File No. 410

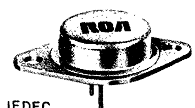
RCA

Solid State
Division

Power Transistors
2N5838
2N5839
2N5840

SILICON N-P-N POWER TRANSISTORS

High-Voltage High-Power Types For Switching and Linear Applications in Military, Industrial, and Commercial Equipment



JEDEC
TO-3

H-1570

RCA 2N5838, 2N5839 and 2N5840** are epitaxial silicon n-p-n power transistors utilizing a multiple-emitter-site structure. These devices employ the popular JEDEC TO-3 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 bridge amplifiers, ignition circuits, and other high-voltage switching applications.

** Formerly RCA Dev. types TA7513, TA7530, and TA7420 respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N5838	2N5839	2N5840	
*COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	275	300	375	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:				
* With base open, V_{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}) $\leq$ 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. 2.			
At case temperatures above 25° C and V_{CE} above 40 V	See Figs. 1 & 2.			
*TEMPERATURE RANGE:				
Storage & Operating (Junction)	-65 to +200			°C
*PIN TEMPERATURE (During Soldering): At distances $\geq$ 1/32 in. (0.8 mm) from 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.

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

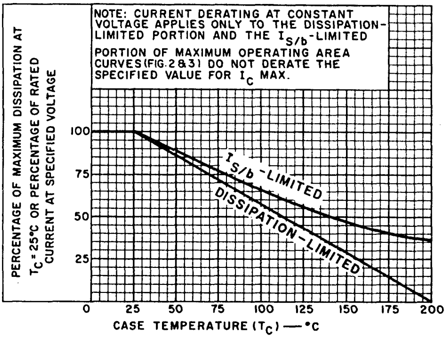


Fig. 1 - Derating curves for all types.

ELECTRICAL CHARACTERISTICS, *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 2N5838 Min.	2N5838 Max.	2N5839 Min.	2N5839 Max.	2N5840 Min.	2N5840 Max.	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, T_C=100°C	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	$V_{CEO(sus)}$[e]			0.2[a]		250[b]	-	275[b]	-	350[b]	-	V
* With base-emitter junction reverse biased	$V_{CEX(sus)}$[e]		-1.5	0.1[a]		275[b]	-	300[b]	-	375[b]	-	V
With external base-to-emitter resistance (R_{BE}) = 50 Ω	$V_{CER(sus)}$[e]			0.2[a]		275[b]	-	300[b]	-	375[b]	-	V
* Emitter-to-Base Voltage I_E = 0.02 A	V_{EBO}					6	-	6	-	6	-	V
* DC Forward-Current Transfer Ratio	h_{FE}	5 3 2		0.5[a] 2[a] 3[a]		20 - 8	- - 40	20 10 -	- 50 -	20 10 -	- 50 -	
* Base-to-Emitter Saturation Voltage	$V_{BE(sat)}$			2[a] 3[a]	0.2 0.375	- -	- 2	- -	2 -	- -	2 -	V
* Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$			2[a] 3[a]	0.2 0.375	- -	- 1	- -	1.5 -	- -	1.5 -	V
Output Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{obo}					-	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	-	
Forward-Bias, Second-Breakdown Collector Current: t = 1 s, nonrepetitive	$I_{S/b}$[c]	40				2.5	-	2.5	-	2.5	-	A
Second Breakdown[c] Energy (With base reverse biased) R_B = 50 Ω, L = 100 μH	$E_{S/b}$[d]		-4			0.45	-	0.45	-	0.45	-	mJ
Thermal Resistance: (Junction-to-Case)	$R_{\theta JC}$	10		5			1.75	-	1.75	-	1.75	°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 sustaining voltages $V_{CEO(sus)}$, $V_{CEX(sus)}$ and $V_{CER(sus)}$, MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig. 4.

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

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

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

SWITCHING-TIME CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS VOLTAGE V dc	CURRENT A dc		LIMITS 2N5838		2N5839		2N5840		UNITS
		V_{CC}	I_C	I_B●	Max.	Typ.	Max.	Typ.	Max.	Typ.	
Switching Times: Delay	t_d		2	0.2	-	-	-	0.07	-	0.07	μs
(See Figs. 11, 15, & 16)		200	3	0.375	-	0.06	-		-	-	μs
* Rise	t_r		2	0.2	-	-	1.5	0.6	1.75	0.6	μs
(See Figs. 12, 15, & 16)		200	3	0.375	1.5	0.8	-	-	-	-	μs
* Storage	t_s		2	0.2	-	-	3.75	1.75	3.0	1.75	μs
(See Figs. 13, 15, & 16)		200	3	0.375	3.0	1.0	-		-	-	μs
* Fall	t_f		2	0.2	-	-	1.5	0.35	1.5	0.35	μs
(See Figs. 14, 15, & 16)		200	3	0.375	1.5	0.4	-	-	-	-	μs

* In accordance with JEDEC registration data format (JS-6 RDF-1). ● $I_{B1} = I_{B2}$ = value shown.

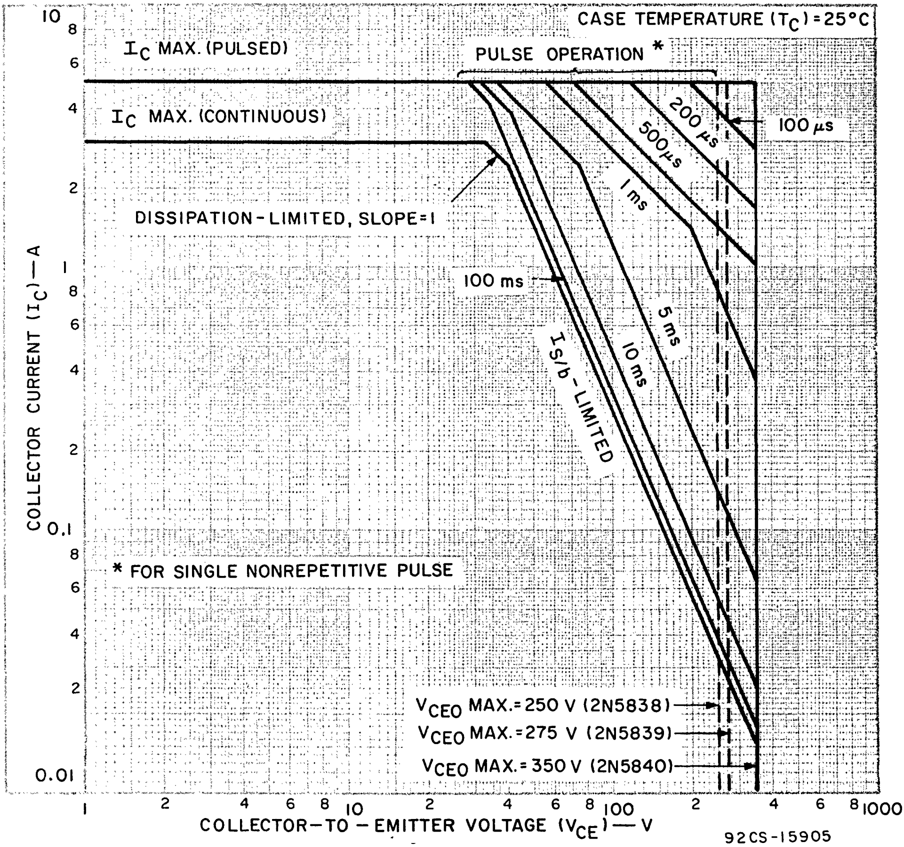


Fig. 2 - Maximum operating areas for all types.

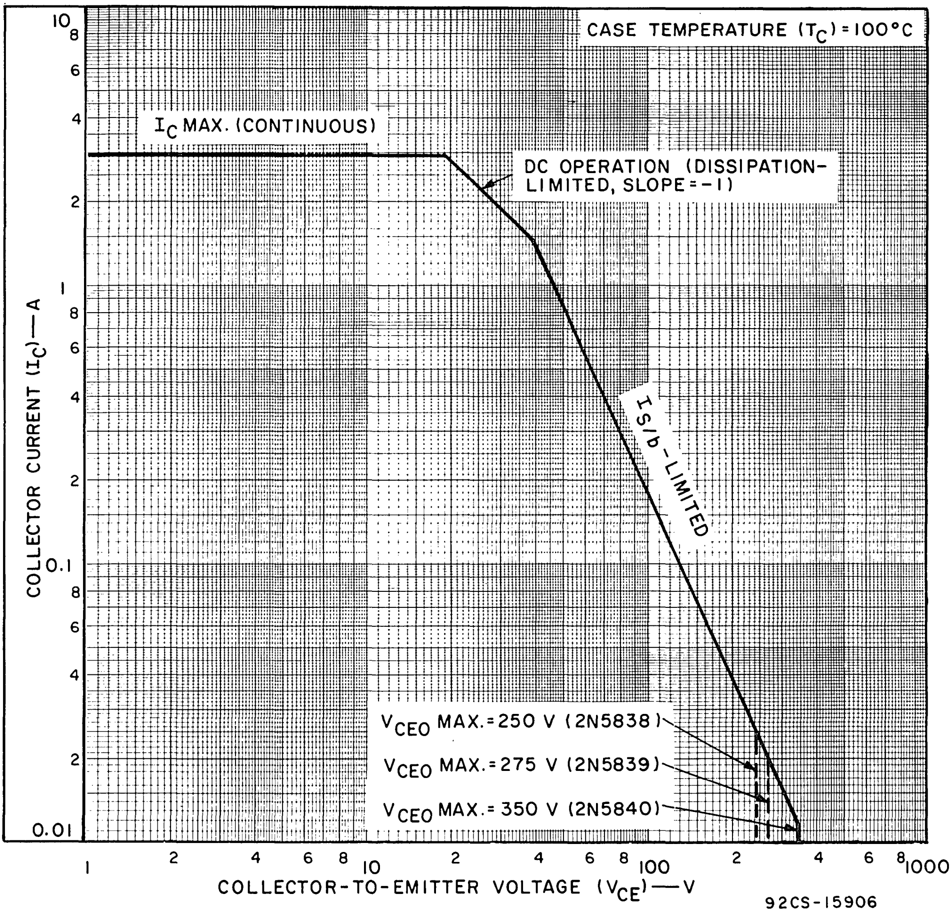
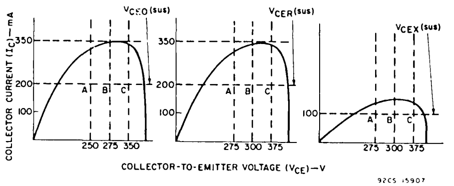


Fig. 3 - Maximum operating areas for all types.



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. 4 - Oscilloscope display for measurement of sustaining voltages (test circuit shown in Fig. 5).

TERMINAL CONNECTIONS

Pin 1 - Base
Pin 2 - Emitter
Mounting Flange, Case - Collector

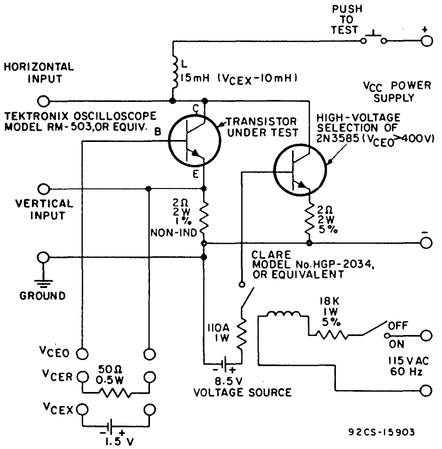


Fig. 5 - Circuit used to measure sustaining voltages $V_{CEO}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$ for all types.

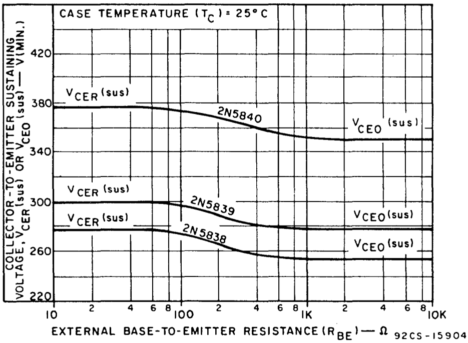


Fig. 6 - Collector-to-emitter sustaining voltage characteristics for all types.

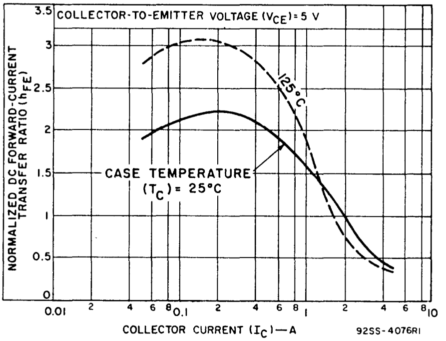


Fig. 7 - Typical normalized dc beta characteristics for all types.

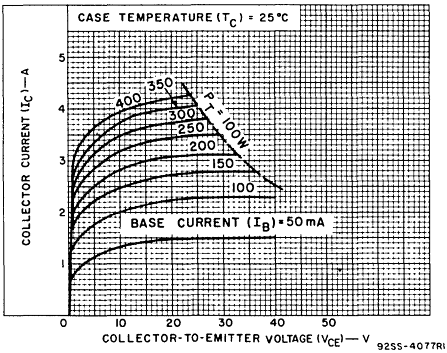


Fig. 8 - Typical output characteristics for all types.

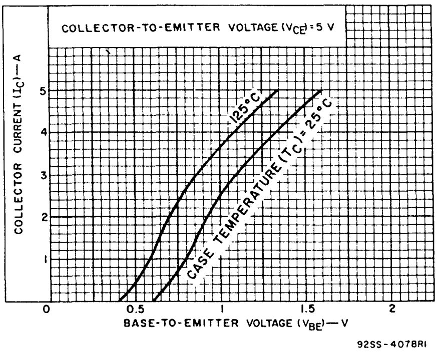


Fig. 9 - Typical transfer characteristics for all types.

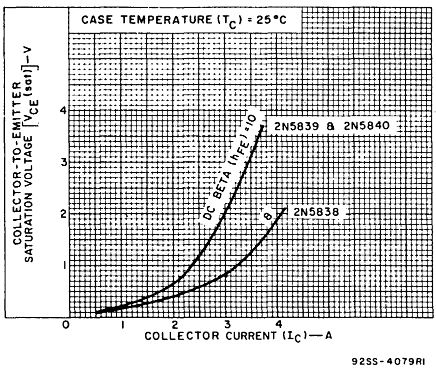


Fig. 10 - Typical saturation voltage characteristics for all types.

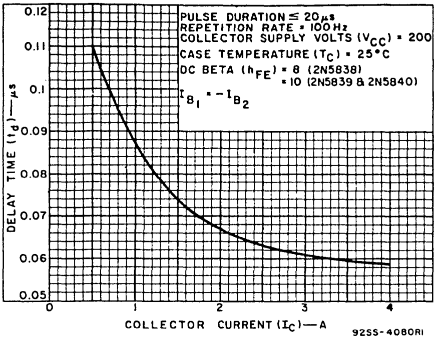


Fig. 11 - Typical delay-time characteristic for all types.

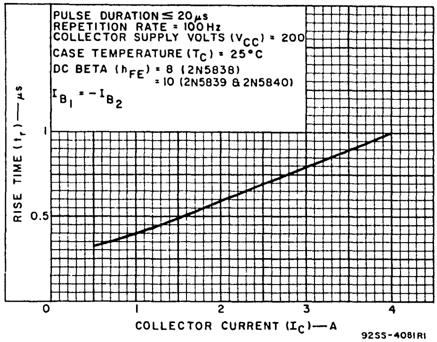


Fig. 12 - Typical rise-time characteristic for all types.

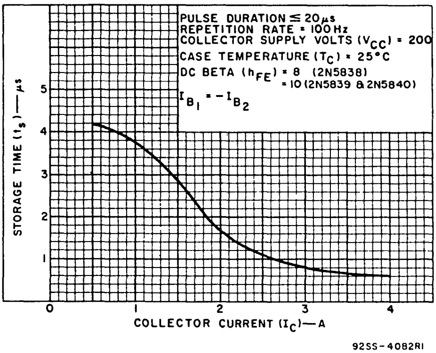


Fig. 13 - Typical storage-time characteristic for all types.

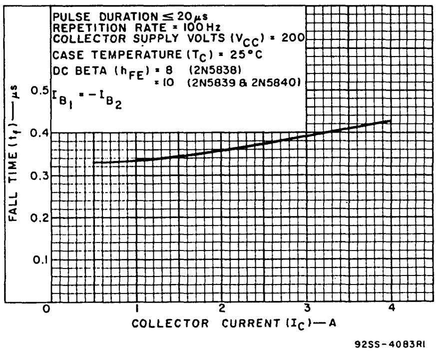


Fig. 14 - Typical fall-time characteristic for all types.

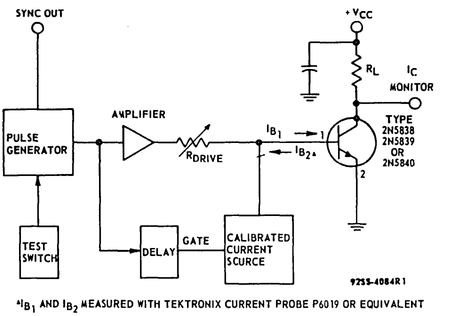


Fig. 15 - Circuit used to measure switching times for all types.

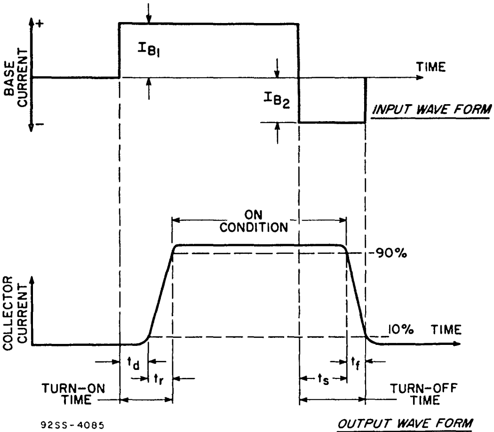


Fig. 16 - Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 15).