

# NPN Silicon Transistors

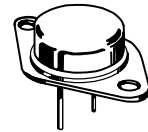
... fast switching speeds and high current capacity ideally suit these parts for use in switching regulators, inverters, wide-band amplifiers and power oscillators in industrial and commercial applications.

- High Speed —  $t_f = 0.5 \mu s$  (Max)
- High Current —  $I_C(\text{max}) = 30$  Amps
- Low Saturation —  $V_{CE(\text{sat})} = 2.5$  V (Max) @  $I_C = 20$  Amps

**2N5038\***  
**2N5039**

\*Motorola Preferred Device

**20 AMPERE  
NPN SILICON  
POWER TRANSISTORS  
75 and 90 VOLTS  
140 WATTS**



**CASE 1-07  
TO-204AA  
(TO-3)**

### \*MAXIMUM RATINGS

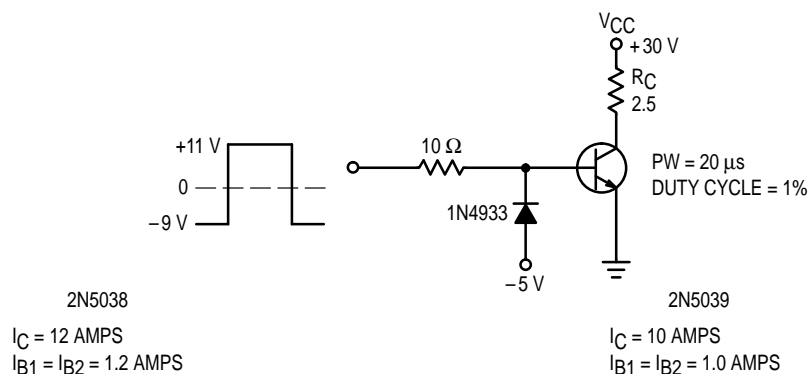
Rating	Symbol	2N5038	2N5039	Unit
Collector-Base Voltage	$V_{CBO}$	150	120	Vdc
Collector-Emitter Voltage	$V_{CEV}$	150	120	Vdc
Emitter-Base Voltage	$V_{EBO}$	7		Vdc
Collector Current — Continuous	$I_C$	20		Adc
Peak (1)	$I_{CM}$	30		
Base Current — Continuous	$I_B$	5		Adc
Total Device Dissipation @ $T_C = 25^\circ C$	$P_D$	140		Watts
Derate above $25^\circ C$		0.8		W/ $^\circ C$
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-65 to +200		$^\circ C$

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	$^\circ C/W$

\* Indicates JEDEC Registered Data.

(1) Pulse Test: Pulse Width  $\leq 10$  ms, Duty Cycle  $\leq 50\%$ .



**Figure 1. Switching Time Test Circuit**

Preferred devices are Motorola recommended choices for future use and best overall value.

REV 7

## 2N5038 2N5039

\*ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Sustaining Voltage (1) ( $I_C = 200\text{ mA}$ , $I_B = 0$ )	$V_{CEO(sus)}$	90 75	— —	Vdc
Collector Cutoff Current ( $V_{CE} = 140\text{ Vdc}$ , $V_{BE(off)} = 1.5\text{ V}$ ) ( $V_{CE} = 110\text{ Vdc}$ , $V_{BE(off)} = 1.5\text{ V}$ ) ( $V_{CE} = 100\text{ Vdc}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ , $T_C = 150^\circ\text{C}$ ) ( $V_{CE} = 85\text{ Vdc}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ , $T_C = 150^\circ\text{C}$ )	$I_{CEX}$	— — — —	50 50 10 10	mAdc
Emitter Cutoff Current ( $V_{EB} = 5\text{ Vdc}$ , $I_C = 0$ )  ( $V_{EB} = 7\text{ Vdc}$ , $I_C = 0$ )	$I_{EBO}$	— — —	5 15 50	mAdc

### ON CHARACTERISTICS (1)

DC Current Gain ( $I_C = 12\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ ) ( $I_C = 10\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ )	$h_{FE}$	20 20	100 100	—
Collector–Emitter Saturation Voltage ( $I_C = 20\text{ Adc}$ , $I_B = 5\text{ Adc}$ )	$V_{CE(sat)}$	—	2.5	Vdc
Base–Emitter Saturation Voltage ( $I_C = 20\text{ Adc}$ , $I_B = 5\text{ Adc}$ )	$V_{BE(sat)}$	—	3.3	Vdc

### DYNAMIC CHARACTERISTICS

Magnitude of Common–Emitter Small–Signal Short–Circuit Forward Current Transfer Ratio ( $I_C = 2\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 5\text{ MHz}$ )	$ h_{fe} $	12	—	—
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### SWITCHING CHARACTERISTICS

RESISTIVE LOAD						
Rise Time	$(V_{CC} = 30\text{ Vdc})$					
Storage Time						
Fall Time	$(I_C = 12\text{ Adc}, I_{B1} = I_{B2} = 1.2\text{ Adc})$	2N5038	$t_r$	—	0.5	$\mu\text{s}$
	$(I_C = 10\text{ Adc}, I_{B1} = I_{B2} = 1\text{ Adc})$	2N5039	$t_s$	—	1.5	$\mu\text{s}$
			$t_f$	—	0.5	$\mu\text{s}$

\* Indicates JEDEC Registered Data.

(1) Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

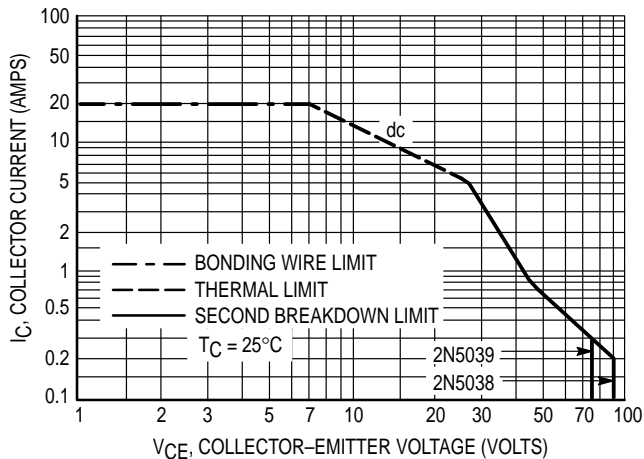
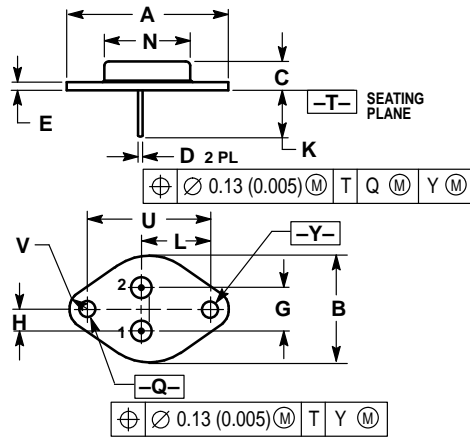


Figure 2. Forward Bias Safe Operating Area

There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate  $I_C - V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

Second breakdown pulse limits are valid for duty cycles to 10%. At high case temperatures, thermal limitations may reduce the power that can be handled to values less than the limitations imposed by second breakdown.

PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. ALL RULES AND NOTES ASSOCIATED WITH REFERENCED TO-204AA OUTLINE SHALL APPLY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.550 REF		39.37 REF	
B	—	1.050	—	26.67
C	0.250	0.335	6.35	8.51
D	0.038	0.043	0.97	1.09
E	0.055	0.070	1.40	1.77
G	0.430 BSC		10.92 BSC	
H	0.215 BSC		5.46 BSC	
K	0.440	0.480	11.18	12.19
L	0.665 BSC		16.89 BSC	
N	—	0.830	—	21.08
Q	0.151	0.165	3.84	4.19
U	1.187 BSC		30.15 BSC	
V	0.131	0.188	3.33	4.77

STYLE 1:  
 PIN 1: BASE  
 2: EMITTER  
 CASE: COLLECTOR

CASE 1-07  
 TO-204AA (TO-3)  
 ISSUE Z

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