# **HEF4001B**

# **Quad 2-input NOR gate**

Rev. 9 — 21 November 2011

**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 °C to +125 °C
- Complies with JEDEC standard JESD 13-B
- Inputs and outputs are protected against electrostatic effects

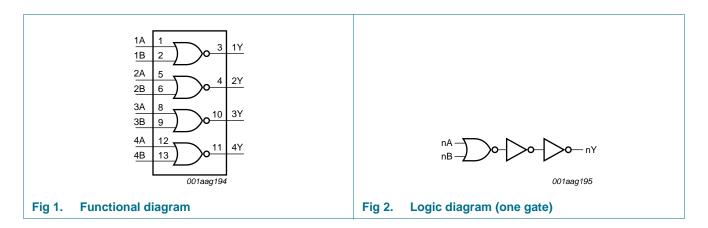
### 3. Ordering information

Table 1. Ordering information

All types operate from −40 °C to +125 °C

Type number	Package	nckage									
	Name	Description	Version								
HEF4001BP	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1								
HEF4001BT	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1								

## 4. Functional diagram



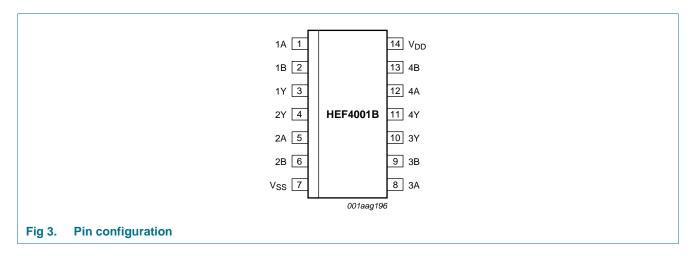


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## 5. Pinning information

### 5.1 Pinning



## 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	Н
L	Н	L
Н	L	L
Н	Н	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  $V_{SS} = 0 \text{ V}$  (ground).

					•
Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DD}$	supply voltage		-0.5	+18	V
I <sub>IK</sub>	input clamping current	$V_I < -0.5 \text{ V or } V_I > V_{DD} + 0.5 \text{ V}$	-	±10	mA
VI	input voltage		-0.5	$V_{DD} + 0.5$	V
l <sub>OK</sub>	output clamping current	$V_O < -0.5 \text{ V or } V_O > V_{DD} + 0.5 \text{ V}$	-	±10	mA
I <sub>I/O</sub>	input/output current		-	±10	mA
I <sub>DD</sub>	supply current		-	50	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>amb</sub>	ambient temperature		-40	+125	°C
P <sub>tot</sub>	total power dissipation	$T_{amb} = -40  ^{\circ}\text{C} \text{ to + } 125  ^{\circ}\text{C}$			
		DIP14	<u>[1]</u> -	750	mW
		SO14	[2] _	500	mW
Р	power dissipation	per output	-	100	mW

<sup>[1]</sup> For DIP14 packages: above  $T_{amb}$  = 70 °C,  $P_{tot}$  derates linearly with 12 mW/K.

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

Parameter	Conditions	Min	Тур	Max	Unit
supply voltage		3	-	15	V
input voltage		0	-	$V_{DD}$	V
ambient temperature	in free air	-40	-	+125	°C
input transition rise and fall rate	$V_{DD} = 5 V$	-	-	3.75	μs/V
	V <sub>DD</sub> = 10 V	-	-	0.5	μs/V
	V <sub>DD</sub> = 15 V	-	-	0.08	μs/V
	supply voltage input voltage ambient temperature	supply voltage input voltage ambient temperature in free air input transition rise and fall rate $ V_{DD} = 5 \text{ V} $ $V_{DD} = 10 \text{ V} $	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	supply voltage $ \begin{array}{ccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

<sup>[2]</sup> For SO14 packages: above  $T_{amb}$  = 70 °C,  $P_{tot}$  derates linearly with 8 mW/K.

## 9. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	V <sub>DD</sub>	T <sub>amb</sub> =	–40 °C	T <sub>amb</sub> =	+25 °C	T <sub>amb</sub> =	+85 °C	T <sub>amb</sub> = ·	+125 °C	Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
$V_{IH}$	HIGH-level	$ I_O  < 1 \mu A$	5 V	3.5	-	3.5	-	3.5	-	3.5	-	V
	input voltage		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	$ I_O  < 1 \mu A$	5 V	-	1.5	-	1.5	-	1.5	-	1.5	V
	input voltage		10 V	-	3.0	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	-	4.0	V
V <sub>OH</sub>	HIGH-level	$ I_{O}  < 1 \mu A$	5 V	4.95	-	4.95	-	4.95	-	4.95	-	V
	output voltage		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	$ I_{O}  < 1 \mu A$	5 V	-	0.05	-	0.05	-	0.05	-	0.05	V
	output voltage		10 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	-	0.05	V
I <sub>OH</sub>	HIGH-level	$V_0 = 2.5 \text{ V}$	5 V	-	-1.7	-	-1.4	-	-1.1	-	-1.1	mΑ
	output current	$V_0 = 4.6 \text{ V}$	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mΑ
		$V_0 = 9.5 \text{ V}$	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mΑ
		$V_0 = 13.5 \text{ V}$	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mΑ
I <sub>OL</sub>	LOW-level	$V_0 = 0.4 \ V$	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mΑ
	output current	$V_0 = 0.5 \ V$	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mΑ
		$V_0 = 1.5 \text{ V}$	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mΑ
II	input leakage current		15 V	-	±0.1	-	±0.1	-	±1.0	-	±1.0	μΑ
I <sub>DD</sub>	supply current	all valid input	5 V	-	0.25	-	0.25	-	7.5	-	7.5	μΑ
		combinations;	10 V	-	0.5	-	0.5	-	15.0	-	15.0	μΑ
		$I_O = 0 A$	15 V	-	1.0	-	1.0	-	30.0	-	30.0	μΑ
Cı	input capacitance			-	-	-	7.5	-	-	-	-	pF

## 10. Dynamic characteristics

Table 7. Dynamic characteristics

 $T_{amb}$  = 25 °C; for waveforms see <u>Figure 4</u>; for test circuit see <u>Figure 5</u>; unless otherwise specified.

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

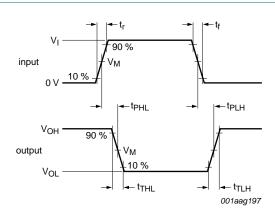
<sup>[1]</sup> The typical value of the propagation delay and output transition time can be calculated with the extrapolation formula (C<sub>L</sub> in pF).

Table 8. Dynamic power dissipation

 $V_{SS} = 0 \ V; \ t_f = t_f \le 20 \ ns; \ T_{amb} = 25 \ ^{\circ}C.$ 

Symbol	Parameter	$V_{DD}$	Typical formula	Where
$P_{D}$	dynamic power dissipation	5 V	$P_D = 1100 \times f_i + \Sigma (f_o \times C_L) \times V_{DD}^2 (\mu W)$	$f_i$ = input frequency in MHz;
		10 V	$P_D = 5000 \times f_i + \Sigma (f_0 \times C_L) \times V_{DD}^2 (\mu W)$	f <sub>o</sub> = output frequency in MHz;
		15 V	$P_D = 14200 \times f_i + \Sigma (f_0 \times C_L) \times V_{DD}^2 (\mu W)$	$C_L$ = output load capacitance in pF;
				$\Sigma(f_0 \times C_L)$ = sum of the outputs;
				V <sub>DD</sub> = supply voltage in V.

### 11. Waveforms



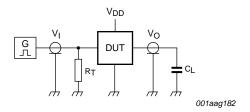
Measurement points are given in Table 9.

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 <sub>M</sub>	V <sub>M</sub>
5 V to 15 V	0.5V <sub>DD</sub>	0.5V <sub>DD</sub>



Test data is given in <u>Table 10</u>.

Definitions for test circuit:

DUT = Device Under Test.

C<sub>L</sub> = load capacitance including jig and probe capacitance.

 $R_T$  = termination resistance should be equal to the output impedance  $Z_0$  of the pulse generator.

Fig 5. Test circuit for measuring switching times

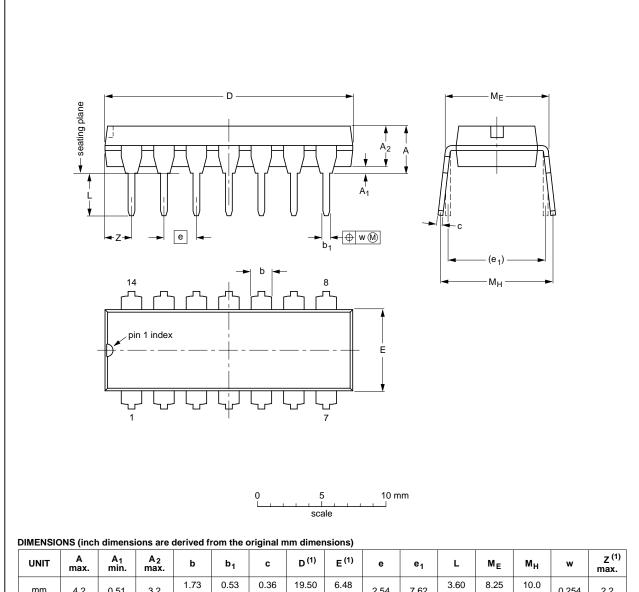
Table 10. Test data

Supply voltage	Input		Load
$V_{DD}$	VI	t <sub>r</sub> , t <sub>f</sub>	CL
5 V to 15 V	$V_{SS}$ or $V_{DD}$	≤ 20 ns	50 pF

## 12. Package outline

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

SOT27-1



UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	С	D <sup>(1)</sup>	E <sup>(1)</sup>	е	e <sub>1</sub>	L	ME	M <sub>H</sub>	w	Z <sup>(1)</sup> max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.02	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 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.

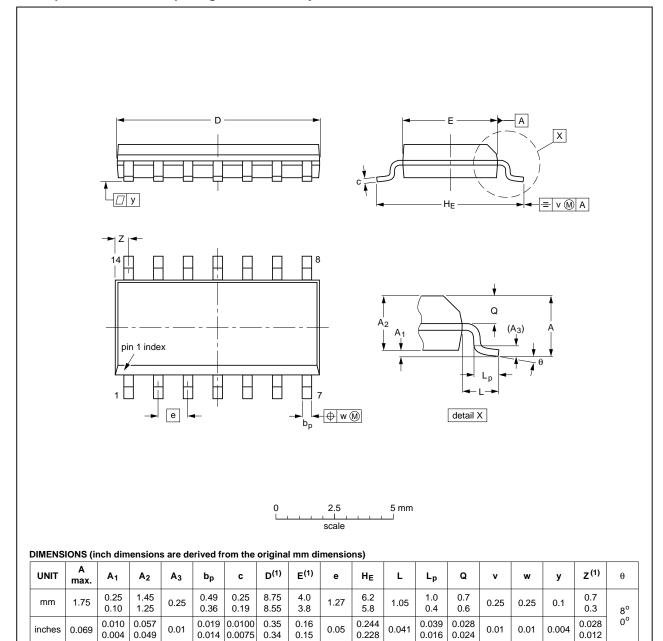
OUTLINE		REFER	ENCES		EUROPEAN PROJECTION	ISSUE DATE	
VERSION	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE	
SOT27-1	050G04	MO-001	SC-501-14			<del>99-12-27</del> 03-02-13	

Fig 6. Package outline SOT27-1 (DIP14)

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

SOT108-1



#### Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE	REFERENCES				EUROPEAN	ISSUE DATE
VERSION	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE
SOT108-1	076E06	MS-012				<del>99-12-27</del> 03-02-19

Fig 7. Package outline SOT108-1 (SO14)

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## 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.9	20111121	Product data sheet	-	HEF4001B v.8
Modifications:	<ul> <li>Legal pages</li> </ul>	s updated.		
	<ul> <li>Changes in</li> </ul>	"General description" and "l	Features and benefits".	
	<ul> <li>Section "Ap</li> </ul>	plications" 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	-	-
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#### 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.

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