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## NC7S04 TinyLogic® HS Inverter

### General Description

The NC7S04 is a single high performance CMOS Inverter. Advanced Silicon Gate CMOS fabrication assures high speed and low power circuit operation over a broad  $V_{CC}$  range. ESD protection diodes inherently guard both input and output with respect to the  $V_{CC}$  and GND rails. Three stages of gain between input and output assures high noise immunity and reduced sensitivity to input edge rate.

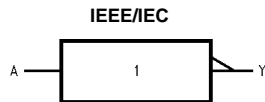
### Features

- Space saving SOT23 or SC70 5-lead package
- Ultra small MicroPak™ leadless package
- High Speed:  $t_{PD} = 3$  ns typ
- Low Quiescent Power:  $I_{CC} < 1 \mu A$
- Balanced Output Drive: 2 mA  $I_{OL}$ , -2 mA  $I_{OH}$
- Broad  $V_{CC}$  Operating Range: 2V – 6V
- Balanced Propagation Delays
- Specified for 3V operation

### Ordering Code:

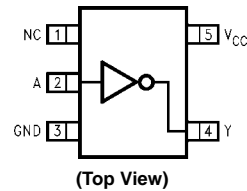
| Order Number | Package Number | Product Code Top Mark | Package Description                   | Supplied As               |
|--------------|----------------|-----------------------|---------------------------------------|---------------------------|
| NC7S04M5X    | MA05B          | 7S04                  | 5-Lead SOT23, JEDEC MO-178, 1.6mm     | 3k Units on Tape and Reel |
| NC7S04P5X    | MAA05A         | S04                   | 5-Lead SC70, EIAJ SC-88a, 1.25mm Wide | 3k Units on Tape and Reel |
| NC7S04L6X    | MAC06A         | AA                    | 6-Lead MicroPak, 1.0mm Wide           | 5k Units on Tape and Reel |

### Logic Symbol



### Connection Diagrams

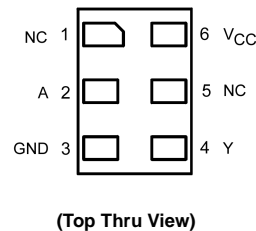
#### Pin Assignments for SC70 and SOT23



### Pin Descriptions

| Pin Names | Description |
|-----------|-------------|
| A         | Input       |
| Y         | Output      |
| NC        | No Connect  |

#### Pad Assignments for MicroPak



### Function Table

$$Y = \bar{A}$$

| Input | Output |
|-------|--------|
| A     | Y      |
| L     | H      |
| H     | L      |

H = HIGH Logic Level  
L = LOW Logic Level

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MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

| Absolute Maximum Ratings (Note 1)                                      |                          | Recommended Operating Conditions (Note 2)   |                |
|--|--------------------------|---|----------------|
| Supply Voltage ( $V_{CC}$ )  | -0.5V to +7.0V           | Supply Voltage ( $V_{CC}$ )   | 2.0V to 6.0V   |
| DC Input Diode Current ( $I_{IK}$ )                                    |                          | Input Voltage ( $V_{IN}$ )  | 0V to $V_{CC}$ |
| @ $V_{IN} \leq -0.5V$  | -20 mA                   | Output Voltage ( $V_{OUT}$ )  | 0V to $V_{CC}$ |
| @ $V_{IN} \geq V_{CC} + 0.5V$  | +20 mA                   | Operating Temperature ( $T_A$ )   | -40°C to +85°C |
| DC Input Voltage ( $V_{IN}$ )  | -0.5V to $V_{CC} + 0.5V$ | Input Rise and Fall Time ( $t_r, t_f$ )   |                |
| DC Output Diode Current ( $I_{OK}$ )                                   |                          | $V_{CC}$ @ 2.0V   | 0 to 1000 ns   |
| @ $V_{OUT} \leq -0.5V$   | -20 mA                   | $V_{CC}$ @ 3.0V   | 0 to 750 ns    |
| @ $V_{OUT} \geq V_{CC} + 0.5V$   | +20 mA                   | $V_{CC}$ @ 4.5V   | 0 to 500 ns    |
| DC Output Voltage ( $V_{OUT}$ )  | -0.5V to $V_{CC} + 0.5V$ | $V_{CC}$ @ 6.0V   | 0 to 400 ns    |
| DC Output Source or Sink Current ( $I_{OUT}$ )                         | $\pm 12.5$ mA            | Thermal Resistance ( $\theta_{JA}$ )  |                |
| DC $V_{CC}$ or Ground Current per Output Pin ( $I_{CC}$ or $I_{GND}$ ) | $\pm 25$ mA              | SOT23-5   | 300°C/W        |
| Storage Temperature ( $T_{STG}$ )                                      | -65°C to +150°C          | SC70-5  | 425°C/W        |
| Junction Temperature ( $T_J$ )   | 150°C                    | <b>Note 1:</b> Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, with-out exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. Fairchild does not recommend operation of circuits outside the databook specifications. |                |
| Lead Temperature ( $T_L$ ) (Soldering, 10 seconds)                     | 260°C                    | <b>Note 2:</b> Unused inputs must be held HIGH or LOW. They may not float.  |                |
| Power Dissipation ( $P_D$ ) @ +85°C                                    |                          |   |                |
| SOT23-5  | 200 mW                   |   |                |
| SC70-5   | 150 mW                   |   |                |

**DC Electrical Characteristics**

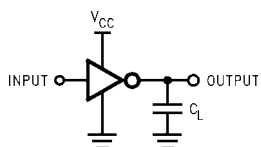
| Symbol   | Parameter                 | $V_{CC}$ (V) | $T_A = +25^\circ\text{C}$ |           |              | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ |               | Units                          | Conditions                                      |   |
|----------|---------------------------|--------------|---------------------------|-----------|--------------|---|---------------|--------------------------------|---|---|
|          |                           |              | Min                       | Typ       | Max          | Min   | Max           |                                |   |   |
| $V_{IH}$ | HIGH Level Input Voltage  | 2.0          | 1.50                      |           |              | 1.50  |               | V                              |   |   |
|          |                           | 3.0 - 6.0    | 0.7 $V_{CC}$              |           |              | 0.7 $V_{CC}$                                    |               |                                |   |   |
| $V_{IL}$ | LOW Level Input Voltage   | 2.0          |                           |           | 0.50         |   | 0.50          | V                              |   |   |
|          |                           | 3.0 - 6.0    |                           |           | 0.3 $V_{CC}$ |   | 0.3 $V_{CC}$  |                                |   |   |
| $V_{OH}$ | HIGH Level Output Voltage | 2.0          | 1.90                      | 2.0       |              | 1.90  |               | V                              | $I_{OH} = -20 \mu\text{A}$<br>$V_{IN} = V_{IL}$ |   |
|          |                           | 3.0          | 2.90                      | 3.0       |              | 2.90  |               |                                |   |   |
|          |                           | 4.5          | 4.40                      | 4.5       |              | 4.40  |               |                                |   |   |
|          |                           | 6.0          | 5.90                      | 6.0       |              | 5.90  |               |                                |   |   |
|          |                           |              | 3.0                       | 2.68      | 2.85         |   | 2.63          |                                | V   | $V_{IN} = V_{IL}$<br>$I_{OH} = -1.3 \text{ mA}$<br>$I_{OH} = -2.0 \text{ mA}$<br>$I_{OH} = -2.6 \text{ mA}$ |
|          |                           |              | 4.5                       | 4.18      | 4.35         |   | 4.13          |                                |   |   |
|          |                           |              | 6.0                       | 5.68      | 5.85         |   | 5.63          |                                |   |   |
|          |                           |              |                           |           |              |   |               |                                |   |   |
| $V_{OL}$ | LOW Level Output Voltage  | 2.0          |                           | 0.0       | 0.10         |   | 0.10          | V                              | $I_{OL} = 20 \mu\text{A}$<br>$V_{IN} = V_{IH}$  |   |
|          |                           | 3.0          |                           | 0.0       | 0.10         |   | 0.10          |                                |   |   |
|          |                           | 4.5          |                           | 0.0       | 0.10         |   | 0.10          |                                |   |   |
|          |                           | 6.0          |                           | 0.0       | 0.10         |   | 0.10          |                                |   |   |
|          |                           |              | 3.0                       |           | 0.1          | 0.26  |               | 0.33                           | V   | $V_{IN} = V_{IH}$<br>$I_{OL} = 1.3 \text{ mA}$<br>$I_{OL} = 2.0 \text{ mA}$<br>$I_{OL} = 2.6 \text{ mA}$    |
|          |                           |              | 4.5                       |           | 0.1          | 0.26  |               | 0.33                           |   |   |
|          |                           |              | 6.0                       |           | 0.1          | 0.26  |               | 0.33                           |   |   |
|          |                           |              |                           |           |              |   |               |                                |   |   |
| $I_{IN}$ | Input Leakage Current     | 6.0          |                           | $\pm 0.1$ |              | $\pm 1.0$                                       | $\mu\text{A}$ | $V_{IN} = V_{CC}, \text{ GND}$ |   |   |
| $I_{CC}$ | Quiescent Supply Current  | 6.0          |                           | 1.0       |              | 10.0  | $\mu\text{A}$ | $V_{IN} = V_{CC}, \text{ GND}$ |   |   |

## AC Electrical Characteristics

| Symbol           | Parameter                     | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |       |      | T <sub>A</sub> = -40°C to +85°C |     | Units | Conditions             | Figure Number |
|------------------|-------------------------------|------------------------|------------------------|-------|------|---------------------------------|-----|-------|------------------------|---------------|
|                  |                               |                        | Min                    | Typ   | Max  | Min                             | Max |       |                        |               |
| t <sub>PLH</sub> | Propagation Delay             | 5.0                    |                        | 3.0   | 15.0 |                                 |     | ns    | C <sub>L</sub> = 15 pF | Figures 1, 3  |
| t <sub>PHL</sub> |                               | 2.0                    | 18.0                   | 100.0 |      | 125.0                           |     | ns    | C <sub>L</sub> = 50 pF |               |
|                  |                               | 3.0                    | 10.0                   | 27.0  |      | 35.0                            |     |       |                        |               |
|                  |                               | 4.5                    | 7.0                    | 20.0  |      | 25.0                            |     |       |                        |               |
|                  |                               | 6.0                    | 6.0                    | 17.0  |      | 21.0                            |     |       |                        |               |
| t <sub>TLH</sub> | Output Transition Time        | 5.0                    | 3.0                    | 10.0  |      |                                 |     | ns    | C <sub>L</sub> = 15 pF | Figures 1, 3  |
| t <sub>THL</sub> |                               | 2.0                    | 25.0                   | 125.0 |      | 155.0                           |     | ns    | C <sub>L</sub> = 50 pF |               |
|                  |                               | 3.0                    | 16.0                   | 35.0  |      | 45.0                            |     |       |                        |               |
|                  |                               | 4.5                    | 11.0                   | 25.0  |      | 31.0                            |     |       |                        |               |
|                  |                               | 6.0                    | 9.0                    | 21.0  |      | 26.0                            |     |       |                        |               |
| C <sub>IN</sub>  | Input Capacitance             | Open                   | 2.0                    | 10.0  |      | 10.0                            |     | pF    |                        |               |
| C <sub>PD</sub>  | Power Dissipation Capacitance | 5.0                    | 6.0                    |       |      |                                 |     | pF    | (Note 3)               | Figure 2      |

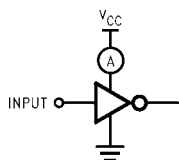
**Note 3:** C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is derived from dynamic operating current consumption (I<sub>CCD</sub>) at no output loading and operating at 50% duty cycle. (See Figure 2.) C<sub>PD</sub> is related to I<sub>CCD</sub> dynamic operating current by the expression:  
 $I_{CCD} = (C_{PD})(V_{CC})(f_{IN}) + (I_{CCstatic})$ .

## AC Loading and Waveforms



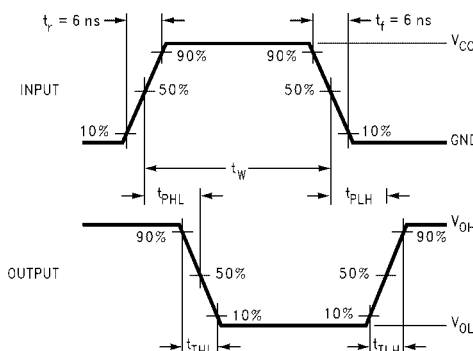
C<sub>L</sub> includes load and stray capacitance  
 Input PRR = 1.0 MHz, t<sub>w</sub> = 500 ns

**FIGURE 1. AC Test Circuit**



Input = AC Waveforms;  
 PRR = Variable; Duty Cycle = 50%

**FIGURE 2. I<sub>CCD</sub> Test Circuit**



**FIGURE 3. AC Waveforms**

## Tape and Reel Specification

### TAPE FORMAT FOR SOT23, SC70

| Package Designator | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| M5X, P5X           | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|                    | Carrier            | 3000            | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |

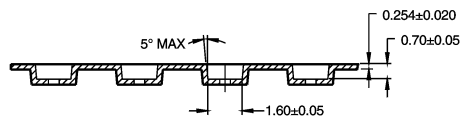
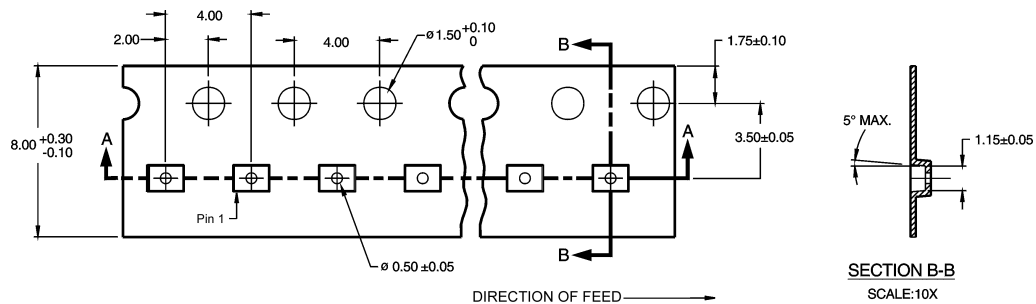
### TAPE DIMENSIONS inches (millimeters)



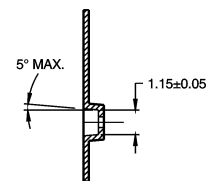
| Package | Tape Size | DIM A           | DIM B           | DIM F                         | DIM K <sub>0</sub>             | DIM P1       | DIM W                      |
|---------|-----------|-----------------|-----------------|-------------------------------|--------------------------------|--------------|----------------------------|
| SC70-5  | 8 mm      | 0.093<br>(2.35) | 0.096<br>(2.45) | 0.138 ± 0.004<br>(3.5 ± 0.10) | 0.053 ± 0.004<br>(1.35 ± 0.10) | 0.157<br>(4) | 0.315 ± 0.004<br>(8 ± 0.1) |
| SOT23-5 | 8 mm      | 0.130<br>(3.3)  | 0.130<br>(3.3)  | 0.138 ± 0.002<br>(3.5 ± 0.05) | 0.055 ± 0.004<br>(1.4 ± 0.11)  | 0.157<br>(4) | 0.315 ± 0.012<br>(8 ± 0.3) |

| Tape and Reel Specification (Continued) |                    |                 |               |                   |
|---|--------------------|-----------------|---------------|-------------------|
| TAPE FORMAT FOR MicroPak                |                    |                 |               |                   |
| Package Designator                      | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
| L6X                                     | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|   | Carrier            | 5000            | Filled        | Sealed            |
|   | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |

**TAPE DIMENSIONS** inches (millimeters)

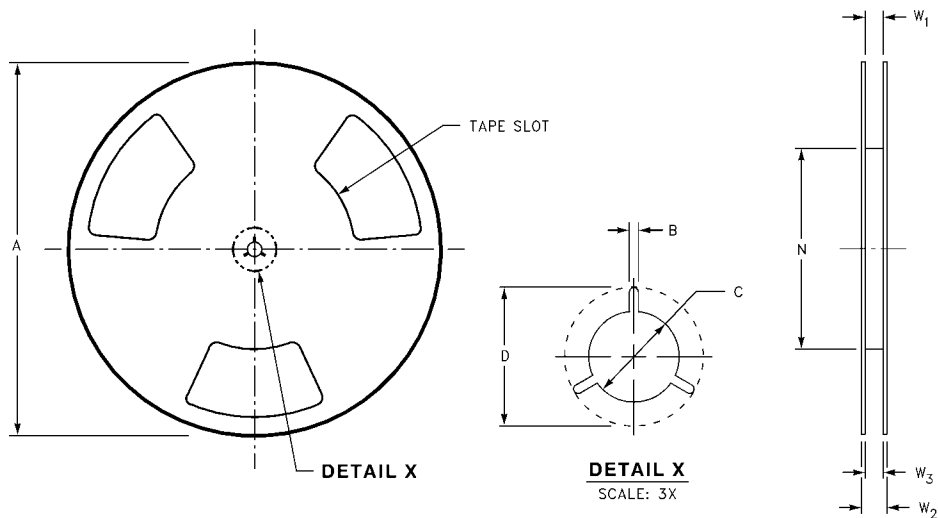


**SECTION A-A**  
SCALE: 10X



**SECTION B-B**  
SCALE: 10X

**REEL DIMENSIONS** inches (millimeters)

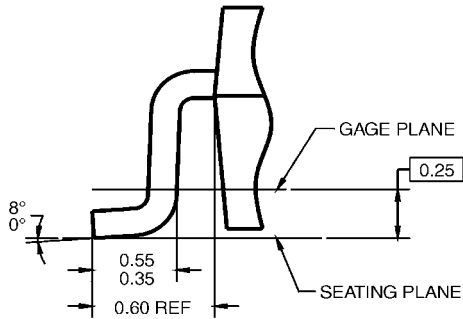
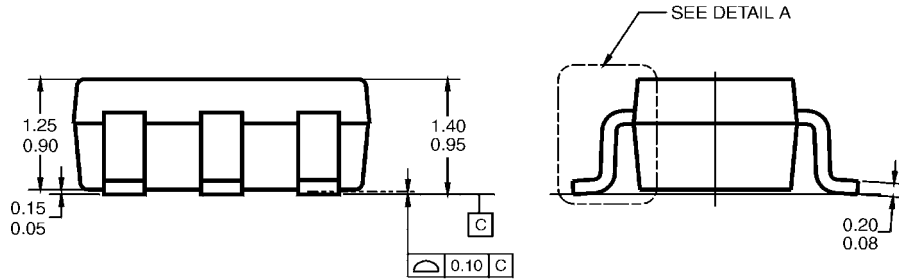


| Tape Size | A              | B               | C                | D                | N                | W1  | W2               | W3                                     |
|-----------|----------------|-----------------|------------------|------------------|------------------|---|------------------|--|
| 8 mm      | 7.0<br>(177.8) | 0.059<br>(1.50) | 0.512<br>(13.00) | 0.795<br>(20.20) | 2.165<br>(55.00) | 0.331 + 0.059/-0.000<br>(8.40 + 1.50/-0.00) | 0.567<br>(14.40) | W1 + 0.078/-0.039<br>(W1 + 2.00/-1.00) |

**Physical Dimensions** inches (millimeters) unless otherwise noted



**LAND PATTERN RECOMMENDATION**



- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE CONFORMS TO JEDEC MO-178, ISSUE B, VARIATION AA, DATED JANUARY 1999.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.

MA05BRevC

DETAIL A

**5-Lead SOT23, JEDEC MO-178, 1.6mm  
 Package Number MA05B**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



NOTES:

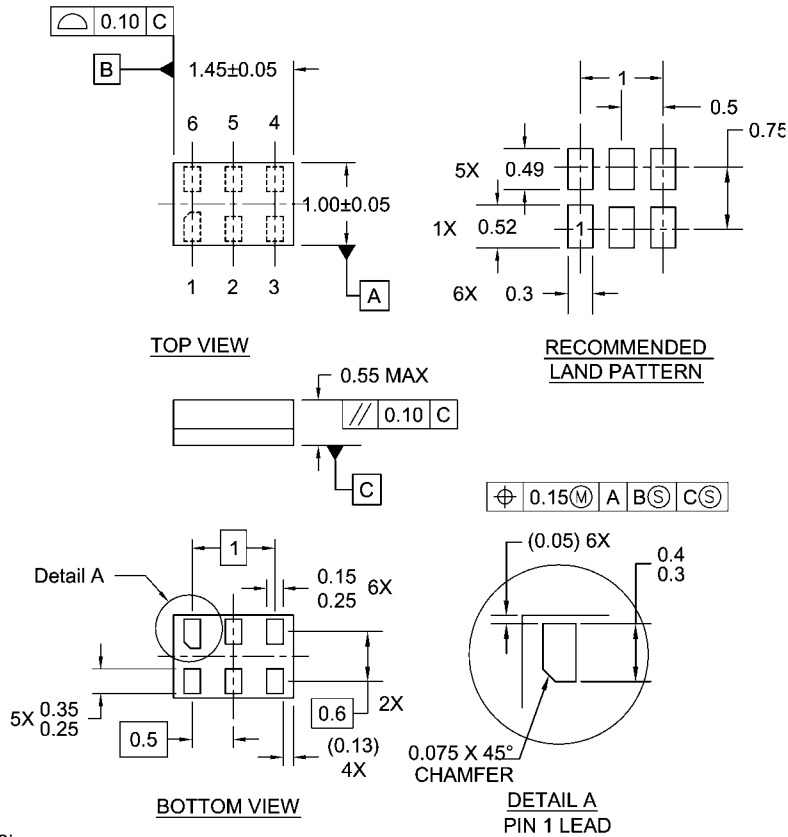
- A. CONFORMS TO EIAJ REGISTERED OUTLINE DRAWING SC88A.
- B. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH.
- C. DIMENSIONS ARE IN MILLIMETERS.

MAA05ARevC

**5-Lead SC70, EIAJ SC-88a, 1.25mm Wide  
Package Number MAA05A**



**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



Notes:

1. JEDEC PACKAGE REGISTRATION IS ANTICIPATED
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-1994

MAC06ARevB

**6-Lead MicroPak, 1.0mm Wide  
Package Number MAC06A**

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