

# MMBT6521LT1G, SMMBT6521LT1G

## Amplifier Transistor

### NPN Silicon

#### Features

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

#### MAXIMUM RATINGS

| Rating                         | Symbol    | Value | Unit  |
|--------------------------------|-----------|-------|-------|
| Collector – Emitter Voltage    | $V_{CEO}$ | 25    | Vdc   |
| Collector – Base Voltage       | $V_{CBO}$ | 40    | Vdc   |
| Emitter – Base Voltage         | $V_{EBO}$ | 4.0   | Vdc   |
| Collector Current — Continuous | $I_C$     | 100   | mA dc |

#### 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 Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

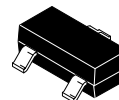
1. FR-5 =  $1.0 \times 0.75 \times 0.062$  in.
2. Alumina =  $0.4 \times 0.3 \times 0.024$  in. 99.5% alumina.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

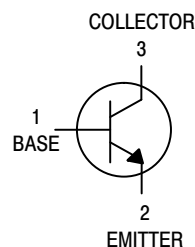


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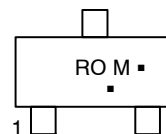
<http://onsemi.com>



SOT-23 (TO-236)  
CASE 318-08  
STYLE 6



#### MARKING DIAGRAM



RO = Specific 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†              |
|---------------|---------------------|------------------------|
| MMBT6521LT1G  | SOT-23<br>(Pb-Free) | 3,000 /<br>Tape & Reel |
| SMMBT6521LT1G | SOT-23<br>(Pb-Free) | 3,000 /<br>Tape & Reel |

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

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## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

| Characteristic                                                                                                                         | Symbol               | Min        | Max      | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------|----------|------|
| <b>OFF CHARACTERISTICS</b>                                                                                                             |                      |            |          |      |
| Collector – Emitter Breakdown Voltage<br>(I <sub>C</sub> = 0.5 mA, I <sub>B</sub> = 0)                                                 | V <sub>(BR)CEO</sub> | 25         | –        | Vdc  |
| Emitter – Base Breakdown Voltage<br>(I <sub>E</sub> = 10 μA, I <sub>C</sub> = 0)                                                       | V <sub>(BR)EBO</sub> | 4.0        | –        | Vdc  |
| Collector Cutoff Current<br>(V <sub>CB</sub> = 30 Vdc, I <sub>E</sub> = 0)                                                             | I <sub>CBO</sub>     | –          | 0.5      | μA   |
| Emitter Cutoff Current<br>(V <sub>EB</sub> = 5.0 Vdc, I <sub>C</sub> = 0)                                                              | I <sub>EBO</sub>     | –          | 10       | nA   |
| <b>ON CHARACTERISTICS</b>                                                                                                              |                      |            |          |      |
| DC Current Gain<br>(I <sub>C</sub> = 100 μA, V <sub>CE</sub> = 10 Vdc)<br>(I <sub>C</sub> = 2.0 mA, V <sub>CE</sub> = 10 Vdc)          | h <sub>FE</sub>      | 150<br>300 | –<br>600 | –    |
| Collector – Emitter Saturation Voltage<br>(I <sub>C</sub> = 50 mA, I <sub>B</sub> = 5.0 mA)                                            | V <sub>CE(sat)</sub> | –          | 0.5      | Vdc  |
| <b>SMALL-SIGNAL CHARACTERISTICS</b>                                                                                                    |                      |            |          |      |
| Output Capacitance<br>(V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)                                                      | C <sub>obo</sub>     | –          | 3.5      | pF   |
| Noise Figure<br>(I <sub>C</sub> = 10 μA, V <sub>CE</sub> = 5.0 Vdc, Power Bandwidth = 15.7 kHz,<br>3.0 dB points @ = 10 Hz and 10 kHz) | NF                   | –          | 3.0      | dB   |

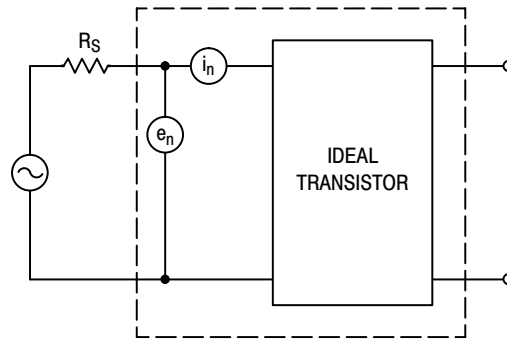


Figure 1. Transistor Noise Model

## EQUIVALENT SWITCHING TIME TEST CIRCUITS

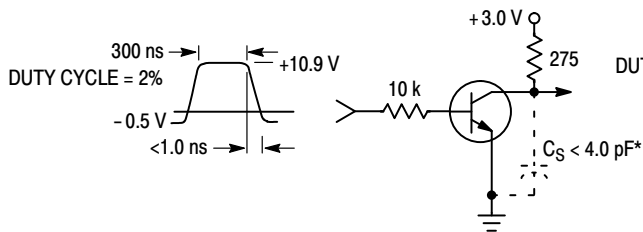


Figure 2. Turn-On Time

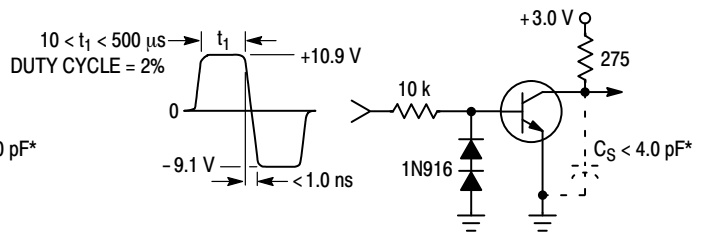


Figure 3. Turn-Off Time

\*Total shunt capacitance of test jig and connectors

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## TYPICAL NOISE CHARACTERISTICS

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

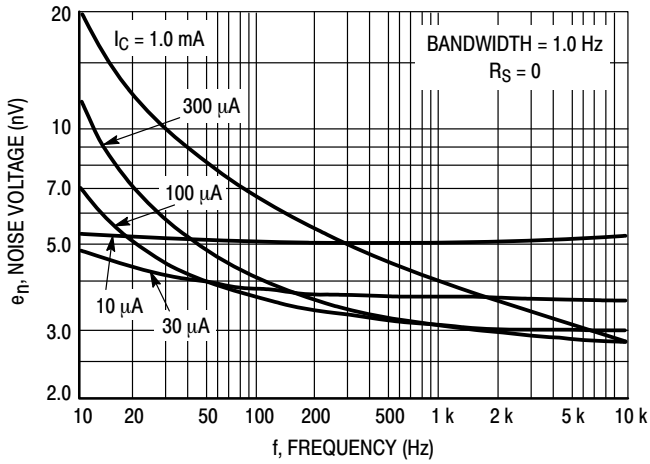


Figure 4. Noise Voltage

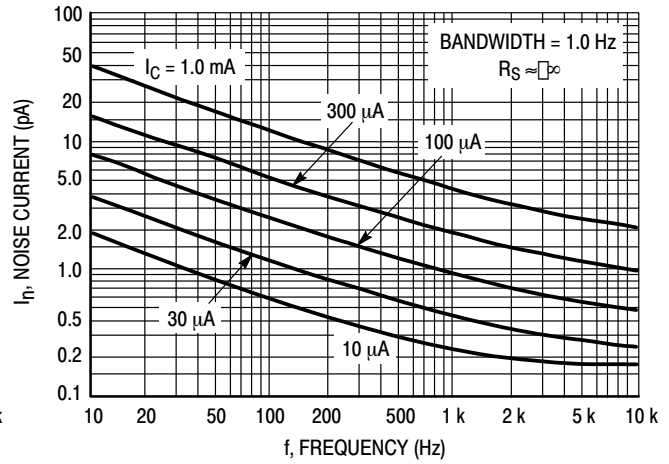


Figure 5. Noise Current

## NOISE FIGURE CONTOURS

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

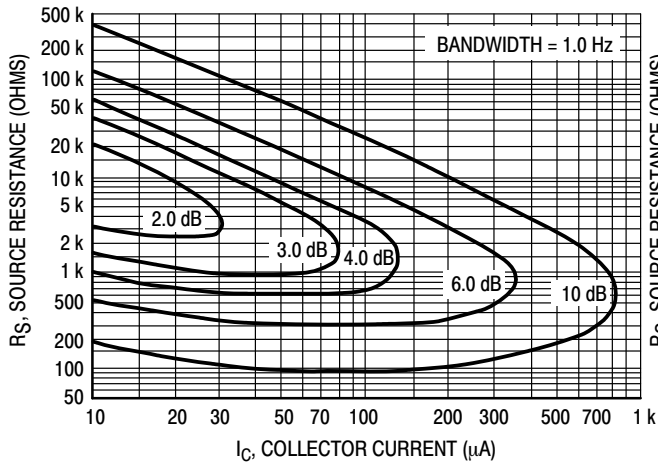


Figure 6. Narrow Band, 100 Hz

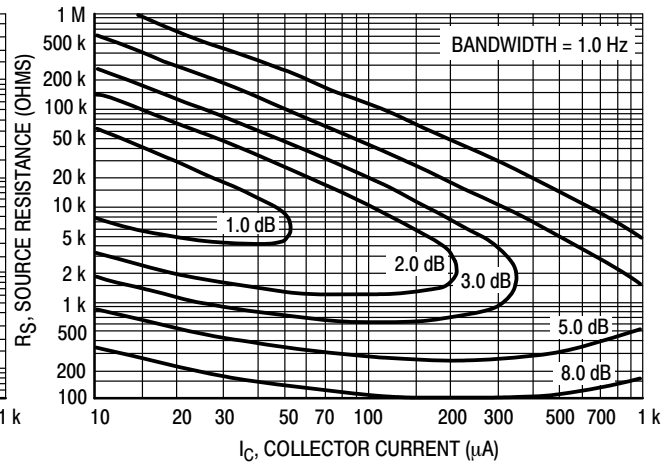


Figure 7. Narrow Band, 1.0 kHz

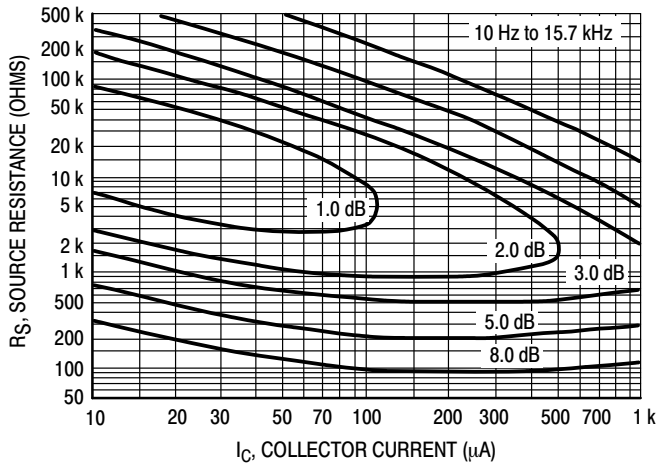


Figure 8. Wideband

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)

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## TYPICAL STATIC CHARACTERISTICS

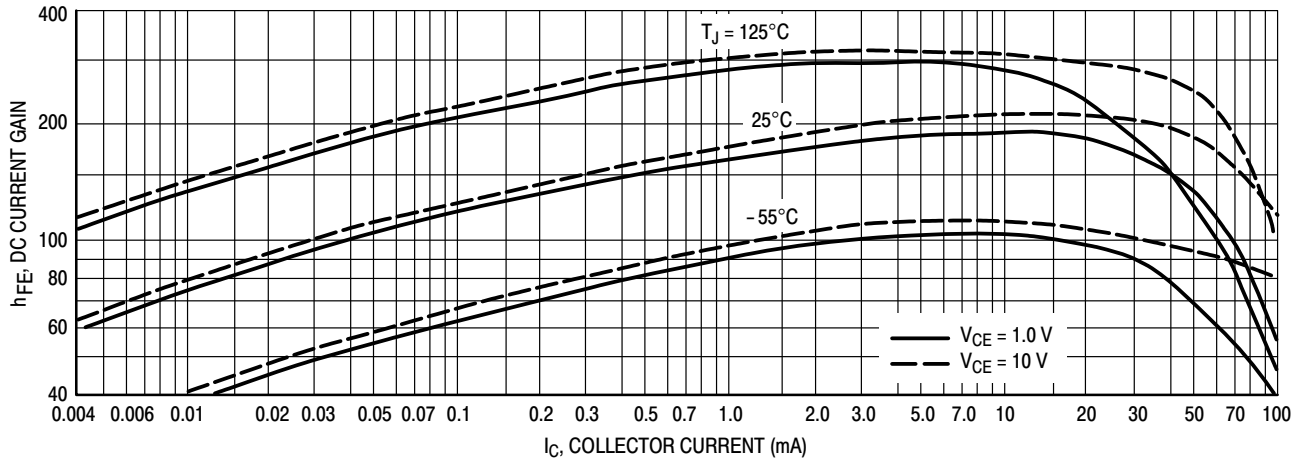


Figure 9. DC Current Gain

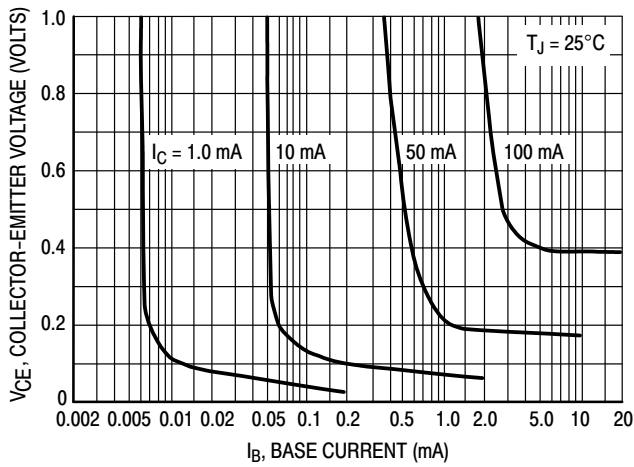


Figure 10. Collector Saturation Region

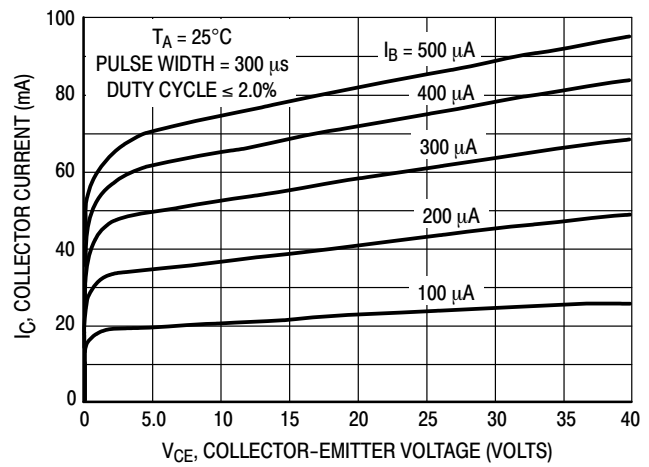


Figure 11. Collector Characteristics

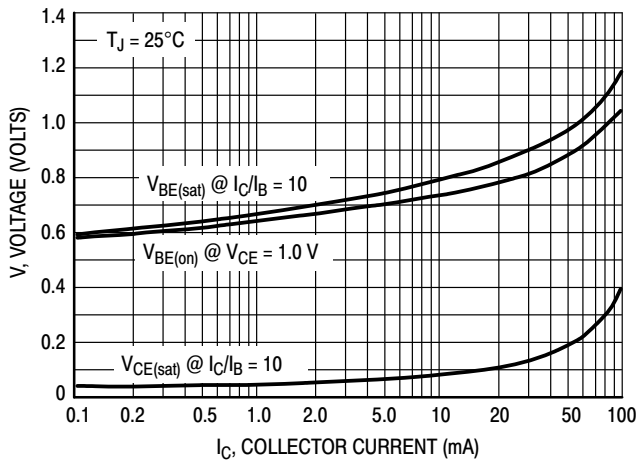


Figure 12. "On" Voltages

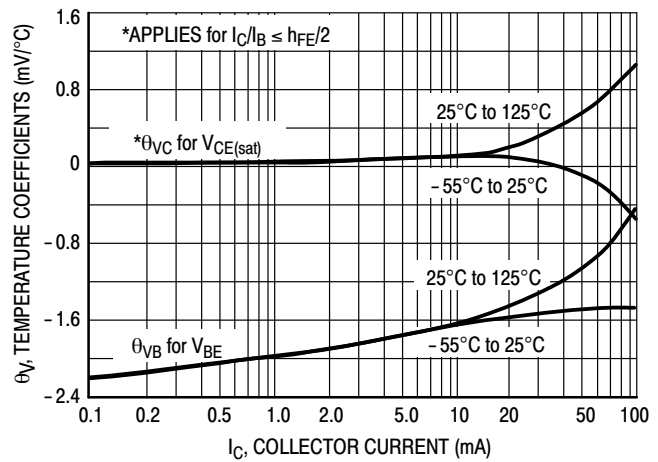


Figure 13. Temperature Coefficients

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## TYPICAL DYNAMIC CHARACTERISTICS

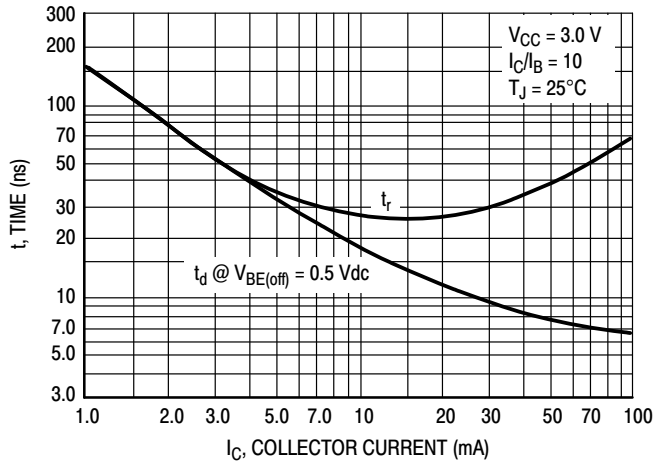


Figure 14. Turn-On Time

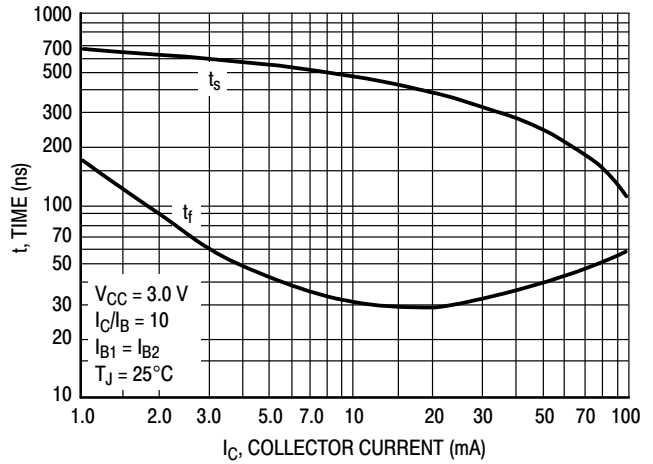


Figure 15. Turn-Off Time

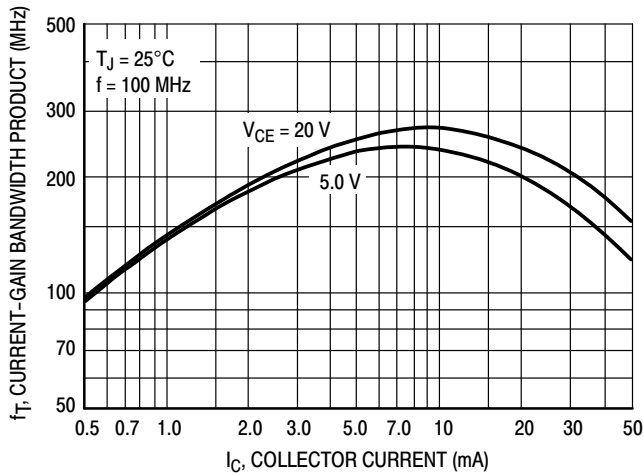


Figure 16. Current-Gain — Bandwidth Product

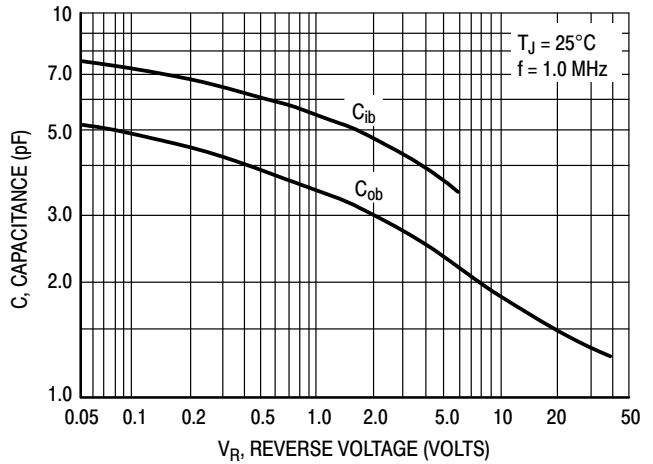


Figure 17. Capacitance

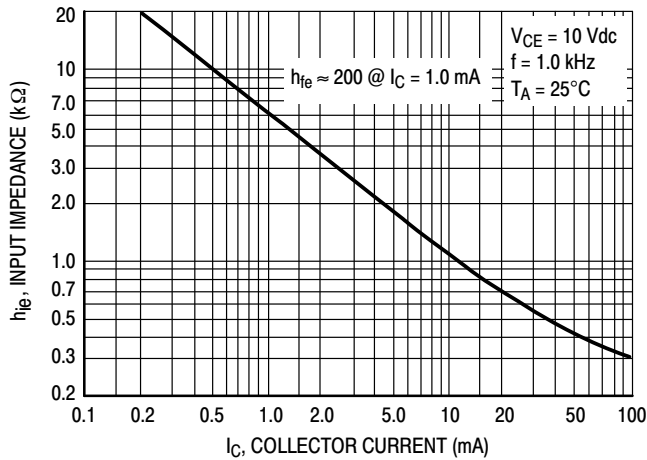


Figure 18. Input Impedance

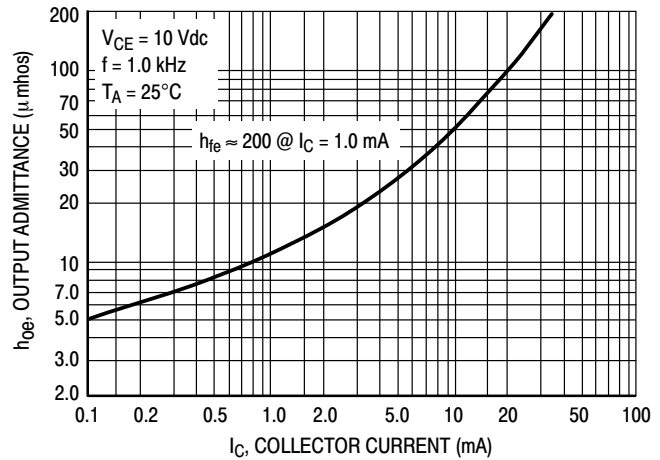


Figure 19. Output Admittance

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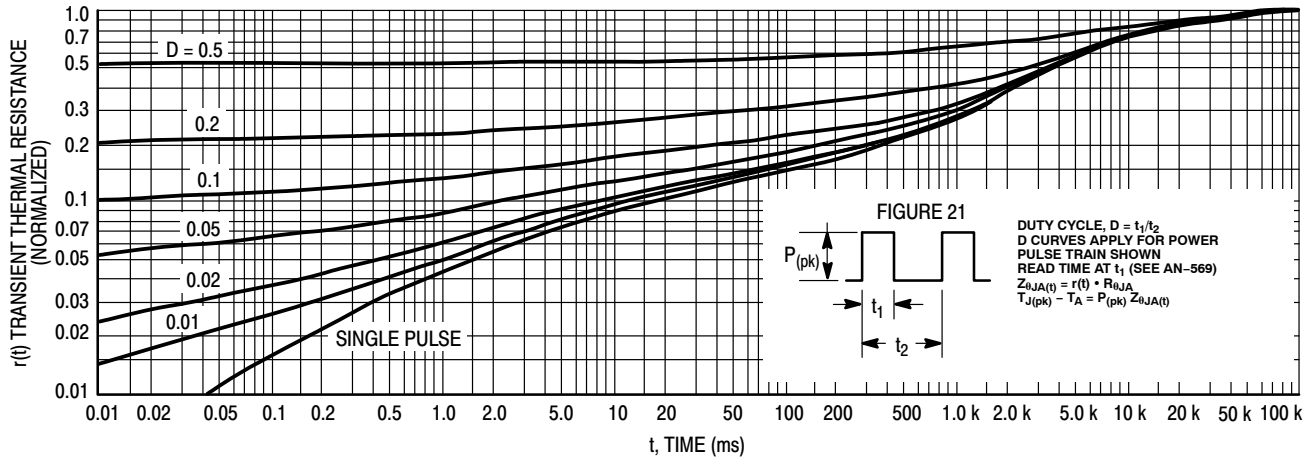


Figure 20. Thermal Response

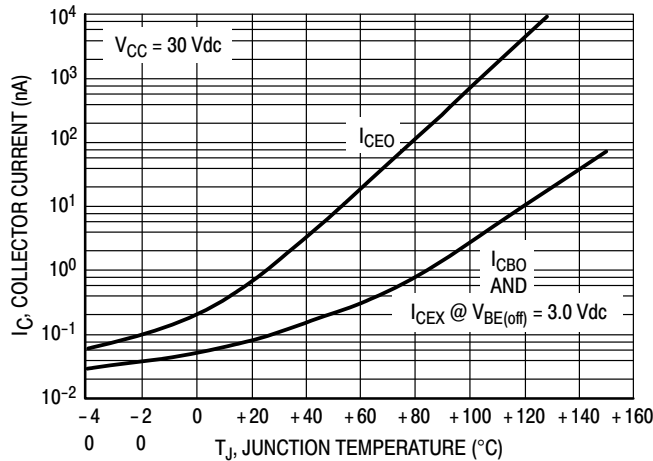


Figure 21.

## DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 21. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 20 was calculated for various duty cycles.

To find  $Z_{\theta JA}(t)$ , multiply the value obtained from Figure 20 by the steady state value  $R_{\theta JA}$ .

Example:

The MPS6521 is dissipating 2.0 watts peak under the following conditions:

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

Using Figure 20 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).

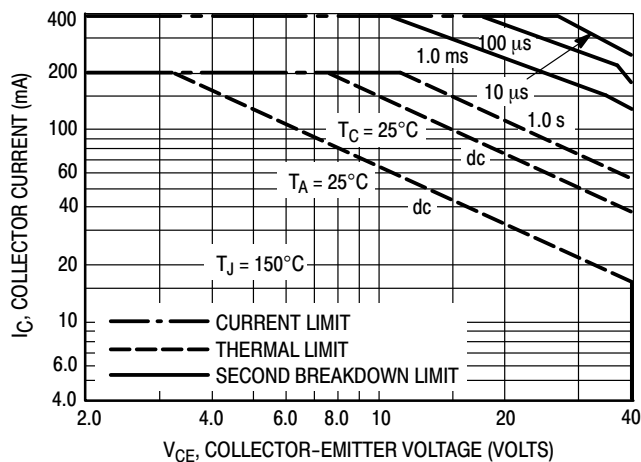


Figure 22.

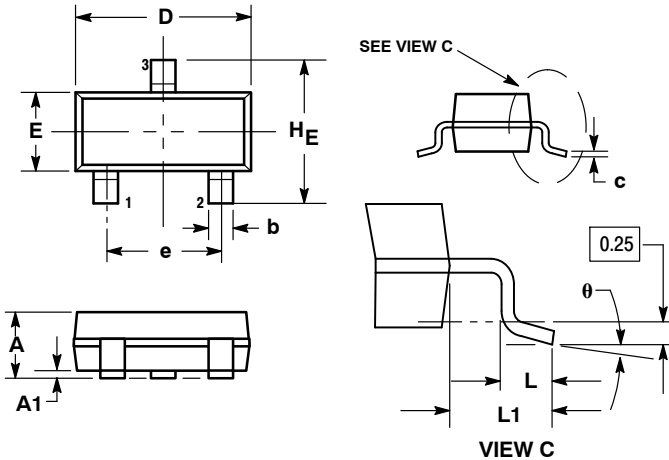
The safe operating area curves indicate  $I_C$ - $V_{CE}$  limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 22 is based upon  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  or  $T_A$  is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 150^\circ\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 20. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

# MMBT6521LT1G, SMMBT6521LT1G

## PACKAGE DIMENSIONS

SOT-23 (TO-236)  
CASE 318-08  
ISSUE AP



### NOTES:

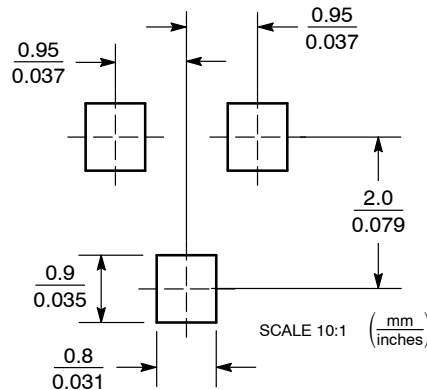
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | MILLIMETERS |      |      | INCHES |       |       |
|-----|-------------|------|------|--------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN    | NOM   | MAX   |
| A   | 0.89        | 1.00 | 1.11 | 0.035  | 0.040 | 0.044 |
| A1  | 0.01        | 0.06 | 0.10 | 0.001  | 0.002 | 0.004 |
| b   | 0.37        | 0.44 | 0.50 | 0.015  | 0.018 | 0.020 |
| c   | 0.09        | 0.13 | 0.18 | 0.003  | 0.005 | 0.007 |
| 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 | 0.081 |
| L   | 0.10        | 0.20 | 0.30 | 0.004  | 0.008 | 0.012 |
| L1  | 0.35        | 0.54 | 0.69 | 0.014  | 0.021 | 0.029 |
| HE  | 2.10        | 2.40 | 2.64 | 0.083  | 0.094 | 0.104 |
| θ   | 0°          | ---  | 10°  | 0°     | ---   | 10°   |

### STYLE 6:

- PIN 1. BASE
- EMITTER
- COLLECTOR

## SOLDERING FOOTPRINT



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