

General Purpose Transistors

NPN Silicon

MMBT2222L, MMBT2222AL, SMMBT2222AL

Features

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

MAXIMUM RATINGS

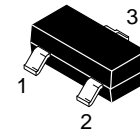
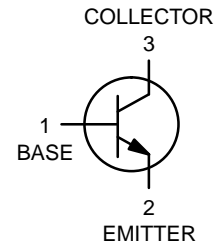
| Rating | Symbol | Value | Unit |
|---|-----------|------------|------|
| Collector – Emitter Voltage MMBT2222L MMBT2222AL, SMMBT2222AL | V_{CEO} | 30 40 | Vdc |
| Collector – Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL | V_{CBO} | 60 75 | Vdc |
| Emitter – Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL | V_{EBO} | 5.0 6.0 | Vdc |
| Collector Current – Continuous | I_C | 600 | mAdc |
| Collector Current – Peak (Note 3) | I_{CM} | 1100 | mAdc |

THERMAL CHARACTERISTICS

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

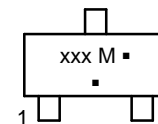
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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



SOT-23
CASE 318
STYLE 6

MARKING DIAGRAM



xxx = 1P or M1B
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

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

MMBT2222L, MMBT2222AL, SMMBT2222AL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Max | Unit | |
|--|---|----------------------|---|--|--------------------|
| OFF CHARACTERISTICS | | | | | |
| Collector–Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | MMBT2222 MMBT2222A | V _{(BR)CEO} | 30 40 | – – | Vdc |
| Collector–Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | MMBT2222 MMBT2222A | V _{(BR)CBO} | 60 75 | – – | Vdc |
| Emitter–Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | MMBT2222 MMBT2222A | V _{(BR)EBO} | 5.0 6.0 | – – | Vdc |
| Collector Cutoff Current (V _{CE} = 60 Vdc, V _{EB(off)} = 3.0 Vdc) | MMBT2222A, SMMBT2222A | I _{CEX} | – | 10 | nAdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) | MMBT2222 MMBT2222A, SMMBT2222A | I _{CBO} | – | 0.01 | μAdc |
| (V _{CB} = 60 Vdc, I _E = 0) | MMBT2222A, SMMBT2222A | | – | 0.01 | |
| (V _{CB} = 50 Vdc, I _E = 0, T _A = 125°C) | MMBT2222 | | – | 10 | |
| (V _{CB} = 60 Vdc, I _E = 0, T _A = 125°C) | MMBT2222A, SMMBT2222A | | – | 10 | |
| Emitter Cutoff Current (V _{EB} = 3.0 Vdc, I _C = 0) | MMBT2222A, SMMBT2222A | I _{EBO} | – | 100 | nAdc |
| Base Cutoff Current (V _{CE} = 60 Vdc, V _{EB(off)} = 3.0 Vdc) | MMBT2222A, SMMBT2222A | I _{BL} | – | 20 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc, T _A = –55°C) (I _C = 150 mAdc, V _{CE} = 10 Vdc) (Note 4) (I _C = 150 mAdc, V _{CE} = 1.0 Vdc) (Note 4) (I _C = 500 mAdc, V _{CE} = 10 Vdc) (Note 4) | MMBT2222A only MMBT2222 MMBT2222A, SMMBT2222A | h _{FE} | 35 50 75 35 100 50 30 40 | – – – – 300 – – – | – |
| Collector–Emitter Saturation Voltage (Note 4) (I _C = 150 mAdc, I _B = 15 mAdc) | MMBT2222 MMBT2222A, SMMBT2222A | V _{CE(sat)} | – – | 0.4 0.3 | Vdc |
| (I _C = 500 mAdc, I _B = 50 mAdc) | MMBT2222 MMBT2222A, SMMBT2222A | | – – | 1.6 1.0 | |
| Base–Emitter Saturation Voltage (Note 4) (I _C = 150 mAdc, I _B = 15 mAdc) | MMBT2222 MMBT2222A, SMMBT2222A | V _{BE(sat)} | – 0.6 | 1.3 1.2 | Vdc |
| (I _C = 500 mAdc, I _B = 50 mAdc) | MMBT2222 MMBT2222A, SMMBT2222A | | – – | 2.6 2.0 | |
| SMALL–SIGNAL CHARACTERISTICS | | | | | |
| Current–Gain – Bandwidth Product (Note 5) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | MMBT2222 MMBT2222A, SMMBT2222A | f _T | 250 300 | – – | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | – | 8.0 | pF |
| Input Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | MMBT2222 MMBT2222A, SMMBT2222A | C _{ibo} | – – | 30 25 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A | h _{ie} | 2.0 0.25 | 8.0 1.25 | kΩ |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A | h _{re} | – – | 8.0 4.0 | X 10 ^{–4} |
| Small–Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MMBT2222A, SMMBT2222A MMBT2222A, SMMBT2222A | h _{fe} | 50 75 | 300 375 | – |

MMBT2222L, MMBT2222AL, SMMBT2222AL

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

| Characteristic | Symbol | Min | Max | Unit |
|--|------------|-----------|-----------|------------------|
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Admittance ($I_C = 1.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$) ($I_C = 10\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$) | h_{oe} | 5.0 25 | 35 200 | μmhos |
| Collector Base Time Constant ($I_E = 20\text{ mAdc}$, $V_{CB} = 20\text{ Vdc}$, $f = 31.8\text{ MHz}$) | r_b, C_c | - | 150 | ps |
| Noise Figure ($I_C = 100\ \mu\text{Adc}$, $V_{CE} = 10\text{ Vdc}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) | NF | - | 4.0 | dB |

SWITCHING CHARACTERISTICS (MMBT2222A only)

| | | | | | |
|--------------|---|-------|---|-----|----|
| Delay Time | $(V_{CC} = 30\text{ Vdc}$, $V_{BE(\text{off})} = -0.5\text{ Vdc}$, $I_C = 150\text{ mAdc}$, $I_{B1} = 15\text{ mAdc}$) | t_d | - | 10 | ns |
| Rise Time | | t_r | - | 25 | |
| Storage Time | $(V_{CC} = 30\text{ Vdc}$, $I_C = 150\text{ mAdc}$, $I_{B1} = I_{B2} = 15\text{ mAdc}$) | t_s | - | 225 | ns |
| Fall Time | | t_f | - | 60 | |

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.

- Pulse Test: Pulse Width $\leq 300\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$.
- f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

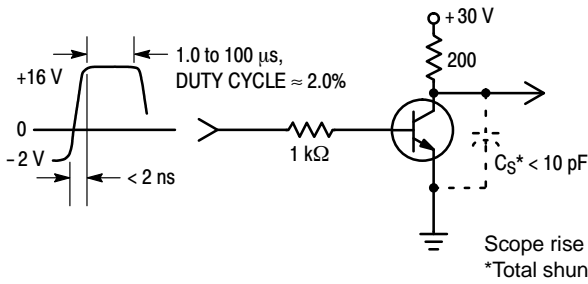


Figure 1. Turn-On Time

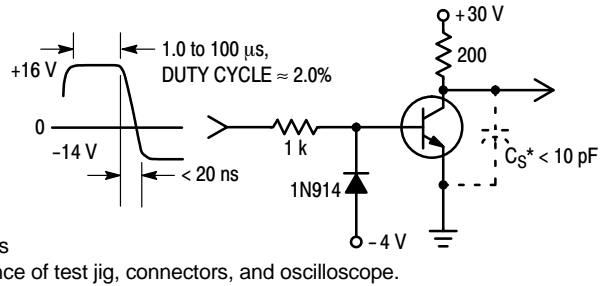


Figure 2. Turn-Off Time

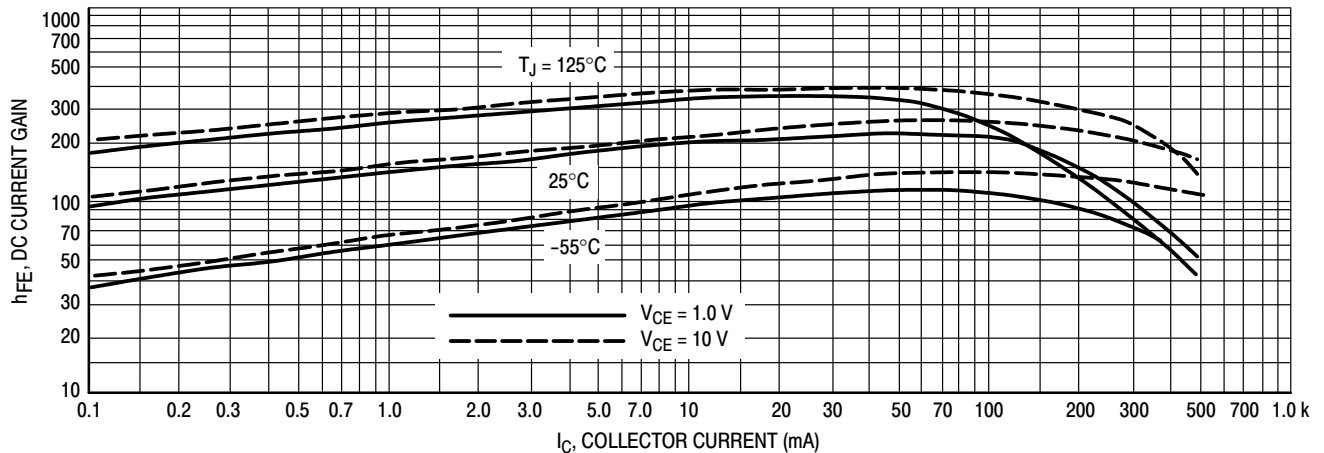


Figure 3. DC Current Gain

MMBT2222L, MMBT2222AL, SMMBT2222AL

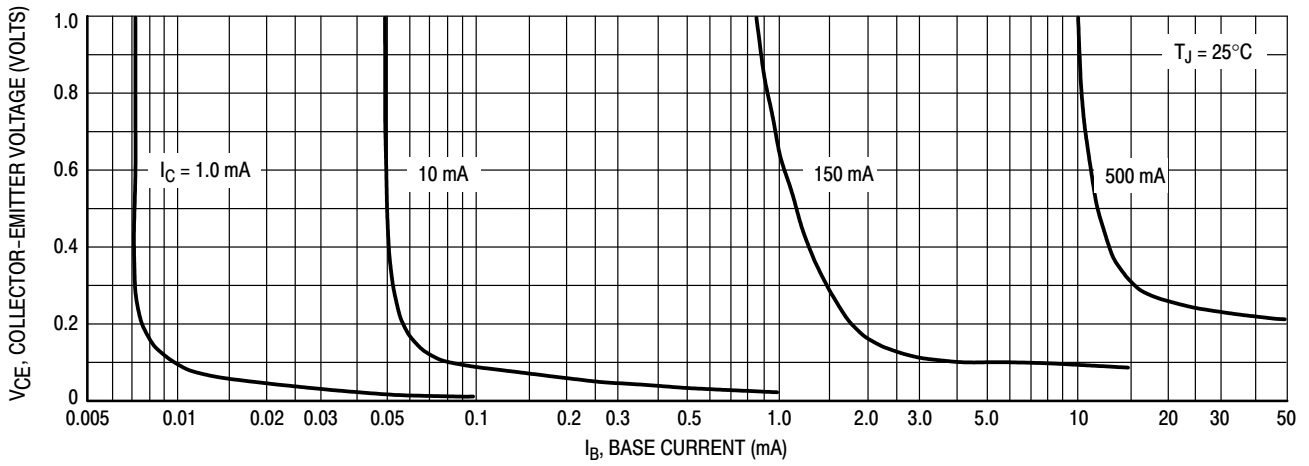


Figure 4. Collector Saturation Region

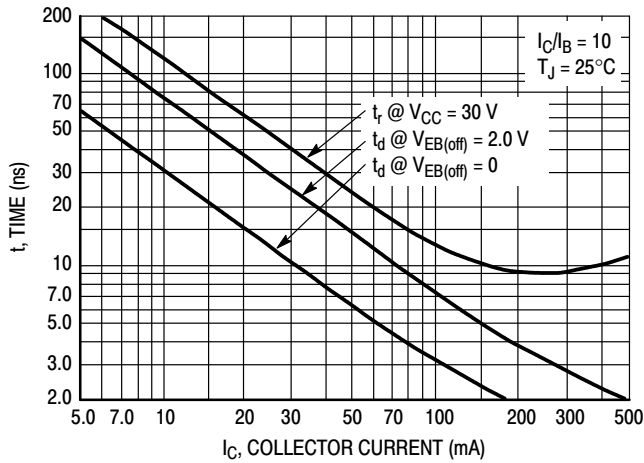


Figure 5. Turn-On Time

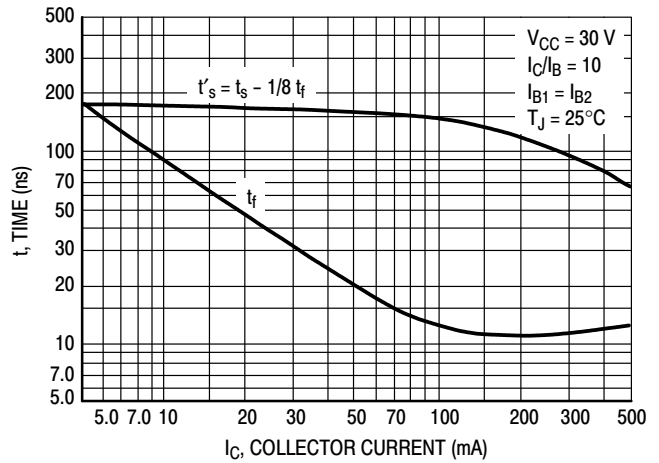


Figure 6. Turn-Off Time

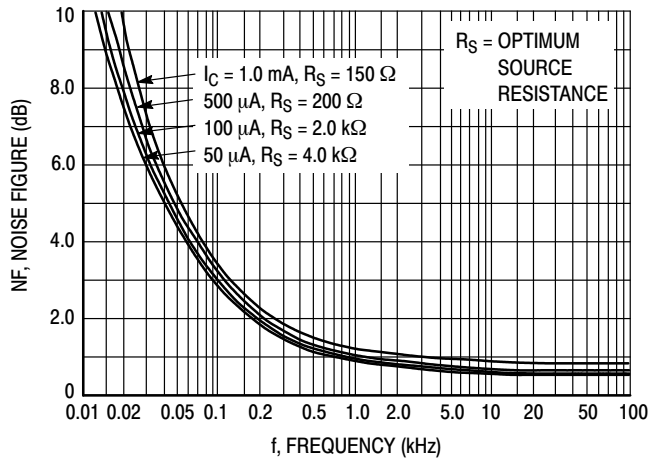


Figure 7. Frequency Effects

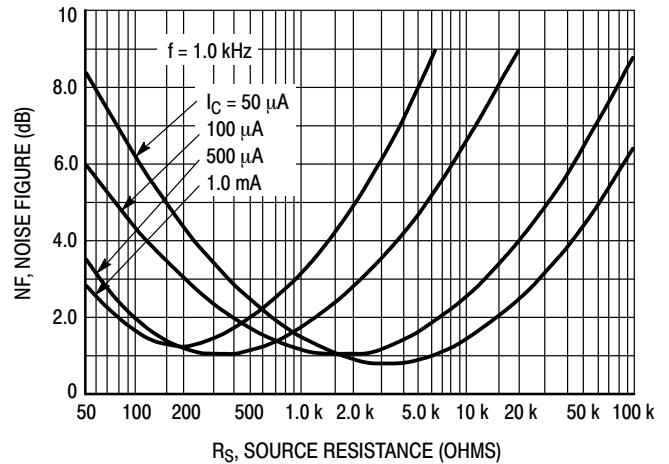


Figure 8. Source Resistance Effects

MMBT2222L, MMBT2222AL, SMMBT2222AL

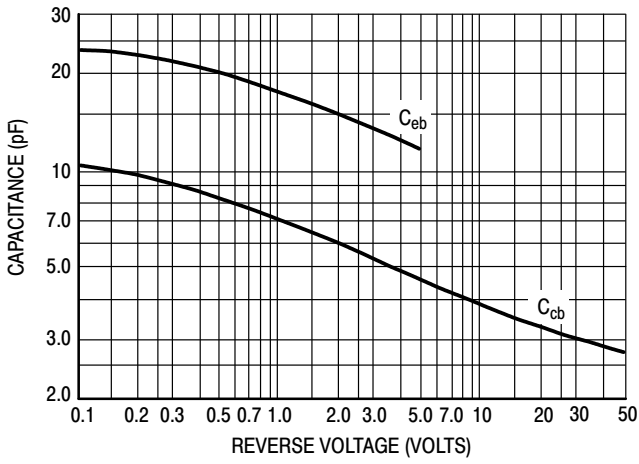


Figure 9. Capacitances

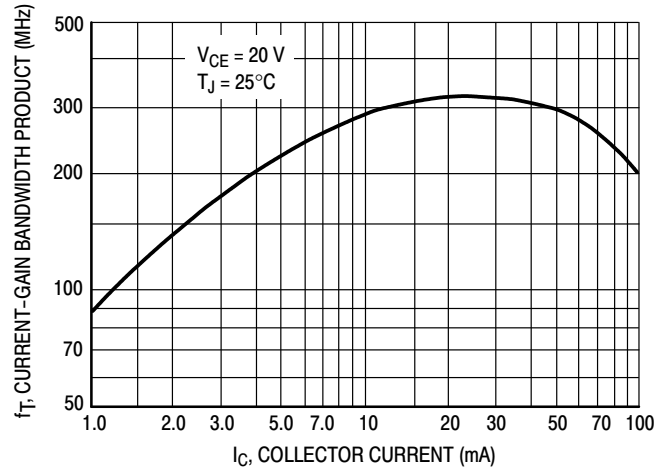


Figure 10. Current-Gain Bandwidth Product

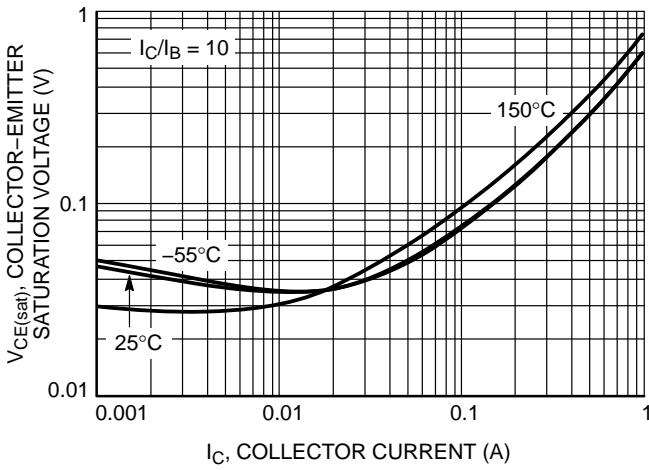


Figure 11. Collector-Emitter Saturation Voltage vs. Collector Current

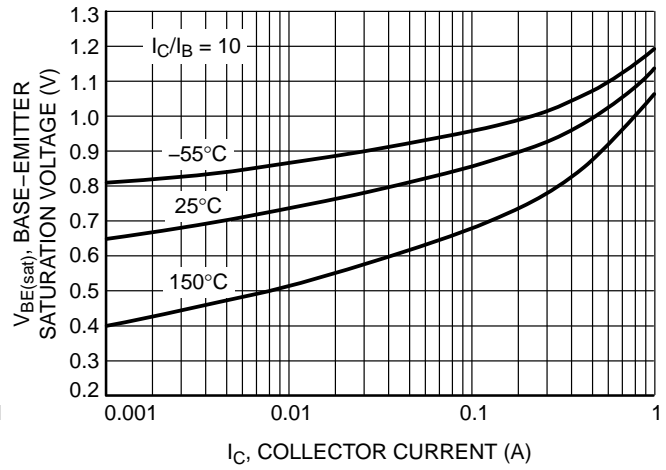


Figure 12. Base-Emitter Saturation Voltage vs. Collector Current

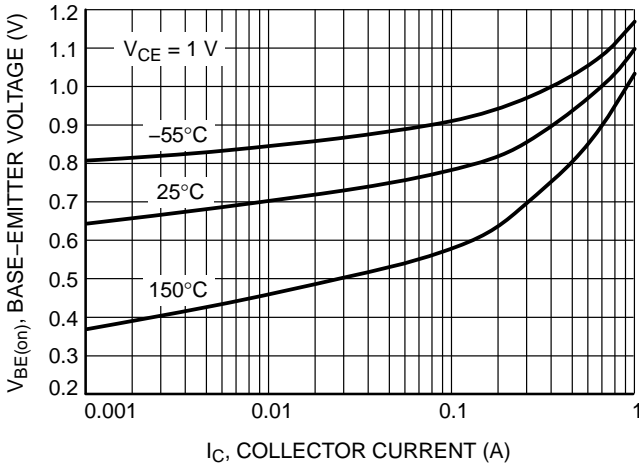


Figure 13. Base-Emitter Voltage vs. Collector Current

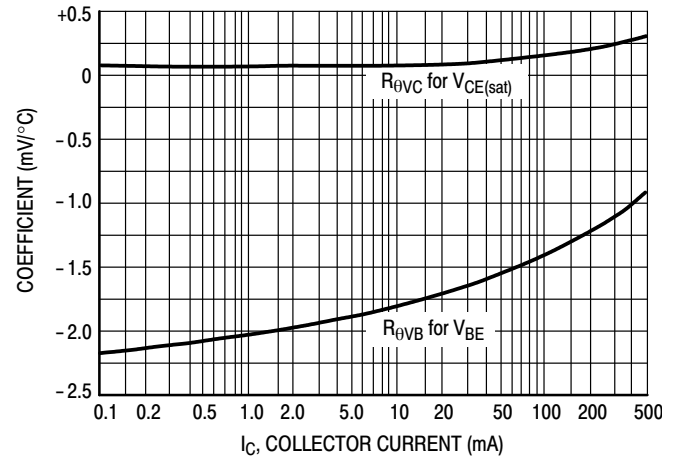


Figure 14. Temperature Coefficients

MMBT2222L, MMBT2222AL, SMMBT2222AL

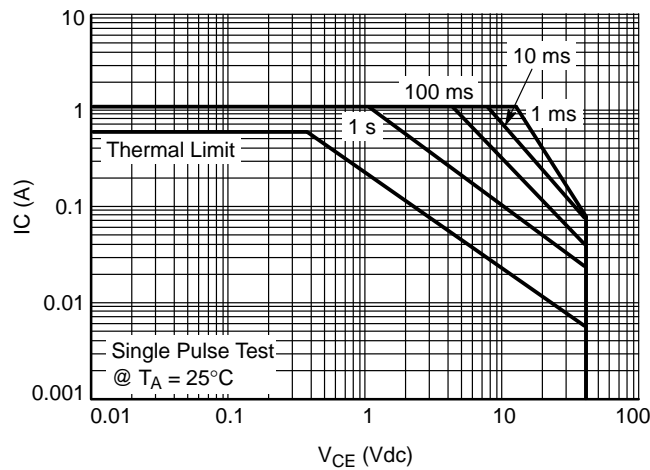


Figure 15. Safe Operating Area

ORDERING INFORMATION

| Device | Specific Marking Code | Package | Shipping† |
|----------------------------------|-----------------------|---------------------|----------------------|
| MMBT2222LT1G | M1B | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| MMBT2222ALT1G, SMMBT2222ALT1G | 1P | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| MMBT2222LT3G | M1B | SOT-23 (Pb-Free) | 10,000 / Tape & Reel |
| MMBT2222ALT3G, SMMBT2222ALT3G | 1P | SOT-23 (Pb-Free) | 10,000 / Tape & Reel |

†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.

*S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable.

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° |

RECOMMENDED SOLDERING FOOTPRINT



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.

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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| DESCRIPTION: | SOT-23 (TO-236) | PAGE 1 OF 1 |

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