

HEF4104B

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

Rev. 10 — 14 December 2021

Product data sheet

1. General description

The HEF4104B 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} .

2. Features and benefits

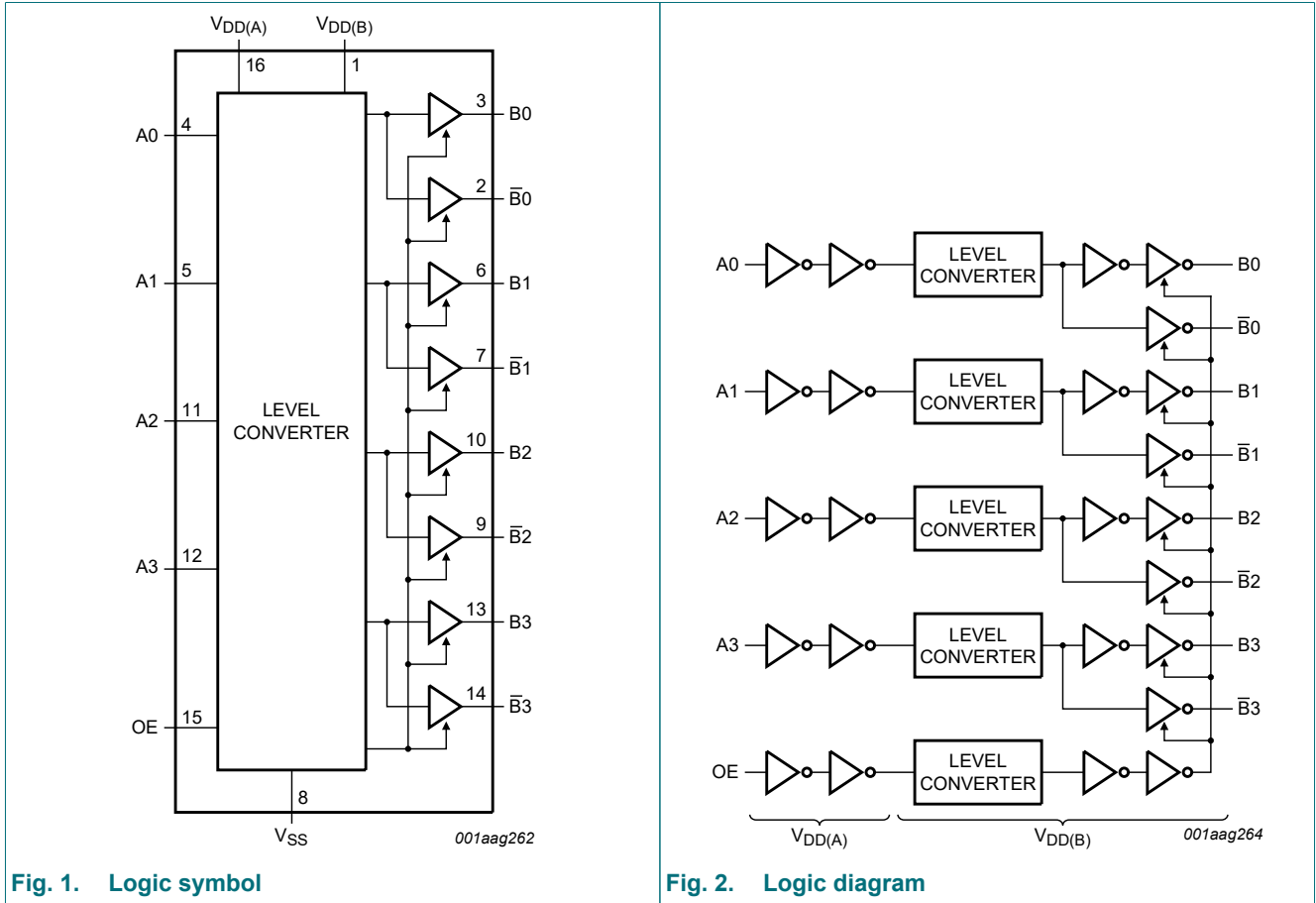
- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Complies with JEDEC standard JESD 13-B
- ESD protection:
 - HBM JESD22-A114F exceeds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

3. Ordering information

Table 1. Ordering information

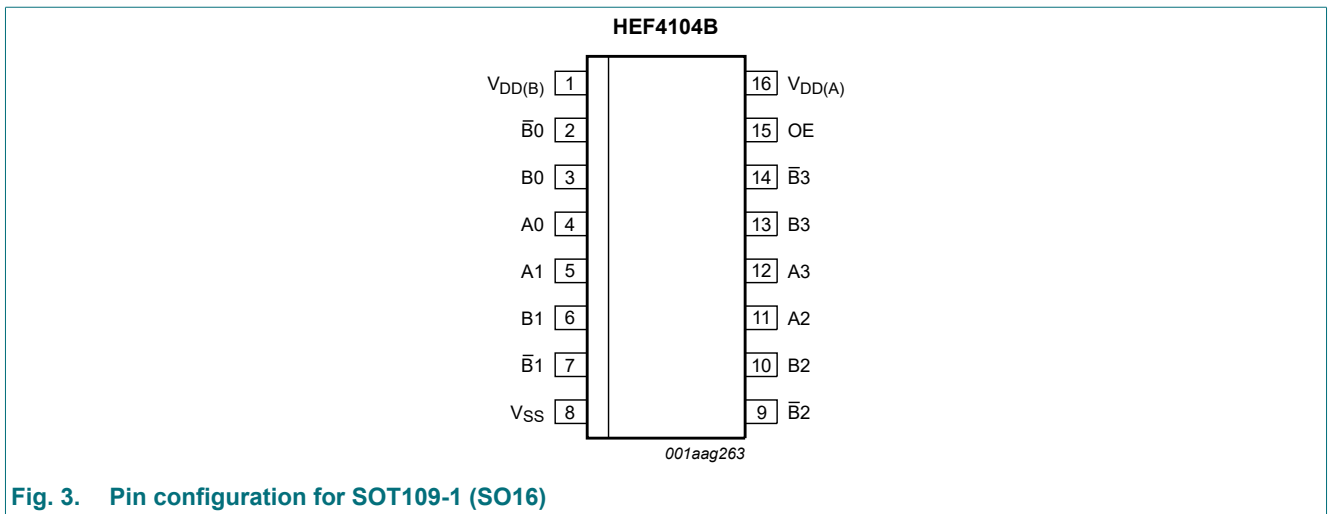
Type number	Package			
	Temperature range	Name	Description	Version
HEF4104BT	-40 °C to +85 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

4. Functional diagram



5. Pinning information

5.1. Pinning



5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
$V_{DD(B)}$	1	supply voltage port B
$\bar{B}0, \bar{B}1, \bar{B}2, \bar{B}3$	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_{SS}	8	common negative supply voltage (0 V)
OE	15	output enable input
$V_{DD(A)}$	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	$\bar{B}n$
H	An	$\bar{A}n$
L	Z	Z

7. Limiting values

Table 4. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DD(A)}$	supply voltage A	port A; $V_{DD(A)} \leq V_{DD(B)}$	-0.5	+18	V
$V_{DD(B)}$	supply voltage B	port B; $V_{DD(B)} \geq V_{DD(A)}$	-0.5	+18	V
I_{IK}	input clamping current	$V_I < -0.5$ V or $V_I > V_{DD(A)} + 0.5$ V	-	± 10	mA
V_I	input voltage		-0.5	$V_{DD(A)} + 0.5$	V
I_{OK}	output clamping current	$V_O < -0.5$ V or $V_O > V_{DD(B)} + 0.5$ V	-	± 10	mA
$I_{I/O}$	input/output current		-	± 10	mA
I_{DD}	supply current	[1]	-	50	mA
T_{stg}	storage temperature		-65	+150	°C
T_{amb}	ambient temperature		-40	+85	°C
P_{tot}	total power dissipation	$T_{amb} = -40$ °C to +85 °C	-	500	mW
P	power dissipation	per output	-	100	mW

[1] I_{DD} is the combined current of $I_{DD(A)}$ and $I_{DD(B)}$.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DD(A)}$	supply voltage A		3	-	$\leq V_{DD(B)}$	V
$V_{DD(B)}$	supply voltage B		$\geq V_{DD(A)}$	-	15	V
V_I	input voltage		0	-	$V_{DD(A)}$	V
T_{amb}	ambient temperature	in free air	-40	-	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD(A)} = 5\text{ V}$	-	-	3.75	$\mu\text{s/V}$
		$V_{DD(A)} = 10\text{ V}$	-	-	0.5	$\mu\text{s/V}$
		$V_{DD(A)} = 15\text{ V}$	-	-	0.08	$\mu\text{s/V}$

9. Static characteristics

Table 6. Static characteristics

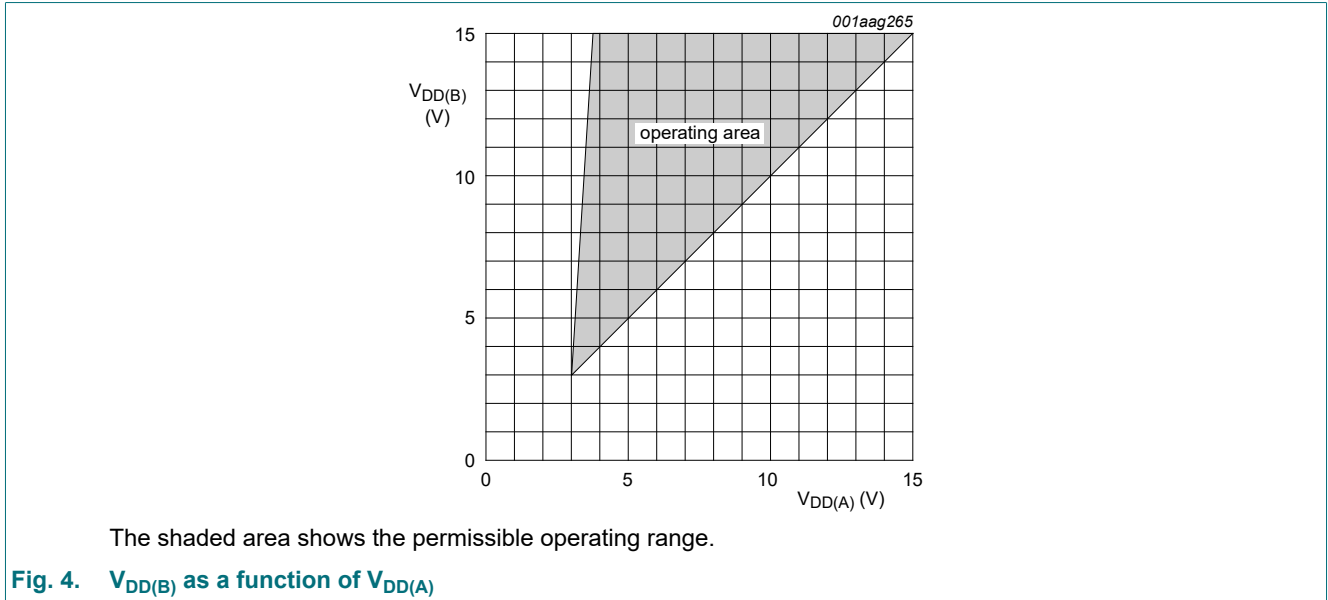
$V_{DD(A)} = V_{DD(B)}$; $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or $V_{DD(A)}$; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD} [1]	$T_{amb} = -40\text{ °C}$		$T_{amb} = +25\text{ °C}$		$T_{amb} = +85\text{ °C}$		Unit
				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	-	V
			10 V	7.0	-	7.0	-	7.0	-	V
			15 V	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	V
			10 V	-	3.0	-	3.0	-	3.0	V
			15 V	-	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	-	V
			10 V	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	V
V_{OL}	LOW-level output voltage	$ I_O < 1\ \mu\text{A}$	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_{OH}	HIGH-level output current	$V_O = 2.5\text{ V}$	5 V	-	-1.7	-	-1.4	-	-1.1	mA
		$V_O = 4.6\text{ V}$	5 V	-	-0.52	-	-0.44	-	-0.36	mA
		$V_O = 9.5\text{ V}$	10 V	-	-1.3	-	-1.1	-	-0.9	mA
		$V_O = 13.5\text{ V}$	15 V	-	-3.6	-	-3.0	-	-2.4	mA
I_{OL}	LOW-level output current	$V_O = 0.4\text{ V}$	5 V	0.52	-	0.44	-	0.36	-	mA
		$V_O = 0.5\text{ V}$	10 V	1.3	-	1.1	-	0.9	-	mA
		$V_O = 1.5\text{ V}$	15 V	3.6	-	3.0	-	2.4	-	mA
I_I	input leakage current		15 V	-	± 0.3	-	± 0.3	-	± 1.0	μA
I_{DD}	supply current	all valid input combinations; $I_O = 0\text{ A}$	5 V [2]	-	20	-	20	-	150	μA
			10 V	-	40	-	40	-	300	μA
			15 V	-	80	-	80	-	600	μA
I_{OZ}	OFF-state output current	HIGH; $V_O = V_{DD(B)}$	15 V	-	1.6	-	1.6	-	12.0	μA
		LOW; $V_O = V_{SS}$	15 V	-	-1.6	-	-1.6	-	-12.0	μA

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

Symbol	Parameter	Conditions	V _{DD} [1]	T _{amb} = -40 °C		T _{amb} = +25 °C		T _{amb} = +85 °C		Unit
				Min	Max	Min	Max	Min	Max	
C _I	input capacitance	digital inputs	-	-	-	-	7.5	-	-	pF

- [1] V_{DD} is the same as V_{DD(A)} and V_{DD(B)}.
- [2] I_{DD} is the combined current of I_{DD(A)} and I_{DD(B)}.



10. Dynamic characteristics

Table 7. Dynamic characteristics

T_{amb} = 25 °C unless otherwise specified; for test circuit see Fig. 7.

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

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

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

[1] 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_{DD(A)} = V_{DD(B)}; V_{SS} = 0 V; t_r = t_f ≤ 20 ns; T_{amb} = 25 °C.

Symbol	Parameter	V _{DD} [1]	Typical formula (μW)	where
P _D	dynamic power dissipation	5 V	$P_D = 3000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f _i = input frequency in MHz; f _o = output frequency in MHz; C _L = output load capacitance in pF; Σ(f _o × C _L) = sum of the outputs; V _{DD} = supply voltage in V.
		10 V	$P_D = 12200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 31000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

[1] V_{DD} is the same as V_{DD(A)} and V_{DD(B)}.

10.1. Waveforms and test circuit

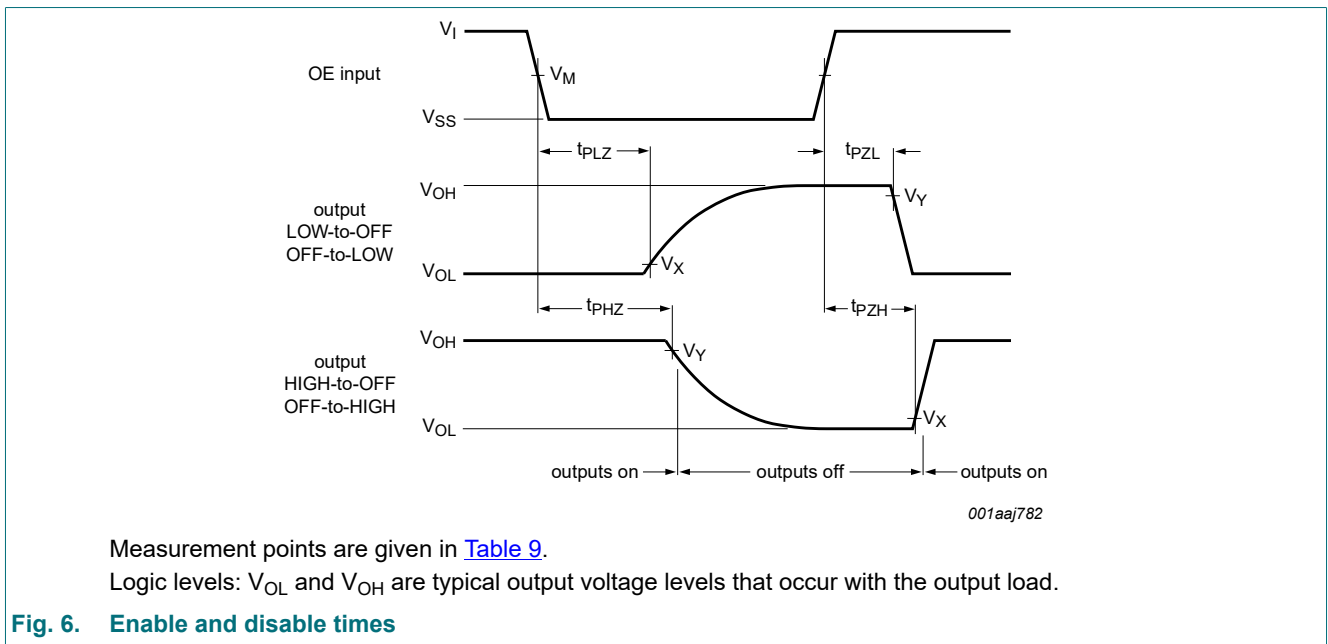
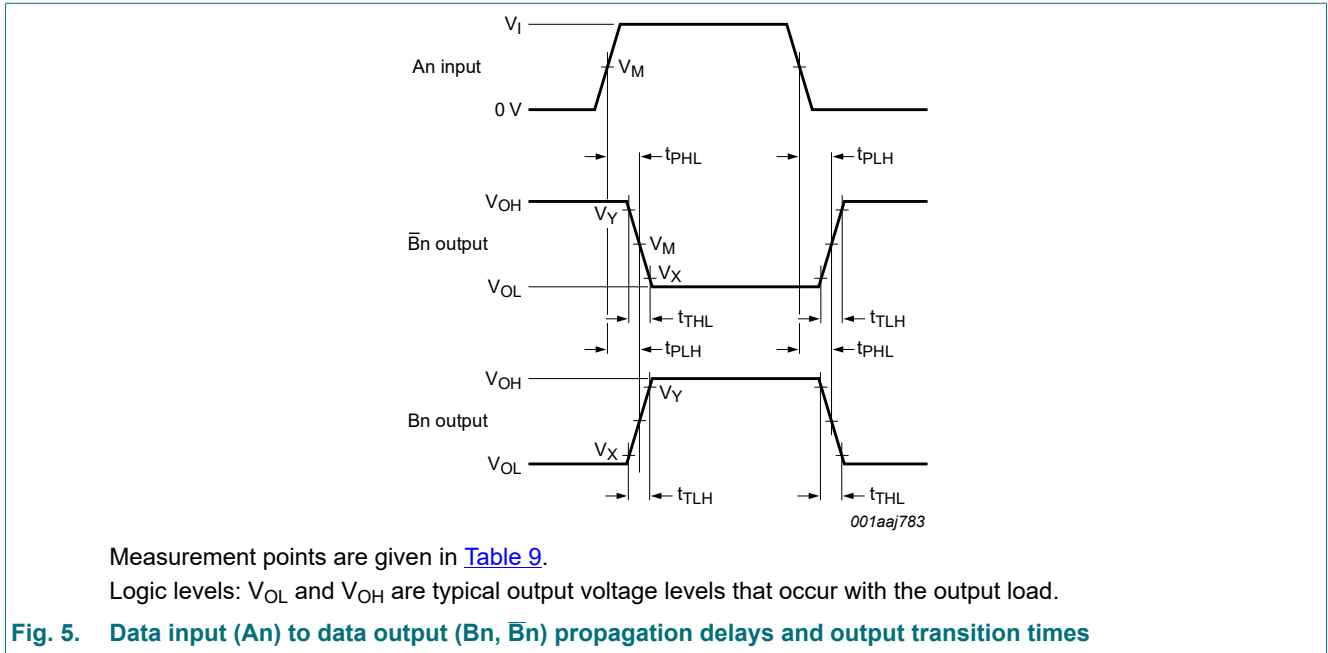
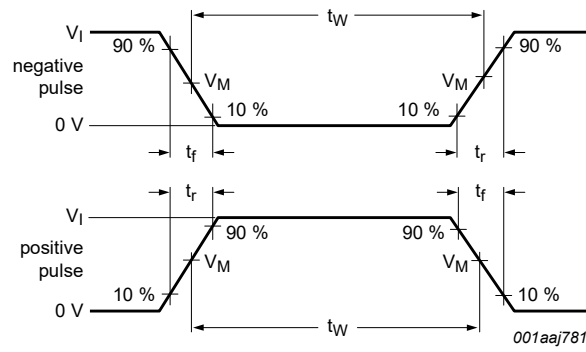


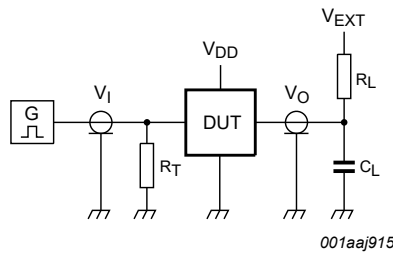
Table 9. Measurement points

Input		Output		
V_I	V_M	V_M	V_X	V_Y
V_{SS} or $V_{DD(A)}$	$0.5V_{DD(A)}$	$0.5V_{DD(B)}$	$0.1V_{DD(B)}$	$0.9V_{DD(B)}$

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



a. Input waveforms



b. Test circuit

Test data given in [Table 10](#).

Definitions for test circuit:

C_L = Load capacitance including jig and probe capacitance

R_L = Load resistance

R_T = Termination resistance should be equal to the output impedance Z_o of the pulse generator

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	≤ 20 ns	1 k Ω	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
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
HEF4104B v.10	20211214	Product data sheet	-	HEF4104B v.8
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Section 1 and Section 2 updated. Section 12 added. 			
HEF4104B v.9	20160329	Product data sheet	-	HEF4104B v.8
Modifications:	<ul style="list-style-type: none"> Type number HEF4104BP (SOT38-4) removed. 			
HEF4104B v.8	20111111	Product data sheet	-	HEF4104B v.7
Modifications:	<ul style="list-style-type: none"> Section Applications removed Table 6: I_{OH} minimum values changed to maximum 			
HEF4104B v.7	20091216	Product data sheet	-	HEF4104B v.6
HEF4104B v.6	20091102	Product data sheet	-	HEF4104B v.5
HEF4104B v.5	20090728	Product data sheet	-	HEF4104B v.4
HEF4104B v.4	20090305	Product data sheet	-	HEF4104B_CNV v.3
HEF4104B_CNV v.3	19950101	Product specification	-	HEF4104B_CNV v.2
HEF4104B_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.

- [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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