

74AVC16T245-Q100

16-bit dual supply translating transceiver with configurable voltage translation; 3-state

Rev. 2 — 14 January 2019

Product data sheet

1. General description

The 74AVC16T245-Q100 is a 16-bit transceiver with bidirectional level voltage translation and 3-state outputs. The device can be used as two 8-bit transceivers or as a 16-bit transceiver. It has dual supplies ($V_{CC(A)}$ and $V_{CC(B)}$) for voltage translation and four 8-bit input-output ports (nAn and nBn). Each port has its own output enable (nOE) and send/receive ($nDIR$) input for direction control. $V_{CC(A)}$ and $V_{CC(B)}$ can be independently supplied with any voltage between 0.8 V and 3.6 V. This flexibility makes the device suitable for low voltage translation between any of the following voltages: 0.8 V, 1.2 V, 1.5 V, 1.8 V, 2.5 V and 3.3 V. A HIGH on $nDIR$ selects transmission from nAn to nBn while a LOW on $nDIR$ selects transmission from nBn to nAn . A HIGH on nOE causes the outputs to assume a high-impedance OFF-state

The device is fully specified for partial power-down applications using I_{OFF} . The I_{OFF} circuitry disables the output, preventing any damaging backflow current through the device when it is powered down. In suspend mode when either $V_{CC(A)}$ or $V_{CC(B)}$ are at GND level, both nAn and nBn are in the high-impedance OFF-state.

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:
 - $V_{CC(A)}$: 0.8 V to 3.6 V
 - $V_{CC(B)}$: 0.8 V to 3.6 V
- Complies with JEDEC standards:
 - JESD8-12 (0.8 V to 1.3 V)
 - JESD8-11 (0.9 V to 1.65 V)
 - JESD8-7 (1.2 V to 1.95 V)
 - JESD8-5 (1.8 V to 2.7 V)
 - JESD8-B (2.7 V to 3.6 V)
- ESD protection:
 - MIL-STD-883, method 3015 class 3B exceeds 8000 V
 - HBM JESD22-A114E class 3B exceeds 8000 V
 - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)
- Maximum data rates:
 - 380 Mbit/s (≥ 1.8 V to 3.3 V translation)
 - 200 Mbit/s (≥ 1.1 V to 3.3 V translation)
 - 200 Mbit/s (≥ 1.1 V to 2.5 V translation)
 - 200 Mbit/s (≥ 1.1 V to 1.8 V translation)
 - 150 Mbit/s (≥ 1.1 V to 1.5 V translation)
 - 100 Mbit/s (≥ 1.1 V to 1.2 V translation)
- Suspend mode
- Latch-up performance exceeds 100 mA per JESD 78 Class II
- Inputs accept voltages up to 3.6 V
- I_{OFF} circuitry provides partial Power-down mode operation

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|---------------------|-------------------|-------------|---|----------|
| | Temperature range | Name | Description | |
| 74AVC16T245DGV-Q100 | -40 °C to +125 °C | TSSOP48 [1] | plastic thin shrink small outline package; 48 leads; body width 4.4 mm; lead pitch 0.4 mm | SOT480-1 |

[1] Also known as TVSOP48.

4. Functional diagram

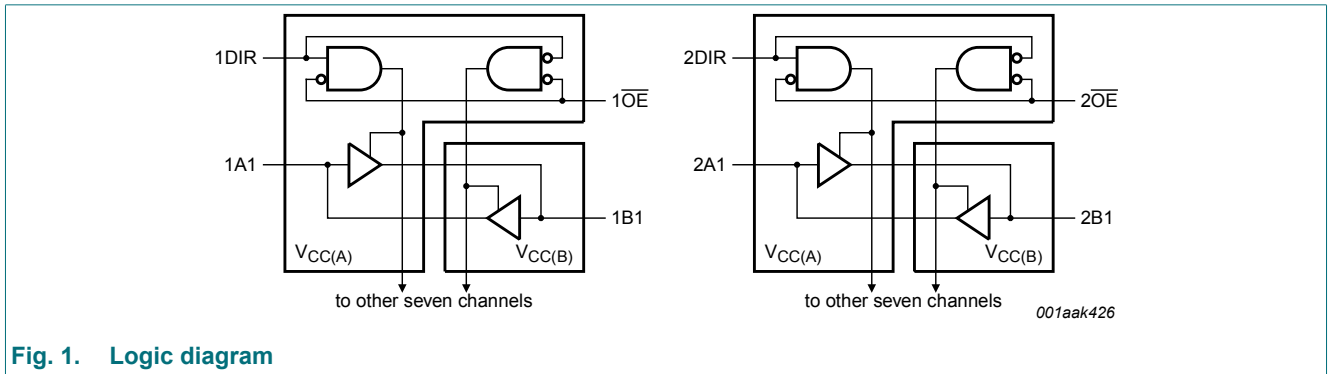


Fig. 1. Logic diagram

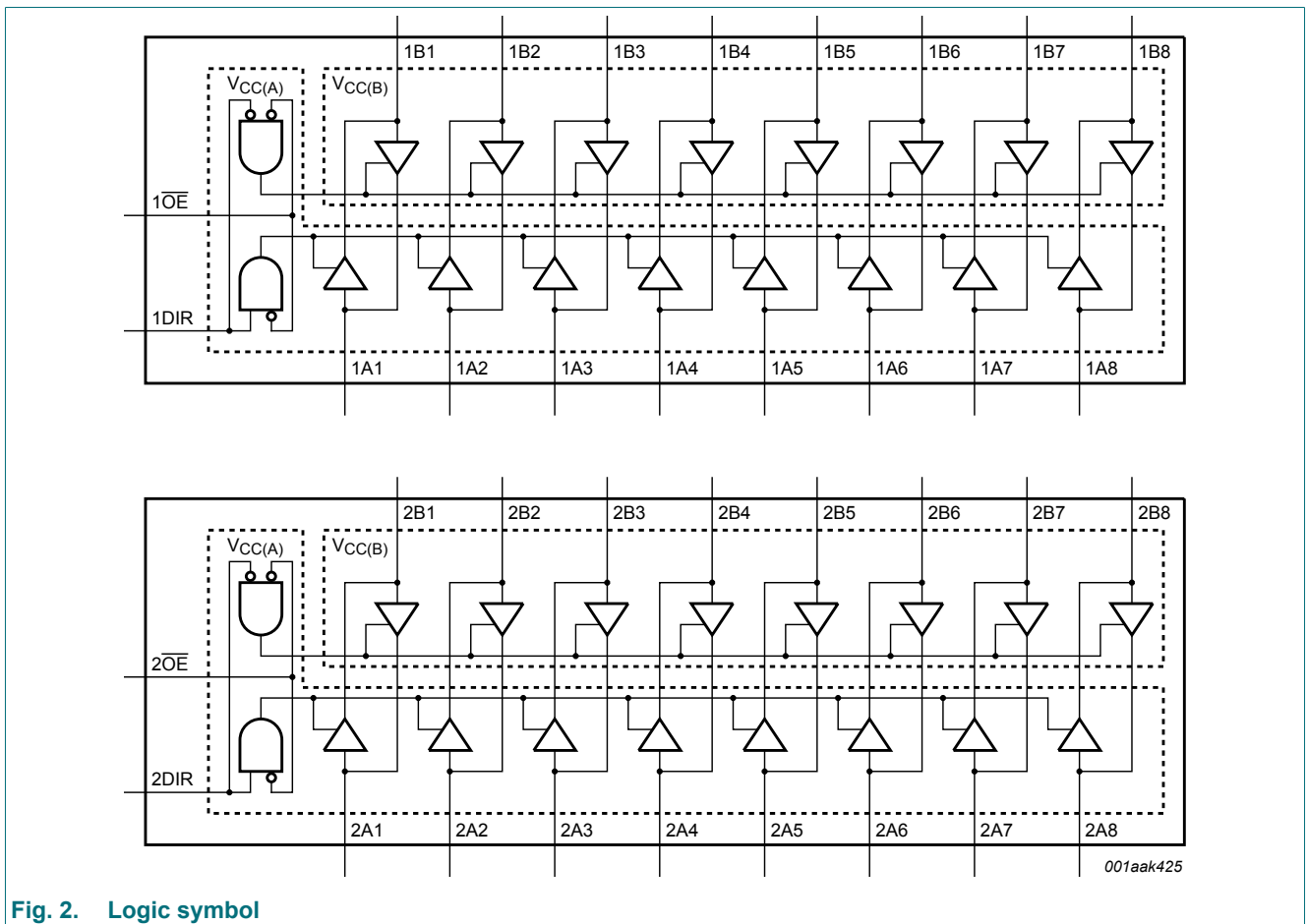


Fig. 2. Logic symbol

5. Pinning information

5.1. Pinning

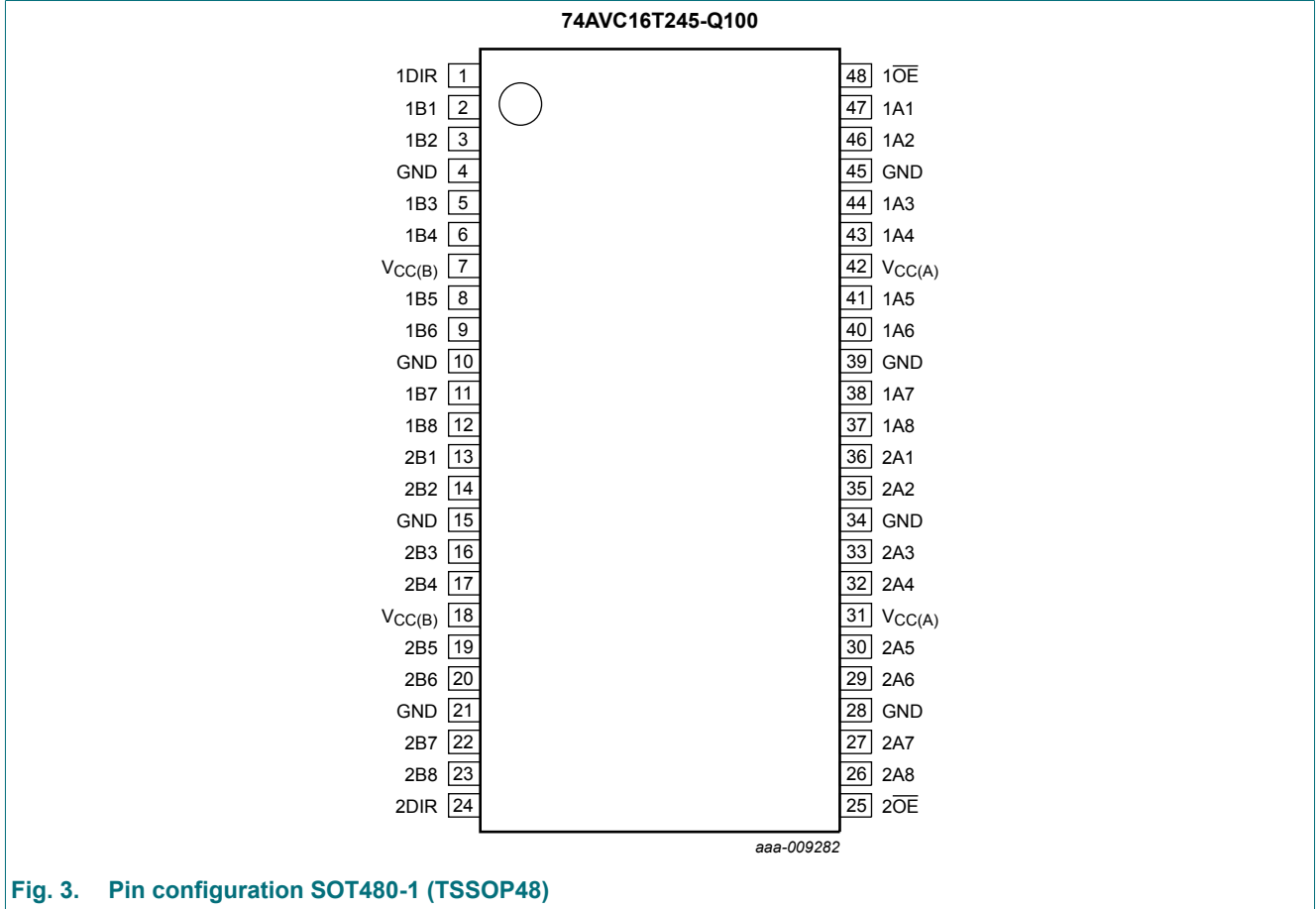


Fig. 3. Pin configuration SOT480-1 (TSSOP48)

5.2. Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|--|--------------------------------|---|
| 1DIR, 2DIR | 1, 24 | direction control |
| 1B1, 1B2, 1B3, 1B4, 1B5, 1B6, 1B7, 1B8 | 2, 3, 5, 6, 8, 9, 11, 12 | data input or output |
| 2B1, 2B2, 2B3, 2B4, 2B5, 2B6, 2B7, 2B8 | 13, 14, 16, 17, 19, 20, 22, 23 | data input or output |
| GND [1] | 4, 10, 15, 21, 28, 34, 39, 45 | ground (0 V) |
| V _{CC(B)} | 7, 18 | supply voltage B (nBn inputs are referenced to V _{CC(B)}) |
| 1OE, 2OE | 48, 25 | output enable input (active LOW) |
| 1A1, 1A2, 1A3, 1A4, 1A5, 1A6, 1A7, 1A8 | 47, 46, 44, 43, 41, 40, 38, 37 | data input or output |
| 2A1, 2A2, 2A3, 2A4, 2A5, 2A6, 2A7, 2A8 | 36, 35, 33, 32, 30, 29, 27, 26 | data input or output |
| V _{CC(A)} | 31, 42 | supply voltage A (nAn, nOE and nDIR inputs are referenced to V _{CC(A)}) |

[1] All GND pins must be connected to ground (0 V).

6. Functional description

Table 3. Function table

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

| Supply voltage | Input | | Input/output [1] | |
|----------------|---------|----------|------------------|-----------|
| | nOE [2] | nDIR [2] | nAn [2] | nBn [2] |
| 0.8 V to 3.6 V | L | L | nAn = nBn | input |
| 0.8 V to 3.6 V | L | H | input | nBn = nAn |
| 0.8 V to 3.6 V | H | X | Z | Z |
| GND [1] | X | X | Z | Z |

[1] If at least one of $V_{CC(A)}$ or $V_{CC(B)}$ is at GND level, the device goes into suspend mode.

[2] The nAn, nDIR and nOE input circuit is referenced to $V_{CC(A)}$; The nBn input circuit is referenced to $V_{CC(B)}$.

7. Limiting values

Table 4. 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 | +4.6 | V |
| $V_{CC(B)}$ | supply voltage B | | -0.5 | +4.6 | V |
| I_{IK} | input clamping current | $V_I < 0$ V | -50 | - | mA |
| V_I | input voltage | | -0.5 | +4.6 | V |
| I_{OK} | output clamping current | $V_O < 0$ V | -50 | - | mA |
| V_O | output voltage | Active mode | -0.5 | $V_{CCO} + 0.5$ | V |
| | | Suspend or 3-state mode | -0.5 | +4.6 | V |
| I_O | output current | $V_O = 0$ V to V_{CCO} | - | ± 50 | mA |
| I_{CC} | supply current | per $V_{CC(A)}$ or $V_{CC(B)}$ pin | - | 100 | mA |
| I_{GND} | ground current | per GND pin | -100 | - | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40$ °C to +125 °C; | - | 500 | mW |

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

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

[3] $V_{CCO} + 0.5$ V should not exceed 4.6 V.

[4] Above 60 °C the value of P_{tot} derates linearly with 5.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---------------------|-------------------------------------|---|-----|-----------|------|
| $V_{CC(A)}$ | supply voltage A | | 0.8 | 3.6 | V |
| $V_{CC(B)}$ | supply voltage B | | 0.8 | 3.6 | V |
| V_I | input voltage | | 0 | 3.6 | V |
| V_O | output voltage | Active mode [1] | 0 | V_{CCO} | V |
| | | Suspend or 3-state mode | 0 | 3.6 | V |
| T_{amb} | ambient temperature | | -40 | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CCI} = 0.8 \text{ V to } 3.6 \text{ V}$ [2] | - | 5 | ns/V |

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

[2] V_{CCI} is the supply voltage associated with the input port.

9. Static characteristics

Table 6. Typical static characteristics at $T_{amb} = 25 \text{ °C}$

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------|---------------------------|---|-----|-------------|------------|---------------|
| V_{OH} | HIGH-level output voltage | $V_I = V_{IH}$ or V_{IL} | | | | |
| | | $I_O = -1.5 \text{ mA}$; $V_{CC(A)} = V_{CC(B)} = 0.8 \text{ V}$ | - | 0.69 | - | V |
| V_{OL} | LOW-level output voltage | $V_I = V_{IH}$ or V_{IL} | | | | |
| | | $I_O = 1.5 \text{ mA}$; $V_{CC(A)} = V_{CC(B)} = 0.8 \text{ V}$ | - | 0.07 | - | V |
| I_I | input leakage current | nDIR, \overline{nOE} input; $V_I = 0 \text{ V}$ or 3.6 V ; $V_{CC(A)} = V_{CC(B)} = 0.8 \text{ V to } 3.6 \text{ V}$ | - | ± 0.025 | ± 0.25 | μA |
| I_{OZ} | OFF-state output current | A or B port; $V_O = 0 \text{ V}$ or V_{CCO} ; $V_{CC(A)} = V_{CC(B)} = 3.6 \text{ V}$ [2] | - | ± 0.5 | ± 2.5 | μA |
| | | suspend mode A port; $V_O = 0 \text{ V}$ or V_{CCO} ; $V_{CC(A)} = 3.6 \text{ V}$; $V_{CC(B)} = 0 \text{ V}$ [2] | - | ± 0.5 | ± 2.5 | μA |
| | | suspend mode B port; $V_O = 0 \text{ V}$ or V_{CCO} ; $V_{CC(A)} = 0 \text{ V}$; $V_{CC(B)} = 3.6 \text{ V}$ [2] | - | ± 0.5 | ± 2.5 | μA |
| I_{OFF} | power-off leakage current | A port; V_I or $V_O = 0 \text{ V to } 3.6 \text{ V}$; $V_{CC(A)} = 0 \text{ V}$; $V_{CC(B)} = 0.8 \text{ V to } 3.6 \text{ V}$ | - | ± 0.1 | ± 1 | μA |
| | | B port; V_I or $V_O = 0 \text{ V to } 3.6 \text{ V}$; $V_{CC(B)} = 0 \text{ V}$; $V_{CC(A)} = 0.8 \text{ V to } 3.6 \text{ V}$ | - | ± 0.1 | ± 1 | μA |
| C_I | input capacitance | nDIR, \overline{nOE} input; $V_I = 0 \text{ V}$ or 3.3 V ; $V_{CC(A)} = V_{CC(B)} = 3.3 \text{ V}$ | - | 2.0 | - | pF |
| $C_{I/O}$ | input/output capacitance | A and B port; $V_O = 3.3 \text{ V}$ or 0 V ; $V_{CC(A)} = V_{CC(B)} = 3.3 \text{ V}$ | - | 4.5 | - | pF |

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

[2] For I/O ports, the parameter I_{OZ} includes the input leakage current.

16-bit dual supply translating transceiver with configurable voltage translation; 3-state

Table 7. 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 | data input | | | | | |
| | | V _{CCI} = 0.8 V | 0.70V _{CCI} | - | 0.70V _{CCI} | - | V |
| | | V _{CCI} = 1.1 V to 1.95 V | 0.65V _{CCI} | - | 0.65V _{CCI} | - | V |
| | | V _{CCI} = 2.3 V to 2.7 V | 1.6 | - | 1.6 | - | V |
| | | V _{CCI} = 3.0 V to 3.6 V | 2 | - | 2 | - | V |
| | | nDIR, nOE input | | | | | |
| | | V _{CC(A)} = 0.8 V | 0.70V _{CC(A)} | - | 0.70V _{CC(A)} | - | V |
| | | V _{CC(A)} = 1.1 V to 1.95 V | 0.65V _{CC(A)} | - | 0.65V _{CC(A)} | - | V |
| | | V _{CC(A)} = 2.3 V to 2.7 V | 1.6 | - | 1.6 | - | V |
| V _{CC(A)} = 3.0 V to 3.6 V | 2 | - | 2 | - | V | | |
| V _{IL} | LOW-level input voltage | data input | | | | | |
| | | V _{CCI} = 0.8 V | - | 0.30V _{CCI} | - | 0.30V _{CCI} | V |
| | | V _{CCI} = 1.1 V to 1.95 V | - | 0.35V _{CCI} | - | 0.35V _{CCI} | V |
| | | V _{CCI} = 2.3 V to 2.7 V | - | 0.7 | - | 0.7 | V |
| | | V _{CCI} = 3.0 V to 3.6 V | - | 0.8 | - | 0.8 | V |
| | | nDIR, nOE input | | | | | |
| | | V _{CC(A)} = 0.8 V | - | 0.30V _{CC(A)} | - | 0.30V _{CC(A)} | V |
| | | V _{CC(A)} = 1.1 V to 1.95 V | - | 0.35V _{CC(A)} | - | 0.35V _{CC(A)} | V |
| | | V _{CC(A)} = 2.3 V to 2.7 V | - | 0.7 | - | 0.7 | V |
| V _{CC(A)} = 3.0 V to 3.6 V | - | 0.8 | - | 0.8 | V | | |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | | |
| | | I _O = -100 μA; V _{CC(A)} = V _{CC(B)} = 0.8 V to 3.6 V | V _{CCO} - 0.1 | - | V _{CCO} - 0.1 | - | V |
| | | I _O = -3 mA; V _{CC(A)} = V _{CC(B)} = 1.1 V | 0.85 | - | 0.85 | - | V |
| | | I _O = -6 mA; V _{CC(A)} = V _{CC(B)} = 1.4 V | 1.05 | - | 1.05 | - | V |
| | | I _O = -8 mA; V _{CC(A)} = V _{CC(B)} = 1.65 V | 1.2 | - | 1.2 | - | V |
| | | I _O = -9 mA; V _{CC(A)} = V _{CC(B)} = 2.3 V | 1.75 | - | 1.75 | - | V |
| I _O = -12 mA; V _{CC(A)} = V _{CC(B)} = 3.0 V | 2.3 | - | 2.3 | - | V | | |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | | |
| | | I _O = 100 μA; V _{CC(A)} = V _{CC(B)} = 0.8 V to 3.6 V | - | 0.1 | - | 0.1 | V |
| | | I _O = 3 mA; V _{CC(A)} = V _{CC(B)} = 1.1 V | - | 0.25 | - | 0.25 | V |
| | | I _O = 6 mA; V _{CC(A)} = V _{CC(B)} = 1.4 V | - | 0.35 | - | 0.35 | V |
| | | I _O = 8 mA; V _{CC(A)} = V _{CC(B)} = 1.65 V | - | 0.45 | - | 0.45 | V |
| | | I _O = 9 mA; V _{CC(A)} = V _{CC(B)} = 2.3 V | - | 0.55 | - | 0.55 | V |
| I _O = 12 mA; V _{CC(A)} = V _{CC(B)} = 3.0 V | - | 0.7 | - | 0.7 | V | | |

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| Symbol | Parameter | Conditions | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|------------------|---------------------------|---|------------------|-----|-------------------|-----|------|
| | | | Min | Max | Min | Max | |
| I _I | input leakage current | nDIR, n \overline{OE} input; V _I = 0 V or 3.6 V; V _{CC(A)} = V _{CC(B)} = 0.8 V to 3.6 V | - | ±1 | - | ±5 | µA |
| I _{OZ} | OFF-state output current | A or B port; V _O = 0 V or V _{CCO} ; V _{CC(A)} = V _{CC(B)} = 3.6 V [2] | - | ±5 | - | ±30 | µA |
| | | suspend mode A port; V _O = 0 V or V _{CCO} ; V _{CC(A)} = 3.6 V; V _{CC(B)} = 0 V [2] | - | ±5 | - | ±30 | µA |
| | | suspend mode B port; V _O = 0 V or V _{CCO} ; V _{CC(A)} = 0 V; V _{CC(B)} = 3.6 V [2] | - | ±5 | - | ±30 | 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)} = 0.8 V to 3.6 V | - | ±5 | - | ±30 | µA |
| | | B port; V _I or V _O = 0 V to 3.6 V; V _{CC(B)} = 0 V; V _{CC(A)} = 0.8 V to 3.6 V | - | ±5 | - | ±30 | µA |
| I _{CC} | supply current | A port; V _I = 0 V or V _{CCI} ; I _O = 0 A | | | | | |
| | | V _{CC(A)} = 0.8 V to 3.6 V; V _{CC(B)} = 0.8 V to 3.6 V | - | 30 | - | 125 | µA |
| | | V _{CC(A)} = 1.1 V to 3.6 V; V _{CC(B)} = 1.1 V to 3.6 V | - | 25 | - | 100 | µA |
| | | V _{CC(A)} = 3.6 V; V _{CC(B)} = 0 V | - | 25 | - | 100 | µA |
| | | V _{CC(A)} = 0 V; V _{CC(B)} = 3.6 V | -5 | - | -20 | - | µA |
| | | B port; V _I = 0 V or V _{CCI} ; I _O = 0 A | | | | | |
| | | V _{CC(A)} = 0.8 V to 3.6 V; V _{CC(B)} = 0.8 V to 3.6 V | - | 30 | - | 125 | µA |
| | | V _{CC(A)} = 1.1 V to 3.6 V; V _{CC(B)} = 1.1 V to 3.6 V | - | 25 | - | 100 | µA |
| | | V _{CC(A)} = 3.6 V; V _{CC(B)} = 0 V | -5 | - | -20 | - | µA |
| | | V _{CC(A)} = 0 V; V _{CC(B)} = 3.6 V | - | 25 | - | 100 | µA |
| | | A plus B port (I _{CC(A)} + I _{CC(B)}); I _O = 0 A; V _I = 0 V or V _{CCI} ; V _{CC(A)} = 0.8 V to 3.6 V; V _{CC(B)} = 0.8 V to 3.6 V | - | 55 | - | 185 | µA |
| | | A plus B port (I _{CC(A)} + I _{CC(B)}); I _O = 0 A; V _I = 0 V or V _{CCI} ; V _{CC(A)} = 1.1 V to 3.6 V; V _{CC(B)} = 1.1 V to 3.6 V | - | 45 | - | 150 | µA |

[1] V_{CCI} is the supply voltage associated with the data input port; V_{CCO} is the supply voltage associated with the output port.

[2] For I/O ports, the parameter I_{OZ} includes the input leakage current.

Table 8. Typical total supply current (I_{CC(A)} + I_{CC(B)})

| V _{CC(A)} | V _{CC(B)} | | | | | | | Unit |
|--------------------|--------------------|-------|-------|-------|-------|-------|-------|------|
| | 0 V | 0.8 V | 1.2 V | 1.5 V | 1.8 V | 2.5 V | 3.3 V | |
| 0 V | 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | µA |
| 0.8 V | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 1.6 | µA |
| 1.2 V | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.8 | µA |
| 1.5 V | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.4 | µA |
| 1.8 V | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | µA |
| 2.5 V | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | µA |
| 3.3 V | 0.1 | 1.6 | 0.8 | 0.4 | 0.2 | 0.1 | 0.1 | µA |

10. Dynamic characteristics

Table 9. Typical power dissipation capacitance at $V_{CC(A)} = V_{CC(B)}$ and $T_{amb} = 25\text{ °C}$

Voltages are referenced to GND (ground = 0 V). [1][2]

| Symbol | Parameter | Conditions | $V_{CC(A)} = V_{CC(B)}$ | | | | | | Unit |
|----------|-------------------------------|---|-------------------------|-------|-------|-------|-------|-------|------|
| | | | 0.8 V | 1.2 V | 1.5 V | 1.8 V | 2.5 V | 3.3 V | |
| C_{PD} | power dissipation capacitance | A port: (direction nAn to nBn); output enabled | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | pF |
| | | A port: (direction nAn to nBn); output disabled | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | pF |
| | | A port: (direction nBn to nAn); output enabled | 9 | 9.7 | 9.8 | 10.3 | 11.7 | 13.7 | pF |
| | | A port: (direction nBn to nAn); output disabled | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | pF |
| | | B port: (direction nAn to nBn); output enabled | 9 | 9.7 | 9.8 | 10.3 | 11.7 | 13.7 | pF |
| | | B port: (direction nAn to nBn); output disabled | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | pF |
| | | B port: (direction nBn to nAn); output enabled | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | pF |
| | | B port: (direction nBn to nAn); output disabled | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | pF |

- [1] C_{PD} is used to determine the dynamic power dissipation (P_D in μW). $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ 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; $\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs.
- [2] $f_i = 10\text{ MHz}$; $V_i = \text{GND to } V_{CC}$; $t_r = t_f = 1\text{ ns}$; $C_L = 0\text{ pF}$; $R_L = \infty\ \Omega$.

Table 10. Typical dynamic characteristics at $V_{CC(A)} = 0.8\text{ V}$ and $T_{amb} = 25\text{ °C}$

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6; for wave forms see Fig. 4 and Fig. 5. [1]

| Symbol | Parameter | Conditions | $V_{CC(B)}$ | | | | | | Unit |
|-----------|-------------------|-------------------------|-------------|-------|-------|-------|-------|-------|------|
| | | | 0.8 V | 1.2 V | 1.5 V | 1.8 V | 2.5 V | 3.3 V | |
| t_{pd} | propagation delay | nAn to nBn | 14.4 | 7.0 | 6.2 | 6.0 | 5.9 | 6.0 | ns |
| | | nBn to nAn | 14.4 | 12.4 | 12.1 | 11.9 | 11.8 | 11.8 | ns |
| t_{dis} | disable time | \overline{nOE} to nAn | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | ns |
| | | \overline{nOE} to nBn | 17.6 | 10.0 | 9.0 | 9.1 | 8.7 | 9.3 | ns |
| t_{en} | enable time | \overline{nOE} to nAn | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | ns |
| | | \overline{nOE} to nBn | 22.2 | 11.1 | 9.8 | 9.4 | 9.4 | 9.6 | ns |

- [1] t_{pd} is the same as t_{PLH} and t_{PHL} ;
 t_{dis} is the same as t_{PLZ} and t_{PHZ} ;
 t_{en} is the same as t_{PZL} and t_{PZH} .

Table 11. Typical dynamic characteristics at $V_{CC(B)} = 0.8\text{ V}$ and $T_{amb} = 25\text{ °C}$

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6; for wave forms see Fig. 4 and Fig. 5. [1]

| Symbol | Parameter | Conditions | $V_{CC(A)}$ | | | | | | Unit |
|-----------|-------------------|-------------------------|-------------|-------|-------|-------|-------|-------|------|
| | | | 0.8 V | 1.2 V | 1.5 V | 1.8 V | 2.5 V | 3.3 V | |
| t_{pd} | propagation delay | nAn to nBn | 14.4 | 12.4 | 12.1 | 11.9 | 11.8 | 11.8 | ns |
| | | nBn to nAn | 14.4 | 7.0 | 6.2 | 6.0 | 5.9 | 6.0 | ns |
| t_{dis} | disable time | \overline{nOE} to nAn | 16.2 | 5.9 | 4.4 | 4.2 | 3.1 | 3.5 | ns |
| | | \overline{nOE} to nBn | 17.6 | 14.2 | 13.7 | 13.6 | 13.3 | 13.1 | ns |
| t_{en} | enable time | \overline{nOE} to nAn | 21.9 | 6.4 | 4.4 | 3.5 | 2.6 | 2.3 | ns |
| | | \overline{nOE} to nBn | 22.2 | 17.7 | 17.2 | 17.0 | 16.8 | 16.7 | ns |

- [1] t_{pd} is the same as t_{PLH} and t_{PHL} ;
 t_{dis} is the same as t_{PLZ} and t_{PHZ} ;
 t_{en} is the same as t_{PZL} and t_{PZH} .

16-bit dual supply translating transceiver with configurable voltage translation; 3-state

Table 12. Dynamic characteristics for temperature range -40 °C to +85 °C

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6; for wave forms see Fig. 4 and Fig. 5. [1]

| Symbol | Parameter | Conditions | V _{CC(B)} | | | | | | | | | | Unit |
|---|-------------------|--------------------------|--------------------|------|---------------|------|----------------|------|---------------|------|---------------|------|------|
| | | | 1.2 V ± 0.1 V | | 1.5 V ± 0.1 V | | 1.8 V ± 0.15 V | | 2.5 V ± 0.2 V | | 3.3 V ± 0.3 V | | |
| | | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| V_{CC(A)} = 1.1 V to 1.3 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 9.2 | 0.5 | 6.9 | 0.5 | 6.0 | 0.5 | 5.1 | 0.5 | 4.9 | ns |
| | | nBn to nAn | 0.5 | 9.2 | 0.5 | 8.7 | 0.5 | 8.5 | 0.5 | 8.2 | 0.5 | 8.0 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.5 | 11.6 | 1.5 | 11.6 | 1.5 | 11.6 | 1.5 | 11.6 | 1.5 | 11.6 | ns |
| | | n \overline{OE} to nBn | 1.5 | 12.5 | 1.5 | 9.7 | 1.5 | 9.5 | 1.0 | 8.1 | 1.0 | 8.9 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 1.0 | 14.5 | 1.0 | 14.5 | 1.0 | 14.5 | 1.0 | 14.5 | 1.0 | 14.5 | ns |
| | | n \overline{OE} to nBn | 1.1 | 14.9 | 1.1 | 11.0 | 1.1 | 9.6 | 1.0 | 8.1 | 1.0 | 7.7 | ns |
| V_{CC(A)} = 1.4 V to 1.6 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 8.7 | 0.5 | 6.2 | 0.5 | 5.2 | 0.5 | 4.1 | 0.5 | 3.7 | ns |
| | | nBn to nAn | 0.5 | 6.9 | 0.5 | 6.2 | 0.5 | 5.9 | 0.5 | 5.6 | 0.5 | 5.5 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.5 | 9.1 | 1.5 | 9.1 | 1.5 | 9.1 | 1.5 | 9.1 | 1.5 | 9.1 | ns |
| | | n \overline{OE} to nBn | 1.5 | 11.4 | 1.5 | 8.7 | 1.5 | 7.5 | 1.0 | 6.5 | 1.0 | 6.3 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 1.0 | 10.1 | 1.0 | 10.1 | 1.0 | 10.1 | 1.0 | 10.1 | 1.0 | 10.1 | ns |
| | | n \overline{OE} to nBn | 1.0 | 13.5 | 1.0 | 10.1 | 0.5 | 8.1 | 0.5 | 5.9 | 0.5 | 5.2 | ns |
| V_{CC(A)} = 1.65 V to 1.95 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 8.5 | 0.5 | 5.9 | 0.5 | 4.8 | 0.5 | 3.7 | 0.5 | 3.3 | ns |
| | | nBn to nAn | 0.5 | 6.0 | 0.5 | 5.2 | 0.5 | 4.8 | 0.5 | 4.5 | 0.5 | 4.4 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.5 | 7.7 | 1.5 | 7.7 | 1.5 | 7.7 | 1.5 | 7.7 | 1.5 | 7.7 | ns |
| | | n \overline{OE} to nBn | 1.5 | 11.1 | 1.5 | 8.4 | 1.5 | 7.1 | 1.0 | 5.9 | 1.0 | 5.7 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 1.0 | 7.8 | 1.0 | 7.8 | 1.0 | 7.8 | 1.0 | 7.8 | 1.0 | 7.8 | ns |
| | | n \overline{OE} to nBn | 1.0 | 13.0 | 1.0 | 9.2 | 0.5 | 7.4 | 0.5 | 5.3 | 0.5 | 4.5 | ns |
| V_{CC(A)} = 2.3 V to 2.7 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 8.2 | 0.5 | 5.6 | 0.5 | 4.6 | 0.5 | 3.3 | 0.5 | 2.8 | ns |
| | | nBn to nAn | 0.5 | 5.1 | 0.5 | 4.1 | 0.5 | 3.7 | 0.5 | 3.4 | 0.5 | 3.2 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.0 | 6.1 | 1.0 | 6.1 | 1.0 | 6.1 | 1.0 | 6.1 | 1.0 | 6.1 | ns |
| | | n \overline{OE} to nBn | 1.0 | 10.6 | 1.0 | 7.9 | 1.0 | 6.6 | 1.0 | 6.1 | 1.0 | 5.2 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 0.5 | 5.3 | 0.5 | 5.3 | 0.5 | 5.3 | 0.5 | 5.3 | 0.5 | 5.3 | ns |
| | | n \overline{OE} to nBn | 0.5 | 12.5 | 0.5 | 9.4 | 0.5 | 7.3 | 0.5 | 5.1 | 0.5 | 4.5 | ns |
| V_{CC(A)} = 3.0 V to 3.6 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 8.0 | 0.5 | 5.5 | 0.5 | 4.4 | 0.5 | 3.2 | 0.5 | 2.7 | ns |
| | | nBn to nAn | 0.5 | 4.9 | 0.5 | 3.7 | 0.5 | 3.3 | 0.5 | 2.9 | 0.5 | 2.7 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 0.5 | 5.0 | 0.5 | 5.0 | 0.5 | 5.0 | 0.5 | 5.0 | 0.5 | 5.0 | ns |
| | | n \overline{OE} to nBn | 1.0 | 10.3 | 1.0 | 7.7 | 1.0 | 6.5 | 1.0 | 5.2 | 0.5 | 5.0 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 0.5 | 4.3 | 0.5 | 4.3 | 0.5 | 4.2 | 0.5 | 4.1 | 0.5 | 4.0 | ns |
| | | n \overline{OE} to nBn | 0.5 | 12.4 | 0.5 | 9.3 | 0.5 | 7.2 | 0.5 | 4.9 | 0.5 | 4.0 | ns |

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

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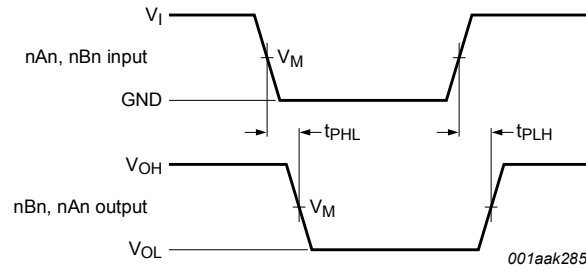
Table 13. Dynamic characteristics for temperature range -40 °C to +125 °C

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6; for wave forms see Fig. 4 and Fig. 5. [1]

| Symbol | Parameter | Conditions | V _{CC(B)} | | | | | | | | | | Unit |
|---|-------------------|--------------------------|--------------------|------|---------------|------|----------------|------|---------------|------|---------------|------|------|
| | | | 1.2 V ± 0.1 V | | 1.5 V ± 0.1 V | | 1.8 V ± 0.15 V | | 2.5 V ± 0.2 V | | 3.3 V ± 0.3 V | | |
| | | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| V_{CC(A)} = 1.1 V to 1.3 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 10.2 | 0.5 | 7.6 | 0.5 | 6.6 | 0.5 | 5.7 | 0.5 | 5.4 | ns |
| | | nBn to nAn | 0.5 | 10.2 | 0.5 | 9.6 | 0.5 | 9.4 | 0.5 | 9.1 | 0.5 | 8.8 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.5 | 12.8 | 1.5 | 12.8 | 1.5 | 12.8 | 1.5 | 12.8 | 1.5 | 12.8 | ns |
| | | n \overline{OE} to nBn | 1.5 | 13.8 | 1.5 | 10.7 | 1.5 | 10.5 | 1.0 | 9.0 | 1.5 | 9.8 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 1.0 | 16.0 | 1.0 | 16.0 | 1.0 | 16.0 | 1.0 | 16.0 | 1.0 | 16.0 | ns |
| | | n \overline{OE} to nBn | 1.1 | 16.4 | 1.1 | 12.1 | 1.1 | 10.6 | 1.0 | 9.0 | 1.0 | 8.5 | ns |
| V_{CC(A)} = 1.4 V to 1.6 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 9.6 | 0.5 | 6.9 | 0.5 | 5.8 | 0.5 | 4.6 | 0.5 | 4.1 | ns |
| | | nBn to nAn | 0.5 | 7.6 | 0.5 | 6.9 | 0.5 | 6.5 | 0.5 | 6.2 | 0.5 | 6.1 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.5 | 10.1 | 1.5 | 10.1 | 1.5 | 10.1 | 1.5 | 10.1 | 1.5 | 10.1 | ns |
| | | n \overline{OE} to nBn | 1.5 | 12.6 | 1.5 | 9.6 | 1.5 | 8.3 | 1.0 | 7.2 | 1.0 | 7.0 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 1.0 | 11.2 | 1.0 | 11.2 | 1.0 | 11.2 | 1.0 | 11.2 | 1.0 | 11.2 | ns |
| | | n \overline{OE} to nBn | 1.0 | 14.9 | 1.0 | 11.2 | 0.5 | 9.0 | 0.5 | 6.5 | 0.5 | 5.8 | ns |
| V_{CC(A)} = 1.65 V to 1.95 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 9.4 | 0.5 | 6.5 | 0.5 | 5.3 | 0.5 | 4.1 | 0.5 | 3.7 | ns |
| | | nBn to nAn | 0.5 | 6.6 | 0.5 | 5.8 | 0.5 | 5.3 | 0.5 | 5.0 | 0.5 | 4.9 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.5 | 8.5 | 1.5 | 8.5 | 1.5 | 8.5 | 1.5 | 8.5 | 1.5 | 8.5 | ns |
| | | n \overline{OE} to nBn | 1.5 | 12.3 | 1.5 | 9.3 | 1.5 | 7.9 | 1.0 | 6.5 | 1.0 | 6.3 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 1.0 | 8.6 | 1.0 | 8.6 | 1.0 | 8.6 | 1.0 | 8.6 | 1.0 | 8.6 | ns |
| | | n \overline{OE} to nBn | 1.0 | 14.3 | 1.0 | 10.2 | 0.5 | 8.2 | 0.5 | 5.9 | 0.5 | 5.0 | ns |
| V_{CC(A)} = 2.3 V to 2.7 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 9.1 | 0.5 | 6.2 | 0.5 | 5.1 | 0.5 | 3.7 | 0.5 | 3.1 | ns |
| | | nBn to nAn | 0.5 | 5.7 | 0.5 | 4.6 | 0.5 | 4.1 | 0.5 | 3.8 | 0.5 | 3.6 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 1.0 | 6.8 | 1.0 | 6.8 | 1.0 | 6.8 | 1.0 | 6.8 | 1.0 | 6.8 | ns |
| | | n \overline{OE} to nBn | 1.0 | 11.7 | 1.0 | 8.7 | 1.0 | 7.3 | 1.0 | 6.8 | 1.0 | 5.8 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 0.5 | 5.9 | 0.5 | 5.9 | 0.5 | 5.9 | 0.5 | 5.9 | 0.5 | 5.9 | ns |
| | | n \overline{OE} to nBn | 0.5 | 13.8 | 0.5 | 10.4 | 0.5 | 8.1 | 0.5 | 5.7 | 0.5 | 5.0 | ns |
| V_{CC(A)} = 3.0 V to 3.6 V | | | | | | | | | | | | | |
| t _{pd} | propagation delay | nAn to nBn | 0.5 | 8.8 | 0.5 | 6.1 | 0.5 | 4.9 | 0.5 | 3.6 | 0.5 | 3.0 | ns |
| | | nBn to nAn | 0.5 | 5.4 | 0.5 | 4.1 | 0.5 | 3.7 | 0.5 | 3.2 | 0.5 | 3.0 | ns |
| t _{dis} | disable time | n \overline{OE} to nAn | 0.5 | 5.5 | 0.5 | 5.5 | 0.5 | 5.5 | 0.5 | 5.5 | 0.5 | 5.5 | ns |
| | | n \overline{OE} to nBn | 1.0 | 11.4 | 1.0 | 8.5 | 1.0 | 7.2 | 1.0 | 5.8 | 0.5 | 5.5 | ns |
| t _{en} | enable time | n \overline{OE} to nAn | 0.5 | 4.8 | 0.5 | 4.8 | 0.5 | 4.7 | 0.5 | 4.6 | 0.5 | 4.4 | ns |
| | | n \overline{OE} to nBn | 0.5 | 13.7 | 0.5 | 10.3 | 0.5 | 8.0 | 0.5 | 5.4 | 0.5 | 4.4 | ns |

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

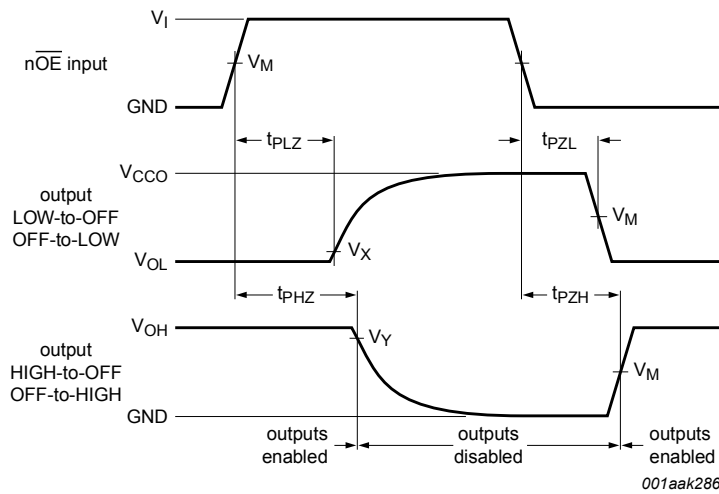
10.1. Waveforms and test circuit



Measurement points are given in Table 14.

V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig. 4. The data input (nAn, nBn) to output (nBn, nAn) propagation delay times



Measurement points are given in Table 14.

V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig. 5. Enable and disable times

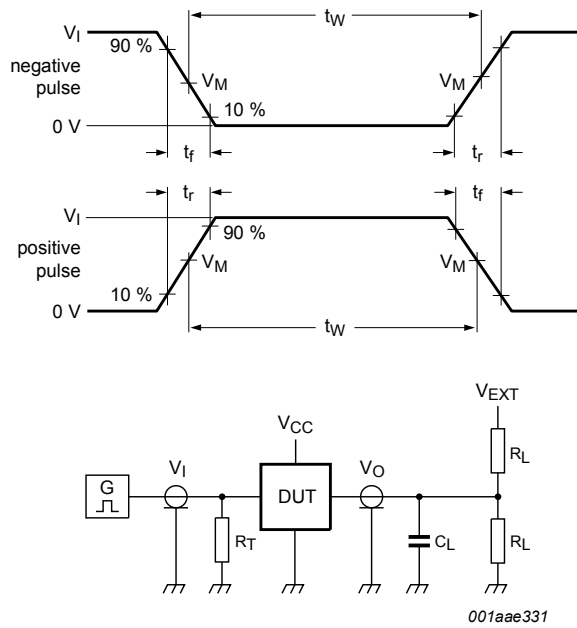
Table 14. Measurement points

| Supply voltage | Input [1] | Output [2] | | |
|------------------------|--------------|--------------|-------------------|-------------------|
| $V_{CC(A)}, V_{CC(B)}$ | V_M | V_M | V_X | V_Y |
| 0.8 V to 1.6 V | $0.5V_{CCI}$ | $0.5V_{CCO}$ | $V_{OL} + 0.1 V$ | $V_{OH} - 0.1 V$ |
| 1.65 V to 2.7 V | $0.5V_{CCI}$ | $0.5V_{CCO}$ | $V_{OL} + 0.15 V$ | $V_{OH} - 0.15 V$ |
| 3.0 V to 3.6 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 data input port.

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

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Test data is given in [Table 15](#).
 R_L = Load resistance.
 C_L = Load capacitance including jig and probe capacitance.
 R_T = Termination resistance.
 V_{EXT} = External voltage for measuring switching times.

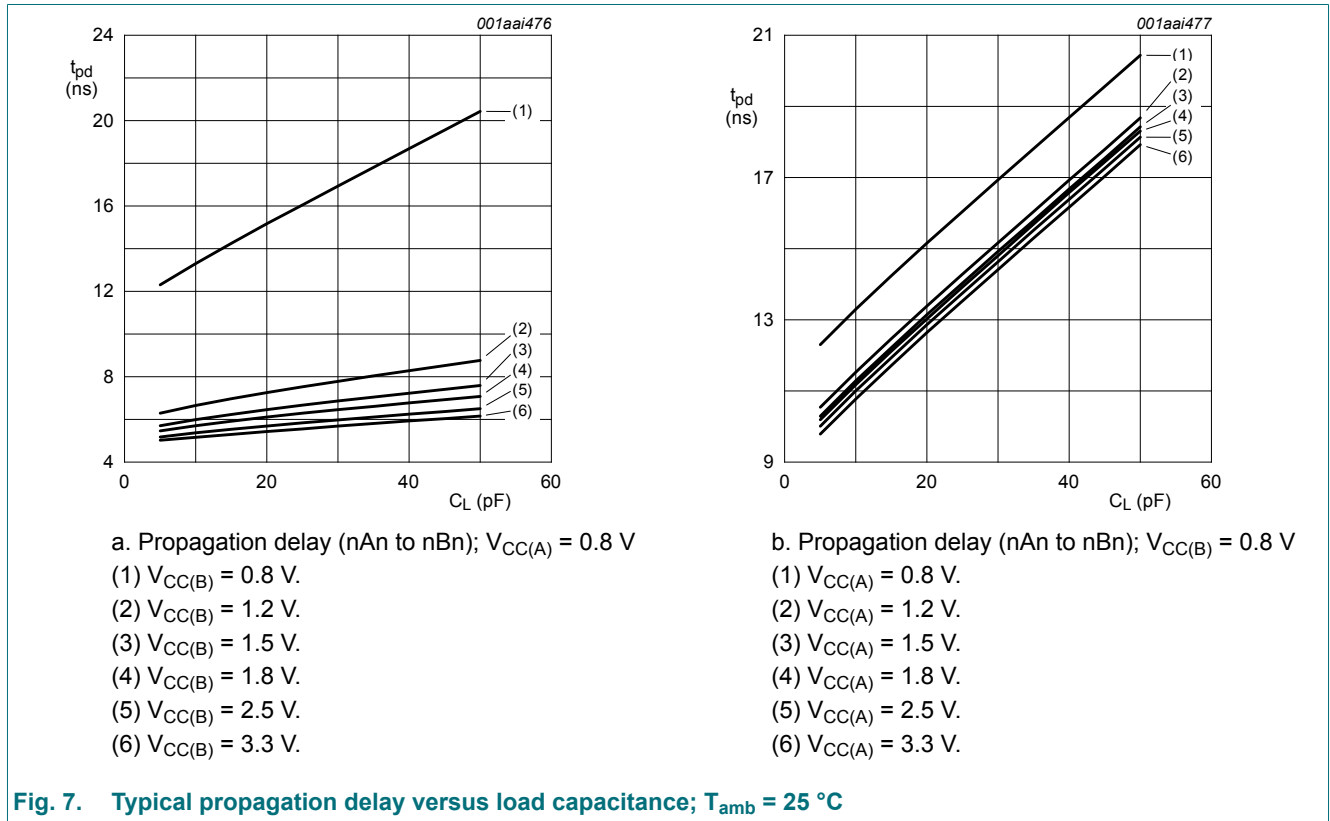
Fig. 6. Test circuit for measuring switching times

Table 15. Test data

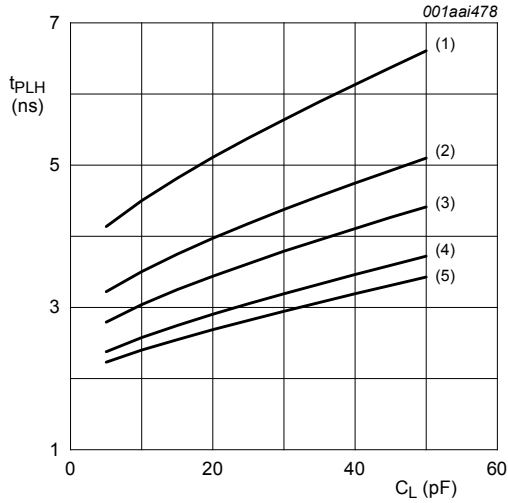
| Supply voltage | Input | | Load | | V_{EXT} | | |
|------------------------|-----------|-------------------------|-------|--------------|--------------------|--------------------|------------------------|
| $V_{CC(A)}, V_{CC(B)}$ | V_I [1] | $\Delta t/\Delta V$ [2] | C_L | R_L | t_{PLH}, t_{PHL} | t_{PZH}, t_{PHZ} | t_{PZL}, t_{PLZ} [3] |
| 0.8 V to 1.6 V | V_{CCI} | ≤ 1.0 ns/V | 15 pF | 2 k Ω | open | GND | $2V_{CCO}$ |
| 1.65 V to 2.7 V | V_{CCI} | ≤ 1.0 ns/V | 15 pF | 2 k Ω | open | GND | $2V_{CCO}$ |
| 3.0 V to 3.6 V | V_{CCI} | ≤ 1.0 ns/V | 15 pF | 2 k Ω | open | GND | $2V_{CCO}$ |

[1] V_{CCI} is the supply voltage associated with the data input port.
 [2] $dV/dt \geq 1.0$ V/ns
 [3] V_{CCO} is the supply voltage associated with the output port.

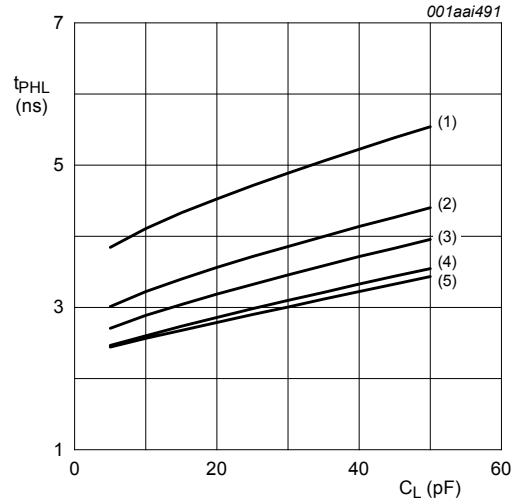
11. Typical propagation delay characteristics



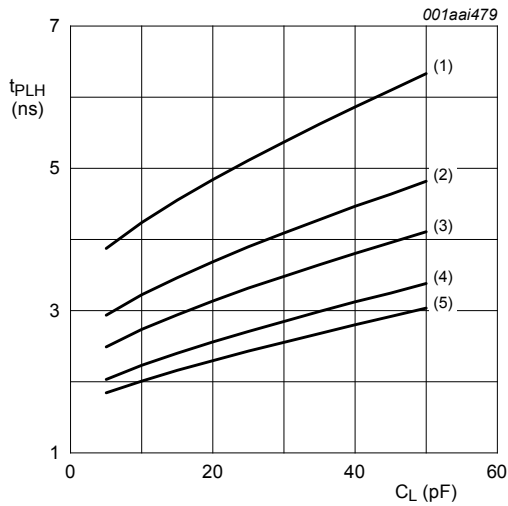
16-bit dual supply translating transceiver with configurable voltage translation; 3-state



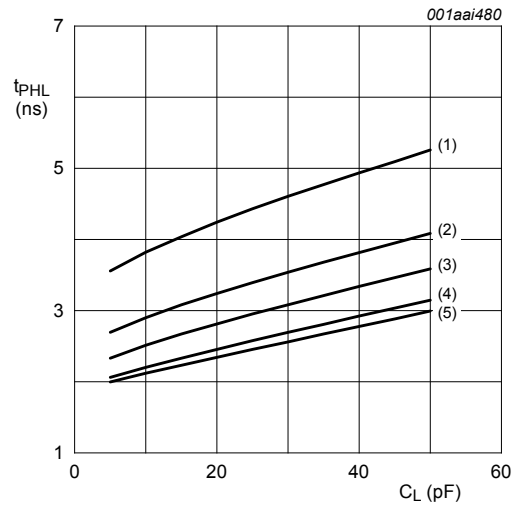
a. LOW to HIGH propagation delay (nAn to nBn); $V_{CC(A)} = 1.2\text{ V}$



b. HIGH to LOW propagation delay (nAn to nBn); $V_{CC(A)} = 1.2\text{ V}$



c. LOW to HIGH propagation delay (nAn to nBn); $V_{CC(A)} = 1.5\text{ V}$

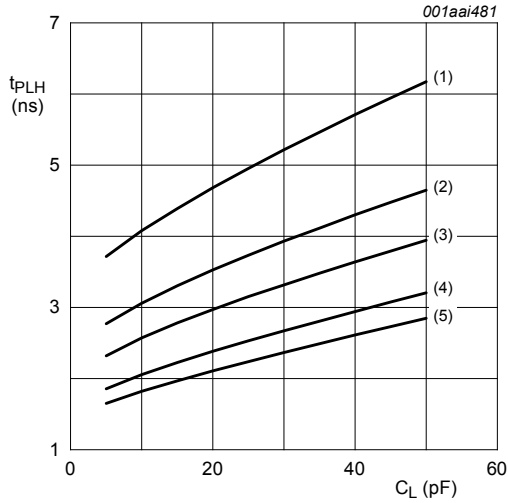


d. HIGH to LOW propagation delay (nAn to nBn); $V_{CC(A)} = 1.5\text{ V}$

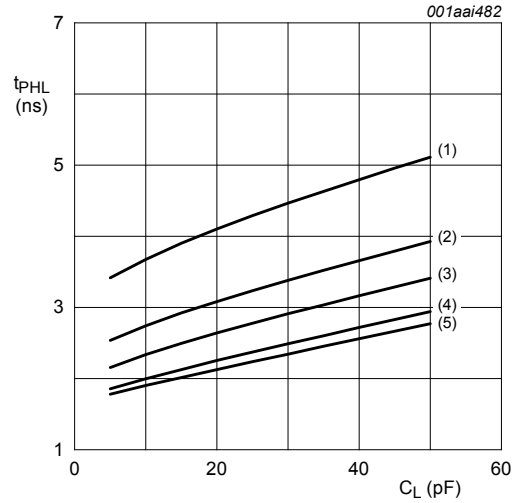
- (1) $V_{CC(B)} = 1.2\text{ V}$.
- (2) $V_{CC(B)} = 1.5\text{ V}$.
- (3) $V_{CC(B)} = 1.8\text{ V}$.
- (4) $V_{CC(B)} = 2.5\text{ V}$.
- (5) $V_{CC(B)} = 3.3\text{ V}$.

Fig. 8. Typical propagation delay versus load capacitance; $T_{amb} = 25\text{ °C}$

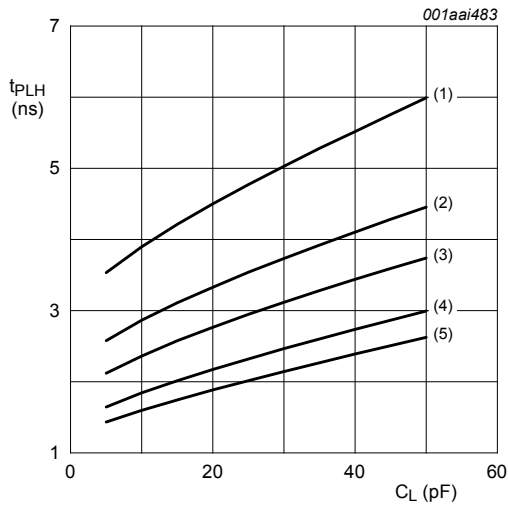
16-bit dual supply translating transceiver with configurable voltage translation; 3-state



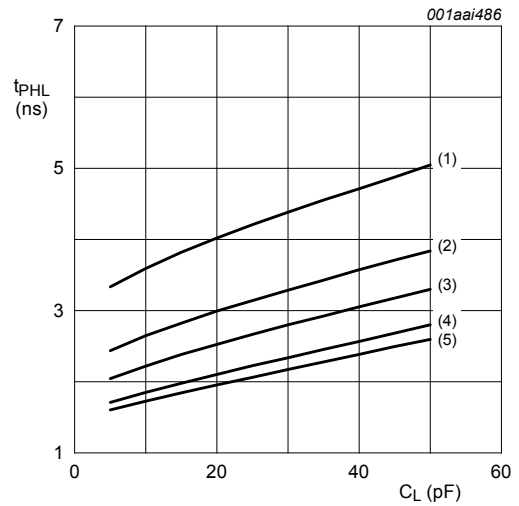
a. LOW to HIGH propagation delay (nAn to nBn); $V_{CC(A)} = 1.8\text{ V}$



b. HIGH to LOW propagation delay (nAn to nBn); $V_{CC(A)} = 1.8\text{ V}$



c. LOW to HIGH propagation delay (nAn to nBn); $V_{CC(A)} = 2.5\text{ V}$

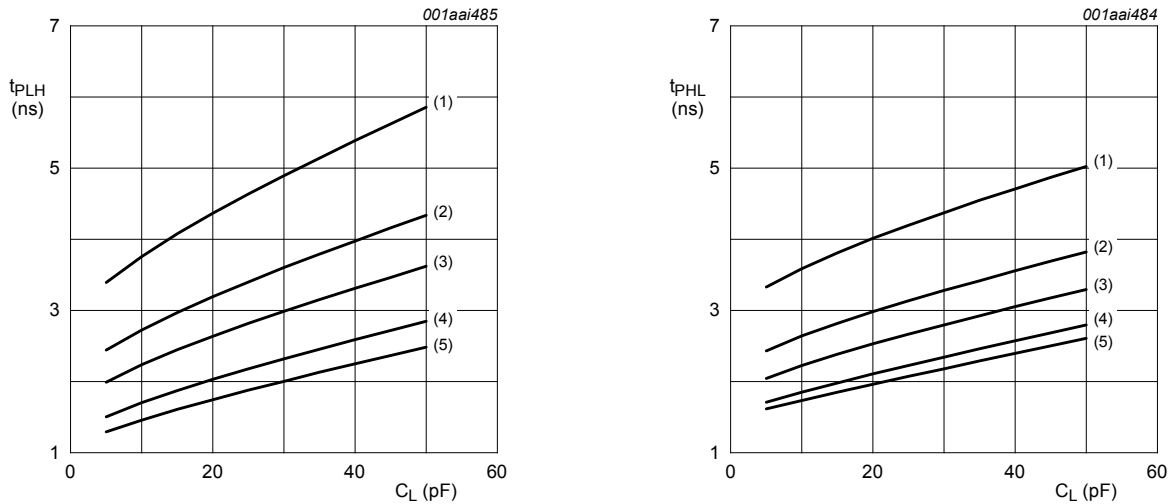


d. HIGH to LOW propagation delay (nAn to nBn); $V_{CC(A)} = 2.5\text{ V}$

- (1) $V_{CC(B)} = 1.2\text{ V}$.
- (2) $V_{CC(B)} = 1.5\text{ V}$.
- (3) $V_{CC(B)} = 1.8\text{ V}$.
- (4) $V_{CC(B)} = 2.5\text{ V}$.
- (5) $V_{CC(B)} = 3.3\text{ V}$.

Fig. 9. Typical propagation delay versus load capacitance; $T_{amb} = 25\text{ °C}$

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a. LOW to HIGH propagation delay (nAn to nBn);
 $V_{CC(A)} = 3.3\text{ V}$

- (1) $V_{CC(B)} = 1.2\text{ V}$.
- (2) $V_{CC(B)} = 1.5\text{ V}$.
- (3) $V_{CC(B)} = 1.8\text{ V}$.
- (4) $V_{CC(B)} = 2.5\text{ V}$.
- (5) $V_{CC(B)} = 3.3\text{ V}$.

b. HIGH to LOW propagation delay (nAn to nBn);
 $V_{CC(A)} = 3.3\text{ V}$

Fig. 10. Typical propagation delay versus load capacitance; $T_{amb} = 25\text{ °C}$

12. Package outline

TSSOP48: plastic thin shrink small outline package; 48 leads; body width 4.4 mm; lead pitch 0.4 mm

SOT480-1

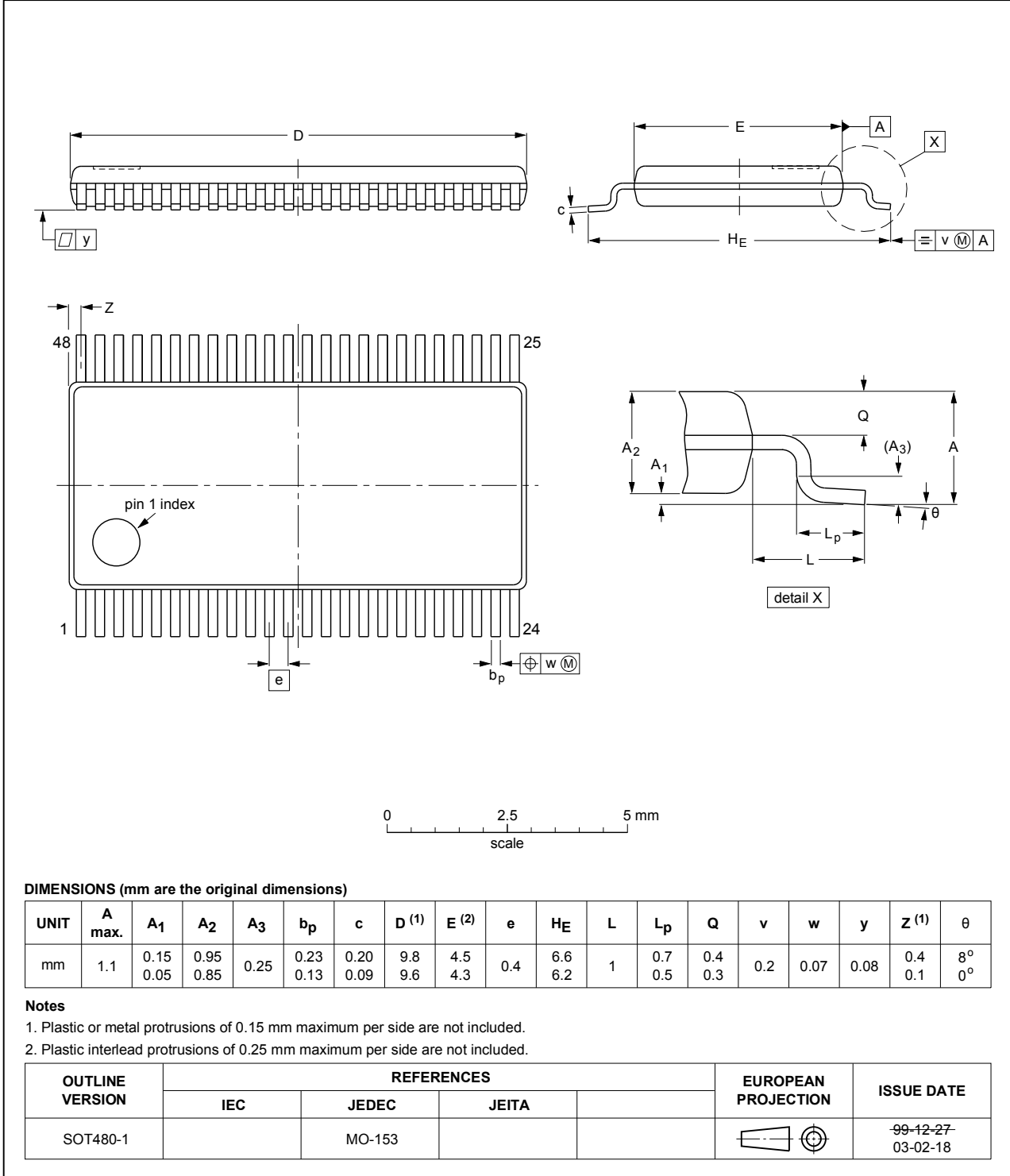


Fig. 11. Package outline SOT480-1 (TSSOP48)

13. Abbreviations

Table 16. Abbreviations

| Acronym | Description |
|---------|-------------------------|
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MIL | Military |
| MM | Machine Model |

14. Revision history

Table 17. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------------|---|--------------------|---------------|----------------------|
| 74AVC16T245_Q100 v.2 | 20190114 | Product data sheet | - | 74AVC16T245_Q100 v.1 |
| 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. | | | |
| 74AVC16T245_Q100 v.1 | 20131028 | Product data sheet | - | - |

15. 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>.

Definitions

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For sales office addresses, please send an email to: salesaddresses@nexperia.com

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