ESD11N5.0ST5G

ESD Protection Diodes
Micro-Packaged Diodes for ESD Protection

The ESD11N is designed to protect voltage sensitive components that require ultra-low capacitance from ESD and transient voltage events. Excellent clamping capability, low capacitance, low leakage, and fast response time, make these parts ideal for ESD protection on designs where board space is at a premium. Because of its low capacitance, it is suited for use in high frequency designs such as USB 2.0 high speed and antenna line applications.

Specification Features
- Low Capacitance 0.6 pF
- Low Clamping Voltage
- Small Body Outline Dimensions: 0.60 mm x 0.30 mm
- Low Body Height: 0.3 mm
- Stand–off Voltage: 5.0 V
- Low Leakage
- Response Time is < 1 ns
- IEC61000–4–2 Level 4 ESD Protection
- These Devices are Pb–Free, Halogen Free/BFR Free and are RoHS Compliant

Mechanical Characteristics
MOUNTING POSITION: Any
QUALIFIED MAX REFLOW TEMPERATURE: 260°C
Device Meets MSL 1 Requirements

MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61000–4–2 (ESD) Contact Air</td>
<td>PD</td>
<td>±8.0</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±15</td>
<td></td>
</tr>
<tr>
<td>Total Power Dissipation on FR–5 Board (Note 1) @ TA = 25°C</td>
<td>PD</td>
<td>250</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>RthJA</td>
<td>400</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction and Storage Temperature Range</td>
<td>TJ, TSJG</td>
<td>–40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Lead Solder Temperature – Maximum (10 Second Duration)</td>
<td>TL</td>
<td>260</td>
<td>°C</td>
</tr>
</tbody>
</table>

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. FR–5 = 1.0 x 0.75 x 0.62 in.

See Application Note AND8308/D for further description of survivability specs.
**ELECTRICAL CHARACTERISTICS** (TA = 25°C unless otherwise noted)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPP</td>
<td>Maximum Reverse Peak Pulse Current</td>
</tr>
<tr>
<td>VC</td>
<td>Clamping Voltage @ IPP</td>
</tr>
<tr>
<td>VRWM</td>
<td>Working Peak Reverse Voltage</td>
</tr>
<tr>
<td>IR</td>
<td>Maximum Reverse Leakage Current @ VRWM</td>
</tr>
<tr>
<td>VBR</td>
<td>Breakdown Voltage @ IT</td>
</tr>
<tr>
<td>IT</td>
<td>Test Current</td>
</tr>
</tbody>
</table>

*See Application Note AND8308/D for detailed explanations of datasheet parameters.

**ELECTRICAL CHARACTERISTICS** (TA = 25°C unless otherwise noted)

<table>
<thead>
<tr>
<th>Device</th>
<th>Device Marking</th>
<th>VRWM (V)</th>
<th>IR (µA) @ VRWM</th>
<th>VBR (V) @ IT (Note 2)</th>
<th>IT</th>
<th>C (pF)</th>
<th>Vc (V) @ IPP = 1 A</th>
<th>Vc Per IEC61000–4–2 (Note 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD11N5.0ST5G</td>
<td>N5S0</td>
<td>5.0</td>
<td>1.0</td>
<td>5.8</td>
<td>1.0</td>
<td>0.6</td>
<td>0.9</td>
<td>12</td>
</tr>
</tbody>
</table>

2. VBR is measured with a pulse test current IT at an ambient temperature of 25°C.
3. Surge current waveforms per Figure 5.
4. For test procedure see Figures 3 and 4 and Application Note AND8307/D.

**Figure 1. ESD Clamping Voltage Screenshot**
Positive 8 kV Contact per IEC61000–4–2

**Figure 2. ESD Clamping Voltage Screenshot**
Negative 8 kV Contact per IEC61000–4–2
IEC 61000–4–2 Spec.

<table>
<thead>
<tr>
<th>Level</th>
<th>Test Voltage (kV)</th>
<th>First Peak Current (A)</th>
<th>Current at 30 ns (A)</th>
<th>Current at 60 ns (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>7.5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>15</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>22.5</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>30</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

Figure 3. IEC61000–4–2 Spec

Figure 4. Diagram of ESD Test Setup

The following is taken from Application Note AND8308/D – Interpretation of Datasheet Parameters for ESD Devices.

ESD Voltage Clamping

For sensitive circuit elements it is important to limit the voltage that an IC will be exposed to during an ESD event to as low a voltage as possible. The ESD clamping voltage is the voltage drop across the ESD protection diode during an ESD event per the IEC61000–4–2 waveform. Since the IEC61000–4–2 was written as a pass/fail spec for larger systems such as cell phones or laptop computers it is not clearly defined in the spec how to specify a clamping voltage at the device level. ON Semiconductor has developed a way to examine the entire voltage waveform across the ESD protection diode over the time domain of an ESD pulse in the form of an oscilloscope screenshot, which can be found on the datasheets for all ESD protection diodes. For more information on how ON Semiconductor creates these screenshots and how to interpret them please refer to AND8307/D.

Figure 5. 8 x 20 μs Pulse Waveform

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The following is taken from Application Note AND8398/D – Board Level Application Note for 0201 DSN2 Package.

**Printed Circuit Board Solder Pad Design**

Based on results of board mount testing, ON Semiconductor’s recommended mounting pads and solder mask opening are shown in Figure 6. Maximum acceptable PCB mounting pads and solder mask opening are shown in Figure 7.

![Figure 6. Recommended Mounting Pattern](image)

![Figure 7. Maximum Recommended Mounting](image)

**Solder Mask**

Two types of PCB solder mask openings commonly used for surface mount leadless style packages are:

1. Non Solder Masked Defined (NSMD)
2. Solder Masked Defined (SMD)

The solder mask is pulled away from the solderable metallization for NSMD pads, while the solder mask overlaps the edge of the metallization for SMD pads as shown in Figure 8. For SMD pads, the solder mask restricts the flow of solder paste on the top of the metallization and prevents the solder from flowing down the side of the metal pad. This is different from the NSMD configuration where the solder flows both across the top and down the sides of the PCB metallization.

![Figure 8. Comparison of NSMD vs. SMD Pads](image)

**PCB Solderable Metallization**

There are currently three common solderable coatings which are used for PCB surface mount devices- OSP, ENiAu, and HASL.

The first coating consists of an Organic Solderability Protectant (OSP) applied over the bare copper features. OSP coating assists in reducing oxidation in order to preserve the copper metallization for soldering. It allows for multiple passes through reflow ovens without degradation of solderability. The OSP coating is dissolved by the flux when solder paste is applied to the metal features. Coating thickness recommended by OSP manufacturers is between 0.25 and 0.35 microns.

The second coating is plated electroless nickel/immersion gold over the copper pad. The thickness of the electroless nickel layer is determined by the allowable internal material stresses and the temperature excursions the board will be subjected to throughout its lifetime. Even though the gold metallization is typically a self-limiting process, the thickness should be at least 0.05 μm thick, but not consist of more than 5% of the overall solder volume. Excessive gold in the solder joint can create gold embrittlement. This may affect the reliability of the joint.

The third is a tin-lead coating, commonly called Hot Air Solder Level (HASL). This type of PCB pad finish is not recommended for this type packages. The major issue is the inability to consistently control the amount of solder coating applied to each pad. This results in dome-shaped pads of various heights. As the industry moves to finer and finer pitch, solder bridging between mounting pads becomes a common problem when using this coating.

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It is imperative that the coating is conformal, uniform, and free of impurities to insure a consistent mounting process. Due to the package’s extremely small size, we only recommend the use of the electroless nickel/immersion gold metallization over the copper pads.

**PCB Circuit Trace Width**

The width of the PCB circuit trace plays an important role in the reduction of component tilting when the solder is reflowed. A solderable circuit trace allows the solder to wick or run down the trace, reducing the overall thickness of the solder on the PCB and under the component. Due to the small nature of the solder pad and component, the solder on the PCB will tend to form a bump causing the component to slide down the side of that solder bump resulting in a tilted component on the PCB. Allowing the solder to wick or run down the PCB circuit trace, will reduce the solder thickness and in turn prevent the solder from forming a ball on the PCB pad. This was observed during ON Semiconductor board mounting evaluations. The best results to prevent tilting used a PCB circuit trace equal to the width of the mounting pad. The length of the solder wicking or run out is controlled by the solder mask opening.

**Solder Type**

Solder pastes such as Cookson Electronics’ WS3060 with a Type 4 or smaller sphere size are recommended. WS3060 has a water-soluble flux for cleaning. Cookson Electronics’ PNC0106A can be used if a no-clean flux is preferred.

**Solder Stencil Screening**

Stencil screening of the solder paste onto the PCB is commonly used in the industry. The recommended stencil thickness for this part is 0.1 mm (0.004 in). The sidewalls of the stencil openings should be tapered approximately five degrees along with an electro-polish finish to aid in the release of the paste when the stencil is removed from the PCB. See Figure 9 for the recommended stencil opening size and pitch shown on the recommended PCB mounting pads and solder mask opening from Figure 6.

A second stencil option is shown in Figure 10. This option increases the amount of solder paste applied to the PCB through the stencil. This second option increases the stencil opening size and pitch. The PCB mounting pads and solder mask opening on the board do not change from the recommendations in Figure 6.

**Figure 10. Maximum Stencil Pattern**

Note: If the maximum stencil opening option from Figure 10 is used, tilt may occur on some of the packages. This was evident in the board mounting study we conducted. The stencil with the largest openings may improve solder release from the stencil along with slightly increasing the package shear strength.

**Package Placement**

Due to the small package size and because the pads are on the underside of the package, an automated pick and place procedure with magnification is recommended. A dual image optical system where the underside of the package can be aligned to the PCB should be used. Pick and place equipment with a standard tolerance of +/- 0.05 mm (0.002 in) or better is recommended. The package self aligns during the reflow process due to the surface tension of the solder.
NOTES:
2. CONTROLLING DIMENSION: MILLIMETERS.

<table>
<thead>
<tr>
<th>MILLIMETERS</th>
<th>DIM</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.24</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>0.00</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>0.20</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>0.30</td>
<td>BSC</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>0.40</td>
<td>BSC</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>0.10</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

GENERAL MARKING DIAGRAM1:
- PIN 1
  - XXXX = Specific Device Code
  - YYYY = Year Code

GENERAL MARKING DIAGRAM2:
- PIN 1
  - X = Specific Device Code
  - M = Date Code

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, “G”, may or not be present. Some products may not follow the Generic Marking.

CATHODE BAND MONTH CODING
- XXXX = Specific Device Code
- YYYY = Year Code
- (EXAMPLE) INDICATES AUG 2009

MOUNTING FOOTPRINT:
- DIMENSIONS: MILLIMETERS
  - 0.28
  - 0.75
  - 0.30

See Application Note AND8398/D for more mounting details

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.