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ON Semiconductor®

# 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.

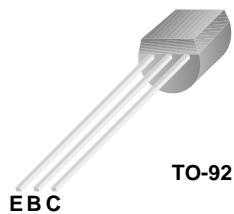


Figure 1. 2N4403 Device Package

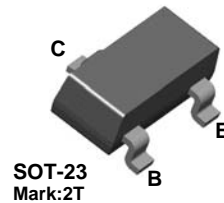


Figure 2. MMBT4403 Device Package

## 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:

1. These ratings are based on a maximum junction temperature of  $150^\circ\text{C}$ .
2. 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		$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	$^\circ\text{C}/\text{W}$

### Notes:

3. 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.
4. 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
<b>Off Characteristics</b>					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage <sup>(5)</sup>	$I_C = -1.0\text{ mA}, I_B = 0$	-40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = -0.1\text{ mA}, I_E = 0$	-40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = -0.1\text{ mA}, I_C = 0$	-5.0		V
$I_{BL}$	Base Cut-Off Current	$V_{CE} = -35\text{ V}, V_{EB} = -0.4\text{ V}$		-0.1	$\mu\text{A}$
$I_{CEX}$	Collector Cut-Off Current	$V_{CE} = -35\text{ V}, V_{EB} = -0.4\text{ V}$		-0.1	$\mu\text{A}$
<b>On Characteristics</b>					
$h_{FE}$	DC Current Gain	$I_C = -0.1\text{ mA}, V_{CE} = -1.0\text{ V}$	30		
		$I_C = -1.0\text{ mA}, V_{CE} = -1.0\text{ V}$	60		
		$I_C = -10\text{ mA}, V_{CE} = -1.0\text{ V}$	100		
		$I_C = -150\text{ mA}, V_{CE} = -2.0\text{ V}^{(5)}$	100	300	
		$I_C = -500\text{ mA}, V_{CE} = -2.0\text{ V}^{(5)}$	20		
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage <sup>(5)</sup>	$I_C = -150\text{ mA}, I_B = -15\text{ mA}$		-0.40	V
		$I_C = -500\text{ mA}, I_B = -50\text{ mA}$		-0.75	
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = -150\text{ mA}, I_B = -15\text{ mA}^{(5)}$	-0.75	-0.95	V
		$I_C = -500\text{ mA}, I_B = -50\text{ mA}$		-1.30	
<b>Small Signal Characteristics</b>					
$f_T$	Current Gain - Bandwidth Product	$I_C = -20\text{ mA}, V_{CE} = -10\text{ V}, f = 100\text{ MHz}$	200		MHz
$C_{cb}$	Collector-Base Capacitance	$V_{CB} = -10\text{ V}, I_E = 0, f = 140\text{ kHz}$		8.5	pF
$C_{eb}$	Emitter-Base Capacitance	$V_{BE} = -0.5\text{ V}, I_C = 0, f = 140\text{ kHz}$		30	pF
$h_{ie}$	Input Impedance	$I_C = -1.0\text{ mA}, V_{CE} = -10\text{ V}, f = 1.0\text{ kHz}$	1.5	15.0	$\text{k}\Omega$
$h_{re}$	Voltage Feedback Ratio	$I_C = -1.0\text{ mA}, V_{CE} = -10\text{ V}, f = 1.0\text{ kHz}$	0.1	8.0	$\times 10^{-4}$
$h_{fe}$	Small-Signal Current Gain	$I_C = -1.0\text{ mA}, V_{CE} = -10\text{ V}, f = 1.0\text{ kHz}$	60	500	
$h_{oe}$	Output Admittance	$I_C = -1.0\text{ mA}, V_{CE} = -10\text{ V}, f = 1.0\text{ kHz}$	1	100	$\mu\text{mhos}$
<b>Switching Characteristics</b>					
$t_d$	Delay Time	$V_{CC} = -30\text{ V}, I_C = -150\text{ mA}, I_{B1} = -15\text{ mA}$		15	ns
$t_r$	Rise Time			20	ns
$t_s$	Storage Time	$V_{CC} = -30\text{ V}, I_C = -150\text{ mA}, I_{B1} = I_{B2} = -15\text{ mA}$		225	ns
$t_f$	Fall Time			30	ns

**Note:**

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

## Typical Performance Characteristics

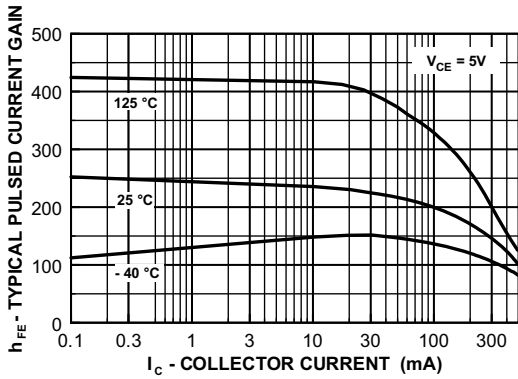


Figure 3. Typical Pulsed Current Gain vs. Collector Current

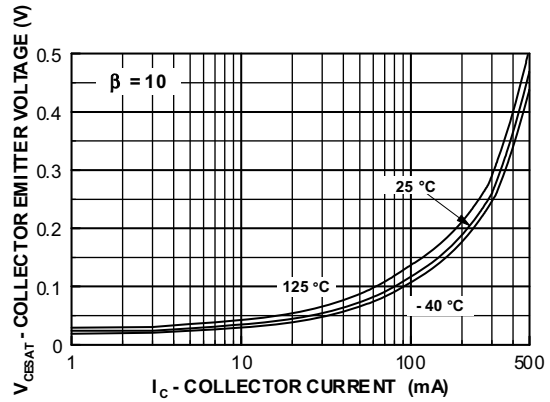


Figure 4. Collector-Emitter Saturation Voltage vs. Collector Current

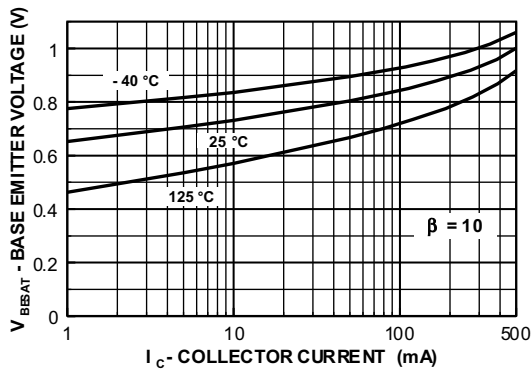


Figure 5. Base-Emitter Saturation Voltage vs. Collector Current

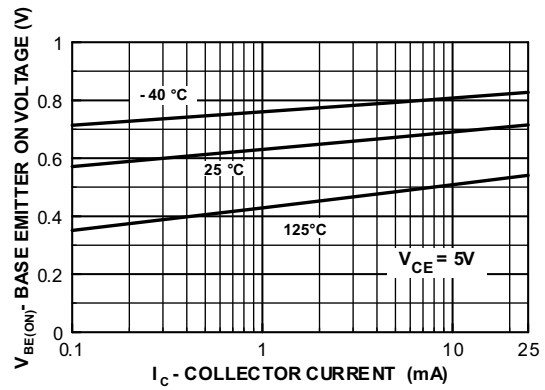


Figure 6. Base-Emitter On Voltage vs. Collector Current

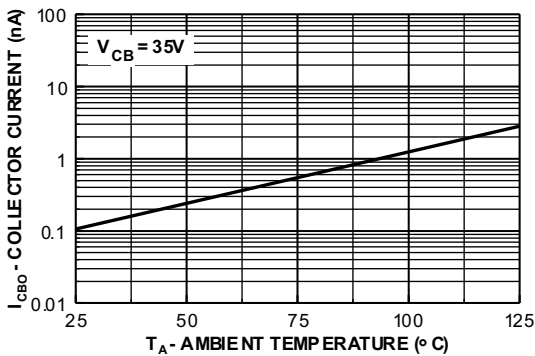


Figure 7. Collector Cut-Off Current vs. Ambient Temperature

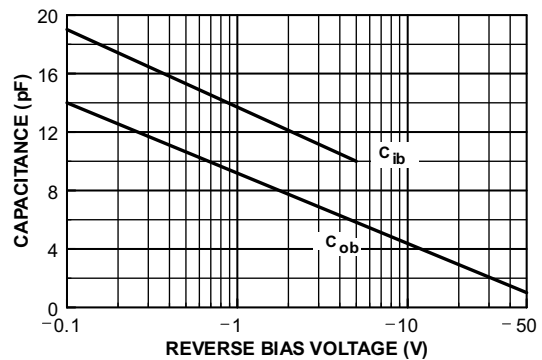
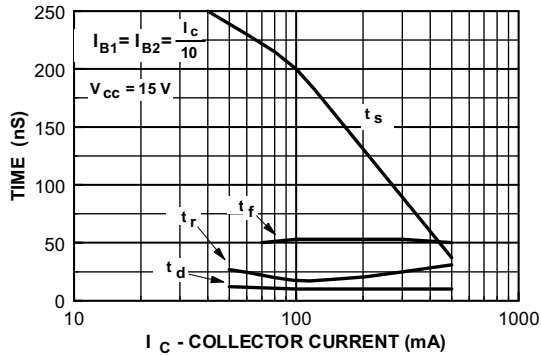
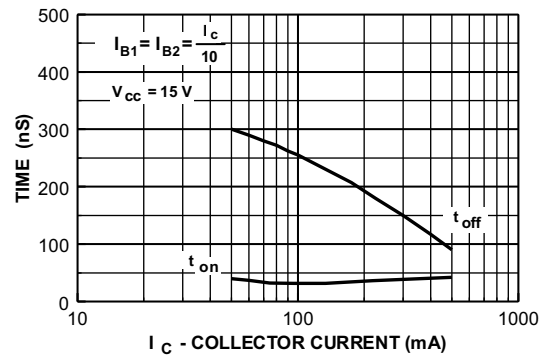


Figure 8. Input and Output Capacitance vs. Reverse Bias Voltage

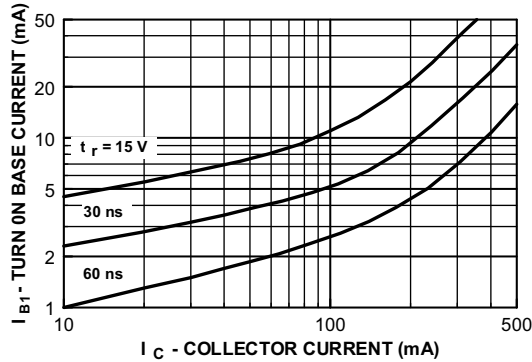
**Typical Performance Characteristics** (Continued)



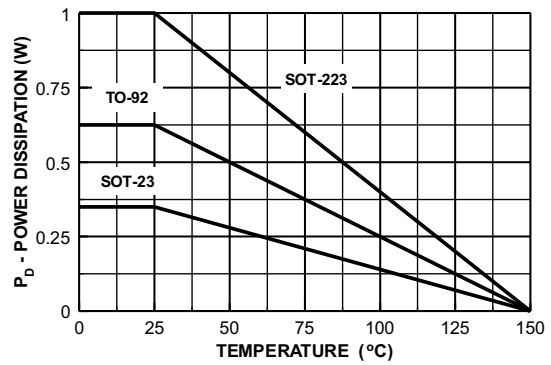
**Figure 9. Switching Times vs. Collector Current**



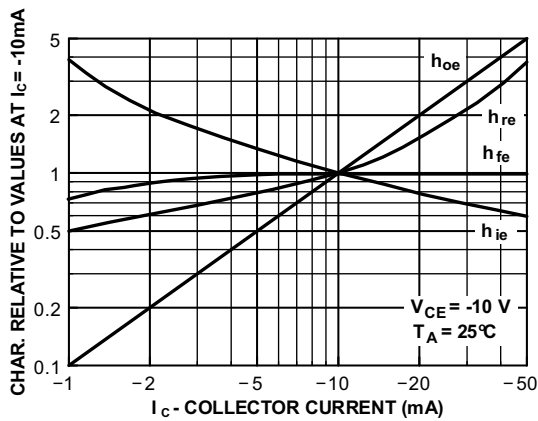
**Figure 10. Turn-On and Turn-Off Times vs. Collector Current**



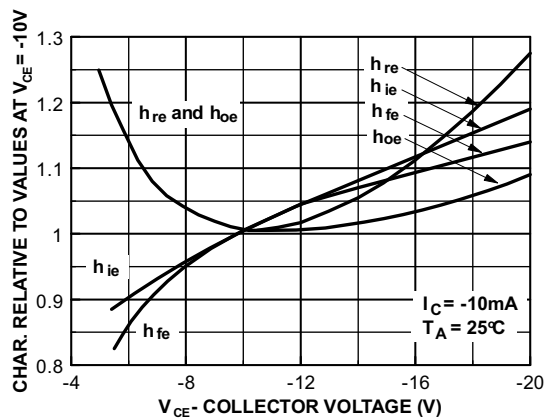
**Figure 11. Rise Time vs. Collector and Turn-On Base Currents**



**Figure 12. Power Dissipation vs. Ambient Temperature**



**Figure 13. Common Emitter Characteristics**



**Figure 14. Common Emitter Characteristics**

Typical Performance Characteristics (Continued)

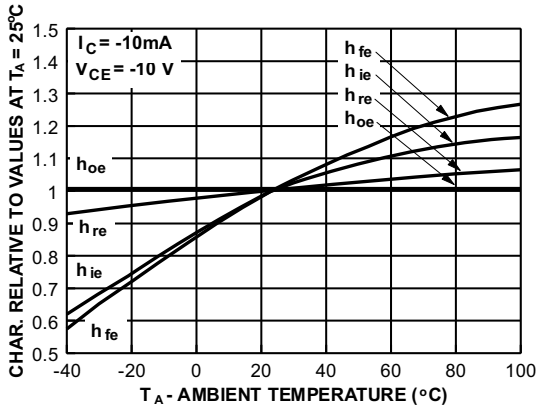
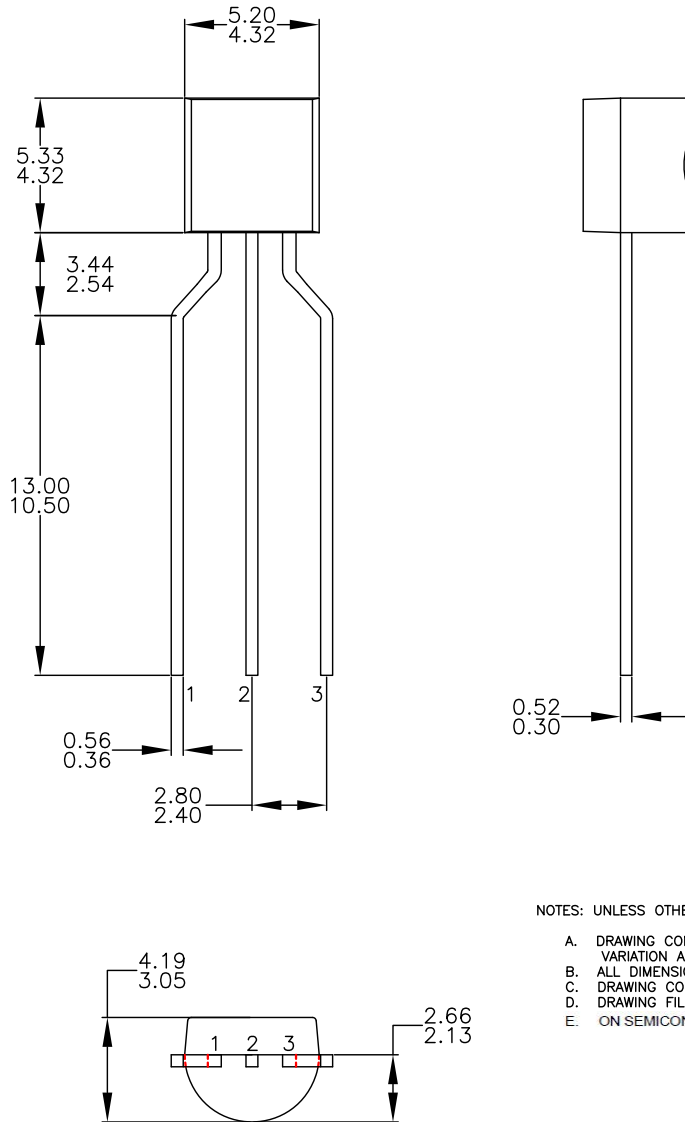


Figure 15. Common Emitter Characteristics

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

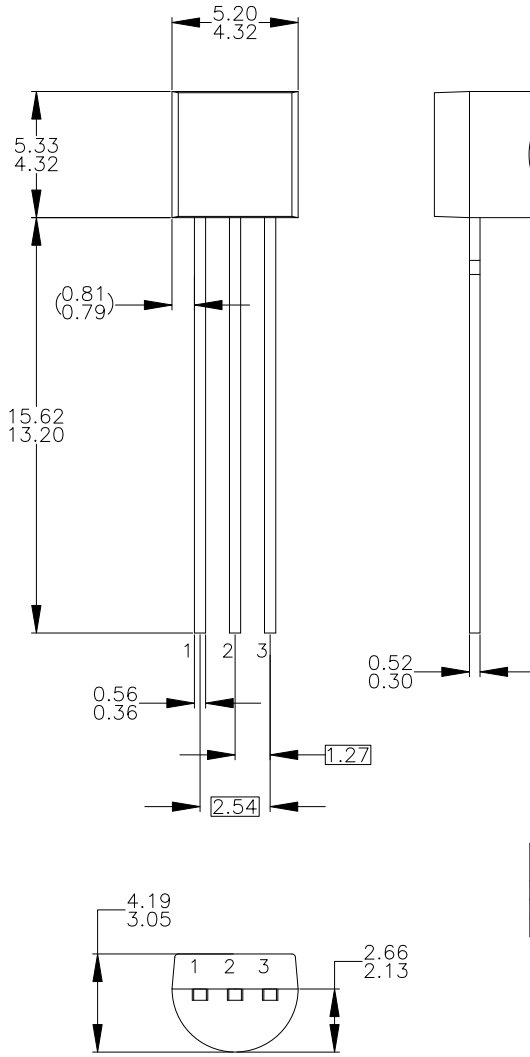
Figure 16. 3-LEAD, TO-92, MOLDED 0.200 IN LINE SPACING LD FORM (J61Z OPTION) (ACTIVE)

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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

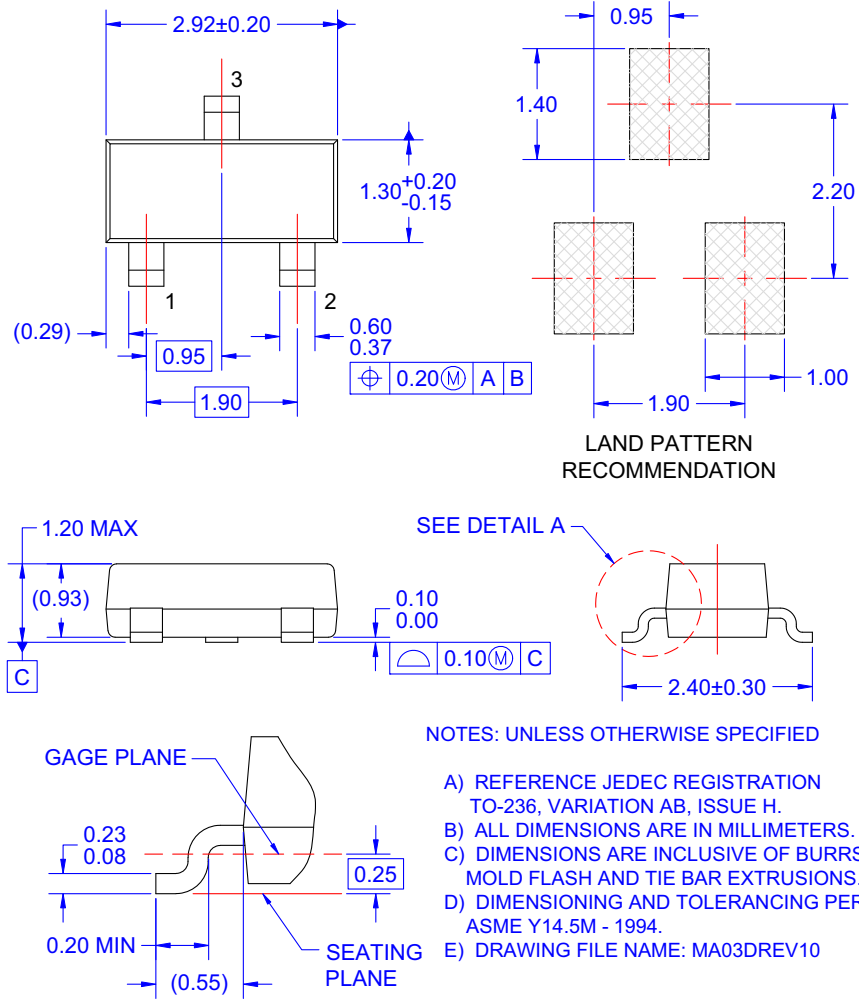
- E) FOR PACKAGE 92, 94, 96, 97 AND 98: PIN CONFIGURATION DRAIN "D" AND SOURCE "S" ARE INTERCHANGEABLE AT JFET "F" OPTION.
- F) DRAWING FILENAME: MKT-ZA03DREV3.

**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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