

# ESD Protection Diode

## Ultra-Low Capacitance

## Micro-Packaged Diodes for ESD Protection

### ESD7410

The ESD7410 is designed to protect voltage sensitive components that require ultra-low capacitance from ESD and transient voltage events. It has industry leading capacitance linearity over voltage making it ideal for RF applications. This capacitance linearity combined with the extremely small package and low insertion loss makes this part well suited for use in antenna line applications for wireless handsets and terminals.

#### Features

- Ultra-Low Capacitance: < 1.0 pF Max
  - Industry Leading Capacitance Linearity Over Voltage
- Insertion Loss: 0.1 dB at 1 GHz; 0.3 dB at 3 GHz
- Low Leakage: < 1  $\mu$ A
- IEC61000-4-2 (ESD): Level 4  $\pm$ 30 kV Contact
- ISO 10605 (ESD) 330 pF/2 k $\Omega$   $\pm$ 30 kV Contact
- SZESD7410MXWT5G – Wettable Flank Package for optimal Automated Optical Inspection (AOI)
- SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### Typical Applications

- RF Signal ESD Protection
- Active Antenna ESD Protection
- Near Field Communications

#### MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

| Rating                                                                                              | Symbol                             | Value          | Unit       |
|-----------------------------------------------------------------------------------------------------|------------------------------------|----------------|------------|
| Total Power Dissipation (Note 2) @ T <sub>A</sub> = 25°C<br>Thermal Resistance, Junction-to-Ambient | P <sub>D</sub><br>R <sub>θJA</sub> | 300<br>400     | mW<br>°C/W |
| Peak Power Dissipation<br>8/20 Double Exponential Waveform                                          | P <sub>PK</sub>                    | 136            | W          |
| Junction and Storage Temperature Range                                                              | T <sub>J</sub> , T <sub>stg</sub>  | -55 to<br>+150 | °C         |
| Lead Solder Temperature – Maximum<br>(10 Second Duration)                                           | T <sub>L</sub>                     | 260            | °C         |
| Maximum Peak Pulse Current 8/20                                                                     | I <sub>PP</sub>                    | 6.4            | A          |
| IEC 61000-4-2 Contact (Note 1)                                                                      | ESD                                | $\pm$ 30       | kV         |
| IEC 61000-4-2 Air                                                                                   |                                    | $\pm$ 30       | kV         |
| ISO 10605 Contact (330 pF / 330 $\Omega$ )                                                          |                                    | $\pm$ 30       | kV         |
| ISO 10605 Contact (330 pF / 2 k $\Omega$ )                                                          |                                    | $\pm$ 30       | kV         |
| ISO 10605 Contact (150 pF / 2 k $\Omega$ )                                                          |                                    | $\pm$ 30       | kV         |
| Human Body Model (HBM)                                                                              |                                    | $\pm$ 8        | kV         |

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.

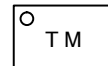
- Non-repetitive current pulse at T<sub>A</sub> = 25°C, per IEC61000-4-2 waveform.
- Mounted with recommended minimum pad size, DC board FR-4



#### MARKING DIAGRAM



X2DFN2  
CASE 714AB



T = Specific Device Code  
M = Date Code



X2DFNW2  
CASE 711BG



D = Specific Device Code  
M = Date Code

#### ORDERING INFORMATION

| Device          | Package           | Shipping <sup>†</sup> |
|-----------------|-------------------|-----------------------|
| ESD7410N2T5G    | X2DFN2 (Pb-Free)  | 8000 / Tape & Reel    |
| SZESD7410N2T5G  | X2DFN2 (Pb-Free)  | 8000 / Tape & Reel    |
| ESD7410MXWT5G   | X2DFNW2 (Pb-Free) | 8000 / Tape & Reel    |
| SZESD7410MXWT5G | X2DFNW2 (Pb-Free) | 8000 / Tape & Reel    |

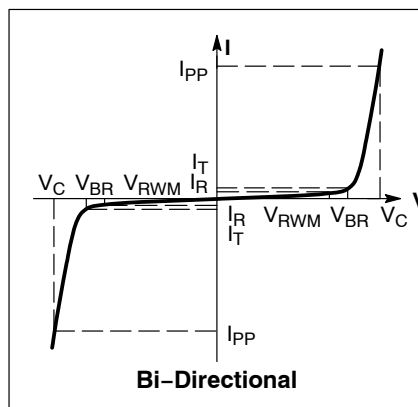
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# ELECTRICAL CHARACTERISTICS

(T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol           | Parameter                                          |
|------------------|----------------------------------------------------|
| I <sub>PP</sub>  | Maximum Reverse Peak Pulse Current                 |
| V <sub>C</sub>   | Clamping Voltage @ I <sub>PP</sub>                 |
| V <sub>RWM</sub> | Working Peak Reverse Voltage                       |
| I <sub>R</sub>   | Maximum Reverse Leakage Current @ V <sub>RWM</sub> |
| V <sub>BR</sub>  | Breakdown Voltage @ I <sub>T</sub>                 |
| I <sub>T</sub>   | Test Current                                       |

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



# ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol           | Parameter                      | Condition                                                                                            | Min                 | Typ                    | Max        | Unit |
|------------------|--------------------------------|------------------------------------------------------------------------------------------------------|---------------------|------------------------|------------|------|
| V <sub>RWM</sub> | Reverse Working Voltage        |                                                                                                      |                     |                        | 9.5        | V    |
| V <sub>BR</sub>  | Breakdown Voltage              | I <sub>T</sub> = 1 mA (Note 3)                                                                       | 10                  |                        |            | V    |
| I <sub>R</sub>   | Reverse Leakage Current        | V <sub>RWM</sub> = 9.5 V                                                                             |                     |                        | 1.0        | μA   |
| V <sub>C</sub>   | Clamping Voltage               | IEC 61000-4-2, ±8 kV Contact                                                                         | See Figures 7 and 8 |                        |            | V    |
| V <sub>C</sub>   | Clamping Voltage, TLP (Note 4) | I <sub>PP</sub> = 8 A<br>I <sub>PP</sub> = 16 A<br>I <sub>PP</sub> = -8 A<br>I <sub>PP</sub> = -16 A |                     | 18<br>20<br>-18<br>-20 |            | V    |
| I <sub>PP</sub>  | Reverse Peak Pulse Current     | IEC 61000-4-2 (8/20 μs)                                                                              | 5.0                 |                        |            | A    |
| V <sub>C</sub>   | Clamping Voltage (8/20 μs)     | I <sub>PP</sub> = 5.0 A                                                                              |                     | 18.4                   | 19.4       | V    |
| R <sub>DYN</sub> | Dynamic Resistance             | TLP Pulse                                                                                            |                     | 1.0                    |            | Ω    |
| C <sub>J</sub>   | Junction Capacitance           | V <sub>R</sub> = 0 V, f = 1 MHz<br>V <sub>R</sub> = 0 V, f = 1 GHz                                   |                     | 0.40<br>0.35           | 1.0<br>0.7 | pF   |
|                  | Insertion Loss                 | f = 1 GHz<br>f = 3 GHz                                                                               |                     | 0.1<br>0.3             |            | dB   |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Breakdown voltage is tested from pin 1 to 2 and pin 2 to 1.

4. ANSI/ESD STM5.5.1 – Electrostatic Discharge Sensitivity Testing using Transmission Line Pulse (TLP) Model.

TLP conditions: Z<sub>0</sub> = 50 Ω, t<sub>p</sub> = 100 ns, t<sub>r</sub> = 4 ns, averaging window; t<sub>1</sub> = 30 ns to t<sub>2</sub> = 60 ns.

TYPICAL CHARACTERISTICS

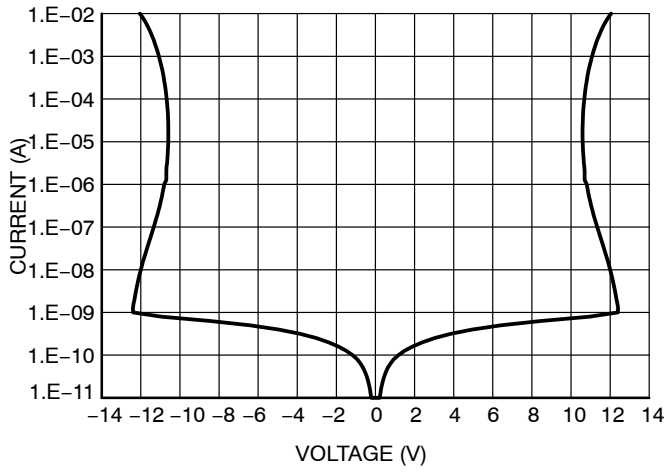


Figure 1. Typical IV Characteristics

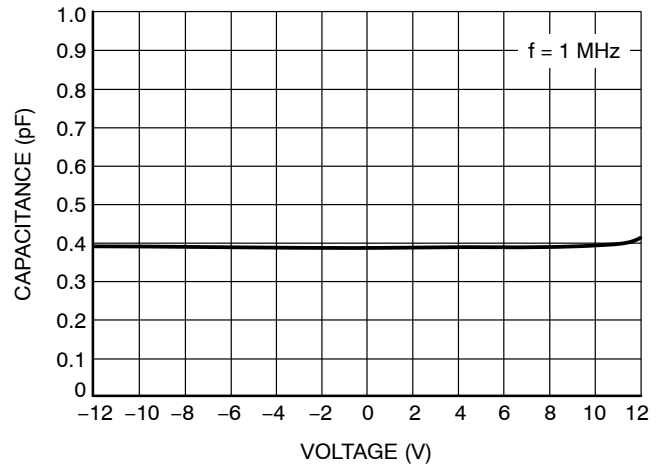


Figure 2. Typical CV Characteristics

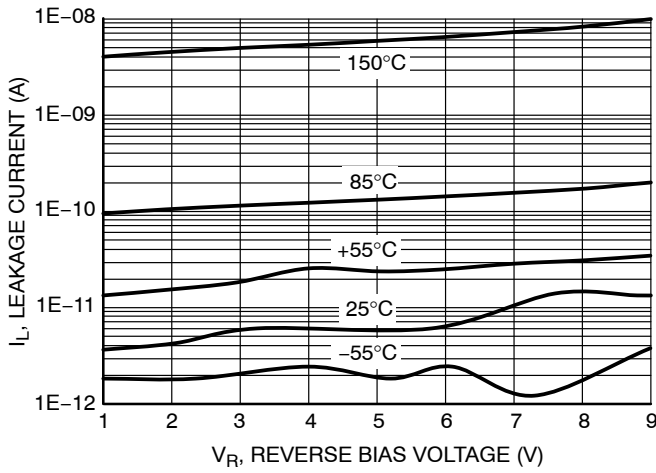


Figure 3.  $I_R$  vs. Temperature Characteristics

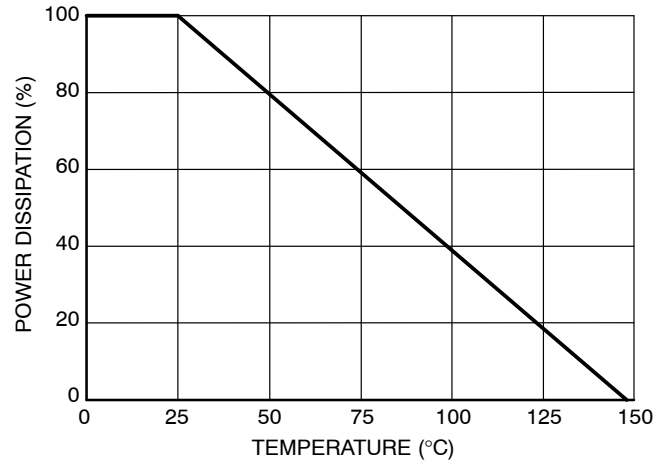


Figure 4. Steady State Power Derating

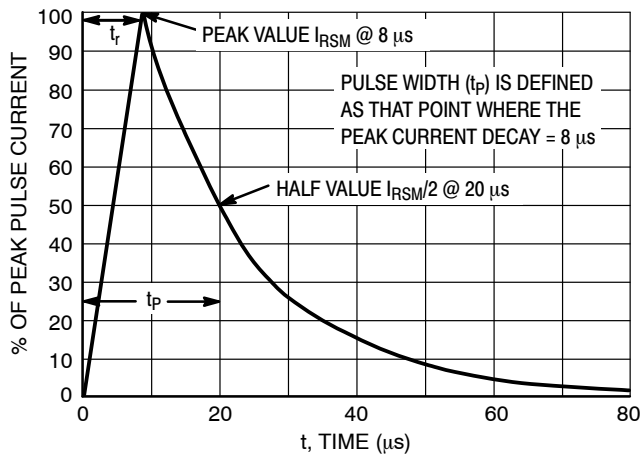


Figure 5. 8 X 20  $\mu$ s Pulse Waveform

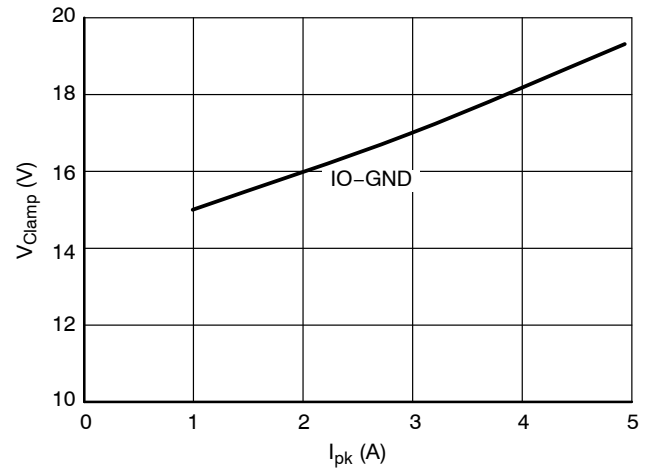
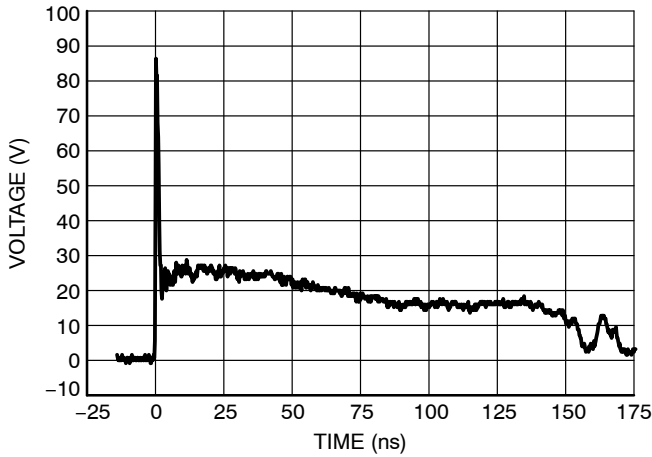
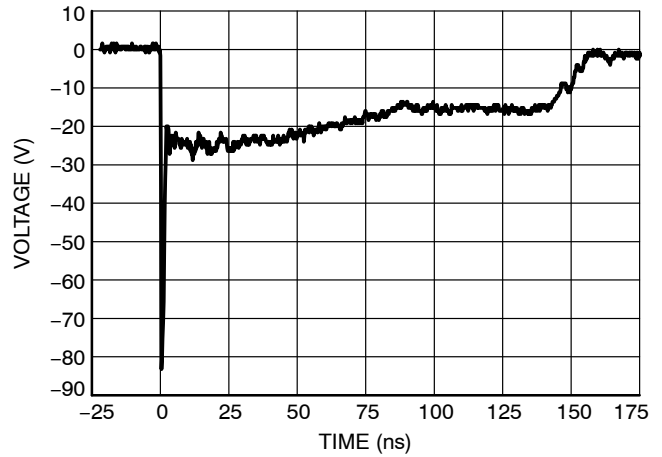


Figure 6. Clamping Voltage vs. Peak Pulse Current (8/20  $\mu$ s)

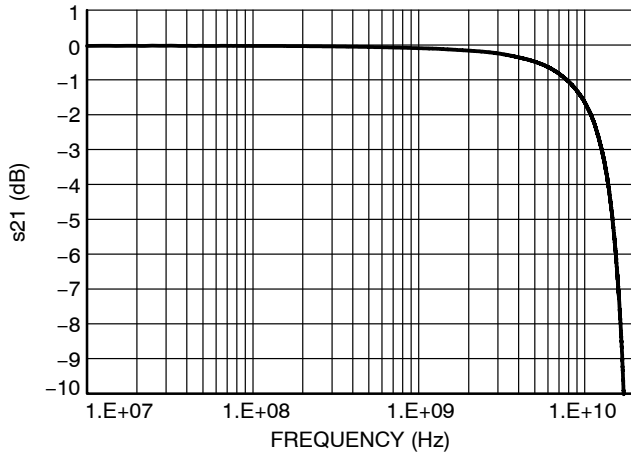
## TYPICAL CHARACTERISTICS



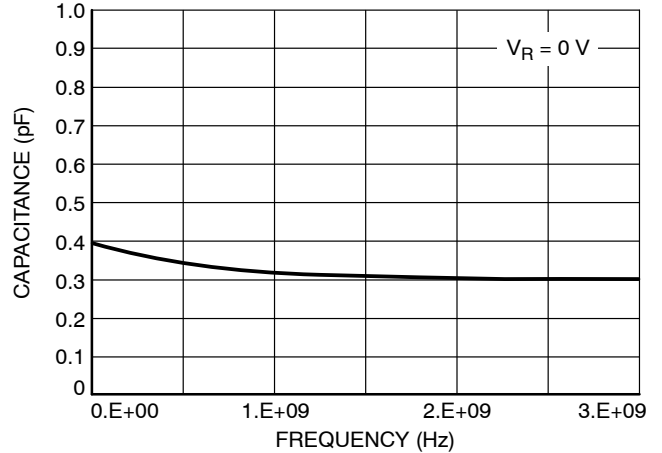
**Figure 7. Typical IEC61000-4-2 +8 kV Contact ESD Clamping Voltage**



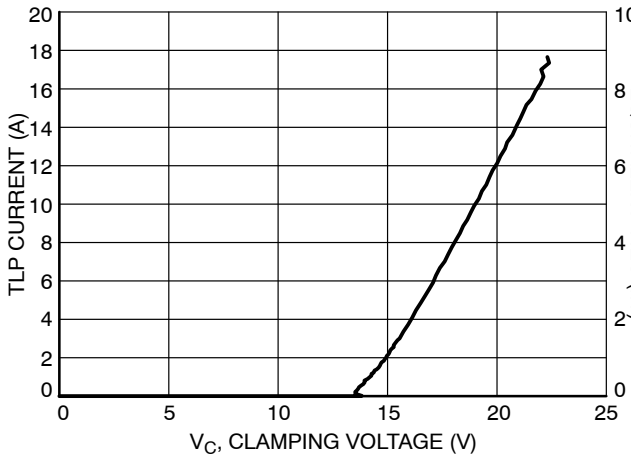
**Figure 8. Typical IEC61000-4-2 -8 kV Contact ESD Clamping Voltage**



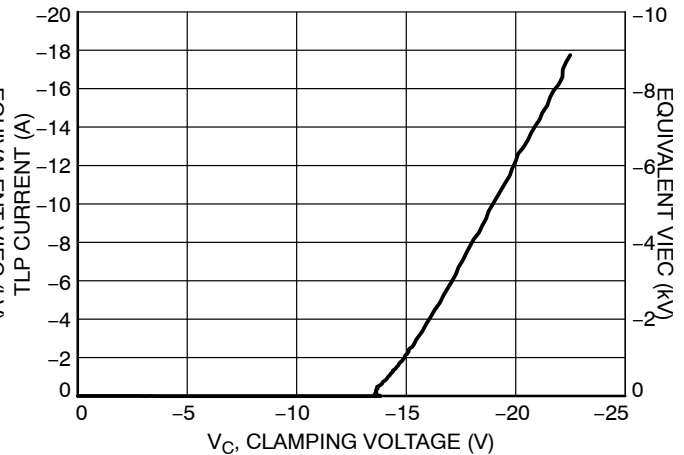
**Figure 9. Typical Insertion Loss ESD7410N2T5G**



**Figure 10. Typical Capacitance over Frequency ESD7410N2T5G**



**Figure 11. Positive TLP I-V Curve**



**Figure 12. Negative TLP I-V Curve**

NOTE: TLP parameter:  $Z_0 = 50 \Omega$ ,  $t_p = 100 \text{ ns}$ ,  $t_r = 300 \text{ ps}$ , averaging window:  $t_1 = 30 \text{ ns}$  to  $t_2 = 60 \text{ ns}$ .  $V_{IEC}$  is the equivalent voltage stress level calculated at the secondary peak of the IEC 61000-4-2 waveform at  $t = 30 \text{ ns}$  with  $2 \text{ A/kV}$ . See TLP description below for more information.

## IEC 61000-4-2 Spec.

| Level | Test Voltage (kV) | First Peak Current (A) | Current at 30 ns (A) | Current at 60 ns (A) |
|-------|-------------------|------------------------|----------------------|----------------------|
| 1     | 2                 | 7.5                    | 4                    | 2                    |
| 2     | 4                 | 15                     | 8                    | 4                    |
| 3     | 6                 | 22.5                   | 12                   | 6                    |
| 4     | 8                 | 30                     | 16                   | 8                    |

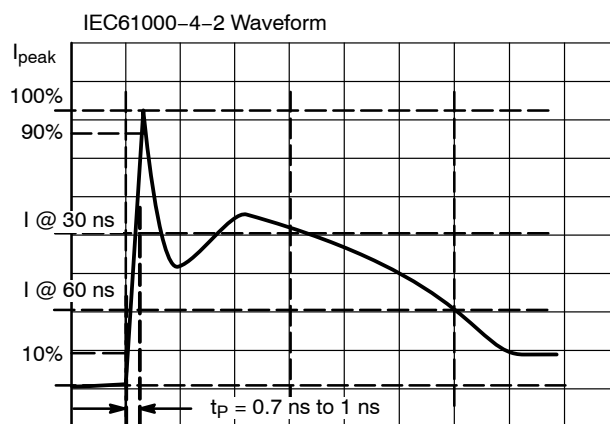


Figure 13. IEC61000-4-2 Spec

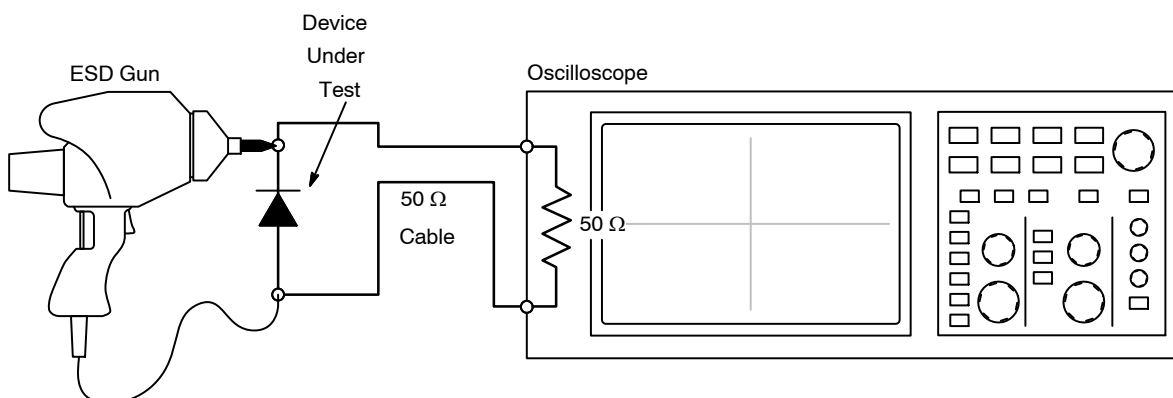


Figure 14. Diagram of ESD Clamping Voltage Test Setup

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.

### Transmission Line Pulse (TLP) Measurement

Transmission Line Pulse (TLP) provides current versus voltage (I-V) curves in which each data point is obtained from a 100 ns long rectangular pulse from a charged transmission line. A simplified schematic of a typical TLP system is shown in Figure 15. TLP I-V curves of ESD protection devices accurately demonstrate the product's ESD capability because the 10s of amps current levels and under 100 ns time scale match those of an ESD event. This is illustrated in Figure 16 where an 8 kV IEC 61000-4-2 current waveform is compared with TLP current pulses at 8 A and 16 A. A TLP I-V curve shows the voltage at which the device turns on as well as how well the device clamps voltage over a range of current levels.

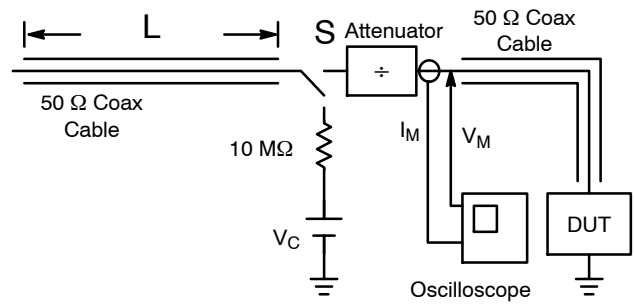


Figure 15. Simplified Schematic of a Typical TLP System

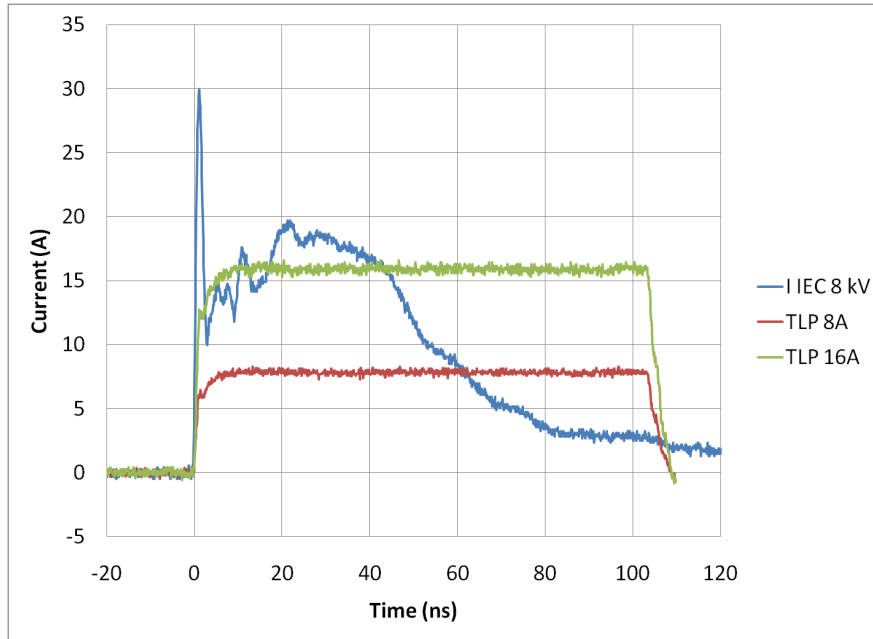
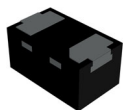
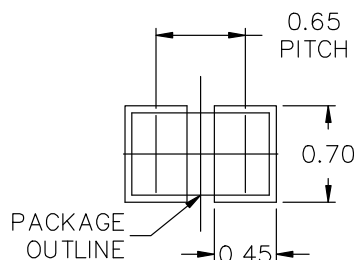
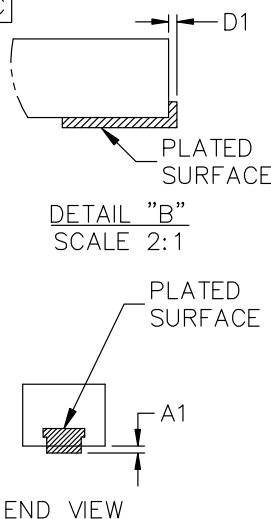
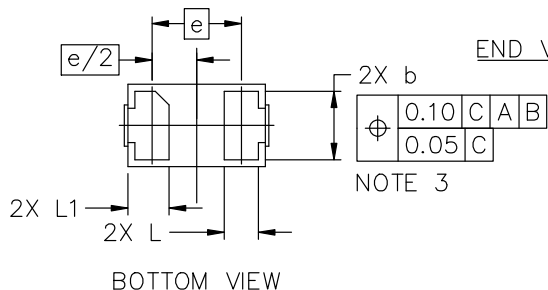
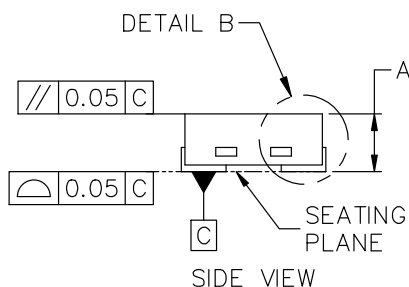
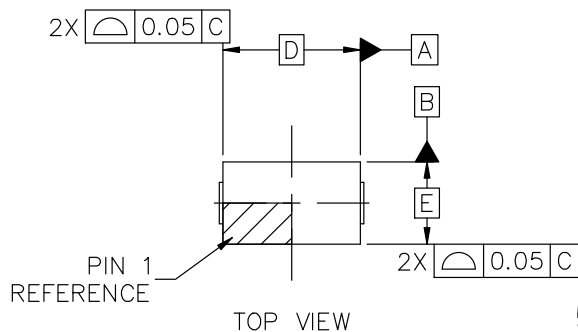


Figure 16. Comparison Between 8 kV IEC 61000-4-2 and 8 A and 16 A TLP Waveforms



**X2DFNW2 1.00x0.60x0.37, 0.65P**  
**CASE 711BG**  
**ISSUE D**

DATE 29 FEB 2024



NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5-2018.
2. ALL DIMENSION ARE IN MILLIMETERS.
3. DIMENSION b APPLIES TO THE PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 FROM THE TERMINAL TIP.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.34        | 0.37 | 0.40 |
| A1  | ---         | ---  | 0.05 |
| b   | 0.45        | 0.50 | 0.55 |
| D   | 1.00 BSC    |      |      |
| D1  | ---         | ---  | 0.05 |
| E   | 0.60 BSC    |      |      |
| e   | 0.65 BSC    |      |      |
| L   | 0.22 REF    |      |      |
| L1  | 0.24        | 0.28 | 0.34 |

**GENERIC MARKING DIAGRAM\***



XX = Specific Device Code  
M = Date Code

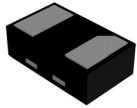
\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G", may or not be present. Some products may not follow the Generic Marking.

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\* FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERM/D.

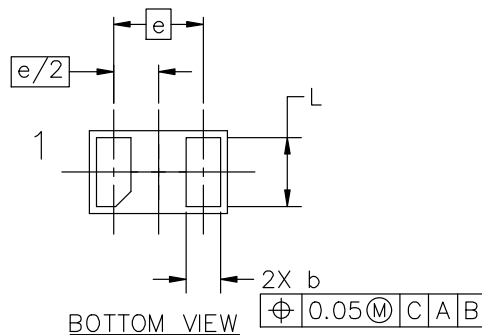
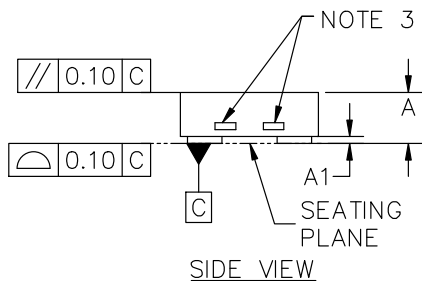
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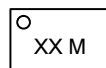


**X2DFN2 1.00x0.60x0.37, 0.65P**  
**CASE 714AB**  
**ISSUE C**

DATE 21 FEB 2024



### GENERIC MARKING DIAGRAM\*



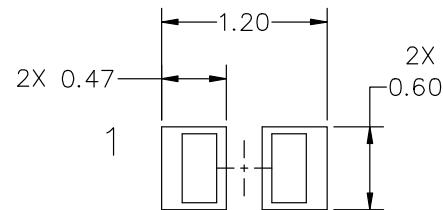
XX = Specific Device Code  
M = Date Code

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

### NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5-2018.
2. ALL DIMENSION ARE IN MILLIMETERS.
3. EXPOSED COPPER ALLOWED AS SHOW.

| DIM | MILLIMETERS |      |       |
|-----|-------------|------|-------|
|     | MIN.        | NOM. | MAX.  |
| A   | 0.34        | 0.37 | 0.40  |
| A1  | ---         | 0.03 | 0.050 |
| b   | 0.20        | 0.25 | 0.30  |
| D   | 0.95        | 1.00 | 1.05  |
| E   | 0.55        | 0.60 | 0.65  |
| e   | 0.65 BSC    |      |       |
| L   | 0.45        | 0.50 | 0.55  |



### RECOMMENDED MOUNTING FOOTPRINT\*

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