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November 2014

2N4401 / MMBT4401 NPN General-Purpose Amplifier

Description

This device is designed for use as a medium power amplifier and switch requiring collector currents up to 500 mA.

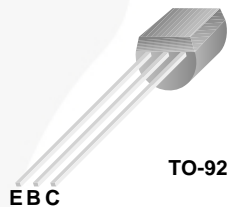


Figure 1. 2N4401 Device Package

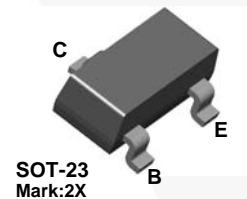


Figure 2. MMBT4401 Device Package

Ordering Information

| Part Number | Marking | Package | Packing Method |
|-------------|---------|-----------|----------------|
| 2N4401BU | 2N4401 | TO-92 3L | Bulk |
| 2N4401TF | 2N4401 | TO-92 3L | Tape and Reel |
| 2N4401TFR | 2N4401 | TO-92 3L | Tape and Reel |
| 2N4401TA | 2N4401 | TO-92 3L | Ammo |
| 2N4401TAR | 2N4401 | TO-92 3L | Ammo |
| MMBT4401 | 2X | SOT-23 3L | Tape and Reel |

2N4401 / MMBT4401 — NPN General-Purpose Amplifier

Absolute Maximum Ratings^{(1),(2)}

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 | 60 | V |
| V_{EBO} | Emitter-Base Voltage | 6.0 | 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°C .
2. These are steady-state limits. Fairchild 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 |
|-----------------|-----------------------------------------|-----------------------|-------------------------|---------------------------|
| | | 2N4401 ⁽³⁾ | MMBT4401 ⁽⁴⁾ | |
| P_D | Total Device Dissipation | 625 | 350 | mW |
| | Derate Above 25°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 |
|---------------|-----------------------------------------------------|----------------------------------------------------------------------------------------------|------|------|------------------|
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage ⁽⁵⁾ | $I_C = 1.0\text{ mA}, I_B = 0$ | 40 | | V |
| $V_{(BR)CBO}$ | Collector-Base Breakdown Voltage | $I_C = 0.1\text{ mA}, I_E = 0$ | 60 | | V |
| $V_{(BR)EBO}$ | Emitter-Base Breakdown Voltage | $I_E = 0.1\text{ mA}, I_C = 0$ | 6.0 | | V |
| I_{BL} | Base Cut-Off Current | $V_{CE} = 35\text{ V}, V_{EB} = 0.4\text{ V}$ | | 0.1 | μA |
| I_{CEX} | Collector Cut-Off Current | $V_{CE} = 35\text{ V}, V_{EB} = 0.4\text{ V}$ | | 0.1 | μA |
| h_{FE} | DC Current Gain ⁽⁵⁾ | $I_C = 0.1\text{ mA}, V_{CE} = 1.0\text{ V}$ | 20 | | |
| | | $I_C = 1.0\text{ mA}, V_{CE} = 1.0\text{ V}$ | 40 | | |
| | | $I_C = 10\text{ mA}, V_{CE} = 1.0\text{ V}$ | 80 | | |
| | | $I_C = 150\text{ mA}, V_{CE} = 1.0\text{ V}$ | 100 | 300 | |
| | | $I_C = 500\text{ mA}, V_{CE} = 2.0\text{ V}$ | 40 | | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage ⁽⁵⁾ | $I_C = 150\text{ mA}, I_B = 15\text{ mA}$ | | 0.40 | V |
| | | $I_C = 500\text{ mA}, I_B = 50\text{ mA}$ | | 0.75 | |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage ⁽⁵⁾ | $I_C = 150\text{ mA}, I_B = 15\text{ mA}$ | 0.75 | 0.95 | V |
| | | $I_C = 500\text{ mA}, I_B = 50\text{ mA}$ | | 1.20 | |
| f_T | Current Gain - Bandwidth Product | $I_C = 20\text{ mA}, V_{CE} = 10\text{ V},$ $f = 100\text{ MHz}$ | 250 | | MHz |
| C_{cb} | Collector-Base Capacitance | $V_{CB} = 5.0\text{ V}, I_E = 0,$ $f = 140\text{ kHz}$ | | 6.5 | 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 | $I_C = 1.0\text{ mA}, V_{CE} = 10\text{ V},$ $f = 1.0\text{ kHz}$ | 1.0 | 15.0 | $k\Omega$ |
| 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 | $I_C = 1.0\text{ mA}, V_{CE} = 10\text{ V},$ $f = 1.0\text{ kHz}$ | 40 | 500 | |
| h_{oe} | Output Admittance | $I_C = 1.0\text{ mA}, V_{CE} = 10\text{ V},$ $f = 1.0\text{ kHz}$ | 1.0 | 30 | μmhos |
| t_d | Delay Time | $V_{CC} = 30\text{ V}, V_{EB} = 2\text{ V},$ $I_C = 150\text{ mA}, I_{B1} = 15\text{ mA}$ | | 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

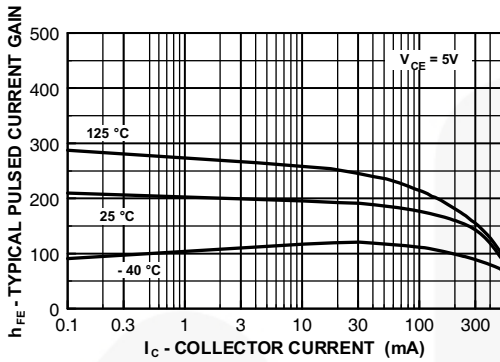


Figure 3. Typical Pulsed Current Gain vs. Collector Current

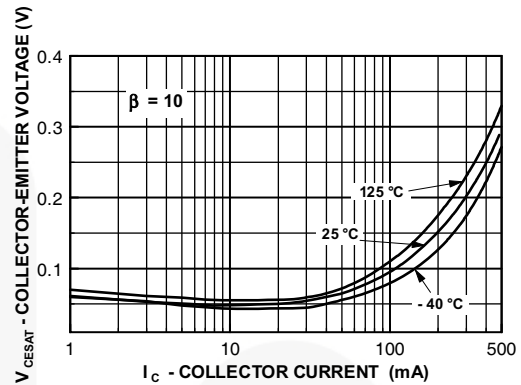


Figure 4. Collector-Emitter Saturation Voltage vs. Collector Current

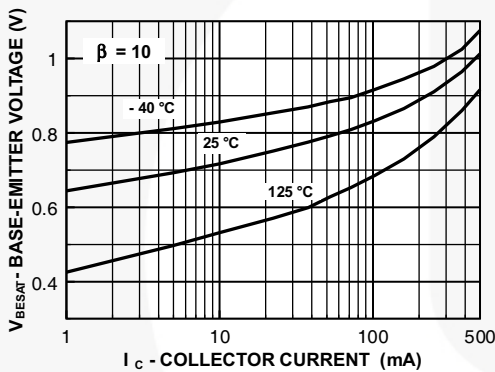


Figure 5. Base-Emitter Saturation Voltage vs. Collector Current

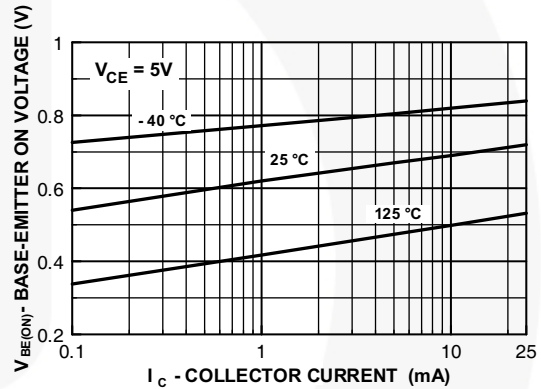


Figure 6. Base-Emitter On Voltage vs. Collector Current

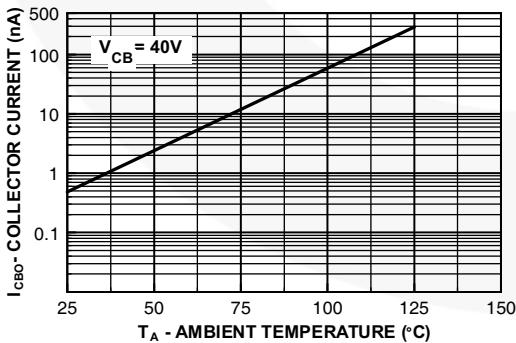


Figure 7. Collector Cut-Off Current vs. Ambient Temperature

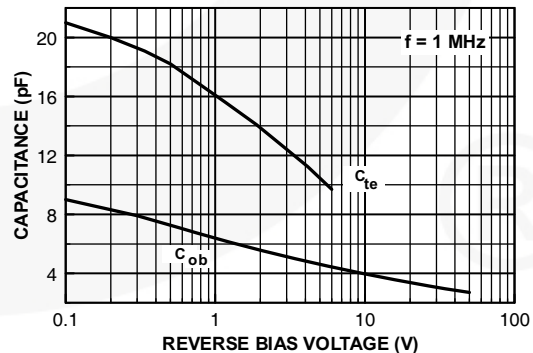


Figure 8. Emitter Transition and Output Capacitance vs. Reverse Bias Voltage

Typical Performance Characteristics (Continued)

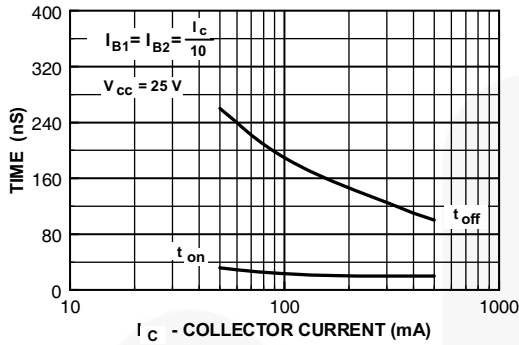


Figure 9. Turn-On and Turn-Off Times vs. Collector Current

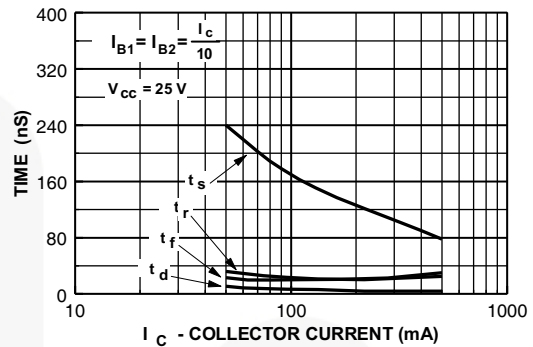


Figure 10. Switching Times vs. Collector Current

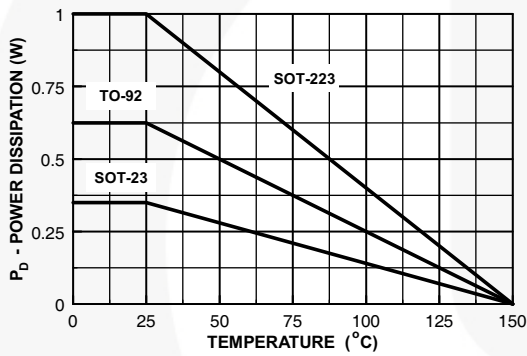


Figure 11. Power Dissipation vs. Ambient Temperature

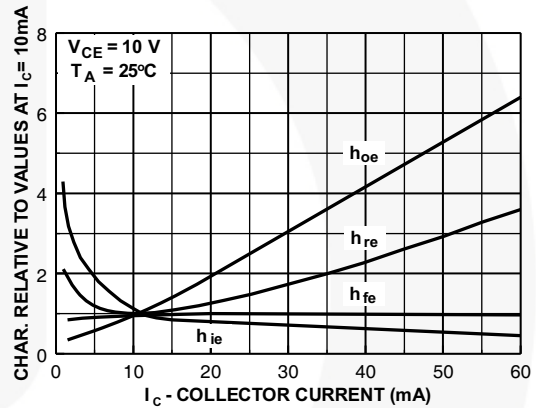


Figure 12. Common Emitter Characteristics

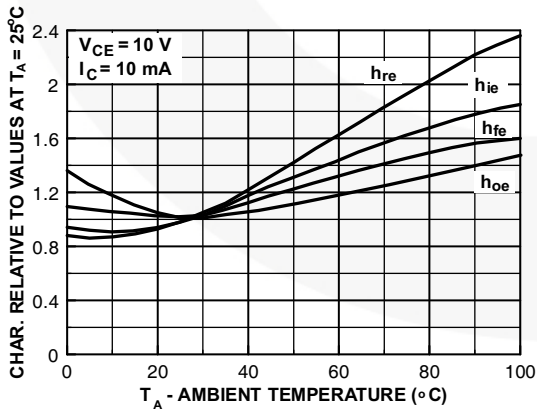


Figure 13. Common Emitter Characteristics

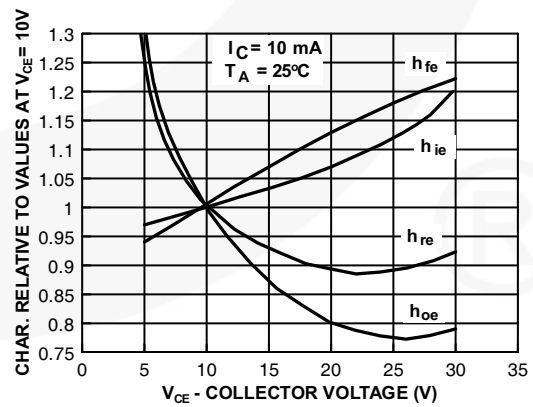
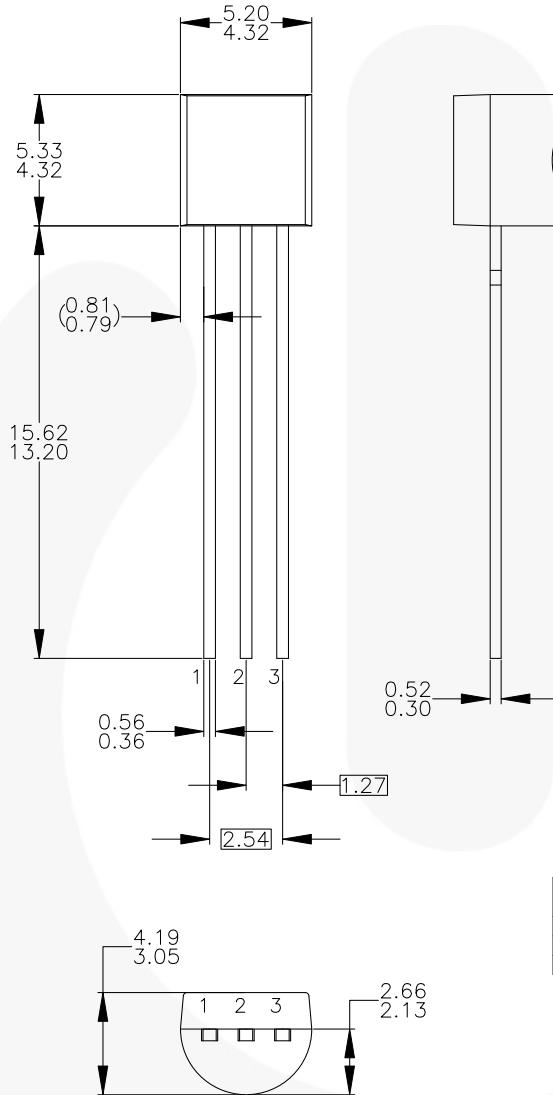


Figure 14. Common Emitter Characteristics

Physical Dimensions



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 15. 3-Lead, TO-92, JEDEC TO-92 Compliant Straight Lead Configuration, Bulk Type

Physical Dimensions (Continued)

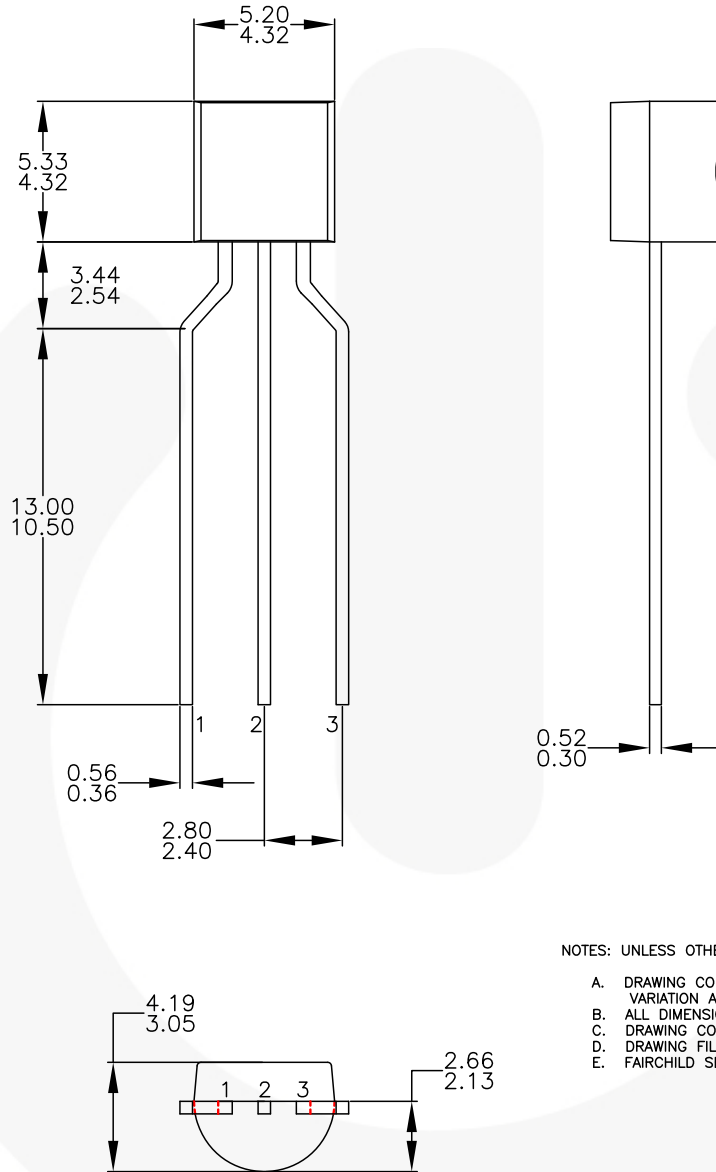


Figure 16. 3-Lead, TO-92, Molded, 0.2 In Line Spacing Lead Form, Ammo, Tape and Reel Type

Physical Dimensions (Continued)

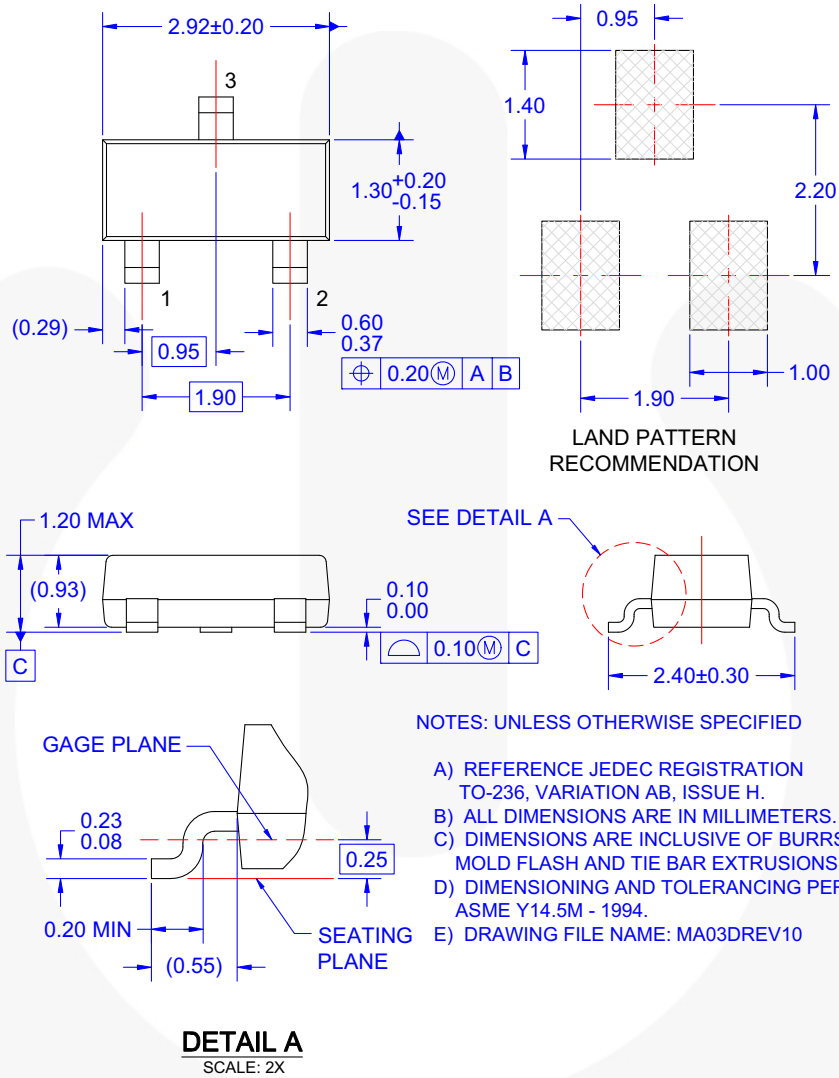


Figure 17. 3-LEAD, SOT23, JEDEC TO-236, LOW PROFILE