



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 μ s 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

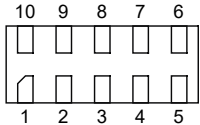
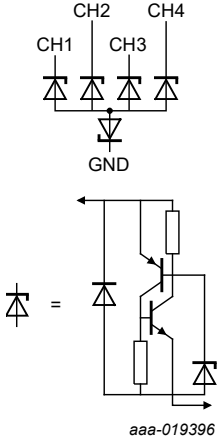
Table 1. Quick reference data

| 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

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|--------------------------|---|---|
| 1 | CH1 | channel 1 ESD protection |  <p>Transparent top view DFN2510A-10 (SOT1176-2)</p> |  <p>aaa-019396</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 | | |
|------------------|-------------|--|-----------|
| | 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 |

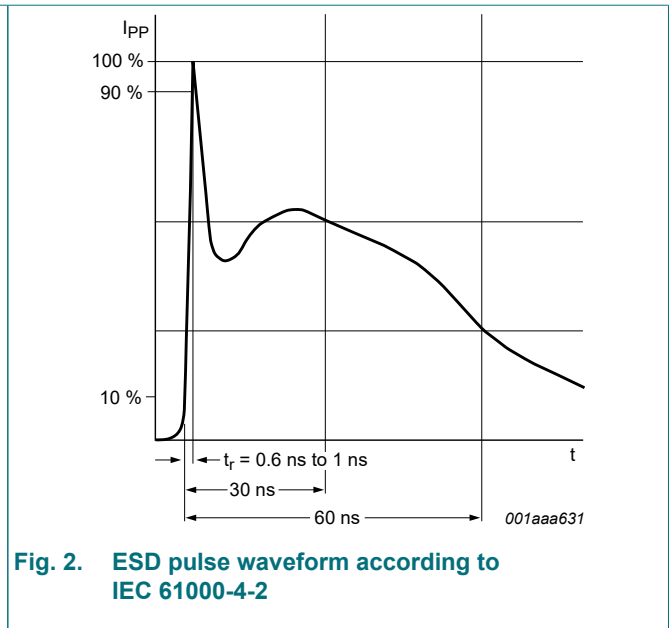
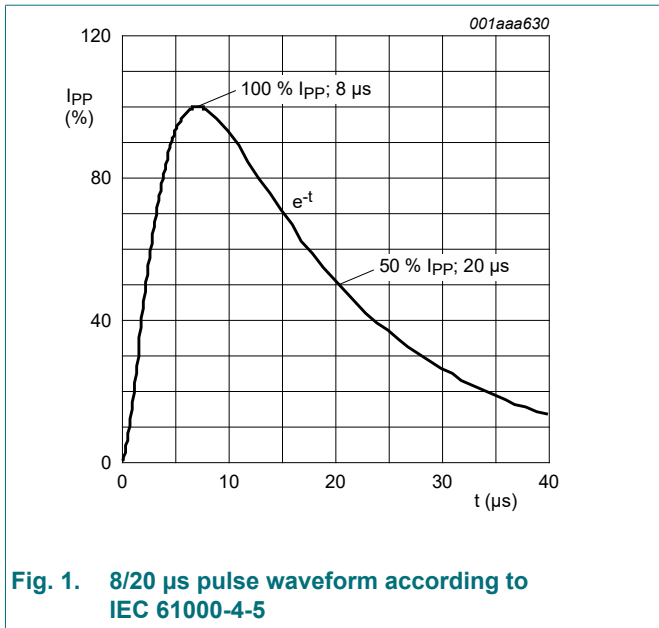
8. Limiting values

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 | $t_p = 8/20 \mu s$ | [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.

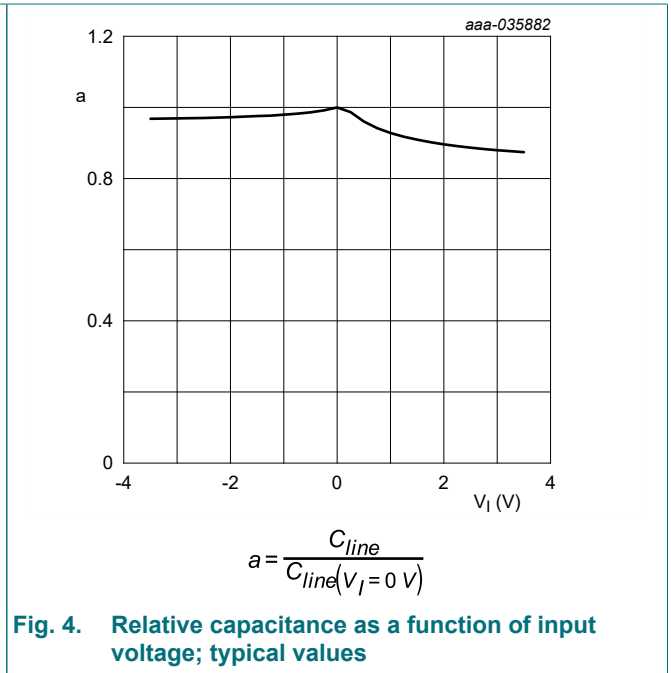
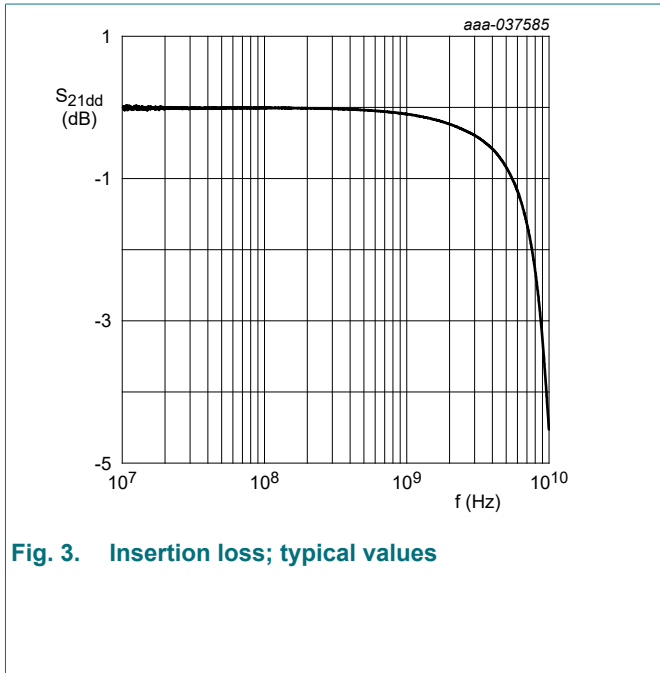


9. Characteristics

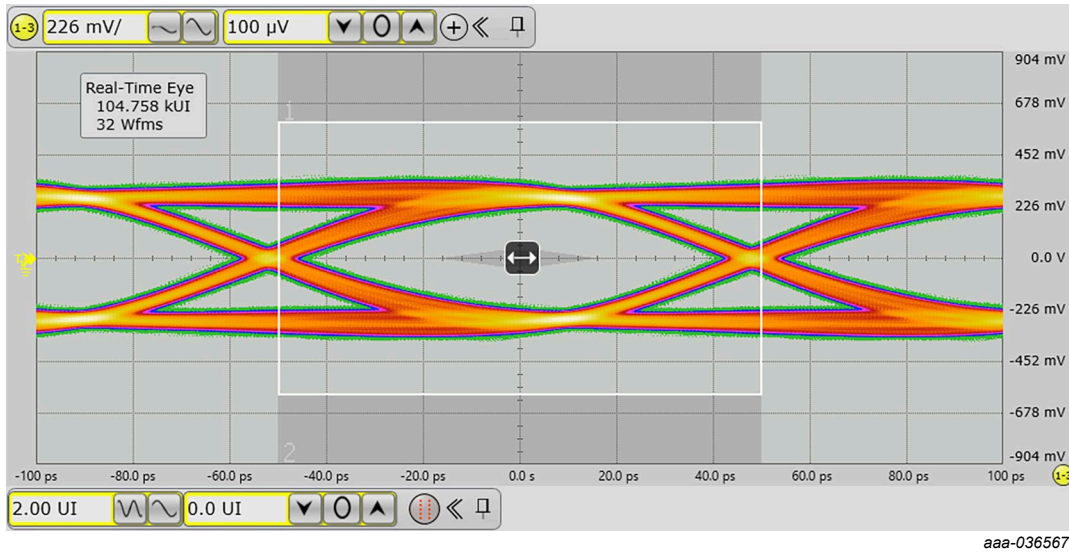
Table 6. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|-----------|-------------------------|---|---------|------|------|------|----------|
| V_{BR} | breakdown voltage | $I_R = 1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$ | 5.5 | 9.1 | 11.5 | V | |
| V_{CL} | clamping voltage | $I_{TLP} = 8 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ | [1] [2] | - | 5.2 | - | V |
| | | $I_{TLP} = 16 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ | [1] [2] | - | 8 | - | V |
| | | $I_{PPM} = 6.5 \text{ A}; t_p = 8/20 \text{ } \mu\text{s}; T_{amb} = 25 \text{ }^\circ\text{C}$ | [3] [2] | - | 5.4 | - | V |
| I_{RM} | reverse leakage current | $V_{RWM} = 3.3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | 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] [2] | - | 0.34 | - | Ω |
| | | $I_R = -10 \text{ A}; t_p = 100 \text{ ns}; T_{amb} = 25 \text{ }^\circ\text{C}$ | [1] [2] | - | 0.34 | - | Ω |
| C_d | diode capacitance | $f = 1 \text{ MHz}; V_R = 1.5 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$ | [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

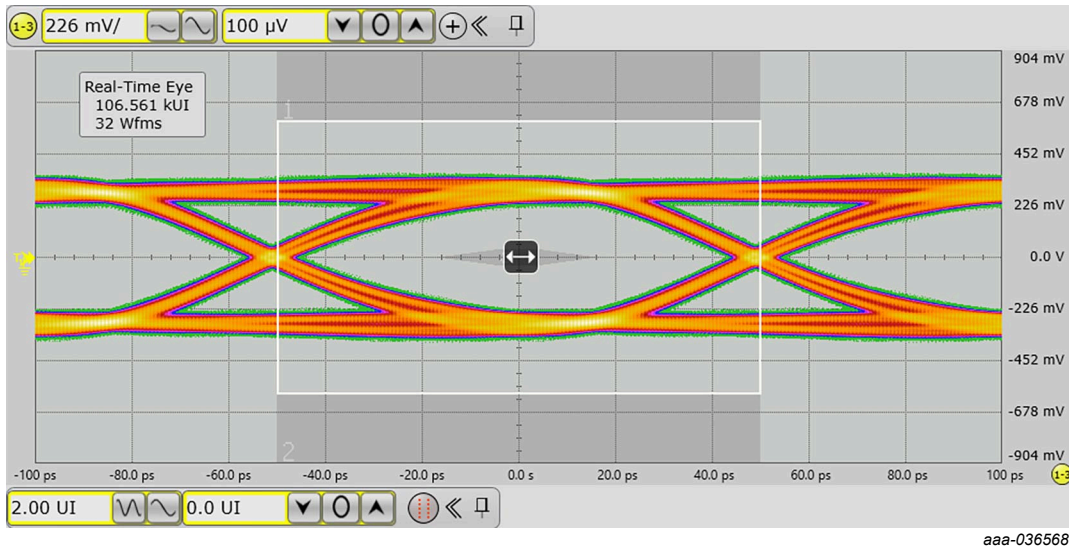


Extremely low capacitance bidirectional ESD protection diode array



Data rate: 10 Gbit/s

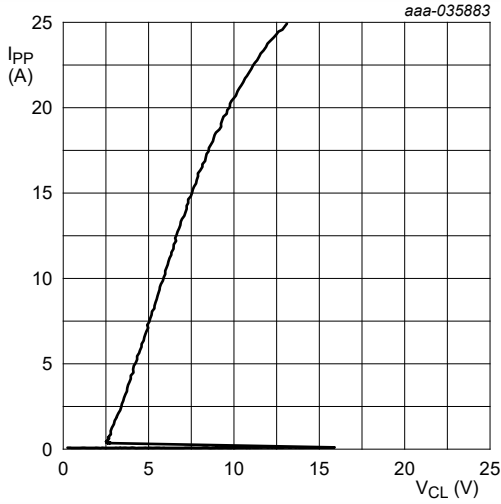
Fig. 5. USB3.2 eye diagram, PCB with device; typical values



Data rate: 10 Gbit/s

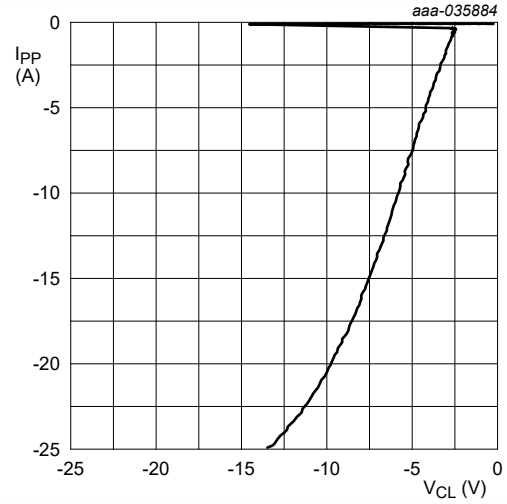
Fig. 6. USB3.2 eye diagram, PCB without device; typical values

Extremely low capacitance bidirectional ESD protection diode array



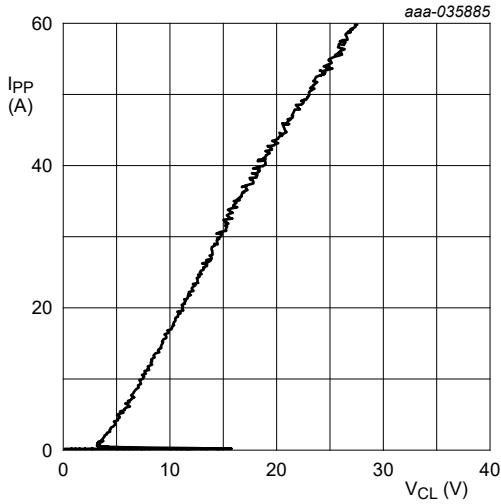
Transmission Line Pulse (TLP);
 $t_p = 100 \text{ ns}$; $t_r = 1 \text{ ns}$; pin 2

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



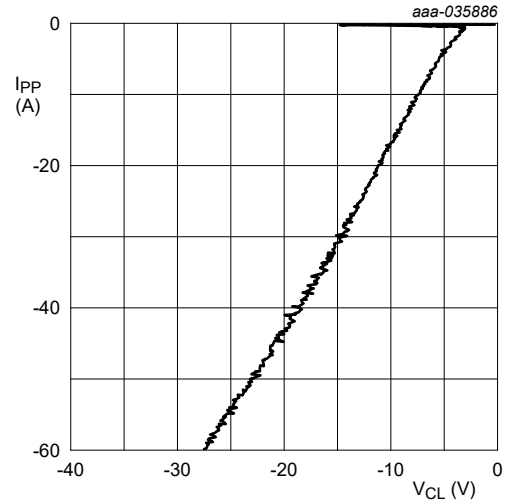
Transmission Line Pulse (TLP);
 $t_p = 100 \text{ ns}$; $t_r = 1 \text{ ns}$; pin 2

Fig. 8. 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

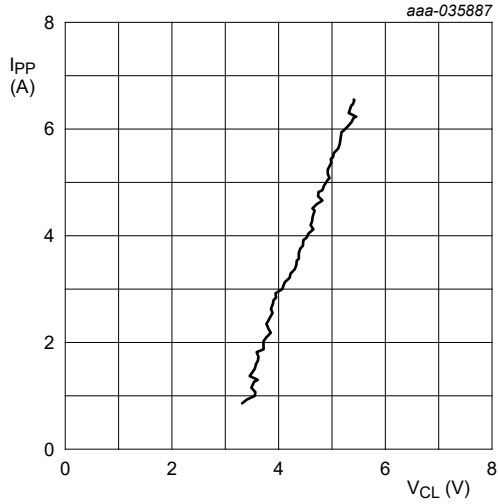
Fig. 9. Dynamic resistance with positive clamping; typical values



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

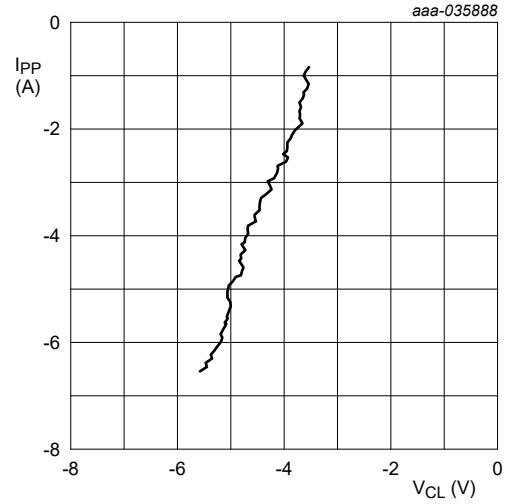
Fig. 10. Dynamic resistance with negative clamping; typical values

Extremely low capacitance bidirectional ESD protection diode array



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

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



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

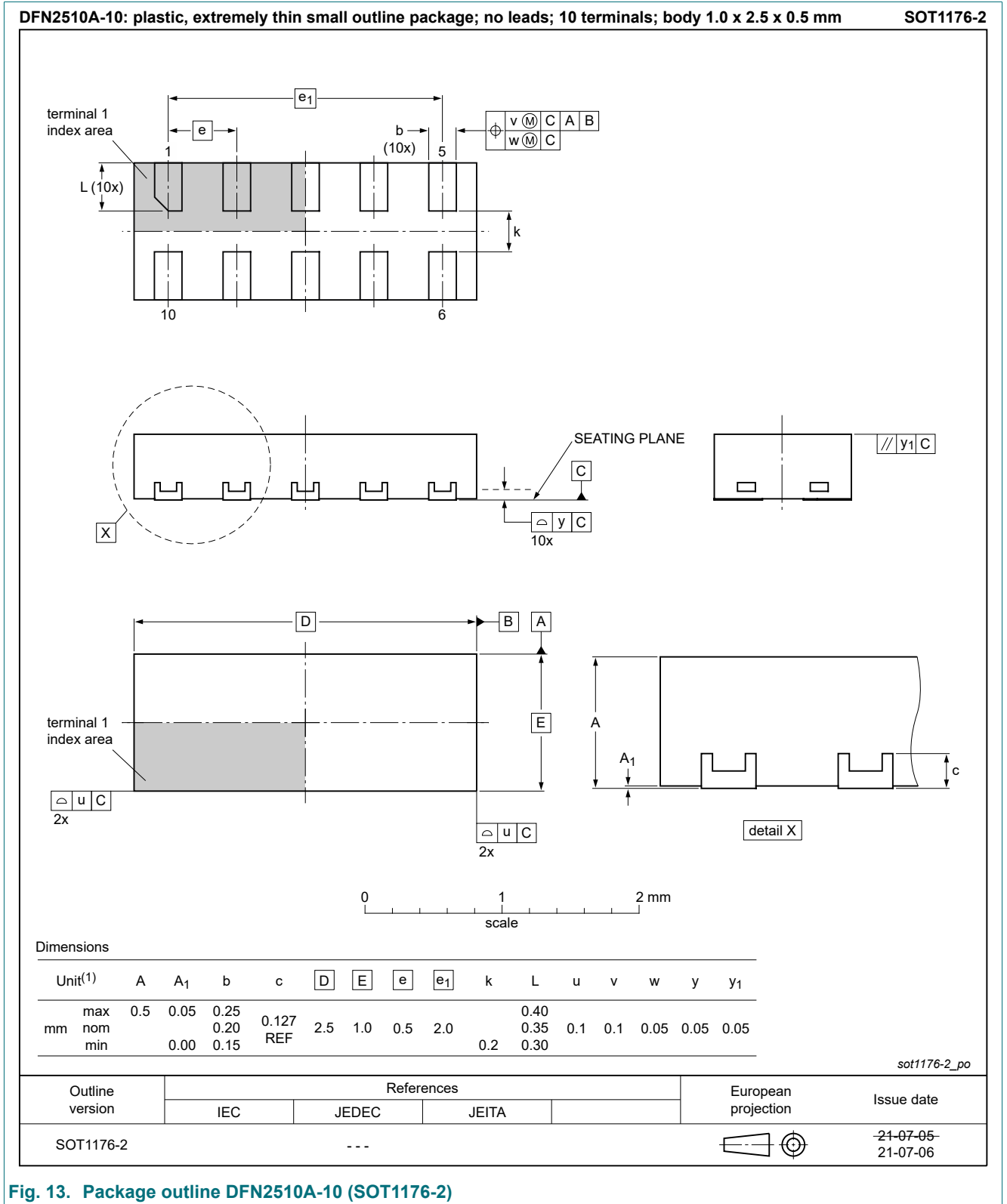


Fig. 13. Package outline DFN2510A-10 (SOT1176-2)

13. Soldering

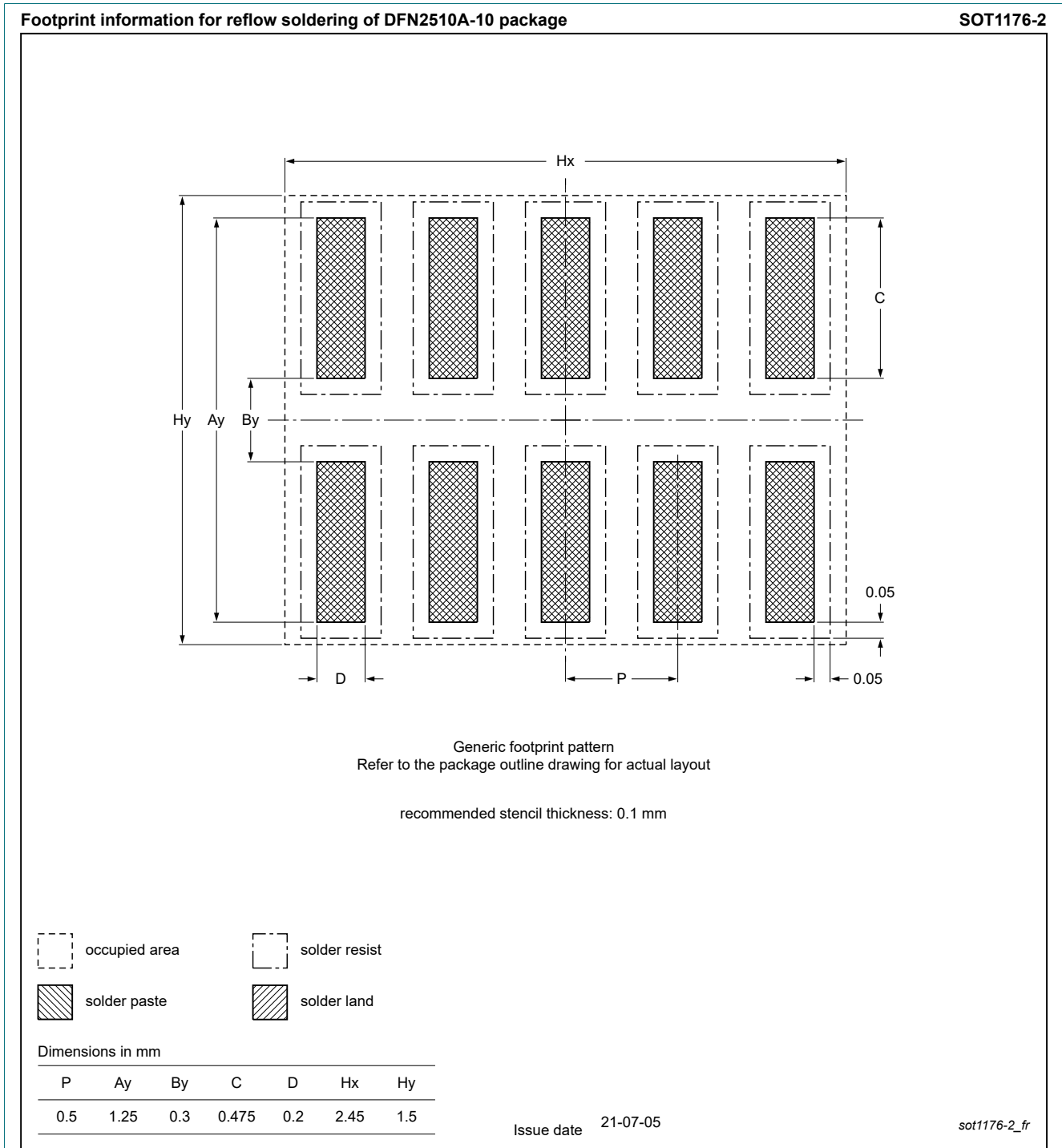


Fig. 14. Reflow soldering footprint for DFN2510A-10 (SOT1176-2)

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: | <ul style="list-style-type: none">• 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. |

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- [2] The term 'short data sheet' is explained in section "Definitions".
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