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## 2N4403 / MMBT4403 PNP General-Purpose Amplifier

### Description

This device is designed for use as a general-purpose amplifier and switch for collector currents to 500 mA.

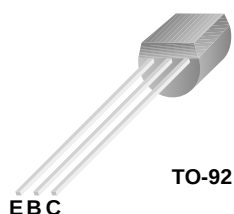


Figure 1. 2N4403 Device Package

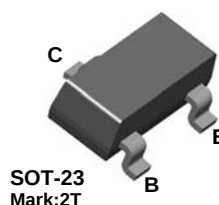


Figure 2. MMBT4403 Device Package

### Ordering Information

| Part Number | Marking | Package   | Packing Method |
|-------------|---------|-----------|----------------|
| 2N4403BU    | 2N4403  | TO-92 3L  | Bulk           |
| 2N4403TF    | 2N4403  | TO-92 3L  | Tape and Reel  |
| 2N4403TFR   | 2N4403  | TO-92 3L  | Tape and Reel  |
| 2N4403TA    | 2N4403  | TO-92 3L  | Ammo           |
| 2N4403TAR   | 2N4403  | TO-92 3L  | Ammo           |
| MMBT4403    | 2T      | SOT-23 3L | Tape and Reel  |

## Absolute Maximum Ratings<sup>(1),(2)</sup>

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

| Symbol         | Parameter                                        | Value       | Unit             |
|----------------|--------------------------------------------------|-------------|------------------|
| $V_{CEO}$      | Collector-Emitter Voltage                        | -40         | V                |
| $V_{CBO}$      | Collector-Base Voltage                           | -40         | V                |
| $V_{EBO}$      | Emitter-Base Voltage                             | -5.0        | V                |
| $I_C$          | Collector Current - Continuous                   | -600        | mA               |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to +150 | $^\circ\text{C}$ |

### Notes:

- These ratings are based on a maximum junction temperature of  $150^\circ\text{C}$ .
- These are steady-state limits. ON Semiconductor should be consulted on applications involving pulsed or low-duty cycle operations.

## Thermal Characteristics

Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

| Symbol          | Parameter                               | Max.                  |                         | Unit                 |
|-----------------|-----------------------------------------|-----------------------|-------------------------|----------------------|
|                 |                                         | 2N4403 <sup>(3)</sup> | MMBT4403 <sup>(4)</sup> |                      |
| $P_D$           | Total Device Dissipation                | 625                   | 350                     | mW                   |
|                 | Derate Above $25^\circ\text{C}$         | 5.0                   | 2.8                     | mW/ $^\circ\text{C}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case    | 83.3                  |                         | $^\circ\text{C/W}$   |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 200                   | 357                     | $^\circ\text{C/W}$   |

### Notes:

- PCB size: FR-4, 76 mm x 114 mm x 1.57 mm (3.0 inch x 4.5 inch x 0.062 inch) with minimum land pattern size.
- Device mounted on FR-4 PCB 1.6 inch x 1.6 inch x 0.06 inch.

## Electrical Characteristics

Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

| Symbol                       | Parameter                                           | Conditions                                                                                    | Min.  | Max.  | Unit              |
|------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------|-------|-------|-------------------|
| Off Characteristics          |                                                     |                                                                                               |       |       |                   |
| V <sub>(BR)CEO</sub>         | Collector-Emitter Breakdown Voltage <sup>(5)</sup>  | I <sub>C</sub> = -1.0 mA, I <sub>B</sub> = 0                                                  | -40   |       | V                 |
| V <sub>(BR)CBO</sub>         | Collector-Base Breakdown Voltage                    | I <sub>C</sub> = -0.1 mA, I <sub>E</sub> = 0                                                  | -40   |       | V                 |
| V <sub>(BR)EBO</sub>         | Emitter-Base Breakdown Voltage                      | I <sub>E</sub> = -0.1 mA, I <sub>C</sub> = 0                                                  | -5.0  |       | V                 |
| I <sub>BL</sub>              | Base Cut-Off Current                                | V <sub>CE</sub> = -35 V, V <sub>EB</sub> = -0.4 V                                             |       | -0.1  | μA                |
| I <sub>CEX</sub>             | Collector Cut-Off Current                           | V <sub>CE</sub> = -35 V, V <sub>EB</sub> = -0.4 V                                             |       | -0.1  | μA                |
| On Characteristics           |                                                     |                                                                                               |       |       |                   |
| h <sub>FE</sub>              | DC Current Gain                                     | I <sub>C</sub> = -0.1 mA, V <sub>CE</sub> = -1.0 V                                            | 30    |       |                   |
|                              |                                                     | I <sub>C</sub> = -1.0 mA, V <sub>CE</sub> = -1.0 V                                            | 60    |       |                   |
|                              |                                                     | I <sub>C</sub> = -10 mA, V <sub>CE</sub> = -1.0 V                                             | 100   |       |                   |
|                              |                                                     | I <sub>C</sub> = -150 mA, V <sub>CE</sub> = -2.0 V <sup>(5)</sup>                             | 100   | 300   |                   |
|                              |                                                     | I <sub>C</sub> = -500 mA, V <sub>CE</sub> = -2.0 V <sup>(5)</sup>                             | 20    |       |                   |
| V <sub>CE(sat)</sub>         | Collector-Emitter Saturation Voltage <sup>(5)</sup> | I <sub>C</sub> = -150 mA, I <sub>B</sub> = -15 mA                                             |       | -0.40 | V                 |
|                              |                                                     | I <sub>C</sub> = -500 mA, I <sub>B</sub> = -50 mA                                             |       | -0.75 |                   |
| V <sub>BE(sat)</sub>         | Base-Emitter Saturation Voltage                     | I <sub>C</sub> = -150 mA, I <sub>B</sub> = -15 mA <sup>(5)</sup>                              | -0.75 | -0.95 | V                 |
|                              |                                                     | I <sub>C</sub> = -500 mA, I <sub>B</sub> = -50 mA                                             |       | -1.30 |                   |
| Small Signal Characteristics |                                                     |                                                                                               |       |       |                   |
| f <sub>T</sub>               | Current Gain - Bandwidth Product                    | I <sub>C</sub> = -20 mA, V <sub>CE</sub> = -10 V, f = 100 MHz                                 | 200   |       | MHz               |
| C <sub>cb</sub>              | Collector-Base Capacitance                          | V <sub>CB</sub> = -10 V, I <sub>E</sub> = 0, f = 140 kHz                                      |       | 8.5   | pF                |
| C <sub>eb</sub>              | Emitter-Base Capacitance                            | V <sub>BE</sub> = -0.5 V, I <sub>C</sub> = 0, f = 140 kHz                                     |       | 30    | pF                |
| h <sub>ie</sub>              | Input Impedance                                     | I <sub>C</sub> = -1.0 mA, V <sub>CE</sub> = -10 V, f = 1.0 kHz                                | 1.5   | 15.0  | kΩ                |
| h <sub>re</sub>              | Voltage Feedback Ratio                              | I <sub>C</sub> = -1.0 mA, V <sub>CE</sub> = -10 V, f = 1.0 kHz                                | 0.1   | 8.0   | x10 <sup>-4</sup> |
| h <sub>fe</sub>              | Small-Signal Current Gain                           | I <sub>C</sub> = -1.0 mA, V <sub>CE</sub> = -10 V, f = 1.0 kHz                                | 60    | 500   |                   |
| h <sub>oe</sub>              | Output Admittance                                   | I <sub>C</sub> = -1.0 mA, V <sub>CE</sub> = -10 V, f = 1.0 kHz                                | 1     | 100   | μmhos             |
| Switching Characteristics    |                                                     |                                                                                               |       |       |                   |
| t <sub>d</sub>               | Delay Time                                          | V <sub>CC</sub> = -30 V, I <sub>C</sub> = -150 mA, I <sub>B1</sub> = -15 mA                   |       | 15    | ns                |
| t <sub>r</sub>               | Rise Time                                           |                                                                                               |       | 20    | ns                |
| t <sub>s</sub>               | Storage Time                                        | V <sub>CC</sub> = -30 V, I <sub>C</sub> = -150 mA, I <sub>B1</sub> = I <sub>B2</sub> = -15 mA |       | 225   | ns                |
| t <sub>f</sub>               | Fall Time                                           |                                                                                               |       | 30    | ns                |

### Note:

5. Pulse test: pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2.0\%$ .

# Typical Performance Characteristics

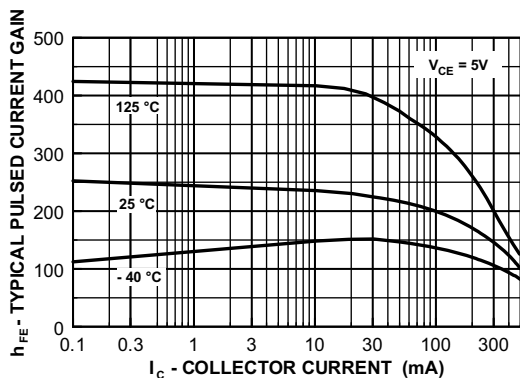


Figure 3. Typical Pulsed Current Gain vs. Collector Current

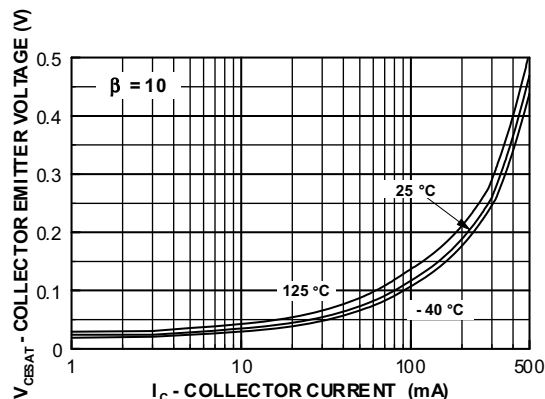


Figure 4. Collector-Emitter Saturation Voltage vs. Collector Current

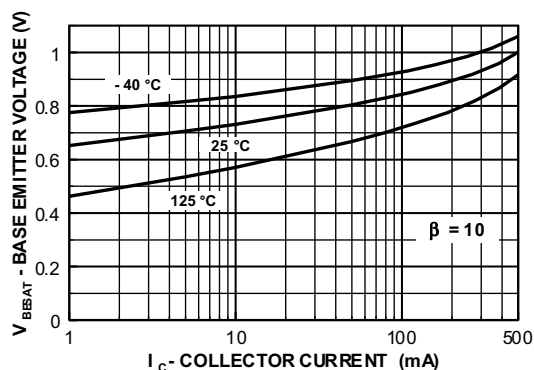


Figure 5. Base-Emitter Saturation Voltage vs. Collector Current

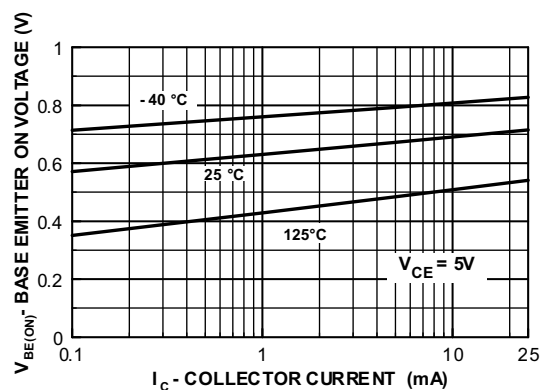


Figure 6. Base-Emitter On Voltage vs. Collector Current

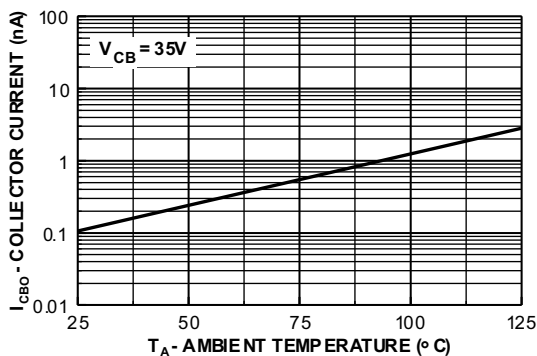


Figure 7. Collector Cut-Off Current vs. Ambient Temperature

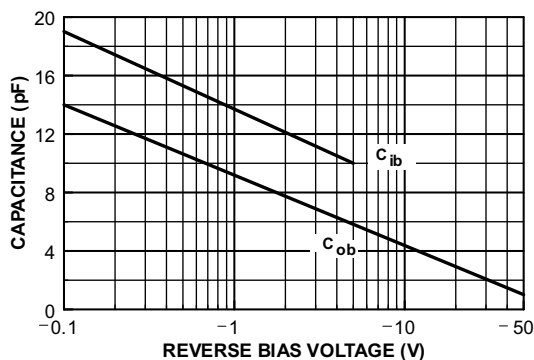


Figure 8. Input and Output Capacitance vs. Reverse Bias Voltage

# Typical Performance Characteristics (Continued)

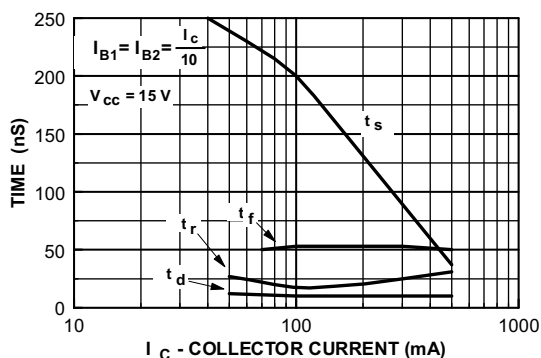


Figure 9. Switching Times vs. Collector Current

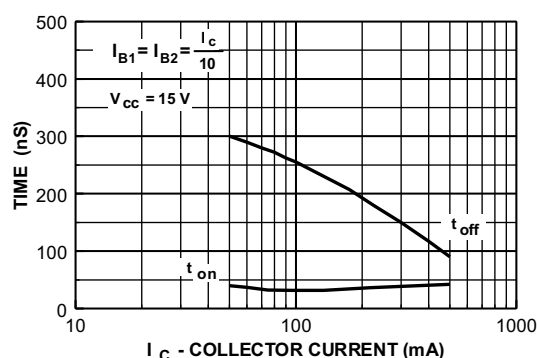


Figure 10. Turn-On and Turn-Off Times vs. Collector Current

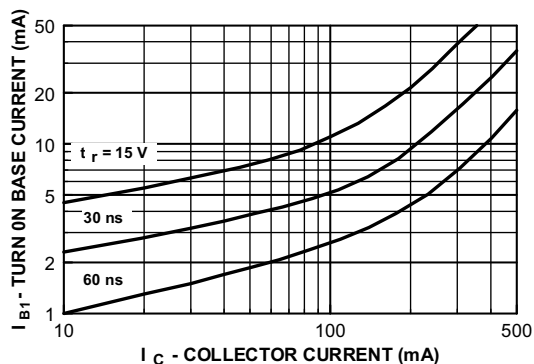


Figure 11. Rise Time vs. Collector and Turn-On Base Currents

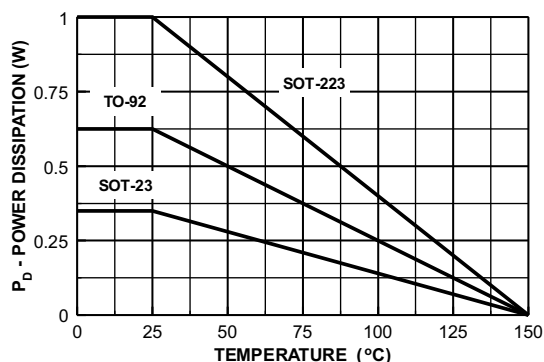


Figure 12. Power Dissipation vs. Ambient Temperature

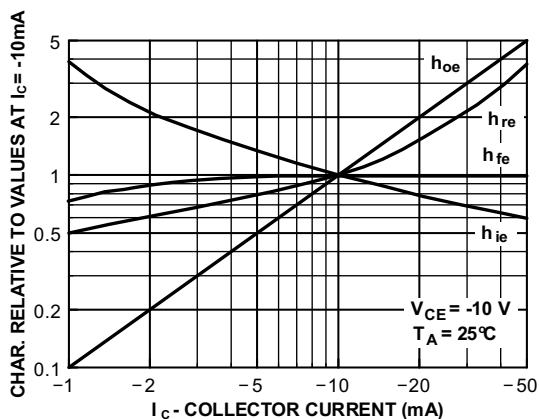


Figure 13. Common Emitter Characteristics

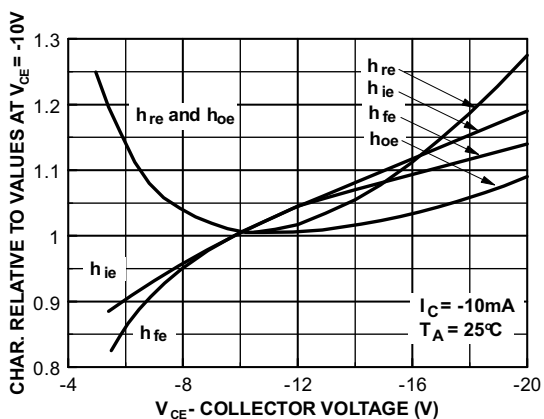


Figure 14. Common Emitter Characteristics

# Typical Performance Characteristics (Continued)

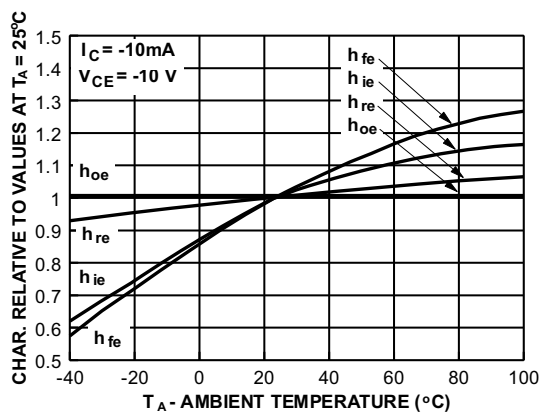
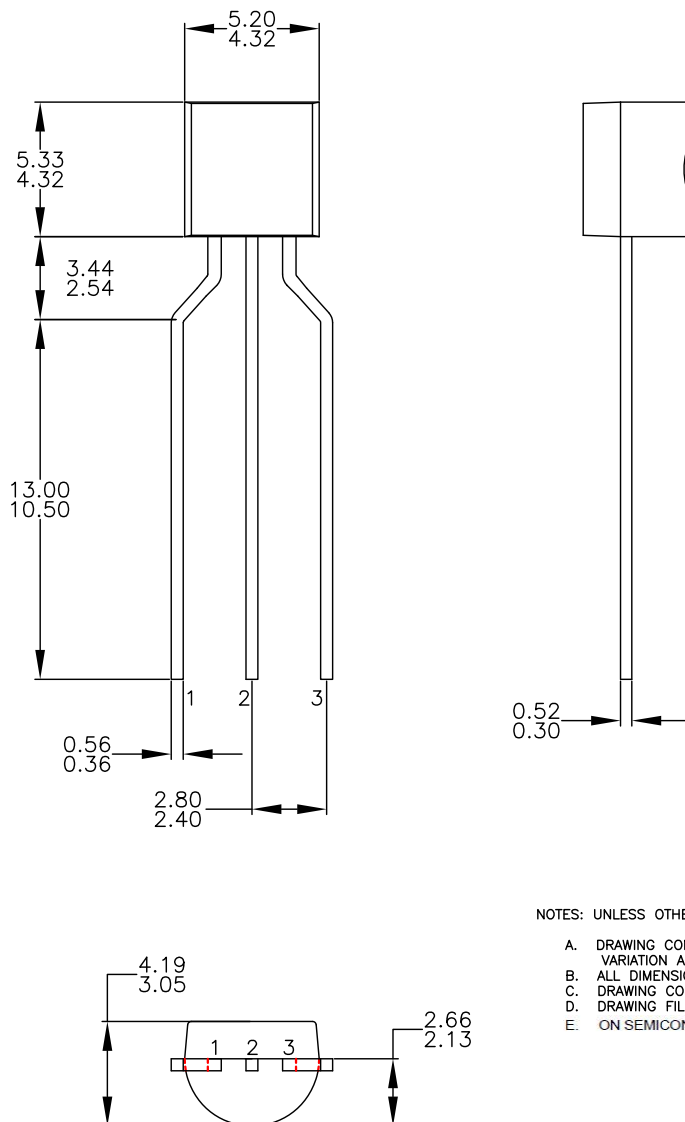


Figure 15. Common Emitter Characteristics

## Physical Dimensions

## TO-92 3L (Tape and Reel, Ammo)



NOTES: UNLESS OTHERWISE SPECIFIED

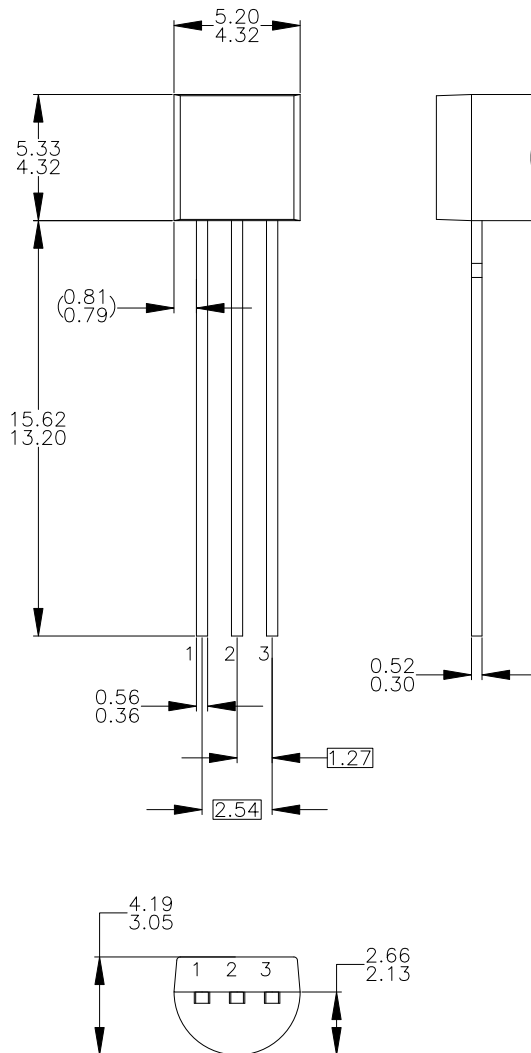
- A. DRAWING CONFORMS TO JEDEC MS-013, VARIATION AC.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5M-2009.
- D. DRAWING FILENAME: MKT-ZA03FREV3.
- E. ON SEMICONDUCTOR

**Figure 16. 3-LEAD, TO-92, MOLDED 0.200 IN LINE SPACING LD FORM (J61Z OPTION) (ACTIVE)**

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Physical Dimensions (Continued)

TO-92 3L (Bulk)



NOTES: UNLESS OTHERWISE SPECIFIED

- A) DRAWING WITH REFERENCE TO JEDEC TO-92 RECOMMENDATIONS.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DRAWING CONFORMS TO ASME Y14.5M-1994.
- D) TO-92 (92,94,96,97,98) PIN CONFIGURATION:

| PIN | 92 |   |   | 94 |   |   | 96 |   |   | 97 |   |   | 98 |   |   |
|-----|----|---|---|----|---|---|----|---|---|----|---|---|----|---|---|
|     | P  | F | M | P  | F | M | B  | F | M | P  | F | M | P  | F | M |
| 1   | E  | S | S | E  | S | S | B  | D | G | C  | G | D | C  | G | D |
| 2   | B  | D | G | C  | G | D | E  | S | S | B  | D | G | E  | S | S |
| 3   | C  | G | D | B  | D | G | C  | G | D | E  | S | S | B  | D | G |

LEGEND:

P - BIPOLAR E - EMITTER D - DRAIN  
F - JFET B - BASE S - SOURCE  
M - DMOS C - COLLECTOR G - GATE

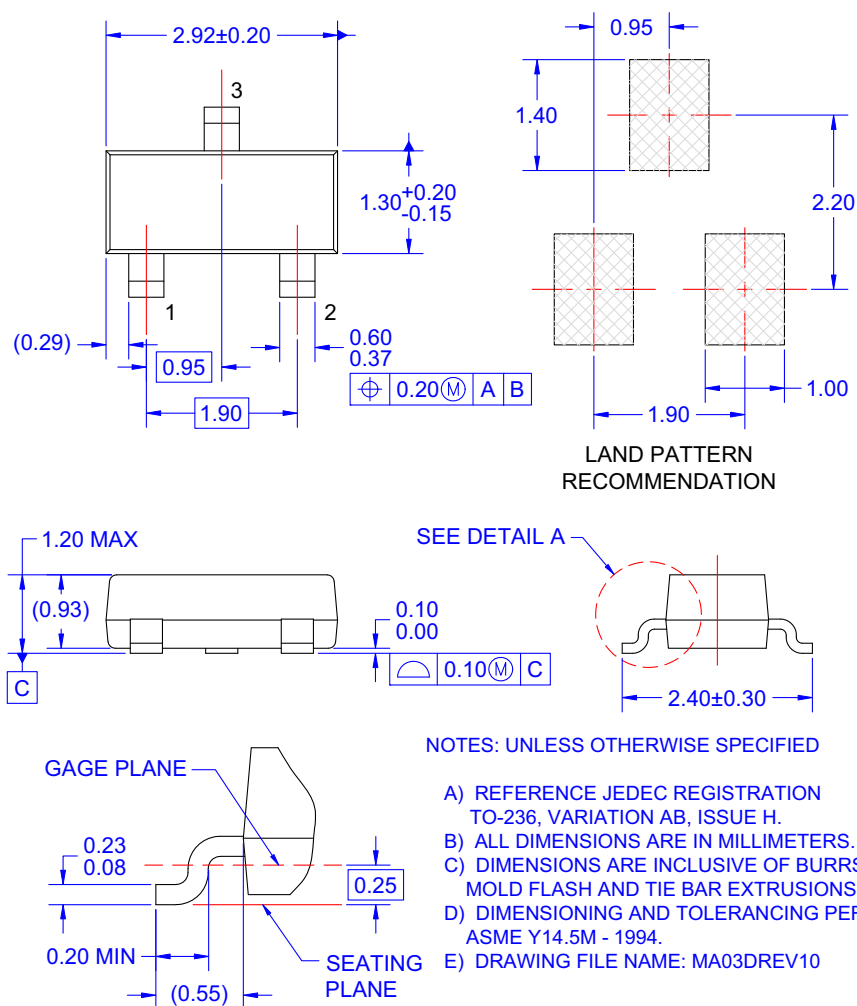
- E) FOR PACKAGE 92, 94, 96, 97 AND 98:  
PIN CONFIGURATION DRAIN "D" AND SOURCE "S"  
ARE INTERCHANGEABLE AT JFET "F" OPTION.
- F) DRAWING FILENAME: MKT-ZA03DREV3.

Figure 17. 3-LEAD, JEDEC TO-92 COMPLIANT STRAGHIT LEAD CONFIGURATION (OLD TO92AM3)

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## Physical Dimensions (Continued)

## SOT-23 3L



**DETAIL A**  
 SCALE: 2X

**Figure 18. 3-LEAD, SOT23, JEDEC TO-236, LOW PROFILE (ACTIVE)**

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