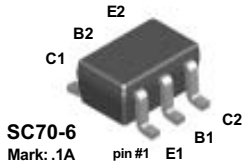
ON Semiconductor®

# FFB3904 / FMB3904 / MMPQ3904
# NPN Multi-Chip General Purpose Amplifier

## Description

This device is designed as a general-purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier. Sourced from Process 23.

## Block Diagram




The pinouts are symmetrical; pin 1 and pin 4 are interchangeable. Units inside the carrier tape can be of either orientation (0 deg and 180 deg) and will not affect the functionality of the device.

**Figure 1. FFB3904 Device Package**

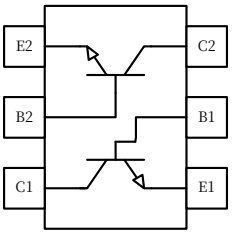



**Figure 2. FFB3904 Internal Connection**

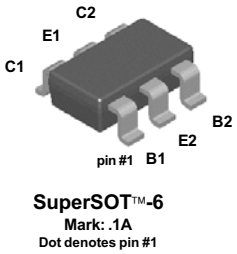



**Figure 3. FMB3904 Device Package**

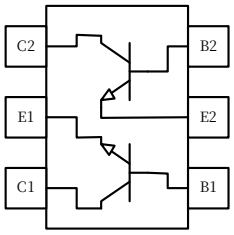



**Figure 4. FMB3904 Internal Connection**

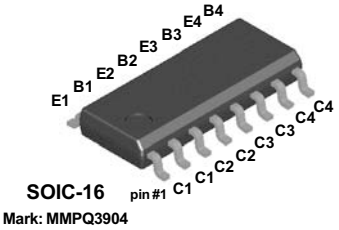



**Figure 5. MMPQ3904 Device Package**

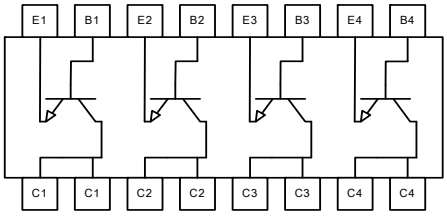



**Figure 6. MMPQ3904 Internal Connection**

## Ordering Information

| Part Number | Top Mark | Package | Packing Method |
|---|---|---|---|
| FFB3904 | .1A | SC70 6L | Tape and Reel |
| FMB3904 | .1A | SSOT 6L | Tape and Reel |
| MMPQ3904 | MMPQ3904 | SOIC 16L | Tape and Reel |

## Absolute Maximum Ratings(1)

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°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 | 200 | mA |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to +150 | °C |

**Note:**

1. These ratings are based on a maximum junction temperature of 150°C. These are steady-state limits. ON Semiconductor should be consulted on applications involving pulsed or low-duty cycle operations.

## Thermal Characteristics(2)

Values are at $T_A$ = 25°C unless otherwise noted.

| Symbol | Parameter | Max. | | | Unit |
|---|---|---|---|---|---|
| | | FFB3904 | FMB3904 | MMPQ3904 | |
| $P_D$ | Total Device Dissipation | 300 | 700 | 1,000 | mW |
| | Derate above 25°C | 2.4 | 5.6 | 8.0 | mW/°C |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 415 | 180 | | °C/W |
| | Thermal Resistance, Junction to Ambient, Effective 4 Die | | | 125 | |
| | Thermal Resistance, Junction to Ambient, Each Die | | | 240 | |

**Note:**

2. PCB size: FR-4 76 x 114 x 0.6T $mm^3$ (3.0 inch x 4.5 inch x 0.062 inch) with minimum land pattern size.

## Electrical Characteristics

Values are at $T_A$ = 25°C unless otherwise noted.

| Symbol | Parameter | | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | | |
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage | | $I_C$ = 1.0 mA, $I_B$ = 0 | 40 | | | V |
| $V_{(BR)CBO}$ | Collector-Base Breakdown Voltage | | $I_C$ = 10 μA, $I_E$ = 0 | 60 | | | V |
| $V_{(BR)EBO}$ | Emitter-Base Breakdown Voltage | | $I_E$ = 10 μA, $I_C$ = 0 | 6.0 | | | V |
| $I_{BL}$ | Base Cut-Off Current | | $V_{CE}$ = 30 V, $V_{BE}$ = -3 V | | | 50 | nA |
| $I_{CEX}$ | Collector Cut-Off Current | | $V_{CE}$ = 30 V, $V_{BE}$ = -3 V | | | 50 | nA |
| **On Characteristics**[3] | | | | | | | |
| $h_{FE}$ | DC Current Gain | FFB3904, FMB3904 | $I_C$ = 0.1 mA, $V_{CE}$ = 1.0 V | 40 | | | |
| | | MMPQ3904 | | 30 | | | |
| | | FFB3904, FMB3904 | $I_C$ = 1.0 mA, $V_{CE}$ = 1.0 V | 70 | | | |
| | | MMPQ3904 | | 50 | | | |
| | | FFB3904, FMB3904 | $I_C$ = 10 mA, $V_{CE}$ = 1.0 V | 100 | | 300 | |
| | | MMPQ3904 | | 75 | | | |
| | | All Devices | $I_C$ = 50 mA, $V_{CE}$ = 1.0 V | 60 | | | |
| | | All Devices | $I_C$ = 100 mA, $V_{CE}$ = 1.0 V | 30 | | | |
| $V_{CE}$(sat) | Collector-Emitter Saturation Voltage | | $I_C$ = 10 mA, $I_B$ = 1.0 mA | | | 0.2 | V |
| | | | $I_C$ = 50 mA, $I_B$ = 5.0 mA | | | 0.3 | |
| $V_{BE}$(sat) | Base-Emitter Saturation Voltage | | $I_C$ = 10 mA, $I_B$ = 1.0 mA | 0.65 | | 0.85 | V |
| | | | $I_C$ = 50 mA, $I_B$ = 5.0 mA | | | 0.95 | |
| **Small-Signal Characteristics (MMPQ3904 only)** | | | | | | | |
| $f_T$ | Current Gain-Bandwidth Product | | $I_C$ = 10 mA, $V_{CE}$ = 20 V, f = 100 MHz | | 250 | | MHz |
| $C_{ob}$ | Output Capacitance | | $V_{CB}$ = 5.0 V, $I_E$ = 0, f = 140 kHz | | 4.0 | | pF |
| $C_{ib}$ | Input Capacitance | | $V_{BE}$ = 0.5 V, $I_C$ = 0, f = 140 kHz | | 8.0 | | pF |

**Note:**

3. Pulse test: pulse width ≤ 300 μs, duty cycle ≤ 2.0%.

## Typical Performance Characteristics

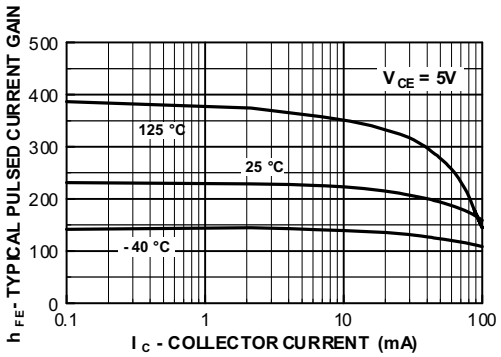



**Figure 7. Typical Pulsed Current Gain vs. Collector Current**

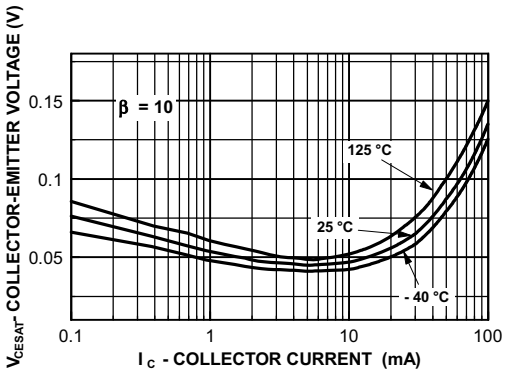



**Figure 8. Collector-Emitter Saturation Voltage vs. Collector Current**

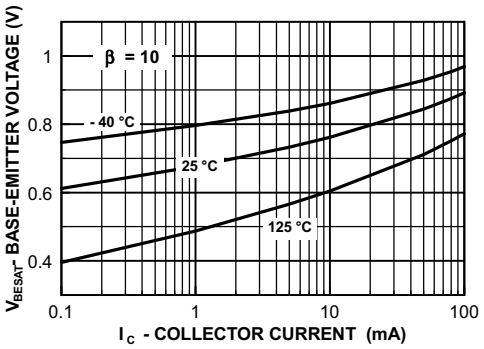



**Figure 9. Base-Emitter Saturation Voltage vs. Collector Current**

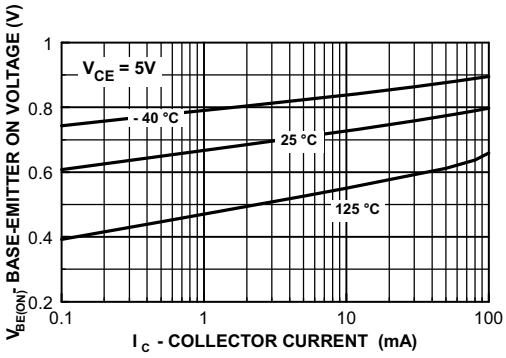



**Figure 10. Base-Emitter On Voltage vs. Collector Current**

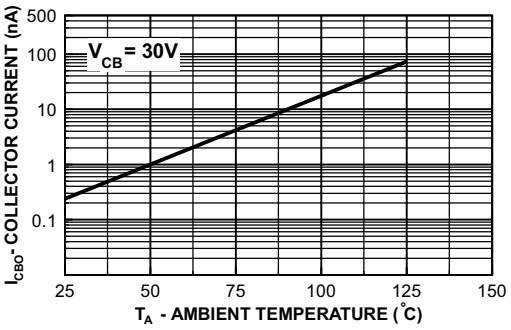



**Figure 11. Collector Cut-Off Current vs. Ambient Temperature**

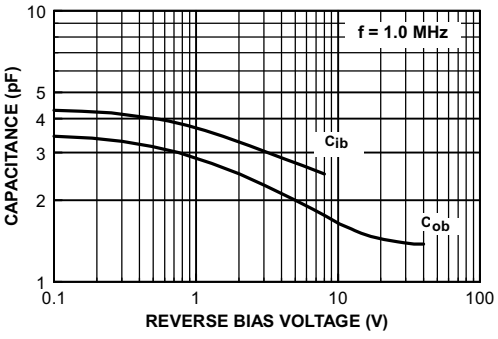



**Figure 12. Capacitance vs. Reverse Bias Voltage**

## Typical Performance Characteristics (Continued)

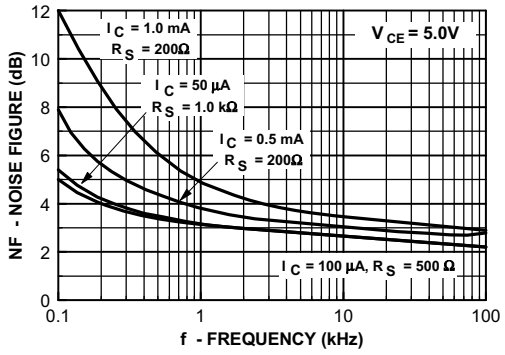



**Figure 13. Noise Figure vs. Frequency**

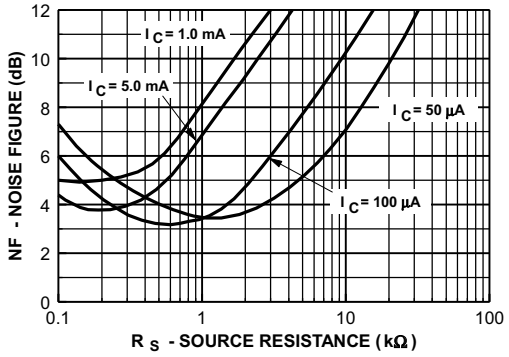



**Figure 14. Noise Figure vs. Source Resistance**

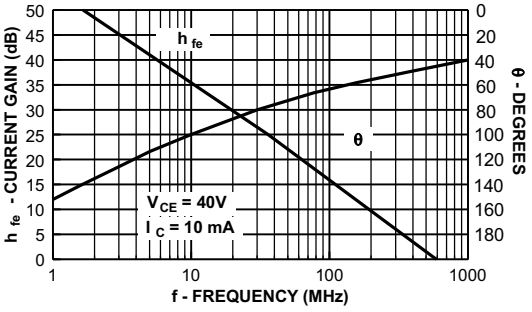



**Figure 15. Current Gain and Phase Angle vs. Frequency**

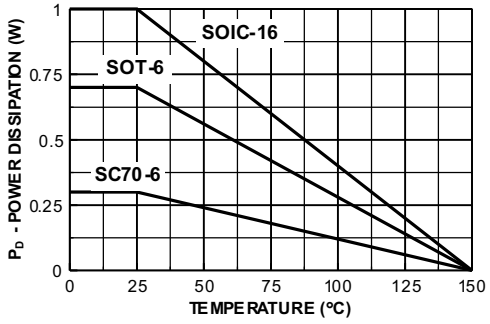



**Figure 16. Power Dissipation vs. Ambient Temperature**

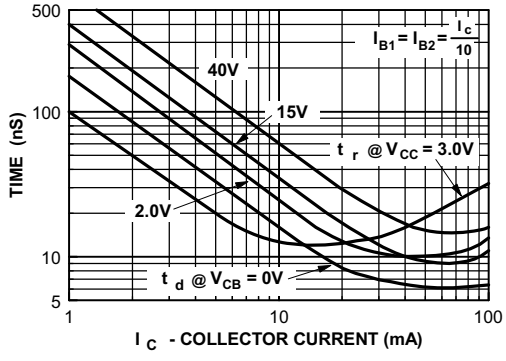



**Figure 17. Turn-On Time vs. Collector Current**

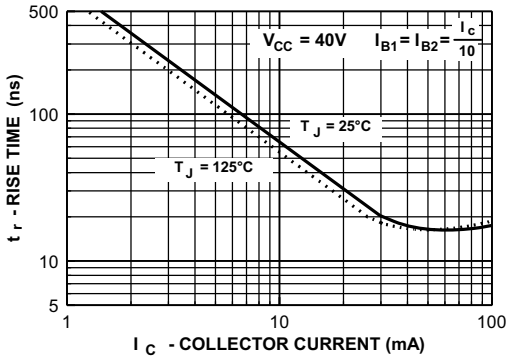



**Figure 18. Rise Time vs. Collector Current**

## Typical Performance Characteristics (Continued)

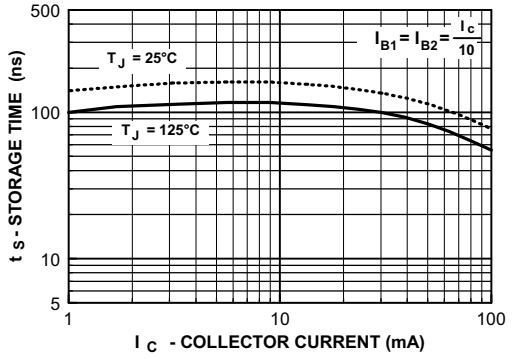



**Figure 19. Storage Time vs. Collector Current**

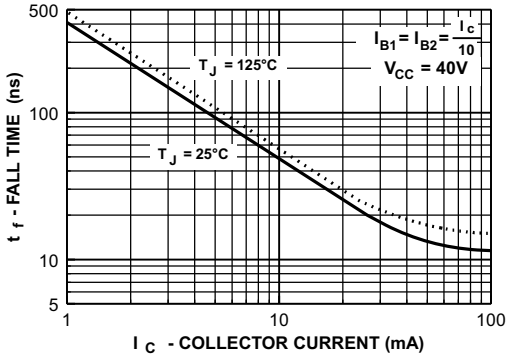



**Figure 20. Fall Time vs. Collector Current**

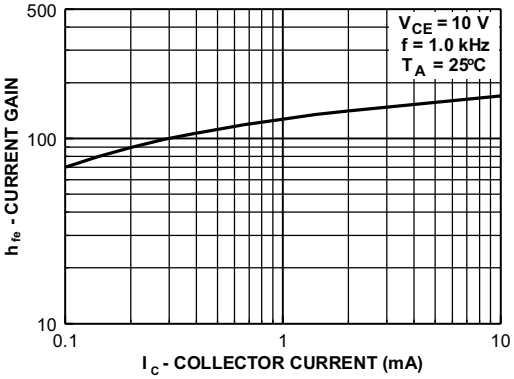



**Figure 21. Current Gain**

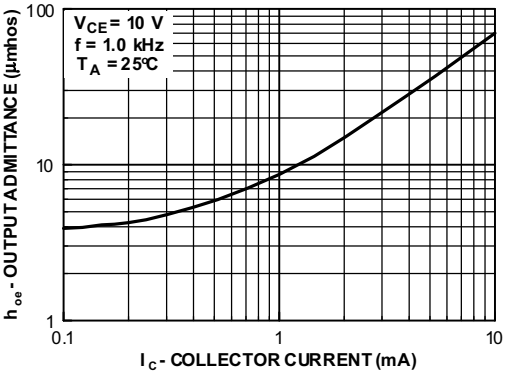



**Figure 22. Output Admittance**

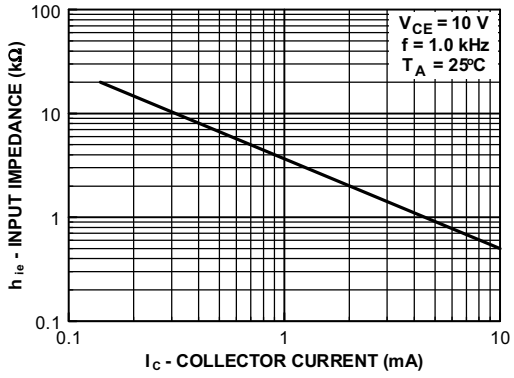



**Figure 23. Input Impedance**

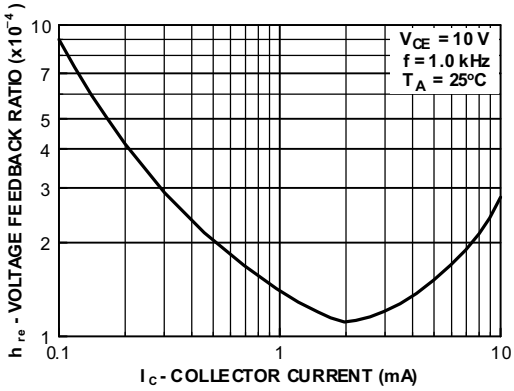



**Figure 24. Voltage Feedback Ratio**

## Physical Dimensions

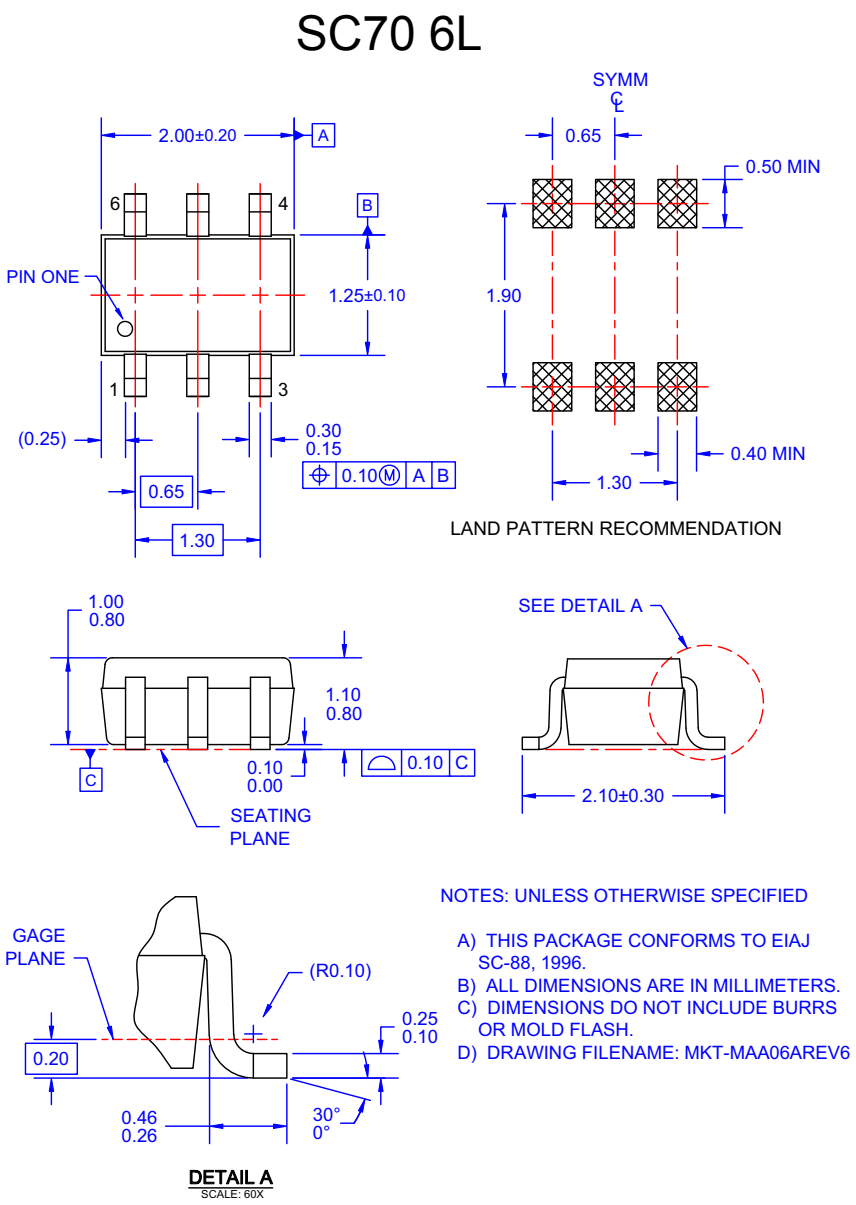



**Figure 25. 6-LEAD, SC70, EIAJ SC-88, 1.25 MM WIDE (ACTIVE)**

## Physical Dimensions (Continued)

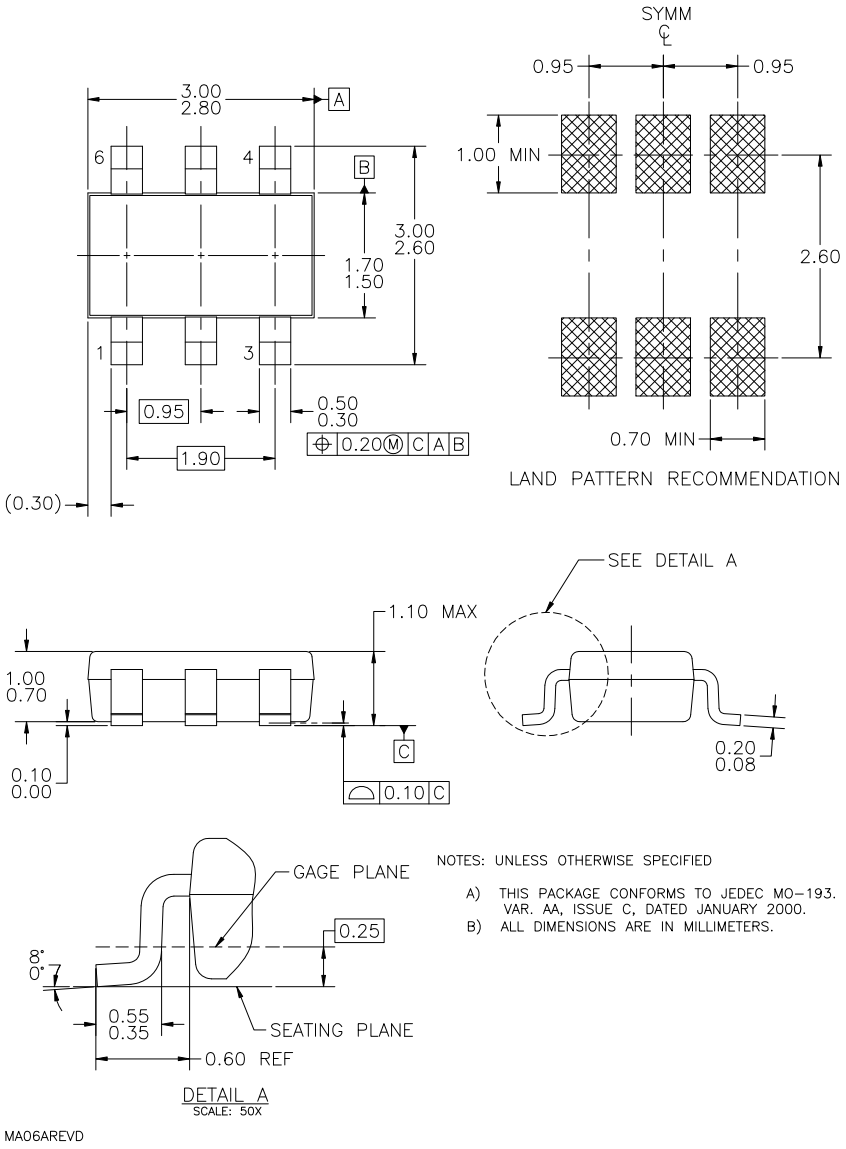



**Figure 26. 6-LEAD, SUPERSOT-6, JEDEC MO-193, 1.6 MM WIDE (ACTIVE)**

## Physical Dimensions (Continued)

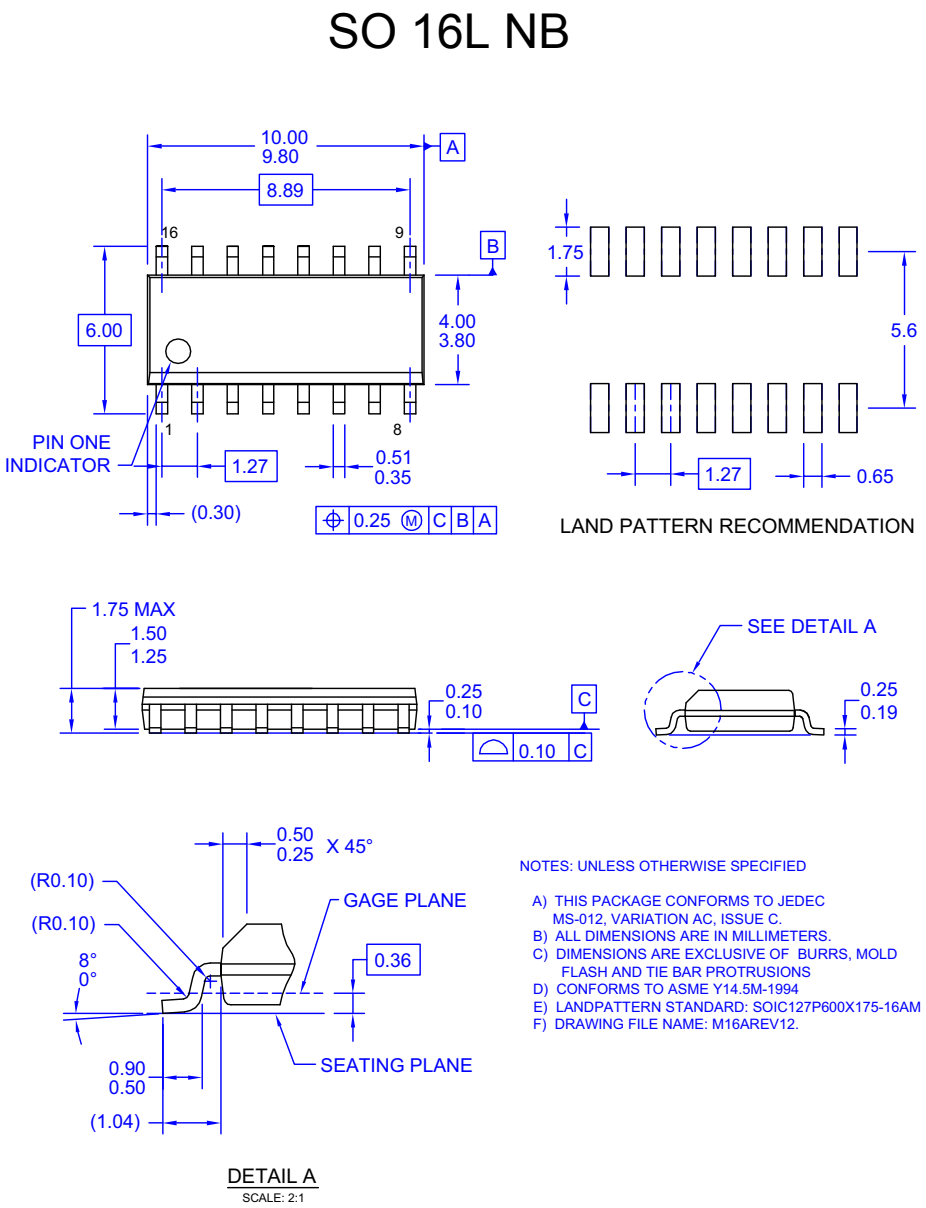



**Figure 27. 16-LEAD, SOIC, JEDEC MS-012, 0.150 inch, NARROW BODY (ACTIVE)**

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