PESDxUSB3S series

ESD protection for differential data lines

Rev. 3 — 26 April 2016 Product data sheet

1. Product profile

1.1 General description

The devices are ElectroStatic Discharge (ESD) protection for one, two and three differential channels.

It is footprint compatible to PCMFxUSB3S common mode filters with ESD protection.

The diodes provide protection to downstream components from ESD voltages up to ±15 kV on each signal line.

Table 1. Product overview

Type number	Number of channels	Package Name
PESD1USB3S	1	WLCSP5
PESD2USB3S	2	WLCSP10
PESD3USB3S	3	WLCSP15

1.2 Features and benefits

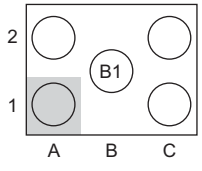
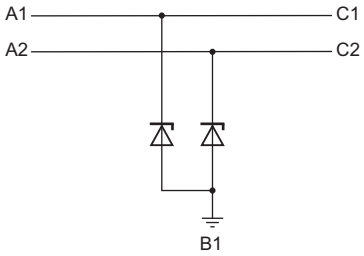
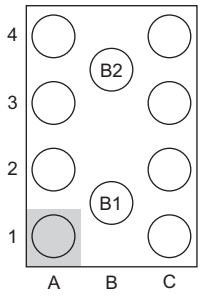
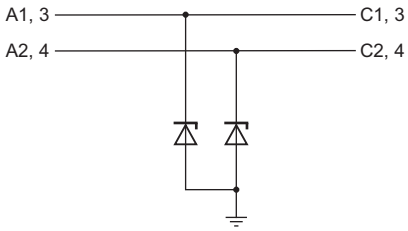
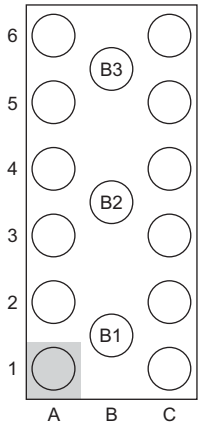
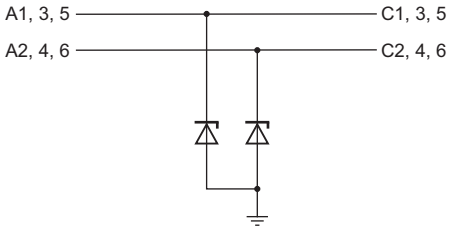
- Allows switching between PCMFxUSB3S common mode filters with ESD protection and PESDxUSB3S ESD protection in the same footprint
- TREOS protection process for very high system-level ESD robustness: superior protection of sensitive Systems on Chips (SoCs)
- ESD protection for one, two and three differential channels up to ±15 kV contact discharge according to IEC 61000-4-2
- Industry-standard WLCSP5, 10 and 15 packages for smallest footprint

1.3 Applications

- Smartphone, cellular and cordless phone
- USB3.1, USB2.0, HDMI2.0, HDMI1.4
- General-purpose downstream ESD protection for differential data lines
- Tablet PC and Mobile Internet Device (MID)
- MIPI D-PHY as used in Camera Serial Interface (CSI) and Display Serial Interface (DSI)

2. Pinning information

Table 2. Pinning

Pin	Symbol	Description	Simplified outline	Graphic symbol
PESD1USB3S (WLCSP5_2-1-2)				
A1	CH1_IN+	channel 1+, external	 Transparent top view **WLCSP5_2-1-2**	 *aaa-021381*
A2	CH1_IN–	channel 1–, external		
B1	GND_CH1	ground channel 1		
C1	CH1_OUT+	channel 1+, internal		
C2	CH1_OUT–	channel 1–, internal		
PESD2USB3S (WLCSP10_4-2-4)				
A1	CH1_IN+	channel 1+, external	 Transparent top view **WLCSP10_4-2-4**	 B1, B2 - no internal connection *aaa-021384*
A2	CH1_IN–	channel 1–, external		
A3	CH2_IN+	channel 2+, external		
A4	CH2_IN–	channel 2–, external		
B1	GND_CH1	ground channel 1		
B2	GND_CH2	ground channel 2		
C1	CH1_OUT+	channel 1+, internal		
C2	CH1_OUT–	channel 1–, internal		
C3	CH2_OUT+	channel 2+, internal		
C4	CH2_OUT–	channel 2–, internal		
PESD3USB3S (WLCSP15_6-3-6)				
A1	CH1_IN+	channel 1+, external	 Transparent top view **WLCSP15_6-3-6**	 B1, B2, B3 - no internal connection *aaa-021385*
A2	CH1_IN–	channel 1–, external		
A3	CH2_IN+	channel 2+, external		
A4	CH2_IN–	channel 2–, external		
A5	CH3_IN+	channel 3+, external		
A6	CH3_IN–	channel 3–, external		
B1	GND_CH1	ground channel 1		
B2	GND_CH2	ground channel 2		
B3	GND_CH3	ground channel 3		
C1	CH1_OUT+	channel 1+, internal		
C2	CH1_OUT–	channel 1–, internal		
C3	CH2_OUT+	channel 2+, internal		
C4	CH2_OUT–	channel 2–, internal		
C5	CH3_OUT+	channel 3+, internal		
C6	CH3_OUT–	channel 3–, internal		

3. Ordering information

Table 3. Ordering information

Type number	Package	
	Name	Description
PESD1USB3S	WLCSP5	wafer level chip-size package; 5 bumps (2-1-2)
PESD2USB3S	WLCSP10	wafer level chip-size package; 10 bumps (4-2-4)
PESD3USB3S	WLCSP15	wafer level chip-size package; 15 bumps (6-3-6)

4. Marking

Table 4. Marking codes

Type number	Marking code
PESD1USB3S	PD1S
PESD2USB3S	PD2S
PESD3USB3S	PD3S

5. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_I	input voltage		-0.5	5	V
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2, level 4; all input pins to ground			
		contact discharge	-15	15	kV
		air discharge	-15	15	kV
		IEC 61000-4-2, level 4; all output pins to ground			
		contact discharge	-2	2	kV
		air discharge	-2	2	kV
I_{PPM}	rated peak-pulse current	t_p = 8/20 μs	-8	8	A
T_{stg}	storage temperature		-40	+125	°C
T_{amb}	ambient temperature		-40	+85	°C

6. Characteristics

6.1 Channel characteristics

Table 6. Channel characteristics

T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_d	diode capacitance	f = 1 MHz; V_I = 2.5 V [1]	-	0.45	-	pF
I_{RM}	reverse leakage current	per line; V_I = 5 V	-	1	100	nA
V_{BR}	breakdown voltage	I_R = 1 mA	6	9	-	V
V_F	forward voltage	I_F = 10 mA	-	0.8	-	V
R_{dyn}	dynamic resistance	TLP [2]				
		positive transient	-	0.16	-	Ω
		negative transient	-	0.16	-	Ω
		surge [3]				
		positive transient	-	0.25	-	Ω
		negative transient	-	0.25	-	Ω

[1] This parameter is guaranteed by design.

[2] 100 ns Transmission Line Pulse (TLP); 50 Ω; pulser at 70 to 90 ns.

[3] According to IEC 61000-4-5 (8/20 μs).

6.2 Frequency characteristics

Table 7. Frequency characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Differential mode: S_{21dd}						
f_{-3dB}	cut-off frequency	[1]	-	17	-	GHz

[1] Normalized to attenuation at 1 MHz.

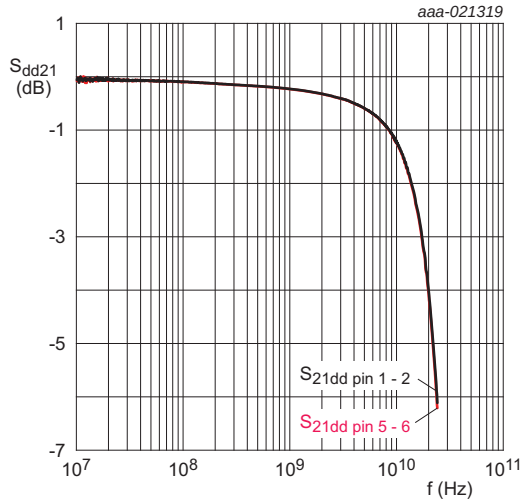


Fig 1. Differential mode insertion loss; typical values

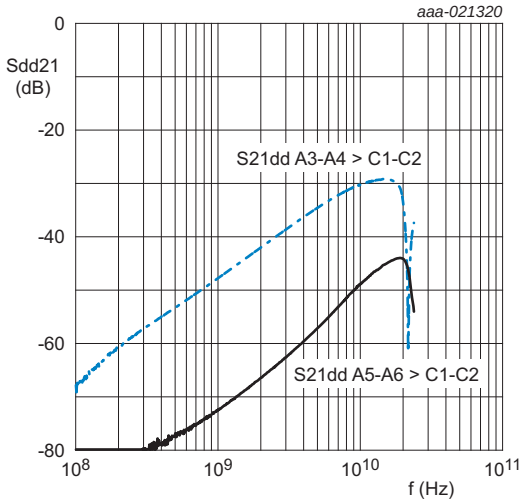
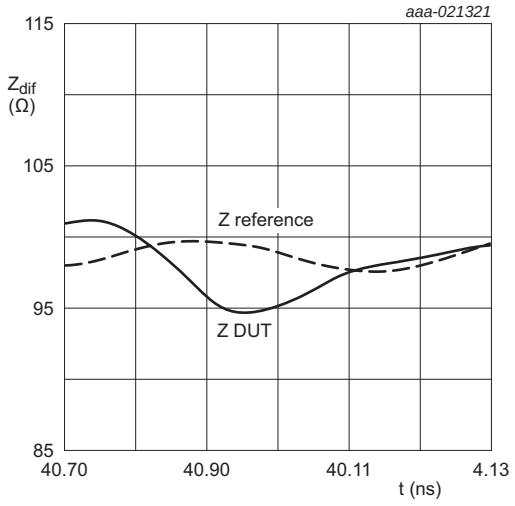
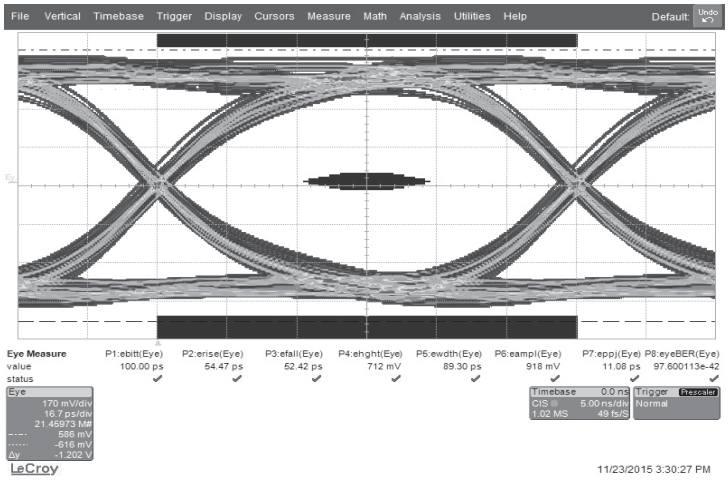


Fig 2. Differential cross-talk; typical values



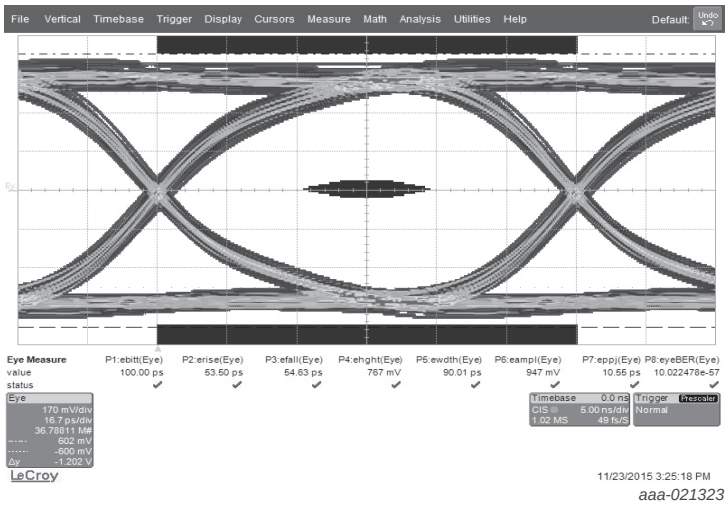
t_r = 200 ps

Fig 3. Differential Time Domain Reflectometer (TDR) plot; typical values



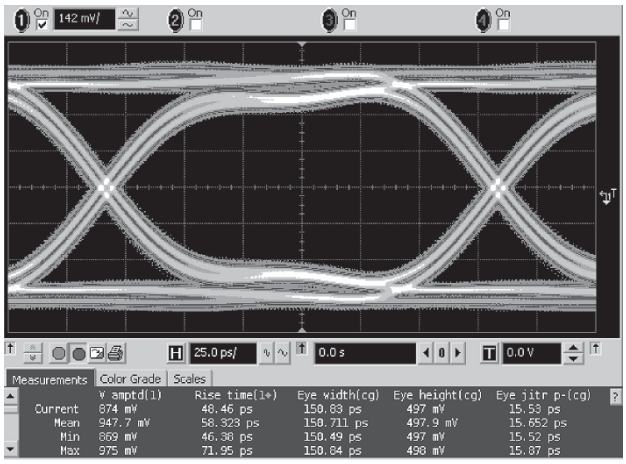
aaa-012322

Fig 4. USB3.1 eye diagram 10 Gbps, test board with PESD3USB3S; typical values



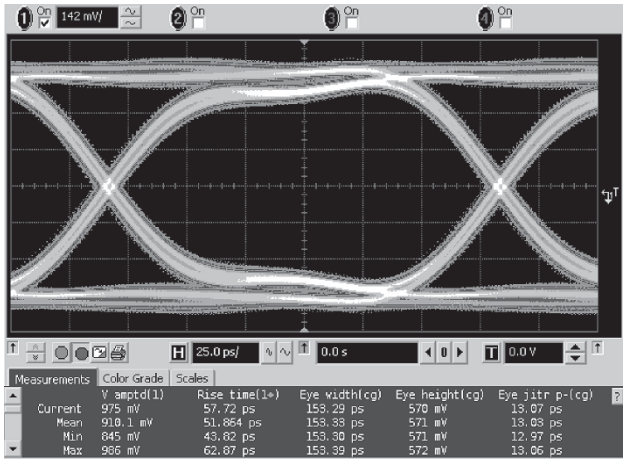
aaa-021323

Fig 5. USB3.1 eye diagram 10 Gbps, test board without device; typical values



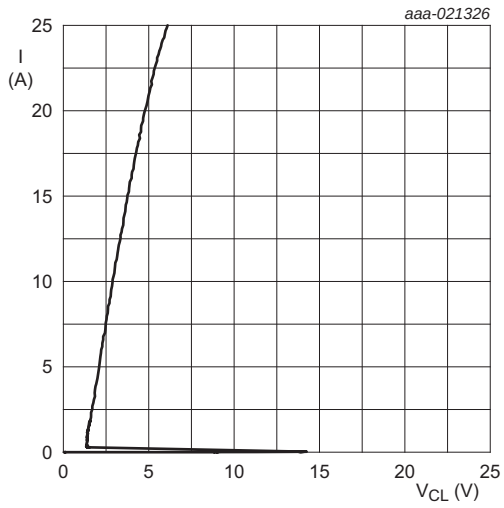
aaa-021324

Fig 6. HDMI 2.0 eye diagram TP1, test board with PESD3USB3S; typical values



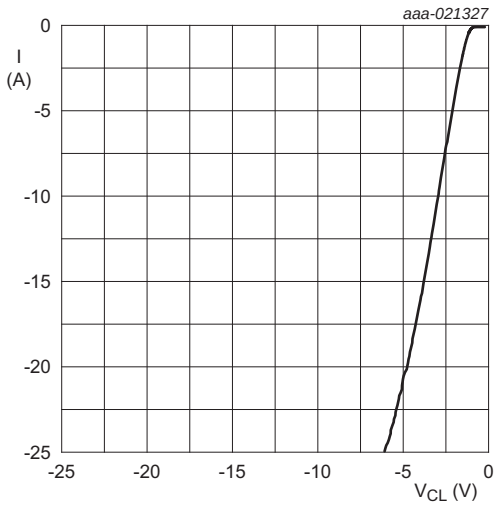
aaa-021325

Fig 7. HDMI 2.0 eye diagram TP1, test board without device; typical values



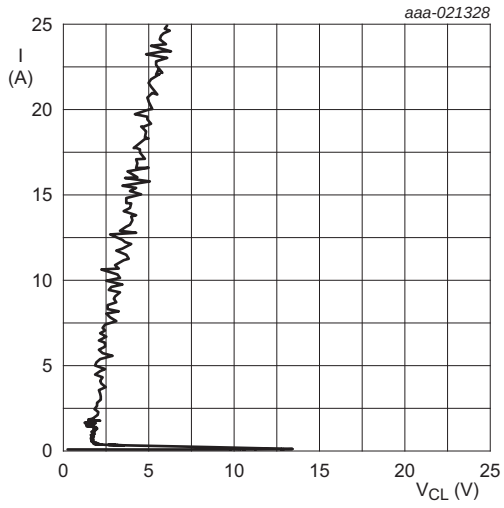
Transmission Line Pulse (TLP) = 100 ns

Fig 8. Dynamic resistance with positive clamping; typical values



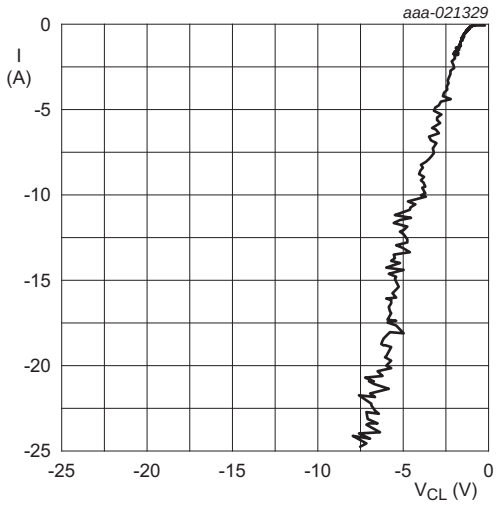
Transmission Line Pulse (TLP) = 100 ns

Fig 9. Dynamic resistance with negative clamping; typical values



Transmission Line Pulse (TLP) = 5 ns

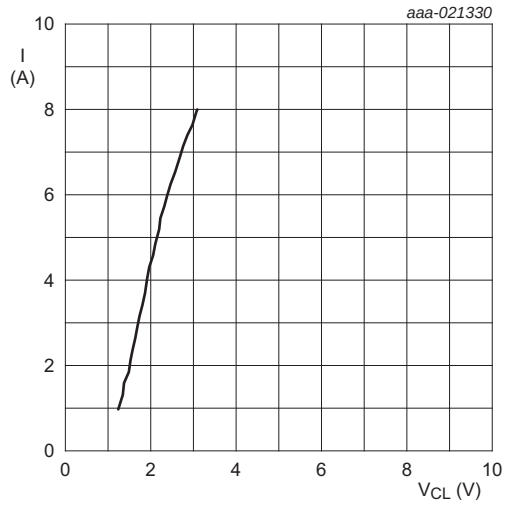
Fig 10. Dynamic resistance with positive clamping; typical values



Transmission Line Pulse (TLP) = 5 ns

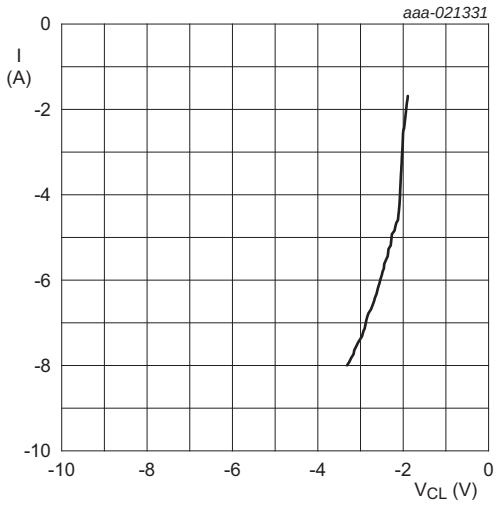
Fig 11. Dynamic resistance with negative clamping; typical values

The device uses an advanced clamping structure showing a negative dynamic resistance. This snap-back behavior strongly reduces the clamping voltage to the system behind the ESD protection during an ESD event. Do not connect unlimited DC current sources to the data lines to avoid keeping the ESD protection device in snap-back state after exceeding breakdown voltage (due to an ESD pulse for instance).



IEC61000-4-5; t_p = 8/20 μs; positive pulse

Fig 12. Dynamic resistance with positive clamping; typical values



IEC61000-4-5; t_p = 8/20 μs; negative pulse

Fig 13. Dynamic resistance with negative clamping; typical values

7. Application information

The device is designed to provide high-level ESD protection for differential high-speed data line pairs such as:

- USB 3.1
- HDMI 2.0
- Transition-Minimized Differential Signaling (TMDS)
- DisplayPort
- external Serial Advanced Technology Attachment (eSATA)
- Low Voltage Differential Signaling (LVDS)

When designing the PCB, give careful consideration to impedance matching and signal coupling. Do not connect the protected signal lines to unlimited current sources like, for example, a battery.

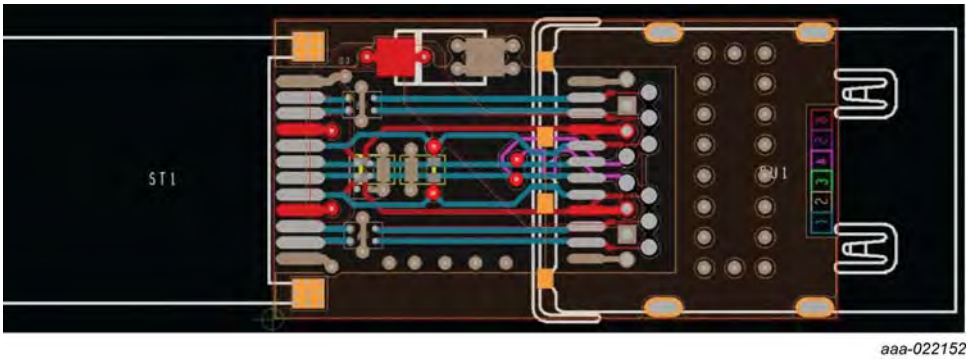
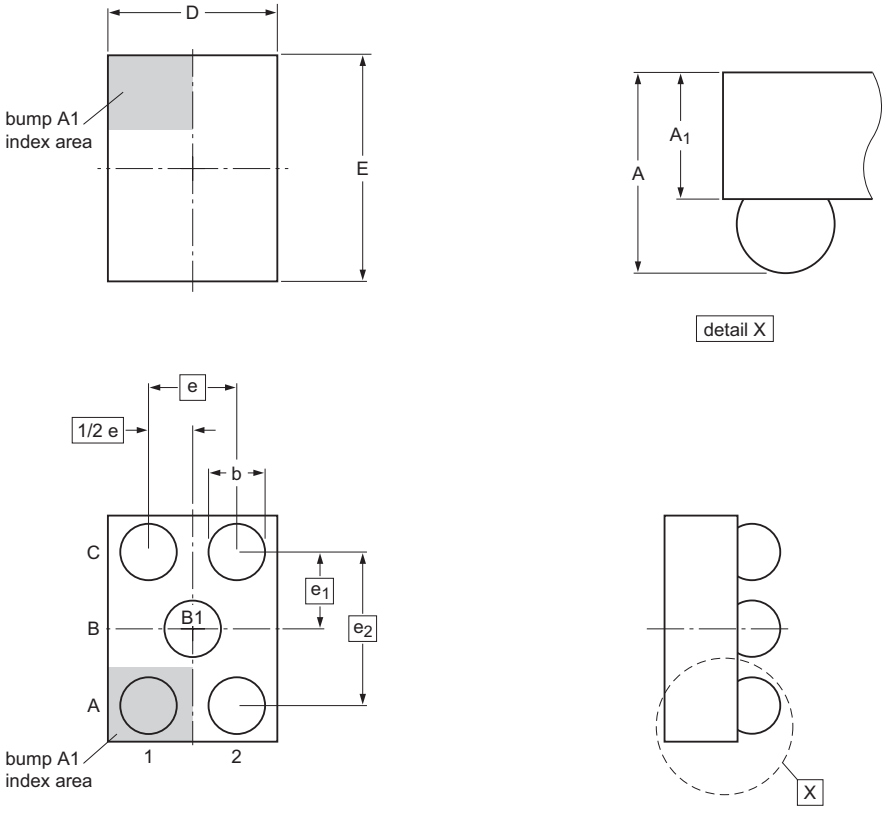


Fig 14. Application diagram: protecting the differential data lines of a USB Type-C connector evaluation dongle with PESD1USB3S

Since the SuperSpeed TX/RX lines are separated by GND or VBUS from the Hi-Speed lines, PESD1USB3S makes it easy to achieve same signal lengths, straight routing, and optimal positioning for ESD protection directly at the connector.

8. Package outline

WLCSP5: wafer level chip-size package; 5 bumps (2-1-2) **PESD1USB3S**



Dimensions (mm are the original dimensions)

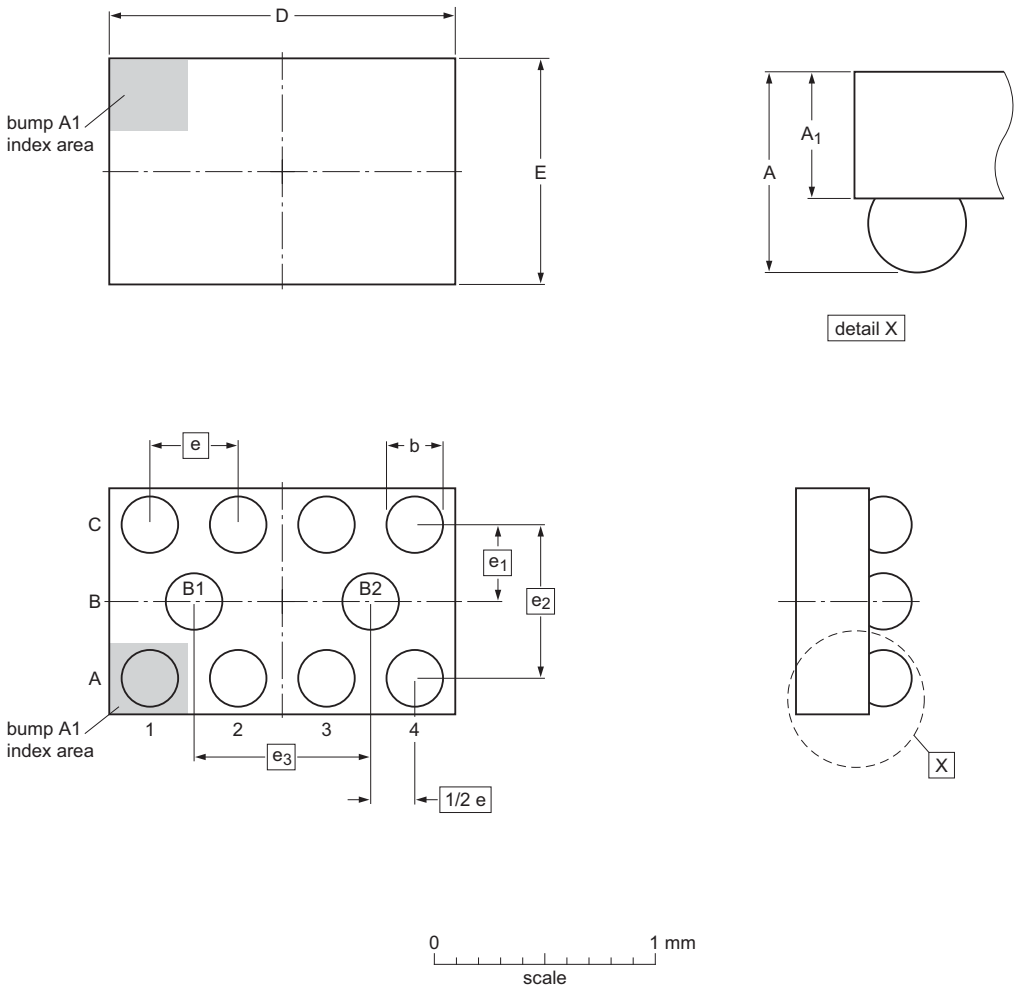
Unit		A	A_1	b	D	E	e	e_1	e_2
mm	max	0.60	0.38	0.31	0.82	1.22			
	nom	0.57	0.37	0.26	0.77	1.17	0.40	0.40	0.80
	min	0.54	0.36	0.21	0.72	1.12			

pesd1usb3s_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
PESD1USB3S						15-12-11

Fig 15. Package outline WLCSP5

WLCSP10: wafer level chip-size package; 10 bumps (4-2-4) **PESD2USB3S**



Dimensions (mm are the original dimensions)

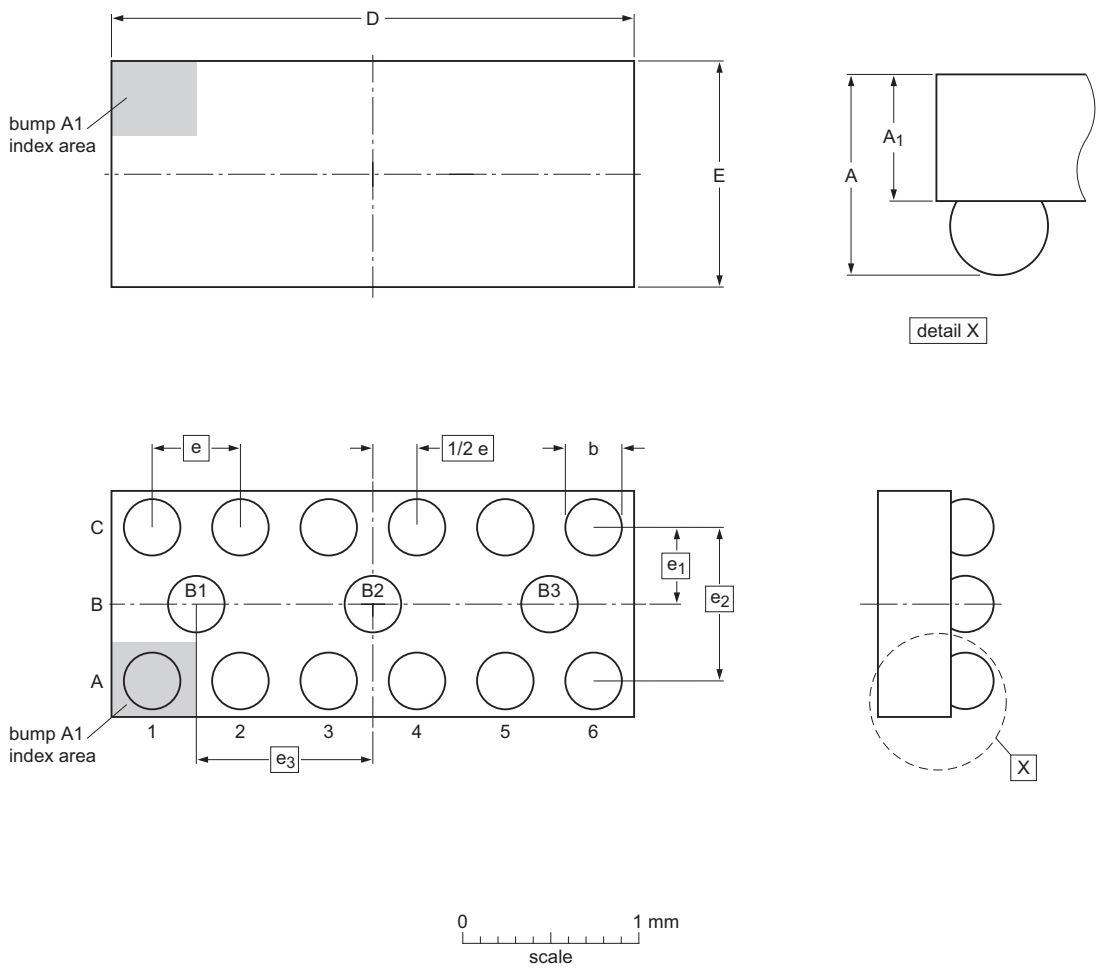
Unit		A	A_1	b	D	E	e	e_1	e_2	e_3
mm	max	0.60	0.38	0.31	1.62	1.22				
	nom	0.57	0.37	0.26	1.57	1.17	0.40	0.40	0.80	0.80
	min	0.54	0.36	0.21	1.52	1.12				

pesd2usb3s_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
PESD2USB3S						15-12-11

Fig 16. Package outline WLCSP10

WLCSP15: wafer level chip-size package; 15 bumps (6-3-6) **PESD3USB3S**



Dimensions (mm are the original dimensions)

Unit		A	A_1	b	D	E	e	e_1	e_2	e_3
mm	max	0.60	0.38	0.31	2.42	1.22				
	nom	0.57	0.37	0.26	2.37	1.17	0.40	0.40	0.80	0.80
	min	0.54	0.36	0.21	2.32	1.12				

pesd3usb3s_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
PESD3USB3S						15-12-11

Fig 17. Package outline WLCSP15

9. Soldering

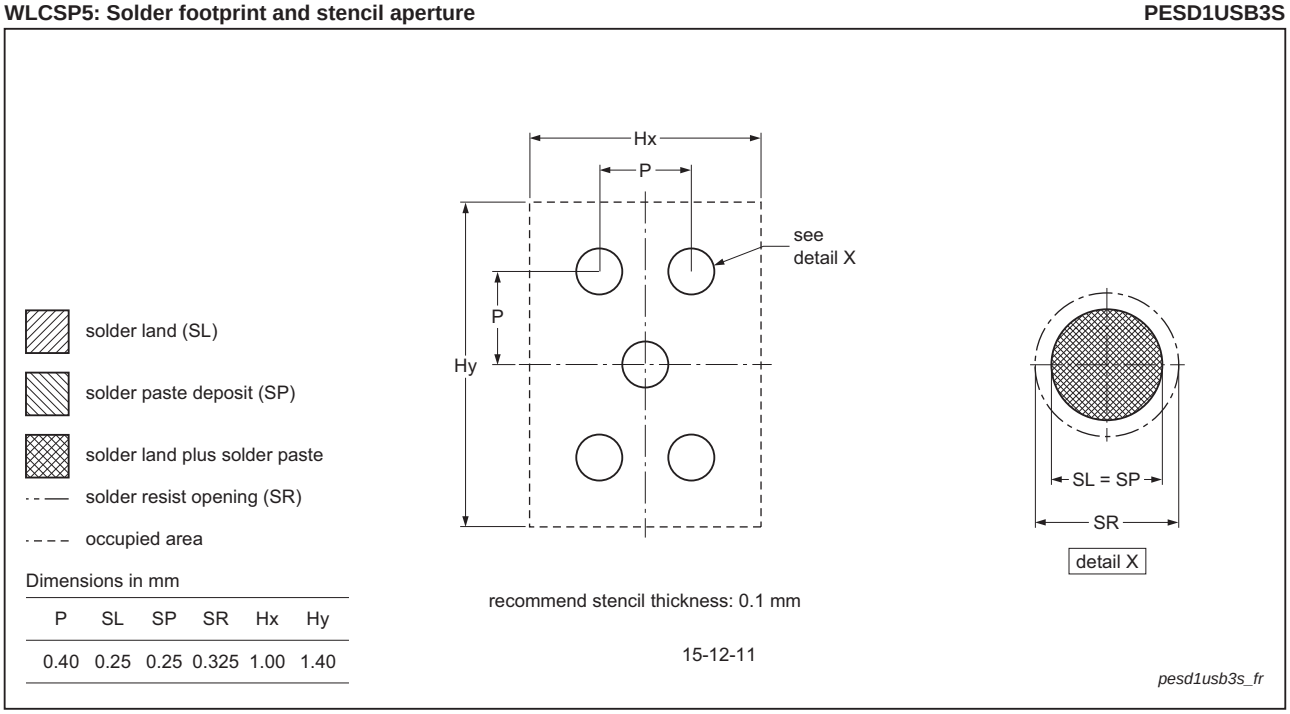
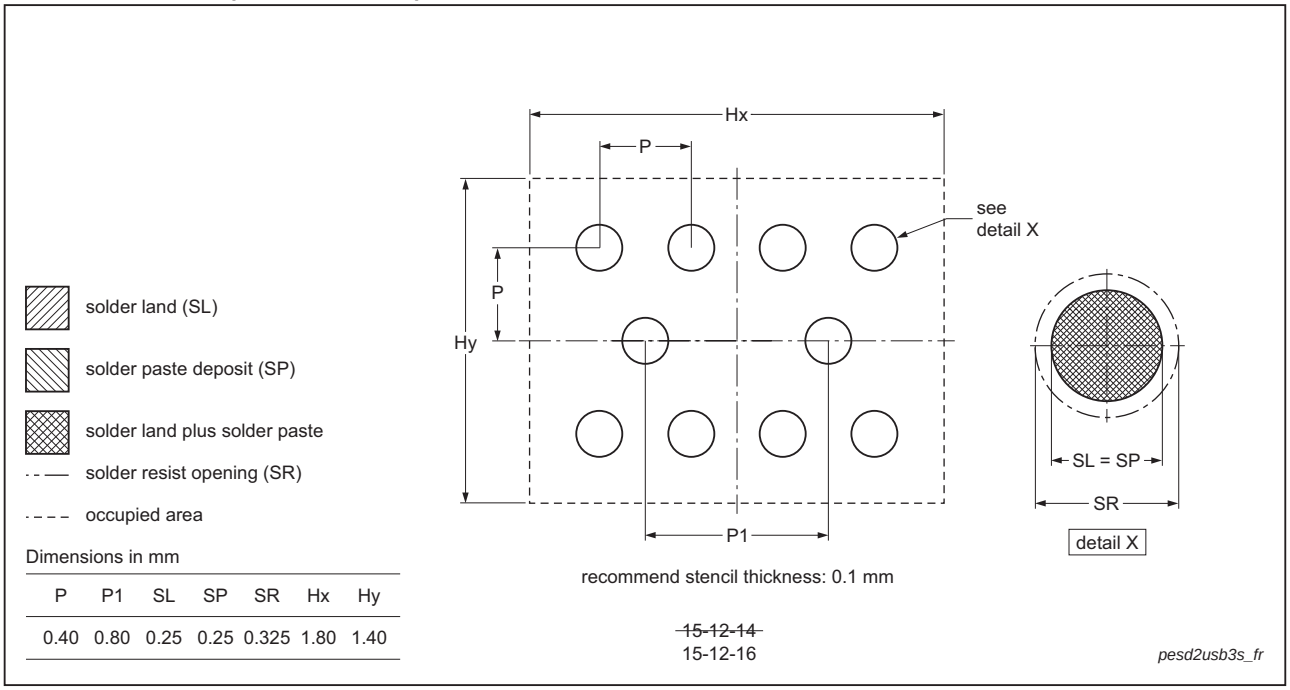


Fig 18. Soldering footprint WLCSP5 (PESD1USB3S)

WLCSP10: Solder footprint and stencil aperture **PESD2USB3S**

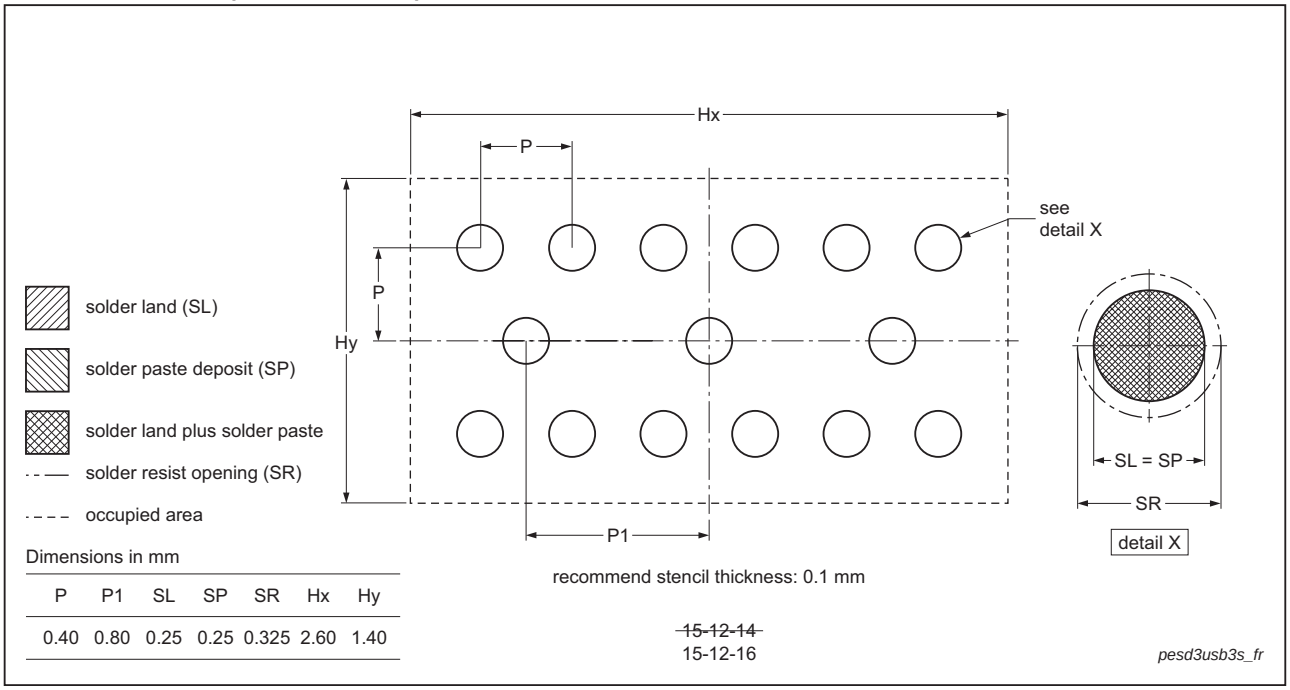


Dimensions in mm

P	P1	SL	SP	SR	Hx	Hy
0.40	0.80	0.25	0.25	0.325	1.80	1.40

Fig 19. Soldering footprint WLCSP10 (PESD2USB3S)

WLCSP15: Solder footprint and stencil aperture **PESD3USB3S**



Dimensions in mm

P	P1	SL	SP	SR	Hx	Hy
0.40	0.80	0.25	0.25	0.325	2.60	1.40

Fig 20. Soldering footprint WLCSP15 (PESD3USB3S)

10. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PESDXUSB3S_SER v.3	20160426	Product data sheet	-	PESDXUSB3S_SER v.2
Modification:	• Product status changed			
PESDXUSB3S_SER v.2	20160127	Preliminary data sheet	-	PESDXUSB3S_SER v.1
PESDXUSB3S_SER v.1	20151216	Objective data sheet	-	-

11. Legal information

11.1 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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12. Contact information

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

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

13. Contents

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