

# HEF4104B-Q100

Quad low-to-high voltage translator with 3-state outputs

Rev. 3 — 25 July 2024

Product data sheet

## 1. General description

The HEF4104B-Q100 is a quad low-to-high voltage translator with complementary 3-state outputs ( $B_n$  and  $\bar{B}_n$ ). A LOW on the output enable input (OE) causes the outputs to assume a high-impedance OFF-state. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{DD}$ .

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 3) and is suitable for use in automotive applications.

## 2. Features and benefits

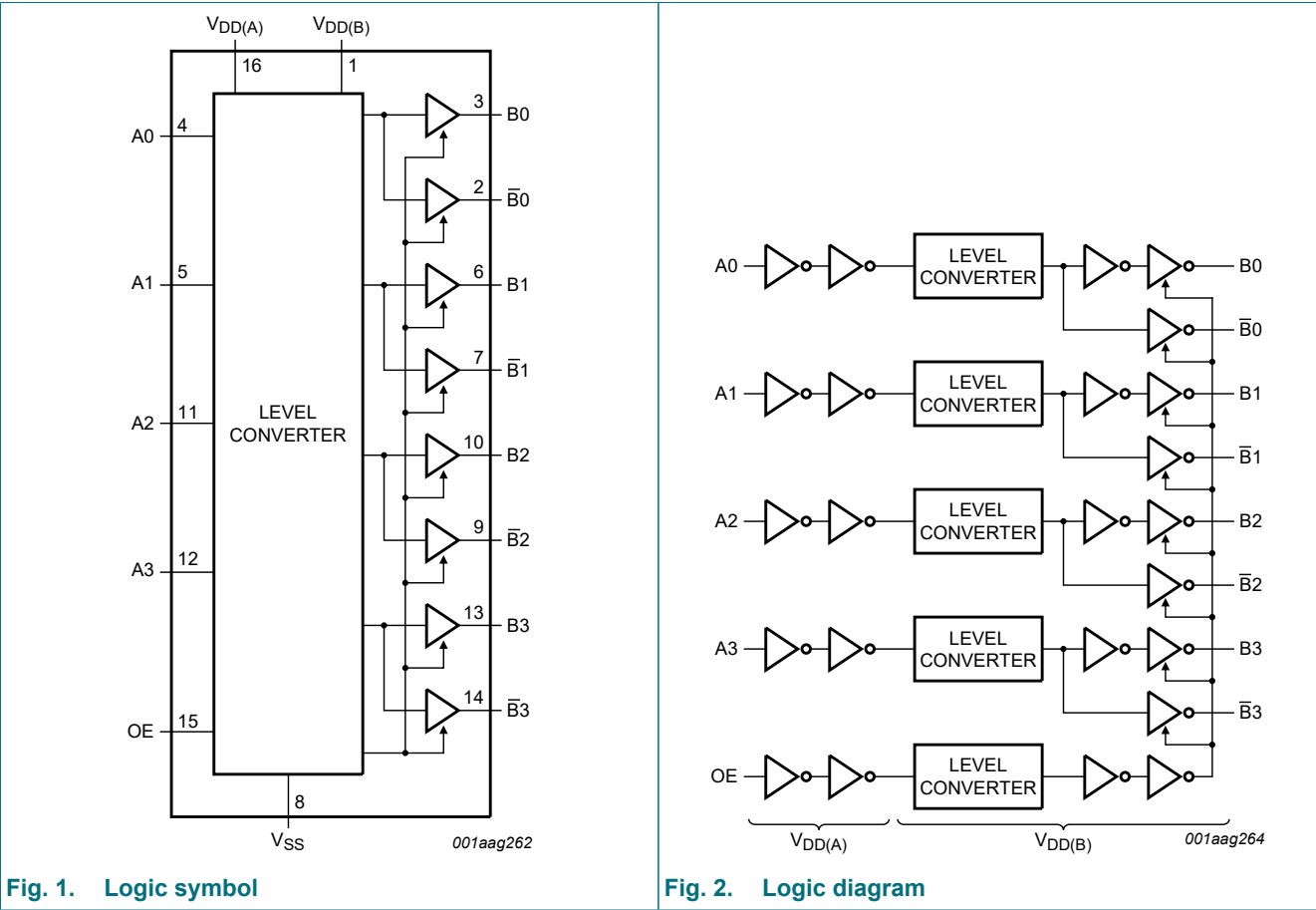
- Automotive product qualification in accordance with AEC-Q100 (Grade 3)
  - Specified from -40 °C to +85 °C
- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Inputs and outputs are protected against electrostatic effects
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V

## 3. Ordering information

Table 1. Ordering information

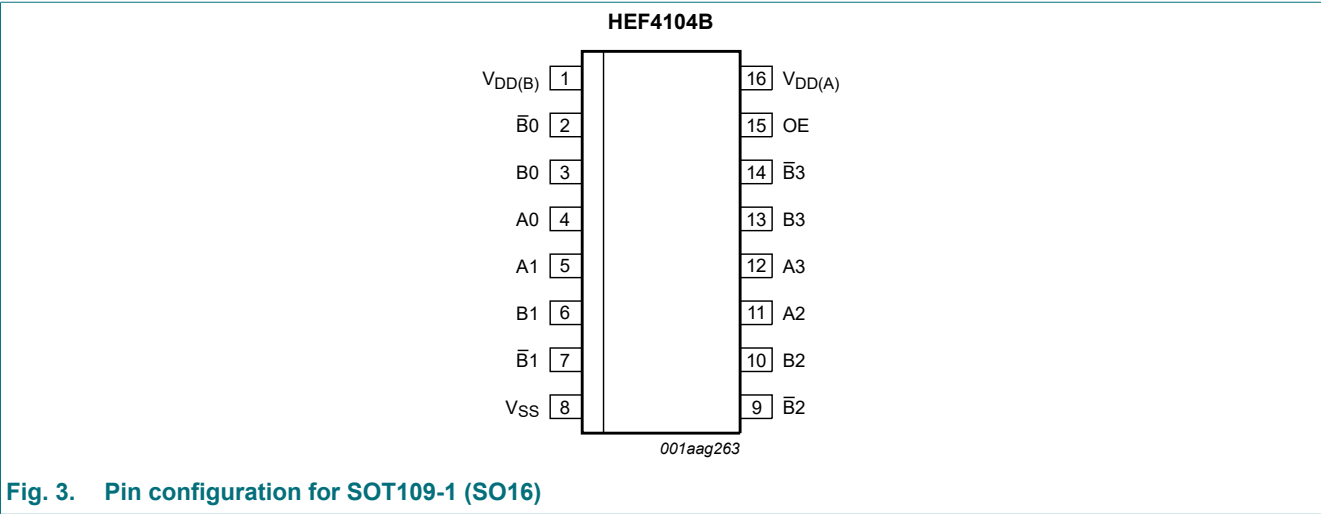
Type number	Package			
	Temperature range	Name	Description	Version
<a href="#">HEF4104BT-Q100</a>	-40 °C to +85 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	<a href="#">SOT109-1</a>

4. Functional diagram



5. Pinning information

5.1. Pinning



5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
V <sub>DD(B)</sub>	1	supply voltage port B
$\overline{B}0, \overline{B}1, \overline{B}2, \overline{B}3$	2, 7, 9, 14	complementary data output
B0, B1, B2, B3	3, 6, 10, 13	data output
A0, A1, A2, A3	4, 5, 11, 12	data input
V <sub>SS</sub>	8	common negative supply voltage (0 V)
OE	15	output enable input
V <sub>DD(A)</sub>	16	supply voltage port A

6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; Z = high-impedance OFF-state.

Control	Output	
OE	Bn	$\overline{B}n$
H	An	$\overline{A}n$
L	Z	Z

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to V<sub>SS</sub> = 0 V (ground).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD(A)</sub>	supply voltage A	port A; V <sub>DD(A)</sub> ≤ V <sub>DD(B)</sub>	-0.5	+18	V
V <sub>DD(B)</sub>	supply voltage B	port B; V <sub>DD(B)</sub> ≥ V <sub>DD(A)</sub>	-0.5	+18	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>DD(A)</sub> + 0.5 V	-	±10	mA
V <sub>I</sub>	input voltage		-0.5	V <sub>DD(A)</sub> + 0.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>DD(B)</sub> + 0.5 V	-	±10	mA
I <sub>I/O</sub>	input/output current		-	±10	mA
I <sub>DD</sub>	supply current	[1]	-	50	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>amb</sub>	ambient temperature		-40	+85	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +85 °C	-	500	mW
P	power dissipation	per output	-	100	mW

[1] I<sub>DD</sub> is the combined current of I<sub>DD(A)</sub> and I<sub>DD(B)</sub>.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DD(A)</sub>	supply voltage A		3	-	≤ V <sub>DD(B)</sub>	V
V <sub>DD(B)</sub>	supply voltage B		≥ V <sub>DD(A)</sub>	-	15	V
V <sub>I</sub>	input voltage		0	-	V <sub>DD(A)</sub>	V
T <sub>amb</sub>	ambient temperature	in free air	-40	-	+85	°C
Δt/ΔV	input transition rise and fall rate	V <sub>DD(A)</sub> = 5 V	-	-	3.75	μs/V
		V <sub>DD(A)</sub> = 10 V	-	-	0.5	μs/V
		V <sub>DD(A)</sub> = 15 V	-	-	0.08	μs/V

9. Static characteristics

Table 6. Static characteristics

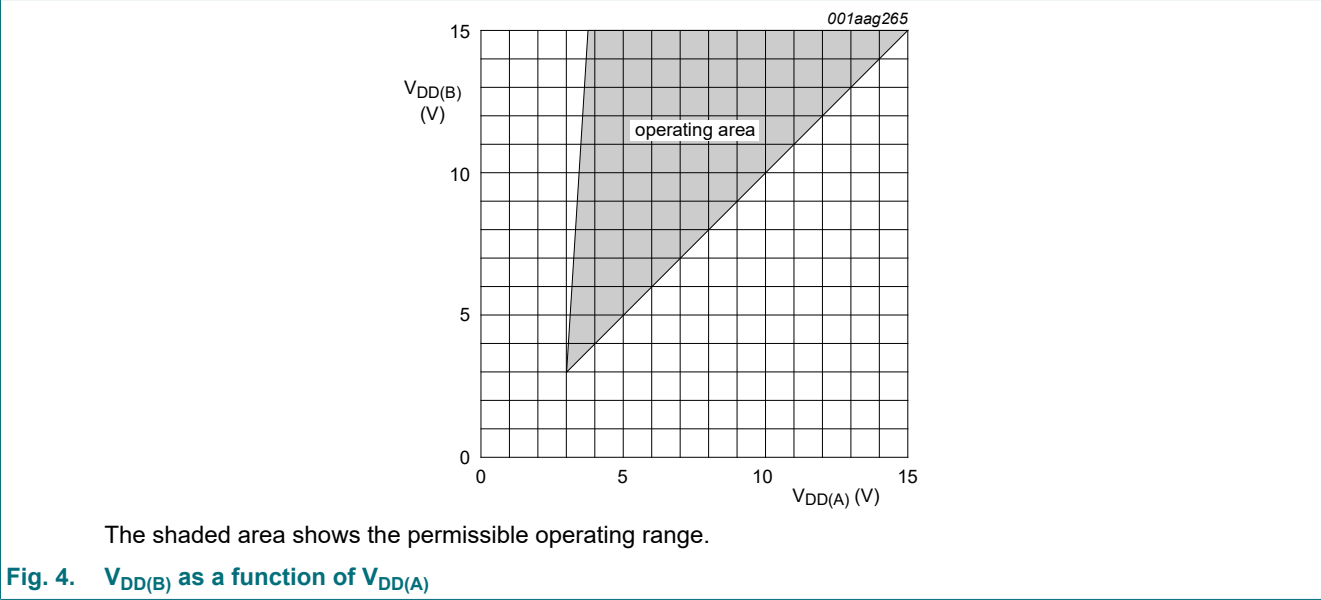
V<sub>DD(A)</sub> = V<sub>DD(B)</sub>; V<sub>SS</sub> = 0 V; V<sub>I</sub> = V<sub>SS</sub> or V<sub>DD(A)</sub>; unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>DD</sub> [1]	T <sub>amb</sub> = -40 °C		T <sub>amb</sub> = +25 °C		T <sub>amb</sub> = +85 °C		Unit
				Min	Max	Min	Max	Min	Max	
V <sub>IH</sub>	HIGH-level input voltage	I <sub>O</sub>   < 1 μA	5 V	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	11.0	-	11.0	-	V
V <sub>IL</sub>	LOW-level input voltage	I <sub>O</sub>   < 1 μA	5 V	-	1.5	-	1.5	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	V
V <sub>OH</sub>	HIGH-level output voltage	I <sub>O</sub>   < 1 μA	5 V	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	V
V <sub>OL</sub>	LOW-level output voltage	I <sub>O</sub>   < 1 μA	5 V	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	V
			15 V	-	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	mA
		V <sub>O</sub> = 4.6 V	5 V	-	-0.52	-	-0.44	-	-0.36	mA
		V <sub>O</sub> = 9.5 V	10 V	-	-1.3	-	-1.1	-	-0.9	mA
		V <sub>O</sub> = 13.5 V	15 V	-	-3.6	-	-3.0	-	-2.4	mA
I <sub>OL</sub>	LOW-level output current	V <sub>O</sub> = 0.4 V	5 V	0.52	-	0.44	-	0.36	-	mA
		V <sub>O</sub> = 0.5 V	10 V	1.3	-	1.1	-	0.9	-	mA
		V <sub>O</sub> = 1.5 V	15 V	3.6	-	3.0	-	2.4	-	mA
I <sub>I</sub>	input leakage current		15 V	-	±0.3	-	±0.3	-	±1.0	μA
I <sub>DD</sub>	supply current	all valid input combinations; I <sub>O</sub> = 0 A	5 V [2]	-	20	-	20	-	150	μA
			10 V	-	40	-	40	-	300	μA
			15 V	-	80	-	80	-	600	μA
I <sub>OZ</sub>	OFF-state output current	HIGH; V <sub>O</sub> = V <sub>DD(B)</sub>	15 V	-	1.6	-	1.6	-	12.0	μA
		LOW; V <sub>O</sub> = V <sub>SS</sub>	15 V	-	-1.6	-	-1.6	-	-12.0	μA

Quad low-to-high voltage translator with 3-state outputs

Symbol	Parameter	Conditions	V <sub>DD</sub> [1]	T <sub>amb</sub> = -40 °C		T <sub>amb</sub> = +25 °C		T <sub>amb</sub> = +85 °C		Unit
				Min	Max	Min	Max	Min	Max	
C <sub>I</sub>	input capacitance	digital inputs	-	-	-	-	7.5	-	-	pF

[1] V<sub>DD</sub> is the same as V<sub>DD(A)</sub> and V<sub>DD(B)</sub>.  
[2] I<sub>DD</sub> is the combined current of I<sub>DD(A)</sub> and I<sub>DD(B)</sub>.



10. Dynamic characteristics

Table 7. Dynamic characteristics

T<sub>amb</sub> = 25 °C unless otherwise specified; for test circuit see Fig. 7.

Symbol	Parameter	Conditions	Extrapolation formula[1]	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	An to Bn, $\overline{Bn}$ ; see Fig. 5					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V	143 ns + (0.55 ns/pF)C <sub>L</sub>	-	170	340	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V	69 ns + (0.23 ns/pF)C <sub>L</sub>	-	80	160	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V	57 ns + (0.16 ns/pF)C <sub>L</sub>	-	65	135	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	An to Bn, $\overline{Bn}$ ; see Fig. 5					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V	143 ns + (0.55 ns/pF)C <sub>L</sub>	-	170	340	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V	69 ns + (0.23 ns/pF)C <sub>L</sub>	-	80	160	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V	62 ns + (0.16 ns/pF)C <sub>L</sub>	-	70	140	ns
t <sub>THL</sub>	HIGH to LOW output transition time	Bn or $\overline{Bn}$ ; see Fig. 6					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V	10 ns + (1.00 ns/pF)C <sub>L</sub>	-	60	120	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V	9 ns + (0.42 ns/pF)C <sub>L</sub>	-	30	60	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V	6 ns + (0.28 ns/pF)C <sub>L</sub>	-	20	40	ns
t <sub>TLH</sub>	LOW to HIGH output transition time	Bn or $\overline{Bn}$ ; see Fig. 6					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V	10 ns + (1.00 ns/pF)C <sub>L</sub>	-	60	120	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V	9 ns + (0.42 ns/pF)C <sub>L</sub>	-	30	60	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V	6 ns + (0.28 ns/pF)C <sub>L</sub>	-	20	40	ns

Quad low-to-high voltage translator with 3-state outputs

Symbol	Parameter	Conditions	Extrapolation formula[1]	Min	Typ	Max	Unit
t <sub>PHZ</sub>	HIGH to OFF-state propagation delay	OE to Bn, $\overline{Bn}$ ; see Fig. 6					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V		-	70	135	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V		-	55	110	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V		-	60	120	ns
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	OE to Bn, $\overline{Bn}$ ; see Fig. 6					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V		-	70	135	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V		-	55	105	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V		-	55	110	ns
t <sub>PZH</sub>	OFF-state to HIGH propagation delay	OE to Bn, $\overline{Bn}$ ; see Fig. 6					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V		-	195	395	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V		-	95	195	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V		-	80	165	ns
t <sub>PZL</sub>	OFF-state to LOW propagation delay	OE to Bn, $\overline{Bn}$ ; see Fig. 6					
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 5 V		-	195	395	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 10 V		-	95	190	ns
		V <sub>DD(A)</sub> = V <sub>DD(B)</sub> = 15 V		-	80	160	ns

[1] 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>DD(A)</sub> = V<sub>DD(B)</sub>; 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> [1]	Typical formula (μW)	where
P <sub>D</sub>	dynamic power dissipation	5 V	P <sub>D</sub> = 3000 × f <sub>i</sub> + Σ(f <sub>o</sub> × C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup>	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> = 12200 × f <sub>i</sub> + Σ(f <sub>o</sub> × C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup>	
		15 V	P <sub>D</sub> = 31000 × f <sub>i</sub> + Σ(f <sub>o</sub> × C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup>	

[1] V<sub>DD</sub> is the same as V<sub>DD(A)</sub> and V<sub>DD(B)</sub>.

10.1. Waveforms and test circuit

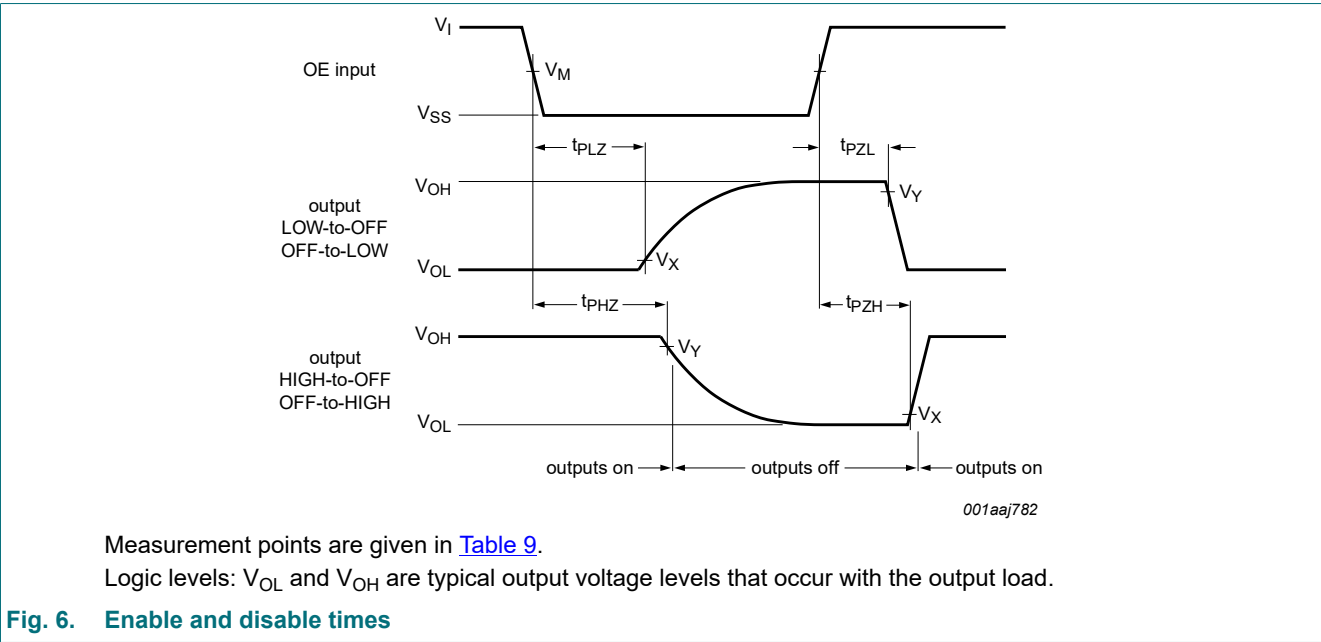
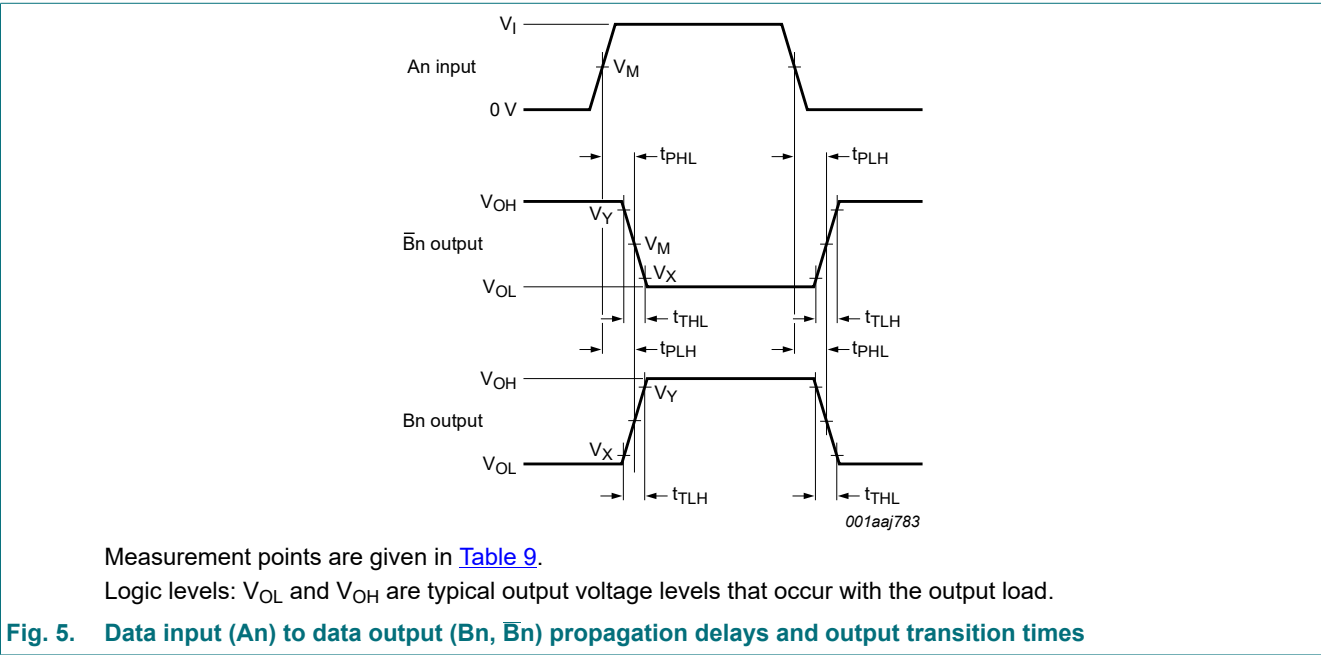


Table 9. Measurement points

Input		Output		
V <sub>I</sub>	V <sub>M</sub>	V <sub>M</sub>	V <sub>X</sub>	V <sub>Y</sub>
V <sub>SS</sub> or V <sub>DD(A)</sub>	0.5V <sub>DD(A)</sub>	0.5V <sub>DD(B)</sub>	0.1V <sub>DD(B)</sub>	0.9V <sub>DD(B)</sub>

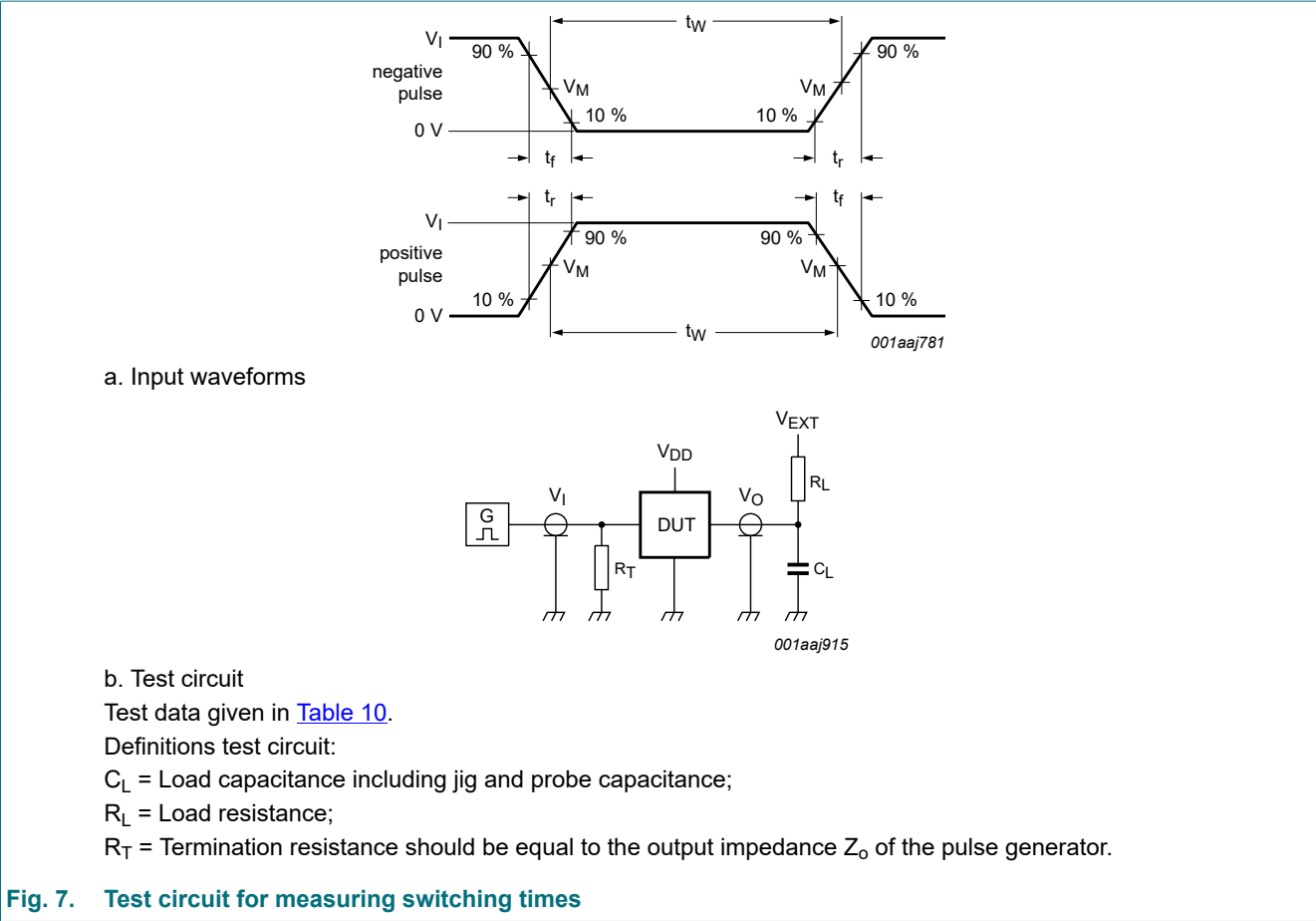


Fig. 7. Test circuit for measuring switching times

Table 10. Test data

Supplies	Input	Load		$V_{EXT}$		
$V_{DD(A)} = V_{DD(B)}$	$t_r, t_f$	$R_L$	$C_L$	$t_{PHL}, t_{PLH}$	$t_{PZL}, t_{PLZ}$	$t_{PZH}, t_{PHZ}$
5 V to 15 V	$\leq 20$ ns	1 k $\Omega$	50 pF	open	$V_{DD(B)}$	$V_{SS}$



11. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

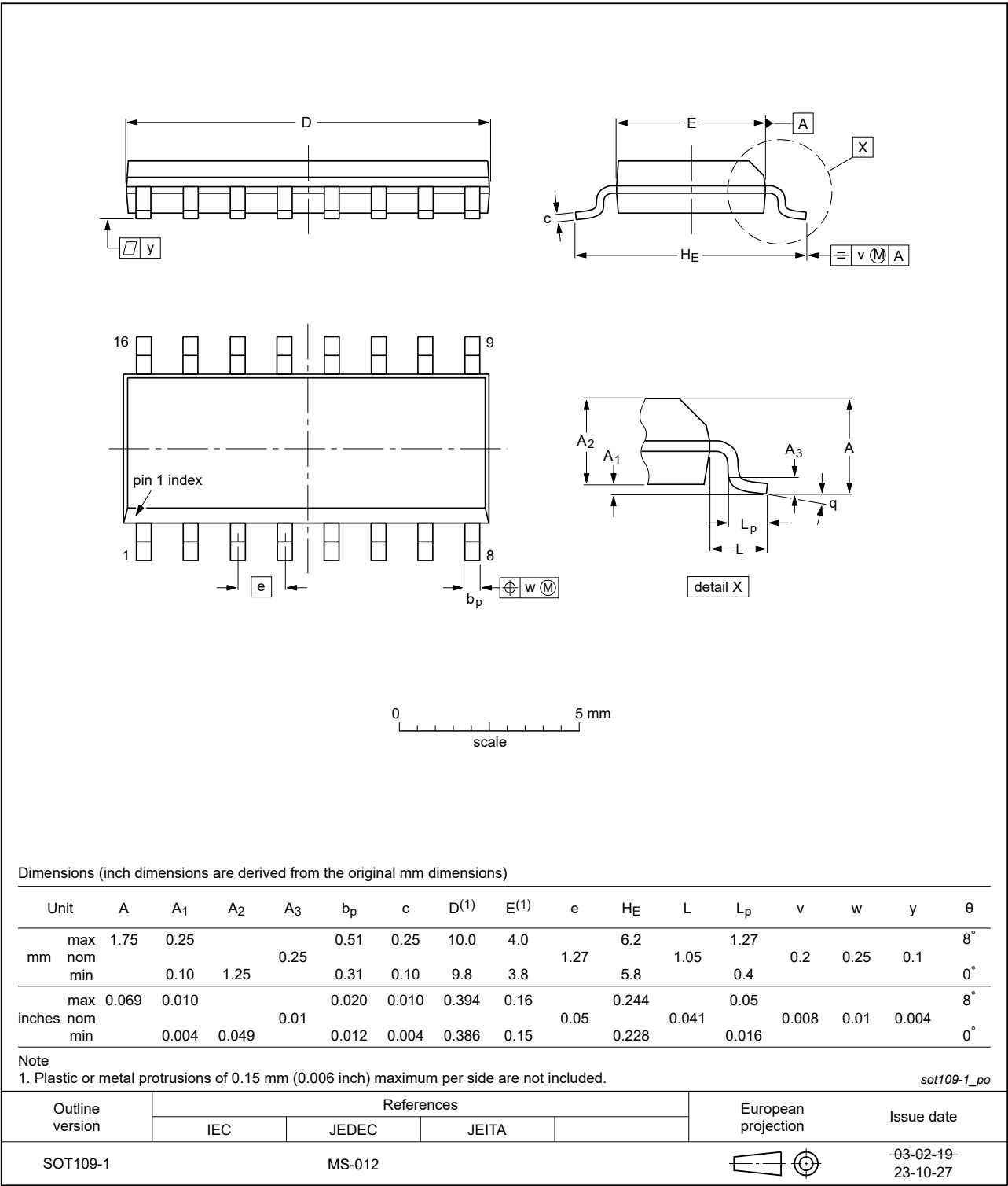


Fig. 8. Package outline SOT109-1 (SO16)

12. Abbreviations

Table 11. Abbreviations

Acronym	Description
ANSI	American National Standards Institute
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
ESDA	ElectroStatic Discharge Association
HBM	Human Body Model
JEDEC	Joint Electron Device Engineering Council

13. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4104B_Q100 v.3	20240725	Product data sheet	-	HEF4104B_Q100 v.2
Modifications:	<ul style="list-style-type: none"><li>Section 2: ESD specification updated according to the latest JEDEC standard.</li><li>Fig. 8: Aligned SO package outline drawing to JEDEC MS-012.</li></ul>			
HEF4104B_Q100 v.2	20211214	Product data sheet	-	HEF4104B_Q100 v.1
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>Section 1 and Section 2 updated.</li><li>Section 12 added.</li></ul>			
HEF4104B_Q100 v.1	20140324	Product data sheet	-	-

## 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.
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