

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

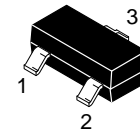
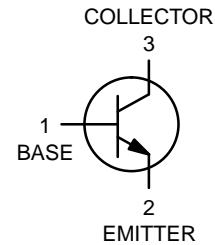
| Rating | Symbol | Value | Unit |
|---|-----------|------------|------|
| Collector-Emitter Voltage MMBT2222L MMBT2222AL, SMMBT2222AL | V_{CEO} | 30 40 | Vdc |
| Collector-Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL | V_{CBO} | 60 75 | Vdc |
| Emitter-Base Voltage MMBT2222L MMBT2222AL, SMMBT2222AL | 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 | $^\circ\text{C}$ |

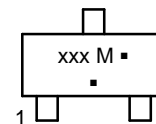
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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 ($I_C = 1.0\text{ mA dc}$, $V_{CE} = 10\text{ V dc}$, $f = 1.0\text{ kHz}$) ($I_C = 10\text{ mA dc}$, $V_{CE} = 10\text{ V dc}$, $f = 1.0\text{ kHz}$) | h_{oe} | 5.0 25 | 35 200 | μmhos |
| Collector Base Time Constant ($I_E = 20\text{ mA dc}$, $V_{CB} = 20\text{ V dc}$, $f = 31.8\text{ MHz}$) | r_b, C_c | - | 150 | ps |
| Noise Figure ($I_C = 100\ \mu\text{A dc}$, $V_{CE} = 10\text{ V dc}$, $R_S = 1.0\text{ k}\Omega$, $f = 1.0\text{ kHz}$) | NF | - | 4.0 | dB |

SWITCHING CHARACTERISTICS (MMBT2222A only)

| | | | | | |
|--------------|--|-------|---|-----|----|
| Delay Time | ($V_{CC} = 30\text{ V dc}$, $V_{BE(\text{off})} = -0.5\text{ V dc}$, $I_C = 150\text{ mA dc}$, $I_{B1} = 15\text{ mA dc}$) | t_d | - | 10 | ns |
| Rise Time | | t_r | - | 25 | |
| Storage Time | ($V_{CC} = 30\text{ V dc}$, $I_C = 150\text{ mA dc}$, $I_{B1} = I_{B2} = 15\text{ mA dc}$) | 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

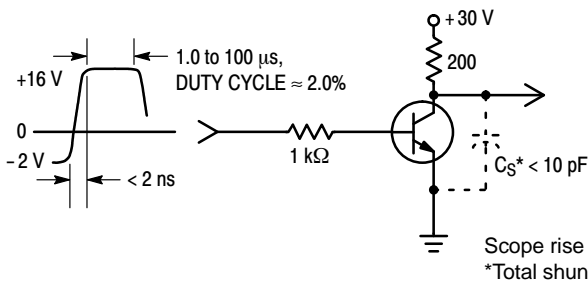


Figure 1. Turn-On Time

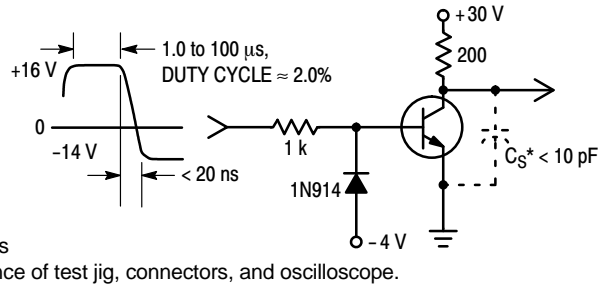


Figure 2. Turn-Off Time

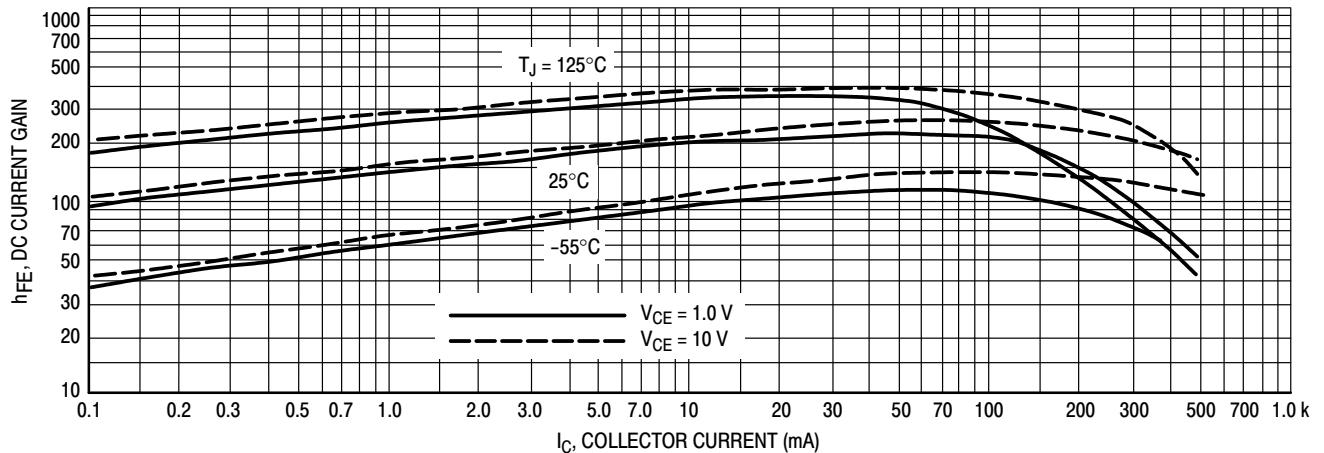


Figure 3. DC Current Gain

MMBT2222L, MMBT2222AL, SMMBT2222AL

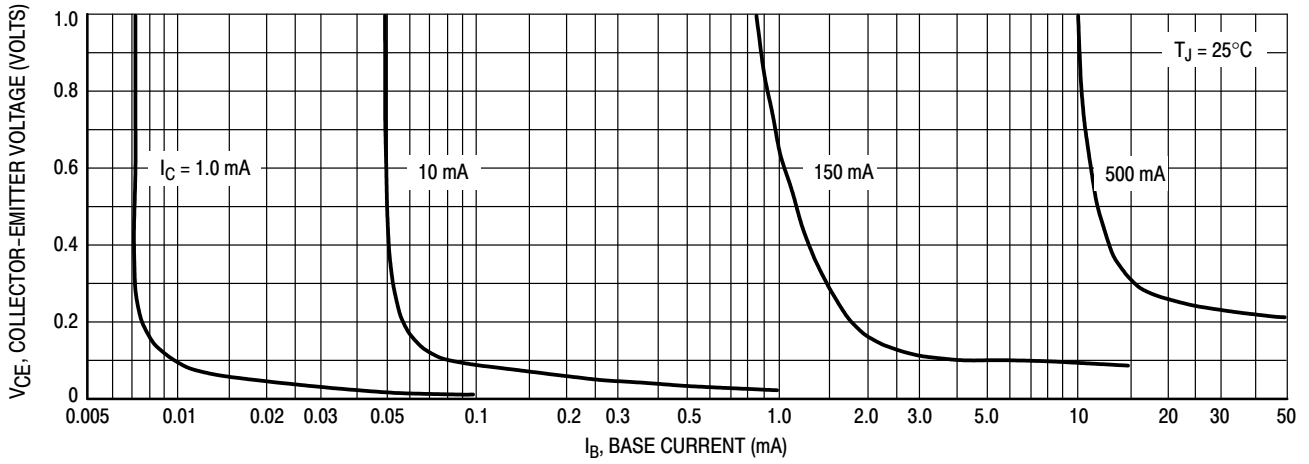


Figure 4. Collector Saturation Region

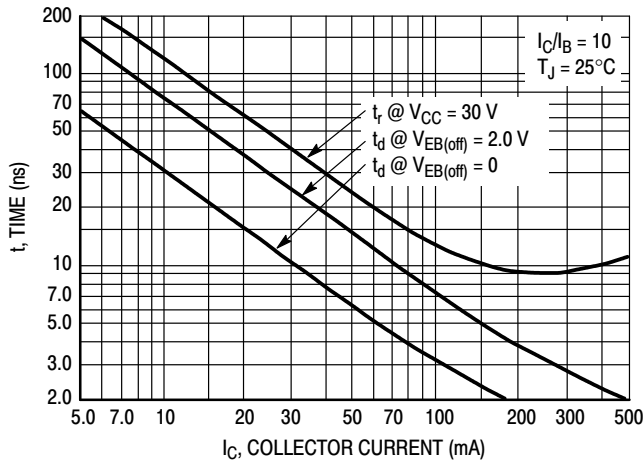


Figure 5. Turn-On Time

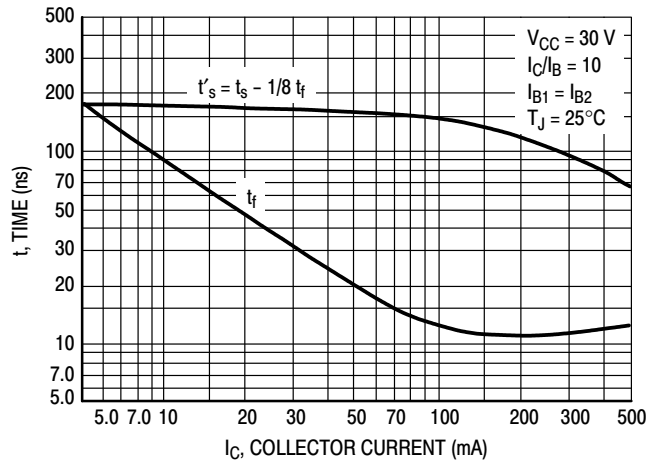


Figure 6. Turn-Off Time



Figure 7. Frequency Effects

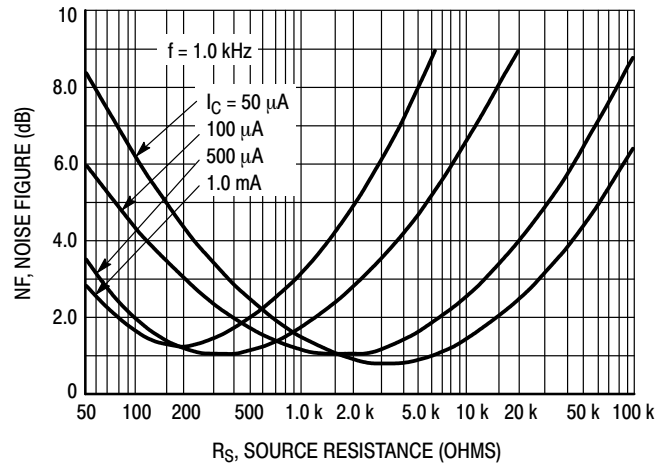


Figure 8. Source Resistance Effects

MMBT2222L, MMBT2222AL, SMMBT2222AL

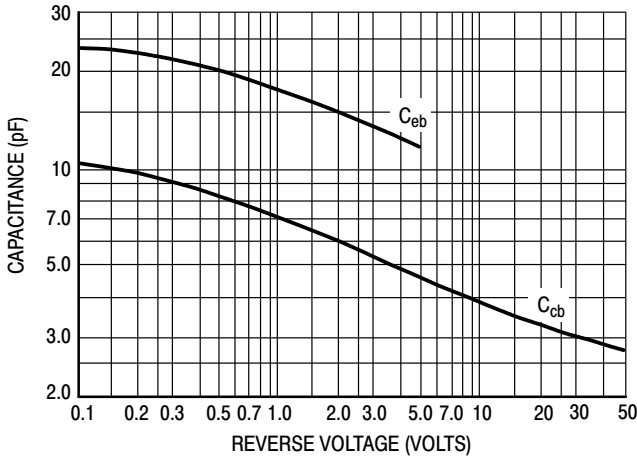


Figure 9. Capacitances

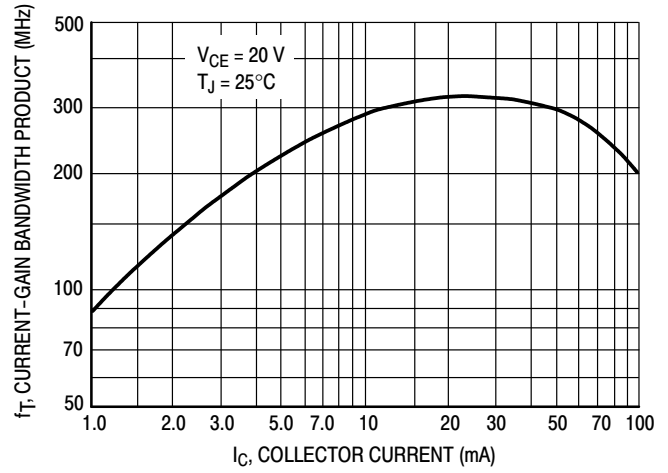


Figure 10. Current-Gain Bandwidth Product

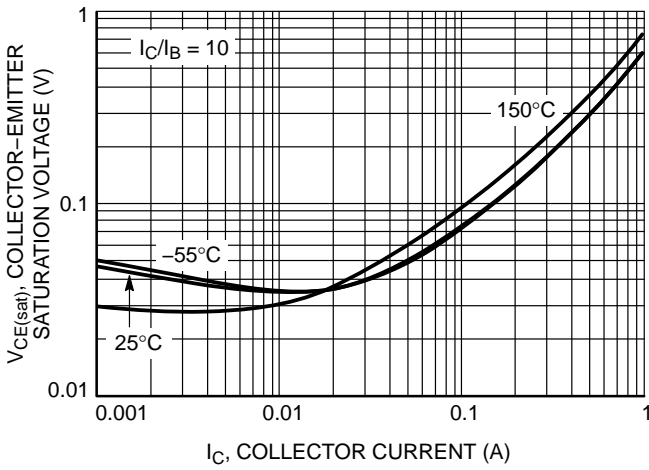


Figure 11. Collector-Emitter Saturation Voltage vs. Collector Current

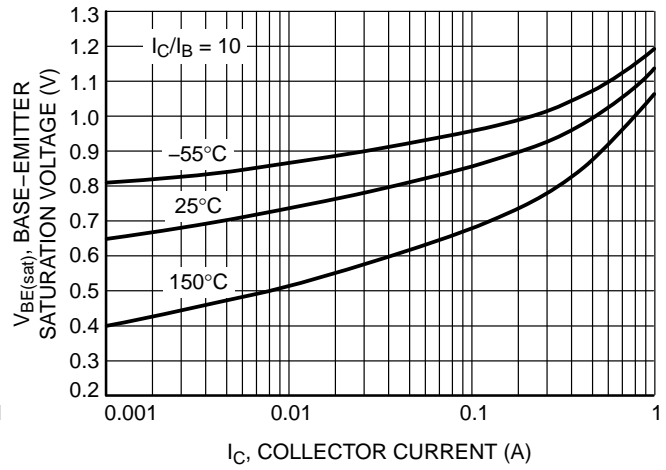


Figure 12. Base-Emitter Saturation Voltage vs. Collector Current

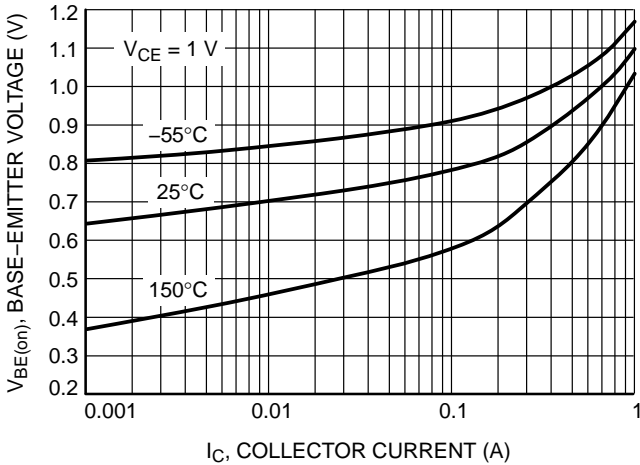


Figure 13. Base-Emitter Voltage vs. Collector Current

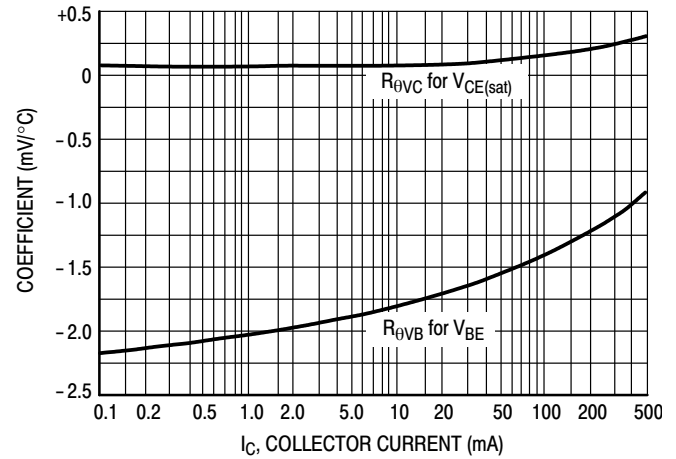


Figure 14. Temperature Coefficients

MMBT2222L, MMBT2222AL, SMMBT2222AL

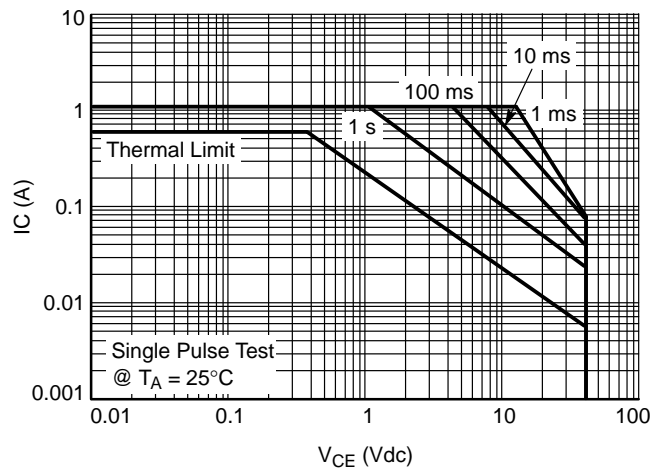


Figure 15. Safe Operating Area

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



SOT-23 (TO-236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

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 |
| H _E | 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. Some products may not follow the Generic Marking.



RECOMMENDED MOUNTING FOOTPRINT

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

STYLES ON PAGE 2

| | | |
|-------------------------|------------------------|--|
| DOCUMENT NUMBER: | 98ASB42226B | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION: | SOT-23 (TO-236) | PAGE 1 OF 2 |

onsemi and ONSEMI are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS



SOT-23 (TO-236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

- | | | | | | |
|---|---|---|---|---|---|
| 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 | | | | |

| | | |
|-------------------------|------------------------|---|
| DOCUMENT NUMBER: | 98ASB42226B | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION: | SOT-23 (TO-236) | PAGE 2 OF 2 |

onsemi and **ONSEMI** are trademarks of Semiconductor Components Industries, LLC dba **onsemi** or its subsidiaries in the United States and/or other countries. **onsemi** reserves the right to make changes without further notice to any products herein. **onsemi** makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. **onsemi** does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at www.onsemi.com/support/sales