



# PESD4USB5UBTBR-Q

Extremely low capacitance unidirectional ESD protection diode array

26 October 2023

Product data sheet

## 1. General description

This unidirectional ESD protection device is designed to protect high-speed interfaces such as SuperSpeed USB 3.2, HDMI, DisplayPort, external Serial Advanced Technology Attachment (eSATA), Low Voltage Differential Signaling (LVDS), and Gigabit Multimedia Serial Link (GMSL) Serializer/Deserializer (SerDes) against ElectroStatic Discharge (ESD).

The device is encapsulated in a leadless small DFN2510A-10 (SOT1176-2) plastic package and provides ESD protection up to 15 kV exceeding IEC 61000-4-2 level 4 and fulfilling ISO 10605.

## 2. Features and benefits

- Unidirectional ESD protection for four signal lines
- $V_{RWM} = 5\text{ V}$  device
- Extremely low clamping voltage to protect sensitive I/Os
- Extremely low clamping voltage: 2.8 V for 8 A 100 ns TLP and 4.4 V for 16 A 100 ns TLP
- IEC 61000-4-4 robust up to 36 A into a 50 Ohm termination (1.8 kV)
- IEC 61000-4-5 (surge):  $I_{PP} = 8.2\text{ A}$  peak pulse (average measured)
- Typical line capacitance of only 0.29 pF
- ESD protection up to  $\pm 15\text{ kV}$  according to IEC 61000-4-2
- Leadless ultra small DFN2510A-10 (SOT1176-2) surface mount package
- Qualified according to AEC-Q101 and recommended for use in automotive applications

## 3. Applications

- Infotainment applications: USB 2.0, USB 3.2 and HDMI 2.1
- Automotive A/V monitors, display and cameras
- SerDes: GMSL, APIX, FPD-Link and LVDS

## 4. Quick reference data

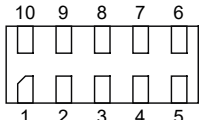
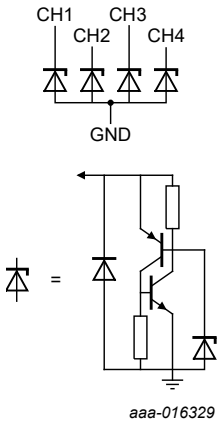
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{RWM}$	reverse standoff voltage		-0.5	-	5	V
$C_d$	diode capacitance	$f = 1\text{ MHz}; V_R = 1.5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	[1]	0.29	0.34	pF

[1] Measured on pin 1

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	CH1	channel 1 ESD protection	 <p>Transparent top view <b>DFN2510A-10 (SOT1176-2)</b></p>	 <p>aaa-016329</p>
2	CH2	channel 2 ESD protection		
3	GND	ground		
4	CH3	channel 3 ESD protection		
5	CH4	channel 4 ESD protection		
6	n.c.	not connected		
7	n.c.	not connected		
8	GND	ground		
9	n.c.	not connected		
10	n.c.	not connected		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
PESD4USB5UBTBR-Q	DFN2510A-10	plastic, extremely thin small outline package; no leads; 10 terminals; body 1.0 x 2.5 x 0.5 mm	SOT1176-2

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PESD4USB5UBTBR-Q	Q5

## 8. Limiting values

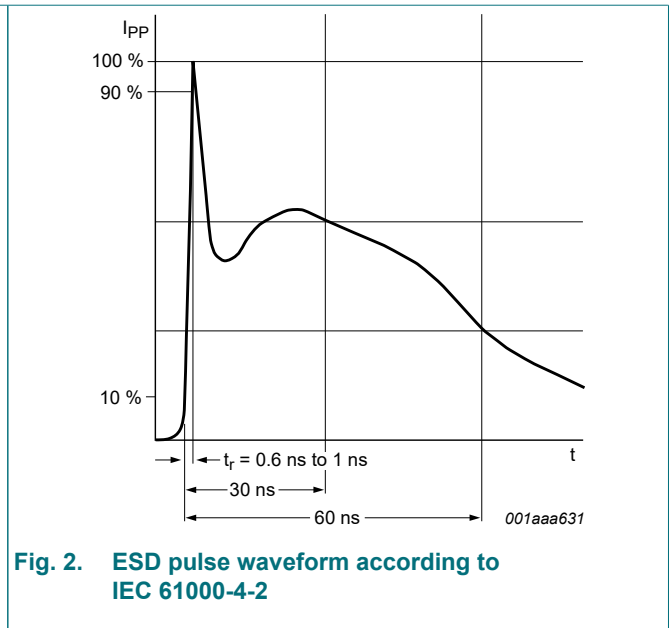
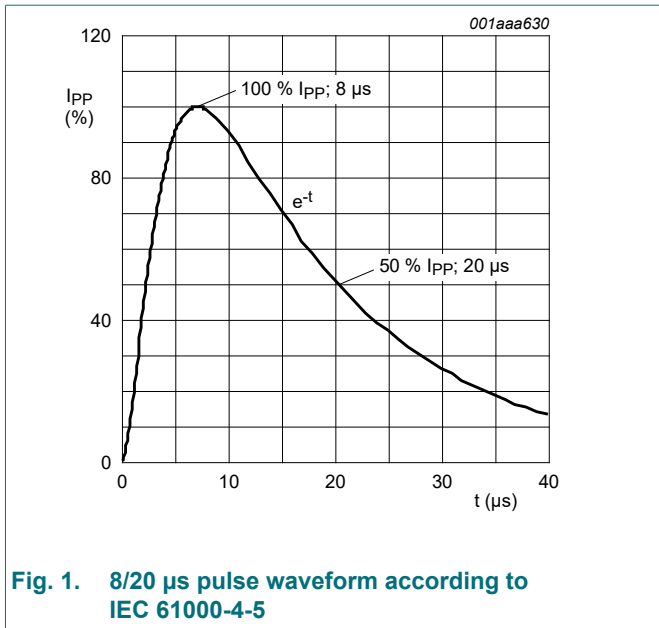
**Table 5. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{RWM}$	reverse standoff voltage		-0.5	5	V
$I_{PPM}$	rated peak pulse current	$t_p = 8/20 \mu s$ [1]	-6.5	6.5	A
$T_{stg}$	storage temperature		-65	150	°C
$T_{amb}$	ambient temperature		-55	150	°C
<b>ESD maximum ratings</b>					
$V_{ESD}$	electrostatic discharge voltage	IEC 61000-4-2; contact discharge [2]	-15	15	kV
		IEC 61000-4-2; air discharge [2]	-15	15	kV
		ISO 10605; contact discharge; $R = 330 \Omega$ ; $C = 150 pF$ [2]	-15	15	kV
		ISO 10605; contact discharge; $R = 330 \Omega$ ; $C = 330 pF$ [2]	-13	13	kV

[1] Non-repetitive current pulse 8/20  $\mu s$  exponentially decaying waveform according to IEC 61000-4-5.

[2] Device stressed with ten non-repetitive ESD pulses.



## 9. Characteristics

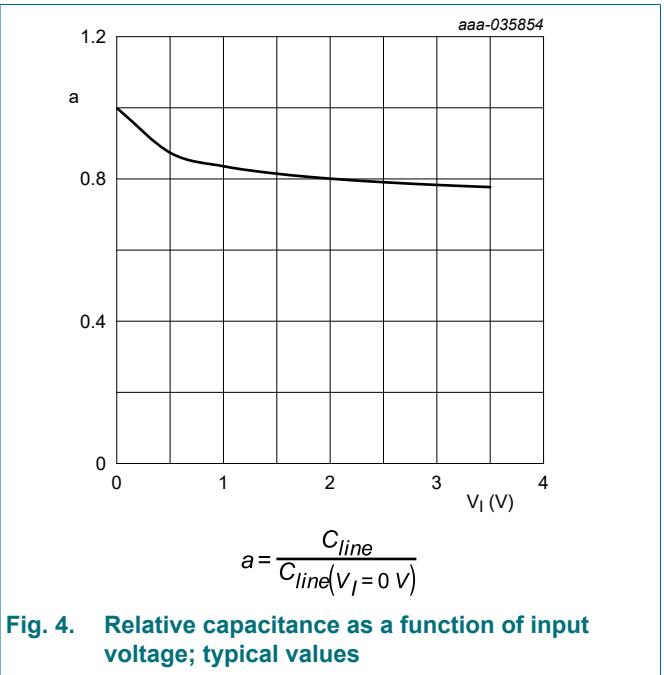
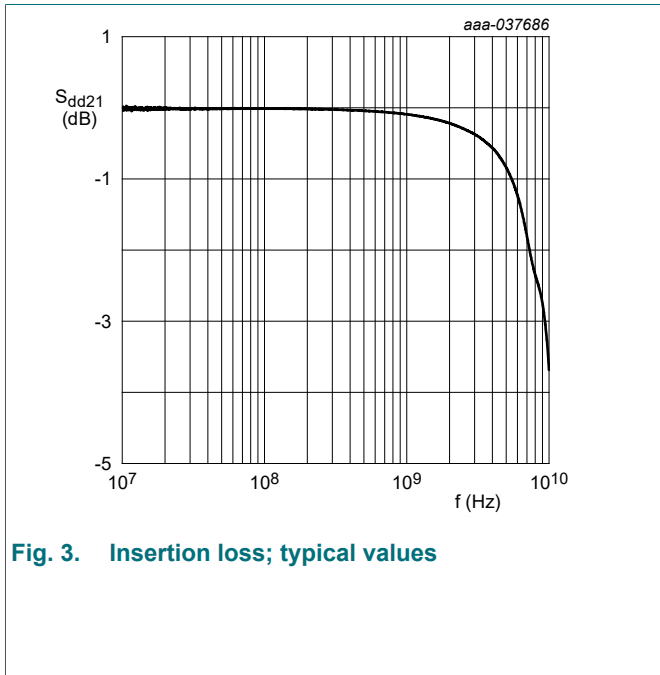
Table 6. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{BR}$	breakdown voltage	$I_R = 1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	6	8.5	10	V
$V_{CL}$	clamping voltage	$I_{TLP} = 8 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ [1]	-	2.8	-	V
		$I_{TLP} = 16 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ [1]	-	4.4	-	V
		$I_{PPM} = 6.5 \text{ A}; t_p = 8/20 \text{ } \mu\text{s}; T_{amb} = 25 \text{ }^\circ\text{C}$ [2]	-	2.9	-	V
$I_{RM}$	reverse leakage current	$V_{RWM} = 5 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	1	100	nA
$R_{dyn}$	dynamic resistance	$I_R = 10 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ [1]	-	0.19	-	$\Omega$
		$I_R = -10 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ [1]	-	0.19	-	$\Omega$
$C_d$	diode capacitance	$f = 1 \text{ MHz}; V_R = 1.5 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$ [3]	-	0.29	0.34	pF

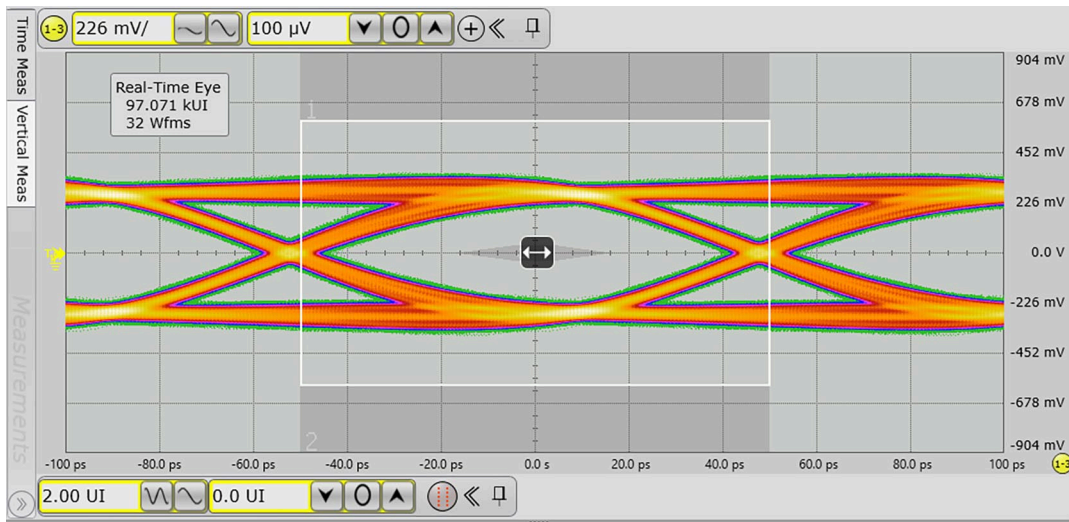
[1] Non-repetitive current pulse, Transmission Line Pulse (TLP); square pulse; ANSI / ESD STM5.5.1-2008 on pin 2

[2] Device stressed with 8/20  $\mu\text{s}$  exponential decay waveform according to IEC 61000-4-5.

[3] Measured on pin 1

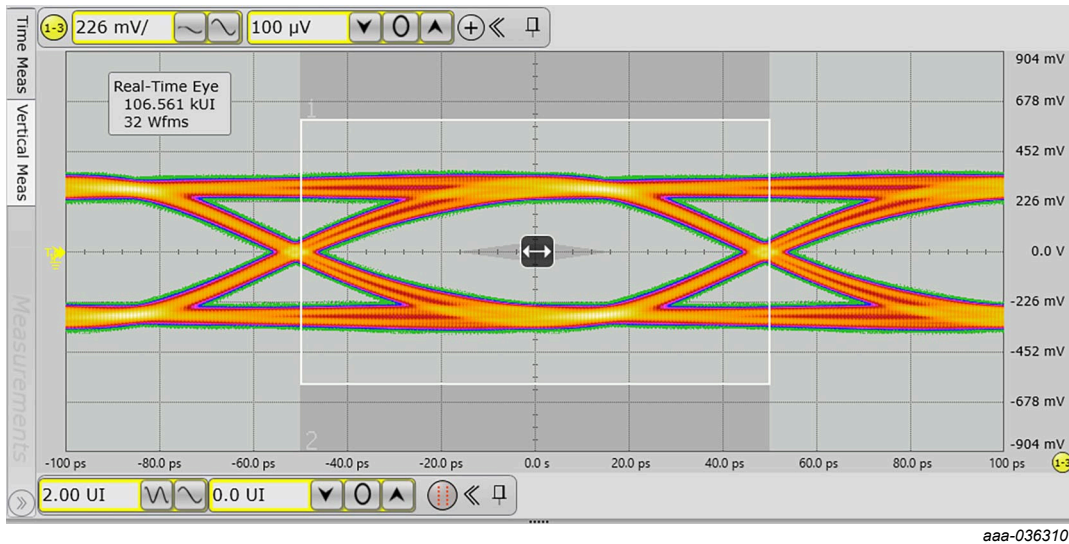


Extremely low capacitance unidirectional ESD protection diode array



Data rate: 10 Gbit/s

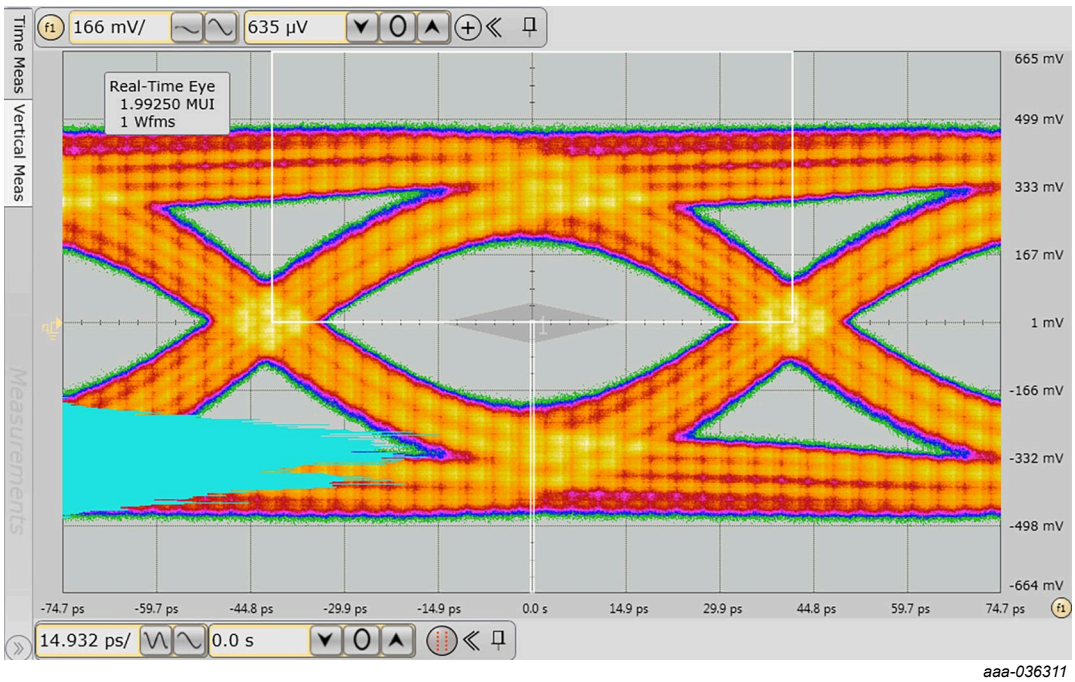
Fig. 5. USB3.2 eye diagram, PCB with device; typical values



Data rate: 10 Gbit/s

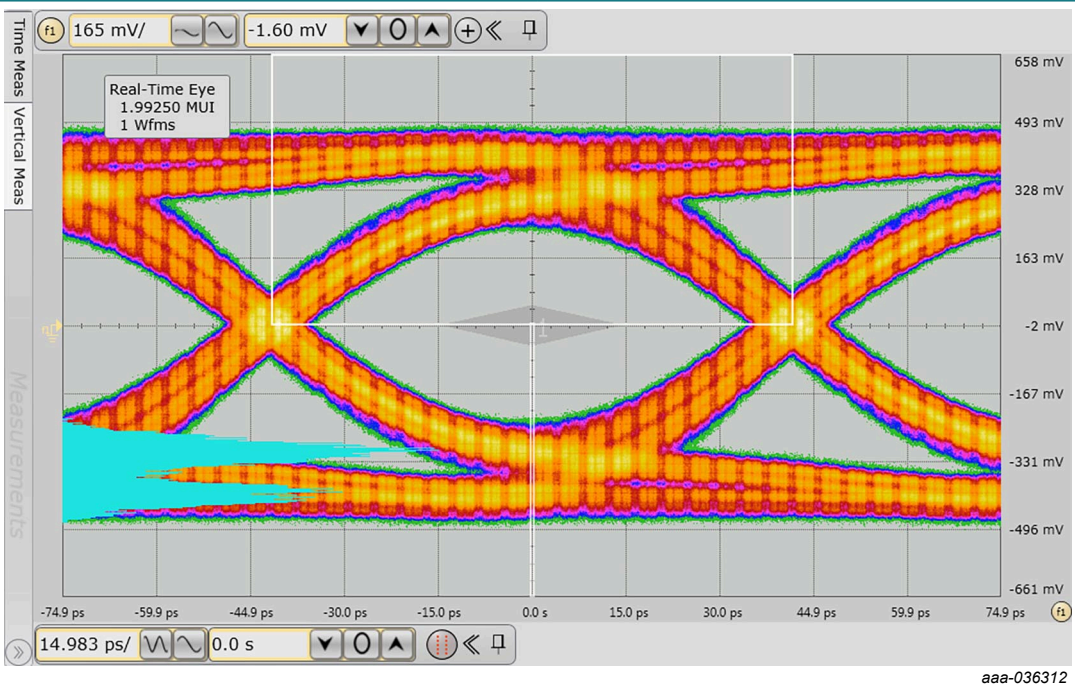
Fig. 6. USB3.2 eye diagram, PCB without device; typical values

Extremely low capacitance unidirectional ESD protection diode array



Short cable model (SCM), no equalizer

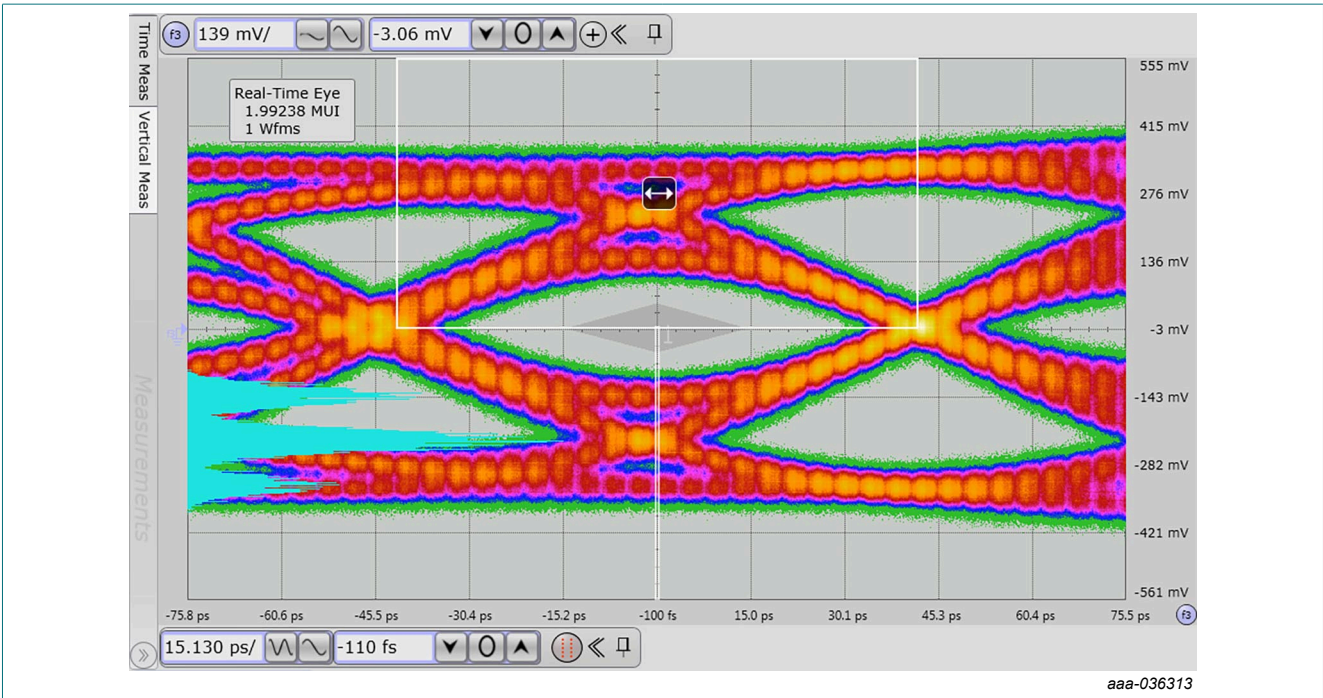
Fig. 7. HDMI 2.1 12G FRL eye diagram, PCB with device; typical values



Short cable model (SCM), no equalizer

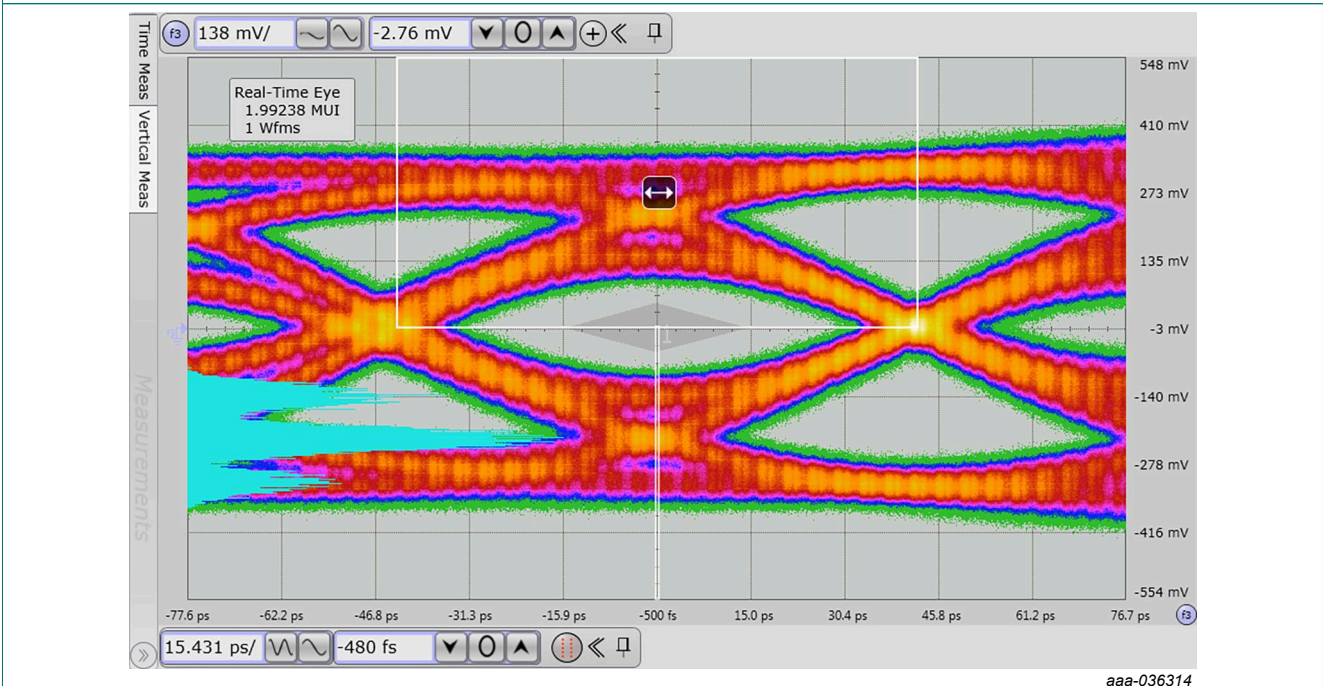
Fig. 8. HDMI 2.1 12G FRL eye diagram, PCB without device; typical values

Extremely low capacitance unidirectional ESD protection diode array



Worst cable model (WCM3), 7dB

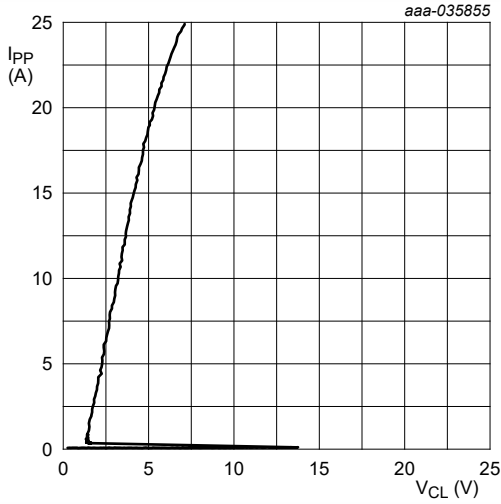
Fig. 9. HDMI 2.1 12G FRL eye diagram, PCB with device; typical values



Worst cable model (WCM3), 6dB

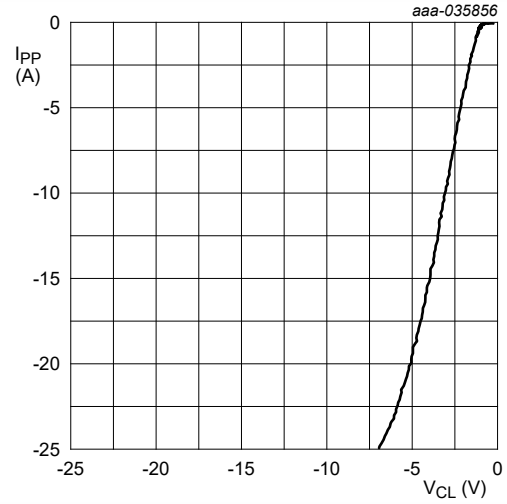
Fig. 10. HDMI 2.1 12G FRL eye diagram, PCB without device; typical values

Extremely low capacitance unidirectional ESD protection diode array



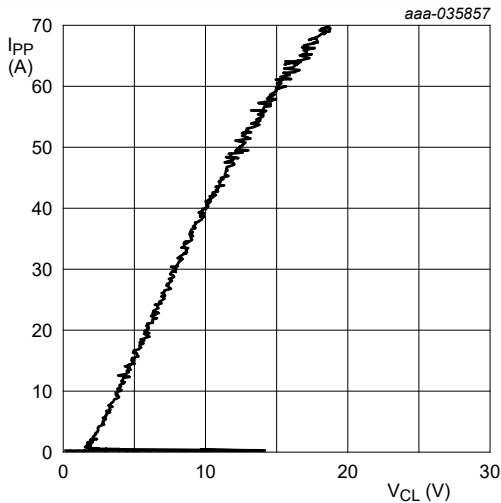
Transmission Line Pulse (TLP);  
 $t_p = 100 \text{ ns}$ ;  $t_r = 1 \text{ ns}$ ; pin 2

**Fig. 11. Dynamic resistance with positive clamping; typical values**



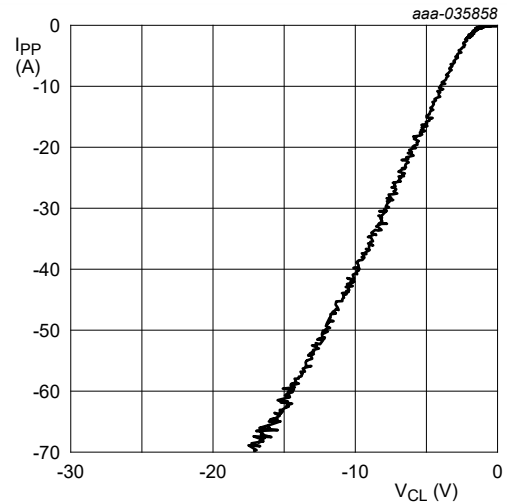
Transmission Line Pulse (TLP);  
 $t_p = 100 \text{ ns}$ ;  $t_r = 1 \text{ ns}$ ; pin 2

**Fig. 12. Dynamic resistance with negative clamping; typical values**



Very Fast Transmission Line Pulse (VF-TLP);  
 $t_p = 5 \text{ ns}$ ;  $t_r = 600 \text{ ps}$ ; pin 2

**Fig. 13. Dynamic resistance with positive clamping; typical values**

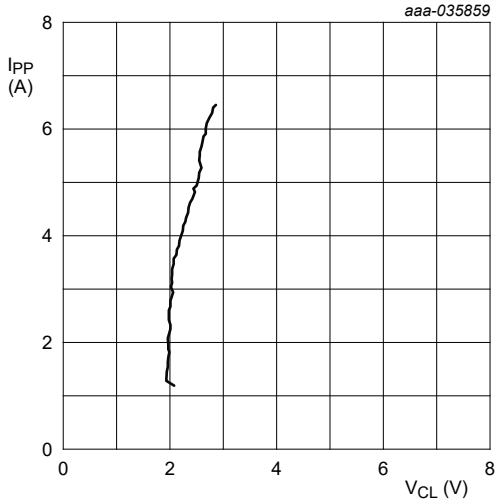


Very Fast Transmission Line Pulse (VF-TLP);  
 $t_p = 5 \text{ ns}$ ;  $t_r = 600 \text{ ps}$ ; pin 2

**Fig. 14. Dynamic resistance with negative clamping; typical values**

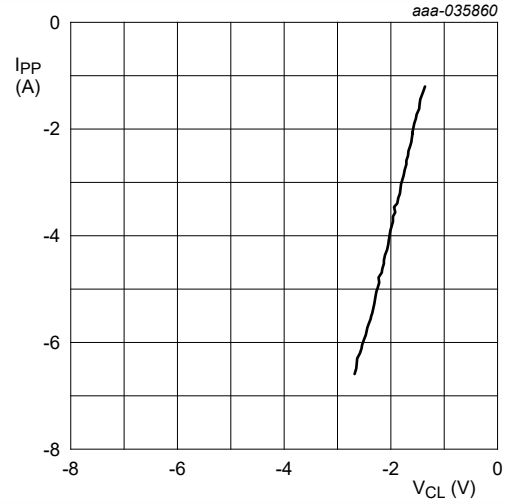


Extremely low capacitance unidirectional ESD protection diode array



IEC 61000-4-5;  $t_p = 8/20 \mu s$ ; positive pulse

**Fig. 15. Dynamic resistance with positive clamping; typical values**



IEC 61000-4-5;  $t_p = 8/20 \mu s$ ; negative pulse

**Fig. 16. Dynamic resistance with negative clamping; typical values**

## 10. Application information

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The device is designed to provide high-level ESD protection for high-speed serial data buses such as HDMI, DisplayPort, automotive video-links, eSATA and LVDS data lines.

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

### Dynamic resistance

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).

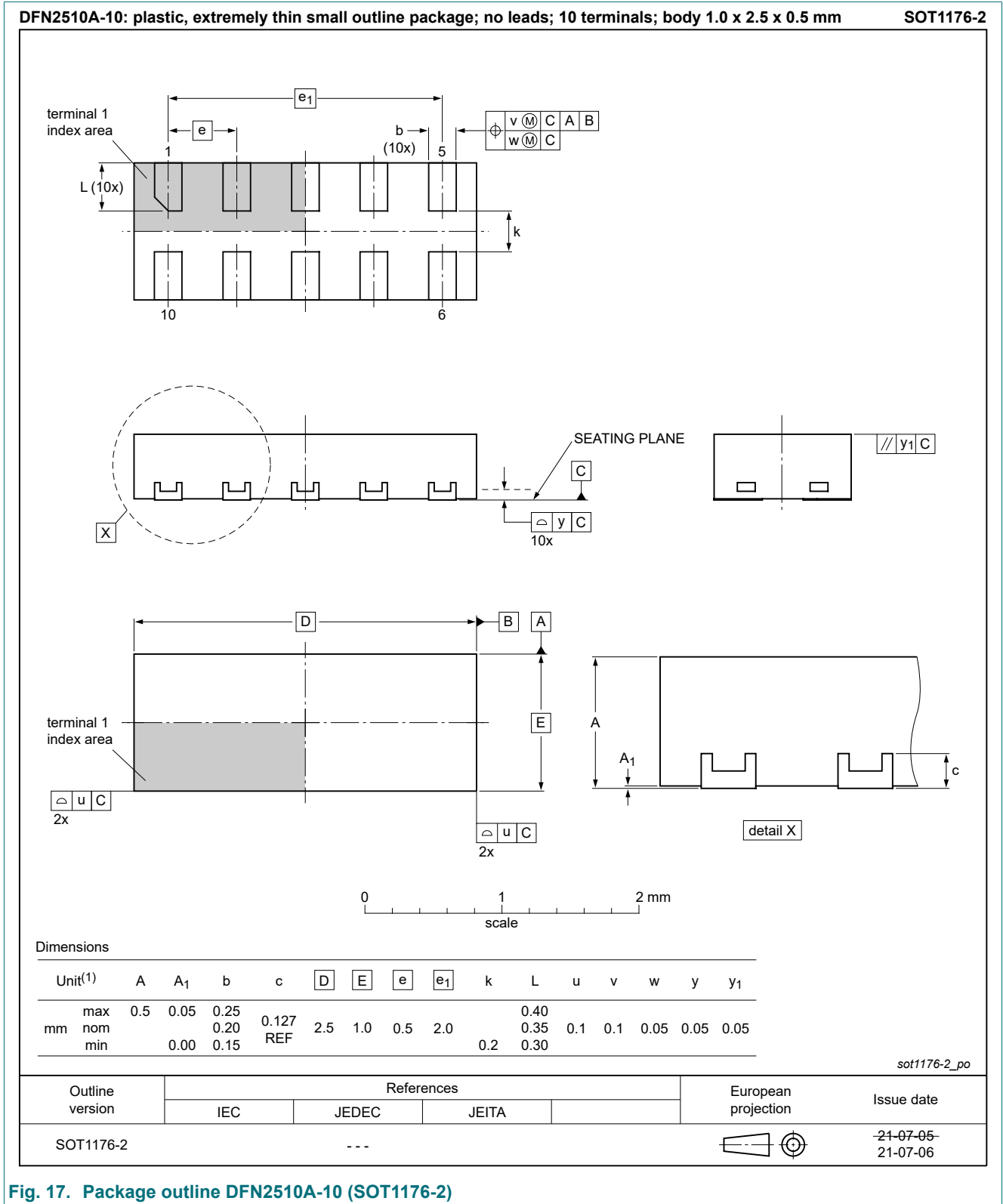
## 11. Test information

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### Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - *Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

## 12. Package outline



**Fig. 17. Package outline DFN2510A-10 (SOT1176-2)**

### 13. Soldering

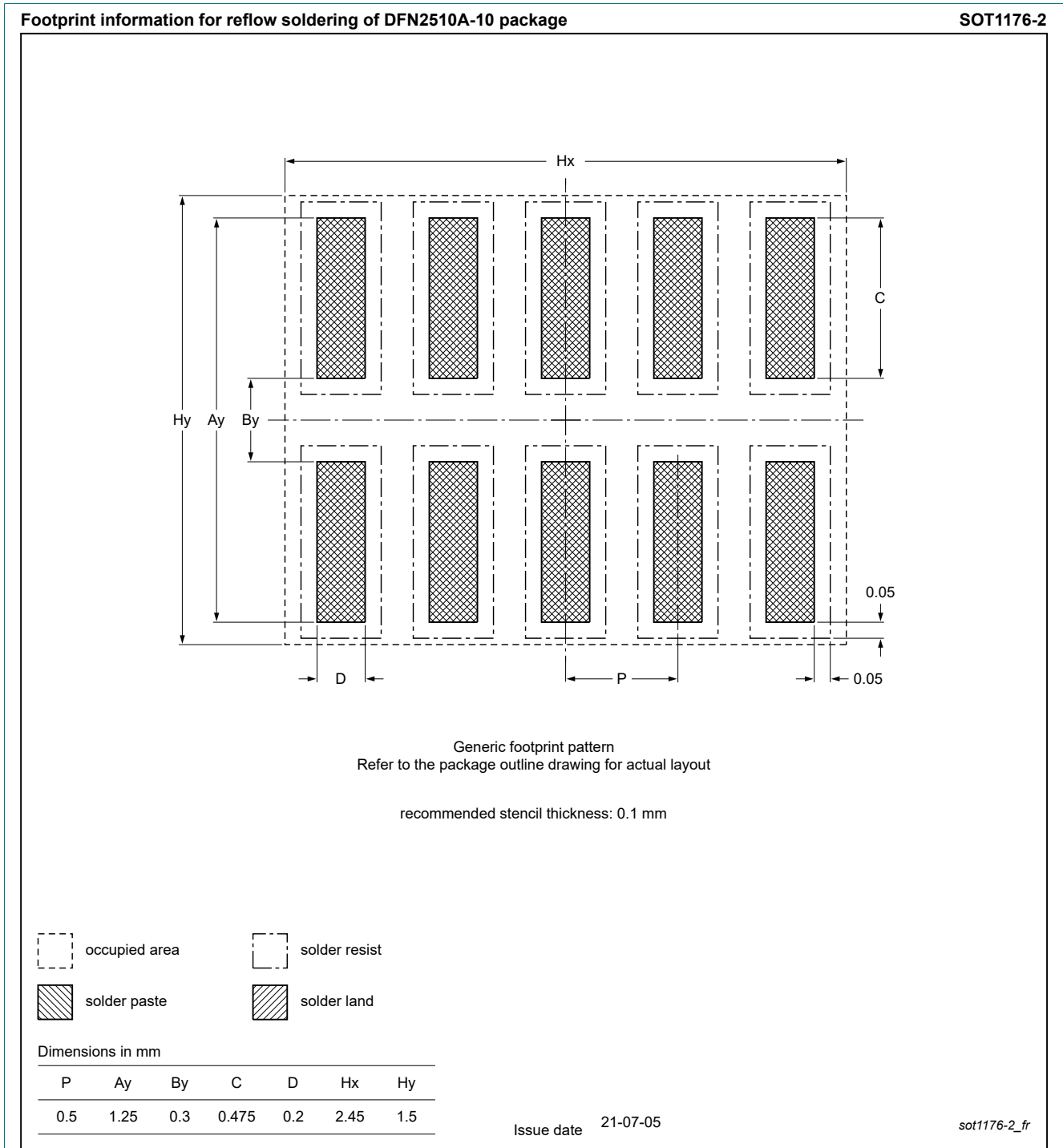


Fig. 18. Reflow soldering footprint for DFN2510A-10 (SOT1176-2)

## 14. Revision history

Table 7. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PESD4USB5UBTBR-Q v.1	20231026	Product data sheet	-	-

## 15. Legal information

### 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".
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