rated V_{CBO})		I_{CBO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 4			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 2A, V_{CE} = 1V)	D44H1, 4, 7, 10 D44H2, 5, 8, 11	h_{FE}	35 60	— —	— —	—
(I_C = 4A, V_{CE} = 1V)	D44H1, 4, 7, 10 D44H2, 5, 8, 11	h_{FE}	20 40	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 8A, I_B = 0.4A)	D44H2, 5, 8, 11	$V_{CE(sat)}$	—	—	1.0	Volts
(I_C = 8A, I_B = 0.8A)	D44H1, 4, 7, 10		—	—	1.0	
Base-Emitter Saturation Voltage (I_C = 8A, I_B = 0.8A)		$V_{BE(sat)}$	—	—	1.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	—	130	pF
Current-Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V)		f_T	—	50	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 5A, I_{B1} = I_{B2} = 0.5A	$t_d + t_r$	—	300	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	140	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

2

D44H Series

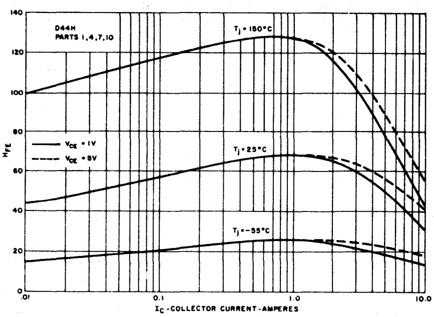


FIG. 1 TYPICAL GAIN CHARACTERISTICS

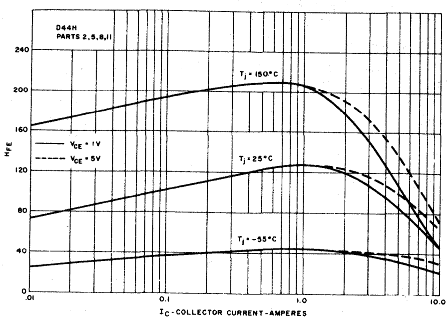


FIG. 2 TYPICAL GAIN CHARACTERISTICS

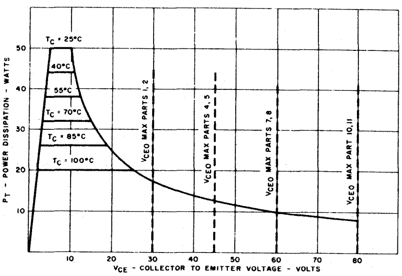


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

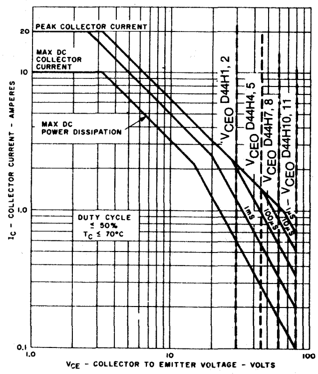


FIG. 4 SAFE REGION OF OPERATION

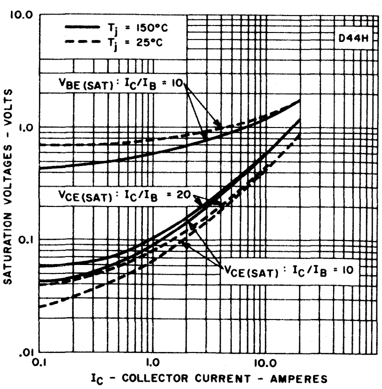


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

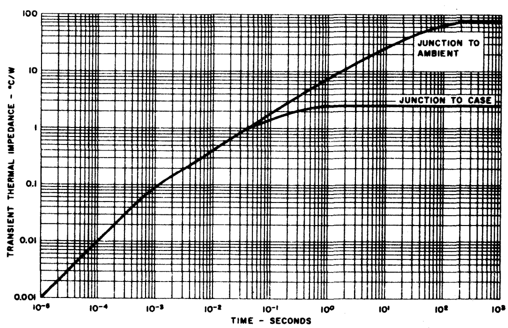


FIG. 6 TRANSIENT THERMAL IMPEDANCE

File Number **15.19**

D44Q Series

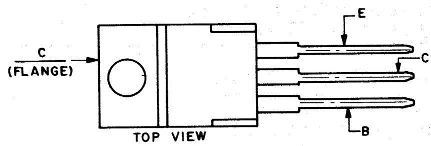
Silicon N-P-N Transistors

For Switching and Linear Applications

Features:
- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

The D44Q-series n-p-n power transistors feature low collector saturation voltage, excellent linearity, and fast switching speed. They are useful for general purposes applications such as: 120 V ac line operated amplifiers, regulators (series, shunt, and switching), high-frequency inverters/converters and tv deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44Q1	D44Q3	D44Q5	UNITS
Collector-Emitter Voltage	V_{CEO}	125	175	225	Volts
Collector-Emitter Voltage	V_{CES}	200	250	300	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous	I_C	4	4	4	A
Base Current — Continuous	I_B	2	2	2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 31.25	1.67 31.25	1.67 31.25	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	4	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

D44Q Series

ELECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 10mA)	D44Q1 D44Q3 D44Q5	$V_{CEO(sus)}$	125 175 225	—	—	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CEO})		I_{CBO}	—	—	10	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 5			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 2A, V_{CE} = 10V) (I_C = 200mA, V_{CE} = 10V)		h_{FE}	20 30	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 200mA)		$V_{CE(sat)}$	—	—	1	V
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 200mA)		$V_{BE(sat)}$	—	—	1.3	V
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)		C_{CBO}	—	40	—	pF
Current Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V)		f_T	—	50	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1.0A, I_{B1} = I_{B2} = 100mA V_{CC} = 50V, t_p = 25 μsec	$t_d + t_r$	—	—	0.2	μs
Storage Time		t_s	—	—	2.0	
Fall Time		t_f	—	—	1.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

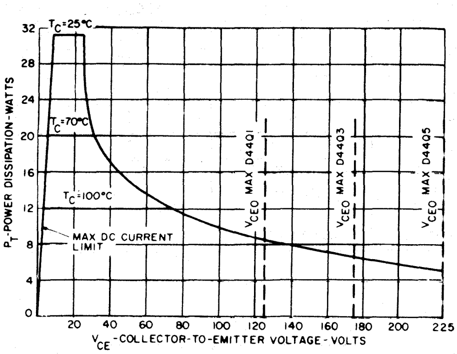


FIG. 1 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

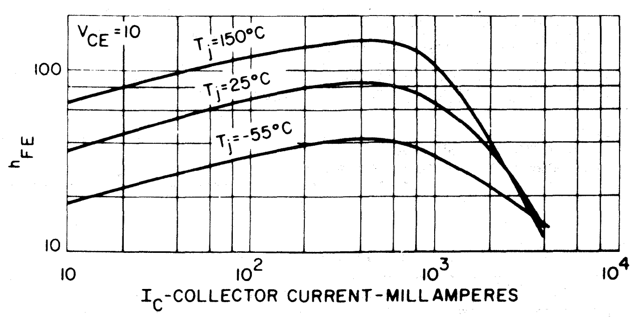


FIG. 2 TYPICAL h_{FE} vs. I_C

D44Q Series

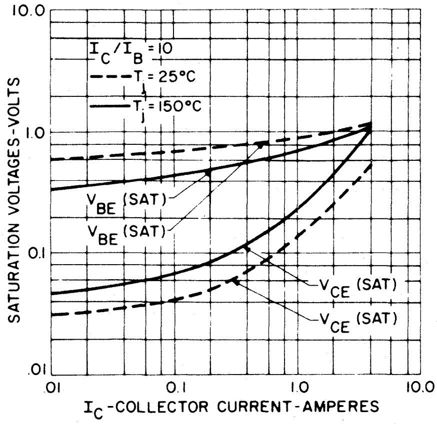


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

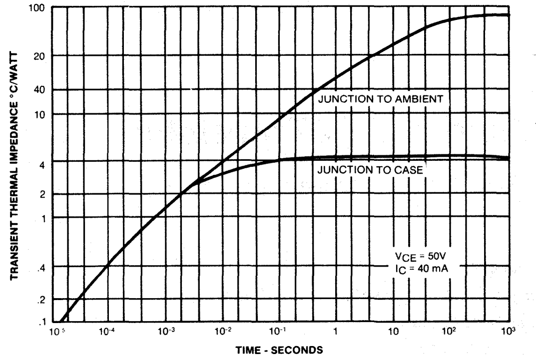


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

2

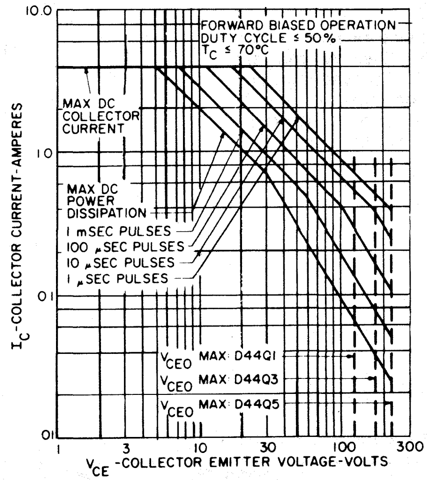


FIG. 5 FORWARD BIAS SAFE OPERATING AREA

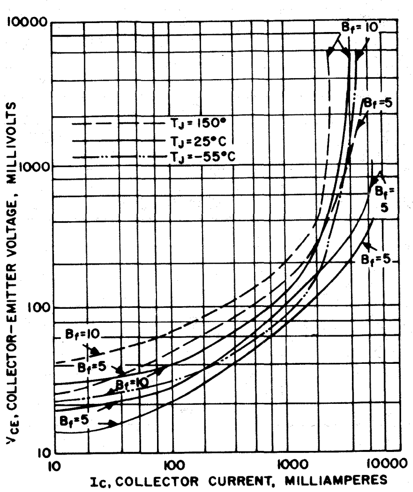


FIG. 6 $V_{CE(SAT)}$ vs. I_C TYPICAL

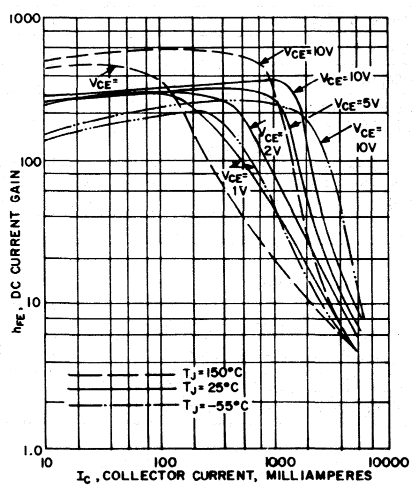


FIG. 7 DC CURRENT GAIN, TYPICAL

D44T Series

File Number **15.20**

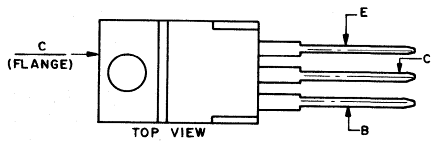
Silicon N-P-N Transistors

For Switching and Linear Applications

Features:
- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

The D44T-series n-p-n power transistors feature low collector saturation voltage, excellent linearity, and fast switching speed. They are useful for general purpose applications such as: 120 V ac line operated amplifiers, regulators (series, shunt, and switching), high frequency inverters/converters, and tv deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44T1,2	D44T3,4	UNITS
Collector-Emitter Voltage	V_{CEO}	250	300	Volts
Collector-Emitter Voltage	V_{CES}	300	400	Volts
Emitter Base Voltage	V_{EBO}	5	5	Volts
Collector Current — Continuous	I_C	2	2	A
Base Current — Continuous	I_B	0.5	0.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25C	P_D	2.1 31.2	2.1 31.2	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	4	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	°C

D44T Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Breakdown Voltage (I_C = 10 μA)	D44T1,2 D44T3,4	BV_{CES}	300 400	— —	— —	Volts
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	10	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 5			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 500mA, V_{CE} = 10V) (I_C = 50mA, V_{CE} = 10V) (I_C = 500mA, V_{CE} = 10V) (I_C = 50mA, V_{CE} = 10V)	D44T1,3 D44T2,4	h_{FE}	30 40 75 40	— — — —	— — 175 —	—
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)		$V_{CE(sat)}$	—	—	1.0	V
Base Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)		$V_{BE(sat)}$	—	—	1.2	V
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)		C_{cb}	—	25	—	pF
Current Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V, f_{test} = 1.0 MHz))		f_T	—	45	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 500mA, I_{B1} = I_{B2} = 50mA V_{CC} = 50V, t_p = 25μsec	$t_d + t_r$	—	0.2	—	μs
Storage Time		t_s	—	3.3	—	
Fall Time		t_f	—	0.6	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

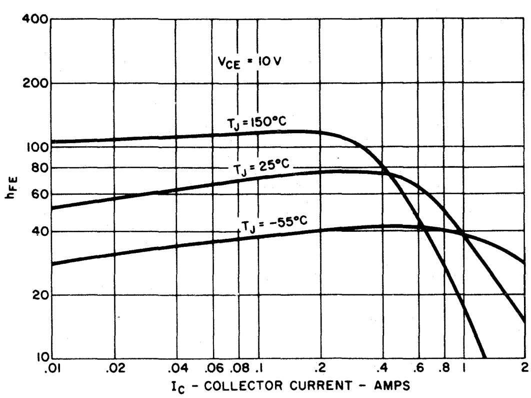


FIG. 1 TYPICAL h_{FE} VS. I_C

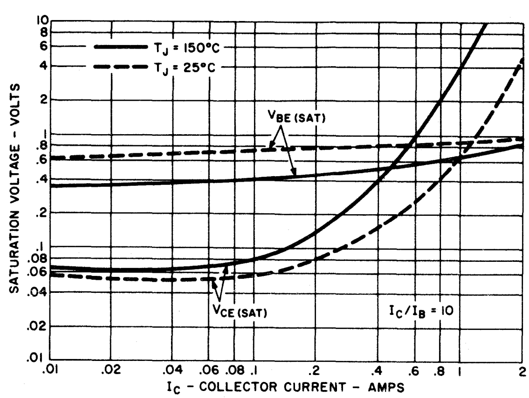


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

D44T Series

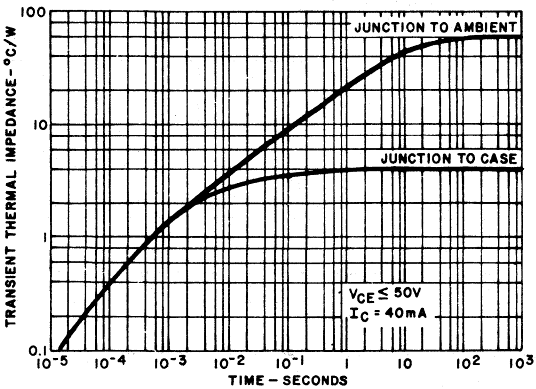


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

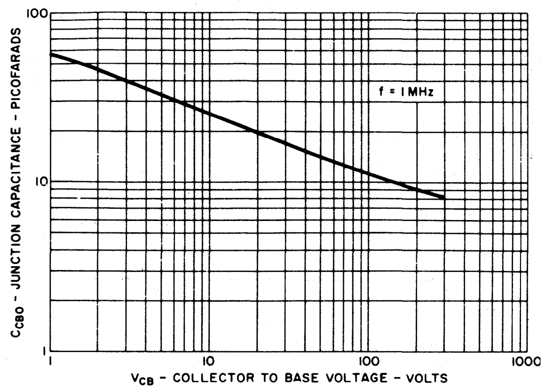


FIG. 4 COLLECTOR TO BASE JUNCTION CAPACITANC VS. REVERSE BIAS VOLTAGE

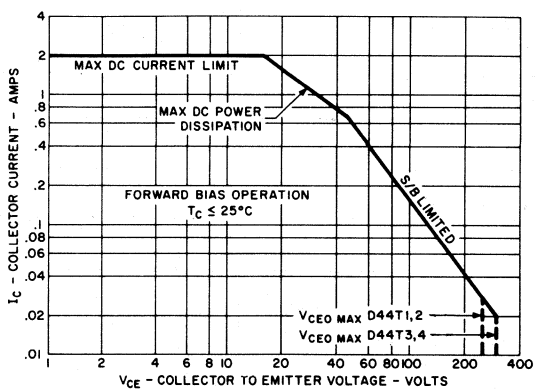


FIG. 5 SAFE REGION OF OPERATION

File Number **15.21**

D44TD Series

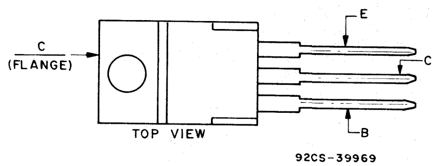
2-A Power-Switching Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other Switching Applications

Features:
- *Performance information tailored for switching applications*
- *100° C maximum limits specified for:*
  - *Switching times*
  - *Saturation voltages*
  - *Leakage currents*
- *300 to 400V* $V_{CEO(sus)}$
- *Very fast turn-off* $t_f < 180$ *nsec (typ.)@1.5A*

The D44TD-series of n-p-n power transistors are designed for use in switching applications requiring high-voltage capability, fast switching speeds, and low-saturation voltages. They are particulary suited for off-line switching power supplies, solid state lighting ballast, inverters, solenoid/relay drivers, and deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44TD3	D44TD4	D44TD5	UNITS
Collector-Emitter Voltage	V_{CEO}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEX}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEV}	400	500	600	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	2 4	2 4	2 4	A
Base Current — Continuous Peak(1)	I_B I_{BM}	0.5 1	0.5 1	0.5 1	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	50 20 0.4	50 20 0.4	50 20 0.4	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse condition, $t_p \leq$ 5msec.

D44TD Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS(1)					
Collector-Emitter Sustaining Voltage (I_C = 25mA, I_B = 0)	D44TD3 D44TD4 D44TD5	$V_{CEO(sus)}$	300 350 400	— — —	Volts
Collector-Emitter Voltage (I_C = 2.0mA, I_{B1} = I_{B2} = .4A) (V_{BE} = -5V, L = 200 µh)	D44TD3 D44TD4 D44TD5	V_{CEX}	300 350 400	— — —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V) (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V, T_C = 100°C)		I_{CEV}	— —	0.1 1.0	mA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)		I_{EBO}	—	1.0	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 13		
Clamped Inductive SOA with Base Reversed Bias		RBSOA	SEE FIGURE 14		
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 1A, V_{CE} = 2V) (I_C = 2A, V_{CE} = 3V)		h_{FE}	8 5	— —	—
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = .2A) (I_C = 2A, I_B = .4A) (I_C = 1A, I_B = .2A, T_C = 100°C)		$V_{CE(SAT)}$	— — —	0.6 1.0 1.0	Volts
Base-Emitter Saturation Voltage (I_C = 2A, I_B = .4A) (I_C = 2A, I_B = .4A, T_C = 100°C)		$V_{BE(SAT)}$	— —	1.2 1.2	Volts
DYNAMIC CHARACTERISTICS					
Current Gain — Bandwidth Product (I_C = .25A, V_{CE} = 10V, f_{test} = 1.0 MHz)		f_T	15	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)		C_{OB}	10	25	pF

SWITCHING CHARACTERISTICS

			MAXIMUM		
Resistive Load (See Figure 17 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 250V, I_C = 1.5A	t_d	.06	.08	µs
Rise Time	I_{B1} = I_{B2} = 0.3A, t_p = 25 µsec	t_r	0.6	0.8	µsec
Storage Time		t_s	2.5	3.0	µsec
Fall Time		t_f	0.5	0.8	µsec
Inductive Load, Clamped (See Figure 17 for Test Circuit)					
Storage Time	V_{CLAMP} = 250V, I_C = 1.5A,	t_{sv}	3.0	3.5	µs
Fall Time	I_{B1} = I_{B2} = 0.3A, t_p = 25µsec	t_f	0.3	0.6	µsec
	$V_{BE(OFF)}$ = -5V	TYPICAL			
Storage Time	L = 200 µh	t_s	2.1	2.6	µsec
Fall Time		t_f	0.18	0.23	µsec

(1) Pulse Duration = 300µs, Duty Factor ≤ 2%. Do not measure on a curve tracer.

D44TD Series

TYPICAL DC CHARACTERISTICS

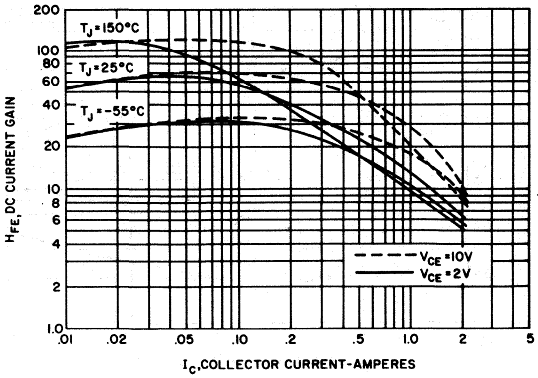


FIGURE 1. DC CURRENT GAIN

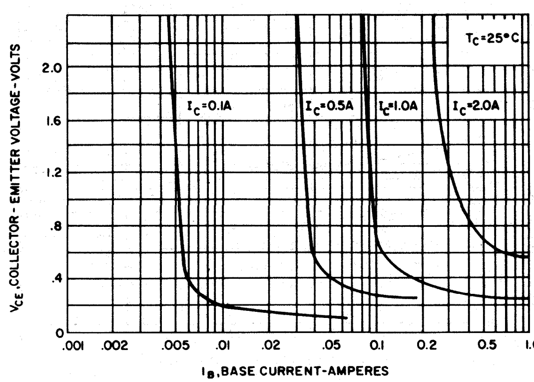


FIGURE 2. COLLECTOR SATURATION REGION

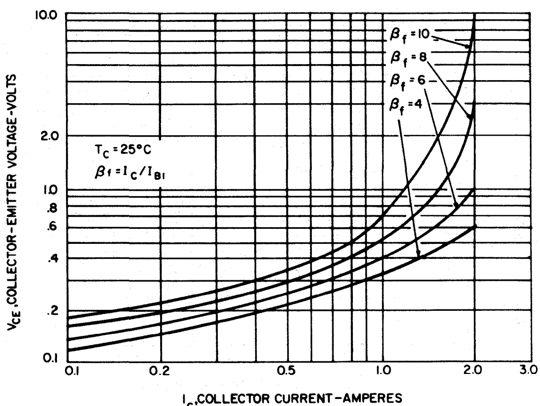


FIGURE 3. $V_{CE(SAT)}$ **VS.** I_C, T_C **= 25°C**

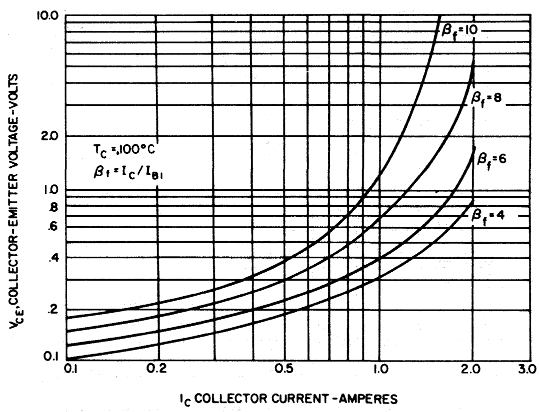


FIGURE 4. $V_{CE(SAT)}$ **VS.** I_C, T_C **= 100°C**

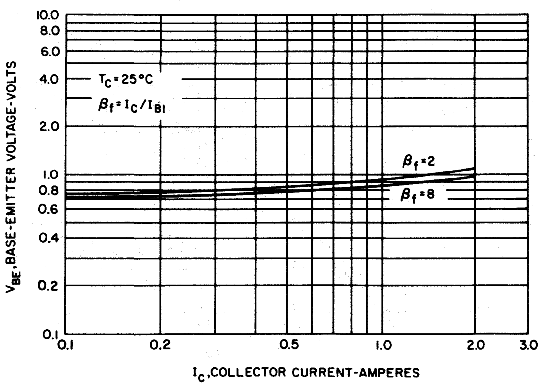


FIGURE 5. $V_{BE(SAT)}$ **VS.** I_C

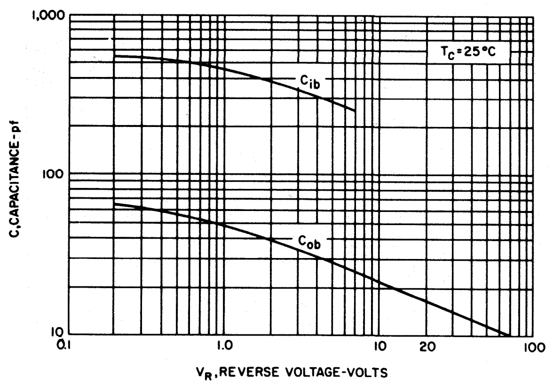


FIGURE 6. CAPACITANCE

D44TD Series

TYPICAL SWITCHING CHARACTERISTICS

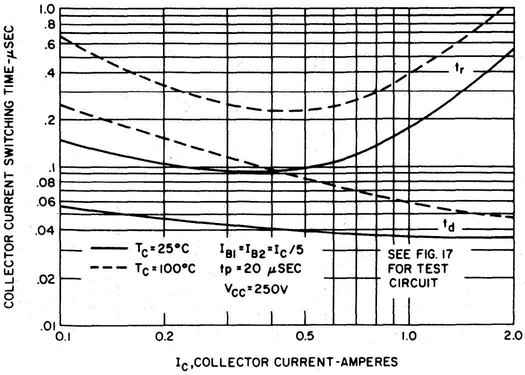


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

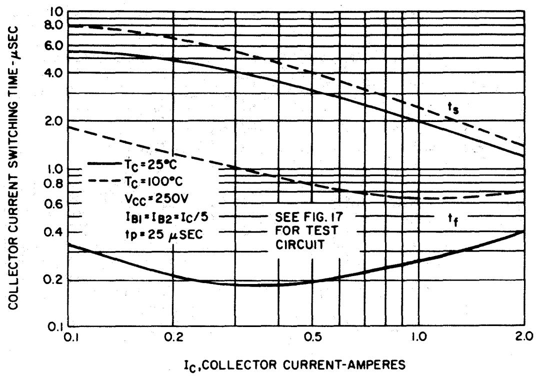


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

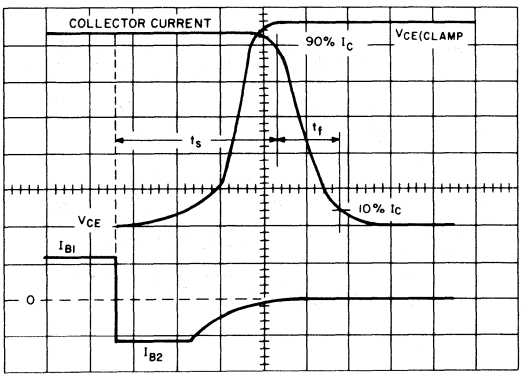


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

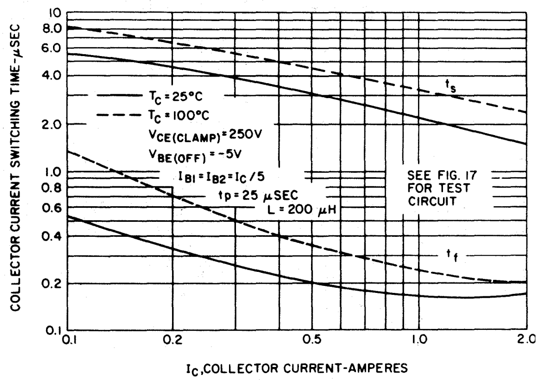


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

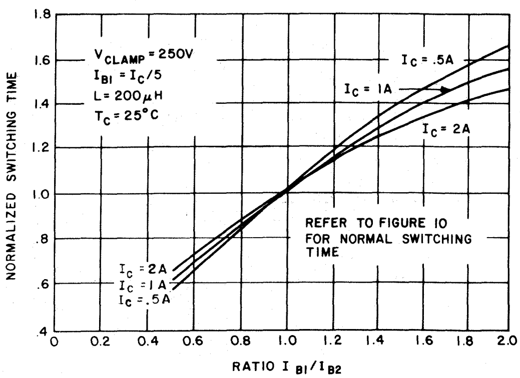


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

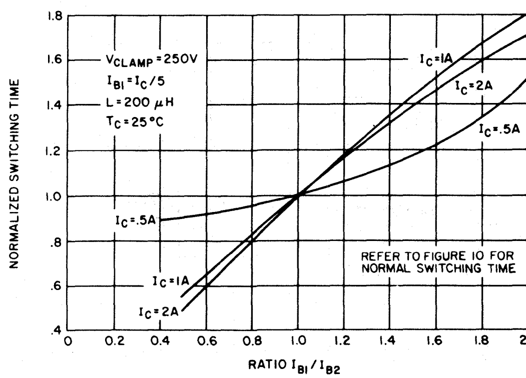


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D44TD Series

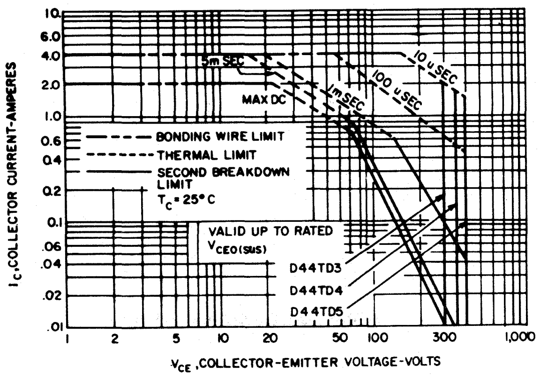


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

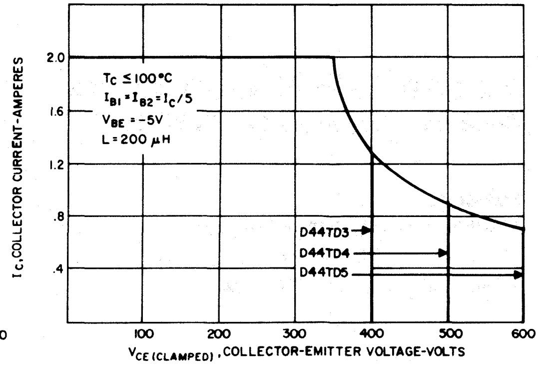


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

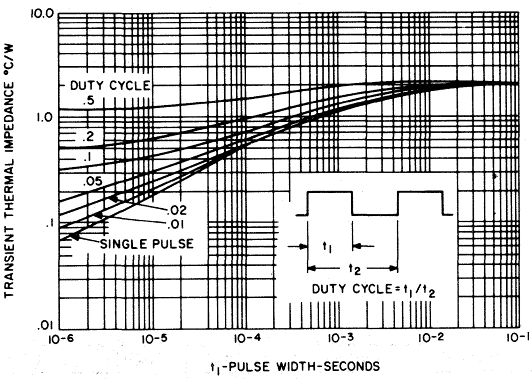


FIGURE 15. TRANSIENT THERMAL RESPONSE

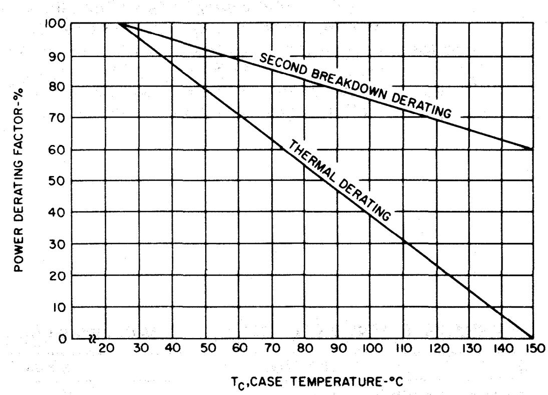


FIGURE 16. POWER DERATING CURVE

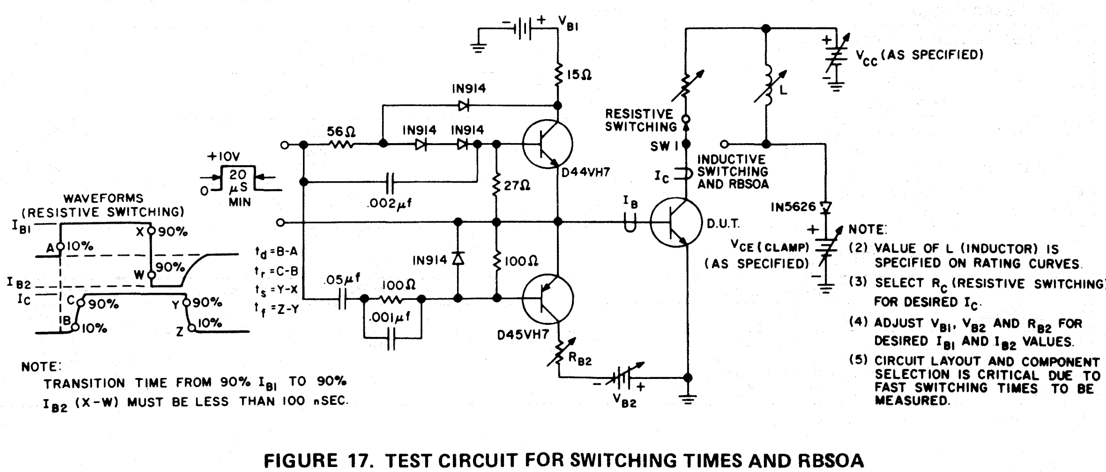


FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

D44VH Series

File Number **15.23**

Silicon N-P-N Transistors

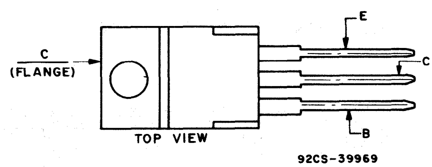
Complementary to the D45VH Series

Features:

- *Fast Switching $t_s \leq 700$ ns resistive*
  $t_f \leq 200$ ns
- *Low $V_{CE(sat)} \leq 0.4V$ @ $I_C = 8A$*

The D44VH series of silicon n-p-n power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44VH1	D44VH4	D44VH7	D44VH10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	30	45	60	80	V
Collector-Emitter Voltage	V_{CEX}	40	55	70	90	V
Collector-Emitter Voltage	V_{CEV}	50	65	80	100	V
Emitter Base Voltage	V_{EBO}	7				V
Collector Current — Continuous — Peak (1)	I_C I_{CM}	15 20				A
Base Current — Continuous — Peak (1)	I_B I_{BM}	5 10				A
Total Power Dissipation @ T_C = 25°C @ T_C = 100°C Derate above 25°C	P_D	83 33 0.67				Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150				°C

THERMAL CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	°C

(1) Pulse measurement condition PW ≤ 6.0 ms, See Figure 14.

LECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
FF CHARACTERISTICS(1)				
;ollector-Emitter Sustaining Voltage(1) (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D44VH1		30	—	
D44VH4		45	—	
D44VH7		60	—	
D44VH10		80	—	
;ollector-Emitter Voltage(2) (I_C = 1A, V_{CLAMP} = Rated V_{CEX}, T_C = 100° C)	V_{CEX}			V
D44VH1		40	—	
D44VH4		55	—	
D44VH7		65	—	
D44VH10		90	—	
;ollector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V)		—	10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V, T_C = 100° C)		—	100	
;ollector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	10	μA
ECOND BREAKDOWN				
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		
N CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
(I_C = 2 A, V_{CE} = 1V)		35	—	
(I_C = 4 A, V_{CE} = 1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = 8A, I_B = 0.4A)		—	0.4	
(I_C = 8A, I_B = 0.4A, T_C = 100° C)		—	0.5	
(I_C = 15A, I_B = 3.0A, T_C = 100° C)		—	0.8	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = 8A, I_B = 0.4A)		—	1.2	
(I_C = 8A, I_B = 0.4A, T_C = 100° C)		—	1.1	

YNAMIC CHARACTERISTICS

		Typical	
Current-Gain — Bandwidth Product (I_C = 0.1A, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	120	pF

WITCHING CHARACTERISTICS

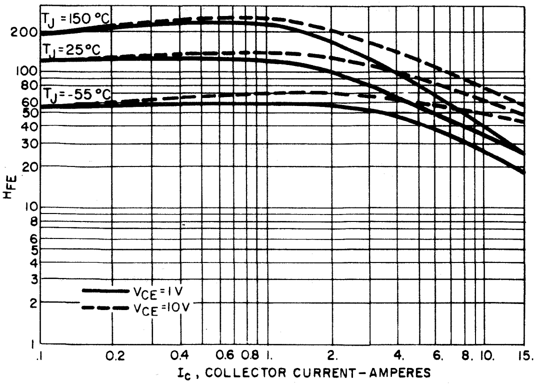
			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25° C	100° C	
Delay Time	V_{CC} = 20V, I_C = 8A I_{B1} = I_{B2} = 0.8A t_p = 25 μsec	t_d	50	—	nsec
Rise Time		t_r	250	—	nsec
Storage Time		t_s	700	—	nsec
Fall Time		t_f	200	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	V_{CC} = 20V, I_C = 8A V_{CLAMP} = Rated V_{CEX} I_{B1} = 0.8A, $V_{BE(off)}$ = -5V L = 200 μh	t_s	800	—	nsec
Fall Time		t_f	180	400	nsec
			Typical		
Storage Time		t_s	280	370	nsec
Fall Time		t_f	130	150	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.
(2) See Figure 15 for Test Circuit.

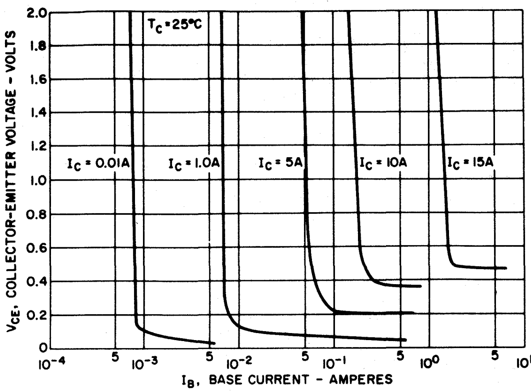
2

D44VH Series

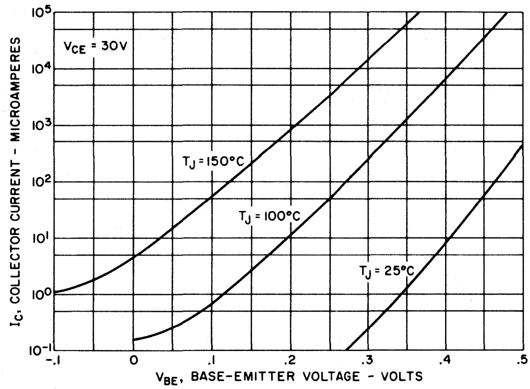
SAFE OPERATING AREA



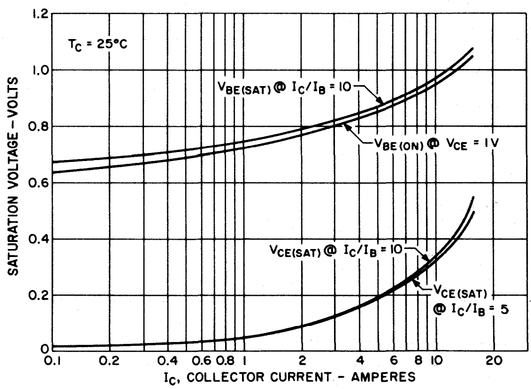
1. DC CURRENT GAIN



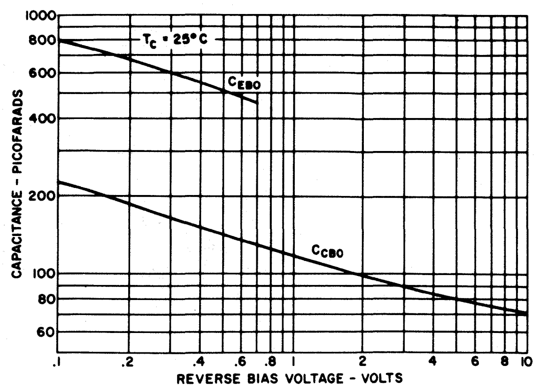
2. COLLECTOR SATURATION REGION



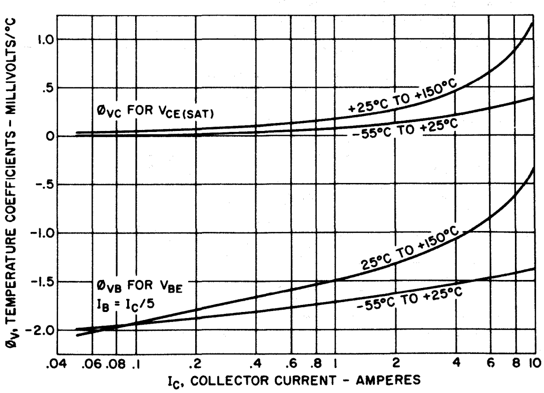
3. COLLECTOR CUTOFF REGION



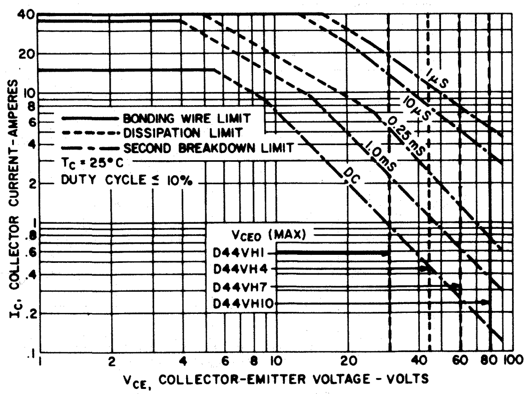
4. SATURATION VOLTAGE



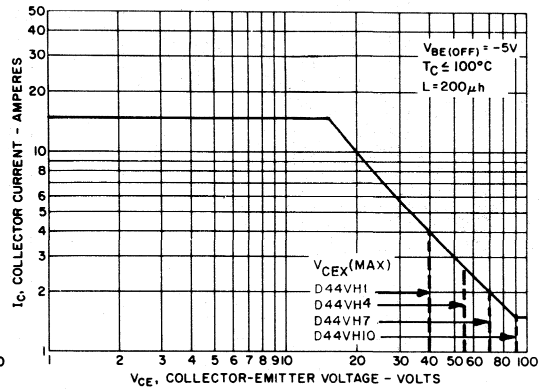
5. CAPACITANCE



6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

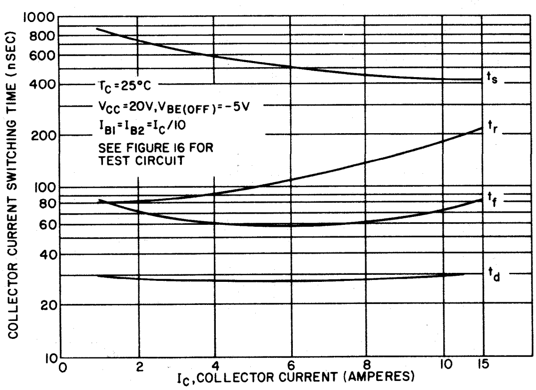


7. FORWARD BIAS SOA

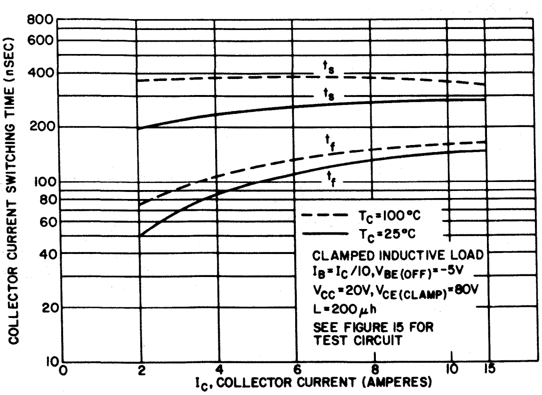


8. REVERSE BIAS SOA

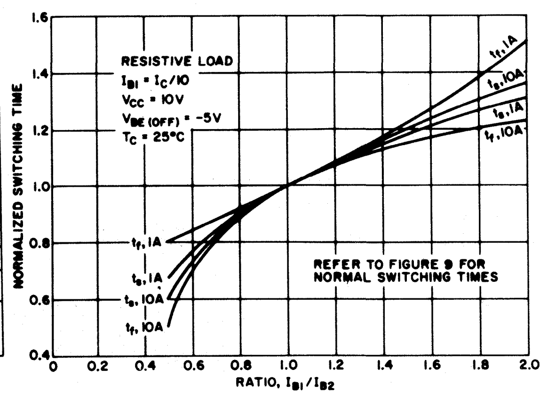
TYPICAL SWITCHING CHARACTERISTICS



9. RESISTIVE SWITCHING TIME

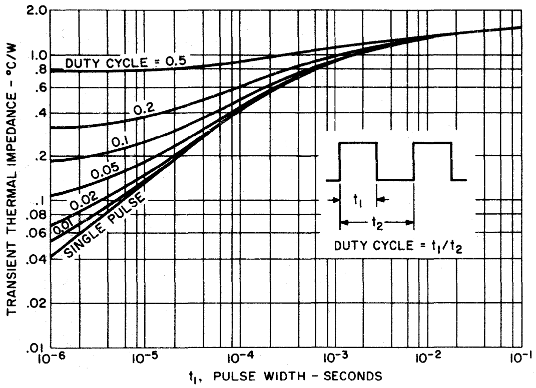


10. CLAMPED INDUCTIVE SWITCHING TIME

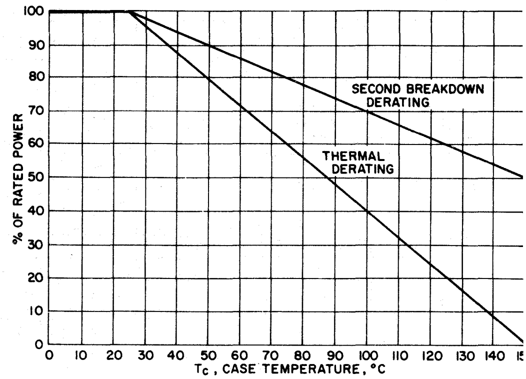


11. SWITCHING TIME VARIATION WITH I_{B2}

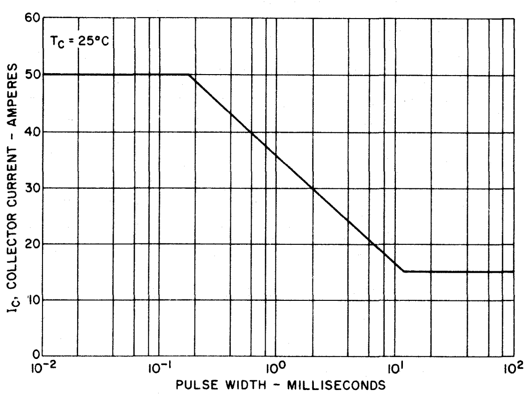
D44VH Series



12. TRANSIENT THERMAL RESPONSE

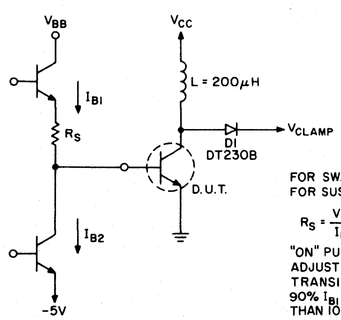


13. POWER DERATING FACTOR



14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS

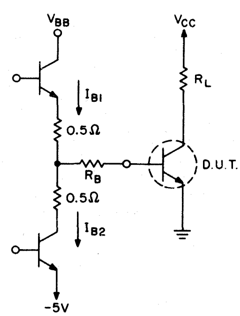


FOR SW. TIMES AND RBSOA
FOR SUSTAINING VOLTAGE

$R_S = \frac{V_{BB}}{I_{B1}}$

"ON" PULSE WIDTH AND V_{CC} ADJUSTED FOR DESIRED PEAK I_C. TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 n S.

15. INDUCTIVE SWITCHING AND V_{CEX}



$R_L = \frac{V_{CC}}{I_C}$, NONINDUCTIVE

$R_B = \frac{V_{BB}}{I_{B1}} - 0.5$

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 n S.

16. RESISTIVE SWITCHING

File Number **15.25**

D44VM Series

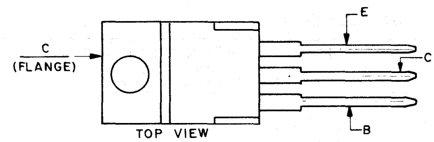
Silicon N-P-N Transistors

Complementary to the D45VM Series

Features:
- *Fast Switching $t_s \leq 500$ ns resistive*
  $t_f \leq 75$ ns
- *Very Low $V_{CE(sat)} \leq 0.4V$ @ $I_C = 4A$*
- *High Gain $H_{FE} \geq 40$ @ $I_C = 4A$*

The D44VM-series of silicon n-p-n power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D44VM1	D44VM4	D44VM7	D44VM10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	30	45	60	80	V
Collector-Emitter Voltage	V_{CEX}	30	45	60	80	V
Collector-Emitter Voltage	V_{CEV}	50	70	80	100	V
Emitter Base Voltage	V_{EB}	7				V
Collector Current — Continuous — Peak (1)	I_C I_{CM}	8 20				A
Base Current — Continuous — Peak (1)	I_B I_{BM}	2 5				A
Total Power Dissipation @ T_C = 25°C @ T_C = 100°C Derate above 25°C	P_D	50 20 0.4				Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150				°C

THERMAL CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	°C

(1) Pulse measurement condition PW ≤ 6.0 ms.

D44VM Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS(1)				
Collector-Emitter Sustaining Voltage(1) (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D44VM1		30	—	
D44VM4		45	—	
D44VM7		60	—	
D44VM10		80	—	
Collector-Emitter Voltage(2) (I_C = 3A, V_{CLAMP} = Rated V_{CEX}, $T_C \leq$ 100°C)	V_{CEX}			V
D44VM1		30	—	
D44VM4		45	—	
D44VM7		60	—	
D44VM10		80	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V)		—	10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V T_C = 100°C)		—	100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	10	μA
SECOND BREAKDOWN				
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		
ON CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
(I_C = 4A, V_{CE} = 1V)		40	—	
(I_C = 6A, V_{CE} = 1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = 4A, I_B = 0.2A)		—	0.4	
(I_C = 6A, I_B = 0.3A)		—	0.6	
(I_C = 8A, I_B = 0.8A, T_C = 100°C)		—	1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = 4A, I_B = 0.2A)		—	1.2	
(I_C = 4A, I_B = 0.2A, T_C = 100°C)		—	1.2	

DYNAMIC CHARACTERISTICS

		Typical	
Current-Gain — Bandwidth Product (I_C = 0.1A, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	70	pF

SWITCHING CHARACTERISTICS

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 30V, I_C = 6A	t_d	30	40	nsec
Rise Time	I_{B1} = I_{B2} = 0.6A	t_r	250	350	nsec
Storage Time	t_p = 25 μsec	t_s	500	600	nsec
Fall Time		t_f	75	250	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CE(CLAMP)}$ = 30V, I_C = 6A	t_s	500	600	nsec
Fall Time	I_{B1} = I_{B2} = 0.6A, $V_{BE(OFF)}$ = -5V	t_f	70	100	nsec
			Typical		
Storage Time	L = 200 μh	t_s	340	430	nsec
Fall Time		t_f	40	57	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.
(2) See Figure 15 for Test Circuit.

D44VM Series

TYPICAL DC CHARACTERISTICS

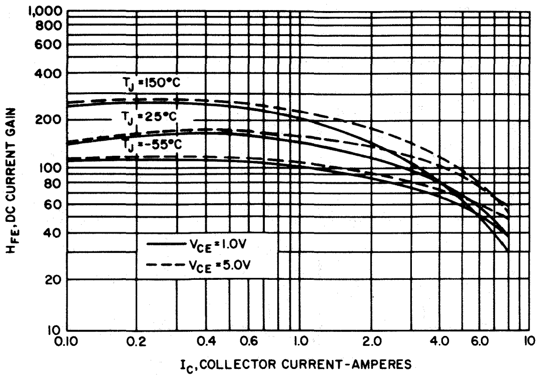


FIGURE 1. DC CURRENT GAIN

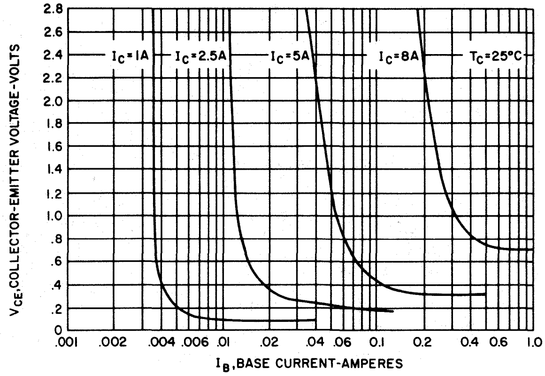


FIGURE 2. COLLECTOR SATURATION REGION

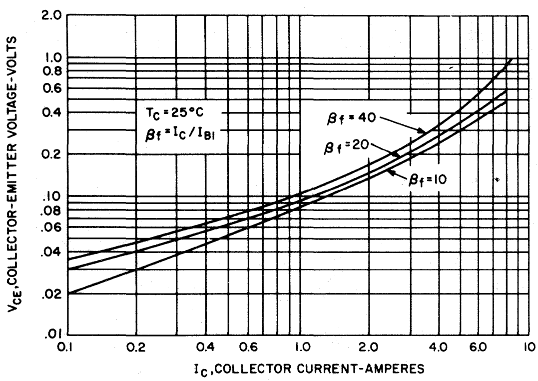


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

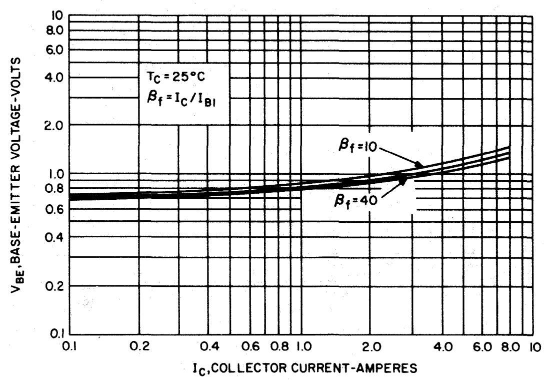


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

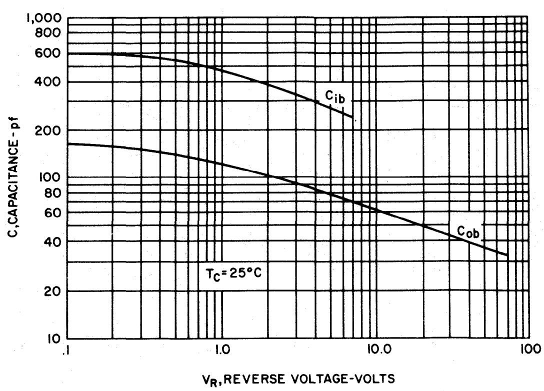


FIGURE 5. CAPACITANCE

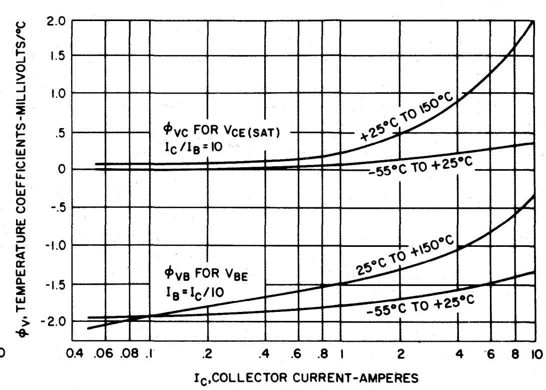


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

D44VM Series

SAFE OPERATING AREA

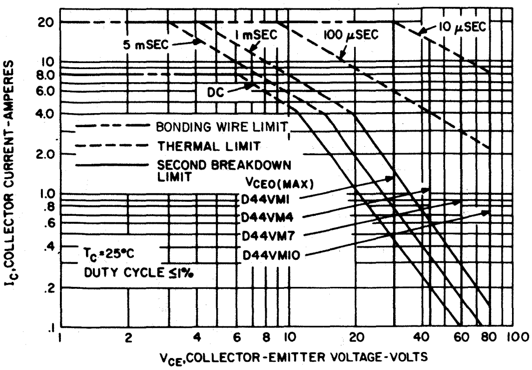


FIGURE 7. FORWARD BIAS SOA

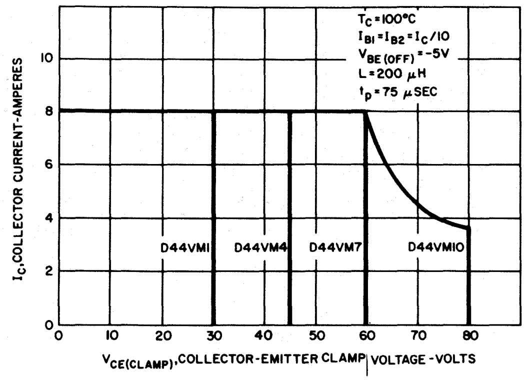


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

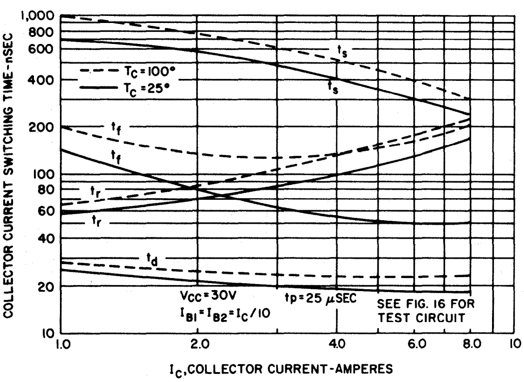


FIGURE 9. RESISTIVE SWITCHING TIME

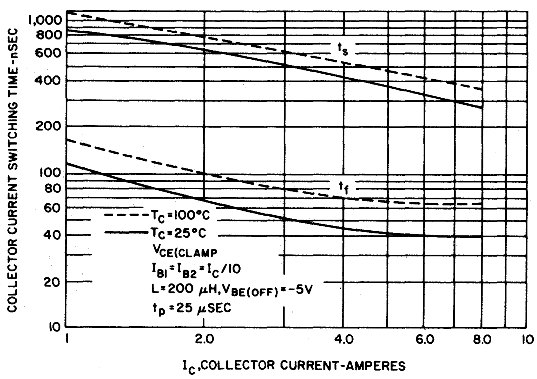


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

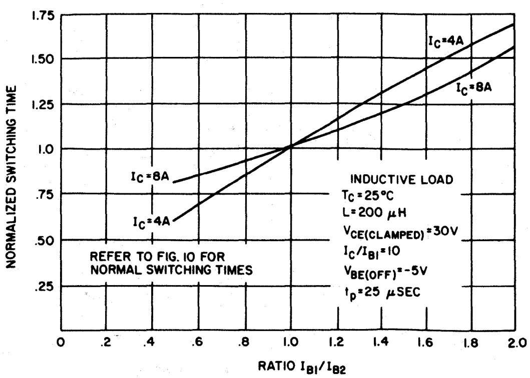


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

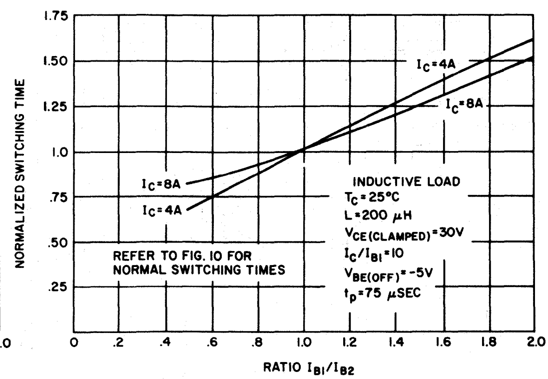


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

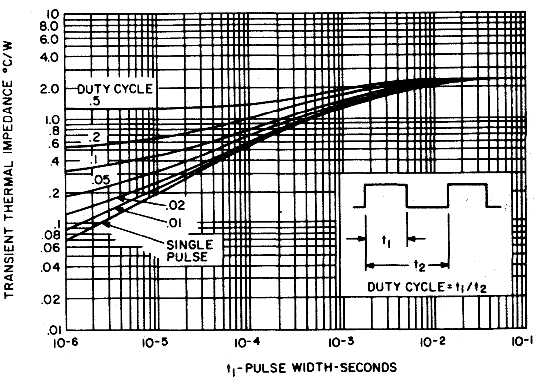


FIGURE 13. TRANSIENT THERMAL RESPONSE

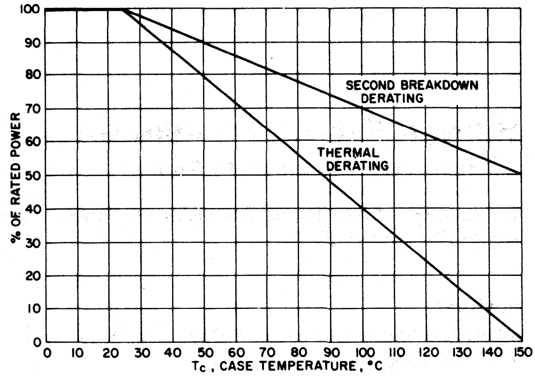
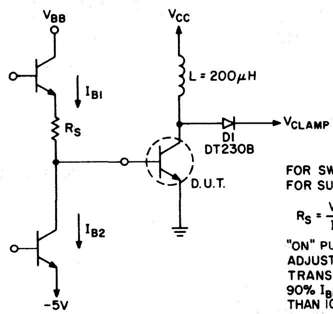


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS

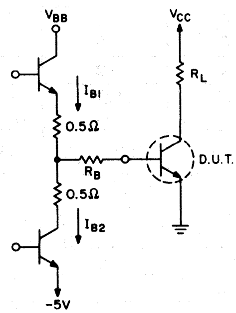


FOR SW. TIMES AND RBSOA
FOR SUSTAINING VOLTAGE

$R_S = \frac{V_{BB}}{I_{B1}}$

"ON" PULSE WIDTH AND V_{CC} ADJUSTED FOR DESIRED PEAK I_C. TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 n S.

FIGURE 15. INDUCTIVE SWITCHING AND V_{CEX}



$R_L = \frac{V_{CC}}{I_C}$, NONINDUCTIVE

$R_B = \frac{V_{BB}}{I_{B1}} - 0.5$

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 n S.

FIGURE 16. RESISTIVE SWITCHING

D45C Series

File Number **15.12**

Silicon P-N-P Transistors

Complementary to the D44C Series

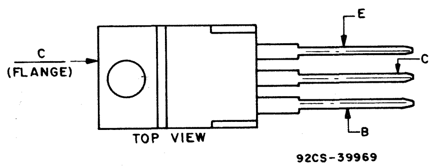
General-Purpose Types for Medium-Power Switching and Amplifier Applications

Features:

- *Very low collector saturation voltage* [*-0.5V typ. @ -3.0A I_C*]
- *Excellent linearity*
- *Fast switching*

TERMINAL DESIGNATIONS

D45C-series p-n-p power transisitors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequency from DC to greater than 1.0 MHz, series, shunt and switching regulators, and low and high frequency inverters/ converters.



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45C1, 2, 3	D45C4, 5, 6	D45C7, 8, 9	D45C10, 11, 12	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-40	-55	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-4 -6	-4 -6	-4 -6	-4 -6	A
Base Current — Continuous	I_B	-2	-2	-2	-2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 30	1.67 30	1.67 30	1.67 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

D45C Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = -100mA)	D45C1, 2, 3	$V_{CEO(sus)}$	-30	—	—	Volts
	D45C4, 5, 6		-45	—	—	
	D45C7, 8, 9		-60	—	—	
	D45C10, 11, 12		-80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 3			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = -0.2A, V_{CE} = -1V)	D45C1, 4, 7, 10	h_{FE}	25	—	—	—
	D45C2, 5, 8, 11		40	—	120	
	D45C3, 6, 9, 12		40	—	120	
(I_C = -1A, V_{CE} = -1V)	D45C1, 4, 7, 10	h_{FE}	10	—	—	—
	D45C2, 5, 8, 11		20	—	—	
(I_C = -2A, V_{CE} = -1V)	D45C3, 6, 9, 12	h_{FE}	20	—	—	
Collector-Emitter Saturation Voltage (I_C = -1A, I_B = -50mA)	D45C2, 5, 8, 11	$V_{CE(sat)}$	—	—	-0.5	Volts
	D45C3, 6, 9, 12		—	—	-0.5	
(I_C = -1A, I_B = -100mA)	D43C1, 4, 7, 10		—	—	-0.5	
Base-Emitter Saturation Voltage (I_C = -1A, I_B = -100mA)		$V_{BE(sat)}$	—	—	-1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product (I_C = -20mA, V_{CE} = -4V)		f_T	—	40	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -1A, I_{B1} = I_{B2} = -0.1A,	$t_d + t_r$	—	50	—	nS
Storage Time	V_{CC} = -1A, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

2

D45C Series

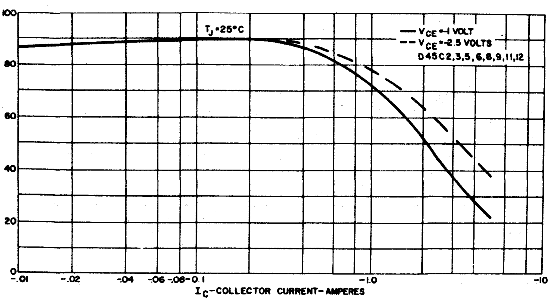


FIG. 1 TYPICAL h_{FE} VS. I_C

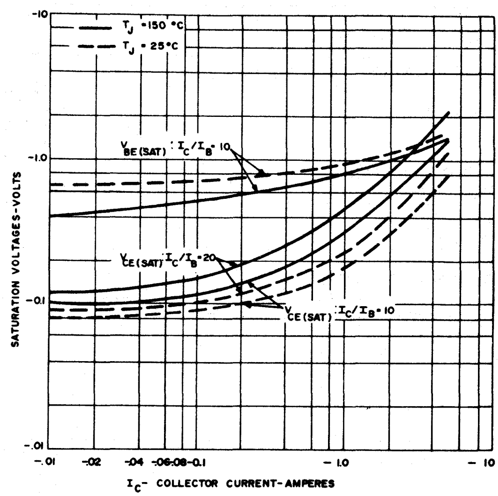


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

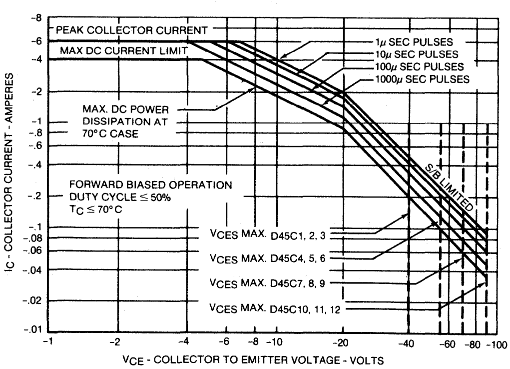


FIG. 3 SAFE REGION OF OPERATION

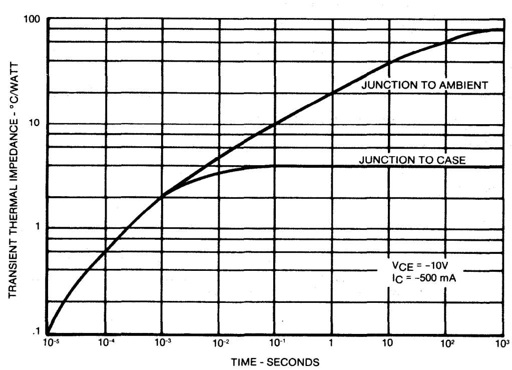


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

File Number **15.14**

D45D Series

6-Ampere P-N-P Darlington Power Transistors

Complementary to the D44D Series

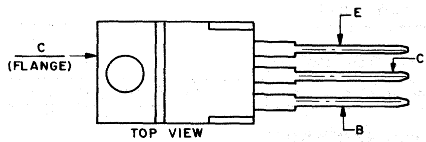
-40, -60, and -80 Volts, 30 Watts
Gain of 2000 at -1 A

Features:
- *Operates from IC without predriver*

Applications:
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*
- *Inverter/Converter*

The D45D-series p-n-p Darlington power transitors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 2000.

TERMINAL DESIGNATIONS



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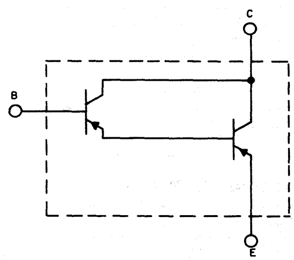


92CS-43154

Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45D1,2	D45D3,4	D45D5,6	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-50	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous	I_C	-6	-6	-6	A
Base Current — Continuous	I_B	-0.5	-0.5	-0.5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 30	2.1 30	2.1 30	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.2	4.2	4.2	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

D45D Series

ELECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Breakdown Voltage (I_C = -50mA)	D45D1,2 D45D3,4 D45D5,6	$V_{CEO(BR)}$	-40 -60 -80	— — —	— — —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES}) (V_{CE} = Rated V_{CES}, V_{BE} = 0.4V)	T_C = 25°C T_C = 125°C	I_{CES} I_{CEV}	— —	— —	-10 -5	μA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-10	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 5			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = -1A, V_{CE} = -2V)		h_{FE}	2,000	5,000	—	—
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -3mA) (I_C = -5A, I_B = -5mA)	 D45D2,4,6 only	$V_{CE(sat)}$	— —	— —	-1.5 -2.0	V V
Base-Emitter Saturation Voltage (I_C = -5A, I_B = -5mA)		$V_{BE(sat)}$	—	—	-2.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	—	75	pF
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -3A, I_{B1} = I_{B2} = -3mA	$t_d + t_r$	—	0.35	—	μs
Storage Time	V_{CC} = 40V, t_p = 25 μsec	t_s	—	0.4	—	
Fall Time		t_f	—	0.3	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

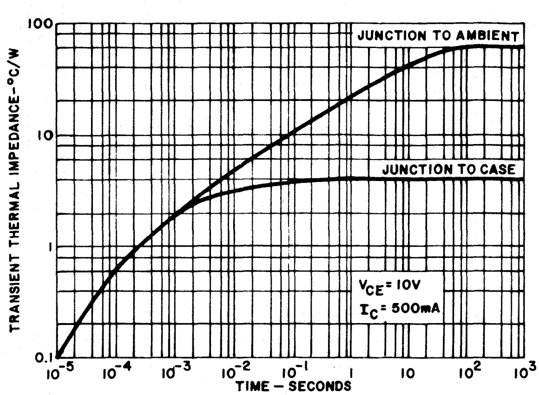


FIG. 1 MAXIMUM TRANSIENT THERMAL IMPEDANCE

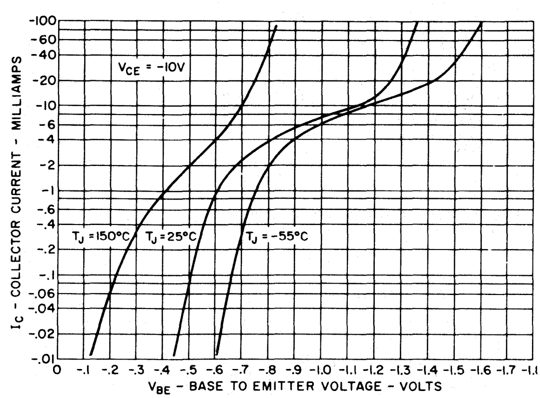
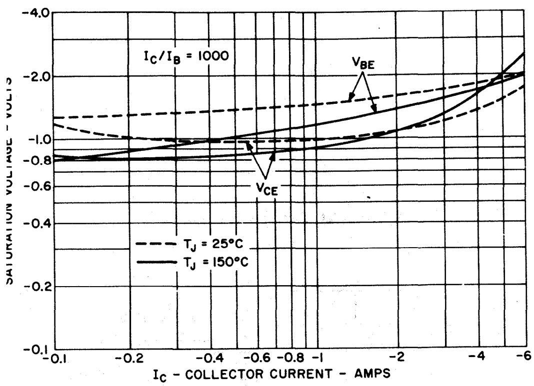


FIG. 2 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

D45D Series



IG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

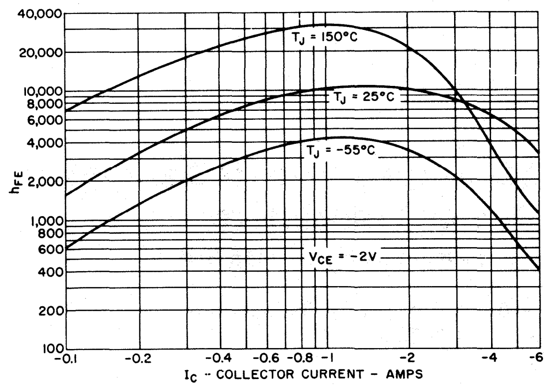


FIG. 4 TYPICAL h_{FE} VS. I_C

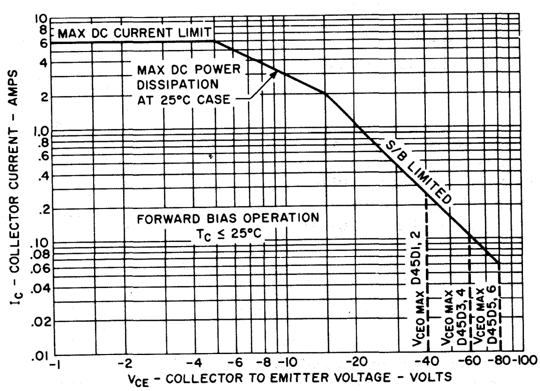


FIG. 5 SAFE REGION OF OPERATION

D45E Series

File Number **15.16**

10-Ampere P-N-P Darlington Power Transistors

Complementary to the D44E Series

-40, -60, and -80 Volts, 50 Watts
Gain of 1000 at -5 A

Features:

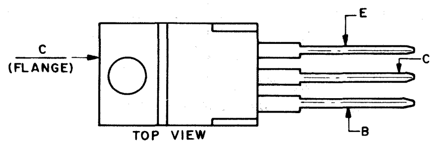
- *Operates from IC without predriver*

Applications:

- *Driver*
- *Regulator*
- *Capacitor Multiplier*
- *Solenoid Driver*
- *Inverter Power Supply*
- *Switch*
- *Audio Output*
- *Relay Substitute*
- *Oscillator*
- *Servo-Amplifier*

The D45E-series p-n-p Darlington power transitors are designed for general purpose switching of multi-ampere loads directly from low-level logic circuitry. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 1000.

TERMINAL DESIGNATIONS



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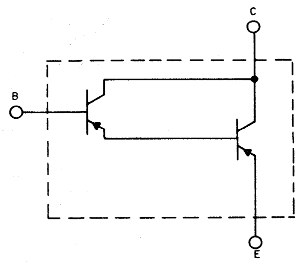


Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45E1	D45E2	D45E3	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-40	-60	-80	Volts
Emitter Base Voltage	V_{EBO}	-7	-7	-7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-10 -20	-10 -20	-10 -20	A
Base Current — Continuous	I_B	-1	-1	-1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	260	260	°C

(1) Pulse Test: Pulse Width = 300ms. Duty Cycle $\leq$ 2%.

D45E Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Voltage (I_C = -100mA)	D45E1	V_{CEO}	-40	—	—	Volts
	D45E2		-60	—	—	
	D45E3		-80	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = -7V)		I_{EBO}	—	—	-1.0	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 6			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = -5A, V_{CE} = -5V)		h_{FE}	1,000	—	—	—
Collector-Emitter Saturation Voltage (I_C = -5.0A, I_B = -10mA)		$V_{CE(sat)}$	—	—	-1.5	V
(I_C = -10.0A, I_B = -20mA)			—	—	-2.0	V
Base-Emitter Saturation Voltage (I_C = -5.0A, I_B = -10mA)		$V_{BE(sat)}$	—	—	-2.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	—	220	pF
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -10A, I_{B1} = I_{B2} = -20mA	$t_d + t_r$	—	0.6	—	μS
Storage Time	V_{CC} = -40V, t_p = 25μsec	t_s	—	2.0	—	
Fall Time		t_f	—	0.5	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

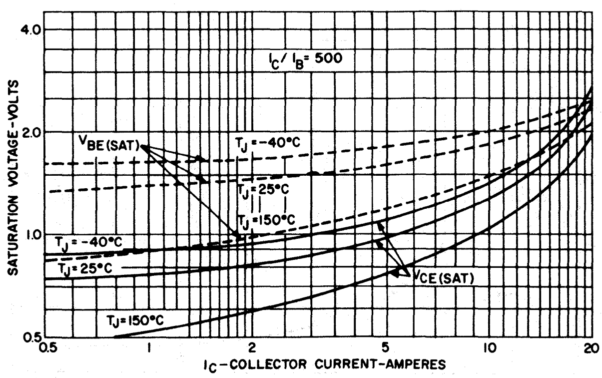


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

D45E Series

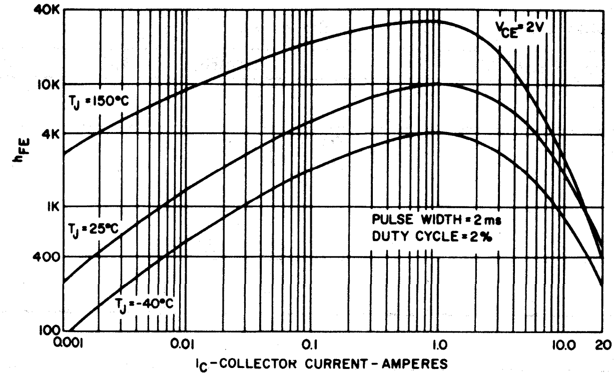


FIG. 2 TYPICAL GAIN CHARACTERISTIC

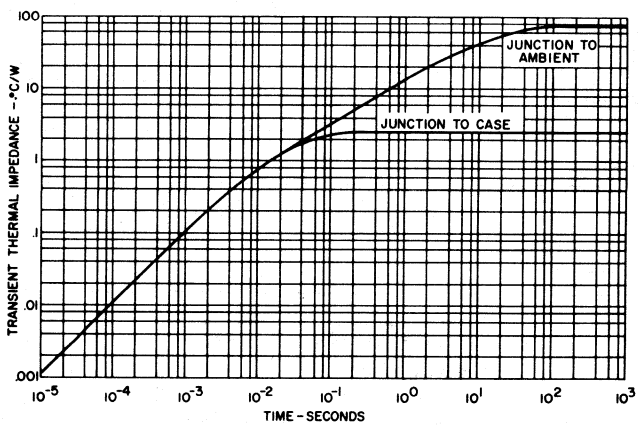


FIG. 3 TRANSIENT THERMAL IMPEDANCE

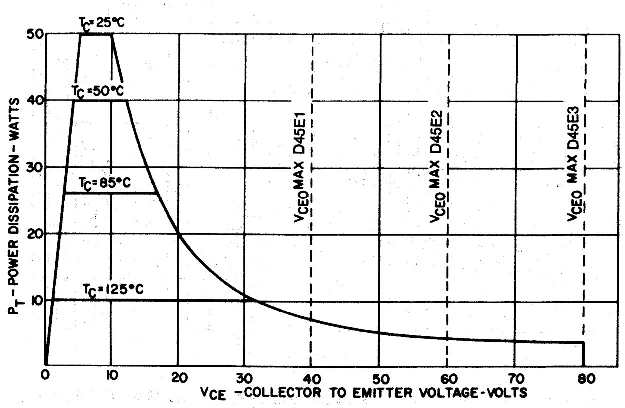


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

D45E Series

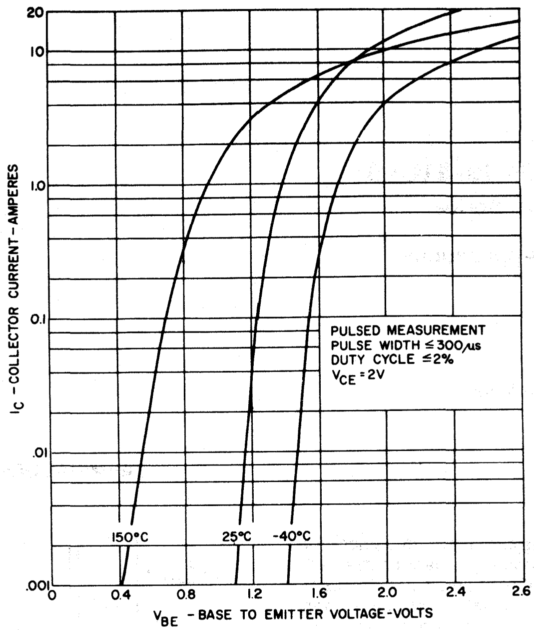


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

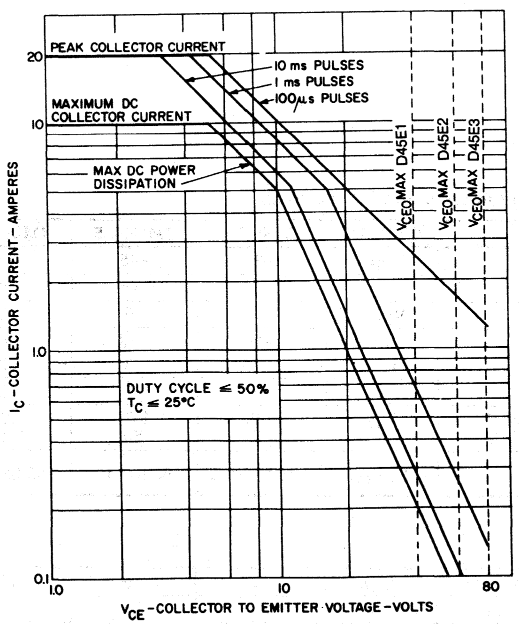


FIG. 6 SAFE REGION OF OPERATION

D45H Series

File Number **15.18**

Silicon P-N-P Transistors

Complementary to the D44H Series

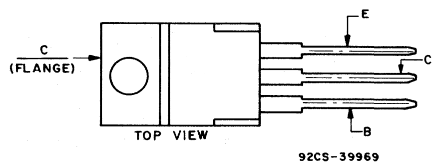
For Switching and Linear Applications

Features:

- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

D45H-series p-n-p power transisitors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequency from DC to greater than 1.0 MHz, series, shunt and switching regulators, and low and high frequency inverters/ converters.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45H1, 2	D45H4, 5	D45H7, 8	D45H10, 11	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-30	-45	-60	-80	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-10 -20	-10 -20	-10 -20	-10 -20	A
Base Current — Continuous	I_B	-5	-5	-5	-5	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.67 50	1.67 50	1.67 50	1.67 50	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	2.5	2.5	2.5	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛″ from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ⩽ 2%.

D45H Series

.ECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
:F CHARACTERISTICS[1]						
·ollector-Emitter Sustaining Voltage (I_C = - 100mA)	D45H1, 2 D45H4, 5 D45H7, 8 D45H10, 11	$V_{CEO(sus)}$	-30 -45 -60 -80	— — — —	— — — —	Volts
;ollector Cutoff Current (V_{CB} = Rated V_{CBO})		I_{CBO}	—	—	-10	μA
:mitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-100	μA
ECOND BREAKDOWN						
;econd Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 4			
N CHARACTERISTICS[1]						
)C Current Gain (I_C = -2A, V_{CE} = -1V)	D45H1, 4, 7, 10 D45H2, 5, 8, 11	h_{FE}	35 60	— —	— —	—
(I_C = -4A, V_{CE} = -1V)	D45H1, 4, 7, 10 D45H2, 5, 8, 11		20 40	— —	— —	
;ollector-Emitter Saturation Voltage (I_C = -8A, I_B = -0.4A) (I_C = -8A, I_B = -0.8A)	D45H1, 4, 7, 10 D45H2, 5, 8, 11	$V_{CE(sat)}$	— —	— —	-1.0 -1.0	Volts
3ase-Emitter Saturation Voltage (I_C = -8A, I_B = -0.8A)		$V_{BE(sat)}$	—	—	-1.5	Volts
'YNAMIC CHARACTERISTICS						
;ollector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	230	—	pF
;urrent-Gain — Bandwidth Product (I_C = -500mA, V_{CE} = -10V)		f_T	—	40	—	MHz
'WITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -5A, I_{B1} = -0.5A	$t_d + t_r$	—	135	—	nS
Storage Time	I_C = -5A, I_{B1} = I_{B2} = -0.5A	t_s	—	500	—	
Fall Time		t_f	—	100	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

2

D45H Series

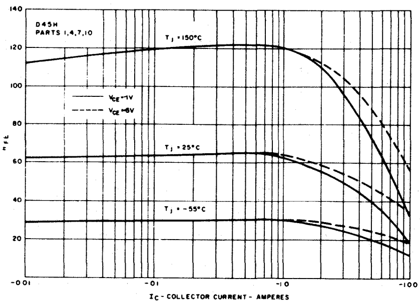


FIG. 1 TYPICAL GAIN CHARACTERISTICS

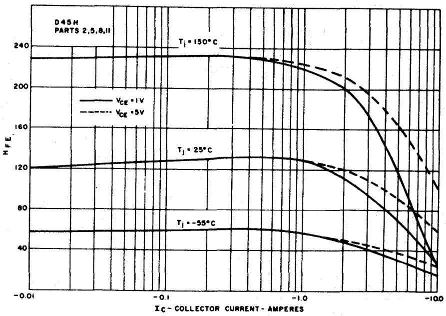


FIG. 2 TYPICAL GAIN CHARACTERISTICS

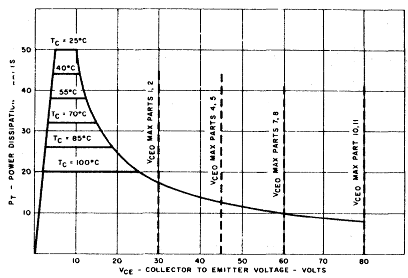


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

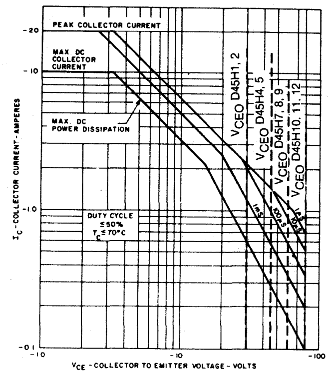


FIG. 4 SAFE REGION OF OPERATION

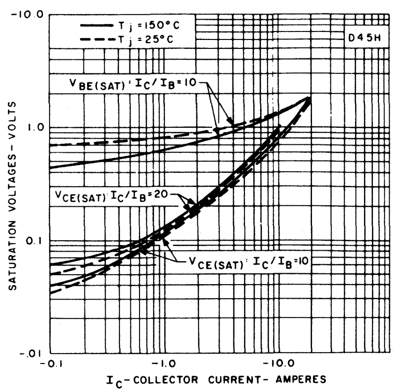


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

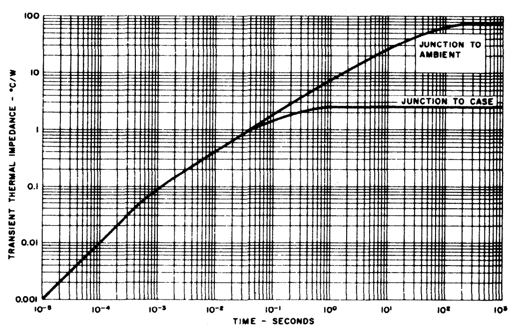


FIG. 6 TRANSIENT THERMAL IMPEDANCE

File Number **15.24**

D45VH Series

Silicon P-N-P Transistors

Complementary to the D44VH Series

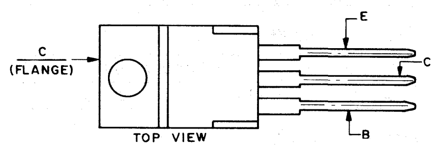
2

Features:

- *Fast Switching $t_s \leq 500$ ns resistive*
  $t_f \leq 100$ ns
- *Low $V_{CE(sat)} \leq 1.0V$ @ $I_C = 8A$*

The D45VH-series of silicon p-n-p power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45VH1	D45VH4	D45VH7	D45VH10	UNITS
Collector-Emitter Voltage	$V_{CEO(sus)}$	-30	-45	-60	-80	Volts
Collector-Emitter Voltage	V_{CEX}	-40	-55	-70	-90	Volts
Collector-Emitter Voltage	V_{CEV}	-50	-70	-80	-100	Volts
Emitter Base Voltage	V_{EBO}	-7	-7	-7	-7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-15 -20	-15 -20	-15 -20	-15 -20	A
Base Current — Continuous Peak(1)	I_B I_{BM}	-5 -10	-5 -10	-5 -10	-5 -10	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	83 33 0.67	83 33 0.67	83 33 0.67	83 33 0.67	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	1.5	1.5	1.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	75	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	235	235	235	235	°C

(1) Pulse measurement condition PW ≤ 6.0 ms, see Figure 14.

D45VH Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS[1]				
Collector-Emitter Sustaining Voltage[1] (I_C = -100mA, I_B = 0)	$V_{CEO(sus)}$			V
D45VH1		-30	—	
D45VH4		-45	—	
D45VH7		-60	—	
D45VH10		-80	—	
Collector-Emitter Voltage[2] (I_C = −10A, V_{CLAMP} = Rated V_{CEX}, T_C = 100°C)	V_{CEX}			V
D45VH1		-40	—	
D45VH4		-55	—	
D45VH7		-70	—	
D45VH10		-90	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V)		—	-10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V, T_C = 100°C)		—	-100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	-100	μA
Emitter Cutoff Current (V_{EB} = -7V, I_C = 0)	I_{EBO}	—	-10	μA
SECOND BREAKDOWN				
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = -2 A, V_{CE} = -1V)		35	—	
(I_C = -4 A, V_{CE} = -1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = -8A, I_B = -0.8A)		—	-1.0	
(I_C = -8A, I_B = -0.8A, T_C = 100°C)		—	-1.1	
(I_C = -15A, I_B = -3.0A, T_C = 100°C)		—	-1.5	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = -8A, I_B = -0.8A)		—	-1.4	
(I_C = -8A, I_B = -0.8A, T_C = 100°C)		—	-1.4	

DYNAMIC CHARACTERISTICS

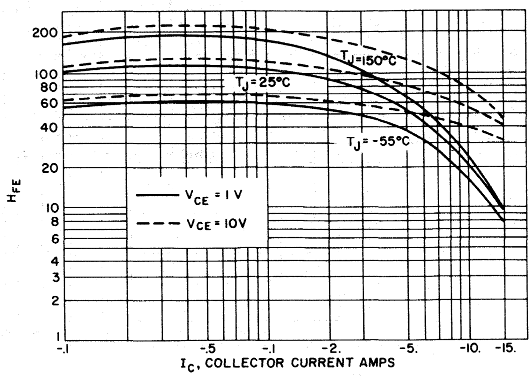
		Typical	
Current-Gain — Bandwidth Product (I_C = -0.1A, V_{CE} = -10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = -10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	275	pF

SWITCHING CHARACTERISTICS

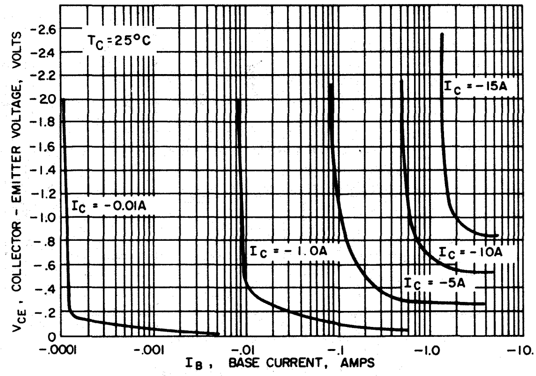
			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = -20V, I_C = -8A I_{B1} = I_{B2} = 0.8A t_p = 25 μsec	t_d	50	—	nsec
Rise Time		t_r	250	—	nsec
Storage Time		t_s	500	—	nsec
Fall Time		t_f	100	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	V_{CC} = -20V, I_C = -8A V_{CLAMP} = Rated V_{CEX} I_{B1} = − 0.8A, $V_{BE(off)}$ = 5V L = 200 μh	t_s	500	600	nsec
Fall Time		t_f	300	400	nsec
			Typical		
Storage Time		t_s	200	320	nsec
Fall Time		t_f	160	180	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.
(2) See Figure 15 for Test Circuit.

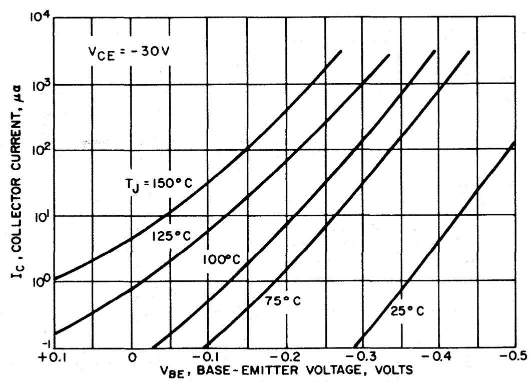
TYPICAL DC CHARACTERISTICS



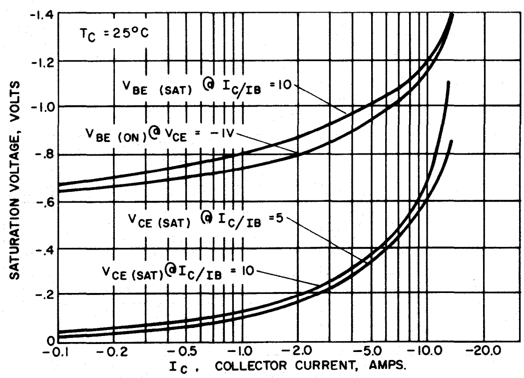
1. DC CURRENT GAIN



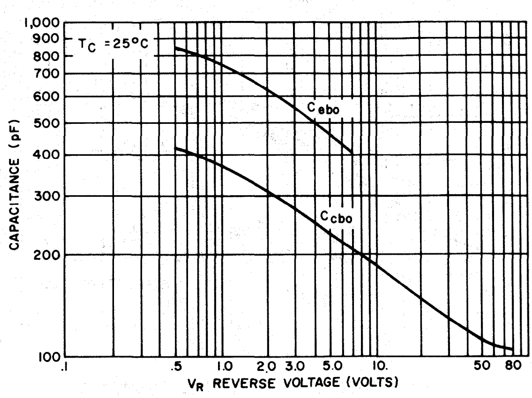
2. COLLECTOR SATURATION REGION



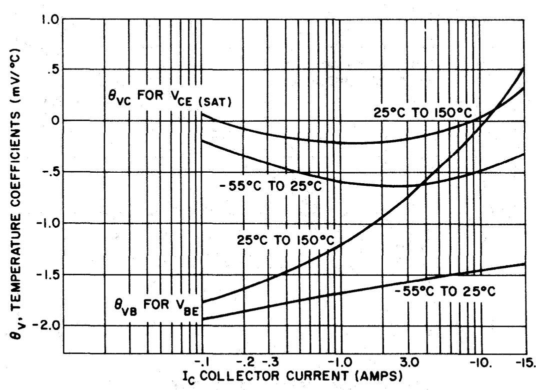
3. COLLECTOR CUTOFF REGION



4. SATURATION VOLTAGE



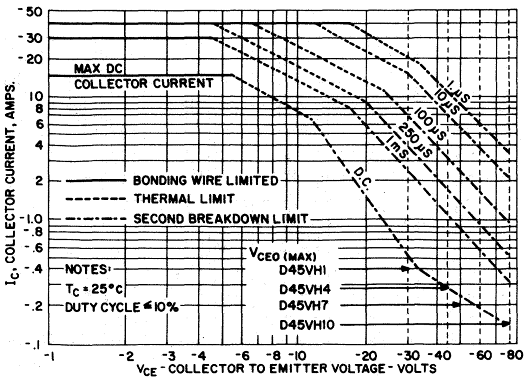
5. CAPACITANCE



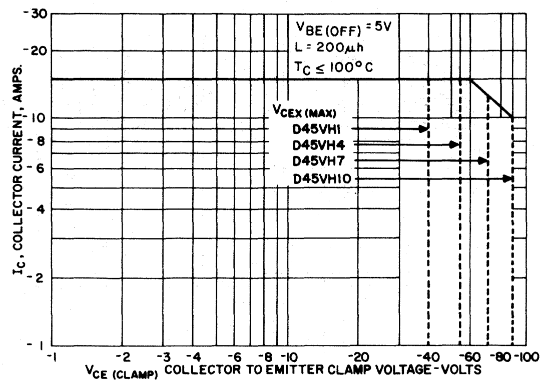
6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

D45VH Series

SAFE OPERATING AREA

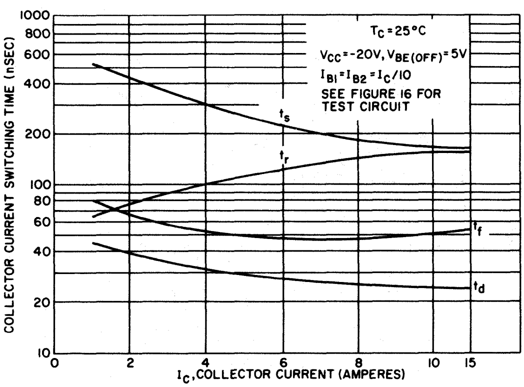


7. FORWARD BIAS SOA

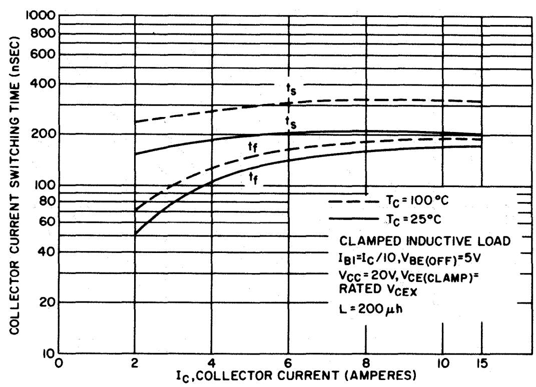


8. REVERSE BIAS SOA

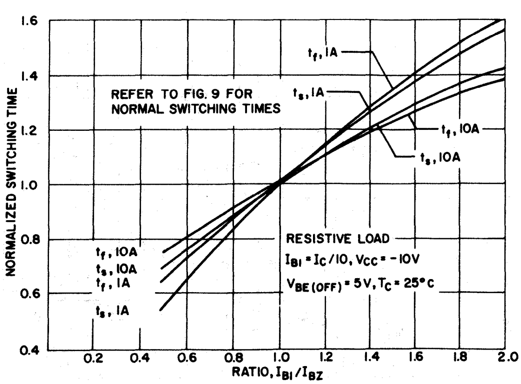
TYPICAL SWITCHING CHARACTERISTICS



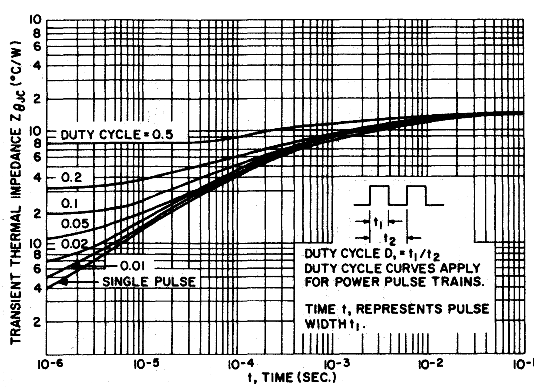
9. RESISTIVE SWITCHING TIME



10. CLAMPED INDUCTIVE SWITCHING TIME



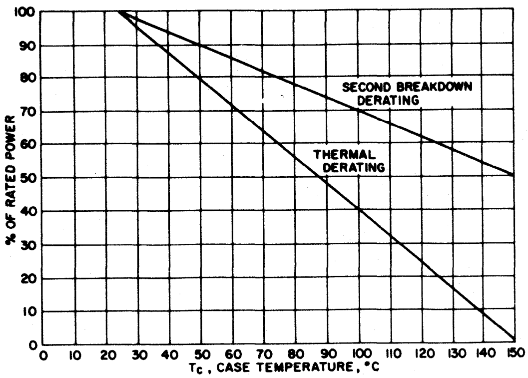
11. SWITCHING TIME VARIATION WITH I_{B2}



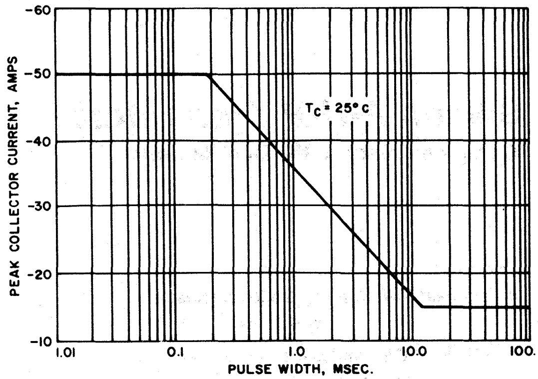
12. TRANSIENT THERMAL RESPONSE

D45VH Series

2

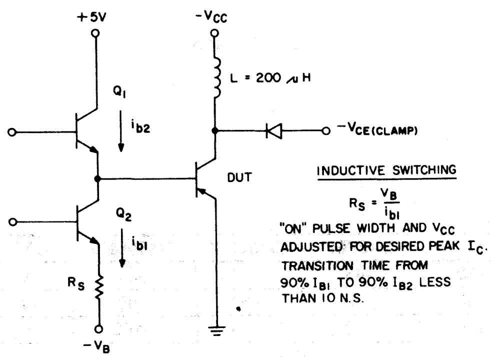


13. POWER DERATING FACTOR

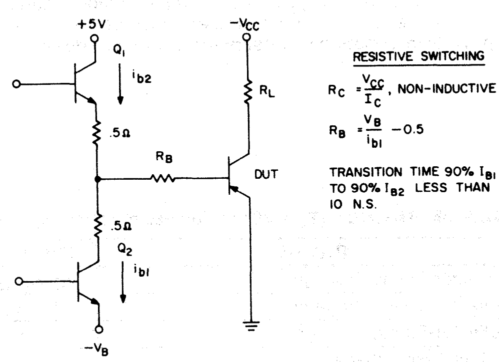


14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS



15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

D45VM Series

File Number **15.26**

Silicon P-N-P Transistors

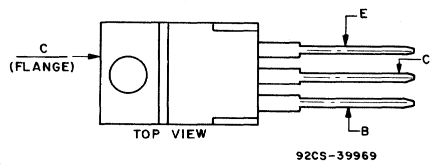
Complementary to the D44VM Series

Features:

- *Very Fast Switching $t_s \leq 500$ ns resistive*
  $t_f \leq 75$ ns
- *Very low $V_{CE}(sat) \leq 0.4V$ @ $I_C = 4A$*
- *High gain $H_{FE} \geq 40$ @ $I_C = 4A$*

The D45VM-series of silicon p-n-p power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design..

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D45VM1	D45VM4	D45VM7	D45VM10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	-30	-45	-60	-80	V
Collector-Emitter Voltage	V_{CEX}	-30	-45	-60	-80	V
Collector-Emitter Voltage	V_{CEV}	-50	-70	-80	-100	V
Emitter Base Voltage	V_{EBO}	-7				V
Collector Current — Continuous — Peak (1)	I_C I_{CM}	-8 -20				A
Base Current — Continuous — Peak (1)	I_B I_{BM}	-2 -5				A
Total Power Dissipation @ T_C = 25°C @ T_C = 100°C Derate above 25°C	P_D	50 20 0.4				Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150				°C

THERMAL CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	°C

(1) Pulse measurement condition PW ≤ 6.0 ms.

D45VM Series

ECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
F CHARACTERISTICS(1)				
ollector-Emitter Sustaining Voltage(1) (I_C = -100mA, I_B = 0)	$V_{CEO(sus)}$			V
D45VM1		-30	—	
D45VM4		-45	—	
D45VM7		-60	—	
D45VM10		-80	—	
ollector-Emitter Voltage(2) (I_C = -3A, V_{CLAMP} = Rated V_{CEX}, $T_C \leq 100°C$)	V_{CEX}			V
D45VM1		-30	—	
D45VM4		-45	—	
D45VM7		-60	—	
D45VM10		-80	—	
ollector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V)		—	-10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V, T_C = 100°C)		—	-100	
ollector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	-100	μA
mitter Cutoff Current (V_{EB} = -7V, I_C = 0)	I_{EBO}	—	-10	μA
ECOND BREAKDOWN				
econd Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
econd Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		
N CHARACTERISTICS(1)				
C Current Gain	h_{FE}			—
(I_C = -4A, V_{CE} = -1V)		40	—	
(I_C = -6A, V_{CE} = -1V)		20	—	
ollector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = -4A, I_B = -0.2A)		—	-0.4	
(I_C = -6A, I_B = -0.3A)		—	-0.6	
(I_C = -8A, I_B = -0.8A, T_C = 100°C)		—	-1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = -4A, I_B = -0.2A)		—	-1.2	
(I_C = -4A, I_B = -0.2A, T_C = 100°C)		—	-1.2	

YNAMIC CHARACTERISTICS

CHARACTERISTICS	SYMBOL	Typical	UNIT
Current-Gain — Bandwidth Product (I_C = -0.1A, V_{CE} = -10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = -10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	70	pF

WITCHING CHARACTERISTICS

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 30V, I_C = -6A	t_d	30	40	nsec
Rise Time	I_{B1} = I_{B2} = 0.6A	t_r	250	350	nsec
Storage Time	t_p = 25 μsec	t_s	500	600	nsec
Fall Time		t_f	75	250	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CE(CLAMP)}$ = 30V, I_C = -6A	t_s	500	600	nsec
Fall Time	I_{B1} = I_{B2} = 0.6A, $V_{BE(OFF)}$ = 5V	t_f	70	100	nsec
			Typical		
Storage Time	L = 200 μh	t_s	340	430	nsec
Fall Time		t_f	40	57	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.
(2) See Figure 15 for Test Circuit.

2

D45VM Series

TYPICAL DC CHARACTERISTICS

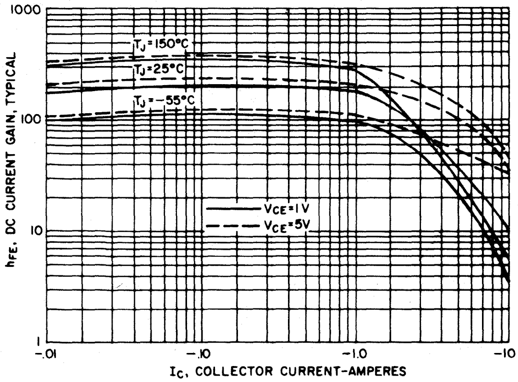


FIGURE 1. DC CURRENT GAIN

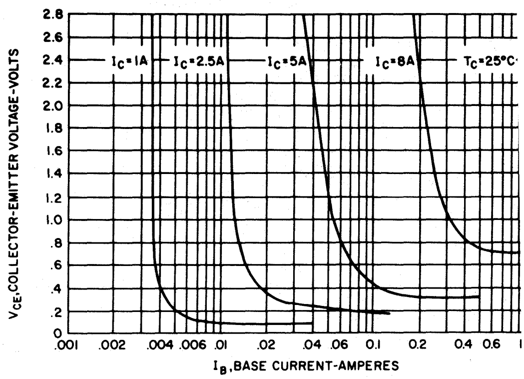


FIGURE 2. COLLECTOR SATURATION REGION

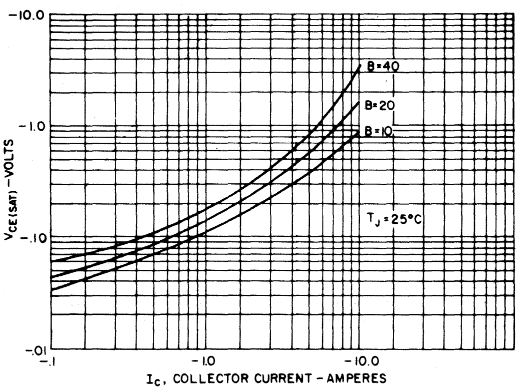


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

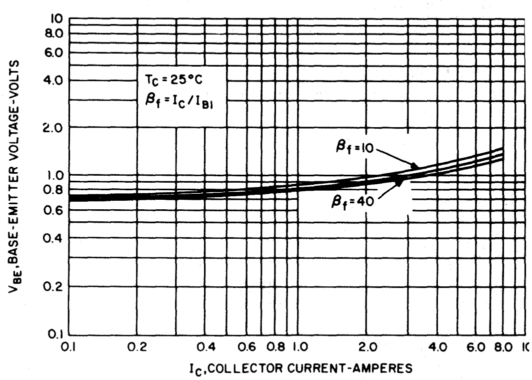


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

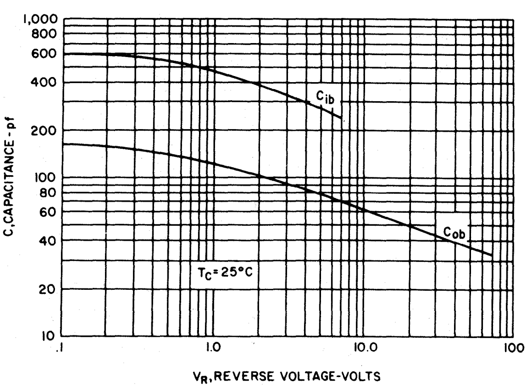


FIGURE 5. CAPACITANCE

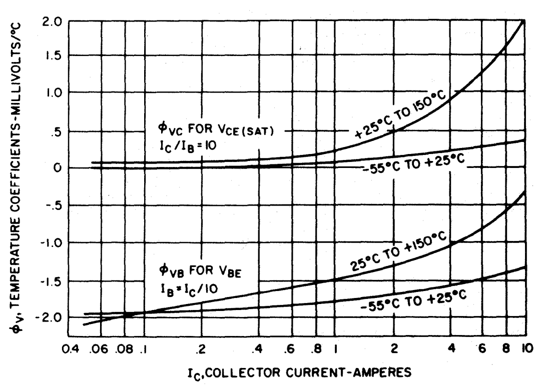


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

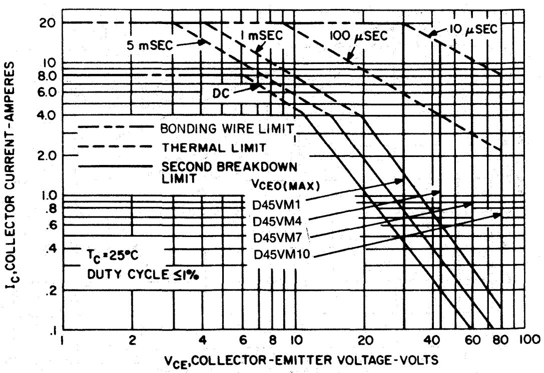


FIGURE 7. FORWARD BIAS SOA

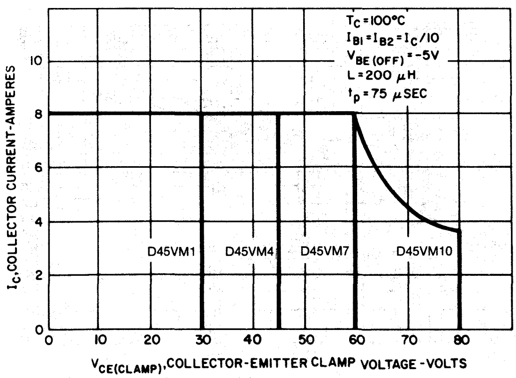


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

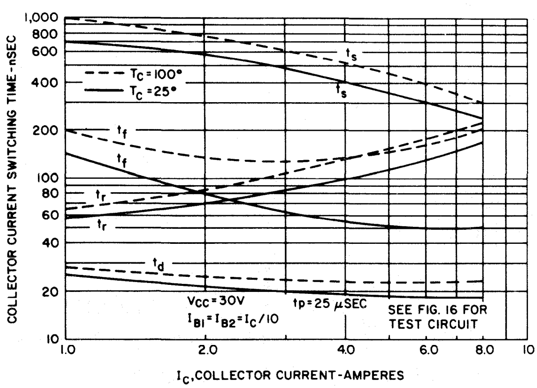


FIGURE 9. RESISTIVE SWITCHING TIME

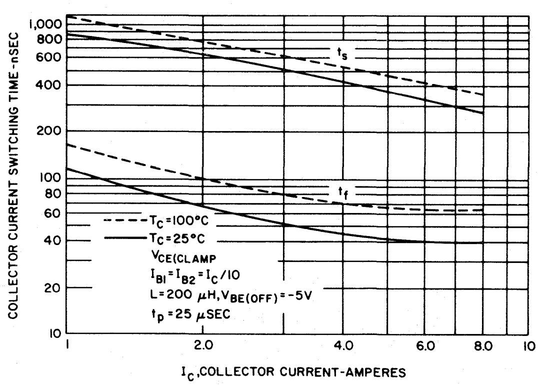


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

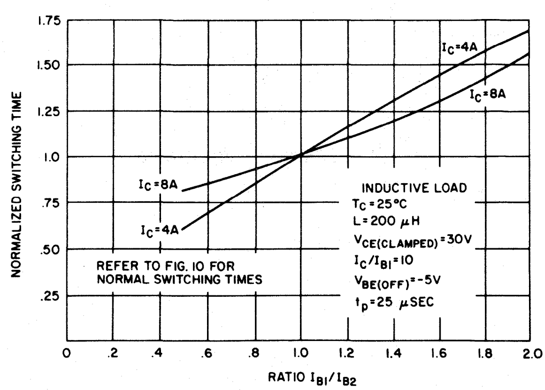


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

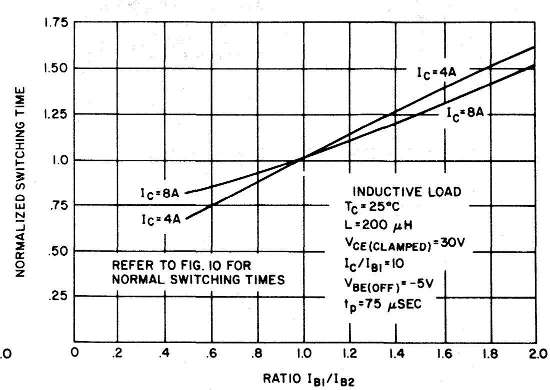


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D45VM Series

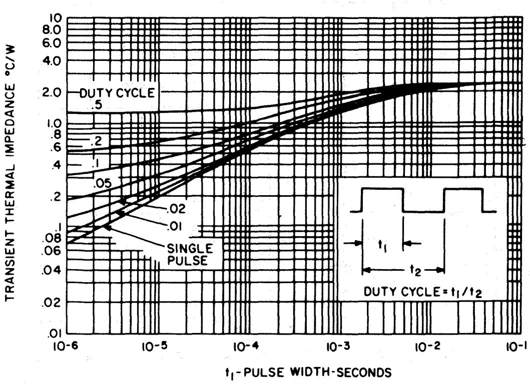


FIGURE 13. TRANSIENT THERMAL RESPONSE

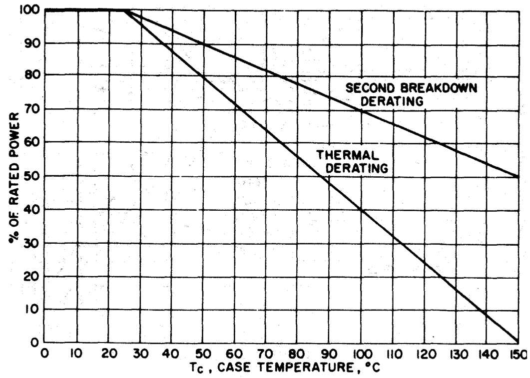
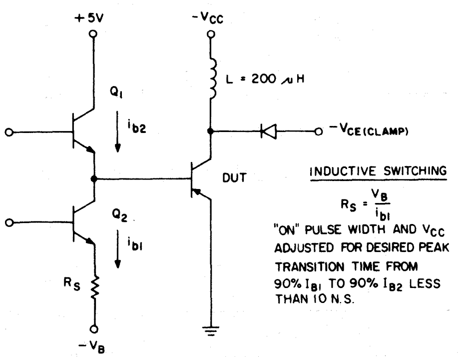
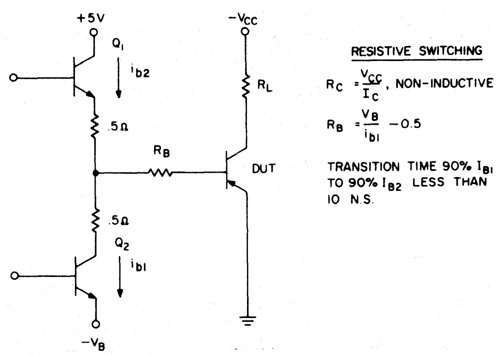


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS



15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

File Number **15.27**

D46TQ1, D46TQ2

High-Speed Silicon N-P-N Power Transistors

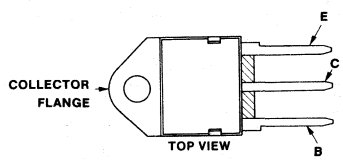
Devices for Switching Applications

Features:

- $V_{CEO(sus)}$ *400 V and 450 V*
- *700 V blocking capability*
- *SOA and switching information*

The D46TQ1 and D46TQ2 are silicon n-p-n power transistors designed for high-voltage, high-speed power switching of inductive circuits where fall time is critical. They are particularly suited for off-line switch-mode applications such as switching regulators, inverters, motor controls, solenoid/relay drivers, and deflection circuits.

TERMINAL DESIGNATIONS



JEDEC TO-218AC

92CS-40257

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D46TQ1	D46TQ2	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	12 24	12 24	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	6 12	6 12	A
Total Power Dissipation @ Tc = 25°C Derate above 25°C	P_D	110 0.88	110 0.88	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.1	1.1	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

D46TQ1, D46TQ2

ELECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = 10mA, I_B = 0)	D46TQ1 D46TQ2	$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CE} = Rated Value, $V_{BE(OFF)}$ = - 1.5V)		I_{CEV}	—	—	1	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)		I_{EBO}	—	—	1	mA
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 5A, V_{CE} = 5V) (I_C = 8A, V_{CE} = 5V)		h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.8A) (I_C = 12A, I_B = 3A)		$V_{CE(sat)}$	— — —	— — —	1 1.5 3	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A)		$V_{BE(sat)}$	— —	— —	1.2 1.6	V

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	V_{CC} = 125V, I_C = 8A	t_d	—	0.06	0.1	μs
Rise Time	I_{B1} = I_{B2} = 1.6A, t_p = 25 μs	t_r	—	0.45	1	
Storage Time	Duty Cycle < 1%	t_s	—	1.3	3	
Fall Time		t_f	—	0.2	0.7	
Inductive Load, Clamped						
Storage Time	(I_C = 8A, V_{CLAMP} = 300V)	t_{sv}	—	0.92	2.3	μs
Crossover Time	(I_{B1} = 1.6A, $V_{BE(OFF)}$ = -5V T_C = 100° C)	t_c	—	0.12	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

D64DS5,6,7
D64ES5,6,7

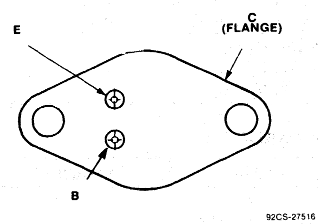
File Number **15.34**

20-Ampere N-P-N Darlington Power Transistors

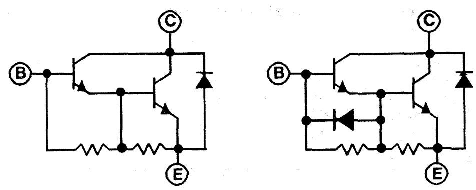
Features:
- *High speed* $t_s < 3.0$ *µsec.,* $t_r < 1.0$ *µsec.*
- *High voltage: 400-500* $V_{CEO(SUS)}$
- *High gain:* h_{FE} *40 minimum @* $I_C = 20A$
- *High current: 30 amperes,* I_C *(Peak)*

The D64DS and D64ES series of silicon n-p-n power Darlington transistors are designed for use in high-speed switching applications. These applications include off-line switching power supplies, PWM ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

TERMINAL DESIGNATIONS



JEDEC TO-204AA



DEVICE CIRCUIT

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D64DS5/ES5	D64DS6/ES6	D64DS7/ES7	UNITS
Collector-Emitter Voltage	V_{CEV}	500	600	700	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage D64DS D64ES	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 30 50	20 30 50	20 30 50	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	5 10	5 10	5 10	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

D64DS5,6,7
D64ES5,6,7

ELECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage (I_C = 0.5A) (V_{clamp} = V_{CEO} Rated)	D64DS5/ES5 D64DS6/ES6 D64DS7/ES7	$V_{CEO(sus)}$	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V_{CE} = Rated Value, V_{BE} = -1.5V)	T_J = 25°C T_J = 150°C	I_{CEV}	— —	— —	1.0 2.5	mA
Emitter Cutoff Current (V_{EB} = 4.5V, I_C = 0) (V_{EB} = 1.5V, I_C = 0)	D64DS D64ES	I_{EBO}	— —	— —	200 200	mA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 26			
ON CHARACTERISTICS						
DC Current Gain (I_C = 30A, V_{CE} = 5V) (I_C = 20A, V_{CE} = 5V) (I_C = 10A, V_{CE} = 5V)		h_{FE}	20 40 100	35 85 160	— — —	—
Collector-Emitter Saturation Voltage (I_C = 30A, I_B = 3A) (I_C = 20A, I_B = 2A) (I_C = 10A, I_B = 1A)		$V_{CE(sat)}$	— — —	2.1 1.6 1.2	3.5 2.5 1.5	V
Base-Emitter Saturation Voltage (I_C = 30A, I_B = 3A) (I_C = 20A, I_B = 2A) (I_C = 10A, I_B = 1A)		$V_{BE(sat)}$	— — —	2.65 2.3 1.8	4 3 2.5	V

SWITCHING CHARACTERISTICS

Resistive Load				TYP. DS	TYP. ES	MAX. DS	MAX. ES	
Delay Time	V_{CC} = 250V	t_d	—	0.05	0.05	0.5	0.5	μsec
Rise Time	I_C = 20A	t_r	—	0.4	0.4	1	1	
Storage Time	I_{B1} = 1A, I_{B2} = -2A	t_s	—	2.2	1.8	5	3	
Fall Time	t_p = 50 μsec	t_f	—	1.6	.45	3	1	

EMITTER-COLLECTOR DIODE CHARACTERISTICS

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Power Dissipation		P_D	—	—	125	Watts
Forward Voltage	(I_F = 10A) (I_P = 25A) (I_F = 25A, T_J = 150°C)	V_F V_F V_F	— — —	1.95 2.80 2.75	3.20 4.00 4.00	Volts Volts Volts
Reverse Recovery Time (I_F = 25A, $di/_{dt}$ = 15A/μsec, R_{B1E} = .25Ω)		T_{rr}	—	3.85	10	μsec
Forward Turn-On Time (I_F = 25A, $di/_{dt}$ = 50A/μsec)		T_{ON}	—	0.42	1.0	μsec
Single Cycle Surge Current (60Hz)		I_{FSM}	—	—	50	Amps
Thermal Resistance		$R_{\theta JC}$	—	—	1.0	°C/Watt

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

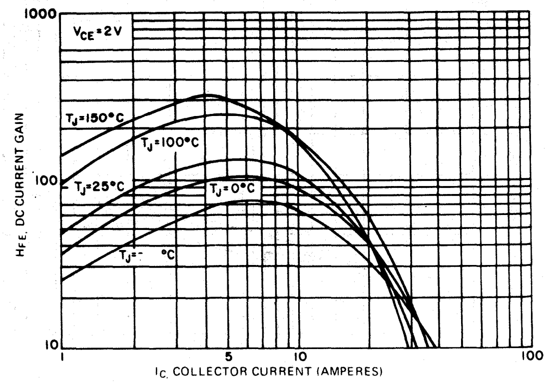


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

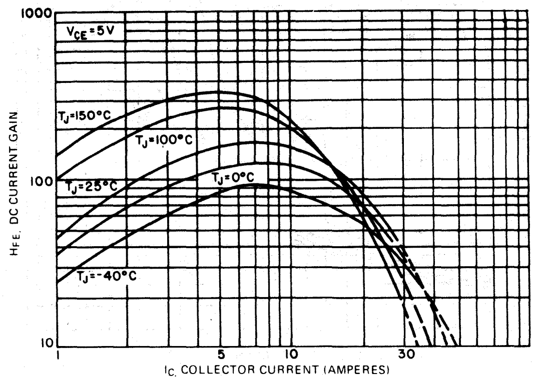


FIGURE 2. DC CURRENT GAIN (V_{CE} = 5V)

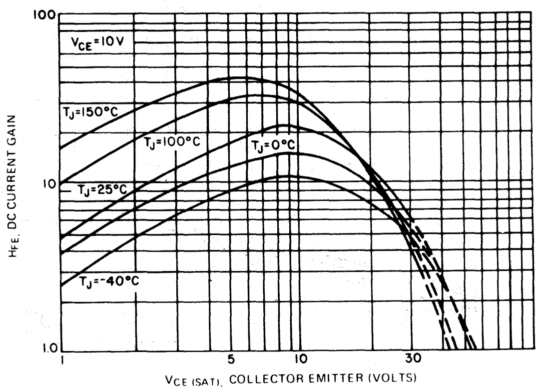


FIGURE 3. DC CURRENT GAIN (V_{CE} = 10V)

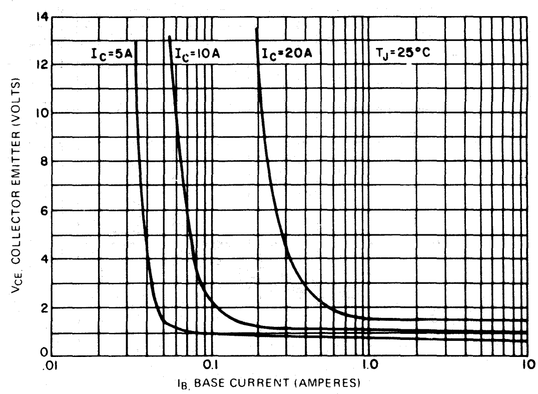


FIGURE 4. COLLECTOR SATURATION REGION

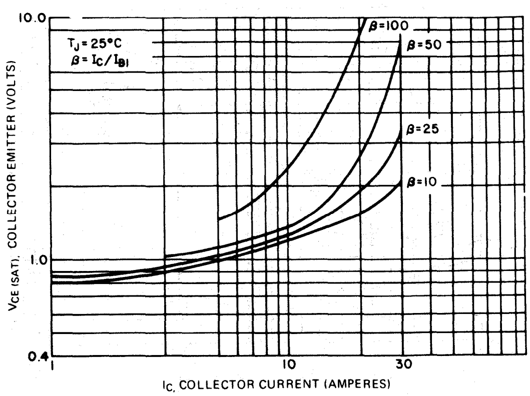


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

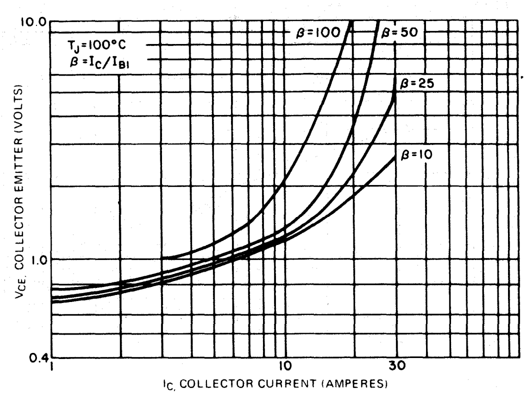


FIGURE 6. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

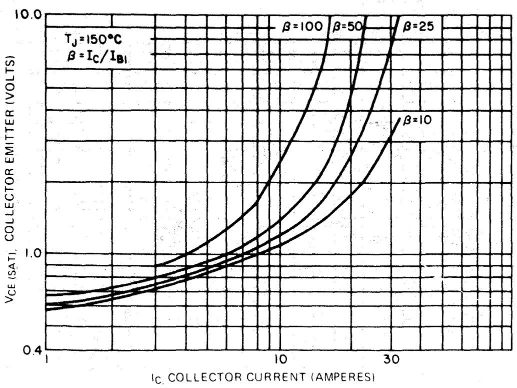


FIGURE 7. $V_{CE(SAT)}$ VS. I_C, T_J = 150°C

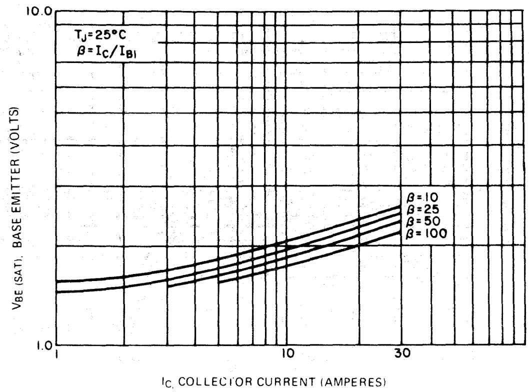


FIGURE 8. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

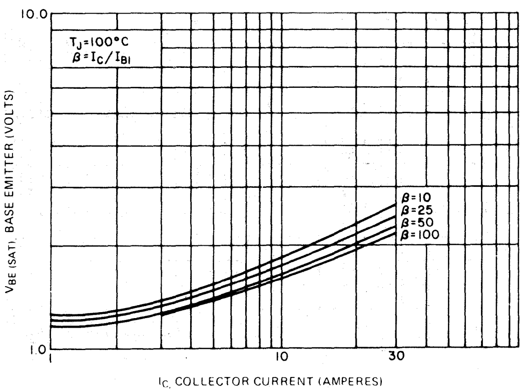


FIGURE 9. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

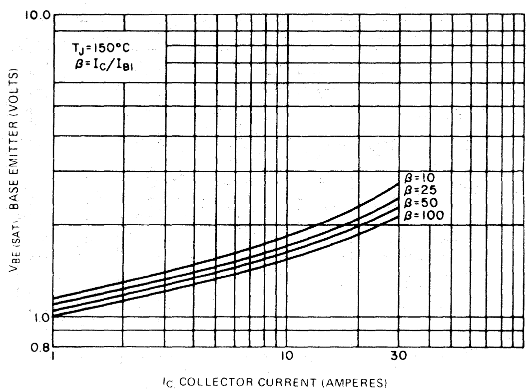


FIGURE 10. $V_{BE(SAT)}$ VS. I_C, T_J = 150°C

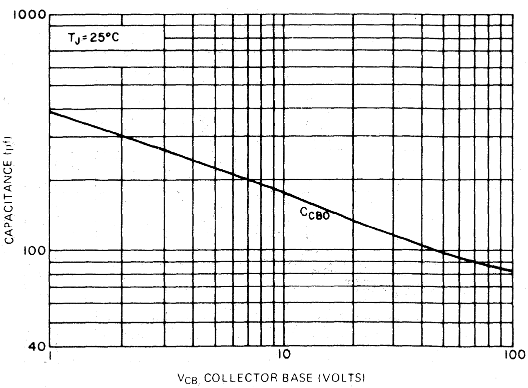


FIGURE 11. CAPACITANCE (C_{CBO})

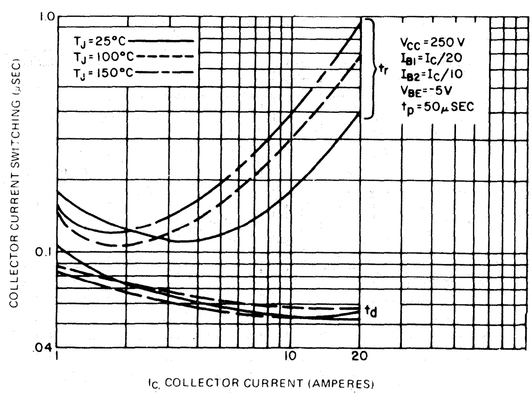


FIGURE 12. TURN-ON TIME (RESISTIVE LOAD) (D64DS ONLY)

TYPICAL CHARACTERISTICS

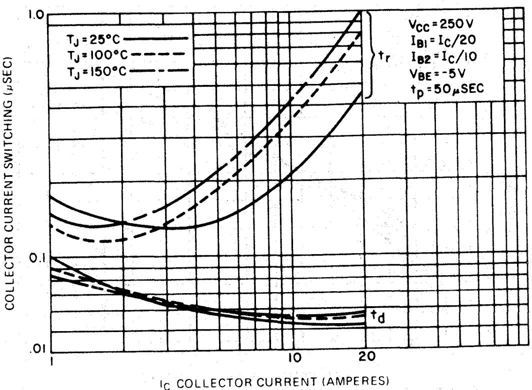


FIGURE 13. TURN-ON TIME (RESISTIVE) (D64ES ONLY)

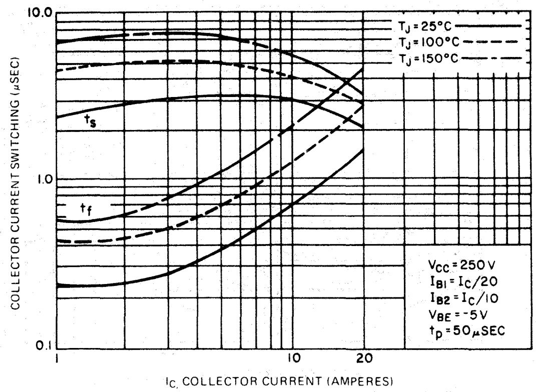


FIGURE 14. TURN-OFF TIME (RESISTIVE) (D64DS ONLY)

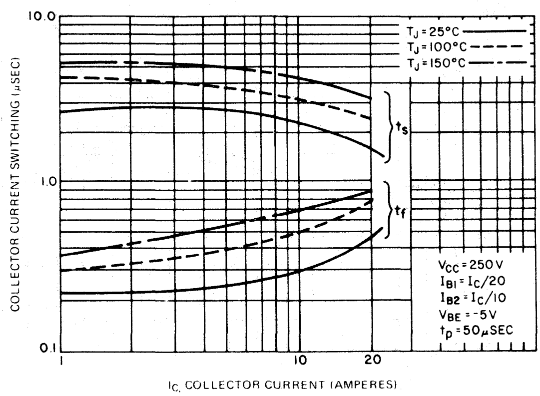


FIGURE 15. TURN-OFF TIME (RESISTIVE) (D64ES ONLY)

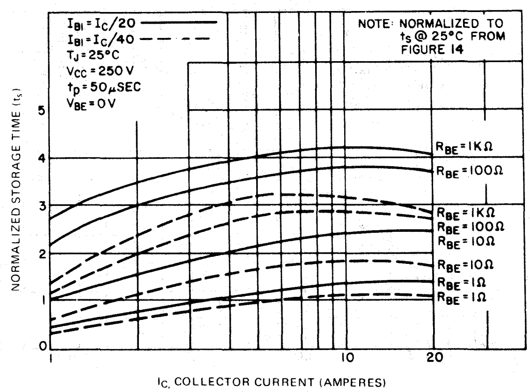


FIGURE 16. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D64DS ONLY)

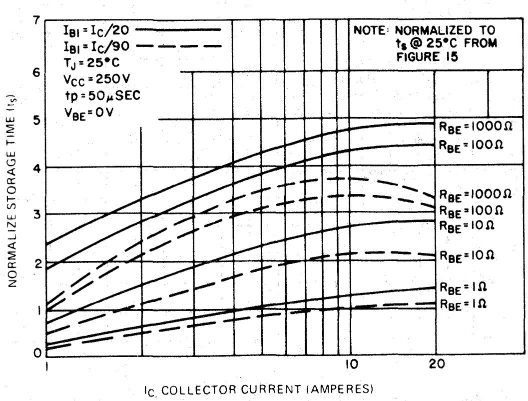


FIGURE 17. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT (D64ES ONLY)

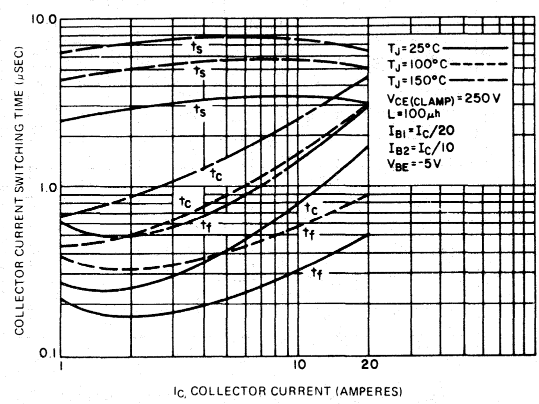


FIGURE 18. CLAMPED INDUCTIVE TURN-OFF TIME (D64DS ONLY)

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

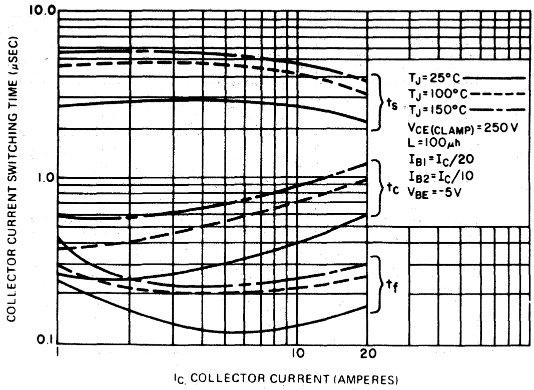


FIGURE 19. CLAMPED INDUCTIVE TURN-OFF TIME (D64ES ONLY)

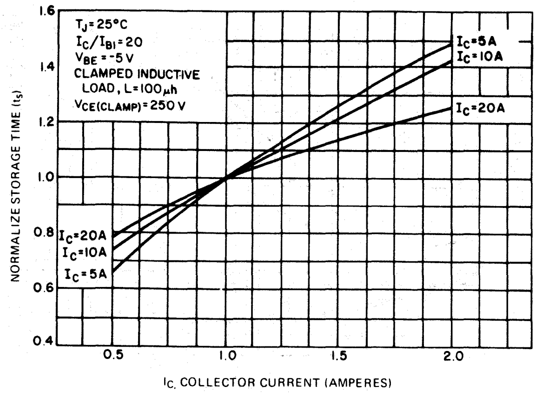


FIGURE 20. STORAGE TIME VARIATION WITH I_{B2} (D64DS ONLY)

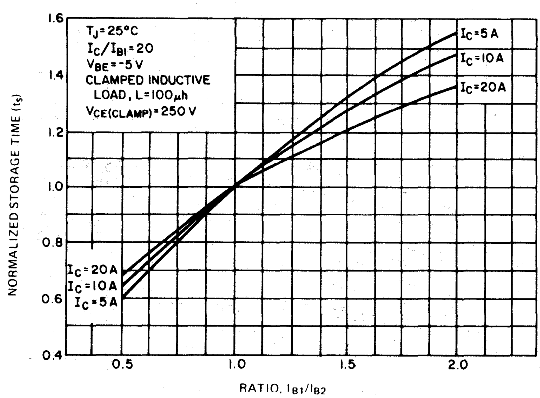


FIGURE 21. STORAGE TIME VARIATION WITH I_{B2} (D64ES ONLY)

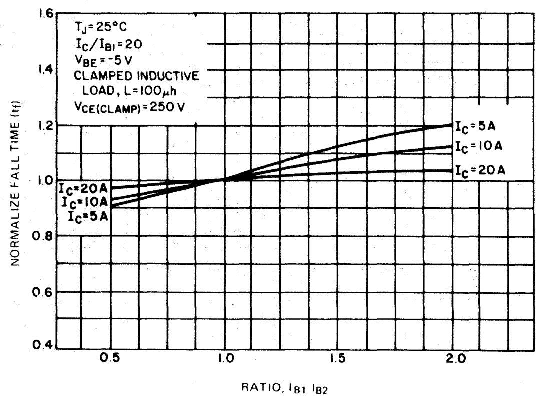


FIGURE 22. FALL TIME VARIATION WITH I_{B2} (D64DS ONLY)

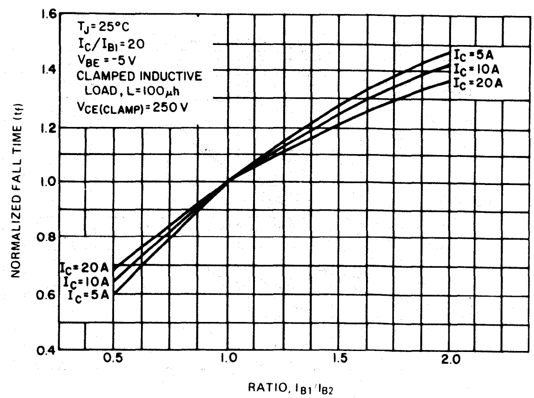


FIGURE 23. FALL TIME VARIATION WITH I_{B2} (D64ES ONLY)

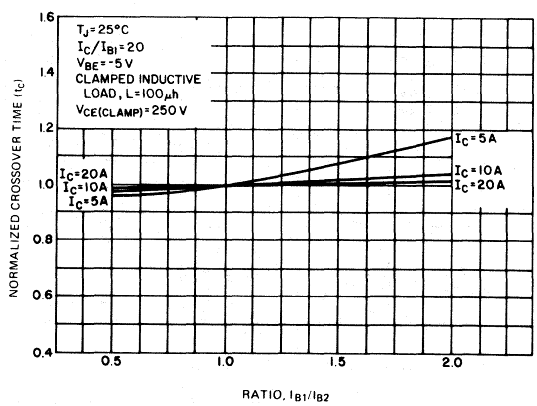


FIGURE 24. CROSS-OVER TIME VARIATION WITH I_{B2} (D64DS ONLY)

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

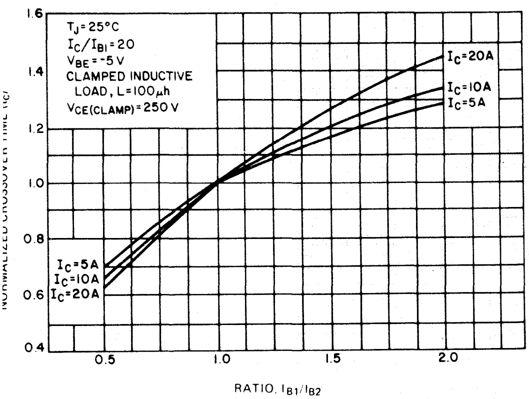


FIGURE 25. CROSS-OVER TIME VARIATION WITH I_{B2} (D64ES ONLY)

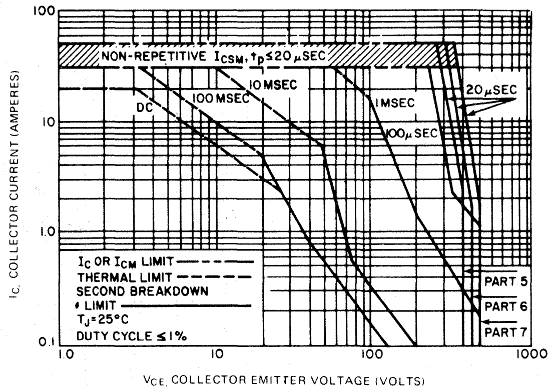


FIGURE 26. FORWARD BIAS SAFE OPERATING AREA

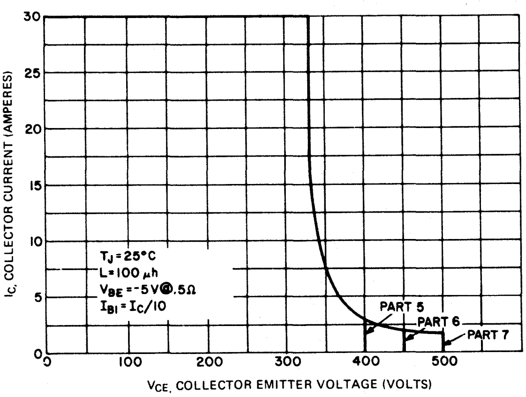


FIGURE 27. REVERSE BIAS SAFE OPERATING AREA

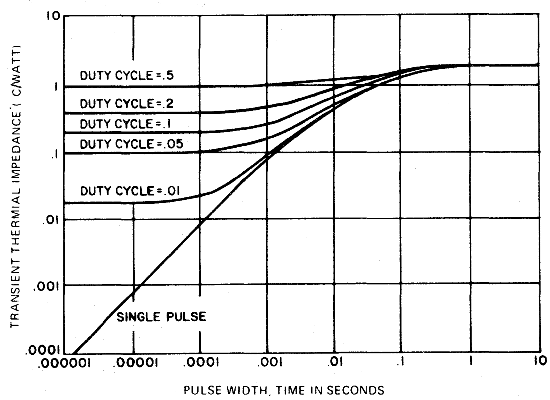


FIGURE 28. TRANSIENT THERMAL RESPONSE

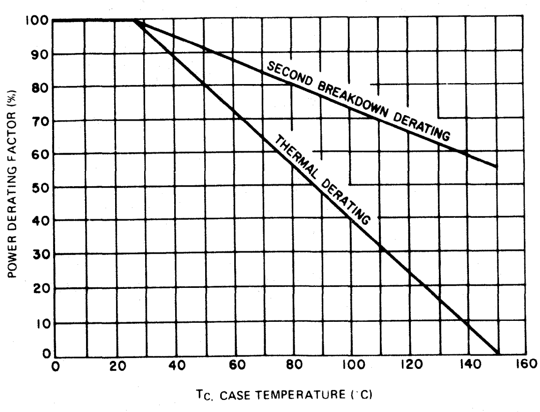


FIGURE 29. POWER DERATING

D64DS5,6,7
D64ES5,6,7

TYPICAL CHARACTERISTICS

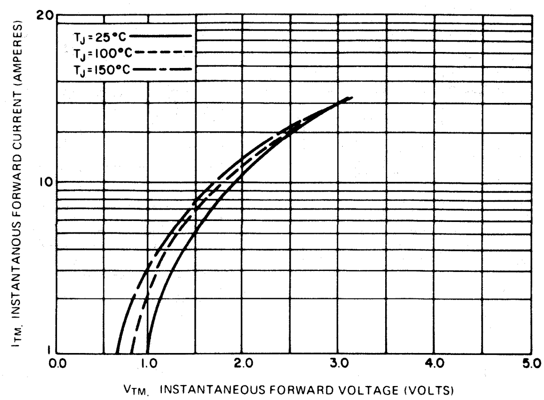


FIGURE 30. DIODE CHARACTERISTICS

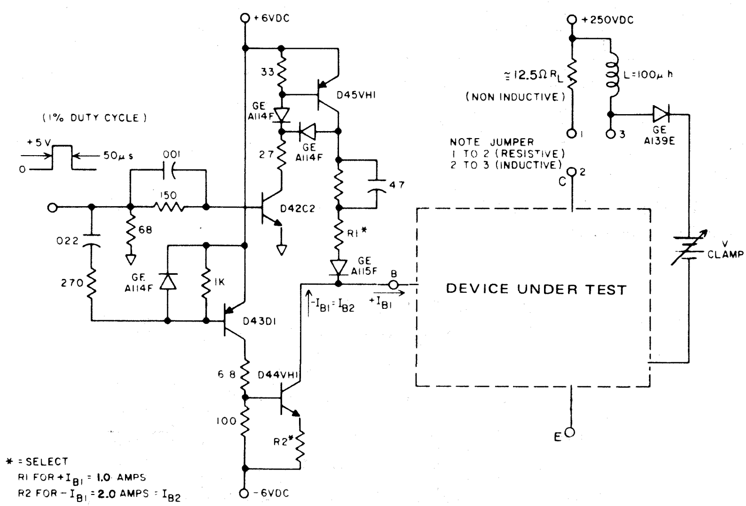


FIGURE 31. SWITCHING TIME TEST CIRCUIT

File Number **15.35**

D64DV5,6,7
D64EV5,6,7

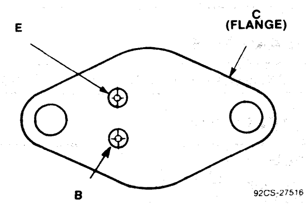
50-Ampere N-P-N Darlington Power Transistors

Features:
- *High speed $t_s < 5.0$ μsec., $t_r < 3.0$ μsec.*
- *High voltage: 400-500 V_{CEO}*
- *High gain: h_{FE} 50 minimum @ 50 amperes, I_C*
- *High current: 75 amperes, I_C (Peak)*

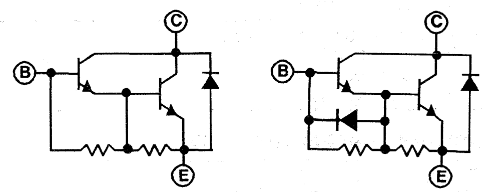
The D64DV and D64EV series of silicon n-p-n power Darlington transistors are designed for use in high-speed switching applications. These applications include off-line switching power supplies, PWM ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

TERMINAL DESIGNATIONS



JEDEC TO-204AE



DEVICE CIRCUIT

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D64DV5/EV5	D64DV6/EV6	D64DV7/EV7	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Collector-Base Voltage	V_{CBO}	500	600	700	Volts
Emitter Base Voltage D64DV D64EV	V_{EBO}	8 5	8 5	8 5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	50 75 125	50 75 125	50 75 125	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	10 20	10 20	10 20	A
Total Power Dissipation @ T_C = 25°C	P_D	180	180	180	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	0.7	0.7	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

D64DV5,6,7
D64EV5,6,7

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage	D64DV5/EV5	$V_{CEO(sus)}$	400	—	—	Volts
(I_C = 0.5A)	D64DV6/EV6		450	—	—	
(V_{clamp} = V_{CEO} Rated)	D64DV6/EV7		500	—	—	
Collector Cutoff Current	T_J = 25°C	I_{CEV}	—	—	1.0	mA
(V_{CE} = Rated Value, V_{BE} = -1.5V)	T_J = 150°C		—	—	2.5	
Emitter Cutoff Current		I_{EBO}				
(V_{EB} = 4.5V, I_C = 0)	D64DV		—	—	350	mA
(V_{EB} = 1.5V, I_C = 0)	D64EV		—	—	350	
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 23			
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				
(I_C = 75A, V_{CE} = 5V)			25	60	—	—
(I_C = 50A, V_{CE} = 5V)			50	135	—	
(I_C = 20A, V_{CE} = 5V)			100	250	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				
(I_C = 75A, I_B = 5A)			—	2.2	3.0	V
(I_C = 50A, I_B = 4A)			—	1.7	2.0	
(I_C = 20A, I_B = 2A)			—	1.15	1.5	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				
(I_C = 75A, I_B = 5A)			—	2.8	3.5	V
(I_C = 50A, I_B = 4A)			—	2.45	3.0	
(I_C = 20A, I_B = 2A)			—	1.95	2.5	

SWITCHING CHARACTERISTICS

				TYP.		MAX.		
Resistive Load				DV	EV	DV	EV	
Delay Time	V_{CC} = 250V	t_d	—	0.09	0.09	0.5	0.5	µs
Rise Time	I_C = 50A	t_r	—	0.5	0.5	1	1	
Storage Time	I_{B1} = 2.5A, I_{B2} = -5A	t_s	—	2.55	2	5	3	
Fall Time	t_p = 50 µsec	t_f	—	1.4	0.64	3	1	

EMITTER-COLLECTOR DIODE CHARACTERISTICS

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
Power Dissipation		P_D	—	—	125	Watts
Forward Voltage	(I_F = 25A)	V_F	—	1.95	3.20	Volts
	(I_P = 50A)	V_F	—	2.60	3.80	Volts
	(I_F = 50A, T_J = 150°C)	V_F	—	2.30	3.50	Volts
Reverse Recovery Time (I_F = 50A, $di/_{dt}$ = 25A/µsec, R_{B1E} = 0.25Ω)		T_{rr}	—	3.85	10.0	µsec
Forward Turn-On Time (I_F = 100A, $di/_{dt}$ = 100A/µsec)		T_{ON}	—	0.75	1.5	µsec
Single Cycle Surge Current (60Hz)		I_{FSM}	—	—	150	Amps
Thermal Resistance		$R_{\theta JC}$	—	—	1.0	°C/Watt

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

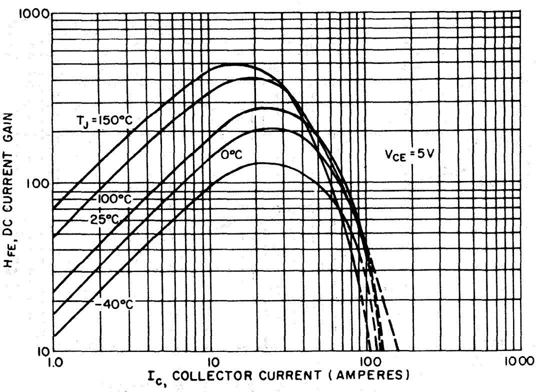


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

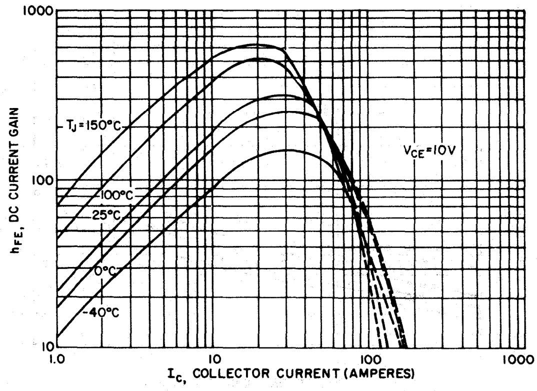


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

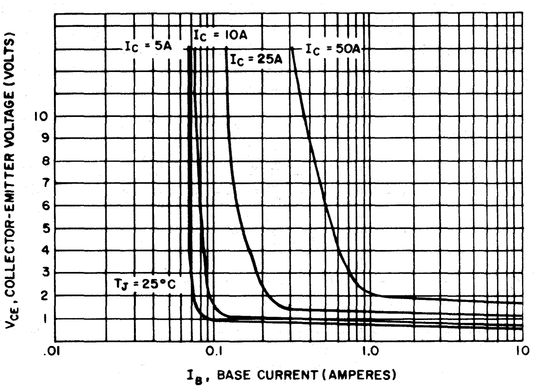


FIGURE 3. COLLECTOR SATURATION REGION

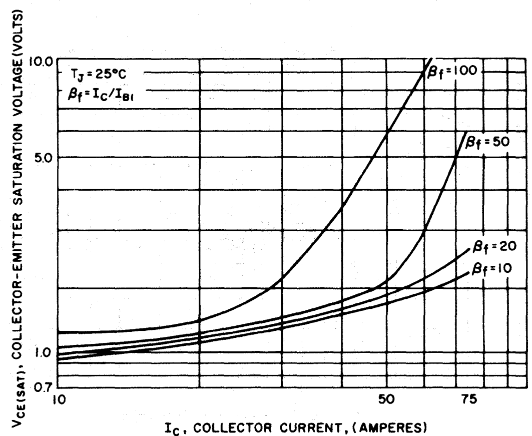


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C, T_J = 25°C

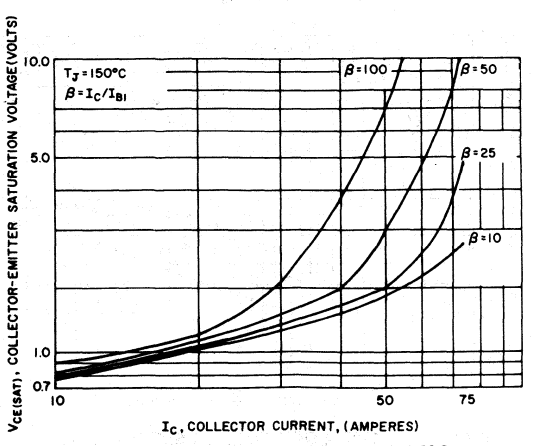


FIGURE 5. $V_{CE\ (SAT)}$ VS I_C, T_J = 150°C

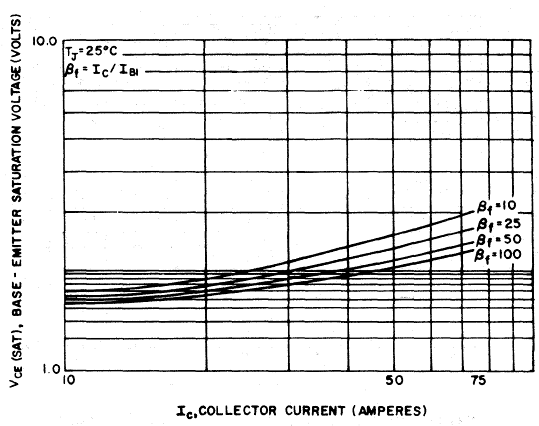


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C, T_J = 25°C

2

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

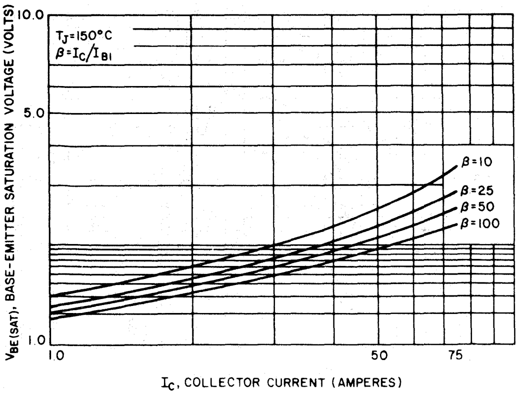


FIGURE 7. $V_{BE\ (SAT)}$ VS I_C, T_J = 150°C

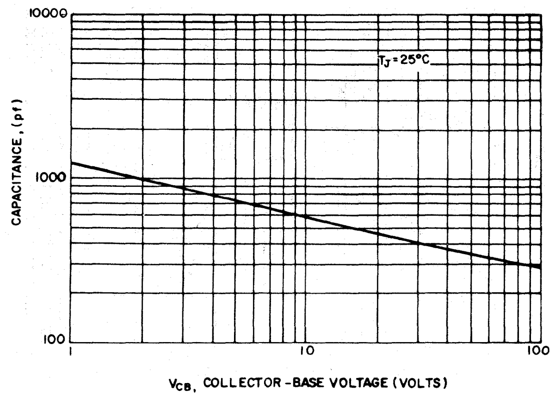


FIGURE 8. CAPACITANCE (C_{CBO})

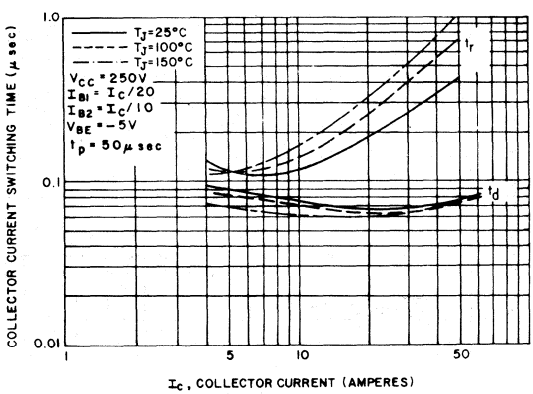


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD)
(D64DV ONLY)

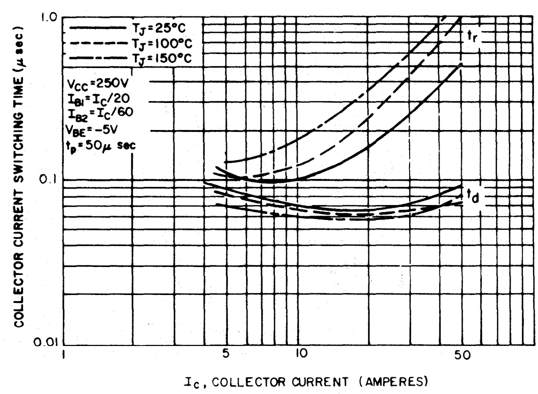


FIGURE 10. TURN-ON TIME (RESISTIVE LOAD)
(D64EV ONLY)

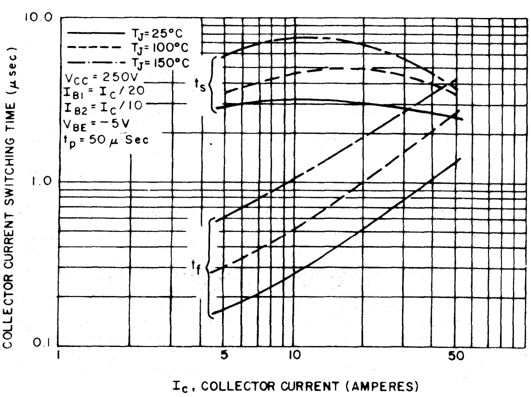


FIGURE 11. TURN-OFF TIME (RESISTIVE LOAD)
(D64DV ONLY)

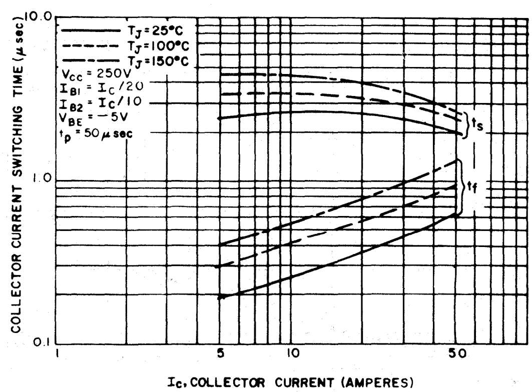


FIGURE 12. TURN-OFF TIME (RESISTIVE LOAD)
(D64EV ONLY)

TYPICAL CHARACTERISTICS

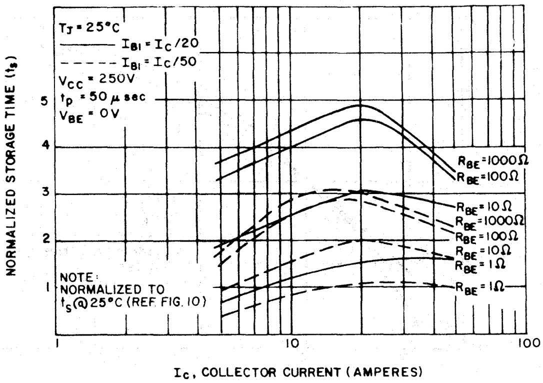


FIGURE 13. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARATIONS) VS COLLECTOR CURRENT (D64DV ONLY)

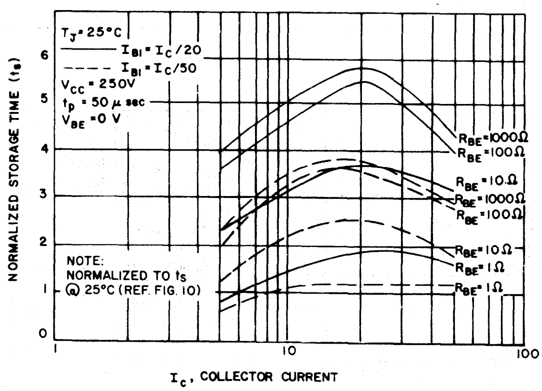


FIGURE 14. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARATIONS) VS COLLECTOR CURRENT (D64EV ONLY)

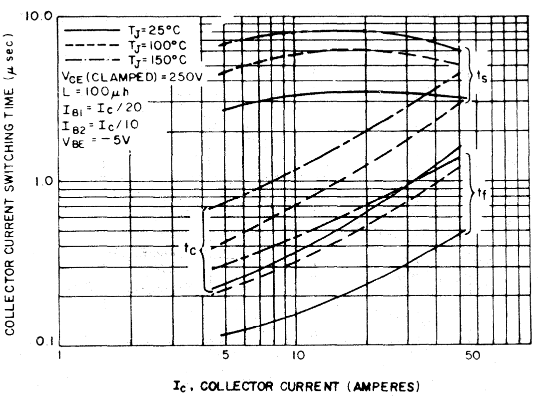


FIGURE 15. CLAMPING INDUCTIVE TURN-OFF TIME (D64DV ONLY)

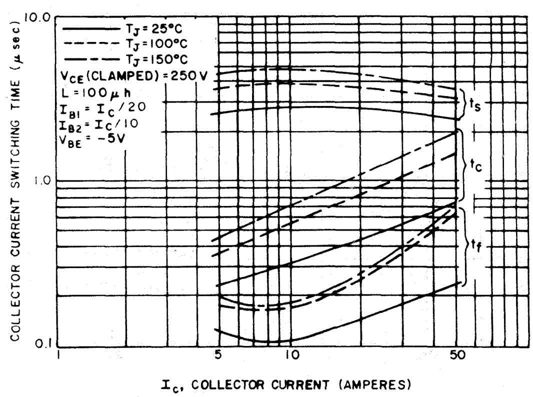


FIGURE 16. CLAMPING INDUCTIVE TURN-OFF TIME (D64EV ONLY)

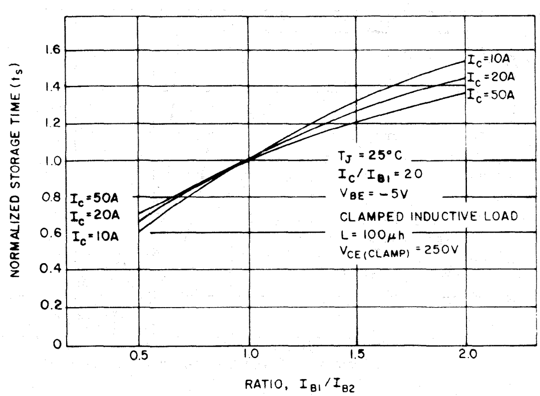


FIGURE 17. STORAGE TIME VARIATION WITH I_{B2} (D64DV ONLY)

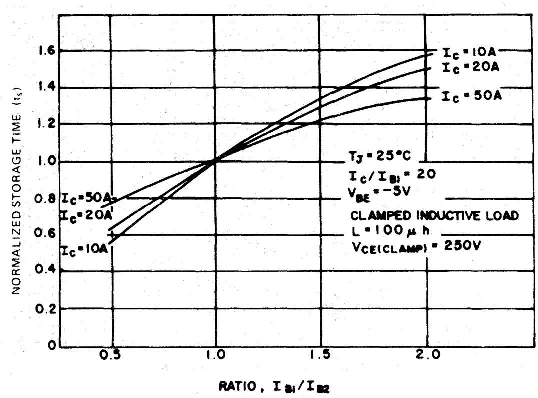


FIGURE 18. STORAGE TIME VARIATION WITH I_{B2} (D64EV ONLY)

2

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

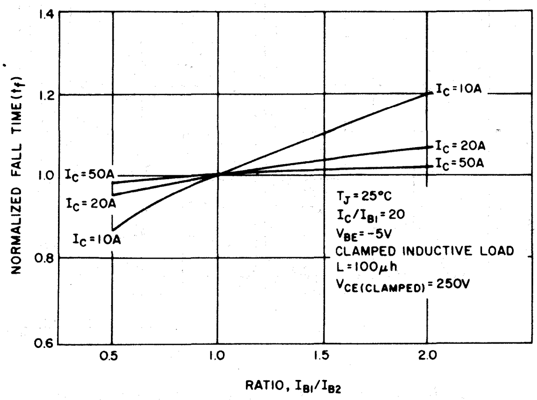


FIGURE 19. FALL TIME VARIATION WITH I_{B2} (D64DV ONLY)

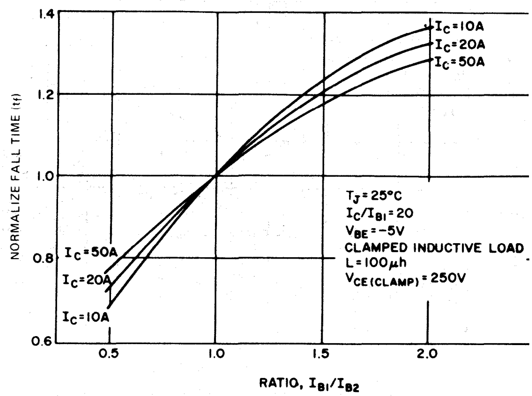


FIGURE 20. FALL TIME VARIATION WITH I_{B2} (D64EV ONLY)

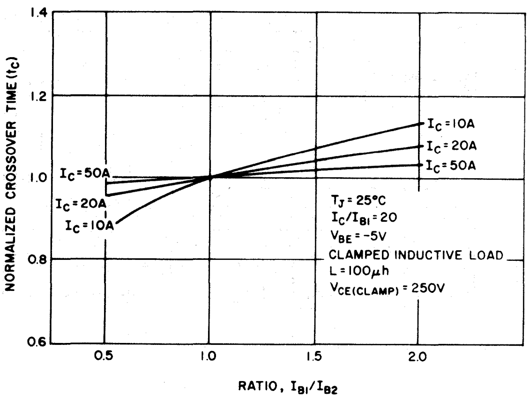


FIGURE 21. CROSSOVER TIME VARIATION WITH I_{B2} (D64DV ONLY)

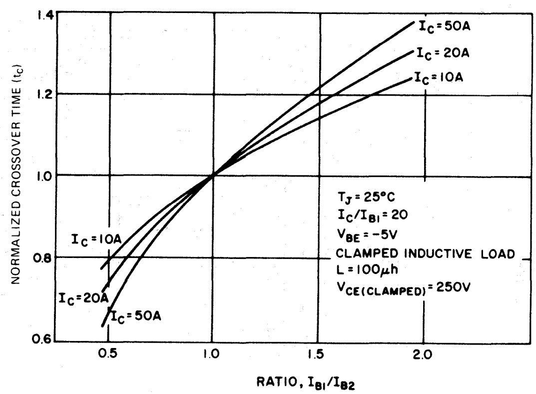


FIGURE 22. CROSSOVER TIME VARIATION WITH I_{B2} (D64EV ONLY)

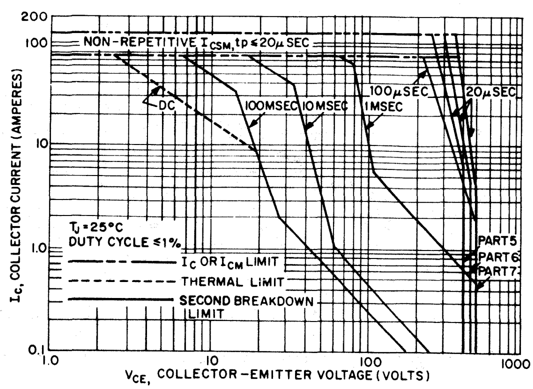


FIGURE 23. FORWARD BIAS SAFE OPERATING AREA

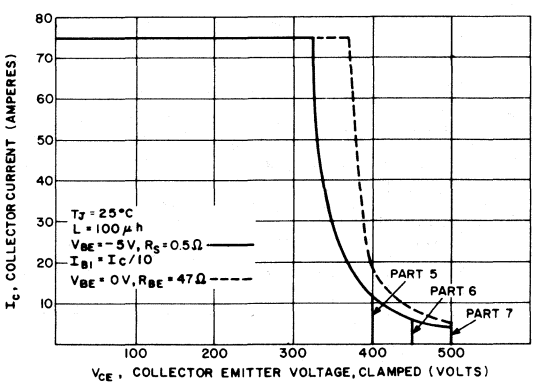


FIGURE 24. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

D64DV5,6,7
D64EV5,6,7

TYPICAL CHARACTERISTICS

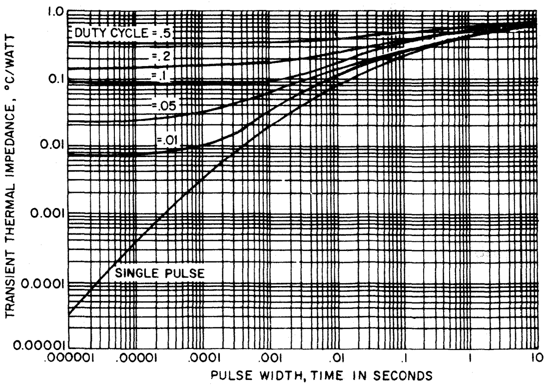


FIGURE 25. TRANSIENT THERMAL RESPONSE

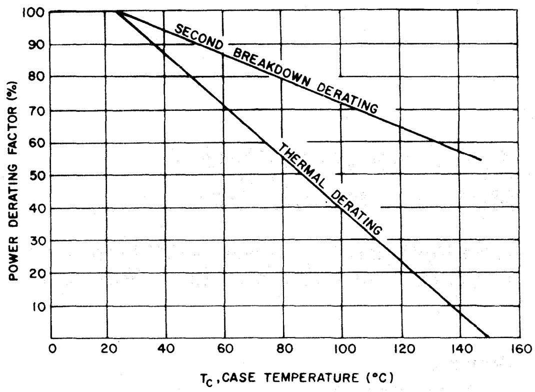


FIGURE 26. POWER DERATING

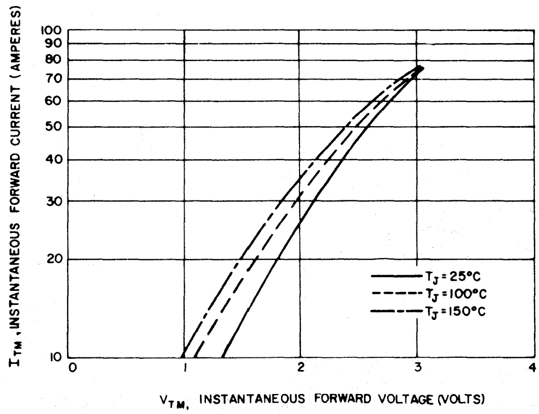


FIGURE 27. FORWARD CHARACTERISTICS

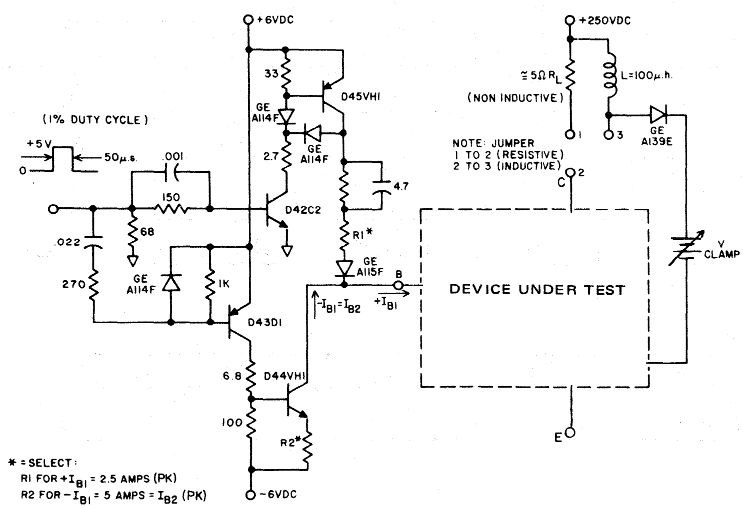


FIGURE 28. SWITCHING TIME TEST CIRCUIT

D64VS3,4,5

File Number **15.36**

15-Ampere N-P-N Power Transistors

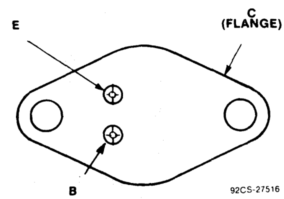
High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:

- *100° C maximum limits specified for:*
  - *Switching times*
  - *Saturation voltages*
  - *Leakage currents*
- *Very fast turn-off, $t_f < 100$ nsec (typ.) @ 15A - inductive load*

The D64VS series of silicon n-p-n power transistors are designed for use in power switching applications requiring high-voltage capability, fast switching speeds, and low-saturation voltages. These devices are optimized to provide a unique combination of ultra-low switching losses and high safe-operating-area (SOA). They are ideally suited for off-line switching power supplies, inverter/converter circuits, and pulse width modulated regulators.

TERMINAL DESIGNATIONS



JEDEC TO -204AA

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D64VS3	D64VS4	D64VS5	UNITS
Collector-Emitter Voltage	V_{CEO}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEX}	300	350	400	Volts
Collector-Emitter Voltage	V_{CEV}	450	500	550	Volts
Emitter Base Voltage	V_{EBO}	7	7	7	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	15 30	15 30	15 30	A
Base Current — Continuous Peak(1)	I_B I_{BM}	5 10	5 10	5 10	A
Emitter Current — Continuous Peak(1)	I_E I_{EM}	20 35	20 35	20 35	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	195 111 1.11	195 111 1.11	195 111 1.11	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	−65 to +200	−65 to +200	−65 to +200	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.9	0.9	0.9	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛″ from Case for 5 Seconds	T_L	235	235	235	°C

(1) Pulse condition, $t_p \leq 5$msec.

D64VS3,4,5

LECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	MAX	UNIT
FF CHARACTERISTICS(1)					
Collector-Emitter Sustaining Voltage(1) (I_C = 100mA)	D64VS3 D64VS4 D64VS5	$V_{CEO(sus)}$	300 350 400	— — —	Volts
Collector-Emitter Voltage (I_C = 15A, I_{B1} = 2.5A, I_{B2} = -3.0A) ($V_{BE(OFF)}$ = -6V, L = 200 μh)	D64VS3 D64VS4 D64VS5	V_{CEX}	300 350 400	— — —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V) (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V, T_C = 100° C)		I_{CEV}	 — —	 0.1 1.0	mA
Emitter Cutoff Current (V_{EB} = 7V)		I_{EBO}	—	1.0	mA
ECOND BREAKDOWN					
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 13		
Clamped Inductive SOA with Base Reversed Bias		RBSOA	SEE FIGURE 14		
N CHARACTERISTICS(1)					
DC Current Gain (I_C = 10A, V_{CE} = 2V) (I_C = 15A, V_{CE} = 2V)		h_{FE}	 10 8	 — —	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 1.67A) (I_C = 15A, I_B = 2.5A) (I_C = 15A, I_B = 2.5A, T_C = 100°C)		$V_{CE(SAT)}$	 — — —	 0.7 1.0 1.5	Volts
Base-Emitter Saturation Voltage (I_C = 15A, I_B = 2.5A) (I_C = 15A, I_B = 2.5A, T_C = 100°C)		$V_{BE(SAT)}$	 — —	 1.5 1.5	Volts
YNAMIC CHARACTERISTICS					
Current Gain — Bandwidth Product (I_C = 1.0A, V_{CE} = 10V, f_{test} = 1.0 MHz)		f_T	15	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)		C_{OB}	150	360	pF

SWITCHING CHARACTERISTICS

			MAXIMUM		
Resistive Load (See Figure 17 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 250V, I_C = 15A	t_d	0.1	0.2	μs
Rise Time	I_{B1} = 2.5, I_{B2} = -3.0A, t_p = 50 μsec	t_r	0.5	0.7	μsec
Storage Time		t_s	2.5	3.0	μsec
Fall Time		t_f	0.4	0.7	μsec
Inductive Load, Clamped (See Figure 17 for Test Circuit)					
Storage Time	I_C = 15A, V_{CLAMP} = 250V	t_s	3.0	3.5	μs
Fall Time	I_{B1} = 2.5A, I_{B2} = -3.0A, $V_{BE(OFF)}$ = -6V L = 200 μh, t_p = 25μsec	t_f	0.3	0.6	μsec
			TYPICAL		
Storage Time		t_s	1.8	2.5	μsec
Fall Time		t_f	0.085	0.13	μsec

(1) Pulse Duration = 300μs, Duty Factor ≤ 2%. Do not measure on a curve tracer.

2

D64VS3,4,5

TYPICAL DC CHARACTERISTICS

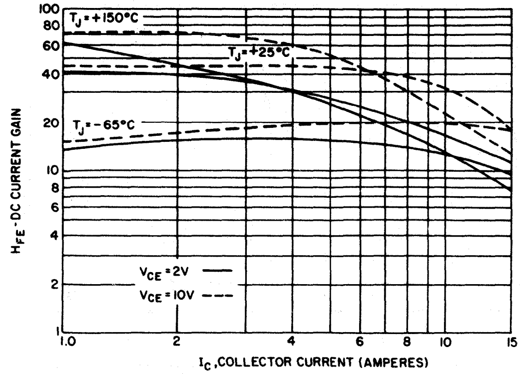


FIGURE 1. DC CURRENT GAIN

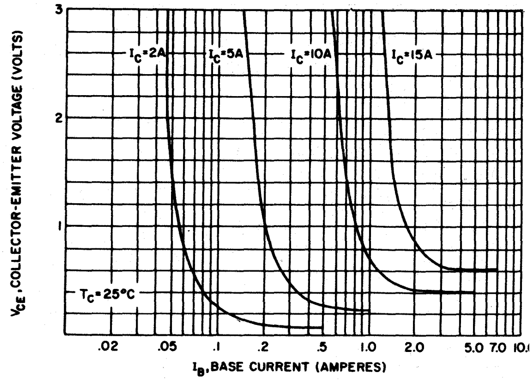


FIGURE 2. COLLECTOR SATURATION REGION

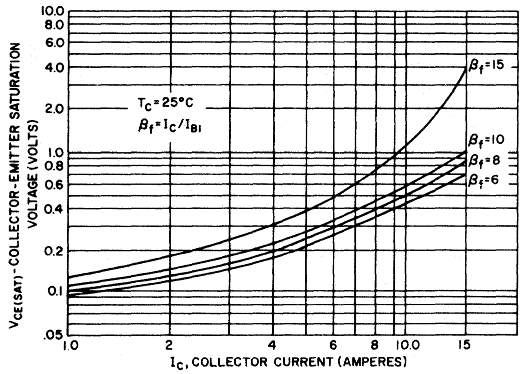


FIGURE 3. $V_{CE(sat)}$ vs I_C, $T_C = 25°C$

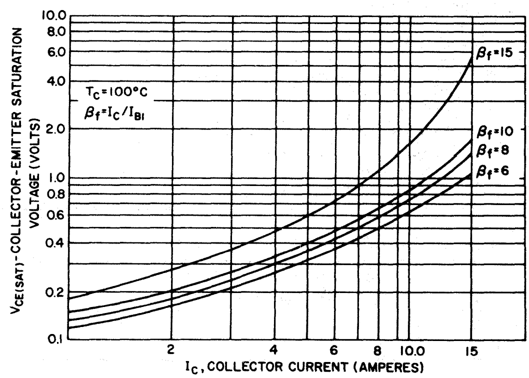


FIGURE 4. $V_{CE(sat)}$ vs I_C, $T_C = 100°C$

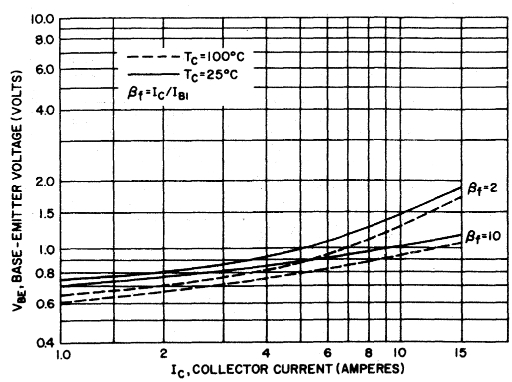


FIGURE 5. $V_{BE(sat)}$ vs I_C

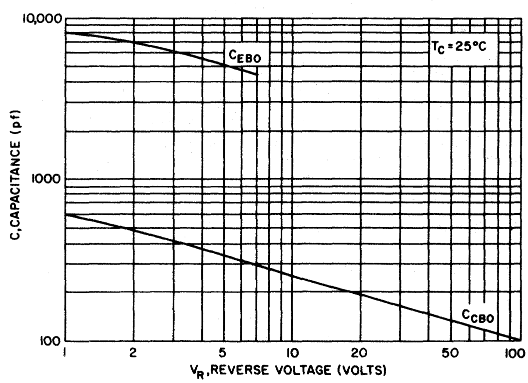


FIGURE 6. CAPACITANCE

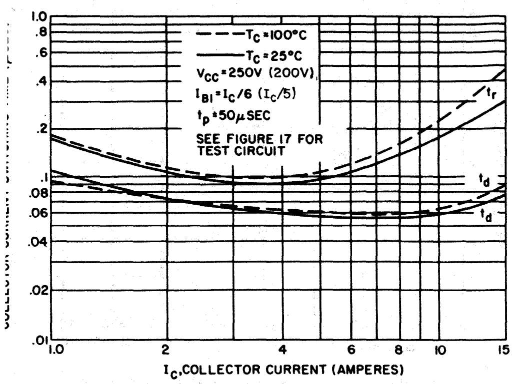


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

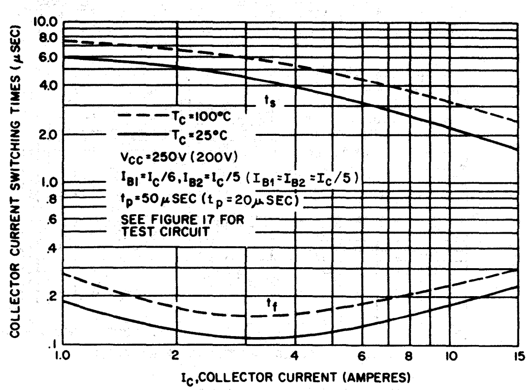


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

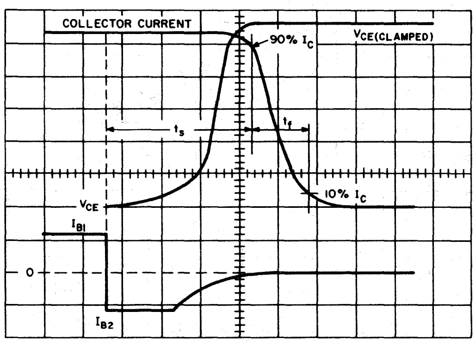


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

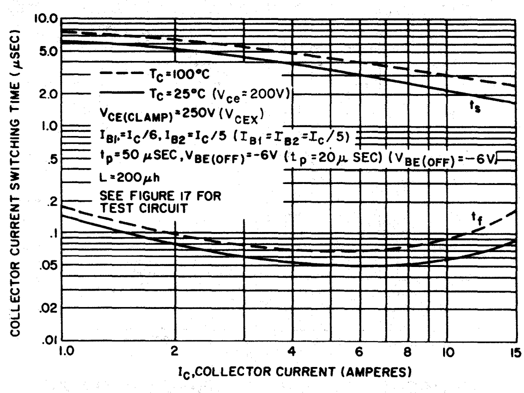


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

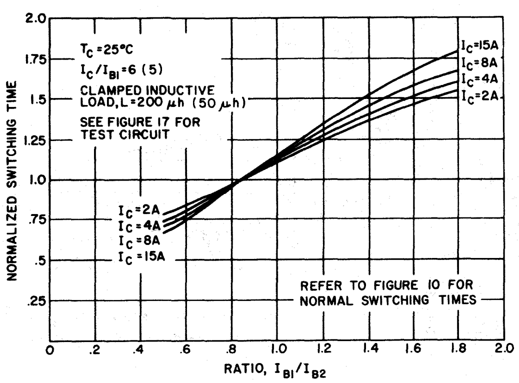


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

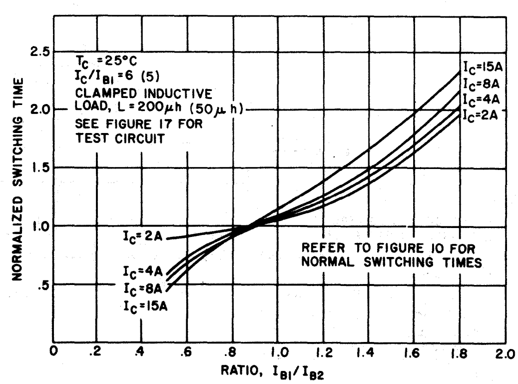


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

D64VS3,4,5

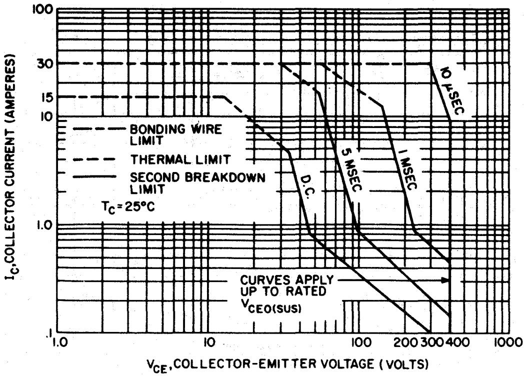


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

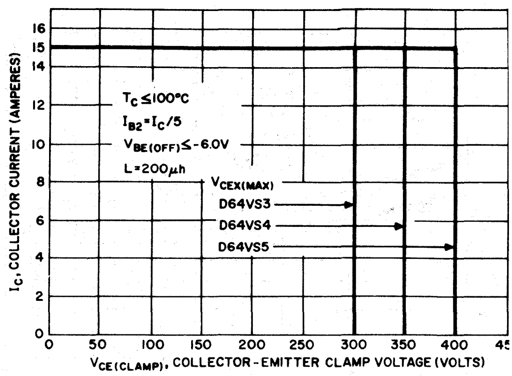


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

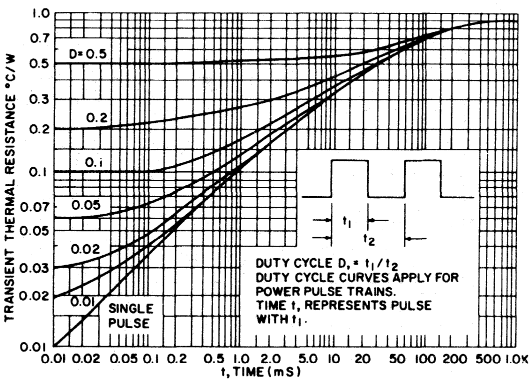


FIGURE 15. TRANSIENT THERMAL RESPONSE

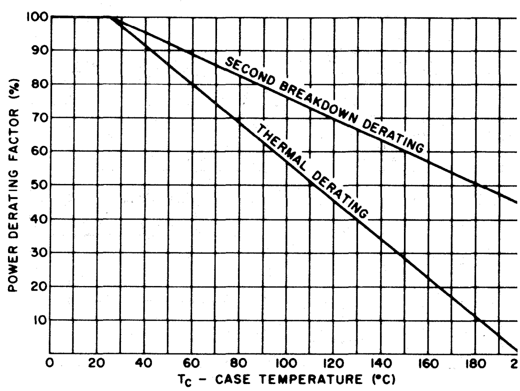
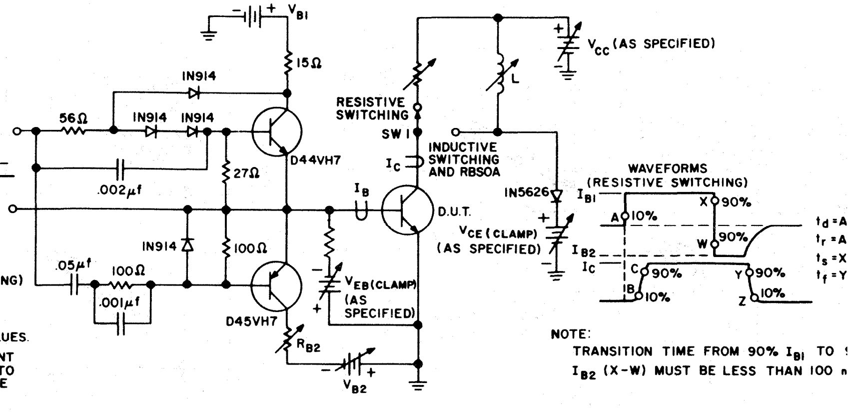


FIGURE 16. POWER DERATING



NOTE:
(2) VALUE OF L (INDUCTOR) IS SPECIFIED ON RATING CURVES.
(3) SELECT R_C (RESISTIVE SWITCHING) FOR DESIRED I_C.
(4) ADJUST V_{B1}, V_{B2} AND R_{B2} FOR TIME DESIRED I_{B1} AND I_{B2} VALUES.
(5) CIRCUIT LAYOUT AND COMPONENT SELECTION IS CRITICAL DUE TO FAST SWITCHING TIMES TO BE MEASURED.

NOTE:
TRANSITION TIME FROM 90% I_{B1} TO 9… I_{B2} (X-W) MUST BE LESS THAN 100 n…

FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

File Number **15.51**

D72F5T1, D72F5T2

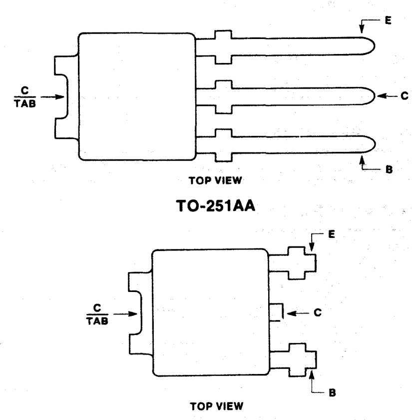
5-Ampere Silicon N-P-N Power Transistors

Features:
- *Low V_{CE} (sat)*
- *Fast switching speed*
- *Complementary to D73F5T1,2*

The D72F5T1 and D72F5T2 silicon n-p-n power transistors are designed for high current switching applications. They are intended for use in circuits such as converters, inverters, and pulse-width-modulated regulators.

The D72F5T1 is supplied in the JEDEC TO-251 package and the D72F5T2 is supplied in the JEDEC TO-252 surface-mount package.

TERMINAL DESIGNATION



2

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	D72F5T1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	50	Volts
Collector-Base Voltage	V_{CBO}	60	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	5	A
Base Current — Continuous	I_B	1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 20	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS [1]

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	260	°C

(1) See page 7-16 for thermal considerations.

D72F5T1, D72F5T2

ELECTRICAL CHARACTERISTICS (T_A = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Volts
Collector Cut-off Current (V_{CB} = 50V, I_E = 0)	I_{CBO}	—	—	1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	1	μA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			
ON CHARACTERISTICS					
DC Current Gain (I_C = 1A, V_{CE} = 1V)	h_{FE}	70	—	240	—
(I_C = 3A, V_{CE} = 1V)	h_{FE}	30	—	—	
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 0.15A)	$V_{CE(sat)}$	—	0.2	0.4	V
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 0.15A)	$V_{BE(sat)}$	—	0.9	1.2	Volts

SWITCHING CHARACTERISTICS

Turn-on Time	V_{CC} = 30V	t_{on}	—	0.1	—	μs
Storage Time	I_{B1} = $-I_{B2}$ = 0.15A	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.1	—	

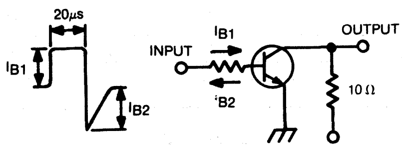


FIG. 1 SWITCHING TIME TEST CIRCUIT

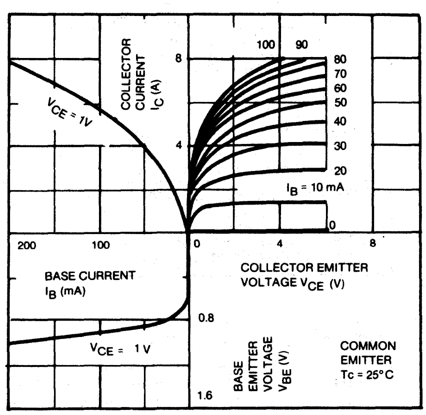


FIG. 2 STATIC CHARACTERISTICS

D72F5T1, D72F5T2

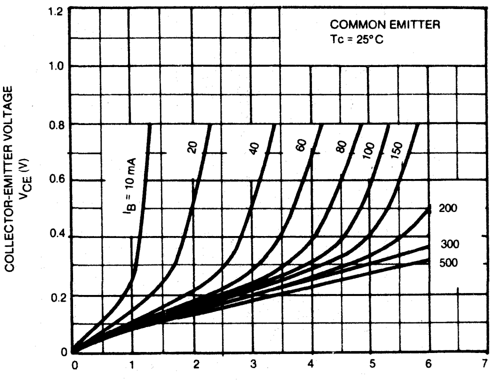


FIG. 3 V_{CE} - I_C

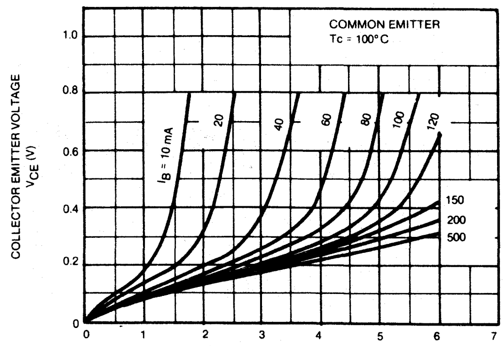


FIG. 4 V_{CE} - I_C

2

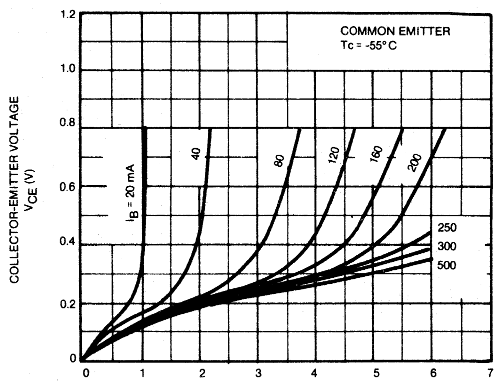


FIG. 5 V_{CE} - I_C

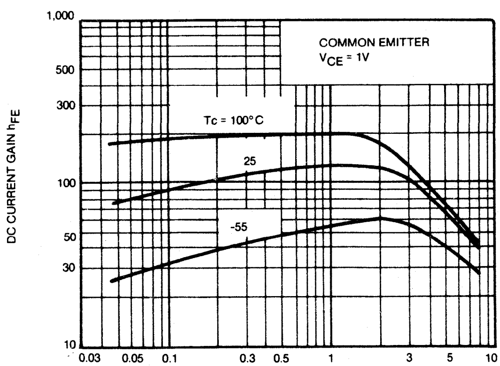


FIG. 6 h_{FE} - I_C

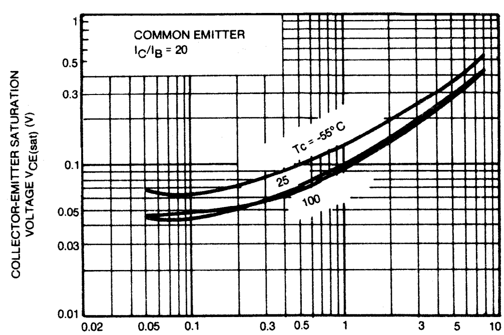


FIG. 7 $V_{CE(sat)}$ - I_C

D72F5T1, D72F5T2

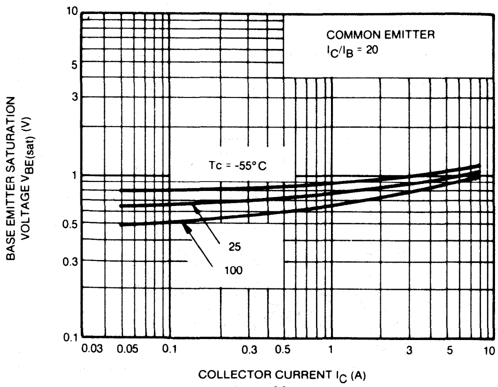


FIG. 8 $V_{BE(sat)}$ - I_C

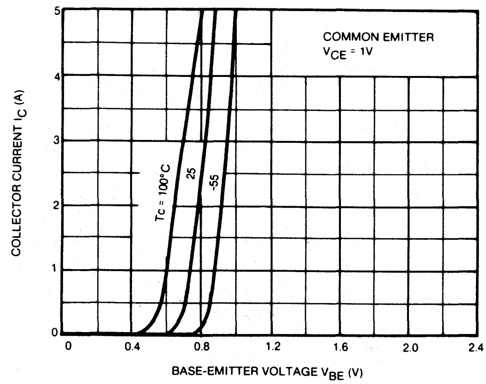


FIG. 9 I_C - V_{BE}

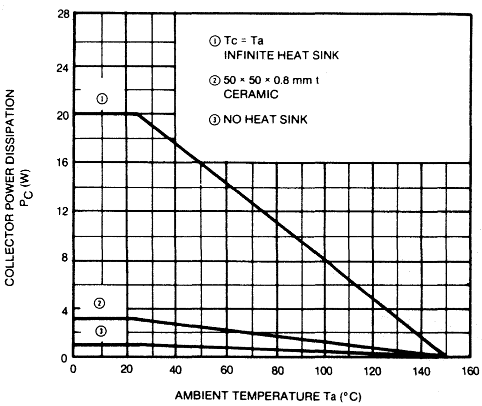


FIG. 10 P_C - Ta

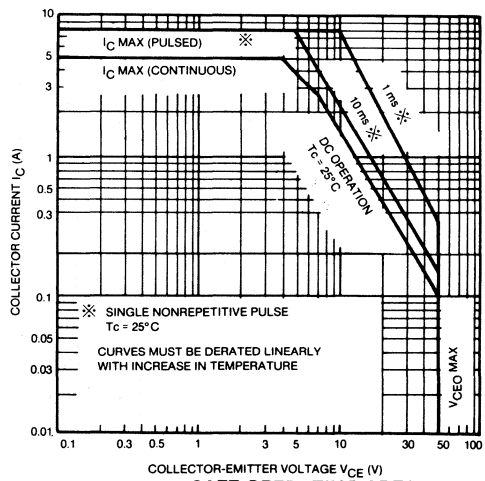


FIG. 11 SAFE OPERATING AREA

File Number **15.52**

D72FY4D1, D72FY4D2

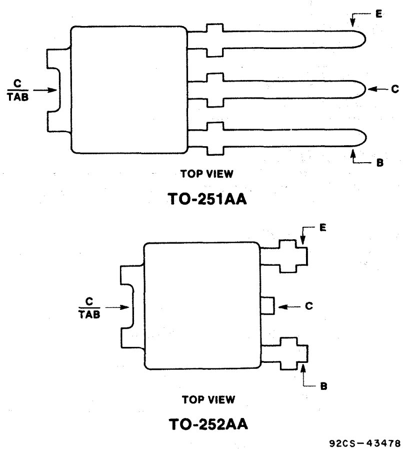
4-Ampere N-P-N Power Darlington Transistors

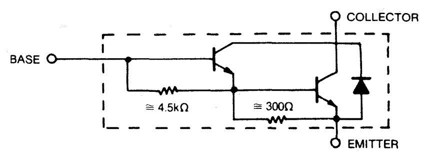
Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 2000*
- *Complementary to D73FY4D1,2*

The D72FY4D1 and D72FY4D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D72FY4D1 is supplied in the JEDEC TO-251 package and the D72FY4D2 is supplied in the JEDEC TO-252 surface-mount package.

TERMINAL DESIGNATION





Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D72FY4D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	80	Volts
Collector-Base Voltage	V_{CBO}	100	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	4	A
Base Current — Continuous	I_B	-1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS [1]

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 7-16 for thermal considerations.

D72FY4D1, D72FY4D2

ELECTRICAL CHARACTERISTICS (T_A = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	80	—	—	Volts
Collector Cutoff Current (V_{CB} = 100V, I_E = 0)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	-2.5	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
ON CHARACTERISTICS					
DC Current Gain (I_C = 1A, V_{CE} = 2V)	h_{FE}	2000	—	—	—
(I_C = 3A, V_{CE} = 2V)	h_{FE}	1000	—	—	
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 6mA)	$V_{BE(sat)}$	—	—	2.0	Volts

SWITCHING CHARACTERISTICS

Characteristic	Condition	SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V	t_{on}	—	0.2	—	μs
Storage Time	I_{B1} = $-I_{B2}$ = 6mA	t_{stg}	—	1.5	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.6	—	

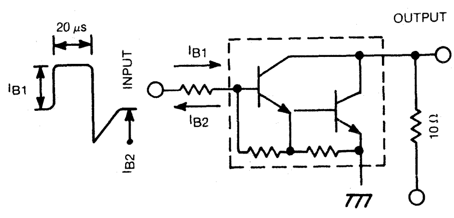


FIG. 1 SWITCHING TIME TEST CIRCUIT

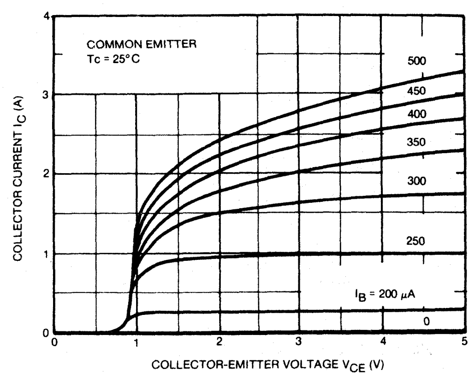


FIG. 2 I_C - V_{CE}

D72FY4D1, D72FY4D2

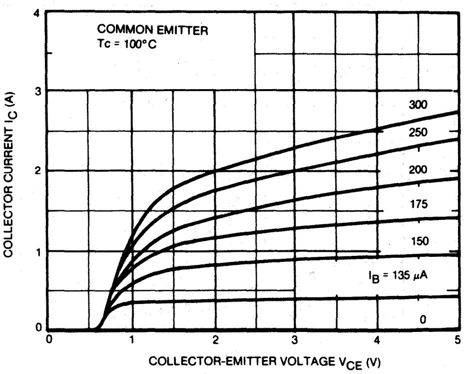


FIG. 3 I_C - V_{CE}

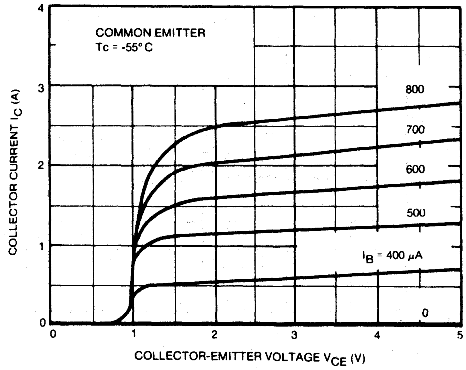


FIG. 4 I_C - V_{CE}

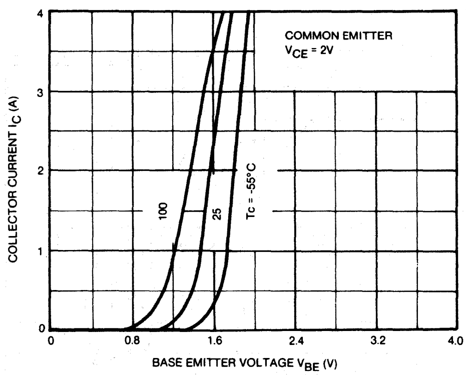


FIG. 5 I_C - V_{BE}

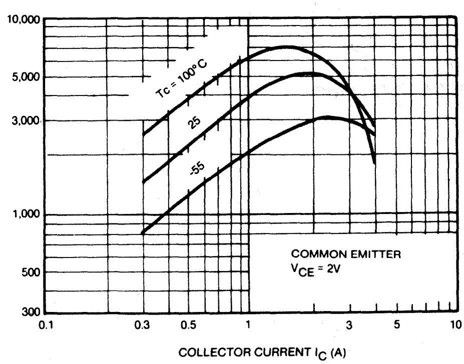


FIG. 6 h_{FE} - I_C

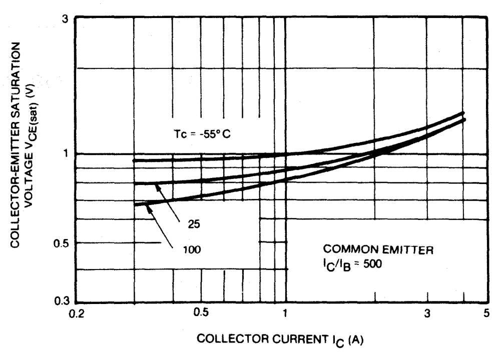


FIG. 7 $V_{CE(sat)}$ - I_C

2

D72FY4D1, D72FY4D2

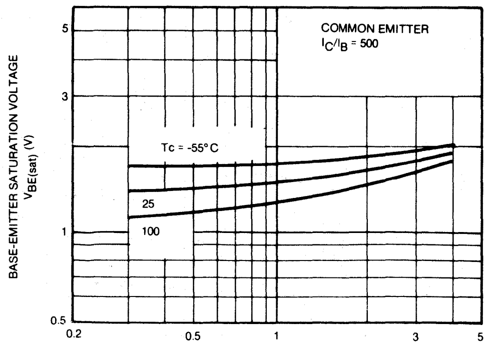


FIG. 8 $V_{BE(sat)}$ - I_C

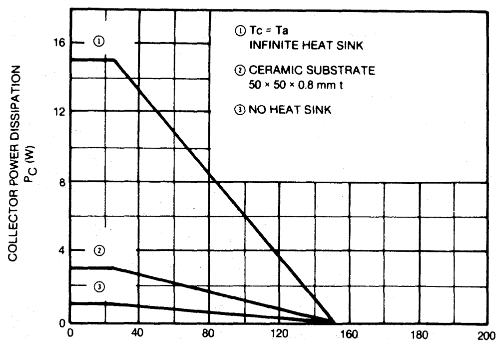


FIG. 9 P_C - Ta

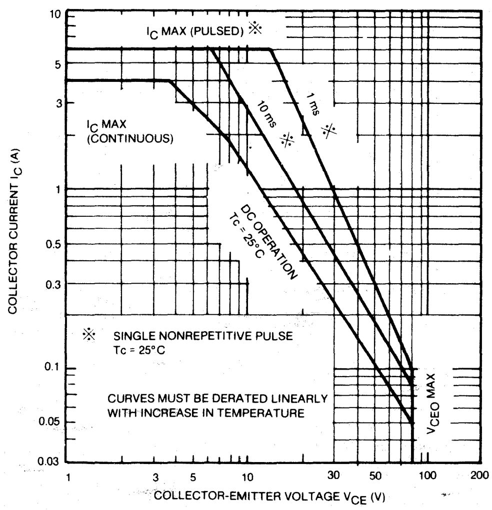


FIG. 10 SAFE OPERATING AREA

File Number **15.53**

D72K3D1, D72K3D2

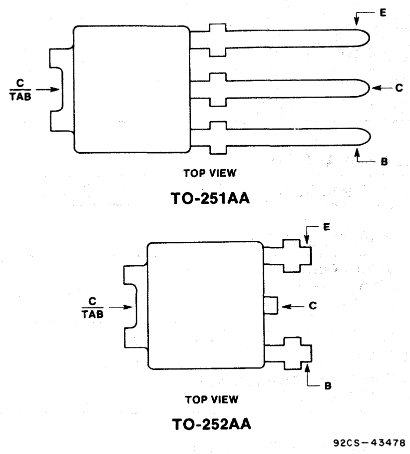
3-Ampere N-P-N Power Darlington Transistors

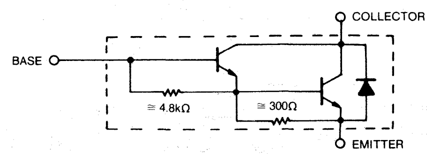
Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 2000*
- *Complementary to D73K3D1,2*

The D72K3D1 and D72K3D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D72K3D1 is supplied in the JEDEC TO-251 package and the D72K3D2 is supplied in the JEDEC TO-252 surface-mount package.

TERMINAL DESIGNATION





Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	D72K3D	UNITS
Collector-Emitter Voltage	V_{CEO}	40	Volts
Collector-Base Voltage	V_{CBO}	60	Volts
Emitter Base Voltage	V_{EBO}	5	Volts
Collector Current — Continuous	I_C	3	A
Base Current — Continuous	I_B	0.3	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS (1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 7-16 for thermal considerations.

D72K3D1, D72K3D2

ELECTRICAL CHARACTERISTICS (T_A = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25mA, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Volts
Collector Cutoff Current (V_{CB} = 60V, I_E = 0)	I_{CBO}	—	—	20	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	2.5	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
ON CHARACTERISTICS					
DC Current Gain (I_C = 1A, V_{CE} = 2V)	h_{FE}	2000	—	—	—
(I_C = 3A, V_{CE} = 2V)	h_{FE}	1000	—	—	
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 4mA)	$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 4mA)	$V_{BE(sat)}$	—	—	2.0	Volts

SWITCHING CHARACTERISTICS

	Conditions	Symbol	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = 30V	t_{on}	—	0.1	—	μs
Storage Time	I_{B1} = $-I_{B2}$ = 6mA	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.2	—	

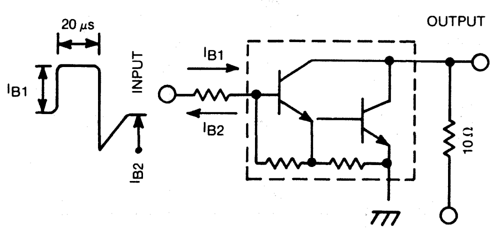


FIG. 1 SWITCHING TIME TEST CIRCUIT

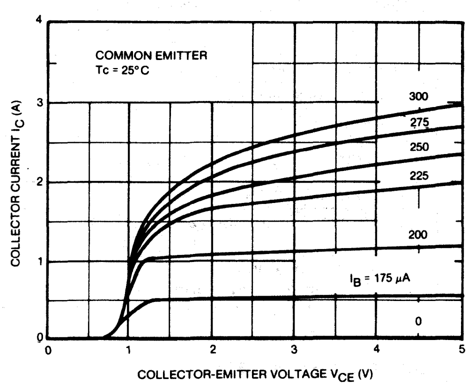


FIG. 2 I_C - V_{CE}

D72K3D1, D72K3D2

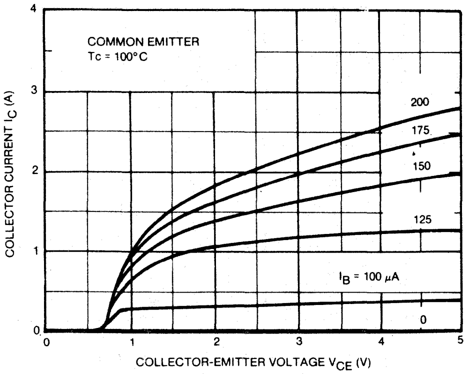


FIG. 3 I_C - V_{CE}

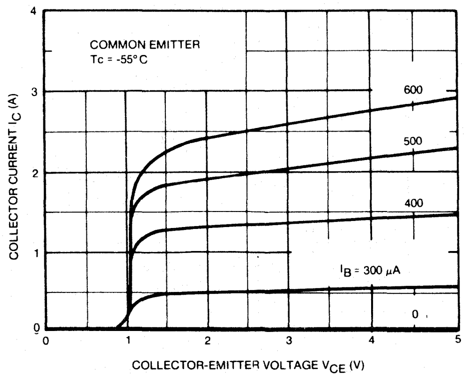


FIG. 4 I_C - V_{CE}

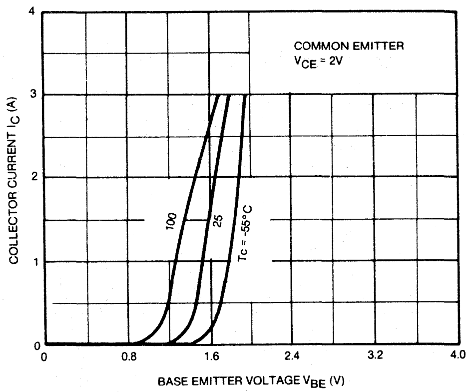


FIG. 5 I_C - V_{BE}

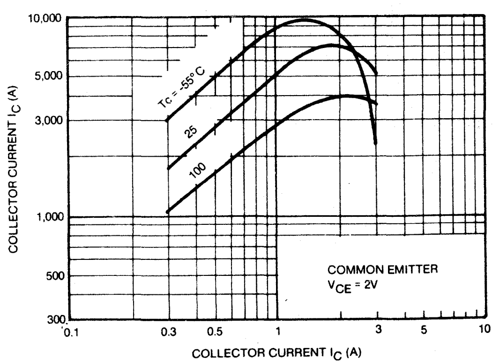


FIG. 6 h_{FE} - I_C

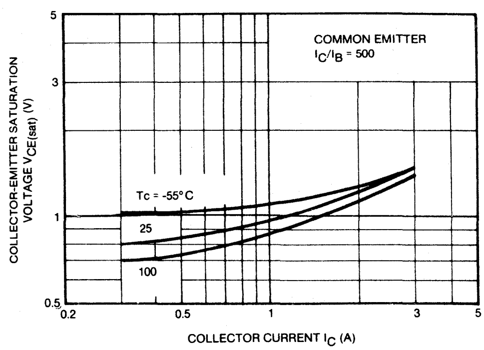


FIG. 7 $V_{CE(sat)}$ - I_C

D72K3D1, D72K3D2

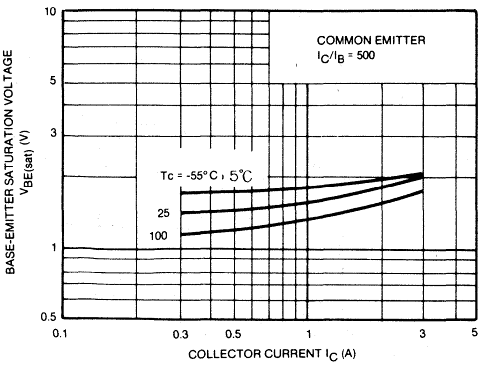


FIG. 8 $V_{BE(sat)}$ - I_C

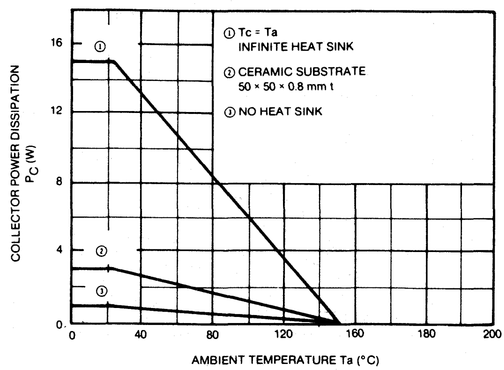


FIG. 9 P_C - Ta

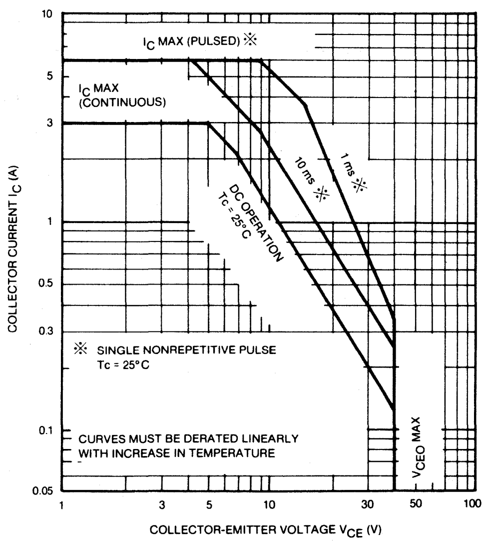


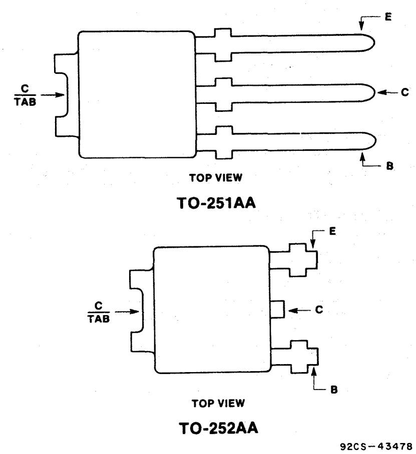
FIG. 10 SAFE OPERATING AREA

File Number **15.55**

D72Y1.5D1, D72Y1.5D2

1.5-Ampere N-P-N Darlington Power Transistors

TERMINAL DESIGNATION

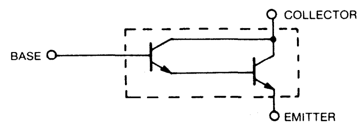


2

Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 4000*

The D72Y1.5D1 and D72Y1.5D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance gain characteristics.

The D72Y.15D1 is supplied in the JEDEC TO-251 package and the D72Y1.5D2 is supplied in the JEDEC TO-252 surface-mount package.



Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D72Y1.5D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	30	Volts
Collector-Base Voltage	V_{CBO}	30	Volts
Emitter Base Voltage	V_{EBO}	10	Volts
Collector Current — Continuous	I_C	1.5	A
Base Current — Continuous	I_B	0.15	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 10	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS (1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 7-16 for thermal considerations.

D72Y1.5D1, D72Y1.5D2

ELECTRICAL CHARACTERISTICS (T_A = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)		$V_{(BR)CEO}$	30	—	—	Volts
Collector Cutoff Current (V_{CB} = 30V, I_E = 0)		I_{CBO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 10V, I_C = 0)		I_{EBO}	—	—	-10	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 10			
ON CHARACTERISTICS						
DC Current Gain (I_C = 150mA, V_{CE} = 2V)		h_{FE}	4000	—	—	—
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 1mA)		$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 1mA)		$V_{BE(sat)}$	—	—	2.2	Volts
SWITCHING CHARACTERISTICS						
Turn-on Time	V_{CC} = 15V	t_{on}	—	0.18	—	μs
Storage Time	I_{B1} = $-I_{B2}$ = 1mA	t_{stg}	—	0.6	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.3	—	

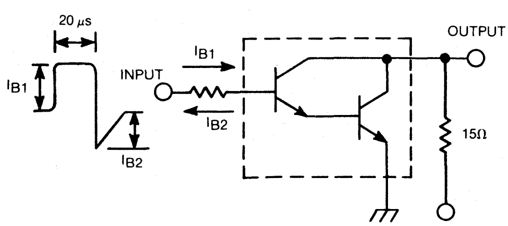


FIG. 1 SWITCHING TIME TEST CIRCUIT

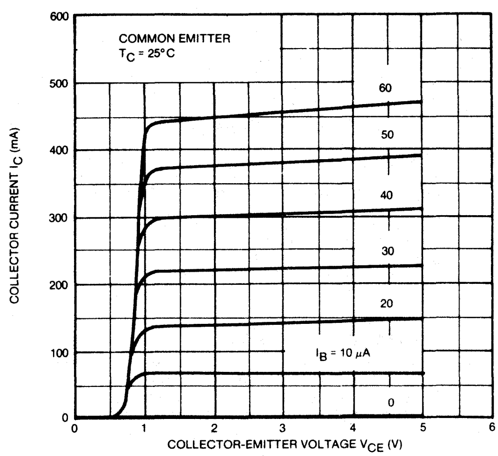


FIG. 2 I_C - V_{CE}

D72Y1.5D1, D72Y1.5D2

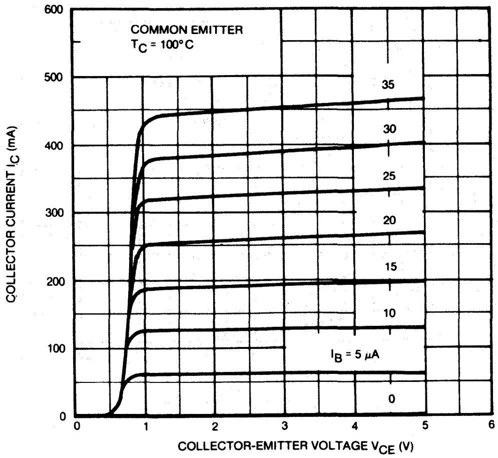


FIG. 3 I_C - V_{CE}

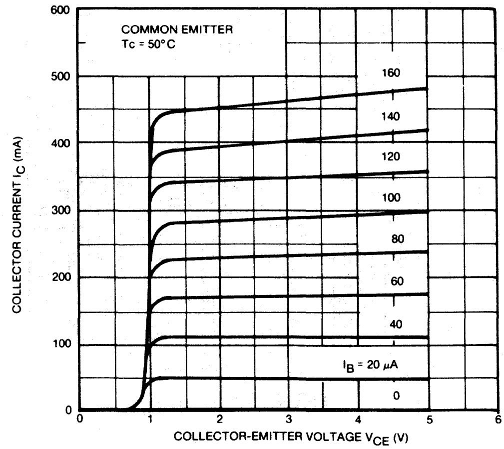


FIG. 4 I_C - V_{CE}

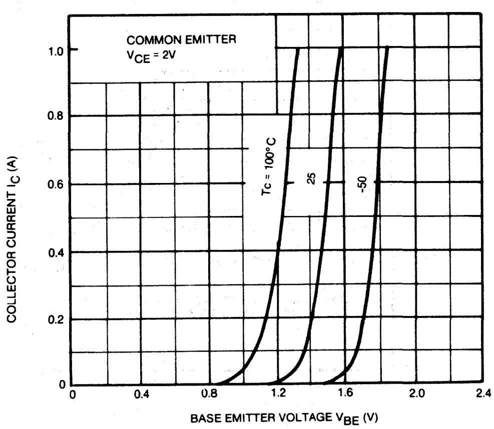


FIG. 5 I_C - V_{BE}

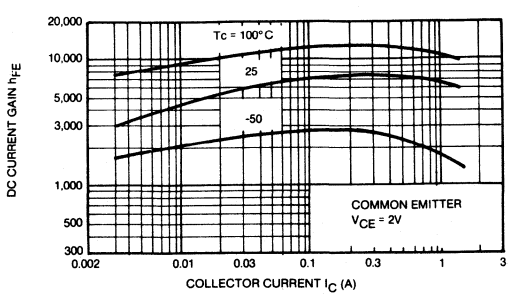


FIG. 6 h_{FE} - I_C

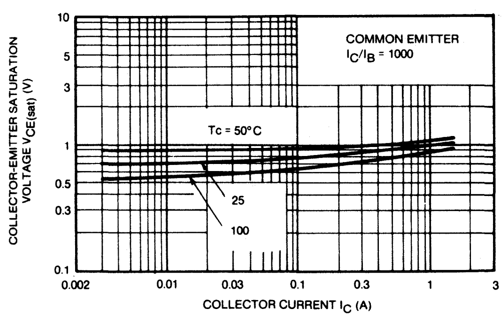


FIG. 7 $V_{CE(sat)}$ - I_C

D72Y1.5D1, D72Y1.5D2

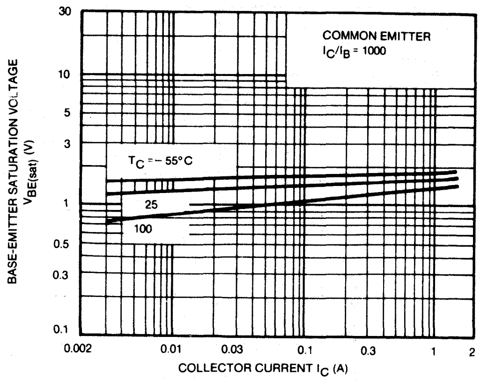


FIG. 8 $V_{BE(sat)}$ - I_C

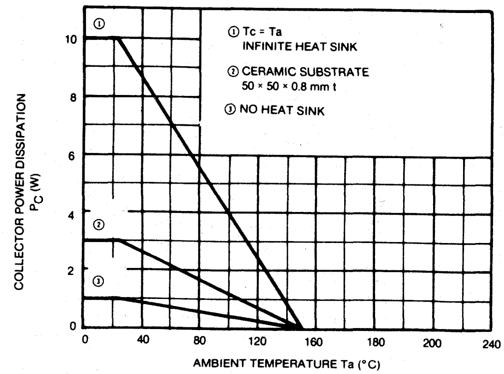


FIG. 9 P_C - Ta

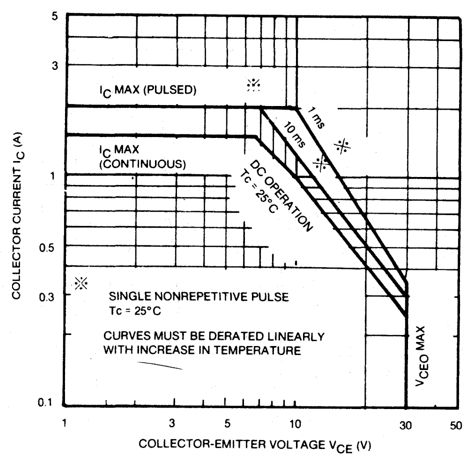


FIG. 10 SAFE OPERATING AREA

File Number **15.56**

D73F5T1, D73F5T2

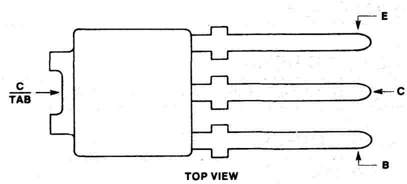
5-Ampere Silicon P-N-P Power Transistors

Features:
- *Low V_{CE} (sat)*
- *Fast switching speed*
- *Complementary to D72F5T1,2*

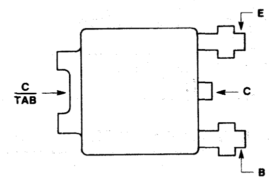
The D73F5T1 and D73F5T2 silicon p-n-p power transistors are designed for high current switching applications. They are intended for use in circuits such as converters, inverters, and pulse-width-modulated regulators.

The D73F5T1 is supplied in the JEDEC TO-251 package and the D73F5T2 is supplied in the JEDEC TO-252 surface-mount package.

TERMINAL DESIGNATION



TO-251AA



TO-252AA

92CS-43478

2

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D73F5T1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	-50	Volts
Collector-Base Voltage	V_{CBO}	-60	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-5	A
Base Current — Continuous	I_B	-1	A
Total Power Dissipation @ T_C = 25°C @ T_C = 25°C	P_D	1.0 20	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS (1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 7-16 for thermal considerations.

D73F5T1, D73F5T2

ELECTRICAL CHARACTERISTICS (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	-50	—	—	Volts
Collector Cutoff Current (V_{CB} = 50V, I_E = 0)	I_{CBO}	—	—	-1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	-1	μA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			
ON CHARACTERISTICS					
DC Current Gain (I_C = -1A, V_{CE} = -1V)	h_{FE}	70	—	240	—
(I_C = -3A, V_{CE} = -1V)	h_{FE}	30	—	—	
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -0.15A)	$V_{CE(sat)}$	—	-0.2	-0.4	V
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -0.15A)	$V_{BE(sat)}$	—	-0.9	-1.2	Volts

SWITCHING CHARACTERISTICS

Characteristic	Conditions	SYMBOL	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -30V	t_{on}	—	0.1	—	μs
Storage Time	$-I_{B1} = I_{B2}$ = 0.15A	t_{stg}	—	1.0	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.1	—	

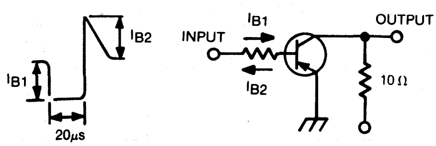


FIG. 1 SWITCHING TIME TEST CIRCUIT

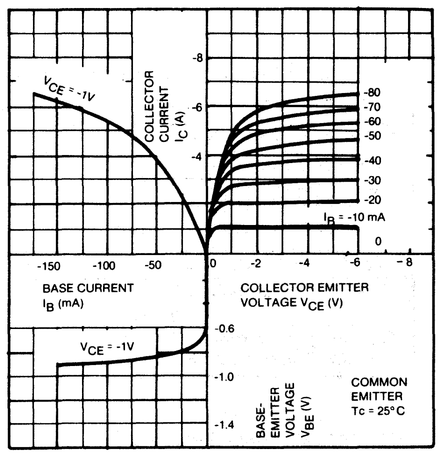


FIG. 2 STATIC CHARACTERISTICS

D73F5T1, D73F5T2

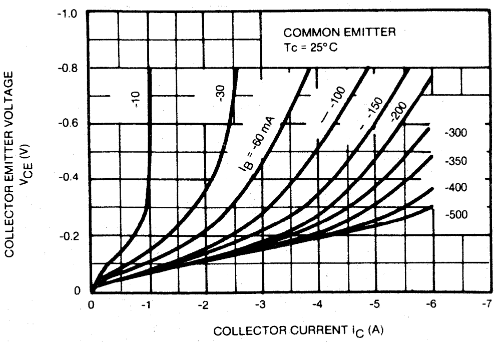


FIG. 3 V_{CE} - I_C

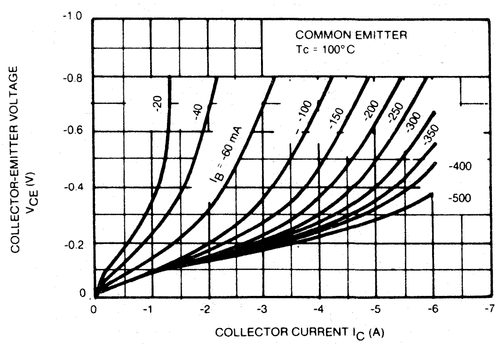


FIG. 4 V_{CE} - I_C

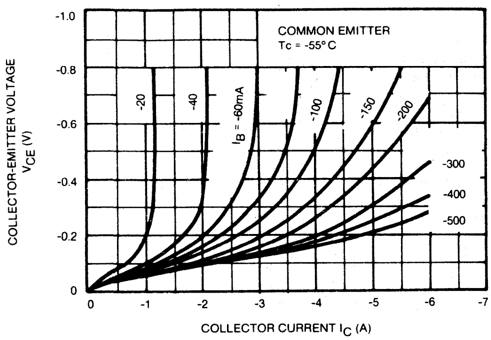


FIG. 5 V_{CE} - I_C

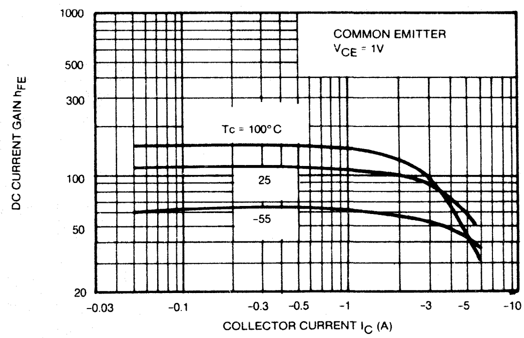


FIG. 6 h_{FE} - I_C

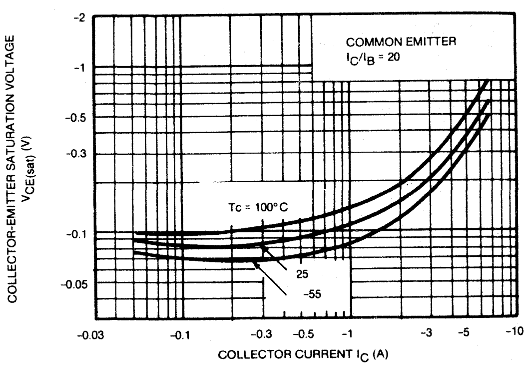


FIG. 7 $V_{CE(sat)}$ - I_C

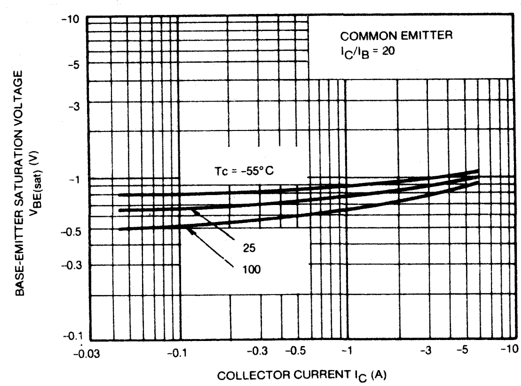


FIG. 8 $V_{BE(sat)}$ - I_C

2

D73F5T1, D73F5T2

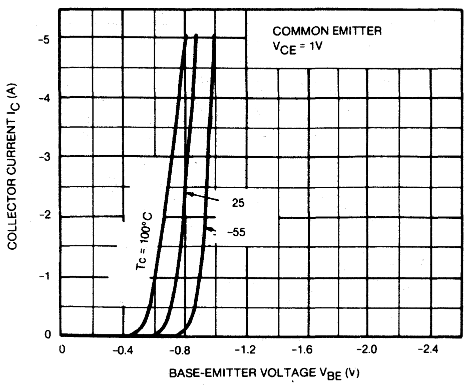


FIG. 9 I_C - V_{BE}

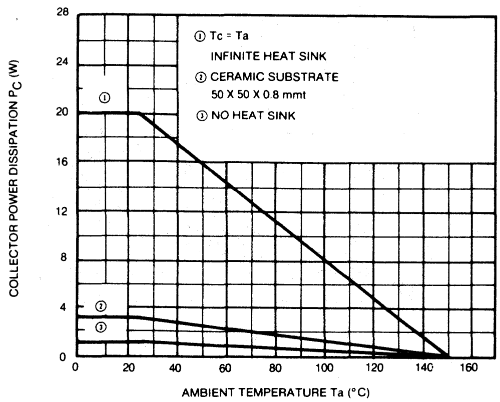


FIG. 10 P_C - Ta

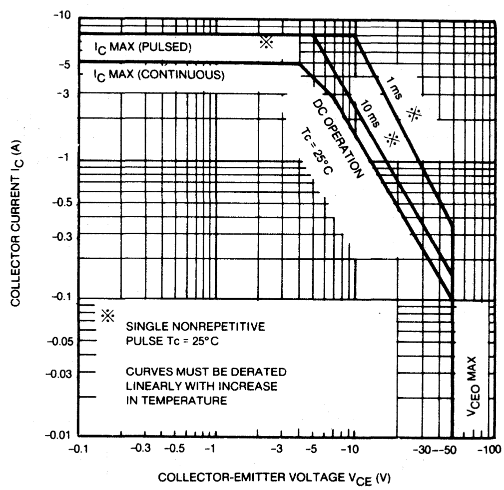


FIG. 11 SAFE OPERATING AREA

File Number **15.57**

D73FY4D1, D73FY4D2

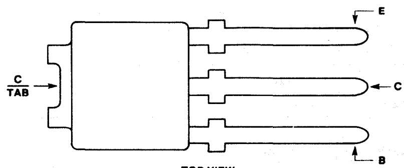
4-Ampere P-N-P Power Darlington Transistors

Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 2000*
- *Complementary to D72FY4D1,2*

The D73FY4D1 and D73FY4D2 silicon p-n-p power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

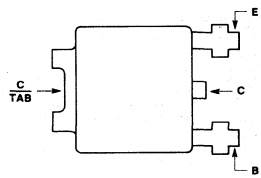
The D73FY4D1 is supplied in the JEDEC TO-251 package and the D73FY4D2 is supplied in the JEDEC TO-252 surface-mount package.

TERMINAL DESIGNATION



TOP VIEW

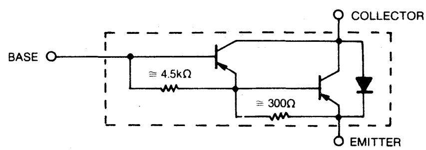
TO-251AA



TOP VIEW

TO-252AA

92CS-43478



Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D73FY4D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	-80	Volts
Collector-Base Voltage	V_{CBO}	-100	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-4	A
Base Current — Continuous	I_B	-0.4	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS (1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 7-16 for thermal considerations.

D73FY4D1, D73FY4D2

ELECTRICAL CHARACTERISTICS (T_A = 25° C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = -10mA, I_B = 0)	$V_{(BR)CEO}$	-80	—	—	Volts
Collector Cutoff Current (V_{CB} = -100V, I_E = 0)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-2.5	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 9			
ON CHARACTERISTICS					
DC Current Gain (I_C = -1A, V_{CE} = -2V)	h_{FE}	2000	—	—	—
(I_C = -3A, V_{CE} = -2V)	h_{FE}	1000	—	—	
Collector-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Saturation Voltage (I_C = -3A, I_B = -6mA)	$V_{BE(sat)}$	—	—	-2.0	Volts

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -30V	t_{on}	—	0.15	—	μs
Storage Time	$-I_{B1} = I_{B2}$ = 6mA	t_{stg}	—	0.80	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.40	—	

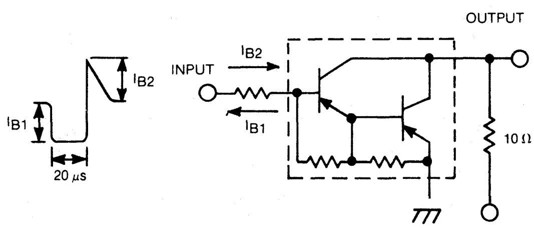


FIG. 1 SWITCHING TIME TEST CIRCUIT

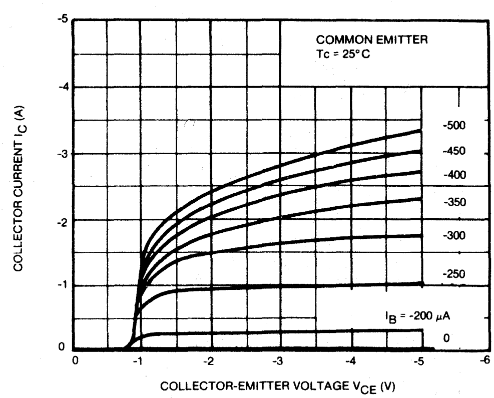


FIG. 2 I_C - V_{CE}

D73FY4D1, D73FY4D2

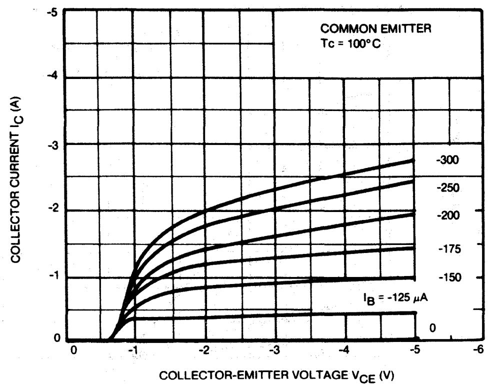


FIG. 3 I_C - V_{CE}

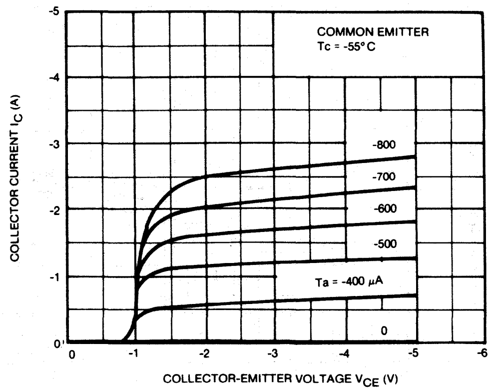


FIG. 4 I_C - V_{CE}

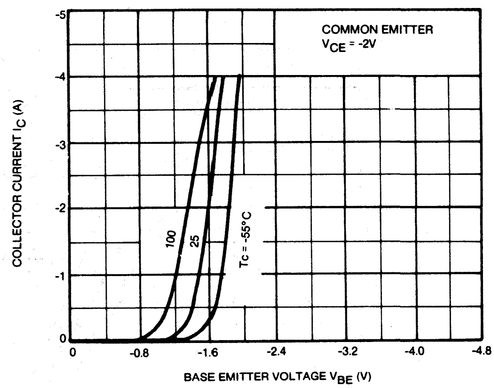


FIG. 5 I_C - V_{BE}

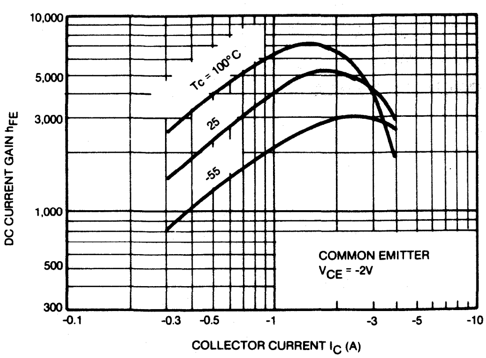


FIG. 6 h_{FE} - I_C

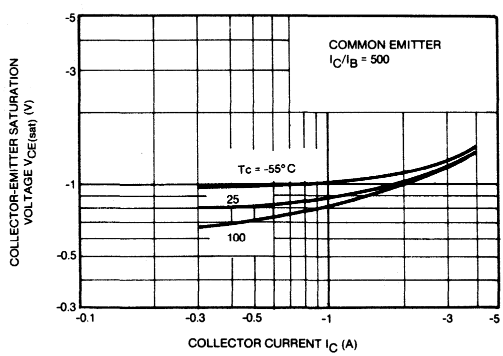


FIG. 7 $V_{CE(sat)}$ - I_C

D73FY4D1, D73FY4D2

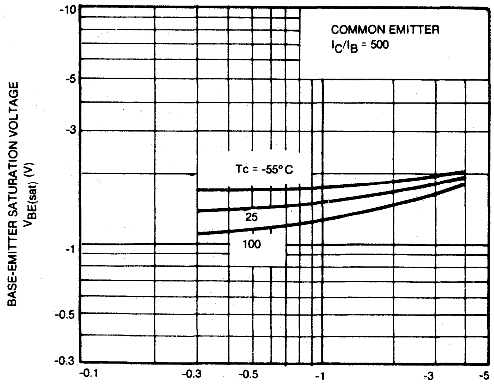


FIG. 8 $V_{BE(sat)}$ - I_C

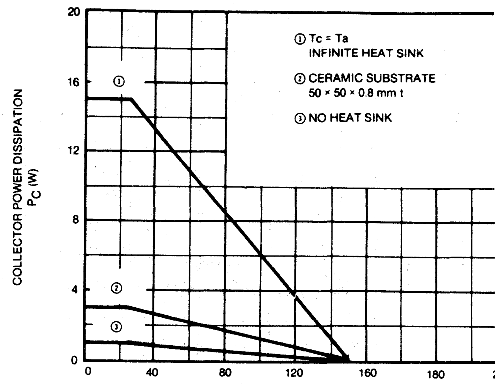


FIG. 9 P_C - Ta

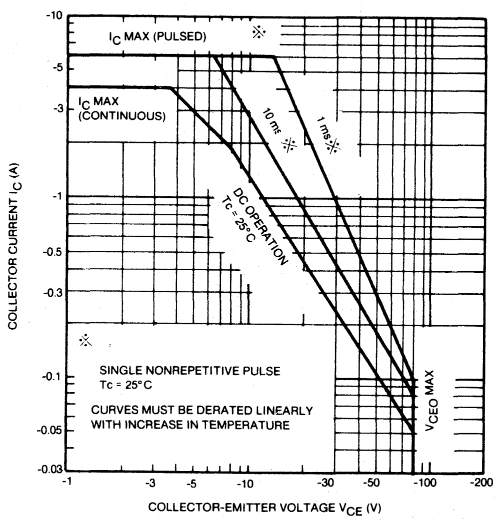


FIG. 10 SAFE OPERATING AREA

File Number **15.58**

D73K3D1, D73K3D2

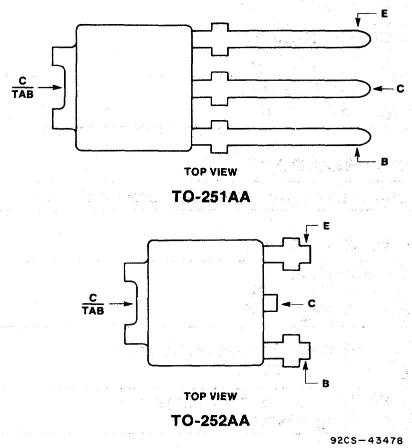
3-Ampere P-N-P Power Darlington Transistors

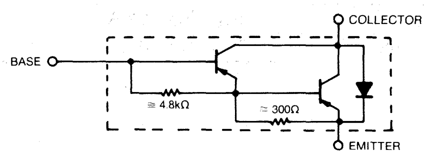
Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 2000*
- *Complementary to D72K3D1,2*

The D73K3D1 and D73K3D2 silicon p-n-p power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

The D73K3D1 is supplied in the JEDEC TO-251 package and the D73K3D2 us supplied in the JEDEC TO-252 surface-mount package.

TERMINAL DESIGNATION





Schematic diagram for all types.

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	D73K3D1,2	UNITS
Collector-Emitter Voltage	V_{CEO}	-40	Volts
Collector-Base Voltage	V_{CBO}	-60	Volts
Emitter Base Voltage	V_{EBO}	-5	Volts
Collector Current — Continuous	I_C	-3	A
Base Current — Continuous	I_B	-0.3	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.0 15	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	°C

THERMAL CHARACTERISTICS(1)

Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	235	°C

(1) See page 7-16 for thermal considerations.

D73K3D1, D73K3D2

ELECTRICAL CHARACTERISTICS (T_A = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = -25mA, I_B = 0)	$V_{(BR)CEO}$	-40	—	—	Volts
Collector Cutoff Current (V_{CB} = -60V, I_E = 0)	I_{CBO}	—	—	-20	μA
Emitter Cutoff Current (V_{EB} = -5V, I_C = 0)	I_{EBO}	—	—	-2.5	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 10			
ON CHARACTERISTICS					
DC Current Gain (I_C = -1A, V_{CE} = -2V)	h_{FE}	2000	—	—	—
(I_C = -3A, V_{CE} = -2V)	h_{FE}	1000	—	—	
Collector-Emitter Saturation Voltage (I_C = -2A, I_B = -4mA)	$V_{CE(sat)}$	—	—	-1.5	V
Base-Emitter Saturation Voltage (I_C = -2A, I_B = -4mA)	$V_{BE(sat)}$	—	—	-2.0	Volts

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	MIN	TYP	MAX	UNIT
Turn-on Time	V_{CC} = -30V	t_{on}	—	0.30	—	μs
Storage Time	$-I_{B1} = I_{B2}$ = 6mA	t_{stg}	—	0.60	—	
Fall Time	Duty Cycle ≦ 1%	t_f	—	0.25	—	

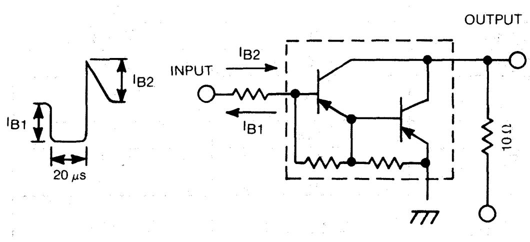


FIG. 1 SWITCHING TIME TEST CIRCUIT

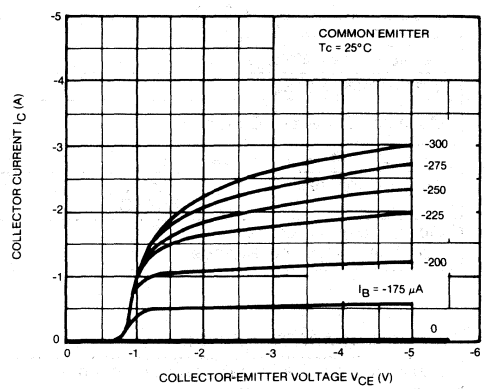


FIG. 2 I_C - V_{CE}

D73K3D1, D73K3D2

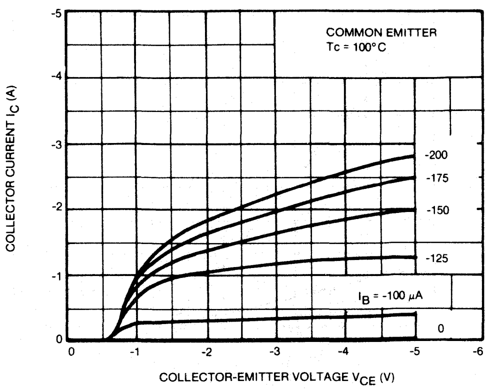


FIG. 3 I_C - V_{CE}

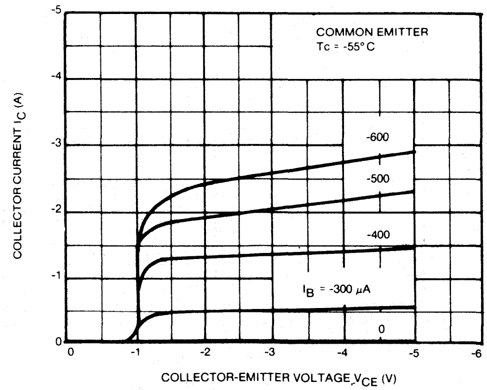


FIG. 4 I_C - V_{CE}

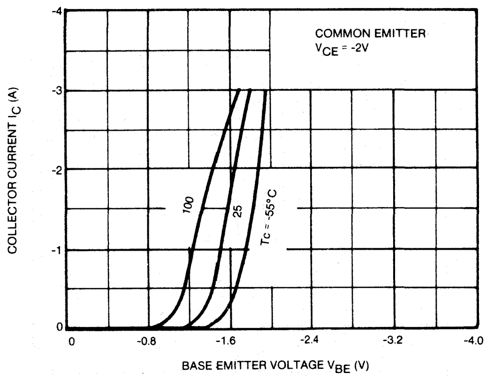


FIG. 5 I_C - V_{BE}

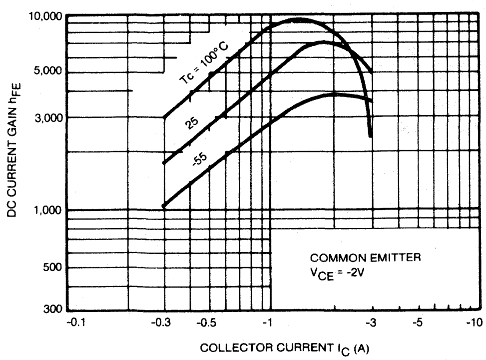


FIG. 6 h_{FE} - I_C

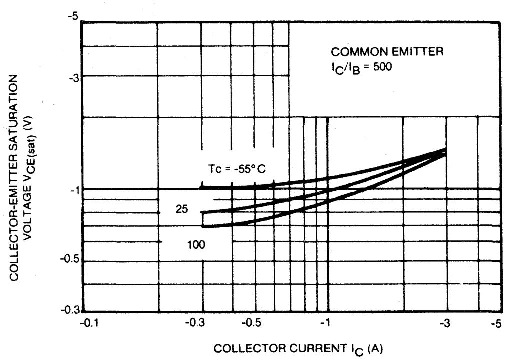


FIG. 7 $V_{CE(sat)}$ - I_C

2

D73K3D1, D73K3D2

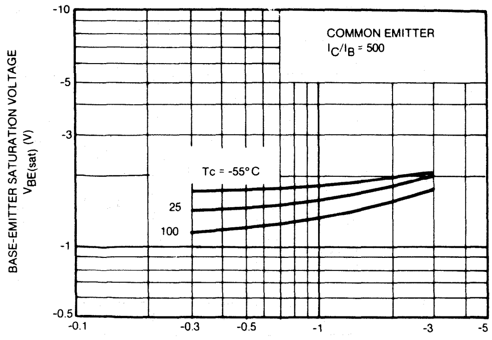


FIG. 8 $V_{BE(sat)}$ - I_C

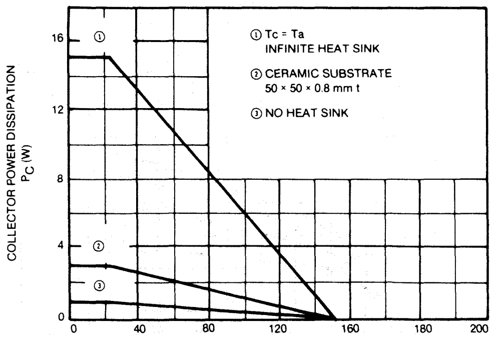


FIG. 9 P_C - Ta

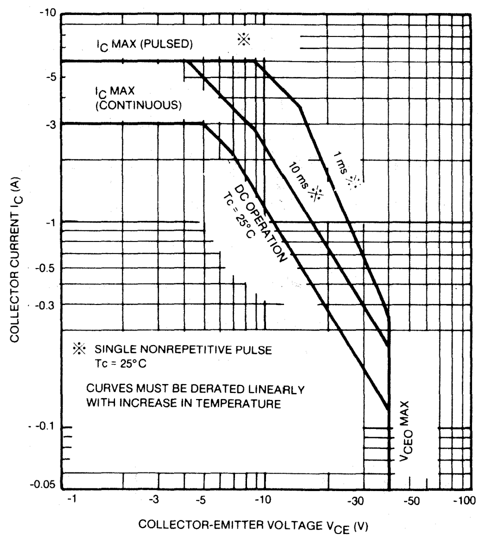


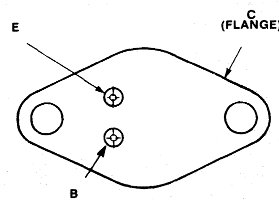
FIG. 10 SAFE OPERATING AREA

File Number **15.84**

GE5060, GE5061, GE5062

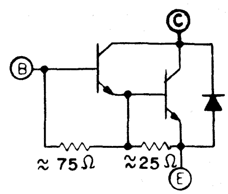
20-Ampere N-P-N Darlington Power Transistors

TERMINAL DESIGNATION



92CS-27516

JEDEC TO-204AA



DEVICE CIRCUIT

Features:

- *High-voltage operation: 350, 400, 450 volts*
- *Gain of 100 at 10A*

Applications:

- *Series/shunt regulators*
- *Automotive ignition*
- *Power switching*
- *Solenoid driver*

The GE5060, GE5061, and GE5062 silicon n-p-n Darlington power transistors are designed for use in high-speed switching applications, such as: off-line power supplies, AC and DC motor control, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	GE5060	GE5061	GE5062	UNITS
Collector-Base Voltage	V_{CBO}	400	450	500	Volts
Collector-Emitter Voltage	V_{CEO}	350	400	450	Volts
Emitter Base Voltage	V_{EBO}	8	8	8	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 25 42.5	20 25 42.5	20 25 42.5	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	4 6	4 6	4 6	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

GE5060, GE5061, GE5062

ELECTRICAL CHARACTERISTICS (T_C = 25° C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = 0.5mA) (V_{clamp} = V_{CEO} Rated)	GE5060 GE5061 GE5062	$V_{CEO(sus)}$	350 400 450	— — —	— — —	Volts
Collector-Base Voltage (I_C = 0.25mA)	GE5060 GE5061 GE5062	V_{CBO}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V_{CB} = V_{CBO} Rated)		I_{CBO}	—	—	0.25	mA
Emitter Cutoff Current (V_{EB} = 4.5V, I_C = 0)		I_{EBO}	—	—	200	mA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 16			
Clamped Inductive SOA with Base Reversed Biased		RBSOA	SEE FIGURE 17			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 10A, V_{CE} = 5V) (I_C = 15A, V_{CE} = 5V) (I_C = 20A, V_{CE} = 5V)		h_{FE}	100 40 15	160 115 65	— — —	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 1A) (I_C = 10A, I_B = 2A) (I_C = 20A, I_B = 2A)		$V_{CE(sat)}$	— — —	1.2 1.15 1.6	1.5 1.4 2	V
Base-Emitter Voltage (I_C = 10A, I_B = 1A) (I_C = 20A, I_B = 2A)		$V_{BE(sat)}$	— —	1.95 2.3	2.5 3.5	V
SWITCHING CHARACTERISTICS						
Resistive Load						
Rise Time	I_C = 15A, I_{B1} = 0.75A, I_{B2} = -1.5A	t_r	—	0.3	—	μs
Storage Time	V_{CC} = 300V, t_p = 50 μsec	t_s	—	2.7	—	
Fall Time		t_f	—	1.15	—	
Inductive Load, Clamped						
Storage Time	V_{CC} = 300V, L = 100 μH	t_s	—	3.3	—	μs
Crossover Time	I_C = 15A, I_{B1} = 0.75A, I_{B2} = -1.5A	t_c	—	1.7	—	
Fall Time		t_f	—	0.4	—	
EMITTER-COLLECTOR DIODE CHARACTERISTICS						
Forward Voltage I_F = 10A I_F = 25A		V_F	— —	1.9 2.8	— —	Volts

TYPICAL CHARACTERISTICS

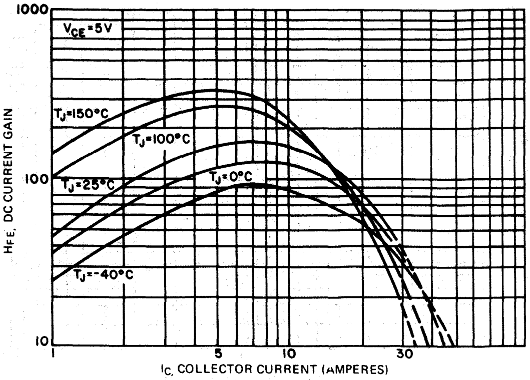


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

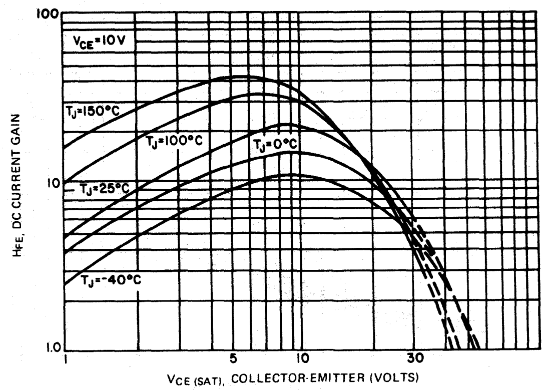


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

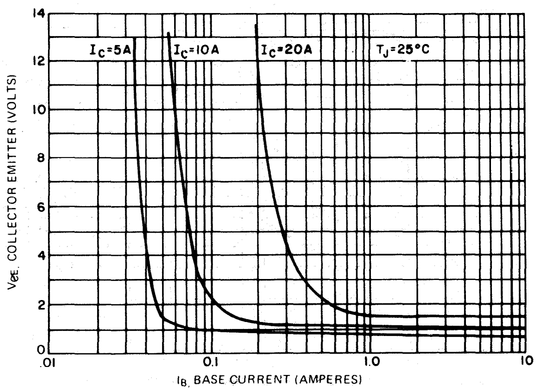


FIGURE 3. COLLECTOR SATURATION REGION

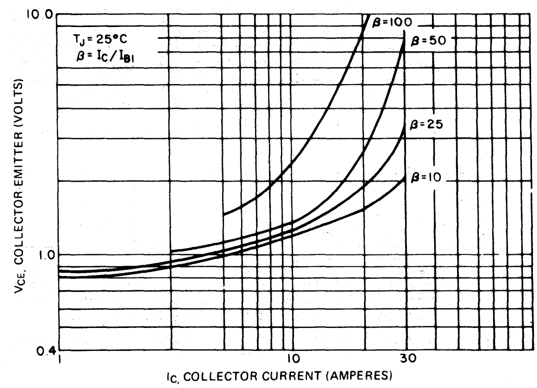


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

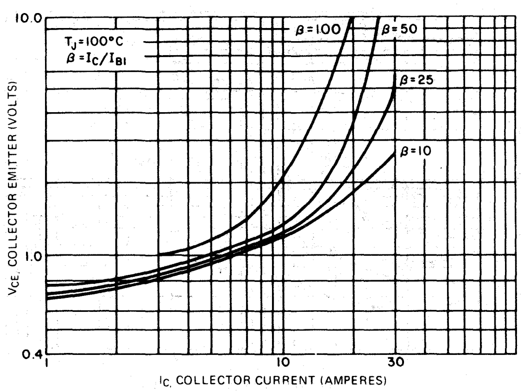


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

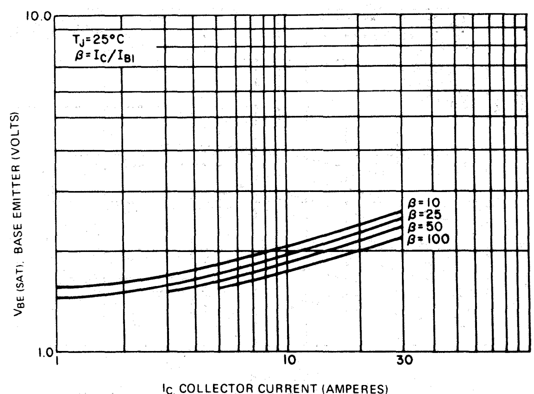


FIGURE 6. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

2

GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

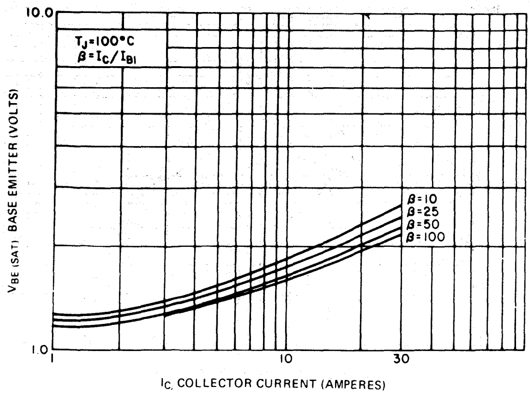


FIGURE 7. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

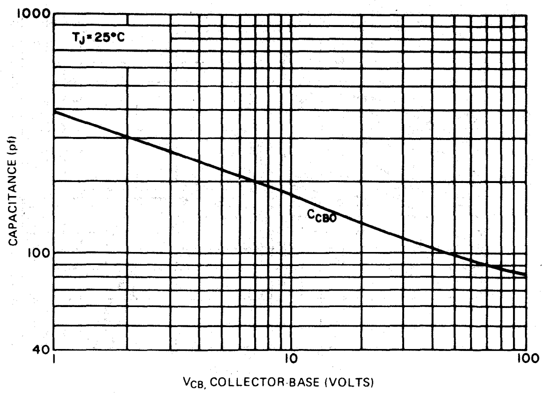


FIGURE 8. CAPACITANCE (C_{CBO})

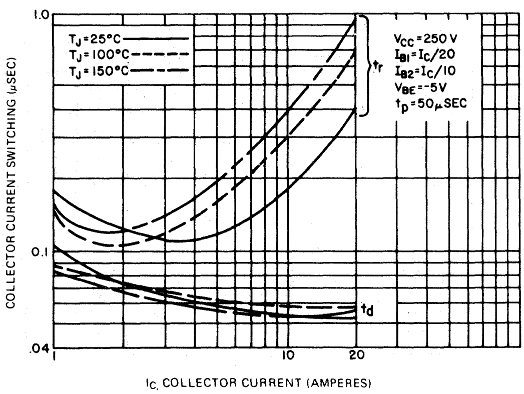


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD)

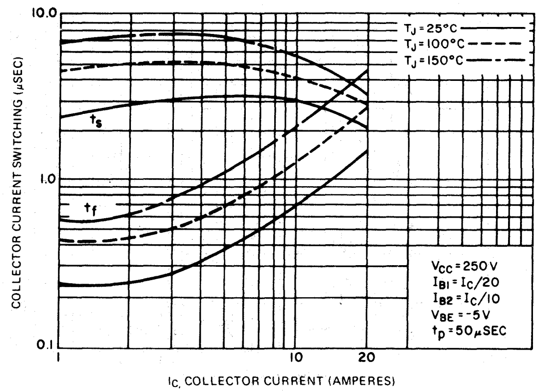


FIGURE 10. TURN-OFF TIME (RESISTIVE)

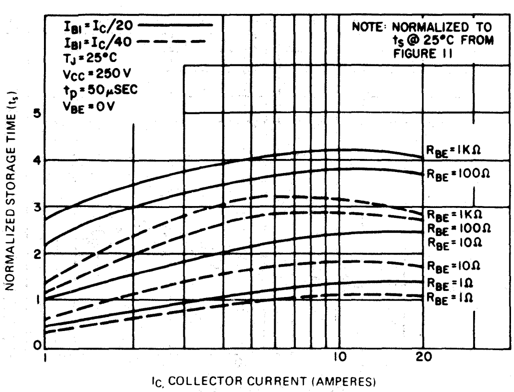


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

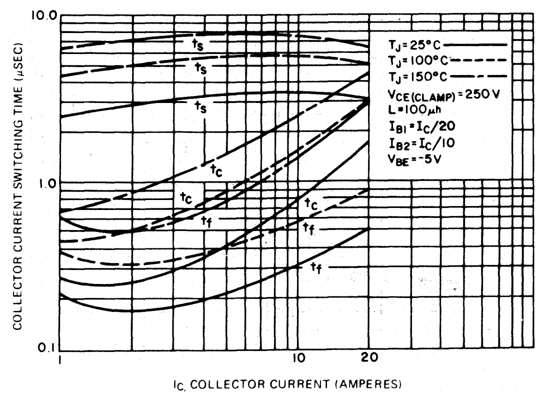


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

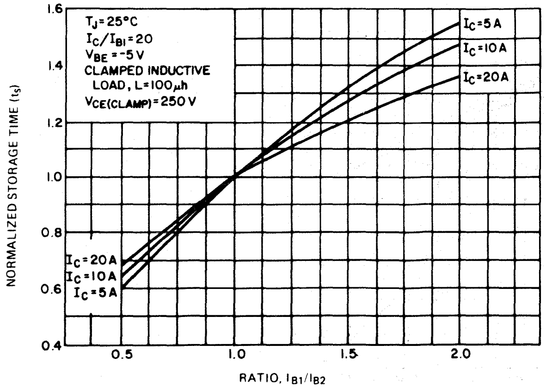


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

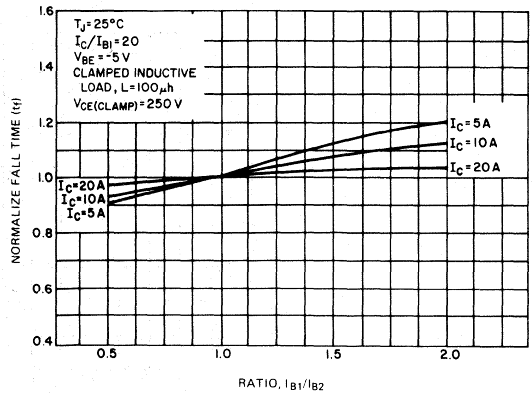


FIGURE 14. FALL TIME VARIATION WITH I_{B2}

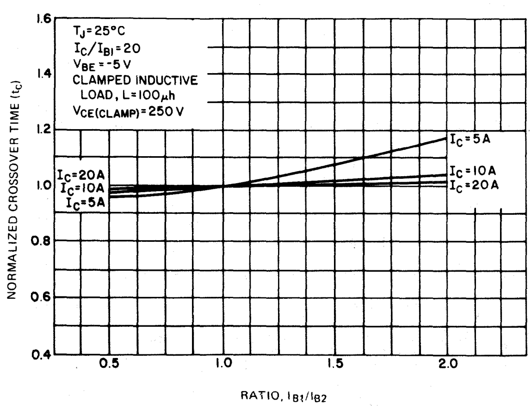


FIGURE 15. CROSS-OVER TIME VARIATION WITH I_{B2}

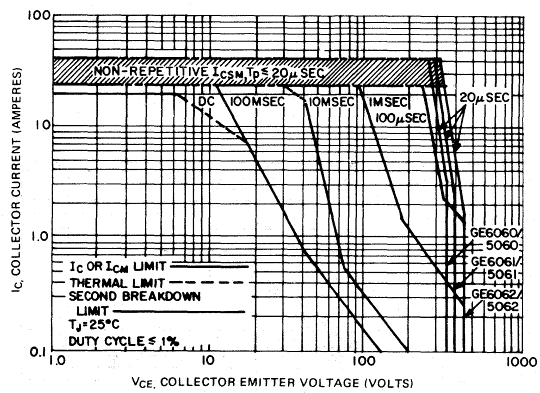


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

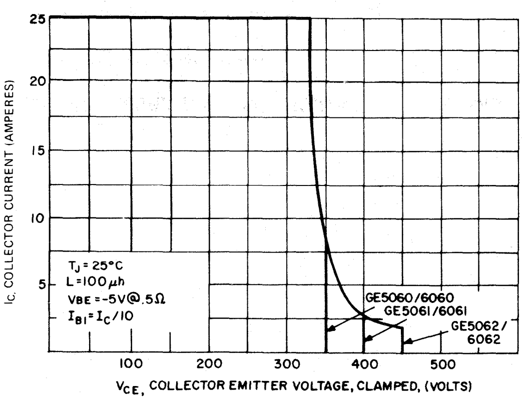


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

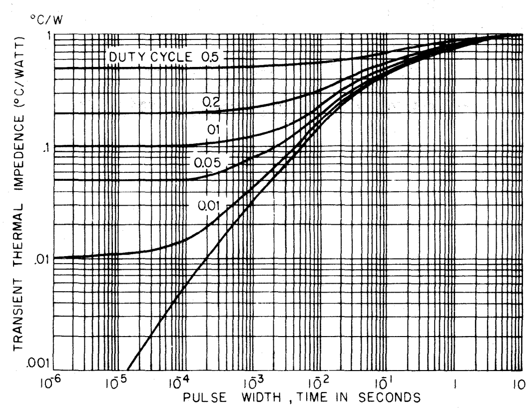


FIGURE 18. TRANSIENT THERMAL RESPONSE

GE5060, GE5061, GE5062

TYPICAL CHARACTERISTICS

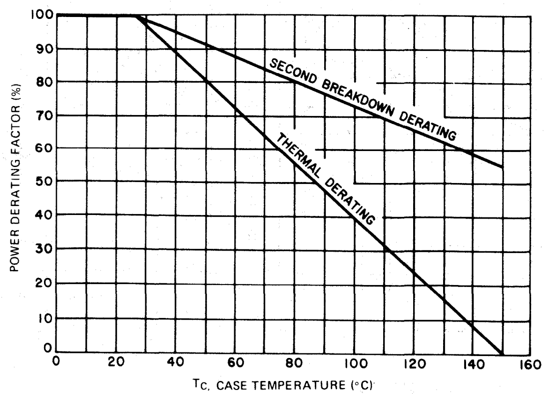


FIGURE 19. POWER DERATING

DIODE CHARACTERISTICS

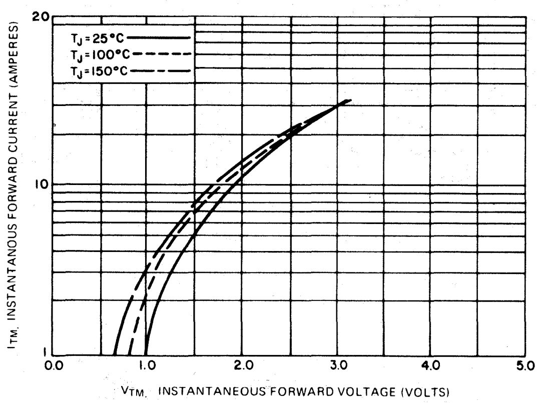


FIGURE 20. FORWARD CHARACTERISTICS

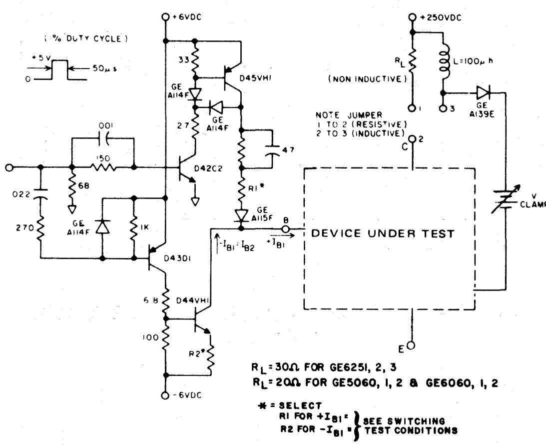


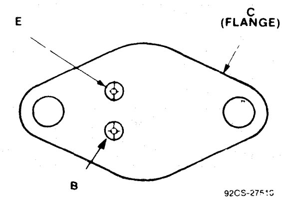
FIGURE 21. SWITCHING TIME TEST CIRCUIT

File Number **15.85**

GE6060, GE6061, GE6062

20-Ampere N-P-N Darlington Power Transistors

TERMINAL DESIGNATION



JEDEC TO-204AA

Features:

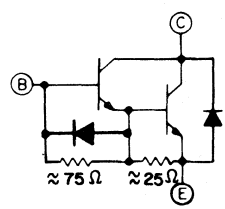
- *High-voltage operation: 350, 400, 450 volts*
- *Gain of 40 at 10A*

Applications:

- *Series/shunt regulators*
- *Automotive ignition*
- *Power switching*
- *Solenoid driver*

The GE6060, GE6061, and GE6062 silicon n-p-n Darlington power transistors are designed for use in high-speed switching applications, such as: off-line power supplies, AC and DC motor control, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.



DEVICE CIRCUIT

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	GE6060	GE6061	GE6062	UNITS
Collector-Base Voltage	V_{CBO}	400	450	500	Volts
Collector-Emitter Voltage	V_{CEO}	350	400	450	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	20 25 42.5	20 25 42.5	20 25 42.5	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	4 6	4 6	4 6	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	1	1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

GE6060, GE6061, GE6062

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = 0.5mA) (V_{clamp} = V_{CEO} Rated)	GE6060 GE6061 GE6062	$V_{CEO(sus)}$	350 400 450	— — —	— — —	Volts
Collector-Base Voltage (I_C = 0.25mA)	GE6060 GE6061 GE6062	V_{CBO}	400 450 500	— — —	— — —	Volts
Collector Cutoff Current (V_{CB} = V_{CBO} Rated)		I_{CBO}	—	—	0.25	mA
Emitter Cutoff Current (V_{EB} = 1.5V, I_C = 0)		I_{EBO}	—	—	200	mA

SECOND BREAKDOWN

Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 14
Clamped Inductive SOA with Base Reversed Biased	RBSOA	SEE FIGURE 17

ON CHARACTERISTICS(1)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (I_C = 10A, V_{CE} = 5V) (I_C = 15A, V_{CE} = 5V) (I_C = 20A, V_{CE} = 5V)	h_{FE}	40 30 10	160 115 65	— — —	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 1A) (I_C = 10A, I_B = 2A) (I_C = 20A, I_B = 2A)	$V_{CE(sat)}$	— — —	1.2 1.15 1.6	1.5 1.4 2	V
Base-Emitter Voltage (I_C = 5A, I_B = 0.5A) (I_C = 20A, I_B = 2A)	$V_{BE(sat)}$	— —	1.95 2.3	2.5 3.5	V

SWITCHING CHARACTERISTICS

Resistive Load						
Rise Time	V_{CC} = 300V, t_p = 50 μs	t_r	—	0.3	0.4	μs
Storage Time	I_C = 15A, I_{B1} = 1.5A, I_{B2} = -2.25A	t_s	—	2.3	2.5	
Fall Time		t_f	—	0.5	1	
Inductive Load, Clamped						
Storage Time	V_{CC} = 300V, L = 100 μH	t_s	—	2.6	—	μs
Crossover Time	I_C = 15A, I_{B1} = 1.5A, I_{B2} = -2.25A	t_c	—	0.5	—	
Fall Time		t_f	—	0.12	—	

EMITTER-COLLECTOR DIODE CHARACTERISTICS

Forward Voltage I_F = 10A I_F = 25A	V_F	— —	1.9 2.8	— —	Volts

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

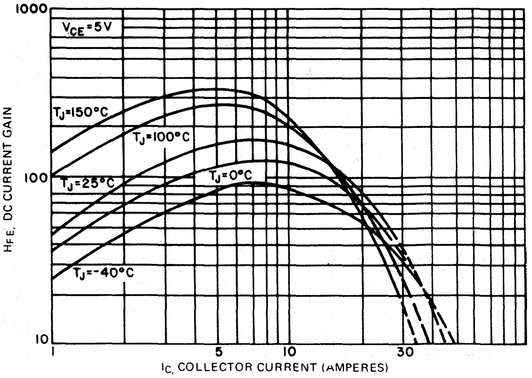


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

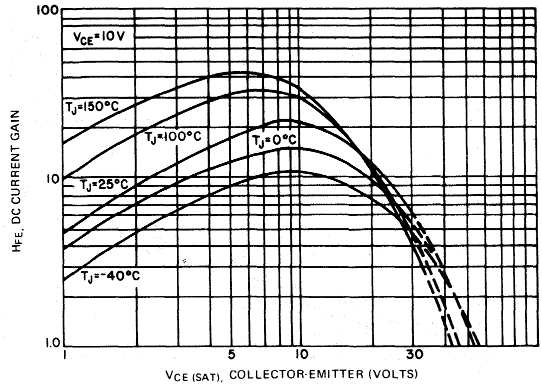


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

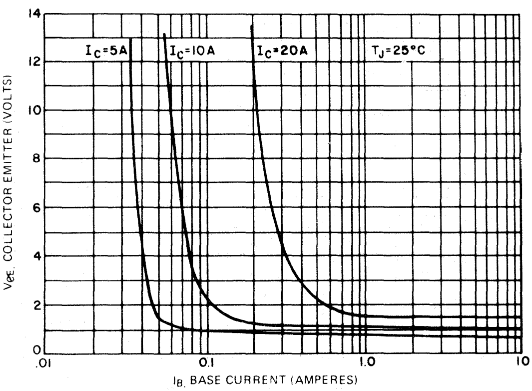


FIGURE 3. COLLECTOR SATURATION REGION

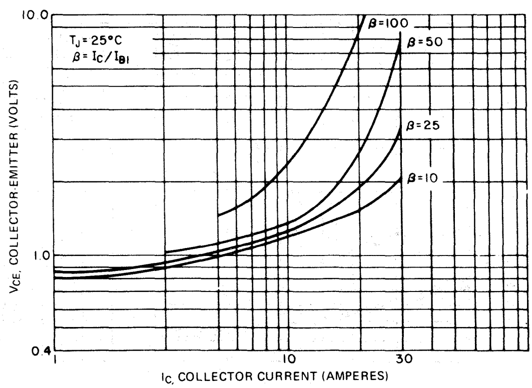


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

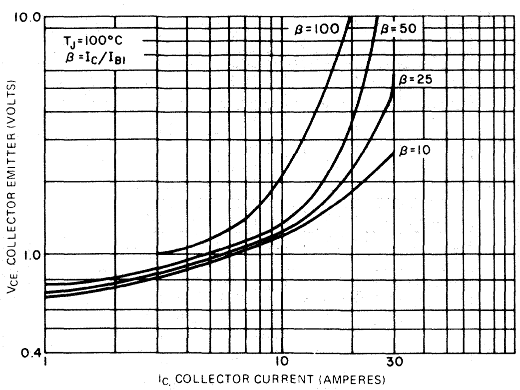


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

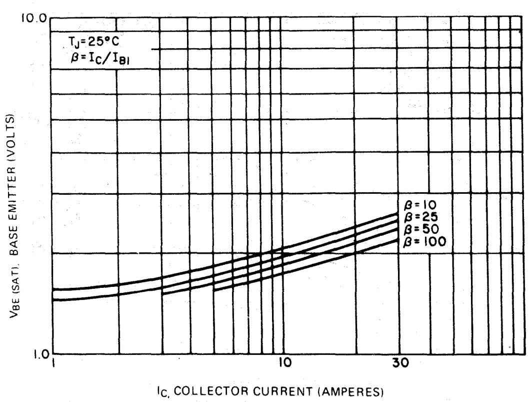


FIGURE 6. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

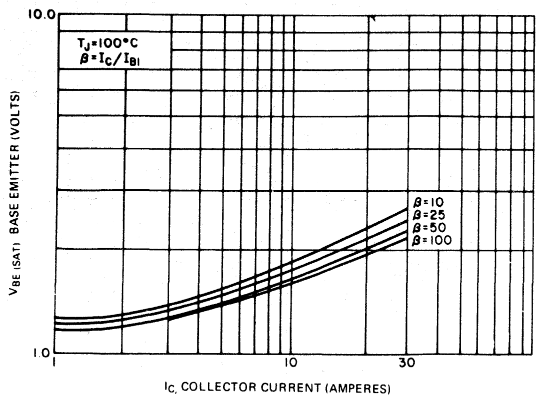


FIGURE 7. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

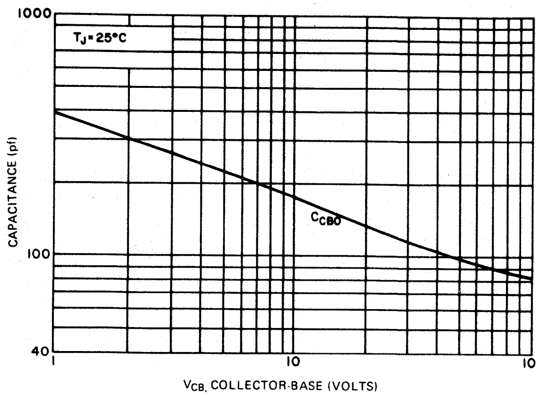


FIGURE 8. CAPACITANCE (C_{CBO})

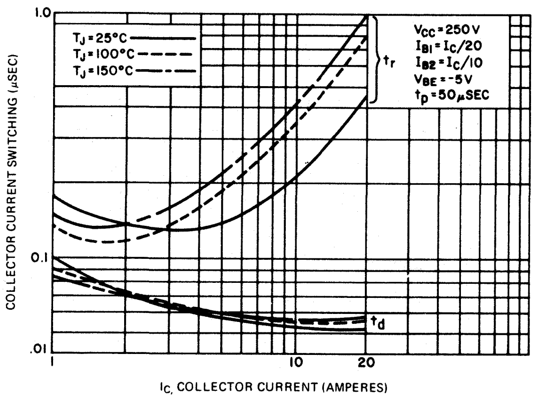


FIGURE 9. TURN-ON TIME (RESISTIVE)

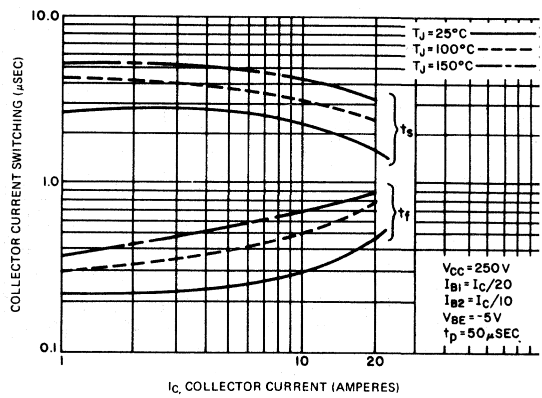


FIGURE 10. TURN-OFF TIME (RESISTIVE)

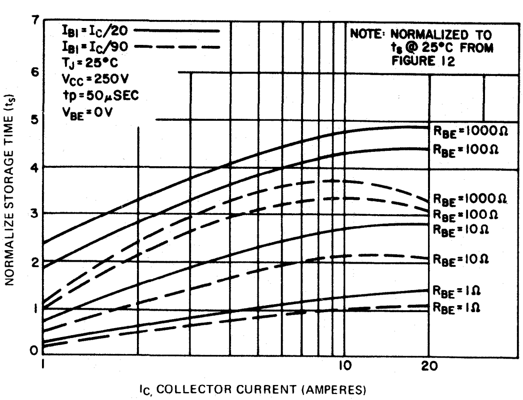


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

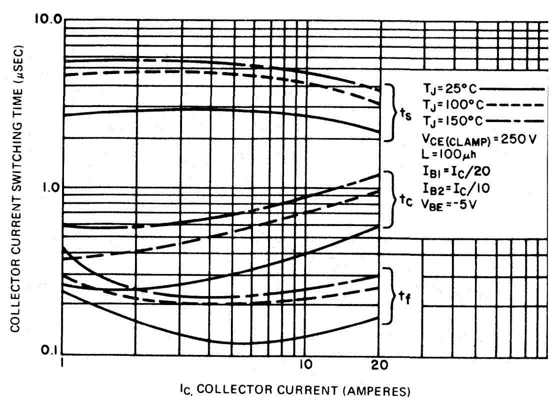


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

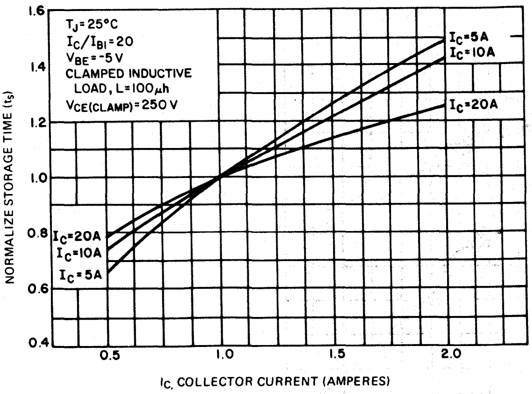


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

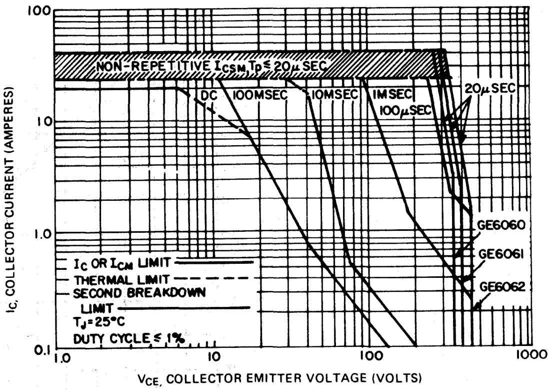


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

2

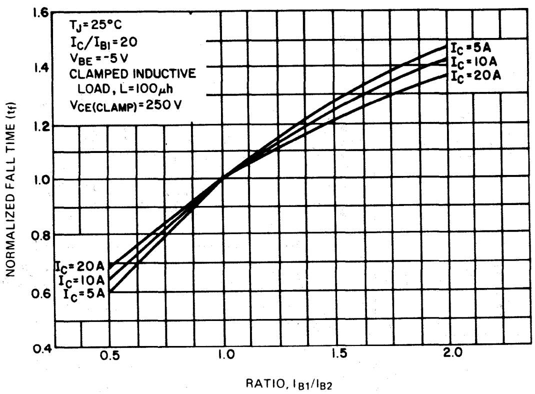


FIGURE 15. FALL TIME VARIATION WITH I_{B2}

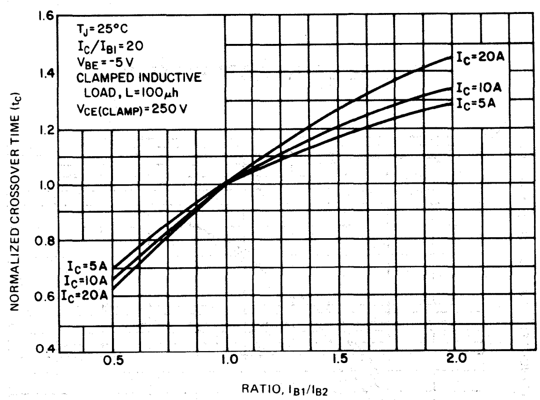


FIGURE 16. CROSS-OVER TIME VARIATION WITH I_{B2}

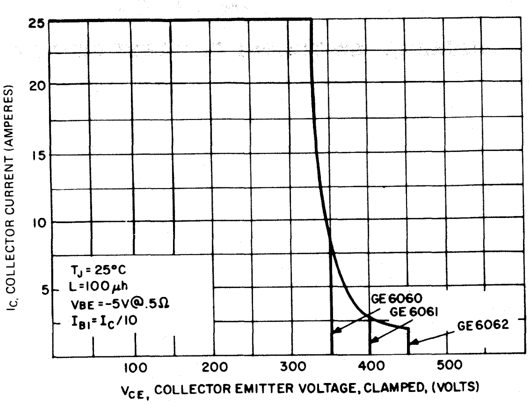


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

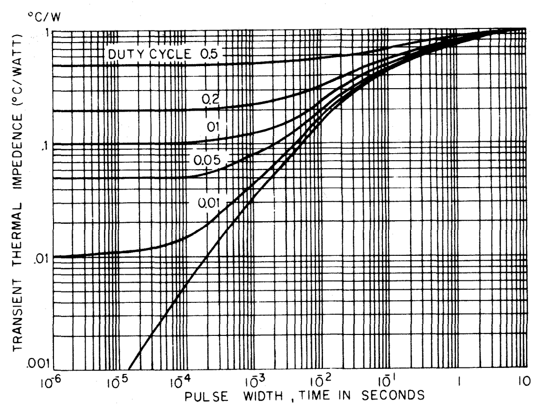


FIGURE 18. TRANSIENT THERMAL RESPONSE

GE6060, GE6061, GE6062

TYPICAL CHARACTERISTICS

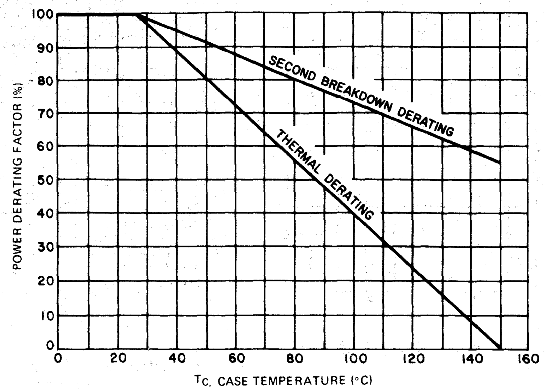


FIGURE 19. POWER DERATING

DIODE CHARACTERISTICS

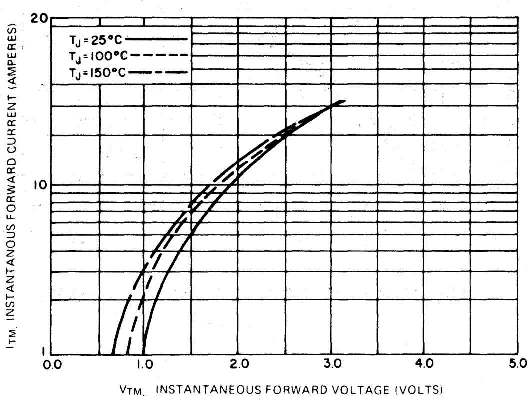


FIGURE 20. FORWARD CHARACTERISTICS

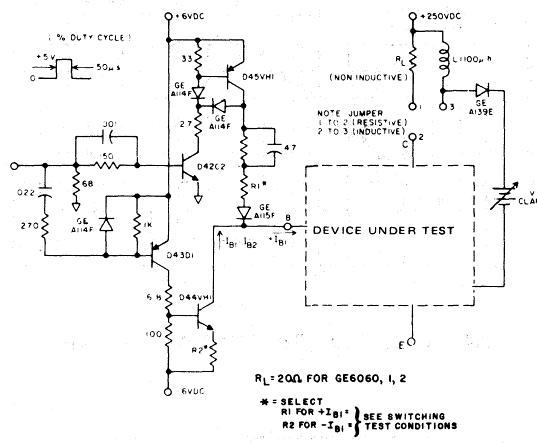


FIGURE 21. SWITCHING TIME TEST CIRCUIT

File Number **15.86**

GE6251, GE6252, GE6253

10-Ampere N-P-N Darlington Power Transistors

Features:

- *High-voltage operation: 400, 450, 500 volts*
- *Gain of 60 at 3A*

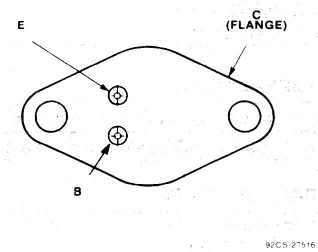
Applications:

- *Series/shunt regulators*
- *Automotive ignition*
- *Power switching*
- *Solenoid driver*

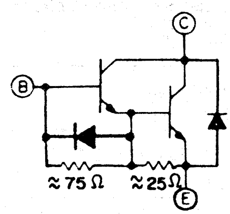
The GE6251, GE6252, and GE6253 silicon n-p-n Darlington power transistors are designed for use in high-speed switching applications, such as: off-line power supplies, AC and DC motor control, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA steel hermetic package.

TERMINAL DESIGNATION



JEDEC TO-204AA



DEVICE CIRCUIT

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	GE6251	GE6252	GE6253	UNITS
Collector-Base Voltage	V_{CBO}	450	500	550	Volts
Collector-Emitter Voltage	V_{CEO}	400	450	500	Volts
Emitter Base Voltage	V_{EBO}	5	5	5	Volts
Collector Current — Continuous Peak (Repetitive) Peak (Non-Repetitive)	I_C I_{CM} I_{CSM}	10 15 25	10 15 25	10 15 25	A
Base Current — Continuous Peak (Non-Repetitive)	I_B I_{BM}	3 5	3 5	3 5	A
Total Power Dissipation @ T_C = 25°C	P_D	125	125	125	Watts
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1		1	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	300	300	300	°C

GE6251, GE6252, GE6253

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = 0.5A) (V_{clamp} = V_{CEO} Rated)	GE6251 GE6252 GE6253	$V_{CEO(sus)}$	400 450 500	— — —	— — —	Volts
Collector-Base Voltage (I_C = 1mA)	GE6251 GE6252 GE6253	V_{CBO}	450 500 550	— — —	— — —	Volts
Collector Cutoff Current (V_{CB} = V_{CBO} Rated)		I_{CBO}	—	—	1	mA
Emitter Cutoff Current (V_{EB} = 1.5V, I_C = 0)		I_{EBO}	—	—	200	mA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 16			
Clamped Inductive SOA with Base Reversed Biased		RBSOA	SEE FIGURE 19			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 3A, V_{CE} = 5V) (I_C = 5A, V_{CE} = 5V) (I_C = 10A, V_{CE} = 5V)		h_{FE}	60 50 30	125 170 160	— — —	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 0.5A) (I_C = 10A, I_B = 2A)		$V_{CE(sat)}$	— —	1 1.15	1.5 2.0	V
Base-Emitter Voltage (I_C = 5A, I_B = 0.5A)		$V_{BE(sat)}$	—	1.75	2.5	V
SWITCHING CHARACTERISTICS						
Resistive Load						
Rise Time	V_{CC} = 300V, t_p = 50 μsec	t_r	—	0.2	0.25	μs
Storage Time	I_C = 10A, I_{B1} = 1A, I_{B2} = -2A	t_s	—	2.1	2.5	
Fall Time		t_f	—	0.2	1.0	
Inductive Load, Clamped						
Storage Time	V_{CC} = 300V, L = 100 μH	t_s	—	2.35	—	μs
Crossover Time	I_C = 10A, I_{B1} = 1A, I_{B2} = -2A	t_c	—	0.28	—	
Fall Time		t_f	—	0.09	—	
EMITTER-COLLECTOR DIODE CHARACTERISTICS						
Forward Voltage I_F = 10A		V_F	—	1.9	—	Volts

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

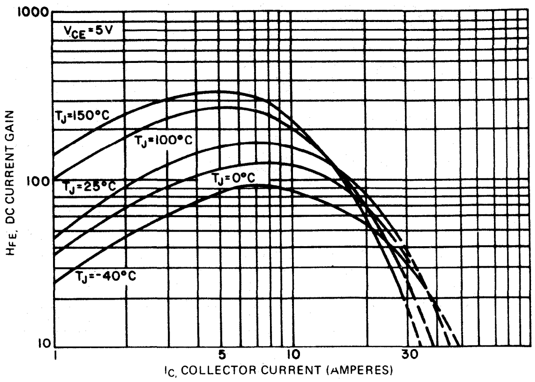


FIGURE 1. DC CURRENT GAIN (V_{CE} = 2V)

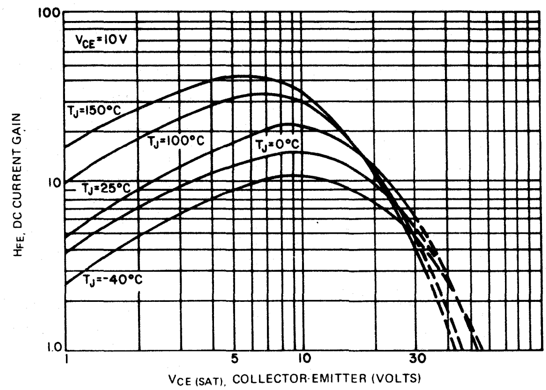


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

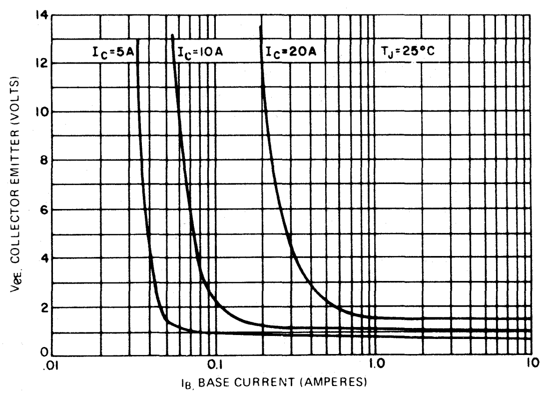


FIGURE 3. COLLECTOR SATURATION REGION

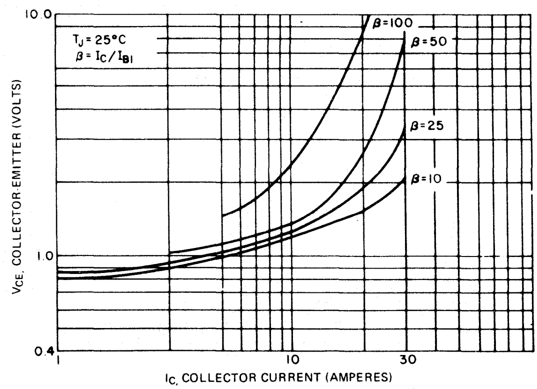


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_J = 25°C

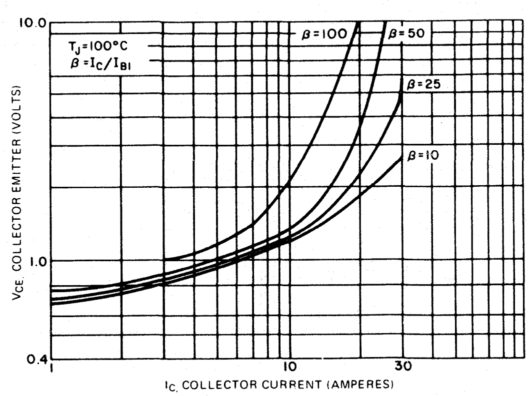


FIGURE 5. $V_{CE(SAT)}$ VS. I_C, T_J = 100°C

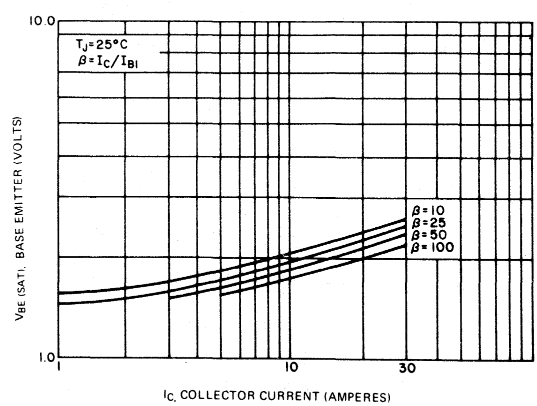


FIGURE 6. $V_{BE(SAT)}$ VS. I_C, T_J = 25°C

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

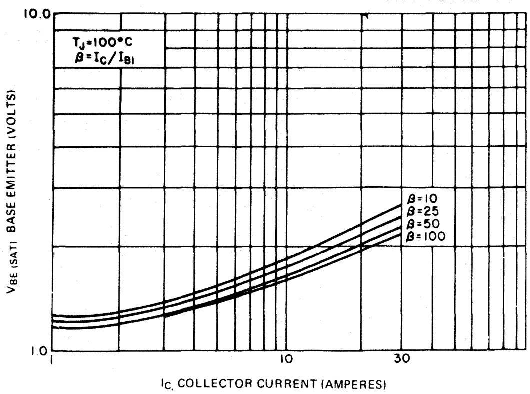


FIGURE 7. $V_{BE(SAT)}$ VS. I_C, T_J = 100°C

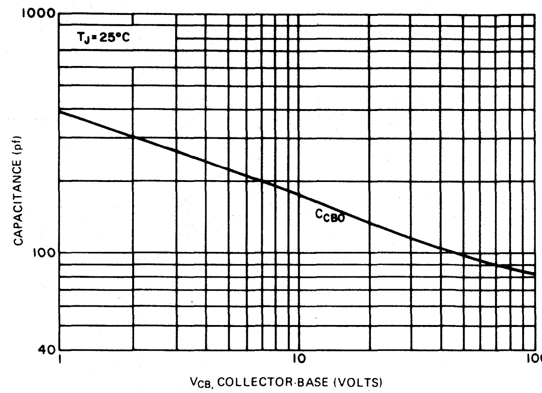


FIGURE 8. CAPACITANCE (C_{CBO})

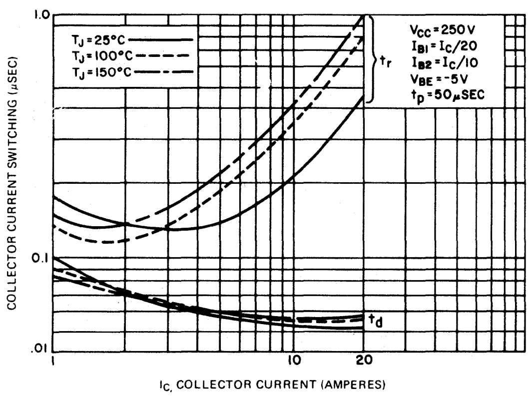


FIGURE 9. TURN-ON TIME (RESISTIVE)

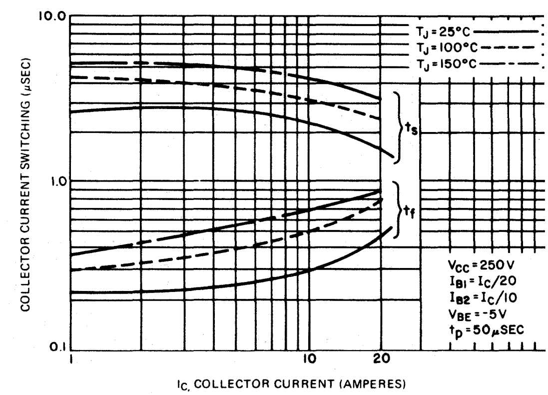


FIGURE 10. TURN-OFF TIME (RESISTIVE)

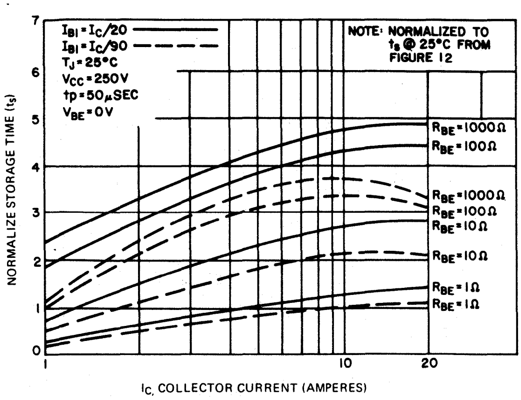


FIGURE 11. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARIATIONS) VS. COLLECTOR CURRENT

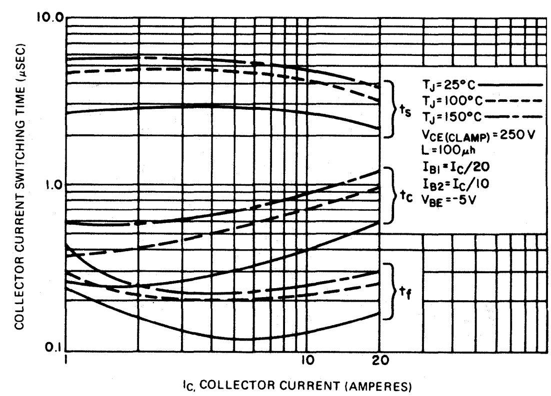


FIGURE 12. CLAMPED INDUCTIVE TURN-OFF TIME

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

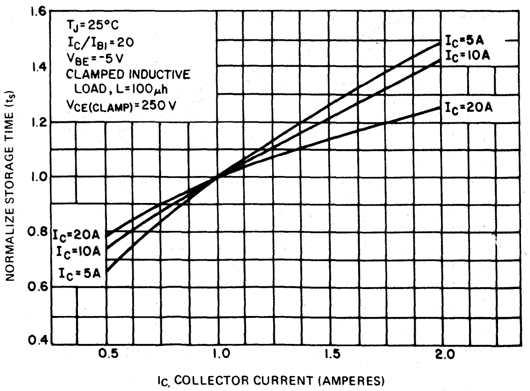


FIGURE 13. STORAGE TIME VARIATION WITH I_{B2}

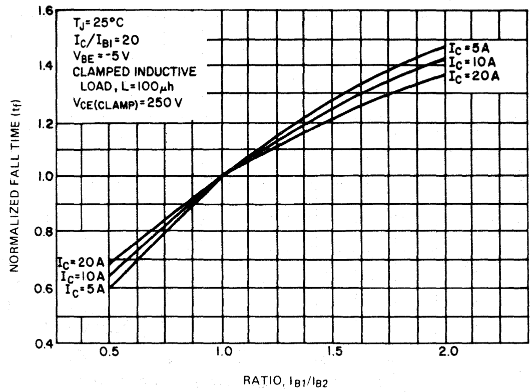


FIGURE 14. FALL TIME VARIATION WITH I_{B2}

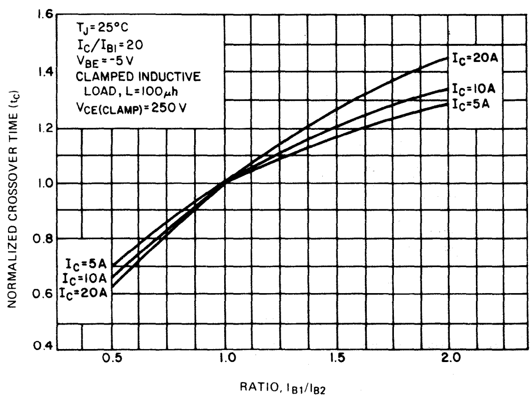


FIGURE 15. CROSS-OVER TIME VARIATION WITH I_{B2}

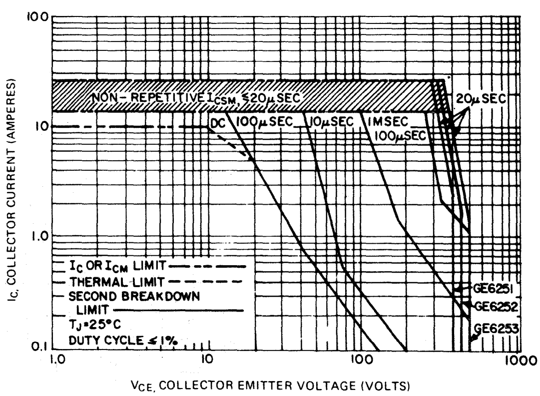


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

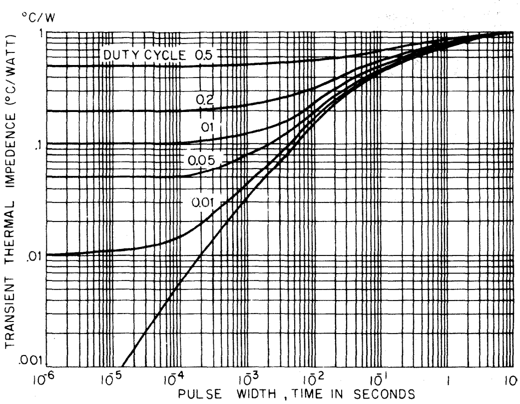


FIGURE 17. TRANSIENT THERMAL RESPONSE

DIODE CHARACTERISTICS

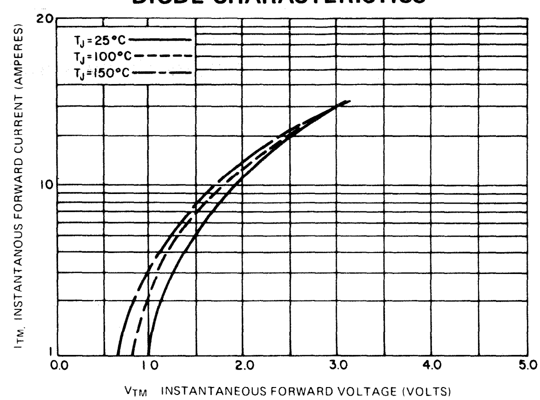


FIGURE 18 FORWARD CHARACTERISTICS

GE6251, GE6252, GE6253

TYPICAL CHARACTERISTICS

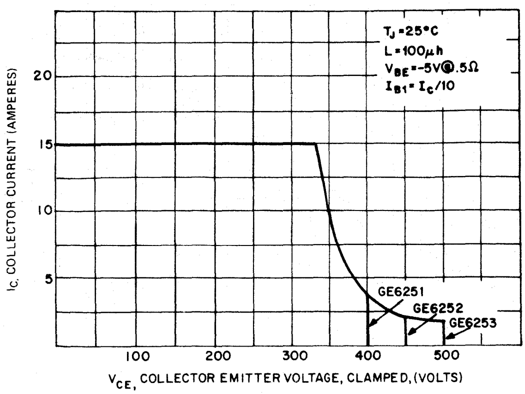


FIGURE 19. REVERSE BIAS SAFE OPERATING AREA

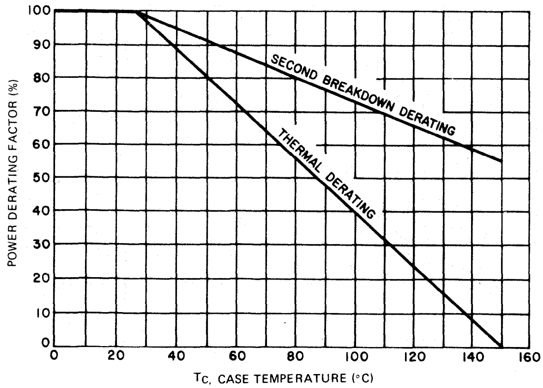


FIGURE 20. POWER DERATING

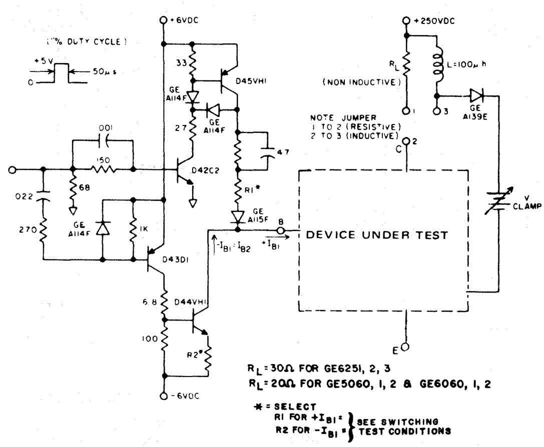


FIGURE 21. SWITCHING TIME TEST CIRCUIT

File Number **15.77**

GE10000-GE10009

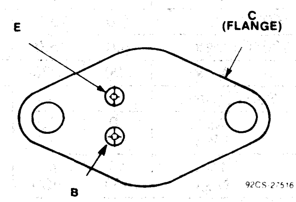
2

Silicon N-P-N Darlington Power Transistors

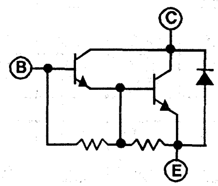
The GE10000 thru GE10009 series of silicon n-p-n power Darlington transistors are designed for power switching applications requiring high-voltage capability and fast switching speeds. They are ideally suited for off-line switching power supplies, ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AA hermetic steel package.

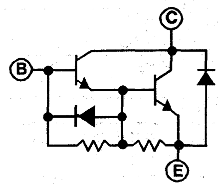
TERMINAL DESIGNATIONS



JEDEC TO -204AA



GE10000 THRU GE10003



GE10004 THRU GE10009

DEVICE CIRCUIT

MAXIMUM RATINGS (25° C) (unless otherwise specified)

Voltages	GE 10000	GE 10001	GE 10002	GE 10003	GE 10004	GE 10005	GE 10006	GE 10007	GE 10008	GE 10009	Units
$V_{CEO(SUS)}$	350	400	350	400	350	400	350	400	450	500	Volts
V_{CEX}, (T_C = 100° C)	400	450	400	450	400	450	400	450	450	500	
V_{CEV}	450	500	450	500	450	500	450	500	650	700	Volts
V_{EBO}	8	8	8	8	8	8	8	8	8	8	Volts
Currents											
I_C	20	20	10	10	20	20	10	10	20	20	Amps
I_{CM}	30	30	20	20	30	30	20	20	30	30	Amps
I_B	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Amps
I_{BM}	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	Amps
Power Dissipation											
P_D(T_C = 25° C)	175	175	150	150	175	175	150	150	175	175	Watts
P_D(T_C = 100° C)	100	100	85	85	100	100	85	85	100	100	Watts
Derate above 25° C	1.0	1.0	.86	.86	1.0	1.0	.86	.86	1.0	1.0	W/° C
Temperatures											
T_{stg} and T_J	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	° C
T_L[1]	+275	+275	+275	+275	+275	+275	+275	+275	+275	+275	° C
Thermal Resistance	1.0	1.0	1.17	1.17	1.0	1.0	1.17	1.17	1.0	1.0	° C/Watt

1) Max. Lead Temperature for soldering purposes 1/8" from case for 5 seconds.

GE10000-GE10009

DEVICE ELECTRICAL CHARACTERISTICS

(Test conditions on next page ,T_C = 25°C except as noted)

STATIC		GE 10000	GE 10001	GE 10002	GE 10003	GE 10004	GE 10005	GE 10006	GE 10007	GE 10008	GE 10009	Units
(1) $V_{CEO(SUS)}$	Min.	350	400	350	400	350	400	350	400	450	500	Volts
(2) $V_{CEX(SUS)}$, (T_C = 100°C)	Min.	400	450	400	450	400	450	400	450	450	500	Volts
(3) $V_{CEX(SUS)}$, (T_C = 100°C)	Min.	295	345	315	365	295	345	315	365	295	345	Volts
(4) I_{CEV}	Max.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	mA
I_{CEV}, (T_C = 150°C)	Max.	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	mA
(5) I_{CER}, (T_C = 100°C)	Max.	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	mA
(6) I_{EBO}	Max.	200	200	200	200	200	200	200	200	200	200	mA
(7) $I_{s/b}$	See Figure	15	15	16	16	15	15	16	16	17	17	
(8) h_{FE}	Min. Max.	50 600	50 600	40 500	40 500	50 600	50 600	40 500	40 500	40 400	40 400	
(9) h_{FE}	Min. Max.	40 400	40 400	30 300	30 300	40 400	40 400	30 300	30 300	30 300	30 300	
(10) $V_{CE(SAT)}$	Max.	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	Volts
(11) $V_{CE(SAT)}$	Max.	3.0	3.0	2.9	2.9	3.0	3.0	2.9	2.9	3.5	3.5	Volts
(12) $V_{CE(SAT)}$, (T_C = 100°C)	Max.	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5	Volts
(13) $V_{BE(SAT)}$	Max.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Volts
$V_{BE(SAT)}$, (T_C = 100°C)	Max.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Volts
(14) DIODE V_F	Typ. Max.	1.95 5.0	1.95 5.0	1.5 5.0	1.5 5.0	1.95 5.0	1.95 5.0	1.5 5.0	1.5 5.0	1.95 5.0	1.95 5.0	Volts Volts
DYNAMIC												
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{TEST} = 1MHz)	Typ. Max.	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	175 325	pF pF
SWITCHING												
(1) Resistive t_d	Typ. Max.	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.045 .200	.04 .25	.04 .25	μs μs
t_r	Typ. Max.	.23 .60	.23 .60	.14 .40	.14 .40	.22 .60	.22 .60	.11 .40	.11 .40	.18 1.0	.18 1.0	μs μs
t_s	Typ. Max.	1.7 3.5	1.7 3.5	1.5 3.0	1.5 3.0	1.2 1.5	1.2 1.5	1.3 1.5	1.3 1.5	1.2 2.0	1.2 2.0	μs μs
t_f	Typ. Max.	.85 2.4	.85 2.4	.40 1.5	.40 1.5	.25 .50	.25 .50	.15 .50	.15 .50	.20 .60	.20 .60	μs μs
(2) Inductive (T_C = 100°C) t_s	Typ. Max.	4.4 6.5	4.4 6.5	4.2 6.0	4.2 6.0	2.9 4.0	2.9 4.0	3.2 4.0	3.2 4.0	3.0 4.0	3.0 4.0	μs μs
t_f	Typ. Max.	.54 1.5	.54 1.5	.39 1.5	.39 1.5	.19 1.0	.19 1.0	.18 1.0	.18 1.0	.20 1.0	.20 1.0	μs μs
t_c	Typ. Max.	1.7 3.0	1.7 3.0	1.0 2.5	1.0 2.5	.62 1.5	.62 1.5	.46 1.5	.46 1.5	.60 1.5	.60 1.5	μs μs
(3) Inductive t_s	Typ.	2.2	2.2	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	μs
t_f	Typ.	.30	.30	.20	.20	.10	.10	.10	.10	.10	.10	μs
t_c	Typ.	1.0	1.0	.50	.50	.30	.30	.22	.22	.30	.30	μs

GE10000-GE10009

STATIC TEST CONDITIONS

	APPLIES TO
(1) $V_{CEX(SUS)}$	APPLIES TO
a) I_C = 250mA, I_B = 0, V_{CLAMP} = V_{CEO} Rated	GE10000 Thru GE10007
b) I_C = 100mA, I_B = 0, V_{CLAMP} = V_{CEO} Rated	GE10008, 9
(2) $V_{CEX(SUS)}$	APPLIES TO
a) I_C = 2A, V_{CLAMP} = V_{CEX} Rated	GE10000, 1, 4, 5, 8, 9
b) I_C = 1A, V_{CLAMP} = V_{CEX} Rated	GE10002, 3, 6, 7
(3) $V_{CEX(SUS)}$	APPLIES TO
a) I_C = 10A, V_{CLAMP} = V_{CEX} Rated	GE10000, 1, 4, 5, 8, 9
b) I_C = 5A, V_{CLAMP} = V_{CEX} Rated	GE10002, 3, 6, 7
(4) I_{CEV}	APPLIES TO
V_{CEV} = Rated Valve, V_{BE} = 1.5V	All
(5) I_{CER}	APPLIES TO
V_{CE} = Rated Valve, R_{BE} = 50Ω	All
(6) I_{EBO}	APPLIES TO
V_{EB} = 8V, I_C = 0	GE10000, 1, 2, 3
V_{EB} = 2V, I_C = 0	GE10004, 5, 6, 7, 8, 9
(7) $I_{s/b}$ SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE	
(8) h_{FE}	APPLIES TO
(a) I_C = 5A, V_{CE} = 5V	GE10000, 1, 4, 5, 8, 9
(b) I_C = 2.5A, V_{CE} = 5V	GE10002, 3, 6, 7
(9) h_{FE}	APPLIES TO
I_C = 10A, V_{CE} = 5V	GE10000, 4, 5, 8, 9
I_C = 5A, V_{CE} = 5V	GE10002, 3, 6, 7
(10) $V_{CE(SAT)}$	APPLIES TO
a) I_C = 10A, I_B = .4A	GE10000, 1, 4, 5
b) I_C = 5A, I_B = .25A	GE10002, 3, 6, 7
c) I_C = 5A, I_B = .5A	GE10008, 9
(11) $V_{CE(SAT)}$	APPLIES TO
a) I_C = 20A, I_B = 1A	GE10000, 1, 4, 5
b) I_C = 10A, I_B = 1A	GE10002, 3, 6, 7
c) I_C = 20A, I_B = 2A	GE10008, 9
(12) $V_{CE(SAT)}$ SAME AS (10) BUT T_C = 100°C	
(13) $V_{BE(SAT)}$	APPLIES TO
a) I_C = 10A, I_B = .4A	GE10000, 1, 4, 5
b) I_C = 5A, I_B = .25A	GE10002, 3, 6, 7
c) I_C = 10A, I_B = .5A	GE10008, 9
(14) DIODE V_F	APPLIES TO
a) I_F = 10A	GE10000, 4, 5, 8, 9
b) I_F = 5A	GE10002, 3, 6, 7

SWITCHING TEST CONDITIONS

	APPLIES TO
(1) RESISTIVE	APPLIES TO
V_{CC}=250V, t_p=50μs, Duty ≤ 2%	
a) I_C = 10A, I_{B1} = .4A, I_{B2} = 1.6A	GE10000, 1, 4, 5
b) I_C = 5A, I_{B1} = .25A, I_{B2} = 1A	GE10002, 3, 6, 7
c) I_C = 10A, I_{B1} = .5A, I_{B2} = 2A	GE10008, 9
(2) INDUCTIVE	APPLIES TO
V_{CLAMP} = 250V, L = 100μh, T_C = 100°C	
a) I_C = 10A, I_{B1} = .4A, I_{B2} = 1.6A	GE10000, 1, 4, 5
b) I_C = 5A, I_B = .25A, I_{B2} = 1A	GE10002, 3, 6, 7
c) I_C = 10A, I_B = .5A, I_{B2} = 2A	GE10008, 9
(3) INDUCTIVE Same as (2), but T_C = 25°C	

Note: See FIGURE 24 for Switching Time Test Circuit.

GE10000-GE10009

TYPICAL CHARACTERISTICS

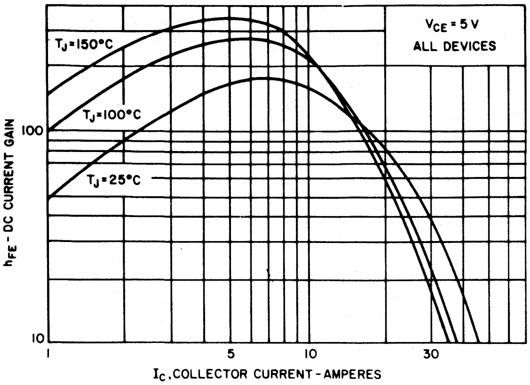


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

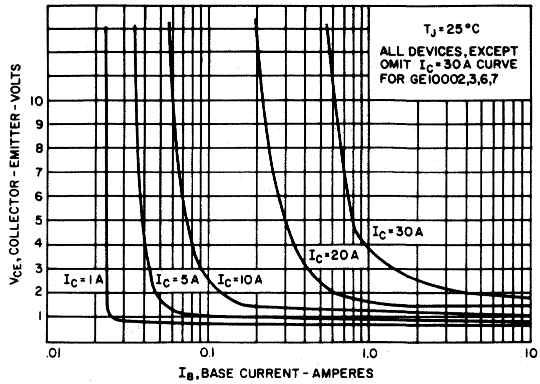


FIGURE 2. COLLECTOR SATURATION REGION

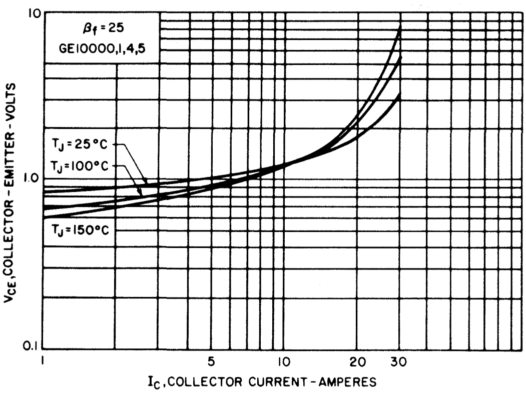


FIGURE 3. $V_{CE\ (SAT)}$ VS I_C

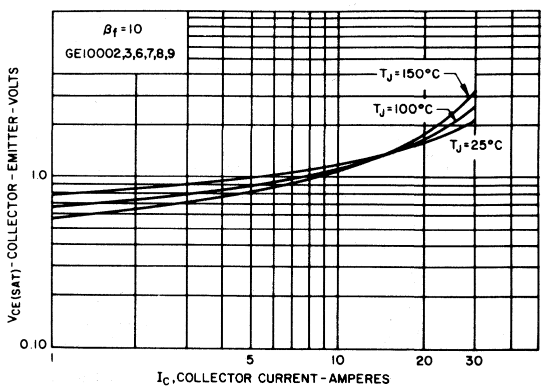


FIGURE 4. I_C COLLECTOR CURRENT (AMPERES)

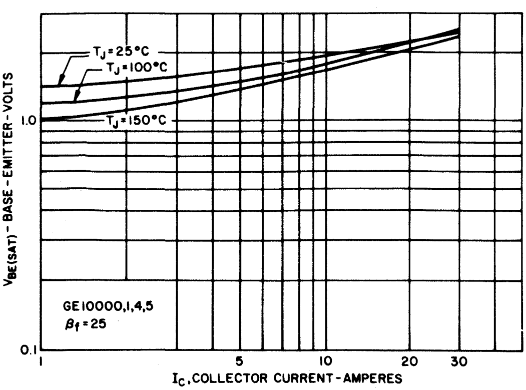


FIGURE 5. $V_{BE\ (SAT)}$ VS I_C

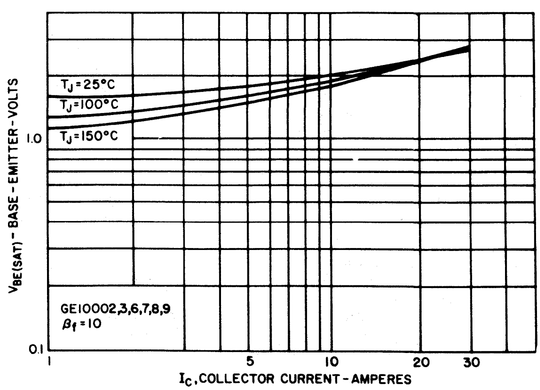


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C

GE10000-GE10009

TYPICAL CHARACTERISTICS

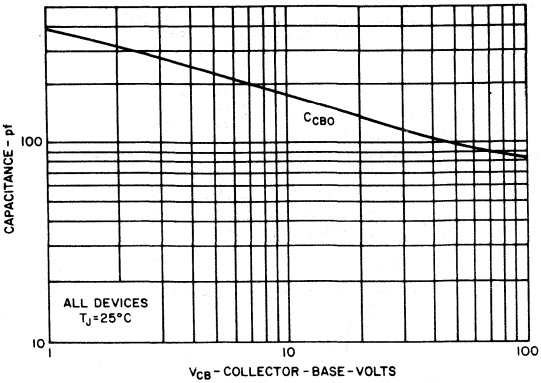


FIGURE 7. CAPACITANCE (C_{CBO})

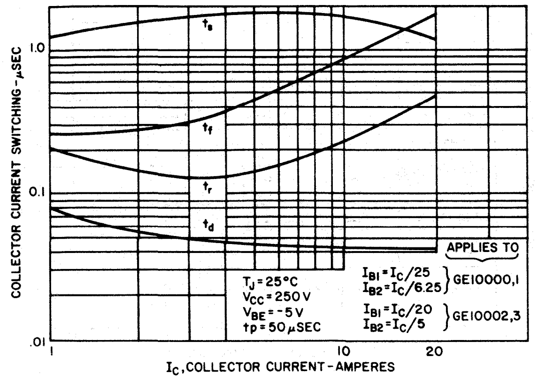


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

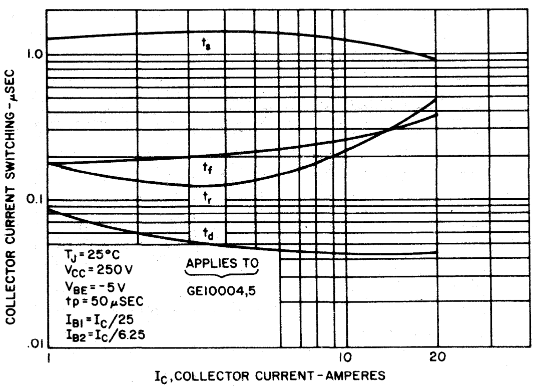


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

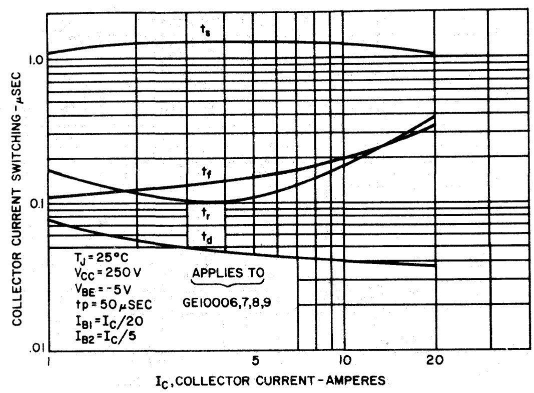


FIGURE 10. RESISTIVE SWITCHING PERFORMANCE

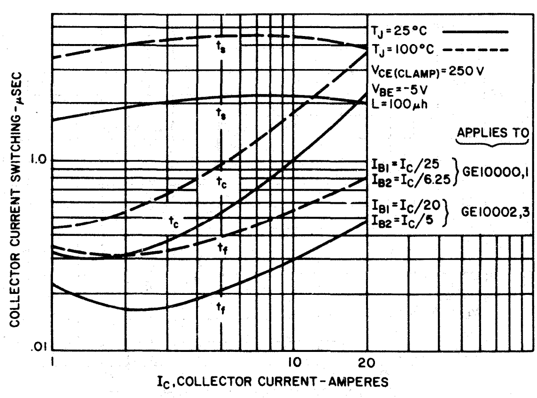


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

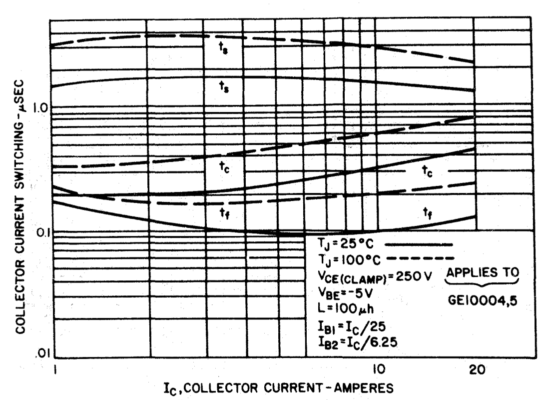


FIGURE 12. INDUCTIVE SWITCHING PERFORMANCE

GE10000-GE10009

TYPICAL CHARACTERISTICS

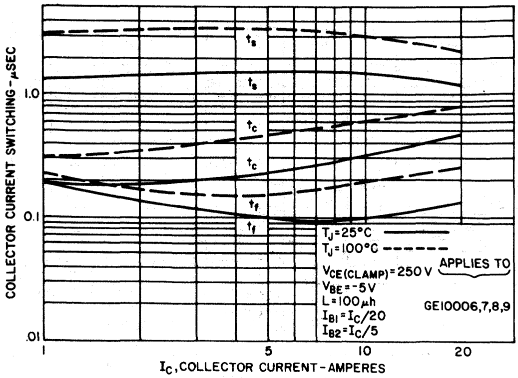


FIGURE 13. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

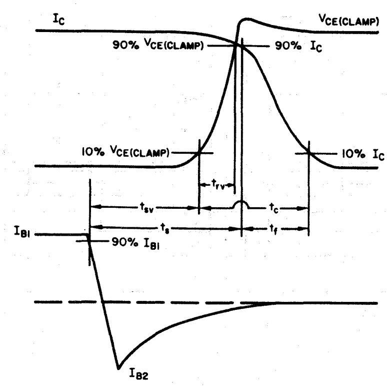


FIGURE 14. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

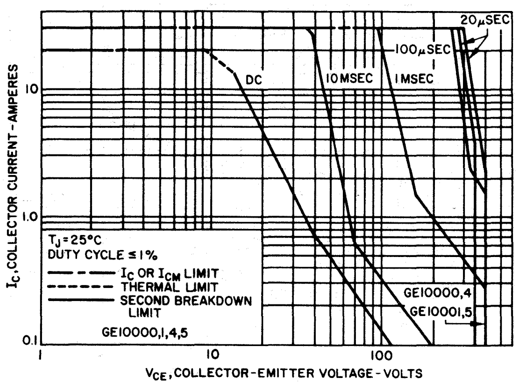


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

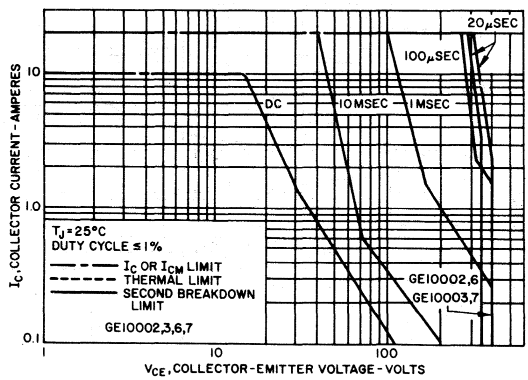


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA

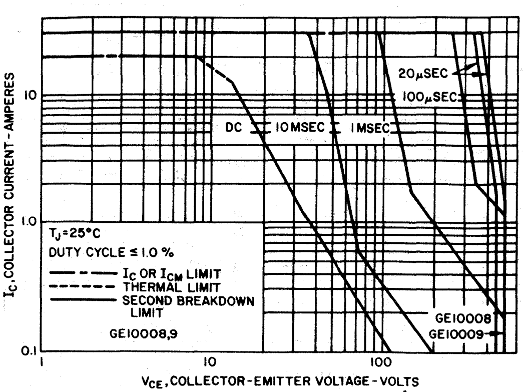


FIGURE 17. FORWARD BIAS SAFE OPERATING AREA

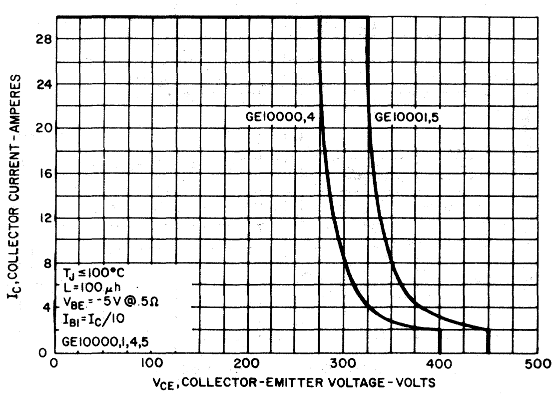


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

GE10000-GE10009

TYPICAL CHARACTERISTICS

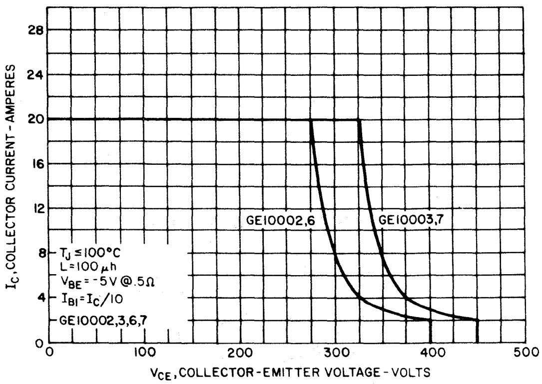


FIGURE 19. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

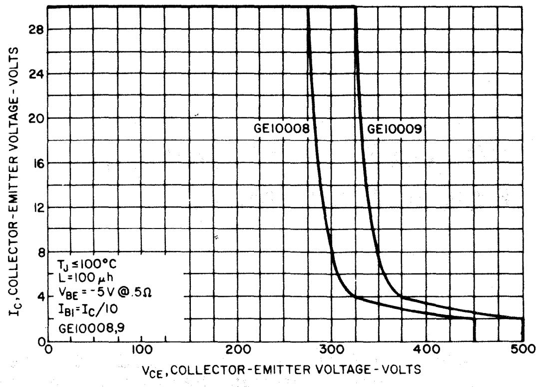


FIGURE 20. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

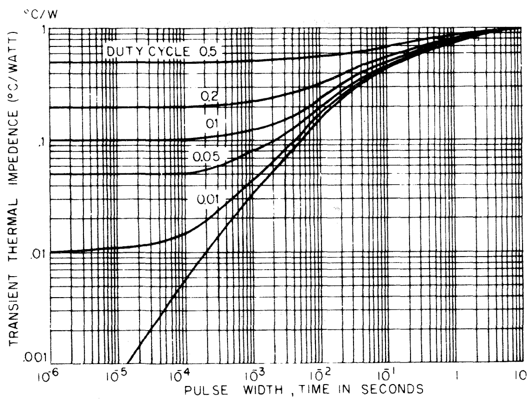


FIGURE 21. TRANSIENT THERMAL RESPONSE

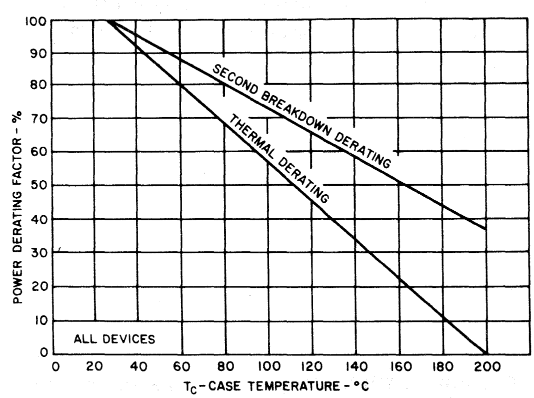


FIGURE 22. POWER DERATING

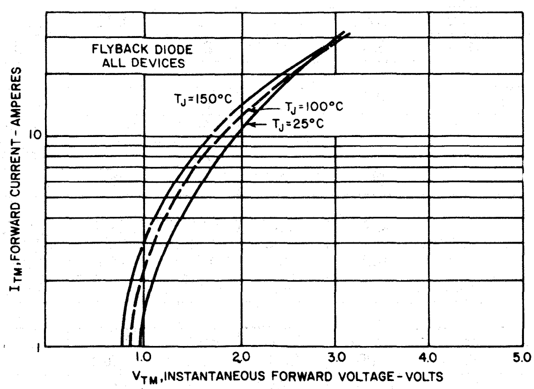


FIGURE 23. FORWARD CHARACTERISTICS

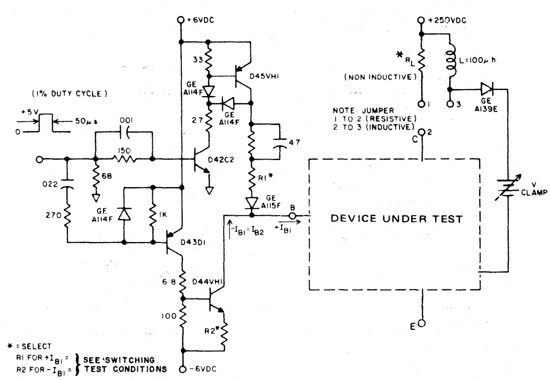


FIGURE 24. SWITCHING TIME TEST CIRCUIT

2

GE10015,16,20,21,22,23

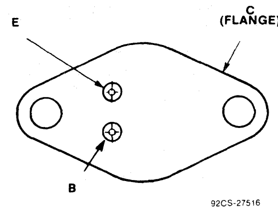
File Number **15.78**

Silicon N-P-N Darlington Power Transistors

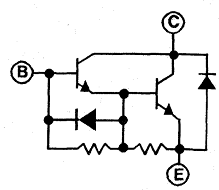
The GE10015, GE10016 and GE10020 thru GE10023 series of silicon n-p-n power Darlington transistors are designed for use in power switching applications requiring high-voltage capability and fast switching speeds. They are ideally suited for off-line switching power supplies, ac and dc motor controls, UPS systems, ultrasonic equipment, and other high-frequency power conversion equipment.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

TERMINAL DESIGNATIONS



JEDEC TO-204AE



DEVICE CIRCUIT

MAXIMUM RATINGS (25° C) (unless otherwise specified)

Voltages	**Symbol**	**GE 10015**	**GE 10016**	**GE 10020**	**GE 10021**	**GE 10022**	**GE 10023**	**Units**
Collector Emitter	$V_{CEO(SUS)}$	400	500	200	250	350	400	Volts
Collector Emitter	V_{CEV}	600	700	300	350	450	600	Volts
Emitter Base	V_{EBO}	8.0	8.0	8.0	8.0	8.0	8.0	Volts
Currents								
Collector Current (continuous)	I_C	50	50	60	60	40	40	Amps
Collector Current (peak)	I_{CM}	75	75	100	100	60	60	Amps
Base Current (continuous)	I_B	10	10	20	20	20	20	Amps
Base Current (peak)	I_{BM}	15	15	30	30	30	30	Amps
Power Dissipation								
Power Dissipation	$P_D(T_C = 25°C)$	250	250	250	250	250	250	Watts
Power Dissipation	$P_D(T_C = 100°C)$	143	143	143	143	143	143	Watts
	Derate above 25°C	1.43	1.43	1.43	1.43	1.43	1.43	W/°C
Temperatures								
Storage and Junction	T_{stg} and T_J	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	-65 to +200	°C
Soldering[1]	T_L[1]	+275	+275	+275	+275	+275	+275	°C
Thermal Resistance	$R_{\theta JC}$	0.7	0.7	0.7	0.7	0.7	0.7	°C/Watt

1) Max. lead temperature for soldering purposes 1/8" from case for 5 seconds.

GE10015,16,20,21,22,23

DEVICE ELECTRICAL CHARACTERISTICS
(Test conditions on next page ,T_C = 25°C except as noted)

STATIC		GE 10015	GE 10016	GE 10020	GE 10021	GE 10022	GE 10023	Units
(1) $V_{CEO(SUS)}$	Min.	400	500	200	250	350	400	Volts
(2) I_{CEV} I_{CEV} (T_C = 150°C)	Max. Max.	.25 5.00	.25 5.00	.25 5.00	.25 5.00	.25 5.00	.25 5.00	mA mA
(3) I_{EBO}	Max.	350	350	175	175	175	175	mA
(4) $I_{s/b}$	See Figure	13	13	14	14	15	15	
(5) h_{FE}	Min. Max.	25 —	25 —	75 1000	75 1000	50 600	50 600	
(6) h_{FE}	Min. Max.	10 —	10 —	— —	— —	— —	— —	
(7) $V_{CE(SAT)}$	Max.	2.2	2.2	2.2	2.2	2.2	2.2	Volts
(8) $V_{CE(SAT)}$	Max.	5	5	4	4	5	5	Volts
(9) $V_{CE(SAT}$	Max.	2.5	2.5	2.4	2.4	2.5	2.5	Volts
(10) $V_{BE(SAT}$	Max.	2.75	2.75	3.00	3.00	2.5	2.5	Volts
(11) $V_{BE(SAT)}$, (T_C = 100°C)	Max.			3.5	3.5	2.5	2.5	Volts
(12) DIODE V_F	Typ. Max.	1.9 5.0	1.9 5.0	2.1 5.0	2.1 5.0	1.9 5.0	1.9 5.0	Volts Volts
DYNAMIC								
OUTPUT CAPACITANCE (V_{CB} = 10V, I_E = 0, f_{TEST} = 1MHz)	Typ. Max.	580 750	580 750	580 750	580 750	580 750	580 750	pF pF
SWITCHING								
(1) Resistive t_d	Typ. Max.	.09 .30	.09 .30	.095 .20	.095 .20	.09 .25	.09 .25	μs μs
t_r	Typ. Max.	.20 1.00	.20 1.00	.32 1.00	.32 1.00	.20 1.00	.20 1.00	μs μs
t_s	Typ. Max.	1.45 2.5	1.45 2.5	1.50 3.5	1.50 3.5	1.45 2.5	1.45 2.5	μs μs
t_f	Typ. Max.	.25 1.0	.25 1.0	.30 .50	.30 .50	.25 .90	.25 .90	μs μs
(2) Inductive (T_C = 100°C) t_s	Typ. Max.	2.8 —	2.8 —	2.7 4.5	2.7 4.5	2.8 5.0	2.8 5.0	μs μs
t_f	Typ. Max.	.21 —	.21 —	.30 1.0	.30 1.0	.21 1.0	.21 1.0	μs μs
t_c	Typ. Max.	.68 —	.68 —	.85 2.0	.85 2.0	.68 2.0	.68 2.0	μs μs
(3) Inductive (T_C = 25°C) t_s	Typ. Max.	1.6 3.0	1.6 3.0	1.8 —	1.8 —	1.6 —	1.6 —	μs μs
t_f	Typ. Max.	.10 .50	.10 .50	.12 —	.12 —	.10 —	.10 —	μs μs
t_c	Typ. Max.	.30 1.0	.30 1.0	.40 —	.40 —	.30 —	.30 —	μs μs

2

GE10015,16,20,21,22,23

TEST CONDITIONS

STATIC

(1) $V_{CEO(SUS)}$ I_C = 100mA, V_{CLAMP} = V_{CEO} Rated	APPLIES TO All
(2) I_{CEV} V_{CEV} = Rated Valve, V_{BE} = -1.5V	APPLIES TO All
(3) I_{EBO} I_{EB} = 2.0 Volts	APPLIES TO All
(4) $I_{s/b}$ SEE APPROPRIATE FORWARD BIAS SECOND BREAKDOWN FIGURE	
(5) h_{FE} (a) I_C = 10A, V_{CE} = 5V (b) I_C = 15A, V_{CE} = 5V (c) I_C = 20A, V_{CE} = 5V	APPLIES TO GE10022, 23 GE10020, 21 GE10015, 16
(6) h_{FE} I_C = 40A, V_{CE} = 5V	APPLIES TO GE10015, 16
(7) $V_{CE(SAT)}$ a) I_C = 20A, I_B = 1A b) I_C = 30A, I_B = 1.2A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(8) $V_{CE(SAT)}$ (a) I_C = 40A, V_{CE} = 5V (b) I_C = 50A, V_{CE} = 10V (c) I_C = 60A, V_{CE} = 5V	APPLIES TO GE10022, 23 GE10015, 16 GE10020, 21
(9) $V_{CE(SAT)}$ (a) I_C = 20A, I_B = 1A (b) I_C = 30A, I_B = 1.2A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(10) $V_{BE(SAT)}$ (a) I_C = 20A, I_B = 1A (b) I_C = 30A, I_B = 1.2A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(11) $V_{BE(SAT)}$ SAME AS (10) BUT T_C = 100°C	
(12) DIODE V_F a) I_F = 20A b) I_F = 30A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21

SWITCHING

(1) RESISTIVE t_p = 50μs, Duty Cycle $\leq$ 2% a) V_{CC} = 250V, I_C = 20A, I_{B1} = 1A, I_{B2} = 4A b) V_{CC} = 175V, I_C = 30A, I_{B1} = 1A, I_{B2} = 4A	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(2) INDUCTIVE L = 100μh, I_{B1} = 1A, I_{B2} = 4A, T_C = 100°C a) I_C = 20A, V_{CLAMP} = 250V b) I_C = 30A, V_{CLAMP} = 175V	APPLIES TO GE10015, 16, 22, 23 GE10020, 21
(3) INDUCTIVE SAME AS (2), BUT T_C = 25°C	

NOTE: See FIGURE 22 for Switching Time Test Circuit.

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

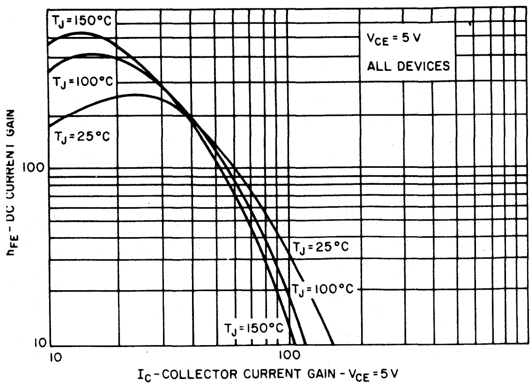


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

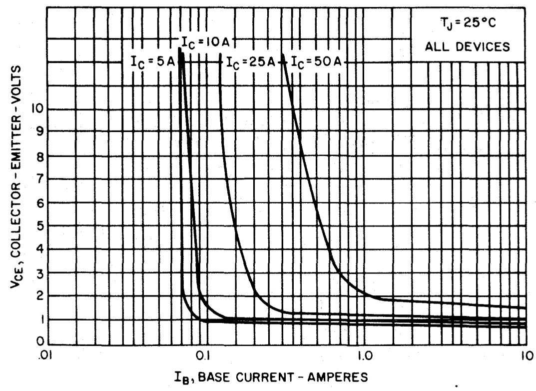


FIGURE 2. COLLECTOR SATURATION REGION

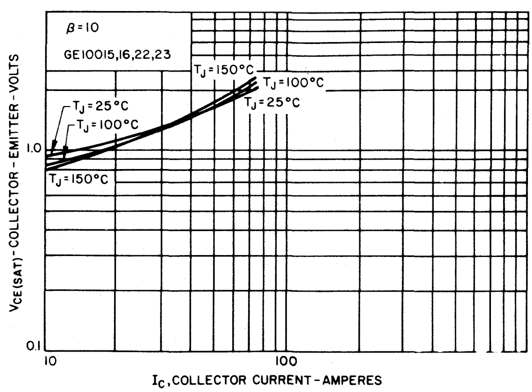


FIGURE 3. $V_{CE\ (SAT)}$ VS I_C

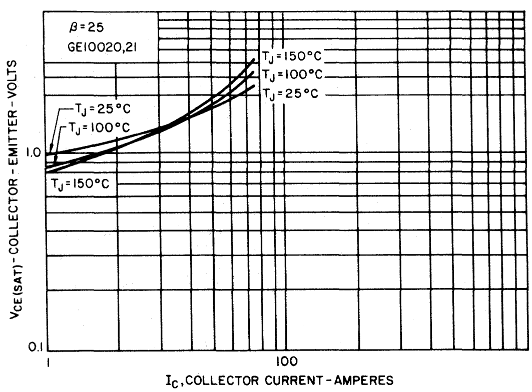


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C

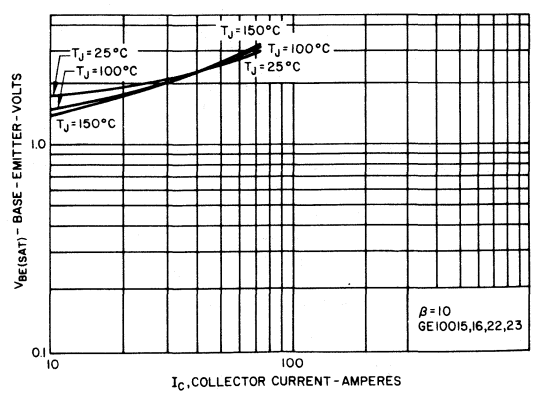


FIGURE 5. $V_{BE\ (SAT)}$ VS I_C

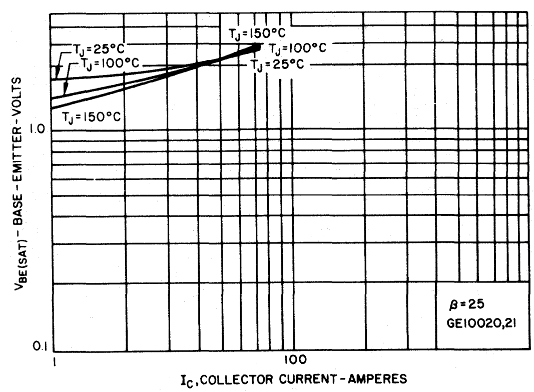


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C

2

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

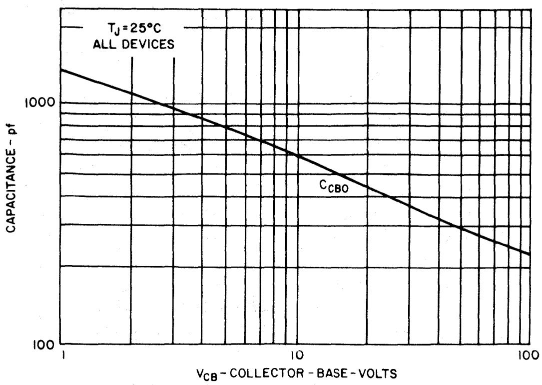


FIGURE 7. CAPACITANCE (C_{CBO})

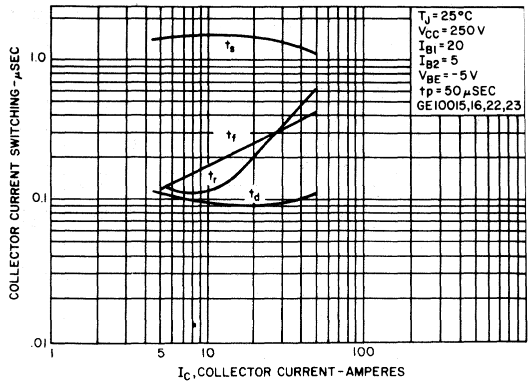


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

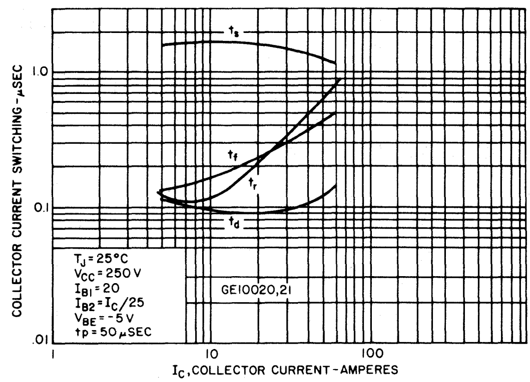


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

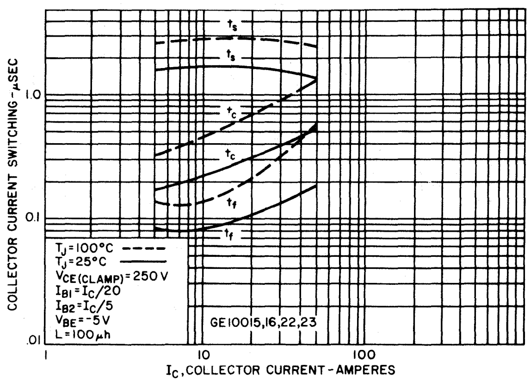


FIGURE 10. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

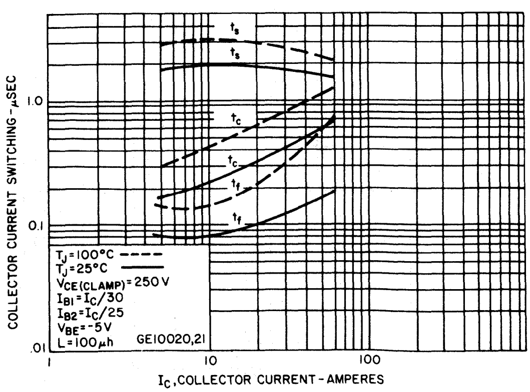


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

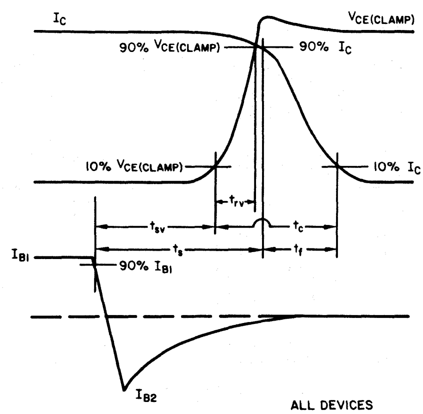


FIGURE 12. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

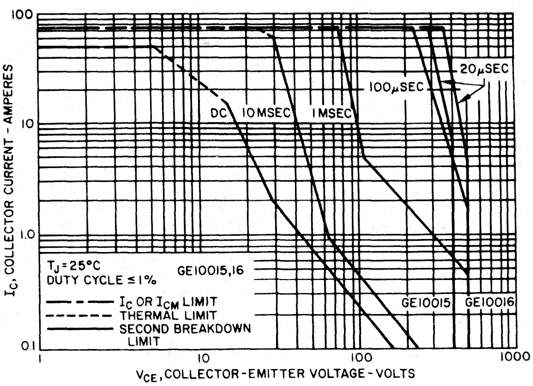


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

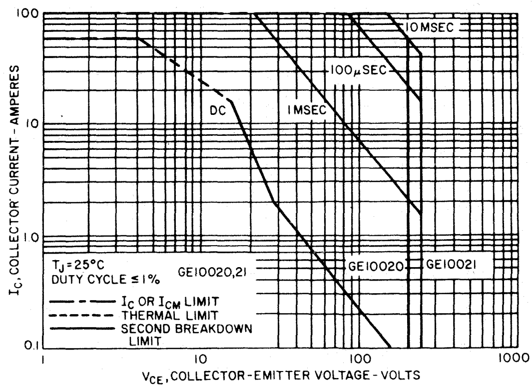


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

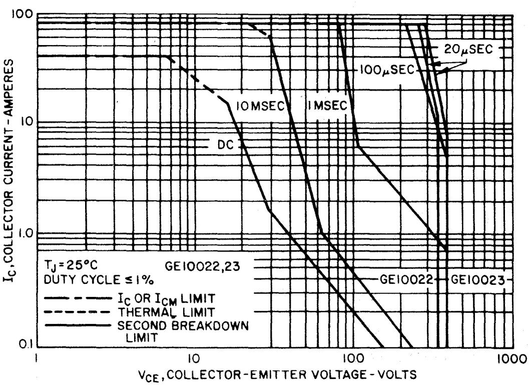


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

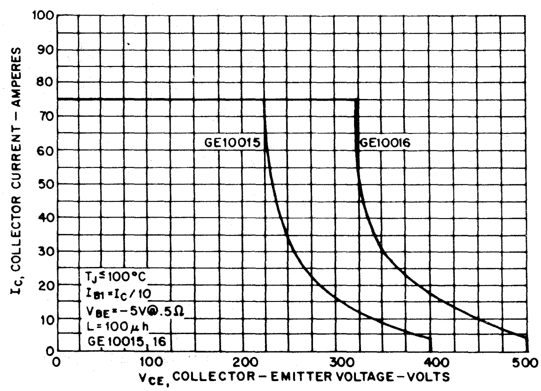


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA (CLAMPED)

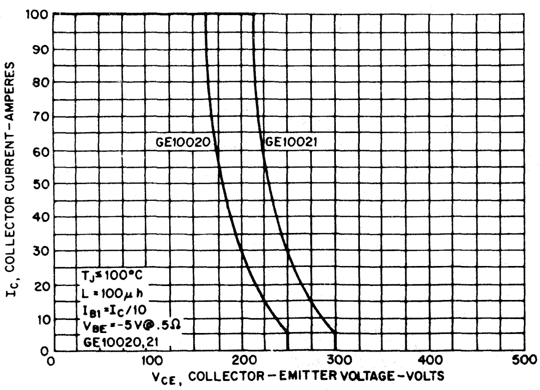


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

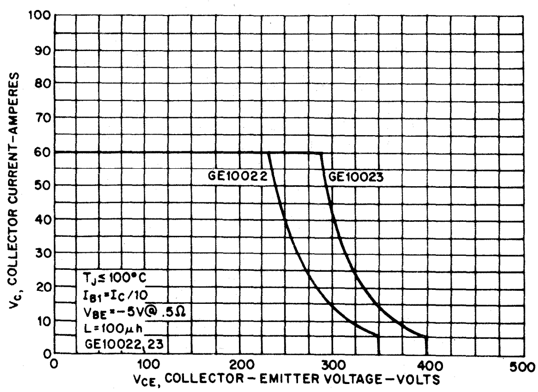


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA

GE10015,16,20,21,22,23

TYPICAL CHARACTERISTICS

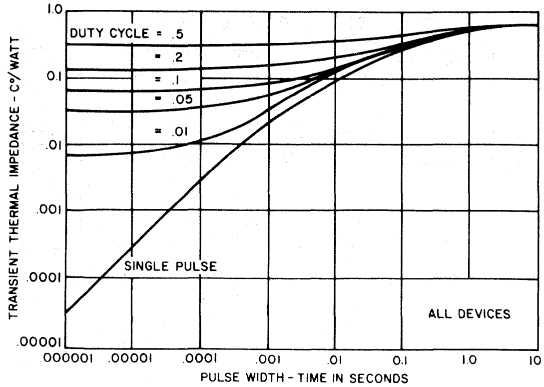


FIGURE 19. TRANSIENT THERMAL RESPONSE

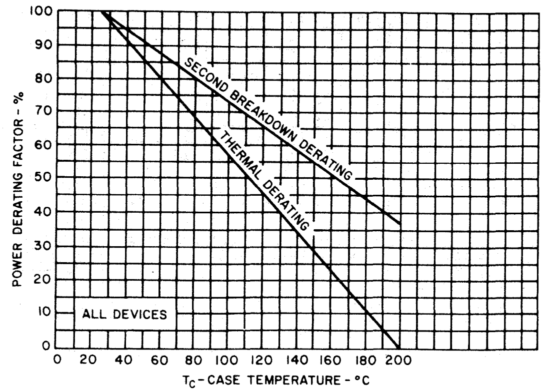


FIGURE 20. POWER DERATING

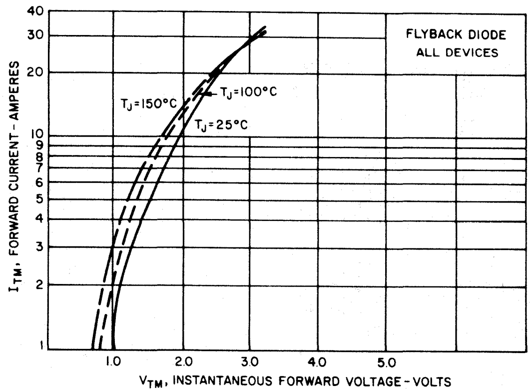


FIGURE 21. FORWARD CHARACTERISTICS

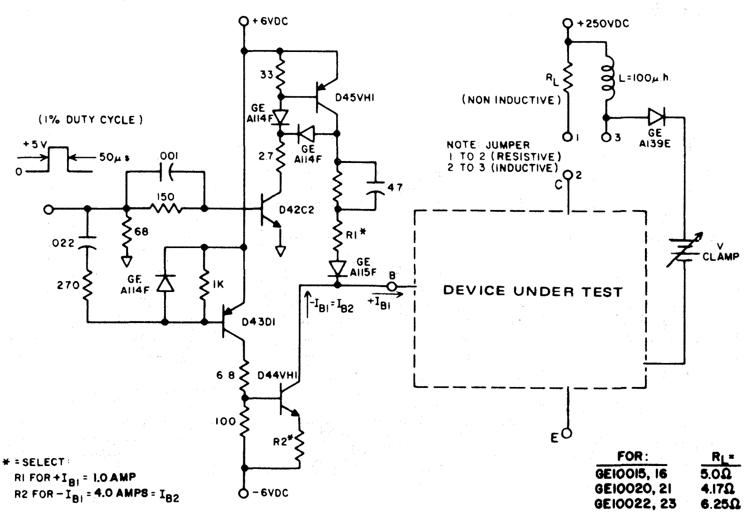


FIGURE 22. SWITCHING TIME TEST CIRCUIT

* = SELECT:
R1 FOR $+I_{B1}$ = 1.0 AMP
R2 FOR $-I_{B1}$ = 4.0 AMPS = I_{B2}

FOR:	R_L =
GE10015, 16	5.0Ω
GE10020, 21	4.17Ω
GE10022, 23	6.25Ω

File Number **15.79**

GE13070P, GE13071P

High-Speed Silicon N-P-N Power Transistors

Devices for Switching Applications

2

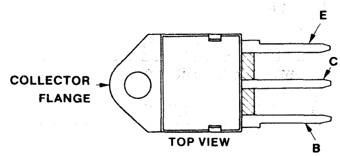
Features:

- *Fast Turn-Off Times:*
  100 ns inductive fall time @ 25° C (Typ)
  150 ns inductive crossover time @ 25° C (Typ)
  400 ns inductive storage time @ 25° C (Typ)
- *Operating temperature range -65 to +150° C*

The GE13070P and GE13071P silicon n-p-n transistors are designed for high-voltage, high-speed switching applications in inductive circuits where fall time is critical. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage currents, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-218AC plastic package.

TERMINAL DESIGNATION



JEDEC TO-218AC

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	GE13070P	GE13071P	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	5 8	5 8	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	2 4	2 4	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25°C	P_D	100 40 0.8	100 40 0.8	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	1.25	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

GE13070P, GE13071P

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]					
Collector-Emitter Sustaining Voltage (I_C = 100mA, I_B = 0) GE13070P	$V_{CEO(sus)}$	400	—	—	Volts
GE13071P		450	—	—	
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = -1.5V)	I_{CEV}	—	—	0.5	mA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -1.5V, T_C = 100°C)		—	—	2.5	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100°C)	I_{CER}	—	—	3	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)	I_{EBO}	—	—	1	mA
ON CHARACTERISTICS[1]					
DC Current Gain (I_C = 3A, V_{CE} = 5V)	h_{FE}	8	—	—	—
Collector-Emitter Saturation Voltage (I_C = 3A, I_B = 0.6A)	$V_{CE(sat)}$	—	—	1	V
(I_C = 5A, I_B = 1A)		—	—	3	
(I_C = 3A, I_B = 0.6A, T_C = 100°C)		—	—	2	
Base-Emitter Saturation Voltage (I_C = 3A, I_B = 0.6A)	$V_{BE(sat)}$	—	—	1.5	V
(I_C = 3A, I_B = 0.6A, T_C = 100°C)		—	—	1.5	

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	MIN	TYP	MAX	UNIT
Resistive Load							
Delay Time	(V_{CC} = 250V, I_C = 3A		t_d	—	0.03	0.05	μs
Rise Time	I_{B1} = 0.4A, t_p = 30 μs		t_r	—	0.1	0.4	
Storage Time	Duty Cycle < 2%, $V_{BE(OFF)}$ = -5V)		t_s	—	0.4	1.5	
Fall Time			t_f	—	0.175	0.5	
Inductive Load, Clamped							
Storage Time	$I_{C(pk)}$ = 3A	(T_J = 100°C)	t_{sv}	—	0.7	2	μs
Crossover Time	I_{B1} = 0.4A		t_c	—	0.28	0.5	
Fall Time	$V_{BE(off)}$ = -5V		t_{fi}	—	0.15	0.3	
Storage Time	$V_{CE(PK)}$ = 250V	(T_J = 25°C)	t_{sv}	—	0.4	—	
Crossover Time			t_c	—	0.15	—	
Fall Time			t_{fi}	—	0.1	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

File Number **1870**

MJ13090, MJ13091

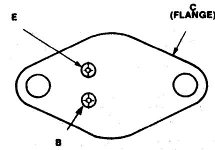
15-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:
- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 650 V to 750 V*
- *Low $V_{CE}(sat)$ at I_C = 15 A*

Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2

The RCA MJ13090 and MJ13091 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for 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 MJ13090 and MJ13091 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MJ13090	MJ13091	
V_{CEV}			
V_{BE} = −1.5 V	650	750	V
V_{CEO}	400	450	V
V_{EBO}	6	6	V
I_C	15	15	A
I_{CM}	20	20	A
I_B	5	5	A
I_{BM}	10	10	A
P_T			
@ T_C = 25° C	175	175	W
@ T_C = 100° C	100	100	W
T_C above 25° C, derate linearly	1	1	W/° C
T_{stg}, T_J	−65 to +200	−65 to +200	° C
T_L			
At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.	275	275	° C
$R_{\theta JC}$	1	1	° C/W

MJ13090, MJ13091

ELECTRICAL CHARACTERISTICS at T_C = 25°C unless otherwise noted

CHARACTERISTIC			Symbol	LIMITS Min.	Typ.	Max.	UNITS
OFF CHARACTERISTICS[1]							
Collector-Emitter Sustaining Voltage I_C = 100 mA, I_B = 0	MJ13090		V_{CEO}(sus)	400	—	—	V dc
	MJ13091			450	—	—	
Collector Cutoff Current			I_{CEV}				mA dc
V_{CEV} = Rated Value, V_{BE}(off) = 1.5 V dc				—	—	0.5	
V_{CEV} = Rated Value, V_{BE}(off) = 1.5 V dc, 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	mA dc
Emitter Cutoff Current V_{EB} = 6 V dc, I_C = 0			I_{EBO}	—	—	1	mA dc
SECOND BREAKDOWN							
Second Breakdown Collector Current with Base Forward Biased			$I_{S/b}$	See Fig. 1			
Clamped Inductive SOA with Base Reverse Biased			RBSOA	See Fig. 2			
ON CHARACTERISTICS[1]							
Collector-Emitter Saturation Voltage			V_{CE}(sat)				V dc
I_C = 10 A dc, I_B = 2 A dc				—	—	1	
I_C = 15 A dc, I_B = 3 A dc				—	—	3	
I_C = 10 A dc, I_B = 2 A dc, T_C = 100°C				—	—	2	
Base-Emitter Saturation Voltage			V_{BE}(sat)				V dc
I_C = 10 A dc, I_B = 2 A dc				—	—	1.5	
I_C = 10 A dc, I_B = 2 A dc, T_C = 100°C				—	—	1.5	
DC Current Gain I_C = 10 A dc, V_{CE} = 3 V dc			h_{FE}	8	—	—	
DYNAMIC CHARACTERISTICS							
Output Capacitance V_{CB} = 10 V dc, I_E = 0, f_{test} = 1 kHz			C_{ob}	—	—	350	pF
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	V_{CC} = 250 V dc, I_C = 10 A dc, I_{B1} = 1.25 A dc, t_p = 30 μs, Duty Cycle≤2%, V_{BE}(off) = 5 V dc		t_d	—	0.03	0.05	μs
Rise Time			t_r	—	0.13	0.5	
Storage Time			t_s	—	0.55	2.5	
Fall Time			t_f	—	0.1	0.5	
Inductive Load, Clamped							
Storage Time	$I_{C(pk)}$ = 10 A, I_{B1} = 1.25 A dc, V_{BE}(off)= 5 V dc, $V_{CE(pk)}$ = 250 V	T_J = 100°C	t_{sv}	—	0.8	3	μs
Fall Time			t_{fi}	—	0.15	0.3	
Crossover Time			t_c	—	0.175	0.4	
Storage Time		T_J = 25°C	t_{sv}	—	0.5	—	
Fall Time			t_{fi}	—	0.1	—	
Crossover Time			t_c	—	0.15	—	

[1]Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

MJ13090, MJ13091

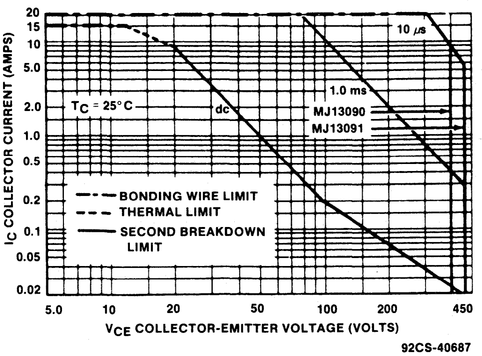


Fig. 1 - Maximum forward-bias safe-operating-areas for both types.

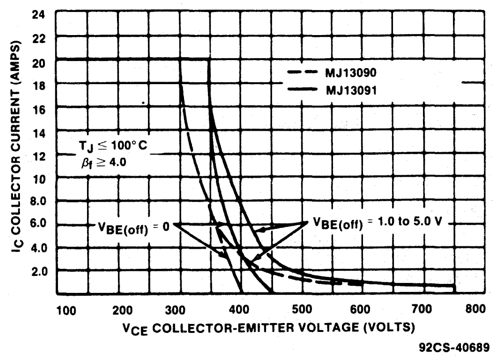


Fig. 2 - Maximum reverse-bias safe-operating-areas for both types.

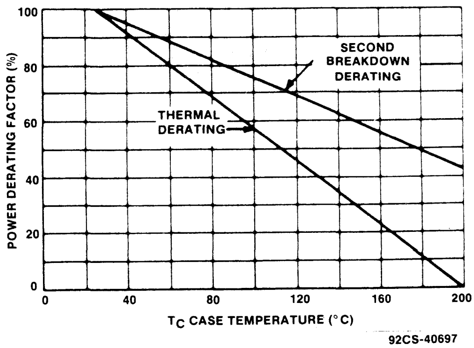


Fig. 3 - Dissipation and $I_{s/b}$ derating curves for both types.

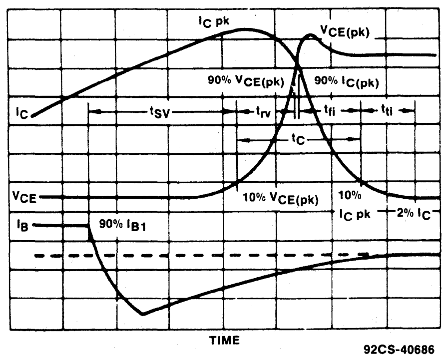


Fig. 4 - Inductive switching measurements display.

2

MJ15001, MJ15002

File Number **1093**

Complementary N-P-N/P-N-P Silicon Power Transistors

Rugged Devices, Broadly Applicable For Industrial and Commerical Use

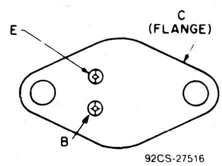
Features:

- *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	mA
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.

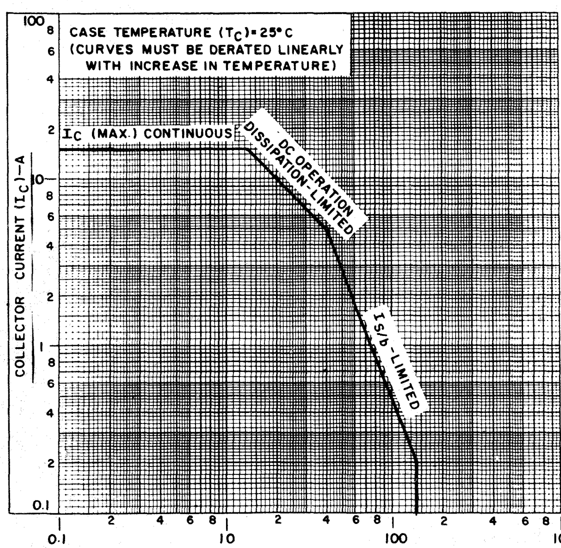


Fig. 1 - Maximum operating area for both types.

MJ15001, MJ15002

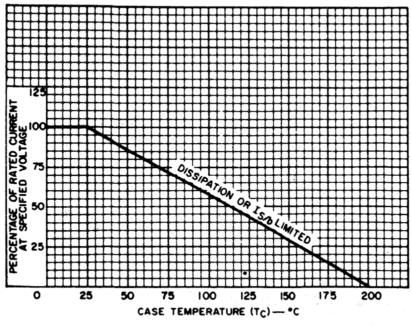


Fig. 2 - Current derating curve for both types.

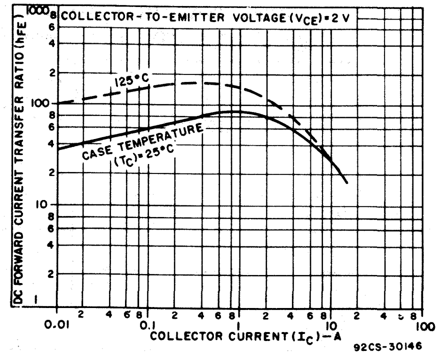


Fig. 3 - Typical dc beta characteristics as a function of collector current for MJ15001.

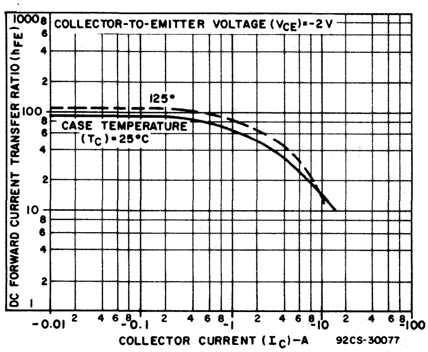


Fig. 4 - Typical dc beta characteristics as a function of collector current for MJ15002.

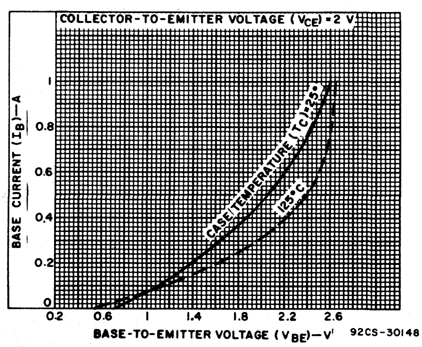


Fig. 5 - Typical input characteristics for MJ15001.

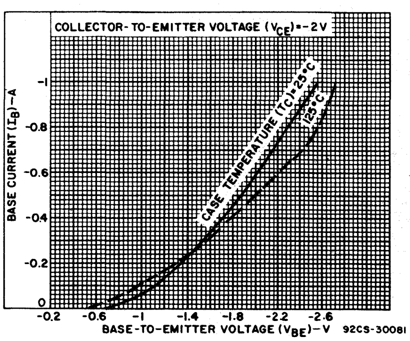


Fig. 6 - Typical input characteristics for MJ15002.

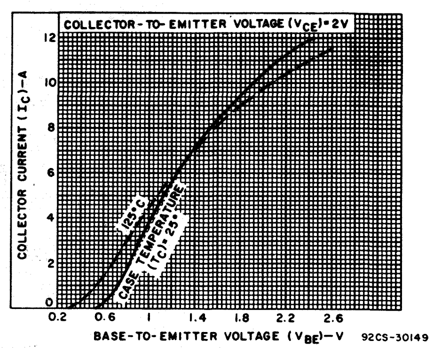


Fig. 7 - Typical transfer characteristics for MJ15001.

MJ15001, MJ15002

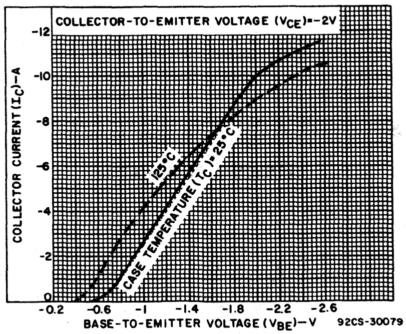


Fig. 8 - Typical transfer characteristics for MJ15002.

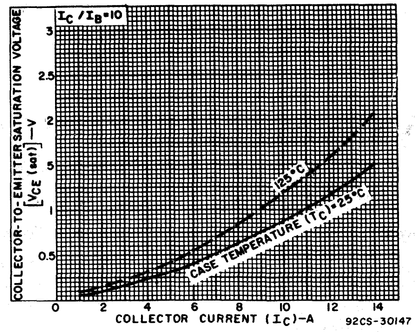


Fig. 9 - Typical saturation voltage characteristics for MJ15001.

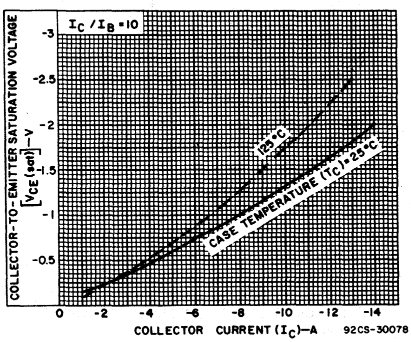


Fig. 10 - Typical saturation voltage characteristics for MJ15002.

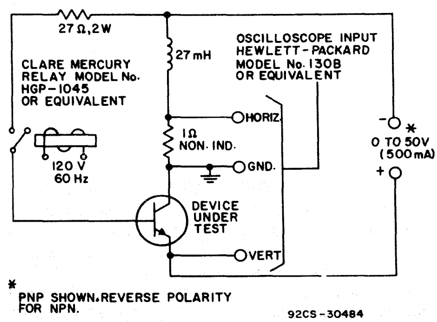


Fig. 11 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$.

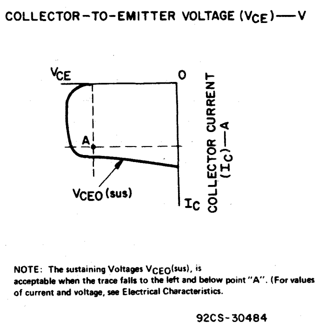


Fig. 12 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 11).

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

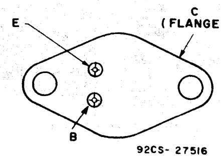
Features:

- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 850 V*
- *Low $V_{CE}(sat)$ at I_c = 10A*

Applications:

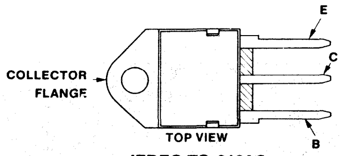
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



MJ16010
MJ16012

JEDEC TO-204AA
(200 mil diameter pin isolation)



MJH16010
MJH16012

JEDEC TO-218AC

92CS-40257

The MJ16010, MJ16012, MJH16010, and MJH16012 SwitchMax II series of silicon n-p-n power transistors feature high voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are specified at 100°C to provide information necessary for worst-case design.

The MJ16010 and MJ16012 transistors are supplied in steel JEDEC TO-204AA hermetic packages. The MJH16010 and MJH16012 transistors are supplied in JEDEC TO-218AC plastic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MJ16010 MJ16012	MJH16010 MJH16012	
V_{CEV} V_{BE} = −1.5 V	850	850	V
V_{CEO}	450	450	V
V_{EBO}	6	6	V
I_C(sat)	10	10	A
I_C	15	15	A
I_{CM}	20	20	A
I_B	10	10	A
I_{BM}	15	15	A
P_T @ T_C = 25°C	175	135	W
@ T_C = 100°C	100	53.8	W
T_C above 25°C, derate linearly	1	1.08	W/°C
T_{stg}, T_J	-65 to 200	-65 to 150	°C
TL At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max		235	°C
T_L At distance ≥ 1/16" in. (1.58 mm) from seating plane for 10 s max.	235		°C
$R_{\theta JC}$	1	0.93	°C/W

MJ16010, MJ16012, MJH16010, MJH16012

MJ16010, MJH16010

ELECTRICAL CHARACTERISTICS (T_C = 25°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 (V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	I_{CEV}	—	—	0.25	mAdc
(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 (I_C = 5.0 Adc, I_B = 0.7 Adc)	$V_{CE(sat)}$	—	0.5	2.5	Vdc
(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 (I_C = 10 Adc, I_B = 1.3 Adc)	$V_{BE(sat)}$	—	1.0	1.5	Vdc
(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 (V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)			I_{CEV}	— —	— —	0.25 1.5	mAdc
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 (I_C = 5.0 Adc, I_B = 0.5 Adc) (I_C = 10 Adc, I_B = 1.0 Adc) (I_C = 10 Adc, I_B = 1.0 Adc, T_C = 100°C)			$V_{CE(sat)}$	— — —	— — —	2.5 3.0 3.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 Adc, I_B = 1.0 Adc) (I_C = 10 Adc, I_B = 1.0 Adc, T_C = 100°C)			$V_{BE(sat)}$	— —	— —	1.5 1.5	Vdc
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							
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

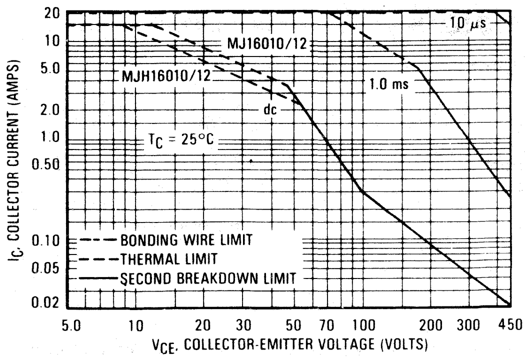


Fig. 1 — Maximum forward-bias safe-operating-areas for all types.

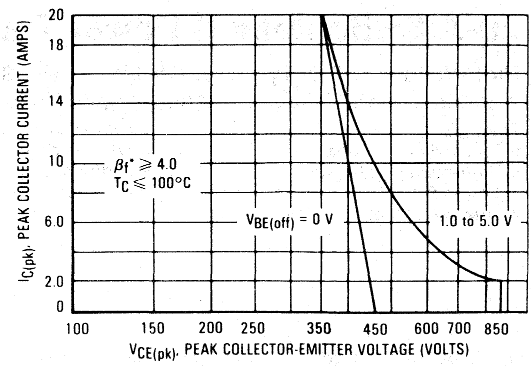


Fig. 2 — Maximum reverse-bias safe-operating-areas for all types.

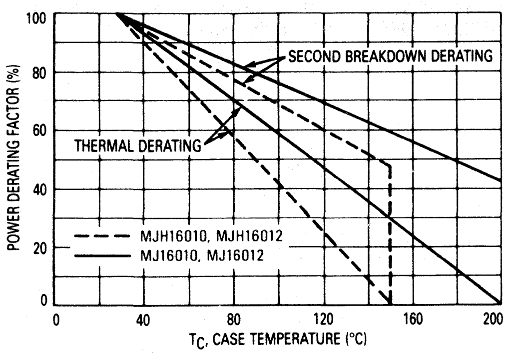


Fig. 3 — Dissipation and $I_{s\,b}$ derating curves for all types.

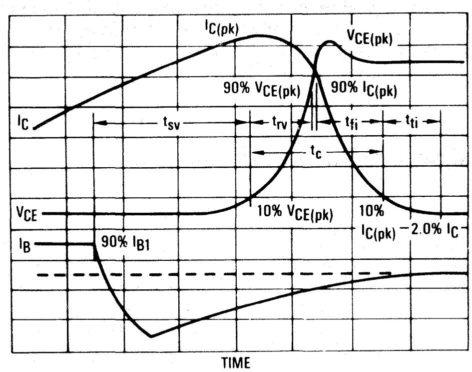


Fig. 4 — Inductive switching measurements display.

MJ16014, MJ16016

File Number **1871**

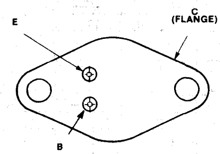
20-A SwitchMax II Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

Features:
- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 850 V*
- *Low $V_{CE}(sat)$ at I_C = 10 A*

Applications:
- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AE

The RCA MJ16014 and MJ16016 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for 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 MJ16014 and MJ16016 transistors are supplied in steel modified JEDEC TO-204AE hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MJ16014 MJ16016	
V_{CEV}		
V_{BE} = −1.5 V	850	V
V_{CEO}	450	V
V_{EBO}	6	V
I_C	20	A
I_{CM}	30	A
I_B	10	A
I_{BM}	20	A
P_T		
@ T_C = 25° C	250	W
@ T_C = 100° C	143	W
T_C above 25° C, derate linearly	1.43	W/° C
T_{stg}, T_J	-65 to +200	° C
T_L		
At distance ≥ ⅛ in. (3.17 mm) from seating plane for 10 s max.	275	° C
$R_{\theta JC}$	0.7	° C/W

MJ16014, MJ16016

MJ16014
ELECTRICAL CHARACTERISTICS at T_C = 25°C unless otherwise noted

CHARACTERISTIC			Symbol	LIMITS Min.	Typ.	Max.	UNITS
OFF CHARACTERISTICS[1]							
Collector-Emitter Sustaining Voltage I_C = 100 mA, I_B = 0			$V_{CEO}(sus)$	450	—	—	V dc
Collector Cutoff Current V_{CEV} = 850 V dc, $V_{BE}(off)$ = 1.5 V dc V_{CEV} = 850 V dc, $V_{BE}(off)$ = 1.5 V dc, T_C = 100°C			I_{CEV}	— —	— —	0.25 1.5	mA dc
Collector Cutoff Current V_{CE} = 850 V dc, R_{BE} = 50 Ω, T_C = 100°C			I_{CER}	—	—	2.5	mA dc
Emitter Cutoff Current V_{EB} = 6 V dc, I_C = 0			I_{EBO}	—	—	1	mA dc
SECOND BREAKDOWN							
Second Breakdown Collector Current with Base Forward Biased			$I_{S/b}$	See Fig. 1			
Clamped Inductive SOA with Base Reverse Biased			RBSOA	See Fig. 2			
ON CHARACTERISTICS[1]							
Collector-Emitter Saturation Voltage I_C = 10 A dc, I_B = 1.3 A dc I_C = 15 A dc, I_B = 2 A dc I_C = 15 A dc, I_B = 2 A dc, T_C = 100°C			$V_{CE}(sat)$	— — —	— — —	2.5 3 3	V dc
Base-Emitter Saturation Voltage I_C = 15 A dc, I_B = 2 A dc I_C = 15 A dc, I_B = 2 A dc, T_C = 100°C			$V_{BE}(sat)$	— —	— —	1.5 1.5	V dc
DC Current Gain I_C = 20 A dc, V_{CE} = 5 V dc			h_{FE}	5	—	—	
DYNAMIC CHARACTERISTICS							
Output Capacitance V_{CB} = 10 V dc, I_E = 0, f_{test} = 1 kHz			C_{ob}	—	—	500	pF
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	I_C = 15 A dc, V_{CC} = 250 V dc, I_{B1} = 2 A dc, PW = 30 µs, Duty Cycle≤2%	I_{B2} = 4 A dc, R_B = 1.6 Ω	t_d	—	20	50	ns
Rise Time			t_r	—	200	500	ns
Storage Time			t_s	—	1200	2700	ns
Fall Time			t_f	—	200	350	ns
Storage Time		$V_{BE}(off)$=5 V dc	t_s	—	650	—	ns
Fall Time			t_f	—	80	—	ns
Inductive Load							
Storage Time	I_C = 15 A dc, I_{B1} = 2 A dc, $V_{BE}(off)$= 5 V dc, $V_{CE(pk)}$=400 V dc	T_C = 100°C	t_{sv}	—	800	2700	ns
Fall Time			t_{fi}	—	50	200	ns
Crossover Time			t_c	—	90	250	ns
Storage Time		T_C = 150°C	t_{sv}	—	1050	—	ns
Fall Time			t_{fi}	—	70	—	ns
Crossover Time			t_c	—	120	—	ns

[1]Pulse Test: Pulse Width = 300 µs, Duty Cycle ≤ 2%.

MJ16014, MJ16016

MJ16016
ELECTRICAL CHARACTERISTICS at T_C = 25° C unless otherwise noted

CHARACTERISTIC		Symbol		LIMITS Min.	Typ.	Max.	UNITS
OFF CHARACTERISTICS[1]							
Collector-Emitter Sustaining Voltage I_C = 100 mA, I_B = 0		V_{CEO}(sus)		450	—	—	V dc
Collector Cutoff Current V_{CEV} = 850 V dc, V_{BE}(off) = 1.5 V dc		I_{CEV}		—	—	0.25	mA dc
V_{CEV} = 850 V dc, V_{BE}(off) = 1.5 V dc, T_C = 100° C				—	—	1.5	mA dc
Collector Cutoff Current V_{CE} = 850 V dc, R_{BE} = 50 Ω, T_C = 100° C		I_{CER}		—	—	2.5	mA dc
Emitter Cutoff Current V_{EB} = 6 V dc, I_C = 0		I_{EBO}		—	—	1	mA dc
SECOND BREAKDOWN							
Second Breakdown Collector Current with Base Forward Biased		$I_{S/b}$		See Fig. 1			
Clamped Inductive SOA with Base Reverse Biased		RBSOA		See Fig. 2			
ON CHARACTERISTICS[1]							
Collector-Emitter Saturation Voltage I_C = 10 A dc, I_B = 1 A dc		V_{CE}(sat)		—	—	2.5	V dc
I_C = 15 A dc, I_B = 1.5 A dc				—	—	3	V dc
I_C = 15 A dc, I_B = 1.5 A dc, T_C = 100° C				—	—	3	V dc
Base-Emitter Saturation Voltage I_C = 15 A dc, I_B = 1.5 A dc		V_{BE}(sat)		—	—	1.5	V dc
I_C = 15 A dc, I_B = 1.5 A dc, T_C = 100° C				—	—	1.5	V dc
DC Current Gain I_C = 20 A dc, V_{CE} = 5 V dc		h_{FE}		7	—	—	
DYNAMIC CHARACTERISTICS							
Output Capacitance V_{CB} = 10 V dc, I_E = 0, f_{test} = 1 kHz		C_{ob}		—	—	500	pF
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	I_C = 15 A dc, V_{CC} = 250 V dc, I_{B1} = 1.5 A dc, PW = 30 μs, Duty Cycle≤2%	I_{B2} = 3 A dc, R_B = 1.6 Ω	t_d	—	20	50	ns
Rise Time			t_r	—	200	500	ns
Storage Time			t_s	—	900	2200	ns
Fall Time			t_f	—	100	250	ns
Storage Time		V_{BE}(off)=5 V dc	t_s	—	500	—	ns
Fall Time			t_f	—	40	—	ns
Inductive Load							
Storage Time	I_C = 15 A dc, I_{B1} = 1.5 A dc, V_{BE}(off)= 5 V dc, $V_{CE(pk)}$=400 V dc	T_C = 100° C	t_{sv}	—	750	2500	ns
Fall Time			t_{fi}	—	30	150	ns
Crossover Time			t_c	—	50	200	ns
Storage Time		T_C = 150° C	t_{sv}	—	900	—	ns
Fall Time			t_{fi}	—	30	—	ns
Crossover Time			t_c	—	70	—	ns

[1]Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

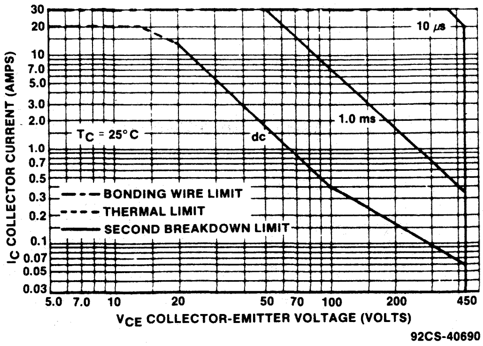


Fig. 1 - Maximum forward-bias safe-operating-areas for both types.

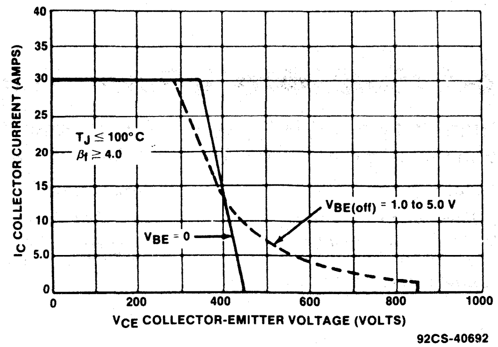


Fig. 2 - Maximum reverse-bias safe-operating-areas for both types.

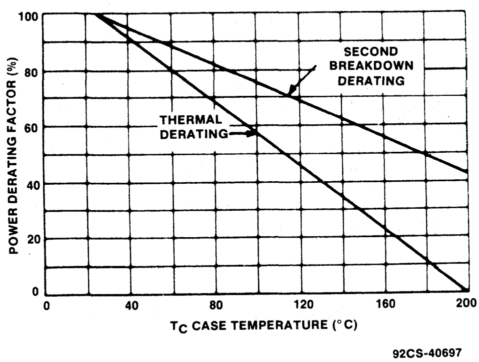


Fig. 3 - Dissipation and $I_{s/b}$ derating curves for both types.

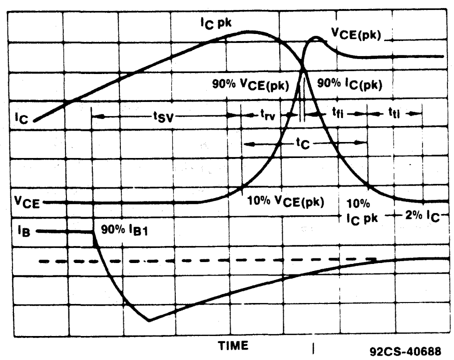


Fig. 4 - Inductive switching measurements display.

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

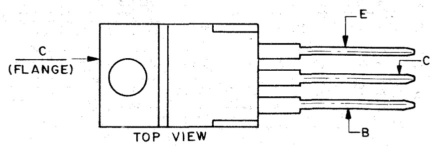
Features:

- *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 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

MJE13004, MJE13005

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%.

2

MJE13004, MJE13005

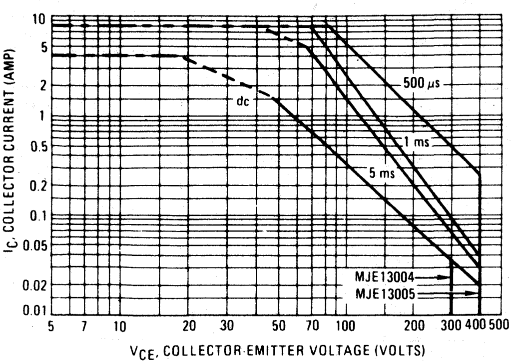


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

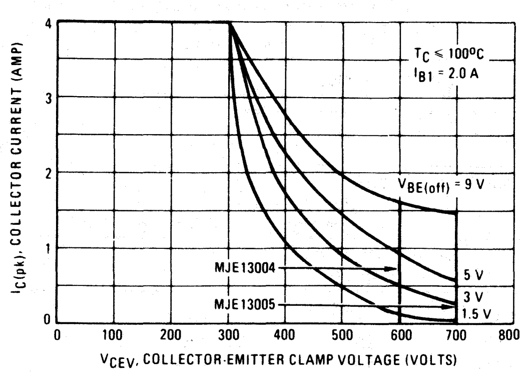


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

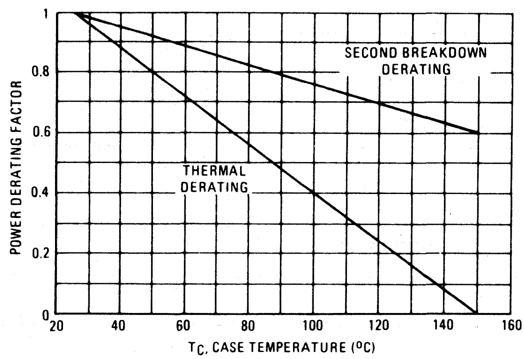


Fig. 3 — Dissipation and $I_{s\,b}$ derating curves for both types.

File Number **15.89**

MJE13006

High-Speed Silicon N-P-N Power Transistors

2

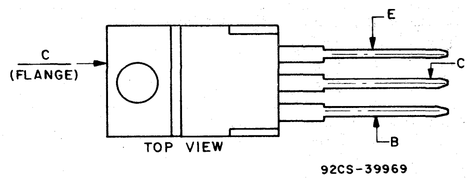
Features:

- $V_{CEO[sus]}$ = 300V (Min.)
- V_{CEV} = 600V blocking capability
- Excellent switching time: t_r = 1.5 μs (Max.), t_f = 0.7 μs (Max.)

The MJE13006 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	MJE13006	UNITS
Collector-Emitter Voltage	V_{CEO}	300	Volts
Collector-Emitter Voltage	V_{CEV}	600	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	8 16	A
Base Current — Continuous Pulse	I_B I_{BP}	4 8	A
Emitter Current — Continuous Pulse	I_E I_{EP}	12 24	A
Collector Power Dissipation T_A = 25°C Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation T_C = 25°C Derate above 25°C	P_C	80 640	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	°C

MJE13006

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)					
Collector-Emitter Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	300	—	—	Volts
Collector Cutoff Current (V_{CE} = 600V, V_{BE} = -1.5V)	I_{CEV}	—	—	1	mA
(V_{CE} = 600V, V_{BE} = -1.5V, T_C = 100°C)		—	—	5	
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)	I_{EBO}	—	—	1	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1			
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 2			
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 2A, V_{CE} = 5V)	h_{FE}	8	—	60	—
(I_C = 5A, V_{CE} = 5V)		5	—	30	
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 0.4A)	$V_{CE(sat)}$	—	—	1	V
(I_C = 5A, I_B = 1A)		—	—	2	
(I_C = 8A, I_B = 2A)		—	—	3	
(I_C = 5A, I_B = 1A, T_C = 100°C)		—	—	3	
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 0.4A)	$V_{BE(sat)}$	—	—	1.2	V
(I_C = 5A, I_B = 1A)		—	—	1.6	
(I_C = 5A, I_B = 1A, T_C = 100°C)		—	—	1.5	
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{ob}	—	90	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	4	—	—	MHz

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 5A	t_d	—	—	0.1	μs
Rise Time	I_{B1} = $-I_{B2}$ = 1A, t_p = 25 μs	t_r	—	—	1.5	
Storage Time	Duty Cycle < 1%)	t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	Inductive Load (I_C = 5A, V_{clamp} = 300V, I_{B1} = 1A,	t_{sv}	—	—	2.3	μs
Crossover Time	$V_{BE(off)}$ = -5V, T_C = 100°C)	t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

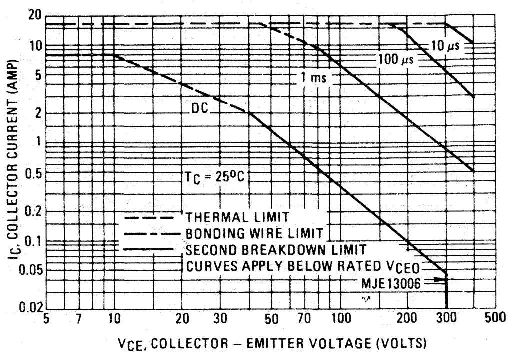


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

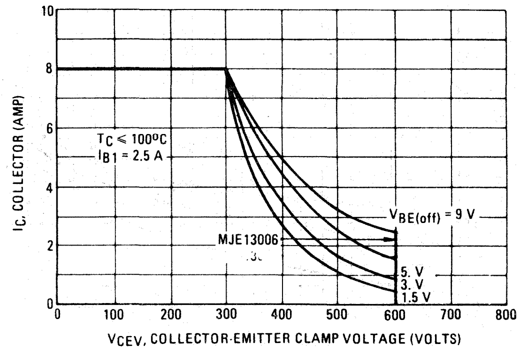


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

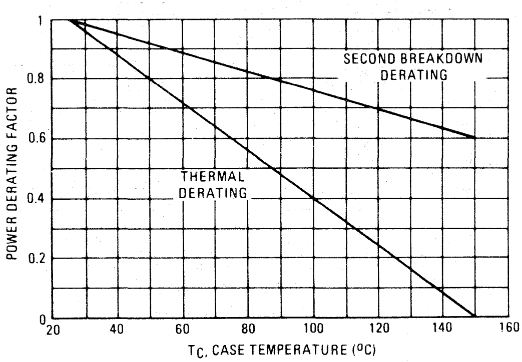


FIGURE 3 – FORWARD BIAS POWER DERATING

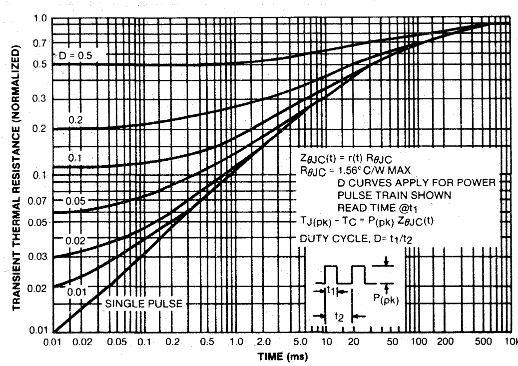


FIGURE 4 TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$)]

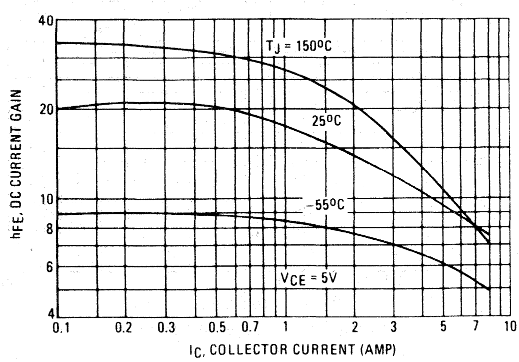


FIGURE 5 –DC CURRENT GAIN

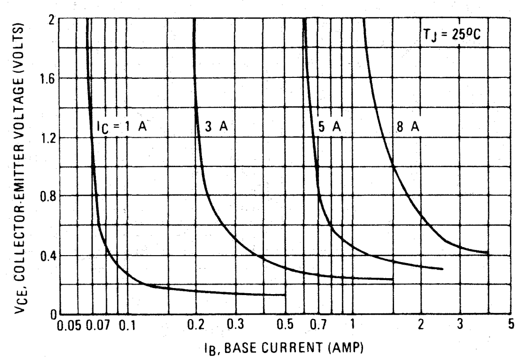


FIGURE 6 – COLLECTOR SATURATION REGION

MJE13006

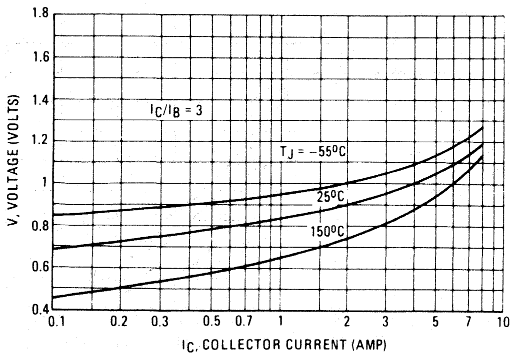


FIGURE 7 — BASE-EMITTER SATURATION VOLTAGE

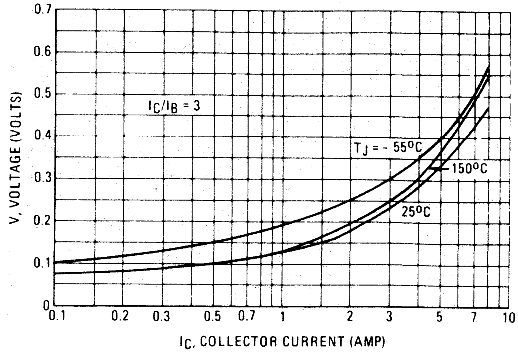


FIGURE 8 — COLLECTOR-EMITTER SATURATION VOLTAGE

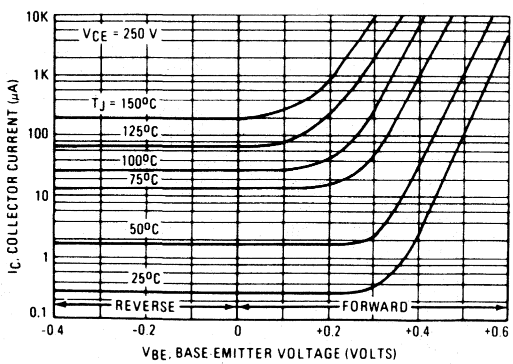


FIGURE 9 — COLLECTOR CUTOFF REGION

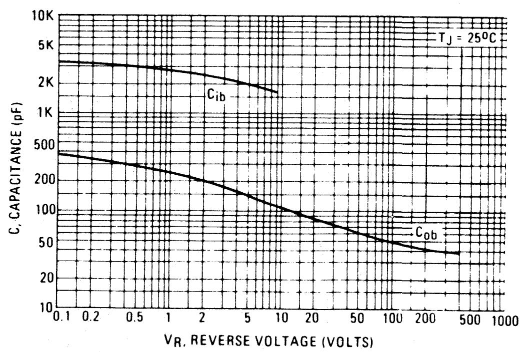


FIGURE 10 — CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

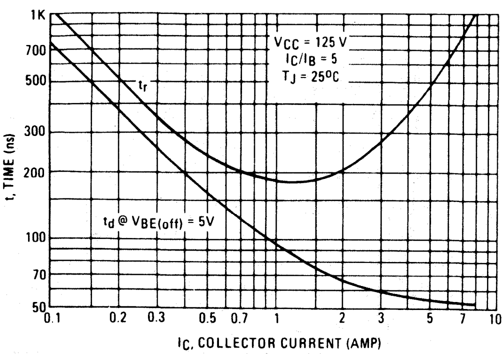


FIGURE 11 — TURN-ON TIME

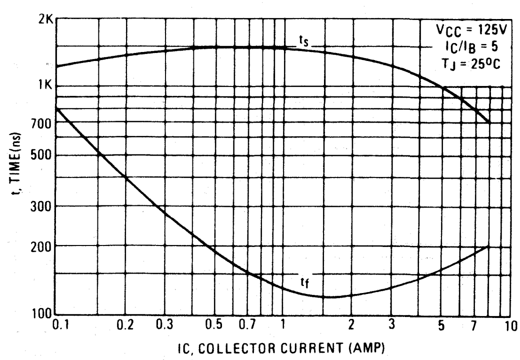


FIGURE 12 — TURN-OFF TIME

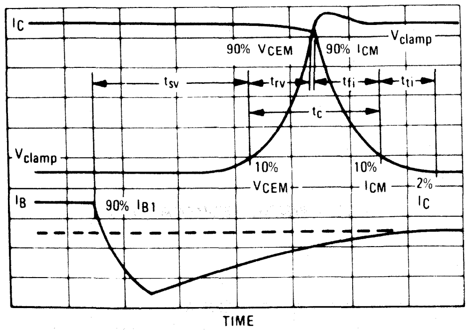


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

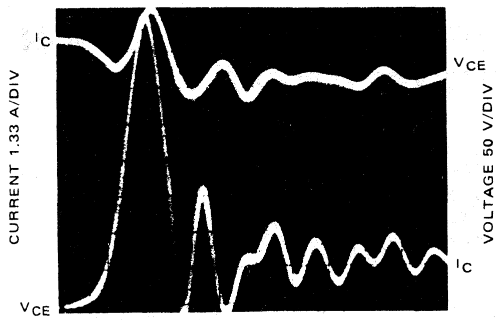


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 8A with I_{B1} = 1.6A and $V_{BE(off)}$ = 5 V)

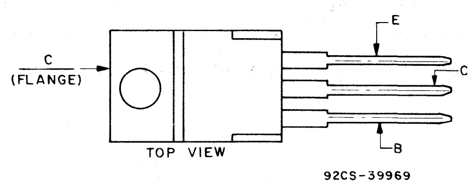
MJE13007 File Number **15.90**

High-Speed Silicon N-P-N Power Transistors

Features:

- $V_{CEO[sus]}$ = 400V (Min.)
- V_{CEV} = 700V blocking capability
- Excellent switching time: t_r = 1.5 μs (Max.), t_f = 0.7 μs (Max.)

TERMINAL DESIGNATION



JEDEC TO-220AB

The MJE13007 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	MJE13007	UNITS
Collector-Emitter Voltage	V_{CEO}	400	Volts
Collector-Emitter Voltage	V_{CEV}	700	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	8 16	A
Base Current — Continuous Pulse	I_B I_{BP}	4 8	A
Emitter Current — Continuous Pulse	I_E I_{EP}	12 24	A
Collector Power Dissipation T_A = 25°C Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation T_C = 25°C Derate above 25°C	P_C	80 640	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	°C

MJE13007

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Voltage (I_C = 10mA, I_B = 0)		$V_{CEO(sus)}$	400	—	—	Volts
Collector Cutoff Current (V_{CE} = 700V, V_{BE} = -1.5V) (V_{CE} = 700V, V_{BE} = -1.5V, T_C = 100°C)		I_{CEV}	— —	— —	1 5	mA
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)		I_{EBO}	—	—	1	mA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 1			
Clamped Inductive SOA with Base Reversed Bias		RBSOA	SEE FIGURE 2			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 2A, V_{CE} = 5V) (I_C = 5A, V_{CE} = 5V)		h_{FE}	8 5	— —	60 30	—
Collector-Emitter Saturation Voltage (I_C = 2A, I_B = 0.4A) (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 2A) (I_C = 5A, I_B = 1A, T_C = 100°C)		$V_{CE(sat)}$	— — — —	— — — —	1 2 3 3	V
Base-Emitter Saturation Voltage (I_C = 2A, I_B = 0.4A) (I_C = 5A, I_B = 1A) (I_C = 5A, I_B = 1A, T_C = 100°C)		$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)		C_{ob}	—	90	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1 MHz)		f_T	4	—	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 2A	t_d	—	—	0.1	μs
Rise Time	I_{B1} = -I_{B2} = 0.4A, t_p = 25 μs	t_r	—	—	1.5	
Storage Time	Duty Cycle < 1%)	t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	Inductive Load (I_C = 5A, V_{clamp} = 300V, I_{B1} = 1A,	t_{sv}	—	—	2.3	μs
Crossover Time	$V_{BE(off)}$ = -5V, T_C = 100°C)	t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

MJE13007

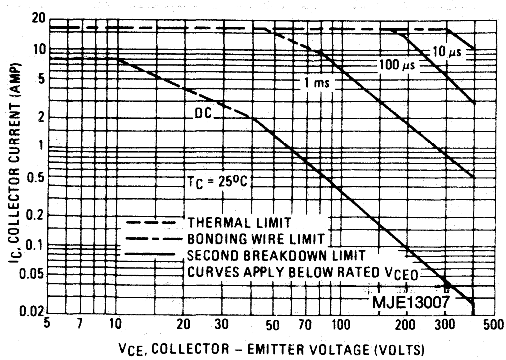


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

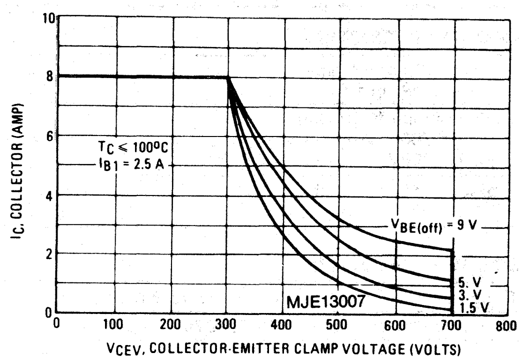


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

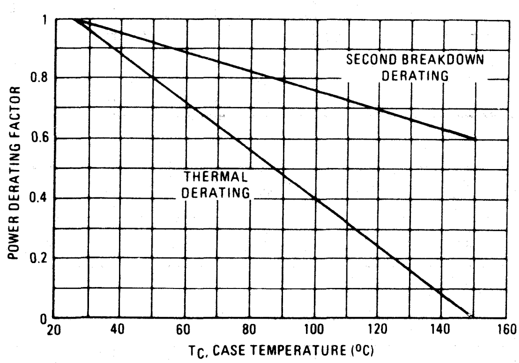


FIGURE 3 – FORWARD BIAS POWER DERATING

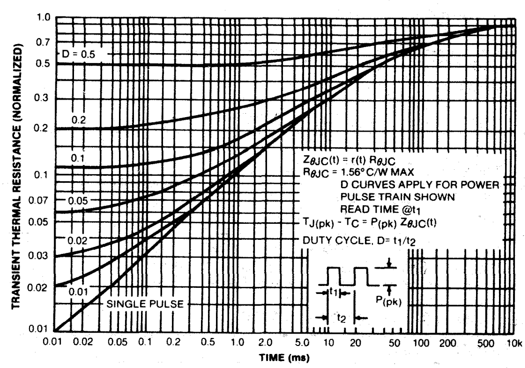


FIGURE 4 TYPICAL THERMAL RESPONSE [(ZθJC(t)]

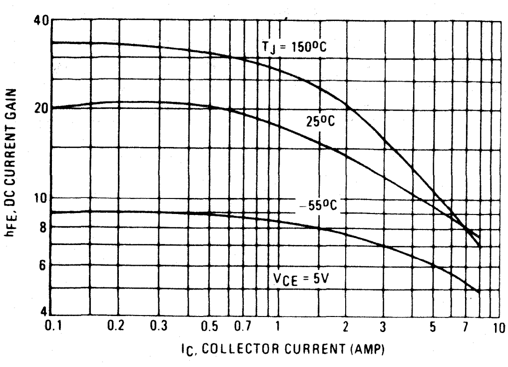


FIGURE 5 –DC CURRENT GAIN

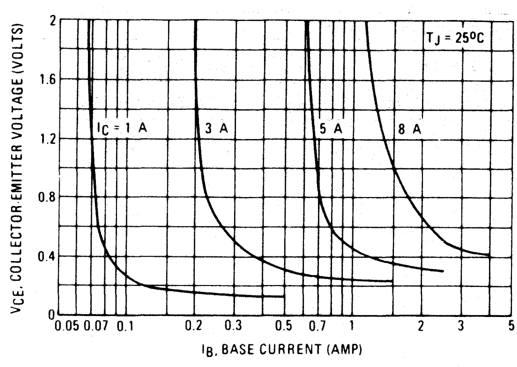


FIGURE 6 – COLLECTOR SATURATION REGION

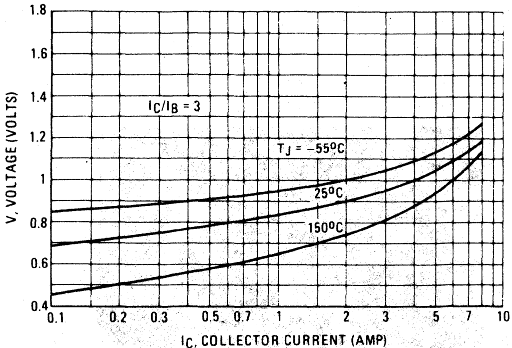


FIGURE 7 — BASE-EMITTER SATURATION VOLTAGE

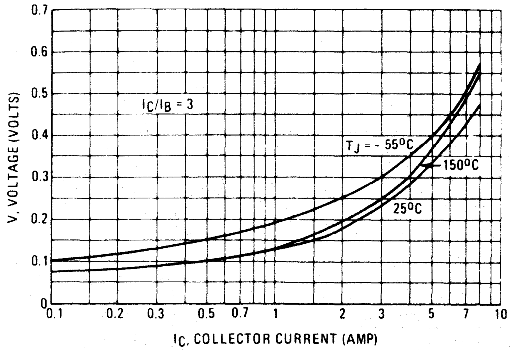


FIGURE 8 — COLLECTOR-EMITTER SATURATION VOLTAGE

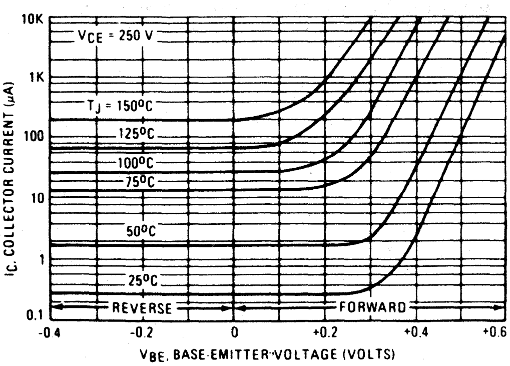


FIGURE 9 — COLLECTOR CUTOFF REGION

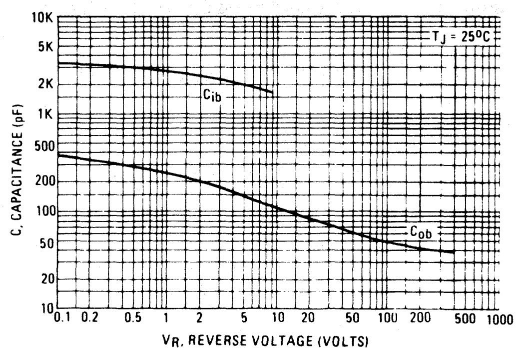


FIGURE 10 — CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

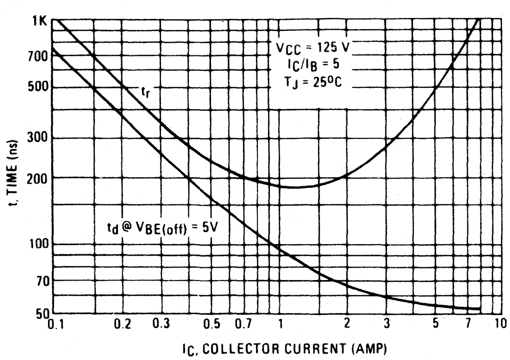


FIGURE 11 — TURN-ON TIME

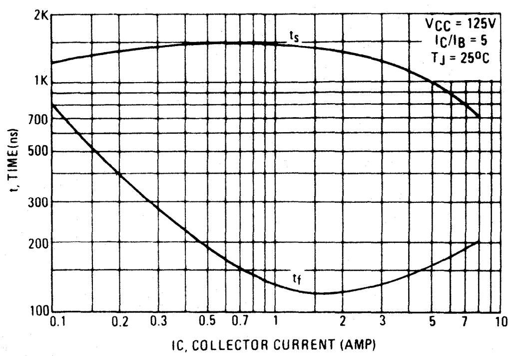


FIGURE 12 — TURN-OFF TIME

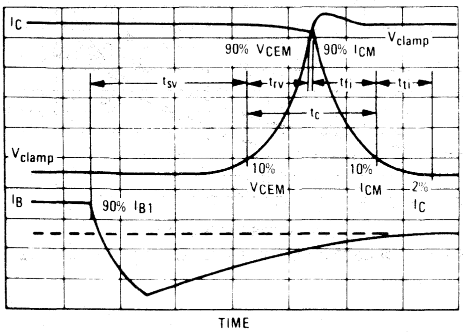


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

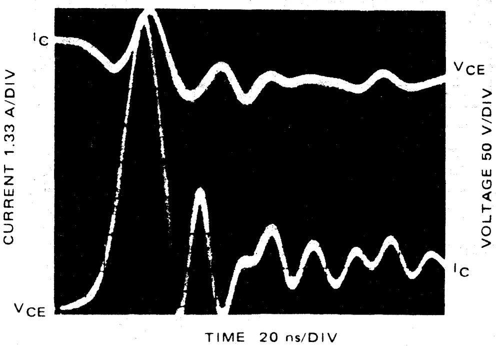


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 8A with I_{B1} = 1.6A and $V_{BE(off)}$ = 5 V)

File Number **15.91**

MJE13008

High-Speed Silicon N-P-N Power Transistors

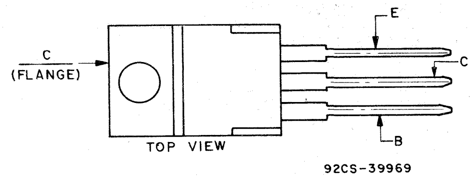
Features:

- *$V_{CEO[sus]}$ = 300V (Min.)*
- *V_{CEV} = 600V blocking capability*
- *Excellent switching time: t_r = 1 μs (Max.), t_f = 0.7 μs (Max.)*

The MJE13008 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25°C and 100°C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25°C) (unless otherwise specified)

RATING	SYMBOL	MJE13008	UNITS
Collector-Emitter Voltage	V_{CEO}	300	Volts
Collector-Emitter Voltage	V_{CEV}	600	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	12 24	A
Base Current — Continuous Pulse	I_B I_{BP}	6 12	A
Emitter Current — Continuous Pulse	I_E I_{EP}	18 36	A
Collector Power Dissipation T_A = 25°C Derate above 25°C	P_C	2 16	Watts mW/°C
Collector Power Dissipation T_C = 25°C Derate above 25°C	P_C	100 800	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	°C

MJE13008

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)					
Collector-Emitter Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	300	—	—	Volts
Collector Cutoff Current (V_{CE} = 600V, V_{BE} = -1.5V) (V_{CE} = 600V, V_{BE} = -1.5V, T_C = 100°C)	I_{CEV}	— —	— —	1 5	mA
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)	I_{EBO}	—	—	1	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1			
Clamped Inductive SOA with Base Reversed Bias	RBSOA	SEE FIGURE 2			
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 5A, V_{CE} = 5V) (I_C = 8A, V_{CE} = 5V)	h_{FE}	8 6	— —	40 30	—
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A) (I_C = 12A, I_B = 3A) (I_C = 8A, I_B = 1.6A, T_C = 100°C)	$V_{CE(sat)}$	— — — —	— — — —	1 1.5 3 2	V
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A) (I_C = 8A, I_B = 1.6A) (I_C = 8A, I_B = 1.6A, T_C = 100°C)	$V_{BE(sat)}$	— — —	— — —	1.2 1.6 1.5	V
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz)	C_{ob}	—	130	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	4	—	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 8A	t_d	—	—	0.1	μs
Rise Time	I_{B1} = $-I_{B2}$ = 1.6A, t_p = 25 μs	t_r	—	—	1	
Storage Time	Duty Cycle < 1%)	t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	(I_C = 8A, V_{clamp} = 300V	t_{sv}	—	—	2.3	μs
Crossover Time	I_{B1} = 1.6A, $V_{BE(off)}$ = -5V, T_C = 100°C)	t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2%.

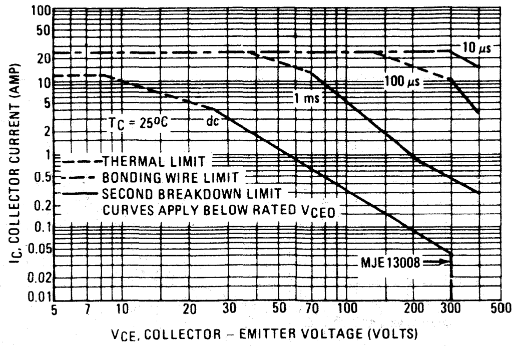


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

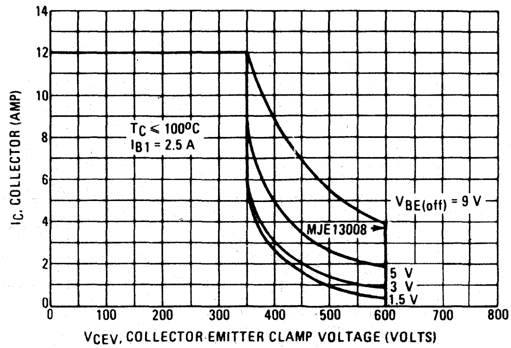


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

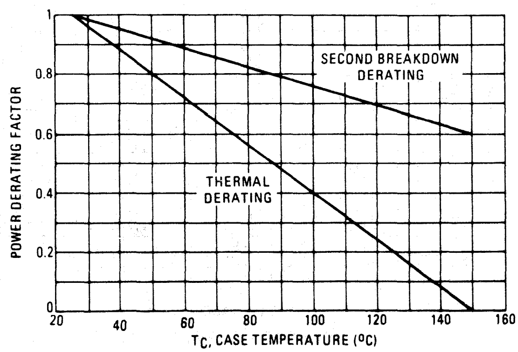


FIGURE 3 – FORWARD BIAS POWER DERATING

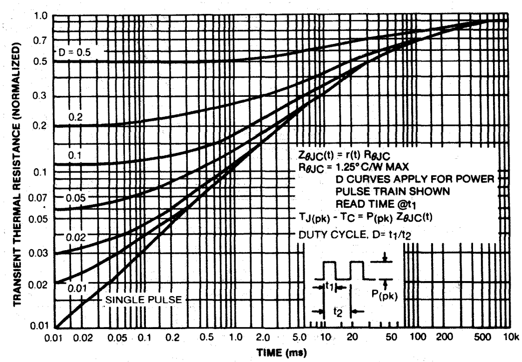


FIGURE 4 TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$)]

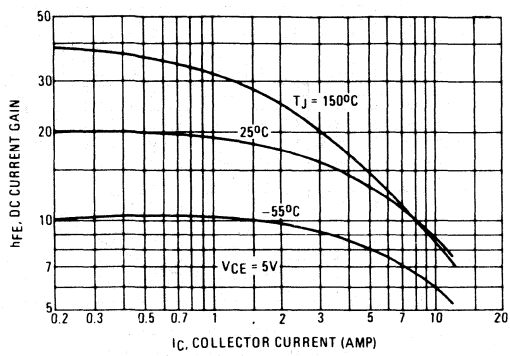


FIGURE 5 – DC CURRENT GAIN

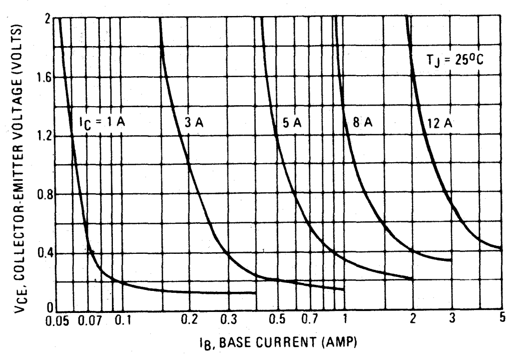


FIGURE 6 – COLLECTOR SATURATION REGION

MJE13008

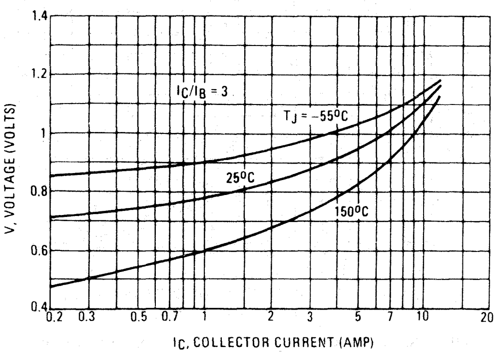


FIGURE 7 – BASE-EMITTER SATURATION VOLTAGE

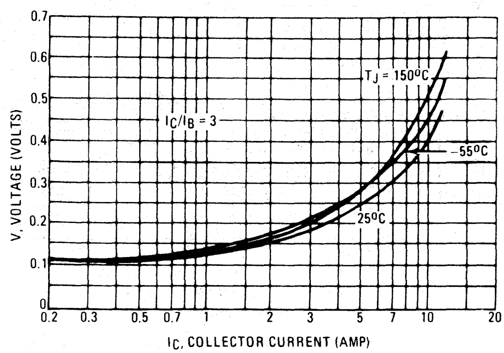


FIGURE 8 – COLLECTOR-EMITTER SATURATION VOLTAGE

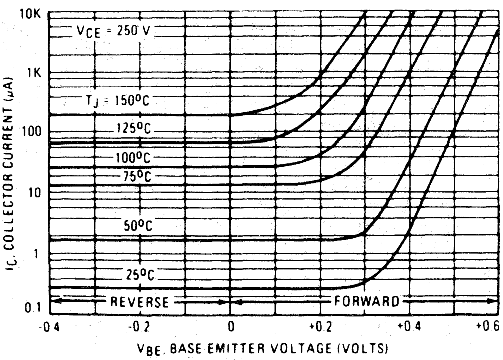


FIGURE 9 – COLLECTOR CUTOFF REGION

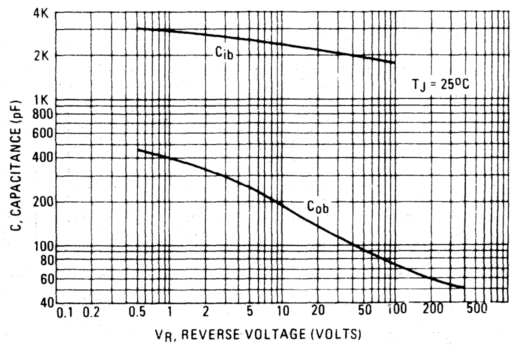


FIGURE 10 – CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

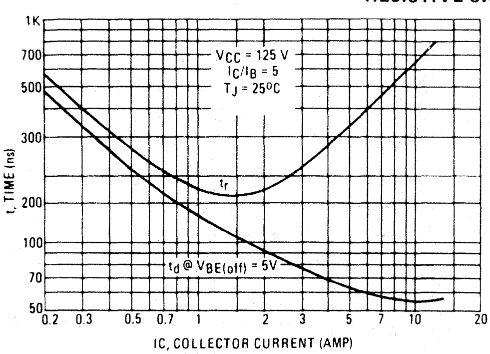


FIGURE 11 – TURN-ON TIME

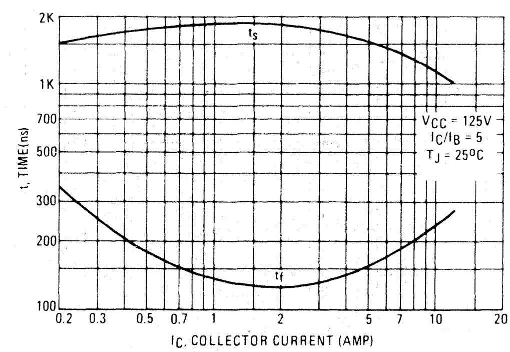


FIGURE 12 – TURN-OFF TIME

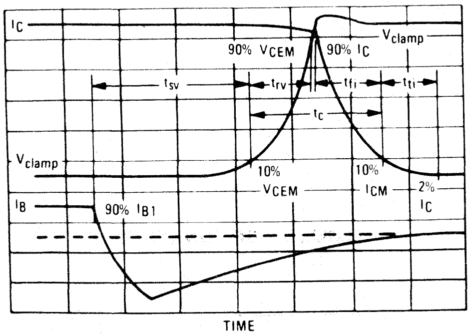


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

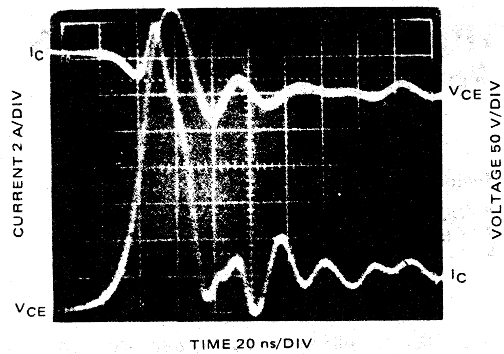


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 12 A with I_{B1} = 2.4 A and $V_{BE(off)}$ = 5 V)

2

MJE13009

File Number **15.92**

High-Speed Silicon N-P-N Power Transistors

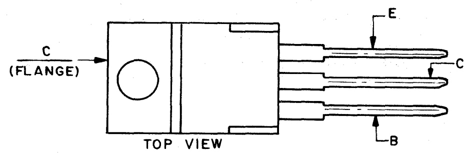
Features:

- $V_{CEO[sus]}$ = 400V (Min.)
- V_{CEV} = 700V blocking capability
- *Excellent switching time:* t_r = 1 μs (Max.), t_f = 0.7 μs (Max.)

The MJE13009 silicon n-p-n power transistor features high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25° C and 100° C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	MJE13009	UNITS
Collector-Emitter Voltage	$V_{CEO(sus)}$	400	Volts
Collector-Emitter Voltage	V_{CEV}	700	Volts
Emitter Base Voltage	V_{EBO}	9	Volts
Collector Current — Continuous Pulse	I_C I_{CP}	12 24	A
Base Current — Continuous Pulse	I_B I_{BP}	6 12	A
Emitter Current — Continuous Pulse	I_E I_{EP}	18 36	A
Collector Power Dissipation T_A = 25°C Derate above 25° C	P_C	2 16	Watts mW/° C
Collector Power Dissipation T_C = 25°C Derate above 25° C	P_C	100 800	Watts mW/° C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-65 to +150	° C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	° C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	° C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	° C

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)					
Collector-Emitter Voltage (I_C = 10mA, I_B = 0)	$V_{CEO(sus)}$	400	—	—	Volts
Collector Cutoff Current (V_{CE} = 700V, V_{BE} = -1.5V)	I_{CEV}	—	—	1	mA
(V_{CE} = 700V, V_{BE} = -1.5V, T_C = 100°C)		—	—	5	
Emitter Cutoff Current (V_{EB} = 9V, I_C = 0)	I_{EBO}	—	—	1	mA
SECOND BREAKDOWN					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1			
Clamped Inductive soa with Base Reversed Bias	RBSOA	SEE FIGURE 2			
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 5A, V_{CE} = 5V)	h_{FE}	8	—	40	—
(I_C = 8A, V_{CE} = 5V)		6	—	30	
Collector-Emitter Saturation Voltage (I_C = 5A, I_B = 1A)	$V_{CE(sat)}$	—	—	1	V
(I_C = 8A, I_B = 1.6A)		—	—	1.5	
(I_C = 12A, I_B = 3A)		—	—	3	
(I_C = 8A, I_B = 1.6A, T_C = 100°C)		—	—	2	
Base-Emitter Saturation Voltage (I_C = 5A, I_B = 1A)	$V_{BE(sat)}$	—	—	1.2	V
(I_C = 8A, I_B = 1.6A)		—	—	1.6	
(I_C = 8A, I_B = 1.6A, T_C = 100°C)		—	—	1.5	
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 0.1 MHz	C_{ob}	—	130	—	pF
Current Gain — Bandwidth Product (I_C = 500mA, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	4	—	—	MHz

SWITCHING CHARACTERISTICS

CHARACTERISTIC	Conditions	SYMBOL	MIN	TYP	MAX	UNIT
Resistive Load						
Delay Time	(V_{CC} = 125V, I_C = 8A	t_d	—	—	0.1	μs
Rise Time	I_{B1} = $-I_{B2}$ = 1.6A, t_p = 25 μs	t_r	—	—	1	μs
Storage Time	Duty Cycle < 1%)	t_s	—	—	3	
Fall Time		t_f	—	—	0.7	
Inductive Load, Clamped						
Storage Time	(I_C = 8A, V_{clamp} = 300V	t_{sv}	—	—	2.3	μs
Crossover Time	I_{B1} = 1.6A, $V_{BE(off)}$ = 5V, T_C = 100°C)	t_c	—	—	0.7	

(1) Pulse Test: Pulse Width - 300 μs Duty Cycle ≤ 2%.

2

MJE13009

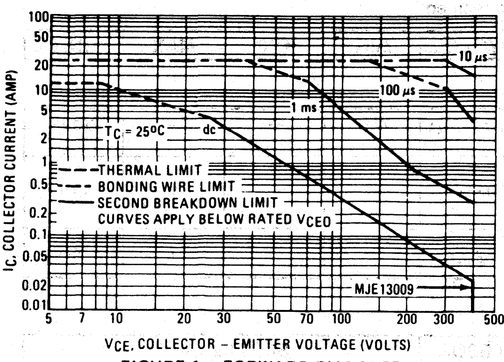


FIGURE 1 – FORWARD BIAS SAFE OPERATING AREA

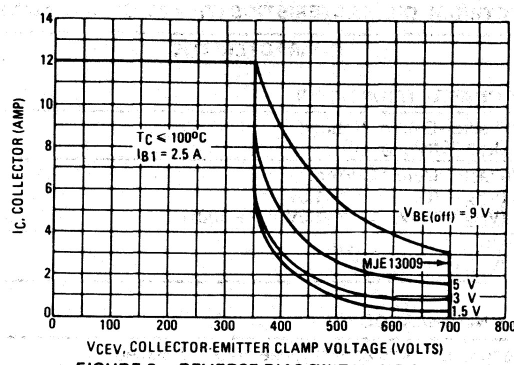


FIGURE 2 – REVERSE BIAS SWITCHING SAFE OPERATING AREA

The Safe Operating Area figures shown in Figures 1 and 2 are specified ratings for these devices under the test conditions shown.

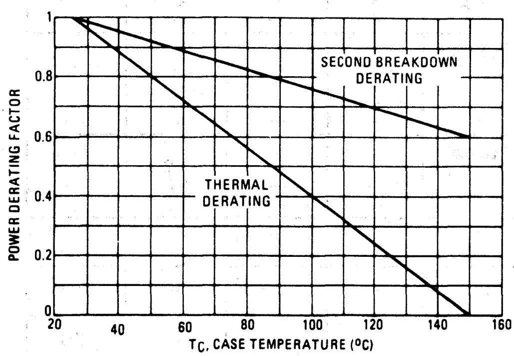


FIGURE 3 – FORWARD BIAS POWER DERATING

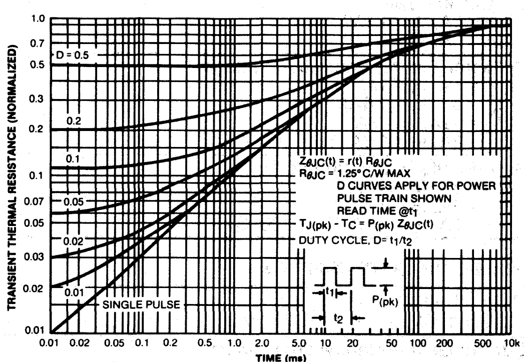


FIGURE 4 – TYPICAL THERMAL RESPONSE [($Z_{\theta JC}(t)$]

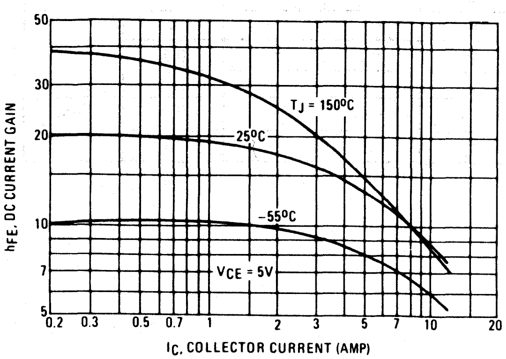


FIGURE 5 – DC CURRENT GAIN

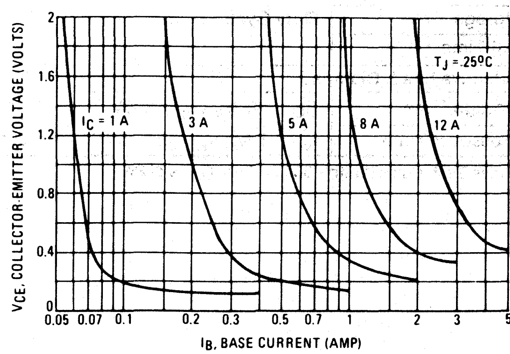


FIGURE 6 – COLLECTOR SATURATION REGION

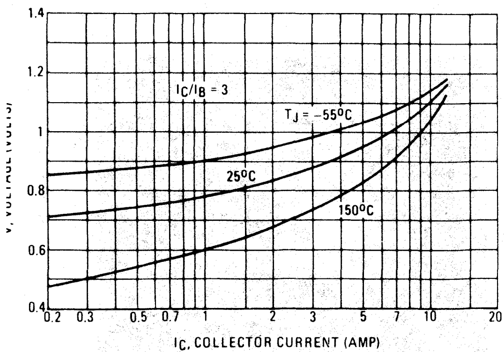


FIGURE 7 — BASE-EMITTER SATURATION VOLTAGE

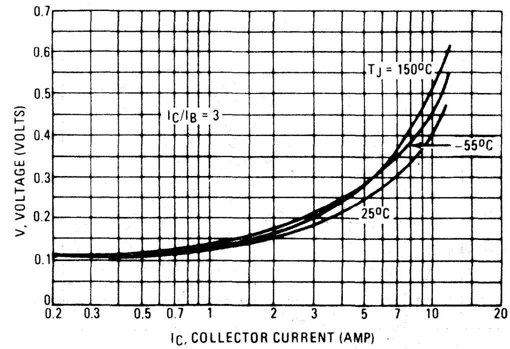


FIGURE 8 — COLLECTOR-EMITTER SATURATION VOLTAGE

2

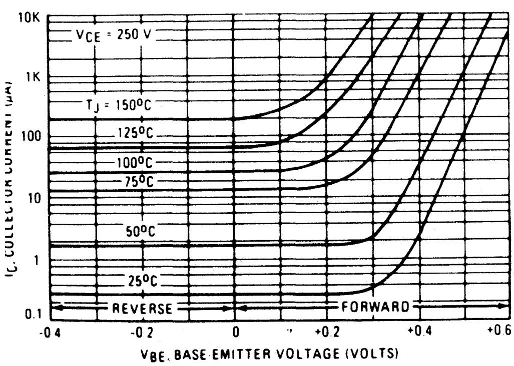


FIGURE 9 — COLLECTOR CUTOFF REGION

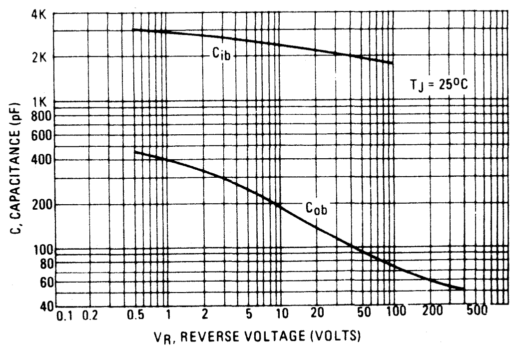


FIGURE 10 — CAPACITANCE

RESISTIVE SWITCHING PERFORMANCE

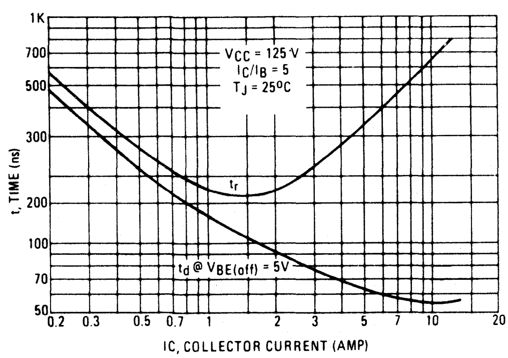


FIGURE 11 — TURN-ON TIME

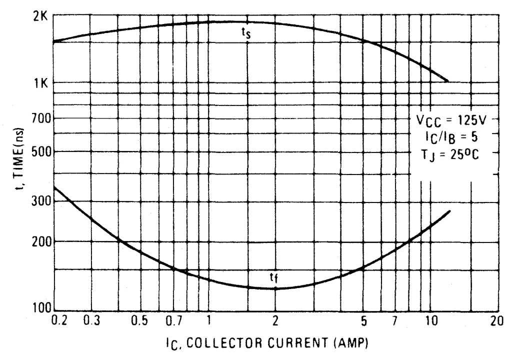


FIGURE 12 — TURN-OFF TIME

MJE13009

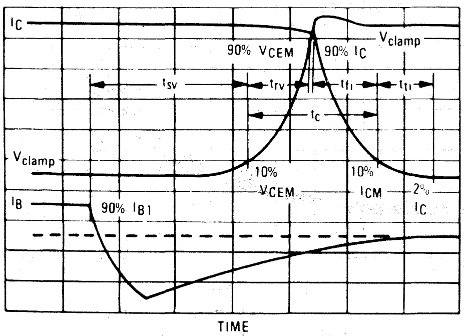


FIGURE 13 – INDUCTIVE SWITCHING MEASUREMENTS

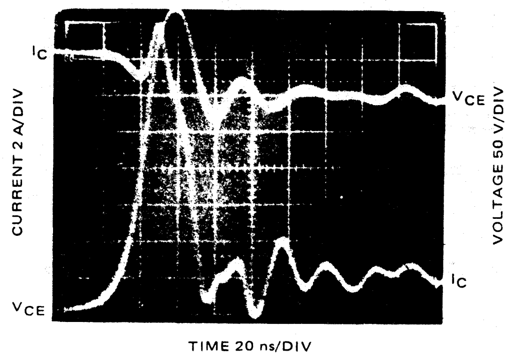


FIGURE 14 – TYPICAL INDUCTIVE SWITCHING WAVEFORMS (at 300 V and 12 A with I_{B1} = 2.4 A and $V_{BE(off)}$ = 5 V)

File Number **1841**

MJE13070, MJE13071

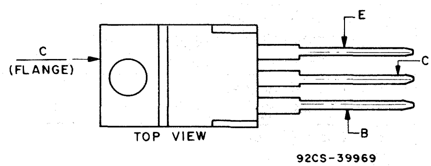
5-A *SwitchMax* II Power Transistors

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

2

The MJE13070 and MJE13071 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, saturation voltages are specified at 100°C to provide information necessary for worst-case design.

These transistors are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MJE13070	MJE13071	
V_{CEV}			
V_{BE} = -1.5 V	650	750	V
V_{CEO}	400	450	V
V_{EBO}	6	6	V
I_C(sat)	5	5	A
I_C	5	5	A
I_{CM}	8	8	A
I_B	2	2	A
I_{BM}	4	4	A
P_T			
@ T_C = 25°C	80	80	W
@ T_C = 100°C	32	32	W
T_C above 25°C, derate linearly	0.64	0.64	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
$R_{\theta JC}$	1.56	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	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							
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%.

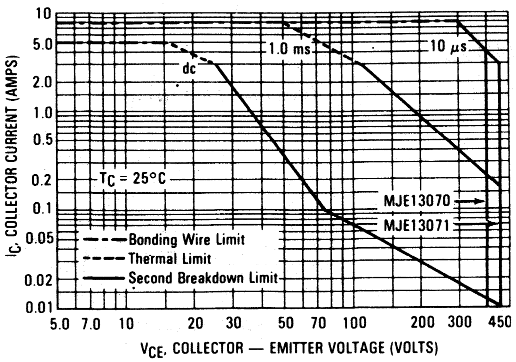


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

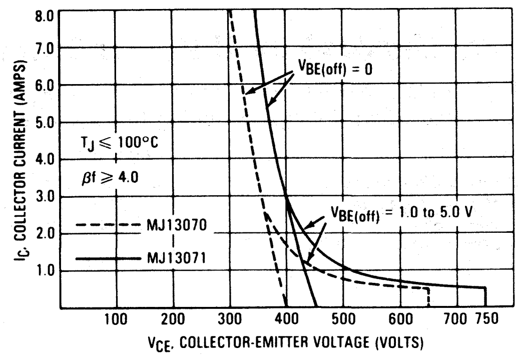


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

2

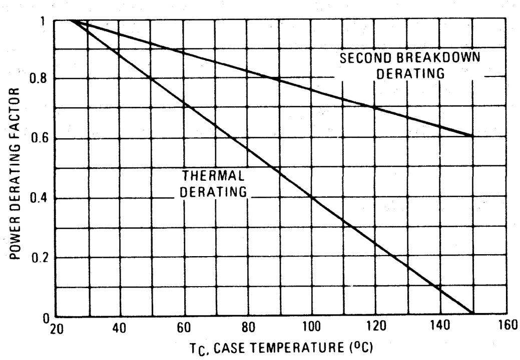


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

MJE16002, MJE16004

File Number **1842**

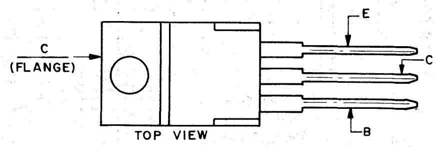
5-A *SwitchMax* II Power Transistors

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 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

MJE16002, MJE16004

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 MJE16002 — (I_C = 3.0 Adc, V_{CC} = 250 Vdc, I_{B1} = 0.4 Adc, PW = 30 μs, Duty Cycle ≤2.0%)					
Delay Time (I_{B2} = 0.8 Adc, R_{B2} = 8.0 Ω)	t_d	—	40	100	ns
Rise Time (I_{B2} = 0.8 Adc, R_{B2} = 8.0 Ω)	t_r	—	80	300	
Storage Time (I_{B2} = 0.8 Adc, R_{B2} = 8.0 Ω)	t_s	—	900	3000	
Fall Time (I_{B2} = 0.8 Adc, R_{B2} = 8.0 Ω)	t_f	—	20	300	
Storage Time ($V_{BE(off)}$ = 5.0 Vdc)	t_s	—	330	—	
Fall Time ($V_{BE(off)}$ = 5.0 Vdc)	t_f	—	100	—	
Resistive Load MJE16004 — (I_C = 3.0 Adc, V_{CC} = 250 Vdc, I_{B1} = 0.3 Adc, PW = 30 μs, Duty Cycle ≤2.0%)					
Delay Time (I_{B2} = 0.6 Adc, R_{B2} = 8.0 Ω)	t_d	—	40	100	ns
Rise Time (I_{B2} = 0.6 Adc, R_{B2} = 8.0 Ω)	t_r	—	110	300	
Storage Time (I_{B2} = 0.6 Adc, R_{B2} = 8.0 Ω)	t_s	—	750	2700	
Fall Time (I_{B2} = 0.6 Adc, R_{B2} = 8.0 Ω)	t_f	—	150	350	
Storage Time ($V_{BE(off)}$ = 5.0 Vdc)	t_s	—	270	—	
Fall Time ($V_{BE(off)}$ = 5.0 Vdc)	t_f	—	90	—	

(1) Pulse Test: PW - 300 μs, Duty Cycle ≤2%.

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%.

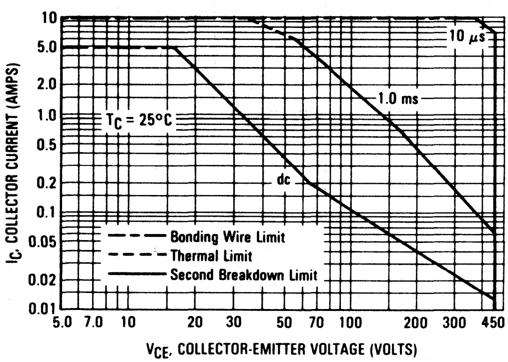


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

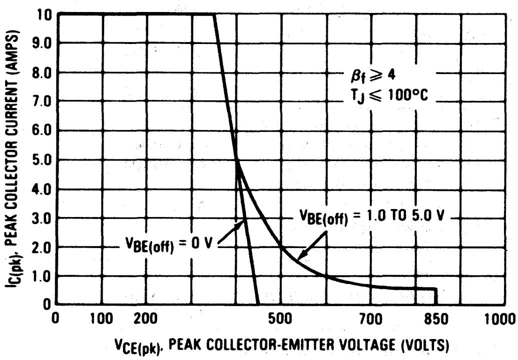


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

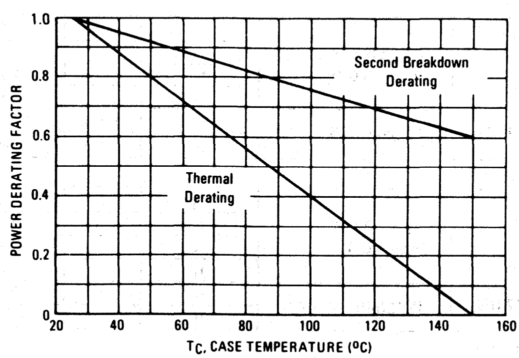


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

File Number **15.94**

MJH13090, MJH13091

High-Speed Silicon N-P-N Power Transistors

2

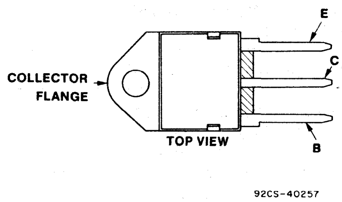
Features:

100° C Performance Specified for:
- *Reverse-Biased SOA with inductive loads*
- *Switching times with inductive loads*
- *Saturation voltages*
- *Leakage currents*

The MJH13090 and MJH13091 silicon n-p-n power transistors are designed for high-voltage, high-speed switching applications in inductive circuits where fall time is critical. They are particularly suited for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These transistors are tested for parameters that are essential to the design of high-power switching circuits. Resistive and inductive switching times, leakage current, and saturation voltages are specified at 25° C and 100° C to provide information necessary for worst-case design.

These devices are supplied in the JEDEC TO-218AC plastic package.

TERMINAL DESIGNATION



JEDEC TO-218AC

MAXIMUM RATINGS (T_A = 25° C) (unless otherwise specified)

RATING	SYMBOL	MJH13090	MJH13091	UNITS
Collector-Emitter Voltage	V_{CEO}	400	450	Volts
Collector-Emitter Voltage	V_{CEV}	650	750	Volts
Emitter Base Voltage	V_{EBO}	6	6	Volts
Collector Current — Continuous Peak (Repetitive)(1)	I_C I_{CM}	15 20	15 20	A
Base Current — Continuous Peak (Non-Repetitive)(1)	I_B I_{BM}	5 10	5 10	A
Total Power Dissipation @ Tc = 25°C @ Tc = 100°C Derate above 25° C	P_D	125 50 1	125 50 1	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	1.0	°C/W
Maximum Lead Temperature for Soldering Purpose: ⅛" from Case for 5 Seconds	T_L	275	275	°C

(1) Pulse Test: Pulse Width = 5ms. Duty Cycle ≤ 10%.

MJH13090, MJH13091

ELECTRICAL CHARACTERISTICS (T_C = 25°C) (unless otherwise specified)

CHARACTERISTIC			SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]							
Collector-Emitter Sustaining Voltage (I_C = 100mA, I_B = 0)	MJH13090 MJH13091		$V_{CEO(sus)}$	400 450	— —	— —	Volts
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V) (V_{CEV} = Rated Value, $V_{BE(OFF)}$ = -1.5V, T_C = 100°C)			I_{CEV}	— —	— —	0.5 2.5	mA
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50Ω, T_C = 100°C)			I_{CER}	—	—	3	mA
Emitter Cutoff Current (V_{EB} = 6V, I_C = 0)			I_{EBO}	—	—	1	mA
SECOND BREAKDOWN							
Second Breakdown with Base Forward Biased			FBSOA	SEE FIGURE 12			
Clamped Inductive SOA with Base Reversed Bias			RBSOA	SEE FIGURE 13			
ON CHARACTERISTICS[1]							
DC Current Gain (I_C = 10A, V_{CE} = 3V)			h_{FE}	8	—	—	—
Collector-Emitter Saturation Voltage (I_C = 10A, I_B = 2A) (I_C = 15A, I_B = 3A) (I_C = 10A, I_B = 2A, T_C = 100°C)			$V_{CE(sat)}$	— — —	— — —	1 3 2	V
Base-Emitter Saturation Voltage (I_C = 10A, I_B = 2A) (I_C = 10A, I_B = 2A, T_C = 100°C)			$V_{BE(sat)}$	— —	— —	1.5 1.5	V
SWITCHING CHARACTERISTICS							
Resistive Load							
Delay Time	V_{CC} = 250V, I_C = 10A		t_d	—	0.03	0.05	μs
Rise Time	I_{B1} = -I_{B2} = 1.25A,		t_r	—	0.13	0.5	
Storage Time	t_p = 30 μsec		t_s	—	0.55	2.5	
Fall Time			t_f	—	0.1	0.5	
Inductive Load, Clamped							
Storage Time	$I_{CC(PK)}$ = 10A	(T_J = 100°C)	t_{sv}	—	0.8	3	μs
Crossover Time	I_{B1} = 1.25A		t_c	—	0.175	0.4	
Fall Time	$V_{BE(OFF)}$ = -5V		t_{fi}	—	0.15	0.3	
Storage Time	$V_{CE(PK)}$ = 250V	(T_J = 25°C)	t_{sv}	—	0.5	—	
Crossover Time			t_c	—	0.15	—	
Fall Time			t_{fi}	—	0.1	—	

(1) Pulse Test: Pulse Width - 300μs Duty Cycle ≤ 2.%

TYPICAL ELECTRICAL CHARACTERISTICS

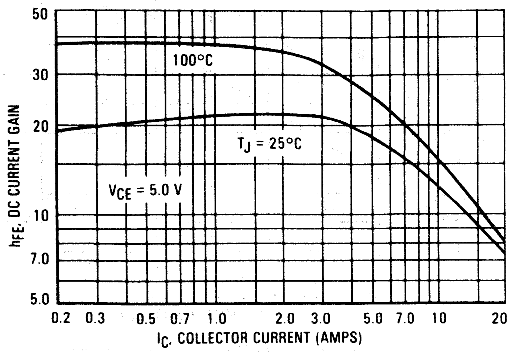


FIGURE 1 — DC CURRENT GAIN

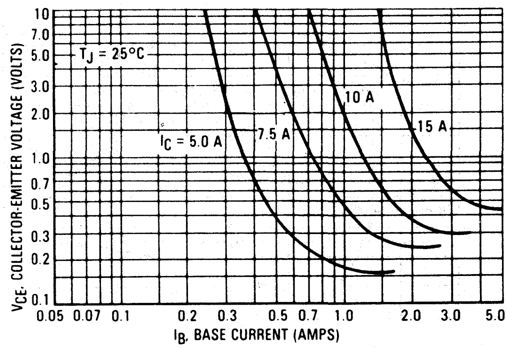


FIGURE 2 — COLLECTOR SATURATION REGION

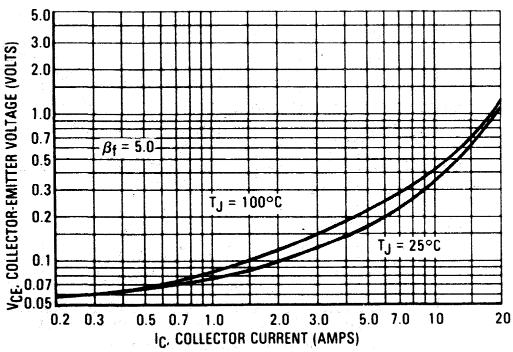


FIGURE 3 — COLLECTOR-EMITTER SATURATION VOLTAGE

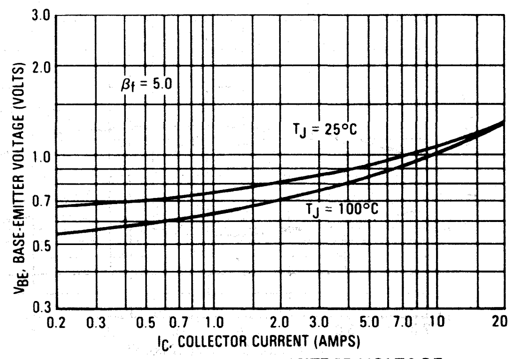


FIGURE 4 — BASE-EMITTER VOLTAGE

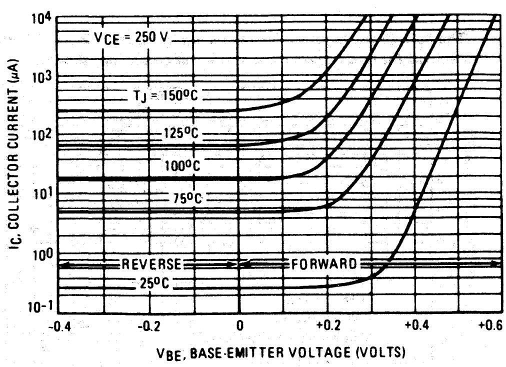


FIGURE 5 — COLLECTOR CUTOFF REGION

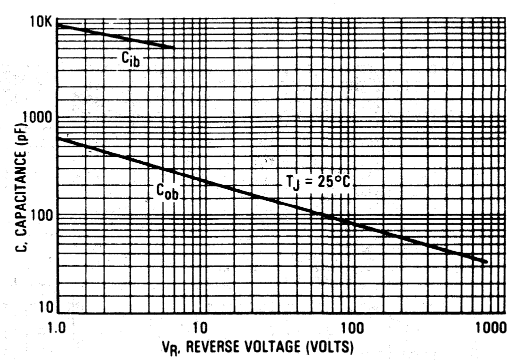


FIGURE 6 — CAPACITANCE

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MJH13090, MJH13091

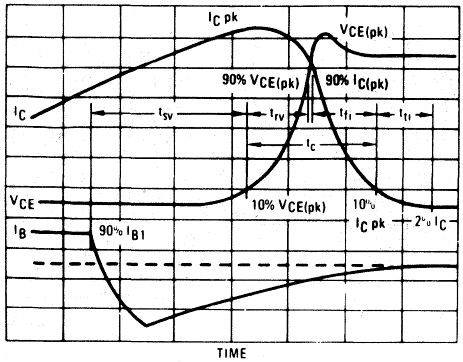


FIGURE 7 — INDUCTIVE SWITCHING MEASUREMENTS

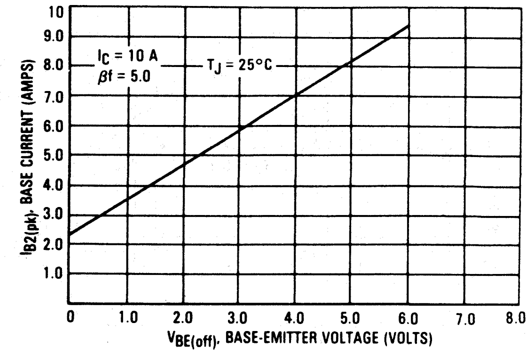


FIGURE 8 — PEAK REVERSE CURRENT

INDUCTIVE SWITCHING

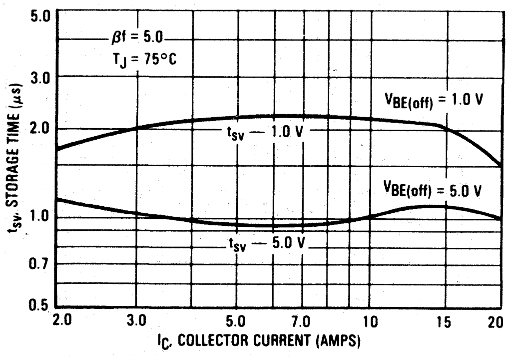


FIGURE 9 — STORAGE TIME

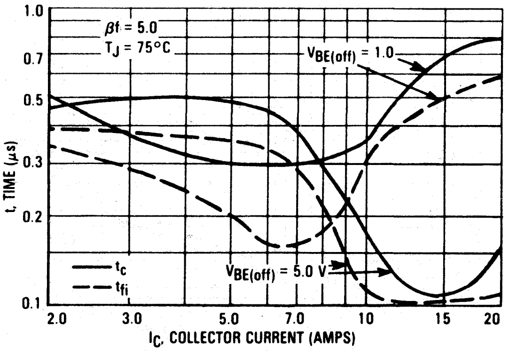


FIGURE 10 — CROSSOVER AND FALL TIMES

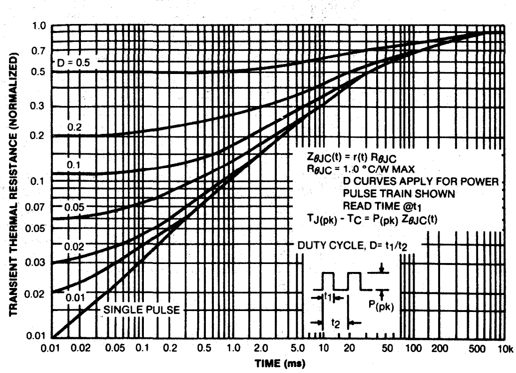


FIGURE 11 TYPICAL THERMAL RESPONSE $[(Z_{\theta JC}(t)]$

The Safe Operating Area figures shown in Figures 12 and 13 are specified for these devices under the test conditions shown.

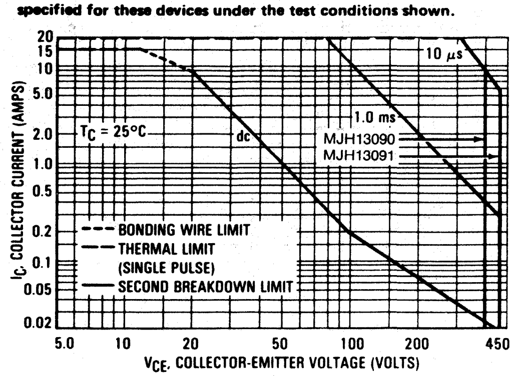


FIGURE 12 — FORWARD BIAS SAFE OPERATING AREA

MJH13090, MJH13091

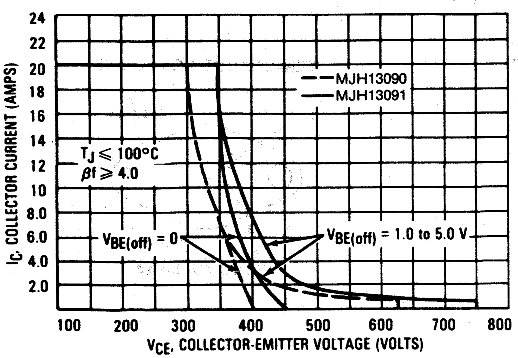


FIGURE 13 — REVERSE BIAS SAFE OPERATING AREA

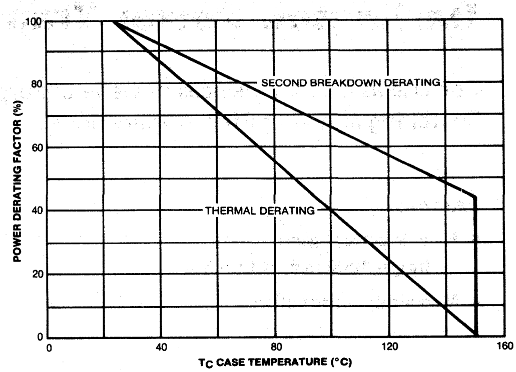


FIGURE 14 — POWER DERATING

2

RCA1000, RCA1001 File Number **594**

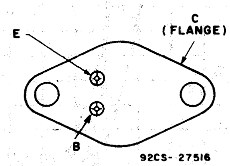
8-Ampere Silicon N-P-N Darlington Power Transistors

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.

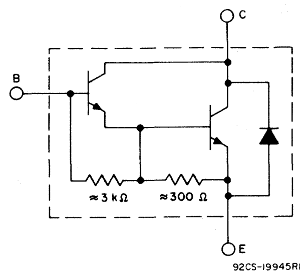


Fig. 1 — Schematic diagram for all types.

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%.

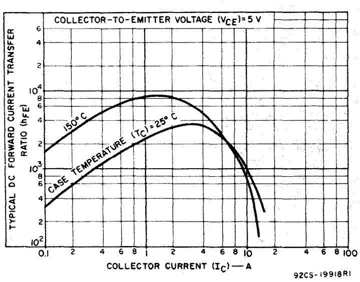


Fig. 2 — Typical dc beta characteristics for both types.

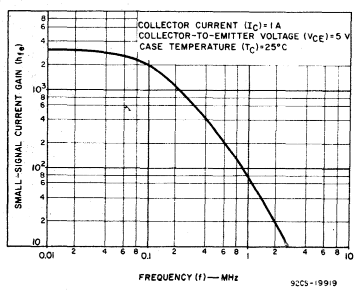


Fig. 3 — Typical small-signal gain for both types.

RCA1000, RCA1001

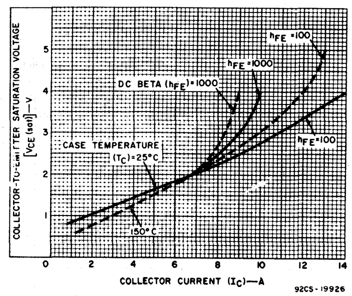


Fig. 4 — Typical saturation characteristics for both types.

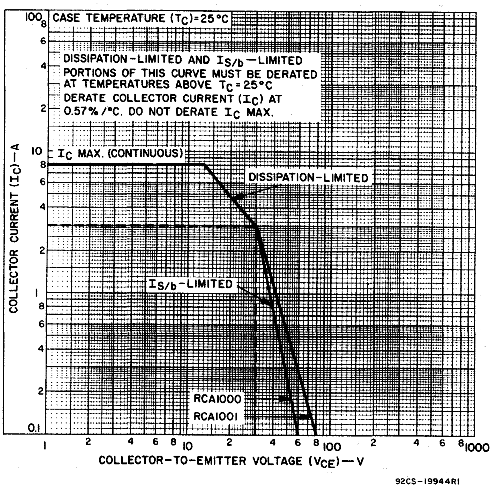


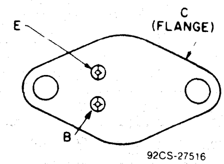
Fig. 5 — DC safe-area-of-operation for both types.

File Number **908**

RCA1B04, RCA1B05

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).

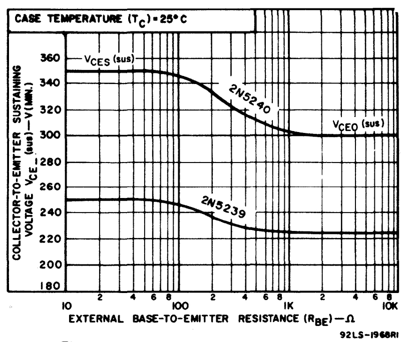


Fig. 1 — Derating curves for all types.

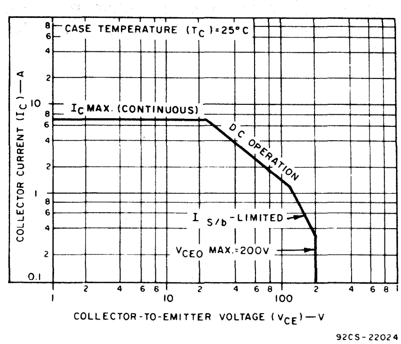


Fig. 2 — Maximum operating areas for RCA1B04.

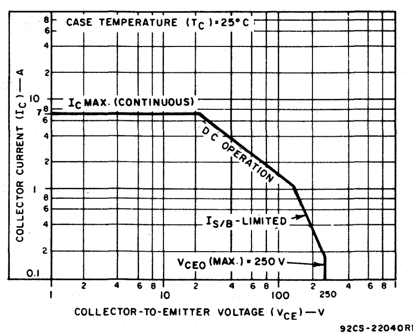


Fig. 3 — Maximum operating areas for RCA1B05.

File Number **618**

RCA3054, RCA3055

Silicon N-P-N VERSAWATT Transistors

Designed for Medium-Power Linear and Switching Service in Consumer, Automotive, and Industrial Applications

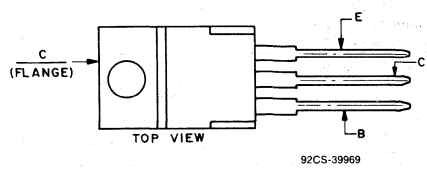
Features:

- **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

RCA3054, RCA3055

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.

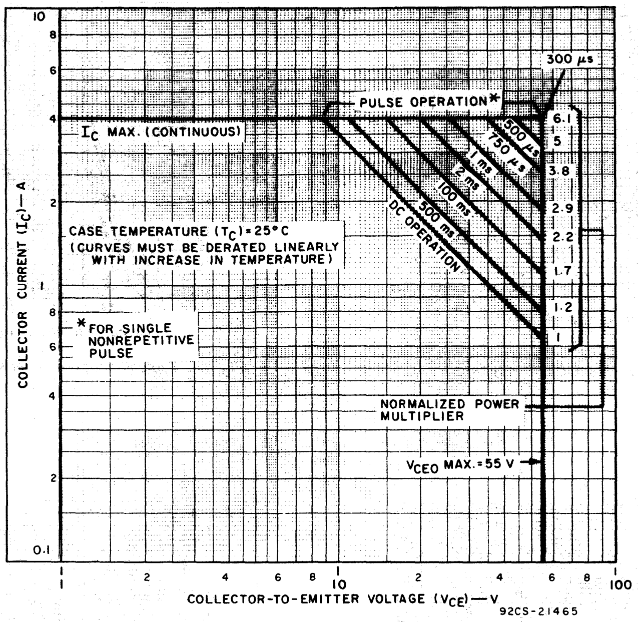


Fig. 1 — Maximum operating areas for RCA3054.

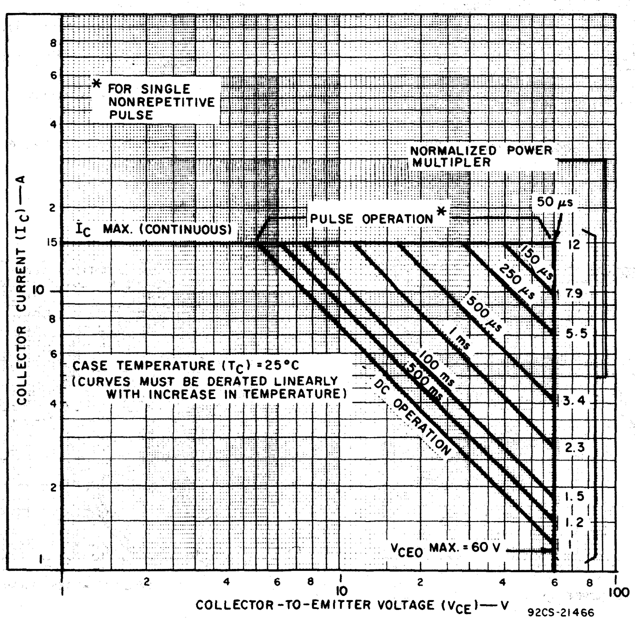


Fig. 2 — Maximum operating areas for RCA3055.

RCA3054, RCA3055

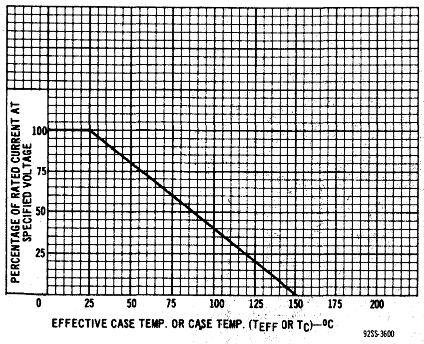


Fig. 3 — Derating curve for both types.

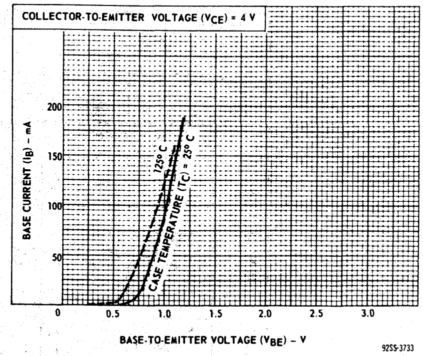


Fig. 4 — Typical input characteristics for RCA3054.

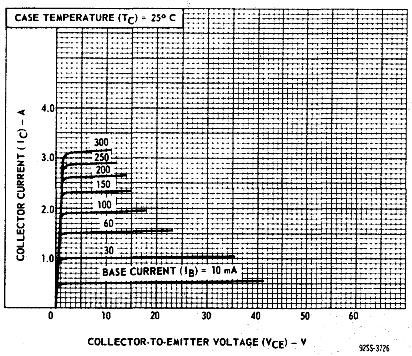


Fig. 5 — Typical output characteristics for RCA3054.

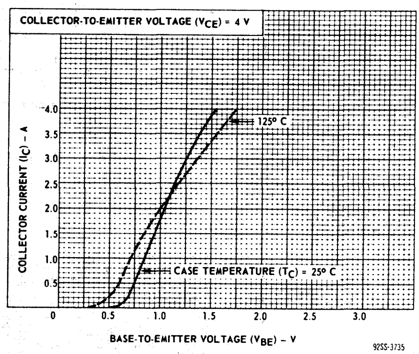


Fig. 6 — Typical transfer characteristics for RCA3054.

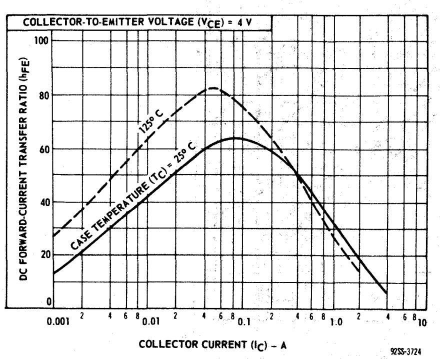


Fig. 7 — Typical dc beta characteristics for RCA3054.

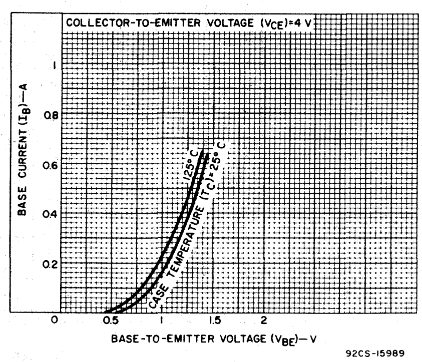


Fig. 8 — Typical input characteristics for RCA3055.

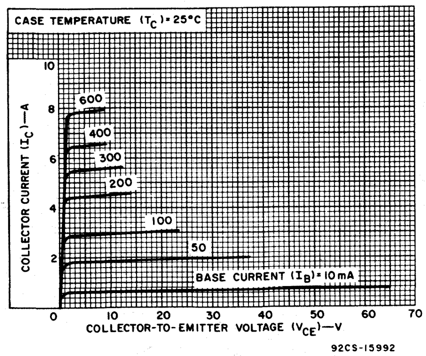


Fig. 9 — Typical output characteristics for RCA3055.

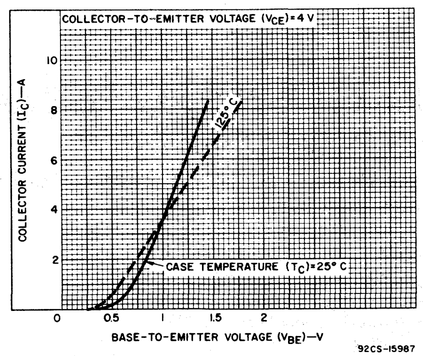


Fig. 10 — Typical transfer characteristics for RCA3055.

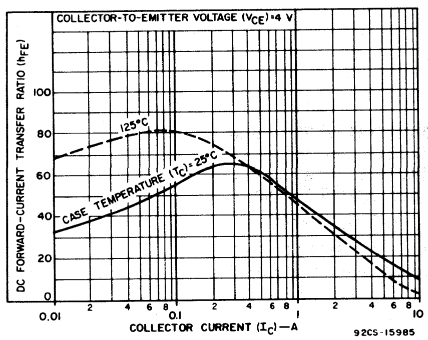


Fig. 11 — Typical dc beta characteristics for RCA3055.

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

File Number **1060**

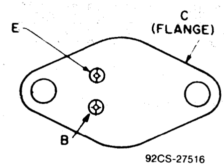
Silicon N-P-N Epitaxial-Base High Power Transistors

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: VOLTAGE V dc		CURRENT A dc	LIMITS: RCA3773		MJ15003		UNITS
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CBO}	160[a]			–	4	–	–	mA
	140[a]			–	2	–	1	mA
I_{CEX}	140	−1.5		–	1	–	0.1	mA
I_{CEX} T_C = 150°C	140	−1.5		–	5	–	2	mA
I_{CEO} I_B = 0	140			–	–	–	0.25	mA
	120			–	1	–	–	mA
I_{EBO}	–	7		–	1	–	–	mA
	–	5		–	–	–	0.1	mA
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] $R_{BE} \leq$ 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		8[c]	–	2.2	–	–	V
	2		5[c]	–	–	–	2	V
$V_{CE}(sat)$ I_B = 3.2A			16[c]	–	4	–	–	V
= 0.8A			8[c]	–	1.4	–	–	V
= 0.5A			5[c]	–	–	–	1	V
$I_{S/b}$ t_p = 1 s nonrep.	100			1.5	–	1	–	A
	50			–	–	5	–	A
$\|h_{fe}\|$ f = 0.5 MHz	10		0.5	4	–	4	–	
f_T				2	–	2	–	MHz
h_{fe} f = 1 kHz	4		1	40	–	–	–	
C_{ob} f = 0.1 MHz	10[a]			–	500	–	500	pF
$R_{\theta JC}$	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 V_{CE}	TEST CONDITIONS: VOLTAGE V dc V_{BE}	TEST CONDITIONS: CURRENT A dc I_C	LIMITS RCA8638C Min.	LIMITS RCA8638C Max.	LIMITS RCA8638D Min.	LIMITS RCA8638D Max.	LIMITS RCA8638E Min.	LIMITS RCA8638E Max.	UNITS
I_{CBO}	140[a]			–	1	–	–	–	–	
	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	–	–	mA
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] $R_{BE} \leqslant 100\Omega$			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		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	–	
$\lvert h_{fe} \rvert$ 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

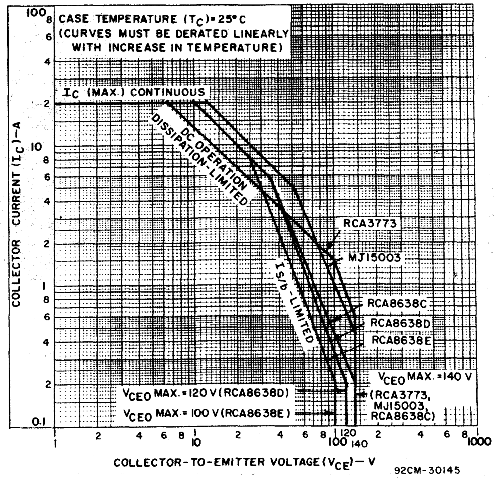


Fig. 1 - Maximum operating areas for all types.

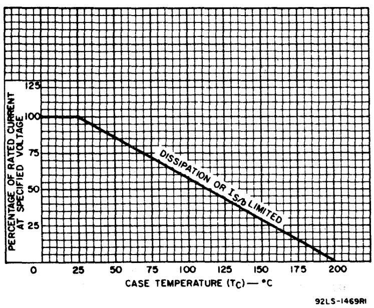


Fig. 2 - Current derating curve for all types.

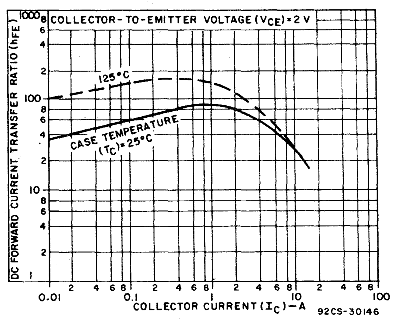


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

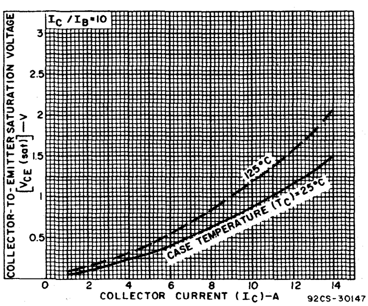


Fig. 4 - Typical saturation voltage characteristics for all types.

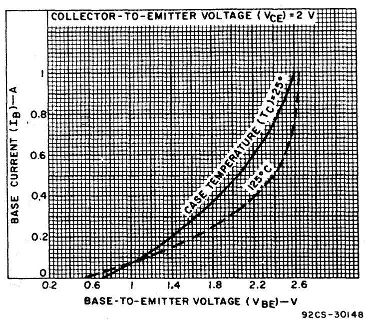


Fig. 5 - Typical input characteristics for all types.

RCA3773, MJ15003, RCA8638C, RCA8638D, RCA8638E

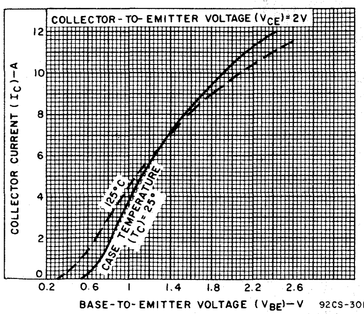


Fig. 6 - Typical transfer characteristics for all types.

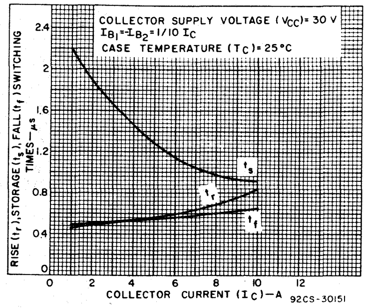


Fig. 7 - Typical saturated-switching times for all types.

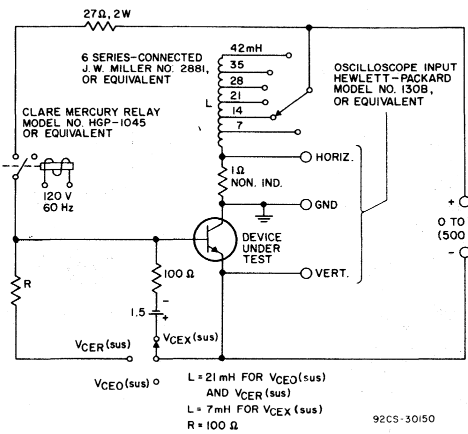


Fig. 8 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

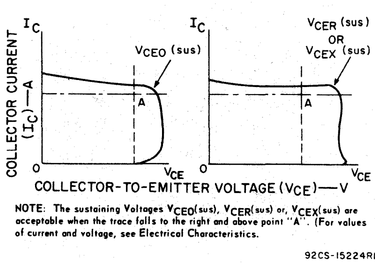


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

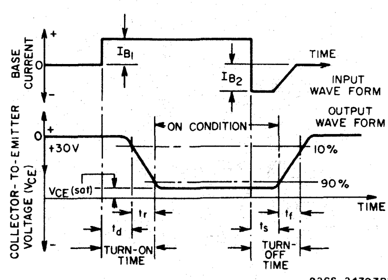


Fig. 10 - Oscilloscope display for measurement of switching times for all types.

File Number **1205**

RCA6340, RCA6341

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*

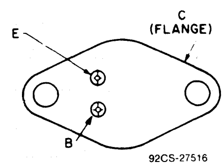
RCA6340 and RCA6341 silicon n-p-n power transistors which feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pusle-width-modulated regulators and a variety of power switching circuits.

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 $\leq$ 2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) MUST NOT be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 80 V, t_p = 10 μs.

[e] $I_{B1} = -I_{B2}$.

RCA6340, RCA6341

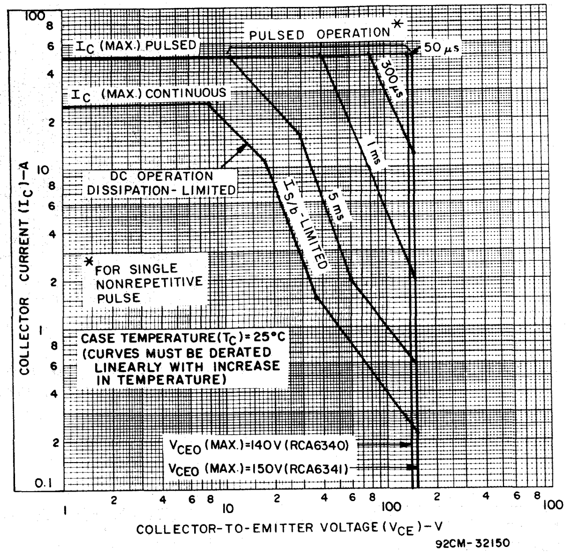


Fig. 1 - Maximum operating areas for both types.

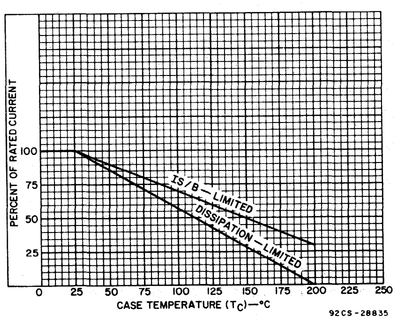


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for both types.

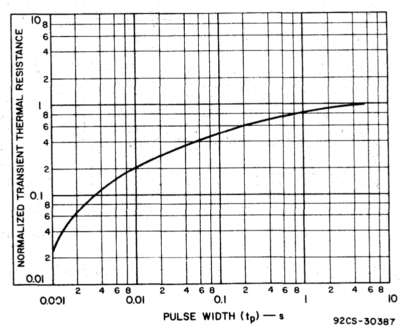


Fig. 3 - Typical thermal-response characteristic for both types.

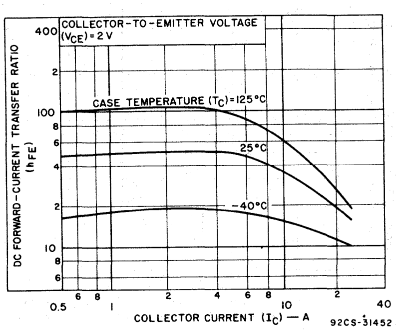


Fig. 4 - Typical dc beta characteristics for both types.

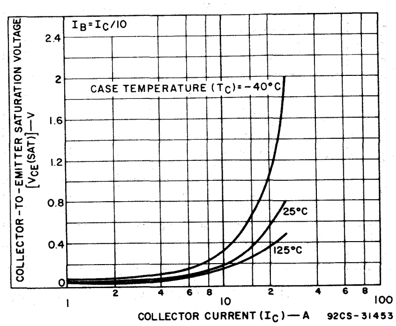


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for both types.

RCA6340, RCA6341

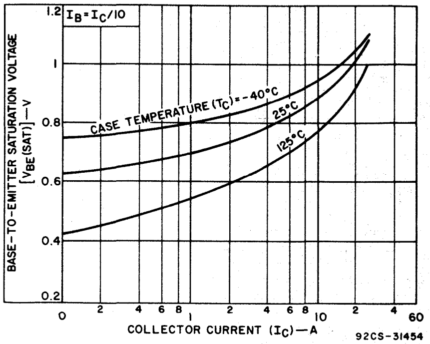


Fig. 6 - Typical base-to-emitter saturation voltage characteristic for both types.

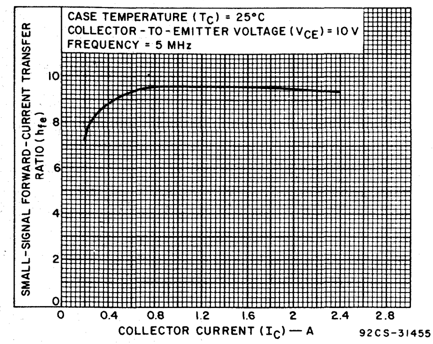


Fig. 7 - Typical small-signal forward-current transfer ratio characteristic for both types (f = 5 MHz).

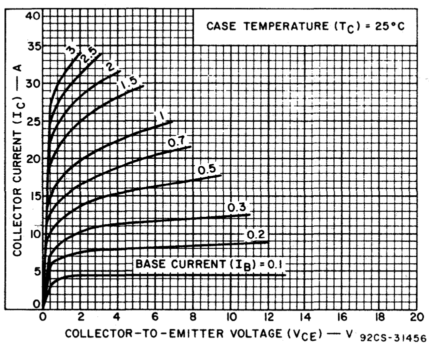


Fig. 8 - Typical output characteristics for both types.

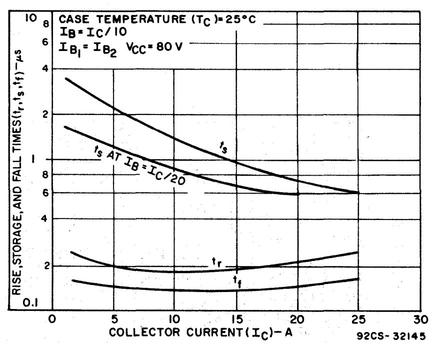


Fig. 9 - Typical saturated-switching-time characteristics as a function of collector current for both types.

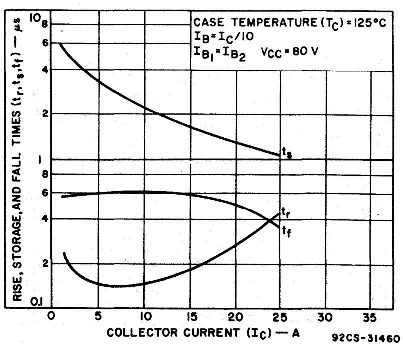


Fig. 10 - Typical saturated-switching-time characteristics at T_C = 125° C as a function of collector current for both types.

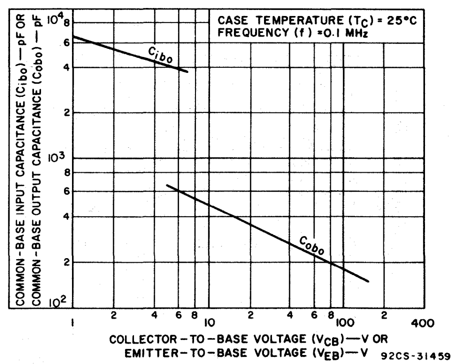


Fig. 11 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for both types.

RCA6340, RCA6341

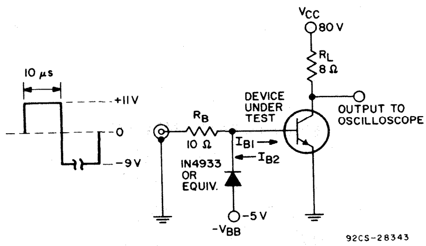


Fig. 12 - Switching-time test circuit.

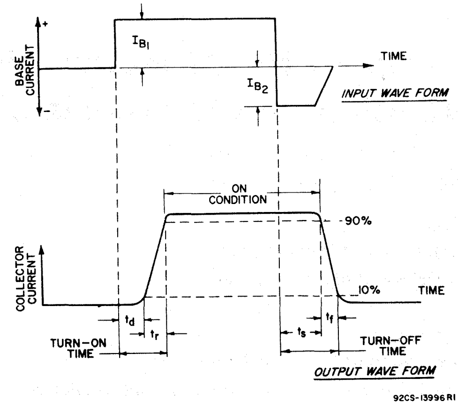


Fig. 13 - Phase relationship between input current and output current showing reference points for specification of switching times.

RCA8766 Series File Number **973**

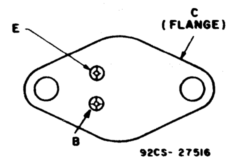
10-Ampere N-P-N Monolithic Darlington Power Transistors

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 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.

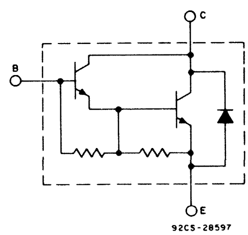


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA8766 RCA8766A	RCA8766B RCA8766C	RCA8766D RCA8766E	
V_{CBO}	350	400	450	V
$V_{CER}(sus)$ $R_{BE} = 50\ \Omega$	350	400	450	V
$V_{CEO}(sus)$	350	400	450	V
V_{EBO}	5	5	5	V
I_C	10	10	10	A
I_{CM}	15	15	15	A
I_B	1	1	1	A
P_T $T_C \leq 25°C$	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 VOLTAGE V dc	CURRENT A dc		LIMITS RCA8766 RCA8766A		RCA8766B RCA8766C		RCA8766D RCA8766E		UNITS
	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%.

RCA8766 Series

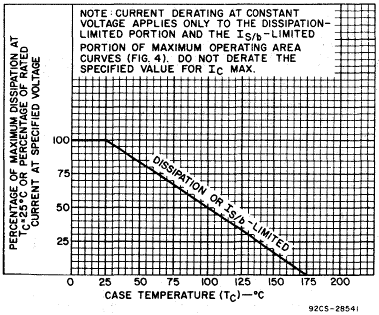


Fig. 2 — Derating curves for all types.

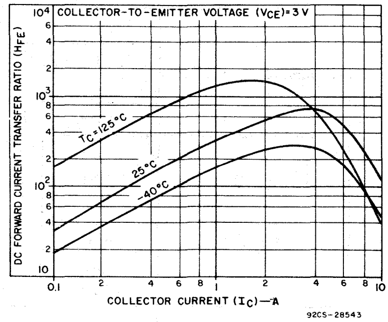


Fig. 3 — Typical DC beta characteristics for all types.

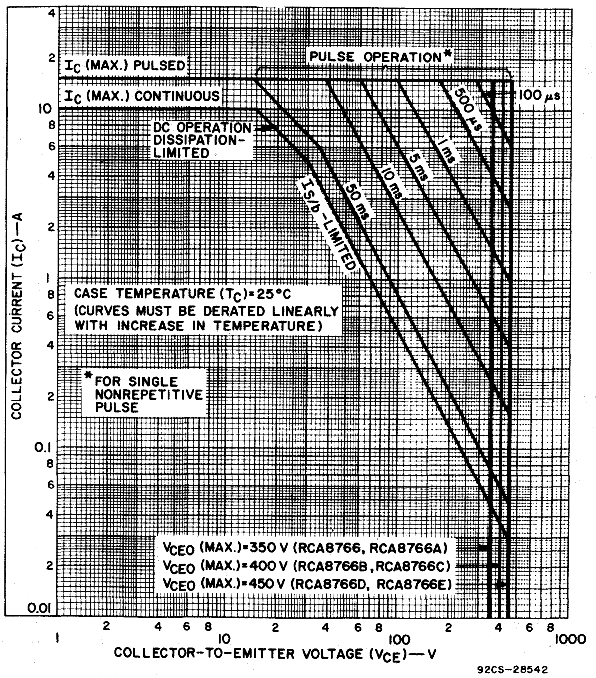


Fig. 4 — Maximum operating areas for all types.

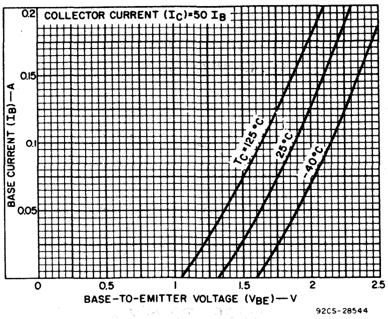


Fig. 5 — Typical input characteristics for all types.

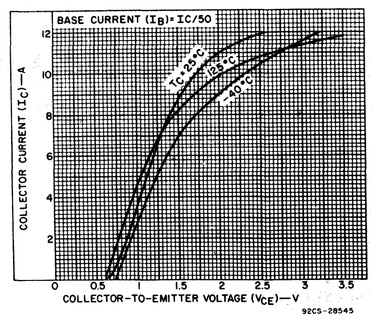


Fig. 6 — Typical output characteristics for all types.

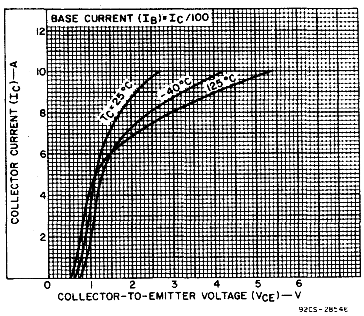


Fig. 7 — Typical output characteristics for all types.

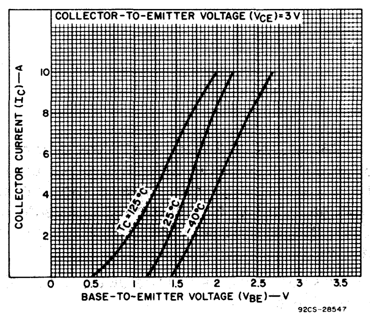


Fig. 8 — Typical transfer characteristics all types.

RCA9166A, RCA9166B, MJ15022, MJ15024

File Number **1293**

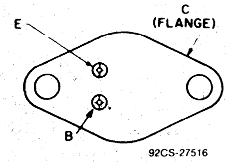
Silicon N-P-N Epitaxial-Base High-Power Transistors

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:*

	RCA9166A	RCA9166B	MJ15024	MJ15022	
V_{CBO}	—	—	400	350	V
$V_{CER}(sus)$ R_{BE} = 100 Ω	275	225	275	225	V
$V_{CEO}(sus)$	250	200	250	200	V
V_{EBO}		5			V
I_C		16			A
I_{CM}		30			A
I_B		5			A
P_T					
At $T_C \leq 25°C$		250			W
At $T_C > 25°C$ ... Derate linearly		1.43			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

RCA9166A, RCA9166B, MJ15022, MJ15024

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C)=25° C Unless Otherwise Specified*

CHARAC-TERISTIC	TEST CONDITIONS			LIMITS								UNITS
	VOLTAGE V dc		CUR-RENT A dc	RCA9166A		RCA9166B		MJ15024		MJ15022		
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	400[a]			—	—	—	—	—	1	—	—	
	350[a]			—	—	—	—	—	—	—	1	
I_{CEO}	200			—	1	—	—	—	0.5	—	—	
	150			—	—	—	1	—	—	—	0.5	
I_{CEX}	400	−1.5		—	—	—	—	—	0.5	—	0.5	mA
	250	−1.5		—	—	—	—	—	0.25	—	—	
	200	−1.5		—	—	—	—	—	—	—	0.25	
I_{CER} R_{BE}=100 Ω,	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_{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	—	—	—	—	V
	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%.

2

RCA9166A, RCA9166B, MJ15022, MJ15024

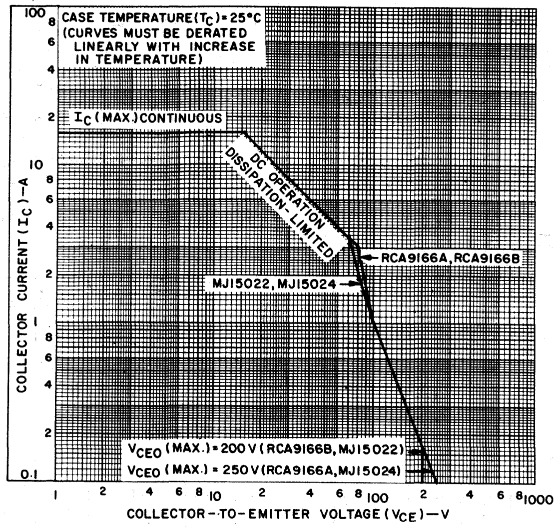


Fig. 1 - Maximum operating areas for all types.

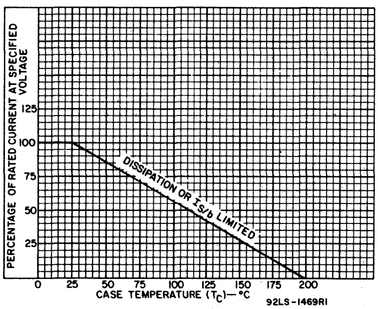


Fig. 2 - Current derating curve for all types.

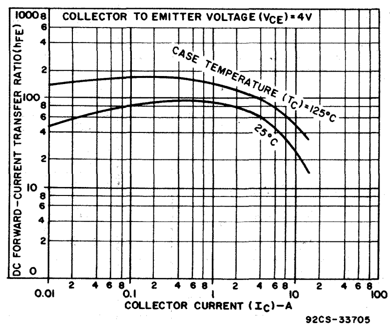


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

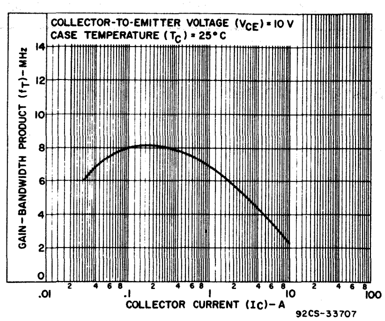


Fig. 4 - Typical gain-bandwidth product for all types.

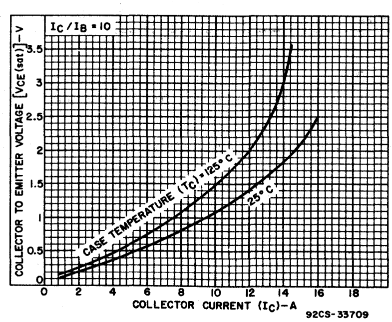


Fig. 5 - Typical saturation voltage characteristics for all types.

RCA9166A, RCA9166B, MJ15022, MJ15024

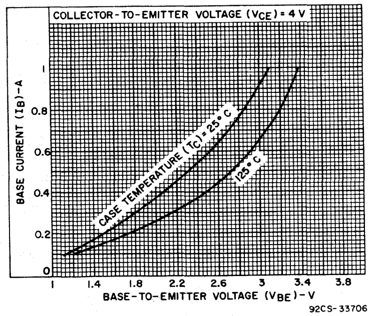


Fig. 6 - Typical input characteristics for all types.

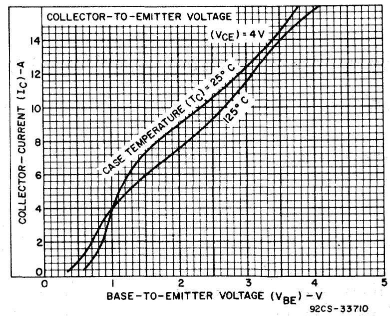


Fig. 7 - Typical transfer characteristics.

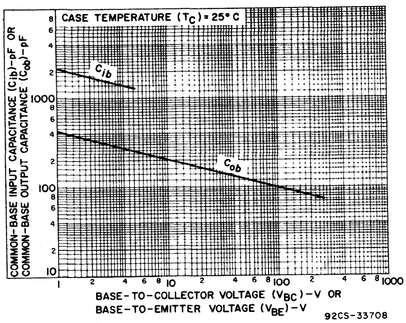


Fig. 8 - Typical common-base input or output capacitance characteristics as a function of reverse voltages for all types.

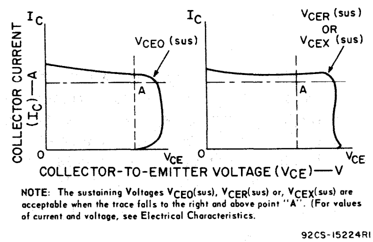


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 10).

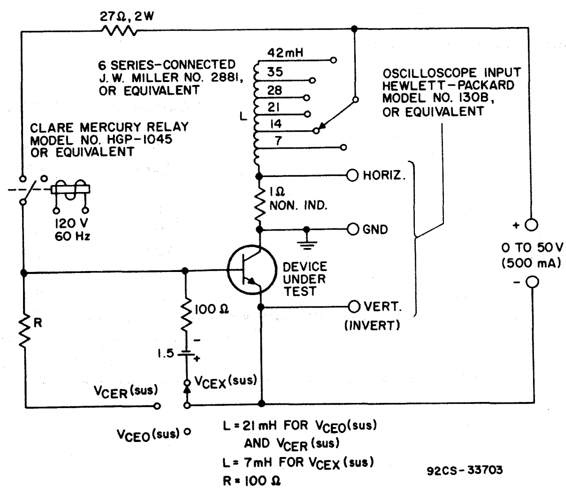


Fig. 10 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

2

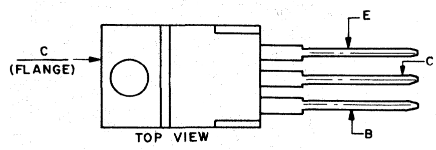
RCA9202A, RCA9202B, RCA9202C

File Number **1414**

4-Ampere N-P-N Darlington Power Transistors

300, 350 and 400 Volts, 65 Watts, Gain of 750 at 2A

TERMINAL DESIGNATIONS



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.

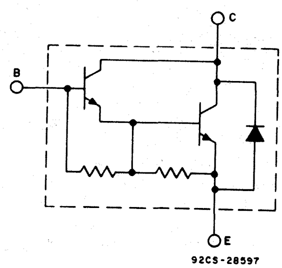


Fig. 1 - Schematic diagram for all types.

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

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	—	—	—	—	mA
	350[a]	—	—	—	—	—	—	0.2	—	—	
	400[a]	—	—	—	—	—	—	—	—	0.2	
I_{CEO}	250	—	—	0	—	0.5	—	—	—	—	
	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.

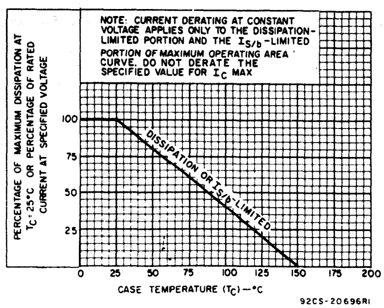


Fig. 2 - Derating curve for all types.

RCA9202A, RCA9202B, RCA9202C

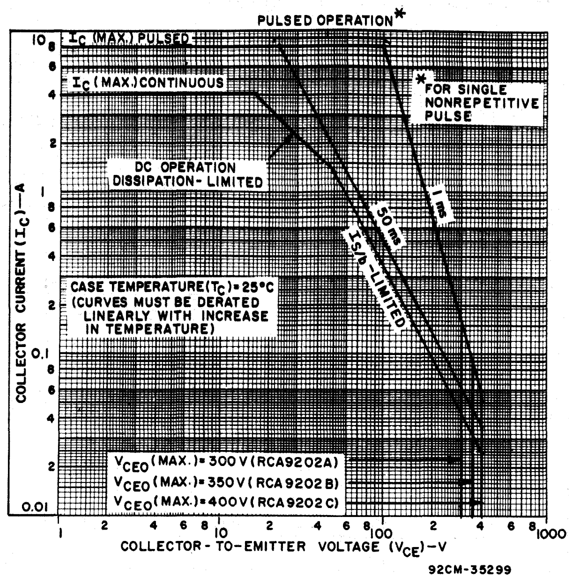


Fig. 3 - Maximum operating areas for all types.

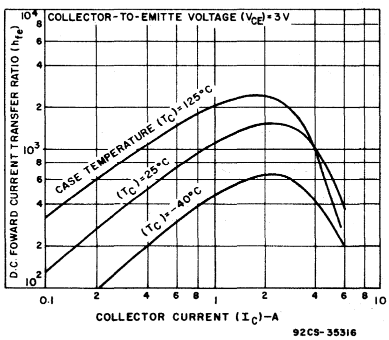


Fig. 4 - Typical dc beta characteristics for all types.

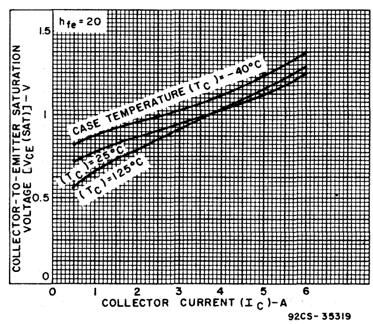


Fig. 5 - Typical saturation characteristics for all types.

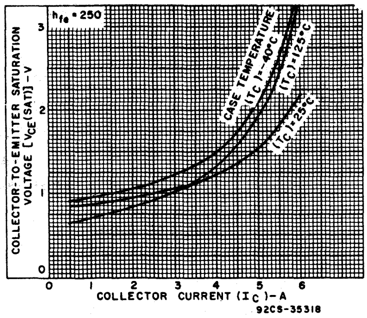


Fig. 6 - Typical saturation characteristics for all types.

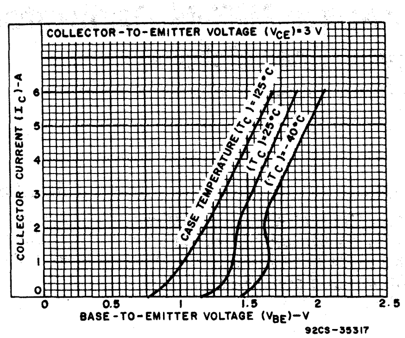


Fig. 7 - Typical transfer characteristics for all types.

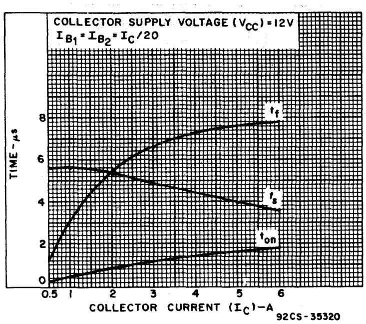


Fig. 8 - Typical saturated switching characteristics for all types.

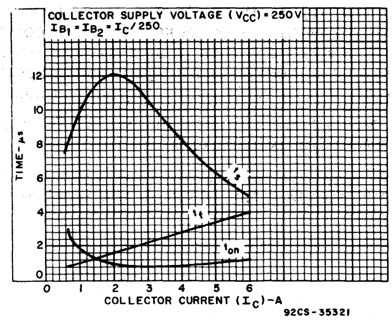


Fig. 9 - Typical saturated switching characteristics for all types.

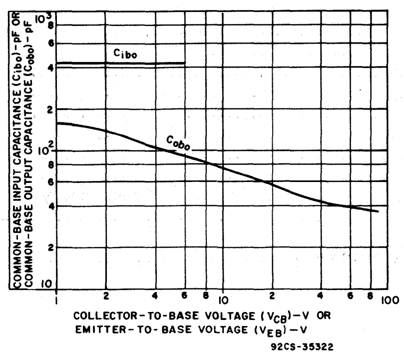


Fig. 10 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics (all types).

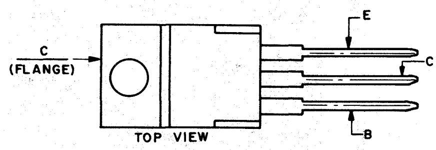
RCA9203A, RCA9203B

File Number **1413**

4-Ampere N-P-N Darlington Power Transistors

250 and 300 Volts, 50 Watts
Gain of 500 at 2 A

TERMINAL DESIGNATIONS



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.

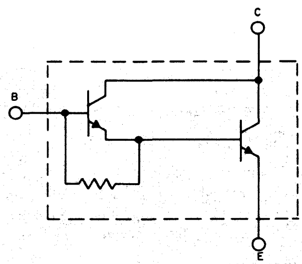


Fig. 1 - Schematic diagram for all types.

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} $I_E = 0$	250[a]	—	—	—	—	0.2	—	—	mA
	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.

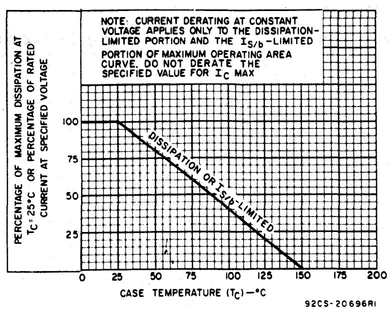


Fig. 2 - Derating curve for all types.

RCA9203A, RCA9203B

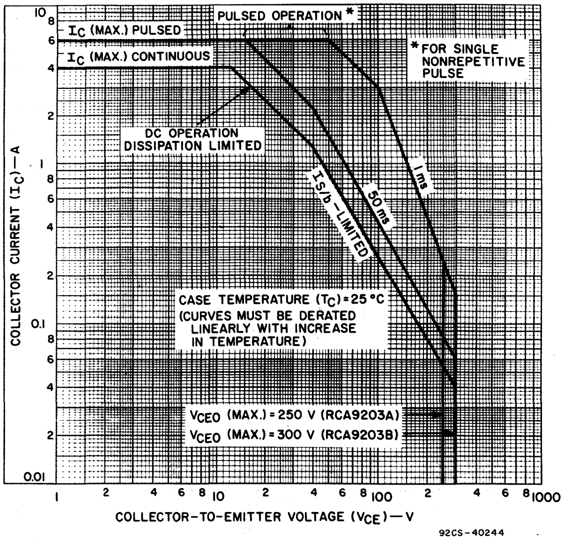


Fig. 3 - Maximum operating areas for all types.

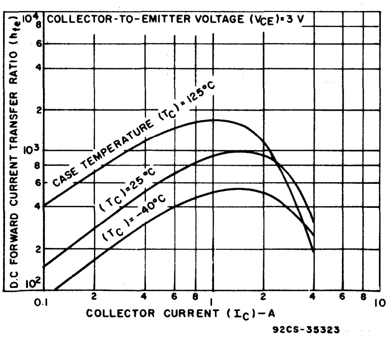


Fig. 4 - Typical dc beta characteristics for all types.

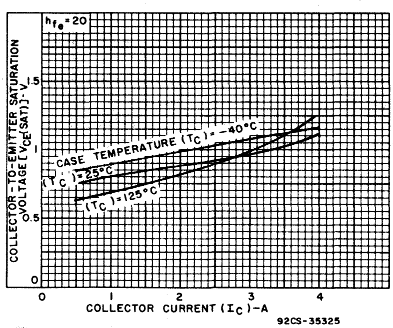


Fig. 5 - Typical saturation characteristics for all types.

RCA9203A, RCA9203B

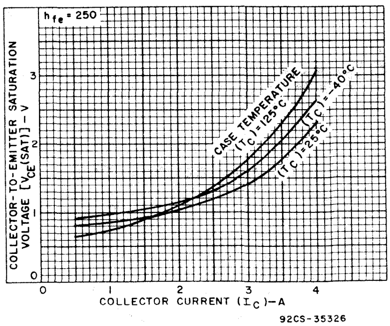


Fig. 6 - Typical saturation characteristics for all types.

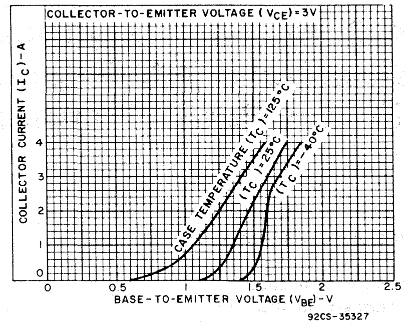


Fig. 7 - Typical transfer characteristics for all types.

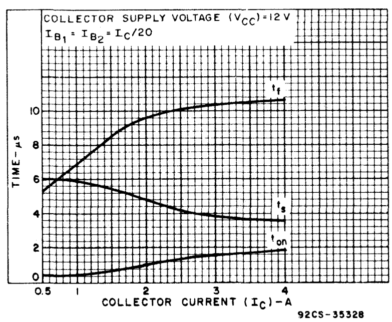


Fig. 8 - Typical saturated switching characteristics for all types.

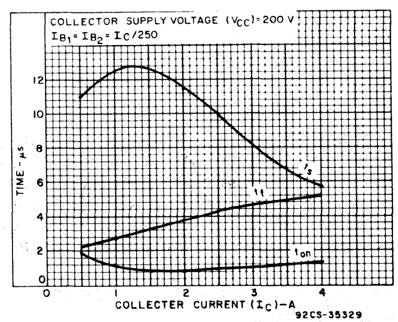


Fig. 9 - Typical saturated switching characteristics for all types.

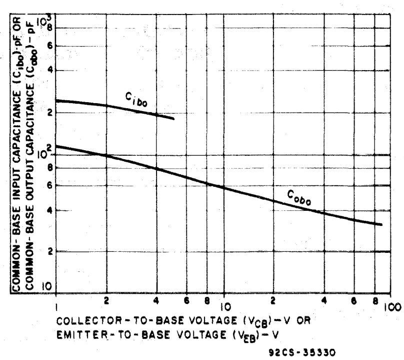


Fig. 10 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics (all types).

2

RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D

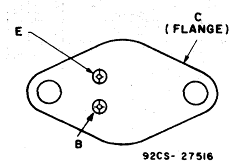
File Number **1448**

50-A Complementary High-Current, Medium-Voltage N-P-N and P-N-P Silicon Darlington Power Transistors

Features:
- *300 W at 25° C case temperature*
- *50-A rated collector current*
- *Hard glass passivation*
- *Wire-bonded construction*

Applications:
- *General purpose*
- *Low-speed switching*
- *DC motor control*

TERMINAL DESIGNATIONS



JEDEC TO-204AE
(141 mil diameter pin isolation)

The RCA9228A, RCA9228B, RCA9228C, RCA9228D and the RCA9229A*, RCA9229B*, RCA9229C*, RCA9229D* are complementary n-p-n and p-n-p silicon Darlington transistors designed for general-purpose amplifier and low-speed switching applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-204AE hermetic steel package.

*The RCA9228A, RCA9228B, RCA9228C, RCA9228D and RCA9229A, RCA9229B, RCA9229C, RCA9229D were formerly RCA developmental nos. TA9228 and TA9229, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	RCA9228A RCA9229A•	RCA9228B RCA9229B•	RCA9228C RCA9229C•	RCA9228D RCA9229D•	
V_{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

ELECTRICAL CHARACTERISTICS, *Case Temperature (T_C) = 25° C Unless Otherwise Specified*

CHARACTERISTIC	TEST CONDITIONS				LIMITS								UNITS
	VOLTAGE V dc		CURRENT A dc		RCA9228A RCA9229A•		RCA9228B RCA9229B•		RCA9228C RCA9229C•		RCA9228D RCA9229D•		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	50				—	0.5	—	—	—	—	—	—	mA
	70				—	—	—	0.5	—	—	—	—	
	90				—	—	—	—	—	0.5	—	—	
	110				—	—	—	—	—	—	—	0.5	
I_{EBO}		-5			—	5	—	5	—	5	—	5	mA
V_{CEO}(sus)	a		0.1b		60	—	80	—	100	—	120	—	V
h_{FE}	3		25		2000	—	2000	—	2000	—	2000	—	
	5		50		400	—	400	—	400	—	400	—	
V_{BE}(sat)			25	0.2	—	3	—	3	—	3	—	3	V
			50	0.3	—	4.5	—	4.5	—	4.5	—	4.5	
V_{CE}(sat)			25	0.25	—	2.5	—	2.5	—	2.5	—	2.5	V
			50	0.5	—	3.5	—	3.5	—	3.5	—	3.5	
$I_{S/b}$ t = 0.5 sec.	30				10	—	10	—	10	—	10	—	A
C_{obo} V_{CB} = 10 V													
RCA9228A,B,C,D					Typ. 300		Typ. 300		Typ. 300		Typ. 300		pF
RCA9229A,B,C,D					Typ. 600		Typ. 600		Typ. 600		Typ. 600		
h_{fe} at f = 1 MHz					Typ. 5		Typ. 5		Typ. 5		Typ. 5		
$R\theta_{JC}$					—	0.416	—	0.416	—	0.416	—	0.416	°C/W

• For p-n-p devices, voltage and current values are negative.

a CAUTION: Sustaining voltage V_{CEO}(sus) MUST NOT be measured on a curve tracer.

b Pulsed: Pulse duration = 300 μs, duty factor < 2%.

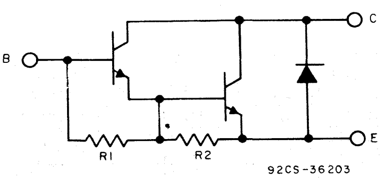


Fig. 1 - Schematic diagram for RCA9228A, RCA9228B, RCA9228C, RCA9228D.

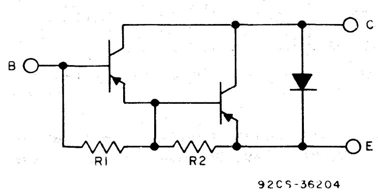
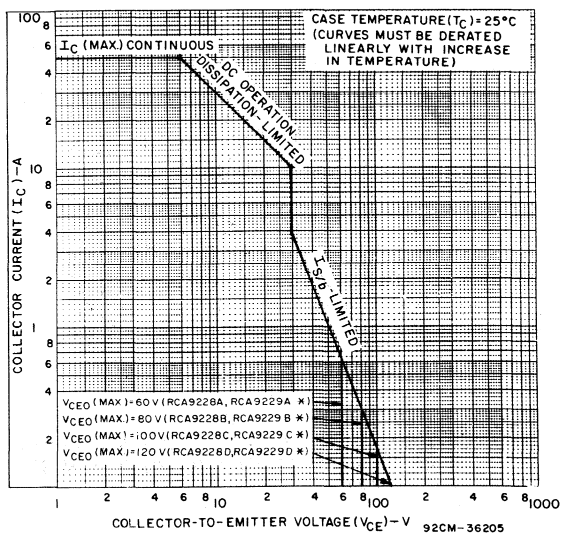


Fig. 2 - Schematic diagram for RCA9229A, RCA9229B, RCA9229C, RCA9229D.



*FOR p-n-p DEVICES, VOLTAGE AND CURRENT VALUES ARE NEGATIVE

Fig. 3 - Maximum operating areas for all types.

RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D

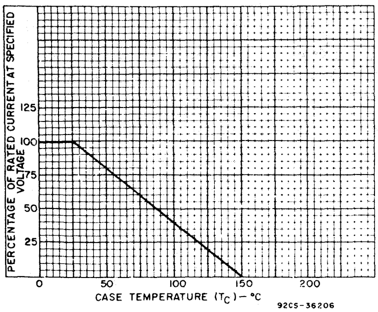


Fig. 4 - Current derating curve for all types.

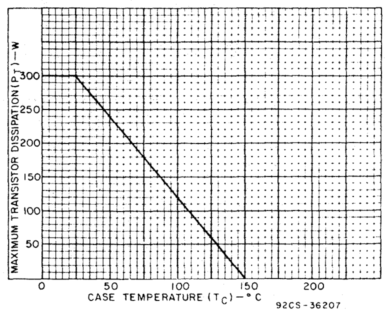


Fig. 5 - Power derating curve for all types.

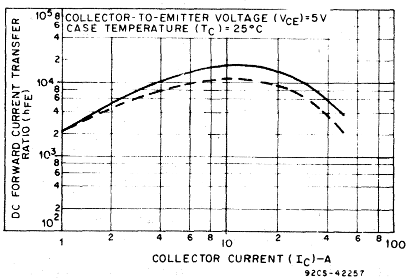


Fig. 6 - Typical dc beta characteristics for all types.

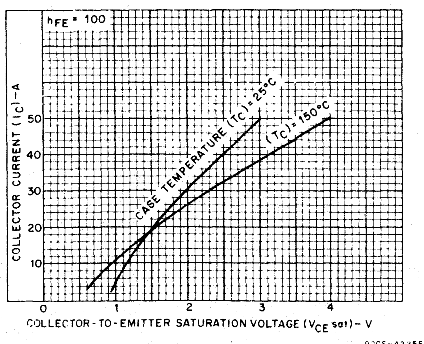


Fig. 7 - Typical collector-to-emitter saturation voltage characteristics for RCA9228A, RCA9228B, RCA9228C and RCA9228D.

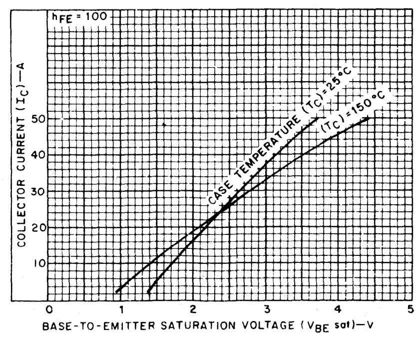


Fig. 8 - Typical base-to-emitter saturation voltage characteristics for RCA9228A, RCA9228B, RCA9228C and RCA9228D.

RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D

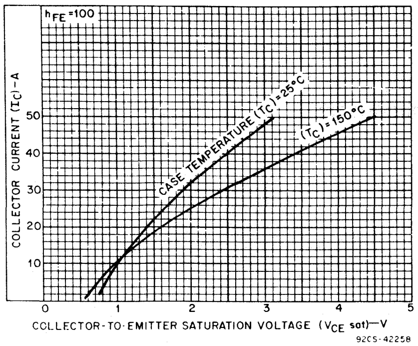


Fig. 9 - Typical collector-to-emitter saturation voltage characteristics for RCA9229A, RCA9229B, RCA9229C and RCA9229D.

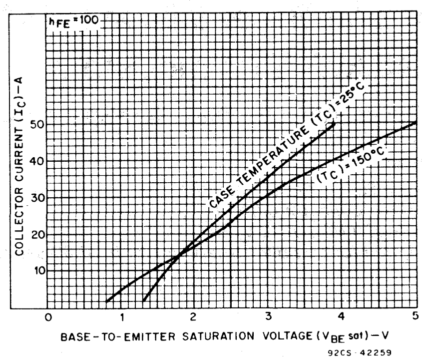


Fig. 10 - Typical base-to-emitter saturation voltage characteristics for RCA9229A, RCA9229B, RCA9229C and RCA9229D.

2

TIP29, TIP29A, TIP29B, TIP29C

File Number **990**

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

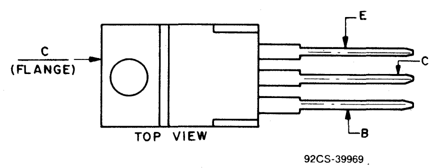
- *30 W at 25°C case temperature*
- *3 A rated collector current*
- *Min. f_T of 3 MH_Z at 10 V, 200 mA*
- *Designed for complementary use with TIP30-series p-n-p types**

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. VOLTAGE V dc V_{CE}	TEST COND. CURRENT A dc I_C	TIP29 Min.	TIP29 Max.	TIP29A Min.	TIP29A Max.	TIP29B Min.	TIP29B Max.	TIP29C Min.	TIP29C Max.	Units
I_{CEO}	30		–	0.3	–	0.3	–	–	–	–	
I_B=0	60		–	–	–	–	–	0.3	–	0.3	mA
I_{CES}	40		–	0.2	–	–	–	–	–	–	
V_{EB}=0	60		–	–	–	0.2	–	–	–	–	mA
	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=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
$R_{\theta JC}$			–	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.

2

TIP29, TIP29A, TIP29B, TIP29C

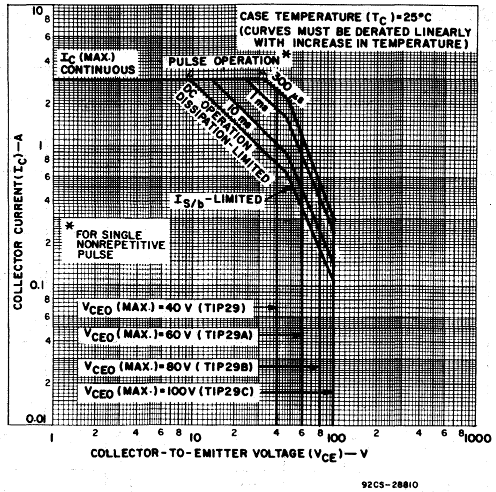


Fig. 1 — Maximum operating areas for all types.

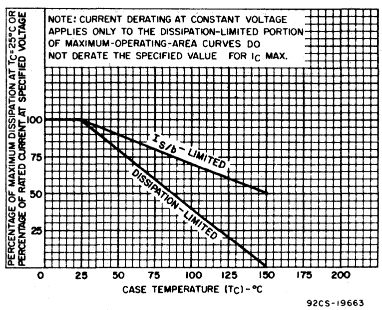


Fig. 2 — Derating curve for all types.

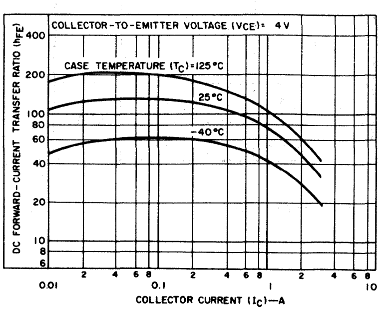


Fig. 3 — Typical dc beta characteristics for TIP29, TIP29A, and TIP29B.

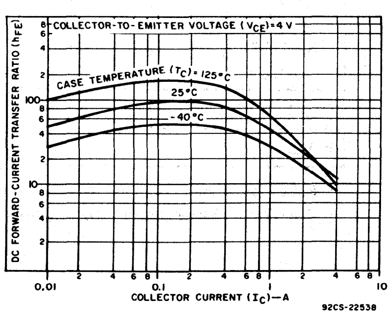
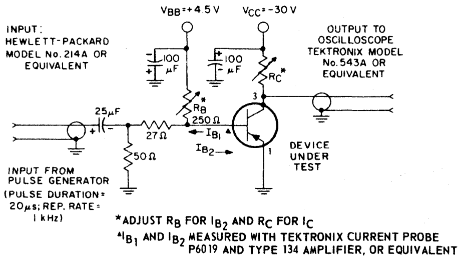


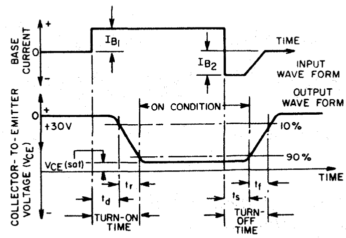
Fig. 4 — Typical dc beta characteristics for TIP29C.

TIP29, TIP29A, TIP29B, TIP29C



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.

2

TIP30, TIP30A, TIP30B, TIP30C

File Number **988**

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

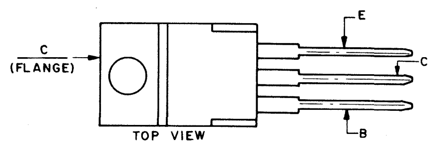
- *30 W at 25°C case temperature*
- *3 A rated collector current*
- *Min. f_T of 3 MHz at -10 V, -200 mA*
- *Designed for complementary use with TIP29-series n-p-n types**

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 V_{CE}	TEST COND. CURRENT A dc I_C	LIMITS TIP30 Min.	TIP30 Max.	TIP30A Min.	TIP30A Max.	TIP30B Min.	TIP30B Max.	TIP30C Min.	TIP30C Max.	Units
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=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.

2

TIP30, TIP30A, TIP30B, TIP30C

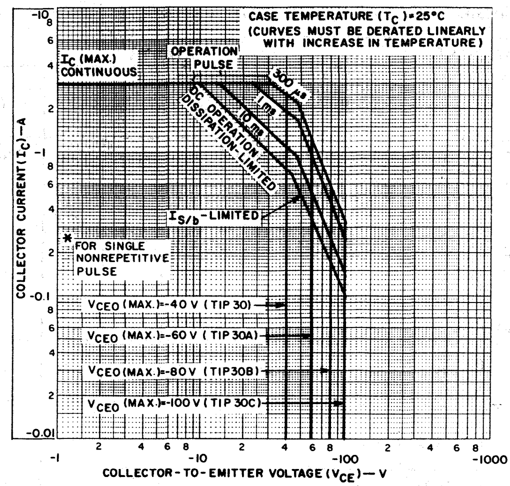


Fig. 1 — Maximum operating areas for all types.

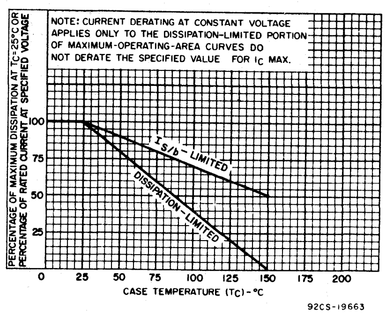


Fig. 2 — Derating curve for all types.

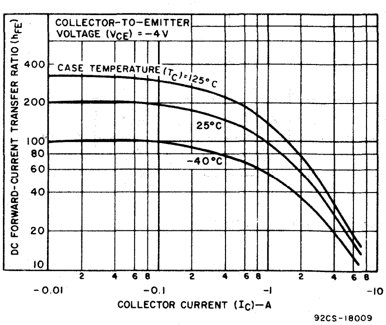


Fig. 3 — Typical dc beta characteristics for TIP30, TIP30A, and TIP30B.

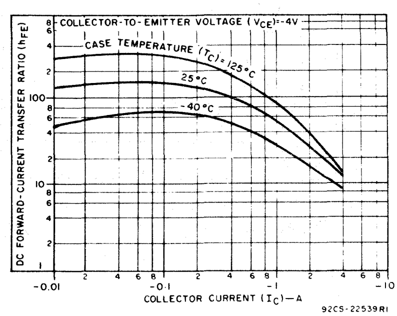


Fig. 4 — Typical dc beta characteristics for TIP30C.

TIP30, TIP30A, TIP30B, TIP30C

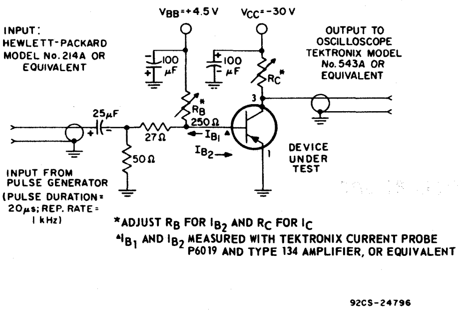


Fig. 5 — Circuit used to measure saturated switching times for all types.

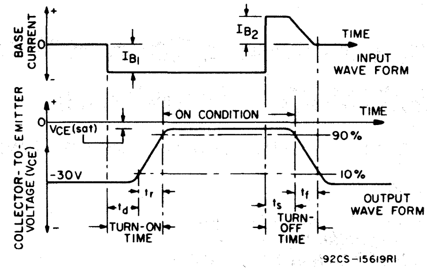


Fig. 6 — Oscilloscope display for measurement of switching times.

2

TIP31, TIP31A, TIP31B, TIP31C

File Number **991**

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

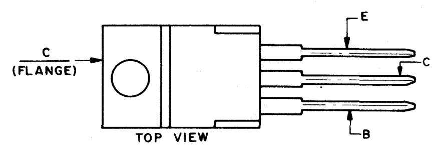
- *40 W at 25°C case temperature*
- *5 A rated collector current*
- *Min. f_T of 3 MHz at 10 V, 500 mA*
- *Designed for complementary use with TIP32-series p-n-p types**

The RCA-TIP31, TIP31A, TIP31B, and TIP31C are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP32 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP32-series devices are given in RCA data bulletin File No. 987

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} I_B=0	30		–	0.3	–	0.3	–	–	–	–	mA
	60		–	–	–	–	–	0.3	–	0.3	mA
I_{CES} V_{EB}=0	40		–	0.2	–	–	–	–	–	–	mA
	60		–	–	–	0.2	–	–	–	–	mA
	80		–	–	–	–	–	0.2	–	–	mA
	100		–	–	–	–	–	–	–	0.2	mA
I_{EBO} V_{BE}=–5V		0	–	1	–	1	–	1	–	1	mA
$V_{CEO(sus)}$ I_B=0		0.03[a]	40[b]	–	60[b]	–	80[b]	–	100[b]	–	V
h_{FE}	4	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.

2

TIP31, TIP31A, TIP31B, TIP31C

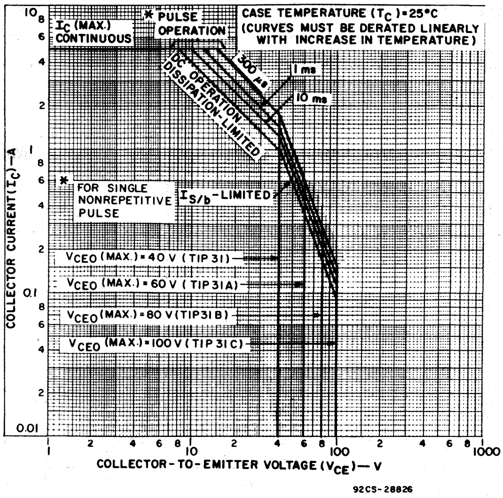


Fig. 1 — Maximum operating areas for all types.

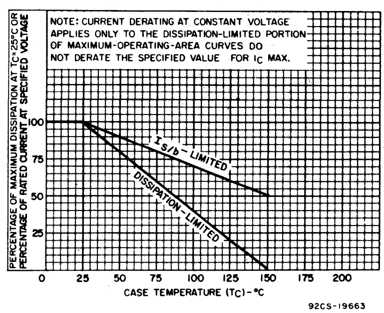


Fig.2 — Derating curve for all types.

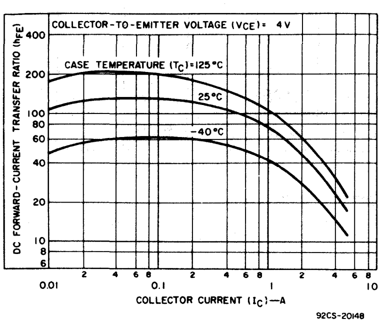


Fig. 3 — Typical dc beta characteristics for TIP31, TIP31A, and TIP31B.

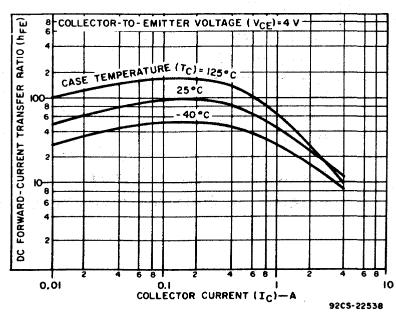


Fig. 4 — Typical dc beta characteristics for TIP31C.

TIP31, TIP31A, TIP31B, TIP31C

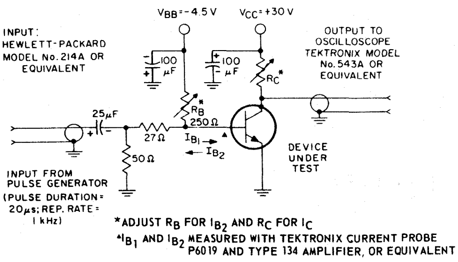


Fig. 5 — Circuit used to measure saturated switching times for all types.

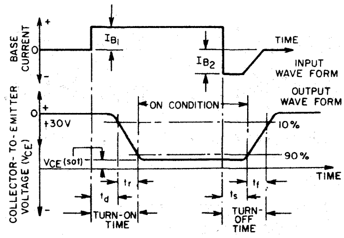


Fig. 6 — Oscilloscope display for measurement of switching times.

2

TIP32, TIP32A, TIP32B, TIP32C

File Number **987**

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

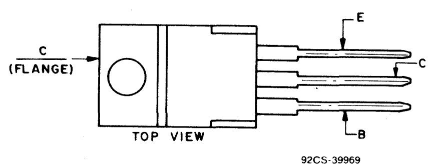
- *40 W at 25°C case temperature*
- *5 A rated collector current*
- *Min. f_T of 3 MHz at -10 V, -500 mA*
- *Designed for complementary use with TIP31-series n-p-n types**

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 V_{CE}	TEST COND. CURRENT A dc I_C	TIP32 Min.	TIP32 Max.	TIP32A Min.	TIP32A Max.	TIP32B Min.	TIP32B Max.	TIP32C Min.	TIP32C Max.	Units
I_{CEO} I_B=0	−30		–	−0.3	–	−0.3	–	–	–	–	mA
	−60		–	–	–	–	–	−0.3	–	−0.3	
I_{CES} V_{EB}=0	−40		–	−0.2	–	–	–	–	–	–	mA
	−60		–	–	–	−0.2	–	–	–	–	
	−80		–	–	–	–	–	−0.2	–	–	
	−100		–	–	–	–	–	–	–	−0.2	
I_{EBO} V_{BE}=5V		0	–	−1	–	−1	–	−1	–	−1	mA
$V_{CEO(sus)}$ I_B=0		−0.03[a]	−40[b]	–	−60[b]	–	−80[b]	–	−100[b]	–	V
h_{FE}	−4	−1[a]	25	–	25	–	25	–	25	–	
	−4	−3[a]	10	50	10	50	10	50	10	50	
V_{BE}	−4	−3[a]	–	−1.8	–	−1.8	–	−1.8	–	−1.8	V
$V_{CE(sat)}$ I_B= −0.375A		−3[a]	–	−1.2	–	−1.2	–	−1.2	–	−1.2	V
h_{fe} f=1 kHz	−10	−0.5	20	–	20	–	20	–	20	–	
$\|h_{fe}\|$ f=1 MHz	−10	−0.5	3	–	3	–	3	–	3	–	
t_{ON} (t_d+t_r) V_{CC}= −30V R_L=30Ω I_{B1}=I_{B2} =−0.1A		−1	0.2 (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
$R_{\theta JC}$			–	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.

2

TIP32, TIP32A, TIP32B, TIP32C

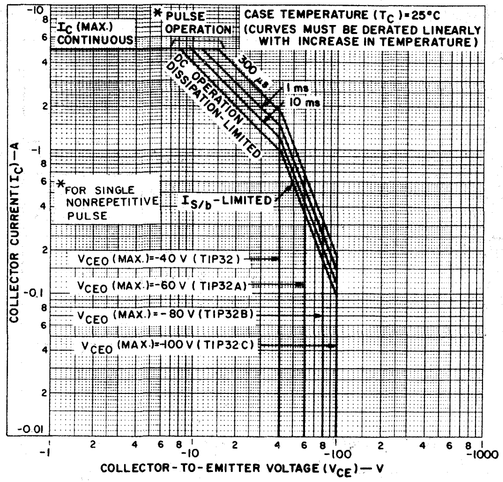


Fig. 1 — Maximum operating areas for all types.

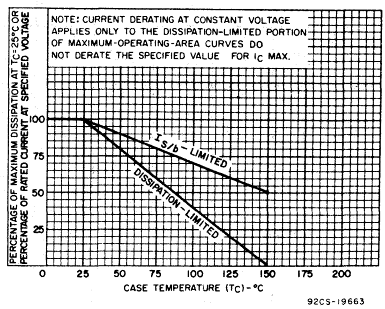


Fig.2 — Derating curve for all types.

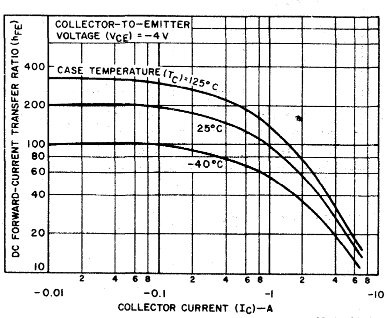


Fig. 3 — Typical dc beta characteristics for TIP32, TIP32A, and TIP32B.

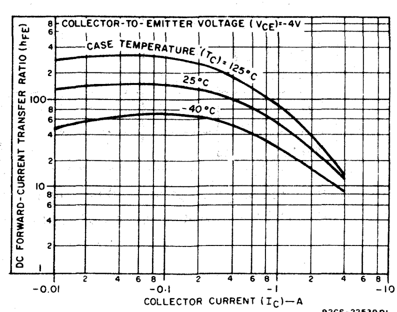


Fig. 4 — Typical dc beta characteristics for TIP32C.

TIP32, TIP32A, TIP32B, TIP32C

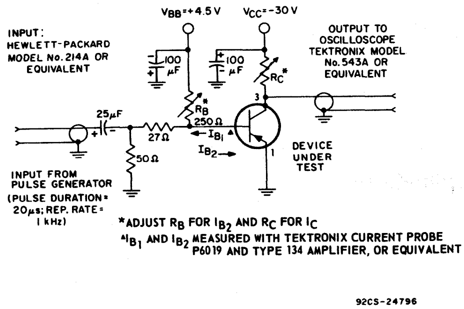


Fig. 5 — Circuit used to measure saturated switching times for all types.

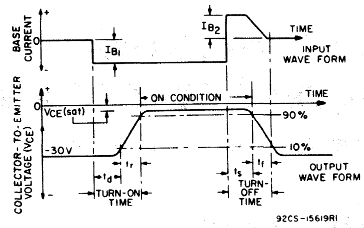


Fig. 6 — Oscilloscope display for measurement of switching times.

2

TIP41, TIP41A, TIP41B, TIP41C

File Number **992**

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

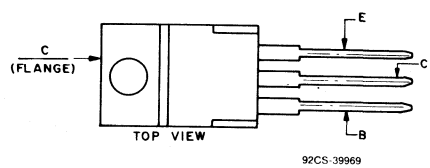
Features:

- *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*

CHARAC-TERISTIC	TEST CONDITIONS Voltage V dc	TEST CONDITIONS Current A dc	LIMITS TIP41		LIMITS TIP41A		LIMITS TIP41B		LIMITS TIP41C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	30		–	0.7	–	0.7	–	–	–	–	mA
I_B=0	60		–	–	–	–	–	0.7	–	0.7	
I_{CES}	40		–	0.4	–	–	–	–	–	–	mA
V_{BE}=0	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	°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.*

TIP41, TIP41A, TIP41B, TIP41C

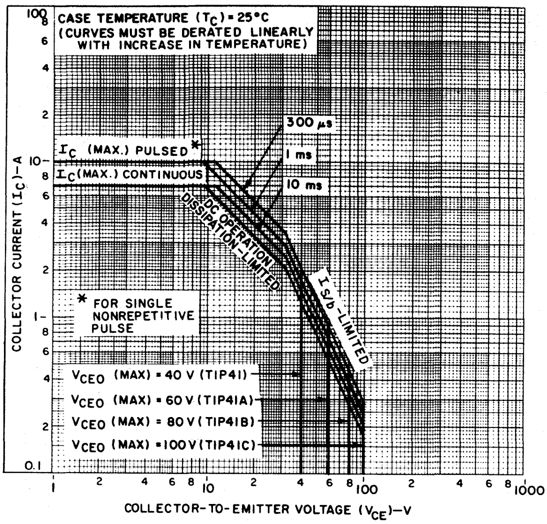


Fig. 1 — Maximum operating areas for all types.

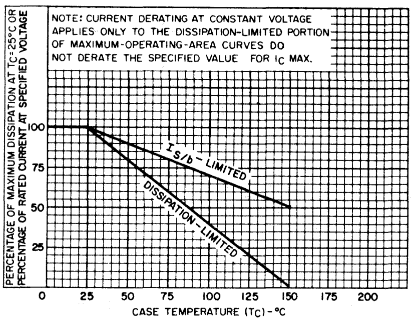


Fig. 2 — Derating curves for all types.

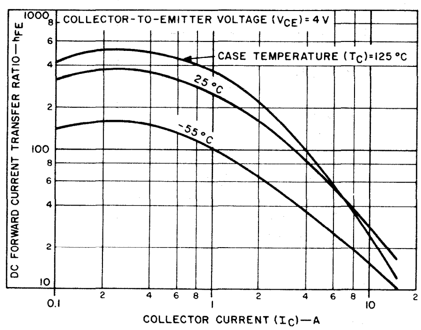


Fig. 3 — Typical dc beta characteristics for all types.

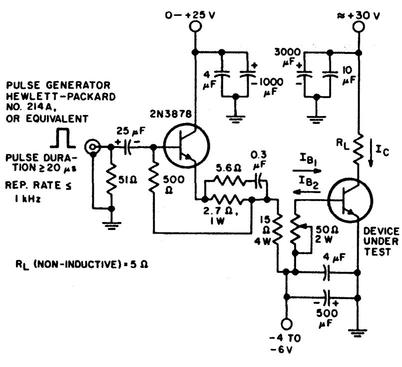


Fig. 4 — Circuit used to measure saturated switching times for all types.

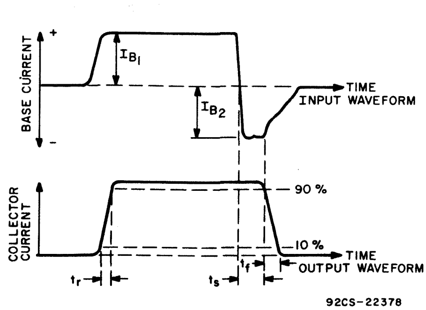


Fig. 5 — Oscilloscope display for measurement of switching times.

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**

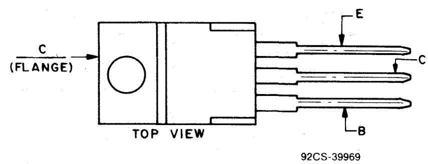
2

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	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	–	–	–	–	mA
	-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, $R_L = 5\ \Omega$, $I_{B1} = I_{B2} = -0.6$ 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.)		
$R_{\theta JC}$			–	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.

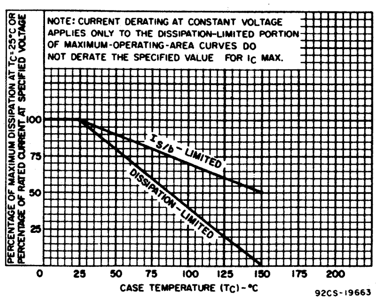


Fig. 1 — Derating curve for all types.

TIP42, TIP42A, TIP42B, TIP42C

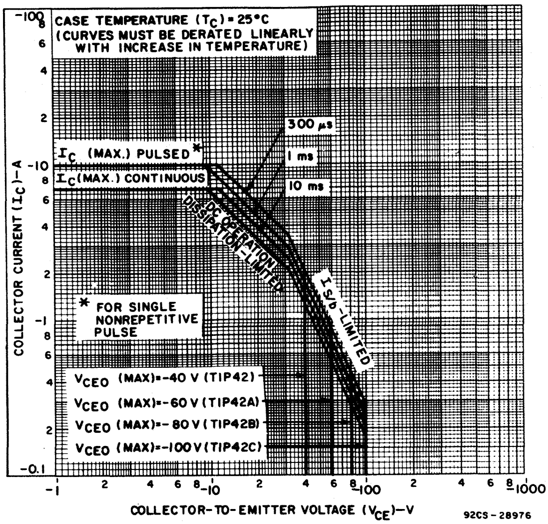


Fig. 2 — Maximum operating areas for all types.

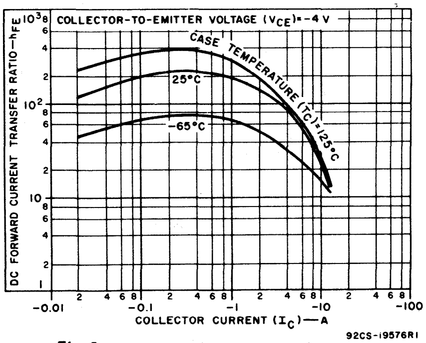


Fig. 3 — Typical dc beta characteristics for TIP42, TIP42A, and TIP42B.

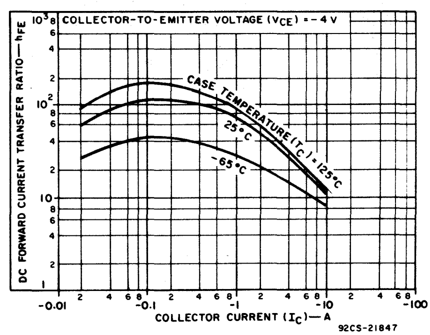
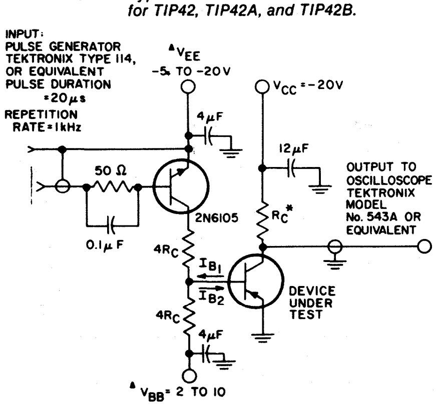


Fig. 4 — Typical dc beta characteristics for TIP42C.



* 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.

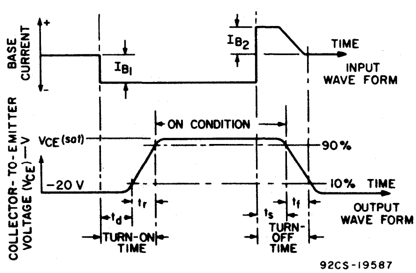


Fig. 6 — Oscilloscope display for measurement of switching times.

2

TIP47, TIP48, TIP49, TIP50

File Number **978**

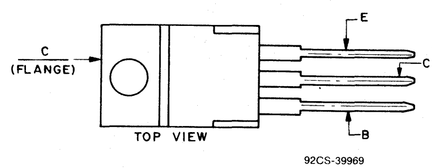
High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:
- *VERSAWATT package*
- *Maximum safe-area-of-operation curves*

The TIP47, TIP48, TIP49, and TIP50 are silicon n-p-n transistors. Typical applications for these transistors include high-voltage switches, switching regulators, TV horizontal-deflection circuits, power supplies, and TV audio-output circuits. They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP47	TIP48	TIP49	TIP50	
V_{CBO}	350	400	450	500	V
V_{CEO}(sus)	250	300	350	400	V
V_{EBO}	5	5	5	5	V
I_C	1	1	1	1	A
I_{CM}	2	2	2	2	A
I_B	0.6	0.6	0.6	0.6	A
P_T:					
T_C up to 25°C	40	40	40	40	W
T_C above 25°C .... Derate linearly	0.32				W/°C
T_A up to 25°C	1.8				W
T_{stg}, T_J	-65 to 150				°C
T_L:					
At distance ≥ 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		TIP48		TIP49		TIP50		UNITS
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} $I_B = 0$	150		–	1	–	–	–	–	–	–	mA
	200		–	–	–	1	–	–	–	–	mA
	250		–	–	–	–	–	1	–	–	mA
	300		–	–	–	–	–	–	–	1	mA
I_{CES} $V_{EB} = 0$	350		–	1	–	–	–	–	–	–	mA
	400		–	–	–	1	–	–	–	–	mA
	450		–	–	–	–	–	1	–	–	mA
	500		–	–	–	–	–	–	–	1	mA
I_{EBO} $V_{BE} = -5$ V		0	–	1	–	1	–	1	–	1	mA
h_{FE}	10	1[a]	10	–	10	–	10	–	10	–	
	10	0.3[a]	30	150	30	150	30	150	30	150	
$V_{CEO(sus)}$ $I_B = 0$		0.03[a]	250[b]	–	300[b]	–	350[b]	–	400[b]	–	V
V_{BE}	10	1[a]	–	1.5	–	1.5	–	1.5	–	1.5	V
$V_{CE(sat)}$ $I_B = 0.2$ A		1[a]	–	1	–	1	–	1	–	1	V
$\|h_{fe}\|$ f = 1 MHz	10	0.2	10	–	10	–	10	–	10	–	
f_T f = 1 MHz	10	0.2	10	–	10	–	10	–	10	–	MHz
h_{fe} f = 1 kHz	10	0.2	25	–	25	–	25	–	25	–	
$I_{S/b}$ t = 0.5 s	100	–	0.4	–	0.4	–	0.4	–	0.4	–	A
t_{ON} ($t_d + t_r$)[c,d] $V_{CC} = 200$ V		1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		μs
t_s[c,d] $V_{CC} = 200$ V		1	2 (typ.)		2 (typ.)		2 (typ.)		2 (typ.)		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.

2

TIP47, TIP48, TIP49, TIP50

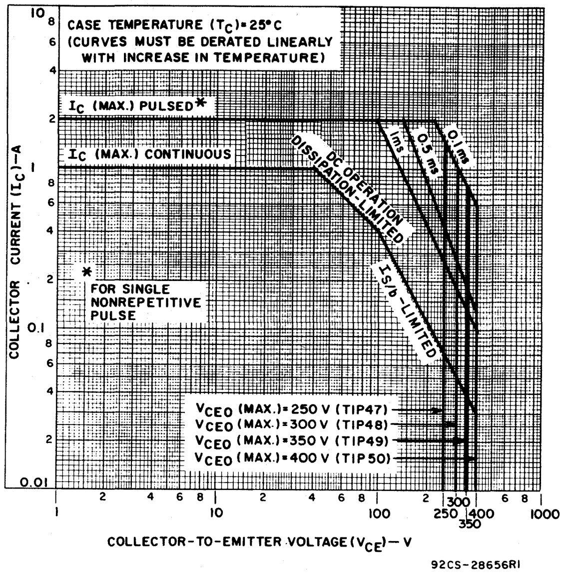


Fig. 1 — Maximum operating areas for all types.

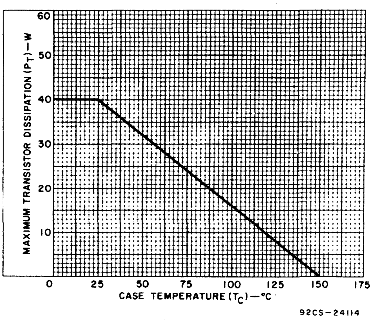


Fig.2 — Derating curve for all types.

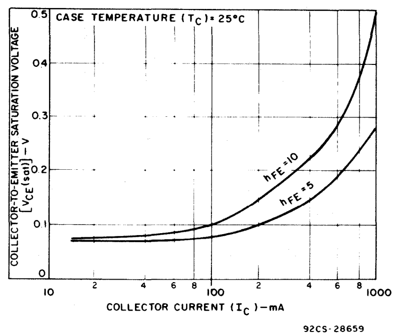


Fig. 3 — Typical saturation-voltage characteristics for all types.

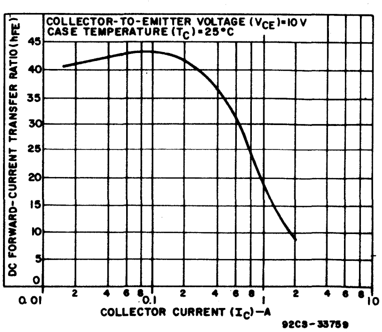


Fig.4 — Typical dc beta characteristics for all types.

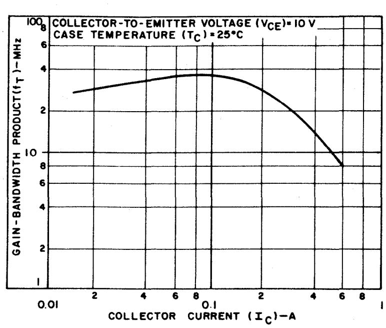


Fig.5 — Typical gain-bandwidth characteristics for all types.

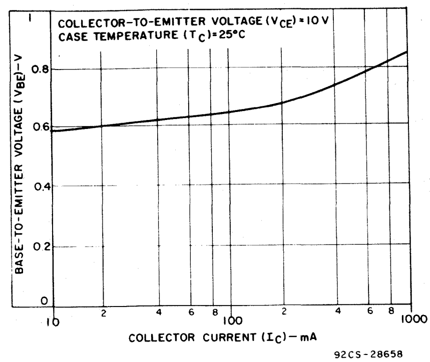


Fig.6 — Typical base-to-emitter voltage vs. collector current.

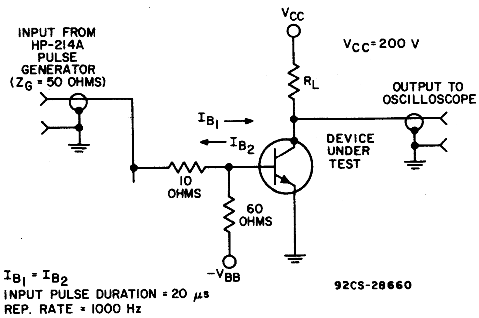


Fig. 7 — Circuit used to measure saturated switching times.

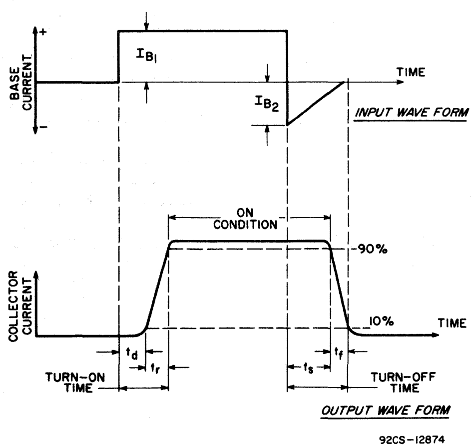


Fig. 8 — Phase relationship between input and output currents, showing reference points for specification of switching times.

TIP100, TIP101, TIP102

File Number **1153**

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 80 Watts
Gain of 1000 at 3 A

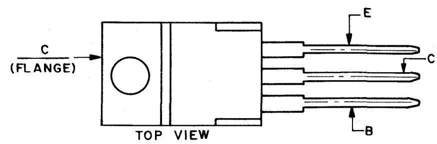
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

- **Power switching**
- **Hammer drivers**
- **Audio amplifiers**
- **Series and shunt regulators**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The TIP100, TIP101 and TIP102 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

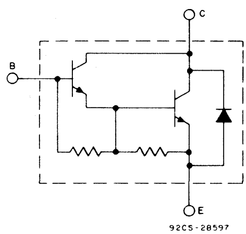


Fig. 1 – Schematic diagram for all types.

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

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS: Voltage V dc V_{CE}	Voltage V dc V_{BE}	Current A dc I_C	Current A dc I_B	LIMITS TIP100 Min.	TIP100 Max.	TIP101 Min.	TIP101 Max.	TIP102 Min.	TIP102 Max.	UNITS
I_{CBO}, $I_E = 0$	60				–	50	–	–	–	–	μA
	80				–	–	–	50	–	–	
	100				–	–	–	–	–	50	
I_{CEO}	30			0	–	50	–	–	–	–	
	40			0	–	–	–	50	–	–	
	50			0	–	–	–	–	–	50	
I_{EBO}		–5	0		–	8	–	8	–	8	mA
$V_{CEO}(sus)$			0.03^b	0	60	–	80	–	100	–	V
h_{FE}	4		3^b		1000	20,000	1000	20,000	1000	20,000	
	4		8^b		200	–	200	–	200	–	
V_{BE}	4		8^b		–	2.8	–	2.8	–	2.8	V
$V_{CE}(sat)$			3^b	0.006	–	2	–	2	–	2	
			8^b	0.08	–	2.5	–	2.5	–	2.5	
V_F			–10		–	2.8	–	2.8	–	2.8	
t_d^c			8	0.08	0.035 typ.		0.035 typ.		0.035 typ.		μs
t_r^c			8	0.08	0.35 typ.		0.35 typ.		0.35 typ.		
t_s^c			8	0.08^d	1.8 typ.		1.8 typ.		1.8 typ.		
t_f^c			8	0.08^d	2.45 typ.		2.45 typ.		2.45 typ.		
$I_{S/b}$ 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} $I_{B_1} = -I_{B_2}$.

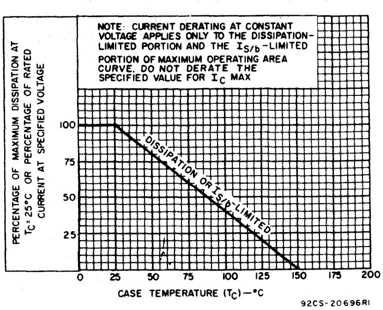


Fig. 2 – Derating curve for all types.

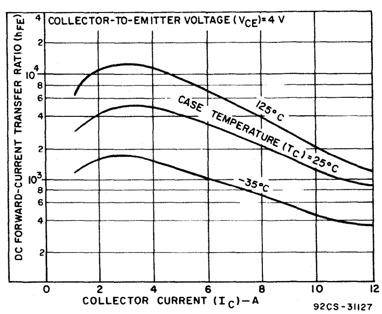


Fig. 3 – Typical dc-beta characteristics for all types.

TIP100, TIP101, TIP102

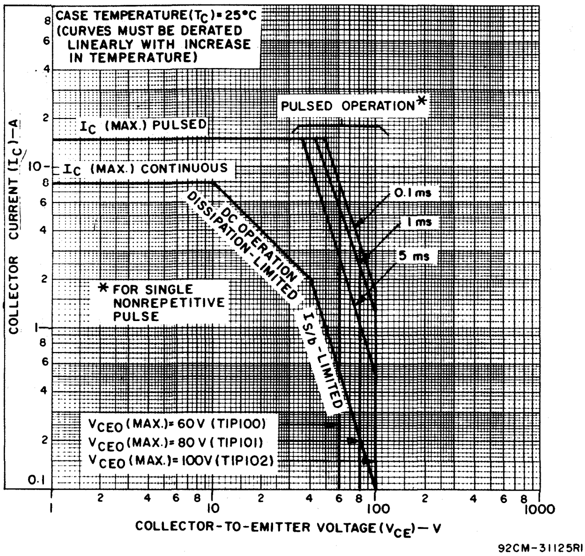


Fig. 4 — Maximum operating areas for all types (T_C = 25°C).

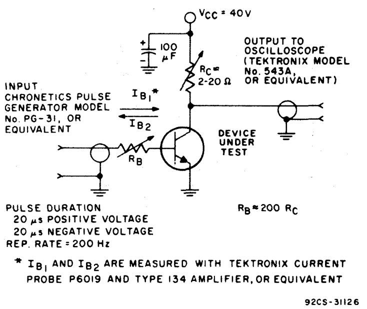


Fig. 5 — Circuit used to measure saturated switching times.

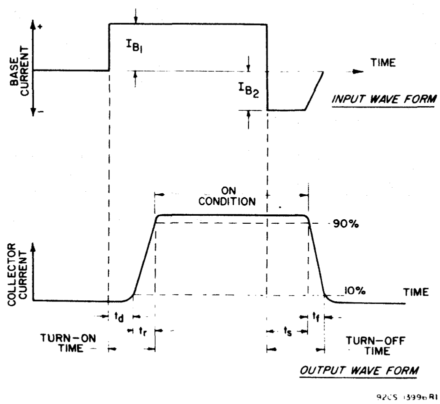


Fig. 6 — Phase relationship between input current and output current showing reference points for specification of switching times.

File Number **1336**

TIP110, TIP111, TIP112

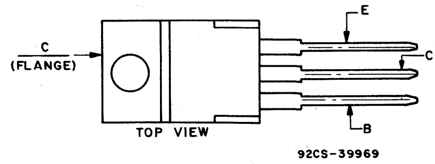
2-Ampere N-P-N Darlington Power Transistors

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

2

The TIP110, TIP111 and TIP112 series monolithic n-p-n silicon Darlington transistors are designed for low and medium frequency power applications. The construction of these devices provides good forward-bias second-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.

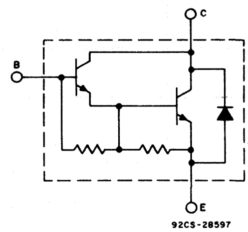


Fig. 1 - Schematic diagram for all types.

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] 80[a] 100[a]	— — —	— — —	— — —	— — —	1 — —	— — —	— 1 —	— — —	— — 1	mA
I_{CEO}	30 40 50	— — —	— — —	0 0 0	— — —	2 — —	— — —	— 2 —	— — —	— — 2	mA
I_{EBO}	—	-5	0	—	—	2	—	2	—	2	mA
$V_{CEO}(sus)$	—	—	0.03[b]	0	60	—	80	—	100	—	V
h_{FE}	4 4	— —	1[b] 2[b]	— —	1000 500	— —	1000 500	— —	1000 500	— —	—
V_{BE}	4	—	2[b]	—	—	2.8	—	2.8	—	2.8	V
$V_{CE}(sat)$	—	—	2[b]	0.008	—	2.5	—	2.5	—	2.5	V
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	°C/W

[a] V_{CB} value. [b] Pulsed: Pulsed duration = 300 μs, duty factor $\leq$2%.

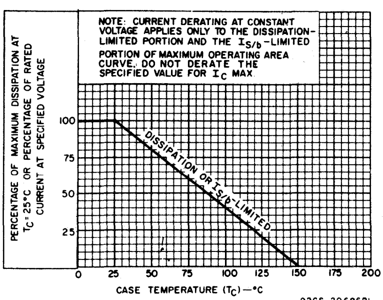


Fig. 2 - Derating curve for all types.

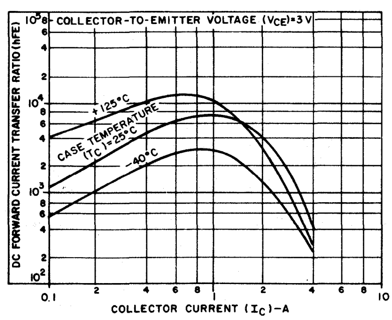


Fig. 3 - Typical dc-beta characteristics for all types.

TIP110, TIP111, TIP112

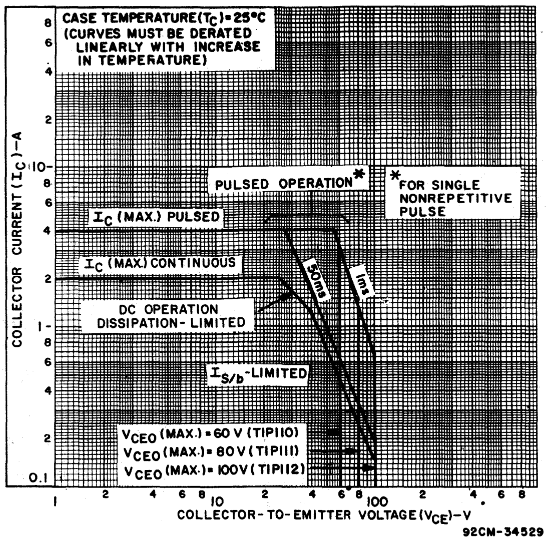


Fig. 4 - Maximum operating areas for all types (T_C = 25° C).

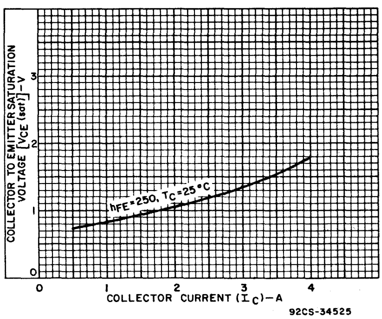


Fig. 5 - Typical saturation characteristics for all types.

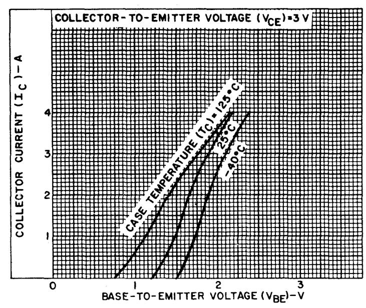


Fig. 6 - Typical transfer characteristics for all types.

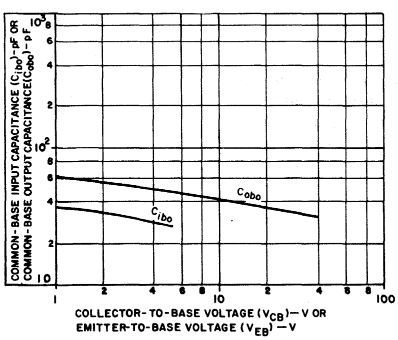


Fig. 7 - Typical common-base input (C_{ibo}) or output (C_{obo}) capaciatance characteristic (all types).

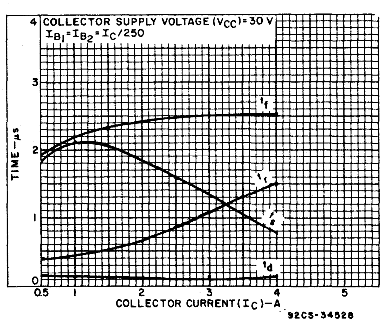


Fig. 8 - Typical saturated switching characteristics (all types).

TIP110, TIP111, TIP112

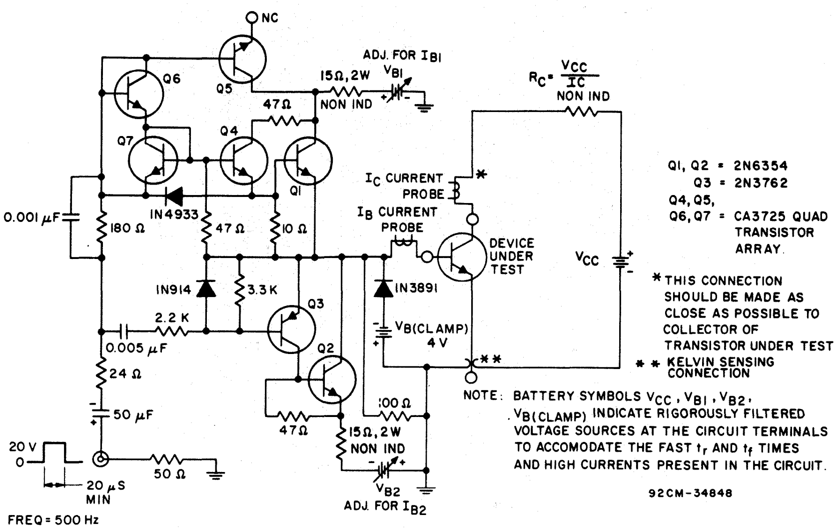
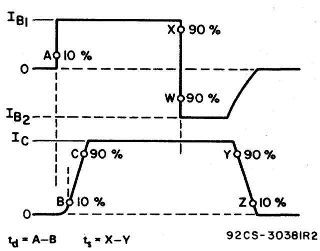


Fig. 9 - Circuit for measuring switching times.



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.

File Number **1387**

TIP115, TIP116, TIP117

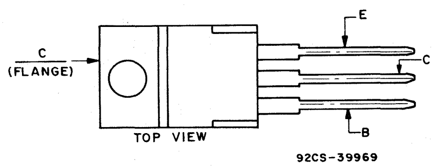
2-Ampere P-N-P Darlington Power Transistors

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

2

The TIP115, TIP116, and TIP117 series are monolithic p-n-p silicon Darlington transistors designed for low and medium frequency power applications. The construction of these devices provides good 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.

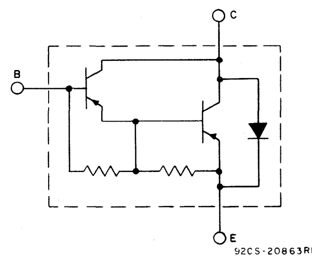


Fig. 1 - Schematic diagram for all types.

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%.

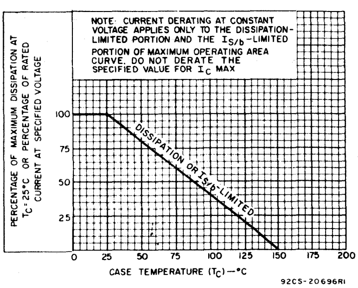


Fig. 2 - Derating curve for all types.

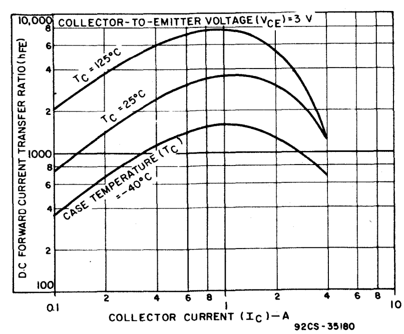


Fig. 3 - Typical dc-beta characteristics for all types.

TIP115, TIP116, TIP117

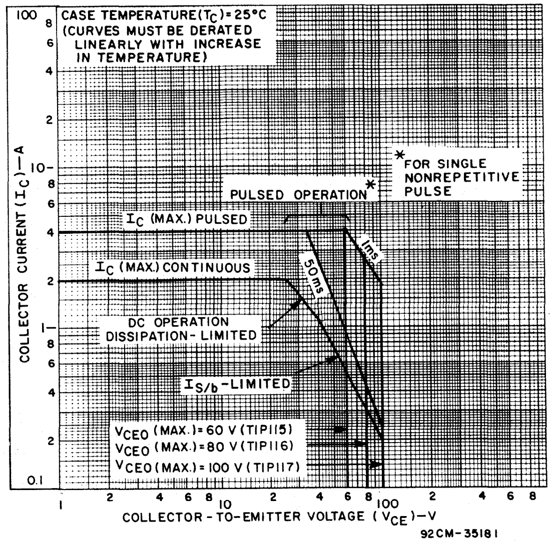


Fig. 4 - Maximum operating areas for all types (Tc = 25° C).

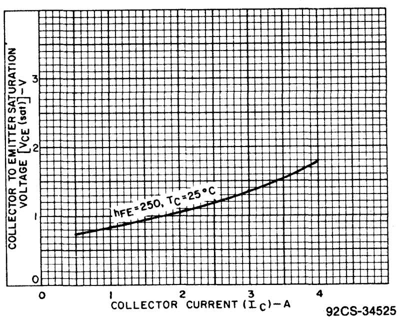


Fig. 5 - Typical saturation characteristics for all types.

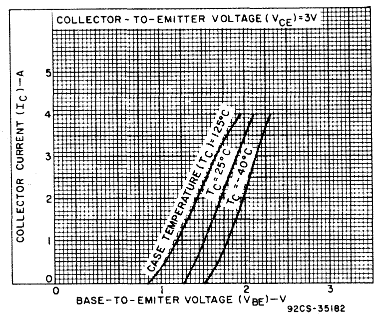


Fig. 6 - Typical transfer characteristics for all types.

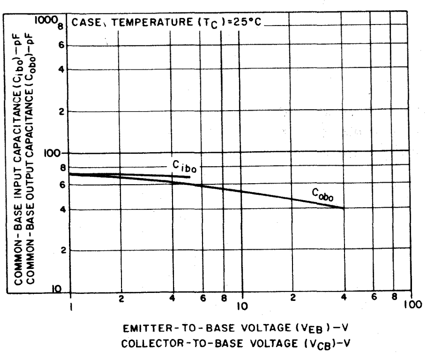


Fig. 7 - Typical common-base input (Cibo) or output (Cobo) capaciatance characteristic (all types).

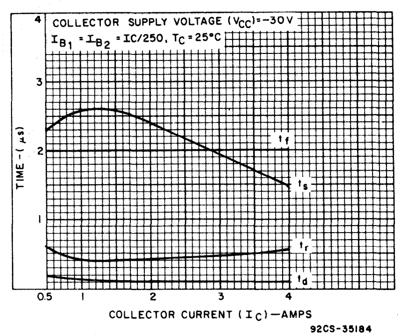


Fig. 8 - Typical saturated switching characteristics (all types).

TIP115, TIP116, TIP117

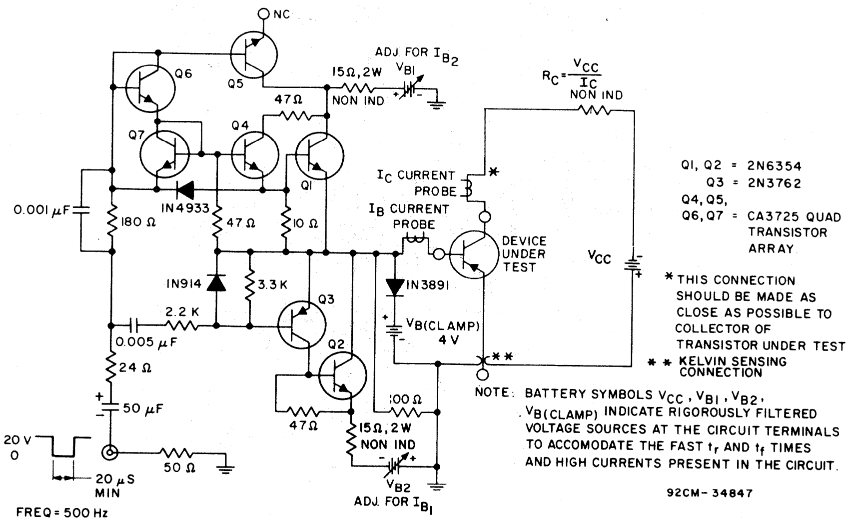
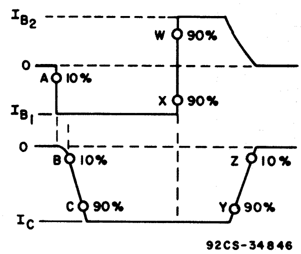


Fig. 9 - Circuit for measuring switching times.



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_{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.

File Number **998**

TIP120, TIP121, TIP122

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

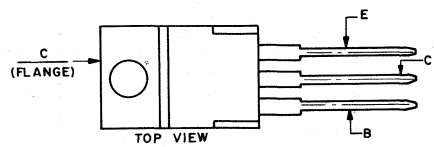
Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Series and shunt regulators
- Audio amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The TIP120, TIP121 and TIP122 are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

The TIP120, TIP121 and TIP122 are n-p-n complements of the TIP125, TIP126 and TIP127 described in data bulletin File 997.

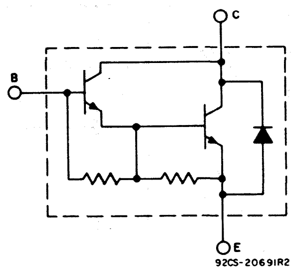


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP120	TIP121	TIP122	
V_{CBO}	60	80	100	V
V_{CER}(sus) R_{BE} = 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%.

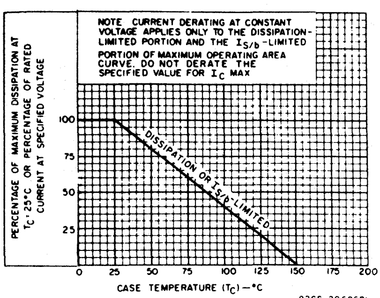


Fig. 2 — Derating curve for all types.

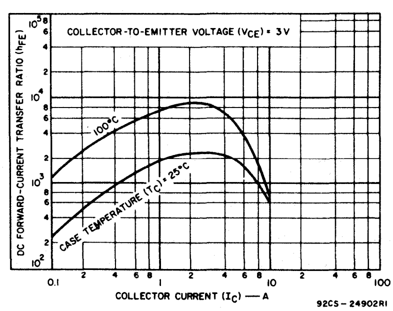


Fig. 3 — Typical dc beta characteristics for all types.

TIP120, TIP121, TIP122

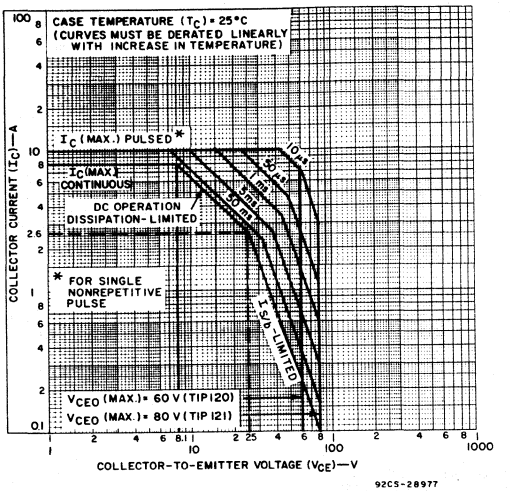


Fig. 4 — Maximum operating areas for TIP120 and TIP121.

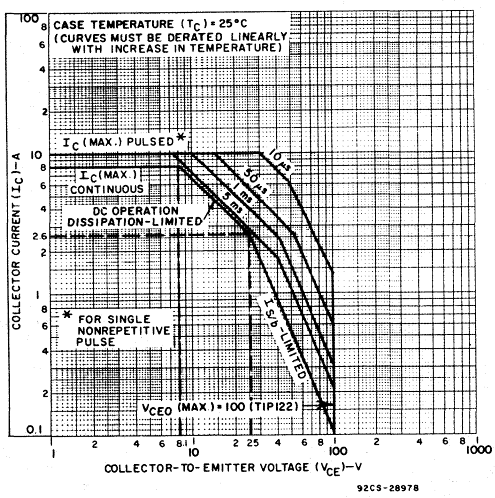


Fig. 5 — Maximum operating areas for TIP122.

TIP120, TIP121, TIP122

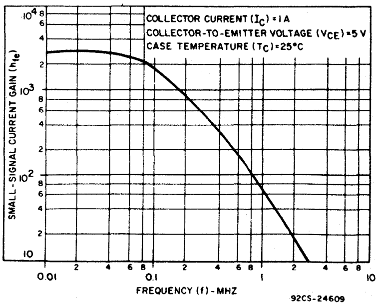


Fig. 6 — Typical small-signal current gain for all types.

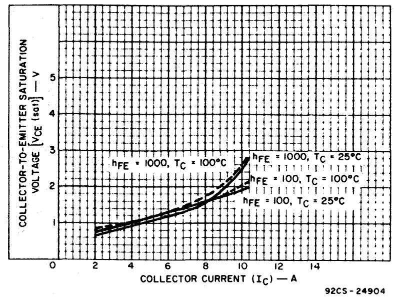


Fig. 7 — Typical saturation characteristics for all types.

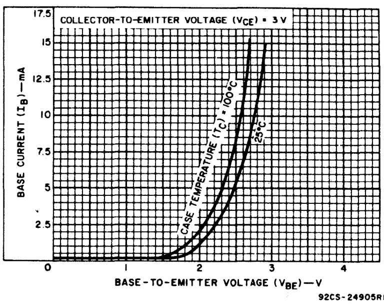


Fig. 8 — Typical input characteristics for all types.

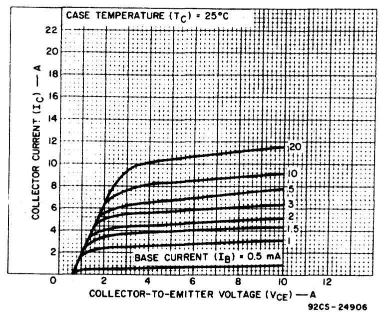


Fig. 9 — Typical output characteristics for all types.

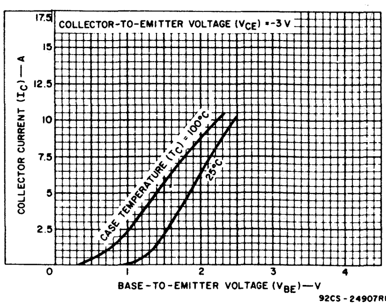


Fig. 10 — Typical transfer characteristics for all types.

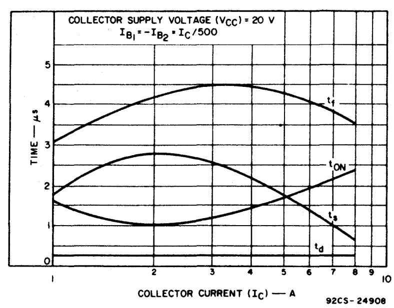


Fig. 11 — Typical saturated switching characteristics for all types.

File Number **997**

TIP125, TIP126, TIP127

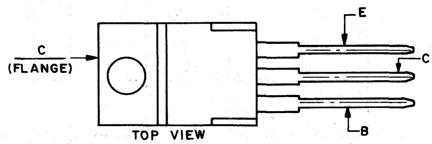
8-Ampere P-N-P Darlington Power Transistors

−60, −80, and −100 Volts, 65 Watts
Gain of 1000 at −3 A
Gain of 500 at −0.75 A

Features:
- Operates from IC without predriver
- Low leakage at high temperature

Applications:
- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

TERMINAL DESIGNATIONS



92CS-39969

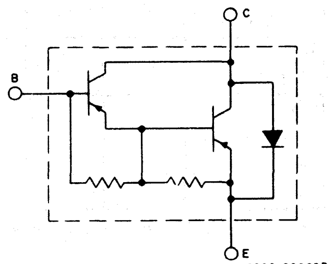
JEDEC TO-220AB

2

The TIP125, TIP126 and TIP127 are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

These devices are supplied in the JEDEC TO-220AB (VERSAWATT) package.

The TIP125, TIP126 and TIP127 are p-n-p complements of the TIP120, TIP121 and TIP122 described in data bulletin File 998.



92CS-20863RI

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 Voltage V dc V_{CE}	Current A dc I_C	I_B	LIMITS TIP125 Min.	TIP125 Max.	TIP126 Min.	TIP126 Max.	TIP127 Min.	TIP127 Max.	UNITS
I_{CEO}	−30		0	–	−0.5	–	–	–	–	mA
	−40		0	–	–	–	−0.5	–	–	
	−50		0	–	–	–	–	–	−0.5	
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	−0.75[a]		500	–	500	–	500	–	
	−3	−3[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	–	−4	–	−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. 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%.

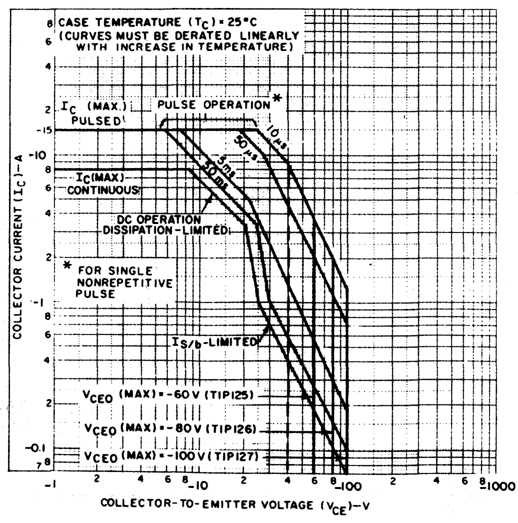


Fig. 2 — Maximum operating areas for all types.

TIP125, TIP126, TIP127

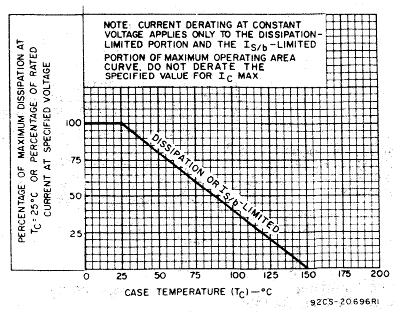


Fig. 3 — Dissipation derating curve for all types.

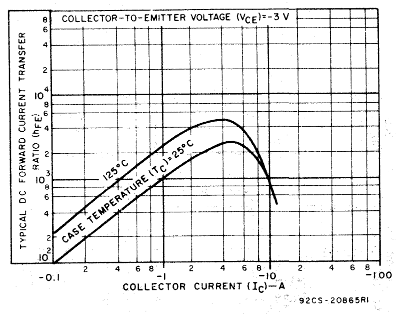


Fig. 4 — Typical dc beta characteristics for all types.

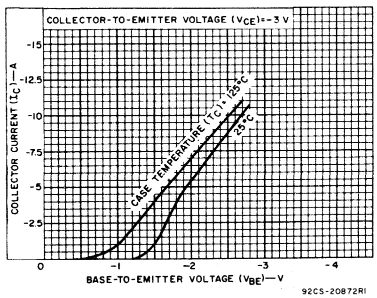


Fig. 5 — Typical transfer characteristics for all types.

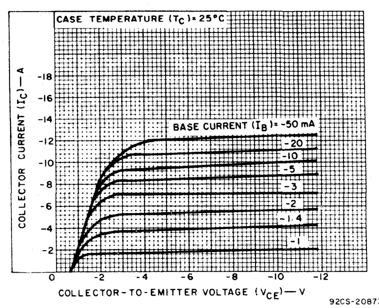


Fig. 6 — Typical output characteristics for all types.

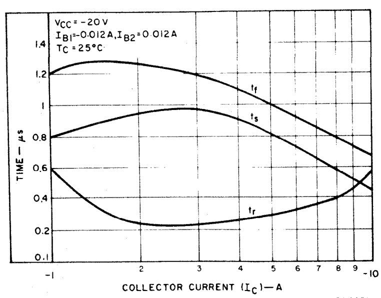


Fig. 7 — Typical saturated switching-time characteristics for all types.

TIP125, TIP126, TIP127

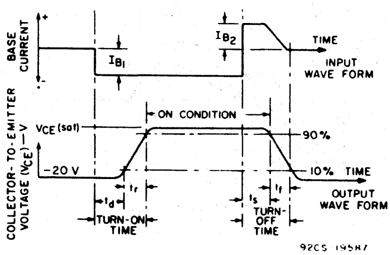


Fig. 8 — Phase relationship between input current and output voltage showing reference points for specification of switching-times.

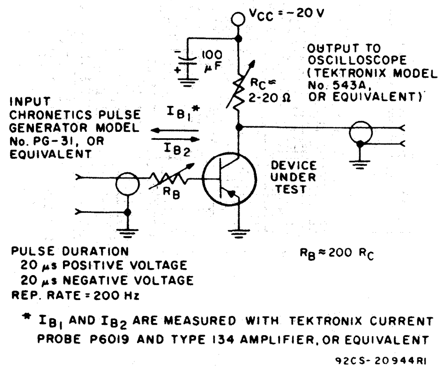


Fig. 9 — Circuit used to measure saturated switching-times.

File Number **1212**

TIP562, TIP563

Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

Features:

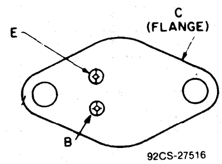
- V_{CEO} — 300 V and 400 V
- I_C — 10 A
- P_T — 100 W

2

The TIP562 and TIP563 silicon n-p-n power transistors feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators, and a variety of power-switching circuits.

The TIP562 and TIP563 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP562	TIP563	
V_{CBO}	300	400	V
$V_{CEO(SUS)}$	300	400	V
V_{EBO}	8		V
I_C	10		A
I_{CM}	15		A
I_B	2		A
P_T:			
At T_C up to 100°C	100		W
T_J, T_{stg}	-65 to +200		°C
T_L:			
At distances ≥ 1/16 in. (1.58 mm) from case for 10 s max.	200		°C

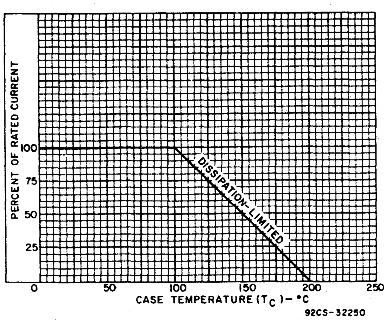


Fig. 1 - Dissipation derating curve.

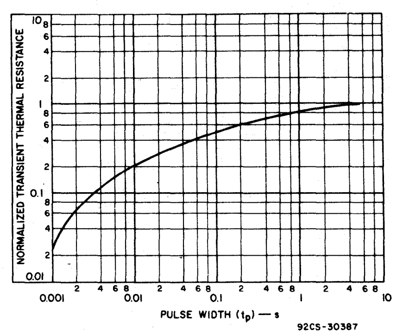


Fig. 2 - Typical thermal-response characteristic.

TIP562, TIP563

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST CONDITIONS: 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	
I_{CBO}, $I_E = 0$	300[b]	—	—	—	—	—	100	—	—	—	μA
	400[b]	—	—	—	—	—	—	—	—	100	
I_{EBO}	—	8	0	—	—	—	5	—	—	5	mA
V_{CEO}(sus)[a]	—	—	0.1	—	300	—	—	400	—	—	V
V_{BE}(sat)[a]	—	—	10	1.66	—	—	1.4	—	—	1.4	
V_{CE}(sat)[2]	—	—	10	1.66	—	—	1.2	—	—	1.2	
	—	—	15	5	—	—	2.0	—	—	2.0	
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	—	
t_s ($I_{B1} = I_{B2}$)	V_{CC} = 180 V	−5.2	10	2	—	1.2	—	—	1.2	—	
t_f ($I_{B1} = I_{B2}$)	V_{CC} = 180 V	−5.2	10	2	—	0.3	—	—	0.3	—	
t_c V_{CC} = 135 V, L = 50 μH, R_C = 13.5 Ω	—	−6	10	2	—	—	700	—	—	700	ns
$R_{\theta JC}$	—	—	—	—	—	—	1.0	—	—	1.0	°C/W

[a]Pulsed, pulse duration = 300 μs, duty factor ≤2%. [b]V_{CB} value.

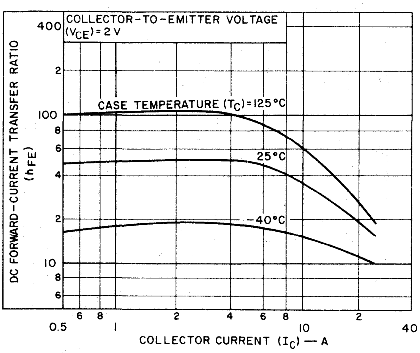


Fig. 3 - Typical dc beta characteristics for both types.

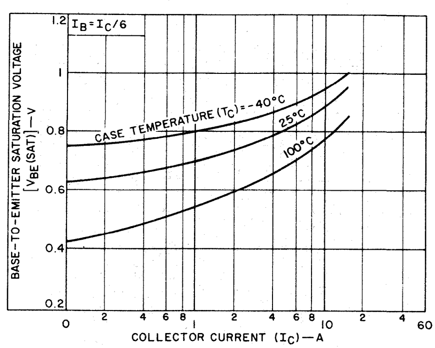


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for both types.

2

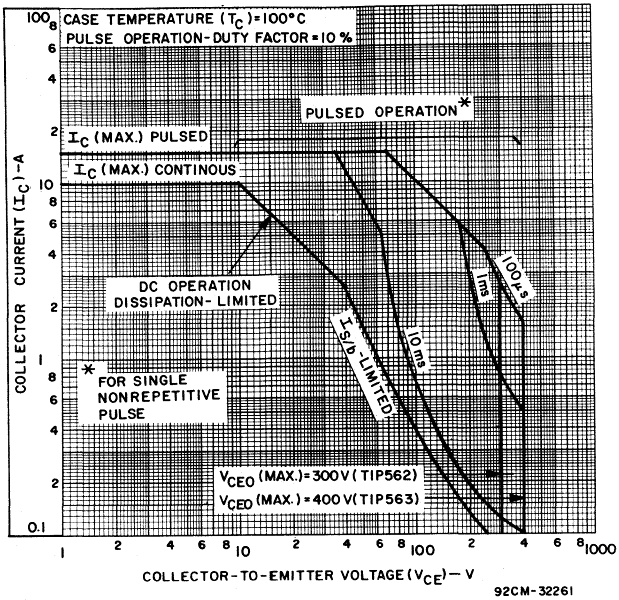


Fig. 5 - Maximum operating areas (T_C = 100°C).

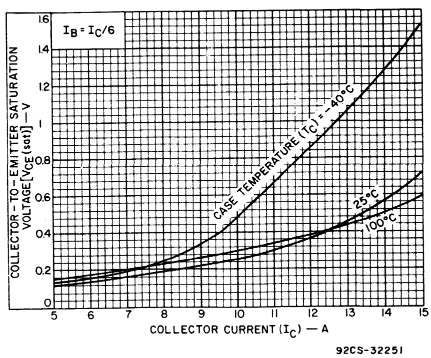


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for both types.

Power Hybrid Circuits

Technical Data

3

HC2000H File Number **566**

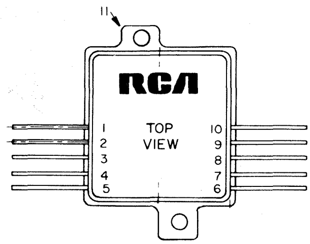
Multi-Purpose 7-Ampere Operational Amplifier

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.

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

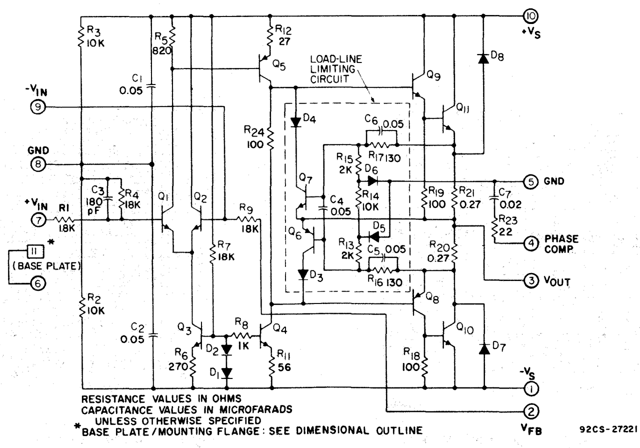


Fig. 1 – Schematic diagram of type HC2000H power hybrid circuit operational amplifier.

HC2000H

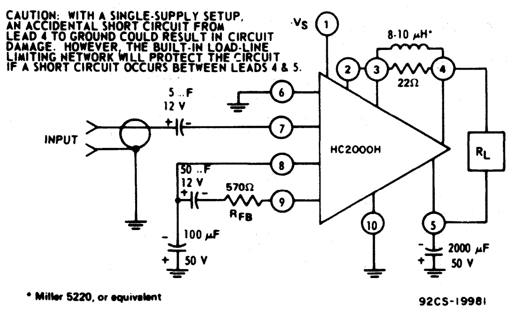


Fig. 2 – Type HC2000H power hybrid circuit with external connections for operation with a single power supply.

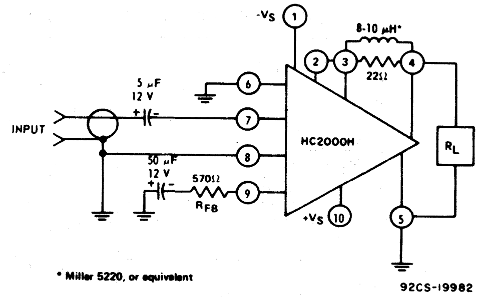


Fig. 3 – Type HC2000H power hybrid circuit with external connections (and split power supply) for measuring relative response and distortion; see Figs. 8 & 9.

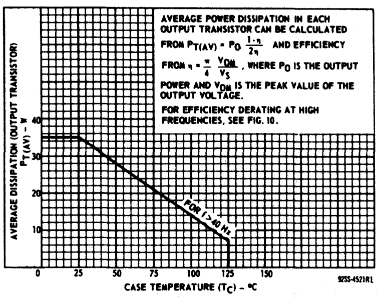


Fig. 4 – Dissipation (average) derating curve for each output transistor (for symmetrical waveforms with f > 40 Hz).

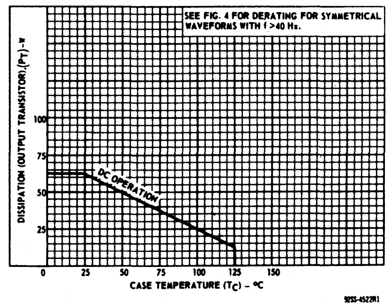


Fig. 5 – Dissipation (dc) derating curve for each output transistor.

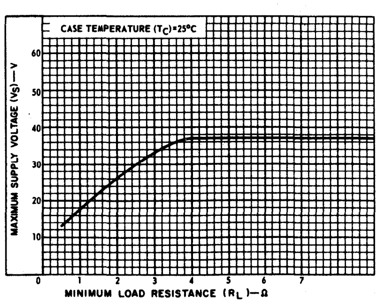


Fig. 6 – Maximum allowable supply voltage vs. load resistance.

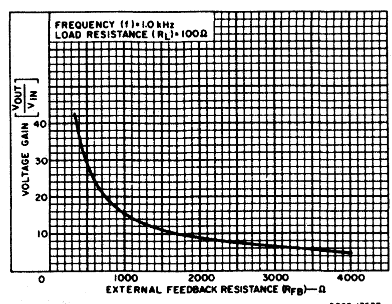


Fig. 7 – Closed-loop voltage gain vs. external feedback resistance.

HC2000H

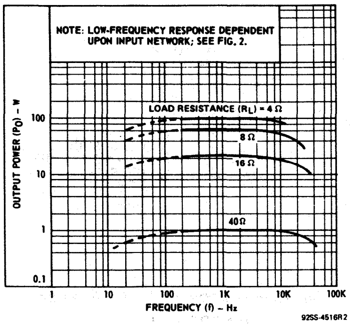


Fig. 8 — Output power vs. frequency.

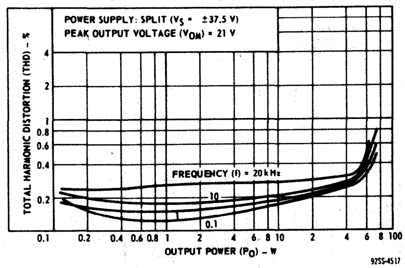


Fig. 9 — Total harmonic distortion with split power supply.

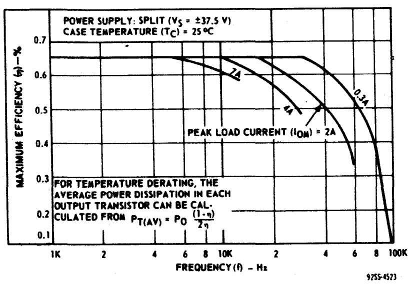


Fig. 10 — Maximum efficiency vs. frequency for several values of peak load current.

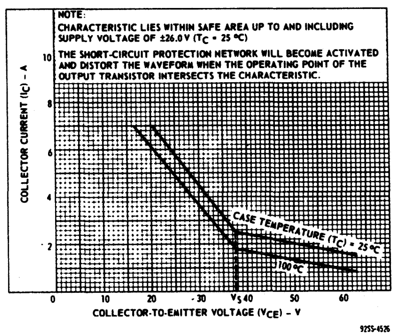


Fig. 11 — Characteristics of built-in load-line-limiting circuit.

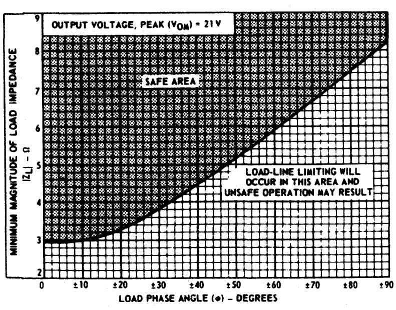


Fig. 12 — Minimum load impedance vs. load phase angle and safe area of operation.

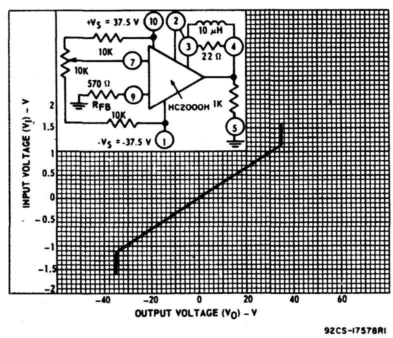


Fig. 13 — Gain linearity characteristic.

HC2000H

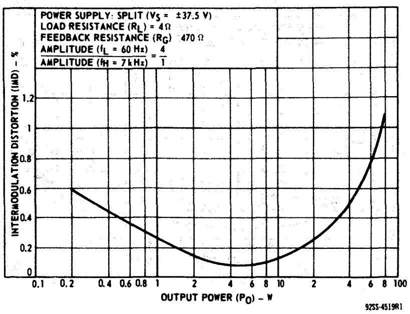


Fig. 14 — Intermodulation distortion with split supply and 4-ohm load.

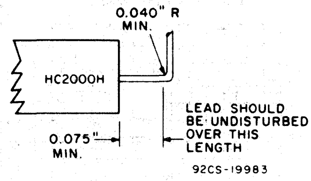


Fig. 15 — Recommended lead-bending specification.

File Number **681**

HC2500

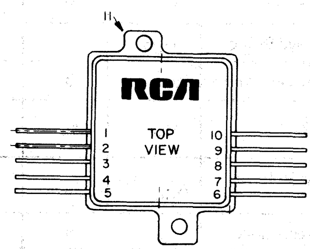
Multi-Purpose, Low-Distortion 7-Ampere Operational Amplifier

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*

TERMINAL DESIGNATIONS



92CS-40377

RCA type HC2500• is a complete solid-state hybrid amplifier in a compact hermetic package. It employs a quasi-complementary-symmetry output circuit.

The HC2500 is a low-distortion, 100-watt linear amplifier. The output section can be externally biased class AB for low inter-modulation and total harmonic distortion. Terminals are available for external frequency compensation, external short-circuit protection, and inverting and non-inverting inputs.

The HC2500 is recommended for the following applications; servo amplifiers (ac, dc, PWM), deflection amplifiers, power operational amplifiers, voltage regulators, driven inverters, hi-fi amplifiers, PA systems, and solenoid drivers.

•Derived from RCA Dev. No. TA8651A.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

SUPPLY VOLTAGE:
- Between leads 1 and 10 .... 75 V

OUTPUT CURRENT (Peak) .... 7 A

TOTAL DISSIPATION:
- Per output device .... See Figs. 4 & 5

TEMPERATURE RANGE:
- Storage .... −55 to +125°C
- Output junction .... −55 to +150°C

LEAD TEMPERATURE (During Soldering):
- At distance ⩾ 1/8 in. (3.17 mm) from case for 10 s max. .... 235°C

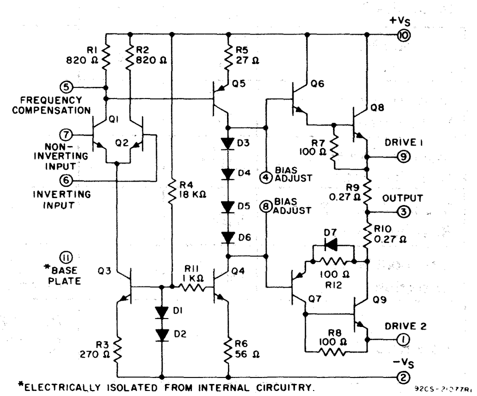


Fig. 1 – Schematic diagram of type HC2500 operational amplifier.

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

3

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				LIMITS			UNITS
			SPECIAL NOTES	FREQ. (f)–kHz	OUTPUT POWER (P_O)–W	LOAD RESIST. (R_L)–Ω	MIN.	TYP.	MAX.	
Offset Voltage	V_{offset}	3	Measured Pin 3 to Gnd	–	–	4	–	–	±250	mV
Quiescent Current	I_o	3	Idling 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*

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

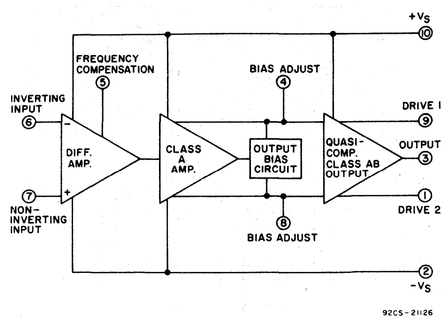


Fig. 2 — Block diagram of HC2500 100-watt class AB amplifier.

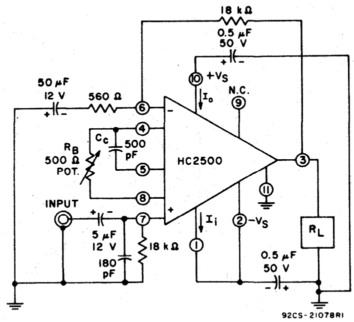


Fig. 3 — Typical test circuit with split supply for measuring A_{CL}, I_i, I_o, V_{offset}, f_H, THD, and IMD.

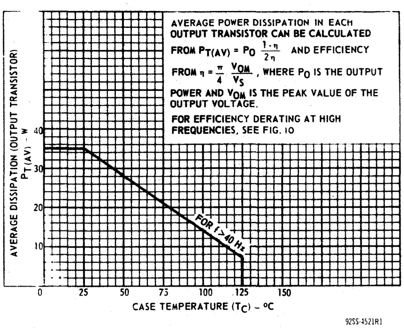


Fig. 4 — Dissipation (average) derating curve for each output transistor (for symmetrical waveforms with f >40 Hz).

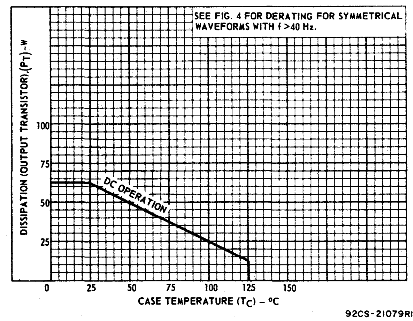


Fig. 5 — Dissipation derating curve for each output transistor.

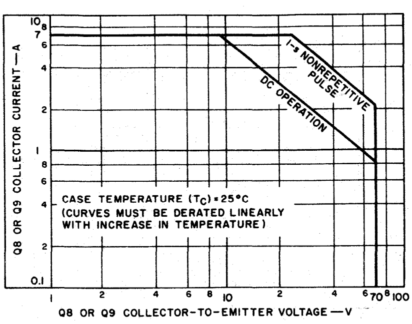


Fig. 6 — Maximum operating area for HC2500.

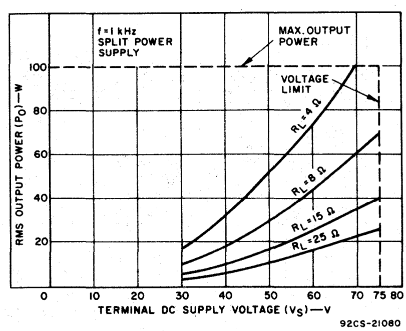


Fig. 7 — Output power as a function of supply voltage, with various values of load resistance, for symmetrical sine-wave operation.

HC2500

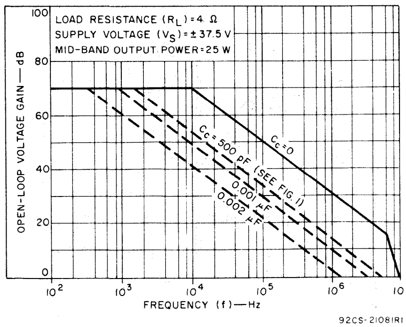


Fig. 8 — Typical open-loop voltage gain vs. frequency.

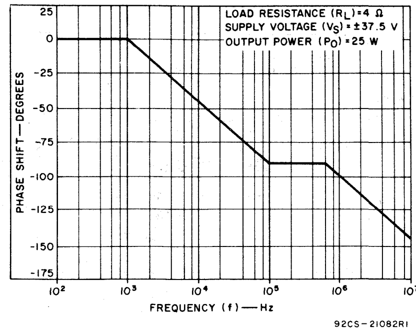


Fig. 9 — Typical open-loop phase shift vs. frequency.

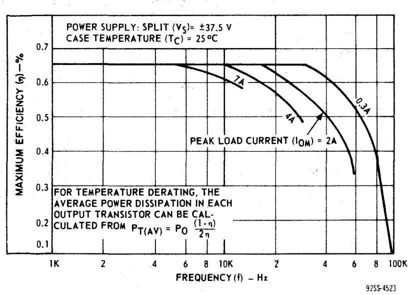


Fig. 10 — Maximum efficiency vs. frequency for several values of peak load current.

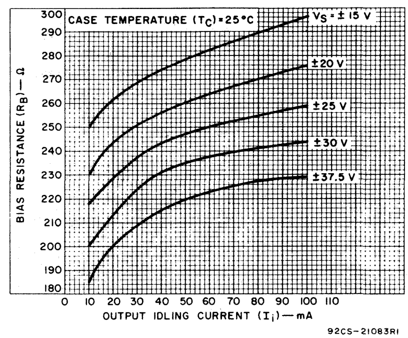


Fig. 11 — Bias resistor (R_B in Fig. 3) value vs. output idling current (I_i).

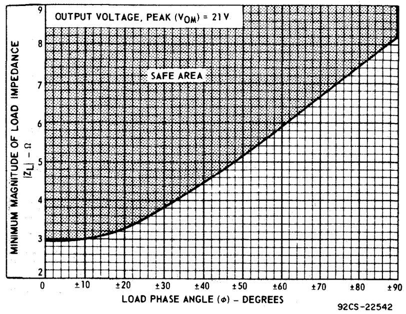


Fig. 12 — Minimum load impedance vs. load phase angle and safe area of operation.

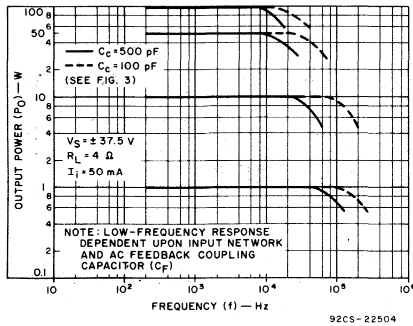


Fig. 13 — Output power vs. frequency.

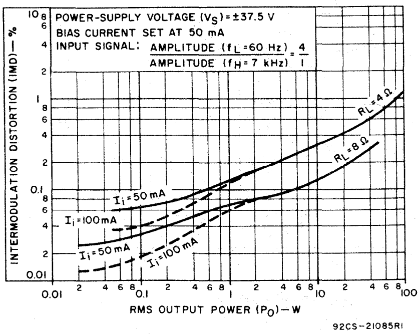


Fig. 14 — Typical intermodulation distortion vs. rms output power.

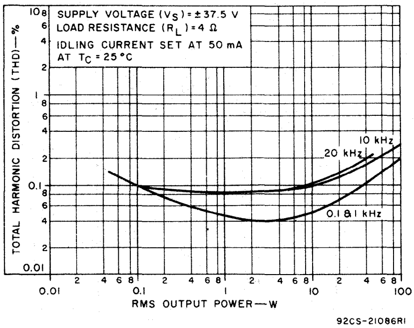


Fig. 15 — Typical total harmonic distortion vs. rms output power.

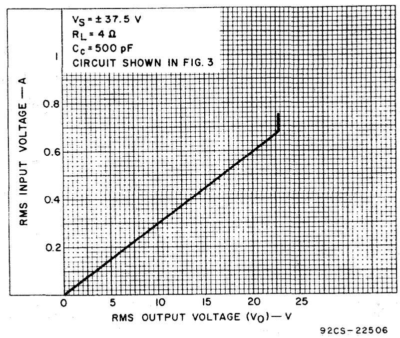


Fig. 16 — Input sensitivity.

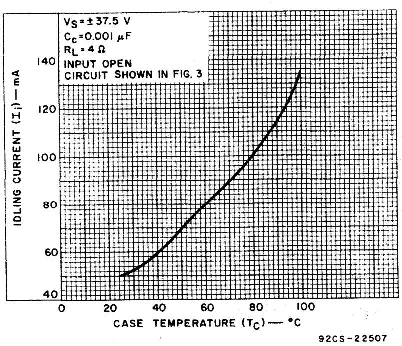


Fig. 17 — Typical idling-current dirft.

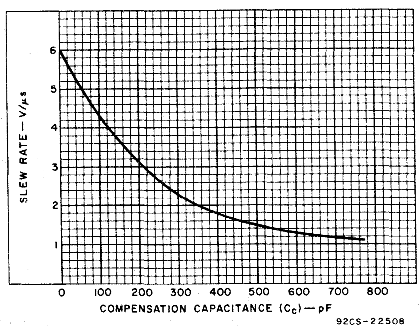


Fig. 18 — Typical slew rate vs. value of compensation capacitor, C_c (test circuit shown in Fig. 21).

HC2500

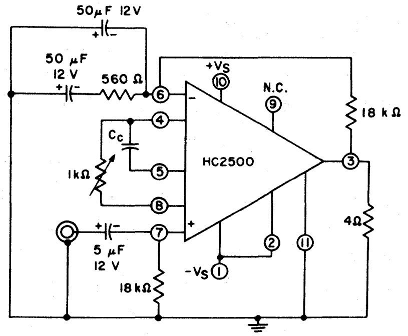
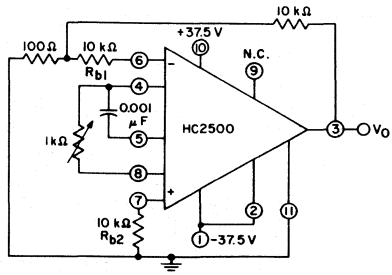


Fig. 19 — Test circuit for open-loop gain and phase response.



$V_{IO} = -\frac{V_O}{100}$ 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.

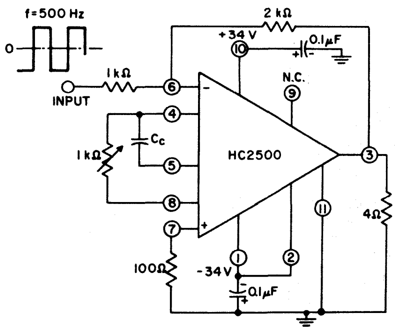
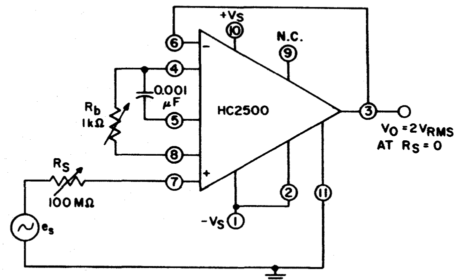


Fig. 21 — Circuit used to test slew rate.

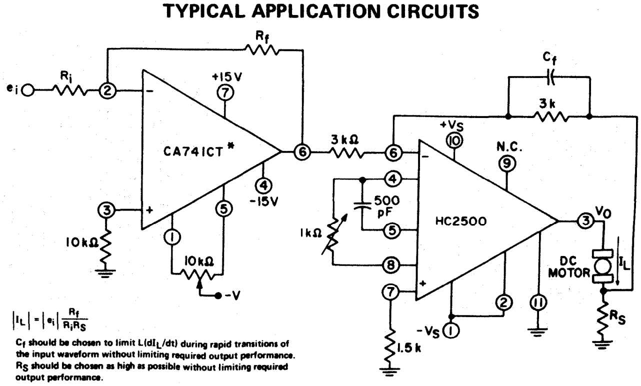


$R_{CM} = 9\,R_S$ with series resistance (R_S) increased from zero until output voltage (V_O) is reduced by 10%.

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.

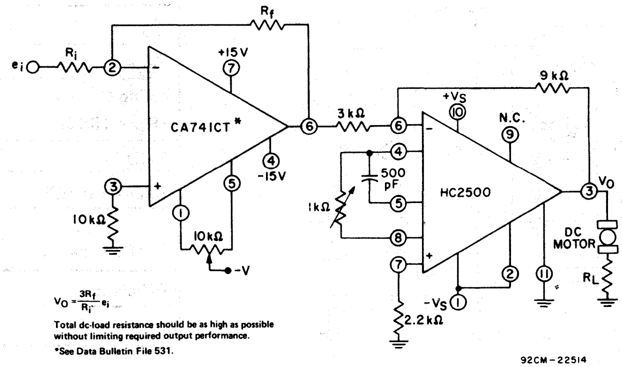


Fig. 24 – Voltage-feedback motor-control circuit.

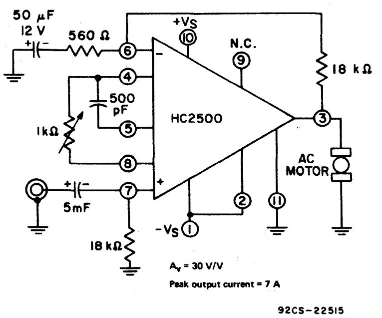
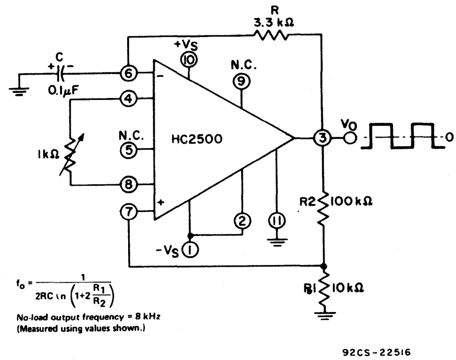


Fig. 25 – AC motor control.



$$f_o = \frac{1}{2RC \ln\left(1+2\frac{R_1}{R_2}\right)}$$

Fig. 26 – High-power astable multivibrator.

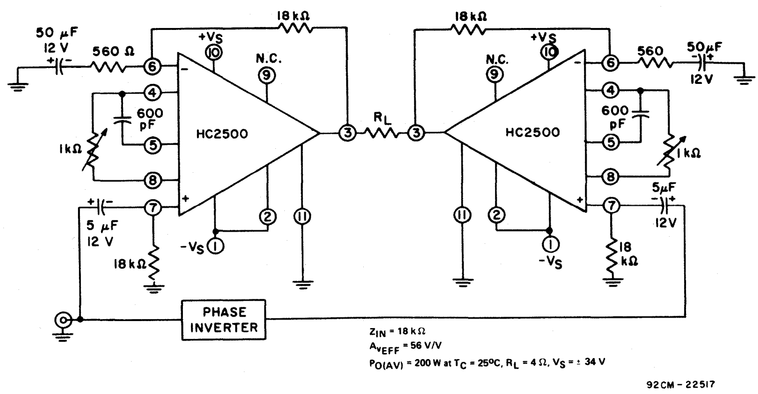
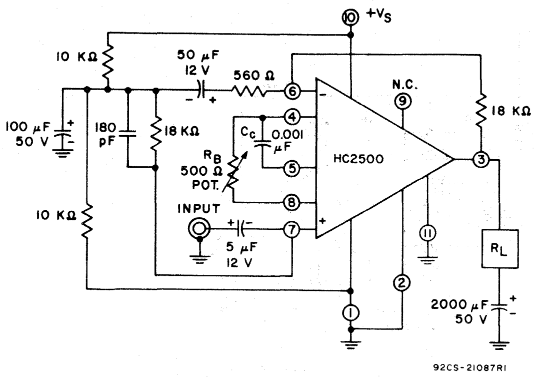


Fig. 27 – Bridge circuit for loads greater than 100 watts.

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 Rectifiers
Technical Data

4

1N4245, 1N4246, 1N4247
1N4248, 1N4249

File Number **2093**

1-A, Glass-Passivated Junction Silicon Rectifiers

Features:
- *High-temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers*
- *Glass-passivated junction in DO-204AP package*
- *1A operation at $T_A = 55°C$ with no thermal runaway*
- *Typical reverse current less than 0.5μA*
- *Exceeds environmental standard of MIL-STD-19500*
- *Hermetically sealed package*
- *High-temperature soldering guaranteed: 350° C/10 s/0.375 in. (9.5 mm) lead length*

TERMINAL DESIGNATIONS

DO-204AP

The GE/RCA 1N4245, 1N4246, 1N4247, 1N4248, and 1N4249 are glass-passivated "transient voltage protected", silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 1000 watts in reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

MAXIMUM RATINGS, *Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:*

	1N4245	1N4246	1N4247	1N4248	1N4249	
*MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, ... V_{RRM}	200	400	600	800	1000	V
*MAXIMUM RMS INPUT (SUPPLY) VOLTAGE:						
For resistive or inductive loads, ... V_{RMS}	140	280	420	560	700	V
*MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ... $V_{R(DC)}$	200	400	600	800	1000	V
*MAXIMUM AVERAGE FORWARD CURRENT:						
For resistive or inductive loads, $T_A = 55°C$ .... I_O			1			A
*MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:						
For 8.3 ms half sine wave, superimposed on rated load, $T_A = 55°C$ .. I_{FSM}			50			A
*OPERATING TEMPERATURE RANGE .... T_{opr}			-65 to +160			°C
*STORAGE TEMPERATURE RANGE .... T_{stg}			-65 to +200			°C

* In accordance with JEDEC registration format.

1N4245, 1N4246, 1N4247
1N4248, 1N4249

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

	CHARACTERISTIC		LIMITS FOR ALL TYPES			UNITS
			MIN.	TYP.	MAX.	
*	Maximum Instantaneous Forward-Voltage Drop (at 1A)	V_F	—	—	1.2	V
*	Maximum Reverse Current:	I_R				
	At maximum dc reverse (blocking) voltage, T_A = 25°C		—	—	1	µA
	T_A = 125°C		—	—	25	µA
	At average full-cycle, lead length = 0.375 in. (9.5 mm), T_A = 55°C		—	—	50	µA
	Junction Capacitance (at 1 MHz and applied reverse voltage = 4 V)	C_J	—	15	—	pF

* In accordance with JEDEC registration format.

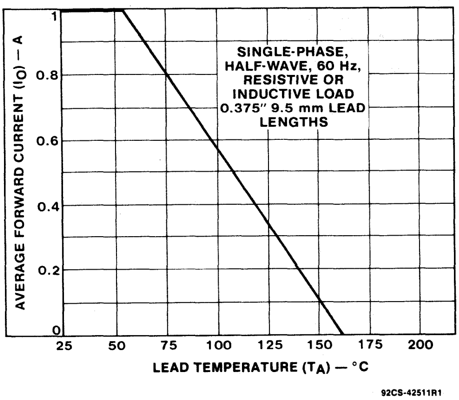


Fig. 1 - Maximum average forward output current characteristic.

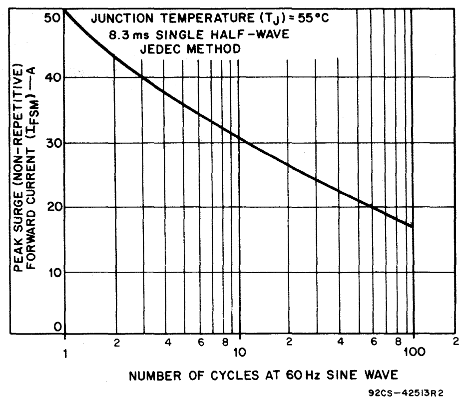


Fig. 2 - Maximum peak surge (non-repetitive) forward current characteristic.

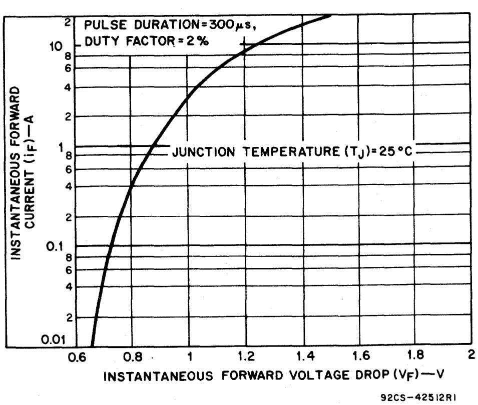


Fig. 3 - Typical instantaneous forward current characteristic.

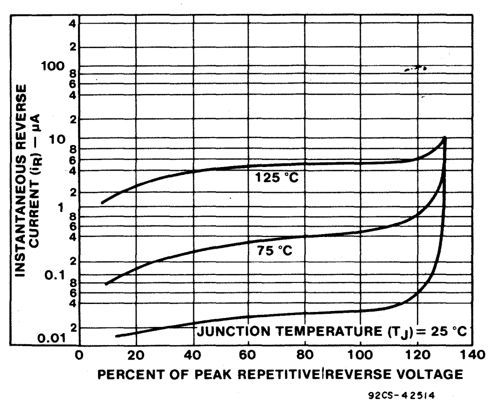


Fig. 4 - Typical reverse leakage current characteristics.

1N4245, 1N4246, 1N4247
1N4248, 1N4249

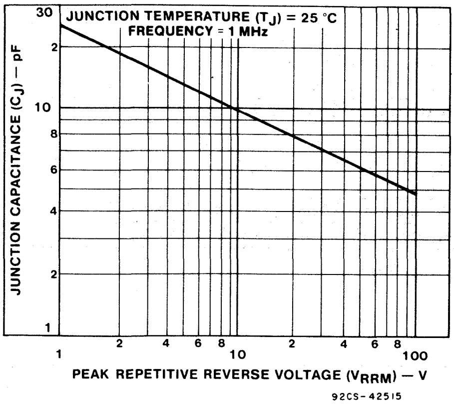


Fig. 5 - Typical junction capacitance characteristic.

File Number **2176**

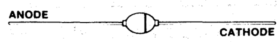
1N5059, 1N5060, 1N5061, 1N5062

1-A, Glass-Passivated Junction Silicon Rectifiers

Features:

- *High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers*
- *Glass passivated junction*
- *1A operation at $T_A = 100°C$ with no thermal runaway*
- *Low reverse current*
- *Exceeds environmental standard of MIL-STD-19500*
- *Hermetically sealed package*
- *High temperature soldering: 350°C/10 S/0.375 in. (9.5mm) lead length*

TERMINAL DESIGNATIONS



DO-204AP

The GE/RCA 1N5059, 1N5060, 1N5061, and 1N5062 are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 800 watts in reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

MAXIMUM RATINGS, *Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:*

		1N5059	1N5060	1N5061	1N5062	
*MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE,	V_{RRM}	200	400	600	800	V
MAXIMUM RMS SUPPLY VOLTAGE: For resistive or inductive loads,	V_{RMS}	140	280	420	560	V
*MAXIMUM DC REVERSE (BLOCKING) VOLTAGE,	$V_{R(DC)}$	200	400	600	800	V
*MAXIMUM AVERAGE FORWARD CURRENT: For resistive or inductive loads, $T_A = 75°C$,	I_O	1				A
*MAXIMUM PEAK SURGE FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load,	I_{FSM}	50				A
OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE,	T_j, T_{stg}	-65 to +175				°C

*In accordance with JEDEC registration format.

1N5059, 1N5060, 1N5061, 1N5062

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES			UNITS
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop:* At 1A, T_A = 75°C	V_F	—	—	1.2	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) T_A = 25°C	I_R	—	—	5	μA
T_A = 175°C		—	—	150†	μA
Maximum Reverse Current:* At maximum DC reverse (blocking) voltage, T_A = 25°C	I_R	—	—	5	μA
T_A = 175°C		—	—	300‡	μA
Maximum Reverse Recovery Time: At I_F = 0.5A, I_R = 1A, I_{rr} = 0.25A	t_{rr}	—	—	2	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	15	—	pF

*In accordance with JEDEC registration format.
†100μA for 1N5061 and 1N5062.
‡200μA for 1N5061 and 1N5062.

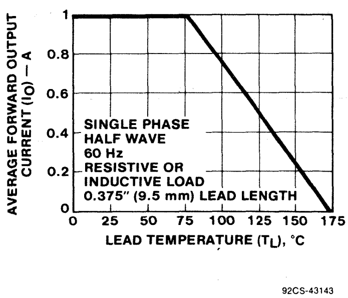


Fig. 1 - Maximum average forward output current characteristic.

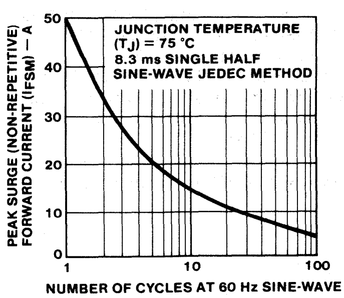


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

1N5059, 1N5060, 1N5061, 1N5062

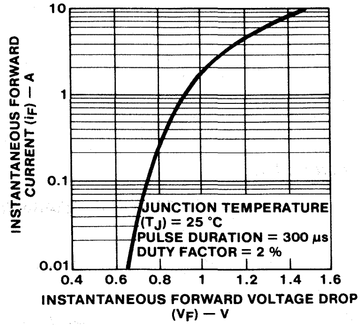


Fig. 3 - Typical instantaneous forward current characteristic.

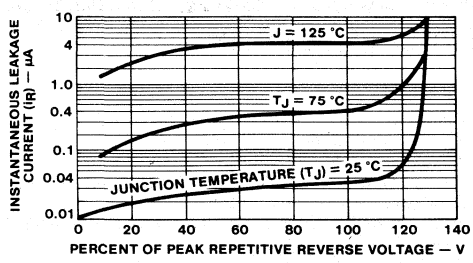


Fig. 4 - Typical reverse leakage current characteristics.

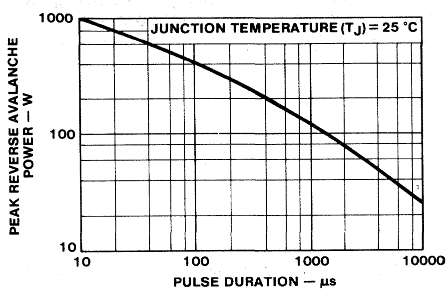


Fig. 5 - Maximum non-repetitive reverse avalanche power.

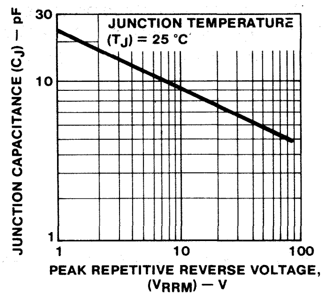


Fig. 6 - Typical junction capacitance characteristic.

4

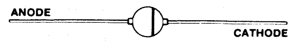
1N5624, 1N5625, 1N5626, 1N5627

File Number **2181**

3-A, Glass-Passivated Junction Silicon Rectifiers

Features:
- *High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers*
- *Glass passivated junction*
- *3A operation at $T_A = 70°C$ with no thermal runaway*
- *Low reverse leakage current*
- *Exceeds environmental standard of MIL-STD-19500*
- *Hermetically sealed package*
- *High temperature soldering: 350°C/10 s/0.375 in. (9.5mm) lead length*

TERMINAL DESIGNATIONS



GE-3

The GE/RCA 1N5624, 1N5625, 1N5626, and 1N5627 are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 800 watts in reverse direction without damage. Voltage transients generated by househcld or industrial power lines are dissipated.

These rectifiers are supplied in a GE-3 package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads†:*

	1N5624	1N5625	1N5626	1N5627	
*MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	200	400	600	800	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	140	280	420	560	V
*MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ... $V_{R(DC)}$	200	400	600	800	V
*MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:					
Lead Length = 0.375 in. (9.5 mm); T_A = 70°C, ... I_O	3				A
*MAXIMUM PEAK SURGE (NON—REPETITIVE) FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	125				A
*OPERATING JUNCTION TEMPERATURE, ... T_j	-65 to +175				°C
*STORAGE TEMPERATURE, ... T_{stg}	-65 to +200				°C

*In accordance with JEDEC registration format.
†For capacitive load derate current by 20%.

1N5624, 1N5625, 1N5626, 1N5627

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS	LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
* Maximum Instantaneous Forward-Voltage Drop: V_F				
At 3A $T_A = 25°C$	—	—	1	V
$T_A = 70°C$	—	—	0.95	V
* Maximum Full-Load Reverse Current: I_R				
At average full-cycle, lead length = 0.375 in. (9.5mm), $T_A = 70°C$	—	—	150‡	μA
* Maximum Reverse Current: I_R				
At maximum DC reverse (blocking) voltage, $T_A = 25°C$	—	—	5	μA
$T_A = 175°C$	—	—	300†	μA
Typical Junction Capacitance: C_J				
At frequency = 1 MHz and applied reverse voltage = 4V	—	40	—	pF

*In accordance with JEDEC registration format.
†200μA for 1N5624 and 1N5625.
‡100μA for 1N5626 and 1N5627.

4

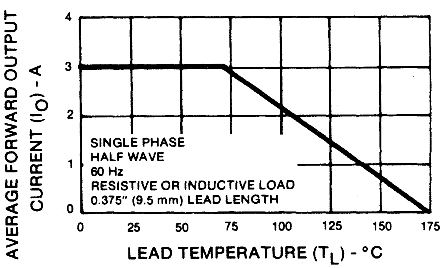


Fig. 1 - Maximum average forward output current characteristic.

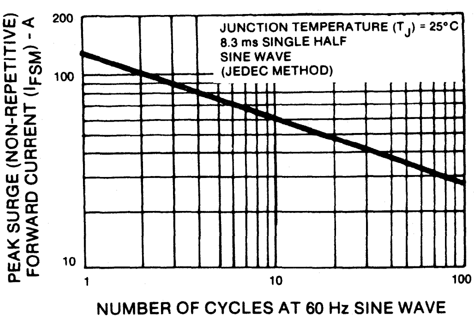


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

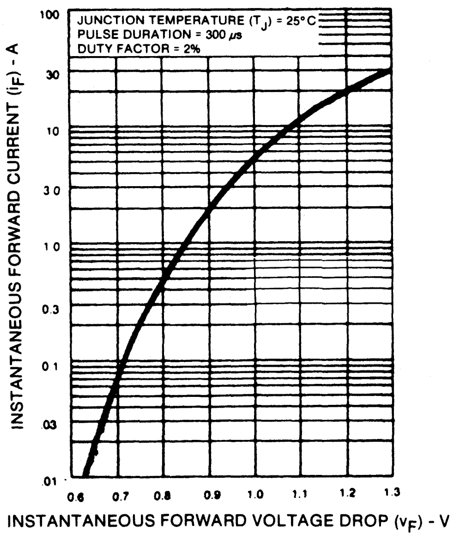


Fig. 3 - Typical instantaneous forward current characteristic.

1N5624, 1N5625, 1N5626, 1N5627

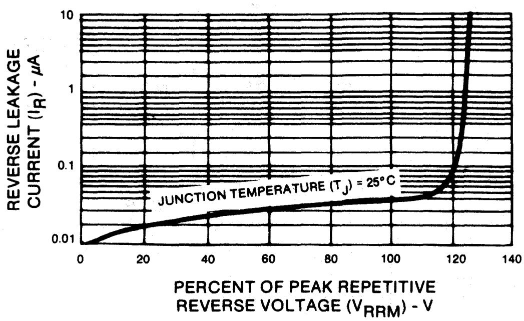


Fig. 4 - Typical reverse leakage current characteristics.

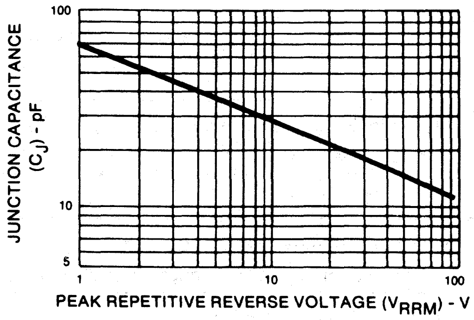


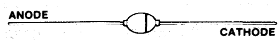
Fig. 5 - Typical junction capacitance characteristic.

File Number **2178**

A14A, A14C, A14E, A14F, A14P

1-A, Glass-Passivated Junction Silicon Rectifiers

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

Features:

- *High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers*
- *Glass passivated junction*
- *1A operation at $T_A = 100°C$ with no thermal runaway*
- *Low reverse current*
- *Exceeds environmental standard of MIL-STD-19500*
- *Hermetically sealed package*
- *High temperature soldering: 350°C/10 s/0.375 in. (9.5mm) lead length*

The GE/RCA A14A, A14C, A14E, A14F, and A14P are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 1000 watts in reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

4

MAXIMUM RATINGS, *Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:*

	A14F	A14A	A14C	A14E	A14P	
MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, ... V_{RRM}	50	100	300	500	1000	V
MAXIMUM RMS (SUPPLY) VOLTAGE:						
For resistive or inductive loads, ... V_{RMS}	35	70	210	350	700	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ... $V_{R(DC)}$	50	100	300	500	1000	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:						
For resistive or inductive loads, $T_A = 100°C$ .... I_O			1			A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:						
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}			50			A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ... T_j, T_{stg}			-65 to +175			°C

A14A, A14C, A14E, A14F, A14P

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 1A	V_F	—	—	1.2*	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) T_A = 100°C	I_R	—	—	200	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage	I_R	—	—	2	μA
Maximum Reverse Recovery Time: At I_F = 0.5A, I_R = 1A, I_{rr} = 0.25A	t_{rr}	—	—	2	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	15	—	pF

*1.1 V for A14C, A14E, and A14P.

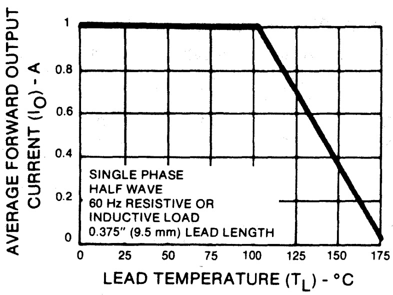


Fig. 1 - Maximum average forward output current characteristic.

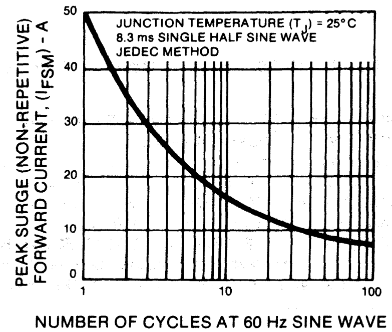


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

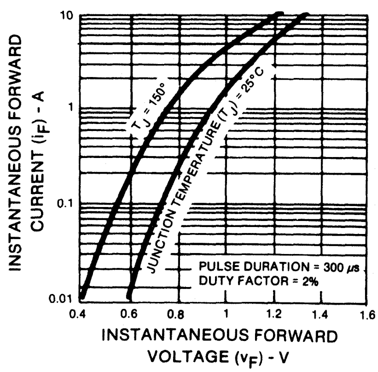


Fig. 3 - Typical instantaneous forward current characteristic.

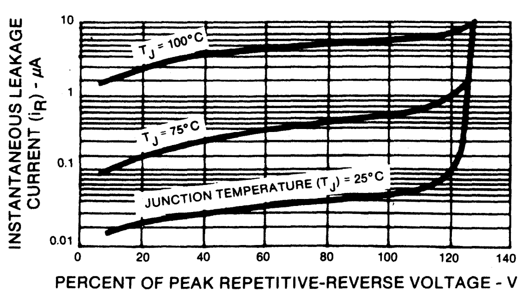


Fig. 4 - Typical reverse leakage current characteristics.

A14A, A14C, A14E, A14F, A14P

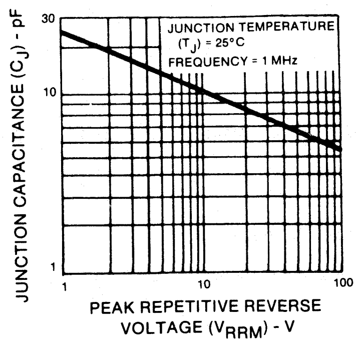


Fig. 5 - Typical junction capacitance characteristic.

4

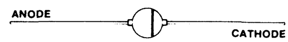
A15A, A15F

File Number **2175**

3-A, Glass-Passivated Junction Silicon Rectifiers

Features:
- *High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers*
- *Glass passivated junction*
- *3A operation at $T_A = 70°C$ with no thermal runaway*
- *Low reverse current*
- *Exceeds environmental standard of MIL-STD-19500*
- *Hermetically sealed package*
- *High temperature soldering: 350°C/10 s/0.375 in. (9.5mm) lead length*

TERMINAL DESIGNATIONS



GE-3

The GE/RCA A15A and A15F are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 100 watts in reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a GE-3 package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:*

		A15F	A15A	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE,	V_{RRM}	50	100	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE,	V_{RMS}	35	70	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE,	$V_{R(DC)}$	50	100	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT: Lead Length = 0.375 in. (9.5 mm); $T_A = 70°C$,	I_O	3		A
MAXIMUM PEAK SURGE (NON—REPETITIVE) FORWARD CURRENT: For 8.3 ms half sine wave, superimposed on rated load,	I_{FSM}	125		A
OPERATING JUNCTION AND STORAGE TEMPERATURE,	T_j, T_{stg}	-65 to +175		°C

*For capacitive load derate current by 20%.

A15A, A15F

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 3A	V_F	—	—	1.2	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm), T_A = 70°C	I_R	—	—	200	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage	I_R	—	—	5	μA
Maximum Reverse Recovery Time: At I_F = 0.5A, I_R = 1A, I_{rr} = 0.25A	t_{rr}	—	—	3	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	40	—	pF

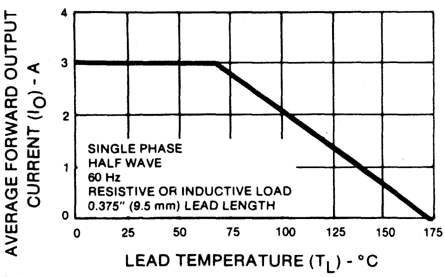


Fig. 1 - Maximum average forward output current characteristic.

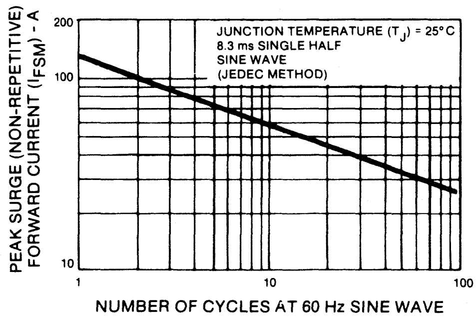


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

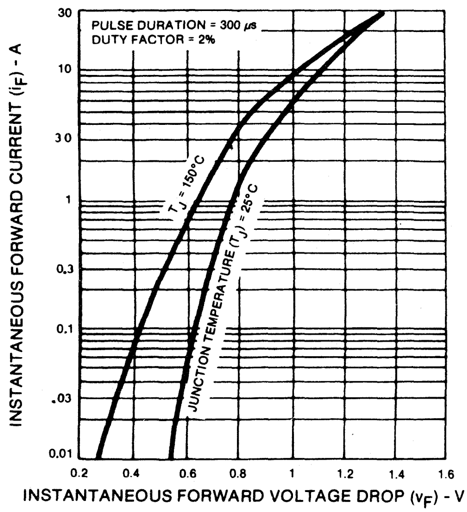


Fig. 3 - Typical instantaneous forward current characteristics.

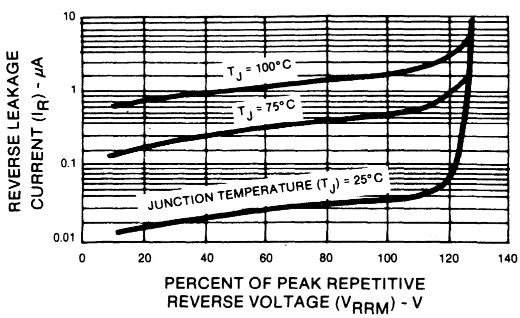


Fig. 4 - Typical reverse leakage current characteristics.

A15A, A15F

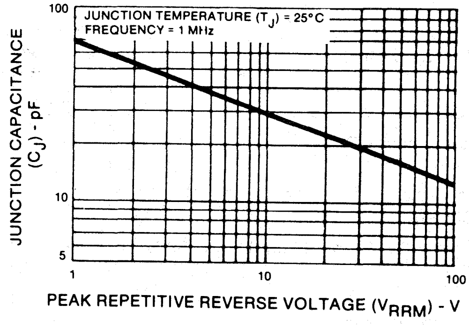


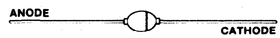
Fig. 5 - Typical junction capacitance characteristic.

File Number **2179**

A114 Series

1-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

Features:

- *Glass passivated junction*
- *Fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low reverse current leakage*
- *High surge current capability*

The GE/RCA A114A, A114B, A114C, A114D, A114E, A114F, and A114M are fast-recovery silicon rectifiers (t_{rr} = 200 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60-Hz, half-wave resistive or inductive loads*:*

	A114F	A114A	A114B	A114C	A114D	A114E	A114M	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	50	100	200	300	400	500	600	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	35	70	140	210	280	350	420	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ...$V_{R(DC)}$	50	100	200	300	400	500	600	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:								
Lead Length = 0.375 in. (9.5 mm); T_A = 55°C, ... I_O				1				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:								
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}				30				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ...T_j, T_{stg}				-65 to +175				°C

*For capacitive load derate current by 20%.

4

A114 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 1A	V_F	—	—	1.3	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) $T_A = 25°C$	I_R	—	—	1	μA
$T_A = 150°C$		—	—	100	μA
Maximum DC Reverse Current at Maximum DC Reverse (Blocking) Voltage	I_R	—	—	2	μA
Maximum Reverse Recovery Time: At $I_F = 0.5A$, $I_R = 1A$, $I_{rr} = 0.25A$	t_{rr}	—	—	150*	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	10	—	pF

*200 ns for A115M.

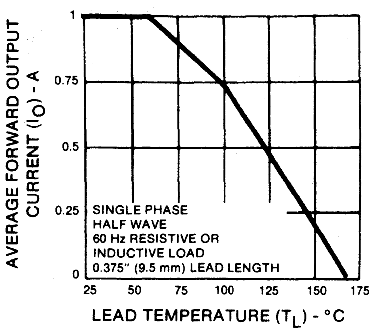


Fig. 1 - Maximum average forward output current characteristic.

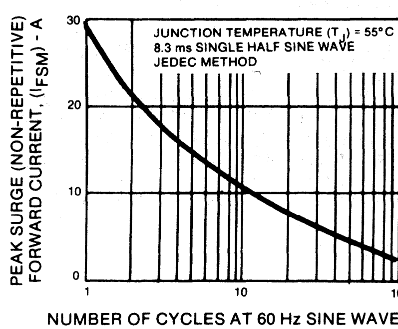


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A114 Series

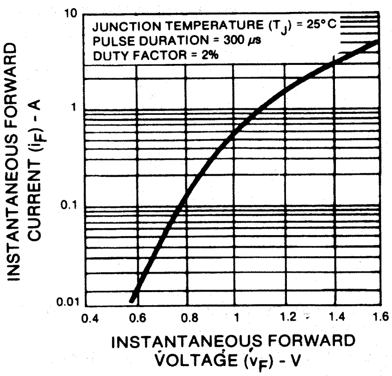


Fig. 3 - Typical instantaneous forward current characteristic.

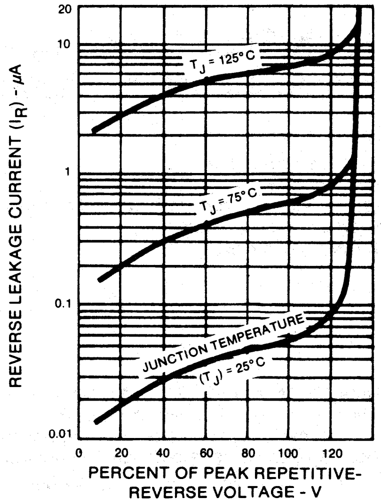


Fig. 4 - Typical reverse leakage current characteristics.

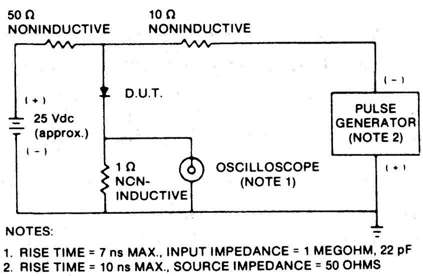


Fig. 5 - Reverse-recovery time test circuit.

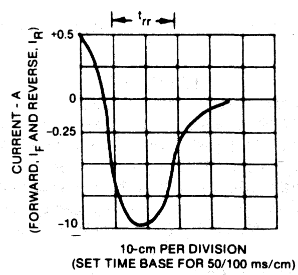


Fig. 6 - Reverse-recovery time waveform.

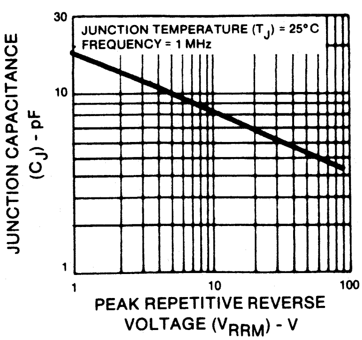


Fig. 7 - Typical junction capacitance characteristic.

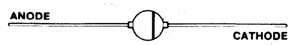
A115 Series

File Number **2180**

3-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:
- *Glass passivated junction*
- *Fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low reverse current leakage*
- *High surge current capability*

TERMINAL DESIGNATIONS



GE-3

92CS-43476

The GE/RCA A115A, A115B, A115C, A115D, A115E, A115F, and A115M are fast-recovery silicon rectifiers (t_{rr} = 250 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed GE-3 package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60-Hz, half-wave resistive or inductive loads*:*

	A115F	A115A	A115B	A115C	A115D	A115E	A115M	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	50	100	200	300	400	500	600	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	35	70	140	210	280	350	420	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ...$V_{R(DC)}$	50	100	200	300	400	500	600	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:								
Lead Length = 0.375 in. (9.5 mm); T_A = 55°C, ... I_O	3							A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:								
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	100							A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ...T_j, T_{stg}	−65 to +175							°C

*For capacitive load derate current by 20%.

A115 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 3A	V_F	—	—	1.3	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm) T_A = 25°C	I_R	—	—	2	μA
T_A = 150°C		—	—	100	μA
Maximum DC Reverse Current at Maximum DC Blocking Voltage	I_R	—	—	5	μA
Maximum Reverse Recovery Time: At I_F = 0.5A, I_R = 1A, I_{rr} = 0.25A	t_{rr}	—	—	150*	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	40	—	pF

*250 ns for A115M.

4

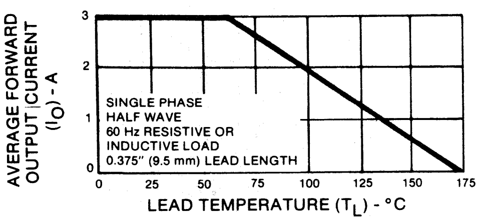


Fig. 1 - Maximum average forward output current characteristic.

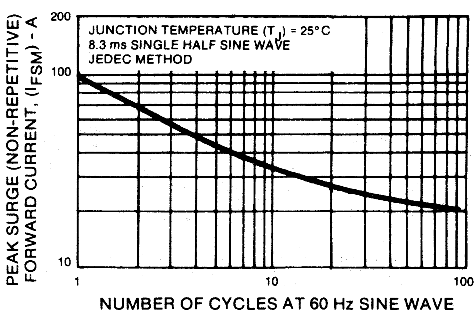


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A115 Series

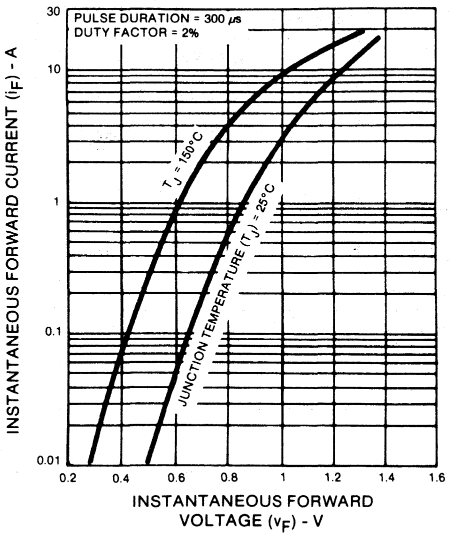


Fig. 3 - Typical instantaneous forward current characteristic.

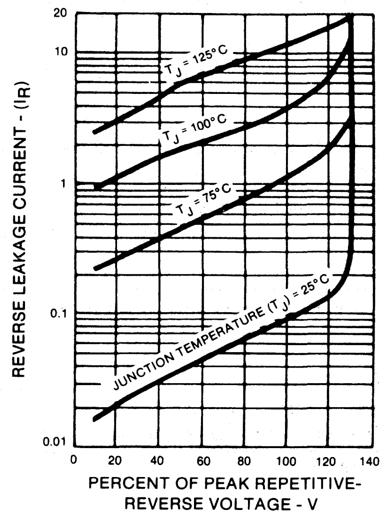


Fig. 4 - Typical reverse leakage current characteristics.

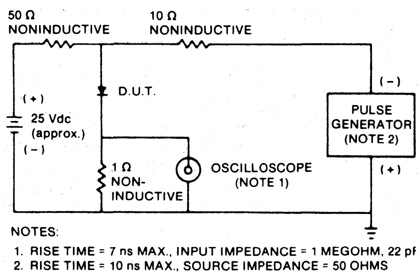


Fig. 5 - Reverse-recovery time test circuit.

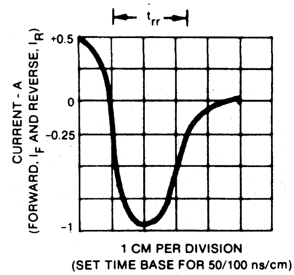


Fig. 6 - Reverse-recovery time waveform.

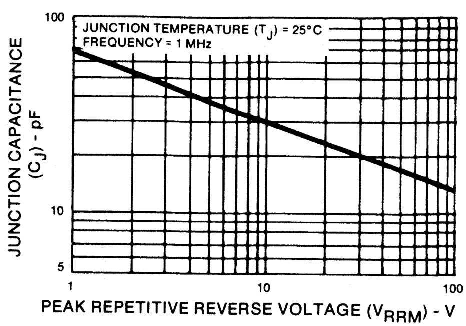


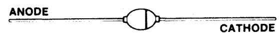
Fig. 7 - Typical junction capacitance characteristic.

File Number **2164**

A214 Series

2-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

Features:

- *Glass passivated junction*
- *Ultra-fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low leakage current*
- *High surge current capability*

The GE/RCA A214A, A214B, A214F, and A214G are ultra-fast recovery silicon rectifiers (t_{rr} = 35 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

4

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:*

	A214F	A214A	A214G	A214B	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	35	70	105	105	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ...$V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:					
Lead Length = 0.375 in. (9.5 mm); T_A = 55°C, ... I_O	2				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	50				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ...T_j, T_{stg}	−65 to +175				°C

*For capacitive load derate current by 20%.

A214 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	LIMITS FOR ALL TYPES TYP.	LIMITS FOR ALL TYPES MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 2A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25°C$	I_R	—	—	2	μA
$T_A = 150°C$		—	—	50	μA
Maximum Reverse Recovery Time: At $I_F = 0.5A$, $I_R = 1A$, $I_{rr} = 0.25A$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	45	—	pF
Thermal Resistance: Junction-to-Ambient at 0.375 in. (9.5 mm) lead length.	$R\theta_{JA}$	—	60	—	°C/W

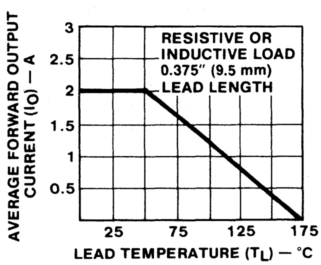


Fig. 1 - Maximum average forward output current characteristic.

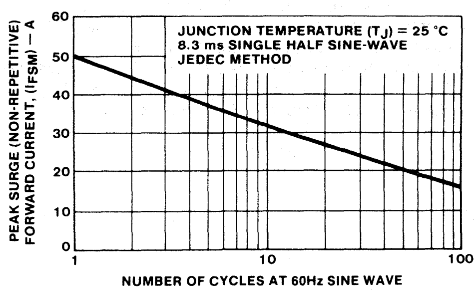


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

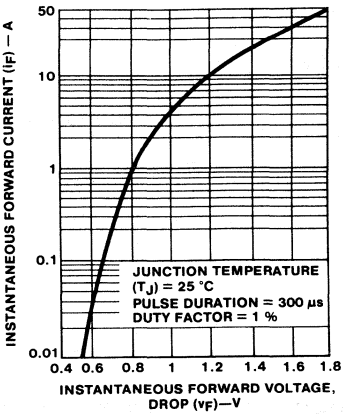


Fig. 3 - Typical instantaneous forward current characteristic.

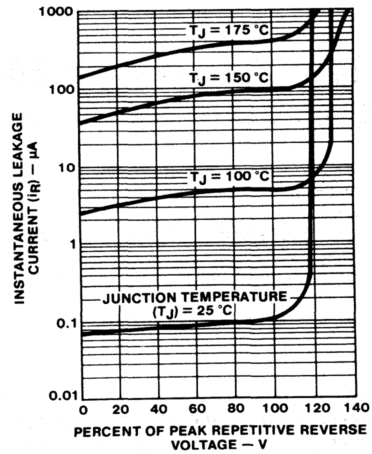
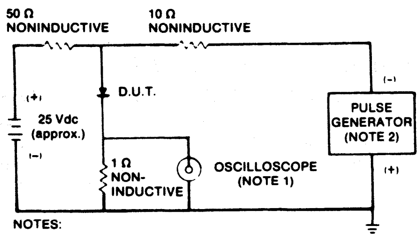


Fig. 4 - Typical reverse leakage current characteristics.



NOTES:

1. RISE TIME = 7 ns MAX., INPUT IMPEDANCE = 1 MEGOHM, 22 pF
2. RISE TIME = 10 ns MAX., SOURCE IMPEDANCE = 50 OHMS

Fig. 5 - Reverse-recovery time test circuit.

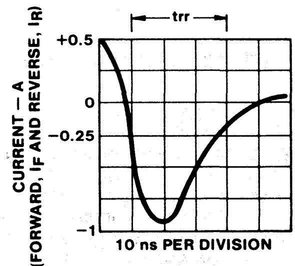


Fig. 6 - Reverse-recovery time waveform.

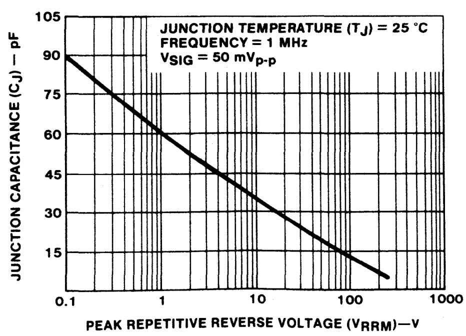


Fig. 7 - Typical junction capacitance characteristic.

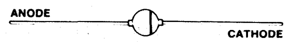
A315 Series

File Number **2163**

3-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:
- *Glass passivated junction*
- *Ultra-fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low leakage current*
- *High surge current capability*

TERMINAL DESIGNATIONS



GE-4

92CS-43477

The GE/RCA A315A, A315B, A315F, and A315G are ultra-fast recovery silicon rectifiers (t_{rr} = 35 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed GE-4 package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:*

		A315F	A315A	A315G	A315B	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE,	V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE,	V_{RMS}	35	70	105	105	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE,	$V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:						
Lead Length = 0.375 in. (9.5 mm); T_L = 55°C,	I_O	3				A
MAXIMUM PEAK SURGE (NON—REPETITIVE) FORWARD CURRENT:						
For 8.3 ms half sine wave, superimposed on rated load, T_L = 55°C,	I_{FSM}	135				A
OPERATING JUNCTION AND STORAGE TEMPERATURE,	T_j T_{stg}	-65 to +175				°C

*For capacitive load derate current by 20%.

A315 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 3A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25°C$	I_R	—	—	3	μA
$T_A = 150°C$		—	—	50	μA
Maximum Reverse Recovery Time: At $I_F = 0.5A$, $I_R = 1A$, $I_{rr} = 0.25A$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	100	—	pF

4

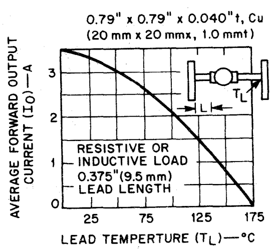


Fig. 1 - Maximum average forward output current characteristic.

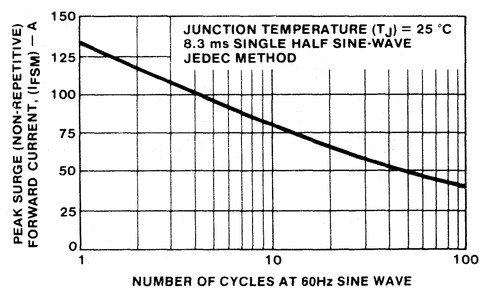


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

A315 Series

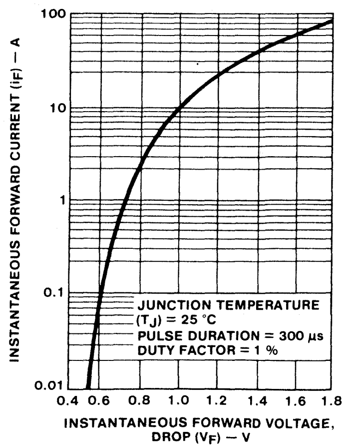


Fig. 3 - Typical instantaneous forward current characteristic.

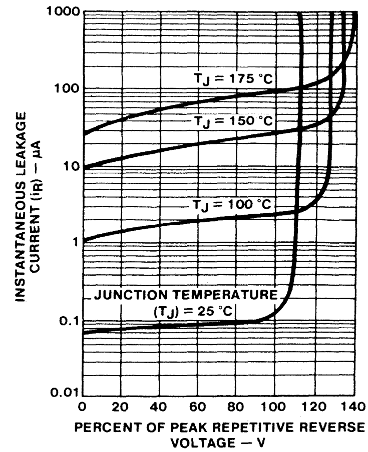


Fig. 4 - Typical reverse leakage current characteristics.

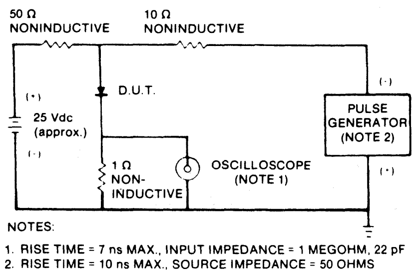


Fig. 5 - Reverse-recovery time test circuit.

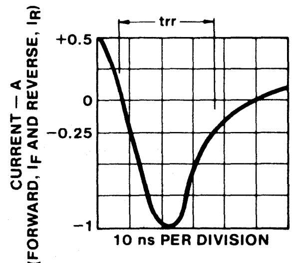


Fig. 6 - Reverse-recovery time waveform.

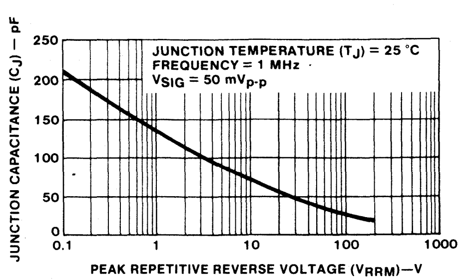


Fig. 7 - Typical junction capacitance characteristic.

File Number **1412**

BYW51-100, BYW51-150, BYW51-200

Dual 8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

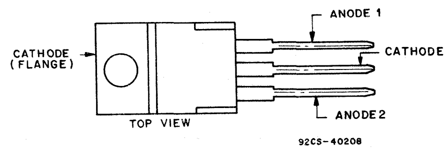
Features:

- *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) $di_F/dt > 50A/\mu s$, $I_{RM}(rec) < 1A$, $I_{RR} = 0.25A$

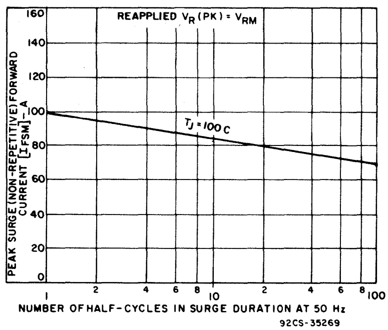


Fig. 1 - Peak surge forward current vs. surge duration.

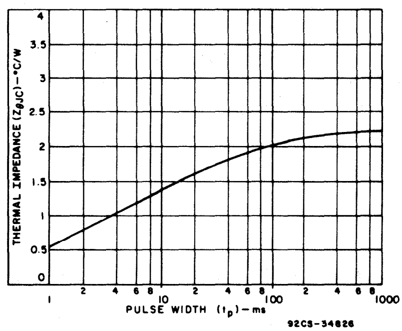


Fig. 2 - Thermal impedance vs. pulse width (per junction).

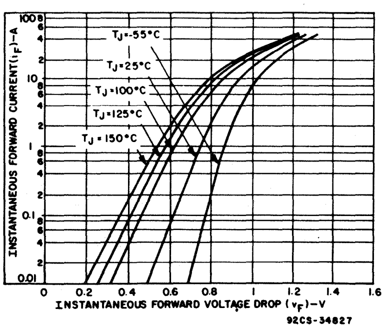


Fig. 3 - Typical forward current vs. forward-voltage drop.

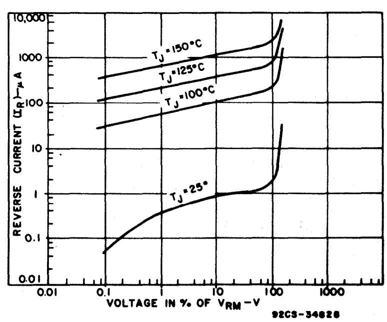


Fig. 4 - Typical reverse current vs. voltage.

File Number **2097**

DB1 Series

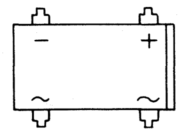
1-A, Single-Phase, Full-Wave Bridge Silicon Rectifiers

Miniaturized Package

Features:
- Glass passivated construction
- Surge ratings: 50 A
- Designed for PC board mounting
- UL recognized package material
- Exceeds environmental standards of MIL-S-19500

TERMINAL DESIGNATIONS

DC OUTPUT



AC INPUT

BR-4

92CS-43474

The GE/RCA DB1 Series are full-wave bridge silicon rectifiers intended for low-power rectification.

These bridge rectifiers are supplied in BR-4 compact plastic package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:*

		DB1F	DB1A	DB1B	DB1D	DB1M	DB1N	DB1P	
MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE	V_{RRM}	50	100	200	400	600	800	1000	V
MAXIMUM RMS BRIDGE INPUT (SUPPLY) VOLTAGE	V_{RMS}	35	70	140	280	420	560	700	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE	$V_{R(DC)}$	50	100	200	400	600	800	1000	V
MAXIMUM AVERAGE FORWARD CURRENT: For resisitive or inductive loads, T_A = 40°C	I_O	1							A
MAXIMUM PEAK SURGE FORWARD CURRENT: For 8.3 ms half sine-wave, superimposed on rated load	I_{FSM}	50							A
FUSING CURRENT (For Bridge Rectifier Protection) T_J = −55°C, t = 1 to 8.35 ms	I^2t	10							A^2s
OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE	T_J, T_{stg}	−55 to +150							°C

*For capacitive load derate current by 20% or use conduction angle data (derating curve) Fig. 5.

DB1 Series

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T) = 25°C Unless Otherwise Specified

CHARACTERISTICS	SYMBOL	LIMITS FOR ALL TYPES MIN.	TYP.	MAX	UNITS
Maximum Instantaneous Forward Voltage Drop (per Bridge Element): At 1A	V_F	—	—	1.1	V
Maximum Reverse Current: At Maximum DC reverse (blocking) voltage, T_J = 25°C	I_R	—	—	10	μA
T_J = 125°C	I_R	—	—	0.5	mA
Typical Junction Capacitance (per Bridge Element): Measured at 2 MHz, applied reverse voltage = 4V	C_J	—	25	—	pF
Typical Thermal Resistance: Junction-to-Ambient, pc board mounted	$R_{\theta JA}$	—	80	—	°C/W

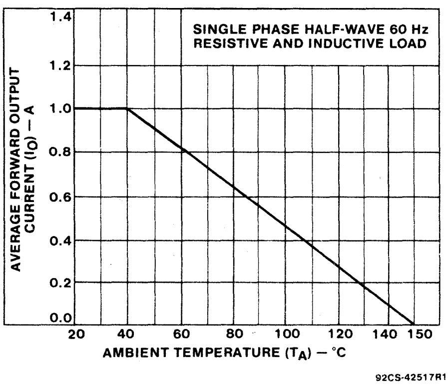


Fig. 1 - Maximum forward (output) current characteristic.

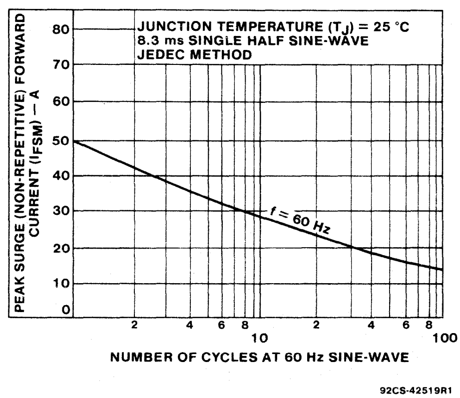


Fig. 2 - Maximum peak (non-repetitive) surge forward current characteristic. (per bridge element)

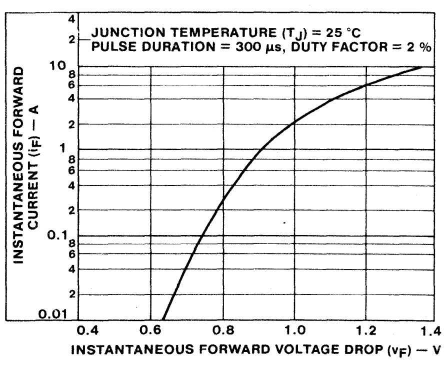


Fig. 3 - Typical instantaneous forward current characteristic.

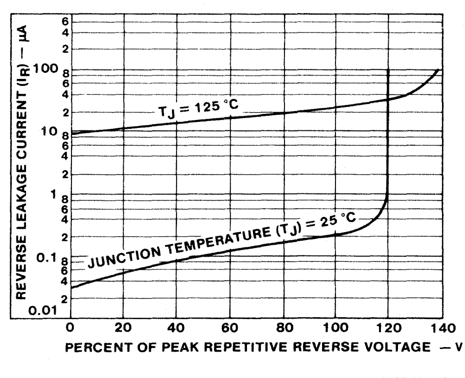


Fig. 4 - Typical reverse leakage current characteristic. (per bridge element)

DB1 Series

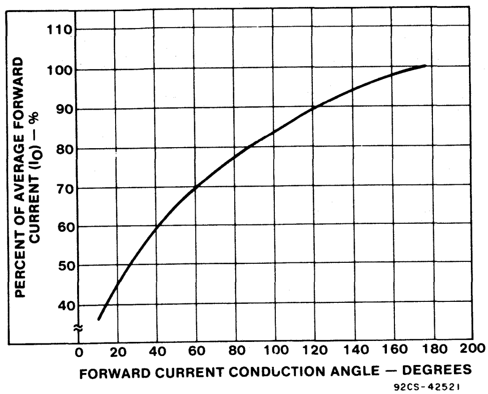


Fig. 5 — Typical percent of average forward current characteristic. (derating curve for shortened conduction angle)

4

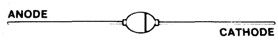
GE1001, GE1002, GE1003, GE1004

File Number **2161**

1-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:
- *Glass passivated junction*
- *Ultra-fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low reverse current leakage*
- *High surge current capability*

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

The GE/RCA GE1001, GE1002, GE1003, and GE1004 are ultra-fast-recovery silicon rectifiers (t_{rr} = 35 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60-Hz, half-wave resistive or inductive loads *:*

	GE1001	GE1002	GE1003	GE1004	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	35	70	105	140	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ...$V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:					
Lead Length = 0.375 in. (9.5 mm); T_A = 55°C, ... I_O	1				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	30				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ...T_j, T_{stg}	-65 to +175				°C

* For capacitive load derate current by 20%.

GE1001, GE1002, GE1003, GE1004

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTIC		LIMITS FOR ALL TYPES			UNITS
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1 A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum dc reverse (blocking) voltage, T_A = 25°C	I_R	—	—	2	μA
T_A = 150°C		—	—	50	μA
Maximum Reverse Recovery Time: At I_F = 0.5 A, I_R = 1 A, I_{rr} = 0.25 A	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4 V	C_J	—	45	—	pF
Thermal Resistance: Junction-to-Ambient (At lead lengths of 0.375 in. (9.5 mm)	$R_{\theta JA}$	—	—	65	°C/W

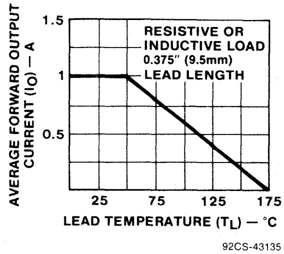


Fig. 1 - Maximum average forward output current characteristic.

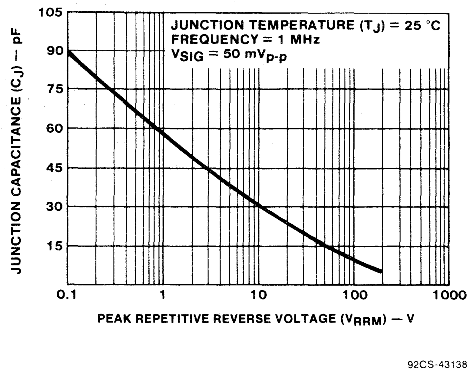


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

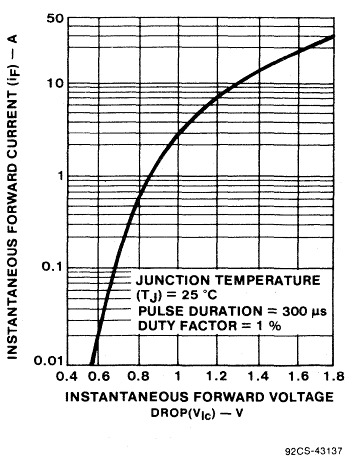


Fig. 3 - Typical instantaneous forward current characteristic.

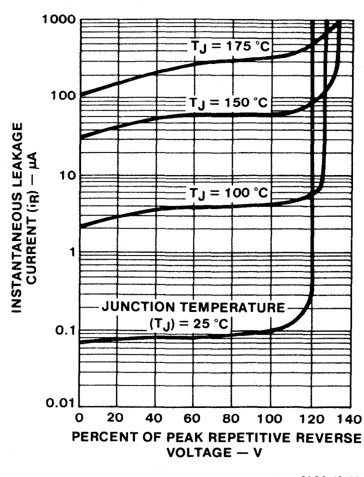
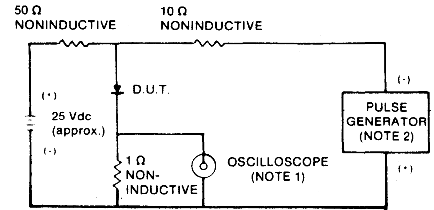


Fig. 4 - Typical reverse leakage current characteristics.

4

GE1001, GE1002, GE1003, GE1004



NOTES:
1. RISE TIME = 7 ns MAX., INPUT IMPEDANCE = 1 MEGOHM, 22 pF
2. RISE TIME = 10 ns MAX., SOURCE IMPEDANCE = 50 OHMS

Fig. 5 - Reverse-recovery time test circuit.

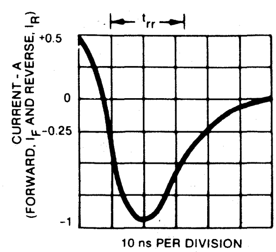


Fig. 6 - Reverse-recovery time waveform.

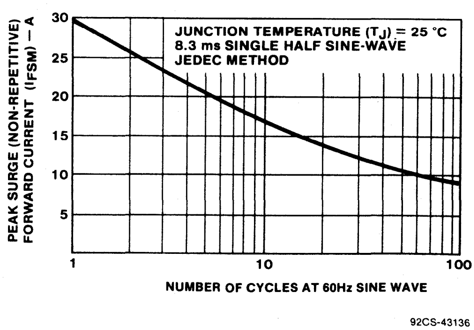


Fig. 7 - Typical junction capacitance characteristic.

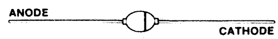
File Number **2165**

GE1101, GE1102, GE1103, GE1104

2.5-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:
- *Glass passivated junction*
- *Ultra-fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low reverse leakage current*
- *High surge current capability*

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

The GE/RCA GE1101, GE1102, GE1103, and GE1104 are ultra-fast recovery silicon rectifiers (t_{rr} = 35 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed JEDEC DO-204AP package.

4

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:*

	GE1101	GE1102	GE1103	GE1104	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	35	70	105	140	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ...$V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:					
Lead Length = 0.375 in. (9.5 mm); T_A = 55°C, ... I_O	2.5				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	50				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ...T_j, T_{stg}	-65 to +175				°C

*For capacitive load derate current by 20%.

GE1101, GE1102, GE1103, GE1104

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 2A	V_F	—	—	0.95	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25°C$	I_R	—	—	2	μA
$T_A = 150°C$		—	—	50	μA
Maximum Reverse Recovery Time: At $I_F = 0.5A$, $I_R = 1A$, $I_{rr} = 0.25A$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	45	—	pF
Thermal Resistance: Junction-to-Ambient at 0.375 in. (9.5 mm) lead length.	$R\theta_{JA}$	—	60	—	°C/W

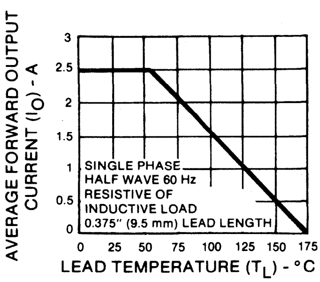


Fig. 1 - Maximum average forward output current characteristic.

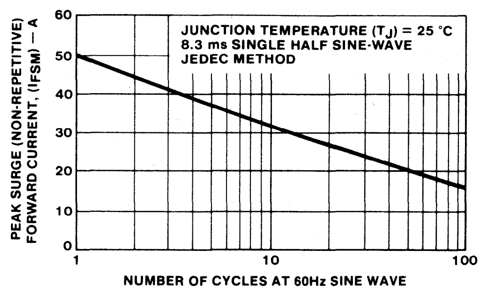


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

GE1101, GE1102, GE1103, GE1104

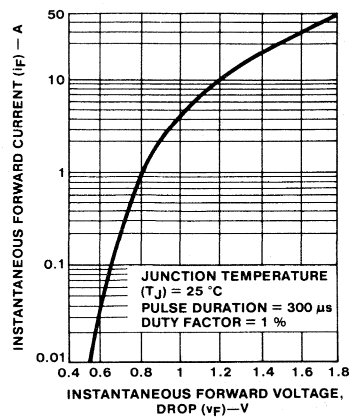


Fig. 3 - Typical instantaneous forward current characteristic.

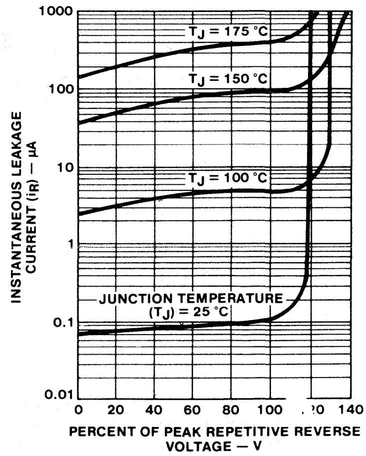
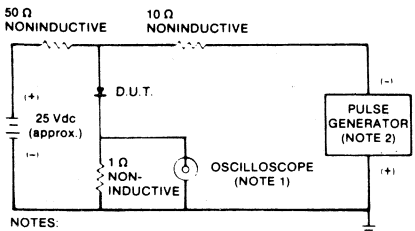


Fig. 4 - Typical reverse leakage current characteristics.



NOTES:

1. RISE TIME = 7 ns MAX., INPUT IMPEDANCE = 1 MEGOHM, 22 pF
2. RISE TIME = 10 ns MAX., SOURCE IMPEDANCE = 50 OHMS

Fig. 5 - Reverse-recovery time test circuit.

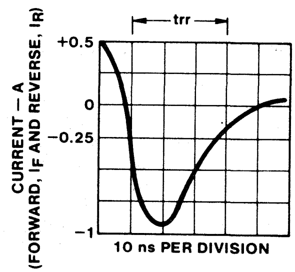


Fig. 6 - Reverse-recovery time waveform.

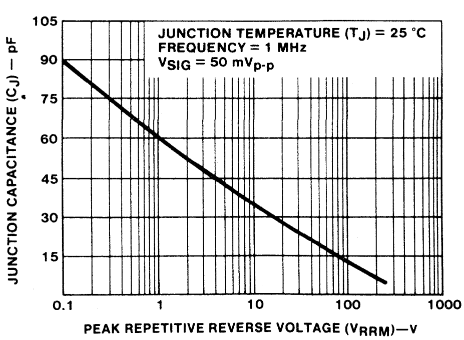


Fig. 7 - Typical junction capacitance characteristic.

GE1301, GE1302, GE1303, GE1304

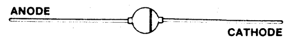
File Number **2166**

6-A, High-Speed, High-Efficiency Glass-Passivated Junction Silicon Rectifiers

Features:

- *Glass passivated junction*
- *Ultra-fast recovery times*
- *Low forward voltage drop, high-current capability*
- *Low leakage current*
- *High surge current capability*

TERMINAL DESIGNATIONS



GE-4

92CS-43477

The GE/RCA GE1301, GE1302, GE1303, and GE1304 are ultra-fast recovery silicon rectifiers (t_{rr} = 35 ns max.) featuring low forward voltage drop, high-current capability. They use glass passivated epitaxial construction.

These rectifiers are intended for TV deflection, inverter, high-frequency power supplies, energy recovery, and output rectification.

These types are supplied in unitized-glass hermetically-sealed GE-4 package.

MAXIMUM RATINGS, *Absolute-Maximum Values; for single-phase, 60Hz, half-wave resistive or inductive loads*:*

	GE1301	GE1302	GE1303	GE1304	
MAXIMUM PEAK REPETITIVE REVERSE VOLTAGE, ... V_{RRM}	50	100	150	200	V
MAXIMUM RMS INPUT (SUPPLY) VOLTAGE, ... V_{RMS}	35	70	105	140	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ...$V_{R(DC)}$	50	100	150	200	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:					
Lead Length = 0.375 in. (9.5 mm); T_A = 55°C, ... I_O	6				A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:					
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	150				A
OPERATING JUNCTION AND STORAGE TEMPERATURE, ...T_j, T_{stg}	-65 to +175				°C

*For capacitive load derate current by 20%.

GE1301, GE1302, GE1303, GE1304

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES MIN.	TYP.	MAX.	UNITS
Maximum Instantaneous Forward-Voltage Drop: At 2A	V_F	—	—	0.975	V
Maximum Reverse Current: At maximum DC reverse (blocking) voltage, $T_A = 25°C$	I_R	—	—	5	μA
$T_A = 150°C$		—	—	50	μA
Maximum Reverse Recovery Time: At $I_F = 0.5A$, $I_R = 1A$, $I_{rr} = 0.25A$	t_{rr}	—	—	35	ns
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	100	—	pF
Thermal Resistance: Junction- to-Lead at 0.375 in. (9.5 mm)	$R\theta_{JL}$	—	16	—	°C/W

4

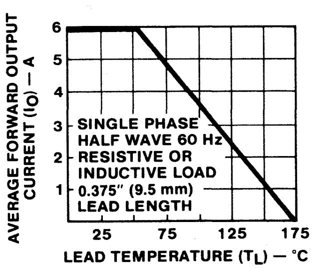


Fig. 1 - Maximum average forward output current characteristic.

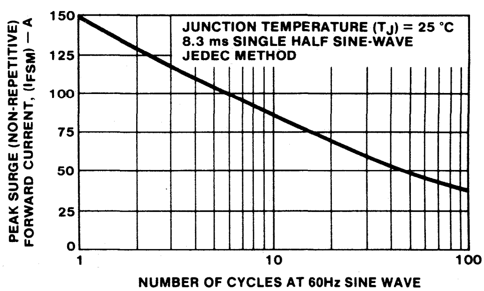


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

GE1301, GE1302, GE1303, GE1304

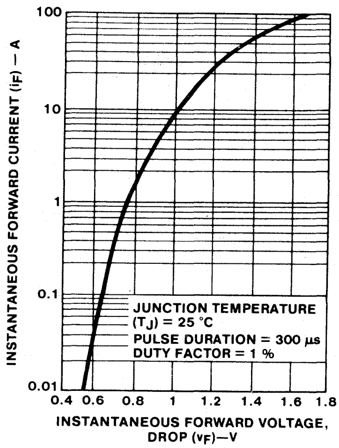


Fig. 3 - Typical instantaneous forward current characteristic.

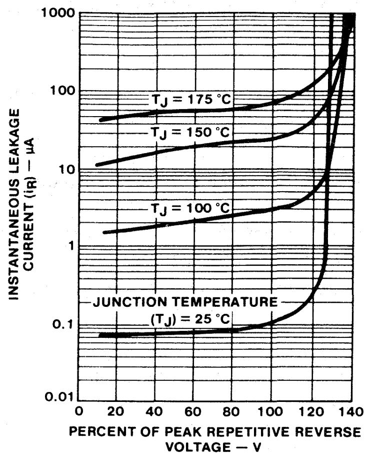
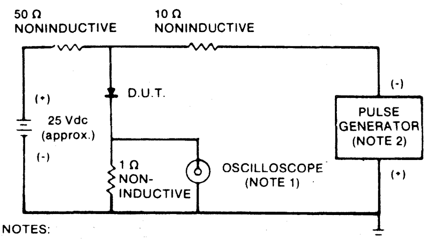


Fig. 4 - Typical reverse leakage current characteristics.



NOTES:
1. RISE TIME = 7 ns MAX., INPUT IMPEDANCE = 1 MEGOHM, 22 pF
2. RISE TIME = 10 ns MAX., SOURCE IMPEDANCE = 50 OHMS

Fig. 5 - Reverse-recovery time test circuit.

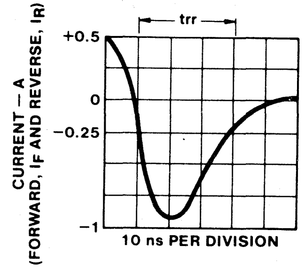


Fig. 6 - Reverse-recovery time waveform.

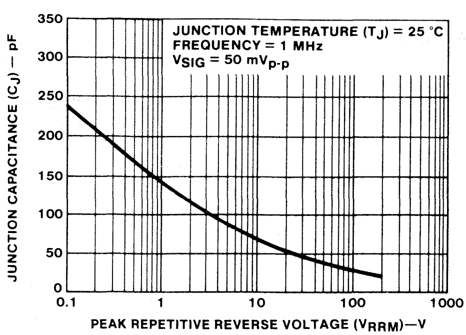


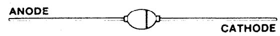
Fig. 7 - Typical junction capacitance characteristic.

File Number **2177**

GER4001-GER4007

1-A, Glass-Passivated Junction Silicon Rectifiers

TERMINAL DESIGNATIONS



DO-204AP

92CS-43475

Features:

- *High temperature metallurgically bonded, no compression contacts as found in diode-constructed rectifiers*
- *Glass passivated junction*
- *1A operation at T_A = 100°C with no thermal runaway*
- *Low reverse current*
- *Exceeds environmental standard of MIL-STD-19500*
- *Hermetically sealed package*
- *High temperature soldering: 350°C/10 s/0.375 in. (9.5mm) lead length*

The GE/RCA GER4001-GER4007 are glass-passivated "transient voltage protected," silicon rectifiers intended for general-purpose applications.

These rectifiers will dissipate up to 1000 watts in reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

These rectifiers are supplied in a JEDEC DO-204AP package.

MAXIMUM RATINGS, *Absolute-Maximum Values; Supply Frequency of 60Hz, resistive or inductive loads:*

	GER4001	GER4002	GER4003	GER4004	GER4005	GER4006	GER4007	
MAXIMUM PEAK (REPETITIVE) REVERSE VOLTAGE, ... V_{RRM}	50	100	200	400	600	800	1000	V
MAXIMUM RMS (SUPPLY) VOLTAGE:								
For resistive or inductive loads, ... V_{RMS}	35	70	140	280	420	560	700	V
MAXIMUM DC REVERSE (BLOCKING) VOLTAGE, ... $V_{R(DC)}$	50	100	200	400	600	800	1000	V
MAXIMUM AVERAGE FORWARD OUTPUT CURRENT:								
For resistive or inductive loads, T_A = 100°C .... I_O	1							A
MAXIMUM PEAK SURGE (NON-REPETITIVE) FORWARD CURRENT:								
For 8.3 ms half sine wave, superimposed on rated load, ... I_{FSM}	50							A
OPERATING JUNCTION AND STORAGE								
TEMPERATURE RANGE, ... T_j, T_{stg}	-65 to +175							°C

GER4001-GER4007

ELECTRICAL CHARACTERISTICS, At Ambient Temperature (T_A) = 25°C Unless Otherwise Specified

CHARACTERISTICS		LIMITS FOR ALL TYPES			UNITS
		MIN.	TYP.	MAX.	
Maximum Instantaneous Forward-Voltage Drop: At 1A	V_F	—	—	1.2*	V
Maximum Full-Load Reverse Current: At average full-cycle, lead length = 0.375 in. (9.5mm), T_A = 100°C	I_R	—	—	200	μA
Maximum Reverse Current: At maximum DC reverse (blocking) voltage	I_R	—	—	2	μA
Maximum Reverse Recovery Time: At I_F = 0.5A, I_R = 1A, I_{rr} = 0.25A	t_{rr}	—	—	2	μs
Typical Junction Capacitance: At frequency = 1 MHz and applied reverse voltage = 4V	C_J	—	15	—	pF

*1.1 V for GER4003-GER4007.

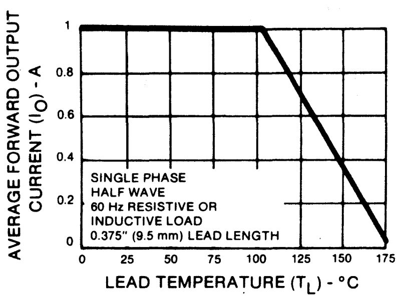


Fig. 1 - Maximum average forward output current characteristic.

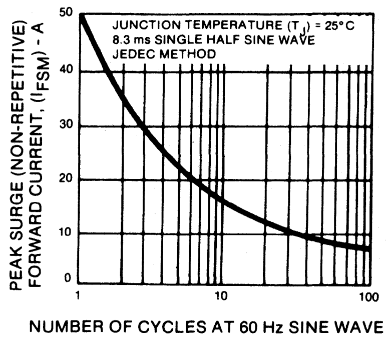


Fig. 2 - Maximum peak surge non-repetitive forward current characteristic.

GER4001-GER4007

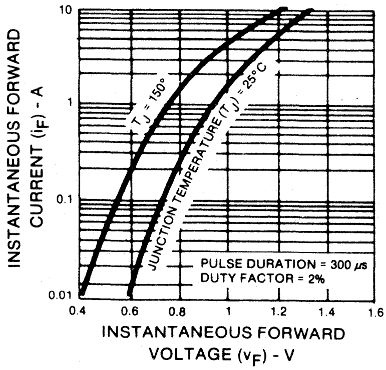


Fig. 3 - Typical instantaneous forward current characteristic.

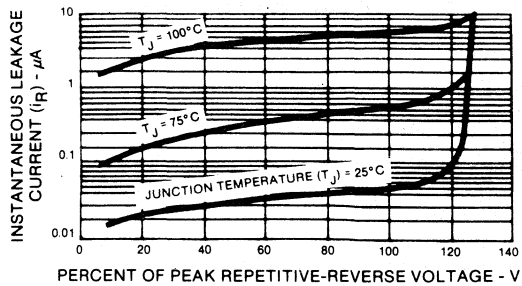


Fig. 4 - Typical reverse leakage current characteristics.

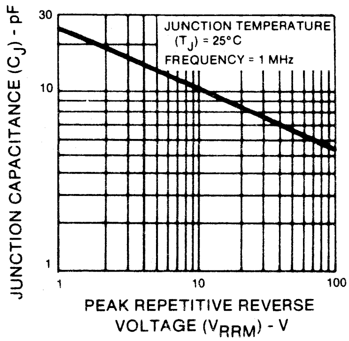


Fig. 5 - Typical junction capacitance characteristic.

4

MUR-810, MUR-815, MUR-820
RUR-810, RUR-815, RUR-820

File Number 1355

8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

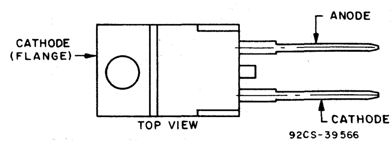
Features:

- *Ultra fast recovery time (<35 ns)*
- *Low forward voltage*
- *Low thermal resistance*
- *Planar design*
- *Wire-bonded construction*

Applications:

- *General Purpose*
- *Power switching circuits to 100 kHz*
- *Output rectification in switching power supplies*

TERMINAL DESIGNATIONS



JEDEC TO-220AC

The MUR-810, MUR-815, MUR-820, RUR-810, RUR-815, and RUR-820* are low forward voltage drop ultra-fast-recovery rectifiers ($t_{rr}<50$ ns). They use a glass-passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and flywheel diodes in a variety of high-frequency pulse-width modulated switching regulators. Their low stored charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AC plastic packages.

*Formerly RCA Dev. Nos. TA9223B, TA9223B, and TA9223C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MUR-810 RUR-810	MUR-815 RUR-815	MUR-820 RUR-820	
VRM	100	150	200	V
IF (Average)				
T_A = 25°C (No Heat Sink)		3		A
T_A = 25°C (With Heat Sink)[a]		8		A
T_C = 150°C		8		A
IFSM (surge)				
8.3ms, 1/2 cycle, non-repetitive		100		A
Tstg, T_J		-65 to 175		°C
T_L (Lead temperature during soldering)				
At distance > 1/8in. (3.17mm) from case for 10 S max.		260		°C

(a) Wakefield type 295 heat sink with convection cooling

MUR-810, MUR-815, MUR-820
RUR-810, RUR-815, RUR-820

ELECTRICAL CHARACTERISTICS

CHARACTERISTICS	TEST CONDITIONS T_J °C	Voltage V_R V	Current i_F A	LIMITS MUR-810 RUR-810 Min.	Max.	MUR-815 RUR-815 Min.	Max.	MUR-820 RUR-820 Min.	Max.	UNITS
i_R	25	100		—	5	—	—	—	—	μA
		150		—	—	—	5	—	—	
		200		—	—	—	—	—	5	
	150	100		—	250	—	—	—	—	
		150		—	—	—	250	—	—	
		200		—	—	—	—	—	250	
V_F	25		8	—	0.975	—	0.975	—	1	V
	150		8	—	0.895	—	0.895	—	0.895	
t_{rr}	25		1 (a)	—	35	—	35	—	35	ns
$R_{\theta JC}$				—	3	—	3	—	2	°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) $< 1A$, $I_{RR} = 0.25A$

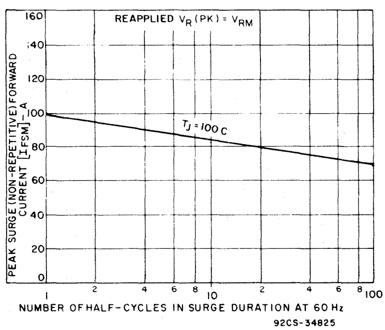


Fig. 1 - Peak surge forward current vs. surge duration.

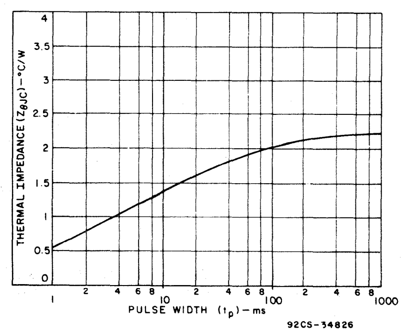


Fig. 2 - Thermal impedance vs. pulse width.

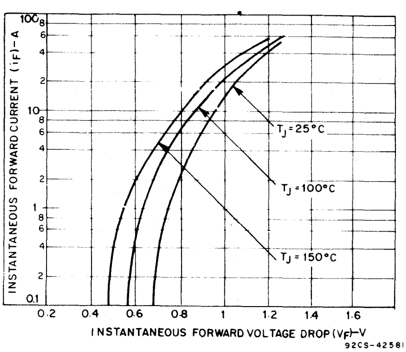


Fig. 3 - Typical forward current vs. forward-voltage drop.

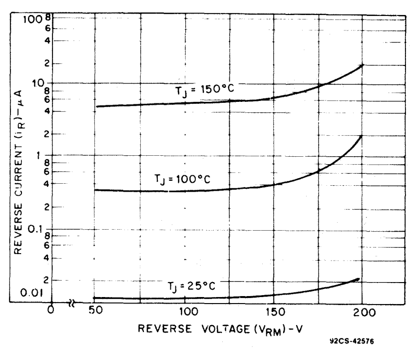


Fig. 4 - Typical reverse current vs. voltage.

4

MUR-840, MUR-850, MUR-860
RUR-840, RUR-850, RUR-860

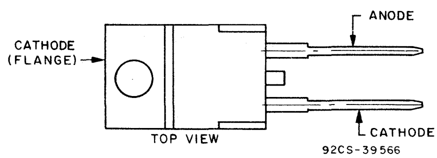
File Number **2091**

8-A, High-Speed, High-Voltage, High Efficiency Epitaxial Silicon Rectifiers

Features:
- *Ultra fast recovery time (< 50 ns)*
- *Low forward voltage*
- *Low thermal resistance*
- *Hard glass passivation*
- *Wire-bonded construction*

Applications:
- *General Purpose*
- *Power switching circuits to 100 kHz*
- *Output rectification in switching power supplies*

TERMINAL DESIGNATIONS



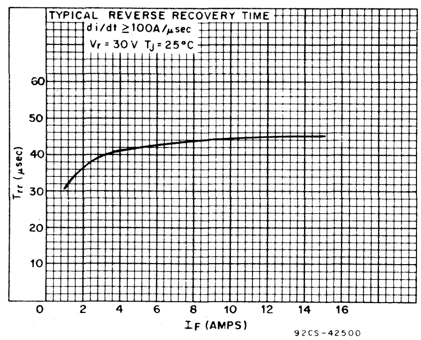
JEDEC TO-220AC

The MUR-840, MUR-850, MUR-860, RUR-840, RUR-850, and RUR-860* are low forward voltage drop ultra-fast-recovery rectifiers (trr<50 ns). They use a glass-passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and flywheel diodes in a variety of high-frequency pulse-width modulated switching regulators. Their low stored charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AC plastic packages.

*Formerly RCA Dev. No. TA9616.



Typical reverse recovery time - all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MUR-840 RUR-840	MUR-850 RUR-850	MUR-860 RUR-860	UNIT
Peak Repetitive Reverse Voltage, V_{RRM} / Working Peak Reverse Voltage, V_{RWM} / DC Blocking Voltage, V_R	400	500	600	V
Average Rectified Forward Current, $I_{F(AV)}$ Total Device, (Rated V_R), T_C = 150°C		8		A
Peak Repetitive Forward Current, I_{FM} (Rated V_R, Square Wave, 20 kHz), T_C = 150°C		16		A
Nonrepetitive Peak Surge Current, I_{FSM} (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		100		A
Operating Junction Temperature and Storage Temperature, T_J, T_{stg}		-65 to + 175		°C
Lead Temperature During Soldering, T_L At distance > 1/8 in. (3.17 mm) from case for 10 s max.		260		°C

MUR-840, MUR-850, MUR-860
RUR-840, RUR-850, RUR-860

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
				MUR-840 RUR-840		MUR-850 RUR-850		MUR-860 RUR-860		
	T_J °C	V_R V	I_F A	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
i_R	25	400		—	10	—	—	—	—	µA
		500		—	—	—	10	—	—	
		600		—	—	—	—	—	10	
	150	400		—	500	—	—	—	—	
		500		—	—	—	500	—	—	
		600		—	—	—	—	—	500	
V_F	25		8	—	1.3	—	1.5	—	1.5	V
	150		8	—	1.0	—	1.2	—	1.2	
t_{rr}	25		1 *	—	60	—	60	—	60	ns
			0.5 **	—	50	—	50	—	50	
$R_{\theta JC}$				—	2	—	2	—	2	°C/W

* di/dt = 50 A/µs
** i_R = 1.0A, I_{REC} = 0.25 A

4

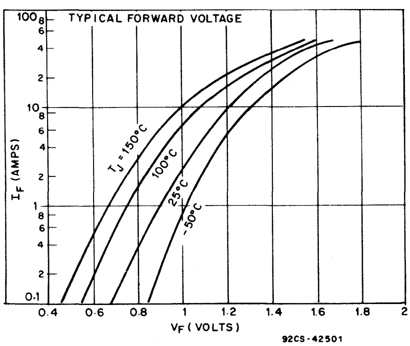


Fig. 1 - Typical forward voltage - MUR-840, RUR-840.

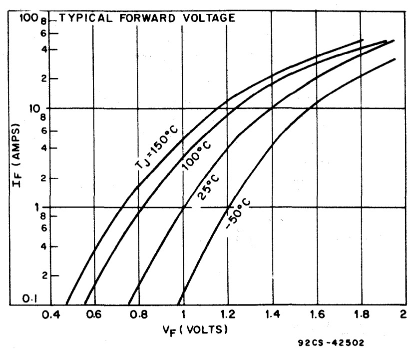


Fig. 2 - Typical forward voltage - MUR-850, MUR-860, RUR-850, and RUR-860.

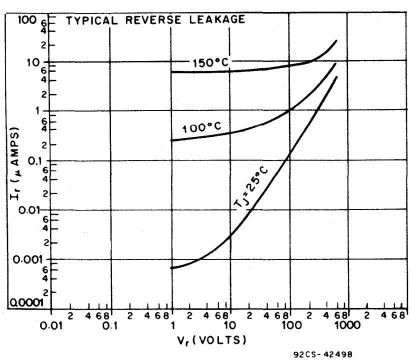


Fig. 3 - Typical reverse leakage - MUR-840, RUR-840.

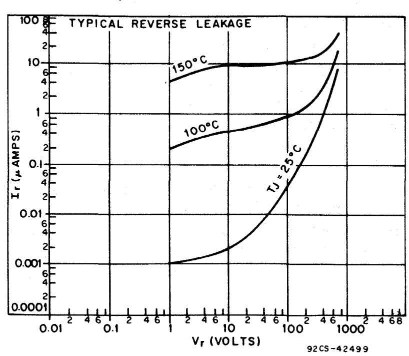


Fig. 4 - Typical reverse leakage - MUR-850, MUR-860, RUR-850, and RUR-860.

MUR-1610CT, MUR-1615CT, MUR-1620CT
RUR-1610CT, RUR-1615CT, RUR-1620CT

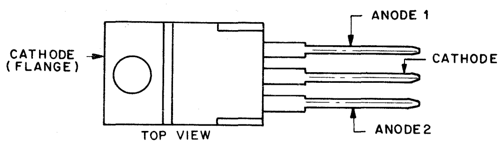
File Number **1885**

Dual 8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

Features:
- *Ultra-fast-recovery time (< 35 ns)*
- *Low forward voltage*
- *Low thermal resistance*
- *Hard glass passivation*
- *Wire-bonded construction*

Applications:
- *General Purpose*
- *Power switching circuits to 100 kHz*
- *Full-wave rectification*

TERMINAL DESIGNATIONS



JEDEC TO-204AE

The MUR-1610CT, MUR-1615CT, MUR-1620CT, RUR-1610CT, RUR-1615CT, and RUR-1620CT* are low forward voltage drop ultra-fast-recovery rectifiers (trr < 35 ns). They use a glass-passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and flywheel diodes in a variety of high-frequency pulse-width modulated switching regulators. Their low stored charge and attendant fast reverse-recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AB plastic packages.

*Formerly RCA Dev. No. TA9224A.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MUR-1610CT RUR-1610CT	MUR-1615CT RUR-1615CT	MUR-1620CT RUR-1620CT	Unit
Peak Repetitive Reverse Voltage, V_{RRM} / Working Peak Reverse Voltage, V_{RWM} / DC Blocking Voltage, V_R	100	150	200	V
Average Rectified Forward Current - per leg, $I_{F(AV)}$		8		A
Total Device, (Rated V_R), T_C = 150°C - total device		16		A
Peak Repetitive Forward Current - per diode leg, I_{FM} (Rated V_R, Square Wave, 20 kHz), T_C = 150°C		16		A
Nonrepetitive Peak Surge Current, I_{FSM} (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		100		A
Operating Junction Temperature and Storage Temperature, T_J, T_{stg}		-65 to +175		°C
(Lead temperature during soldering) At distance > 1/8 in. (3.17 mm) from case for 10 s max.		260		°C

MUR-1610CT, MUR-1615CT, MUR-1620CT
RUR-1610CT, RUR-1615CT, RUR-1620CT

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	T_J °C	Voltage V_R V	Current I_F A	MUR-1610CT RUR-1610CT MIN.	MUR-1610CT RUR-1610CT MAX.	MUR-1615CT RUR-1615CT MIN.	MUR-1615CT RUR-1615CT MAX.	MUR-1620CT RUR-1620CT MIN.	MUR-1620CT RUR-1620CT MAX.	
i_R	25	100	—	—	5	—	—	—	—	μA
	25	150	—	—	—	—	5	—	—	
	25	200	—	—	—	—	—	—	5	
	150	100	—	—	250	—	—	—	—	
	150	150	—	—	—	—	250	—	—	
	150	200	—	—	—	—	—	—	250	
V_F	25	—	8	—	0.975	—	0.975	—	1	V
	150	—	8	—	0.895	—	0.895	—	0.895	
t_{rr}	25	—	1 *	—	35	—	35	—	35	ns
	25	—	0.5 **	—	25	—	25	—	25	
$R\theta_{JC}$	—	—	—	—	3	—	3	—	3	°C/W

* di/dt = 50 A/μs. ** i_R = 1.0 A, I_{REC} = 0.25 A.

MUR-1610CT, MUR-1615CT, RUR-1610CT, RUR-1615CT

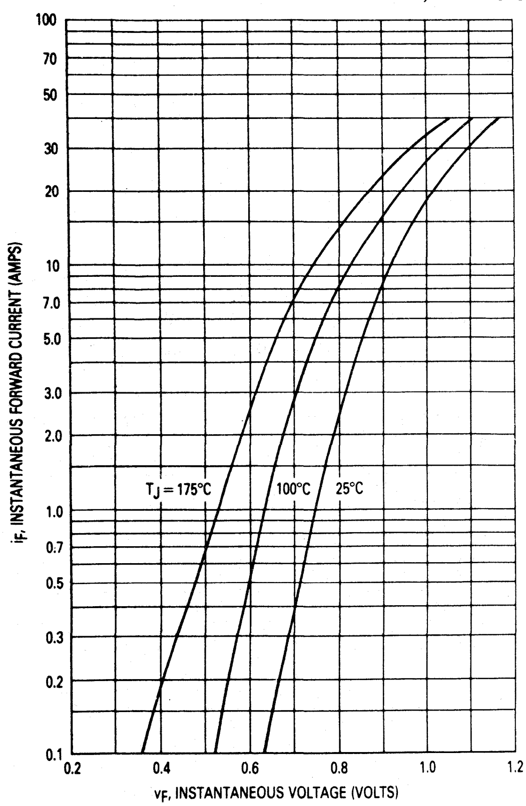


Fig. 1 - Typical forward voltage, per leg.

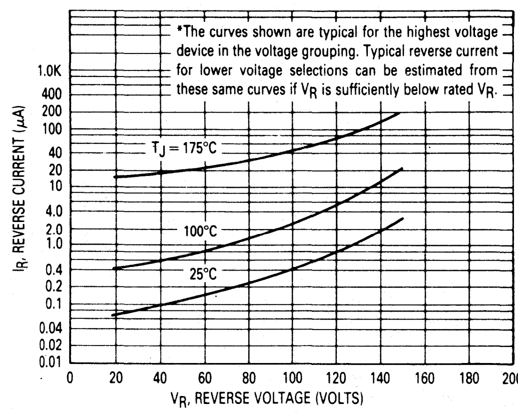


*Fig. 2 - Typical reverse current, per leg *.*

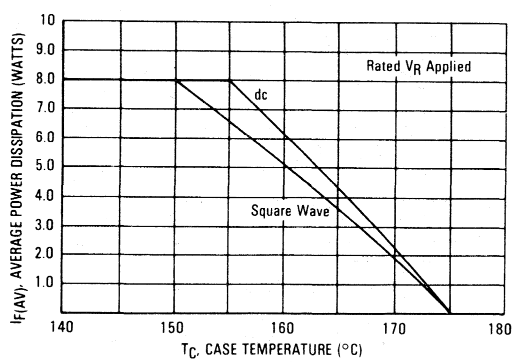


Fig. 3 - Current derating case, per leg.

MUR-1610CT, MUR-1615CT, MUR-1620CT
RUR-1610CT, RUR-1615CT, RUR-1620CT

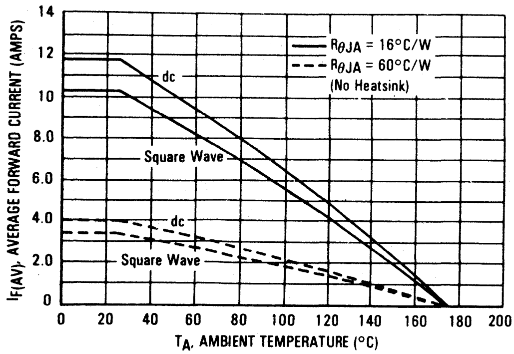


Fig. 4 - Current derating, ambient, per leg.

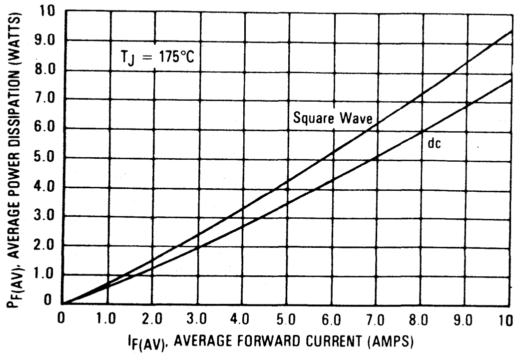


Fig. 5 - Power dissipation, per leg.

MUR-1620CT, RUR-1620CT

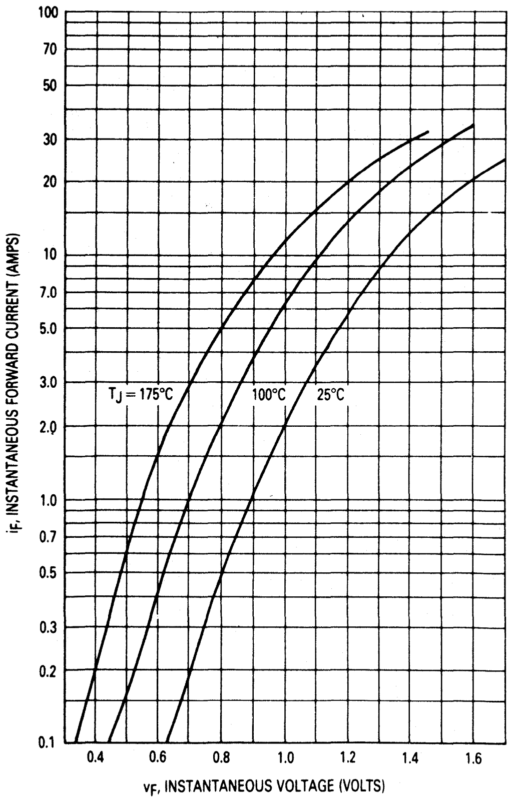


Fig. 6 - Typical forward voltage, per leg.

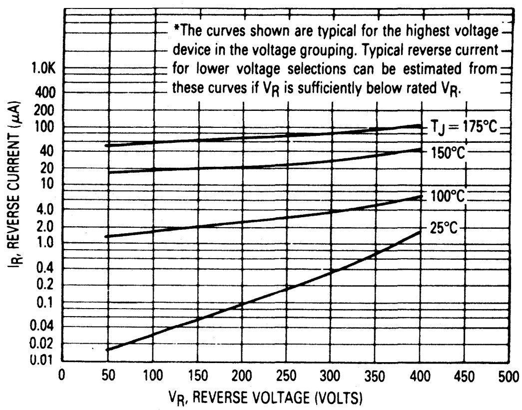


*Fig. 7 - Typical reverse current, per leg *.*

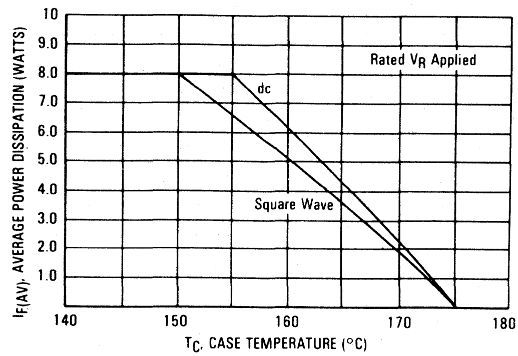


Fig. 8 - Current derating, case, per leg.

MUR-1610CT, MUR-1615CT, MUR-1620CT RUR-1610CT, RUR-1615CT, RUR-1620CT

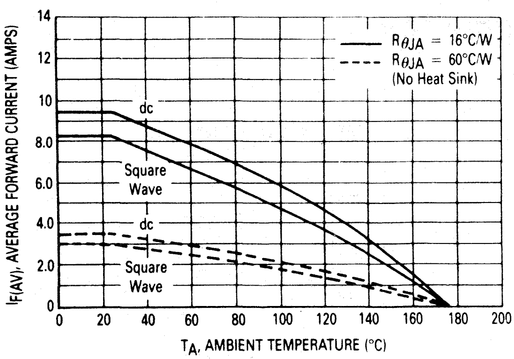


Fig. 9 - Current derating, ambient, per leg.

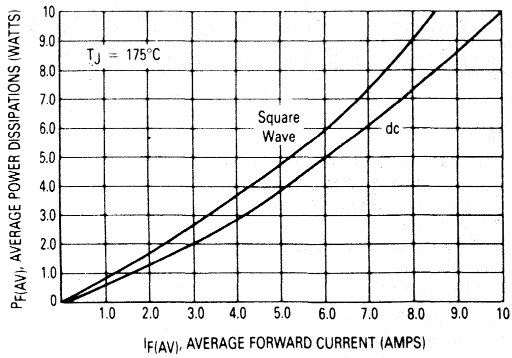


Fig. 10 - Power dissipation, per leg.

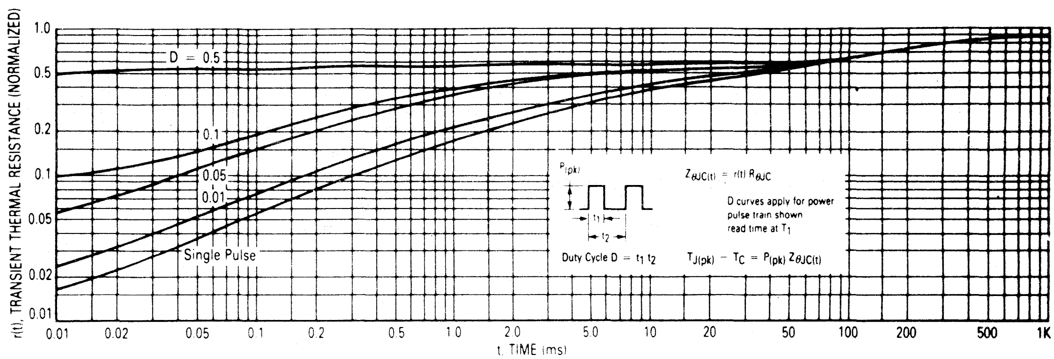


Fig. 11 - Thermal response.

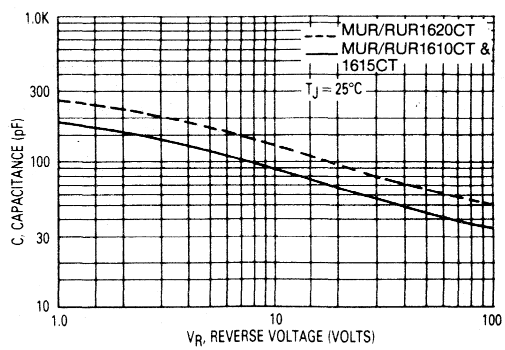


Fig. 12 - Typical capacitance, per leg.

RUR-D810, RUR-D815, RUR-D820

File Number **1356**

Dual 8-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

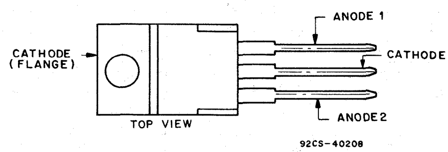
Features:

- *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 (t_{rr} <35 ns). They use a glass passivated ion-implanted epitaxial construction.

These devices are intended for use as output rectifiers and fly wheel diodes in a variety of high-frequency pulse-width modulated and switching regulators. Their low stored charge and attendant fast reverse recovery behavior minimize electrical noise generation and in many circuits markedly reduce the turn-on dissipation of the associated power switching transistors.

All are supplied in TO-220AB plastic packages.

*Formerly RCA Dev. No. TA9224A, TA9224B, and TA9224C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values, per Junction:*

	RUR-D810	RUR-D815	RUR-D820	
V_{RM}	100	150	200	V
I_F (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
I_{FSM} (surge)				
8.3ms, 1/2 cycle, non-repetitive		100		A
T_{stg}, 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

CHARAC-TERISTICS	TEST CONDITIONS			LIMITS						UNITS
	T_J °C	Voltage V_R V	Current i_F A	RUR-D810		RUR-D815		RUR-D820		
				Min.	Max.	Min.	Max.	Min.	Max.	
i_R	25	100		—	5	—	—	—	—	µA
		150		—	—	—	5	—	—	
		200		—	—	—	—	—	5	
	100	100		—	400	—	—	—	—	
		150		—	—	—	400	—	—	
		200		—	—	—	—	—	400	
V_F	25		8	—	0.95	—	0.95	—	1	V
	100		8	—	0.89	—	0.89	—	0.94	
t_{rr}	25		8(a)	—	35	—	35	—	35	ns
$R_{\theta JC}$				—	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) $< 1A$, $I_{RR} = 0.25A$

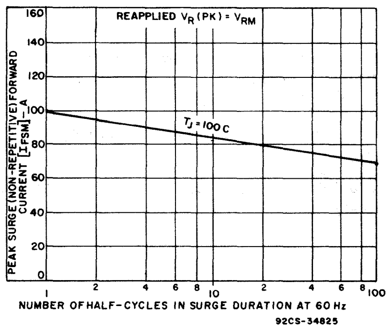


Fig. 1 — Peak surge foward current vs. surge duration.

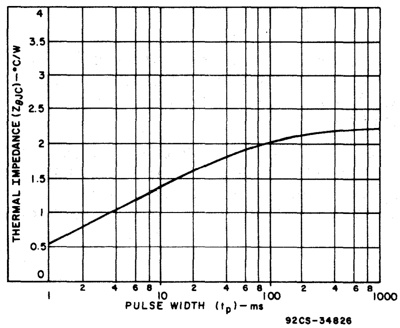


Fig. 2 - Thermal impedance vs. pulse width (per junction).

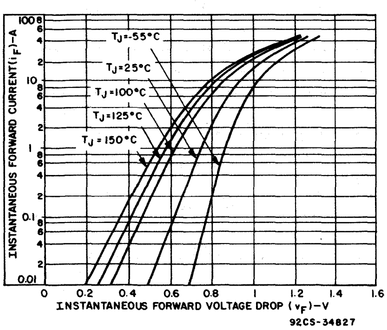


Fig. 3 — Typical forward current vs. forward-voltage drop.

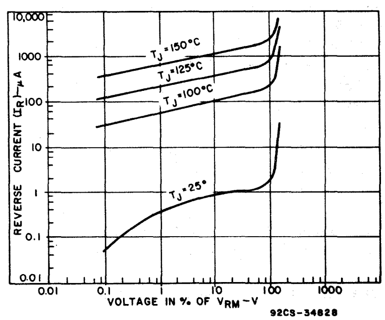


Fig. 4 — Typical reverse current vs. voltage.

4

RUR-D1610, RUR-D1615, RUR-D1620

File Number **1383**

Dual 16-A, High-Speed, High Efficiency Epitaxial Silicon Rectifiers

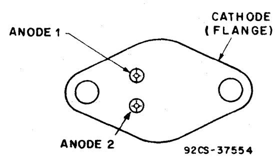
Features:

- *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_H V	Current I_I 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
RθJC				—	1.5	—	1.5	—	1.5	°C/W
RθJA				—	30	—	30	—	30	
C_J	25	10	0	80 Typ.		80 Typ.		80 Typ.		pF

(a) $di_F/dt > 40A/\mu s$, $I_{RM}(rec) < 1A$, $I_{RR} = 0.25A$

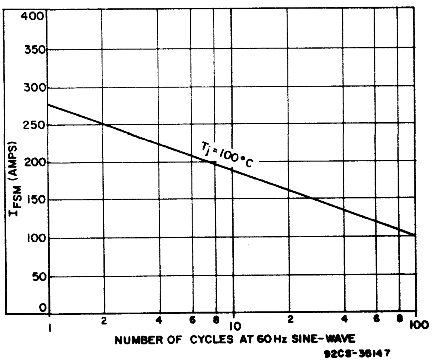


Fig. 1 - Peak surge forward current vs. surge duration.

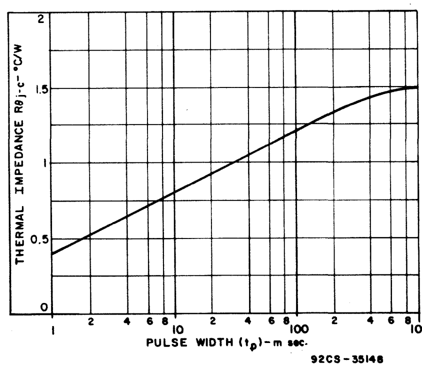


Fig. 2 - Thermal impedance vs. pulse width (per junction).

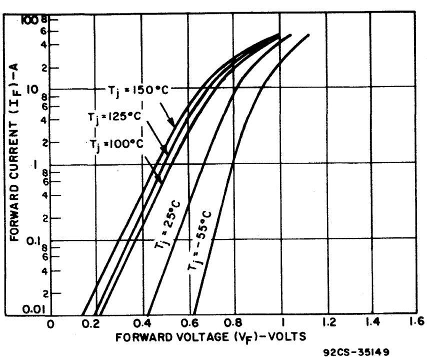


Fig. 3 - Typical forward current vs. forward-voltage drop.

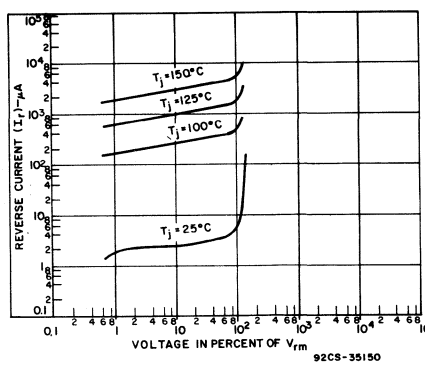


Fig. 4 - Typical reverse current vs. voltage.

Power Transistor Chips

Technical Data

5

Power Transistor Chips

Chip Type No.	$V_{CEO(SUS)}$ (V) min.	I_{CEO} (μA) max.	I_{CES} (μA) max.	I_{EBO} (mA) max.	$V_{CE(SAT)}$ (V) max.	h_{FE} min.	File No.
PC44E	66	—	0.5	0.9†	—	1200	1932
PC44H	33	—	0.02	0.1	—	35	1933
PC45E•	-66	—	-0.4	-0.9	—	1200	1934
PC45H•	-33	—	-0.1	-0.1	—	40	1935
PC1482	60	—	—	0.01	1.4	35 - 100	1792
PC2102	60	5	—	0.005	1	40	1416
PC3439	—	20	—	0.015	1	40 - 150	1417
PC3442	140	200□	—	5	1	20 - 70	1793
PC3585	300	—	200	0.5	0.75	25	1794
PC3879	75	5□	—	10	1.2	20 - 80	1795
PC4036•	-60	-5	—	-5†	-1	40	1418
PC5038	90	20□	—	50	1	20 - 100	1796
PC5240	300	100	—	100†	2	20	1797
PC5303	80	100	—	50†	1	15	1395
PC5320	60	10	—	5†	1	30	1419
PC5322•	-60	-10	—	-5†	-1	30	1420
PC5415•	—	-25	—	-15†	-2	30 - 150	1421
PC5671	90	10□	—	10	0.75	20 - 100	1798
PC6079	350	—	0.5□	1	3	12	1799
PC6107•	-60	-20△	—	-20†	-2	50	1391
PC6213•	-225	—	-0.5□	-0.5	-1.6	10	1800
PC6247•	-80	-100△	—	-20†	-3.5	20 - 100	1801
PC6284	80	100	—	2	2	750-20K	1392
PC6287•	-80	-100	—	-2	-2	750 - 20K	1393
PC6292	80	20△	—	20†	—	20 - 150	1390
PC6354	120	20□	—	5	1	10 - 100	1802
PC6385	80	100△	—	2	2	2000	1803
PC6388	80	20△	—	2	4	—	1407
PC6476	80	20△	—	100†	0.5	20 - 150	1804
PC6478	140	2□	—	2	1	25 - 150	1805
PC6488	80	20△	—	10†	3.5	20	1806
PC6491•	40	20△	—	20†	1.2	20 - 110	1807
PC6650•	-80	-100△	—	-2	-1.5	2K - 20K	1808
PC6668•	-70	-20	—	-2	-1.5	—	1408
PC6673	400	—	100	2	1	10	1409
PC6678	400	—	100	1	1	8	1404
PC6688	180	—	50	100†	1.5	25	1403
PC6704	130	100	—	100†	0.7	20	1809
PC6754	400	—	100	2	1	8	1810
PC6773	350	—	100	2	1	10	1410
PC8638	125	100△	—	50†	1	25 - 125	1400
PC8766	—	100	—	10	1.8	220	1402
PC9116•	-120	-100△	—	-50†	-1	25	1401
PC9166	250	1□	—	1	1	30	1399
PC9202	300	500	—	10	1.5	250	1396
PC9203	250	500	—	1	2	100	1398
PC13005	400	—	100	1	1	8	2149
PC16010	400	—	100	1	1	8	2150
PCTIP110	80	20	—	2	2.5	500	1405
PCTIP115•	-60	-20	—	-2	-2.5	500	1406

• p-n-p † μA □ mA △ I_{CBO}

High-Reliability Power Devices

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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.

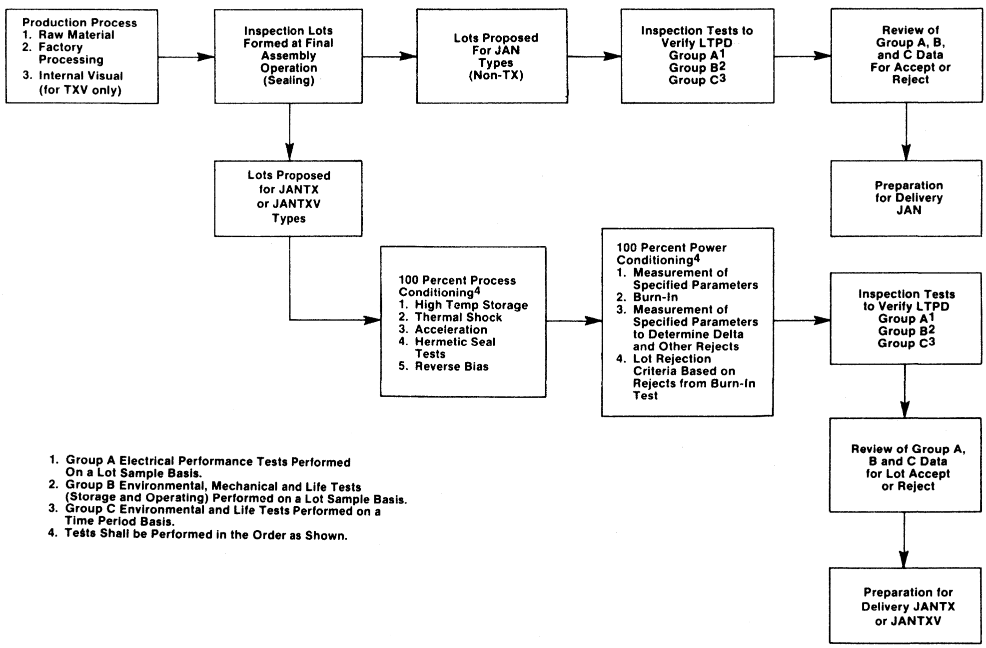
Military and aerospace requirements for high-reliability solid-state devices are extremely large and diverse, not only in terms of performance, operating conditions, and reliability, but also in terms of logistics and procurement. As a result of these requirements, the military services have jointly 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).



92CM-25057RI

Order of procedure diagram for JAN, JANTX, and JANTXV solid-state devices.

JAN, JANTX, and JANTXV Devices

MIL-S-19500 is the specification for the familiar "JAN" type discrete solid state devices. Levels of reliability are defined by MIL-S-19500. JAN types receive Group A, Group B, and Group C lot sampling only, and are the least expensive. JANTX types receive 100 percent process conditioning, and power conditioning, and are subjected to lot rejection based on delta parameter criteria in addition to Group A, Group B, and Group C lot sampling. JANTXV types are subjected to 100 percent (JTXV) internal visual inspection in addition to all of the JANTX tests in accordance with MIL-STD-750 test methods and MIL-S-19500.

DESC publishes "QPL-19500," a Qualified Products List of all types and suppliers approved to produce and brand devices in accordance with MIL-S-19500.

QPL Approved Types

Harris is presently qualified on the following devices. Prices and delivery quotations may be obtained from your local sales representative.

JAN and JANTX Bipolar Power Transistors

Types	MIL-S-19500/	Package	Polarity	P_T (W)	I_C (A)	V_{CEO} (V)	h_{FE} Min.	h_{FE} I_C(A)	f_T (MHz)
2N3439, 2N3440	368	TO-205AD/TO-39	N-P-N	0.8	1	350	40	0.02	15
2N3584, 2N3585	384	TO-213AA/TO-66	N-P-N	35	2	300	25	1	15
2N3879	526	TO-213AA/TO-66	N-P-N	35	7	75	20	4	40
2N5038, 2N5039	439*	TO-204AA/TO-3	N-P-N	140	20	90	20	12	60
2N5302, 2N5303	456*	TO-204AA/TO-3	N-P-N	200	30	80	15	15	2
2N5415S, 2N5416S	485	TO-205AD/TO-39	P-N-P	0.75	-1	-300	30	-0.05	15
2N5671, 2N5672	488*	TO-204AA/TO-3	N-P-N	140	30	120	20	20	50
2N6032, 2N6033	528*	TO-204AE/TO-3	N-P-N	140	50	120	10	50	50
2N6211-2N6213	461	TO-213AA/TO-66	P-N-P	35	-2	-350	30	-1	20
2N6283, 2N6284	504*	TO-204AA/TO-3	N-P-N	175	20	100	1250	10	8
2N6286, 2N6287	505*	TO-204AA/TO-3	P-N-P	175	-20	-100	1250	-10	8
2N6306, 2N6308	498*	TO-204AA/TO-3	N-P-N	125	8	350	15	3	5
2N6383-2N6385	523*	TO-204AA/TO-3	N-P-N	100	10	80	1000	5	20
2N6546, 2N6547	525*	TO-204AA/TO-3	N-P-N	175	15	300	12	5	60
2N6648-2N6650	527*	TO-204AA/TO-3	P-N-P	85	-10	-80	1000	-5	20
2N6671, 2N6673	536*	TO-204AA/TO-3	N-P-N	150	10	400	10	5	15
2N6674, 2N6675	537*	TO-204AA/TO-3	N-P-N	175	20	400	8	10	15
2N6676, 2N6678	538*	TO-204AA/TO-3	N-P-N	175	20	400	8	10	15

*Available in **JANTXV** form.

Radiation-Resistant Power Transistors

The following Harris bipolar silicon power transistors are manufactured using special design and processing techniques to assure continued functional performance after exposure to specified dosages of neutron and gamma radiation.

The following types are recommended for those applications where radiation tolerance is a critical factor. Radiation tolerance is not covered by present slash (/) specifications. Device capabilities and system requirements are generally limited to a custom specification basis.

Harris Radiation-Hardened Bipolar Power Transistors

Types	Description	Package	Gamma Intensity (RAD(Si)/s)	Neutron Fluence (N/cm²2)
2N3879	75V/7A, N-P-N Hi-Speed	TO-213AA	1×10^7	5×10^{13}
2N5038	90V/20A, N-P-N Hi-Speed	TO-204AA	1×10^7	5×10^{13}
2N5320	75V/2A, N-P-N Small-Sig.	TO-205AD	1×10^7	5×10^{13}
2N5322	75V/2A, P-N-P Small-Sig.	TO-205AD	1×10^7	5×10^{13}
2N5672	120V/30A, N-P-N Hi-Speed	TO-204AA	1×10^7	5×10^{13}
2N6248	100V/10A, P-N-P EPI-Base	TO-204AA	1×10^7	5×10^{13}
2N6673	400V/8A, N-P-N Hi-Speed	TO-204AA	1×10^7	5×10^{13}
2N6688	200V/20A, N-P-N Hi-Speed	TO-204AA	1×10^7	5×10^{13}
2N7142*	60V/12A, N-P-N Hi-Speed	TO-204AA	1×10^8	1×10^{14}
2N7143*	80V/12A, N-P-N Hi-Speed	TO-204AA	1×10^8	1×10^{14}
2N7144*	60V/12A, N-P-N Hi-Speed	Radial	1×10^8	1×10^{14}
2N7145*	80V/12A, N-P-N Hi-Speed	Radial	1×10^8	1×10^{14}
2N7146*	60V/12A, N-P-N Hi-Speed	TO-257AA	1×10^8	1×10^{14}
2N7147*	80V/12A, N-P-N Hi-Speed	TO-257AA	1×10^8	1×10^{14}

*Formerly RCA Dev. type TA9107.

Neutron-Radiation Compensation

In Harris radiation-resistant bipolar power transistors, the base width is made as narrow as possible (consistent with other design objectives) to achieve a minimum base transit time so that a maximum number of minority carriers can complete the journey through the base. The narrower base width thus compensates for the major cause of failure in transistors exposed to neutron radiation, the reduction in minority-carrier lifetime and the corresponding decrease in transistor current gain. The voltage-supporting region in the collector is also made as narrow as feasible and is heavily doped. In this way, the series-resistance path is made as low as possible to compensate for the rise in collector series resistance and the resultant higher saturation voltage caused by exposure of the transistor to neutron radiation.

The problem of increased leakage currents is solved by use of epitaxial-planar transistors. The initial leakage in these transistors is so small that even the higher levels caused by neutron bombardment are unlikely to cause failure.

Because the narrower base width and reduced collector resistivity used to improve transistor radiation resistance are contradictory to the design requirement for high-voltage, high-energy transistors, designers should adjust circuits to require the minimum possible emitter-to-collector voltage-breakdown capability. In addition, ratings for transistors should be specified in accordance with the way in which the devices are to be used. (i.e., V_{CE} or V_{CEV}, and never V_{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 Harris radiation-resistant transistors, the distance from the base contact to the farthest point of the base under the emitter is reduced to the minimum possible value to achieve a substantial increase in the gamma threshold level at which the secondary photocurrent starts.

See Application Note AN-6320 for Data

Custom-Ordered Added Value Screening

Added Value Screening for Power Bipolar Transistors and Chips

Many solid-state devices not yet covered by military specifications, because they are too new, offer the most recent technological advances or have special performance characteristics which offer advantages to the designer of high-reliability equipment. Harris cooperates with the users of such devices in establishment of high-reliability specifications patterned after MIL standards, which allow these designs to be approved for use in military and aerospace systems, as well as commercial equipment.

Most procurements of solid-state devices for military systems are made by the equipment contractor from the MIL-STD parts list as awards are received for electronic equipment. Some military and aerospace programs, because of their size, duration, or special requirements (Minuteman and Peacekeeper are two examples), require that special specifications and process methods, or even special production lines, be established and tailored to the particular functional, reliability, and economic needs of the program. Harris has frequently used the resource of its laboratories, production facilities, and expert technical staff to contribute to the success of such programs.

All Harris high-reliability solid-state power devices are processed in accordance with provisions of MIL-S-19500. The desired screening test sequence can be chosen from the models shown in the screening table.

Class S devices provide wafer lot control traceability from wafer diffusion through screening.

Class S chips also provide wafer lot control traceability from wafer diffusion through screening. A sample of 22 devices taken from this lot is assembled in a suitable package. The assembled sample devices are subjected to the Class S screening sequence in the table below. Class S chips are released for shipment when the assembled sample devices successfully pass the screen.

Class V devices are screened for precap internal visual inspection plus burn-in and domestic assembly. Such devices are referred to as JANTXV. Class X devices are 100% burned-in and are referred to as JANTX.

Group B and Group C tests will be performed when requested in accordance with MIL-S-19500.

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
1. Internal Visual	2072	For transistors.	100%	100%	—
2. High Temp Life (LTPD) (stabilization bake)	1032	24 hrs min at max rated storage temp.	100%	100%	100%
3. Thermal shock (temp cycling)	1051	No dwell is required at 25° C. Test condition C, 20 cycles, t (extremes) > 10 min.	100%	100%	100%
4. Constant acceleration 1/	2006	Y_1 direction at 20,000 G min except at 10,000 G min for devices with power rating of > 10 watts at T_C = 25° C. The 1 min hold time requirement shall not apply.	100%	100%	100%

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Custom-Ordered Added Value Screening

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
5. Hermetic Seal Fine 1/	1071	Test condition G or H, max leak rate = $5x10^{-8}$ 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.)

Custom-Ordered Added Value Screening

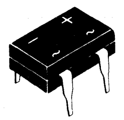
Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
10. Power Burn-In		As specified.	100%	100%	100%
Burn-In (Transistors)		Transistors. Test condition B.	240 hrs (min)	160 hrs (min)	160 hrs (min)
Burn-In (Thyristors) 3/	1040	Thyristors.	240 hrs (min)	96 hrs (min)	96 hrs (min)
11. Final Electrical Test		As specified.	100%	100%	100%
Interim Electrical		All interim and delta parameter measurements must be completed within 96 hrs after removal from burn-in conditions.	Interim electrical and delta parameters as a minimum. (Read and record.)	Interim electrical and delta parameters as a minimum. (Read and record.)	Interim electrical and delta parameters as a minimum. (Read and record.)
Other Electrical Parameters			Group A, sub-groups 2 and 3.	Group A, sub-groups 2 and 3.	Group A, sub-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 $\geq$ 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.

6

Package Designations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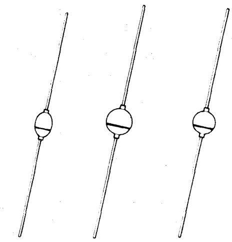
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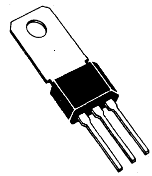
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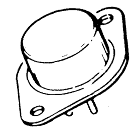
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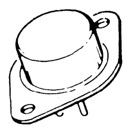
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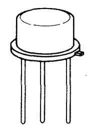
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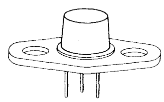
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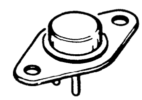
w/Flange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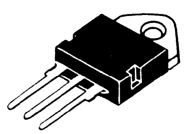
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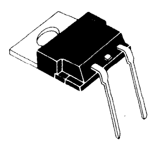
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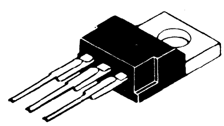
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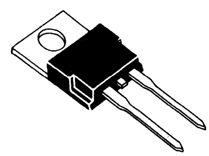
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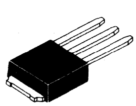
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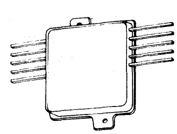
TO-252AA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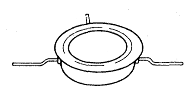
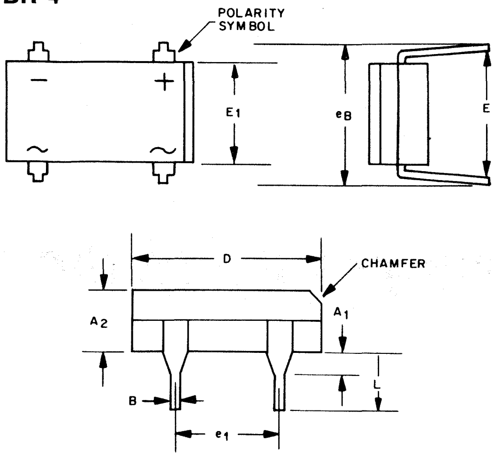

RADIAL PKG.

Package Information

7

Dimensional Outlines

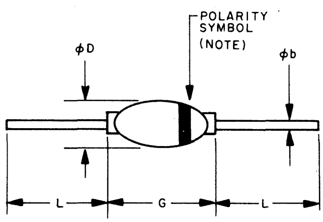
BR-4



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A_1	0.060 TYP.		1.5 TYP.		
A_2	0.125	0.135	3.2	3.4	
B	0.016	0.020	4.1	5.1	
D	0.355	0.365	9.0	9.3	
E	0.300	0.350	7.6	8.9	
E_1	0.245	0.255	6.2	6.5	
e_1	0.195	0.205	5.0	5.2	
e_B	0.290	0.310	7.4	7.9	
L	0.155	0.165	3.9	4.2	

92CS-42582

DO-204AP

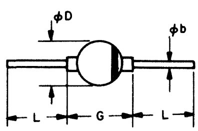


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
φb	0.028	0.034	0.71	0.86	
φD	0.100	0.150	2.5	3.8	
G	—	0.240	—	6.1	
L	1.000	—	25.4	—	

NOTE:
COLOR BAND (POLARITY SYMBOL) INDICATES CATHODE CONNECTION.

92CS-42583R1

GE-3

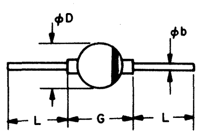


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
φb	0.048	0.052	1.2	1.3	
φD	0.170	0.250	4.3	6.3	
G	—	0.300	—	7.6	
L	1	—	25.4	—	

NOTE:
COLOR BAND (POLARITY SYMBOL) INDICATES CATHODE CONNECTION.

92CS-42648

GE-4



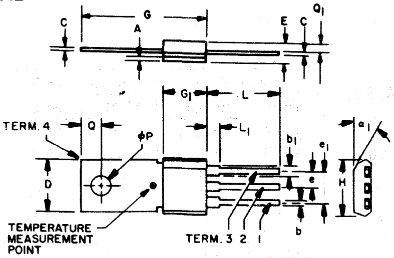
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
φb	0.037	0.042	0.94	1.07	
φD	0.115	0.180	2.9	4.6	
G	—	0.300	—	7.6	
L	1	—	25.4	—	

92CS-42647

NOTE:
COLOR BAND (POLARITY SYMBOL) INDICATES CATHODE CONNECTION.

Dimensional Outlines

TO-202AB
VERSATAB

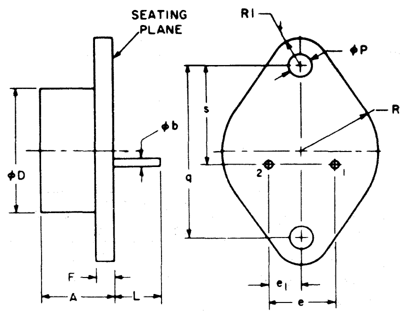


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.05	—	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
c	0.018	0.026	0.457	0.660	
D	0.305	0.325	7.747	8.255	
E	0.130	0.150	3.302	3.810	
e	0.095	0.105	2.413	2.667	
e_1	0.190	0.210	4.826	5.334	
G	0.760	0.840	19.31	21.33	
G_1	0.230	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

Notes:
1: Package contour optional within dimensions specified.
2: Lead dimensions uncontrolled in this zone.
3: Controlling dimensions: inch.

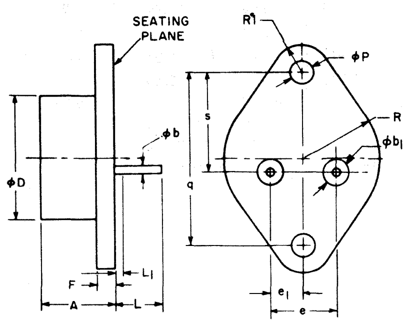
TO-204AA



SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	**0.250**	**0.450**	**6.4**	**11.4**	
ϕb	**0.038**	**0.043**	**0.966**	**1.092**	
ϕD	—	**0.875**	—	**22.22**	
e	**0.420**	**0.440**	**10.67**	**11.17**	
e_1	**0.205**	**0.225**	**5.21**	**5.71**	
F	—	**0.135**	—	**3.42**	
L	**0.312**	—	**7.93**	—	
ϕP	**0.151**	**0.161**	**3.84**	**4.08**	
q	**1.187 BSC**		**30.15 BSC**		
R	—	**0.525**	—	**13.33**	
R_1	—	**0.188**	—	**4.77**	
s	**0.655**	**0.675**	**16.64**	**17.14**	

92CS-37249R1

TO-204AA
200-mil diameter pin isolation



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.35	11.35	
ϕb	0.038	0.043	0.96	1.092	1
ϕb_1	0.200 NOM.		5.08 NOM.		
ϕD	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	2
e_1	0.205	0.225	5.21	5.71	2
F	0.060	0.135	1.53	3.42	
L	0.312	0.500	7.93	12.70	
L_1	—	0.050	—	1.27	1
ϕP	0.151	0.161	3.836	4.089	
q	1.177	1.197	29.90	30.40	
R	0.495	0.525	12.58	13.33	
R_1	0.131	0.188	3.33	4.77	
s	0.655	0.675	16.64	17.14	

92CS-32102

Notes:
1: ϕb applies between L_1 and L. Diameter is uncontrolled in L_1.

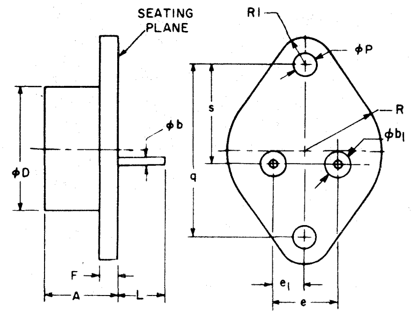
2: These dimensions should be measured at points 0.050 in. (1.270 mm) to 0.055 in. (1.397 mm) below seating plane. When gage is not used, measurement will be made at seating plane.

7

Dimensional Outlines

TO-204AE

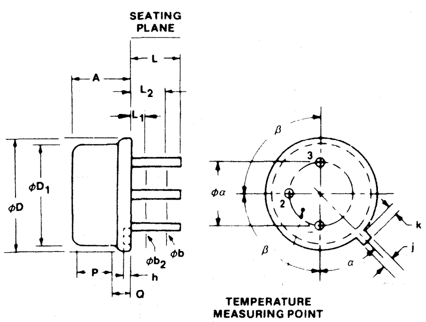
141-mil diameter pin isolation



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.4	11.4	
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

TO-205AD



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
ϕa	0.200 BSC		5.08 BSC		4
A	0.240	0.260	6.10	6.60	
ϕb	0.016	0.021	0.41	0.53	5
ϕb_2	0.016	0.019	0.41	0.48	5
ϕD	0.335	0.370	8.51	9.39	
ϕD_1	0.305	0.335	7.75	8.50	2
h	0.009	0.041	0.23	1.04	
j	0.028	0.034	0.72	0.86	
k	0.029	0.045	0.74	1.14	1
L	0.500	0.750	12.70	19.05	5
L_1	—	0.050	—	1.27	5
L_2	0.250	—	6.35	—	5
P	0.100	—	2.54	—	2
Q	—	0.050	—	1.27	3
α	45° NOMINAL				
β	90° NOMINAL				

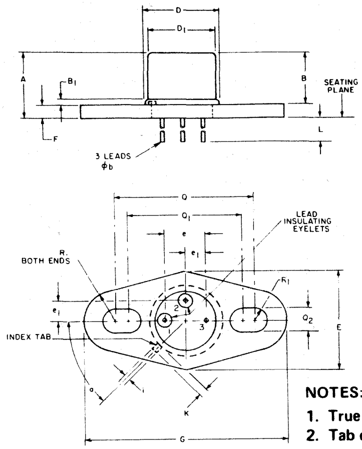
92CS-39772

Notes:

1. Dimension k measured from ϕD maximum.
2. ϕD_1 shall not vary more than 0.010 in Zone P. This zone controlled for automatic handling.
3. Details of outline in this zone optional.
4. Leads at gauge plane 0.054-0.055 below seating plane shall be within 0.007 radius of positional tolerance at MMC relative to tab at MMC. Device may be measured by direct methods or by gauge and gauging procedure described on JEDEC gauge drawing GS-1.
5. ϕb_2 applies between L_1 and L_2. ϕb applies between L_2 and L minimum. Diameter is uncontrolled in L_1 and beyond L minimum.

Dimensional Outlines

TO-205AD
WITH FLANGE

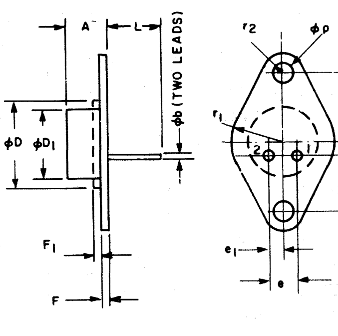


NOTES:
1. True position.
2. Tab centerline.

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
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	
α	45° T.P.				1, 2

92CS-22333

TO-213AA



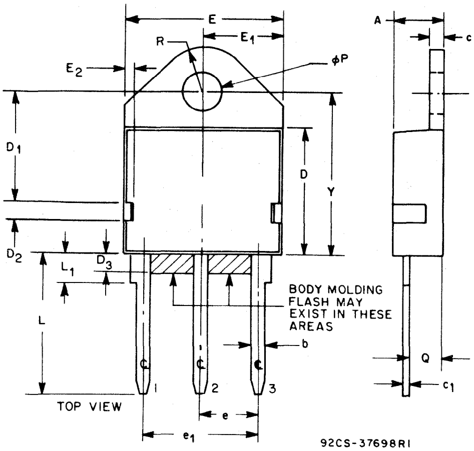
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.250	.340	6.35	8.63	
θ_b	.028	.034	.712	.863	
θD	—	.620	—	15.74	3
θD_1	.470	.500	11.94	12.70	
e	.190	.210	4.83	5.33	
e_1	.093	.107	2.37	2.71	
F	.050	.075	1.27	1.90	4
F_1	—	.050	—	1.27	3
L	.360	—	9.15	—	
θP	.142	.162	3.61	4.08	
q	.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.

Dimensional Outlines

TO-218AC



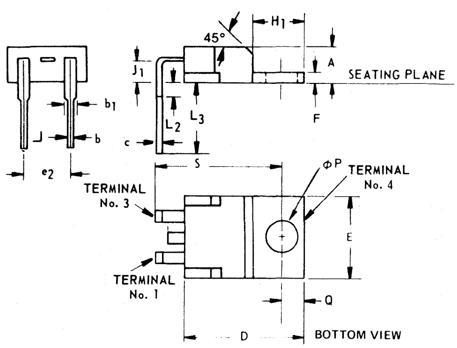
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.165	0.200	4.191	5.080	
b	0.040	0.065	1.016	1.651	
c	0.053	0.065	1.346	1.651	
c_1	0.015	0.030	0.381	0.762	
D	0.460	0.505	11.68	12.827	
D_1	0.395	0.415	10.033	10.541	
D_2	0.070	0.090	1.778	2.286	
D_3	—	0.600	—	1.524	
E	0.610	0.640	15.494	16.256	1
E_1	0.305	0.320	7.747	8.128	
E_2	0.040	0.060	1.016	1.524	
e	0.205	0.225	5.207	5.715	4
e_1	0.420	0.440	10.688	11.176	4
L	0.500	0.632	12.700	16.05	
L_1	—	0.150	—	3.81	2
ϕP	0.157	0.167	3.988	4.241	
Q	0.093	0.126	2.36	3.200	
R	0.170	0.190	4.318	4.826	1
Y	0.600	0.650	15.24	16.51	

92CS-37698R2

NOTES:

1. **Tab outline optional within boundaries of dimensions E and R.**
2. **Lead dimensions uncontrolled in L_1.**
3. **Maximum radius of 0.050" on all body edges and corners.**
4. **Position of lead to be measured 0.185-0.190" from bottom of dimension D.**
5. **Controlling dimension: inch.**

TO-220AA
VERSAWATT



NOTES:

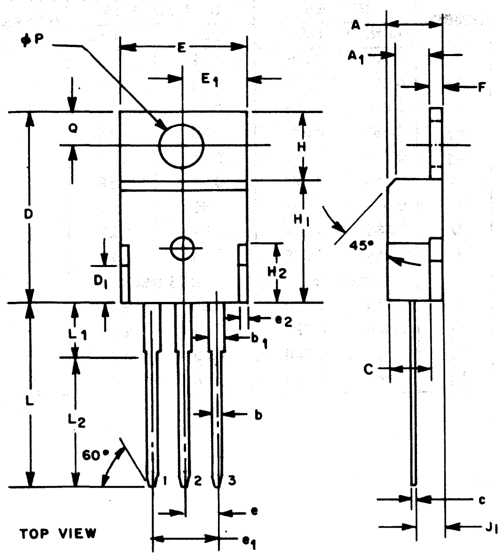
1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

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

Dimensional Outlines

TO-220AB
VERSAWATT



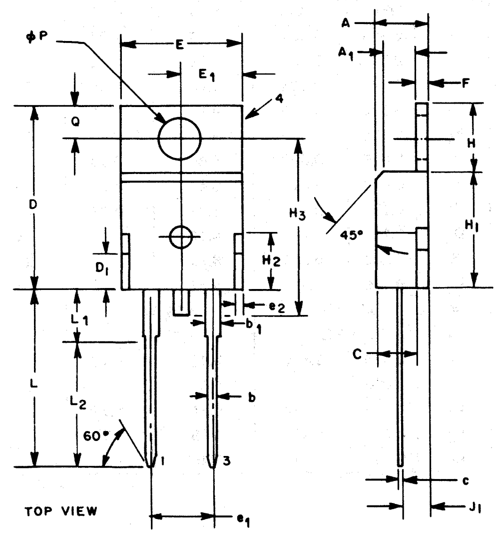
SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.140	0.190	3.56	4.82
A_1	0.080	0.085	2.03	2.16
b	0.020	0.045	0.51	1.14
b_1	0.045	0.070	1.14	1.77
C	—	0.125	—	3.18
c	0.015	0.025	0.38	0.63
D	0.560	0.625	14.23	15.87
D_1	—	0.100	—	2.54
E	0.380	0.420	9.66	10.66
e	0.090	0.110	2.29	2.79
e_1	0.190	0.210	4.83	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

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

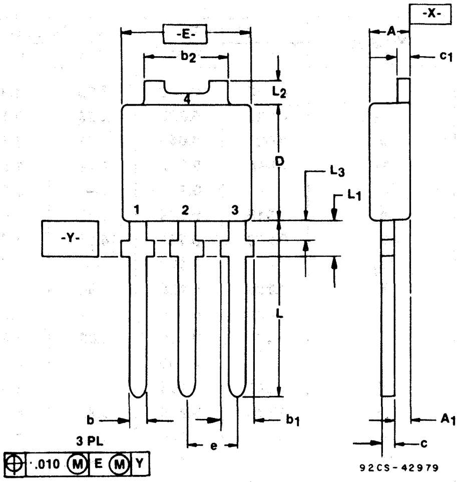
NOTES:

1. Position of lead to be measured 0.250-0.255 in. (6.350-6.477 mm) from case.

92CS-34830R1

Dimensional Outlines

TO-251AA



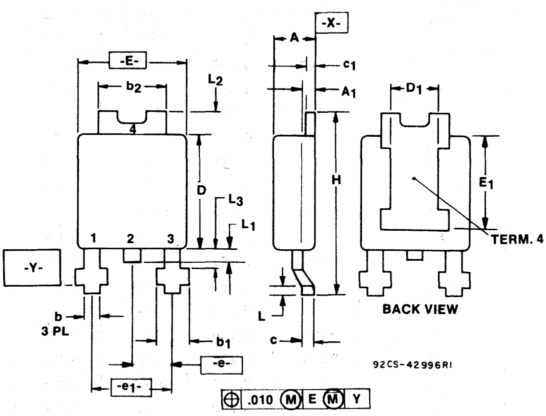
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.086	0.094	2.19	2.38	
A_1	0.035	0.045	0.89	1.14	
b	0.025	0.035	0.64	0.89	2
b_1	0.030	0.045	0.76	1.14	
b_2	0.205	0.215	5.21	5.46	4
c	0.018	0.023	0.46	0.58	
c_1	0.018	0.023	0.46	0.58	
D	0.235	0.245	5.97	6.22	
E	0.250	0.265	6.35	6.73	2
e	0.090 BSC		2.28 BSC		
L	0.350	0.380	8.89	9.65	
L_1	0.075	0.090	1.91	2.28	
L_2	0.035	0.050	0.89	1.27	4
L_3	0.045	0.060	1.15	1.52	3

92CS-42862

NOTES:

1. -X- is datum surface. (seating plane)
2. -E- and -Y- are datums.
3. Lead dimension uncontrolled in L_3.
4. Tab contour optional within dimensions b_2 and L_2.
5. Controlling dimension: inch.

TO-252AA



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.086	0.094	2.19	2.38	
A_1	0.035	0.045	0.89	1.14	
b	0.025	0.035	0.64	0.88	2
b_1	0.030	0.045	0.76	1.14	
b_2	0.205	0.215	5.21	5.46	4
c	0.018	0.023	0.46	0.58	
c_1	0.018	0.023	0.46	0.58	
D	0.235	0.245	5.97	6.22	
D_1	0.170	—	4.32	—	1, 5
E	0.250	0.265	6.35	6.73	2
E_1	0.170	—	4.32	—	1, 5
e	0.090 BSC		2.28 BSC		
e_1	0.180 BSC		4.57 BSC		
H	0.370	0.410	9.40	10.42	
L	0.020	—	0.51	—	6
L_1	0.025	0.040	0.64	1.02	
L_2	0.035	0.050	0.88	1.27	4
L_3	0.045	0.060	1.15	1.52	3

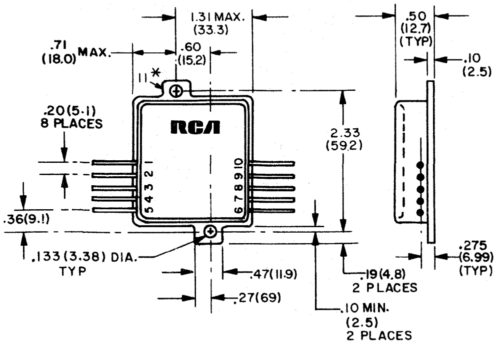
92CS-42863

NOTES:

1. -X- is datum surface. (seating plane)
2. -E- and -Y- are datums.
3. Lead dimension uncontrolled in L_3.
4. Tab contour optional within dimensions b_2 and L_2.
5. D_1 and E_1 establishes a minimum mounting surface for Terminal 4.
6. L is the terminal length for soldering.
7. Controlling dimension: inch.

Dimensional Outlines

HYBRID-CIRCUIT PACKAGE



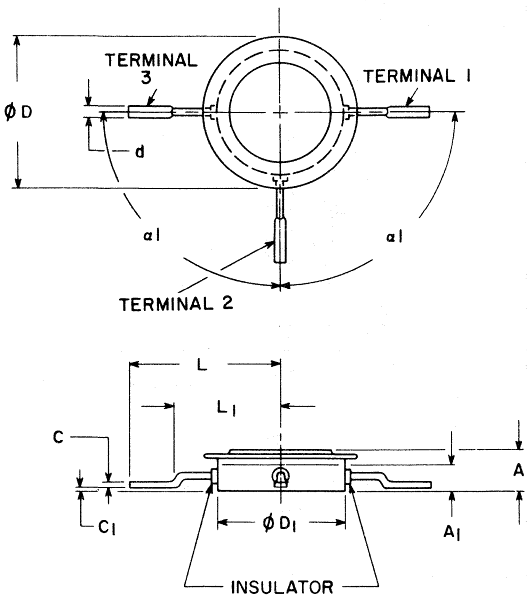
92CS-37519

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.

RADIAL PACKAGE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.200	—	5.08	
A_1	—	0.125	—	3.17	1
C	0.015	0.019	0.38	0.48	
C_1	—	0.015	—	0.38	
ϕD	—	0.710	—	18.03	
ϕD_1	0.615	0.690	15.62	17.52	1
d	0.042	0.046	1.06	1.16	
L	0.700	0.710	17.78	18.03	
L_1	—	0.510	—	12.95	
α_1	$90° \pm 2°$		$90° \pm 2°$		

92CS-20224R1

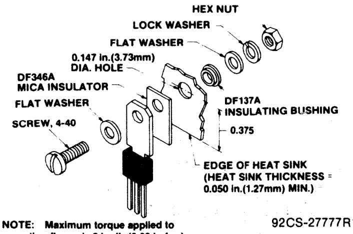
Note:

1. Controlled area of the diameter does not include the brazed area around the ceramic and terminal 2.

7

Suggested Hardware and Mounting Arrangements

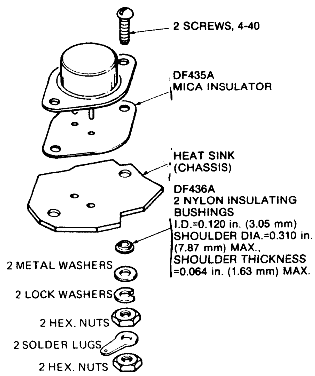
TO-202AB



NOTE: Maximum torque applied to mounting flange is 8 in.-lb (0.09 kgf-m)

92CS-27777R1

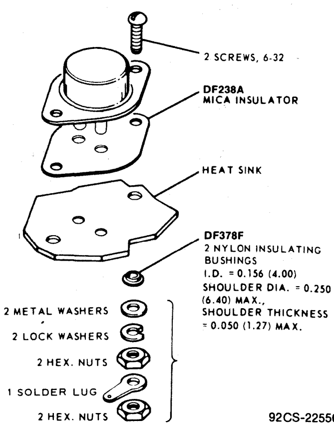
TO-204AA
200-mil diameter pin isolation



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lbs. (0.09 kgf m).

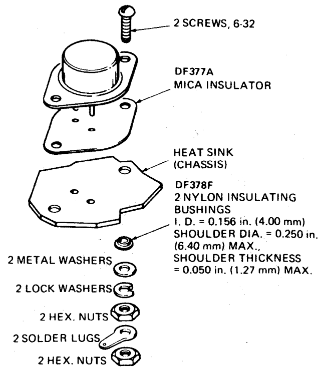
92CS-33203

TO-204AE



92CS-22556R1

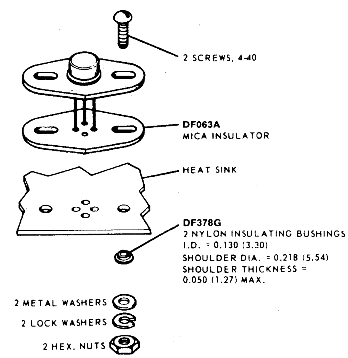
TO-204AA



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in. lbs. (0.14 kgf m).

92CS-22558R2

TO-205AD
WITH FLANGE

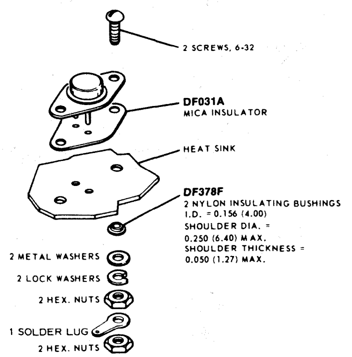


Note: Maximum torque applied to mounting flange is 8 in.-lb. (0.09 kgfm).

92CS-22567E

Suggested Hardware and Mounting Arrangements

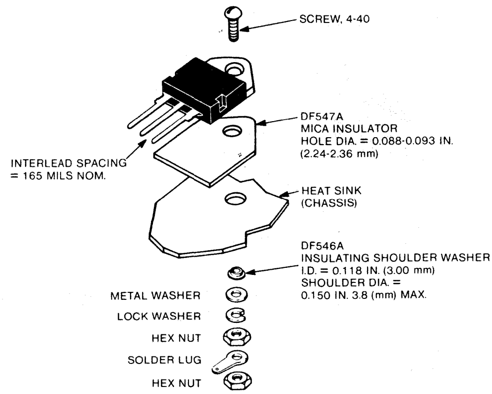
TO-213AA



Note: Maximum torque applied to mounting flange is 12 in.-lb. (0.14 kgfm)

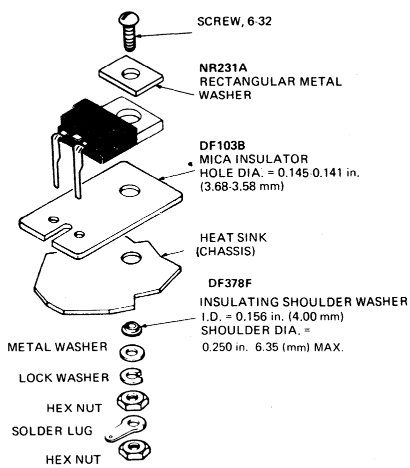
92CS-22560R5

TO-218AC



92CS-39588

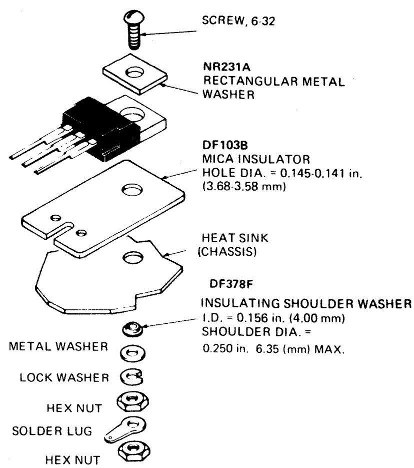
TO-220AA



NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in.-lb. (0.09 kgf·m)

92CS-40181

TO-220AB



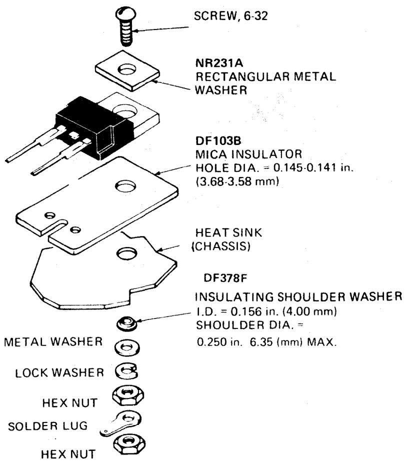
NOTE: MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in. lb. (0.09 kgf m)

92CS-39586

7

Suggested Hardware and Mounting Arrangements

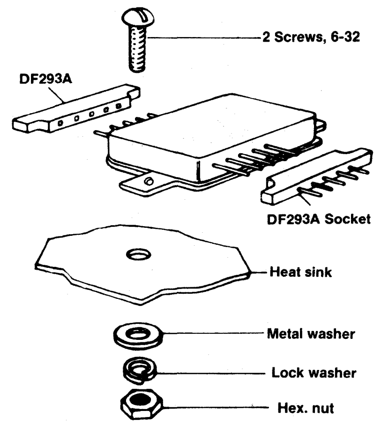
TO-220AC



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in. lb. (0.09 kgf m)

92CS-39587

POWER HYBRID CIRCUIT PACKAGE

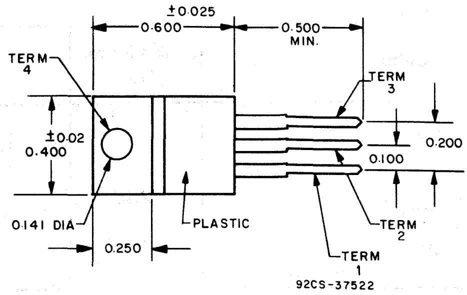


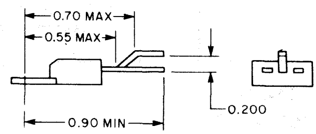
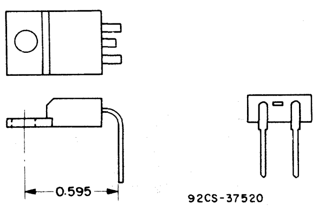
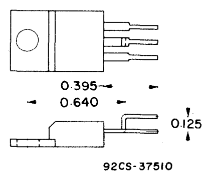
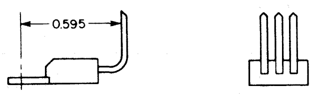
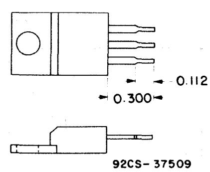
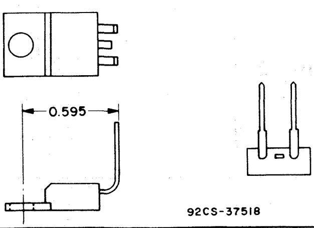
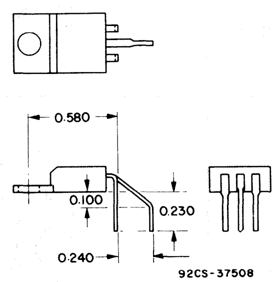
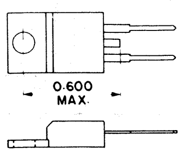
Note: Maximum torque applied to mounting flange is 24 in-lb (0.3 kgf-m).
DF293A is a socket to enable simple connection of this module.

92CS-27782R1

Lead Forms for Plastic Power Packages

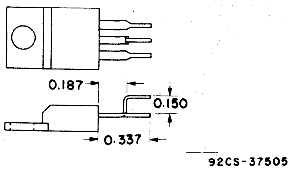
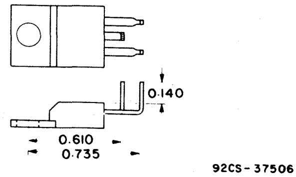
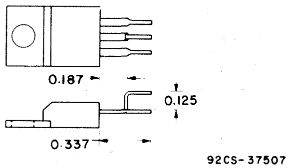
TO-220
VERSAWATT



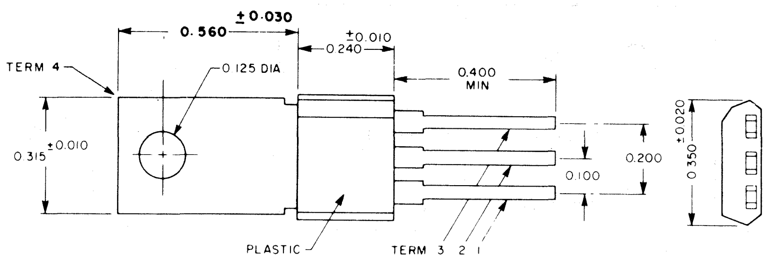
Lead Form No.	Outline	Lead Form No.	Outline
6200		6226	
6201		6255	
6203		6258	
6204		6261	
6206			

Lead Forms for Plastic Power Packages

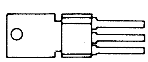
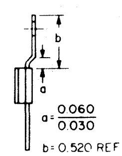
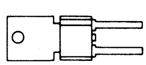
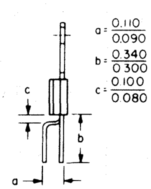
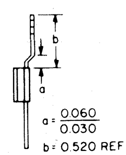
TO-220
VERSAWATT (Cont'd)

Lead Form No.	Outline	Lead Form No.	Outline
6263		6265	
6264			

TO-202
VERSATAB

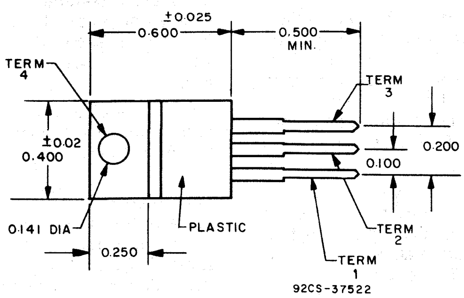


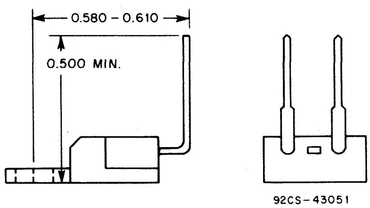
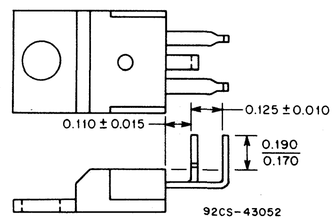
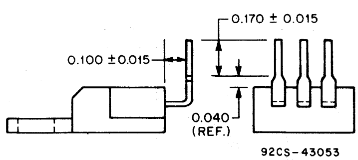
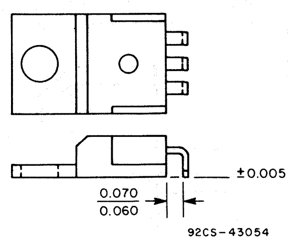
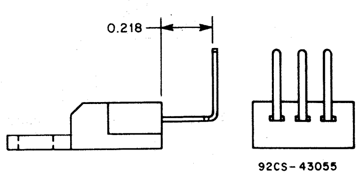
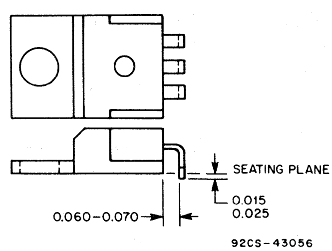
Top View

Lead Form No.	Outline	Lead Form No.	Outline
Type 1		Type 12	
Type 3			
Type 11		Type 32	

Surface-Mount Lead Forms

TO-220
VERSAWATT



Lead Form No.	Outline	Lead Form No.	Outline
DR 6204		DR 6269	
DR 6259		DR 6274	
DR 6260		DR 6280	

7

Surface-Mounted Devices Mounting and Handling Considerations

General — Since the external epoxy portions of the TO-251AA and TO-252AA surface-mounted devices are much smaller than on conventional transistor packages, these devices are often more susceptible to high-temperature/high-humidity conditions. Thus, these surface-mounted devices should be coated or encapsulated when used in high-temperature/high-humidity environment.

Preheating — Both TO-251AA and TO-252AA "D-Pak" transistors must be preheated prior to being mounted on circuit boards. There are several methods of preheating, including use of an infrared heat panel, parabolic infrared lamp, or hot air circulation. Preheat the devices at 100-150°C for two minutes, raising the temperature as gradually as possible, since the device pellets may be damaged by an abrupt thermal shock.

Soldering — Both TO-251AA and TO-252AA transistors are specified for 250°C solder temperature for 20 seconds duration. It is important to use a solder with a melting temperature of 190°C or lower. In general, soldering conditions range from 220-240°C for 3-5 seconds.

When using molten solder in the metal mask method, avoid uneven printing and deformation. Recommended uniform solder printing thickness is at least 200μm to ensure lead wire solderability.

When using a soldering iron to mount a device to the circuit board, care should be taken to avoid damage and/or dislocation of the device. (For this reason, soldering irons are recommended only for experimental or repair work.) For proper bonding, the soldering iron tip should be 1mm or less in diameter, and 250°C for 3 seconds or less. Never touch the epoxy package with the soldering iron.

Figures 1 and 2 show the relationship between soldering temperature and preheating time for various device mounting procedures.

Flux removal — After surface-mounted devices have been soldered to the circuit board/substrate, excess flux must be removed to prevent corrosion of the device and lead wires. Organic flux may be removed by rinsing; but inorganic flux must be cleaned with an olefin cleaner such as Freon TE or Di-Freon Solvent S3-E.

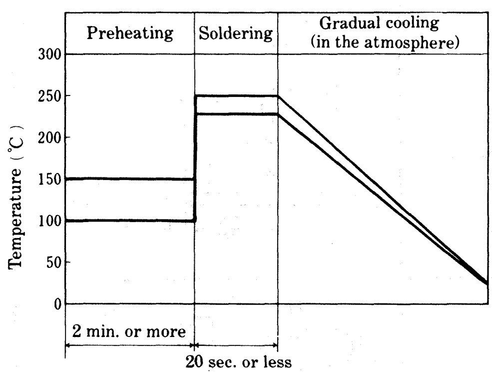


Fig. 1 — Solder dip method.

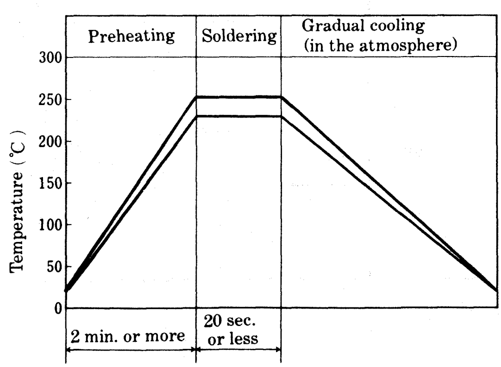


Fig. 2 — Reflow solder method.

Surface-Mounted Devices Power Dissipation Considerations

Maximum power dissipation for the TO-251AA is 1W; however, when the TO-252AA is mounted directly to a ceramic substrate, the power dissipation is increased to 2-3W. Figure 3 illustrates the maximum power dissipation for either the D72F5T1 or the D73F5T1 transistor mounted to a ceramic substrate.

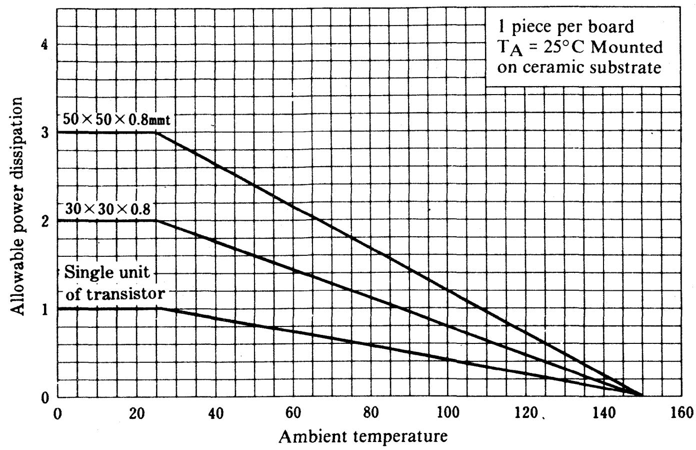


Fig. 3 — $P_{D(max)}$ vs. T_A characteristics of either the D72F5T1 or D73F5T1 transistor mounted on a ceramic substrate.

Certain circuit designs (such as motor drives and flash circuits) require devices to be rated for transient conditions as well as for their overall power dissipation capability. The relationship between maximum power dissipation and pulse width under transient conditions for typical TO-251AA devices is shown in figure 4.

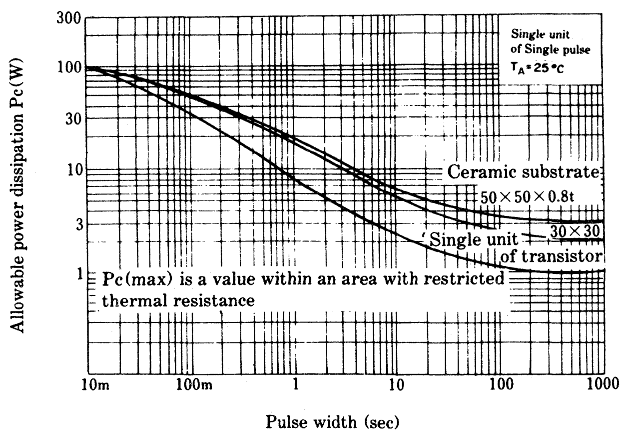


Fig. 4 — P_D vs. T_A characteristics of D72F5T1 and D73F5T1 under transient conditions.

7

Application Notes

8

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 methods exist to evaluate it. The method pr this Note allows description of the safe oper for both dc and pulse operation without : the transistor to breakdown. Botn n-p-n : transistors in hermetic or plastic packag evaluated, and the complete safe-area cur automatically described in a short time.

AN-6605 ....
Application of RCA Power Devices In High-Frequency Inverter/Converter C
The current trend in power inverter design is to use high-frequency switching and direct operation off the available utilit 110 or 220 volts). The use of higher ope quencies reduce the magnetic materials re the size of the filter capacitors. This Not the use of RCA power transistors and selected high-frequency inverter/converter ap

AN-6624 ....
Voltage Limitations of Power Transist
This Note summarizes the primary fa determine the voltage limitations of power used in common-emitter circuits with typic emitter circuit terminations. The material defines terms and the various operating reg transistor as shown in typical volt-ampe teristics, develops the analytic relation operation in each of the regions, and relat the operating regions to the physical actic place within the transistor structure.

AN-6679 ....
Theoretical Relationships in Ca Discharge Ignition Systems
There has been both confusion and exa concerning the electrical performance of c discharge, or CD, ignition systems. The t relationships developed in this Note allow sis of the fundamentals of this type of igniti and an evaluation of the maximum per levels attainable. Three types of systems, t clamped system, the free-ringing system (clamp) and the free-ringing single-cycle s analyzed and compared.

AN-6688 ....
A Practical Approach to an Audio-A Design
This Note discusses general consideratio requirements, and performance for a 20-v amplifier.

AN-6741 ....
RCA 15-Ampere SwitchMax Power Tra In a 340-Watt 20kHz Flyback Converter
This Note describes the use of the RCA 2 15-ampere SwitchMax power transistor, as pulse-width-modulated fly-back-converter s final power-output stage, in a 20-kHZ off-li converter that provides 340 watts of outpu Adjunct circuitry, such as the driver stage, bias amplifier, and overvoltage and ov protection circuits, are also discussed.

Application Note Abstracts

Transistors

| .... 16 pages
lt, Off-the-Line, Half-Bridge Converter nly Two 15-Ampere 'SwitchMax' High-Power Transistors
amine and demonstrate the capabilities of ew series of 'SwitchMax' power transistors ical switching application, a 900-watt half-onverter was constructed and studied. The switches at a 20-kilohertz rate and with alterations can operate from either 120 or s. It was built using conventional circuitry but -compact modular format so that it would be cessible for instrumentation connections and ent or design alteration. The power switches the RCA-2N6678 'SwitchMax' 15-ampere t)] 450-volt (V_{CEX}) high-speed transistors.

4 .... 6 pages
ost High-Power Audio Amplifiers Using A 8638 and RCA 9116 Transistor Families
Note discusses the basic considerations and nents for design of the output stage for class io amplifiers using devices selected from the 538 and RCA9116 families, depending on the desired. Operation with load impedances an eight ohms is also discussed for the various ategories.

0 .... 12 pages
Watt, 40-kHz, Off-Line Forward Converter One SwitchMax Transistor
increased availability of reliable high-current, ltage, fast switches, such as RCA's Switch-ries devices, and the development of function-e-width-modulating integrated circuits have reduced the cost of the off-line medium-high-frequency forward converters used in the tion of precisely conditioned low-voltage This Note describes the possibilities of the d-converter circuit and demonstrates the per-ce of the RCA 2N6673 SwitchMax transistor 0-watt 15-volt 15-ampere off-line converter ng at 40 kHz from a 120-volt 60-cycle line.

00 .... 6 pages
t Set for Measuring h_{fe} and f_T as a on of Collector Current
Application Note describes a technique and cuit, the Swept-I_C Test Set, that measures the racteristic of a power transistor at a fixed test ncy while the collector current, I_C, is "swept," ed, repetitively, at a linear rate, from zero to a ermined maximum.

19 .... 8 pages
witchMax Transistor
SwitchMax transistor families, designed for equency off-line switching power supplies, con-s, switching regulators and pulse-widthmod-amplifiers, are rated for 5, 10, 15, and 25-e operating currents. They have high safe-ing-area (SOA) ratings in both the forward-bias ductive turn-off (clamped $E_{S/b}$) modes. These ilities are combined with V_{CEO} ratings of up to lts, 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.