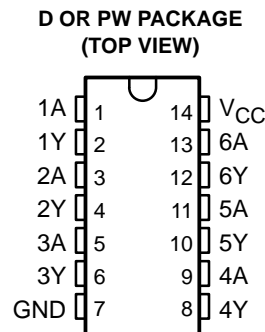


- Q Devices Meet Automotive Performance Requirements
- Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval
- EPIC™ (Enhanced-Performance Implanted CMOS) Process
- Operating Range 2-V to 5.5-V V_{CC}
- Latch-Up Performance Exceeds 250 mA Per JESD 17



description

The SN74AHC04Q contains six independent inverters. This device performs the Boolean function $Y = \bar{A}$.

ORDERING INFORMATION

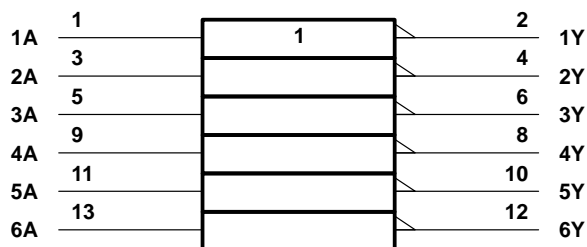
| T _A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------|---------------|-----------------------|------------------|
| -40°C to 125°C | SOIC – D | Tape and reel | SN74AHC04QDR | AHC04Q |
| | TSSOP – PW | Tape and reel | SN74AHC04QPWR | HA04Q |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE (each inverter)

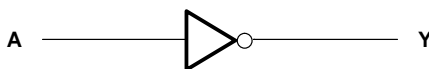
| INPUT A | OUTPUT Y |
|------------|-------------|
| H | L |
| L | H |

logic symbol‡



‡ This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram, each inverter (positive logic)



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**TEXAS
INSTRUMENTS**

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SN74AHC04Q HEX INVERTER

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

| | |
|--|----------------------------|
| Supply voltage range, V_{CC} | -0.5 V to 7 V |
| Input voltage range, V_I (see Note 1) | -0.5 V to 7 V |
| Output voltage range, V_O (see Note 1) | -0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, I_{IK} ($V_I < 0$) | -20 mA |
| Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) | ±20 mA |
| Continuous output current, I_O ($V_O = 0$ to V_{CC}) | ±25 mA |
| Continuous current through V_{CC} or GND | ±50 mA |
| Package thermal impedance, θ_{JA} (see Note 2): D package | 86°C/W |
| PW package | 113°C/W |
| Storage temperature range, T_{stg} | -65°C to 150°C |

† 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.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 3)

| | | MIN | MAX | UNIT |
|---------------------|------------------------------------|--------------------------|----------|------|
| V_{CC} | Supply voltage | 2 | 5.5 | V |
| V_{IH} | High-level input voltage | $V_{CC} = 2$ V | 1.5 | V |
| | | $V_{CC} = 3$ V | 2.1 | |
| | | $V_{CC} = 5.5$ V | 3.85 | |
| V_{IL} | Low-level input voltage | $V_{CC} = 2$ V | 0.5 | V |
| | | $V_{CC} = 3$ V | 0.9 | |
| | | $V_{CC} = 5.5$ V | 1.65 | |
| V_I | Input voltage | 0 | 5.5 | V |
| V_O | Output voltage | 0 | V_{CC} | V |
| I_{OH} | High-level output current | $V_{CC} = 2$ V | -50 | μA |
| | | $V_{CC} = 3.3$ V ± 0.3 V | -4 | mA |
| | | $V_{CC} = 5$ V ± 0.5 V | -8 | |
| I_{OL} | Low-level output current | $V_{CC} = 2$ V | 50 | μA |
| | | $V_{CC} = 3.3$ V ± 0.3 V | 4 | mA |
| | | $V_{CC} = 5$ V ± 0.5 V | 8 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | $V_{CC} = 3.3$ V ± 0.3 V | 100 | ns/V |
| | | $V_{CC} = 5$ V ± 0.5 V | 20 | |
| T_A | Operating free-air temperature | -40 | 125 | °C |

NOTE 3: All unused inputs of the device must be held at V_{CC} 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 _{CC} | T _A = 25°C | | | MIN | MAX | UNIT |
|-----------------|---|-----------------|-----------------------|-----|------|-----|-----|------|
| | | | MIN | TYP | MAX | | | |
| V _{OH} | I _{OH} = -50 μA | 2 V | 1.9 | 2 | | 1.9 | V | |
| | | 3 V | 2.9 | 3 | | 2.9 | | |
| | | 4.5 V | 4.4 | 4.5 | | 4.4 | | |
| | I _{OH} = -4 mA | 3 V | 2.58 | | 2.48 | | | |
| | I _{OH} = -8 mA | 4.5 V | 3.94 | | 3.8 | | | |
| V _{OL} | I _{OL} = 50 μA | 2 V | | | 0.1 | 0.1 | V | |
| | | 3 V | | | 0.1 | 0.1 | | |
| | | 4.5 V | | | 0.1 | 0.1 | | |
| | I _{OL} = 4 mA | 3 V | | | 0.36 | 0.5 | | |
| | I _{OL} = 8 mA | 4.5 V | | | 0.36 | 0.5 | | |
| I _I | V _I = 5.5 V or GND | 0 V to 5.5 V | | | ±0.1 | ±1 | μA | |
| I _{CC} | V _I = V _{CC} or GND, I _O = 0 | 5.5 V | | | 2 | 20 | μA | |
| C _i | V _I = V _{CC} or GND | 5 V | | 2 | 10 | | pF | |

switching characteristics over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | T _A = 25°C | | | MIN | MAX | UNIT |
|------------------|--------------|-------------|------------------------|-----------------------|-----|------|-----|------|------|
| | | | | MIN | TYP | MAX | | | |
| t _{PLH} | A | Y | C _L = 15 pF | | 5 | 8.9 | 1 | 10.5 | ns |
| t _{PHL} | | | | | 5 | 8.9 | 1 | 10.5 | |
| t _{PLH} | A | Y | C _L = 50 pF | | 7.5 | 11.4 | 1 | 13 | ns |
| t _{PHL} | | | | | 7.5 | 11.4 | 1 | 13 | |

switching characteristics over recommended operating free-air temperature range, V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | T _A = 25°C | | | MIN | MAX | UNIT |
|------------------|--------------|-------------|------------------------|-----------------------|-----|-----|-----|-----|------|
| | | | | MIN | TYP | MAX | | | |
| t _{PLH} | A | Y | C _L = 15 pF | | 3.8 | 5.5 | 1 | 6.5 | ns |
| t _{PHL} | | | | | 3.8 | 5.5 | 1 | 6.5 | |
| t _{PLH} | A | Y | C _L = 50 pF | | 5.3 | 7.5 | 1 | 8.5 | ns |
| t _{PHL} | | | | | 5.3 | 7.5 | 1 | 8.5 | |

noise characteristics, V_{CC} = 5 V, C_L = 50 pF, T_A = 25°C (see Note 4)

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|------|-----|------|
| V _{OL(P)} Quiet output, maximum dynamic V _{OL} | | 0.4 | | V |
| V _{OL(V)} Quiet output, minimum dynamic V _{OL} | | -0.4 | | V |
| V _{OH(V)} Quiet output, minimum dynamic V _{OH} | | 4.8 | | V |
| V _{IH(D)} High-level dynamic input voltage | 3.5 | | | V |
| V _{IL(D)} Low-level dynamic input voltage | | | 1.5 | V |

NOTE 4: Characteristics are for surface-mount packages only.

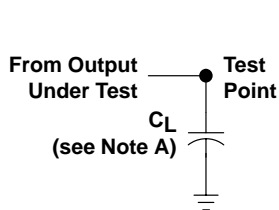
SN74AHC04Q HEX INVERTER

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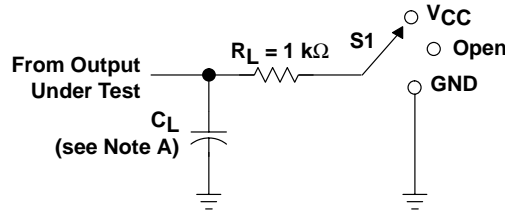
operating characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | TEST CONDITIONS | TYP | UNIT |
|--|-----------------------------|-----|------|
| C_{pd} Power dissipation capacitance | No load, $f = 1\text{ MHz}$ | 12 | pF |

PARAMETER MEASUREMENT INFORMATION

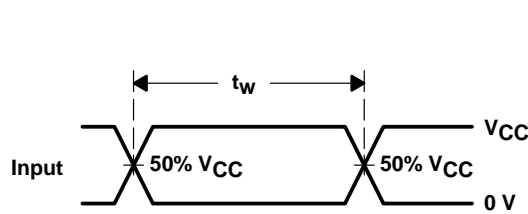


LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

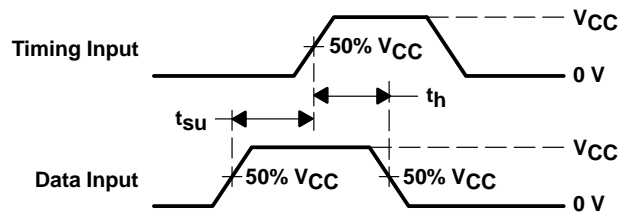


LOAD CIRCUIT FOR
3-STATE AND OPEN-DRAIN OUTPUTS

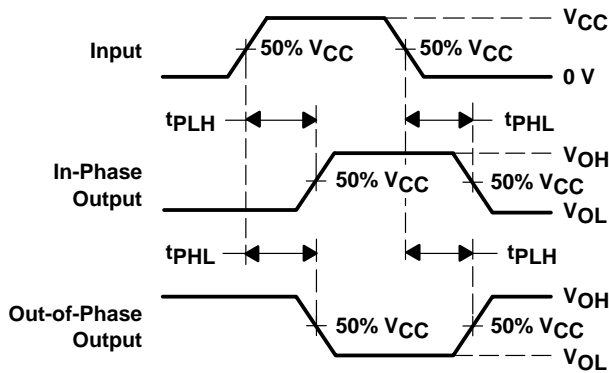
| TEST | S1 |
|-------------------|----------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | V_{CC} |
| t_{PHZ}/t_{PZH} | GND |
| Open Drain | V_{CC} |



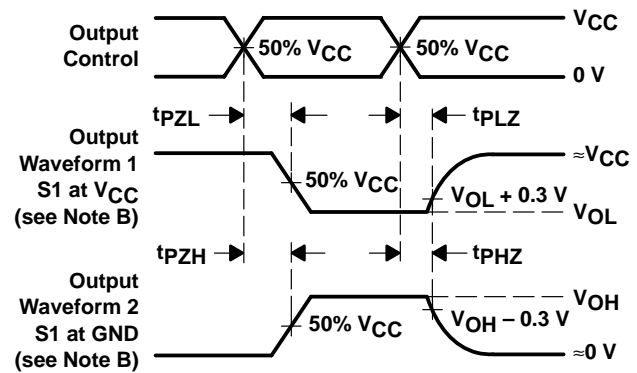
VOLTAGE WAVEFORMS
PULSE DURATION



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:
- C_L includes probe and jig capacitance.
 - 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.
 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 1\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 3\text{ ns}$, $t_f \leq 3\text{ ns}$.
 - The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| SN74AHC04QDR | ACTIVE | SOIC | D | 14 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | AHC04Q | Samples |

(1) 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.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

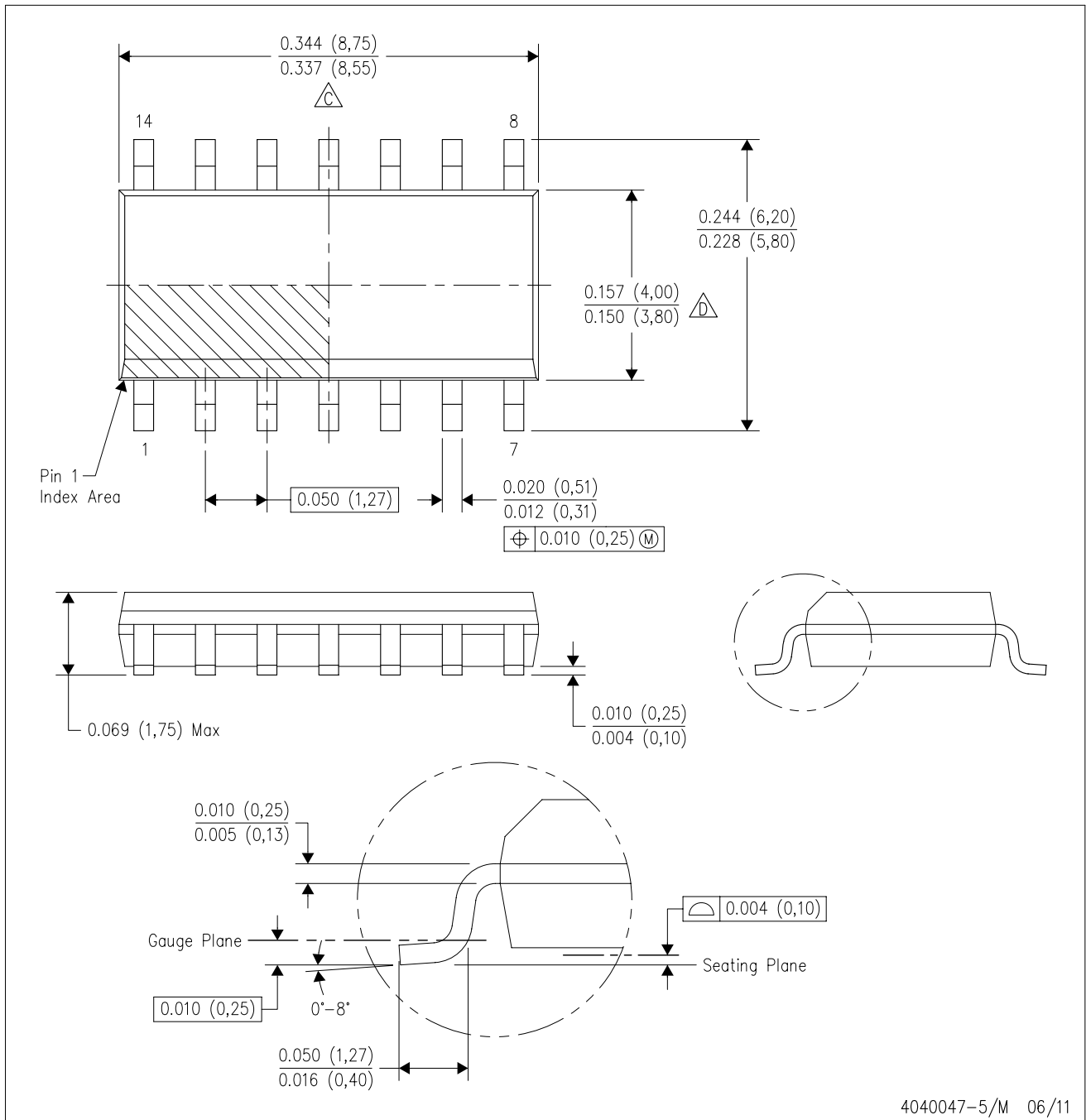
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - $\triangle D$ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AB.

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