ON Semiconductor®

# NC7SZ04
# TinyLogic® UHS Inverter

## Features

- Ultra-High Speed: $t_{PD}$ 2.4ns (Typical) into 50pF at 5V $V_{CC}$
- High Output Drive: ±24mA at 3V $V_{CC}$
- Broad $V_{CC}$ Operating Range: 1.65V to 5.5V
- Matches Performance of LCX when Operated at 3.3V $V_{CC}$
- Power Down High Impedance Inputs/Outputs
- Over-Voltage Tolerance Inputs Facilitate 5V to 3V Translation
- Proprietary Noise/EMI Reduction Circuitry
- Ultra-Small MicroPak™ Packages
- Space-Saving SOT23 and SC70 Packages

## Description

The NC7SZ04 is a single inverter from ON Semiconductor's Ultra-High Speed (UHS) series of TinyLogic®. 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 $V_{CC}$ operating range. The inputs and output are high-impedance when $V_{CC}$ is 0V. Inputs tolerate voltages up to 6V, independent of $V_{CC}$ operating voltage.

## Ordering Information

| Part Number | Top Mark | Package | Packing Method |
|---|---|---|---|
| NC7SZ04M5X | 7Z04 | 5-Lead SOT23, JEDEC MO-178 1.6mm | 3000 Units on Tape & Reel |
| NC7SZ04P5X | Z04 | 5-Lead SC70, EIAJ SC-88a, 1.25mm Wide | 3000 Units on Tape & Reel |
| NC7SZ04L6X | CC | 6-Lead MicroPak™, 1.00mm Wide | 5000 Units on Tape & Reel |
| NC7SZ04FHX | CC | 6-Lead, MicroPak2™, 1x1mm Body, .35mm Pitch | 5000 Units on Tape & Reel |


October-2017, Rev. 2

Publication Order Number:
NC7SZ04/D

## Connection Diagrams

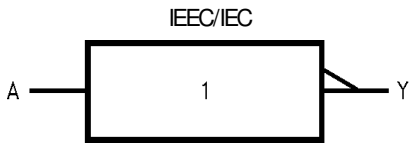



**Figure 1. Logic Symbol**

## Pin Configurations

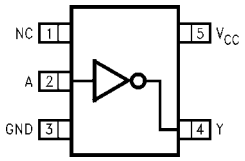



**Figure 2. SC70 and SOT23 (Top View)**

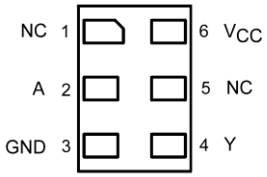



**Figure 3. MicroPak™ (Top Through View)**

## 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 | $V_{CC}$ | 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 |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | -0.5 | 6.0 | V |
| $V_{IN}$ | DC Input Voltage | | -0.5 | 6.0 | V |
| $V_{OUT}$ | DC Output Voltage | | -0.5 | 6.0 | V |
| $I_{IK}$ | DC Input Diode Current | $V_{IN}$ < -0.5V | | -50 | mA |
| | | $V_{IN}$ > 6.0V | | +20 | |
| $I_{OK}$ | DC Output Diode Current | $V_{OUT}$ < -0.5V | | -50 | mA |
| | | $V_{OUT}$ > 6V, $V_{CC}$=GND | | +20 | |
| $I_{OUT}$ | DC Output Current | | | ±50 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | | | ±50 | mA |
| $T_{STG}$ | Storage Temperature Range | | -65 | +150 | °C |
| $T_J$ | Junction Temperature Under Bias | | | +150 | °C |
| $T_L$ | Junction Lead Temperature (Soldering, 10 Seconds) | | | +260 | °C |
| $P_D$ | 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 |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage Operating | | 1.65 | 5.50 | V |
| | Supply Voltage Data Retention | | 1.5 | 5.5 | |
| $V_{IN}$ | Input Voltage | | 0 | 5.5 | V |
| $V_{OUT}$ | Output Voltage | | 0 | $V_{CC}$ | V |
| $T_A$ | Operating Temperature | | -40 | +85 | °C |
| $t_r$, $t_f$ | Input Rise and Fall Times | $V_{CC}$ at 1.8V, 2.5V ±0.2V | 0 | 20 | ns/V |
| | | $V_{CC}$ at 3.3V ± 0.3V | 0 | 10 | |
| | | $V_{CC}$ at 5.0V ± 0.5V | 0 | 5 | |

| | | | | | |
|---|---|---|---|---|---|
| $\theta_{JA}$ | Thermal Resistance | SOT-23 | | 300 | °C/W |
| | | SC70-5 | | 425 | |
| | | MicroPak™-6 | | 500 | |
| | | MicroPak2™-6 | | 560 | |

**Note:**

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

## DC Electrical Characteristics

| Symbol | Parameter | $V_{CC}$ | Conditions | $T_A$=25°C | | | $T_A$=-40 to 85°C | | Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| $V_{IH}$ | HIGH Level Input Voltage | 1.65 to 1.95 | | $0.75V_{CC}$ | | | $0.75V_{CC}$ | | V |
| | | 2.30 to 5.50 | | $0.70V_{CC}$ | | | $0.70V_{CC}$ | | |
| $V_{IL}$ | LOW Level Input Voltage | 1.65 to 1.95 | | | | $0.25V_{CC}$ | | $0.25V_{CC}$ | V |
| | | 2.30 to 5.50 | | | | $0.30V_{CC}$ | | $0.30V_{CC}$ | |
| $V_{OH}$ | HIGH Level Output Voltage | 1.65 | $V_{IN}=V_{IL}$, $I_{OH}$=-100µA | 1.55 | 1.65 | | | | V |
| | | 1.80 | | 1.70 | 1.80 | | 1.70 | | |
| | | 2.30 | | 2.20 | 2.30 | | 2.20 | | |
| | | 3.00 | | 2.90 | 3.00 | | 2.90 | | |
| | | 4.50 | | 4.40 | 4.50 | | 4.40 | | |
| | | 1.65 | $I_{OH}$=-4mA | 1.29 | 1.52 | | 1.29 | | |
| | | 2.30 | $I_{OH}$=-8mA | 1.90 | 2.15 | | 1.90 | | |
| | | 3.00 | $I_{OH}$=-16mA | 2.40 | 2.80 | | 2.40 | | |
| | | 3.00 | $I_{OH}$=-24mA | 2.30 | 2.68 | | 2.30 | | |
| | | 4.50 | $I_{OH}$=-32mA | 3.80 | 4.20 | | 3.80 | | |
| $V_{OL}$ | LOW Level Output Voltage | 1.65 | $V_{IN}=V_{IH}$, $I_{OL}$=100µA | | 0.00 | 0.10 | | 0.10 | V |
| | | 1.80 | | | 0.00 | 0.10 | | 0.10 | |
| | | 2.30 | | | 0.00 | 0.10 | | 0.10 | |
| | | 3.00 | | | 0.00 | 0.10 | | 0.10 | |
| | | 4.50 | | | 0.00 | 0.10 | | 0.10 | |
| | | 1.65 | $I_{OL}$=4mA | | 0.80 | 0.24 | | 0.24 | |
| | | 2.30 | $I_{OL}$=8mA | | 0.10 | 0.30 | | 0.30 | |
| | | 3.00 | $I_{OL}$=16mA | | 0.15 | 0.40 | | 0.40 | |
| | | 3.00 | $I_{OL}$=24mA | | 0.22 | 0.55 | | 0.55 | |
| | | 4.50 | $I_{OL}$=32mA | | 0.22 | 0.55 | | 0.55 | |
| $I_{IN}$ | Input Leakage Current | 0 to 5.5 | $0 \le V_{IN} \le 5.5V$ | | | ±1 | | ±10 | µA |
| $I_{OFF}$ | Power Off Leakage Current | 0 | $V_{IN}$ or $V_{OUT}$=5.5V | | | 1 | | 10 | µA |
| $I_{CC}$ | Quiescent Supply Current | 1.65 to 5.50 | $V_{IN}$=5.5V, GND | | | 2.0 | | 20 | µA |

## AC Electrical Characteristics

| Symbol | Parameter | $V_{CC}$ | Conditions | $T_A$=25°C | | | $T_A$=-40 to 85°C | | Units | Figure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | | |
| $t_{PLH}$, $t_{PHL}$ | Propagation Delay | 1.65 | $C_L$=15pF, $R_L$=1MΩ | 2.0 | 5.3 | 11.4 | 2.0 | 12.0 | ns | Figure 4 Figure 5 |
| | | 1.80 | | 2.0 | 4.4 | 9.5 | 2.0 | 10.0 | | |
| | | 2.50 ± 0.20 | | 0.8 | 2.9 | 6.5 | 0.8 | 7.0 | | |
| | | 3.30 ± 0.30 | | 0.5 | 2.1 | 4.5 | 0.5 | 4.7 | | |
| | | 5.00 ± 0.50 | | 0.5 | 1.8 | 3.9 | 0.5 | 4.1 | | |
| | | 3.30 ± 0.30 | $C_L$=50pF, $R_L$=500Ω | 1.5 | 2.9 | 5.0 | 1.5 | 5.2 | | |
| | | 5.00 ± 0.50 | | 0.8 | 2.4 | 4.3 | 0.8 | 4.5 | | |
| $C_{IN}$ | Input Capacitance | 0.00 | | | 4 | | | | pF | |
| $C_{PD}$ | Power Dissipation Capacitance(2) | 3.30 | | | 20 | | | | pF | Figure 6 |
| | | 5.00 | | | 26 | | | | | |

**Note:**

2. $C_{PD}$ is defined as the value of the internal equivalent capacitance which is derived from dynamic operating current consumption ($I_{CCD}$) at no output lading and operating at 50% duty cycle. $C_{PD}$ is related to $I_{CCD}$ dynamic operating current by the expression: $I_{CCD}=(C_{PD})(V_{CC})(f_{IN})+(I_{CC}static)$.

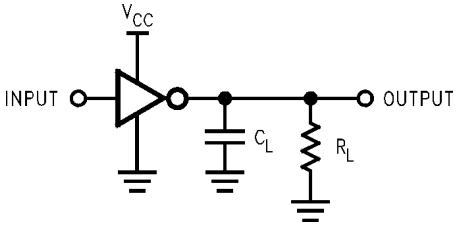



**Figure 4. AC Test Circuit**

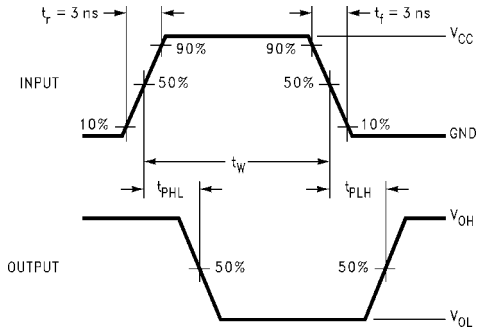
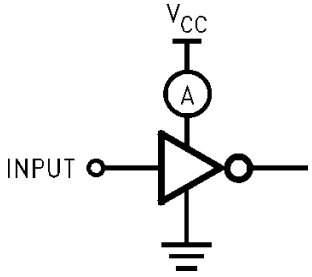



**Figure 5. AC Waveforms**




**Note:**

3. Input=AC Waveform; $t_r$=$t_f$=1.8ns; PRR=10MHz; Duty Cycle=50%.

**Figure 6. $I_{CCD}$ Test Circuit**

## Physical Dimensions

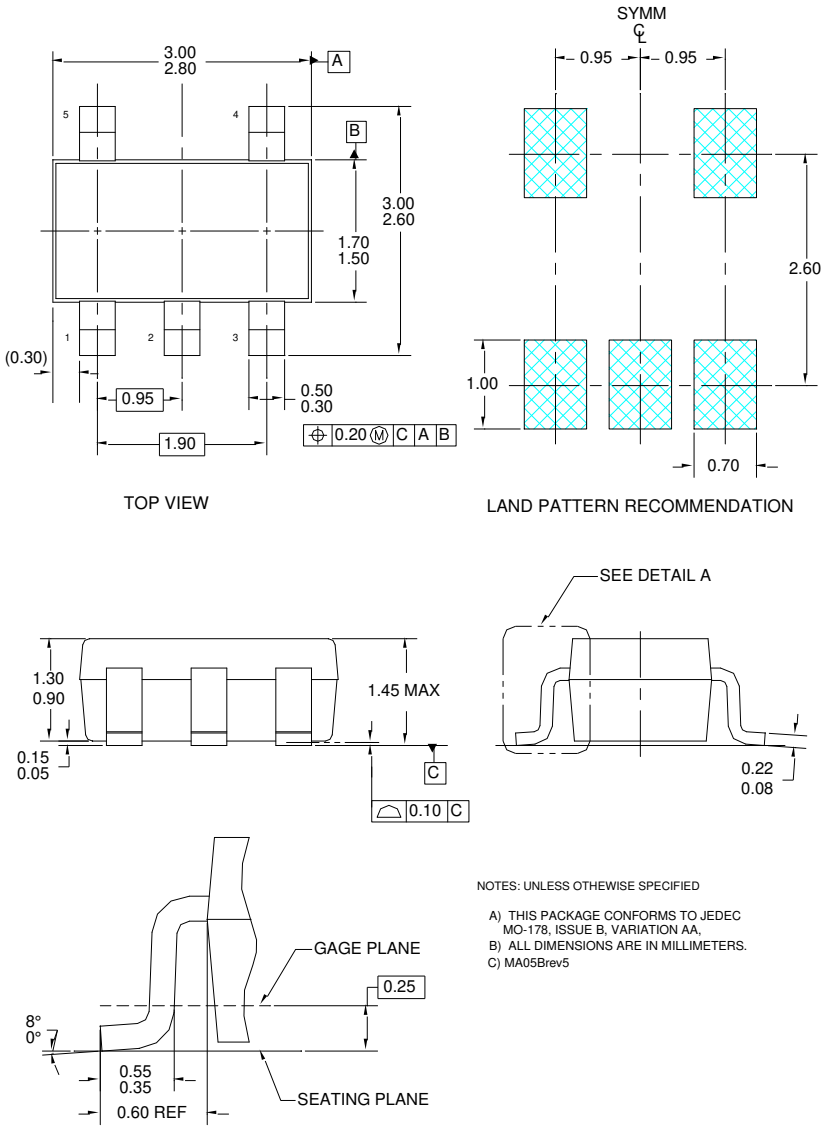



**Figure 7. 5-Lead SOT23, JEDEC MO-178 1.6mm**

*Package drawings are provided as a service to customers considering ON Semiconductor components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a ON Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of ON Semiconductor's worldwide terms and conditions, specifically the warranty therein, which covers ON Semiconductor products.*

## Tape and Reel Specification

| 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

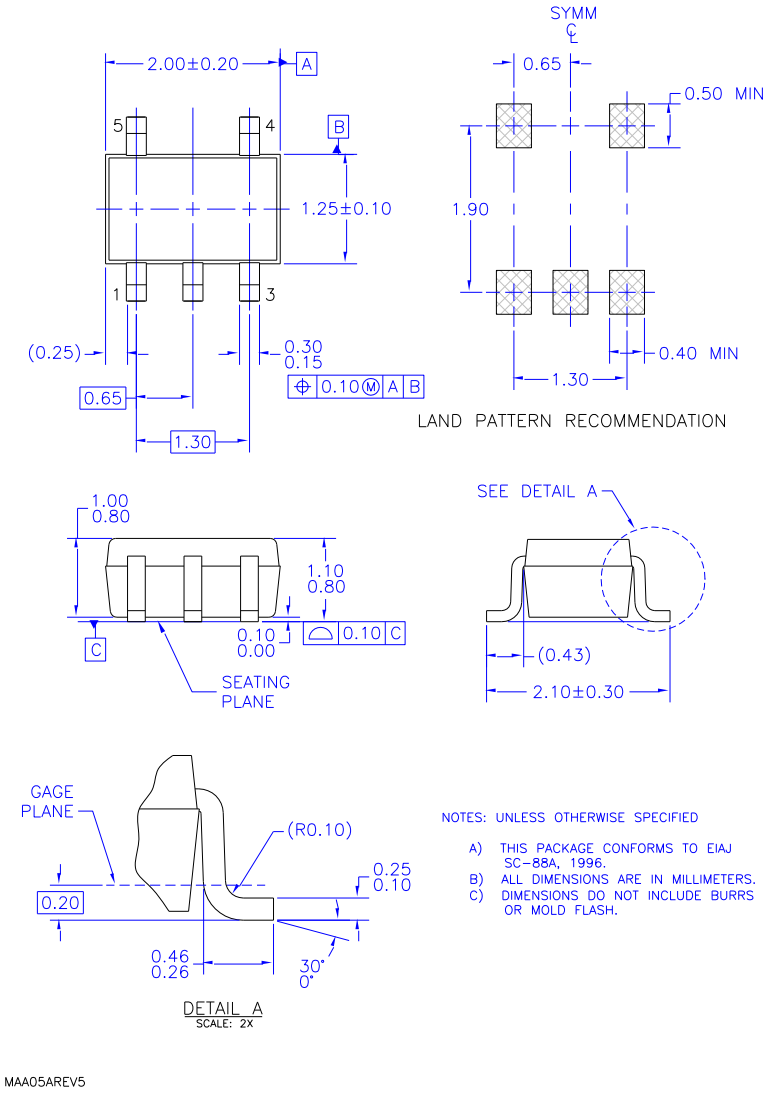



**Figure 8. 5-Lead, SC70, EIAJ SC-88a, 1.25mm Wide**

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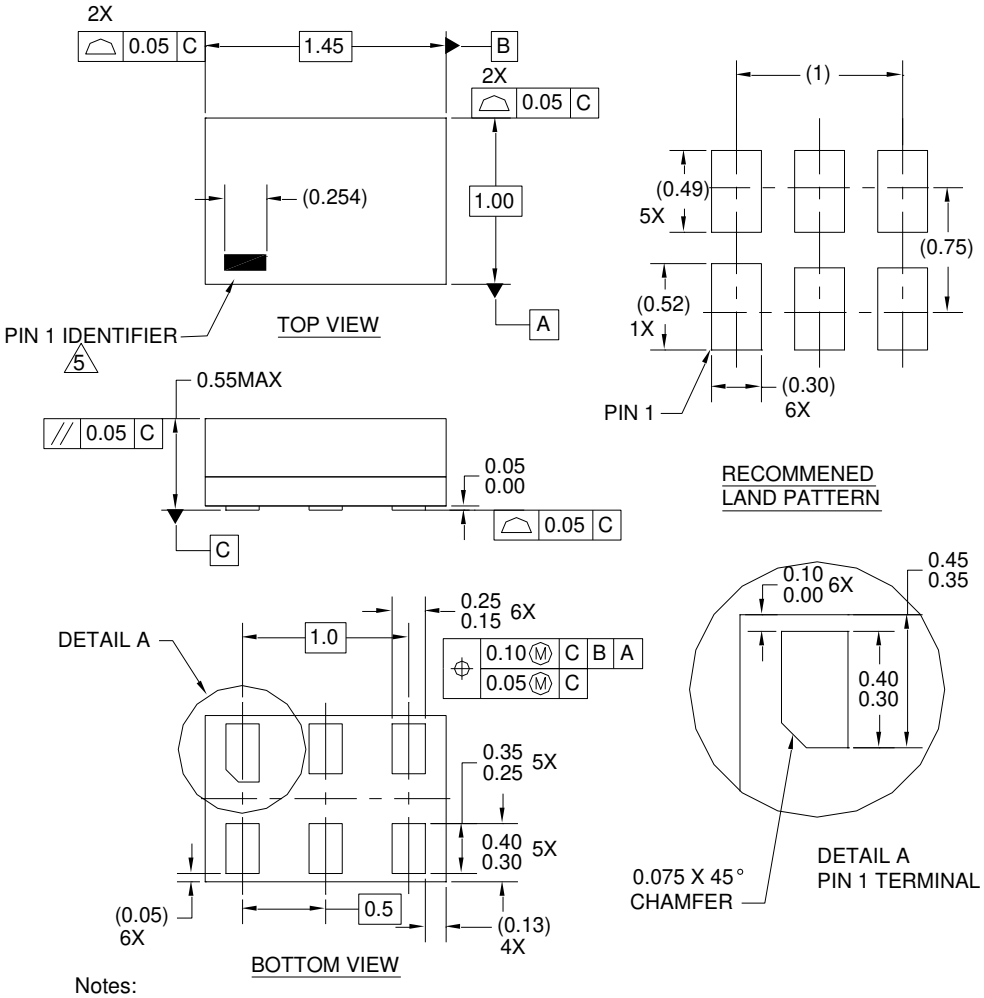
## Tape and Reel Specification

| 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
4. FILENAME AND REVISION: MAC06AREV4
5. PIN ONE IDENTIFIER IS 2X LENGTH OF ANY OTHER LINE IN THE MARK CODE LAYOUT.

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

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## Tape and Reel Specification

| 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

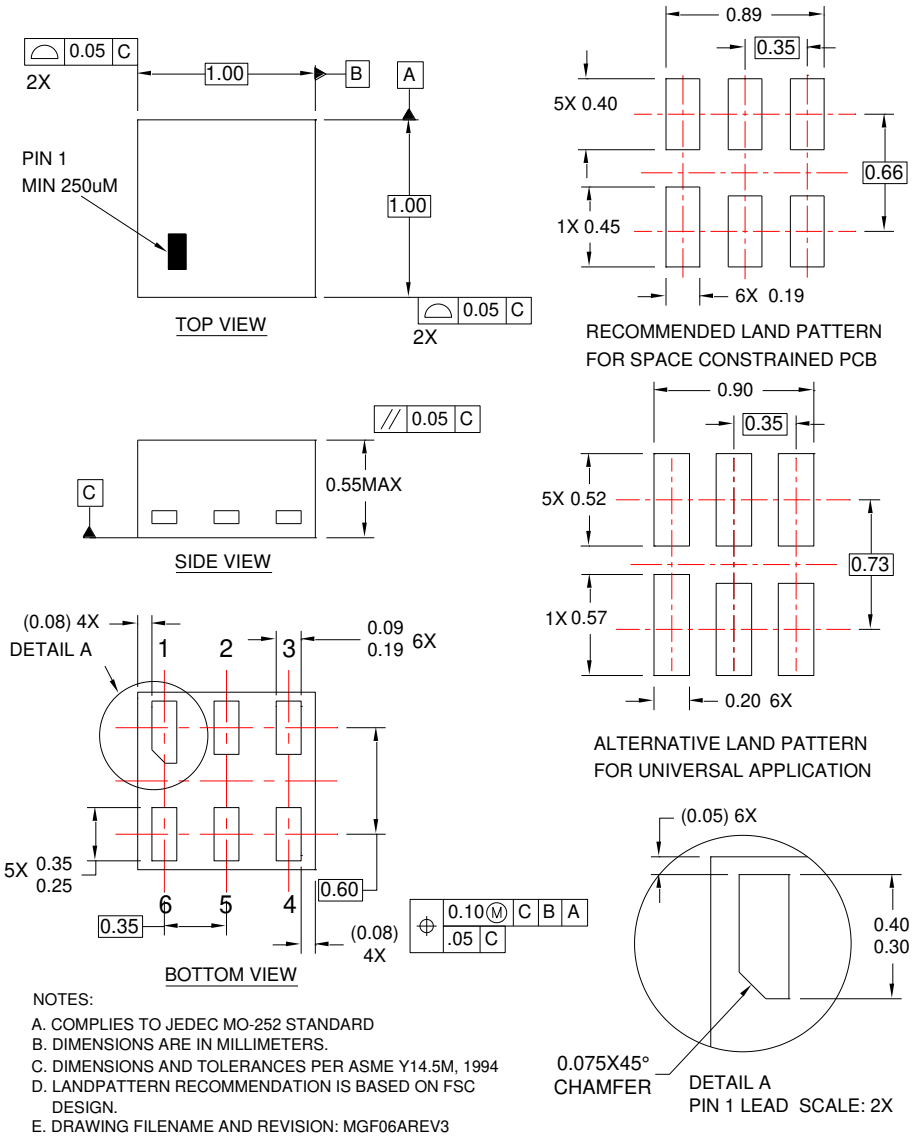


**Figure 10. 6-Lead, MicroPak2™, 1x1mm Body, .35mm Pitch**

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## Tape and Reel Specification

| 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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