

# Hex Inverter

## MC74VHC04

The MC74VHC04 is an advanced high speed CMOS inverter fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

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 V, allowing the interface of 5 V systems to 3 V systems.

### Features

- High Speed:  $t_{PD} = 3.8 \text{ ns}$  (Typ) at  $V_{CC} = 5 \text{ V}$
- Low Power Dissipation:  $I_{CC} = 2 \mu\text{A}$  (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 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: HBM > 2000 V; Machine Model > 200 V
- Chip Complexity: 36 FETs or 9 Equivalent Gates
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

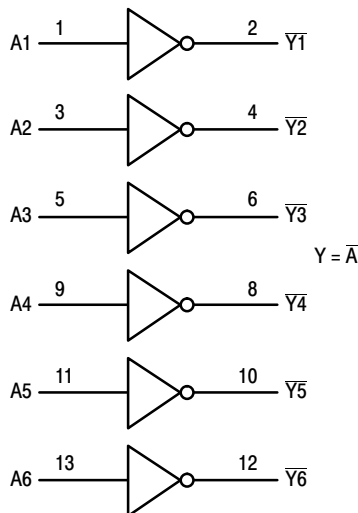


Figure 1. Logic Diagram

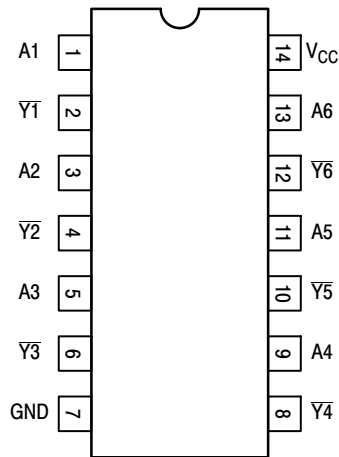


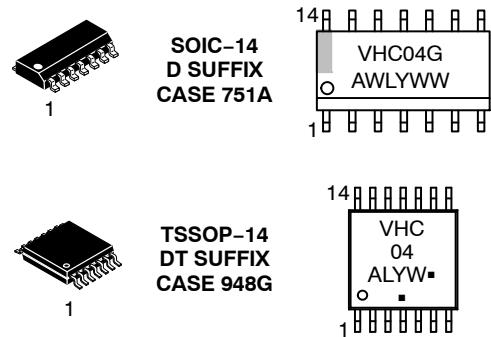
Figure 2. Pinout:  
14-Lead Packages  
(Top View)



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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      | Y       |
| L      | H       |
| H      | L       |

### ORDERING INFORMATION

| Device          | Package            | Shipping†          |
|-----------------|--------------------|--------------------|
| MC74VHC04DR2G   | SOIC-14 (Pb-Free)  | 2500 / Tape & Reel |
| MC74VHC04DTR2G  | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |
| NLV74VHC04DTR2G | TSSOP-14 (Pb-Free) | 2500 / Tape & Reel |

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

# MC74VHC04

## MAXIMUM RATINGS

| Symbol    | Parameter   | Value                  | Unit |
|-----------|---|------------------------|------|
| $V_{CC}$  | DC Supply Voltage   | -0.5 to + 7.0          | V    |
| $V_{in}$  | DC 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                        | $\pm 50$               | mA   |
| $P_D$     | Power Dissipation in Still Air, SOIC Package†<br>TSSOP Package† | 500<br>450             | mW   |
| $T_{stg}$ | Storage Temperature   | - 65 to + 150          | °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,  $V_{in}$  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.

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.

†Derating — SOIC Package: - 7 mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

## RECOMMENDED OPERATING CONDITIONS

| Symbol     | Parameter  | 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  | -40 | + 85      | °C   |
| $t_r, t_f$ | Input Rise and Fall Time<br>$V_{CC} = 3.3V \pm 0.3V$<br>$V_{CC} = 5.0V \pm 0.5V$ | 0   | 100<br>20 | ns/V |

## DC ELECTRICAL CHARACTERISTICS

| Symbol   | Parameter                         | Test Conditions  | $V_{CC}$<br>V        | $T_A = 25^\circ\text{C}$    |                   |                             | $T_A = -40 \text{ to } 85^\circ\text{C}$ |                             | Unit          |
|----------|-----------------------------------|--|----------------------|-----------------------------|-------------------|-----------------------------|--|-----------------------------|---------------|
|          |                                   |  |                      | Min                         | Typ               | Max                         | Min                                      | Max                         |               |
| $V_{IH}$ | Minimum High-Level Input Voltage  |  | 2.0<br>3.0 to<br>5.5 | 1.50<br>$V_{CC} \times 0.7$ |                   |                             | 1.50<br>$V_{CC} \times 0.7$              |                             | V             |
| $V_{IL}$ | Maximum Low-Level Input Voltage   |  | 2.0<br>3.0 to<br>5.5 |                             |                   | 0.50<br>$V_{CC} \times 0.3$ |  | 0.50<br>$V_{CC} \times 0.3$ | V             |
| $V_{OH}$ | Minimum High-Level Output Voltage | $V_{in} = V_{IH} \text{ or } V_{IL}$<br>$I_{OH} = -50\mu\text{A}$                        | 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             |
|          |                                   | $V_{in} = V_{IH} \text{ or } V_{IL}$<br>$I_{OH} = -4\text{mA}$<br>$I_{OH} = -8\text{mA}$ | 3.0<br>4.5           | 2.58<br>3.94                |                   |                             | 2.48<br>3.80                             |                             |               |
| $V_{OL}$ | Maximum Low-Level Output Voltage  | $V_{in} = V_{IH} \text{ or } V_{IL}$<br>$I_{OL} = 50\mu\text{A}$                         | 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             |
|          |                                   | $V_{in} = V_{IH} \text{ or } V_{IL}$<br>$I_{OL} = 4\text{mA}$<br>$I_{OL} = 8\text{mA}$   | 3.0<br>4.5           |                             |                   | 0.36<br>0.36                |  | 0.44<br>0.44                |               |
| $I_{in}$ | Maximum Input Leakage Current     | $V_{in} = 5.5 \text{ or } GND$   | 0 to 5.5             |                             |                   | $\pm 0.1$                   |  | $\pm 0.1$                   | $\mu\text{A}$ |
| $I_{CC}$ | Maximum Quiescent Supply Current  | $V_{in} = V_{CC} \text{ or } GND$  | 5.5                  |                             |                   | 2.0                         |  | 20.0                        | $\mu\text{A}$ |

# MC74VHC04

## AC ELECTRICAL CHARACTERISTICS (Input $t_r = t_f = 3.0\text{ns}$ )

| Symbol                   | Parameter   | Test Conditions   | $T_A = 25^\circ\text{C}$ |            |             | $T_A = -40 \text{ to } 85^\circ\text{C}$ |             | Unit |
|--------------------------|---|---|--------------------------|------------|-------------|--|-------------|------|
|                          |   |   | Min                      | Typ        | Max         | Min                                      | Max         |      |
| $t_{PLH}$ ,<br>$t_{PHL}$ | Maximum Propagation Delay,<br>A or B to $\bar{Y}$ | $V_{CC} = 3.3 \pm 0.3\text{V}$ $C_L = 15\text{pF}$<br>$C_L = 50\text{pF}$ |                          | 5.0<br>7.5 | 7.1<br>10.6 | 1.0<br>1.0                               | 8.5<br>12.0 | ns   |
|                          |   | $V_{CC} = 5.0 \pm 0.5\text{V}$ $C_L = 15\text{pF}$<br>$C_L = 50\text{pF}$ |                          | 3.8<br>5.3 | 5.5<br>7.5  | 1.0<br>1.0                               | 6.5<br>8.5  |      |
| $C_{in}$                 | Maximum Input Capacitance                         |   |                          | 4          | 10          |  | 10          | pF   |

| Symbol   | Parameter   | Typical @ $25^\circ\text{C}$ , $V_{CC} = 5.0\text{V}$ |     | Unit |
|----------|---|---|-----|------|
|          |   | Min   | Max |      |
| $C_{PD}$ | Power Dissipation Capacitance (Per Inverter) (Note 1) | 18  |     | pF   |

1.  $C_{PD}$  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:  $I_{CC(OPR)} = C_{PD} \cdot V_{CC} \cdot f_{in} + I_{CC}/6$  (per buffer).  $C_{PD}$  is used to determine the no-load dynamic power consumption;  $P_D = C_{PD} \cdot V_{CC}^2 \cdot f_{in} + I_{CC} \cdot V_{CC}$ .

## NOISE CHARACTERISTICS (Input $t_r = t_f = 3.0\text{ns}$ , $C_L = 50\text{pF}$ , $V_{CC} = 5.0\text{V}$ )

| Symbol    | Characteristic                           | $T_A = 25^\circ\text{C}$ |      | Unit |
|-----------|--|--------------------------|------|------|
|           |  | Typ                      | Max  |      |
| $V_{OLP}$ | Quiet Output Maximum Dynamic $V_{OL}$    | 0.4                      | 0.8  | V    |
| $V_{OLV}$ | Quiet Output Minimum Dynamic $V_{OL}$    | -0.4                     | -0.8 | V    |
| $V_{IHD}$ | Minimum High Level Dynamic Input Voltage |                          | 3.5  | V    |
| $V_{ILD}$ | Maximum Low Level Dynamic Input Voltage  |                          | 1.5  | V    |

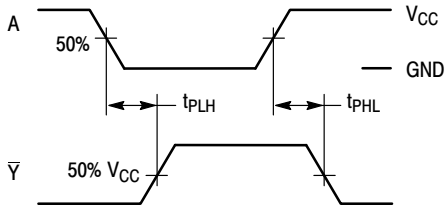
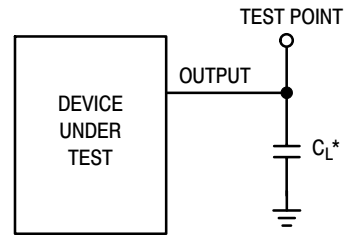


Figure 3. Switching Waveforms



\*Includes all probe and jig capacitance

Figure 4. Test Circuit

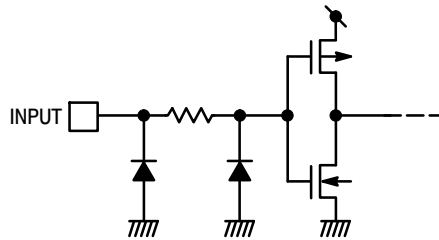
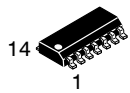


Figure 5. Input Equivalent Circuit

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-14 NB  
CASE 751A-03  
ISSUE L

DATE 03 FEB 2016



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 1.35        | 1.75 | 0.054     | 0.068 |
| A1  | 0.10        | 0.25 | 0.004     | 0.010 |
| A3  | 0.19        | 0.25 | 0.008     | 0.010 |
| b   | 0.35        | 0.49 | 0.014     | 0.019 |
| D   | 8.55        | 8.75 | 0.337     | 0.344 |
| E   | 3.80        | 4.00 | 0.150     | 0.157 |
| e   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 5.80        | 6.20 | 0.228     | 0.244 |
| h   | 0.25        | 0.50 | 0.010     | 0.019 |
| L   | 0.40        | 1.25 | 0.016     | 0.049 |
| M   | 0°          | 7°   | 0°        | 7°    |

SOLDERING FOOTPRINT\*



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.

GENERIC MARKING DIAGRAM\*



- XXXXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- Y = Year
- WW = Work Week
- G = Pb-Free Package

\*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.

STYLES ON PAGE 2

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**SOIC-14**  
**CASE 751A-03**  
**ISSUE L**

DATE 03 FEB 2016

STYLE 1:  
 PIN 1. COMMON CATHODE  
 2. ANODE/CATHODE  
 3. ANODE/CATHODE  
 4. NO CONNECTION  
 5. ANODE/CATHODE  
 6. NO CONNECTION  
 7. ANODE/CATHODE  
 8. ANODE/CATHODE  
 9. ANODE/CATHODE  
 10. NO CONNECTION  
 11. ANODE/CATHODE  
 12. ANODE/CATHODE  
 13. NO CONNECTION  
 14. COMMON ANODE

STYLE 2:  
 CANCELLED

STYLE 3:  
 PIN 1. NO CONNECTION  
 2. ANODE  
 3. ANODE  
 4. NO CONNECTION  
 5. ANODE  
 6. NO CONNECTION  
 7. ANODE  
 8. ANODE  
 9. ANODE  
 10. NO CONNECTION  
 11. ANODE  
 12. ANODE  
 13. NO CONNECTION  
 14. COMMON CATHODE

STYLE 4:  
 PIN 1. NO CONNECTION  
 2. CATHODE  
 3. CATHODE  
 4. NO CONNECTION  
 5. CATHODE  
 6. NO CONNECTION  
 7. CATHODE  
 8. CATHODE  
 9. CATHODE  
 10. NO CONNECTION  
 11. CATHODE  
 12. CATHODE  
 13. NO CONNECTION  
 14. COMMON ANODE

STYLE 5:  
 PIN 1. COMMON CATHODE  
 2. ANODE/CATHODE  
 3. ANODE/CATHODE  
 4. ANODE/CATHODE  
 5. ANODE/CATHODE  
 6. NO CONNECTION  
 7. COMMON ANODE  
 8. COMMON CATHODE  
 9. ANODE/CATHODE  
 10. ANODE/CATHODE  
 11. ANODE/CATHODE  
 12. ANODE/CATHODE  
 13. NO CONNECTION  
 14. COMMON ANODE

STYLE 6:  
 PIN 1. CATHODE  
 2. CATHODE  
 3. CATHODE  
 4. CATHODE  
 5. CATHODE  
 6. CATHODE  
 7. CATHODE  
 8. ANODE  
 9. ANODE  
 10. ANODE  
 11. ANODE  
 12. ANODE  
 13. ANODE  
 14. ANODE

STYLE 7:  
 PIN 1. ANODE/CATHODE  
 2. COMMON ANODE  
 3. COMMON CATHODE  
 4. ANODE/CATHODE  
 5. ANODE/CATHODE  
 6. ANODE/CATHODE  
 7. ANODE/CATHODE  
 8. ANODE/CATHODE  
 9. ANODE/CATHODE  
 10. ANODE/CATHODE  
 11. COMMON CATHODE  
 12. COMMON ANODE  
 13. ANODE/CATHODE  
 14. ANODE/CATHODE

STYLE 8:  
 PIN 1. COMMON CATHODE  
 2. ANODE/CATHODE  
 3. ANODE/CATHODE  
 4. NO CONNECTION  
 5. ANODE/CATHODE  
 6. ANODE/CATHODE  
 7. COMMON ANODE  
 8. COMMON ANODE  
 9. ANODE/CATHODE  
 10. ANODE/CATHODE  
 11. NO CONNECTION  
 12. ANODE/CATHODE  
 13. ANODE/CATHODE  
 14. COMMON CATHODE

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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



**TSSOP-14 WB**  
CASE 948G  
ISSUE C

DATE 17 FEB 2016

SCALE 2:1



**NOTES:**

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- 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.
- DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
- 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.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
- 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°    |

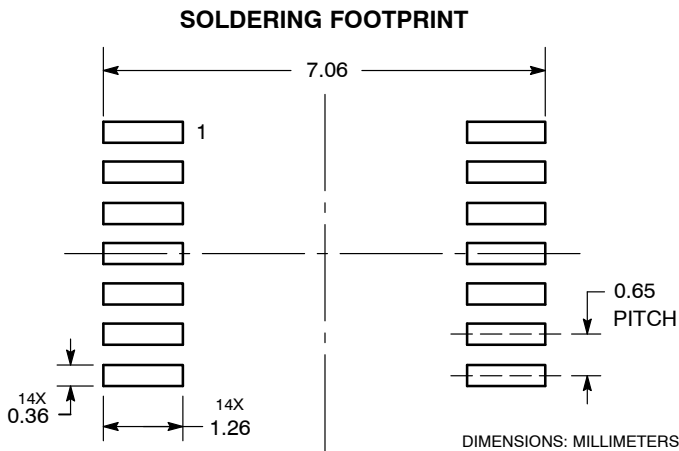
**GENERIC MARKING DIAGRAM\***



- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = 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.



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