ESD protection for differential data lines

Rev. 2 — 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 PCMFxUSB30 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
PESD1USB30	1	WLCSP5
PESD2USB30	2	WLCSP10
PESD3USB30	3	WLCSP15

1.2 Features and benefits

- Allows switching between PCMFxUSB30 common mode filters with ESD protection and PESDxUSB30 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
PESD1	USB30 (WLCSP	5_2-1-2)		
A1	CH1_IN+	channel 1+, external		
A2	CH1_IN-	channel 1-, external	2	A1 C1 A2 C2
B1	GND_CH1	ground channel 1	(B1)	A2 C2
C1	CH1_OUT+	channel 1+, internal		
C2	CH1_OUT-	channel 1-, internal	A B C	4 4
			Transparent top view	
			WLCSP5_2-1-2	<u>÷</u> B1
				aaa-021381
PESD2	2USB30 (WLCSP	10_4-2-4)		
A1	CH1_IN+	channel 1+, external		A1, 3 C1, 3
A2	CH1_IN-	channel 1-, external	4	A2, 4 C2, 4
А3	CH2_IN+	channel 2+, external	B2)	12,1
A4	CH2_IN-	channel 2-, external	3 0	* *
B1	GND_CH1	ground channel 1		4 4
B2	GND_CH2	ground channel 2	(B1)	
C1	CH1_OUT+	channel 1+, internal		= B1, B2 - no internal connection
C2	CH1_OUT-	channel 1-, internal	A B C	aaa-021384
C3	CH2_OUT+	channel 2+, internal	Transparent top view	dda-U2 1304
C4	CH2_OUT-	channel 2-, internal	WLCSP10_4-2-4	
PESD3	BUSB30 (WLCSP	15_6-3-6)		
A1	CH1_IN+	channel 1+, external		A1, 3, 5 C1, 3, 5
A2	CH1_IN-	channel 1-, external	6	A1, 3, 5 C1, 3, 5 A2, 4, 6 C2, 4, 6
А3	CH2_IN+	channel 2+, external	(B3)	72, 1, 0
A4	CH2_IN-	channel 2-, external	5	* *
A5	CH3_IN+	channel 3+, external	4	4 4
A6	CH3_IN-	channel 3-, external	(B2)	
B1	GND_CH1	ground channel 1	3	B1, B2, B3 - no internal connection
B2	GND_CH2	ground channel 2		aaa-021385
В3	GND_CH3	ground channel 3	2 (B1)	
C1	CH1_OUT+	channel 1+, internal	1	
C2	CH1_OUT-	channel 1-, internal	A B C	
C3	CH2_OUT+	channel 2+, internal	Transparent top view	
C4	CH2_OUT-	channel 2-, internal	WLCSP15_6-3-6	
C5	CH3_OUT+	channel 3+, internal		
C6	CH3_OUT-	channel 3-, internal		

3. Ordering information

Table 3. Ordering information

Type number	Package			
	Name	Description		
PESD1USB30	WLCSP5	wafer level chip-size package; 5 bumps (2-1-2)		
PESD2USB30	WLCSP10	wafer level chip-size package; 10 bumps (4-2-4)		
PESD3USB30	WLCSP15	wafer level chip-size package; 15 bumps (6-3-6)		

4. Marking

Table 4. Marking codes

•	
Type number	Marking code
PESD1USB30	PD1S
PESD2USB30	PD2S
PESD3USB30	PD3S

5. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
VI	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	А
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	Тур	Max	Unit
C_d	diode capacitance	$f = 1 \text{ MHz}; V_I = 2.5 \text{ V}$	-	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

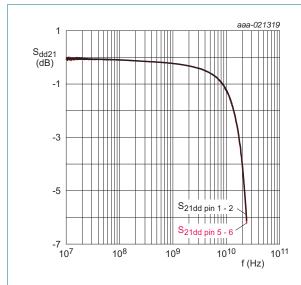
- [1] This parameter is guaranteed by design.
- [2] 100 ns Transmission Line Pulse (TLP); 50 Ω ; pulser at 70 to 90 ns.
- [3] According to IEC 61000-4-5 (8/20 μ s).

6.2 Frequency characteristics

Table 7. Frequency characteristics

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
Different	ial mode: S _{21dd}					
f _{-3dB}	cut-off frequency	[1]	-	17	-	GHz

[1] Normalized to attenuation at 1 MHz.



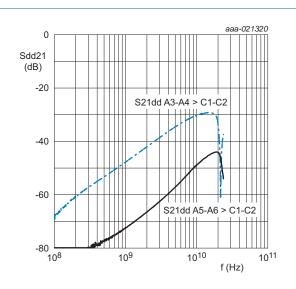
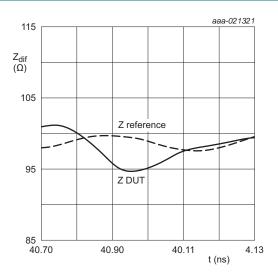


Fig 1. Differential mode insertion loss; typical values





 $t_{r} = 200 \text{ ps}$

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

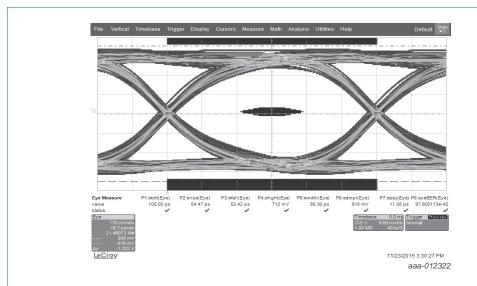


Fig 4. USB3.1 eye diagram 10 Gbps, test board with PESD3USB30; typical values

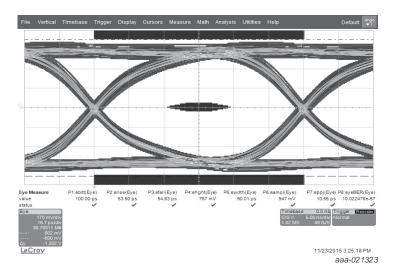


Fig 5. USB3.1 eye diagram 10 Gbps, test board without device; typical values

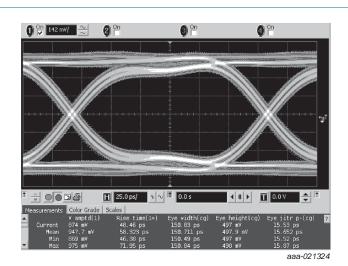


Fig 6. HDMI 2.0 eye diagram TP1, test board with PESD3USB30; typical values

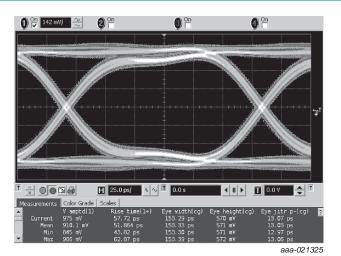


Fig 7. HDMI 2.0 eye diagram TP1, test board without device; typical values

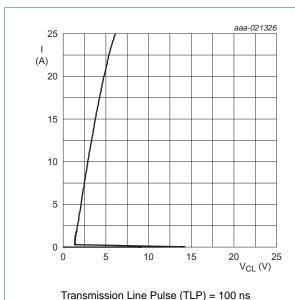
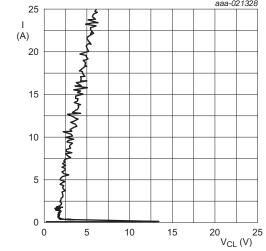
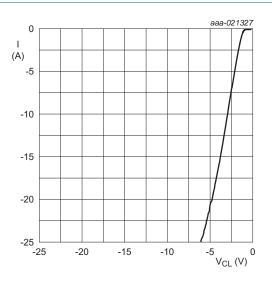


Fig 8. Dynamic resistance with positive clamping; typical values



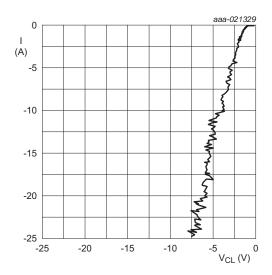
Transmission Line Pulse (TLP) = 5 ns

Fig 10. 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 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).

ESD protection for differential data lines

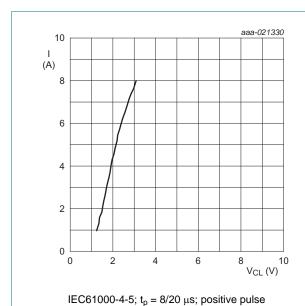
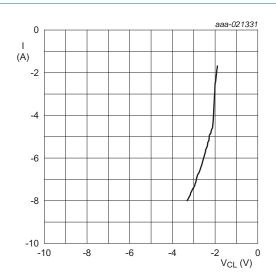


Fig 12. Dynamic resistance with positive clamping; typical values



IEC61000-4-5; $t_p = 8/20 \mu s$; 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.

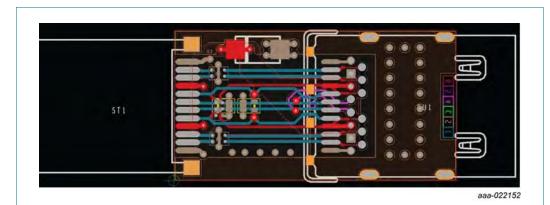


Fig 14. Application diagram: protecting the differential data lines of a USB Type-C connector evaluation dongle with PESD1USB30

Since the SuperSpeed TX/RX lines are separated by GND or VBUS from the Hi-Speed lines, PESD1USB30 makes it easy to achieve same signal lengths, straight routing, and optimal positioning for ESD protection directly at the connector.

8. Package outline

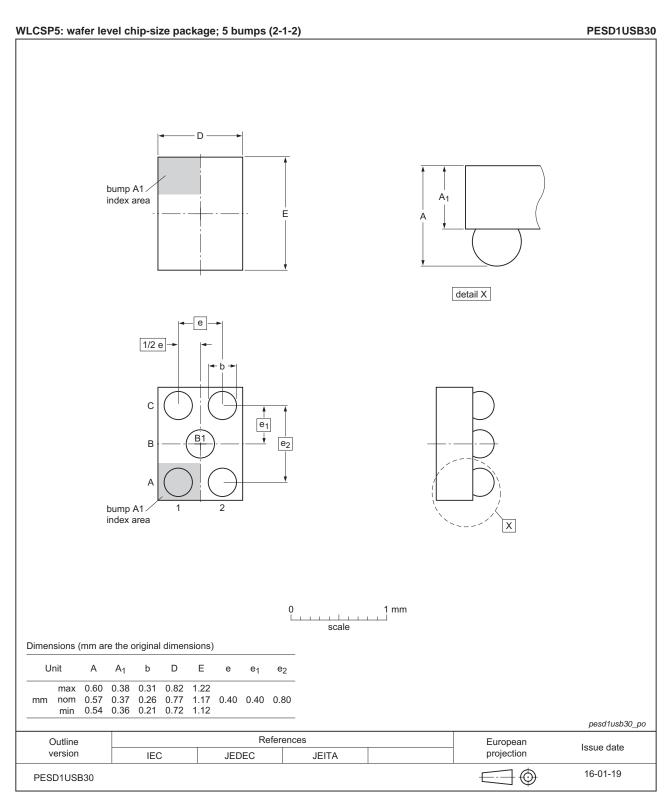


Fig 15. Package outline WLCSP5

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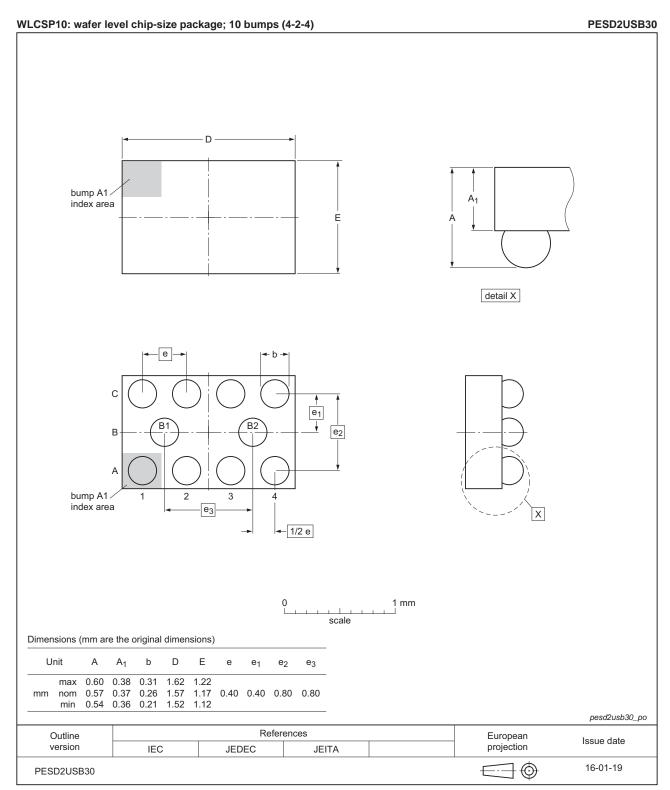


Fig 16. Package outline WLCSP10

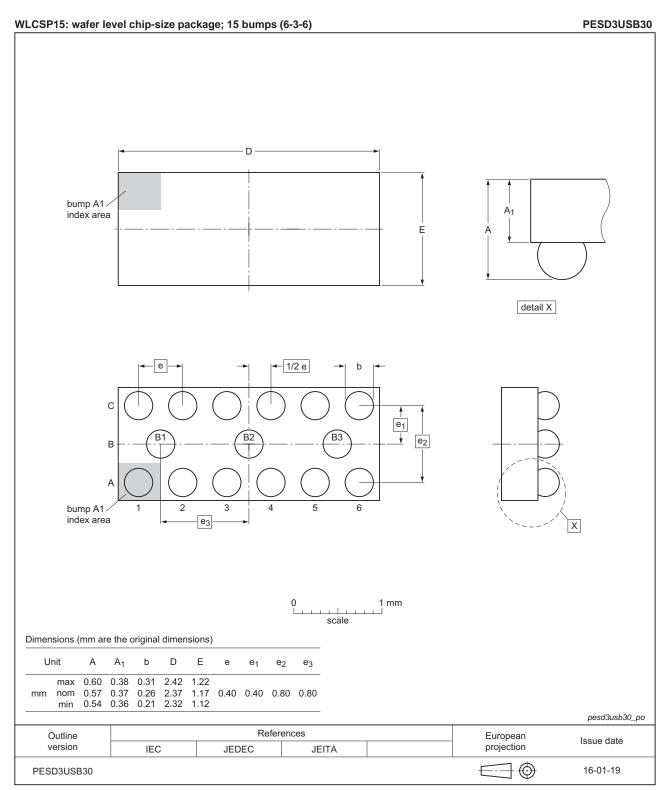


Fig 17. Package outline WLCSP15

9. Soldering

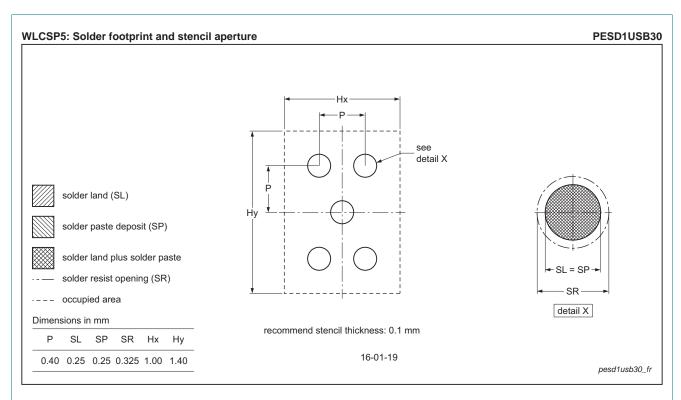


Fig 18. Soldering footprint WLCSP5 (PESD1USB30)

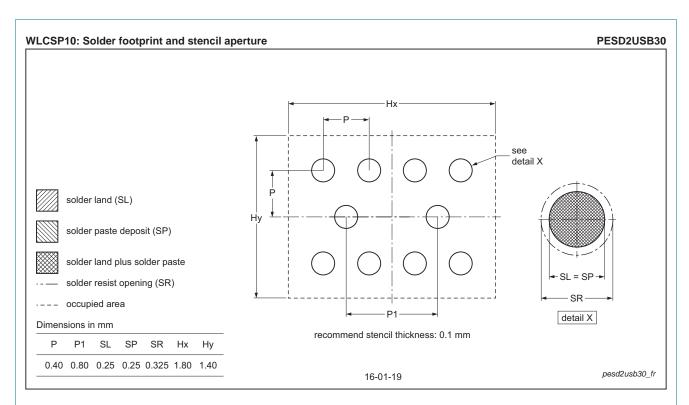


Fig 19. Soldering footprint WLCSP10 (PESD2USB30)

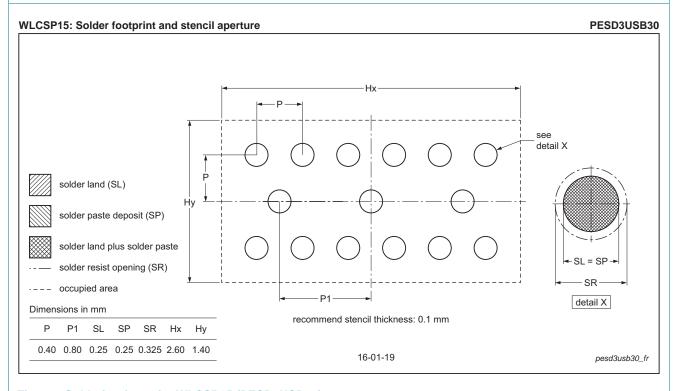


Fig 20. Soldering footprint WLCSP15 (PESD3USB30)

10. Revision history

Table 8. Revision history

Document ID	Release date		Change notice	Supersedes
PESDXUSB30_SER v.2	20160426	Product data sheet	-	PESDXUSB30_SER v.1
Modification:	Product s	tatus changed		
PESDXUSB30_SER v.1	20160127	Preliminary data sheet	-	

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Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
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Product [short] data sheet	Production	This document contains the product specification.

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ESD protection for differential data lines

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