

# NX3DV221

High-speed USB 2.0 switch with enable

Rev. 4 — 19 June 2013

Product data sheet

## 1. General description

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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

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- 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  $\mu$ A maximum)
- 6  $\Omega$  (maximum) ON resistance
- 0.1  $\Omega$  (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

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- Routes signals for USB 1.0, 1.1 and 2.0



## 4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
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 <sup>[1]</sup>
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

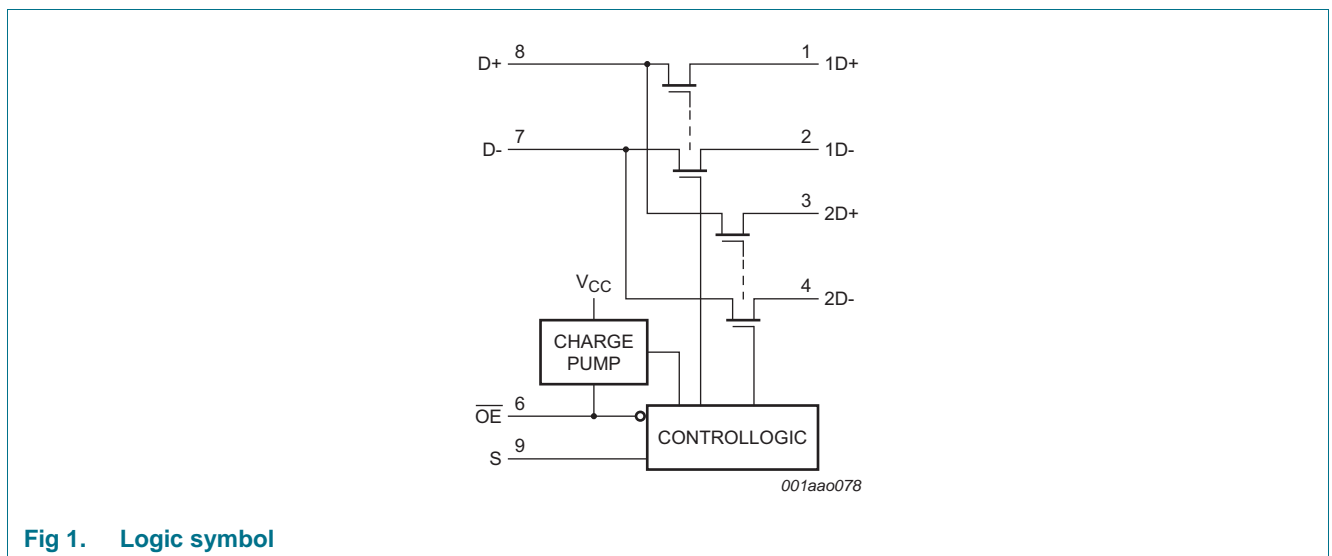
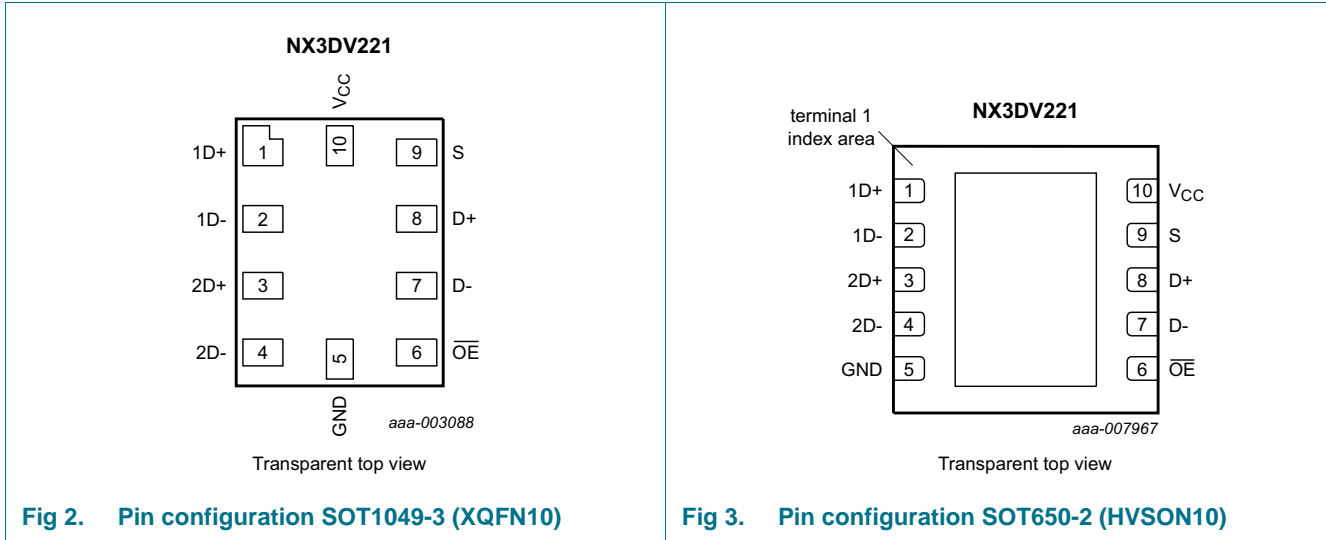


Fig 1. Logic symbol

## 7. Pinning information

### 7.1 Pinning



**Fig 2. Pin configuration SOT1049-3 (XQFN10)**

**Fig 3. Pin configuration SOT650-2 (HVSON10)**

### 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 <sub>CC</sub>	10	supply voltage

## 8. Functional description

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

Input	$\overline{\text{OE}}$	Channel
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		-	$\pm 120$	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).

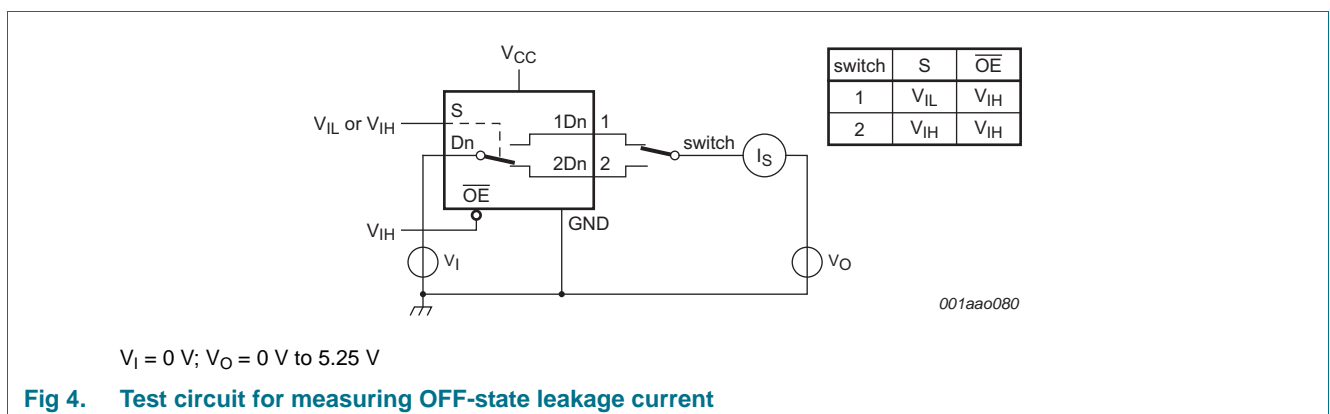
Symbol	Parameter	Conditions	$T_{amb} = 25$ °C			$T_{amb} = -40$ °C to +85 °C		Unit
			Min	Typ	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 2.3$ V to 2.7 V	-	-	-	$0.46V_{CC}$	-	V
		$V_{CC} = 2.7$ V to 3.6 V	-	-	-	$0.46V_{CC}$	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.3$ V to 2.7 V	-	-	-	-	$0.25V_{CC}$	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	-	-	$\pm 1$	$\mu$ A

**Table 7. Static characteristics ...continued**

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

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

### 11.1 Test circuits



**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 <sub>amb</sub> = -40 °C to +85 °C			T <sub>amb</sub> = -40 °C to +85 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
R <sub>ON</sub>	ON resistance	V <sub>CC</sub> = 2.3 V, 3.0 V see Figure 5						
		V <sub>I</sub> = 0 V; I <sub>I</sub> = 30 mA	-	3.6	-	-	6	Ω
		V <sub>I</sub> = 2.4 V; I <sub>I</sub> = -15 mA	-	4.3	-	-	7	Ω
ΔR <sub>ON</sub>	ON resistance mismatch between channels	V <sub>CC</sub> = 2.3 V, 3.0 V <sup>[2]</sup>						
		V <sub>I</sub> = 0 V; I <sub>I</sub> = 30 mA	-	0.1	-	-	-	Ω
		V <sub>I</sub> = 1.7 V; I <sub>I</sub> = -15 mA	-	0.1	-	-	-	Ω
R <sub>ON(flat)</sub>	ON resistance (flatness)	V <sub>CC</sub> = 2.3 V, 3.0 V; V <sub>I</sub> = 0 V to V <sub>CC</sub> <sup>[3]</sup>						
		I <sub>I</sub> = 30 mA	-	0.8	-	-	-	Ω
		I <sub>I</sub> = -15 mA	-	0.7	-	-	-	Ω

- [1] Typical values are measured at T<sub>amb</sub> = 25 °C.
- [2] Measured at identical V<sub>CC</sub>, temperature and input voltage.
- [3] Flatness is defined as the difference between the maximum and minimum value of ON resistance measured at identical V<sub>CC</sub> and temperature.

11.3 ON resistance test circuit and waveforms

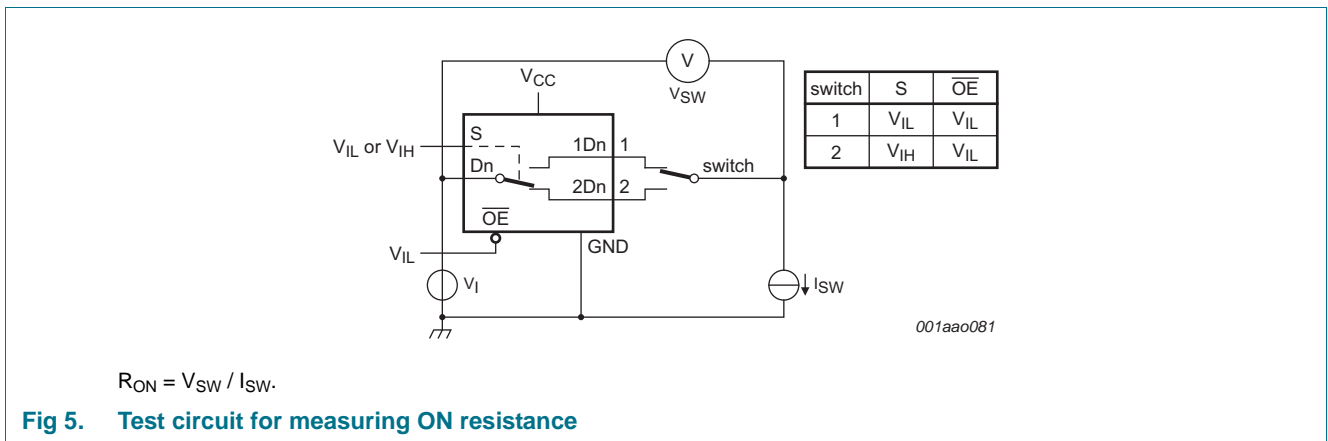


Fig 5. Test circuit for measuring ON resistance

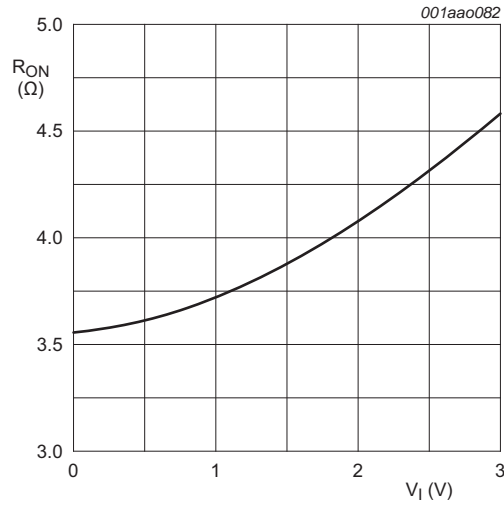


Fig 6. ON resistance as a function of input voltage

## 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 <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
t <sub>pd</sub>	propagation delay	Dn to nDn or nDn to Dn; see Figure 7 [2][3]	-	0.25	-	-	-	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	0.25	-	-	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	0.25	-	-	-	ns
t <sub>en</sub>	enable time	S to Dn, nDn; see Figure 9 [3]	-	-	-	-	50	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	-	-	-	30	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	-	-	-	30	ns
		OE to Dn, nDn; see Figure 9 [3]	-	-	-	-	32	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	-	-	-	17	ns
t <sub>dis</sub>	disable time	S to Dn, nDn; see Figure 9 [3]	-	-	-	-	23	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	-	-	-	12	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	-	-	-	10	ns
		OE to Dn, nDn; see Figure 9 [3]	-	-	-	-	12	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	-	-	-	10	ns

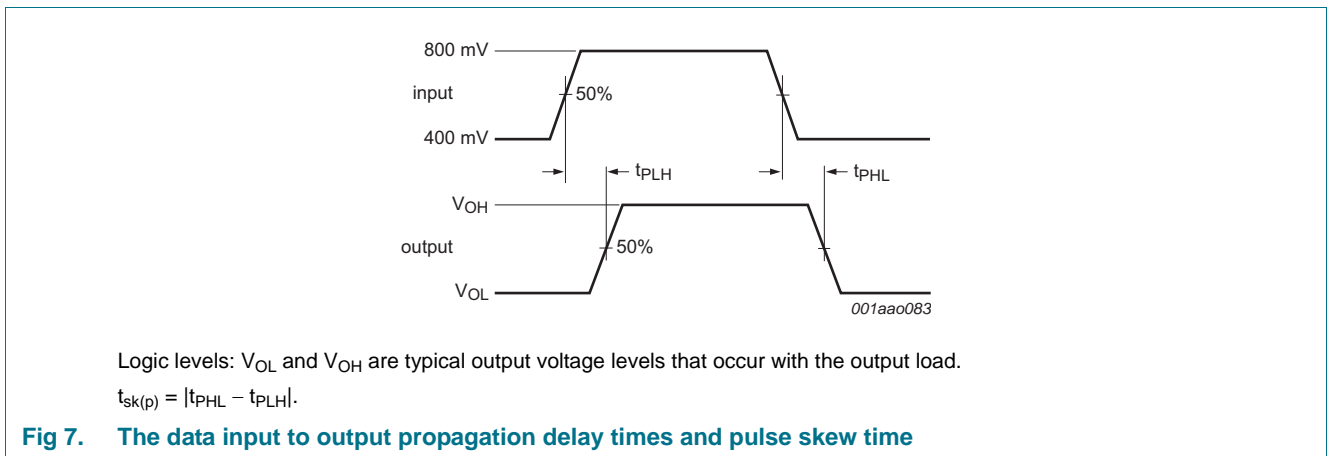
**Table 9. Dynamic characteristics ...continued**

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

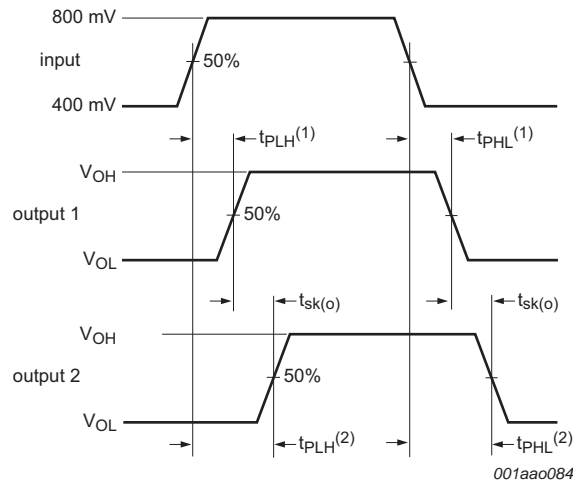
Symbol	Parameter	Conditions	T <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		Unit	
			Min	Typ <sup>[1]</sup>	Max	Min	Max		
t <sub>sk(o)</sub>	output skew time	see <a href="#">Figure 8</a>							
			V <sub>CC</sub> = 2.3 V to 2.7 V	-	0.1	-	-	0.2	ns
			V <sub>CC</sub> = 3.0 V to 3.6 V	-	0.1	-	-	0.2	ns
t <sub>sk(p)</sub>	pulse skew time	see <a href="#">Figure 7</a>							
			V <sub>CC</sub> = 2.3 V to 2.7 V	-	0.1	-	-	0.2	ns
			V <sub>CC</sub> = 3.0 V to 3.6 V	-	0.1	-	-	0.2	ns

- [1] Typical values are measured at T<sub>amb</sub> = 25 °C and V<sub>CC</sub> = 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<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.
- [4] Guaranteed by design.

### 12.1 Waveforms, test circuit and graphs

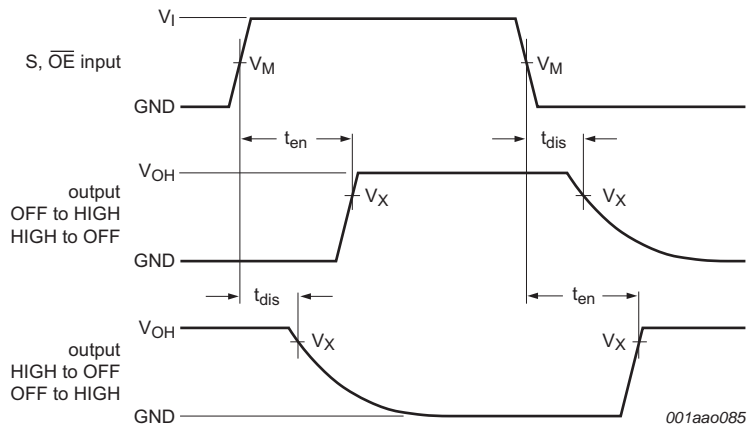






Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.  
 $t_{sk(o)} = |t_{PLH(1)} - t_{PLH(2)}|$  or  $|t_{PHL(1)} - t_{PHL(2)}|$ .

**Fig 8. Output skew time**

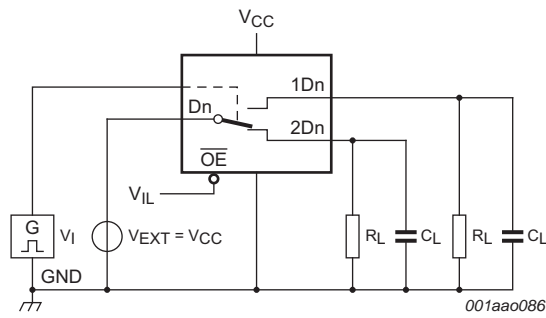


Measurement points are given in [Table 10](#).  
 Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**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.

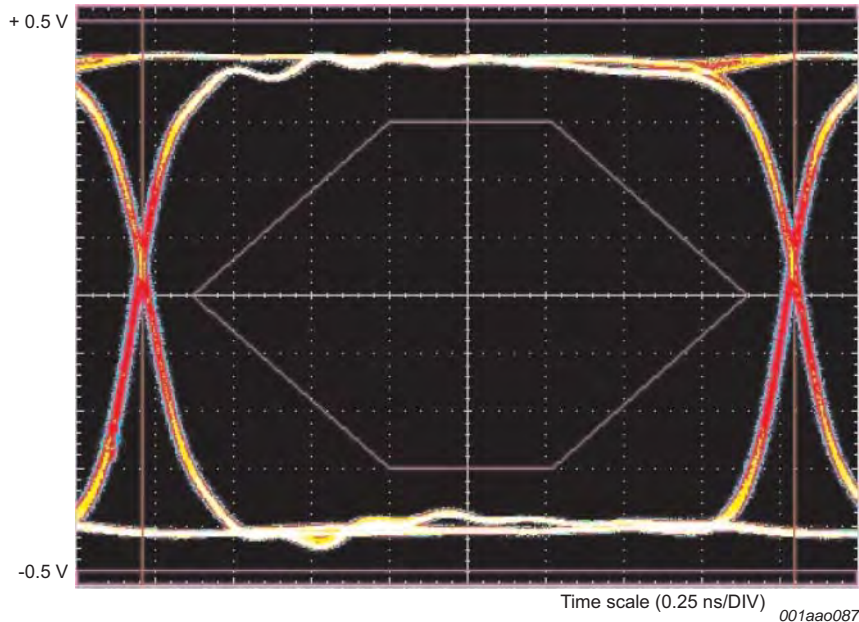
$V_{EXT}$  = External voltage for measuring switching times.

$V_I$  may be connected to S or  $\overline{OE}$ .

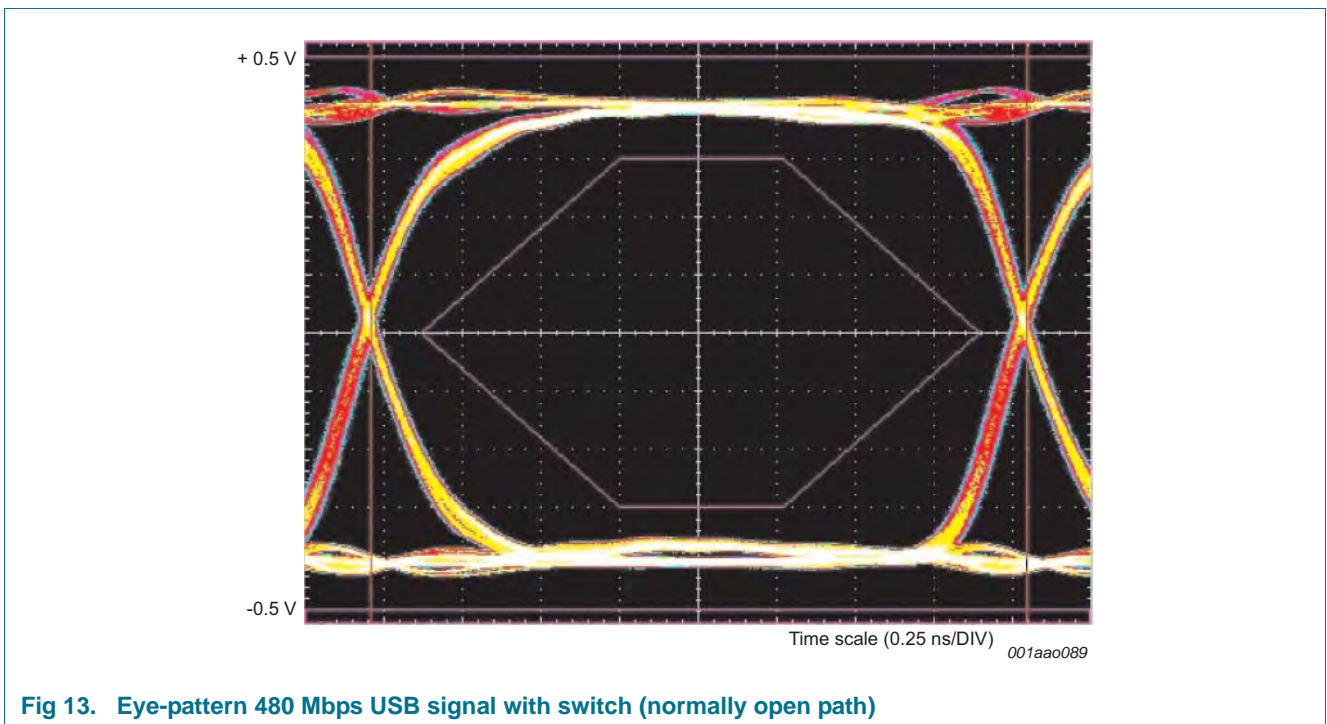
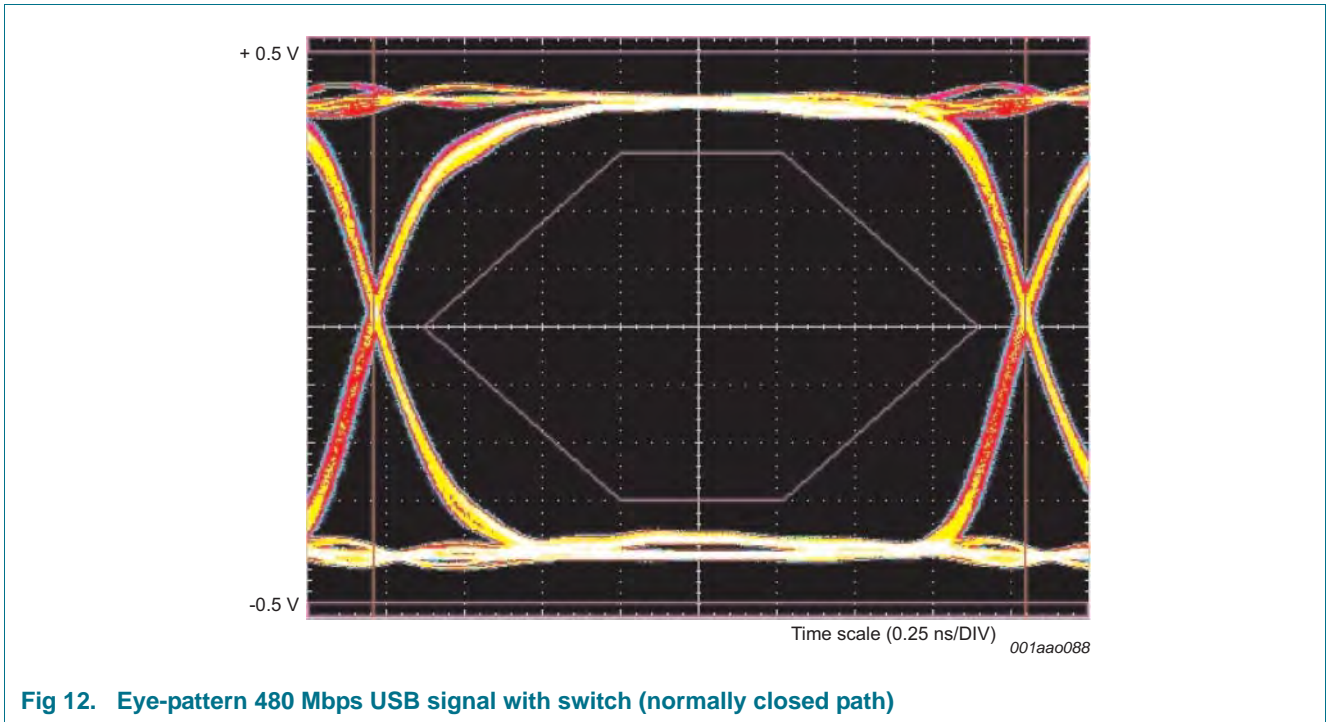
**Fig 10. Test circuit for switching times**

**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	$\leq 5$ ns	50 pF	500 $\Omega$



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



### 12.2 Additional dynamic characteristics

**Table 12. Additional dynamic characteristics**

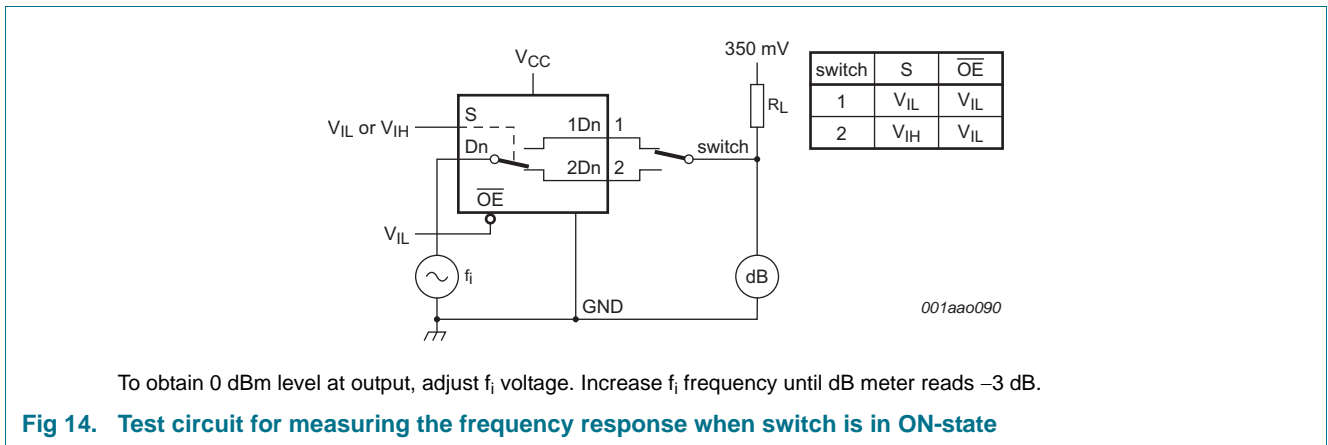
At recommended operating conditions; voltages are referenced to GND (ground = 0 V);  $V_i = \text{GND}$  or  $V_{CC}$  (unless otherwise specified);  $t_r = t_f \leq 5 \text{ ns}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

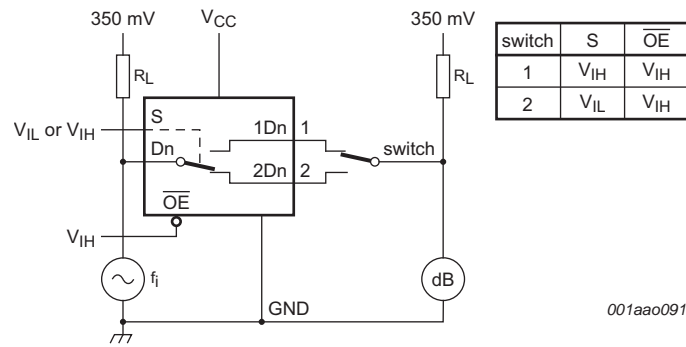
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{(-3\text{dB})}$	-3 dB frequency response	$R_L = 50 \text{ } \Omega$ ; see <a href="#">Figure 14</a>	<a href="#">[1][2]</a>			
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	-	1.0	-	GHz
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$	-	1.0	-	GHz
$\alpha_{\text{iso}}$	isolation (OFF-state)	$f_i = 250 \text{ MHz}$ ; $R_L = 50 \text{ } \Omega$ ; see <a href="#">Figure 15</a>	<a href="#">[1][2]</a>			
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	-	-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 <a href="#">Figure 16</a>	<a href="#">[1][2]</a>			
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	-	-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).

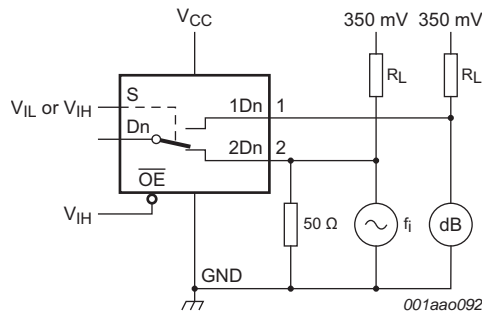
### 12.3 Test circuits





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

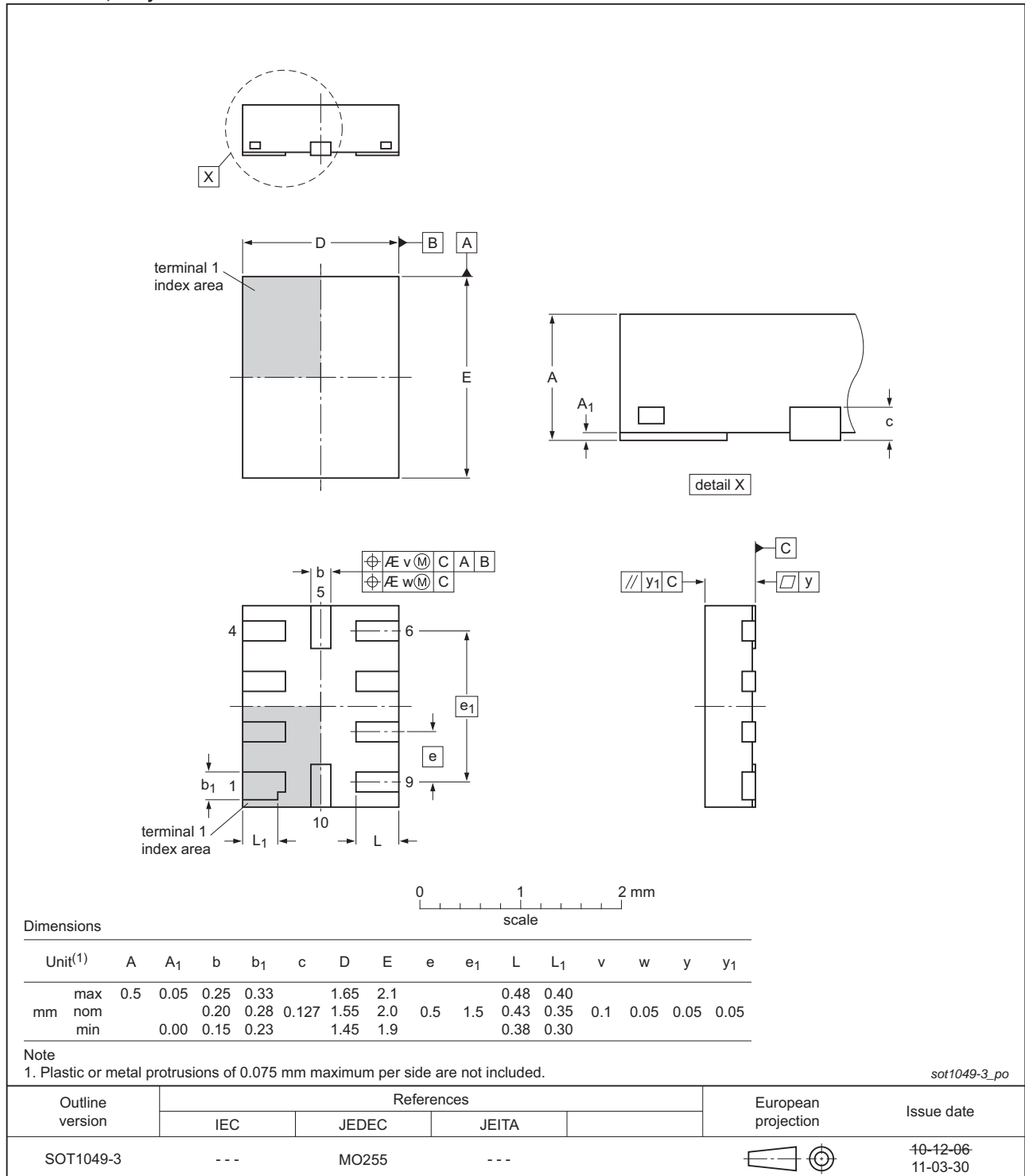


Fig 17. Package outline SOT1049-3 (XQFN10)

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

SOT650-2

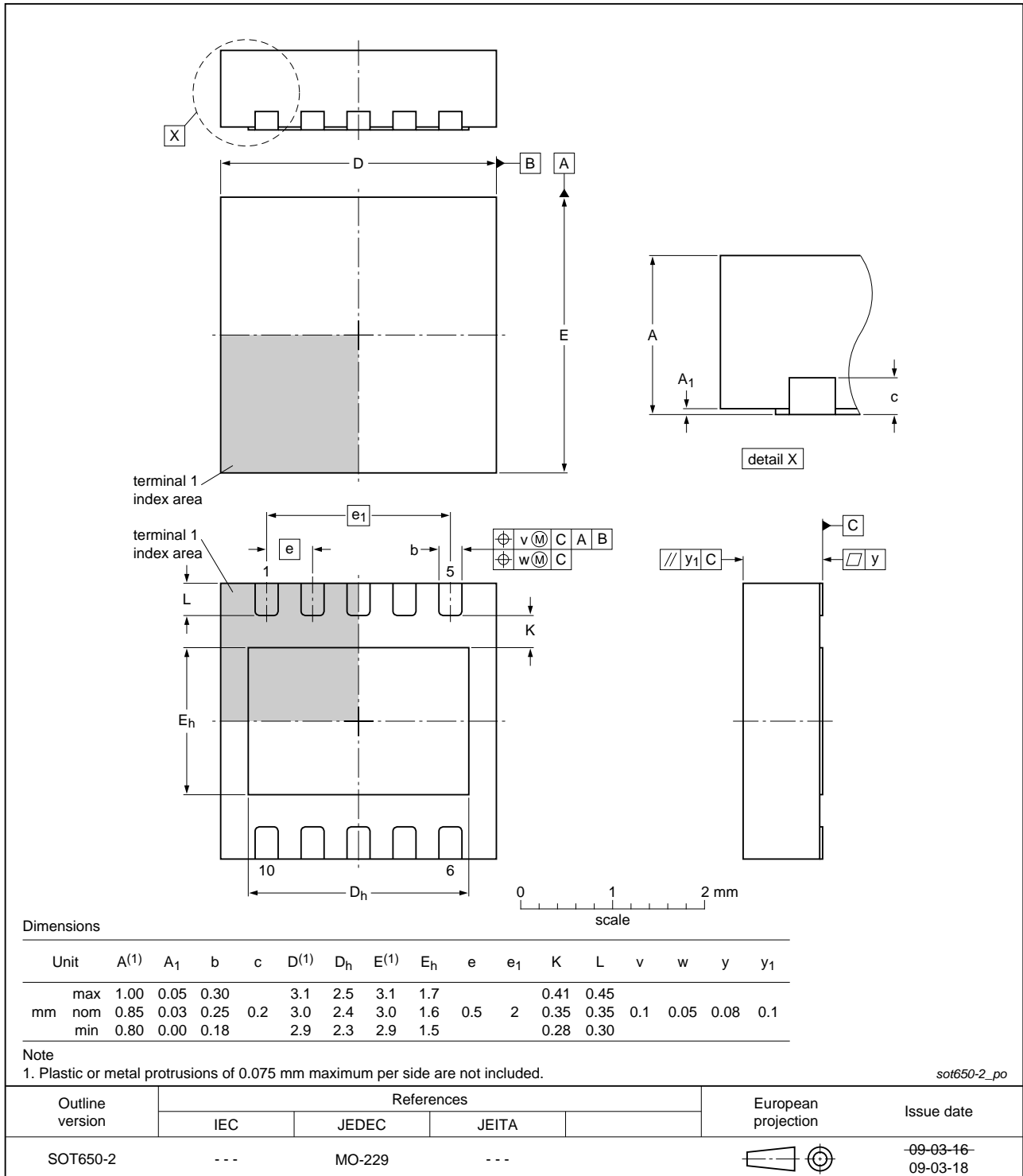


Fig 18. Package outline SOT650-2 (HVSON10)

## 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"><li>Type number NX3DV221TK added.</li><li>Package outline drawing added (<a href="#">Figure 18</a>).</li></ul>			
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 <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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**18. Contents**

**1 General description . . . . . 1**

**2 Features and benefits . . . . . 1**

**3 Applications . . . . . 1**

**4 Ordering information . . . . . 2**

**5 Marking . . . . . 2**

**6 Functional diagram . . . . . 2**

**7 Pinning information . . . . . 3**

7.1 Pinning . . . . . 3

7.2 Pin description . . . . . 3

**8 Functional description . . . . . 3**

**9 Limiting values . . . . . 4**

**10 Recommended operating conditions . . . . . 4**

**11 Static characteristics . . . . . 4**

11.1 Test circuits . . . . . 5

11.2 ON resistance . . . . . 6

11.3 ON resistance test circuit and waveforms . . . . 6

**12 Dynamic characteristics . . . . . 7**

12.1 Waveforms, test circuit and graphs . . . . . 8

12.2 Additional dynamic characteristics . . . . . 12

12.3 Test circuits . . . . . 12

**13 Package outline . . . . . 14**

**14 Abbreviations . . . . . 16**

**15 Revision history . . . . . 16**

**16 Legal information . . . . . 17**

16.1 Data sheet status . . . . . 17

16.2 Definitions . . . . . 17

16.3 Disclaimers . . . . . 17

16.4 Trademarks . . . . . 18

**17 Contact information . . . . . 18**

**18 Contents . . . . . 19**

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