

# 2N3902 NPN (SILICON)

# 2N5157

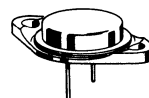
## HIGH VOLTAGE NPN SILICON TRANSISTORS

... designed for use in high-voltage inverters, converters, switching regulators and line operated amplifiers.

- High Collector-Emitter Voltage –  $V_{CEX} = 700$  Vdc
- Excellent DC Current Gain –  
 $h_{FE} = 10$  (Min) @  $I_C = 2.5$  Adc
- Low Collector-Emitter Saturation Voltage –  
 $V_{CE(sat)} = 0.8$  Vdc (Max) @  $I_C = 1.0$  Adc

## 3.5 AMPERE POWER TRANSISTORS NPN SILICON

400 and 500 VOLTS  
100 WATTS



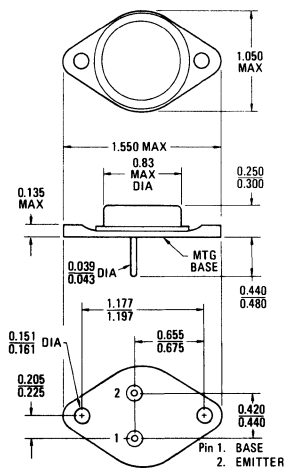
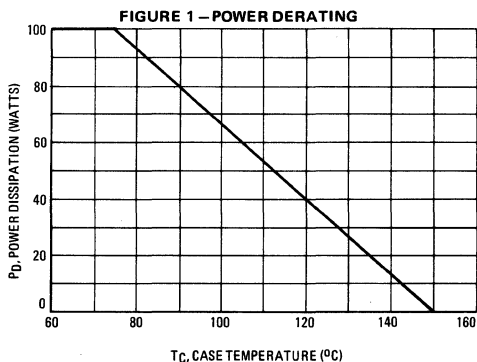
### \*MAXIMUM RATINGS

Rating	Symbol	2N3902	2N5157	Unit
Collector-Emitter Voltage	$V_{CEO}$	400	500	Vdc
Collector-Emitter Voltage	$V_{CEX}$	700		Vdc
Emitter-Base Voltage	$V_{EB}$	5.0	6.0	Vdc
Collector Current – Continuous	$I_C$	3.5		A dc
Base Current	$I_B$	2.0		A dc
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ Derate above $75^\circ\text{C}$	$P_D$	100	1.33	Watts W/ $^\circ\text{C}$
Operating Junction Temperature Range	$T_J$	-65 to +150		$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +200		$^\circ\text{C}$

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$\theta_{JC}$	0.75	$^\circ\text{C}/\text{W}$

\*Indicates JEDEC Registered Data



To convert inches to millimeters multiply by 25.4  
All JEDEC dimensions and notes apply  
Collector connected to case

CASE 11  
TO-3

# 2N3902, 2N5157 (continued)

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

Characteristic	Symbol	Min	Max	Unit	
<b>OFF CHARACTERISTICS</b>					
Collector-Emitter Sustaining Voltage ( $I_C = 100 \text{ mAdc}$ , $I_B = 0$ ) (See Figure 12)	2N3902 2N5157	$V_{CEO(sus)}$	325 400	—	Vdc
Collector-Emitter Breakdown Voltage ( $I_C = 3.5 \text{ Adc}$ , $R_{BE} = 10 \text{ Ohms}$ ) (See Figure 12)	2N5157	$BV_{CER}$	500	—	Vdc
Collector Cutoff Current ( $V_{CE} = 400 \text{ Vdc}$ , $I_B = 0$ )	2N3902	$I_{CEO}$	0.25	—	mAdc
( $V_{CE} = 500 \text{ Vdc}$ , $I_B = 0$ )	2N5157		0.25	—	
Collector Cutoff Current ( $V_{CE} = 700 \text{ Vdc}$ , $V_{EB(off)} = 1.5 \text{ Vdc}$ )	2N3902	$I_{CEX}$	—	2.5	mAdc
( $V_{CE} = 400 \text{ Vdc}$ , $V_{EB(off)} = 1.5 \text{ Vdc}$ , $T_C = 125^\circ\text{C}$ )	2N5157		—	0.5	
	Both Types		—	0.5	
Emitter Cutoff Current ( $V_{BE} = 5.0 \text{ Vdc}$ , $I_C = 0$ )	2N3902	$I_{EBO}$	—	5.0	mAdc
( $V_{BE} = 6.0 \text{ Vdc}$ , $I_C = 0$ )	2N5157		—	5.0	

### ON CHARACTERISTICS(1)

DC Current Gain ( $I_C = 1.0 \text{ Adc}$ , $V_{CE} = 5.0 \text{ Vdc}$ )	2N3902, 2N5157	$h_{FE}$	30	90	—
( $I_C = 2.5 \text{ Adc}$ , $V_{CE} = 5.0 \text{ Vdc}$ )	2N3902, 2N5157		10	—	
( $I_C = 1.0 \text{ Adc}$ , $V_{CE} = 5.0 \text{ Vdc}$ , $T_C = -55^\circ\text{C}$ )	2N5157		10	—	
Collector-Emitter Saturation Voltage ( $I_C = 1.0 \text{ Adc}$ , $I_B = 0.1 \text{ Adc}$ )	2N3902, 2N5157	$V_{CE(sat)}$	—	0.8	Vdc
( $I_C = 2.5 \text{ Adc}$ , $I_B = 0.5 \text{ Adc}$ )	2N3902		—	2.5	
( $I_C = 3.5 \text{ Adc}$ , $I_B = 0.7 \text{ Adc}$ )	2N5157		—	2.5	
Base-Emitter Saturation Voltage ( $I_C = 1.0 \text{ Adc}$ , $I_B = 0.1 \text{ Adc}$ )	2N3902, 2N5157	$V_{BE(sat)}$	—	1.5	Vdc
( $I_C = 2.5 \text{ Adc}$ , $I_B = 0.5 \text{ Adc}$ )	2N3902		—	2.0	
( $I_C = 3.5 \text{ Adc}$ , $I_B = 0.7 \text{ Adc}$ )	2N5157		—	2.0	

### DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product ( $I_C = 0.2 \text{ Adc}$ , $V_{CE} = 10 \text{ Vdc}$ )	2N3902	$f_T$	2.8	—	MHz
( $I_C = 0.2 \text{ Adc}$ , $V_{CE} = 12 \text{ Vdc}$ )	2N5157		2.8	—	
Output Capacitance ( $V_{CB} = 20 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	2N5157	$C_{ob}$	—	150	pF

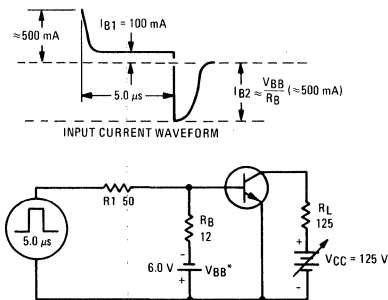
### SWITCHING CHARACTERISTICS

Turn-On Time ( $V_{CC} = 125 \text{ Vdc}$ , $I_C = 1.0 \text{ Adc}$ , $I_{B1} = 0.1 \text{ Adc}$ )	2N5157	$t_{on}$	—	0.8	$\mu\text{s}$
Turn-Off Time ( $V_{CC} = 125 \text{ Vdc}$ , $I_C = 1.0 \text{ Adc}$ , $I_{B1} = 0.1 \text{ Adc}$ , $I_{B2} = 0.5 \text{ Adc}$ )	2N5157	$t_{off}$	—	1.7	$\mu\text{s}$

\*Indicates JEDEC Registered Data

(1) Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

FIGURE 2 - SWITCHING TIMES TEST CIRCUIT



5.0% Duty Cycle  
 $t_r = 100 \text{ ns}$

\*For 2N3902 - change  $V_{BE}$  to 5.0 V.

FIGURE 3 - TURN-ON TIME

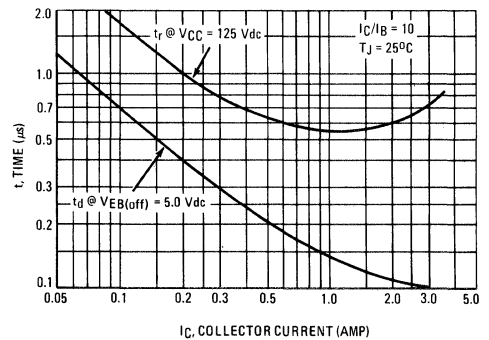


FIGURE 4 – THERMAL RESPONSE

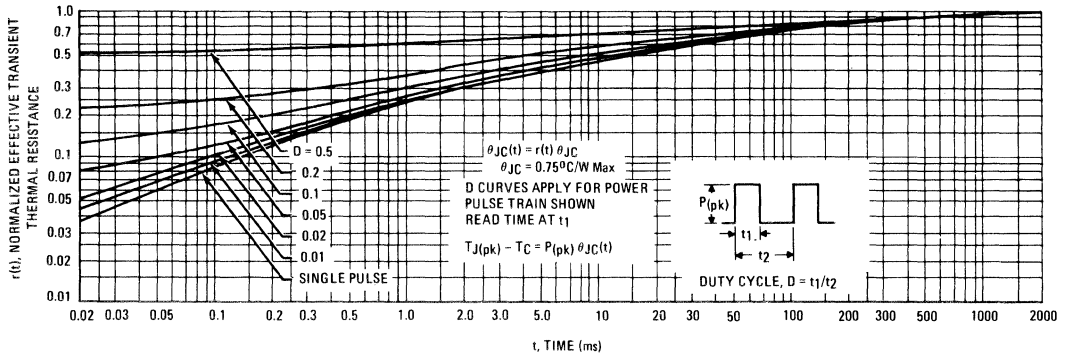
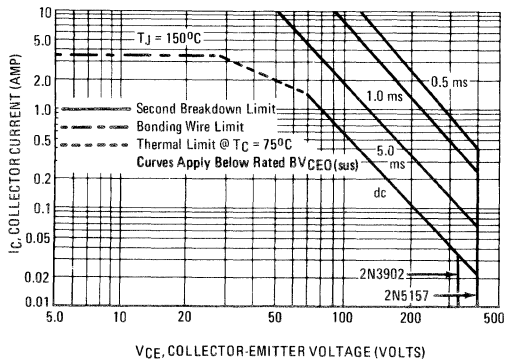


FIGURE 5 – ACTIVE-REGION SAFE-OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary 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.

The data of Figure 5 is based on  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided  $T_{J(pk)} \leq 150^\circ\text{C}$ . At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown. (See AN-415)

FIGURE 6 – TURN-OFF TIME

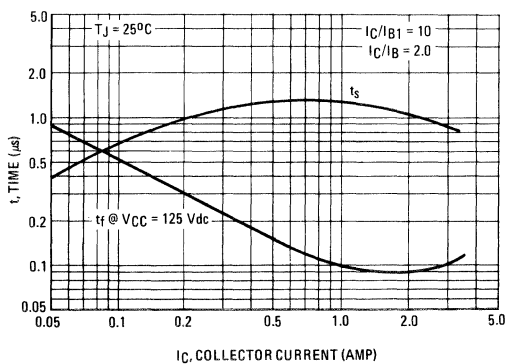
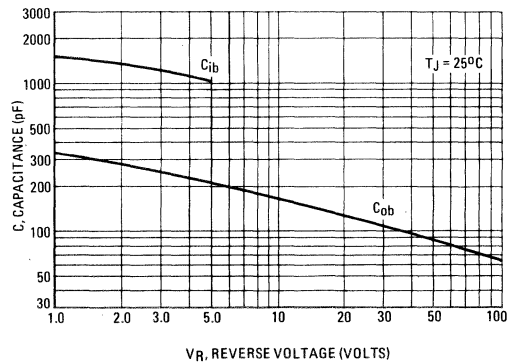


FIGURE 7 – CAPACITANCE



2N3902, 2N5157 (continued)

FIGURE 8 – DC CURRENT GAIN

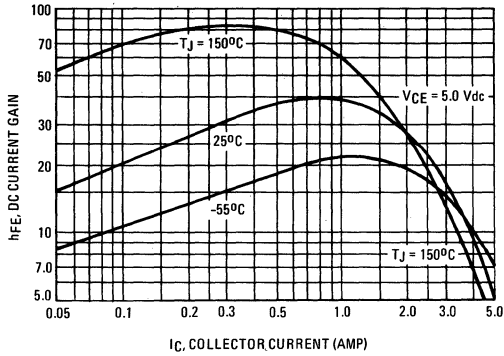


FIGURE 9 – "ON" VOLTAGES

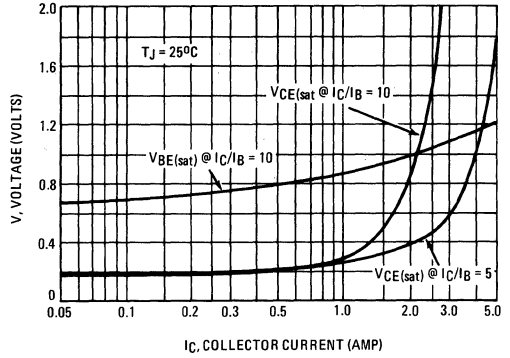


FIGURE 10 – COLLECTOR CUT-OFF REGION

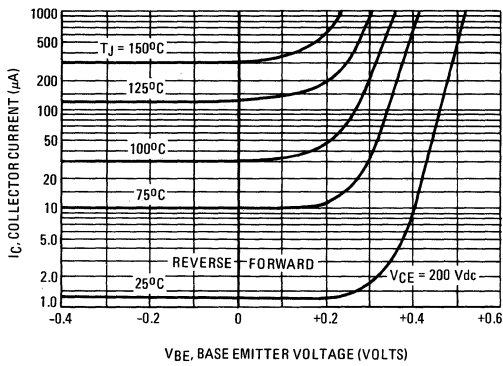


FIGURE 11 – TEMPERATURE COEFFICIENTS

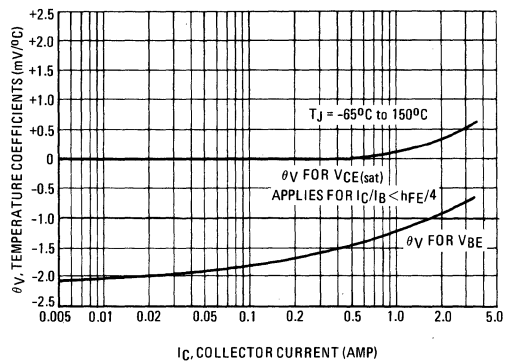


FIGURE 12 – COLLECTOR-EMITTER SUSTAINING VOLTAGE TEST CIRCUITS AND LOAD LINES

