

## NPN HIGH POWER SILICON TRANSISTOR

Qualified per MIL-PRF-19500/371

### Devices

2N3902

2N5157

### Qualified Level

JAN  
JANTX

### MAXIMUM RATINGS

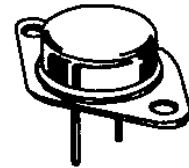
| Ratings                                                                                                                 | Symbol         | 2N3902      | 2N5157 | Unit               |
|-------------------------------------------------------------------------------------------------------------------------|----------------|-------------|--------|--------------------|
| Collector-Emitter Voltage                                                                                               | $V_{CEO}$      | 400         | 500    | Vdc                |
| Emitter-Base Voltage                                                                                                    | $V_{EBO}$      | 5.0         | 6.0    | Vdc                |
| Collector-Base Voltage                                                                                                  | $V_{CBO}$      | 700         |        | Vdc                |
| Base Current                                                                                                            | $I_B$          | 2.0         |        | Adc                |
| Collector Current                                                                                                       | $I_C$          | 3.5         |        | Adc                |
| Total Power Dissipation<br>@ $T_A = +25^{\circ}\text{C}$ <sup>(1)</sup><br>@ $T_C = +75^{\circ}\text{C}$ <sup>(2)</sup> | $P_T$          | 5.0         |        | W                  |
|                                                                                                                         |                | 100         |        | W                  |
| Operating & Storage Temperature Range                                                                                   | $T_j, T_{stg}$ | -65 to +200 |        | $^{\circ}\text{C}$ |

### THERMAL CHARACTERISTICS

| Characteristics                      | Symbol          | Max. | Unit                 |
|--------------------------------------|-----------------|------|----------------------|
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | 1.25 | $^{\circ}\text{C/W}$ |

1) Derate linearly 29 mW/ $^{\circ}\text{C}$  for  $T_A > +25^{\circ}\text{C}$

2) Derate linearly 0.8 mW/ $^{\circ}\text{C}$  for  $T_C > +75^{\circ}\text{C}$



TO-3 (TO-204AA)\*

\*See Appendix A for Package Outline

### ELECTRICAL CHARACTERISTICS

| Characteristics | Symbol | Min. | Max. | Unit |
|-----------------|--------|------|------|------|
|-----------------|--------|------|------|------|

### OFF CHARACTERISTICS

|                                                                                              |        |           |     |                 |
|----------------------------------------------------------------------------------------------|--------|-----------|-----|-----------------|
| Collector-Emitter Cutoff Current<br>$V_{CE} = 325 \text{ Vdc}$<br>$V_{CE} = 400 \text{ Vdc}$ | 2N3902 | $I_{CEO}$ | 250 | $\mu\text{Adc}$ |
|                                                                                              | 2N5157 |           |     |                 |
| Collector-Emitter Cutoff Current<br>$V_{BE} = 1.5 \text{ Vdc}; V_{CE} = 700 \text{ Vdc}$     |        | $I_{CEX}$ | 500 | $\mu\text{Adc}$ |
| Emitter-Base Cutoff Current<br>$V_{EB} = 5.0 \text{ Vdc}$<br>$V_{EB} = 6.0 \text{ Vdc}$      | 2N3902 | $I_{EBO}$ | 200 | $\mu\text{Adc}$ |
|                                                                                              | 2N5157 |           |     |                 |

### ON CHARACTERISTICS<sup>(3)</sup>

|                                                                                                                                          |               |  |     |     |
|------------------------------------------------------------------------------------------------------------------------------------------|---------------|--|-----|-----|
| Base-Emitter Saturation Voltage<br>$I_C = 1.0 \text{ Adc}; I_B = 0.1 \text{ Adc}$<br>$I_C = 3.5 \text{ Adc}; I_B = 0.7 \text{ Adc}$      | $V_{BE(sat)}$ |  | 1.5 | Vdc |
|                                                                                                                                          |               |  | 2.0 |     |
| Collector-Emitter Saturation Voltage<br>$I_C = 1.0 \text{ Adc}; I_B = 0.1 \text{ Adc}$<br>$I_C = 3.5 \text{ Adc}; I_B = 0.7 \text{ Adc}$ | $V_{CE(sat)}$ |  | 0.8 | Vdc |
|                                                                                                                                          |               |  | 2.5 |     |

**ELECTRICAL CHARACTERISTICS (con't)**

| Characteristics                                                                                                                                                                                                                                            | Symbol                | Min.                | Max.       | Unit |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------|------------|------|
| <b>ON CHARACTERISTICS<sup>(3)</sup> (con't)</b>                                                                                                                                                                                                            |                       |                     |            |      |
| Forward-Current Transfer Ratio<br>I <sub>C</sub> = 0.5 Adc; V <sub>CE</sub> = 5.0 Vdc<br>I <sub>C</sub> = 1.0 Adc; V <sub>CE</sub> = 5.0 Vdc<br>I <sub>C</sub> = 2.5 Adc; V <sub>CE</sub> = 5.0 Vdc<br>I <sub>C</sub> = 3.5 Adc; V <sub>CE</sub> = 5.0 Vdc | h <sub>FE</sub>       | 25<br>30<br>10<br>5 | 90         |      |
| Collector-Emitter Sustaining Voltage<br>I <sub>C</sub> = 100 mAdc<br>2N3902<br>2N5157                                                                                                                                                                      | V <sub>CEO(sus)</sub> |                     | 325<br>400 | Vdc  |

**DYNAMIC CHARACTERISTICS**

|                                                                                                                            |                  |     |     |    |
|----------------------------------------------------------------------------------------------------------------------------|------------------|-----|-----|----|
| Small-Signal Short-Circuit Forward Current Transfer Ratio<br>I <sub>C</sub> = 0.2 Adc; V <sub>CE</sub> = 10 Vdc, f = 1 MHz | h <sub>fe</sub>  | 2.5 | 25  |    |
| Output Capacitance<br>V <sub>CB</sub> = 10 Vdc; I <sub>E</sub> = 0, 100 kHz ≤ f ≤ 1.0 MHz                                  | C <sub>obo</sub> |     | 250 | pF |

**SWITCHING CHARACTERISTICS**

|                                                                                                                              |                  |  |     |    |
|------------------------------------------------------------------------------------------------------------------------------|------------------|--|-----|----|
| Turn-On Time<br>V <sub>CC</sub> = 125 Vdc; I <sub>C</sub> = 1.0 Adc; I <sub>B1</sub> = 0.1 Adc                               | t <sub>on</sub>  |  | 0.8 | μs |
| Turn-Off Time<br>V <sub>CC</sub> = 125 Vdc; I <sub>C</sub> = 1.0 Adc; I <sub>B1</sub> = 0.1 Adc; -I <sub>B2</sub> = 0.50 Adc | t <sub>off</sub> |  | 1.7 | μs |

**SAFE OPERATING AREA****DC Tests (continuous)**T<sub>C</sub> = +25°C; t ≥ 1.0 s (See Figure 3 of MIL-PRF-19500/371)**Test 1**V<sub>CE</sub> = 28.6 Vdc, I<sub>C</sub> = 3.5 Adc**Test 2**V<sub>CE</sub> = 70 Vdc, I<sub>C</sub> = 1.43 Adc**Test 3**V<sub>CE</sub> = 325 Vdc, I<sub>C</sub> = 55 mAdc 2N3902V<sub>CE</sub> = 400 Vdc, I<sub>C</sub> = 35 mAdc 2N5157**Switching Tests****Load condition C (unclamped inductive load)**T<sub>C</sub> = 25°C; duty cycle ≤ 10%; R<sub>S</sub> = 0.1 Ω (See Figure 4 of MIL-PRF-19500/371)**Test 1**t<sub>p</sub> = approximately 3 ms (vary to obtain I<sub>C</sub>); R<sub>BB1</sub> = 20 Ω; V<sub>BB1</sub> = 10 Vdc; R<sub>BB2</sub> = 3 kΩ;V<sub>BB2</sub> = 1.5 Vdc; V<sub>CC</sub> = 50 Vdc; I<sub>C</sub> = 3.5 Adc; L = 60 mH; R = 3 Ω; R<sub>L</sub> ≤ 14Ω.**Test 2**t<sub>p</sub> = approximately 3 ms (vary to obtain I<sub>C</sub>); R<sub>BB1</sub> = 100 Ω; V<sub>BB1</sub> = 10 Vdc; R<sub>BB2</sub> = 3 kΩ;V<sub>BB2</sub> = 1.5 Vdc; I<sub>C</sub> = 0.6 Adc V<sub>CC</sub> = 50 Vdc; L = 200 mH; R = 8 Ω; R<sub>L</sub> ≤ 83Ω.**Switching Tests****Load condition (clamped inductive load)**T<sub>C</sub> = +25°C; duty cycle ≤ 10%. (See Figure 5 of MIL-PRF-19500/371)**Test 1**t<sub>p</sub> = approximately 30 ms (vary to obtain I<sub>C</sub>); R<sub>S</sub> = 0.1 Ω; R<sub>BB1</sub> = 20 Ω; V<sub>BB1</sub> = 10 Vdc; R<sub>BB2</sub> = 100 Ω;V<sub>BB2</sub> = 1.5 Vdc; V<sub>CC</sub> = 50 Vdc; I<sub>C</sub> = 3.5 Adc; L = 60 mH; R = 3 Ω; R<sub>L</sub> ≥ 0Ω.

(A suitable clamping circuit or diode can be used.)

Clamp Voltage = 400 +0, -5 Vdc 2N3902

Clamp Voltage = 500 +0, -5 Vdc 2N5157

(Clamped voltage must be reached)

3.) Pulse Test: Pulse Width = 300μs, Duty Cycle ≤ 2.0%.