

# Hex Schmitt-Trigger Inverter with LSTTL Compatible Inputs

## High-Performance Silicon-Gate CMOS

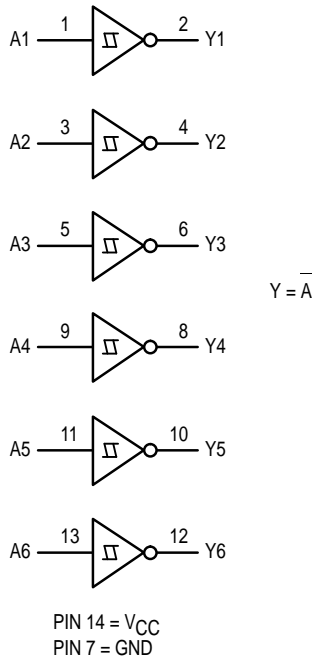
The MC54/74HCT14A may be used as a level converter for interfacing TTL or NMOS outputs to high-speed CMOS inputs.

The HCT14A is identical in pinout to the LS14.

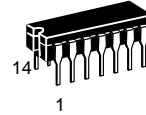
The HCT14A is useful to "square up" slow input rise and fall times. Due to the hysteresis voltage of the Schmitt trigger, the HCT14A finds applications in noisy environments.

- Output Drive Capability: 10 LSTTL Loads
- TTL/NMOS-Compatible Input Levels
- Outputs Directly Interface to CMOS, NMOS and TTL
- Operating Voltage Range: 4.5 to 5.5 V
- Low Input Current: 1.0  $\mu$ A
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 72 FETs or 18 Equivalent Gates

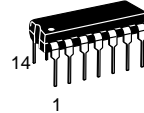
### LOGIC DIAGRAM



## MC54/74HCT14A



**J SUFFIX**  
CERAMIC PACKAGE  
CASE 632-08



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646-06



**D SUFFIX**  
SOIC PACKAGE  
CASE 751A-03

### ORDERING INFORMATION

|             |         |
|-------------|---------|
| MC54HCTXXAJ | Ceramic |
| MC74HCTXXAN | Plastic |
| MC74HCTXXAD | SOIC    |

### PIN ASSIGNMENT

|     |   |    |          |
|-----|---|----|----------|
| A1  | 1 | 14 | $V_{CC}$ |
| Y1  | 2 | 13 | A6       |
| A2  | 3 | 12 | Y6       |
| Y2  | 4 | 11 | A5       |
| A3  | 5 | 10 | Y5       |
| Y3  | 6 | 9  | A4       |
| GND | 7 | 8  | Y4       |

### FUNCTION TABLE

| Input<br>A | Output<br>Y |
|------------|-------------|
| L          | H           |
| H          | L           |



# MC54/74HCT14A

## MAXIMUM RATINGS\*

| Symbol           | Parameter   | Value                          | Unit     |
|------------------|---|--------------------------------|----------|
| V <sub>CC</sub>  | DC Supply Voltage (Referenced to GND)   | - 0.5 to + 7.0                 | V        |
| V <sub>in</sub>  | DC Input Voltage (Referenced to GND)  | - 1.5 to V <sub>CC</sub> + 1.5 | V        |
| V <sub>out</sub> | DC Output Voltage (Referenced to GND)   | - 0.5 to V <sub>CC</sub> + 0.5 | V        |
| I <sub>in</sub>  | DC Input Current, per Pin   | ± 20                           | mA       |
| I <sub>out</sub> | DC Output Current, per Pin  | ± 25                           | mA       |
| I <sub>CC</sub>  | DC Supply Current, V <sub>CC</sub> and GND Pins   | ± 50                           | mA       |
| P <sub>D</sub>   | Power Dissipation in Still Air, Plastic or Ceramic DIP†<br>SOIC Package†                          | 750<br>500                     | mW       |
| T <sub>stg</sub> | Storage Temperature   | - 65 to + 150                  | °C       |
| T <sub>L</sub>   | Lead Temperature, 1 mm from Case for 10 Seconds<br>(Plastic DIP or SOIC Package)<br>(Ceramic DIP) | 260<br>300                     | °C<br>°C |

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<sub>in</sub> and V<sub>out</sub> should be constrained to the range GND ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>CC</sub>. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

\* Maximum Ratings are those values beyond which damage to the device may occur.

Functional operation should be restricted to the Recommended Operating Conditions

† Derating — Plastic DIP: - 10 mW/°C from 65° to 125°C

Ceramic DIP: - 10 mW/°C from 100° to 125°C

SOIC Package: - 7 mW/°C from 65° to 125°C

For high frequency or heavy load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

## RECOMMENDED OPERATING CONDITIONS

| Symbol                             | Parameter  | Min  | Max             | Unit |
|------------------------------------|--|------|-----------------|------|
| V <sub>CC</sub>                    | DC Supply Voltage (Referenced to GND)                | 4.5  | 5.5             | V    |
| V <sub>in</sub> , V <sub>out</sub> | DC Input Voltage, Output Voltage (Referenced to GND) | 0    | V <sub>CC</sub> | V    |
| T <sub>A</sub>                     | Operating Temperature, All Package Types             | - 55 | + 125           | °C   |
| t <sub>r</sub> , t <sub>f</sub>    | Input Rise and Fall Time (Figure 1)                  | —    | *               | ns   |

\* No Limit when V<sub>in</sub> ≈ 50% V<sub>CC</sub>, I<sub>CC</sub> > 1 mA.

## DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

| Symbol              | Parameter                                      | Test Conditions  | V <sub>CC</sub><br>Volts | Temperature Limit |            |            |            |            |            | Unit |
|---------------------|--|--|--------------------------|-------------------|------------|------------|------------|------------|------------|------|
|                     |  |  |                          | - 55 to<br>25°C   |            | ≤ 85°C     |            | ≤ 125°C    |            |      |
|                     |  |  |                          | Min               | Max        | Min        | Max        | Min        | Max        |      |
| V <sub>T+</sub> max | Maximum Positive-Going Input Threshold Voltage | V <sub>out</sub> = 0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>out</sub>   ≤ 20 μA | 4.5<br>5.5               |                   | 1.9<br>2.1 |            | 1.9<br>2.1 |            | 1.9<br>2.1 | V    |
| V <sub>T+</sub> min | Minimum Positive-Going Input Threshold Voltage | V <sub>out</sub> = 0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>out</sub>   ≤ 20 μA | 4.5<br>5.5               | 1.2<br>1.4        |            | 1.2<br>1.4 |            | 1.2<br>1.4 |            | V    |
| V <sub>T-</sub> max | Maximum Positive-Going Input Threshold Voltage | V <sub>out</sub> = 0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>out</sub>   ≤ 20 μA | 4.5<br>5.5               |                   | 1.2<br>1.4 |            | 1.2<br>1.4 |            | 1.2<br>1.4 |      |
| V <sub>T-</sub> min | Minimum Positive-Going Input Threshold Voltage | V <sub>out</sub> = 0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>out</sub>   ≤ 20 μA | 4.5<br>5.5               | 0.5<br>0.6        |            | 0.5<br>0.6 |            | 0.5<br>0.6 |            |      |
| V <sub>H</sub> max  | Maximum Hysteresis Voltage                     | V <sub>out</sub> = 0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>out</sub>   ≤ 20 μA | 4.5<br>5.5               |                   | 1.4<br>1.5 |            | 1.4<br>1.5 |            | 1.4<br>1.5 |      |
| V <sub>H</sub> min  | Minimum Hysteresis Voltage                     | V <sub>out</sub> = 0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>out</sub>   ≤ 20 μA | 4.5<br>5.5               | 0.4<br>0.4        |            | 0.4<br>0.4 |            | 0.4<br>0.4 |            |      |
| V <sub>OH</sub>     | Minimum High-Level Output Voltage              | V <sub>in</sub> < V <sub>T-</sub> min<br> I <sub>out</sub>   ≤ 20 μA               | 4.5<br>5.5               | 4.4<br>5.4        |            | 4.4<br>5.4 |            | 4.4<br>5.4 |            | V    |
|                     |  | V <sub>in</sub> < V <sub>T-</sub> min<br> I <sub>out</sub>   ≤ 4.0 mA              | 4.5                      | 3.98              |            | 3.84       |            | 3.7        |            |      |

NOTE: Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

(continued)

**DC CHARACTERISTICS** (Voltages Referenced to GND) – **continued**

| Symbol           | Parameter                                      | Test Conditions   | V <sub>CC</sub><br>Volts | Temperature Limit |            |        |               |         |            | Unit |
|------------------|--|---|--------------------------|-------------------|------------|--------|---------------|---------|------------|------|
|                  |  |   |                          | – 55 to 25°C      |            | ≤ 85°C |               | ≤ 125°C |            |      |
|                  |  |   |                          | Min               | Max        | Min    | Max           | Min     | Max        |      |
| V <sub>OL</sub>  | Maximum Low-Level Output Voltage               | V <sub>in</sub> < V <sub>T-min</sub><br> I <sub>out</sub>   ≤ 20 μA   | 4.5<br>5.5               |                   | 0.1<br>0.1 |        | 0.1<br>0.1    |         | 0.1<br>0.1 | V    |
|                  |  | V <sub>in</sub> < V <sub>T-min</sub><br> I <sub>out</sub>   ≤ 4.0 mA  | 4.5                      |                   | 0.26       |        | 0.33          |         | 0.4        |      |
| I <sub>in</sub>  | Maximum Input Leakage Current                  | V <sub>in</sub> = V <sub>CC</sub> or GND  | 5.5                      |                   | ± 0.1      |        | ± 1.0         |         | ± 1.0      | μA   |
| I <sub>CC</sub>  | Maximum Quiescent Supply Current (per package) | V <sub>in</sub> = V <sub>CC</sub> or GND<br>I <sub>out</sub> = 0 μA   | 5.5                      |                   | 1.0        |        | 10            |         | 40         | μA   |
| ΔI <sub>CC</sub> | Additional Quiescent Supply Current            | V <sub>in</sub> = 2.4 V, Any One Input<br>V <sub>in</sub> = V <sub>CC</sub> or GND, Other Inputs<br>I <sub>out</sub> = 0 μA | 5.5                      |                   | ≥ – 55°C   |        | 25°C to 125°C |         |            | mA   |
|                  |  |   |                          |                   | 2.9        | 2.4    |               |         |            |      |

**AC CHARACTERISTICS** (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6.0 ns)

| Symbol                                 | Parameter   | Test Conditions   |            | Guaranteed Limit |     |        |     |         |     | Unit |
|--|---|---|------------|------------------|-----|--------|-----|---------|-----|------|
|  |   |   |            | – 55 to 25°C     |     | ≤ 85°C |     | ≤ 125°C |     |      |
|  |   |   |            | Min              | Max | Min    | Max | Min     | Max |      |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Maximum Propagation Delay, Input A to Output Y (L to H) | V <sub>CC</sub> = 5.0 V ± 10%<br>C <sub>L</sub> = 50 pF, Input t <sub>r</sub> = t <sub>f</sub> = 6.0 ns | Fig. 1 & 2 |                  | 32  |        | 40  |         | 48  | ns   |
| t <sub>TLH</sub> ,<br>t <sub>THL</sub> | Maximum Output Transition Time. Any Output              | V <sub>CC</sub> = 5.0 V ± 10%<br>C <sub>L</sub> = 50 pF, Input t <sub>r</sub> = t <sub>f</sub> = 6.0 ns | Fig. 1 & 2 |                  | 15  |        | 19  |         | 22  | ns   |

NOTE: For propagation delays with loads other than 50 pF, and information on typical parametric values, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

| C <sub>PD</sub> | Power Dissipation Capacitance (Per Inverter)* | Typical @ 25°C, V <sub>CC</sub> = 5.0 V |  | pF |
|-----------------|---|---|--|----|
|                 |   | 32                                      |  |    |
|                 |   |   |  |    |

\* 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 + I<sub>CC</sub> V<sub>CC</sub>. For load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

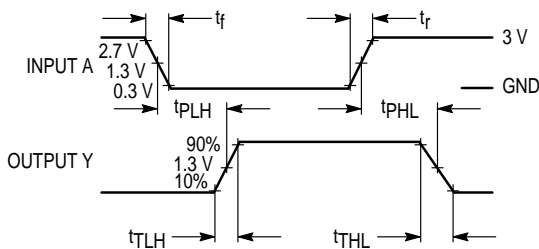
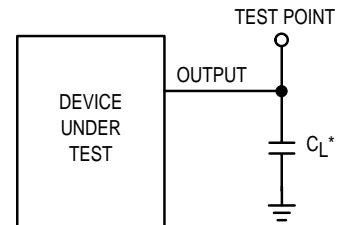


Figure 1. Switching Waveforms

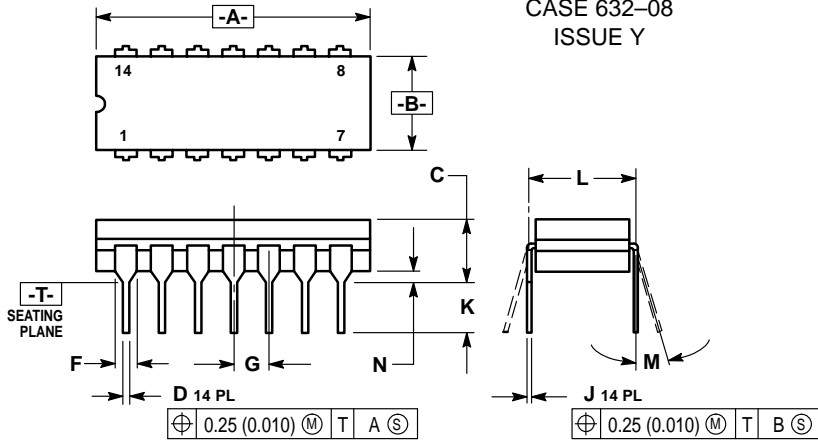


\* Includes all probe and jig capacitance

Figure 2. Test Circuit

OUTLINE DIMENSIONS

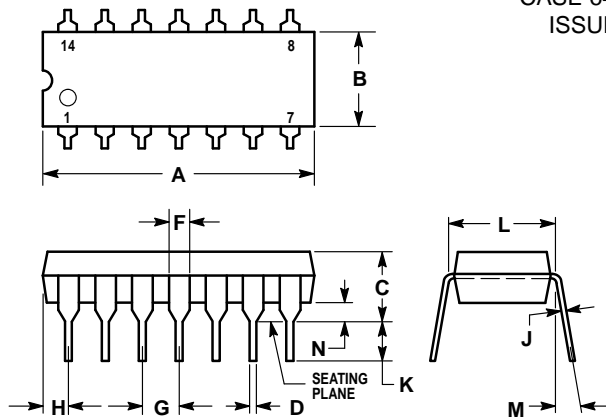
**J SUFFIX**  
**CERAMIC DIP PACKAGE**  
 CASE 632-08  
 ISSUE Y



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
  4. DIMENSION F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.750     | 0.785 | 19.05       | 19.94 |
| B   | 0.245     | 0.280 | 6.23        | 7.11  |
| C   | 0.155     | 0.200 | 3.94        | 5.08  |
| D   | 0.015     | 0.020 | 0.39        | 0.50  |
| F   | 0.055     | 0.065 | 1.40        | 1.65  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| J   | 0.008     | 0.015 | 0.21        | 0.38  |
| K   | 0.125     | 0.170 | 3.18        | 4.31  |
| L   | 0.300 BSC |       | 7.62 BSC    |       |
| M   | 0° 15°    |       | 0° 15°      |       |
| N   | 0.020     | 0.040 | 0.51        | 1.01  |

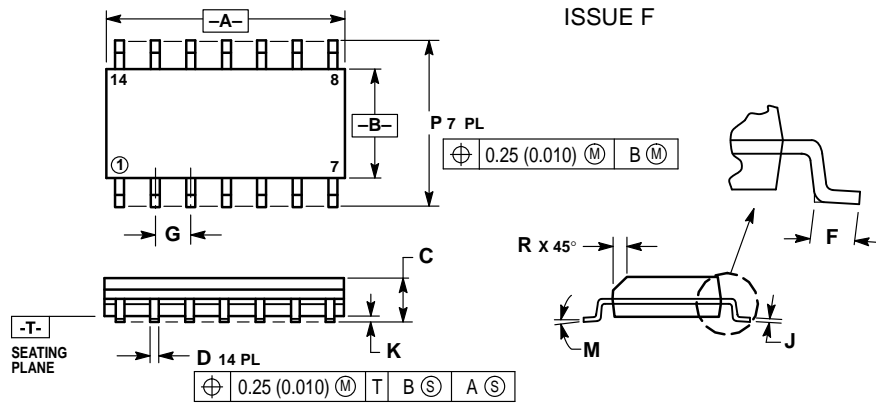
**N SUFFIX**  
**PLASTIC DIP PACKAGE**  
 CASE 646-06  
 ISSUE L



- NOTES:
1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
  2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
  3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
  4. ROUNDED CORNERS OPTIONAL.


| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.715     | 0.770 | 18.16       | 19.56 |
| B   | 0.240     | 0.260 | 6.10        | 6.60  |
| C   | 0.145     | 0.185 | 3.69        | 4.69  |
| D   | 0.015     | 0.021 | 0.38        | 0.53  |
| F   | 0.040     | 0.070 | 1.02        | 1.78  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.052     | 0.095 | 1.32        | 2.41  |
| J   | 0.008     | 0.015 | 0.20        | 0.38  |
| K   | 0.115     | 0.135 | 2.92        | 3.43  |
| L   | 0.300 BSC |       | 7.62 BSC    |       |
| M   | 0° 10°    |       | 0° 10°      |       |
| N   | 0.015     | 0.039 | 0.39        | 1.01  |

**D SUFFIX**  
**PLASTIC SOIC PACKAGE**  
 CASE 751A-03  
 ISSUE F



- 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 |

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MC54/74HCT14A/D

