NC7SZU04

TinyLogic UHS Unbuffered Inverter

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 VCC operating range. The device is specified to operate over the 1.65 V to 5.5 V VCC range.

Features

- Unbuffered for Crystal Oscillator and Analog Applications
- Balanced Output Drive: ±16 mA at 4.5 V VCC
- Broad VCC Operating Range: 1.65 V to 5.5 V
- Matches Performance of LCX Operated at 3.3 V VCC
- Low Quiescent Power: ICC < 2 μA, VCC = 5.5 V, TA = 25°C
- Ultra–Small MicroPak™ Packages
- Space–Saving SC–74A and SC–88A Packages
- These Devices are Pb–Free, Halogen Free/BFR Free and are RoHS Compliant

Figure 1. Logic Symbol

IEEE / IEC

ORDERING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 6 of this data sheet.
Pin Configurations

Figure 2. SC88A and SC−74A (Top View)

Figure 3. MicroPak (Top Through View)

PIN DEFINITIONS

<table>
<thead>
<tr>
<th>Pin # SC−88A / SC74A</th>
<th>Pin # MicroPak</th>
<th>Name</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1, 5</td>
<td>NC</td>
<td>No Connect</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>A</td>
<td>Input</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Y</td>
<td>Output</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>VCC</td>
<td>Supply Voltage</td>
</tr>
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</table>

FUNCTION TABLE (Y = /A)

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Y</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

H = HIGH Logic Level
L = LOW Logic Level
### ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>Supply Voltage</td>
<td>-0.5</td>
<td>6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{IN}$</td>
<td>DC Input Voltage</td>
<td>-0.5</td>
<td>6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>DC Output Voltage</td>
<td>-0.5</td>
<td>6.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_{IK}$</td>
<td>DC Input Diode Current</td>
<td>$V_{IN} &lt; -0.5\ V$</td>
<td>-</td>
<td>-50</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN} &gt; V_{CC} + 5.0\ V$</td>
<td>-</td>
<td>+20</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OK}$</td>
<td>DC Output Diode Current</td>
<td>$V_{OUT} &lt; -0.5\ V$</td>
<td>-</td>
<td>-50</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{OUT} &gt; 0.5\ V, V_{CC} = \text{GND}$</td>
<td>-</td>
<td>+20</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>DC Output Current</td>
<td>-</td>
<td>±50</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$I_{CC}$ or $I_{GND}$</td>
<td>DC $V_{CC}$ or Ground Current</td>
<td>-</td>
<td>±100</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$T_{STG}$</td>
<td>Storage Temperature Range</td>
<td>-65</td>
<td>+150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_{J}$</td>
<td>Junction Temperature Under Bias</td>
<td>-</td>
<td>+150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_{L}$</td>
<td>Junction Lead Temperature (Soldering, 10 Seconds)</td>
<td>-</td>
<td>+260</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$P_{D}$</td>
<td>Power Dissipation in Still Air</td>
<td>SC–74A</td>
<td>-</td>
<td>225</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC–88A</td>
<td>-</td>
<td>190</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MicroPak–6</td>
<td>-</td>
<td>327</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>MicroPak2™–6</td>
<td>-</td>
<td>327</td>
<td></td>
</tr>
<tr>
<td>ESD</td>
<td>Human Body Model, JEDEC: JESD22–A114</td>
<td>-</td>
<td>4000</td>
<td>V</td>
<td></td>
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<tr>
<td></td>
<td>Charge Device Model, JEDEC: JESD22–C101</td>
<td>-</td>
<td>2000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### RECOMMENDED OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>Supply Voltage Operating</td>
<td>1.65</td>
<td>5.50</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply Voltage Data Retention</td>
<td>1.50</td>
<td>5.50</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{IN}$</td>
<td>Input Voltage</td>
<td>0</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>0</td>
<td>$V_{CC}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$T_{A}$</td>
<td>Operating Temperature</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$\theta_{JA}$</td>
<td>Thermal Resistance</td>
<td>SC–74A</td>
<td>-</td>
<td>555</td>
<td>°C/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC–88A</td>
<td>-</td>
<td>659</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MicroPak–6</td>
<td>-</td>
<td>382</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MicroPak2–6</td>
<td>-</td>
<td>382</td>
<td></td>
</tr>
</tbody>
</table>

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

1. Unused inputs must be held HIGH or LOW. They may not float.
## DC ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>$V_{CC}$ (V)</th>
<th>Conditions</th>
<th>$T_A = +25^\circ$C</th>
<th>$T_A = -40$ to $+85^\circ$C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
</tr>
<tr>
<td>$V_{IH}$</td>
<td>HIGH Level Input Voltage</td>
<td>1.8 to 2.7</td>
<td>$V_{CC}$ = 0.85 V</td>
<td>0.85 $V_{CC}$</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0 to 5.5</td>
<td>$V_{CC}$ = 0.80 V</td>
<td>0.80 $V_{CC}$</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>$V_{IL}$</td>
<td>LOW Level Input Voltage</td>
<td>1.8 to 2.7</td>
<td>$V_{CC}$ = 0.15 V</td>
<td>–</td>
<td>–</td>
<td>0.15 $V_{CC}$</td>
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<tr>
<td></td>
<td></td>
<td>3.0 to 5.5</td>
<td>$V_{CC}$ = 0.20 V</td>
<td>–</td>
<td>–</td>
<td>0.20 $V_{CC}$</td>
</tr>
<tr>
<td>$V_{OH}$</td>
<td>HIGH Level Output Voltage</td>
<td>1.65</td>
<td>$V_{IN} = V_{IL}$, $I_{OH} = -100 \mu A$</td>
<td>1.55</td>
<td>1.65</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.80</td>
<td>–</td>
<td>1.60</td>
<td>1.80</td>
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<td></td>
<td></td>
<td>2.30</td>
<td>–</td>
<td>2.10</td>
<td>2.30</td>
<td>–</td>
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<td></td>
<td></td>
<td>3.00</td>
<td>–</td>
<td>2.70</td>
<td>3.00</td>
<td>–</td>
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<tr>
<td></td>
<td></td>
<td>4.50</td>
<td>–</td>
<td>4.00</td>
<td>4.40</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.65</td>
<td>$V_{IN} = GND$</td>
<td>$I_{OH} = -4 mA$</td>
<td>1.29</td>
<td>1.52</td>
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<td></td>
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<td>2.30</td>
<td>–</td>
<td>1.90</td>
<td>2.14</td>
<td>–</td>
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<td></td>
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<td>3.00</td>
<td>–</td>
<td>2.40</td>
<td>2.75</td>
<td>–</td>
</tr>
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<td></td>
<td></td>
<td>3.00</td>
<td>–</td>
<td>2.30</td>
<td>2.61</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.50</td>
<td>–</td>
<td>3.80</td>
<td>4.13</td>
<td>–</td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>LOW Level Output Voltage</td>
<td>1.65</td>
<td>$V_{IN} = V_{IH}$, $I_{OL} = 100 \mu A$</td>
<td>–</td>
<td>0.00</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.80</td>
<td>–</td>
<td>–</td>
<td>0.00</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.30</td>
<td>–</td>
<td>–</td>
<td>0.00</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.00</td>
<td>–</td>
<td>–</td>
<td>0.00</td>
<td>0.30</td>
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<tr>
<td></td>
<td></td>
<td>4.50</td>
<td>–</td>
<td>–</td>
<td>0.00</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.65</td>
<td>$V_{IN} = V_{CC}$</td>
<td>$I_{OL} = 4 mA$</td>
<td>–</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.30</td>
<td>–</td>
<td>–</td>
<td>0.10</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.00</td>
<td>–</td>
<td>–</td>
<td>0.17</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.00</td>
<td>–</td>
<td>–</td>
<td>0.25</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.50</td>
<td>–</td>
<td>–</td>
<td>0.226</td>
<td>0.55</td>
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<tr>
<td>$I_{IN}$</td>
<td>Input Leakage Current</td>
<td>1.65 to 5.5</td>
<td>$V_{IN} = 5.5$ V, $GND$</td>
<td>–</td>
<td>–</td>
<td>±1</td>
</tr>
<tr>
<td>$I_{CC}$</td>
<td>Quiescent Supply Current</td>
<td>1.65 to 5.50</td>
<td>$V_{IN} = 5.5$ V, $GND$</td>
<td>–</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>$I_{CCPEAK}$</td>
<td>Peak Supply Current in Analog Operation</td>
<td>1.8</td>
<td>$V_{OUT} = Open$, $V_{IN} = Adjust$ for Peak $I_{CC}$ Current</td>
<td>–</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5</td>
<td>–</td>
<td>4</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3</td>
<td>–</td>
<td>10</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0</td>
<td>–</td>
<td>30</td>
<td>–</td>
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</table>
AC ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>$V_{CC}$ (V)</th>
<th>Conditions</th>
<th>$T_A = +25^\circ C$</th>
<th>$T_A = -40$ to $+85^\circ C$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
</tr>
<tr>
<td>$t_{PLH}$, $t_{PHL}$</td>
<td>Propagation Delay (Figure 4, 5)</td>
<td>1.65</td>
<td>$C_L = 15$ pF, $R_L = 1$ MΩ</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.80</td>
<td>–</td>
<td>–</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.50 ±0.20</td>
<td>–</td>
<td>–</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.30 ±0.30</td>
<td>–</td>
<td>–</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.00 ±0.50</td>
<td>–</td>
<td>–</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.30 ±0.30</td>
<td>$C_L = 50$ pF, $R_L = 500$ Ω</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.00 ±0.50</td>
<td>–</td>
<td>–</td>
<td>5.0</td>
</tr>
<tr>
<td>$C_{IN}$</td>
<td>Input Capacitance</td>
<td>0.00</td>
<td>–</td>
<td>4.5</td>
<td>–</td>
</tr>
<tr>
<td>$C_{PD}$</td>
<td>Power Dissipation Capacitance (Note 2) (Figure 6)</td>
<td>3.30</td>
<td>–</td>
<td>6.3</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.00</td>
<td>–</td>
<td>9.5</td>
<td>–</td>
</tr>
</tbody>
</table>

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 loading and operating at 50% duty cycle. $C_{PD}$ is related to $I_{CCD}$ dynamic operating current by the expression:

$$I_{CCD} = (C_{PD}) (V_{CC}) f_{IN} + (I_{CCDstatic})$$

Figure 4. AC Test Circuit

Figure 5. AC Waveforms

NOTE:
3. $C_L$ includes load and stray capacitance.
4. Input PRR = 1.0 MHz; $t_W = 500$ ns

5. 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 $I_{CCPEAK}$ specification in the DC Electrical Characteristics table.
6. Input = AC Waveform; $t_f = 1.8$ ns; PRR = Variable; Duty Cycle = 50%.

Figure 6. $I_{CCD}$ Test Circuit
### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Top Mark</th>
<th>Packages</th>
<th>Shipping†</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC7SZU04M5X</td>
<td>7ZU4</td>
<td>SC–74A</td>
<td>3000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>NC7SZU04P5X</td>
<td>ZU4</td>
<td>SC–88A</td>
<td>3000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>NC7SZU04L6X</td>
<td>C5</td>
<td>SIP6, MicroPak</td>
<td>5000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>NC7SZU04FHX</td>
<td>C5</td>
<td>UDFN6, MicroPak2</td>
<td>5000 / Tape &amp; Reel</td>
</tr>
</tbody>
</table>

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
NC7SZU04

PACKAGE DIMENSIONS

SIP6 1.45X1.0
CASE 127EB
ISSUE O

NOTES:
1. CONFORMS TO JEDEC STANDARD MO-252 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-2009
4. PIN ONE IDENTIFIER IS 2X LENGTH OF ANY OTHER LINE IN THE MARK CODE LAYOUT.

www.onsemi.com
NOTES:
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE.

<table>
<thead>
<tr>
<th>DIM</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0.01</td>
<td>0.10</td>
</tr>
<tr>
<td>b</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>c</td>
<td>0.10</td>
<td>0.26</td>
</tr>
<tr>
<td>D</td>
<td>2.85</td>
<td>3.15</td>
</tr>
<tr>
<td>E</td>
<td>2.50</td>
<td>3.00</td>
</tr>
<tr>
<td>E1</td>
<td>1.05</td>
<td>1.65</td>
</tr>
<tr>
<td>d</td>
<td>0.95 SSC</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>0.20</td>
<td>0.60</td>
</tr>
<tr>
<td>M</td>
<td>0°</td>
<td>10°</td>
</tr>
</tbody>
</table>

DIMENSIONS: MILLIMETERS

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.
**PACKAGE DIMENSIONS**

SC–88A (SC–70 5 Lead), 1.25x2
CASE 419AC–01
ISSUE A

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**Notes:**
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-203.
NC7SZU04

PACKAGE DIMENSIONS

UDFN6 1.0X1.0, 0.35P
CASE 517DP
ISSUE 0

TOP VIEW

SIDES VIEW

BOTTOM VIEW

RECOMMENDED LAND PATTERN FOR SPACE CONSTRANDED PCB

ALTERNATIVE LAND PATTERN FOR UNIVERSAL APPLICATION

NOTES:
A. COMPLIES TO JEDEC MO-252 STANDARD
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 2009

0.075X45° CHAMFER PIN 1 LEAD SCALE: 2X

DETAIL A