

# NTS0102

Dual supply translating transceiver; open-drain; auto direction sensing

Rev. 4.5 — 6 July 2023

Product data sheet

## 1 General description

The NTS0102 is a 2-bit, dual supply translating transceiver with auto direction sensing, that enables bidirectional voltage level translation. It features two 2-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 1.65 V and 3.6 V and  $V_{CC(B)}$  can be supplied at any voltage between 2.3 V and 5.5 V, making the device suitable for translating between any of the voltage nodes (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:
  - $V_{CC(A)}$ : 1.65 V to 3.6 V and  $V_{CC(B)}$ : 2.3 V to 5.5 V
- Maximum data rates:
  - Push-pull: 50 Mbit/s
- $I_{OFF}$  circuitry provides partial Power-down mode operation
- Inputs accept voltages up to 5.5 V
- ESD protection:
  - HBM JESD22-A114E Class 2 exceeds 2500 V for A port
  - HBM JESD22-A114E Class 3B exceeds 8000 V for B port
  - CDM JESD22-C101E exceeds 1500 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 Applications

- I<sup>2</sup>C/SMBus
- UART
- GPIO

## 4 Ordering information

Table 1. Ordering information

| Type number | Topside marking | Package |   |          |
|-------------|-----------------|---------|---|----------|
|             |                 | Name    | Description   | Version  |
| NTS0102DP   | s02             | TSSOP8  | plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm | SOT505-2 |



## Dual supply translating transceiver; open-drain; auto direction sensing

Table 1. Ordering information...continued

| Type number | Topside marking | Package |   |           |
|-------------|-----------------|---------|---|-----------|
|             |                 | Name    | Description   | Version   |
| NTS0102GT   | s02             | XSON8   | plastic extremely thin small outline package; no leads; 8 terminals; body 1 × 1.95 × 0.5 mm   | SOT833-1  |
| NTS0102GD   | s02             | XSON8   | plastic extremely thin small outline package; no leads; 8 terminals; body 3 × 2 × 0.5 mm      | SOT996-2  |
| NTS0102GF   | s2              | XSON8   | extremely thin small outline package; no leads; 8 terminals; body 1.35 × 1 × 0.5 mm           | SOT1089   |
| NTS0102TL   | tS2             | XSON8   | plastic extremely thin small outline package; no leads; 8 terminals; body 3 × 2 × 0.5 mm      | SOT1052-2 |
| NTS0102JK   | s2              | X2SON8  | super thin small outline; no leads, 8 terminals, 0.35 mm pitch, 1.35 mm x 1 mm x 0.32 mm body | SOT2015-1 |

## 4.1 Ordering options

Table 2. Ordering options

| Type number              | Orderable part number | Package | Packing method <sup>[1]</sup> | Minimum order quantity | Temperature       |
|--------------------------|-----------------------|---------|-------------------------------|------------------------|-------------------|
| NTS0102DP                | NTS0102DP,125         | TSSOP8  | Reel 7" Q3 NDP                | 3000                   | -40 °C to +125 °C |
| NTS0102GT                | NTS0102GT,115         | XSON8   | Reel 7" Q1 NDP                | 5000                   | -40 °C to +125 °C |
| NTS0102GD <sup>[2]</sup> | NTS0102GD,125         | XSON8   | Reel 7" Q3 NDP                | 3000                   | -40 °C to +125 °C |
| NTS0102GF                | NTS0102GF,115         | XSON8   | Reel 7" Q1 NDP                | 5000                   | -40 °C to +125 °C |
| NTS0102TL                | NTS0102TLH            | XSON8   | Reel 7" Q3 NDP                | 4000                   | -40 °C to +125 °C |
| NTS0102JK                | NTS0102JKZ            | X2SON8  | Reel 7" Q1 NDP<br>SSB         | 6000                   | -40 °C to +125 °C |

[1] Standard packing quantities and other packaging data are available at [www.nxp.com/packages/](http://www.nxp.com/packages/).

[2] Discontinuation Notice 202111012DN - drop in replacement is NTS0102TLH.

The TL package has a center pad vs no center pad for the GD package. The TL package pad is not electrically connected to the silicon and is not required to connect to the PCB so it can drop onto the GD package PCB layout. If the existing GD package has a trace underneath the risk is low since the TL package center pad is not connected to the silicon. If there are multiple traces there could be EMI and cross talk. In both cases the customer needs to evaluate risk.

Note: The length and width are reversed between the "GD" and "TL" package drawings but the shorter edge contains the pins and is 2.0 mm in both cases.

### 5 Functional diagram

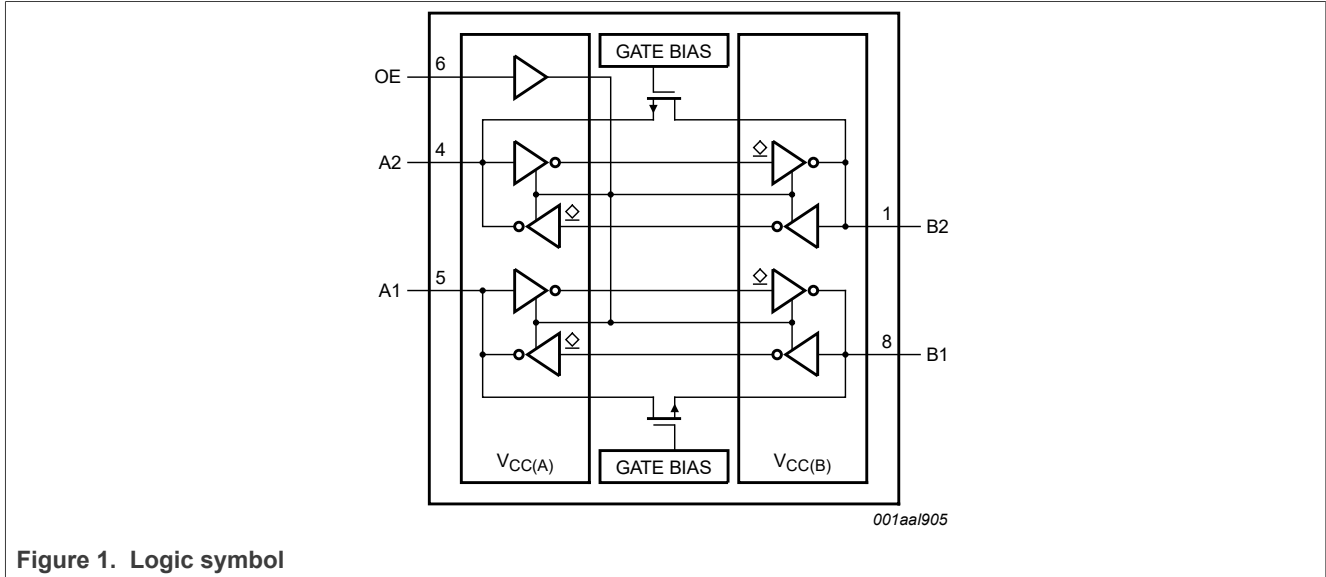


Figure 1. Logic symbol

### 6 Pinning information

#### 6.1 Pinning

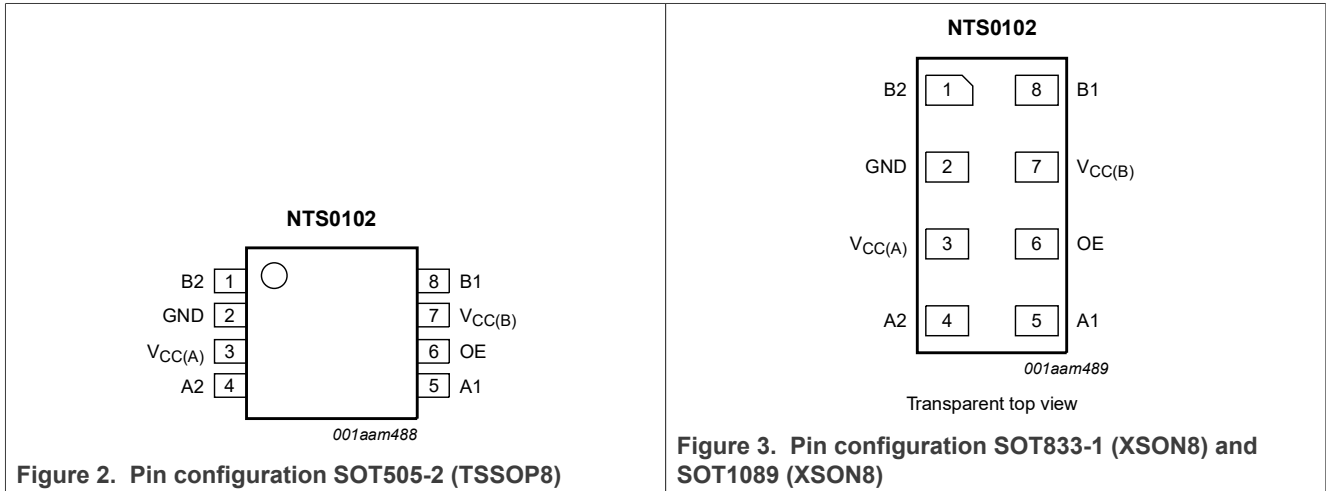
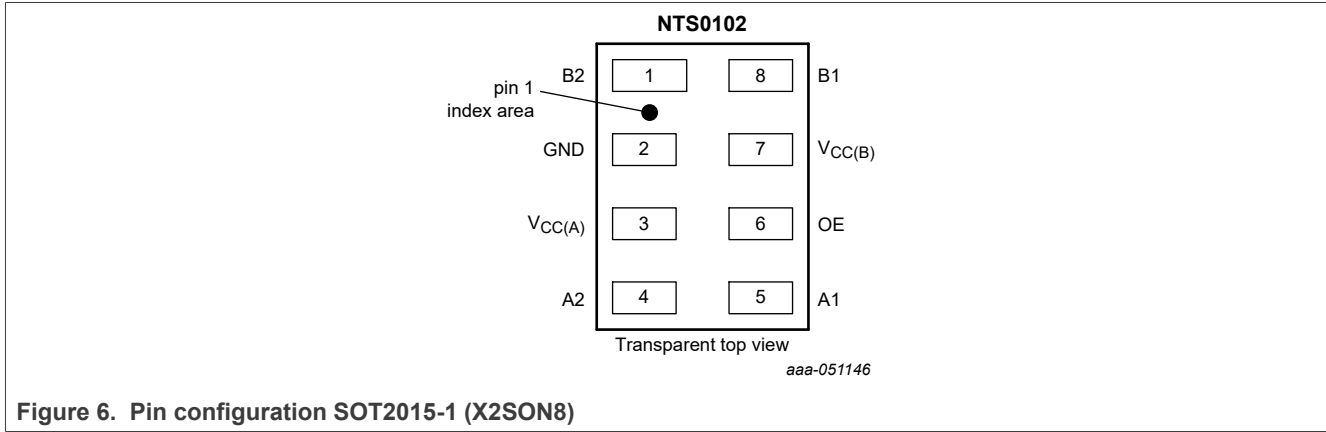
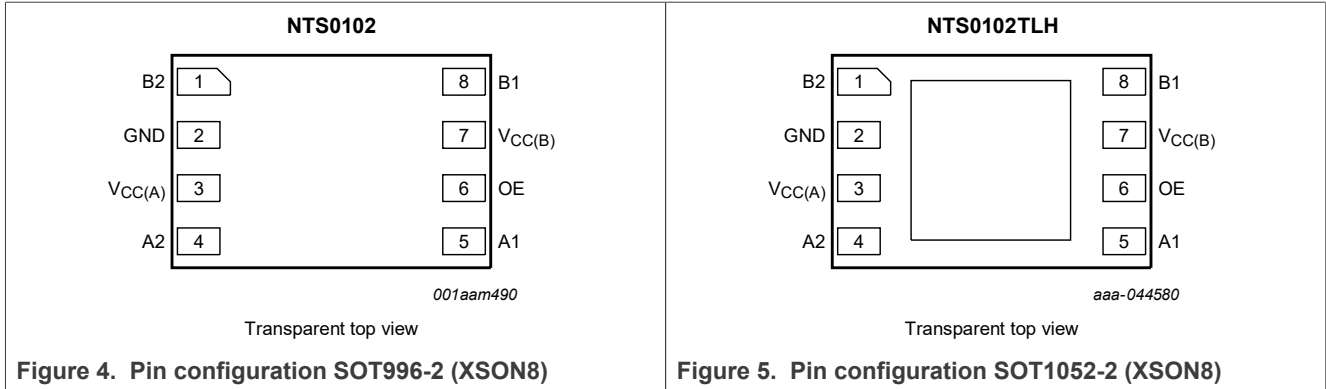


Figure 2. Pin configuration SOT505-2 (TSSOP8)

Figure 3. Pin configuration SOT833-1 (XSON8) and SOT1089 (XSON8)



### 6.2 Pin description

Table 3. Pin description

| Symbol      | Pin  | Description   |
|-------------|------|---|
| B2, B1      | 1, 8 | data input or output (referenced to $V_{CC(B)}$ )             |
| GND         | 2    | ground (0 V)  |
| $V_{CC(A)}$ | 3    | supply voltage A  |
| A2, A1      | 4, 5 | data input or output (referenced to $V_{CC(A)}$ )             |
| OE          | 6    | output enable input (active HIGH; referenced to $V_{CC(A)}$ ) |
| $V_{CC(B)}$ | 7    | supply voltage B  |

## 7 Functional description

Table 4. Function table<sup>[1]</sup>

| Supply voltage        |                    | Input | Input/output    |                 |
|-----------------------|--------------------|-------|-----------------|-----------------|
| $V_{CC(A)}$           | $V_{CC(B)}$        | OE    | An              | Bn              |
| 1.65 V to $V_{CC(B)}$ | 2.3 V to 5.5 V     | L     | Z               | Z               |
| 1.65 V to $V_{CC(B)}$ | 2.3 V to 5.5 V     | H     | input or output | output or input |
| GND <sup>[2]</sup>    | GND <sup>[2]</sup> | X     | Z               | Z               |

## Dual supply translating transceiver; open-drain; auto direction sensing

- [1] H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.  
 [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           | A port and OE input [1] [2]       | -0.5 | +6.5            | V    |
|             |                         | B port [1] [2]                    | -0.5 | +6.5            | V    |
| $V_O$       | output voltage          | Active mode [1] [2]               |      |                 |      |
|             |                         | A or B port                       | -0.5 | $V_{CCO} + 0.5$ | V    |
|             |                         | Power-down or 3-state mode [1]    |      |                 |      |
|             |                         | A port                            | -0.5 | +4.6            | V    |
|             |                         | B port                            | -0.5 | +6.5            | 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 $V_{CCO}$ [2]      | —    | $\pm 50$        | 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 [3] | —    | 250             | mW   |

- [1] The minimum input and minimum output voltage ratings may be exceeded if the input and output current ratings are observed.  
 [2]  $V_{CCO}$  is the supply voltage associated with the output.  
 [3] For TSSOP8 package: above 55 °C, the value of  $P_{tot}$  derates linearly with 2.5 mW/K.  
 For XSON8 packages: above 118 °C, the value of  $P_{tot}$  derates linearly with 7.8 mW/K.

## 9 Recommended operating conditions

**Table 6. Recommended operating conditions<sup>[1][2]</sup>**

| Symbol              | Parameter                           | Conditions   | Min  | Max  | Unit |
|---------------------|-------------------------------------|--|------|------|------|
| $V_{CC(A)}$         | supply voltage A                    |  | 1.65 | 3.6  | V    |
| $V_{CC(B)}$         | supply voltage B                    |  | 2.3  | 5.5  | V    |
| $T_{amb}$           | ambient temperature                 |  | -40  | +125 | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | A or B port; push-pull driving                                 |      |      |      |
|                     |                                     | $V_{CC(A)} = 1.65$ V to 3.6 V;<br>$V_{CC(B)} = 2.3$ V to 5.5 V | —    | 10   | ns/V |
|                     |                                     | OE input   |      |      |      |
|                     |                                     | $V_{CC(A)} = 1.65$ V to 3.6 V;<br>$V_{CC(B)} = 2.3$ V to 5.5 V | —    | 10   | ns/V |

Dual supply translating transceiver; open-drain; auto direction sensing

- [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  $V_{CC(B)}$ .

## 10 Static characteristics

**Table 7. Typical static characteristics**

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

| Symbol    | Parameter                 | Conditions   | Min | Typ | Max     | Unit          |
|-----------|---------------------------|--|-----|-----|---------|---------------|
| $I_I$     | input leakage current     | OE input; $V_I = 0\text{ V to }3.6\text{ V}$ ; $V_{CC(A)} = 1.65\text{ V to }3.6\text{ V}$ ; $V_{CC(B)} = 2.3\text{ V to }5.5\text{ V}$              | —   | —   | $\pm 1$ | $\mu\text{A}$ |
| $I_{OZ}$  | OFF-state output current  | A or B port; $V_O = 0\text{ V or }V_{CCO}$ ; $V_{CC(A)} = 1.65\text{ V to }3.6\text{ V}$ ; $V_{CC(B)} = 2.3\text{ V to }5.5\text{ V}$ <sup>[1]</sup> | —   | —   | $\pm 1$ | $\mu\text{A}$ |
| $I_{OFF}$ | 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 $V_O = 0\text{ V to }5.5\text{ V}$ ; $V_{CC(B)} = 0\text{ V}$ ; $V_{CC(A)} = 0\text{ V to }3.6\text{ V}$                            | —   | —   | $\pm 1$ | $\mu\text{A}$ |
| $C_I$     | input capacitance         | OE input; $V_{CC(A)} = 3.3\text{ V}$ ; $V_{CC(B)} = 3.3\text{ V}$  | —   | 1   | —       | pF            |
| $C_{I/O}$ | input/output capacitance  | A port   | —   | 5   | —       | pF            |
|           |                           | B port   | —   | 8.5 | —       | pF            |
|           |                           | A or B port; $V_{CC(A)} = 3.3\text{ V}$ ; $V_{CC(B)} = 3.3\text{ V}$   | —   | 11  | —       | pF            |

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

**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          |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------|
|             | 2.5 V       |             | 3.3 V       |             | 5.0 V       |             |               |
|             | $I_{CC(A)}$ | $I_{CC(B)}$ | $I_{CC(A)}$ | $I_{CC(B)}$ | $I_{CC(A)}$ | $I_{CC(B)}$ |               |
| 1.8 V       | 0.1         | 0.5         | 0.1         | 1.5         | 0.1         | 4.6         | $\mu\text{A}$ |
| 2.5 V       | 0.1         | 0.1         | 0.1         | 0.8         | 0.1         | 3.8         | $\mu\text{A}$ |
| 3.3 V       | —           | —           | 0.1         | 0.1         | 0.1         | 2.8         | $\mu\text{A}$ |

**Table 9. Static characteristics**

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

| Symbol   | Parameter                | Conditions   | $-40\text{ }^{\circ}\text{C to }+85\text{ }^{\circ}\text{C}$ |     | $-40\text{ }^{\circ}\text{C to }+125\text{ }^{\circ}\text{C}$ |     | Unit |
|----------|--------------------------|--|--|-----|---|-----|------|
|          |                          |  | Min  | Max | Min   | Max |      |
| $V_{IH}$ | HIGH-level input voltage | A port   |  |     |   |     |      |
|          |                          | $V_{CC(A)} = 1.65\text{ V to }1.95\text{ V}$ ; $V_{CC(B)} = 2.3\text{ V to }5.5\text{ V}$ <sup>[1]</sup> | $V_{CCI} - 0.2$  | —   | $V_{CCI} - 0.2$   | —   | V    |
|          |                          | $V_{CC(A)} = 2.3\text{ V to }3.6\text{ V}$ ; $V_{CC(B)} = 2.3\text{ V to }5.5\text{ V}$ <sup>[1]</sup>   | $V_{CCI} - 0.4$  | —   | $V_{CCI} - 0.4$   | —   | V    |

Dual supply translating transceiver; open-drain; auto direction sensing

Table 9. Static characteristics...continued

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

| Symbol    | Parameter                 | Conditions   | -40 °C to +85 °C |                 | -40 °C to +125 °C |                 | Unit          |
|-----------|---------------------------|--|------------------|-----------------|-------------------|-----------------|---------------|
|           |                           |  | Min              | Max             | Min               | Max             |               |
|           |                           | B port   |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$ <sup>[1]</sup>   | $V_{CCI} - 0.4$  | —               | $V_{CCI} - 0.4$   | —               | V             |
|           |                           | OE input   |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$  | $0.65V_{CC(A)}$  | —               | $0.65V_{CC(A)}$   | —               | V             |
| $V_{IL}$  | LOW-level input voltage   | A or B port  |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$  | —                | 0.15            | —                 | 0.15            | V             |
|           |                           | OE input   |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$  | —                | $0.35V_{CC(A)}$ | —                 | $0.35V_{CC(A)}$ | V             |
| $V_{OH}$  | HIGH-level output voltage | $I_O = -20 \mu\text{A}$  |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$ <sup>[2]</sup>   | $0.67V_{CCO}$    | —               | $0.67V_{CCO}$     | —               | V             |
| $V_{OL}$  | LOW-level output voltage  | A or B port; $I_O = 1 \text{ mA}$ <sup>[2]</sup>   |                  |                 |                   |                 |               |
|           |                           | $V_I \leq 0.15 \text{ V}; V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$                                   | —                | 0.4             | —                 | 0.4             | V             |
| $I_I$     | input leakage current     | OE input; $V_I = 0 \text{ V to } 3.6 \text{ V}; V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$             | —                | $\pm 2$         | —                 | $\pm 12$        | $\mu\text{A}$ |
| $I_{OZ}$  | OFF-state output current  | A or B port; $V_O = 0 \text{ V or } V_{CCO}; V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$ <sup>[2]</sup> | —                | $\pm 2$         | —                 | $\pm 12$        | $\mu\text{A}$ |
| $I_{OFF}$ | power-off leakage current | A port; $V_I \text{ or } V_O = 0 \text{ V to } 3.6 \text{ V}; V_{CC(A)} = 0 \text{ V}; V_{CC(B)} = 0 \text{ V to } 5.5 \text{ V}$                      | —                | $\pm 2$         | —                 | $\pm 12$        | $\mu\text{A}$ |
|           |                           | B port; $V_I \text{ or } V_O = 0 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 0 \text{ V}; V_{CC(A)} = 0 \text{ V to } 3.6 \text{ V}$                      | —                | $\pm 2$         | —                 | $\pm 12$        | $\mu\text{A}$ |
| $I_{CC}$  | supply current            | $V_I = 0 \text{ V or } V_{CCI}; I_O = 0 \text{ A}$ <sup>[1]</sup>  |                  |                 |                   |                 |               |
|           |                           | $I_{CC(A)}$  |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$  | —                | 2.4             | —                 | 15              | $\mu\text{A}$ |
|           |                           | $V_{CC(A)} = 3.6 \text{ V}; V_{CC(B)} = 0 \text{ V}$   | —                | 2.2             | —                 | 15              | $\mu\text{A}$ |
|           |                           | $V_{CC(A)} = 0 \text{ V}; V_{CC(B)} = 5.5 \text{ V}$   | —                | -1              | —                 | -8              | $\mu\text{A}$ |
|           |                           | $I_{CC(B)}$  |                  |                 |                   |                 |               |
|           |                           | $V_{CC(A)} = 1.65 \text{ V to } 3.6 \text{ V}; V_{CC(B)} = 2.3 \text{ V to } 5.5 \text{ V}$  | —                | 12              | —                 | 30              | $\mu\text{A}$ |
|           |                           | $V_{CC(A)} = 3.6 \text{ V}; V_{CC(B)} = 0 \text{ V}$   | —                | -1              | —                 | -5              | $\mu\text{A}$ |
|           |                           | $V_{CC(A)} = 0 \text{ V}; V_{CC(B)} = 5.5 \text{ V}$   | —                | 1               | —                 | 6               | $\mu\text{A}$ |

Dual supply translating transceiver; open-drain; auto direction sensing

**Table 9. Static characteristics...continued**

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

| Symbol | Parameter | Conditions  | -40 °C to +85 °C |      | -40 °C to +125 °C |     | Unit |
|--------|-----------|---|------------------|------|-------------------|-----|------|
|        |           |   | Min              | Max  | Min               | Max |      |
|        |           | $I_{CC(A)} + I_{CC(B)}$   |                  |      |                   |     |      |
|        |           | $V_{CC(A)} = 1.65\text{ V to }3.6\text{ V}; V_{CC(B)} = 2.3\text{ V to }5.5\text{ V}$ | —                | 14.4 | —                 | 30  | µA   |

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

### 11 Dynamic characteristics

**Table 10. Dynamic characteristics for temperature range -40 °C to +85 °C<sup>[1]</sup>**

Voltages are referenced to GND (ground = 0 V); for test circuit, see [Figure 9](#); for wave forms see [Figure 7](#) and [Figure 8](#).

| Symbol   | Parameter                          | Conditions                               | $V_{CC(B)}$   |      |               |     |               |      | Unit   |
|--|------------------------------------|--|---------------|------|---------------|-----|---------------|------|--------|
|  |                                    |  | 2.5 V ± 0.2 V |      | 3.3 V ± 0.3 V |     | 5.0 V ± 0.5 V |      |        |
|  |                                    |  | Min           | Max  | Min           | Max | Min           | Max  |        |
| <b><math>V_{CC(A)} = 1.8\text{ V} \pm 0.15\text{ V}</math></b> |                                    |  |               |      |               |     |               |      |        |
| $t_{PHL}$  | HIGH to LOW propagation delay      | A to B                                   | —             | 4.6  | —             | 4.7 | —             | 5.8  | ns     |
| $t_{PLH}$  | LOW to HIGH propagation delay      | A to B                                   | —             | 6.8  | —             | 6.8 | —             | 7.0  | ns     |
| $t_{PHL}$  | HIGH to LOW propagation delay      | B to A                                   | —             | 4.4  | —             | 4.5 | —             | 4.7  | ns     |
| $t_{PLH}$  | LOW to HIGH propagation delay      | B to A                                   | —             | 5.3  | —             | 4.5 | —             | 0.5  | ns     |
| $t_{en}$   | enable time                        | OE to A; B                               | —             | 200  | —             | 200 | —             | 200  | ns     |
| $t_{dis}$  | disable time                       | OE to A; no external load <sup>[2]</sup> | —             | 25   | —             | 25  | —             | 25   | ns     |
|  |                                    | OE to B; no external load <sup>[2]</sup> | —             | 25   | —             | 25  | —             | 25   | ns     |
|  |                                    | OE to A                                  | —             | 230  | —             | 230 | —             | 230  | ns     |
|  |                                    | OE to B                                  | —             | 200  | —             | 200 | —             | 200  | ns     |
| $t_{TLH}$  | LOW to HIGH output transition time | A port                                   | 3.2           | 9.5  | 2.3           | 9.3 | 1.8           | 7.6  | ns     |
|  |                                    | B port                                   | 3.3           | 10.8 | 2.7           | 9.1 | 2.7           | 7.6  | ns     |
| $t_{THL}$  | HIGH to LOW output transition time | A port                                   | 2.0           | 5.9  | 1.9           | 6.0 | 1.7           | 13.3 | ns     |
|  |                                    | B port                                   | 2.9           | 7.6  | 2.8           | 7.5 | 2.8           | 10.0 | ns     |
| $t_{sk(o)}$  | output skew time                   | between channels <sup>[3]</sup>          | —             | 0.7  | —             | 0.7 | —             | 0.7  | ns     |
| $t_W$  | pulse width                        | data inputs                              | 20            | —    | 20            | —   | 20            | —    | ns     |
| $f_{data}$   | data rate                          |  | —             | 50   | —             | 50  | —             | 50   | Mbit/s |
| <b><math>V_{CC(A)} = 2.5\text{ V} \pm 0.2\text{ V}</math></b>  |                                    |  |               |      |               |     |               |      |        |
| $t_{PHL}$  | HIGH to LOW propagation delay      | A to B                                   | —             | 3.2  | —             | 3.3 | —             | 3.4  | ns     |



Dual supply translating transceiver; open-drain; auto direction sensing

Table 10. Dynamic characteristics for temperature range -40 °C to +85 °C<sup>[1]</sup>...continued

Voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 9; for wave forms see Figure 7 and Figure 8.

| Symbol                                   | Parameter                          | Conditions                               | V <sub>CC(B)</sub> |     |               |     |               |     | Unit   |
|--|------------------------------------|--|--------------------|-----|---------------|-----|---------------|-----|--------|
|  |                                    |  | 2.5 V ± 0.2 V      |     | 3.3 V ± 0.3 V |     | 5.0 V ± 0.5 V |     |        |
|  |                                    |  | Min                | Max | Min           | Max | Min           | Max |        |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | A to B                                   | —                  | 3.5 | —             | 4.1 | —             | 4.4 | ns     |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | B to A                                   | —                  | 3.0 | —             | 3.6 | —             | 4.3 | ns     |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | B to A                                   | —                  | 2.5 | —             | 1.6 | —             | 0.7 | ns     |
| t <sub>en</sub>                          | enable time                        | OE to A; B                               | —                  | 200 | —             | 200 | —             | 200 | ns     |
| t <sub>dis</sub>                         | disable time                       | OE to A; no external load <sup>[2]</sup> | —                  | 20  | —             | 20  | —             | 20  | ns     |
|  |                                    | OE to B; no external load <sup>[2]</sup> | —                  | 20  | —             | 20  | —             | 20  | ns     |
|  |                                    | OE to A                                  | —                  | 200 | —             | 200 | —             | 200 | ns     |
|  |                                    | OE to B                                  | —                  | 200 | —             | 200 | —             | 200 | ns     |
| t <sub>TLH</sub>                         | LOW to HIGH output transition time | A port                                   | 2.8                | 7.4 | 2.6           | 6.6 | 1.8           | 6.2 | ns     |
|  |                                    | B port                                   | 3.2                | 8.3 | 2.9           | 7.9 | 2.4           | 6.8 | ns     |
| t <sub>THL</sub>                         | HIGH to LOW output transition time | A port                                   | 1.9                | 5.7 | 1.9           | 5.5 | 1.8           | 5.3 | ns     |
|  |                                    | B port                                   | 2.2                | 7.8 | 2.4           | 6.7 | 2.6           | 6.6 | ns     |
| t <sub>sk(o)</sub>                       | output skew time                   | between channels <sup>[3]</sup>          | —                  | 0.7 | —             | 0.7 | —             | 0.7 | ns     |
| t <sub>W</sub>                           | pulse width                        | data inputs                              | 20                 | —   | 20            | —   | 20            | —   | ns     |
| f <sub>data</sub>                        | data rate                          |  | —                  | 50  | —             | 50  | —             | 50  | Mbit/s |
| <b>V<sub>CC(A)</sub> = 3.3 V ± 0.3 V</b> |                                    |  |                    |     |               |     |               |     |        |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | A to B                                   | —                  | —   | —             | 2.4 | —             | 3.1 | ns     |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | A to B                                   | —                  | —   | —             | 4.2 | —             | 4.4 | ns     |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | B to A                                   | —                  | —   | —             | 2.5 | —             | 3.3 | ns     |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | B to A                                   | —                  | —   | —             | 2.5 | —             | 2.6 | ns     |
| t <sub>en</sub>                          | enable time                        | OE to A; B                               | —                  | —   | —             | 200 | —             | 200 | ns     |
| t <sub>dis</sub>                         | disable time                       | OE to A; no external load <sup>[2]</sup> | —                  | —   | —             | 15  | —             | 15  | ns     |
|  |                                    | OE to B; no external load <sup>[2]</sup> | —                  | —   | —             | 15  | —             | 15  | ns     |
|  |                                    | OE to A                                  | —                  | —   | —             | 260 | —             | 260 | ns     |
|  |                                    | OE to B                                  | —                  | —   | —             | 200 | —             | 200 | ns     |
| t <sub>TLH</sub>                         | LOW to HIGH output transition time | A port                                   | —                  | —   | 2.3           | 5.6 | 1.9           | 5.9 | ns     |
|  |                                    | B port                                   | —                  | —   | 2.5           | 6.4 | 2.1           | 7.4 | ns     |

Dual supply translating transceiver; open-drain; auto direction sensing

Table 10. Dynamic characteristics for temperature range -40 °C to +85 °C<sup>[1]</sup>...continued

Voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 9; for wave forms see Figure 7 and Figure 8.

| Symbol             | Parameter                          | Conditions       | V <sub>CC(B)</sub> |     |               |     |               |     | Unit   |    |
|--------------------|------------------------------------|------------------|--------------------|-----|---------------|-----|---------------|-----|--------|----|
|                    |                                    |                  | 2.5 V ± 0.2 V      |     | 3.3 V ± 0.3 V |     | 5.0 V ± 0.5 V |     |        |    |
|                    |                                    |                  | Min                | Max | Min           | Max | Min           | Max |        |    |
| t <sub>THL</sub>   | HIGH to LOW output transition time | A port           | —                  | —   | 2.0           | 5.4 | 1.9           | 5.0 | ns     |    |
|                    |                                    | B port           | —                  | —   | 2.3           | 7.4 | 2.4           | 7.6 | ns     |    |
| t <sub>sk(o)</sub> | output skew time                   | between channels | [3]                | —   | —             | —   | 0.7           | —   | 0.7    | ns |
| t <sub>W</sub>     | pulse width                        | data inputs      | —                  | —   | 20            | —   | 20            | —   | ns     |    |
| f <sub>data</sub>  | data rate                          |                  | —                  | —   | —             | 50  | —             | 50  | Mbit/s |    |

[1] 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>.

[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 11. Dynamic characteristics for temperature range -40 °C to +125 °C<sup>[1]</sup>

Voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 9; for wave forms see Figure 7 and Figure 8.

| Symbol                              | Parameter                          | Conditions                | V <sub>CC(B)</sub> |     |               |     |               |     | Unit |    |
|-------------------------------------|------------------------------------|---------------------------|--------------------|-----|---------------|-----|---------------|-----|------|----|
|                                     |                                    |                           | 2.5 V ± 0.2 V      |     | 3.3 V ± 0.3 V |     | 5.0 V ± 0.5 V |     |      |    |
|                                     |                                    |                           | Min                | Max | Min           | Max | Min           | Max |      |    |
| V <sub>CC(A)</sub> = 1.8 V ± 0.15 V |                                    |                           |                    |     |               |     |               |     |      |    |
| t <sub>PHL</sub>                    | HIGH to LOW propagation delay      | A to B                    | —                  | 5.8 | —             | 5.9 | —             | 7.3 | ns   |    |
| t <sub>PLH</sub>                    | LOW to HIGH propagation delay      | A to B                    | —                  | 8.5 | —             | 8.5 | —             | 8.8 | ns   |    |
| t <sub>PHL</sub>                    | HIGH to LOW propagation delay      | B to A                    | —                  | 5.5 | —             | 5.7 | —             | 5.9 | ns   |    |
| t <sub>PLH</sub>                    | LOW to HIGH propagation delay      | B to A                    | —                  | 6.7 | —             | 5.7 | —             | 0.7 | ns   |    |
| t <sub>en</sub>                     | enable time                        | OE to A; B                | —                  | 200 | —             | 200 | —             | 200 | ns   |    |
| t <sub>dis</sub>                    | disable time                       | OE to A; no external load | [2]                | —   | 30            | —   | 30            | —   | 30   | ns |
|                                     |                                    | OE to B; no external load | [2]                | —   | 30            | —   | 30            | —   | 30   | ns |
|                                     |                                    | OE to A                   |                    | —   | 250           | —   | 250           | —   | 250  | ns |
|                                     |                                    | OE to B                   |                    | —   | 220           | —   | 220           | —   | 220  | ns |
| t <sub>TLH</sub>                    | LOW to HIGH output transition time | A port                    |                    | 3.2 | 11.9          | 2.3 | 11.7          | 1.8 | 9.5  | ns |
|                                     |                                    | B port                    |                    | 3.3 | 13.5          | 2.7 | 11.4          | 2.7 | 9.5  | ns |
| t <sub>THL</sub>                    | HIGH to LOW output transition time | A port                    |                    | 2.0 | 7.4           | 1.9 | 7.5           | 1.7 | 16.7 | ns |
|                                     |                                    | B port                    |                    | 2.9 | 9.5           | 2.8 | 9.4           | 2.8 | 12.5 | ns |
| t <sub>sk(o)</sub>                  | output skew time                   | between channels          | [3]                | —   | 0.8           | —   | 0.8           | —   | 0.8  | ns |
| t <sub>W</sub>                      | pulse width                        | data inputs               |                    | 20  | —             | 20  | —             | 20  | —    | ns |

Dual supply translating transceiver; open-drain; auto direction sensing

Table 11. Dynamic characteristics for temperature range -40 °C to +125 °C<sup>[1]</sup>...continued  
 Voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 9; for wave forms see Figure 7 and Figure 8.

| Symbol                                   | Parameter                          | Conditions                               | V <sub>CC(B)</sub> |      |               |     |               |     | Unit   |  |
|--|------------------------------------|--|--------------------|------|---------------|-----|---------------|-----|--------|--|
|  |                                    |  | 2.5 V ± 0.2 V      |      | 3.3 V ± 0.3 V |     | 5.0 V ± 0.5 V |     |        |  |
|  |                                    |  | Min                | Max  | Min           | Max | Min           | Max |        |  |
| f <sub>data</sub>                        | data rate                          |  | —                  | 50   | —             | 50  | —             | 50  | Mbit/s |  |
| <b>V<sub>CC(A)</sub> = 2.5 V ± 0.2 V</b> |                                    |  |                    |      |               |     |               |     |        |  |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | A to B                                   | —                  | 4.0  | —             | 4.2 | —             | 4.3 | ns     |  |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | A to B                                   | —                  | 4.4  | —             | 5.2 | —             | 5.5 | ns     |  |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | B to A                                   | —                  | 3.8  | —             | 4.5 | —             | 5.4 | ns     |  |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | B to A                                   | —                  | 3.2  | —             | 2.0 | —             | 0.9 | ns     |  |
| t <sub>en</sub>                          | enable time                        | OE to A; B                               | —                  | 200  | —             | 200 | —             | 200 | ns     |  |
| t <sub>dis</sub>                         | disable time                       | OE to A; no external load <sup>[2]</sup> | —                  | 25   | —             | 25  | —             | 25  | ns     |  |
|  |                                    | OE to B; no external load <sup>[2]</sup> | —                  | 25   | —             | 25  | —             | 25  | ns     |  |
|  |                                    | OE to A                                  | —                  | 220  | —             | 220 | —             | 220 | ns     |  |
|  |                                    | OE to B                                  | —                  | 220  | —             | 220 | —             | 220 | ns     |  |
| t <sub>TLH</sub>                         | LOW to HIGH output transition time | A port                                   | 2.8                | 9.3  | 2.6           | 8.3 | 1.8           | 7.8 | ns     |  |
|  |                                    | B port                                   | 3.2                | 10.4 | 2.9           | 9.7 | 2.4           | 8.3 | ns     |  |
| t <sub>THL</sub>                         | HIGH to LOW output transition time | A port                                   | 1.9                | 7.2  | 1.9           | 6.9 | 1.8           | 6.7 | ns     |  |
|  |                                    | B port                                   | 2.2                | 9.8  | 2.4           | 8.4 | 2.6           | 8.3 | ns     |  |
| t <sub>sk(o)</sub>                       | output skew time                   | between channels <sup>[3]</sup>          | —                  | 0.8  | —             | 0.8 | —             | 0.8 | ns     |  |
| t <sub>w</sub>                           | pulse width                        | data inputs                              | 20                 | —    | 20            | —   | 20            | —   | ns     |  |
| f <sub>data</sub>                        | data rate                          |  | —                  | 50   | —             | 50  | —             | 50  | Mbit/s |  |
| <b>V<sub>CC(A)</sub> = 3.3 V ± 0.3 V</b> |                                    |  |                    |      |               |     |               |     |        |  |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | A to B                                   | —                  | —    | —             | 3.0 | —             | 3.9 | ns     |  |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | A to B                                   | —                  | —    | —             | 5.3 | —             | 5.5 | ns     |  |
| t <sub>PHL</sub>                         | HIGH to LOW propagation delay      | B to A                                   | —                  | —    | —             | 3.2 | —             | 4.2 | ns     |  |
| t <sub>PLH</sub>                         | LOW to HIGH propagation delay      | B to A                                   | —                  | —    | —             | 3.2 | —             | 3.3 | ns     |  |
| t <sub>en</sub>                          | enable time                        | OE to A; B                               | —                  | —    | —             | 200 | —             | 200 | ns     |  |
| t <sub>dis</sub>                         | disable time                       | OE to A; no external load <sup>[2]</sup> | —                  | —    | —             | 20  | —             | 20  | ns     |  |
|  |                                    | OE to B; no external load <sup>[2]</sup> | —                  | —    | —             | 20  | —             | 20  | ns     |  |

Dual supply translating transceiver; open-drain; auto direction sensing

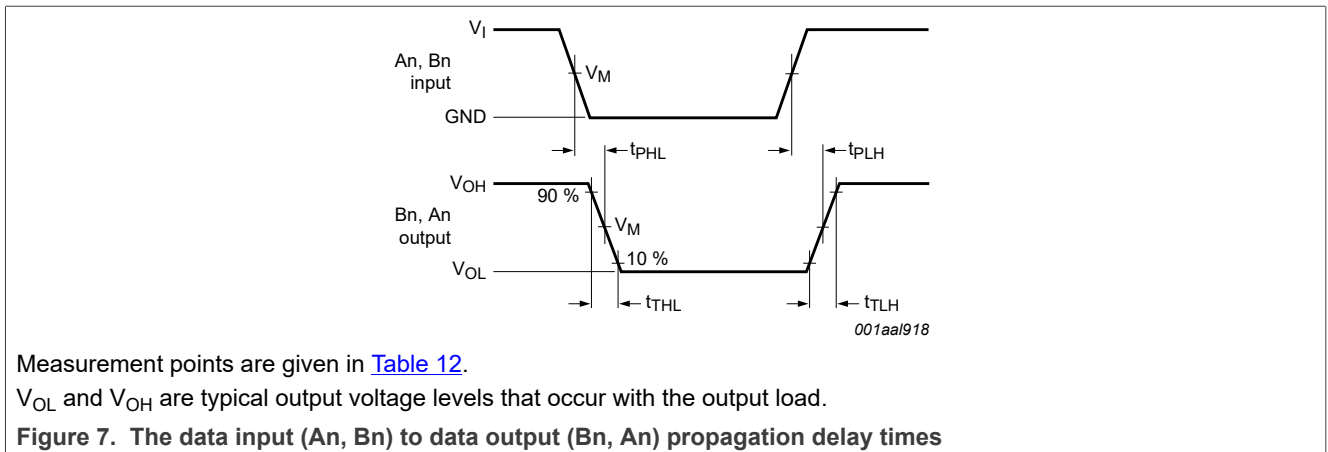
Table 11. Dynamic characteristics for temperature range -40 °C to +125 °C<sup>[1]</sup>...continued

Voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 9; for wave forms see Figure 7 and Figure 8.

| Symbol             | Parameter                          | Conditions       | V <sub>CC(B)</sub> |     |               |     |               |     | Unit   |
|--------------------|------------------------------------|------------------|--------------------|-----|---------------|-----|---------------|-----|--------|
|                    |                                    |                  | 2.5 V ± 0.2 V      |     | 3.3 V ± 0.3 V |     | 5.0 V ± 0.5 V |     |        |
|                    |                                    |                  | Min                | Max | Min           | Max | Min           | Max |        |
|                    |                                    | OE to A          | —                  | —   | —             | 280 | —             | 280 | ns     |
|                    |                                    | OE to B          | —                  | —   | —             | 220 | —             | 220 | ns     |
| t <sub>TLH</sub>   | LOW to HIGH output transition time | A port           | —                  | —   | 2.3           | 7.0 | 1.9           | 7.4 | ns     |
|                    |                                    | B port           | —                  | —   | 2.5           | 8.0 | 2.1           | 9.3 | ns     |
| t <sub>THL</sub>   | HIGH to LOW output transition time | A port           | —                  | —   | 2.0           | 6.8 | 1.9           | 6.3 | ns     |
|                    |                                    | B port           | —                  | —   | 2.3           | 9.3 | 2.4           | 9.5 | ns     |
| t <sub>sk(o)</sub> | output skew time                   | between channels | [3]                | —   | —             | 0.8 | —             | 0.8 | ns     |
| t <sub>W</sub>     | pulse width                        | data inputs      | —                  | —   | 20            | —   | 20            | —   | ns     |
| f <sub>data</sub>  | data rate                          |                  | —                  | —   | —             | 50  | —             | 50  | Mbit/s |

- [1] 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>.
- [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.

## 12 Waveforms



Dual supply translating transceiver; open-drain; auto direction sensing

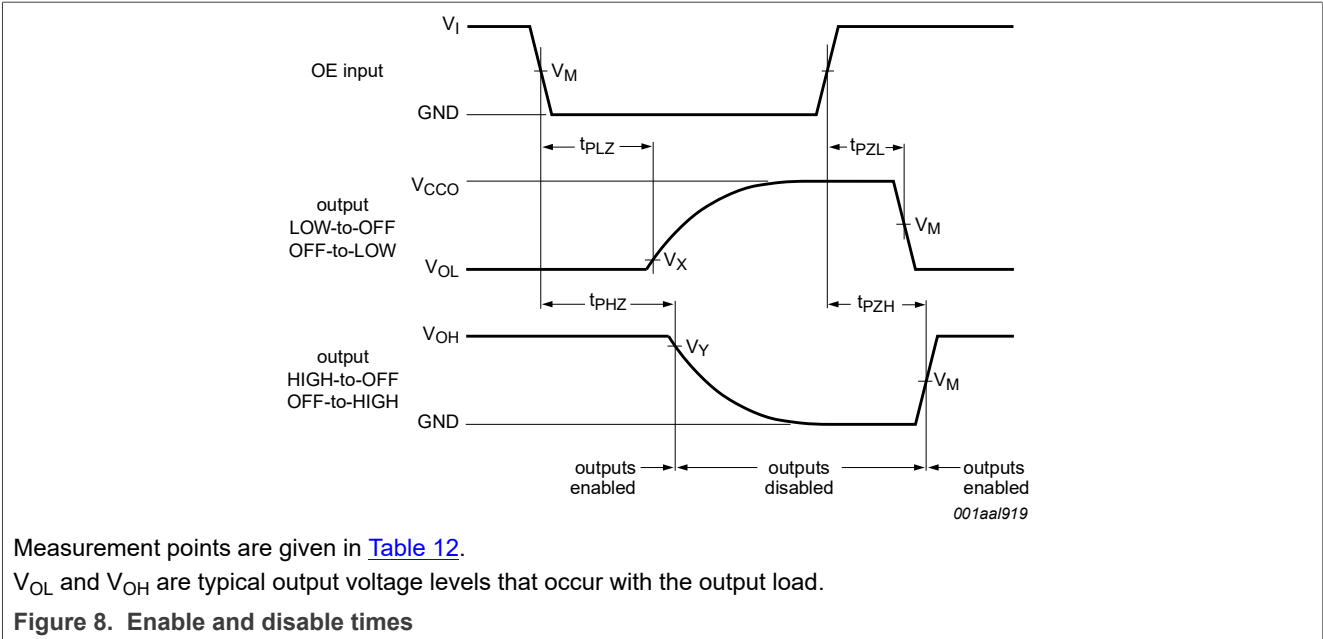


Table 12. Measurement points<sup>[1][2]</sup>

| Supply voltage | Input        | Output       |                   |                   |
|----------------|--------------|--------------|-------------------|-------------------|
| $V_{CCO}$      | $V_M$        | $V_M$        | $V_X$             | $V_Y$             |
| 1.8 V ± 0.15 V | $0.5V_{CCI}$ | $0.5V_{CCO}$ | $V_{OL} + 0.15 V$ | $V_{OH} - 0.15 V$ |
| 2.5 V ± 0.2 V  | $0.5V_{CCI}$ | $0.5V_{CCO}$ | $V_{OL} + 0.15 V$ | $V_{OH} - 0.15 V$ |
| 3.3 V ± 0.3 V  | $0.5V_{CCI}$ | $0.5V_{CCO}$ | $V_{OL} + 0.3 V$  | $V_{OH} - 0.3 V$  |
| 5.0 V ± 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.  
 [2]  $V_{CCO}$  is the supply voltage associated with the output.

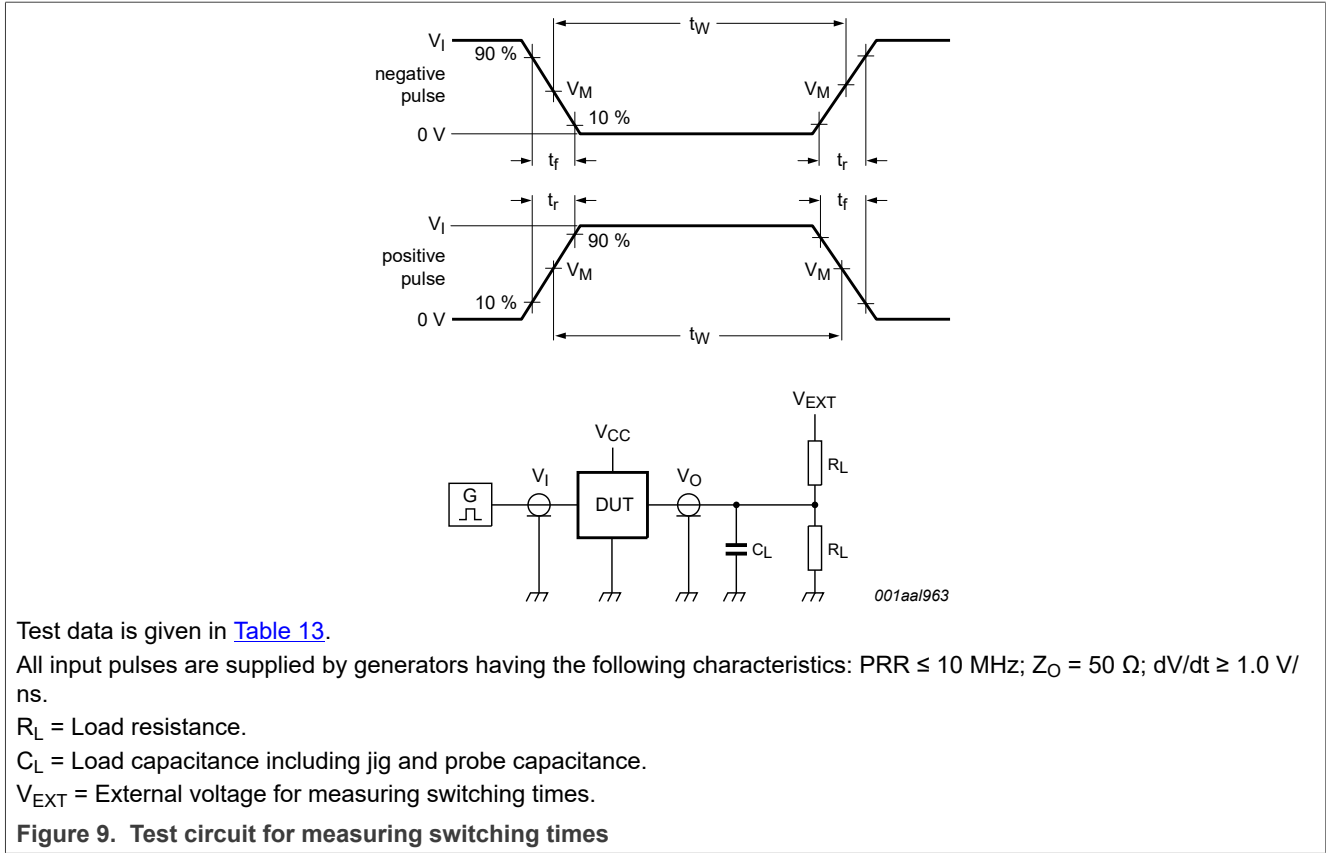


Table 13. Test data

| Supply voltage     |                    | Input                         |            | Load           |                               | V <sub>EXT</sub>                    |                                     |  |
|--------------------|--------------------|-------------------------------|------------|----------------|-------------------------------|-------------------------------------|-------------------------------------|--|
| V <sub>CC(A)</sub> | V <sub>CC(B)</sub> | V <sub>I</sub> <sup>[1]</sup> | Δt/ΔV      | C <sub>L</sub> | R <sub>L</sub> <sup>[2]</sup> | t <sub>PLH</sub> , t <sub>PHL</sub> | t <sub>PZH</sub> , t <sub>PHZ</sub> | t <sub>PZL</sub> , t <sub>PLZ</sub> <sup>[3]</sup> |
| 1.65 V to 3.6 V    | 2.3 V to 5.5 V     | V <sub>CCI</sub>              | ≤ 1.0 ns/V | 15 pF          | 50 kΩ, 1 MΩ                   | open                                | open                                | 2V <sub>CCO</sub>                                  |

[1] V<sub>CCI</sub> is the supply voltage associated with the input.  
 [2] For measuring data rate, pulse width, propagation delay, and output rise and fall measurements, R<sub>L</sub> = 1 MΩ; for measuring enable and disable times, R<sub>L</sub> = 50 kΩ.  
 [3] V<sub>CCO</sub> is the supply voltage associated with the output.

## 13 Application information

### 13.1 Applications

Voltage level-translation applications. The NTS0102 can be used in point-to-point applications to interface between devices or systems operating at different supply voltages. The device is primarily targeted at I<sup>2</sup>C or 1-wire which use open-drain drivers, it may also be used in applications where push-pull drivers are connected to the ports, however the NTB0102 may be more suitable.

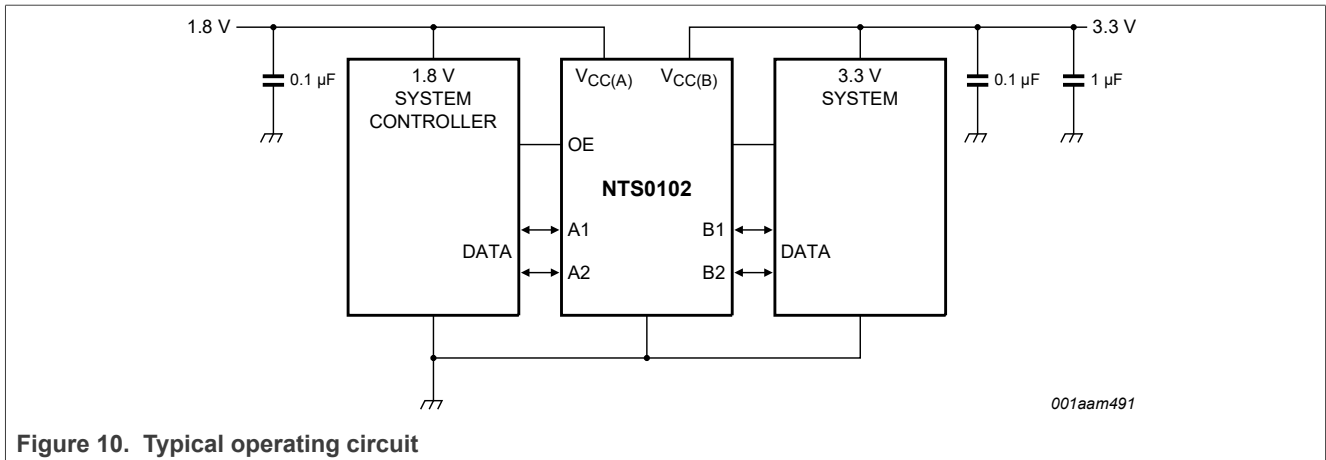


Figure 10. Typical operating circuit

### 13.2 Architecture

The architecture of the NTS0102 is shown in Figure 11. The device does not require an extra input signal to control the direction of data flow from A to B or B to A.

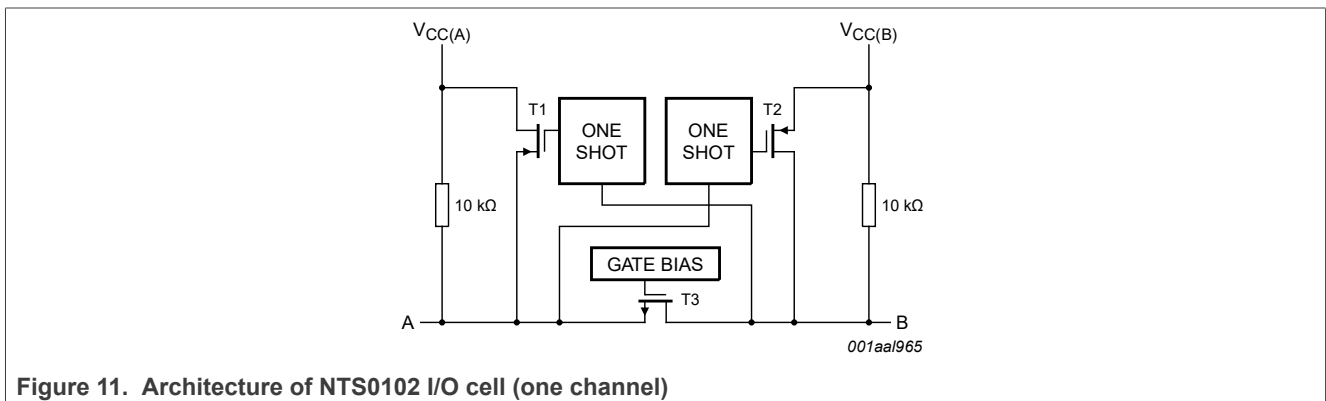


Figure 11. Architecture of NTS0102 I/O cell (one channel)

The NTS0102 is a "switch" type voltage translator, it employs two key circuits to enable voltage translation:

1. A pass-gate transistor (N-channel) that ties the ports together.
2. An output edge-rate accelerator that detects and accelerates rising edges on the I/O pins.

The gate bias voltage of the pass gate transistor (T3) is set at approximately one threshold voltage above the  $V_{CC}$  level of the low-voltage side. During a LOW-to-HIGH transition, the output one-shot accelerates the output transition by switching on the PMOS transistors (T1, T2) bypassing the 10 kΩ pull-up resistors and increasing current drive capability. The one-shot is activated once the input transition reaches approximately  $V_{CC}/2$ ; it is de-activated approximately 50 ns after the output reaches  $V_{CC}/2$ . During the acceleration time, the driver output resistance is between approximately 50 Ω and 70 Ω. To avoid signal contention and minimize dynamic  $I_{CC}$ , the user should wait for the one-shot circuit to turn-off before applying a signal in the opposite direction. Pull-up resistors are included in the device for DC current sourcing capability.

### 13.3 Input driver requirements

As the NTS0102 is a switch type translator, properties of the input driver directly effect the output signal. The external open-drain or push-pull driver applied to an I/O determines the static current sinking capability of the system; the max data rate, HIGH-to-LOW output transition time ( $t_{THL}$ ), and propagation delay ( $t_{PHL}$ ) are

dependent upon the output impedance and edge-rate of the external driver. The limits provided for these parameters in the data sheet assume a driver with output impedance below 50  $\Omega$  is used.

### 13.4 Output load considerations

The maximum lumped capacitive load that can be driven is dependent 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 NTS0102 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 (approximately 50 ns).

### 13.5 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 NTS0102 includes circuitry that disables all output ports when either  $V_{CC(A)}$  or  $V_{CC(B)}$  is switched off.

### 13.6 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.

### 13.7 Pull-up or pull-down resistors on I/Os lines

Each A port I/O has an internal 10 k $\Omega$  pull-up resistor to  $V_{CC(A)}$ , and each B port I/O has an internal 10 k $\Omega$  pull-up resistor to  $V_{CC(B)}$ . If a smaller value of pull-up resistor is required, an external resistor must be added parallel to the internal 10 k $\Omega$ , this effects the  $V_{OL}$  level. When OE goes LOW the internal pull-ups of the NTS0102 are disabled.

### 13.8 GD package vs TL package

Due to differences in package construction the TL package has a center pad vs no center pad for the GD package. The following section provides guidance in replacement vs new applications.

- **No trace under GD package**

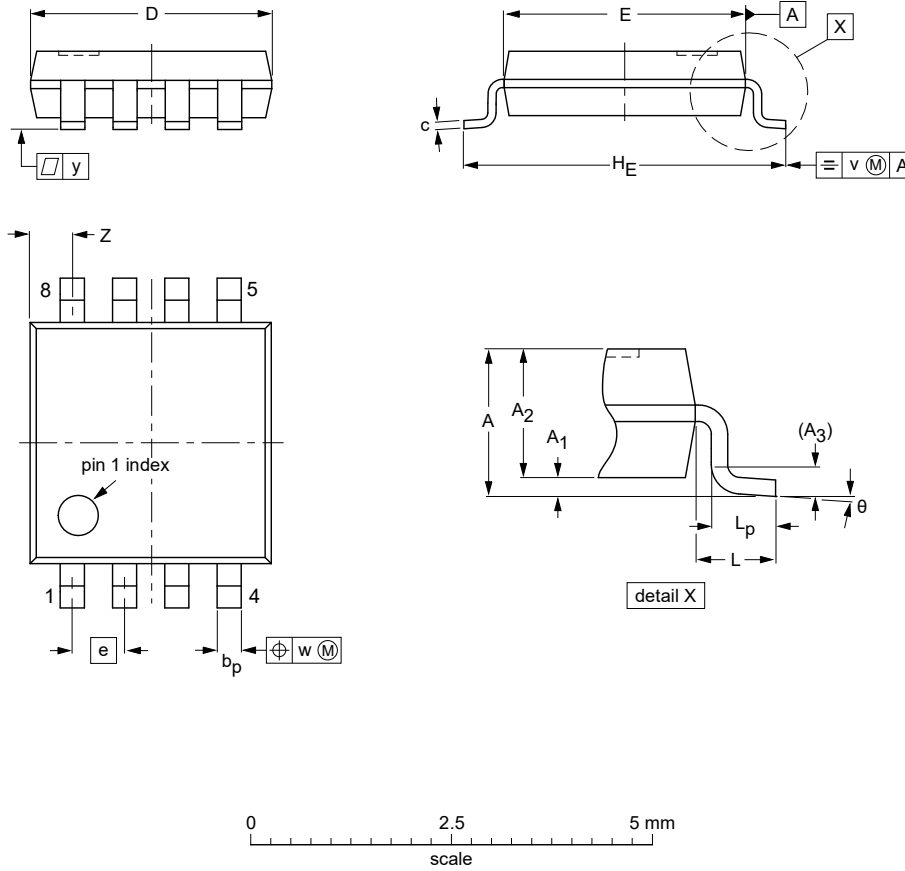
1. Replacement of GD package: The pad is not electrically connected to the silicon (no wire bond and epoxy is not conductive) and can be left floating. It is not required to be connected to the PCB. Simply place the TL package on the same PCB traces as the existing GD package.



2. New use of the TL package: Place PCB trace for soldering of the center pad based on PCB layout recommendations for better mechanical connection and thermal conductivity. The PCB center pad can be connect to GND or left floating.
- **Trace under the GD package**
    1. Replacement of GD package: It is not best practice to have center pad over the trace but since the TL package center pad is not connected to the silicon the risk is low. If there are multiple traces there could be EMI and cross talk. In both cases the customer needs to evaluate risk.
    2. New use of the TL package: Do not route traces under the package

14 Package outline

TSSOP8: plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm SOT505-2



DIMENSIONS (mm are the original dimensions)

| UNIT | A<br>max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c            | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | H <sub>E</sub> | L   | L <sub>p</sub> | v   | w    | y   | Z <sup>(1)</sup> | θ        |
|------|-----------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|-----|----------------|-----|------|-----|------------------|----------|
| mm   | 1.1       | 0.15<br>0.00   | 0.95<br>0.75   | 0.25           | 0.38<br>0.22   | 0.18<br>0.08 | 3.1<br>2.9       | 3.1<br>2.9       | 0.65 | 4.1<br>3.9     | 0.5 | 0.47<br>0.33   | 0.2 | 0.13 | 0.1 | 0.70<br>0.35     | 8°<br>0° |

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE<br>VERSION | REFERENCES |       |       | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|-------|-------|------------------------|------------|
|                    | IEC        | JEDEC | JEITA |                        |            |
| SOT505-2           |            | ---   |       |                        | 02-01-16   |

Figure 12. Package outline SOT505-2 (TSSOP8)

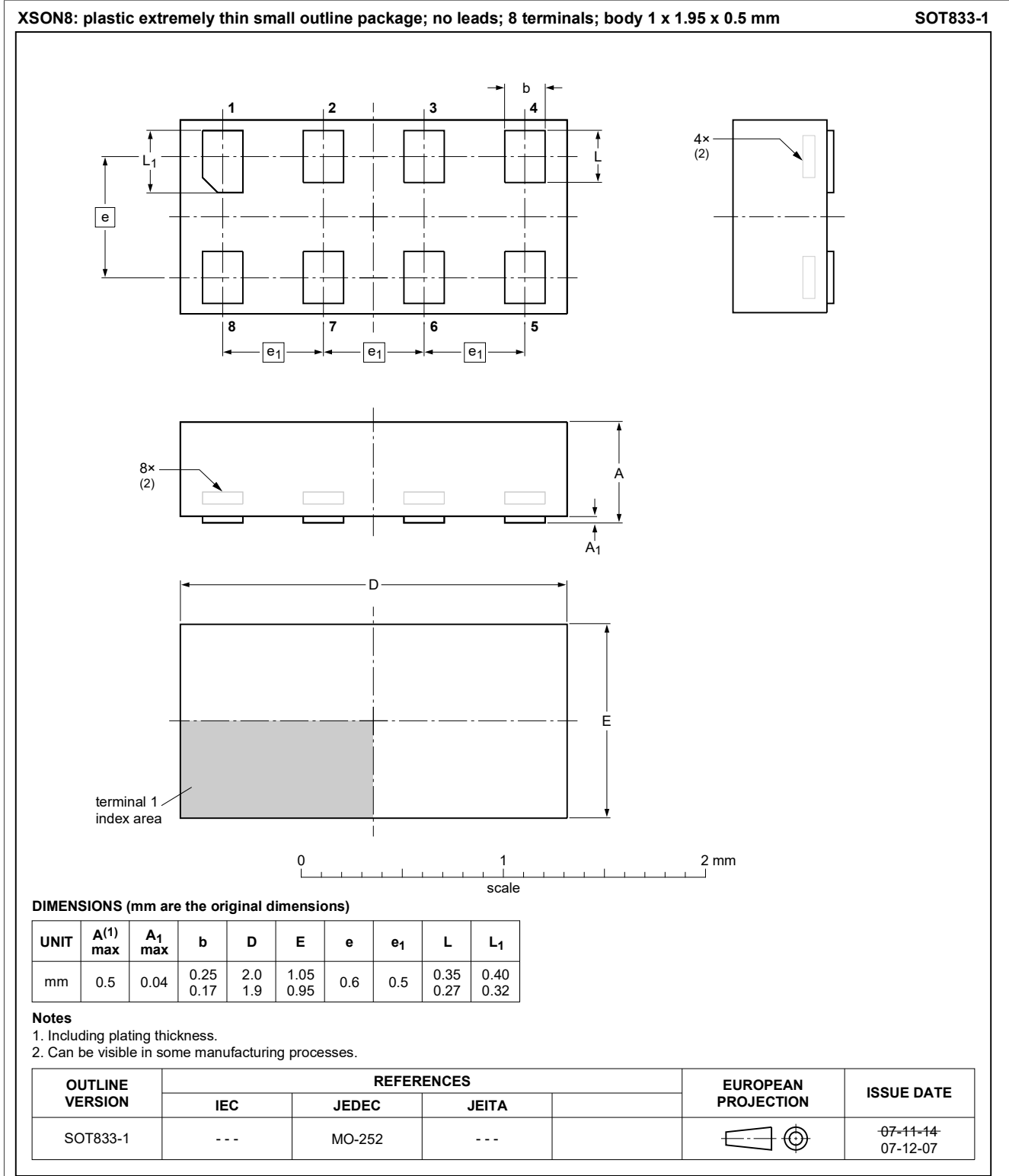


Figure 13. Package outline SOT833-1 (XSON8)

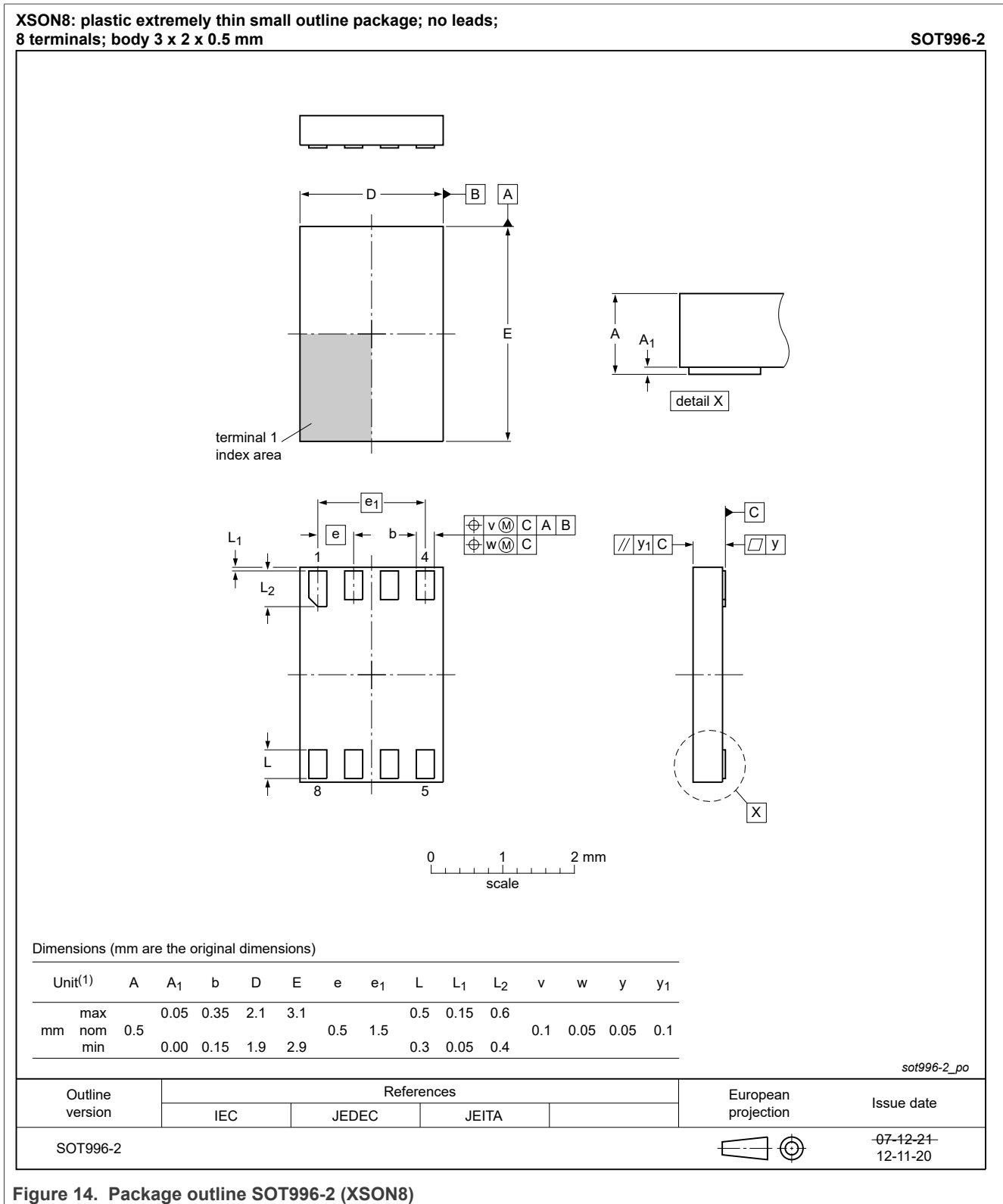


Figure 14. Package outline SOT996-2 (XSON8)

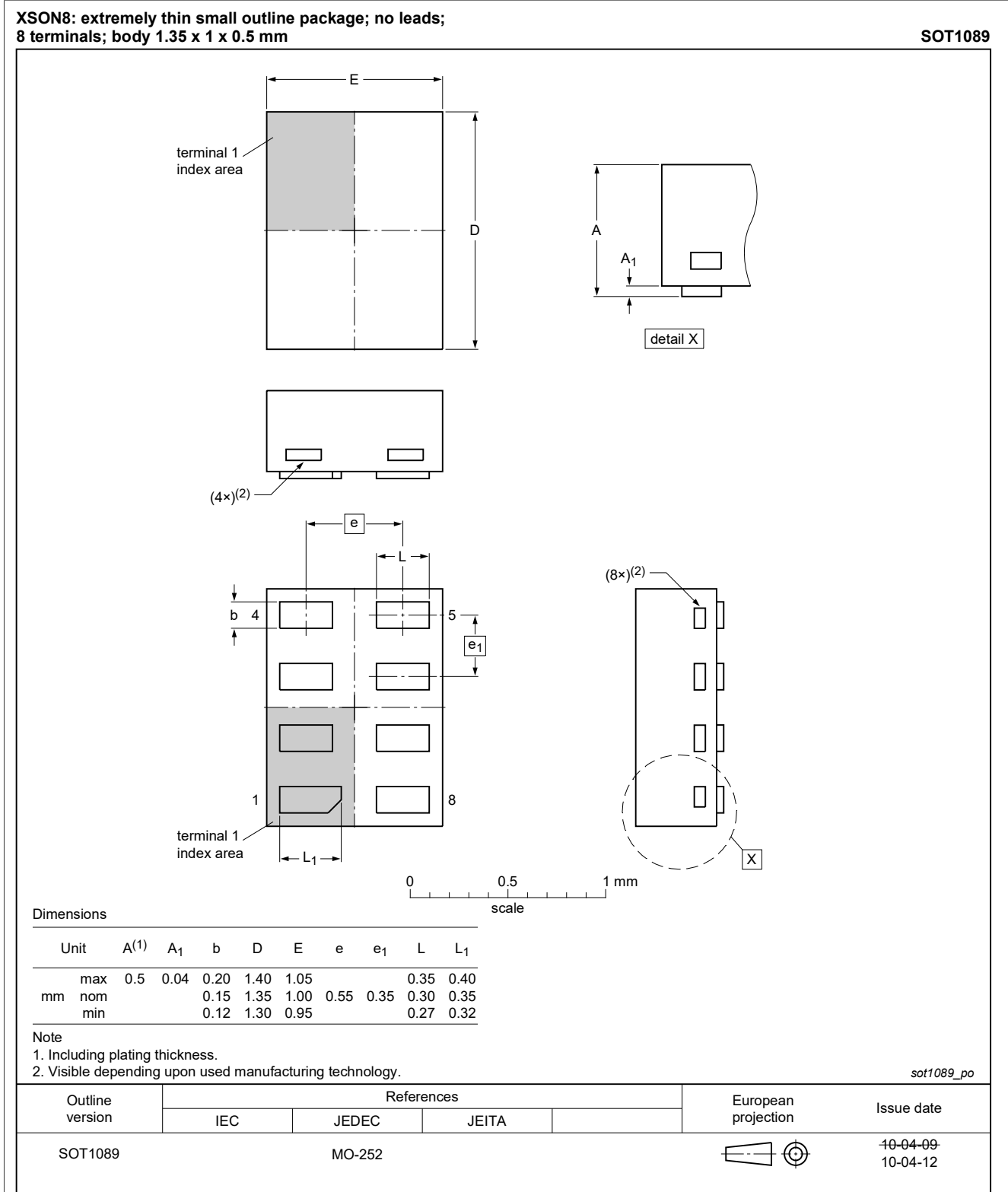


Figure 15. Package outline SOT1089 (XSON8)

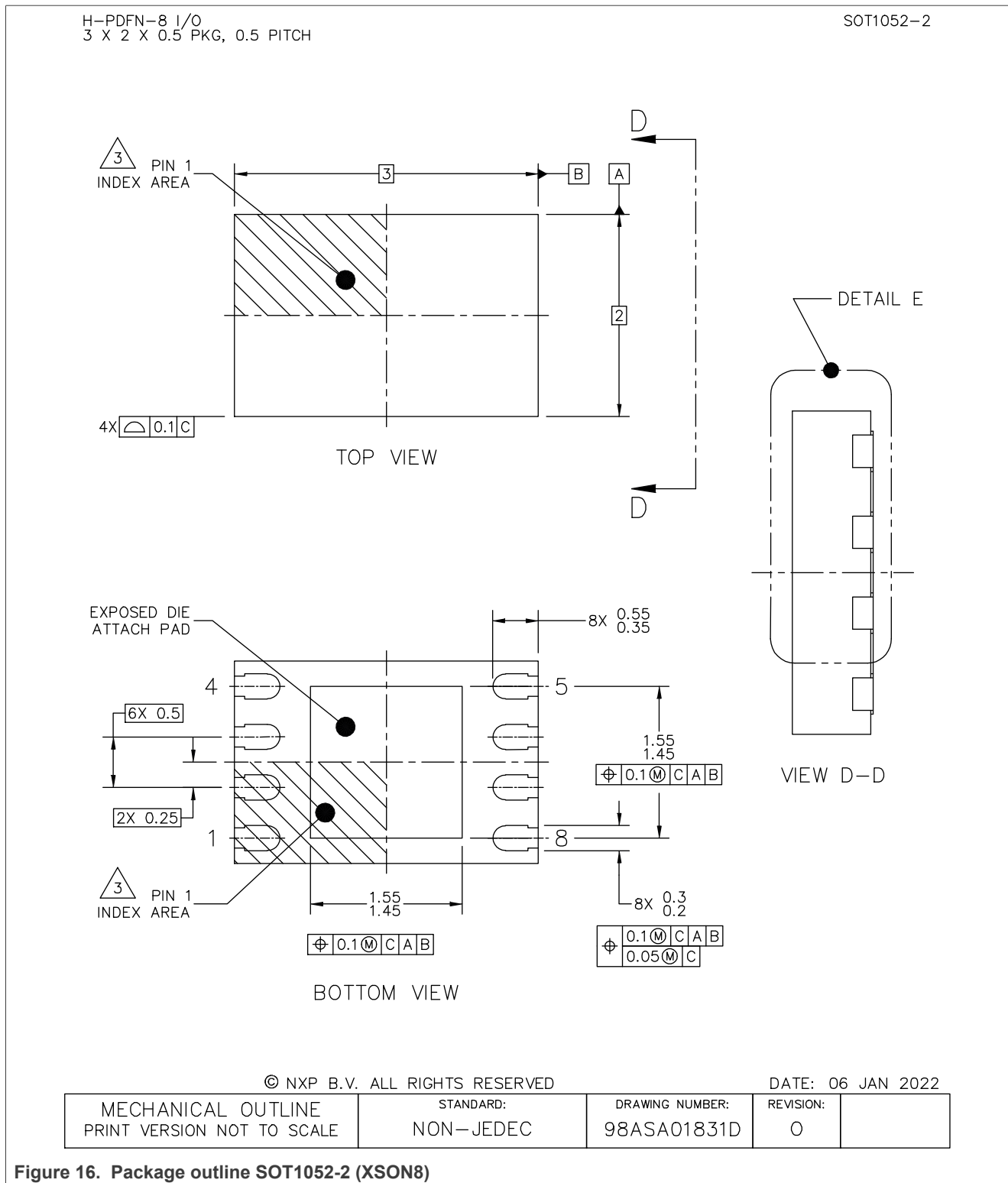
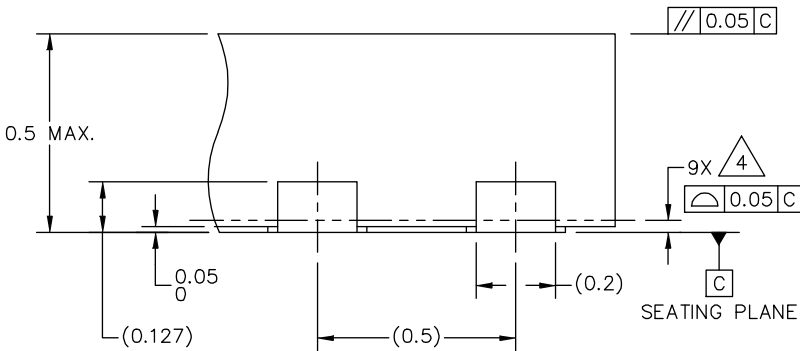


Figure 16. Package outline SOT1052-2 (XSON8)

H-PDFN-8 I/O  
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052-2



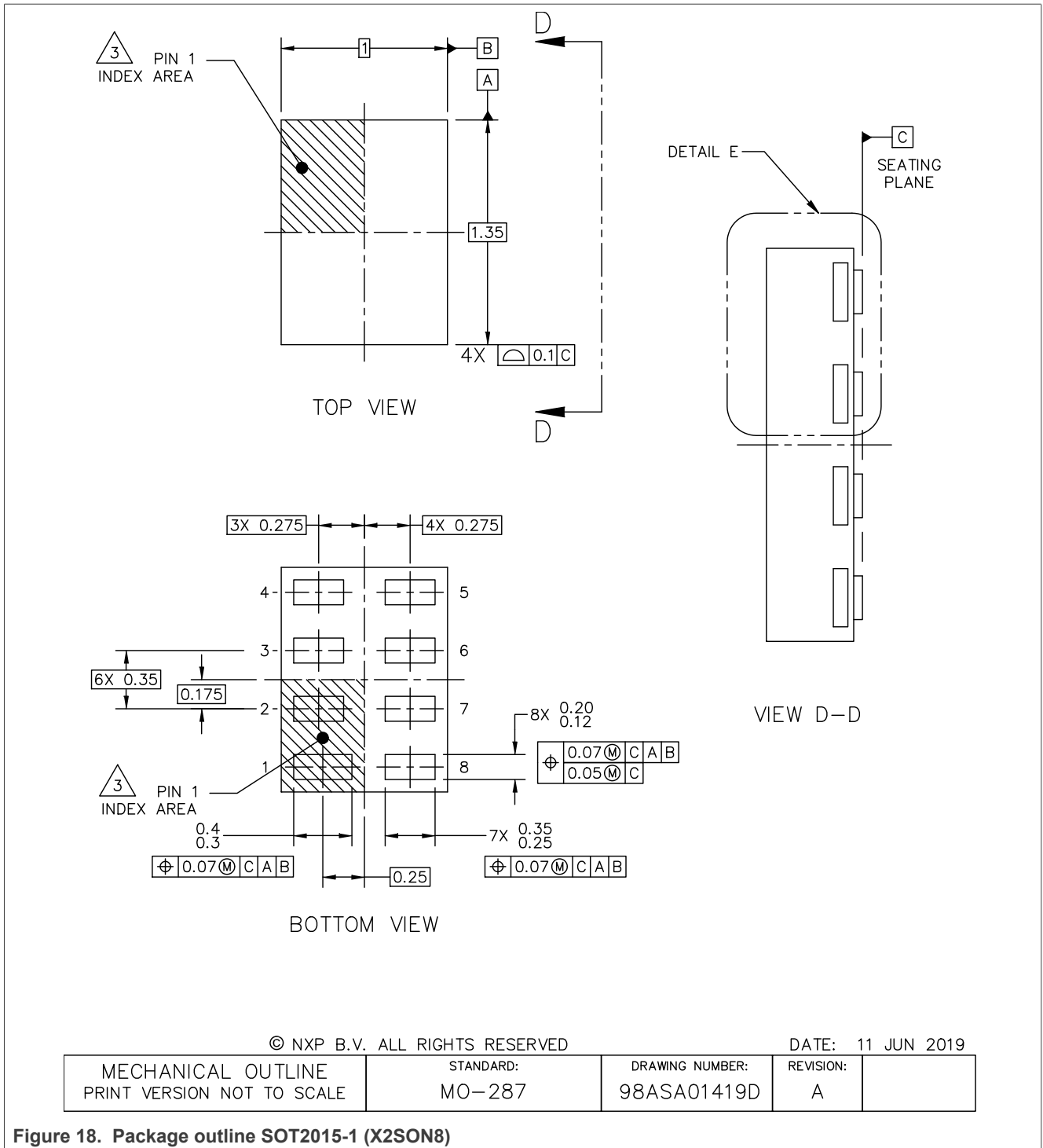
DETAIL E  
VIEW ROTATED 90° CW

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|--|------------------------|--------------------------------|----------------|--|

Figure 17. Package outline SOT1052-2 (XSON8)





## 15 Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note AN10365 “Surface mount reflow soldering description”.

### 15.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 15.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 15.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

### 15.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 19](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board

Dual supply translating transceiver; open-drain; auto direction sensing

- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 14](#) and [Table 15](#)

Table 14. SnPb eutectic process (from J-STD-020D)

| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm³)                    |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 235                             | 220   |
| ≥ 2.5                  | 220                             | 220   |

Table 15. Lead-free process (from J-STD-020D)

| Package thickness (mm) | Package reflow temperature (°C) |             |        |
|------------------------|---------------------------------|-------------|--------|
|                        | Volume (mm³)                    |             |        |
|                        | < 350                           | 350 to 2000 | > 2000 |
| < 1.6                  | 260                             | 260         | 260    |
| 1.6 to 2.5             | 260                             | 250         | 245    |
| > 2.5                  | 250                             | 245         | 245    |

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 19](#).

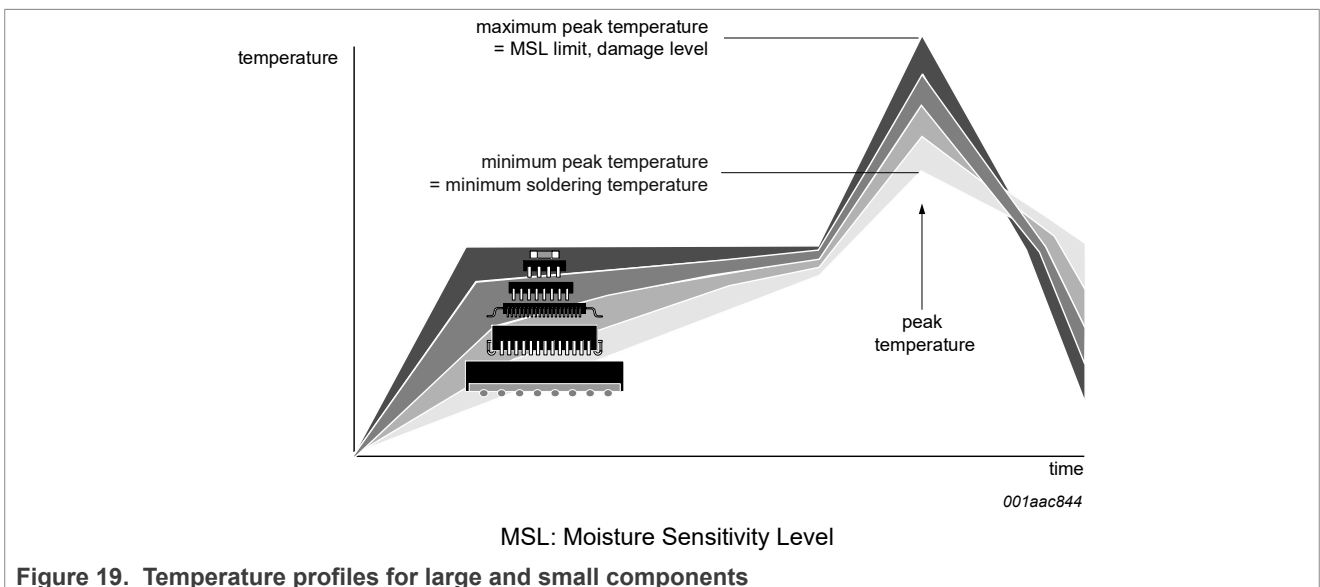


Figure 19. Temperature profiles for large and small components

For further information on temperature profiles, refer to Application Note AN10365 “Surface mount reflow soldering description”.

16 Soldering: PCB footprints

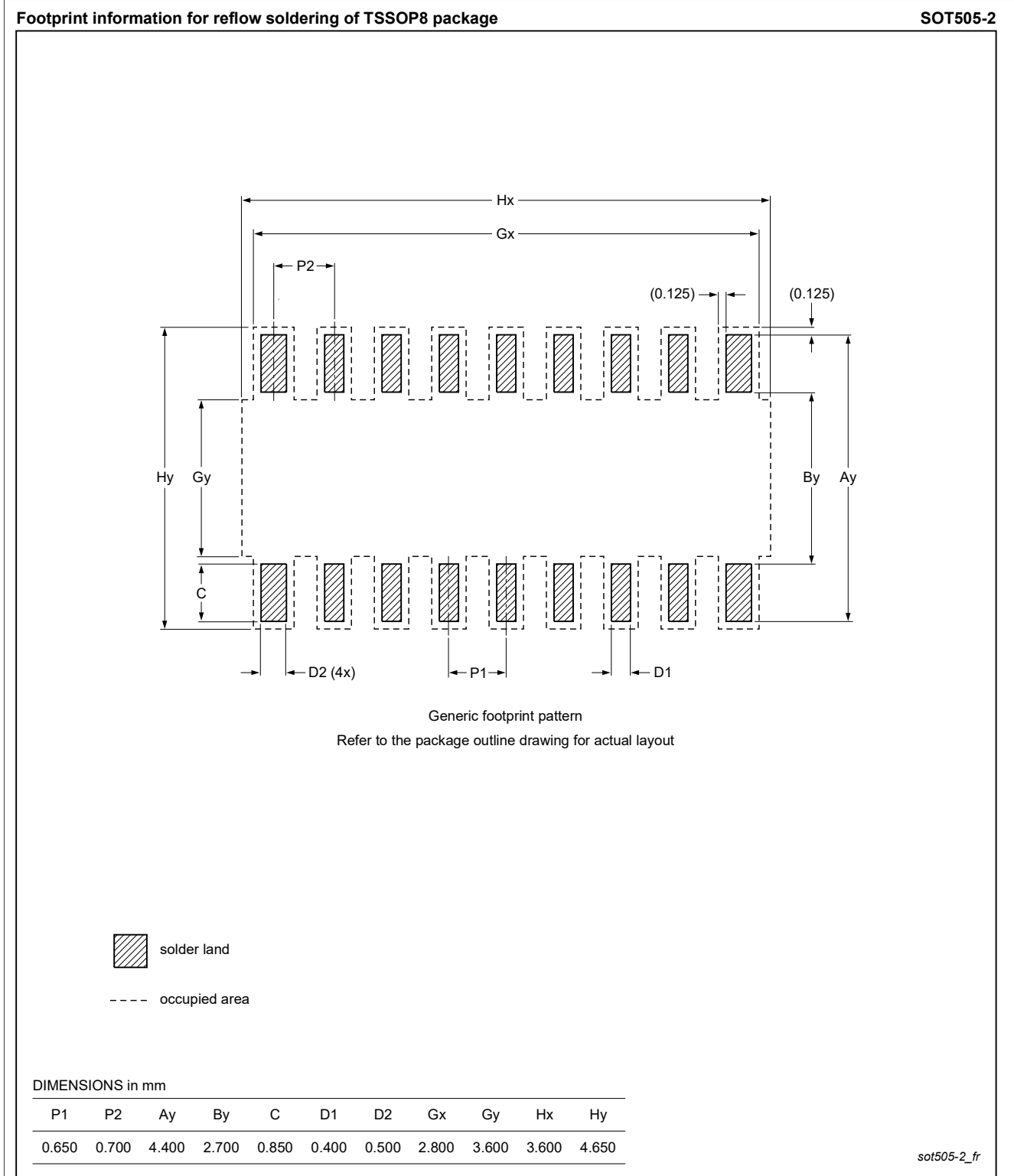
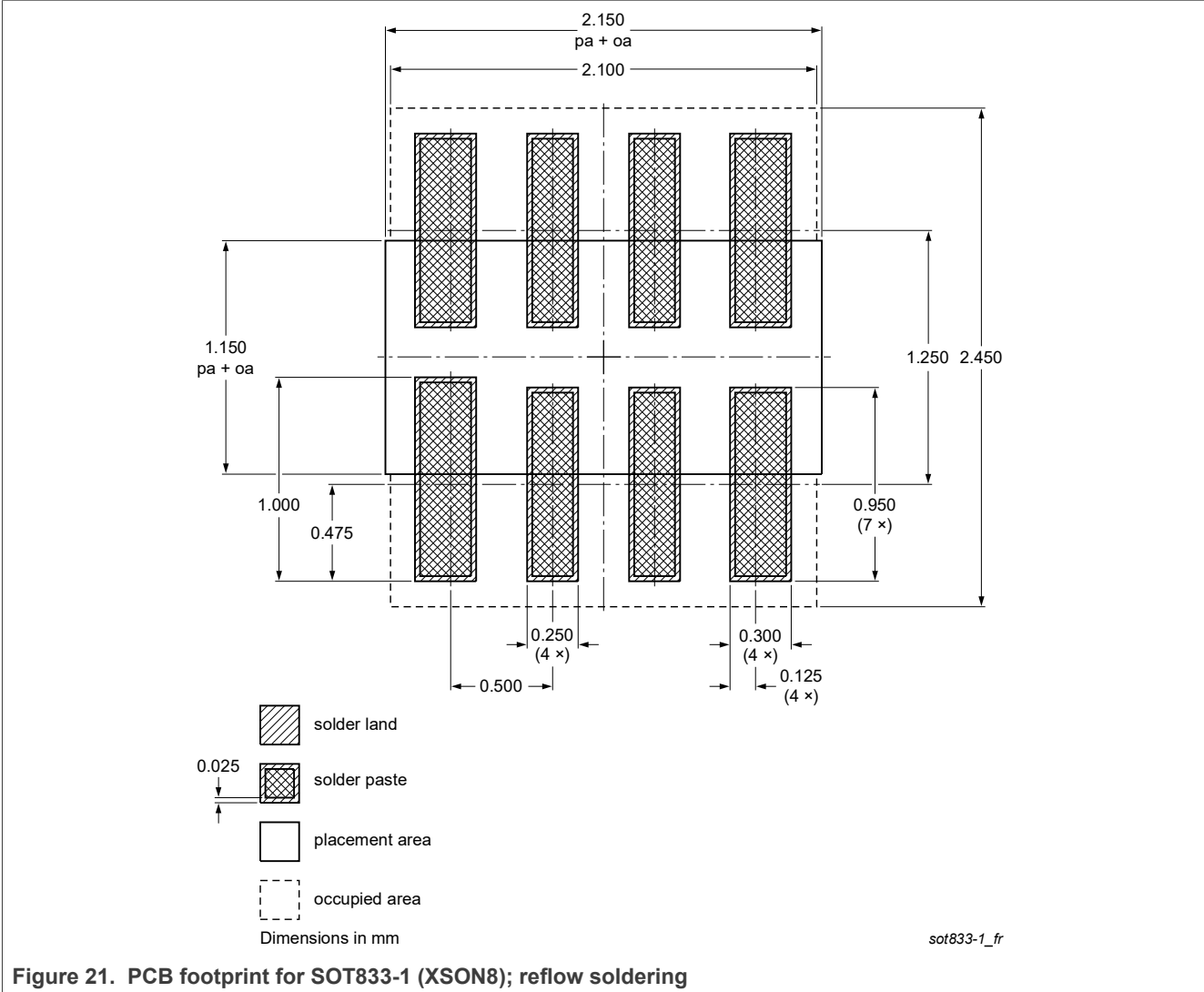
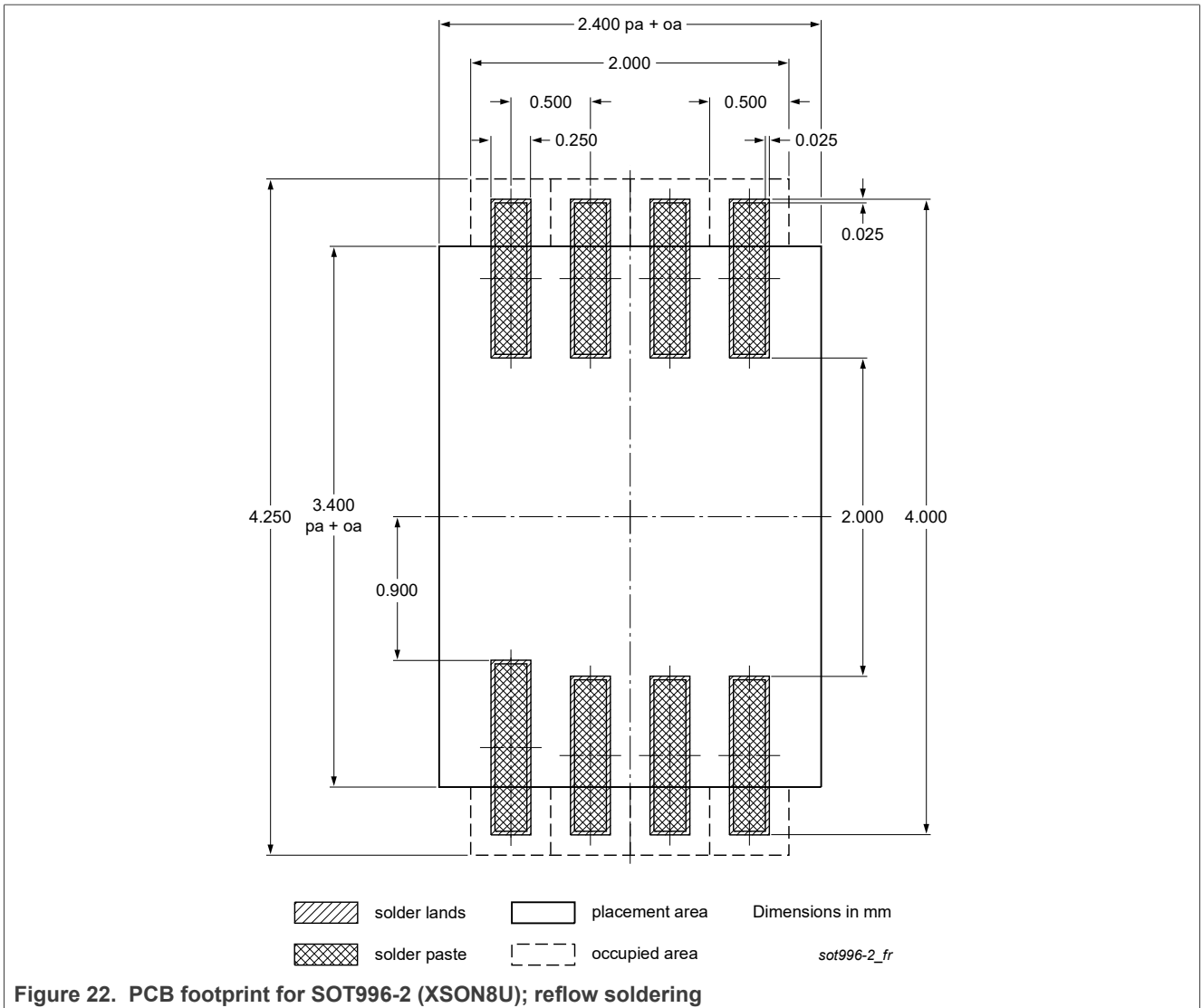
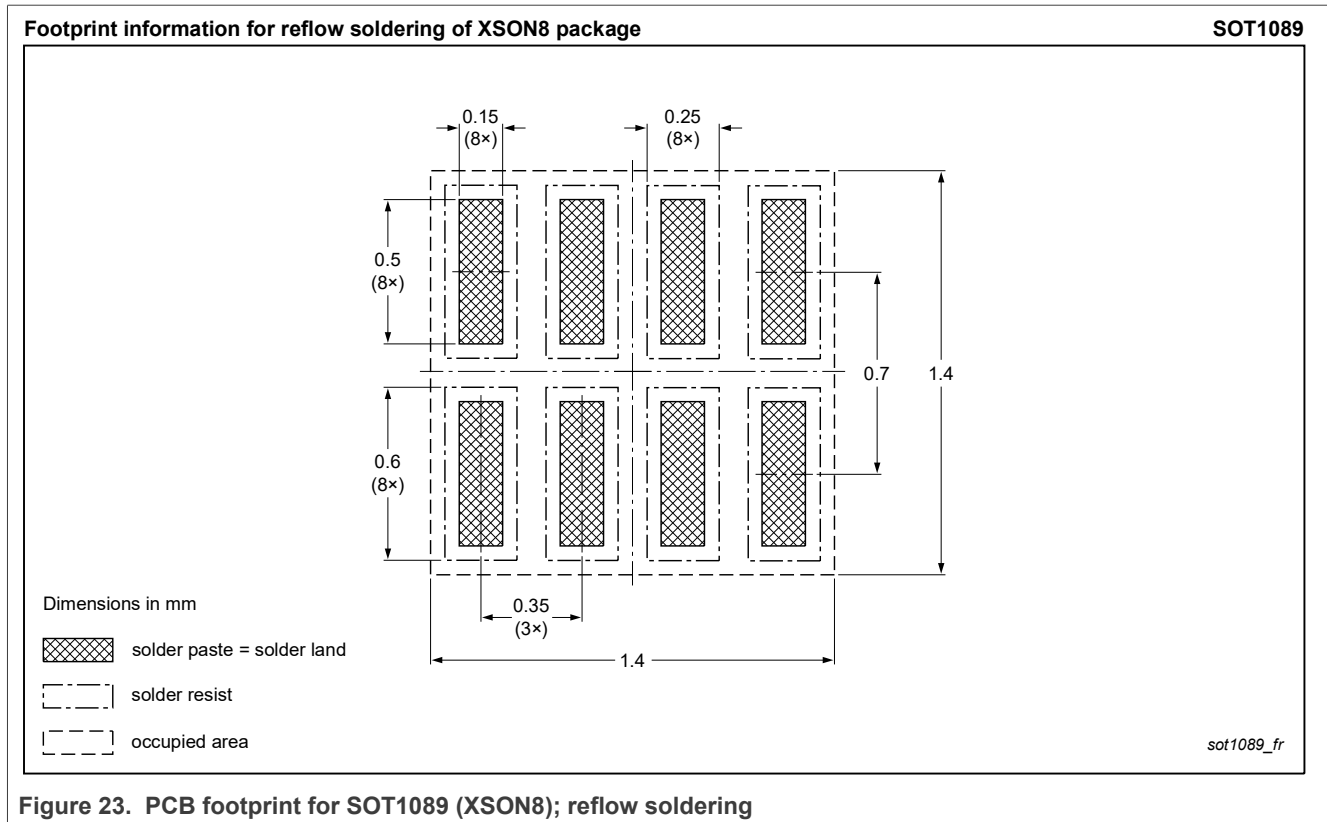


Figure 20. PCB footprint for SOT505-2 (TSSOP8); reflow soldering

Dual supply translating transceiver; open-drain; auto direction sensing

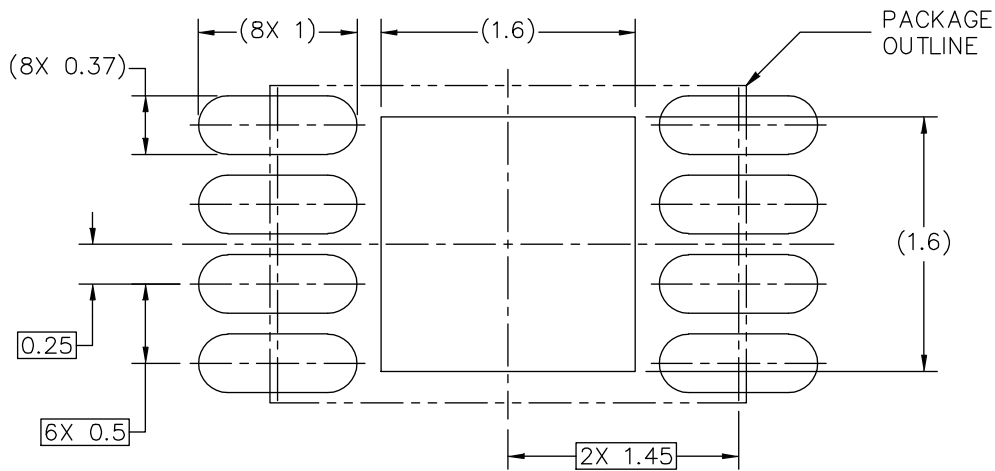






H-PDFN-8 I/O  
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052-2



PCB DESIGN GUIDELINES  
RECOMMENDED SOLDER MASK OPENING PATTERN

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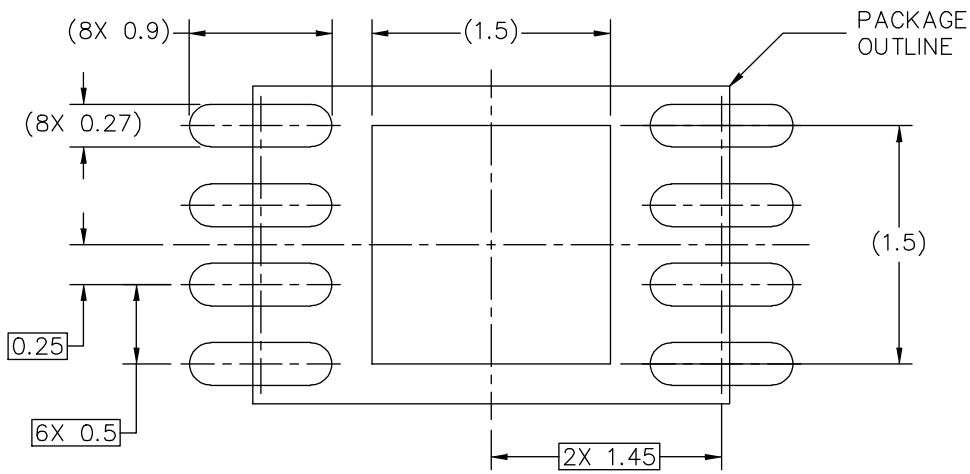
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|--|------------------------|--------------------------------|----------------|--|

Figure 24. PCB footprint for SOT1052-2 (XSON8); recommended solder mask opening pattern

Dual supply translating transceiver; open-drain; auto direction sensing

H-PDFN-8 I/O  
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052-2



PCB DESIGN GUIDELINES  
RECOMMENDED I/O PADS AND SOLDERABLE AREA

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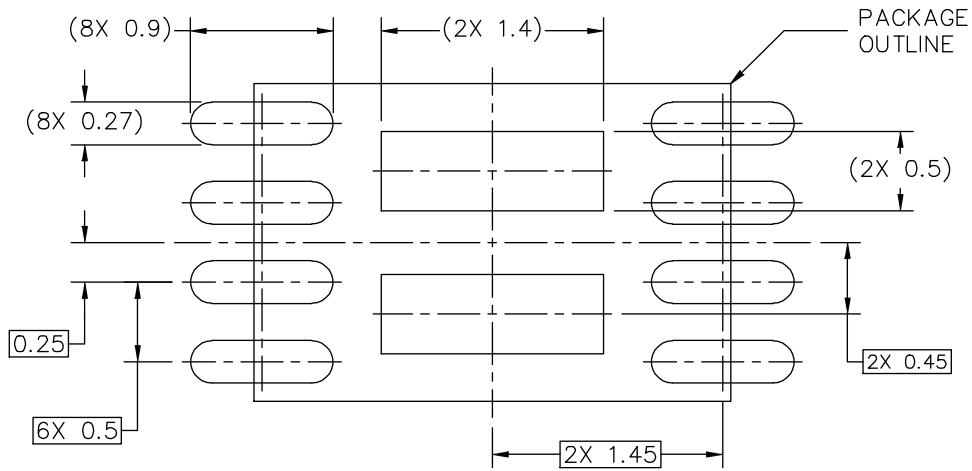
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|--|------------------------|--------------------------------|----------------|
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|--|------------------------|--------------------------------|----------------|

Figure 25. PCB footprint for SOT1052-2 (XSON8); recommended I/O pads and solderable area



H-PDFN-8 I/O  
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052-2



RECOMMENDED STENCIL THICKNESS 0.125

PCB DESIGN GUIDELINES – RECOMMENDED SOLDER PASTE STENCIL

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|--|------------------------|--------------------------------|----------------|--|

Figure 26. PCB footprint for SOT1052-2 (XSON8); recommended solder paste stencil

Dual supply translating transceiver; open-drain; auto direction sensing

H-PDFN-8 I/O  
3 X 2 X 0.5 PKG, 0.5 PITCH

SOT1052-2

NOTES:

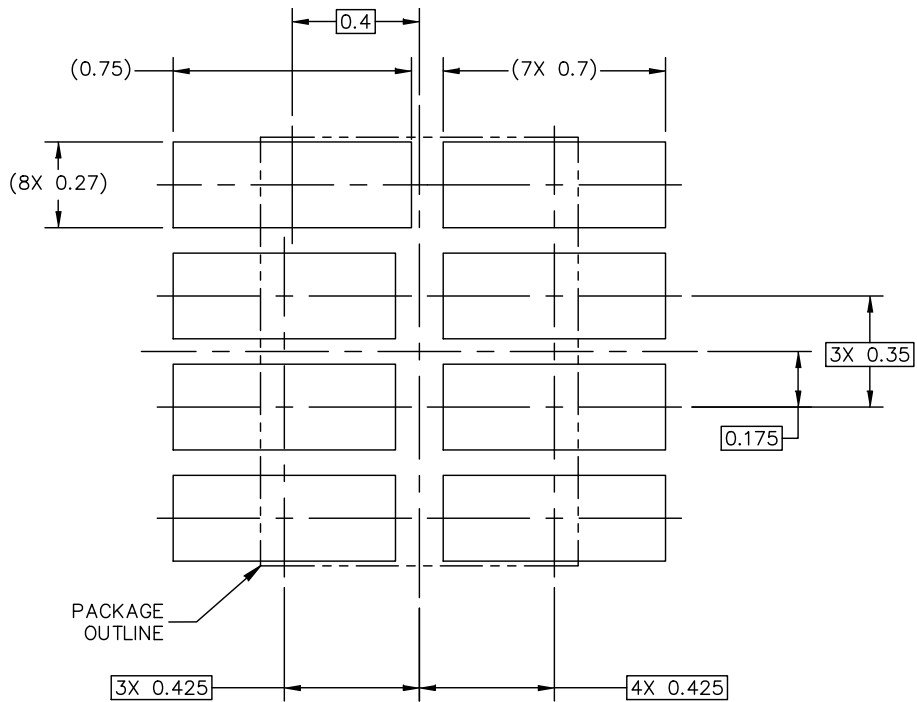
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2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PIN 1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. COPLANARITY APPLIES TO LEADS, DIE ATTACH FLAG.
5. MIN. METAL GAP FOR LEAD TO EXPOSED PAD SHALL BE 0.2 MM.

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|--|------------------------|--------------------------------|----------------|--|

Figure 27. PCB footprint for SOT1052-2 (XSON8); notes



PCB DESIGN GUIDELINES – SOLDER MASK OPENING PATTERN

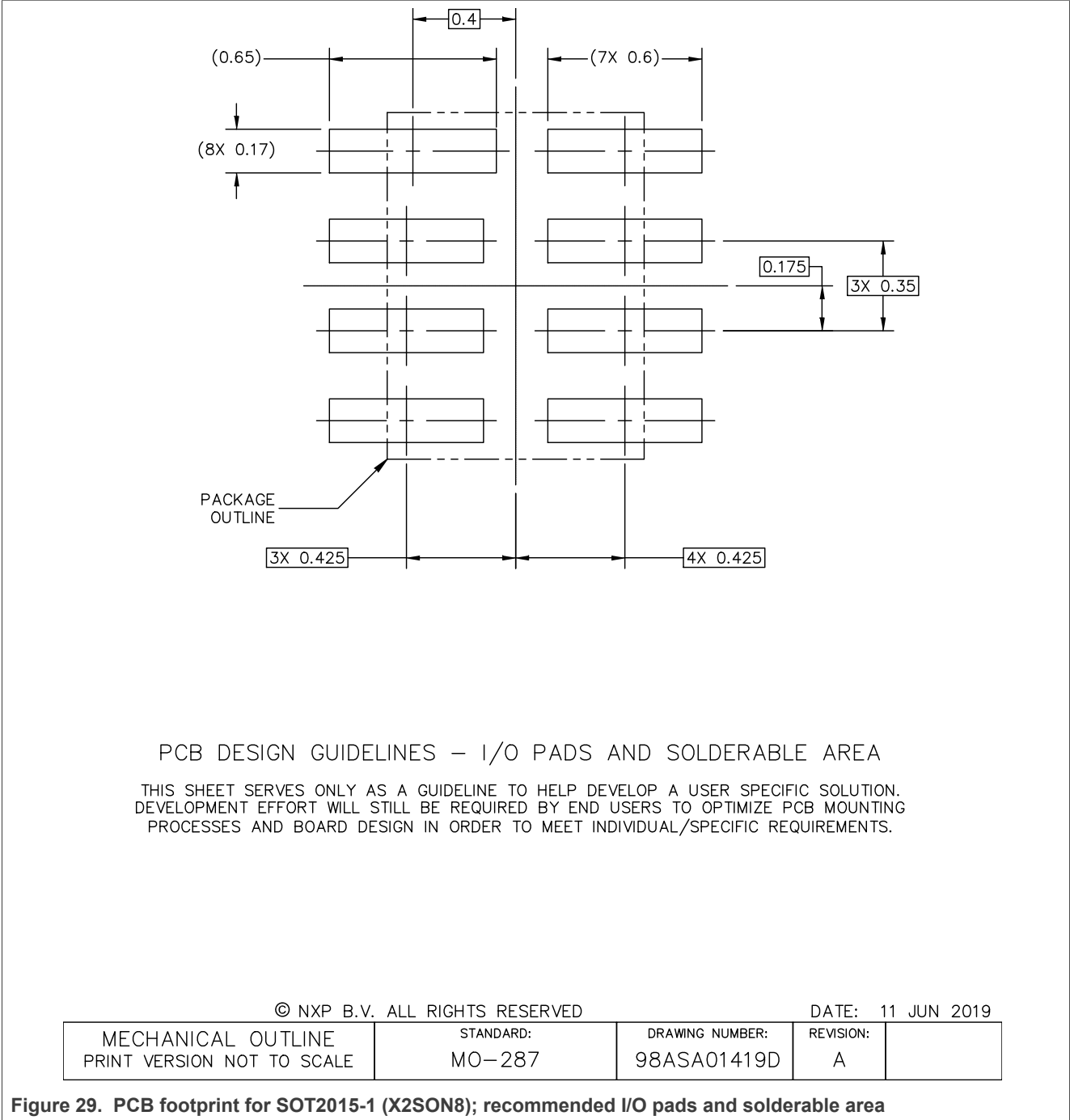
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|--|---------------------|--------------------------------|----------------|--|

Figure 28. PCB footprint for SOT2015-1 (X2SON8); recommended solder mask opening pattern



Dual supply translating transceiver; open-drain; auto direction sensing

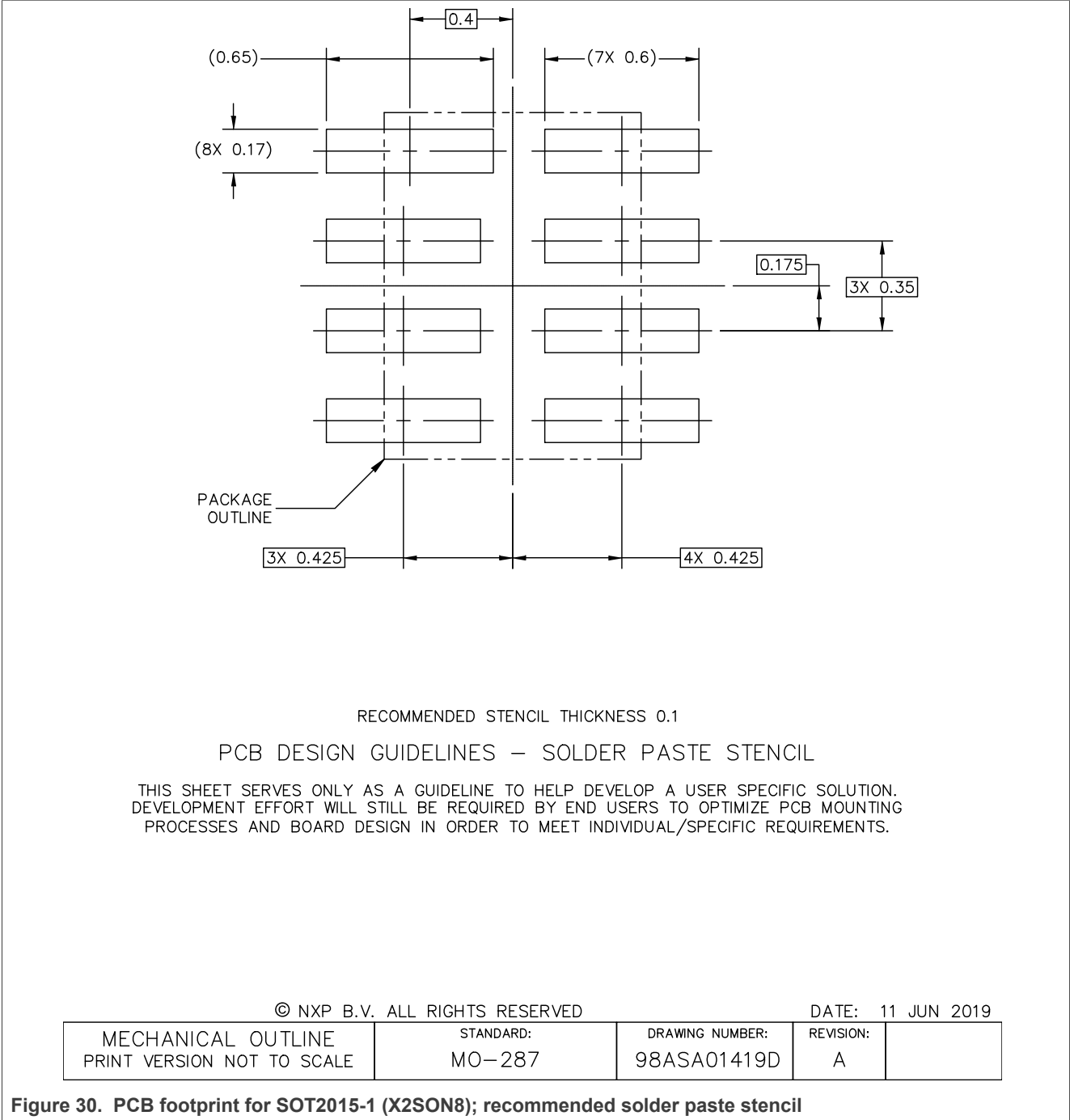


Figure 30. PCB footprint for SOT2015-1 (X2SON8); recommended solder paste stencil

Dual supply translating transceiver; open-drain; auto direction sensing

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PIN 1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. COPLANARITY APPLIES TO LEADS.
5. MIN METAL GAP SHOULD BE 0.15 MM.

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Figure 31. PCB footprint for SOT2015-1 (X2SON8); notes

## 17 Abbreviations

Table 16. Abbreviations

| Acronym          | Description                                 |
|------------------|---|
| CDM              | Charged Device Model                        |
| CMOS             | Complementary Metal Oxide Semiconductor     |
| DUT              | Device Under Test                           |
| ESD              | ElectroStatic Discharge                     |
| GPIO             | General Purpose Input Output                |
| HBM              | Human Body Model                            |
| I <sup>2</sup> C | Inter-Integrated Circuit                    |
| MM               | Machine Model                               |
| PCB              | Printed-circuit board                       |
| PMOS             | Positive Metal Oxide Semiconductor          |
| SMBus            | System Management Bus                       |
| UART             | Universal Asynchronous Receiver Transmitter |
| UTLP             | Ultra Thin Leadless Package                 |

## 18 Revision history

Table 17. Revision history

| Document ID    | Release date                  | Data sheet status  | Change notice | Supersedes    |
|----------------|-------------------------------|--------------------|---------------|---------------|
| NTS0102 v.4.5  | 20230706                      | Product data sheet | —             | NTS0102 v.4.4 |
| Modifications: | • Added type number NTS0102JK |                    |               |               |
| NTS0102 v.4.4  | 20221006                      | Product data sheet | 202210008I    | NTS0102 v.4.3 |
| NTS0102 v.4.3  | 20220420                      | Product data sheet | —             | NTS0102 v.4.2 |
| NTS0102 v.4.2  | 20220303                      | Product data sheet | —             | NTS0102 v.4.1 |
| NTS0102 v.4.1  | 20211112                      | Product data sheet | —             | NTS0102 v.4   |
| NTS0102 v.4    | 20130123                      | Product data sheet | —             | NTS0102 v.3   |
| NTS0102 v.3    | 20111117                      | Product data sheet | —             | NTS0102 v.2   |
| NTS0102 v.2    | 20110411                      | Product data sheet | —             | NTS0102 v.1   |
| NTS0102 v.1    | 20100921                      | Product data sheet | —             | —             |

## 19 Legal information

### 19.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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 URL <http://www.nxp.com>.

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## Dual supply translating transceiver; open-drain; auto direction sensing

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Tables

|         |                                  |   |          |   |    |
|---------|----------------------------------|---|----------|---|----|
| Tab. 1. | Ordering information             | 1 | Tab. 10. | Dynamic characteristics for temperature range -40 °C to +85 °C  | 8  |
| Tab. 2. | Ordering options                 | 2 | Tab. 11. | Dynamic characteristics for temperature range -40 °C to +125 °C | 10 |
| Tab. 3. | Pin description                  | 4 | Tab. 12. | Measurement points  | 13 |
| Tab. 4. | Function table                   | 4 | Tab. 13. | Test data   | 14 |
| Tab. 5. | Limiting values                  | 5 | Tab. 14. | SnPb eutectic process (from J-STD-020D)                         | 26 |
| Tab. 6. | Recommended operating conditions | 5 | Tab. 15. | Lead-free process (from J-STD-020D)                             | 26 |
| Tab. 7. | Typical static characteristics   | 6 | Tab. 16. | Abbreviations   | 39 |
| Tab. 8. | Typical supply current           | 6 | Tab. 17. | Revision history  | 39 |
| Tab. 9. | Static characteristics           | 6 |          |   |    |

Figures

|          |   |    |          |  |    |
|----------|---|----|----------|--|----|
| Fig. 1.  | Logic symbol  | 3  | Fig. 21. | PCB footprint for SOT833-1 (XSON8); reflow soldering                           | 28 |
| Fig. 2.  | Pin configuration SOT505-2 (TSSOP8)                                     | 3  | Fig. 22. | PCB footprint for SOT996-2 (XSON8U); reflow soldering                          | 29 |
| Fig. 3.  | Pin configuration SOT833-1 (XSON8) and SOT1089 (XSON8)                  | 3  | Fig. 23. | PCB footprint for SOT1089 (XSON8); reflow soldering                            | 30 |
| Fig. 4.  | Pin configuration SOT996-2 (XSON8)                                      | 4  | Fig. 24. | PCB footprint for SOT1052-2 (XSON8); recommended solder mask opening pattern   | 31 |
| Fig. 5.  | Pin configuration SOT1052-2 (XSON8)                                     | 4  | Fig. 25. | PCB footprint for SOT1052-2 (XSON8); recommended I/O pads and solderable area  | 32 |
| Fig. 6.  | Pin configuration SOT2015-1 (X2SON8)                                    | 4  | Fig. 26. | PCB footprint for SOT1052-2 (XSON8); recommended solder paste stencil          | 33 |
| Fig. 7.  | The data input (An, Bn) to data output (Bn, An) propagation delay times | 12 | Fig. 27. | PCB footprint for SOT1052-2 (XSON8); notes                                     | 34 |
| Fig. 8.  | Enable and disable times  | 13 | Fig. 28. | PCB footprint for SOT2015-1 (X2SON8); recommended solder mask opening pattern  | 35 |
| Fig. 9.  | Test circuit for measuring switching times                              | 14 | Fig. 29. | PCB footprint for SOT2015-1 (X2SON8); recommended I/O pads and solderable area | 36 |
| Fig. 10. | Typical operating circuit   | 15 | Fig. 30. | PCB footprint for SOT2015-1 (X2SON8); recommended solder paste stencil         | 37 |
| Fig. 11. | Architecture of NTS0102 I/O cell (one channel)                          | 15 | Fig. 31. | PCB footprint for SOT2015-1 (X2SON8); notes                                    | 38 |
| Fig. 12. | Package outline SOT505-2 (TSSOP8)                                       | 18 |          |  |    |
| Fig. 13. | Package outline SOT833-1 (XSON8)  | 19 |          |  |    |
| Fig. 14. | Package outline SOT996-2 (XSON8)  | 20 |          |  |    |
| Fig. 15. | Package outline SOT1089 (XSON8)   | 21 |          |  |    |
| Fig. 16. | Package outline SOT1052-2 (XSON8)                                       | 22 |          |  |    |
| Fig. 17. | Package outline SOT1052-2 (XSON8)                                       | 23 |          |  |    |
| Fig. 18. | Package outline SOT2015-1 (X2SON8)                                      | 24 |          |  |    |
| Fig. 19. | Temperature profiles for large and small components                     | 26 |          |  |    |
| Fig. 20. | PCB footprint for SOT505-2 (TSSOP8); reflow soldering                   | 27 |          |  |    |

## Contents

|           |  |           |
|-----------|--|-----------|
| <b>1</b>  | <b>General description</b>                   | <b>1</b>  |
| <b>2</b>  | <b>Features and benefits</b>                 | <b>1</b>  |
| <b>3</b>  | <b>Applications</b>                          | <b>1</b>  |
| <b>4</b>  | <b>Ordering information</b>                  | <b>1</b>  |
| 4.1       | Ordering options                             | 2         |
| <b>5</b>  | <b>Functional diagram</b>                    | <b>3</b>  |
| <b>6</b>  | <b>Pinning information</b>                   | <b>3</b>  |
| 6.1       | Pinning                                      | 3         |
| 6.2       | Pin description                              | 4         |
| <b>7</b>  | <b>Functional description</b>                | <b>4</b>  |
| <b>8</b>  | <b>Limiting values</b>                       | <b>5</b>  |
| <b>9</b>  | <b>Recommended operating conditions</b>      | <b>5</b>  |
| <b>10</b> | <b>Static characteristics</b>                | <b>6</b>  |
| <b>11</b> | <b>Dynamic characteristics</b>               | <b>8</b>  |
| <b>12</b> | <b>Waveforms</b>                             | <b>12</b> |
| <b>13</b> | <b>Application information</b>               | <b>14</b> |
| 13.1      | Applications                                 | 14        |
| 13.2      | Architecture                                 | 15        |
| 13.3      | Input driver requirements                    | 15        |
| 13.4      | Output load considerations                   | 16        |
| 13.5      | Power up                                     | 16        |
| 13.6      | Enable and disable                           | 16        |
| 13.7      | Pull-up or pull-down resistors on I/Os lines | 16        |
| 13.8      | GD package vs TL package                     | 16        |
| <b>14</b> | <b>Package outline</b>                       | <b>18</b> |
| <b>15</b> | <b>Soldering of SMD packages</b>             | <b>25</b> |
| 15.1      | Introduction to soldering                    | 25        |
| 15.2      | Wave and reflow soldering                    | 25        |
| 15.3      | Wave soldering                               | 25        |
| 15.4      | Reflow soldering                             | 25        |
| <b>16</b> | <b>Soldering: PCB footprints</b>             | <b>27</b> |
| <b>17</b> | <b>Abbreviations</b>                         | <b>39</b> |
| <b>18</b> | <b>Revision history</b>                      | <b>39</b> |
| <b>19</b> | <b>Legal information</b>                     | <b>40</b> |

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