

# MMBT5087L

## Low Noise Transistor

### PNP Silicon

#### Features

- NSV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### MAXIMUM RATINGS

| Rating                         | Symbol    | Value | Unit |
|--------------------------------|-----------|-------|------|
| Collector – Emitter Voltage    | $V_{CEO}$ | -50   | Vdc  |
| Collector – Base Voltage       | $V_{CBO}$ | -50   | Vdc  |
| Emitter – Base Voltage         | $V_{EBO}$ | -3.0  | Vdc  |
| Collector Current – Continuous | $I_C$     | -50   | mAdc |

#### THERMAL CHARACTERISTICS

| Characteristic                                                                                                      | Symbol          | Max         | Unit                       |
|---------------------------------------------------------------------------------------------------------------------|-----------------|-------------|----------------------------|
| Total Device Dissipation FR-5 Board,<br>(Note 1) $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$        | $P_D$           | 225<br>1.8  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient                                                                             | $R_{\theta JA}$ | 556         | $^\circ\text{C/W}$         |
| Total Device Dissipation Alumina<br>Substrate, (Note 2) $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$           | 300<br>2.4  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient                                                                             | $R_{\theta JA}$ | 417         | $^\circ\text{C/W}$         |
| Junction and Storage Temperature                                                                                    | $T_J, T_{stg}$  | -55 to +150 | $^\circ\text{C}$           |

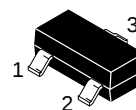
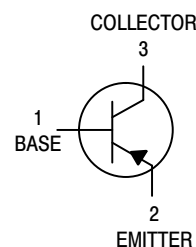
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. FR-5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



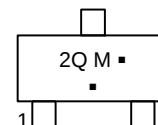
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SOT-23 (TO-236)  
CASE 318  
STYLE 6

#### MARKING DIAGRAM



2Q = Device Code  
M = Date Code\*  
■ = Pb-Free Package

(Note: Microdot may be in either location)

\*Date Code orientation and/or overbar may vary depending upon manufacturing location.

#### ORDERING INFORMATION

| Device                           | Package             | Shipping <sup>†</sup>   |
|----------------------------------|---------------------|-------------------------|
| MMBT5087LT1G,<br>NSVMMBT5087LT1G | SOT-23<br>(Pb-Free) | 3,000 / Tape &<br>Reel  |
| MMBT5087LT3G,<br>NSVMMBT5087LT3G | SOT-23<br>(Pb-Free) | 10,000 / Tape &<br>Reel |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# MMBT5087L

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

| Characteristic                                                                                                     | Symbol        | Min | Max        | Unit |
|--------------------------------------------------------------------------------------------------------------------|---------------|-----|------------|------|
| <b>OFF CHARACTERISTICS</b>                                                                                         |               |     |            |      |
| Collector-Emitter Breakdown Voltage<br>( $I_C = -1.0\text{ mA}$ , $I_B = 0$ )                                      | $V_{(BR)CEO}$ | -50 | -          | Vdc  |
| Collector-Base Breakdown Voltage<br>( $I_C = -100\text{ }\mu\text{A}$ , $I_E = 0$ )                                | $V_{(BR)CBO}$ | -50 | -          | Vdc  |
| Collector Cutoff Current<br>( $V_{CB} = -10\text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = -35\text{ Vdc}$ , $I_E = 0$ ) | $I_{CBO}$     | -   | -10<br>-50 | nAdc |

## ON CHARACTERISTICS

|                                                                                                                                                                                                          |               |                   |               |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------|---------------|-----|
| DC Current Gain<br>( $I_C = -100\text{ }\mu\text{A}$ , $V_{CE} = -5.0\text{ Vdc}$ )<br>( $I_C = -1.0\text{ mA}$ , $V_{CE} = -5.0\text{ Vdc}$ )<br>( $I_C = -10\text{ mA}$ , $V_{CE} = -5.0\text{ Vdc}$ ) | $h_{FE}$      | 250<br>250<br>250 | 800<br>-<br>- | -   |
| Collector-Emitter Saturation Voltage<br>( $I_C = -10\text{ mA}$ , $I_B = -1.0\text{ mA}$ )                                                                                                               | $V_{CE(sat)}$ | -                 | -0.3          | Vdc |
| Base-Emitter Saturation Voltage<br>( $I_C = -10\text{ mA}$ , $I_B = -1.0\text{ mA}$ )                                                                                                                    | $V_{BE(sat)}$ | -                 | 0.85          | Vdc |

## SMALL-SIGNAL CHARACTERISTICS

|                                                                                                                                                                                                                                                   |           |        |            |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|------------|-----|
| Current-Gain — Bandwidth Product<br>( $I_C = -500\text{ }\mu\text{A}$ , $V_{CE} = -5.0\text{ Vdc}$ , $f = 20\text{ MHz}$ )                                                                                                                        | $f_T$     | 40     | -          | MHz |
| Output Capacitance<br>( $V_{CB} = -5.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )                                                                                                                                                           | $C_{obo}$ | -      | 4.0        | pF  |
| Small-Signal Current Gain<br>( $I_C = -1.0\text{ mA}$ , $V_{CE} = -5.0\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )                                                                                                                                       | $h_{fe}$  | 250    | 900        | -   |
| Noise Figure<br>( $I_C = -20\text{ mA}$ , $V_{CE} = -5.0\text{ Vdc}$ , $R_S = 10\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = -100\text{ }\mu\text{A}$ , $V_{CE} = -5.0\text{ Vdc}$ , $R_S = 3.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ ) | NF        | -<br>- | 2.0<br>2.0 | dB  |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## TYPICAL NOISE CHARACTERISTICS

( $V_{CE} = -5.0\text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$ )

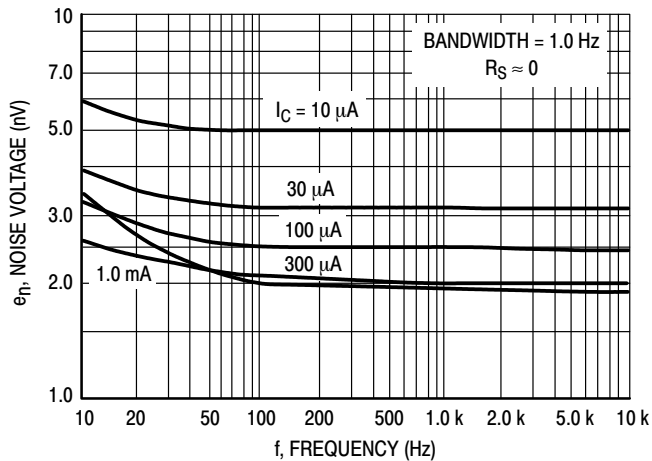


Figure 1. Noise Voltage

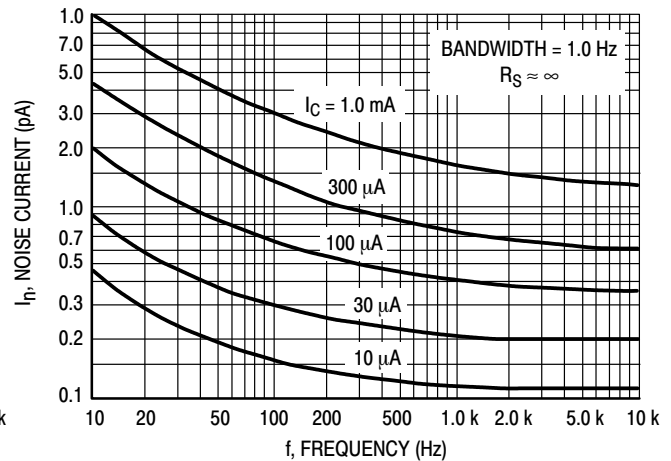


Figure 2. Noise Current

## NOISE FIGURE CONTOURS

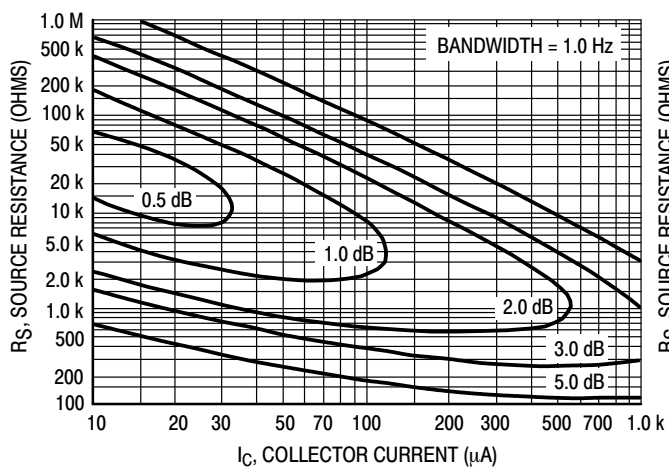
 $(V_{CE} = -5.0 \text{ Vdc}, T_A = 25^\circ\text{C})$ 

Figure 3. Narrow Band, 100 Hz

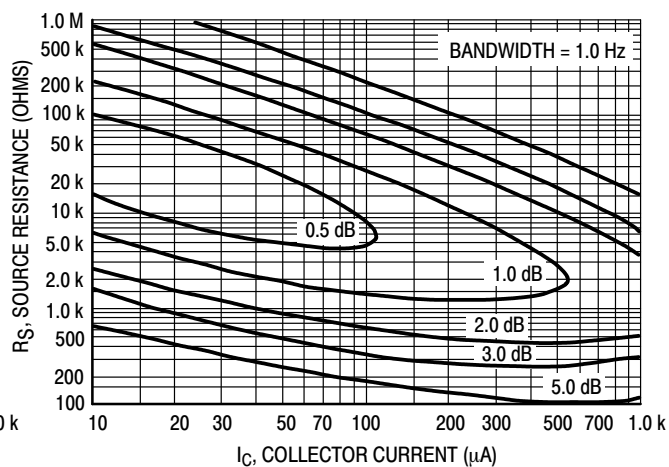


Figure 4. Narrow Band, 1.0 kHz

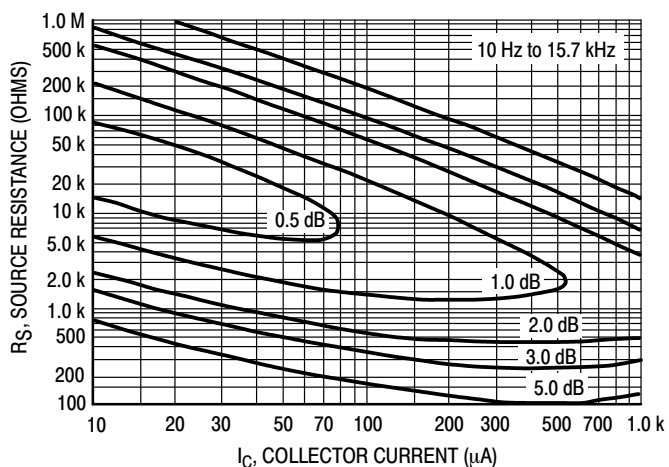


Figure 5. Wideband

Noise Figure is Defined as:

$$NF = 20 \log_{10} \left[ \frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S} \right]^{1/2}$$

 $e_n$  = Noise Voltage of the Transistor referred to the input. (Figure 3) $I_n$  = Noise Current of the Transistor referred to the input. (Figure 4) $K$  = Boltzman's Constant ( $1.38 \times 10^{-23} \text{ J/}^\circ\text{K}$ ) $T$  = Temperature of the Source Resistance ( $^\circ\text{K}$ ) $R_S$  = Source Resistance (Ohms)

## TYPICAL STATIC CHARACTERISTICS

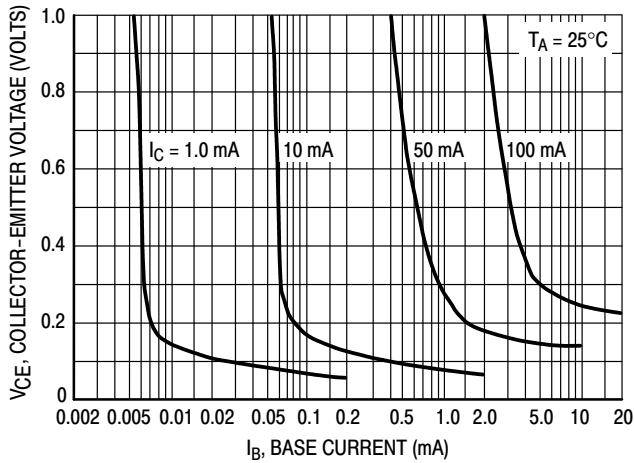


Figure 6. Collector Saturation Region

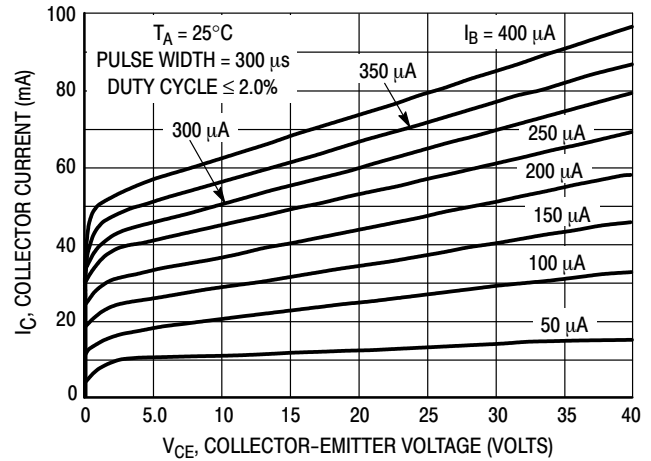


Figure 7. Collector Characteristics

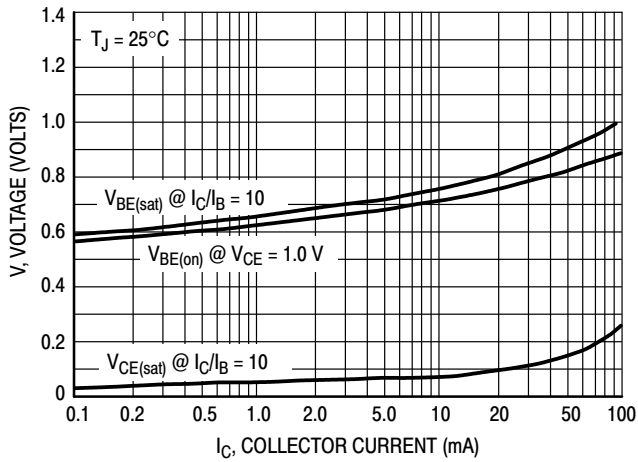


Figure 8. "On" Voltages

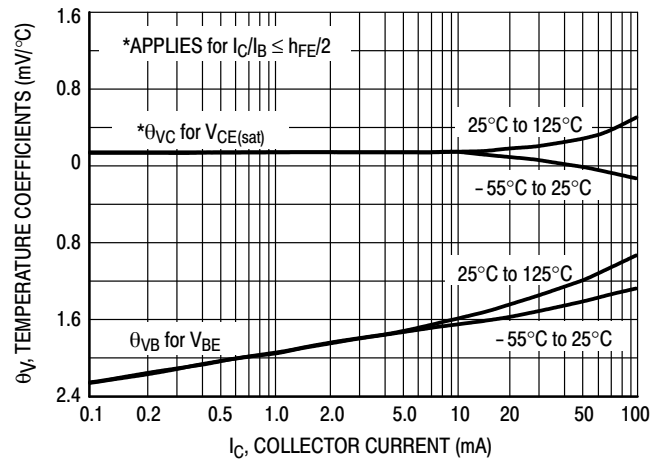


Figure 9. Temperature Coefficients

## TYPICAL DYNAMIC CHARACTERISTICS

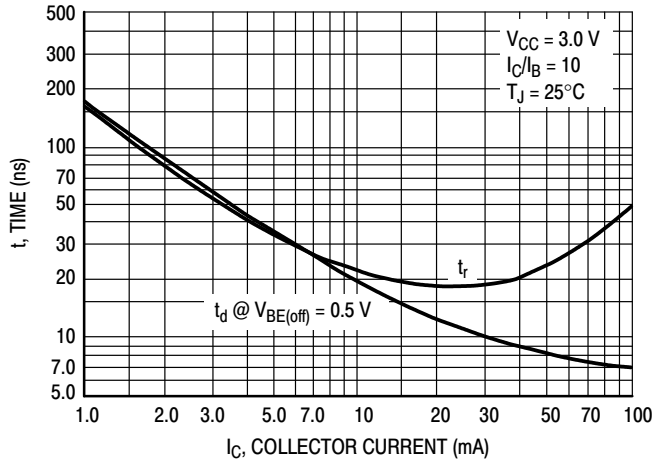


Figure 10. Turn-On Time

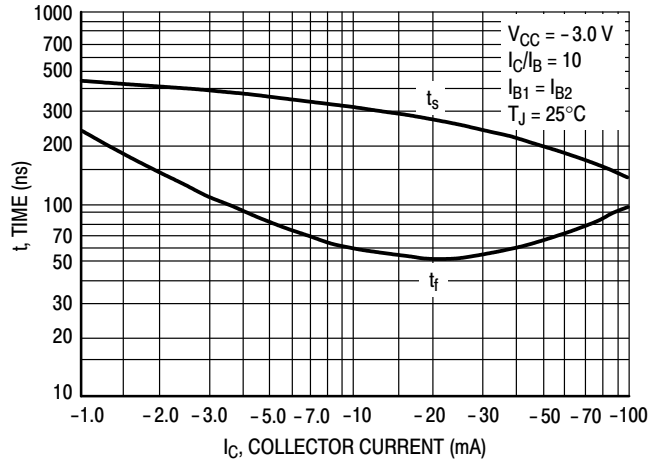


Figure 11. Turn-Off Time

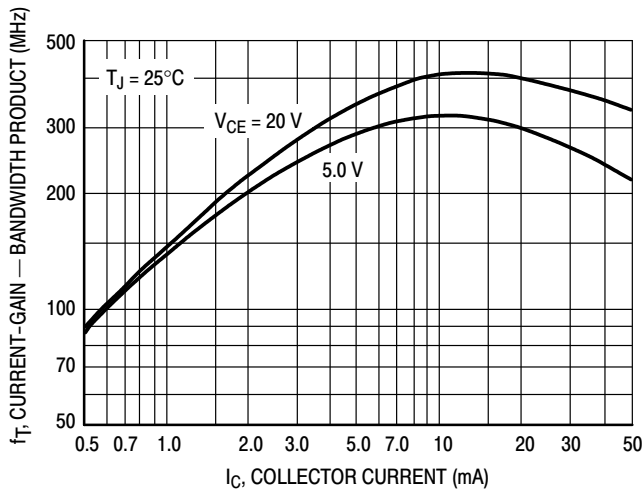


Figure 12. Current-Gain — Bandwidth Product

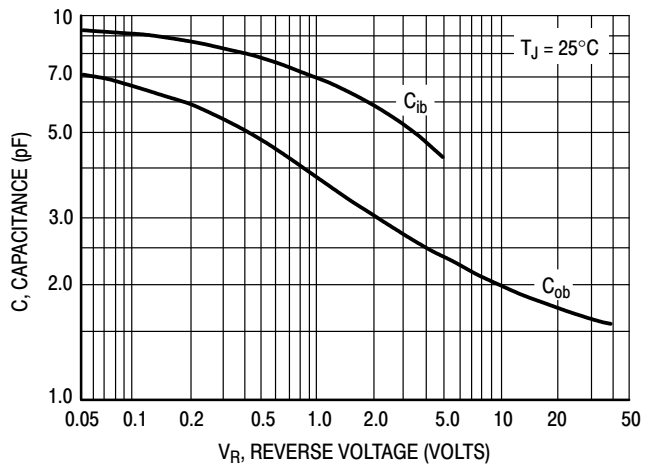


Figure 13. Capacitance

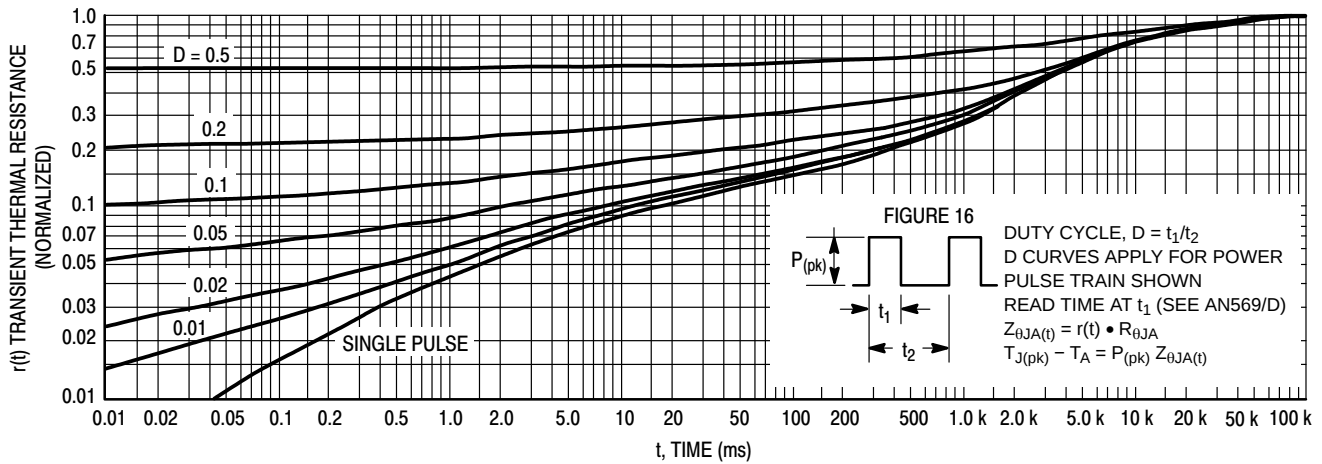


Figure 14. Thermal Response

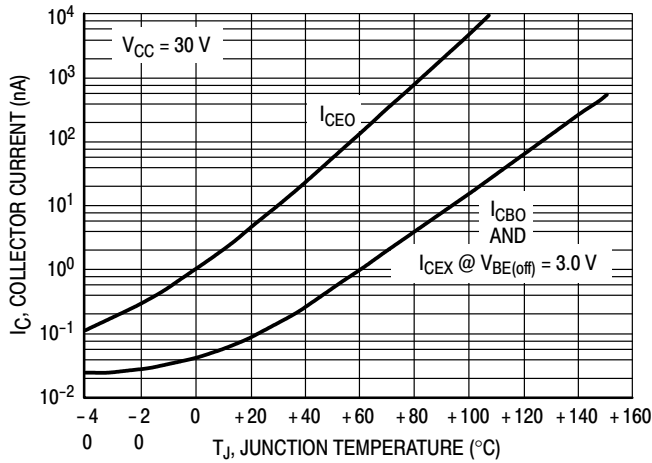


Figure 15. Typical Collector Leakage Current

#### DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 16. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 14 was calculated for various duty cycles.

To find  $Z_{\theta JA(t)}$ , multiply the value obtained from Figure 14 by the steady state value  $R_{\theta JA}$ .

Example:

Dissipating 2.0 watts peak under the following conditions:

$t_1 = 1.0$  ms,  $t_2 = 5.0$  ms ( $D = 0.2$ )

Using Figure 14 at a pulse width of 1.0 ms and  $D = 0.2$ , the reading of  $r(t)$  is 0.22.

The peak rise in junction temperature is therefore

$$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88^\circ\text{C}.$$

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at [www.onsemi.com](http://www.onsemi.com).

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®



### SOT-23 (TO-236) CASE 318-08 ISSUE AS

DATE 30 JAN 2018

SCALE 4:1



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | MILLIMETERS |      |      | INCHES |       |       |
|-----|-------------|------|------|--------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN    | NOM   | MAX   |
| A   | 0.89        | 1.00 | 1.11 | 0.035  | 0.039 | 0.044 |
| A1  | 0.01        | 0.06 | 0.10 | 0.000  | 0.002 | 0.004 |
| b   | 0.37        | 0.44 | 0.50 | 0.015  | 0.017 | 0.020 |
| c   | 0.08        | 0.14 | 0.20 | 0.003  | 0.006 | 0.008 |
| D   | 2.80        | 2.90 | 3.04 | 0.110  | 0.114 | 0.120 |
| E   | 1.20        | 1.30 | 1.40 | 0.047  | 0.051 | 0.055 |
| e   | 1.78        | 1.90 | 2.04 | 0.070  | 0.075 | 0.080 |
| L   | 0.30        | 0.43 | 0.55 | 0.012  | 0.017 | 0.022 |
| L1  | 0.35        | 0.54 | 0.69 | 0.014  | 0.021 | 0.027 |
| HE  | 2.10        | 2.40 | 2.64 | 0.083  | 0.094 | 0.104 |
| T   | 0°          | ---  | 10°  | 0°     | ---   | 10°   |

#### GENERIC MARKING DIAGRAM\*



XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

#### RECOMMENDED SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

STYLE 1 THRU 5:  
CANCELLED

STYLE 6:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

STYLE 7:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR

STYLE 8:  
PIN 1. ANODE  
2. NO CONNECTION  
3. CATHODE

STYLE 9:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

STYLE 10:  
PIN 1. DRAIN  
2. SOURCE  
3. GATE

STYLE 11:  
PIN 1. ANODE  
2. CATHODE  
3. CATHODE-ANODE

STYLE 12:  
PIN 1. CATHODE  
2. CATHODE  
3. ANODE

STYLE 13:  
PIN 1. SOURCE  
2. DRAIN  
3. GATE

STYLE 14:  
PIN 1. CATHODE  
2. GATE  
3. ANODE

STYLE 15:  
PIN 1. GATE  
2. CATHODE  
3. ANODE

STYLE 16:  
PIN 1. ANODE  
2. CATHODE  
3. CATHODE

STYLE 17:  
PIN 1. NO CONNECTION  
2. ANODE  
3. CATHODE

STYLE 18:  
PIN 1. NO CONNECTION  
2. CATHODE  
3. ANODE

STYLE 19:  
PIN 1. CATHODE  
2. ANODE  
3. CATHODE-ANODE

STYLE 20:  
PIN 1. CATHODE  
2. ANODE  
3. GATE

STYLE 21:  
PIN 1. GATE  
2. SOURCE  
3. DRAIN

STYLE 22:  
PIN 1. RETURN  
2. OUTPUT  
3. INPUT

STYLE 23:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE

STYLE 24:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE

STYLE 25:  
PIN 1. ANODE  
2. CATHODE  
3. GATE

STYLE 26:  
PIN 1. CATHODE  
2. ANODE  
3. NO CONNECTION

STYLE 27:  
PIN 1. CATHODE  
2. CATHODE  
3. CATHODE

STYLE 28:  
PIN 1. ANODE  
2. ANODE  
3. ANODE

|                         |                        |                                                                                                                                                                                  |
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