



**THE DATASHEET OF  
NXB0104PWJ**



# NXB0104

Dual supply translating transceiver; auto direction sensing;  
3-state

Rev. 4 — 4 April 2024

Product data sheet

## 1. General description

The NXB0104 is a 4-bit, dual supply translating transceiver with auto direction sensing, that enables bidirectional voltage level translation. It features two 4-bit input-output ports (An and Bn), one output enable input (OE) and two supply pins ( $V_{CC(A)}$  and  $V_{CC(B)}$ ).  $V_{CC(A)}$  can be supplied at any voltage between 1.2 V and 3.6 V and  $V_{CC(B)}$  can be supplied at any voltage between 1.65 V and 5.5 V, making the device suitable for translating between any of the low voltage nodes (1.2 V, 1.5 V, 1.8 V, 2.5 V, 3.3 V and 5.0 V). Pins An and OE are referenced to  $V_{CC(A)}$  and pins Bn are referenced to  $V_{CC(B)}$ . A LOW level at pin OE causes the outputs to assume a high-impedance OFF-state. This device is fully specified for partial power-down applications using  $I_{OFF}$ . The  $I_{OFF}$  circuitry disables the output, preventing the damaging backflow current through the device when it is powered down.

## 2. Features and benefits

- Wide supply voltage range:
  - $V_{CC(A)}$ : 1.2 V to 3.6 V and  $V_{CC(B)}$ : 1.65 V to 5.5 V
- $I_{OFF}$  circuitry provides partial Power-down mode operation
- Inputs accept voltages up to 5.5 V
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2500 V for A port
  - HBM: ANSI/ESDA/JEDEC JS-001 class 3B exceeds 15000 V for B port
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- Latch-up performance exceeds 100 mA per JESD 78B Class II
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

## 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
<a href="#">NXB0104PW</a>	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	<a href="#">SOT402-1</a>
<a href="#">NXB0104BQ</a>	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	DHVQFN14	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85$ mm	<a href="#">SOT762-1</a>
<a href="#">NXB0104GU12</a>	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	XQFN12	plastic, extremely thin quad flat package; no leads; 12 terminals; body $1.70 \times 2.0 \times 0.50$ mm	<a href="#">SOT1174-1</a>

### 4. Marking

Table 2. Marking

Type number	Marking code
NXB0104PW	NXB0104
NXB0104BQ	B0104
NXB0104GU12	n4

### 5. Functional diagram

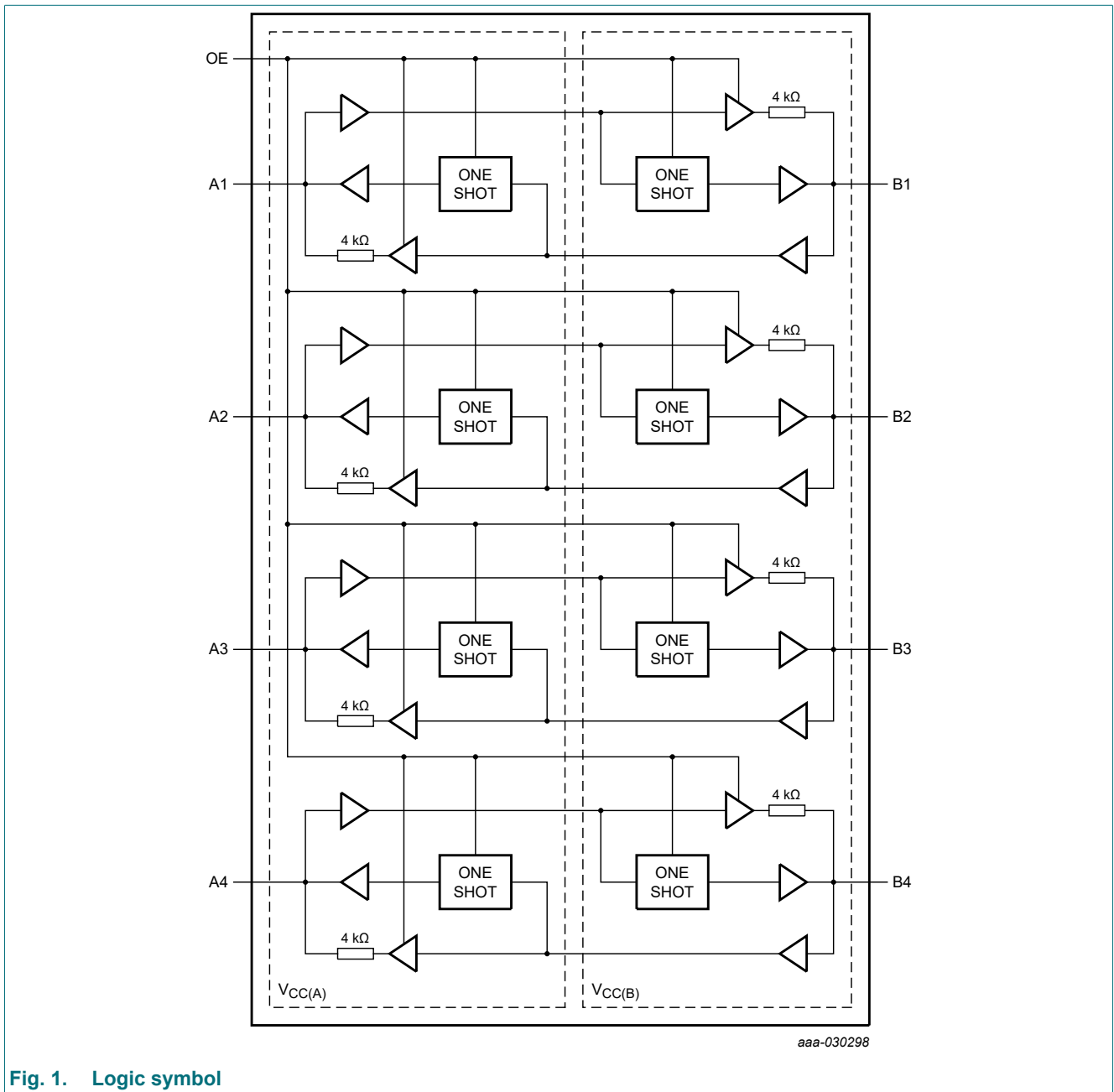


Fig. 1. Logic symbol

## 6. Pinning information

### 6.1. Pinning

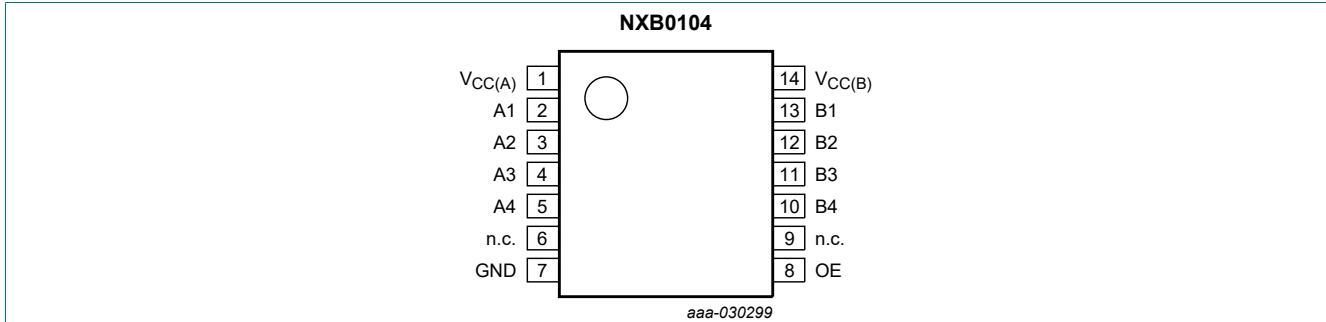
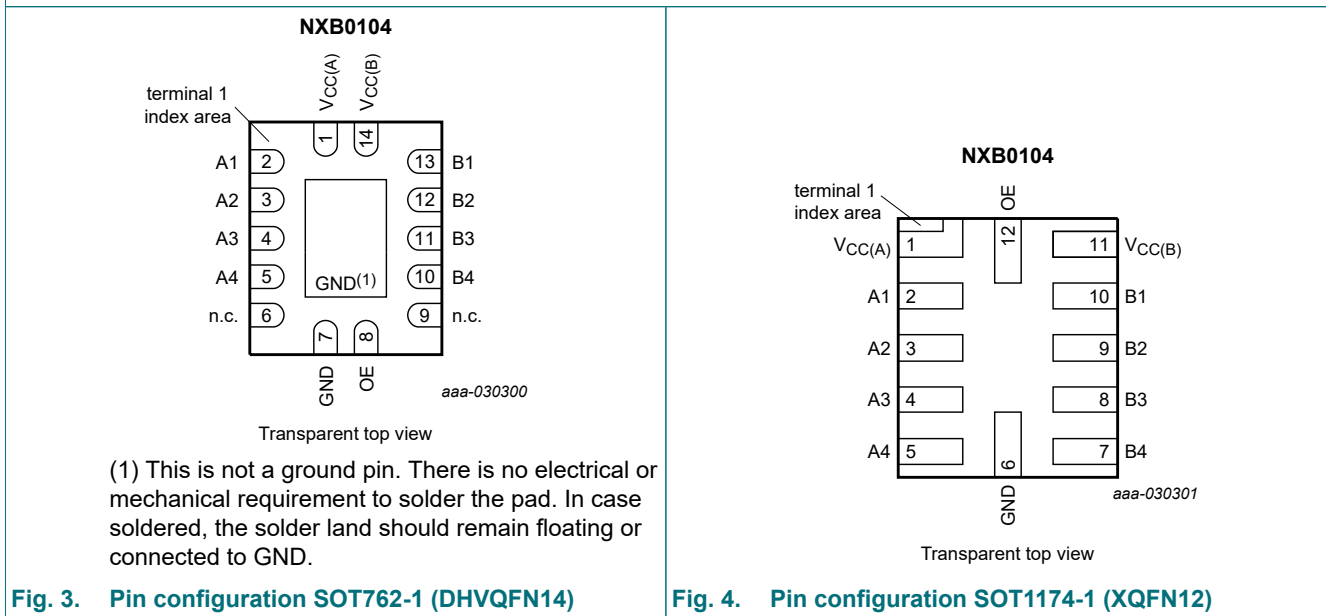


Fig. 2. Pin configuration SOT402-1 (TSSOP14)



(1) This is not a ground pin. There is no electrical or mechanical requirement to solder the pad. In case soldered, the solder land should remain floating or connected to GND.

Fig. 3. Pin configuration SOT762-1 (DHVQFN14)

Fig. 4. Pin configuration SOT1174-1 (XQFN12)

### 6.2. Pin description

Table 3. Pin description

Symbol	Pin		Description
	SOT402-1 and SOT762-1	SOT1174-1	
V <sub>CC(A)</sub>	1	1	supply voltage A
A1, A2, A3, A4	2, 3, 4, 5	2, 3, 4, 5	data input or output (referenced to V <sub>CC(A)</sub> )
n.c.	6, 9	-	not connected
GND	7	6	ground (0 V)
OE	8	12	output enable input (active HIGH; referenced to V <sub>CC(A)</sub> )
B4, B3, B2, B1	10, 11, 12, 13	7, 8, 9, 10	data input or output (referenced to V <sub>CC(B)</sub> )
V <sub>CC(B)</sub>	14	11	supply voltage B

## 7. Functional description

**Table 4. Function table**

H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.

Supply voltage		Input	Input/output	
V <sub>CC(A)</sub> [1]	V <sub>CC(B)</sub>	OE	An	Bn
1.2 V to 3.6 V	1.65 V to 5.5 V	L	Z	Z
1.2 V to 3.6 V	1.65 V to 5.5 V	H	input or output	output or input
GND[2]	GND[2]	X	Z	Z

[1] V<sub>CC(A)</sub> must be less than or equal to V<sub>CC(B)</sub>.

[2] When either V<sub>CC(A)</sub> or V<sub>CC(B)</sub> is at GND level, the device goes into power-down mode.

## 8. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC(A)</sub>	supply voltage A		-0.5	+6.5	V
V <sub>CC(B)</sub>	supply voltage B		-0.5	+6.5	V
V <sub>I</sub>	input voltage	OE [1]	-0.5	+6.5	V
		Power-down or 3-state mode			
		An, Bn [1]	-0.5	+6.5	V
		Active mode			
		An, Bn [1] [2] [3]	-0.5	V <sub>CCI</sub> + 0.5	V
V <sub>O</sub>	output voltage	Power-down or 3-state mode			
		An, Bn [1]	-0.5	+6.5	V
		Active mode			
		An, Bn [1] [3] [4]	-0.5	V <sub>CCO</sub> + 0.5	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < 0 V	-50	-	mA
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < 0 V	-50	-	mA
I <sub>O</sub>	output current	V <sub>O</sub> = 0 V to V <sub>CCO</sub> [4]	-	±50	mA
I <sub>CC</sub>	supply current	I <sub>CC(A)</sub> or I <sub>CC(B)</sub>	-	100	mA
I <sub>GND</sub>	ground current		-100	-	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +125 °C			
		SOT402-1 (TSSOP14) and SOT762-1 (DHSVFN14) package [5]	-	500	mW
		SOT1174-1 (XQFN12) package	-	250	mW

[1] The minimum input and minimum output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] V<sub>CCI</sub> is the supply voltage associated with the input.

[3] V<sub>CCI</sub> + 0.5 V or V<sub>CCO</sub> + 0.5 V should not exceed 6.5 V.

[4] V<sub>CCO</sub> is the supply voltage associated with the output.

[5] For SOT402-1 (TSSOP14) package: P<sub>tot</sub> derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHSVFN14) package: P<sub>tot</sub> derates linearly with 9.6 mW/K above 98 °C.

## 9. Recommended operating conditions

Table 6. Recommended operating conditions [1] [2]

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC(A)}$	supply voltage A		1.2	3.6	V
$V_{CC(B)}$	supply voltage B		1.65	5.5	V
$V_I$	input voltage	OE	0	5.5	V
		Power-down or 3-state mode			
		An	0	3.6	V
		Bn	0	5.5	V
		Active mode			
	An, Bn	[3]	0	$V_{CCI}$	V
$V_O$	output voltage	Power-down or 3-state mode			
		An	0	3.6	V
		Bn	0	5.5	V
		Active mode			
		An, Bn	[4]	0	$V_{CCO}$
$T_{amb}$	ambient temperature		-40	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC(A)} = 1.2\text{ V to }3.6\text{ V};$ $V_{CC(B)} = 1.65\text{ V to }5.5\text{ V}$	-	40	ns/V

[1] The A and B sides of an unused I/O pair must be held in the same state, both at  $V_{CCI}$  or both at GND.

[2]  $V_{CC(A)}$  must be less than or equal to  $V_{CC(B)}$ .

[3]  $V_{CCI}$  is the supply voltage associated with the input.

[4]  $V_{CCO}$  is the supply voltage associated with the output.

## 10. Static characteristics

Table 7. Typical static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V);  $T_{amb} = 25\text{ °C}$ . [1]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{OH}$	HIGH-level output voltage	A port; $V_{CC(A)} = 1.2\text{ V}; I_O = -20\text{ }\mu\text{A}$	-	1.1	-	V
$V_{OL}$	LOW-level output voltage	A port; $V_{CC(A)} = 1.2\text{ V}; I_O = 20\text{ }\mu\text{A}$	-	0.09	-	V
$I_I$	input leakage current	OE input; $V_I = 0\text{ V to }3.6\text{ V}; V_{CC(A)} = 1.2\text{ V to }3.6\text{ V};$ $V_{CC(B)} = 1.65\text{ V to }5.5\text{ V}$	-	-	$\pm 1$	$\mu\text{A}$
$I_{OZ}$	OFF-state output current	OE = 0 V; [2] A port: $V_I$ or $V_O = 0\text{ V to }3.6\text{ V};$ B port: $V_I$ or $V_O = 0\text{ V to }5.5\text{ V};$	-	-	$\pm 1$	$\mu\text{A}$
$I_{OFF}$	power-off leakage current	A port; $V_I$ or $V_O = 0\text{ V to }3.6\text{ V}; V_{CC(A)} = 0\text{ V};$ $V_{CC(B)} = 0\text{ V to }5.5\text{ V}$	-	-	$\pm 1$	$\mu\text{A}$
		B port; $V_I$ or $V_O = 0\text{ V to }5.5\text{ V}; V_{CC(B)} = 0\text{ V};$ $V_{CC(A)} = 0\text{ V to }3.6\text{ V}$	-	-	$\pm 1$	$\mu\text{A}$

## Dual supply translating transceiver; auto direction sensing; 3-state

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC}$	supply current	$V_I = 0\text{ V}$ or $V_{CC(I)}$ ; $I_O = 0\text{ A}$ [3]				
		$I_{CC(A)}$ ; $V_{CC(A)} = 1.2\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	0.05	-	$\mu\text{A}$
		$I_{CC(B)}$ ; $V_{CC(A)} = 1.2\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	3.3	-	$\mu\text{A}$
		$I_{CC(A)} + I_{CC(B)}$ ; $V_{CC(A)} = 1.2\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	3.5	-	$\mu\text{A}$
$C_I$	input capacitance	OE input; $V_{CC(A)} = 1.2\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	2.8	-	pF
$C_{I/O}$	input/output capacitance	A port; $V_{CC(A)} = 1.2\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	4.0	-	pF
		B port; $V_{CC(A)} = 1.2\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	7.5	-	pF

[1]  $V_{CC(A)}$  must be less than or equal to  $V_{CC(B)}$ .

[2]  $V_{CCO}$  is the supply voltage associated with the output.

[3]  $V_{CCI}$  is the supply voltage associated with the input.

**Table 8. Typical supply current**

At recommended operating conditions; voltages are referenced to GND (ground = 0 V);  $T_{amb} = 25\text{ }^\circ\text{C}$ .

$V_{CC(A)}$	$V_{CC(B)}$								Unit
	1.8 V		2.5 V		3.3 V		5.0 V		
	$I_{CC(A)}$	$I_{CC(B)}$	$I_{CC(A)}$	$I_{CC(B)}$	$I_{CC(A)}$	$I_{CC(B)}$	$I_{CC(A)}$	$I_{CC(B)}$	
1.2 V	10	10	10	10	10	20	10	1050	nA
1.5 V	10	10	10	10	10	10	10	650	nA
1.8 V	10	10	10	10	10	10	10	350	nA
2.5 V	-	-	10	10	10	10	10	40	nA
3.3 V	-	-	-	-	10	10	10	10	nA

**Table 9. Static characteristics**

At recommended operating conditions; voltages are referenced to GND (ground = 0 V). [1]

Symbol	Parameter	Conditions	-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	A or B port and OE input [2]					
		$V_{CC(A)} = 1.2\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	$0.65V_{CCI}$	-	$0.65V_{CCI}$	-	V
$V_{IL}$	LOW-level input voltage	A or B port and OE input [2]					
		$V_{CC(A)} = 1.2\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	$0.35V_{CCI}$	-	$0.35V_{CCI}$	V
$V_{OH}$	HIGH-level output voltage	A or B port; $I_O = -20\text{ }\mu\text{A}$ [3]					
		A port; $V_{CC(A)} = 1.4\text{ V}$ to $3.6\text{ V}$	$V_{CCO} - 0.4$	-	$V_{CCO} - 0.4$	-	V
		B port; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	$V_{CCO} - 0.4$	-	$V_{CCO} - 0.4$	-	V
$V_{OL}$	LOW-level output voltage	A or B port; $I_O = 20\text{ }\mu\text{A}$ [3]					
		A port; $V_{CC(A)} = 1.4\text{ V}$ to $3.6\text{ V}$	-	0.4	-	0.4	V
		B port; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	0.4	-	0.4	V
$I_I$	input leakage current	OE input; $V_I = 0\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(A)} = 1.2\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(B)} = 1.65\text{ V}$ to $5.5\text{ V}$	-	$\pm 2$	-	$\pm 5$	$\mu\text{A}$
$I_{OZ}$	OFF-state output current	OE = 0 V; A port: $V_I$ or $V_O = 0\text{ V}$ to $3.6\text{ V}$ ; B port: $V_I$ or $V_O = 0\text{ V}$ to $5.5\text{ V}$ ;	-	$\pm 2$	-	$\pm 10$	$\mu\text{A}$
$I_{OFF}$	power-off leakage current	A port; $V_I$ or $V_O = 0\text{ V}$ to $3.6\text{ V}$ ; $V_{CC(A)} = 0\text{ V}$ ; $V_{CC(B)} = 0\text{ V}$ to $5.5\text{ V}$	-	$\pm 2$	-	$\pm 10$	$\mu\text{A}$
		B port; $V_I$ or $V_O = 0\text{ V}$ to $5.5\text{ V}$ ; $V_{CC(B)} = 0\text{ V}$ ; $V_{CC(A)} = 0\text{ V}$ to $3.6\text{ V}$	-	$\pm 2$	-	$\pm 10$	$\mu\text{A}$

## Dual supply translating transceiver; auto direction sensing; 3-state

Symbol	Parameter	Conditions	-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Max	Min	Max	
I <sub>CC</sub>	supply current	V <sub>I</sub> = 0 V or V <sub>CCI</sub> ; I <sub>O</sub> = 0 A [2]					
		I <sub>CC(A)</sub>					
		OE = LOW; V <sub>CC(A)</sub> = 1.4 V to 3.6 V; V <sub>CC(B)</sub> = 1.65 V to 5.5 V	-	5	-	15	μA
		OE = HIGH; V <sub>CC(A)</sub> = 1.4 V to 3.6 V; V <sub>CC(B)</sub> = 1.65 V to 5.5 V	-	5	-	20	μA
		V <sub>CC(A)</sub> = 3.6 V; V <sub>CC(B)</sub> = 0 V	-	2	-	15	μA
		V <sub>CC(A)</sub> = 0 V; V <sub>CC(B)</sub> = 5.5 V	-	-2	-	-15	μA
		I <sub>CC(B)</sub>					
		OE = LOW; V <sub>CC(A)</sub> = 1.4 V to 3.6 V; V <sub>CC(B)</sub> = 1.65 V to 5.5 V	-	5	-	15	μA
		OE = HIGH; V <sub>CC(A)</sub> = 1.4 V to 3.6 V; V <sub>CC(B)</sub> = 1.65 V to 5.5 V	-	5	-	20	μA
		V <sub>CC(A)</sub> = 3.6 V; V <sub>CC(B)</sub> = 0 V	-	-2	-	-15	μA
		V <sub>CC(A)</sub> = 0 V; V <sub>CC(B)</sub> = 5.5 V	-	2	-	15	μA
		I <sub>CC(A)</sub> + I <sub>CC(B)</sub>					
		V <sub>CC(A)</sub> = 1.4 V to 3.6 V; V <sub>CC(B)</sub> = 1.65 V to 5.5 V	-	10	-	40	μA

[1] V<sub>CC(A)</sub> must be less than or equal to V<sub>CC(B)</sub>.

[2] V<sub>CCI</sub> is the supply voltage associated with the input.

[3] V<sub>CCO</sub> is the supply voltage associated with the output.

## 11. Dynamic characteristics

Table 10. Typical dynamic characteristics for temperature 25 °C

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 8; for waveforms see Fig. 5, Fig. 6 and Fig. 7.

Symbol [1]	Parameter	Conditions	V <sub>CC(B)</sub>				Unit
			1.8 V	2.5 V	3.3 V	5.0 V	
V <sub>CC(A)</sub> = 1.2 V; T <sub>amb</sub> = 25 °C							
t <sub>pd</sub>	propagation delay	A to B	7.5	6.0	5.5	5.2	ns
		B to A	6.6	5.6	5.1	4.9	ns
t <sub>en</sub>	enable time	OE to A, B	0.5	0.5	0.5	0.5	μs
t <sub>dis</sub>	disable time	OE to A; no external load [2]	8.3	8.3	8.3	8.3	ns
		OE to B; no external load [2]	10.4	9.4	9.3	8.8	ns
		OE to A	81	69	83	68	ns
		OE to B	81	69	83	68	ns
t <sub>t</sub>	transition time	A port	4.3	4.3	4.3	4.4	ns
		B port	2.7	2.1	1.8	1.5	ns
t <sub>sk(o)</sub>	output skew time	between channels [3]	0.2	0.2	0.2	0.2	ns
t <sub>W</sub>	pulse width	data inputs	15	13	13	13	ns
f <sub>data</sub>	data rate		70	80	80	80	Mbps

[1] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>; t<sub>en</sub> is the same as t<sub>PZL</sub> and t<sub>PZH</sub>; t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>; t<sub>t</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>

[2] Delay between OE going LOW and when the outputs are actually disabled.

[3] Skew between any two outputs of the same package switching in the same direction.

## Dual supply translating transceiver; auto direction sensing; 3-state

Table 11. Dynamic characteristics for temperature range -40 °C to +85 °C

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 8; for waveforms see Fig. 5, Fig. 6 and Fig. 7.

Symbol [1]	Parameter	Conditions	V <sub>CC(B)</sub>								Unit
			1.8 V ± 0.15 V		2.5 V ± 0.2 V		3.3 V ± 0.3 V		5.0 V ± 0.5 V		
			Min	Max	Min	Max	Min	Max	Min	Max	
<b>V<sub>CC(A)</sub> = 1.5 V ± 0.1 V</b>											
t <sub>pd</sub>	propagation delay	A to B	1.4	12.9	1.2	10.1	1.1	10.0	0.8	9.9	ns
		B to A	0.9	14.2	0.7	12.0	0.4	11.7	0.3	13.7	ns
t <sub>en</sub>	enable time	OE to A, B	-	1.0	-	1.0	-	1.0	-	1.0	µs
t <sub>dis</sub>	disable time	OE to A; no external load [2]	1.0	17.9	1.0	17.9	1.0	17.9	1.0	17.9	ns
		OE to B; no external load [2]	1.0	21.0	1.0	16.6	1.0	15.1	1.0	14.4	ns
		OE to A	-	100	-	100	-	100	-	100	ns
		OE to B	-	150	-	105	-	150	-	105	ns
t <sub>t</sub>	transition time	A port	0.9	5.1	0.9	5.1	0.9	5.1	0.9	5.1	ns
		B port	0.9	4.7	0.6	3.2	0.5	2.5	0.4	2.7	ns
t <sub>sk(o)</sub>	output skew time	between channels [3]	-	0.5	-	0.5	-	0.5	-	0.5	ns
t <sub>W</sub>	pulse width	data inputs	25	-	25	-	25	-	25	-	ns
f <sub>data</sub>	data rate		-	40	-	40	-	40	-	40	Mbps
<b>V<sub>CC(A)</sub> = 1.8 V ± 0.15 V</b>											
t <sub>pd</sub>	propagation delay	A to B	1.6	11.0	1.4	7.7	1.3	6.8	1.2	6.5	ns
		B to A	1.5	12.0	1.3	8.4	1.0	7.6	0.9	7.1	ns
t <sub>en</sub>	enable time	OE to A, B	-	1.0	-	1.0	-	1.0	-	1.0	µs
t <sub>dis</sub>	disable time	OE to A; no external load [2]	1.0	14.7	1.0	14.7	1.0	14.7	1.0	14.7	ns
		OE to B; no external load [2]	1.0	18.2	1.0	14.5	1.0	13.7	1.0	12.7	ns
		OE to A	-	120	-	120	-	120	-	120	ns
		OE to B	-	150	-	105	-	150	-	105	ns
t <sub>t</sub>	transition time	A port	0.8	4.1	0.8	4.1	0.8	4.1	0.8	4.1	ns
		B port	0.9	4.7	0.6	3.2	0.5	2.5	0.4	2.7	ns
t <sub>sk(o)</sub>	output skew time	between channels [3]	-	0.5	-	0.5	-	0.5	-	0.5	ns
t <sub>W</sub>	pulse width	data inputs	20	-	17	-	17	-	17	-	ns
f <sub>data</sub>	data rate		-	49	-	60	-	60	-	60	Mbps

## Dual supply translating transceiver; auto direction sensing; 3-state

Symbol [1]	Parameter	Conditions	$V_{CC(B)}$								Unit
			$1.8\text{ V} \pm 0.15\text{ V}$		$2.5\text{ V} \pm 0.2\text{ V}$		$3.3\text{ V} \pm 0.3\text{ V}$		$5.0\text{ V} \pm 0.5\text{ V}$		
			Min	Max	Min	Max	Min	Max	Min	Max	
<b><math>V_{CC(A)} = 2.5\text{ V} \pm 0.2\text{ V}</math></b>											
$t_{pd}$	propagation delay	A to B	-	-	1.1	6.3	1.0	5.2	0.9	4.7	ns
		B to A	-	-	1.2	6.6	1.1	5.1	0.9	4.4	ns
$t_{en}$	enable time	OE to A, B	-	-	-	1.0	-	1.0	-	1.0	$\mu\text{s}$
$t_{dis}$	disable time	OE to A; no external load [2]	-	-	1.0	9.7	1.0	9.7	1.0	9.7	ns
		OE to B; no external load [2]	-	-	1.0	12.9	1.0	12.0	1.0	11.0	ns
		OE to A	-	-	-	85	-	85	-	85	ns
		OE to B	-	-	-	105	-	150	-	100	ns
$t_t$	transition time	A port	-	-	0.7	3.0	0.7	3.0	0.7	3.0	ns
		B port	-	-	0.7	3.2	0.5	2.5	0.4	2.7	ns
$t_{sk(o)}$	output skew time	between channels [3]	-	-	-	0.5	-	0.5	-	0.5	ns
$t_W$	pulse width	data inputs	-	-	12	-	10	-	10	-	ns
$f_{data}$	data rate		-	-	-	85	-	100	-	100	Mbps
<b><math>V_{CC(A)} = 3.3\text{ V} \pm 0.3\text{ V}</math></b>											
$t_{pd}$	propagation delay	A to B	-	-	-	-	0.9	4.7	0.8	4.0	ns
		B to A	-	-	-	-	1.0	4.9	0.9	3.8	ns
$t_{en}$	enable time	OE to A, B	-	-	-	-	-	1.0	-	1.0	$\mu\text{s}$
$t_{dis}$	disable time	OE to A; no external load [2]	-	-	-	-	1.0	9.4	1.0	9.4	ns
		OE to B; no external load [2]	-	-	-	-	1.0	11.3	1.0	10.4	ns
		OE to A	-	-	-	-	-	125	-	125	ns
		OE to B	-	-	-	-	-	150	-	100	ns
$t_t$	transition time	A port	-	-	-	-	0.7	2.5	0.7	2.5	ns
		B port	-	-	-	-	0.5	2.5	0.4	2.7	ns
$t_{sk(o)}$	output skew time	between channels [3]	-	-	-	-	-	0.5	-	0.5	ns
$t_W$	pulse width	data inputs	-	-	-	-	10	-	10	-	ns
$f_{data}$	data rate		-	-	-	-	-	100	-	100	Mbps

[1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ ;  $t_{en}$  is the same as  $t_{PZL}$  and  $t_{PZH}$ ;  $t_{dis}$  is the same as  $t_{PLZ}$  and  $t_{PHZ}$ ;  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$

[2] Delay between OE going LOW and when the outputs are actually disabled.

[3] Skew between any two outputs of the same package switching in the same direction.

## Dual supply translating transceiver; auto direction sensing; 3-state

Table 12. Dynamic characteristics for temperature range -40 °C to +125 °C

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 8; for waveforms see Fig. 5, Fig. 6 and Fig. 7.

Symbol [1]	Parameter	Conditions	V <sub>CC(B)</sub>								Unit
			1.8 V ± 0.15 V		2.5 V ± 0.2 V		3.3 V ± 0.3 V		5.0 V ± 0.5 V		
			Min	Max	Min	Max	Min	Max	Min	Max	
<b>V<sub>CC(A)</sub> = 1.5 V ± 0.1 V</b>											
t <sub>pd</sub>	propagation delay	A to B	1.4	15.9	1.2	13.1	1.1	13.0	0.8	12.9	ns
		B to A	0.9	17.2	0.7	15.0	0.4	14.7	0.3	16.7	ns
t <sub>en</sub>	enable time	OE to A, B	-	1.0	-	1.0	-	1.0	-	1.0	µs
t <sub>dis</sub>	disable time	OE to A; no external load [2]	1.0	18.3	1.0	18.3	1.0	18.3	1.0	18.3	ns
		OE to B; no external load [2]	1.0	21.8	1.0	17.7	1.0	16.1	1.0	15.2	ns
		OE to A	-	105	-	105	-	105	-	105	ns
		OE to B	-	155	-	110	-	155	-	105	ns
t <sub>t</sub>	transition time	A port	0.9	7.1	0.9	7.1	0.9	7.1	0.9	7.1	ns
		B port	0.9	6.5	0.6	5.2	0.5	4.8	0.4	4.7	ns
t <sub>sk(o)</sub>	output skew time	between channels [3]	-	0.5	-	0.5	-	0.5	-	0.5	ns
t <sub>W</sub>	pulse width	data inputs	25	-	25	-	25	-	25	-	ns
f <sub>data</sub>	data rate		-	40	-	40	-	40	-	40	Mbps
<b>V<sub>CC(A)</sub> = 1.8 V ± 0.15 V</b>											
t <sub>pd</sub>	propagation delay	A to B	1.6	14.0	1.4	10.7	1.3	9.8	1.2	9.5	ns
		B to A	1.5	15.0	1.3	11.4	1.0	10.6	0.9	10.1	ns
t <sub>en</sub>	enable time	OE to A, B	-	1.0	-	1.0	-	1.0	-	1.0	µs
t <sub>dis</sub>	disable time	OE to A; no external load [2]	1.0	15.0	1.0	15.0	1.0	15.0	1.0	15.0	ns
		OE to B; no external load [2]	1.0	19.8	1.0	15.3	1.0	14.5	1.0	13.5	ns
		OE to A	-	125	-	125	-	125	-	125	ns
		OE to B	-	150	-	105	-	150	-	105	ns
t <sub>t</sub>	transition time	A port	0.8	6.2	0.8	6.1	0.8	6.1	0.8	6.1	ns
		B port	0.9	5.8	0.6	5.2	0.5	4.8	0.4	4.7	ns
t <sub>sk(o)</sub>	output skew time	between channels [3]	-	0.5	-	0.5	-	0.5	-	0.5	ns
t <sub>W</sub>	pulse width	data inputs	22	-	19	-	19	-	19	-	ns
f <sub>data</sub>	data rate		-	45	-	55	-	55	-	55	Mbps

## Dual supply translating transceiver; auto direction sensing; 3-state

Symbol [1]	Parameter	Conditions	$V_{CC(B)}$								Unit
			$1.8\text{ V} \pm 0.15\text{ V}$		$2.5\text{ V} \pm 0.2\text{ V}$		$3.3\text{ V} \pm 0.3\text{ V}$		$5.0\text{ V} \pm 0.5\text{ V}$		
			Min	Max	Min	Max	Min	Max	Min	Max	
<b><math>V_{CC(A)} = 2.5\text{ V} \pm 0.2\text{ V}</math></b>											
$t_{pd}$	propagation delay	A to B	-	-	1.1	9.3	1.0	8.2	0.9	7.7	ns
		B to A	-	-	1.2	9.6	1.1	8.1	0.9	7.4	ns
$t_{en}$	enable time	OE to A, B	-	-	-	1.0	-	1.0	-	1.0	$\mu\text{s}$
$t_{dis}$	disable time	OE to A; no external load [2]	-	-	1.0	10.1	1.0	10.1	1.0	10.1	ns
		OE to B; no external load [2]	-	-	1.0	13.5	1.0	12.7	1.0	11.7	ns
		OE to A	-	-	-	85	-	85	-	85	ns
		OE to B	-	-	-	105	-	150	-	100	ns
$t_t$	transition time	A port	-	-	0.7	5.0	0.7	5.0	0.7	5.0	ns
		B port	-	-	0.7	4.6	0.5	4.8	0.4	4.7	ns
$t_{sk(o)}$	output skew time	between channels [3]	-	-	-	0.5	-	0.5	-	0.5	ns
$t_W$	pulse width	data inputs	-	-	14	-	13	-	10	-	ns
$f_{data}$	data rate		-	-	-	75	-	80	-	100	Mbps
<b><math>V_{CC(A)} = 3.3\text{ V} \pm 0.3\text{ V}</math></b>											
$t_{pd}$	propagation delay	A to B	-	-	-	-	0.9	7.7	0.8	7.0	ns
		B to A	-	-	-	-	1.0	7.9	0.9	6.8	ns
$t_{en}$	enable time	OE to A, B	-	-	-	-	-	1.0	-	1.0	$\mu\text{s}$
$t_{dis}$	disable time	OE to A; no external load [2]	-	-	-	-	1.0	9.9	1.0	9.9	ns
		OE to B; no external load [2]	-	-	-	-	1.0	12.1	1.0	10.9	ns
		OE to A	-	-	-	-	-	125	-	125	ns
		OE to B	-	-	-	-	-	150	-	100	ns
$t_t$	transition time	A port	-	-	-	-	0.7	4.5	0.7	4.5	ns
		B port	-	-	-	-	0.5	4.1	0.4	4.7	ns
$t_{sk(o)}$	output skew time	between channels [3]	-	-	-	-	-	0.5	-	0.5	ns
$t_W$	pulse width	data inputs	-	-	-	-	10	-	10	-	ns
$f_{data}$	data rate		-	-	-	-	-	100	-	100	Mbps

[1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ ;  $t_{en}$  is the same as  $t_{PZL}$  and  $t_{PZH}$ ;  $t_{dis}$  is the same as  $t_{PLZ}$  and  $t_{PHZ}$ ;  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$

[2] Delay between OE going LOW and when the outputs are actually disabled.

[3] Skew between any two outputs of the same package switching in the same direction.

**Table 13. Typical power dissipation capacitance**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 8. [1] [2]

Symbol	Parameter	Conditions	V <sub>CC(A)</sub>							Unit	
			1.2 V	1.2 V	1.5 V	1.8 V	2.5 V	2.5 V	3.3 V		
			V <sub>CC(B)</sub>								
			1.8 V	5.0 V	1.8 V	1.8 V	2.5 V	5.0 V	3.3 V to 5.0 V		
<b>T<sub>amb</sub> = 25 °C</b>											
C <sub>PD</sub>	power dissipation capacitance	outputs enabled; OE = V <sub>CC(A)</sub>									
		A port: (direction A to B)	6	5	6	6	6	5	5	pF	
		A port: (direction B to A)	8	8	8	8	8	8	8	pF	
		B port: (direction A to B)	26	30	26	26	27	30	30	pF	
		B port: (direction B to A)	23	28	22	22	22	26	26	pF	
		outputs disabled; OE = GND									
		A port: (direction A to B)	0.05	0.05	0.05	0.09	0.08	0.08	0.06	pF	
		A port: (direction B to A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	pF	
		B port: (direction A to B)	0.00	0.02	0.00	0.00	0.00	0.00	0.00	pF	
		B port: (direction B to A)	0.06	0.09	0.06	0.06	0.06	0.07	0.07	pF	

[1] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).

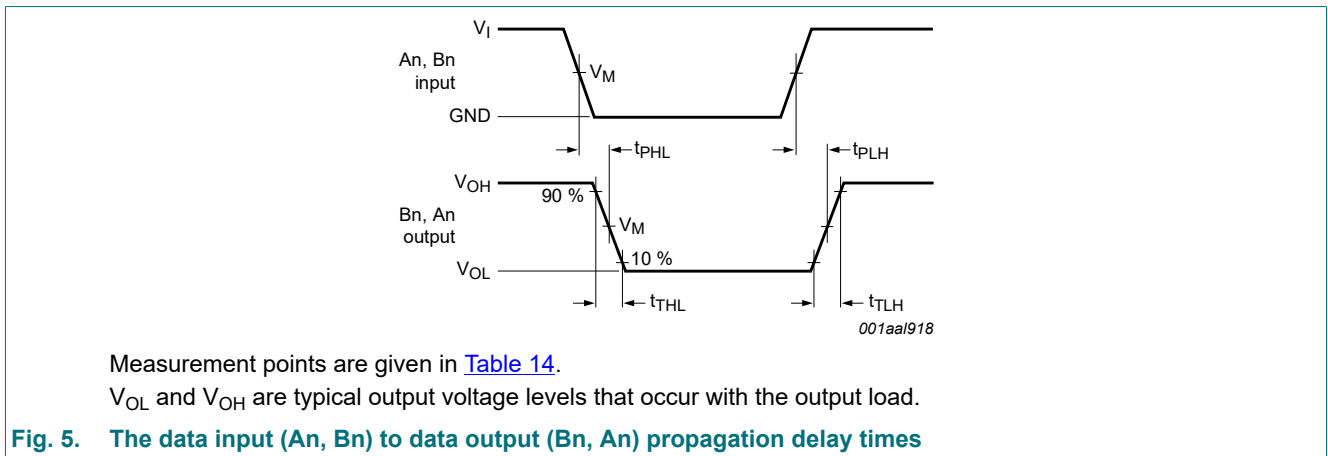
$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz; f<sub>o</sub> = output frequency in MHz; C<sub>L</sub> = load capacitance in pF;

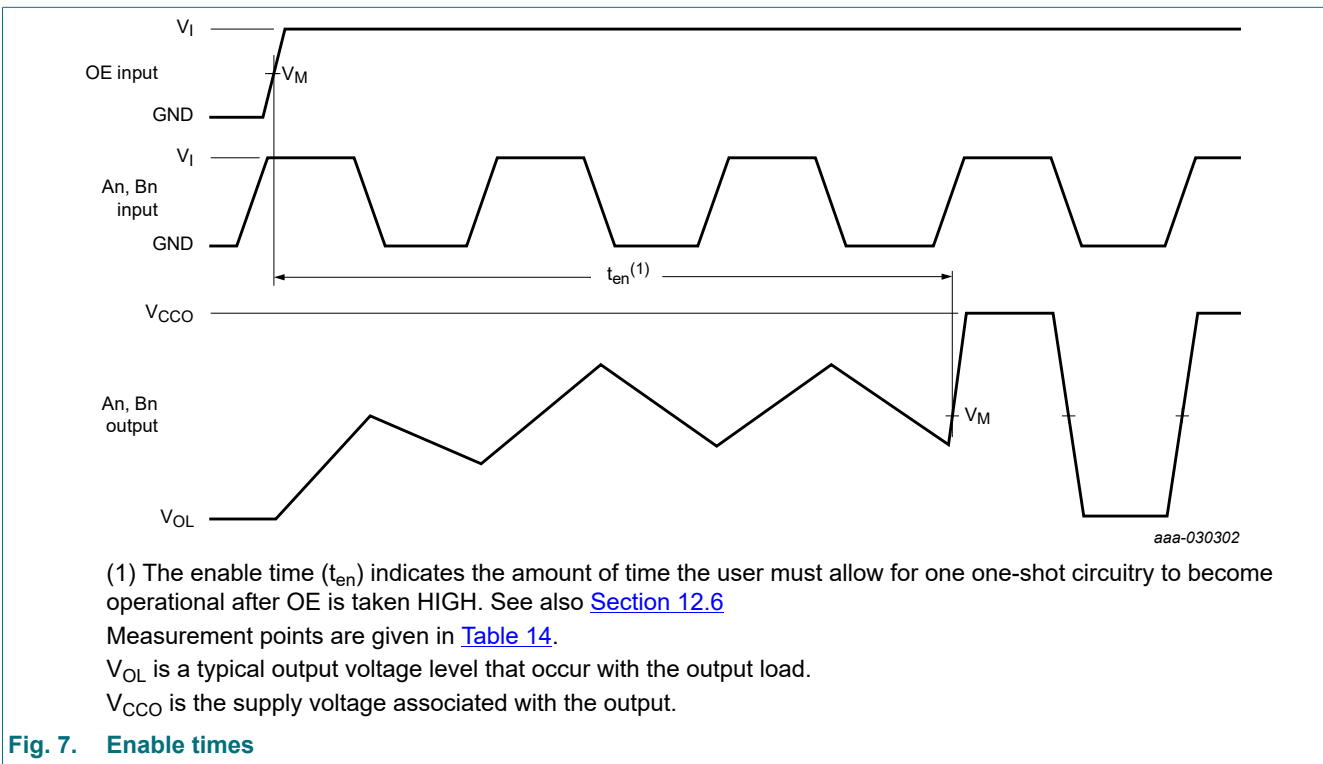
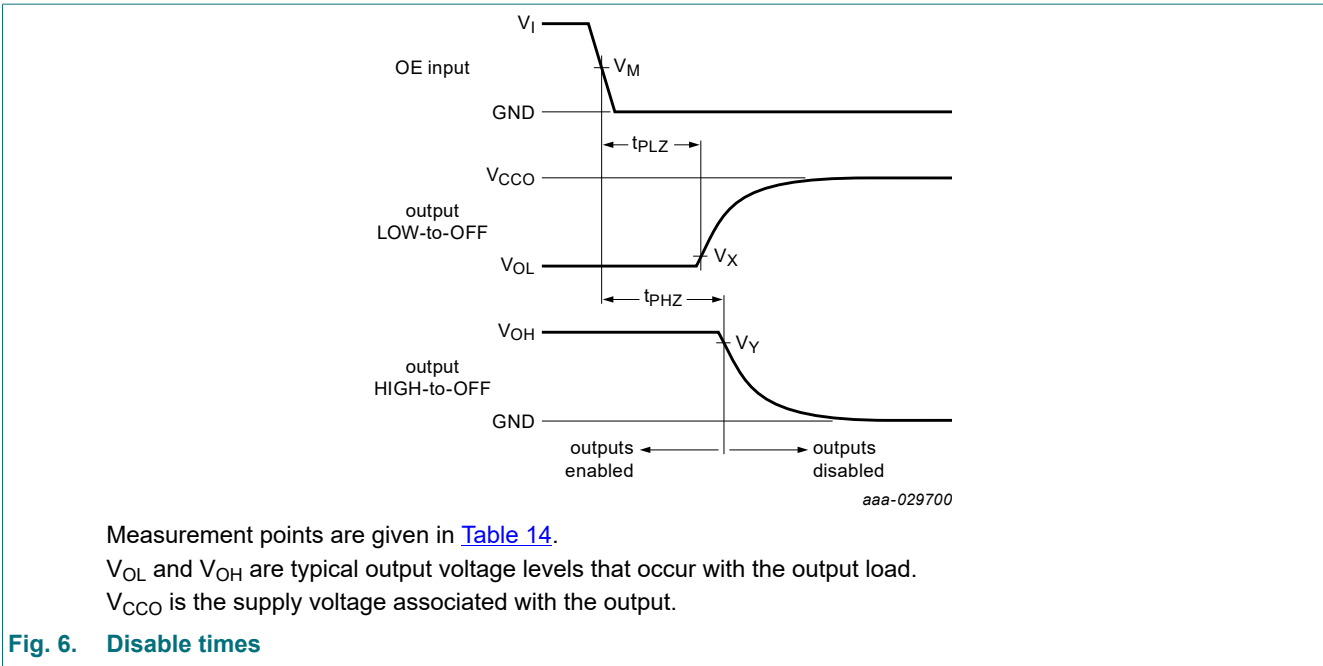
V<sub>CC</sub> = supply voltage in V; N = number of inputs switching;  $\sum(C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.

[2] f<sub>i</sub> = 10 MHz; V<sub>I</sub> = GND to V<sub>CC</sub>; t<sub>r</sub> = t<sub>f</sub> = 1 ns; C<sub>L</sub> = 0 pF; R<sub>L</sub> = ∞ Ω.

### 11.1. Waveforms and test circuit



Dual supply translating transceiver; auto direction sensing; 3-state



Dual supply translating transceiver; auto direction sensing; 3-state

Table 14. Measurement points [1]

Supply voltage	Input	Output		
$V_{CCO}$	$V_M$	$V_M$	$V_X$	$V_Y$
1.2 V	$0.5V_{CCI}$	$0.5V_{CCO}$	$V_{OL} + 0.1 V$	$V_{OH} - 0.1 V$
$1.5 V \pm 0.1 V$	$0.5V_{CCI}$	$0.5V_{CCO}$	$V_{OL} + 0.1 V$	$V_{OH} - 0.1 V$
$1.8 V \pm 0.15 V$	$0.5V_{CCI}$	$0.5V_{CCO}$	$V_{OL} + 0.15 V$	$V_{OH} - 0.15 V$
$2.5 V \pm 0.2 V$	$0.5V_{CCI}$	$0.5V_{CCO}$	$V_{OL} + 0.15 V$	$V_{OH} - 0.15 V$
$3.3 V \pm 0.3 V$	$0.5V_{CCI}$	$0.5V_{CCO}$	$V_{OL} + 0.3 V$	$V_{OH} - 0.3 V$
$5.0 V \pm 0.5 V$	$0.5V_{CCI}$	$0.5V_{CCO}$	$V_{OL} + 0.3 V$	$V_{OH} - 0.3 V$

[1]  $V_{CCI}$  is the supply voltage associated with the input and  $V_{CCO}$  is the supply voltage associated with the output.

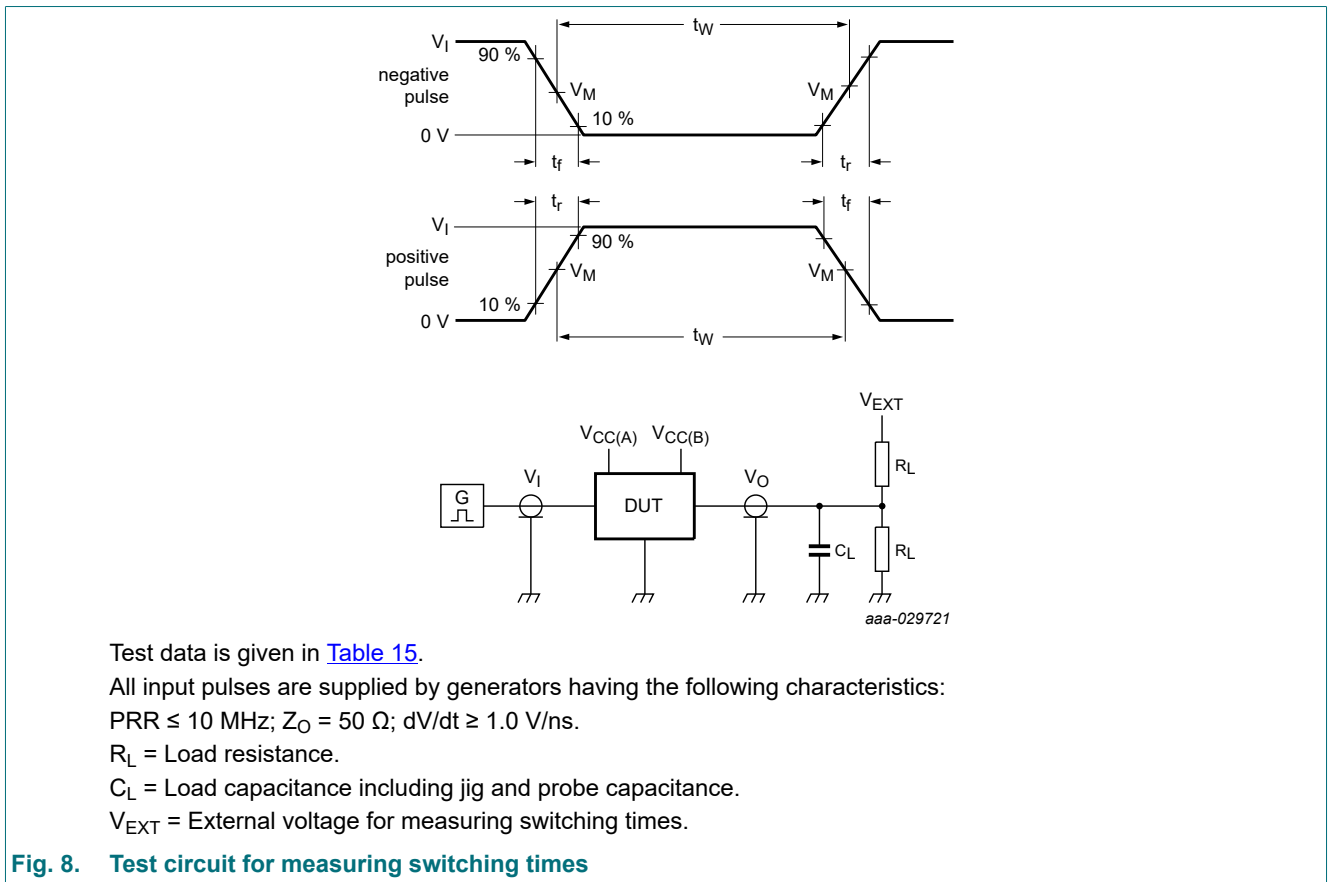


Table 15. Test data

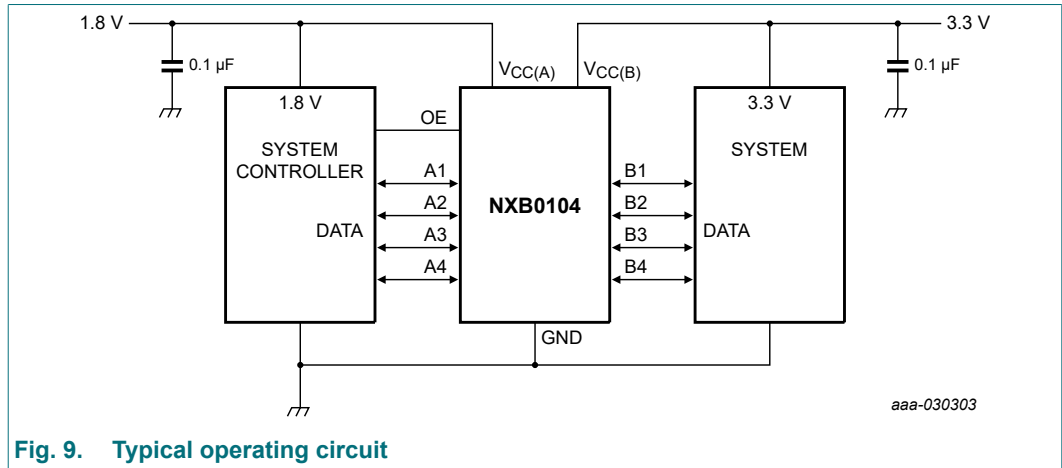
Supply voltage		Input		Load		$V_{EXT}$			
$V_{CC(A)}$	$V_{CC(B)}$	$V_I$ [1]	$\Delta t/\Delta V$	$C_L$	$R_L$ [2]	$t_{PLH}$ , $t_{PHL}$	$t_{en}$	$t_{PHZ}$	$t_{PLZ}$ [3]
1.2 V to 3.6 V	1.65 V to 5.5 V	$V_{CCI}$	$\leq 1.0 \text{ ns/V}$	15 pF	50 kΩ, 1 MΩ	open	open	open	$2V_{CCO}$

- [1]  $V_{CCI}$  is the supply voltage associated with the input.
- [2] For measuring data rate, pulse width, propagation delay, output rise and fall time and enable time,  $R_L = 1 \text{ M}\Omega$ .  
For measuring disable time,  $R_L = 50 \text{ k}\Omega$ .
- [3]  $V_{CCO}$  is the supply voltage associated with the output.

## 12. Application information

### 12.1. Voltage level-translation applications

The NXB0104 can be used to interface between devices or systems operating at different supply voltages. See [Fig. 9](#) for a typical operating circuit using the NXB0104.



**Fig. 9.** Typical operating circuit

### 12.2. Architecture

The architecture of the NXB0104 is shown in [Fig. 10](#). The device does not require an extra input signal to control the direction of data flow from A to B or from B to A. In a static state, the output drivers of the NXB0104 can maintain a defined output level, but the output architecture is designed to be weak, so that they can be overdriven by an external driver when data on the bus starts flowing in the opposite direction. The output one shots detect rising or falling edges on the A or B ports. During a rising edge, the one shots turn on the PMOS transistors (T1, T3) for a short duration, accelerating the low-to-high transition. Similarly, during a falling edge, the one shots turn on the NMOS transistors (T2, T4) for a short duration, accelerating the high-to-low transition. During output transitions the typical output impedance is 70  $\Omega$  at  $V_{CCO} = 1.2\text{ V}$  to 1.8 V, 50  $\Omega$  at  $V_{CCO} = 1.8\text{ V}$  to 3.3 V and 40  $\Omega$  at  $V_{CCO} = 3.3\text{ V}$  to 5.0 V.

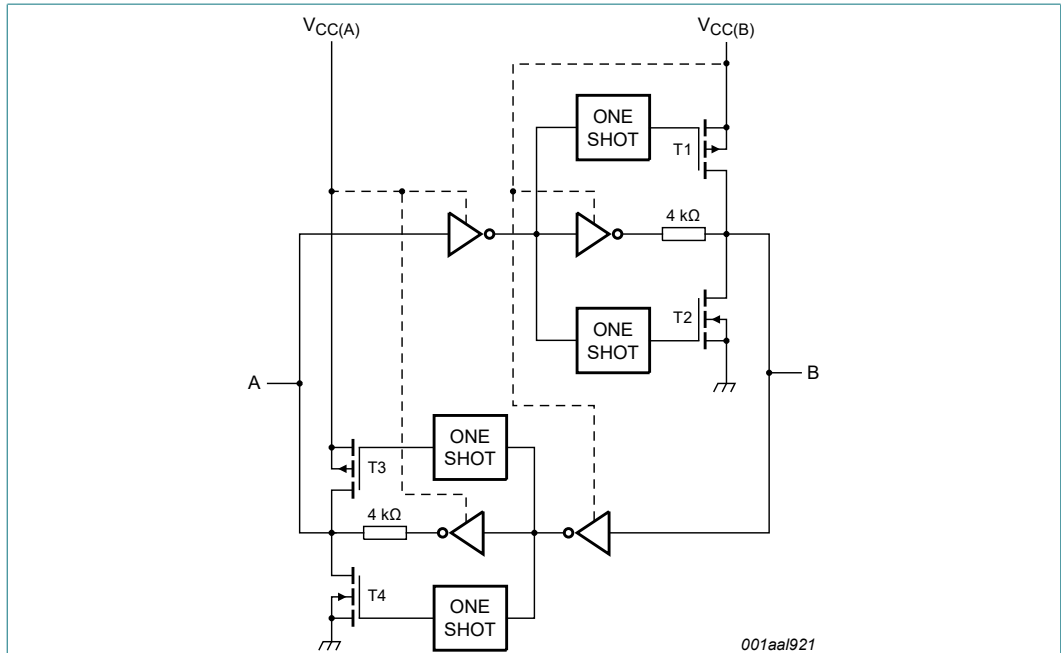
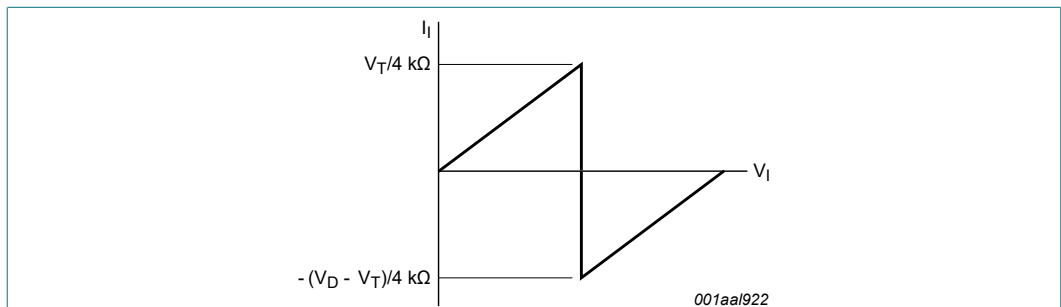


Fig. 10. Architecture of NXB0104 I/O cell (one channel)

### 12.3. Input driver requirements

For correct operation, the device driving the data I/Os of the NXB0104 must have a minimum drive capability of  $\pm 2$  mA. See Fig. 11 for a plot of typical input current versus input voltage.



$V_T$ : input threshold voltage of the NXB0104 (typically  $V_{CC1} / 2$ ).  
 $V_D$ : supply voltage of the external driver.

Fig. 11. Typical input current versus input voltage graph

### 12.4. Output load considerations

The maximum lumped capacitive load that can be driven is dependant upon the one-shot pulse duration. In cases with very heavy capacitive loading there is a risk that the output will not reach the positive rail within the one-shot pulse duration. To avoid excessive capacitive loading and to ensure correct triggering of the one-shot it's recommended to use short trace lengths and low capacitance connectors on NXB0104 PCB layouts. To ensure low impedance termination and avoid output signal oscillations and one-shot re-triggering, the length of the PCB trace should be such that the round trip delay of any reflection is within the one-shot pulse duration.

## 12.5. Power up

During operation  $V_{CC(A)}$  must never be higher than  $V_{CC(B)}$ , however during power-up  $V_{CC(A)} \geq V_{CC(B)}$  does not damage the device, so either power supply can be ramped up first. There is no special power-up sequencing required. The NXB0104 includes circuitry that disables all output ports when either  $V_{CC(A)}$  or  $V_{CC(B)}$  is switched off.

## 12.6. Enable and disable

An output enable input (OE) is used to disable the device. Setting OE = LOW causes all I/Os to assume the high-impedance OFF-state. The disable time ( $t_{dis}$  with no external load) indicates the delay between when OE goes LOW and when outputs actually become disabled. The enable time ( $t_{en}$ ) indicates the amount of time the user must allow for one one-shot circuitry to become operational after OE is taken HIGH. To ensure the high-impedance OFF-state during power-up or power-down, pin OE should be tied to GND through a pull-down resistor, the minimum value of the resistor is determined by the current-sourcing capability of the driver.

## 12.7. Pull-up or pull-down resistors on I/O lines

As mentioned previously the NXB0104 is designed with low static drive strength to drive capacitive loads of up to 70 pF. To avoid output contention issues, any pull-up or pull-down resistors used must be kept higher than 50 k $\Omega$ . For this reason the NXB0104 is not recommended for use in open drain driver applications such as 1-Wire or I<sup>2</sup>C. For these applications, the NXS0104 level translator is recommended.

### 13. Package outline

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

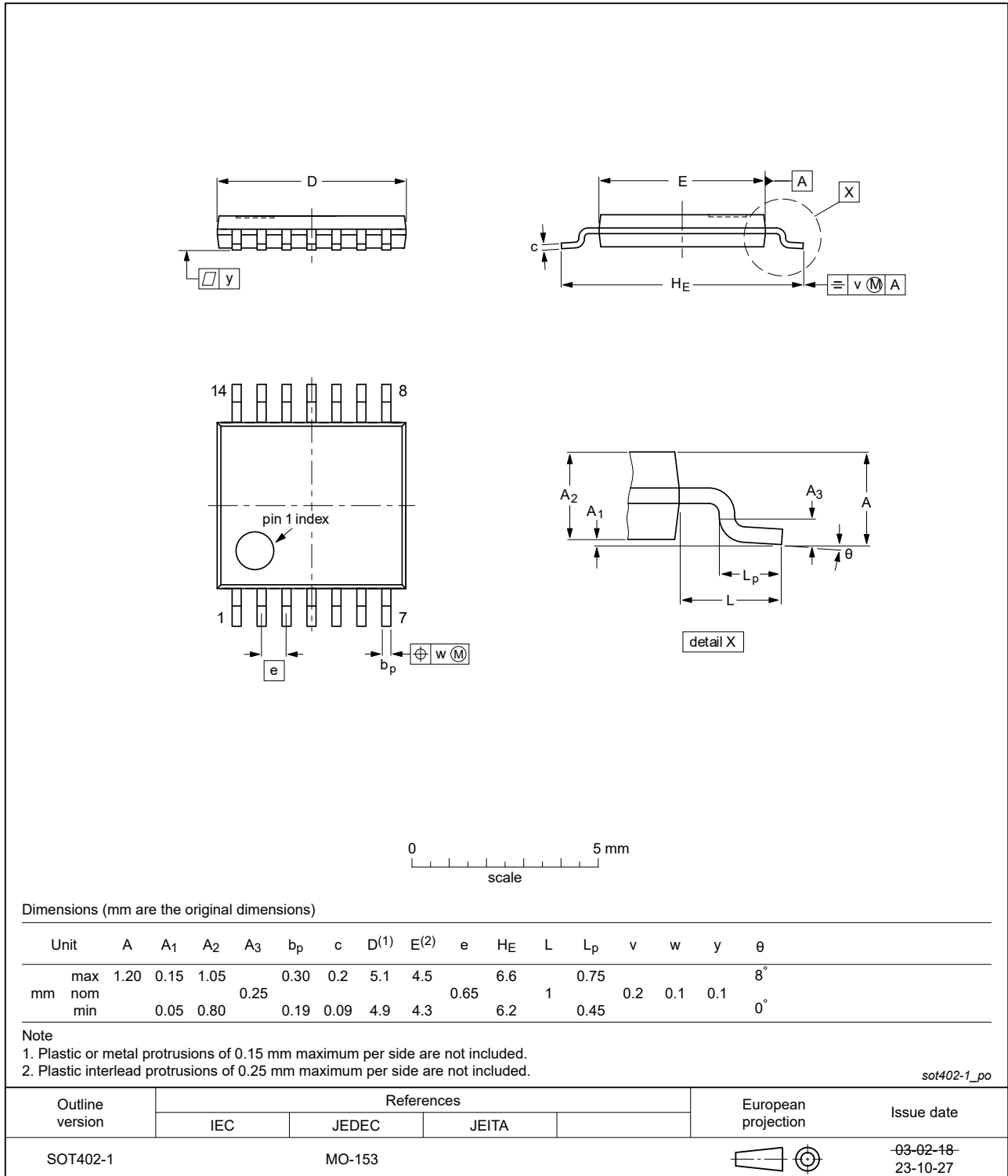


Fig. 12. Package outline SOT402-1 (TSSOP14)

Dual supply translating transceiver; auto direction sensing; 3-state

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

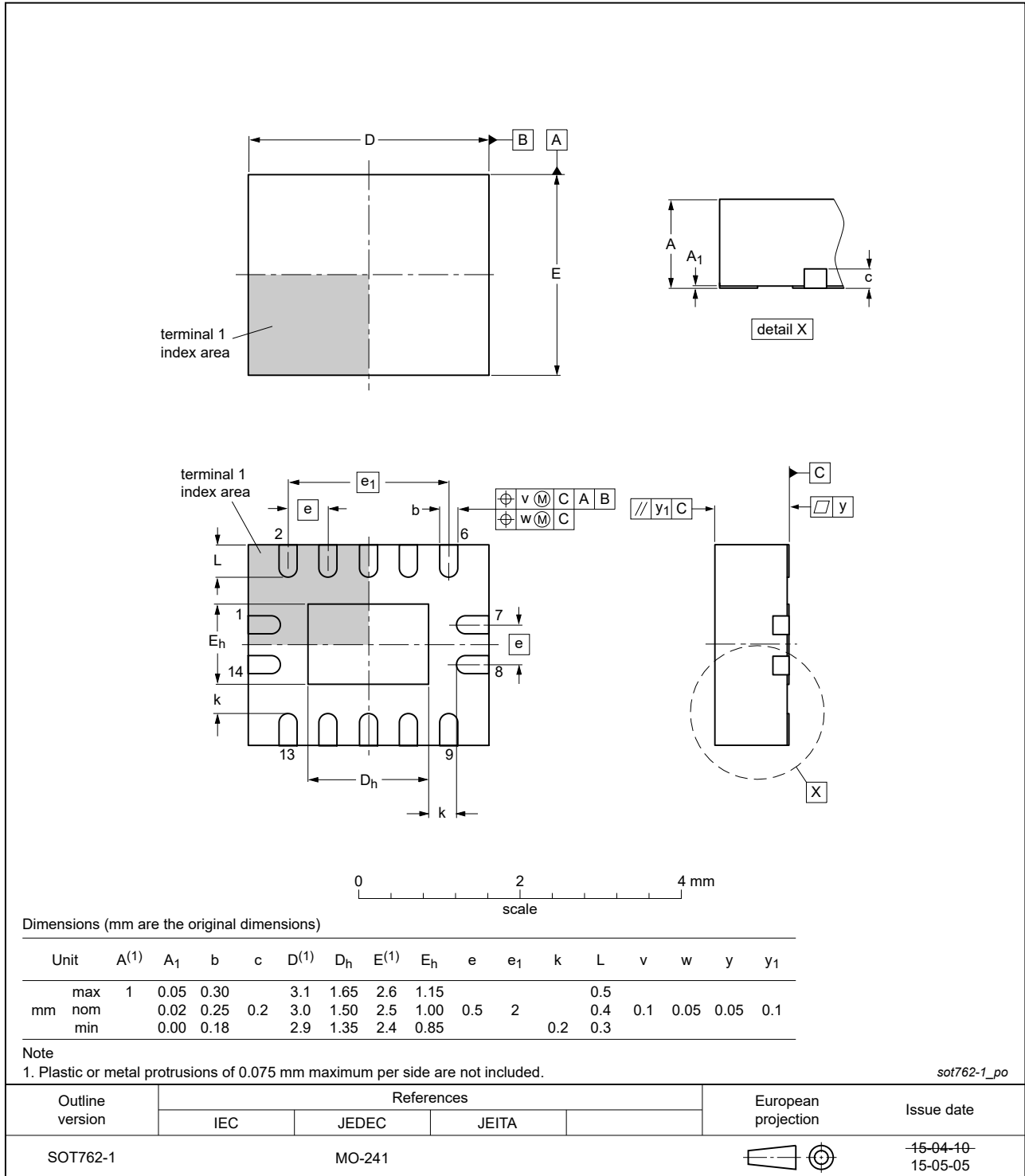


Fig. 13. Package outline SOT762-1 (DHVQFN14)

XQFN12: plastic, extremely thin quad flat package; no leads;  
12 terminals; body 1.70 x 2.00 x 0.50 mm

SOT1174-1

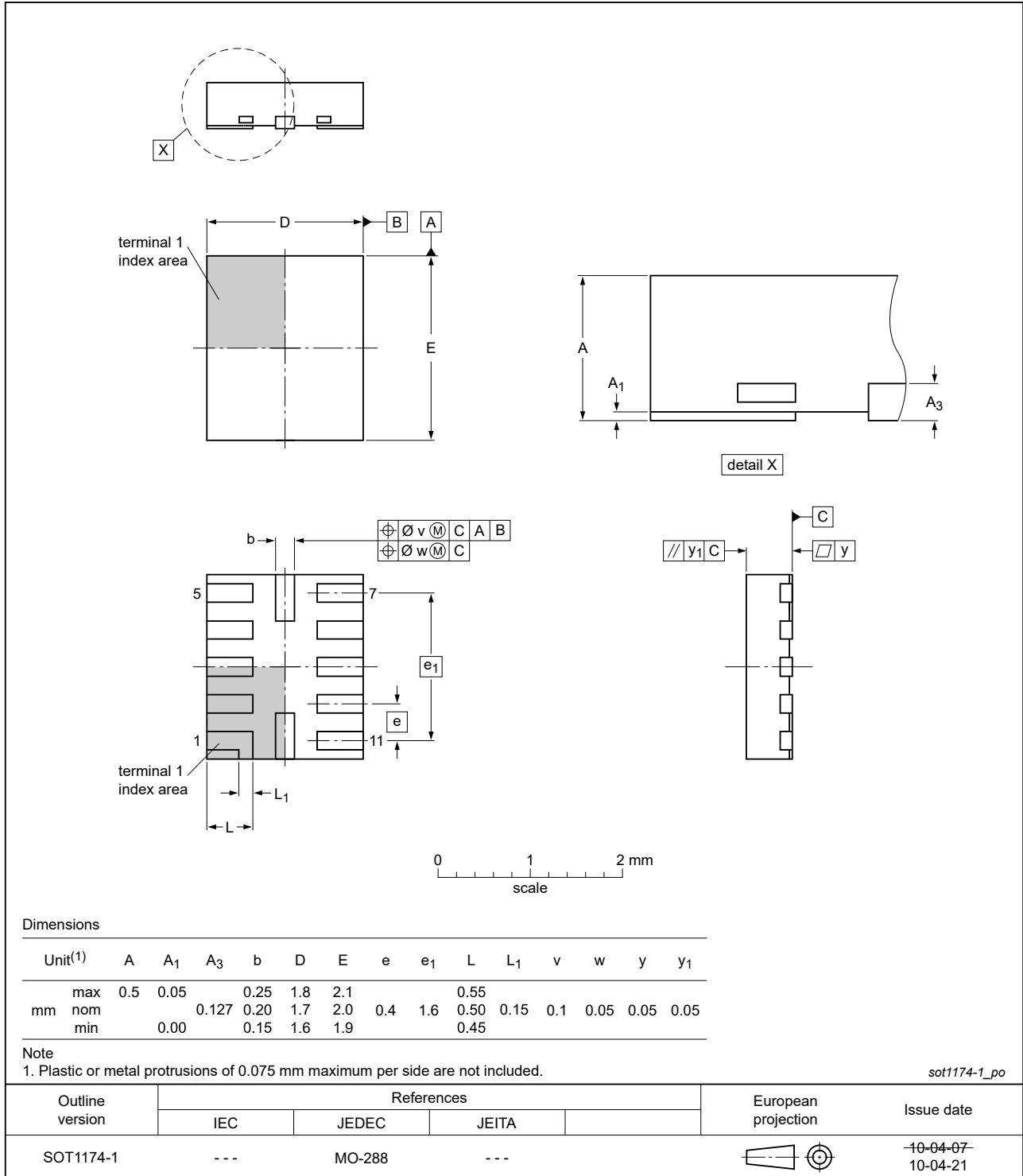


Fig. 14. Package outline SOT1174-1 (XQFN12)

## 14. Abbreviations

Table 16. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	Electro Static Discharge
HBM	Human Body Model

## 15. Revision history

Table 17. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NXB0104 v.4	20240404	Product data sheet	-	NXB0104 v.3
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Fig. 12</a>: Aligned TSSOP package outline drawing to JEDEC MO-153.</li> <li><a href="#">Section 2</a>: ESD specification updated according to the latest JEDEC standard.</li> </ul>			
NXB0104 v.3	20201113	Product data sheet	-	NXB0104 v.2
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Table 11</a> and <a href="#">Table 12</a>: Disable times updated.</li> </ul>			
NXB0104 v.2	20200729	Product data sheet	-	NXB0104 v.1
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Table 5</a>: Values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
NXB0104 v.1	20190911	Product data sheet	-	-

## 16. 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.
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