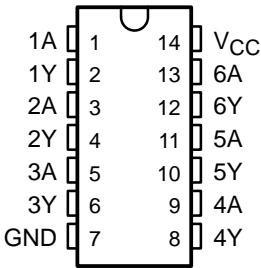


- AC Types Feature 1.5-V to 5.5-V Operation and Balanced Noise Immunity at 30% of the Supply Voltage
- Speed of Bipolar F, AS, and S, With Significantly Reduced Power Consumption
- Balanced Propagation Delays
- ± 24 -mA Output Drive Current
 - Fanout to 15 F Devices
- SCR-Latchup-Resistant CMOS Process and Circuit Design
- Exceeds 2-kV ESD Protection Per MIL-STD-883, Method 3015

CD54AC04 . . . F PACKAGE
CD74AC04 . . . E OR M PACKAGE
(TOP VIEW)



description

The 'AC04 devices contain six independent inverters. The devices perform the Boolean function $Y = \overline{A}$.

ORDERING INFORMATION

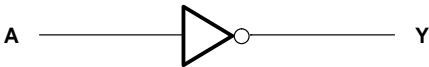
| TA | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|----------|---------------|-----------------------|------------------|
| –55°C to 125°C | PDIP – E | Tube | CD74AC04E | CD74AC04E |
| | SOIC – M | Tube | CD74AC04M | AC04M |
| | | Tape and reel | CD74AC04M96 | |
| | CDIP – F | Tube | CD54AC04F3A | CD54AC04F3A |

† 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 diagram, each inverter (positive logic)



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

CD54AC04, CD74AC04 HEX INVERTERS

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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 6 V |
| Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1) | ±20 mA |
| Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1) | ±50 mA |
| Continuous output current, I_O ($V_O = 0$ to V_{CC}) | ±50 mA |
| Continuous current through V_{CC} or GND | ±100 mA |
| Package thermal impedance, θ_{JA} (see Note 2): E package | 80°C/W |
| M package | 86°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)

| | | | $T_A = 25^\circ\text{C}$ | | –40°C TO 85°C | | –55°C TO 125°C | | UNIT |
|---------------------|------------------------------------|---|--------------------------|----------|---------------|----------|----------------|----------|------|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| V_{CC} | Supply voltage | | 1.5 | 5.5 | 1.5 | 5.5 | 1.5 | 5.5 | V |
| V_{IH} | High-level input voltage | $V_{CC} = 1.5\text{ V}$ | 1.2 | | 1.2 | | 1.2 | | V |
| | | $V_{CC} = 3\text{ V}$ | 2.1 | | 2.1 | | 2.1 | | |
| | | $V_{CC} = 5.5\text{ V}$ | 3.85 | | 3.85 | | 3.85 | | |
| V_{IL} | Low-level input voltage | $V_{CC} = 1.5\text{ V}$ | | 0.3 | | 0.3 | | 0.3 | V |
| | | $V_{CC} = 3\text{ V}$ | | 0.9 | | 0.9 | | 0.9 | |
| | | $V_{CC} = 5.5\text{ V}$ | | 1.65 | | 1.65 | | 1.65 | |
| V_I | Input voltage | | 0 | V_{CC} | 0 | V_{CC} | 0 | V_{CC} | V |
| V_O | Output voltage | | 0 | V_{CC} | 0 | V_{CC} | 0 | V_{CC} | V |
| I_{OH} | High-level output current | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | –24 | | –24 | | –24 | mA |
| I_{OL} | Low-level output current | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | 24 | | 24 | | 24 | mA |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | $V_{CC} = 1.5\text{ V to }3\text{ V}$ | | 50 | | 50 | | 50 | ns/V |
| | | $V_{CC} = 3.6\text{ V to }5.5\text{ V}$ | | 20 | | 20 | | 20 | |

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 | | –40°C TO 85°C | | –55°C TO 125°C | | UNIT |
|-----------------|---|---------------------------|-----------------|-----------------------|-----|---------------|-----|----------------|-----|------|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| V _{OH} | V _I = V _{IH} or V _{IL} | I _{OH} = –50 µA | 1.5 V | 1.4 | | 1.4 | | 1.4 | | V |
| | | | 3 V | 2.9 | | 2.9 | | 2.9 | | |
| | | | 4.5 V | 4.4 | | 4.4 | | 4.4 | | |
| | | I _{OH} = –4 mA | 3 V | 2.58 | | 2.48 | | 2.4 | | |
| | | I _{OH} = –24 mA | 4.5 V | 3.94 | | 3.8 | | 3.7 | | |
| | | I _{OH} = –50 mA† | 5.5 V | | | | | 3.85 | | |
| | | I _{OH} = –75 mA† | 5.5 V | | | 3.85 | | | | |
| V _{OL} | V _I = V _{IH} or V _{IL} | I _{OL} = 50 µA | 1.5 V | 0.1 | | 0.1 | | 0.1 | | V |
| | | | 3 V | 0.1 | | 0.1 | | 0.1 | | |
| | | | 4.5 V | 0.1 | | 0.1 | | 0.1 | | |
| | | I _{OL} = 12 mA | 3 V | 0.36 | | 0.44 | | 0.5 | | |
| | | I _{OL} = 24 mA | 4.5 V | 0.36 | | 0.44 | | 0.5 | | |
| | | I _{OL} = 50 mA† | 5.5 V | | | | | 1.65 | | |
| | | I _{OL} = 75 mA† | 5.5 V | | | 1.65 | | | | |
| I _I | V _I = V _{CC} or GND | | 5.5 V | ±0.1 | | ±1 | | ±1 | | µA |
| I _{CC} | V _I = V _{CC} or GND, I _O = 0 | | 5.5 V | 4 | | 40 | | 80 | | µA |
| C _i | | | | 10 | | 10 | | 10 | | pF |

† Test one output at a time, not exceeding 1-second duration. Measurement is made by forcing indicated current and measuring voltage to minimize power dissipation. Test verifies a minimum 50-Ω transmission-line drive capability at 85°C and 75-Ω transmission-line drive capability at 125°C.

switching characteristics over recommended operating free-air temperature range,
V_{CC} = 1.5 V, C_L = 50 pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | –40°C TO 85°C | | –55°C TO 125°C | | UNIT |
|------------------|--------------|-------------|---------------|-----|----------------|-----|------|
| | | | MIN | MAX | MIN | MAX | |
| t _{PLH} | A | Y | | 74 | | 81 | ns |
| t _{PHL} | | | | 74 | | 81 | |

switching characteristics over recommended operating free-air temperature range,
V_{CC} = 3.3 V ± 0.3 V, C_L = 50 pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | –40°C TO 85°C | | –55°C TO 125°C | | UNIT |
|------------------|--------------|-------------|---------------|-----|----------------|-----|------|
| | | | MIN | MAX | MIN | MAX | |
| t _{PLH} | A | Y | 2.3 | 8.3 | 2.3 | 9.1 | ns |
| t _{PHL} | | | 2.3 | 8.3 | 2.3 | 9.1 | |

CD54AC04, CD74AC04 HEX INVERTERS

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switching characteristics over recommended operating free-air temperature range,
 $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$, $C_L = 50\text{ pF}$ (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | –40°C TO 85°C | | –55°C TO 125°C | | UNIT |
|-----------|-----------------|----------------|------------------|-----|-------------------|-----|------|
| | | | MIN | MAX | MIN | MAX | |
| t_{PLH} | A | Y | 1.7 | 5.9 | 1.6 | 6.5 | ns |
| t_{PHL} | | | 1.7 | 5.9 | 1.6 | 6.5 | |

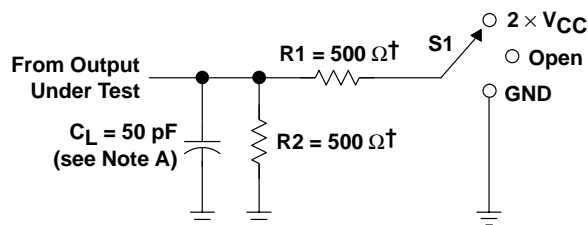
operating characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | | TYP | UNIT |
|-----------|-------------------------------|-----|------|
| C_{pd} | Power dissipation capacitance | 105 | pF |



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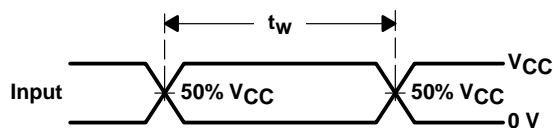
PARAMETER MEASUREMENT INFORMATION



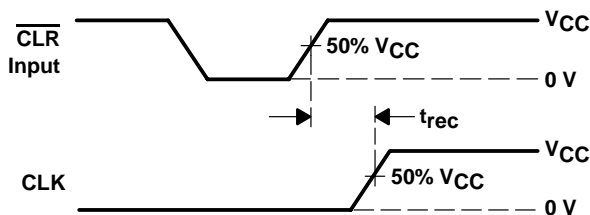
† When $V_{CC} = 1.5 \text{ V}$, $R_1 = R_2 = 1 \text{ k}\Omega$

LOAD CIRCUIT

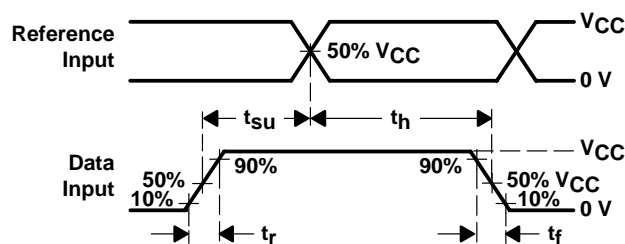
| TEST | S1 |
|-------------------|-------------------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | $2 \times V_{CC}$ |
| t_{PHZ}/t_{PZH} | GND |



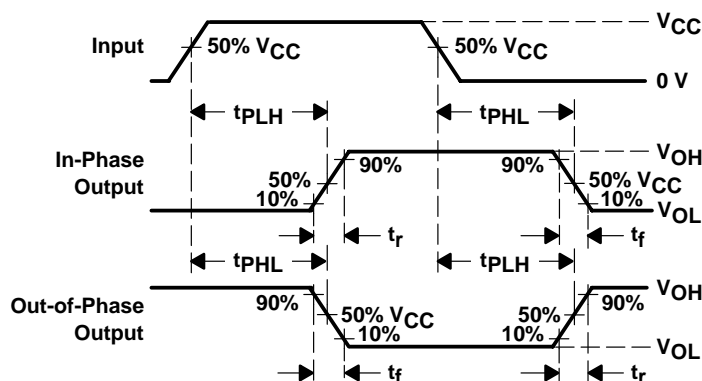
VOLTAGE WAVEFORMS
PULSE DURATION



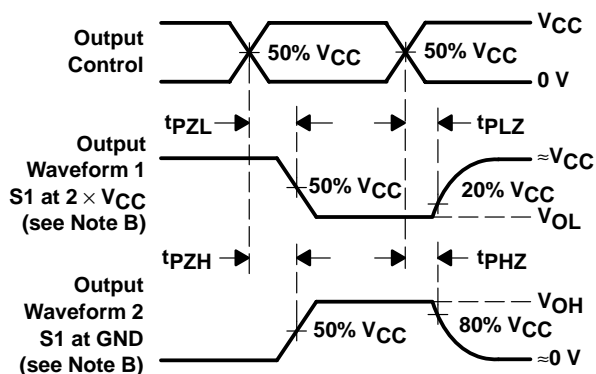
VOLTAGE WAVEFORMS
RECOVERY TIME



VOLTAGE WAVEFORMS
SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY AND OUTPUT TRANSITION TIMES



VOLTAGE WAVEFORMS
OUTPUT ENABLE AND DISABLE TIMES

- NOTES:
- A. C_L includes probe and test-fixture 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: $PRR \leq 1 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r = 3 \text{ ns}$, $t_f = 3 \text{ ns}$. Phase relationships between waveforms are arbitrary.
 - D. For clock inputs, f_{max} is measured with the input duty cycle at 50%.
 - E. The outputs are measured one at a time with one input transition per measurement.
 - F. t_{PLH} and t_{PHL} are the same as t_{pd} .
 - G. t_{PZL} and t_{PZH} are the same as t_{en} .
 - H. t_{PLZ} and t_{PHZ} are the same as t_{dis} .

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CD54AC04F3A | ACTIVE | CDIP | J | 14 | 1 | TBD | Call TI | N / A for Pkg Type |
| CD74AC04E | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| CD74AC04EE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| CD74AC04M | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CD74AC04M96 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CD74AC04M96E4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| CD74AC04ME4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽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⁾ 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)

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

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J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



| PINS ** DIM | 14 | 16 | 18 | 20 |
|----------------|------------------------|------------------------|------------------------|------------------------|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T**)

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



| PINS ** DIM | 14 | 16 | 18 | 20 |
|---------------------|------------------|------------------|------------------|------------------|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| MS-001 VARIATION | AA | BB | AC | AD |



4040049/E 12/2002

NOTES:

- A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



NOTES:

- All linear dimensions are in inches (millimeters).
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- Falls within JEDEC MS-012 variation AB.

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