



ON Semiconductor®

# NC7SZU04 TinyLogic® UHS Unbuffered Inverter

## Features

- Unbuffered for Crystal Oscillator and Analog Applications
- Balanced Output Drive:  $\pm 16\text{mA}$  at 4.5V  $V_{CC}$
- Broad  $V_{CC}$  Operating Range: 1.65V to 5.5V
- Matches Performance of LCX Operated at 3.3V  $V_{CC}$
- Low Quiescent Power:  $I_{CC} < 2\mu\text{A}$ ,  $V_{CC} = 5.5\text{V}$ ,  $T_A = 25^\circ\text{C}$
- Ultra-Small MicroPak™ Packages
- Space-Saving SOT23 and SC70 Packages

## Description

The NC7SZU04 is a single unbuffered inverter from ON Semiconductor's Ultra-High Speed series of TinyLogic®. The special purpose unbuffered circuit design is primarily intended for crystal oscillator or analog applications. The device is fabricated with advanced CMOS technology to achieve ultra-high speed with high output drive while maintaining low static power dissipation over a broad  $V_{CC}$  operating range. The device is specified to operate over the 1.65V to 5.5V  $V_{CC}$  range.

## Ordering Information

| Part Number | Top Mark |  Eco Status | Package                                    | Packing Method            |
|-------------|----------|--|--|---------------------------|
| NC7SZU04M5X | 7ZU4     | RoHS   | 5-Lead SOT23, JEDEC MO-178 1.6mm           | 3000 Units on Tape & Reel |
| NC7SZU04P5X | ZU4      | RoHS   | 5-Lead SC70, EIAJ SC-88a, 1.25mm Wide      | 3000 Units on Tape & Reel |
| NC7SZU04L6X | C5       | RoHS   | 6-Lead MicroPak™, 1.00mm Wide              | 5000 Units on Tape & Reel |
| NC7SZU04FHX | C5       | Green  | 6-Lead, MicroPak2, 1x1mm Body, .35mm Pitch | 5000 Units on Tape & Reel |

## Connection Diagrams

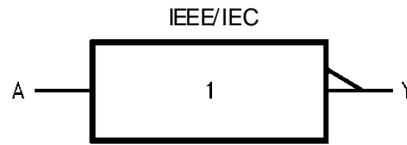


Figure 1. Logic Symbol

## Pin Configurations

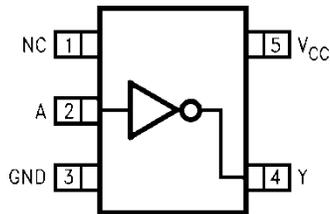


Figure 2. SC70 and SOT23 (Top View)

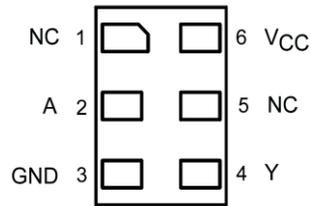


Figure 3. MicroPak (Top Through View)

## Pin Definitions

| Pin # SC70 / SOT23 | Pin # MicroPak | Name            | Description    |
|--------------------|----------------|-----------------|----------------|
| 1                  | 1,5            | NC              | No Connect     |
| 2                  | 2              | A               | Input          |
| 3                  | 3              | GND             | Ground         |
| 4                  | 4              | Y               | Output         |
| 5                  | 6              | V <sub>CC</sub> | Supply Voltage |

## Function Table

Y = /A

| Inputs | Output |
|--------|--------|
| A      | Y      |
| L      | H      |
| H      | L      |

H = HIGH Logic Level

L = LOW Logic Level

## Absolute Maximum Ratings

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.

| Symbol                              | Parameter   |   | Min. | Max. | Unit |
|-------------------------------------|---|---|------|------|------|
| V <sub>CC</sub>                     | Supply Voltage                                    |   | -0.5 | 6.0  | V    |
| V <sub>IN</sub>                     | DC Input Voltage                                  |   | -0.5 | 6.0  | V    |
| V <sub>OUT</sub>                    | DC Output Voltage                                 |   | -0.5 | 6.0  | V    |
| I <sub>IK</sub>                     | DC Input Diode Current                            | V <sub>IN</sub> < -0.5V                       |      | -50  | mA   |
|                                     |   | V <sub>IN</sub> > V <sub>CC</sub> +5.0V       |      | +20  |      |
| I <sub>OK</sub>                     | DC Output Diode Current                           | V <sub>OUT</sub> < -0.5V                      |      | -50  | mA   |
|                                     |   | V <sub>OUT</sub> > 0.5V, V <sub>CC</sub> =GND |      | +50  |      |
| I <sub>OUT</sub>                    | DC Output Current                                 |   |      | ±50  | mA   |
| I <sub>CC</sub> or I <sub>GND</sub> | DC V <sub>CC</sub> or Ground Current              |   |      | ±100 | mA   |
| T <sub>STG</sub>                    | Storage Temperature Range                         |   | -65  | +150 | °C   |
| T <sub>J</sub>                      | Junction Temperature Under Bias                   |   |      | +150 | °C   |
| T <sub>L</sub>                      | Junction Lead Temperature (Soldering, 10 Seconds) |   |      | +260 | °C   |
| P <sub>D</sub>                      | Power Dissipation at +85°C                        | SOT-23  |      | 200  | mW   |
|                                     |   | SC70-5  |      | 150  |      |
|                                     |   | MicroPak-6                                    |      | 130  |      |
|                                     |   | MicroPak2-6                                   |      | 120  |      |
| ESD                                 | Human Body Model, JEDEC:JESD22-A114               |   |      | 4000 | V    |
|                                     | Charge Device Model, JEDEC:JESD22-C101            |   |      | 2000 |      |

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. ON Semiconductor does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol           | Parameter                     | Conditions  | Min. | Max.            | Unit |
|------------------|-------------------------------|-------------|------|-----------------|------|
| V <sub>CC</sub>  | Supply Voltage Operating      |             | 1.65 | 5.50            | V    |
|                  | Supply Voltage Data Retention |             | 1.50 | 5.50            |      |
| V <sub>IN</sub>  | Input Voltage                 |             | 0    | 5.5             | V    |
| V <sub>OUT</sub> | Output Voltage                |             | 0    | V <sub>CC</sub> | V    |
| T <sub>A</sub>   | Operating Temperature         |             | -40  | +85             | °C   |
| θ <sub>JA</sub>  | Thermal Resistance            | SOT-23      |      | 300             | °C/W |
|                  |                               | SC70-5      |      | 425             |      |
|                  |                               | MicroPak-6  |      | 500             |      |
|                  |                               | MicroPak2-6 |      | 560             |      |

**Note:**

- Unused inputs must be held HIGH or LOW. They may not float.

### DC Electrical Characteristics

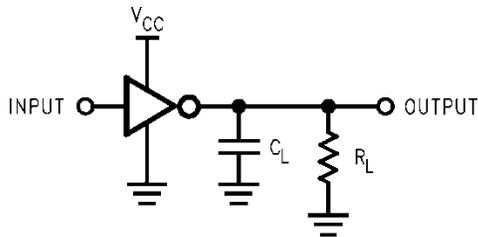
| Symbol              | Parameter                               | V <sub>CC</sub> | Conditions   | T <sub>A</sub> =+25°C  |      |                     | T <sub>A</sub> =-40 to +85°C |                     | Units |      |
|---------------------|---|-----------------|--|------------------------|------|---------------------|------------------------------|---------------------|-------|------|
|                     |   |                 |  | Min.                   | Typ. | Max.                | Min.                         | Max.                |       |      |
| V <sub>IH</sub>     | HIGH Level Input Voltage                | 1.8 to 2.7      |  | 0.85V <sub>CC</sub>    |      |                     | 0.85V <sub>CC</sub>          |                     | V     |      |
|                     |   | 3.0 to 5.5      |  | 0.80V <sub>CC</sub>    |      |                     | 0.80V <sub>CC</sub>          |                     |       |      |
| V <sub>IL</sub>     | LOW Level Input Voltage                 | 1.8 to 2.7      |  |                        |      | 0.15V <sub>CC</sub> |                              | 0.15V <sub>CC</sub> | V     |      |
|                     |   | 3.0 to 5.5      |  |                        |      | 0.20V <sub>CC</sub> |                              | 0.20V <sub>CC</sub> |       |      |
| V <sub>OH</sub>     | HIGH Level Output Voltage               | 1.65            | V <sub>IN</sub> =V <sub>IL</sub> , I <sub>OH</sub> =-100μA                       | 1.55                   | 1.65 |                     | 1.55                         |                     | V     |      |
|                     |   | 1.80            |  | 1.60                   | 1.80 |                     | 1.60                         |                     |       |      |
|                     |   | 2.30            |  | 2.10                   | 2.30 |                     | 2.10                         |                     |       |      |
|                     |   | 3.00            |  | 2.70                   | 3.00 |                     | 2.70                         |                     |       |      |
|                     |   | 4.50            |  | 4.00                   | 4.40 |                     | 4.00                         |                     |       |      |
|                     |   | 1.65            | V <sub>IN</sub> =GND   | I <sub>OH</sub> =-4mA  | 1.29 | 1.52                |                              | 1.29                |       |      |
|                     |   | 2.30            |  | I <sub>OH</sub> =-4mA  | 1.90 | 2.14                |                              | 1.90                |       |      |
|                     |   | 3.00            |  | I <sub>OH</sub> =-8mA  | 2.40 | 2.75                |                              | 2.40                |       |      |
|                     |   | 3.00            |  | I <sub>OH</sub> =-12mA | 2.30 | 2.61                |                              | 2.30                |       |      |
|                     |   | 4.50            |  | I <sub>OH</sub> =-16mA | 3.80 | 4.13                |                              | 3.80                |       |      |
| V <sub>OL</sub>     | LOW Level Output Voltage                | 1.65            | V <sub>IN</sub> =V <sub>IH</sub> , I <sub>OL</sub> =100μA                        |                        | 0.00 | 0.10                |                              | 0.10                | V     |      |
|                     |   | 1.80            |  |                        | 0.00 | 0.20                |                              | 0.20                |       |      |
|                     |   | 2.30            |  |                        | 0.00 | 0.20                |                              | 0.20                |       |      |
|                     |   | 3.00            |  |                        | 0.00 | 0.30                |                              | 0.30                |       |      |
|                     |   | 4.50            |  |                        | 0.00 | 0.50                |                              | 0.50                |       |      |
|                     |   | 1.65            | V <sub>IN</sub> =V <sub>CC</sub>   | I <sub>OL</sub> =4mA   |      | 0.80                | 0.24                         |                     |       | 0.24 |
|                     |   | 2.30            |  | I <sub>OL</sub> =4mA   |      | 0.10                | 0.30                         |                     |       | 0.30 |
|                     |   | 3.00            |  | I <sub>OL</sub> =8mA   |      | 0.17                | 0.40                         |                     |       | 0.40 |
|                     |   | 3.00            |  | I <sub>OL</sub> =12mA  |      | 0.25                | 0.55                         |                     |       | 0.55 |
|                     |   | 4.50            |  | I <sub>OL</sub> =16mA  |      | 0.226               | 0.55                         |                     |       | 0.55 |
| I <sub>IN</sub>     | Input Leakage Current                   | 0 to 5.5        | V <sub>IN</sub> =5.5V, GND   |                        |      | ±1                  |                              | ±10                 | μA    |      |
| I <sub>CC</sub>     | Quiescent Supply Current                | 1.65 to 5.50    | V <sub>IN</sub> =5.5V, GND   |                        |      | 2                   |                              | 20                  | μA    |      |
| I <sub>CCPEAK</sub> | Peak Supply Current in Analog Operation | 1.8             | V <sub>OUT</sub> =Open, V <sub>IN</sub> =Adjust for Peak I <sub>CC</sub> Current |                        | 2    |                     |                              |                     | mA    |      |
|                     |   | 2.5             |  |                        | 4    |                     |                              |                     |       |      |
|                     |   | 3.3             |  |                        | 10   |                     |                              |                     |       |      |
|                     |   | 5.0             |  |                        | 30   |                     |                              |                     |       |      |

## AC Electrical Characteristics

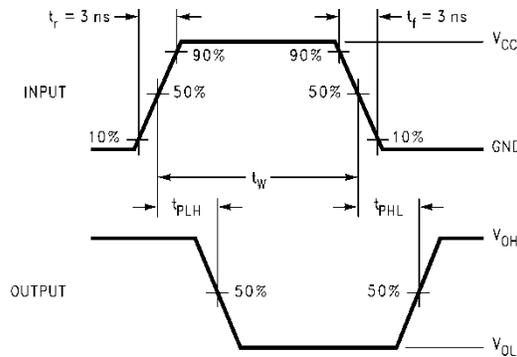
| Symbol                              | Parameter                        | V <sub>CC</sub> | Conditions                                    | T <sub>A</sub> =+25°C                          |      |      | T <sub>A</sub> =-40 to +85°C |      | Units    | Figure               |
|-------------------------------------|----------------------------------|-----------------|---|--|------|------|------------------------------|------|----------|----------------------|
|                                     |                                  |                 |   | Min.   | Typ. | Max. | Min.                         | Max. |          |                      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay                | 1.65            | C <sub>L</sub> =15pF,<br>R <sub>L</sub> =1MΩ, | 1.0  |      | 11.7 | 1.0                          | 12.1 | ns       | Figure 4<br>Figure 5 |
|                                     |                                  | 1.80            |   | 1.0  |      | 8.5  | 1.0                          | 9.0  |          |                      |
|                                     |                                  | 2.50 ± 0.20     |   | 0.8  |      | 6.2  | 0.8                          | 6.5  |          |                      |
|                                     |                                  | 3.30 ± 0.30     |   | 0.5  |      | 4.5  | 0.5                          | 4.8  |          |                      |
|                                     |                                  | 5.00 ± 0.50     |   | 0.5  |      | 3.9  | 0.5                          | 4.1  |          |                      |
|                                     |                                  | 3.30 ± 0.30     |   | C <sub>L</sub> =50pF,<br>R <sub>L</sub> =500Ω, | 1.0  |      | 6.0                          | 1.0  |          |                      |
| 5.00 ± 0.50                         | 0.8                              |                 | 5.0   |  | 0.8  | 5.5  |                              |      |          |                      |
| C <sub>IN</sub>                     | Input Capacitance                | 0.00            |   | 4.5  |      |      |                              | pF   |          |                      |
| C <sub>PD</sub>                     | Power Dissipation Capacitance(2) | 3.30            |   | 6.3  |      |      |                              | pF   | Figure 6 |                      |
|                                     |                                  | 5.00            |   | 9.5  |      |      |                              |      |          |                      |

**Note:**

- C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is derived from dynamic operating current consumption (I<sub>CCD</sub>) at no output loading and operating at 50% duty cycle. C<sub>PD</sub> is related to I<sub>CCD</sub> dynamic operating current by the expression: I<sub>CCD</sub>=(C<sub>PD</sub>)(V<sub>CC</sub>)(f<sub>IN</sub>)+(I<sub>CC</sub>static).



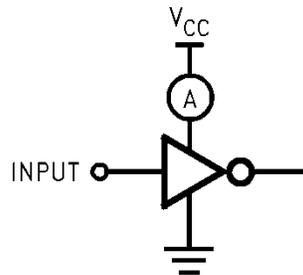
**Figure 4. AC Test Circuit**



**Figure 5. AC Waveforms**

**Note:**

- C<sub>L</sub> includes load and stray capacitance.
- Input PRR=1.0MHz; tw=500ns

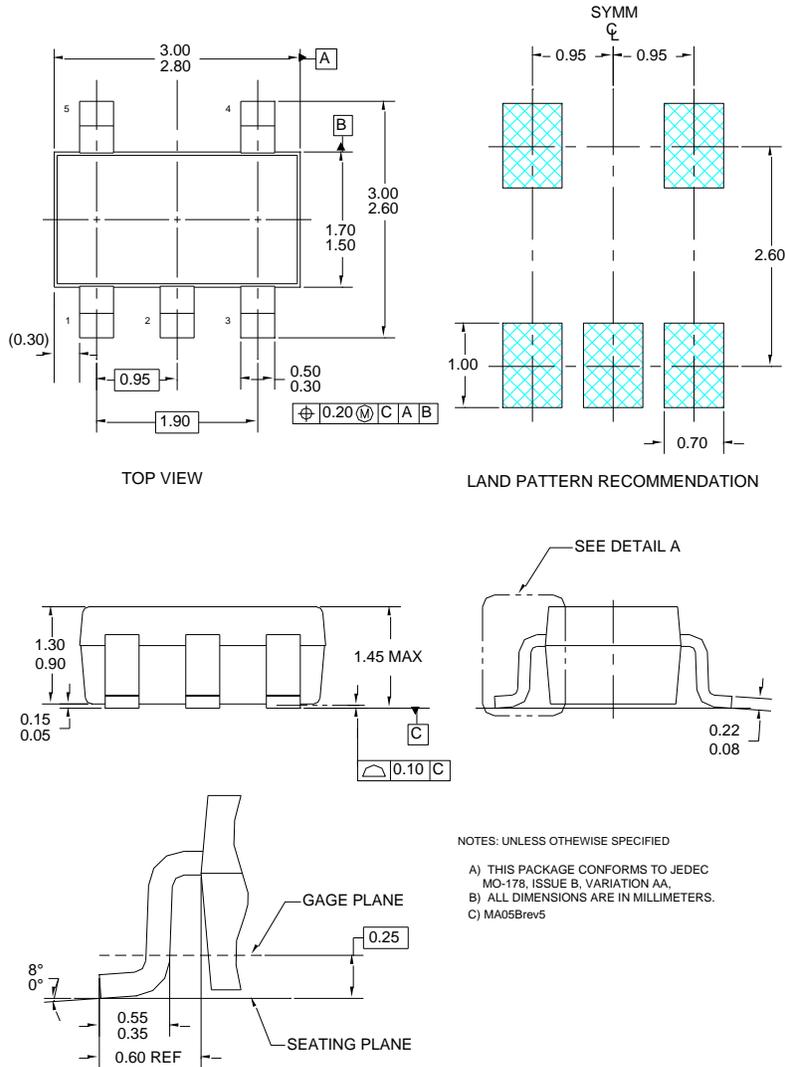


**Figure 6. Test Circuit**

**Note:**

- When operating the NC7SZU04's unbuffered output stage in its linear range, as in oscillator applications, care must be taken to observe maximum power rating for the device and package. The high drive nature of the design of the output stage results in substantial simultaneous conduction currents when the stage is in the linear region. See the I<sub>CCPEAK</sub> specification in the DC Electrical Characteristics table.
- Input=AC Waveform; tr=tr=1.8ns; PRR=variable; Duty Cycle =50%.

**Physical Dimensions**



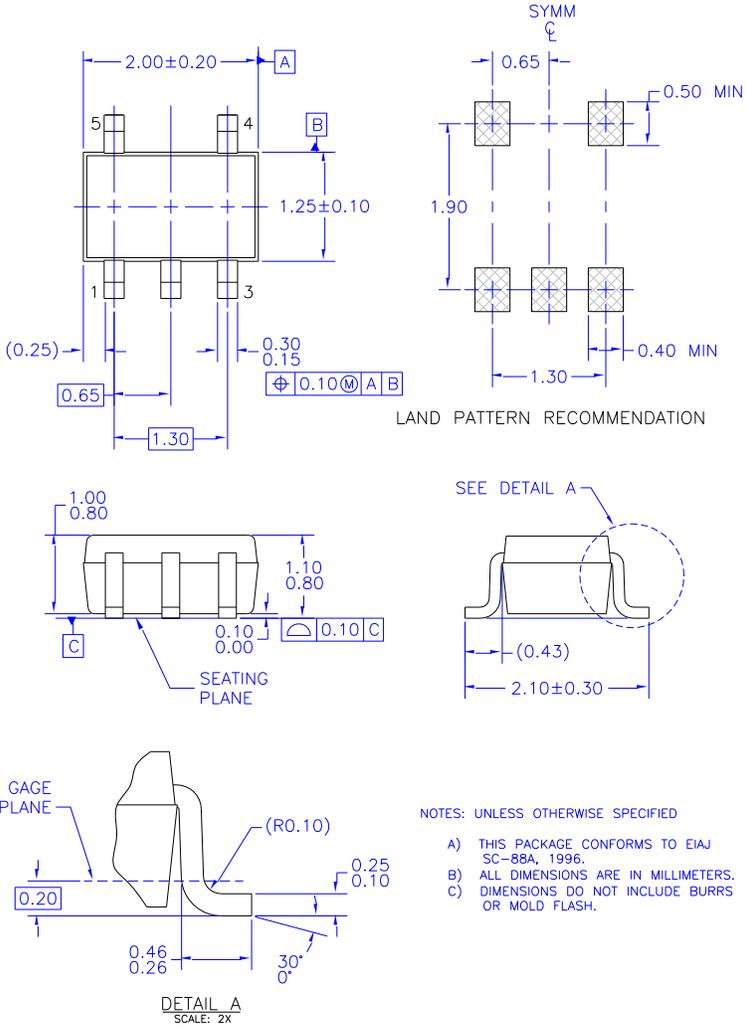
**Figure 7. 5-Lead SOT23, JEDEC MO-178 1.6mm**

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**Tape and Reel Specifications**

| Package Designator | Tape Section       | Cavity Number | Cavity Status | Cover Type Status |
|--------------------|--------------------|---------------|---------------|-------------------|
| M5X                | Leader (Start End) | 125 (Typical) | Empty         | Sealed            |
|                    | Carrier            | 3000          | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (Typical)  | Empty         | Sealed            |

**Physical Dimensions**



MAA05AREV5

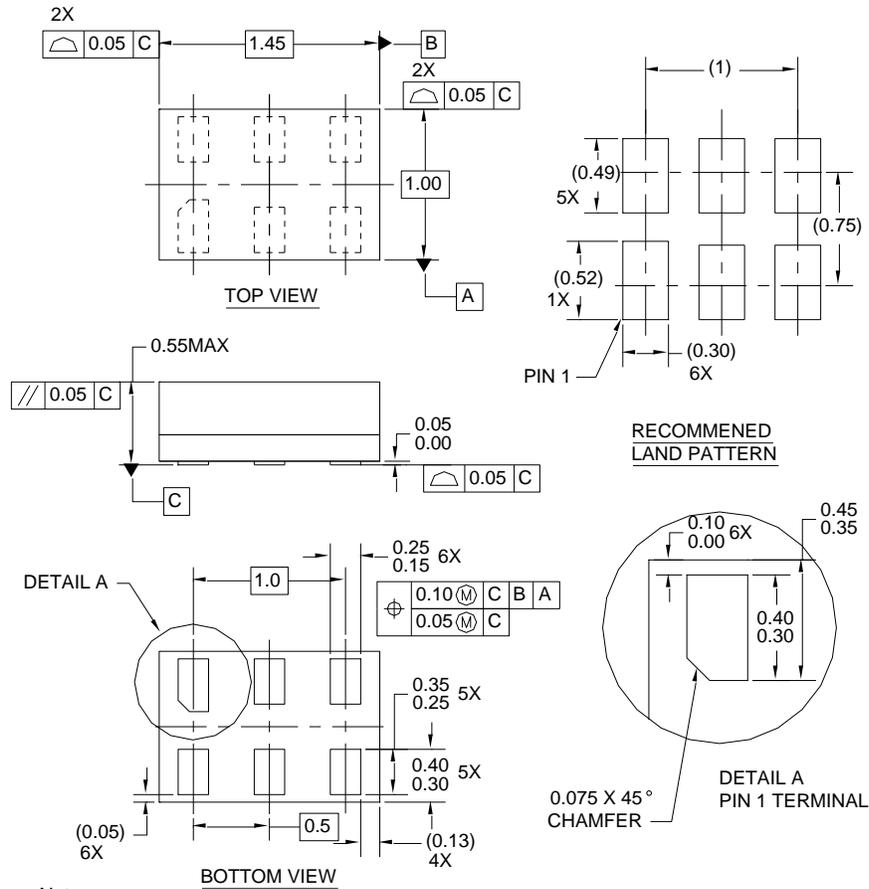
**Figure 8. 5-Lead, SC70, EAJ SC-88a, 1.25mm Wide**

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**Tape and Reel Specifications**

| Package Designator | Tape Section       | Cavity Number | Cavity Status | Cover Type Status |
|--------------------|--------------------|---------------|---------------|-------------------|
| P5X                | Leader (Start End) | 125 (Typical) | Empty         | Sealed            |
|                    | Carrier            | 3000          | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (Typical)  | Empty         | Sealed            |

## Physical Dimensions



Notes:

1. CONFORMS TO JEDEC STANDARD M0-252 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-1994

MAC06AREVC

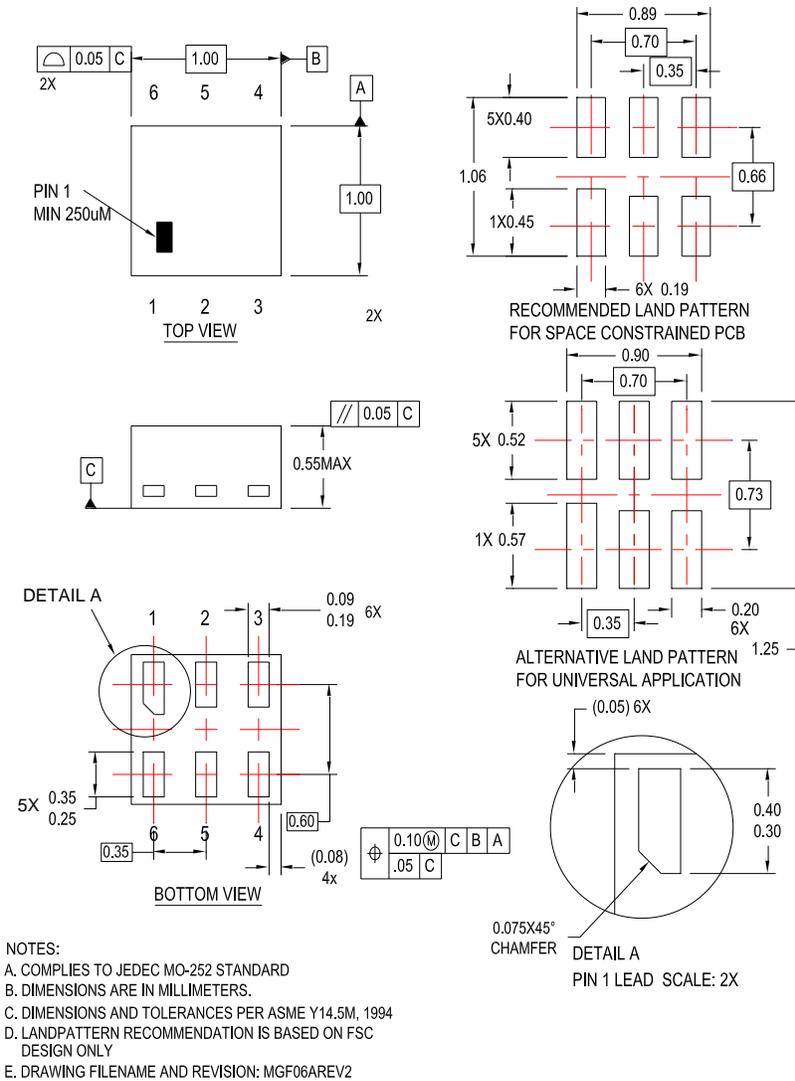
**Figure 9. 6-Lead, MicroPak™, 1.0mm Wide**

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## Tape and Reel Specifications

| Package Designator | Tape Section       | Cavity Number | Cavity Status | Cover Type Status |
|--------------------|--------------------|---------------|---------------|-------------------|
| L6X                | Leader (Start End) | 125 (Typical) | Empty         | Sealed            |
|                    | Carrier            | 5000          | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (Typical)  | Empty         | Sealed            |

## Physical Dimensions



**Figure 10.6-Lead, MicroPak2, 1x1mm Body, .35mm Pitch**

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## Tape and Reel Specifications

| Package Designator | Tape Section       | Cavity Number | Cavity Status | Cover Type Status |
|--------------------|--------------------|---------------|---------------|-------------------|
| FHX                | Leader (Start End) | 125 (Typical) | Empty         | Sealed            |
|                    | Carrier            | 5000          | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (Typical)  | Empty         | Sealed            |

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