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# TinyLogic ULP-A Inverter with Schmitt-Trigger Input

## NC7SP14

The NC7SP14 is a single inverter with Schmitt-Trigger Input in tiny footprint packages. The device is designed to operate for  $V_{CC} = 0.9\text{ V}$  to  $3.6\text{ V}$ .

### Features

- Designed for  $0.9\text{ V}$  to  $3.6\text{ V}$   $V_{CC}$  Operation
- $2.6\text{ ns}$   $t_{PD}$  at  $3.3\text{ V}$  (Typ)
- Inputs/Outputs Over-Voltage Tolerant up to  $3.6\text{ V}$
- $I_{OFF}$  Supports Partial Power Down Protection
- Source/Sink  $2.6\text{ mA}$  at  $3.3\text{ V}$
- Available in SC-88A and MicroPak™ Packages
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

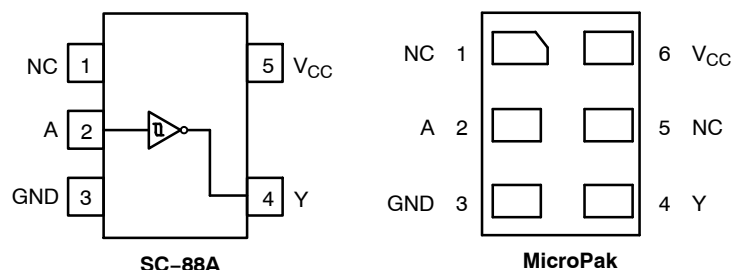


Figure 1. Pinout Diagrams (Top Views)

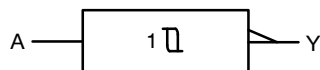


Figure 2. Logic Symbol

### PIN ASSIGNMENT

| Pin | SC-88A   | MicroPak |
|-----|----------|----------|
| 1   | N.C.     | N.C.     |
| 2   | A        | A        |
| 3   | GND      | GND      |
| 4   | Y        | Y        |
| 5   | $V_{CC}$ | N.C.     |
| 6   | –        | $V_{CC}$ |

N.C. = No Connect

### FUNCTION TABLE

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

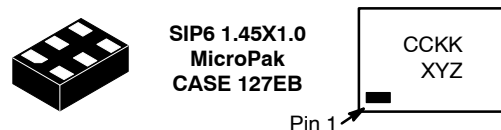
X = Don't Care  
Z = High Impedance State



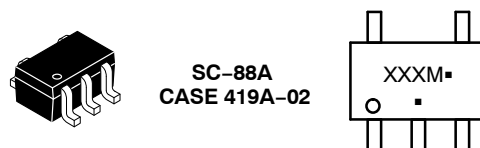
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### MARKING DIAGRAMS



CC = Specific Device Code  
KK = 2-Digit Lot Run Traceability Code  
XY = 2-Digit Date Code  
Z = Assembly Plant Code



XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering, marking and shipping information on page 6 of this data sheet.

# NC7SP14

## MAXIMUM RATINGS

| Symbol                | Characteristics  | Value  | Unit |
|-----------------------|--|--|------|
| $V_{CC}$              | DC Supply Voltage  | -0.5 to +4.3   | V    |
| $V_{IN}$              | DC Input Voltage   | -0.5 to +4.3   | V    |
| $V_{OUT}$             | DC Output Voltage<br>Active-Mode (High or Low State)<br>Tri-State Mode (Note 1)<br>Power-Down Mode ( $V_{CC} = 0$ V) | -0.5 to $V_{CC} + 0.5$<br>-0.5 to +4.3<br>-0.5 to +4.3 | V    |
| $I_{IK}$              | DC Input Diode Current<br>$V_{IN} < GND$   | -50  | mA   |
| $I_{OK}$              | DC Output Diode Current<br>$V_{OUT} < GND$   | -50  | mA   |
| $I_{OUT}$             | DC Output Source/Sink Current  | $\pm 50$   | mA   |
| $I_{CC}$ or $I_{GND}$ | DC Supply Current per Supply Pin or Ground Pin   | $\pm 50$   | mA   |
| $T_{STG}$             | Storage Temperature Range  | -65 to +150  | °C   |
| $T_L$                 | Lead Temperature, 1 mm from Case for 10 Seconds  | 260  | °C   |
| $T_J$                 | Junction Temperature Under Bias  | +150   | °C   |
| $\theta_{JA}$         | Thermal Resistance (Note 2)<br>SC-88A<br>MicroPak  | 377<br>154   | °C/W |
| $P_D$                 | Power Dissipation in Still Air<br>SC-88A<br>MicroPak   | 332<br>812   | mW   |
| MSL                   | Moisture Sensitivity   | Level 1  | -    |
| $F_R$                 | Flammability Rating<br>Oxygen Index: 28 to 34  | UL 94 V-0 @ 0.125 in                                   | -    |
| $V_{ESD}$             | ESD Withstand Voltage (Note 3)<br>Human Body Model<br>Charged Device Model   | 2000<br>1000   | V    |
| $I_{Latchup}$         | Latchup Performance (Note 4)   | $\pm 100$  | mA   |

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.

1. Applicable to devices with outputs that may be tri-stated.
2. Measured with minimum pad spacing on an FR4 board, using 10 mm-by-1 inch, 2 ounce copper trace no air flow per JESD51-7.
3. HBM tested to EIA / JESD22-A114-A. CDM tested to JESD22-C101-A. JEDEC recommends that ESD qualification to EIA/JESD22-A115A (Machine Model) be discontinued.
4. Tested to EIA/JESD78 Class II.

## RECOMMENDED OPERATING CONDITIONS

| Symbol     | Parameter  | Min         | Max                    | Unit |
|------------|--|-------------|------------------------|------|
| $V_{CC}$   | Positive DC Supply Voltage   | 0.9         | 3.6                    | V    |
| $V_{IN}$   | DC Input Voltage   | 0           | 3.6                    | V    |
| $V_{OUT}$  | DC Output Voltage<br>Active-Mode (High or Low State)<br>Tri-State Mode (Note 1)<br>Power-Down Mode ( $V_{CC} = 0$ V) | 0<br>0<br>0 | $V_{CC}$<br>3.6<br>3.6 | V    |
| $T_A$      | Operating Temperature Range  | -40         | +85                    | °C   |
| $t_r, t_f$ | Input Transition Rise and Fall Time  | 0           | No Limit               | ns/V |

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.

# NC7SP14

## DC ELECTRICAL CHARACTERISTICS

| Symbol          | Parameter                  | Condition  | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C  |                       |                       | T <sub>A</sub> = -40°C to +85°C |                       | Unit |
|-----------------|----------------------------|--|---------------------|------------------------|-----------------------|-----------------------|---------------------------------|-----------------------|------|
|                 |                            |  |                     | Min                    | Typ                   | Max                   | Min                             | Max                   |      |
| V <sub>P</sub>  | Positive Threshold Voltage |  | 0.9                 | –                      | 0.62                  | –                     | –                               | –                     | V    |
|                 |                            |  | 1.1                 | –                      | –                     | 1.0                   | –                               | 1.0                   |      |
|                 |                            |  | 1.4                 | –                      | –                     | 1.2                   | –                               | 1.2                   |      |
|                 |                            |  | 1.65                | –                      | –                     | 1.5                   | –                               | 1.5                   |      |
|                 |                            |  | 2.3                 | –                      | –                     | 1.9                   | –                               | 1.9                   |      |
|                 |                            |  | 3.0                 | –                      | –                     | 2.6                   | –                               | 2.6                   |      |
| V <sub>N</sub>  | Negative Threshold Voltage |  | 0.9                 | –                      | 0.34                  | –                     | –                               | –                     | V    |
|                 |                            |  | 1.1                 | 0.15                   | –                     | –                     | 0.15                            | –                     |      |
|                 |                            |  | 1.4                 | 0.2                    | –                     | –                     | 0.2                             | –                     |      |
|                 |                            |  | 1.65                | 0.25                   | –                     | –                     | 0.25                            | –                     |      |
|                 |                            |  | 2.3                 | 0.4                    | –                     | –                     | 0.4                             | –                     |      |
|                 |                            |  | 3.0                 | 0.6                    | –                     | –                     | 0.6                             | –                     |      |
| V <sub>H</sub>  | Hysteresis Voltage         |  | 0.9                 | –                      | 0.29                  | –                     | –                               | –                     | V    |
|                 |                            |  | 1.1                 | 0.08                   | –                     | 0.6                   | 0.08                            | 0.6                   |      |
|                 |                            |  | 1.4                 | 0.09                   | –                     | 0.8                   | 0.09                            | 0.8                   |      |
|                 |                            |  | 1.65                | 0.1                    | –                     | 1.0                   | 0.1                             | 1.0                   |      |
|                 |                            |  | 2.3                 | 0.25                   | –                     | 1.1                   | 0.25                            | 1.1                   |      |
|                 |                            |  | 3.0                 | 0.6                    | –                     | 1.8                   | 0.6                             | 1.8                   |      |
| V <sub>OH</sub> | High-Level Output Voltage  | V <sub>IN</sub> = V <sub>P</sub> or V <sub>N</sub> |                     |                        |                       |                       |                                 |                       | V    |
|                 |                            | I <sub>OH</sub> = -20 µA                           | 0.9                 | –                      | V <sub>CC</sub> - 0.1 | –                     | –                               | –                     |      |
|                 |                            |  | 1.1 to 1.3          | V <sub>CC</sub> - 0.1  | –                     | –                     | V <sub>CC</sub> - 0.1           | –                     |      |
|                 |                            |  | 1.4 to 1.6          | V <sub>CC</sub> - 0.1  | –                     | –                     | V <sub>CC</sub> - 0.1           | –                     |      |
|                 |                            |  | 1.65 to 1.95        | V <sub>CC</sub> - 0.1  | –                     | –                     | V <sub>CC</sub> - 0.1           | –                     |      |
|                 |                            |  | 2.3 to 2.7          | V <sub>CC</sub> - 0.1  | –                     | –                     | V <sub>CC</sub> - 0.1           | –                     |      |
|                 |                            |  | 3.0 to 3.6          | V <sub>CC</sub> - 0.1  | –                     | –                     | V <sub>CC</sub> - 0.1           | –                     |      |
|                 |                            | I <sub>OH</sub> = -0.5 mA                          | 1.1 to 1.3          | 0.75 x V <sub>CC</sub> | –                     | –                     | 0.75 x V <sub>CC</sub>          | –                     |      |
|                 |                            | I <sub>OH</sub> = -1 mA                            | 1.4 to 1.6          | 1.07                   | –                     | –                     | 0.99                            | –                     |      |
|                 |                            | I <sub>OH</sub> = -1.5 mA                          | 1.65 to 1.95        | 1.24                   | –                     | –                     | 1.22                            | –                     |      |
|                 |                            | I <sub>OH</sub> = -2.1 mA                          | 2.3 to 2.7          | 1.95                   | –                     | –                     | 1.87                            | –                     |      |
|                 |                            | I <sub>OH</sub> = -2.6 mA                          | 3.0 to 3.6          | 2.61                   | –                     | –                     | 2.55                            | –                     |      |
| V <sub>OL</sub> | Low-Level Output Voltage   | V <sub>IN</sub> = V <sub>P</sub> or V <sub>N</sub> |                     |                        |                       |                       |                                 |                       | V    |
|                 |                            | I <sub>OL</sub> = 20 µA                            | 0.9                 | –                      | 0.1                   | –                     | –                               | –                     |      |
|                 |                            |  | 1.1 to 1.3          | –                      | –                     | 0.1                   | –                               | 0.1                   |      |
|                 |                            |  | 1.4 to 1.6          | –                      | –                     | 0.1                   | –                               | 0.1                   |      |
|                 |                            |  | 1.65 to 1.95        | –                      | –                     | 0.1                   | –                               | 0.1                   |      |
|                 |                            |  | 2.3 to 2.7          | –                      | –                     | 0.1                   | –                               | 0.1                   |      |
|                 |                            |  | 3.0 to 3.6          | –                      | –                     | 0.1                   | –                               | 0.1                   |      |
|                 |                            | I <sub>OL</sub> = 0.5 mA                           | 1.1 to 1.3          | –                      | –                     | 0.3 x V <sub>CC</sub> | –                               | 0.3 x V <sub>CC</sub> |      |
|                 |                            | I <sub>OL</sub> = 1 mA                             | 1.4 to 1.6          | –                      | –                     | 0.31                  | –                               | 0.37                  |      |
|                 |                            | I <sub>OL</sub> = 1.5 mA                           | 1.65 to 1.95        | –                      | –                     | 0.31                  | –                               | 0.35                  |      |
|                 |                            | I <sub>OL</sub> = 2.1 mA                           | 2.3 to 2.7          | –                      | –                     | 0.31                  | –                               | 0.33                  |      |
|                 |                            | I <sub>OL</sub> = 2.6 mA                           | 3.0 to 3.6          | –                      | –                     | 0.31                  | –                               | 0.33                  |      |

# NC7SP14

## DC ELECTRICAL CHARACTERISTICS (continued)

| Symbol           | Parameter                 | Condition   | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C |     |      | T <sub>A</sub> = -40°C to +85°C |      | Unit |
|------------------|---------------------------|---|---------------------|-----------------------|-----|------|---------------------------------|------|------|
|                  |                           |   |                     | Min                   | Typ | Max  | Min                             | Max  |      |
| I <sub>IN</sub>  | Input Leakage Current     | V <sub>IN</sub> = 0 V to 3.6 V                                    | 0.9 to 3.6          | –                     | –   | ±0.1 | –                               | ±0.5 | μA   |
| I <sub>OFF</sub> | Power Off Leakage Current | V <sub>IN</sub> = 0 V to 3.6 V or V <sub>OUT</sub> = 0 V to 3.6 V | 0                   | –                     | –   | 0.5  | –                               | 0.5  | μA   |
| I <sub>CC</sub>  | Quiescent Supply Current  | V <sub>IN</sub> = V <sub>CC</sub> or GND                          | 0.9 to 3.6          | –                     | –   | 0.9  | –                               | 0.9  | μA   |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## AC ELECTRICAL CHARACTERISTICS

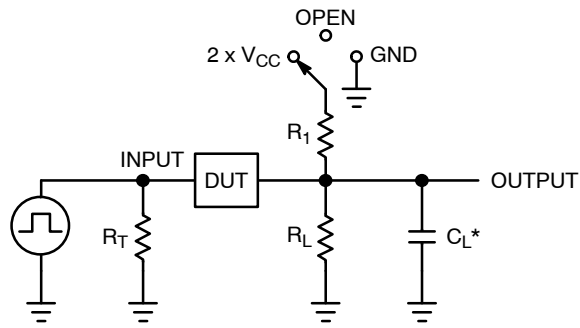
| Symbol                              | Parameter                                   | Condition                                     | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C |      |      | T <sub>A</sub> = -40°C to +85°C |      | Unit |
|-------------------------------------|---|---|---------------------|-----------------------|------|------|---------------------------------|------|------|
|                                     |   |   |                     | Min                   | Typ  | Max  | Min                             | Max  |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay, A to Y (Figures 3 and 4) | R <sub>L</sub> = 1 MΩ, C <sub>L</sub> = 10 pF | 0.9                 | –                     | 47.9 | –    | –                               | –    | ns   |
|                                     |   |   | 1.10 to 1.30        | –                     | 12.8 | 27.0 | –                               | 34.3 |      |
|                                     |   |   | 1.40 to 1.60        | –                     | 6.6  | 14.8 | –                               | 15.0 |      |
|                                     |   |   | 1.65 to 1.95        | –                     | 4.7  | 12.0 | –                               | 12.2 |      |
|                                     |   |   | 2.3 to 2.7          | –                     | 3.1  | 9.4  | –                               | 9.9  |      |
|                                     |   |   | 3.0 to 3.6          | –                     | 2.6  | 8.3  | –                               | 9.0  |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay, A to Y (Figures 3 and 4) | R <sub>L</sub> = 1 MΩ, C <sub>L</sub> = 15 pF | 0.9                 | –                     | 49.3 | –    | –                               | –    | ns   |
|                                     |   |   | 1.10 to 1.30        | –                     | 13.3 | 28.3 | –                               | 37.3 |      |
|                                     |   |   | 1.40 to 1.60        | –                     | 7.0  | 15.5 | –                               | 16.5 |      |
|                                     |   |   | 1.65 to 1.95        | –                     | 5.1  | 12.6 | –                               | 13.6 |      |
|                                     |   |   | 2.3 to 2.7          | –                     | 3.4  | 9.9  | –                               | 10.8 |      |
|                                     |   |   | 3.0 to 3.6          | –                     | 2.7  | 8.7  | –                               | 9.5  |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay, A to Y (Figures 3 and 4) | R <sub>L</sub> = 1 MΩ, C <sub>L</sub> = 30 pF | 0.9                 | –                     | 53.6 | –    | –                               | –    | ns   |
|                                     |   |   | 1.10 to 1.30        | –                     | 14.9 | 32.4 | –                               | 46.3 |      |
|                                     |   |   | 1.40 to 1.60        | –                     | 8.3  | 17.8 | –                               | 18.2 |      |
|                                     |   |   | 1.65 to 1.95        | –                     | 6.2  | 14.4 | –                               | 15.9 |      |
|                                     |   |   | 2.3 to 2.7          | –                     | 4.1  | 11.3 | –                               | 12.8 |      |
|                                     |   |   | 3.0 to 3.6          | –                     | 3.3  | 9.2  | –                               | 10.7 |      |

## CAPACITIVE CHARACTERISTICS

| Symbol           | Parameter                              | Test Condition   | Typical (T <sub>A</sub> = 25°C) | Unit |
|------------------|--|--|---------------------------------|------|
| C <sub>IN</sub>  | Input Capacitance                      | V <sub>CC</sub> = 0 V  | 2.0                             | pF   |
| C <sub>OUT</sub> | Output Capacitance                     | V <sub>CC</sub> = 0 V  | 4.0                             | pF   |
| C <sub>PD</sub>  | Power Dissipation Capacitance (Note 5) | f = 10 MHz, V <sub>CC</sub> = 0.9 to 3.6 V, V <sub>IN</sub> = 0 V or V <sub>CC</sub> | 8.0                             | pF   |

5. C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation I<sub>CC(OPR)</sub> = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>in</sub> + I<sub>CC</sub>. C<sub>PD</sub> is used to determine the no-load dynamic power consumption: P<sub>D</sub> = C<sub>PD</sub> • V<sub>CC</sub><sup>2</sup> • f<sub>in</sub> + I<sub>CC</sub> • V<sub>CC</sub>.

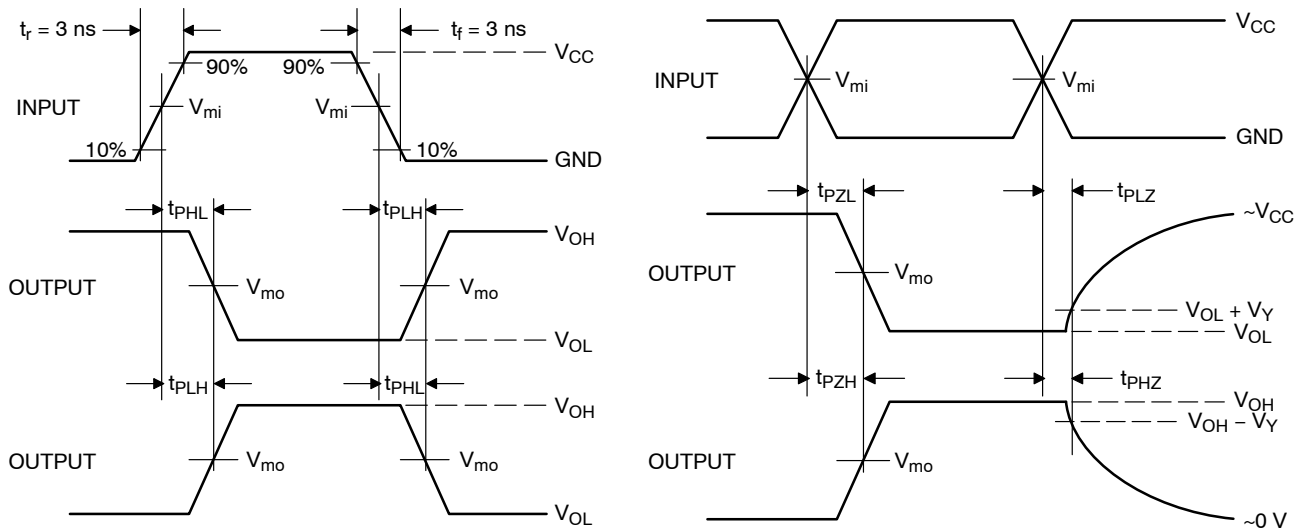
## NC7SP14



$C_L$  includes probe and jig capacitance  
 $R_T$  is  $Z_{OUT}$  of pulse generator (typically 50  $\Omega$ )  
 $f = 1$  MHz

| Test                | Switch Position   |
|---------------------|-------------------|
| $t_{PLH} / t_{PHL}$ | Open              |
| $t_{PLZ} / t_{PZL}$ | $2 \times V_{CC}$ |
| $t_{PHZ} / t_{PZH}$ | GND               |

Figure 3. Test Circuit



| $V_{CC}, V$  | $V_{mi}, V$  | $V_{mo}, V$  | $V_Y, V$ |
|--------------|--------------|--------------|----------|
| 0.9          | $V_{CC} / 2$ | $V_{CC} / 2$ | 0.1      |
| 1.1 to 1.3   | $V_{CC} / 2$ | $V_{CC} / 2$ | 0.1      |
| 1.4 to 1.6   | $V_{CC} / 2$ | $V_{CC} / 2$ | 0.1      |
| 1.65 to 1.95 | $V_{CC} / 2$ | $V_{CC} / 2$ | 0.15     |
| 2.3 to 2.7   | $V_{CC} / 2$ | $V_{CC} / 2$ | 0.15     |
| 3.0 to 3.6   | 1.5          | 1.5          | 0.3      |

Figure 4. Switching Waveforms

## NC7SP14

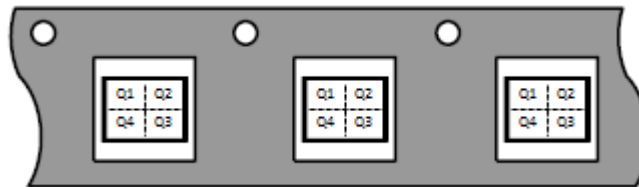
### ORDERING INFORMATION

| Device     | Package  | Marking | Pin 1 Orientation<br>(See below) | Shipping <sup>†</sup> |
|------------|----------|---------|----------------------------------|-----------------------|
| NC7SP14P5X | SC-88A   | P14     | Q4                               | 3000 / Tape & Reel    |
| NC7SP14L6X | MicroPak | K3      | Q4                               | 5000 / Tape & Reel    |

<sup>†</sup>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.

### Pin 1 Orientation in Tape and Reel

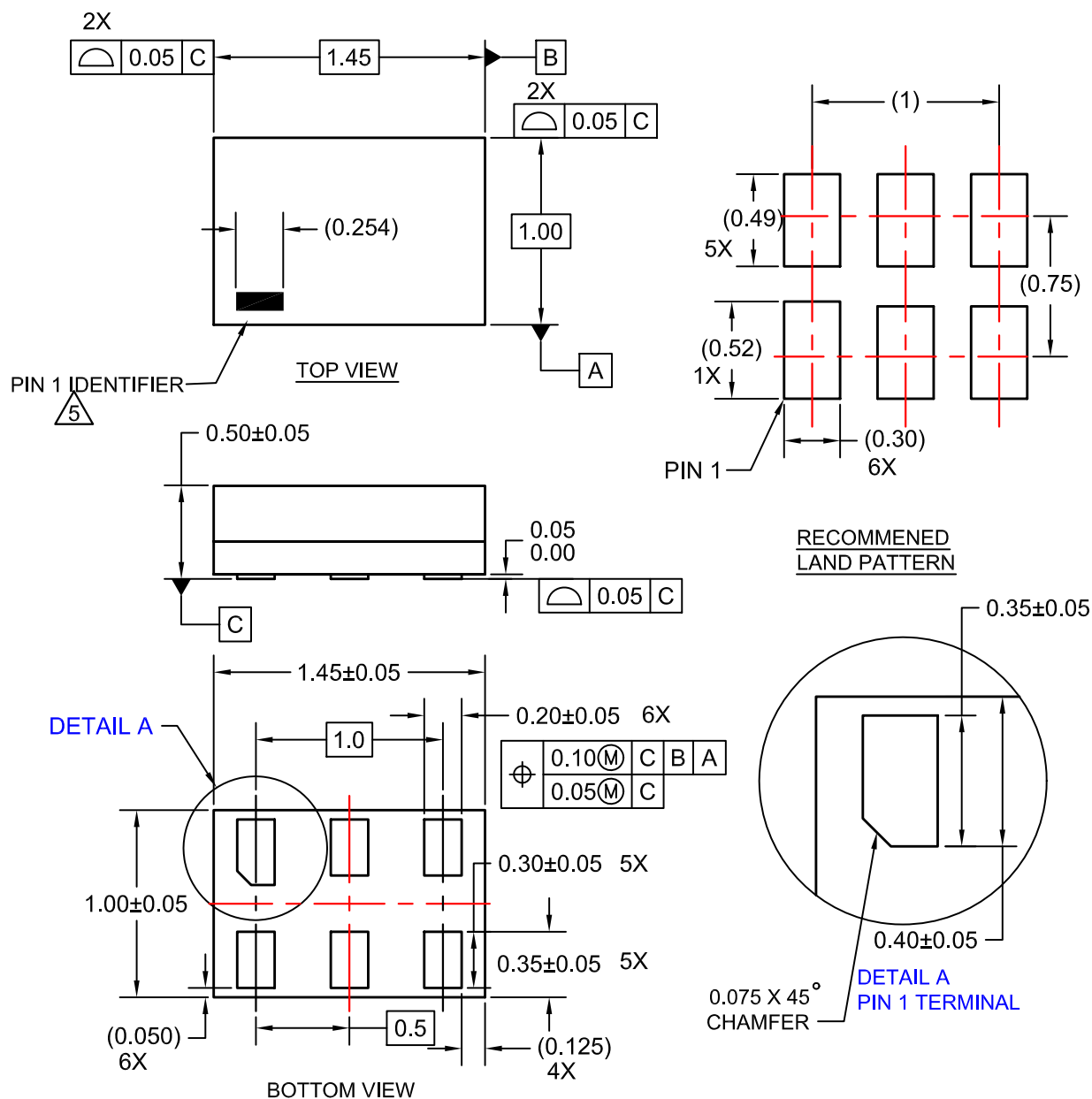
Direction of Feed



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**SIP6 1.45X1.0**  
**CASE 127EB**  
**ISSUE O**


DATE 31 AUG 2016



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.

|                         |                      |   |
|-------------------------|----------------------|---|
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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

NC7SP14

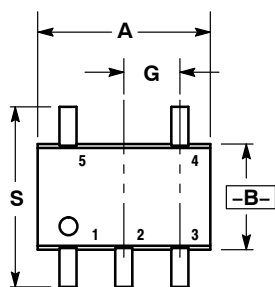
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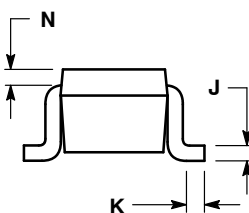
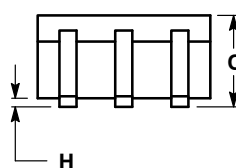
SCALE 2:1

SC-88A (SC-70-5/SOT-353)  
CASE 419A-02  
ISSUE L

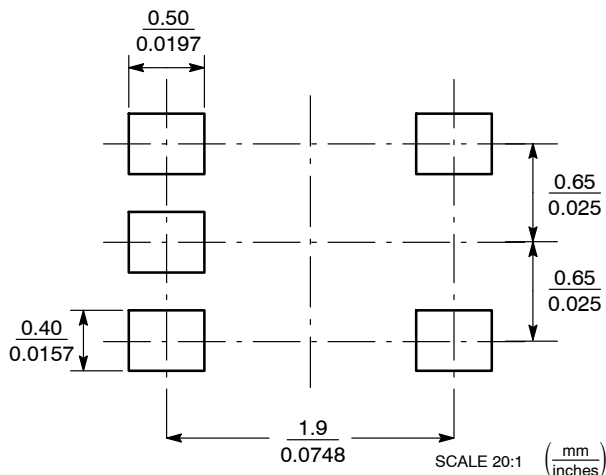
DATE 17 JAN 2013



D 5 PL  $\oplus$  0.2 (0.008) (M) B (M)



## SOLDER FOOTPRINT

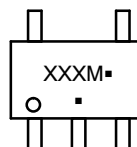


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.071     | 0.087 | 1.80        | 2.20 |
| B   | 0.045     | 0.053 | 1.15        | 1.35 |
| C   | 0.031     | 0.043 | 0.80        | 1.10 |
| D   | 0.004     | 0.012 | 0.10        | 0.30 |
| G   | 0.026 BSC |       | 0.65 BSC    |      |
| H   | ---       | 0.004 | ---         | 0.10 |
| J   | 0.004     | 0.010 | 0.10        | 0.25 |
| K   | 0.004     | 0.012 | 0.10        | 0.30 |
| N   | 0.008 REF |       | 0.20 REF    |      |
| S   | 0.079     | 0.087 | 2.00        | 2.20 |

## GENERIC MARKING DIAGRAM\*



XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLE 1:  
PIN 1. BASE  
2. EMITTER  
3. BASE  
4. COLLECTOR  
5. COLLECTOR

STYLE 2:  
PIN 1. ANODE  
2. EMITTER  
3. BASE  
4. COLLECTOR  
5. CATHODE

STYLE 3:  
PIN 1. ANODE 1  
2. N/C  
3. ANODE 2  
4. CATHODE 2  
5. CATHODE 1

STYLE 4:  
PIN 1. SOURCE 1  
2. DRAIN 1/2  
3. SOURCE 1  
4. GATE 1  
5. GATE 2

STYLE 5:  
PIN 1. CATHODE  
2. COMMON ANODE  
3. CATHODE 2  
4. CATHODE 3  
5. CATHODE 4

STYLE 6:  
PIN 1. EMITTER 2  
2. BASE 2  
3. EMITTER 1  
4. COLLECTOR  
5. COLLECTOR 2/BASE 1

STYLE 7:  
PIN 1. BASE  
2. EMITTER  
3. BASE  
4. COLLECTOR  
5. COLLECTOR

STYLE 8:  
PIN 1. CATHODE  
2. COLLECTOR  
3. N/C  
4. BASE  
5. EMITTER


STYLE 9:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. ANODE  
5. ANODE

Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.

|                  |                          |   |
|------------------|--------------------------|---|
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| DESCRIPTION:     | SC-88A (SC-70-5/SOT-353) | PAGE 1 OF 1   |

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