

## 1. General Description

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The EM74HC00; EM74HCT00 is a quad 2-input NAND gate. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

## 2. Features and Benefits

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- Wide supply voltage range from 2.0 V to 6.0 V
- High noise immunity
- CMOS low power dissipation
- Latch-up performance exceeds 250 mA
- Complies with JEDEC standards:
  - JESD8C (2.7 V to 3.6 V)
  - JESD7A (2.0 V to 6.0 V)
- Input levels:
  - For EM74HC00: CMOS level
  - For EM74HCT00: TTL level
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 3500 V
  - CDM ANSI/ESDA/JEDEC JS-002 Class C3 exceeds 2000 V
- Multiple package options

## EM74HC00; EM74HCT00

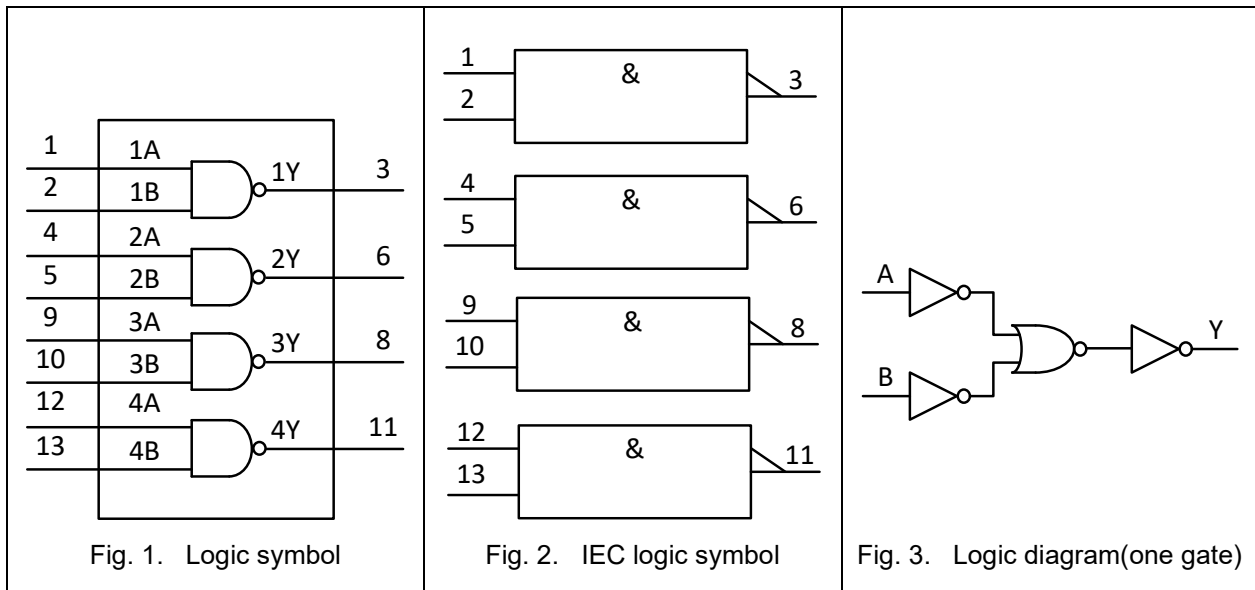
Quad 2-input NAND gate

### 3. Ordering Information

Table 1. Ordering information

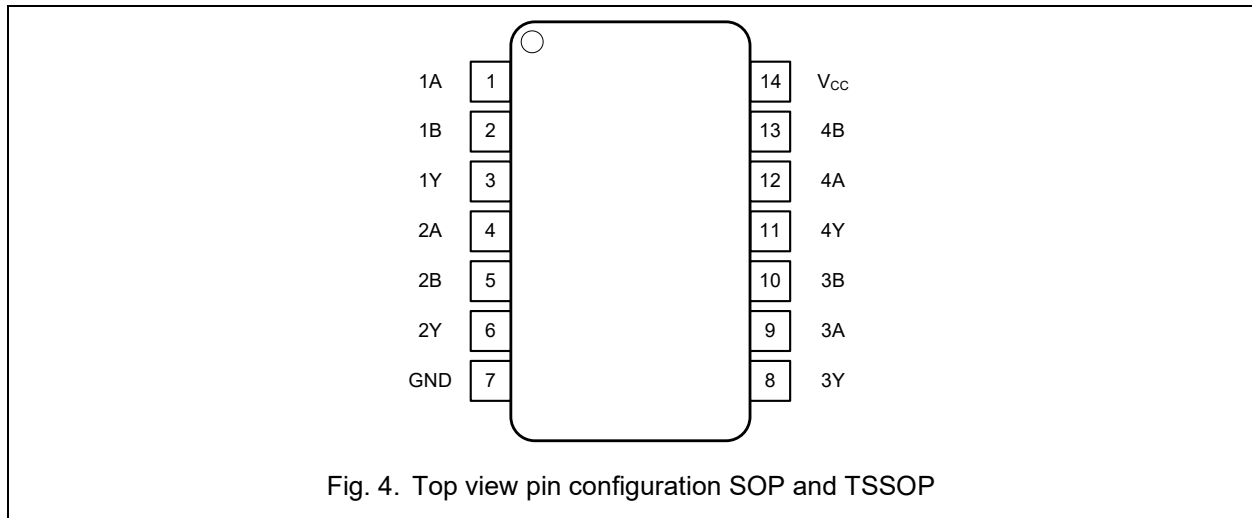
| Type number | Package   |                                                                           |          |
|-------------|-----------|---------------------------------------------------------------------------|----------|
|             | Name      | Description                                                               | Quantity |
| EM74HC00D   | SOP-14L   | plastic small outline package; 14 leads;<br>body width 3.9 mm             | 3000     |
| EM74HCT00D  |           |                                                                           |          |
| EM74HC00PW  | TSSOP-14L | plastic thin shrink small outline package; 14 leads;<br>body width 4.4 mm | 3000     |
| EM74HCT00PW |           |                                                                           |          |

### 4. Function Diagram



## 5. Pinning Information

### 5.1. Pinning



### 5.2. Pin description

**Table 2. Pin description**

| Symbol          | Pin          | Description    |
|-----------------|--------------|----------------|
| 1A, 2A, 3A, 4A  | 1, 4, 9, 12  | Data input     |
| 1B, 2B, 3B, 4B  | 2, 5, 10, 13 | Data input     |
| 1Y, 2Y, 3Y, 4Y  | 3, 6, 8, 11  | Data output    |
| GND             | 7            | Ground (0V)    |
| V <sub>CC</sub> | 14           | Supply voltage |

## 6. Functional Description

**Table 3. Function table**

H = HIGH voltage level; L = LOW voltage level; X = don't care.

| Control |    | Output |
|---------|----|--------|
| nA      | nB | nY     |
| L       | X  | H      |
| X       | L  | H      |
| H       | H  | L      |

## 7. Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

**Table 4. Absolute Maximum Ratings**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND.

| Symbol    | Parameter               | Conditions                                                 | Min  | Max      | Unit |
|-----------|-------------------------|------------------------------------------------------------|------|----------|------|
| $V_{CC}$  | supply voltage          |                                                            | -0.5 | 7.0      | V    |
| $I_{IK}$  | input clamping current  | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ [1] |      | $\pm 20$ | mA   |
| $I_{OK}$  | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1] |      | $\pm 20$ | mA   |
| $I_O$     | output current          | $V_O = -0.5\text{ V}$ to $(V_{CC} + 0.5\text{ V})$         |      | $\pm 25$ | mA   |
| $I_{CC}$  | supply current          |                                                            |      | 50       | mA   |
| $I_{GND}$ | ground current          |                                                            | -50  |          | mA   |
| $P_{tot}$ | total power dissipation |                                                            |      | 500      | mW   |
| $T_{stg}$ | storage temperature     |                                                            | -65  | 150      | °C   |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

## 8. Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. EnergyMath does not recommend exceeding them or designing to Absolute Maximum Ratings.

**Table 5. Recommended Operating Conditions**

| Symbol              | Parameter                           | Conditions              | EM74HC00 |      |          | EM74HCT00 |      |          | Unit |
|---------------------|-------------------------------------|-------------------------|----------|------|----------|-----------|------|----------|------|
|                     |                                     |                         | Min      | Typ  | Max      | Min       | Typ  | Max      |      |
| $V_{CC}$            | supply voltage                      |                         | 2.0      | 5.0  | 6.0      | 4.5       | 5.0  | 5.5      | V    |
| $V_I$               | input voltage                       |                         | 0        |      | $V_{CC}$ | 0         |      | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                         | 0        |      | $V_{CC}$ | 0         |      | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                         | -40      |      | 125      | -40       |      | 125      | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ |          |      | 625      |           |      |          | ns/V |
|                     |                                     | $V_{CC} = 4.5\text{ V}$ |          | 1.67 | 139      |           | 1.67 | 139      | ns/V |
|                     |                                     | $V_{CC} = 6.0\text{ V}$ |          |      | 83       |           |      |          | ns/V |

## 9.Static Characteristics

**Table 6. Static characteristics**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V). Typical values measured at  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise noted).

| Symbol          | Parameter                 | Conditions                                                                                  | -40 °C to +85 °C |     |      | -40 °C to +125 °C |      | Unit |
|-----------------|---------------------------|---------------------------------------------------------------------------------------------|------------------|-----|------|-------------------|------|------|
|                 |                           |                                                                                             | Min              | Typ | Max  | Min               | Max  |      |
| EM74HC00        |                           |                                                                                             |                  |     |      |                   |      |      |
| V <sub>IH</sub> | HIGH-level input voltage  | V <sub>CC</sub> = 2.0 V                                                                     | 1.5              |     |      | 1.5               |      | V    |
|                 |                           | V <sub>CC</sub> = 4.5 V                                                                     | 3.15             |     |      | 3.15              |      | V    |
|                 |                           | V <sub>CC</sub> = 6.0 V                                                                     | 4.2              |     |      | 4.2               |      | V    |
| V <sub>IL</sub> | LOW-level input voltage   | V <sub>CC</sub> = 2.0 V                                                                     |                  |     | 0.5  |                   | 0.5  | V    |
|                 |                           | V <sub>CC</sub> = 4.5 V                                                                     |                  |     | 1.35 |                   | 1.35 | V    |
|                 |                           | V <sub>CC</sub> = 6.0 V                                                                     |                  |     | 1.8  |                   | 1.8  | V    |
| V <sub>OH</sub> | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                         |                  |     |      |                   |      |      |
|                 |                           | I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 2.0 V                                            | 1.9              |     |      | 1.9               |      | V    |
|                 |                           | I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V                                            | 4.4              |     |      | 4.4               |      | V    |
|                 |                           | I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V                                            | 5.9              |     |      | 5.9               |      | V    |
|                 |                           | I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V                                           | 3.84             |     |      | 3.7               |      | V    |
|                 |                           | I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V                                           | 5.34             |     |      | 5.2               |      | V    |
| V <sub>OL</sub> | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                         |                  |     |      |                   |      |      |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 2.0 V                                             |                  |     | 0.1  |                   | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V                                             |                  |     | 0.1  |                   | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V                                             |                  |     | 0.1  |                   | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V                                            |                  |     | 0.33 |                   | 0.4  | V    |
|                 |                           | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V                                            |                  |     | 0.33 |                   | 0.4  | V    |
| I <sub>I</sub>  | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND ;<br>V <sub>CC</sub> = 6.0 V                        |                  |     | ±1   |                   | ±1   | μA   |
| I <sub>CC</sub> | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND ; I <sub>O</sub> = 0 A ;<br>V <sub>CC</sub> = 6.0 V |                  |     | 20   |                   | 40   | μA   |
| C <sub>I</sub>  | input capacitance         |                                                                                             |                  | 7   |      |                   |      | pF   |

# EM74HC00; EM74HCT00

## Quad 2-input NAND gate

| Symbol           | Parameter                 | Conditions                                                                                                                                               | -40 °C to +85 °C |     |      | -40 °C to +125 °C |      | Unit |
|------------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----|------|-------------------|------|------|
|                  |                           |                                                                                                                                                          | Min              | Typ | Max  | Min               | Max  |      |
| EM74HCT00        |                           |                                                                                                                                                          |                  |     |      |                   |      |      |
| V <sub>IH</sub>  | HIGH-level input voltage  | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                         | 2.0              |     |      | 2.0               |      | V    |
| V <sub>IL</sub>  | LOW-level input voltage   | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                         |                  |     | 0.8  |                   | 0.8  | V    |
| V <sub>OH</sub>  | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V                                                                            |                  |     |      |                   |      |      |
|                  |                           | I <sub>O</sub> = -20 μA;                                                                                                                                 | 4.4              |     | 4.4  |                   | V    |      |
|                  |                           | I <sub>O</sub> = -4.0 mA;                                                                                                                                | 3.84             |     | 3.7  |                   | V    |      |
| V <sub>OL</sub>  | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V                                                                            |                  |     |      |                   |      |      |
|                  |                           | I <sub>O</sub> = 20 μA;                                                                                                                                  |                  |     | 0.1  |                   | 0.1  | V    |
|                  |                           | I <sub>O</sub> = 4.0 mA;                                                                                                                                 |                  |     | 0.33 |                   | 0.4  | V    |
| I <sub>I</sub>   | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND ;<br>V <sub>CC</sub> = 5.5 V                                                                                     |                  |     | ±1   |                   | ±1   | μA   |
| I <sub>CC</sub>  | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 5.5 V                                                                   |                  |     | 20   |                   | 40   | μA   |
| ΔI <sub>CC</sub> | additional supply current | per pin ; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; I <sub>O</sub> = 0 A;<br>other inputs at V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 4.5 V to 5.5 V |                  |     | 1.55 |                   | 1.85 | mA   |
| C <sub>I</sub>   | input capacitance         |                                                                                                                                                          |                  | 10  |      |                   |      | pF   |

## 10. Dynamic Characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6. Typical values measured at  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise noted).

| Symbol          | Parameter                     | Conditions                                                                              | -40 °C to +85 °C |     |     | -40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|-----------------------------------------------------------------------------------------|------------------|-----|-----|-------------------|-----|------|
|                 |                               |                                                                                         | Min              | Typ | Max | Min               | Max |      |
| EM74HC00        |                               |                                                                                         |                  |     |     |                   |     |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see Fig. 5 [1]                                                            |                  |     |     |                   |     |      |
|                 |                               | V <sub>CC</sub> = 2.0 V                                                                 |                  |     | 35  |                   | 40  | ns   |
|                 |                               | V <sub>CC</sub> = 4.5 V                                                                 |                  |     | 20  |                   | 25  | ns   |
|                 |                               | V <sub>CC</sub> = 6.0 V                                                                 |                  |     | 15  |                   | 20  | ns   |
| t <sub>t</sub>  | transition time               | see Fig. 5 [2]                                                                          |                  |     |     |                   |     |      |
|                 |                               | V <sub>CC</sub> = 2.0 V                                                                 |                  |     | 9   |                   | 11  | ns   |
|                 |                               | V <sub>CC</sub> = 4.5 V                                                                 |                  |     | 6   |                   | 8   | ns   |
|                 |                               | V <sub>CC</sub> = 6.0 V                                                                 |                  |     | 4   |                   | 5   | ns   |
| C <sub>PD</sub> | power dissipation capacitance | C <sub>L</sub> = 15 pF; f = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> [3]          |                  | 18  |     |                   |     | pF   |
| EM74HCT00       |                               |                                                                                         |                  |     |     |                   |     |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; V <sub>CC</sub> = 4.5 V; see Fig. 5 [1]                                   |                  |     | 16  |                   | 19  | ns   |
| t <sub>t</sub>  | transition time               | V <sub>CC</sub> = 4.5 V; see Fig. 5 [2]                                                 |                  |     | 6   |                   | 8   | ns   |
| C <sub>PD</sub> | power dissipation capacitance | C <sub>L</sub> = 15 pF; f = 1 MHz; V <sub>I</sub> = GND to (V <sub>CC</sub> -1.5 V) [3] |                  | 37  |     |                   |     | pF   |

[1]  $t_{pd}$  is the same as  $t_{PHL}$  and  $t_{PLH}$ .

[2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .

[3]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  where:

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

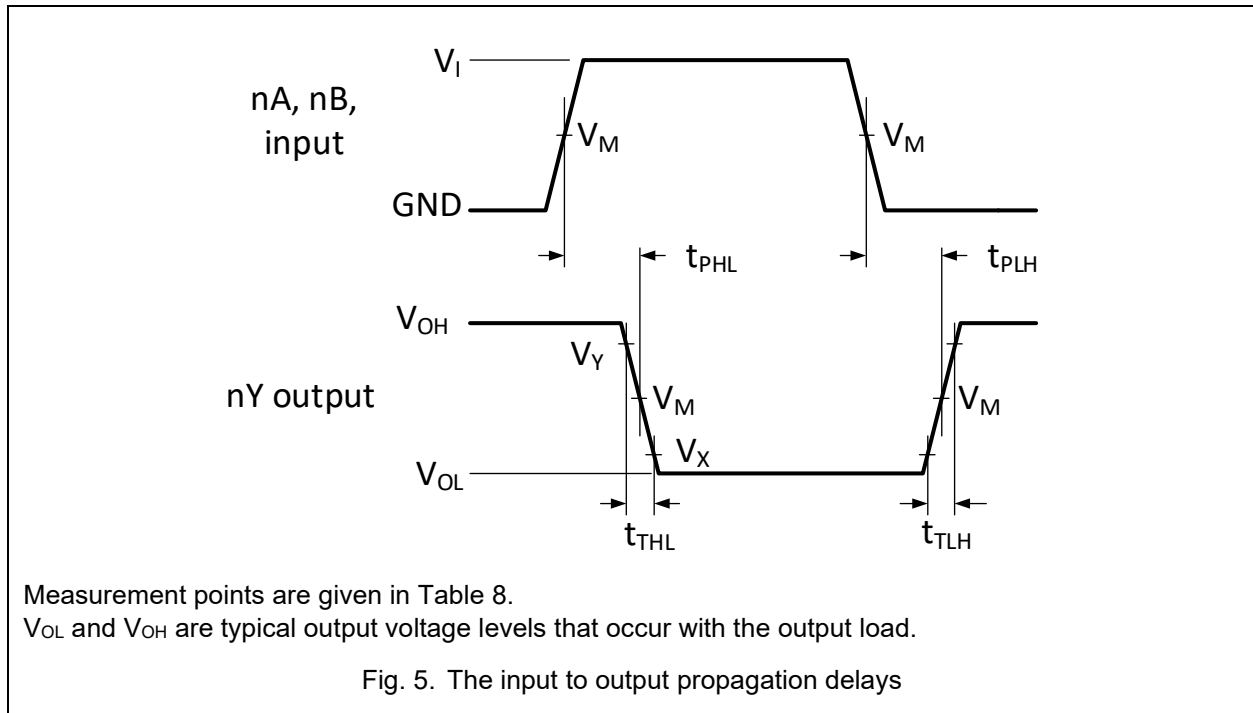
$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in V;

$N$  = number of inputs switching;

$\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

## 10.1. Waveforms and test circuit

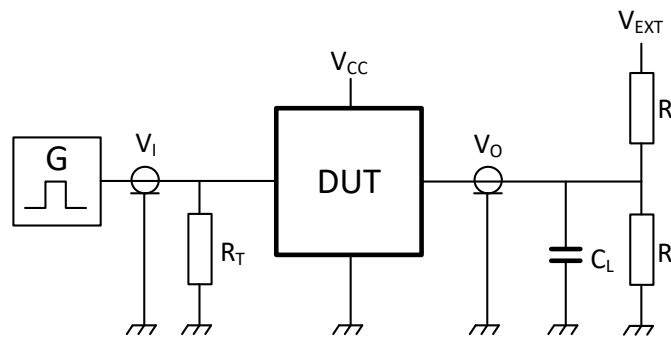
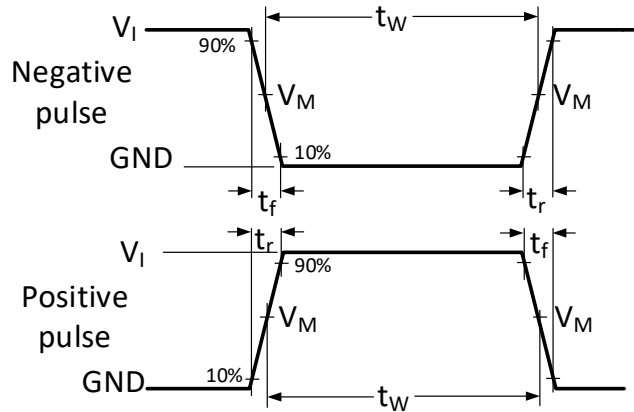


**Table 8. Measurement points**

| Type      | Input       | Output      |             |             |
|-----------|-------------|-------------|-------------|-------------|
|           | $V_M$       | $V_M$       | $V_X$       | $V_Y$       |
| EM74HC00  | $0.5V_{CC}$ | $0.5V_{CC}$ | $0.1V_{CC}$ | $0.9V_{CC}$ |
| EM74HCT00 | 1.3 V       | 1.3 V       | $0.1V_{CC}$ | $0.9V_{CC}$ |

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## Quad 2-input NAND gate



Test data is given in Table 9.

Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

$R_T$  = Termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

$V_{EXT}$  = External voltage for measuring switching times.

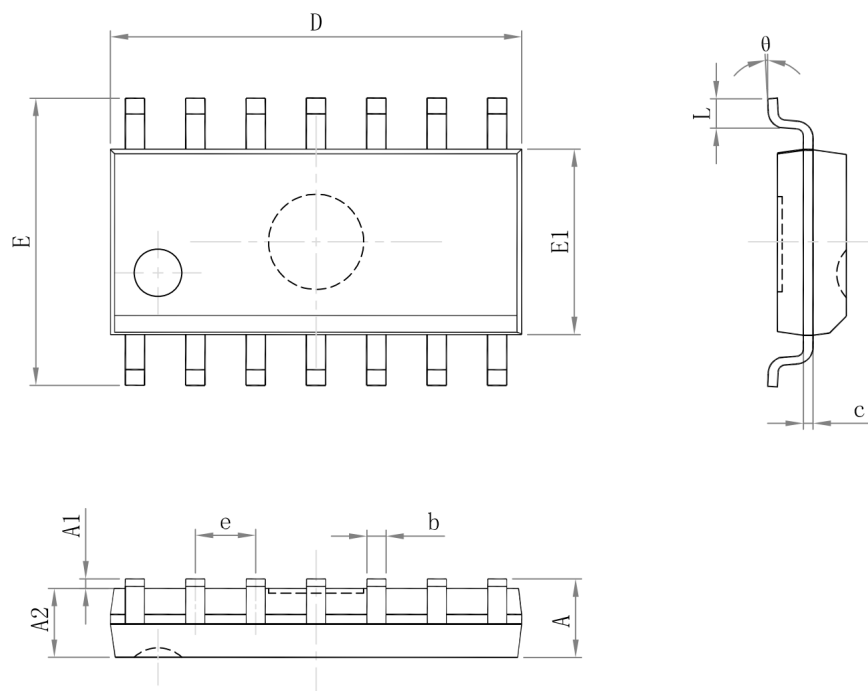
Fig. 6. Test circuit for measuring switching times

Table 9. Test data

| Type      | Input    |                       | Load  |              | $V_{EXT}$          |
|-----------|----------|-----------------------|-------|--------------|--------------------|
|           | $V_I$    | $t_r = t_f$           | $C_L$ | $R_L$        | $t_{PLH}, t_{PHL}$ |
| EM74HC00  | $V_{CC}$ | $\leq 2.5 \text{ ns}$ | 15 pF | 500 $\Omega$ | open               |
| EM74HCT00 | 3 V      | $\leq 2.5 \text{ ns}$ | 15 pF | 500 $\Omega$ | open               |

## 11. Package Outline

### SOP-14L

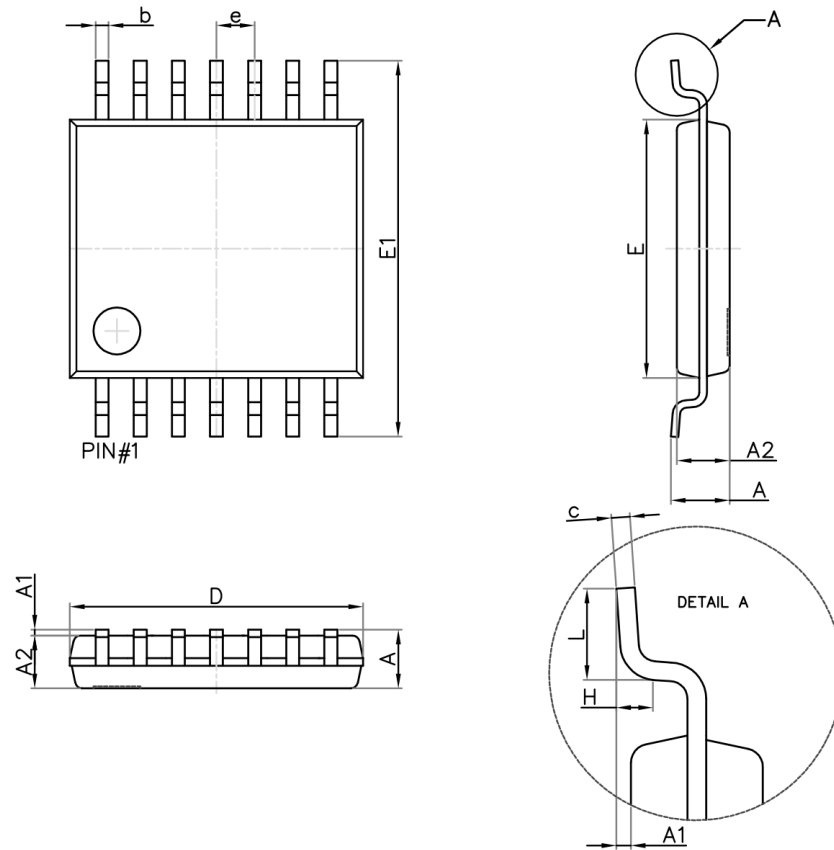


| Symbol   | Dimensions In Millimeters |       | Dimensions In Inches |       |
|----------|---------------------------|-------|----------------------|-------|
|          | Min                       | Max   | Min                  | Max   |
| A        | —                         | 1.750 | —                    | 0.069 |
| A1       | 0.100                     | 0.250 | 0.004                | 0.010 |
| A2       | 1.250                     | —     | 0.049                | —     |
| b        | 0.310                     | 0.510 | 0.012                | 0.020 |
| c        | 0.100                     | 0.250 | 0.004                | 0.010 |
| D        | 8.450                     | 8.850 | 0.333                | 0.348 |
| E        | 5.800                     | 6.200 | 0.228                | 0.244 |
| E1       | 3.800                     | 4.000 | 0.150                | 0.157 |
| e        | 1.270(BSC)                |       | 0.050(BSC)           |       |
| L        | 0.400                     | 1.270 | 0.016                | 0.050 |
| $\theta$ | 0°                        | 8°    | 0°                   | 8°    |

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Quad 2-input NAND gate

## TSSOP-14L



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| D      | 4.900                     | 5.100 | 0.193                | 0.201 |
| E      | 4.300                     | 4.500 | 0.169                | 0.177 |
| b      | 0.190                     | 0.300 | 0.007                | 0.012 |
| c      | 0.090                     | 0.200 | 0.004                | 0.008 |
| E1     | 6.250                     | 6.550 | 0.246                | 0.258 |
| A      | —                         | 1.200 | —                    | 0.047 |
| A2     | 0.800                     | 1.000 | 0.031                | 0.039 |
| A1     | 0.050                     | 0.150 | 0.002                | 0.006 |
| e      | 0.65 (BSC)                |       | 0.026 (BSC)          |       |
| L      | 0.500                     | 0.700 | 0.020                | 0.028 |
| H      | 0.25(TYP)                 |       | 0.01(TYP)            |       |
| θ      | 1°                        | 7°    | 1°                   | 7°    |

## 12. Abbreviations

**Table 10. Abbreviations**

| Acronym | Description                             |
|---------|-----------------------------------------|
| CMOS    | Complementary Metal-Oxide Semiconductor |
| DUT     | Device Under Test                       |
| ESD     | ElectroStatic Discharge                 |
| HBM     | Human Body Model                        |
| CDM     | Charged Device Model                    |
| TTL     | Transistor-Transistor Logic             |

## 13. Revision History

**Table 11. Revision history**

| Document ID           | Release Date | Data sheet status | Change notice | Supersedes |
|-----------------------|--------------|-------------------|---------------|------------|
| EM74HC_HCT00 Rev. 1.0 | Aug 30, 2024 | Product datasheet |               |            |