

T-33-13

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

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

**Features:**

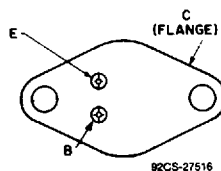
- Maximum safe-area-of-operation curves
- Low saturation voltages
- High voltage ratings
  - $V_{CEr[SUS]} = 375\text{ V [2N5840]}$
  - $300\text{ V [2N5839]}$
  - $275\text{ V [2N5838]}$

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

The 2N5838, 2N5839 and 2N5840<sup>■</sup> 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.

**TERMINAL DESIGNATIONS**



**JEDEC TO-204AA**

**POWER TRANSISTORS**

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

**MAXIMUM RATINGS, Absolute-Maximum Values:**

	<b>2N5838</b>	<b>2N5839</b>	<b>2N5840</b>	
*COLLECTOR-TO-BASE VOLTAGE, $V_{CBO}$ .....	275	300	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
With base open $V_{CE0(SUS)}$ .....	250	275	350	V
With reverse bias ( $V_{BE}$ ) of $-1.5\text{ V}$ , ( $V_{CEV}$ ) (SUS) * .....	275	300	375	V
With external base-to-emitter resistance ( $R_{BE}$ ) $\leq 50\ \Omega$ , $V_{CEr(SUS)}$ .....	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 $25^\circ\text{C}$ and $V_{CE}$ up to $40\text{ V}$ .....	100	100	100	W
At case temperatures up to $25^\circ\text{C}$ and $V_{CE}$ above $40\text{ V}$ .....		See Fig. 1.		
At case temperatures up to $25^\circ\text{C}$ and $V_{CE}$ above $40\text{ V}$ .....		See Figs. 1 & 2.		
*TEMPERATURE RANGE:				
Storage and operating (Junction) .....		$-65$ to $+200$		$^\circ\text{C}$
*PIN TEMPERATURE (During soldering):				
At distances $\geq 1/32$ in. ( $0.8\text{ mm}$ ) from case for $10\text{ s}$ max .....		230		$^\circ\text{C}$

\* In accordance with JEDEC registration data format (JS-6, RDF-1).  
\* Shown as  $V_{CEx(sus)}$  in JEDEC Registration Data.

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Characteristic	Symbol	Test Conditions							Limits									Units
		DC Collector Voltage (V)		DC Emitter or Base Voltage (V)		DC Current (A)			Type 2N5838			Type 2N5839			Type 2N5840			
		V <sub>CE</sub>	V <sub>EB</sub>	V <sub>BE</sub>	I <sub>C</sub>	I <sub>B</sub>	I <sub>E</sub>	Min	Max	Typ	Min	Max	Typ	Min	Max	Typ		
Collector-Cutoff Current: With base open	I <sub>CEO</sub>	200 250						-	2	-	-	2	-	-	2	-	-	mA
With base-emitter junction reverse biased	I <sub>CEV</sub>	265 290 360		-1.5 -1.5 -1.5				-	5	-	-	2	-	-	-	-	-	mA
With base-emitter junction reverse biased	I <sub>CEV</sub> T <sub>C</sub> 100 °C	265 290 360		1.5 1.5 1.5				-	8	-	-	5	-	-	-	-	-	mA
Emitter-Cutoff Current	I <sub>EBO</sub>		-6					-	1	-	-	1	-	-	1	-	-	mA
Collector-to-Emitter Sustaining Voltage (See Figs 4, 5, & 6) With base open	V <sub>CEO(sus)</sub>				0.2			250 <sup>b</sup>				275 <sup>b</sup>	-	-	350 <sup>b</sup>	-	-	V
With base-emitter junction reversed biased	V <sub>CEx(sus)</sub>			1.5	0.1			275 <sup>b</sup>	-	-		300 <sup>b</sup>	-	-	375 <sup>b</sup>	-	-	V
With external base-to-emitter resistance (R <sub>BE</sub> ) = 50 Ω	V <sub>CER(sus)</sub>				0.2			275 <sup>b</sup>	-	-		300 <sup>b</sup>	-	-	375 <sup>b</sup>	-	-	V
Emitter-to-Base Voltage	V <sub>EBO</sub>						0.02	6	-	-	6	-	-	6	-	-	-	V
DC Forward-Current Transfer Ratio	h <sub>FE</sub>	5 3 2			0.5 <sup>b</sup> 0.3 <sup>b</sup> 0.3 <sup>b</sup>			20 - 8	- - 40	-		20 10 50	- - -	-	20 10 50	- - -	-	
Base-to-Emitter Saturation Voltage	V <sub>BE(sat)</sub>				2 3	0.2 0.375			2			2	-	-	2	-	-	V
Collector to Emitter Saturation Voltage	V <sub>CE(sat)</sub>				2 3	0.2 0.375			1			1.5	-	-	1.5	-	-	V
Output Capacitance (At 1 MHz)	C <sub>obo</sub>		10d					D	150			150	-	-	150	-	-	pF
Magnitude of Common Emitter, Small-Signal Short Circuit, Forward Current Transfer Ratio (f = 1 MHz)	h <sub>fe</sub>	10			0.2			5				5	-	-	5	-	-	
Second Breakdown Collector Current (With base forward biased) Pulse duration (non-repetitive) 1 s	I <sub>S/b</sub>	40						2.5				2.5	-	-	2.5	-	-	A
Switching Times: Delay	t <sub>d</sub>	V <sub>CC</sub> = 200			2 3	0.2 <sup>a</sup> 0.375 <sup>a</sup>		-	-	-	-	-	-	0.07	-	-	0.07	
Rise	t <sub>r</sub>	V <sub>CC</sub> = 200			2 3	0.2 <sup>a</sup> 0.375 <sup>a</sup>		-	-	-	1.5	0.6	-	-	1.75	-	0.6	
Storage	t <sub>s</sub>	V <sub>CC</sub> = 200			2 3	0.2 <sup>a</sup> 0.375 <sup>a</sup>		-	-	-	3.75	1.75	-	-	3.0	-	1.75	
Fall	t <sub>f</sub>	V <sub>CC</sub> = 200			2 3	0.2 <sup>a</sup> 0.375 <sup>a</sup>		-	-	-	1.5	0.35	-	-	1.5	-	0.35	
Thermal Resistance (Junction-to-Case)	θ <sub>J-C</sub>	10			5				1.75	-	-	1.75	-	-	1.75	-	-	°C/W

<sup>a</sup> Pulsed; pulse duration ≤ 350 μs, Duty factor = 2%.

<sup>d</sup> V<sub>CB</sub>

<sup>b</sup> CAUTION: The sustaining voltages V<sub>CEO(sus)</sub>, V<sub>CEx(sus)</sub> and V<sub>CER(sus)</sub>, MUST NOT be measured on a curve tracer.

<sup>e</sup> I<sub>B1</sub> = I<sub>B2</sub> = value shown.

<sup>c</sup> I<sub>S/b</sub> 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.

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

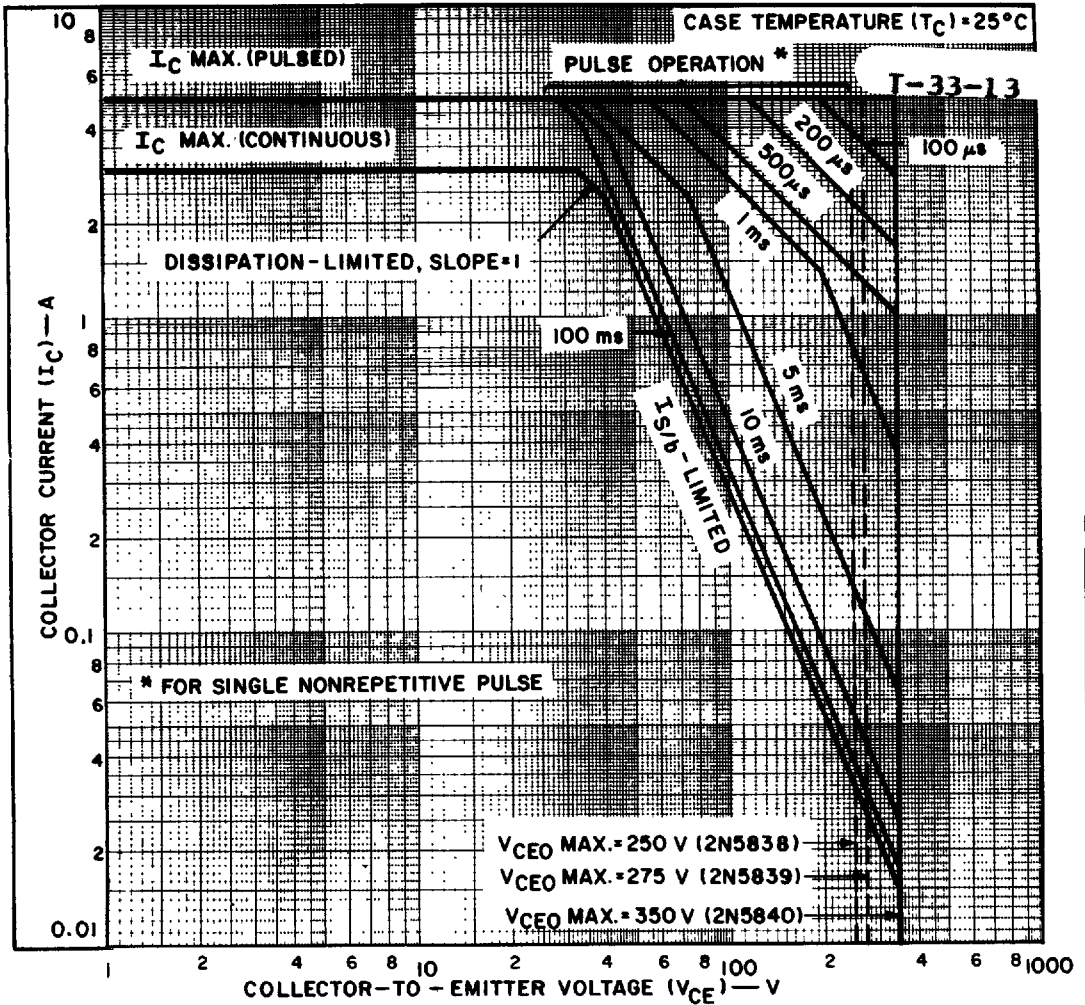


Fig. 1 — Maximum operating areas for all types.

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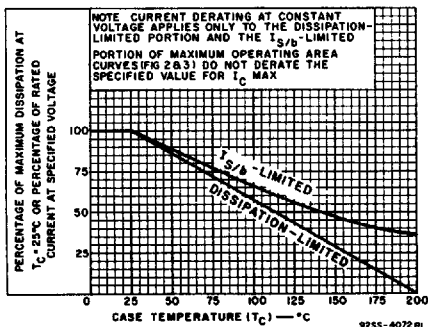


Fig. 2 — Derating curves for all types.

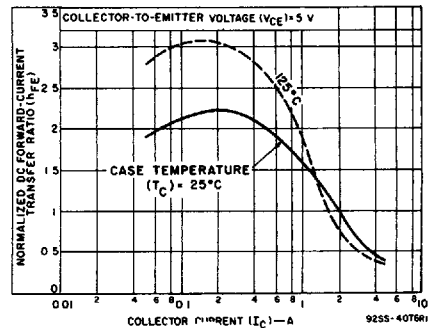
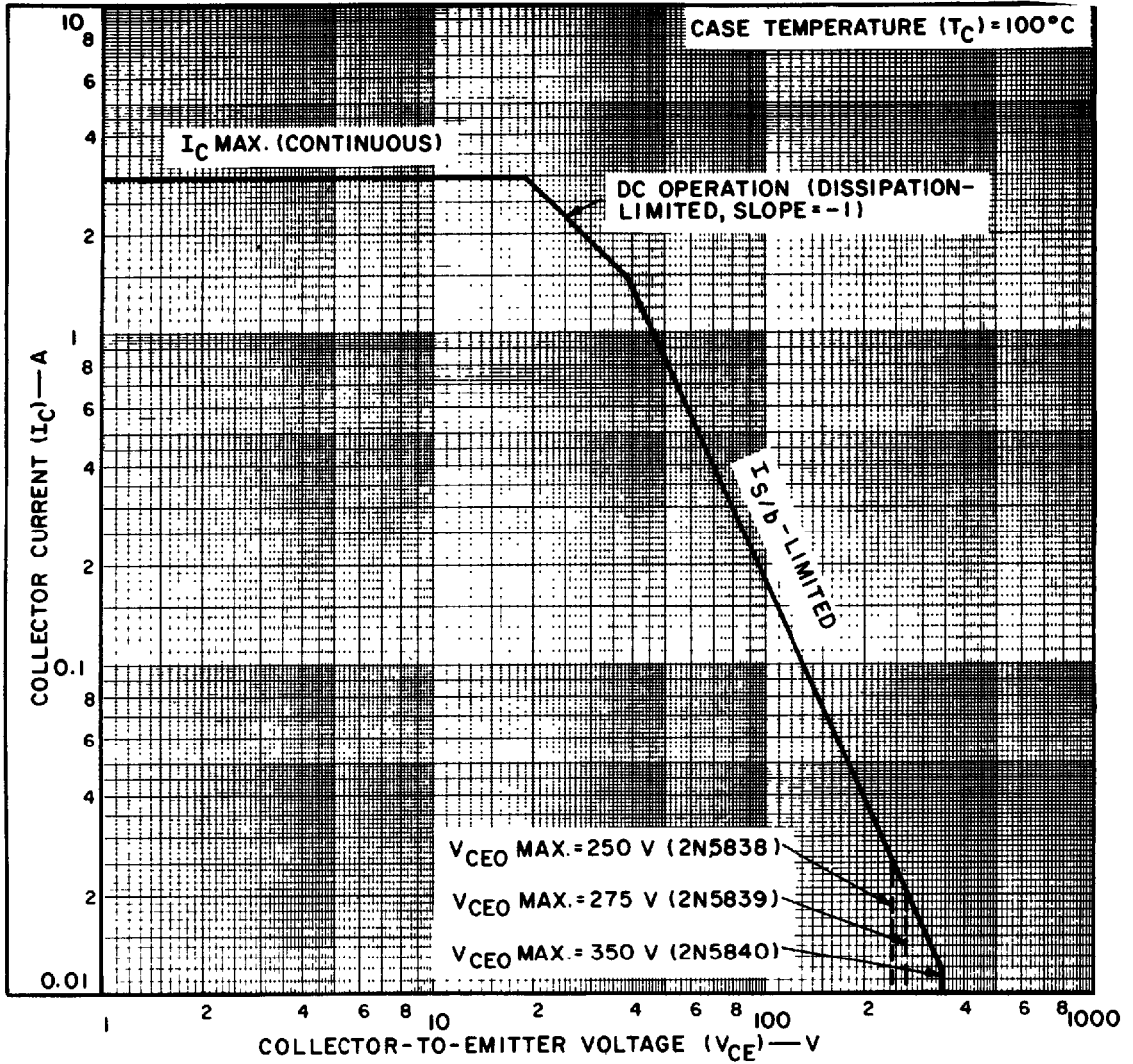


Fig. 3 — Typical normalized dc beta characteristics for all types.

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Fig. 4 — Maximum operating areas for all types.

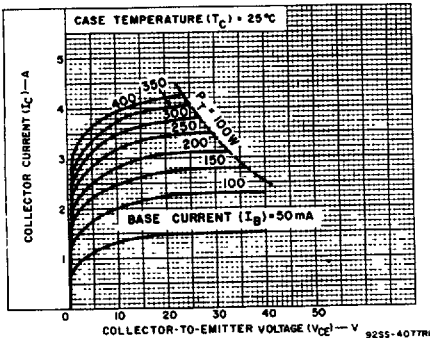


Fig. 5 — Typical output characteristics for all types.

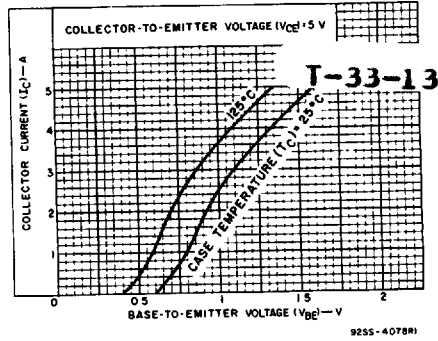


Fig. 6 — Typical transfer characteristics for all types.

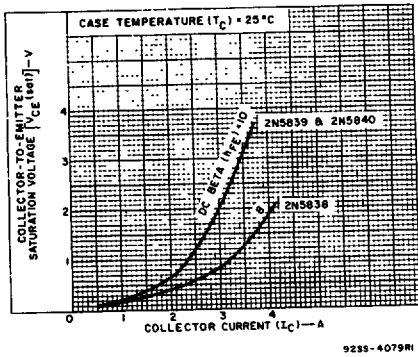


Fig. 7 — Typical saturation voltage characteristics for all types.

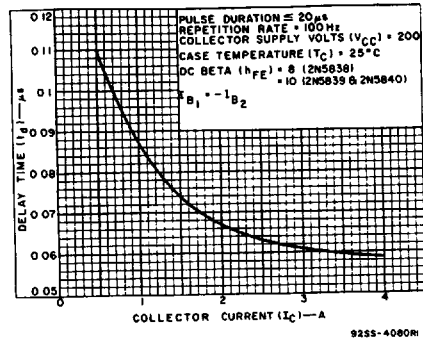


Fig. 8 — Typical delay-time characteristics for all types.

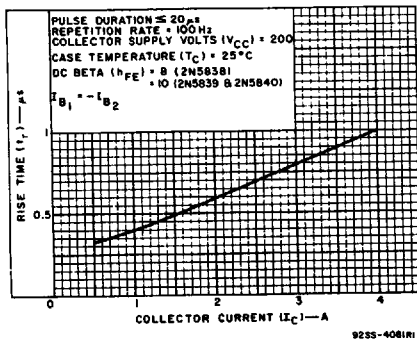


Fig. 9 — Typical rise-time characteristics for all types.

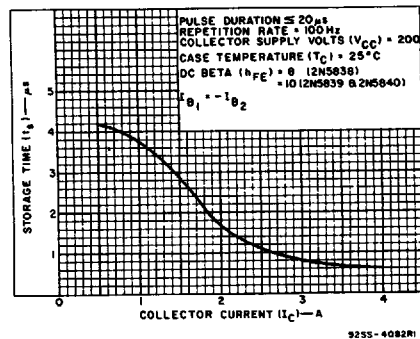


Fig. 10 — Typical storage-time characteristics for all types.

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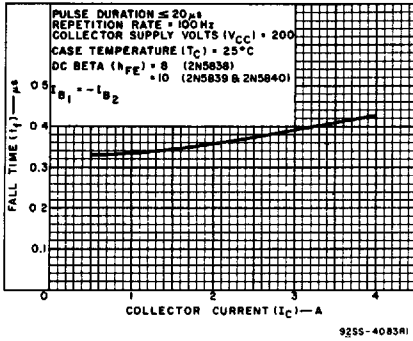
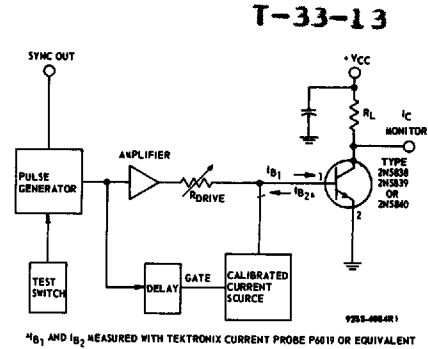


Fig. 11 — Typical fall-time characteristics for all types.



\* $t_{B1}$  and  $t_{B2}$  MEASURED WITH TEKTRONIX CURRENT PROBE P6419 OR EQUIVALENT

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

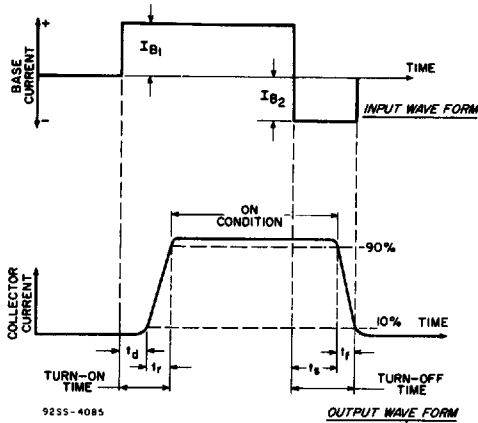


Fig. 13 — Phase relationship between input and output currents showing reference points for specification of switching times.

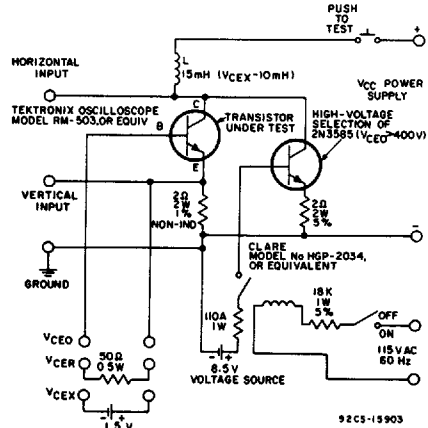
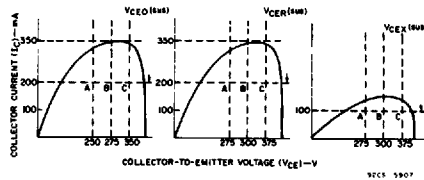


Fig. 14 — Circuit used to measure sustaining voltages  $V_{CE0(sus)}$ ,  $V_{CER(sus)}$ , and  $V_{CEX(sus)}$  for all types.



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

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