PESD4USB3BCTBR-Q

Extremely low capacitance bidirectional ESD protection diode array

9 November 2023 **Product data sheet**

1. General description

This bidirectional 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

- Bidirectional ESD protection for four signal lines
- V_{RWM} = 3.3 V device
- Extremely low clamping voltage to protect sensitive I/Os
- Extremely low clamping voltage: 5.4 V for 6.5 A 8/20 µs surge
- IEC 61000-4-4 robust up to 40 A into a 50 Ohm termination (2 kV)
- IEC 61000-4-5 (surge): I_{PP} = 8.2 A peak pulse (average measured)
- Typical line capacitance of only 0.19 pF
- ESD protection up to ±15 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

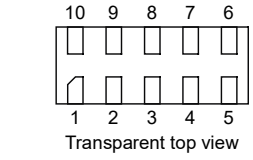
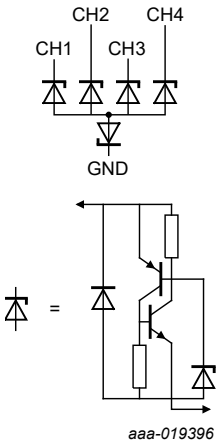
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{RWM}	reverse standoff voltage			-3.3	-	3.3	V
C_d	diode capacitance	f = 1 MHz; V_R = 1.5 V; T_{amb} = 25 °C	[1]	-	0.19	0.23	pF

[1] Measured on pin 1

nexperia

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	CH1	channel 1 ESD protection	 **DFN2510A-10 (SOT1176-2)**	
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		
	Name	Description	Version
PESD4USB3BCTBR-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
PESD4USB3BCTBR-Q	Q9

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			-3.3	3.3	V
I_{PPM}	rated peak pulse current	t_p = 8/20 µs	[1]	-6.5	6.5	A
T_{stg}	storage temperature			-65	150	°C
T_{amb}	ambient temperature			-55	150	°C
ESD maximum ratings						
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 Ω; C = 150 pF	[2]	-15	15	kV
		ISO 10605; contact discharge; R = 330 Ω; C = 330 pF	[2]	-13	13	kV

[1] Non-repetitive current pulse 8/20 µs exponentially decaying waveform according to IEC 61000-4-5.
[2] Device stressed with ten non-repetitive ESD pulses.

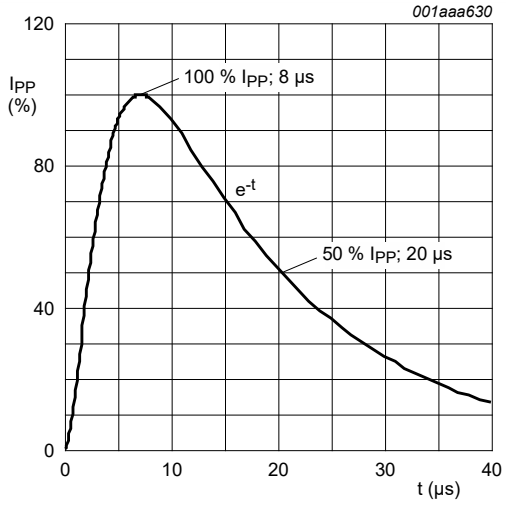


Fig. 1. 8/20 µs pulse waveform according to IEC 61000-4-5

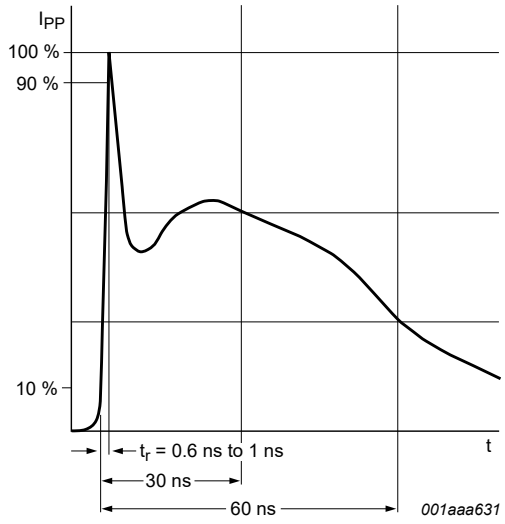


Fig. 2. ESD pulse waveform according to IEC 61000-4-2

9. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{BR}	breakdown voltage	I_R = 1 mA; T_{amb} = 25 °C		5.5	9.1	11.5	V
V_{CL}	clamping voltage	I_{TLP} = 8 A; t_p = 100 ns; T_{amb} = 25 °C	[1] [2]	-	5.2	-	V
		I_{TLP} = 16 A; t_p = 100 ns; T_{amb} = 25 °C	[1] [2]	-	8	-	V
		I_{PPM} = 6.5 A; t_p = 8/20 µs; T_{amb} = 25 °C	[3] [2]	-	5.4	-	V
I_{RM}	reverse leakage current	V_{RWM} = 3.3 V; T_{amb} = 25 °C		-	1	100	nA
R_{dyn}	dynamic resistance	I_R = 10 A; t_p = 100 ns; T_{amb} = 25 °C	[1] [2]	-	0.34	-	Ω
		I_R = -10 A; t_p = 100 ns; T_{amb} = 25 °C	[1] [2]	-	0.34	-	Ω
C_d	diode capacitance	f = 1 MHz; V_R = 1.5 V; T_{amb} = 25 °C	[4]	-	0.19	0.23	pF

[1] Non-repetitive current pulse, Transmission Line Pulse (TLP); square pulse; ANSI / ESD STM5.5.1-2008
[2] Measured on pin 2
[3] Device stressed with 8/20 µs exponential decay waveform according to IEC 61000-4-5.
[4] Measured on pin 1

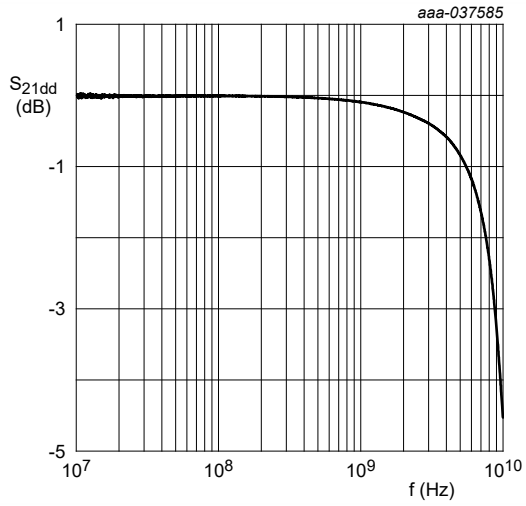
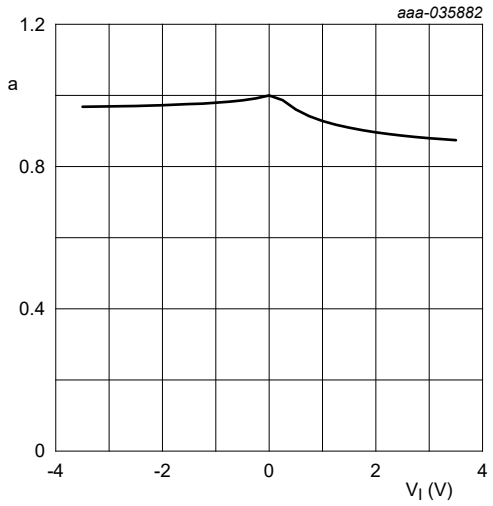
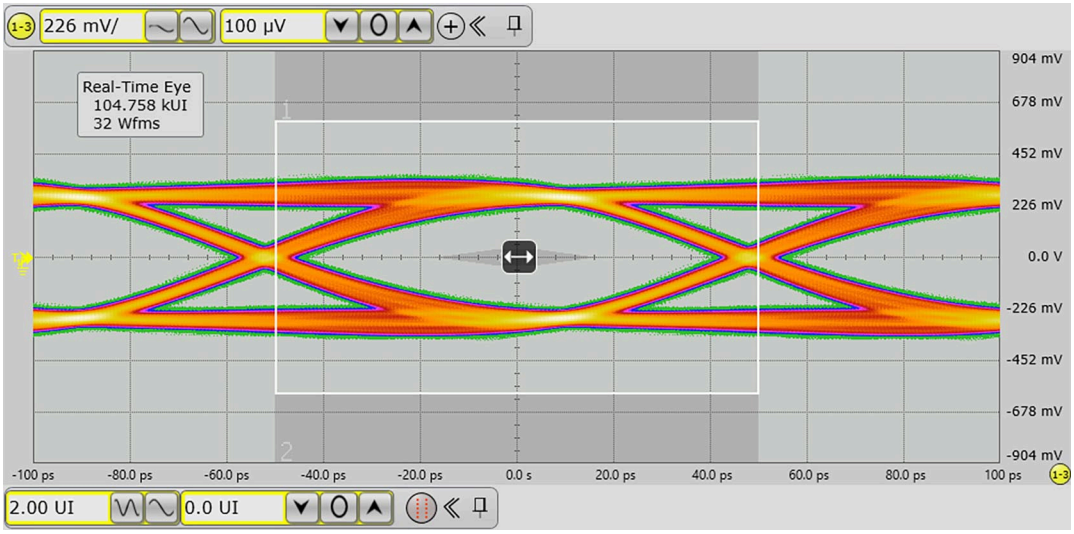


Fig. 3. Insertion loss; typical values



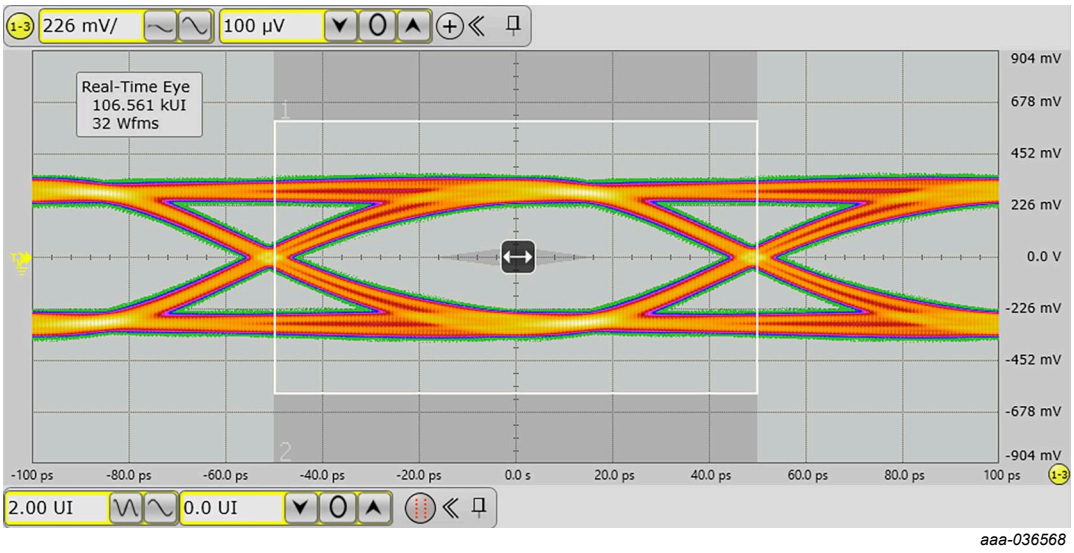
$$a = \frac{C_{line}}{C_{line}(V_I = 0\ V)}$$

Fig. 4. Relative capacitance as a function of input voltage; typical values



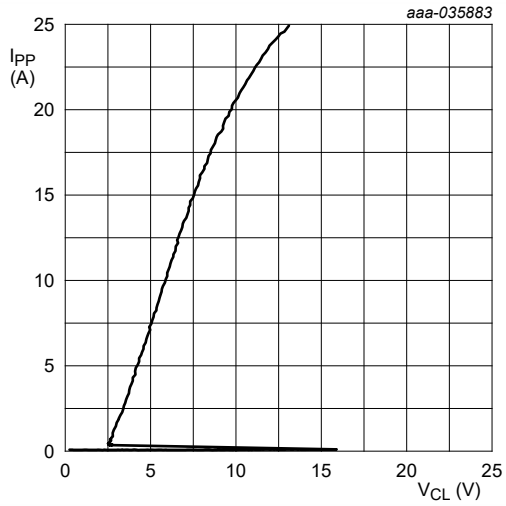
Data rate: 10 Gbit/s

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



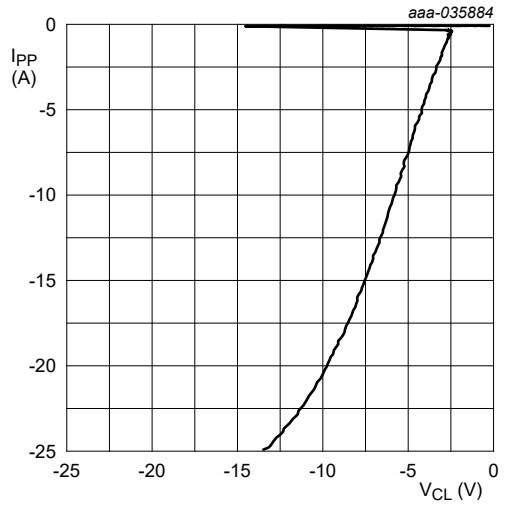
Data rate: 10 Gbit/s

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



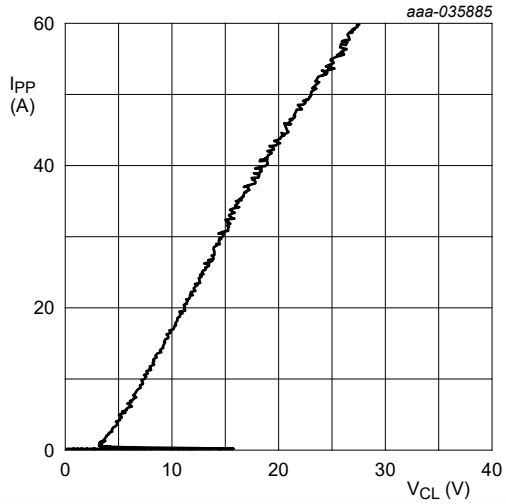
Transmission Line Pulse (TLP);
t_p = 100 ns; t_r = 1 ns; pin 2

Fig. 7. Dynamic resistance with positive clamping; typical values



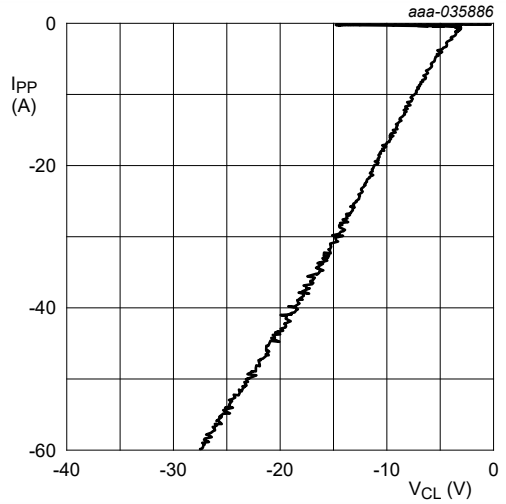
Transmission Line Pulse (TLP);
t_p = 100 ns; t_r = 1 ns; pin 2

Fig. 8. Dynamic resistance with negative clamping; typical values



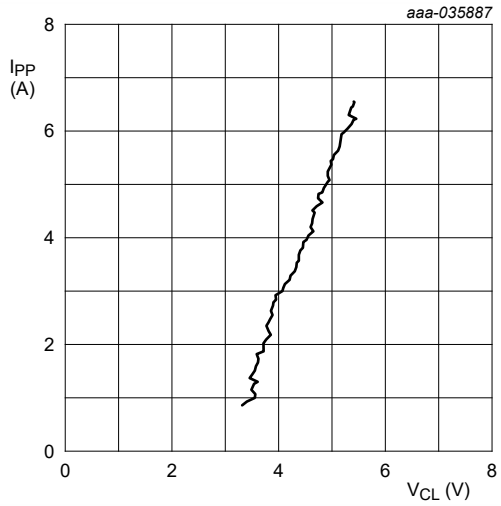
Very Fast Transmission Line Pulse (VF-TLP);
t_p = 5 ns; t_r = 600 ps; pin 2

Fig. 9. Dynamic resistance with positive clamping; typical values



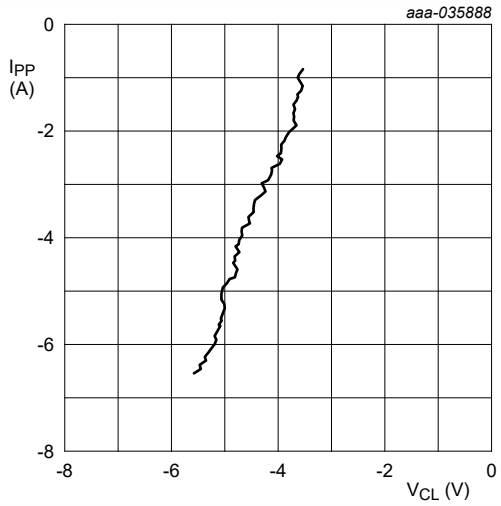
Very Fast Transmission Line Pulse (VF-TLP);
t_p = 5 ns; t_r = 600 ps; pin 2

Fig. 10. Dynamic resistance with negative clamping; typical values



IEC 61000-4-5; t_p = 8/20 µs; positive pulse

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



IEC 61000-4-5; t_p = 8/20 µs; negative pulse

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

10. Application information

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).

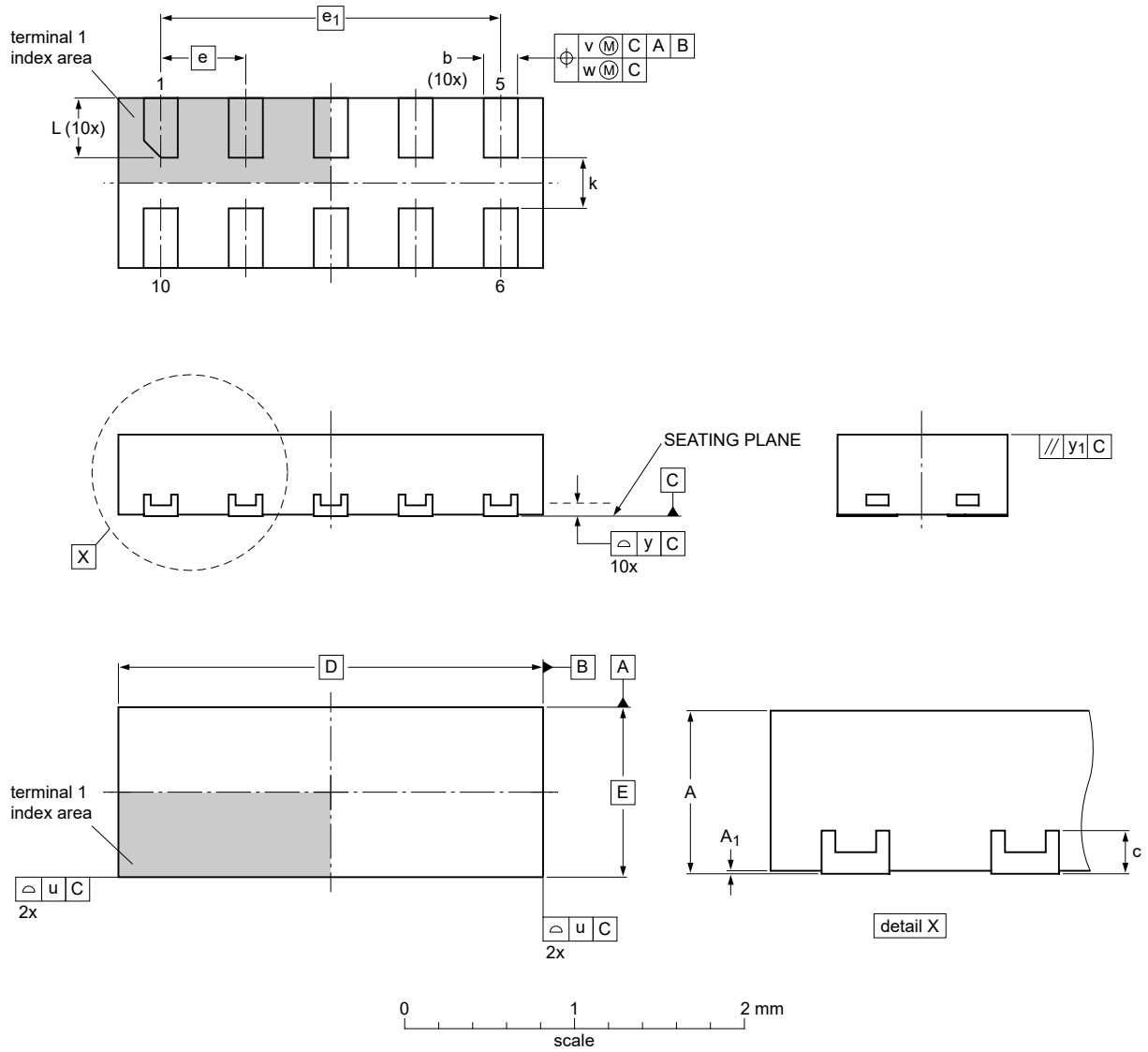
11. Test information

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

DFN2510A-10: plastic, extremely thin small outline package; no leads; 10 terminals; body 1.0 x 2.5 x 0.5 mm **SOT1176-2**



Dimensions

Unit[1]		A	A_1	b	c	D	E	e	e_1	k	L	u	v	w	y	y_1
mm	max	0.5	0.05	0.25	0.127 REF	2.5	1.0	0.5	2.0		0.40	0.1	0.1	0.05	0.05	0.05
	nom			0.20							0.35					
	min		0.00	0.15						0.2	0.30					

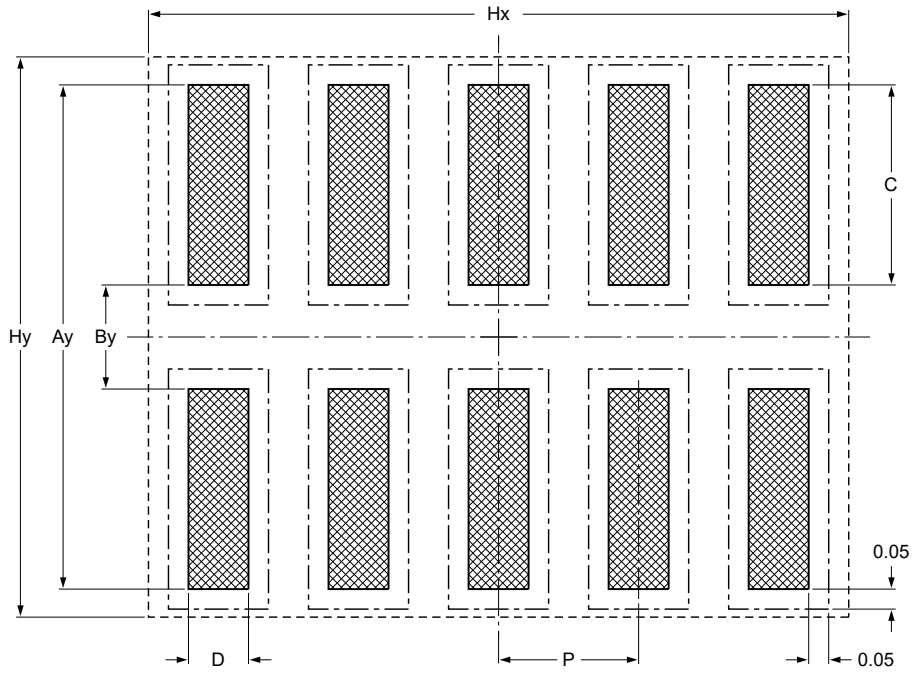
sot1176-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1176-2		---				~~21-07-05~~ 21-07-06

Fig. 13. Package outline DFN2510A-10 (SOT1176-2)

13. Soldering

Footprint information for reflow soldering of DFN2510A-10 package **SOT1176-2**



Generic footprint pattern
Refer to the package outline drawing for actual layout

recommended stencil thickness: 0.1 mm

occupied area
solder resist
solder paste
solder land

Dimensions in mm

P	Ay	By	C	D	Hx	Hy
0.5	1.25	0.3	0.475	0.2	2.45	1.5

Issue date 21-07-05

sot1176-2_fr

Fig. 14. 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
PESD4USB3BCTBR-Q v.2	20231109	Product data sheet	-	PESD4USB3BCTBR-Q v.1
Modifications:	• Changed document status to "Product data sheet" • Complete rework			
PESD4USB3BCTBR-Q v.1	20230823	Preliminary 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".
[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 https://www.nexperia.com.

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Date of release: 9 November 2023