

# High Voltage NPN Silicon Power Transistors

... designed for high voltage inverters, switching regulators and line operated amplifier applications. Especially well suited for switching power supply applications.

- High Voltage Breakdown Rating
- Low Saturation Voltages
- Fast Switching Capability
- High  $E_{S/b}$  Energy Handling Capability

## MAXIMUM RATINGS

| Rating                                                  | Symbol         | Value       | Unit                |
|---------------------------------------------------------|----------------|-------------|---------------------|
| Collector-Emitter Voltage (1)                           | $V_{CEO(sus)}$ | 350         | Vdc                 |
| Collector-Emitter Voltage (1)                           | $V_{CER(sus)}$ | 375         | Vdc                 |
| Collector-Base Voltage (1)                              | $V_{CB}$       | 450         | Vdc                 |
| Emitter-Base Voltage                                    | $V_{EB}$       | 6.0         | Vdc                 |
| Collector Current — Continuous**                        | $I_C$          | 15          | Adc                 |
| — Peak                                                  | $I_{CM}$       | 30          |                     |
| Base Current — Continuous (1)                           | $I_B$          | 10          | Adc                 |
| — Peak                                                  | $I_{BM}$       | 20          |                     |
| Emitter Current — Continuous                            | $I_E$          | 25          | Adc                 |
| — Peak                                                  | $I_{EM}$       | 50          |                     |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$      | $P_D$          | 175         | Watts               |
| @ $T_C = 100^\circ\text{C}$                             |                | 100         |                     |
| Derate above $25^\circ\text{C}^*$                       |                | 1.0         | W/ $^\circ\text{C}$ |
| Operating and Storage Junction (1)<br>Temperature Range | $T_J, T_{stg}$ | -65 to +200 | $^\circ\text{C}$    |

## THERMAL CHARACTERISTICS

| Characteristic                                                                   | Symbol          | Max | Unit               |
|----------------------------------------------------------------------------------|-----------------|-----|--------------------|
| Thermal Resistance, Junction to Case                                             | $R_{\theta JC}$ | 1.0 | $^\circ\text{C/W}$ |
| Maximum Lead Temperature for Soldering<br>Purposes: 1/8" from Case for 5 Seconds | $T_L$           | 275 | $^\circ\text{C}$   |

(1) Indicates JEDEC Registered Data.

\*\* JEDEC Registered Value is 10 A, Motorola Guaranteed Value is 15 A.

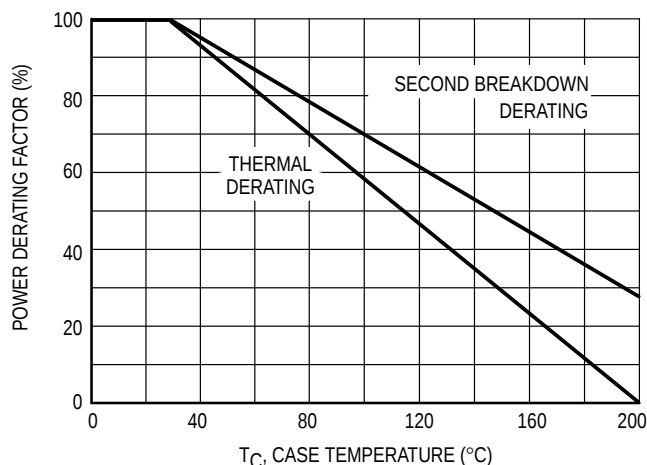
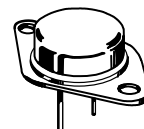


Figure 1. Power Derating

**2N6251**

**15 AMPERE  
POWER TRANSISTOR  
NPN SILICON  
350 VOLTS  
175 WATTS**



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

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

| Characteristic                                                                                                                                                                                         | Symbol         | Min    | Max       | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------|-----------|------|
| Collector–Emitter Sustaining Voltage (Table 1)<br>( $I_C = 200\text{ mA}$ , $I_B = 0$ )                                                                                                                | $V_{CEO(sus)}$ | 350    | —         | Vdc  |
| Collector–Emitter Sustaining Voltage (Table 1)<br>( $I_C = 200\text{ mA}$ )                                                                                                                            | $V_{CER(sus)}$ | 375    | —         | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = \text{Rated } V_{CER}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ )<br>( $V_{CE} = \text{Rated } V_{CER}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ ) | $I_{CEV}$      | —<br>— | 5.0<br>10 | mAdc |
| Collector Cutoff Current<br>( $V_{CE} = 150\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 225\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 300\text{ Vdc}$ , $I_B = 0$ )                                        | $I_{CEO}$      | —      | 5.0       | mAdc |
| Emitter Cutoff Current<br>( $V_{EB} = 6.0\text{ Vdc}$ , $I_C = 0$ )                                                                                                                                    | $I_{EBO}$      | —      | 1.0       | mAdc |

**SECOND BREAKDOWN**

|                                                                                                                                                      |                                                           |           |            |        |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------|------------|--------|-----|
| Second Breakdown Collector Current with base forward<br>biased $t = 1.0\text{ s}$ (non–repetitive)                                                   | ( $V_{CE} = 30\text{ V}$ )<br>( $V_{CE} = 100\text{ V}$ ) | $I_{S/b}$ | 5.8<br>0.3 | —<br>— | Vdc |
| Second Breakdown Energy with base reverse biased (Table 1)<br>( $I_C = 10\text{ A}$ , $V_{BE(off)} = 4.0\text{ Vdc}$ , $L = 50\text{ }\mu\text{H}$ ) |                                                           | $E_{S/b}$ | 2.5        | —      | mJ  |

**ON CHARACTERISTICS (1)**

|                                                                                                                                                                                                     |               |     |     |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----|-----|-----|
| DC Current Gain<br>( $I_C = 10\text{ Adc}$ , $V_{CE} = 3.0\text{ Vdc}$ )                                                                                                                            | $h_{FE}$      | 6.0 | 50  | —   |
| Collector–Emitter Saturation Voltage<br>( $I_C = 10\text{ Adc}$ , $I_B = 1.67\text{ Adc}$ )                                                                                                         | $V_{CE(sat)}$ | —   | 1.5 | Vdc |
| Base–Emitter Saturation Voltage<br>( $I_C = 10\text{ Adc}$ , $I_B = 1.0\text{ Adc}$ )<br>( $I_C = 10\text{ Adc}$ , $I_B = 1.25\text{ Adc}$ )<br>( $I_C = 10\text{ Adc}$ , $I_B = 1.67\text{ Adc}$ ) | $V_{BE(sat)}$ | —   | 2.5 | Vdc |

**DYNAMIC CHARACTERISTICS**

|                                                                                                                         |       |     |   |     |
|-------------------------------------------------------------------------------------------------------------------------|-------|-----|---|-----|
| Current–Gain — Bandwidth Product<br>( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f_{test} = 1.0\text{ MHz}$ ) | $f_T$ | 2.5 | — | MHz |
|-------------------------------------------------------------------------------------------------------------------------|-------|-----|---|-----|

**SWITCHING CHARACTERISTICS**

| Resistive Load (Table 1) |                                                                                                                                                             |       |   |     |               |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---|-----|---------------|
| Rise Time                | $(V_{CC} = 200\text{ Vdc}$ , $I_C = 10\text{ A}$ , Duty<br>Cycle $\leq 2.0\%$ , $t_p = 100\text{ }\mu\text{s}$ )<br>( $I_{B1} = I_{B2} = 1.67\text{ Adc}$ ) | $t_r$ | — | 2.0 | $\mu\text{s}$ |
| Storage Time             |                                                                                                                                                             | $t_s$ | — | 3.5 | $\mu\text{s}$ |
| Fall Time                |                                                                                                                                                             | $t_f$ | — | 1.0 | $\mu\text{s}$ |

\* Indicates JEDEC Registered Data.

(1) Measured on a curve tracer (60 Hz full–wave rectified sine wave).

Table 1. Test Conditions for Dynamic Performance

|                  | $V_{CEO(sus)}$                                                                                                         | $V_{CER(sus)}$                                                                                                           | $E_S/b$                                                                            | RESISTIVE SWITCHING                                     |
|------------------|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------|
| INPUT CONDITIONS |                                                                                                                        |                                                                                                                          |                                                                                    |                                                         |
| CIRCUIT VALUES   | $L_{coil} = 42 \text{ mH}$<br>$R_{coil} = 0.7 \Omega$ , $f_0 = 60 \text{ Hz}$<br>$V_{CC} = 0 \text{ to } 50 \text{ V}$ | $L_{coil} = 14 \text{ mH}$<br>$R_{coil} = 0.05 \Omega$<br>$V_{CC} = 0 \text{ to } 50 \text{ V}$<br>$f_0 = 60 \text{ Hz}$ | $L_{coil} = 50 \mu\text{H}$ , $V_{CC} = 11.5 \text{ V}$<br>$R_{coil} = 0.2 \Omega$ | $V_{CC} = 200 \text{ V}$<br>$R_L = 20 \Omega$           |
| TEST CIRCUITS    | <div><div>INDUCTIVE TEST CIRCUIT</div><div></div><div><div>OUTPUT WAVEFORMS</div><div></div></div></div>               |                                                                                                                          |                                                                                    | <div><div>RESISTIVE TEST CIRCUIT</div><div></div></div> |

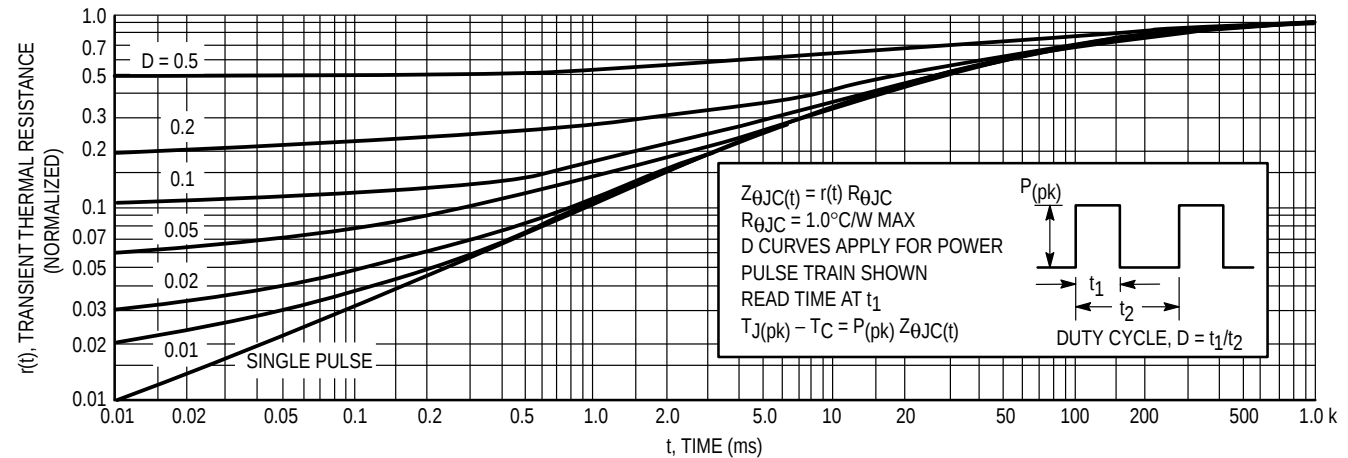


Figure 2. Thermal Response

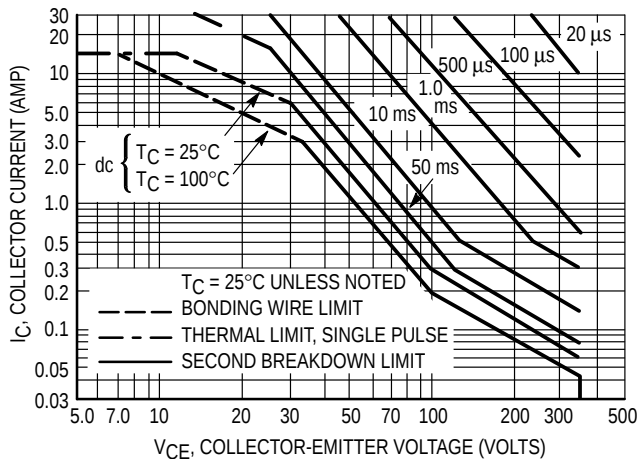


Figure 3. Active-Region Safe Operating Area

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.

The data of Figure 3 is based on  $T_C = 25^\circ\text{C}$ .  $T_J(pk)$  is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when  $T_C \geq 25^\circ\text{C}$ . Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltage shown on Figure 3 may be found at any case temperature by using the appropriate curve on Figure 1.

$T_J(pk)$  may be calculated from the data in Figure 2. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

## DC CHARACTERISTICS

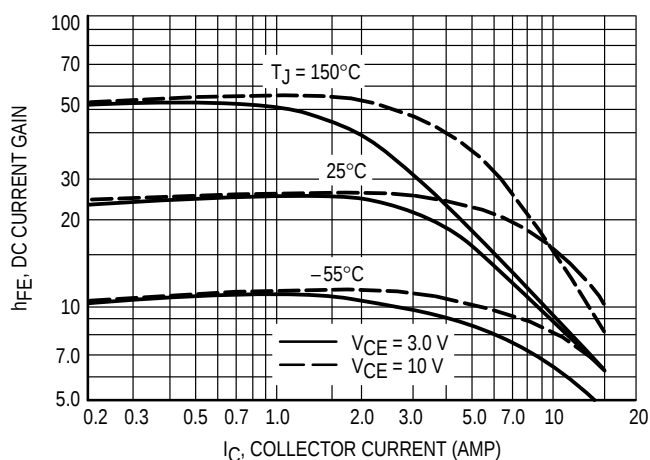


Figure 4. DC Current Gain

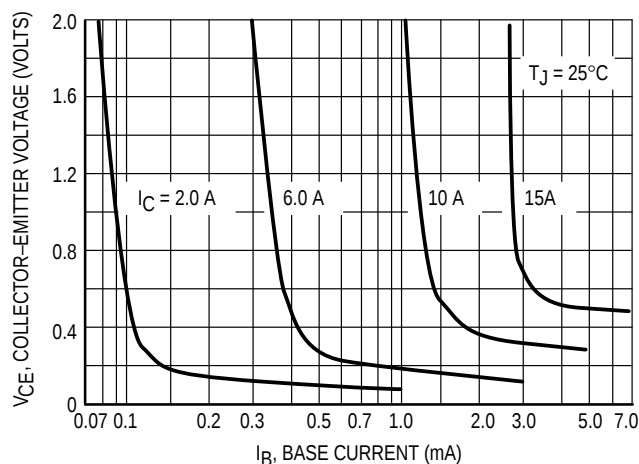


Figure 5. Collector Saturation Region

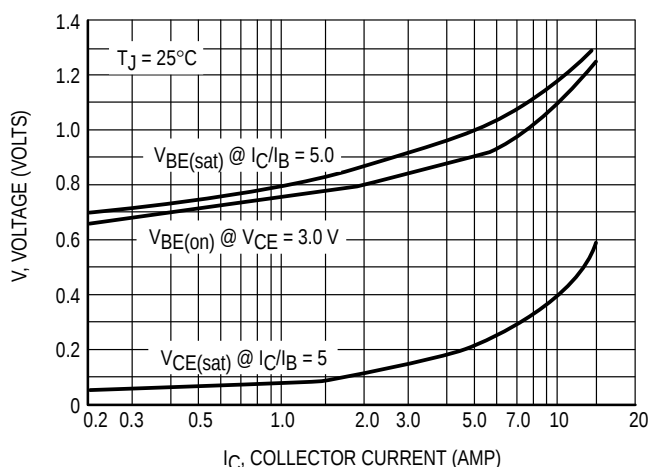


Figure 6. "On" Voltage

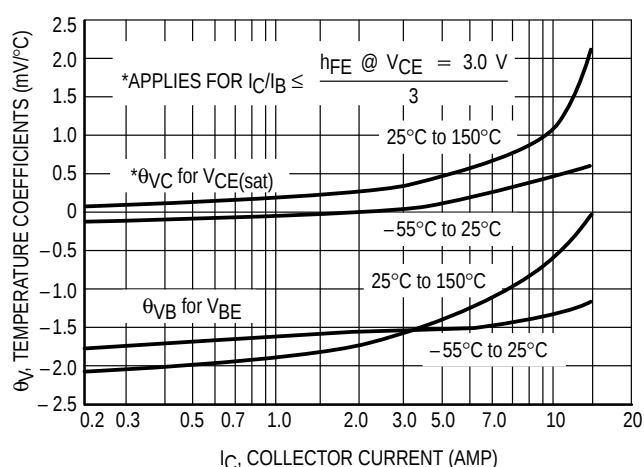


Figure 7. Temperature Coefficients

## RESISTIVE SWITCHING PERFORMANCE

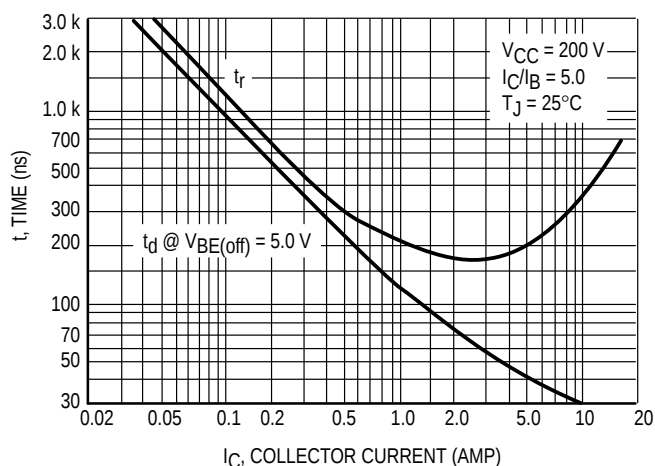


Figure 8. Turn-on Time

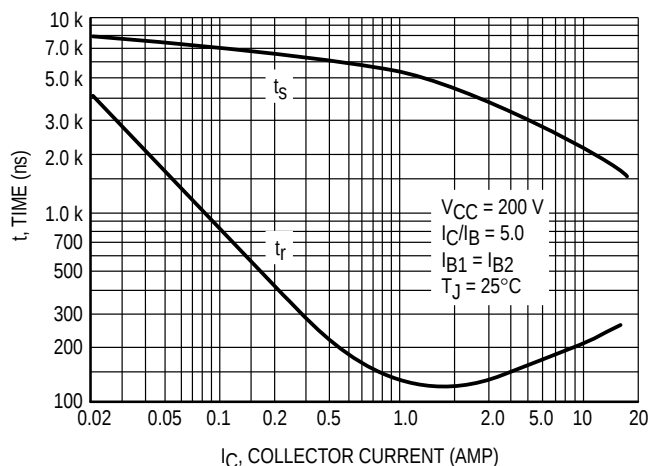
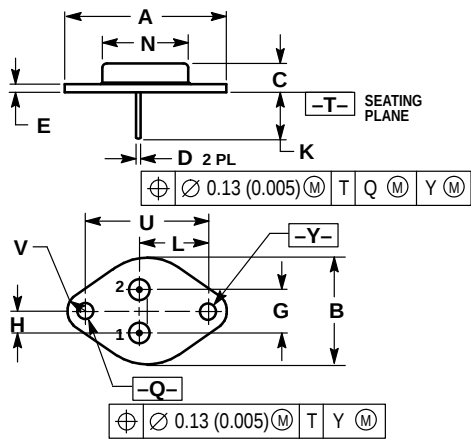


Figure 9. Turn-off Time

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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