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 $C_d = 0.28 \text{ pF}$
- 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 μs peak pulse current

3. Applications

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

4. Quick reference data

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{RWM}$</td>
<td>reverse standoff voltage</td>
<td>$T_{amb} = 25 \degree C$</td>
<td>-</td>
<td>-</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>$C_d$</td>
<td>diode capacitance</td>
<td>$f = 1 \text{ MHz}; V_R = 0 \text{ V}; T_{amb} = 25 \degree C$</td>
<td>-</td>
<td>0.28</td>
<td>0.35</td>
<td>pF</td>
</tr>
</tbody>
</table>
5. Pinning information

Table 2. Pinning information

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Graphic symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>K1</td>
<td>cathode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>K2</td>
<td>cathode</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>PESD3V3Z1BSF</td>
<td>DSN0603-2</td>
<td>Leadless ultra small package; 2 terminals; body 0.6 x 0.3 x 0.3 mm</td>
<td>SOD962-2</td>
</tr>
</tbody>
</table>

7. Marking

Table 4. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code</th>
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</thead>
<tbody>
<tr>
<td>PESD3V3Z1BSF</td>
<td>U</td>
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</table>

8. Limiting values

Table 5. Limiting values

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{PPM}$</td>
<td>rated peak pulse current</td>
<td>$t_p = 8/20 \mu s$</td>
<td>0</td>
<td>9.5</td>
<td>A</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td></td>
<td></td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>ambient temperature</td>
<td></td>
<td>-40</td>
<td>125</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
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</table>

**ESD maximum ratings**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{ESD}$</td>
<td>electrostatic discharge voltage</td>
<td>IEC 61000-4-2; contact discharge</td>
<td>[2]</td>
<td>-20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 61000-4-2; air discharge</td>
<td>[2]</td>
<td>-20</td>
<td>20</td>
</tr>
</tbody>
</table>

[1] Non-repetitive current pulse 8/20 µs exponentially decaying waveform according to IEC61000-4-5.
Extremely low capacitance bidirectional ESD protection diode

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RWM}</td>
<td>reverse standoff</td>
<td>voltage</td>
<td>-</td>
<td>-</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>V_{BR}</td>
<td>breakdown voltage</td>
<td></td>
<td>-</td>
<td>6.9</td>
<td>8</td>
<td>V</td>
</tr>
<tr>
<td>I_{RM}</td>
<td>reverse leakage current</td>
<td></td>
<td>-</td>
<td>1</td>
<td>50</td>
<td>nA</td>
</tr>
<tr>
<td>C_{d}</td>
<td>diode capacitance</td>
<td></td>
<td>-</td>
<td>0.28</td>
<td>0.35</td>
<td>pF</td>
</tr>
<tr>
<td>V_{CL}</td>
<td>clamping voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>R_{dyn}</td>
<td>dynamic resistance</td>
<td></td>
<td>-</td>
<td>0.19</td>
<td>-</td>
<td>Ω</td>
</tr>
<tr>
<td>f_{3dB}</td>
<td>-3 dB cut-off frequency</td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>GHz</td>
</tr>
</tbody>
</table>

[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.
Fig. 3. Insertion loss; typical values

\[ a = \frac{C_d}{C_d(V_{RWM} = 0)} \]

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

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

Rise time = 200 ps
Extremely low capacitance bidirectional ESD protection diode

Data rate: 10 Gbit/s

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

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

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

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

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

**Fig. 15.** Negative clamping voltage (VF-TLP); typical values
**Extremely low capacitance bidirectional ESD protection diode**

<table>
<thead>
<tr>
<th>IEC 61000-4-5; ( t_p = 8/20 ) µs; positive pulse</th>
<th>IEC 61000-4-5; ( t_p = 8/20 ) µs; negative pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fig. 16. Dynamic resistance with positive clamping; typical values</strong></td>
<td><strong>Fig. 17. Dynamic resistance with negative clamping; typical values</strong></td>
</tr>
</tbody>
</table>
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).

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

Leadless ultra small package; 2 terminals; body 0.6 x 0.3 x 0.3 mm

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

Footprint information for reflow soldering of leadless ultra small package; 2 terminals

SOT962-2

Fig. 20. Reflow soldering footprint for DSN0603-2 (SOD962-2)
### 13. Revision history

Table 7. Revision history

<table>
<thead>
<tr>
<th>Data sheet ID</th>
<th>Release date</th>
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<th>Change notice</th>
<th>Supersedes</th>
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<td>PESD3V3Z1BSF v.4</td>
<td>20190909</td>
<td>Product data sheet</td>
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<td>PESD3V3Z1BSF v.3</td>
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<td>Modifications:</td>
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<td></td>
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<tr>
<td>-</td>
<td></td>
<td>Characteristics: Max value added at &quot;breakdown voltage&quot;</td>
<td></td>
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<td>PESD3V3Z1BSF v.3</td>
<td>20180705</td>
<td>Product data sheet</td>
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<td>PESD3V3Z1BSF v.1</td>
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<td>PESD3V3Z1BSF v.1</td>
<td>20161031</td>
<td>Preliminary data sheet</td>
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14. Legal information

Data sheet status

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<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
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<td>Objective [short] data sheet</td>
<td>Development</td>
<td>This document contains data from the respective specification for product development.</td>
</tr>
<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

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Date of release: 9 September 2019