

# MC74VHC14

## Hex Schmitt Inverter

The MC74VHC14 is an advanced high speed CMOS Schmitt inverter fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

Pin configuration and function are the same as the MC74VHC04 but the inputs have hysteresis and, with its Schmitt trigger function, the VHC14 can be used as a line receiver which will receive slow input signals.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output. The inputs tolerate voltages up to 7.0 V, allowing the interface of 5.0 V systems to 3.0 V systems.

### Features

- High Speed:  $t_{PD} = 5.5 \text{ ns}$  (Typ) at  $V_{CC} = 5.0 \text{ V}$
- Low Power Dissipation:  $I_{CC} = 2.0 \mu\text{A}$  (Max) at  $T_A = 25^\circ\text{C}$
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$
- Power Down Protection Provided on Inputs
- Balanced Propagation Delays
- Designed for 2.0 V to 5.5 V Operating Range
- Low Noise:  $V_{OLP} = 0.8 \text{ V}$  (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300 mA
- ESD Performance: Human Body Model > 2000 V;  
Machine Model > 200 V
- Chip Complexity: 60 FETs or 15 Equivalent Gates
- These Devices are Pb-Free and are RoHS Compliant

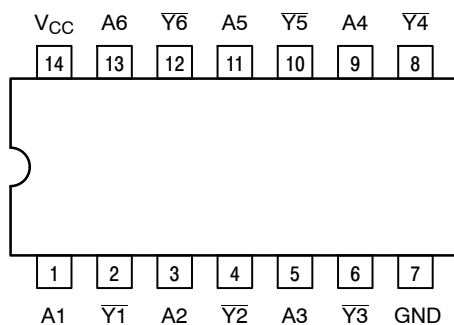


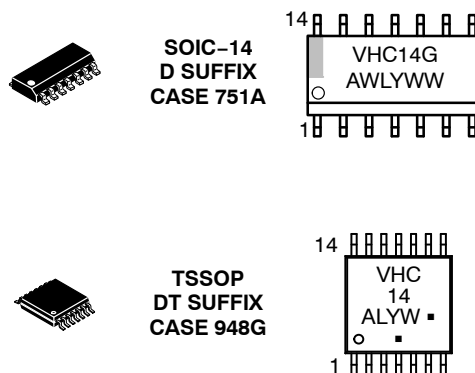
Figure 1. 14-Lead Pinout (Top View)



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### MARKING DIAGRAMS



A = Assembly Location  
WL, L = Wafer Lot  
Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package  
(Note: Microdot may be in either location)

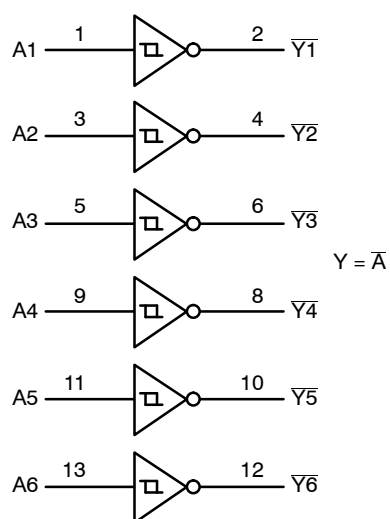
### FUNCTION TABLE

| Inputs | Outputs   |
|--------|-----------|
| A      | $\bar{Y}$ |
| L      | H         |
| H      | L         |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

## MC74VHC14



This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $GND \leq (V_{in} \text{ or } V_{out}) \leq V_{CC}$ . Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or  $V_{CC}$ ). Unused outputs must be left open.

**Figure 2. Logic Diagram**

### MAXIMUM RATINGS

| Symbol        | Parameter                                | Value                                                                                                        | Unit                        |
|---------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------|
| $V_{CC}$      | Positive DC Supply Voltage               | -0.5 to +7.0                                                                                                 | V                           |
| $V_{IN}$      | Digital Input Voltage                    | -0.5 to +7.0                                                                                                 | V                           |
| $V_{OUT}$     | DC Output Voltage                        | -0.5 to $V_{CC}$ +0.5                                                                                        | V                           |
| $I_{IK}$      | Input Diode Current                      | -20                                                                                                          | mA                          |
| $I_{OK}$      | Output Diode Current                     | $\pm 20$                                                                                                     | mA                          |
| $I_{OUT}$     | DC Output Current, per Pin               | $\pm 25$                                                                                                     | mA                          |
| $I_{CC}$      | DC Supply Current, $V_{CC}$ and GND Pins | $\pm 75$                                                                                                     | mA                          |
| $P_D$         | Power Dissipation in Still Air           | SOIC<br>TSSOP<br>200<br>180                                                                                  | mW                          |
| $T_{STG}$     | Storage Temperature Range                | -65 to +150                                                                                                  | $^{\circ}\text{C}$          |
| $V_{ESD}$     | ESD Withstand Voltage                    | Human Body Model (Note 1)<br>Machine Model (Note 2)<br>Charged Device Model (Note 3)<br>>2000<br>>200<br>N/A | V                           |
| $I_{LATCHUP}$ | Latchup Performance                      | Above $V_{CC}$ and Below GND at 125 $^{\circ}\text{C}$ (Note 4)<br>$\pm 300$                                 | mA                          |
| $\theta_{JA}$ | Thermal Resistance, Junction-to-Ambient  | SOIC<br>TSSOP<br>143<br>164                                                                                  | $^{\circ}\text{C}/\text{W}$ |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. Tested to EIA/JESD22-A114-A.
2. Tested to EIA/JESD22-A115-A.
3. Tested to JESD22-C101-A.
4. Tested to EIA/JESD78.

### RECOMMENDED OPERATING CONDITIONS

| Symbol     | Characteristics                                | Min                                                                                      | Max                  | Unit               |
|------------|------------------------------------------------|------------------------------------------------------------------------------------------|----------------------|--------------------|
| $V_{CC}$   | DC Supply Voltage                              | 2.0                                                                                      | 5.5                  | V                  |
| $V_{IN}$   | DC Input Voltage                               | 0                                                                                        | 5.5                  | V                  |
| $V_{OUT}$  | DC Output Voltage                              | 0                                                                                        | $V_{CC}$             | V                  |
| $T_A$      | Operating Temperature Range, All Package Types | -55                                                                                      | 125                  | $^{\circ}\text{C}$ |
| $t_r, t_f$ | Input Rise or Fall Time                        | $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$<br>$V_{CC} = 5.0 \text{ V} \pm 0.5 \text{ V}$ | No limit<br>No limit | ns/V               |

# MC74VHC14

## DC ELECTRICAL CHARACTERISTICS

| Symbol          | Parameter                             | Test Conditions                                                                                              | V <sub>CC</sub><br>V | T <sub>A</sub> = 25°C |                   |                      | -55°C ≤ T <sub>A</sub> ≤ 125°C |                      | Unit |
|-----------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------|----------------------|-----------------------|-------------------|----------------------|--------------------------------|----------------------|------|
|                 |                                       |                                                                                                              |                      | Min                   | Typ               | Max                  | Min                            | Max                  |      |
| V <sub>T+</sub> | Positive Threshold Voltage (Figure 5) |                                                                                                              | 3.0<br>4.5<br>5.5    |                       |                   | 2.20<br>3.15<br>3.85 |                                | 2.20<br>3.15<br>3.85 | V    |
| V <sub>T-</sub> | Negative Threshold Voltage (Figure 5) |                                                                                                              | 3.0<br>4.5<br>6.0    | 0.9<br>1.35<br>1.65   |                   |                      | 0.90<br>1.35<br>1.65           |                      | V    |
| V <sub>H</sub>  | Hysteresis Voltage (Figure 5)         |                                                                                                              | 3.0<br>4.5<br>5.5    | 0.30<br>0.40<br>0.50  |                   | 1.20<br>1.40<br>1.60 | 0.30<br>0.40<br>0.50           | 1.20<br>1.40<br>1.60 | V    |
| V <sub>OH</sub> | Minimum High-Level Output Voltage     | V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OH</sub> = - 50 μA                            | 2.0<br>3.0<br>4.5    | 1.9<br>2.9<br>4.4     | 2.0<br>3.0<br>4.5 |                      | 1.9<br>2.9<br>4.4              |                      | V    |
|                 |                                       | V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OH</sub> = - 4 mA<br>I <sub>OH</sub> = - 8 mA | 3.0<br>4.5           | 2.58<br>3.94          |                   |                      | 2.48<br>3.80                   |                      |      |
| V <sub>OL</sub> | Maximum Low-Level Output Voltage      | V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OL</sub> = 50 μA                              | 2.0<br>3.0<br>4.5    |                       | 0.0<br>0.0<br>0.0 | 0.1<br>0.1<br>0.1    |                                | 0.1<br>0.1<br>0.1    | V    |
|                 |                                       | V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OL</sub> = 4 mA<br>I <sub>OL</sub> = 8 mA     | 3.0<br>4.5           |                       |                   | 0.36<br>0.36         |                                | 0.44<br>0.44         |      |
| I <sub>in</sub> | Maximum Input Leakage Current         | V <sub>in</sub> = 5.5 V or GND                                                                               | 0 to 5.5             |                       |                   | ± 0.1                |                                | ± 1.0                | μA   |
| I <sub>CC</sub> | Maximum Quiescent Supply Current      | V <sub>in</sub> = V <sub>CC</sub> or GND                                                                     | 5.5                  |                       |                   | 2.0                  |                                | 20.0                 | μA   |

## AC ELECTRICAL CHARACTERISTICS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0 ns)

| Symbol                                 | Parameter                                 | Test Conditions                                                                   | T <sub>A</sub> = 25°C |             |              | -55°C ≤ T <sub>A</sub> ≤ 125°C |              | Unit |
|----------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------|-----------------------|-------------|--------------|--------------------------------|--------------|------|
|                                        |                                           |                                                                                   | Min                   | Typ         | Max          | Min                            | Max          |      |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Maximum Propagation Delay,<br>A or B to Y | V <sub>CC</sub> = 3.3 ± 0.3 V    C <sub>L</sub> = 15 pF<br>C <sub>L</sub> = 50 pF |                       | 8.3<br>10.8 | 12.8<br>16.3 | 1.0<br>1.0                     | 15.0<br>18.5 | ns   |
|                                        |                                           | V <sub>CC</sub> = 5.0 ± 0.5 V    C <sub>L</sub> = 15 pF<br>C <sub>L</sub> = 50 pF |                       | 5.5<br>7.0  | 8.6<br>10.6  | 1.0<br>1.0                     | 10.0<br>12.0 |      |
| C <sub>in</sub>                        | Maximum Input Capacitance                 |                                                                                   |                       | 4           | 10           |                                | 10           | pF   |

|                 |                                        |                                         |    |
|-----------------|----------------------------------------|-----------------------------------------|----|
| C <sub>PD</sub> | Power Dissipation Capacitance (Note 5) | Typical @ 25°C, V <sub>CC</sub> = 5.0 V | pF |
|                 |                                        | 21                                      |    |

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>/6 (per buffer). 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>.

## NOISE CHARACTERISTICS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0 ns, C<sub>L</sub> = 50 pF, V<sub>CC</sub> = 5.0 V)

| Symbol           | Characteristic                               | T <sub>A</sub> = 25°C |      | Unit |
|------------------|----------------------------------------------|-----------------------|------|------|
|                  |                                              | Typ                   | Max  |      |
| V <sub>OLP</sub> | Quiet Output Maximum Dynamic V <sub>OL</sub> | 0.4                   | 0.8  | V    |
| V <sub>OLV</sub> | Quiet Output Minimum Dynamic V <sub>OL</sub> | -0.4                  | -0.8 | V    |
| V <sub>IHD</sub> | Minimum High Level Dynamic Input Voltage     |                       | 3.5  | V    |
| V <sub>ILD</sub> | Maximum Low Level Dynamic Input Voltage      |                       | 1.5  | V    |

# MC74VHC14

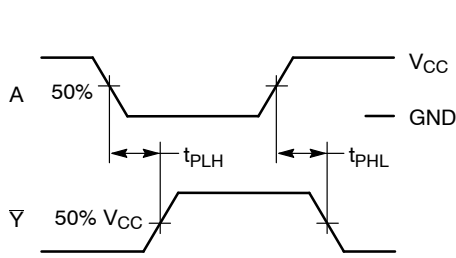
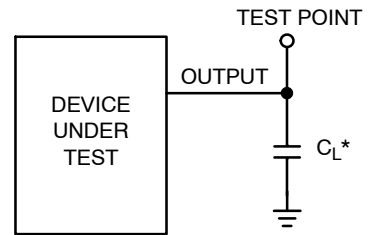


Figure 3. Switching Waveforms



\*Includes all probe and jig capacitance

Figure 4. Test Circuit

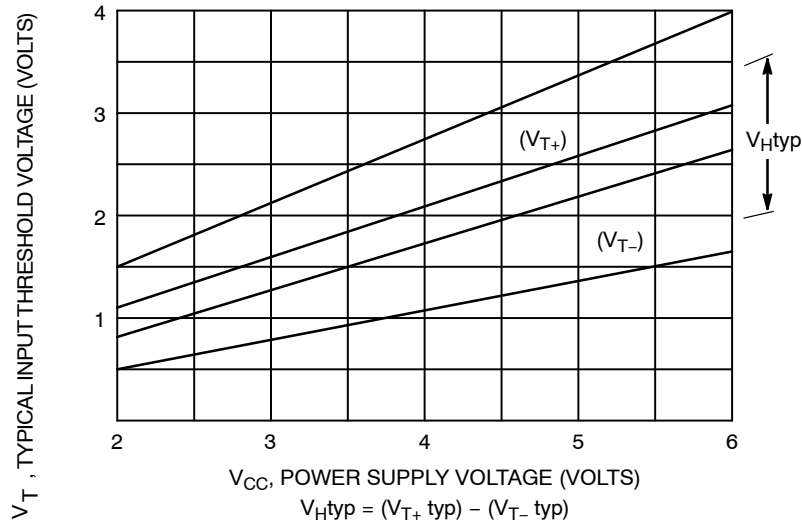


Figure 5. Typical Input Threshold,  $V_{T+}$ ,  $V_{T-}$  versus Power Supply Voltage

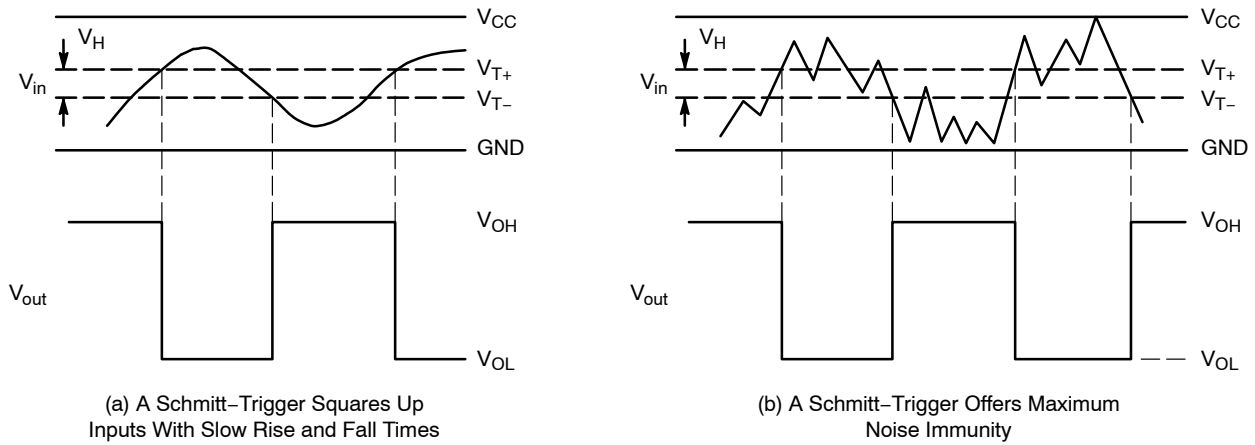


Figure 6. Typical Schmitt-Trigger Applications

## MC74VHC14

### ORDERING INFORMATION

| Device         | Package              | Shipping <sup>†</sup> |
|----------------|----------------------|-----------------------|
| MC74VHC14DG    | SOIC-14<br>(Pb-Free) | 55 Units / Rail       |
| MC74VHC14DR2G  | SOIC-14<br>(Pb-Free) | 2500 / Tape & Reel    |
| MC74VHC14DTG   | TSSOP-14*            | 96 Units / Rail       |
| MC74VHC14DTR2G | TSSOP-14*            | 2500 / Tape & Reel    |

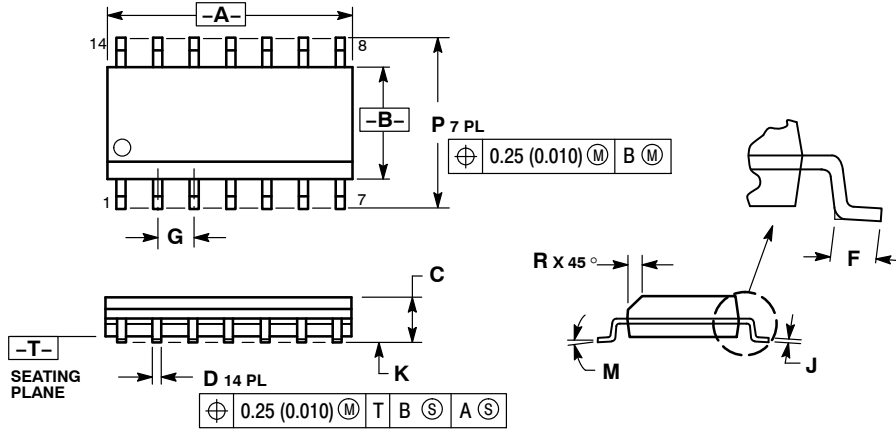
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*This package is inherently Pb-Free.

# MC74VHC14

## PACKAGE DIMENSIONS

SOIC-14  
CASE 751A-03  
ISSUE J

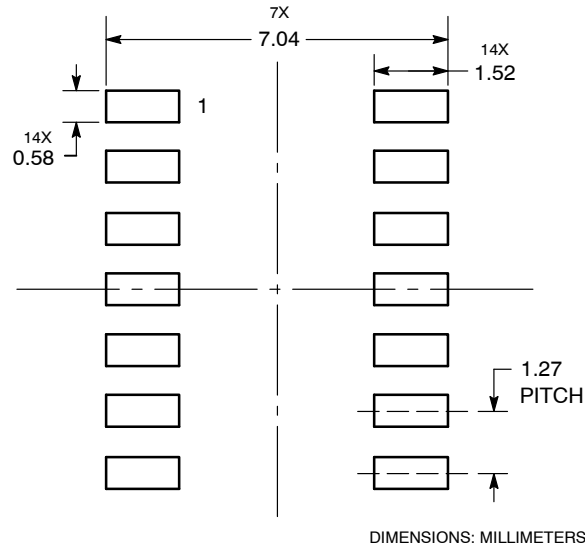


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 8.55        | 8.75 | 0.337     | 0.344 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.054     | 0.068 |
| D   | 0.35        | 0.49 | 0.014     | 0.019 |
| F   | 0.40        | 1.25 | 0.016     | 0.049 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| J   | 0.19        | 0.25 | 0.008     | 0.009 |
| K   | 0.10        | 0.25 | 0.004     | 0.009 |
| M   | 0°          | 7°   | 0°        | 7°    |
| P   | 5.80        | 6.20 | 0.228     | 0.244 |
| R   | 0.25        | 0.50 | 0.010     | 0.019 |

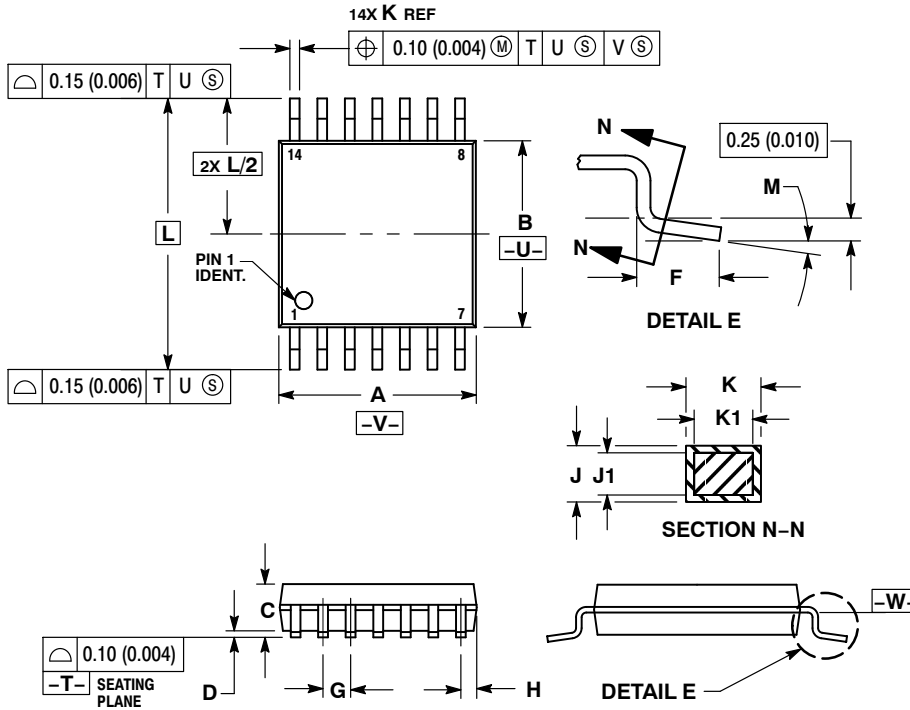
## SOLDERING FOOTPRINT



# MC74VHC14

## PACKAGE DIMENSIONS

TSSOP-14  
CASE 948G-01  
ISSUE B

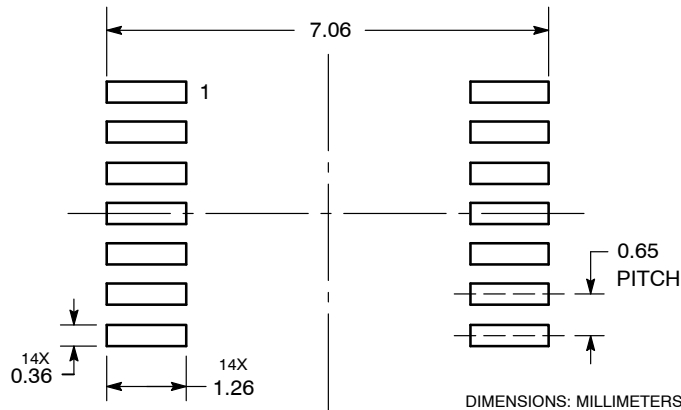


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.90        | 5.10 | 0.193     | 0.200 |
| B   | 4.30        | 4.50 | 0.169     | 0.177 |
| C   | ---         | 1.20 | ---       | 0.047 |
| D   | 0.05        | 0.15 | 0.002     | 0.006 |
| F   | 0.50        | 0.75 | 0.020     | 0.030 |
| G   | 0.65 BSC    |      | 0.026 BSC |       |
| H   | 0.50        | 0.60 | 0.020     | 0.024 |
| J   | 0.09        | 0.20 | 0.004     | 0.008 |
| J1  | 0.09        | 0.16 | 0.004     | 0.006 |
| K   | 0.19        | 0.30 | 0.007     | 0.012 |
| K1  | 0.19        | 0.25 | 0.007     | 0.010 |
| L   | 6.40 BSC    |      | 0.252 BSC |       |
| M   | 0°          | 8°   | 0°        | 8°    |

### SOLDERING FOOTPRINT



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