

# HEF4001B

## Quad 2-input NOR gate

Rev. 11 — 19 November 2021

Product data sheet

## 1. General description

The HEF4001B is a quad 2-input NOR gate. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{DD}$ .

## 2. Features and benefits

- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-B exceeds 200 V
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

## 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
HEF4001BT	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1

## 4. Functional diagram

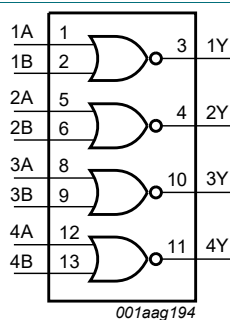


Fig. 1. Functional diagram

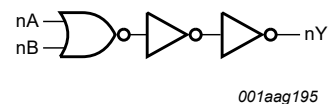
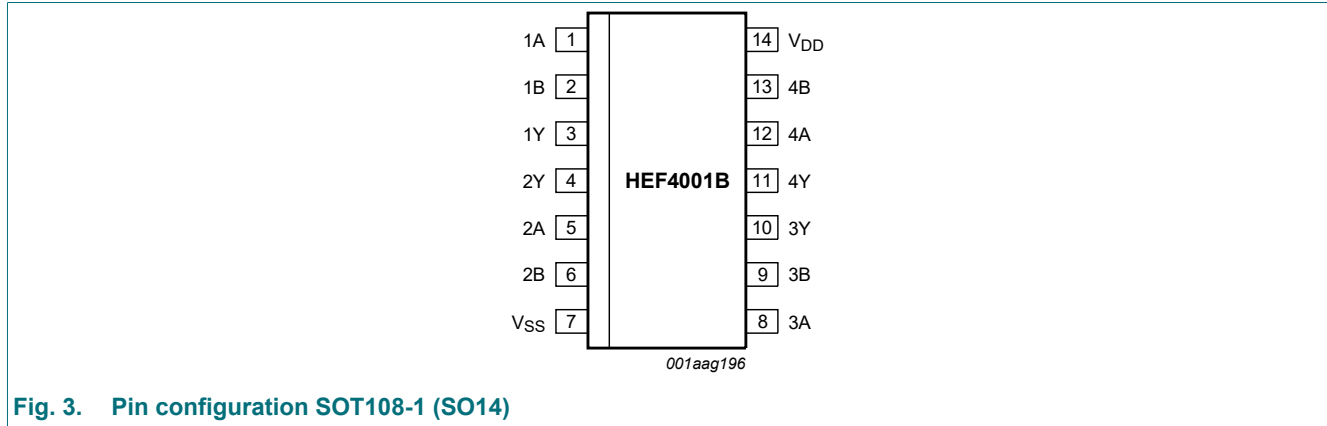


Fig. 2. Logic diagram (one gate)

## 5. Pinning information

### 5.1. Pinning



### 5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1A, 2A, 3A, 4A	1, 5, 8, 12	input
1B, 2B, 3B, 4B	2, 6, 9, 13	input
1Y, 2Y, 3Y, 4Y	3, 4, 10, 11	output
V <sub>SS</sub>	7	ground (0 V)
V <sub>DD</sub>	14	supply voltage

## 6. Functional description

Table 3. Function table

*H = HIGH voltage level; L = LOW voltage level.*

Input		Output
nA	nB	nY
L	L	H
L	H	L
H	L	L
H	H	L

## 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
$I_{IK}$	input clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{DD} + 0.5\text{ V}$	-	$\pm 10$	mA
$V_I$	input voltage		-0.5	$V_{DD} + 0.5$	V
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{DD} + 0.5\text{ V}$	-	$\pm 10$	mA
$I_{I/O}$	input/output current		-	$\pm 10$	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	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$ [1]	-	500	mW
$P$	power dissipation	per output	-	100	mW

[1] For SOT108-1 (SO14) package:  $P_{tot}$  derates linearly with 10.1 mW/K above 100 °C.

## 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	$V_{DD} = 5\text{ V}$	-	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10\text{ V}$	-	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15\text{ V}$	-	-	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	$V_{DD}$	$T_{amb} = -40\text{ °C}$		$T_{amb} = +25\text{ °C}$		$T_{amb} = +85\text{ °C}$		$T_{amb} = +125\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$ I_O  < 1\ \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\ \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\ \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

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 <sub>OL</sub>	LOW-level output voltage	I <sub>O</sub>   < 1 μA	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 <sub>OH</sub>	HIGH-level output current	V <sub>O</sub> = 2.5 V	5 V	-	-1.7	-	-1.4	-	-1.1	-	-1.1	mA
		V <sub>O</sub> = 4.6 V	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
		V <sub>O</sub> = 9.5 V	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
		V <sub>O</sub> = 13.5 V	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mA
I <sub>OL</sub>	LOW-level output current	V <sub>O</sub> = 0.4 V	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		V <sub>O</sub> = 0.5 V	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		V <sub>O</sub> = 1.5 V	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I <sub>I</sub>	input leakage current		15 V	-	±0.1	-	±0.1	-	±1.0	-	±1.0	μA
I <sub>DD</sub>	supply current	all valid input combinations; I <sub>O</sub> = 0 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 <sub>I</sub>	input capacitance			-	-	-	7.5	-	-	-	pF	

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

T<sub>amb</sub> = 25 °C unless otherwise specified.; for waveforms see Fig. 4; for test circuit see Fig. 5.

Symbol	Parameter	Extrapolation formula [1]	V <sub>DD</sub>	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	33 + 0.55 × C <sub>L</sub>	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 × C <sub>L</sub>	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 × C <sub>L</sub>	15 V	-	20	40	ns

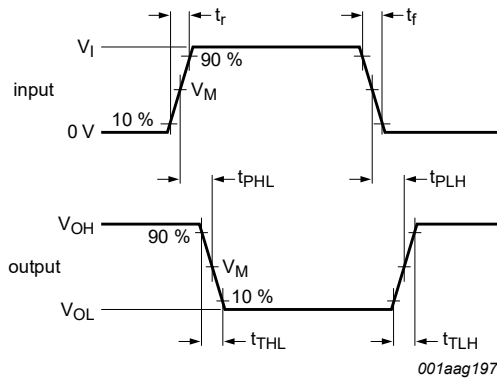
[1] The typical value of the propagation delay and output transition time can be calculated with the extrapolation formula (C<sub>L</sub> in pF).

**Table 8. Dynamic power dissipation**

V<sub>SS</sub> = 0 V; t<sub>r</sub> = t<sub>f</sub> ≤ 20 ns; T<sub>amb</sub> = 25 °C.

Symbol	Parameter	V <sub>DD</sub>	Typical formula	Where
P <sub>D</sub>	dynamic power dissipation	5 V	P <sub>D</sub> = 1100 × f <sub>i</sub> + Σ(f <sub>o</sub> × C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup> (μW)	f <sub>i</sub> = input frequency in MHz; f <sub>o</sub> = output frequency in MHz; C <sub>L</sub> = output load capacitance in pF; Σ(f <sub>o</sub> × C <sub>L</sub> ) = sum of the outputs; V <sub>DD</sub> = supply voltage in V.
		10 V	P <sub>D</sub> = 5000 × f <sub>i</sub> + Σ(f <sub>o</sub> × C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup> (μW)	
		15 V	P <sub>D</sub> = 14200 × f <sub>i</sub> + Σ(f <sub>o</sub> × C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup> (μW)	

10.1. Waveforms and test circuit

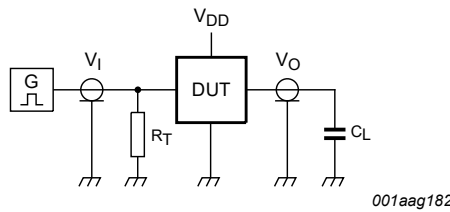


Measurement points are given in [Table 9](#).  
 Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

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 $V_{DD}$	$\leq 20$ ns
		50 pF

### 11. Package outline

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

SOT108-1

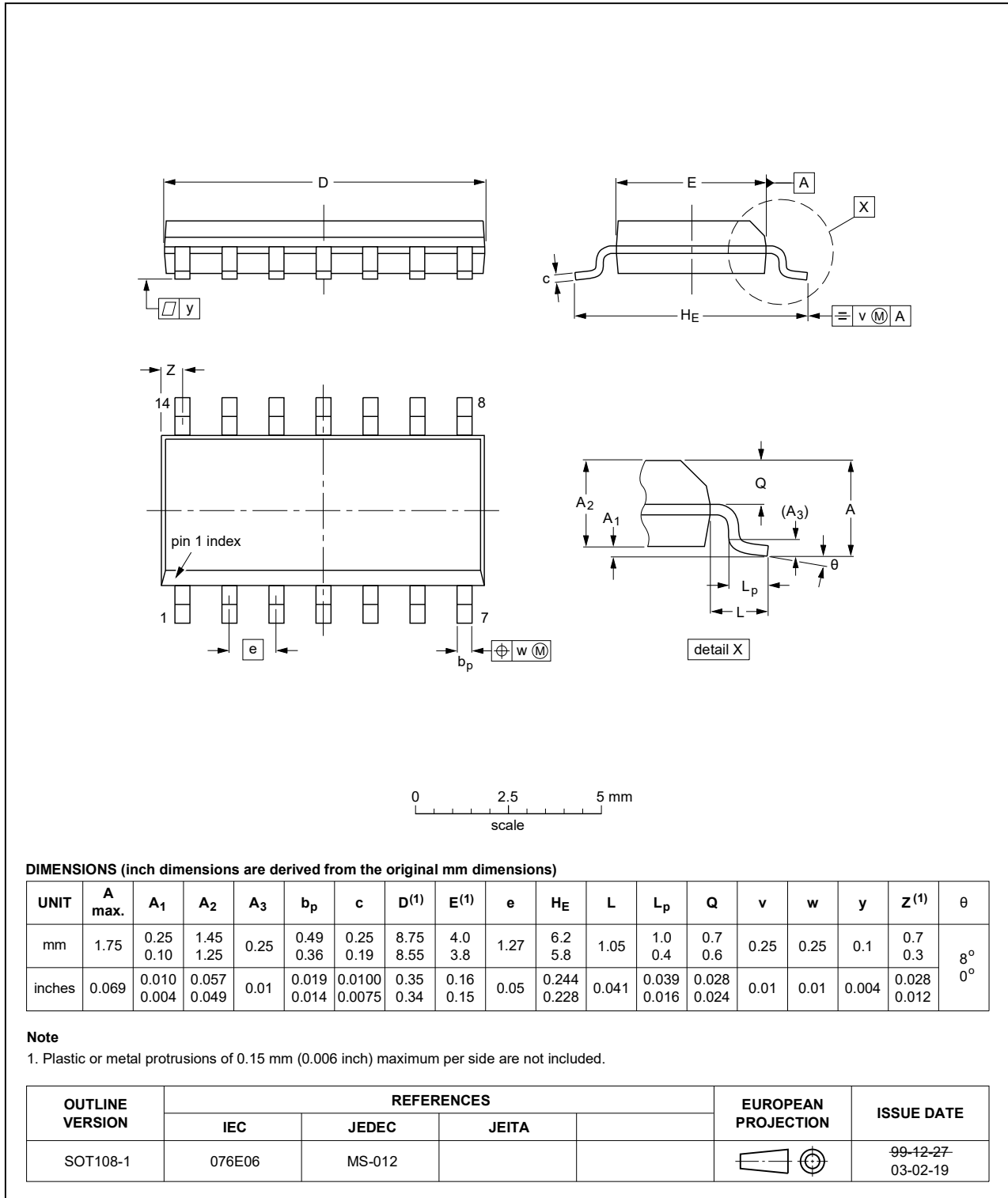


Fig. 6. Package outline SOT108-1 (SO14)

## 12. Abbreviations

Table 11. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

## 13. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4001B v.11	20211119	Product data sheet	-	HEF4001B v.10
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li><a href="#">Table 4</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> <li><a href="#">Section 1</a> and <a href="#">Section 2</a> updated.</li> </ul>			
HEF4001B v.10	20151210	Product data sheet	-	HEF4001B v.9
Modifications:	<ul style="list-style-type: none"> <li>Type number HEF4001BP (SOT27-1) removed.</li> </ul>			
HEF4001B v.9	20111121	Product data sheet	-	HEF4001B v.8
Modifications:	<ul style="list-style-type: none"> <li>Legal pages updated.</li> <li>Changes in <a href="#">Section 1</a> and <a href="#">Section 2</a></li> <li>Section "Applications" removed.</li> </ul>			
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	-	-

## 14. Legal information

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