

2N5038, 2N5039, 2N6496

File Number 698

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

Devices for Switching and Amplifier Circuits in Industrial and Commercial Applications

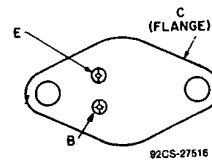
Features:

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

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

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

TERMINAL DESIGNATIONS



JEDEC TO-204AA

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N5038	2N5039	2N6496	
*COLLECTOR-TO-BASE VOLTAGE	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 $R_{BE} \leq 50 \Omega$	$V_{CER(sus)}$ 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)	← 230 →			°C
At distances $\geq 1/32$ in. (0.8 mm) from seating plane for 10 s max.				

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

2N5038, 2N5039, 2N6496

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS							LIMITS						UNITS							
		VOLTAGE V dc			CURRENT A dc				2N5038		2N5039		2N6496									
		V _{CB}	V _{CE}	V _{EB}	V _{BE}	I _C	I _E	I _B	Min.	Max.	Min.	Max.	Min.	Max.								
Collector Cutoff Current: With base open	I _{CEO}	55	70					0	0	—	—	20	—	—	—	—	mA					
With base-emitter junction reverse-biased	I _{CEV}	110	140	130	-1.5	-1.5	0	—	—	50	—	50	—	—	—	—						
At T _C = 150°C		85	100	130	-1.5	-1.5	0	—	—	10	—	10	—	—	—	25						
Emitter Cutoff Current	I _{EBO}			5	7			0	0	—	—	5	—	—	15	—	50	50	mA			
DC Forward-Current Transfer Ratio	h _{FE}	5	5	5	2			2 ^a	10 ^a	20	50	200	30	150	—	—	—	—	—	—		
Magnitude of Small-Signal Forward-Current Transfer Ratio (At f = 5 MHz)	h _{fe}	10						2		12	—	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	—	—	—	—	—	—	—	V	
With R _{BE} ≤ 50 Ω	V _{CER(sus)} ^b							0.2		0	110	—	95	—	130	—	—	—	—	—	V	
Emitter-to-Base Voltage	V _{EBO}							0	0.05	7	—	7	—	7	—	7	—	—	—	—	V	
Base-to-Emitter Voltage	V _{BE}	5	5	2				10 ^a	12 ^a	8 ^a	—	—	—	1.8	—	—	—	—	—	1.6	V	
Collector-to-Emitter Saturation Voltage	V _{CE(sat)}							10 ^a	12 ^a	20 ^a	8 ^a	1.0	1.2	—	1.0	—	2.5	—	2.5	—	1.0	V
Base-to-Emitter Saturation Voltage	V _{BE(sat)}							20 ^a	8 ^a	5	0.8	—	3.3	—	3.3	—	—	—	—	2.0	V	
Output Capacitance	C _{ob}	10						0		—	400	—	400	—	400	—	—	—	—	—	pF	
Second-Breakdown Collector Current ^b (With base forward biased)	I _{S/b} ^d		28	45						5.0	0.9	—	5.0	0.9	—	5.0	0.9	—	—	—	A	
Second-Breakdown Energy (With base reverse biased, R _B = 20 Ω, L = 180 μH)	E _{S/b} ^f					-4	-4	12	8	13	—	13	—	—	—	—	—	—	5.7	—	mJ	
Sat. Switching Rise Time	t _r	V _{CC} = 30 V						10	12	8	1.0 ^e	1.2 ^e	0.8 ^e	—	—	0.5	—	—	—	—	0.5	μs
Sat. Switching Storage Time	t _s	V _{CC} = 30 V						10	12	8	1.0 ^e	1.2 ^e	0.8 ^e	—	1.5	—	—	—	—	—	1.5	μs
Sat. Switching Fall Time	t _f	V _{CC} = 30 V						10	12	8	1.0 ^e	1.2 ^e	0.8 ^e	—	0.5	—	—	—	—	—	0.5	μs
Thermal Resistance (Junction-to-Case)	θ _{JC}		10					10														°C/W

^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.
^c I_{B1} = I_{B2} = value shown.
^d I_{S/b} is defined as the current at which second breakdown occurs at a specified collector voltage with the emitter-base junction forward-biased for transistor operation in the active region.
^e Pulsed; 1-s non-repetitive pulse.
^f E_{S/b} is defined as the energy at which second breakdown occurs under specified reverse-bias conditions. E_{S/b} = ½LI² where L is a series load or leakage inductance and I is the peak collector current.
 *In accordance with JEDEC registration data format (JIS-6, RDF-1)

2N5038, 2N5039, 2N6496

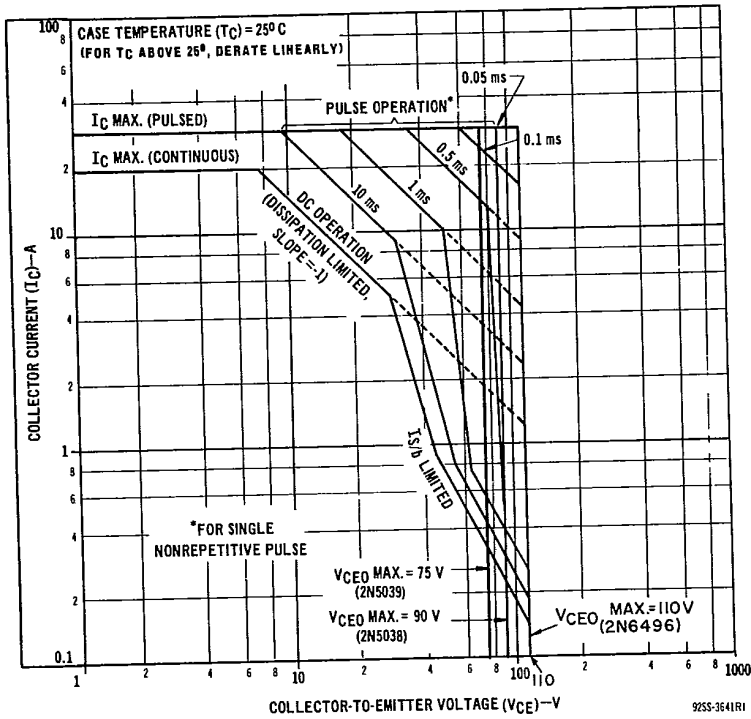


Fig. 1 — Maximum operating areas for all types.

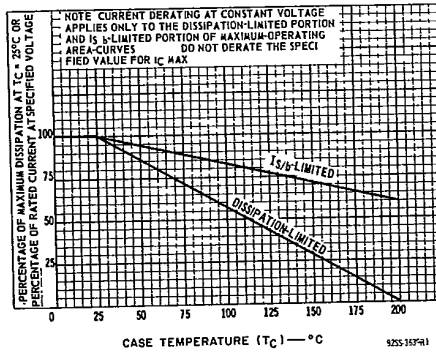


Fig. 2 — Dissipation derating curves for all types.

2N5038, 2N5039, 2N6496

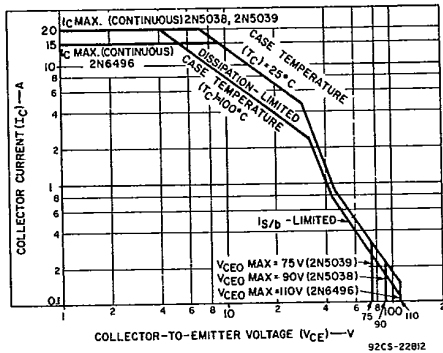


Fig. 3 - Maximum operating areas for all types.

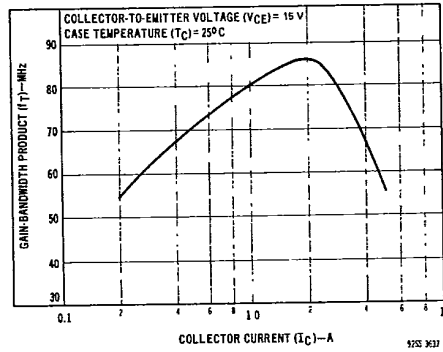


Fig. 4 - Typical gain-bandwidth product for all types.

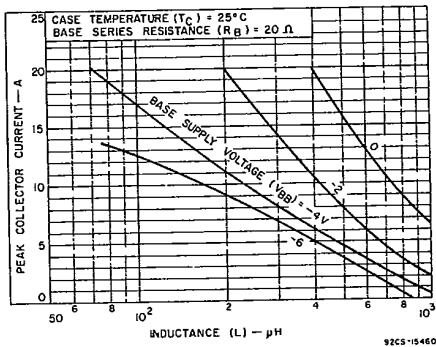


Fig. 5 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

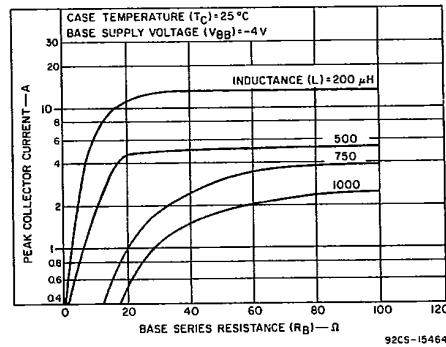


Fig. 6 - Maximum reverse-bias, second-breakdown characteristics for 2N5038 and 2N5039.

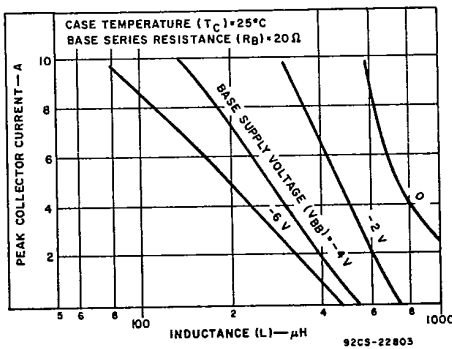


Fig. 7 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

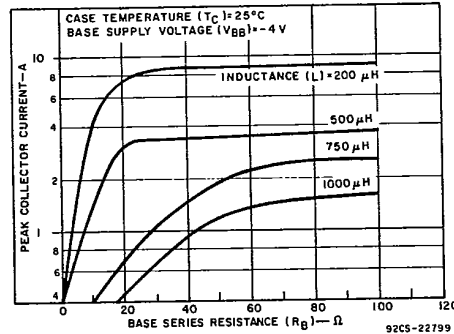


Fig. 8 - Maximum reverse-bias, second-breakdown characteristics for 2N6496.

2N5038, 2N5039, 2N6496

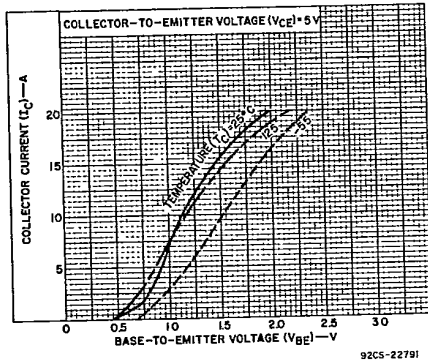


Fig. 9 - Typical transfer characteristics for 2N5038.

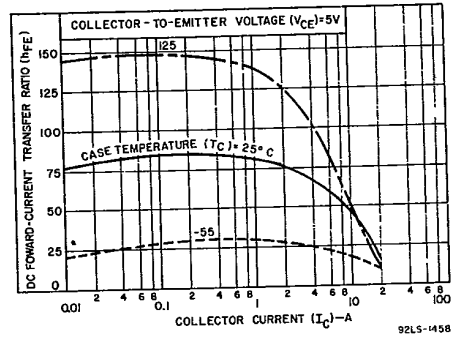


Fig. 10 - Typical dc beta characteristics for 2N5038.

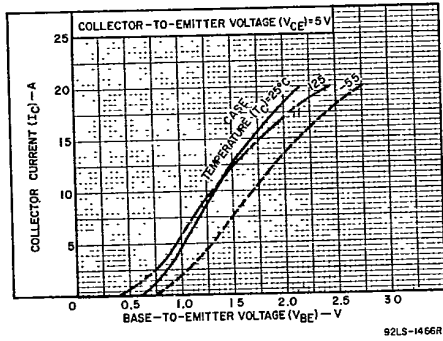


Fig. 11 - Typical transfer characteristics for 2N5039.

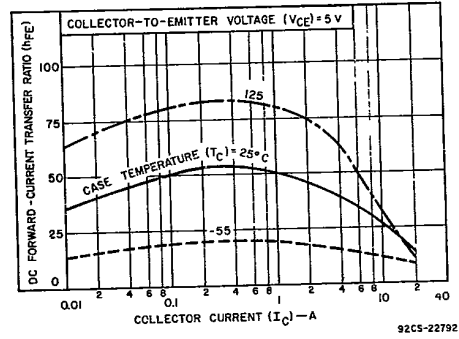


Fig. 12 - Typical dc beta characteristics for 2N5039.

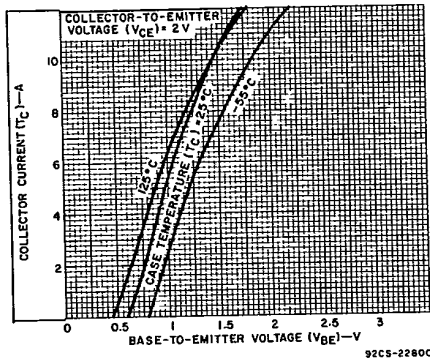


Fig. 13 - Typical transfer characteristics for 2N6496.

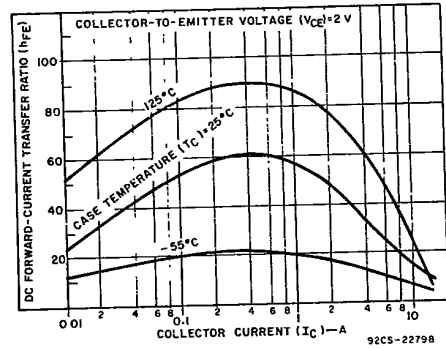


Fig. 14 - Typical dc beta characteristics for 2N6496.

2N5038, 2N5039, 2N6496

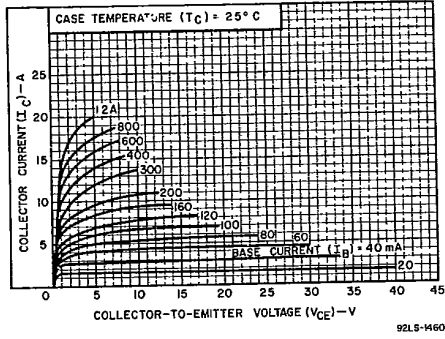


Fig. 15 - Typical output characteristics for 2N5038.

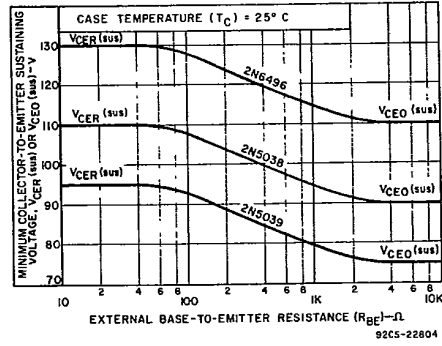


Fig. 16 - Collector-to-emitter sustaining voltage characteristic for all types.

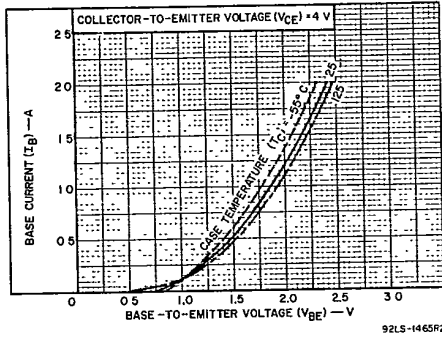


Fig. 17 - Typical output characteristics for 2N5039.

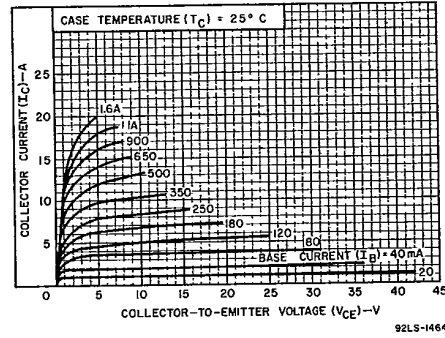


Fig. 18 - Typical input characteristics for 2N5038 and 2N5039.

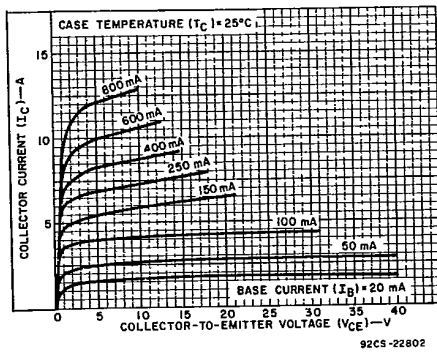


Fig. 19 - Typical output characteristics for 2N6496.

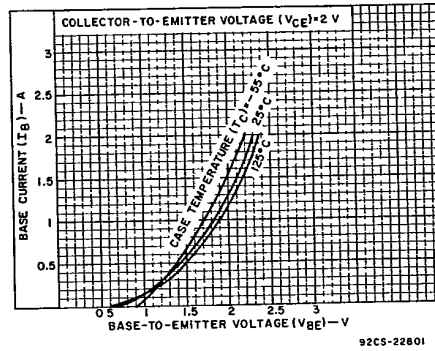


Fig. 20 - Typical input characteristics for 2N6496.

2N5038, 2N5039, 2N6496

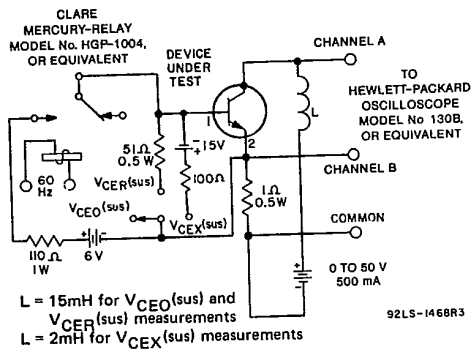
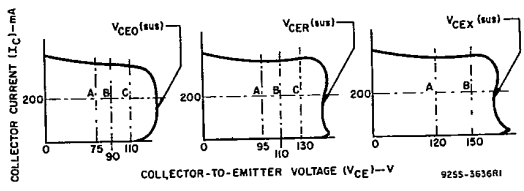


Fig. 21 - Circuit used to measure sustaining voltages $V_{CE0}(sus)$, $V_{CER}(sus)$, and $V_{CEX}(sus)$.



The sustaining voltages ($V_{CE0}(sus)$, $V_{CER}(sus)$, 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).

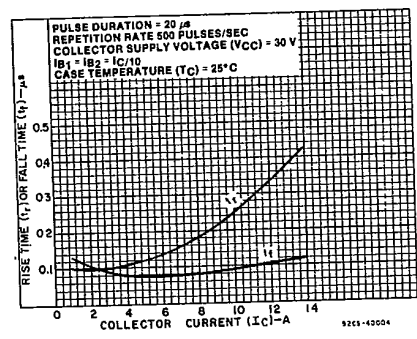


Fig. 23 - Typical rise-time and fall-time characteristics for all types.

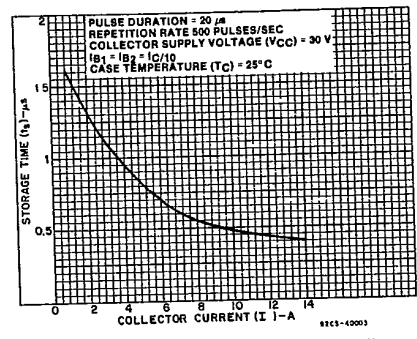


Fig. 24 - Typical storage time characteristic for all types.

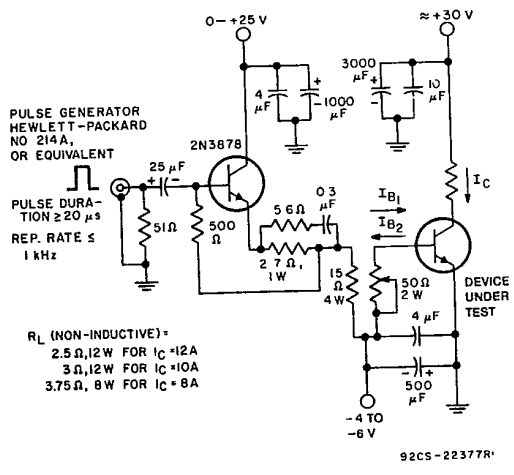


Fig. 25 - Circuit used to measure switching times for all types.

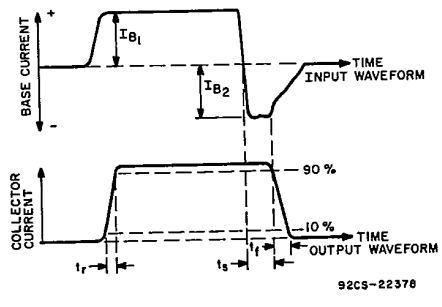


Fig. 26 - Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig. 26).