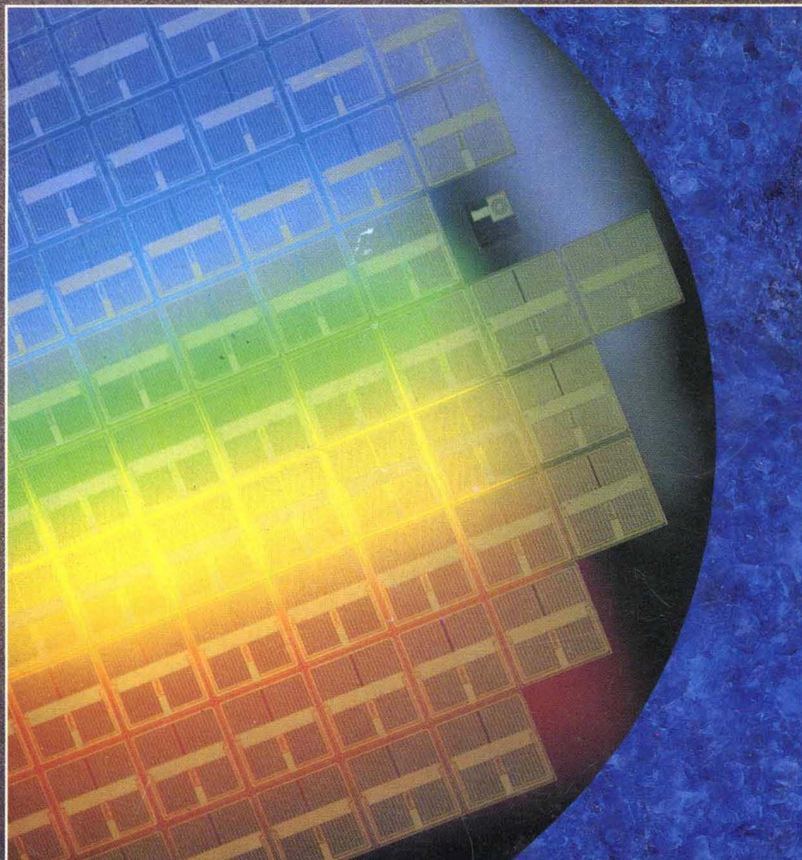
Bipolar Power Transistors

HARRIS



Bipolar Power Transistors

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Separate data sections provide definitive ratings and characteristics for each major category of devices. Data pages for individual devices are organized in numeric-alphanumeric sequence for each section. Because some devices are grouped together to show similarity of function or data, some individual types numbers may be out of sequence. If you have difficulty finding a type number check the Index of Devices, Section 1.

For complete, current and detailed technical specifications on any Harris device please contact the nearest Harris sales, representative or distributor office. See complete worldwide listing in Section 6, page 6-2.

For general information regarding Harris Semiconductor and its products, call 1-800-4-HARRIS

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Shinjuku-ku, Tokyo 163-08 Japan
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BIPOLAR POWER TRANSISTORS

Harris Semiconductor offers an extensive line of bipolar power transistors 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. 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-alpha numeric 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 Section 1, Index to Devices.

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

It is our intention to provide you with the most up-to-date information on Bipolar Power Devices. For complete, current and detailed technical specifications on any Harris devices please contact the nearest Harris sales, representative or distributor office listed in Section 6.

HARRIS
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BIPOLAR POWER TRANSISTORS

BIPOLAR POWER TRANSISTORS TECHNICAL ASSISTANCE

For technical assistance on the Harris products listed in this databook, please contact the Field Applications Engineering staff available at one of the following Harris Sales Offices:

UNITED STATES		
CALIFORNIA	Costa Mesa	714-433-0667
	San Jose	408-922-0977
	Woodland Hills	818-992-0686
FLORIDA	Melbourne	407-724-3551
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JAPAN	Tokyo	81-3-345-8911
KOREA	Seoul	82-2-551-0931
UNITED KINGDOM	Camberley	44-2-766-86886

Index to Devices

1

INDEX TO DEVICES

Index to Devices

Index to Devices (Continued)

Power Transistors
Technical Data

Medium-Power Silicon N-P-N Transistors

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

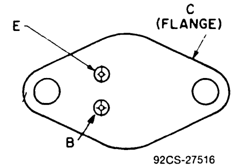
Features:

- *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

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:													
* With base open	I_{CEO}	100				0	–	5	–	–	–	–	
		130				0	–	–	–	–	–	1	mA
		140				0	–	–	–	100	–	–	
Collector-Cutoff Current: With base-emitter junction reversed biased	I_{CEX}	120		–1.5			–	2*	–	–	–	–	mA
		140		–1.5			–	–	–	5*	–	–	
		140		–1.5			–	–	–	1	–	–	
		150		–1.5			–	–	–	–	–	0.05*	
	I_{CEX} (T_C = 150°C)	120		–1.5			–	10*	–	–	–	–	
		140		–1.5			–	–	–	6*	–	–	
		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] * With base open	$V_{CEO}(sus)$				0.1	0	120	–	140	–	150	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.1		130	–	150	–	160	–	V
With base-emitter junction reversed biased	$V_{CEV}(sus)$			–1.5	0.1		140	–	160	–	170	–	V
* DC Forward-Current Transfer Ratio	h_{FE}	2			1		–	–	–	–	20	60	
		2			3		3	–	–	–	5	–	
		4			0.5		20	100	25	100	–	–	
		4			2.7		–	–	5	–	–	–	
Collector-to-Emitter Saturating Voltage	$V_{CE}(sat)$				0.5	0.05	–	1.2*	–	1	–	–	V
					1	0.1	–	–	–	–	–	0.5*	
					2.7	0.9	–	–	–	6*	–	–	
Base-to-Emitter Voltage	V_{BE}	2			1		–	–	–	–	–	1.5*	V
		4			0.5		–	2*	–	1.7	–	–	
		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 Forward Current Transfer Ratio (f = 1 kHz)	h_{fe}	4			0.1		25	–	–	–	25	–	
		4			0.5		–	–	15	75	–	–	
Forward-Bias Second Breakdown Collector Current, Pulse Duration (non-repetitive) = 1 s	$I_{S/b}$	120					0.167	–	–	–	–	–	A
		120					–	–	–	–	0.417	–	
		120					–	–	0.21	–	–	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$						–	8.75	–	7	–	3.5	°C/W

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

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

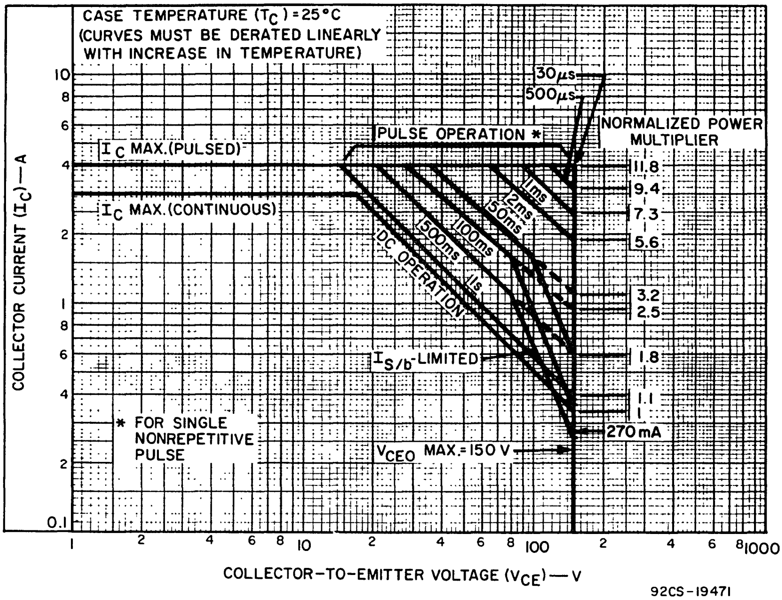


Fig. 1 — Maximum operating areas for type 2N6264.

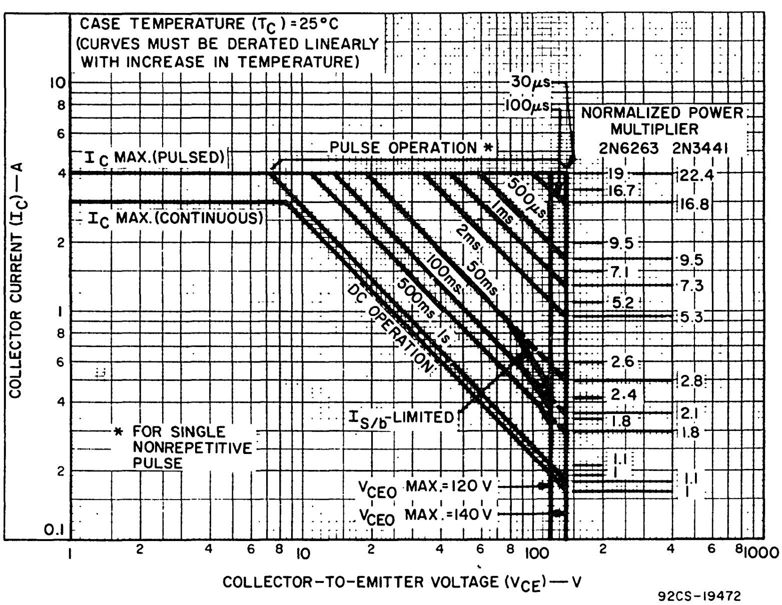


Fig. 2 — Maximum operating areas for types 2N6263 and 2N3441.

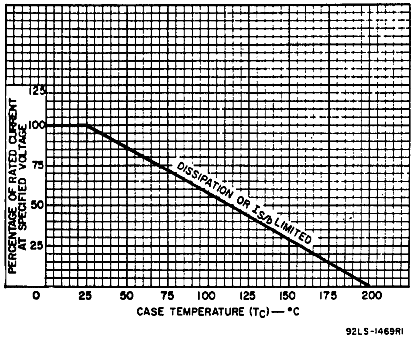


Fig. 3 — Current derating curve for all types.

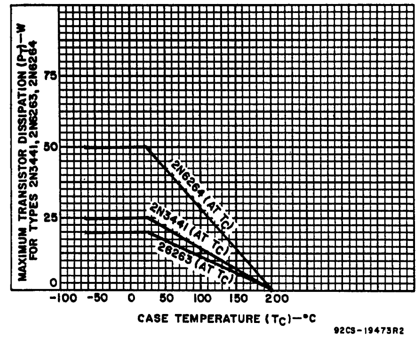


Fig. 4 — Dissipation derating curves for all types.

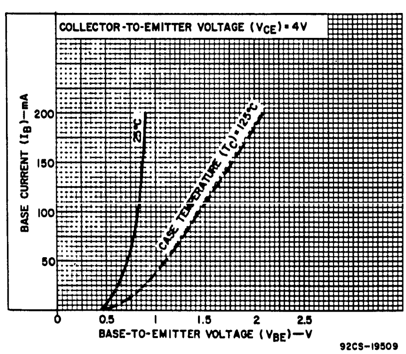


Fig 5 — Typical input characteristics for type 2N6264.

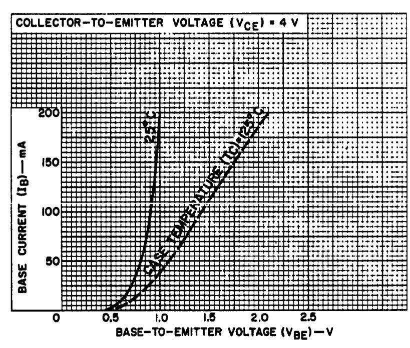


Fig. 6 — Typical input characteristics for type 2N3441.

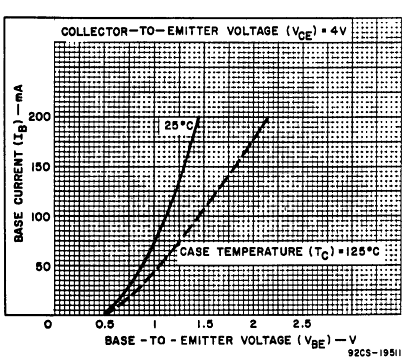


Fig. 7 — Typical input characteristics for type 2N6263.

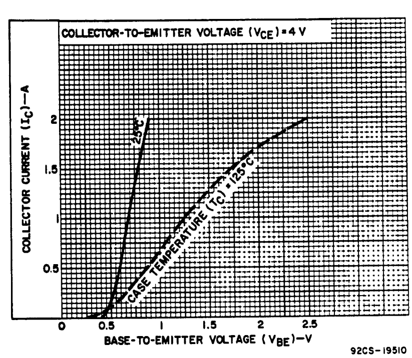


Fig. 8 — Typical transfer characteristics for type 2N6264.

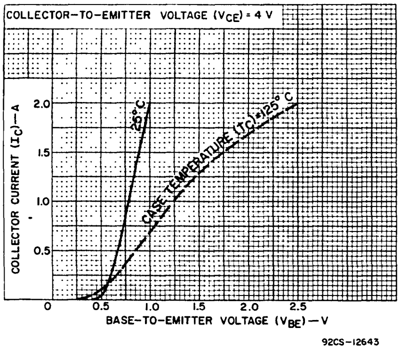


Fig. 9 — Typical transfer characteristics for type 2N3441.

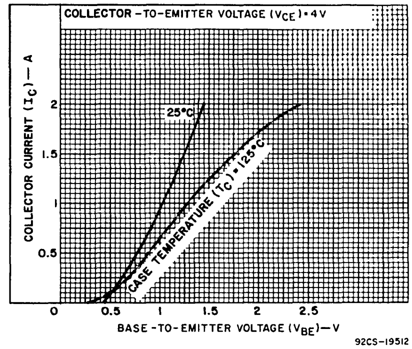


Fig. 10 — Typical transfer characteristics for type 2N6263.

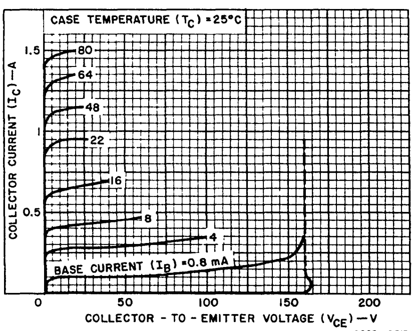


Fig. 11 — Typical output characteristics for type 2N6264.

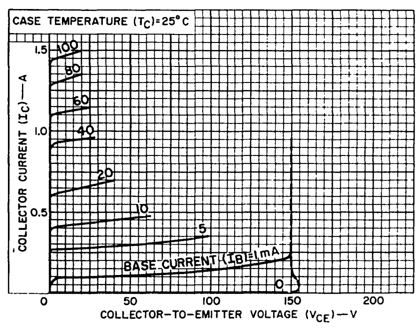


Fig. 12 — Typical output characteristics for type 2N3441.

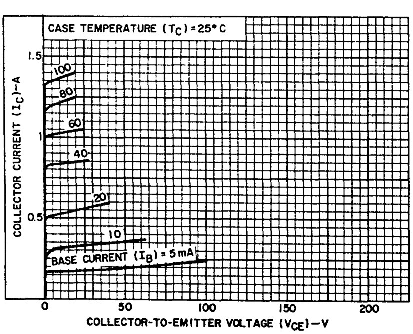


Fig. 13 — Typical output characteristics for type 2N6263.

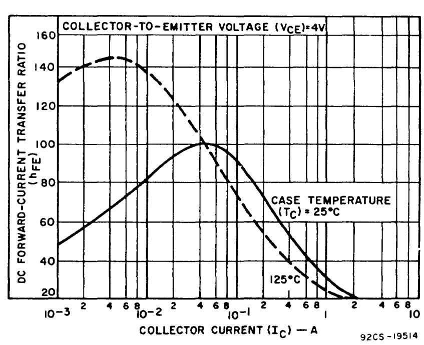


Fig. 14 — Typical dc beta characteristics for type 2N6264.

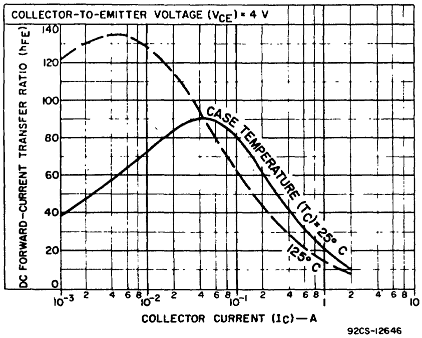


Fig. 15 — Typical dc beta characteristics for type 2N3441.

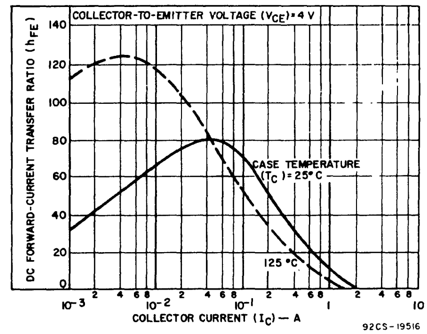


Fig. 16 — Typical dc beta characteristics for type 2N6263.

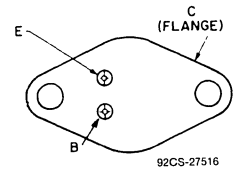
High-Voltage Silicon N-P-N Transistors

High-Power Devices for Applications in Industrial and Commercial Equipment

Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N3442 and 2N4347 are silicon n-p-n transistors intended for a wide variety of high-power, high-voltages 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	
*V_{CBO}	140	160	V
*V_{CEO}	120	140	V
V_{CEX} (V_{BE} = −1.5 V)	140*	160	V
*V_{EBO}	7	7	V
*I_C			
Continuous	5	10	A
Peak	10*	15	A
*I_B			
Continuous	3	7	A
Peak	8*	—	A
*P_T			
At T_C up to 25°C	100	117	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).

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

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

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

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

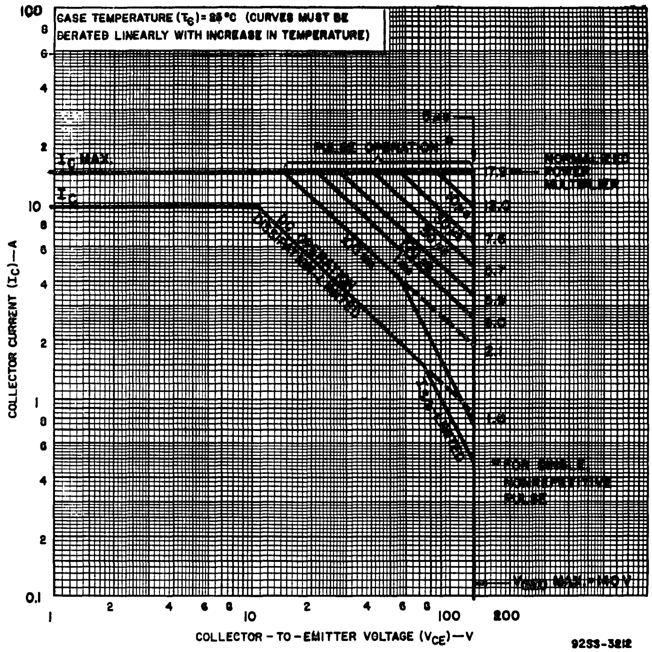


Fig. 1 - Maximum operating areas for type 2N3442.

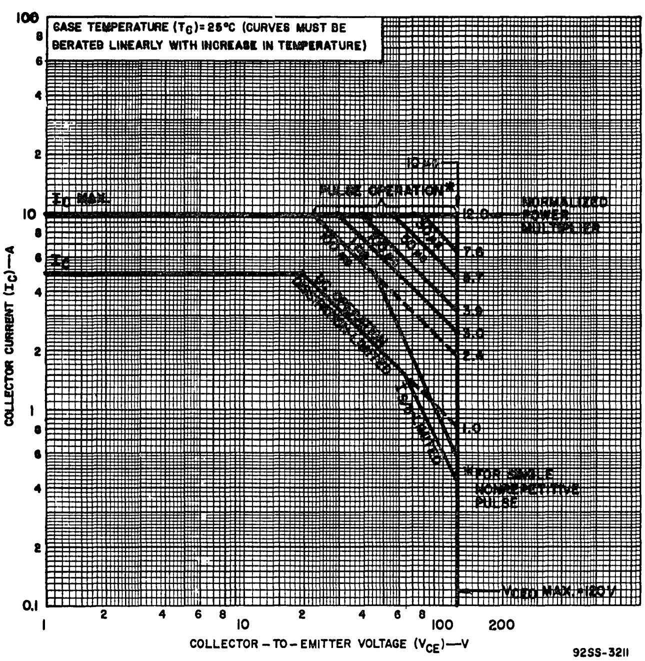


Fig. 2 - Maximum operating areas for type 2N4347.

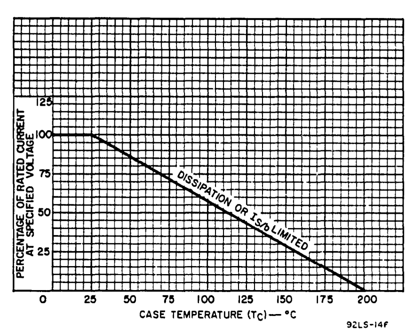


Fig. 3 - Current derating curve for all types

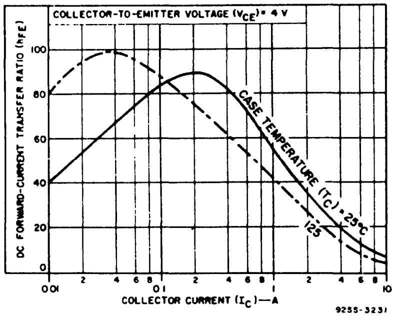


Fig. 4 - Typical dc beta characteristics for type 2N3442.

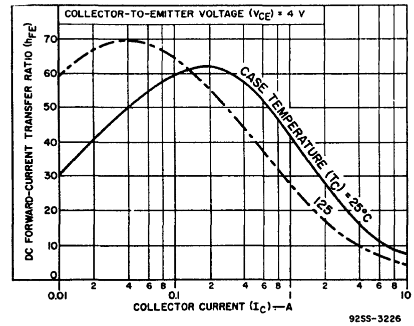


Fig. 5 - Typical dc beta characteristics for type 2N4347.

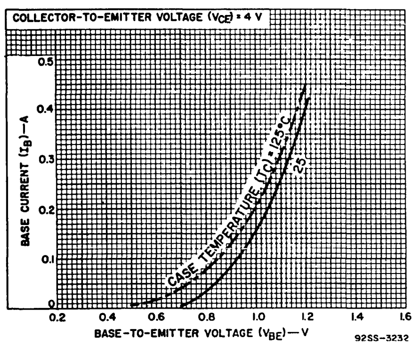


Fig. 6 - Typical input characteristics for type 2N3442.

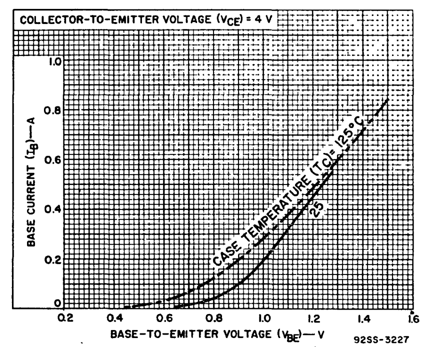


Fig. 7 - Typical input characteristics for type 2N4347.

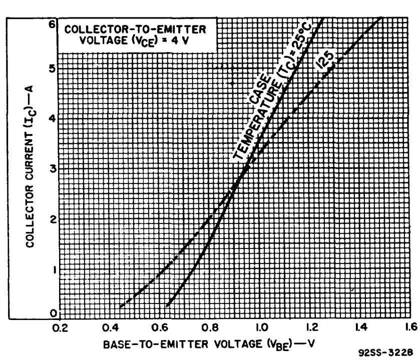


Fig. 8 - Typical transfer characteristics for type 2N3442 and 2N4347.

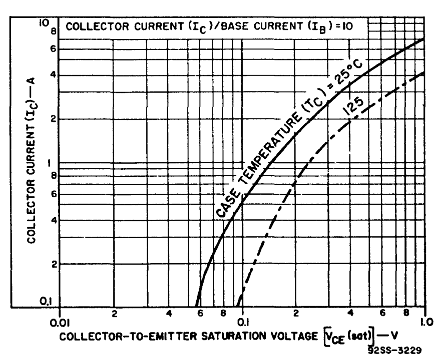


Fig. 9 - Typical saturation-voltage characteristics for all types.

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

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

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

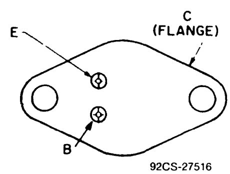
Typical applications for these transistors include high-voltage operational amplifiers, high-voltage switches, switching regulators, converters, inverters, deflection and hi-fi amplifiers.

These transistors are also intended for a wide 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).

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:																	V
* With base open	V_{CEO}(sus)					200		0	175●	–	250●	–	300●	–	300●	–	
With external base-to-emitter resistance (R_{BE}) = 50Ω	I_{CER}		250						–	1.0	–	–	–	–	–	–	mA
			300						–	–	–	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%.

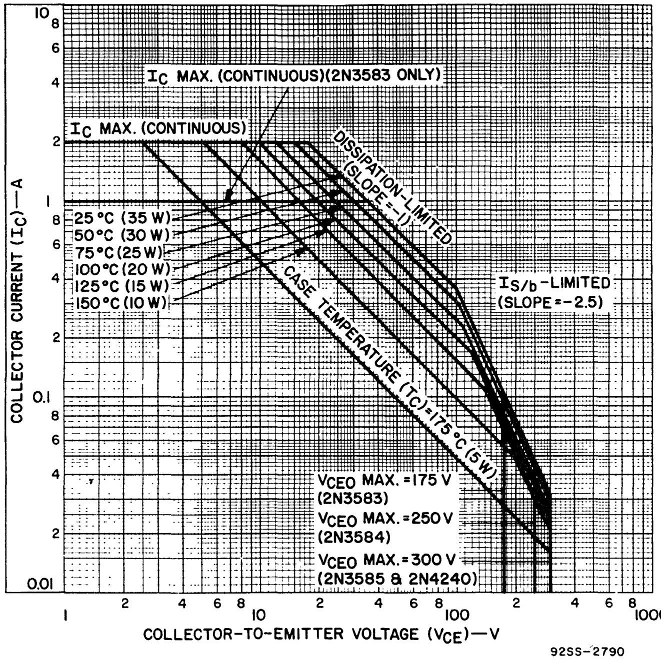


Fig. 1 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (dc conditions).

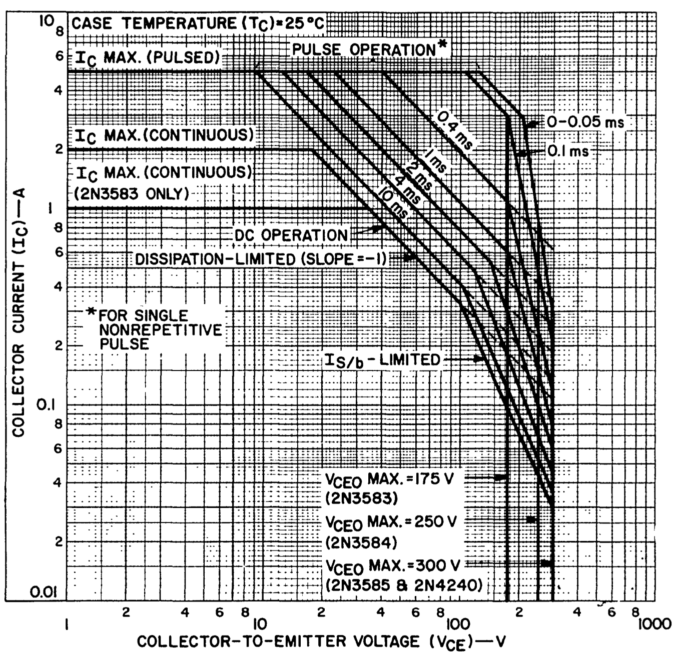


Fig. 2 - Maximum operating areas for types 2N3583, 2N3584, 2N3585, and 2N4240 (pulse conditions).

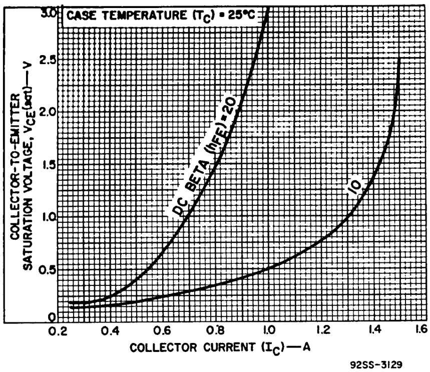


Fig. 3 - Typical collector-to-emitter saturation voltage vs. current for types 2N3584 and 2N3585.

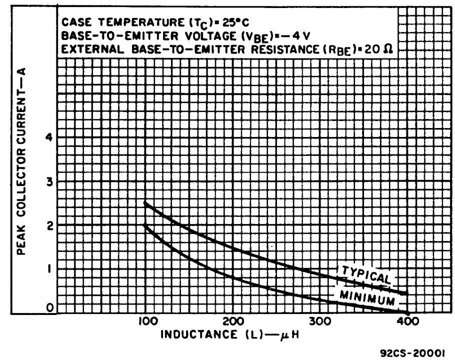


Fig. 4 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

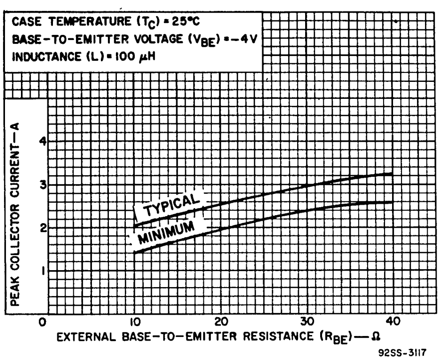


Fig. 5 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

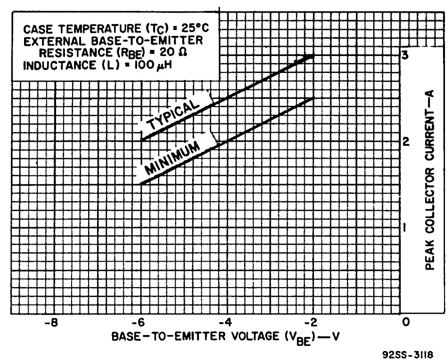


Fig. 6 - Reverse-bias second breakdown characteristics for types 2N3584 and 2N3585.

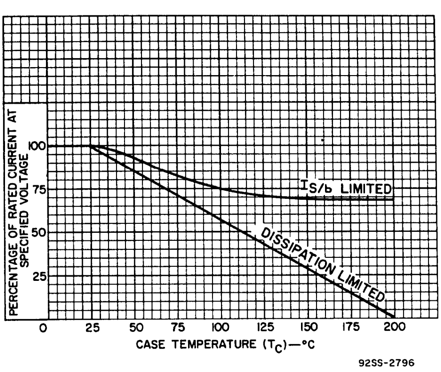


Fig. 7 - Dissipation derating curves for all types.

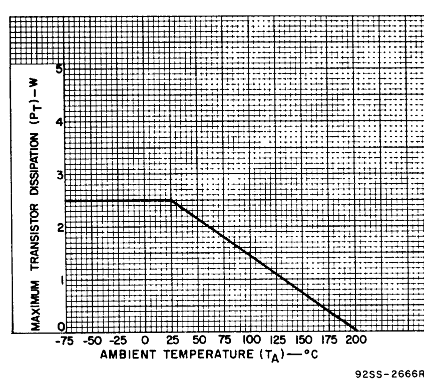


Fig. 8 - Dissipation derating curve for types 2N3583, 2N3584, 2N3585, and 2N4240.

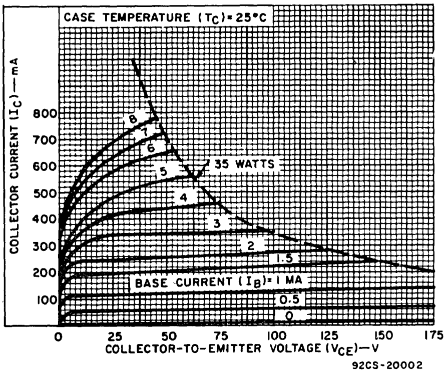


Fig. 9 - Typical output characteristics for type 2N3583.

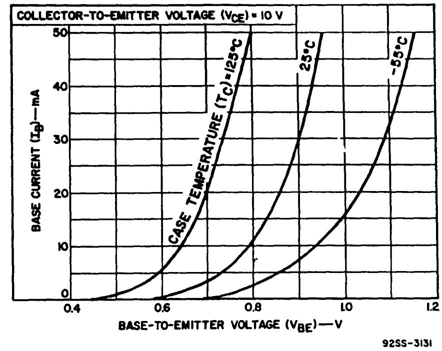


Fig. 10 - Typical input characteristics for all types.

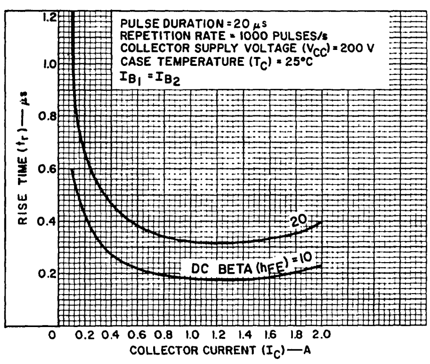


Fig. 11 - Typical rise time vs. collector current for types 2N3584 and 2N3585.

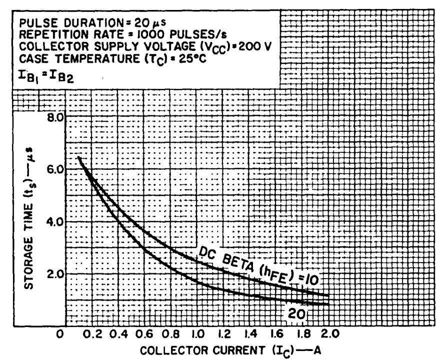


Fig. 12 - Typical storage time vs. collector current for types 2N358 and 2N3585.

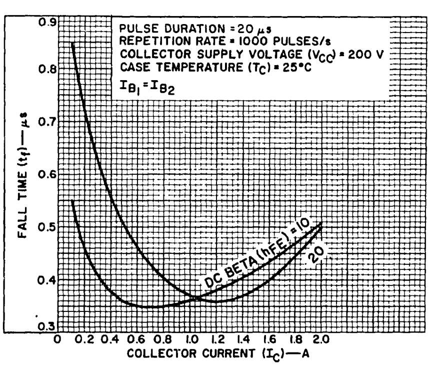


Fig. 13 - Typical fall time vs. collector current for types 2N3584 and 2N3585.

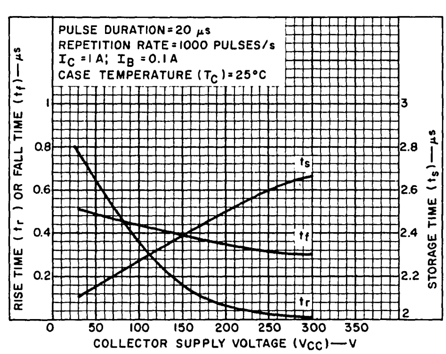


Fig. 14 - Typical rise time, fall time, and storage time vs. collect supply voltage for types 2N3584 and 2N3585.

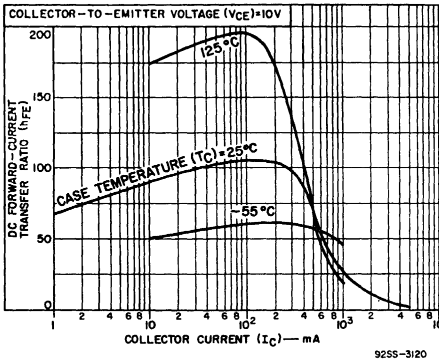


Fig. 15 - Typical dc beta vs. collector current for types 2N3583, and 2N4240.

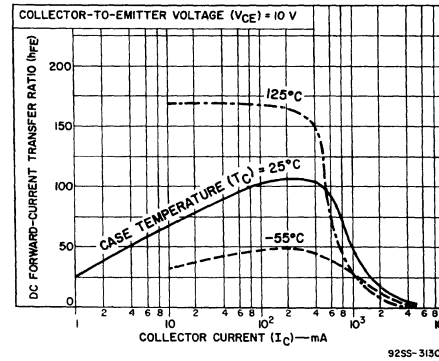


Fig. 16 - Typical dc beta vs. collector current for types 2N3584 and 2N3585.

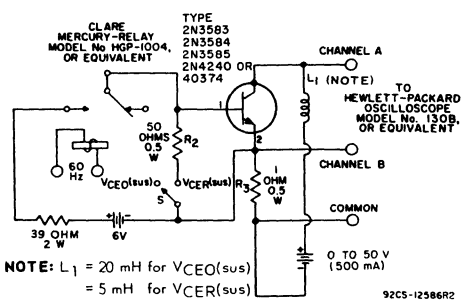
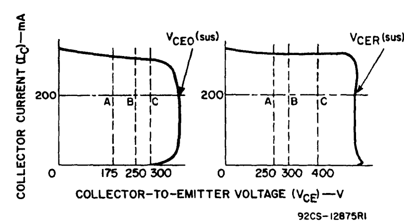


Fig. 17 - Circuit used to measure sustaining voltages V_{CEO}(sus) and V_{CER}(sus) for all types.



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

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

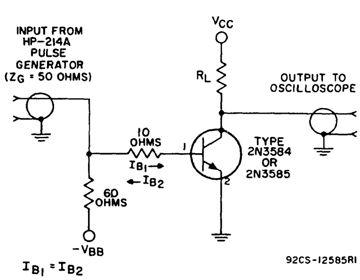


Fig. 19 - Circuit used to measure switching times for types 2N3584 and 2N3585.

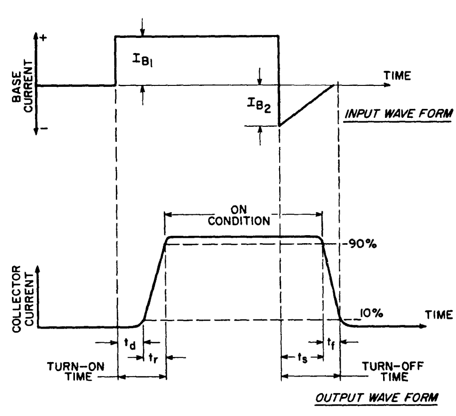


Fig. 20 - Phase relationship between input and output currents, showing reference points for specification of switching times.

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

For High-Speed Switching and Linear-Amplifier Applications

Features:

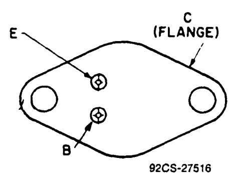
- *Maximum-area-of-operation curves for dc and pulse operation*
- *High substaining voltage*
- *Total saturated transition time less than 1 μs for 2N3879, 2N5202*

The 2N3878, 2N3879 and 2N5202* are epitaxial silicon n-p-n transistors. The 2N3878 is an amplifier type intended for audio-, ultrasonic-, and radio-frequency circuits. Types 2N3879 and 2N5202 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 and TA7285, respectively.

TERMINAL DESIGNATIONS



JEDEC TO-213AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N3878	2N3879	2N5202	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	120	120	100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:					
With external base-to-emitter resistance (R_{BE}) = 50 Ω.	$V_{CER}(sus)$	65	90	75*	V
With base open	$V_{CEO}(sus)$	50*	75*	50	V
*EMITTER-TO-BASE VOLTAGE	V_{EBO}	7	7	6	V
*CONTINUOUS COLLECTOR CURRENT	I_C	4	7	4	A
PEAK COLLECTOR CURRENT	I_{CM}	10	10	5	A
*CONTINUOUS BASE CURRENT	I_B	4	5	2	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		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	°C

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

2N3878, 2N3879, 2N5202

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_{BE}	TEST CONDITIONS CURRENT A dc I_C	TEST CONDITIONS CURRENT A dc I_B	LIMITS 2N3878 Min.	LIMITS 2N3878 Max.	LIMITS 2N3879 Min.	LIMITS 2N3879 Max.	LIMITS 2N5202 Min.	LIMITS 2N5202 Max.	UNITS
* Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}	100 110 120	−1.5 0 −1.5			– – –	– – 25	– – –	– – 25	– – –	10 – –	mA
* With base-emitter junction reverse-biased and T_C = 150°C	I_{CEV}	100 110	−1.5 0			– –	4 –	– –	4 –	– –	10 –	mA
With base open	I_{CEO}	40 70			0 0	– –	5* –	– –	5 –	– –	– –	mA
* Emitter Cutoff Current	I_{EBO}		−6 −7			– –	– 10	– –	– 10	– –	10 –	mA
Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO(sus)}$			0.2	0	50*[a]	–	75*[a]	–	50[a]	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER(sus)}$			0.2	0	65[a]	–	90[a]	–	75[a]	–	V
DC Forward-Current Transfer Ratio	h_{FE}	1.2 2 2 2 5 5		4[b] 0.5[b] 3[b] 4[b] 4[b] 0.5[b]		– 40* – 8* 20* 50*	– 200* – – – 200*	– – – 12* 20 40	– – – 100* 80 –	10* – – – – –	100* – – – – –	
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			3[b] 4[b]	0.3 0.4	– –	– 2	– –	– 1.2	– –	– 1.2	V
* Base-to-Emitter Voltage	V_{BE}	2		4[b]	–	–	2.5	–	–	–	–	V
* Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$			3[b] 4[b]	0.3 0.4	– –	– –	– –	– 2	– –	– 2	V
Collector-to-Base Output Capacitance (f = 1 MHz, V_{CB} = 10 V)	C_{ob}					–	175*	–	175	–	175	pF
Second Breakdown Collector Current: With base forward-biased and 1-s nonrepetitive pulse	$I_{S/b}$	40				750	–	500	–	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	–	
* 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	°C/W

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

[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 %.

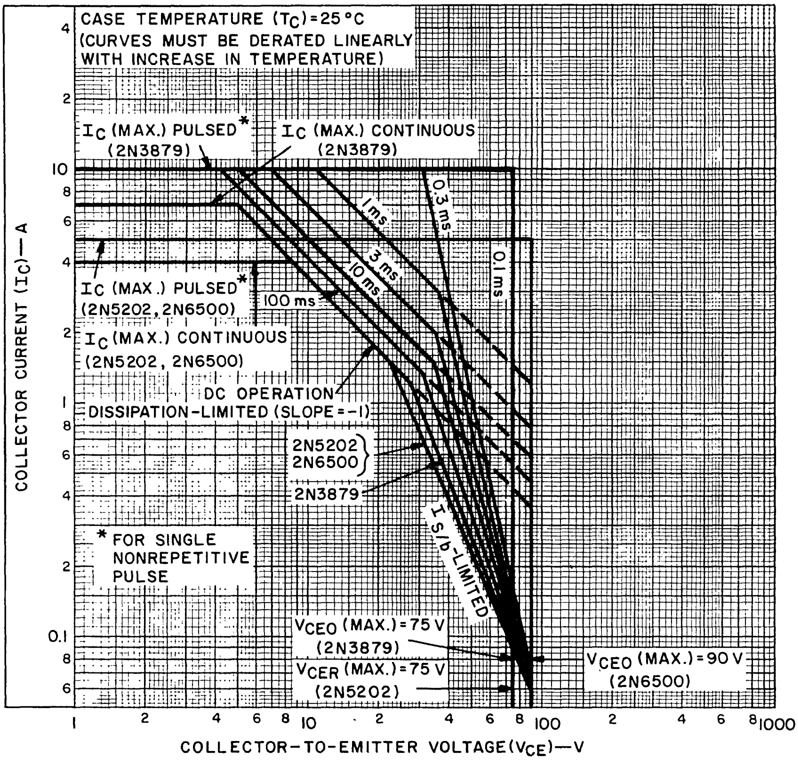


Fig. 1 – Maximum operating areas for 2N3879, 2N5202

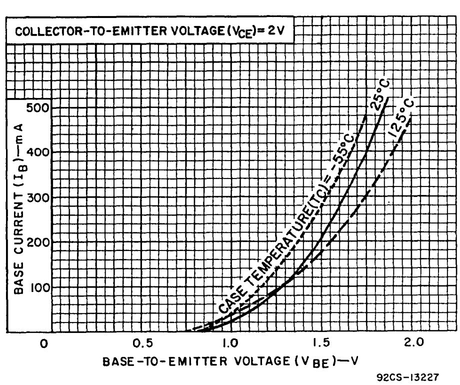


Fig. 2 – Typical input characteristics for all types.

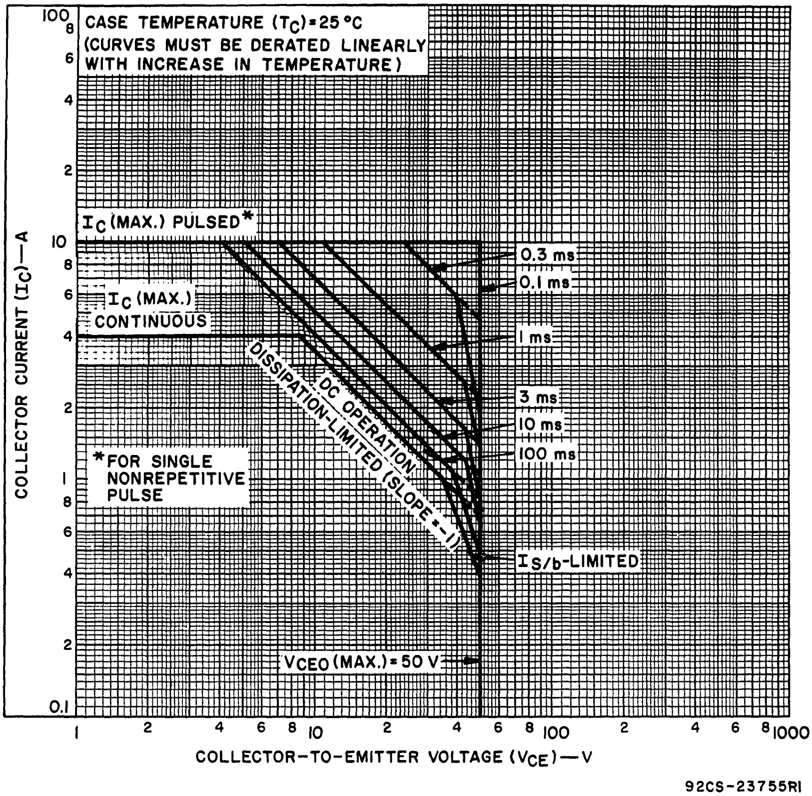


Fig. 3 - Maximum operating areas for 2N3878.

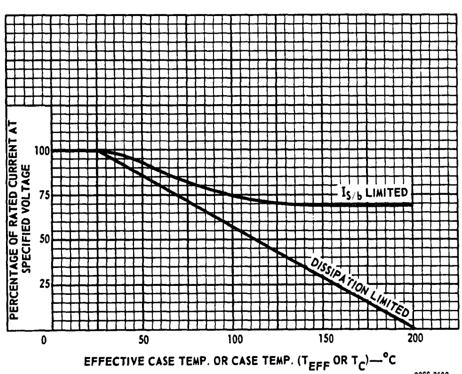


Fig. 4 - Dissipation derating for all types.

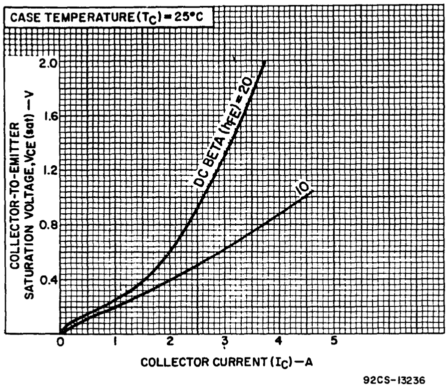


Fig. 5 – Typical saturation-voltage characteristics for 2N3878, and 2N3879.

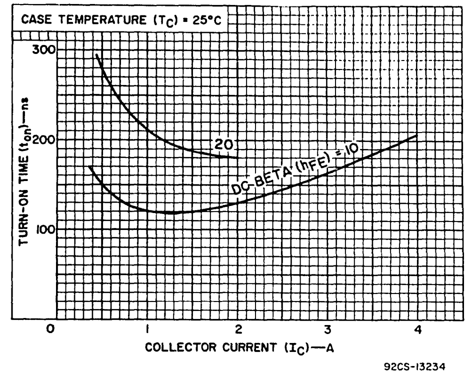


Fig. 6 – Typical turn-on time for 2N3879, 2N5202.

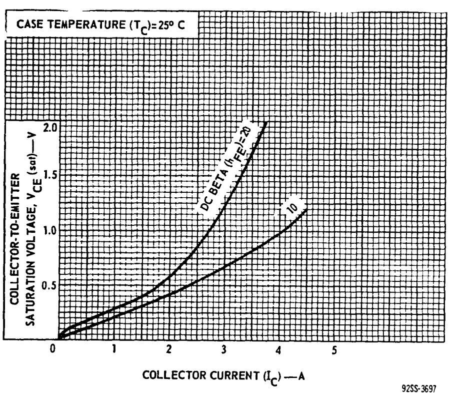


Fig. 7 – Typical saturation-voltage characteristics for 2N5202.

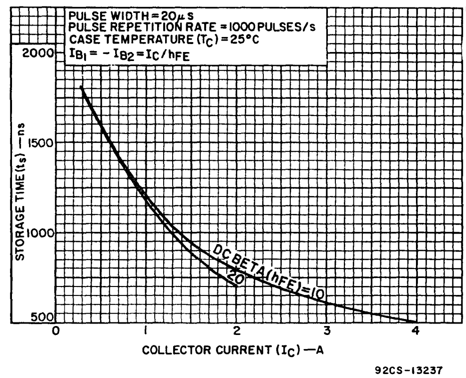


Fig. 8 – Typical storage time for 2N3879, 2N5202

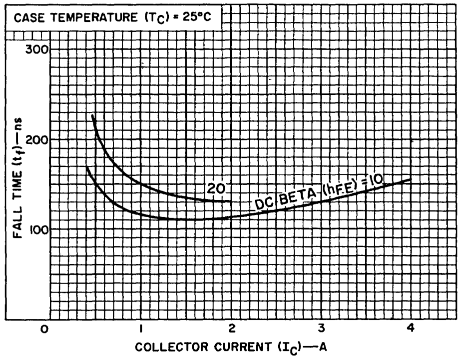


Fig. 9 - Typical fall time for 2N3879, 2N5202.

2 POWER TRANSISTORS

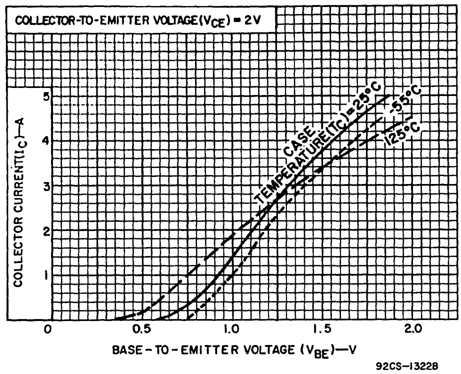


Fig. 10 - Typical transfer characteristics for all types.

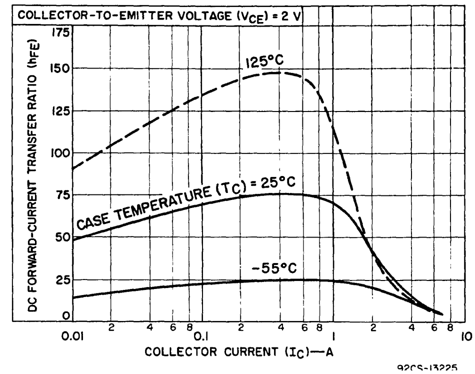


Fig. 11 - Typical dc beta characteristics for 2N3878 and 2N3879.

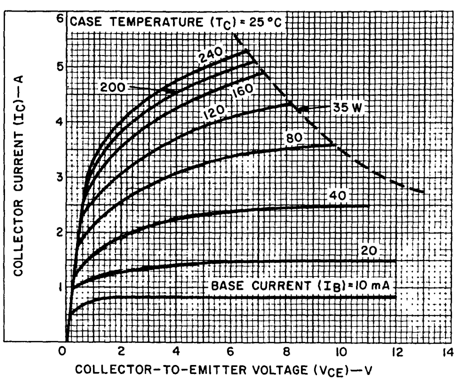


Fig. 12 - Typical output characteristics for 2N3878, 2N3879 and 2N5202.

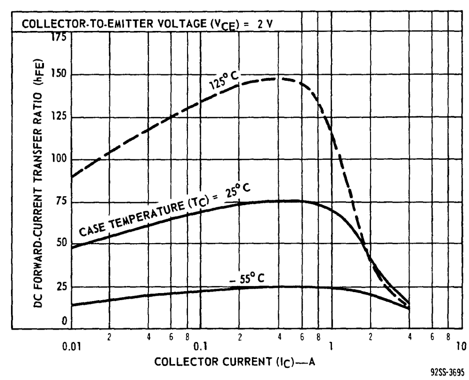


Fig. 13 - Typical dc beta characteristics for 2N5202.

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

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

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

[a] $I_{B1} = I_{B2}$

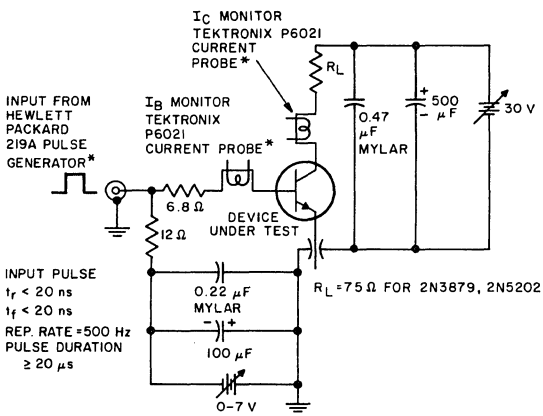


Fig. 14 - Circuit used to measure switching times for 2N3879 and 2N5202.

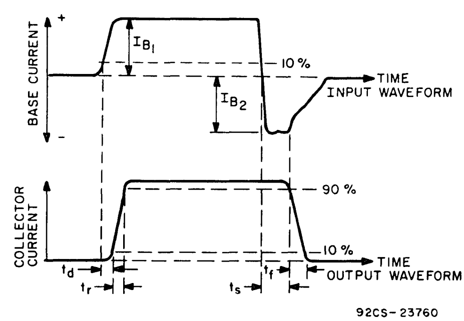


Fig. 15 - Oscilloscope display for measurement of switching times (Circuit shown in Fig. 1).

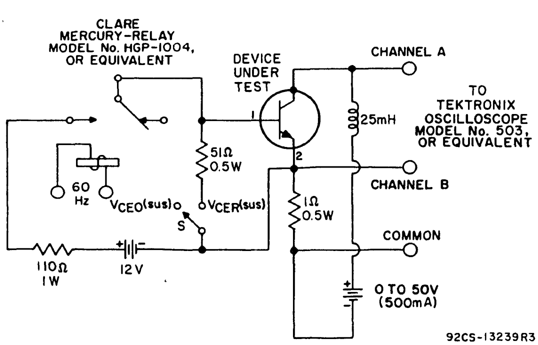
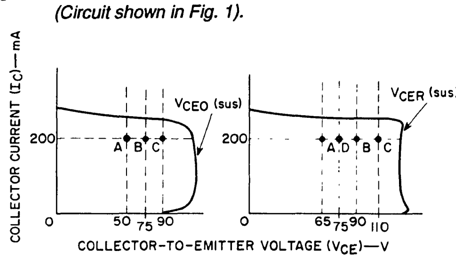


Fig. 16 - Circuit used to measure sustaining voltages, V_{CEO}(sus) and V_{CER}(sus) for all types.



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; and point "B" for type 2N3879. The sustaining voltage V_{CER}(sus) is acceptable when the trace falls to the right and above point "D" for type 2N5202.

Fig. 17 - Oscilloscope display for measurement of sustaining voltages.

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

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

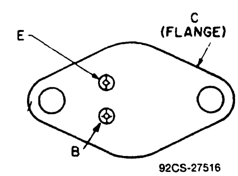
Features:

- *Maximum operating area curves for dc and pulse operation*
- *$I_{S/b}$-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)

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc V_{CB}	V_{CE}	V_{EB}	V_{BE}	CURRENT A dc I_C	I_E	I_B	LIMITS 2N5038 Min.	2N5038 Max.	2N5039 Min.	2N5039 Max.	2N6496 Min.	2N6496 Max.	UNITS
Collector Cutoff Current: With base open	I_{CEO}		55					0	–	–	–	20	–	–	
			70					0	–	20	–	–	–	–	
* With base-emitter junction reverse-biased	I_{CEV}		110		−1.5				–	–	–	50	–	–	
			140		−1.5				–	50	–	–	–	–	
			130		0				–	–	–	–	–	20	mA
* At T_C = 150°C			85		−1.5				–	–	–	10	–	–	
			100		−1.5				–	10	–	–	–	–	
			130		0				–	–	–	–	–	25	
* Emitter Cutoff Current	I_{EBO}			5		0			–	5	–	15	–	–	mA
				7		0			–	50	–	50	–	50	
DC Forward-Current Transfer Ratio	h_{FE}		5			2[a]			50	200	30	150	–	–	
*			5			10[a]			–	–	20	100	–	–	
*			5			12[a]			20	100	–	–	–	–	
*			2			8[a]			–	–	–	–	12	100	
* Magnitude of Small-Signal Forward-Current Transfer Ratio (At f = 5 MHz)	$\|h_{fe}\|$		10			2			12	–	12	–	12	–	
Collector-to-Emitter Sustaining Voltage: * With base open	$V_{CEO}(sus)$[b]					0.2		0	90	–	75	–	110	–	V
With base-emitter junction reverse biased and external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CEX}(sus)$[b]				−1.5	0.2		0	150	–	120	–	–	–	
With $R_{BE} \leqslant 50\ \Omega$	$V_{CER}(sus)$[b]					0.2		0	110	–	95	–	130	–	
Emitter-to-Base Voltage	V_{EBO}					0	0.05		7	–	7	–	7	–	V
Base-to-Emitter Voltage	V_{BE}		5			10[a]			–	–	–	1.8	–	–	
			5			12[a]			–	1.8	–	–	–	–	V
			2			8[a]			–	–	–	–	–	1.6	
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$					10[a]		1.0	–	–	–	1.0	–	–	
						12[a]		1.2	–	1.0	–	–	–	–	V
*						20[a]		5	–	2.5	–	2.5	–	–	
*						8[a]		0.8	–	–	–	–	–	1.0	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$					20[a]		5	–	3.3	–	3.3	–	–	V
						8[a]		0.8	–	–	–	–	–	2.0	
Output Capacitance	C_{ob}	10					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.

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

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

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

[f] $E_{S/b}$ is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. $E_{S/b} = ½LI^2$ where L is a series load or leakage inductance and I is the peak collector current.

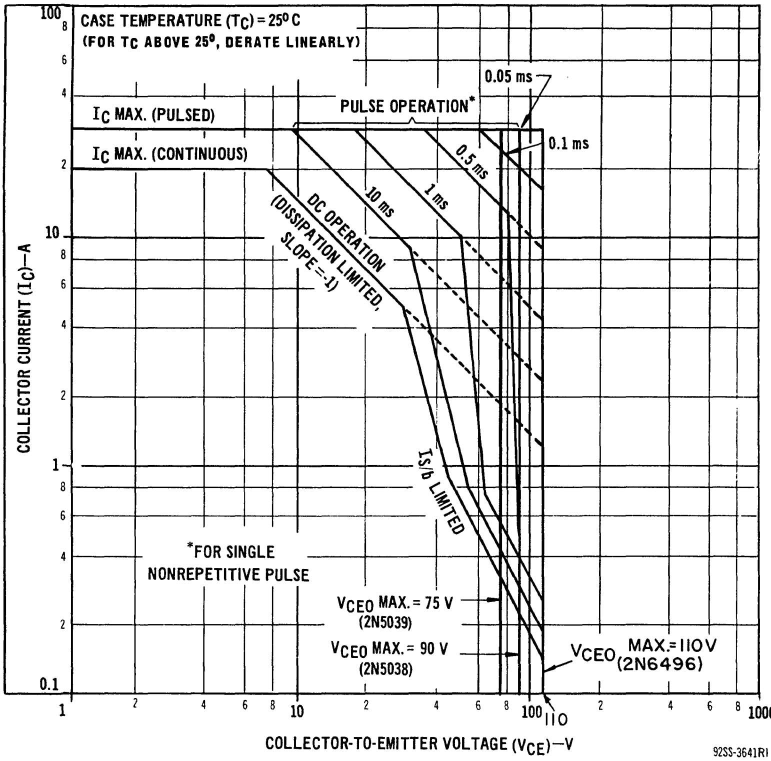


Fig. 1 — Maximum operating areas for all types.

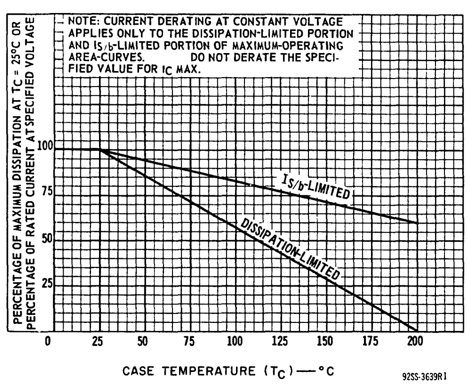


Fig. 2 — Dissipation derating curves for all types.

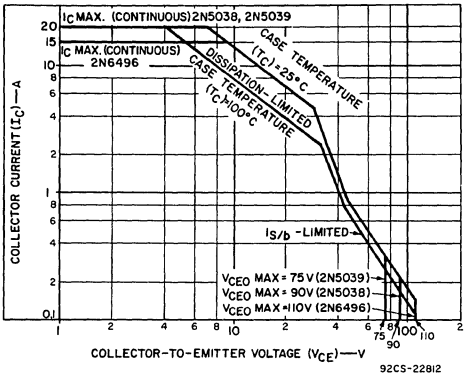


Fig. 3 - Maximum operating areas for all types.

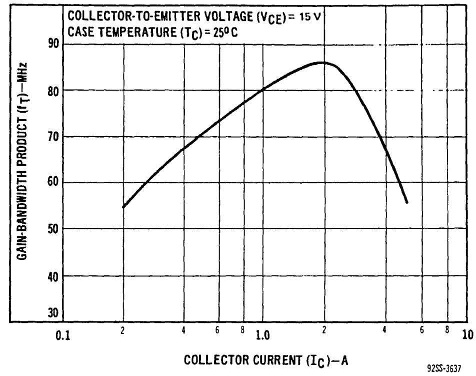


Fig. 4 - Typical gain-bandwidth product for all types.

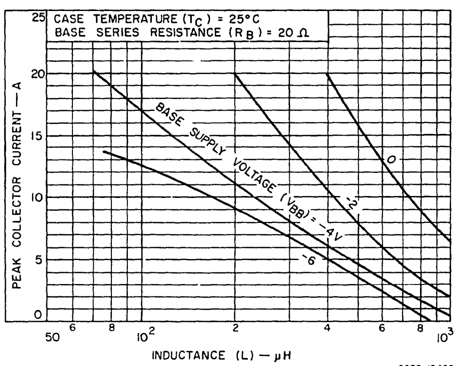


Fig. 5 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

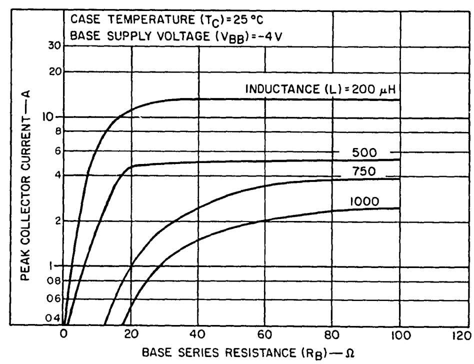


Fig. 6 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

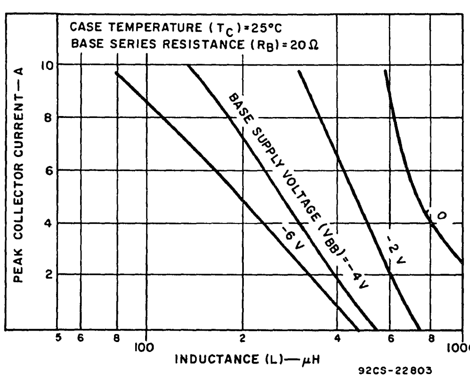


Fig. 7 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

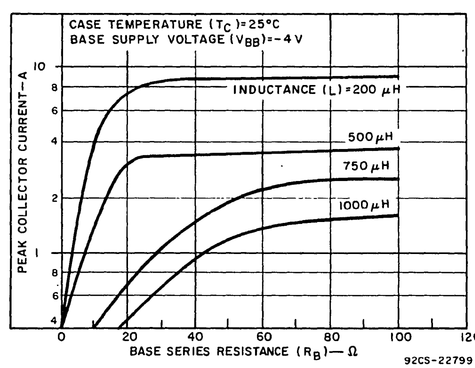


Fig. 8 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

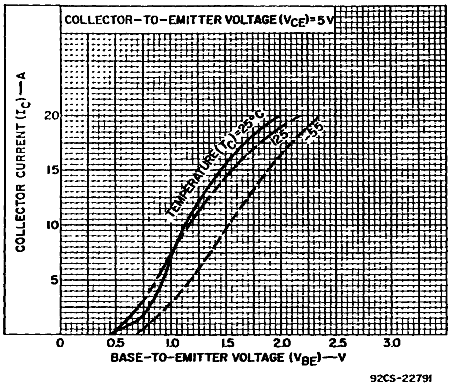


Fig. 9 – Typical transfer characteristics for 2N5038.

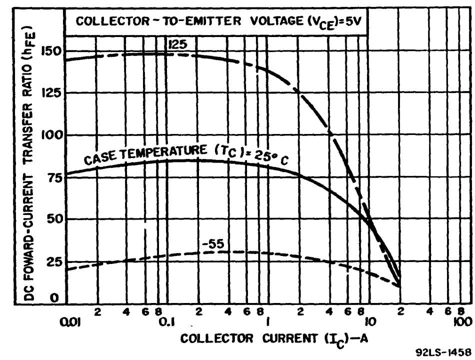


Fig. 10 – Typical dc beta characteristics for 2N5038.

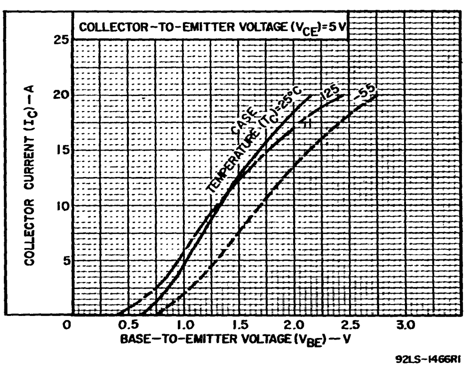


Fig. 11 – Typical transfer characteristics for 2N5039.

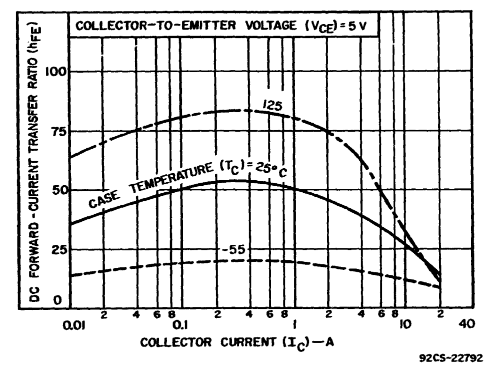


Fig. 12 –Typical dc beta characteristics for 2N5039.

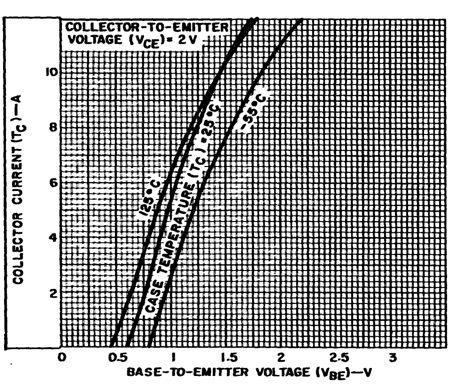


Fig. 13 – Typical transfer characteristics for 2N6496.

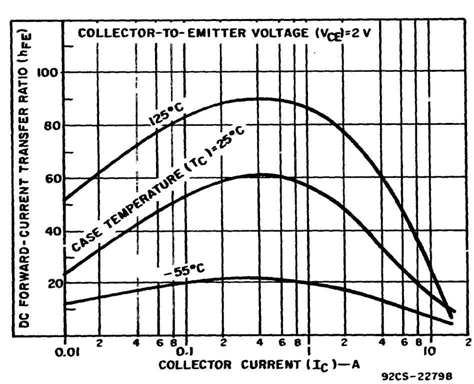


Fig. 14 – Typical dc beta characteristics for 2N6496.

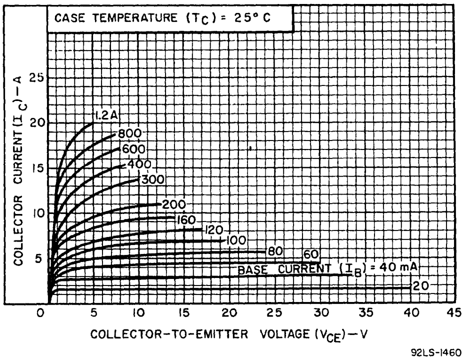


Fig. 15 - Typical output characteristics for 2N5038.

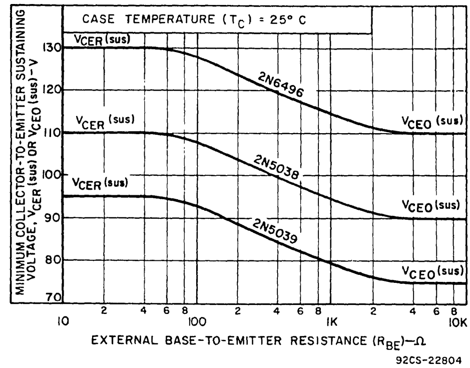


Fig. 16 - Collector-to-emitter sustaining voltage characteristic for all types.

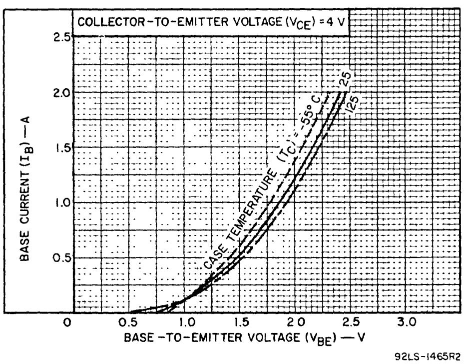


Fig. 17 - Typical output characteristics for 2N5039.

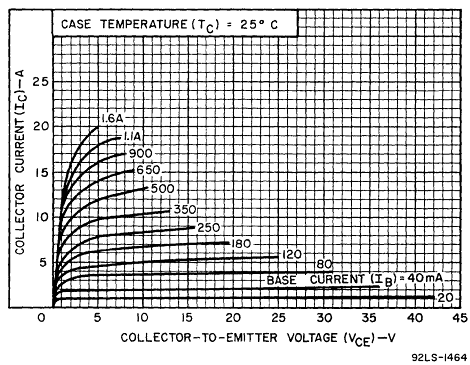


Fig. 18 - Typical input characteristics for 2N5038 and 2N5039.

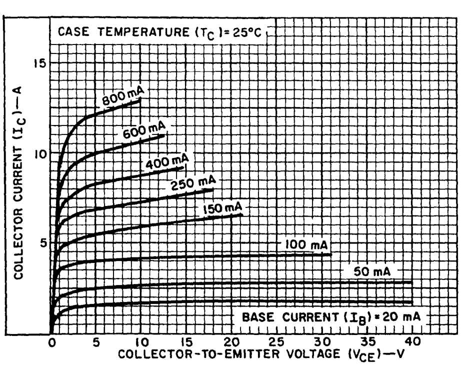


Fig. 19 - Typical output characteristics for 2N6496.

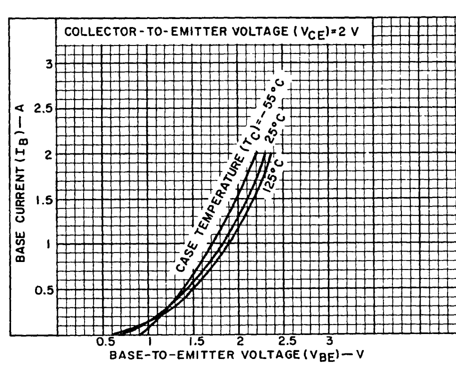


Fig. 20 - Typical input characteristics for 2N6496.

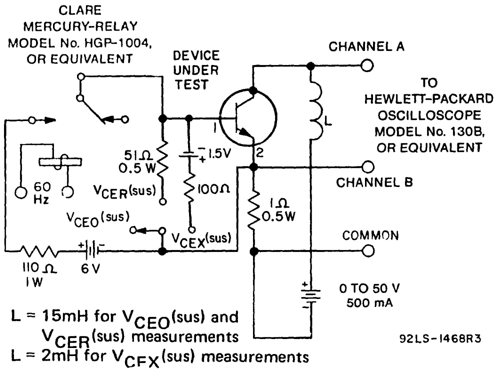
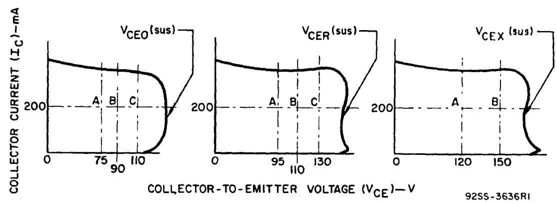


Fig. 21 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus).



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).

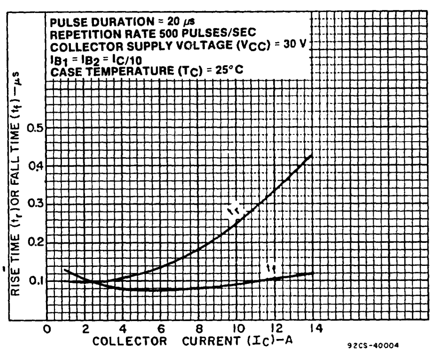


Fig. 23 - Typical rise-time and fall-time characteristics for all types.

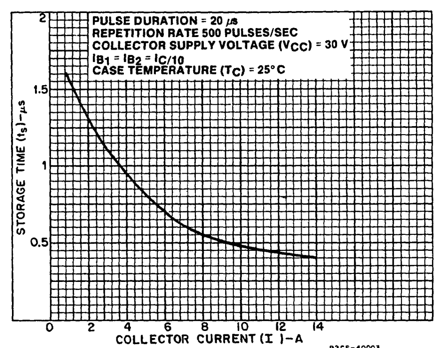


Fig. 24 - Typical storage time characteristic for all types.

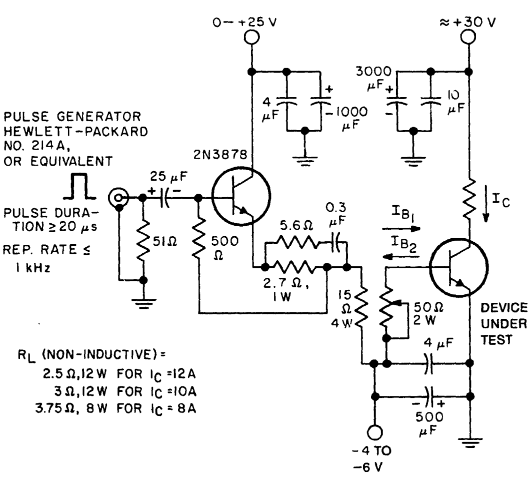


Fig. 25 - Circuit used to measure switching times for all types.

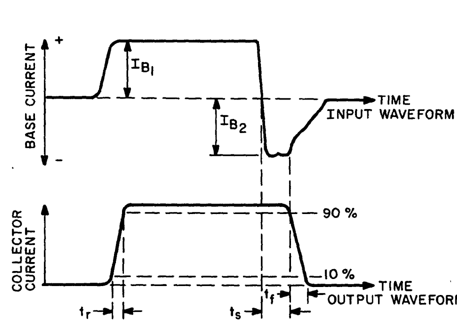


Fig. 26 — Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 26).

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*

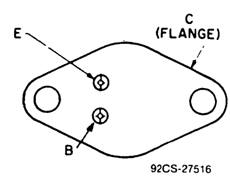
The 2N5239 and 2N5240• are multi epitaxial silicon n-p-n power transistors.

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

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

c V_{CB} value.

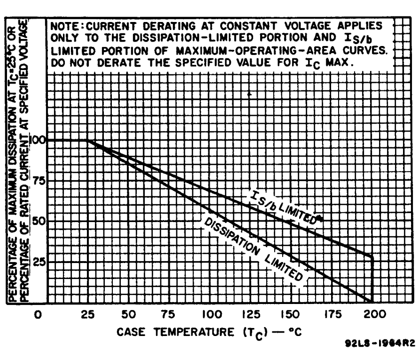


Fig. 1 - Derating curves for both types.

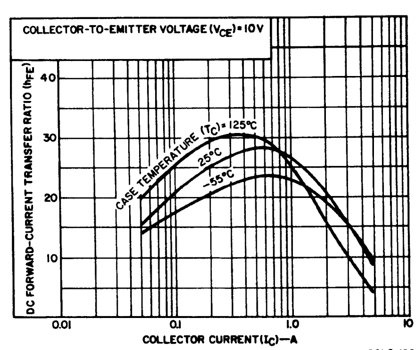


Fig. 2 — Typical dc beta characteristics for both types.

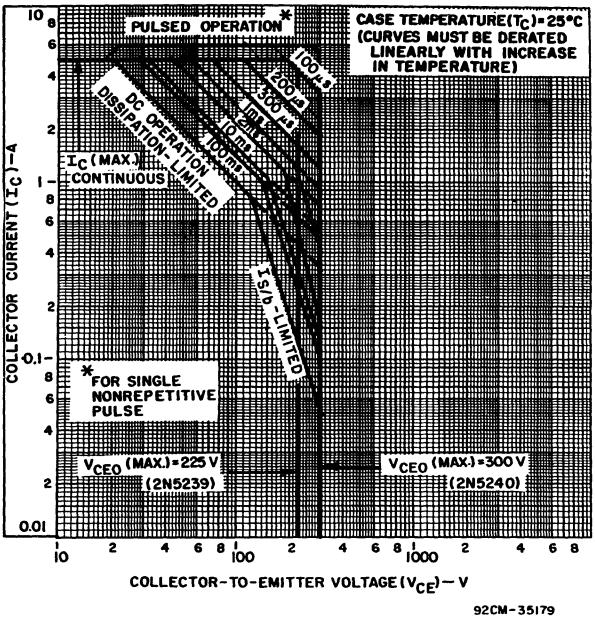


Fig. 3 - Maximum operating areas for both types.

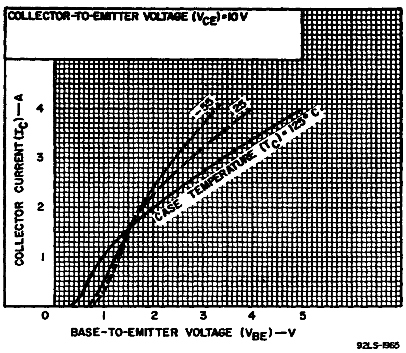


Fig. 4 — Typical transfer characteristics for both types.

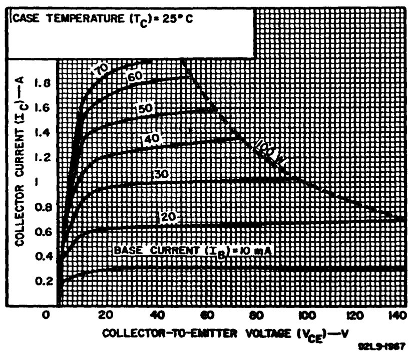


Fig. 5 — Typical output characteristics for both types.

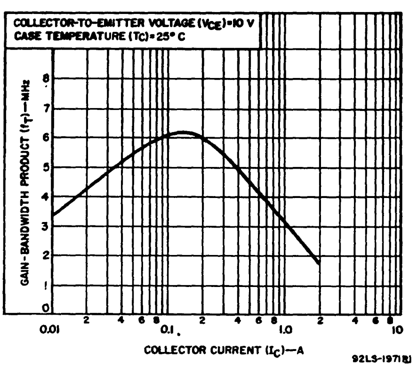


Fig. 6 — Typical gain-bandwidth product as a function of collector current for both types.

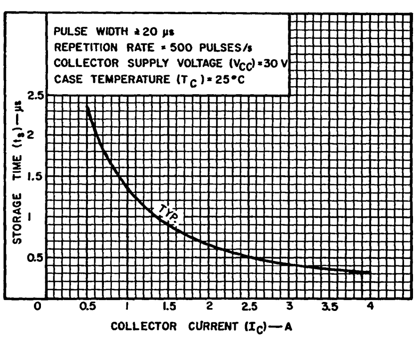


Fig. 7 — Typical saturated-switching time (storage) as a function of collector current for both types.

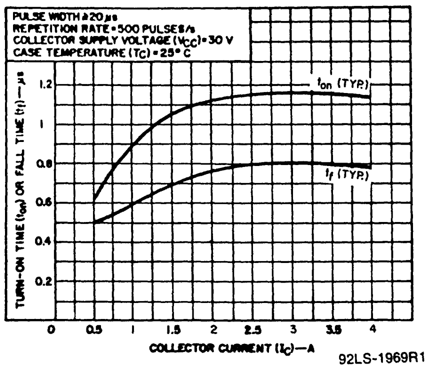


Fig. 8 — Typical saturated-time (turn-on or fall) as a function of collector current for both types.

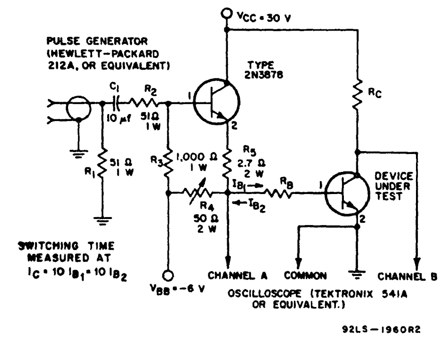


Fig. 9 — Circuit used to measure sustaining voltages, $V_{CEO}(sus)$ and $V_{CER}(sus)$ for both types.

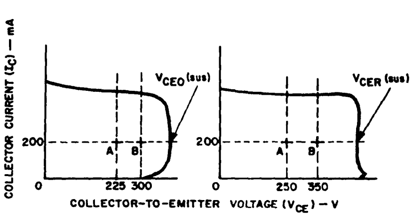


Fig. 10 — Oscilloscope display for $V_{CEO}(sus)$ and $V_{CER}(sus)$ measurement.

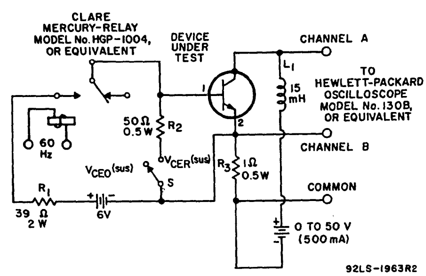


Fig. 11 — Circuit used to measure switching times for both types.

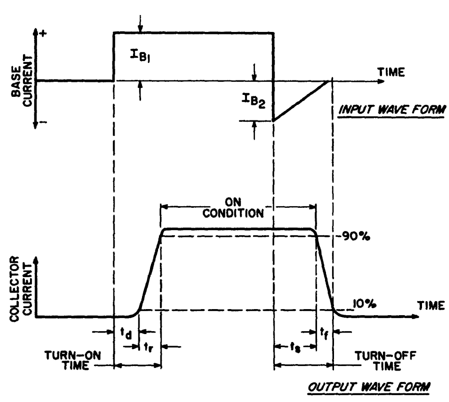
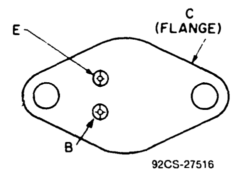


Fig. 12 — Phase relationship between input and output currents showing reference points for specification of switching times.

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 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}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc 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
* $\|h_{fe}\|$ f = 1 MHz	10		1	–	2	–	2	–	2	–	
* h_{fe} f = 1 kHz	10		1	–	40	–	40	–	40	–	
* t_r (See Fig.8)	V_{CC} = 30		10	1	–	1	–	1	–	1	μs
* t_s			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] $I_{B_1} = -I_{B_2}$

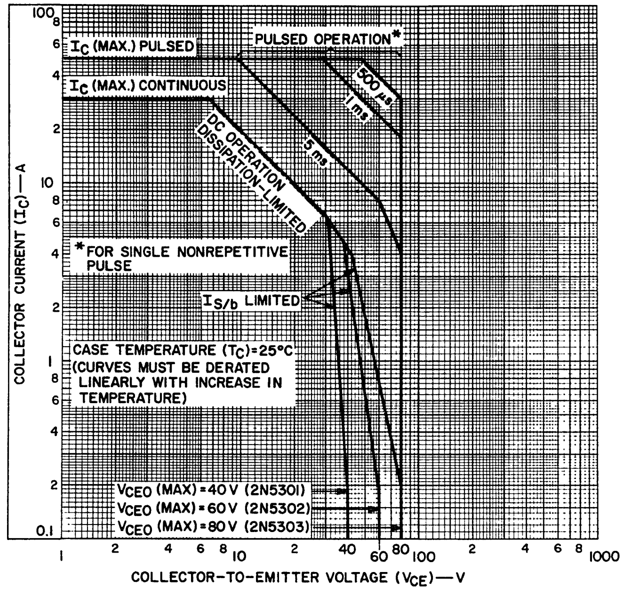


Fig. 1 — Maximum operating areas for 2N5301, 2N5302, and 2N5303.

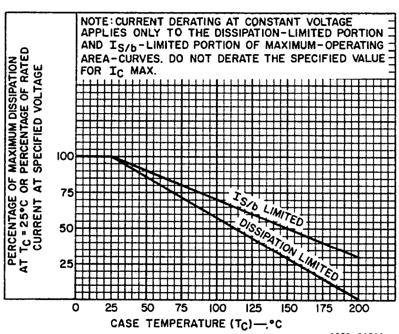


Fig. 2 — Derating curves for 2N5301, 2N5302, and 2N5303.

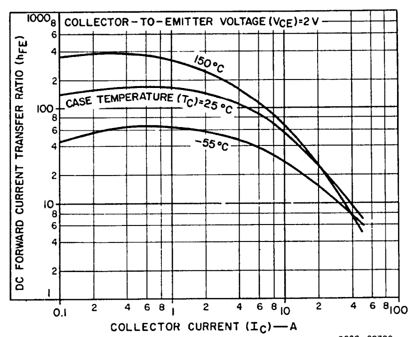


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

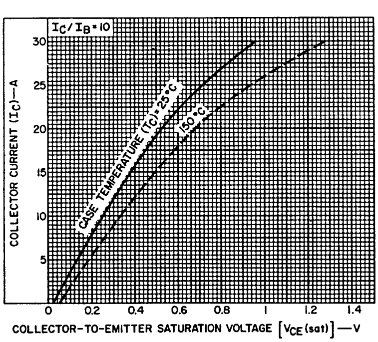


Fig. 4 — Typical saturation voltage characteristics for 2N5301, 2N5302, and 2N5303.

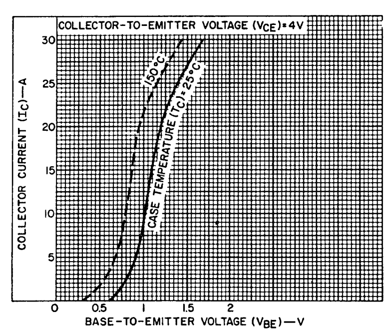


Fig. 5 — Typical transfer characreristics for 2N5301, 2N5302, and 2N5303.

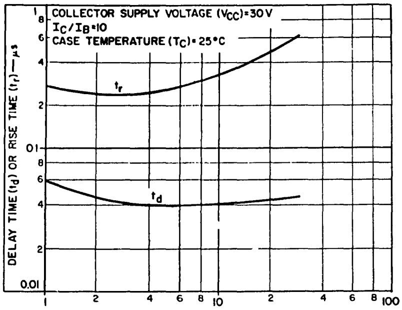


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

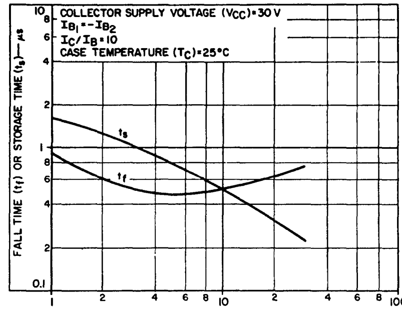


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5301, 2N5302, and 2N5303.

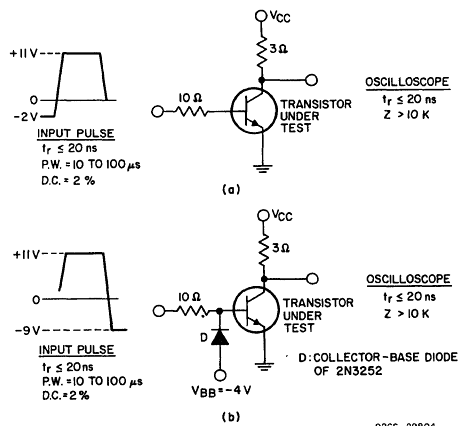


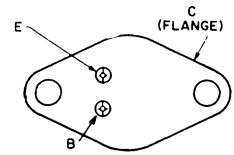
Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5301, 2N5302, and 2N5303.

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

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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

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

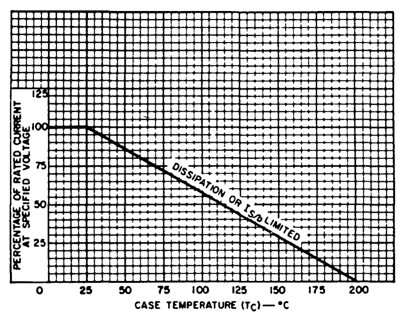


Fig. 1 — Current derating curve for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5629	2N5630	2N5631	
* V_{CEO}	100	120	140	V
* V_{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.

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

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

* In accordance with JEDEC registration data.
[a] V_{CB} value.
[b] CAUTION: Sustaining voltage, $V_{CEO}(sus)$ MUST NOT BE measured on a curve tracer.
[c] Pulsed; pulse duration ≤300 μs. Duty factor ≤2%.

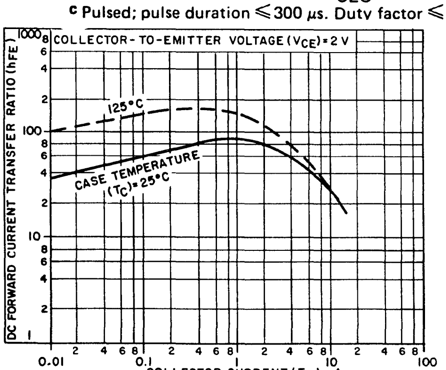


Fig. 2 — Typical dc beta characteristics as a function of collector current for all types.

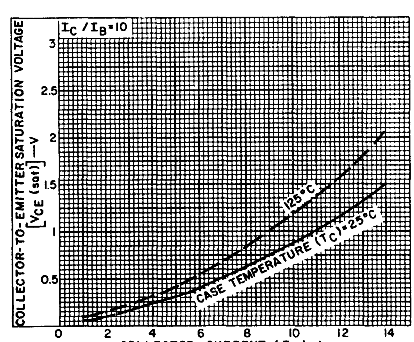


Fig. 3 — Typical saturation voltage characteristics for all types.

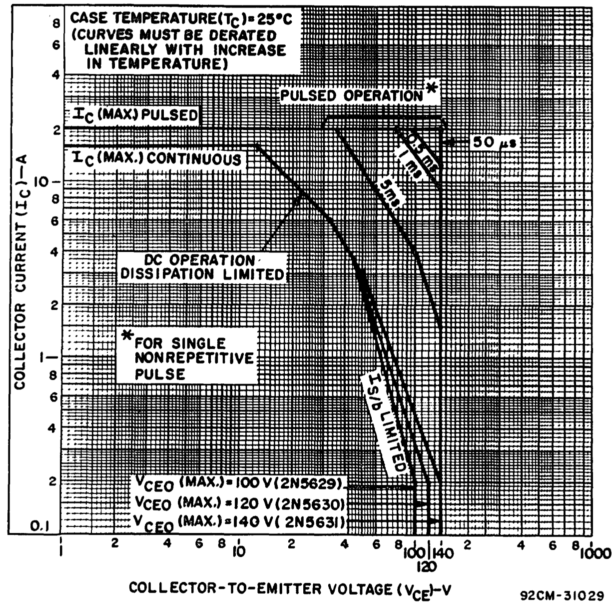


Fig. 4 — Maximum operating areas for all types (T_C = 25°C).

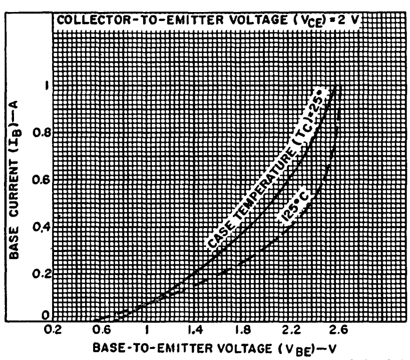


Fig. 5 — Typical input characteristics for all types.

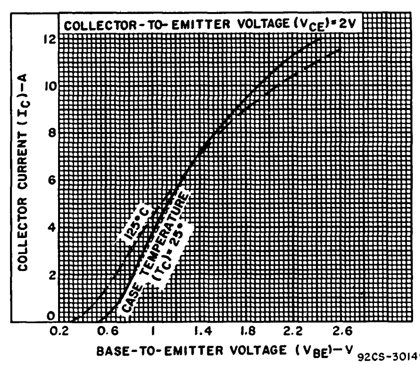


Fig. 6 — Typical transfer characteristics for all types.

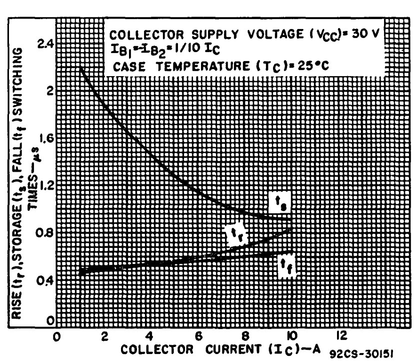


Fig. 7 — Typical saturated-switching times for all types.

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

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

Features:

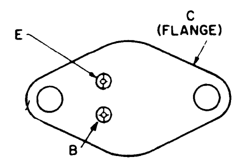
- *Maximum Safe-Area-of-Operation Curves - $I_{S/b}$ limit line beginning at 24 V*
- *Fast Turn-On Time - t_{ON} = 0.5 μs max. at I_C = 15 A*

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).

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

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS: DC Collector Voltage (V) V_{CB}	DC Collector Voltage (V) V_{CE}	DC Emitter or Base Voltage (V) V_{EB}	DC Emitter or Base Voltage (V) V_{BE}	DC Current (A) I_C	DC Current (A) I_E	DC Current (A) I_B	LIMITS: Type 2N5671 Min.	Type 2N5671 Max.	Type 2N5672 Min.	Type 2N5672 Max.	UNITS
	Collector-Cutoff Current	I_{CEO}	–	80	–	–	–	–	0	–	10	–	10	mA
*		I_{CEV}	–	110	–	-1.5	–	–	–	–	12	–	–	mA
*		I_{CEV}	–	135	–	-1.5	–	–	–	–	–	–	10	mA
		(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. $E_{S/b} = ½LI^2$, 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)

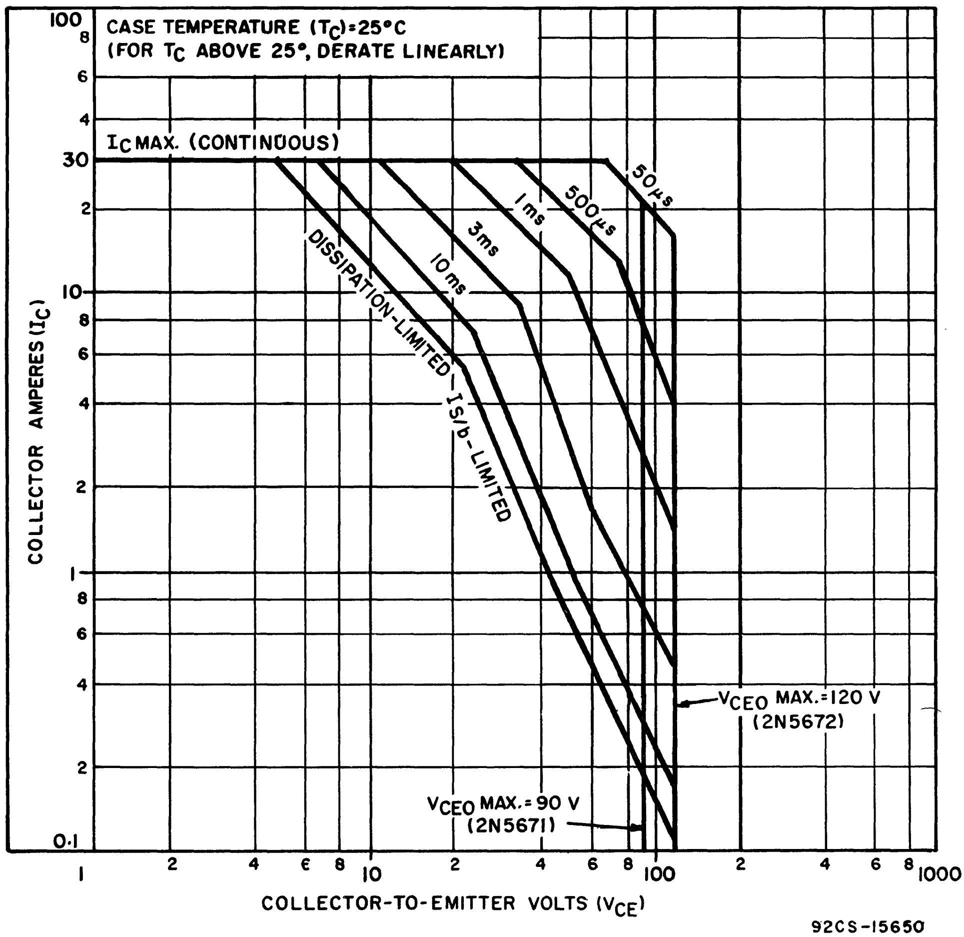


Fig. 1 - Maximum operating areas for types 2N5671 & 2N5672.

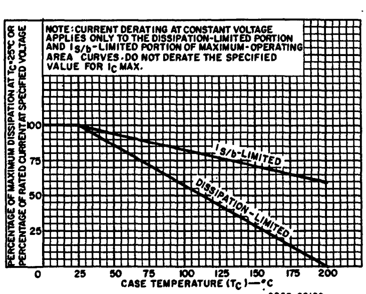


Fig. 2 - Dissipation derating curves for types 2N5671 & 2N5672.

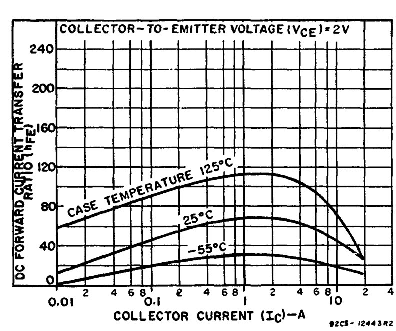


Fig. 3 - Typical dc beta characteristics for types 2N5671 & 2N5672.

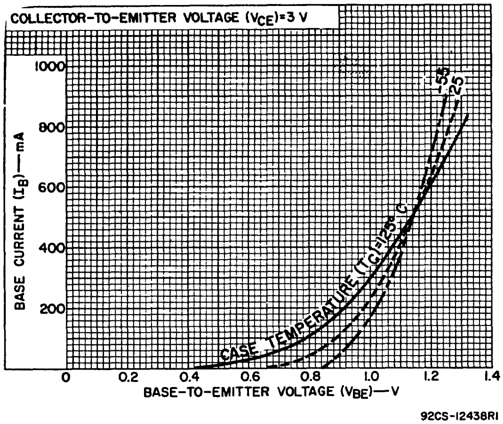


Fig. 4 - Typical input characteristics for types 2N5671 & 2N5672.

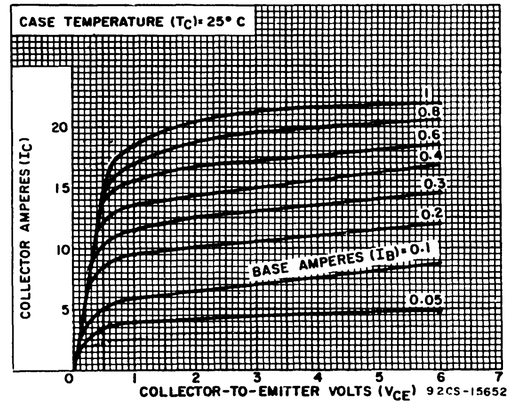


Fig. 5 - Typical output characteristics for types 2N5671 & 2N5672.

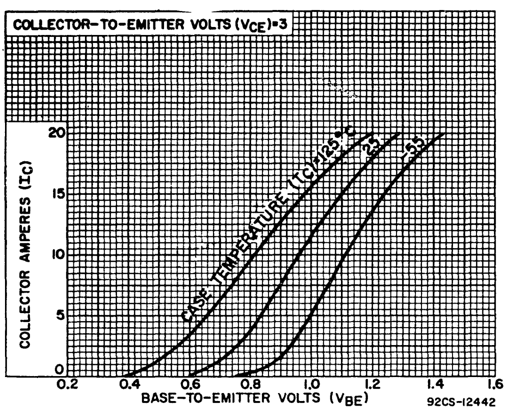


Fig. 6 - Typical transfer characteristics for types 2N5671 & 2N5672.

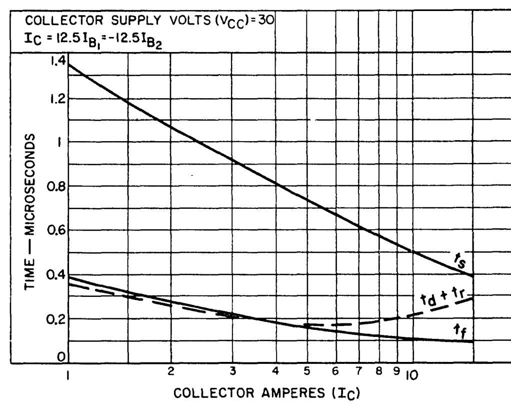


Fig. 7 - Typical saturated switching characteristics for types 2N5671 & 2N5672.

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.

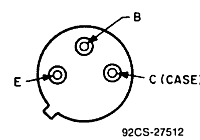
The three types in each family differ primarily in voltage ratings and saturation characteristics.

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.

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.

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

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

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_{BE}	TEST CONDITIONS♦ CURRENT A dc I_C	TEST CONDITIONS♦ 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 45	1.5 –1.5			– –	–10 –	– –	– 10	μA
* At T_C = 150°C	I_{CEX}	–45 45	1.5 –1.5			– –	–1 –	– –	– 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 2		1.6[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	–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] 3.2[a]	0.16 0.8	– –	–1 –2	– –	1 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.

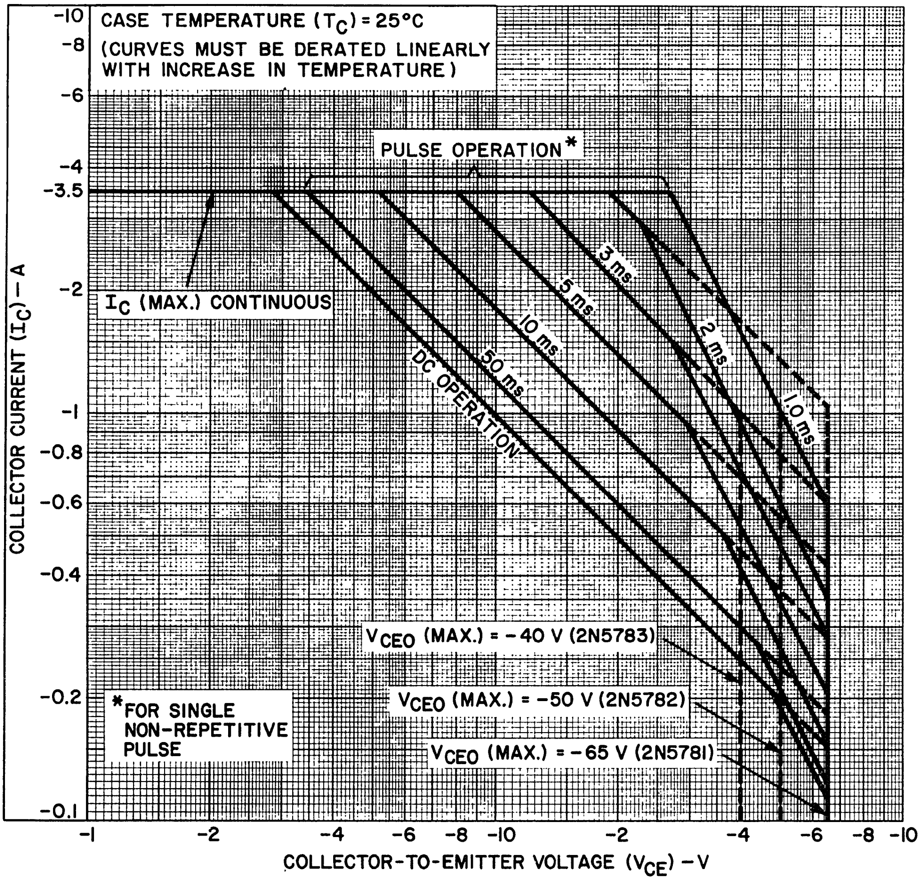
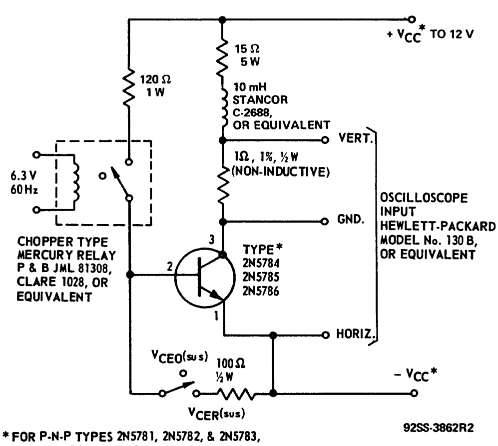
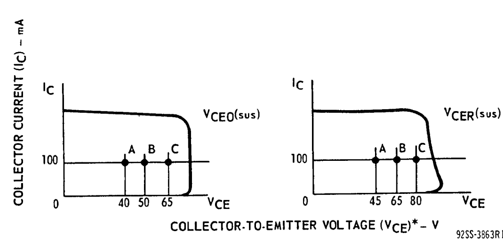


Fig. 1 — Maximum operating areas for types 2N5781, 2N5782, and 2N5783.



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

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).

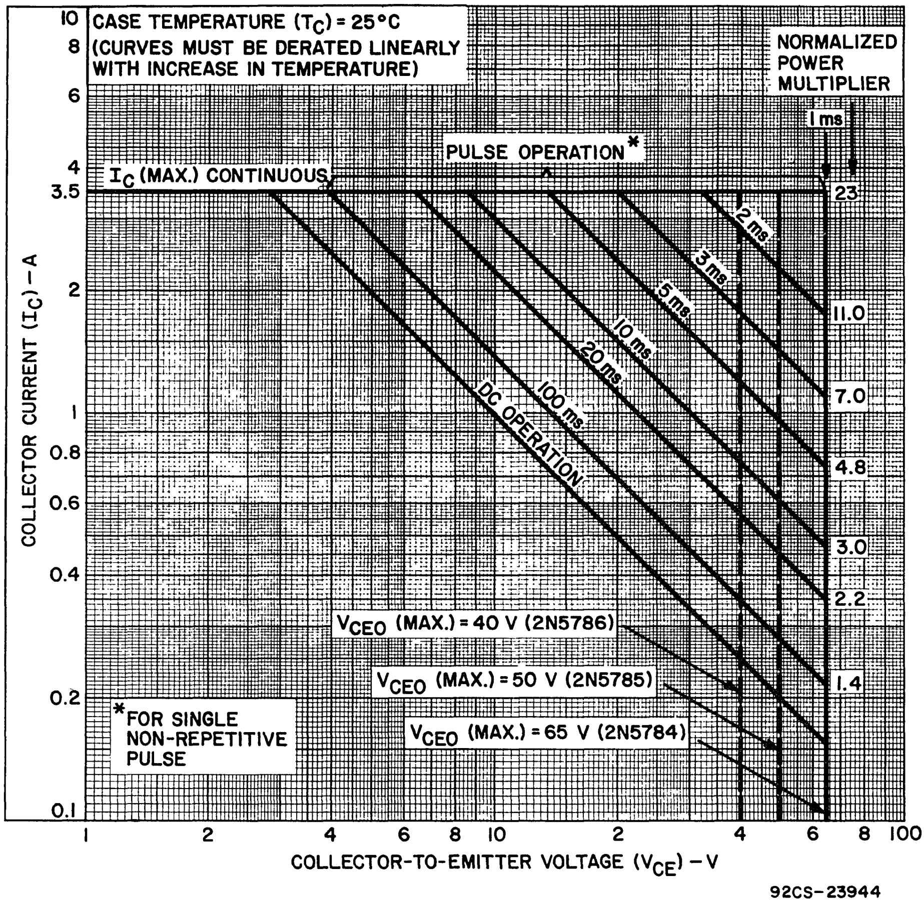


Fig. 4 — Maximum operating areas for types 2N5784, 2N5785, and 2N5786.

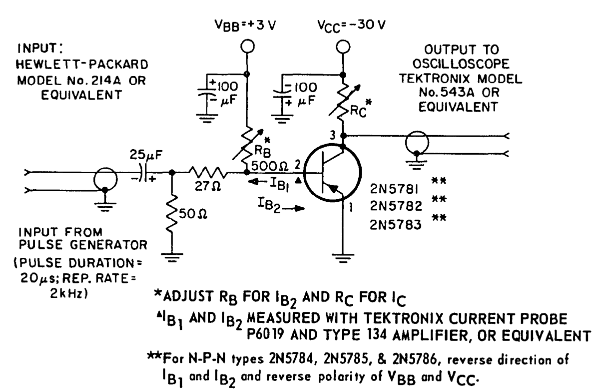


Fig. 5 — Circuit used to measure saturated switching times.

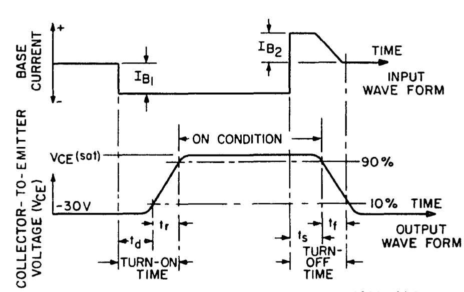


Fig. 6 — Oscilloscope display for measurement of switching times. (Test circuit shown in Fig. 5).

2 POWER TRANSISTORS

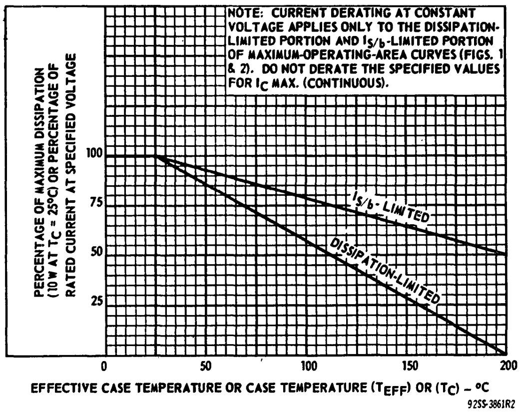


Fig. 7 — Dissipation derating curve for all types.

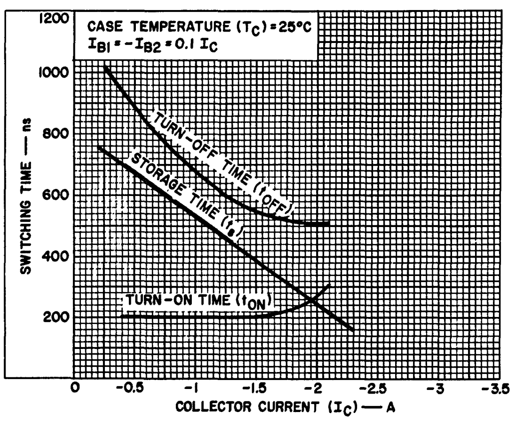


Fig. 8 — Typical saturated switching characteristics for types 2N5781, 2N5782, and 2N5783.

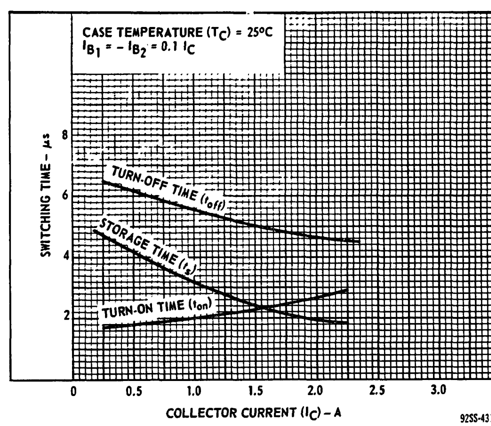


Fig. 9 — Typical saturated switching characteristics for types 2N5784, 2N5785, and 2N5786.

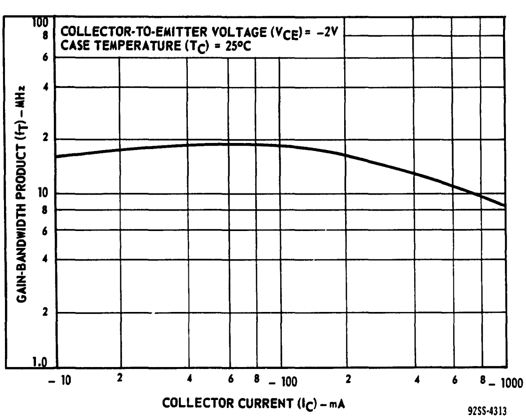


Fig. 10 — Typical gain-bandwidth product for types 2N5781, 2N5782, and 2N5783.

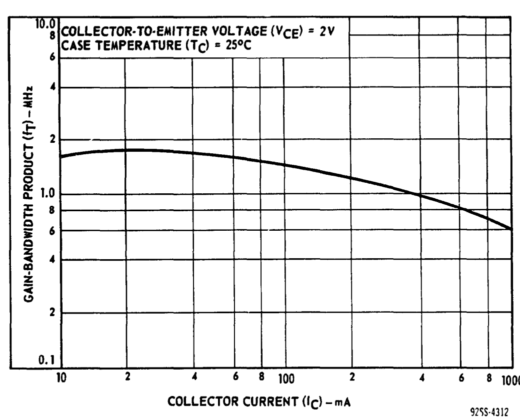


Fig. 11 — Typical gain-bandwidth product for types 2N5784, 2N5785, and 2N5786.

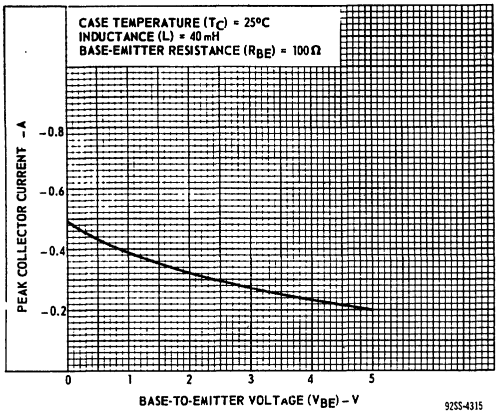


Fig. 12 — Reverse-bias second-breakdown characteristics for types 2N5781, 2N5782, and 2N5783.

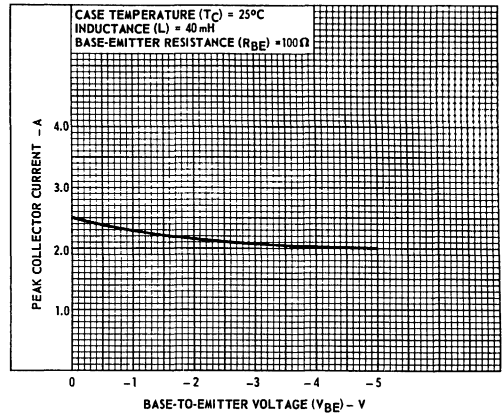


Fig. 13 — Reverse-bias second-breakdown characteristics for types 2N5784, 2N5785, and 2N5786.

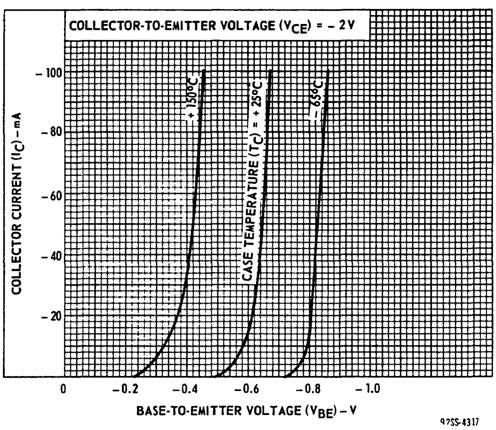


Fig. 14 — Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

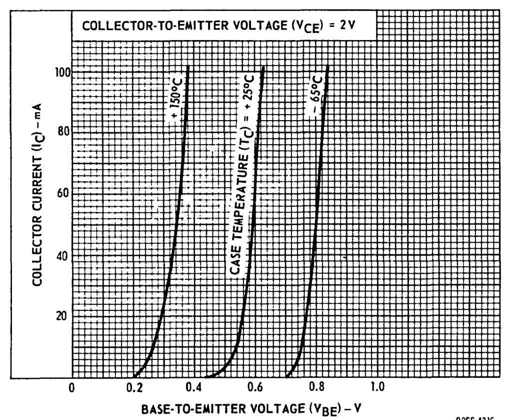


Fig. 15 — Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

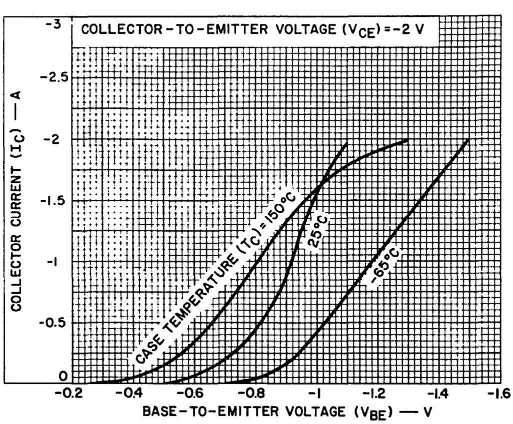


Fig. 16 — Typical transfer characteristics for types 2N5781, 2N5782, and 2N5783.

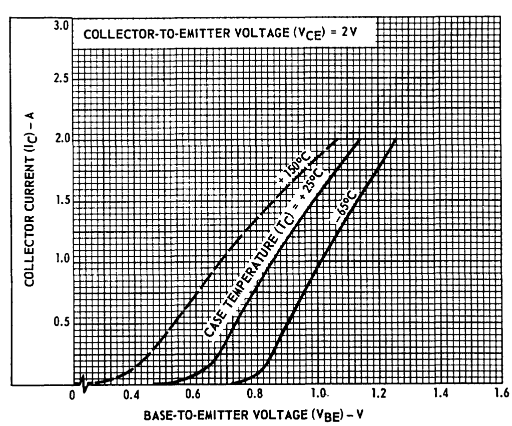


Fig. 17 — Typical transfer characteristics for types 2N5784, 2N5785, and 2N5786.

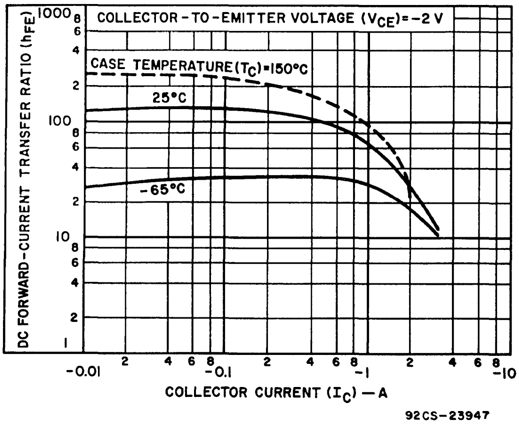


Fig. 18 — Typical dc beta characteristics for type 2N5781.

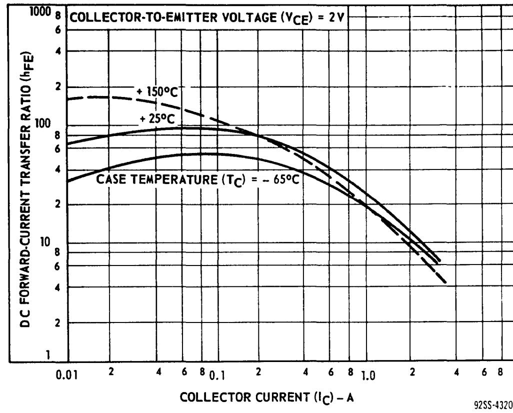


Fig. 19 — Typical dc beta characteristics for type 2N5784.

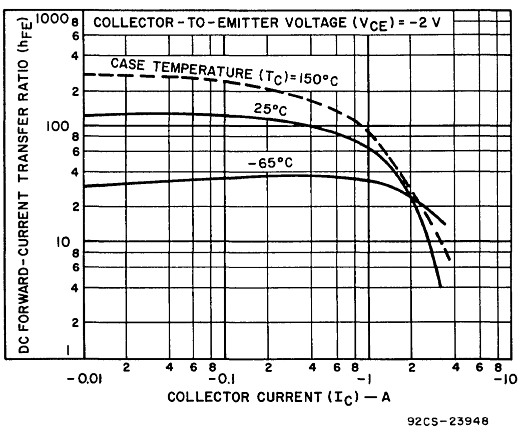


Fig. 20 — Typical dc beta characteristics for type 2N5782.

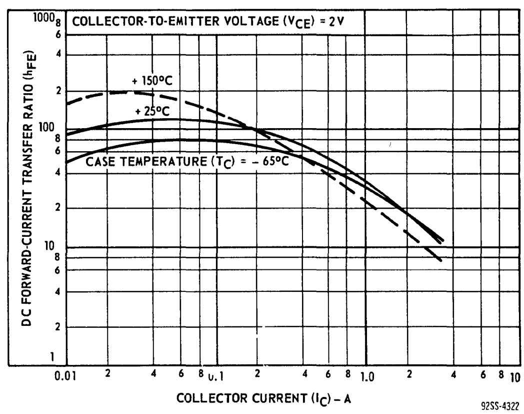


Fig. 21 — Typical dc beta characteristics for type 2N5785.

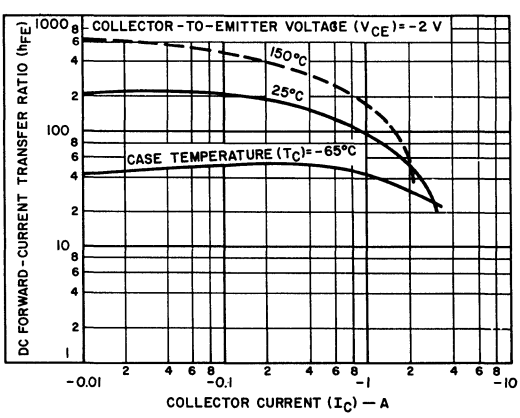


Fig. 22 — Typical dc beta characteristics for type 2N5783.

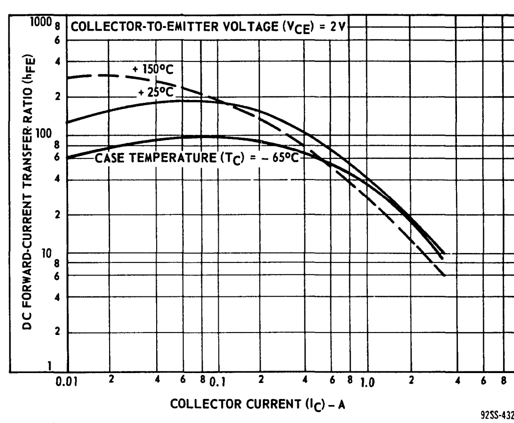


Fig. 23 — Typical dc beta characteristics for type 2N5786.

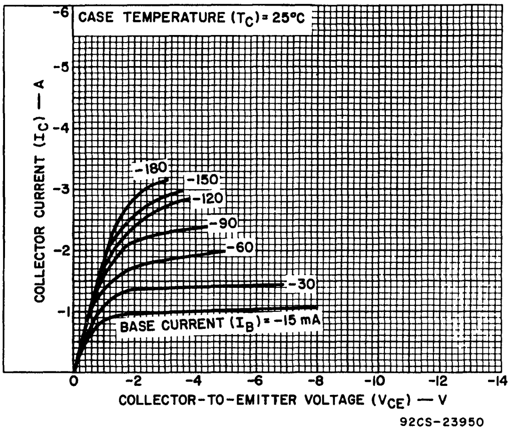


Fig. 24 — Typical output characteristics for type 2N5781.

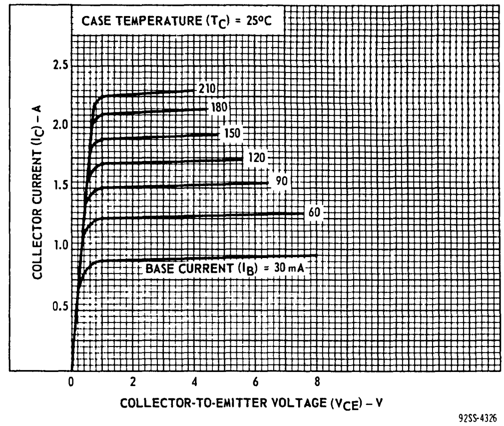


Fig. 25 — Typical output characteristics for type 2N5784.

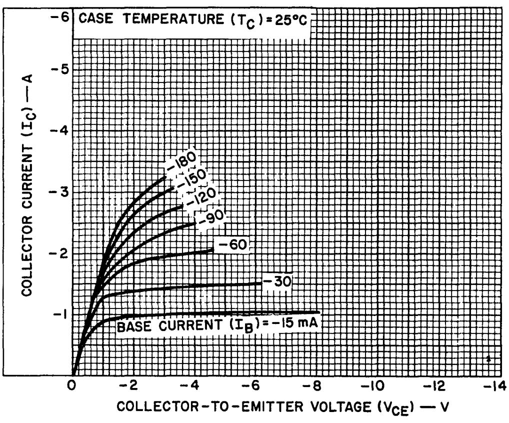


Fig. 26 — Typical output characteristics for type 2N5782.

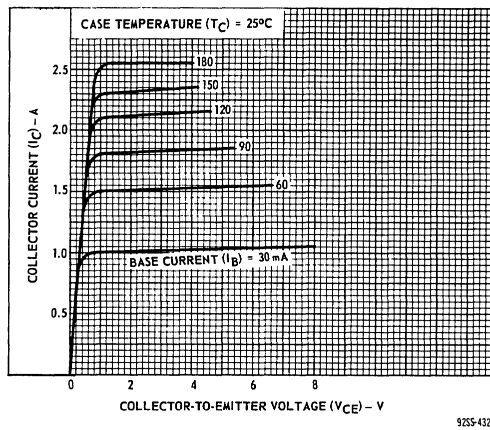


Fig. 27 — Typical output characteristics for type 2N5785.

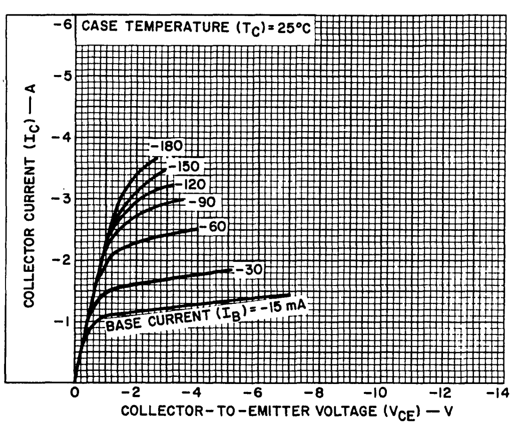


Fig. 28 — Typical output characteristics for type 2N5783.

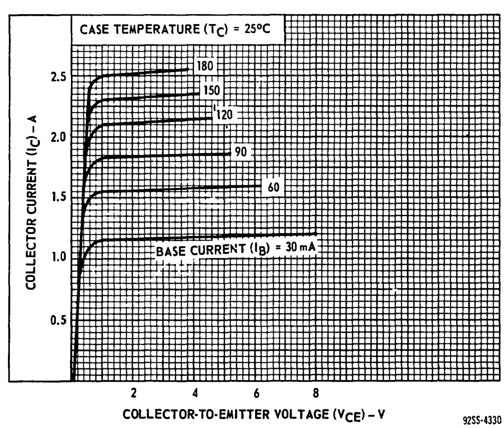


Fig. 29 — Typical output characteristics for type 2N5786.

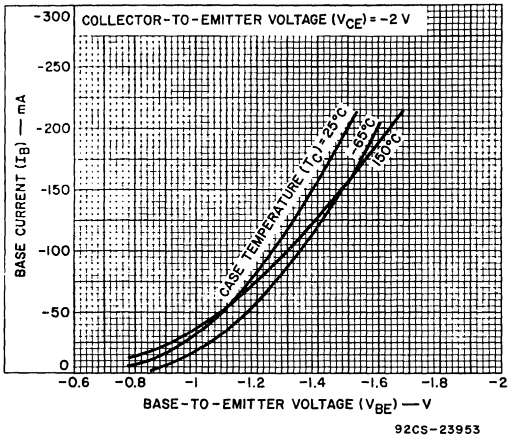


Fig. 30 — Typical input characteristics for type 2N5781.

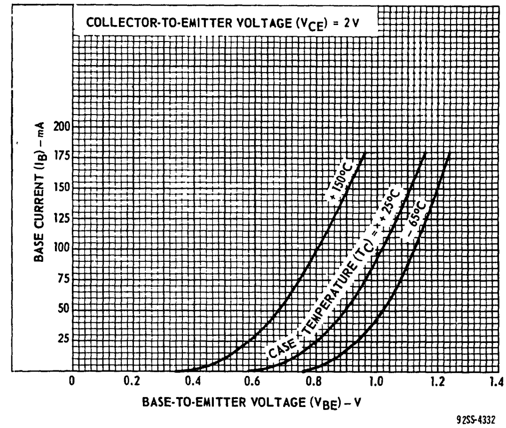


Fig. 31 — Typical input characteristics for type 2N5784.

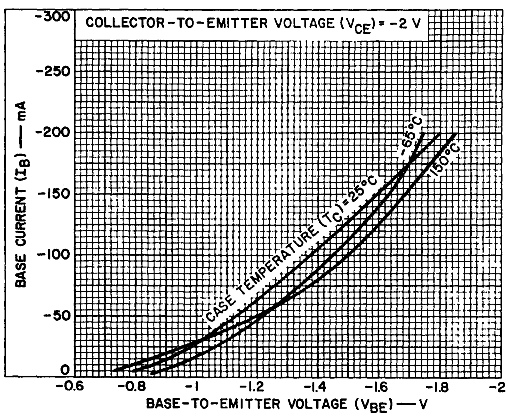


Fig. 32 — Typical input characteristics for type 2N5782.

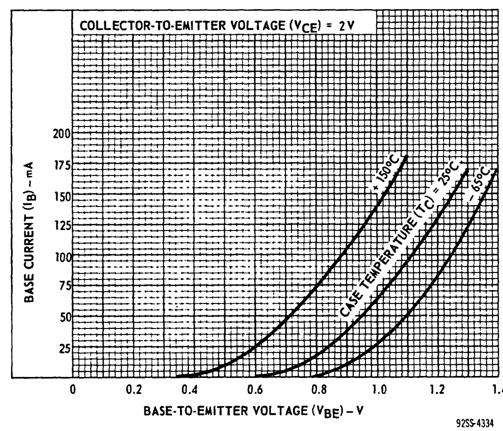


Fig. 33 — Typical input characteristics for type 2N5785.

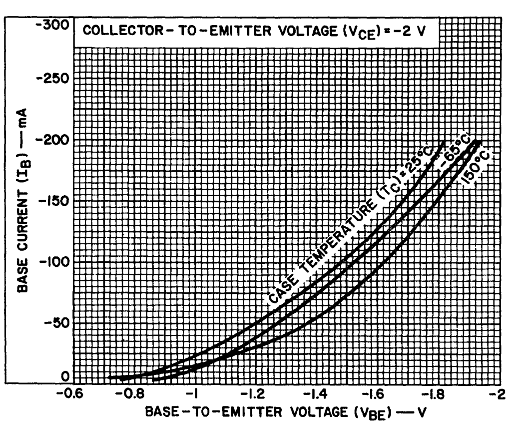


Fig. 34 — Typical input characteristics for type 2N5783.

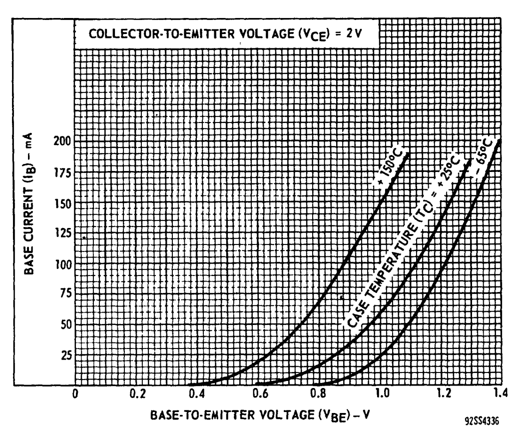


Fig. 35 — Typical input characteristics for type 2N5786.

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

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

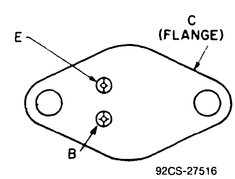
Features:
- *Maximum safe-area-of-operation curves*
- *Low saturation voltages*
- *High voltage ratings*
  $V_{CER}[sus] = 375$ V [2N5840]
  300 V [2N5839]
  275 V [2N5838]
- *High dissipation rating*
  $P_T = 100$ W

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2 POWER TRANSISTORS

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) V_{CE}	DC Emitter or Base Voltage (V) V_{EB}	V_{BE}	DC Current (A) I_C	I_B	I_E	Type 2N5838 Min.	Max.	Typ.	Type 2N5839 Min.	Max.	Typ.	Type 2N5840 Min.	Max.	Typ.	Units
Collector-Cutoff Current: With base open	I_{CEO}	200 250						- -	2 -	- -	- -	- 2	- -	- -	- 2	- -	mA
* With base-emitter junction reverse biased	I_{CEV}	265 290 360		-1.5 -1.5 -1.5				- - -	5 - -	- - -	- - -	- 2 -	- - -	- - -	- - 2	- - -	mA
* With base-emitter junction reverse biased	I_{CEV} T_C 100 °C	265 290 360		-1.5 1.5 -1.5				- - -	8 - -	- - -	- - -	- 5 -	- - -	- - -	- - 5	- - -	mA
* Emitter-Cutoff Current	I_{EBO}		-6					-	1	-	-	1	-	-	1	-	mA
* Collector-to-Emitter Sustaining Voltage (*See Figs. 4, 5, & 6*) With base open	$V_{CEO}(sus)^a$				0.2			250[b]	-	-	275[b]	-	-	350[b]	-	-	V
* With base-emitter junction reversed biased	$V_{CEX}(sus)^a$			-1.5	0.1			275[b]	-	-	300[b]	-	-	375[b]	-	-	V
With external base-to-emitter resistance (R_{BE}) - 50 Ω	$V_{CER}(sus)^a$				0.2			275[b]	-	-	300[b]	-	-	375[b]	-	-	V
* Emitter-to-Base Voltage	V_{EBO}						0.02	6	-	-	6	-	-	6	-	-	V
* DC Forward-Current Transfer Ratio	h_{FE}	5 3 2			0.5[b] 2[b] 3[b]			20 - 8	- - 40	- - -	20 10 -	- 50 -	- - -	20 10 -	- 50 -	- - -	
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$				2 3	0.2 0.375		- -	- 2	- -	- -	2 -	- -	- -	2 -	- -	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				2 3	0.2 0.375		- -	- 1	- -	- -	1.5 -	- -	- -	1.5 -	- -	V
Output Capacitance (At 1 MHz)	C_{obo}		10d				0	-	150	-	-	150	-	-	150	-	pF
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f 1 MHz)	$\|h_{fe}\|$	10			0.2			5	-	-	5	-	-	5	-	-	
Second Breakdown Collector Current (With base forward biased) Pulse duration (non-repetitive) - 1 s	$I_{S/b}$c	40						2.5	-	-	2.5	-	-	2.5	-	-	A
Switching Times: Delay	t_d	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).

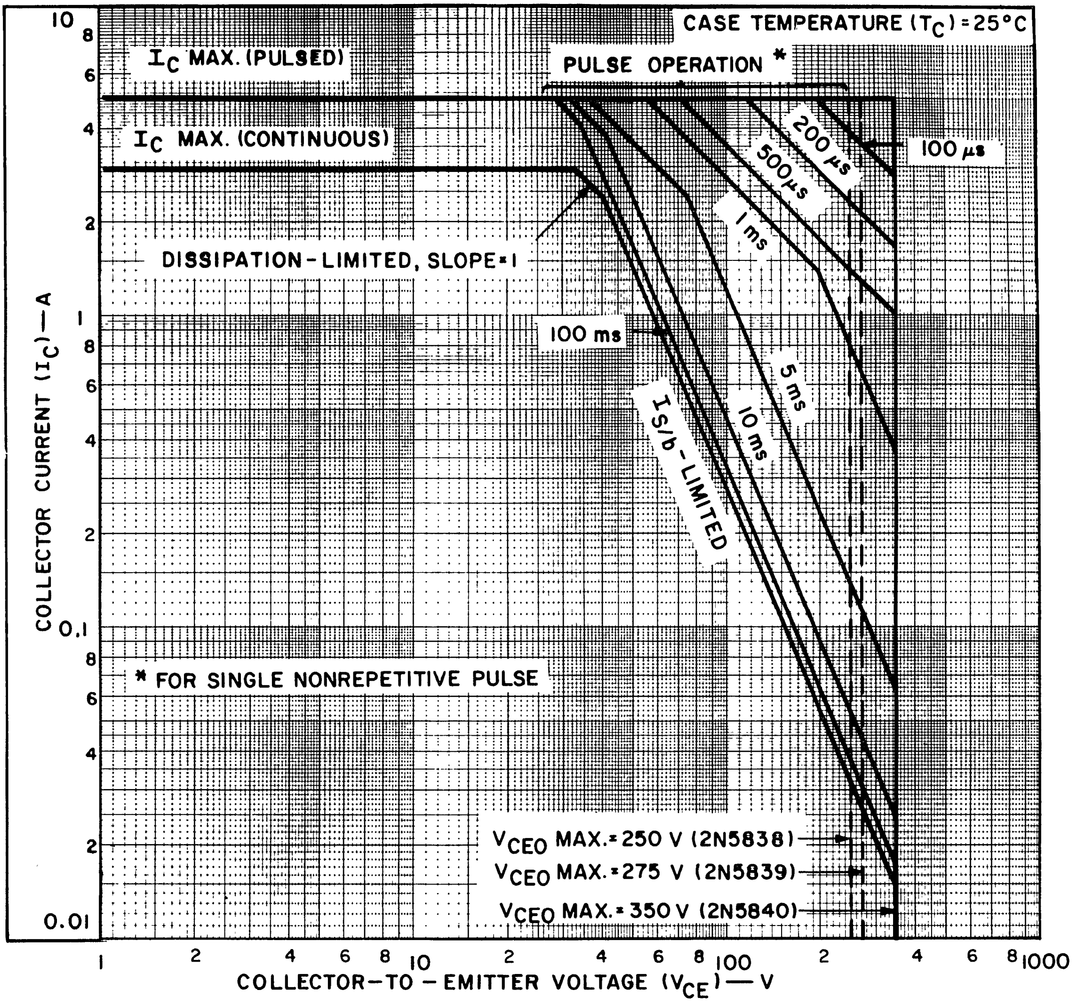


Fig. 1 — Maximum operating areas for all types.

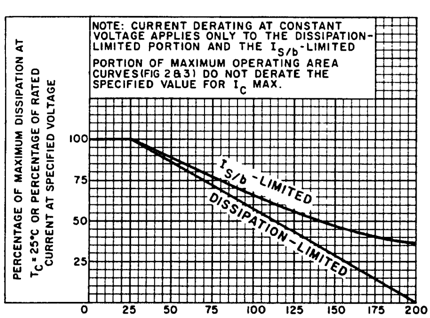


Fig. 2 — Derating curves for all types.

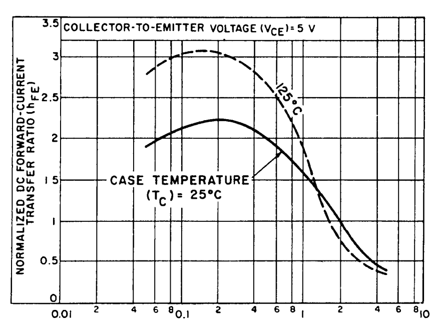
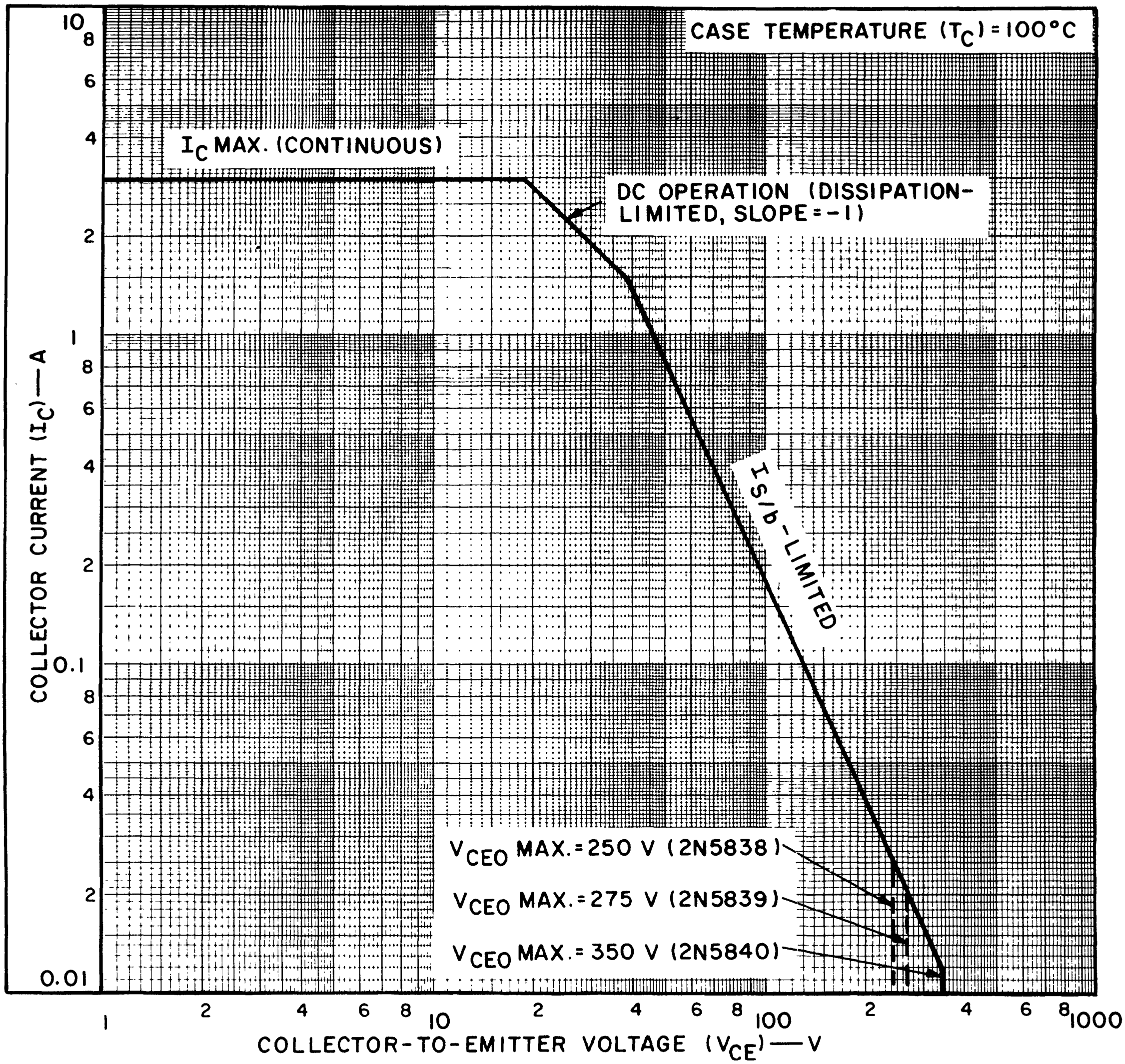


Fig. 3 — Typical normalized dc beta characteristics for all types.



92CS-15906

Fig. 4 — Maximum operating areas for all types.

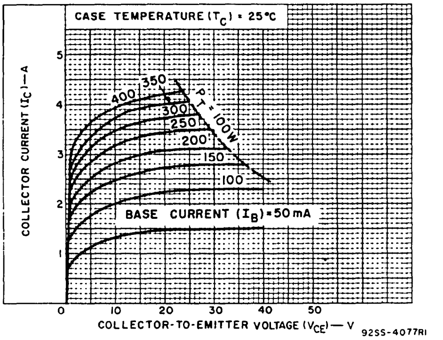


Fig. 5 — Typical output characteristics for all types.

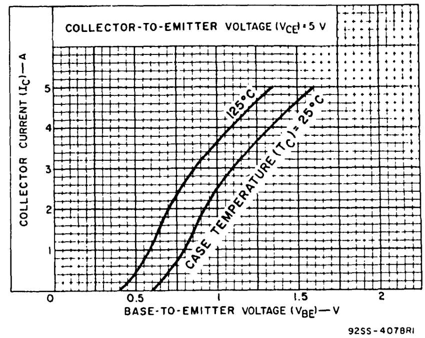


Fig. 6 — Typical transfer characteristics for all types.

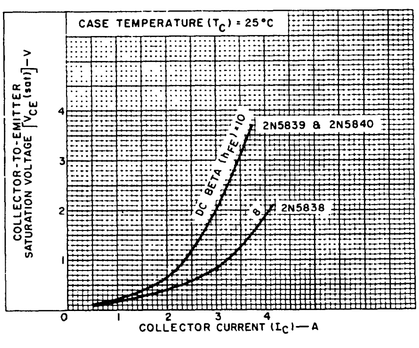


Fig. 7 — Typical saturation voltage characteristics for for all types.

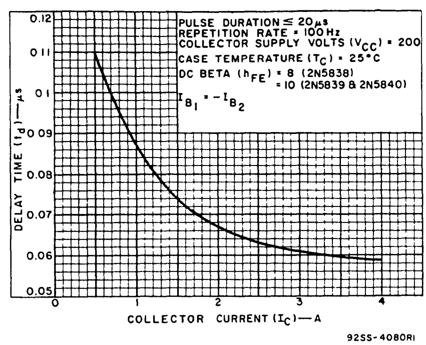


Fig. 8 — Typical delay-time characteristics for all types.

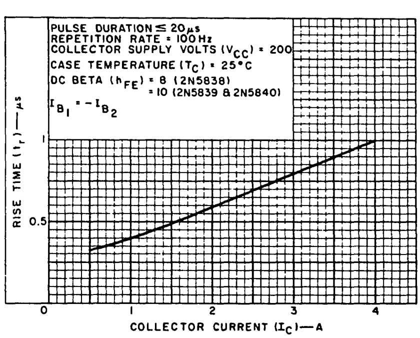


Fig. 9 — Typical rise-time characteristics for all types.

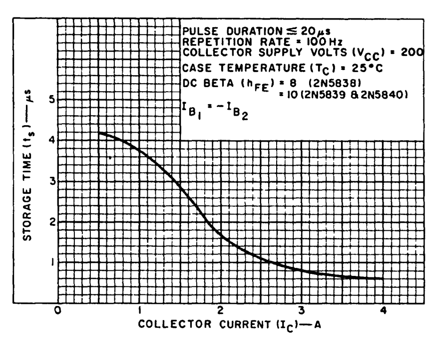


Fig. 10 — Typical storage-time characteristics for all types.

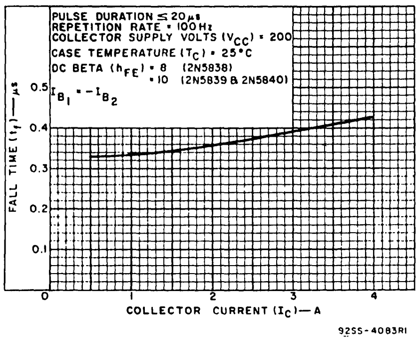


Fig. 11 — Typical fall-time characteristics for all types.

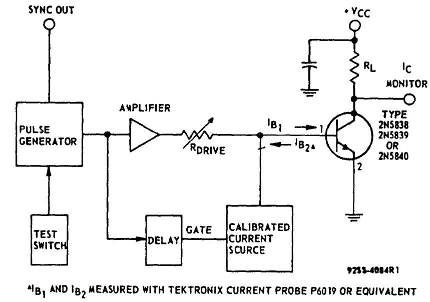


Fig. 12 — Circuit used to measure switching times for all types.

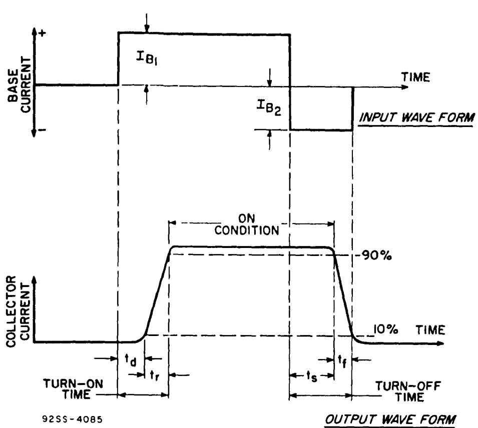


Fig. 13 — Phase relationship between input and output currents showing reference points for specification of switching times.

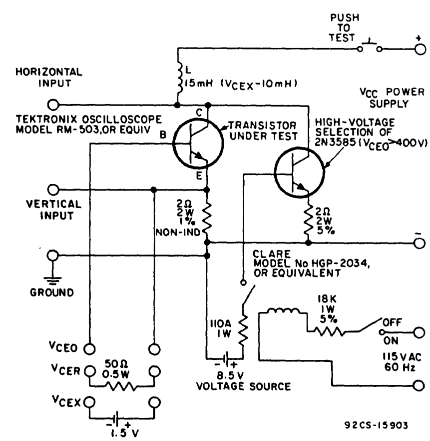
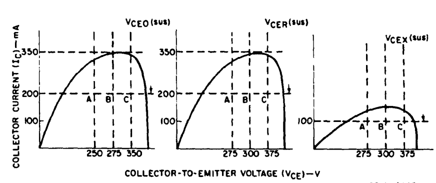


Fig. 14 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.



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.

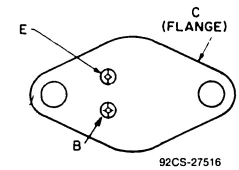
Fig. 15 — Oscilloscope display for measurement of sustaining voltages.

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.**

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		TEST CONDITIONS CURRENT A dc		LIMITS 2N5885		LIMITS 2N5886		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
* I_{CBO}	60[a]				–	1	–	–	mA
	80[a]				–	–	–	1	
* I_{CEX}	60	–1.5			–	1	–	–	
	80	–1.5			–	–	–	1	
* I_{CEX} T_C = 150°C	60	–1.5			–	10	–	–	
	80	–1.5			–	–	–	10	
* I_{CEO}	30				–	2	–	–	
	40				–	–	–	2	
* I_{EBO}		–5			–	1	–	1	
* h_{FE}	4		3[b]		35	–	35	–	
	4		10[b]		20	100	20	100	
	4		25[b]		4	–	4	–	
* V_{CEO}(sus)			0.2		60	–	80	–	V
* V_{BE}	4		10		–	1.5	–	1.5	
* V_{BE}(sat)			25[b]	6.25	–	2.5	–	2.5	
* V_{CE}(sat)			15[b]	1.5	–	1	–	1	
			25[b]	6.25	–	4	–	4	
$I_{S/b}$ t_p = 1 s nonrep.	20				10	–	10	–	A
* $\|h_{fe}\|$ f = 1 MHz	10		1		4	–	4	–	
* h_{fe} f = 1 kHz	4		3		20	–	20	–	
* C_{obo} f = 1 MHz	10[a]				–	500	–	500	pF
* t_r (See Fig. 8)	V_{CC} = 30		10	1	–	0.7	–	0.7	µs
* t_s			10	1[c]	–	1	–	1	
* t_f			10	1[c]	–	0.8	–	0.8	
$R_{\theta JC}$	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] $I_{B_1} = -I_{B_2}$.

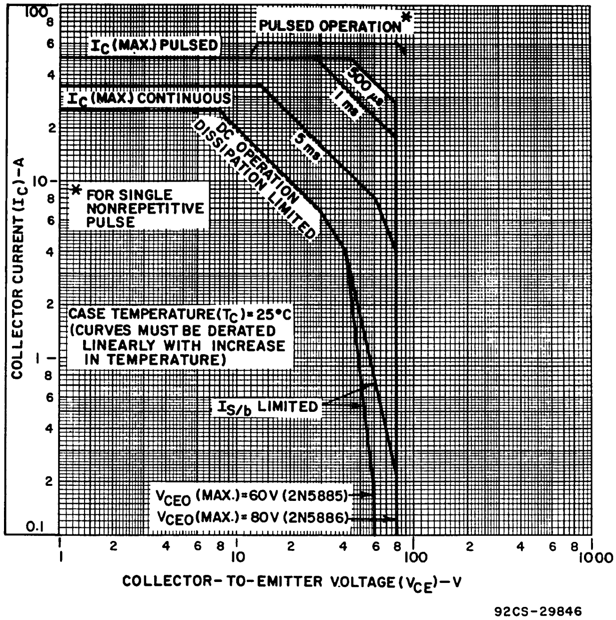


Fig. 1 — Maximum operating areas for 2N5885 and 2N5886.

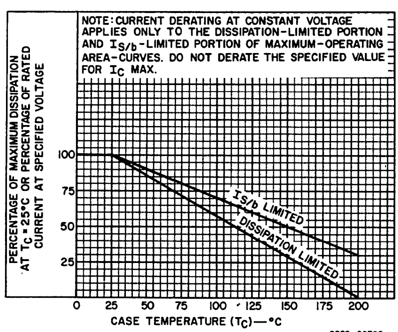


Fig. 2 — Derating curves for 2N5885 and 2N5886.

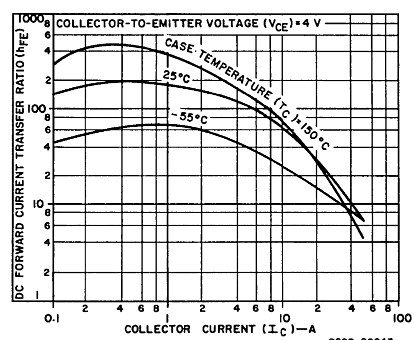


Fig. 3 — Typical dc beta characteristics as a function of collector current for 2N5885 and 2N5886.

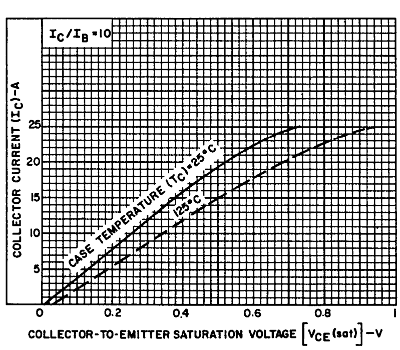


Fig. 4 — Typical saturation voltage characteristics for 2N5885 and 2N5886.

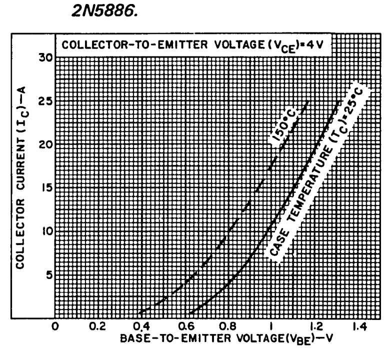


Fig. 5 — Typical transfer characteristics for 2N5885 and 2N5886.

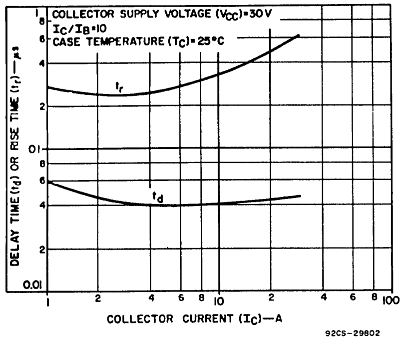


Fig. 6 — Typical delay-time and rise-time characteristics as a function of collector current for 2N5885 and 2N5886.

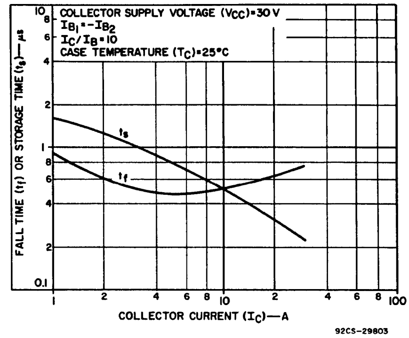


Fig. 7 — Typical storage-time and fall-time characteristics as a function of collector current for 2N5885 and 2N5886.

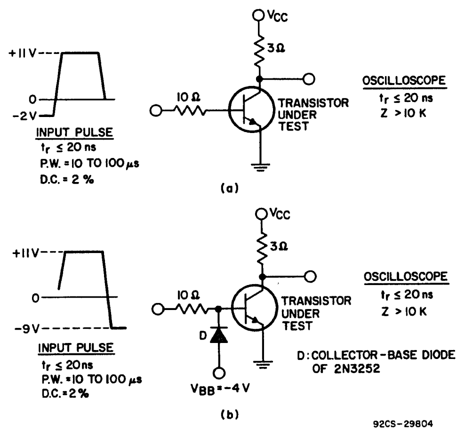


Fig. 8 — Equivalent test circuits for rise-time (a) and fall-time and storage-time (b) measurements for 2N5885 and 2N5886.

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)

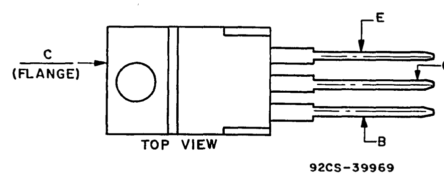
Features:

- *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.

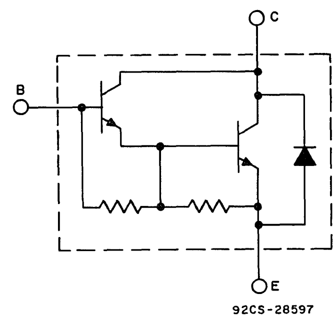


Fig. 1 — Schematic diagram for all types.

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.

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	–	–	–	–	
	4		4		1000	20,000	1000	20,000	–	–	
* h_{FE}	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	
			4	0.016	–	2	–	2	–	–	
* V_{CE}(sat)			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.

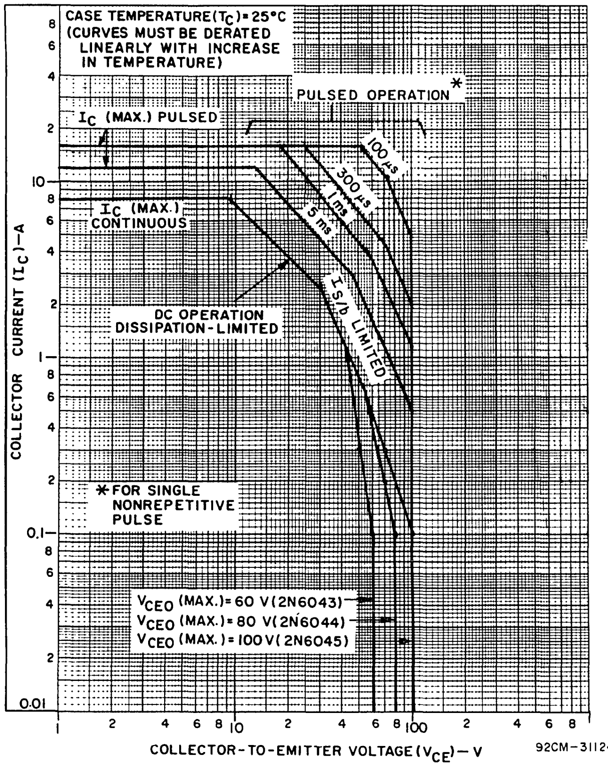


Fig. 2 — Maximum operating areas for all types (T_C = 25°C).

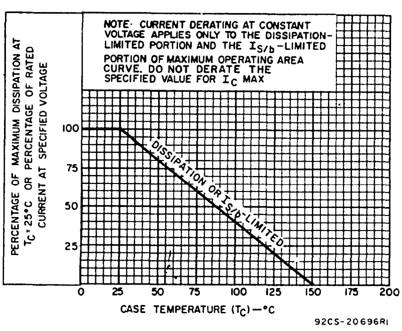


Fig. 3 — Derating curve for all types.

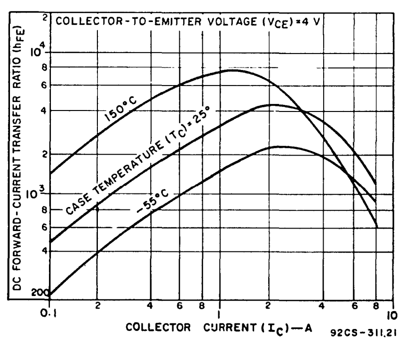


Fig. 4 — Typical dc beta characteristics for all types.

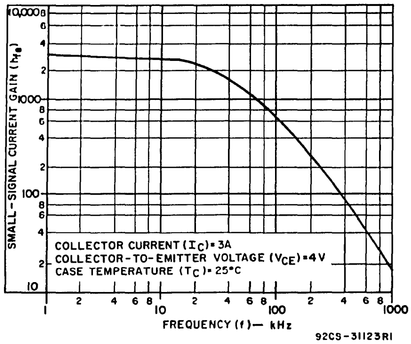


Fig. 5 — Typical small-signal gain for all types.

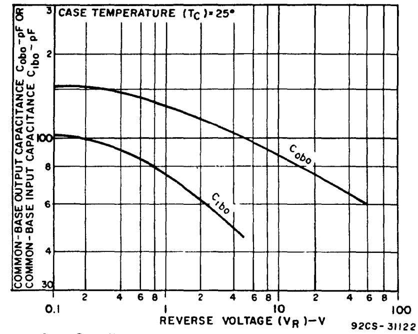


Fig. 6 — Typical common-base input or output capacitance characteristics as a function of reverse voltage for all types.

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

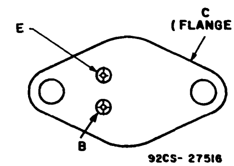
60-80-100 Volts, 150 Watts
Gain of 7000 (Typ.) at 5 A (2N6050, 2N6051, 2N6052)
Gain of 4000 (Typ.) at 5 A (2N6057, 2N6058, 2N6059)

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.

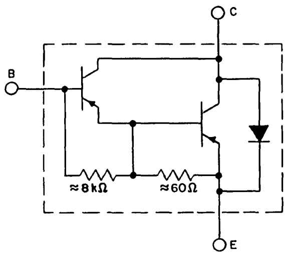
Applications:

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

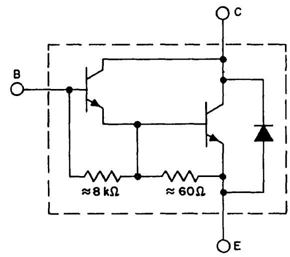
	2N6050● 2N6057	2N6051● 2N6058	2N6052● 2N6059	
* V_{CBO}	60	80	100	V
* $V_{CEO}(sus)$	60	80	100	V
* V_{EBO}		5		V
* I_C		12		A
* I_{CM}		20		A
* I_B		0.2		A
* P_T				
$T_C \leqslant 25°C$		150		W
$T_C > 25°C$ Derate linearly		0.857		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distances ⩾1/16 in.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

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



92CS-29129

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



92CS-29128

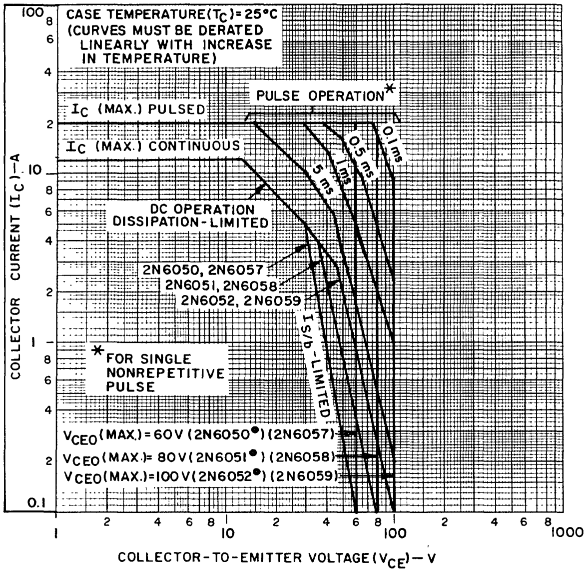
Fig. 2 — Schematic diagram for 2N6057, 2N6058, and 2N6059.

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6050• 2N6057		2N6051• 2N6058		2N6052• 2N6059		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30			0	–	1	–	–	–	–	
	40			0	–	–	–	1	–	–	
	50			0	–	–	–	–	–	1	mA
* I_{CEX}	60	−1.5			–	0.5	–	–	–	–	
	80	−1.5			–	–	–	0.5	–	–	
	100	−1.5			–	–	–	–	–	0.5	
T_C = 150°C	60	−1.5			–	5	–	–	–	–	
	80	−1.5			–	–	–	5	–	–	
	100	−1.5			–	–	–	–	–	5	
* I_{EBO}		−5	0		–	2	–	2	–	2	mA
* V_{CEO}(sus)			0.1[a]	0	60	–	80	–	100	–	V
* h_{FE}	3		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.



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

Fig. 3 — Maximum operating areas for all types.

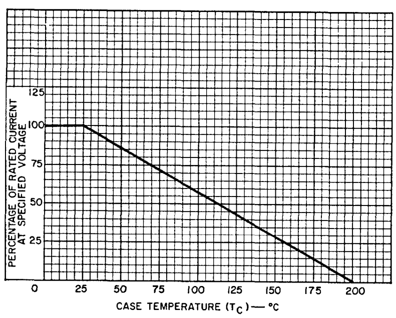


Fig. 4 — Current derating curve for all types.

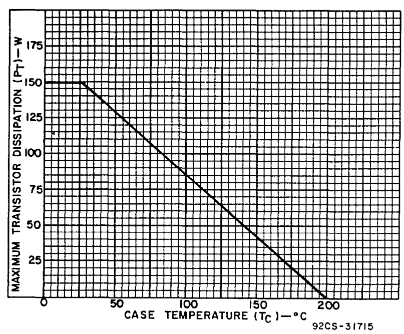


Fig. 5 — Power derating curve for all types.

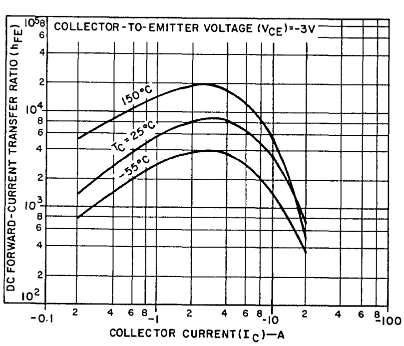


Fig. 6 — Typical dc beta characteristics for 2N6050, 2N6051, and 2N6052.

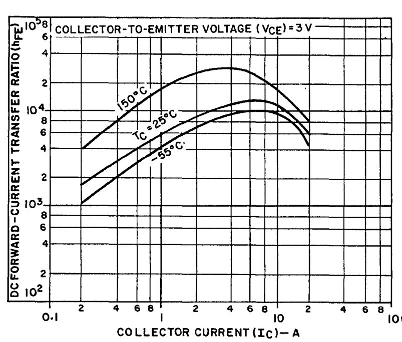


Fig. 7 — Typical dc beta characteristics for 2N6057, 2N6058, and 2N6059.

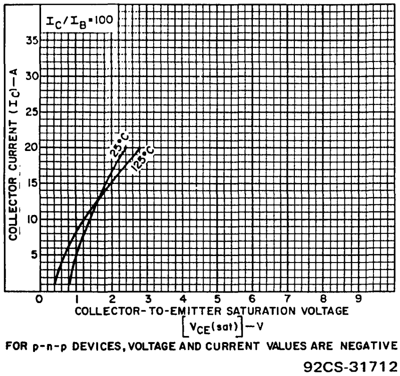


Fig. 8 — Typical saturation characteristics for all types.

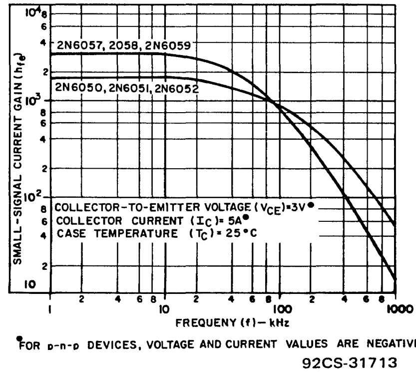


Fig. 9 — Typical small-signal current gain for all types.

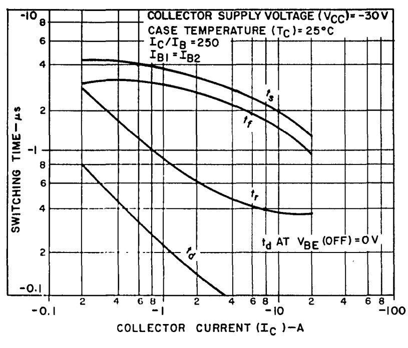


Fig. 10 — Typical switching times for 2N6050, 2N6051, and 2N6052.

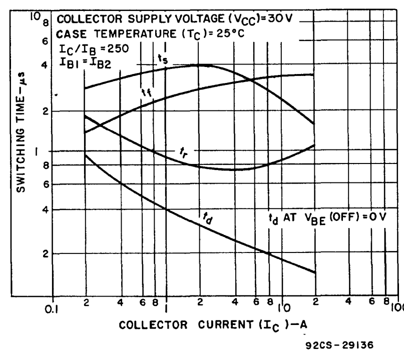


Fig. 11 — Typical switching times for 2N6057, 2N6058, and 2N6059.

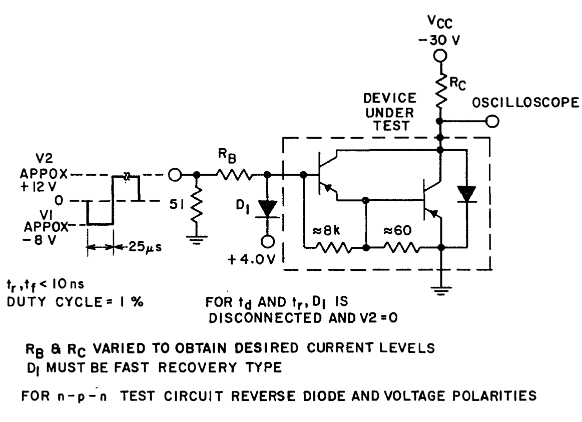


Fig. 12 — Switching times test circuit.

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

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

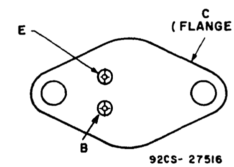
Features:

- **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.

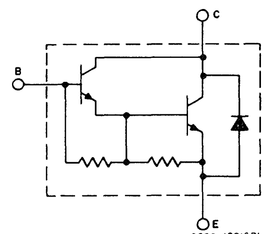


Fig.1 – Schematic diagram of 2N6055 and 2N6056 Darlington power transistors.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

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

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

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

CHARACTERISTIC SYMBOL	TEST CONDITIONS: DC VOLTAGE V			TEST CONDITIONS: DC CURRENT A			LIMITS: 2N6055		LIMITS: 2N6056		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_E	I_B	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30					0	–	0.5	–	–	mA
	40					0	–	–	–	0.5	
I_{CEX}	60		−1.5				–	0.5	–	–	
	80		−1.5				–	–	–	0.5	
I_{CEX} T_C = 150°C	60		−1.5				–	5	–	–	
	80		−1.5				–	–	–	5	
* I_{EBO}		5		0			–	2	–	2	mA
* h_{FE}	3			8[a]			100	–	100	–	
	3			4[a]			750	18,000	750	18,000	
V_{CEO}(sus)				0.1[a]			60[a]	–	80[a]	–	V
V_{CER}(sus) R_{BE} = 100 Ω				0.1[a]			60[a]	–	80[a]	–	
V_{CEX}(sus)			−1.5	0.1[a]			60[a]	–	80[a]	–	
* V_{CE}(sat)				4[a]		0.016	–	2	–	2	V
				8[a]		0.08	–	3	–	3	
* V_{BE}	3			4[a]			–	2.8	–	2.8	V
V_{BE}(sat)				8[a]		0.08	–	4	–	4	
* $\lvert h_{fe} \rvert$ 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						3	–	3	–	A
	40						–	–	2	–	
$R_{\theta JC}$							–	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%.

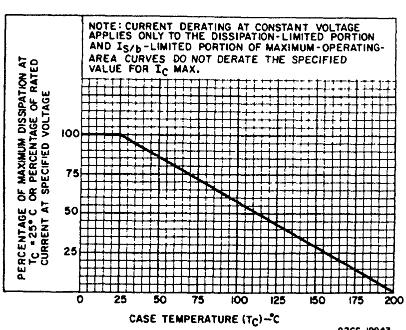


Fig.2 — Derating curve for both types.

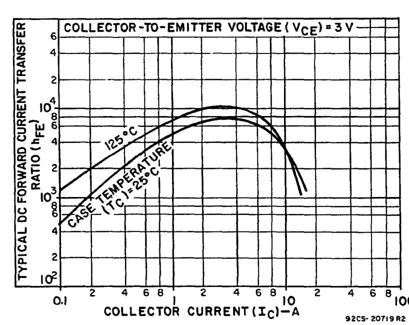


Fig.3 — Typical dc beta characteristics for both types.

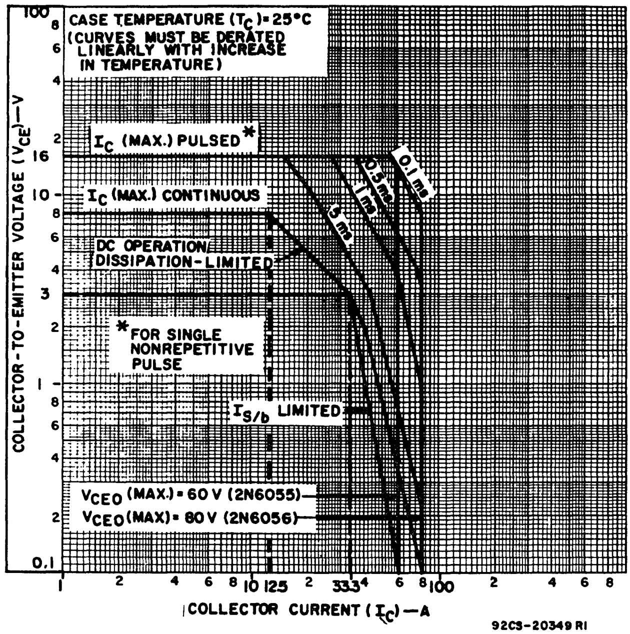


Fig.4 — Maximum operating areas for types 2N6055 and 2N6056.

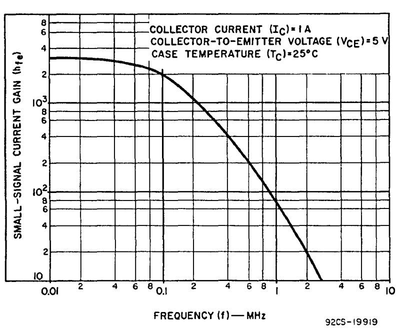


Fig. 5 — Typical small-signal gain for both types.

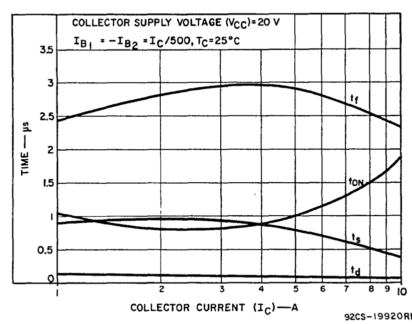


Fig. 6 — Typical saturated switching-time characteristics for both types.

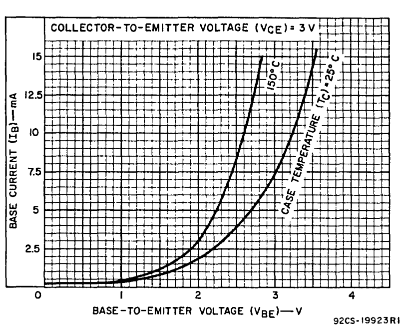


Fig. 7 — Typical input characteristics for both types.

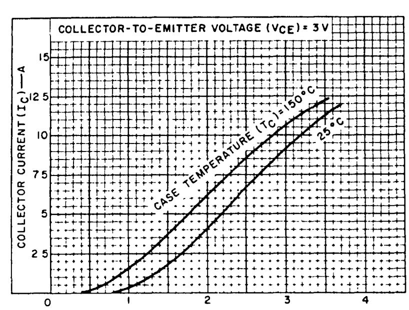


Fig. 8 — Typical transfer characteristics for both types.

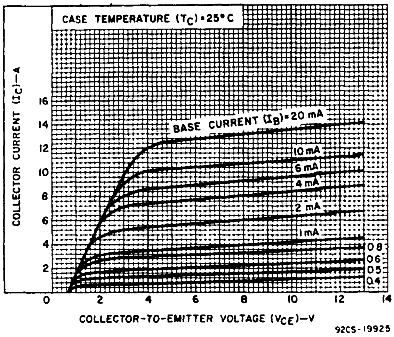


Fig. 9 — Typical output characteristics for both types.

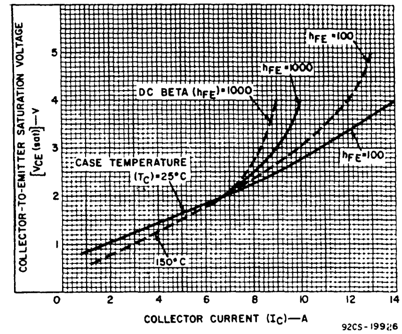


Fig. 10 — Typical saturation-voltage characteristics for both types.

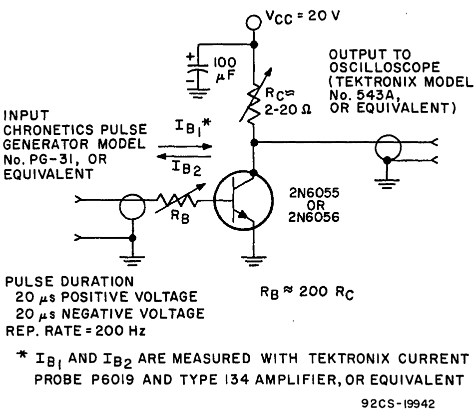


Fig. 11 — Circuit used to measure saturated switching times.

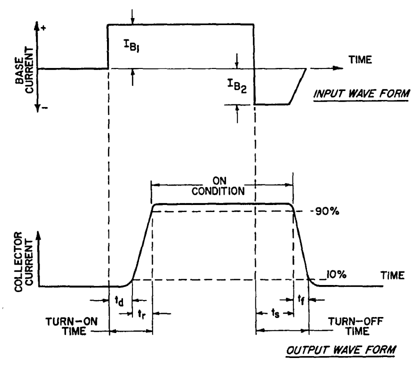


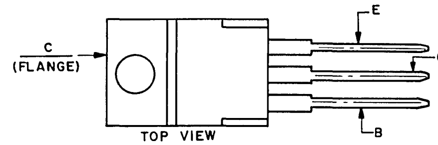
Fig. 12 — Phase relationship between input current and output current showing reference points for specification of switching times

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

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

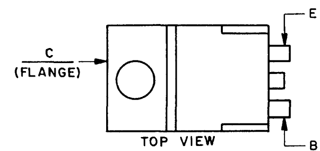
Features:
- *Low saturation voltages*
- *Complementary n-p-n and p-n-p types*
- *Maximum safe-area-of-operation curves specified for dc operation*

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.

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

CHARACTERISTIC	TEST CONDITIONS♦ VOLTAGE V dc		CURRENT A dc		LIMITS 2N6292 2N6293 2N6106♦ 2N6107♦		2N6290 2N6291 2N6108♦ 2N6109♦		2N6288 2N6289 2N6110♦ 2N6111♦		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CER} (R_{BE} = 100 Ω)	75				–	0.1	–	–	–	–	mA
	55				–	–	–	0.1	–	–	mA
	35				–	–	–	–	–	0.1	mA
(R_{BE} = 100Ω, T_C = 150°C)	70				–	2	–	–	–	–	mA
	50				–	–	–	2	–	–	mA
	30				–	–	–	–	–	2	mA
* I_{CEX} (R_{BE} = 100 Ω)	75	–1.5			–	0.1	–	–	–	–	mA
	56	–1.5			–	–	–	0.1	–	–	mA
	37.5	–1.5			–	–	–	–	–	0.1	mA
(R_{BE} = 100 Ω, T_C = 150°C)	70	–1.5			–	2	–	–	–	–	mA
	50	–1.5			–	–	–	2	–	–	mA
	30	–1.5			–	–	–	–	–	2	mA
* I_{CEO}	60			0	–	1	–	–	–	–	mA
	40			0	–	–	–	1	–	–	mA
	20			0	–	–	–	–	–	1	mA
* I_{EBO}		–5	0		–	1	–	1	–	1	mA
* 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	–	V
* 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	–	–	V
	4		3[a]		–	–	–	–	–	1.5	V
	4		7[a]		–	3	–	3	–	3	V
* V_{CE}(sat)			2[a]	0.2	–	1	–	–	–	–	V
			2.5[a]	0.25	–	–	–	1	–	–	V
			3[a]	0.3	–	–	–	–	–	1	V
*			7[a]	3	–	3.5	–	3.5	–	3.5	V
* $\|h_{fe}\|$ (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	–	MHz
* 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	°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) 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.

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

* In accordance with JEDEC registration data

[a] Pulsed: Pulse duration = 300 μs, duty factor = 0.018.

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

[c] V_{CB} value.

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

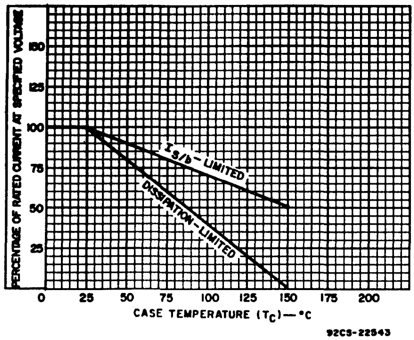


Fig. 1 — Current derating curves for all types.

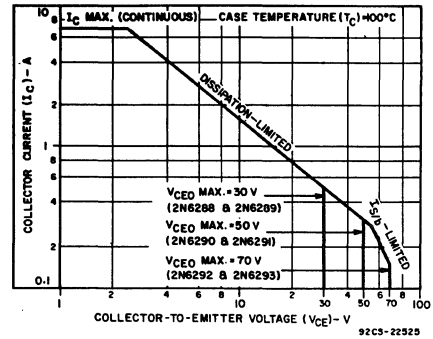


Fig. 2 - Maximum operating areas for 2N6288 — 2N6293 (T_C = 100°C).

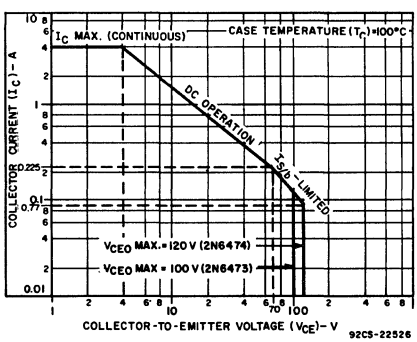


Fig. 3 - Maximum operating areas for 2N6473 — 2N6474 (T_C = 100°C).

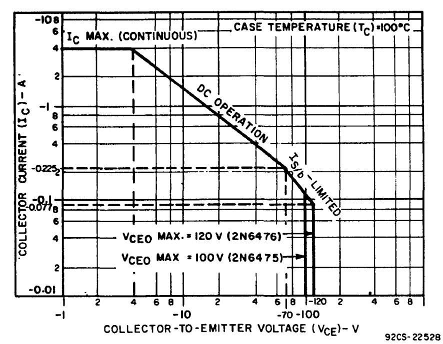


Fig. 4 - Maximum operating areas for 2N6475 and 2N6476 (T_C = 100°C).

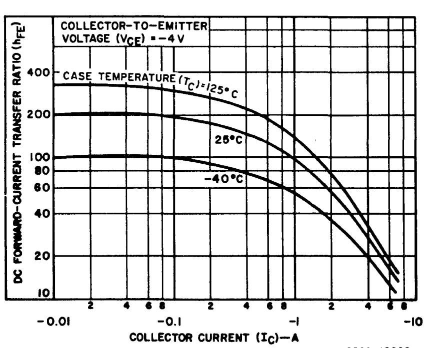


Fig. 5 - Typical dc beta characteristics for 2N6106 — 2N6111.

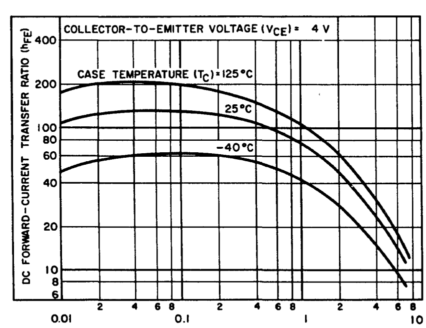


Fig. 6 - Typical dc beta characteristics for 2N6288 — 2N6293.

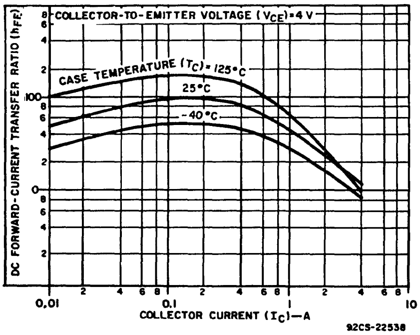


Fig. 7 - Typical dc beta characteristics for 2N6473 and 2N6474.

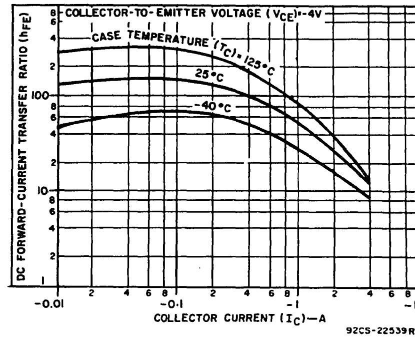


Fig. 8 - Typical dc beta characteristics for 2N6475 and 2N6476.

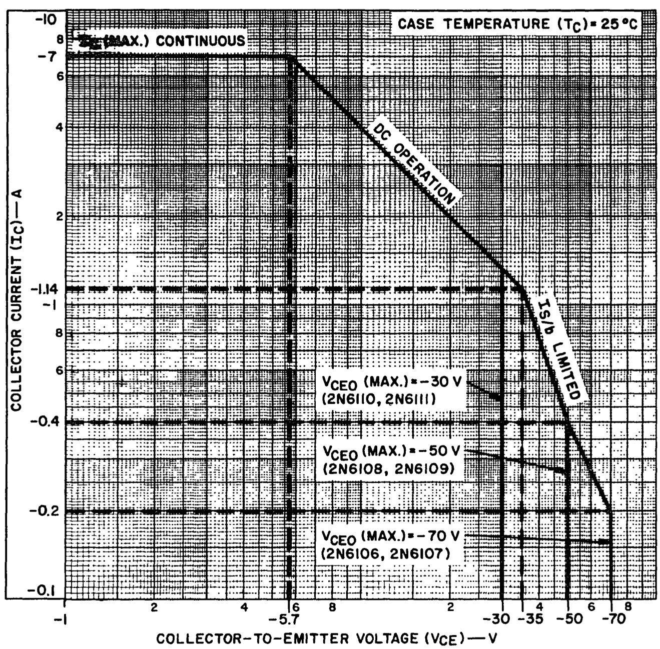


Fig. 9 - Maximum operating areas for 2N6106 – 2N6111 (T_C = 25°C).

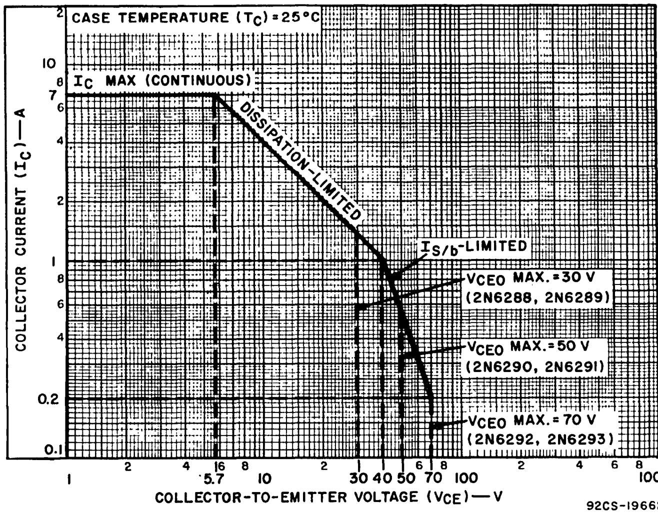


Fig. 10 - Maximum operating areas for 2N6288–2N6293 (T_C = 25°C).

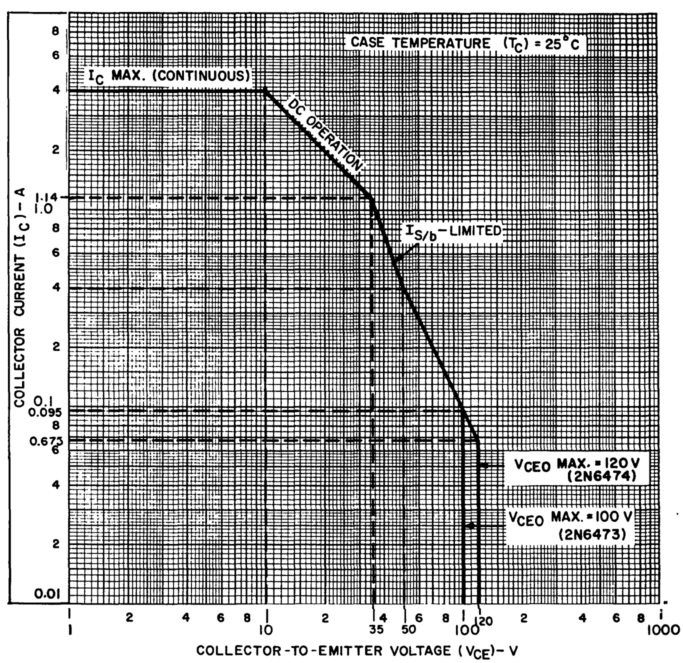


Fig. 11 - Maximum operating areas for 2N6473 and 2N6474 (T_C = 25°C).

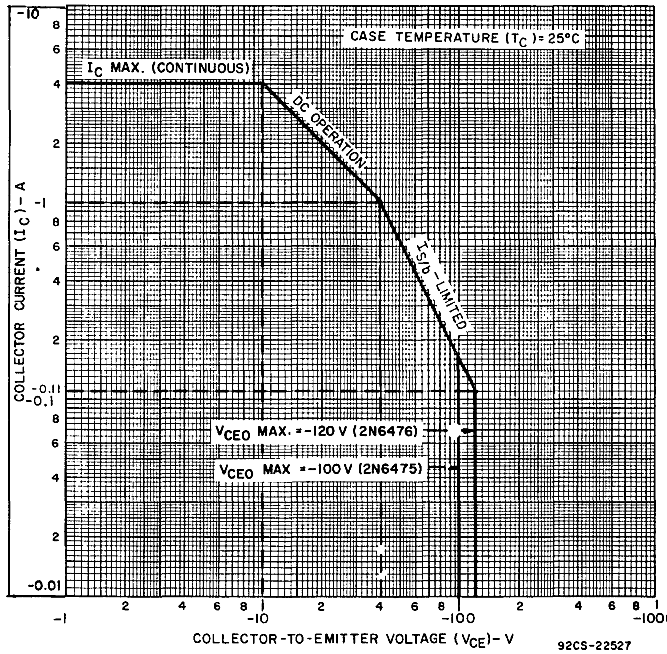


Fig. 12 - Maximum operating areas for 2N6475 – 2N6476 (T_C = 25°C).

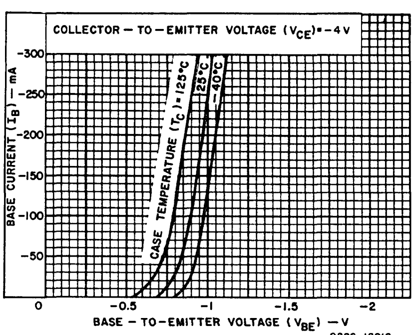


Fig. 13 - Typical input characteristics for 2N6106 – 2N6111, 2N6475, and 2N6476.

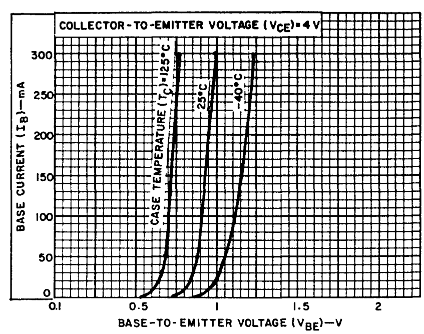


Fig. 14 - Typical input characteristics for 2N6288 – 2N6293.

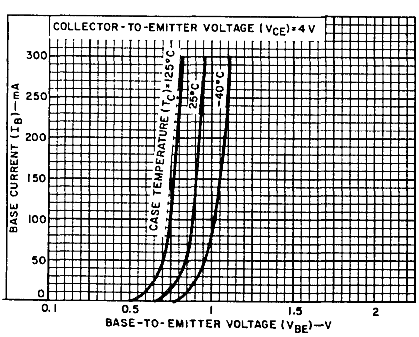


Fig. 15 - Typical input characteristics for 2N6473 2N6474.

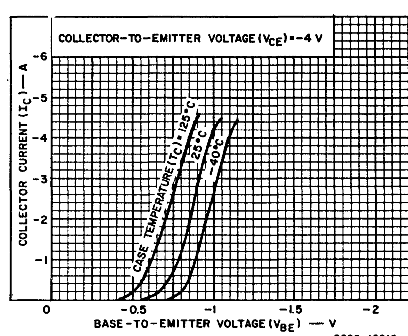


Fig. 16 - Typical transfer characteristics for 2N6106 – 2N6111.

2 POWER TRANSISTORS

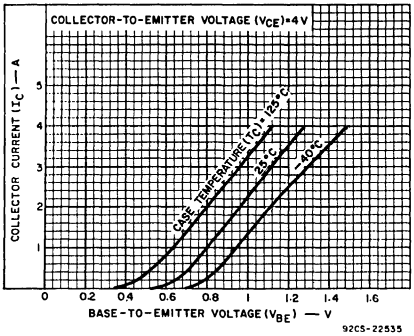


Fig. 17 - Typical transfer characteristics for 2N6288 – 2N6293.

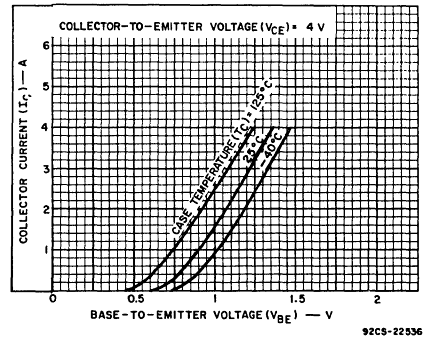


Fig. 18 - Typical transfer characteristics for 2N6473 and 2N6474.

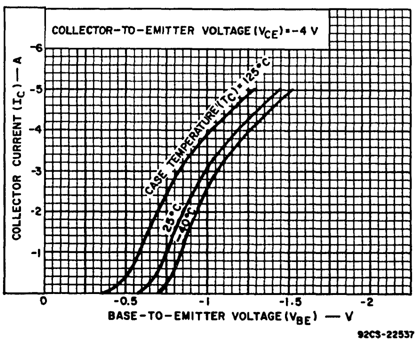


Fig. 19 - Typical transfer characteristics for 2N6475 and 2N6476.

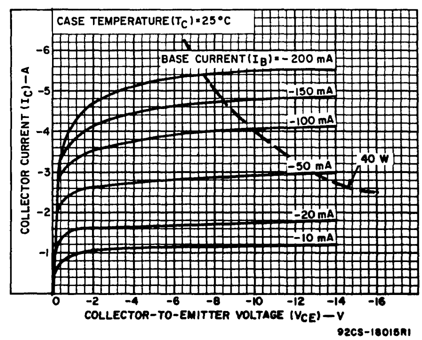


Fig. 20 - Typical output characteristics for 2N6106 – 2N6111.

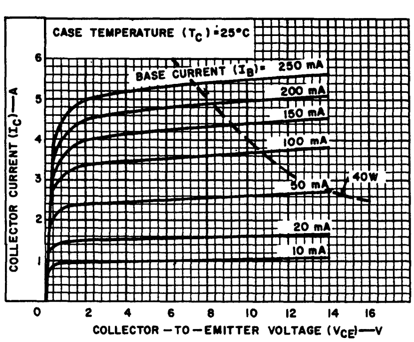


Fig. 21 - Typical output characteristics for 2N6288 – 2N6293.

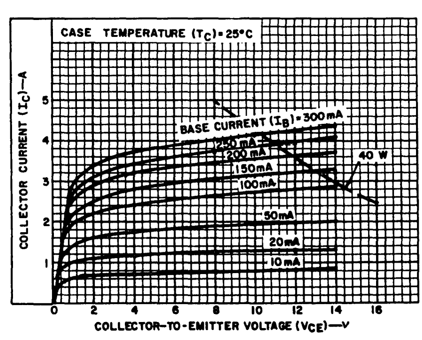


Fig. 22 - Typical output characteristics for 2N6473 and 2N6474.

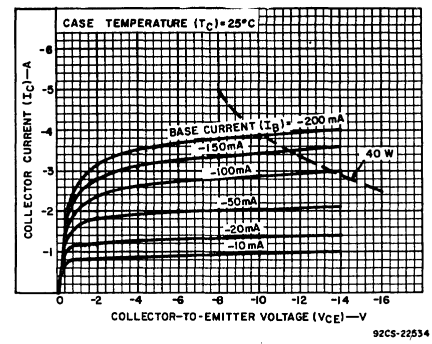


Fig. 23 – Typical output characteristics for 2N6475 and 2N6476.

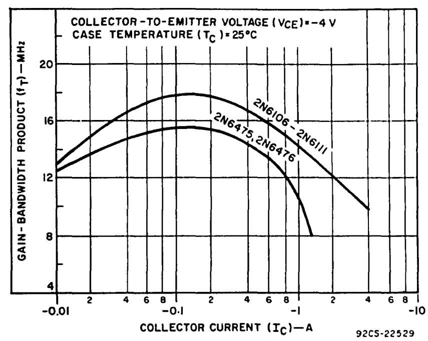


Fig. 24 – Typical gain-bandwidth product 2N6106 – 2N6111, 2N6475, and 2N6476.

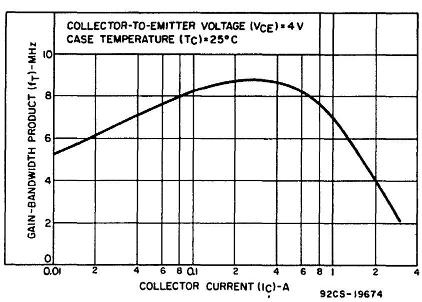


Fig. 25 – Typical gain-bandwidth product for 2N6288 – 2N6293.

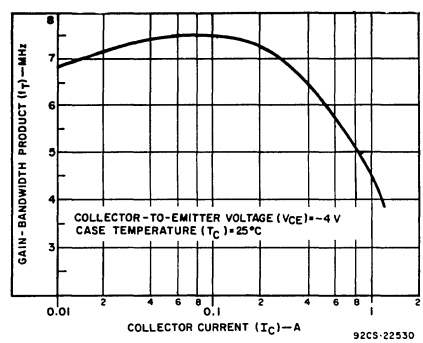


Fig. 26 – Typical gain-bandwidth product for 2N6473 and 2N6474.

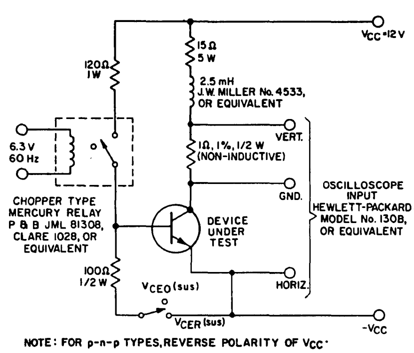
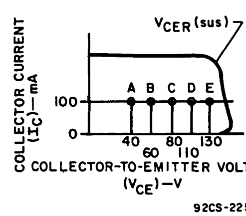


Fig. 27 – Circuit used to measure sustaining voltage V_{CER}(sus) for all types.



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).

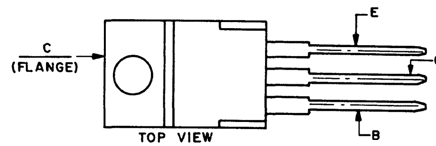
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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

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 $\geq$ 1/8 in. (3.17 mm) from case for 10 s max.			235		°C

*In accordance with JEDEC registration data.

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

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

CHARACTERISTIC	TEST CONDITIONS♦				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6121 2N6124♦		2N6122 2N6125♦		2N6123 2N6126♦		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CBO}	45[a]				–	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	
* $\|h_{fe}\|$ (f=1 MHz)	4		1		2.5	–	2.5	–	2.5	–	
* h_{fe} (f=1 kHz)	2		0.1		25	–	25	–	25	–	
$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	°C/W

* In accordance with JEDEC registration data.

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

[a] V_{CB} value.

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

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

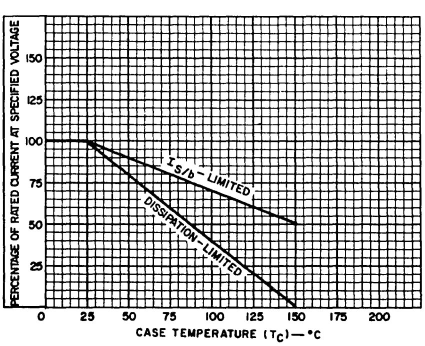


Fig. 1 — Current derating curves for all types.

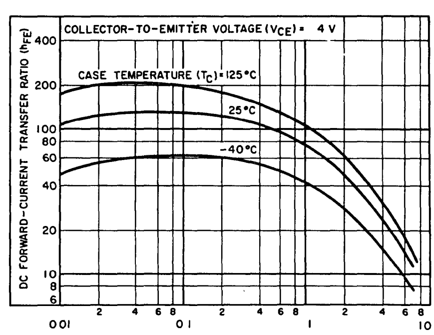


Fig. 2 — Typical dc beta characteristics for all types.

2 POWER TRANSISTORS

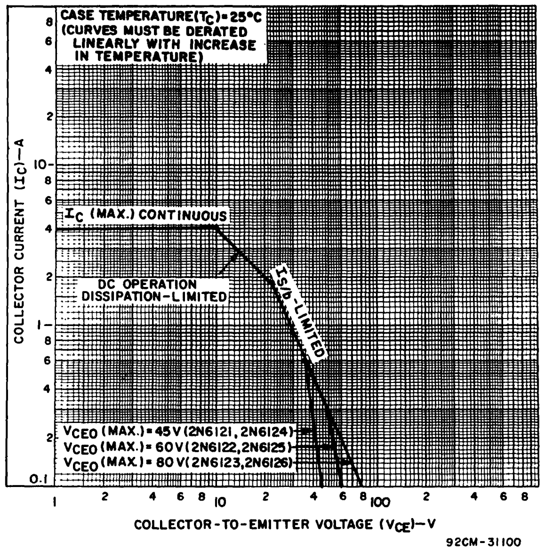


Fig. 3 — Maximum operating areas for all types.

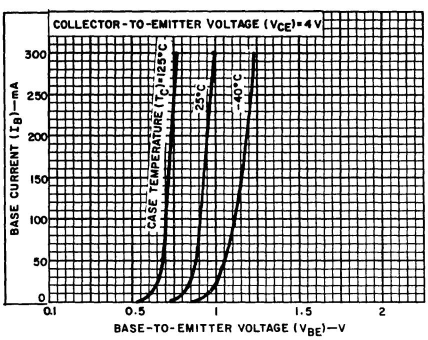


Fig. 4 — Typical input characteristics for all types.

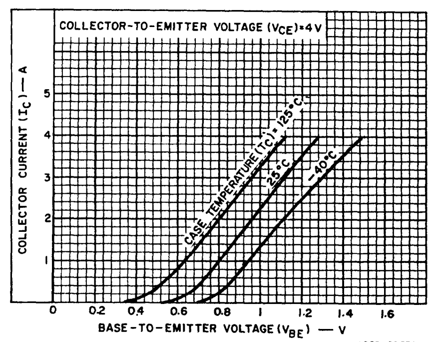


Fig. 5 — Typical transfer characteristics for all types.

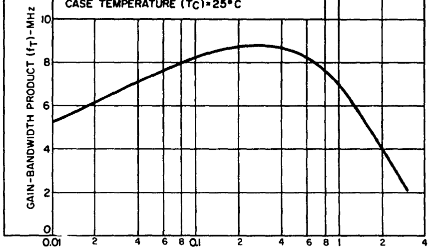


Fig. 6 — Typical gain-bandwidth product.

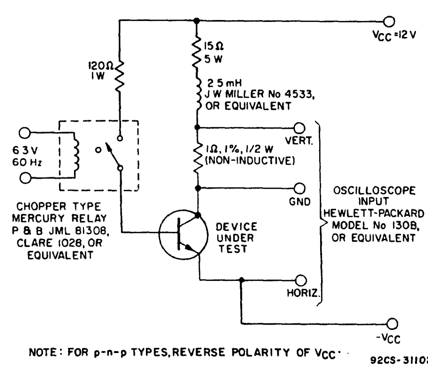


Fig. 7 — Circuit used to measure sustaining voltage $V_{CEO}(sus)$ for all types.

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

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

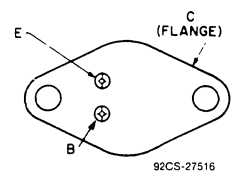
Features:
- *High voltage ratings:*
  $V_{CEO}(sus)$ = -400 V max. (2N6214)
  = -350 V max. (2N6213)
  = -300 V max. (2N6212)
  = -225 V max. (2N6211)

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					LIMITS								UNITS
		Voltage V dc		Current A dc			2N6211		2N6212		2N6213		2N6214		
		V_{CE}	V_{BE}	I_C	I_E	I_B	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With base open	I_{CEO}	−150				0	–	−5	–	−5	–	−5	–	−5	mA
* With base-emitter junction reverse-biased	I_{CEV}	−250	1.5				–	−0.5	–	–	–	–	–	–	mA
		−315	1.5				–	–	–	−0.5	–	–	–	–	
		−360	1.5				–	–	–	–	–	−0.5	–	–	
		−410	1.5				–	–	–	–	–	–	–	−1	
* With base-emitter junction reverse biased and T_C = 100°C	I_{CEV}	−250	1.5				–	−5	–	–	–	–	–	–	mA
		−315	1.5				–	–	–	−5	–	–	–	–	
		−360	1.5				–	–	–	–	–	−5	–	–	
		−410	1.5				–	–	–	–	–	–	–	−10	
* Emitter-Cutoff Current	I_{EBO}		6	0			–	−1	–	−0.5	–	−0.5	–	−0.5	mA
* DC Forward-Current Transfer Ratio	h_{FE}	−2.8		−1[a]			10	100	–	–	–	–	–	–	
		−3.2		−1[a]			–	–	10	100	–	–	–	–	
		−4		−1[a]			–	–	–	–	10	100	–	–	
		−5		−1[a]			–	–	–	–	–	–	10	100	
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			−0.2[a]		0	−225	–	−300	–	−350	–	−400	–	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER}(sus)$			−0.2			−250	–	−325	–	−375	–	−425	–	V
With base-emitter junction reverse-biased and external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CEX}(sus)$		1.5	−0.2			−275	–	−350	–	−400	–	−450	–	V
* Emitter-to-Base Voltage	V_{EBO}					0.5 mA	–	–	−6	–	−6	–	−6	–	V
						1 mA	−6				–	–	–	–	
* Emitter-to-Base Saturation Voltage	$V_{BE}(sat)$			−1[a]		−0.125	–	−1.4	–	−1.4	–	−1.4	–	−1.4	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			−1[a]		−0.125	–	−1.4	–	−1.6	–	−2	–	−2.5	V
Output Capacitance (f = 1 MHz)	C_{obo}	−10 (V_{CB})			0		–	220	–	220	–	220	–	220	pF
Second-Breakdown Collector Current (Base forward-biased)	$I_{S/b}$	−40					−0.875	–	−0.875	–	−0.875	–	−0.875	–	A
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 5 MHz)	$\|h_{fe}\|$	−10		−0.2			4	–	4	–	4	–	4	–	
* Saturated Switching Times: Rise time	t_r	V_{CC} = −200 V		−1		I_{B1} & I_{B2} −0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Storage time	t_s	V_{CC} = −200 V		−1		I_{B1} & I_{B2} −0.125	–	2.5	–	2.5	–	2.5	–	2.5	μs
Fall time	t_f	V_{CC} = −200 V		−1		I_{B1} & I_{B2} −0.125	–	0.6	–	0.6	–	0.6	–	0.6	μs
Thermal Resistance (Junction-to-case)	$R_{\theta JC}$	−10		−1			–	5	–	5	–	5	–	5	°C/W

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

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

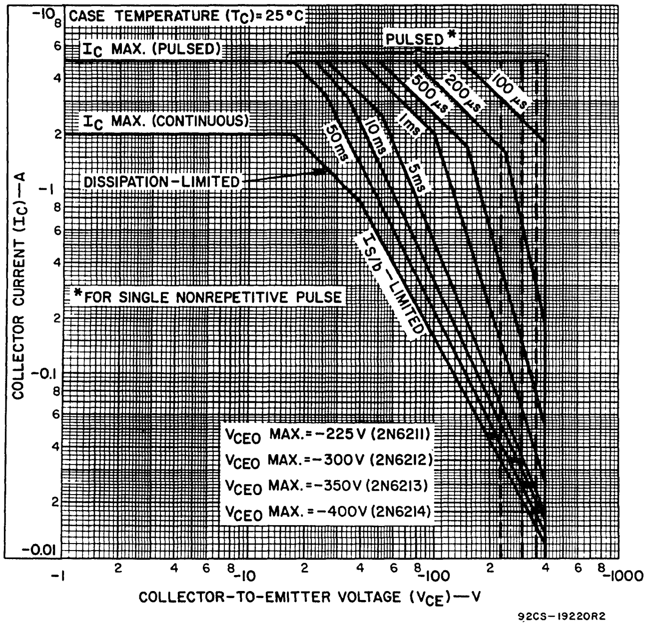


Fig. 1 - Maximum operating areas for all types.

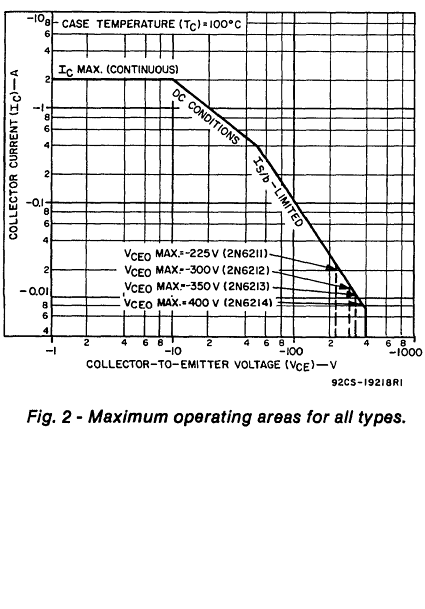


Fig. 2 - Maximum operating areas for all types.

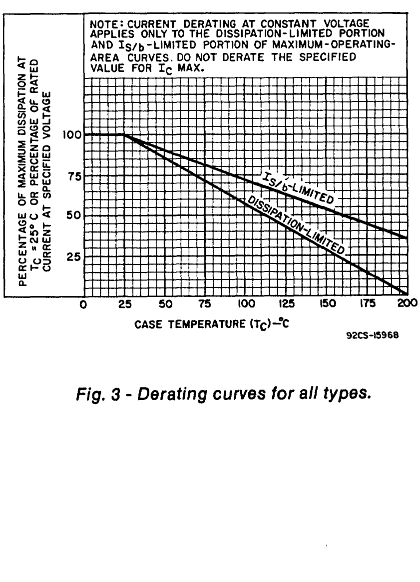


Fig. 3 - Derating curves for all types.

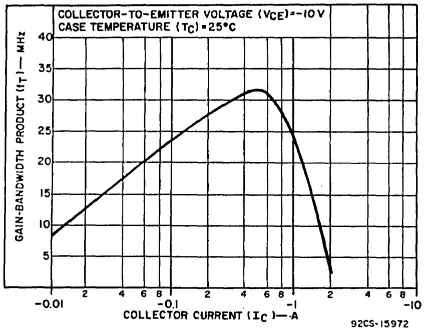


Fig. 4 - Typical gain-bandwidth product for all types.

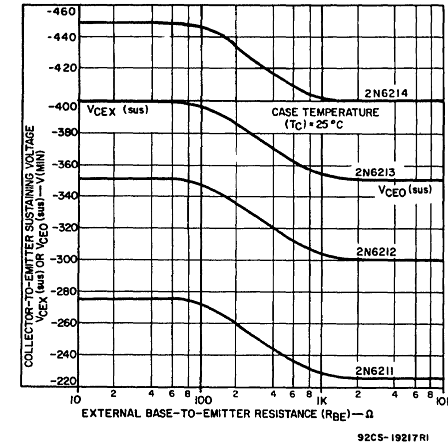


Fig. 5 - Collector-to-emitter sustaining-voltage characteristics for all types.

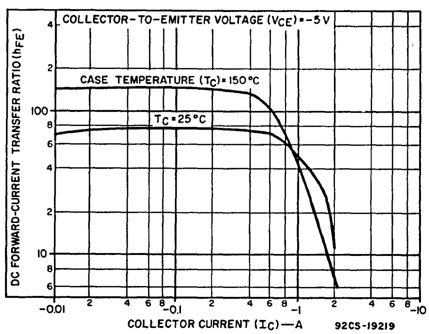


Fig. 6 - Typical dc beta characteristic for all types.

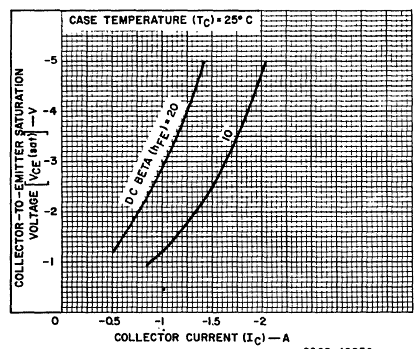


Fig. 7 - Typical saturation-voltage characteristics for all types.

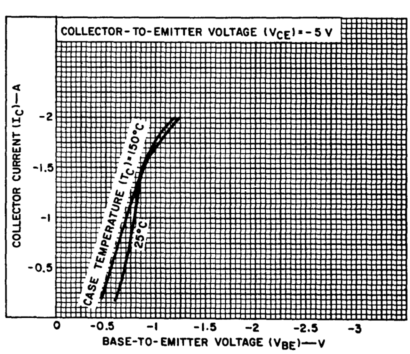


Fig. 8 - Typical transfer characteristics for all types.

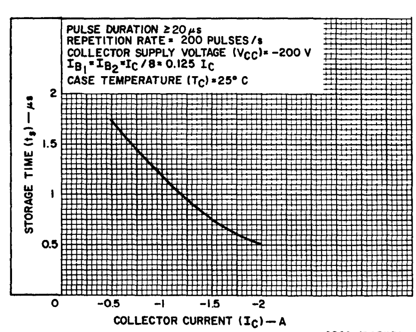


Fig. 9 - Typical storage-time characteristics for all types.

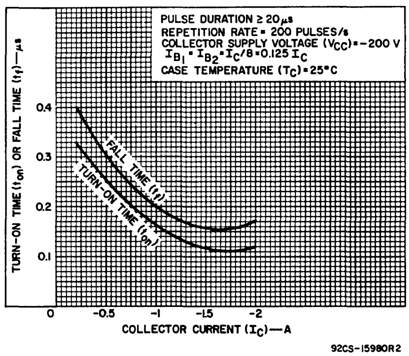


Fig. 10 - Typical turn-on time and fall-time characteristics for all types.

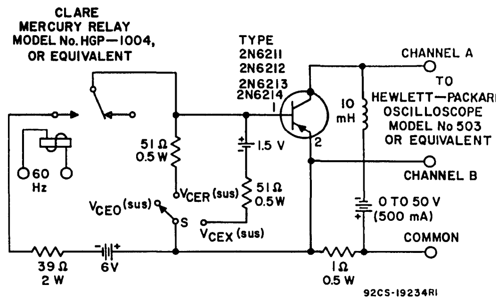


Fig. 11 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$ and $V_{CEX}(sus)$ for all types.

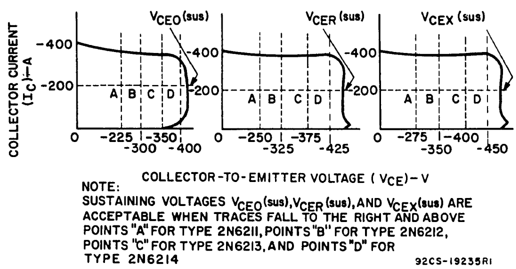


Fig. 12 - Oscilloscope display for measurement of sustaining voltages.

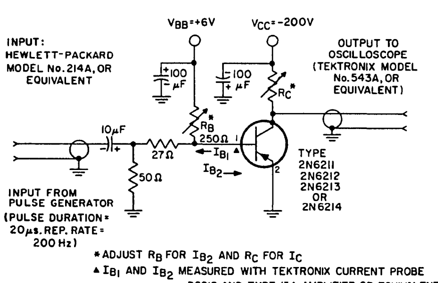


Fig. 13 - Circuit used to measure saturated switching times for all types.

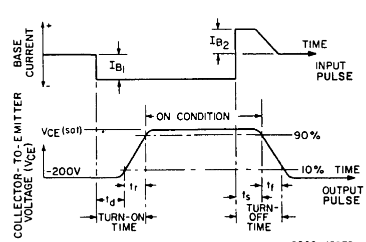


Fig. 14 - Phase relationship between input current and output voltage showing reference points for specification of switching times.

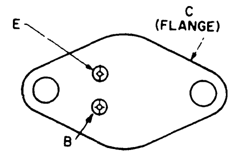
Silicon P-N-P Epitaxial-Base, High-Power Transistors

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



92CS-27516

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).

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}	 V_{BE}	 CURRENT A dc I_C	 I_B	LIMITS 2N6469 Min.	 Max.	 2N6246 Min.	 Max.	UNITS
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: Sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer.*

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}	VOLTAGE V dc, V_{BE}	CURRENT A dc, I_C	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				–	–200	–	–	µA
		–95				–	–	–	–200	
* With base-emitter junction reverse-biased	I_{CEX}	–85	1.5			–	–200	–	–	µA
		–100	1.5			–	–	–	–200	
* With reverse bias, at T_C = 150°C	I_{CEX}	–70	1.5			–	–5	–	–	mA
		–90	1.5			–	–	–	–5	
* With base open	I_{CEO}	–40			0	–	–1	–	–	mA
		–50			0	–	–	–	–1	
* Emitter-Cutoff Current	I_{EBO}		5		0	–	–1	–	–1	mA
* DC Forward-Current Transfer Ratio	h_{FE}	–4		–5[a]		–	–	20	100	
		–4		–6[a]		20	100	–	–	
		–4		–10[a]		–	–	5	–	
		–4		–15[a]		5	–	–	–	
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		–6[a]		–	–1.8	–	–	V
		–4		–5[a]		–	–	–	–1.8	
* Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			–5[a]	–0.5	–	–	–	–1.3	V
				–6[a]	–0.6	–	–1.3	–	–	
				–15[a]	–4	–	–3.5	–	–	
				–10[a]	–2	–	–	–	–3.5	
* 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.*

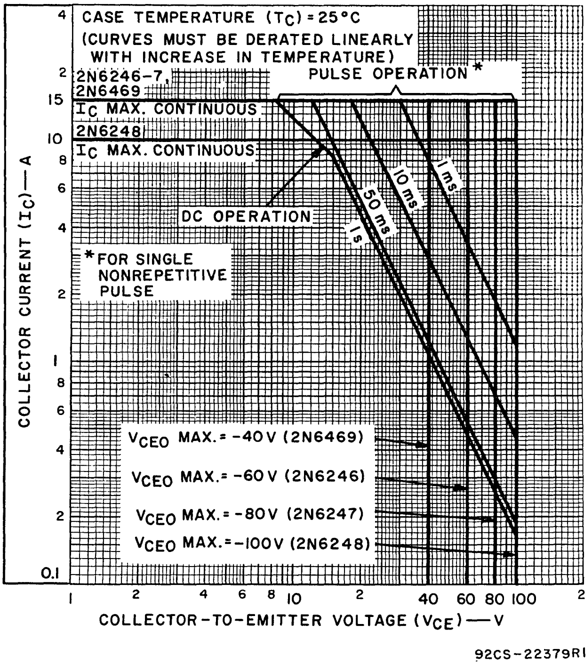


Fig. 1 — Maximum operating areas for all types.

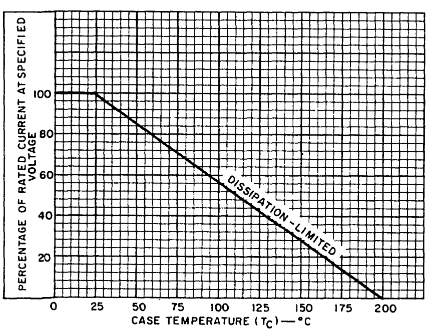


Fig. 2 — Current derating for all types.

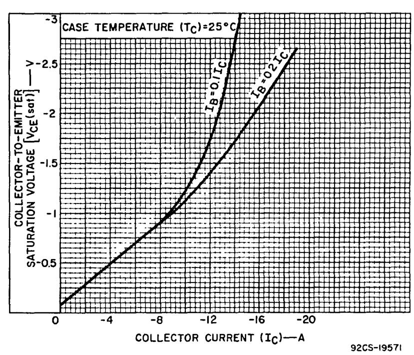


Fig. 3 — Typical collector-to-emitter saturation-voltage characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

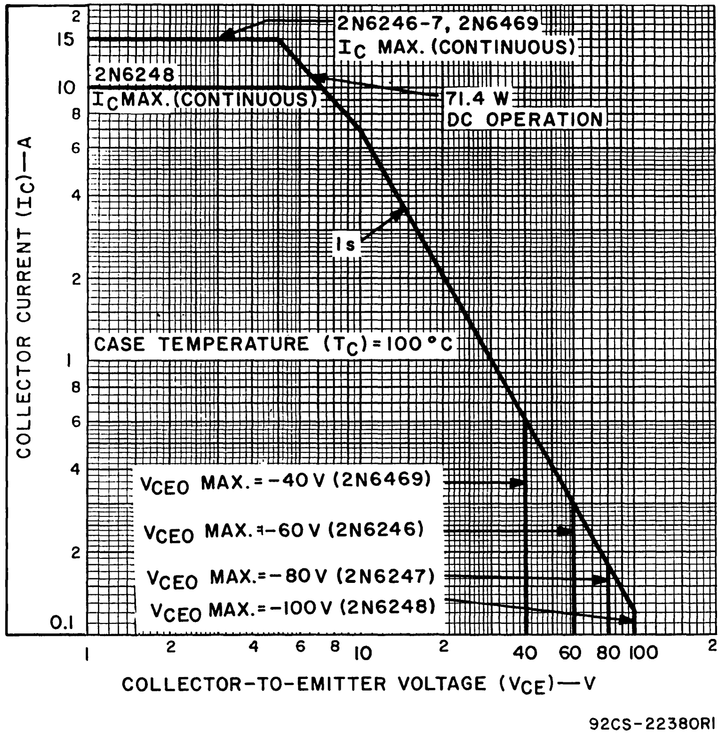


Fig. 4 — Maximum operating areas for all types.

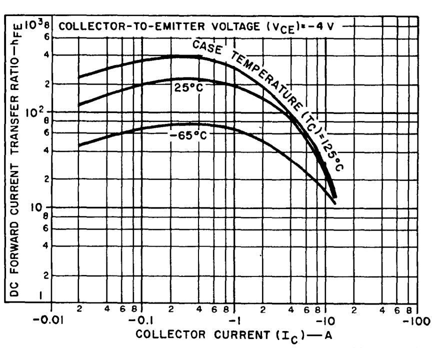


Fig. 5 — Typical dc beta characteristics for 2N6246, 2N6247, and 2N6469.

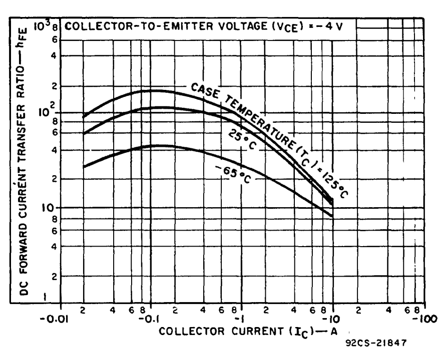


Fig. 6 — Typical dc beta characteristics for 2N6248.

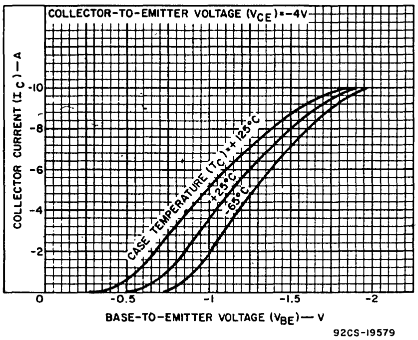


Fig. 7 — Typical transfer characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

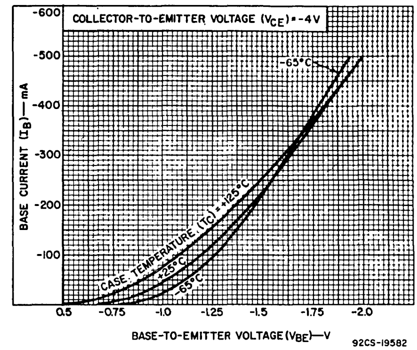


Fig. 8 — Typical input characteristics for 2N6246, 2N6247, and 2N6469.

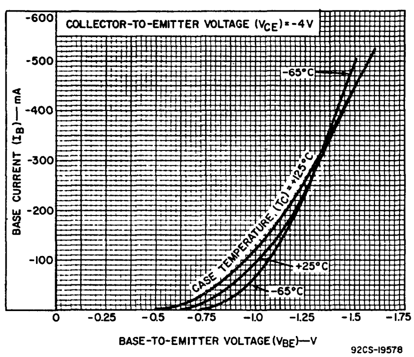


Fig. 9 — Typical input characteristics for 2N6248.

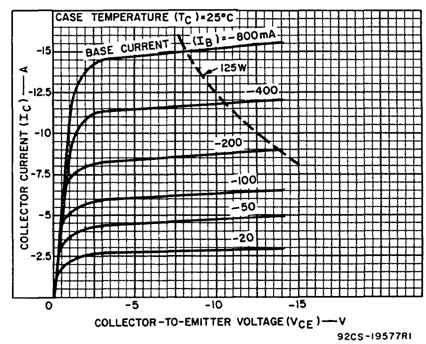


Fig. 10 — Typical output characteristics for 2N6246, 2N6247, and 2N6469.

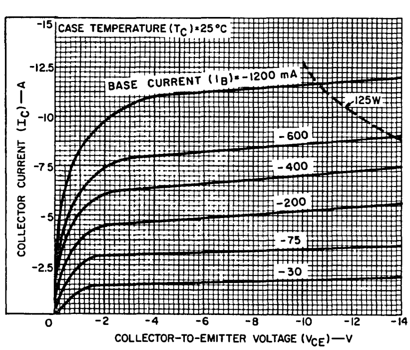


Fig. 11 — Typical output characteristics for 2N6248.

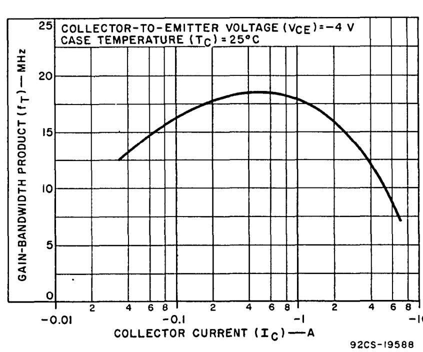


Fig. 12 — Typical gain-bandwidth product vs. collector current for 2N6246, 2N6247, 2N6248, and 2N6469.

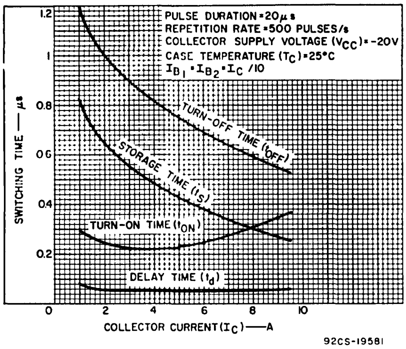


Fig. 13 — Typical saturated switching characteristics for 2N6246, 2N6247, 2N6248, and 2N6469.

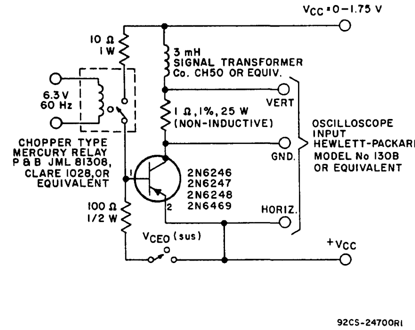


Fig. 14 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ for all types.

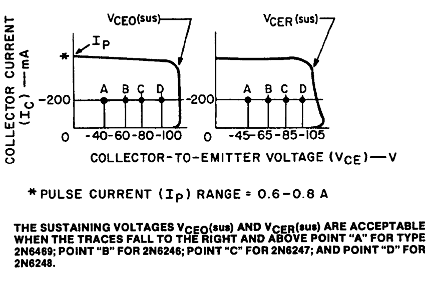


Fig. 15 — Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 14).

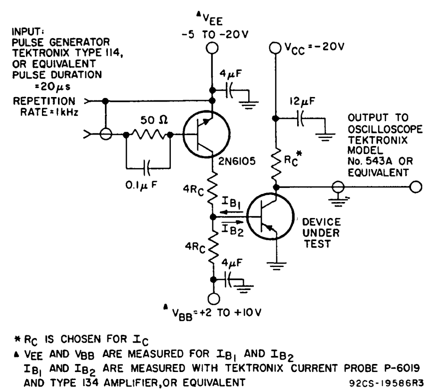


Fig. 16 — Circuit used to measure switching times for 2N6246, 2N6247, 2N6248, and 2N6469.

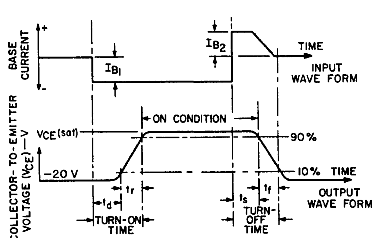


Fig. 17 — Oscilloscope display for measurement of switching times.

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*

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.

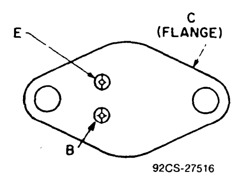
These devices use the popular JEDEC TO-204AA package; they differ mainly in voltage ratings, leakage-current limits, and V_{CE}(sat) ratings.

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).

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

CHARAC-TERISTIC	TEST CONDITIONS DC VOLTAGE (V) V_{CE}	DC CURRENT (A) I_C	I_B	2N6249 MIN.	2N6249 TYP.	2N6249 MAX.	2N6250 MIN.	2N6250 TYP.	2N6250 MAX.	2N6251 MIN.	2N6251 TYP.	2N6251 MAX.	UNITS
I_{CEO}	150		0	–	–	5	–	–	–	–	–	–	
	225		0	–	–	–	–	–	5	–	–	–	
	300		0	–	–	–	–	–	–	–	–	5	
* I_{CEV}	225			–	–	5	–	–	–	–	–	–	
V_{BE} = −1.5	300			–	–	–	–	–	5	–	–	–	mA
	375			–	–	–	–	–	–	–	–	5	
* I_{CEV}	225			–	–	10	–	–	–	–	–	–	
V_{BE} = −1.5	300			–	–	–	–	–	10	–	–	–	
T_C = 125°C	375			–	–	–	–	–	–	–	–	10	
* I_{EBO} V_{BE} = −6				–	–	1	–	–	1	–	–	1	mA
* $V_{CEO}(sus)$		0.2		200[b]	–	–	275[b]	–	–	350[b]	–	–	V
$V_{CER}(sus)$ R_{BE} = 50 Ω		0.2		225[b]	–	–	300[b]	–	–	375[b]	–	–	V
* V_{EBO} I_E = 1 mA				6	–	–	6	–	–	6	–	–	V
* h_{FE}	3	10[a]		10	–	50	–	–	–	–	–	–	
	3	10[a]		–	–	–	8	–	50	–	–	–	
	3	10[a]		–	–	–	–	–	–	6	–	50	
* $V_{BE}(sat)$		10[a]	1	–	–	2.25	–	–	–	–	–	–	
		10[a]	1.25	–	–	–	–	–	2.25	–	–	–	V
		10[a]	1.67	–	–	–	–	–	–	–	–	2.25	
* $V_{CE}(sat)$		10[a]	1	–	–	1.5	–	–	–	–	–	–	
		10[a]	1.25	–	–	–	–	–	1.5	–	–	–	V
		10[a]	1.67	–	–	–	–	–	–	–	–	1.5	
* $\|h_{fe}\|$ f = 1 MHz	10	1		2.5	8	–	2.5	8	–	2.5	8	–	
* $I_{S/b}$ t_p = 1s nonrep.	30			5.8	–	–	5.8	–	–	5.8	–	–	A
* $E_{S/b}$ V_{BE} = −4 R_B = 50 Ω, L = 50 μH		10[c]		2.5	–	–	2.5	–	–	2.5	–	–	mJ
* t_r		10	1	–	0.8	2	–	–	–	–	–	–	
V_{CC} = 200 V,		10	1.25	–	–	–	–	0.8	2	–	–	–	
I_{B1} = $-I_{B2}$		10	1.67	–	–	–	–	–	–	–	0.8	2	
* t_s		10	1	–	1.8	3.5	–	–	–	–	–	–	
V_{CC} = 200 V,		10	1.25	–	–	–	–	1.8	3.5	–	–	–	μs
I_{B1} = $-I_{B2}$		10	1.67	–	–	–	–	–	–	–	1.8	3.5	
* t_f		10	1	–	0.5	1	–	–	–	–	–	–	
V_{CC} = 200 V,		10	1.25	–	–	–	–	0.5	1	–	–	–	
I_{B1} = $-I_{B2}$		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.

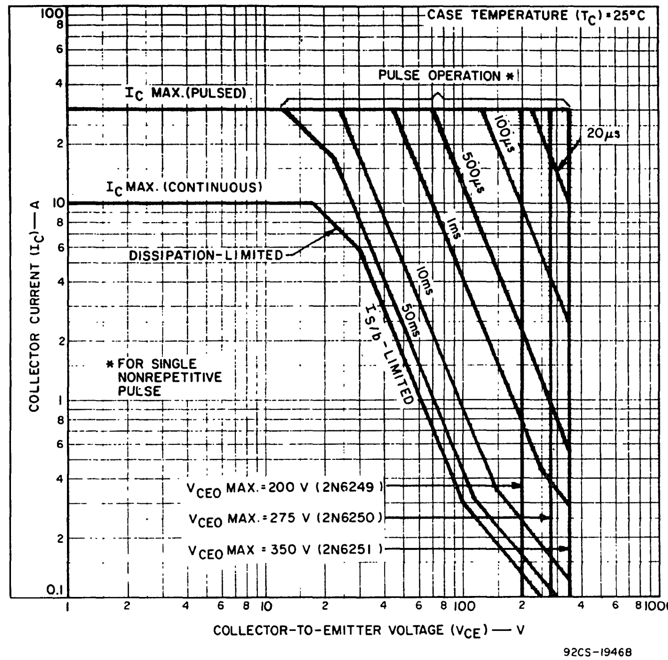


Fig. 1 - Maximum operating areas for all types at T_C = 25° C.

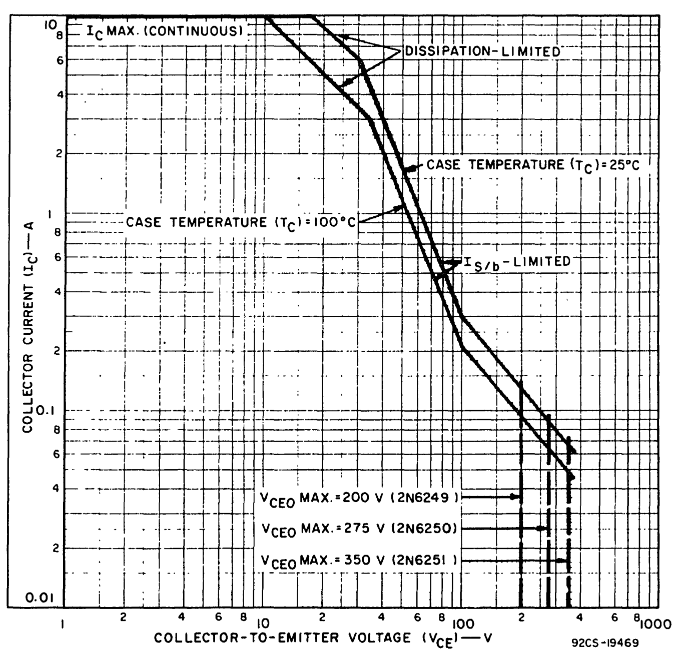


Fig. 2 - Maximum operating areas for all types at T_C = 100° C.

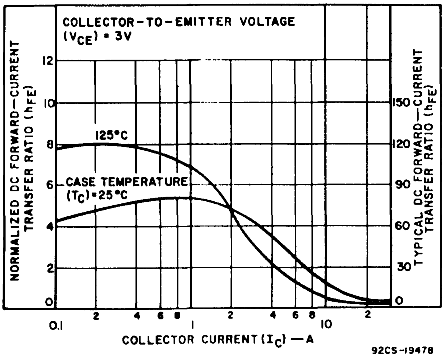


Fig. 3 - Typical normalized dc beta characteristics for all types.

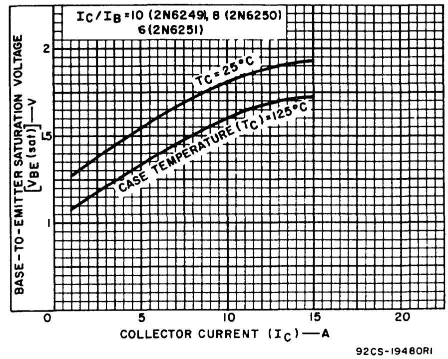


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for all types.

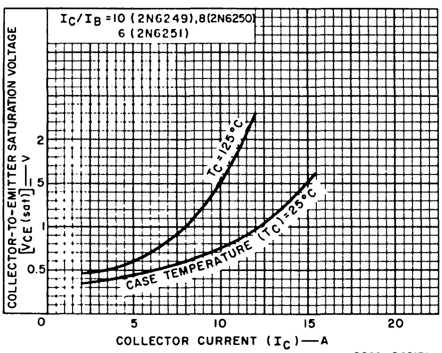


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

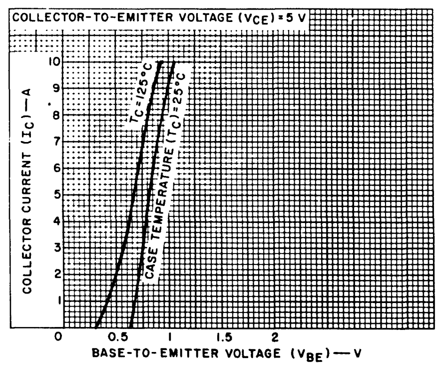


Fig. 6 - Typical transfer characteristics for all types.

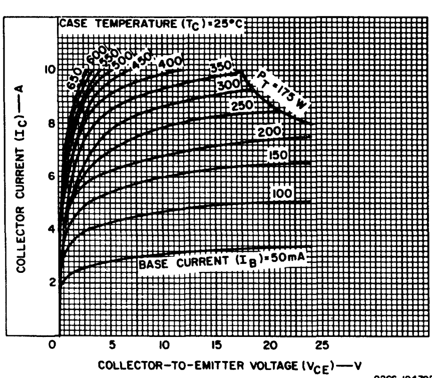


Fig. 7 - Typical output characteristics for all types.

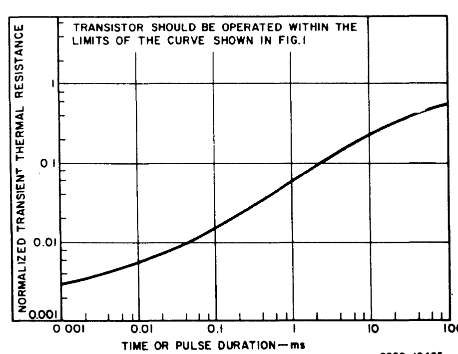


Fig. 8 - Typical thermal response characteristics for all types.

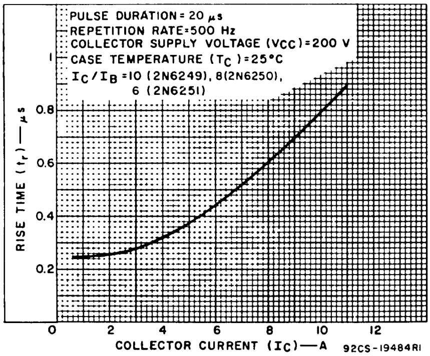


Fig. 9 - Typical rise-time characteristics for all types.

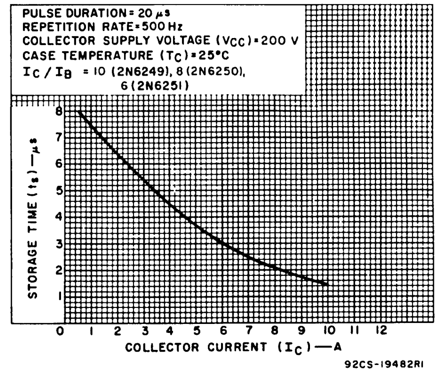


Fig. 10 - Typical storage-time characteristics for all types (with constant forced gain).

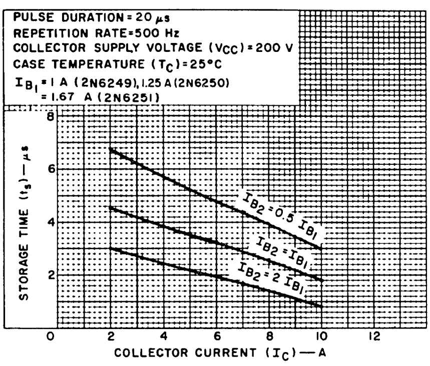


Fig. 11 - Typical storage-time characteristics for all types (with constant base drive).

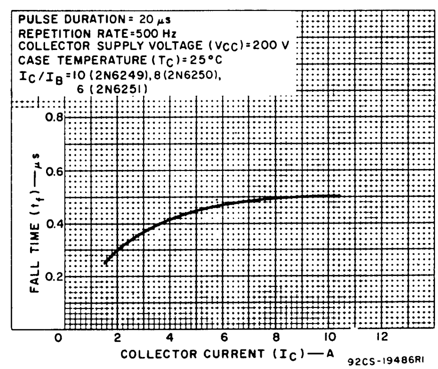


Fig. 12 - Typical fall-time characteristic for all types.

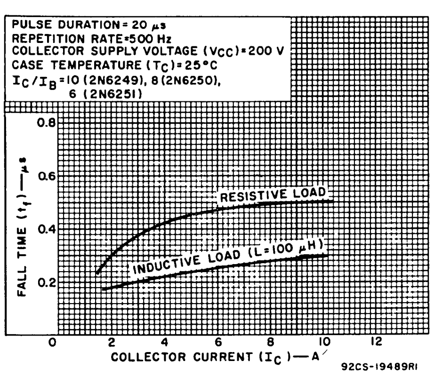


Fig. 13 - Typical inductive- and resistive-load fall-time characteristics for all types.

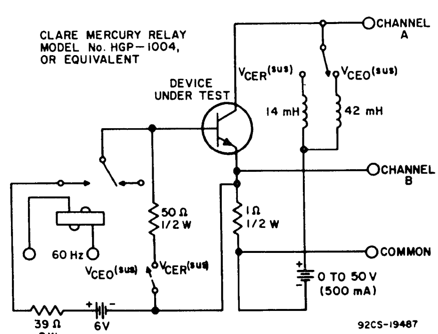
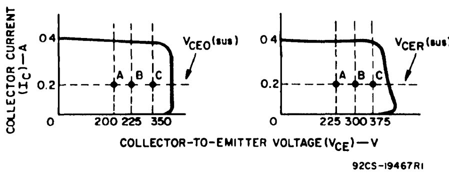


Fig. 14 - Circuit used to measure sustaining voltage V_{CEO}(sus) and V_{CER}(sus) for all types.



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.

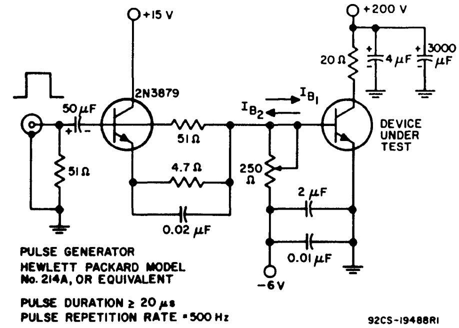


Fig. 16 - Circuit used to measure switching times for all types.

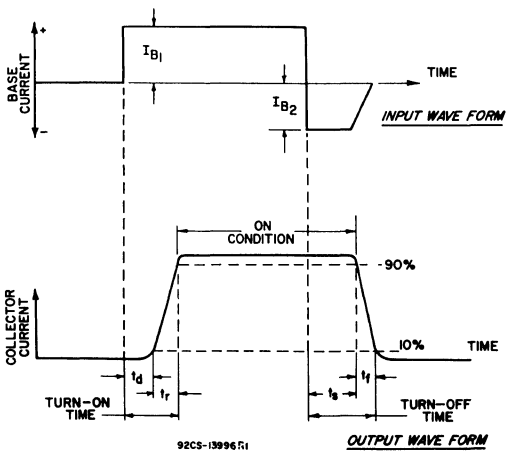


Fig. 17 - Phase relationship between input and output currents showing reference points for specifications of switching times.

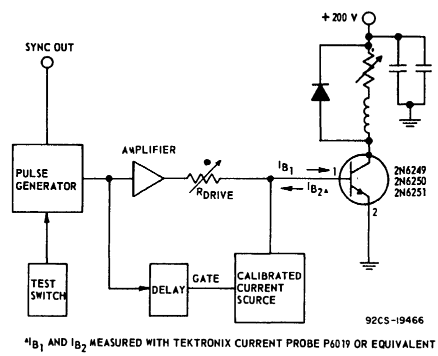


Fig. 18 - Circuit used to measure inductive-load switching times for all types.

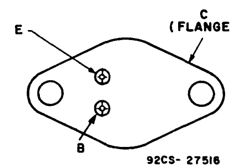
20-Ampere Complementary N-P-N and P-N-P Monolithic Darlington Power Transistors

60-80-100 Volts, 160 Watts
Gain of 2400 (Typ.) at 10 A (2N6282, 2N6283, 2N6284)
Gain of 3500 (Typ.) at 10 A (2N6285, 2N6286, 2N6287)

Features:

- **Operates from IC without predriver**
- **Monolithic construction**

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 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				
$T_C \leq 25^\circ C$	160	160	160	W
$T_C > 25^\circ C$ 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.

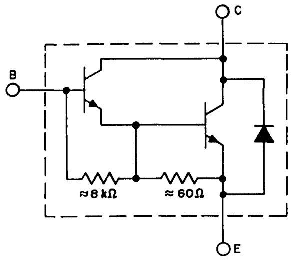


Fig. 1 – Schematic diagram for 2N6282, 2N6283, and 2N6284.

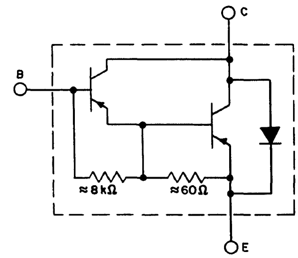
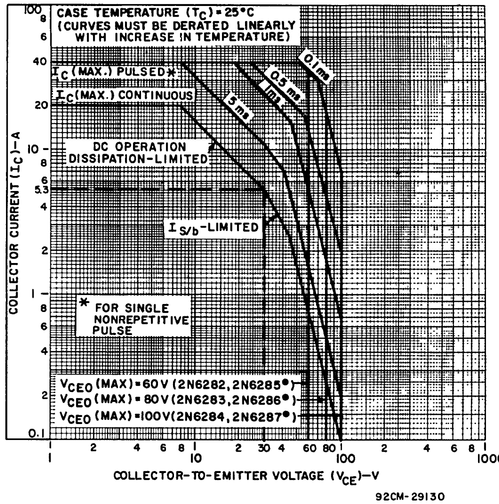


Fig. 2 – Schematic diagram for 2N6285, 2N6286, and 2N6287.

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6282 2N6285●		2N6283 2N6286●		2N6284 2N6287●		
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	30			0	–	1	–	–	–	–	mA
	40			0	–	–	–	1	–	–	
	50			0	–	–	–	–	–	1	
* I_{CEX}	60	−1.5			–	0.5	–	–	–	–	
	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.



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

Fig. 3 — Maximum operating areas for all types.

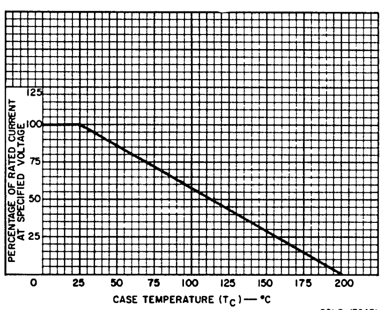


Fig. 4 — Current derating curve for all types.

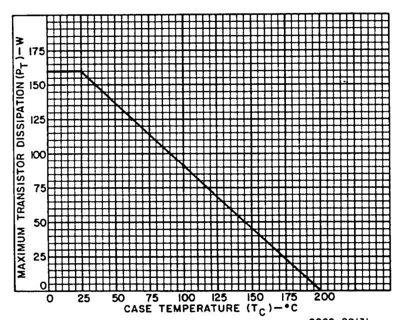


Fig. 5 — Power derating curve for all types.

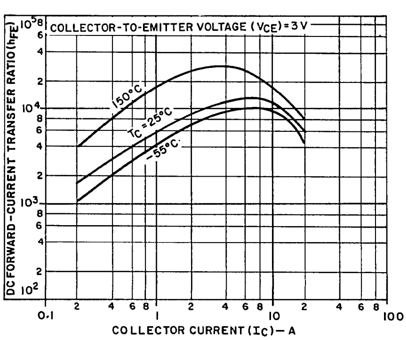


Fig. 6 — Typical dc beta characteristics for 2N6282, 2N6283, and 2N6284.

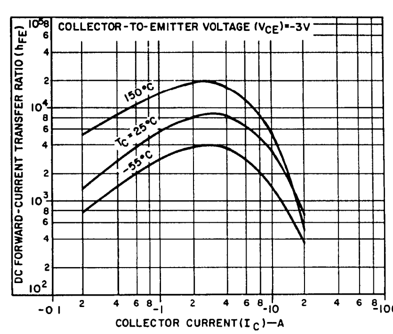


Fig. 7 — Typical dc beta characteristics for 2N6285, 2N6286, and 2N6287.

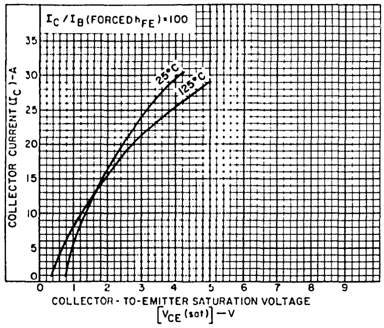


Fig. 8 — Typical saturation characteristics for all types.

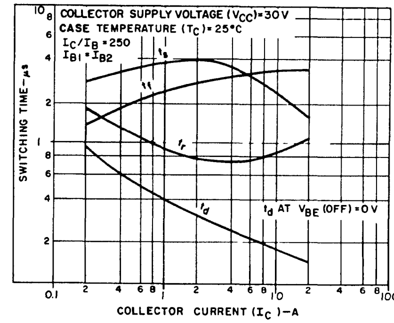


Fig. 9 — Typical switching times for 2N6282, 2N6283, and 2N6284.

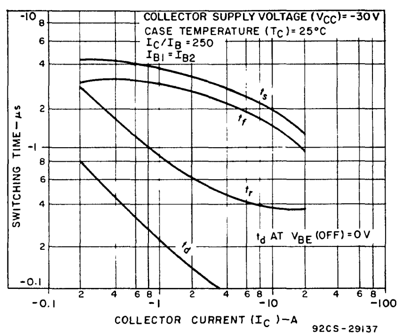


Fig. 10 — Typical switching times for 2N6285, 2N6286, and 2N6287.

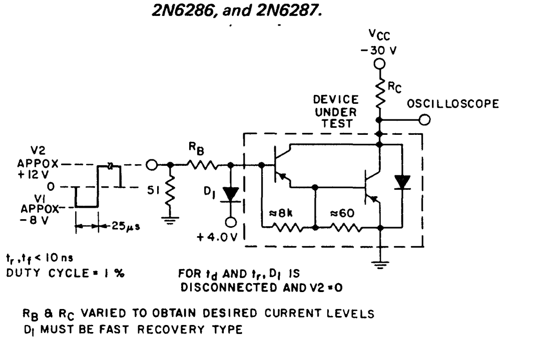


Fig. 11 - Switching times test circuit.

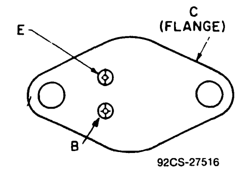
120-V, 10-A, 140-W Silicon N-P-N Planar Transistor

For Switching Applications in
Military and Industrial Equipment

Features:

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

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.

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS						LIMITS		UNITS
		DC VOLTAGE (V)				DC CURRENT (A)		2N6354		
		V_{CE}	V_{CB}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	
* Collector-Cutoff Current: With emitter open	I_{CBO}		150					–	5	mA
With base open	I_{CEO}	100					0	–	20	mA
* With base-emitter junction reverse-biased	I_{CEV}	140			0			–	10	mA
* At T_C = 125°C	I_{CEV}	140			0			–	20	mA
* Emitter-Cutoff Current	I_{EBO}			6.5		0		–	5	mA
* Emitter-to-Base Voltage	V_{EBO}						0.005	6.5	–	V
* Collector-to-Emitter Voltage: At breakdown, with base open	$V_{(BR)CEO}$					0.2	0	120[b]	–	V
With external base-to emitter resistance (R_{BE}) ≤ 100 Ω	$V_{CER(sus)}$[f]					0.2	0	130[b]	–	V
* Saturation Voltage: Collector-to-Emitter	$V_{CE}(sat)$					5[a] 10[a]	0.5 1.0	– –	0.5 1	V
Base-to-Emitter	$V_{BE}(sat)$					5[a] 10[a]	0.5 1.0	– –	1.3 2	V
* DC Forward Current Transfer Ratio	h_{FE}	2 2				5[a] 10[a]		20 10	150 100	
Forward-Bias Second-Breakdown Collector Current[d]	$I_{S/b}$[c]	25 45						5.5 0.5	– –	A
Second-Breakdown Energy (With base reverse biased, R_{BE}=51 Ω, L = 25 µH)	$E_{S/b}$[g]			1		5		0.3	–	mJ
* Magnitude of Common Emitter, Small-Signal, Short-Circuit Forward Current Transfer Ratio (f = 10 MHz)	$\|h_{fe}\|$	10				1		8	–	
* Saturated Switching Time: (See Figs. 11 & 12) Rise Time	t_r	V_{CC} = 30				5 10	0.5[e] 1[e]	– –	0.3 1	µs
Storage Time	t_{s1}	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] $I_{B1} = I_{B2}$ = 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.

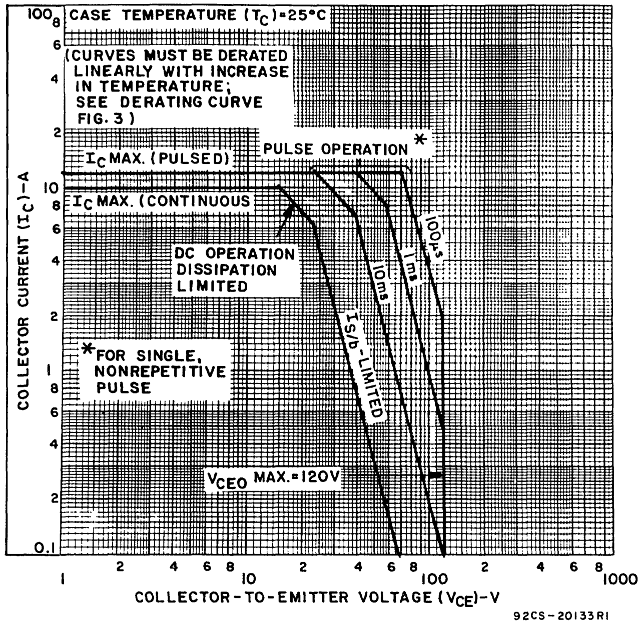


Fig. 1 - Maximum operating areas.

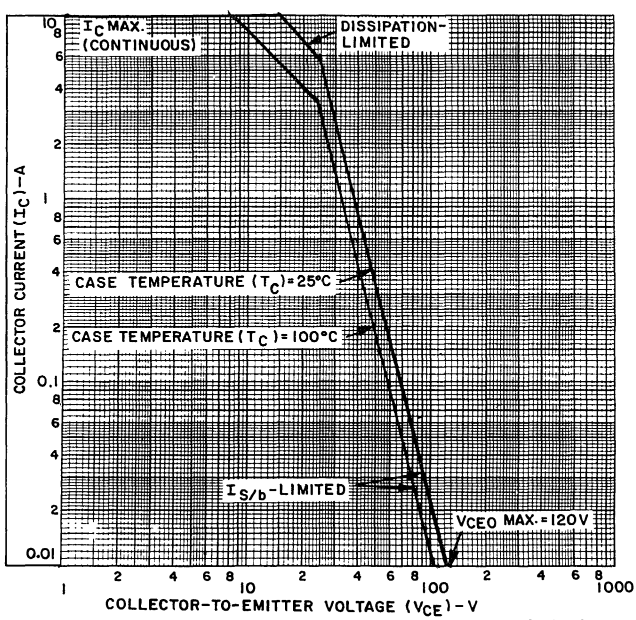


Fig. 2 - Maximum operating areas.

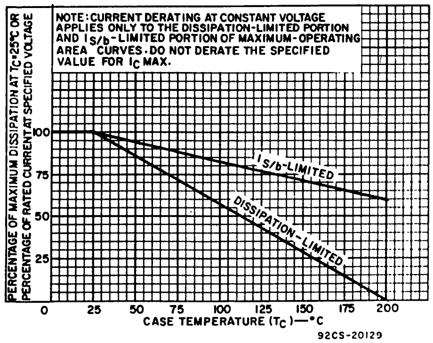


Fig. 3 - Derating curves.

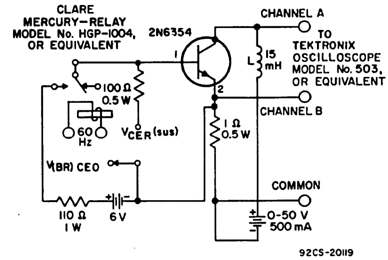
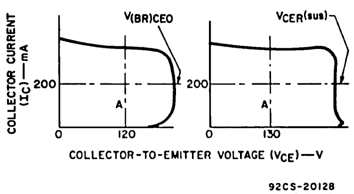


Fig. 4 - Circuit used to measure voltages $V_{(BR)CEO}$ and $V_{CER}(sus)$.



NOTE: The voltages $V_{(BR)CEO}$ and $V_{CER(sus)}$ are acceptable when the trace falls to the right of and above point "A".

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

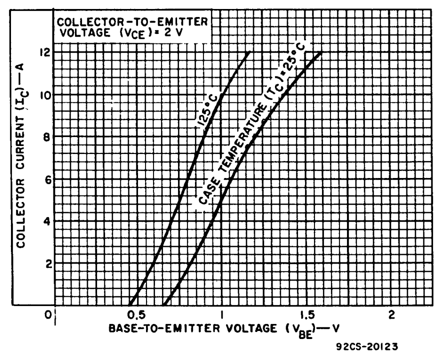


Fig. 6 - Typical transfer characteristics.

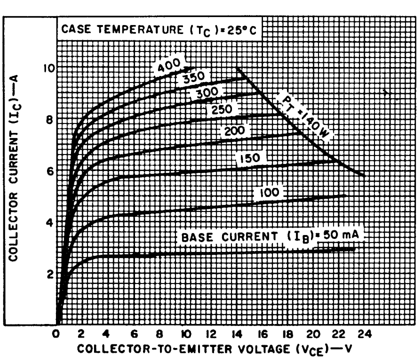


Fig. 7 - Typical output characteristics.

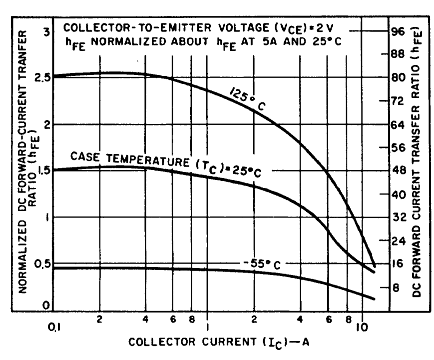


Fig. 8 - Typical normalized dc beta characteristics.

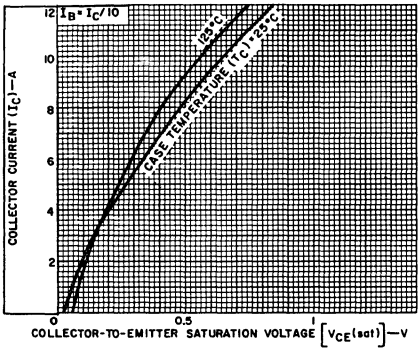


Fig. 9 - Typical saturation voltage characteristics.

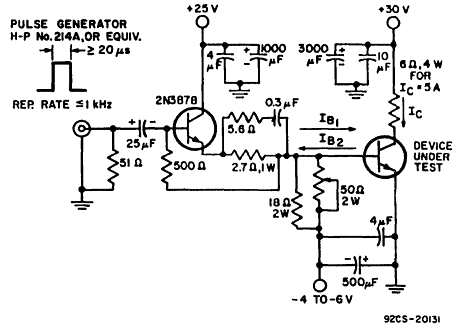


Fig. 10 - Circuit used to measure switching times.

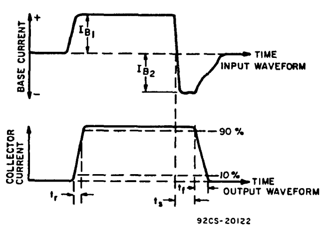


Fig. 11 - Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 11).

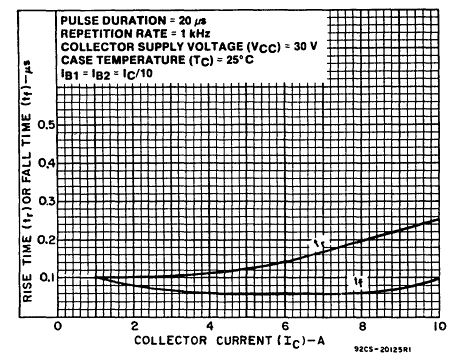


Fig. 12 - Typical rise-and fall-time characteristics.

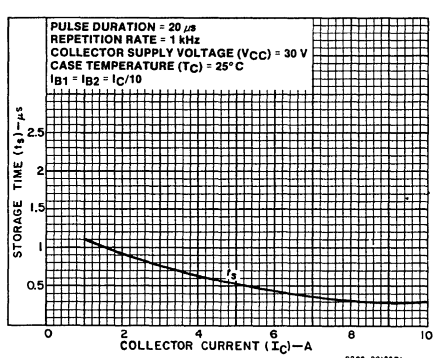


Fig. 13 - Typical storage-time characteristics.

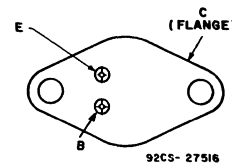
10-Ampere N-P-N Darlington Power Transistors

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6383, 2N6384, and 2N6385• are monolithic n-p-n silicon Darlington transistors designed for low- and medium-frequency power applications. The construction of these devices provides good forward-bias second-breakdown capability; their high gain makes it possible for them to be driven directly from integrated circuits.

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

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

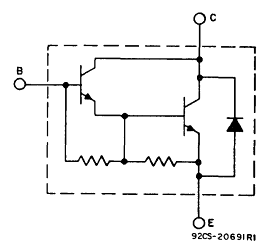


Fig.1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6385	2N6384	2N6383	
$*V_{CBO}$	80	60	40	V
$V_{CER(sus)}$				
$R_{BE} = 100\ \Omega$	80	60	40	V
$*V_{CEO(sus)}$	80	60	40	V
$*V_{CEX}$				
$V_{BE} = -1.5\ V$, $R_{BB} = 100\ \Omega$	80	60	40	V
$*V_{EBO}$	5	5	5	V
$*I_C$	10	10	10	A
I_{CM}	15	15	15	A
$*I_B$	0.25	0.25	0.25	A
$*P_T$				
$T_C \leq 25°C$	100	100	100	W
$T_C > 25°C$		See Fig.2		
$*T_{stg}, T_J$		–65 to +200		°C
$*T_L$				
At distances ≥ 1/32 in. (0.8mm) from seating plane for 10 s max.		235		°C

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

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

CHARACTERISTIC SYMBOL	TEST CONDITIONS VOLTAGE V dc			CURRENT A dc		LIMITS 2N6385		2N6384		2N6383		UNITS
	V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
* I_{CEO}	80				0	–	1	–	–	–	–	mA
	60				0	–	–	–	1	–	–	
	40				0	–	–	–	–	–	1	
* I_{CEV}	80		−1.5			–	0.3	–	–	–	–	
	60		−1.5			–	–	–	0.3	–	–	
	40		−1.5			–	–	–	–	–	0.3	
T_C = 150°C	80		−1.5			–	3	–	–	–	–	
	60		−1.5			–	–	–	3	–	–	
	40		−1.5			–	–	–	–	–	3	
* I_{EBO}		5		0		–	5	–	5	–	5	mA
* $V_{CEO}(sus)$				0.2[a]	0	80	–	60	–	40	–	V
* $V_{CER}(sus)$ R_{BE}=100Ω				0.2[a]		80	–	60	–	40	–	
$V_{CEV}(sus)$			−1.5	0.2[a]		80	–	60	–	40	–	
* h_{FE}	3			5[a]		1000	20,000	1000	20,000	1000	20,000	
	3			10[a]		100	–	100	–	100	–	
* V_{BE}	3			5[a]		–	2.8	–	2.8	–	2.8	V
	3			10[a]		–	4.5	–	4.5	–	4.5	
* $V_{CE}(sat)$				5[a]	0.01[a]	–	2	–	2	–	2	V
				10[a]	0.1[a]	–	3	–	3	–	3	
V_F				−10		–	4	–	4	–	4	
* h_{fe} f = 1 kHz	5			1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	5			1		20	–	20	–	20	–	
* C_{obo} f = 1 MHz	V_{CB} = 10				I_E=0	–	200	–	200	–	200	pF
$I_{S/b}$ t=1 s, non rep.	75					0.22	–	–	–	–	–	A
	55					–	–	0.55	–	–	–	
	30					3.33	–	3.33	–	3.33	–	
$R_{\theta JC}$						–	1.75	–	1.75	–	1.75	°C/W

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

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

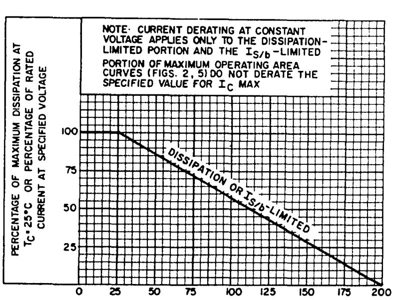


Fig.2 — Derating curves for all types.

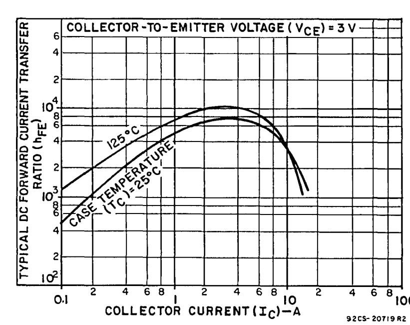


Fig. 3 — Typical dc-beta characteristics for all types.

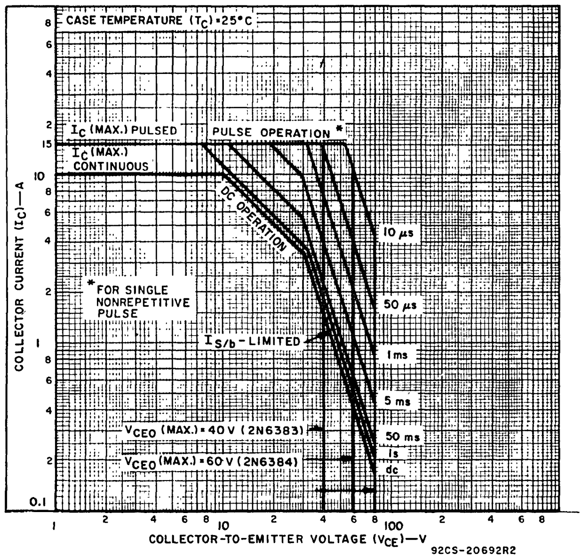


Fig.4 — Maximum operating area for all types.

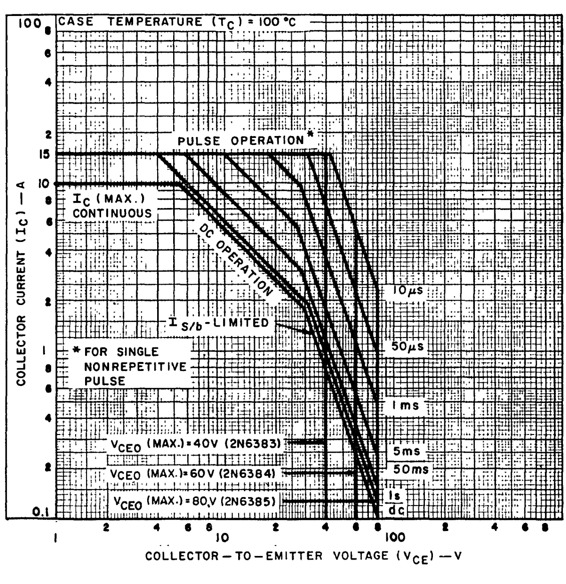


Fig.5 — Maximum operating area for all types.

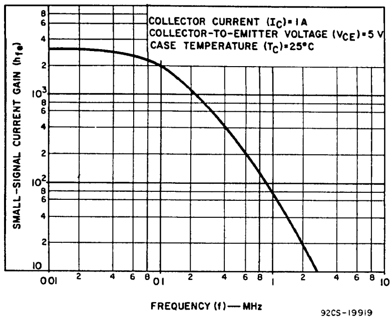


Fig. 6 — Typical small-signal gain for all types.

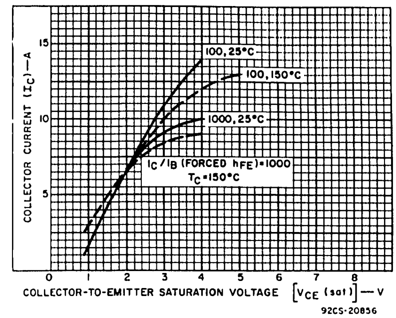


Fig. 7 — Typical saturation characteristics for all types.

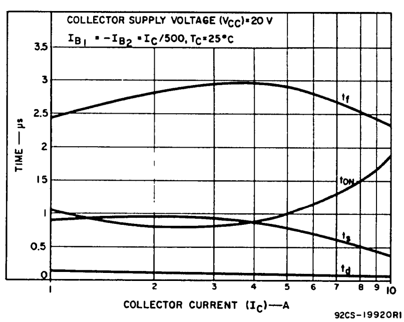


Fig. 8 — Typical saturated switching-time characteristics for all types.

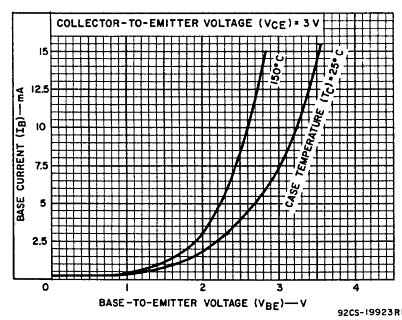


Fig. 9 — Typical input characteristics for all types.

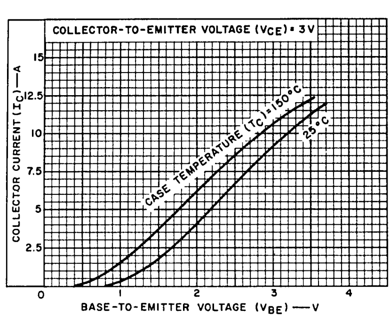


Fig. 10 — Typical transfer characteristics for all types.

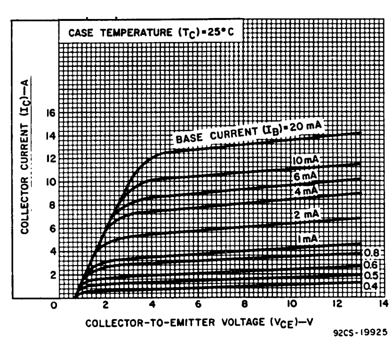


Fig. 11 — Typical output characteristics for all types.

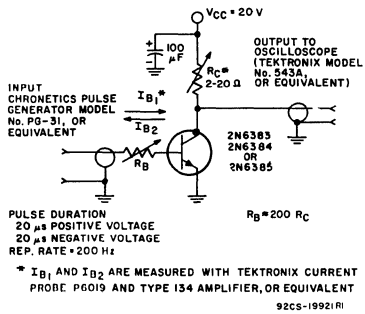


Fig. 12 — Circuit used to measure saturated-switching-times.

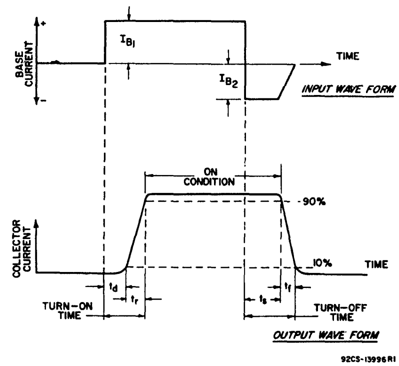


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching-times (test circuit shown in Fig. 14).

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)

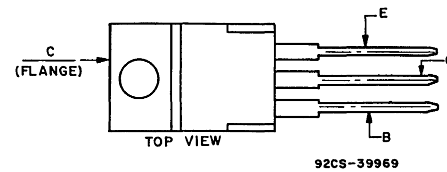
Features:

- **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 (VERSAWATT) plastic package.

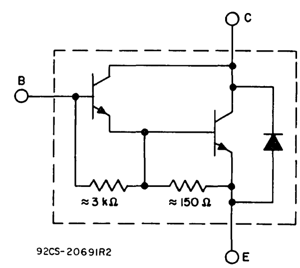


Fig.1 — Schematic diagram for all types.

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.

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.

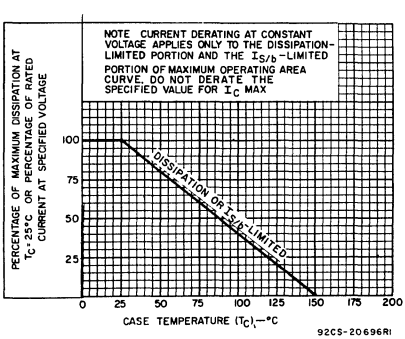


Fig.2 — Derating curve for all types.

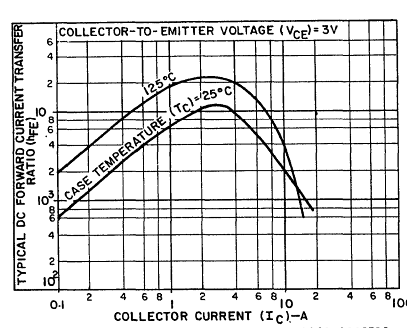


Fig. 3 — Typical dc-beta characteristics for all types.

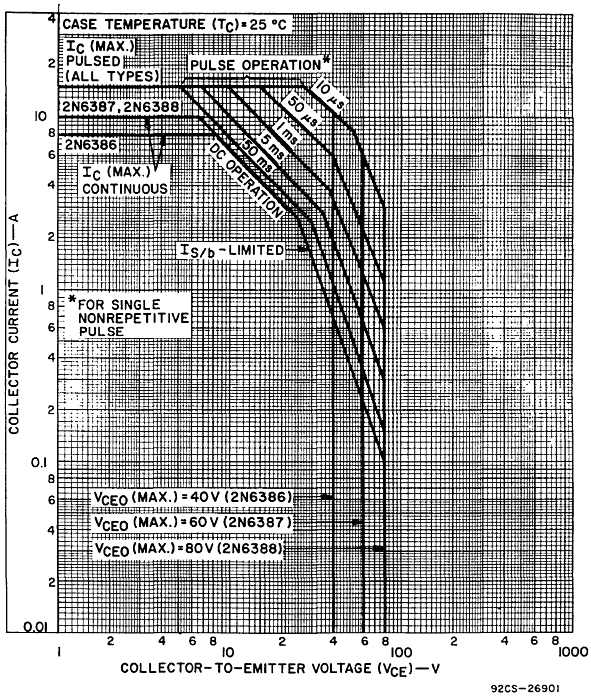


Fig. 4 — Maximum operating areas for all types.

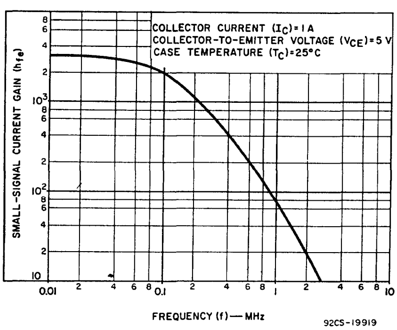


Fig. 5 — Typical small-signal gain for all types.

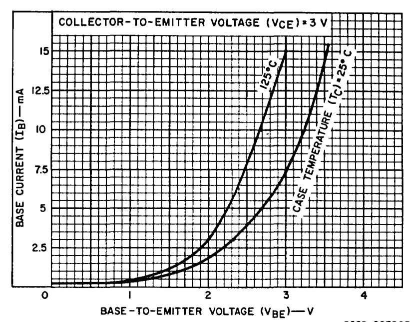


Fig. 6 — Typical input characteristics for all types.

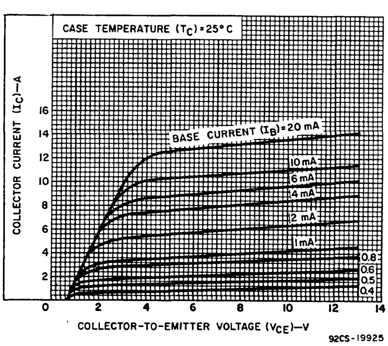


Fig. 7 — Typical output characteristics for all types.

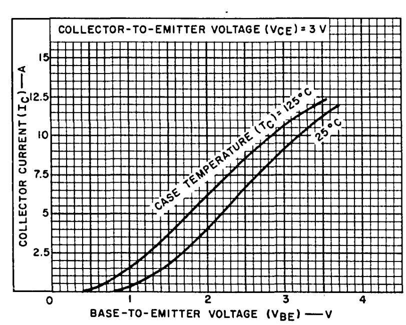


Fig. 8 — Typical transfer characteristics for all types.

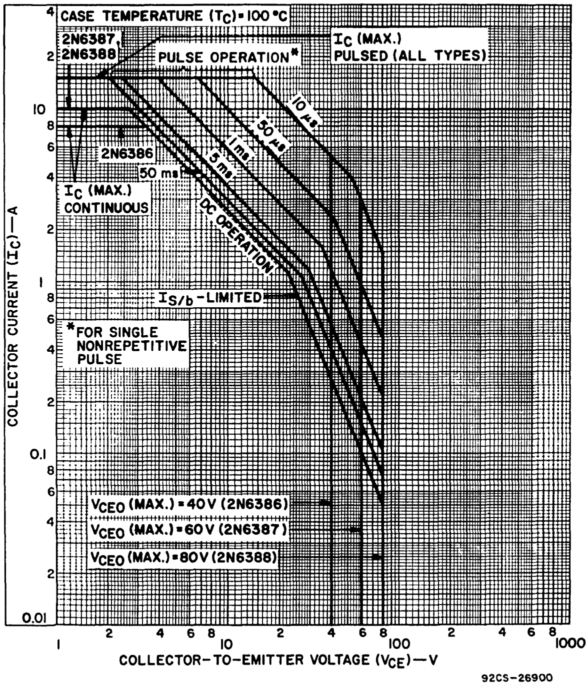


Fig. 9 — Maximum operating areas for all types at T_C = 100° C.

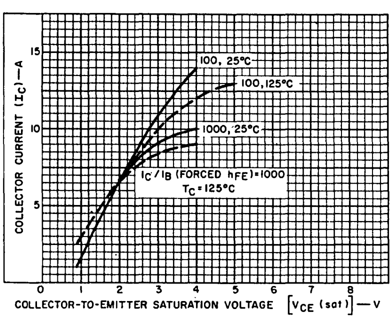


Fig. 10 — Typical saturation characteristics for all types.

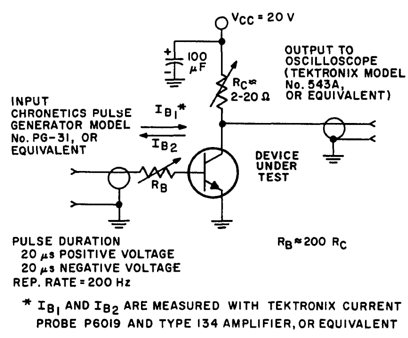


Fig. 11 — Circuit used to measure saturated switching-times.

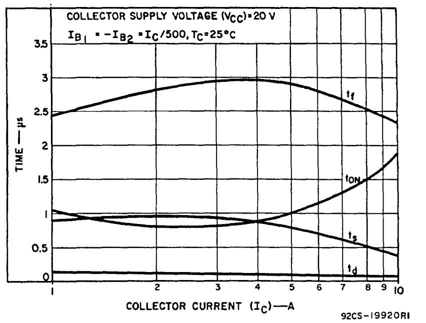


Fig. 12 — Typical saturated switching-time characteristics for all types.

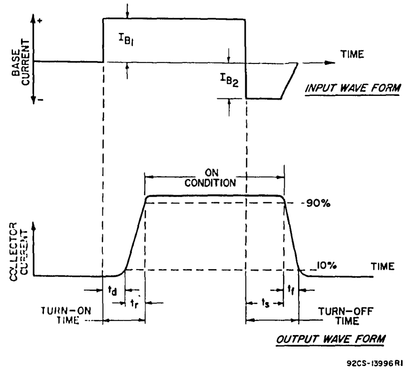


Fig. 13 - Phase relationship between input current and output current showing reference points for specification of switching-times.

2
POWER TRANSISTORS

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

For High-Speed Switching and Linear-Amplifier Applications

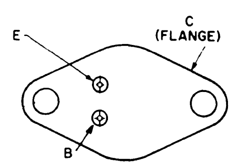
Features:

- *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

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
*	ICEX	−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 = 5 MHz	−10		−0.2		2	–	2	–	3	–	
*	f = 1 kHz	−30		−0.1		25	350	–	–	–	–	
	C_{obo} V_{CB}=10V f = 1 MHz			0		–	180	–	180	–	180	pF
*	t_r[c]			−0.75	−0.075[d]	–	–	–	–	–	0.5	µs
				−1	−0.1[d]	–	–	–	3	–	–	µs
*	t_s[c]			−0.75	−0.075[d]	–	–	–	–	–	6	µs
				−1	−0.1[d]	–	–	–	4	–	–	µs
*	t_f[c]			−0.75	−0.075[d]	–	–	–	–	–	3	µs
				−1	−0.1[d]	–	–	–	3	–	–	µs
	$R_{\theta JC}$	−10		−1		–	5	–	5	–	5	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration ≈ 300 µs, duty factor ≤ 2%.

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

[c] V_{CC} = −200 V, t_p = 20 µs

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

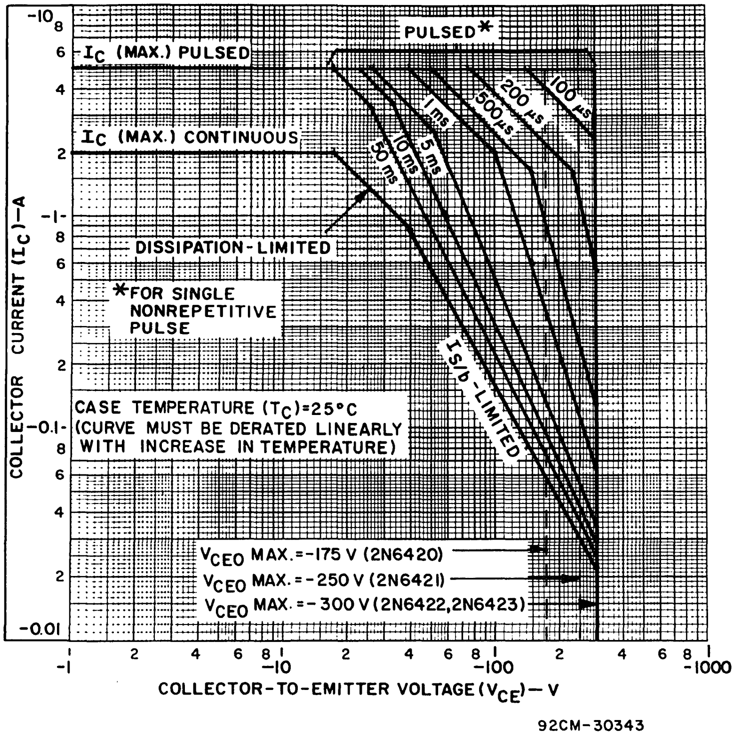


Fig. 1 — Maximum operating areas for all types.

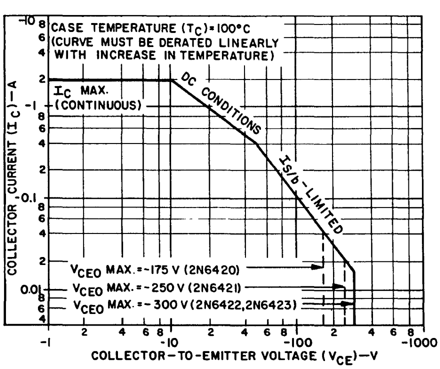


Fig. 2 — Maximum operating areas for all types.

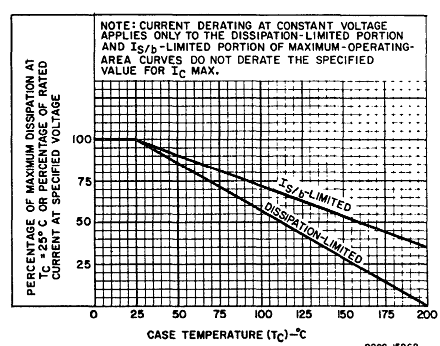


Fig. 3 — Derating curves for all types.

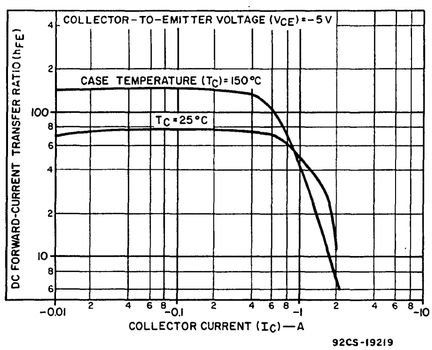


Fig. 4 — Typical dc beta characteristics for all types.

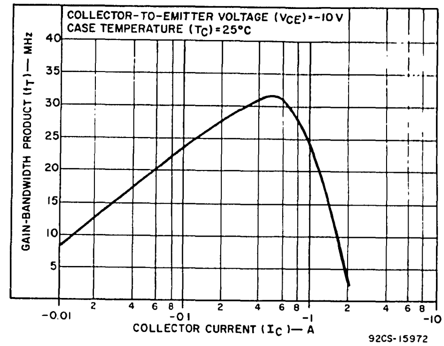


Fig. 5 — Typical gain-bandwidth product for all types.

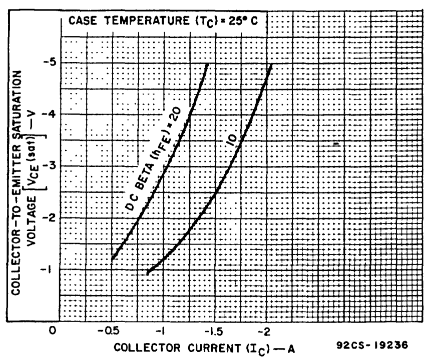


Fig. 6 — Typical saturation-voltage characteristics for all types.

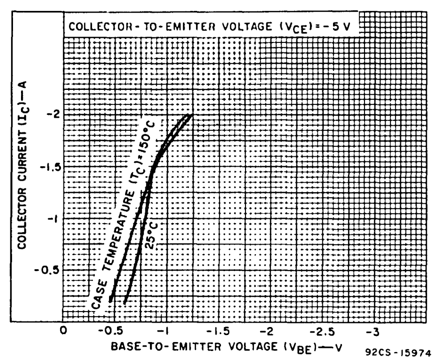


Fig. 7 — Typical transfer characteristics for all types.

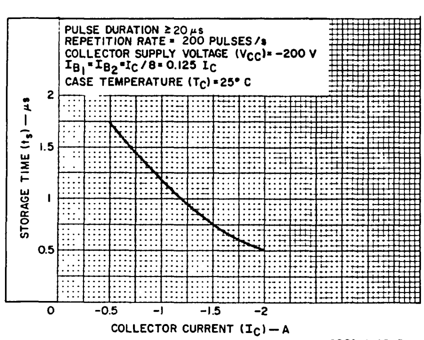


Fig. 8 — Typical storage time characteristic for all types.

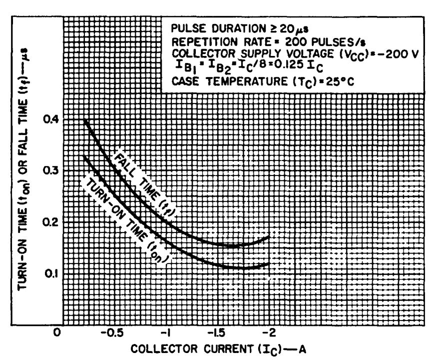


Fig. 9 — Typical turn-on time and fall-time characteristics for all types.

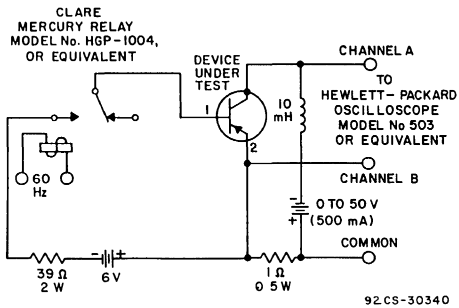


Fig. 10 — Circuit used to measure sustaining voltage V_{CEO} (sus) for all types.

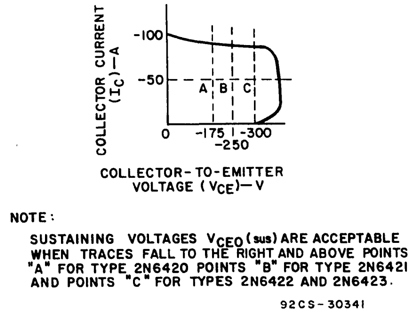


Fig. 11 — Oscilloscope display for measurement of sustaining voltages.

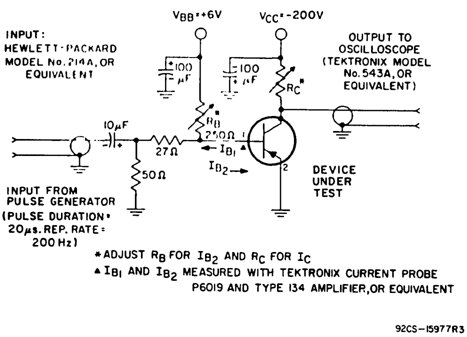


Fig. 12 — Circuit used to measure saturated switching times for all types.

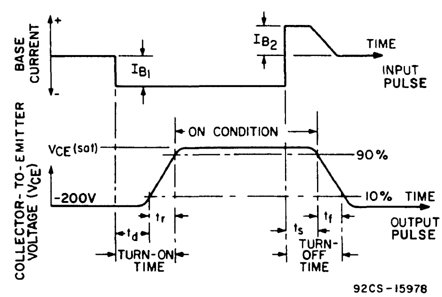


Fig. 13 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

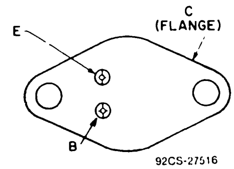
Silicon P-N-P Medium-Power Transistors

General-Purpose Types for Switching Application

Features:

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

TERMINAL DESIGNATIONS



JEDEC TO-213AA

The RCA-2N6467 and 2N6468▲are multiple-epitaxial p-n-p transistors. These devices differ in voltage ratings and in the currents at which the parameters are controlled. All are supplied in the JEDEC TO-213AA package.

▲Formerly RCA Dev Nos. TA8710, and TA8709, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6467	2N6468	
*V_{CBO}	-110	-130	V
*V_{CEX}(sus)			
V_{BE} = 1.5 V, R_{BE} = 100 Ω	-110	-130	V
V_{CER}(sus)			
R_{BE} = 100 Ω	-105	-125	V
V_{CEO}(sus)	-100	-120	V
*V_{EBO}	-5	-5	V
*I_C	-4	-4	A
*I_B	-2	-2	A
*P_T			
Up to 25°C	40	40	W
Above 25°C	See Figs. 1, 2 and 3		
*T_J, T_{stg}	-65 to +200		°C
*T_L			
At distances ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	+235		°C

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

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.*

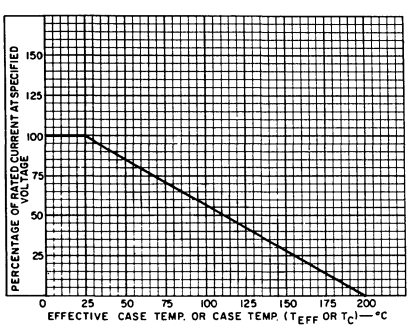


Fig. 1 — Current derating curve for all types.

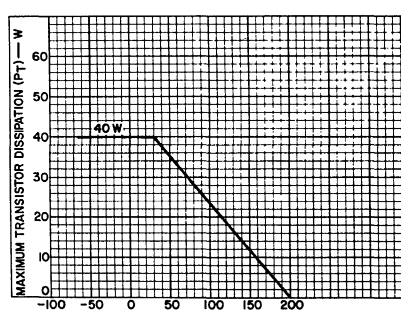


Fig. 2 — Dissipation derating curve for all types.

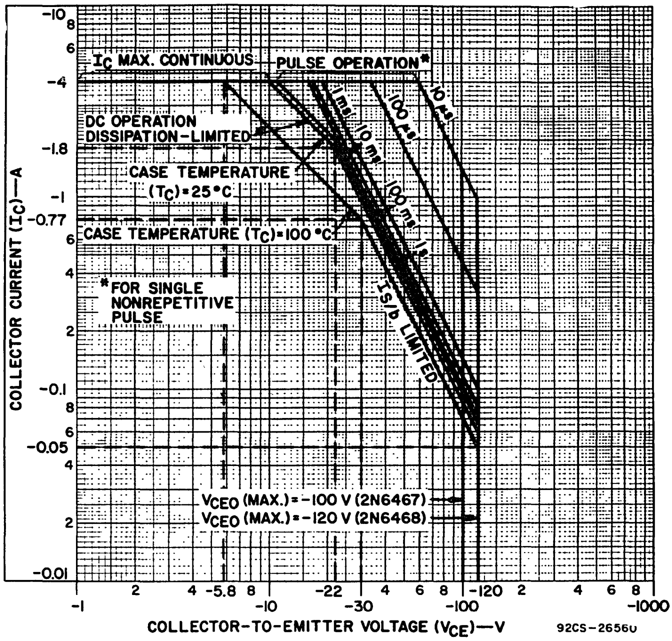


Fig. 3 — Maximum operating areas for 2N6467 and 2N6468.

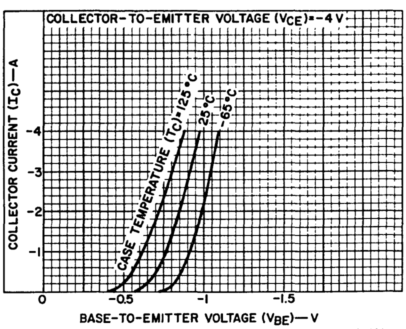


Fig. 4 — Typical transfer characteristics for 2N6467 and 2N6468.

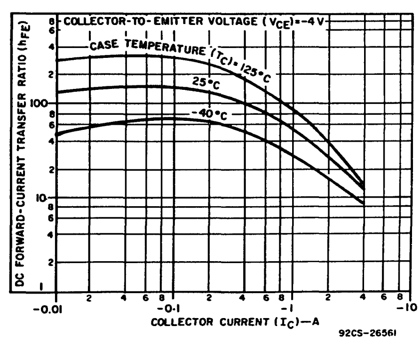


Fig. 5 — Typical dc beta characteristics for 2N6467 and 2N6468.

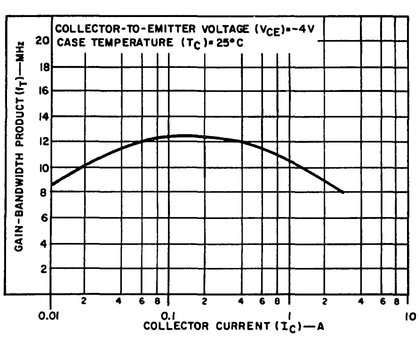


Fig. 6 — Typical gain-bandwidth product by 2N6467 and 2N6468.

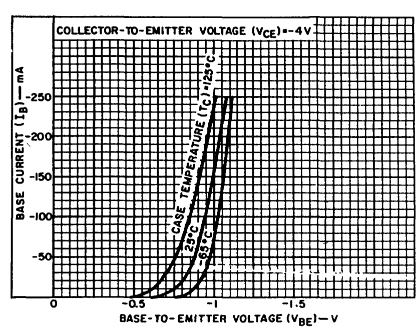


Fig. 7 — Typical input characteristics for 2N6467 and 2N6468.

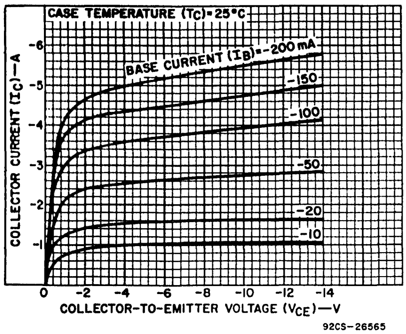


Fig. 8 — Typical output characteristics for 2N6467 and 2N6468.

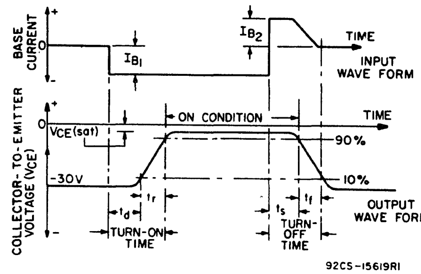


Fig. 9 — Oscilloscope display for measurement of switching times for 2N6467 and 2N6468.

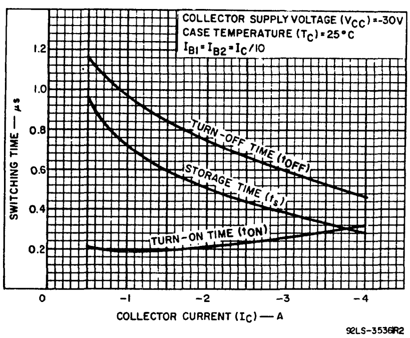


Fig. 10 — Typical saturated switching characteristics for 2N6467 and 2N6468.

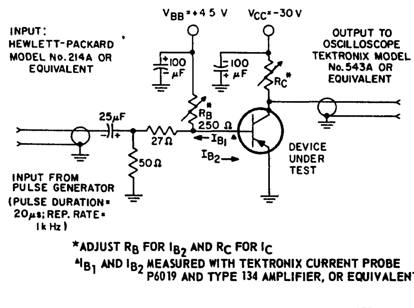


Fig. 11 — Circuit used to measure saturated switching times for 2N6467 and 2N6468.

Medium-Power Silicon N-P-N Transistors

For Intermediate Power Applications in Industrial and Commercial Equipment

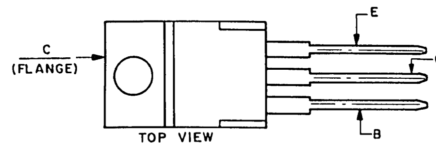
Features:

- *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



92CS-39969

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.

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS				UNITS
		VOLTAGE V dc			CURRENT A dc		2N6477		2N6478		
		V_{CE}	V_{EB}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	
* Collector-Cutoff Current: With base open	I_{CEO}	80				0	–	2	–	–	mA
		100				0	–	–	–	2	
With base-emitter junction reverse-biased	I_{CEV}	130		−1.5			–	2	–	–	
		150		−1.5			–	–	–	2	
At T_C = 150°C	I_{CEV}	120		−1.5			–	10	–	–	
		140		−1.5			–	–	–	10	
* Emitter-Cutoff Current	I_{EBO}		5		0		–	2	–	2	mA
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$				0.1[a]	0	120	–	140	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.1[a]		130	–	150	–	
With base-emitter junction reverse-biased	$V_{CEV}(sus)$			−1.5	0.1[a]		140	–	160	–	
* DC Forward-Current Transfer Ratio	h_{FE}	4			1[a]		25	150	25	150	
		4			2.5[a]		5	–	5	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				1[a]	0.1	–	1	–	1	V
					2.5[a]	0.5	–	2	–	2	
* Base-to-Emitter Voltage	V_{BE}	4			1[a]		–	1.8	–	1.8	V
		4			2.5[a]		–	3	–	3	
* Magnitude of Common-Emitter, Small-Signal, Short-Circuit Forward-Current Transfer Ratio (f = 40 kHz)	$\|h_{fe}\|$	4			0.5		5	–	5	–	
Gain-Bandwidth Product	f_T	4			0.5		200	–	200	–	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	

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

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

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

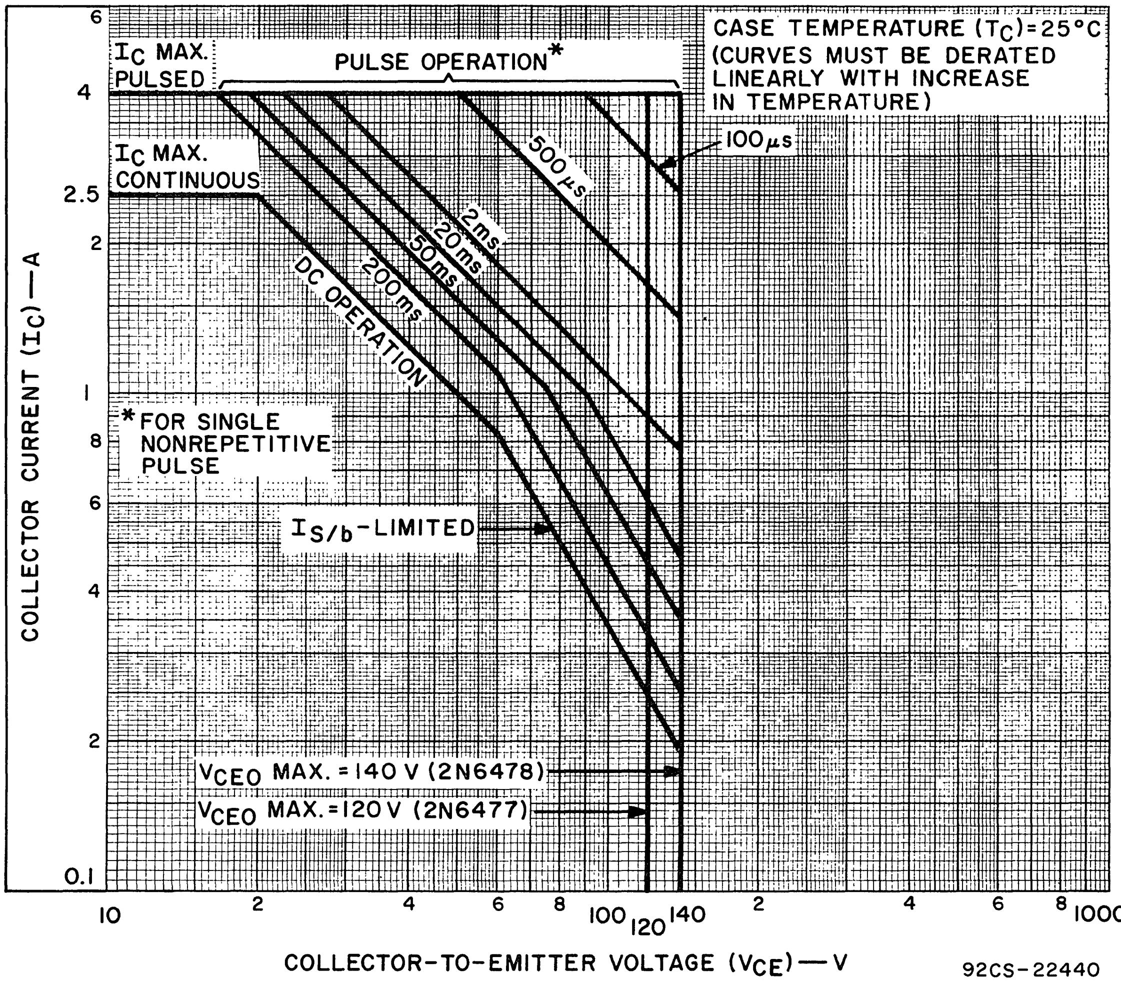


Fig. 1 — Maximum operating areas for both types.

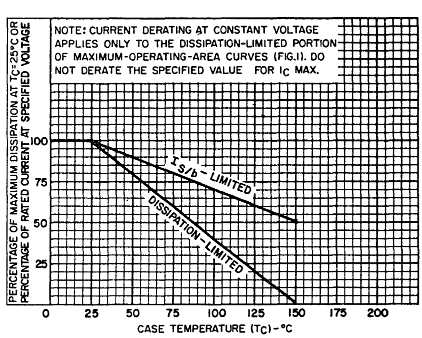


Fig. 2 — Current derating curve for both types.

POWER TRANSISTORS 2

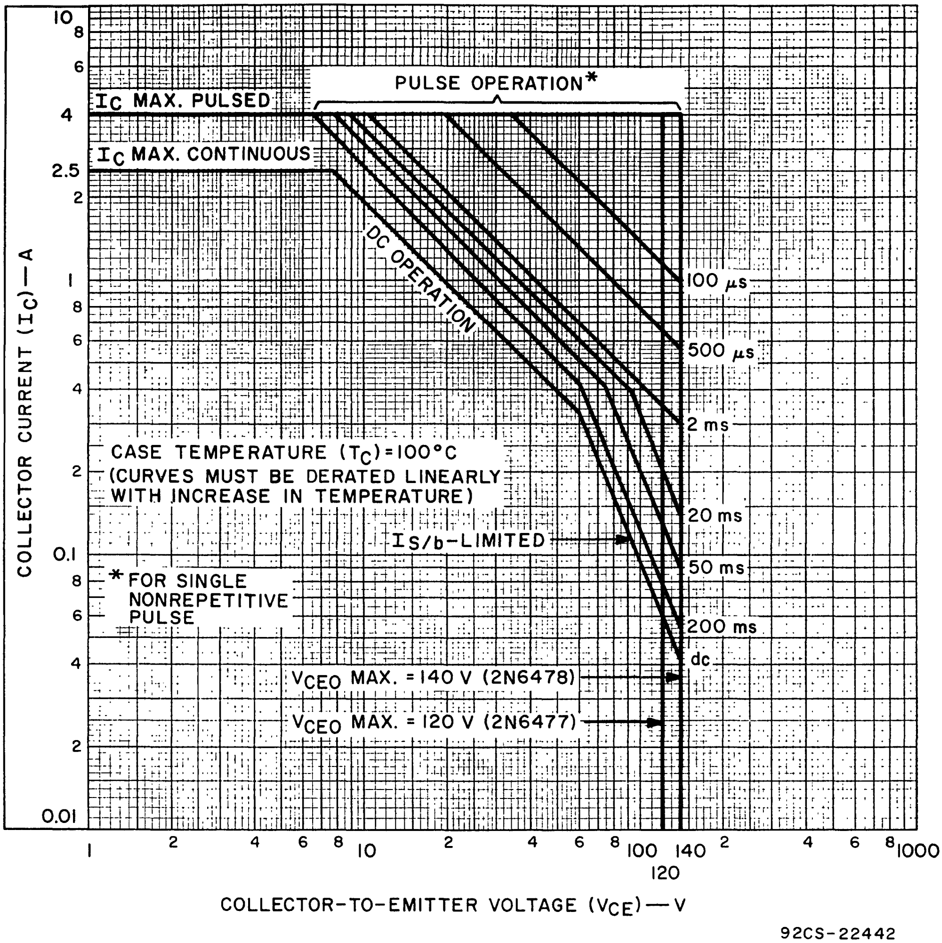


Fig. 3 — Maximum operating areas for both types.

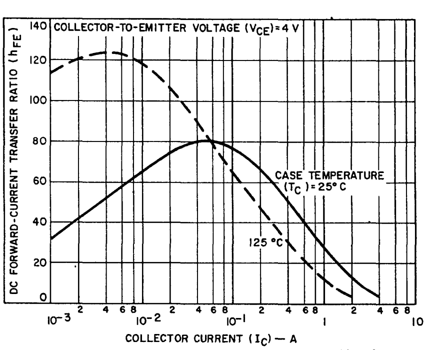


Fig. 4 — Typical dc beta characteristics for 2N6477.

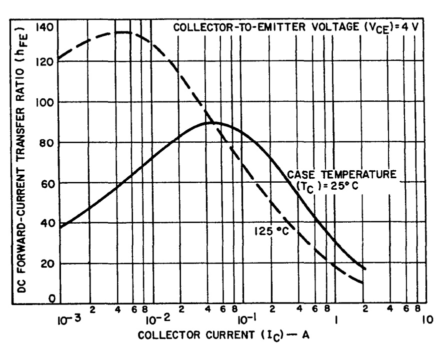


Fig. 5 — Typical dc beta characteristics for 2N6478.

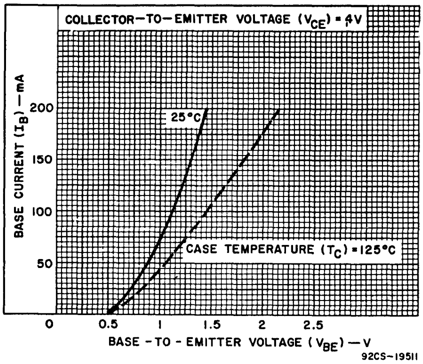


Fig. 6 — Typical input characteristics for 2N6477.

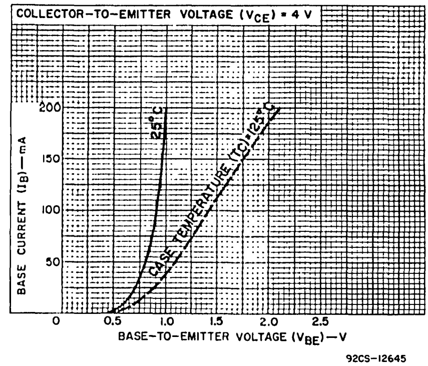


Fig. 7 — Typical input characteristics for 2N6478.

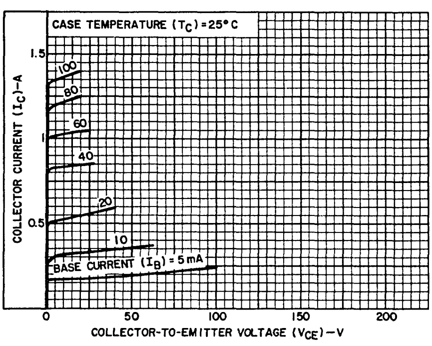


Fig. 8 — Typical output characteristics for 2N6477.

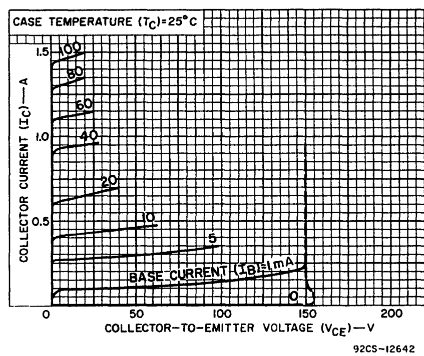


Fig. 9 — Typical output characteristics for 2N6478.

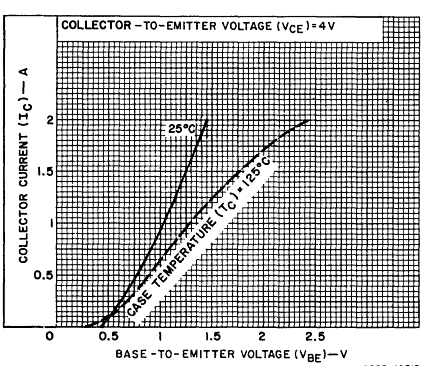


Fig. 10 — Typical transfer characteristics for 2N6477.

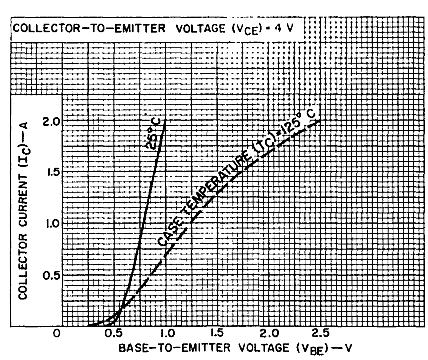


Fig. 11 — Typical transfer characteristics for 2N6478.

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

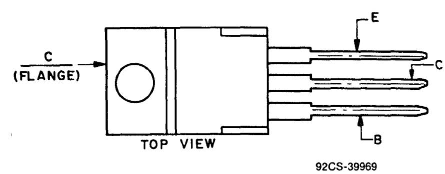
Features:
- *Maximum safe-area-of-operation curves*

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	2N6486	2N6487	2N6488	
		P-N-P	**2N6489†**	**2N6490†**	**2N6491†**	
*COLLECTOR-TO-BASE VOLTAGE	V_{CBO}		50	70	90	V
COLLECTOR-TO-EMITTER VOLTAGE:						
* With 1.5 volts (V_{BE}) of reverse bias, and external base-to-emitter resistance (R_{BE}) = 100 Ω	V_{CEX}		50	70	90	V
With external base-to-emitter resistance (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.

ELECTRICAL CHARACTERISTICS, *At case temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS			LIMITS						UNITS
		VOLTAGE V dc		CURR. A dc	2N6486 2N6489♦		2N6487 2N6490♦		2N6488 2N6491♦		
		V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
Collector-Cutoff Current: With external base-emitter resistance (R_{BE}) = 100Ω	I_{CER}	35 55 75			– – –	500 – –	– – –	– 500 –	– – –	– – 500	μA
* With base-emitter junction reverse biased and external base-to-emitter resistance (R_{BE}) = 100Ω	I_{CEX}	45 65 85	−1.5 −1.5 −1.5		– – –	500 – –	– – –	– 500 –	– – –	– – 500	μA
* At T_C = 150°C	I_{CEX}	40 60 80	−1.5 −1.5 −1.5		– – –	5 – –	– – –	– 5 –	– – –	– – 5	mA
* With base open	I_{CEO}	20 30 40			– – –	1 – –	– – –	– 1 –	– – –	– – 1	mA
* Emitter-Cutoff Current	I_{EBO}		−5	0	–	1	–	1	–	1	mA
* DC Forward-Current Transfer Ratio	h_{FE}	4 4		5[a] 15[a]	20 5	150 –	20 5	150 –	20 5	150 –	
* Collector-to-Emitter Sustaining Voltage With base open	$V_{CEO}(sus)$			0.2	40[b]	–	60[b]	–	80[b]	–	V
With external base-emitter resistance (R_{BE}) = 100Ω	$V_{CER}(sus)$			0.2	45[b]	–	65[b]	–	85[b]	–	V
With base-emitter junction reverse- biased and external base-to-emitter resistance (R_{BE}) = 100Ω	$V_{CEX}(sus)$		−1.5	0.2	50[b]	–	70[b]	–	90[b]	–	V
* Base-to-Emitter Voltage	V_{BE}	4 4		5[a] 15[a]	– –	1.3 3.5	– –	1.3 3.5	– –	1.3 3.5	V
* Collector-to-Emitter Saturation Voltage [I_B = 0.5 A I_B = 5 A]	$V_{CE}(sat)$			5[a] 15[a]	– –	1.3 3.5	– –	1.3 3.5	– –	1.3 3.5	V
* Magnitude of Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio: f = 1 MHz	$\|h_{fe}\|$	4		1	5	–	5	–	5	–	
* Common-Emitter, Small-Signal, Short-Circuit, Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	4		1	25	–	25	–	25	–	
Thermal Resistance: Junction-to-case	$R_{\theta JC}$				–	1.67	–	1.67	–	1.67	°C/W
Junction-to-ambient	$R_{\theta JA}$				–		–	70	–	70	°C/W

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

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

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

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

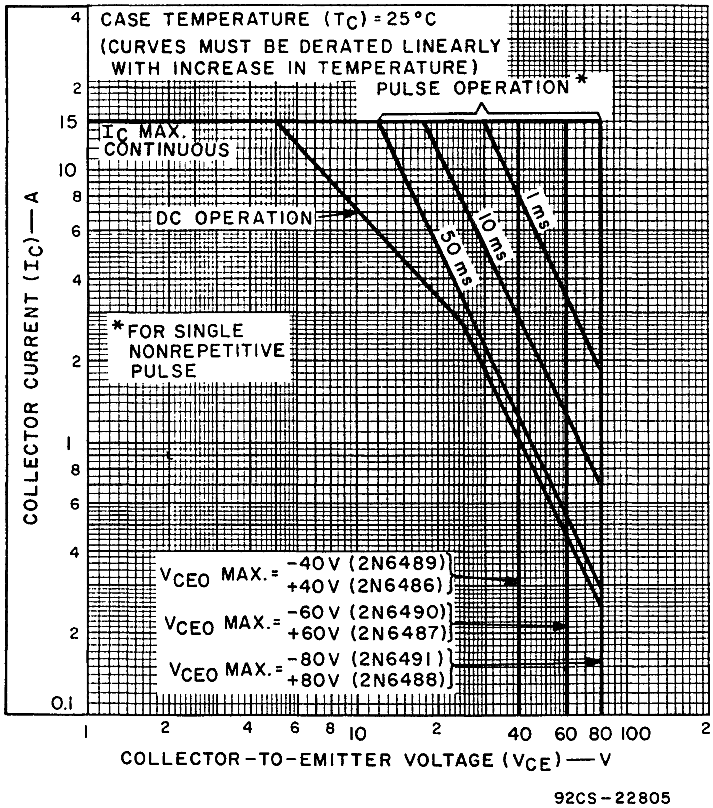


Fig. 1 — Maximum operating areas for all types†.

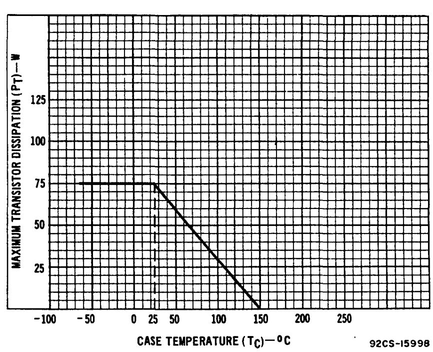


Fig. 2 — Derating chart for all types

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

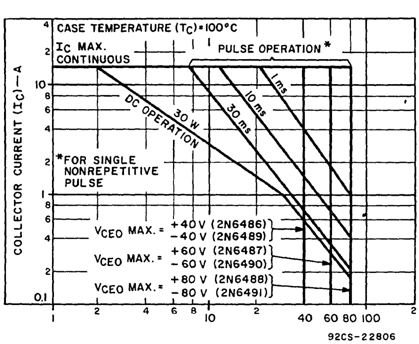


Fig. 3 — Maximum operating areas for all types†.

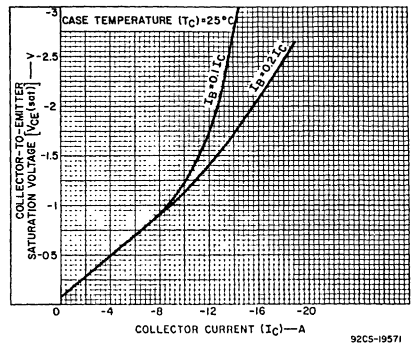


Fig. 4 — Typical collector-to-emitter saturation-voltage characteristics for all types.

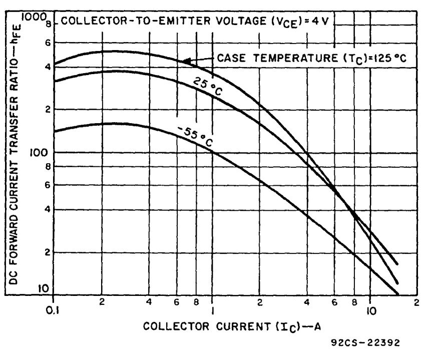


Fig. 5 — Typical dc beta characteristics for 2N6486, 2N6487, and 2N6488.

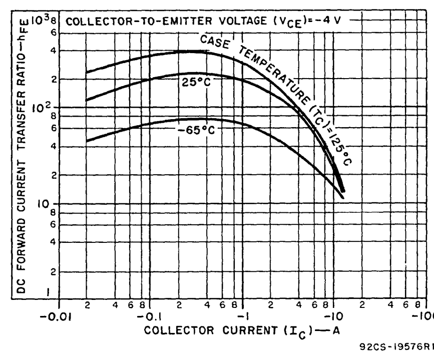


Fig. 6 — Typical dc beta characteristics for 2N6489, 2N6490, and 2N6491.

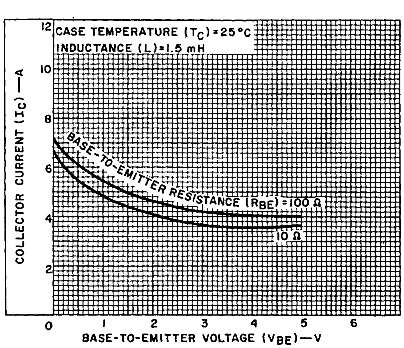


Fig. 7 — Minimum reverse-bias second-breakdown characteristics for all types†.

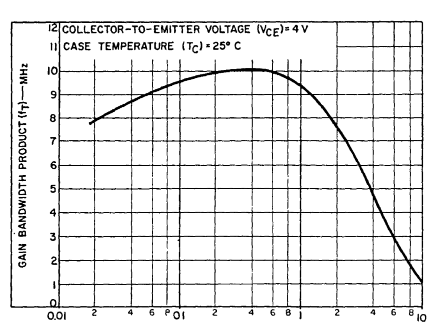


Fig. 8 — Typical gain-bandwidth product vs. collector current for all types†.

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

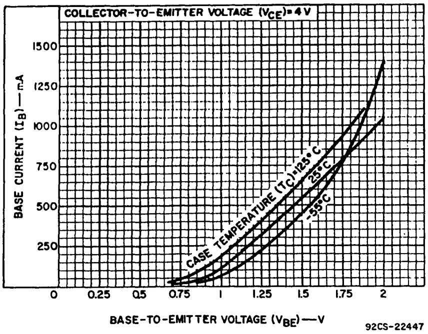


Fig. 9 — Typical input characteristics for all types†.

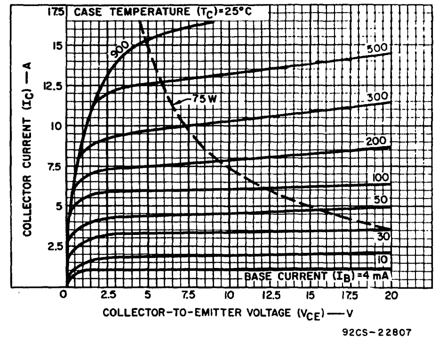


Fig. 10 — Typical output characteristics for all types†.

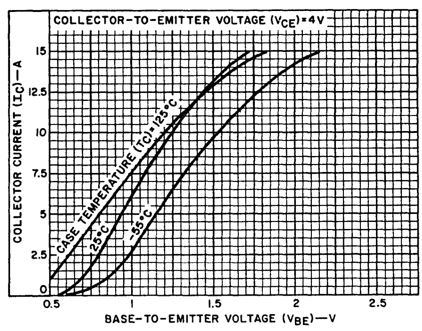


Fig. 11 — Typical transfer characteristics for all types†.

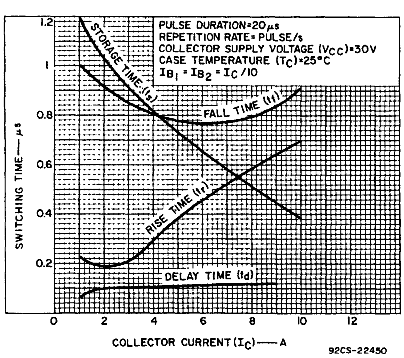


Fig. 12 — Typical saturated switching characteristics for 2N6486, 2N6487, and 2N6488.

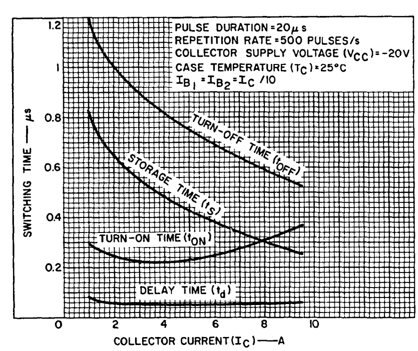


Fig. 13 — Typical saturated switching characteristics for 2N6489, 2N6490, and 2N6491.

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

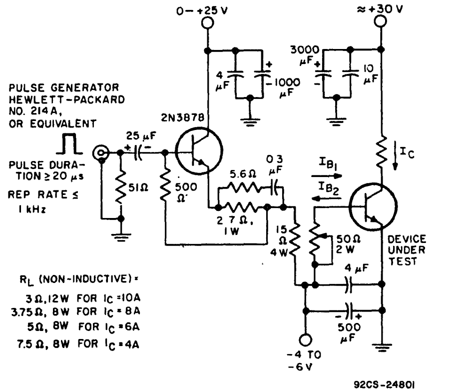


Fig. 14 — Circuit used to measure switching times for 2N6486, 2N6487, and 2N6488.

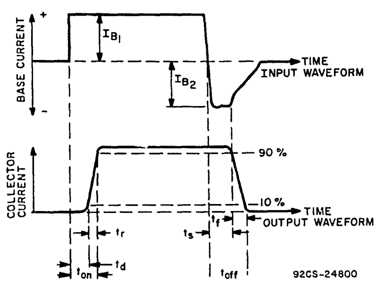
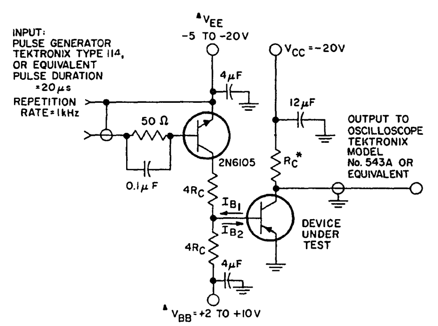


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times (test circuit shown in Fig. 14).



* R_C IS CHOSEN FOR I_C
▲ V_{EE} AND V_{BB} ARE MEASURED FOR I_{B_1} AND I_{B_2}
I_{B_1} AND I_{B_2} ARE MEASURED WITH TEKTRONIX CURRENT PROBE P-6019 AND TYPE 134 AMPLIFIER, OR EQUIVALENT
92CS-19586R3

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

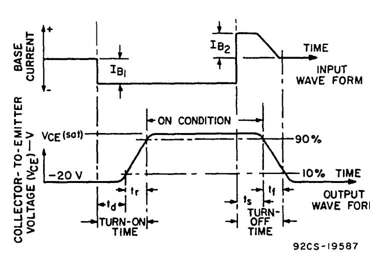
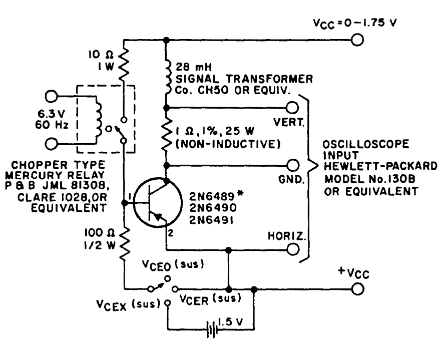
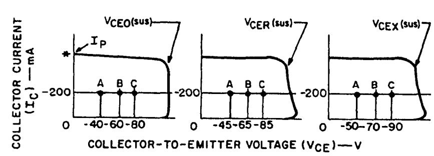


Fig. 17 — Oscilloscope display for measurement for switching times (test circuit shown in Fig. 16).



*FOR N-P-N TYPES 2N6486, 2N6487, AND 2N6488, REVERSE POLARITY OF BATTERY AND V_{CC}.
92CS-22810

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



*PULSE CURRENT (I_P) RANGE = 0.6—0.8 A

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 TYPES 2N6486 AND 2N6489; POINT "B" FOR 2N6487 AND 2N6490; AND POINT "C" FOR 2N6488 AND 2N6491.

92CS-22811

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

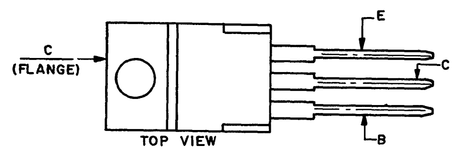
8-Ampere N-P-N Darlington Power Transistors

80, 100, 120 Volts, 60 Watts
Gain of 1000 at 5 A (2N6530, 2N6532)
Gain of 1000 at 3 A (2N6533)
Gain of 500 at 3 A (2N6531)

Features:
- 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.

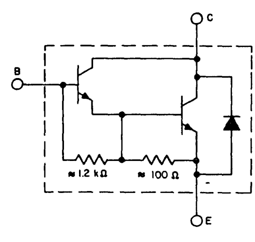


Fig. 1—Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6530	2N6531	2N6532	2N6533	
*V_{CBO}	80	100	100	120	V
V_{CER}(sus)					
R_{BE} = 100 Ω	80	100	100	120	V
V_{CEO}(sus)	80	100	100	120	V
*V_{CEV}(sus)					
V_{BE} = −1.5 V	80	100	100	120	V
*V_{EBO}	5	5	5	5	V
*I_C	8	8	8	8	A
I_{CM}	15	15	15	15	A
*I_B	0.25	0.25	0.25	0.25	A
*P_T					
Up to 25°C	65	65	65	65	W
Above 25°C	See Fig. 3				
*T_J, T_{stg}	−65 to +150				°C
*T_L					
At distances ≥ 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

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

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.

2 POWER TRANSISTORS

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 2N6532 Min.	2N6532 Max.	2N6533 Min.	2N6533 Max.	UNITS
	I_{CEO}	120			0	–	–	–	1	mA
		100			0	–	1	–	–	
*	I_{CEV}	120	−1.5			–	–	–	0.5	
		100	−1.5			–	0.5	–	–	
*	T_C = 125°C	120	−1.5			–	–	–	5	
		100	−1.5			–	5	–	–	
	I_{EBO}		−5	0		–	5	–	5	mA
*	h_{FE}	3		3[a]		–	–	1,000	10,000	
		3		5[a]		1,000	10,000	–	–	
		3		8[a]		100	5,000	100	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_{CEV}(sus)		−1.5	0.2		100[b]	–	120[b]	–	
	V_{BE}	3		3[a]		–	–	–	2.8	V
		3		5[a]		–	2.8	–	–	
		3		8[a]		–	4.5*	–	4.5*	
	V_{CE}(sat)			3[a]	0.006	–	–	–	2	V
				5[a]	0.01	–	2	–	–	
				8[a]	0.08	–	3*	–	3*	
	V_F			5[a]		–	–	–	4	V
				8[a]		–	5	–	–	
	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.

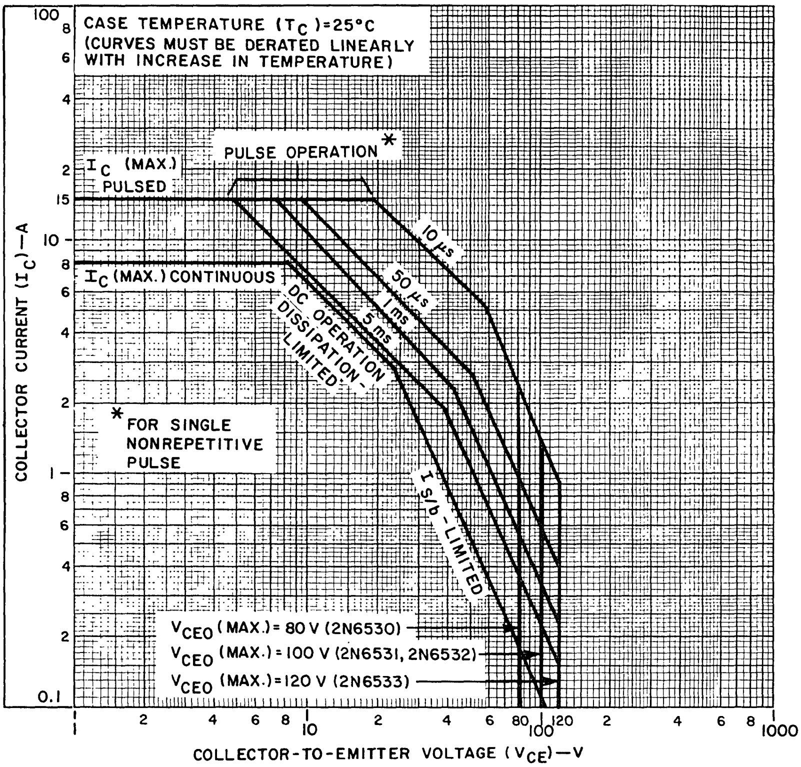


Fig. 2—Maximum operating areas for all types at case temperature of 25°C.

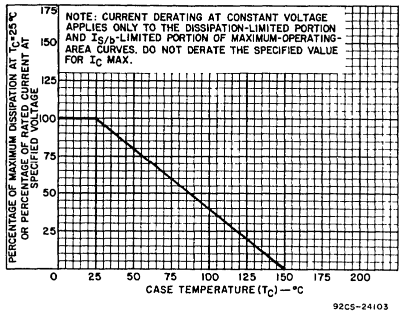


Fig. 3—Dissipation derating curve for all types.

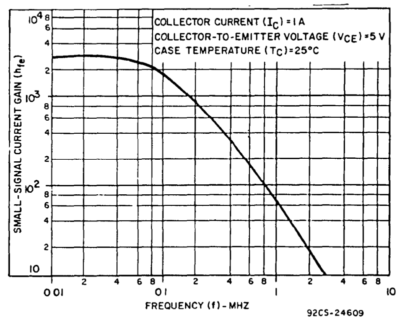


Fig. 4 — Typical small-signal current gain for all types.

2N6530, 2N651, 2N6532, 2N6533

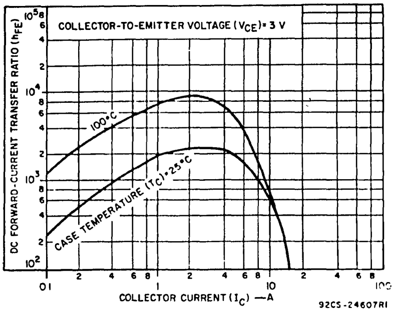


Fig. 5 — *Typical dc beta characteristics for all types.*

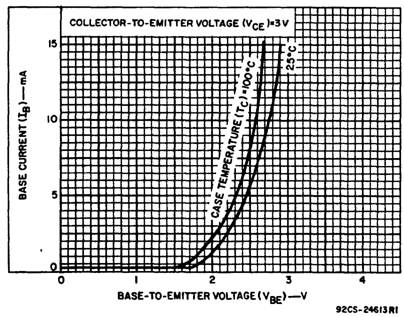


Fig. 6 — *Typical input characteristics for all types.*

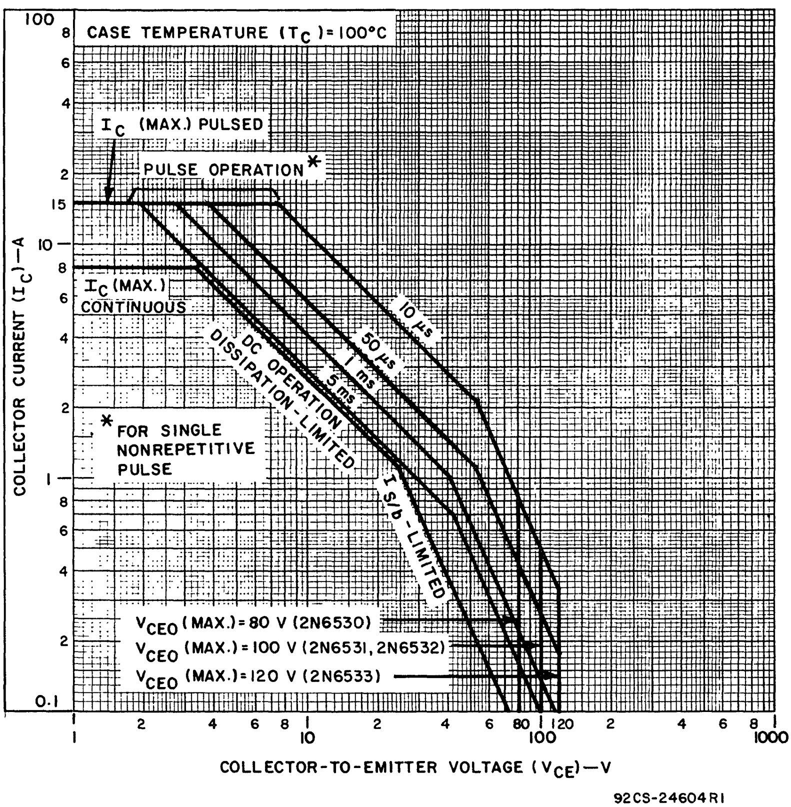


Fig. 7—Maximum operating areas for all types at case temperature of 100°C.

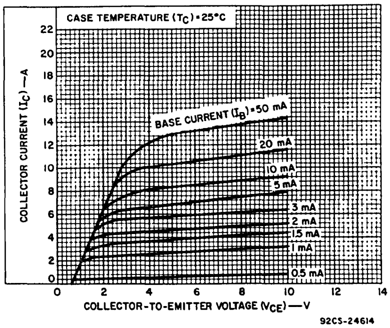


Fig. 8 — Typical output characteristics for all types.

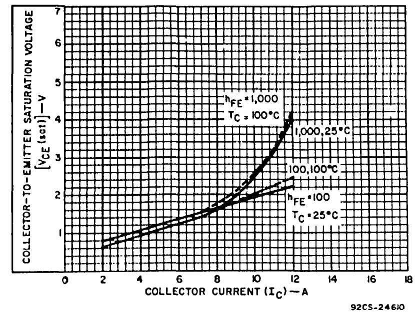


Fig. 9 — Typical saturation characteristics for all types.

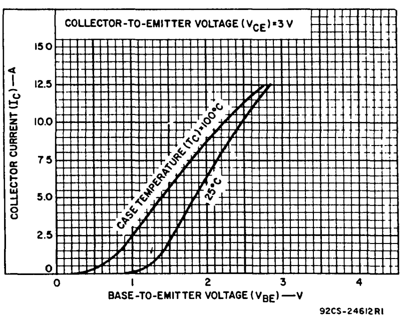


Fig. 10 — Typical transfer characteristics for all types.

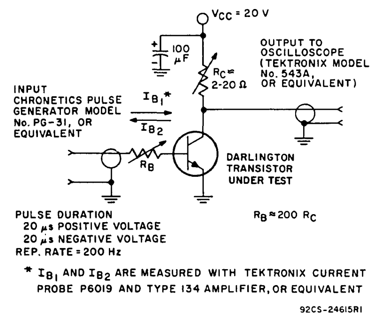


Fig. 11 — Circuit used to measure saturated switching-times.

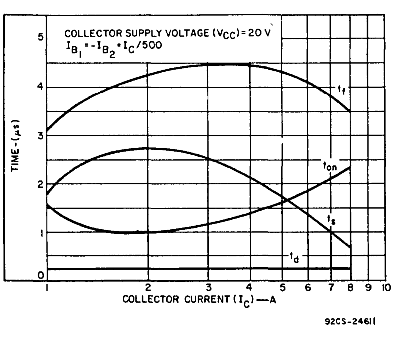


Fig. 12 — Typical saturated switching-time characterictics for all types.

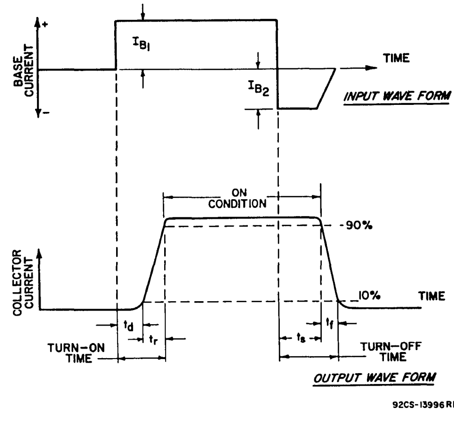


Fig. 13 — Phase relationship between input current and output current, showing reference points for specification of switching-times.

3-, 5-, and 10-A Power-Switching Transistors

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

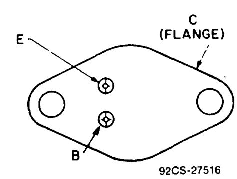
Features:
- *100% High Temperature Tested for 100°C Parameters*
- *Fast Switching Speed*
- *High voltage rating*
  $V_{CEX} = 350$ V
  $= 450$ V [2N6545]
- *Low V_{CE}[sat] at IC = 3-, 5-, and 10-A*

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

The 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	8	8	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	-65 to 200	-65 to 200	-65 to 200	°C
*T_L					
At distance ≥ 1/8 in. (3.17 mm) from seating plane for 5 s max.	275	275	275	275	°C

* In accordance with JEDEC registration data.

ELECTRICAL CHARACTERISTICS Tc = 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.

ELECTRICAL CHARACTERISTICS T_C = 100° C

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

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

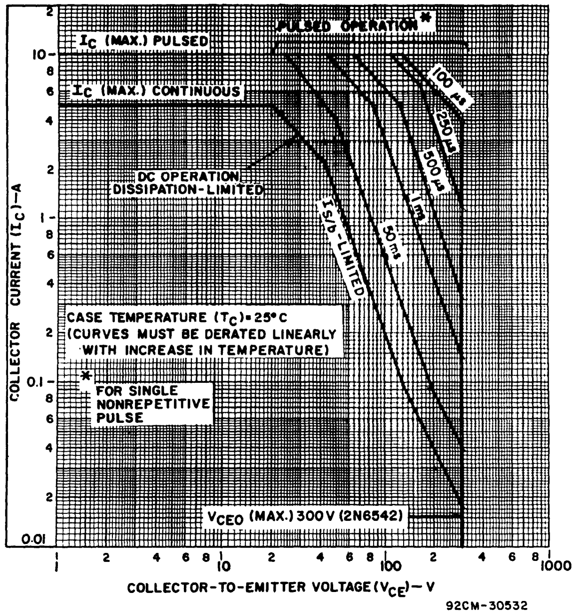


Fig. 1 - Maximum operating areas for type 2N6542 (Tc = 25°).

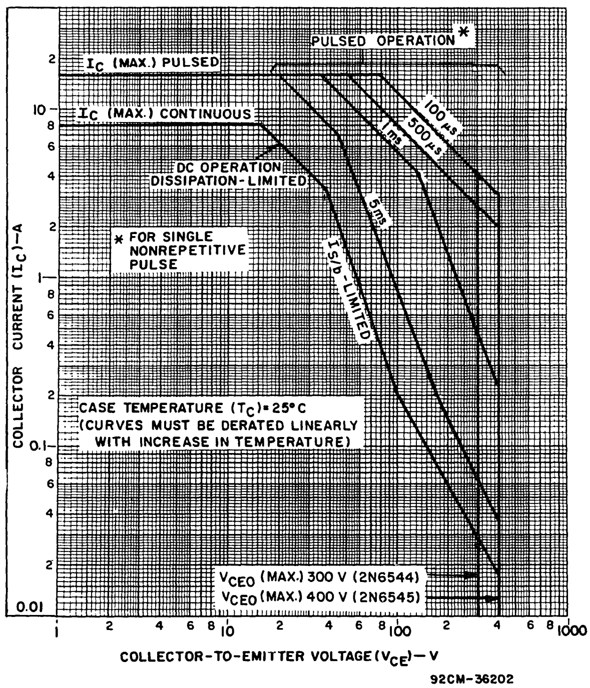


Fig. 2 - Maximum operating areas for type 2N6544 and 2N6545 (Tc = 25° C).

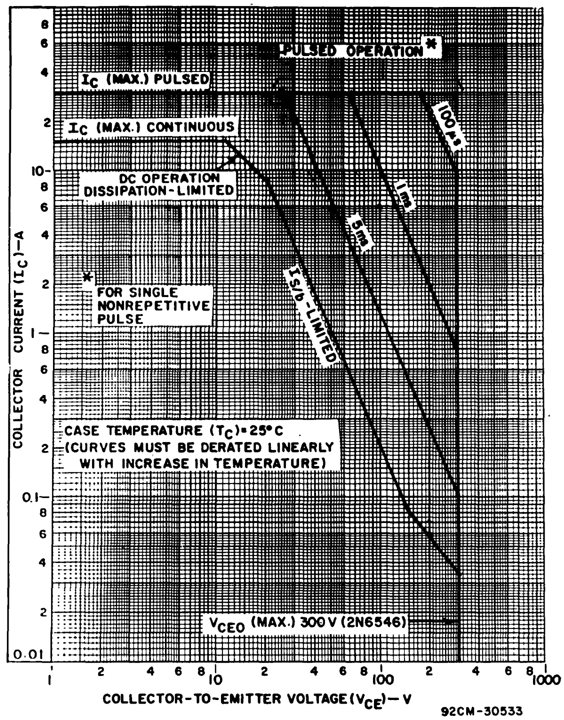


Fig. 3 - Maximum operating areas for type 2N6546 (Tc = 25°)

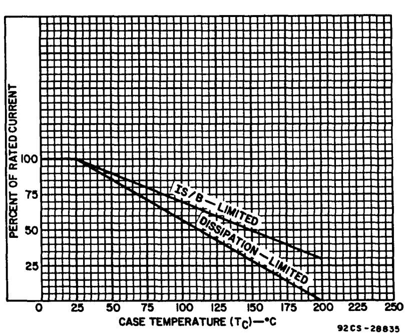


Fig. 4 - Dissipation and Is/b derating curves for all types.

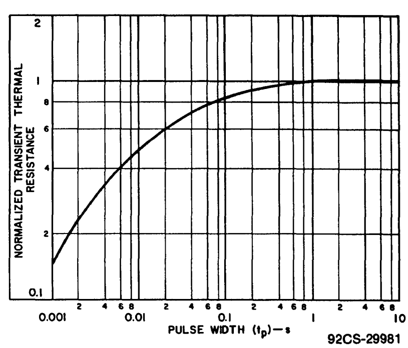


Fig. 5 — Typical thermal-response characteristics for types 2N6542, 2N6544 and 2N6545.

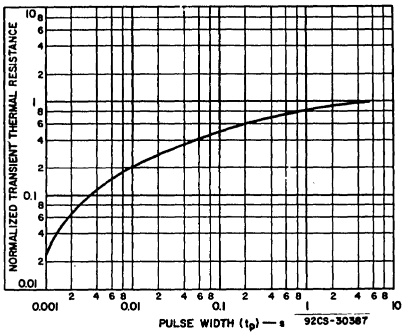


Fig. 6 — Typical thermal-response characteristics for type 2N6546.

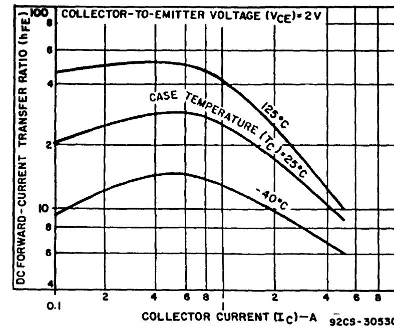


Fig. 7 — Typical dc beta characteristics for type 2N6542.

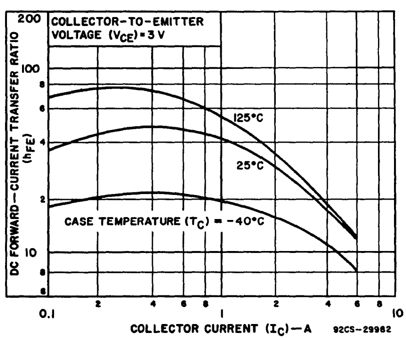


Fig. 8 — Typical dc beta characteristics for type 2N6544.

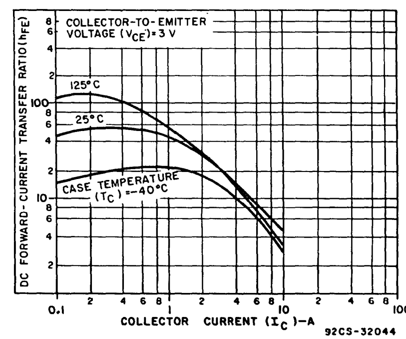


Fig. 9 — Typical dc beta characteristics for type 2N6545.

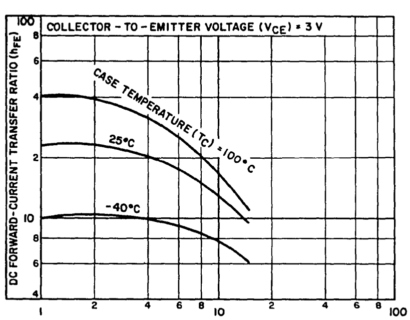


Fig. 10 — Typical dc beta characteristics for type 2N6546.

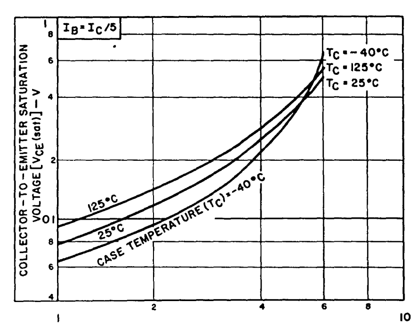


Fig. 11 — Typical collector-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

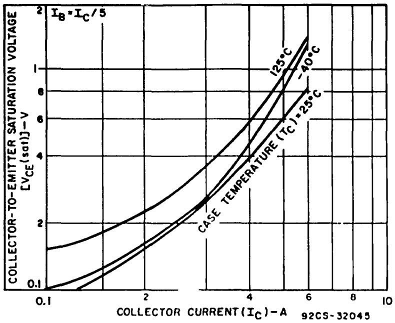


Fig. 12 — Typical collector-to-emitter saturation voltage as a function of collector current for type 2N6545.

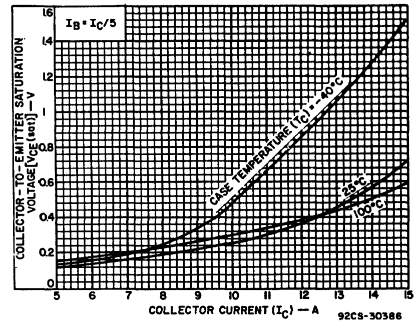


Fig. 13 — Typical collector-to-emitter saturation voltage characteristics for type 2N6546.

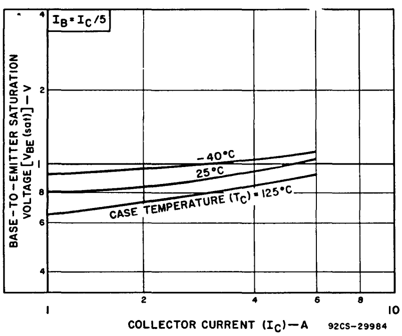


Fig. 14 — Typical base-to-emitter saturation voltage as a function of collector current for types 2N6542 and 2N6544.

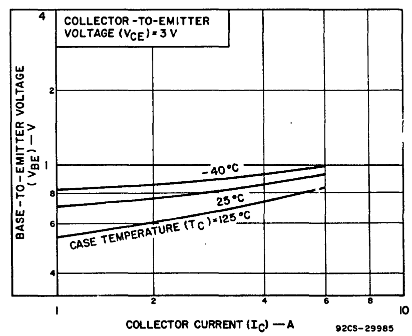


Fig. 15 — Typical base-to-emitter voltage as a function of collector current for types 2N6542 and 2N6544.

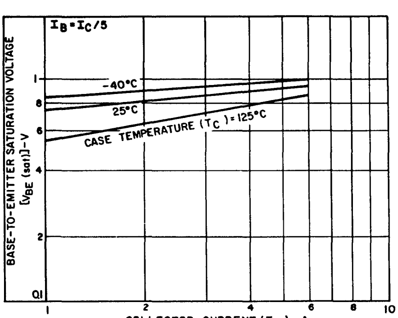


Fig. 16 — Typical base-to-emitter saturation voltage as a function of collector current for type 2N6545.

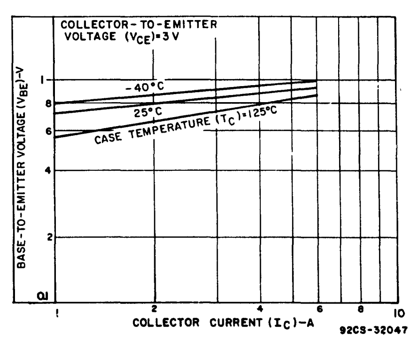


Fig. 17 — Typical base-to-emitter voltage as a function of collector current for type 2N6545.

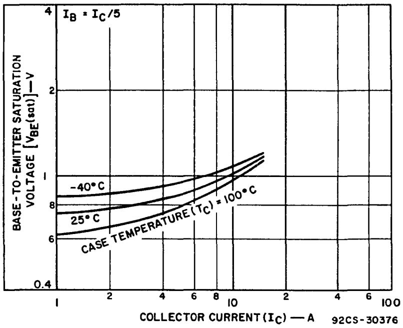


Fig. 18 — Typical base-to-emitter saturation voltage characteristics for type 2N6546.

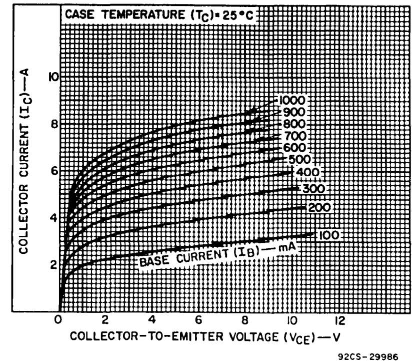


Fig. 19 — Typical output characteristics for types 2N6542 and 2N6544.

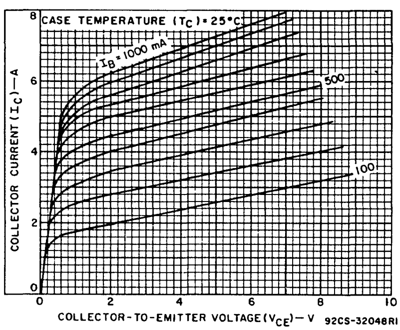


Fig. 20 — Typical output characteristics for type 2N6545.

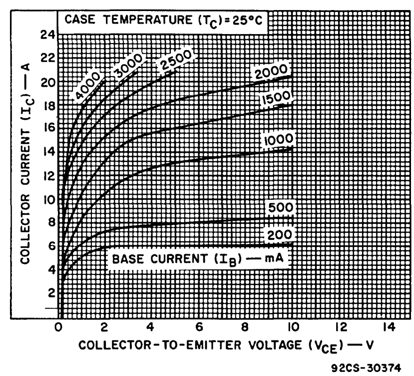


Fig. 21 — Typical output characteristics for type 2N6546.

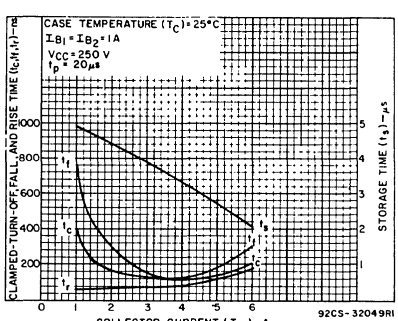


Fig. 22 — Typical saturated switching time characteristics for type 2N6545.

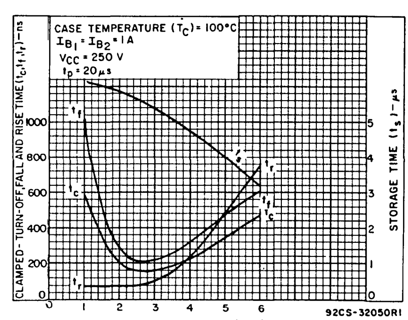


Fig. 23 — Typical saturated switching time characteristics for type 2N6545.

2
POWER TRANSISTORS

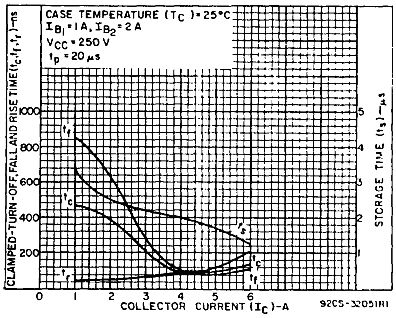


Fig. 24 — Typical saturated switching time characteristics for type 2N6545.

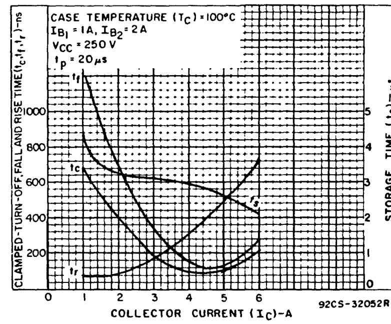


Fig. 25 — Typical saturated switching time characteristics for type 2N6545.

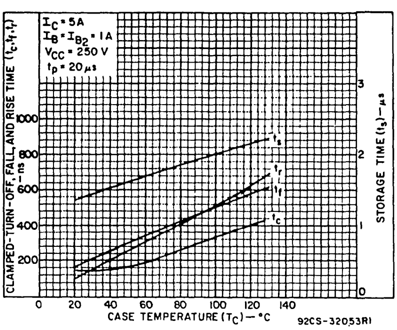


Fig. 26 — Typical saturated switching time characteristics as a function of case temperature for type 2N6545.

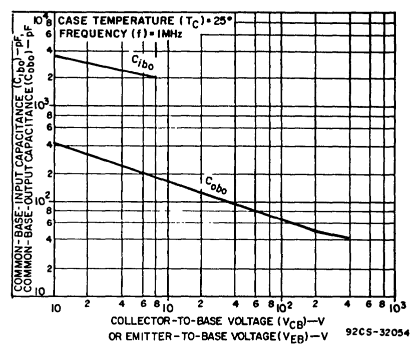


Fig. 27 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for type 2N6545.

File Number **2332**

2N6547

15-Ampere Power-Switching Transistor

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*

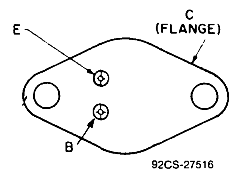
Applications:

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

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

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

TERMINAL DESIGNATION



JEDEC TO-204AA

2 POWER TRANSISTORS

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

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	

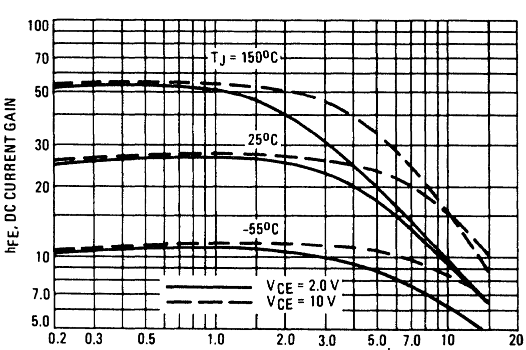


FIGURE 1 — DC CURRENT GAIN

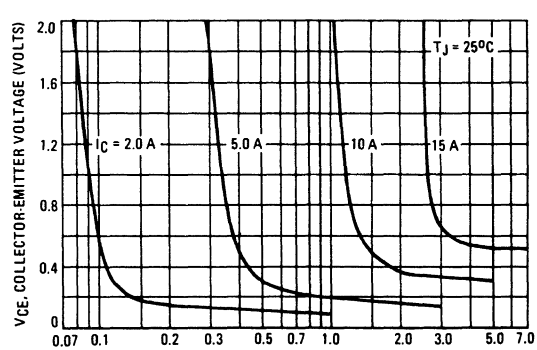


FIGURE 2 — COLLECTOR SATURATION REGION

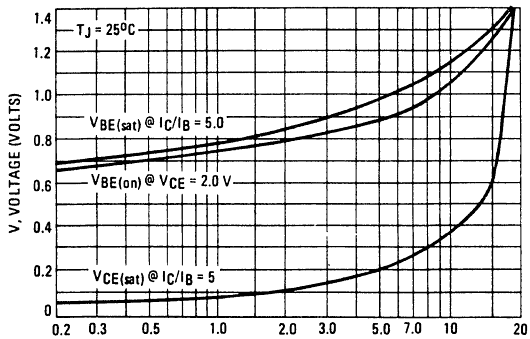


FIGURE 3 – "ON" VOLTAGE

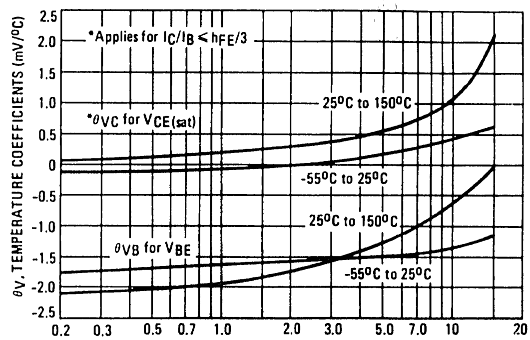


FIGURE 4 – TEMPERATURE COEFFICIENTS

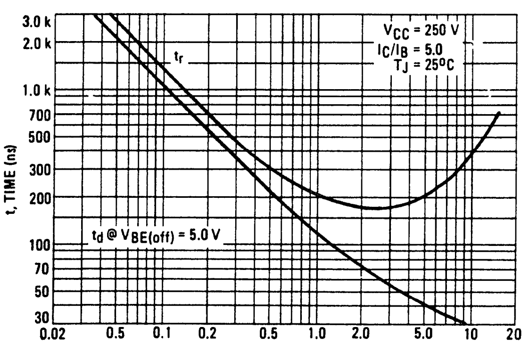


FIGURE 5 – TURN-ON TIME

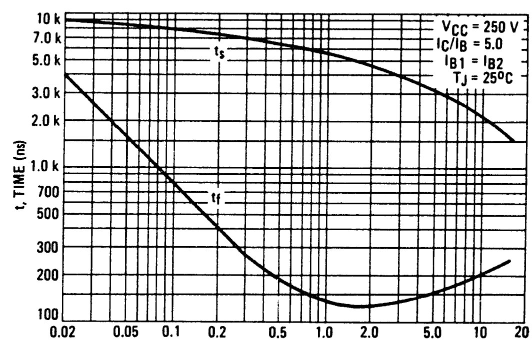


FIGURE 6 – TURN-OFF TIME

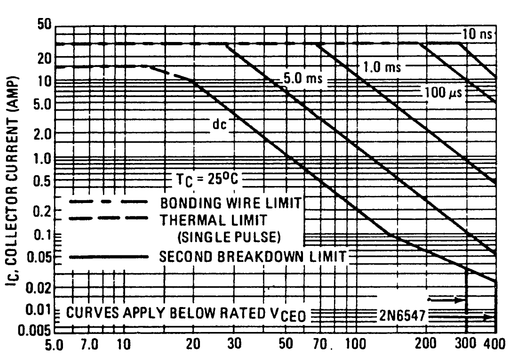


FIGURE 7 – FORWARD BIAS SAFE OPERATING AREA

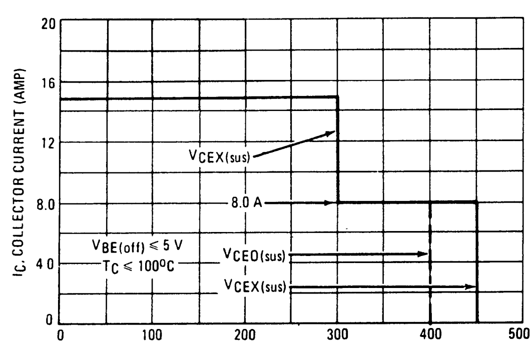


FIGURE 8 – REVERSE BIAS SAFE OPERATING AREA

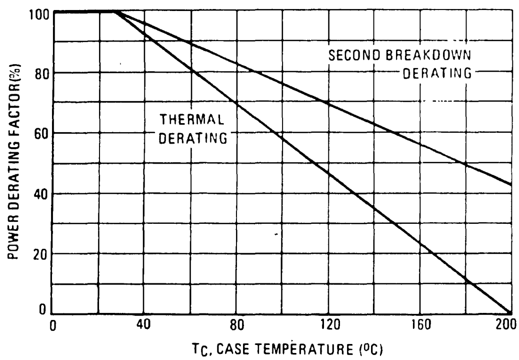


FIGURE 9 — POWER DERATING

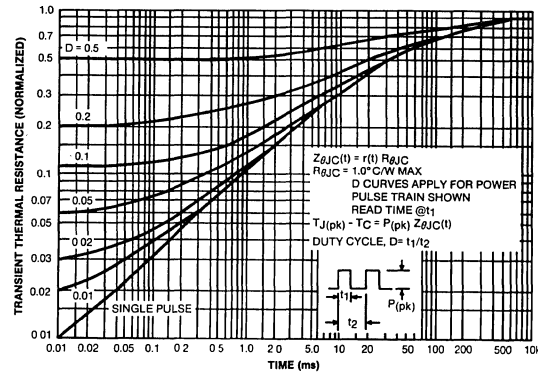


FIGURE 10 - THERMAL RESPONSE

15-Ampere N-P-N Darlington Power Transistors

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

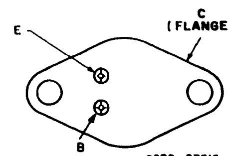
Features:

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

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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

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

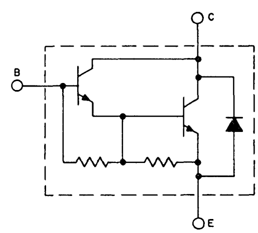


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6576	2N6577	2N6578	
*	V_{CBO}	60	90	120	V
*	$V_{CEO}(sus)$	60	90	120	V
*	V_{EBO}		7		V
*	I_C		15		A
	I_{CM}		30		A
*	I_B		0.25		A
*	P_T				
	$T_C \leq 25^oC$		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.

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

CHARACTERISTIC SYMBOL	TEST CONDITIONS: VOLTAGE V dc			TEST CONDITIONS: CURRENT A dc		LIMITS: 2N6576		2N6577		2N6578		UNITS
	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	
I_{CER}	60					–	5	–	–	–	–	mA
R_{BE} = 10K	90					–	–	–	5	–	–	
* T_C=150°C	120					–	–	–	–	–	5	
I_{CEX}	60		−1.5			–	5	–	–	–	–	
T_C=175°C	90		−1.5			–	–	–	5	–	–	
	120		−1.5			–	–	–	–	–	5	
* I_{EBO}		7		0		–	7.5	–	7.5	–	7.5	mA
* $V_{CEO}(sus)$				0.2[b]	0	60	–	90	–	120	–	V
* h_{FE}	3			0.4[b]		200	–	200	–	200	–	
	3			4[b]		2000	20000	2000	20000	2000	20000	
	3			10[b]		500	5000	500	5000	500	5000	
	4			15[b]		100	–	100	–	100	–	
* $V_{BE}(sat)$			10	0.1[b]		–	3.5	–	3.5	–	3.5	V
			15	0.15[b]		–	4.5	–	4.5	–	4.5	
* $V_{CE}(sat)$				10[b]	0.1	–	2.8	–	2.8	–	2.8	
				15[b]	0.15	–	4	–	4	–	4	V
V_F				−15		–	4.5	–	4.5	–	4.5	
* h_{fe} f=1 MHz	3			3		4	40	4	40	4	40	
* t_d[c]				10	0.1	–	0.15	–	0.15	–	0.15	
* t_r[c]				10	0.1	–	1	–	1	–	1	μs
* t_s[c]				10	0.1[d]	–	2	–	2	–	2	
* t_f[c]				10	0.1[d]	–	7	–	7	–	7	
$I_{S/b}$ t=1 s, non rep.	20					6	–	6	–	6	–	A
$R_{\theta JC}$						–	1.46	–	1.46	–	1.46	°C/W

* In accordance with JEDEC registration data.
[a] V_{CB} value.
[b] Pulsed: Pulse duration = 300 μs, duty factor = 1.8%.
[c] V_{CC} = 30 V, t_p = 300 μs, duty cycle = 2%.
[d] $I_{B_1} = -I_{B_2}$.

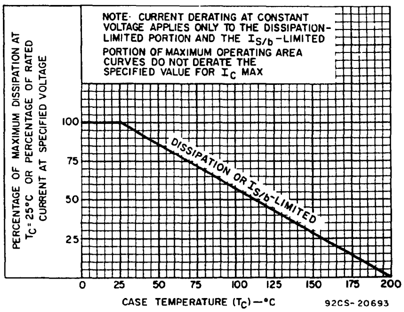


Fig. 2 — Derating curves for all types.

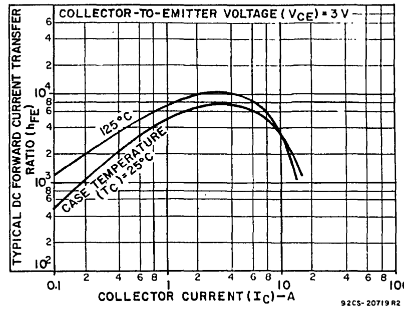


Fig. 3 — Typical dc-beta characteristics for all types.

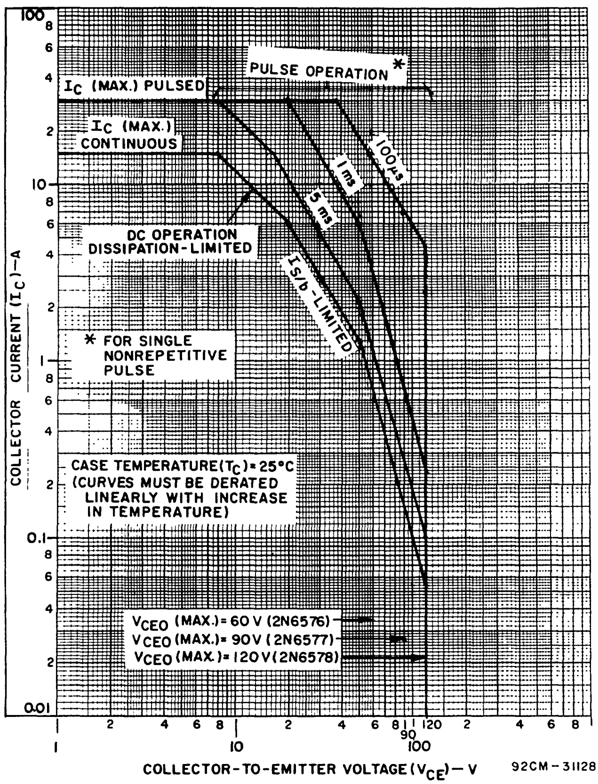


Fig. 4 — Maximum operating areas for all types.

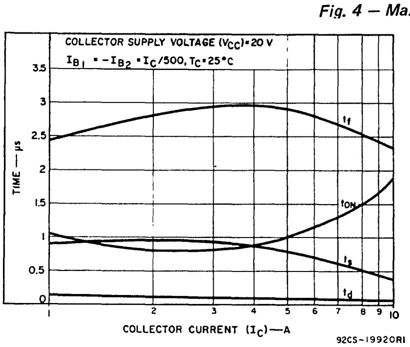


Fig. 5 — Typical saturated switching time characteristics for all types.

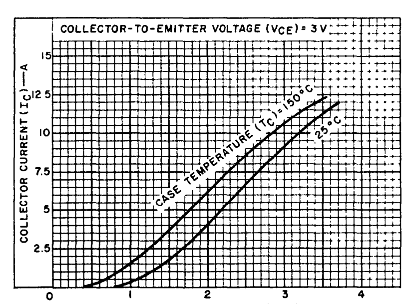


Fig. 6 — Typical transfer characteristics for all types.

2
POWER TRANSISTORS

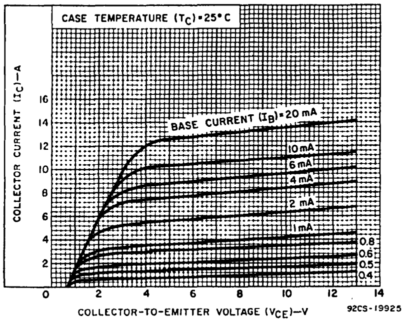


Fig. 7 — Typical output characteristics for all types.

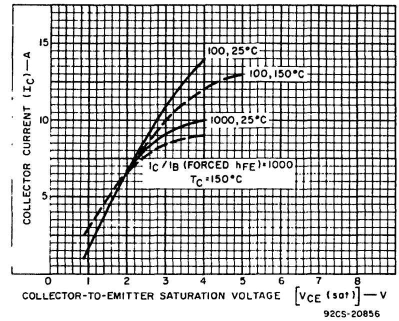


Fig. 8 — Typical saturation characteristics for all types.

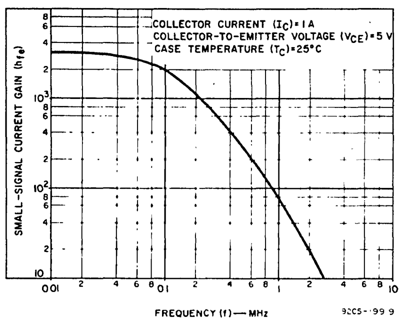


Fig. 9 — Typical small-signal gain for all types.

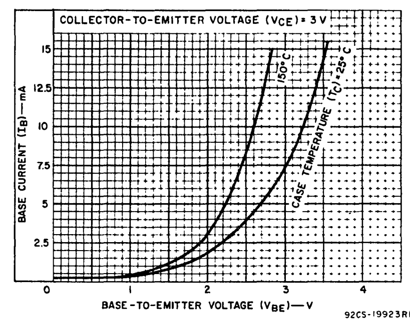


Fig. 10 — Typical input characteristics for all types.

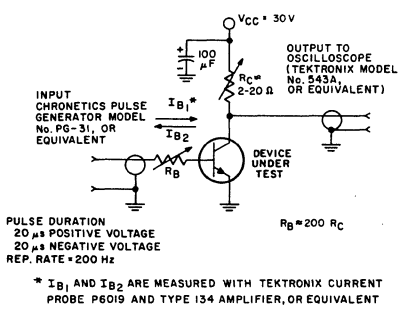
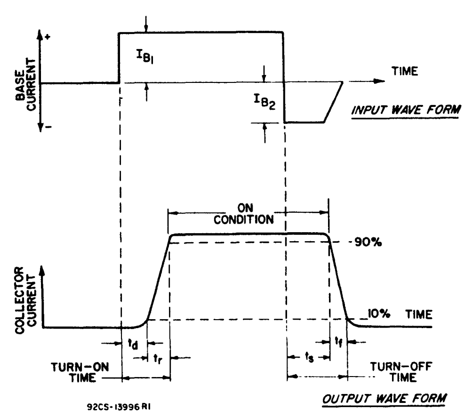


Fig. 11 — Circuit used to measure saturated-switching times.



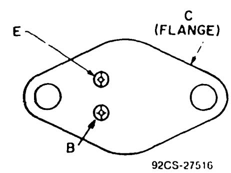
Silicon P-N-P Epitaxial-Base High-Power Transistors

Rugged Devices, Broadly Applicable For Industrial and 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.

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	LIMITS 2N6609 Min.	2N6609 Max.	MJ15004 Min.	MJ15004 Max.	UNITS
I_{CBO}	−160[a]			–	−4	–	–	
*	−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	–	–	mA
* 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_{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	–	–	V
	−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	
$I_{S/b}$	−100			−1.5	–	−1	–	
t_p = 1 s nonrep.	−50			–	–	−5	–	A
$\|h_{fe}\|$								
* 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.

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

CHARACTERISTIC	TEST CONDITIONS			LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc	RCA9116C		RCA9116D		RCA9116E		
	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO}	−140[a]			–	−1	–	–	–	–	mA
	−120[a]			–	–	–	−1	–	–	
	−100[a]			–	–	–	–	–	−1	
I_{CEX}	−140	1.5		–	−1	–	–	–	–	
	−120	1.5		–	–	–	−1	–	–	
I_{CEX} T_C = 150°C	−140	1.5		–	−5	–	–	–	–	
	−120	1.5		–	–	–	−5	–	–	
I_{CEO} I_B = 0	−70			–	−1	–	–	–	–	
	−60			–	–	–	−1	–	–	
I_{EBO}		−5		–	−1	–	−1	–	−1	
h_{FE}	−2		−5[c]	25	150	25	150	–	–	
	−2		−7.5[c]	–	–	–	–	10	100	
	−2		−10[c]	10	–	10	–	–	–	
V_{CER}(sus)[b] R_{BE} ≤ 100Ω			−0.2	−150	–	−130	–	−110	–	V
V_{CEO}(sus)[b]			−0.2	−140	–	−120	–	−100	–	
V_{EBO} I_E = −1 mA			0	−5	–	−5	–	−5	–	
V_{BE}	−2		−7.5[c]	–	–	–	–	–	−3	
	−2		−5[c]	–	−2	–	−2	–	–	
V_{CE}(sat) I_B = −0.75A			−7.5[c]	–	–	–	–	–	−1.5	
= −0.5A			−5[c]	–	−1	–	−1	–	–	
$I_{S/b}$ t_p = 1 s nonrep.	−35			−5.71	–	−5.71	–	–	–	A
	−25			–	–	–	–	−8	–	
$\|h_{fe}\|$ f = 0.5 MHz	−10		−0.5	4	–	4	–	4	–	
f_T				2	–	2	–	2	–	MHz
C_{ob} f = 0.1 MHz	−10[a]			–	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.

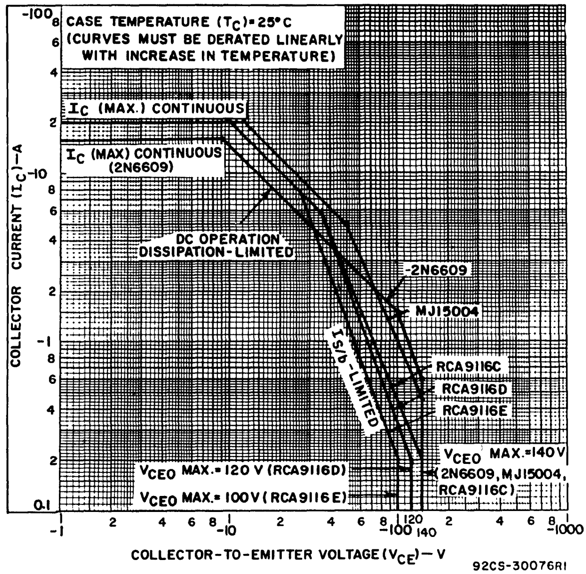


Fig. 1 - Maximum operating areas for all types.

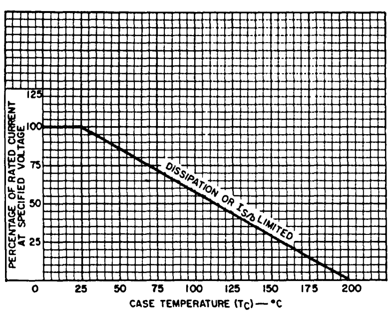


Fig. 2 - Current derating curve for all types.

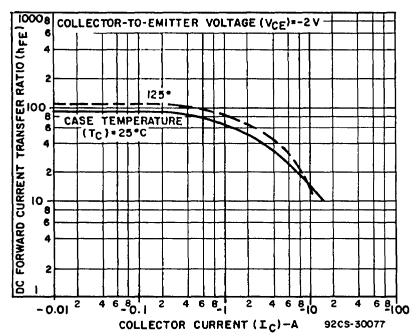


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

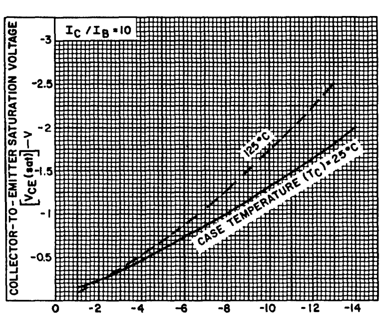


Fig. 4 - Typical saturation voltage characteristics for all types.

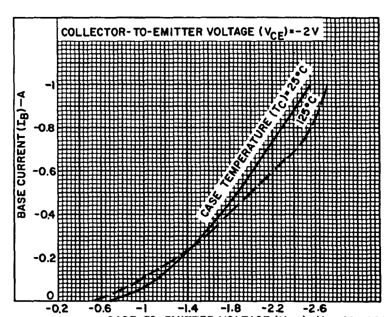


Fig. 5 - Typical input characteristics for all types.

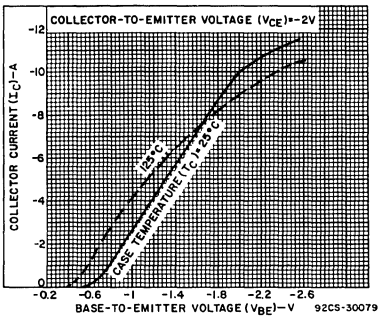


Fig. 6 - Typical transfer characteristics for all types.

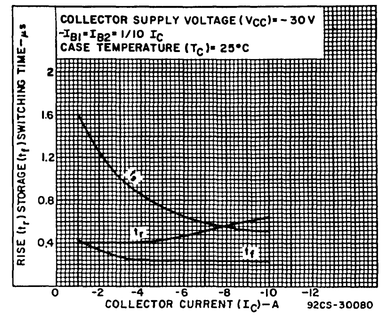


Fig. 7 - Typical saturated-switching times for all types.

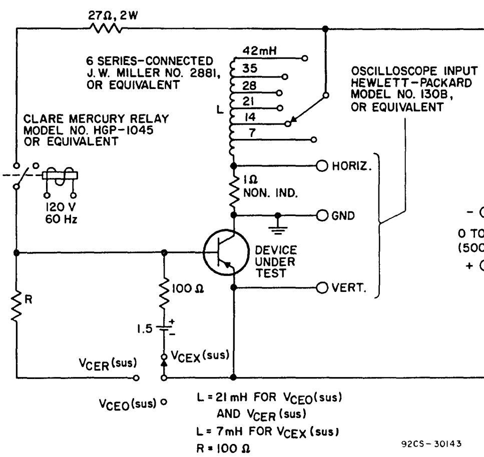


Fig. 8 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

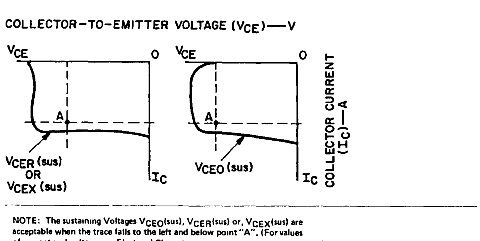


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

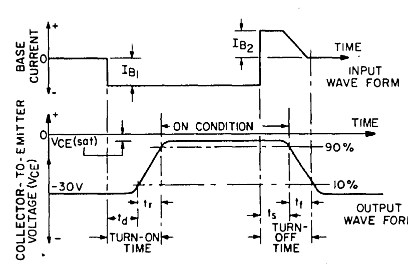


Fig. 10 - Oscilloscope display for measurement of switching times for all types.

10-Ampere P-N-P Darlington Power Transistors

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

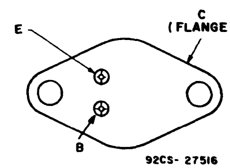
Features:

- **Operates from IC without predriver**

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The 2N6648, 2N6649 and 2N6650● are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. They are complementary to the 2N6383, 2N6384, and 2N6385▲.

The 2N6648, 2N6649, and 2N6650 are supplied in hermetic steel JEDEC TO-204AA packages.

● Formerly RCA Dev. Nos. TA8351, TA8488, and TA8350, respectively.

▲ Technical data for 2N6383, 2N6384, and 2N6385 are given in RCA bulletin File No. 609.

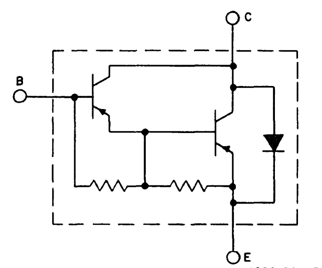


Fig. 1 — Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6648	2N6649	2N6650	
* V_{CBO}	−40	−60	−80	V
V_{CER}(sus) R_{BE} = 100 Ω	−40	−60	−80	V
* V_{CEO}(sus)	−40	−60	−80	V
V_{CEV}(sus) V_{BE} = −1.5 V	−40	−60	−80	V
* V_{EBO}	−5	−5	−5	V
* I_C	−10	−10	−10	A
I_{CM}	−15	−15	−15	A
* I_B	−0.25	−0.25	−0.25	A
* P_T				
$T_C \leq 25^oC$	70	70	70	W
$T_C > 25^oC$ ... Derate linearly		0.56		W/°C
* T_{stg}, T_J		−65 to +150		°C
* T_L At distances ⩾ 1/32 in. (0.8 mm) from seating plane for 10 s max.		235		°C

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

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6648		2N6649		2N6650		UNITS
	V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
I_{CEO}	−40 −60 −80			0 0 0	– – –	−1 – –	– – –	– −1 –	– – –	– – −1	mA
* I_{CEV}	−40 −60 −80	1.5 1.5 1.5			– – –	−0.3 – –	– – –	– −0.3 –	– – –	– – −0.3	
T_C = 150°C	−40 −60 −80	1.5 1.5 1.5			– – –	−3 – –	– – –	– −3 –	– – –	– – −3	
* I_{EBO}		5	0		–	−10	–	−10	–	−10	mA
* V_{CEO}(sus)			−0.2[a]	0	−40	–	−60	–	−80	–	
V_{CER}(sus) R_{BE} = 100 Ω			−0.2[a]		−40	–	−60	–	−80	–	V
V_{CEV}(sus)		1.5	−0.2[a]		−40	–	−60	–	−80	–	
* h_{FE}	−3 −3		−5[a] −10[a]		1000 100	20,000 –	1000 100	20,000 –	1000 100	20,000 –	
V_{BE}	−3 −3		−5[a] −10[a]		– –	−2.8 −4.5*	– –	−2.8 −4.5*	– –	−2.8 −4.5*	V
V_{CE}(sat)			−5[a] −10[a]	−0.01[a] −0.1[a]	– –	−2 −3*	– –	−2 −3*	– –	−2 −3*	V
V_F			10[a]		–	4	–	4	–	4	V
h_{fe} f = 1 kHz	−5		−1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	−5		−1		20	–	20	–	20	–	
$I_{S/b}$ t = 1 s, nonrep.	−35 −25				−1 −2.8	– –	−1 −2.8	– –	−1 −2.8	– –	A
$R_{\theta JC}$					–	1.75	–	1.75	–	1.75	°C/W

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

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

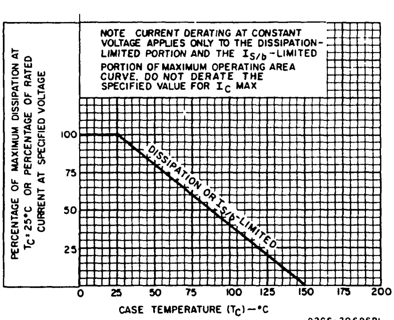


Fig.2 — Derating curve for all types.

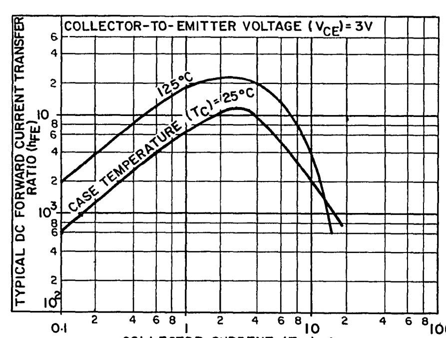


Fig. 3 — Typical dc beta characteristics for all types.

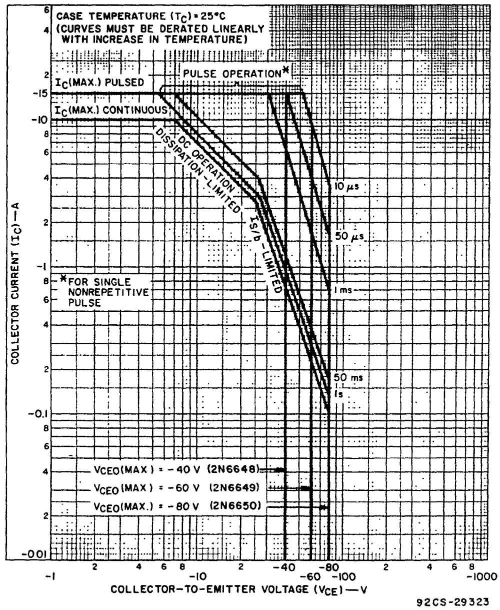


Fig. 4 — Maximum operating areas for all types.

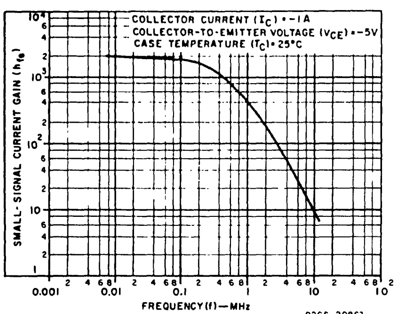


Fig. 5 — Typical small-signal gain for all types.

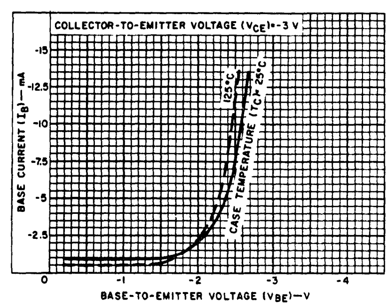


Fig. 6 — Typical input characteristics for all types.

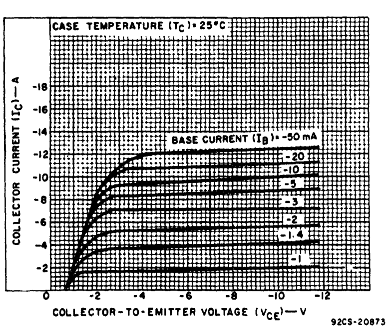


Fig. 7 — Typical output characteristics for all types.

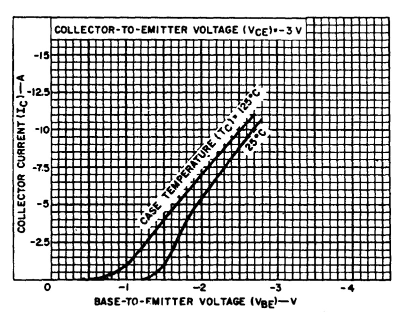


Fig. 8 — Typical transfer characteristics for all types.

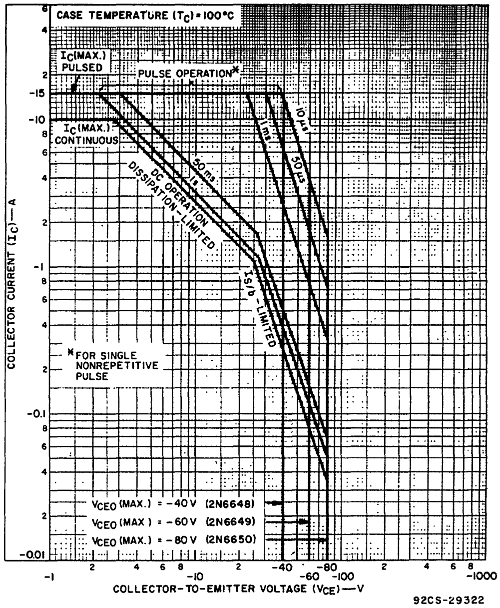


Fig. 9 — Maximum operating areas for all types at T_C = 100° C.

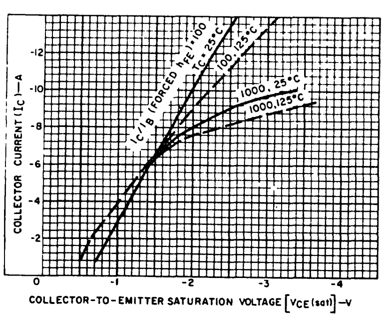


Fig. 10 — Typical saturation characteristics for all types.

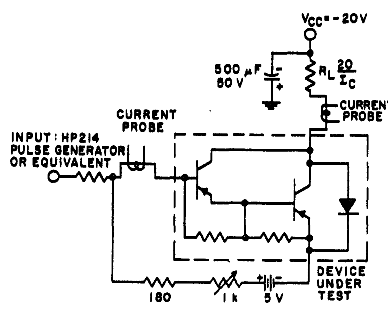


Fig. 11 — Circuit used to measure saturated switching times.

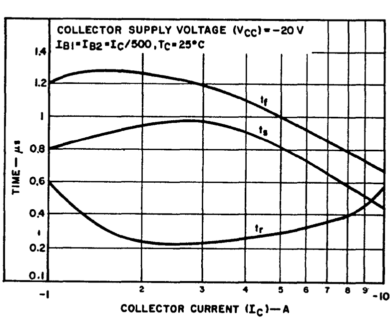


Fig. 12 — Typical saturated switching-time characteristics for all types.

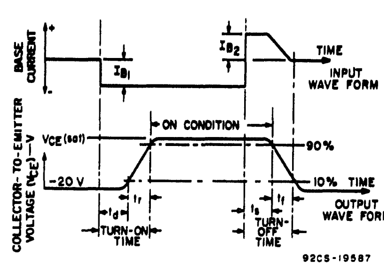


Fig. 13 — Phase relationship between input current and output current showing reference points for specification of switching times.

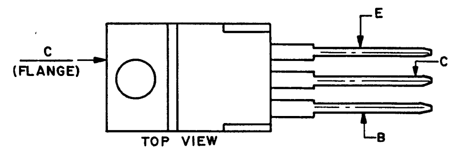
10-Ampere P-N-P Darlington Power Transistors

40-60-80 Volts, 65 Watts
Gain of 1000 at 3 A (2N6666)
Gain of 1000 at 5 A (2N6667, 2N6668)

Features:
- Operates from IC without predriver

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The 2N6666, 2N6667 and 2N6668● are monolithic silicon p-n-p Darlington transistors designed for low- and medium-frequency power applications. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. They are complementary to the 2N6386, 2N6387 and 2N6388▲

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

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

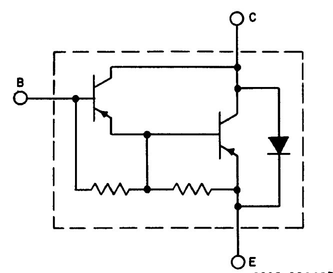


Fig. 1 – Schematic diagram for all types.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6666	2N6667	2N6668	
* V_{CBO}	–40	–60	–80	V
$V_{CER}(sus)$				
R_{BE} = 100 Ω	–40	–60	–80	V
$V_{CEO}(sus)$	–40	–60	–80	V
$V_{CEV}(sus)$				
V_{BE} = –1.5 V	–40	–60	–80	V
* V_{EBO}	–5	–5	–5	V
* I_C	–8	–10	–10	A
I_{CM}	–15	–15	–15	A
* I_B	–0.25	–0.25	–0.25	A
* P_T				
$T_C \leq 25^oC$	65	65	65	W
$T_C > 25^oC$ derate linearly		0.52		$W/^oC$
* 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-4).

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 2N6666 MIN.	MAX.	2N6667 MIN.	MAX.	2N6668 MIN.	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 = 125°C	–80	1.5			–	–	–	–	–	–3	
	–60	1.5			–	–	–	–3	–	–	
	–40	1.5			–	–3	–	–	–	–	
I_{EBO}		5	0		–	–10	–	–10	–	–10	mA
* V_{CEO}(sus)			–0.2[a]	0	–40	–	–60	–	–80	–	V
V_{CER}(sus) R_{BE} = 100 Ω			–0.2[a]		–40	–	–60	–	–80	–	
V_{CEV}(sus)		1.5	–0.2[a]		–40	–	–60	–	–80	–	
* h_{FE}	–3		–3[a]		1000	20,000	–	–	–	–	
	–3		–5[a]		–	–	1000	20,000	1000	20,000	
	–3		–8[a]		100	–	–	–	–	–	
	–3		–10[a]		–	–	100	–	100	–	
V_{BE}	–3		–3[a]		–	–2.8	–	–	–	–	V
	–3		–5[a]		–	–	–	–2.8	–	–2.8	
	–3		–8[a]		–	–4.5	–	–	–	–	
	–3		–10[a]		–	–	–	–4.5	–	–4.5	
* V_{CE}(sat)			–3[a]	–0.006[a]	–	–2	–	–	–	–	V
			–5[a]	–0.01[a]	–	–	–	–2	–	–2	
			–8[a]	–0.08[a]	–	–3	–	–	–	–	
			–10[a]	–0.1[a]	–	–	–	–3	–	–3	
V_F			8[a]		–	4	–	–	–	–	V
			10[a]		–	–	–	4	–	4	
h_{fe} f = 1 kHz	–5		–1		1000	–	1000	–	1000	–	
* $\|h_{fe}\|$ f = 1 MHz	–5		–1		20	–	20	–	20	–	
$I_{S/b}$ t = 1 s, nonrep.	–20				–3.2	–	–3.2	–	–3.2	–	A
$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor = 2%.
*In accordance with JEDEC registration data format (JS-6 RDF-4).

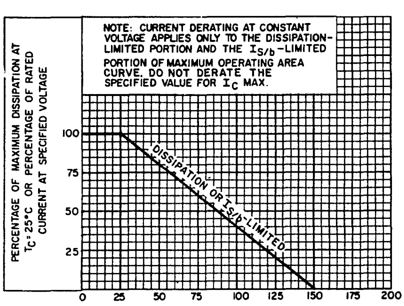


Fig. 2 — Derating curve for all types.

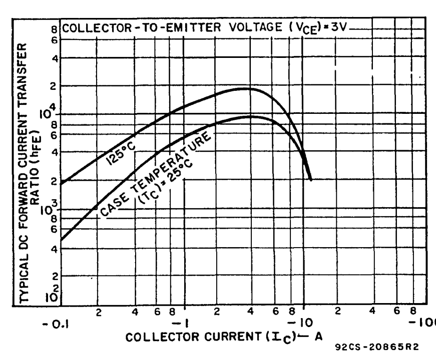


Fig. 3 — Typical dc beta characteristics for all types.

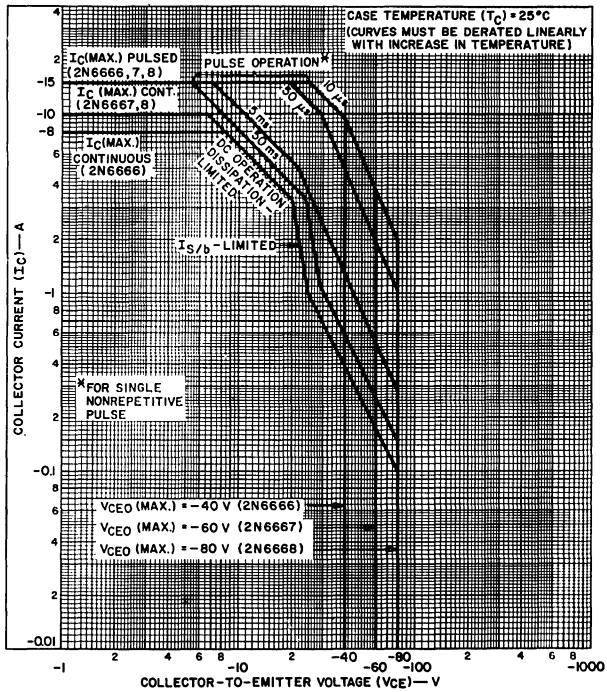


Fig. 4 — Maximum operating areas for all types at T_C = 25° C.

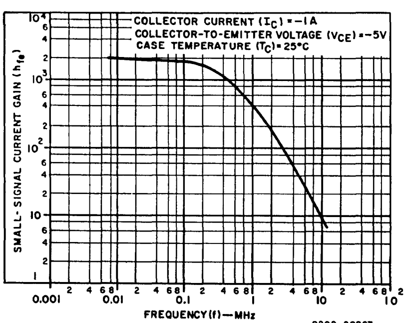


Fig. 5 — Typical small-signal gain for all types.

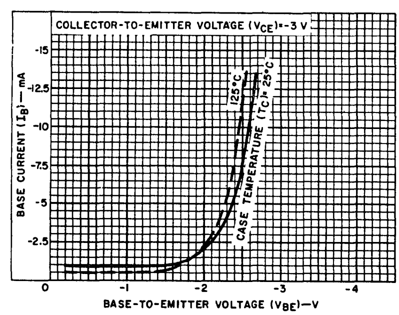


Fig. 6 — Typical input characteristics for all types.

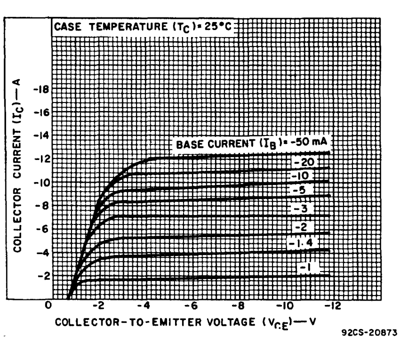


Fig. 7 — Typical output characteristics for all types.

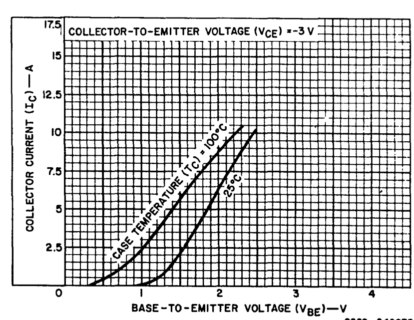


Fig. 8 — Typical transfer characteristics for all types.

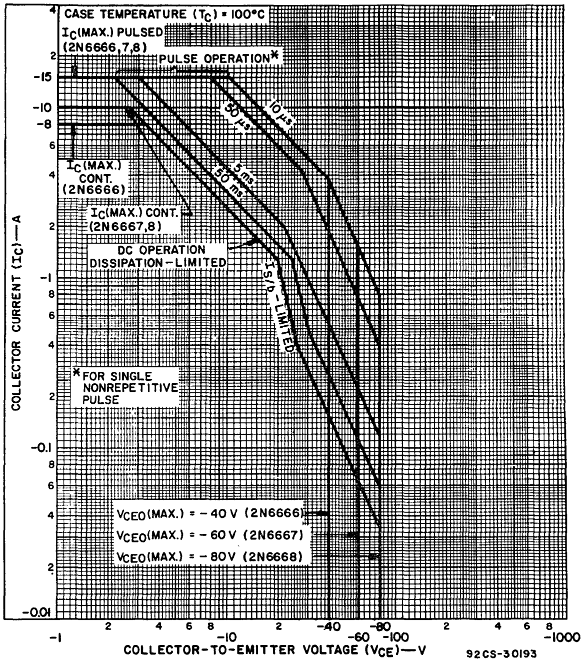


Fig. 9 — Maximum operating areas for all types T_C = 100° C.

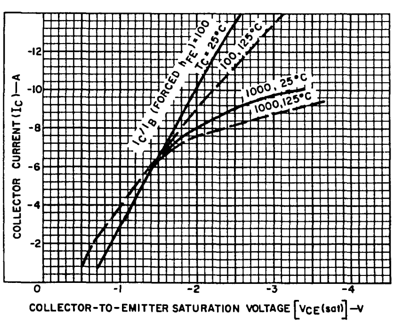


Fig. 10 — Typical saturation characteristics for all types.

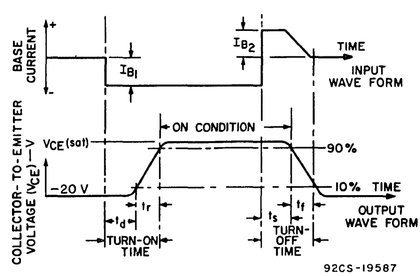


Fig. 11 — Phase relationship between input current and output current showing reference points for specification of switching times.

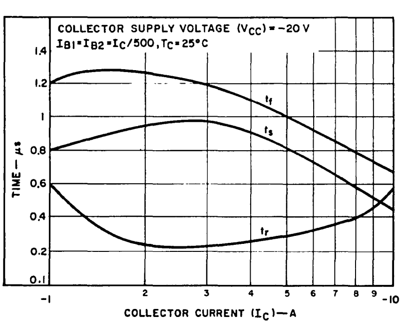


Fig. 12 — Typical saturated switching-time characteristics for all types.

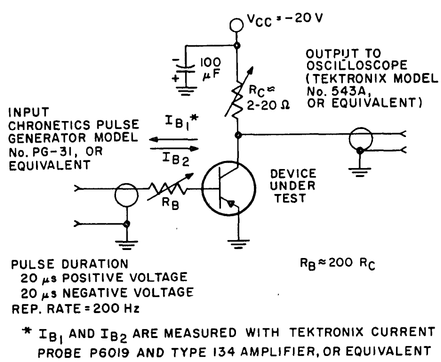


Fig. 13 — Circuit used to measure saturated switching times.

5-A *SwitchMax* Power Transistors

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

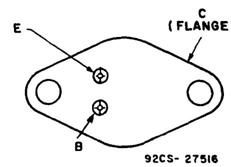
Features:

- *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.

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 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 POWER TRANSISTORS

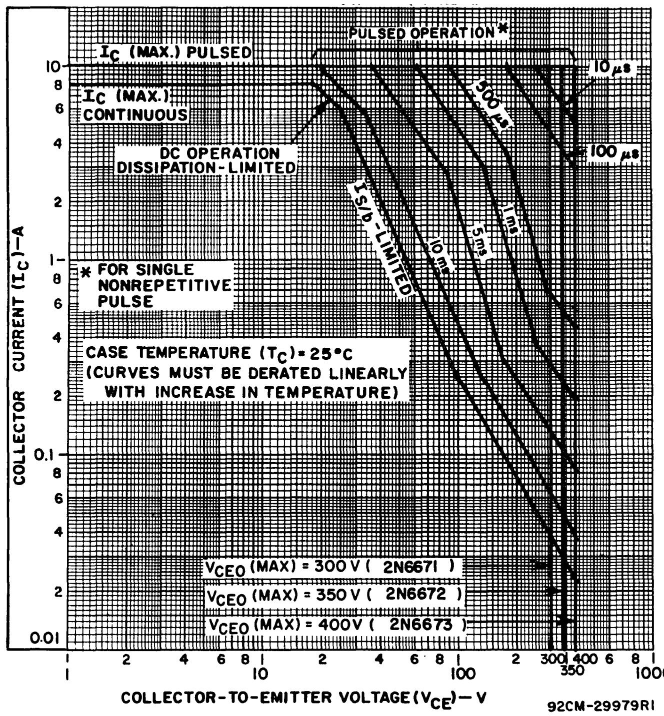


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

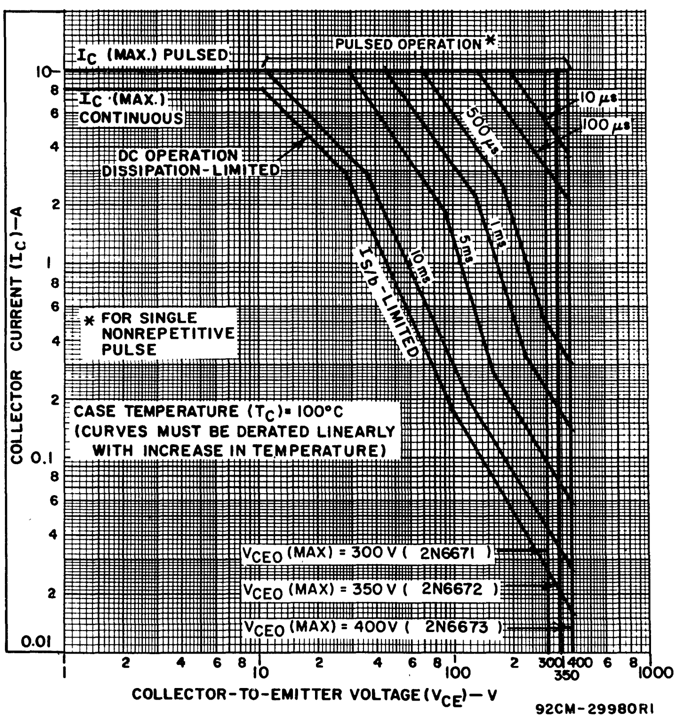


Fig. 2 — Maximum operating areas for all types (T_C =100° C).

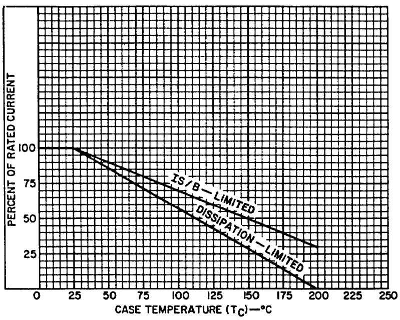


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

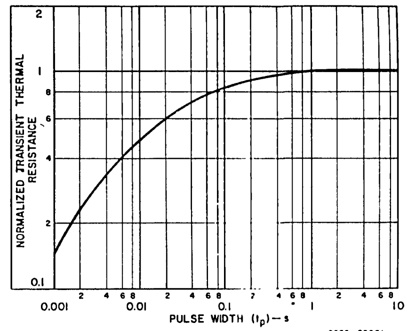


Fig. 4 — Typical thermal-response characteristic for all types.

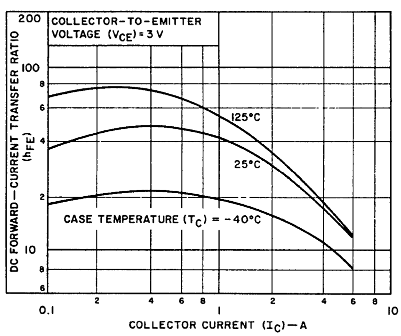


Fig. 5 — Typical dc beta characteristics for all types.

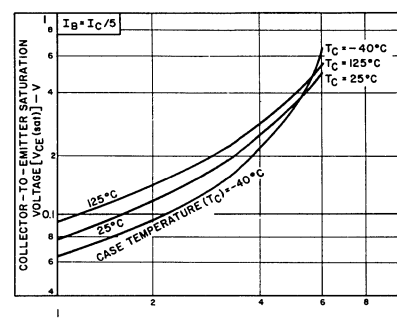


Fig. 6 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

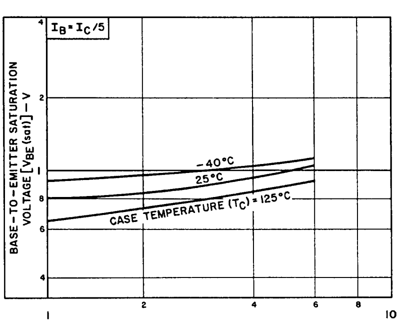


Fig. 7 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

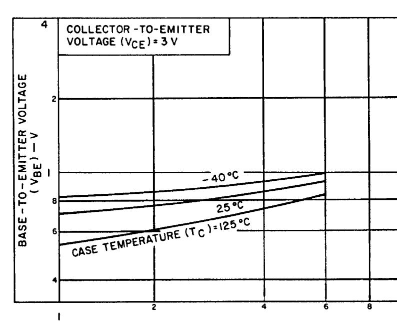


Fig. 8 — Typical base-to-emitter voltage as a function of collector current for all types.

2
POWER TRANSISTORS

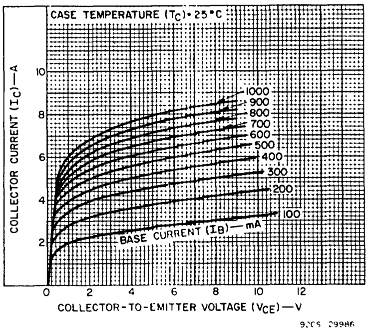


Fig. 9 — Typical output characteristics for all types.

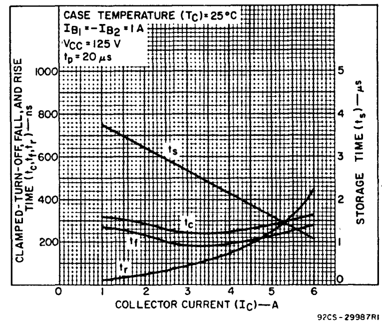


Fig. 10 — Typical saturated switching time characteristics for all types.

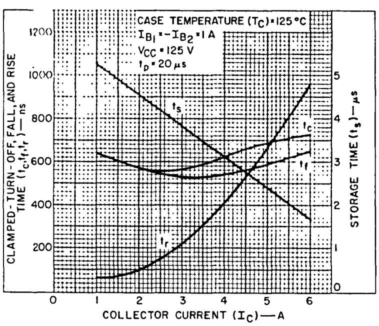


Fig. 11 — Typical saturated switching time characteristics for all types.

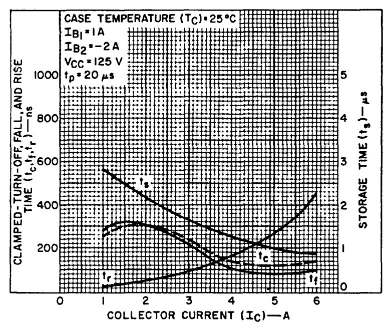


Fig. 12 — Typical saturated switching time characteristics for all types.

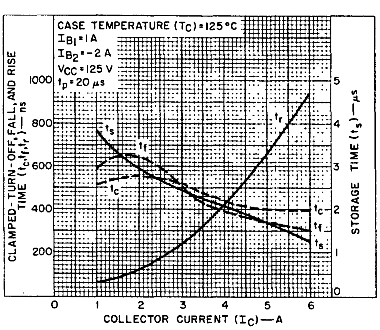


Fig. 13 — Typical saturated switching time characteristics for all types.

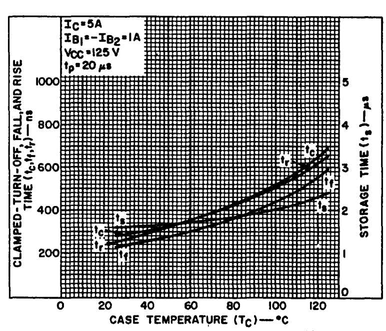


Fig. 14 — Typical saturated switching time characteristics as a function of

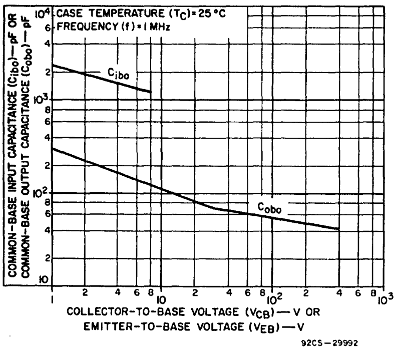


Fig. 15 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

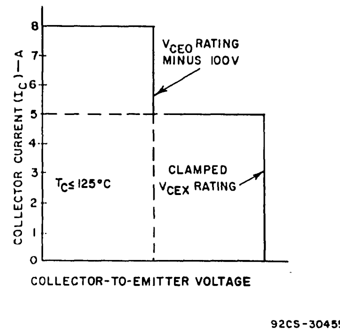


Fig. 16 — Maximum operating conditions for switching between saturation and cutoff.

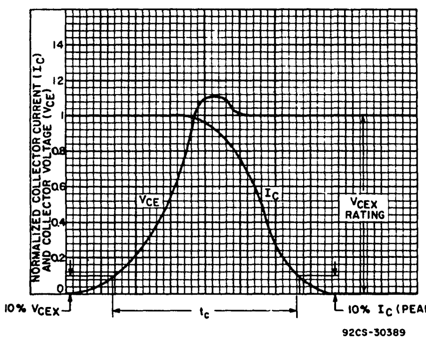


Fig. 17 — Oscilloscope display for measurement of clamped induction switching time (t_c).

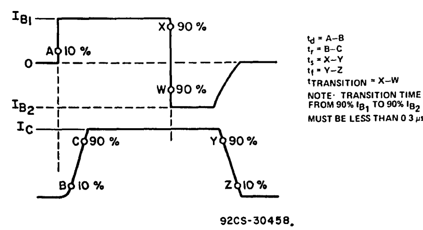
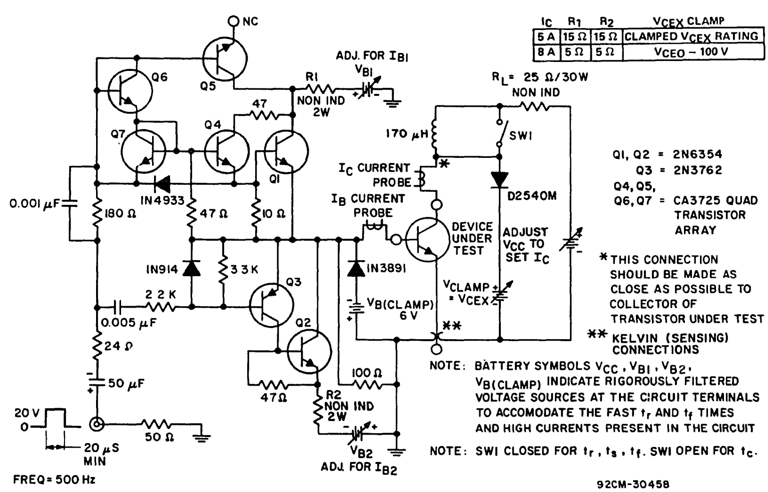


Fig. 18 — Phase relationship between input and output currents showing reference points for specification of switching times.



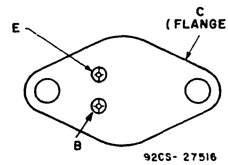
I_C	R1	R2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING
8 A	5 Ω	5 Ω	V_{CEO} – 100 V

Fig. 19 — Circuit for measuring switching times.

10-A SwitchMax Power Transistors

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

TERMINAL DESIGNATIONS



2N6674
2N6675

JEDEC TO-204AA

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*

The 2N6674 and 2N6675 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.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6674	2N6675	
*V_{CEV}				
V_{BE}=-1.5 V		450	650	V
*V_{CEX}(Clamped)				
V_{BE}=-1.5 V		350	450	V
*V_{CEO}		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	1	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
TL				
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max				°C

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

ELECTRICAL CHARACTERISTICS

	CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6674		2N6675		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

[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}=$-I_{B2}$.

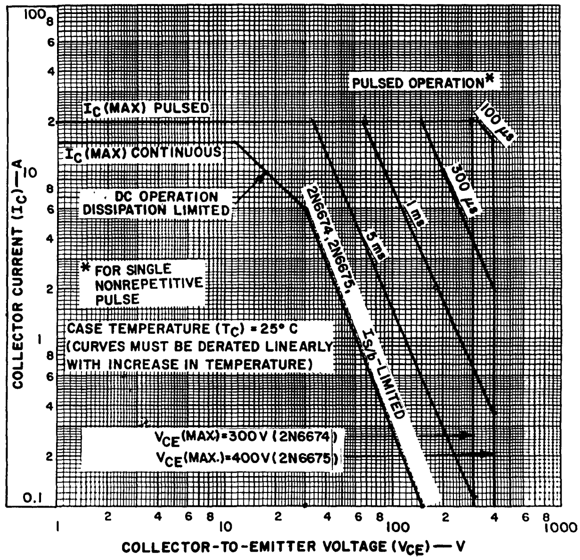


Fig. 1 - Maximum operating areas for all types (T_C = +25°C)

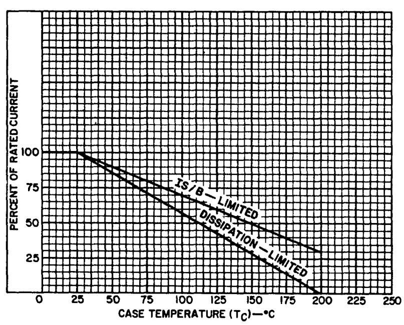


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for 2N6674 and 2N6675.

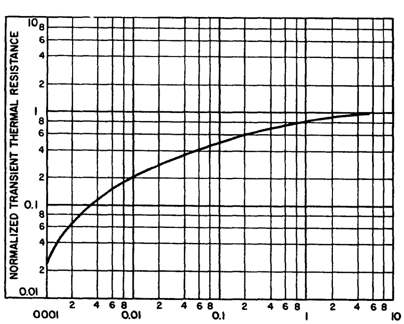


Fig. 3 - Typical thermal-response characteristic for all types.

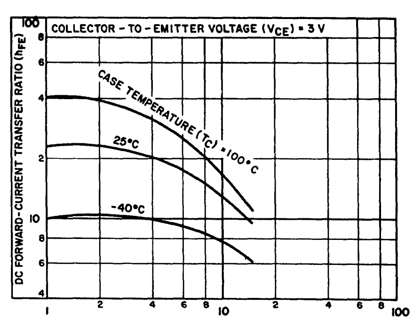


Fig. 4 - Typical dc beta characteristics for all types.

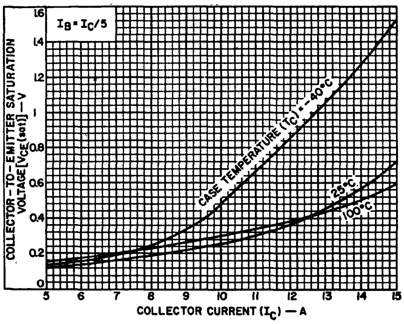


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

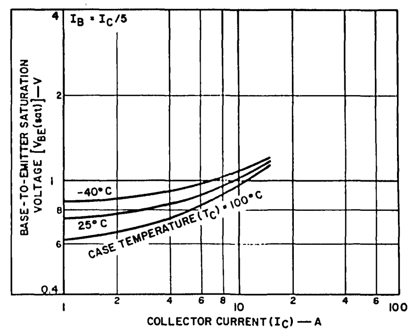


Fig. 6 - Typical base-to-emitter saturation voltage characteristics for all types.

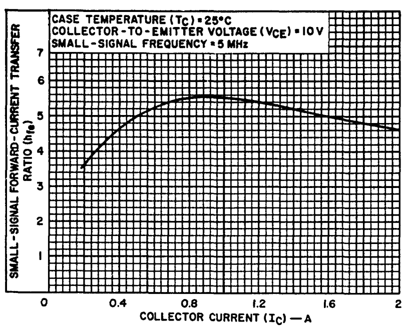


Fig. 7 - Typical small-signal forward current transfer ratio characteristic for all types (f = 5MHz).

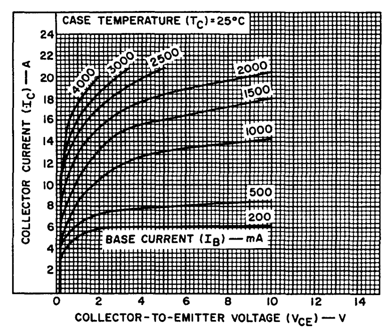


Fig. 8 - Typical output characteristics for all types.

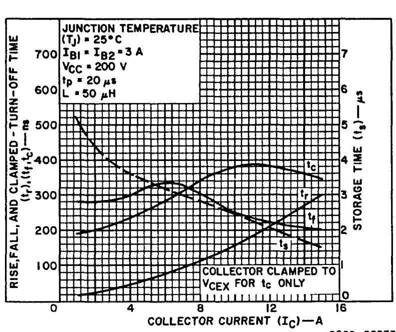


Fig. 9 - Typical saturated-switching-time characteristics at $T_J = 25°C$ as a function of collector current for all types.

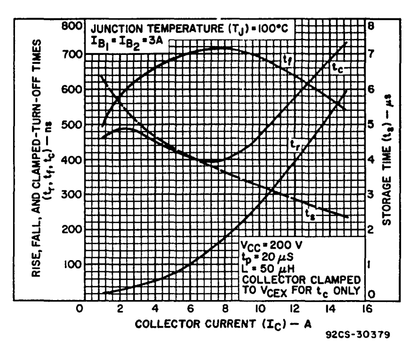


Fig. 10 - Typical saturated-switching-time characteristics at $T_J = 100°C$ as a function of collector current for all types.

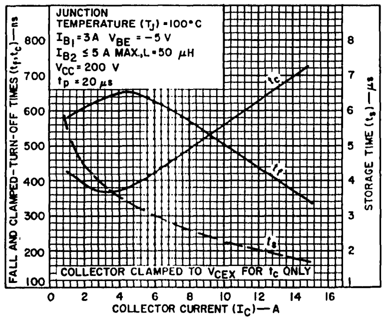


Fig. 11 - Typical saturated-switching-time characteristics at $T_J = 100°C$ as a function of collector current for all types.

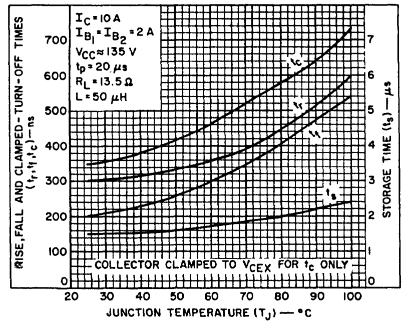


Fig. 12 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

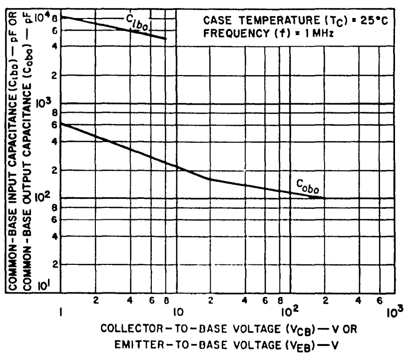


Fig. 13 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

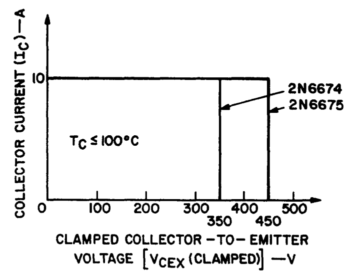


Fig. 14 - Maximum operating conditions for switching between saturation and cutoff for all types.

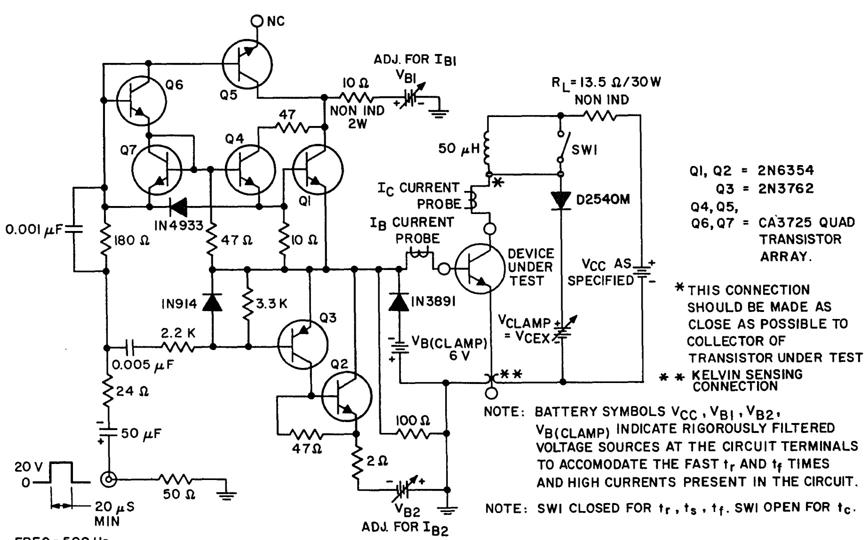


Fig. 15 - Circuit for measuring switching times.

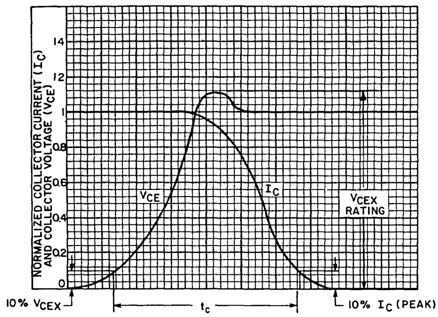


Fig. 16 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

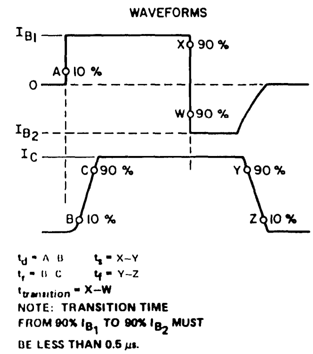


Fig. 17 - Phase relationship between input and output currents showing reference points for specification of switching times.

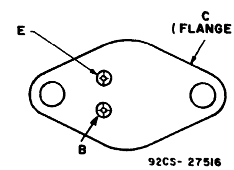
15-A *SwitchMax* Power Transistors

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

Features:
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 350 V to 450 V*
- *Low $V_{CE}(sat)$ at I_C = 15 A*

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

2N6676
2N6677
2N6678

The 2N6676 and 2N6677 and 2N6678 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.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6676	2N6677	2N6678	
* 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
$I_C(sat)$		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		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
T_L				
At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max.				°C

* In accordance with JEDEC registration data (2N6676, 2N6677, 2N6678 only).

ELECTRICAL CHARACTERISTICS

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6676		2N6677		2N6678		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
	T_C=25° C											
*	I_{CEV}	450	-1.5			—	0.1	—	—	—	—	mA
		550	-1.5			—	—	—	0.1	—	—	
		650	-1.5			—	—	—	—	—	0.1	
*	I_{EBO}		-8	0		—	2	—	2	—	2	
*	V_{CEO}(sus)[b]			0.2[a]	0	300	—	350	—	400	—	V
*	h_{FE}	3		15[a]		8	—	8	—	8	—	
*	V_{BE}(sat)			15[a]	3	—	1.5	—	1.5	—	1.5	V
*	V_{CE}(sat)			15[a]	3	—	1	—	1	—	1	
				15[a]	3	—	1.5	—	1.5	—	1.5	
	V_{CEX}[b] (Clamped $E_{S/b}$) L=50 μH, R_{BB}=2 Ω		-6	15	3	350	—	400	—	450	—	
	$I_{S/b}$	30		5.9		1	—	1	—	1	—	s
		100		0.25		1	—	1	—	1	—	
*	$\|h_{fe}\|$ f=5 MHz	10		1		3	10	3	10	3	10	
	f_T	10		1		15	50	15	50	15	50	MHz
*	C_{obo} f=0.1 MHz	10[c]				150	500	150	500	150	500	pF
*	t_d[d]		-6	15	3	—	0.1	—	0.1	—	0.1	μs
*	t_r[d]		-6	15	3	—	0.6	—	0.6	—	0.6	
*	t_s[d]		-6	15	3[e]	—	2.5	—	2.5	—	2.5	
*	t_f[d]		-6	15	3[e]	—	0.5	—	0.5	—	0.5	
*	t_c[f] V_{CC}=200 V, L=50 μH, $R_C \leq 13.5\ \Omega$		-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, $R_C \leq 13.5\ \Omega$		-6	15	3[e]	—	0.8	—	0.8	—	0.8	
*	$R\theta_{JC}$ 2N6676, 2N6677, 2N6678	10		5		—	1	—	1	—	1	°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}.

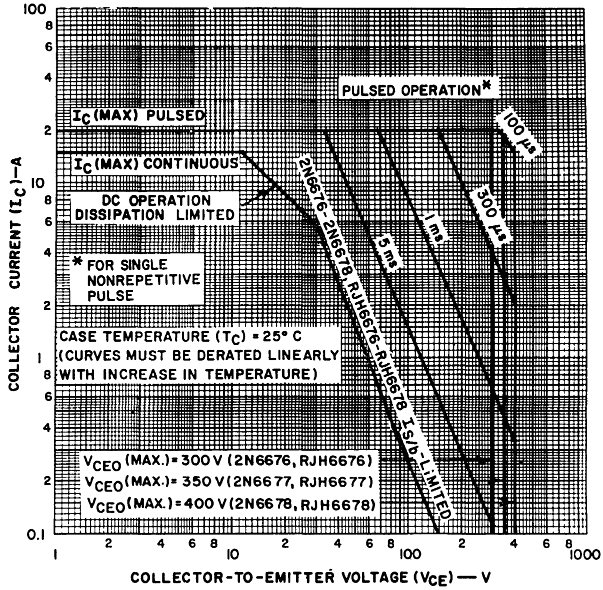


Fig. 1 - Maximum operating areas for all types (T_C = +25°C)

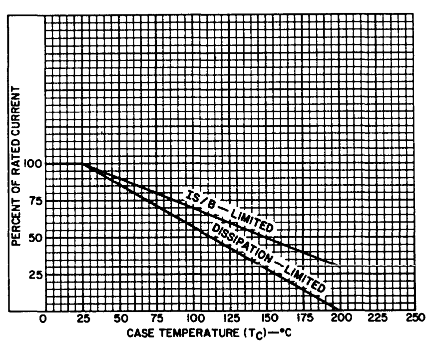


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for 2N6676 and 2N6677 and 2N6678.

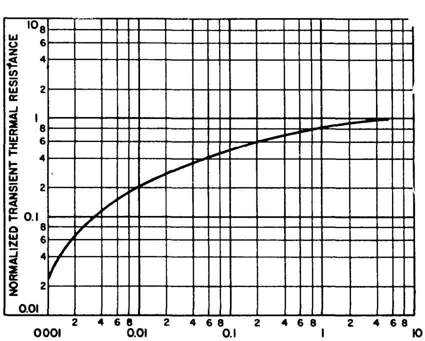


Fig. 3 - Typical thermal-response characteristic for all types.

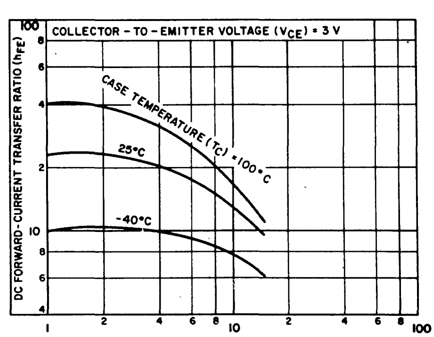


Fig. 4 - Typical dc beta characteristics for all types.

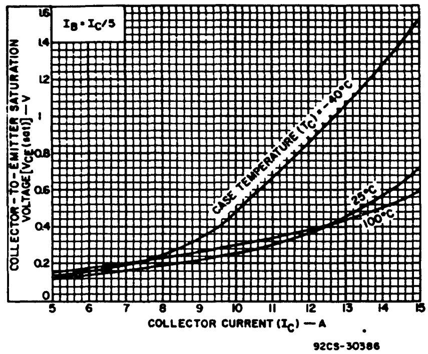


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

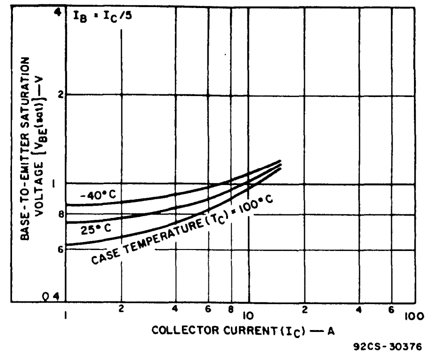


Fig. 6 - Typical base-to-emitter saturation voltage characteristics for all types.

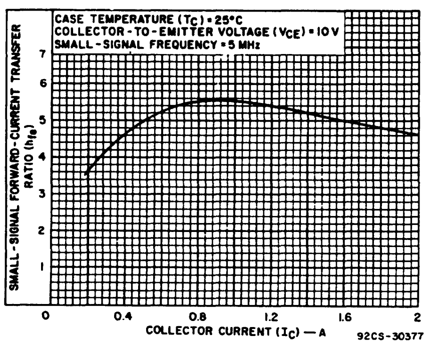


Fig. 7 - Typical small-signal forward current transfer ratio characteristic for all types (f = 5MHz).

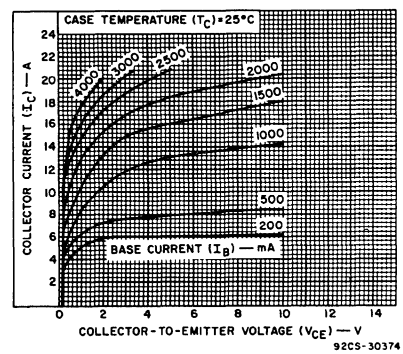


Fig. 8 - Typical output characteristics for all types.

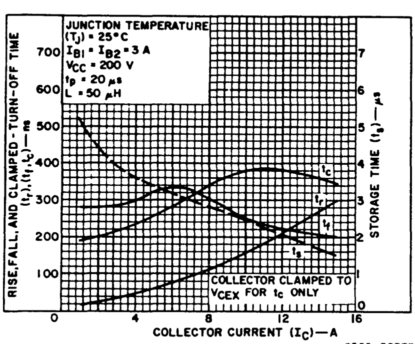


Fig. 9 - Typical saturated-switching-time characteristics at $T_J = 25°C$ as a function of collector current for all types.

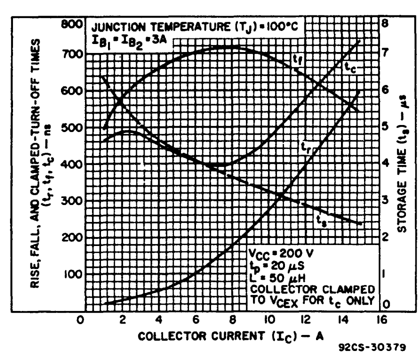


Fig. 10 - Typical saturated-switching-time characteristics at $T_J = 100°C$ as a function of collector current for all types.

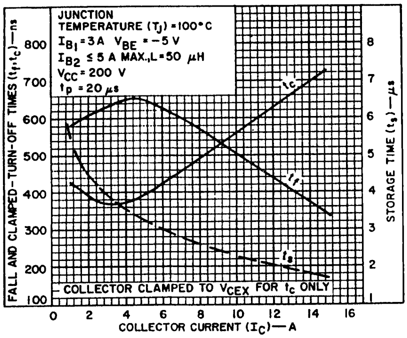


Fig. 11 - Typical saturated-switching-time characteristics at T_J = 100°C as a function of collector current for all types.

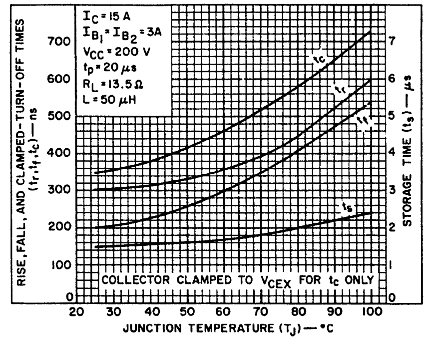


Fig. 12 - Typical saturated-switching-time characteristics as a function of junction temperature for all types.

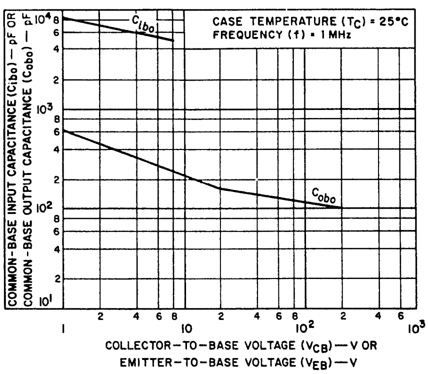


Fig. 13 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

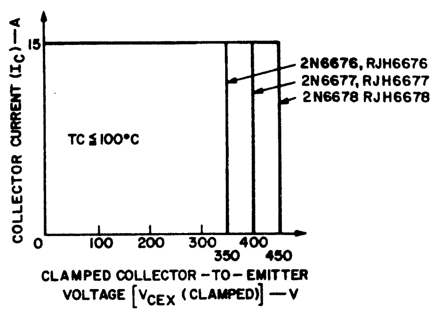


Fig. 14 - Maximum operating conditions for switching between saturation and cutoff for all types.

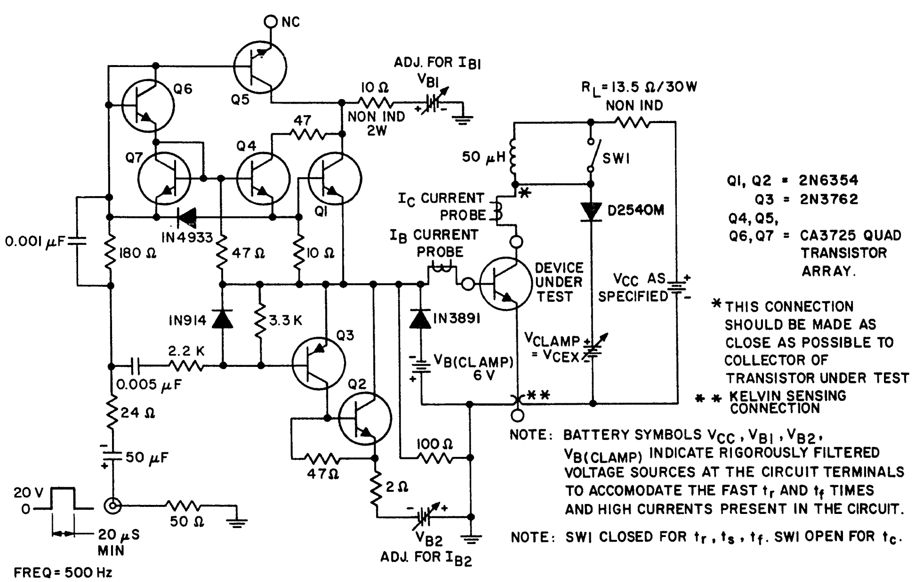


Fig. 15 - Circuit for measuring switching times.

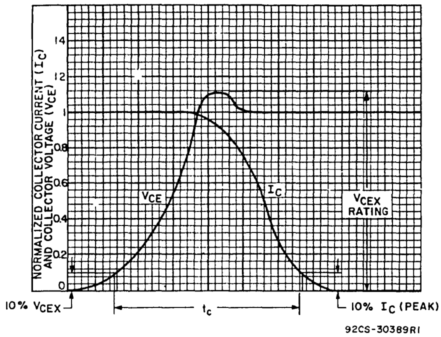


Fig. 16 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

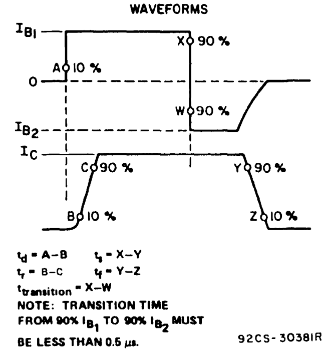
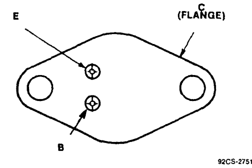


Fig. 17 - Phase relationship between input and output currents showing reference points for specification of switching times.

2 POWER TRANSISTORS

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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 2N6686 and 2N6687 and 2N6688* SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high-safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-current, high-speed transistors are 100% tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C as well as at 25°C, to provide information necessary for worst-case design.

The 2N6686, 2N6687 and 2N6688 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6686	2N6687	2N6688	
* V_{CEV}				
V_{BE} = -1.5 V	260	280	300	V
* V_{CEX} (Clamped)				
V_{BE} = -1.5 V	210	230	250	V
* V_{CEO}	160	180	200	V
* V_{EBO}		8		V
I_C(sat)	25	25	20	A
* I_C	25	25	20	A
I_{CM}		50		A
* I_B		8		A
* P_T				
T_C up to 25°C		200		W
T_C above 25°C, derate linearly		1.14		W/°C
* T_{stg}, T_J		-65 to 200		°C
* T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

* In accordance with JEDEC registration data (2N6686, 2N6687, 2N6688 only).

ELECTRICAL CHARACTERISTICS T_C = 25°C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEV}	260	-1.5	—	—	—	50	—	—	—	—	μA
	280	-1.5	—	—	—	—	—	50	—	—	
	300	-1.5	—	—	—	—	—	—	—	50	
* I_{EBO}	—	-8	0	—	—	100	—	100	—	100	
* $V_{CEO}(sus)^b$	—	—	0.2^a	0	160	—	180	—	200	—	V
* h_{FE}	2	—	1^a	—	30	—	30	—	25	—	—
	2	—	10^a	—	25	100	25	100	20	80	
	2	—	20^a	—	—	—	—	—	15	—	
	2	—	25^a	—	15	—	15	—	—	—	
* $V_{BE}(sat)$	—	—	20^a	2	—	—	—	—	—	1.8	V
	—	—	25^a	2.5	—	1.8	—	1.8	—	—	
* $V_{CE}(sat)$	—	—	20^a	2	—	—	—	—	—	1.5	
	—	—	25^a	2.5	—	1.5	—	1.5	—	—	
* V_{CEX}^b (Clamped $E_{S/b}$) L = 25 μH, R_{BB} = 10 Ω	—	-4	25	3	210	—	230	—	250	—	
$I_{S/b}$ 2N6686, 2N6687, 2N6688	18	—	11.1	—	1	—	1	—	1	—	s
RJH6686, RJH6687, RJH6688	18	—	11.1	—	0.5	—	0.5	—	0.5	—	
* $\|h_{fe}\|$ 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	—	—	
* t_r^d	—	-4	20	2	—	—	—	—	—	0.60	
	—	-4	25	2.5	—	0.60	—	0.60	—	—	
* t_s^d	—	-4	20	2^e	—	—	—	—	—	1.50	
	—	-4	25	2.5^e	—	1.50	—	1.50	—	—	
* t_f^d	—	-4	20	2^e	—	—	—	—	—	0.25	
	—	-4	25	2.5^e	—	0.25	—	0.25	—	—	
* t_c V_{CC} = 80 V, L = 25 μH, $R_C \leq 4$ Ω, Collector clamped to V_{CEX}	—	-4	20	3^e	—	—	—	—	—	0.5	
	—	-4	25	3^e	—	0.5	—	0.5	—	—	

ELECTRICAL CHARACTERISTICS T_C = 25° C

CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
	VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEV}	260	-1.5	—	—	—	0.5	—	—	—	—	mA
	280	-1.5	—	—	—	—	—	0.5	—	—	
	300	-1.5	—	—	—	—	—	—	—	0.5	
V_{CE}(sat)	—	—	20[a]	2	—	—	—	—	—	1.5	V
	—	—	25[a]	2.5	—	1.5	—	1.5	—	—	
t_r[d]	—	-4	20	2	—	—	—	—	—	0.8	μs
	—	-4	25	2.5	—	0.8	—	0.8	—	—	
t_s[d]	—	-4	20	2	—	—	—	—	—	2.5	
	—	-4	25	2.5[e]	—	2.5	—	2.5	—	—	
t_f[d]	—	-4	20	2	—	—	—	—	—	0.8	
	—	-4	25	2.5[e]	—	0.8	—	0.8	—	—	
t_c V_{CC} = 80 V, L = 25 μH, $R_C \leq 4\ \Omega$, Collector Clamped to V_{CEX}	—	-4	20	3[e]	—	—	—	—	—	0.8	
	—	-4	25	3[e]	—	0.8	—	0.8	—	—	
$R\theta_{JC}$ 2N6686, 2N6687, 2N6688	10	—	5	—	—	0.875	—	0.875	—	0.875	°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] $I_{B_1} = -I_{B_2}$.

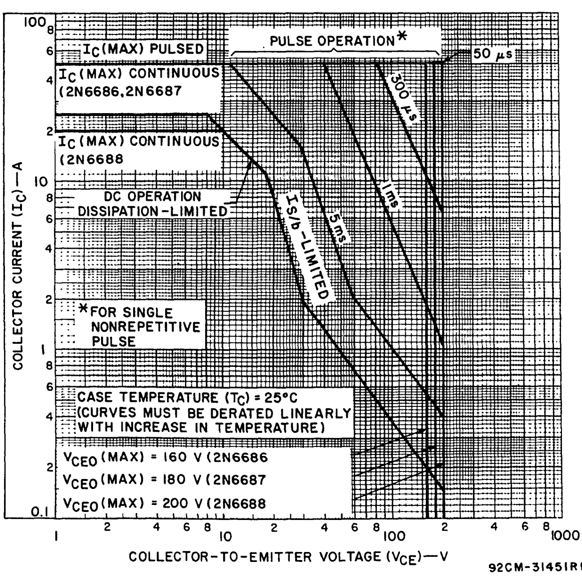


Fig. 1 - Maximum operation areas of all types. (T_C = 25°).

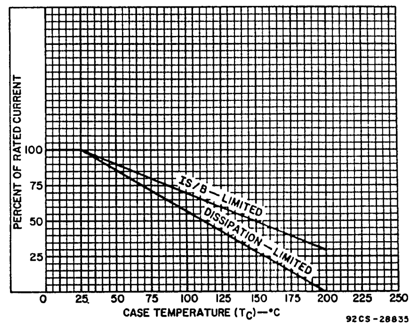


Fig. 2 - Dissipation and $I_{S/b}$ derating curves for 2N6686 and 2N6687 and 2N6688.

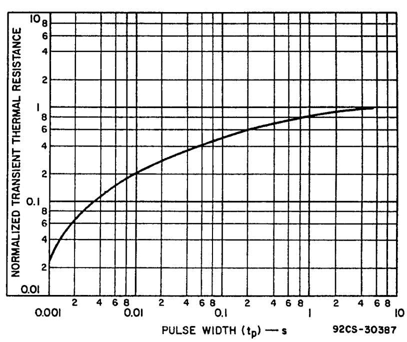


Fig. 3 - Typical thermal-response characteristic for all types.

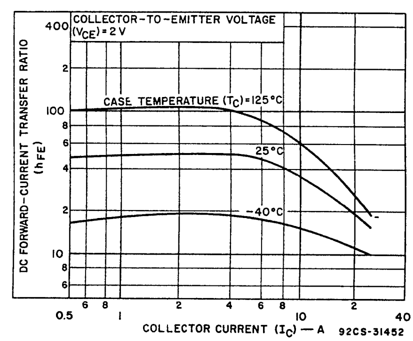


Fig. 4 - Typical dc beta characteristics for all types.

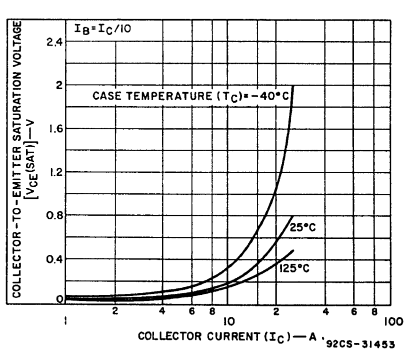


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for all types.

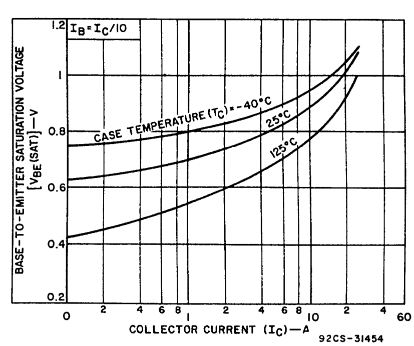


Fig. 6 - Typical base-to-emitter saturation voltage characteristics for all types.

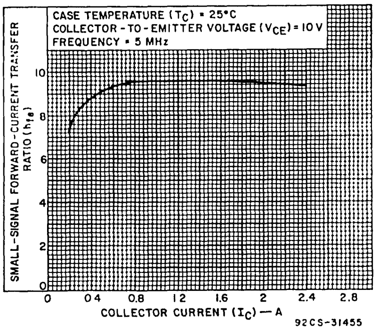


Fig. 7 - Typical small-signal forward current transfer ratio characteristic for all types (f = 5MHz).

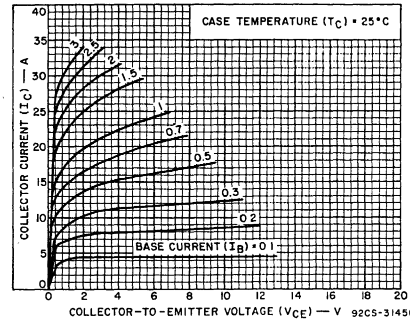


Fig. 8 - Typical output characteristics for all types.

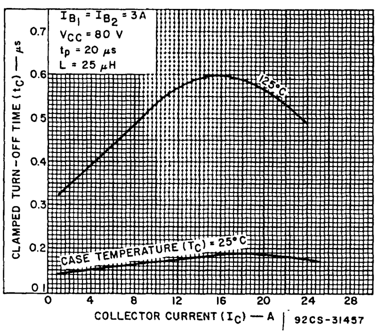


Fig. 9 - Typical clamped turn-off time characteristics for all types.

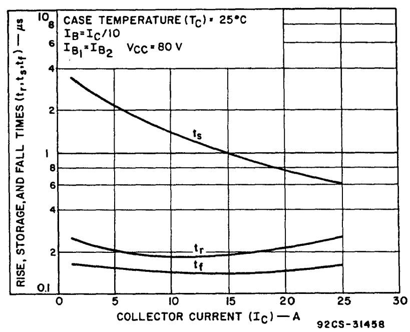


Fig. 10 - Typical saturated-switching-time characteristics as a function of collector current for all types.

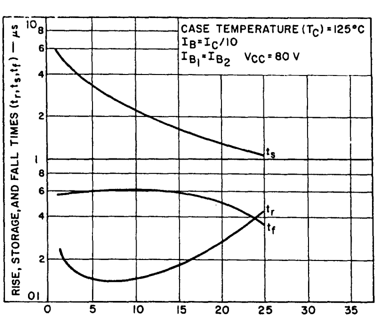


Fig. 11 - Typical saturated-switching-time characteristics at $T_C = 125^oC$ as a function of collector current for all types.

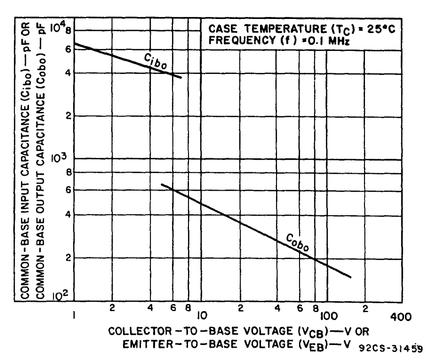


Fig. 12 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics for all types.

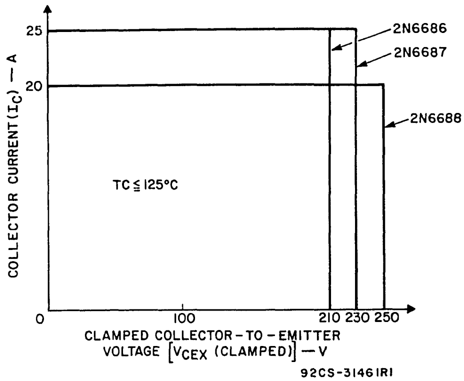


Fig. 13 - Maximum operating conditions for switching between saturation and cutoff for all types.

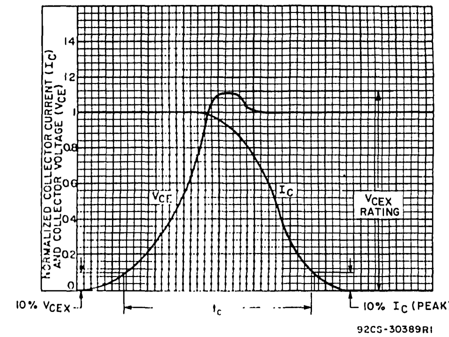


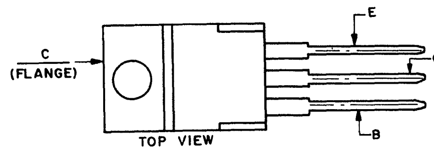
Fig. 14 - Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

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.

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

CHARAC-TERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS 2N6702		2N6703		2N6704		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
* I_{CEV}	140	−1.5			–	100	–	–	–	–	
	160	−1.5			–	–	–	100	–	–	µA
	180	−1.5			–	–	–	–	–	100	
T_C = 125°C	140	−1.5			–	1	–	–	–	–	
	160	−1.5			–	–	–	1	–	–	
	180	−1.5			–	–	–	–	–	1	mA
* I_{EBO}		−7	0		–	100	–	100	–	100	µA
* $V_{CEO}(sus)$[b]			0.01[a]	0	90	–	110	–	130	–	V
* h_{FE}	2		0.2[a]		30	–	30	–	30	–	
	2		4[a]		–	–	–	–	20	–	
	2		5[a]		20	–	20	–	–	–	
* $V_{BE}(sat)$			4[a]	0.4	–	–	–	–	–	1.4	
			5[a]	0.5	–	1.5	–	1.5	–	–	
* $V_{CE}(sat)$			4[a]	0.4	–	–	–	–	–	0.7	V
			5[a]	0.5	–	0.8	–	0.8	–	–	
			7[a]	0.7	–	1.5	–	1.5	–	1.5	
$I_{S/b}$	20		2.5		1	–	1	–	1	–	s
* $\|h_{fe}\|$ f = 5 MHz	10		0.5		10	40	10	40	10	40	
f_T	10		0.5		50	200	50	200	50	200	MHz
* C_{obo} f = 0.1 MHz	10[c]				50	150	50	150	50	150	pF
* t_d[d]		−4	4	0.4	–	–	–	–	–	0.1	
			5	0.5	–	0.1	–	0.1	–	–	
* t_r[d]		−4	4	0.4	–	–	–	–	–	0.25	
			5	0.5	–	0.25	–	0.25	–	–	µs
* t_s[d]		−4	4	0.4[e]	–	–	–	–	–	1	
			5	0.5[e]	–	1	–	1	–	–	
* t_f[d]		−4	4	0.4[e]	–	–	–	–	–	0.5	
			5	0.5[e]	–	0.5	–	0.5	–	–	
* $R_{\theta JC}$	4		5		–	2.5	–	2.5	–	2.5	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 µs, duty factor ≤2%.

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

[c] V_{CB} value.

[d] V_{CC} = 70 V, t_p = 20 µs

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

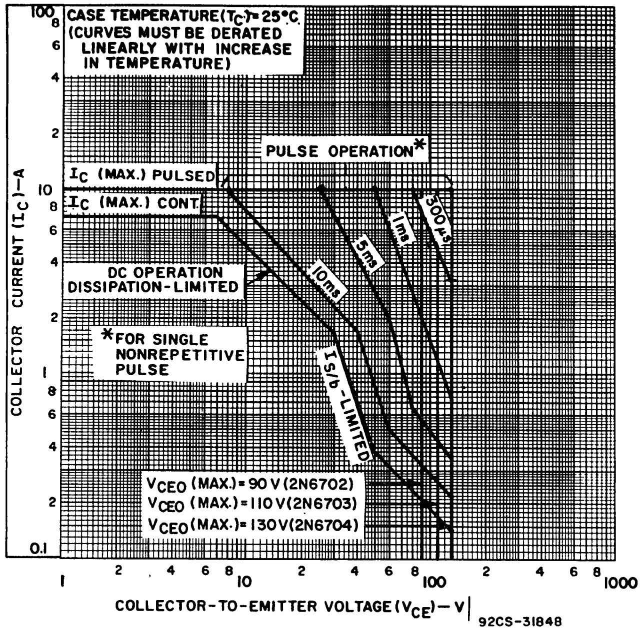


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

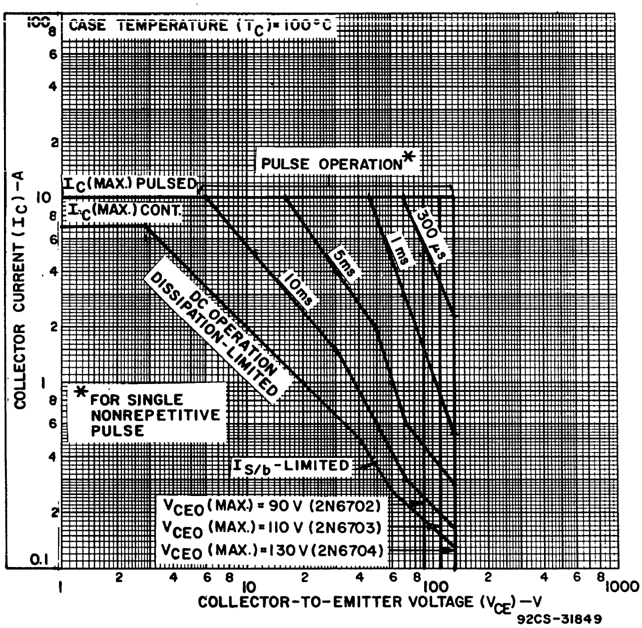


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

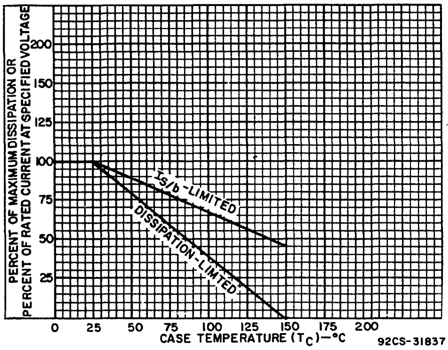


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

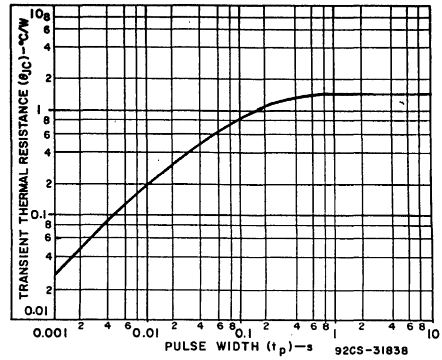


Fig. 4 — Typical thermal-response characteristic for all types.

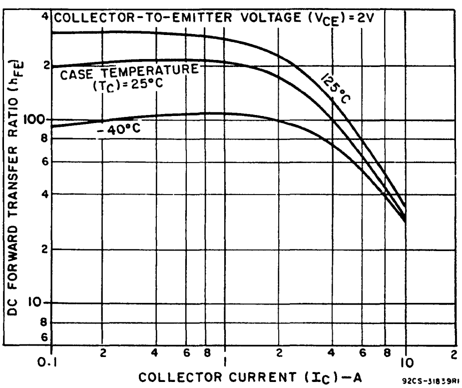


Fig. 5 — Typical dc beta characteristics for all types.

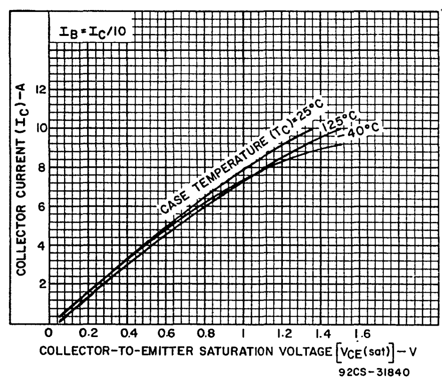


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

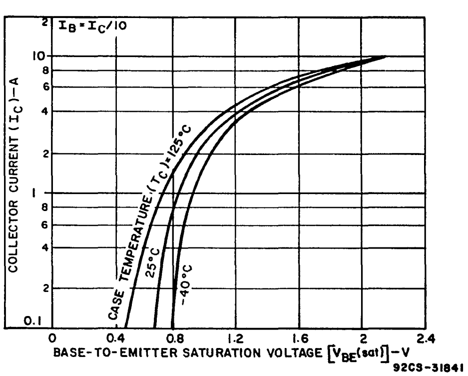


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

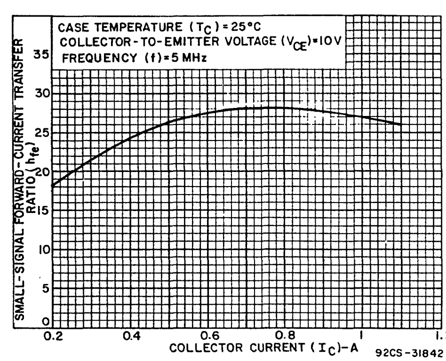


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

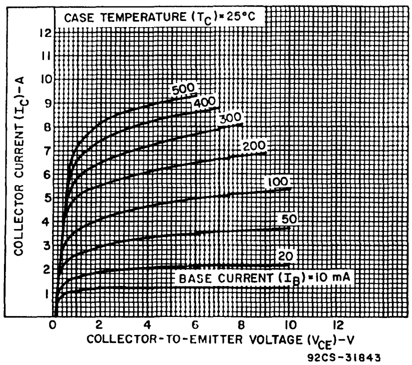


Fig. 9 — Typical output characteristics for all types.

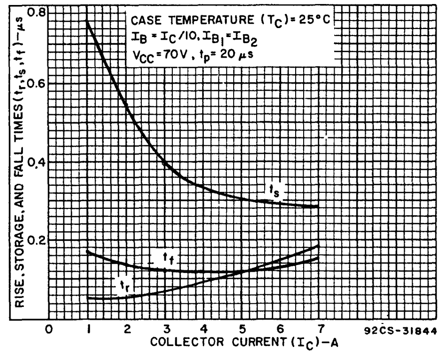


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

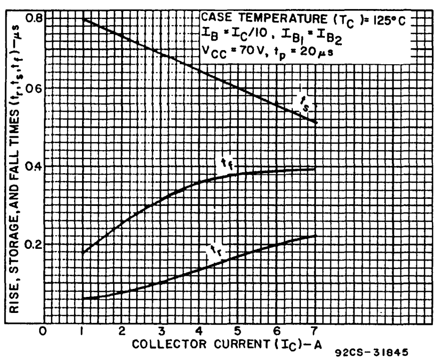


Fig. 11 — Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

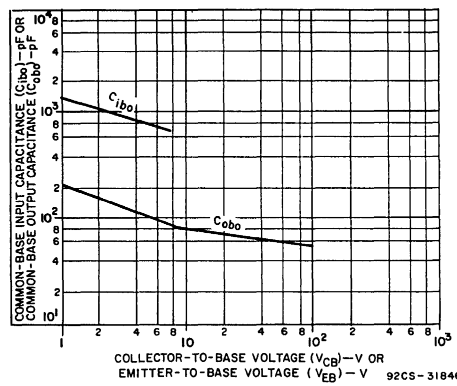


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

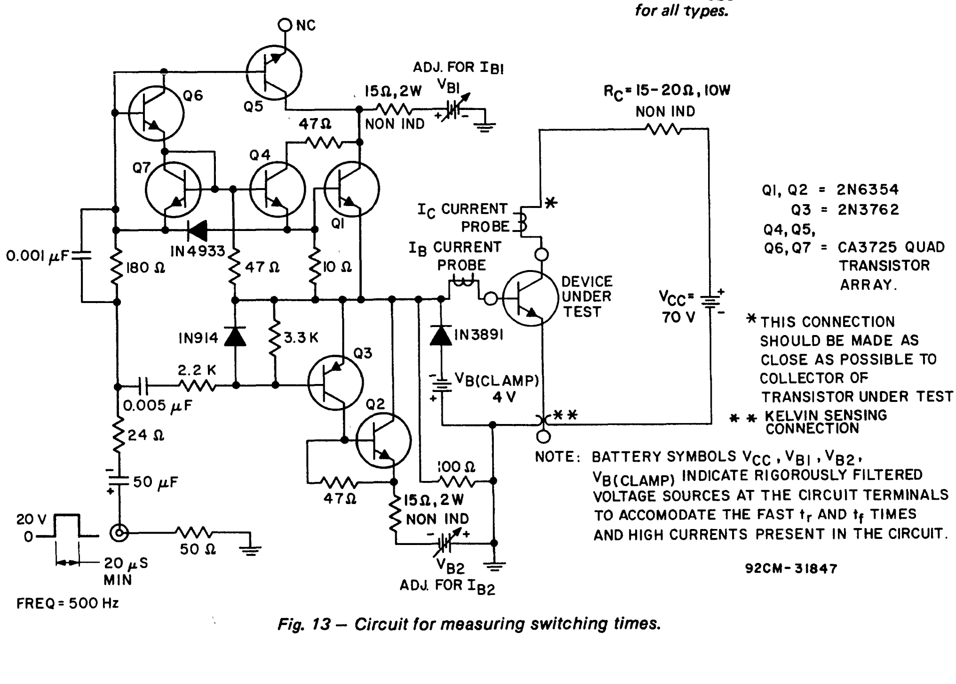
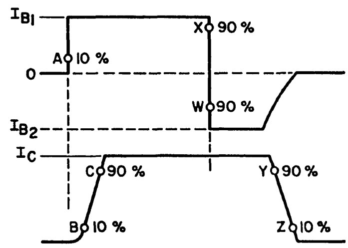


Fig. 13 — Circuit for measuring switching times.



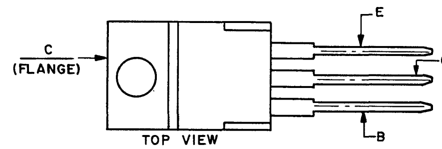
t_d = A–B t_s = X–Y
t_r = B–C t_f = Y–Z
$t_{transition}$ = X–W
NOTE: TRANSITION TIME
FROM 90% I_{B_1} TO 90% I_{B_2} MUST
BE LESS THAN 0.5 μs.

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

5-A *SwitchMax* Power Transistors

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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*

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.

CHARAC-TERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS 2N6738 Min.	Max.	2N6739 Min.	Max.	2N6740 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		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]$I_{B1} = -I_{B2}$.

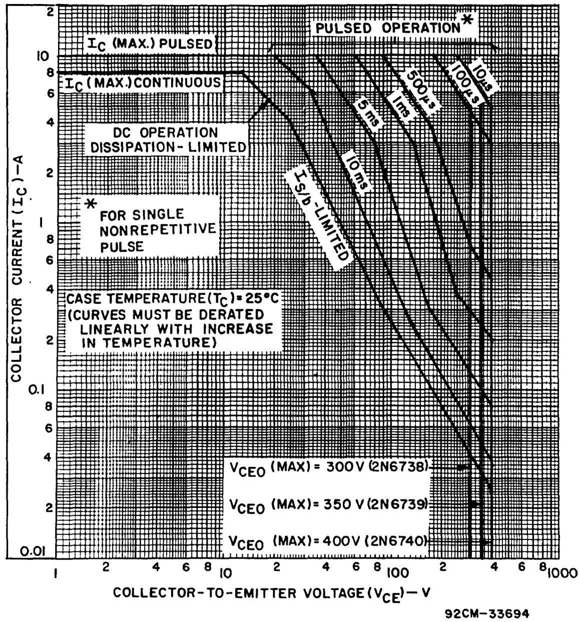


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

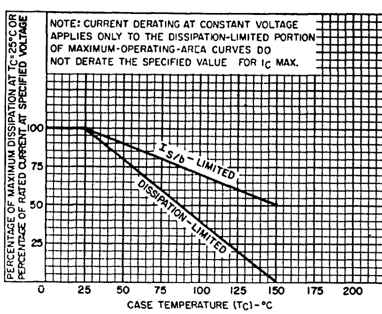


Fig. 2 — Dissipation and derating curve for all types.

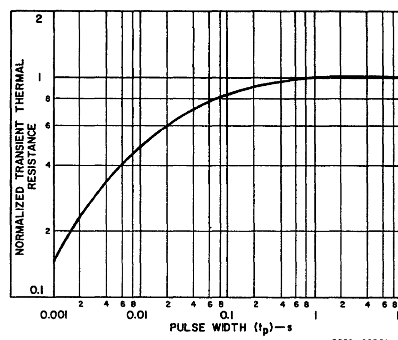


Fig. 3 — Typical thermal-response characteristic for all types.

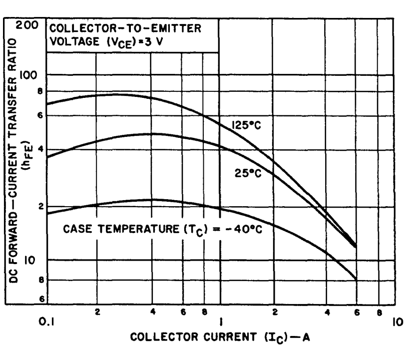


Fig. 4 — Typical dc beta characteristics for all types.

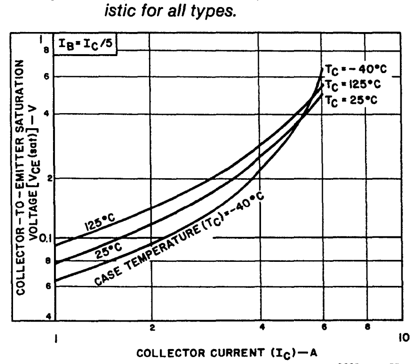


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

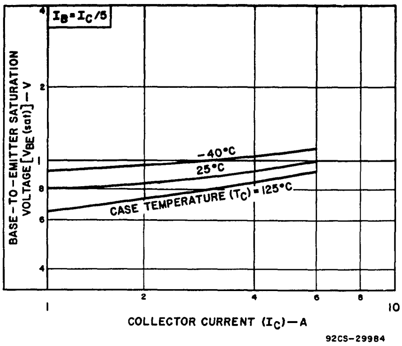


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

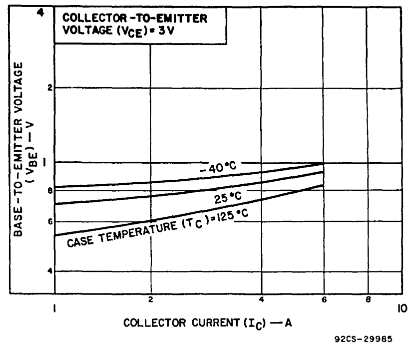


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

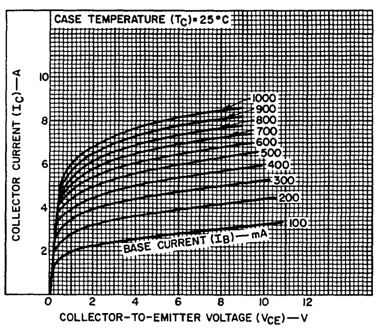


Fig. 8 — Typical output characteristics for all types.

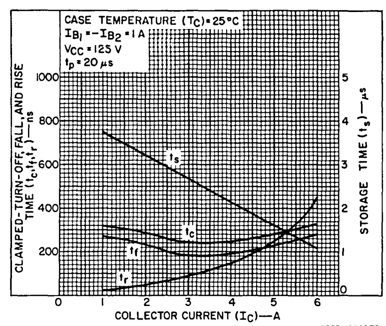


Fig. 9 — Typical saturated switching time characteristics for all types.

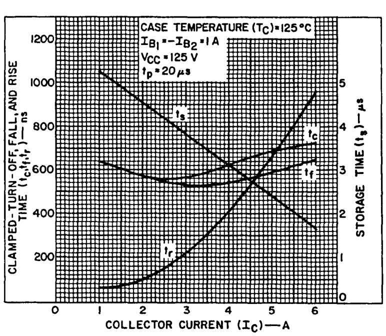


Fig. 10 — Typical saturated switching time characteristics for all types.

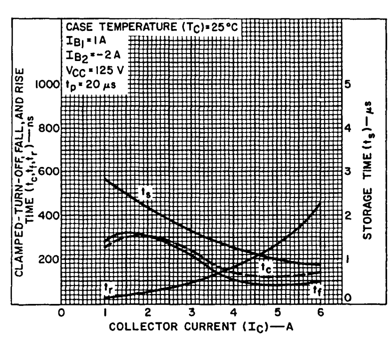


Fig. 11 — Typical saturated switching time characteristics for all types.

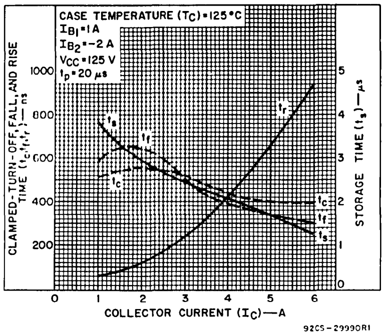


Fig. 12 — Typical saturated switching time characteristics for all types.

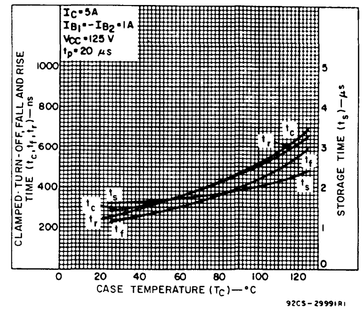


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

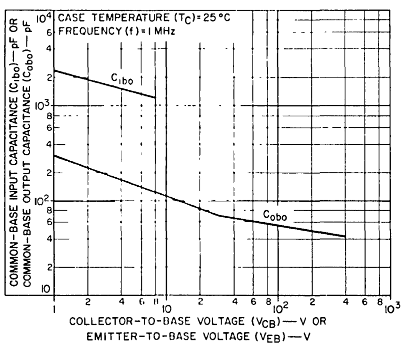


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

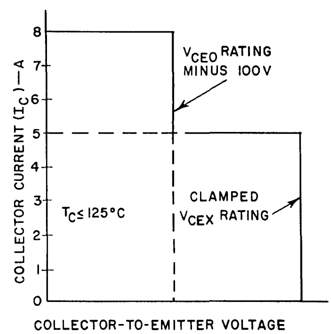


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

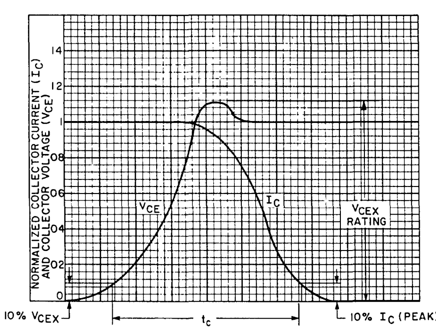


Fig. 16 — Oscilloscope display for measurement of clamped induction switching-time (t_c).

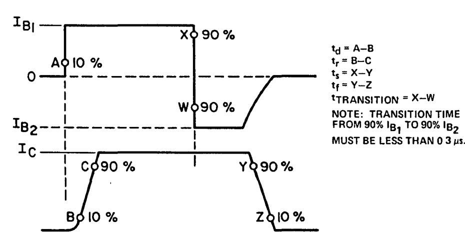


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

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

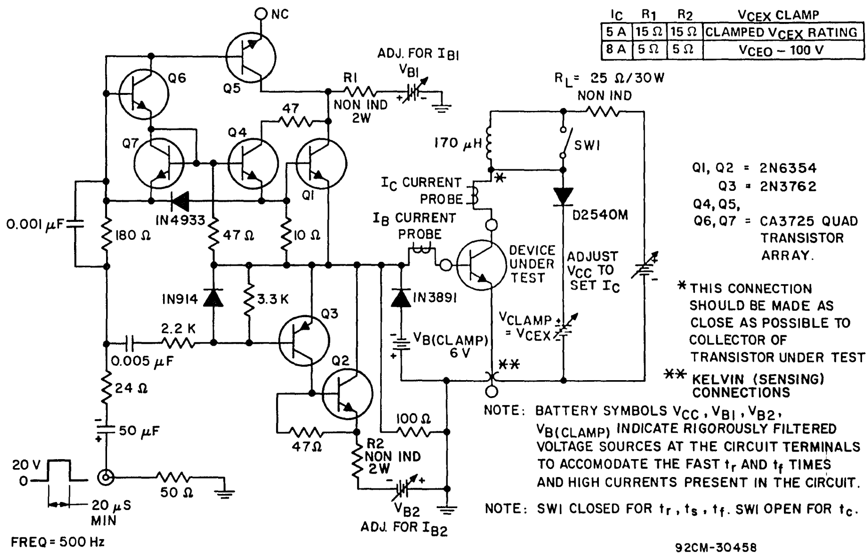


Fig. 18 — Circuit for measuring switching times.

5-A *SwitchMax* Power Transistors

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

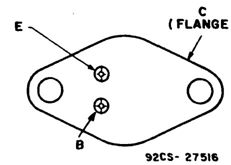
Features:

- *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 ≤ 25°C	150				W
T_C ≥ 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.

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc		CURRENT A dc		LIMITS: 2N6751		2N6752		UNITS
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
T_C = 25°C									
* I_{CEV}	800	−1.5			—	0.1	—	—	mA
	850	−1.5			—	—	—	0.1	
* 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
* $V_{CE}(sat)$			5[a]	1	—	1	—	1	
			10[a]	3	—	3	—	3	
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 μH		−6	5	1[c]	450	—	500	—	
$I_{S/b}$	30		5		1	—	1	—	s
* $\|h_{fe}\|$ f = 5 MHz	10		0.2		3	12	3	12	
f_T	10		0.2		15	60	15	60	MHz
* C_{obo} f = 0.1 MHz	10[d]				50	250	50	250	pF
* t_d[e]		−6	5	1	—	0.1	—	0.1	μs
* t_r[e]		−6	5	1	—	0.4	—	0.4	
* t_s[e]		−6	5	1[c]	—	3	—	3	
* t_f[e]		−6	5	1[c]	—	0.4	—	0.4	
* t_c V_{CC} = 250 V, L = 170 μH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1[c]	—	0.4	—	0.4	
T_C = 100°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	μs
* t_s[e]		−6	5	1[c]	—	5	—	5	
* t_f[e]		−6	5	1[c]	—	0.7	—	0.7	
* t_c V_{CC} = 250 V, L = 170 μH, R_C = 50 Ω, Collector clamped to V_{CEX} *		−6	5	1[c]	—	0.7	—	0.7	
* $R_{\theta JC}$	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

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

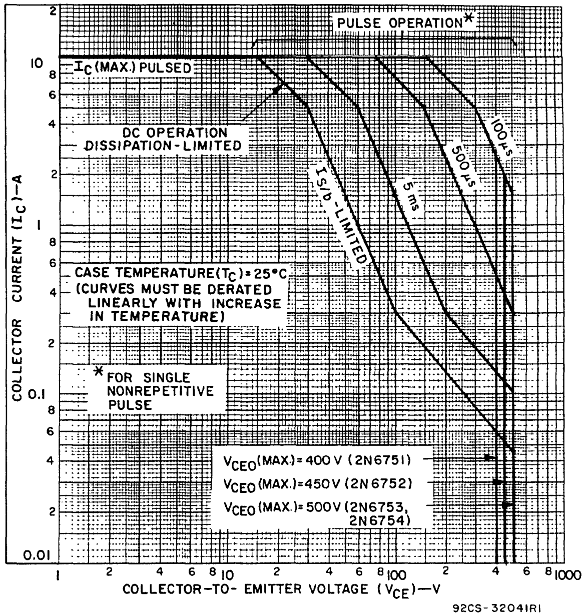


Fig. 1 — Maximum operating areas for all type (TcC).

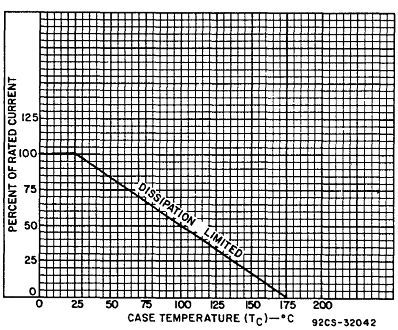


Fig. 2 — Dissipation derating curves for all types.

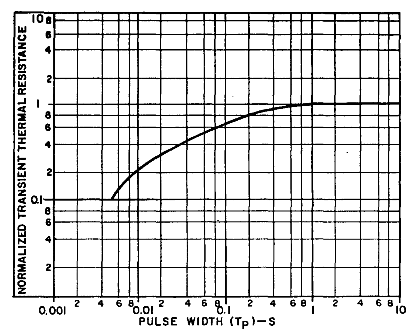


Fig. 3 — Typical thermal-response characteristic for all types.

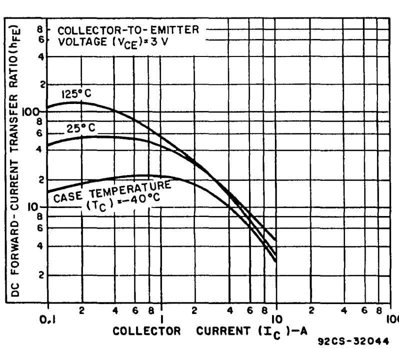


Fig. 4 — Typical dc beta characteristics for all types.

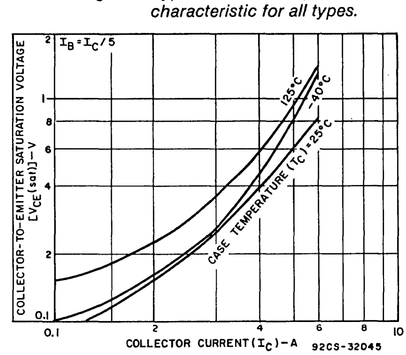


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

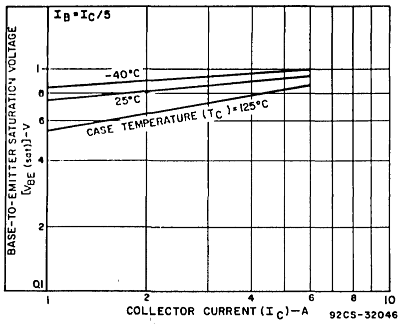


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

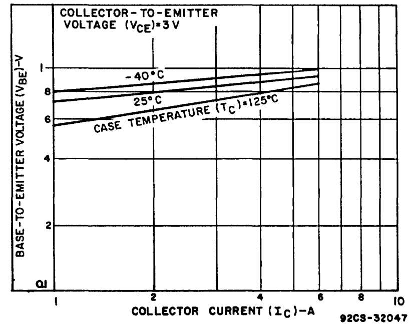


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

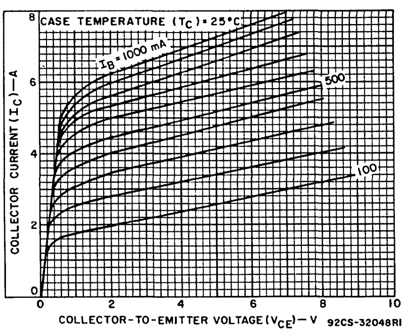


Fig. 8 — Typical output characteristics for all types.

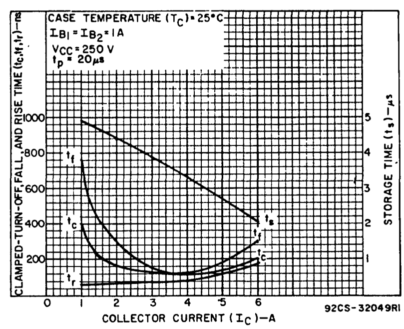


Fig. 9 — Typical saturated switching time characteristics for all types.

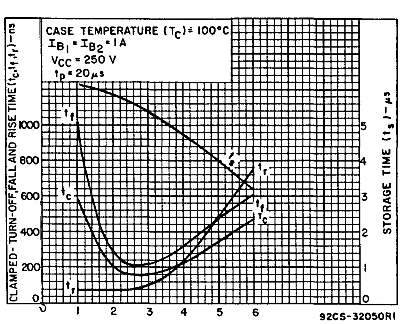


Fig. 10 — Typical saturated switching time characteristics for all types.

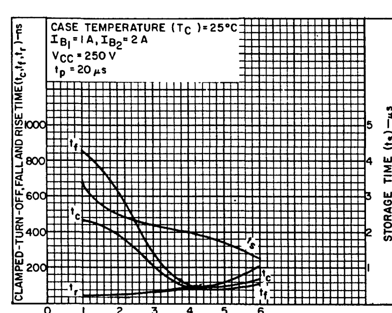


Fig. 11 — Typical saturated switching time characteristics for all types.

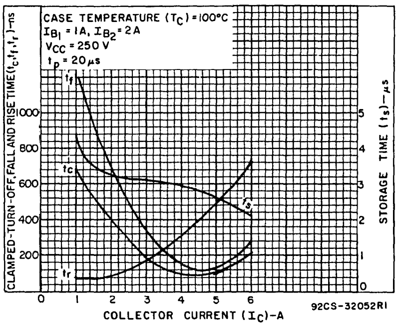


Fig. 12 — Typical saturated switching time characteristics for all types.

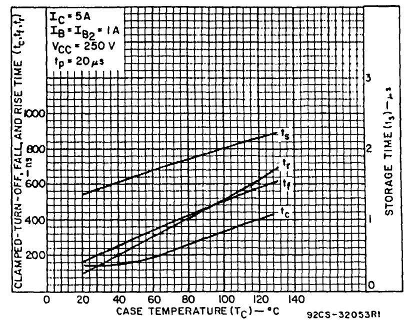


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

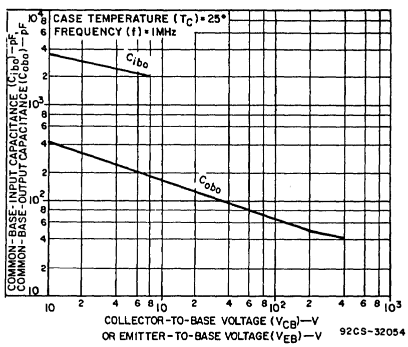


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

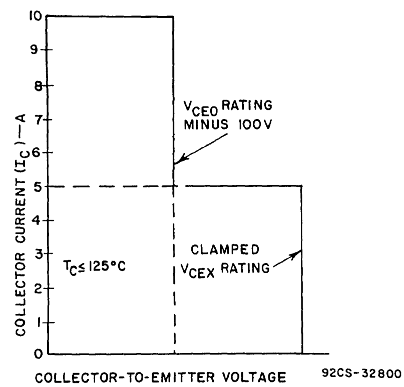


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

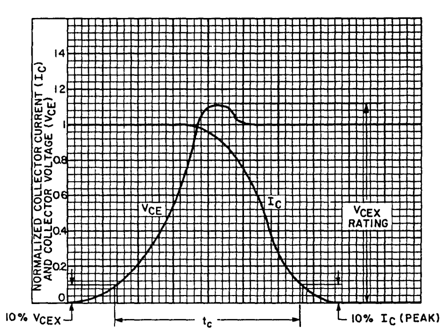


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_C).

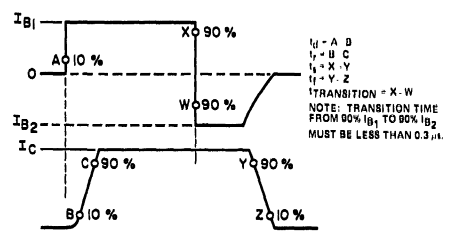


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

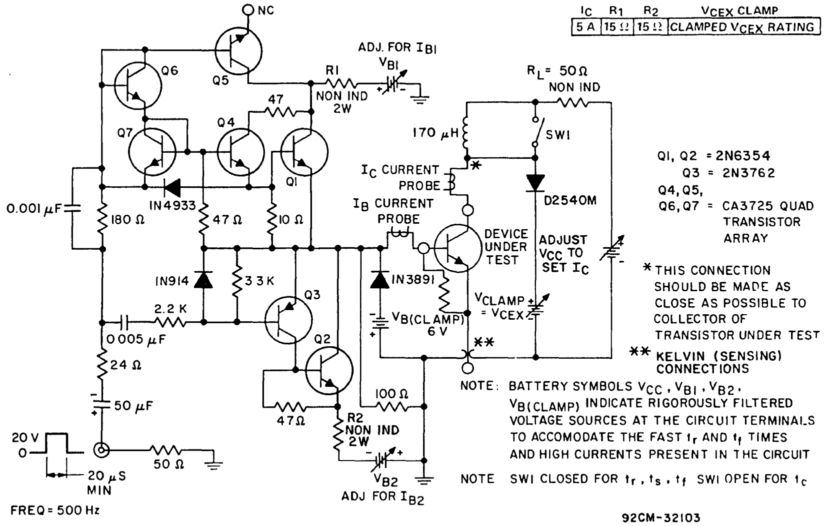


Fig. 18 — Circuit for measuring switching times.

1-A SwitchMax VERSAWATT Transistors

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

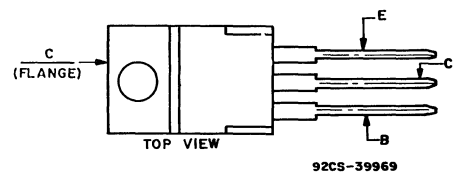
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 350 V to 450 V*
- *Low V_{CE} (sat) at I_C = 1 A*
- *VERSAWATT package*

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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}	V_{BE}	CURRENT A dc: I_C	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]$I_{B_1} = -I_{B_2}$.

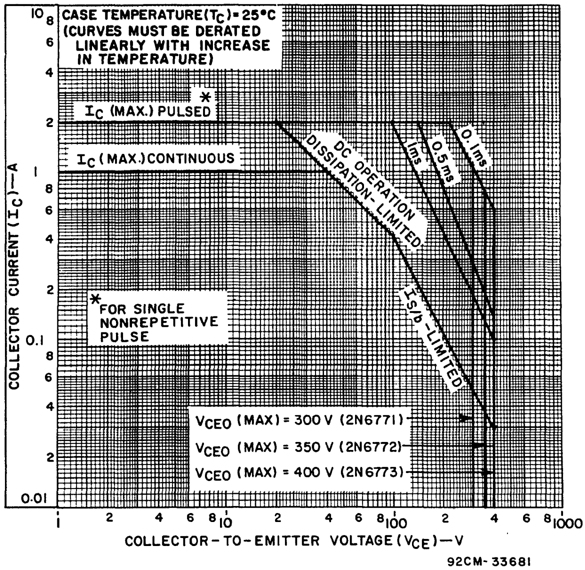


Fig. 1 — Maximum operating areas for all types.

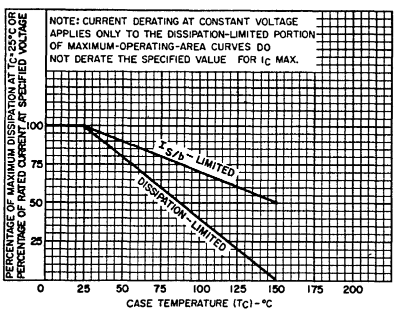


Fig. 2 — Derating curve for all types.

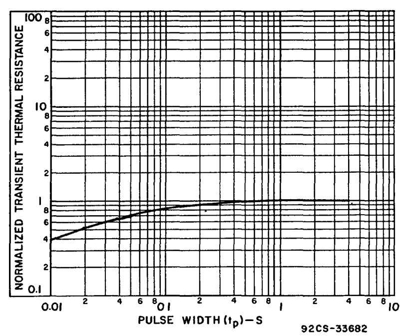


Fig. 3 — Typical thermal-response characteristics for all types.

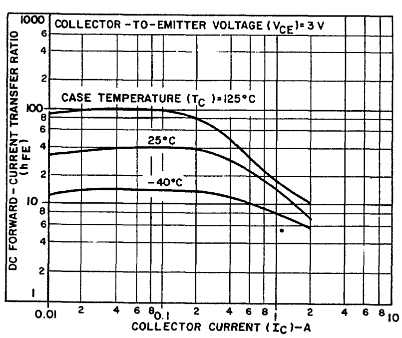


Fig. 4 — Typical dc beta characteristics for all types.

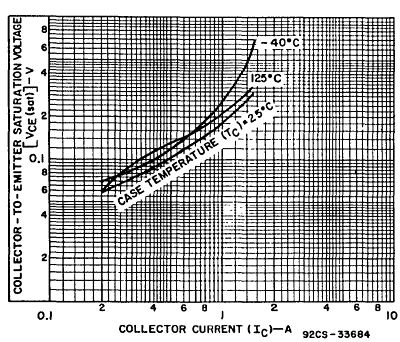


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

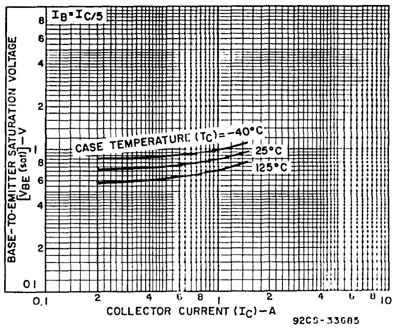


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

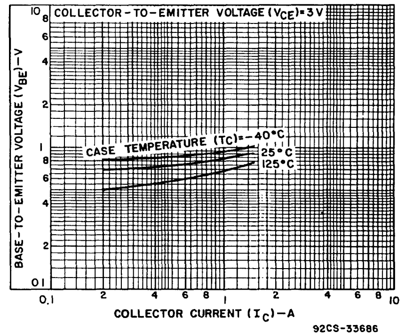


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

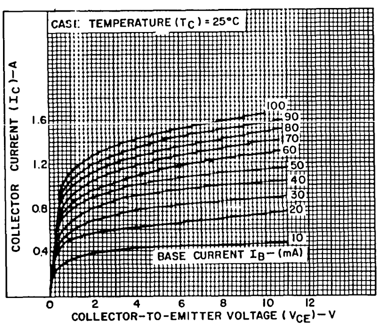


Fig. 8 — Typical output characteristics for all types.

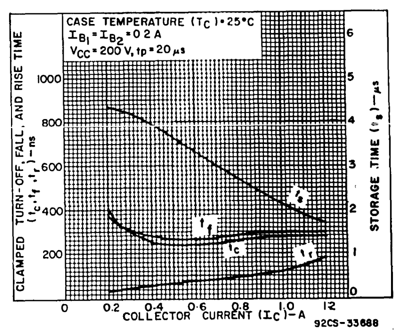


Fig. 9 — Typical saturated-switching-time characteristics for all types.

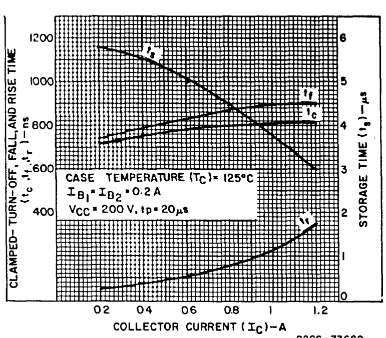


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

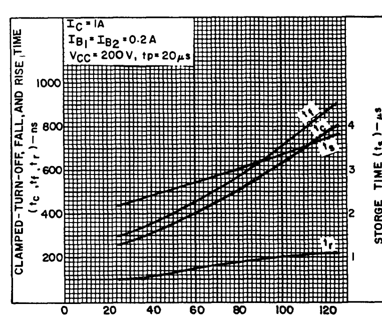


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

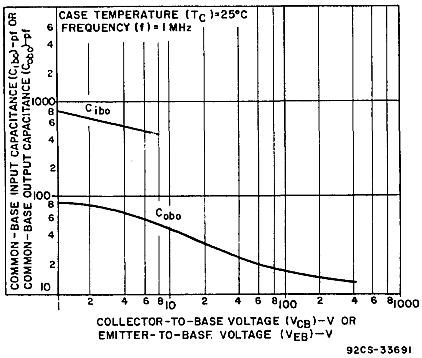


Fig. 12 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

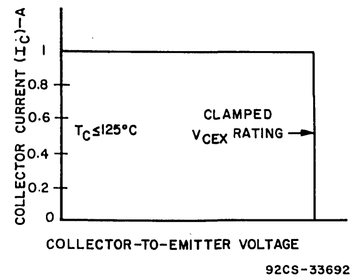


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff.

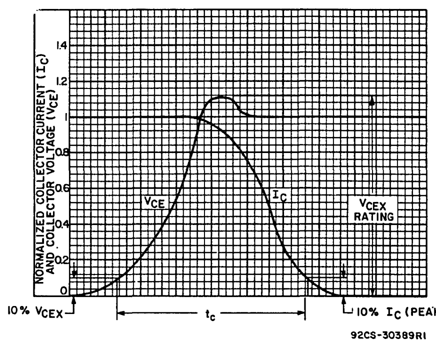


Fig. 14 — Oscilloscope display for measurement of clamped induction switching time (t_c).

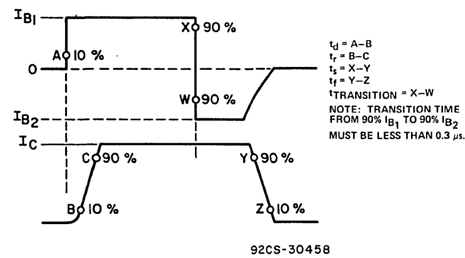


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times.

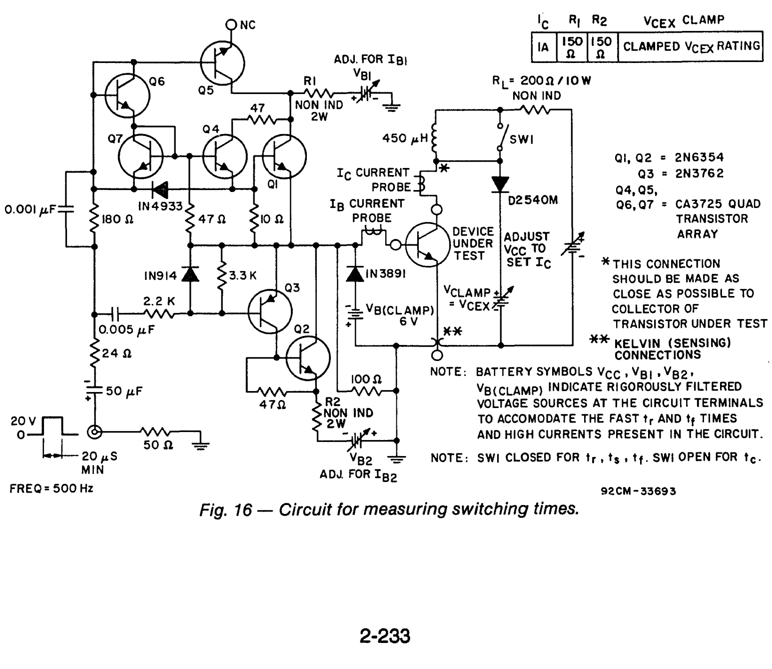


Fig. 16 — Circuit for measuring switching times.

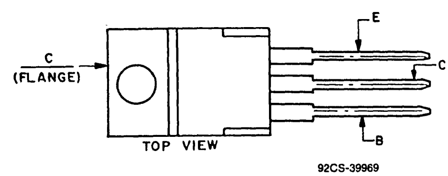
Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

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

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

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 BD239 MIN.	BD239 MAX.	BD239A MIN.	BD239A MAX.	BD239B MIN.	BD239B MAX.	BD239C MIN.	BD239C 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 POWER TRANSISTORS

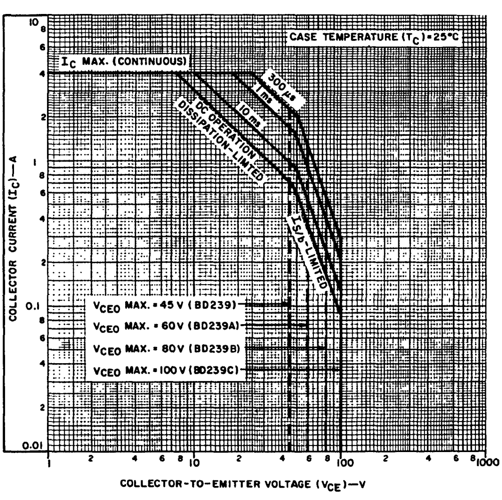


Fig. 1– Maximum safe operating areas for all types.

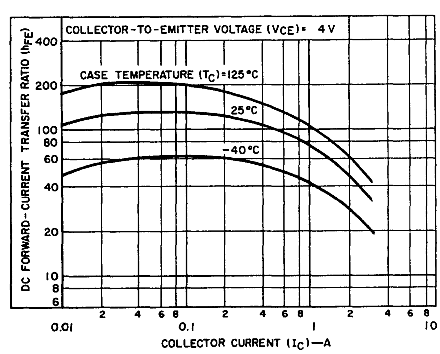


Fig. 2– Typical dc beta characteristics for all types.

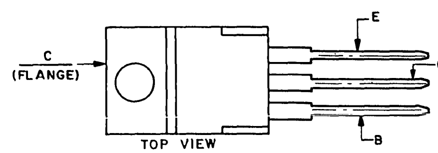
Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

- **30 W at 25°C case temperature**
- **4-A rated collector current**
- **Min. f_T of 3 MHz at 10 V, 200 mA**
- **Complements of n-p-n types BD239, BD239A, BD239B, and BD239C**

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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.

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

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD240		BD240A		BD240B		BD240C		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	−30			0	–	−0.3	–	−0.3	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.3	–	−0.3	mA
With base-to-emitter junction short-circuited	I_{CES}	−45	0			–	−0.2	–	–	–	–	–	–	mA
		−60	0			–	–	–	−0.2	–	–	–	–	mA
		−80	0			–	–	–	–	–	−0.2	–	–	mA
		−100	0			–	–	–	–	–	–	–	−0.2	mA
Emitter Cutoff Current	I_{EBO}		5	0		–	−1	–	−1	–	−1	–	−1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			−0.03[a]	0	−45	–	−60	–	−80	–	−100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	−4		−0.2[a]		40	–	40	–	40	–	40	–	
		−4		−1[a]		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	−4		−1[a]		–	−1.3	–	−1.3	–	−1.3	–	−1.3	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			−1[a]	−0.2	–	−0.7	–	−0.7	–	−0.7	–	−0.7	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	−10		−0.2		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	−10		−0.2		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	4.17	–	4.17	–	4.17	–	4.17	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

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

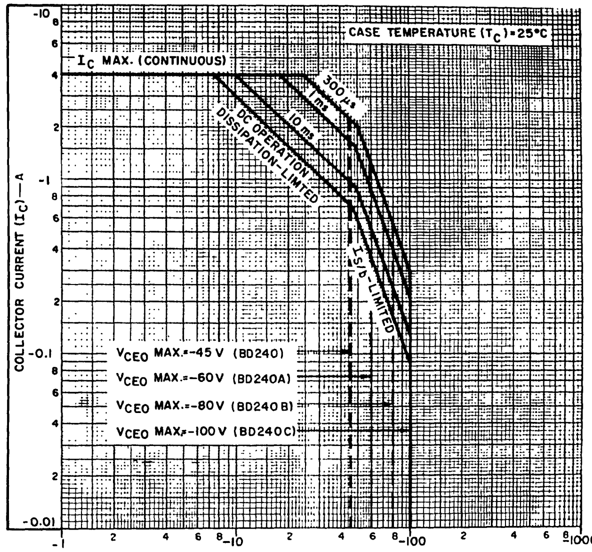


Fig. 1— Maximum safe operating areas for all types.

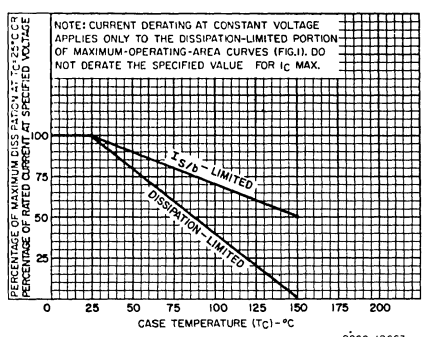


Fig. 2— Derating curves for all types.

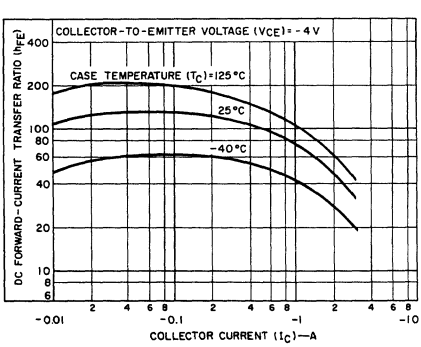


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

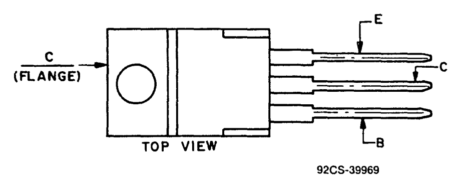
Features:

- **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

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD241		BD241A		BD241B		BD241C		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	30			0	–	0.3	–	0.3	–	–	–	–	mA
		60			0	–	–	–	–	–	0.3	–	0.3	
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.2	–	–	–	–	–	–	
		60	0			–	–	–	0.2	–	–	–	–	
		80	0			–	–	–	–	–	0.2	–	–	
		100	0			–	–	–	–	–	–	–	0.2	
Emitter Cutoff Current	I_{EBO}		–5	0		–	1	–	1	–	1	–	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			0.03[a]	0	45	–	60	–	80	–	100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4		1[a]		25	–	25	–	25	–	25	–	
		4		3[a]		10	–	10	–	10	–	10	–	
Base-to-Emitter Voltage	V_{BE}	4		3[a]		–	1.8	–	1.8	–	1.8	–	1.8	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			3[a]	0.6	–	1.2	–	1.2	–	1.2	–	1.2	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	10		0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10		0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	3.125	–	3.125	–	3.125	–	3.125	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	

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

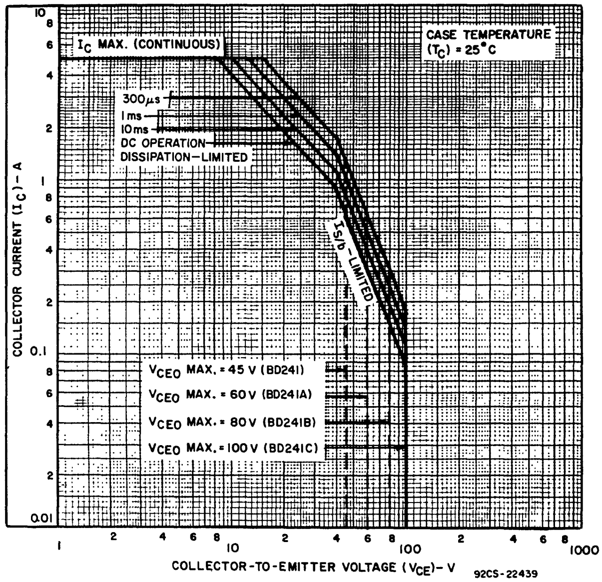


Fig. 1– Maximum safe operating areas for all types.

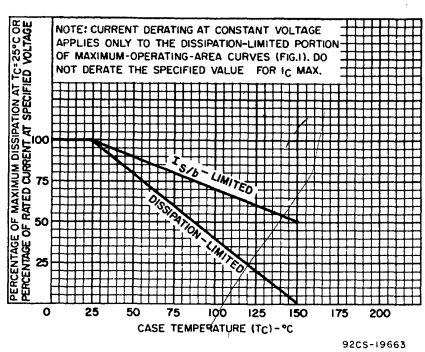


Fig. 2– Derating curves for all types.

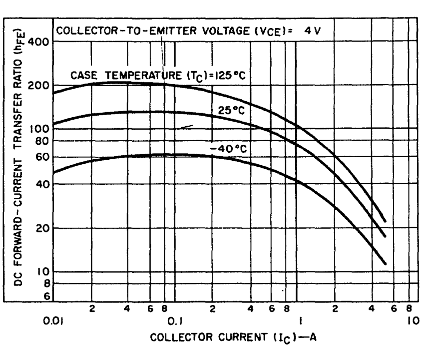


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and
High-Speed-Switching Applications

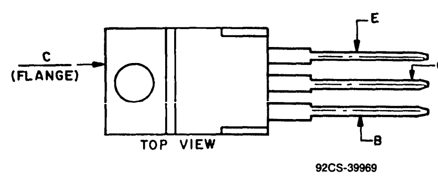
Features:

- 40 W at 25°C case temperature
- 5-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of n-p-n types BD241, BD241A, BD241B, and BD241C

Types BD242, BD242A, BD242B, and BD242C are epitaxial-base silicon p-n-p transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD242-series power transistors are complements of the devices in the BD241 series. (The BD241-series devices are described in File No. 671.)

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

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

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD242		BD242A		BD242B		BD242C		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	−30			0	–	−0.3	–	−0.3	–	–	–	–	mA
		−60			0	–	–	–	–	–	−0.3	–	−0.3	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%.

2 POWER TRANSISTORS

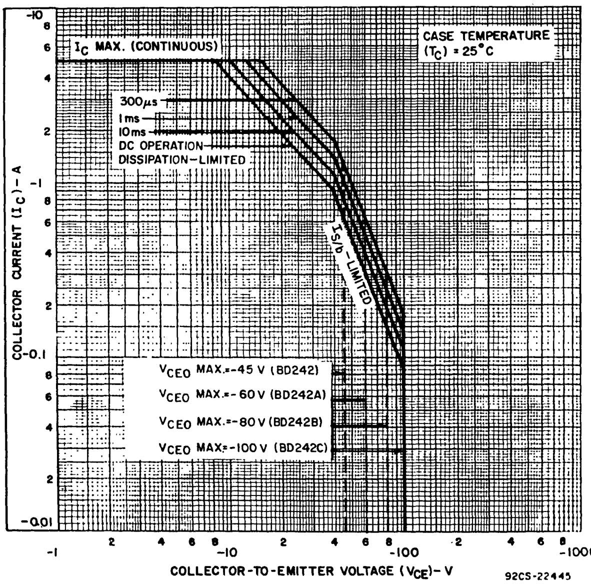


Fig. 1— Maximum safe operating areas for all types.

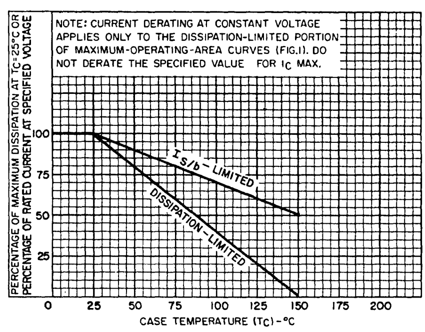


Fig. 2— Derating curves for all types.

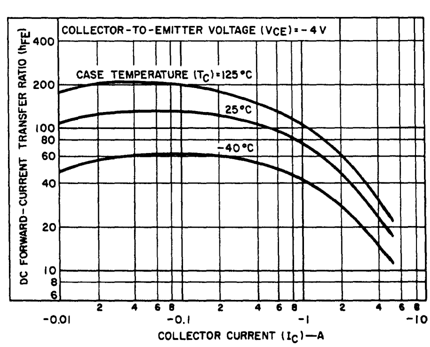


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

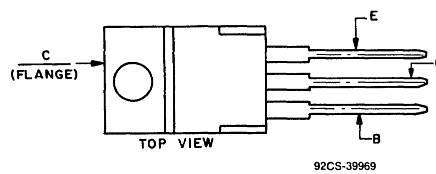
Features:

- 65 W at 25°C case temperature
- 7-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of p-n-p types BD244, BD244A, BD244B, and BD244C

Types BD243, BD243A, BD243B, and BD243C are epitaxial-base silicon n-p-n transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD243-series power transistors are complements of the devices in the BD244 series. (The BD244-series devices are described in File No. 674.)

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

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

ELECTRICAL CHARACTERISTICS *at Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS								UNITS
		VOLTAGE V dc		CURRENT A dc		BD243		BD243A		BD243B		BD243C		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With base open	I_{CEO}	30			0	–	0.7	–	0.7	–	–	–	–	mA
		60			0	–	–	–	–	–	0.7	–	0.7	mA
With base-to-emitter junction short-circuited	I_{CES}	45	0			–	0.4	–	–	–	–	–	–	mA
		60	0			–	–	–	0.4	–	–	–	–	mA
		80	0			–	–	–	–	–	0.4	–	–	mA
		100	0			–	–	–	–	–	–	–	0.4	mA
Emitter Cutoff Current	I_{EBO}		–5	0		–	1	–	1	–	1	–	1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			0.03[a]	0	45	–	60	–	80	–	100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	4		0.3[a]		30	–	30	–	30	–	30	–	
		4		3[a]		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	4		6[a]		–	2	–	2	–	2	–	2	V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			6[a]	1	–	1.5	–	1.5	–	1.5	–	1.5	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	10		0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	10		0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

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

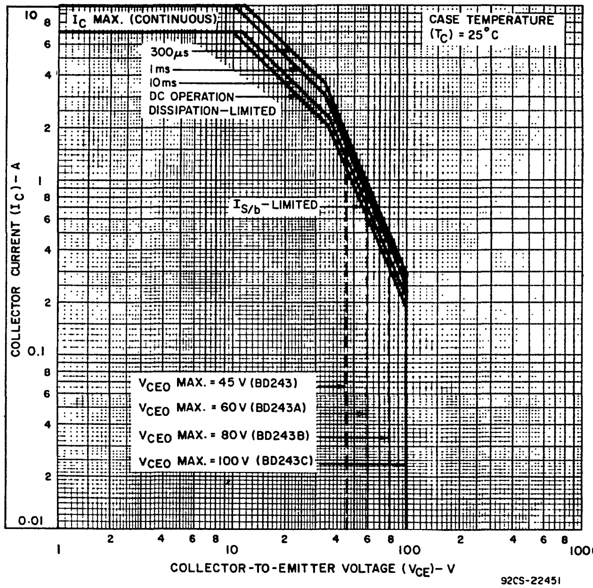


Fig. 1— Maximum safe operating areas for all types.

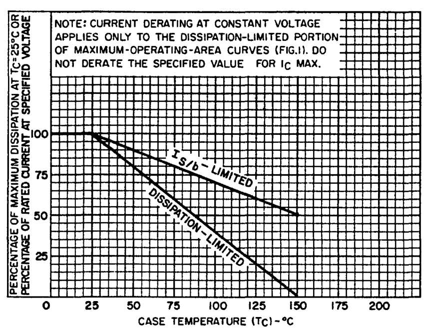


Fig. 2— Derating curves for all types.

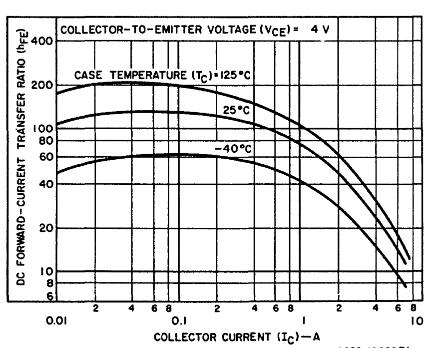


Fig. 3 — Typical dc beta characteristics for all types.

Epitaxial-Base Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

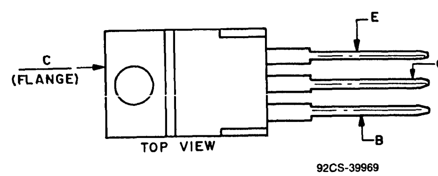
Features:

- 65 W at 25°C case temperature
- 7-A rated collector current
- Min. f_T of 3 MHz at 10 V, 500 mA
- Complements of n-p-n types BD243, BD243A, BD243B, and BD243C

Types BD244, BD244A, BD244B, and BD244C are epitaxial-base silicon p-n-p transistors; they differ only in their voltage ratings. These devices are intended for a wide variety of switching and amplifier applications such as series and shunt regulators, and driver and output stages of high-fidelity amplifiers. The BD244-series power transistors are complements of the devices in the BD243 series. (The BD243-series devices are described in File No. 673.)

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

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

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	mA
With base-to-emitter junction short-circuited	I_{CES}	−45	0			–	−0.4	–	–	–	–	–	–	mA
		−60	0			–	–	–	−0.4	–	–	–	–	mA
		−80	0			–	–	–	–	–	−0.4	–	–	mA
		−100	0			–	–	–	–	–	–	–	−0.4	mA
Emitter Cutoff Current	I_{EBO}		5	0		–	−1	–	−1	–	−1	–	−1	mA
Collector-to-Emitter Breakdown Voltage: With base open	$V_{BR(CEO)}$			−0.03[a]	0	−45	–	−60	–	−80	–	−100	–	V
DC Forward-Current Transfer Ratio	h_{FE}	−4		−0.3[a]		30	–	30	–	30	–	30	–	
		−4		−3[a]		15	–	15	–	15	–	15	–	
Base-to-Emitter Voltage	V_{BE}	−4		−6[a]		–	−2	–	−2	–	−2	–	−2	V
Collector-to-Emitter Saturation Voltage	V_{CE}(sat)			−6[a]	−1	–	−1.5	–	−1.5	–	−1.5	–	−1.5	V
Common-Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 kHz)	h_{fe}	−10		−0.5		20	–	20	–	20	–	20	–	
Magnitude of Common Emitter Small-Signal Short-Circuit Forward-Current Transfer Ratio (f = 1 MHz)	$\|h_{fe}\|$	−10		−0.5		3	–	3	–	3	–	3	–	
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$					–	1.92	–	1.92	–	1.92	–	1.92	°C/W
Junction-to-Ambient	$R_{\theta JA}$					–	62.5	–	62.5	–	62.5	–	62.5	°C/W

[a]Pulsed: Pulse duration = 300 μs, duty factor ≈ 2%.

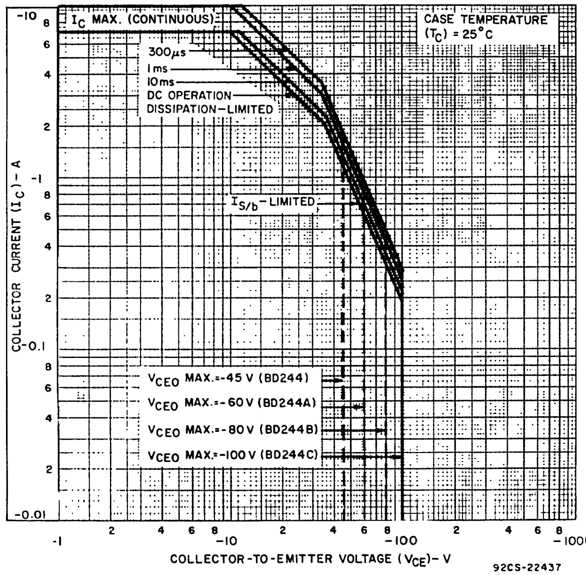


Fig. 1— Maximum safe operating areas for all types.

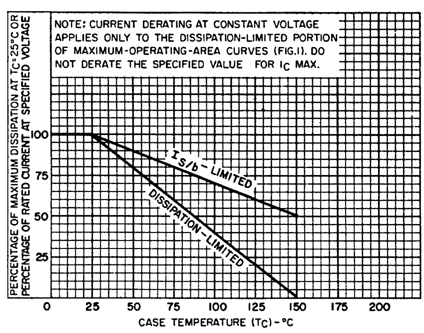


Fig. 2— Derating curves for all types

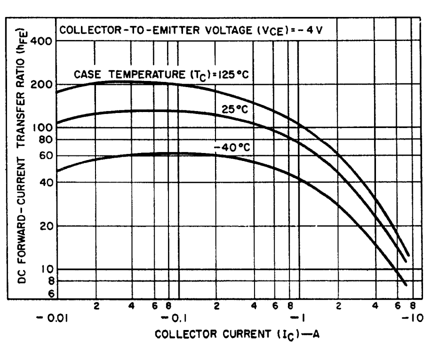
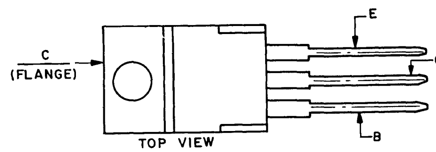


Fig. 3 — Typical dc beta characteristics for all types.

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.

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

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS▲				UNITS
		BD500●		BD500B● BD5001B		
		Min.	Max.	Min.	Max.	
I_{CER} R_{BE} = 100 Ω	V_{CE} = 45 V	—	1	—	—	mA
	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.

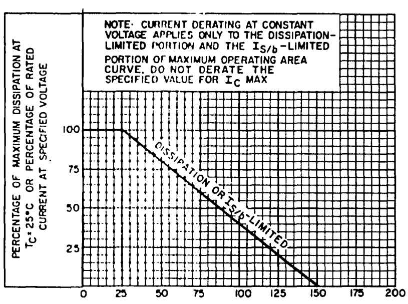


Fig. 1 — Derating curve for all types.

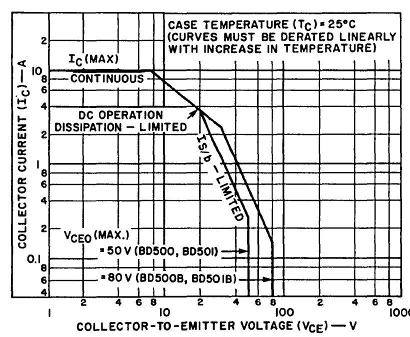


Fig. 2 — Maximum operating areas for all types.

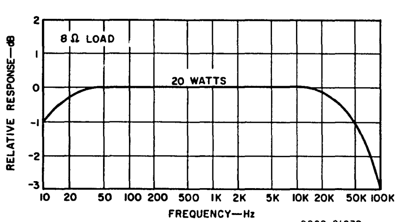


Fig. 3 — Typical frequency response.

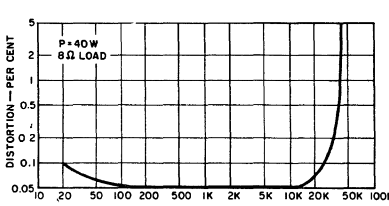


Fig. 4 — Typical total harmonic distortion as a function of frequency.

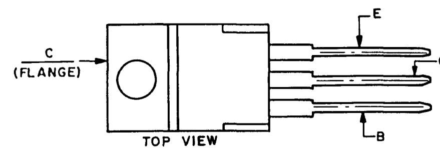
Epitaxial-Base, Silicon N-P-N and P-N-P VERSAWATT Transistors

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 / P-N-P	BD533 / BD534■	BD535 / BD536■	BD537 / 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.

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 (For BD533, BD534 only)	2		2*		60	150	—	—	—	—	
	2		3*		30	—	—	—	—	—	
V_{BE}	2		2*		—	1.5	—	1.5	—	1.5	V
$V_{CE}(sat)$			2*	0.2	—	0.8	—	0.8	—	0.8	
			6*	0.6	0.8●	—	0.8●	—	0.8●	—	
f_T	1		0.5		3	12●	3	12●	3	12●	MHz
$R_{\theta JC}$					—	2.5	—	2.5	—	2.5	°C/W

▲ For p-n-p devices, voltage and current values are negative.
⊕ V_{CB} value
■ **CAUTION:** The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.
* Pulsed: Pulse duration = 300 μs, duty factor = 1.5%.
● Typical values.

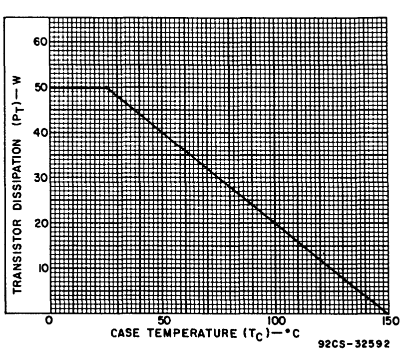


Fig. 1—Derating curve for all types.

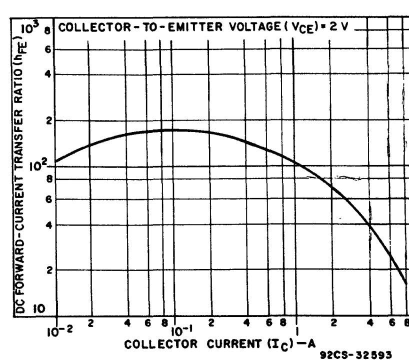


Fig. 2—Typical dc beta characteristic for BD533, BD535, and BD537 types.

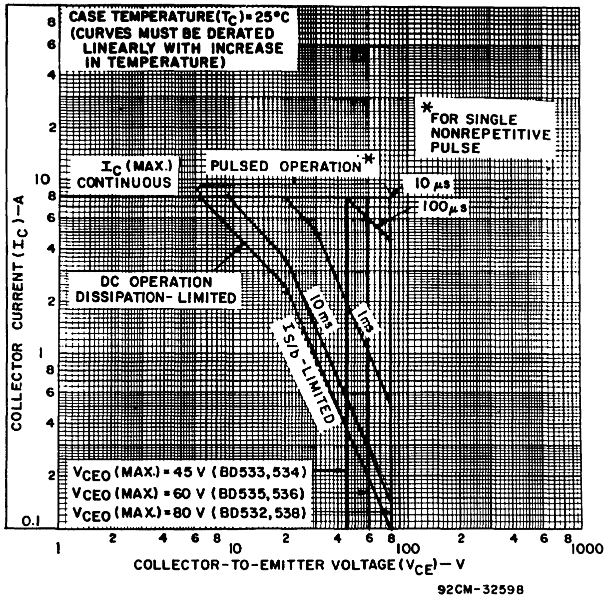


Fig. 3—Maximum safe-operating areas for ali types.

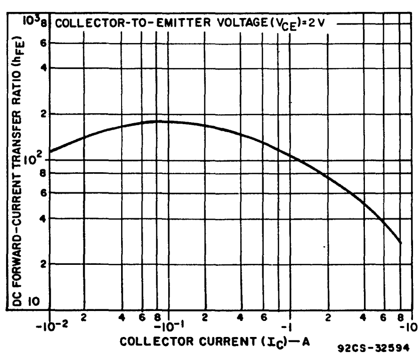


Fig. 4—Typical dc beta characteristic for BD534, BD536, and BD538 types.

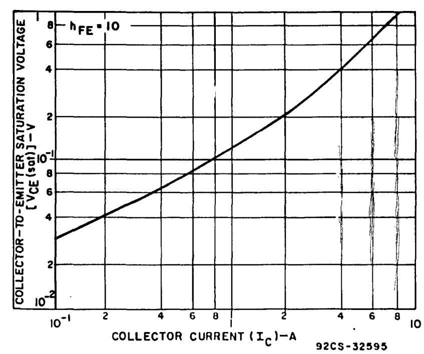


Fig. 5—Typical collector to-emitter saturation voltage characteristic for BD533, BD535, and BD537 types.

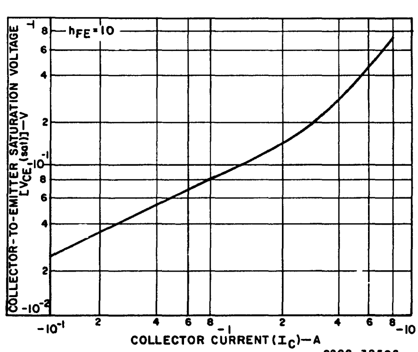


Fig. 6—Typical collector-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

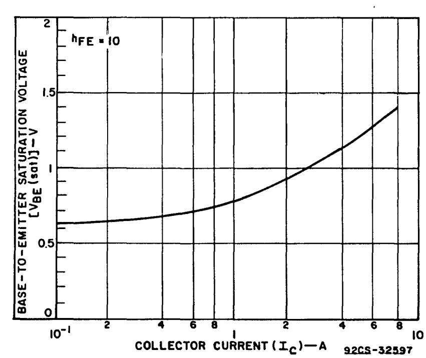


Fig. 7—Typical base-to-emitter saturation voltage characteristic for BD533 BD535, and BD537 types.

2 POWER TRANSISTORS

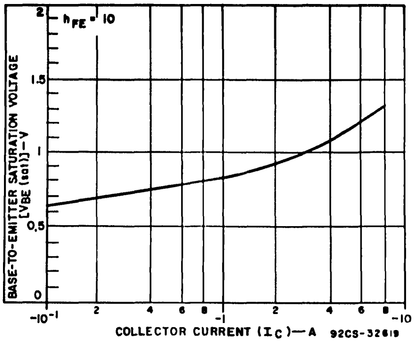


Fig. 8—Typical base-to-emitter saturation voltage characteristic for BD534, BD536, and BD538 types.

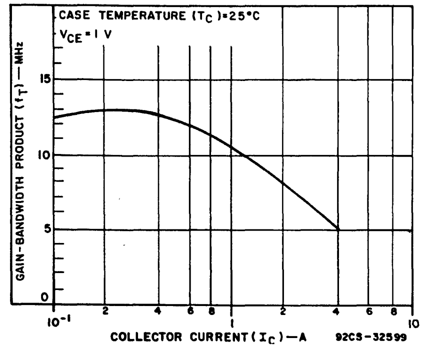


Fig. 9—Typical gain-bandwidth product characteristic for BD533, BD535, and BD537 types.

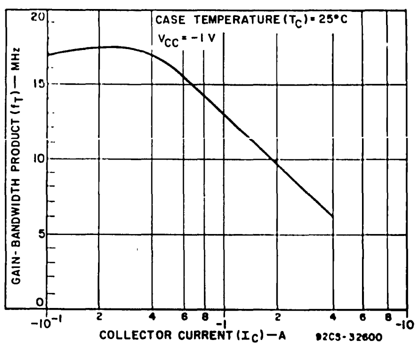


Fig. 10—Typical gain-bandwidth product characteristic for BD534, BD536, and BD538 types.

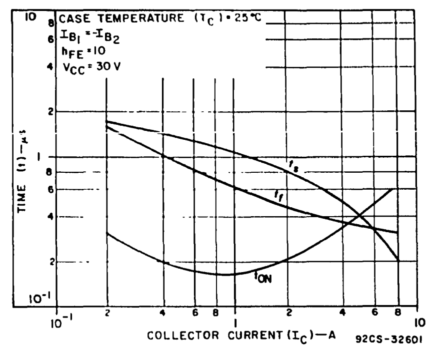


Fig. 11—Typical saturated-switching time characteristics for BD533, BD535, and BD537 types.

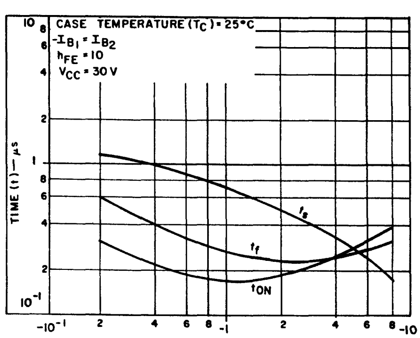


Fig. 12—Typical saturated switching time characteristics for BD534, BD536, and BD538 types.

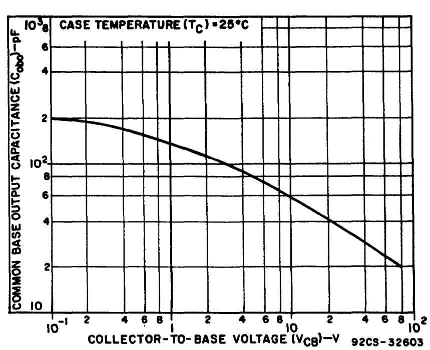


Fig. 13—Typical common-base output capacitance characteristic for BD533, BD535, and BD537 types.

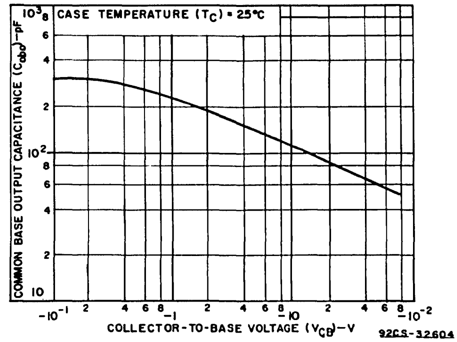
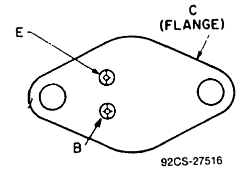


Fig. 14—Typical common-base output capacitance characteristic for BD534, BD536, and BD538 types.

Silicon Transistors for Quasi-Complementary-Symmetry Audio Amplifiers

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BD550 and BD550B are silicon n-p-n transistors especially suitable for applications in audio-amplifier circuits, in which they may be used as either driver or output unit.

The devices, together with a variety of other transistors that serve as input devices, V_{BE} amplifiers for biasing, current sources, load-line limiters (for overload protection), and pre-drivers, may be used to develop several hundred watts of audio output power in quasi-complementary-symmetry audio amplifier configurations that employ parallel output transistors.

The BD-550-series is supplied in the JEDEC TO-204AA hermetic steel case.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BD550	BD550B	
V_{CBO}	130	275	V
V_{CEO}	110	250	V
$V_{CER}(R_{BE} = 100\ \Omega)$	130	275	V
V_{EBO}	5		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

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

CHARAC-TERISTIC	TEST CONDITIONS	LIMITS				UNITS
		BD550		BD550B•		
		Min.	Max.	Min.	Max.	
I_{CER}	V_{CE} = 110 V	—	1	—	—	mA
R_{BE} = 100 Ω	V_{CE} = 250 V	—	—	—	1	
I_{CEO}	V_{CE} = 95 V	—	5	—	—	mA
	V_{CE} = 200 V	—	—	—	5	
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	15	75	–	—	
	I_C = 2A; V_{CE} = 4 V	—	—	10	50	
V_{CE}(sat)	I_C = 4 A; I_B = 0.5 A	—	2	—	—	V
	I_C = 2A; I_B = 0.25 A	—	—	—	2	
V_{BE}	I_C = 4 A; V_{CE} = 4 V	0.75	1.75	—	—	V
	I_C = 2 A; V_{CE} = 4 V	—	—	1	2	
$I_{S/b}$	V_{CE} = 80 V; t = 1 S	1.87	—	—	—	
	V_{CE} = 140 V; t = 1 S	—	—	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).

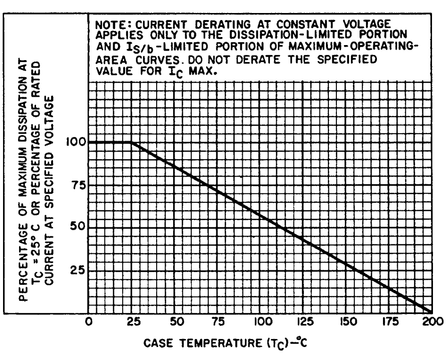


Fig. 1 — Derating curve for all types.

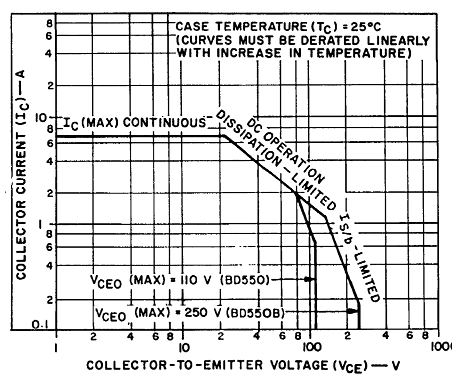


Fig. 2 — Maximum operating areas for all types.

8-Ampere N-P-N Darlington Power Transistors

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

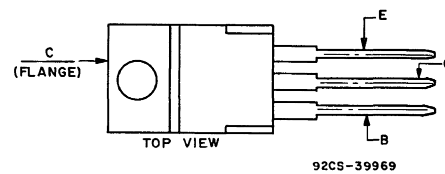
Features:

- 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.

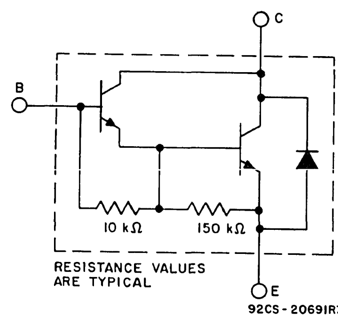


Fig. 1—Schematic diagram for all types.

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

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	
I_{CBO}	45				—	0.2	—	—	
	60				—	—	—	0.2	
T_C = 100°C	45				—	2	—	—	
	60				—	—	—	2	
I_{EBO}			−5	0	—	2	—	2	
$V_{(BR)CEO}$				0.1[a]	45	—	60	—	V
$V_{(BR)CBO}$				0.005	45	—	60	—	
$V_{(BR)EBO}$ I_E = 2 mA					5	—	5	—	
h_{FE}		3		0.5[a]	1500[b]	—	1500[b]	—	
		3		3[a]	750	—	750	—	
		3		6[a]	750[b]	—	750[b]	—	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	
f_T f = 1 MHz		3		3	1	—	1	—	MHz
		3		3	10[b]	—	10[b]	—	
$R_{\theta JC}$					—	2	—	2	°C/W

[a] Pulsed; pulse duration = 200 μs, duty factor = 1%. [b] Typical value.

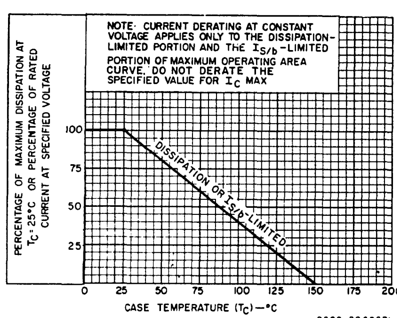


Fig. 2—Derating curve for all types.

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc			CURRENT A dc	BD647		BD649		
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	
I_{CEO}		40 50			— —	0.5 —	— —	— 0.5	mA
I_{CBO}	80 100				— —	0.2 —	— —	— 0.2	mA
T_C = 100°C	80 100				— —	2 —	— —	— 2	mA
I_{EBO}			—5	0	—	2	—	2	mA
$V_{(BR)CEO}$				0.1[a]	80	—	100	—	V
$V_{(BR)CBO}$				0.005	80	—	100	—	V
$V_{(BR)EBO}$ I_E = 2 mA					5	—	5	—	V
h_{FE}		3 3 3		0.5[a] 3[a] 6[a]	1500[b] 750 750[b]	— — —	1500[b] 750 750[b]	— — —	
V_{BE}		3		3[a]	—	2.5	—	2.5	V
$V_{CE}(sat)$ I_B = 12 mA				3[a]	—	2	—	2	V
f_T f = 1 MHz		3 3		3 3	1 10[b]	— —	1 10[b]	— —	MHz
$R_{\theta JC}$					—	2	—	2	°C/W

[a] Pulsed; pulse duration = 200 μs, duty factor = 1%. [b] Typical value.

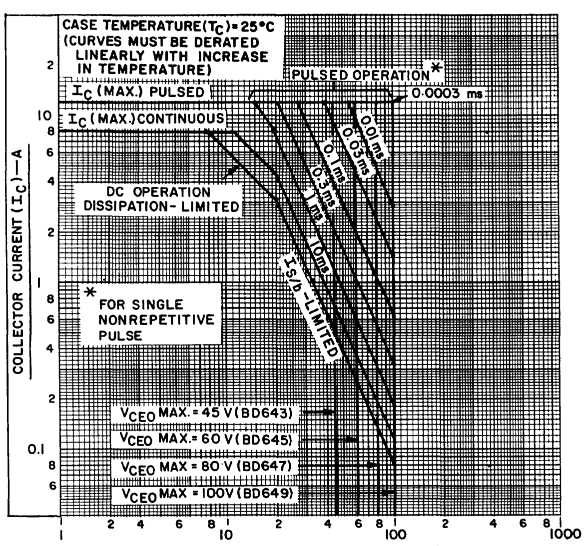


Fig. 3—Maximum operating area for all types.

8-Ampere N-P-N Darlington Power Transistors

45-60-80-100-Volts, 70 Watts

Gain of 750 at 4 A
(BD895A, BD897A, BD899A)

Gain of 750 at 3 A
(BD895, BD897, BD899, BD901)

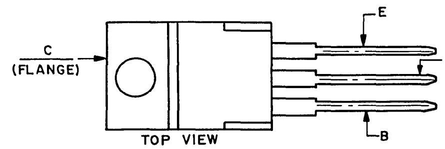
Features:

- **Operated from IC without predriver**
- **Low Leakage at high temperature**

Applications:

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

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.

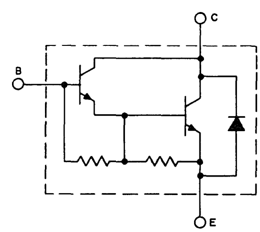


Fig. 1—Schematic diagram for all types.

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

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

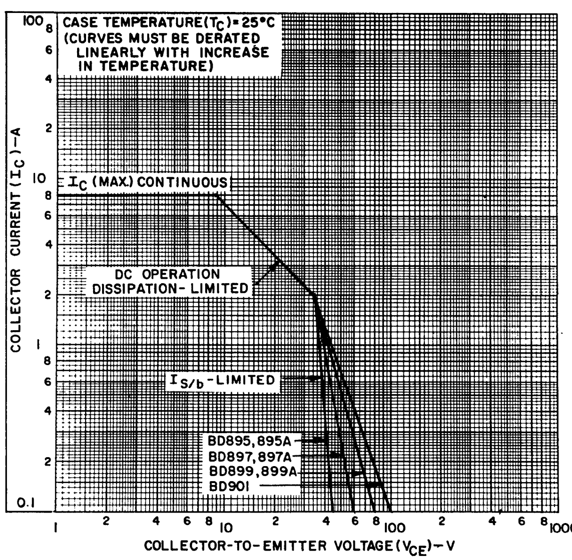


Fig. 2—Maximum operating areas for all types.

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			0	—	500	—	—	µA
		50			0	—	—	—	500	µA
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
$V_{CEO}(sus)$				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%.

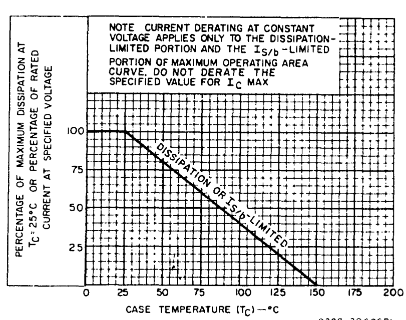


Fig. 3—Derating curve for all types.

2 POWER TRANSISTORS

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

Rugged, Broadly Applicable Devices
For Industrial and Commercial Use

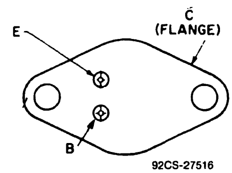
Features:

- *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

The RCA-BDX18 and MJ2955 are epitaxial-base silicon p-n-p transistors featuring high gain at high current. These devices have a dissipation capability of 115 watts (BDX18), and 150 watts (MJ2955) at case temperatures up to 25° C.

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

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BDX18 MJ2955	
V_{CBO}	-100	V
$V_{CER}(sus)$ $R_{BE} = 100\ \Omega$	-70	V
$V_{CEO}(sus)$	-60	V
V_{EBO}	-7	V
I_C	-15	A
I_B	-7	A
P_T At $T_C \leq 25°C$	150 (MJ2955) 115 (BDX18)	W
At $T_C > 25°C$ ... Derate linearly	0.86 (MJ2955) 0.66 (BDX18)	W/°C
T_{stg}, T_J	-65 to 200	°C
T_L At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	235	°C

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS		UNITS
	VOLTAGE V dc		CURRENT A dc		BDX18 MJ2955		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	
I_{CEX} BDX18	-100	1.5	—	—	—	-5	mA
MJ2955	-100	1.5	—	—	—	-1	
I_{CEX}, MJ2955, T_C = 150° C	-100	1.5	—	—	—	-5	mA
BDX18	-60	1.5	—	—	—	-10	
I_{CEO}	-30	—	—	—	—	-0.7	mA
I_{EBO}	—	7	—	—	—	-5	mA
V_{CEO}(sus)	—	—	-0.2	—	-60[b]	—	V
V_{CER}(sus) R_{BE} = 100 Ω	—	—	-0.2	—	-70[b]	—	V
h_{FE} BDX18, MJ2955	-4	—	-4[a]	—	20	70	
Except BDX18	-4	—	-10[a]	—	5	—	
V_{BE}	-4		-4[a]	—	—	-1.8	V
V_{CE}(sat) BDX18, MJ2955	—	—	-4[a]	-0.4	—	-1.1	V
MJ2955 only	—	—	-10[a]	-3.3	—	-3	
f_{hfe} f = 10 kHz MJ2955	-4	—	-1	—	10	—	kHz
$\|h_{fe}\|$ f = 1 MHz BDX18	-4	—	-1	—	2.5	—	
MJ2955	-4	—	-0.5	—	4	—	
h_{fe} f = 1 kHz	-4	—	-1	—	15	120	
$I_{S/B}$ t_p = 1 s nonrep.	-40	—	—	—	2.87	—	A
$R_{\theta JC}$ BDX18	—	—	—	—	—	1.5	°C/W
MJ2955	—	—	—	—	—	1.17	

[a]Pulsed; pulse duration = 300μs, duty factor = 1.8%.
[b]**CAUTION:** Sustaining voltages V_{CEO}(sus) and V_{CER}(sus) *MUST NOT* be measured on a curve tracer.

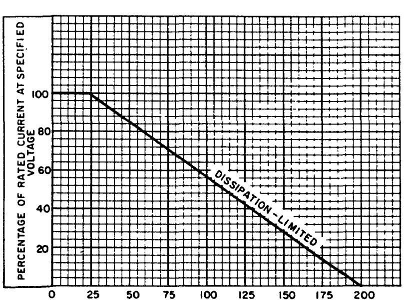


Fig. 1 — Derating curve.

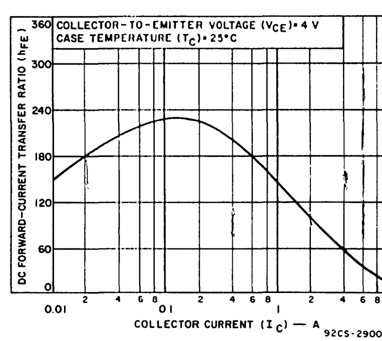


Fig. 2 — Typical dc beta characteristics.

2 POWER TRANSISTORS

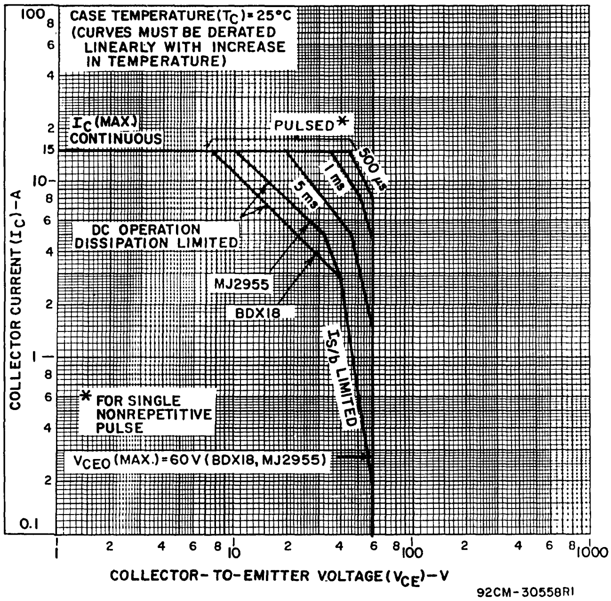


Fig. 3 — Maximum operating areas for BDX18 and MJ2955.

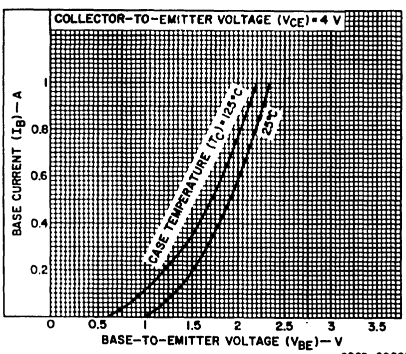


Fig. 4 — Typical input characteristics.

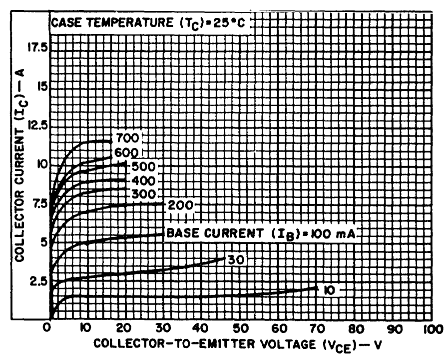


Fig. 5 — Typical output characteristics.

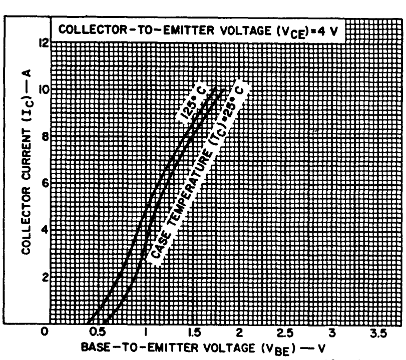


Fig. 6 — Typical transfer characteristics.

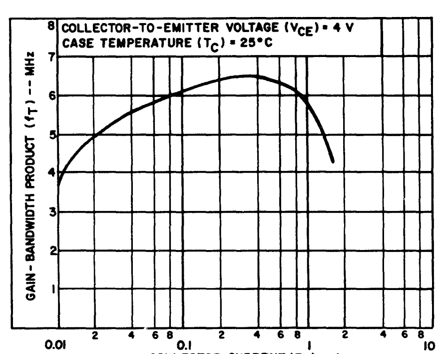


Fig. 7 — Typical gain-bandwidth product.

10-Ampere N-P-N Darlington Power Transistors

45-60-80-100-120 Volts, 70 Watts

Gain of 750 at 4 A (BDX33, BDX33A)
Gain of 750 at 3 A (BDX33B, BDX33C, BDX33D)

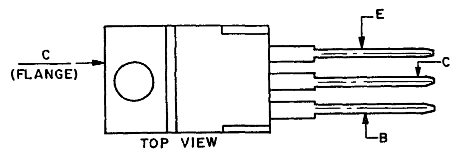
Features:

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

Applications:

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

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.

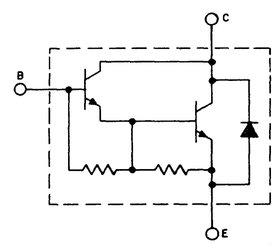


Fig. 1 – Schematic diagram for all types.

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

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%.

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc			CURRENT A dc		LIMITS BDX33C		BDX33D		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}		60			0	–	–	–	0.5	mA
		50			0	–	0.5	–	–	
T_C = 100°C		60			0	–	–	–	10	
		50			0	–	10	–	–	
I_{CBO}	120					–	–	–	1	
	100					–	1	–	–	
T_C = 100°C	120					–	–	–	5	
	100					–	5	–	–	
I_{EBO}			−5	0		–	10	–	10	mA
V_{CEO}(sus)				0.1[a]	0	100	–	120	–	V
V_{CER}(sus) (R_{BE}) = 100 Ω				0.1[a]		100	–	120	–	
V_{CEV}(sus)			−1.5	0.1[a]		100	–	120	–	
h_{FE}		3		3[a]		750	–	750	–	
V_{BE}		3		3[a]		–	2.5	–	2.5	V
V_{CE}(sat)				3[a]	0.006	–	2.5	–	2.5	V
V_F				8		–	4	–	4	V
h_{fe} f = 1 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	–	
$R_{\theta JC}$						–	1.78	–	1.78	°C/W

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

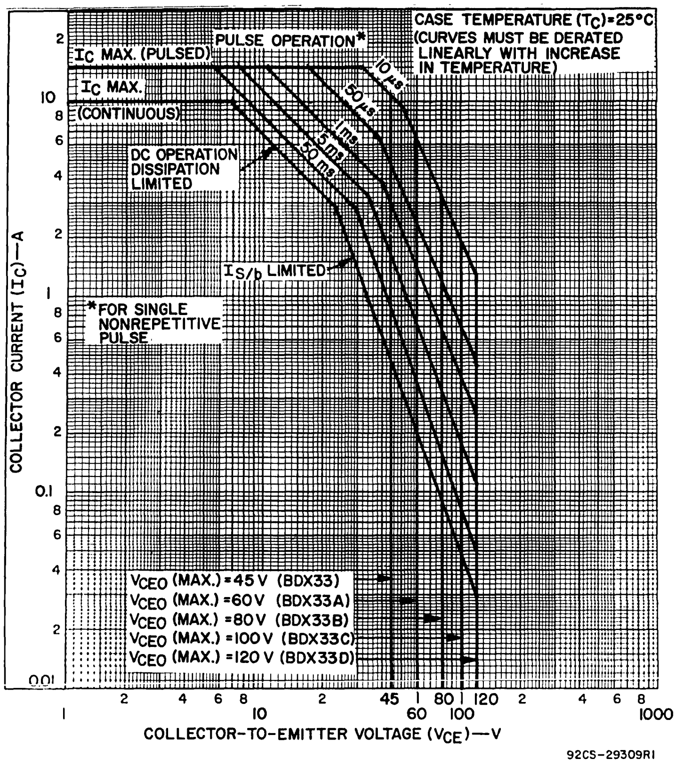


Fig. 2. — Maximum operating areas for BDX33-series types.

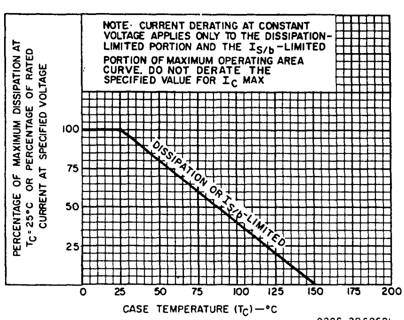


Fig. 3 — Derating curve for all types.

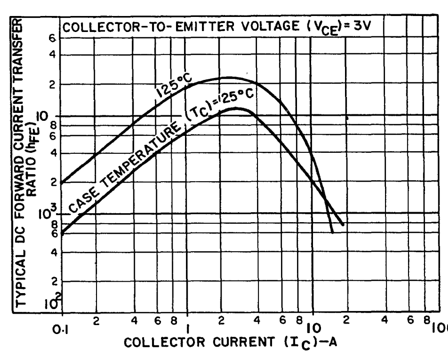


Fig. 4 — Typical dc-beta characteristics for all types.

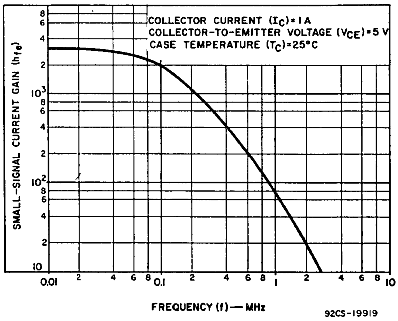


Fig. 5 — Typical small-signal gain for all types.

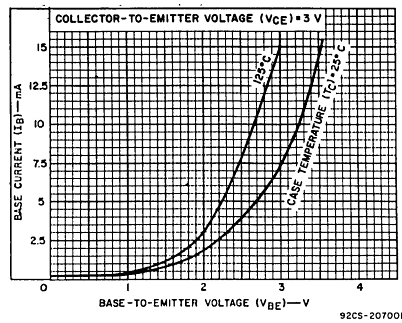


Fig. 6 — Typical Input characteristics for all types.

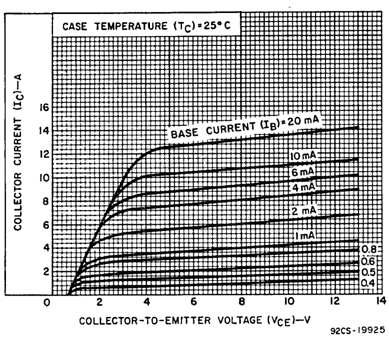


Fig. 7 — Typical output characteristics for all types.

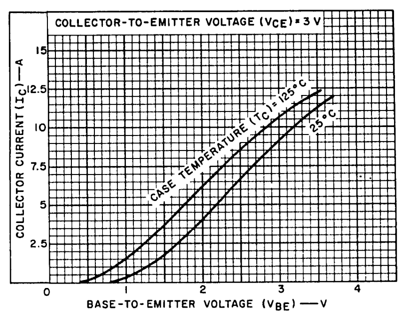


Fig. 8 — Typical transfer characteristics for all types.

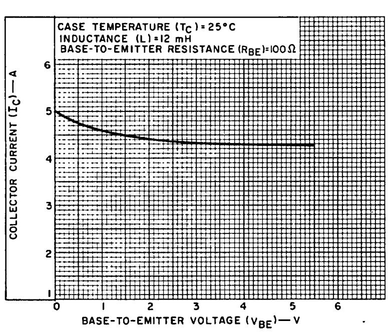


Fig. 9 — Typical saturation characteristics for all types.

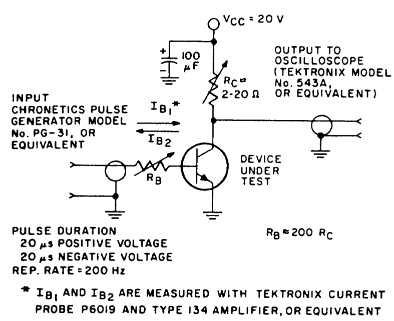


Fig. 10 — Circuit used to measure saturated switching times.

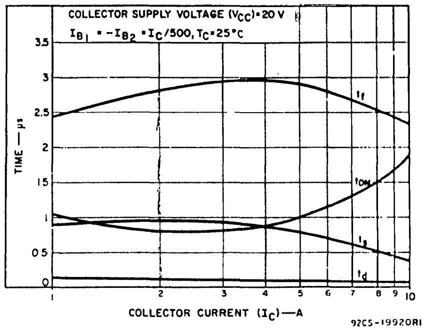


Fig. 11 — Typical saturated switching-time characteristics for all types.

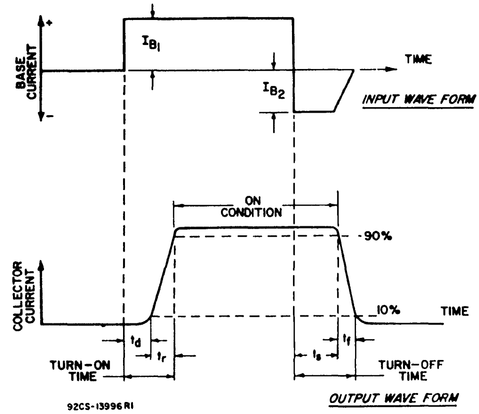


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching times (test circuit shown in Fig. 13).

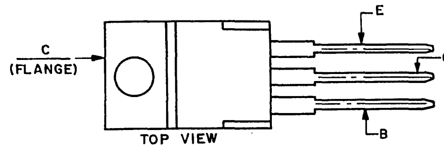
10-Ampere P-N-P Darlington Power Transistors

45-60-80-100-120 Volts, 70 Watts
Gain of 750 at 4 A (BDX34, BDX34A)
Gain of 750 at 3 A (BDX34B, BDX34C, BDX34D)

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

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

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.

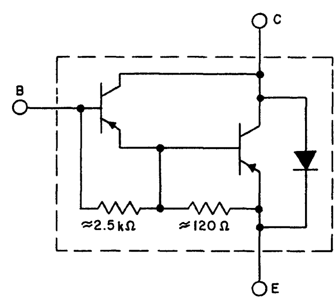


Fig. 1 - Schematic diagram for all types.

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

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

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc			CURRENT A dc	LIMITS BDX34		BDX34A		BDX34B		UNITS
	V_{CB}	V_{CE}	V_{BE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}		-40			—	—	—	—	—	-0.5	mA
		-30			—	—	—	-0.5	—	—	
		-20			—	-0.5	—	—	—	—	
T_C=100°C		-40			—	—	—	—	—	-10	
		-30			—	—	—	-10	—	—	
		-20			—	-10	—	—	—	—	
I_{CBO}	-80				—	—	—	—	—	-1	
	-60				—	—	—	-1	—	—	
	-45				—	-1	—	—	—	—	
T_C=100°C	-80				—	—	—	—	—	-5	
	-60				—	—	—	-5	—	—	
	-45				—	-5	—	—	—	—	
I_{EBO}			5	0	–	-10	—	-10	—	-10	
V_{CEO}(sus)				-0.1[a]	-45	—	-60	—	-80	—	V
V_{CER}(sus) (R_{BE})=100 Ω				-0.1[a]	-45	—	-60	—	-80	—	
V_{CEV}(sus)			1.5	-1.0[a]	-45	—	-60	—	-80	—	
h_{FE}		-3		-3[a]	—	—	—	—	750	—	
		-3		-4[a]	750	—	750	—	—	—	
V_{BE}		-3		-3[a]	—	—	—	—	—	-2.5	V
		-3		-4[a]	—	-2.5	—	-2.5	—	—	
V_{CE}(sat) I_B=-0.006 A				-3[a]	—	—	—	—	—	-2.5	
=-0.008 A				-4[a]	—	-2.5	—	-2.5	—	—	
V_F				-8	—	-4	—	-4	—	-4	
h_{fe} (f=1.0 kHz)		-5		-1	1000	—	1000	—	1000	—	
$\|h_{fe}\|$ (f=1.0 MHz)		-5		-1	20	—	20	—	20	—	
$I_{S/b}$ t_p=0.5s non-rep.		-20			-3.5	—	-3.5	—	-3.5	—	A
		-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%.

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	—	
$I_{S/b}$ t_p=0.5 s non-rep.		-20			-3.5	—	-3.5	—	A
		-33			-1	—	-1	—	A
$R_{\theta JC}$					—	1.78	—	1.78	°C/W

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

2 POWER TRANSISTORS

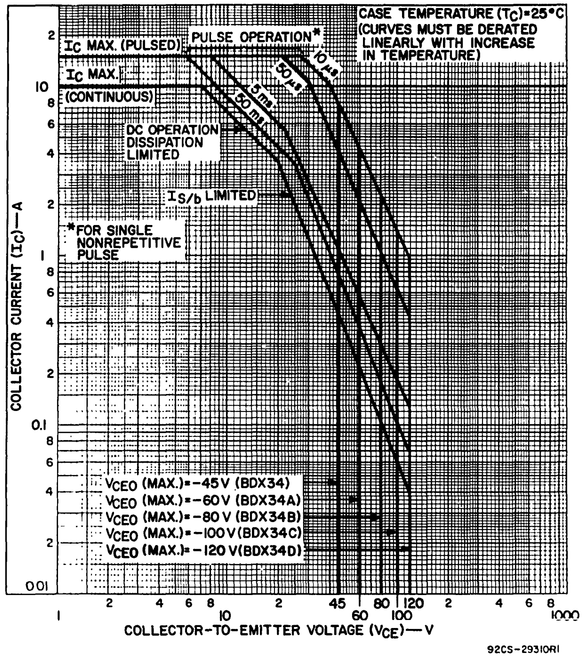


Fig. 2 - Maximum operating areas for BDX34-series types.

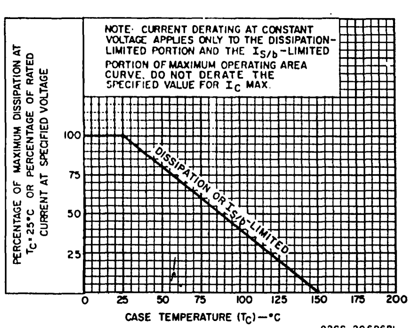


Fig. 3 - Current derating curve for all types.

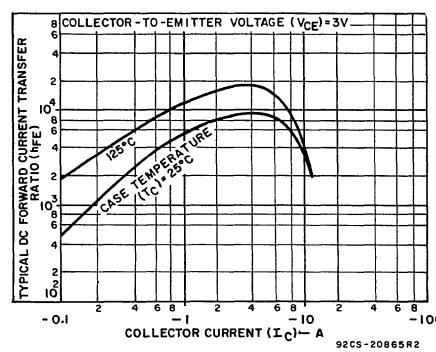


Fig. 4 - Typical dc beta characteristics for all types.

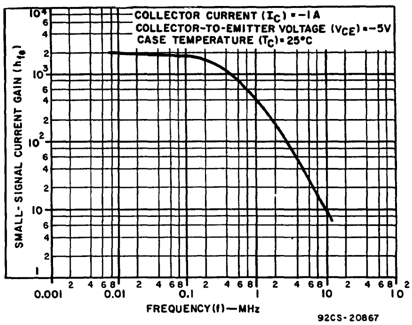


Fig. 5 — Typical small-signal gain for all types.

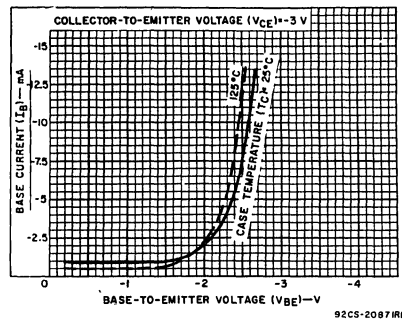


Fig. 6 — Typical input characteristics for all types.

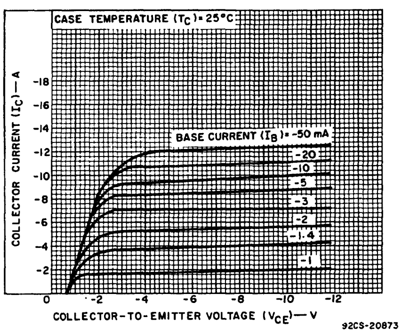


Fig. 7 — Typical output characteristics for all types.

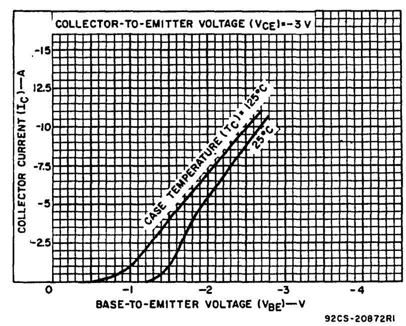


Fig. 8 — Typical transfer characteristics for all types.

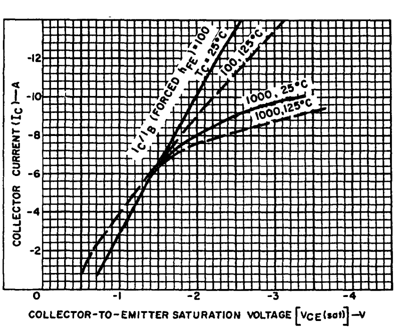


Fig. 9 — Typical saturation characteristics for all types.

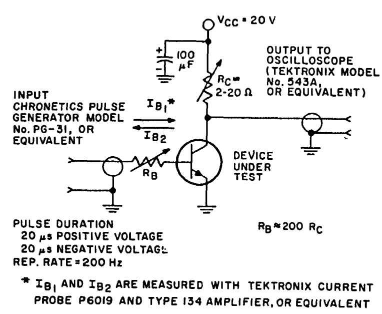


Fig. 10 — Circuit used to measure saturated switching times.

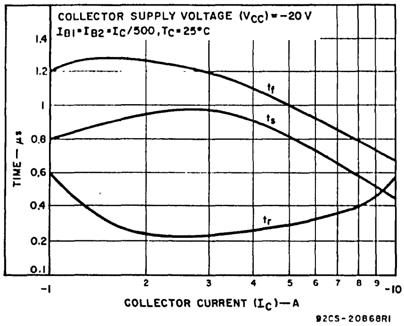


Fig. 11 — Typical saturated switching-time characteristics for all types.

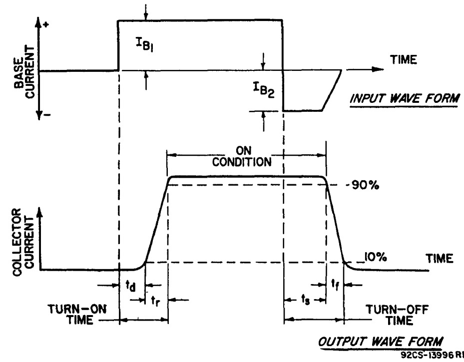


Fig. 12 — Phase relationship between input current and output current showing reference points for specifications of switching

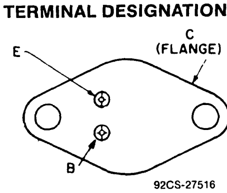
High-Current, High-Power, High-Speed Silicon N-P-N Planar Transistors

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

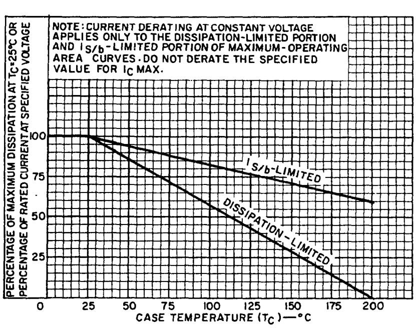


Fig. 1 - Dissipation derating curves for both types.

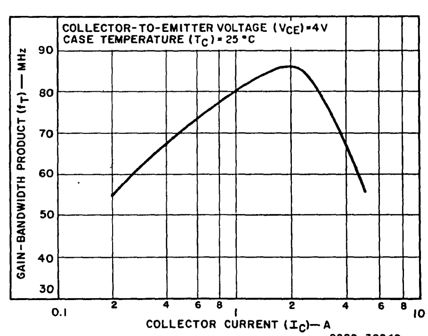


Fig. 2 - Typical gain-bandwidth product for both types.

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.

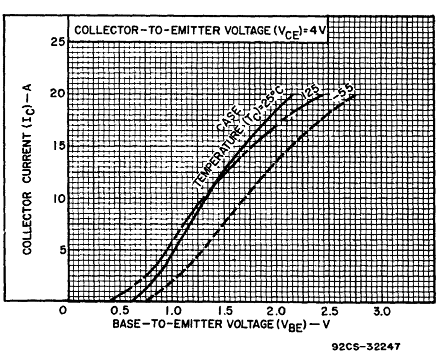


Fig. 3 - Typical transfer characteristics for both types.

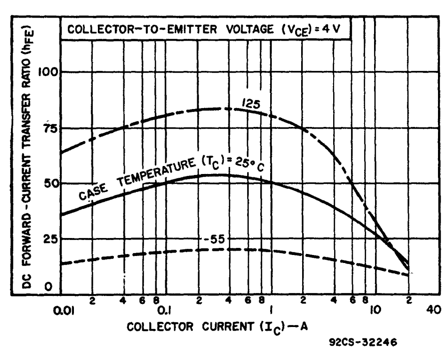


Fig. 4 - Typical dc beta characteristics for both types.

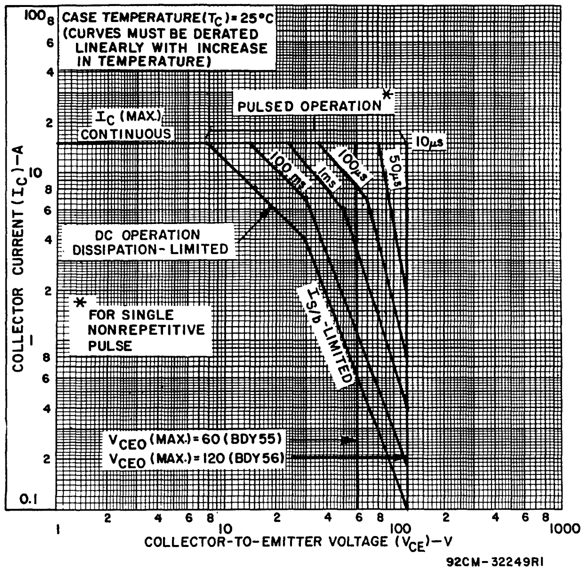


Fig. 5 - Maximum operating areas for both types.

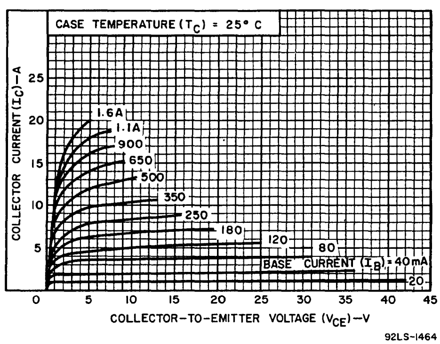


Fig. 6 - Typical output characterstics for both types.

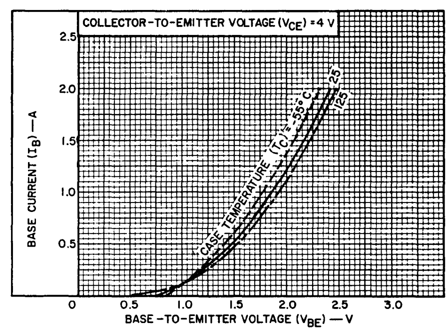


Fig. 7 - Typical input characterstics for both types.

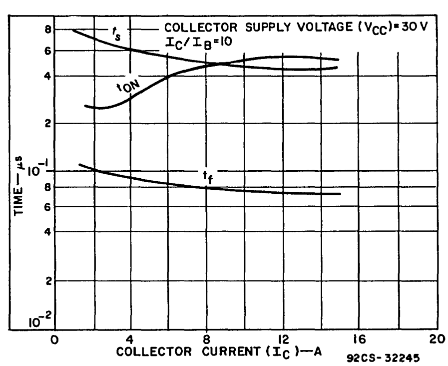


Fig. 8 - Switching-time characterstics as a function of collector current for both types.

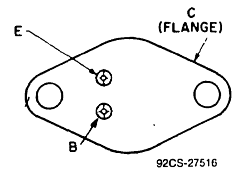
Silicon N-P-N Switching Transistors

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

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.

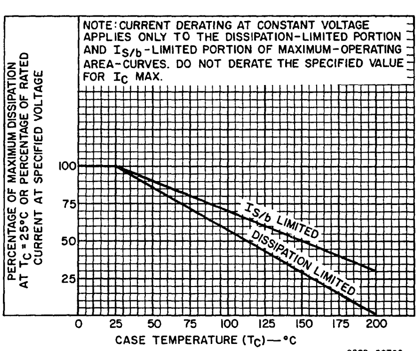


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

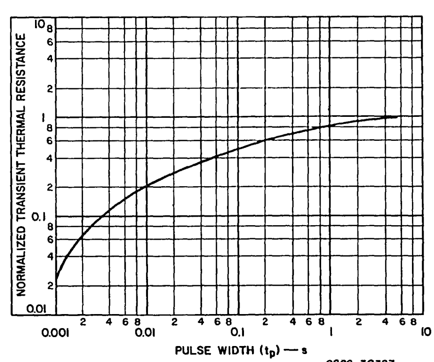


Fig. 2 — Typical thermal-response characteristic.

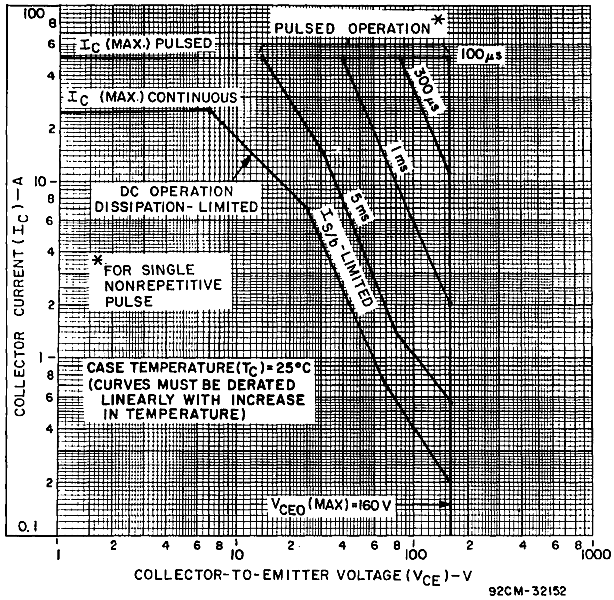


Fig. 3 — Maximum safe-operating areas (T_C = 25° C).

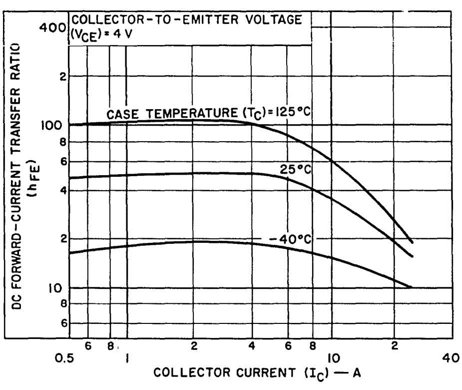


Fig. 4 — Typical dc beta characteristics.

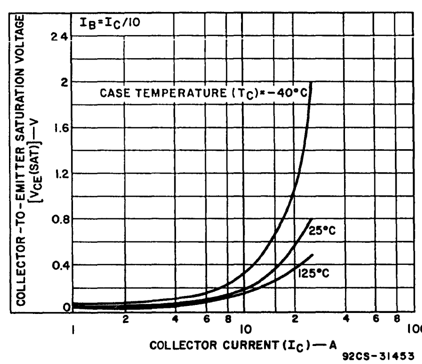


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

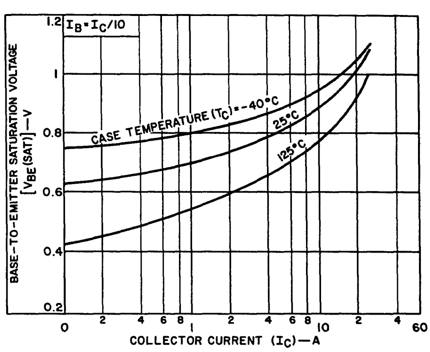


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

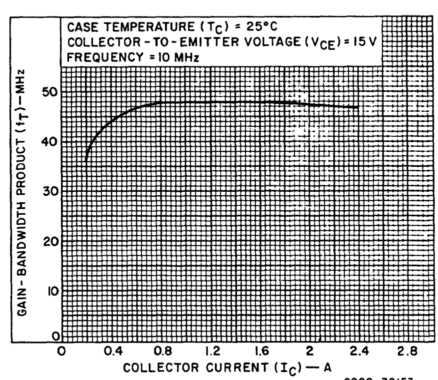


Fig. 7 — Typical gain-bandwidth product.

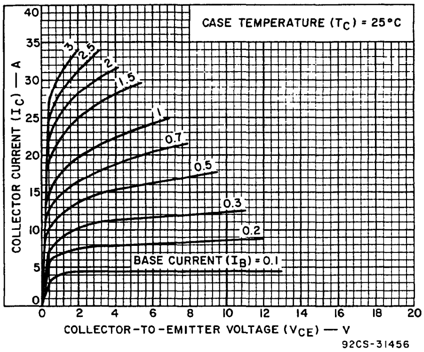


Fig. 8 — Typical output characteristics.

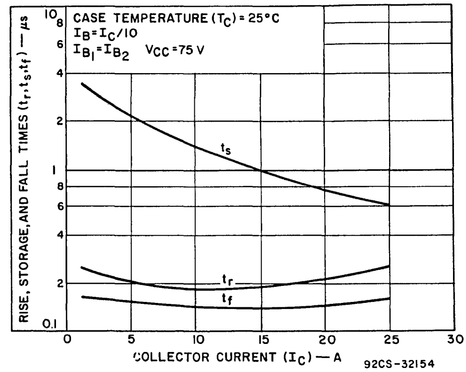


Fig. 9 — Typical saturated-switching-time characteristics as a function of collector current.

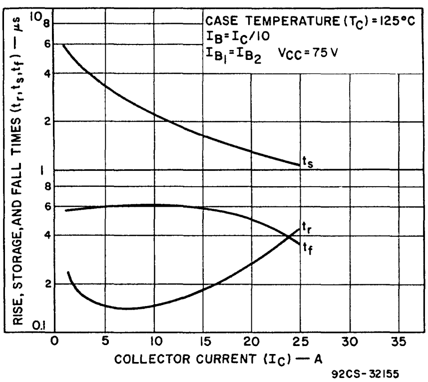


Fig. 10 — Typical switching-time characteristics at T_C = 125° C as a function of collector current.

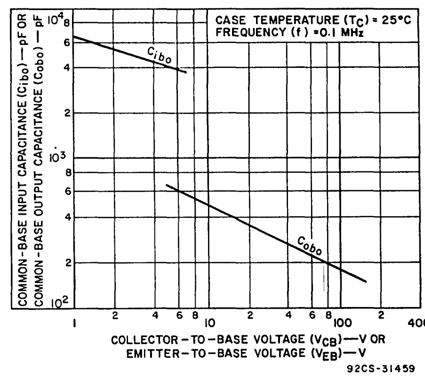


Fig. 11 — Typical common-base input (C_{ibo}) of output (C_{obo}) capacitance characteristics.

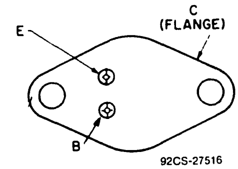
High-Speed Silicon N-P-N Planar Transistors

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.

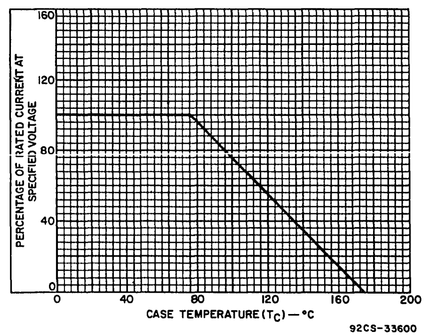


Fig. 1 - Dissipation derating curves for all types.

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

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

Characteristic	Test Conditions: Voltage V dc: V_{CE}	Voltage V dc: V_{BE}	Current A dc: I_C	Current A dc: I_B	Limits: BDY90 Min.	BDY90 Max.	BDY91 Min.	BDY91 Max.	BDY92 Min.	BDY92 Max.	Units
I_{CEX} T_C = 150 °C	120 100 80	−1.5 −1.5 −1.5			— — —	3 — —	— — —	— 3 —	— — —	— — 3	mA
h_{FE}	2 5 5		1[a] 5[a] 10[a]		35 30 20	— 120 —	35 30 20	— 120 —	35 30 20	— 120 —	
$\|h_{fe}\|$ f = 5 MHz	5		0.5		14 Typ.	—	14 Typ.	—	14 Typ.	—	
V_{CEO}(sus)[b]			0.2	0	100	—	80	—	60	—	V
V_{CEX}(sus)[b]		−1.5	0.2	0	120	—	100	—	80	—	V
V_{EBO} I_E = 0.05 A			0		6	—	6	—	6	—	V
V_{CE}(sat)			5[a] 10[a]	0.5 1	— —	0.5 1.5	— —	0.5 1.5	— —	0.5 1.0	V
V_{BE}(sat)			5[a] 10[a]	0.5 1	— —	1.2 1.5	— —	1.2 1.5	— —	1.2 1.5	V
t_{ON} V_{CC} = 30 V			5	0.5[c]	—	0.35	—	0.35	—	0.35	μs
t_s V_{CC} = 30 V			5	0.5[c]	—	1.3	—	1.3	—	1.3	μs
t_f V_{CC} = 30 V			5	0.5[c]	—	0.2	—	0.2	—	0.2	μs
$R_{\theta JC}$	10		10		—	2.5	—	2.5	—	2.5	°C/W

a Pulsed: pulse duration = 300 μs, duty factor ≤ 2 %. c $I_{B1} = -I_{B2}$

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

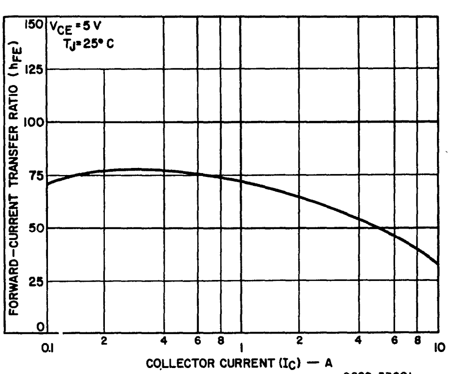


Fig.2 - Typical dc beta characteristics for all types.

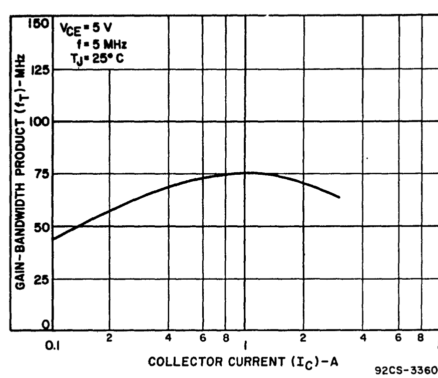


Fig.3 - Typical gain-bandwidth product for all types.

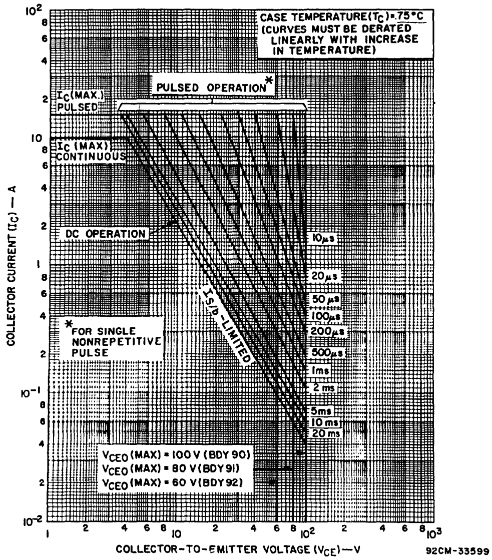


Fig.4 - Maximum operating areas for all types.

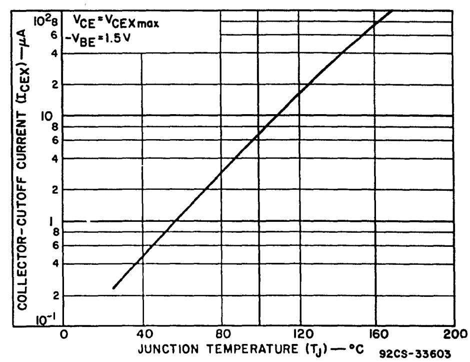


Fig.5 - Typical collector leakage current vs. junction temperature for all types.

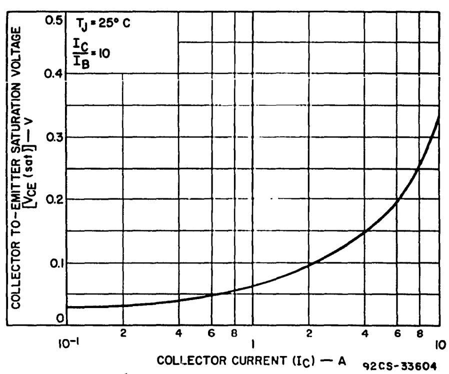


Fig.6 - Typical collector-to-emitter saturation voltage characteristics as a function of collector current for all types.

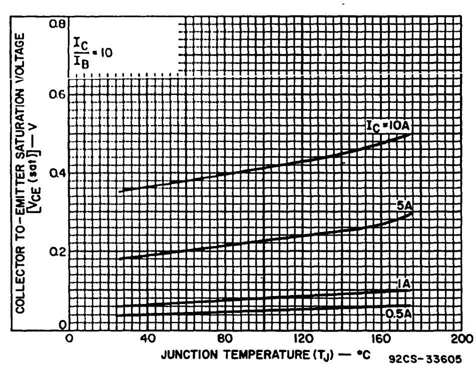


Fig.7 - Typical collector-to-emitter saturation voltage characteristics as a function of junction temperature for all types.

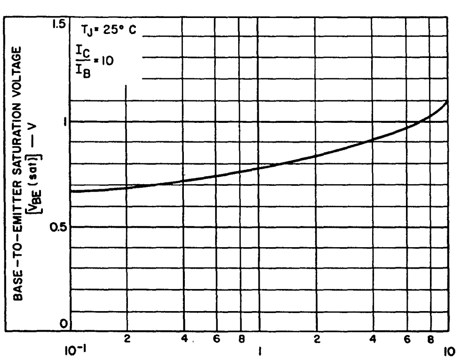


Fig.8 - Typical base-to-emitter saturation voltage characteristics as a function of collector current for all types.

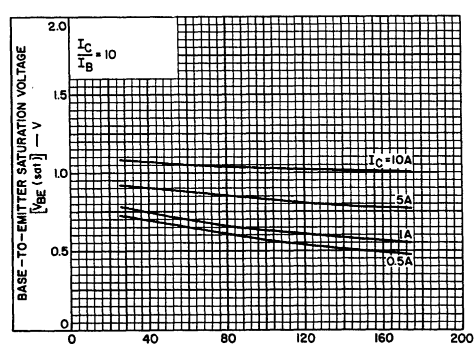


Fig.9 - Typical base-to-emitter saturation voltage characteristics as a function of junction temperature.

5-A *SwitchMax* Power Transistors

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

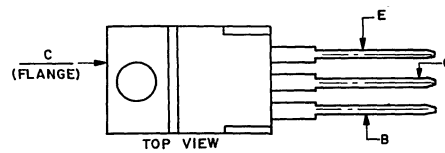
Features:

- *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

ELECTRICAL CHARACTERISTICS

Characteristic	Test Conditions				Limits						Units
	Voltage V dc		Current A dc		BUW41		BUW41A		BUW41B		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 25° C											
I_{CEV}	450	—1.5			—	0.1	—	—	—	—	mA
	550	—1.5			—	—	—	0.1	—	—	
	650	—.5			—	—	—	—	—	0.1	
I_{IEBO}		—8	0		—	2	—	2	—	2	
$V_{CEO}(sus)$[b]			0.2[a]	0	300	—	350	—	400	—	V
h_{FE}	3		5[a]		10	40	10	40	10	40	
$V_{BE}(sat)$			5[a]	1	—	1.6	—	1.6	—	1.6	V
$V_{CE}(sat)$			5[a]	1	—	1	—	1	—	1	
			8[a]	4	—	2	—	2	—	2	
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 µH		—5	5	1[e]	350	—	400	—	450	—	
R_{BB} = 5 Ω		—5	8	3[e]	200	—	250	—	300	—	
$I_{S/b}$	25		4		0.5	—	0.5	—	0.5	—	s
$\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
C_{obo} f=0.1 MHz	10[c]				50	300	50	300	50	300	pF
t_d[d]			5	1	—	0.1	—	0.1	—	0.1	
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	µs

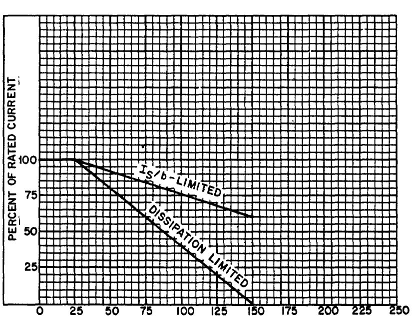


Fig. 1 — Dissipation and $I_{S/b}$ derating curves for all types.

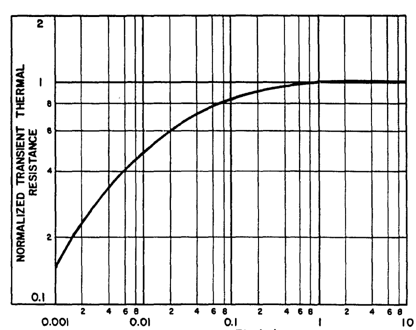


Fig. 2 — Typical thermal-response characteristics for all types.

ELECTRICAL CHARACTERISTICS Continued

Characteristic	Test Conditions: Voltage V dc		Test Conditions: Current A dc		Limits: BUW41		Limits: BUW41A		Limits: BUW41B		Units
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
T_C = 125° C											
I_{CEV}	450	—1.5			—	1	—	—	—	—	mA
	550	—1.5			—	—	—	1	—	—	mA
	650	—1.5			—	—	—	—	—	1	mA
V_{CE}(sat)			5[a]	1	—	2	—	2	—	2	V
t_r[d]			5	1	—	0.8	—	0.8	—	0.8	μs
t_s[d]			5	1[e]	—	4	—	4	—	4	μs
t_f[d]			5	1[e]	—	0.8	—	0.8	—	0.8	μs
t_c V_{CC}= 125 V, L=170 μH, R_C = 25 Ω Collector clamped to V_{CEX}			5	1[e]	—	0.8	—	0.8	—	0.8	μs
$R_{\theta JC}$					—	1.25	—	1.25	—	1.25	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

[a]Pulsed: pulse duration = 300 μs, duty factor ≤2%.

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

[c]V_{CB}value.

[d]V_{CC}=125 V, t_p=20 μs.

[e]I_{B_1}= —I_{B_2}.

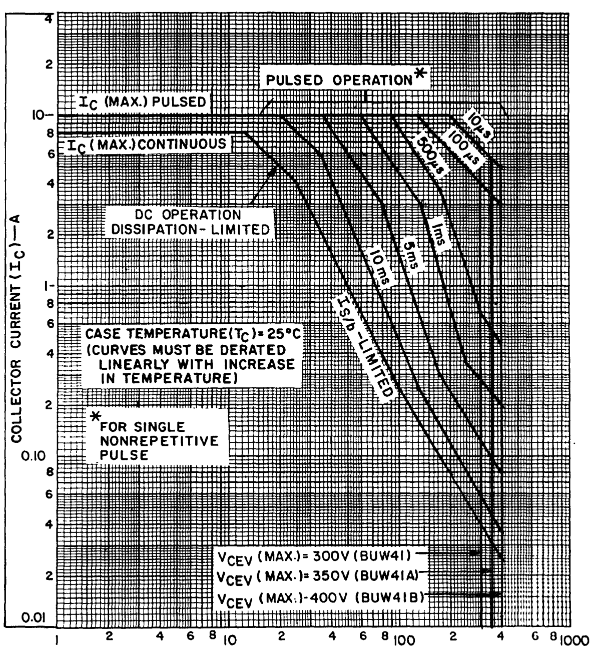


Fig. 3 — Maximum operating areas for all types [T_C = 25° C].

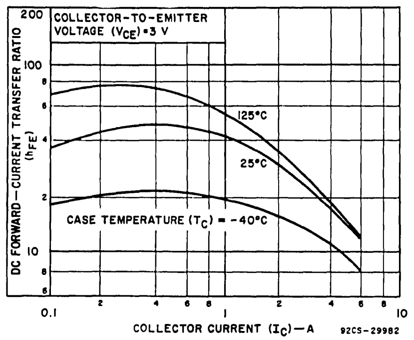


Fig. 4 — Typical dc beta characteristics for all types.

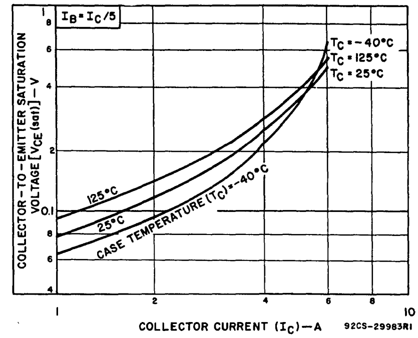


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

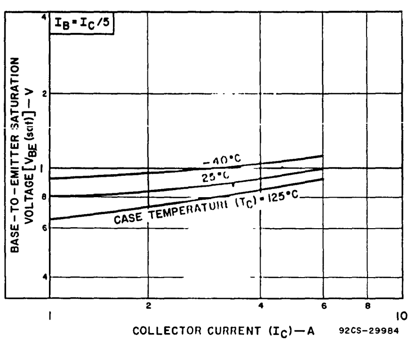


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

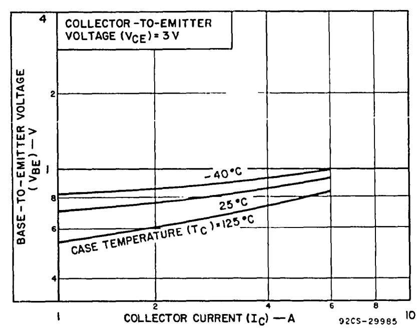


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

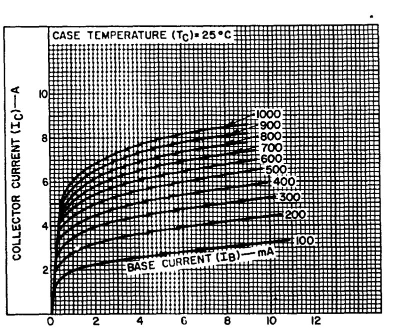


Fig. 8 — Typical output characteristics for all types.

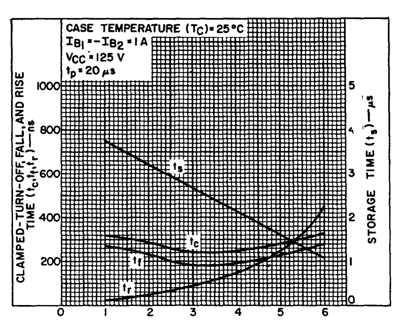


Fig. 9 — Typical saturated-switching-time characteristics for all types.

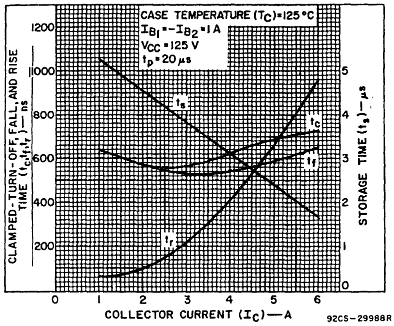


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

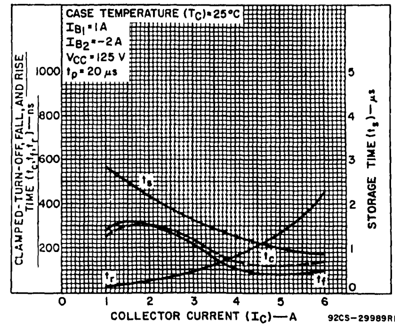


Fig. 11 — Typical saturated-switching-time characteristics for all types.

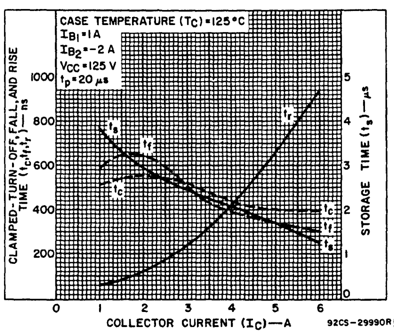


Fig. 12 — Typical saturated-switching-time characteristics for all types.

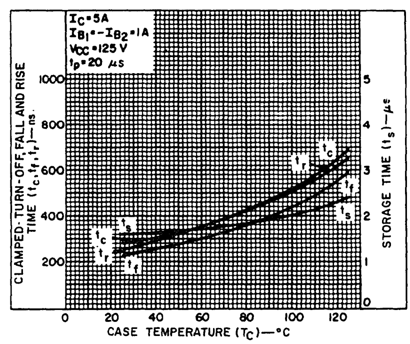


Fig. 13 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

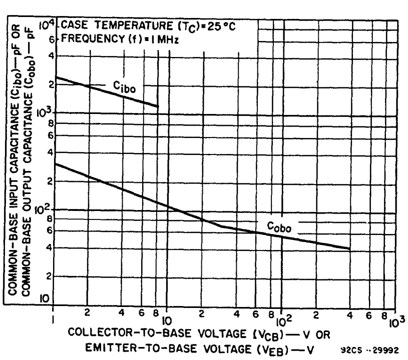


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

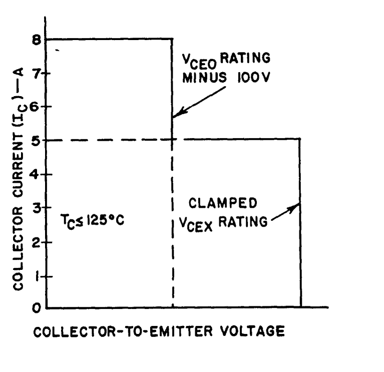


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

2 POWER TRANSISTORS

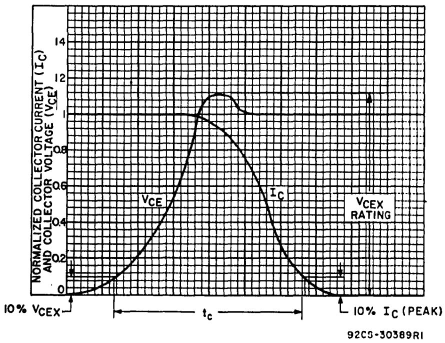


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

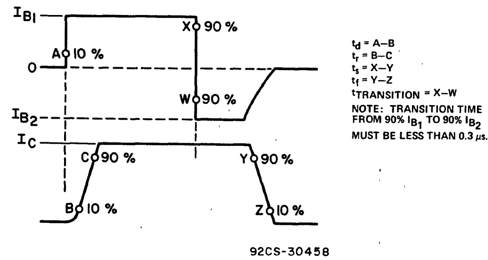
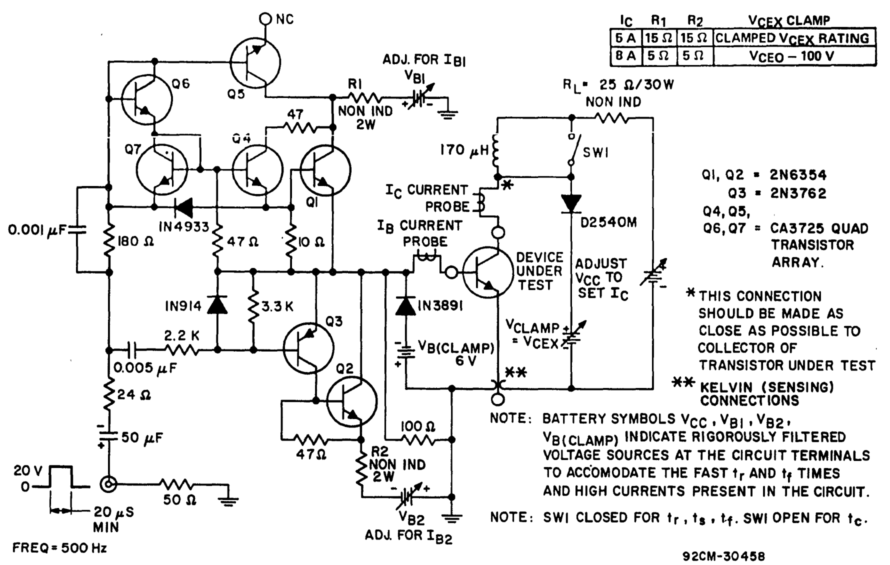


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.



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

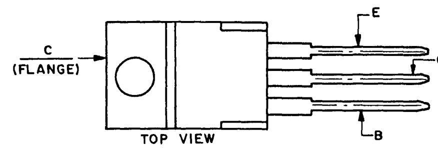
Fig. 18 — Circuit for measuring switching times.

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

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	–	–	µA
	180	−1.5			–	–	–	–	–	100	µA
T_C = 125°C	140	−1.5			–	1	–	–	–	–	mA
	160	−1.5			–	–	–	1	–	–	mA
	180	−1.5			–	–	–	–	–	1	mA
I_{EBO}		−7	0		–	100	–	100	–	100	µA
V_{CEO}(sus)[b]			0.01[a]	0	90	–	110	–	130	–	V
h_{FE}	2		0.2[a]		30	–	30	–	30	–	
	2		4[a]		–	–	–	–	20	–	
	2		5[a]		20	–	20	–	–	–	
V_{BE}(sat)			4[a]	0.4	–	–	–	–	–	1.4	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
$\|h_{fe}\|$ 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	–	–	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

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

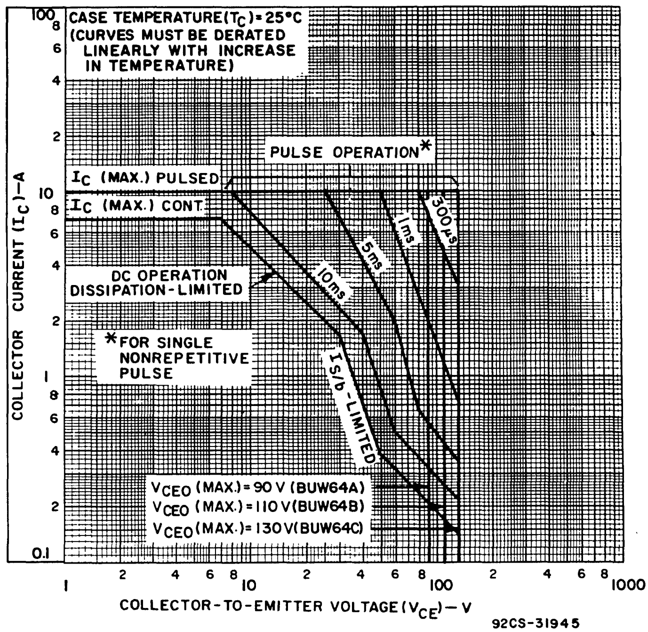


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

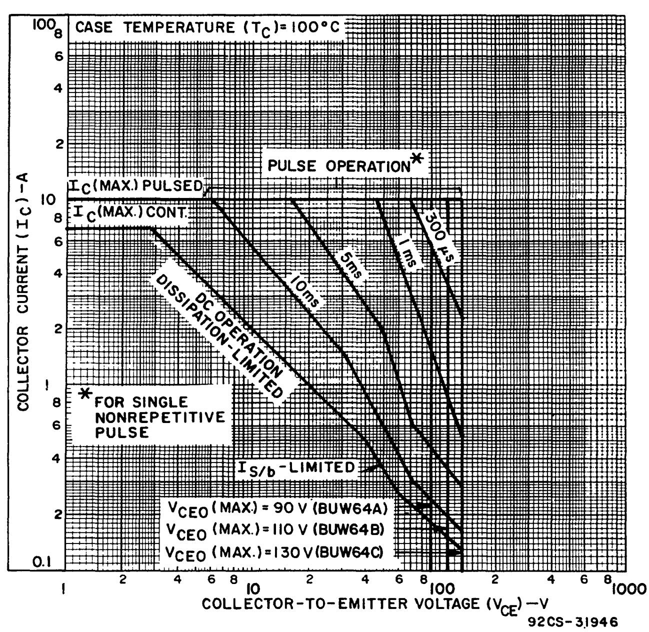


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

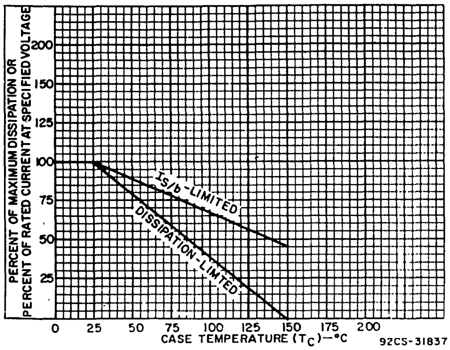


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

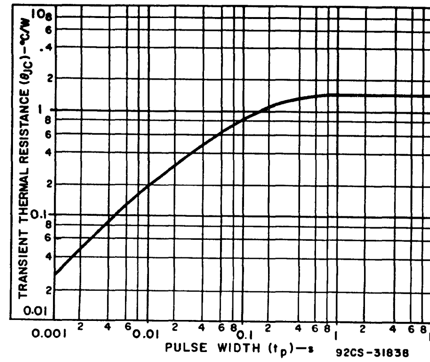


Fig. 4 — Typical thermal-response characteristic for all types.

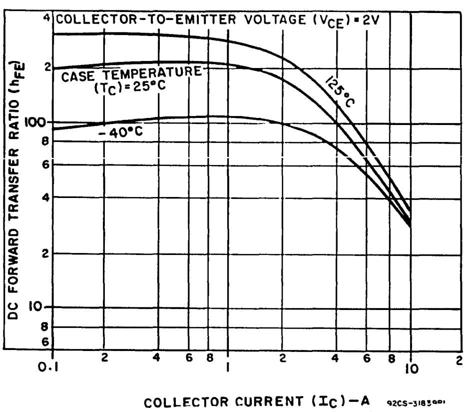


Fig. 5 — Typical dc beta characteristics for all types.

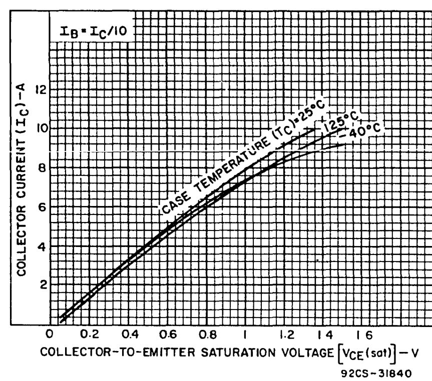


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

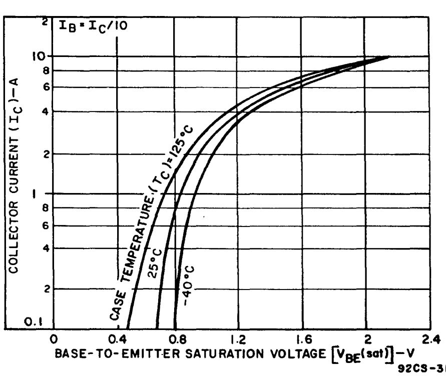


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

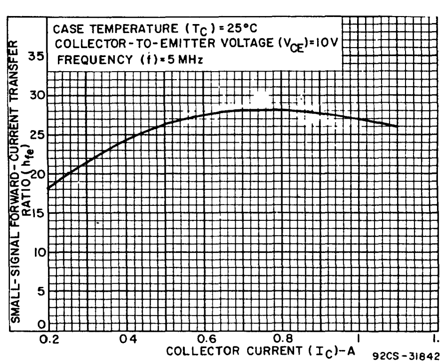


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

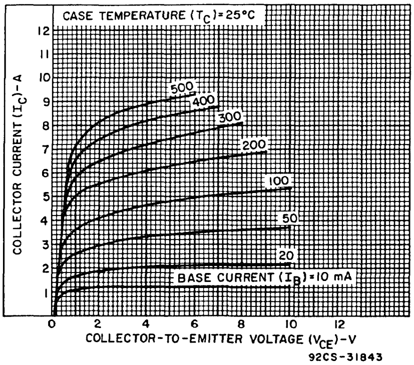


Fig. 9 – Typical output characteristics for all types.

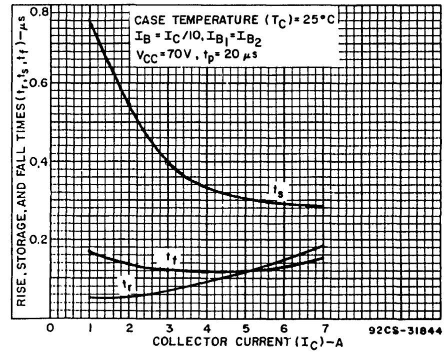


Fig. 10 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

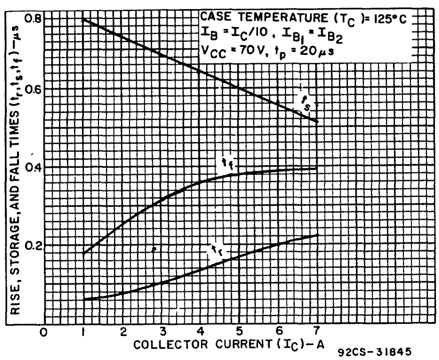


Fig. 11 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

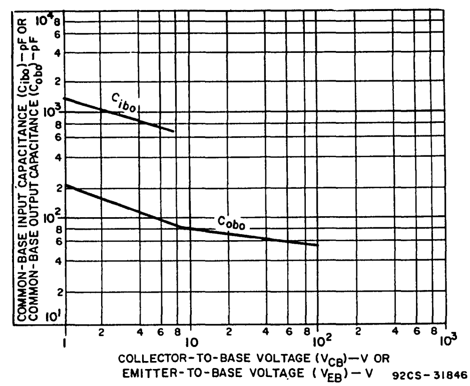


Fig. 12 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

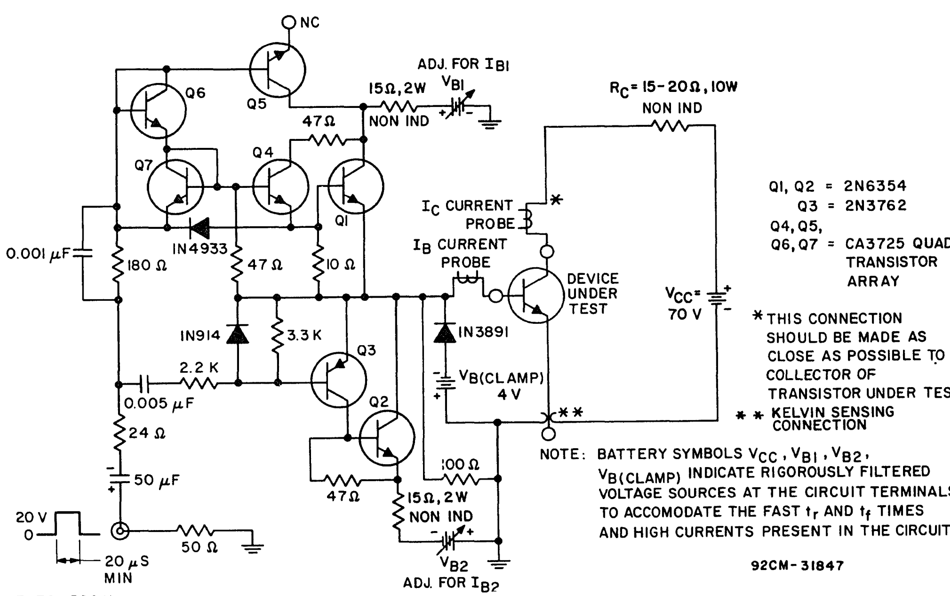
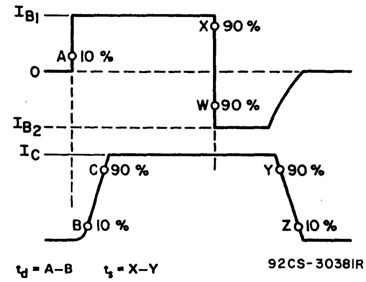


Fig. 13 – Circuit for measuing switching times.



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.

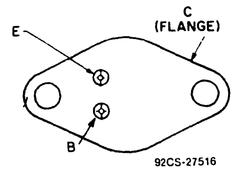
Fig. 14 – Phase relationship between input and output currents showing reference points for specification of switching times.

High-Current, High-Power, High-Speed Silicon N-P-N Power Transistor

Features:

- V_{CEO} - 190 V
- I_C - 20 A
- P_T - 200 W

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUX11A epitaxial-base silicon n-p-n transistor features high-voltage and high-current capabilities together with fast switching speed at low saturation voltage. It is especially suitable for control amplifiers and power-switching circuits, such as converters, inverters, switching regulators, and switching-control amplifiers.

The RCA-BUX11A is supplied in a steel JEDEC TO-204AA hermetic package.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX11A	
V_{CBO}	250	V
V_{CER}		
$R_{BE} = 100\ \Omega$	240	V
V_{CEO}	190	V
V_{CEX}		
$V_{BE} = -1.5$ V	250	V
V_{EBO}	7	V
I_C	20	A
I_{CM}	25	A
I_B	4	A
P_T		
$T_C \leq 25°C$	200	W
$T_C > 25°C$ derate linearly	1.14	W/°C
T_{stg}, T_J	−65 to + 200	°C
T_L		
At distances ≧ 1/32 in. (0.8 mm) from seating plane for 10 s max	235	°C

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	
I_{CEX} $T_C = 125°C$	250	-1.5			—	6	
I_{EBO}		-5			—	1	
$V_{CEO}(sus)$[a]			0.2[b]		190	—	V
$V_{(BR)EBO}$ $I_E = 50$ mA			0		7	—	
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	
$I_{S/b}$ $t_p = 1s$ 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	
t_f $I_{B1} = I_{B2}$	150[c]		15	1.88	—	0.4	
$R\theta_{JC}$					—	0.875	°C/W

[a]CAUTION: The sustaining voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.
[b]Pulsed; pulse duration = 300 µs, duty factor ≤ 2%.
[c]V_{CC}.

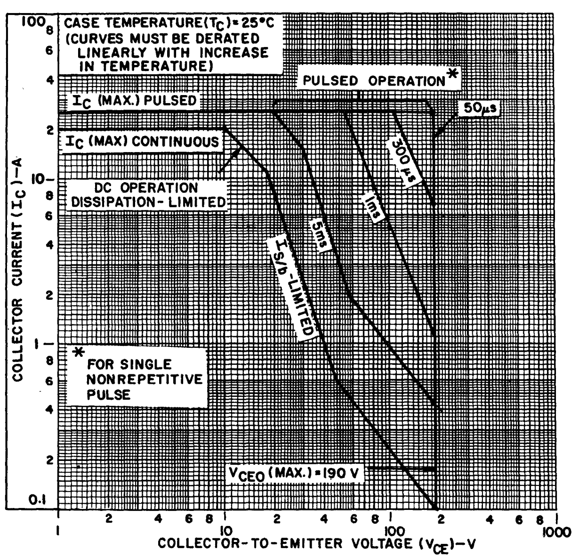


Fig. 1 — Maximum safe-operating areas for BUX11A (T_c = 25°C).

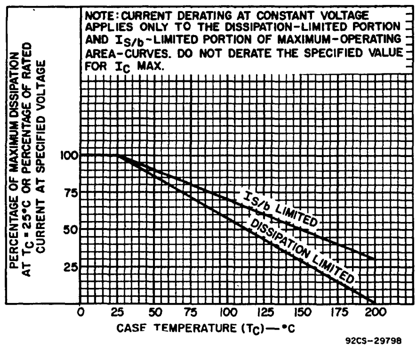


Fig. 2 — Derating curves for $I_{S/b}$ and dissipation.

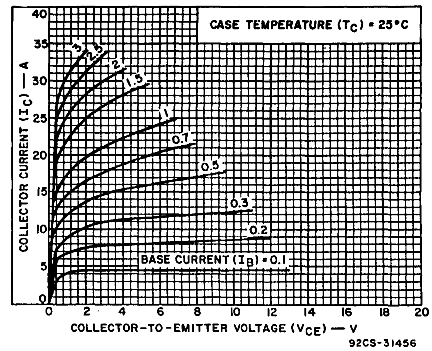


Fig. 3 — Typical output characteristics.

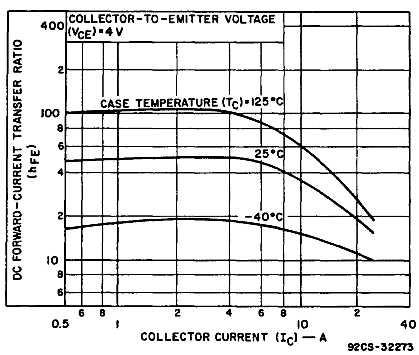


Fig. 4 — Typical dc beta characteristics.

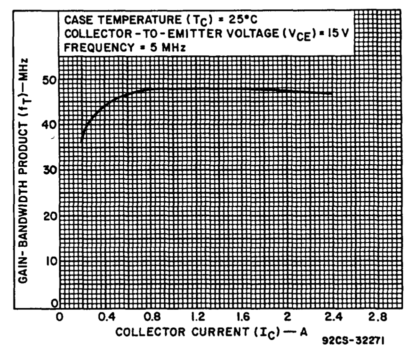


Fig. 5 — Typical gain-bandwidth product.

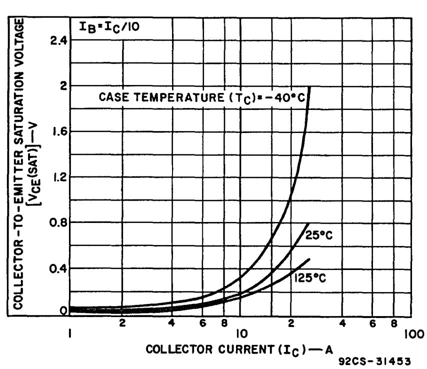


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics.

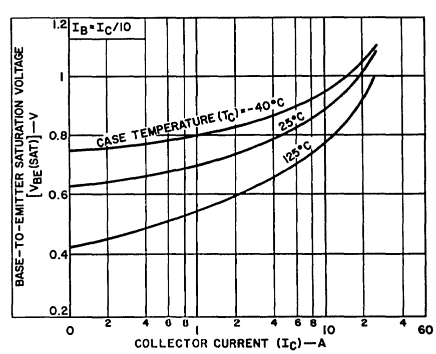


Fig. 7 — Typical base-to-emitter saturation voltage characteristics.

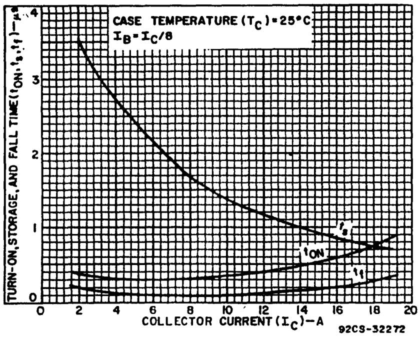


Fig. 8 — Typical saturated-switching times as a function of collector current.

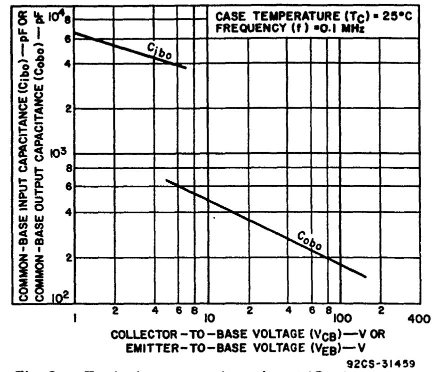


Fig. 9 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic.

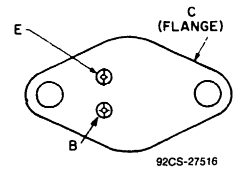
Silicon N-P-N Switching Transistor

For High-Voltage Switching and Amplifier Applications in Industrial and Commercial Equipment

Features:

- V_{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				LIMITS			UNITS
	VOLTAGE V dc		CURRENT A dc		BUX14			
	V_{CE}	V_{BE}	I_C	I_B	Min.	Typ.	Max.	
I_{CEO}	320	—	—	0	—	—	1.5	mA
I_{CEX}	450	−1.5	—	—	—	—	1.5	
T_C = 125°C	450	−1.5	—	—	—	—	6	
I_{EBO}	—	−5	0	—	—	—	1	
$V_{CEO}(sus)$[b]	—	—	0.2[a]	0	400[a]	—	—	V
$V_{(BR)EBO}$ I_E = 0.05 A	—	—	0	—	7	—	—	V
$V_{BE}(sat)$	—	—	6[a]	1.2	—	1	1.5	
$V_{CE}(sat)$	—	—	3[a]	0.6	—	0.2	0.6	
	—	—	6[a]	1.2	—	0.5	1.5	
h_{FE}	4	—	3[a]	—	15	—	60	
	4	—	6[a]	—	8	—	—	
$I_{S/b}$	140	—	—	—	0.15	—	—	A
t = 1 s, nonrepetitive	30	—	—	—	5	—	—	
f_T	15	—	1	—	8	—	—	MHz
t_{on}	V_{CC}	—	6	1.2	—	0.5	1.4	μs
t_s	=	—	6	1.2[c]	—	1	3	
t_f	30 V	—	6	1.2[c]	—	0.3	1.2	
$R_{\theta JC}$	—	—	—	—	—	—	1.17	°C/W

[a]Pulsed, pulse duration = 300 μs, duty factor ≤ 2%.

[b]**CAUTION:** Sustaining Voltage $V_{CEO}(sus)$ *MUST NOT* be measured on a curve tracer.

[c]$I_{B1} = I_{B2}$.

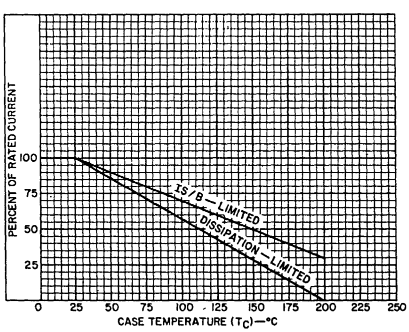


Fig. 1 — Dissipation and $I_{S/b}$ derating curves.

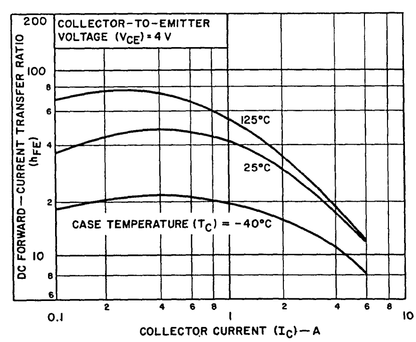


Fig. 2 — Typical dc beta characteristics.

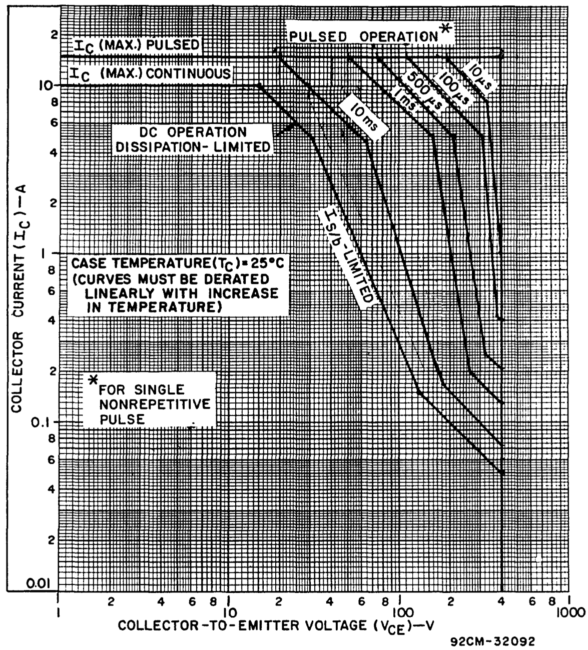


Fig. 3 — Maximum safe-operating areas (T_C = 25° C).

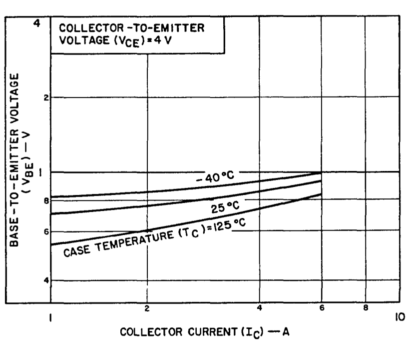


Fig. 4 — Typical base-to-emitter voltage as a function of collector current.

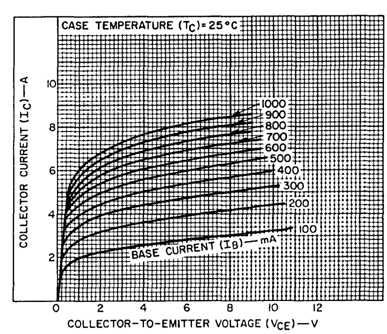


Fig. 5 — Typical output characteristics.

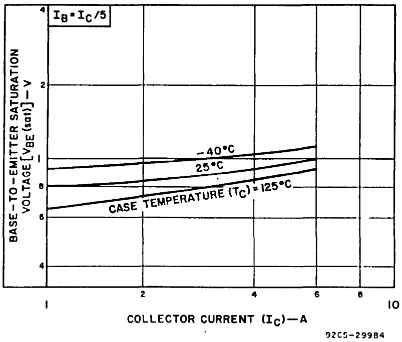


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current.

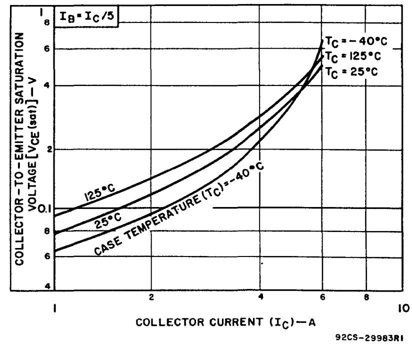


Fig. 7 — Typical collector-to-emitter saturation voltage as a function of collector current.

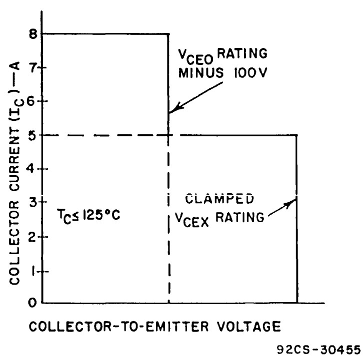


Fig. 8 — Maximum operating conditions for switching between saturation and cutoff.

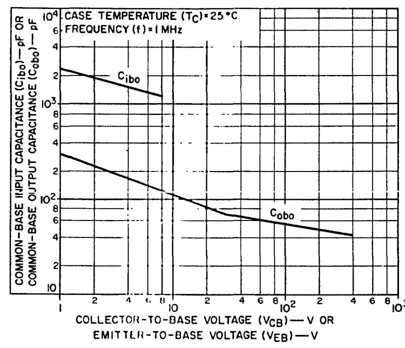


Fig. 9 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage.

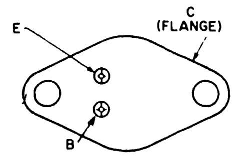
Silicon N-P-N Switching Transistor

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.

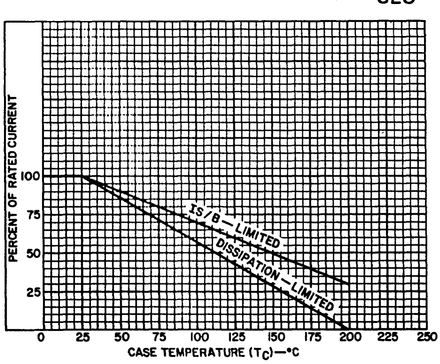


Fig. 1 — Dissipation and $I_{S/b}$ derating curve.

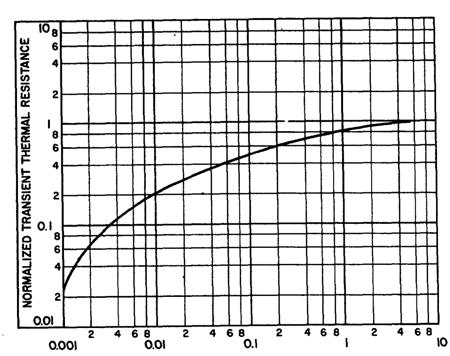


Fig. 2 — Typical thermal-response characteristic.

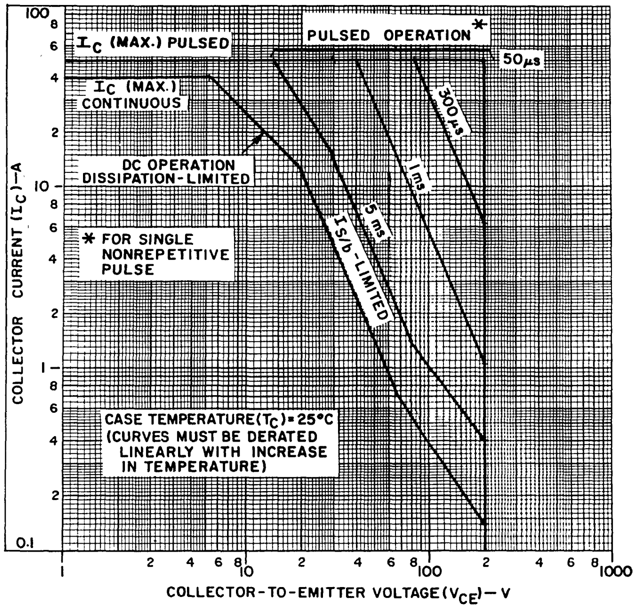


Fig. 3 — Maximum operating areas (T_C = 25° C).

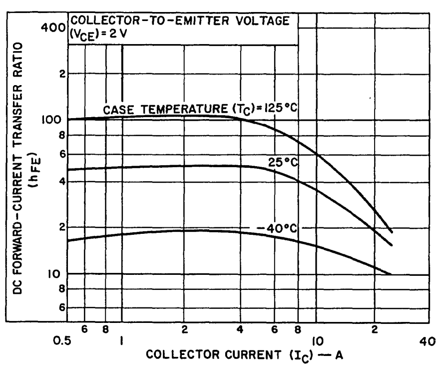


Fig. 4 — Typical dc beta characteristics.

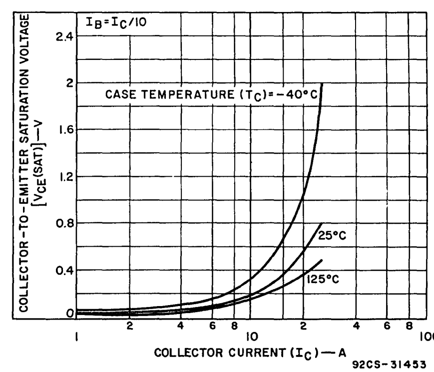


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics.

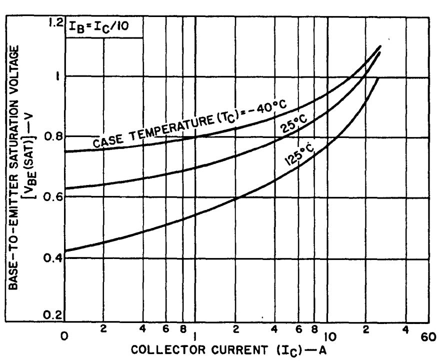


Fig. 6 — Typical base-to-emitter saturation voltage characteristics.

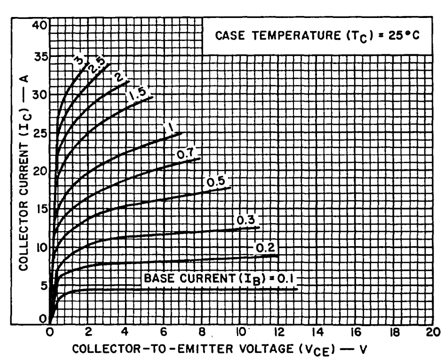


Fig. 7 — Typical output characteristics.

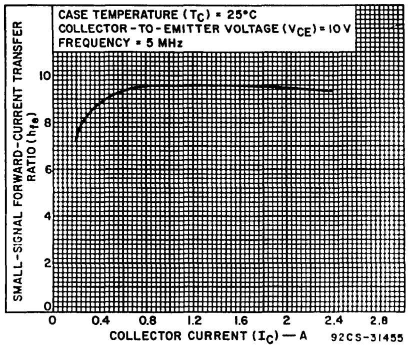


Fig. 8 — Typical small-signal forward-current transfer ratio characteristics.

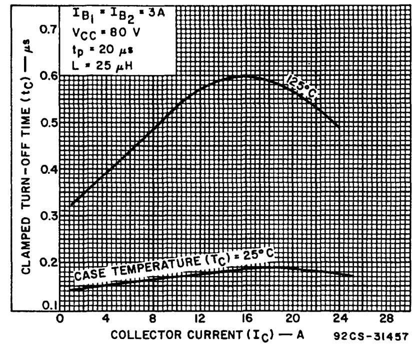


Fig. 9 — Typical clamped turn-off time characteristics.

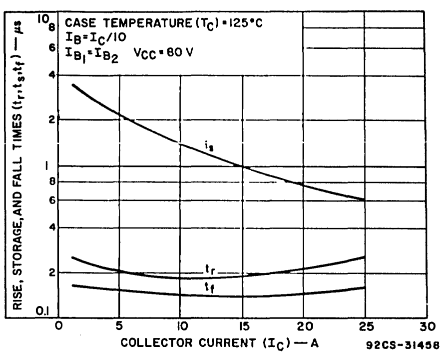


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current.

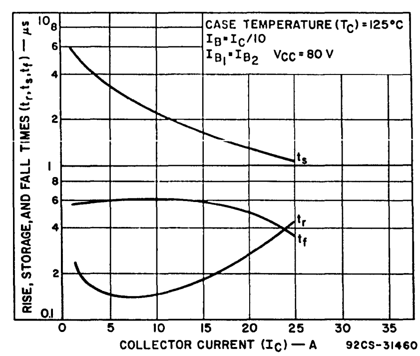


Fig. 11 — Typical-switching-time characteristics at T_C = 125° C as a function of collector current.

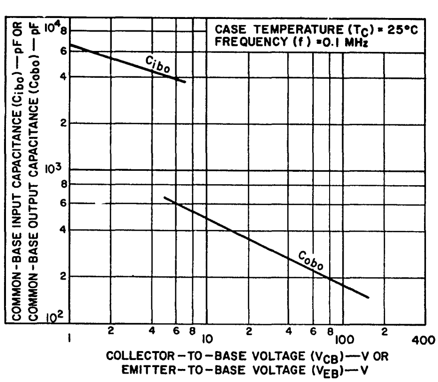


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics.

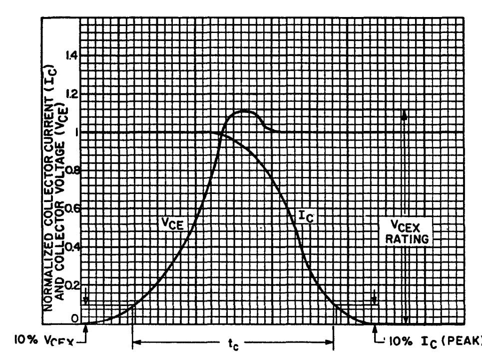


Fig. 13 — Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

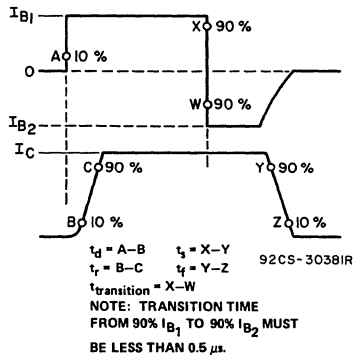


Fig. 14 — Phase relationship between input and output currents showing reference points for specification of switching times.

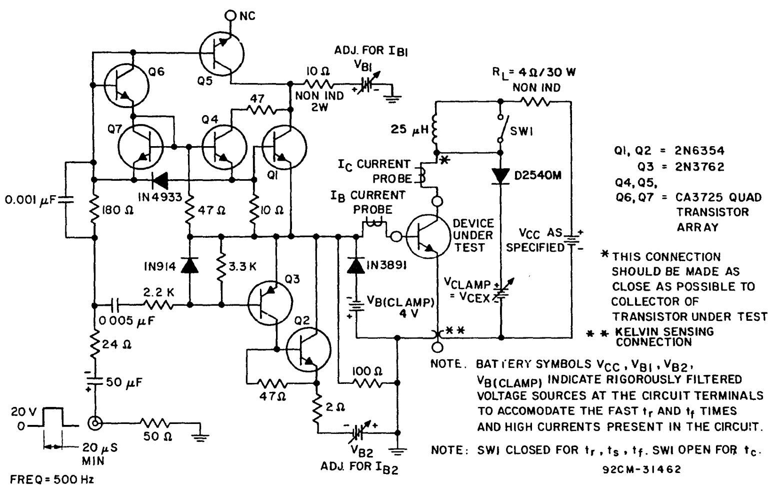


Fig. 15 — Circuit for measuring switching times.

6-A SwitchMax Power Transistors

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

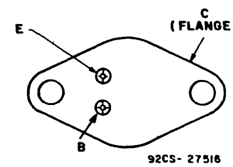
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* V_{CEX} = *450 V — 550 V*
- *Low* V_{CE} *(sat) at* I_C = *6 A*
- *Steel hermetic TO-204AA package*

Applications:

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

TERMINAL DESIGNATIONS



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

The BUX32 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The BUX32-series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX32	BUX32A	BUX32B	
V_{CEV}				
V_{BE}=-1.5 V	800	900	1000	V
V_{CER} $R_{BE} \leq 10\ \Omega$	800	900	1000	V
V_{CEX} (Clamped)				
V_{BE}=-1.5 V	450	500	550	V
V_{CEO}	400	450	500	V
V_{EBO}		8		V
I_C(sat)		6		A
I_C		8		A
I_{CM}		10		A
I_B		4		A
P_T				
T_C up to 25°C		150		W
T_C above 25°C, derate linearly		1.0		W/°C
T_J		-65 to 175		°C
T_{stg}		-65 to 200		°C
T_L				
At distance ≧ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc		CURRENT A dc		LIMITS BUX32		BUX32A		BUX32B		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	—	—	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
$\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
C_{obo} f=0.1 MHz	10[c]				50	250	50	250	50	250	pF
t_d[d]			6	1.2	—	0.1	—	0.1	—	0.1	μs
t_r[d]			6	1.2	—	0.45	—	0.45	—	0.45	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

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_{B1}=-I_{B2}.

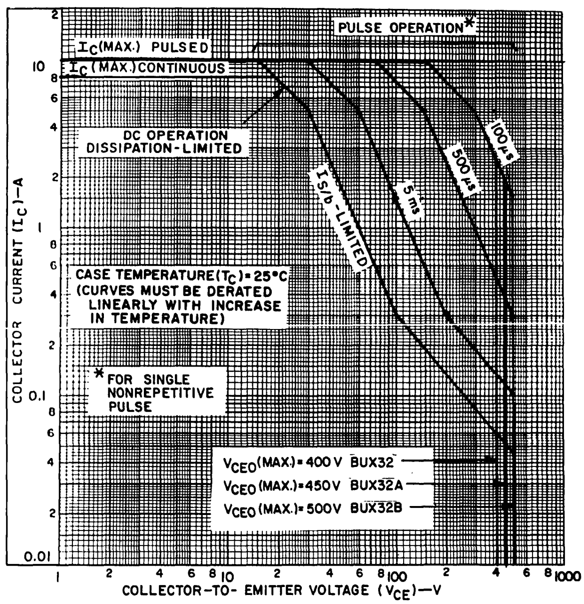


Fig. 1 — Maximum operating areas for all types (T_C).

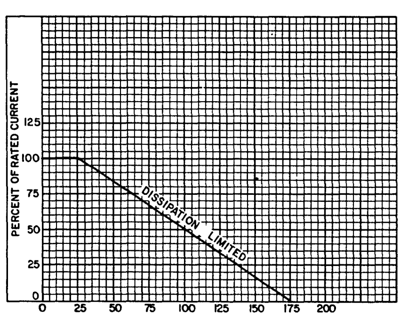


Fig. 2 — Dissipation derating curve for all types.

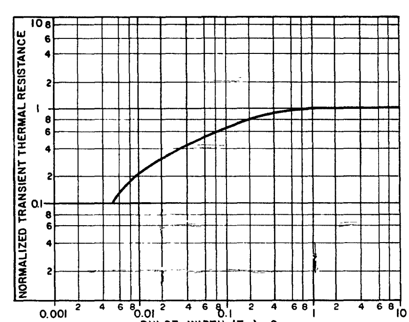


Fig. 3 — Typical thermal-response characteristic for all types.

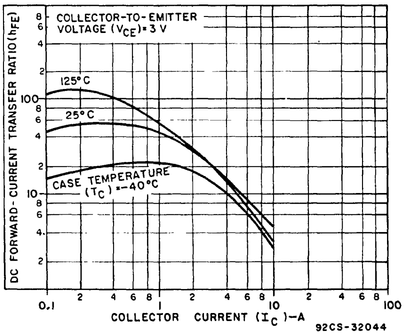


Fig. 4 — Typical dc beta characteristics for all types.

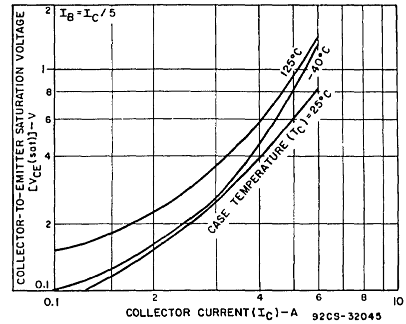


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

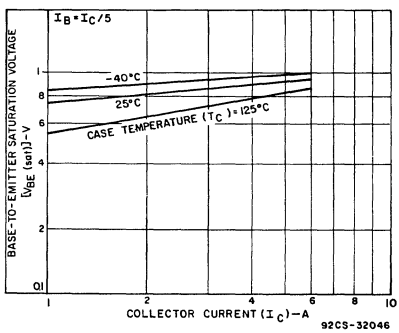


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

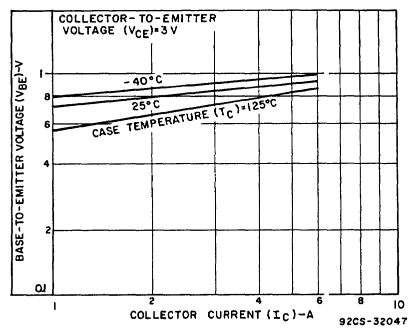


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

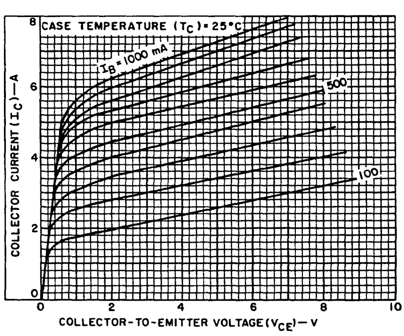


Fig. 8 — Typical output characteristics for all types.

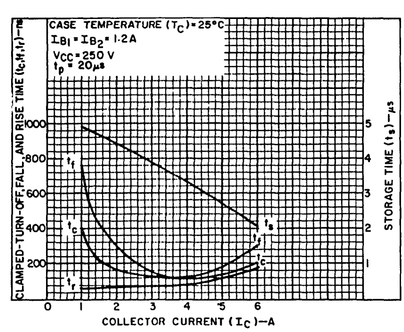


Fig. 9 — Typical saturated switching time characteristics for all types.

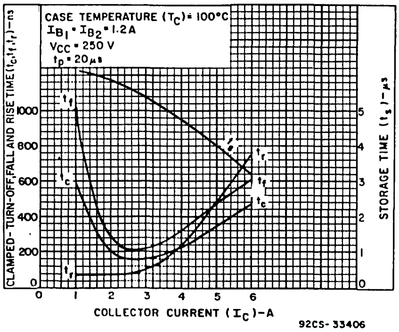


Fig. 10 — Typical saturated switching time characteristics for all types.

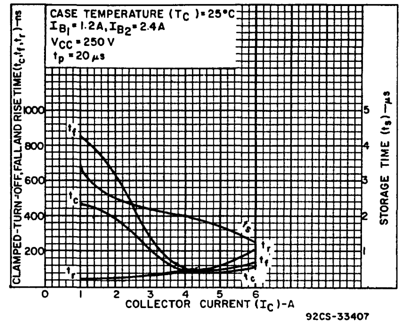


Fig. 11 — Typical saturated switching time characteristics for all types.

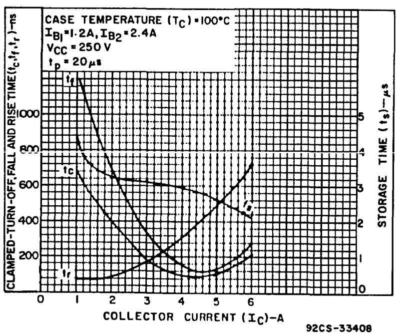


Fig. 12 — Typical saturated switching time characteristics for all types.

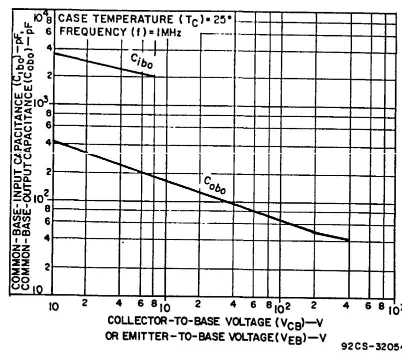


Fig. 13 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

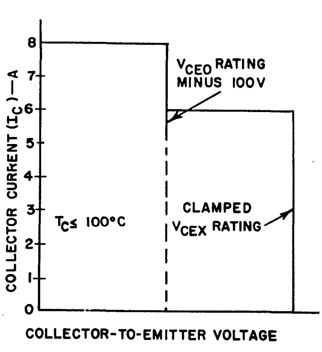


Fig. 14 — Maximum operating conditions for switching between saturation and cutoff.

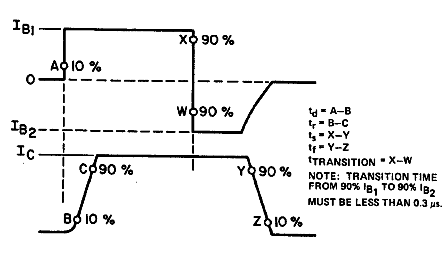


Fig. 15 — Phase relationship between input and output current showing reference points for specification of switching times.

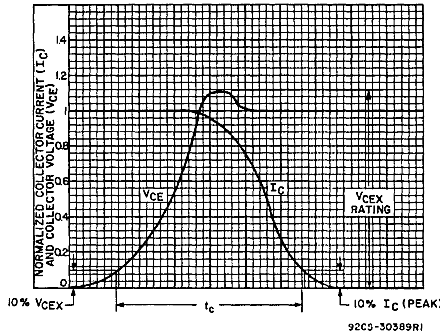


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

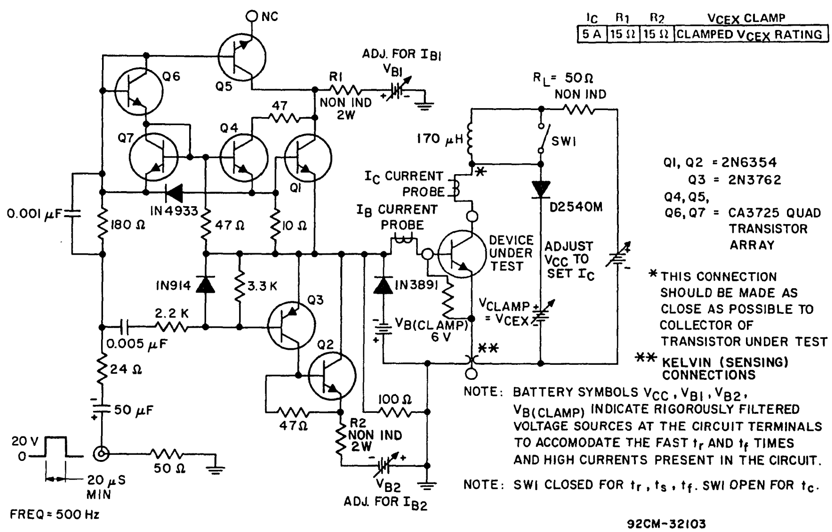


Fig. 17 — Circuit for measuring switching times.

8-A *SwitchMax* Power Transistors

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

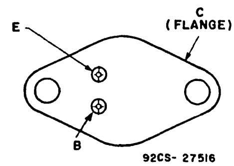
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* *V_{CEX} = 450 V — 550 V*
- *Low V_{CE}(sat) at I_C = 8 A*
- *Steel hermetic TO-204AA package*

Applications:

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

TERMINAL DESIGNATIONS



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

The BUX33 SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for use in off-line power supplies and are also well suited for use in a side range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The BUX33-series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUX33	BUX33A	BUX33B	
V_{CEV}				
V_{BE} = 1.5 V	800	900	1000	V
V_{CER} $R_{BE} \leq 10\ \Omega$	800	900	1000	V
V_{CEX} (Clamped)				
V_{BE} = −1.5 V	450	500	550	V
V_{CEO}	400	450	500	V
V_{EBO}		8		V
I_C(sat)		8		A
I_C		12		A
I_{CM}		15		A
I_B		4		A
P_T				
T_C up to 25°C		150		W
T_C above 25°C, derate linearly		1.0		W/°C
T_J		−65 to 175		°C
T_{stg}		−65 to 200		°C
T_L				
At distance ≧ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

BUX33. BUX33A. BUX33B

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	LIMITS BUX33 Min.	Max.	BUX33A Min.	Max.	BUX33B Min.	Max.	UNITS
T_C = 25° C											
I_{CEV}	800	−1.5			—	0.1	—	—	—	—	mA
	900	−1.5			—	—	—	0.1	—	—	
	1000	−1.5			—	—	—	—	—	0.1	
I_{CER} $R_{BE} \leq 10\ \Omega$	800				—	0.2	—	—	—	—	
	900				—	—	—	0.2	—	—	
	1000				—	—	—	—	—	0.2	
I_{EBO}		−8	0		—	2	—	2	—	2	
$V_{CEO}(sus)$[b]			0.2[a]	0	400	—	450	—	500	—	V
h_{FE}	3		8		6	40	6	40	6	40	
$V_{BE}(sat)$			8	2	—	1.3	—	1.3	—	1.3	V
$V_{CE}(sat)$			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
$\|h_{fe}\|$ f = 5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
C_{obo} f = 0.1 MHz	10[c]				50	250	50	250	50	250	pF
t_d[d]			8	2	—	0.1	—	0.1	—	0.1	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]$I_{B1} = -I_{B2}$.

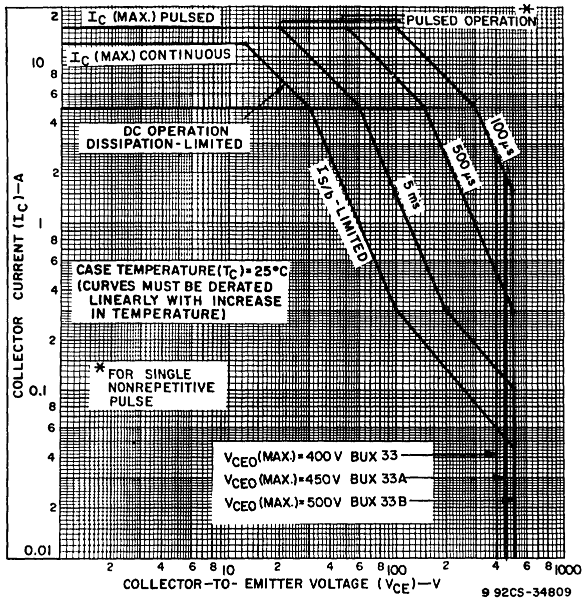


Fig. 1 — Maximum operating areas for all types (T_C).

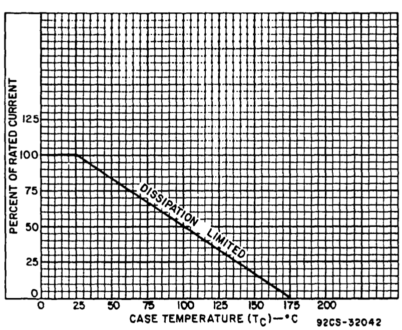


Fig. 2 — Dissipation derating curve for all types.

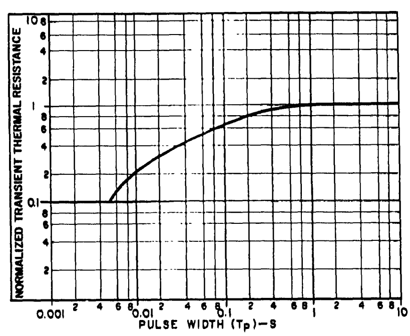


Fig. 3 — Typical thermal-response characteristic for all types.

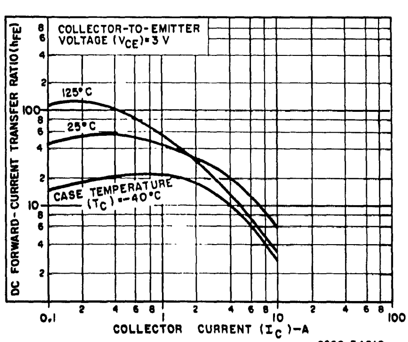


Fig. 4 — Typical dc beta characteristics for all types.

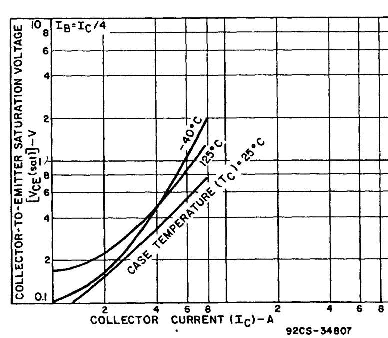


Fig. 5 — Typical collector-to-emitter saturation voltage for all types.

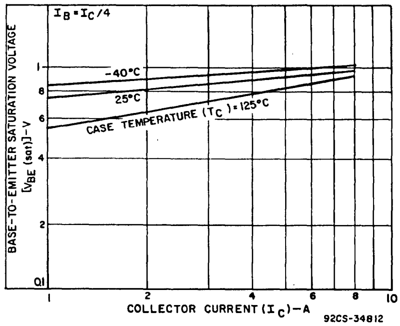


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

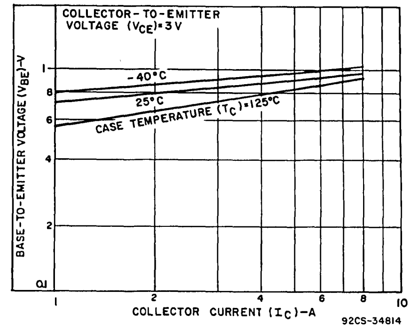


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

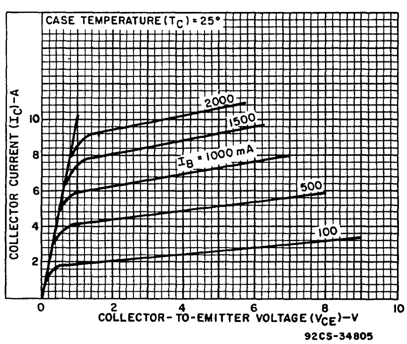


Fig. 8 — Typical output characteristics for all types.

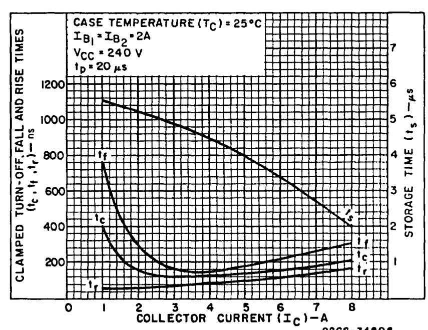


Fig. 9 — Typical saturated switching time characteristics for all types.

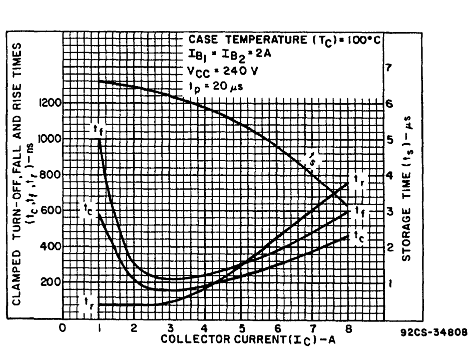


Fig. 10 — Typical saturated switching time characterics for all types.

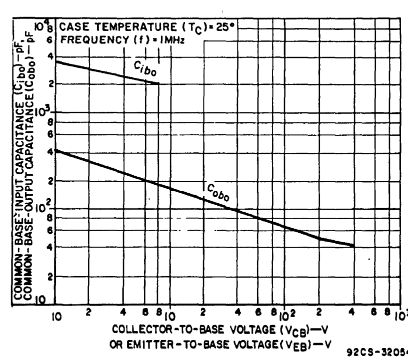


Fig. 11 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

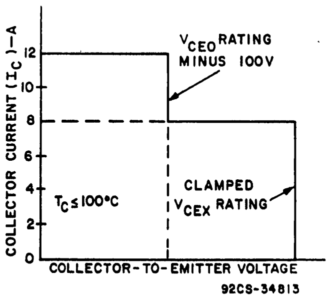


Fig. 12 — Maximum operating conditions for switching between saturation and cutoff.

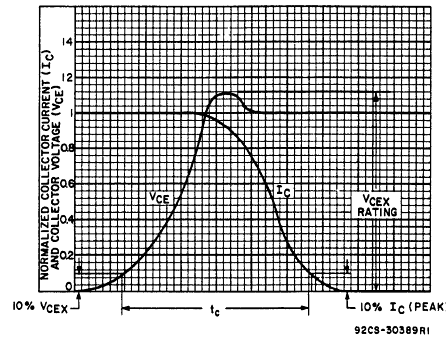


Fig. 13 — Oscilloscope display for measurement of clamped induction switching time (t_c).

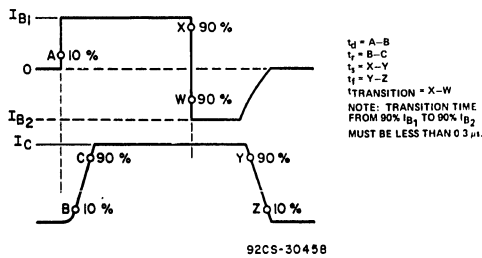


Fig. 14 — Phase relationship between input and output current showing reference points for specification of switching times.

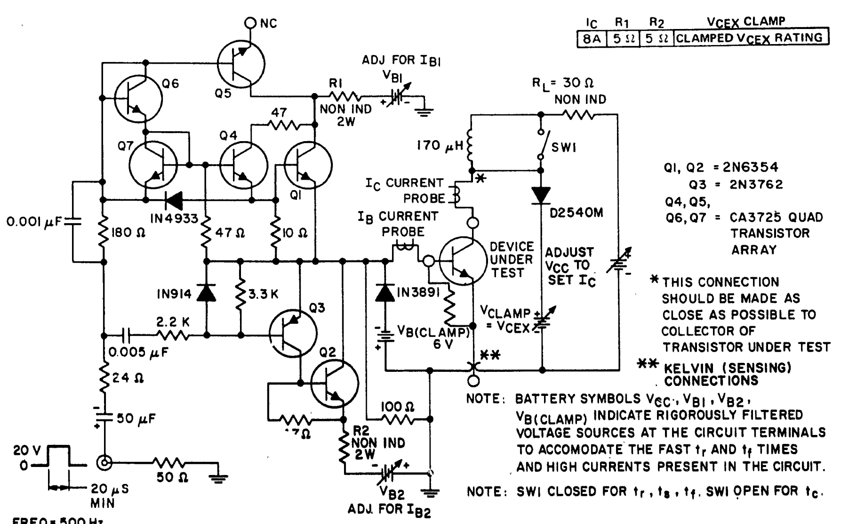


Fig. 15 — Circuit for measuring switching times.

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

For Switching and Amplifier Applications in Industrial and Commercial Service

Features:

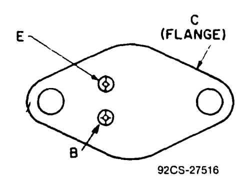
- *Maximum area-of-operation curves for dc and pulse operation - $I_{S/b}$ limit begins at 25 V*
- *Fast turn-on time - 1 μs at I_C = 15 A*
- *High-current capability - h_{FE}, $V_{CE}(sat)$, $V_{BE}(sat)$ measured at I_C = 10 A*

The RCA BUX39 is an epitaxial silicon n-p-n planar transistor that has high current and high power handling capability and fast switching speed.

This device is especially suitable for switching-control amplifiers, power gates, switching regulators, power-switching circuits converters, inverters, control circuits. Other recommended applications include dc-rf amplifiers, and power oscillators.

The BUX39 is supplied in a steel JEDEC TO-204AA hermetic package.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values:*

V_{CBO}	120 V
V_{CEX}	
V_{BE} = -1.5 V	120 V
V_{CER}	
R_{BE} = 100 Ω	110 V
$V_{CEO}(sus)$	90 V
V_{EBO}	7 V
I_C	30 A
I_{CM}	40 A
I_B	6 A
P_T	
$T_C \leq 25°C$	120 W
$T_C \geq 25°C$, derate linearly	0.68 W/°C
T_{stg}, T_J	-65 to 100°C
T_L	
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.	230°C

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: Min.	Typ.	Max.	UNITS
I_{CEO}	70				—	—	1	mA
I_{CEX}	120	−1.5			—	—	1	mA
T_C = 125 °C	120	−1.5			—	—	5	mA
I_{EBO}		−5	0		—	—	1	mA
$V_{CEO}(sus)$[a] L = 25 mH			0.2[b]	0	90	—	—	V
$V_{(BR)EBO}$ I_E = 50 mA			0		7	—	—	V
h_{FE}	4 4		12[b] 20[b]		15 8	— —	45 —	
$V_{BE(sat)}$			20[b]	2.5	—	2.1	2.5	V
$V_{CE(sat)}$			12[b] 20[b]	1.2 2.5	— —	0.7 1.25	1.2 1.6	V
$I_{S/b}$ t = 1 s	45 30				1 4	— —	— —	A
f_T	15		1		8	—	—	MHz
t_{ON} $t_d + t_r$	V_{CC} = 30 V		20	2.5	—	0.8	1.5	μS
t_s			20	2.5[c]	—	0.55	1	μS
t_f			20	2.5[c]		0.15	0.3	μS
$R_{\theta JC}$					—	—	1.46	°C/W

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

b Pulsed; pulse duration ≤ 300 μS, duty factor ≤ 2%.

c $I_{B_1} = -I_{B_2}$.

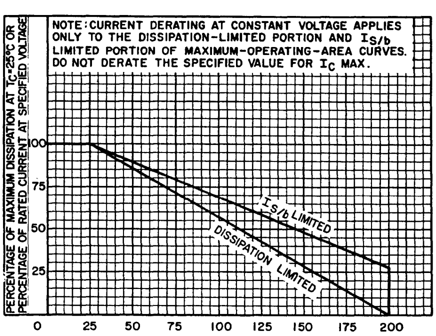


Fig. 1 - Derating curves.

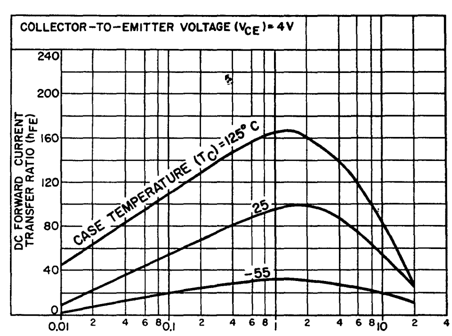


Fig. 2 - Typical DC beta characteristics.

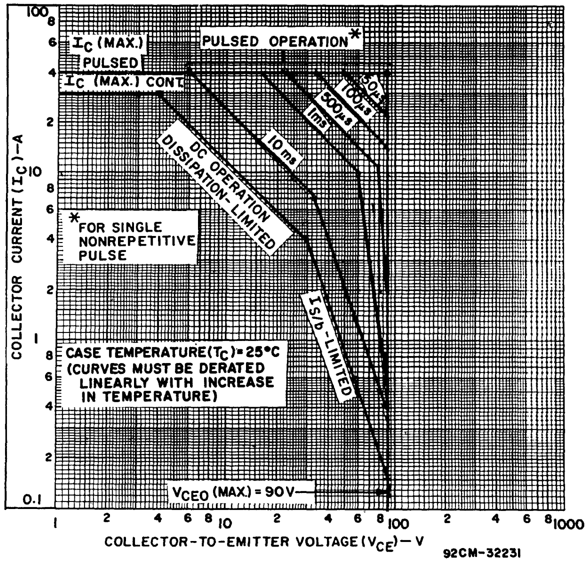


Fig. 3 - Maximum operating areas.

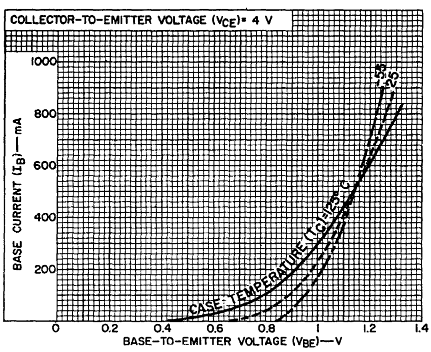


Fig. 4 - Typical input characteristics.

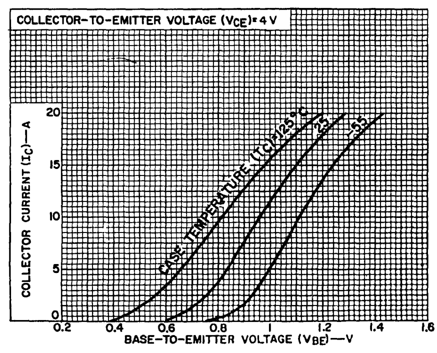


Fig. 5 - Typical transfor characteristics.

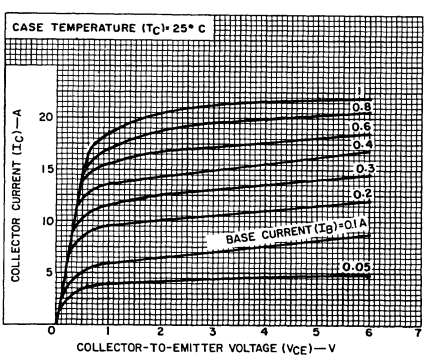


Fig. 6 - Typical output characteristics.

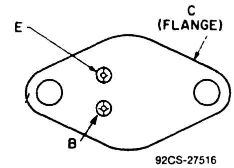
High Voltage Silicon P-N-P Transistors

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

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 BUX66 Min.	BUX66 Max.	BUX66A Min.	BUX66A Max.	UNITS
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.

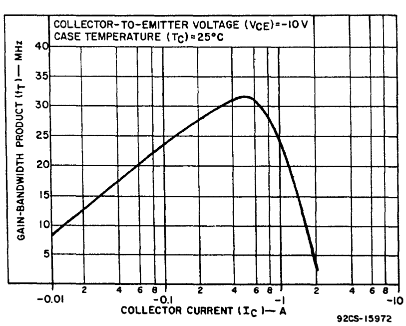


Fig.1 — Typical gain-bandwidth product for all types.

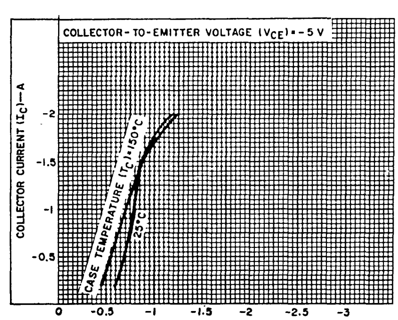


Fig.2 — Typical transfer characteristics for all types.

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

CHARACTERISTIC SYMBOL	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		BUX66B		BUX66C		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEO}	−150			0	–	−5	–	−5	
I_{CEX}	−350	1.5			–	−8	–	–	
	−400	1.5			–	–	–	−8	mA
T_C = 100°C	−350	1.5			–	−10	–	–	
	−400	1.5			–	–	–	−10	
I_{EBO}		6	0		–	−1	–	−1	mA
h_{FE}	−5		−1[a]		10	150	10	150	
V_{CEO}(sus)			−0.2[a]	0	−300[c]	–	−350[c]	–	
V_{CER}(sus) R_{BE} = 50 Ω			−0.2		−325[c]	–	−375[c]	–	V
V_{BE}(sat)			−1[a]	−0.15	–	−1.5	–	−1.5	V
V_{CE}(sat)			−1[a]	−0.15	–	−2.5	–	−2.5	V
C_{obo} V_{CB} = 10 V f = 1 MHz					–	220	–	220	pF
$I_{S/b}$ t = 1 s, nonrep.	−40				−875	–	−875	–	mA
$\lvert h_{fe} \rvert$ f = 5 MHz	−10		−0.2		4	–	4	–	
t_r V_{CC} = −200 V			−1	−0.10[b]	–	0.6	–	0.6	
t_s V_{CC} = −200 V			−1	−0.10[b]	–	2.5	–	2.5	μs
t_f V_{CC} = −200 V			−1	−0.10[b]	–	0.6	–	0.6	
$R_{\theta JC}$					–	5	–	5	°C/W

a Pulsed: Pulse duration = 300 μs; duty factor ⩽ 2%. b $I_{B1} = I_{B2}$

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

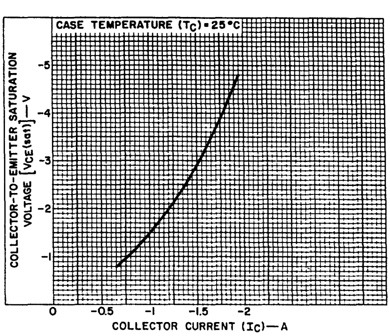


Fig.3 — Typical saturation-voltage characteristic for all types.

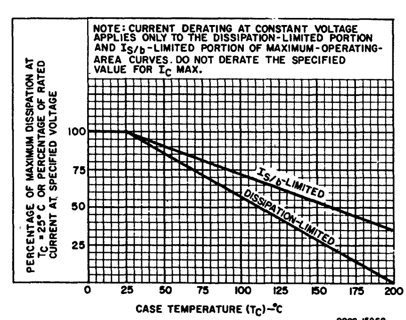


Fig. 4 — Derating curve for all types.

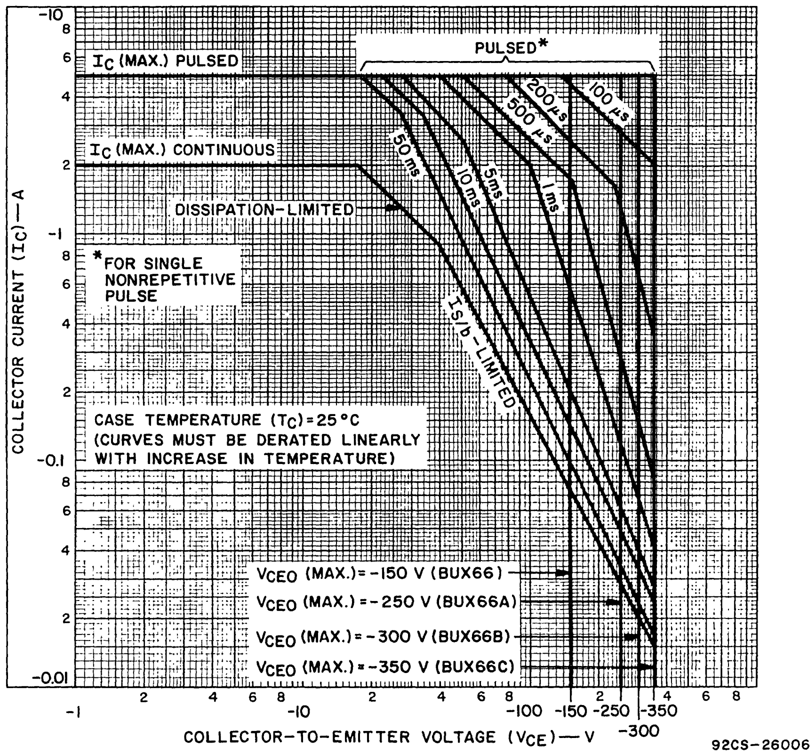


Fig.5 — Maximum operating areas for all types.

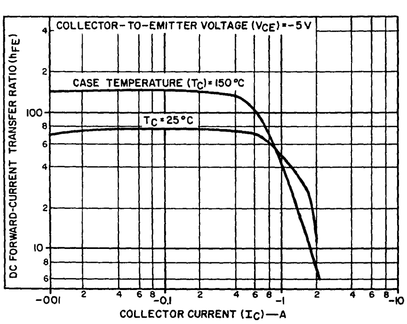


Fig. 6 — Typical dc beta characteristics for all types.

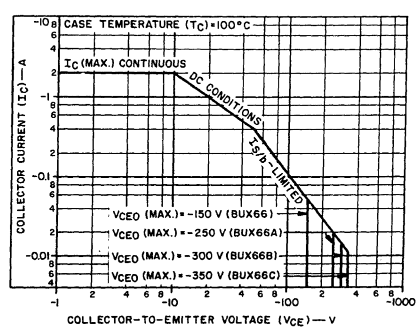


Fig. 7 — Maximum operating areas for all types at T_C = 100° C.

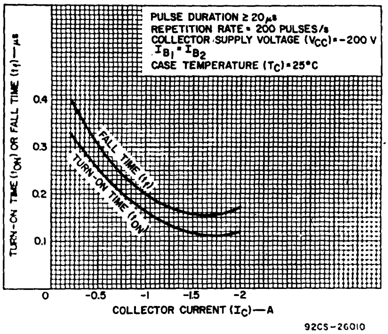


Fig. 8 — Typical turn-on time and fall-time characteristics for all types.

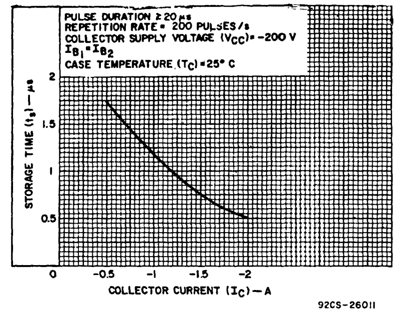


Fig. 9 — Typical storage-time characteristic for all types.

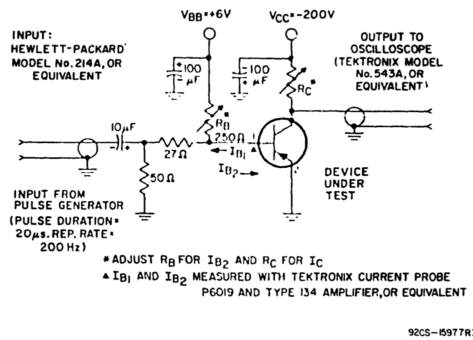


Fig. 10 — Circuit used to measure saturated switching times for all types.

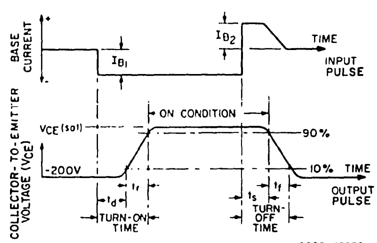


Fig. 11 — Phase relationship between input current and output voltage showing reference points for specification of switching times.

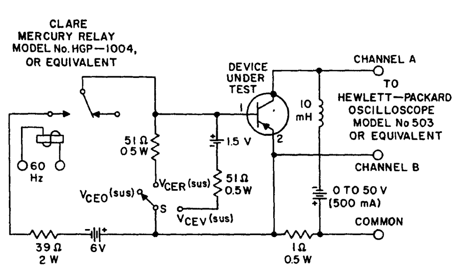
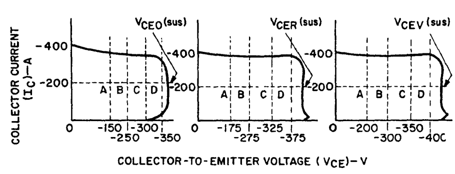


Fig. 12 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEV}(sus)$ for all types.



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.

High Voltage Silicon N-P-N Power Transistors

For Horizontal-Deflection Circuits and Other High-Voltage Switching Applications

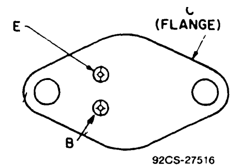
Features:

- *Fast Switching Speed*
- *High Voltage Ratings: V_{CEX} = 500-1000V*

Applications:

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-BUY69 series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, together with high safe-operating-area (SOA) ratings.

They are intended for horizontal-deflection circuit application in black and white television, CRT's, off-line power supplies and a wide range of inverter or converter circuits and pulse-width-modulated regulators.

The RCA-BUY69 series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	BUY69A	BUY69B	BUY69C	
V_{CBO}	1000	800	500	V
V_{CEO}	400	325	200	V
V_{CEX}				
V_{BE} = -2 V	1000	800	500	V
V_{EBO}		8		V
I_C		10		A
I_{CM}(tp = 500 μs)		15		A
I_B		3		A
P_T				
T_C = 25°C		100		W
T_J		200		°C
T_{stg}		-65 to 200		°C
T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	CURRENT A dc I_B	LIMITS BUY69A Min.	BUY69A Max.	BUY69B Min.	BUY69B Max.	BUY69C Min.	BUY69C Max.	UNITS
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.

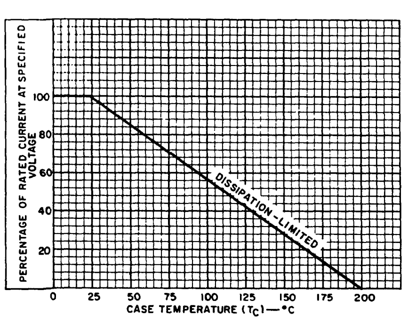


Fig. 1 — Dissipation derating curve for all types.

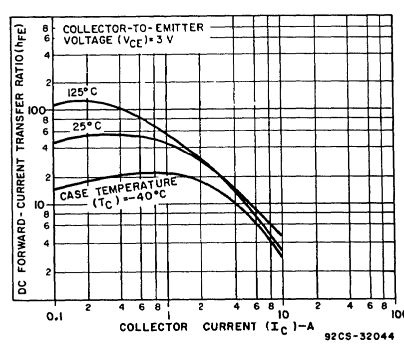


Fig. 2 — Typical dc beta characteristics for all types.

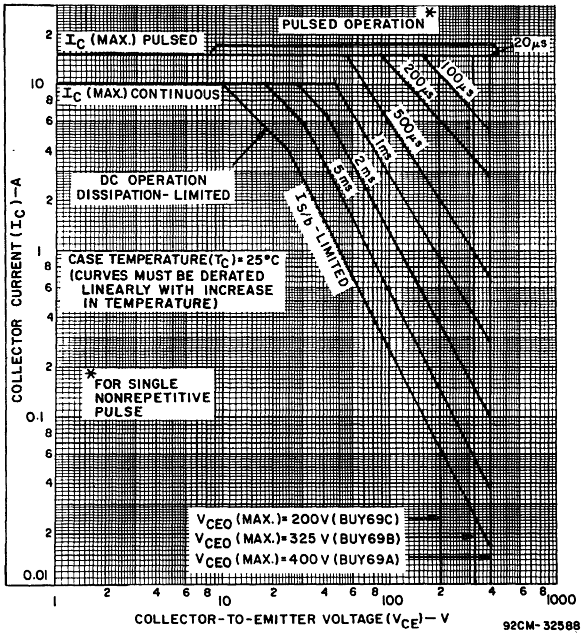


Fig. 3 — Maximum operating areas for all types (T_C =25° C).

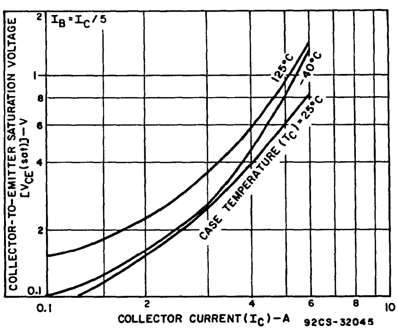


Fig. 5 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

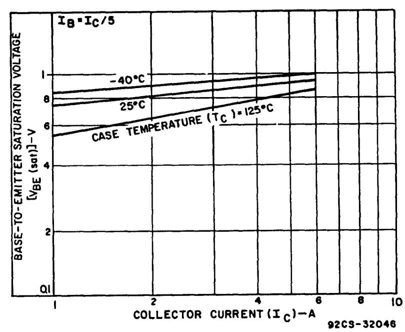


Fig. 4 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

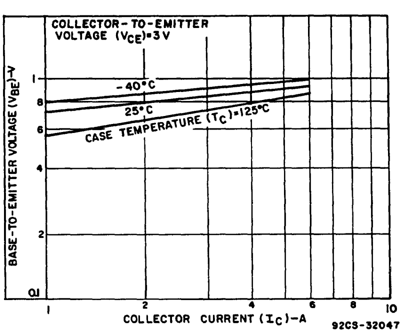


Fig. 6 — Typical base-to-emitter voltage as a function of collector current for all types.

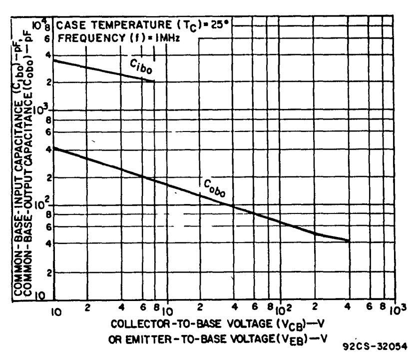


Fig. 7 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

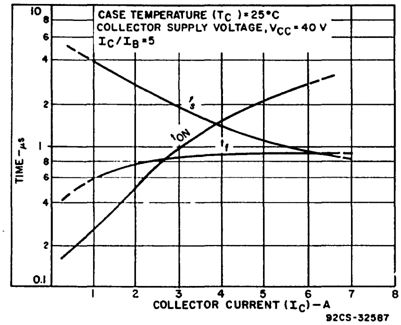


Fig. 8 — Typical switching-time characteristics as a function of collector current.

0.5-Ampere N-P-N Darlington Power Transistors

h_{FE} Min. — 10,000
1.33 Watt power dissipation at T_A = 25°

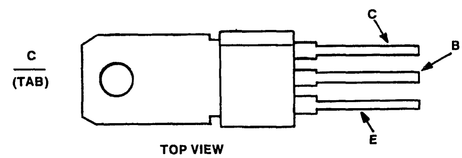
Features:
- *Operates from IC without predriver*

Application:
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*

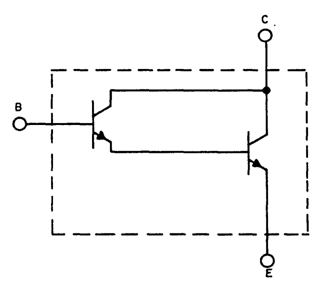
The D40C-series silicon n-p-n Darlington power transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-202AB



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%.

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 D40C4 D40C7	V_{CEO}	30 40 50	— — —	— — —	Volts
Collector Cut-off Current (V_{CE} = Rated V_{CES})	(T_C = 25°C) (T_C = 150°C)	I_{CES} I_{CBO}	— —	— —	0.5 20	μA
Emitter Cutoff Current (V_{EB} = 13V)		I_{EBO}	—	—	0.1	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 2			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 200mA, V_{CE} = 5V)		h_{FE}	10K	—	60K	
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 0.5mA)		$V_{CE(sat)}$	—	—	1.5	V
Base-Emitter Saturation Voltage (I_C = 500mA, I_B = 0.5mA)		$V_{BE(sat)}$	—	—	2.0	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1MHz)		C_{CBO}	—	—	220	pF
Current Gain - Bandwidth Product (I_C = 20mA, V_{CE} = 5V)		f_T	—	75	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 1mA V_{CC} = 30V, t_p = 25 μsec	$t_d + t_r$	—	100	—	ns
Storage Time		t_s	—	350	—	
Fall Time		t_f	—	800	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

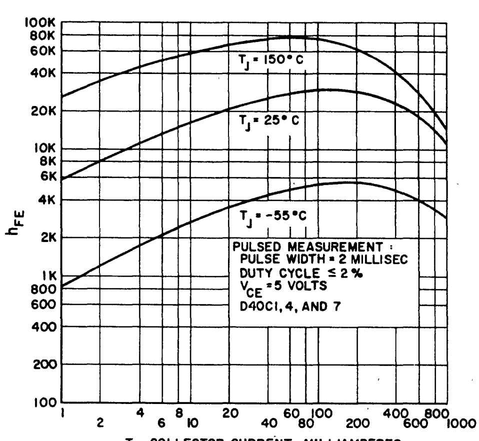


FIG 1. TYPICAL h_{FE} vs. I_C

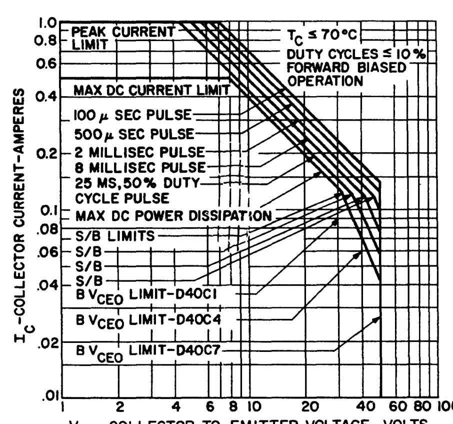


FIG. 2 SAFE REGION OF OPERATION

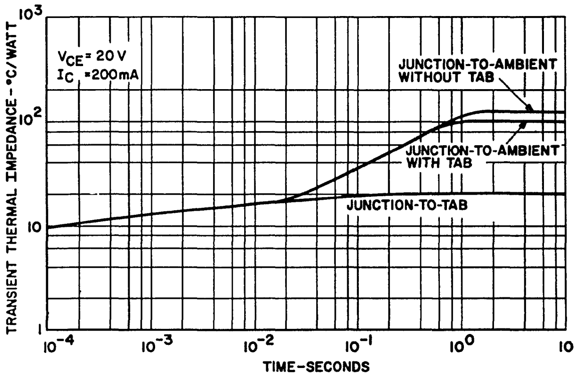


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

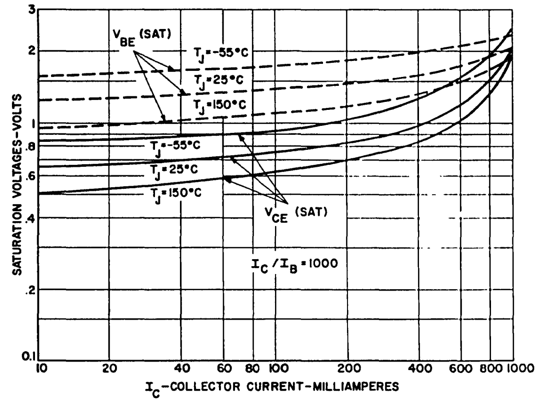


FIG. 4 TYPICAL SATURATION VOLTAGES

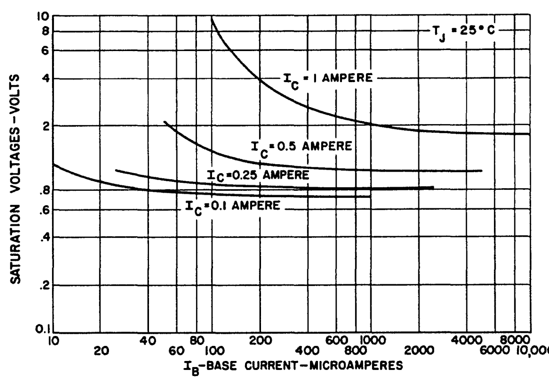


FIG. 5 TYPICAL SATURATION VOLTAGES

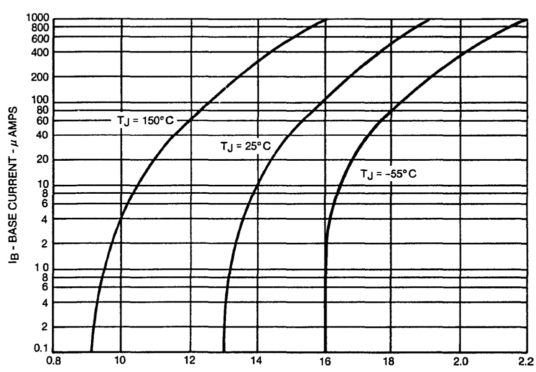


FIG. 6 TYPICAL INPUT CHARACTERISTICS

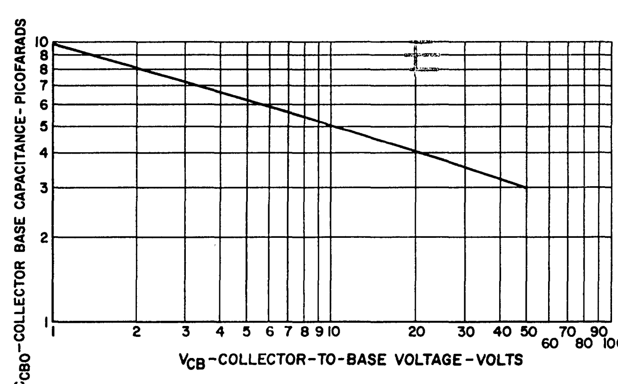


FIG. 7 TYPICAL C_{CBO} vs. VOLTAGE

2

POWER TRANSISTORS

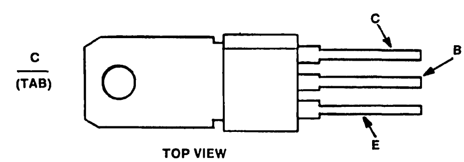
1-Ampere Silicon N-P-N Power Transistors

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%.

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 D40D4, 5 D40D7, 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	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 4			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 100mA, V_{CE} = 2V)	D40D1, 4, 7 D40D2, 5, 8	h_{FE}	50 120	— —	150 360	—
(I_C = 1A, V_{CE} = 2V)	D40D1, 4, 7 D40D2 D40D5, 8	h_{FE}	10 20 10	— — —	— — —	—
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)	D40D1, 2, 4, 5 D40D7, 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 = 1M_{Hz})		C_{CBO}	—	8	—	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 10V)		f_T	—	200	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A	$t_d + t_r$	—	25	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	200	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

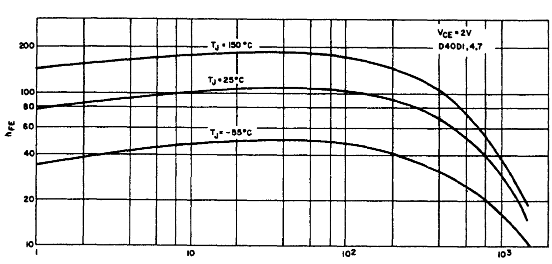


FIG. 1

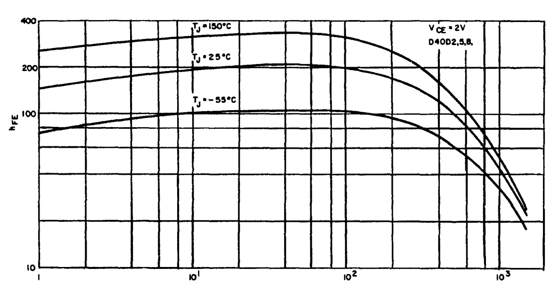


FIG. 2

TYPICAL H_{FE} VS I_C

2-509

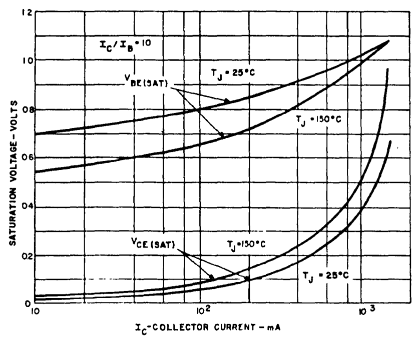


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

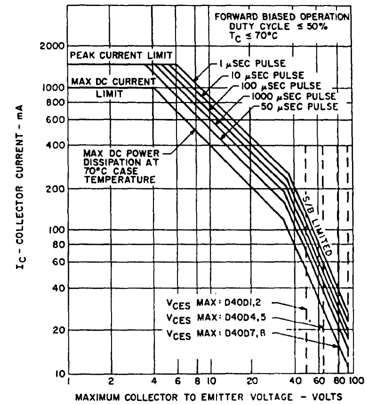


FIG. 4 SAFE REGION OF OPERATION

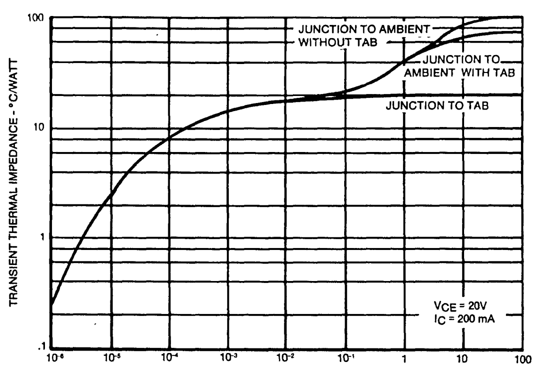


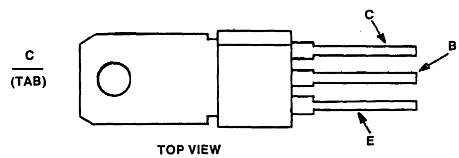
FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

2-Ampere Silicon N-P-N Power Transistors

Complementary to the D41E Series

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%.

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 = 1MHz)		C_{CBO}	—	9	—	pF
Current-Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V)		f_T	—	230	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A	$t_d + t_r$	—	130	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	400	—	
Fall Time		t_f	—	170	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

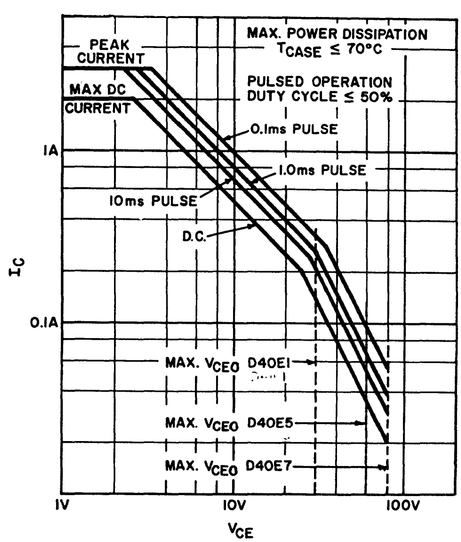


FIG. 1 SAFE REGION OF OPERATION

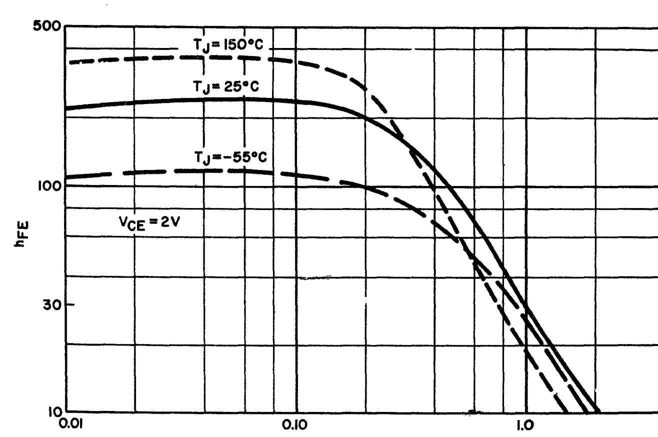


FIG. 2 TYPICAL H_{FE} VS I_C

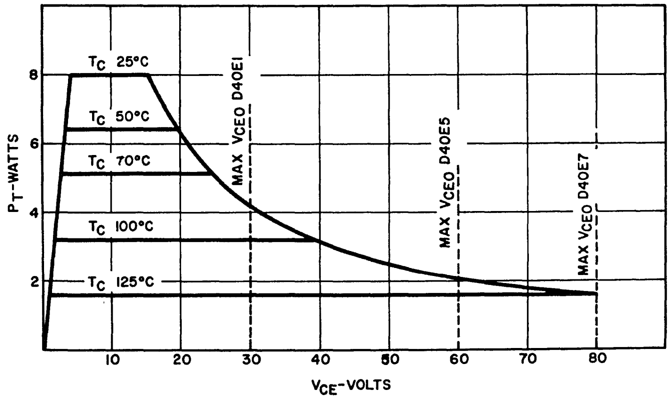


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

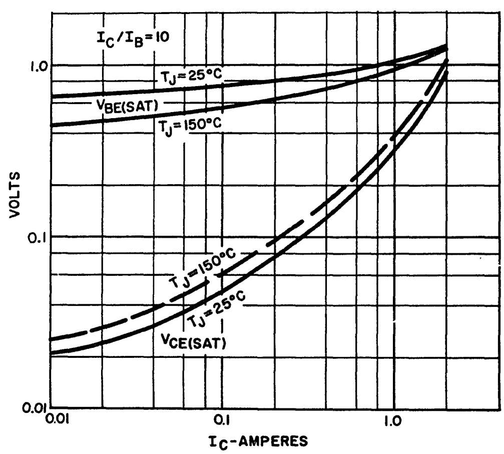


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

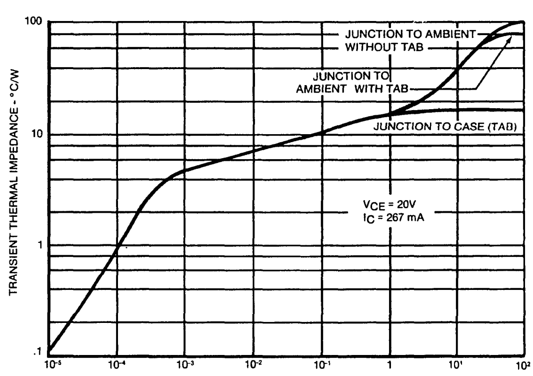


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

POWER TRANSISTORS 2

2-Ampere N-P-N Darlington Power Transistors

Complementary to the D41K Series

Features:

- Operates from IC without predriver

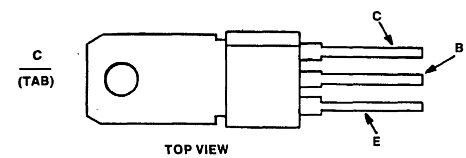
Applications:

- Switching regulator
- Lamp driver
- Touch switch
- Solenoid driver

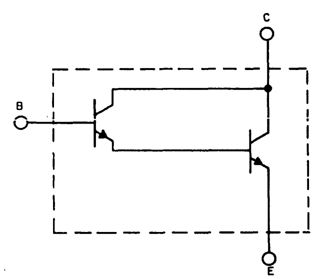
The D40K-series of silicon n-p-n Darlington power transistors are designed for use in general purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

These devices are supplied in the JEDEC TO-202AB plastic package.

TERMINAL DESIGNATIONS



JEDEC TO-202AB



Schematic diagram for all types.

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

RATING	SYMBOL	D40K1,3	D40K2,4	UNITS
Collector-Emitter Voltage	V_{CEO}	30	50	Volts
Collector-Emitter Voltage	V_{CES}	30	50	Volts
Emitter Base Voltage	V_{EBO}	13	13	Volts
Collector Current — Continuous 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%.

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)	D40K1,3 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) (I_C = 1A, V_{CE} = 5V)	D40K1,2 D40K3,4	h_{FE}	1K 1K	— —	— —	— —
Collector-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA) (I_C = 1A, 1_B = 2mA)	D40K1,2 D40K3,4	$V_{CE(sat)}$	— —	— —	1.5 1.5	V V
Base-Emitter Saturation Voltage (I_C = 1.5A, I_B = 3mA) (I_C = 1A, I_B = 2mA)	D40K1,2 D40K3,4	$V_{BE(sat)}$	— —	— —	2.5 2.5	V
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%.

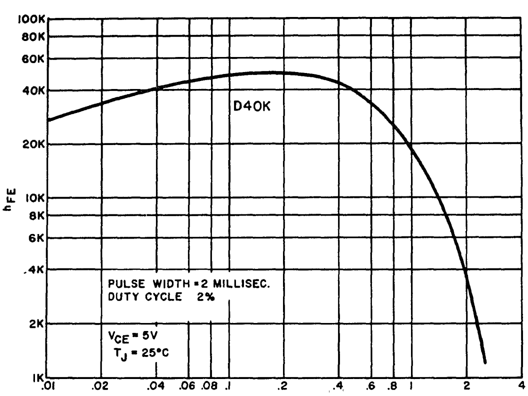


FIG. 1 TYPICAL h_{FE} vs. I_C

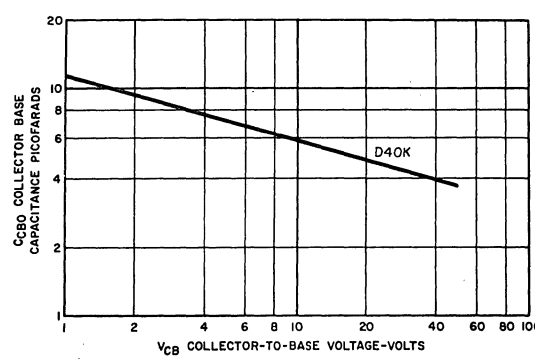
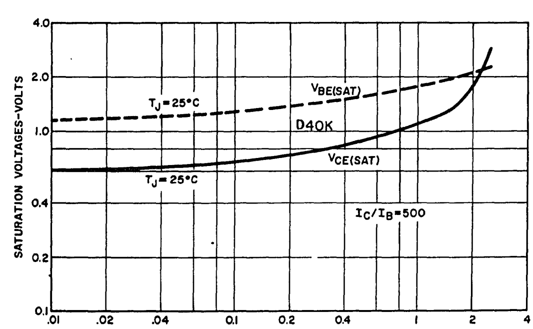


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

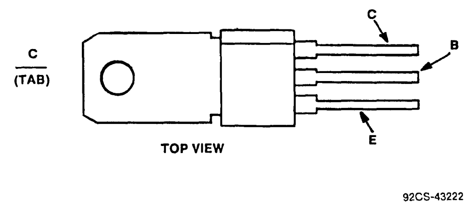
FIG. 3 TYPICAL SATURATION VOLTAGE



Silicon N-P-N Power Transistors

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

TERMINAL DESIGNATIONS



JEDEC TO-202AB

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.

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

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%.

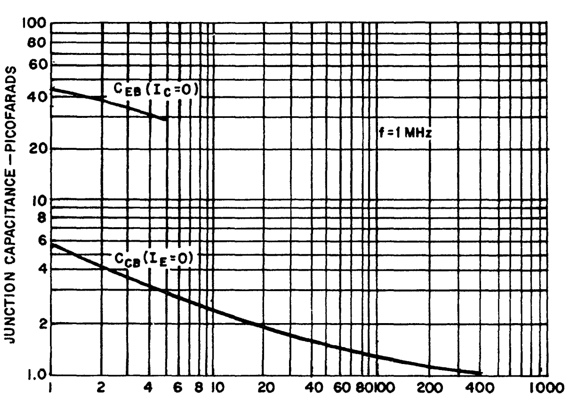


FIG. 1 JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

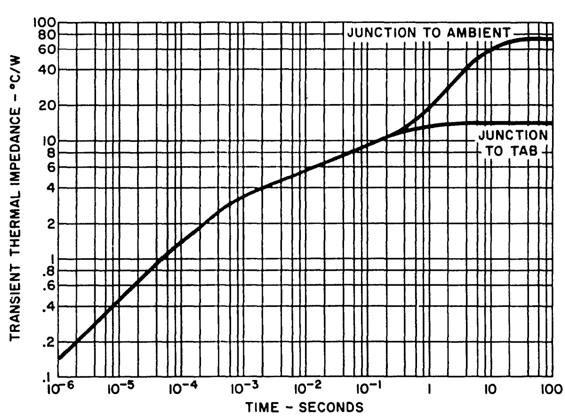


FIG. 2 MAXIMUM TRANSIENT THERMAL IMPEDANCE

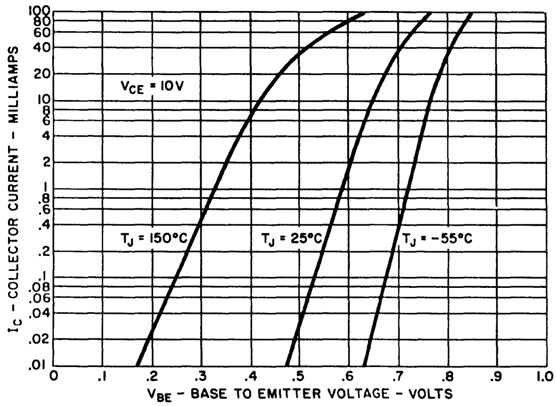


FIG. 3 TYPICAL TRANCONDUCTANCE CHARACTERISTICS

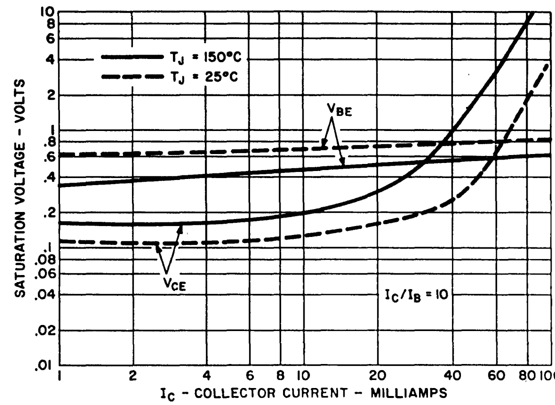


FIG. 4 TYPICAL SATURATION VOLTAGES

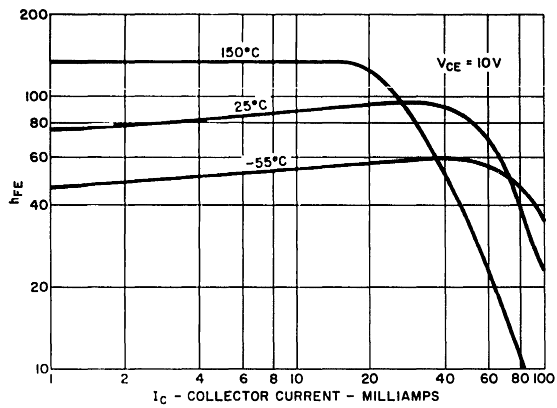


FIG. 5 TYPICAL h_{FE} VS. I_C

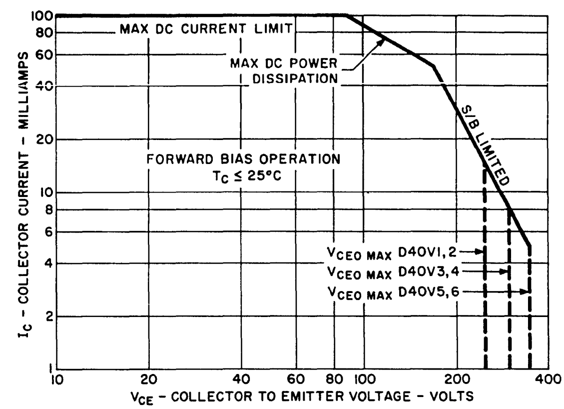


FIG. 6 SAFE REGION OF OPERATION

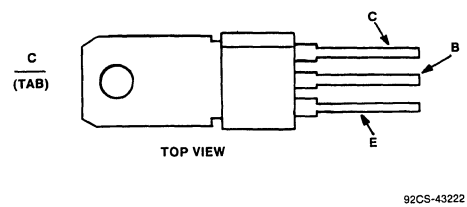
1-Ampere Silicon P-N-P Power Transistors

Complementary to the D40D Series

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -1A I_C).
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



JEDEC TO-202AB

The D41D-series of silicon p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

MAXIMUM RATINGS (T_A = 25° 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%.

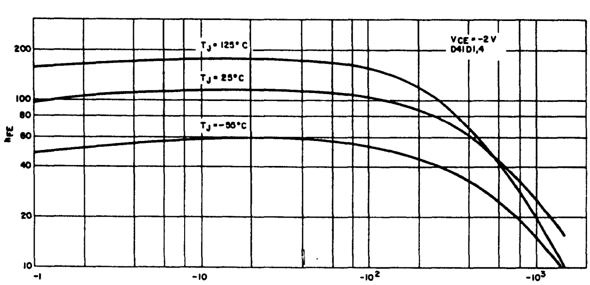


FIG. 1

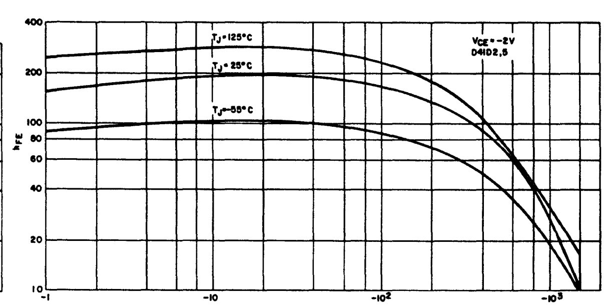


FIG. 2

TYPICAL h_{FE} VS. I_C

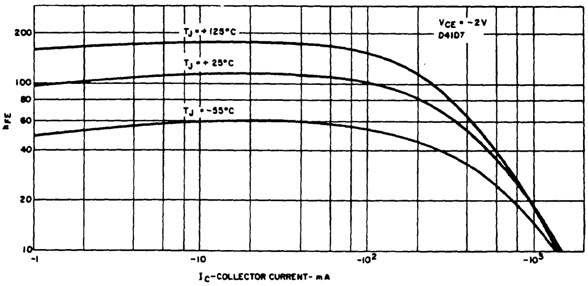


FIG. 3

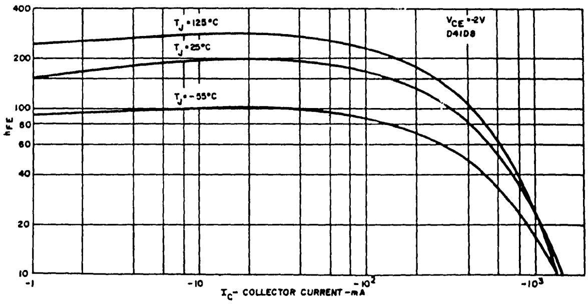


FIG. 4

TYPICAL h_{FE} VS. I_C

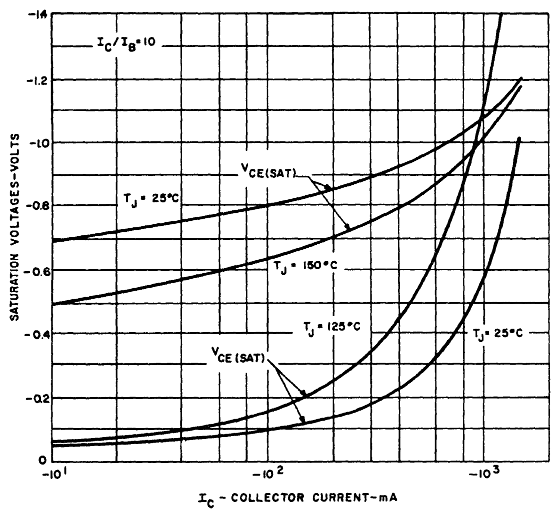


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

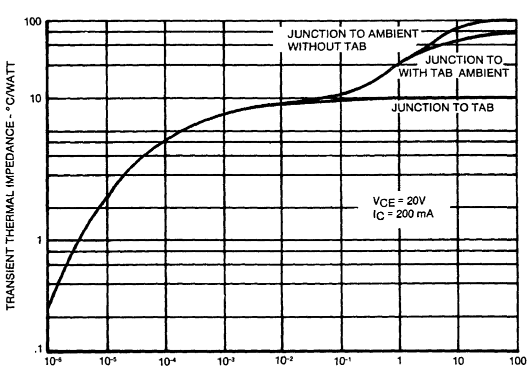


FIG. 6 MAXIMUM TRANSIENT THERMAL IMPEDANCE

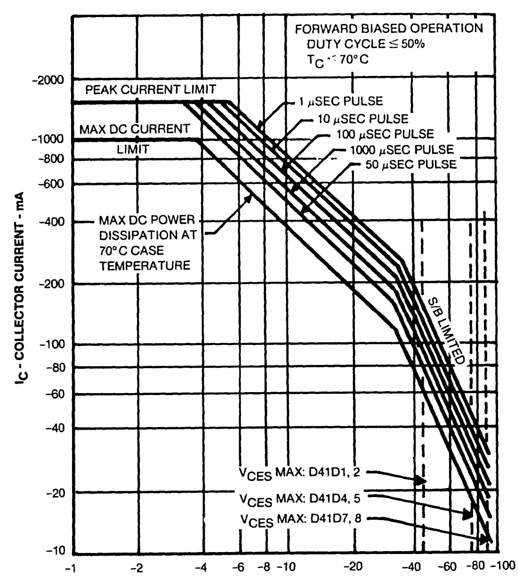


FIG. 7 SAFE REGION OF OPERATION

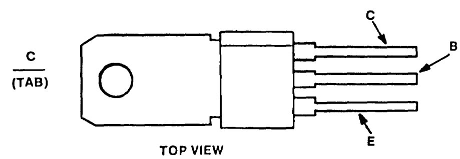
2-Ampere Silicon P-N-P Power Transistors

Complementary to the D40E Series

Features:

- High free-air power dissipation
- Low collector saturation voltage (−0.5V typ. @ -1A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



92CS-43222

JEDEC TO-202AB

The D41E-series of silicon p-n-p power transistors are designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1 MHz; series, shunt and switching regulators; and low and high frequency inverters/converters.

These devices are supplied in the JEDEC TO-202AB plastic package.

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

RATING	SYMBOL	D41E1	D41E5	D41E7	UNITS
Collector-Emitter Voltage	V_{CEO}	-30	-60	-80	Volts
Collector-Emitter Voltage	V_{CES}	-45	-70	-90	Volts
Emitter Base Voltage	V_{EBO}	-5	-5	-5	Volts
Collector Current — Continuous Peak(1)	I_C I_{CM}	-2 -3	-2 -3	-2 -3	A
Base Current — Continuous	I_B	-1	-1	-1	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	1.33 8	1.33 8	1.33 8	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	75	75	75	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15.6	15.6	15.6	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

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

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]					
Collector-Emitter Sustaining Voltage (I_C = -10ma) D41E1	$V_{CEO(sus)}$	-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					
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 1			
ON CHARACTERISTICS[1]					
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					
Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	—	13	—	pF
Current-Gain Bandwidth Product (I_C = −100mA, V_{CE} = −10V)	f_T	—	175	—	MHz
SWITCHING CHARACTERISTICS					
Resistive Load					
Delay Time + Rise Time — I_C = −1A, I_{B1} = I_{B2} = -0.1A	$t_d + t_r$	—	180	—	nS
Storage Time — V_{CC} = -30V, t_p = 25 μsec	t_s	—	250	—	
Fall Time	t_f	—	110	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

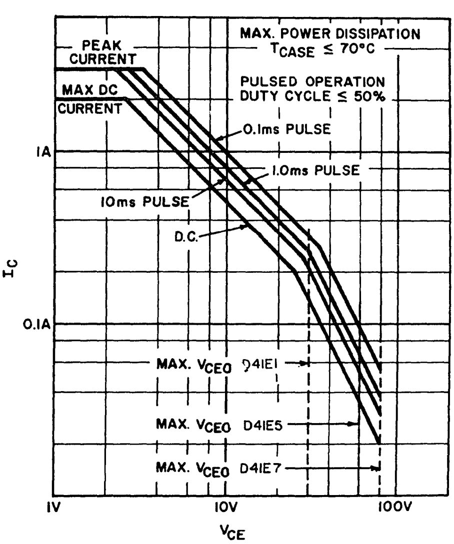


FIG. 1 SAFE REGION OF OPERATION

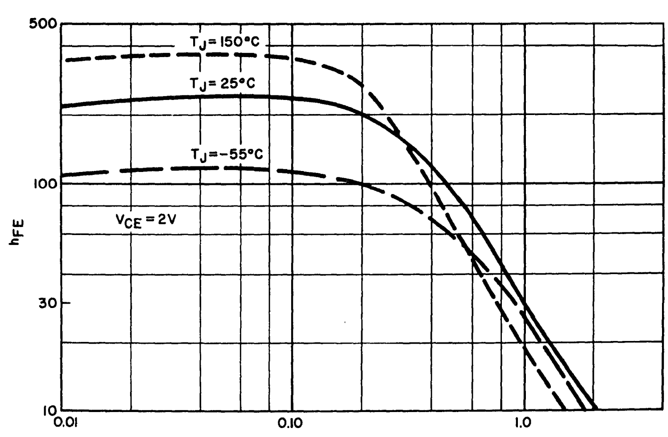


FIG. 2 TYPICAL H_{FE} VS I_C

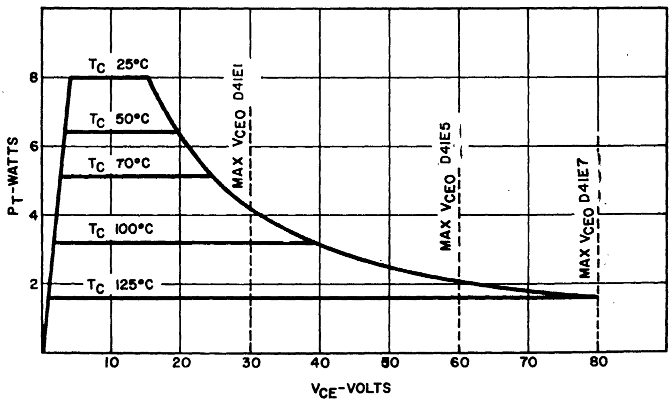


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

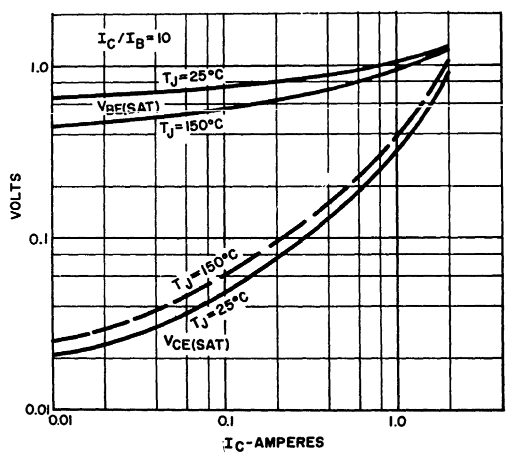


FIG. 4 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

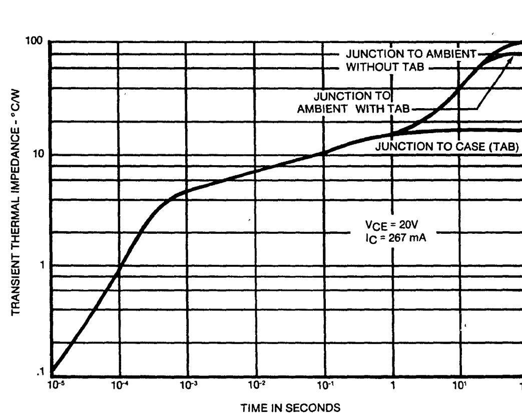


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

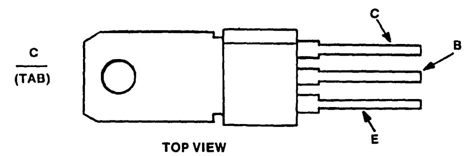
2-Ampere Silicon P-N-P Power Transistors

Complementary to the D40K Series

Features:
- Operates from IC without predriver

Applications:
- Switching regulator
- Lamp driver
- Touch switch
- Solenoid driver

TERMINAL DESIGNATIONS

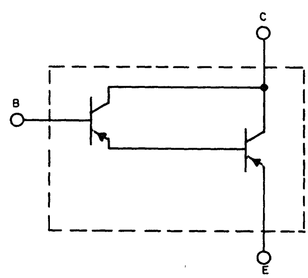


92CS-43222

JEDEC TO-202AB

The D41K-series of silicon p-n-p Darlington power transistors are designed for general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits. The monolithic base-to-emitter resistors have been deleted from the structure to enhance the gain characteristics. These devices feature minimum gains of 10,000.

These devices are supplied in the JEDEC TO-202AB plastic package.



92CS-43261

Schematic diagram for all types.

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%.

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, I_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%.

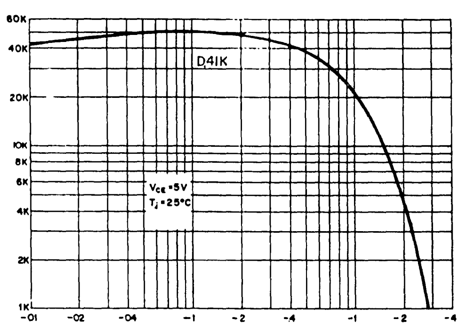


FIG. 1 TYPICAL h_{FE} vs. I_C

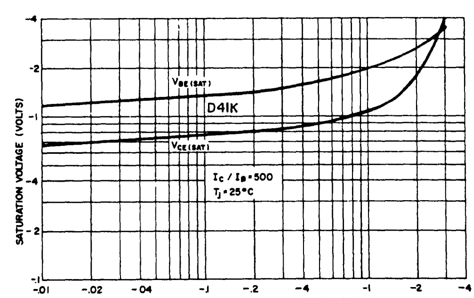


FIG. 2 TYPICAL C_{CBO} vs. VOLTAGE

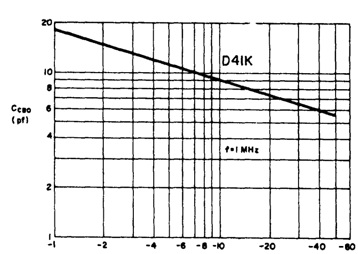
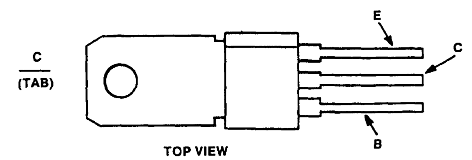


FIG. 3 TYPICAL SATURATION VOLTAGE

3-Ampere Silicon N-P-N Power Transistors

Complementary to the D43C Series

TERMINAL DESIGNATIONS



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	I_C	3	3	3	3	A
Peak(1)	I_{CM}	5	5	5	5	
Base Current — Continuous	I_B	2	2	2	2	A
Total Power Dissipation @ T_A = 25°C @ T_C = 25°C	P_D	2.1 12.5	2.1 12.5	2.1 12.5	2.1 12.5	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	60	60	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	10	10	10	°C/W
Maximum Lead Temperature for Soldering Purposes: ⅛" from Case for 5 Seconds	T_L	+260	+260	+260	+260	°C

(1) Pulse Test Pulse Width = 300ms Duty Cycle ≤ 2%.

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 100mA)	D42C1, 2, 3	$V_{CEO(sus)}$	30	—	—	Volts
	D42C4, 5, 6		45	—	—	
	D42C7, 8, 9		60	—	—	
	D42C10, 11, 12		80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURES 3 & 4			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 200mA, V_{CE} = 1V)	D42C1, 4, 7, 10	h_{FE}	25	—	—	—
	D42C2, 5, 8, 11		100	—	220	
	D42C3, 6, 9, 12		40	—	120	
(I_C = 1A, V_{CE} = 1V)	D42C1, 4, 7, 10	h_{FE}	10	—	—	—
(I_C = 2A, V_{CE} = 1V)	D42C2, 5, 8, 11		20	—	—	
	D42C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 50mA)	D42C2, 5, 8, 11	$V_{CE(sat)}$	—	—	0.5	Volts
	D42C3, 6, 9, 12		—	—	0.5	
(I_C = 1A, I_B = 100mA)	D42C1, 4, 7, 10	$V_{CE(sat)}$	—	—	0.5	Volts
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 100mA)		$V_{BE(sat)}$	—	—	1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1M_{Hz})		C_{CBO}	—	—	100	pF
Current-Gain — Bandwidth Product (I_C = 20mA, V_{CE} = 4V)		f_T	—	50	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = 1A, I_{B1} = I_{B2} = 0.1A,	$t_d + t_r$	—	100	—	nS
Storage Time	V_{CC} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

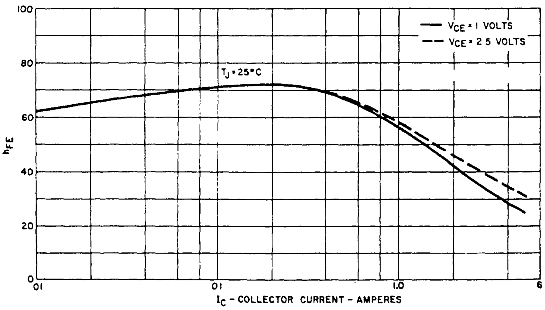


FIG. 1 TYPICAL h_{FE} VS. I_C

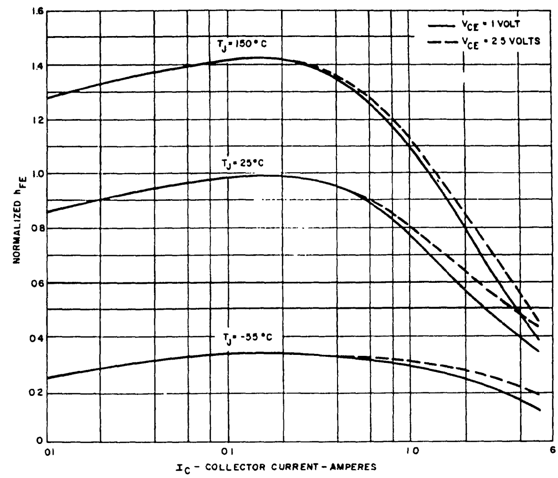


FIG. 2 TYPICAL NORMALIZED h_{FE} VS. I_C

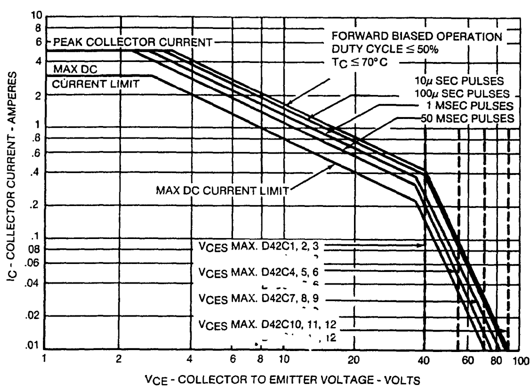


FIG. 3 SAFE REGION OF OPERATION

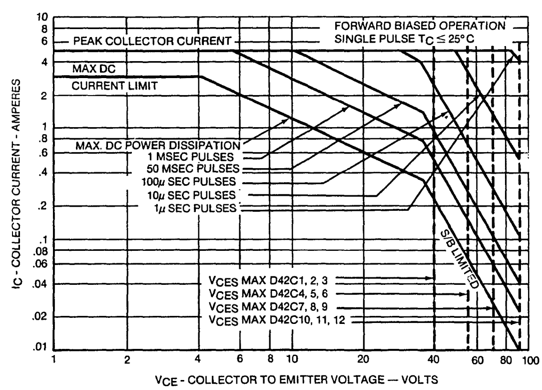


FIG. 4 SAFE REGION OF OPERATION

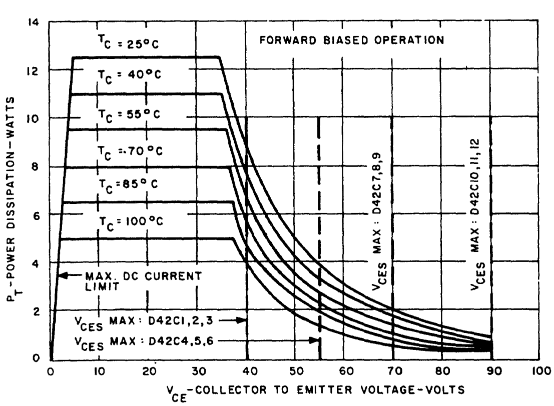


FIG. 5 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

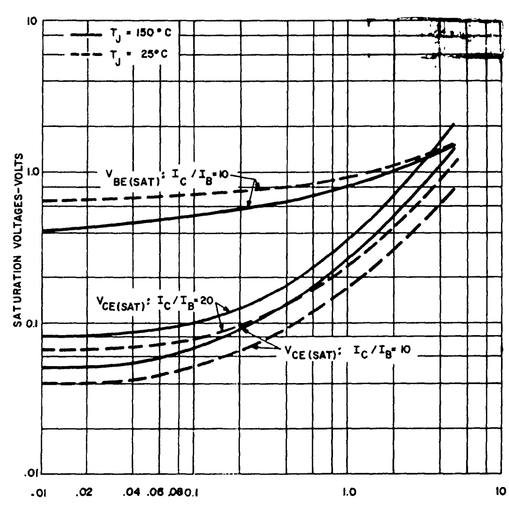


FIG. 6 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

2

POWER TRANSISTORS

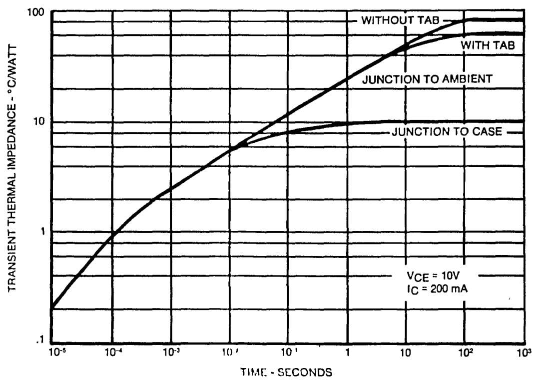


FIG. 7 MAXIMUM TRANSIENT THERMAL IMPEDANCE

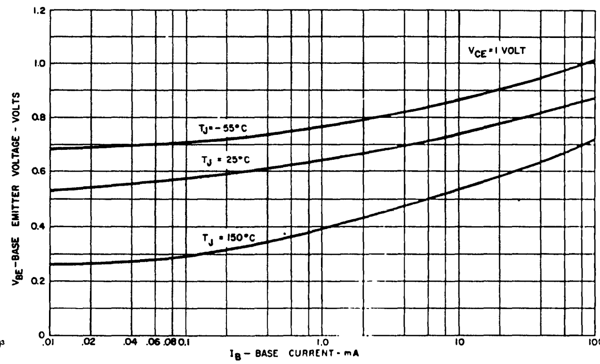


FIG. 8 TYPICAL INPUT CHARACTERISTICS

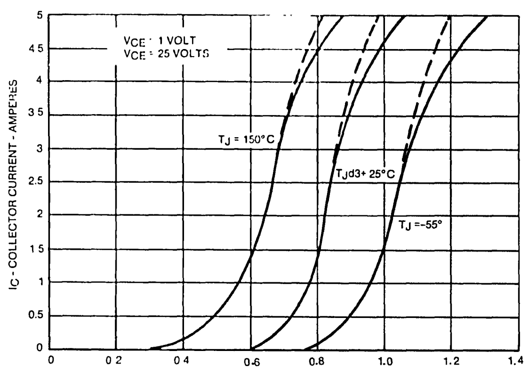


FIG. 9

TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

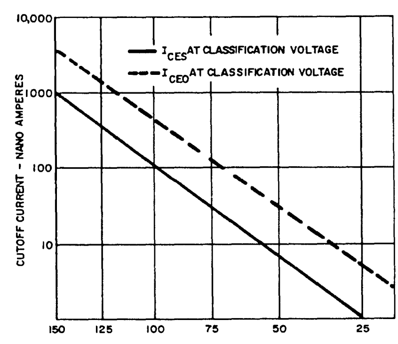


FIG. 10

TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

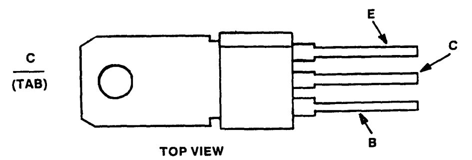
3-Ampere Silicon P-N-P Power Transistors

Complementary to the D42C Series

Features:

- High free-air power dissipation
- Low collector saturation voltage (-0.5V typ. @ -3A I_C)
- Excellent linearity
- Fast switching

TERMINAL DESIGNATIONS



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%.

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 = 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} = 30V, t_p = 25 μsec	t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

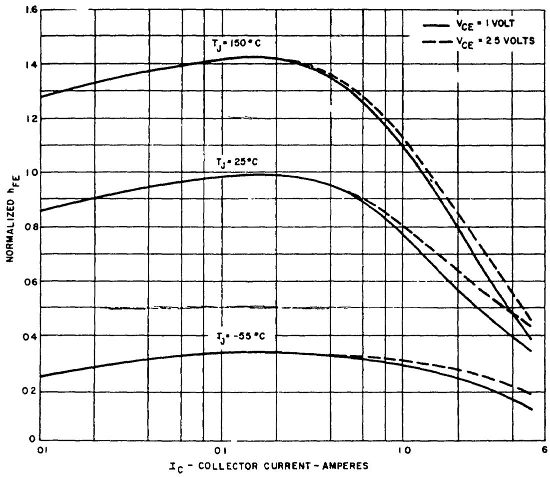


FIG. 1 TYPICAL NORMALIZED h_{FE} VS. I_C

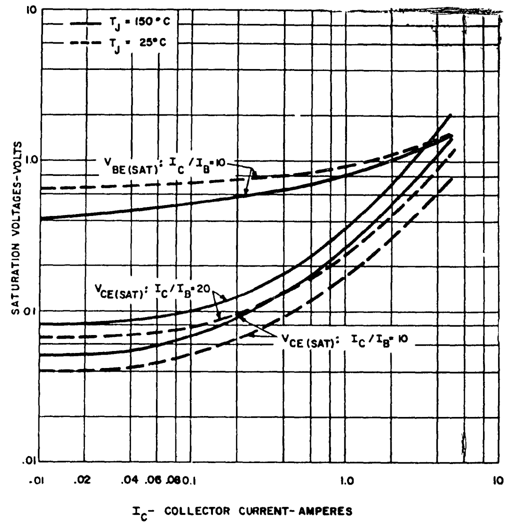


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

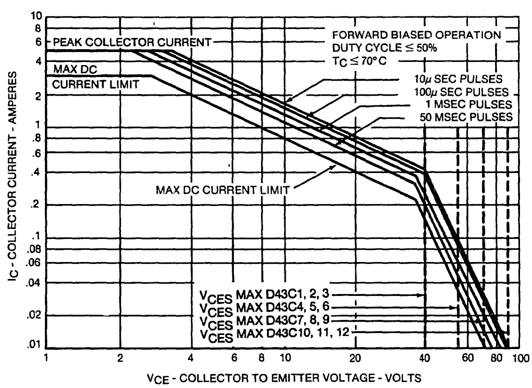


FIG. 3 SAFE REGION OF OPERATION

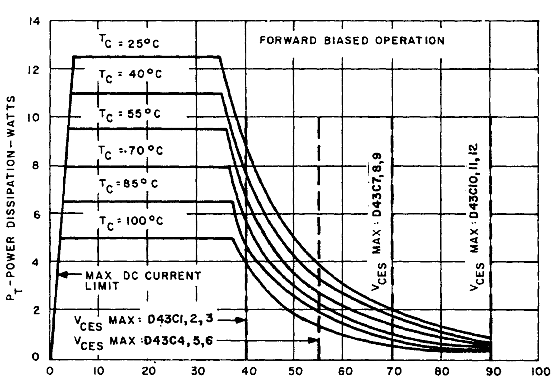


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

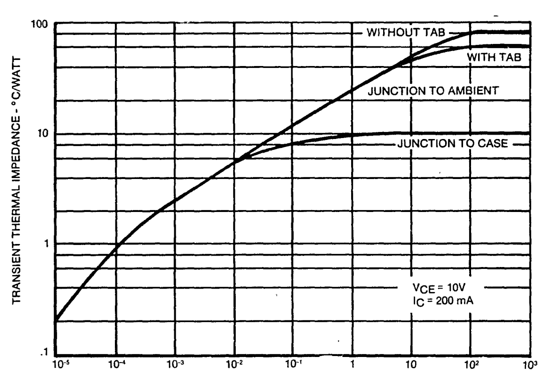


FIG. 5 MAXIMUM TRANSIENT THERMAL IMPEDANCE

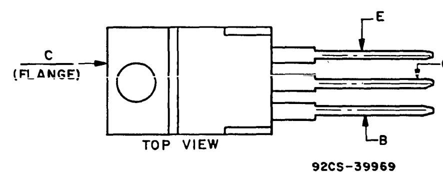
Silicon N-P-N Transistors

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



JEDEC TO-220AB

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.

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%.

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS(1)						
Collector-Emitter Sustaining Voltage (I_C = 100mA)	D44C1, 2, 3	$V_{CEO(sus)}$	30	—	—	Volts
	D44C4, 5, 6		45	—	—	
	D44C7, 8, 9		60	—	—	
	D44C10, 11, 12		80	—	—	
Collector Cutoff Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 3			
ON CHARACTERISTICS(1)						
DC Current Gain (I_C = 0.2A, V_{CE} = 1V)	D44C1, 4, 7, 10	h_{FE}	25	—	—	—
	D44C2, 5, 8, 11		100	—	220	
	D44C3, 6, 9, 12		40	—	120	
(I_C = 1A, V_{CE} = 1V)	D44C1, 4, 7, 10	h_{FE}	10	—	—	—
(I_C = 2A, V_{CE} = 1V)	D44C2, 5, 8, 11		20	—	—	
	D44C3, 6, 9, 12		20	—	—	
Collector-Emitter Saturation Voltage (I_C = 1A, I_B = 50mA)	D44C2, 5, 8, 11	$V_{CE(sat)}$	—	—	0.5	Volts
	D44C3, 6, 9, 12		—	—	0.5	
(I_C = 1A, I_B = 100mA)	D44C1, 4, 7, 10		—	—	0.5	
Base-Emitter Saturation Voltage (I_C = 1A, I_B = 100mA)		$V_{BE(sat)}$	—	—	1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 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, V_{CC} = 30A, t_p = 25 μsec	$t_d + t_r$	—	100	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	75	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

2 POWER TRANSISTORS

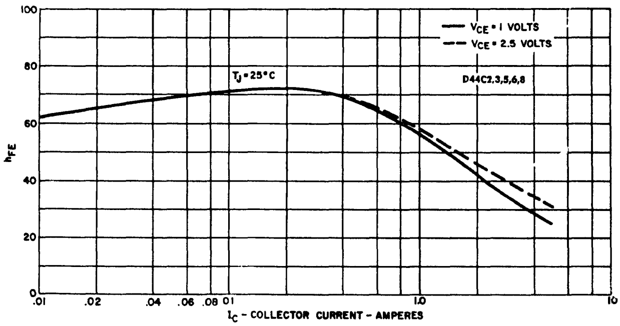


FIG. 1 TYPICAL hFE VS. IC

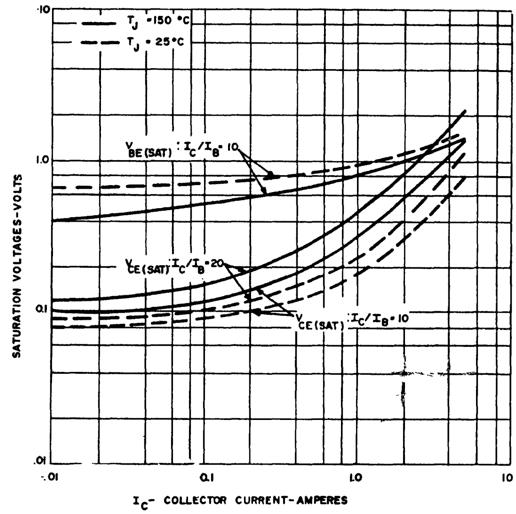


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

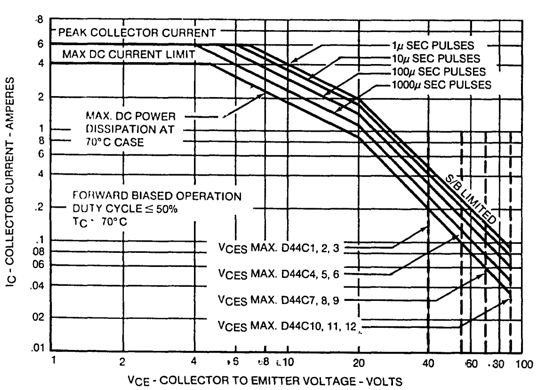


FIG. 3 SAFE REGION OF OPERATION

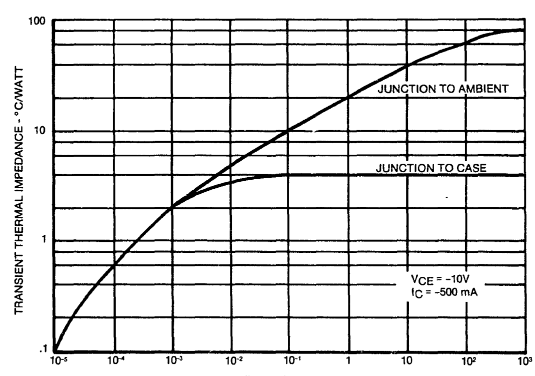


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

6-Ampere N-P-N Darlington Power Transistors

Complementary to the D45D Series

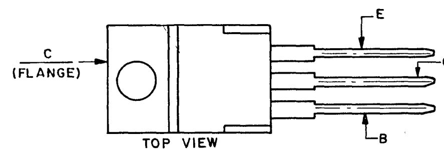
40, 60, and 80 Volts, 30 Watts
Gain of 2000 at 1 A

Features:
- *Operates from IC without predriver*

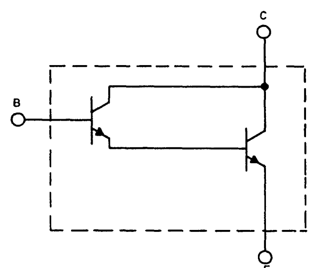
Applications:
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*
- *Inverter/Converter*

The D44D-series n-p-n Darlington power 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

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%.

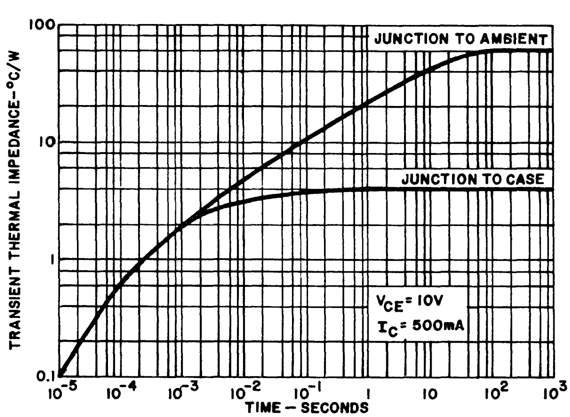


FIG. 1
MAXIMUM TRANSIENT THERMAL IMPEDANCE

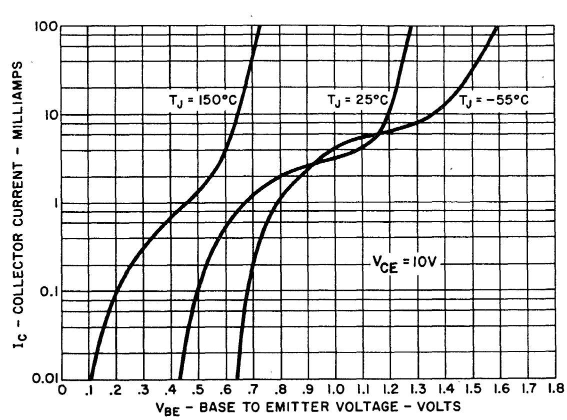


FIG. 2
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

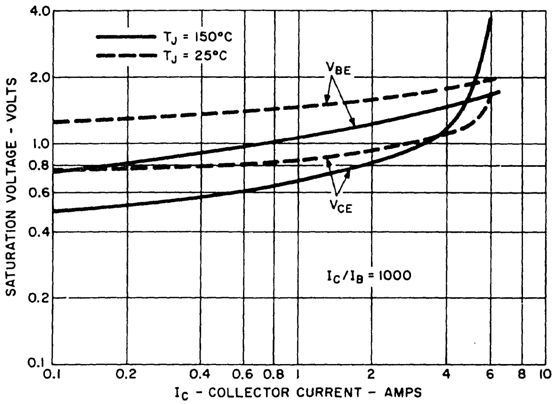


FIG. 3
TYPICAL SATURATION VOLTAGE CHARACTERISTICS

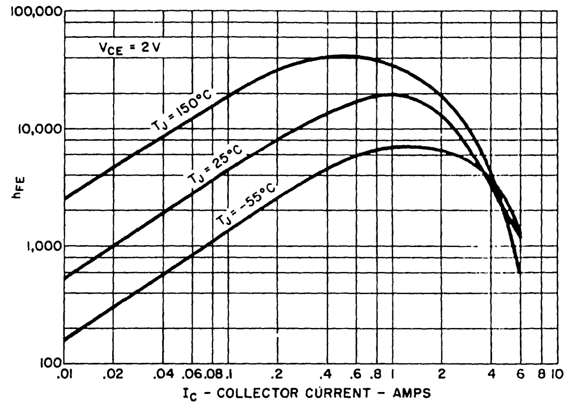


FIG. 4 TYPICAL h_{FE} VS. I_C

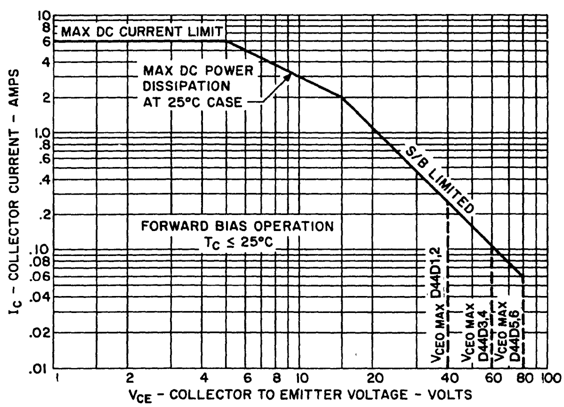


FIG. 5 SAFE REGION OF OPERATION

10-Ampere N-P-N Darlington Power Transistors

Complementary to the D45E Series

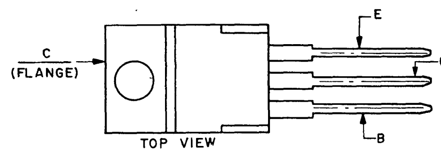
40, 60, and 80 Volts, 50 Watts
Gain of 2000 at 5 A

Features:
- *Operates from IC without predriver*

Applications:
- *Solenoid Driver*
- *Lamp Driver*
- *Relay Substitute*
- *Switching Regulator*
- *Inverter/Convertor*

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



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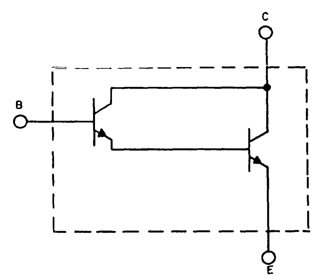


Schematic diagram for all types.

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%.

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	V_{CEO}	40	—	—	Volts
	D44E2		60	—	—	
	D44E3		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}	—	—	130	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 = 25 μsec	t_s	—	2.0	—	
Fall Time		t_f	—	0.5	—	

(1) Pulse Test: PW ≤ 300ms Duty Cycle ≤ 2%.

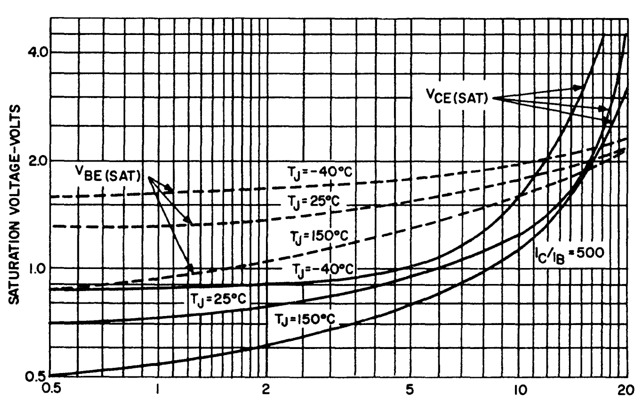


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

2 POWER TRANSISTORS

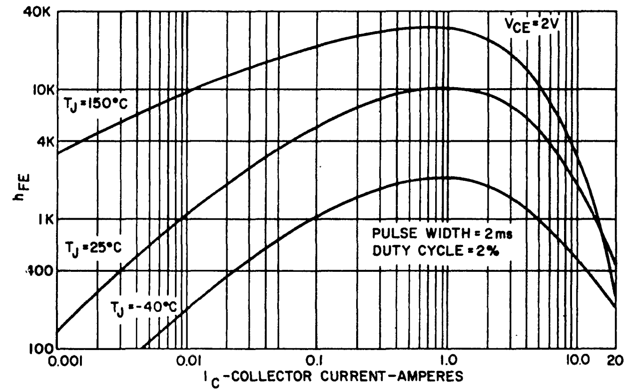


FIG. 2 TYPICAL GAIN CHARACTERISTIC

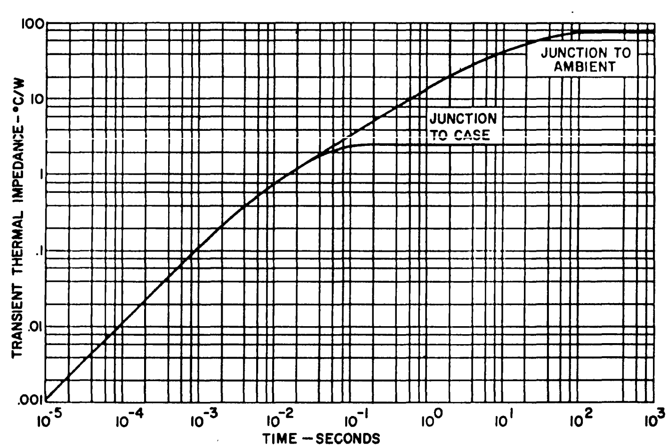


FIG. 3 TRANSIENT THERMAL IMPEDANCE

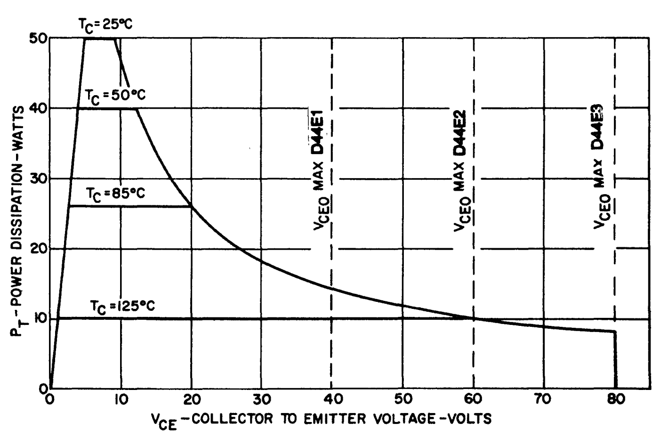


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

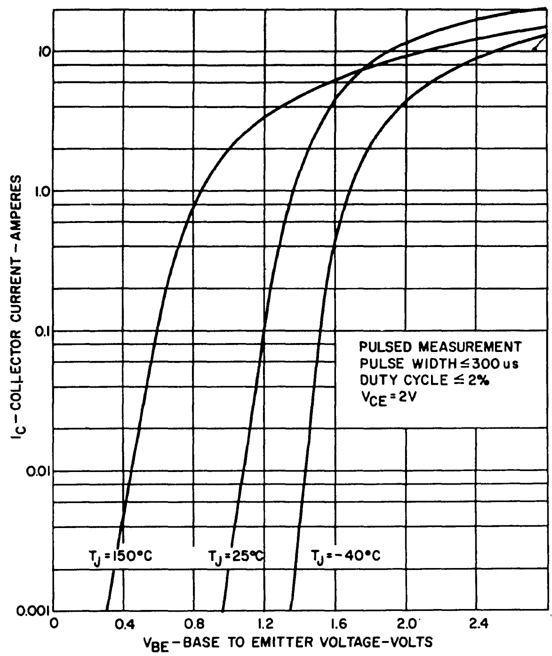


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

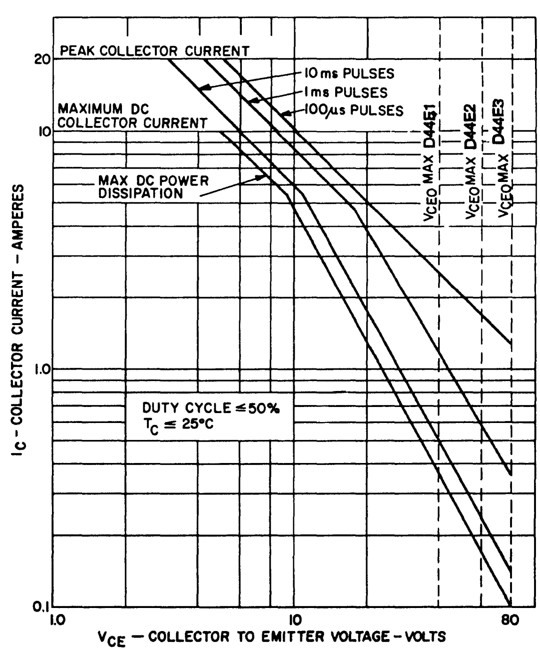


FIG. 6 SAFE REGION OF OPERATION

Silicon N-P-N Transistors

Complementary to the D45H Series

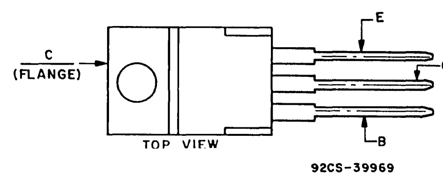
For Switching and Linear Applications

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%.

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = 100mA)	D44H1, 2	$V_{CEO(sus)}$	30	—	—	Volts
	D44H4, 5		45	—	—	
	D44H7, 8		60	—	—	
	D44H10, 11		80	—	—	
Collector Cutoff Current (V_{CB} = Rated V_{CBO})		I_{CBO}	—	—	10	μA
Emitter Cutoff Current (V_{EB} = 5V)		I_{EBO}	—	—	100	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 4			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = 2A, V_{CE} = 1V)	D44H1, 4, 7, 10	h_{FE}	35	—	—	—
	D44H2, 5, 8, 11		60	—	—	
(I_C = 4A, V_{CE} = 1V)	D44H1, 4, 7, 10	h_{FE}	20	—	—	—
	D44H2, 5, 8, 11		40	—	—	
Collector-Emitter Saturation Voltage (I_C = 8A, I_B = 0.4A)	D44H2, 5, 8, 11	$V_{CE(sat)}$	—	—	1.0	Volts
(I_C = 8A, I_B = 0.8A)	D44H1, 4, 7, 10		—	—	1.0	
Base-Emitter Saturation Voltage (I_C = 8A, I_B = 0.8A)		$V_{BE(sat)}$	—	—	1.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1M_{Hz})		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
POWER TRANSISTORS

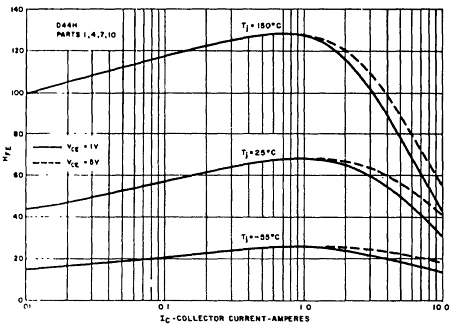


FIG. 1 TYPICAL GAIN CHARACTERISTICS

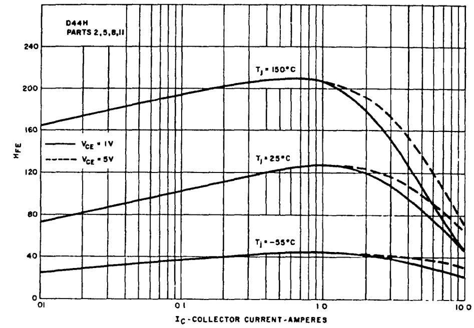


FIG. 2 TYPICAL GAIN CHARACTERISTICS

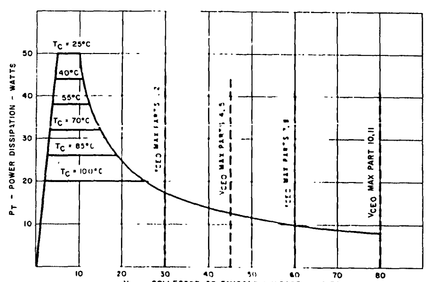


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

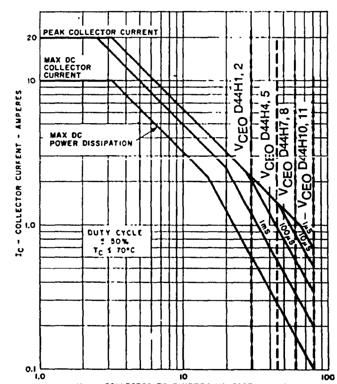


FIG. 4 SAFE REGION OF OPERATION

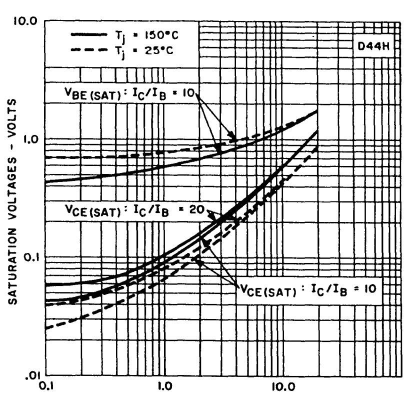


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

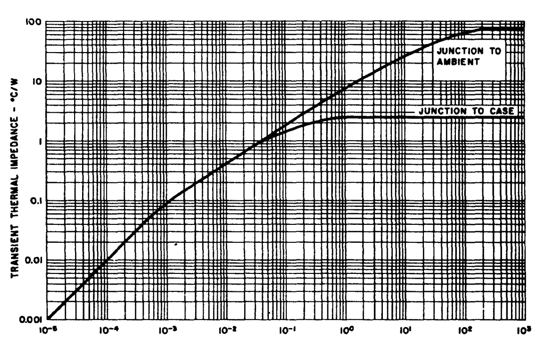


FIG. 6 TRANSIENT THERMAL IMPEDANCE

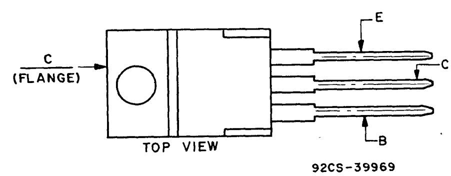
Silicon N-P-N Transistors

For Switching and Linear Applications

Features:
- *Very low collector saturation voltage*
- *Excellent linearity*
- *Fast switching*

TERMINAL DESIGNATIONS

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.



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

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)	h_{FE}	20	—	—	—
DC Current Gain (I_C = 200mA, V_{CE} = 10V)	h_{FE}	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	Conditions	Symbol	MIN	TYP	MAX	UNIT
Delay Time + Rise Time	I_C = 1.0A, I_{B1} = I_{B2} = 100mA, V_{CC} = 50V, t_p = 25 μsec	$t_d + t_r$	—	—	0.2	μs
Storage Time		t_s	—	—	2.0	
Fall Time		t_f	—	—	1.7	

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

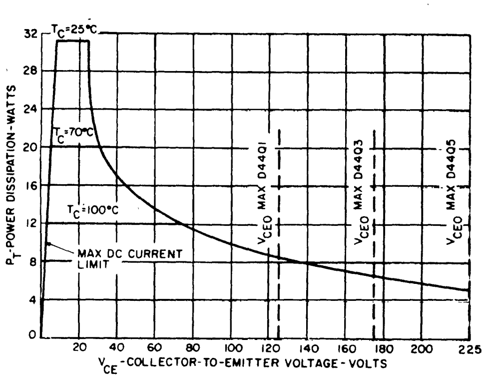


FIG. 1 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

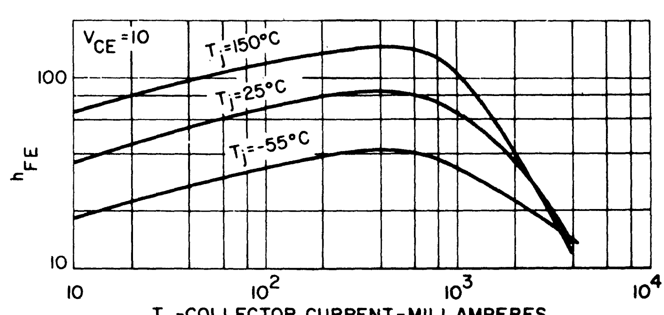


FIG. 2 TYPICAL h_{FE} vs. I_C

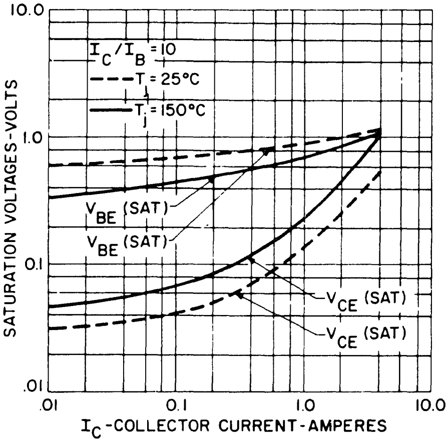


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

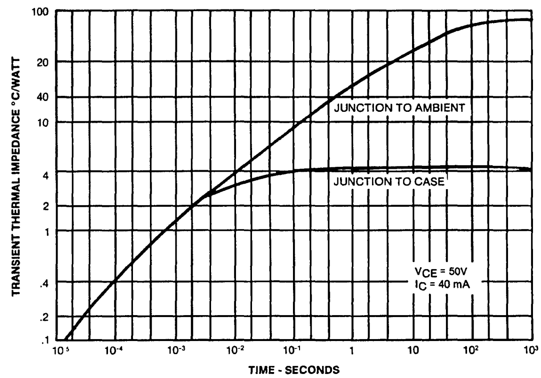


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

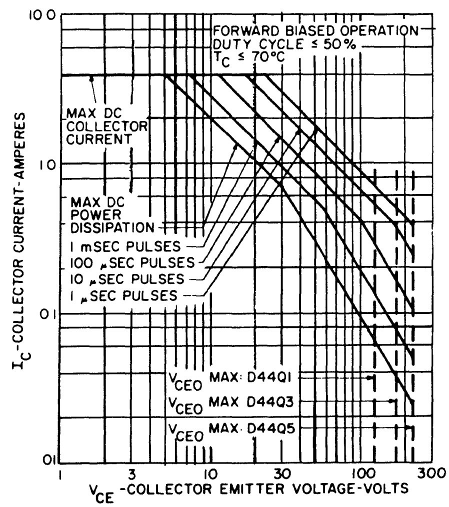


FIG. 5 FORWARD BIAS SAFE OPERATING AREA

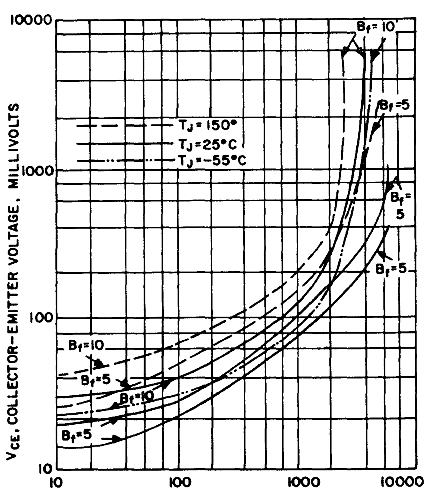


FIG. 6 $V_{CE(SAT)}$ vs. I_C TYPICAL

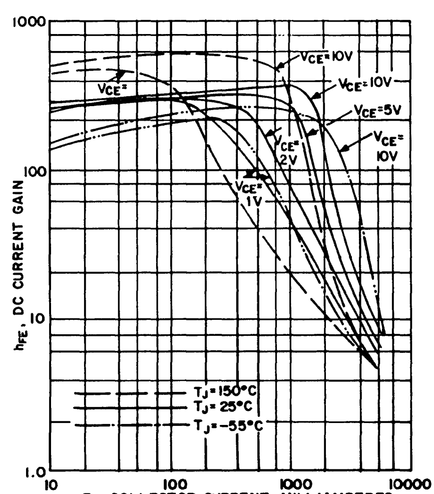


FIG. 7 DC CURRENT GAIN, TYPICAL

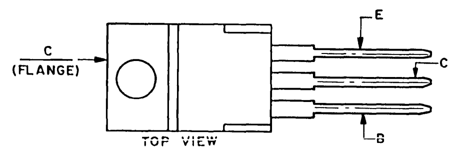
Silicon N-P-N Transistors

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

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		h_{FE}				—
(I_C = 500mA, V_{CE} = 10V)	D44T1,3		30	—	—	
(I_C = 50mA, V_{CE} = 10V)			40	—	—	
(I_C = 500mA, V_{CE} = 10V)	D44T2,4		75	—	175	
(I_C = 50mA, V_{CE} = 10V)			40	—	—	
Collector-Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)		$V_{CE(sat)}$	—	—	1.0	V
Base Emitter Saturation Voltage (I_C = 500mA, I_B = 50mA)		$V_{BE(sat)}$	—	—	1.2	V
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)		C_{cb}	—	25	—	pF
Current Gain — Bandwidth Product (I_C = 100mA, V_{CE} = 10V, f_{test} = 1.0 MHz))		f_T	—	45	—	MHz

SWITCHING CHARACTERISTICS

Resistive Load	Conditions	Symbol	MIN	TYP	MAX	UNIT
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	—	μs
Fall Time		t_f	—	0.6	—	μs

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

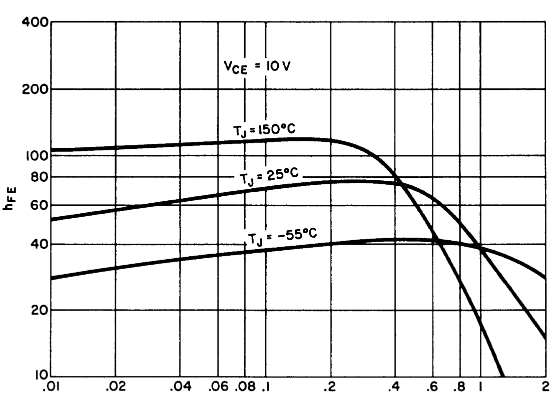


FIG. 1 TYPICAL h_{FE} VS. I_C

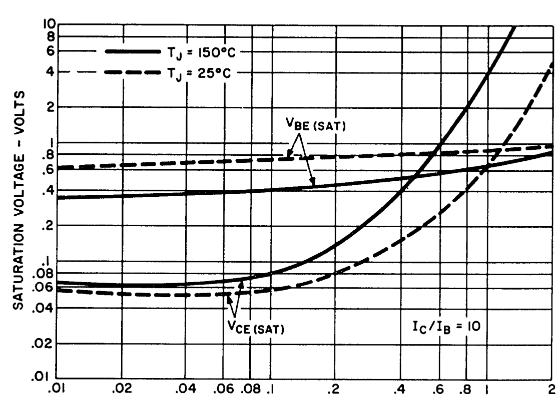


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

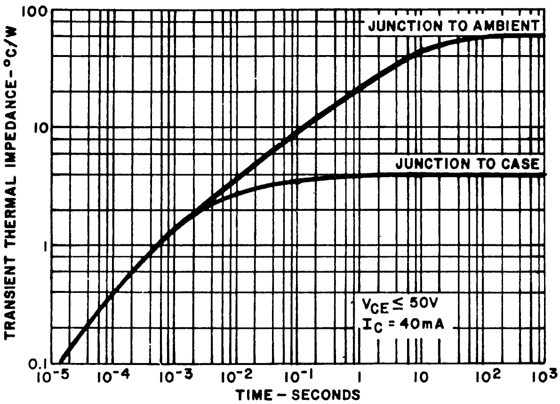


FIG. 3 MAXIMUM TRANSIENT THERMAL IMPEDANCE

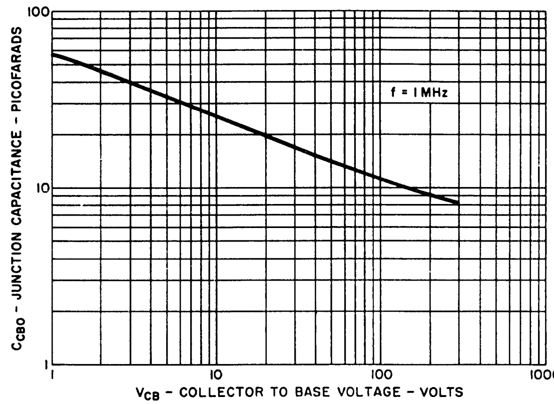


FIG. 4 COLLECTOR TO BASE JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE

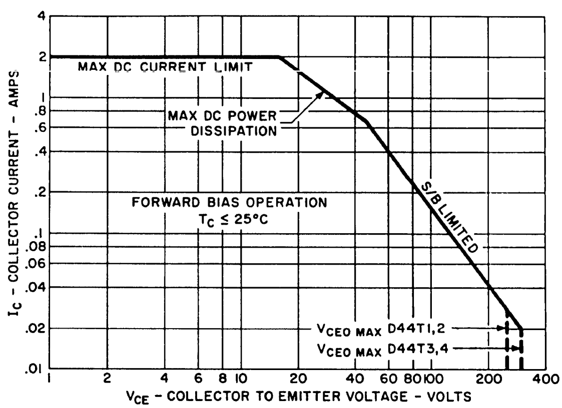


FIG. 5 SAFE REGION OF OPERATION

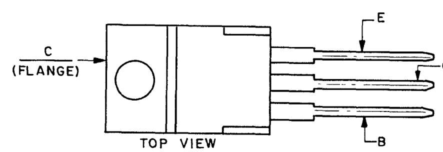
2-A Power-Switching Transistors

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.

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

Resistive Load (See Figure 17 for Test Circuit)		T_C	MAXIMUM 25°C	100°C	
Delay Time	V_{CC} = 250V, I_C = 1.5A	t_d	.06	.08	μs
Rise Time	I_{B1} = I_{B2} = 0.3A, t_p = 25 μsec	t_r	0.6	0.8	μsec
Storage Time		t_s	2.5	3.0	μsec
Fall Time		t_f	0.5	0.8	μsec
Inductive Load, Clamped (See Figure 17 for Test Circuit)					
Storage Time	V_{CLAMP} = 250V, I_C = 1.5A,	t_{sv}	3.0	3.5	μs
Fall Time	I_{B1} = I_{B2} = 0.3A, t_p = 25μsec	t_f	0.3	0.6	μsec
	$V_{BE(OFF)}$ = -5V	TYPICAL			
Storage Time	L = 200 μh	t_s	2.1	2.6	μsec
Fall Time		t_f	0.18	0.23	μsec

(1) Pulse Duration = 300μs, Duty Factor ≤ 2%. Do not measure on a curve tracer.

TYPICAL DC CHARACTERISTICS

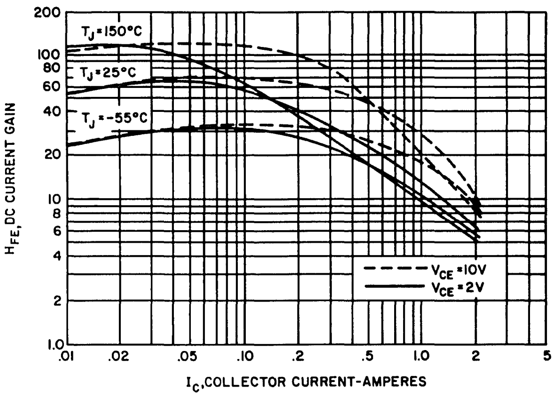


FIGURE 1. DC CURRENT GAIN

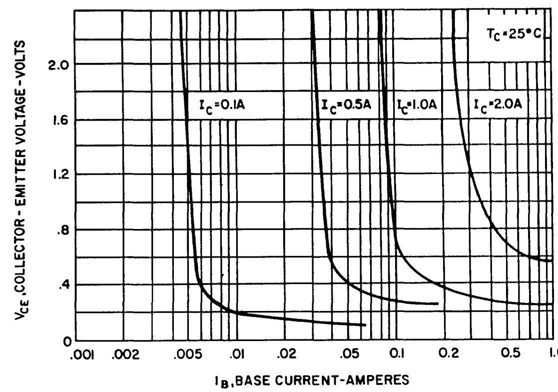


FIGURE 2. COLLECTOR SATURATION REGION

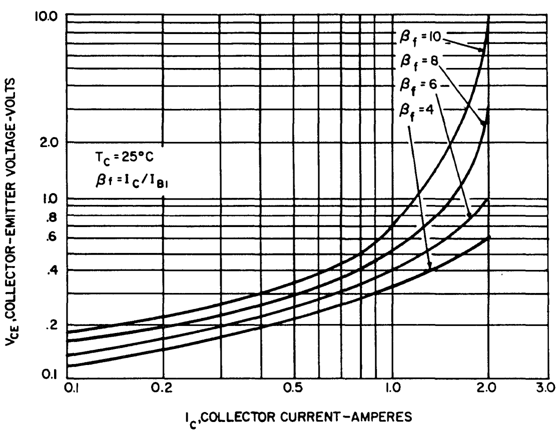


FIGURE 3. $V_{CE(SAT)}$ VS. I_C, T_C = 25°C

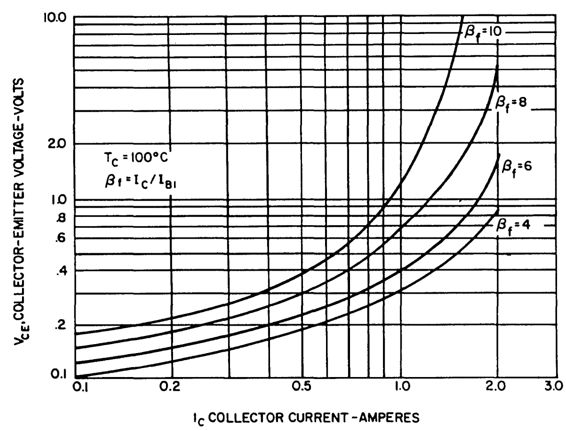


FIGURE 4. $V_{CE(SAT)}$ VS. I_C, T_C = 100°C

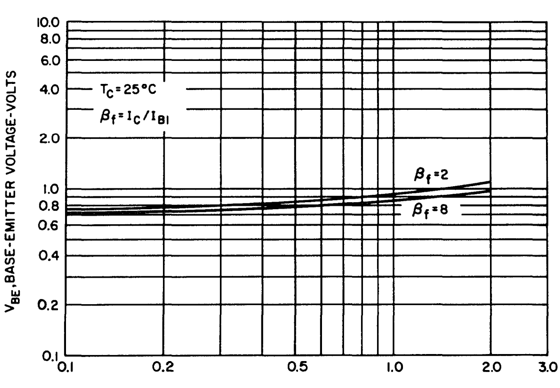


FIGURE 5. $V_{BE(SAT)}$ VS. I_C

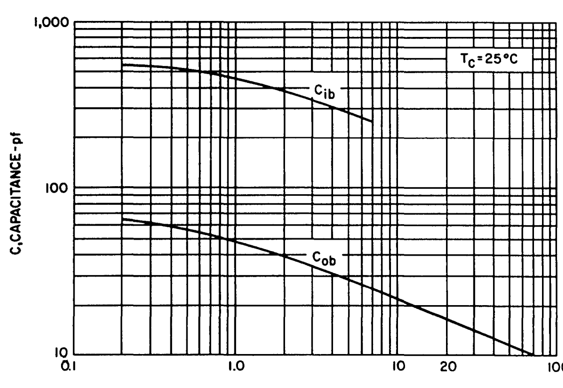


FIGURE 6. CAPACITANCE

2

POWER TRANSISTORS

TYPICAL SWITCHING CHARACTERISTICS

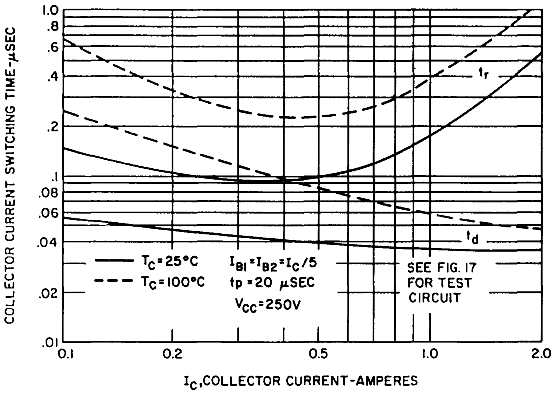


FIGURE 7. TURN-ON TIME RESISTIVE LOAD

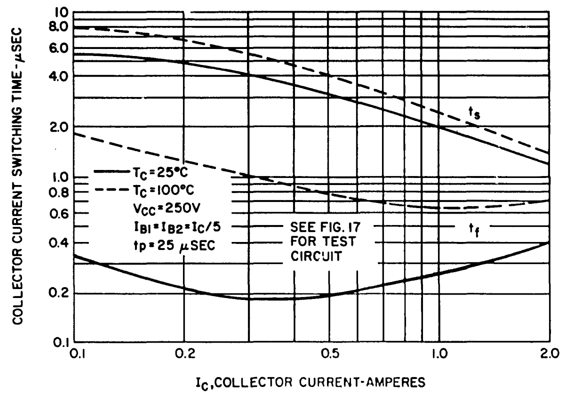


FIGURE 8. TURN-OFF TIME RESISTIVE LOAD

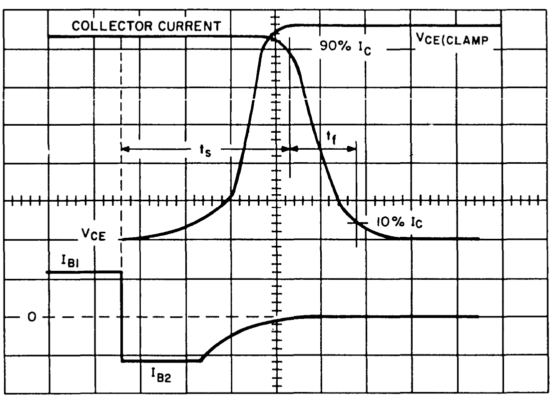


FIGURE 9. INDUCTIVE TURN-OFF WAVEFORMS

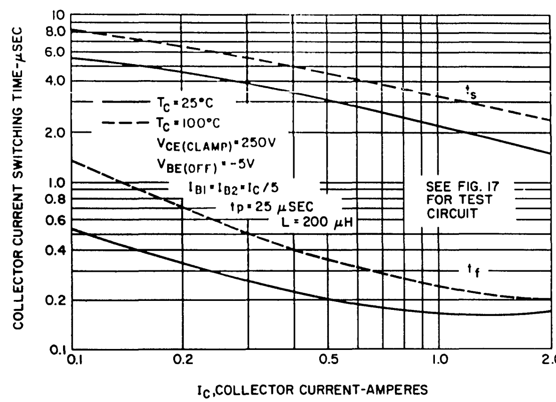


FIGURE 10. CLAMPED INDUCTIVE TURN-OFF TIME

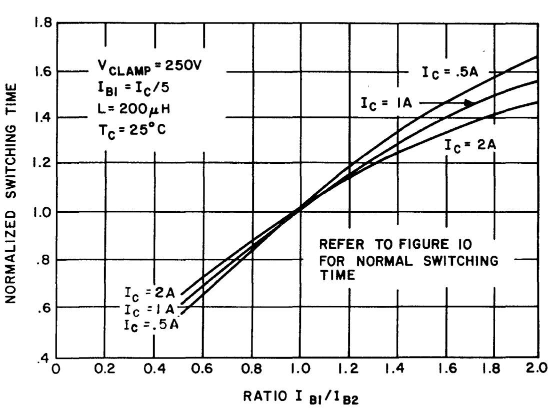


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

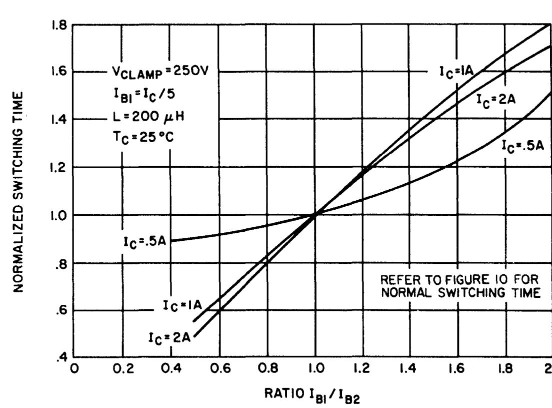


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

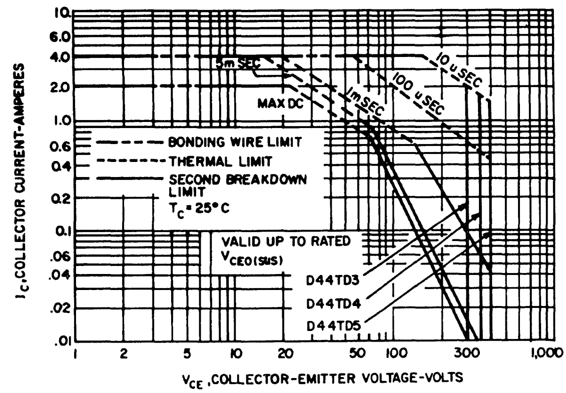


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

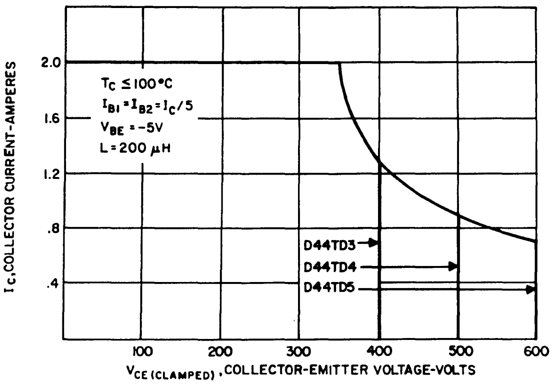


FIGURE 14. CLAMPED REVERSE BIAS SAFE OPERATING AREA

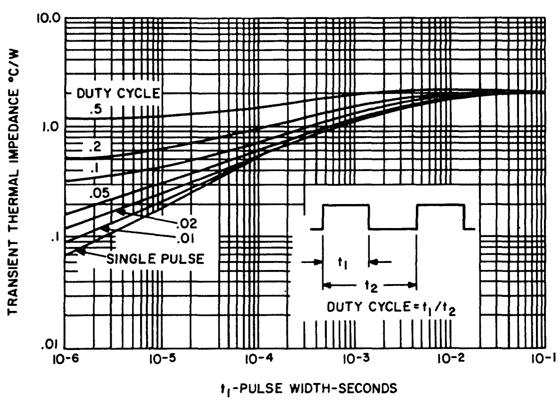


FIGURE 15. TRANSIENT THERMAL RESPONSE

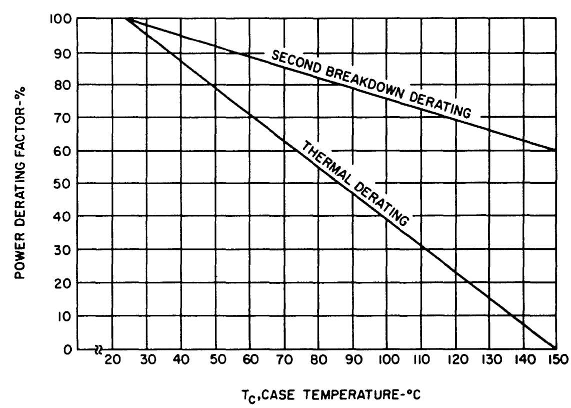


FIGURE 16. POWER DERATING CURVE

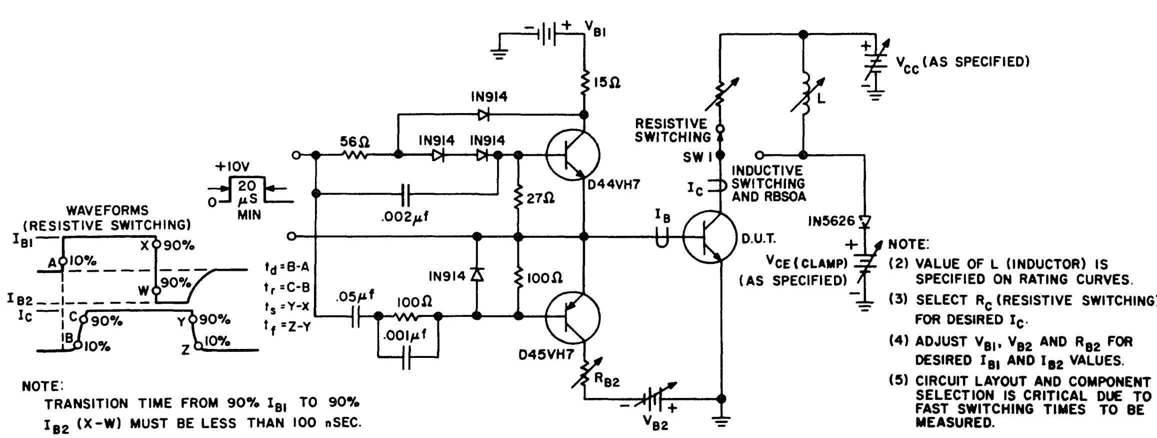


FIGURE 17. TEST CIRCUIT FOR SWITCHING TIMES AND RBSOA

Silicon N-P-N Transistors

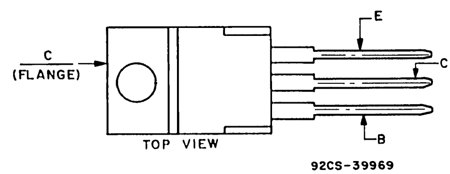
Complementary to the D45VH Series

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.

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

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS[1]				
Collector-Emitter Sustaining Voltage[1] (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D44VH1		30	—	
D44VH4		45	—	
D44VH7		60	—	
D44VH10		80	—	
Collector-Emitter Voltage[2] (I_C = 1A, V_{CLAMP} = Rated V_{CEX}, T_C = 100°C)	V_{CEX}			V
D44VH1		40	—	
D44VH4		55	—	
D44VH7		65	—	
D44VH10		90	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V)		—	10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V, T_C = 100°C)		—	100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	10	μA
SECOND BREAKDOWN				
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = 2 A, V_{CE} = 1V)		35	—	
(I_C = 4 A, V_{CE} = 1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = 8A, I_B = 0.4A)		—	0.4	
(I_C = 8A, I_B = 0.4A, T_C = 100°C)		—	0.5	
(I_C = 15A, I_B = 3.0A, T_C = 100°C)		—	0.8	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = 8A, I_B = 0.4A)		—	1.2	
(I_C = 8A, I_B = 0.4A, T_C = 100°C)		—	1.1	

DYNAMIC CHARACTERISTICS

		Typical	
Current-Gain — Bandwidth Product (I_C = 0.1A, V_{CE} = 10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = 10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	120	pF

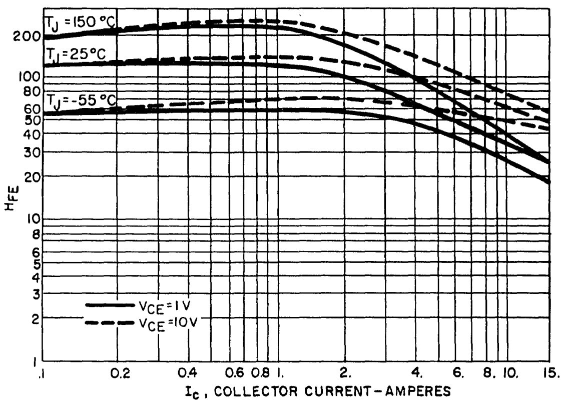
SWITCHING CHARACTERISTICS

			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 20V, I_C = 8A; I_{B1} = I_{B2} = 0.8A; t_p = 25 μsec	t_d	50	—	nsec
Rise Time		t_r	250	—	nsec
Storage Time		t_s	700	—	nsec
Fall Time		t_f	200	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	V_{CC} = 20V, I_C = 8A; V_{CLAMP} = Rated V_{CEX}; I_{B1} = 0.8A, $V_{BE(off)}$ = −5V; L = 200 μh	t_s	800	—	nsec
Fall Time		t_f	180	400	nsec
		Typical			
Storage Time		t_s	280	370	nsec
Fall Time		t_f	130	150	nsec

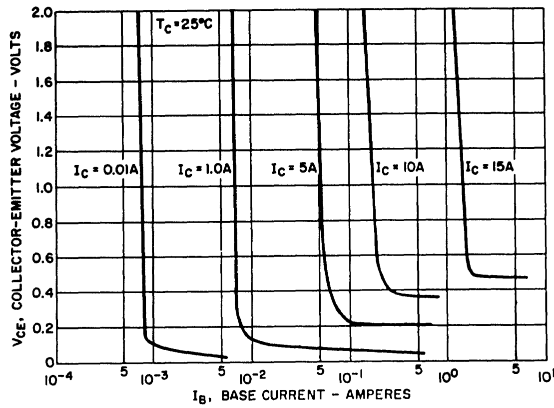
(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.
(2) See Figure 15 for Test Circuit.

2 POWER TRANSISTORS

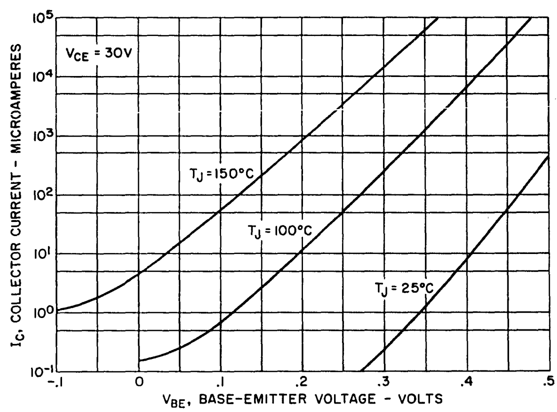
SAFE OPERATING AREA



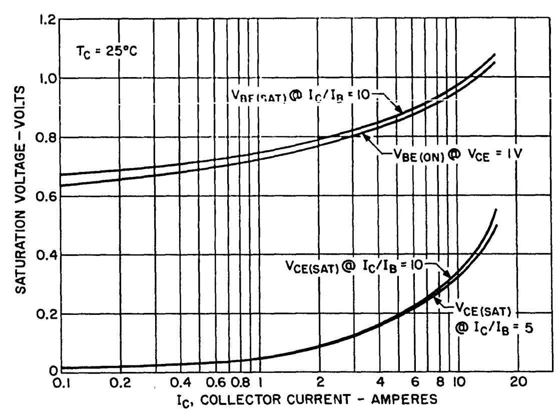
1. DC CURRENT GAIN



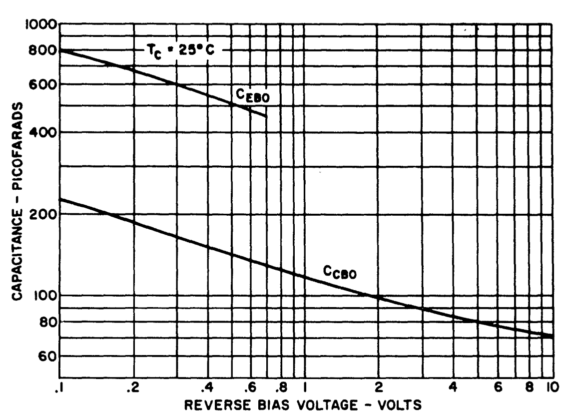
2. COLLECTOR SATURATION REGION



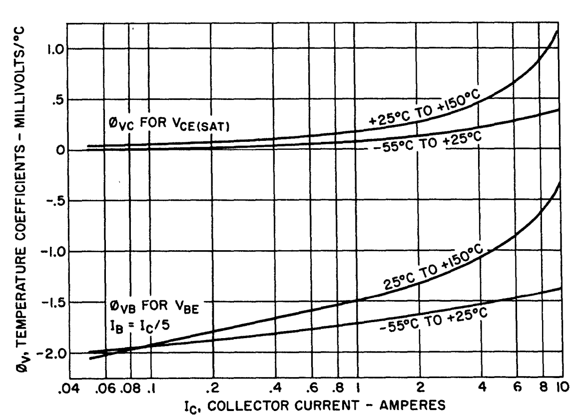
3. COLLECTOR CUTOFF REGION



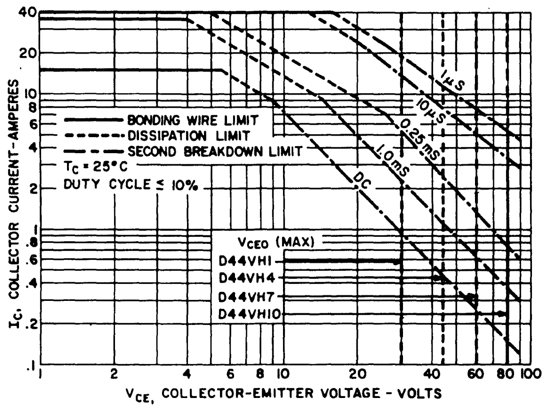
4. SATURATION VOLTAGE



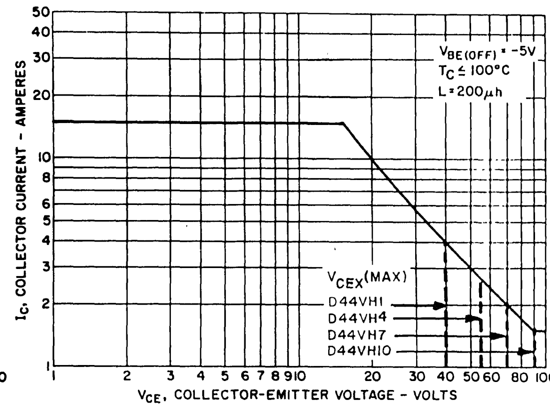
5. CAPACITANCE



6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

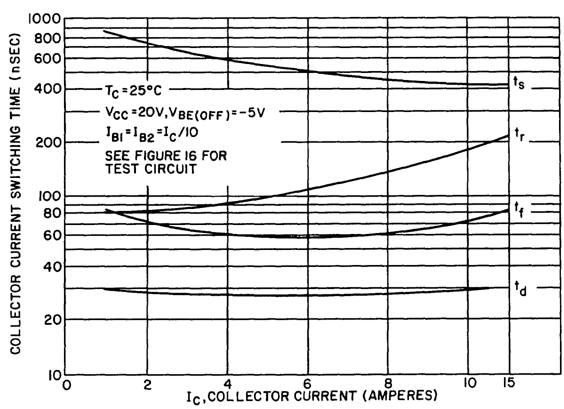


7. FORWARD BIAS SOA

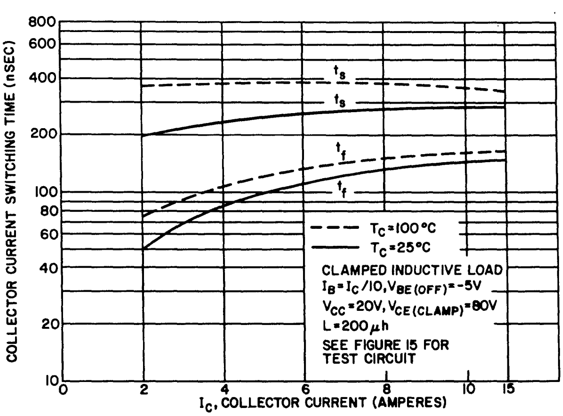


8. REVERSE BIAS SOA

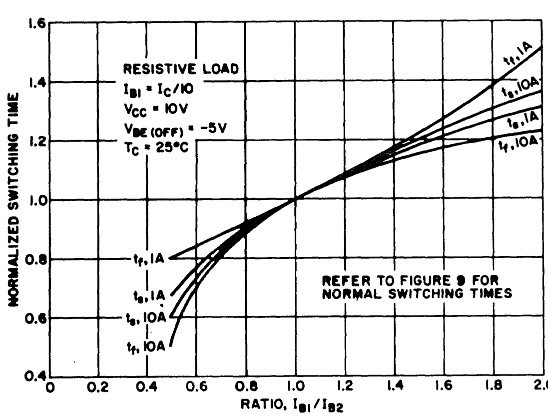
TYPICAL SWITCHING CHARACTERISTICS



9. RESISTIVE SWITCHING TIME



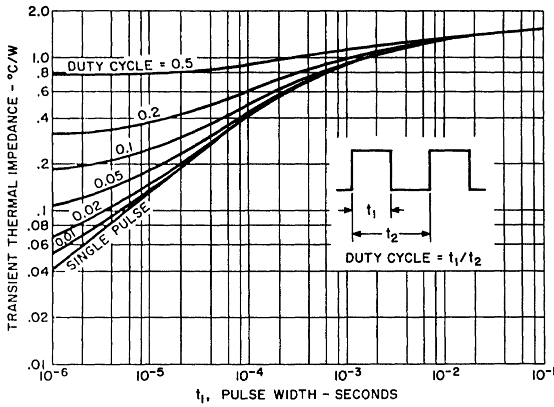
10. CLAMPED INDUCTIVE SWITCHING TIME



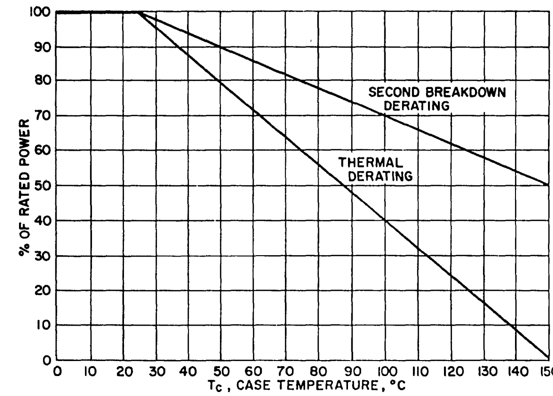
11. SWITCHING TIME VARIATION WITH I_{B2}

2

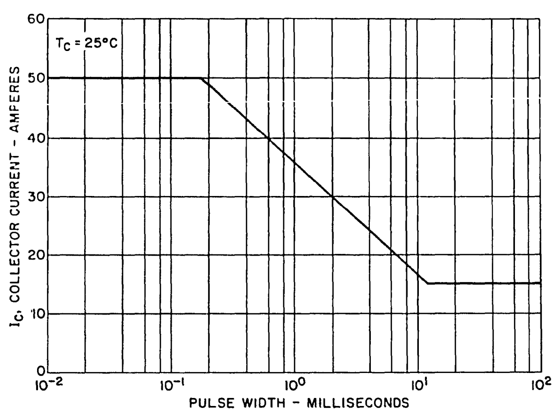
POWER TRANSISTORS



12. TRANSIENT THERMAL RESPONSE

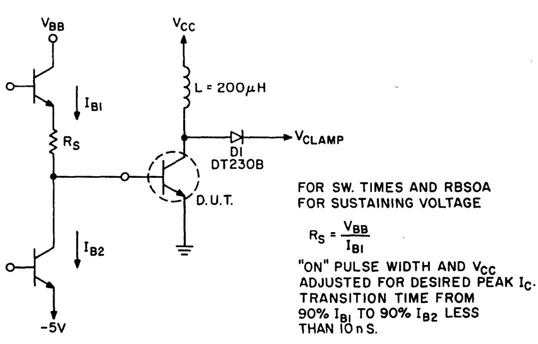


13. POWER DERATING FACTOR

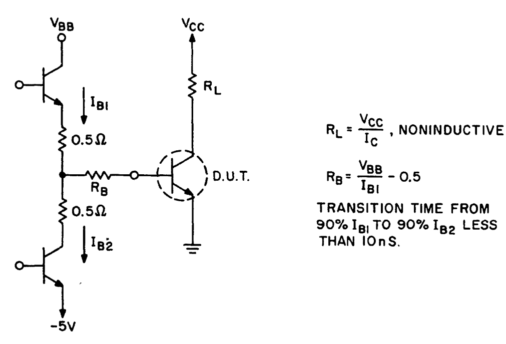


14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS



15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

Silicon N-P-N Transistors

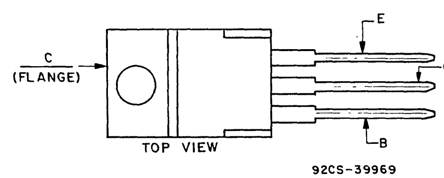
Complementary to the D45VM Series

Features:

- *Fast Switching* $t_s \leq 500$ *ns resistive* $t_f \leq 75$ *ns*
- *Very Low* $V_{CE(sat)} \leq 0.4V$ @ $I_C = 4A$
- *High Gain* $H_{FE} \geq 40$ @ $I_C = 4A$

The D44VM-series of silicon n-p-n power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

2
POWER TRANSISTORS

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

RATING	SYMBOL	D44VM1	D44VM4	D44VM7	D44VM10	UNIT
Collector-Emitter Voltage	$V_{CEO(sus)}$	30	45	60	80	V
Collector-Emitter Voltage	V_{CEX}	30	45	60	80	V
Collector-Emitter Voltage	V_{CEV}	50	70	80	100	V
Emitter Base Voltage	V_{EB}	7				V
Collector Current — Continuous — Peak (1)	I_C I_{CM}	8 20				A
Base Current — Continuous — Peak (1)	I_B I_{BM}	2 5				A
Total Power Dissipation @ T_C = 25°C @ T_C = 100°C Derate above 25° C	P_D	50 20 0.4				Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150				°C

THERMAL CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MAX	UNIT
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	74	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T_L	235	°C

(1) Pulse measurement condition PW ≤ 6.0 ms.

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

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS[(1)]				
Collector-Emitter Sustaining Voltage[(1)] (I_C = 100mA, I_B = 0)	$V_{CEO(sus)}$			V
D44VM1		30	—	
D44VM4		45	—	
D44VM7		60	—	
D44VM10		80	—	
Collector-Emitter Voltage[(2)] (I_C = 3A, V_{CLAMP} = Rated V_{CEX}, $T_C \leqslant$ 100°C)	V_{CEX}			V
D44VM1		30	—	
D44VM4		45	—	
D44VM7		60	—	
D44VM10		80	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V)		—	10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = -4.0V T_C = 100°C)		—	100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	100	μA
Emitter Cutoff Current (V_{EB} = 7V, I_C = 0)	I_{EBO}	—	10	μA
SECOND BREAKDOWN				
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.

TYPICAL DC CHARACTERISTICS

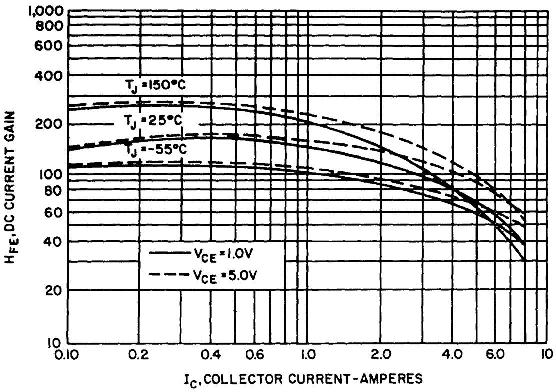


FIGURE 1. DC CURRENT GAIN

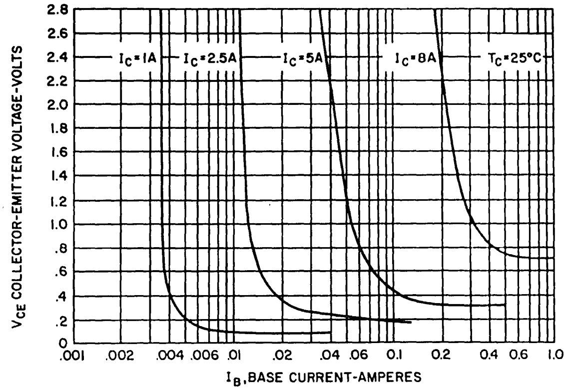


FIGURE 2. COLLECTOR SATURATION REGION

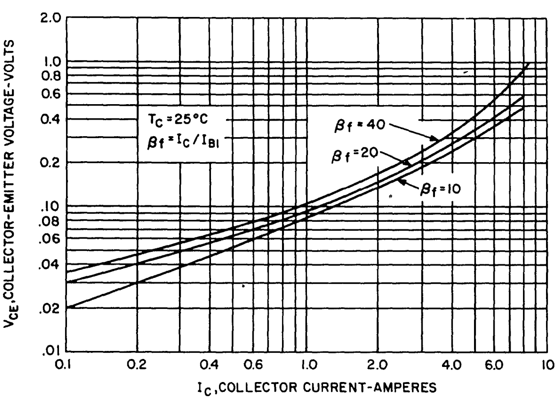


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

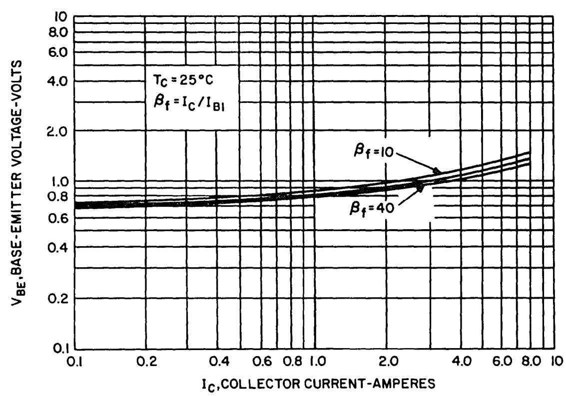


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

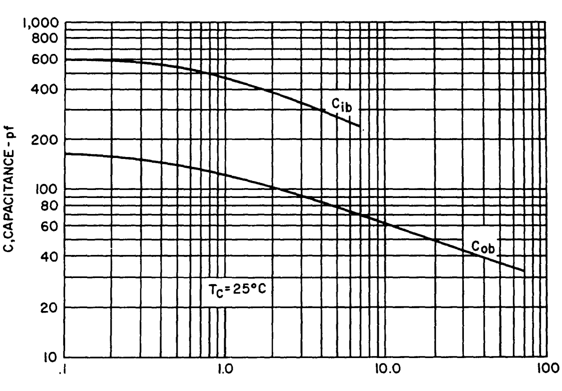


FIGURE 5. CAPACITANCE

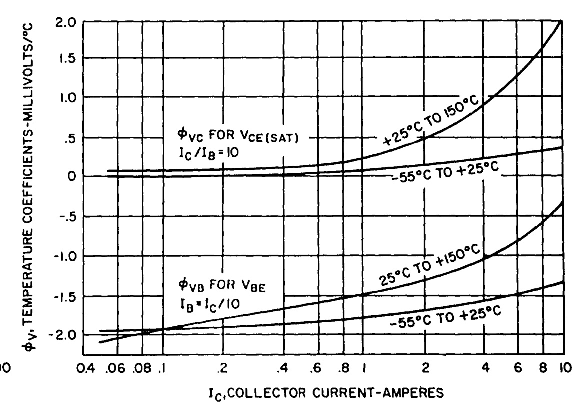


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

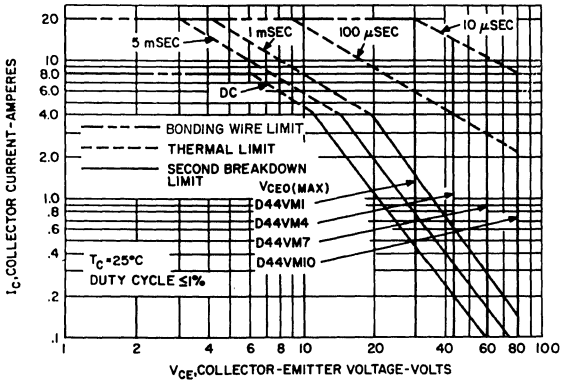


FIGURE 7. FORWARD BIAS SOA

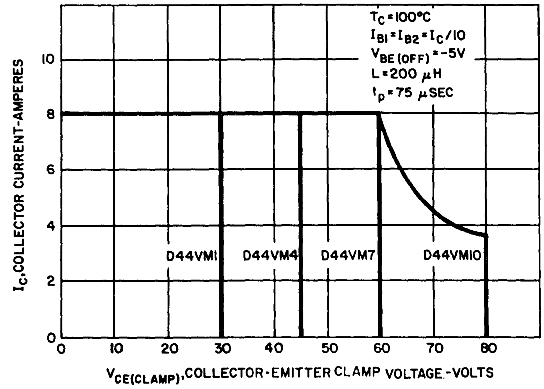


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

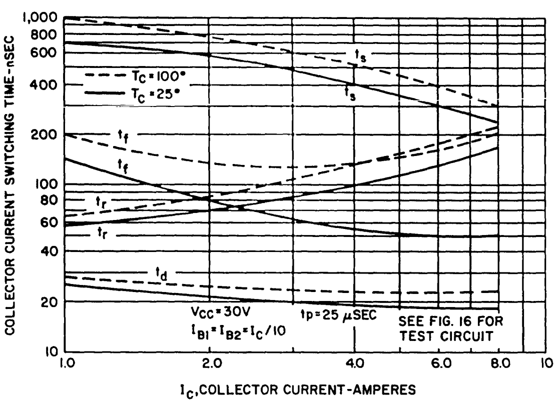


FIGURE 9. RESISTIVE SWITCHING TIME

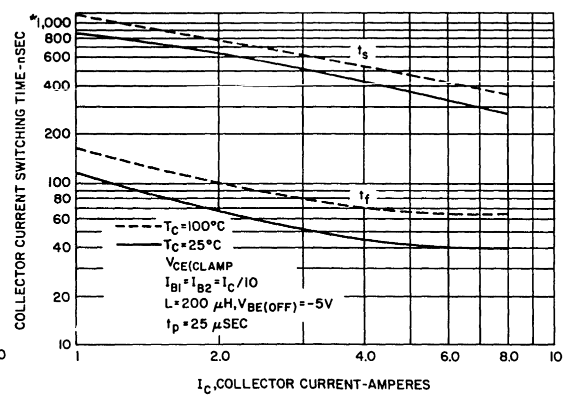


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

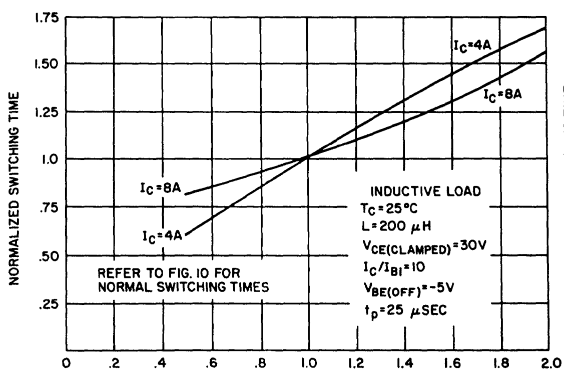


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

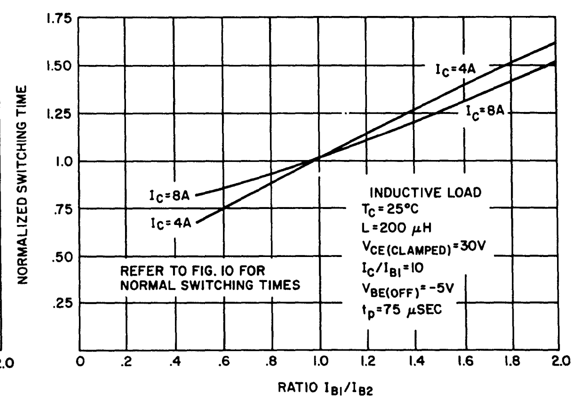


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

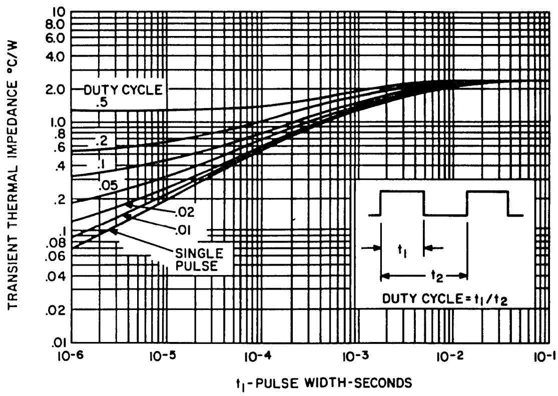


FIGURE 13. TRANSIENT THERMAL RESPONSE

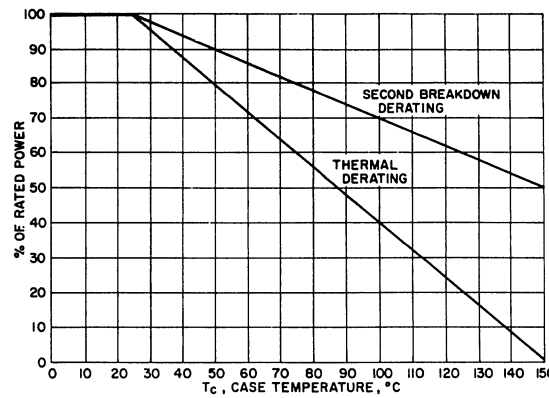
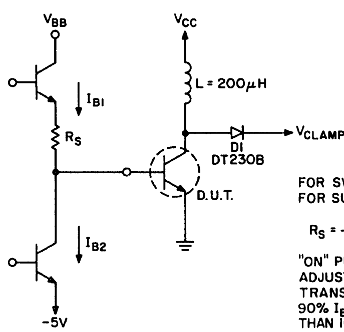


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS

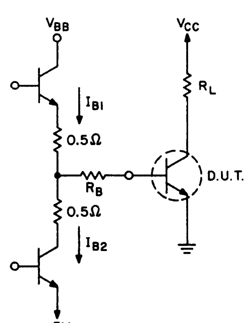


FOR SW. TIMES AND RBSOA
FOR SUSTAINING VOLTAGE

$R_S = \frac{V_{BB}}{I_{B1}}$

"ON" PULSE WIDTH AND V_{CC} ADJUSTED FOR DESIRED PEAK I_C. TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 nS.

FIGURE 15. INDUCTIVE SWITCHING AND V_{CEX}



$R_L = \frac{V_{CC}}{I_C}$, NONINDUCTIVE

$R_B = \frac{V_{BB}}{I_{B1}} - 0.5$

TRANSITION TIME FROM 90% I_{B1} TO 90% I_{B2} LESS THAN 10 nS.

FIGURE 16. RESISTIVE SWITCHING

Silicon P-N-P Transistors

Complementary to the D44C Series

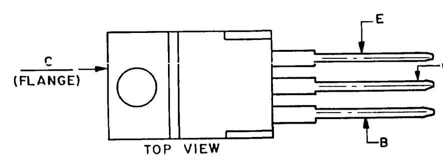
General-Purpose Types for Medium-Power Switching and Amplifier Applications

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.



92CS-39969

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%.

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 D45C4, 5, 6 D45C7, 8, 9 D45C10, 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)	D45C1, 4, 7, 10 D45C2, 5, 8, 11 D45C3, 6, 9, 12	h_{FE}	25 40 40	— — —	— 120 120	—
(I_C = –1A, V_{CE} = –1V)	D45C1, 4, 7, 10 D45C2, 5, 8, 11	h_{FE}	10 20	— —	— —	—
(I_C = –2A, V_{CE} = –1V)	D45C3, 6, 9, 12	h_{FE}	20	—	—	
Collector-Emitter Saturation Voltage (I_C = –1A, I_B = –50mA) (I_C = –1A, I_B = –100mA)	 D45C2, 5, 8, 11 D45C3, 6, 9, 12 D43C1, 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 = 1M_{Hz})		C_{CBO}	—	—	125	pF
Current-Gain — Bandwidth Product (I_C = –20mA, V_{CE} = –4V)		f_T	—	40	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = –1A, I_{B1} = I_{B2} = –0.1A, V_{CC} = –1A, t_p = 25 μsec	$t_d + t_r$	—	50	—	nS
Storage Time		t_s	—	500	—	
Fall Time		t_f	—	50	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

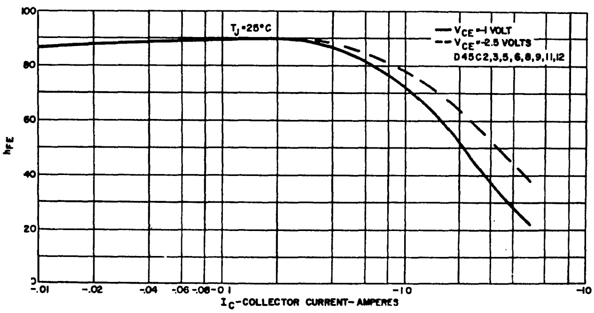


FIG. 1 TYPICAL h_{FE} VS. I_C

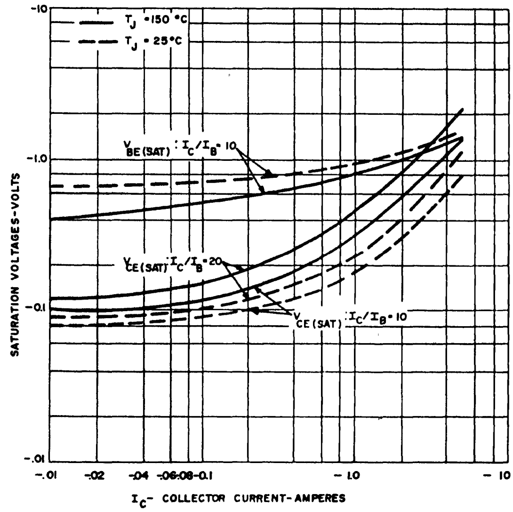


FIG. 2 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

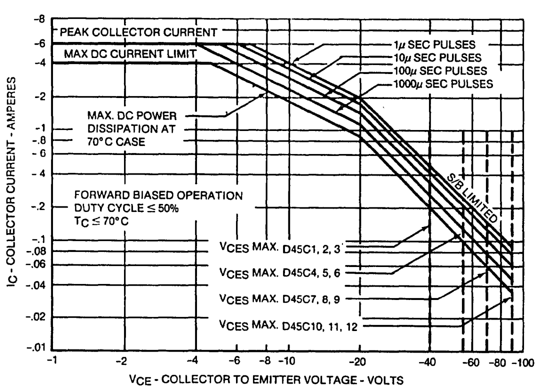


FIG. 3 SAFE REGION OF OPERATION

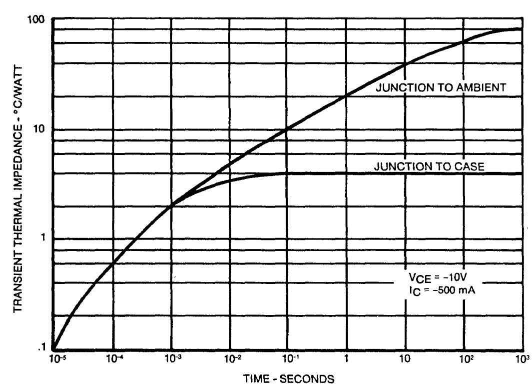


FIG. 4 MAXIMUM TRANSIENT THERMAL IMPEDANCE

6-Ampere P-N-P Darlington Power Transistors

Complementary to the D44D Series

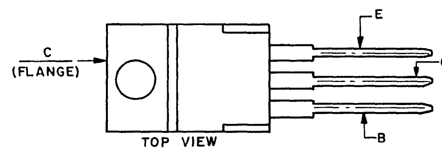
-40, -60, and -80 Volts, 30 Watts
Gain of 2000 at -1 A

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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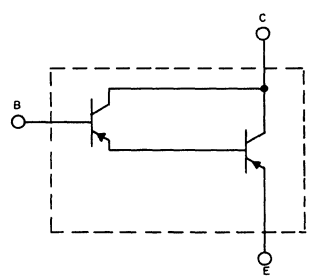

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Schematic diagram for all types.

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

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%.

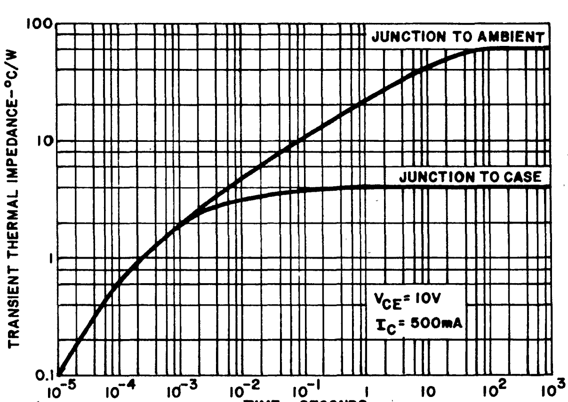


FIG. 1 MAXIMUM TRANSIENT THERMAL IMPEDANCE

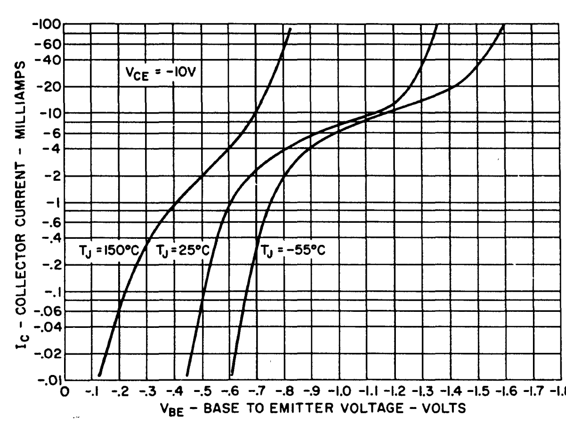


FIG. 2 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

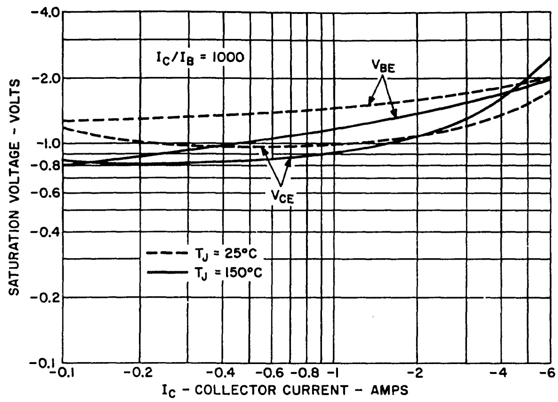


FIG. 3 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

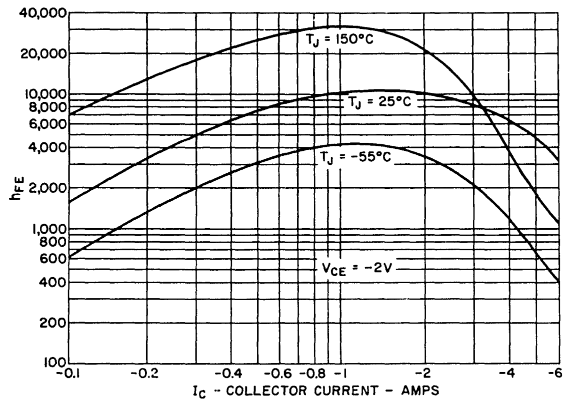


FIG. 4 TYPICAL h_{FE} VS. I_C

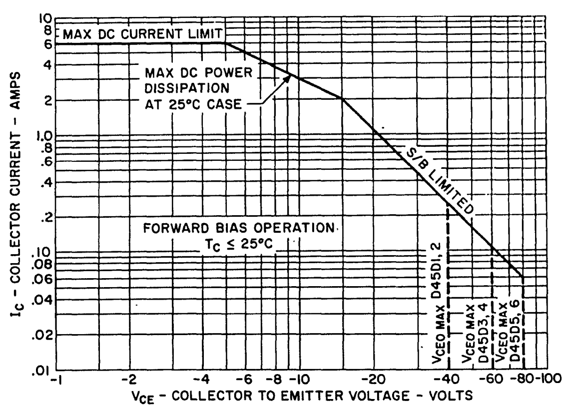


FIG. 5 SAFE REGION OF OPERATION

10-Ampere P-N-P Darlington Power Transistors

Complementary to the D44E Series

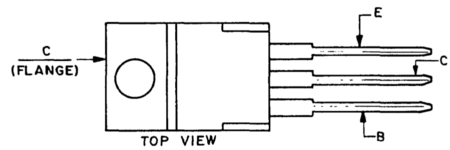
-40, -60, and -80 Volts, 50 Watts
Gain of 1000 at -5 A

Features:
- *Operates from IC without predriver*

Applications:
- *Driver*
- *Regulator*
- *Capacitor Multiplier*
- *Solenoid Driver*
- *Inverter Power Supply*
- *Switch*
- *Audio Output*
- *Relay Substitute*
- *Oscillator*
- *Servo-Amplifier*

The D45E-series p-n-p Darlington power 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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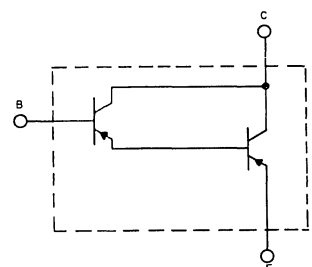


Schematic diagram for all types.

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 ≤ 2%.

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Voltage (I_C = -100mA)	D45E1	V_{CEO}	-40	—	—	Volts
	D45E2		-60	—	—	
	D45E3		-80	—	—	
Collector Cut-off Current (V_{CE} = Rated V_{CES})		I_{CES}	—	—	-10	μA
Emitter Cutoff Current (V_{EB} = -7V)		I_{EBO}	—	—	-1.0	μA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 6			
ON CHARACTERISTICS[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%.

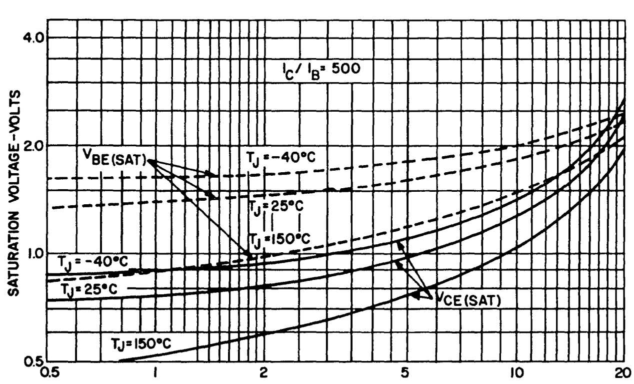


FIG. 1 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

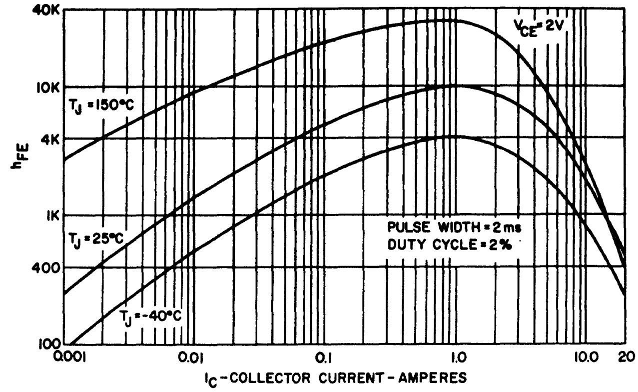


FIG. 2 TYPICAL GAIN CHARACTERISTIC

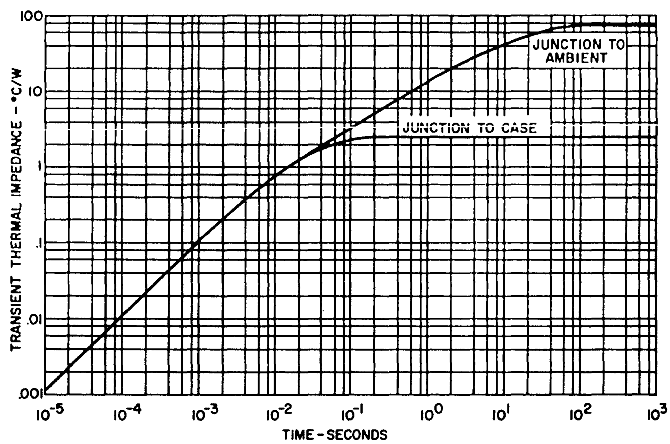


FIG. 3 TRANSIENT THERMAL IMPEDANCE

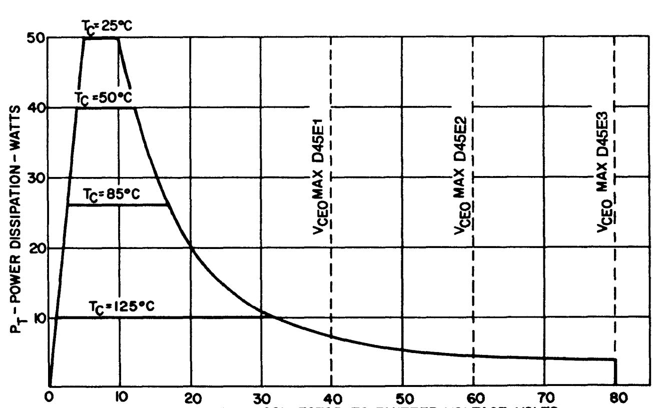


FIG. 4 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

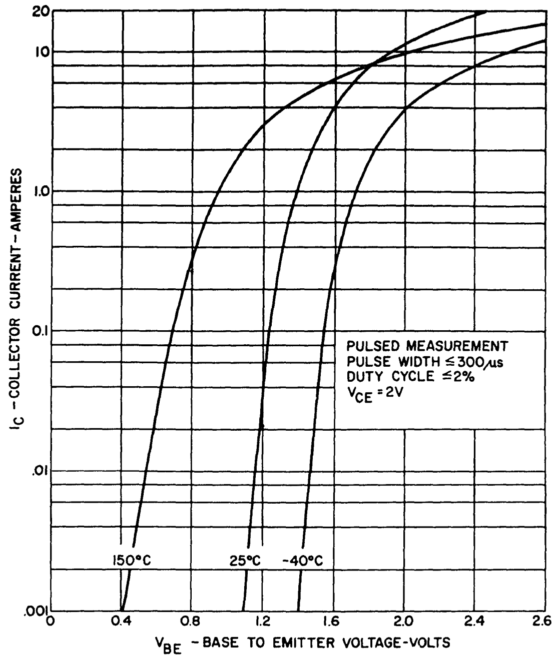


FIG. 5 TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

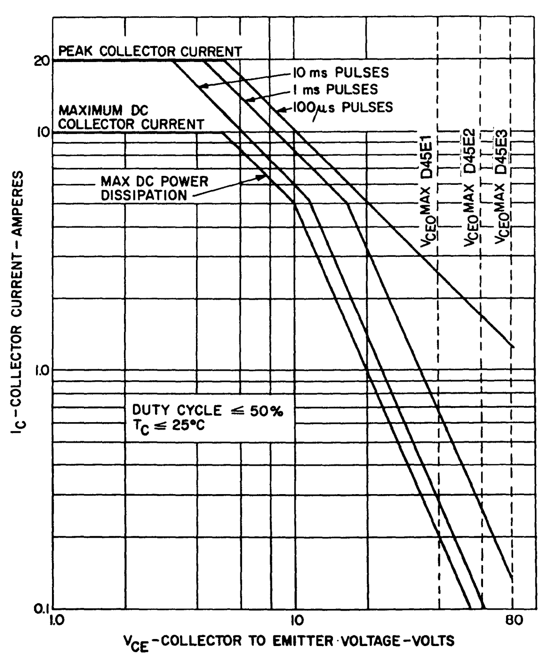


FIG. 6 SAFE REGION OF OPERATION

Silicon P-N-P Transistors

Complementary to the D44H Series

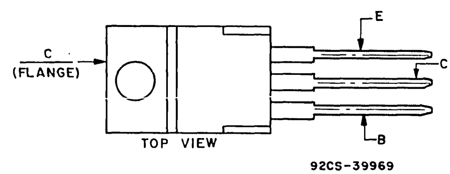
For Switching and Linear Applications

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%.

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

CHARACTERISTIC		SYMBOL	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage (I_C = -100mA)	D45H1, 2	$V_{CEO(sus)}$	-30	—	—	Volts
	D45H4, 5		-45	—	—	
	D45H7, 8		-60	—	—	
	D45H10, 11		-80	—	—	
Collector Cutoff Current (V_{CB} = Rated V_{CBO})		I_{CBO}	—	—	-10	µA
Emitter Cutoff Current (V_{EB} = -5V)		I_{EBO}	—	—	-100	µA
SECOND BREAKDOWN						
Second Breakdown with Base Forward Biased		FBSOA	SEE FIGURE 4			
ON CHARACTERISTICS[1]						
DC Current Gain (I_C = -2A, V_{CE} = -1V)	D45H1, 4, 7, 10	h_{FE}	35	—	—	—
	D45H2, 5, 8, 11		60	—	—	
(I_C = -4A, V_{CE} = -1V)	D45H1, 4, 7, 10		20	—	—	
	D45H2, 5, 8, 11		40	—	—	
Collector-Emitter Saturation Voltage (I_C = -8A, I_B = -0.4A)	D45H1, 4, 7, 10	$V_{CE(sat)}$	—	—	-1.0	Volts
(I_C = -8A, I_B = -0.8A)	D45H2, 5, 8, 11		—	—	-1.0	
Base-Emitter Saturation Voltage (I_C = -8A, I_B = -0.8A)		$V_{BE(sat)}$	—	—	-1.5	Volts
DYNAMIC CHARACTERISTICS						
Collector Capacitance (V_{CB} = -10V, f = 1MHz)		C_{CBO}	—	230	—	pF
Current-Gain — Bandwidth Product (I_C = -500mA, V_{CE} = -10V)		f_T	—	40	—	MHz
SWITCHING CHARACTERISTICS						
Resistive Load						
Delay Time + Rise Time	I_C = -5A, I_{B1} = -0.5A	$t_d + t_r$	—	135	—	nS
Storage Time	I_C = -5A, I_{B1} = I_{B2} = -0.5A	t_s	—	500	—	
Fall Time		t_f	—	100	—	

(1) Pulse Test PW = 300ms Duty Cycle ≤ 2%.

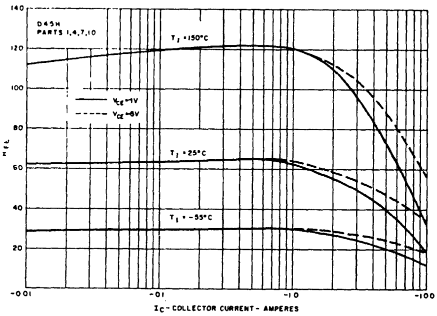


FIG. 1 TYPICAL GAIN CHARACTERISTICS

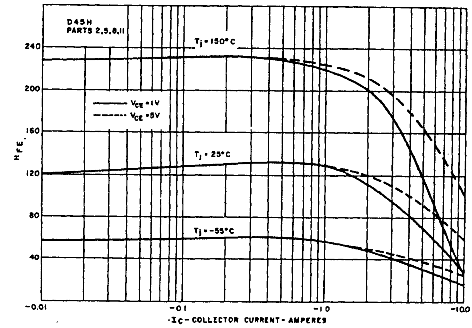


FIG. 2 TYPICAL GAIN CHARACTERISTICS

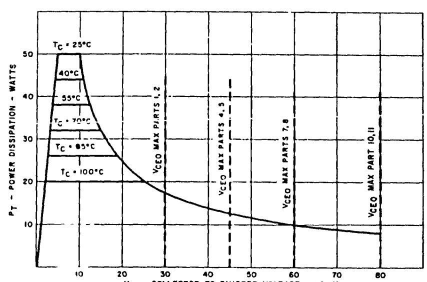


FIG. 3 MAXIMUM PERMISSIBLE DC POWER DISSIPATION

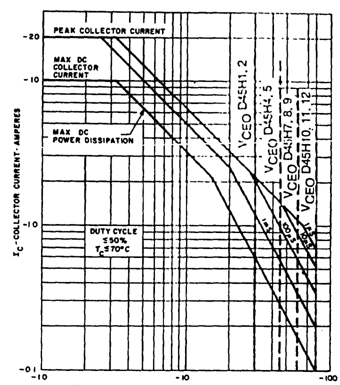


FIG. 4 SAFE REGION OF OPERATION

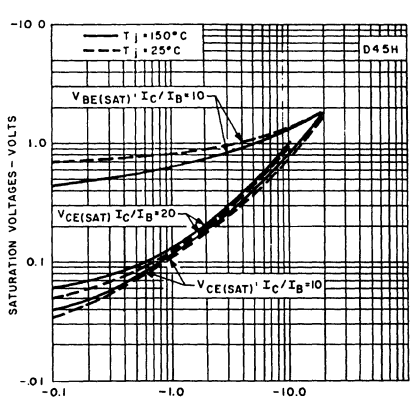


FIG. 5 TYPICAL SATURATION VOLTAGE CHARACTERISTICS

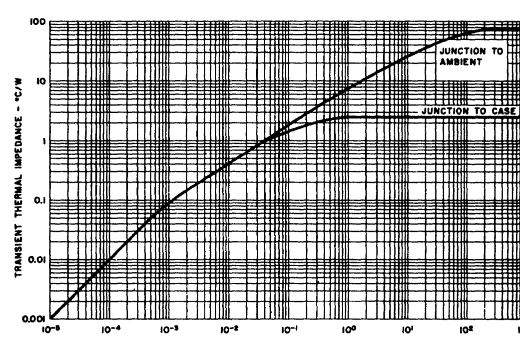


FIG. 6 TRANSIENT THERMAL IMPEDANCE

Silicon P-N-P Transistors

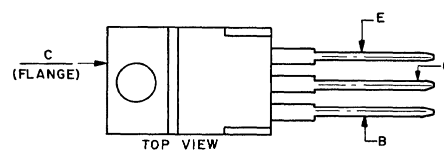
Complementary to the D44VH Series

Features:

- *Fast Switching $t_s \leq 500$ ns resistive*
  $t_f \leq 100$ ns
- *Low $V_{CE(sat)} \leq 1.0V$ @ $I_C = 8A$*

The D45VH-series of silicon p-n-p power transistors are especially designed for use in switching circuits such as switching regulators, high-frequency inverters/converters, and other applications where very fast switching times and low-saturation voltages are necessary. These devices are tested for parameters that relate directly to the design of high-power switching circuits. Switching times, saturation voltages, and leakage currents are specified at 100°C to provide information necessary for worst-case design.

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS (T_A = 25° 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.

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

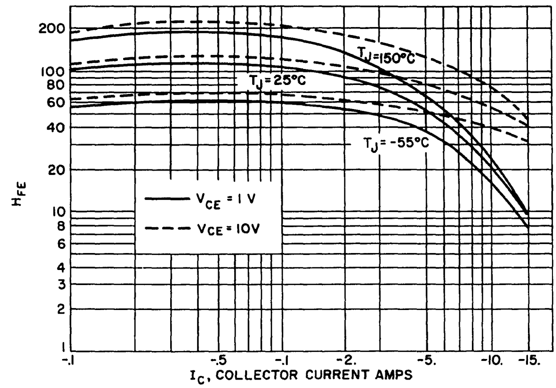
		Typical	
Current-Gain — Bandwidth Product (I_C = -0.1A, V_{CE} = -10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = -10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	275	pF

SWITCHING CHARACTERISTICS

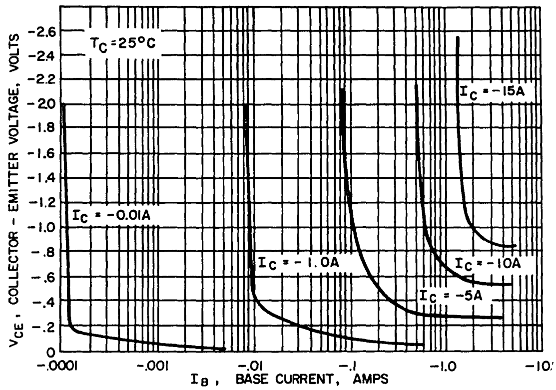
			Maximum		
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = -20V, I_C = -8A	t_d	50	—	nsec
Rise Time	I_{B1} = I_{B2} = 0.8A	t_r	250	—	nsec
Storage Time	t_p = 25 μsec	t_s	500	—	nsec
Fall Time		t_f	100	—	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	V_{CC} = -20V, I_C = -8A	t_s	500	600	nsec
Fall Time	V_{CLAMP} = Rated V_{CEX}	t_f	300	400	nsec
	I_{B1} = - 0.8A, $V_{BE(off)}$ = 5V		**Typical**		
Storage Time	L = 200 μh	t_s	200	320	nsec
Fall Time		t_f	160	180	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ≤ 2%.
(2) See Figure 15 for Test Circuit.

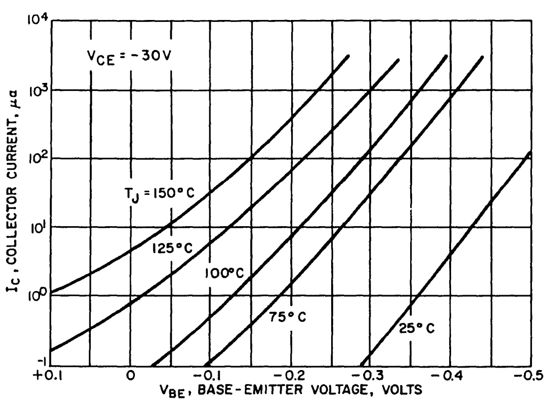
TYPICAL DC CHARACTERISTICS



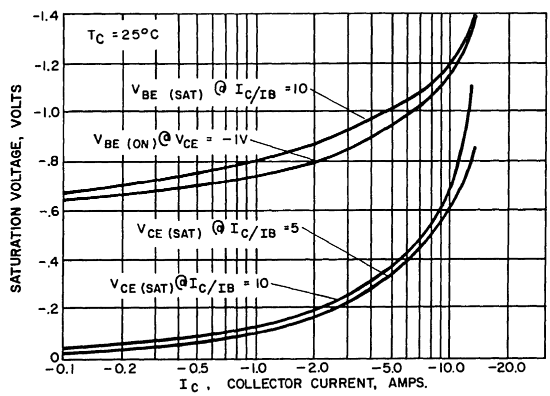
1. DC CURRENT GAIN



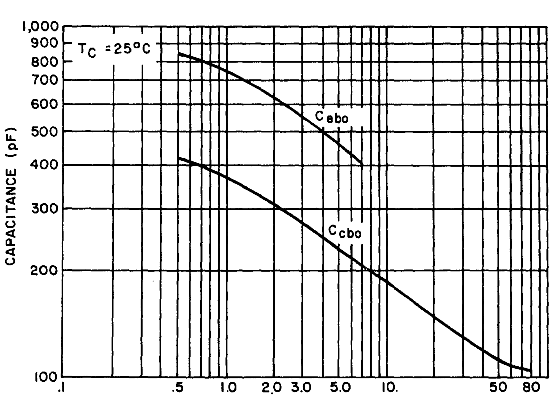
2. COLLECTOR SATURATION REGION



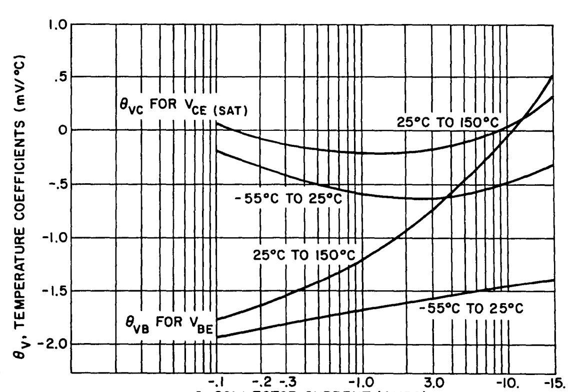
3. COLLECTOR CUTOFF REGION



4. SATURATION VOLTAGE

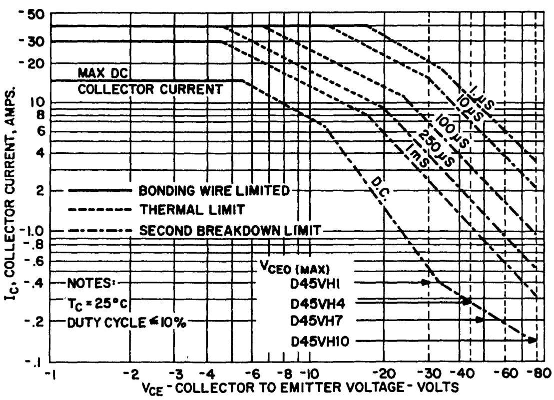


5. CAPACITANCE

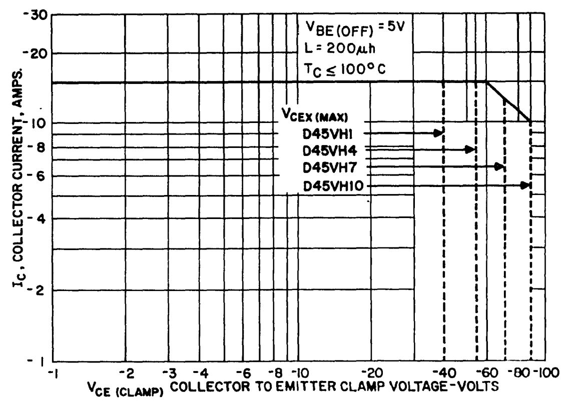


6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

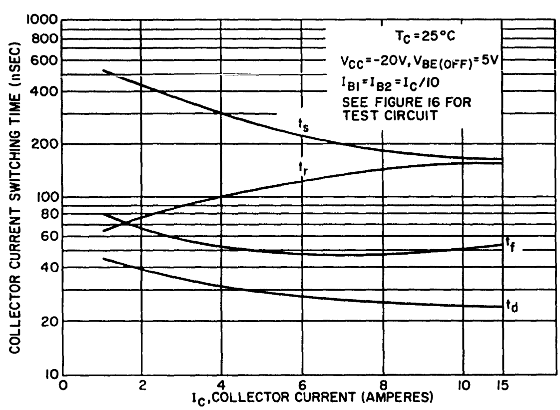


7. FORWARD BIAS SOA

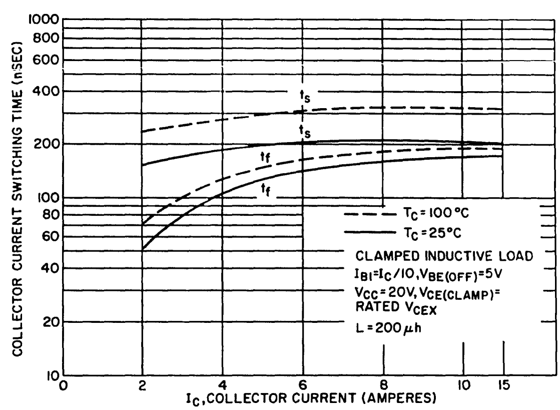


8. REVERSE BIAS SOA

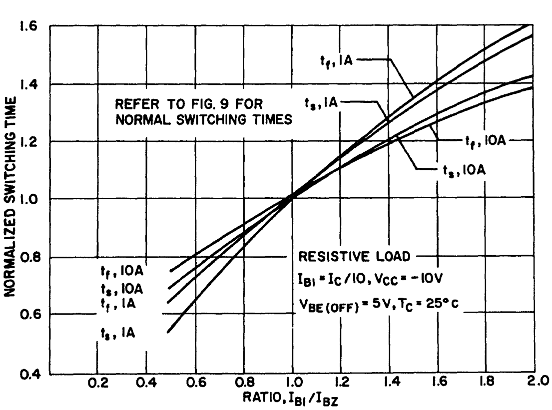
TYPICAL SWITCHING CHARACTERISTICS



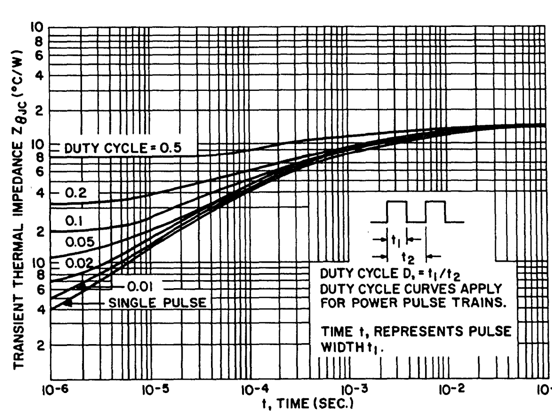
9. RESISTIVE SWITCHING TIME



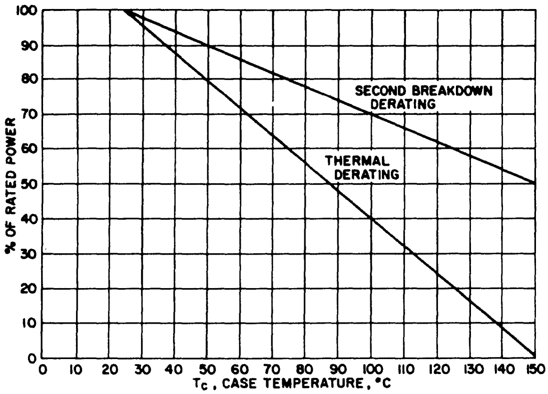
10. CLAMPED INDUCTIVE SWITCHING TIME



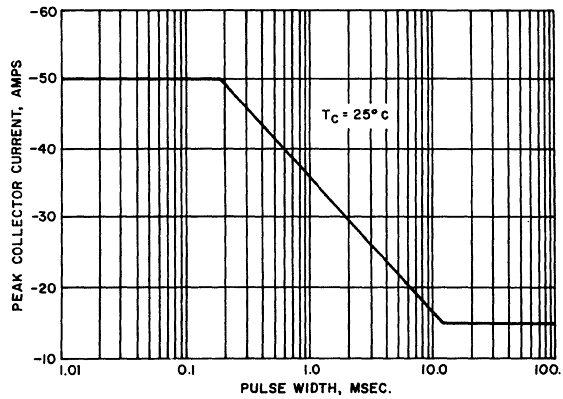
11. SWITCHING TIME VARIATION WITH I_{B2}



12. TRANSIENT THERMAL RESPONSE

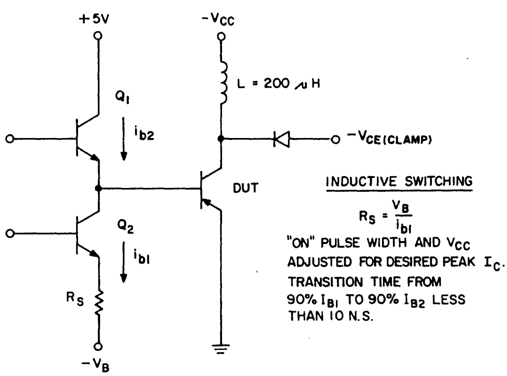


13. POWER DERATING FACTOR

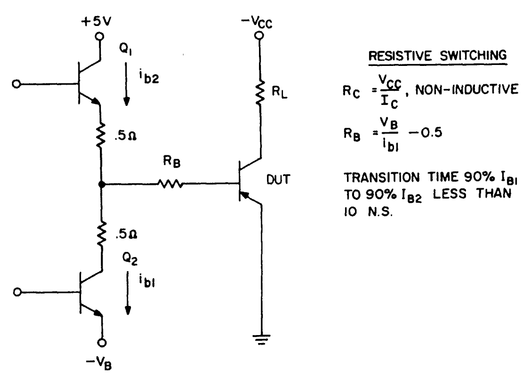


14. MAXIMUM SINGLE PULSE COLLECTOR CURRENT

TEST CIRCUITS



15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

Silicon P-N-P Transistors

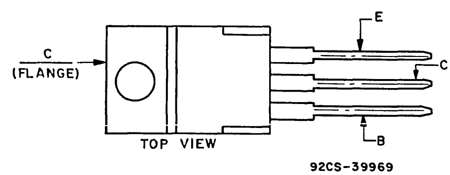
Complementary to the D44VM Series

Features:

- *Very Fast Switching $t_s \leq 500$ ns resistive*
  $t_f \leq 75$ ns
- *Very low $V_{CE(sat)} \leq 0.4V$ @ $I_C = 4A$*
- *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.

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

CHARACTERISTICS	SYMBOL	MIN	MAX	UNIT
OFF CHARACTERISTICS[1]				
Collector-Emitter Sustaining Voltage[1] (I_C = -100mA, I_B = 0)	$V_{CEO(sus)}$			V
D45VM1		-30	—	
D45VM4		-45	—	
D45VM7		-60	—	
D45VM10		-80	—	
Collector-Emitter Voltage[2] (I_C = -3A, V_{CLAMP} = Rated V_{CEX}, $T_C \leqslant$ 100°C)	V_{CEX}			V
D45VM1		-30	—	
D45VM4		-45	—	
D45VM7		-60	—	
D45VM10		-80	—	
Collector Cutoff Current	I_{CEV}			μA
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V)		—	-10	
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 4.0V, T_C = 100°C)		—	-100	
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	-100	μA
Emitter Cutoff Current (V_{EB} = -7V, I_C = 0)	I_{EBO}	—	-10	μA
SECOND BREAKDOWN				
Second Breakdown with Base Forward Biased	F_{BSOA}	SEE FIGURE 7		
Second Breakdown with Base Reverse Biased	R_{BSOA}	SEE FIGURE 8		
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = -4A, V_{CE} = -1V)		40	—	
(I_C = -6A, V_{CE} = -1V)		20	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = -4A, I_B = -0.2A)		—	-0.4	
(I_C = -6A, I_B = -0.3A)		—	-0.6	
(I_C = -8A, I_B = -0.8A, T_C = 100°C)		—	-1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			V
(I_C = -4A, I_B = -0.2A)		—	-1.2	
(I_C = -4A, I_B = -0.2A, T_C = 100°C)		—	-1.2	

DYNAMIC CHARACTERISTICS

CHARACTERISTICS	SYMBOL	Typical	UNIT
Current-Gain — Bandwidth Product (I_C = -0.1A, V_{CE} = -10V, f_{test} = 1 MHz)	f_T	50	MHz
Output Capacitance (V_{CB} = -10V, I_E = 0, f_{test} = 1 MHz)	C_{OB}	70	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Maximum 25°C	Maximum 100°C	Unit
Resistive Load (See Figure 16 for Test Circuit)		T_C	25°C	100°C	
Delay Time	V_{CC} = 30V, I_C = -6A, I_{B1} = I_{B2} = 0.6A, t_p = 25 μsec	t_d	30	40	nsec
Rise Time		t_r	250	350	nsec
Storage Time		t_s	500	600	nsec
Fall Time		t_f	75	250	nsec
Inductive Load, Clamped (See Figure 15 for Test Circuit)					
Storage Time	$V_{CE(CLAMP)}$ = 30V, I_C = -6A, I_{B1} = I_{B2} = 0.6A, $V_{BE(OFF)}$ = 5V	t_s	500	600	nsec
Fall Time		t_f	70	100	nsec
			Typical		
Storage Time	L = 200 μh	t_s	340	430	nsec
Fall Time		t_f	40	57	nsec

(1) Pulse Duration = 300 μsec, Duty Factor ⩽ 2%.
(2) See Figure 15 for Test Circuit.

TYPICAL DC CHARACTERISTICS

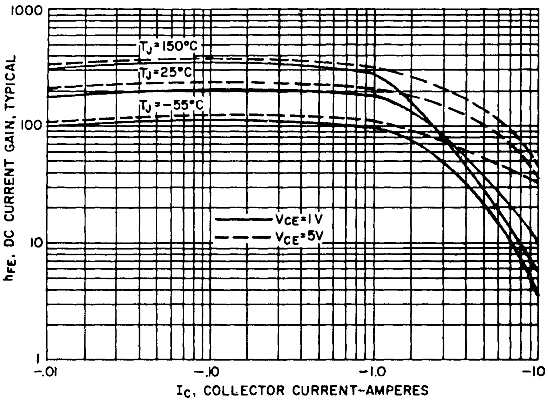


FIGURE 1. DC CURRENT GAIN

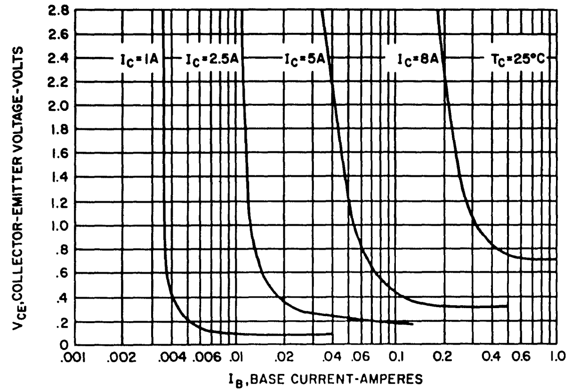


FIGURE 2. COLLECTOR SATURATION REGION

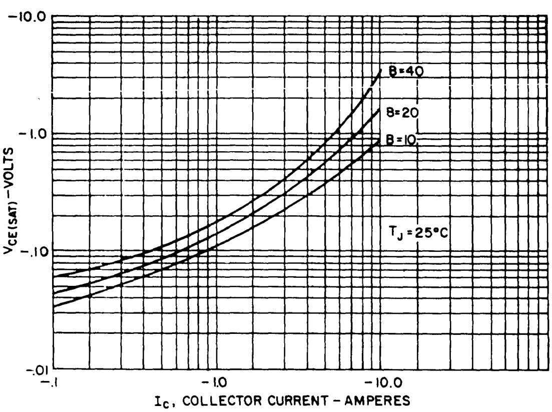


FIGURE 3. $V_{CE(SAT)}$ VS. I_C

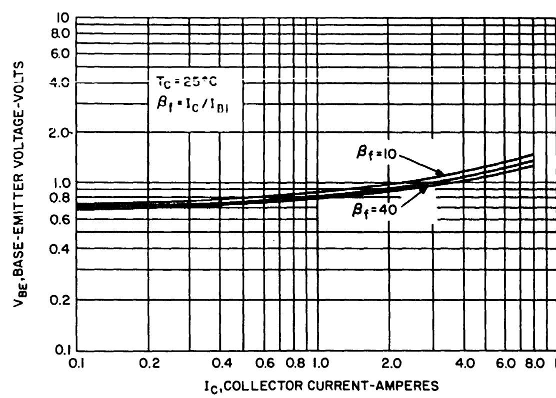


FIGURE 4. $V_{BE(SAT)}$ VS. I_C

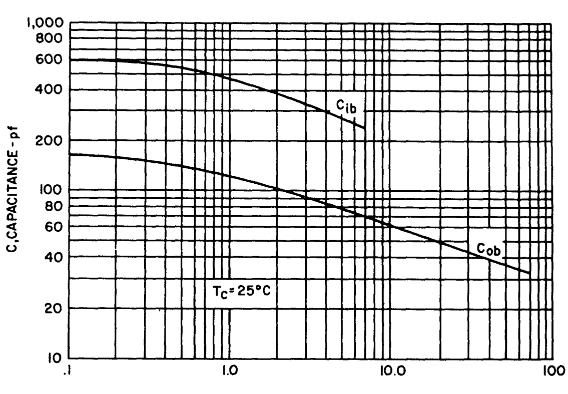


FIGURE 5. CAPACITANCE

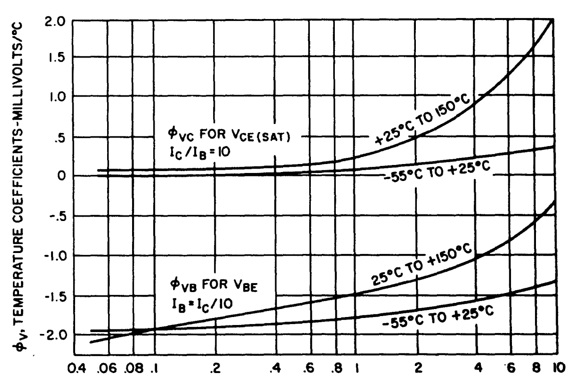


FIGURE 6. SATURATION VOLTAGE TEMPERATURE COEFFICIENTS

SAFE OPERATING AREA

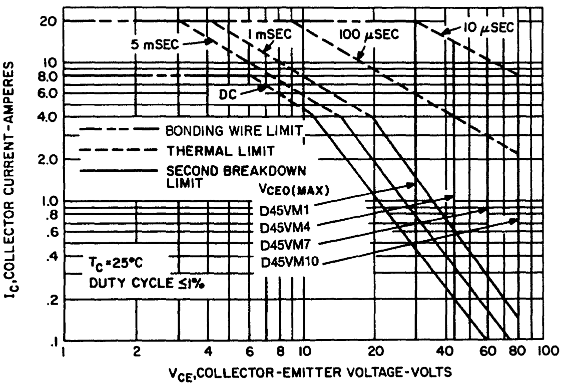


FIGURE 7. FORWARD BIAS SOA

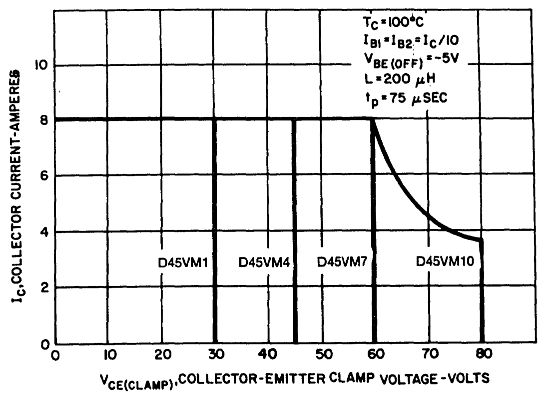


FIGURE 8. CLAMPED REVERSE BIAS SOA

TYPICAL SWITCHING CHARACTERISTICS

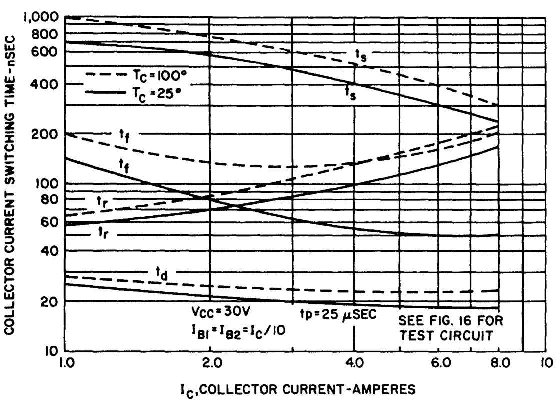


FIGURE 9. RESISTIVE SWITCHING TIME

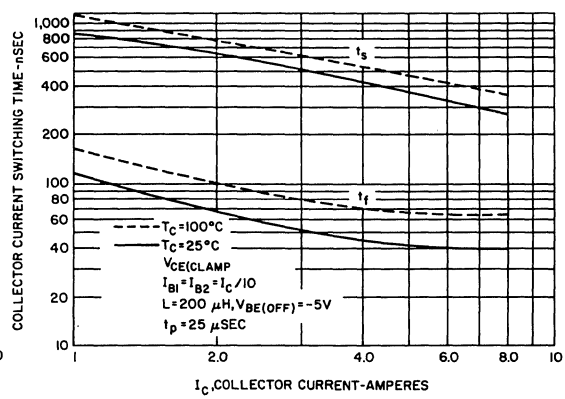


FIGURE 10. CLAMP INDUCTIVE TURN-OFF TIME

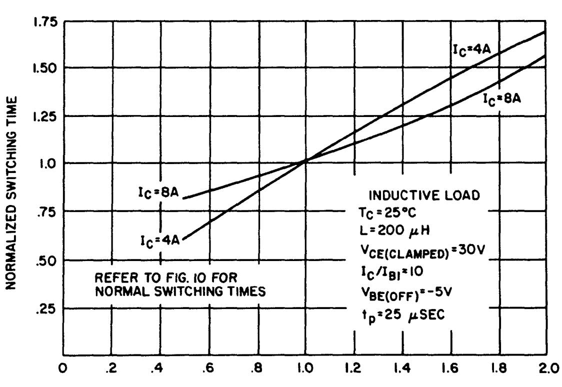


FIGURE 11. STORAGE TIME VARIATION WITH I_{B2}

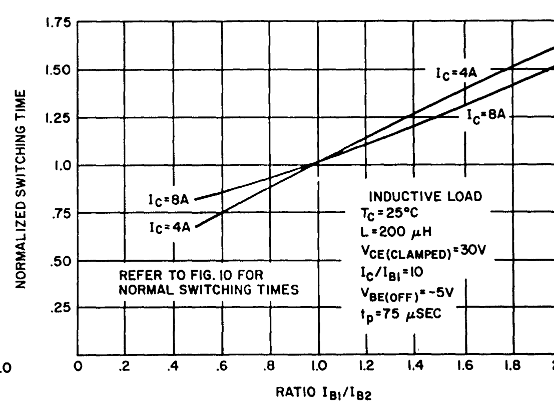


FIGURE 12. FALL TIME VARIATION WITH I_{B2}

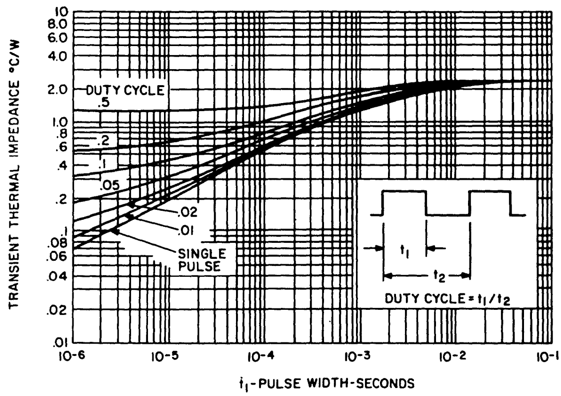


FIGURE 13. TRANSIENT THERMAL RESPONSE

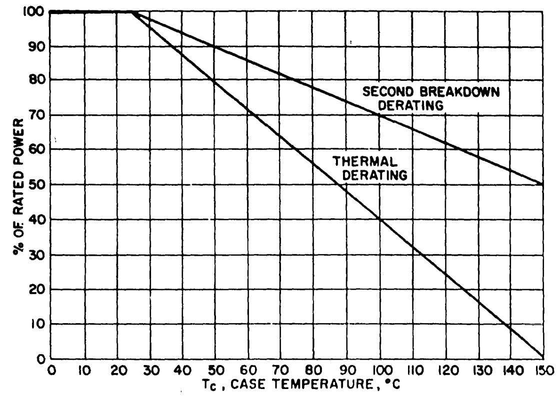
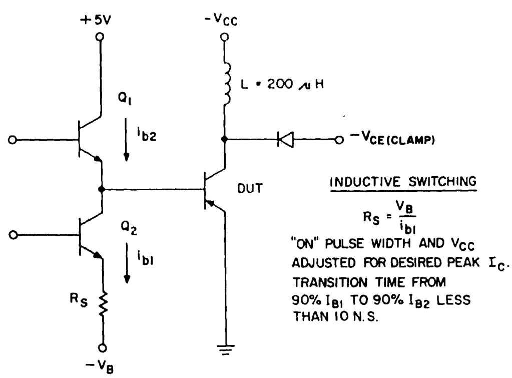
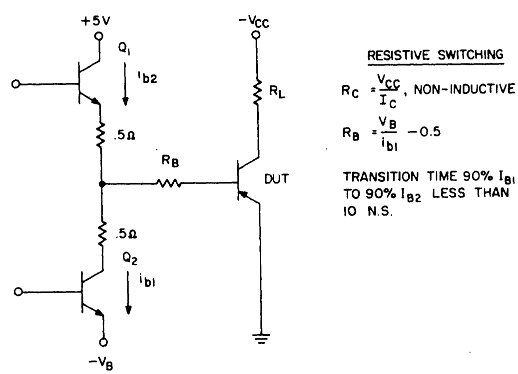


FIGURE 14. POWER DERATING FACTOR

TEST CIRCUITS



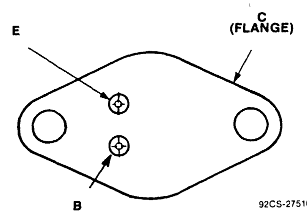
15. INDUCTIVE SWITCHING AND V_{CEX}



16. RESISTIVE SWITCHING

50-Ampere N-P-N Darlington Power Transistors

TERMINAL DESIGNATIONS



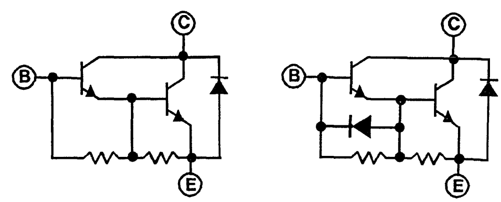
JEDEC TO-204AE

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.



D64DV **D64EV**

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

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

TYPICAL CHARACTERISTICS

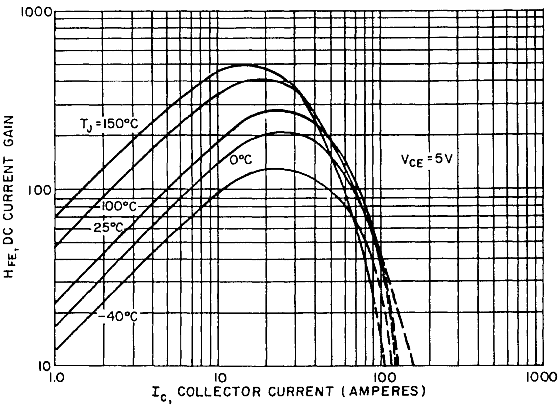


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

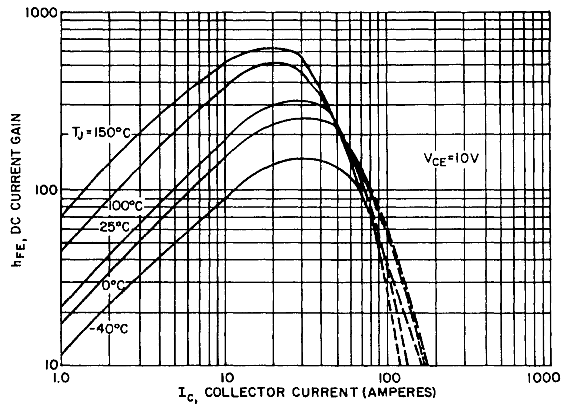


FIGURE 2. DC CURRENT GAIN (V_{CE} = 10V)

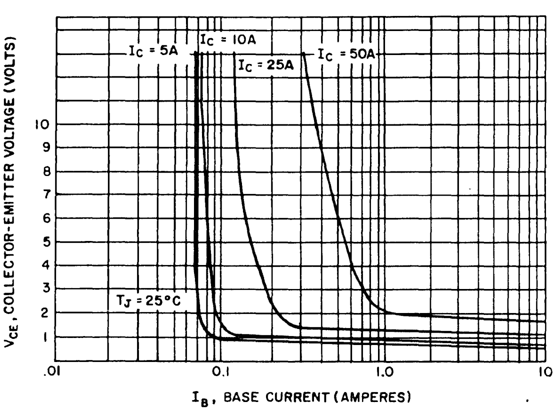


FIGURE 3. COLLECTOR SATURATION REGION

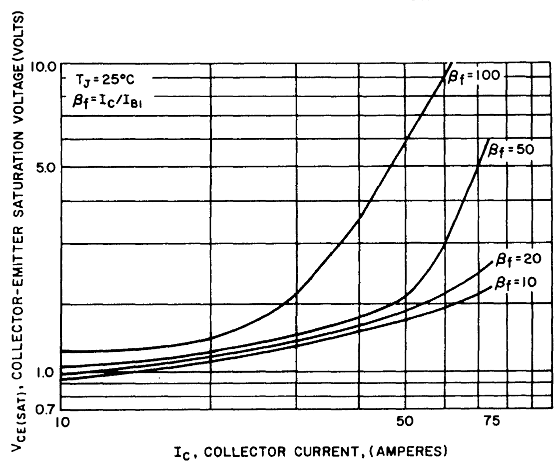


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C, T_J = 25°C

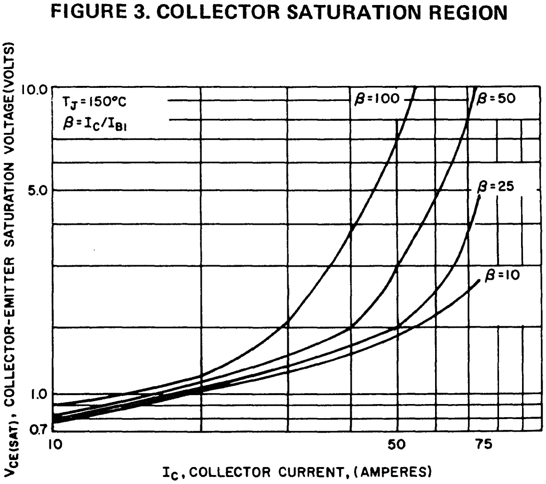


FIGURE 5. $V_{CE\ (SAT)}$ VS I_C, T_J = 150°C

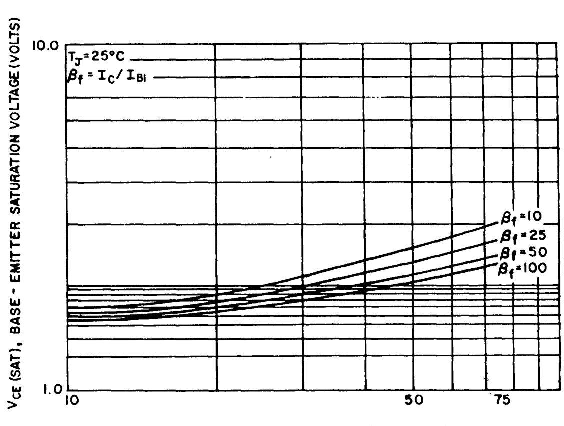


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C, T_J = 25°C

TYPICAL CHARACTERISTICS

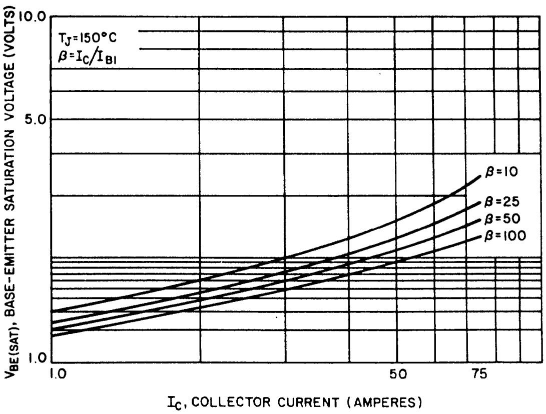


FIGURE 7. $V_{BE\ (SAT)}$ VS I_C, T_J = 150°C

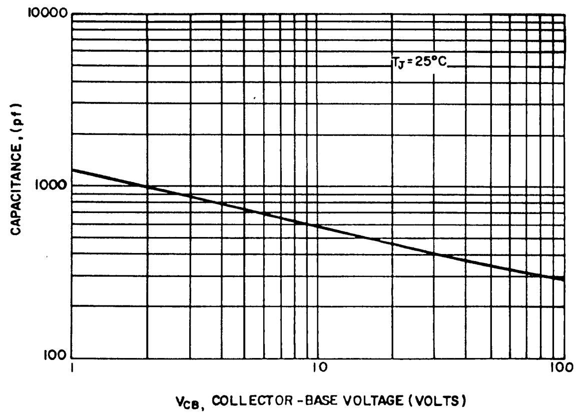


FIGURE 8. CAPACITANCE (C_{CBO})

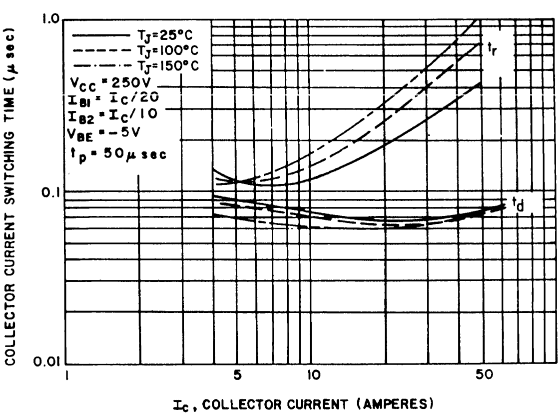


FIGURE 9. TURN-ON TIME (RESISTIVE LOAD) (D64DV ONLY)

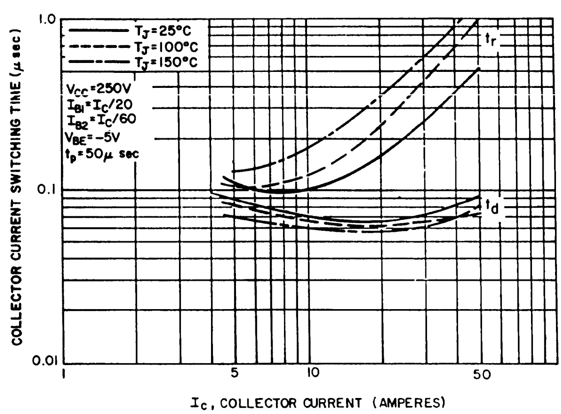


FIGURE 10. TURN-ON TIME (RESISTIVE LOAD) (D64EV ONLY)

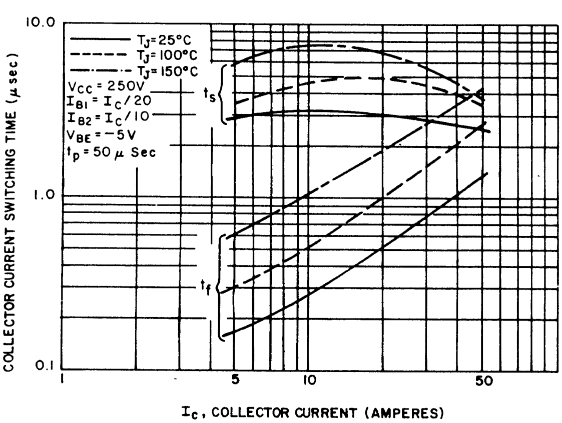


FIGURE 11. TURN-OFF TIME (RESISTIVE LOAD) (D64DV ONLY)

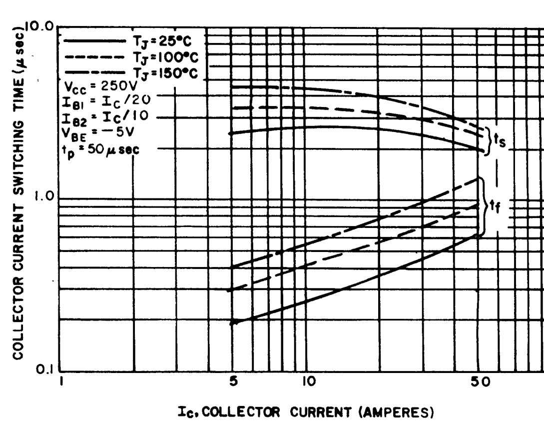


FIGURE 12. TURN-OFF TIME (RESISTIVE LOAD) (D64EV ONLY)

TYPICAL CHARACTERISTICS

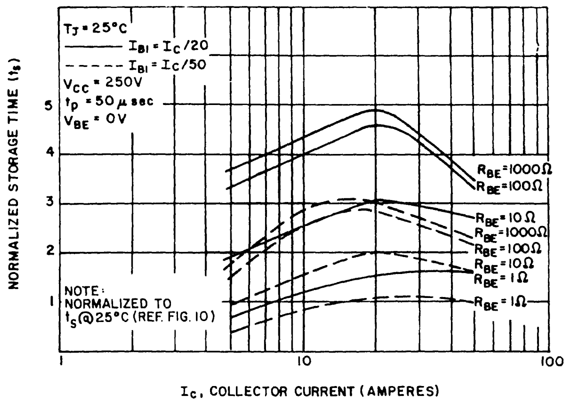


FIGURE 13. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARATIONS) VS COLLECTOR CURRENT (D64DV ONLY)

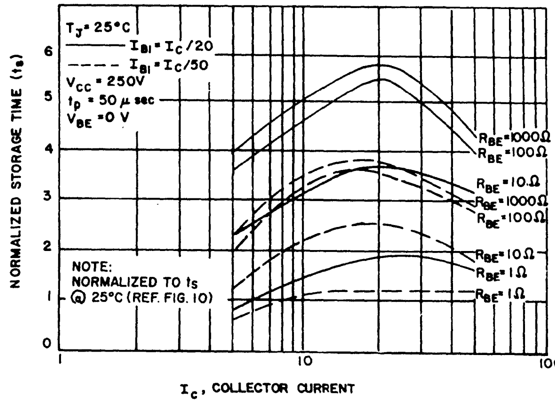


FIGURE 14. NORMALIZED RESISTIVE SWITCHING STORAGE TIME (R_{BE} VARATIONS) VS COLLECTOR CURRENT (D64EV ONLY)

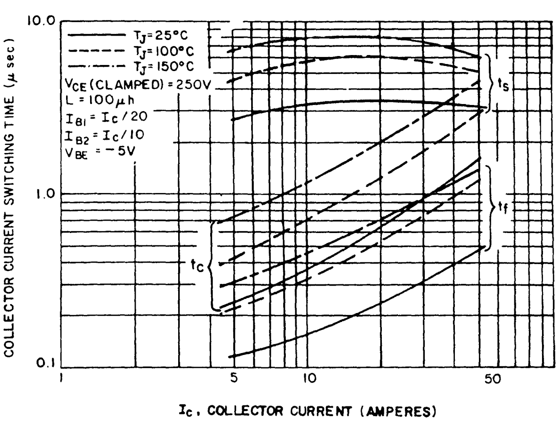


FIGURE 15. CLAMPING INDUCTIVE TURN-OFF TIME (D64DV ONLY)

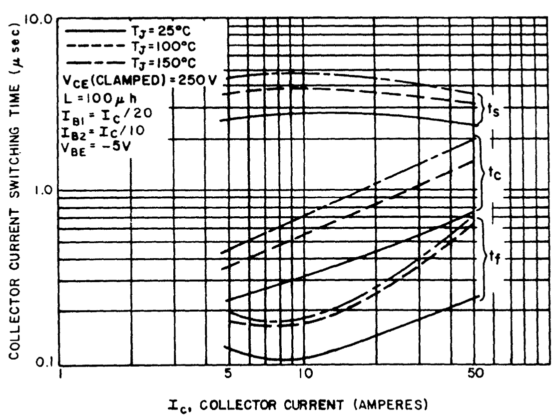


FIGURE 16. CLAMPING INDUCTIVE TURN-OFF TIME (D64EV ONLY)

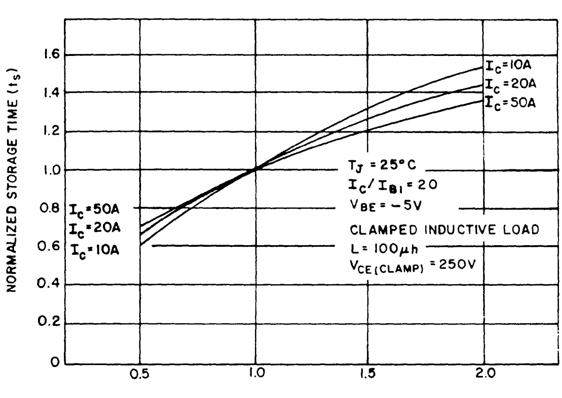


FIGURE 17. STORAGE TIME VARIATION WITH I_{B2} (D64DV ONLY)

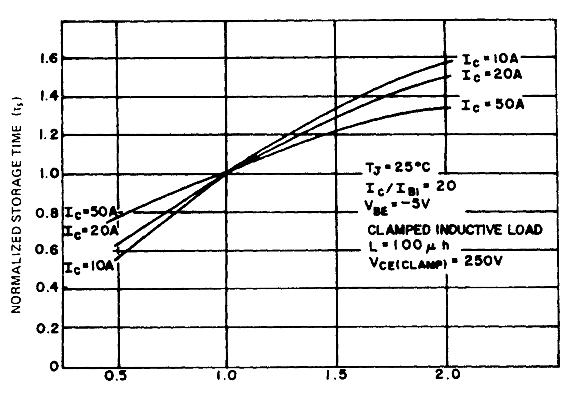


FIGURE 18. STORAGE TIME VARIATION WITH I_{B2} (D64EV ONLY)

TYPICAL CHARACTERISTICS

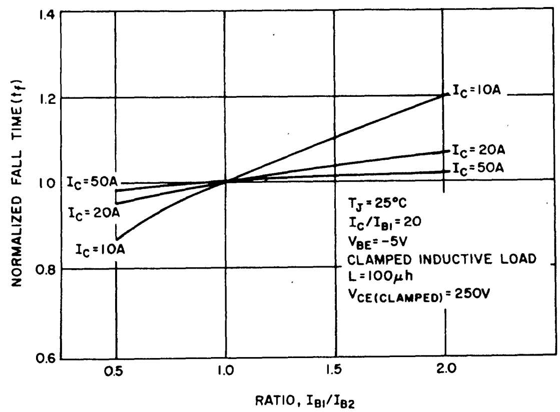


FIGURE 19. FALL TIME VARIATION WITH I_{B2} (D64DV ONLY)

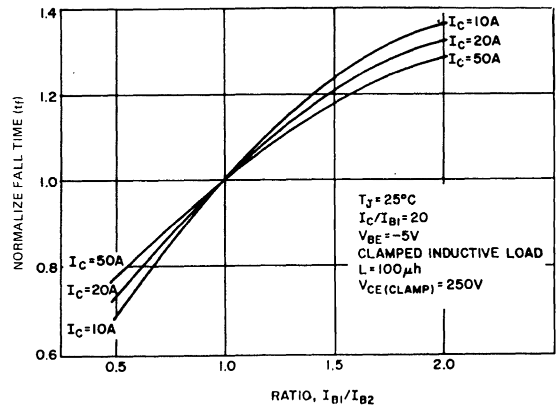


FIGURE 20. FALL TIME VARIATION WITH I_{B2} (D64EV ONLY)

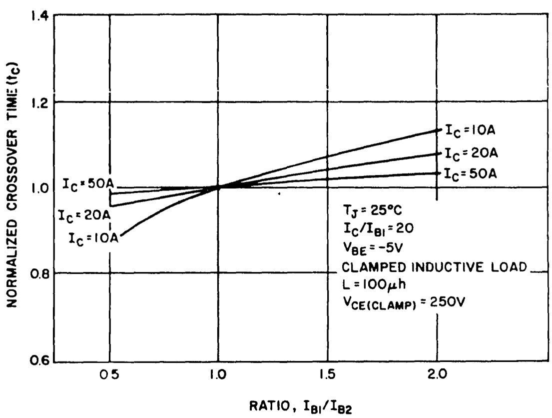


FIGURE 21. CROSSOVER TIME VARIATION WITH I_{B2} (D64DV ONLY)

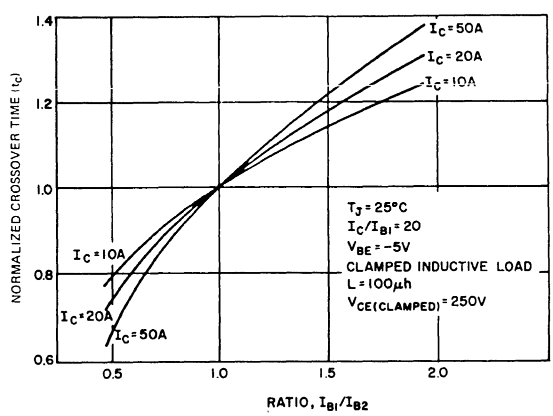


FIGURE 22. CROSSOVER TIME VARIATION WITH I_{B2} (D64EV ONLY)

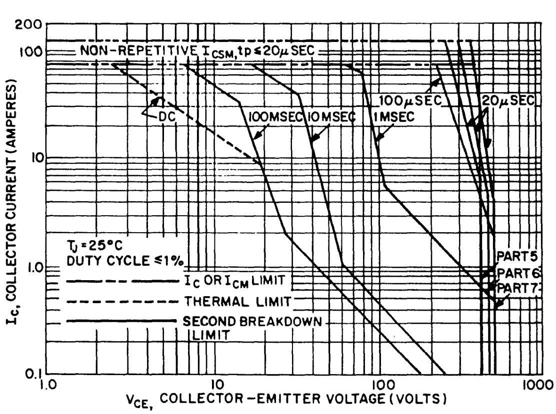


FIGURE 23. FORWARD BIAS SAFE OPERATING AREA

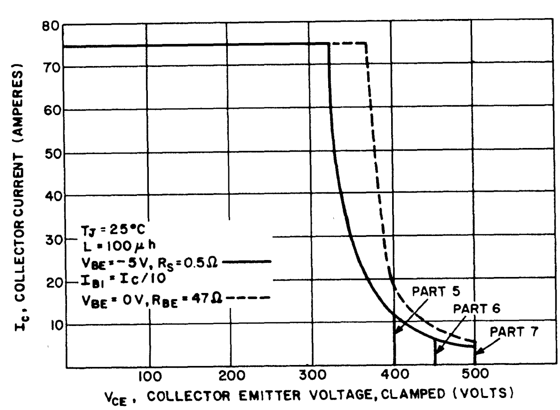


FIGURE 24. REVERSE BIAS SAFE OPERATING AREA (CLAMPED)

TYPICAL CHARACTERISTICS

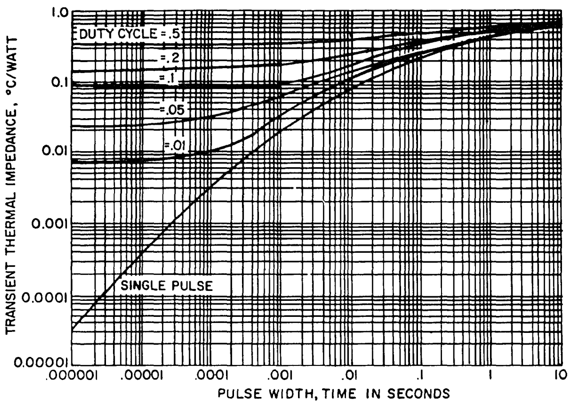


FIGURE 25. TRANSIENT THERMAL RESPONSE

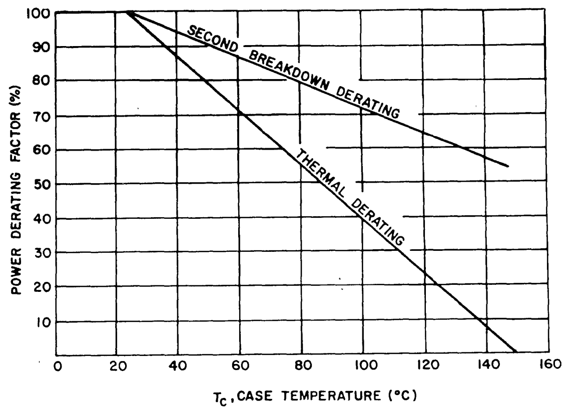


FIGURE 26. POWER DERATING

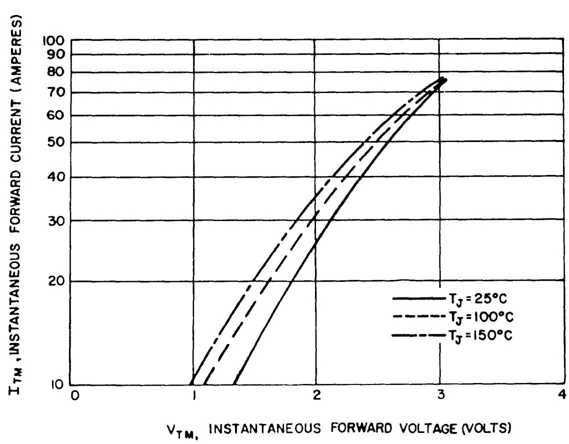


FIGURE 27. FORWARD CHARACTERISTICS

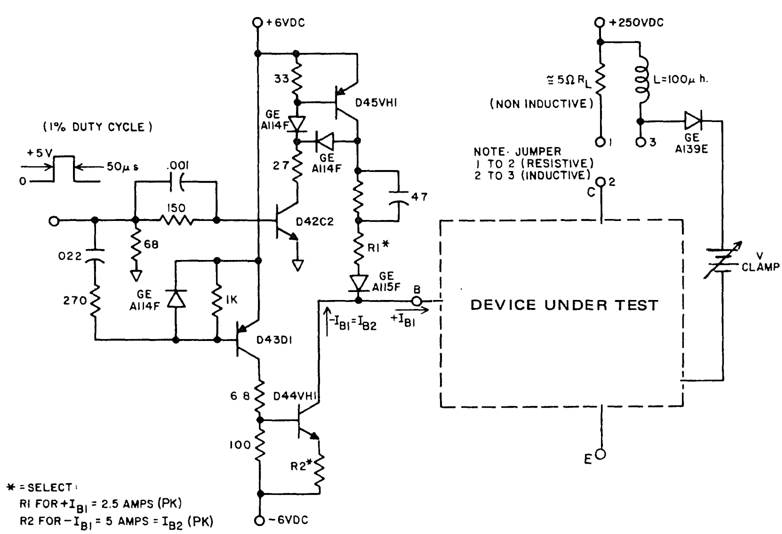


FIGURE 28. SWITCHING TIME TEST CIRCUIT

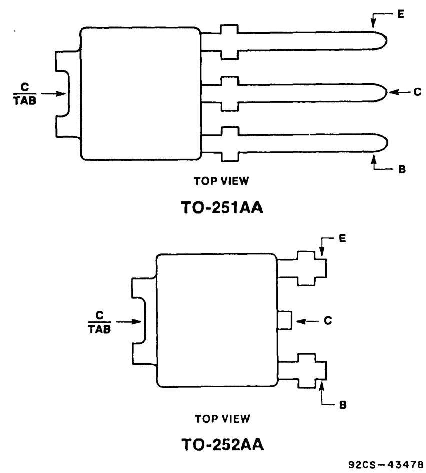
5-Ampere Silicon N-P-N Power Transistors

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



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.

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

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	—	

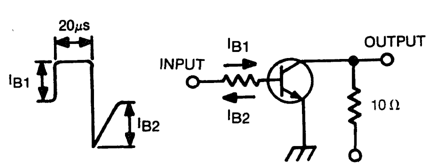


FIG. 1 SWITCHING TIME TEST CIRCUIT

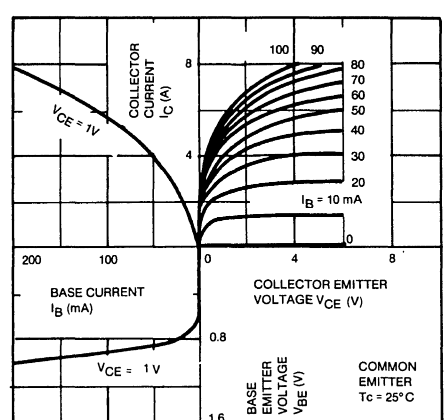


FIG. 2 STATIC CHARACTERISTICS

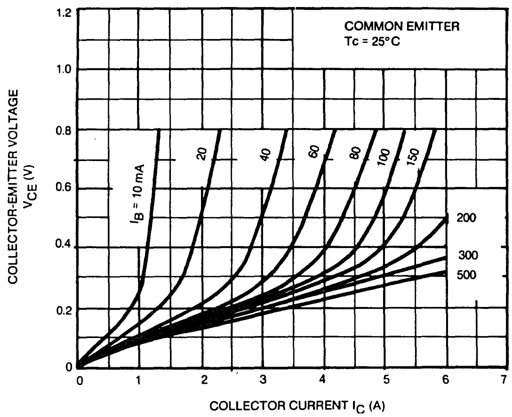


FIG. 3 V_{CE} - I_C

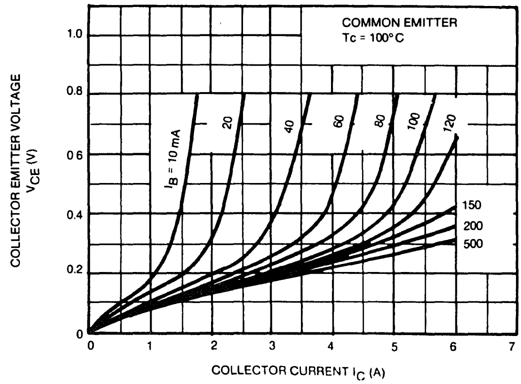


FIG. 4 V_{CE} - I_C

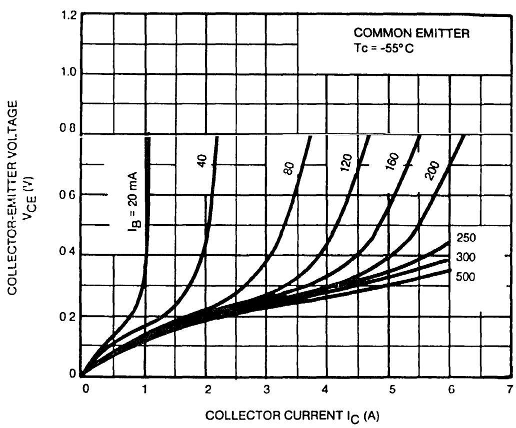


FIG. 5 V_{CE} - I_C

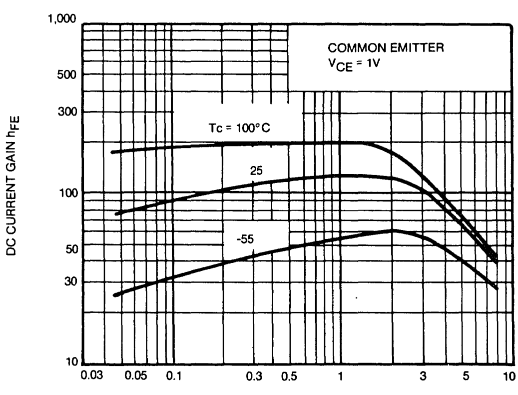


FIG. 6 h_{FE} - I_C

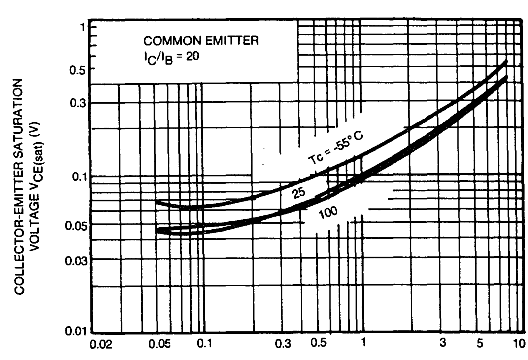


FIG. 7 $V_{CE(sat)}$ - I_C

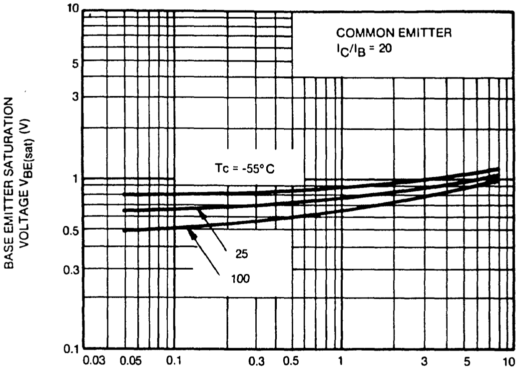


FIG. 8 $V_{BE(sat)}$ - I_C

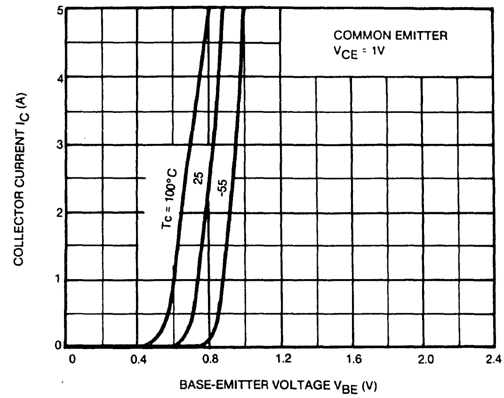


FIG. 9 I_C - V_{BE}

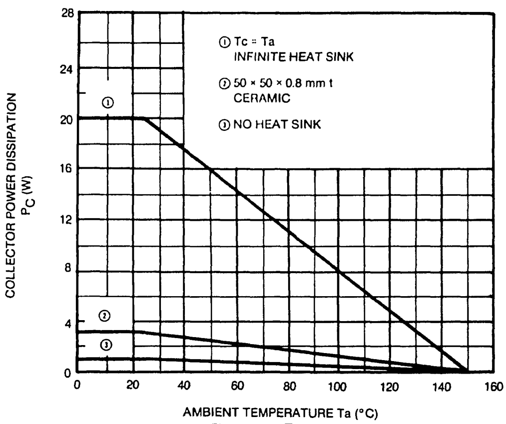


FIG. 10 P_C - Ta

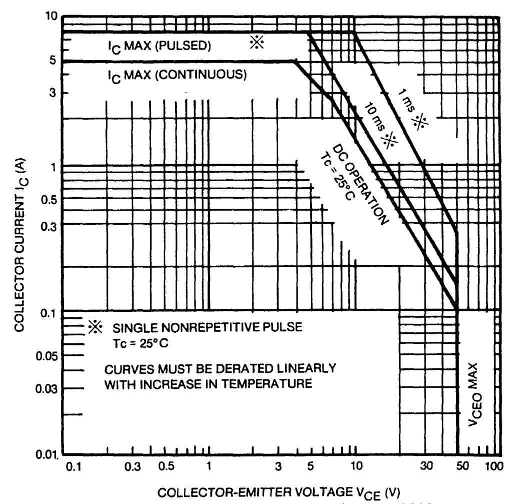


FIG. 11 SAFE OPERATING AREA

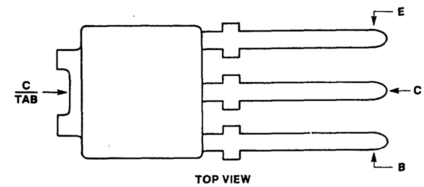
4-Ampere N-P-N Power Darlington Transistors

Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 2000*
- *Complementary to D73FY4D1,2*

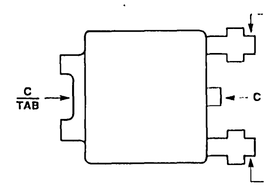
The D72FY4D1 and D72FY4D2 silicon n-p-n power Darlington transistors are designed for use in general-purpose amplifier and medium-speed switching circuits. The high gain of these devices makes it possible for them to be driven directly from integrated circuits.

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

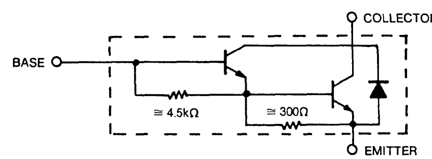


TO-251AA



TO-252AA

92CS-43478



Schematic diagram

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.

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	Conditions	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	—	

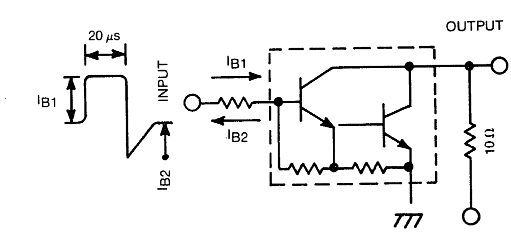


FIG. 1 SWITCHING TIME TEST CIRCUIT

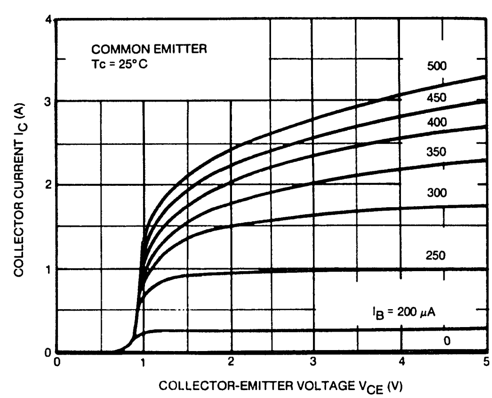


FIG. 2 I_C - V_{CE}

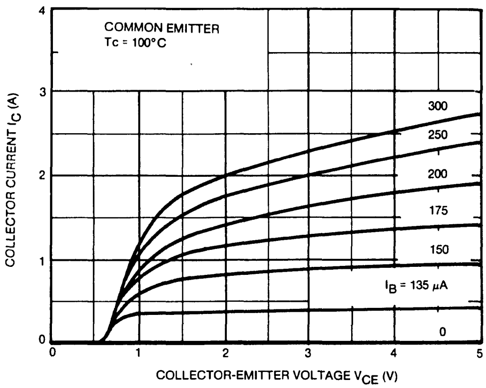


FIG. 3 I_C - V_{CE}

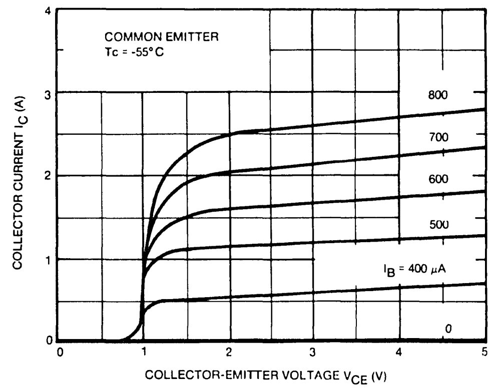


FIG. 4 I_C - V_{CE}

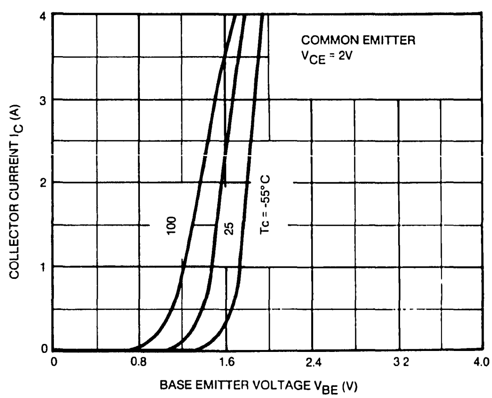


FIG. 5 I_C - V_{BE}

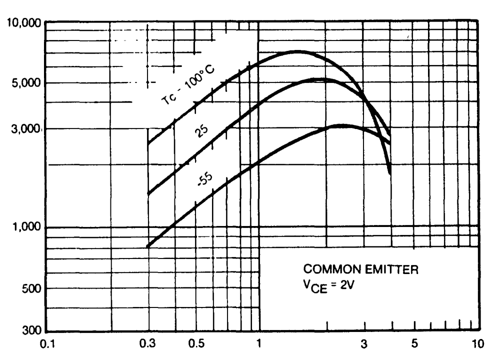


FIG. 6 h_{FE} - I_C

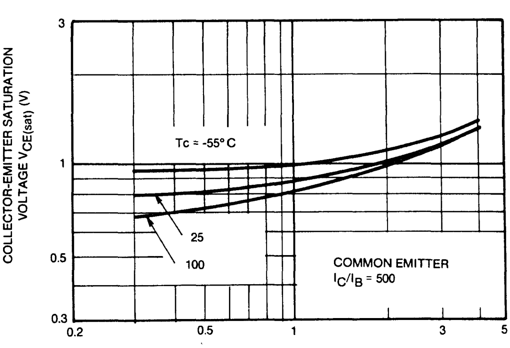


FIG. 7 $V_{CE(sat)}$ - I_C

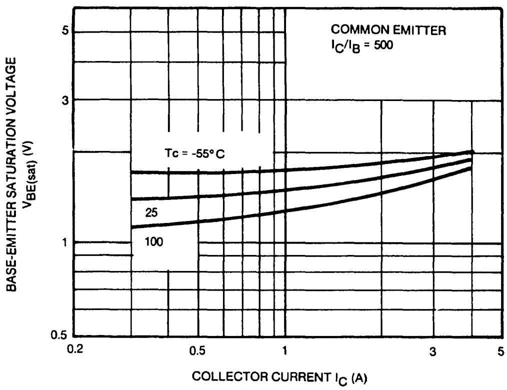


FIG. 8 $V_{BE(sat)}$ - I_C

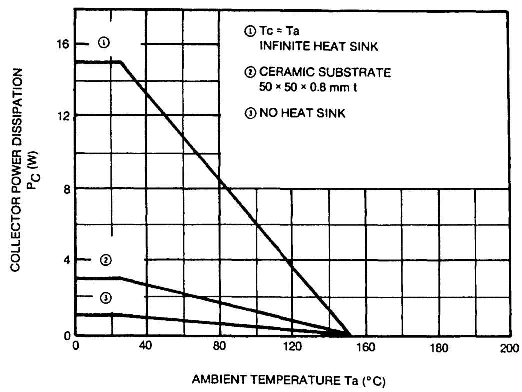


FIG. 9 P_C - Ta

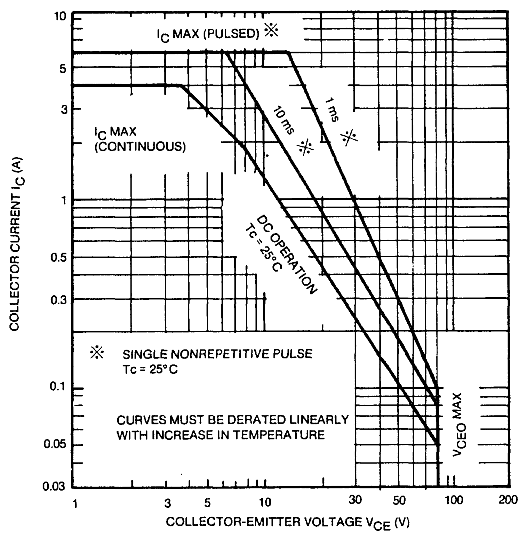


FIG. 10 SAFE OPERATING AREA

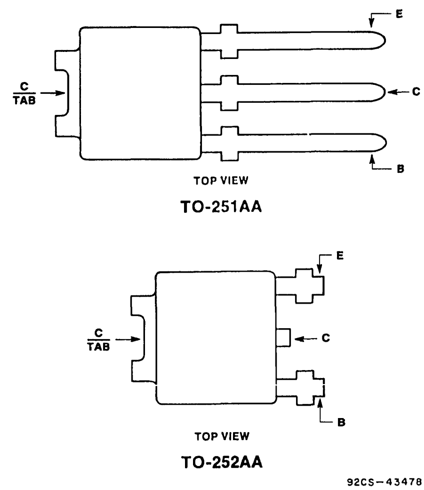
5-Ampere Silicon P-N-P Power Transistors

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



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.

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

OFF CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	-50	—	—	Volts
Collector Cutoff Current (V_{CB} = 50V, I_E = 0)	I_{CBO}	—	—	-1	μA
Emitter Cutoff Current (V_{EB} = 5V, I_C = 0)	I_{EBO}	—	—	-1	μA

SECOND BREAKDOWN

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Second Breakdown with Base Forward Biased	FBSOA	SEE FIGURE 11			

ON CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
DC Current Gain (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	—	

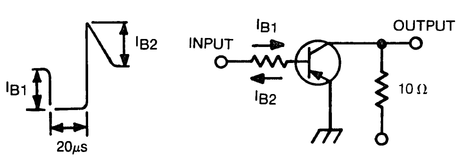


FIG. 1 SWITCHING TIME TEST CIRCUIT

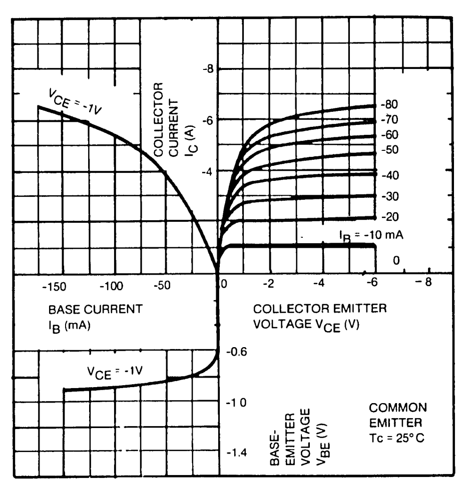


FIG. 2 STATIC CHARACTERISTICS

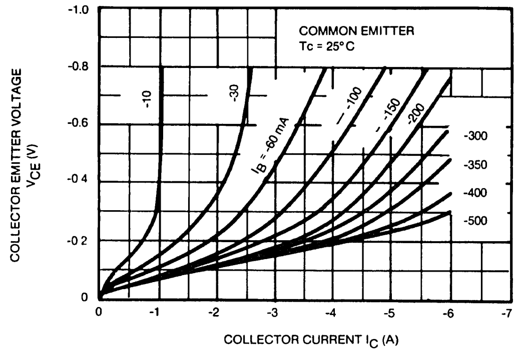


FIG. 3 V_{CE} - I_C

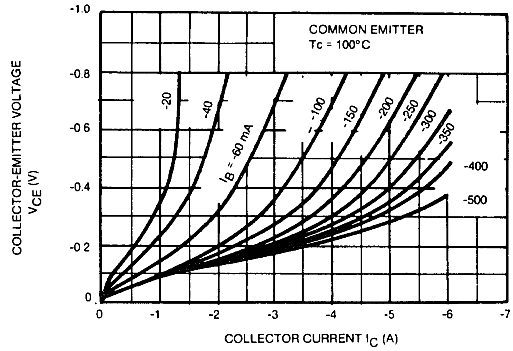


FIG. 4 V_{CE} - I_C

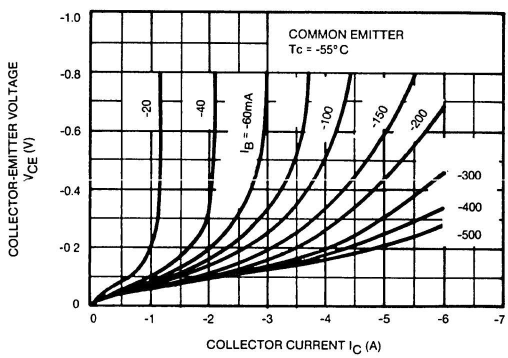


FIG. 5 V_{CE} - I_C

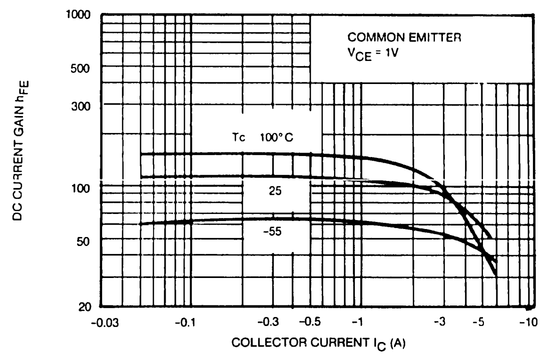


FIG. 6 h_{FE} - I_C

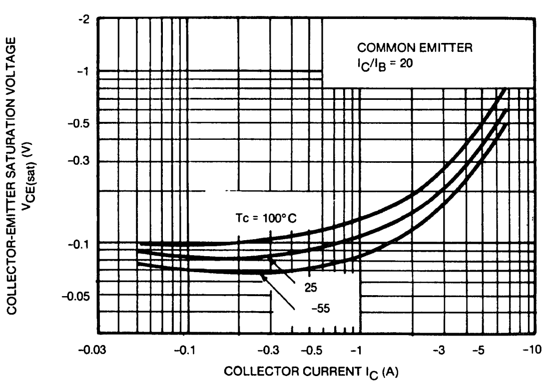


FIG. 7 $V_{CE(sat)}$ - I_C

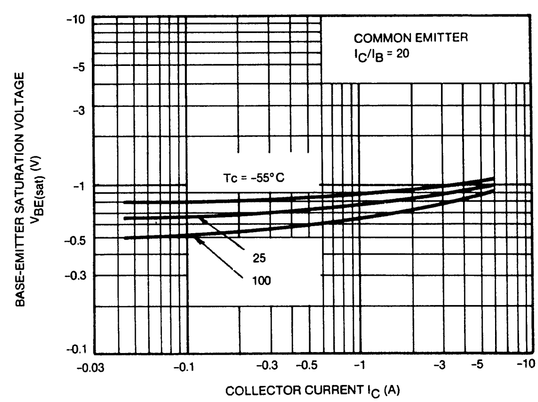


FIG. 8 $V_{BE(sat)}$ - I_C

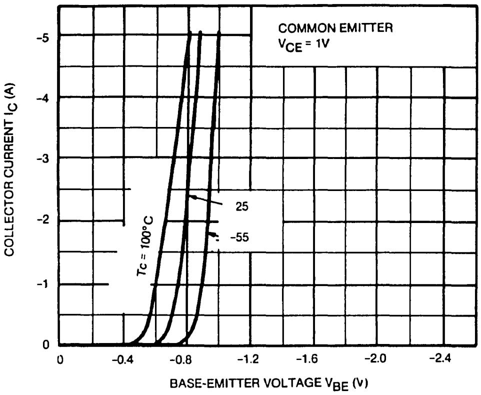


FIG. 9 I_C - V_{BE}

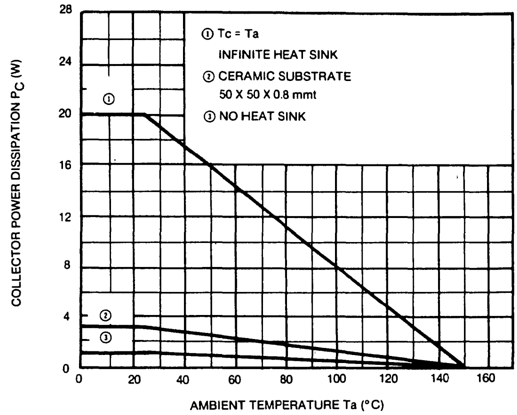


FIG. 10 P_C - Ta

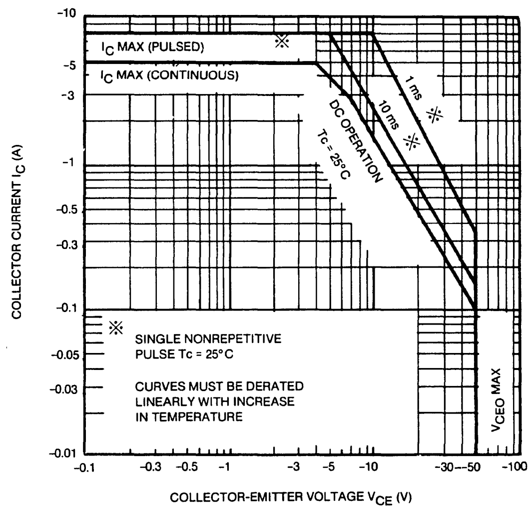


FIG. 11 SAFE OPERATING AREA

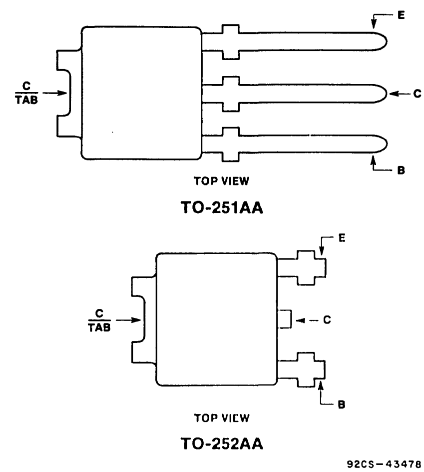
4-Ampere P-N-P Power Darlington Transistors

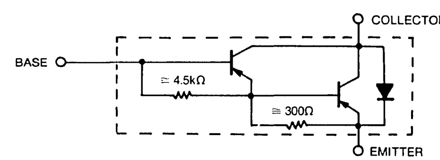
Features:
- *Operates from IC without predriver*
- *h_{FE} Min. = 2000*
- *Complementary to D72FY4D1,2*

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





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.

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					
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	—	

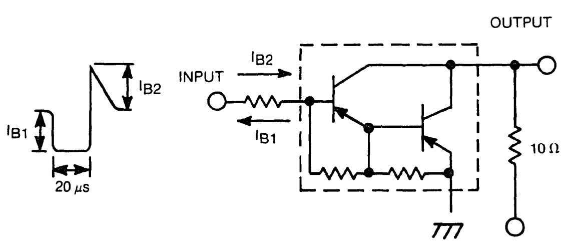


FIG. 1 SWITCHING TIME TEST CIRCUIT

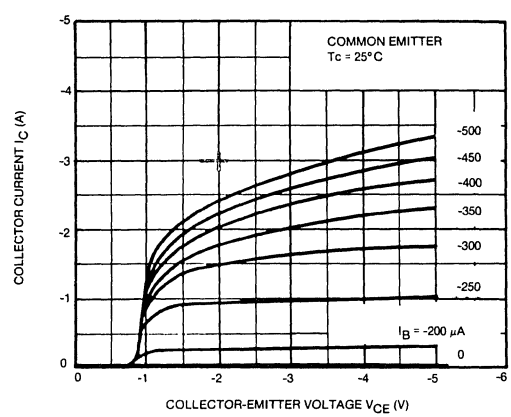


FIG. 2 I_C - V_{CE}

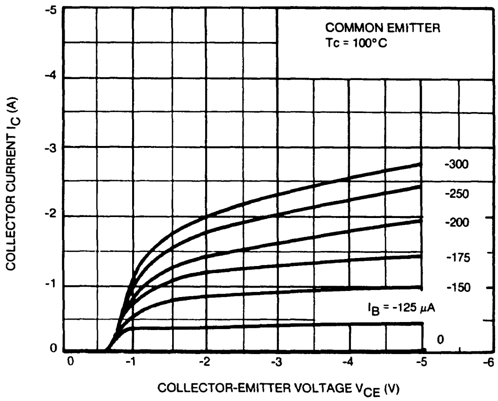


FIG. 3 I_C - V_{CE}

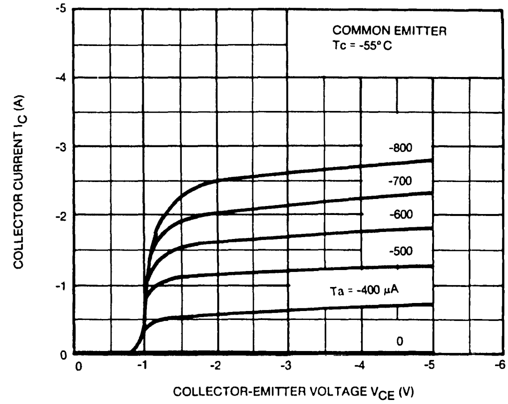


FIG. 4 I_C - V_{CE}

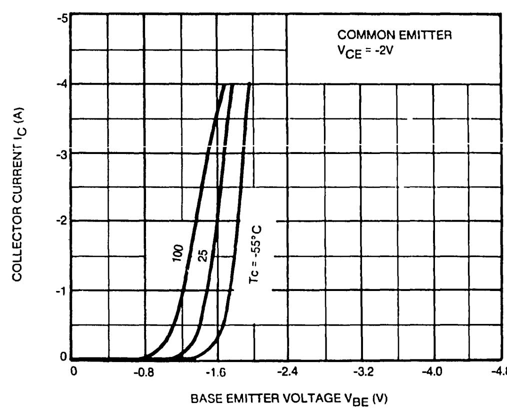


FIG. 5 I_C - V_{BE}

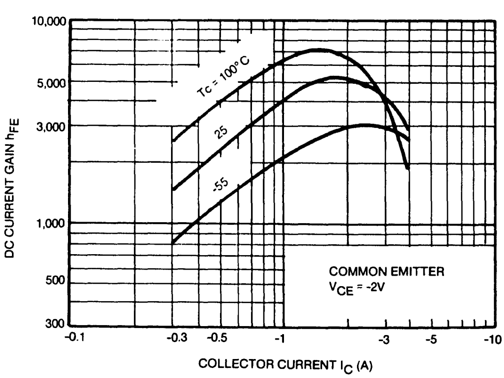


FIG. 6 h_{FE} - I_C

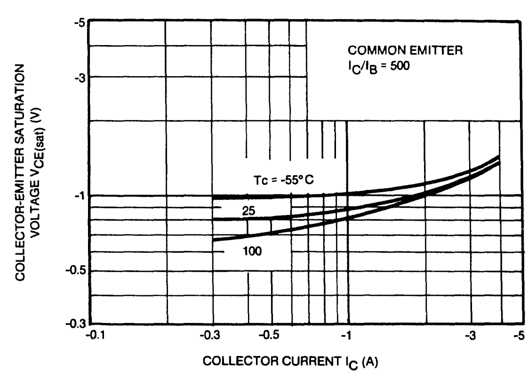


FIG. 7 $V_{CE(sat)}$ - I_C

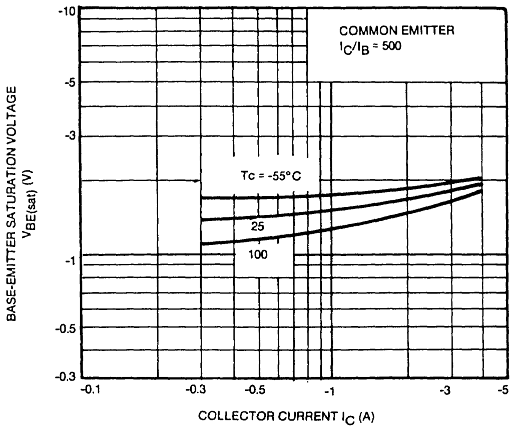


FIG. 8 $V_{BE(sat)}$ - I_C

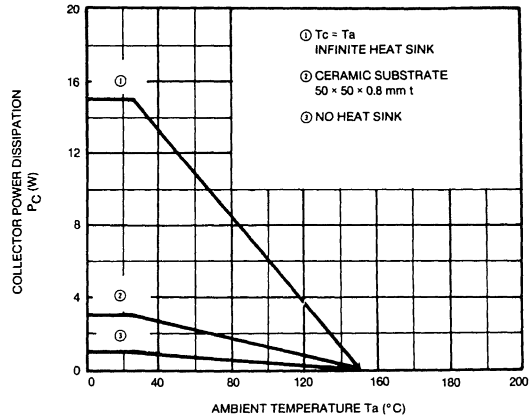


FIG. 9 P_C - Ta

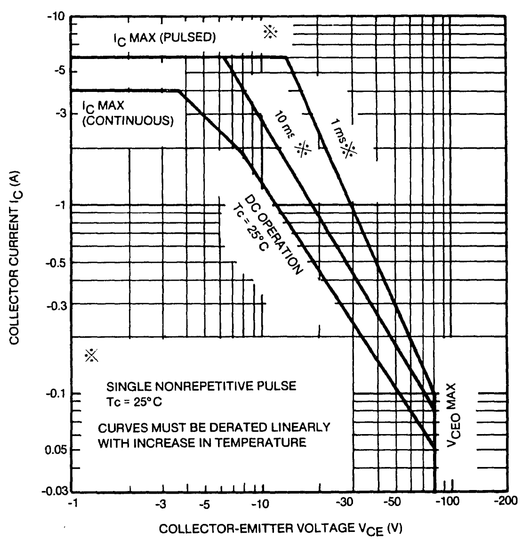


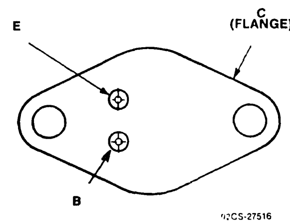
FIG. 10 SAFE OPERATING AREA

Silicon N-P-N Darlington Power Transistors

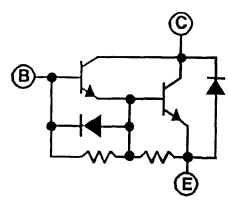
The GE10015, GE10016 and GE10020 thru GE10023 series of silicon n-p-n power Darlington transistors are designed for use in power switching applications requiring high-voltage capability and fast switching speeds. They are ideally suited for off-line switching power supplies, ac and dc motor controls, 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.

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

TEST CONDITIONS

STATIC

	APPLIES TO
(1) $V_{CEO(SUS)}$ I_C = 100mA, V_{CLAMP} = V_{CEO} Rated	All
(2) I_{CEV} V_{CEV} = Rated Valve, V_{BE} = -1.5V	All
(3) I_{EBO} I_{EB} = 2.0 Volts	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	 GE10022, 23 GE10020, 21 GE10015, 16
(6) h_{FE} I_C = 40A, V_{CE} = 5V	 GE10015, 16
(7) $V_{CE(SAT)}$ a) I_C = 20A, I_B = 1A b) I_C = 30A, I_B = 1.2A	 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	 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	 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	 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	 GE10015, 16, 22, 23 GE10020, 21

SWITCHING

	APPLIES TO
(1) RESISTIVE t_p = 50μs, Duty Cycle ≤ 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	 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	 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.

TYPICAL CHARACTERISTICS

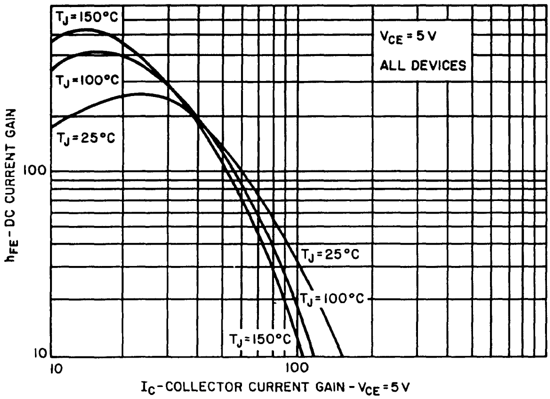


FIGURE 1. DC CURRENT GAIN (V_{CE} = 5V)

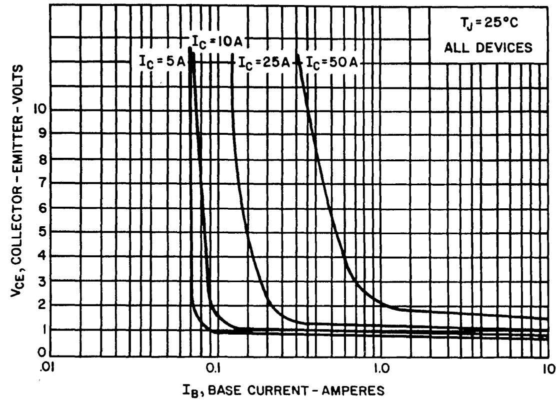


FIGURE 2. COLLECTOR SATURATION REGION

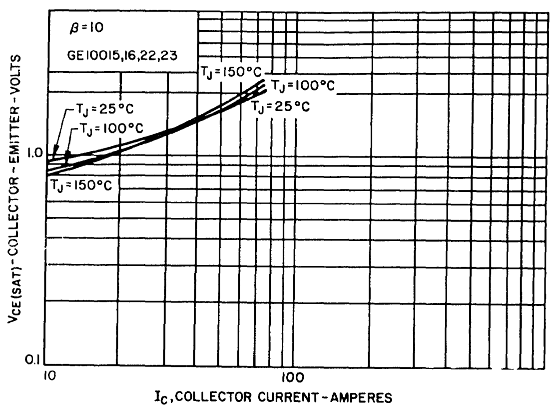


FIGURE 3. $V_{CE\ (SAT)}$ VS I_C

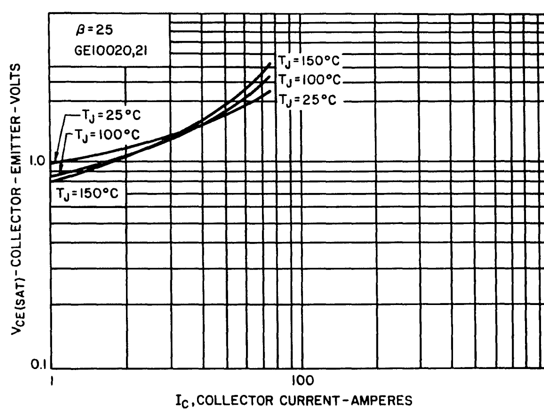


FIGURE 4. $V_{CE\ (SAT)}$ VS I_C

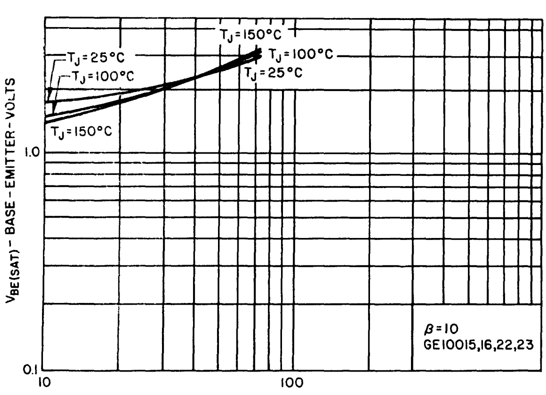


FIGURE 5. $V_{BE\ (SAT)}$ VS I_C

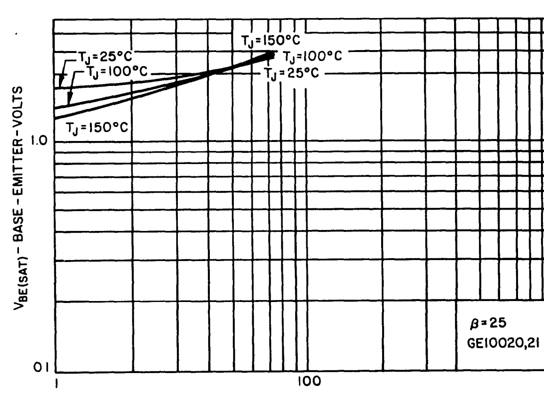


FIGURE 6. $V_{BE\ (SAT)}$ VS I_C

TYPICAL CHARACTERISTICS

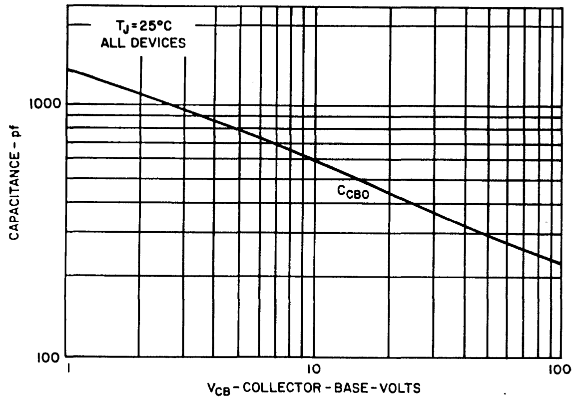


FIGURE 7. CAPACITANCE (C_{CBO})

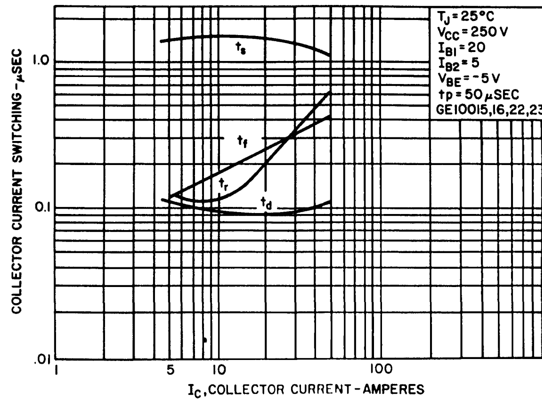


FIGURE 8. RESISTIVE SWITCHING PERFORMANCE

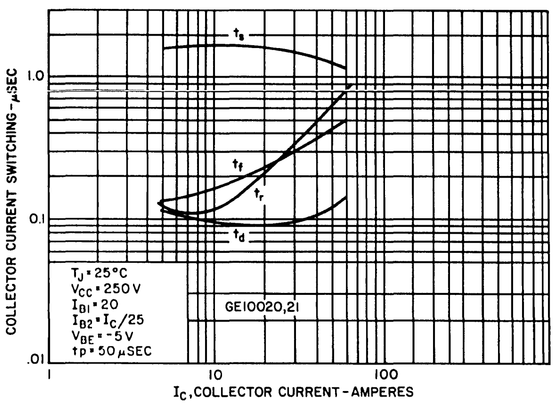


FIGURE 9. RESISTIVE SWITCHING PERFORMANCE

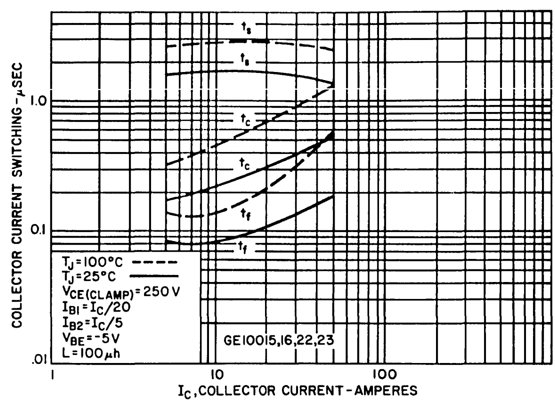


FIGURE 10. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

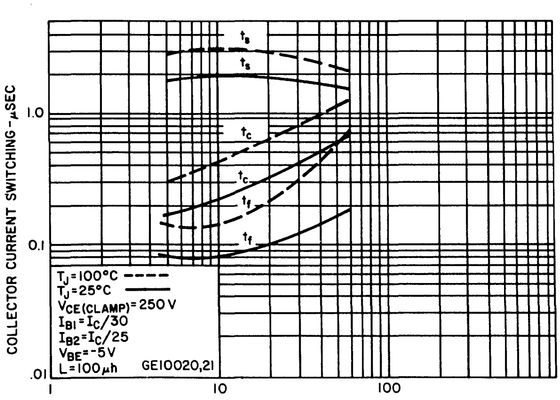


FIGURE 11. INDUCTIVE SWITCHING PERFORMANCE (CLAMPED)

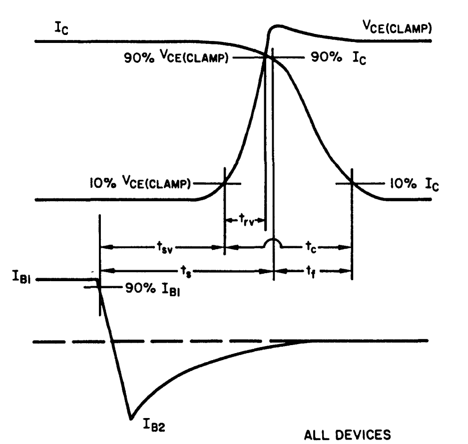


FIGURE 12. INDUCTIVE SWITCHING TURN-OFF WAVEFORMS

TYPICAL CHARACTERISTICS

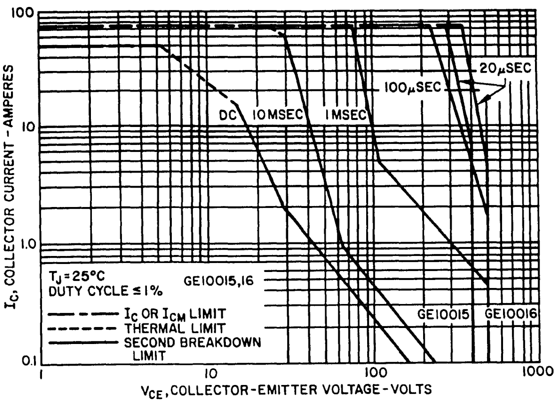


FIGURE 13. FORWARD BIAS SAFE OPERATING AREA

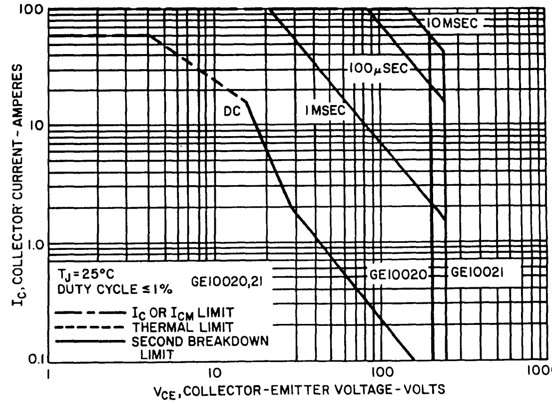


FIGURE 14. FORWARD BIAS SAFE OPERATING AREA

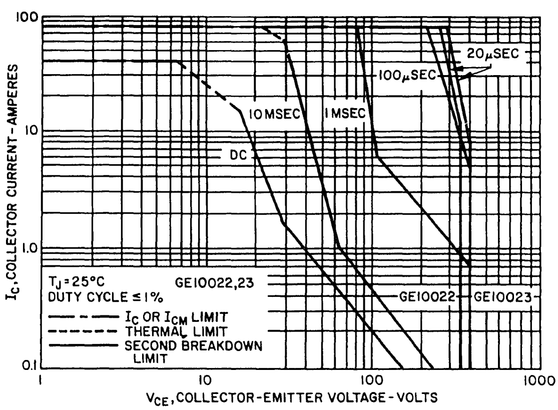


FIGURE 15. FORWARD BIAS SAFE OPERATING AREA

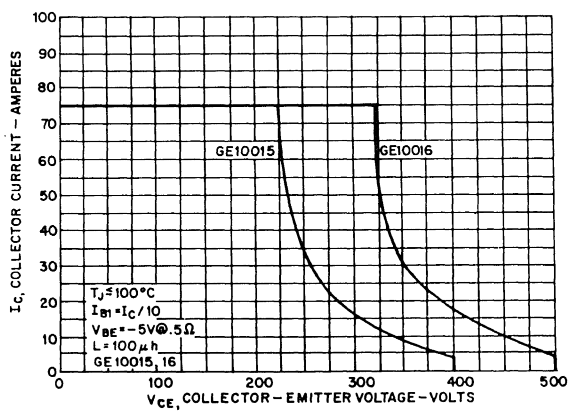


FIGURE 16. FORWARD BIAS SAFE OPERATING AREA (CLAMPED)

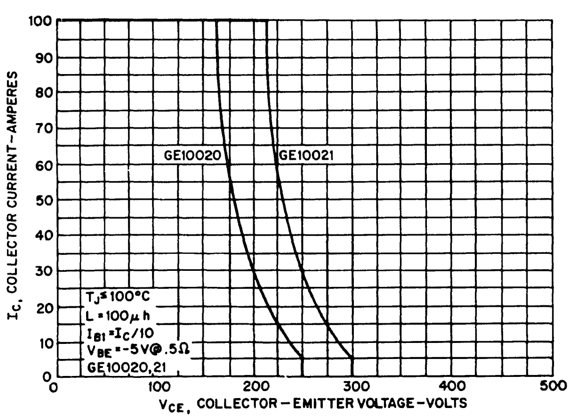


FIGURE 17. REVERSE BIAS SAFE OPERATING AREA

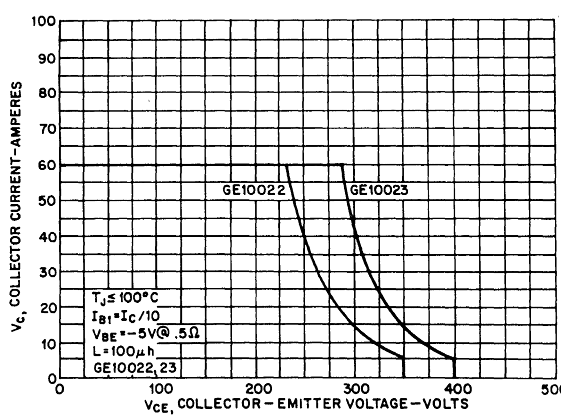


FIGURE 18. REVERSE BIAS SAFE OPERATING AREA

TYPICAL CHARACTERISTICS

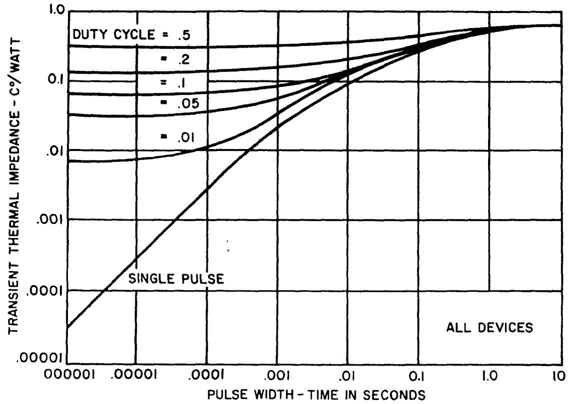


FIGURE 19. TRANSIENT THERMAL RESPONSE

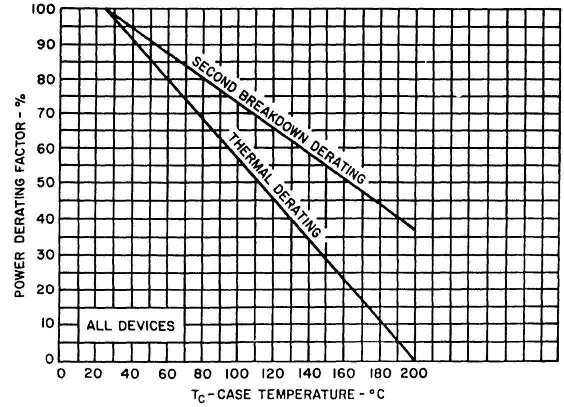


FIGURE 20. POWER DERATING

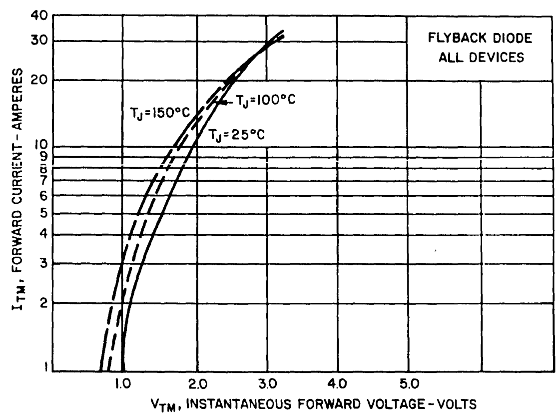


FIGURE 21. FORWARD CHARACTERISTICS

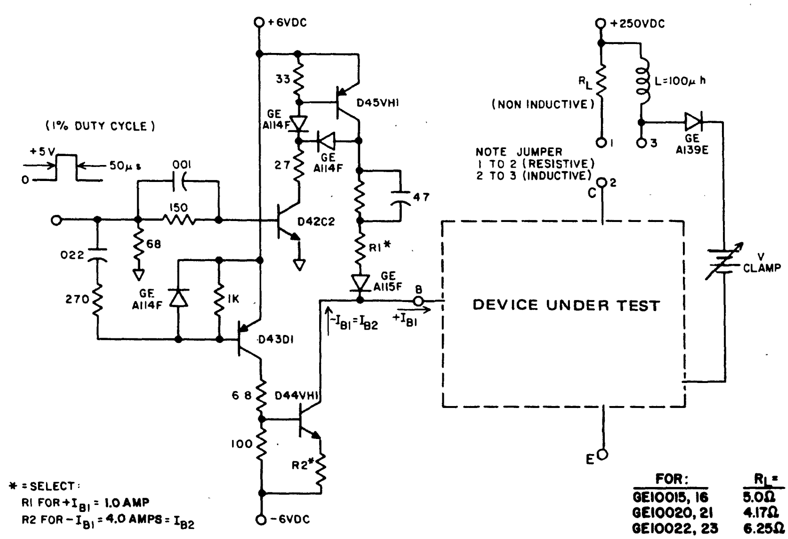


FIGURE 22. SWITCHING TIME TEST CIRCUIT

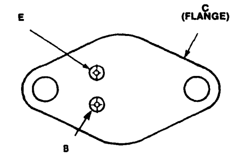
15-A SwitchMax II Power Transistors

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

Features:
- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 650 V to 750 V*
- *Low $V_{CE}(sat)$ at I_C = 15 A*

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA MJ13090 and MJ13091 SwitchMax II series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies, converter circuits, and pulse-width-modulated regulators. These high-voltage, high-speed transistors are tested for 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		V
I_C	15		A
I_{CM}	20		A
I_B	5		A
I_{BM}	10		A
P_T			
@ T_C = 25° C	175		W
@ T_C = 100° C	100		W
T_C above 25° C, derate linearly	1		W/° C
T_{stg}, T_J	-65 to +200		° C
T_L			
At distance ≥ ⅛ in. (3.17 mm) from seating plane for 10 s max.	275		° C
$R_{\theta JC}$	1		° C/W

ELECTRICAL CHARACTERISTICS at T_C = 25° C unless otherwise noted

CHARACTERISTIC	Conditions	Symbol	LIMITS Min.	Typ.	Max.	UNITS
OFF CHARACTERISTICS[1]						
Collector-Emitter Sustaining Voltage I_C = 100 mA, I_B = 0	MJ13090 MJ13091	$V_{CEO}(sus)$	400 450	— —	— —	V dc
Collector Cutoff Current V_{CEV} = Rated Value, $V_{BE}(off)$ = 1.5 V dc V_{CEV} = Rated Value, $V_{BE}(off)$ = 1.5 V dc, T_C = 100° C		I_{CEV}	— —	— —	0.5 2.5	mA dc
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 I_C = 10 A dc, I_B = 2 A dc I_C = 15 A dc, I_B = 3 A dc I_C = 10 A dc, I_B = 2 A dc, T_C = 100° C		$V_{CE}(sat)$	— — —	— — —	1 3 2	V dc
Base-Emitter Saturation Voltage I_C = 10 A dc, I_B = 2 A dc I_C = 10 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 = 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%.

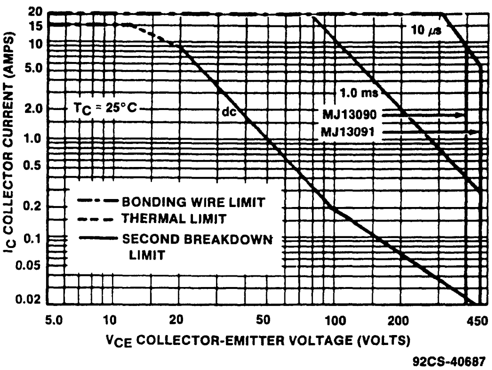


Fig. 1 - Maximum forward-bias safe-operating-areas for both types.

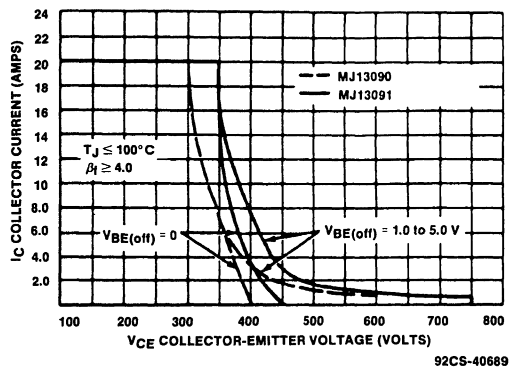


Fig. 2 - Maximum reverse-bias safe-operating-areas for both types.

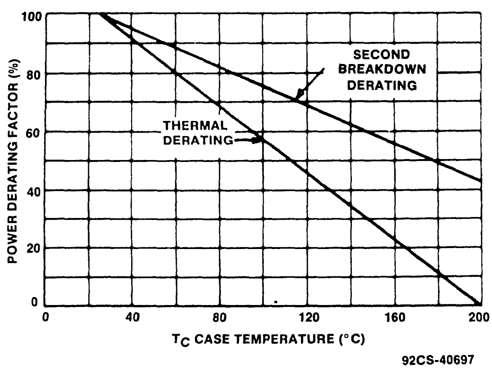


Fig. 3 - Dissipation and $I_{S/b}$ derating curves for both types.

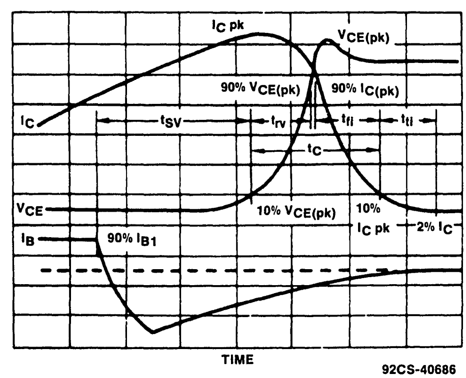


Fig. 4 - Inductive switching measurements display.

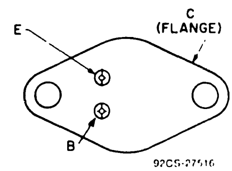
Complementary N-P-N/P-N-P Silicon Power Transistors

Rugged Devices, Broadly Applicable For Industrial and 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

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.

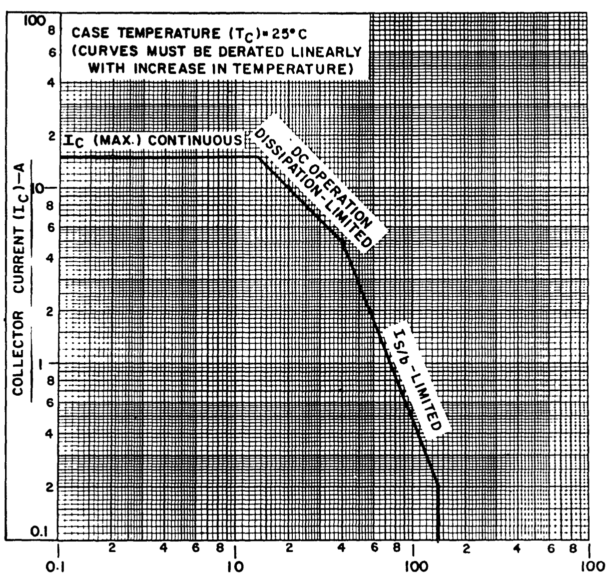


Fig. 1 - Maximum operating area for both types.

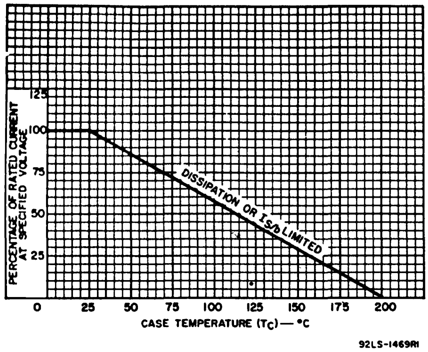


Fig. 2 - Current derating curve for both types.

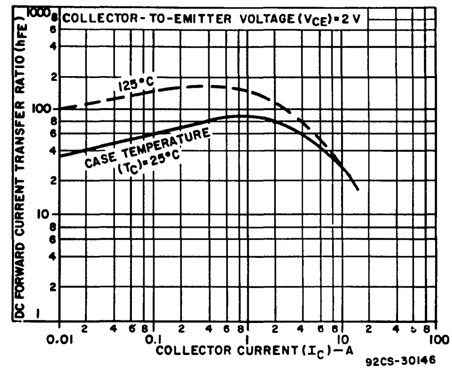


Fig. 3 - Typical dc beta characteristics as a function of collector current for MJ15001.

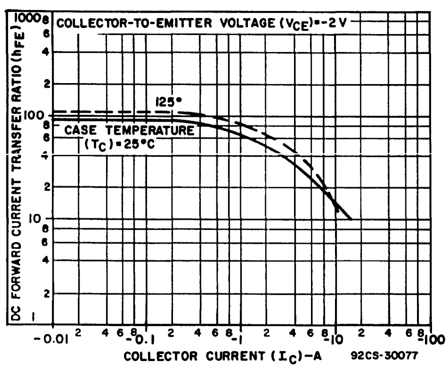


Fig. 4 - Typical dc beta characteristics as a function of collector current for MJ15002.

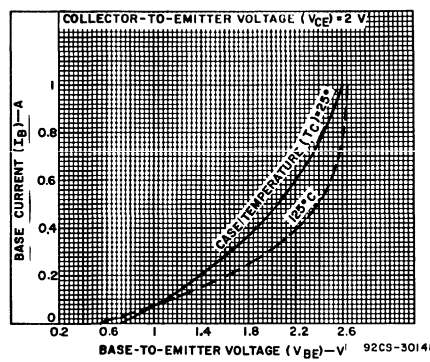


Fig. 5 - Typical input characteristics for MJ15001.

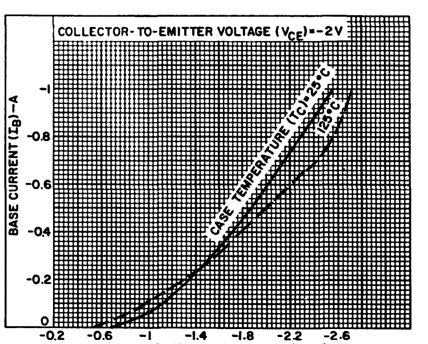


Fig. 6 - Typical input characteristics for MJ15002.

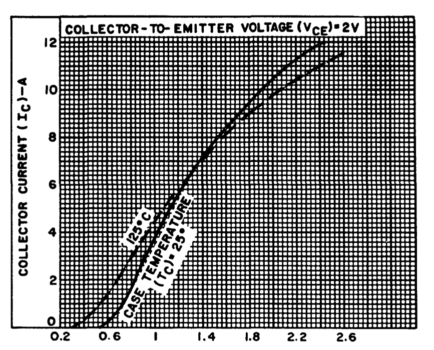


Fig. 7 - Typical transfer characteristics for MJ15001.

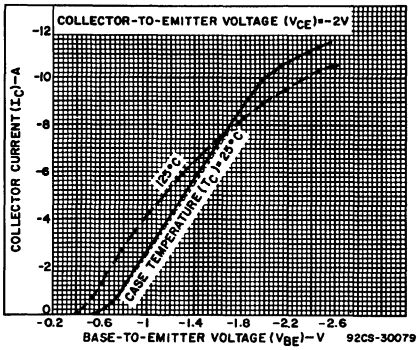


Fig. 8 - Typical transfer characteristics for MJ15002.

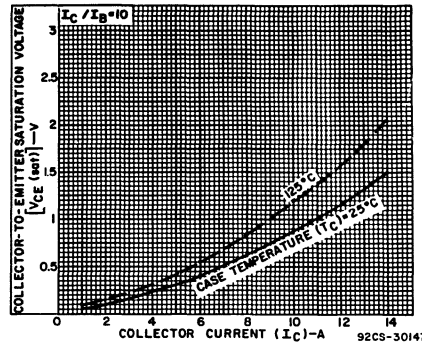


Fig. 9 - Typical saturation voltage characteristics for MJ15001.

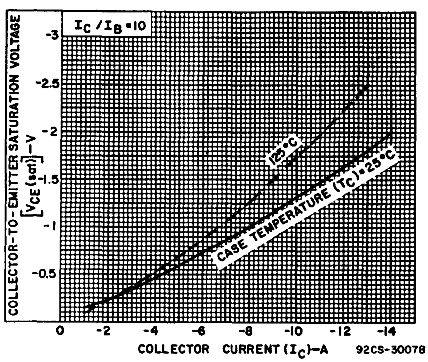


Fig. 10 - Typical saturation voltage characteristics for MJ15002.

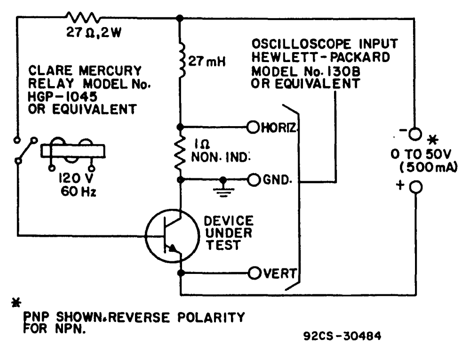


Fig. 11 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$.

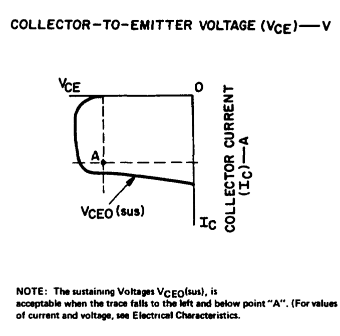


Fig. 12 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 11).

5-A *SwitchMax* II Power Transistors

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

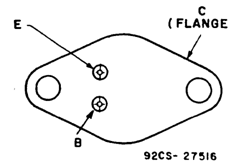
Features:

- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 850 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)

The MJ16010 and MJ16012 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.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

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

MJ16010

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100 mA, I_B = 0)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current	I_{CEV}				mAdc
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc)		—	—	0.25	
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		—	—	1.5	
Collector Cutoff Current (V_{CE} = 850 Vdc, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	—	1.0	mAdc
SECOND BREAKDOWN					
Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Figure 1			
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Figure 2			
ON CHARACTERISTICS (1)					
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 5.0 Adc, I_B = 0.7 Adc)		—	0.5	2.5	
(I_C = 10 Adc, I_B = 1.3 Adc)		—	1.0	3.0	
(I_C = 10 Adc, I_B = 1.3 Adc, T_C = 100°C)		—	—	3.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 10 Adc, I_B = 1.3 Adc)		—	1.0	1.5	
(I_C = 10 Adc, I_B = 1.3 Adc, T_C = 100°C)		—	—	1.5	
DC Current Gain (I_C = 15 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)	C_{ob}	—	—	400	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Resistive Load							
Delay Time	(I_C = 10 Adc, V_{CC} = 250 Vdc, I_{B1} = 1.3 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 2.6 Adc, R_B = 1.6 Ω)	t_d	—	40	—	ns
Rise Time			t_r	—	100	—	
Storage Time			t_s	—	1400	—	
Fall Time			t_f	—	140	—	
Storage Time		($V_{BE(off)}$ = 5.0 Vdc)	t_s	—	600	—	
Fall Time			t_f	—	100	—	
Inductive Load							
Storage Time	(I_C = 10 Adc, I_{B1} = 1.3 Adc, $V_{BE(off)}$ = 5.0 Vdc, $V_{CE(pk)}$ = 400 Vdc)	(T_C = 100°C)	t_{sv}	—	800	1800	ns
Fall Time			t_{fi}	—	50	200	
Crossover Time			t_c	—	100	250	
Storage Time		(T_C = 150°C)	t_{sv}	—	860	—	
Fall Time			t_{fi}	—	40	—	
Crossover Time			t_c	—	80	—	

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

MJ16012

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector-Emitter Sustaining Voltage (I_C = 100 mA, I_B = 0)	$V_{CEO(sus)}$	450	—	—	Vdc
Collector Cutoff Current	I_{CEV}				mAdc
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc)		—	—	0.25	
(V_{CEV} = 850 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		—	—	1.5	
Collector Cutoff Current (V_{CE} = 850 Vdc, R_{BE} = 50 Ω, T_C = 100°C)	I_{CER}	—	—	2.5	mAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	—	1.0	mAdc
SECOND BREAKDOWN					
Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Figure 1			
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Figure 2			
ON CHARACTERISTICS (1)					
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 5.0 Adc, I_B = 0.5 Adc)		—	—	2.5	
(I_C = 10 Adc, I_B = 1.0 Adc)		—	—	3.0	
(I_C = 10 Adc, I_B = 1.0 Adc, T_C = 100°C)		—	—	3.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 10 Adc, I_B = 1.0 Adc)		—	—	1.5	
(I_C = 10 Adc, I_B = 1.0 Adc, T_C = 100°C)		—	—	1.5	
DC Current Gain (I_C = 15 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	7.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)	C_{ob}	—	—	400	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Resistive Load							
Delay Time	(I_C = 10 Adc, V_{CC} = 250 Vdc, I_{B1} = 1.0 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 2.0 Adc, R_B = 1.6 Ω)	t_d	—	40	—	ns
Rise Time			t_r	—	100	—	
Storage Time			t_s	—	1400	—	
Fall Time			t_f	—	140	—	
Storage Time		($V_{BE(off)}$ = 5.0 Vdc)	t_s	—	600	—	
Fall Time			t_f	—	100	—	
Inductive Load							
Storage Time	(I_C = 10 Adc, I_{B1} = 1.0 Adc, $V_{BE(off)}$ = 5.0 Vdc, $V_{CE(pk)}$ = 400 Vdc)	(T_C = 100°C)	t_{sv}	—	800	1500	ns
Fall Time			t_{fi}	—	50	150	
Crossover Time			t_c	—	100	200	
Storage Time		(T_C = 150°C)	t_{sv}	—	860	—	
Fall Time			t_{fi}	—	40	—	
Crossover Time			t_c	—	80	—	

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

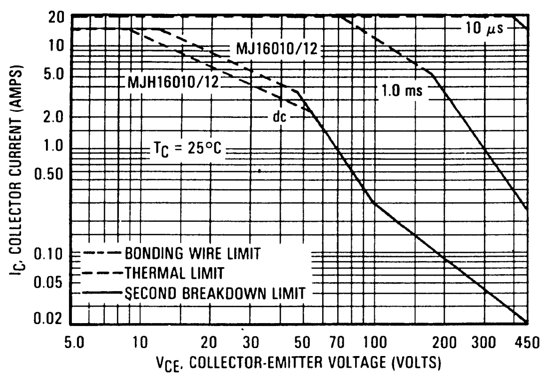


Fig. 1 — Maximum forward-bias safe-operating-areas for all types.

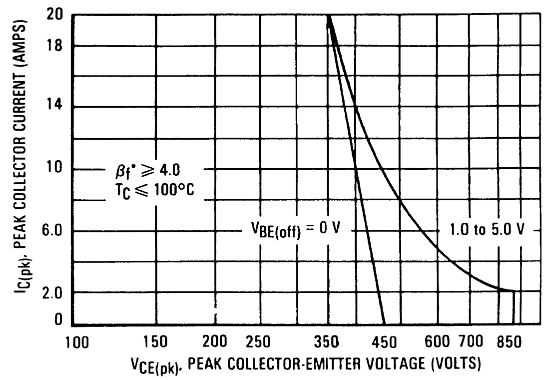


Fig. 2 — Maximum reverse-bias safe-operating-areas for all types.

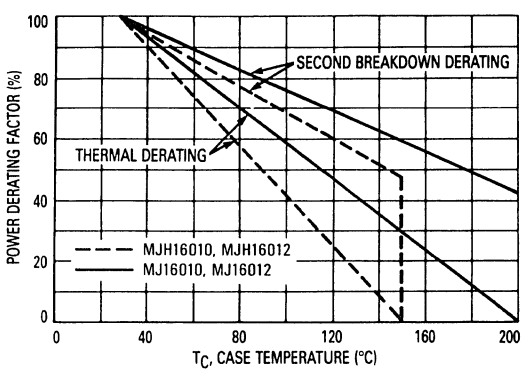


Fig. 3 — Dissipation and $I_{s\,b}$ derating curves for all types.

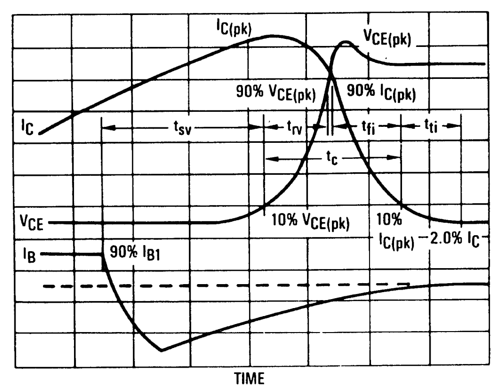


Fig. 4 — Inductive switching measurements display.

4-A *SwitchMax* II Power Transistors

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

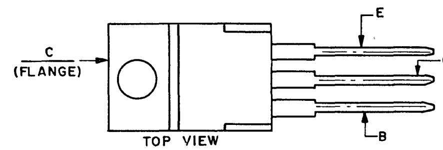
Features:

- *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		V
I_C(sat)	4		A
I_C	4		A
I_{CM}	8		A
I_B	2		A
I_{BM}	4		A
P_T			
@ T_C = 25°C	75		W
@ T_C = 100°C	45		W
T_C above 25°C, derate linearly	0.6		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
$R_{\theta JC}$	1.67		°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Sustaining Voltage (I_C = 10 mA, I_B = 0) MJE13004	$V_{CEO(sus)}$	300	–	–	Vdc
MJE13005		400	–	–	
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc)	I_{CEV}	–	–	1	mAdc
(V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, T_C = 100°C)		–	–	5	
Emitter Cutoff Current (V_{EB} = 9 Vdc, I_C = 0)	I_{EBO}	–	–	1	mAdc
SECOND BREAKDOWN					
Second Breakdown Collector Current with base forward biased	$I_{S/b}$		See Figure 1		
Clamped Inductive SOA with Base Reverse Biased	RBSOA		See Figure 2		
***ON CHARACTERISTICS**					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	10	–	60	–
(I_C = 2 Adc, V_{CE} = 5 Vdc)		8	–	40	
Collector-Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.2 Adc)	$V_{CE(sat)}$	–	0.2	0.5	Vdc
(I_C = 2 Adc, I_B = 0.5 Adc)		–	0.3	0.6	
(I_C = 4 Adc, I_B = 1 Adc)		–	0.7	1	
(I_C = 2 Adc, I_B = 0.5 Adc, T_C = 100°C)		–	–	1	
Base-Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.2 Adc)	$V_{BE(sat)}$	–	0.90	1.2	Vdc
(I_C = 2 Adc, I_B = 0.5 Adc)		–	0.95	1.6	
(I_C = 2 Adc, I_B = 0.5 Adc, T_C = 100°C)		–	–	1.5	
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 mAdc, V_{CE} = 10 Vdc, f = 1 MHz)	f_T	4	–	–	MHz
Output Capacitance (V_{CB} - 10 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	200	–	pF
SWITCHING CHARACTERISTICS					
Resistive Load					
Delay Time (V_{CC} = 125 Vdc, I_C = 2 A, I_{B1} = I_{B2} = 0.4 A, t_p = 25 μs, Duty Cycle ≤ 1%)	t_d	–	0.02	0.1	μs
Rise Time	t_r	–	0.08	0.7	μs
Storage Time	t_s	–	1.90	4	μs
Fall Time	t_f	–	0.16	0.9	μs
Inductive Load, Clamped					
Voltage Storage Time (I_C = 2 A, V_{clamp} = 300 Vdc, I_{B1} = 0.4 A, $V_{BE(off)}$ = 5 Vdc, T_C = 100°C)	t_{sv}	–	1.60	4	μs
Crossover Time	t_c	–	0.15	0.9	μs
Fall Time	t_{fi}	–	0.05	–	μs

*Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.

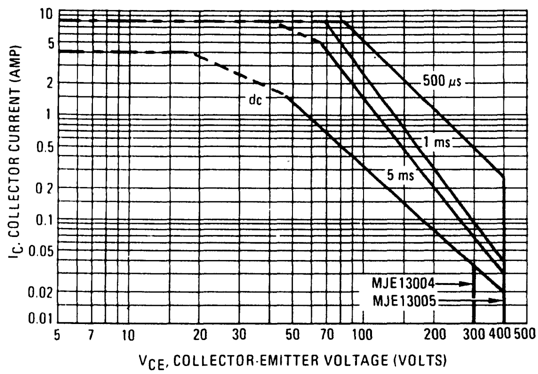


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

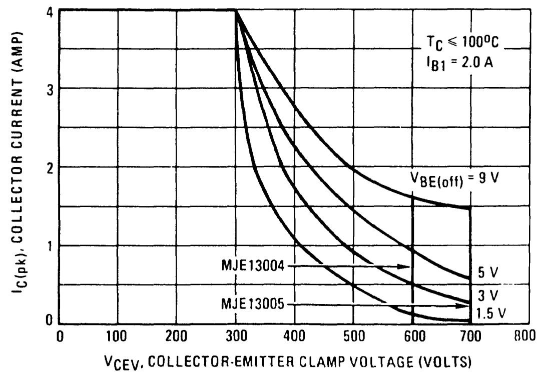


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

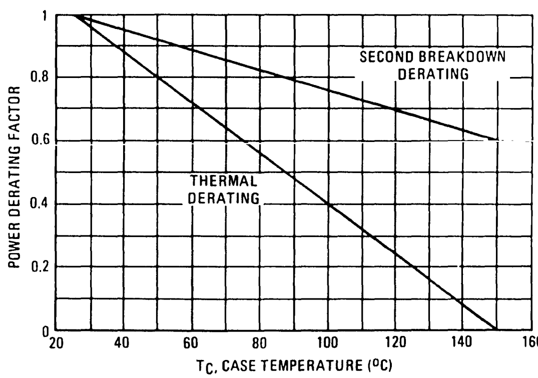


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

5-A *SwitchMax* II Power Transistors

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

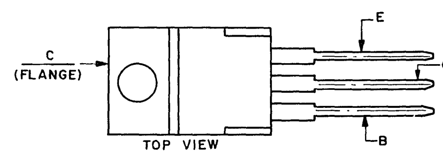
Features:

- *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



92CS-39969

JEDEC TO-220AB

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:*

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

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

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Resistive Load							
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%

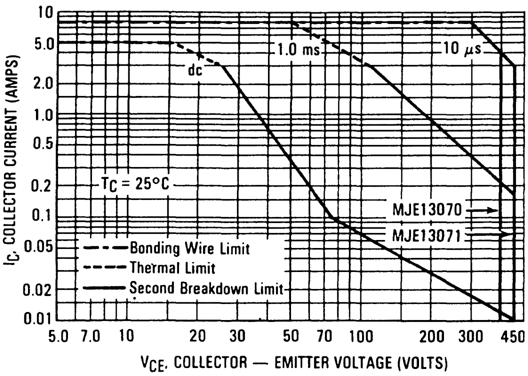


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

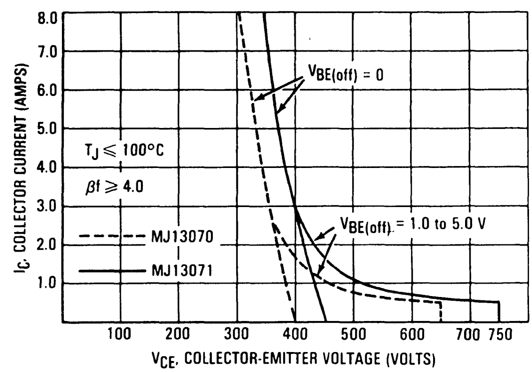


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

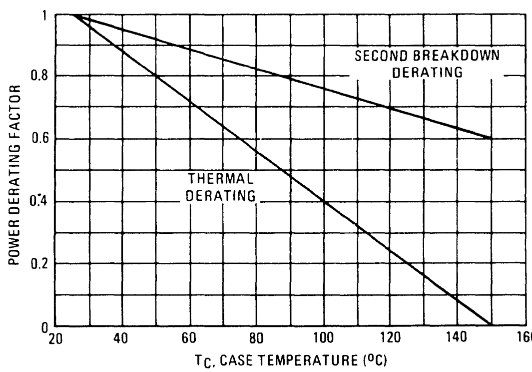


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

5-A SwitchMax II Power Transistors

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

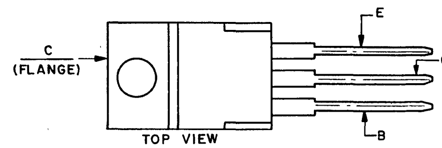
Features:

- *Fast switching speed*
- *High-voltage ratings:* *V_{CEV} = 850 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

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			Symbol	Min	Typ	Max	Unit
Delay Time	(I_C = 3.0 Adc, V_{CC} = 250 Vdc, I_{B1} = 0.4 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 0.8 Adc, R_{B2} = 8.0 Ω)	t_d	—	40	100	ns
Rise Time			t_r	—	80	300	
Storage Time			t_s	—	900	3000	
Fall Time			t_f	—	20	300	
Storage Time		($V_{BE(off)}$ = 5.0 Vdc)	t_s	—	330	—	
Fall Time			t_f	—	100	—	
Resistive Load MJE16004							
Delay Time	(I_C = 3.0 Adc, V_{CC} = 250 Vdc, I_{B1} = 0.3 Adc, PW = 30 μs, Duty Cycle ≤2.0%)	(I_{B2} = 0.6 Adc, R_{B2} = 8.0 Ω)	t_d	—	40	100	ns
Rise Time			t_r	—	110	300	
Storage Time			t_s	—	750	2700	
Fall Time			t_f	—	150	350	
Storage Time		($V_{BE(off)}$ = 5.0 Vdc)	t_s	—	270	—	
Fall Time			t_f	—	90	—	

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

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%.

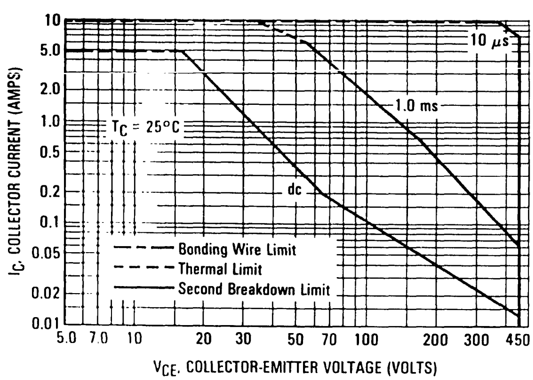


Fig. 1 — Maximum forward-bias safe-operating-areas for both types.

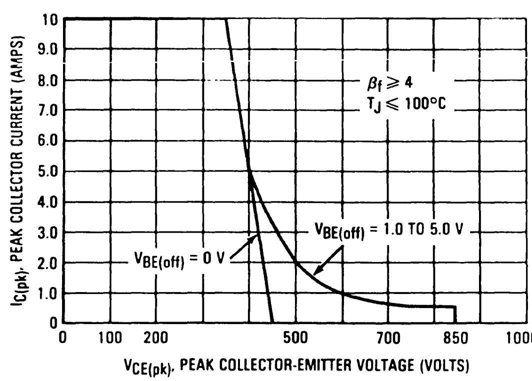


Fig. 2 — Maximum reverse-bias safe-operating-areas for both types.

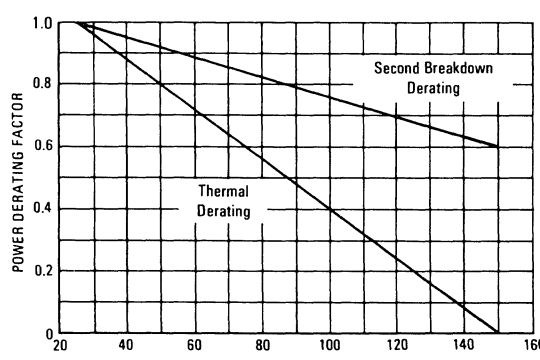


Fig. 3 — Dissipation and $I_{s/b}$ derating curves for both types.

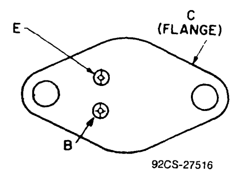
Silicon N-P-N Epitaxial-Base High Power Transistors

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

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	VOLTAGE V dc V_{BE}	CURRENT A dc I_C	LIMITS: RCA3773 Min.	RCA3773 Max.	MJ15003 Min.	MJ15003 Max.	UNITS
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} ≤ 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.

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

CHARACTERISTIC	TEST CONDITIONS: VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	LIMITS: RCA8638C Min.	Max.	RCA8638D Min.	Max.	RCA8638E Min.	Max.	UNITS
I_{CBO}	140[a]			–	1	–	–	–	–	mA
	120[a]			–	–	–	1	–	–	
	100[a]			–	–	–	–	–	1	
I_{CEX}	140	1.5		–	1	–	–	–	–	
	120	1.5		–	–	–	1	–	–	
I_{CEX} T_C = 150°C	140	1.5		–	5	–	–	–	–	
	120	1.5		–	–	–	5	–	–	
I_{CEO} I_B = 0	70			–	1	–	–	–	–	
	60			–	–	–	1	–	–	
I_{EBO}	–	5		–	1	–	1	–	1	
h_{FE}	2		5[c]	25	150	25	150	–	–	
	2		7.5[c]	–	–	–	–	10	100	
	2		10[c]	10	–	10	–	–	–	
V_{CER}(sus)[b] $R_{BE} \leqslant 100\Omega$			0.2	150	–	130	–	110	–	V
V_{CEO}(sus)[b]			0.2	140	–	120	–	100	–	
V_{EBO} I_E = 1 mA			0	5	–	5	–	5	–	
V_{BE}	2		7.5[c]	–	–	–	–	–	3	
	2		5[c]	–	2	–	2	–	–	
V_{CE}(sat) I_B = 0.75A			7.5[c]	–	–	–	–	–	1.5	
= 0.5A			5[c]	–	1	–	1	–	–	
$I_{S/b}$ t_p = 1 s nonrep.	35			5.71	–	5.71	–	–	–	A
	25			–	–	–	–	8	–	
$\|h_{fe}\|$ f = 0.5 MHz	10		0.5	4	–	4	–	4	–	
f_T				2	–	2	–	2	–	MHz
C_{ob} f = 0.1 MHz	10[a]			–	500	–	500	–	500	pF
$R_{\theta JC}$	10		10	–	0.875	–	0.875	–	0.875	°C/W

[a] V_{CB}

[b] **CAUTION:** Sustaining voltages V_{CEX}(sus), V_{CER}(sus), and V_{CEO}(sus) *MUST NOT* be measured on a curve tracer. See Figs. 8 and 9.

[c] Pulsed; pulse duration = 300 μs, duty factor = 1.8%.

[d] Measured at I_E = −0.1 mA.

2 POWER TRANSISTORS

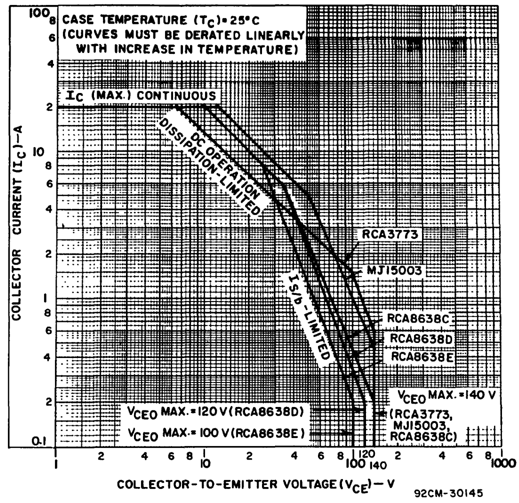


Fig. 1 - Maximum operating areas for all types.

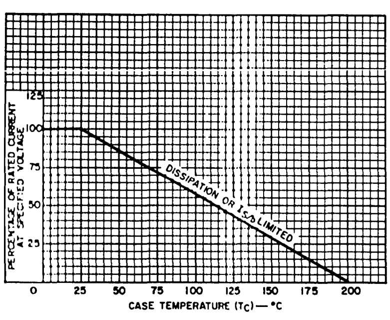


Fig. 2 - Current derating curve for all types.

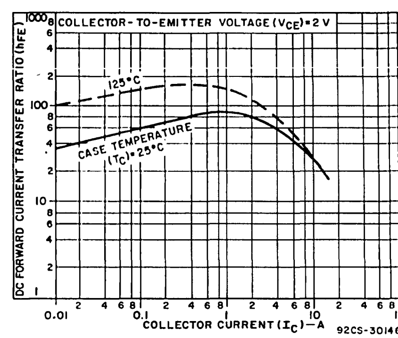


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

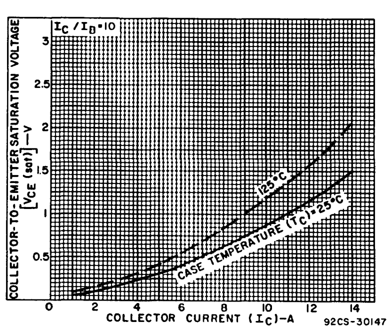


Fig. 4 - Typical saturation voltage characteristics for all types.

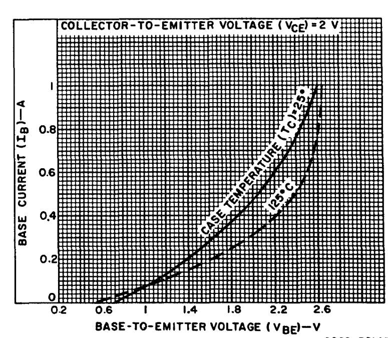


Fig. 5 - Typical input characteristics for all types.

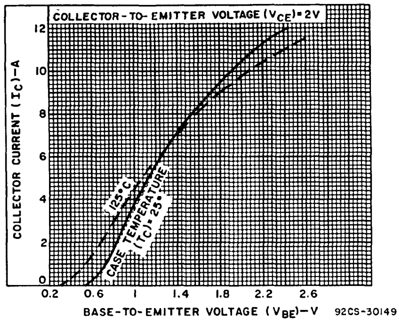


Fig. 6 - Typical transfer characteristics for all types.

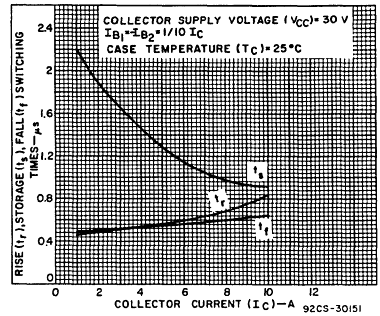


Fig. 7 - Typical saturated-switching times for all types.

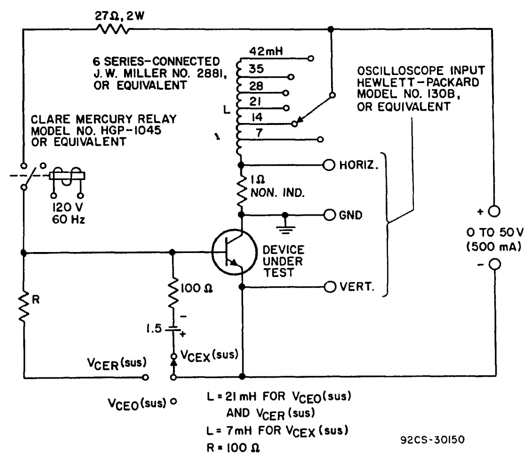


Fig. 8 - Circuit used to measure sustaining voltages V_{CEO}(sus), V_{CER}(sus), and V_{CEX}(sus) for all types.

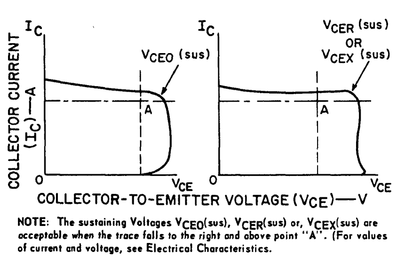


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 8).

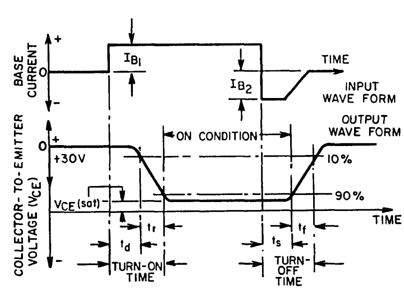


Fig. 10 - Oscilloscope display for measurement of switching times for all types.

25-A Silicon N-P-N Power Transistors

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

Features:

- *Fast switching speed*
- *Low $V_{CE}(sat)$*
- *Steel hermetic TO-204AA package*

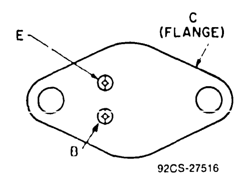
RCA6340 and RCA6341 silicon n-p-n power transistors which feature fast switching speeds, low saturation voltage, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pusle-width-modulated regulators and a variety of power switching circuits.

These high-current, high-speed transistors are 100-percent tested for parameters that are essential to the design of high-power switching circuits.

The RCA6340 and RCA6341 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

These types are similar to the 2N6340 and 2N6341 except for the C_{obo}, h_{FE} measured at I_C of 0.5A, and I_{B1}, I_{B2} conditions for switching times.

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute Maximum Values:*

	RCA6340	RCA6341	
V_{CBO}	160	180	V
V_{CEO}	140	150	V
V_{EBO}	3		V
I_C	25		A
I_{CM}	50		A
I_B	10		A
P_T			
T_C up to 25°C	200		W
T_C above 25°C, derate linearly	1.143		W/°C
T_{stg}, T_J	-65 to 200		°C
T_L			
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235		°C

RCA6340, RCA6341

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

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		RCA6340		RCA6341		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
I_{CEV}	150	-1.5	—	—	—	10	—	—	µA
	150	-1.5	—	—	—	—	—	10	
T_C = 150°C	140	-1.5	—	—	—	1	—	—	mA
	150	-1.5	—	—	—	—	—	1	
I_{CBO}	160[c]	—	—	—	—	10	—	—	µA
	180[c]	—	—	—	—	—	—	10	
I_{EBO}	—	-6	0	—	—	100	—	100	
$V_{CEO}(sus)$[b]	—	—	0.05[a]	0	140	—	150	—	V
h_{FE}	2	—	0.5[a]	—	30	—	30	—	
	2	—	10[a]	—	30	120	30	120	
	2	—	25[a]	—	12	—	12	—	
V_{BE}	2	—	10[a]	—	—	1.8	—	1.8	V
$V_{BE}(sat)$	—	—	10[a]	1	—	1.8	—	1.8	
	—	—	25[a]	2.5	—	2.5	—	2.5	
$V_{CE}(sat)$	—	—	10[a]	1	—	1	—	1	
	—	—	25[a]	2.5	—	1.8	—	1.8	
$I_{s/b}$	18	—	11.1	—	1	—	1	—	s
h_{fe} f = 5 MHz	10	—	1	—	8	—	8	—	
f_T	10	—	1	—	40	—	40	—	MHz
C_{obo} f = 0.1 MHz	10[c]	—	—	—	—	600	—	600	pF
t_r[d]	—	-6	10	0.5	—	0.3	—	0.3	µs
t_s[d]	—	-6	10	0.5[e]	—	2.0	—	2.0	
t_f[d]	—	-6	10	0.5[e]	—	0.25	—	0.25	
$R_{\theta JC}$	10	—	5	—	—	0.875	—	0.875	°C/W

[a] Pulsed; pulse duration = 300 µs, duty factory ≤ 2%.

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

[c] V_{CB} value.

[d] V_{CC} = 80 V, t_p = 10 µs.

[e] $I_{B1} = -I_{B2}$.

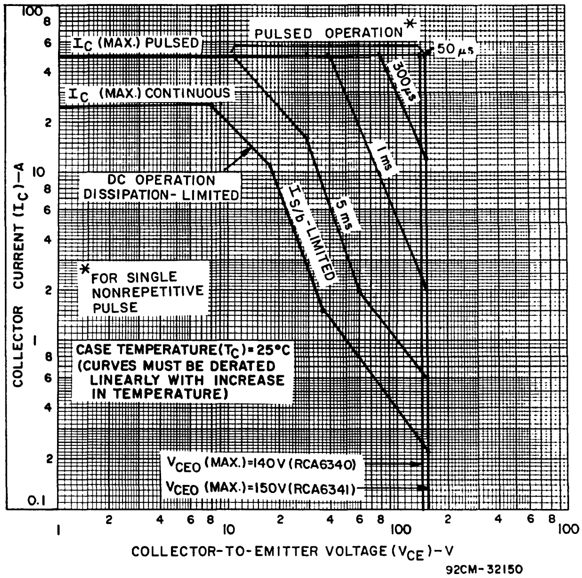


Fig. 1 - Maximum operating areas for both types.

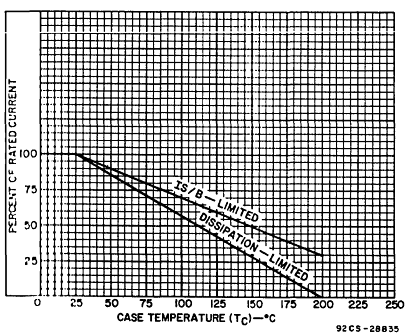


Fig. 2 - Dissipation and $I_{s/b}$ derating curves for both types.

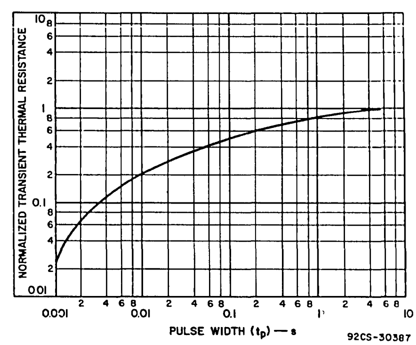


Fig. 3 - Typical thermal-response characteristic for both types.

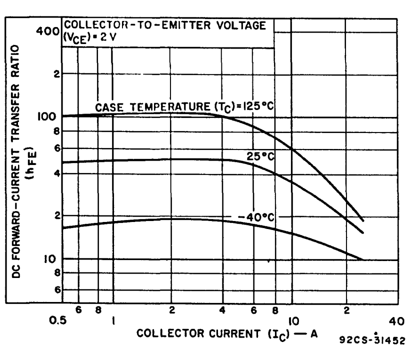


Fig. 4 - Typical dc beta characteristics for both types.

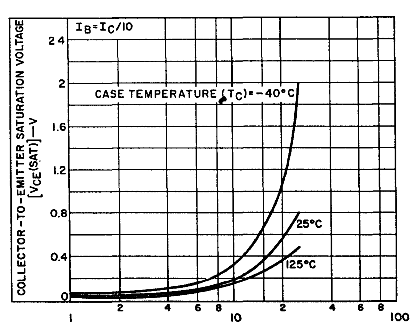


Fig. 5 - Typical collector-to-emitter saturation voltage characteristics for both types.

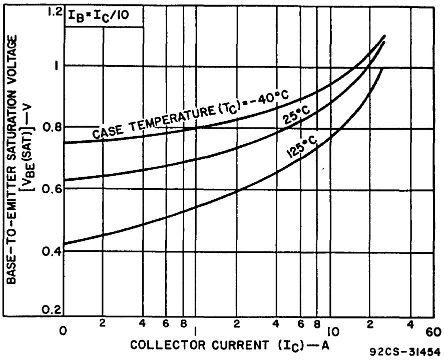


Fig. 6 - Typical base-to-emitter saturation voltage characteristic for both types.

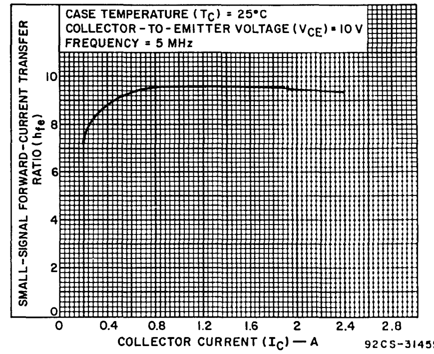


Fig. 7 - Typical small-signal forward-current transfer ratio characteristic for both types (f = 5 MHz).

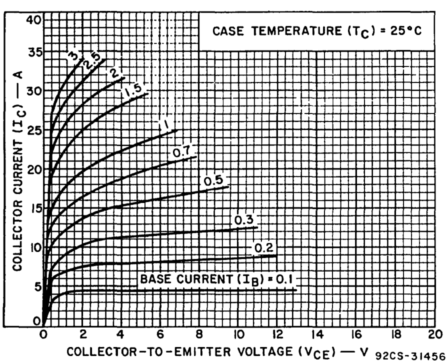


Fig. 8 - Typical output characteristics for both types.

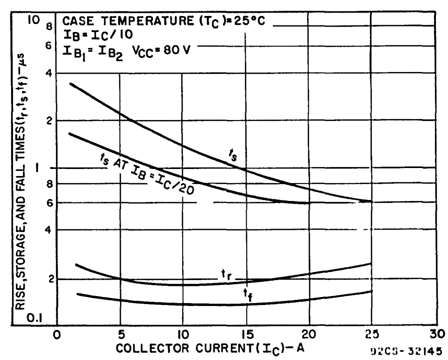


Fig. 9 - Typical saturated-switching-time characteristics as a function of collector current for both types.

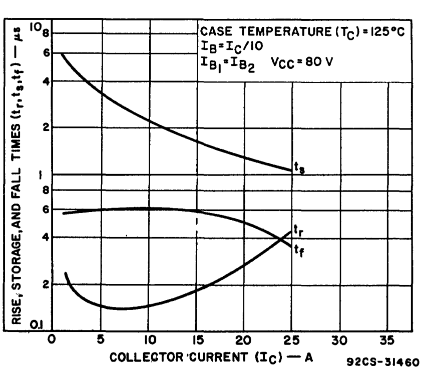


Fig. 10 - Typical saturated-switching-time characteristics at T_C = 125° C as a function of collector current for both types.

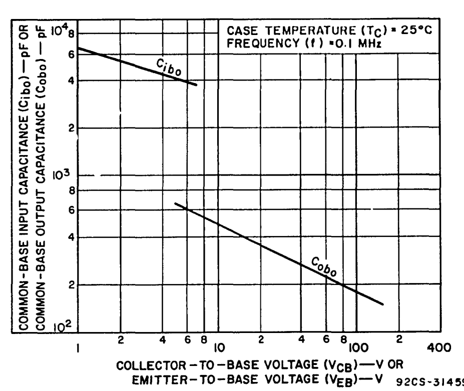


Fig. 11 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for both types.

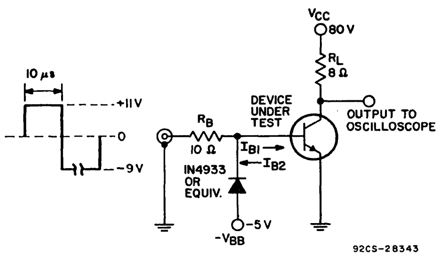


Fig. 12 - Switching-time test circuit.

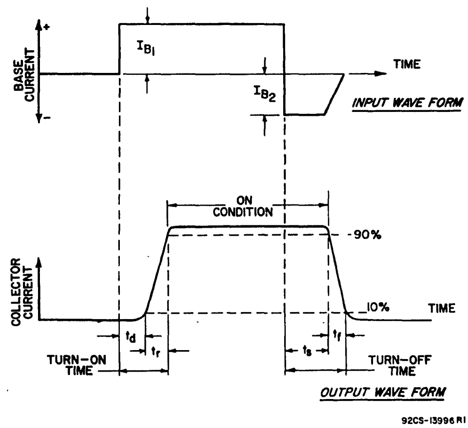


Fig. 13 - Phase relationship between input current and output current showing reference points for specification of switching times.

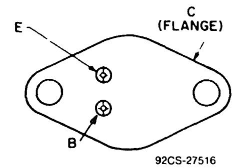
Silicon N-P-N Epitaxial-Base High-Power Transistors

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 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.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	MJ15024	MJ15022	
V_{CBO}	400	350	V
$V_{CER}(sus)$ R_{BE} = 100 Ω	275	225	V
$V_{CEO}(sus)$	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

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

CHARAC-TERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CUR-RENT A dc I_C	LIMITS MJ15024 Min.	MJ15024 Max.	MJ15022 Min.	MJ15022 Max.	UNITS
I_{CBO}	400[a]			—	1	—	—	mA
	350[a]			—	—	—	1	
I_{CEO}	200			—	0.5	—	—	
	150			—	—	—	0.5	
I_{CEX}	400	−1.5		—	0.5	—	0.5	
	250	−1.5		—	0.25	—	—	
	200	−1.5		—	—	—	0.25	
I_{CER} $R_{BE}=100\ \Omega$,	200			—	4	—	—	
$T_C=150°C$	150			—	—	—	4	
h_{FE}	4		3[c]	—	—	—	—	
	4		5[c]	—	—	—	—	
	4		8[c]	15	60	15	60	
	4		16[c]	5	—	5	—	
$V_{CEO}(sus)$[b]			0.1	250	—	200	—	V
$V_{CER}(sus)$[b] $R_{BE}=100\ \Omega$			0.1	275	—	225	—	
V_{EBO} $I_E=1$ mA				—	—	—	—	
$I_E=0.5$ mA				5	—	5	—	
V_{BE}	4		3[c]	—	—	—	—	
	4		8[c]	—	2.2	—	2.2	
$V_{CE}(sat)$ $I_B=0.3$ A			3[c]	—	—	—	—	
$I_B=0.8$ 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			2	—	2	—	A
nonrep.	50			5	—	5	—	
$\|h_{fe}\|$ f=1 MHz	10		1	4	20	4	20	
f_T	10		1	4	20	4	20	MHz
C_{ob}	10[a]			—	500	—	500	pF
$R_{\theta JC}$	10		10	—	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%.

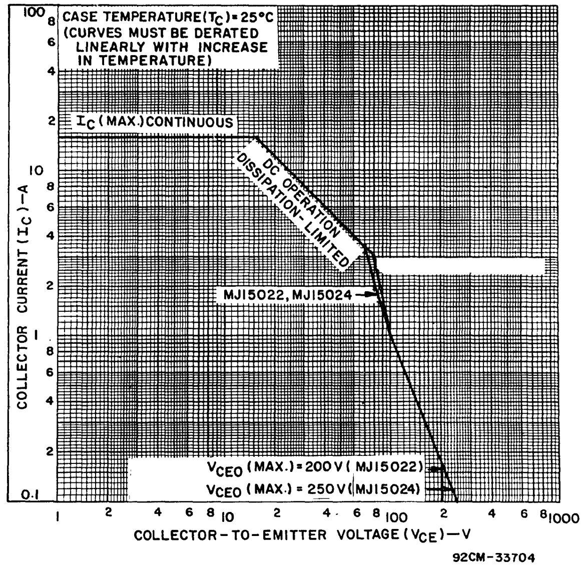


Fig. 1 - Maximum operating areas for all types.

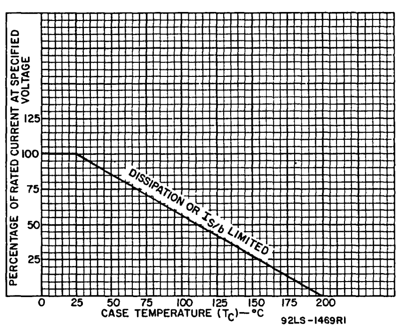


Fig. 2 - Current derating curve for all types.

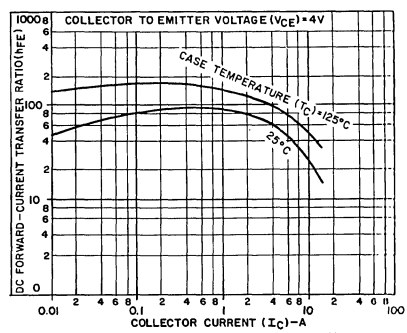


Fig. 3 - Typical dc beta characteristics as a function of collector current for all types.

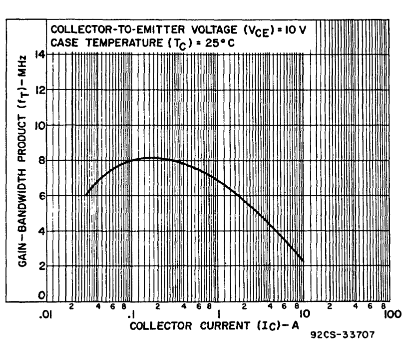


Fig. 4 - Typical gain-bandwidth product for all types.

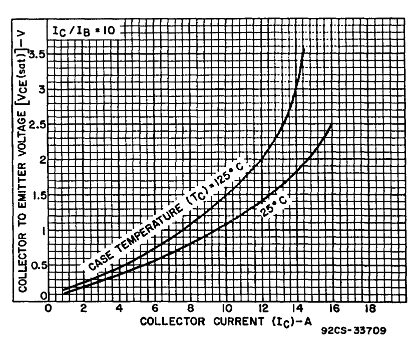


Fig. 5 - Typical saturation voltage characteristics for all types.

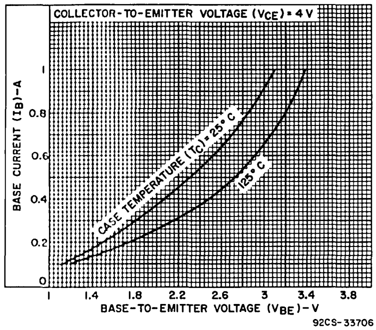


Fig. 6 - Typical input characteristics for all types.

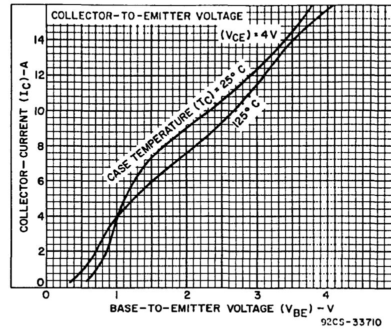


Fig. 7 - Typical transfer characteristics.

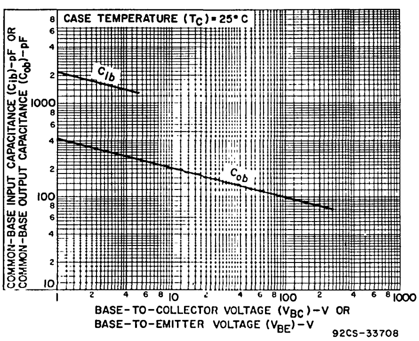


Fig. 8 - Typical common-base input or output capacitance characteristics as a function of reverse voltages for all types.

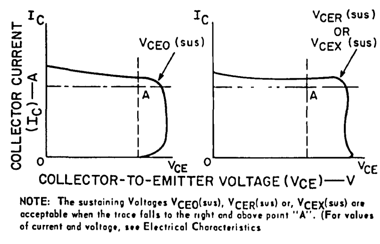


Fig. 9 - Oscilloscope display for measurement of sustaining voltages. (Test circuit shown in Fig. 10).

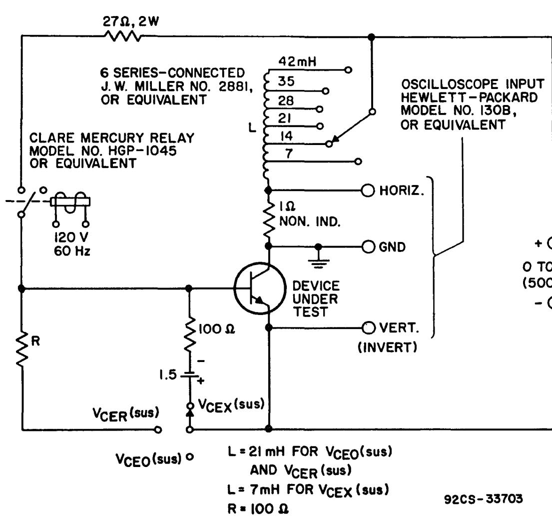
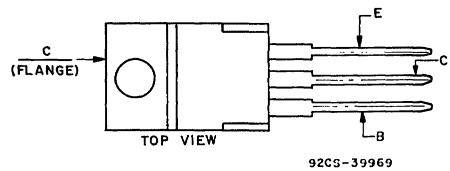


Fig. 10 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

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.

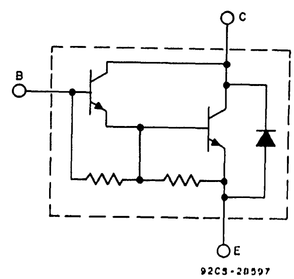


Fig. 1 - Schematic diagram for all types.

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 ≤ 2%.

[c]Caution: Sustaining voltage, $V_{CEO}(sus)$, must not be measured on a curve tracer.

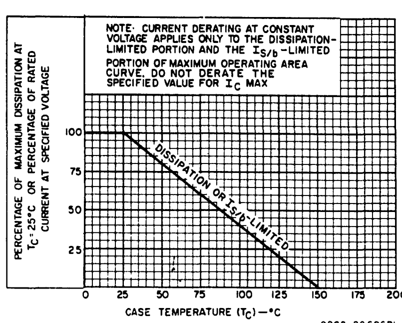


Fig. 2 - Derating curve for all types.

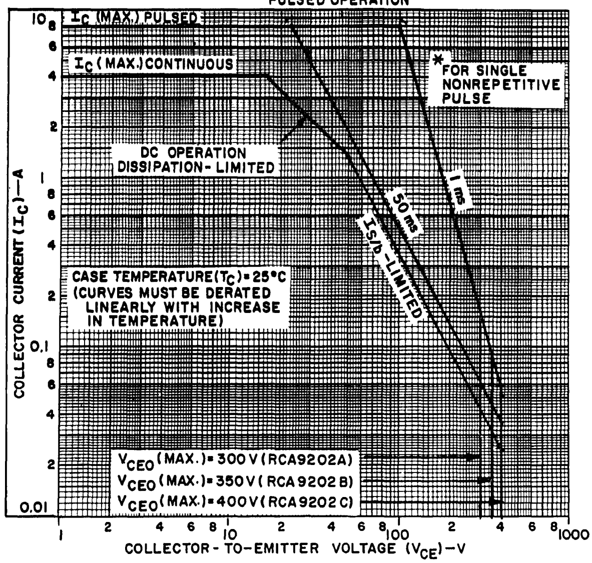


Fig. 3 - Maximum operating areas for all types.

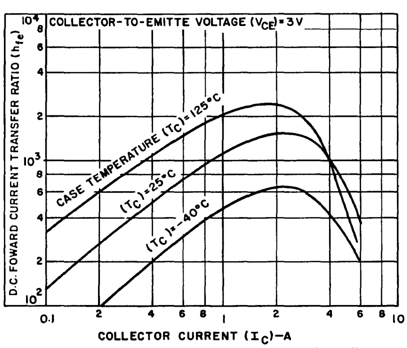


Fig. 4 - Typical dc beta characteristics for all types.

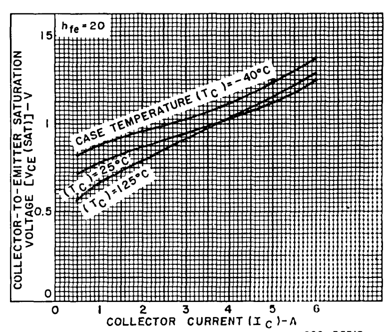


Fig. 5 - Typical saturation characteristics for all types.

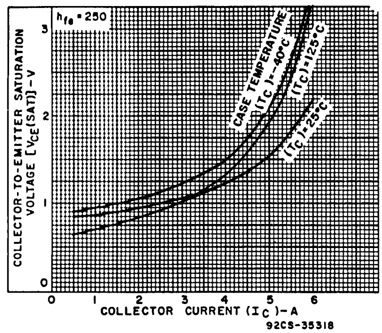


Fig. 6 - Typical saturation characteristics for all types.

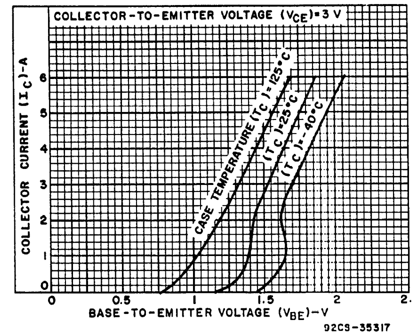


Fig. 7 - Typical transfer characteristics for all types.

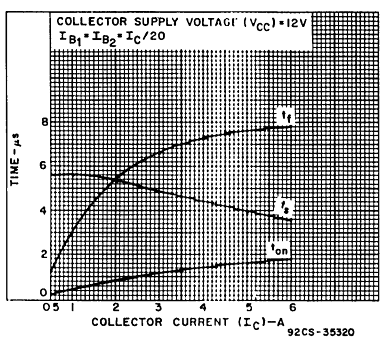


Fig. 8 - Typical saturated switching characteristics for all types.

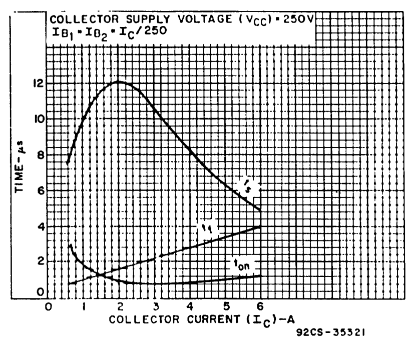


Fig. 9 - Typical saturated switching characteristics for all types.

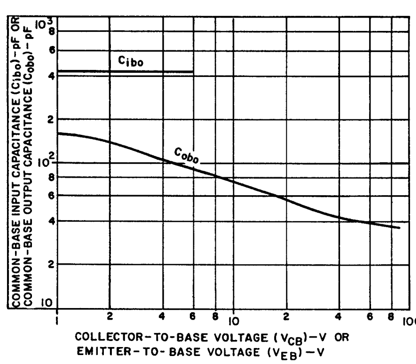


Fig. 10 - Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristics (all types).

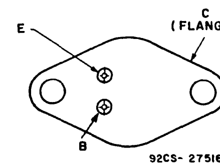
RCA9228A, RCA9228B, RCA9228C, RCA9228D
RCA9229A, RCA9229B, RCA9229C, RCA9229D

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.

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*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.

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%.

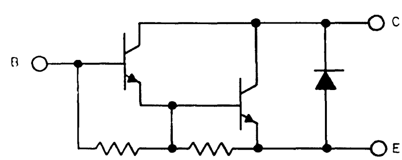


Fig. 1 - Schematic diagram for RCA9228A, RCA9228B, RCA9228C, RCA9228D.

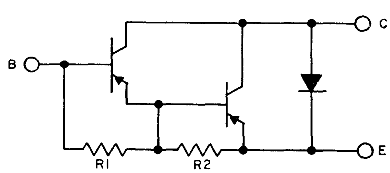


Fig. 2 - Schematic diagram for RCA9229A, RCA9229B, RCA9229C, RCA9229D.

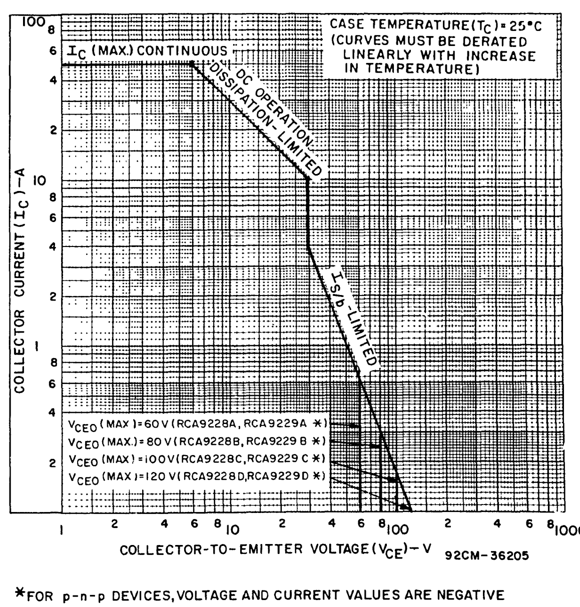


Fig. 3 - Maximum operating areas for all types.

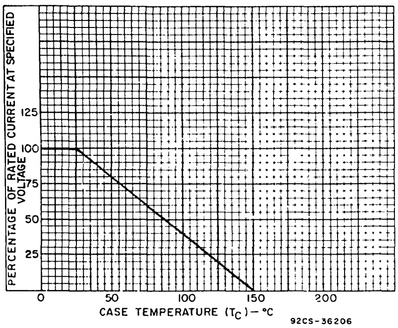


Fig. 4 - Current derating curve for all types.

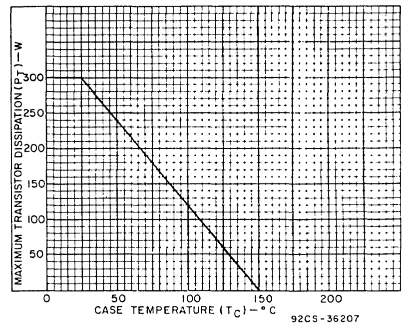


Fig. 5 - Power derating curve for all types.

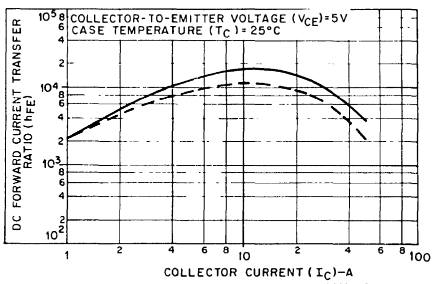


Fig. 6 - Typical dc beta characteristics for all types.

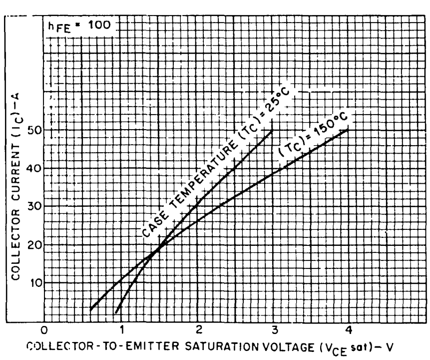


Fig. 7 - Typical collector-to-emitter saturation voltage characteristics for RCA9228A, RCA9228B, RCA9228C and RCA9228D.

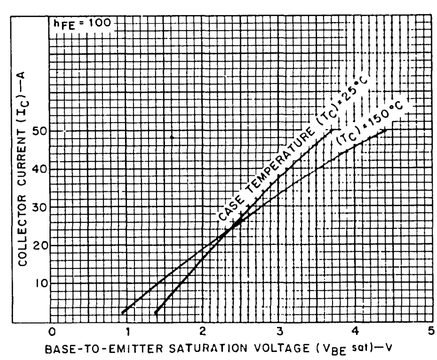


Fig. 8 - Typical base-to-emitter saturation voltage characteristics for RCA9228A, RCA9228B, RCA9228C and RCA9228D.

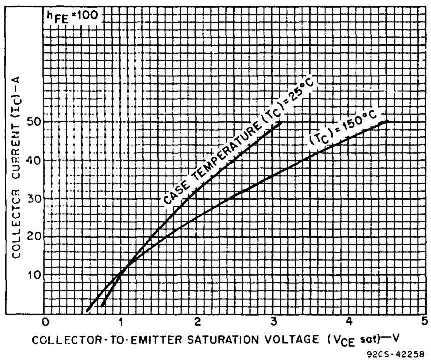


Fig. 9 - Typical collector-to-emitter saturation voltage characteristics for RCA9229A, RCA9229B, RCA9229C and RCA9229D.

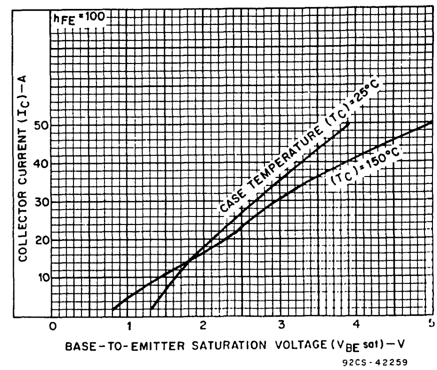


Fig. 10 - Typical base-to-emitter saturation voltage characteristics for RCA9229A, RCA9229B, RCA9229C and RCA9229D.

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 80 Watts
Gain of 1000 at 3 A

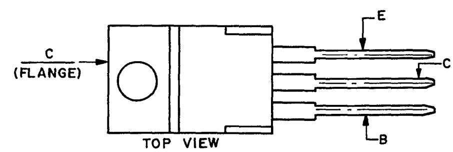
Features:

- Operates from IC without predriver
- Low leakage at high temperature

Applications:

- Power switching
- Hammer drivers
- Audio amplifiers
- Series and shunt regulators

TERMINAL DESIGNATIONS

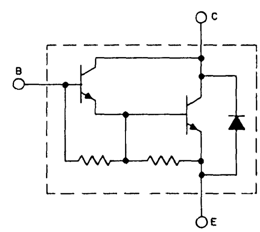


92CS-39969

JEDEC TO-220AB

The 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.



92CS-28597

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*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP100		TIP101		TIP102		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} $I_E = 0$	60 80 100				– – –	50 – –	– – –	– 50 –	– – –	– – 50	μA
I_{CEO}	30 40 50			0 0 0	– – –	50 – –	– – –	– 50 –	– – –	– – 50	μA
I_{EBO}		–5	0		–	8	–	8	–	8	mA
$V_{CEO}(sus)$			0.03[b]	0	60	–	80	–	100	–	V
h_{FE}	4 4		3[b] 8[b]		1000 200	20,000 –	1000 200	20,000 –	1000 200	20,000 –	
V_{BE}	4		8[b]		–	2.8	–	2.8	–	2.8	V
$V_{CE}(sat)$			3[b] 8[b]	0.006 0.08	– –	2 2.5	– –	2 2.5	– –	2 2.5	V
V_F			–10		–	2.8	–	2.8	–	2.8	V
t_d[c] t_r[c] t_s[c] t_f[c]			8 8 8 8	0.08 0.08 0.08[d] 0.08[d]	0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		0.035 typ. 0.35 typ. 1.8 typ. 2.45 typ.		μs
$I_{S/b}$ t=0.15 s non-rep. pulse	40				2	–	2	–	2	–	A
$R_{\theta JC}$					–	1.56	–	1.56	–	1.56	°C/W

[a] V_{CB} value. [b] Pulsed: Pulse duration = 300 μs, duty factor ≤2%. [c] V_{CC} = 40 V [d] $I_{B_1} = -I_{B_2}$

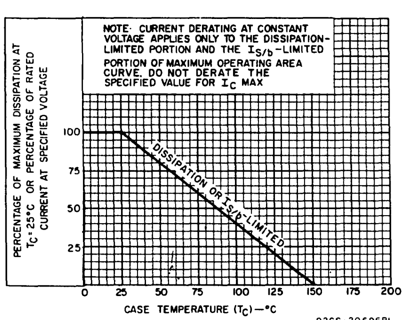


Fig. 2 — Derating curve for all types.

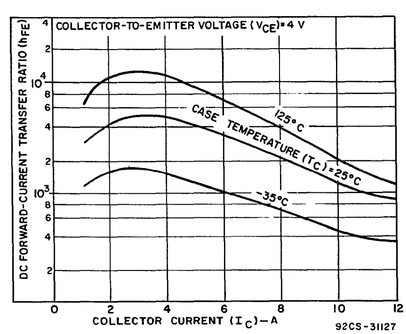


Fig. 3 — Typical dc-beta characteristics for all types.

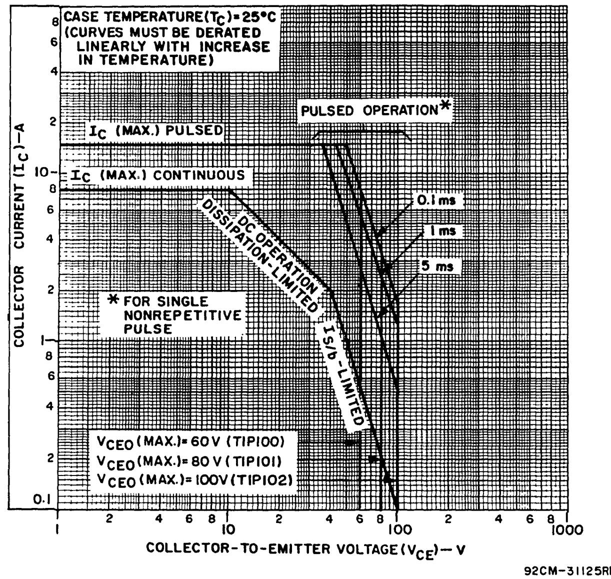


Fig. 4 — Maximum operating areas for all types (T_C = 25°C).

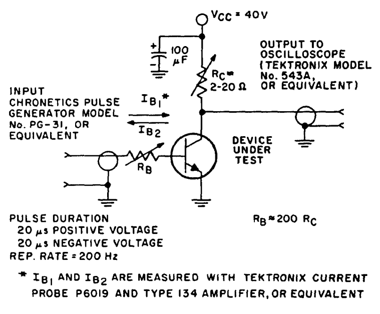


Fig. 5 — Circuit used to measure saturated switching times.

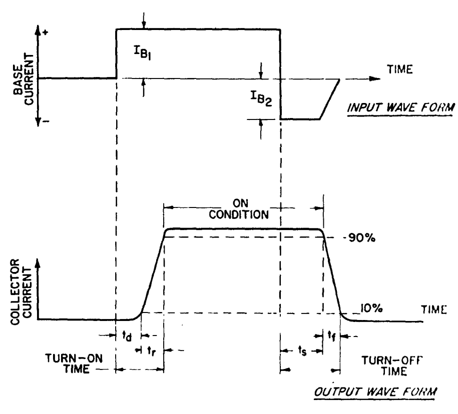


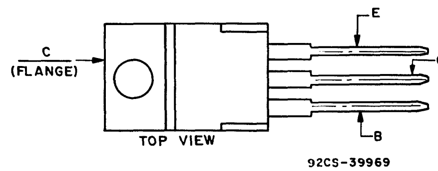
Fig. 6 — Phase relationship between input current and output current showing reference points for specification of switching times.

2-Ampere N-P-N Darlington Power Transistors

For Low and Medium Frequency Power Switching, Hammer Driver, Audio Amplifier, and Series and Shunt Regulator Applications

Features:
- *Operates from IC without predriver*
- *Gain of 1000 at 1A*
- *Low leakage at high temperatures*
- *Designed for completementary use with TIP-115, 116, and 117*
- *Hard glass passivation*
- *Wire-bonded construction*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The 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.

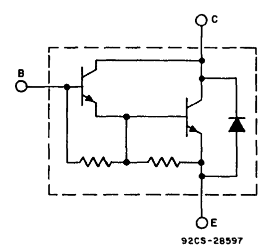


Fig. 1 - Schematic diagram for all types.

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

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%.

2

POWER TRANSISTORS

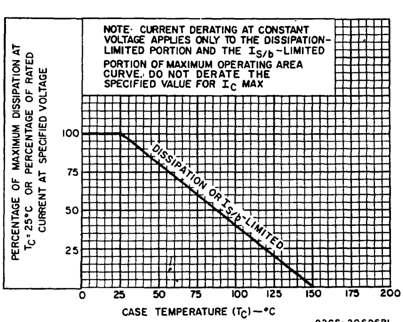


Fig. 2 - Derating curve for all types.

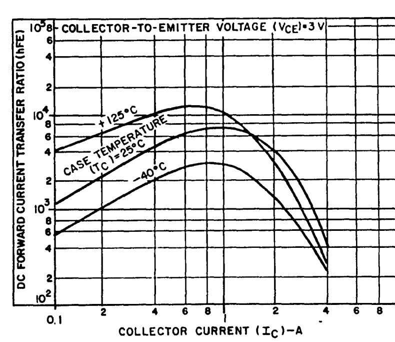


Fig. 3 - Typical dc-beta characteristics for all types.

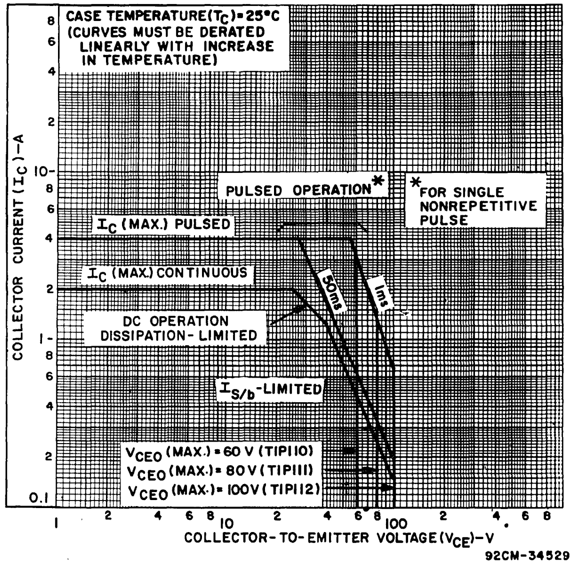


Fig. 4 - Maximum operating areas for all types (T_C = 25° C).

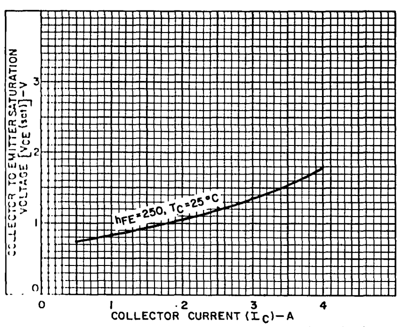


Fig. 5 - Typical saturation characteristics for all types.

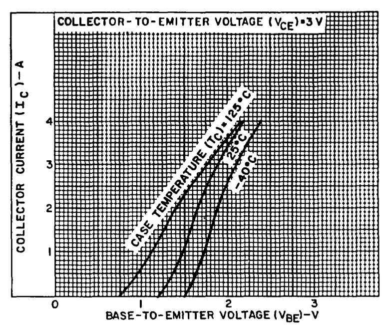


Fig. 6 - Typical transfer characteristics for all types.

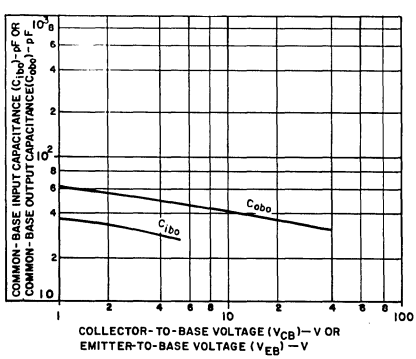


Fig. 7 - Typical common-base input (C_{ibo}) or output (C_{obo}) capaciatance characteristic (all types).

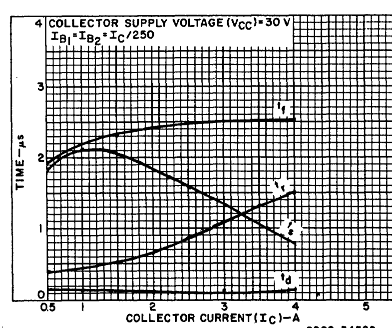


Fig. 8 - Typical saturated switching characteristics (all types).

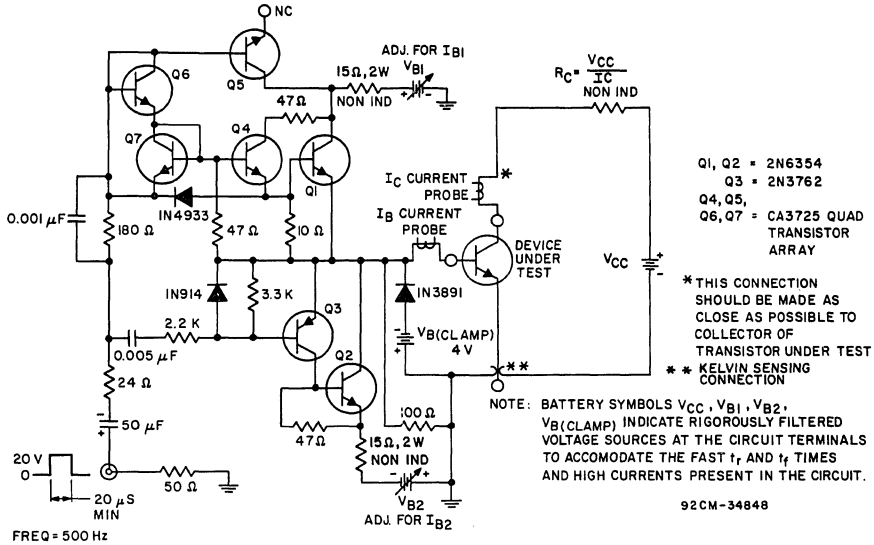
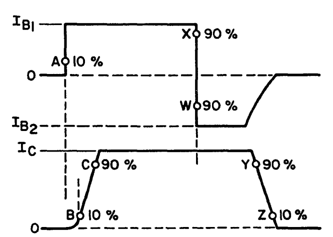


Fig. 9 - Circuit for measuring switching times.



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.

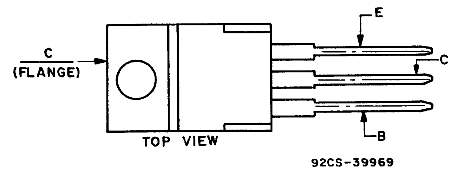
2-Ampere P-N-P Darlington Power Transistors

For Low and Medium Frequency Power Switching, Hammer Driver, Audio Amplifier, and Series and Shunt Regulator Applications

Features:

- *Operates from IC without predriver*
- *Gain of 1000 at 1A*
- *Low leakage at high temperatures*
- *Designed for completementary use with TIP110, TIP111 and TIP112*
- *Hard glass passivation*
- *Wire-bonded construction*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The 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.

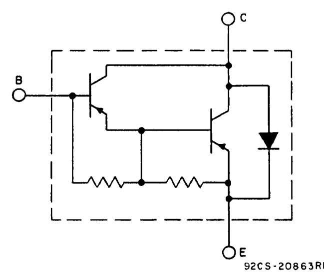


Fig. 1 - Schematic diagram for all types.

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

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 ≤ 2%.

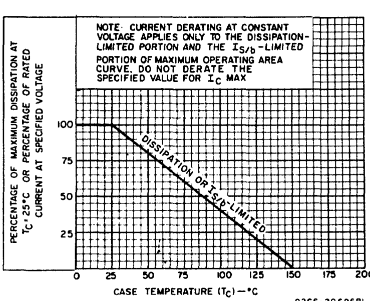


Fig. 2 - Derating curve for all types.

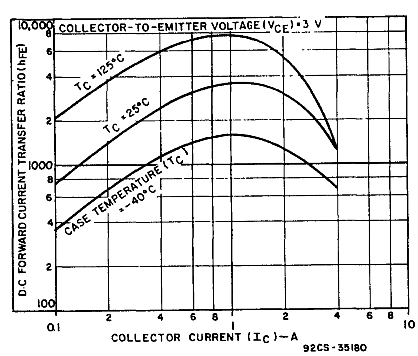


Fig. 3 - Typical dc-beta characteristics for all types.

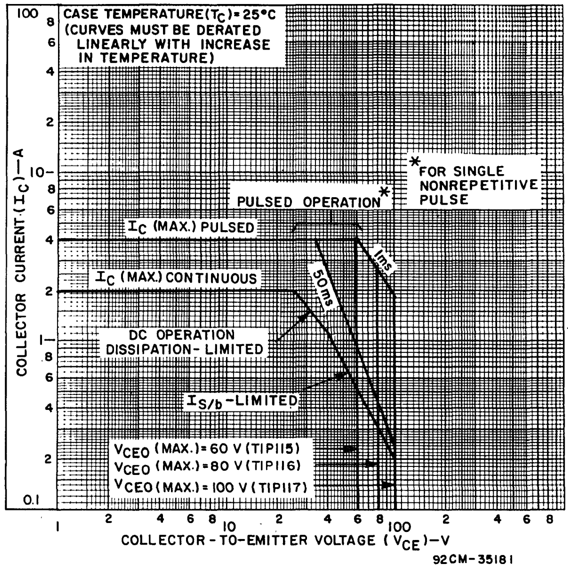


Fig. 4 - Maximum operating areas for all types (Tc = 25° C).

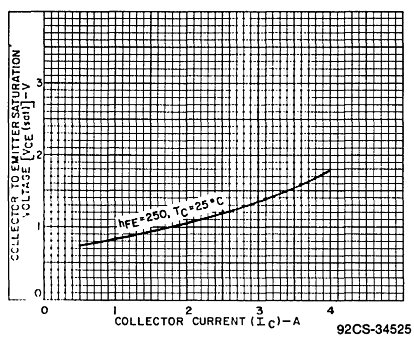


Fig. 5 - Typical saturation characteristics for all types.

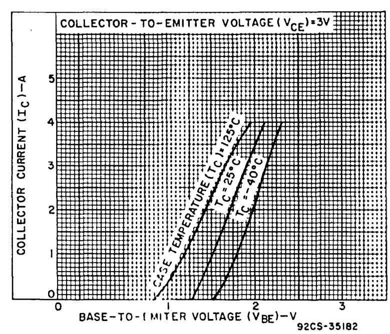


Fig. 6 - Typical transfer characteristics for all types.

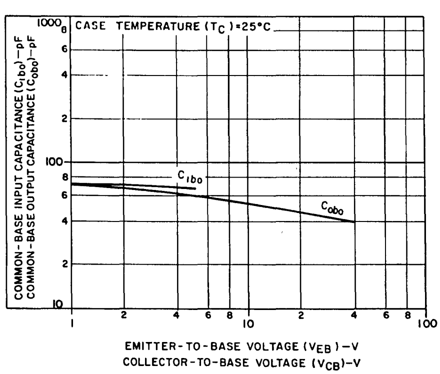


Fig. 7 - Typical common-base input (Cibo) or output (Cobo) capaciatance characteristic (all types).

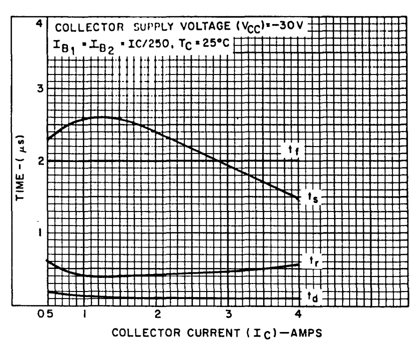


Fig. 8 - Typical saturated switching characteristics (all types).

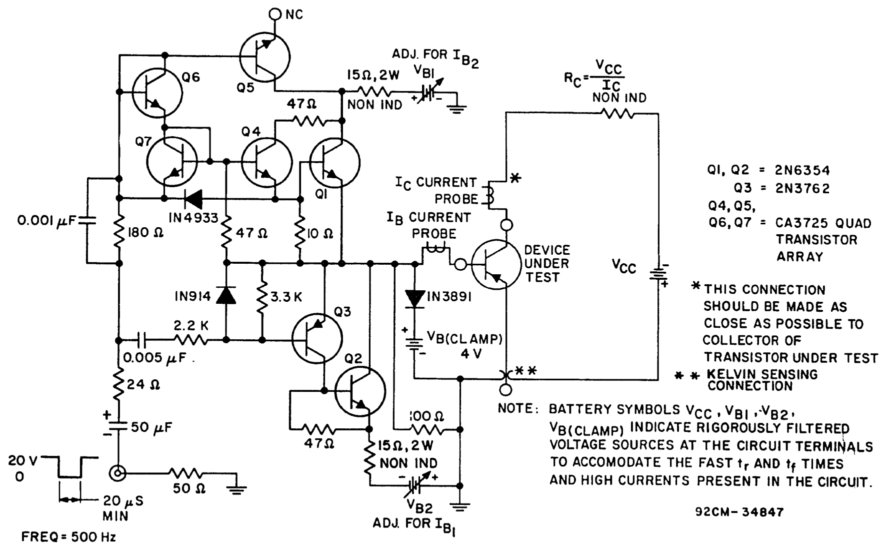


Fig. 9 - Circuit for measuring switching times.

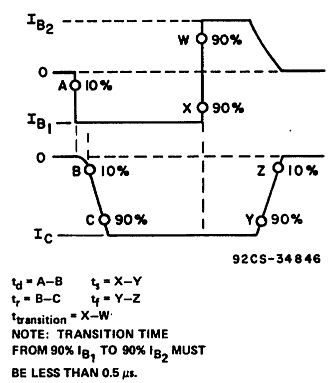


Fig. 10 - Phase relationship between input and output currents showing reference points for specification of switching times.

8-Ampere N-P-N Darlington Power Transistors

60, 80, and 100 Volts, 65 Watts
Gain of 1000 at 0.5 A
Gain of 1000 at 3 A

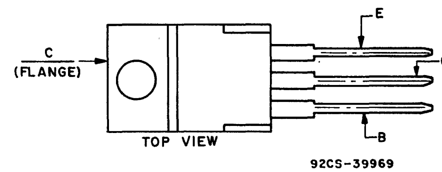
Features:

- **Operates from IC without predriver**
- **Low leakage at high temperature**

Applications:

- **Power switching**
- **Audio amplifiers**
- **Hammer drivers**
- **Series and shunt regulators**

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.

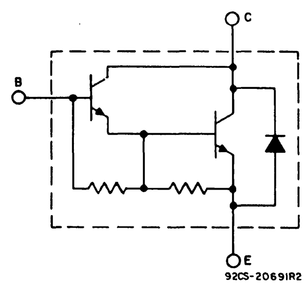


Fig. 1 — Schematic diagram for all types.

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

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARAC-TERISTIC	TEST CONDITIONS				LIMITS						UNITS
	Voltage V dc		Current A dc		TIP120		TIP121		TIP122		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CBO} I_E=0	60				–	0.2	–	–	–	–	mA
	80				–	–	–	0.2	–	–	
	100				–	–	–	–	–	0.2	
I_{CEO}	30			0	–	0.5	–	–	–	–	
	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%.

2 POWER TRANSISTORS

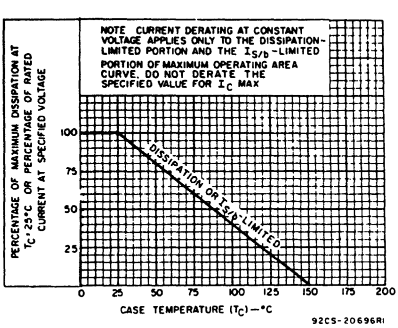


Fig. 2 — Derating curve for all types.

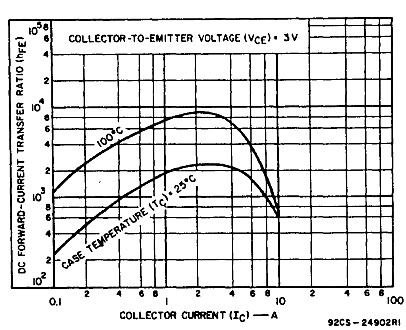


Fig. 3 — Typical dc beta characteristics for all types.

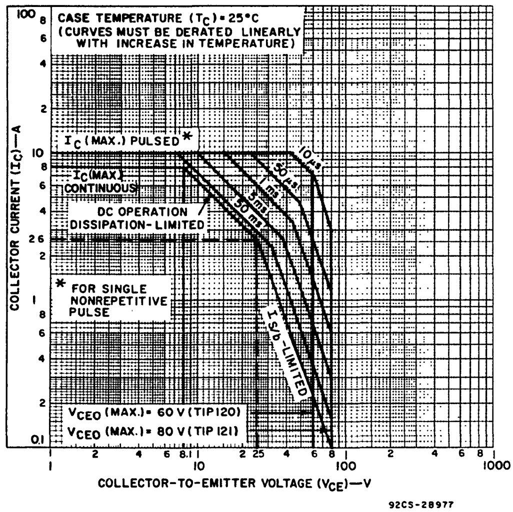


Fig. 4 — Maximum operating areas for TIP120 and TIP121.

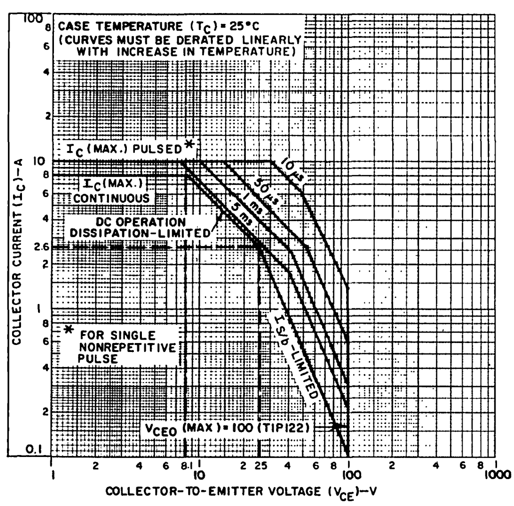


Fig. 5 — Maximum operating areas for TIP122.

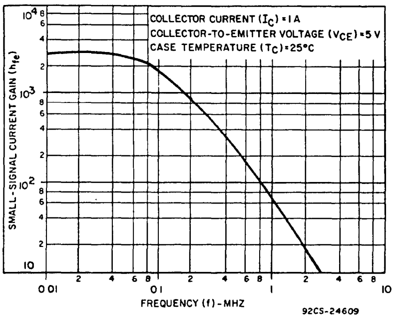


Fig. 6 — Typical small-signal current gain for all types.

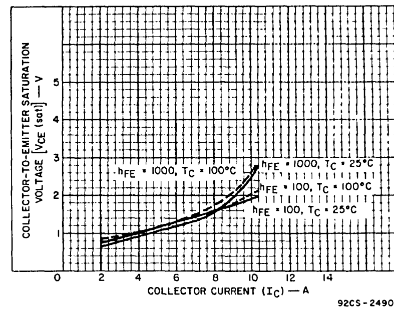


Fig. 7 — Typical saturation characteristics for all types.

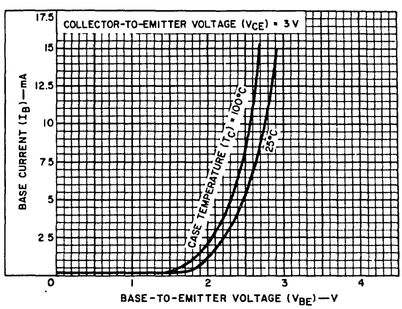


Fig. 8 — Typical input characteristics for all types.

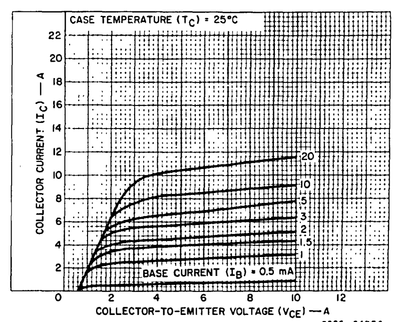


Fig. 9 — Typical output characteristics for all types.

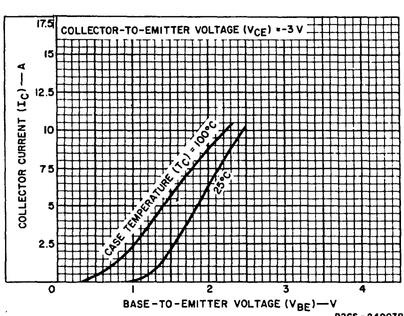


Fig. 10 — Typical transfer characteristics for all types.

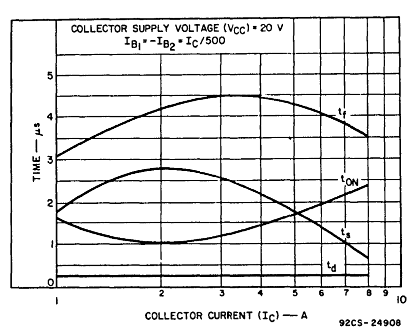


Fig. 11 — Typical saturated switching characteristics for all types.

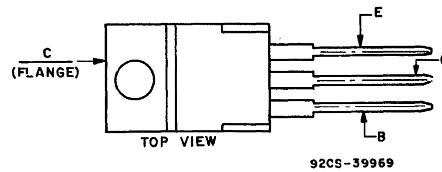
8-Ampere P-N-P Darlington Power Transistors

−60, −80, and −100 Volts, 65 Watts
Gain of 1000 at −3 A
Gain of 500 at −0.75 A

Features:
- Operates from IC without predriver
- Low leakage at high temperature

Applications:
- Power switching
- Audio amplifiers
- Hammer drivers
- Series and shunt regulators

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The 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.

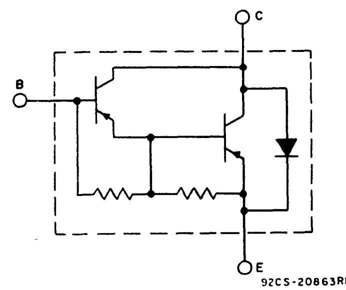


Fig. 1 – Schematic diagram for all types.

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

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARAC-TERISTIC	TEST CONDITIONS			LIMITS						UNITS
	Voltage V dc	Current A dc		TIP125		TIP126		TIP127		
	V_{CE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO}	−30		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%.

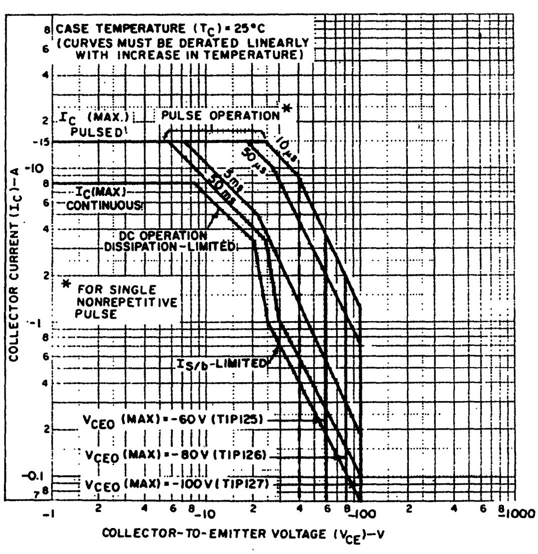


Fig. 2 — Maximum operating areas for all types.

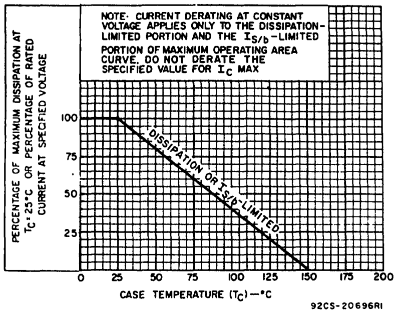


Fig. 3 — Dissipation derating curve for all types.

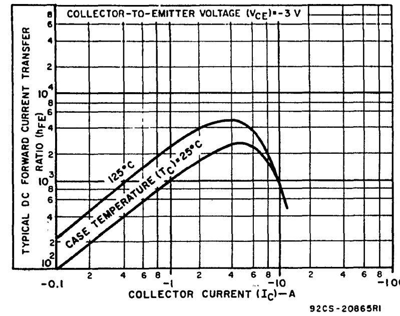


Fig. 4 — Typical dc beta characteristics for all types.

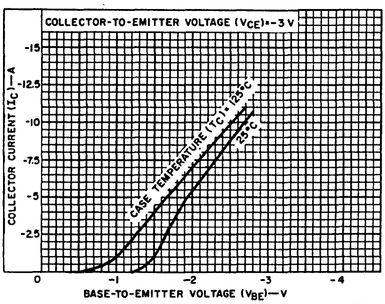


Fig. 5 — Typical transfer characteristics for all types.

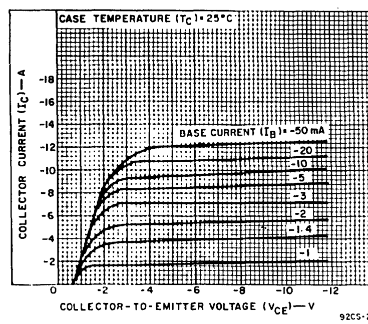


Fig. 6 — Typical output characteristics for all types.

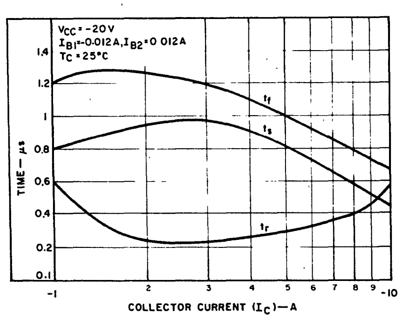


Fig. 7 — Typical saturated switching-time characteristics for all types.

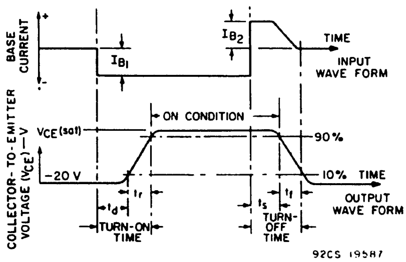


Fig. 8 — Phase relationship between input current and output voltage showing reference points for specification of switching-times.

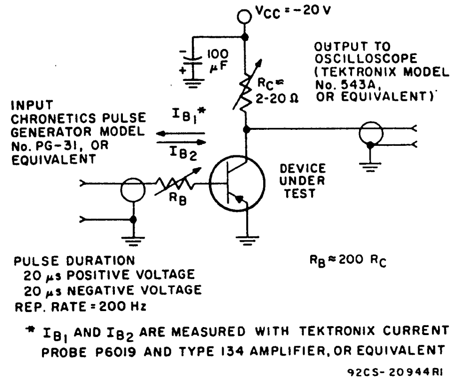


Fig. 9 — Circuit used to measure saturated switching-times.

2

POWER TRANSISTORS

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

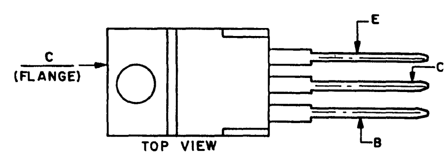
Features:
- *30 W at 25°C case temperature*
- *3 A rated collector current*
- *Min. f_T of 3 MHz at 10 V, 200 mA*
- *Designed for complementary use with TIP30-series p-n-p types**

The RCA-TIP29, TIP29A, TIP29B, and TIP29C are epitaxial-base, silicon n-p-n transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP30 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP30-series devices are given in RCA data bulletin File No. 988

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP29	TIP29A	TIP29B	TIP29C	
V_{CBO}	40	60	80	100	V
V_{CEO}	40	60	80	100	V
V_{EBO}	5	5	5	5	V
I_C	3	3	3	3	A
I_B	1	1	1	1	A
P_T:					
At $T_C \leq 25°C$	30	30	30	30	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ ... Derate linearly	0.24				W/°C
T_{stg}, T_J	-65 to 150				°C
T_L (During soldering): At distance 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

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} 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	0.4 (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 POWER TRANSISTORS

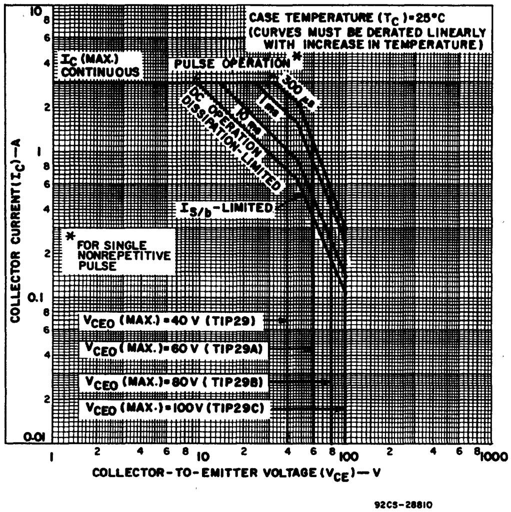


Fig. 1 — Maximum operating areas for all types.

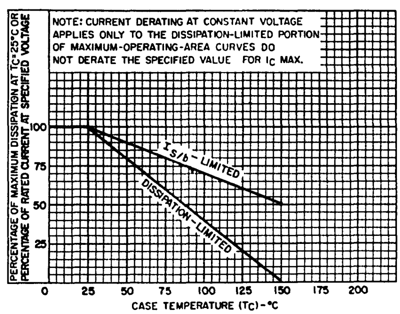


Fig.2 — Derating curve for all types.

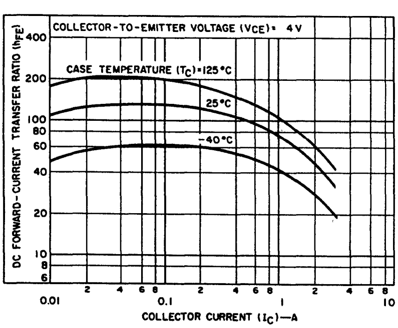


Fig. 3 — Typical dc beta characteristics for TIP29, TIP29A, and TIP29B.

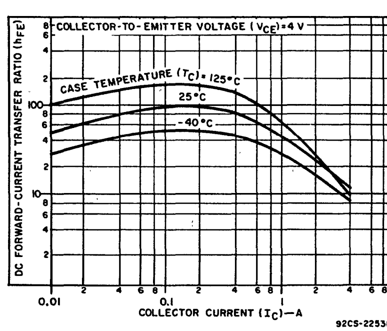


Fig. 4 — Typical dc beta characteristics for TIP29C.

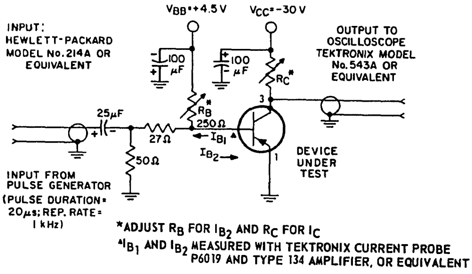


Fig. 5 — Circuit used to measure saturated switching times for all types.

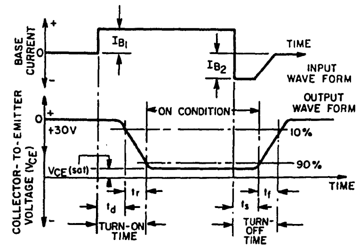


Fig. 6 — Oscilloscope display for measurement of switching times.

2 POWER TRANSISTORS

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

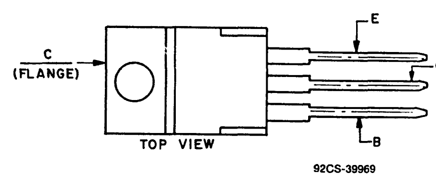
- *30 W at 25°C case temperature*
- *3 A rated collector current*
- *Min. f_T of 3 MHz at -10 V, -200 mA*
- *Designed for complementary use with TIP29-series n-p-n types**

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

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST COND. VOLTAGE V dc	TEST COND. CURRENT A dc	LIMITS TIP30		LIMITS TIP30A		LIMITS TIP30B		LIMITS TIP30C		Units
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} I_B=0	−30		–	−0.3	–	−0.3	–	–	–	–	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	−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.

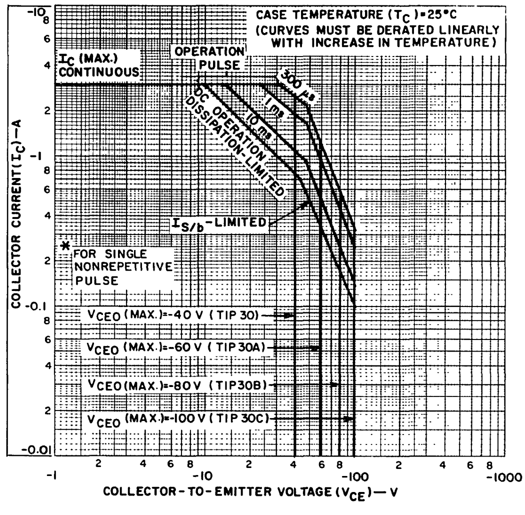


Fig.1 — Maximum operating areas for all types.

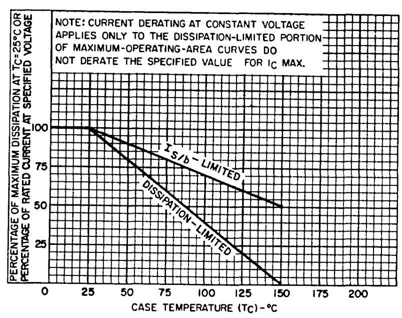


Fig.2 — Derating curve for all types.

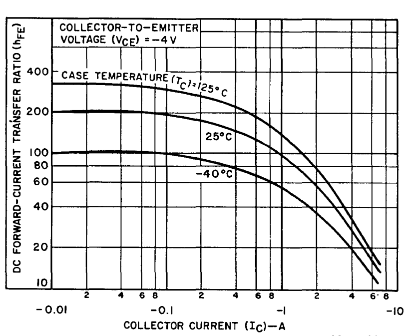


Fig. 3 — Typical dc beta characteristics for TIP30, TIP30A, and TIP30B.

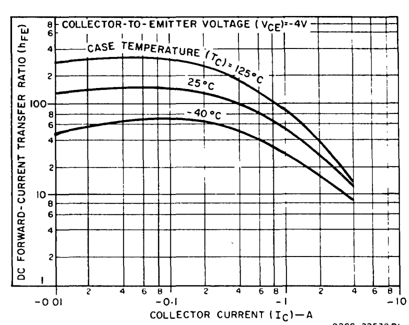


Fig. 4 — Typical dc beta characteristics for TIP30C.

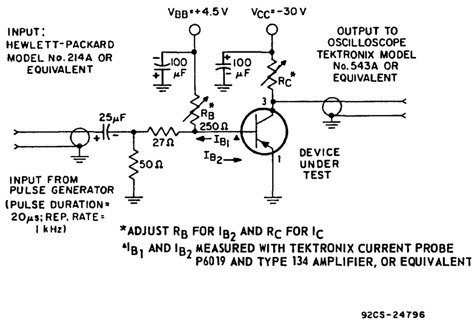


Fig. 5 — Circuit used to measure saturated switching times for all types.

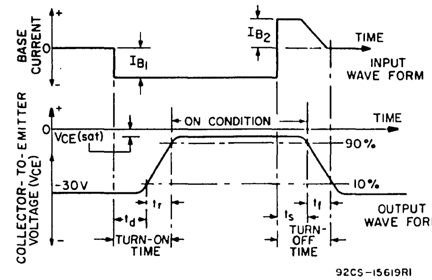


Fig. 6 — Oscilloscope display for measurement of switching times.

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

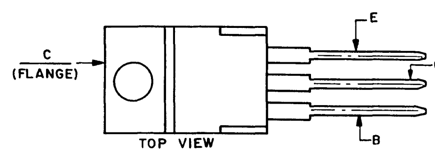
- *40 W at 25°C case temperature*
- *5 A rated collector current*
- *Min. f_T of 3 MHz at 10 V, 500 mA*
- *Designed for complementary use with TIP32-series p-n-p types**

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

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	TIP31 Min.	TIP31 Max.	TIP31A Min.	TIP31A Max.	TIP31B Min.	TIP31B Max.	TIP31C Min.	TIP31C 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	0.4 (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.

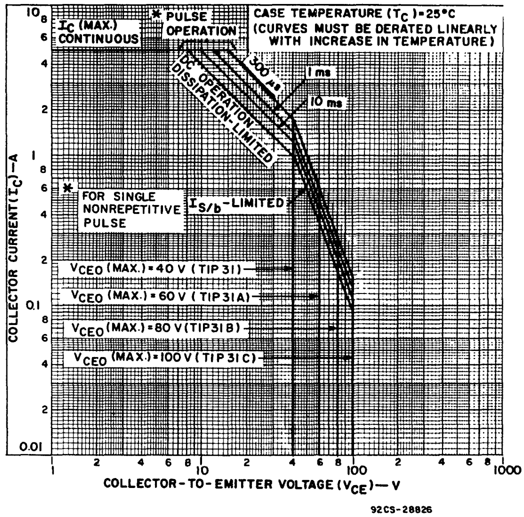


Fig.1 — Maximum operating areas for all types.

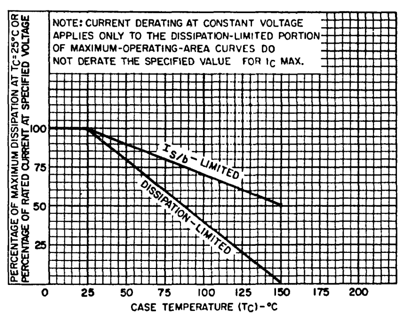


Fig.2 — Derating curve for all types.

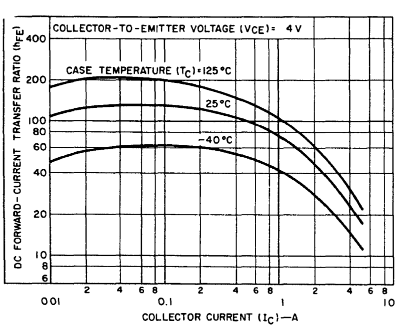


Fig. 3 — Typical dc beta characteristics for TIP31, TIP31A, and TIP31B.

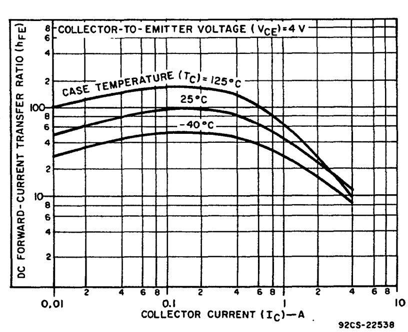


Fig. 4 — Typical dc beta characteristics for TIP31C.

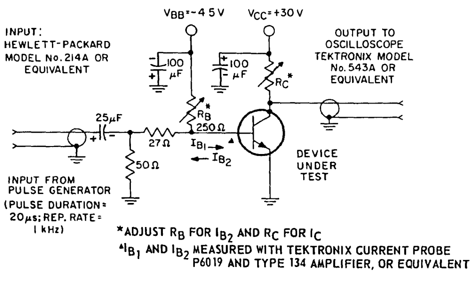


Fig. 5 — Circuit used to measure saturated switching times for all types.

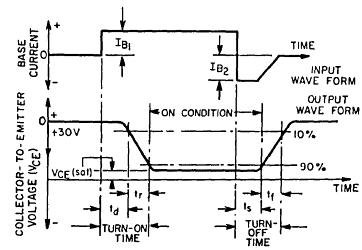


Fig. 6 — Oscilloscope display for measurement of switching times.

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

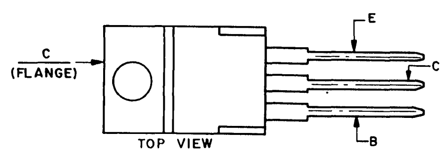
- *40 W at 25°C case temperature*
- *5 A rated collector current*
- *Min. f_T of 3 MHz at -10 V, -500 mA*
- *Designed for complementary use with TIP31-series n-p-n types**

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

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.

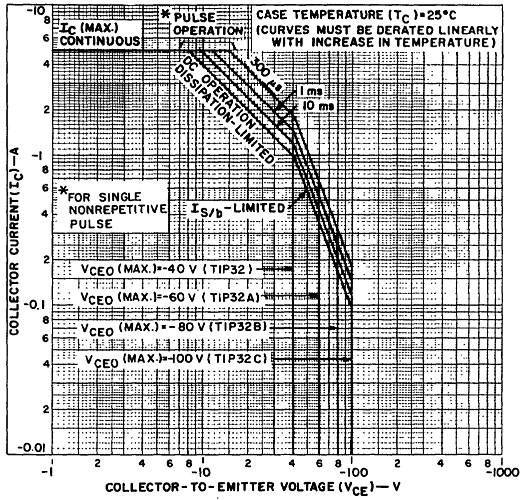


Fig. 1 — Maximum operating areas for all types.

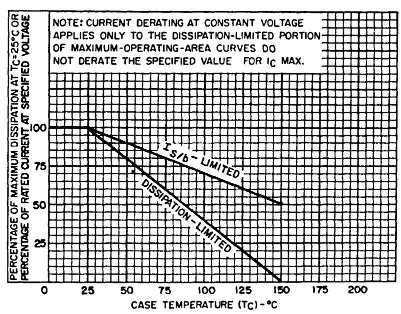


Fig. 2 — Derating curve for all types.

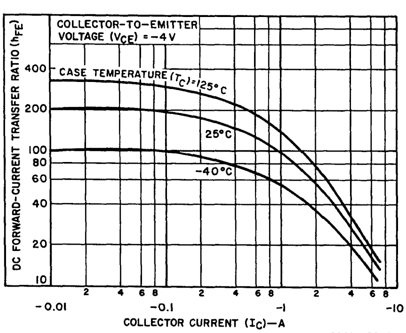


Fig. 3 — Typical dc beta characteristics for TIP32, TIP32A, and TIP32B.

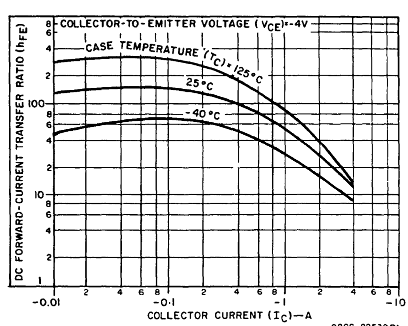


Fig. 4 — Typical dc beta characteristics for TIP32C.

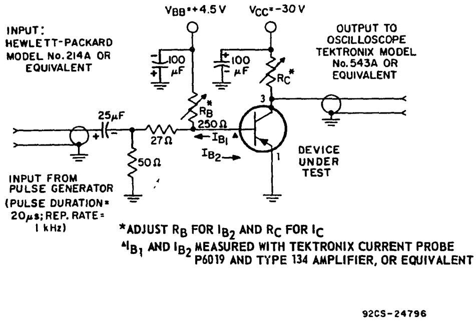


Fig. 5 — Circuit used to measure saturated switching times for all types.

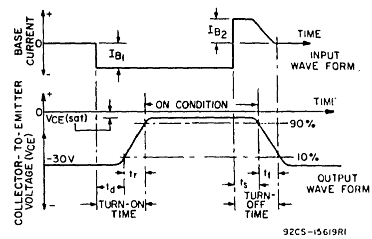


Fig. 6 — Oscilloscope display for measurement of switching times.

2 POWER TRANSISTORS

Epitaxial-Base, Silicon N-P-N VERSAWATT Transistors

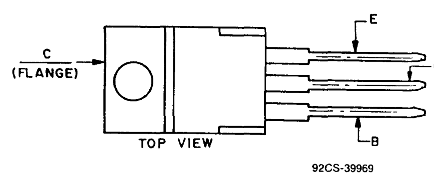
For Power-Amplifier and High-Speed-Switching Applications

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

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	TEST CONDITIONS Voltage V dc V_{CE}	Current A dc I_C	LIMITS TIP41 Min.	TIP41 Max.	TIP41A Min.	TIP41A Max.	TIP41B Min.	TIP41B Max.	TIP41C Min.	TIP41C Max.	Units
I_{CEO}	30		–	0.7	–	0.7	–	–	–	–	mA
I_B=0	60		–	–	–	–	–	0.7	–	0.7	mA
I_{CES}	40		–	0.4	–	–	–	–	–	–	mA
V_{BE}=0	60		–	–	–	0.4	–	–	–	–	mA
	80		–	–	–	–	–	0.4	–	–	mA
	100		–	–	–	–	–	–	–	0.4	mA
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.*

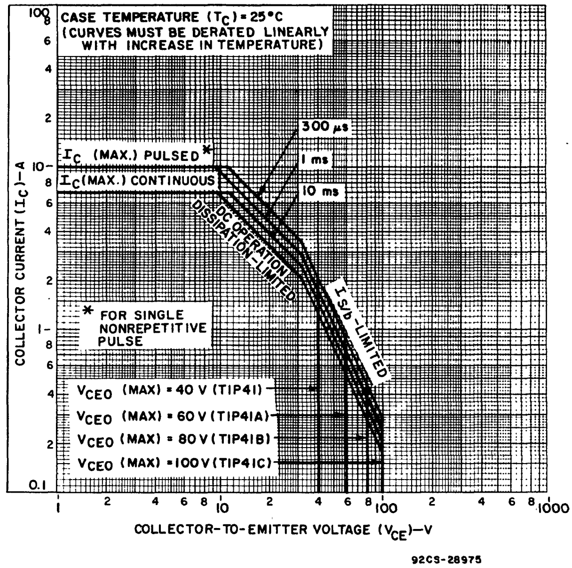


Fig. 1 — Maximum operating areas for all types.

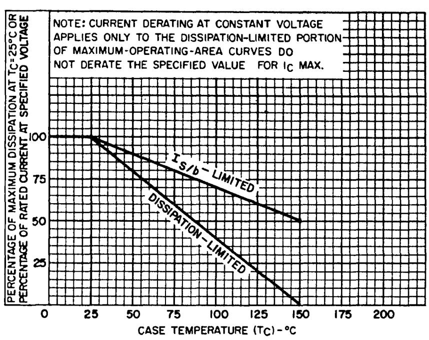


Fig. 2 — Derating curves for all types.

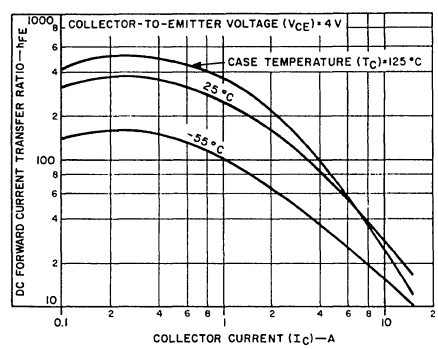


Fig. 3 — Typical dc beta characteristics for all types.

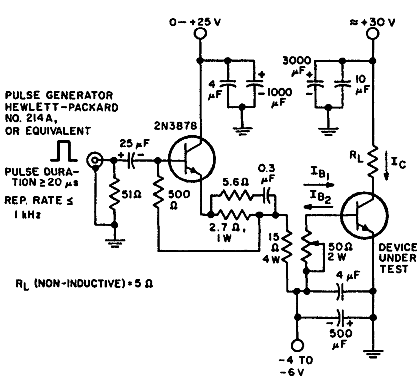


Fig. 4 — Circuit used to measure saturated switching times for all types.

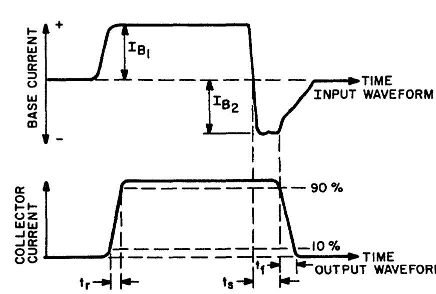


Fig. 5 — Oscilloscope display for measurement of switching times.

Epitaxial-Base, Silicon P-N-P VERSAWATT Transistors

For Power-Amplifier and High-Speed-Switching Applications

Features:

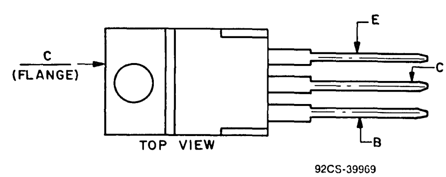
- *65 W at 25°C case temperature*
- *7 A rated collector current*
- *Min. f_T of 3 MHz at 10 V, 500 mA*
- *Designed for complementary use with TIP41-series n-p-n types**

The RCA-TIP42, TIP42A, TIP42B, and TIP42C are epitaxial-base, silicon p-n-p transistors intended for a wide variety of switching and amplifier applications, such as series and shunt regulators and driver and output stages of high-fidelity amplifiers. These power transistors are designed for complementary use with devices in the TIP41 series. They differ from each other in voltage ratings.

They are supplied in the JEDEC TO-220AB (VERSAWATT) plastic package.

* Technical data for the TIP41-series devices are given in RCA data bulletin File No. 992

TERMINAL DESIGNATIONS



JEDEC TO-220AB

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	TIP42	TIP42A	TIP42B	TIP42C	
V_{CBO}	-40	-60	-80	-100	V
V_{CEO}	-40	-60	-80	-100	V
V_{EBO}	-5	-5	-5	-5	V
I_C	-7	-7	-7	-7	A
I_{CM}	-10	-10	-10	-10	A
I_B	-3	-3	-3	-3	A
P_T:					
At $T_C \leq 25°C$	65	65	65	65	W
At $T_A \leq 25°C$	2	2	2	2	W
At $T_C > 25°C$ ... Derate linearly at	0.52				W/°C
T_{stg}, T_J	-65 to 150				°C
T_L (During soldering):					
At distance 1/8 in. (3.17 mm) from case for 10 s max.	235				°C

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} $I_B = 0$	−30 −60		– –	−0.7 –	– –	−0.7 –	– –	– −0.7	– –	– −0.7	mA
I_{CES} $V_{EB} = 0$	−40 −60 −80 −100		– – – –	−0.4 – – –	– – – –	– −0.4 – –	– – – –	– – −0.4 –	– – – –	– – – −0.4	mA
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 −4	−0.3[a] −3[a]	30 15	– 150	30 15	– 150	30 15	– 150	30 15	– 150	
V_{BE}	−4	−6[a]	–	−2.2	–	−2.2	–	−2.2	–	−2.2	V
$V_{CE}(sat)$ $I_B = -0.6$ A		−6[a]	–	−2	–	−2	–	−2	–	−2	V
h_{fe} f = 1 kHz	−10	−0.5	20	–	20	–	20	–	20	–	
$\|h_{fe}\|$ f = 1 MHz	−10	−0.5	3	–	3	–	3	–	3	–	
t_{ON} ($t_d + t_r$) $V_{CC} = -30$ V $R_L = 5\ \Omega$ $I_{B1} = I_{B2} = -0.6$ A		−6	0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		0.3 (typ.)		μs
t_{OFF} ($t_s + t_f$) $V_{CC} = -30$ V $R_L = 5\ \Omega$ $I_{B1} = I_{B2} = -0.6$ A		−6	0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		0.7 (typ.)		μs
$R_{\theta JC}$			–	1.92	–	1.92	–	1.92	–	1.92	°C/W
$R_{\theta JA}$			–	62.5	–	62.5	–	62.5	–	62.5	°C/W

[a] Pulsed, pulse duration = 300 μs, duty factor ⩽2%.
[b] *CAUTION:* Sustaining voltage, $V_{CEO}(sus)$, ***MUST NOT*** be measured on a curve tracer.

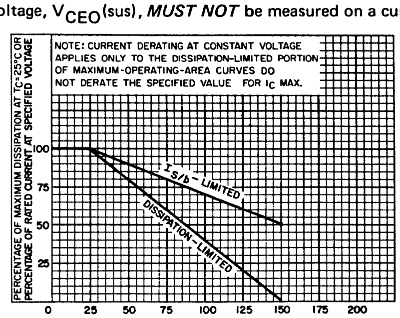


Fig. 1 — Derating curve for all types.

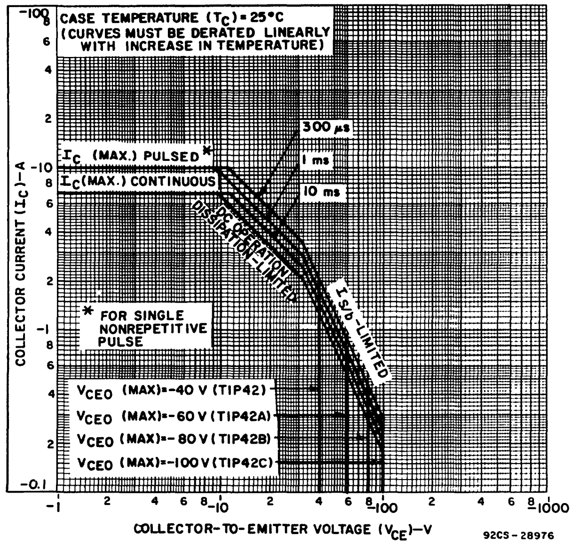


Fig. 2 — Maximum operating areas for all types.

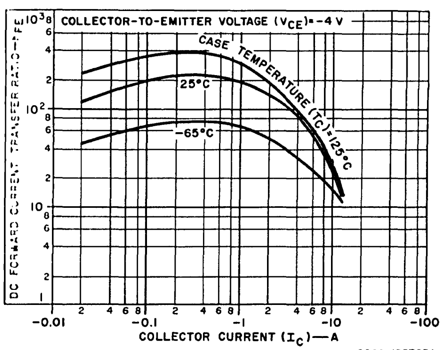


Fig. 3 — Typical dc beta characteristics for TIP42, TIP42A, and TIP42B.

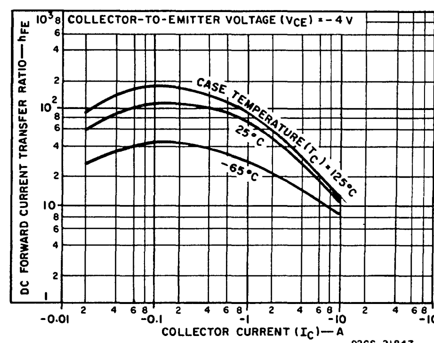
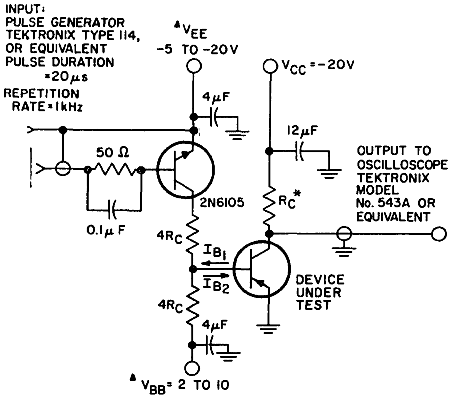


Fig. 4 — Typical dc beta characteristics for TIP42C.



* 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.

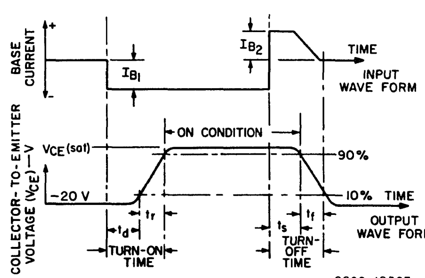


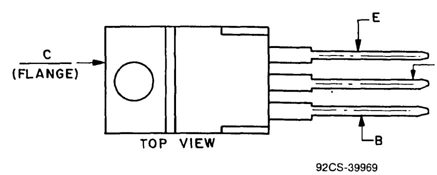
Fig. 6 — Oscilloscope display for measurement of switching times.

High-Voltage Silicon N-P-N Transistors

For High-Speed Switching and Linear-Amplifier Applications

Features:
- *VERSAWATT package*
- *Maximum safe-area-of-operation curves*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

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.

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

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C unless otherwise specified*

CHARACTERISTIC	TEST COND.		LIMITS								UNITS
	VOLTAGE V dc	CURRENT A dc	TIP47		TIP48		TIP49		TIP50		
	V_{CE}	I_C	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
I_{CEO} $I_B = 0$	150		–	1	–	–	–	–	–	–	mA
	200		–	–	–	1	–	–	–	–	
	250		–	–	–	–	–	1	–	–	
	300		–	–	–	–	–	–	–	1	
I_{CES} $V_{EB} = 0$	350		–	1	–	–	–	–	–	–	mA
	400		–	–	–	1	–	–	–	–	
	450		–	–	–	–	–	1	–	–	
	500		–	–	–	–	–	–	–	1	
I_{EBO} $V_{BE} = -5$ V		0	–	1	–	1	–	1	–	1	mA
h_{FE}	10	1[a]	10	–	10	–	10	–	10	–	
	10	0.3[a]	30	150	30	150	30	150	30	150	
$V_{CEO(sus)}$ $I_B = 0$		0.03[a]	250[b]	–	300[b]	–	350[b]	–	400[b]	–	V
V_{BE}	10	1[a]	–	1.5	–	1.5	–	1.5	–	1.5	V
$V_{CE(sat)}$ $I_B = 0.2$ A		1[a]	–	1	–	1	–	1	–	1	V
$\|h_{fe}\|$ f = 1 MHz	10	0.2	10	–	10	–	10	–	10	–	
f_T f = 1 MHz	10	0.2	10	–	10	–	10	–	10	–	MHz
h_{fe} f = 1 kHz	10	0.2	25	–	25	–	25	–	25	–	
$I_{S/b}$ t = 0.5 s	100	–	0.4	–	0.4	–	0.4	–	0.4	–	A
t_{ON} $(t_d + t_r)$[c,d] $V_{CC} = 200$ V		1	0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		0.2 (typ.)		μs
t_s[c,d] $V_{CC} = 200$ V		1	2 (typ.)		2 (typ.)		2 (typ.)		2 (typ.)		
t_f[c,d] $V_{CC} = 200$ V		1	0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		0.5 (typ.)		
$R_{\theta JC}$			–	3.12	–	3.12	–	3.12	–	3.12	°C/W
$R_{\theta JA}$			–	70	–	70	–	70	–	70	

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.

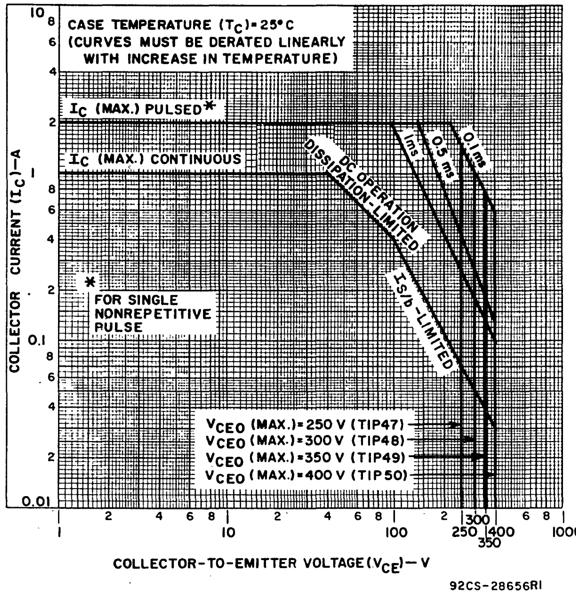


Fig. 1 — Maximum operating areas for all types.

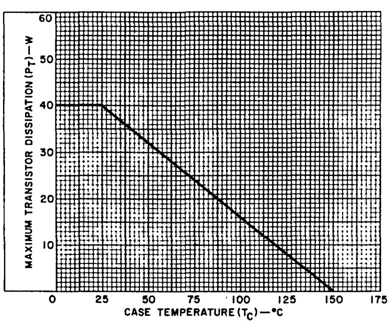


Fig. 2 — Derating curve for all types.

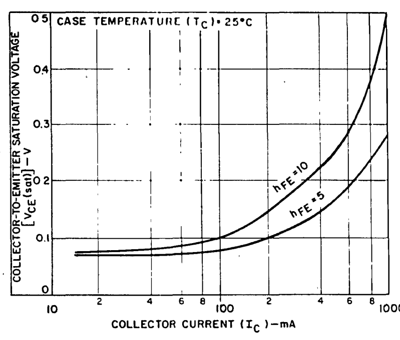


Fig. 3 — Typical saturation-voltage characteristics for all types.

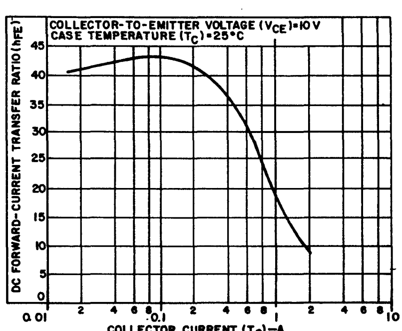


Fig. 4 — Typical dc beta characteristics for all types.

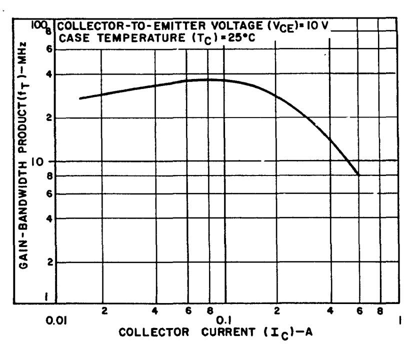


Fig. 5 — Typical gain-bandwidth characteristics for all types.

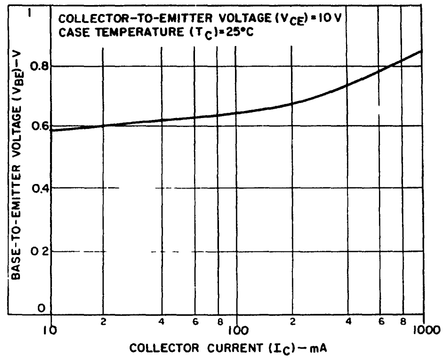


Fig.6 — Typical base-to-emitter voltage vs. collector current.

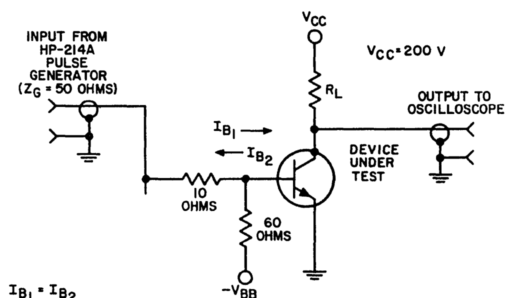


Fig. 7 — Circuit used to measure saturated switching times.

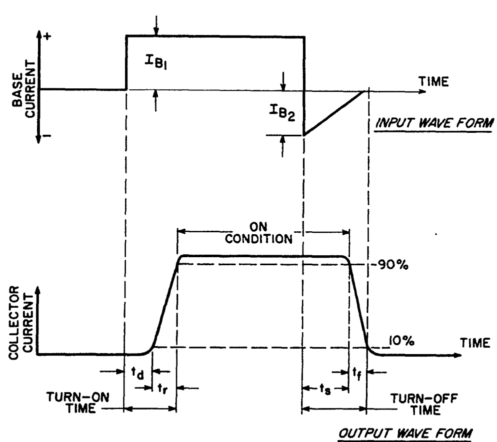


Fig. 8 — Phase relationship between input and output currents, showing reference points for specification of switching times.

2
POWER TRANSISTORS

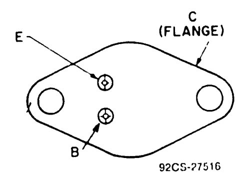
Silicon N-P-N Switching Transistors

For Switching Applications in Industrial and Commercial Equipment

Features:

- V_{CEO} — *300 V and 400 V*
- I_C — *10 A*
- P_T — *100 W*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

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.

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

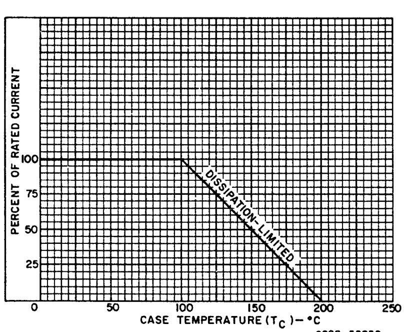


Fig. 1 - Dissipation derating curve.

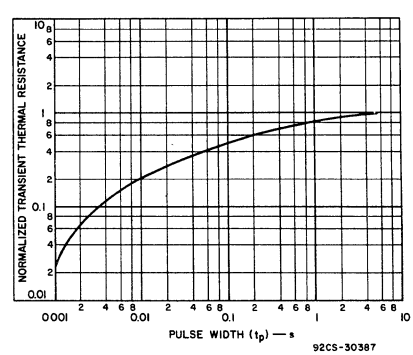


Fig. 2 - Typical thermal-response characteristic.

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 TIP562 Min.	Typ.	Max.	TIP563 Min.	Typ.	Max.	UNITS
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.

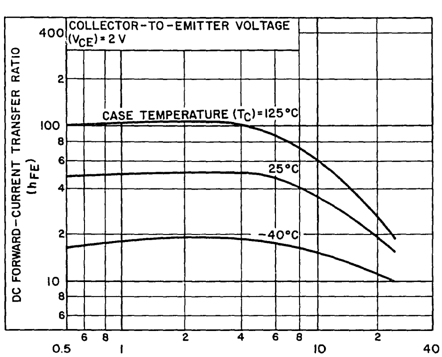


Fig. 3 - Typical dc beta characteristics for both types.

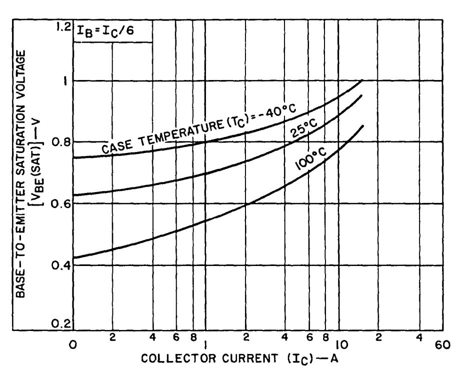


Fig. 4 - Typical base-to-emitter saturation voltage characteristics for both types.

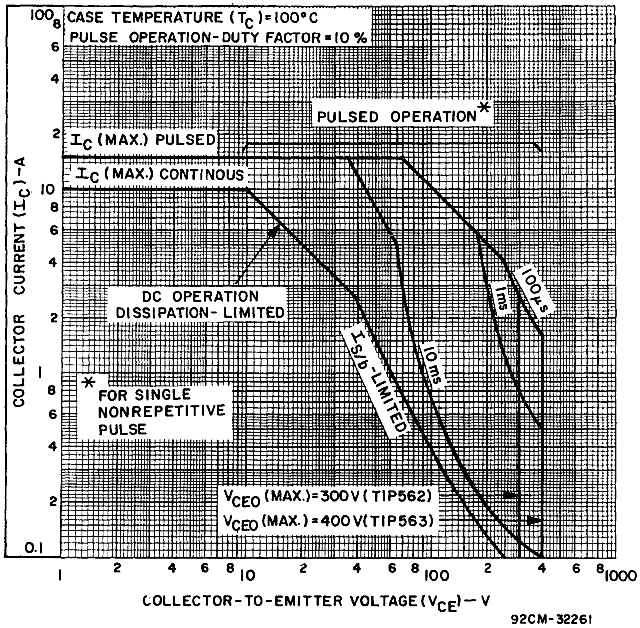


Fig. 5 - Maximum operating areas ($T_C = 100°C$).

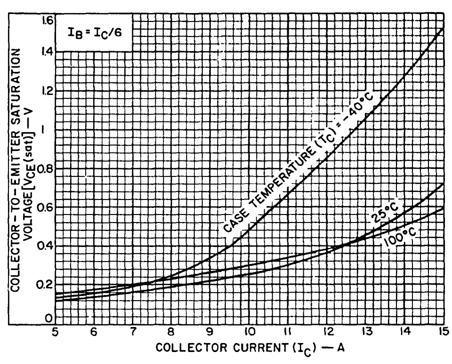


Fig. 6 - Typical collector-to-emitter saturation voltage characteristics for both types.

High-Reliability Power Transistors

3

HIGH-REL POWER TRANSISTORS

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.

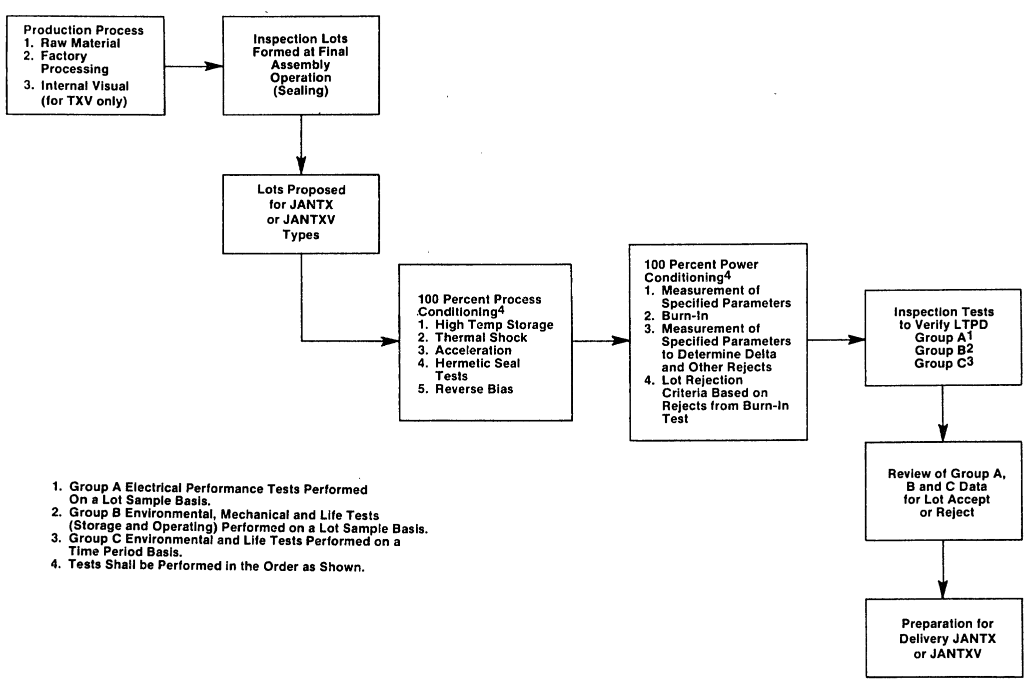
Military and aerospace requirements for high-reliability solid-state devices are extremely large and diverse, not only in terms of performance, operating conditions, and reliability, but also in terms of logistics and procurement. As a result of these requirements, the military services have jointly 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.

JANTX, and JANTXV Solid-State Power Devices

The major military specification used for the procurement of standard solid-state devices by the military is MIL-S-19500, which covers the devices such as discrete transistors, thyristors, and diodes.

MIL-S-19500 is the specification for the familiar "JAN" type solid state devices. Detailed electrical specifications are prepared as needed by the three military services and coordinated by the Defense Electronic Supply Center (DESC).



1. Group A Electrical Performance Tests Performed On a Lot Sample Basis.
2. Group B Environmental, Mechanical and Life Tests (Storage and Operating) Performed on a Lot Sample Basis.
3. Group C Environmental and Life Tests Performed on a Time Period Basis.
4. Tests Shall be Performed in the Order as Shown.

Order of procedure diagram for JANTX and JANTXV solid-state devices.

JANTX and JANTXV Devices

MIL-S-19500 is the specification for the familiar "JAN" type discrete solid state devices. 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 office, representative or distributor listed in Section 6.

JANTX and JANTXV 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)
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
2N5671, 2N5672	486	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
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

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

Added Value Screening for Power Bipolar Transistors and Chips

Many solid-state devices not yet covered by military specifications, because they are too new, offer the most recent technological advances or have special performance characteristics which offer advantages to the designer of high-reliability equipment. Harris cooperates with the users of such devices in establishment of high-reliability specifications patterned after MIL standards, which allow these designs to be approved for use in military and aerospace systems, as well as commercial equipment.

Most procurements of solid-state devices for military systems are made by the equipment contractor from the MIL-STD parts list as awards are received for electronic equipment. Some military and aerospace programs, because of their size, duration, or special requirements (Minuteman and Peacekeeper are two examples), require that special specifications and process methods, or even special production lines, be established and tailored to the particular functional, reliability, and economic needs of the program. Harris has frequently used the resource of its laboratories, production facilities, and expert technical staff to contribute to the success of such programs.

All Harris high-reliability solid-state power devices are processed in accordance with provisions of MIL-S-19500. The desired screening test sequence can be chosen from the models shown in the screening table.

Class S devices provide wafer lot control traceability from wafer diffusion through screening.

Class S chips also provide wafer lot control traceability from wafer diffusion through screening. A sample of 22 devices taken from this lot is assembled in a suitable package. The assembled sample devices are subjected to the Class S screening sequence in the table below. Class S chips are released for shipment when the assembled sample devices successfully pass the screen.

Class V devices are screened for precap internal visual inspection plus burn-in and domestic assembly. Such devices are referred to as JANTXV. Class X devices are 100% burned-in and are referred to as JANTX.

Group B and Group C tests will be performed when requested in accordance with MIL-S-19500.

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
1. Internal Visual	2072	For transistors.	100%	100%	—
2. High Temp Life (LTPD) (stabilization bake)	1032	24 hrs min at max rated storage temp.	100%	100%	100%
3. Thermal shock (temp cycling)	1051	No dwell is required at 25° C. Test condition C, 20 cycles, t (extremes) > 10 min.	100%	100%	100%
4. Constant acceleration 1/	2006	Y_1 direction at 20,000 G min except at 10,000 G min for devices with power rating of > 10 watts at T_C = 25° C. The 1 min hold time requirement shall not apply.	100%	100%	100%

Custom-Ordered Added Value Screening

Added Value High-Reliability Screening for Harris Bipolar Power Transistors

SCREEN	MIL-STD-750 METHOD	CONDITION	CLASS S REQUIREMENTS	CLASS V REQUIREMENTS	CLASS X REQUIREMENTS
5. Hermetic Seal Fine 1/	1071	Test condition G or H, max leak rate = $5x10^{-8}$ atm cc/s except $5x10^{-7}$ atm cc/s for devices with internal cavity > 0.3 cc.	Optional if done in screen 14.	100% 4/	100% 4/
Gross		Test condition A, C, D, E, or F.	Optional	100% 4/	100% 4/
6. Serialization		See 3.7.9.	100%		
7. Interim Electrical Parameters		As specified.	100% (Read and record)		
8. High Temp Reverse Bias (HTRB)		48 hrs min at T_A = 150° C (min) and minimum applied voltage as follows:			
Burn-in (for transistors)	1039	Transistors - 80% (min) of rated V_{CB} (bipolar), $V_{GS(FET)}$, or $V_{DS(FET)}$ as applicable. Test condition A.	100%	100%	100%
9. Interim electrical and delta parameters		As specified but including all delta parameters as a minimum. Leakage current shall be measured on each device before any other test is made.	100% (Measure all specified parameters within 16 hrs after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 11.)	100% (Measure all specified parameters within 24 hrs after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 11.)	100% (Measure all specified parameters within 24 hrs after removal of applied voltage in HTRB. Record those parameters which have a delta limit.) (See screen 11.)

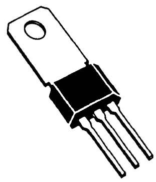
Added Value High-Reliability Screening for Harris Bipolar Power Transistors

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%	—	—

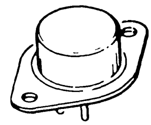
*1/ Omit fine leak seal test and constant acceleration test for double plug, non-internal cavity diode construction.
*2/ The radiographic and seal screens for JANS may be performed in any order following final electrical test. Glass diodes shall not be painted until after seal tests. When hermetic seal 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 ≥ 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.

Package Information

Package Designations



TO-202AB



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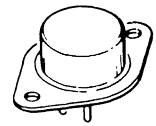
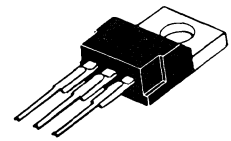


(0.060 In.-Dia. Pins)

TO-204AE



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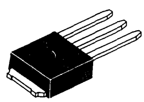
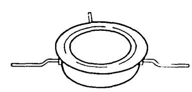
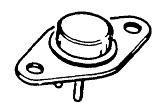


TO-251AA

TO-252AA

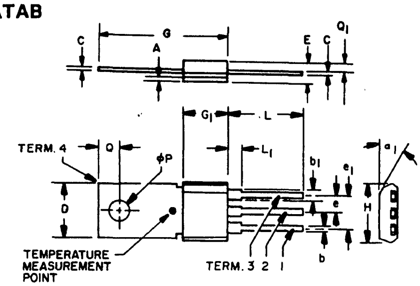


RADIAL PKG.



TO-213AA

TO-202AB
VERSATAB

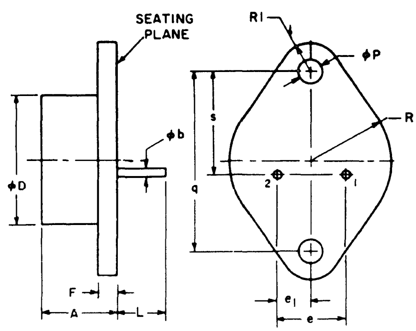


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.05	—	1.270	1
b	0.023	0.029	0.584	0.736	
b_1	0.045	0.055	1.143	1.397	1
c	0.018	0.026	0.457	0.660	
D	0.305	0.325	7.747	8.255	
E	0.130	0.150	3.302	3.810	
e	0.095	0.105	2.413	2.667	
e_1	0.190	0.210	4.826	5.334	
G	0.760	0.840	19.31	21.33	
G_1	0.230	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.

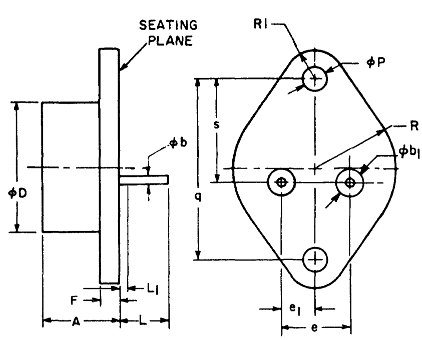
TO-204AA



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

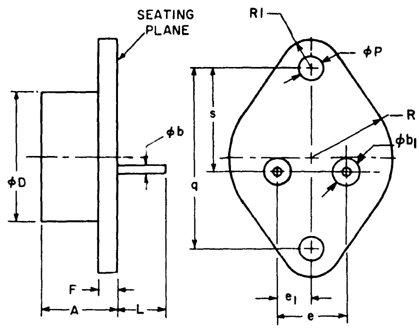
Notes:
1: ϕb applies between L_1 and L. Diameter is uncontrolled in L_1.

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.

Dimensional Outlines

TO-204AE

141-mil diameter pin isolation

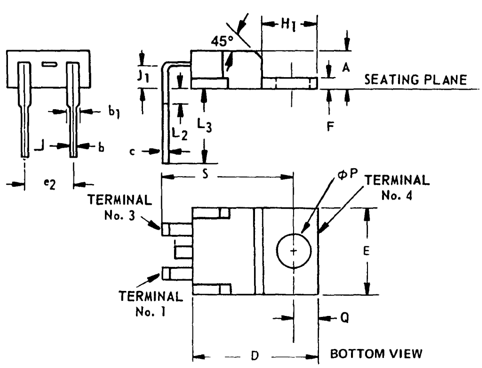


SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.250	0.450	6.4	11.4	
ϕb	0.057	0.063	1.45	1.60	
ϕb_1	0.141 NOM.		3.58 NOM.		
ϕD	—	0.875	—	22.22	
e	0.420	0.440	10.67	11.17	
e_1	0.205	0.225	5.21	5.71	
F	0.060	0.135	1.53	3.42	
L	0.440	0.480	11.18	12.19	
ϕP	0.151	0.161	3.84	4.08	
q	1.187	BSC	30.15	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-220AA

VERSAWATT



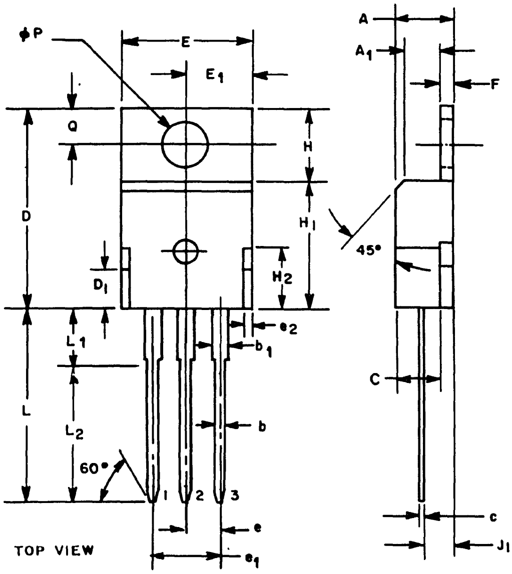
NOTES:

1. Tab contour optional within H_1 and E.
2. Position of lead to be measured 0.050 – 0.055 in. (1.270 – 1.397 mm) below seating plane.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.140	0.190	3.56	4.82	–
b	0.020	0.045	0.51	1.14	–
b_1	0.045	0.070	1.15	1.77	–
c	0.015	0.025	0.38	0.63	–
D	0.560	0.625	14.23	15.87	–
E	0.380	0.420	9.66	10.66	1
e_2	0.190	0.210	4.83	5.33	2
F	0.045	0.055	1.14	1.39	–
H_1	0.230	0.270	5.85	6.85	1
J_1	0.080	0.115	2.04	2.92	–
L_2	–	0.050	–	1.27	–
L_3	0.360	0.422	9.15	10.71	–
ϕP	0.139	0.147	3.531	3.733	–
Q	0.100	0.120	2.54	3.04	–
S	0.580	0.610	14.74	15.49	–

92CS-37524R1

TO-220AB
VERSAWATT

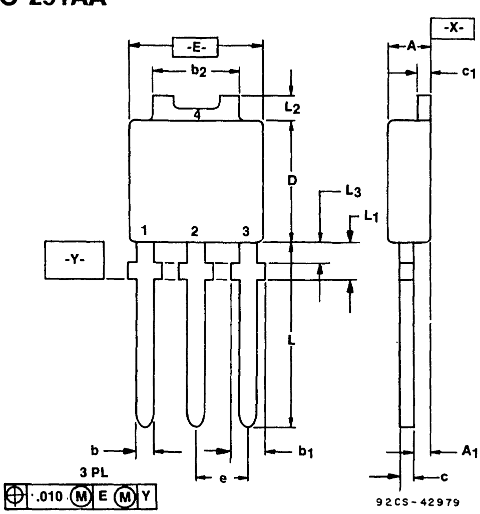


NOTES:
1. Position of lead to be measured 0.250-0.255 in. (6.350-6.477 mm) from case.

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

92CS-34697R1

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

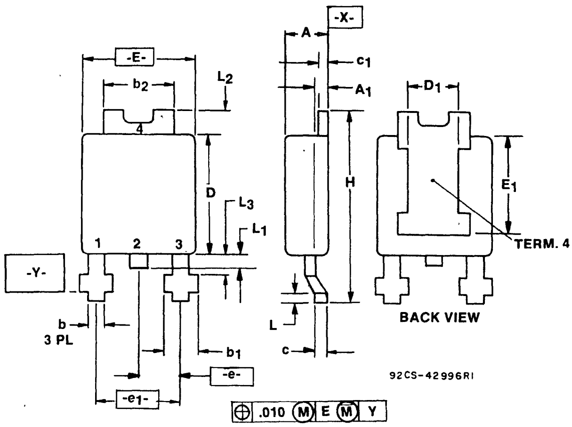
92CS-42862

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.

4 PACKAGE INFORMATION

Dimensional Outlines

TO-252AA



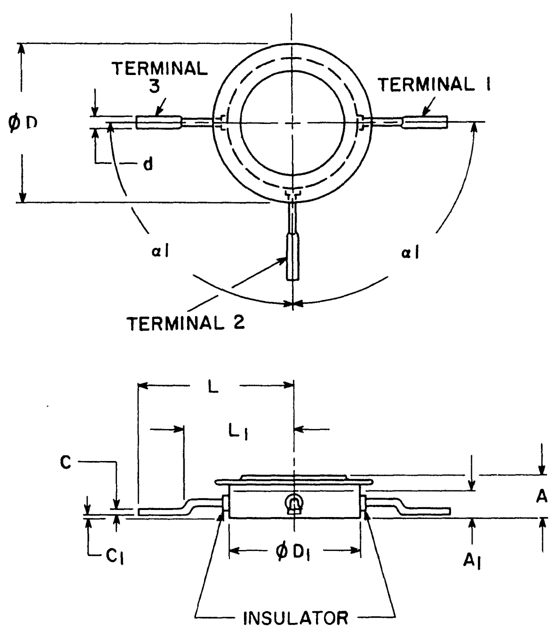
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.086	0.094	2.19	2.38	
A_1	0.035	0.045	0.89	1.14	
b	0.025	0.035	0.64	0.88	2
b_1	0.030	0.045	0.76	1.14	
b_2	0.205	0.215	5.21	5.46	4
c	0.018	0.023	0.46	0.58	
c_1	0.018	0.023	0.46	0.58	
D	0.235	0.245	5.97	6.22	
D_1	0.170	—	4.32	—	1, 5
E	0.250	0.265	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.

RADIAL PACKAGE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	0.200	—	5.08	
A_1	—	0.125	—	3.17	1
C	0.015	0.019	0.38	0.48	
C_1	—	0.015	—	0.38	
ϕD	—	0.710	—	18.03	
ϕD_1	0.615	0.690	15.62	17.52	1
d	0.042	0.046	1.06	1.16	
L	0.700	0.710	17.78	18.03	
L_1	—	0.510	—	12.95	
α_1	90° ± 2°		90° ± 2°		

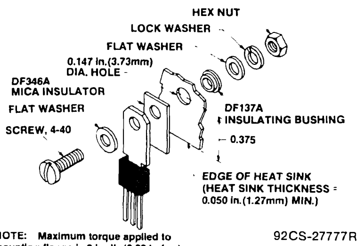
92CS-20224R1

Note:

1. Controlled area of the diameter does not include the brazed area around the ceramic and terminal 2.

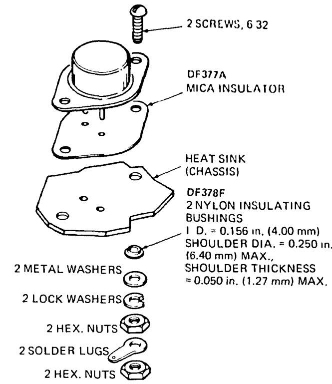
Suggested Hardware and Mounting Arrangements

TO-202AB



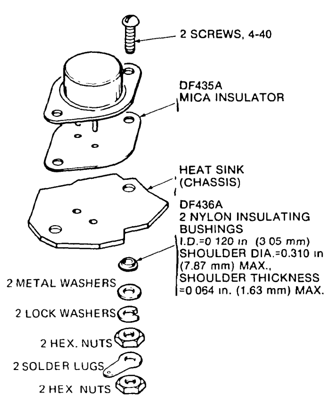
NOTE: Maximum torque applied to mounting flange is 8 in.-lb (0.09 kgf-m)

TO-204AA



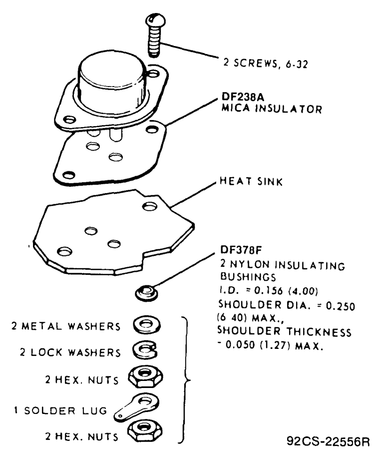
NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 12 in lbs (0 14 kgf m)

TO-204AA
200-mil diameter pin isolation



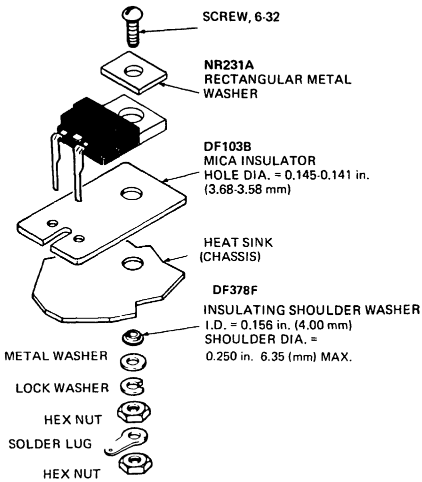
NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lbs (0 09 kgf m)

TO-204AE



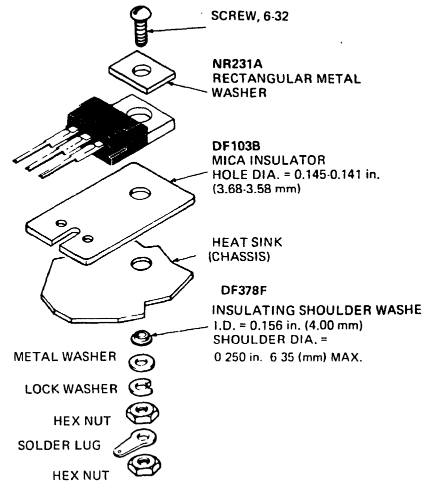
4 PACKAGE INFORMATION

TO-220AA



NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lb (0 09 kgf m)

TO-220AB

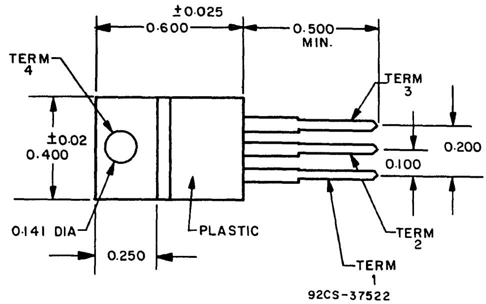


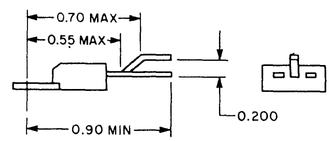
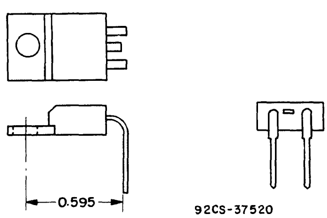
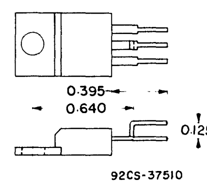
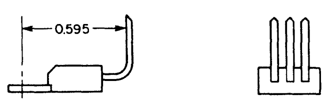
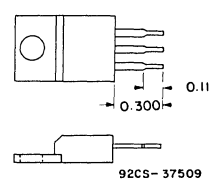
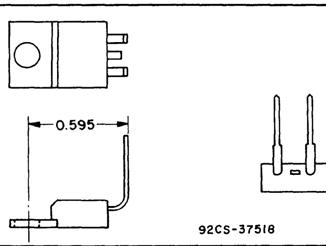
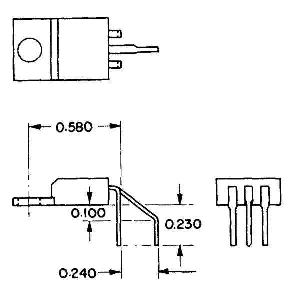
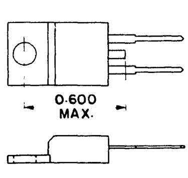
NOTE MAXIMUM TORQUE APPLIED TO MOUNTING FLANGE IS 8 in lb (0 09 kgf m)

92CS-39586

Lead Forms for Plastic Power Packages

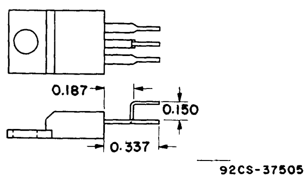
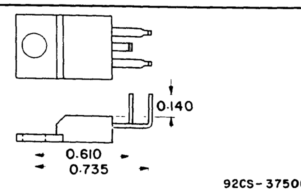
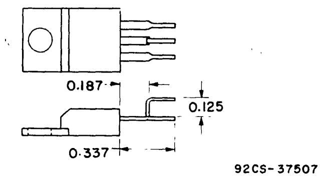
TO-220
VERSAWATT



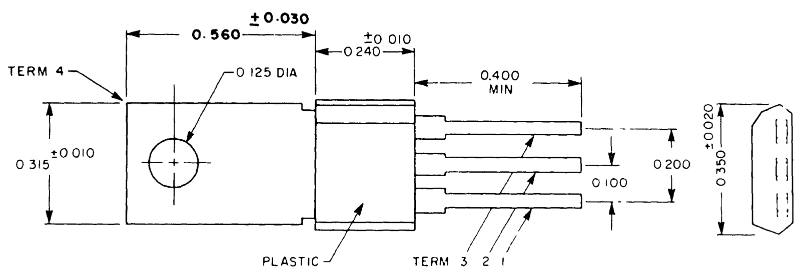
Lead Form No.	Outline	Lead Form No.	Outline
6200		6226	
6201		6255	
6203		6258	
6204		6261	
6206			

Lead Forms for Plastic Power Packages

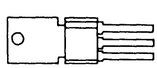
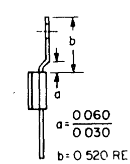
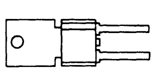
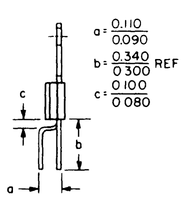
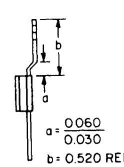
TO-220
VERSAWATT (Cont'd)

Lead Form No.	Outline	Lead Form No.	Outline
6263		6265	
6264			

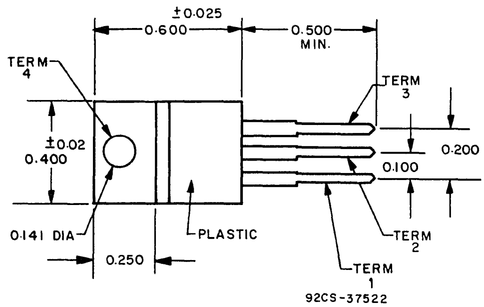
TO-202
VERSATAB

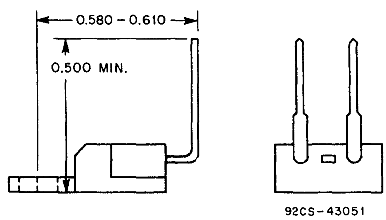
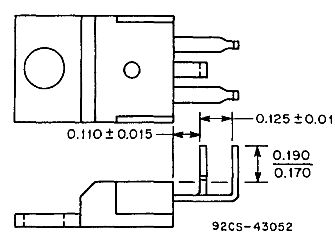
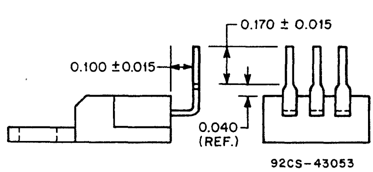
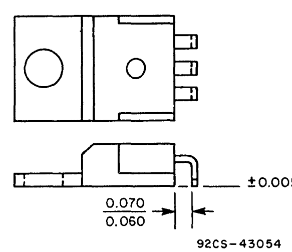
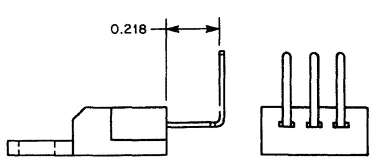
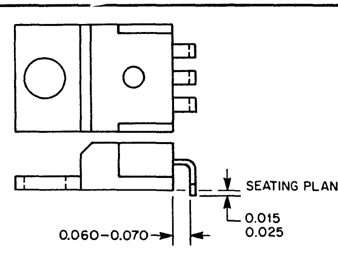


Top View

Lead Form No.	Outline	Lead Form No.	Outline
Type 1		Type 12	
Type 3			
Type 11		Type 32	

TO-220
VERSAWATT



Lead Form No.	Outline	Lead Form No.	Outline
DR 6204		**DR 6269**	
DR 6259		**DR 6274**	
DR 6260		**DR 6280**	

Surface-Mounted Devices Mounting and Handling Considerations

General — Since the external epoxy portions of the TO-251AA and TO-252AA surface-mounted devices are much smaller than on conventional transistor packages, these devices are often more susceptible to high-temperature/high-humidity conditions. Thus, these surface-mounted devices should be coated or encapsulated when used in high-temperature/high-humidity environment.

Preheating — Both TO-251AA and TO-252AA "D-Pak" transistors must be preheated prior to being mounted on circuit boards. There are several methods of preheating, including use of an infrared heat panel, parabolic infrared lamp, or hot air circulation. Preheat the devices at 100-150°C for two minutes, raising the temperature as gradually as possible, since the device pellets may be damaged by an abrupt thermal shock.

Soldering — Both TO-251AA and TO-252AA transistors are specified for 250°C solder temperature for 20 seconds duration. It is important to use a solder with a melting temperature of 190°C or lower. In general, soldering conditions range from 220-240°C for 3-5 seconds.

When using molten solder in the metal mask method, avoid uneven printing and deformation. Recommended uniform solder printing thickness is at least 200μm to ensure lead wire solderability.

When using a soldering iron to mount a device to the circuit board, care should be taken to avoid damage and/or dislocation of the device. (For this reason, soldering irons are recommended only for experimental or repair work.) For proper bonding, the soldering iron tip should be 1mm or less in diameter, and 250°C for 3 seconds or less. Never touch the epoxy package with the soldering iron.

Figures 1 and 2 show the relationship between soldering temperature and preheating time for various device mounting procedures.

Flux removal — After surface-mounted devices have been soldered to the circuit board/substrate, excess flux must be removed to prevent corrosion of the device and lead wires. Organic flux may be removed by rinsing; but inorganic flux must be cleaned with an olefin cleaner such as Freon TE or Di-Freon Solvent S3-E.

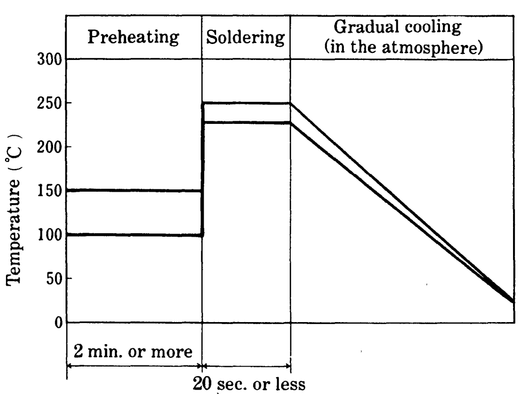


Fig. 1 — Solder dip method.

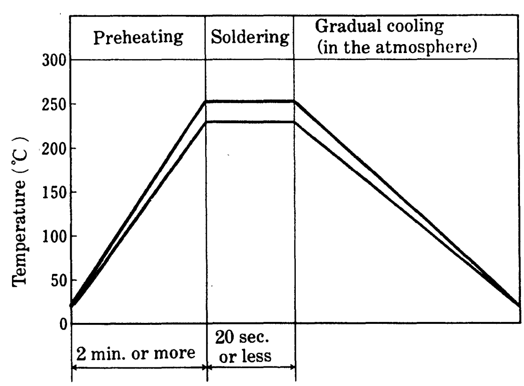


Fig. 2 — Reflow solder method.

Surface-Mounted Devices Power Dissipation Considerations

Maximum power dissipation for the TO-251AA is 1W; however, when the TO-252AA is mounted directly to a ceramic substrate, the power dissipation is increased to 2-3W. Figure 3 illustrates the maximum power dissipation for either the D72F5T1 or the D73F5T1 transistor mounted to a ceramic substrate.

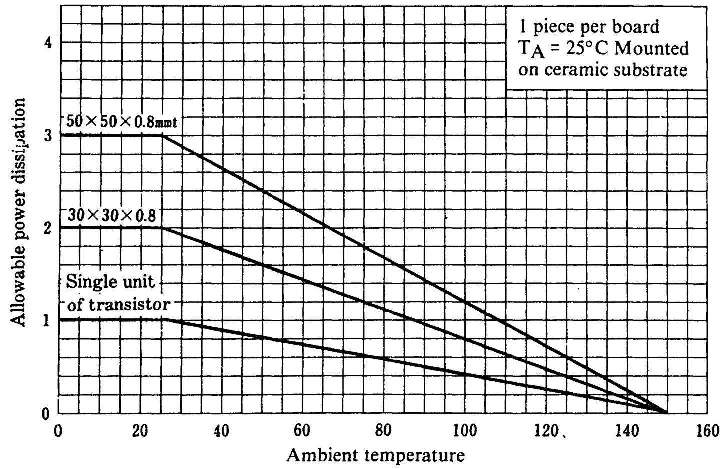


Fig. 3 — $P_{D(max)}$ vs. T_A characteristics of either the D72F5T1 or D73F5T1 transistor mounted on a ceramic substrate.

Certain circuit designs (such as motor drives and flash circuits) require devices to be rated for transient conditions as well as for their overall power dissipation capability. The relationship between maximum power dissipation and pulse width under transient conditions for typical TO-251AA devices is shown in figure 4.

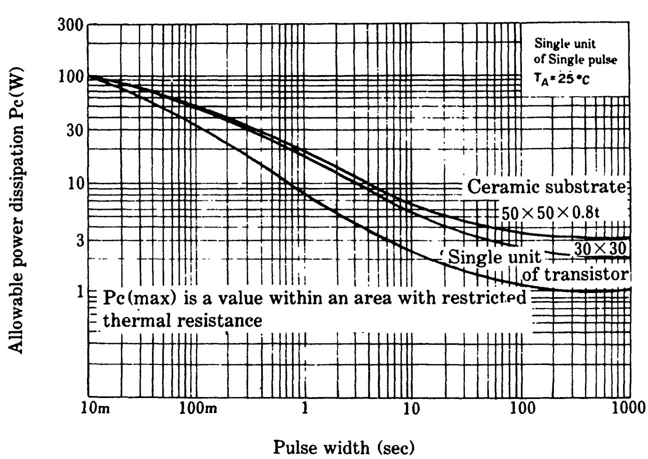


Fig. 4 — P_D vs. T_A characteristics of D72F5T1 and D73F5T1 under transient conditions.

Application Note Abstracts

Application Note Abstracts

Power Transistors

AN-4509 ....8 pages
Compact 5-Volt Power Supplies Using High-Voltage Power Transistors
The use of low-cost, industrial-type, high voltage power transistors and fast-recovery rectifiers to achieve size and weight reductions and efficiency improvements in 5-volt dc power supplies with output currents of 50 amperes or more are discussed. The supplies described, like those used in high-reliability aerospace applications, use switching rather than dissipating regulators to eliminate the need for a 60-Hz power transformer and heat sinks for the transistors. A complete switching-regulator power supply is described in detail.

AN-4573 ....6 pages
Testing for Forward-Bias Second Breakdown in Power Transistors
The design of a non-destructive forward-bias second-breakdown test facility that determines the forward-bias second-breakdown safe-operating locus for power transistors is described. Detailed schematic diagrams of test circuits that can be used to test devices with collector-current ratings up to 2.5 amperes and sustaining collector-to-emitter voltage [V_{CEO}(sus)] ratings up to 300 volts, or with ratings to 5 amperes and 100 volts, are given.

AN-4612 ....4 pages
Thermal-Cycling Rating System for Silicon Power Transistors
The basic causes of thermal fatigue in silicon power transistors are analyzed, and a rating chart that makes it possible for a circuit designer to avoid such failures during the operating life of his equipment is described. Examples are provided on the use of this chart to determine the transistor operating conditions required to assure a desired thermal-cycling capability and to determine whether the thermal-cycling capability is adequate for the requirements of a given application.

AN-6145 ....8 pages
A Test Set for Nondestructive Safe-Area Measurements Under High-Voltage, High-Current Conditions
The determination of the safe-operating area of power transistors at high volt/ampere products under pulsed and repetitive-pulsed conditions, nondestructively, is made possible by the test set described in this Note. System philosophy, design, construction, and operation are detailed.

AN-6163 ....12 pages
Quantitative Measurement of Thermal-Cycling Capability of Silicon Power Transistors
This Note discusses the methods used to test the thermal-cycling capability of power transistors. A brief description of thermal fatigue, application requirements, and rating charts is given. A detailed discussion of the practical design and construction of thermal-cycling racks is also included along with actual test conditions for various power transistor types. Acceleration factors, failure indicators, failure mechanisms, and real-time control of thermal-cycling capability of factory products are discussed. Some information is also given on hermetic versus plastic-package thermal-cycling reliability.

AN-6249 ....6 pages
Real-Time Controls of Silicon Power-Transistor Reliability
This Note compares the traditional, classical approach to the reliability-assurance testing of power transistors with a newer classification of testing: Real-Time Control, RTC. The classical approach is commonly referred to as Group B, and involves a series of mechanical, environmental, and life stress tests. RTC involves a continuous, systematic evaluation and control in "real time" of basic, potential failure mechanisms. It is an important supplement to a total program of reliability assurance.

AN-6281 ....6 pages
Accurate Measurement of Sustaining Voltage of Power Transistors — A Pulsed-Breakdown Test Set
Several techniques for the measurement of the primary (sustaining) breakdown voltage of power transistors are in common use today. The characteristics and limitations of these test methods frequently make rapid and accurate sustaining-voltage readings on power transistors difficult or impossible. The test set described in this Note fills the need for accurate, laboratory-type, sustaining-voltage measuring equipment, although circuitry used in the test set design may be adapted to high-speed testing equipment as well. A complete parts list and calibration sequence are given.

AN-6320 ....8 pages
Radiation-Hardness Capability of RCA Silicon Power Transistors
The types of radiation damage that might be experienced by a power device and the tests used to determine the design most effective in preventing these types of damage are described.

AN-6330 ....12 pages
A Safe-Area Rating System for Power Inverters Handling Capacitive and Inductive Loads
Although transistor power inverters have classically been evaluated with resistive loads, the reliability of practical inverters often depends on inductive and capacitive loads and associated starting transient considerations. This Note describes a safe-area rating system for transistors and relates this system to self-excited single-transformer, self-excited double transformer, and driven inverters operating into resistive, capacitive, and inductive loads under both steady-state and starting conditions.

AN-6423 ....8 pages
Thirty-Watt (RMS) True Complementary — Symmetry Audio Amplifier Using BDX33 and BDX34 Darlington Transistors
Monolithic-silicon Darlington transistors designed for low- and medium-frequency power applications are especially suitable for audio-output applications. This Note describes the design and performance of an audio amplifier that incorporates such devices.

AN-6425 ....8 pages
Automatic Analyzer for Determining Safe Operating Area of Power Transistors
The safe operating area is one of the most important ratings of a power transistor, yet only a few methods exist to evaluate it. The method presented in this Note allows description of the safe operating area for both dc and pulse operation without subjecting the transistor to breakdown. Botn n-p-n and p-n-p transistors in hermetic or plastic packages can be evaluated, and the complete safe-area curve can be automatically described in a short time.

AN-6605 ....16 pages
Application of RCA Power Devices in Off-Line, High-Frequency Inverter/Converter Circuits
The current trend in power inverter/converter design is to use high-frequency switching techniques and direct operation off the available utility lines (i.e., 110 or 220 volts). The use of higher operating frequencies reduce the magnetic materials required and the size of the filter capacitors. This Note discusses the use of RCA power transistors and SCR's in selected high-frequency inverter/converter applications.

AN-6624 ....16 pages
Voltage Limitations of Power Transistors
This Note summarizes the primary factors that determine the voltage limitations of power transistors used in common-emitter circuits with typical base-to-emitter circuit terminations. The material presented defines terms and the various operating regions of the transistor as shown in typical volt-ampere characteristics, develops the analytic relations defining operation in each of the regions, and relates each of the operating regions to the physical actions taking place within the transistor structure.

AN-6679 ....32 pages
Theoretical Relationships in Capacitive-Discharge Ignition Systems
There has been both confusion and exaggeration concerning the electrical performance of capacitive-discharge, or CD, ignition systems. The theoretical relationships developed in this Note allow the analysis of the fundamentals of this type of ignition system and an evaluation of the maximum performance levels attainable. Three types of systems, the diode-clamped system, the free-ringing system (no diode clamp) and the free-ringing single-cycle system are analyzed and compared.

AN-6688 ....20 pages
A Practical Approach to an Audio-Amplifier Design
This Note discusses general considerations, design requirements, and performance for a 20-watt, hi-fi amplifier.

AN-6741 ....8 pages
RCA 15-Ampere SwitchMax Power Transistors in a 340-Watt 20kHz Flyback Converter
This Note describes the use of the RCA 2N6676, a 15-ampere SwitchMax power transistor, as a driven pulse-width-modulated fly-back-converter stage, the final power-output stage, in a 20-kHZ off-line power converter that provides 340 watts of output power. Adjunct circuitry, such as the driver stage, reverse-bias amplifier, and overvoltage and overcurrent protection circuits, are also discussed.

Power Transistors

AN-6743 .... 16 pages
900-Watt, Off-the-Line, Half-Bridge Converter Using Only Two 15-Ampere 'SwitchMax' High-Voltage Power Transistors
To examine and demonstrate the capabilities of RCA's new series of 'SwitchMax' power transistors in a typical switching application, a 900-watt half-bridge converter was constructed and studied. The circuit switches at a 20-kilohertz rate and with minimal alterations can operate from either 120 or 240 volts. It was built using conventional circuitry but in a non-compact modular format so that it would be easily accessible for instrumentation connections and component or design alteration. The power switches used are the RCA-2N6678 'SwitchMax' 15-ampere [$I_{CE(sat)}$] 450-volt (V_{CEX}) high-speed transistors.

AN-6744 .... 6 pages
Low-Cost High-Power Audio Amplifiers Using the RCA 8638 and RCA 9116 Transistor Families
This Note discusses the basic considerations and requirements for design of the output stage for class AB audio amplifiers using devices selected from the RCA 8638 and RCA9116 families, depending on the output desired. Operation with load impedances other than eight ohms is also discussed for the various power categories.

AN-6760 .... 12 pages
A 230-Watt, 40-kHz, Off-Line Forward Converter Using One SwitchMax Transistor
The increased availability of reliable high-current, high-voltage, fast switches, such as RCA's Switch-Max series devices, and the development of functional pulse-width-modulating integrated circuits have greatly reduced the cost of the off-line medium-power, high-frequency forward converters used in the production of precisely conditioned low-voltage power. This Note describes the possibilities of the forward-converter circuit and demonstrates the performance of the RCA 2N6673 SwitchMax transistor in a 230-watt 15-volt 15-ampere off-line converter operating at 40 kHz from a 120-volt 60-cycle line.

AN-6800 .... 6 pages
A Test Set for Measuring h_{fe} and f_T as a Function of Collector Current
This Application Note describes a technique and test circuit, the Swept-I_C Test Set, that measures the h_{fe} characteristic of a power transistor at a fixed test frequency while the collector current, I_C, is "swept," or varied, repetitively, at a linear rate, from zero to a predetermined maximum.

AN-6819 .... 8 pages
The SwitchMax Transistor
The SwitchMax transistor families, designed for high-frequency off-line switching power supplies, converters, switching regulators and pulse-widthmodulated amplifiers, are rated for 5, 10, 15, and 25-ampere operating currents. They have high safe-operating-area (SOA) ratings in both the forward-bias and inductive turn-off (clamped $E_{S/b}$) modes. These capabilities are combined with V_{CEO} ratings of up to 500 volts, and V_{CEV} ratings to 1000 volts.

AN-6820 .... 8 pages
Typical Switching Speed Versus Temperature Data for SwitchMax Transistors Under Non-JEDEC Conditions
Since the introduction of the SwitchMax power-transistor line in 1978, a great amount of study of device behavior in special situations has resulted in the accumulation of a large volume of switching-speed data on hundreds of devices. This Note distills the data into a qualitative picture of SwitchMax-device performance at other than JEDEC-registered switching-test conditions.

AN-6827 .... 4 pages
40-Watt Automotive Audio-Power Booster
In recent years, there has been a growing demand for higher power-output capability in automotive tape and audio systems. One of the factors limiting output capability is the 12-volt automotive-system voltage. This Note describes the combination of a dc-to-dc regulated up-converter and a simple and economical output amplifier that will deliver 40 watts into a 4-ohm load.

AN-6828 .... 4 pages
In-Socket, High-Temperature, Dynamic Testing of Power Transistors
The measurement, at elevated temperatures, of dynamic parameters such as switching time, is a problem in in-chamber facilities because of the critical nature of lead length and dress. A solution to this problem, the approach described in this Note, involves the location of a source of heat at the socket of the device under test. This "hot-socket" method, in which controlled amounts of power are supplied to the socket heaters, is adaptable to curve-tracer measurements where IR drops are critical at high current. Kelvin connections are used at the collector and emitter terminals, mandating a five-terminal socket.

AN-6857 .... 4 pages
20-Ampere Monolithic-Darlington Power Transistors in a Sine-Wave-Inverter Output Stage
This Note describes the use of the type 2N6284 power transistor, a 20-ampere, n-p-n, monolithic darlington, and its complement, the type 2N6287 (p-n-p), as low-cost high-output-power single-ended power inverters. Either transistor can be used with equivalent performance results; the choice of type is dependent only upon the polarity of the dc voltage supply available.

An-6866 .... 6 pages
Practical Aspects of Voltage-Breakdown Testing of Power Transistors and Darlingtons
In specifying voltage-breakdown requirements for power transistors and power darlingtons, a customer will choose a limit which he feels will protect his application. However, during the testing of the product to verify this limit, either the manufacturer or the customer may damage the device. This Note reviews the common methods of measurement of avalanche breakdown voltage. It points out why damage occurs to power transistors as a result of these measurements and suggests methods that may reduce the incidence of damage. The Note also points out that avalanche breakdown testing is performed at voltages beyond the maximum ratings of the device and that such testing should only be undertaken after all necessary precautions have been taken, and with a complete understanding of the risks.

AN-6896 .... 8 pages
Safe Operating Area and the Design of Reliable Audio Power Amplifiers
The reilability of an audio power amplifier can depend on the designer's understanding of the Safe Operating Area, SOA, of the transistors employed, and his freedom to implement safeguards against the failure of those devices. The designer can overcome the limits placed by economics and other factors on this freedom, while assuring optimum reliability and performance from his designs, by working within the constraints imposed by the SOA ratings. This Note discusses the use of these ratings through example, and the protection circuits required in a proper design.

AN-6904 .... 12 pages
One-Hundred-Watt True-Complementary-Symmetry Audio Amplifier Using BD750 and BD751 Silicon Transistors
The BD750 and BD751 series of power transistors are complementary p-n-p and n-p-n series, respectively, selected from the ballasted epitaxial-base silicon transistor families, RCA8638 and RCA9116. They feature high-dissipation capability, low saturation voltage, maximum safe-operating area, a gain-bandwidth product (f_T) higher than 4 MHz, and high gain at high current levels. The transistors are especially suitable for use in the output stage of true-complementary high power audio amplifiers.

Power Hybrid Circuits

AN-4483 .... 6 pages
General Application Considerations for the RCA-HC2000H Hybrid Linear Power Amplifier
This Note briefly describes the RCA HC-2000H hybrid linear amplifier and discusses such operating considerations as dc and ac power dissipation, efficiency as a function of frequency, protection against excessive load variations and reactive loads, and heat-sink requirements.

AN-4782 .... 6 pages
General Application Considerations for the RCA-HC2000H Power Hybrid Operational Amplifier
The RCA-HC2000H is a power hybrid operational amplifier that can deliver 100 watts rms to a 4-ohm load at a maximum peak current of 7 amperes. It operates from a maximum power-supply voltage of 75 volts (single ended) or ±37.5 volts (split). The low-profile package is light in weight and can be used with either printed-circuit-board connections or commercially available 0.110-inch quick-disconnect push-on terminals. This Note briefly describes the HC2000H and discusses some general application considerations for this amplifier.

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Columbia
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Columbia
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Anthem
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TEL: (617) 769-6000
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Peabody
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Livonia
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Livonia
TEL: (313) 462-1205
Hamilton/Avnet
Novi
TEL: (313) 347-4270
Grandville
TEL: (616) 531-0345

MINNESOTA
Anthem
Eden Prairie
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Arrow/Schweber
Eden Prarie
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Bloomington
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Minnetonka
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Manchester
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NEW JERSEY
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Albuquerque
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Rochester
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Syracuse
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NORTH CAROLINA
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TEL: (919) 876-3132
EMC
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(704) 394-6195
Hall-Mark
Raleigh
TEL: (919) 878-0712
Hamilton/Avnet
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TEL: (919) 878-0819

OHIO
Arrow/Schweber
Solon
TEL: (216) 248-3990
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TEL: (513) 435-5563
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Columbus
TEL: (614) 299-4161
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TEL: (216) 442-3441
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Worthington
TEL: (614) 888-3313
Solon
TEL: (216) 349-4632
Hamilton/Avnet
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TEL: (513) 439-6700
TEL: (513) 439-6721
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TEL: (614) 882-7389
Solon
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OKLAHOMA
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TEL: (918) 252-7537
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Tulsa
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Hamilton/Avnet
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Beaverton
TEL: (503) 629-8090
Anthem
Beaverton
TEL: (503) 643-1114
Hamilton/Avnet
Beaverton
(503) 627-0201
Wyle Laboratories
Beaverton
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PENNSYLVANIA
Anthem
Horsham
TEL: (215) 443-5150
Arrow/Schweber
Pittsburgh
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AUSTRIA
Transistor Vertriebsgesellschaft mbH & Co KG
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TWX: 133738

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FAX: 358 59 432367

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78140 Velizy
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TEL: 33 1 34 65 40 27 (Sales)
FAX: 33 1 39 64 054
TLX: 697060

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FAX: 33 1 69 20 00 61

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FAX: 972 3 544 7650
TWX: 33572

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20092 Cinisello Balsamo
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FAX: 39 2 248 66 20
39 2 262 22 158 (ROSE)
TWX: 324019

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FAX: 46 8 744 34 03

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CH - 8010 Zurich
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FAX: 41 1 276 12 34
TWX: 822966

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Elektronik Mamulleri
Pazarlama AS
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FAX: 90 1 598 5353
TWX: 21137

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FAX: 44 276 682 323

Laser Electronics
Ballynamoney
Greenore
Co. Louth, Ireland
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FAX: 353 4273518
TWX: 43679

S.M.D.
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FAX: 44 942 54867

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FAX: 44 555 51562
TWX: 777404

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FAX: 49 89 6376201
TLX: 529051

Harris Semiconductor GmbH
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FAX: 49 4106 68850
TLX: 211582

Harris Semiconductor GmbH
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FAX: 49 7031 873 849
TLX: 7265431

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FAX: 49 6061 5039
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Nieresch 32
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FAX: 49 2502 1889
TWX: 892565

Fink Handelvertretung
Margreider Platz
Laurinweg 1
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FAX: 49 89 6098 170
TWX: 529298

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YU - 61000 Ljubljana
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FAX: 38 61 191 112
TWX: 31639

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AUSTRIA
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TEL: 43 222 82 94 01 0
FAX: 43 222 82 64 40
TWX: 133738

BELGIUM
Diode Belgium
Keiberg II
Minervastraat, 14/B2
B-1930 Zaventem
TEL: 32 2 725 45 11
FAX: 32 2 725 46 60

* **Inelco Components & Networks Company SA/NV**
Avenue des Croix de Guerre 94
B - 1120 Brussels
TEL: 32 2 244 28 11
FAX: 32 2 216 46 06
TWX: 64475

DENMARK
Ditz Schweitzer A/S
Vallensbaekvej 41
Postboks 5
DK - 2605 Brondby
TEL: 45 42 45 30 44
FAX: 45 42 45 92 06
TWX: 33257

FRANCE
* **Almex**
48 rue de l'Aubepino
Zone Industrielle
D'Antony-BP 102
F - 92160 Antony
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FAX: 33 1 46 66 60 28
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* **CCI Electronique**
5 Rue Marcelin Berthelot
Zone Industrielle D'Antony
BP 92
F - 92164 Antony Cedex
TEL: 33 1 46 66 21 82
FAX: 33 1 40 96 92 26
TWX: 203881

* **Avnet RTF**
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FAX: 33 1 49 65 27 38
TWX: 632247

* **Tekelec Airtronic**
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TWX: 634018

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F - 17027 LA Rochelle Cedex
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FAX: 33 46 45 04 44
TWX: 793034

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Zai De Courtaboeuf
Avenue Des Andes
91952 Les Ulis Cedex
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FAX: 33 1 69 28 43 96
TWX: 600333

Eltek Semiconducteurs
Z. A. De La Tuilerie
B. P. 1077
78204 Mantes-La-Jolie
TEl: 33 1 34 77 16 16
FAX: 33 1 34 77 95 79
TWX: 699737

FINLAND

Yleiselektroniikka OY Telercas
P.O. Box 63
Luomannotko, 6
SF - 02201 Espoo
TEL: 358 0 452 16 22
FAX: 358 0 452 33 37

GREECE

Semicon Co.
104 Aeolou Street
GR - 10564 Athens
TEL: 30 1 32 53 626
FAX: 30 1 321 60 63
TWX: 216684

ISRAEL

Aviv Electronics Ltd
P.O. Box 24190
5, Arad Street
Ramat Hahayal
IS - Tel-Aviv 69710
TEL: 972 3 544 7262
FAX: 972 3 544 7650
TWX: 33572

ITALY

Eurelettronica SpA
Via Enrico Fermi, 8
I - 20090 Assago (MI)
TEL: 39 2 488 00 22
FAX: 39 2 488 02 75

EBV Elektronik SRL
Via Frova, 34
F-20092 Cinisello Balsamo (MI)
TEL: 39 2 660.17111
FAX: 39 2 660.17020

Lasi Elettronica SpA
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FAX: 39 2 66 10 13 85
TWX: 352040

Silverstar Ltd.
Viale Fulvio Testi 280
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TEL: 39 2 66 12 51
FAX: 39 2 66 10 13 59
TWX: 332189

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*** Auriema Nederland BV**
Doornakkersweg, 26
NL - 5642 MP Eindhoven
TEL: 31 40 81 65 65
FAX: 31 40 81 18 15
TWX: 51992

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Coltbaan 17
NL - 3439 NG Nieuwegein
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FAX: 31 3402 9 12 34

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Hans H. Schive A/S
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Postboks 185
N - 1371 Asker
TEL: 47 2 900 900
FAX: 47 2 904 484
TWX: 19124

PORTUGAL

Cristalonica Componentes De Radio E Televisao, Lda
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TWX: 45550

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Salvatierra 4
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FAX: 34 1 729 37 52
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Box 9060
S - 126 09 Hagersten
TEL: 46 8 744 03 00
FAX: 46 8 774 34 03
TWX: 13077

SWITZERLAND

BASiX fur Elektronik AG
Hardturmstrasse 181
Postfach
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TEL: 41 1 276 11 11
FAX: 41 1 276 12 34
TWX: 822966

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34630 Sefakoy/ Istanbul
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FAX: 90 1 598 5353
TWX: 21137

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Jubilee Road
Letchworth
Hertfordshire SG6 1QH
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FAX: 44 462 682467
TWX: 826505

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FAX: 44 279 441687
TWX: 818801

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FAX: 44 532 633404
TWX: 55147

Jermyn Distribution
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FAX: 44 732 451251
TWX: 95142

Macro Marketing Ltd
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FAX: 44 628 666873
TWX: 847945

Micromark Electronics Ltd.
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Berkshire SL6 4DT
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FAX: 44 628 783799
TWX: 847397

Thame Components
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Thame, Oxfordshire OX9 3UQ
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TWX: 837917

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FAX: 44 61 627 4321
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FAX: 44 803 83 3011

Rood Technology
Test House Mill Lane
Alton
Hampshire GU34 2QG
TEL: 44 420 88022
FAX: 44 420 87259
TLX: 858456

GERMANY

Alfred Neye Enatechnik GmbH
Schillerstrasse 14
D - 2085 Quickborn
TEL: 49 4106 61 20
FAX: 49 4106 61 22 68
TWX: 213590

Bit-Electronic AG
Dingolfinger Strasse 6
Postfach 800245
D - 8000 Muenchen 80
TEL: 49 89 41 80 07 0
FAX: 49 89 41 80 07 20
TWX: 5212931

ECS Hilmar Frehsdorf GmbH
Electronic Components Service
Carl-Zeiss Strasse 3
D - 2085 Quickborn
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FAX: 49 4106 700537
TWX: 213693

Indeg Industrie Elektronik GmbH
Postfach 1563
Emil Kommerling Str. 5
D - 6780 Pirmasens
TEL: 49 6331 94 065
FAX: 49 6331 94 064
TWX: 452269

Jermyn GmbH
IM Dachsstueck 9
D - 6250 Limburg 4
TEL: 49 6431 508 0
FAX: 49 6431 508 289
TLX: 415257 0

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D - 8011 Putzbrunn-
Bei-Muenchen
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FAX: 49 89 46 11 270
TWX: 529504

Spoerle Electronic KG
Max-Planck Strasse 1-3
D - 6072 Dreieich
1- Bei-Frankfurt
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FAX: 49 6103 30 42 01
TWX: 417972

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Shinjuku NS Bldg. Box 6153
2-4-1 Nishi-Shinjuku
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FAX: 81-3-3345-8910

SOUTH ASIA
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Harris Semiconductor H.K. Ltd.
13/F Fourseas Building
208-212 Nathan Road
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TLX: 78043645

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FAX: (61) 2-439-6435

KOREA
Harris Semiconductor YH
RM #419-1 4TH FL.
Korea Air Terminal Bldg.
159-1, Sam Sung-Dong,
Kang Nam-ku, Seoul
135-728, Korea
TEL: 82-2-551-0931/4
FAX: 82-2-551-0930

Inhwa Company, Ltd.
3 Flr., Suh Kang Bldg.
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Kangnam-ku, Seoul
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FAX: 822-557-5043

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FAX: 65-293-4301
TLX: RS36460 RCASIN

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Harris Semiconductor
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600 Ming Chuan East Road
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FAX: 886-2-715-3029
TLX: 78525174

Asian Pacific Authorized Distributors

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Dodwell Engineering
7/F, Cavendish Centre
23 Yip Hing Street
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FAX: (852) 873-0625

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166 Wai Yip Street
Kwun Tong, Kowloon
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8 Hok Cheung Street
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FAX: (852) 334-8649

Sunnice Electronics Co., Ltd.
Flat F, 5/F, Everest Ind. Ctr.
396 Kwun Tong Road
Kowloon,
TEL: (852) 790-8073
FAX: (852) 763-5477

Willas Co., Ltd.
8F, Wing Tai Centre
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Kwun Tong, Kowloon
TEL: (852) 3414281
FAX: (852) 3431229

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FAX: 03-3597-8975

Macnica Inc.
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Jepico Corp.
Shinjuku Daiichi Seimei Bldg.
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Micron, Inc.
Misuzu Bldg.
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Okura Electronics Co., Ltd.
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Takachiho Koheki Co., Ltd.
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KOREA
KumOh Electric Co., Ltd.
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Device Electronics PTE, Ltd.
605B MacPherson Road
04-12 Citimac Ind. Complex
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