# MMUN2211LT1 Series

# Bias Resistor Transistor

## NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SOT-23 package which is designed for low power surface mount applications.

### Features

- Simplifies Circuit Design
- Reduces Board Space and Component Count
- Pb–Free Packages are Available

### MAXIMUM RATINGS ($T_A$ = 25°C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector-Base Voltage | $V_{CBO}$ | 50 | Vdc |
| Collector-Emitter Voltage | $V_{CEO}$ | 50 | Vdc |
| Collector Current | $I_C$ | 100 | mAdc |

### THERMAL CHARACTERISTICS

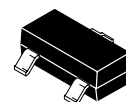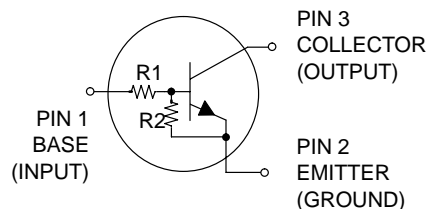| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Total Device Dissipation $T_A$ = 25°C<br>Derate above 25°C | $P_D$ | 246 (Note 1)<br>400 (Note 2)<br>1.5 (Note 1)<br>2.0 (Note 2) | mW<br><br>°C/W |
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 508 (Note 1)<br>311 (Note 2) | °C/W |
| Thermal Resistance, Junction-to-Lead | $R_{\theta JL}$ | 174 (Note 1)<br>208 (Note 2) | °C/W |
| Junction and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to +150 | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.
1. FR–4 @ minimum pad
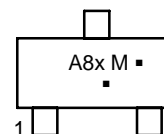2. FR–4 @ 1.0 x 1.0 inch pad

## ON Semiconductor®

**http://onsemi.com**

PIN 3 COLLECTOR (OUTPUT)

R1

R2

PIN 1 BASE (INPUT)

PIN 2 EMITTER (GROUND)

### MARKING DIAGRAM

**SOT–23**
**CASE 318**
**STYLE 6**

A8x M ▪

1

A8x = Specific Device Code
M = Date Code
▪ = Pb–Free Package
(Note: Microdot may be in either location)

### ORDERING INFORMATION

**Preferred** devices are recommended choices for future use and best overall value.

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

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Collector-Base Cutoff Current ($V_{CB}$ = 50 V, $I_E$ = 0) | | $I_{CBO}$ | – | – | 100 | nAdc |
| Collector-Emitter Cutoff Current ($V_{CE}$ = 50 V, $I_B$ = 0) | | $I_{CEO}$ | – | – | 500 | nAdc |
| Emitter-Base Cutoff Current<br>($V_{EB}$ = 6.0 V, $I_C$ = 0) | MMUN2211LT1<br>MMUN2212LT1<br>MMUN2213LT1<br>MMUN2214LT1<br>MMUN2215LT1<br>MMUN2216LT1<br>MMUN2230LT1<br>MMUN2231LT1<br>MMUN2232LT1<br>MMUN2233LT1<br>MMUN2234LT1<br>MMUN2238LT1<br>MMUN2241LT1 | $I_{EBO}$ | –<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>– | –<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>– | 0.5<br>0.2<br>0.1<br>0.2<br>0.9<br>1.9<br>4.3<br>2.3<br>1.5<br>0.18<br>0.13<br>4.0<br>0.1 | mAdc |
| Collector-Base Breakdown Voltage ($I_C$ = 10 μA, $I_E$ = 0) | | $V_{(BR)CBO}$ | 50 | – | – | Vdc |
| Collector-Emitter Breakdown Voltage (Note 3), ($I_C$ = 2.0 mA, $I_B$ = 0) | | $V_{(BR)CEO}$ | 50 | – | – | Vdc |
| **ON CHARACTERISTICS** (Note 3) | | | | | | |
| DC Current Gain<br>($V_{CE}$ = 10 V, $I_C$ = 5.0 mA) | MMUN2211LT1<br>MMUN2212LT1<br>MMUN2213LT1<br>MMUN2214LT1<br>MMUN2215LT1<br>MMUN2216LT1<br>MMUN2230LT1<br>MMUN2231LT1<br>MMUN2232LT1<br>MMUN2233LT1<br>MMUN2234LT1<br>MMUN2238LT1<br>MMUN2241LT1 | $h_{FE}$ | 35<br>60<br>80<br>80<br>160<br>160<br>3.0<br>8.0<br>15<br>80<br>80<br>160<br>160 | 60<br>100<br>140<br>140<br>350<br>350<br>5.0<br>15<br>30<br>200<br>150<br>350<br>350 | –<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>–<br>– | |
| Collector-Emitter Saturation Voltage ($I_C$ = 10 mA, $I_B$ = 0.3 mA)<br>($I_C$ = 10 mA, $I_B$ = 5 mA)  MMUN2230LT1/MMUN2231LT1<br>($I_C$ = 10 mA, $I_B$ = 1 mA)  MMUN2215LT1/MMUN2216LT1<br>    MMUN2232LT1/MMUN2233LT1/MMUN2234LT1/<br>    MMUN2238LT1 | | $V_{CE(sat)}$ | – | – | 0.25 | Vdc |

3.  Pulse Test: Pulse Width < 300 μs, Duty Cycle <  2.0%.

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

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **ON CHARACTERISTICS** (Note 4) | | | | | | |
| Output Voltage (on) | | $V_{OL}$ | | | | Vdc |
| ($V_{CC}$ = 5.0 V, $V_B$ = 2.5 V, $R_L$ = 1.0 k Ω)    MMUN2211LT1 | | | – | – | 0.2 | |
| MMUN2212LT1 | | | – | – | 0.2 | |
| MMUN2214LT1 | | | – | – | 0.2 | |
| MMUN2215LT1 | | | – | – | 0.2 | |
| MMUN2216LT1 | | | – | – | 0.2 | |
| MMUN2230LT1 | | | – | – | 0.2 | |
| MMUN2231LT1 | | | – | – | 0.2 | |
| MMUN2232LT1 | | | – | – | 0.2 | |
| MMUN2233LT1 | | | – | – | 0.2 | |
| MMUN2234LT1 | | | – | – | 0.2 | |
| MMUN2238LT1 | | | – | – | 0.2 | |
| ($V_{CC}$ = 5.0 V, $V_B$ = 3.5 V, $R_L$ = 1.0 k Ω)    MMUN2213LT1 | | | – | – | 0.2 | |
| ($V_{CC}$ = 5.0 V, $V_B$ = 5.0 V, $R_L$ = 1.0 k Ω)    MMUN2241LT1 | | | – | – | 0.2 | |
| Output Voltage (off) ($V_{CC}$ = 5.0 V, $V_B$ = 0.5 V, $R_L$ = 1.0 k Ω) | | $V_{OH}$ | 4.9 | – | – | Vdc |
| ($V_{CC}$ = 5.0 V, $V_B$ = 0.050 V, $R_L$ = 1.0 k Ω)    MMUN2230LT1 | | | | | | |
| ($V_{CC}$ = 5.0 V, $V_B$ = 0.25 V, $R_L$ = 1.0 k Ω)    MMUN2215LT1 | | | | | | |
| MMUN2216LT1 | | | | | | |
| MMUN2233LT1 | | | | | | |
| MMUN2238LT1 | | | | | | |
| Input Resistor    MMUN2211LT1 | | R1 | 7.0 | 10 | 13 | kΩ |
| MMUN2212LT1 | | | 15.4 | 22 | 28.6 | |
| MMUN2213LT1 | | | 32.9 | 47 | 61.1 | |
| MMUN2214LT1 | | | 7.0 | 10 | 13 | |
| MMUN2215LT1 | | | 7.0 | 10 | 13 | |
| MMUN2216LT1 | | | 3.3 | 4.7 | 6.1 | |
| MMUN2230LT1 | | | 0.7 | 1.0 | 1.3 | |
| MMUN2231LT1 | | | 1.5 | 2.2 | 2.9 | |
| MMUN2232LT1 | | | 3.3 | 4.7 | 6.1 | |
| MMUN2233LT1 | | | 3.3 | 4.7 | 6.1 | |
| MMUN2234LT1 | | | 15.4 | 22 | 28.6 | |
| MMUN2238LT1 | | | 1.54 | 2.2 | 2.88 | |
| MMUN2241LT1 | | | 70 | 100 | 130 | |
| Resistor Ratio | MMUN2211LT1/MMUN2212LT1/MMUN2213LT1 | R1/R2 | 0.8 | 1.0 | 1.2 | |
| | MMUN2214LT1 | | 0.17 | 0.21 | 0.25 | |
| | MMUN2215LT1/MMUN2216LT1/MMUN2238LT1 | | – | – | – | |
| | MMUN2241LT1 | | – | – | – | |
| | MMUN2230LT1/MMUN2231LT1/MMUN2232LT1 | | 0.8 | 1.0 | 1.2 | |
| | MMUN2233LT1 | | 0.055 | 0.1 | 0.185 | |
| | MMUN2234LT1 | | 0.38 | 0.47 | 0.56 | |

4.  Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%.

## TYPICAL ELECTRICAL CHARACTERISTICS
### MMUN2211LT1
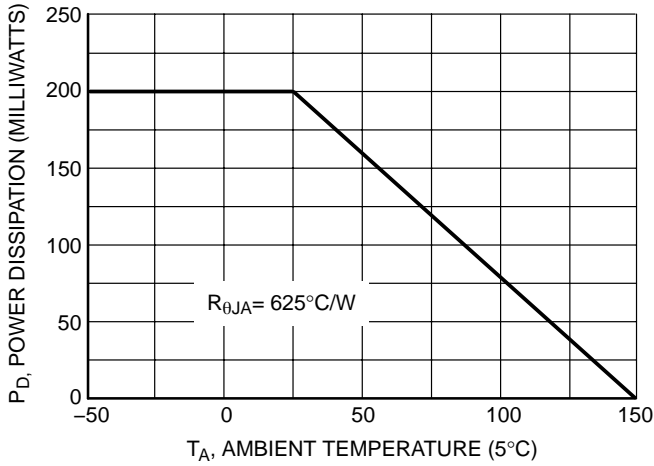
**Figure 1. Derating Curve**
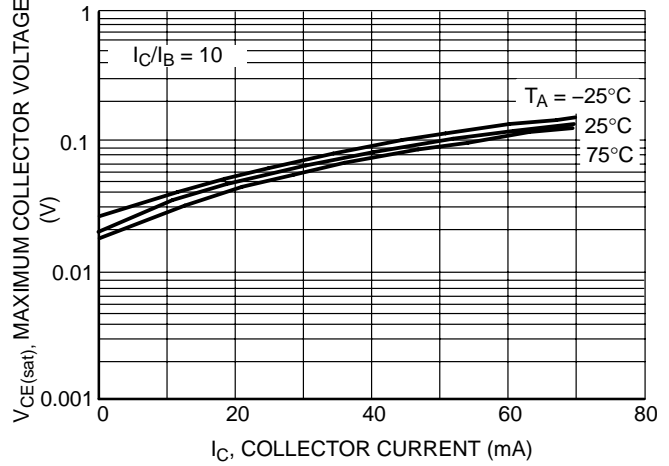
**Figure 2. $V_{CE(sat)}$ vs. $I_C$**
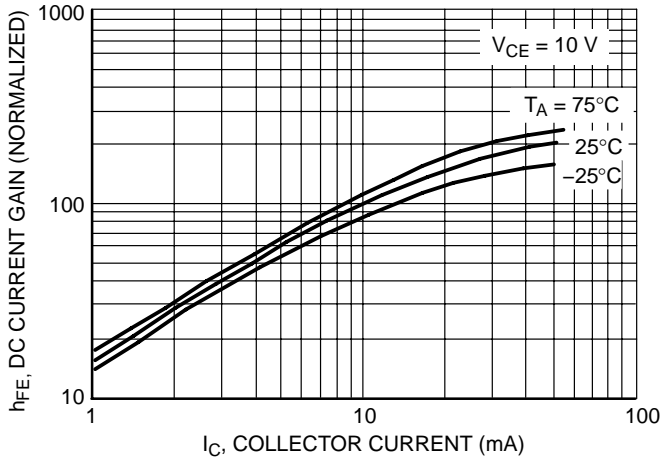
**Figure 3. DC Current Gain**
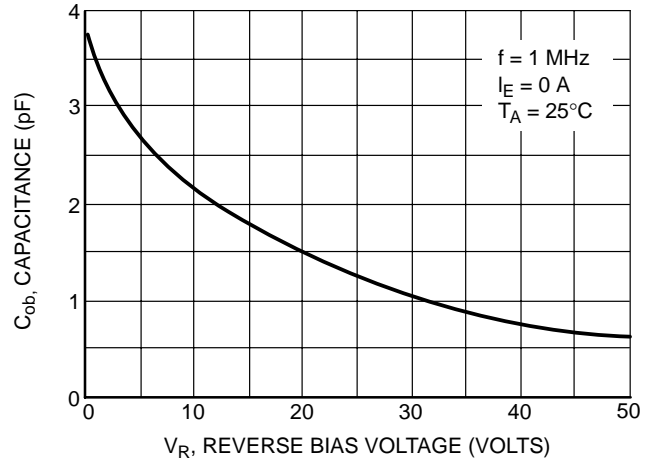
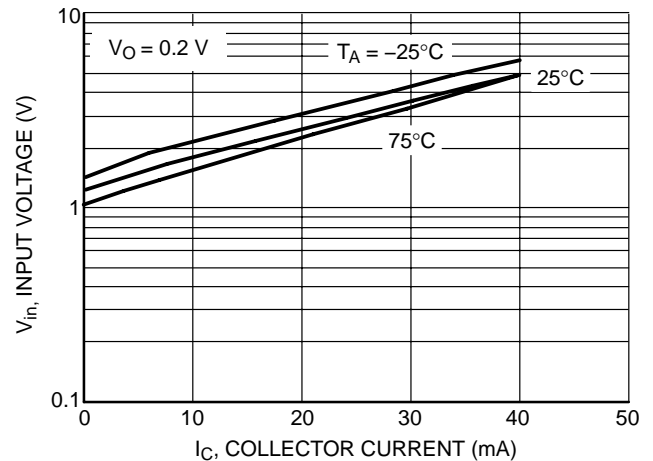**Figure 4. Output Capcitance**
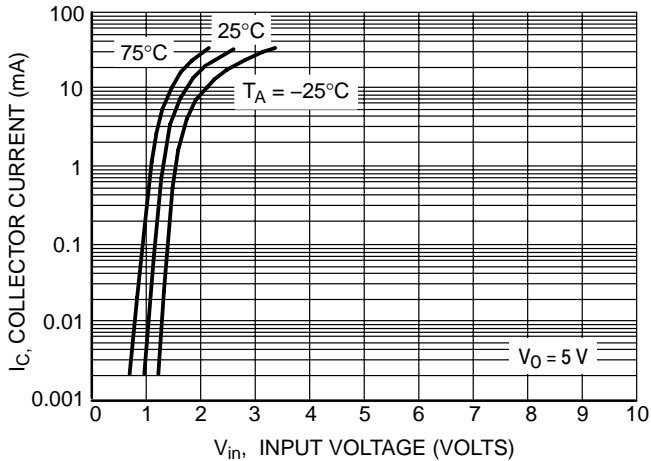
**Figure 5. Output Current vs. Input Voltage**

**Figure 6. Input Voltage vs. Output Current**

## TYPICAL ELECTRICAL CHARACTERISTICS
### MMUN2212LT1

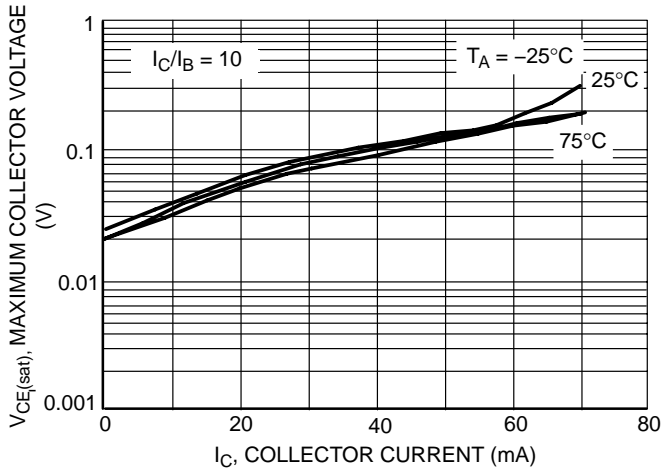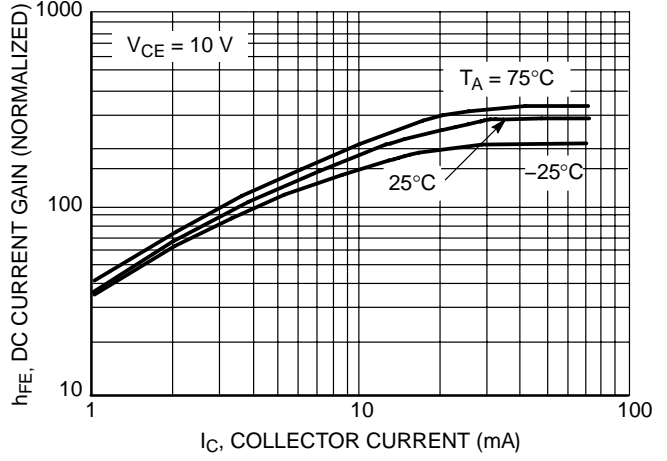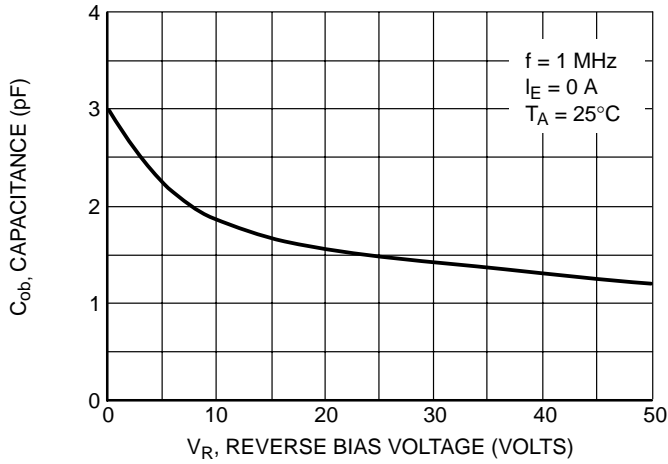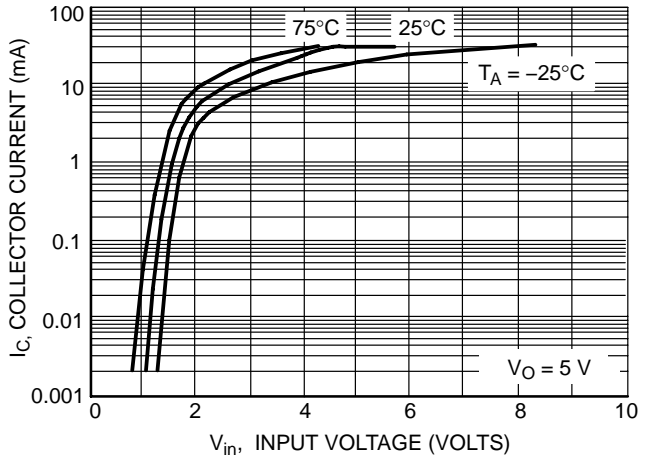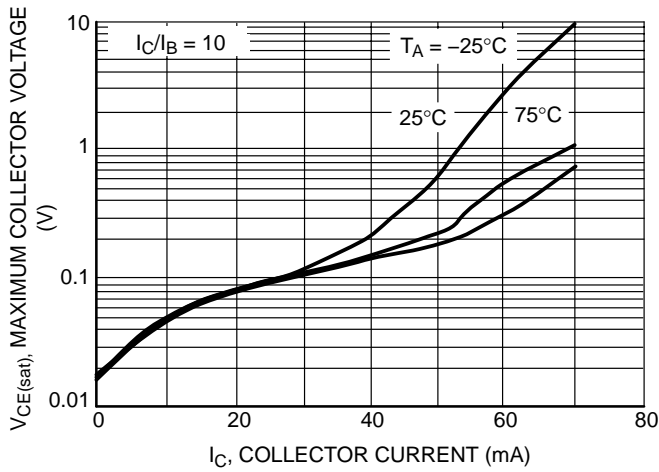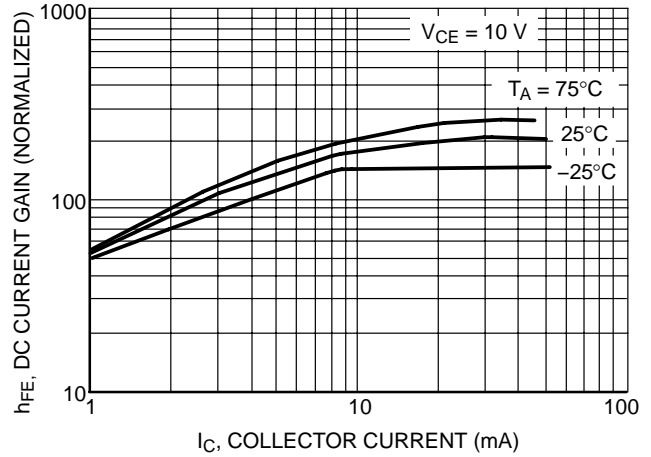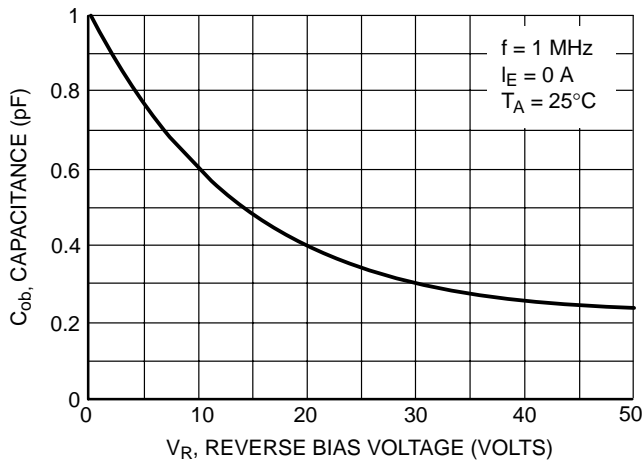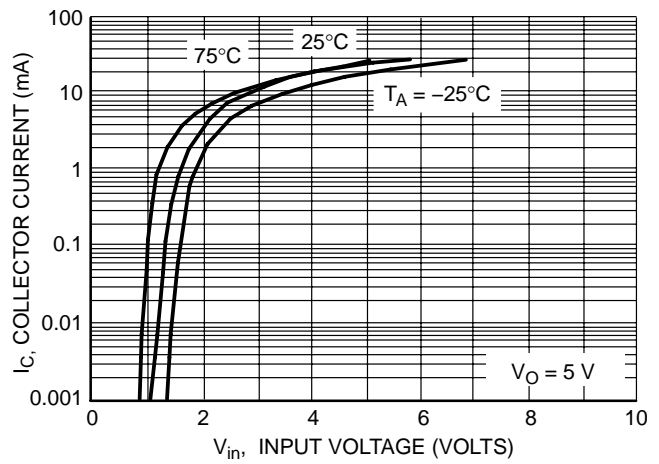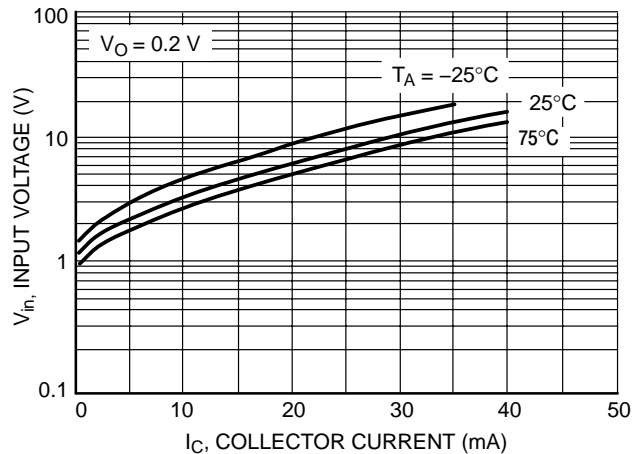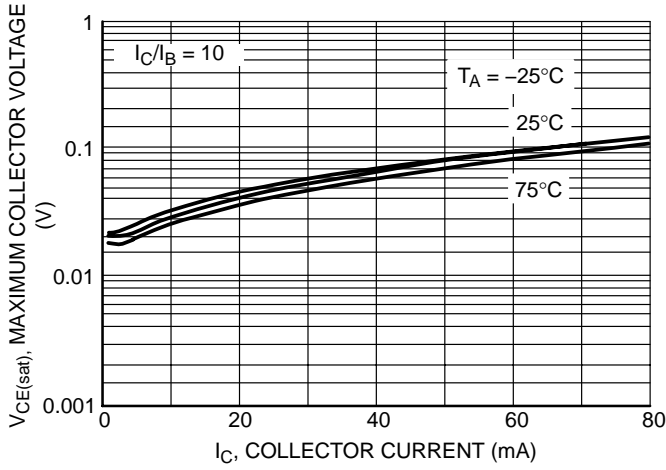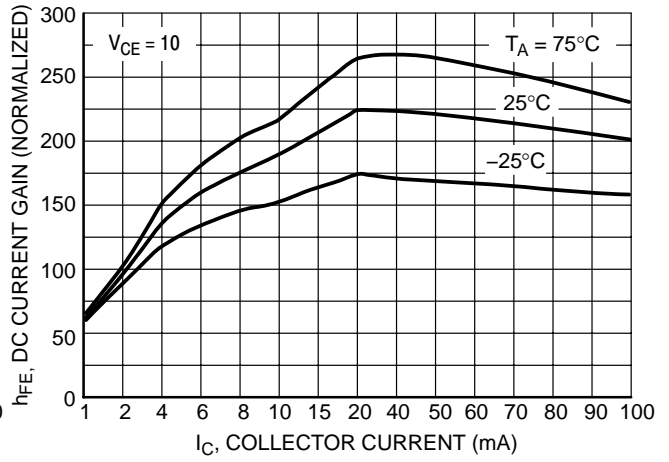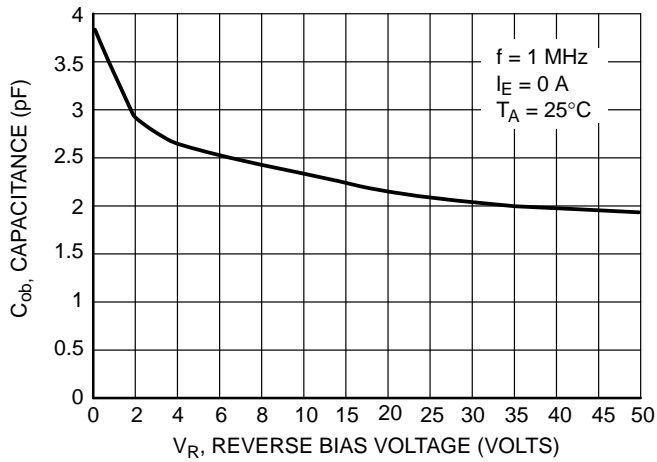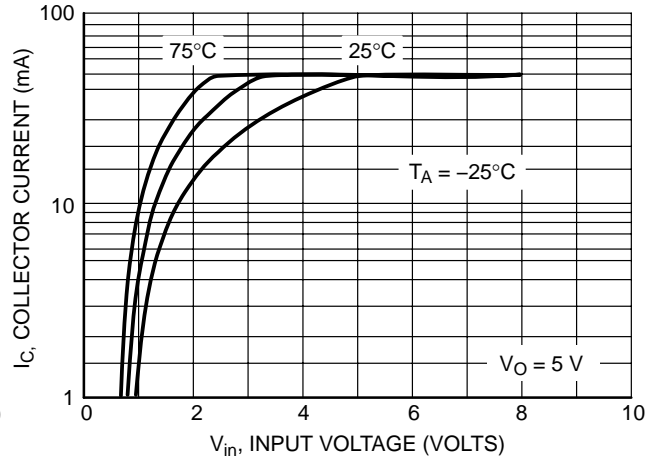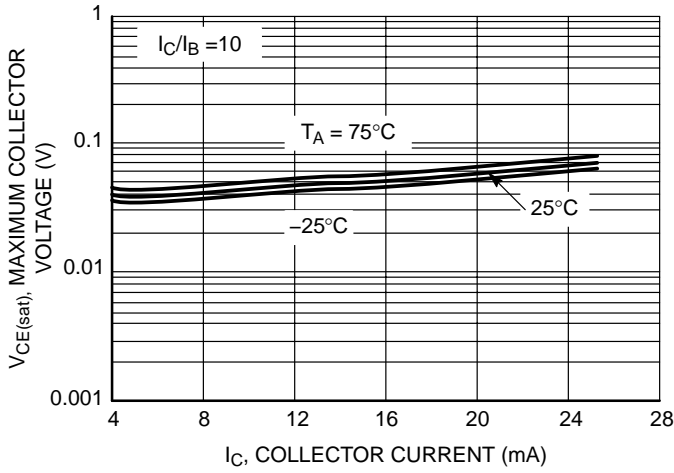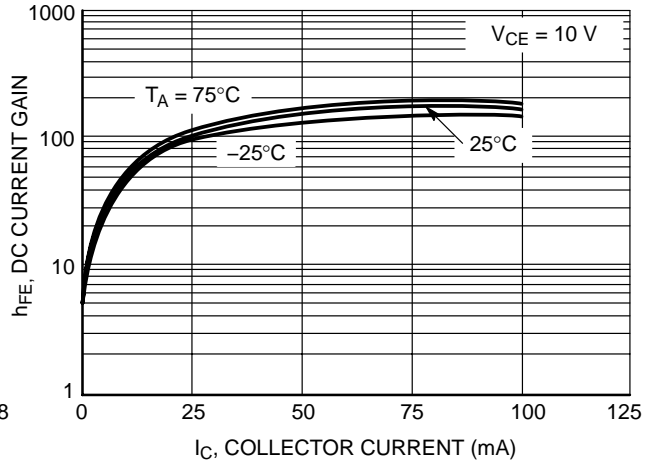**Figure 7. V_CE(sat) vs. I_C**

**Figure 8. DC Current Gain**

**Figure 9. Output Capacitance**

**Figure 10. Output Current vs. Input Voltage**
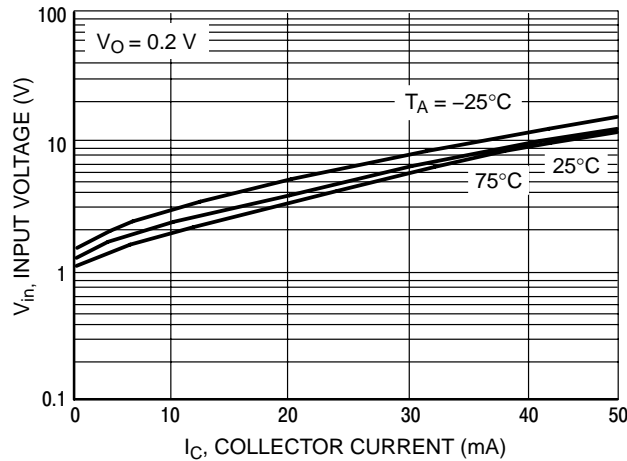
**Figure 11. Input Voltage vs. Output Current**

## TYPICAL ELECTRICAL CHARACTERISTICS
### MMUN2213LT1



**Figure 12. $V_{CE(sat)}$ vs. $I_C$**



**Figure 13. DC Current Gain**
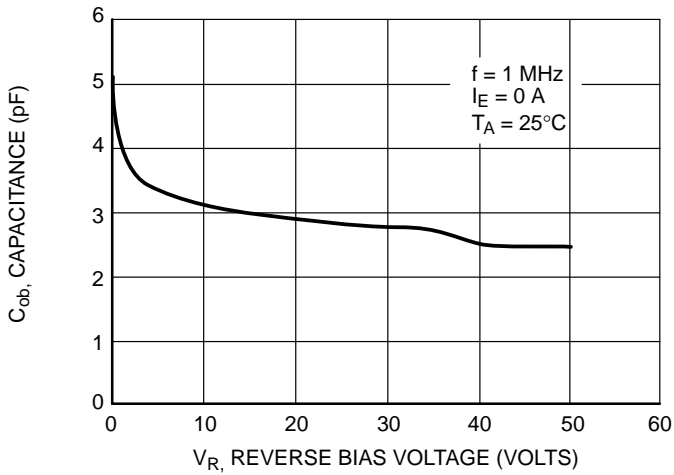


**Figure 14. Output Capacitance**



**Figure 15. Output Current vs. Input Voltage**



**Figure 16. Input Voltage vs. Output Current**

## TYPICAL ELECTRICAL CHARACTERISTICS
### MMUN2214LT1

**Figure 17. V_CE(sat) vs. I_C**

**Figure 18. DC Current Gain**

**Figure 19. Output Capacitance**

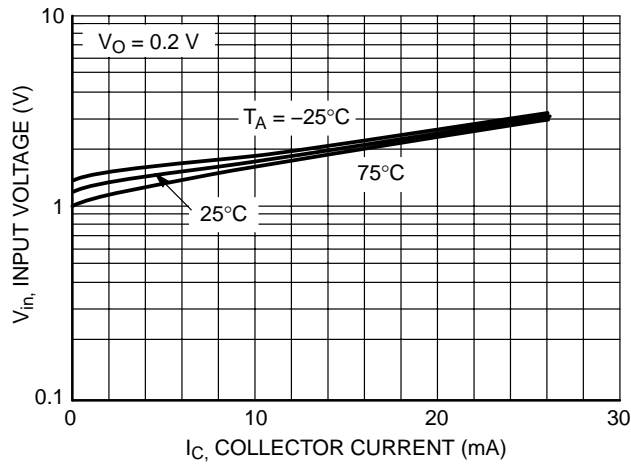**Figure 20. Output Current vs. Input Voltage**
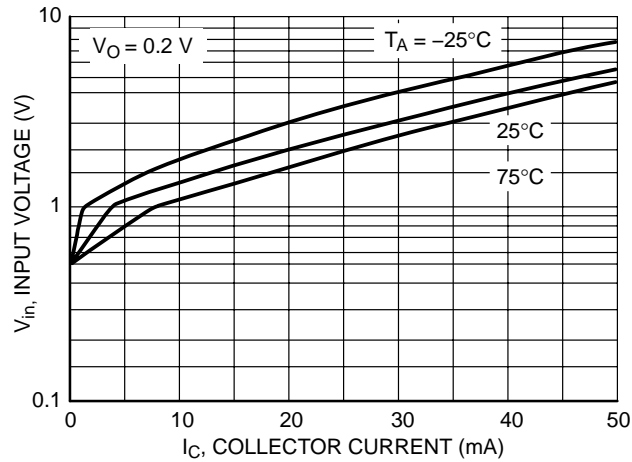
**Figure 21. Input Voltage vs. Output Current**

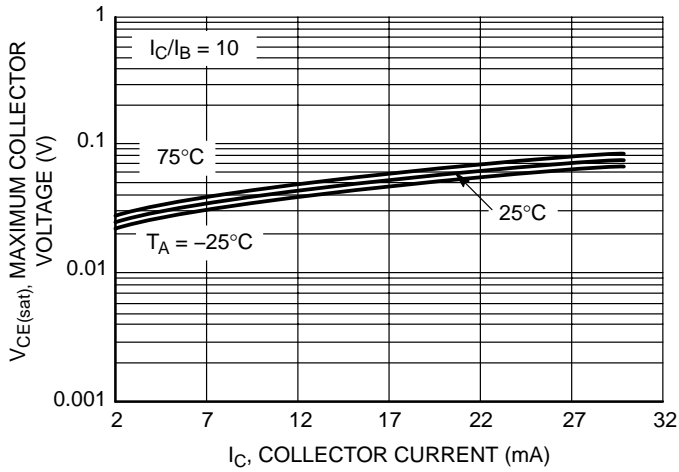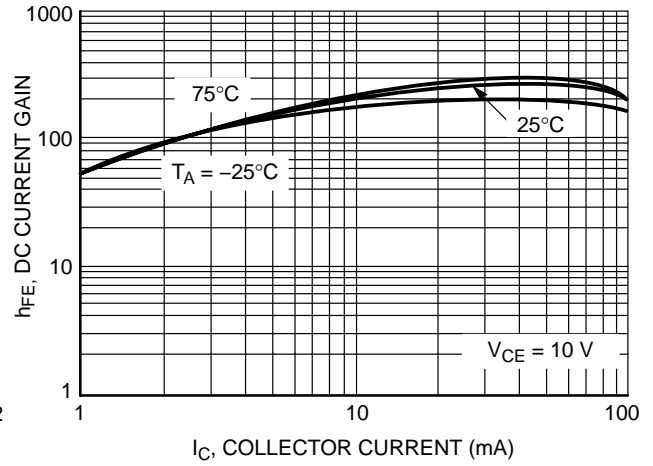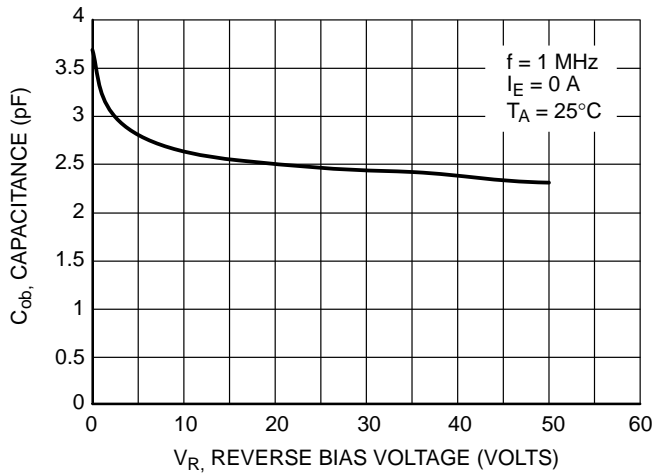# MMUN2211LT1 Series

## TYPICAL ELECTRICAL CHARACTERISTICS
### MMUN2232LT1

**Figure 22. $V_{CE(sat)}$ vs. $I_C$**

**Figure 23. DC Current Gain**

**Figure 24. Output Capacitance**
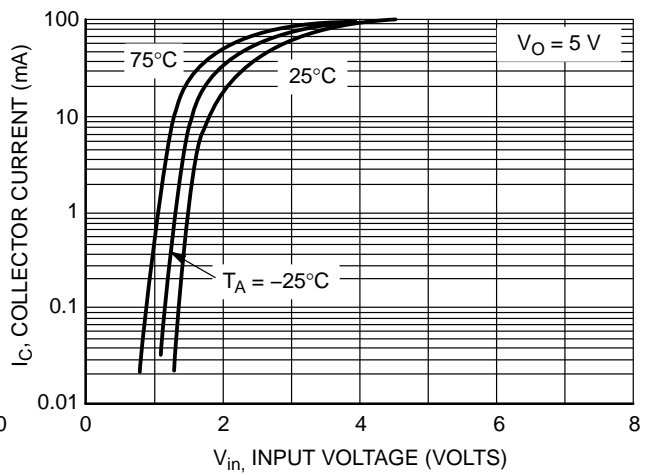
**Figure 25. Output Current vs. Input Voltage**

**Figure 26. Output Voltage vs. Input Current**

## TYPICAL ELECTRICAL CHARACTERISTICS
### MMUN2233LT1



**Figure 27. $V_{CE(sat)}$ vs. $I_C$**



**Figure 28. DC Current Gain**
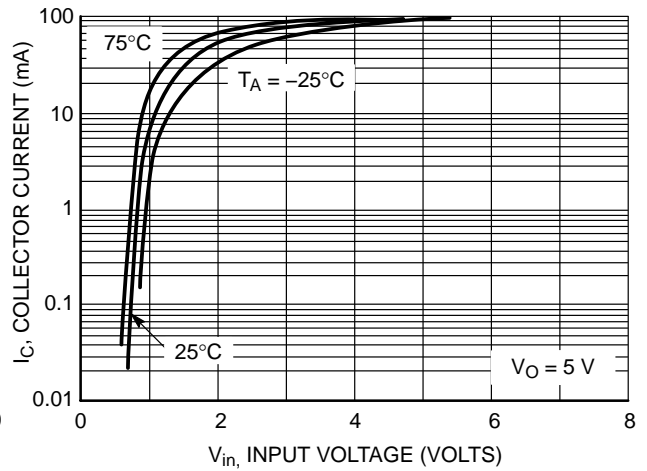


**Figure 29. Output Capacitance**



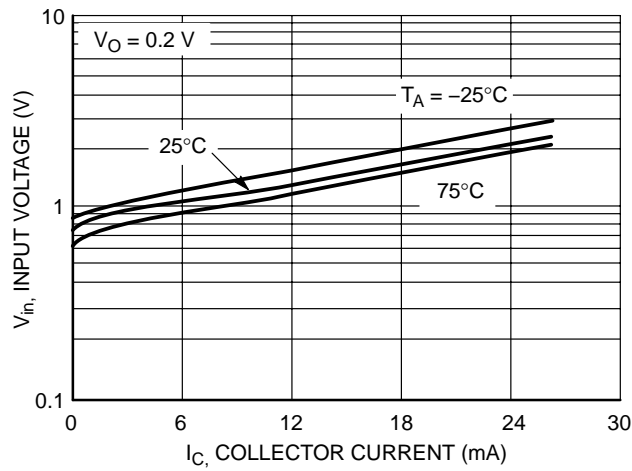**Figure 30. Output Current vs. Input Voltage**



**Figure 31. Input Voltage  vs. Output Current**

# MMUN2211LT1 Series
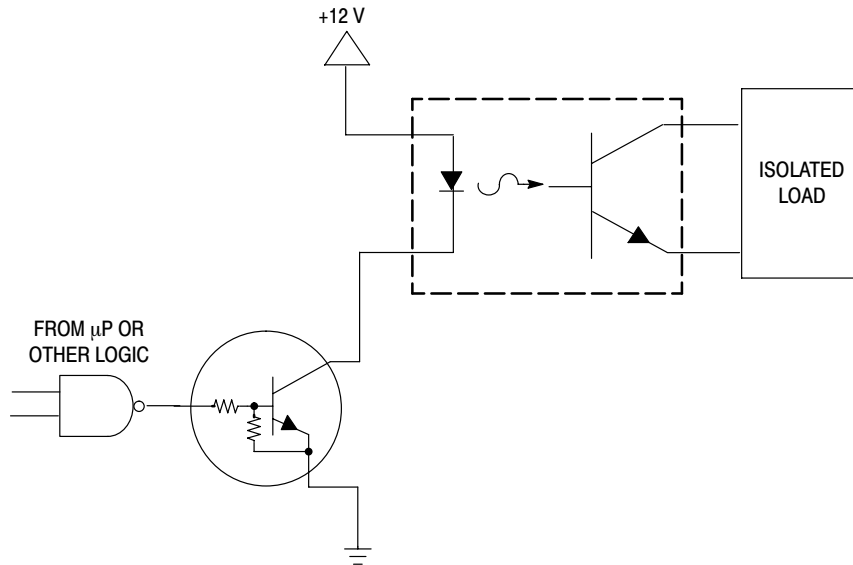
## TYPICAL APPLICATIONS FOR NPN BRTs



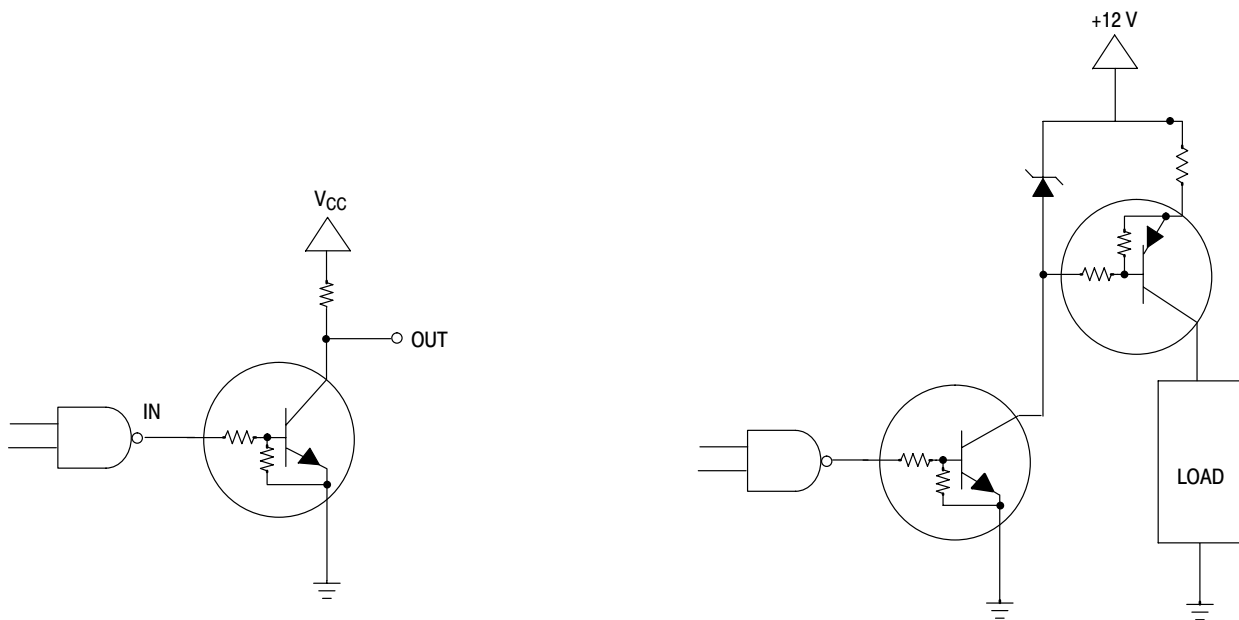**Figure 32. Level Shifter: Connects 12 or 24 Volt Circuits to Logic**



**Figure 33. Open Collector Inverter: Inverts the Input Signal**



**Figure 34. Inexpensive, Unregulated Current Source**

**ORDERING INFORMATION**

| Device | Marking | R1(k) | R2(k) | Package | Shipping† |
|---|---|---|---|---|---|
| MMUN2211LT1 | A8A | 10 | 10 | SOT−23 | 3000 / Tape & Reel |
| MMUN2211LT1G | | 10 | 10 | SOT−23 (Pb−Free) | |
| MMUN2211LT3 | | 10 | 10 | SOT−23 | 10,000 / Tape & Reel |
| MMUN2211LT3G | | 10 | 10 | SOT−23 (Pb−Free) | |
| MMUN2112LT1 | A8B | 22 | 22 | SOT−23 | 3000 / Tape & Reel |
| MMUN2212LT1G | | 22 | 22 | SOT−23 (Pb−Free) | |
| MMUN2213LT1 | A8C | 47 | 47 | SOT−23 | |
| MMUN2213LT1G | | 47 | 47 | SOT−23 (Pb−Free) | |
| MMUN2214LT1 | A8D | 10 | 47 | SOT−23 | |
| MMUN2214LT1G | | 10 | 47 | SOT−23 (Pb−Free) | |
| MMUN2215LT1 | A8E | 10 | ∞ | SOT−23 | |
| MMUN2215LT1G | | 10 | ∞ | SOT−23 (Pb−Free) | |
| MMUN2216LT1 | A8F | 4.7 | ∞ | SOT−23 | |
| MMUN2216LT1G | | 4.7 | ∞ | SOT−23 (Pb−Free) | |
| MMUN2230LT1 | A8G | 1.0 | 1.0 | SOT−23 | |
| MMUN2230LT1G | | 1.0 | 1.0 | SOT−23 (Pb−Free) | |
| MMUN2231LT1 | A8H | 2.2 | 2.2 | SOT−23 | |
| MMUN2231LT1G | | 2.2 | 2.2 | SOT−23 (Pb−Free) | |
| MMUN2232LT1 | A8J | 4.7 | 4.7 | SOT−23 | |
| MMUN2232LT1G | | 4.7 | 4.7 | SOT−23 (Pb−Free) | |
| MMUN2233LT1 | A8K | 4.7 | 47 | SOT−23 | |
| MMUN2233LT1G | | 4.7 | 47 | SOT−23 (Pb−Free) | |
| MMUN2234LT1 | A8L | 22 | 47 | SOT−23 | |
| MMUN2234LT1G | | 22 | 47 | SOT−23 (Pb−Free) | |
| MMUN2234LT3 | | 22 | 47 | SOT−23 | 10,000 / Tape & Reel |
| MMUN2234LT3G | | 22 | 47 | SOT−23 (Pb−Free) | |
| MMUN2238LT1 | A8R | 2.2 | ∞ | SOT−23 | 3000 / Tape & Reel |
| MMUN2238LT1G | | 2.2 | ∞ | SOT−23 (Pb−Free) | |
| MMUN2241LT1 | A8U | 100 | ∞ | SOT−23 | |
| MMUN2241LT1G | | 100 | ∞ | SOT−23 (Pb−Free) | |

†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.

# MMUN2211LT1 Series

## PACKAGE DIMENSIONS
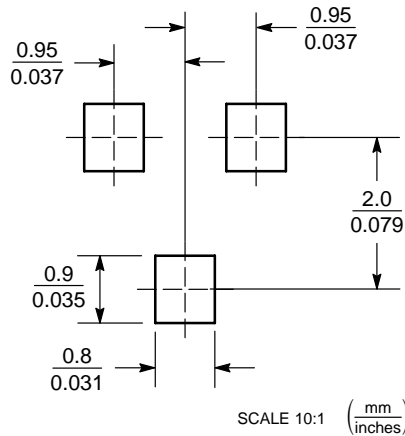
**SOT–23 (TO–236)**
CASE 318–08
ISSUE AL
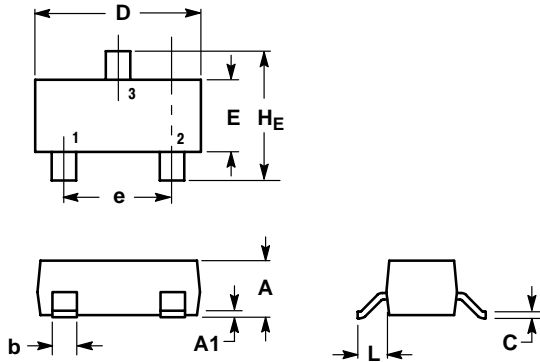


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318–01 THRU –07 AND –09 OBSOLETE, NEW STANDARD 318–08.

| 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 | 0.35 | 0.54 | 0.69 | 0.014 | 0.021 | 0.029 |
| H$_E$ | 2.10 | 2.40 | 2.64 | 0.083 | 0.094 | 0.104 |

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

## SOLDERING FOOTPRINT*



$\frac{0.95}{0.037}$

$\frac{0.95}{0.037}$

$\frac{2.0}{0.079}$

$\frac{0.9}{0.035}$

$\frac{0.8}{0.031}$

SCALE 10:1 $\left(\dfrac{mm}{inches}\right)$

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