



**THE DATASHEET OF
HEF4001BT,653**



HEF4001B

Quad 2-input NOR gate

Rev. 10 — 10 December 2015

Product data sheet

1. General description

The HEF4001B is a quad 2-input NOR gate. The outputs are fully buffered for the highest noise immunity and pattern insensitivity to output impedance.

It operates over a recommended V_{DD} power supply range of 3 V to 15 V referenced to V_{SS} (usually ground). Unused inputs must be connected to V_{DD} , V_{SS} , or another input.

2. Features and benefits

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B
- Inputs and outputs are protected against electrostatic effects

3. Ordering information

Table 1. Ordering information

All types operate from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$

| Type number | Package | | Version |
|-------------|---------|--|----------|
| | Name | Description | |
| HEF4001BT | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |

4. Functional diagram

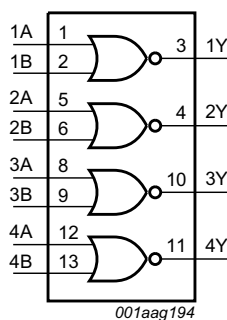


Fig 1. Functional diagram

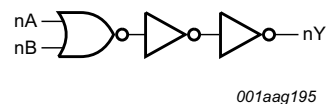


Fig 2. Logic diagram (one gate)

5. Pinning information

5.1 Pinning

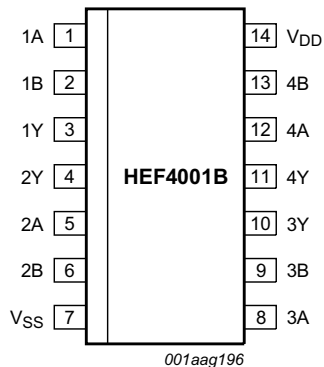


Fig 3. Pin configuration

5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|-----------------|--------------|----------------|
| nA | 1, 5, 8, 12 | input |
| nB | 2, 6, 9, 13 | input |
| nY | 3, 4, 10, 11 | output |
| V _{SS} | 7 | ground (0 V) |
| V _{DD} | 14 | supply voltage |

6. Functional description

Table 3. Function table^[1]

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

[1] H = HIGH voltage level; L = LOW voltage level.

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to $V_{SS} = 0$ V (ground).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|-------------------------|--|------|----------------|------|
| V_{DD} | supply voltage | | -0.5 | +18 | V |
| I_{IK} | input clamping current | $V_I < -0.5$ V or $V_I > V_{DD} + 0.5$ V | - | ± 10 | mA |
| V_I | input voltage | | -0.5 | $V_{DD} + 0.5$ | V |
| I_{OK} | output clamping current | $V_O < -0.5$ V or $V_O > V_{DD} + 0.5$ V | - | ± 10 | mA |
| $I_{I/O}$ | input/output current | | - | ± 10 | mA |
| I_{DD} | supply current | | - | 50 | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| T_{amb} | ambient temperature | | -40 | +125 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40$ °C to +125 °C | | | |
| | | SO14 [1] | - | 500 | mW |
| P | power dissipation | per output | - | 100 | mW |

[1] For SO14 packages: above $T_{amb} = 70$ °C, P_{tot} derates linearly with 8 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------|-------------------------------------|-----------------|-----|-----|----------|-----------------|
| V_{DD} | supply voltage | | 3 | - | 15 | V |
| V_I | input voltage | | 0 | - | V_{DD} | V |
| T_{amb} | ambient temperature | in free air | -40 | - | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{DD} = 5$ V | - | - | 3.75 | $\mu\text{s/V}$ |
| | | $V_{DD} = 10$ V | - | - | 0.5 | $\mu\text{s/V}$ |
| | | $V_{DD} = 15$ V | - | - | 0.08 | $\mu\text{s/V}$ |

9. Static characteristics

Table 6. Static characteristics

$V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} ; unless otherwise specified.

| Symbol | Parameter | Conditions | V_{DD} | $T_{amb} = -40\text{ }^{\circ}\text{C}$ | | $T_{amb} = +25\text{ }^{\circ}\text{C}$ | | $T_{amb} = +85\text{ }^{\circ}\text{C}$ | | $T_{amb} = +125\text{ }^{\circ}\text{C}$ | | Unit |
|----------|---------------------------|---|----------|---|-----------|---|-----------|---|-----------|--|-----------|---------------|
| | | | | Min | Max | Min | Max | Min | Max | Min | Max | |
| V_{IH} | HIGH-level input voltage | $ I_O < 1\text{ }\mu\text{A}$ | 5 V | 3.5 | - | 3.5 | - | 3.5 | - | 3.5 | - | V |
| | | | 10 V | 7.0 | - | 7.0 | - | 7.0 | - | 7.0 | - | V |
| | | | 15 V | 11.0 | - | 11.0 | - | 11.0 | - | 11.0 | - | V |
| V_{IL} | LOW-level input voltage | $ I_O < 1\text{ }\mu\text{A}$ | 5 V | - | 1.5 | - | 1.5 | - | 1.5 | - | 1.5 | V |
| | | | 10 V | - | 3.0 | - | 3.0 | - | 3.0 | - | 3.0 | V |
| | | | 15 V | - | 4.0 | - | 4.0 | - | 4.0 | - | 4.0 | V |
| V_{OH} | HIGH-level output voltage | $ I_O < 1\text{ }\mu\text{A}$ | 5 V | 4.95 | - | 4.95 | - | 4.95 | - | 4.95 | - | V |
| | | | 10 V | 9.95 | - | 9.95 | - | 9.95 | - | 9.95 | - | V |
| | | | 15 V | 14.95 | - | 14.95 | - | 14.95 | - | 14.95 | - | V |
| V_{OL} | LOW-level output voltage | $ I_O < 1\text{ }\mu\text{A}$ | 5 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 10 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 15 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| I_{OH} | HIGH-level output current | $V_O = 2.5\text{ V}$ | 5 V | - | -1.7 | - | -1.4 | - | -1.1 | - | -1.1 | mA |
| | | $V_O = 4.6\text{ V}$ | 5 V | - | -0.64 | - | -0.5 | - | -0.36 | - | -0.36 | mA |
| | | $V_O = 9.5\text{ V}$ | 10 V | - | -1.6 | - | -1.3 | - | -0.9 | - | -0.9 | mA |
| | | $V_O = 13.5\text{ V}$ | 15 V | - | -4.2 | - | -3.4 | - | -2.4 | - | -2.4 | mA |
| I_{OL} | LOW-level output current | $V_O = 0.4\text{ V}$ | 5 V | 0.64 | - | 0.5 | - | 0.36 | - | 0.36 | - | mA |
| | | $V_O = 0.5\text{ V}$ | 10 V | 1.6 | - | 1.3 | - | 0.9 | - | 0.9 | - | mA |
| | | $V_O = 1.5\text{ V}$ | 15 V | 4.2 | - | 3.4 | - | 2.4 | - | 2.4 | - | mA |
| I_I | input leakage current | | 15 V | - | ± 0.1 | - | ± 0.1 | - | ± 1.0 | - | ± 1.0 | μA |
| I_{DD} | supply current | all valid input combinations; $I_O = 0\text{ A}$ | 5 V | - | 0.25 | - | 0.25 | - | 7.5 | - | 7.5 | μA |
| | | | 10 V | - | 0.5 | - | 0.5 | - | 15.0 | - | 15.0 | μA |
| | | | 15 V | - | 1.0 | - | 1.0 | - | 30.0 | - | 30.0 | μA |
| C_I | input capacitance | | | - | - | - | 7.5 | - | - | - | pF | |

10. Dynamic characteristics

Table 7. Dynamic characteristics

$T_{amb} = 25\text{ °C}$; for waveforms see [Figure 4](#); for test circuit see [Figure 5](#); unless otherwise specified.

| Symbol | Parameter | Extrapolation formula ^[1] | V _{DD} | Min | Typ | Max | Unit |
|------------------|------------------------------------|--------------------------------------|-----------------|-----|-----|-----|------|
| t _{PHL} | HIGH to LOW propagation delay | $33 + 0.55 \times C_L$ | 5 V | - | 60 | 120 | ns |
| | | $14 + 0.23 \times C_L$ | 10 V | - | 25 | 50 | ns |
| | | $12 + 0.16 \times C_L$ | 15 V | - | 20 | 40 | ns |
| t _{PLH} | LOW to HIGH propagation delay | $23 + 0.55 \times C_L$ | 5 V | - | 50 | 100 | ns |
| | | $14 + 0.23 \times C_L$ | 10 V | - | 25 | 45 | ns |
| | | $12 + 0.16 \times C_L$ | 15 V | - | 20 | 35 | ns |
| t _{THL} | HIGH to LOW output transition time | $10 + 1.00 \times C_L$ | 5 V | - | 60 | 120 | ns |
| | | $9 + 0.42 \times C_L$ | 10 V | - | 30 | 60 | ns |
| | | $6 + 0.28 \times C_L$ | 15 V | - | 20 | 40 | ns |
| t _{TLH} | LOW to HIGH output transition time | $10 + 1.00 \times C_L$ | 5 V | - | 60 | 120 | ns |
| | | $9 + 0.42 \times C_L$ | 10 V | - | 30 | 60 | ns |
| | | $6 + 0.28 \times C_L$ | 15 V | - | 20 | 40 | ns |

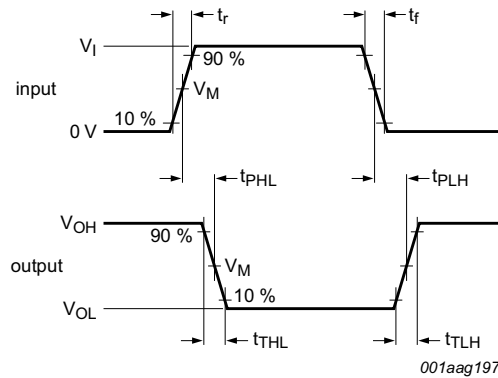
[1] The typical value of the propagation delay and output transition time can be calculated with the extrapolation formula (C_L in pF).

Table 8. Dynamic power dissipation

$V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ °C}$.

| Symbol | Parameter | V _{DD} | Typical formula | Where |
|----------------|---------------------------|-----------------|--|--|
| P _D | dynamic power dissipation | 5 V | $P_D = 1100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ (μW) | f_i = input frequency in MHz; f_o = output frequency in MHz; C_L = output load capacitance in pF; $\Sigma(f_o \times C_L)$ = sum of the outputs; V_{DD} = supply voltage in V. |
| | | 10 V | $P_D = 5000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ (μW) | |
| | | 15 V | $P_D = 14200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ (μW) | |

11. Waveforms

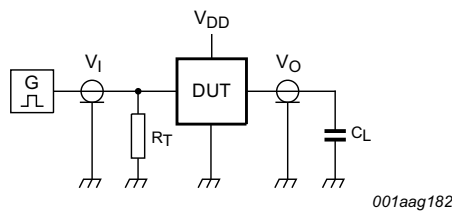


Measurement points are given in [Table 9](#).
 Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 4. Propagation delay, output transition time

Table 9. Measurement points

| Supply voltage | Input | Output |
|----------------|-------------|-------------|
| V_{DD} | V_M | V_M |
| 5 V to 15 V | $0.5V_{DD}$ | $0.5V_{DD}$ |



Test data is given in [Table 10](#).
 Definitions for test circuit:
 DUT = Device Under Test.
 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.

Fig 5. Test circuit for measuring switching times

Table 10. Test data

| Supply voltage | Input | Load |
|----------------|----------------------|--------------|
| V_{DD} | V_I | C_L |
| 5 V to 15 V | V_{SS} or V_{DD} | ≤ 20 ns |
| | | 50 pF |

12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

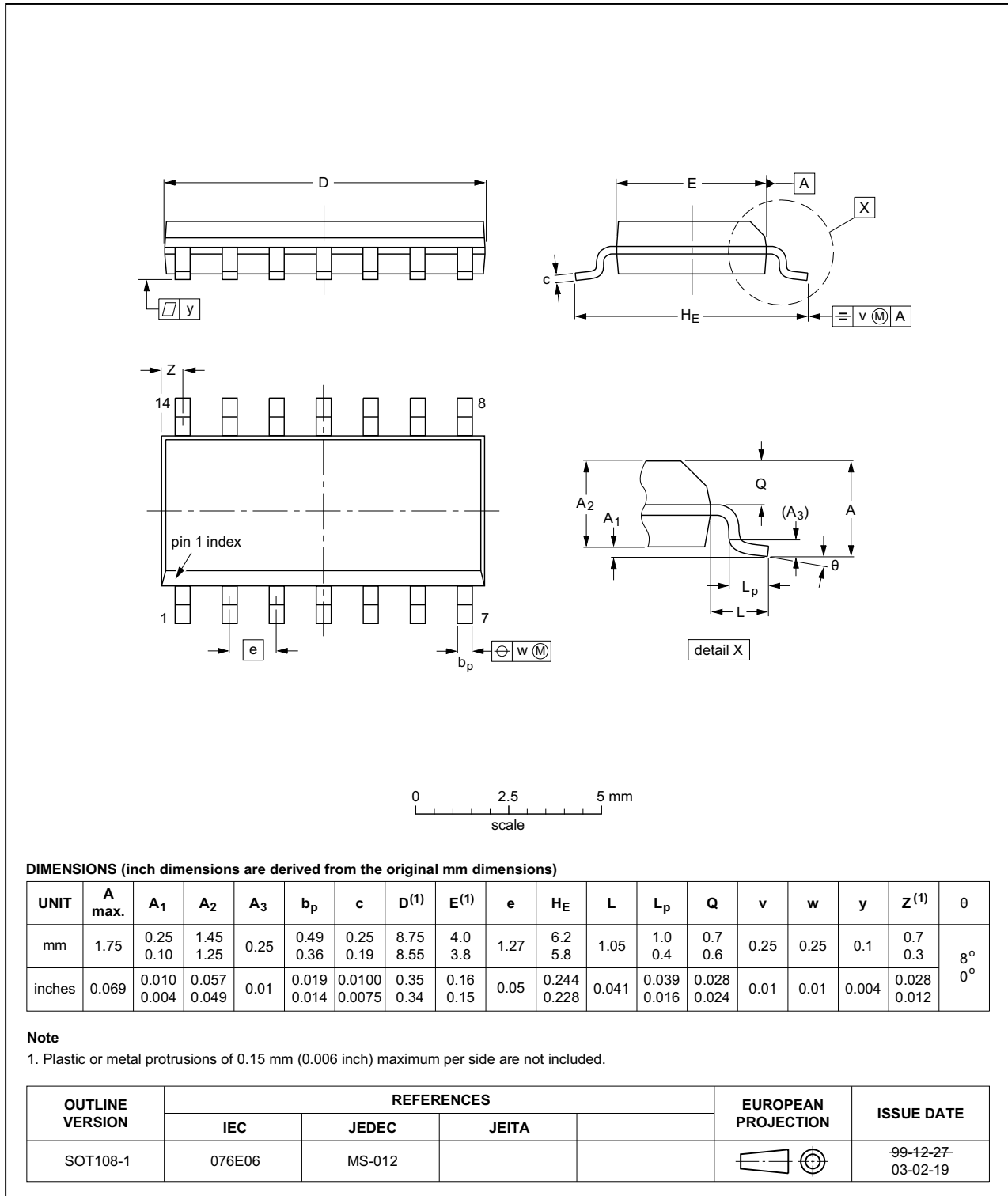


Fig 6. Package outline SOT108-1 (SO14)

13. Abbreviations

Table 11. Abbreviations

| Acronym | Description |
|---------|-------------------|
| DUT | Device Under Test |

14. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------|--|-----------------------|---------------|------------------|
| HEF4001B v.10 | 20151210 | Product data sheet | - | HEF4001B v.9 |
| Modifications: | <ul style="list-style-type: none"> Type number HEF4001BP (SOT27-1) removed. | | | |
| HEF4001B v.9 | 20111121 | Product data sheet | - | HEF4001B v.8 |
| Modifications: | <ul style="list-style-type: none"> Legal pages updated. Changes in "General description" and "Features and benefits". Section "Applications" removed. | | | |
| HEF4001B v.8 | 20110913 | Product data sheet | - | HEF4001B v.7 |
| HEF4001B v.7 | 20091027 | Product data sheet | - | HEF4001B v.6 |
| HEF4001B v.6 | 20090618 | Product data sheet | - | HEF4001B v.5 |
| HEF4001B v.5 | 20080327 | Product data sheet | - | HEF4001B v.4 |
| HEF4001B v.4 | 20070731 | Product data sheet | - | HEF4001B_CNV v.3 |
| HEF4001B_CNV v.3 | 19950101 | Product specification | - | HEF4001B_CNV v.2 |
| HEF4001B_CNV v.2 | 19950101 | Product specification | - | - |

15. Legal information

15.1 Data sheet status

| Document status ^{[1][2]} | Product status ^[3] | Definition |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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