# 74HC02; 74HCT02

## Quad 2-input NOR gate

**Product data sheet**

## 1. General description

The 74HC02; 74HCT02 are high-speed Si-gate CMOS devices that comply with JEDEC standard no. 7A. They are pin compatible with Low-power Schottky TTL (LSTTL).

The 74HC02; 74HCT02 provides a quad 2-input NOR function.

## 2. Features

- Input levels:
  - For 74HC02: CMOS level
  - For 74HCT02: TTL level
- ESD protection:
  - HBM JESD22-A114E exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from –40 °C to +85 °C and from –40 °C to +125 °C

## 3. Ordering information

**Table 1. Ordering information**

| Type number | Package | | | |
|---|---|---|---|---|
| | Temperature range | Name | Description | Version |
| 74HC02N | –40 °C to +125 °C | DIP14 | plastic dual in-line package; 14 leads (300 mil) | SOT27-1 |
| 74HCT02N | | | | |
| 74HC02D | –40 °C to +125 °C | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |
| 74HCT02D | | | | |
| 74HC02DB | –40 °C to +125 °C | SSOP14 | plastic shrink small outline package; 14 leads; body width 5.3 mm | SOT337-1 |
| 74HCT02DB | | | | |
| 74HC02PW | –40 °C to +125 °C | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |
| 74HCT02PW | | | | |
| 74HC02BQ | –40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm | SOT762-1 |
| 74HCT02BQ | | | | |

## 6. Functional description

**Table 3. Function table[1]**

| Input | | Output |
|---|---|---|
| **nA** | **nB** | **nY** |
| L | L | H |
| X | H | L |
| H | X | L |

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

## 7. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | | –0.5 | +7 | V |
| $I_{IK}$ | input clamping current | $V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V | [1] | - | ±20 | mA |
| $I_{OK}$ | output clamping current | $V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V | [1] | - | ±20 | mA |
| $I_O$ | output current | $-0.5$ V $< V_O < V_{CC} + 0.5$ V | | - | ±25 | mA |
| $I_{CC}$ | supply current | | | - | 50 | mA |
| $I_{GND}$ | ground current | | | –50 | - | mA |
| $T_{stg}$ | storage temperature | | | –65 | +150 | °C |
| $P_{tot}$ | total power dissipation | | [2] | | | |
| | DIP14 package | | | - | 750 | mW |
| | SO14, (T)SSOP14 and DHVQFN14 packages | | | - | 500 | mW |

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

[2] For DIP14 package: $P_{tot}$ derates linearly with 12 mW/K above 70 °C.
For SO14 package: $P_{tot}$ derates linearly with 8 mW/K above 70 °C.
For (T)SSOP14 packages: $P_{tot}$ derates linearly with 5.5 mW/K above 60 °C.
For DHVQFN14 packages: $P_{tot}$ derates linearly with 4.5 mW/K above 60 °C.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

*Voltages are referenced to GND (ground = 0 V)*

| Symbol | Parameter | Conditions | 74HC02 | | | 74HCT02 | | | 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 |

**Table 5. Recommended operating conditions** *…continued*

*Voltages are referenced to GND (ground = 0 V) …continued*

| Symbol | Parameter | Conditions | 74HC02 | | | 74HCT02 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC}$ = 2.0 V | - | - | 625 | - | - | - | ns/V |
| | | $V_{CC}$ = 4.5 V | - | 1.67 | 139 | - | 1.67 | 139 | ns/V |
| | | $V_{CC}$ = 6.0 V | - | - | 83 | - | - | - | ns/V |

## 9. Static characteristics

**Table 6. Static characteristics**

*At recommended operating conditions; voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | 25 °C | | | –40 °C to +85 °C | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| **74HC02** | | | | | | | | | | |
| $V_{IH}$ | HIGH-level input voltage | $V_{CC}$ = 2.0 V | 1.5 | 1.2 | - | 1.5 | - | 1.5 | - | V |
| | | $V_{CC}$ = 4.5 V | 3.15 | 2.4 | - | 3.15 | - | 3.15 | - | V |
| | | $V_{CC}$ = 6.0 V | 4.2 | 3.2 | - | 4.2 | - | 4.2 | - | V |
| $V_{IL}$ | LOW-level input voltage | $V_{CC}$ = 2.0 V | - | 0.8 | 0.5 | - | 0.5 | - | 0.5 | V |
| | | $V_{CC}$ = 4.5 V | - | 2.1 | 1.35 | - | 1.35 | - | 1.35 | V |
| | | $V_{CC}$ = 6.0 V | - | 2.8 | 1.8 | - | 1.8 | - | 1.8 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | | | |
| | | $I_O$ = –20 µA; $V_{CC}$ = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | 1.9 | - | V |
| | | $I_O$ = –20 µA; $V_{CC}$ = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | $I_O$ = –20 µA; $V_{CC}$ = 6.0 V | 5.9 | 6.0 | - | 5.9 | - | 5.9 | - | V |
| | | $I_O$ = –4.0 mA; $V_{CC}$ = 4.5 V | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V |
| | | $I_O$ = –5.2 mA; $V_{CC}$ = 6.0 V | 5.48 | 5.81 | - | 5.34 | - | 5.2 | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | | | |
| | | $I_O$ = 20 µA; $V_{CC}$ = 2.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | $I_O$ = 20 µA; $V_{CC}$ = 4.5 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | $I_O$ = 20 µA; $V_{CC}$ = 6.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | $I_O$ = 4.0 mA; $V_{CC}$ = 4.5 V | - | 0.15 | 0.26 | - | 0.33 | - | 0.4 | V |
| | | $I_O$ = 5.2 mA; $V_{CC}$ = 6.0 V | - | 0.16 | 0.26 | - | 0.33 | - | 0.4 | V |
| $I_I$ | input leakage current | $V_I$ = $V_{CC}$ or GND; $V_{CC}$ = 6.0 V | - | - | ±0.1 | - | ±1 | - | ±1 | µA |
| $I_{CC}$ | supply current | $V_I$ = $V_{CC}$ or GND; $I_O$ = 0 A; $V_{CC}$ = 6.0 V | - | - | 2.0 | - | 20 | - | 40 | µA |
| $C_I$ | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

**Table 6. Static characteristics** *…continued*

*At recommended operating conditions; voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | 25 °C | | | –40 °C to +85 °C | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| **74HCT02** | | | | | | | | | | |
| $V_{IH}$ | HIGH-level input voltage | $V_{CC}$ = 4.5 V to 5.5 V | 2.0 | 1.6 | - | 2.0 | - | 2.0 | - | V |
| $V_{IL}$ | LOW-level input voltage | $V_{CC}$ = 4.5 V to 5.5 V | - | 1.2 | 0.8 | - | 0.8 | - | 0.8 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$; $V_{CC}$ = 4.5 V | | | | | | | | |
| | | $I_O$ = –20 μA | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | $I_O$ = –4.0 mA | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$; $V_{CC}$ = 4.5 V | | | | | | | | |
| | | $I_O$ = 20 μA; $V_{CC}$ = 4.5 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | $I_O$ = 5.2 mA; $V_{CC}$ = 6.0 V | - | 0.15 | 0.26 | - | 0.33 | - | 0.4 | V |
| $I_I$ | input leakage current | $V_I$ = $V_{CC}$ or GND; $V_{CC}$ = 6.0 V | - | - | ±0.1 | - | ±1 | - | ±1 | μA |
| $I_{CC}$ | supply current | $V_I$ = $V_{CC}$ or GND; $I_O$ = 0 A; $V_{CC}$ = 6.0 V | - | - | 2.0 | - | 20 | - | 40 | μA |
| $\Delta I_{CC}$ | additional supply current | per input pin; $V_I$ = $V_{CC}$ – 2.1 V; $I_O$ = 0 A; other inputs at $V_{CC}$ or GND; $V_{CC}$ = 4.5 V to 5.5 V | - | 150 | 540 | - | 675 | - | 735 | μA |
| $C_I$ | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

*GND = 0 V;* $C_L$ = 50 pF; *for load circuit see Figure 7.*

| Symbol | Parameter | Conditions | | 25 °C | | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Max (85 °C) | Max (125 °C) | |
| **74HC02** | | | | | | | | | |
| $t_{pd}$ | propagation delay | nA, nB to nY; see Figure 6 | [1] | | | | | | |
| | | $V_{CC}$ = 2.0 V | | - | 25 | 90 | 115 | 135 | ns |
| | | $V_{CC}$ = 4.5 V | | - | 9 | 18 | 23 | 27 | ns |
| | | $V_{CC}$ = 5.0 V; $C_L$ = 15 pF | | - | 7 | - | - | - | ns |
| | | $V_{CC}$ = 6.0 V | | - | 7 | 15 | 20 | 23 | ns |
| $t_t$ | transition time | see Figure 6 | [2] | | | | | | |
| | | $V_{CC}$ = 2.0 V | | - | 19 | 75 | 95 | 110 | ns |
| | | $V_{CC}$ = 4.5 V | | - | 7 | 15 | 19 | 22 | ns |
| | | $V_{CC}$ = 6.0 V | | - | 6 | 13 | 16 | 19 | ns |
| $C_{PD}$ | power dissipation capacitance | per package; $V_I$ = GND to $V_{CC}$ | [3] | - | 22 | - | - | - | pF |

**Table 7. Dynamic characteristics**

*GND = 0 V;* $C_L$ = 50 pF; *for load circuit see Figure 7.*

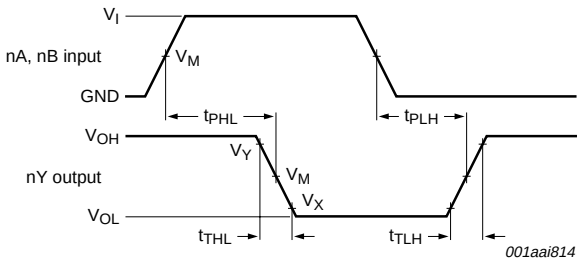
| Symbol | Parameter | Conditions | | 25 °C | | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Max (85 °C) | Max (125 °C) | |
| **74HCT02** | | | | | | | | | |
| $t_{pd}$ | propagation delay | nA, nB to nY; see Figure 6 | [1] | | | | | | |
| | | $V_{CC}$ = 4.5 V | | - | 11 | 19 | 24 | 29 | ns |
| | | $V_{CC}$ = 5.0 V; $C_L$ = 15 pF | | - | 9 | - | - | - | ns |
| $t_t$ | transition time | $V_{CC}$ = 4.5 V; see Figure 6 | [2] | - | 7 | 15 | 19 | 22 | ns |
| $C_{PD}$ | power dissipation capacitance | per package; $V_I$ = GND to $V_{CC}$ – 1.5 V | [3] | - | 24 | - | - | - | 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 µW):
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma (C_L \times V_{CC}^2 \times f_o)$ 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.

## 11. Waveforms



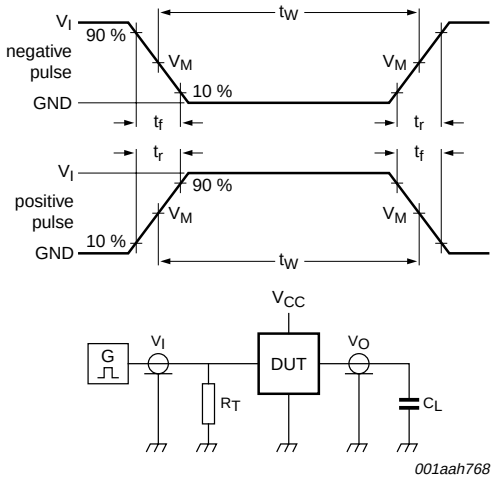

Measurement points are given in Table 9.

$V_{OL}$ and $V_{OH}$ are typical voltage output levels that occur with the output load.

**Fig 6. Input to output propagation delays**

**Table 8. Measurement points**

| Type | Input | Output | | |
|---|---|---|---|---|
| | $V_M$ | $V_M$ | $V_X$ | $V_Y$ |
| 74HC02 | 0.5$V_{CC}$ | 0.5$V_{CC}$ | 0.1$V_{CC}$ | 0.9$V_{CC}$ |
| 74HCT02 | 1.3 V | 1.3 V | 0.1$V_{CC}$ | 0.9$V_{CC}$ |




Test data is given in Table 9.

Definitions test circuit:

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

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

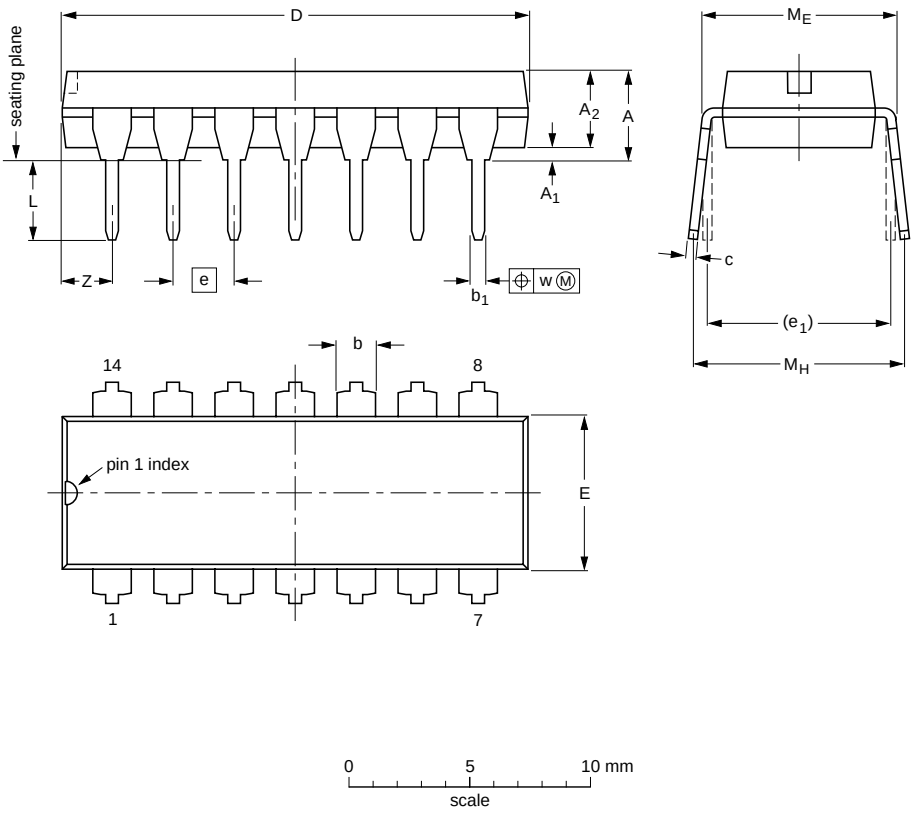
**Fig 7. Load circuitry for measuring switching times**

**Table 9. Test data**

| Type | Input | | Load | Test |
|---|---|---|---|---|
| | $V_I$ | $t_r$, $t_f$ | $C_L$ | |
| 74HC02 | $V_{CC}$ | 6.0 ns | 15 pF, 50 pF | $t_{PLH}$, $t_{PHL}$ |
| 74HCT02 | 3.0 V | 6.0 ns | 15 pF, 50 pF | $t_{PLH}$, $t_{PHL}$ |

## 12. Package outline

**DIP14: plastic dual in-line package; 14 leads (300 mil)** **SOT27-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ min. | $A_2$ max. | b | $b_1$ | c | D (1) | E (1) | e | $e_1$ | L | $M_E$ | $M_H$ | w | Z (1) max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.2 | 0.51 | 3.2 | 1.73<br>1.13 | 0.53<br>0.38 | 0.36<br>0.23 | 19.50<br>18.55 | 6.48<br>6.20 | 2.54 | 7.62 | 3.60<br>3.05 | 8.25<br>7.80 | 10.0<br>8.3 | 0.254 | 2.2 |
| inches | 0.17 | 0.02 | 0.13 | 0.068<br>0.044 | 0.021<br>0.015 | 0.014<br>0.009 | 0.77<br>0.73 | 0.26<br>0.24 | 0.1 | 0.3 | 0.14<br>0.12 | 0.32<br>0.31 | 0.39<br>0.33 | 0.01 | 0.087 |

**Note**

1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT27-1 | 050G04 | MO-001 | SC-501-14 | | | |

**Fig 8. Package outline SOT27-1 (DIP14)**