



PUSB3AB4

ESD protection for ultra high-speed interfaces

10 October 2019

Product data sheet

1. General description

The device is designed to protect high-speed interfaces such as SuperSpeed USB 3.2 at 10 Gbps, High-Definition Multimedia Interface (HDMI), DisplayPort, external Serial Advanced Technology Attachment (eSATA) and Low Voltage Differential Signaling (LVDS) interfaces against ElectroStatic Discharge (ESD).

The device includes a high-level ESD protection diode structure protecting sensitive transmitters and receivers for ultra high-speed signal lines. The device is encapsulated in a leadless small DFN2510A-10 (SOT1176-1) plastic package.

All signal lines are protected by a special diode configuration offering ultra low line capacitance of only 0.2 pF maximum. These diodes utilize a snapback structure in order to provide protection to downstream components from ESD voltages up to ± 15 kV contact exceeding IEC 61000-4-2, level 4.

2. Features and benefits

- System-level ESD protection for USB 2.0 and SuperSpeed USB 3.2 at 10 Gbps, HDMI, DisplayPort, eSATA and LVDS
- Line capacitance of only 0.2 pF maximum for each channel
- Outstanding system protection: extremely deep snapback combined with dynamic resistance of only 0.4Ω
- All signal lines with integrated rail-to-rail clamping diodes for downstream ESD protection of ± 15 kV exceeding IEC 61000-4-2, level 4
- Matched 0.5 mm trace spacing
- Signal lines with ≤ 0.05 pF matching capacitance between signal pairs
- Design-friendly 'pass-through' signal routing

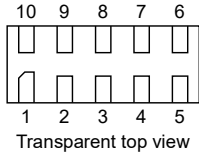
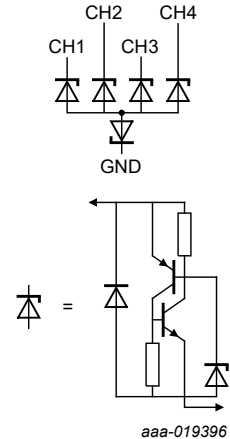
3. Applications

The device is designed for high-speed receiver and transmitter port protection:

- Smartphones, tablet computers, Mobile Internet Devices (MID) and portable devices
- TVs and monitors
- DVD recorders and players
- Notebooks, main board graphic cards and ports
- Set-top boxes and game consoles

4. Pinning information

Table 1. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|--------------------------|---|---|
| 1 | CH1 | channel 1 ESD protection |  <p>Transparent top view</p> <p>DFN2510A-10 (SOT1176-1)</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. | no connection | | |
| 8 | GND | ground | | |
| 9 | n.c. | not connected | | |
| 10 | n.c. | not connected | | |

5. Ordering information

Table 2. Ordering information

| Type number | Package | | |
|-------------|-------------|---|-----------|
| | Name | Description | Version |
| PUSB3AB4 | DFN2510A-10 | plastic, leadless extremely thin small outline package; 10 terminals; 0.5 mm pitch; 2.5 mm x 1 mm x 0.5 mm body | SOT1176-1 |

6. Marking

Table 3. Marking codes

| Type number | Marking code |
|-------------|--------------|
| PUSB3AB4 | AB |

7. Limiting values

Table 4. Limiting values

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|-----------|---------------------------------|---|-----|------|-----|------|
| V_I | input voltage | | | -3.3 | 3.3 | V |
| I_{PPM} | rated peak pulse current | $t_p = 8/20 \mu s$ | [1] | -7 | 7 | A |
| V_{ESD} | electrostatic discharge voltage | IEC 61000-4-2, level 4; contact discharge | [2] | -15 | 15 | kV |
| | | IEC 61000-4-2, level 4; air discharge | [2] | -15 | 15 | kV |
| T_{stg} | storage temperature | | | -55 | 125 | °C |
| T_{amb} | ambient temperature | | | -40 | 85 | °C |

[1] In positive and negative direction.

[2] All pins to ground.

8. Characteristics

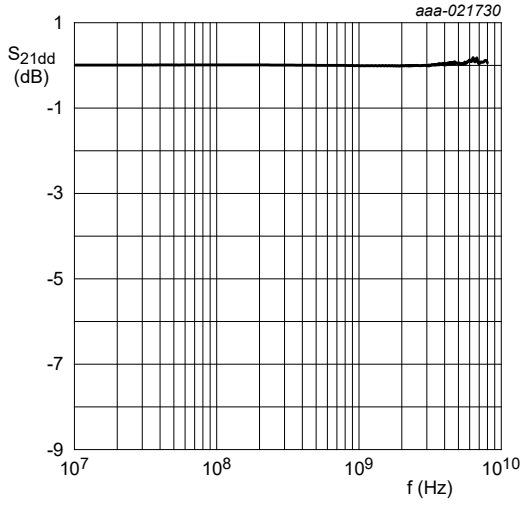
Table 5. Characteristics

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|------------|-------------------------|---|-----|-----|------|------|----------|
| V_{BR} | breakdown voltage | $I_I = 1 \text{ mA}$; $T_{amb} = 25 \text{ °C}$ | | 5.5 | 9 | 11.5 | V |
| V_{sbck} | snapback voltage | $I_I = 1 \text{ A}$; TLP 100/10 ns; $T_{amb} = 25 \text{ °C}$ | | - | 3.3 | - | V |
| V_{CL} | clamping voltage | $I_{PP} = 5 \text{ A}$; positive transient; $T_{amb} = 25 \text{ °C}$ | [1] | - | 5 | - | V |
| | | $I_{PP} = -5 \text{ A}$; negative transient; $T_{amb} = 25 \text{ °C}$ | [1] | - | -5 | - | V |
| I_{RM} | reverse leakage current | per channel; $V_I = 5 \text{ V}$; $T_{amb} = 25 \text{ °C}$ | | - | 1 | 100 | nA |
| r_{dyn} | dynamic resistance | TLP; positive transient; $T_{amb} = 25 \text{ °C}$ | [2] | - | 0.4 | - | Ω |
| | | TLP; negative transient; $T_{amb} = 25 \text{ °C}$ | [2] | - | 0.4 | - | Ω |
| C_{line} | line capacitance | $f = 1 \text{ MHz}$; $V_I = 1.5 \text{ V}$; $T_{amb} = 25 \text{ °C}$ | [3] | - | 0.17 | 0.2 | pF |

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

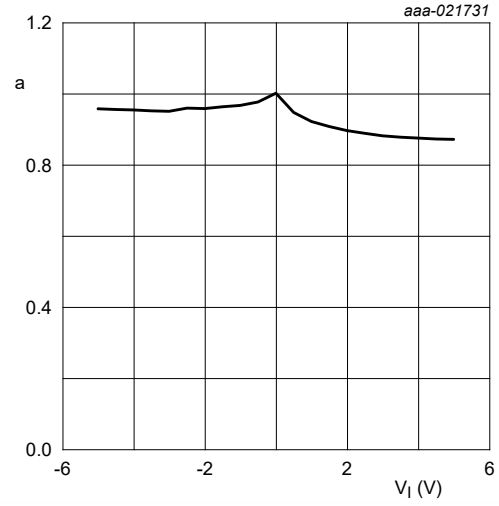
[2] 100 ns Transmission Line Pulse (TLP), 50 Ω , pulser at 80 ns.

[3] The parameter is guaranteed by design.



differential mode

Fig. 1. Insertion loss; typical values



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

Fig. 2. Relative capacitance as a function of input voltage; typical values

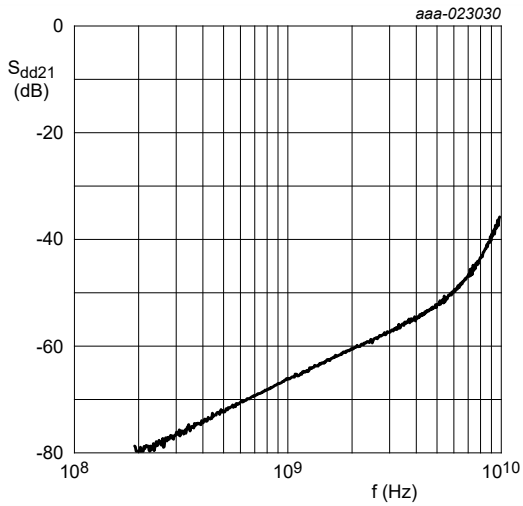
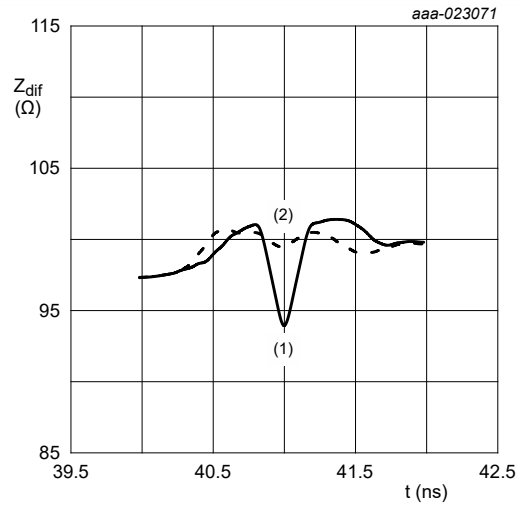


Fig. 3. Differential crosstalk; typical values

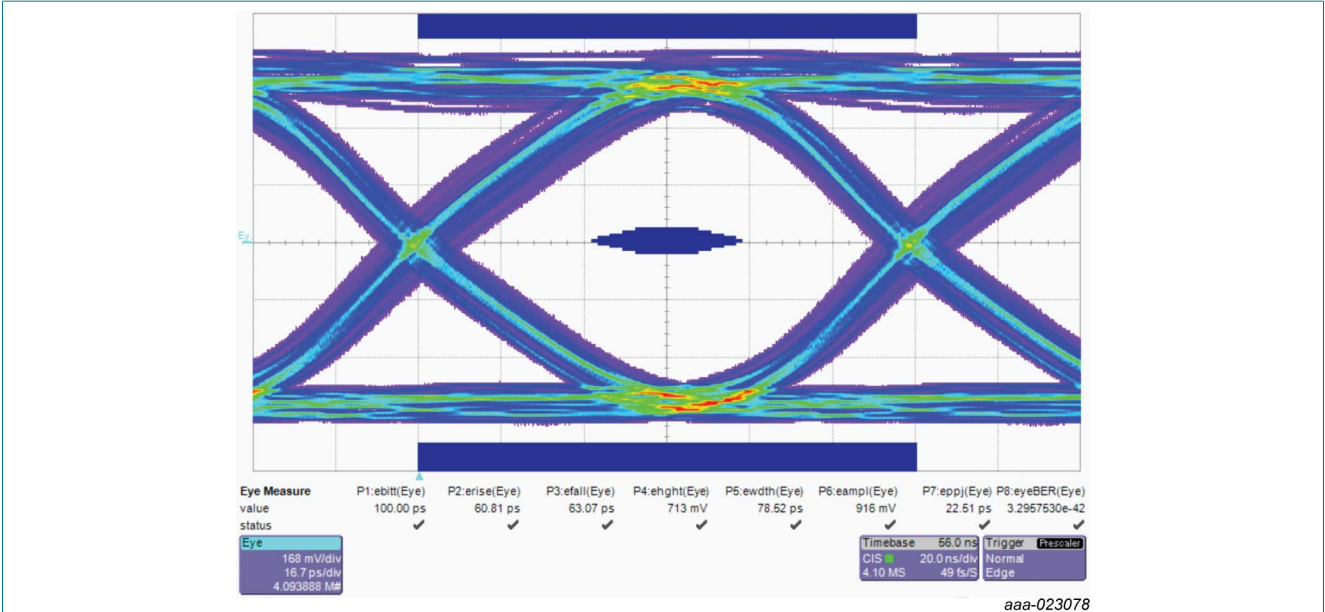


$t_r = 200 \text{ ps}$

(1) Device on reference board

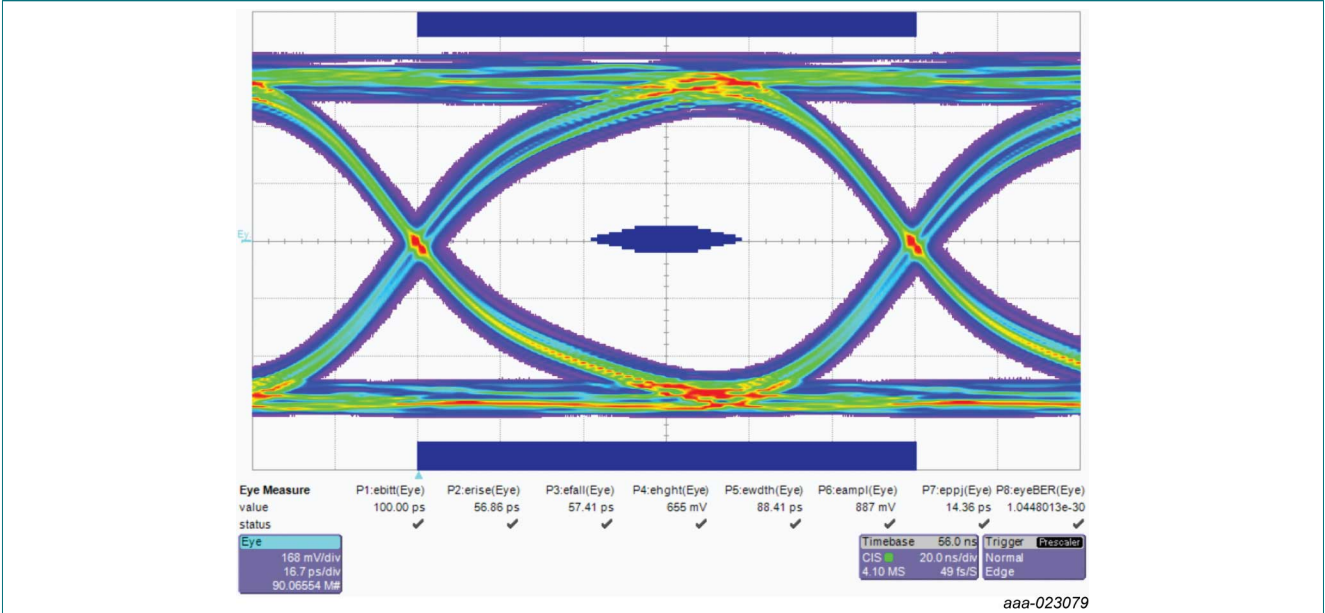
(2) Reference board without Device Under Test (DUT)

Fig. 4. Differential Time Domain Reflectometer (TDR) plot; typical values



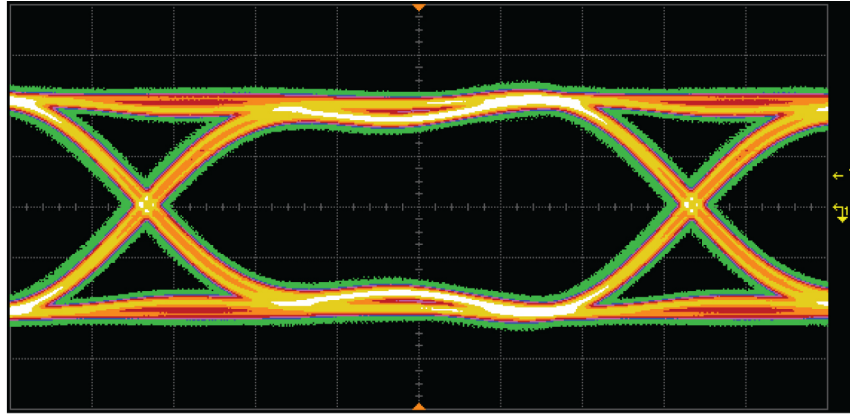
Data rate: 10 Gbit/s

Fig. 5. USB 3.2 eye diagram, PCB with device



Data rate: 10 Gbit/s

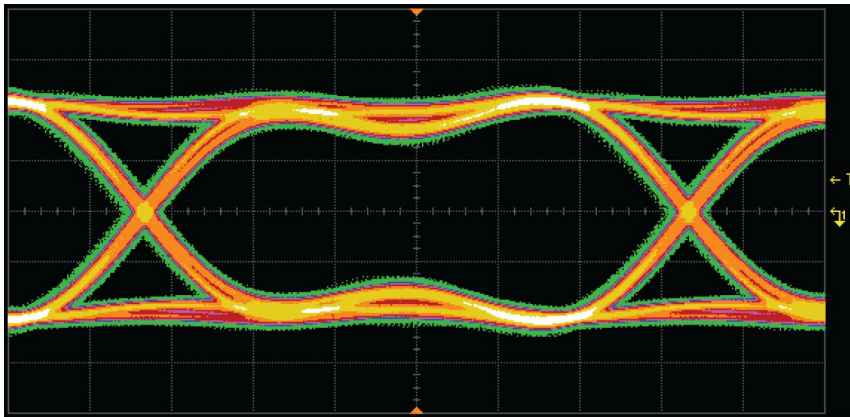
Fig. 6. USB 3.2 eye diagram, PCB without device



aaa-023080

Test frequency: 148.5 MHz
 Differential swing voltage: 840 mV
 Horizontal scale: 25 ps/div

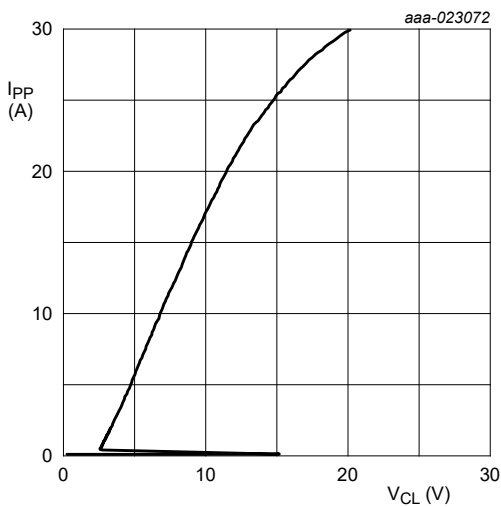
Fig. 7. HDMI 2.0 TP1 eye diagram, PCB with device



aaa-023081

Test frequency: 148.5 MHz
 Differential swing voltage: 906 mV
 Horizontal scale: 25 ps/div

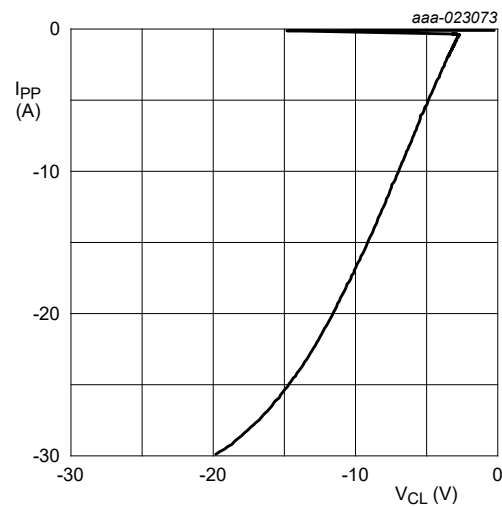
Fig. 8. HDMI 2.0 TP1 eye diagram, PCB without device



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$t_p = 100$ ns; Transmission Line Pulse (TLP)

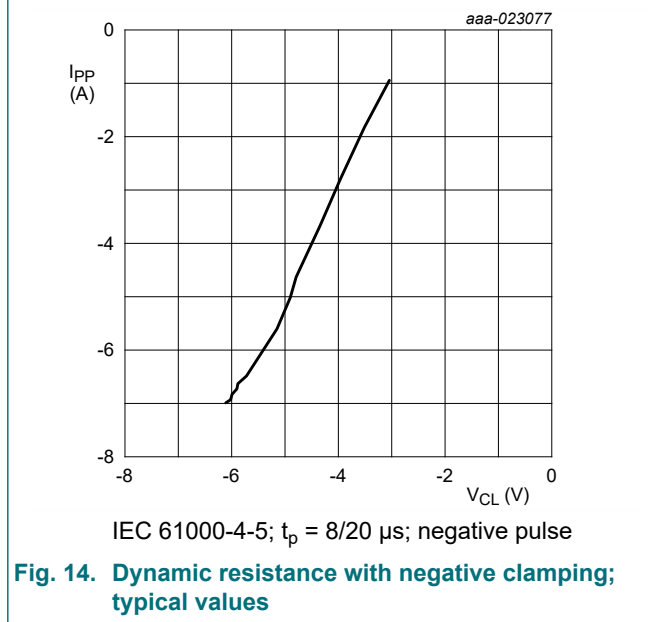
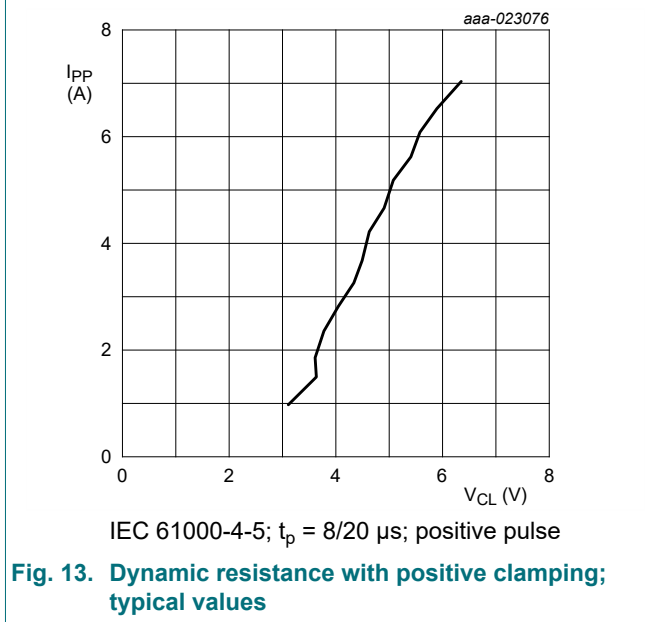
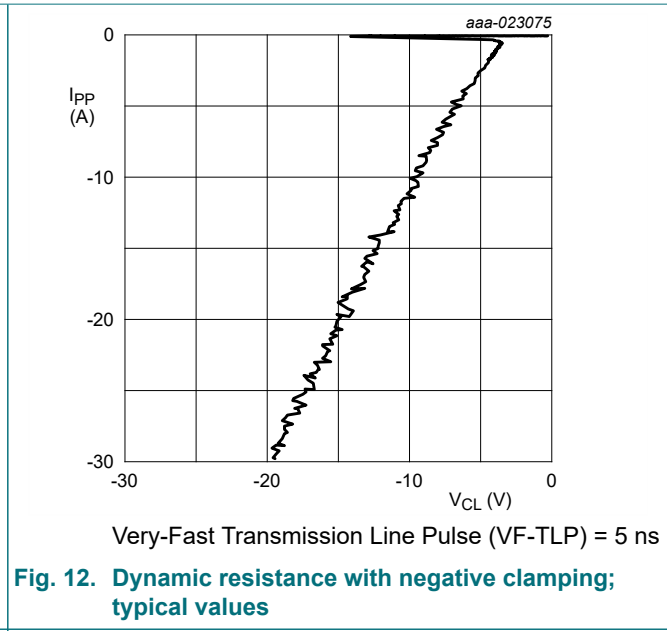
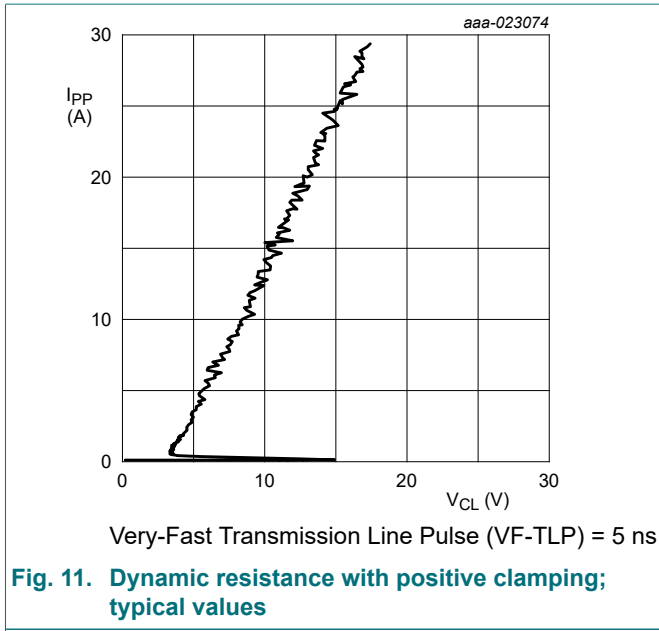
Fig. 9. Dynamic resistance with positive clamping; typical values



aaa-023073

$t_p = 100$ ns; Transmission Line Pulse (TLP)

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



9. Application information

The device is designed to provide high-level ESD protection for high-speed serial data buses such as HDMI, DisplayPort, 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).

10. Package outline

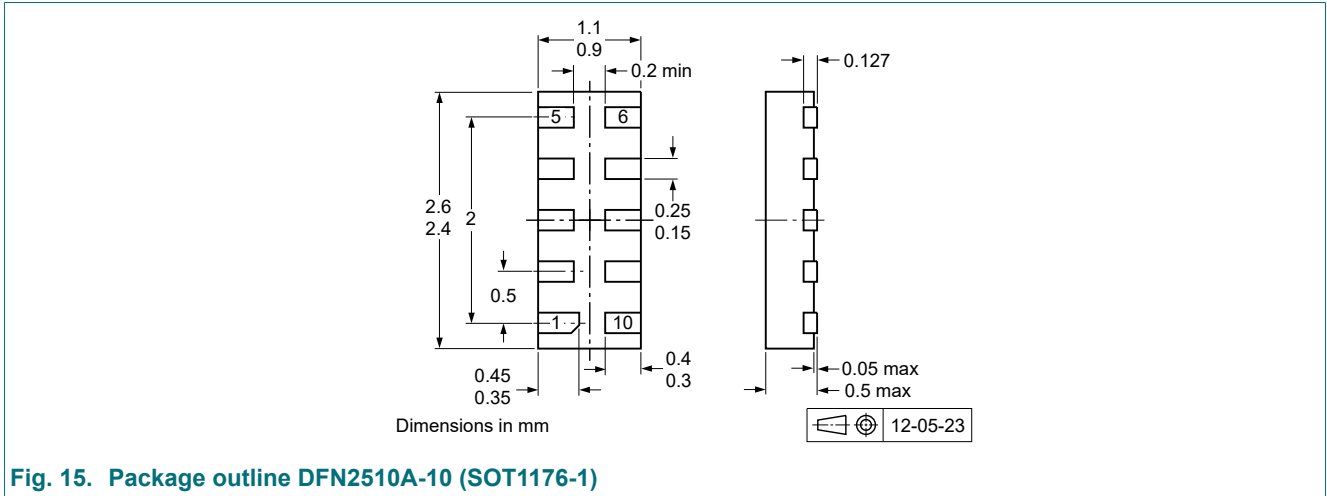


Fig. 15. Package outline DFN2510A-10 (SOT1176-1)

11. Soldering

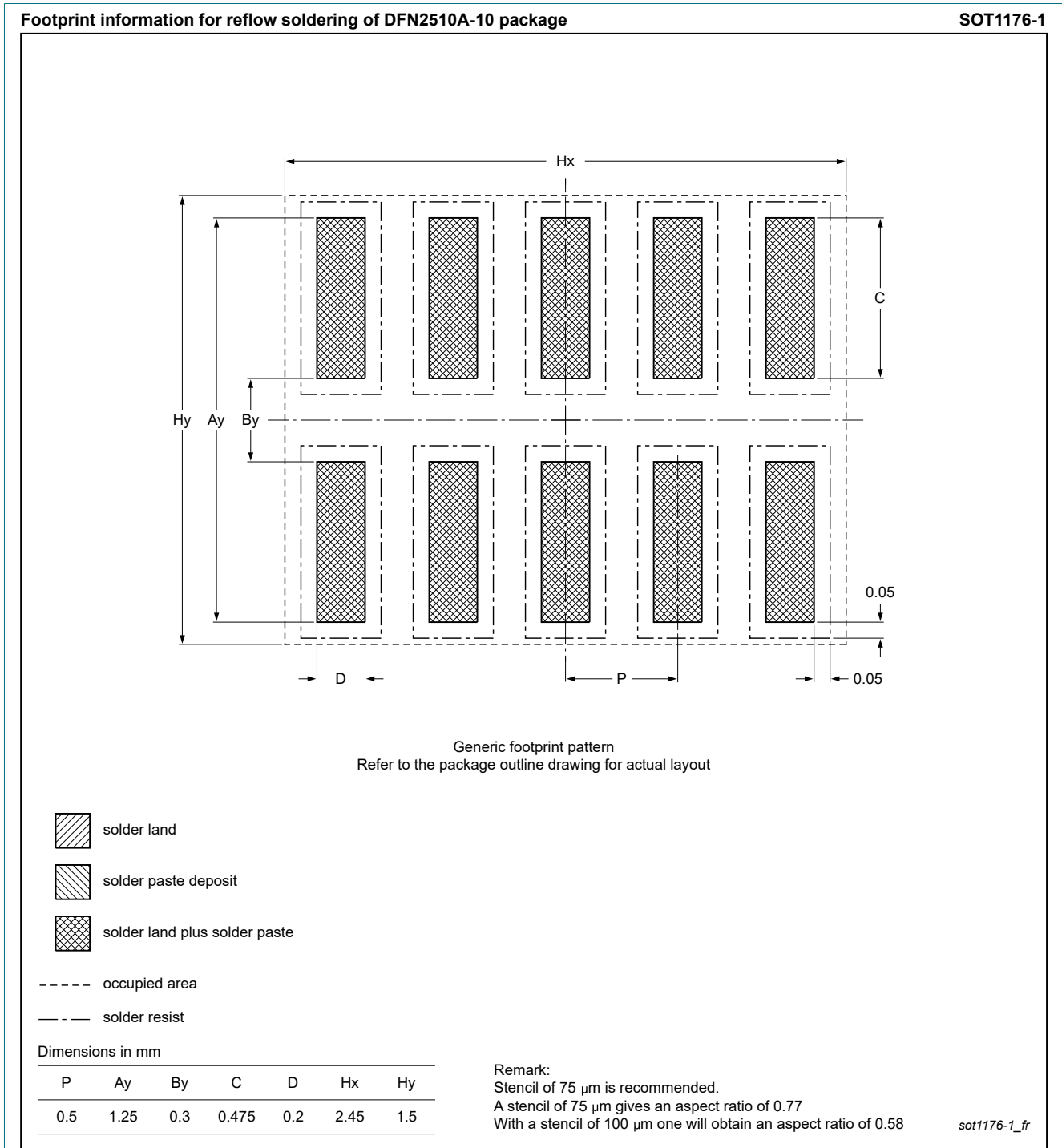


Fig. 16. Reflow soldering footprint for DFN2510A-10 (SOT1176-1)

12. Revision history

Table 6. Revision history

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|--|----------------------|---------------|--------------|
| PUSB3AB4 v.3 | 20191010 | Product data sheet | - | PUSB3AB4 v.2 |
| Modifications: | • Table "Limiting values": added breakdown voltage V_{BR} maximum value. | | | |
| PUSB3AB4 v.2 | 20160504 | Product data sheet | - | PUSB3AB4 v.1 |
| PUSB3AB4 v.1 | 20150825 | Objective data sheet | - | - |

13. 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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Contents

| | |
|---------------------------------|----|
| 1. General description..... | 1 |
| 2. Features and benefits..... | 1 |
| 3. Applications..... | 1 |
| 4. Pinning information..... | 2 |
| 5. Ordering information..... | 2 |
| 6. Marking..... | 2 |
| 7. Limiting values..... | 3 |
| 8. Characteristics..... | 3 |
| 9. Application information..... | 7 |
| 10. Package outline..... | 8 |
| 11. Soldering..... | 9 |
| 12. Revision history..... | 10 |
| 13. Legal information..... | 11 |

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Date of release: 10 October 2019
