1. General description

Extremely low capacitance bidirectional ElectroStatic Discharge (ESD) protection diode, 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 the damage caused by ESD and other transients.

2. Features and benefits

- Bidirectional ESD protection of one line
- Extremely low diode capacitance $C_d = 0.45$ pF
- Extremely low clamping to protect sensitive I/Os
- Extremely low-inductance protection path to ground
- ESD protection up to ± 30 kV according to IEC 61000-4-2
- Surge robustness $I_{PPM} = 15$ A according to IEC 61000-4-5
- Ultra small SMD package

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></td>
<td>-</td>
<td>-</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>$C_d$</td>
<td>diode capacitance</td>
<td>$f = 1$ MHz; $V_R = 0$ V</td>
<td>-</td>
<td>0.45</td>
<td>0.6</td>
<td>pF</td>
</tr>
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</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 (diode 1)</td>
<td><img src="image" alt="Simplified outline" /></td>
<td><img src="image" alt="Graphic symbol" /></td>
</tr>
<tr>
<td>2</td>
<td>K2</td>
<td>cathode (diode 2)</td>
<td></td>
<td></td>
</tr>
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</table>

6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package Name</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>PESD3V3Z1BCSF</td>
<td>DSN0603-2</td>
<td>silicon, leadless ultra small package; 2 terminals; 0.4 mm pitch; 0.6 mm x 0.3 mm x 0.3 mm body</td>
<td>SOD962-2</td>
</tr>
</tbody>
</table>

7. Marking

Table 4. Marking codes

<table>
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<th>Type number</th>
<th>Marking code</th>
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<tr>
<td>PESD3V3Z1BCSF</td>
<td>C4</td>
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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>$V_{RWM}$</td>
<td>reverse standoff voltage</td>
<td></td>
<td>-</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>$I_{PPM}$</td>
<td>rated peak pulse current $t_p = 8/20 \mu s$</td>
<td></td>
<td>[1]</td>
<td>15</td>
<td>A</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>
</tr>
</tbody>
</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>[3]</td>
<td>30</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 61000-4-2; air discharge</td>
<td>[3]</td>
<td>30</td>
<td>kV</td>
</tr>
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[1] Device stressed with 8/20 μs exponential decay waveform according to IEC 61000-4-5.
[2] In positive and negative direction.
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_{BR} )</td>
<td>breakdown voltage</td>
<td>( I_R = 1 \text{ mA} )</td>
<td>-</td>
<td>6.8</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( I_{RM} )</td>
<td>reverse leakage current</td>
<td>( V_{RWM} = 3.3 \text{ V} )</td>
<td>[1]</td>
<td>1</td>
<td>50</td>
<td>nA</td>
</tr>
<tr>
<td>( C_d )</td>
<td>diode capacitance</td>
<td>( f = 1 \text{ MHz}; \ V_R = 0 \text{ V} )</td>
<td>-</td>
<td>0.45</td>
<td>0.6</td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( f = 1 \text{ MHz}; \ V_R = 1.5 \text{ V} )</td>
<td>-</td>
<td>0.4</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>( V_{CL} )</td>
<td>clamping voltage</td>
<td>( I_{PPM} = 4 \text{ A} )</td>
<td>[2]</td>
<td>3.1</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_{PPM} = 15 \text{ A} )</td>
<td>[2]</td>
<td>4.8</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( R_{dyn} )</td>
<td>dynamic resistance</td>
<td>( I_R = 10 \text{ A} )</td>
<td>[3]</td>
<td>0.11</td>
<td>-</td>
<td>( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_R = -10 \text{ A} )</td>
<td>[3]</td>
<td>0.11</td>
<td>-</td>
<td>( \Omega )</td>
</tr>
<tr>
<td>( f_{-3dB} )</td>
<td>-3 dB cut-off frequency</td>
<td>normalized to attenuation at 1 MHz</td>
<td>-</td>
<td>14.3</td>
<td>-</td>
<td>GHz</td>
</tr>
</tbody>
</table>

[2] Device stressed with 8/20 \( \mu \text{s} \) exponential decay waveform according to IEC 61000-4-5.
Fig. 3. Insertion loss; typical values

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

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

rise time = 200 ps

Fig. 5. Differential Time Domain Reflectometer (TDR) plot; typical values
Fig. 6. USB 3.1 eye diagram, PCB with device; typical values

Fig. 7. USB 3.1 eye diagram, PCB without device; typical values
Data rate: 10 Gbit/s

**Fig. 8.** USB 3.1 eye diagram, PCB with device; typical values

Data rate: 10 Gbit/s

**Fig. 9.** USB 3.1 eye diagram, PCB without device; typical values
Fig. 10. HDMI2.0 TP1 eye diagram, PCB with device; typical values

Fig. 11. HDMI2.0 TP1 eye diagram, PCB without device; typical values
Fig. 12. HDMI2.0 TP2 eye diagram, PCB with device; typical values

Fig. 13. HDMI2.0 TP2 eye diagram, PCB without device; typical values
Extremely low capacitance bidirectional ESD protection diode

PESD3V3Z1BCSF

Fig. 14. Dynamic resistance with positive clamping; typical values

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

Fig. 15. Dynamic resistance with negative clamping; typical values

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

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

$t_r = 600 \text{ ps}$
$t_p = 5 \text{ ns}; \text{ Transmission Line Pulse (TLP)}$

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

$t_r = 600 \text{ ps}$
$t_p = 5 \text{ ns}; \text{ Transmission Line Pulse (TLP)}
Extremely low capacitance bidirectional ESD protection diode

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

**Fig. 18.** Dynamic resistance with positive clamping; typical values

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

**Fig. 19.** Dynamic resistance with negative clamping; typical values

\( t_r = 1 \text{ ns} \)
(1) TLP current
(2) TLP voltage

**Fig. 20.** TLP voltage and current over time, 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. 21. 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

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

Fig. 22. Package outline DSN0603-2 (SOD962-2)
12. Soldering

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

Dimensions in mm

Fig. 23. 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>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
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<tr>
<td>PESD3V3Z1BCSF v.3</td>
<td>20190329</td>
<td>Product data sheet</td>
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<td>PESD3V3Z1BCSF v.2</td>
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<td>Modifications:</td>
<td></td>
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<td>Updated package</td>
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<td>PESD3V3Z1BCSF v.2</td>
<td>20180712</td>
<td>Product data sheet</td>
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<td>PESD3V3Z1BCSF v.1</td>
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<td>PESD3V3Z1BCSF v.1</td>
<td>20180418</td>
<td>Objective data sheet</td>
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**Nexperia**

Extremely low capacitance bidirectional ESD protection diode

### 14. Legal information

#### Data sheet status

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<tbody>
<tr>
<td>Objective [short] data sheet</td>
<td>Development</td>
<td>This document contains data from the specific specification for product development.</td>
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<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>

[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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