

## NPN HIGH POWER SILICON TRANSISTOR

Qualified per MIL-PRF-19500/ 371

### Devices

**2N3902**

**2N5157**

### Qualified Level

**JAN  
JANTX**

### MAXIMUM RATINGS

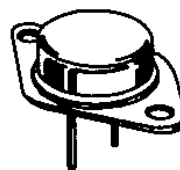
| Ratings                                                              | Symbol         | 2N3902      | 2N5157 | Unit               |
|----------------------------------------------------------------------|----------------|-------------|--------|--------------------|
| Collector-Emitter Voltage                                            | $V_{CEO}$      | 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 @ $T_A = +25^{\circ}\text{C}$ <sup>(1)</sup> | $P_T$          | 5.0         |        | W                  |
| @ $T_C = +75^{\circ}\text{C}$ <sup>(2)</sup>                         |                | 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 W/ $^{\circ}\text{C}$  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>$V_{BE} = 1.5 \text{ Vdc}$ | 2N3902 | $I_{CEO}$ | 250 | $\mu\text{Adc}$ |
| $V_{CE} = 400 \text{ Vdc}$                                                                   | 2N5157 |           | 250 |                 |
| 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>$V_{EB} = 5.0 \text{ Vdc}$                                    | 2N3902 | $I_{EBO}$ | 200 | $\mu\text{Adc}$ |
| $V_{EB} = 6.0 \text{ Vdc}$                                                                   | 2N5157 |           | 200 |                 |

### 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<br>2.0 | Vdc |
| 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<br>2.5 | Vdc |

**2N3902, 2N5157 JAN SERIES**

**ELECTRICAL CHARACTERISTICS (con't)**

| Characteristics                                                                                                                                                                                                                                    | Symbol         | Min.                | Max. | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------------------|------|------|
| <b>ON CHARACTERISTICS<sup>(3)</sup> (con't)</b>                                                                                                                                                                                                    |                |                     |      |      |
| Forward-Current Transfer Ratio<br>$I_C = 0.5 \text{ Adc}; V_{CE} = 5.0 \text{ Vdc}$<br>$I_C = 1.0 \text{ Adc}; V_{CE} = 5.0 \text{ Vdc}$<br>$I_C = 2.5 \text{ Adc}; V_{CE} = 5.0 \text{ Vdc}$<br>$I_C = 3.5 \text{ Adc}; V_{CE} = 5.0 \text{ Vdc}$ | $h_{FE}$       | 25<br>30<br>10<br>5 | 90   |      |
| Collector-Emitter Sustaining Voltage<br>$I_C = 100 \text{ mAdc}$<br><div style="display: flex; justify-content: space-between;"><span>2N3902</span><span>2N5157</span></div>                                                                       | $V_{CEO(sus)}$ | 325<br>400          |      | Vdc  |

**DYNAMIC CHARACTERISTICS**

|                                                                                                                                  |            |     |     |    |
|----------------------------------------------------------------------------------------------------------------------------------|------------|-----|-----|----|
| Small-Signal Short-Circuit Forward Current Transfer Ratio<br>$I_C = 0.2 \text{ Adc}; V_{CE} = 10 \text{ Vdc}, f = 1 \text{ MHz}$ | $ h_{fe} $ | 2.5 | 25  |    |
| Output Capacitance<br>$V_{CB} = 10 \text{ Vdc}; I_E = 0, 100 \text{ kHz} \leq f \leq 1.0 \text{ MHz}$                            | $C_{obo}$  |     | 250 | pF |

**SWITCHING CHARACTERISTICS**

|                                                                                                                          |           |  |     |         |
|--------------------------------------------------------------------------------------------------------------------------|-----------|--|-----|---------|
| Turn-On Time<br>$V_{CC} = 125 \text{ Vdc}; I_C = 1.0 \text{ Adc}; I_{B1} = 0.1 \text{ Adc}$                              | $t_{on}$  |  | 0.8 | $\mu s$ |
| Turn-Off Time<br>$V_{CC} = 125 \text{ Vdc}; I_C = 1.0 \text{ Adc}; I_{B1} = 0.1 \text{ Adc}; -I_{B2} = 0.50 \text{ Adc}$ | $t_{off}$ |  | 1.7 | $\mu s$ |

**SAFE OPERATING AREA**

**DC Tests (continuous)**

$T_C = +25^\circ\text{C}; t \geq 1.0 \text{ s}$  (See Figure 3 of MIL-PRF-19500/371)

**Test 1**

$V_{CE} = 28.6 \text{ Vdc}, I_C = 3.5 \text{ Adc}$

**Test 2**

$V_{CE} = 70 \text{ Vdc}, I_C = 1.43 \text{ Adc}$

**Test 3**

$V_{CE} = 325 \text{ Vdc}, I_C = 55 \text{ mAdc}$  2N3902

$V_{CE} = 400 \text{ Vdc}, I_C = 35 \text{ mAdc}$  2N5157

**Switching Tests**

**Load condition C (unclamped inductive load)**

$T_C = 25^\circ\text{C};$  duty cycle  $\leq 10\%; R_S = 0.1 \Omega$  (See Figure 4 of MIL-PRF-19500/371)

**Test 1**

$t_P =$  approximately 3 ms (vary to obtain  $I_C$ );  $R_{BB1} = 20 \Omega; V_{BB1} = 10 \text{ Vdc}; R_{BB2} = 3 \text{ k}\Omega;$

$V_{BB2} = 1.5 \text{ Vdc}; V_{CC} = 50 \text{ Vdc}; I_C = 3.5 \text{ Adc}; L = 60 \text{ mH}; R = 3 \Omega; R_L \leq 14\Omega.$

**Test 2**

$t_P =$  approximately 3 ms (vary to obtain  $I_C$ );  $R_{BB1} = 100 \Omega; V_{BB1} = 10 \text{ Vdc}; R_{BB2} = 3 \text{ k}\Omega;$

$V_{BB2} = 1.5 \text{ Vdc}; I_C = 0.6 \text{ Adc}; V_{CC} = 50 \text{ Vdc}; L = 200 \text{ mH}; R = 8 \Omega; R_L \leq 83\Omega.$

**Switching Tests**

**Load condition (clamped inductive load)**

$T_C = +25^\circ\text{C};$  duty cycle  $\leq 10\%.$  (See Figure 5 of MIL-PRF-19500/371)

**Test 1**

$t_P =$  approximately 30 ms (vary to obtain  $I_C$ );  $R_S = 0.1 \Omega; R_{BB1} = 20 \Omega; V_{BB1} = 10 \text{ Vdc}; R_{BB2} = 100 \Omega;$

$V_{BB2} = 1.5 \text{ Vdc}; V_{CC} = 50 \text{ Vdc}; I_C = 3.5 \text{ Adc}; L = 60 \text{ mH}; R = 3 \Omega; R_L \geq 0\Omega.$

(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 = 300 $\mu s$ , Duty Cycle  $\leq 2.0\%.$

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