

# NX5DV715

## Dual supply 1-of-2 VGA switch

Rev. 3 — 4 November 2011

Product data sheet

## 1. General description

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The NX5DV715 is a dual supply 1-to-2 VGA switch. It integrates high-bandwidth SPDT switches with level-translating buffers and level translating switches to provide switching of input RGB, H-Sync, V-Sync and DDC signals to either of two output channels.

The NX5DV715 is characterized for operation from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ .

## 2. Features and benefits

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- RGB switches:
  - ◆ Low ON resistance ( $4\ \Omega$  typical)
  - ◆ Low ON capacitance (12 pF typical)
  - ◆ Low output skew (50 ps)
- Low power consumption ( $< 2\ \mu\text{A}$ )
- Level translation of sync and DDC signals
- Over-voltage tolerant inputs
- ESD protection:
  - ◆ HBM JESD22-A114F Class 3A exceeds 4 kV
  - ◆ MM JESD22-A115-A exceeds 200 V
  - ◆ CDM JESD22-C101D exceeds 1000 V
  - ◆ IEC61000-4-2 contact discharge exceeds 4 kV for I/Os
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$

## 3. Applications

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- Notebook Computers
- Docking stations
- Digital projectors
- Computer monitors
- Servers
- Storage



### 4. Ordering information

Table 1. Ordering information

Type number	Package		Description	Version
	Temperature range	Name		
NX5DV715HF	-40 °C to +85 °C	HWQFN32	plastic thermal enhanced very very thin quad flat package; no leads; 32 terminals; body 3 × 6 × 0.75 mm	SOT1180-1

### 5. Functional diagram

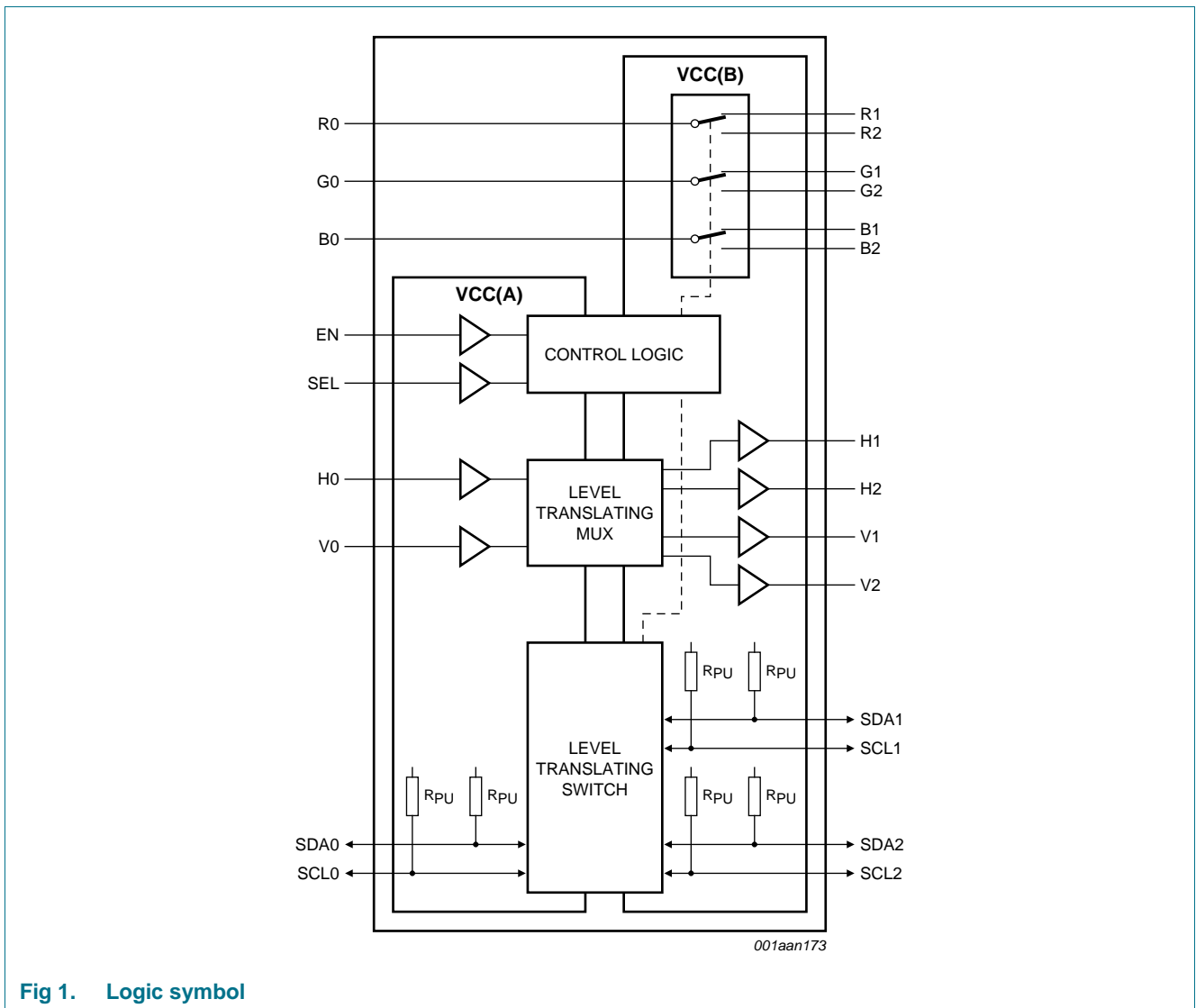
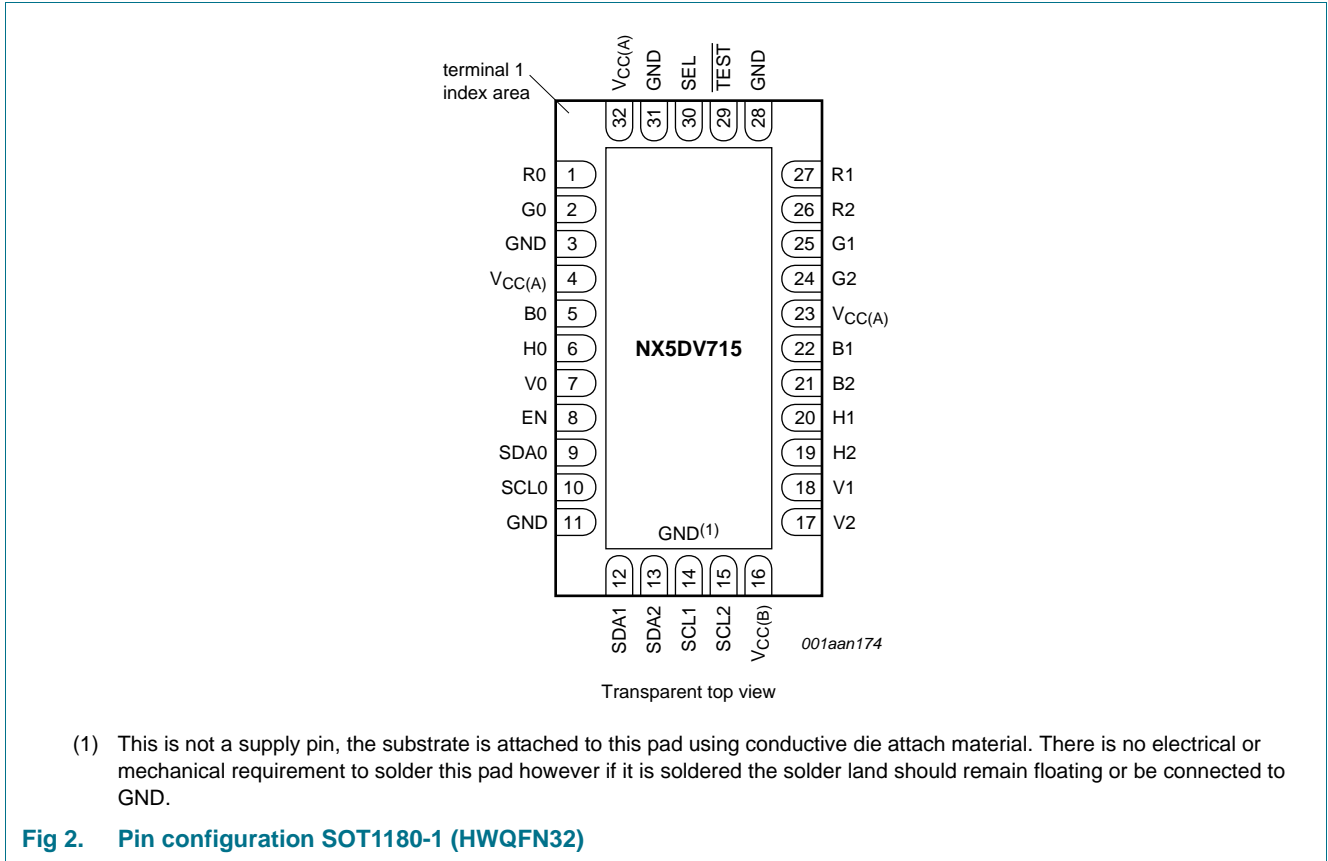


Fig 1. Logic symbol

## 6. Pinning information

### 6.1 Pinning



### 6.2 Pin description

**Table 2. Pin description**

Symbol	Pin	Description
R0, G0, B0	1, 2, 5	RGB input or output
GND	3, 11, 28, 31	ground (0 V)
V <sub>CC(A)</sub>	4, 23, 32	supply voltage A
H0	6	horizontal sync input
V0	7	vertical sync input
EN	8	enable input (active HIGH)
SDA0	9	SDA0 input or output
SCL0	10	SCL0 input or output
SDA1, SDA2	12, 13	SDA input or output
SCL1, SCL2	14, 15	SCL input or output
V <sub>CC(B)</sub>	16	supply voltage B
V1, V2	18, 17	vertical sync output
H1, H2	20, 19	horizontal sync output

**Table 2. Pin description ...continued**

Symbol	Pin	Description
R1, G1, B1, R2, G2, B2	27, 25, 22, 26, 24, 21	RGB input or output
TEST <sup>[1]</sup>	29	test pin (active LOW)
SEL	30	select input

[1] Test pin used to enable test mode. For normal usage, this pin must be connected to  $V_{CC(A)}$ .

## 7. Functional description

The NX5DV715 integrates high-bandwidth SPDT switches, level-translating buffers and level translating SPDT switches to provide a complete solution for 1-to-2 switching of VGA signals. An enable input (EN) is used to enable or disable the device and a select input (SEL) is used to determine which output is selected. When EN = LOW the device is disabled; all switches will be off, pull-up resistors will be disabled and H1, V1, H2, V2 will be forced LOW.

### 7.1 RGB switches

The NX5DV715 provides three identical single pole double throw high-bandwidth switches to route standard VGA RGB signals (see [Table 3](#)).

**Table 3. Function table RGB**

*H = HIGH voltage level; L = LOW voltage level; X = Don't care.*

Input		Switch
EN	SEL	
H	L	R0 to R1; G0 to G1; B0 to B1
H	H	R0 to R2; G0 to G2; B0 to B2
L	X	switches Rn, Gn, Bn off

### 7.2 H-Sync/V-Sync level translator

The horizontal and vertical synchronization buffers have inputs (H0, V0) referenced to  $V_{CC(A)}$  and outputs (H1, V1 and H2, V2) that are referenced to  $V_{CC(B)}$ . This allows level translation of synchronization signals from as low as 2.0 V up to 5.5 V and supports low-voltage CMOS or TTL-compatible graphics controllers meeting the VESA specification for output drive of  $\pm 8$  mA. The EN input also controls the level shifter (See [Table 4](#)).

**Table 4. Function table HV**

*H = HIGH voltage level; L = LOW voltage level; X = Don't care.*

Input		Switch
EN	SEL	
H	L	H1 = H0; V1 = V0; H2, V2 = L
H	H	H2 = H0; V2 = V0; H1, V1 = L
L	X	L

### 7.3 Display-Data Channel Multiplexer

The NX5DV715 provides two identical SPDT active-level translating switches to route DDC signals (See [Table 5](#)). The switch outputs are limited to a diode drop less than the voltage applied on  $V_{CC(A)}$ . To provide VESA I<sup>2</sup>C-compatible signals 3.3 V should be applied to  $V_{CC(A)}$ . If voltage translation is not required  $V_{CC(A)}$  should be connected to  $V_{CC(B)}$ . Switch terminals include integrated pull-up resistors; inputs (SDA0, SCL0) are pulled up to  $V_{CC(A)}$ , outputs (SDA1, SCL1 and SDA2, SCL2) are pulled up to  $V_{CC(B)}$ . When the NX5DV715 is disabled (EN = LOW), the pull-up resistors are also disabled.

**Table 5. Function table DDC**  
*H = HIGH voltage level; L = LOW voltage level; X = Don't care.*

Input		Switch
EN	SEL	
H	L	SDA0 to SDA1, SCL0 to SCL1
H	H	SDA0 to SDA2, SCL0 to SCL2
L	X	switches SDA <sub>n</sub> , SCL <sub>n</sub> off

## 8. Limiting values

**Table 6. 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	V
$V_{CC(B)}$	supply voltage B		-0.5	+6	V
$V_I$	input voltage		[1] -0.5	+6	V
$V_{SW}$	switch voltage		[1] -0.5	+6	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
$I_{OK}$	output clamping current	$V_O < 0$ V	-50	-	mA
$I_O$	output current	$V_O = 0$ V to $V_{CC(B)}$	-	±50	mA
$I_{CC}$	supply current	$I_{CC(A)}$ or $I_{CC(B)}$	-	100	mA
$I_{GND}$	ground current		-100	-	mA
$I_{SW}$	switch current	$V_{SW} > -0.5$ V or $V_{SW} < 6$ V; source or sink current	-	±30	mA
		$V_{SW} > -0.5$ V or $V_{SW} < 6$ V; pulsed at 1 ms duration, < 10 % duty cycle; peak current	-	±90	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +85 °C	[2] -	250	mW

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

[2] For HWQFN32 package: above 137 °C the value of  $P_{tot}$  derates linearly with 20.5 mW/K.

## 9. Recommended operating conditions

**Table 7. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC(A)}$	supply voltage A		2	3.3	5.5	V
$V_{CC(B)}$	supply voltage B		4.5	5.0	5.5	V
$T_{amb}$	ambient temperature	operating in free-air	-40	+25	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC(A)} = 2.3 \text{ V to } 2.7 \text{ V}$	[1] -	20	-	ns/V
		$V_{CC(A)} = 3 \text{ V to } 3.6 \text{ V}$	[1] -	10	-	ns/V
		$V_{CC(A)} = 4.5 \text{ V to } 5.5 \text{ V}$	[1] -	5	-	ns/V

[1] Applies to control signal levels.

## 10. Static characteristics

**Table 8. Static characteristics**

$V_{CC(B)} = 4.5 \text{ V to } 5.5 \text{ V}$ ;  $V_{CC(A)} = 2 \text{ V to } 5.5 \text{ V}$ , unless otherwise specified; Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	$T_{amb} = -40 \text{ °C to } +85 \text{ °C}$			Unit
			Min	Typ [1]	Max	
<b>General</b>						
$I_{CC(A)}$	supply current A	$V_{CC(A)} = 3.3 \text{ V}$ ; EN = $V_{CC(A)}$ or GND; for H1, H2, V1, V2: $I_O = 0 \text{ A}$ ; SCLn, SDAn unconnected	-	-	2.0	$\mu\text{A}$
$I_{CC(B)}$	supply current B	$V_{CC(B)} = 5.0 \text{ V}$ ; EN = $V_{CC(A)}$ or GND; for H1, H2, V1, V2: $I_O = 0 \text{ A}$ ; SCLn, SDAn unconnected	-	-	2.0	$\mu\text{A}$
<b>HV buffer</b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC(A)} = 3 \text{ V to } 3.6 \text{ V}$	2	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC(A)} = 3 \text{ V to } 3.6 \text{ V}$	-	-	0.8	V
$V_H$	hysteresis voltage		-	50	-	mV
$I_I$	input leakage current	$V_{CC(B)} = V_{CC(A)} = 5.5 \text{ V}$ ; $V_I = \text{GND to } V_{CC(A)}$	-	-	$\pm 1$	$\mu\text{A}$
$V_{OH}$	HIGH-level output voltage	$I_O = -8 \text{ mA}$	$V_{CC(B)} - 0.5$	-	-	V
$V_{OL}$	LOW-level output voltage	$I_O = 8 \text{ mA}$	-	-	0.5	V
$I_{OFF}$	power-off leakage current	$V_I$ or $V_O = 0 \text{ V to } 5.5 \text{ V}$ ; $V_{CC(B)} = 0 \text{ V}$ ; $V_{CC(A)} = 0 \text{ V to } 5.5 \text{ V}$	-	-	$\pm 1$	$\mu\text{A}$
<b>RGB switches</b>						
$I_{S(OFF)}$	OFF-state leakage current	$V_{CC(B)} = 5.5 \text{ V}$ ; $V_I = 0.3 \text{ V or } 5.5 \text{ V}$ ; $V_O = 0 \text{ V to } V_{CC(B)}$ ; EN = $V_{CC(A)}$ or GND; See <a href="#">Figure 3</a>	-	-	$\pm 1$	$\mu\text{A}$
$I_{S(ON)}$	ON-state leakage current	$V_{CC(B)} = 5.5 \text{ V}$ ; $V_I = 0.3 \text{ V or } 5.5 \text{ V}$ ; $V_O = 0 \text{ V to } V_{CC(B)}$ ; EN = $V_{CC(A)}$ ; See <a href="#">Figure 4</a>	-	-	$\pm 1$	$\mu\text{A}$
$R_{ON}$	ON resistance	$V_I = 0.7 \text{ V}$ ; $I_{SW} = -10 \text{ mA}$ ; See <a href="#">Figure 5</a> and <a href="#">Figure 6</a>	[4] -	4	-	$\Omega$

**Table 8. Static characteristics ...continued**

$V_{CC(B)} = 4.5\text{ V to }5.5\text{ V}$ ;  $V_{CC(A)} = 2\text{ V to }5.5\text{ V}$ , unless otherwise specified; Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			Unit
			Min	Typ <sup>[1]</sup>	Max	
$\Delta R_{ON}$	ON resistance mismatch between channels	$V_I = \text{GND to }0.7\text{ V}$ ; $I_{SW} = -10\text{ mA}$ <a href="#">[2]</a>	-	0.5	-	$\Omega$
$R_{ON(\text{flat})}$	ON resistance (flatness)	$V_I = \text{GND to }0.7\text{ V}$ ; $I_{SW} = -10\text{ mA}$ <a href="#">[3]</a>	-	0.5	-	$\Omega$
$C_{S(\text{OFF})}$	OFF-state capacitance		-	4.5	-	pF
$C_{S(\text{ON})}$	ON-state capacitance		-	12	-	pF
<b>SDAn, SCLn</b>						
$I_{S(\text{OFF})}$	OFF-state leakage current	$V_{CC(B)} = 5.5\text{ V}$ ; $V_{CC(A)} = 3.6\text{ V}$ ; SCL0, SDA0, SCL1, SCL2, SDA1, SDA2 = $V_{CC(A)}$ or GND; $V_O = 0\text{ V to }V_{CC(B)}$ ; EN = GND; See <a href="#">Figure 3</a> <a href="#">[5]</a>	-	-	$\pm 1$	$\mu\text{A}$
$R_{ON}$	ON resistance	$V_{CC(A)} = 2\text{ V}$ ; $V_I = 0.4\text{ V}$ ; $I_{SW} = \pm 2\text{ mA}$ ; See <a href="#">Figure 5</a> and <a href="#">Figure 7</a>	-	9	-	$\Omega$
$C_{S(\text{ON})}$	ON-state capacitance		-	15	-	pF
$R_{PU}$	pull-up resistance		-	4.7	-	k $\Omega$
<b>Control Logic (SEL, EN)</b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC(A)} = 2.3\text{ V to }2.7\text{ V}$	1.7	-	-	V
		$V_{CC(A)} = 3.0\text{ V to }3.6\text{ V}$	2.0	-	-	V
		$V_{CC(A)} = 4.5\text{ V to }5.5\text{ V}$	$0.7V_{CC(A)}$	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC(A)} = 2.3\text{ V to }2.7\text{ V}$	-	-	0.7	V
		$V_{CC(A)} = 3.0\text{ V to }3.6\text{ V}$	-	-	0.8	V
		$V_{CC(A)} = 4.5\text{ V to }5.5\text{ V}$	-	-	$0.3V_{CC(A)}$	V
$V_H$	hysteresis voltage		-	50	-	mV
$I_I$	input leakage current	$V_{CC(A)} = 5.5\text{ V}$ ; $V_I = \text{GND to }V_{CC(A)}$	-	-	$\pm 1$	$\mu\text{A}$

[1] All typical values are measured at  $V_{CC(B)} = 5\text{ V}$ ,  $V_{CC(A)} = 3.3\text{ V}$  and  $T_{amb} = 25\text{ °C}$  unless otherwise specified.

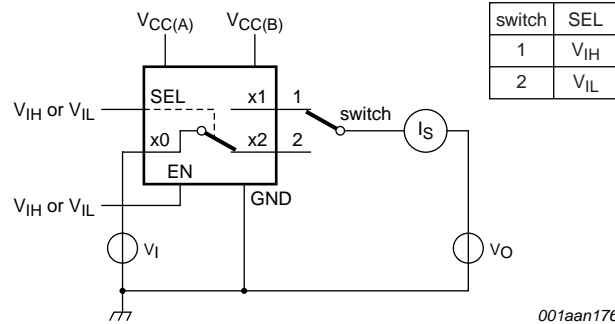
[2] Measured at identical  $V_{CC}$ , temperature and input voltage.

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

[4] Guarantees the LOW level.

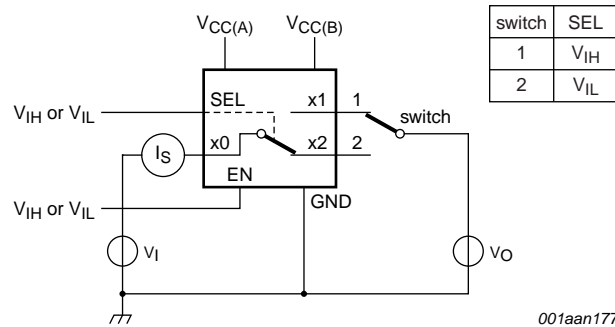
[5] Guarantees the HIGH level.

10.1 Test circuits and waveforms



x0 refers to R0, G0, B0, SCL0 or SDA0  
 x1 refers to R1, G1, B1, SCL1 or SDA1  
 x2 refers to R2, G2, B2, SCL2 or SDA2

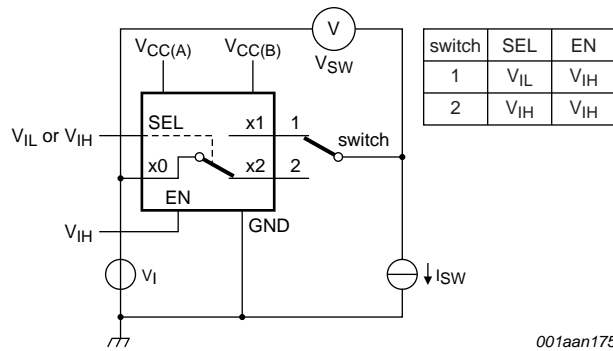
Fig 3. Test circuit for measuring OFF-state leakage current



x0 refers to R0, G0, B0, SCL0 or SDA0  
 x1 refers to R1, G1, B1, SCL1 or SDA1  
 x2 refers to R2, G2, B2, SCL2 or SDA2

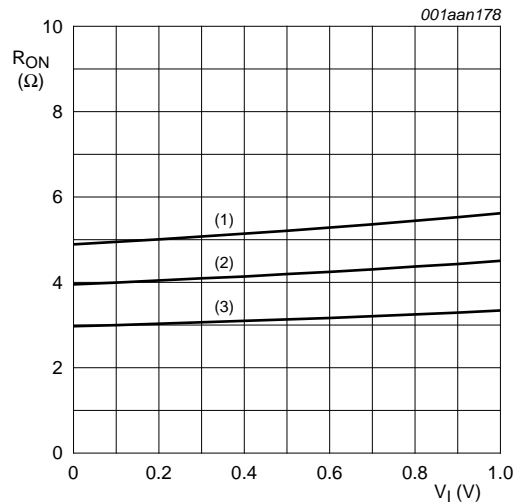
Fig 4. Test circuit for measuring ON-state leakage current





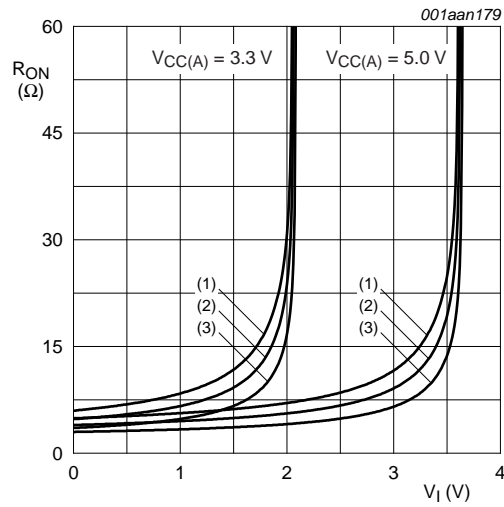
x0 refers to R0, G0, B0, SCL0 or SDA0  
 x1 refers to R1, G1, B1, SCL1 or SDA1  
 x2 refers to R2, G2, B2, SCL2 or SDA2  
 $R_{ON} = V_{SW} / I_{SW}$ .

**Fig 5. Test circuit for measuring ON resistance**



- (1) T<sub>amb</sub> = 85 °C
- (2) T<sub>amb</sub> = 25 °C
- (3) T<sub>amb</sub> = -40 °C

**Fig 6. ON resistance as a function of input voltage (RGB switches)**



- (1)  $T_{amb} = 85\text{ °C}$
- (2)  $T_{amb} = 25\text{ °C}$
- (3)  $T_{amb} = -40\text{ °C}$

Fig 7. ON resistance as a function of input voltage (DDC switches)

## 11. Dynamic characteristics

Table 9. Dynamic characteristics

At recommended operating conditions; Voltages are referenced to GND (ground = 0 V;  $V_{CC(B)} = 4.5\text{ V to }5.5\text{ V}$ ;  $V_{CC(A)} = 2\text{ V to }5.5\text{ V}$ .

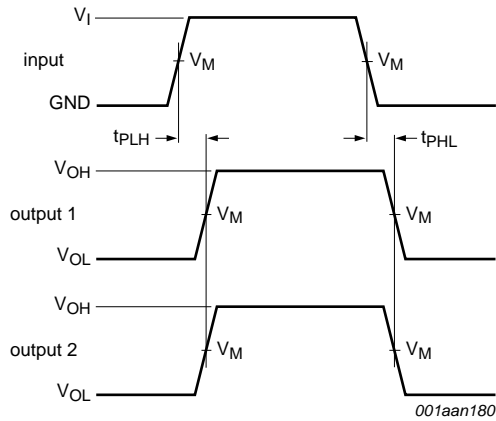
Symbol	Parameter	Conditions	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			Unit
			Min	Typ <sup>[1]</sup>	Max	
$t_{pd}$	propagation delay	H0 to H1, H2 and V0 to V1, V2; See <a href="#">Figure 8</a> and <a href="#">Figure 9</a> <sup>[2]</sup>	-	3	-	ns
$t_{en}$	enable time	EN and SEL to all other outputs; See <a href="#">Figure 10</a> and <a href="#">Figure 11</a>	-	15	-	ns
$t_{dis}$	disable time	EN and SEL to all other outputs; See <a href="#">Figure 10</a> and <a href="#">Figure 11</a>	-	5	-	ns
$t_{b-m}$	break-before-make time	See <a href="#">Figure 12</a>	-	10	-	ns
$t_{sk(o)}$	output skew time	Skew between any Rn, Gn and Bn ports; see <a href="#">Figure 8</a> <sup>[3]</sup>	-	50	-	ps

[1] All typical values are measured at  $V_{CC(B)} = 5\text{ V}$ ;  $V_{CC(A)} = 3.3\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ .

[2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

[3] Guaranteed by design.

11.1 Test circuits and waveforms



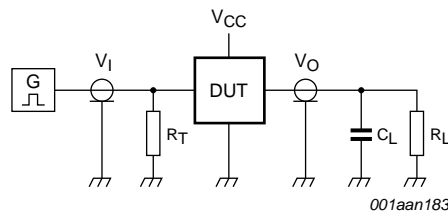
Measurement points are given in [Table 10](#).

$$t_{sk(o)} = |t_{PLH1} - t_{PLH2}|$$

Fig 8. Test circuit for measuring propagation delay times

Table 10. Measurement points

Input		Output	
$V_M$	$V_I$	$V_x$	$V_M$
$0.5V_{CC(A)}$	GND to $V_{CC(A)}$	$0.9V_{OH}$	$0.5V_{CC(B)}$



Test data is given in [Table 11](#).

Definitions:

DUT = Device Under Test.

$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

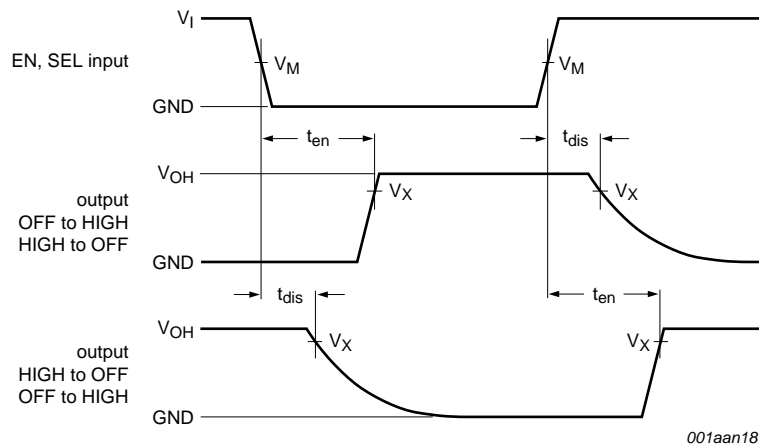
$C_L$  = Load capacitance including test jig and probe.

$R_L$  = Load resistance.

Fig 9. Test circuit for measuring propagation delay times

Table 11. Test data

Input	Load	
$t_r, t_f$	$C_L$	$R_L$
$\leq 2.5 \text{ ns}$	10 pF	1 k $\Omega$

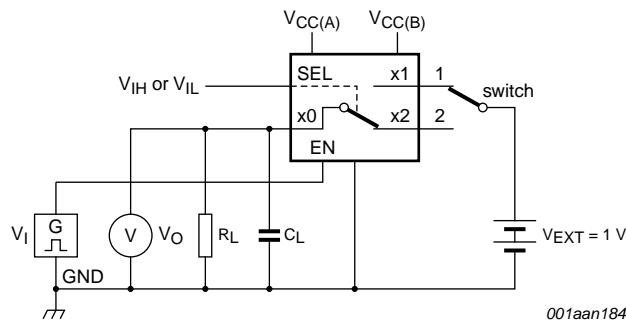


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Measurement points are given in [Table 10](#).

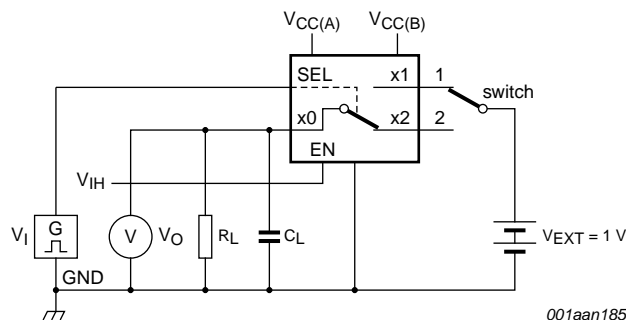
Logic level:  $V_{OH}$  is typical output voltage level that occurs with the output load.

**Fig 10. Enable and disable times**



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a. EN to switch outputs



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b. SEL to switch outputs

Test data is given in [Table 12](#).

x0 refers to R0, G0, B0, SCL0 or SDA0

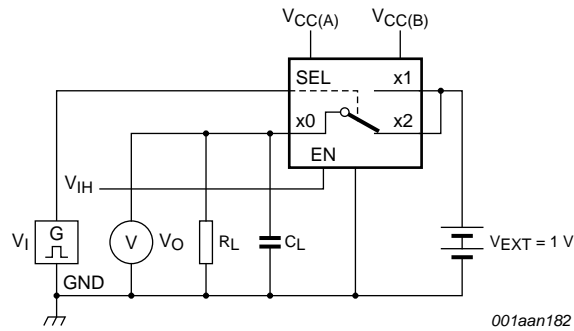
x1 refers to R1, G1, B1, SCL1 or SDA1

x2 refers to R2, G2, B2, SCL2 or SDA2

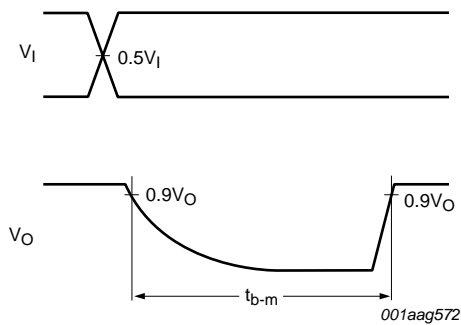
**Fig 11. Test circuit for measuring enable and disable times**

Table 12. Test data

Input		Load	
$t_r, t_f$	$V_I$	$C_L$	$R_L$
$\leq 2.5 \text{ ns}$	GND to $V_{CC(A)}$	10 pF	100 $\Omega$



a. Test circuit



b. Input and output measurement points

Test data is given in [Table 12](#).

x0 refers to R0, G0, B0, SCL0 or SDA0

x1 refers to R1, G1, B1, SCL1 or SDA1

x2 refers to R2, G2, B2, SCL2 or SDA2

Fig 12. Test circuit for measuring break-before-make timing

## 12. Additional dynamic characteristics

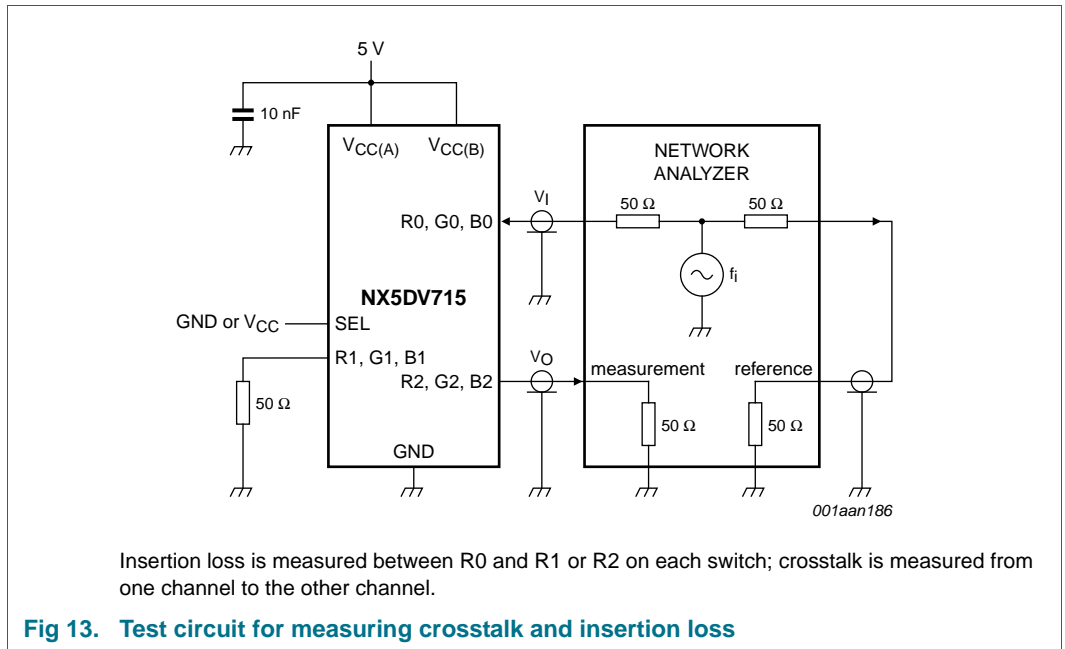
**Table 13. Additional dynamic characteristics**

$V_{CC(B)} = 5.0\text{ V} \pm 10\%$ ,  $V_{CC(A)} = 2\text{ V to } 5.5\text{ V}$ , unless otherwise specified; Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	$T_{\text{amb}} = -40\text{ }^{\circ}\text{C to } +85\text{ }^{\circ}\text{C}$			Unit	
			Min	Typ	Max		
$f_{(-3\text{dB})}$	-3 dB frequency response	$R_L = 50\ \Omega$ ; see <a href="#">Figure 13</a>	[1]	-	600	-	MHz
$\alpha_{\text{ins}}$	Insertion loss	$f_i = 1\text{ MHz}$ ; $R_L = R_S = 50\ \Omega$ ; see <a href="#">Figure 13</a>	-	-	0.6	-	dB
Xtalk	crosstalk	between switches; $f_i = 50\text{ MHz}$ ; $R_L = 50\ \Omega$ ; see <a href="#">Figure 13</a>	[1]	-	-50	-	dB

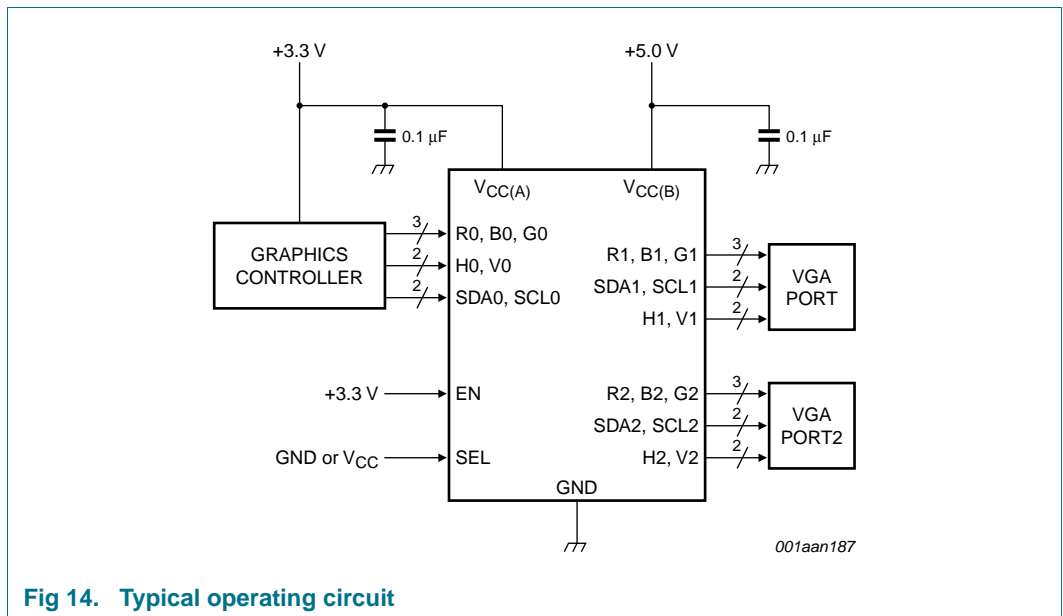
[1]  $f_i$  is biased at  $0.5V_{CC}$ .

### 12.1 Test circuits



### 13. Application information

The NX5DV715 provides the level shifting necessary to drive two standard VGA ports from a graphic controller as low as 2.2 V. Internal buffers drive the H-Sync and V-Sync signals to VGA standard TTL levels. The DDC multiplexer provides level shifting by clamping signals to a diode drop less than  $V_{CC(A)}$  (See [Figure 14](#)). Connect  $V_{CC(A)}$  to 3.3 V for normal operation, or to  $V_{CC(B)}$  to disable voltage clamping for DDC signals



**Fig 14. Typical operating circuit**

14. Package outline

HWQFN32: plastic thermal enhanced very very thin quad flat package; no leads;  
32 terminals; 3 x 6 x 0.75 mm

SOT1180-1

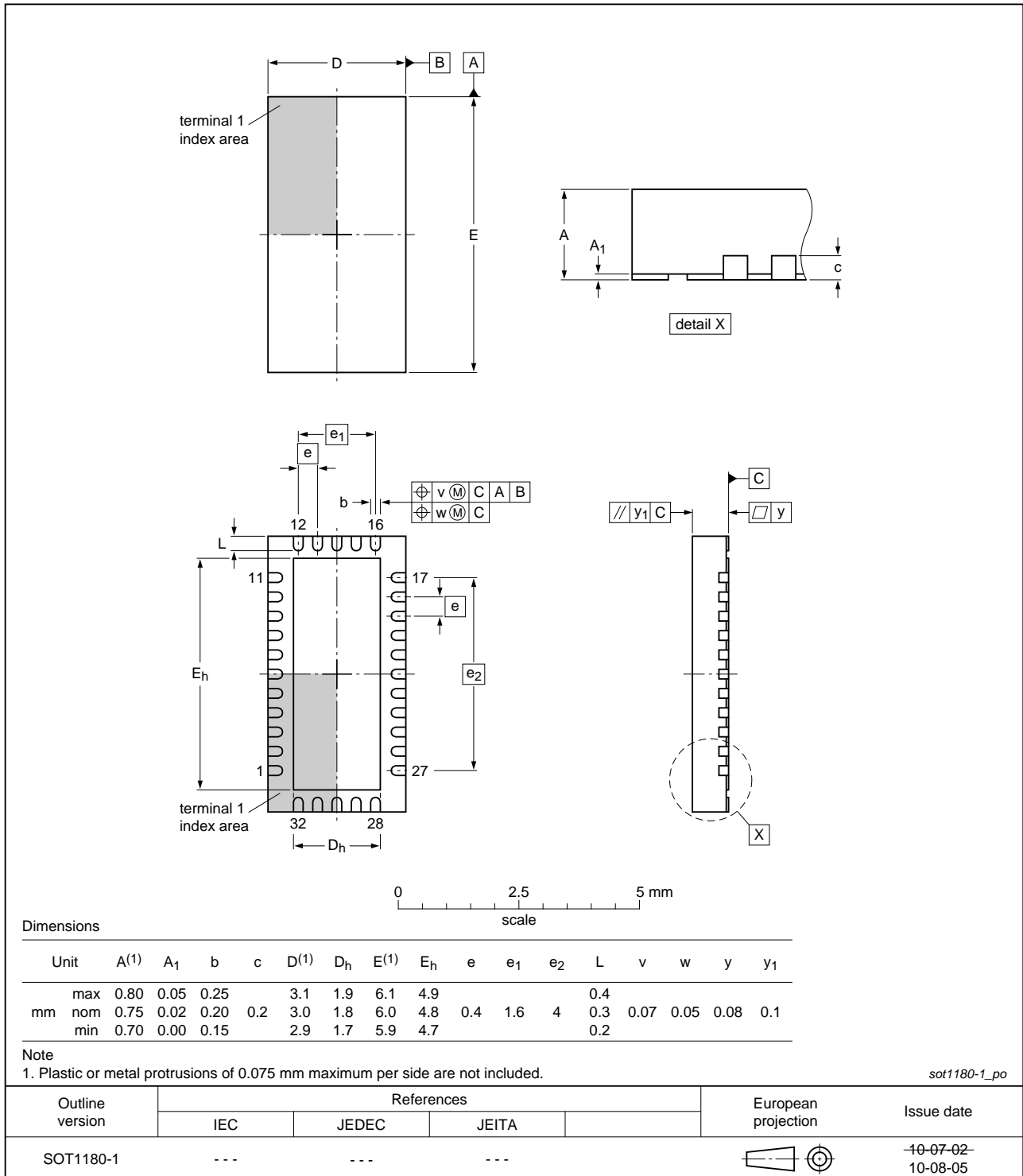


Fig 15. Package outline SOT1180-1 (HWQFN32)



## 15. Abbreviations

Table 14. Abbreviations

Acronym	Description
CDM	Charged Device Model
DDC	Display Data Channel
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
RGB	Red Green Blue
TTL	Transistor-Transistor Logic
VESA	Video Electronics Standards Association

## 16. Revision history

Table 15. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NX5DV715 v.3	20111104	Product data sheet	-	NX5DV715 v.2
Modifications:	<ul style="list-style-type: none"><li>Legal pages updated</li></ul>			
NX5DV715 v.2	20110725	Product data sheet	-	NX5DV715 v.1
NX5DV715 v.1	20101220	Product data sheet	-	-

## 17. Legal information

### 17.1 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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