

NX3DV221

High-speed USB 2.0 switch with enable

Rev. 4 — 19 June 2013

Product data sheet

1. General description

The NX3DV221 is a high-bandwidth switch designed for the switching of high-speed USB 2.0 signals in handset and consumer applications. These applications could be cell phones, digital cameras, and notebooks with hubs or controllers with limited USB I/Os. The wide bandwidth (1 GHz) of this switch allows signal to pass with minimum edge and phase distortion. The device multiplexes differential outputs from a USB host device to one of two corresponding outputs. The switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. It is designed for low bit-to-bit skew and high channel-to-channel noise isolation, and is compatible with various standards, such as high-speed USB 2.0 (480 Mbps).

2. Features and benefits

- Wide supply voltage range from 2.3 V to 3.6 V
- Switch voltage accepts signals up to 5.5 V
- 1.8 V control logic at $V_{CC} = 3.6$ V
- Low-power mode when \overline{OE} is HIGH (2 μ A maximum)
- 6 Ω (maximum) ON resistance
- 0.1 Ω (typical) ON resistance mismatch between channels
- 6 pF (typical) ON-state capacitance
- High bandwidth (1.0 GHz typical)
- Latch-up performance exceeds 100 mA per JESD 78B Class II Level A
- ESD protection:
 - ◆ HBM JESD22-A114F Class 3A exceeds 8000 V
 - ◆ CDM JESD22-C101E exceeds 1000 V
 - ◆ HBM exceeds 12000 V for I/O to GND protection
- Specified from -40 °C to $+85$ °C

3. Applications

- Routes signals for USB 1.0, 1.1 and 2.0



4. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|-------------|-------------------|---------|---|-----------|
| | Temperature range | Name | Description | Version |
| NX3DV221GM | −40 °C to +85 °C | XQFN10 | plastic extremely thin quad flat package; no leads; 10 terminals; body 2 × 1.55 × 0.5 mm | SOT1049-3 |
| NX3DV221TK | −40 °C to +85 °C | HVSON10 | plastic thermal enhanced very thin small outline package; no leads; 10 terminals; 3 × 3 × 0.85 mm | SOT650-2 |

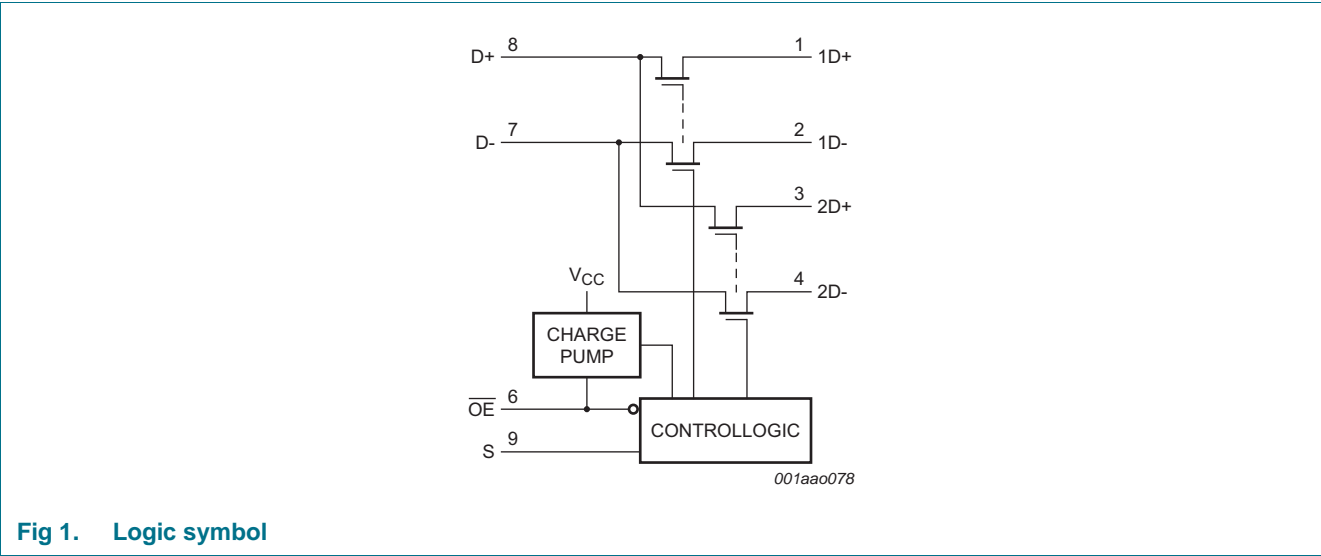
5. Marking

Table 2. Marking

| Type number | Marking code ^[1] |
|-------------|-----------------------------|
| NX3DV221GM | x21 |
| NX3DV221TK | x21 |

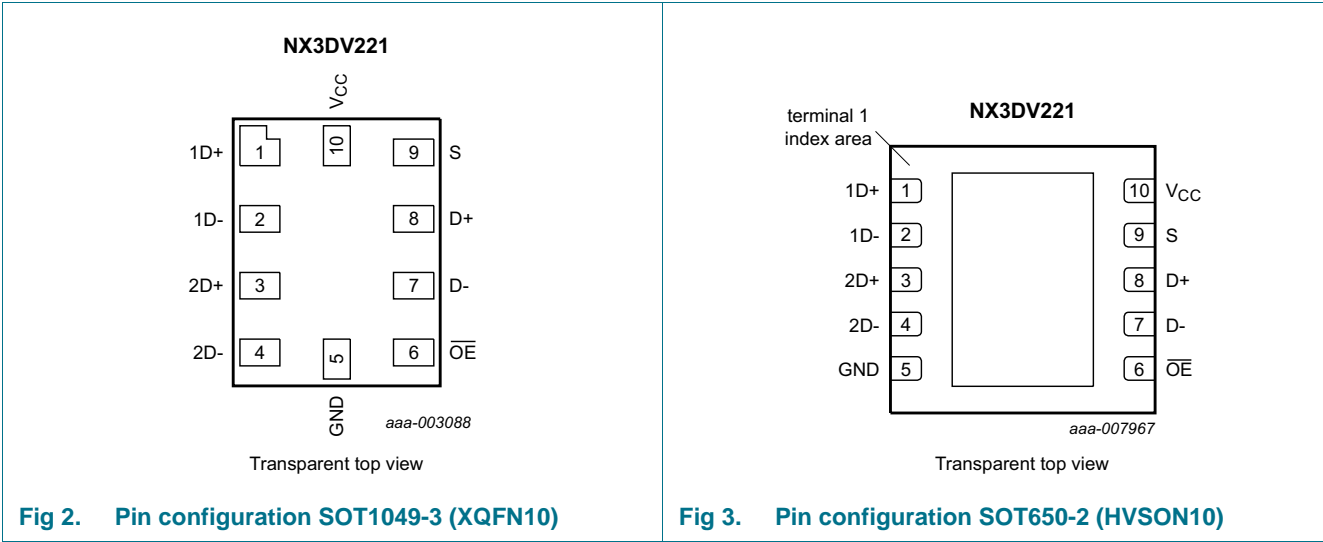
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

6. Functional diagram



7. Pinning information

7.1 Pinning



7.2 Pin description

Table 3. Pin description

| Symbol | Pin | Description |
|------------------------|-----|----------------------------------|
| 1D+ | 1 | independent input or output |
| 1D– | 2 | independent input or output |
| 2D+ | 3 | independent input or output |
| 2D– | 4 | independent input or output |
| GND | 5 | ground (0 V) |
| $\overline{\text{OE}}$ | 6 | output enable input (active LOW) |
| D– | 7 | common input or output |
| D+ | 8 | common input or output |
| S | 9 | select input |
| V _{CC} | 10 | supply voltage |

8. Functional description

Table 4. Function table^[1]

| Input | | Channel |
|-------|------------------------|--------------------|
| S | $\overline{\text{OE}}$ | |
| L | L | D+ = 1D+; D– = 1D– |
| H | L | D+ = 2D+; D– = 2D– |
| X | H | switches off |

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care.

9. 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} | supply voltage | | -0.5 | +4.6 | V |
| V_I | input voltage | S, \overline{OE} input | [1] -0.5 | +7.0 | V |
| V_{SW} | switch voltage | | [2] -0.5 | +7.0 | V |
| I_{IK} | input clamping current | $V_I < -0.5$ V | -50 | - | mA |
| I_{SK} | switch clamping current | $V_I < -0.5$ V | -50 | - | mA |
| I_{SW} | switch current | | - | ± 120 | mA |
| I_{CC} | supply current | | - | +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 | - | 250 | mW |

[1] The minimum input voltage rating may be exceeded if the input current rating is observed.

[2] The minimum and maximum switch voltage ratings may be exceeded if the switch clamping current rating is observed.

10. Recommended operating conditions

Table 6. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|---------------------|--------------------------|-----|----------|------|
| V_{CC} | supply voltage | | 2.3 | 3.6 | V |
| V_I | input voltage | S, \overline{OE} input | 0 | V_{CC} | V |
| V_{SW} | switch voltage | | 0 | 5.5 | V |
| T_{amb} | ambient temperature | | -40 | +85 | °C |

11. Static characteristics

Table 7. Static characteristics

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

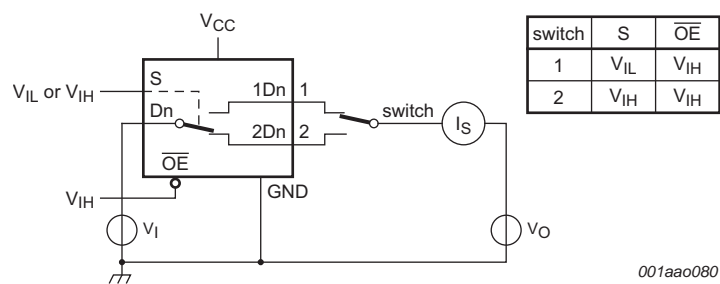
| Symbol | Parameter | Conditions | $T_{amb} = 25$ °C | | | $T_{amb} = -40$ °C to +85 °C | | Unit |
|----------|--------------------------|--|-------------------|------|-----|------------------------------|--------------|---------|
| | | | Min | Typ | Max | Min | Max | |
| V_{IH} | HIGH-level input voltage | $V_{CC} = 2.3$ V to 2.7 V | - | - | - | $0.46V_{CC}$ | - | V |
| | | $V_{CC} = 2.7$ V to 3.6 V | - | - | - | $0.46V_{CC}$ | - | V |
| V_{IL} | LOW-level input voltage | $V_{CC} = 2.3$ V to 2.7 V | - | - | - | - | $0.25V_{CC}$ | V |
| | | $V_{CC} = 2.7$ V to 3.6 V | - | - | - | - | $0.25V_{CC}$ | V |
| V_{IK} | input clamping voltage | $V_{CC} = 2.7$ V, 3.6 V; $I_I = -18$ mA | - | - | - | - | -1.8 | V |
| I_I | input leakage current | S, \overline{OE} input; $V_{CC} = 0$ V, 2.7 V, 3.6; $V_I = GND$ to 3.6 V | - | 0.01 | - | - | ± 1 | μA |

Table 7. Static characteristics ...continued

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

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | Unit |
|---------------------|---------------------------|---|--------------------------|------|-----|-------------------------------------|------|------|
| | | | Min | Typ | Max | Min | Max | |
| I _{OFF} | power-off leakage current | per pin; V _{CC} = 0 V | | | | | | |
| | | V _{SW} = 0 V to 2.7 V | - | 0.01 | - | - | ±2.0 | μA |
| | | V _{SW} = 0 V to 3.6 V | - | 0.01 | - | - | ±2.0 | μA |
| | | V _{SW} = 0 V to 5.25 V | - | 0.01 | - | - | ±3.0 | μA |
| I _{S(OFF)} | OFF-state leakage current | nD+ and nD- ports; see Figure 4 | | | | | | |
| | | V _{CC} = 2.7 V, 3.6 V | - | - | - | - | ±1 | μA |
| I _{CC} | supply current | V _{CC} = 2.7 V, 3.6 V | | | | | | |
| | | $\overline{\text{OE}}$ = GND | - | 18.5 | - | - | 30 | μA |
| | | $\overline{\text{OE}}$ = V _{CC} (low-power mode) | - | 0.01 | - | - | 2 | μA |
| ΔI _{CC} | additional supply current | S, $\overline{\text{OE}}$ input; one input at 1.8 V; other inputs at GND or V _{CC} | | | | | | |
| | | V _{CC} = 2.7 V | - | 0.8 | - | - | 1.8 | μA |
| | | V _{CC} = 3.6 V | - | 12.5 | - | - | 20 | μA |
| C _I | input capacitance | V _{SW} = GND or V _{CC} ; V _{CC} = 2.5 V, 3.3 V | - | 1 | - | - | 2.5 | pF |
| C _{S(OFF)} | OFF-state capacitance | V _{SW} = GND or V _{CC} ; V _{CC} = 2.5 V, 3.3 V | - | 3 | - | - | 5.0 | pF |
| C _{S(ON)} | ON-state capacitance | V _{SW} = GND or V _{CC} ; V _{CC} = 2.5 V, 3.3 V | - | 6 | - | - | 7.5 | pF |

11.1 Test circuits



V_I = 0 V; V_O = 0 V to 5.25 V

Fig 4. Test circuit for measuring OFF-state leakage current

11.2 ON resistance

Table 8. ON resistance

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for graphs see [Figure 6](#).

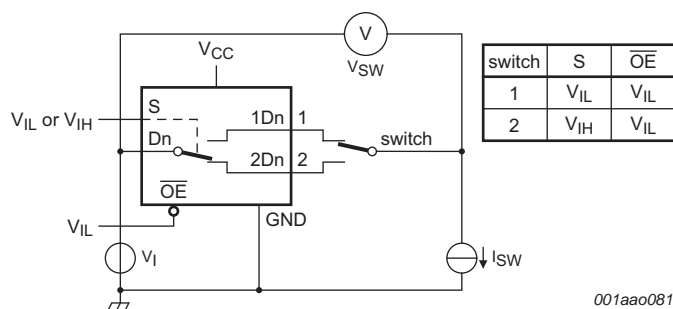
| Symbol | Parameter | Conditions | T _{amb} = -40 °C to +85 °C | | | T _{amb} = -40 °C to +85 °C | | Unit |
|-----------------------|---|--|-------------------------------------|--------------------|-----|-------------------------------------|-----|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| R _{ON} | ON resistance | V _{CC} = 2.3 V, 3.0 V see Figure 5 | | | | | | |
| | | V _I = 0 V; I _I = 30 mA | - | 3.6 | - | - | 6 | Ω |
| | | V _I = 2.4 V; I _I = -15 mA | - | 4.3 | - | - | 7 | Ω |
| ΔR _{ON} | ON resistance mismatch between channels | V _{CC} = 2.3 V, 3.0 V [2] | | | | | | |
| | | V _I = 0 V; I _I = 30 mA | - | 0.1 | - | - | - | Ω |
| | | V _I = 1.7 V; I _I = -15 mA | - | 0.1 | - | - | - | Ω |
| R _{ON(flat)} | ON resistance (flatness) | V _{CC} = 2.3 V, 3.0 V; [3] V _I = 0 V to V _{CC} | | | | | | |
| | | I _I = 30 mA | - | 0.8 | - | - | - | Ω |
| | | I _I = -15 mA | - | 0.7 | - | - | - | Ω |

[1] Typical values are measured at T_{amb} = 25 °C.

[2] Measured at identical V_{CC}, temperature and input voltage.

[3] Flatness is defined as the difference between the maximum and minimum value of ON resistance measured at identical V_{CC} and temperature.

11.3 ON resistance test circuit and waveforms



$$R_{ON} = V_{SW} / I_{SW}$$

Fig 5. Test circuit for measuring ON resistance

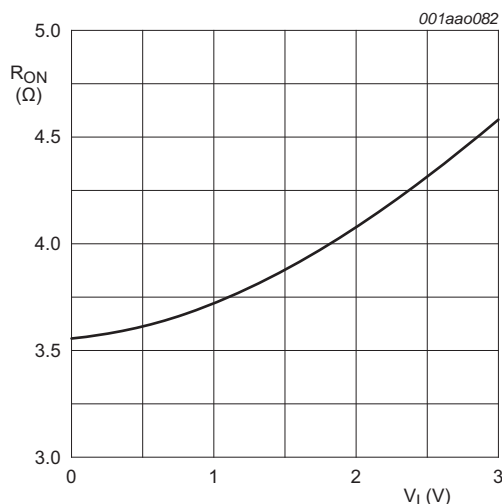


Fig 6. ON resistance as a function of input voltage

12. Dynamic characteristics

Table 9. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for test circuit, see [Figure 10](#).

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = –40 °C to +85 °C | | Unit |
|------------------|-------------------|--|--------------------------|--------------------|-----|-------------------------------------|-----|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| t _{pd} | propagation delay | Dn to nDn or nDn to Dn; see Figure 7 ^{[2][3]} | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | 0.25 | - | - | - | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | 0.25 | - | - | - | ns |
| t _{en} | enable time | S to Dn, nDn; see Figure 9 ^[3] | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | - | - | - | 50 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | - | - | - | 30 | ns |
| | | OE to Dn, nDn; see Figure 9 ^[3] | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | - | - | - | 32 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | - | - | - | 17 | ns |
| t _{dis} | disable time | S to Dn, nDn; see Figure 9 ^[3] | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | - | - | - | 23 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | - | - | - | 12 | ns |
| | | OE to Dn, nDn; see Figure 9 ^[3] | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | - | - | - | 12 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | - | - | - | 10 | ns |

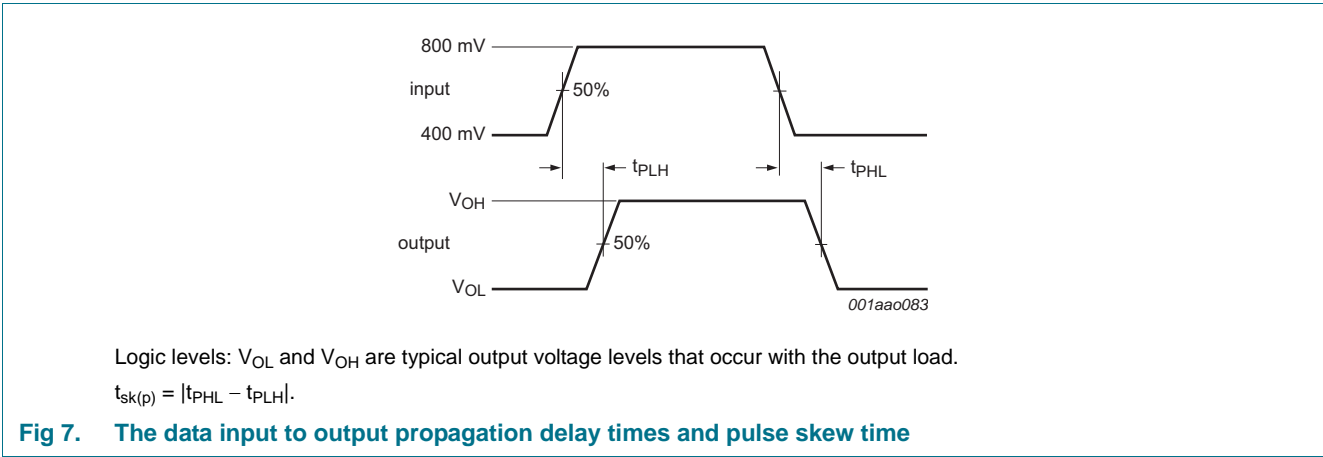
Table 9. Dynamic characteristics ...continued

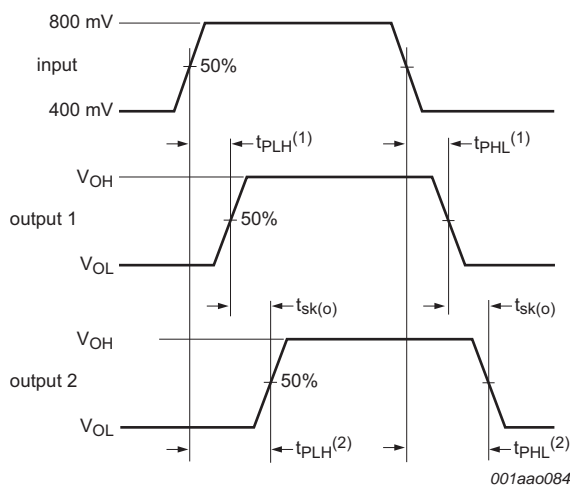
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 10.

| Symbol | Parameter | Conditions | T _{amb} = 25 °C | | | T _{amb} = -40 °C to +85 °C | | Unit |
|--------------------|------------------|----------------------------------|--------------------------|--------------------|-----|-------------------------------------|-----|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| t _{sk(o)} | output skew time | see Figure 8 | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | 0.1 | - | - | 0.2 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | 0.1 | - | - | 0.2 | ns |
| t _{sk(p)} | pulse skew time | see Figure 7 | | | | | | |
| | | V _{CC} = 2.3 V to 2.7 V | - | 0.1 | - | - | 0.2 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | - | 0.1 | - | - | 0.2 | ns |

- [1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 2.5 V and 3.3 V respectively.
- [2] The propagation delay is the calculated RC time constant of the typical ON resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).
- [3] t_{pd} is the same as t_{PLH} and t_{PHL}.
- [4] Guaranteed by design.

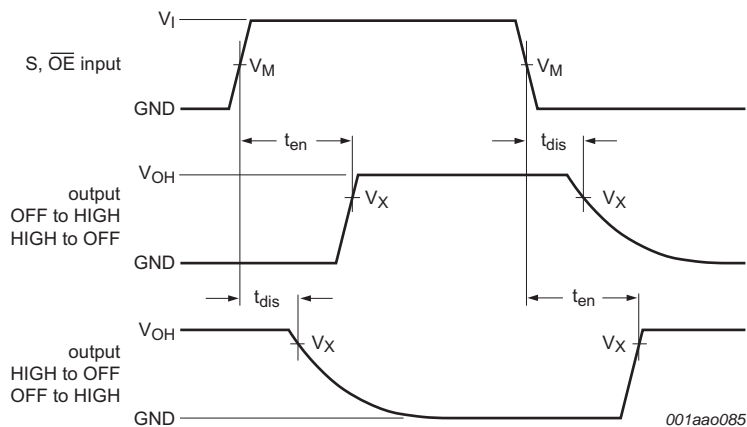
12.1 Waveforms, test circuit and graphs





Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.
 $t_{sk(o)} = |t_{PLH(1)} - t_{PLH(2)}|$ or $|t_{PHL(1)} - t_{PHL(2)}|$.

Fig 8. Output skew time

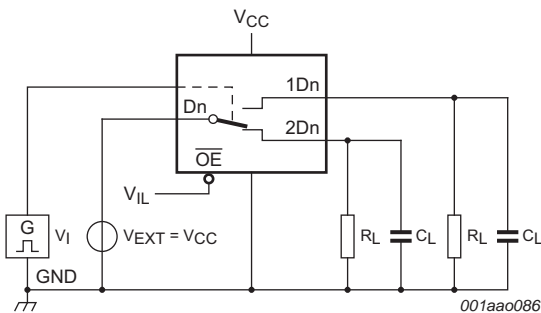


Measurement points are given in [Table 10](#).
Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 9. Enable and disable times

Table 10. Measurement points

| Supply voltage | Input | | Output |
|----------------|----------|-------|-------------|
| V_{CC} | V_M | V_I | V_X |
| 2.3 V to 3.6 V | $0.5V_I$ | 1.8 V | $0.9V_{OH}$ |



Test data is given in [Table 11](#).
Definitions test circuit:
 R_L = Load resistance.
 C_L = Load capacitance including jig and probe capacitance.
 V_{EXT} = External voltage for measuring switching times.
 V_I may be connected to S or \overline{OE} .

Fig 10. Test circuit for switching times

Table 11. Test data

| Supply voltage | Input | | Load | |
|----------------|-------|-------------|-------|--------------|
| V_{CC} | V_I | t_r, t_f | C_L | R_L |
| 2.3 V to 3.6 V | 1.8 V | ≤ 5 ns | 50 pF | 500 Ω |

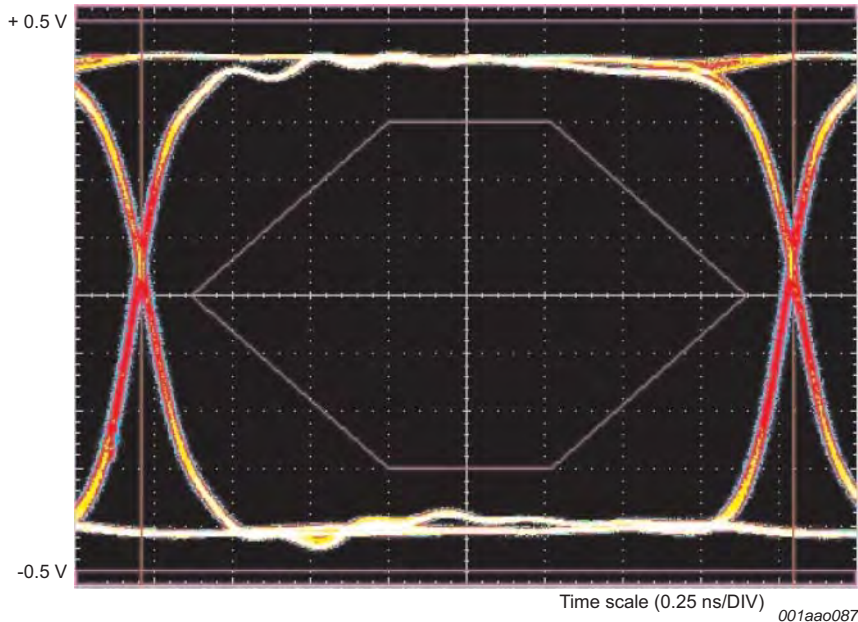


Fig 11. Eye-pattern 480 Mbps USB signal with no switch.

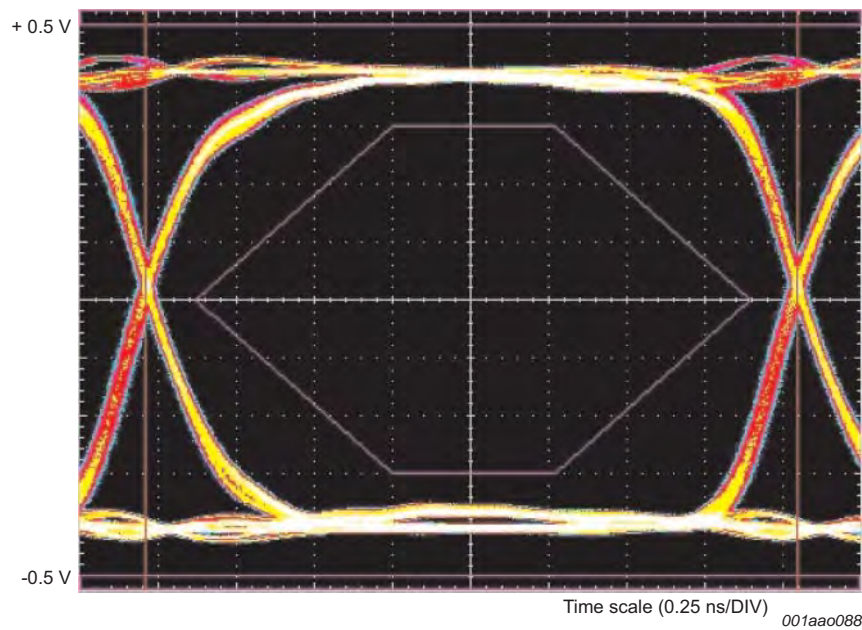


Fig 12. Eye-pattern 480 Mbps USB signal with switch (normally closed path)

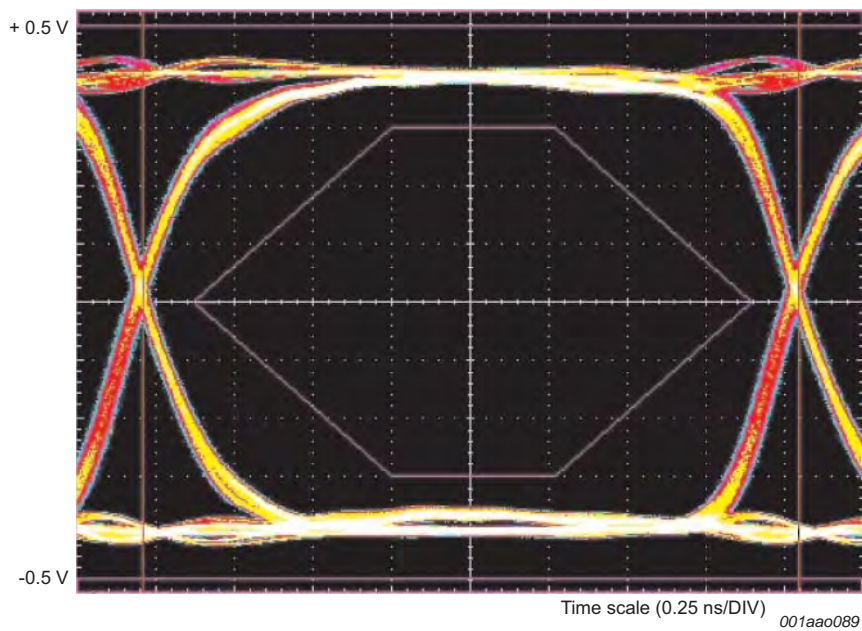


Fig 13. Eye-pattern 480 Mbps USB signal with switch (normally open path)

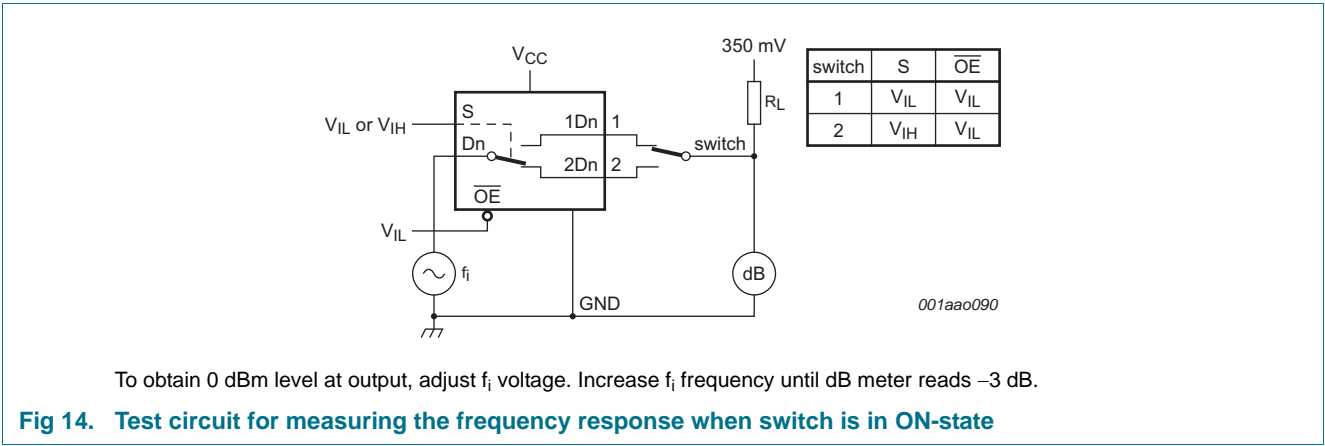
12.2 Additional dynamic characteristics

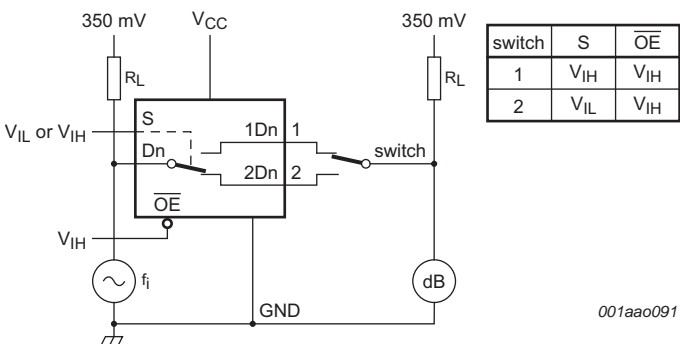
Table 12. Additional dynamic characteristics
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); $V_I = \text{GND or } V_{CC}$ (unless otherwise specified); $t_r = t_f \leq 5 \text{ ns}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------------|--------------------------|--|------------------------|-----|-----|------|
| $f_{(-3\text{dB})}$ | −3 dB frequency response | $R_L = 50 \text{ }\Omega$; see Figure 14 | [1][2] | | | |
| | | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ | - | 1.0 | - | GHz |
| | | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$ | - | 1.0 | - | GHz |
| α_{iso} | isolation (OFF-state) | $f_i = 250 \text{ MHz}$; $R_L = 50 \text{ }\Omega$; see Figure 15 | [1][2] | | | |
| | | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ | - | −38 | - | dB |
| | | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$ | - | −38 | - | dB |
| Xtalk | crosstalk | between switches; $f_i = 250 \text{ MHz}$; $R_L = 50 \text{ }\Omega$; see Figure 16 | [1][2] | | | |
| | | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ | - | −40 | - | dB |
| | | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$ | - | −40 | - | dB |

- [1] f_i is biased at 350 mV.
- [2] $V_i = 632 \text{ mV (p-p)}$.

12.3 Test circuits





To obtain 0 dBm level at input, adjust f_i voltage.

Fig 15. Test circuit for measuring isolation (OFF-state)

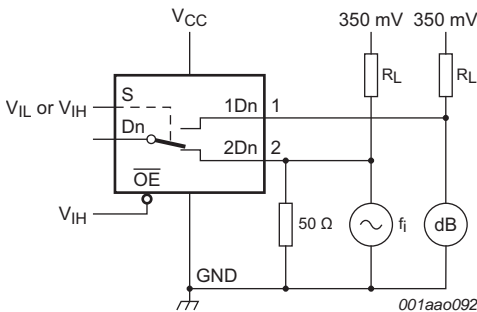


Fig 16. Test circuit for measuring crosstalk

13. Package outline

XQFN10: plastic, extremely thin quad flat package; no leads;
10 terminals; body 1.55 x 2.00 x 0.50 mm

SOT1049-3

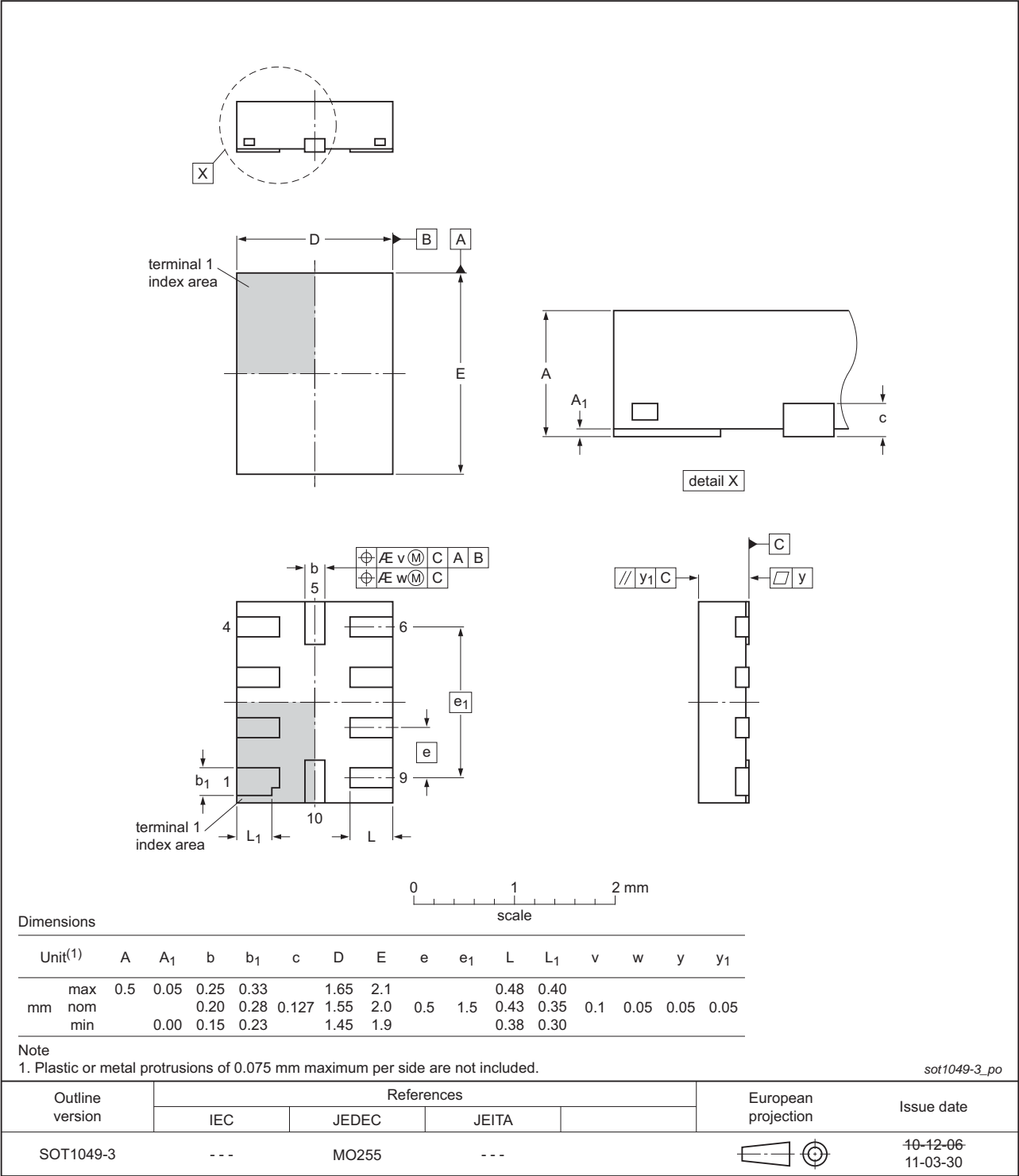


Fig 17. Package outline SOT1049-3 (XQFN10)

HVSON10: plastic thermal enhanced very thin small outline package; no leads;
10 terminals; 3 x 3 x 0.85 mm

SOT650-2

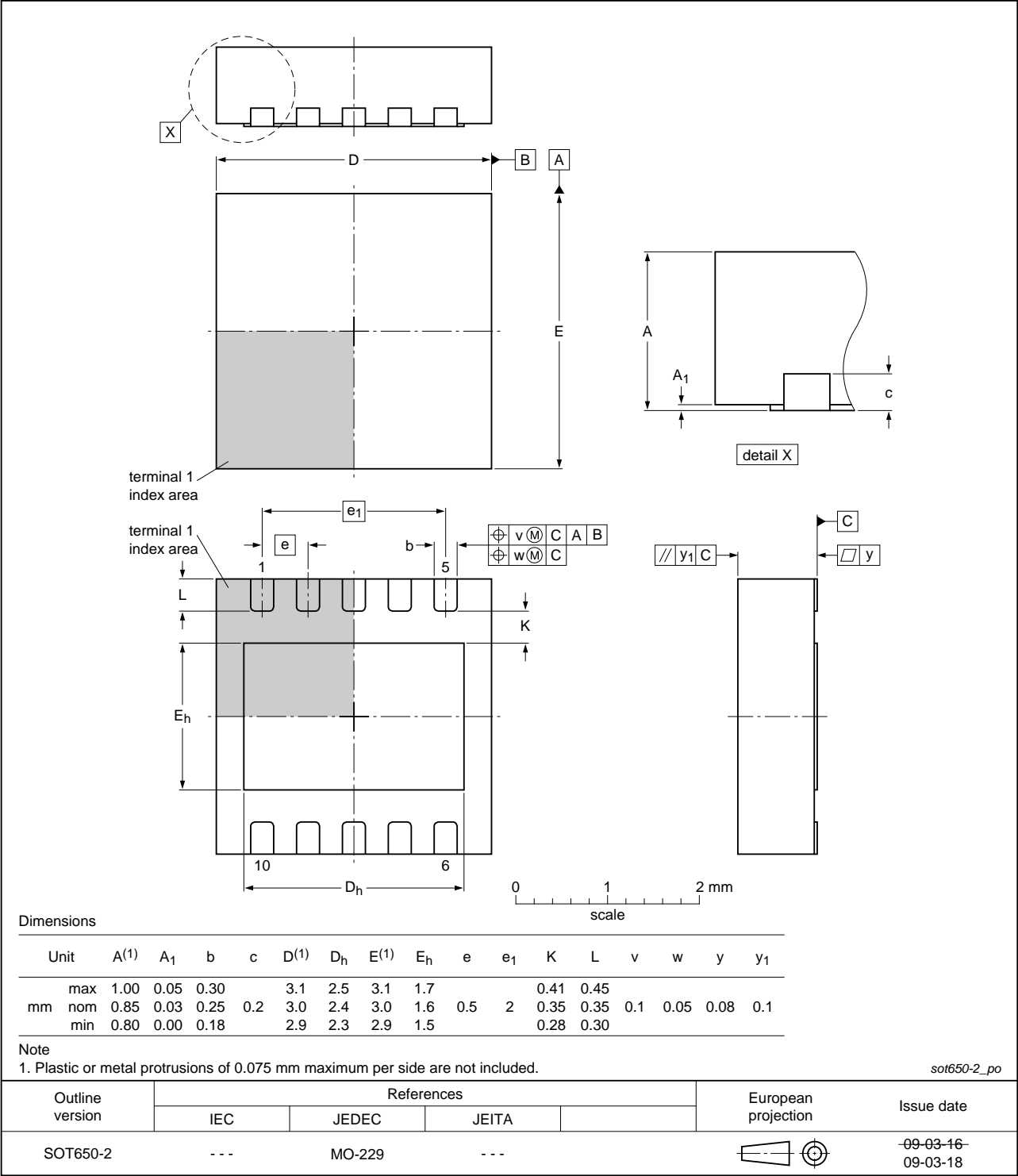


Fig 18. Package outline SOT650-2 (HVSON10)

14. Abbreviations

Table 13. Abbreviations

| Acronym | Description |
|---------|---|
| CDM | Charged Device Model |
| CMOS | Complementary Metal Oxide Semiconductor |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |

15. Revision history

Table 14. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|--|--------------------|---------------|--------------|
| NX3DV221 v.4 | 20130619 | Product data sheet | - | NX3DV221 v.3 |
| Modifications: | <ul style="list-style-type: none">Type number NX3DV221TK added.Package outline drawing added (Figure 18). | | | |
| NX3DV221 v.3 | 20120705 | Product data sheet | - | NX3DV221 v.2 |
| NX3DV221 v.2 | 20111109 | Product data sheet | - | NX3DV221 v.1 |
| NX3DV221 v.1 | 20110421 | Product data sheet | - | - |

16. Legal information

16.1 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 URL <http://www.nxp.com>.

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