Quad 2-input NAND gate Rev. 1 — 26 June 2013

Product data sheet

General description 1.

The HEF4011B-Q100 is a quad 2-input NAND 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 $V_{\text{DD}},\,V_{\text{SS}},\,\text{or}$ another input.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

Features and benefits 2.

- Automotive product qualification in accordance with AEC-Q100 (Grade 1) Specified from –40 °C to +85 °C and from –40 °C to +125 °C
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- ESD protection:
 - MIL-STD-833, method 3015 exceeds 2000 V
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)
- Complies with JEDEC standard JESD 13-B

Ordering information 3.

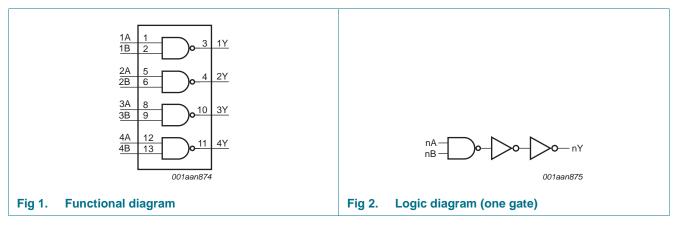
Table 1. **Ordering information**

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

Type number	Package	Package						
	Name	Description	Version					
HEF4011BT-Q100	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1					

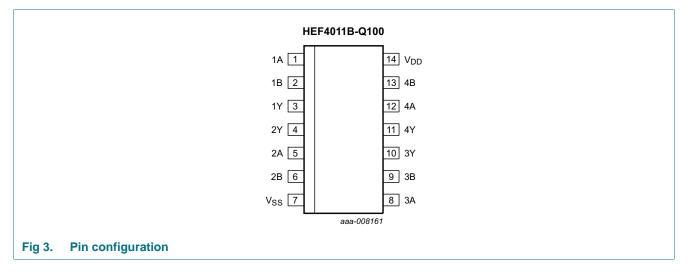


Functional diagram 4.



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 _{SS} V _{DD}	14	supply voltage

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Functional description 6.

	Function table ^[1]		
Input			Output
nA		nB	nY
L		L	Н
L		Н	Н
Н		L	Н
Н		Н	L

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

Limiting values 7.

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
VI	input voltage		-0.5	V_{DD} + 0.5	V
I _{OK}	output clamping current	$V_{\rm O}$ < –0.5 V or V_{\rm 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	$T_{amb} = -40 \text{ °C to} + 125 \text{ °C}$	<u>[1]</u> _	500	mW
Р	power dissipation	per output	-	100	mW

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

Recommended operating conditions 8.

Table 5. **Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
V _{DD}	supply voltage		3	-	15	V
VI	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	μs/V
		V _{DD} = 10 V	-	-	0.5	μs/V
		V _{DD} = 15 V	-	-	0.08	μs/V

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9. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	V _{DD}	T _{amb} =	–40 °C	T _{amb} =	+25 °C	T _{amb} =	+85 °C	T _{amb} = ·	+125 °C	Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
V _{IH}	HIGH-level	I _O < 1 μA	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_0 < 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 _{OH}	HIGH-level	$ I_0 < 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_0 < 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 _{OH}	HIGH-level	$V_{O} = 2.5 V$	5 V	-	-1.7	-	-1.4	-	-1.1	-	-1.1	mA
	output current	$V_{O} = 4.6 V$	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
		$V_{O} = 9.5 V$	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
		V _O = 13.5 V	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mA
I _{OL}	LOW-level	$V_{O} = 0.4 V$	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
	output current	$V_{O} = 0.5 V$	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		$V_{O} = 1.5 V$	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I	input leakage current		15 V	-	±0.1	-	±0.1	-	±1.0	-	±1.0	μΑ
I _{DD}	supply current	all valid input	5 V	-	0.25	-	0.25	-	7.5	-	7.5	μA
		combinations; $I_0 = 0 A$	10 V	-	0.5	-	0.5	-	15.0	-	15.0	μA
		O = O A	15 V	-	1.0	-	1.0	-	30.0	-	30.0	μA
CI	input capacitance			-	-	-	7.5	-	-	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

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

Symbol	Parameter	Extrapolation formula ^[1]	V_{DD}	Min	Тур	Мах	Unit
t _{pd}	propagation delay	$28 \textbf{+} 0.55 \times C_L$	5 V	[2] _	55	110	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).

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

Table 8. Dynamic power dissipation

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

Symbol	Parameter	V_{DD}	Typical formula	Where
PD	dynamic power dissipation	5 V	$P_D = 1300 \times f_i + \Sigma(f_o \times C_L) \times V_DD^2 \ (\muW)$	f_i = input frequency in MHz;
		10 V	$P_D = 6000 \times f_i + \Sigma(f_o \times C_L) \times V_DD^2 \text{ (}\muW\text{)}$	$f_o = output frequency in MHz;$
		15 V	$P_{D} = 20100 \times f_{i} + \Sigma(f_{o} \times C_{L}) \times V_{DD}^2 \; (\muW)$	C_L = output load capacitance in pF;
				$\Sigma(f_o \times C_L)$ = sum of the outputs;
				V_{DD} = supply voltage in V.

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11. Waveforms

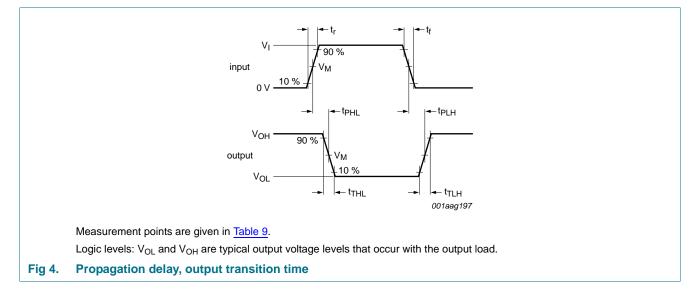


Table 9. **Measurement points**

Supply voltage	Input	Output
V _{DD}	V _M	V _M
5 V to 15 V	0.5V _{DD}	0.5V _{DD}

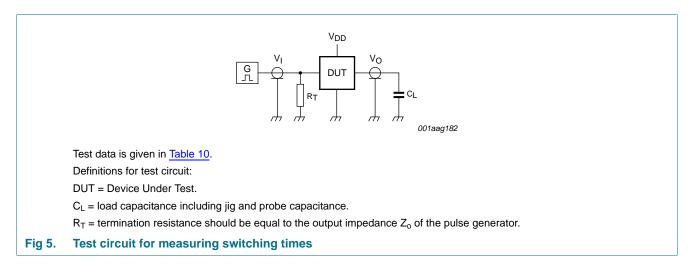


Table 10. Test data

Supply voltage	Input		Load
V _{DD}	VI	t _r , t _f	CL
5 V to 15 V	V _{SS} or V _{DD}	≤ 20 ns	50 pF

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12. Package outline

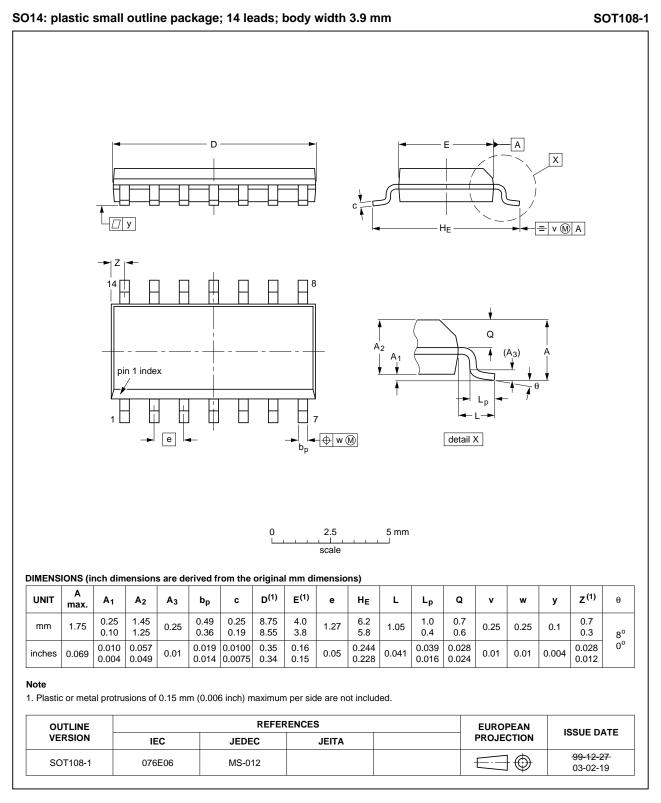


Fig 6. Package outline SOT108-1 (SO14)

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13. Abbreviations

Table 11. Ab	previations
Acronym	Description
HBM	Human Body Model
ESD	ElectroStatic Discharge
MM	Machine Model
MIL	Military

14. Revision history

Table 12. Revision history									
Document ID	Release date	Data sheet status	Change notice	Supersedes					
HEF4011B_Q100 v.1	20130626	Product data sheet	-	-					

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.
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