

NXB0104-Q100

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

Rev. 4 — 2 May 2022

Product data sheet

1. General description

The NXB0104-Q100 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.

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

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- 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 2.5 kV for A port
 - HBM: ANSI/ESDA/Jedec JS-001 Class 3B exceeds 15 kV for B port
 - CDM: ANSI/ESDA/Jedec JS-002 Class C3 exceeds 1.5 kV
 - MIL-STD-883, method 3015 Class 2 exceeds 2.5 kV for A port
 - MIL-STD-883, method 3015 Class 3B exceeds 15 kV for B port
- Latch-up performance exceeds 100 mA per JESD 78B Class II
- Multiple package options
- DHVQFN package with Side-Wettable Flanks enabling Automatic Optical Inspection (AOI) of solder joints

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|----------------------------------|-------------------|----------|--|---------------------------|
| | Temperature range | Name | Description | Version |
| NXB0104PW-Q100 | -40 °C to +125 °C | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |
| NXB0104BQ-Q100 | -40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm | SOT762-1 |
| NXB0104GU12-Q100 | -40 °C to +125 °C | XQFN12 | plastic, extremely thin quad flat package; no leads; 12 terminals; body 1.70 × 2.0 × 0.50 mm | SOT1174-1 |

4. Marking

Table 2. Marking

| Type number | Marking code |
|------------------|--------------|
| NXB0104PW-Q100 | NXB0104 |
| NXB0104BQ-Q100 | B0104 |
| NXB0104GU12-Q100 | n4 |

5. Functional diagram

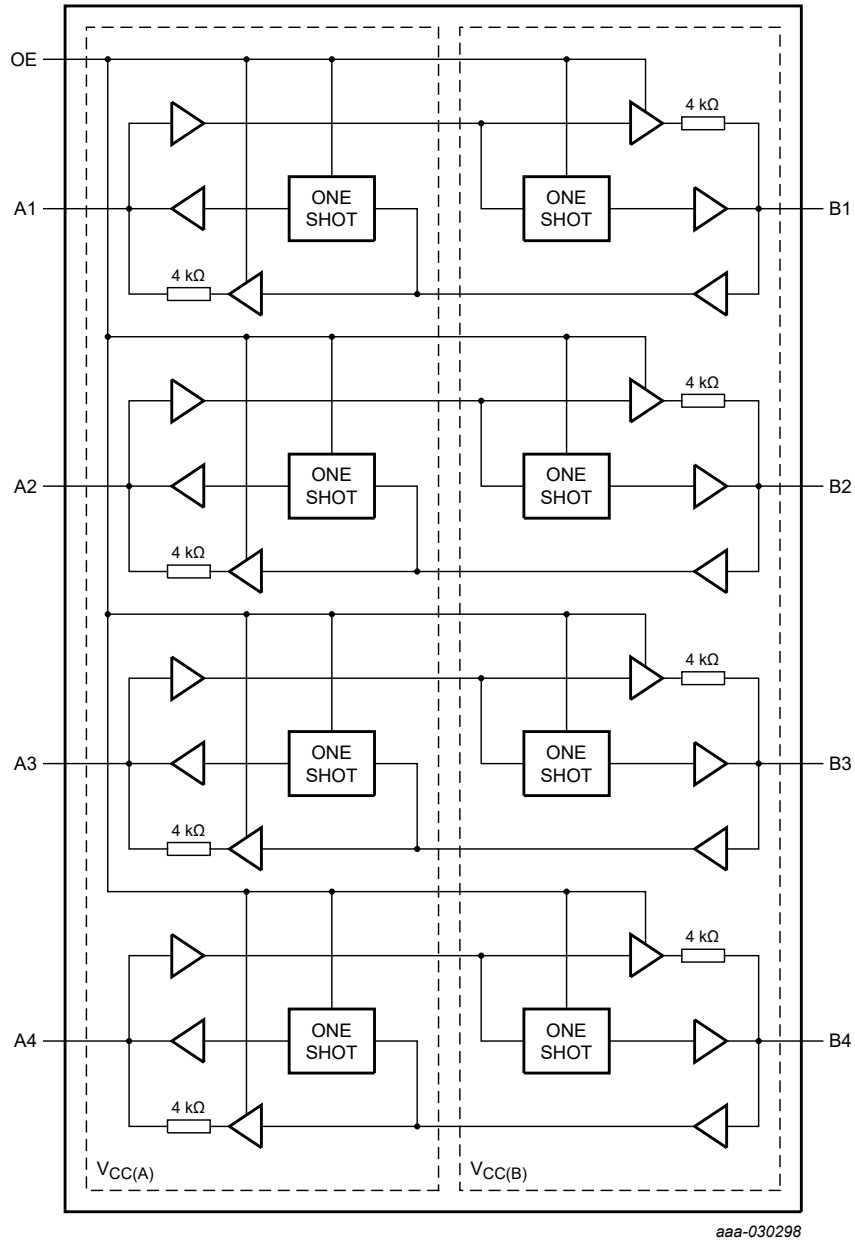


Fig. 1. Logic symbol

6. Pinning information

6.1. Pinning

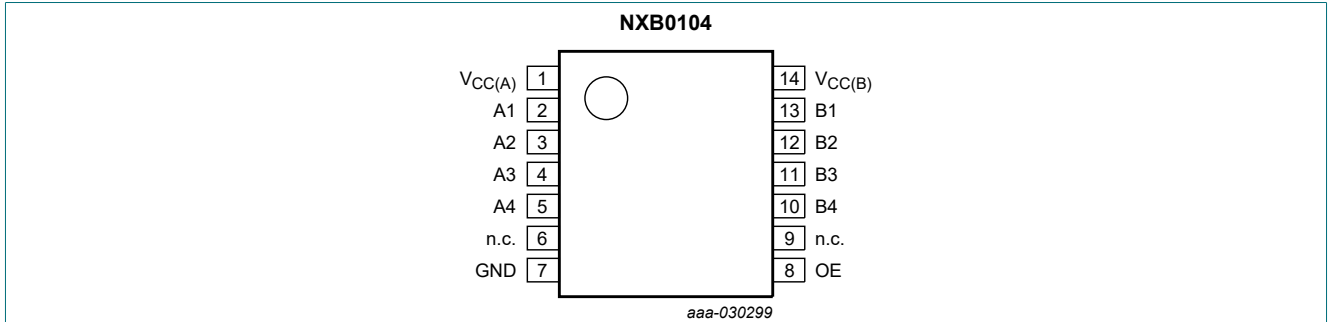


Fig. 2. Pin configuration SOT402-1 (TSSOP14)

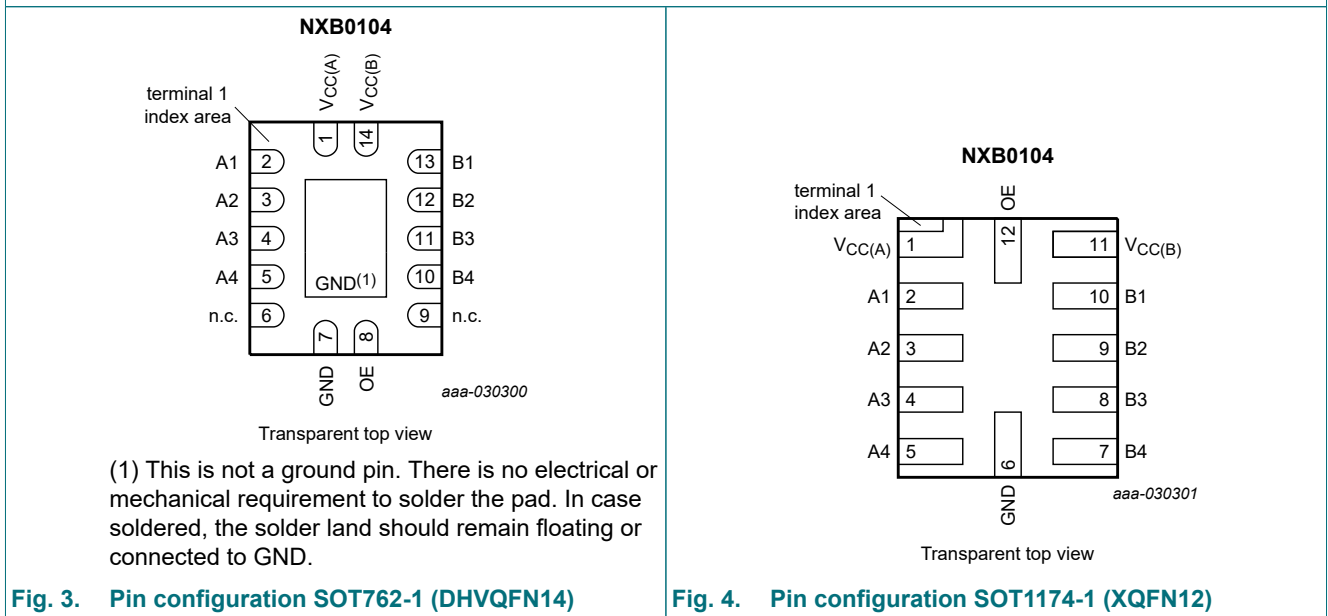


Fig. 3. Pin configuration SOT762-1 (DHVQFN14)

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 _{CC} (A) | 1 | 1 | supply voltage A |
| A1, A2, A3, A4 | 2, 3, 4, 5 | 2, 3, 4, 5 | data input or output (referenced to V _{CC} (A)) |
| n.c. | 6, 9 | - | not connected |
| GND | 7 | 6 | ground (0 V) |
| OE | 8 | 12 | output enable input (active HIGH; referenced to V _{CC} (A)) |
| B4, B3, B2, B1 | 10, 11, 12, 13 | 7, 8, 9, 10 | data input or output (referenced to V _{CC} (B)) |
| V _{CC} (B) | 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 | |
|-----------------|-----------------|-------|-----------------|-----------------|
| $V_{CC(A)}$ [1] | $V_{CC(B)}$ | 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] $V_{CC(A)}$ must be less than or equal to $V_{CC(B)}$.

[2] When either $V_{CC(A)}$ or $V_{CC(B)}$ 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 |
|-------------|-------------------------|--|------|-----------------|------|
| $V_{CC(A)}$ | supply voltage A | | -0.5 | +6.5 | V |
| $V_{CC(B)}$ | supply voltage B | | -0.5 | +6.5 | V |
| V_I | 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 | $V_{CCI} + 0.5$ | V |
| V_O | 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 | $V_{CCO} + 0.5$ | V |
| I_{IK} | input clamping current | $V_I < 0$ V | -50 | - | mA |
| I_{OK} | output clamping current | $V_O < 0$ V | -50 | - | mA |
| I_O | output current | $V_O = 0$ V to V_{CCO} [4] | - | ± 50 | mA |
| I_{CC} | supply current | $I_{CC(A)}$ or $I_{CC(B)}$ | - | 100 | mA |
| I_{GND} | ground current | | -100 | - | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40$ °C to +125 °C | | | |
| | | SOT402-1 (TSSOP14) and SOT762-1 (DHFQFN14) 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_{CCI} is the supply voltage associated with the input.

[3] $V_{CCI} + 0.5$ V or $V_{CCO} + 0.5$ V should not exceed 6.5 V.

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

[5] For SOT402-1 (TSSOP14) package: P_{tot} derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHFQFN14) package: P_{tot} 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; $V_{CC(A)} = 1.2\text{ V}; I_O = -20\ \mu\text{A}$ | - | 1.1 | - | V |
| V_{OL} | LOW-level output voltage | A port; $V_{CC(A)} = 1.2\text{ V}; I_O = 20\ \mu\text{A}$ | - | 0.09 | - | V |
| I_I | input leakage current | OE input; $V_I = 0\text{ V to }3.6\text{ V}; V_{CC(A)} = 1.2\text{ V to }3.6\text{ V};$ $V_{CC(B)} = 1.65\text{ V to }5.5\text{ V}$ | - | - | ± 1 | μA |
| 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 $V_O = 0\text{ V to }5.5\text{ V};$ | - | - | ± 1 | μA |
| I_{OFF} | power-off leakage current | A port; V_I or $V_O = 0\text{ V to }3.6\text{ V}; V_{CC(A)} = 0\text{ V};$ $V_{CC(B)} = 0\text{ V to }5.5\text{ V}$ | - | - | ± 1 | μA |
| | | B port; V_I or $V_O = 0\text{ V to }5.5\text{ V}; V_{CC(B)} = 0\text{ V};$ $V_{CC(A)} = 0\text{ V to }3.6\text{ V}$ | - | - | ± 1 | μA |

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|------------------|--------------------------|--|-----|------|-----|------|
| I _{CC} | supply current | V _I = 0 V or V _{CC(I)} ; I _O = 0 A [3] | | | | |
| | | I _{CC(A)} ; V _{CC(A)} = 1.2 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 0.05 | - | μA |
| | | I _{CC(B)} ; V _{CC(A)} = 1.2 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 3.3 | - | μA |
| | | I _{CC(A)} + I _{CC(B)} ; V _{CC(A)} = 1.2 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 3.5 | - | μA |
| C _I | input capacitance | OE input; V _{CC(A)} = 1.2 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 2.8 | - | pF |
| C _{I/O} | input/output capacitance | A port; V _{CC(A)} = 1.2 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 4.0 | - | pF |
| | | B port; V _{CC(A)} = 1.2 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 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 °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 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 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 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 0.35V _{CCI} | - | 0.35V _{CCI} | V |
| V _{OH} | HIGH-level output voltage | A or B port; I _O = -20 μA [3] | | | | | |
| | | A port; V _{CC(A)} = 1.4 V to 3.6 V | V _{CCO} - 0.4 | - | V _{CCO} - 0.4 | - | V |
| | | B port; V _{CC(B)} = 1.65 V to 5.5 V | V _{CCO} - 0.4 | - | V _{CCO} - 0.4 | - | V |
| V _{OL} | LOW-level output voltage | A or B port; I _O = 20 μA [3] | | | | | |
| | | A port; V _{CC(A)} = 1.4 V to 3.6 V | - | 0.4 | - | 0.4 | V |
| | | B port; V _{CC(B)} = 1.65 V to 5.5 V | - | 0.4 | - | 0.4 | V |
| I _I | input leakage current | OE input; V _I = 0 V to 3.6 V; V _{CC(A)} = 1.2 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | ±2 | - | ±5 | μA |
| I _{OZ} | OFF-state output current | OE = 0 V; A port: V _I or V _O = 0 V to 3.6 V; B port: V _I or V _O = 0 V to 5.5 V; [3] | - | ±2 | - | ±10 | μA |
| I _{OFF} | power-off leakage current | A port; V _I or V _O = 0 V to 3.6 V; V _{CC(A)} = 0 V; V _{CC(B)} = 0 V to 5.5 V | - | ±2 | - | ±10 | μA |
| | | B port; V _I or V _O = 0 V to 5.5 V; V _{CC(B)} = 0 V; V _{CC(A)} = 0 V to 3.6 V | - | ±2 | - | ±10 | μA |

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| Symbol | Parameter | Conditions | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|-----------------|----------------|---|------------------|-----|-------------------|-----|------|
| | | | Min | Max | Min | Max | |
| I _{CC} | supply current | V _I = 0 V or V _{CCI} ; I _O = 0 A [2] | | | | | |
| | | I _{CC(A)} | | | | | |
| | | OE = LOW; V _{CC(A)} = 1.4 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 5 | - | 15 | μA |
| | | OE = HIGH; V _{CC(A)} = 1.4 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 5 | - | 20 | μA |
| | | V _{CC(A)} = 3.6 V; V _{CC(B)} = 0 V | - | 2 | - | 15 | μA |
| | | V _{CC(A)} = 0 V; V _{CC(B)} = 5.5 V | - | -2 | - | -15 | μA |
| | | I _{CC(B)} | | | | | |
| | | OE = LOW; V _{CC(A)} = 1.4 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 5 | - | 15 | μA |
| | | OE = HIGH; V _{CC(A)} = 1.4 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 5 | - | 20 | μA |
| | | V _{CC(A)} = 3.6 V; V _{CC(B)} = 0 V | - | -2 | - | -15 | μA |
| | | V _{CC(A)} = 0 V; V _{CC(B)} = 5.5 V | - | 2 | - | 15 | μA |
| | | I _{CC(A)} + I _{CC(B)} | | | | | |
| | | V _{CC(A)} = 1.4 V to 3.6 V; V _{CC(B)} = 1.65 V to 5.5 V | - | 10 | - | 40 | μA |

- [1] V_{CC(A)} must be less than or equal to V_{CC(B)}.
- [2] V_{CCI} is the supply voltage associated with the input.
- [3] V_{CCO} 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 _{CC(B)} | | | | Unit |
|--|-------------------|-------------------------------|--------------------|-------|-------|-------|------|
| | | | 1.8 V | 2.5 V | 3.3 V | 5.0 V | |
| V _{CC(A)} = 1.2 V; T _{amb} = 25 °C | | | | | | | |
| t _{pd} | 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 _{en} | enable time | OE to A, B | 0.5 | 0.5 | 0.5 | 0.5 | μs |
| t _{dis} | 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 _t | 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 _{sk(o)} | output skew time | between channels [3] | 0.2 | 0.2 | 0.2 | 0.2 | ns |
| t _W | pulse width | data inputs | 15 | 13 | 13 | 13 | ns |
| f _{data} | data rate | | 70 | 80 | 80 | 80 | 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.

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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 _{CC(B)} | | | | | | | | 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 | |
| V_{CC(A)} = 1.5 V ± 0.1 V | | | | | | | | | | | |
| t _{pd} | 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 _{en} | enable time | OE to A, B | - | 1.0 | - | 1.0 | - | 1.0 | - | 1.0 | µs |
| t _{dis} | 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 _t | 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 _{sk(o)} | output skew time | between channels [3] | - | 0.5 | - | 0.5 | - | 0.5 | - | 0.5 | ns |
| t _W | pulse width | data inputs | 25 | - | 25 | - | 25 | - | 25 | - | ns |
| f _{data} | data rate | | - | 40 | - | 40 | - | 40 | - | 40 | Mbps |
| V_{CC(A)} = 1.8 V ± 0.15 V | | | | | | | | | | | |
| t _{pd} | 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 _{en} | enable time | OE to A, B | - | 1.0 | - | 1.0 | - | 1.0 | - | 1.0 | µs |
| t _{dis} | 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 _t | 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 _{sk(o)} | output skew time | between channels [3] | - | 0.5 | - | 0.5 | - | 0.5 | - | 0.5 | ns |
| t _W | pulse width | data inputs | 20 | - | 17 | - | 17 | - | 17 | - | ns |
| f _{data} | data rate | | - | 49 | - | 60 | - | 60 | - | 60 | Mbps |

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| Symbol [1] | Parameter | Conditions | V _{CC(B)} | | | | | | | | 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 | |
| V_{CC(A)} = 2.5 V ± 0.2 V | | | | | | | | | | | |
| 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 | µs |
| 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 |
| V_{CC(A)} = 3.3 V ± 0.3 V | | | | | | | | | | | |
| 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 | µs |
| 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 _{CC(B)} | | | | | | | | 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 | |
| V_{CC(A)} = 1.5 V ± 0.1 V | | | | | | | | | | | |
| t _{pd} | 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 _{en} | enable time | OE to A, B | - | 1.0 | - | 1.0 | - | 1.0 | - | 1.0 | µs |
| t _{dis} | 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 _t | 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 _{sk(o)} | output skew time | between channels [3] | - | 0.5 | - | 0.5 | - | 0.5 | - | 0.5 | ns |
| t _W | pulse width | data inputs | 25 | - | 25 | - | 25 | - | 25 | - | ns |
| f _{data} | data rate | | - | 40 | - | 40 | - | 40 | - | 40 | Mbps |
| V_{CC(A)} = 1.8 V ± 0.15 V | | | | | | | | | | | |
| t _{pd} | 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 _{en} | enable time | OE to A, B | - | 1.0 | - | 1.0 | - | 1.0 | - | 1.0 | µs |
| t _{dis} | 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 _t | 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 _{sk(o)} | output skew time | between channels [3] | - | 0.5 | - | 0.5 | - | 0.5 | - | 0.5 | ns |
| t _W | pulse width | data inputs | 22 | - | 19 | - | 19 | - | 19 | - | ns |
| f _{data} | 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 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 | |
| V_{CC(A)} = 2.5 V ± 0.2 V | | | | | | | | | | | |
| 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 | µs |
| 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 |
| V_{CC(A)} = 3.3 V ± 0.3 V | | | | | | | | | | | |
| 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 | µs |
| 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.

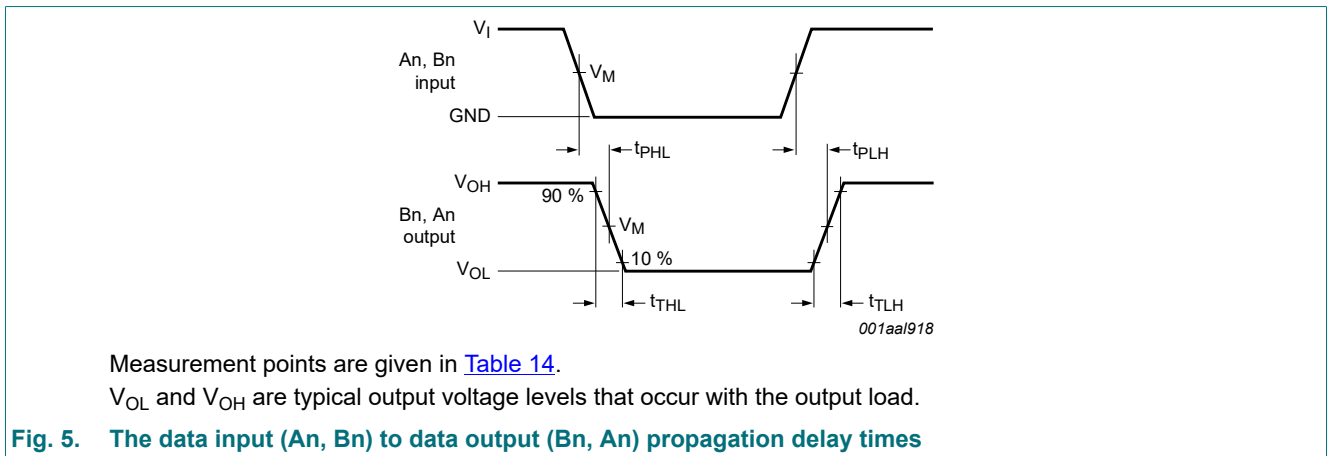
Table 13. Typical power dissipation capacitance

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

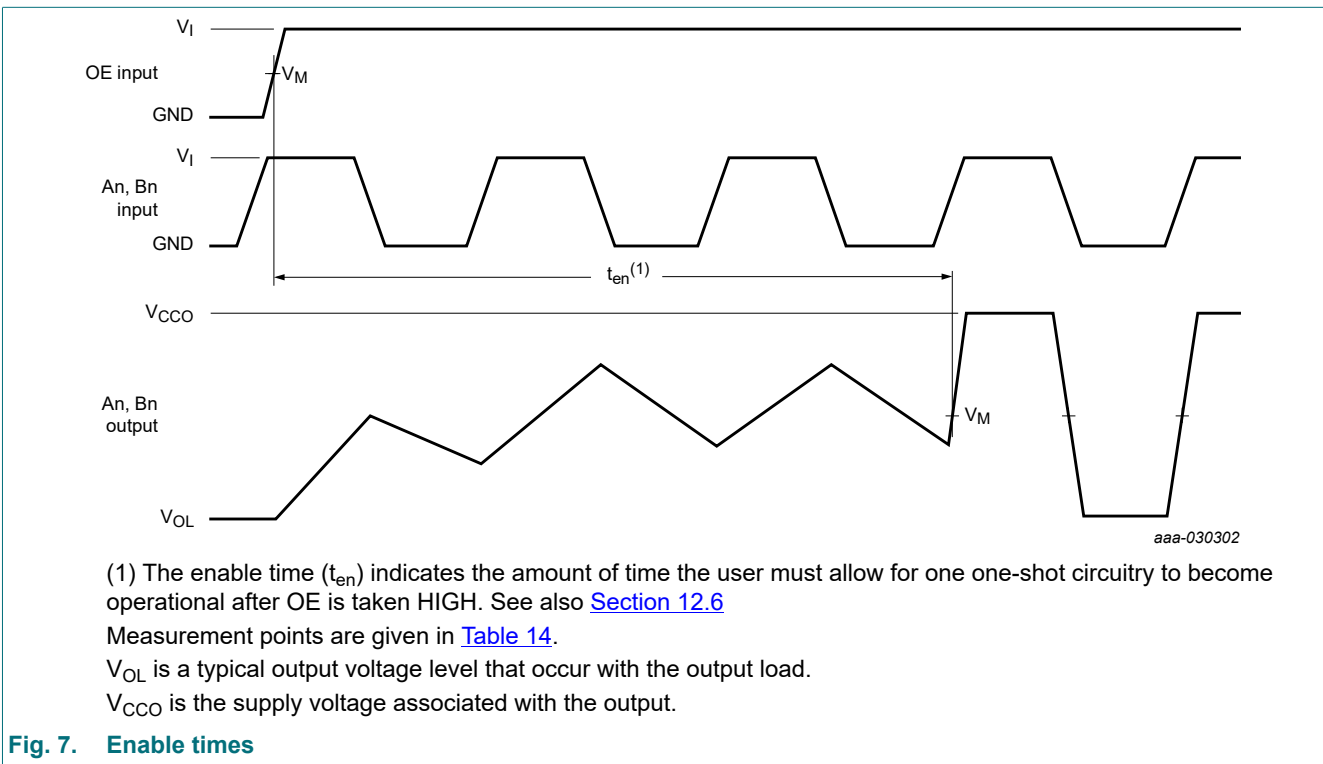
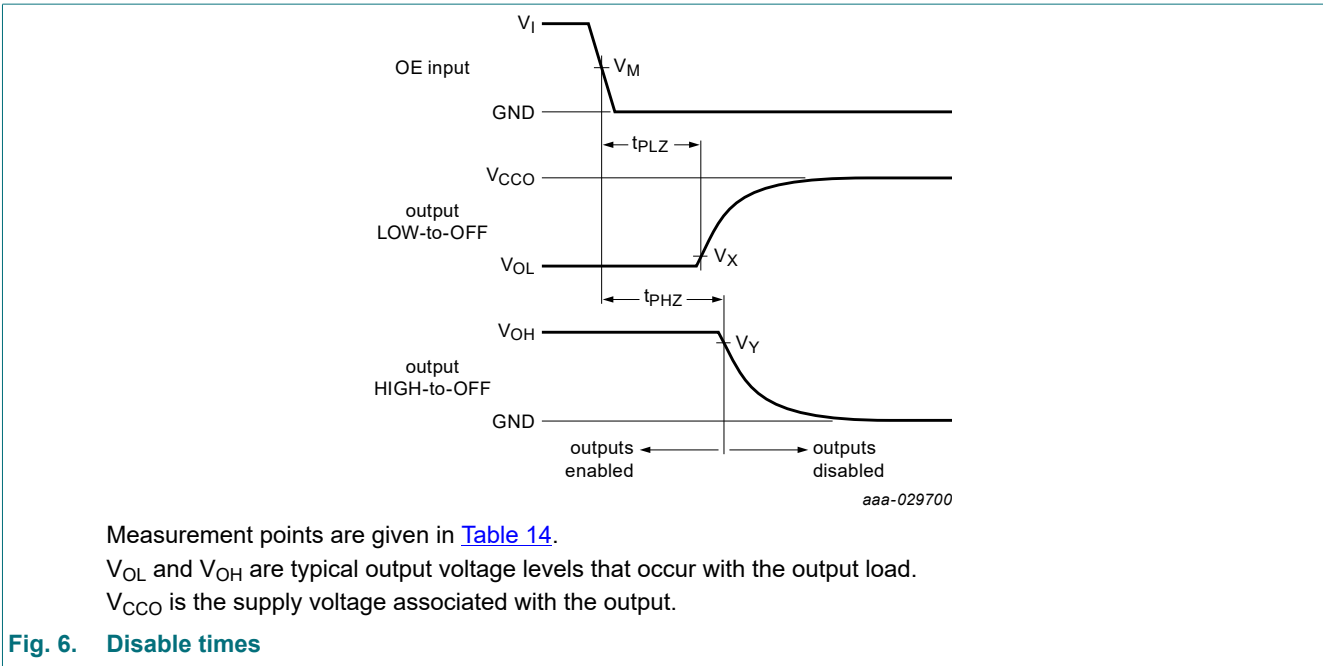
| Symbol | Parameter | Conditions | V _{CC(A)} | | | | | | | Unit | |
|--------------------------------|-------------------------------|--|--------------------|-------|-------|-------|-------|-------|----------------|------|--|
| | | | 1.2 V | 1.2 V | 1.5 V | 1.8 V | 2.5 V | 2.5 V | 3.3 V | | |
| | | | V _{CC(B)} | | | | | | | | |
| | | | 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 | | |
| T_{amb} = 25 °C | | | | | | | | | | | |
| C _{PD} | power dissipation capacitance | outputs enabled; OE = V _{CC(A)} | | | | | | | | | |
| | | 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_{PD} is used to determine the dynamic power dissipation (P_D in μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz; f_o = output frequency in MHz; C_L = load capacitance in pF;
 V_{CC} = 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_i = 10 MHz; V_I = GND to V_{CC}; t_r = t_f = 1 ns; C_L = 0 pF; R_L = ∞ 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.

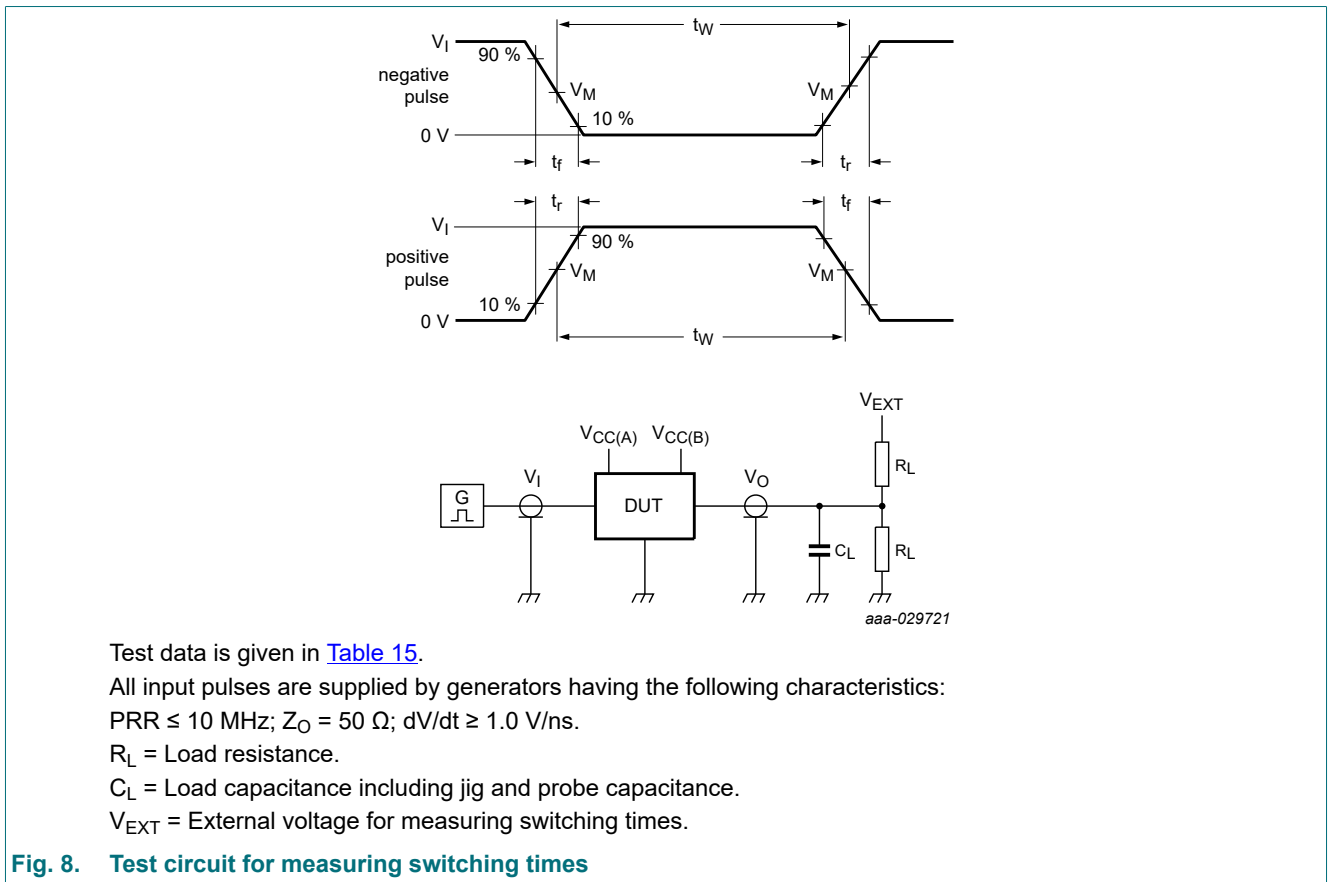


Table 15. Test data

| 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-Q100 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-Q100.

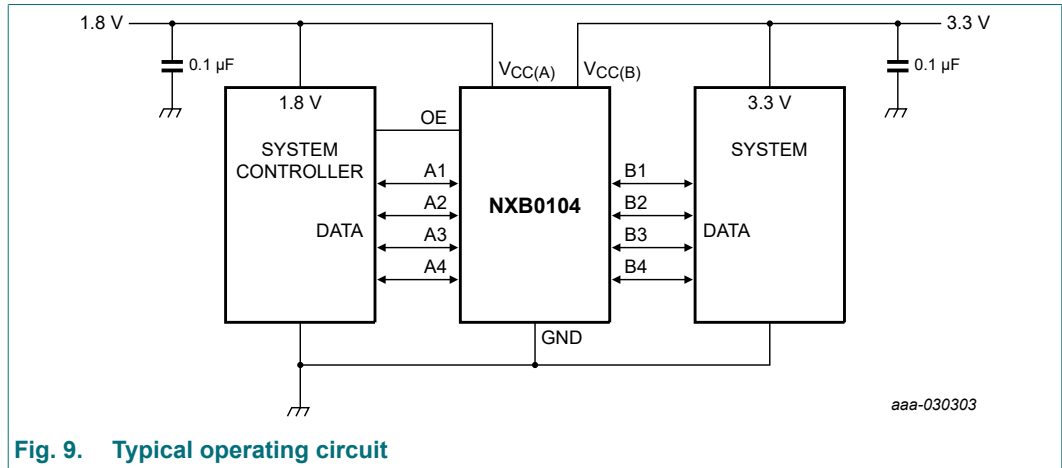


Fig. 9. Typical operating circuit

12.2. Architecture

The architecture of the NXB0104-Q100 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-Q100 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 Ω at $V_{CCO} = 1.2\text{ V}$ to 1.8 V, 50 Ω at $V_{CCO} = 1.8\text{ V}$ to 3.3 V and 40 Ω at $V_{CCO} = 3.3\text{ V}$ to 5.0 V.

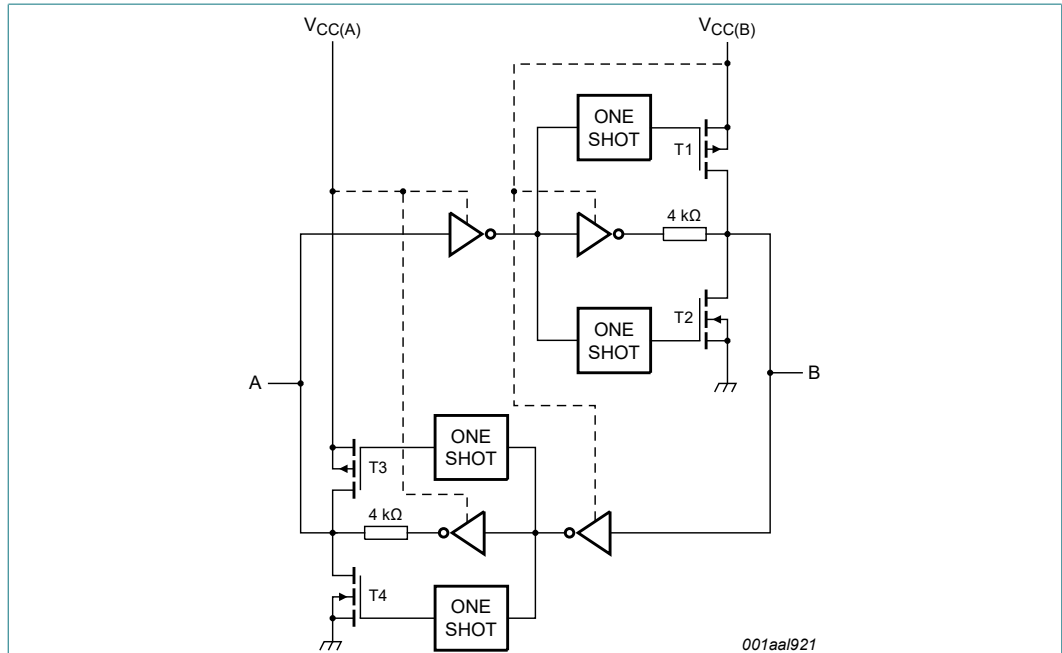
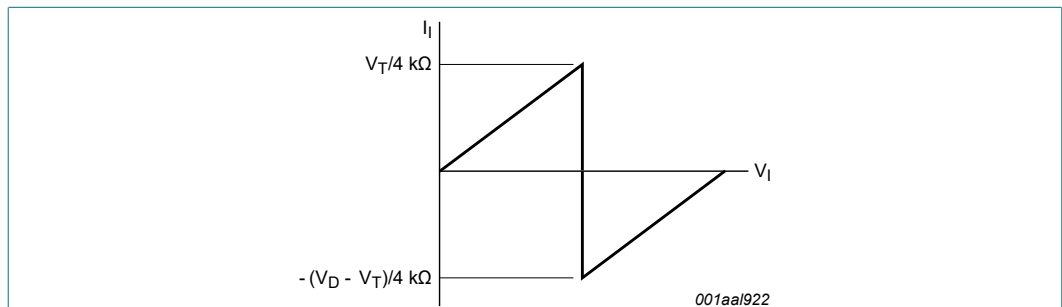


Fig. 10. Architecture of NXB0104-Q100 I/O cell (one channel)

12.3. Input driver requirements

For correct operation, the device driving the data I/Os of the NXB0104-Q100 must have a minimum drive capability of ± 2 mA. See Fig. 11 for a plot of typical input current versus input voltage.



V_T : input threshold voltage of the NXB0104-Q100 (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-Q100 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-Q100 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-Q100 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 Ω . For this reason the NXB0104-Q100 is not recommended for use in open drain driver applications such as 1-Wire or I²C. For these applications, the NXS0104-Q100 level translator is recommended.

13. Package outline

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

SOT402-1

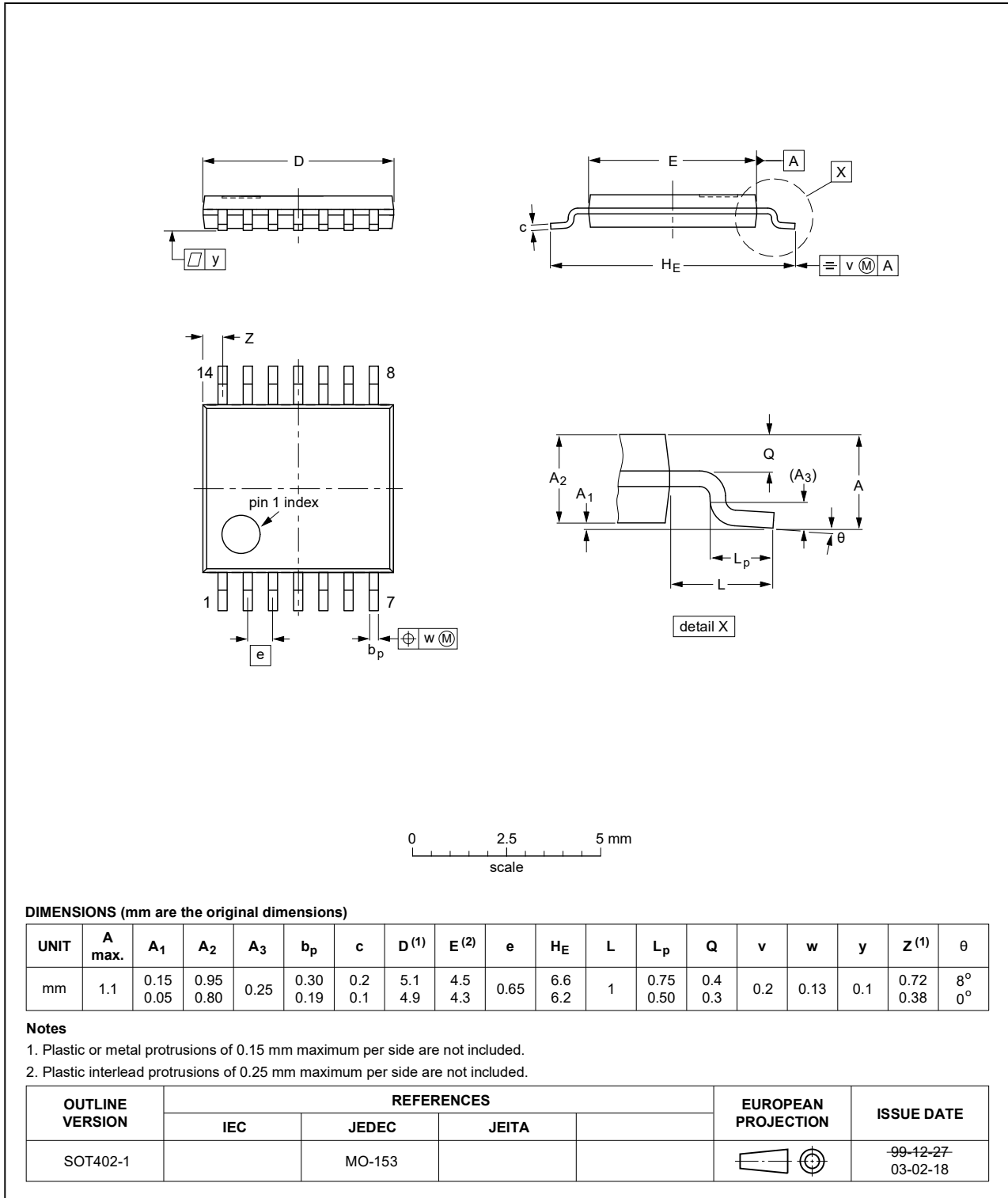


Fig. 12. Package outline SOT402-1 (TSSOP14)

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

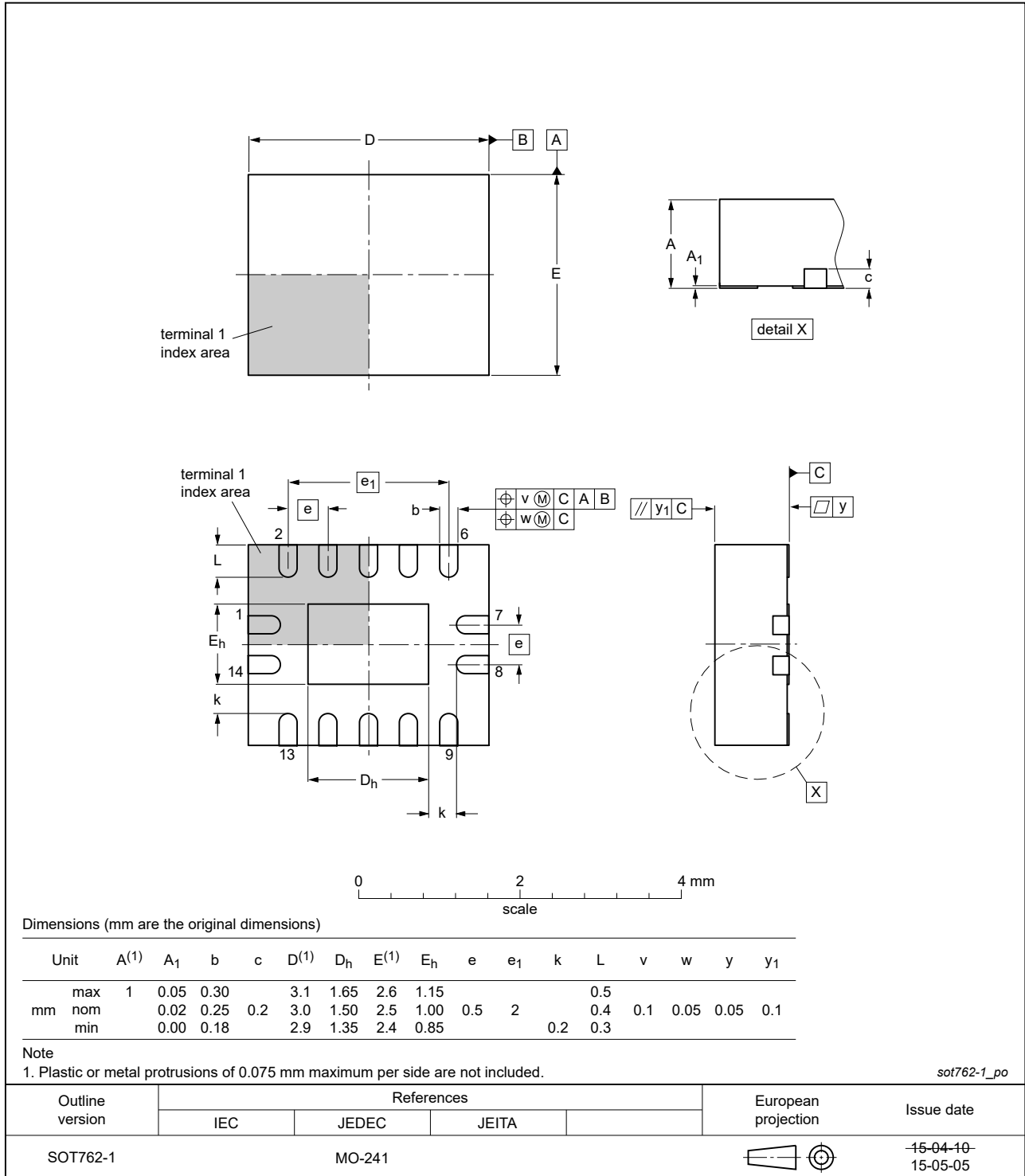


Fig. 13. Package outline SOT762-1 (DHVQFN14)

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

SOT1174-1

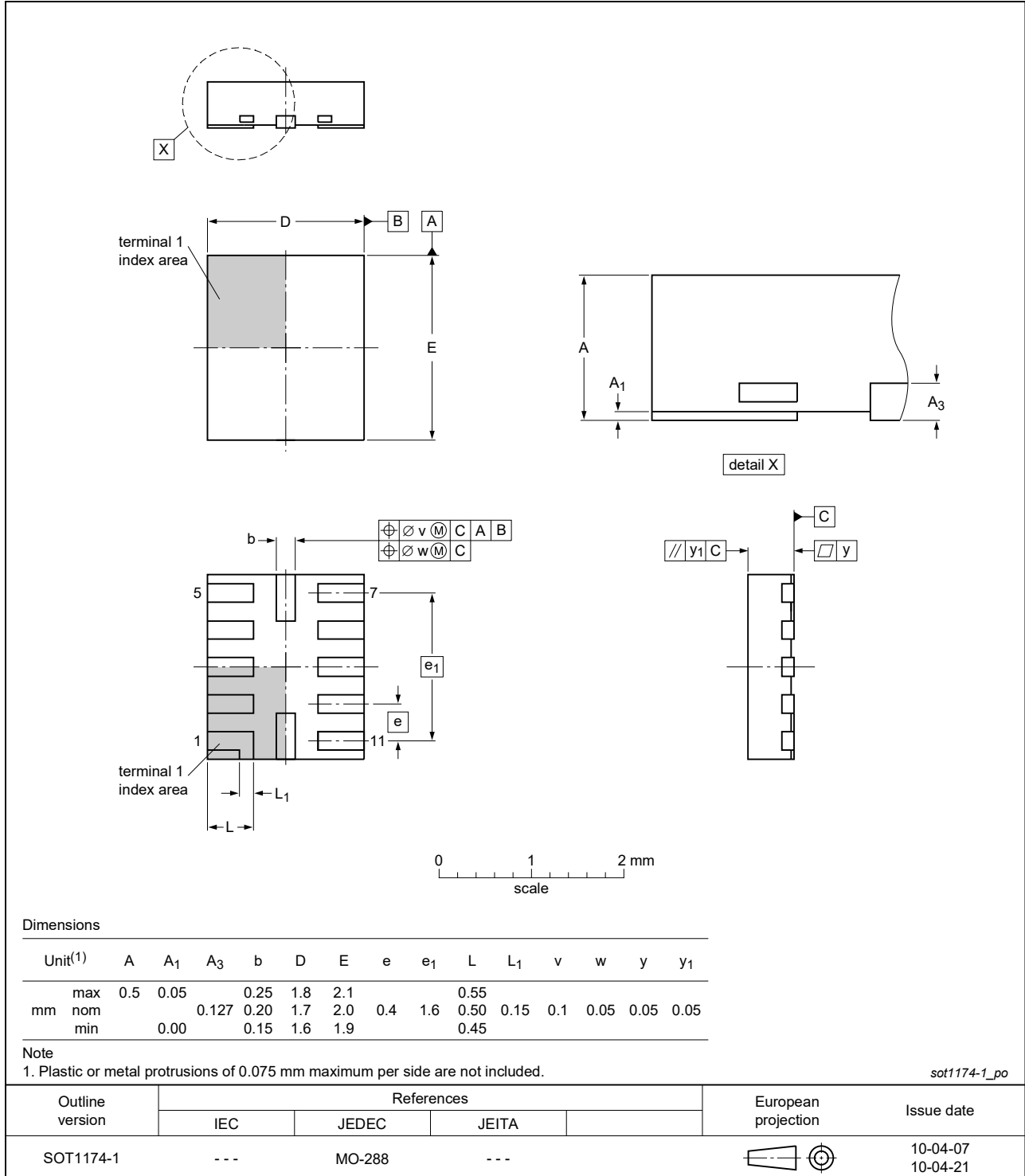


Fig. 14. Package outline SOT1174-1 (XQFN12)

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_Q100 v.4 | 20220502 | Product data sheet | - | NXB0104_Q100 v.3 |
| Modifications: | <ul style="list-style-type: none"> Type number NXB0104GU12-Q100 (SOT1174-1/XQFN12) added. | | | |
| NXB0104_Q100 v.3 | 20201113 | Product data sheet | - | NXB0104_Q100 v.2 |
| Modifications: | <ul style="list-style-type: none"> Table 11 and Table 12: Disable times updated. | | | |
| NXB0104_Q100 v.2 | 20200729 | Product data sheet | - | NXB0104_Q100 v.1 |
| Modifications: | <ul style="list-style-type: none"> Section 2 updated. Table 3: corrected (Errata). Table 5: Values for P_{tot} total power dissipation corrected (Errata). | | | |
| NXB0104_Q100 v.1 | 20190912 | 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.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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