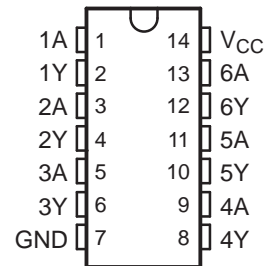


## HEX INVERTER

### FEATURES

- Qualified for Automotive Applications
- 2-V to 5.5-V  $V_{CC}$  Operation
- Unbuffered Outputs
- Typical  $V_{OLP}$  (Output Ground Bounce)  
<0.8 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Typical  $V_{OHV}$  (Output  $V_{OH}$  Undershoot)  
>2.3 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Supports Mixed-Mode Voltage Operation on All Ports

**PW PACKAGE  
(TOP VIEW)**


### DESCRIPTION/ORDERING INFORMATION

This hex inverter is designed for 2-V to 5.5-V  $V_{CC}$  operation.

The SN74LVU04A-Q1 contains six independent inverters with unbuffered outputs. This device performs the Boolean function  $Y = \bar{A}$ .

#### ORDERING INFORMATION<sup>(1)</sup>

| $T_A$                                      | PACKAGE <sup>(2)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|--|------------------------|--------------|-----------------------|------------------|
| $-40^\circ\text{C}$ to $125^\circ\text{C}$ | TSSOP – PW             | Reel of 2000 | SN74LVU04AQPWRQ1      | LU04AQ           |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

#### FUNCTION TABLE (EACH INVERTER)

| INPUT<br>A | OUTPUT<br>Y |
|------------|-------------|
| H          | L           |
| L          | H           |

#### LOGIC DIAGRAM, EACH INVERTER (POSITIVE LOGIC)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## Absolute Maximum Ratings<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|                           |   | MIN                                   | MAX                   | UNIT |
|---------------------------|---|---------------------------------------|-----------------------|------|
| V <sub>CC</sub>           | Supply voltage range                              | −0.5                                  | 7                     | V    |
| V <sub>I</sub>            | Input voltage range <sup>(2)</sup>                | −0.5                                  | 7                     | V    |
| V <sub>O</sub>            | Output voltage range <sup>(2)(3)</sup>            | −0.5                                  | V <sub>CC</sub> + 0.5 | V    |
| I <sub>IK</sub>           | Input clamp current                               | V <sub>I</sub> < 0                    | −20                   | mA   |
| I <sub>OK</sub>           | Output clamp current                              | V <sub>O</sub> < 0                    | −50                   | mA   |
| I <sub>O</sub>            | Continuous output current                         | V <sub>O</sub> = 0 to V <sub>CC</sub> | ±25                   | mA   |
|                           | Continuous current through V <sub>CC</sub> or GND |                                       | ±50                   | mA   |
| θ <sub>JA</sub>           | Package thermal impedance <sup>(4)</sup>          |                                       | 113                   | °C/W |
| ESD rating <sup>(5)</sup> | Human-Body Model                                  |                                       | 1.5 (H1C)             | kV   |
|                           | Charged-Device Model                              |                                       | 1 (C5)                |      |
|                           | Machine Model                                     |                                       | 200 (M3)              | V    |
| T <sub>stg</sub>          | Storage temperature range                         | −65                                   | 150                   | °C   |

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) This value is limited to 5.5 V maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.
- (5) ESD protection level per AEC Q100 classification

## Recommended Operating Conditions<sup>(1)</sup>

|                 |                                | MIN                              | MAX                   | UNIT |
|-----------------|--------------------------------|----------------------------------|-----------------------|------|
| V <sub>CC</sub> | Supply voltage                 | 2                                | 5.5                   | V    |
| V <sub>IH</sub> | High-level input voltage       | V <sub>CC</sub> = 2 V            | 1.7                   | V    |
|                 |                                | V <sub>CC</sub> = 2.3 V to 2.7 V | V <sub>CC</sub> × 0.8 |      |
|                 |                                | V <sub>CC</sub> = 3 V to 3.6 V   | V <sub>CC</sub> × 0.8 |      |
|                 |                                | V <sub>CC</sub> = 4.5 V to 5.5 V | V <sub>CC</sub> × 0.8 |      |
| V <sub>IL</sub> | Low-level input voltage        | V <sub>CC</sub> = 2 V            | 0.3                   | V    |
|                 |                                | V <sub>CC</sub> = 2.3 V to 2.7 V | V <sub>CC</sub> × 0.2 |      |
|                 |                                | V <sub>CC</sub> = 3 V to 3.6 V   | V <sub>CC</sub> × 0.2 |      |
|                 |                                | V <sub>CC</sub> = 4.5 V to 5.5 V | 0.8                   |      |
| V <sub>I</sub>  | Input voltage                  | 0                                | 5.5                   | V    |
| V <sub>O</sub>  | Output voltage                 | 0                                | V <sub>CC</sub>       | V    |
| I <sub>OH</sub> | High-level output current      | V <sub>CC</sub> = 2 V            | −50                   | mA   |
|                 |                                | V <sub>CC</sub> = 2.3 V to 2.7 V | −2                    |      |
|                 |                                | V <sub>CC</sub> = 3 V to 3.6 V   | −6                    |      |
|                 |                                | V <sub>CC</sub> = 4.5 V to 5.5 V | −12                   |      |
| I <sub>OL</sub> | Low-level output current       | V <sub>CC</sub> = 2 V            | 50                    | mA   |
|                 |                                | V <sub>CC</sub> = 2.3 V to 2.7 V | 2                     |      |
|                 |                                | V <sub>CC</sub> = 3 V to 3.6 V   | 6                     |      |
|                 |                                | V <sub>CC</sub> = 4.5 V to 5.5 V | 12                    |      |
| T <sub>A</sub>  | Operating free-air temperature | −40                              | 125                   | °C   |

- (1) All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER       | TEST CONDITIONS   |                                   | V <sub>CC</sub> | –40°C to 125°C        |     |     | –40°C to 85°C         |     |     | UNIT |
|-----------------|---|-----------------------------------|-----------------|-----------------------|-----|-----|-----------------------|-----|-----|------|
|                 |   |                                   |                 | MIN                   | TYP | MAX | MIN                   | TYP | MAX |      |
| V <sub>OH</sub> | I <sub>OH</sub> = –50 μA                                    | V <sub>IL</sub> = 0 V             | 2 V to 5.5 V    | V <sub>CC</sub> – 0.1 |     |     | V <sub>CC</sub> – 0.1 |     |     | V    |
|                 | I <sub>OH</sub> = –2 mA                                     |                                   | 2.3 V           | 2                     |     |     | 2                     |     |     |      |
|                 | I <sub>OH</sub> = –6 mA                                     |                                   | 3 V             | 2.48                  |     |     | 2.48                  |     |     |      |
|                 | I <sub>OH</sub> = –12 mA                                    |                                   | 4.5 V           | 3.7                   |     |     | 3.8                   |     |     |      |
| V <sub>OL</sub> | I <sub>OL</sub> = 50 μA                                     | V <sub>IH</sub> = V <sub>CC</sub> | 2 V to 5.5 V    |                       |     |     | 0.1                   |     |     | V    |
|                 | I <sub>OL</sub> = 2 mA                                      |                                   | 2.3 V           | 0.4                   |     |     | 0.4                   |     |     |      |
|                 | I <sub>OL</sub> = 6 mA                                      |                                   | 3 V             | 0.44                  |     |     | 0.44                  |     |     |      |
|                 | I <sub>OL</sub> = 12 mA                                     |                                   | 4.5 V           | 0.55                  |     |     | 0.55                  |     |     |      |
| I <sub>I</sub>  | V <sub>I</sub> = 5.5 V or GND                               |                                   | 0 V to 5.5 V    | ±1                    |     |     | ±1                    |     |     | μA   |
| I <sub>CC</sub> | V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0 |                                   | 5.5 V           | 20                    |     |     | 20                    |     |     | μA   |
| C <sub>i</sub>  | V <sub>I</sub> = V <sub>CC</sub> or GND                     |                                   | 3.3 V           | 4                     |     |     | 4                     |     |     | pF   |

## Switching Characteristics

 over recommended operating free-air temperature range, V<sub>CC</sub> = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

| PARAMETER       | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE       | T <sub>A</sub> = 25°C |      |     | –40°C to 125°C |     | –40°C to 85°C |     | UNIT |
|-----------------|--------------|-------------|------------------------|-----------------------|------|-----|----------------|-----|---------------|-----|------|
|                 |              |             |                        | MIN                   | TYP  | MAX | MIN            | MAX | MIN           | MAX |      |
| t <sub>pd</sub> | A            | Y           | C <sub>L</sub> = 50 pF | 4.7                   | 11.4 |     | 1              | 16  | 1             | 13  | ns   |

## Switching Characteristics

 over recommended operating free-air temperature range, V<sub>CC</sub> = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

| PARAMETER       | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE       | T <sub>A</sub> = 25°C |     |     | –40°C to 125°C |     | –40°C to 85°C |     | UNIT |
|-----------------|--------------|-------------|------------------------|-----------------------|-----|-----|----------------|-----|---------------|-----|------|
|                 |              |             |                        | MIN                   | TYP | MAX | MIN            | MAX | MIN           | MAX |      |
| t <sub>pd</sub> | A            | Y           | C <sub>L</sub> = 50 pF | 3.9                   | 7   |     | 1              | 11  | 1             | 8   | ns   |

## Noise Characteristics

 V<sub>CC</sub> = 3.3 V, C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C<sup>(1)</sup>

| PARAMETER          |   | MIN | TYP  | MAX  | UNIT |
|--------------------|---|-----|------|------|------|
| V <sub>OL(P)</sub> | Quiet output, maximum dynamic V <sub>OL</sub> |     | 0.5  | 0.8  | V    |
| V <sub>OL(V)</sub> | Quiet output, minimum dynamic V <sub>OL</sub> |     | –0.1 | –0.8 | V    |
| V <sub>OH(V)</sub> | Quiet output, minimum dynamic V <sub>OH</sub> |     | 3    |      | V    |
| V <sub>IH(D)</sub> | High-level dynamic input voltage              |     | 2.31 |      | V    |
| V <sub>IL(D)</sub> | Low-level dynamic input voltage               |     |      | 0.99 | V    |

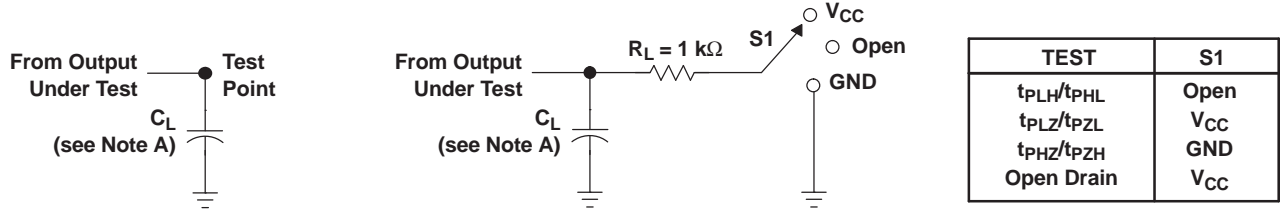
(1) Characteristics are for surface-mount packages only.

## Operating Characteristics

 T<sub>A</sub> = 25°C

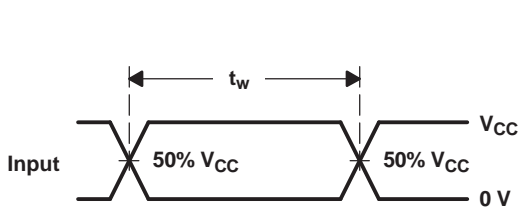
| PARAMETER       |                               | TEST CONDITIONS                    | V <sub>CC</sub> | TYP | UNIT |
|-----------------|-------------------------------|------------------------------------|-----------------|-----|------|
| C <sub>pd</sub> | Power dissipation capacitance | C <sub>L</sub> = 50 pF, f = 10 MHz | 3.3 V           | 5.6 | pF   |
|                 |                               |                                    | 5 V             | 6.7 |      |

PARAMETER MEASUREMENT INFORMATION

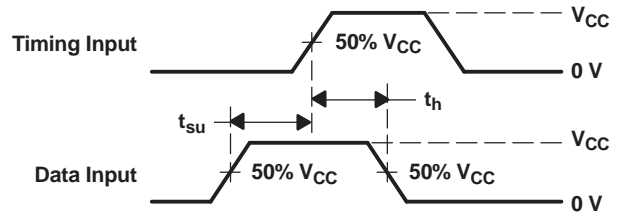


LOAD CIRCUIT FOR TOTEM-POLE OUTPUTS

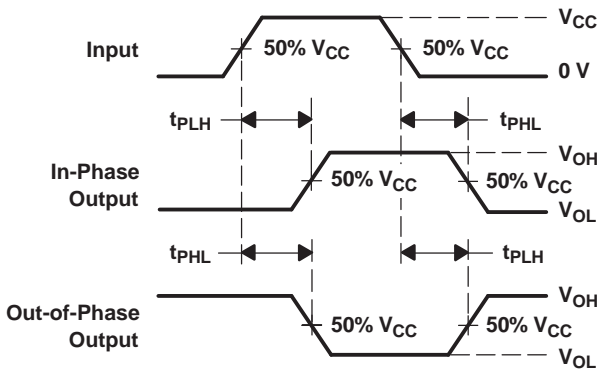
LOAD CIRCUIT FOR 3-STATE AND OPEN-DRAIN OUTPUTS



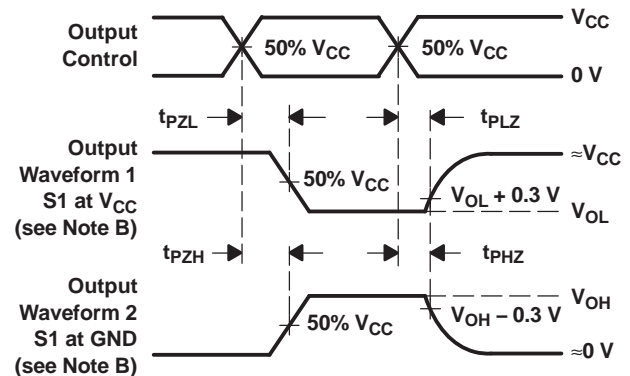
VOLTAGE WAVEFORMS PULSE DURATION



VOLTAGE WAVEFORMS SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES LOW- AND HIGH-LEVEL ENABLING

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.  
 C. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 3\text{ ns}$ ,  $t_f \leq 3\text{ ns}$ .  
 D. The outputs are measured one at a time, with one input transition per measurement.  
 E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .  
 F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .  
 G.  $t_{PHL}$  and  $t_{PLH}$  are the same as  $t_{pd}$ .  
 H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuits and Voltage Waveforms

**PACKAGING INFORMATION**

| Orderable Device   | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| SN74LVU04AQPWRG4Q1 | ACTIVE                | TSSOP        | PW              | 14   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74LVU04AQPWRQ1   | ACTIVE                | TSSOP        | PW              | 14   | 2000        | Pb-Free (RoHS)          | CU NIPDAU        | Level-1-250C-UNLIM           |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**OTHER QUALIFIED VERSIONS OF SN74LVU04A-Q1 :**

- Catalog: [SN74LVU04A](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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