



# PESD3V3Z1BSF

Extremely low capacitance bidirectional ESD protection diode

9 September 2019

Product data sheet

## 1. General description

Extremely low capacitance bidirectional ElectroStatic Discharge (ESD) protection diode, which is part of the TrEOS protection family. The device is housed in a DSN0603-2 (SOD962-2) leadless ultra small Surface-Mounted Device (SMD) package designed to protect one signal line from damage caused by ESD and other transients.

## 2. Features and benefits

- Bidirectional ESD protection of one line
- Extremely low diode capacitance  $C_d = 0.28$  pF
- Extremely low clamping voltage to protect sensitive I/Os
- Extremely low inductance protection path to ground
- ESD protection up to 20 kV according to IEC 61000-4-2
- Ultra small SMD package
- 9.5 A maximum 8/20  $\mu$ s peak pulse current

## 3. Applications

- Cellular handsets and accessories
- Portable electronics
- Communication systems
- Computers and peripherals

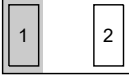
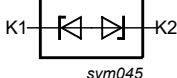
## 4. Quick reference data

Table 1. Quick reference data

| Symbol    | Parameter                | Conditions                                  | Min | Typ  | Max  | Unit |
|-----------|--------------------------|---|-----|------|------|------|
| $V_{RWM}$ | reverse standoff voltage | $T_{amb} = 25$ °C                           | -   | -    | 3.3  | V    |
| $C_d$     | diode capacitance        | $f = 1$ MHz; $V_R = 0$ V; $T_{amb} = 25$ °C | -   | 0.28 | 0.35 | pF   |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline   | Graphic symbol  |
|-----|--------|-------------|--|---|
| 1   | K1     | cathode     |  <p>Transparent<br/>top view</p> <p><b>DSN0603-2 (SOD962-2)</b></p> |  <p>sym045</p> |
| 2   | K2     | cathode     |  |   |

## 6. Ordering information

Table 3. Ordering information

| Type number  | Package   |  |          |
|--------------|-----------|--|----------|
|              | Name      | Description  | Version  |
| PESD3V3Z1BSF | DSN0603-2 | Leadless ultra small package; 2 terminals; body 0.6 x 0.3 x 0.3 mm | SOD962-2 |

## 7. Marking

Table 4. Marking codes

| Type number  | Marking code |
|--------------|--------------|
| PESD3V3Z1BSF | U            |

## 8. Limiting values

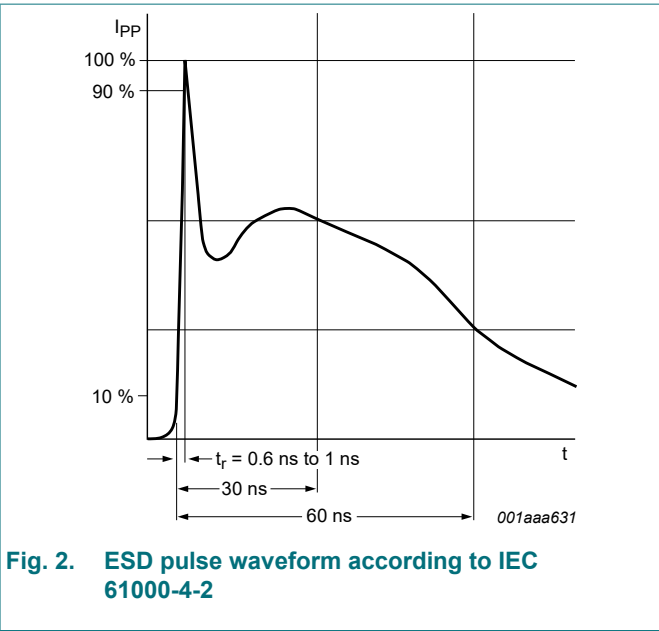
Table 5. Limiting values

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

| Symbol                     | Parameter                       | Conditions                       |     | Min | Max | Unit |
|----------------------------|---------------------------------|----------------------------------|-----|-----|-----|------|
| $I_{PPM}$                  | rated peak pulse current        | $t_p = 8/20 \mu s$               | [1] | -   | 9.5 | A    |
| $T_j$                      | junction temperature            |                                  |     | -   | 150 | °C   |
| $T_{amb}$                  | ambient temperature             |                                  |     | -40 | 125 | °C   |
| $T_{stg}$                  | storage temperature             |                                  |     | -65 | 150 | °C   |
| <b>ESD maximum ratings</b> |                                 |                                  |     |     |     |      |
| $V_{ESD}$                  | electrostatic discharge voltage | IEC 61000-4-2; contact discharge | [2] | -20 | 20  | kV   |
|                            |                                 | IEC 61000-4-2; air discharge     | [2] | -20 | 20  | kV   |

[1] Non-repetitive current pulse 8/20  $\mu s$  exponentially decaying waveform according to IEC61000-4-5.

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



## 9. Characteristics

Table 6. Characteristics

| Symbol            | Parameter                | Conditions   | Min | Typ  | Max  | Unit |
|-------------------|--------------------------|--|-----|------|------|------|
| V <sub>RWM</sub>  | reverse standoff voltage | T <sub>amb</sub> = 25 °C                                     | -   | -    | 3.3  | V    |
| V <sub>BR</sub>   | breakdown voltage        | I <sub>R</sub> = 1 mA; T <sub>amb</sub> = 25 °C              | -   | 6.9  | 8    | V    |
| I <sub>RM</sub>   | reverse leakage current  | V <sub>RWM</sub> = 3.3 V; T <sub>amb</sub> = 25 °C           | -   | 1    | 50   | nA   |
| C <sub>d</sub>    | diode capacitance        | f = 1 MHz; V <sub>R</sub> = 0 V; T <sub>amb</sub> = 25 °C    | -   | 0.28 | 0.35 | pF   |
|                   |                          | f = 1 MHz; V <sub>R</sub> = 1.5 V; T <sub>amb</sub> = 25 °C  | -   | 0.25 | -    | pF   |
| V <sub>CL</sub>   | clamping voltage         | I <sub>PP</sub> = 4 A; T <sub>amb</sub> = 25 °C              | [1] | 3.7  | -    | V    |
|                   |                          | I <sub>PPM</sub> = 9.5 A; T <sub>amb</sub> = 25 °C           | [1] | 5.3  | -    | V    |
| R <sub>dyn</sub>  | dynamic resistance       | 4 A ≤ I <sub>R</sub> ≤ 16 A; T <sub>amb</sub> = 25 °C        | [2] | 0.19 | -    | Ω    |
|                   |                          | -4 A ≤ I <sub>R</sub> ≤ -16 A; T <sub>amb</sub> = 25 °C      | [2] | 0.19 | -    | Ω    |
| f <sub>-3dB</sub> | -3 dB cut-off frequency  | T <sub>amb</sub> = 25 °C; Normalized to attenuation at 1 MHz | -   | 17   | -    | GHz  |

[1] Non-repetitive current pulse 8/20 μs exponential decay waveform according to IEC 61000-4-5.

[2] Non-repetitive current pulse, Transmission Line Pulse (TLP) tp = 100 ns; square pulse; pulser at 70 ns to 90 ns; ANSI / ESD STM5.5.1-2008.

Extremely low capacitance bidirectional ESD protection diode

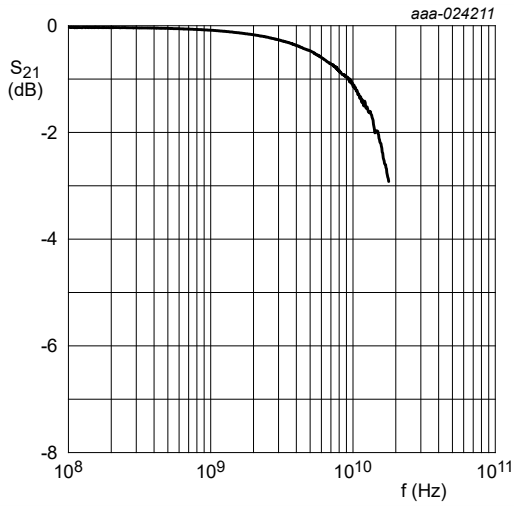
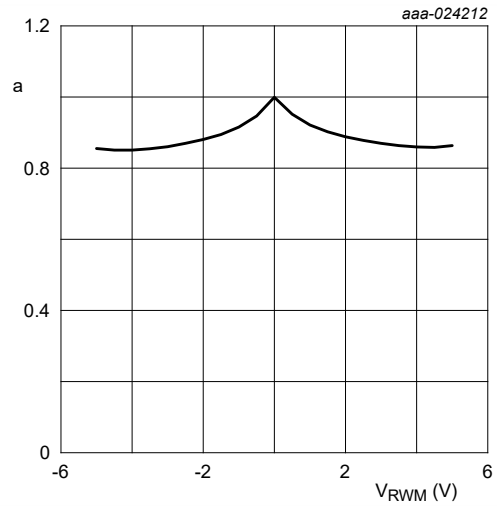
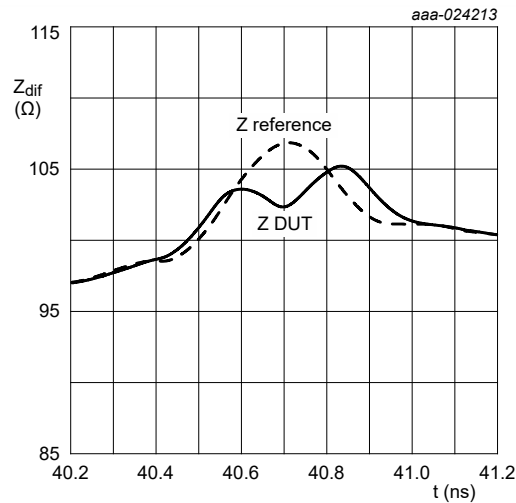


Fig. 3. Insertion loss; typical values



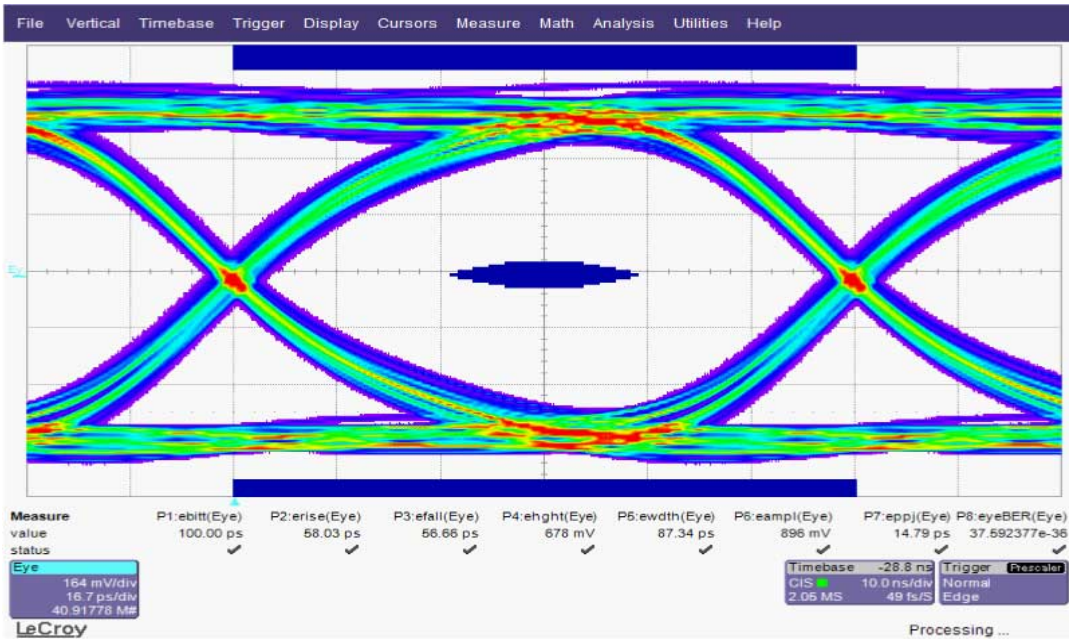
$$a = \frac{C_d}{C_d(V_{RWM} = 0 \text{ V})}$$

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



Rise time = 200 ps

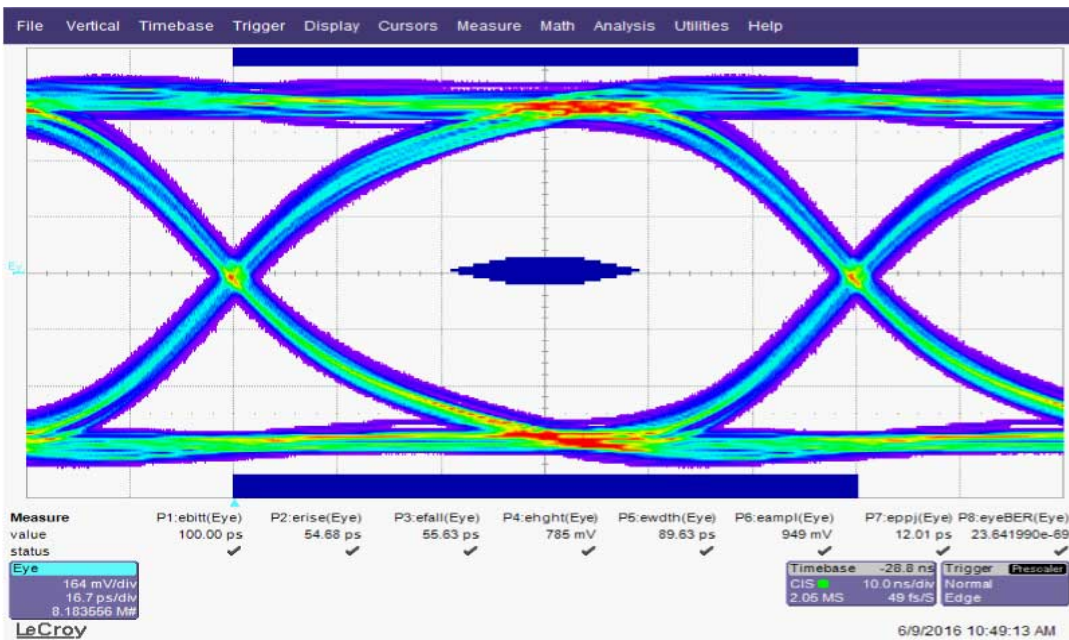
Fig. 5. Differential Time Domain Reflectometer (TDR) plot; typical values



aaa-024214

Data rate: 10 Gbit/s

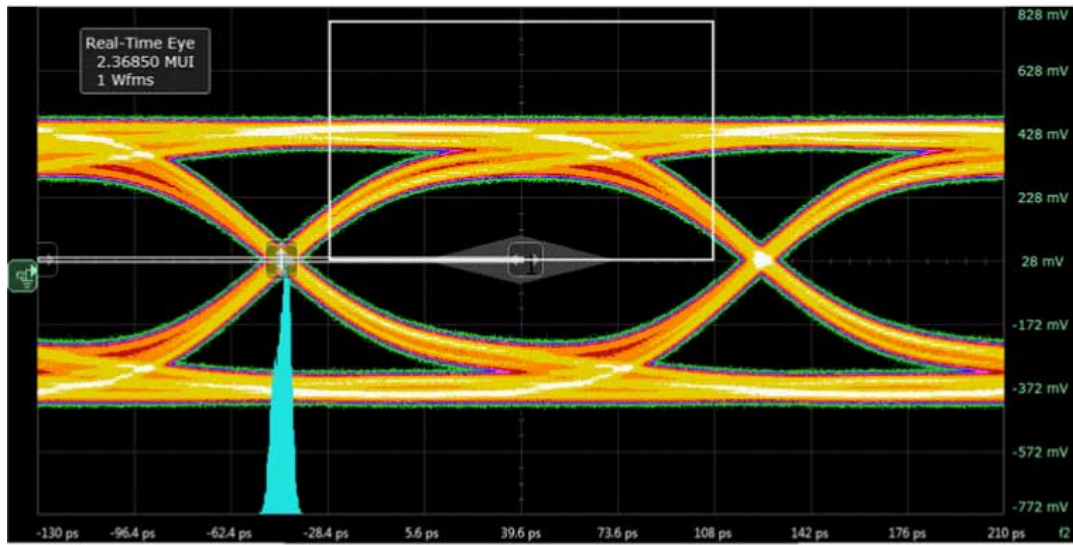
Fig. 6. USB 3.2 eye diagram, PCB with device; typical values



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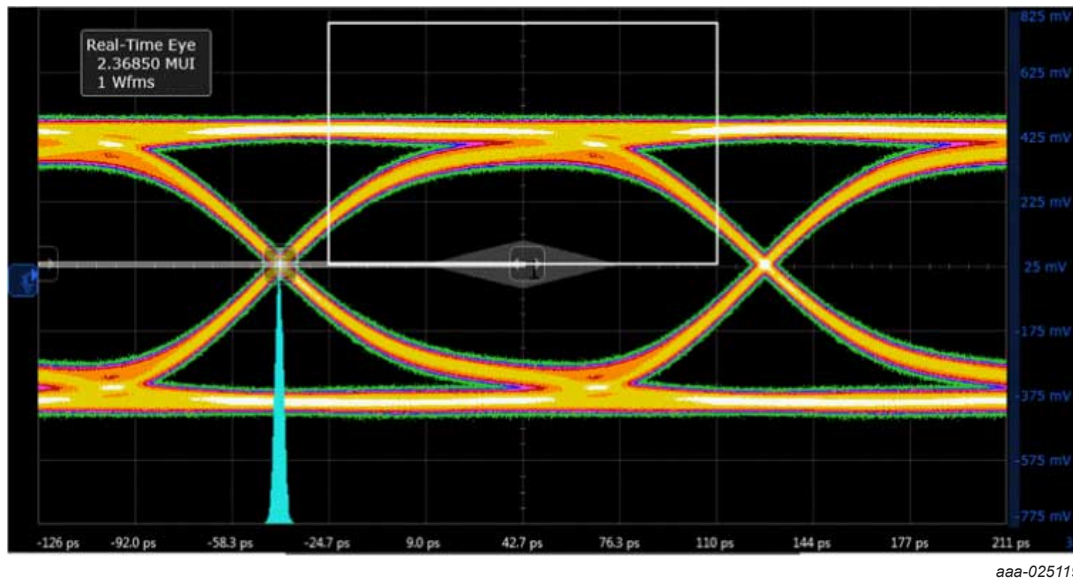
Data rate: 10 Gbit/s

Fig. 7. USB 3.2 eye diagram, PCB without device; typical values



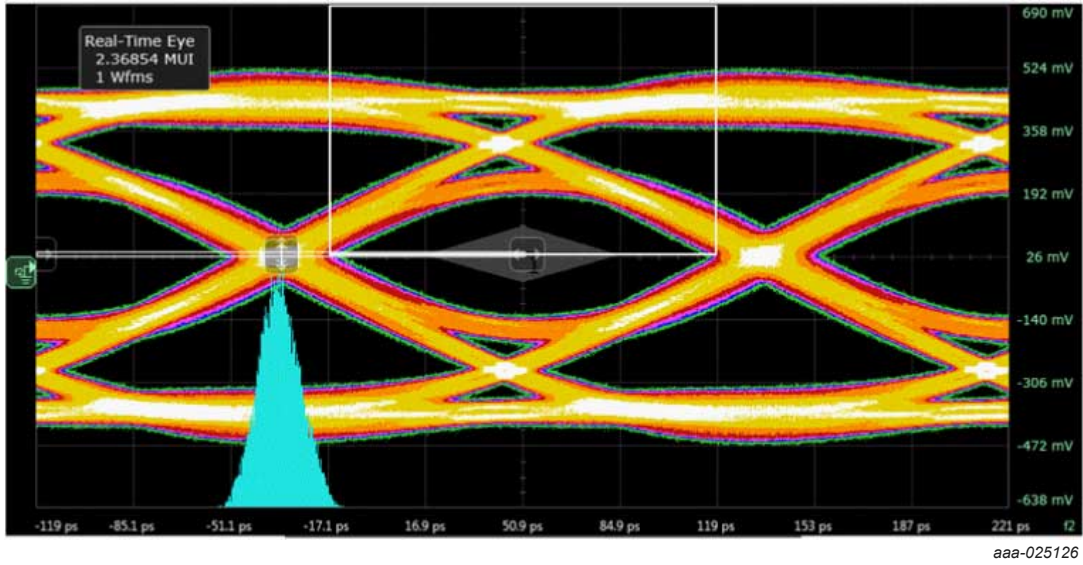
Test frequency: 148.5 MHz  
 Differential swing voltage: 845 mV  
 Horizontal scale: 34 ps/div  
 Vertical scale: 200 mV/div

**Fig. 8. HDMI 2.0 TP1 eye diagram, PCB with device; typical values**



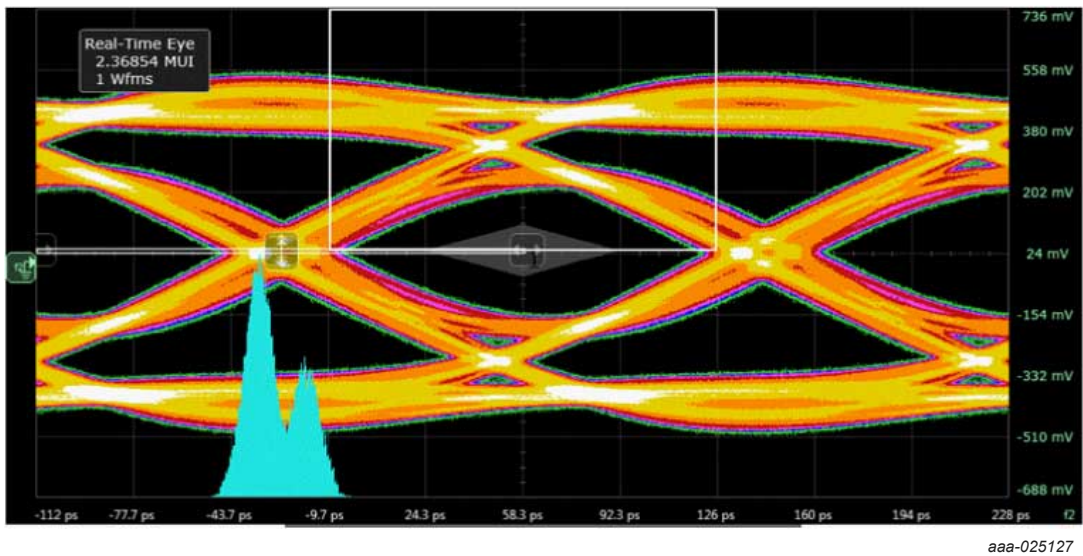
Test frequency: 148.5 MHz  
 Differential swing voltage: 844 mV  
 Horizontal scale: 34 ps/div  
 Vertical scale: 200 mV/div

**Fig. 9. HDMI 2.0 TP1 eye diagram, PCB without device; typical values**



Test frequency: 148.5 MHz  
 Differential swing voltage: 806 mV  
 Horizontal scale: 34 ps/div  
 Vertical scale: 266 mV/div  
 Remark: Measured at Test Point 2 (TP2) worst cable emulator, reference cable equalizer and worst case positive skew

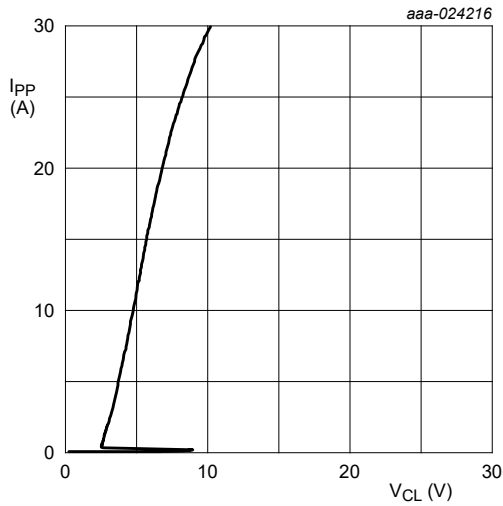
Fig. 10. HDMI 2.0 TP2 eye diagram, PCB with device; typical values



Test frequency: 148.5 MHz  
 Differential swing voltage: 823 mV  
 Horizontal scale: 34 ps/div  
 Vertical scale: 178 mV/div  
 Remark: Measured at Test Point 2 (TP2) worst cable emulator, reference cable equalizer and worst case positive skew

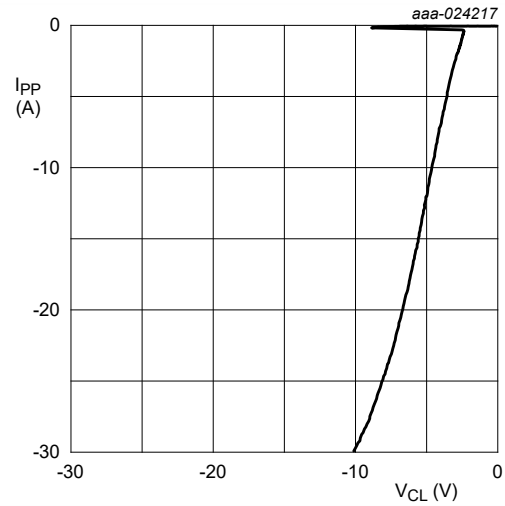
Fig. 11. HDMI 2.0 TP2 eye diagram, PCB without device; typical values

Extremely low capacitance bidirectional ESD protection diode



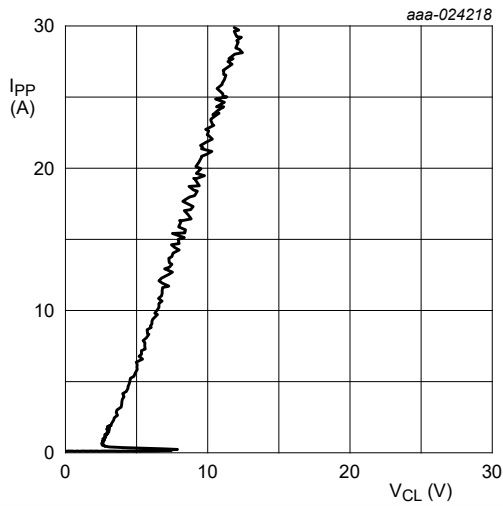
Transmission Line Pulse (TLP) = 100 ns;  
rise time = 1 ns

Fig. 12. Positive clamping voltage (TLP); typical values



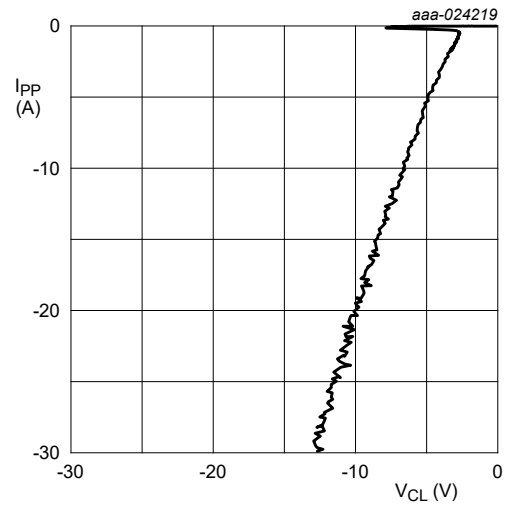
Transmission Line Pulse (TLP) = 100 ns;  
rise time = 1 ns

Fig. 13. Negative clamping voltage (TLP); typical values



Very Fast Transmission Line Pulse (VF-TLP) = 5 ns

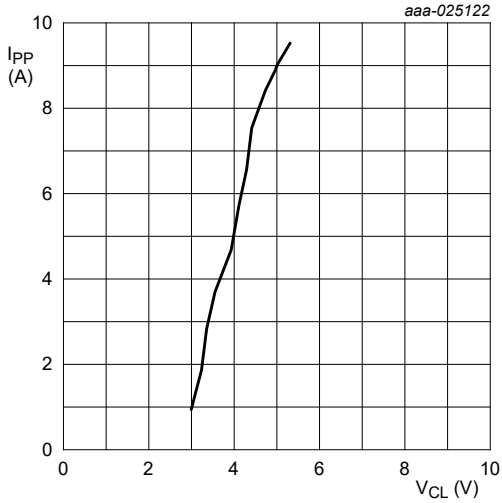
Fig. 14. Positive clamping voltage (VF-TLP); typical values



Very Fast Transmission Line Pulse (VF-TLP) = 5 ns

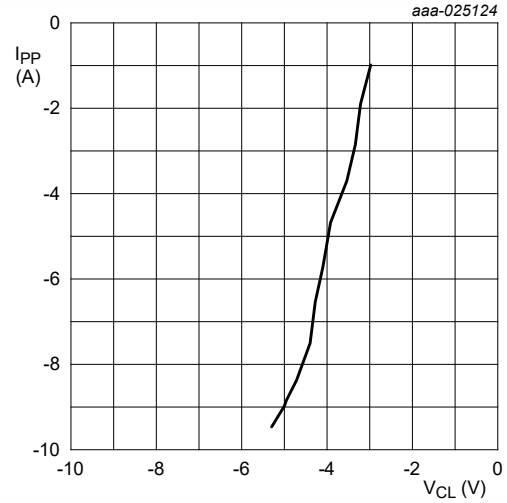
Fig. 15. Negative clamping voltage (VF-TLP); typical values





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

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



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

**Fig. 17. Dynamic resistance with negative clamping; typical values**

## 10. Application information

The device is designed for the protection of one bidirectional data line from surge pulses and ESD damage. The device is suitable on lines where the signal polarities are both positive and negative with respect to ground.

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).

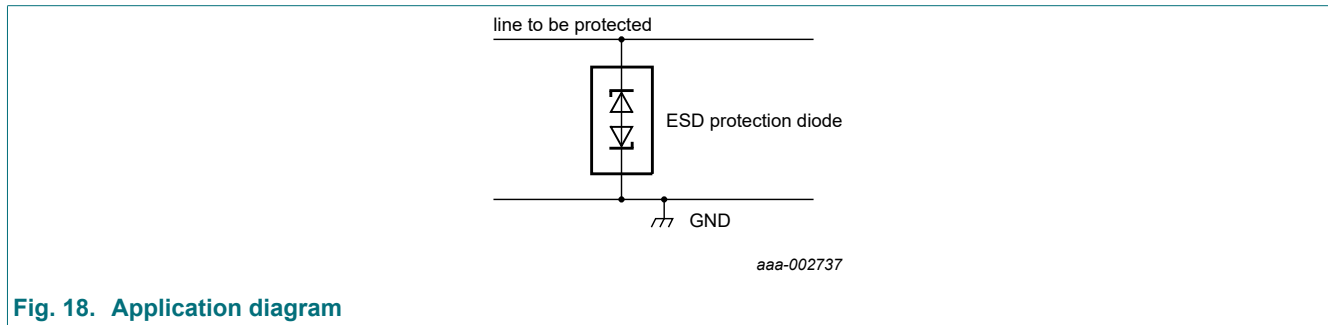


Fig. 18. Application diagram

### Circuit board layout and protection device placement

Circuit board layout is critical for the suppression of ESD, Electrical Fast Transient (EFT) and surge transients. The following guidelines are recommended:

1. Place the device as close to the input terminal or connector as possible.
2. Minimize the path length between the device and the protected line.
3. Keep parallel signal paths to a minimum.
4. Avoid running protected conductors in parallel with unprotected conductors.
5. Minimize all Printed-Circuit Board (PCB) conductive loops including power and ground loops.
6. Minimize the length of the transient return path to ground.
7. Avoid using shared transient return paths to a common ground point.
8. Use ground planes whenever possible. For multilayer PCBs, use ground vias.

### 11. Package outline

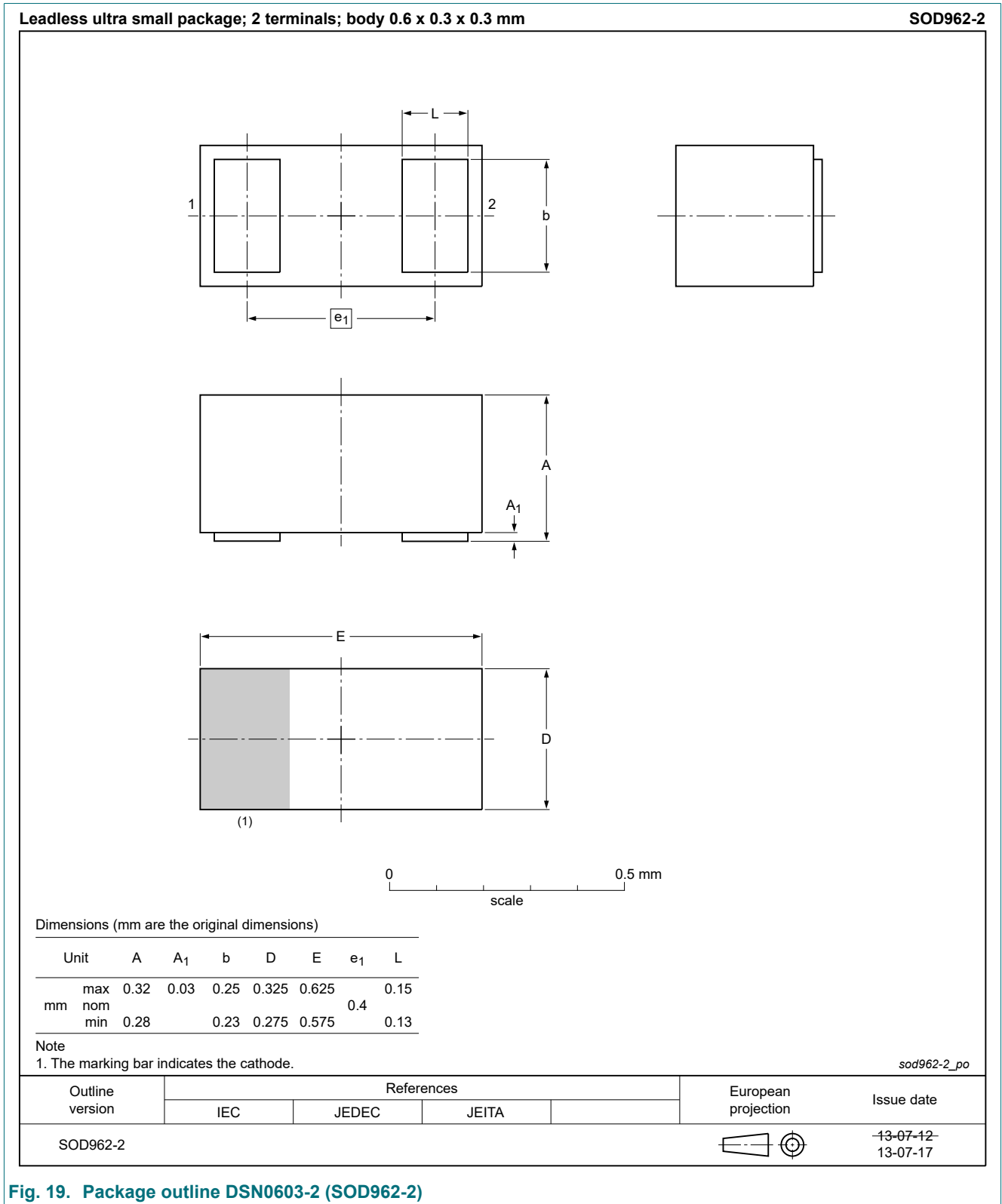
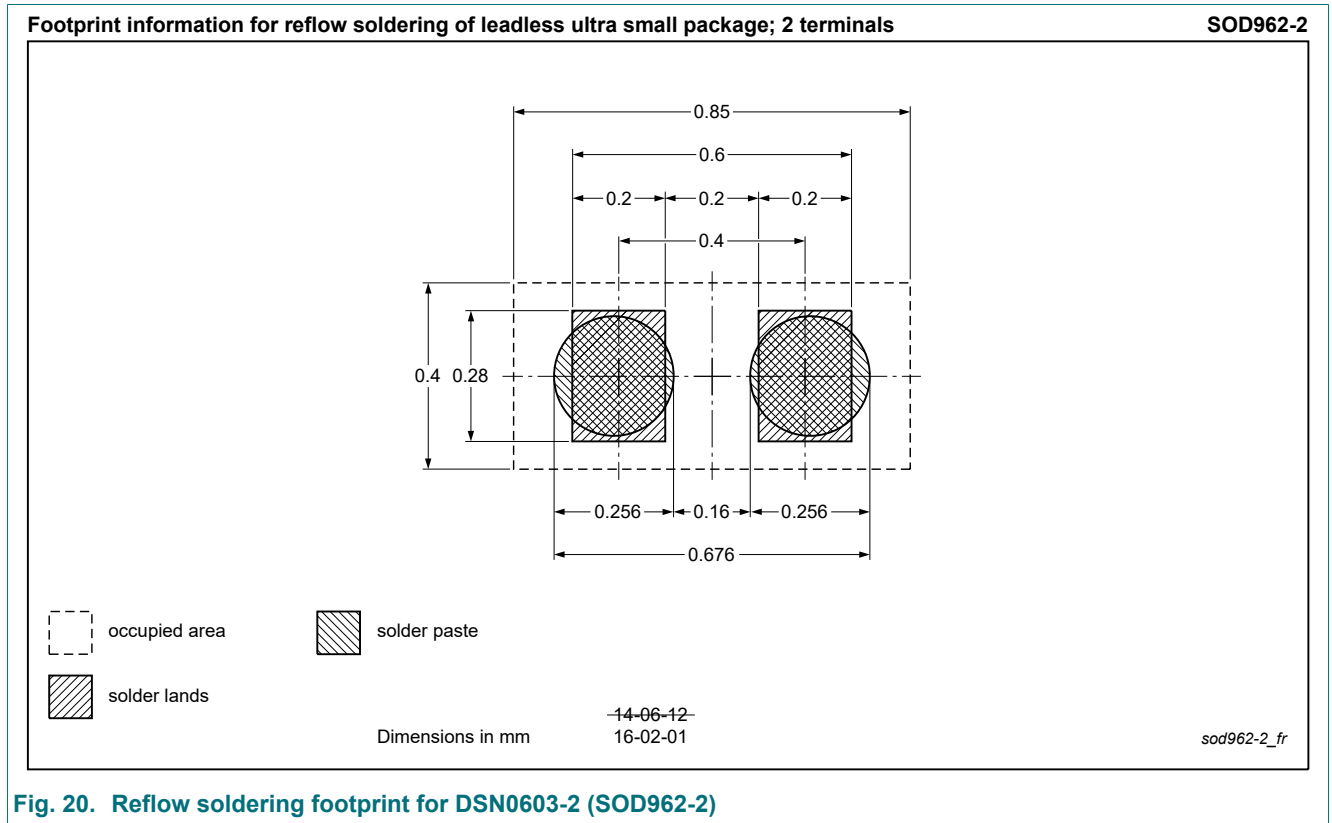


Fig. 19. Package outline DSN0603-2 (SOD962-2)

## 12. Soldering



## 13. Revision history

Table 7. Revision history

| Data sheet ID    | Release date  | Data sheet status      | Change notice | Supersedes       |
|------------------|---|------------------------|---------------|------------------|
| PESD3V3Z1BSF v.4 | 20190909  | Product data sheet     | -             | PESD3V3Z1BSF v.3 |
| Modifications:   | • Characteristics: Max value added at "breakdown voltage" |                        |               |                  |
| PESD3V3Z1BSF v.3 | 20180705  | Product data sheet     | -             | PESD3V3Z1BSF v.2 |
| PESD3V3Z1BSF v.2 | 20170116  | Product data sheet     | -             | PESD3V3Z1BSF v.1 |
| PESD3V3Z1BSF v.1 | 20161031  | Preliminary data sheet | -             | -                |

## 14. 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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