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 μA 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

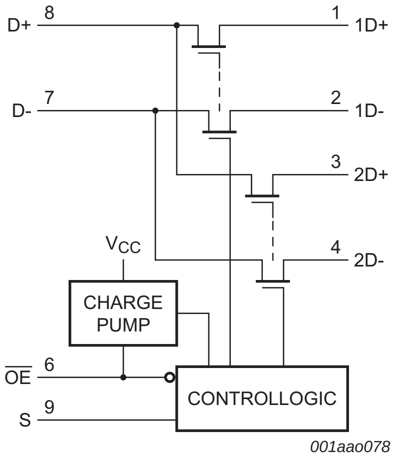
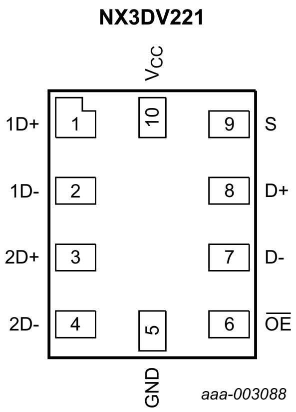


Fig 1. Logic symbol

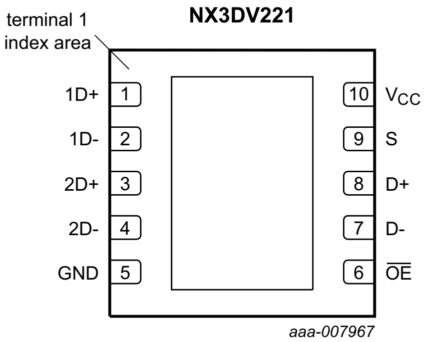
7. Pinning information

7.1 Pinning



Transparent top view

Fig 2. Pin configuration SOT1049-3 (XQFN10)



Transparent top view

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_{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

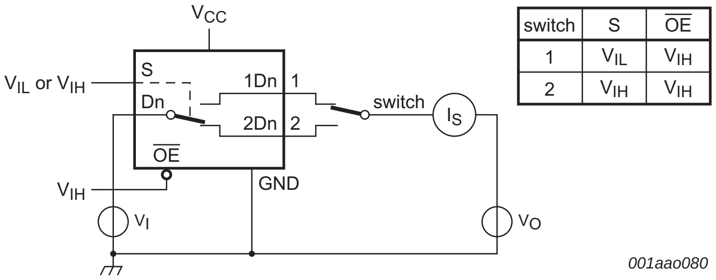
At recommended operating conditions; voltages are referenced to GND (ground 0 V).

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						
		$\overline{OE}$ = GND	-	18.5	-	-	30	μA
		$\overline{OE}$ = V_{CC} (low-power mode)	-	0.01	-	-	2	μA
ΔI_{CC}	additional supply current	S, $\overline{OE}$ 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



switch	S	$\overline{OE}$
1	V_{IL}	V_{IH}
2	V_{IH}	V_{IH}

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.

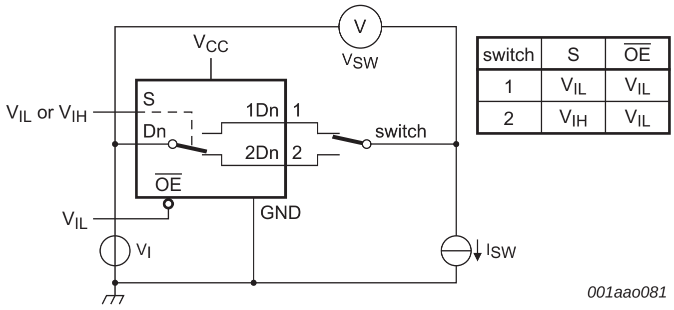
Symbol	Parameter	Conditions	T_{amb} = –40 °C to +85 °C			T_{amb} = –40 °C to +85 °C		Unit
			Min	Typ[1]	Max	Min	Max	
R_{ON}	ON resistance	V_{CC} = 2.3 V, 3.0 V see Figure 5						
		V_I = 0 V; I_I = 30 mA	-	3.6	-	-	6	Ω
		V_I = 2.4 V; I_I = –15 mA	-	4.3	-	-	7	Ω
ΔR_{ON}	ON resistance mismatch between channels	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; V_I = 0 V to V_{CC} [3]						
		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



switch	S	$\overline{OE}$
1	V_{IL}	V_{IL}
2	V_{IH}	V_{IL}

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

Fig 5. Test circuit for measuring ON resistance

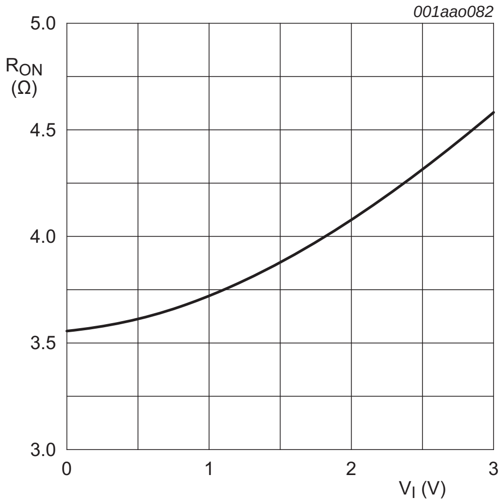


Fig 6. ON resistance as a function of input voltage

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
		$\overline{OE}$ 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
		$\overline{OE}$ 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	[4]						
		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	[4]						
		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

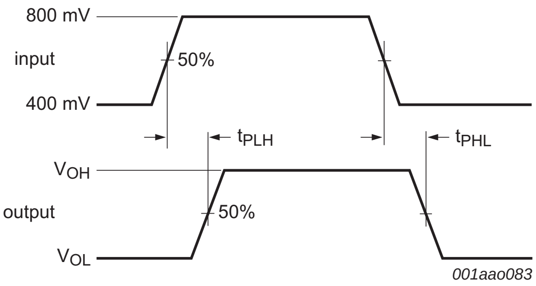
[1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 2.5 V and 3.3 V respectively.

[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.

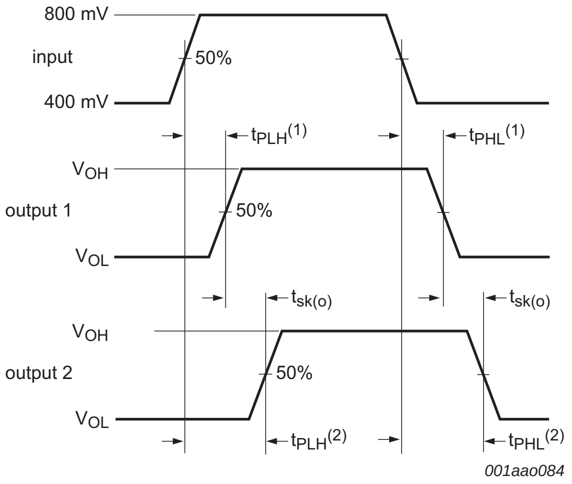
12.1 Waveforms, test circuit and graphs



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

$t_{sk(p)} = |t_{PHL} - t_{PLH}|$.

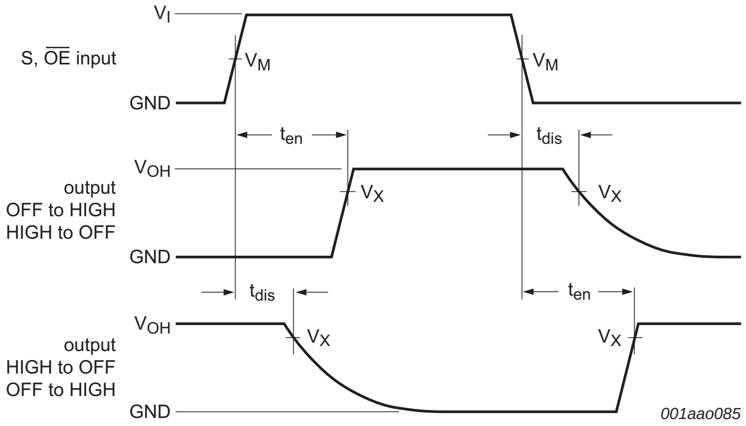
Fig 7. The data input to output propagation delay times and pulse skew time



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



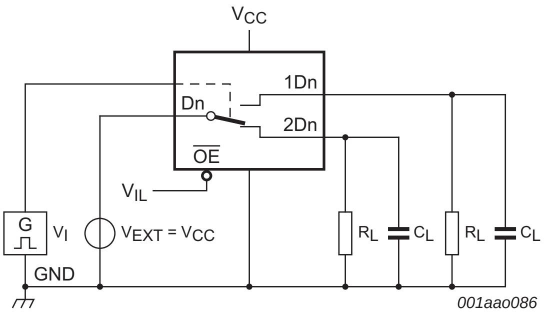
Measurement points are given in Table 10.

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

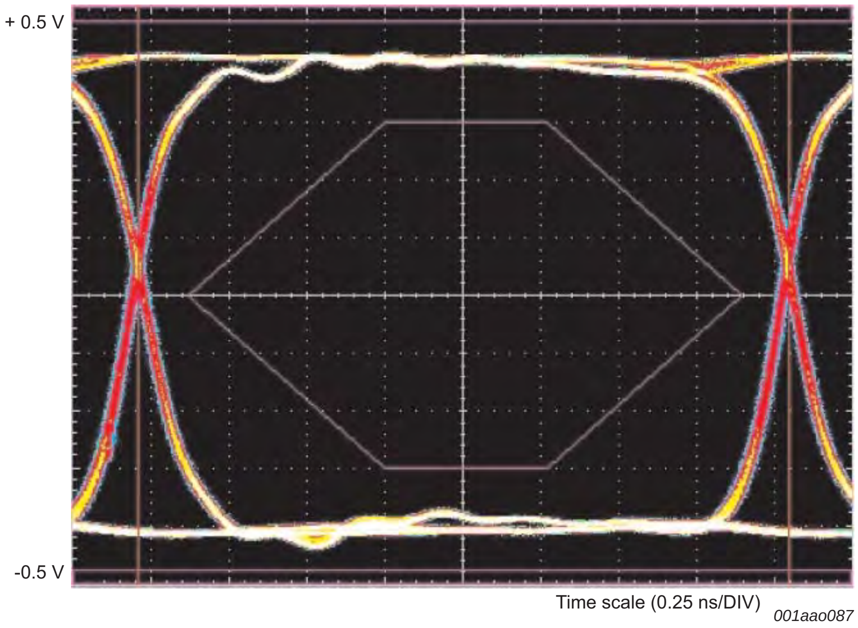


Fig 11. Eye-pattern 480 Mbps USB signal with no switch.

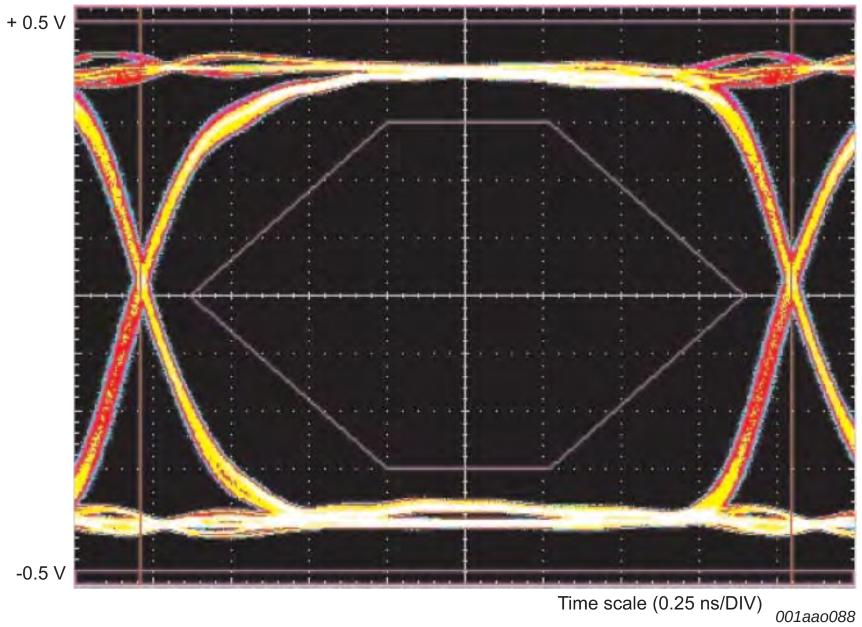


Fig 12. Eye-pattern 480 Mbps USB signal with switch (normally closed path)

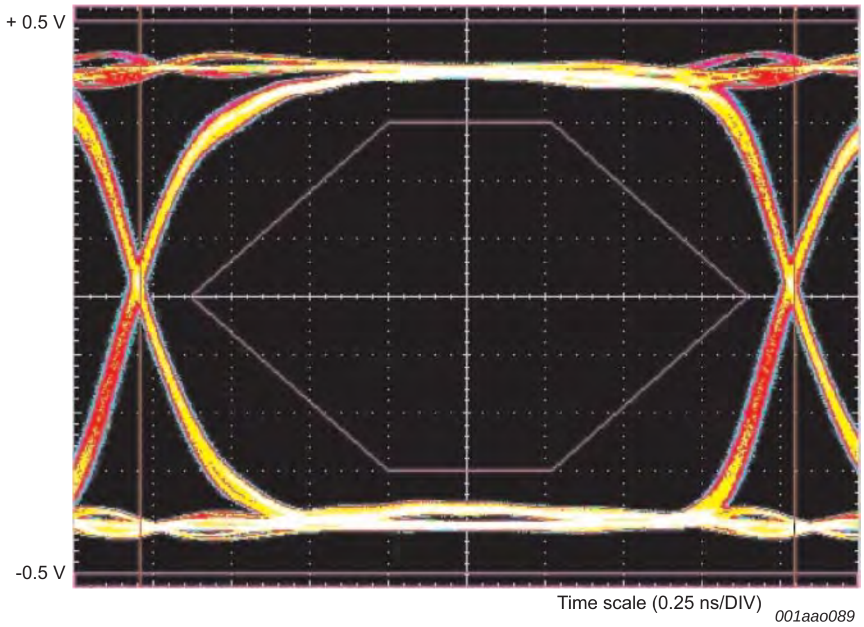


Fig 13. Eye-pattern 480 Mbps USB signal with switch (normally open path)

12.2 Additional dynamic characteristics

Table 12. Additional dynamic characteristics

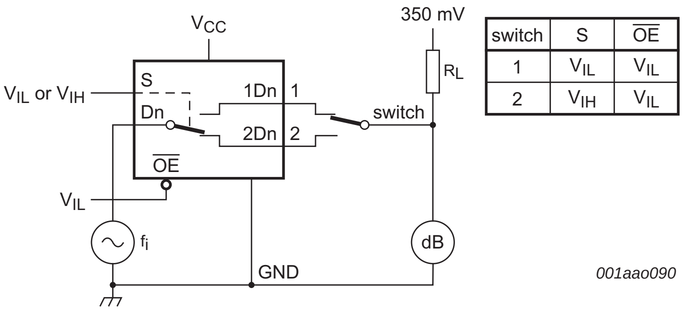
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); V_I = GND or V_{CC} (unless otherwise specified); $t_r = t_f \leq 5$ ns; $T_{amb} = 25$ °C.

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

[1] f_i is biased at 350 mV.

[2] V_i = 632 mV (p-p).

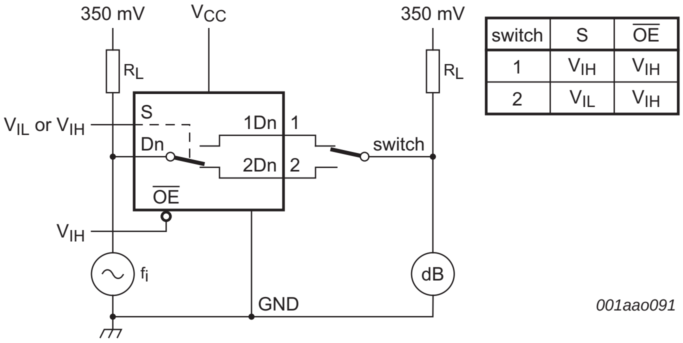
12.3 Test circuits



switch	S	$\overline{OE}$
1	V_{IL}	V_{IL}
2	V_{IH}	V_{IL}

To obtain 0 dBm level at output, adjust f_i voltage. Increase f_i frequency until dB meter reads –3 dB.

Fig 14. Test circuit for measuring the frequency response when switch is in ON-state



switch	S	$\overline{OE}$
1	V_{IH}	V_{IH}
2	V_{IL}	V_{IH}

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

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

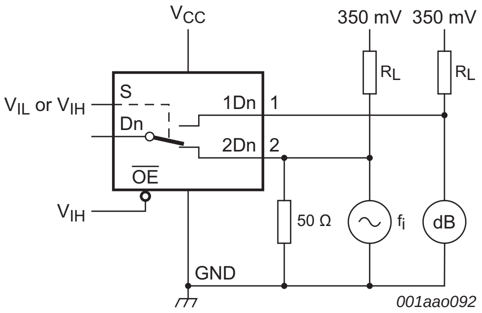
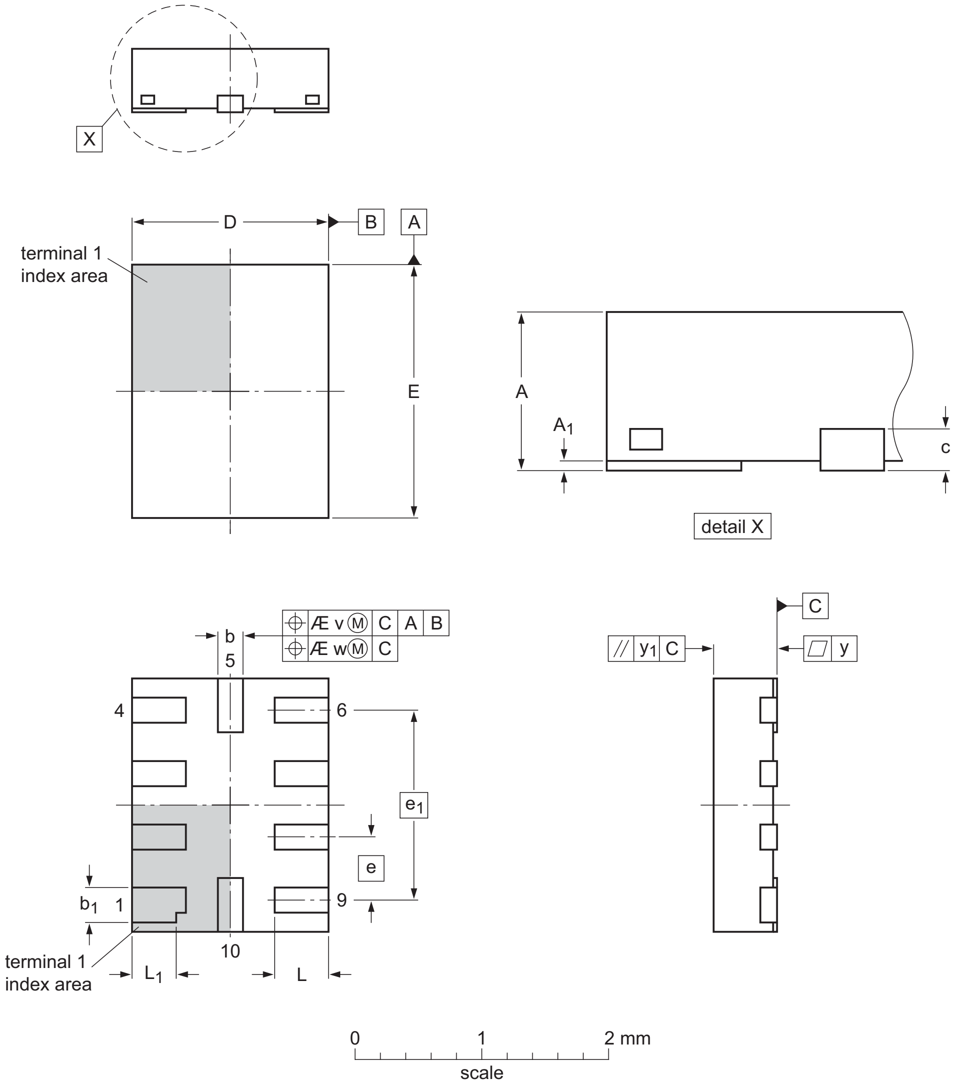


Fig 16. Test circuit for measuring crosstalk

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**



Dimensions

Unit$^{(1)}$		A	A_1	b	b_1	c	D	E	e	e_1	L	L_1	v	w	y	y_1
mm	max	0.5	0.05	0.25	0.33		1.65	2.1			0.48	0.40				
	nom			0.20	0.28	0.127	1.55	2.0	0.5	1.5	0.43	0.35	0.1	0.05	0.05	0.05
	min		0.00	0.15	0.23		1.45	1.9			0.38	0.30				

Note

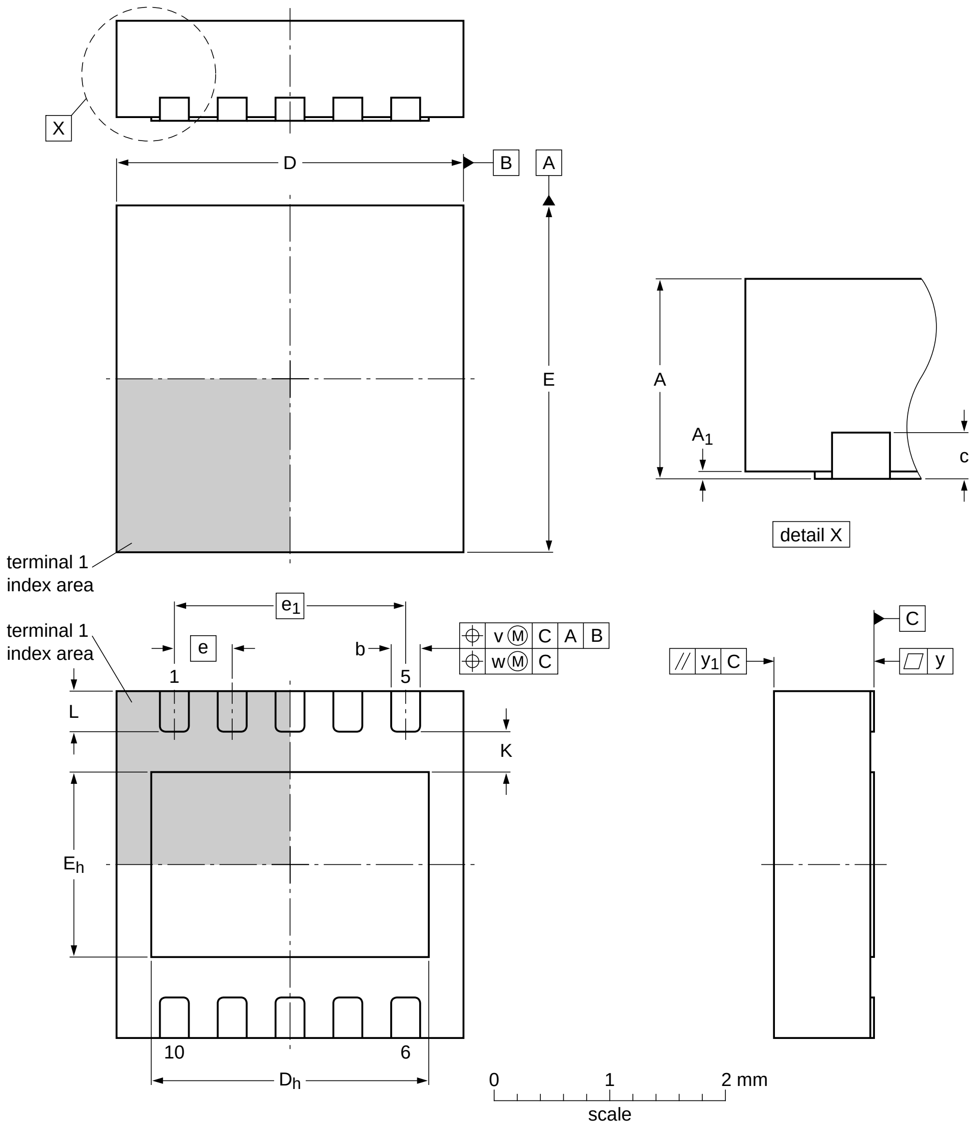
1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot1049-3_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1049-3	- - -	MO255	- - -			~~10-12-06~~ 11-03-30

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**



Dimensions

Unit		$A^{(1)}$	A_1	b	c	$D^{(1)}$	D_h	$E^{(1)}$	E_h	e	e_1	K	L	v	w	y	y_1
mm	max	1.00	0.05	0.30	0.2	3.1	2.5	3.1	1.7	0.5	2	0.41	0.45	0.1	0.05	0.08	0.1
	nom	0.85	0.03	0.25		3.0	2.4	3.0	1.6			0.35	0.35				
	min	0.80	0.00	0.18		2.9	2.3	2.9	1.5			0.28	0.30				

Note
1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot650-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT650-2	- - -	MO-229	- - -			~~09-03-16~~ 09-03-18

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:	• 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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17. Contact information

For more information, please visit: **http://www.nxp.com**

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