

# MMBT4401M3T5G

## NPN Switching Transistor

The MMBT4401M3T5G device is a spin-off of our popular SOT-23 three-leaded device. It is designed for general purpose switching applications and is housed in the SOT-723 surface mount package. This device is ideal for low-power surface mount applications where board space is at a premium.

### Features

- Reduces Board Space
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value | Unit |
|--------------------------------|-----------|-------|------|
| Collector – Emitter Voltage    | $V_{CEO}$ | 40    | Vdc  |
| Collector – Base Voltage       | $V_{CBO}$ | 60    | Vdc  |
| Emitter – Base Voltage         | $V_{EBO}$ | 6.0   | Vdc  |
| Collector Current – Continuous | $I_C$     | 600   | mAdc |

### THERMAL CHARACTERISTICS

| Characteristic                                                                                                      | Symbol          | Max         | Unit                       |
|---------------------------------------------------------------------------------------------------------------------|-----------------|-------------|----------------------------|
| Total Device Dissipation<br>FR-5 Board (Note 1)<br>$T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$      | $P_D$           | 265<br>2.1  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance,<br>Junction-to-Ambient                                                                          | $R_{\theta JA}$ | 470         | $^\circ\text{C/W}$         |
| Total Device Dissipation<br>Alumina Substrate, (Note 2) $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$           | 640<br>5.1  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance,<br>Junction-to-Ambient                                                                          | $R_{\theta JA}$ | 195         | $^\circ\text{C/W}$         |
| 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.

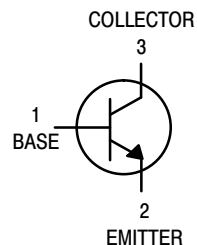
1. FR-5 =  $1.0 \times 0.75 \times 0.062$  in.

2. Alumina =  $0.4 \times 0.3 \times 0.024$  in. 99.5% alumina.

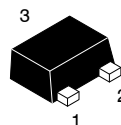


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### MARKING DIAGRAM



SOT-723  
CASE 631AA  
STYLE 1



AF = Specific Device Code  
M = Date Code

### ORDERING INFORMATION

| Device        | Package              | Shipping†          |
|---------------|----------------------|--------------------|
| MMBT4401M3T5G | SOT-723<br>(Pb-Free) | 8000 / 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.

# MMBT4401M3T5G

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

| Characteristic                                                                          | Symbol        | Min | Max | Unit            |
|-----------------------------------------------------------------------------------------|---------------|-----|-----|-----------------|
| <b>OFF CHARACTERISTICS</b>                                                              |               |     |     |                 |
| Collector – Emitter Breakdown Voltage (Note 3)<br>( $I_C = 1.0\text{ mA}$ , $I_B = 0$ ) | $V_{(BR)CEO}$ | 40  | –   | Vdc             |
| Collector – Base Breakdown Voltage<br>( $I_C = 0.1\text{ mA}$ , $I_E = 0$ )             | $V_{(BR)CBO}$ | 60  | –   | Vdc             |
| Emitter – Base Breakdown Voltage<br>( $I_E = 0.1\text{ mA}$ , $I_C = 0$ )               | $V_{(BR)EBO}$ | 6.0 | –   | Vdc             |
| Base Cutoff Current<br>( $V_{CE} = 35\text{ Vdc}$ , $V_{EB} = 0.4\text{ Vdc}$ )         | $I_{BEV}$     | –   | 0.1 | $\mu\text{Adc}$ |
| Collector Cutoff Current<br>( $V_{CE} = 35\text{ Vdc}$ , $V_{EB} = 0.4\text{ Vdc}$ )    | $I_{CEX}$     | –   | 0.1 | $\mu\text{Adc}$ |

## ON CHARACTERISTICS (Note 3)

|                                                                                                                                                                                                                                                                                                             |               |                             |                         |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------|-------------------------|-----|
| DC Current Gain<br>( $I_C = 0.1\text{ mA}$ , $V_{CE} = 1.0\text{ Vdc}$ )<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 1.0\text{ Vdc}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 1.0\text{ Vdc}$ )<br>( $I_C = 150\text{ mA}$ , $V_{CE} = 1.0\text{ Vdc}$ )<br>( $I_C = 500\text{ mA}$ , $V_{CE} = 2.0\text{ Vdc}$ ) | $h_{FE}$      | 20<br>40<br>80<br>100<br>40 | –<br>–<br>–<br>300<br>– | –   |
| Collector – Emitter Saturation Voltage<br>( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ )<br>( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ )                                                                                                                                                              | $V_{CE(sat)}$ | –<br>–                      | 0.4<br>0.75             | Vdc |
| Base – Emitter Saturation Voltage<br>( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ )<br>( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ )                                                                                                                                                                   | $V_{BE(sat)}$ | 0.75<br>–                   | 0.95<br>1.2             | Vdc |

## SMALL-SIGNAL CHARACTERISTICS

|                                                                                                                  |          |     |     |                  |
|------------------------------------------------------------------------------------------------------------------|----------|-----|-----|------------------|
| Current – Gain – Bandwidth Product<br>( $I_C = 20\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 100\text{ MHz}$ ) | $f_T$    | 250 | –   | MHz              |
| Collector – Base Capacitance<br>( $V_{CB} = 5.0\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )                 | $C_{cb}$ | –   | 6.5 | pF               |
| Emitter – Base Capacitance<br>( $V_{EB} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ )                   | $C_{eb}$ | –   | 30  | pF               |
| Input Impedance<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )                   | $h_{ie}$ | 1.0 | 15  | k $\Omega$       |
| Voltage Feedback Ratio<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )            | $h_{re}$ | 0.1 | 8.0 | $\times 10^{-4}$ |
| Small – Signal Current Gain<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )       | $h_{fe}$ | 40  | 500 | –                |
| Output Admittance<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )                 | $h_{oe}$ | 1.0 | 30  | $\mu\text{mhos}$ |

## SWITCHING CHARACTERISTICS

|              |                                                                                                            |                |   |     |    |
|--------------|------------------------------------------------------------------------------------------------------------|----------------|---|-----|----|
| Delay Time   | (V <sub>CC</sub> = 30 Vdc, V <sub>EB</sub> = 2.0 Vdc,<br>I <sub>C</sub> = 150 mA, I <sub>B1</sub> = 15 mA) | t <sub>d</sub> | – | 15  | ns |
| Rise Time    |                                                                                                            | t <sub>r</sub> | – | 20  |    |
| Storage Time | (V <sub>CC</sub> = 30 Vdc, I <sub>C</sub> = 150 mA,<br>I <sub>B1</sub> = I <sub>B2</sub> = 15 mA)          | t <sub>s</sub> | – | 225 | ns |
| Fall Time    |                                                                                                            | t <sub>f</sub> | – | 30  |    |

3. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

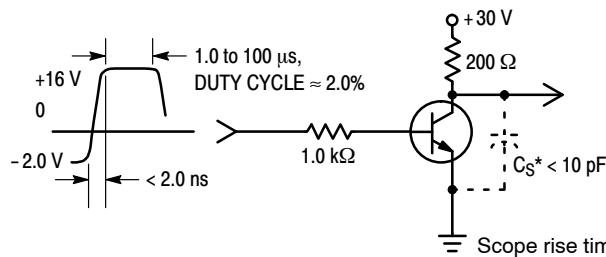


Figure 1. Turn-On Time

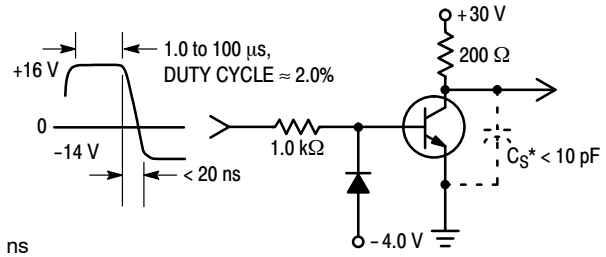


Figure 2. Turn-Off Time

# MMBT4401M3T5G

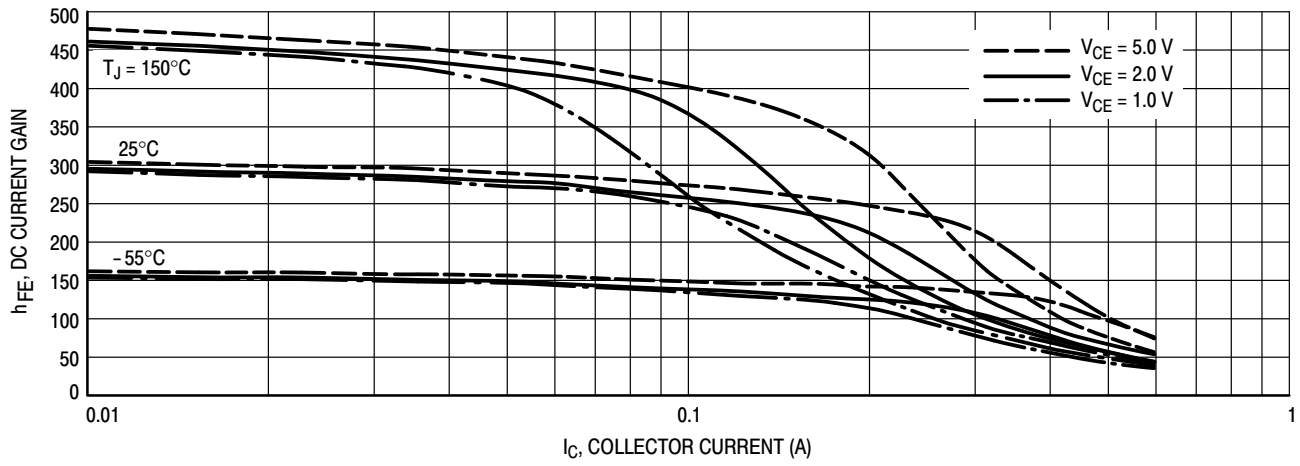


Figure 3. DC Current Gain

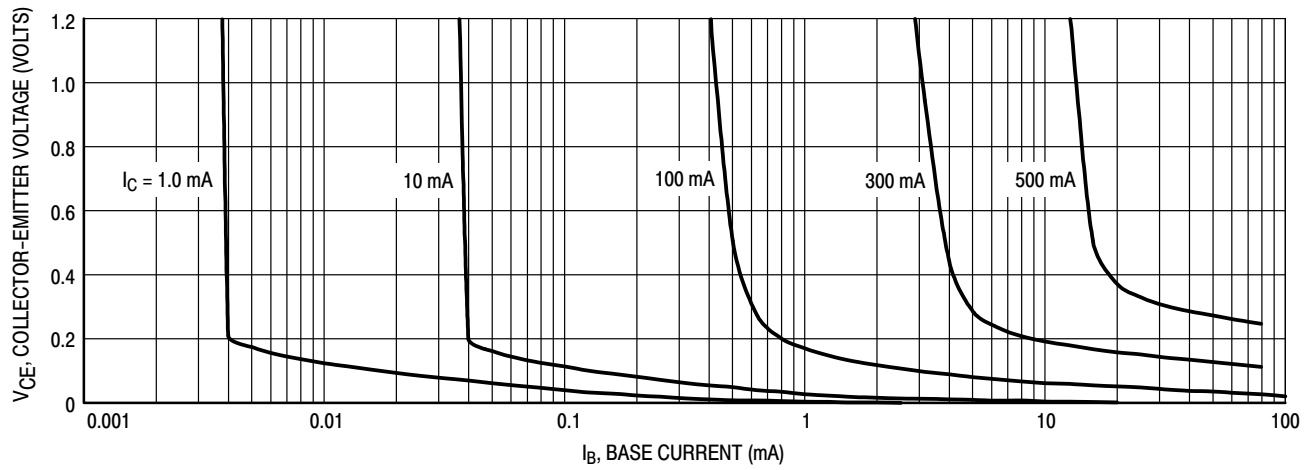


Figure 4. Collector Saturation Region

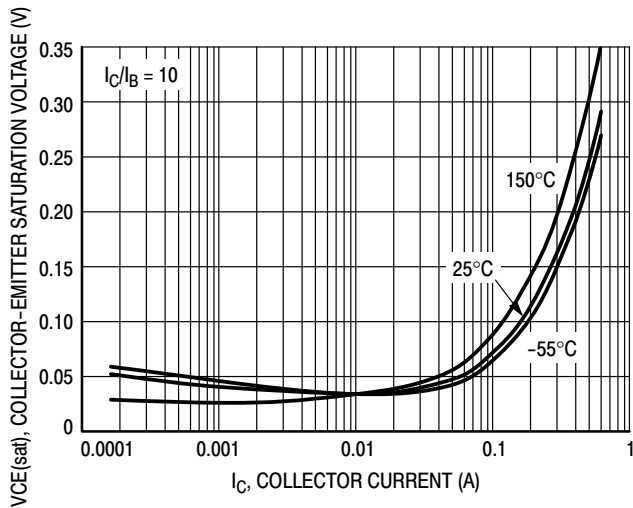


Figure 5. Collector-Emitter Saturation Voltage vs. Collector Current

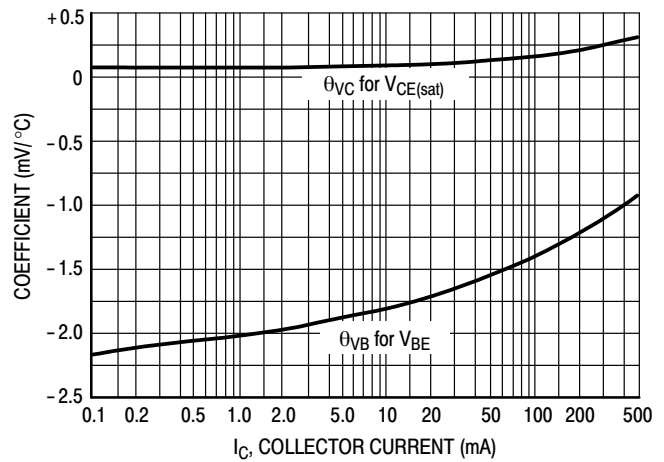
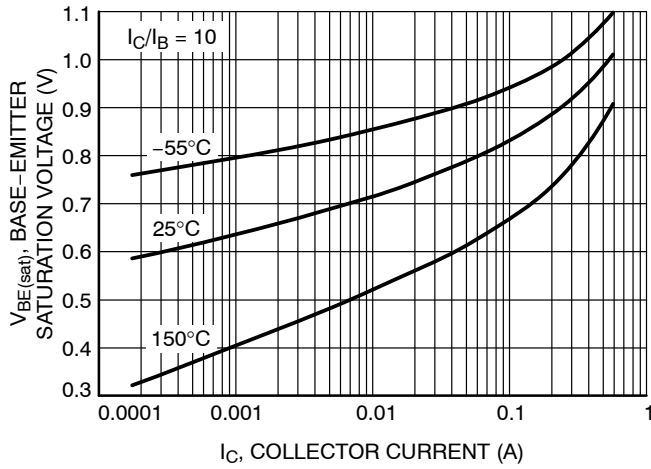
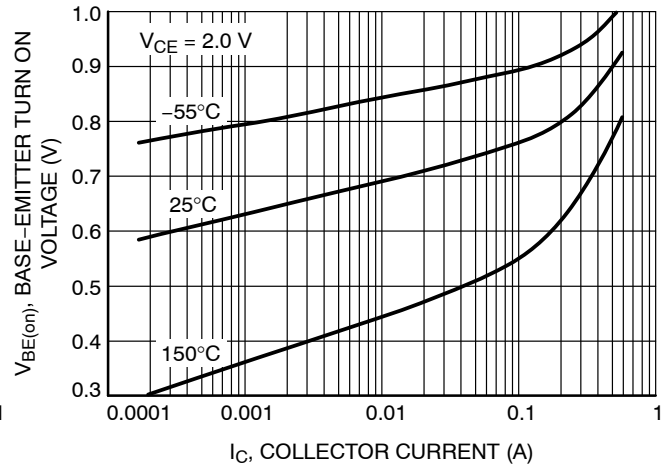


Figure 6. Temperature Coefficients

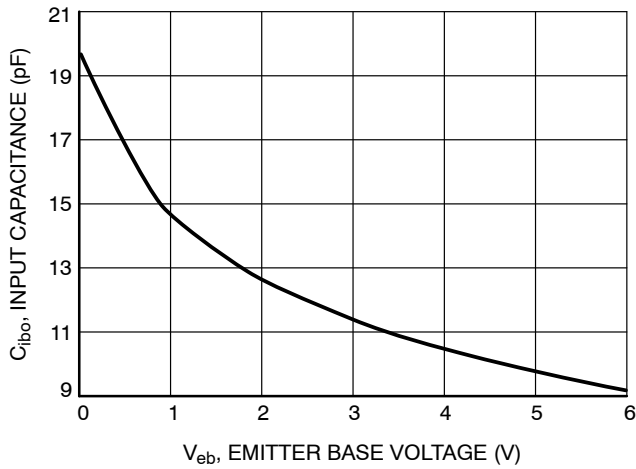
# MMBT4401M3T5G



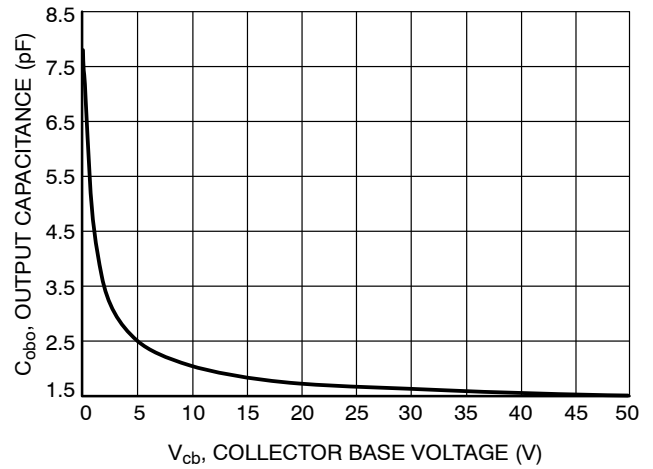
**Figure 7. Base-Emitter Saturation Voltage vs. Collector Current**



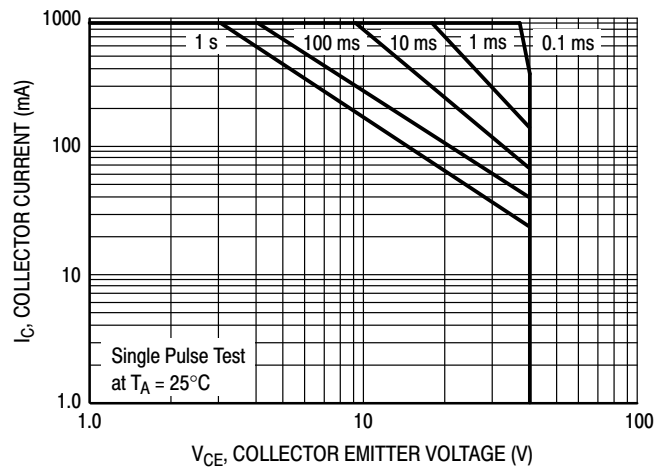
**Figure 8. Base-Emitter Turn On Voltage vs. Collector Current**



**Figure 9. Input Capacitance vs. Emitter Base Voltage**



**Figure 10. Output Capacitance vs. Collector Base Voltage**



**Figure 11. Safe Operating Area**

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

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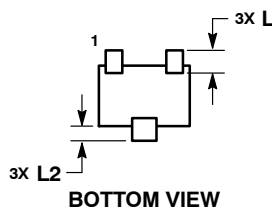
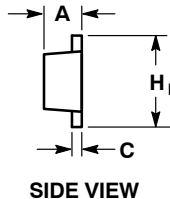
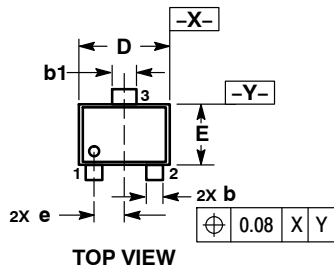
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SCALE 4:1

## SOT-723 CASE 631AA-01 ISSUE D

DATE 10 AUG 2009

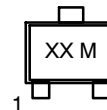


### NOTES:

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 BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

| MILLIMETERS |          |      |      |
|-------------|----------|------|------|
| DIM         | MIN      | NOM  | MAX  |
| A           | 0.45     | 0.50 | 0.55 |
| b           | 0.15     | 0.21 | 0.27 |
| b1          | 0.25     | 0.31 | 0.37 |
| C           | 0.07     | 0.12 | 0.17 |
| D           | 1.15     | 1.20 | 1.25 |
| E           | 0.75     | 0.80 | 0.85 |
| e           | 0.40 BSC |      |      |
| H E         | 1.15     | 1.20 | 1.25 |
| L           | 0.29 REF |      |      |
| L2          | 0.15     | 0.20 | 0.25 |

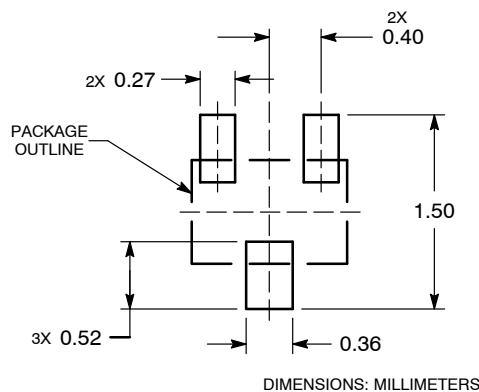
### GENERIC MARKING DIAGRAM\*



XX = Specific Device Code  
M = Date Code

- STYLE 1:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR
- STYLE 2:  
PIN 1. ANODE  
2. N/C  
3. CATHODE
- STYLE 3:  
PIN 1. ANODE  
2. ANODE  
3. CATHODE
- STYLE 4:  
PIN 1. CATHODE  
2. CATHODE  
3. ANODE
- STYLE 5:  
PIN 1. GATE  
2. SOURCE  
3. DRAIN

### RECOMMENDED SOLDERING FOOTPRINT\*



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

\*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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