

# ESD Protection Diodes

## Low Capacitance ESD Protection Diode for High Speed Data Line

### ESD8551, SZESD8551

The ESD8551 ESD protection diodes are designed to protect high speed data lines from ESD. Ultra-low capacitance and low ESD clamping voltage make this device an ideal solution for protecting voltage sensitive high speed data lines.

#### Features

- Low Capacitance (0.30 pF Max, I/O to GND)
- Protection for the Following IEC Standards:  
IEC 61000-4-2 (Level 4) & ISO 10605
- Low ESD Clamping Voltage
- SZESD8551MXWT5G – 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

- USB 3.0
- MHL 2.0
- eSATA

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

| Rating   | Symbol           | Value       | Unit |
|--|------------------|-------------|------|
| Operating Junction Temperature Range           | T <sub>J</sub>   | -55 to +125 | °C   |
| Storage Temperature Range                      | T <sub>stg</sub> | -55 to +150 | °C   |
| Lead Solder Temperature – Maximum (10 Seconds) | T <sub>L</sub>   | 260         | °C   |
| IEC 61000-4-2 Contact                          | ESD              | ±20         | kV   |
| IEC 61000-4-2 Air                              |                  | ±20         |      |
| ISO 10605 150 pF/2 kΩ                          |                  | ±30         |      |
| ISO 10605 330 pF/2 kΩ                          |                  | ±30         |      |
| ISO 10605 330 pF/330 Ω                         |                  | ±15         |      |

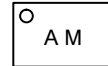
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

See Application Note AND8308/D for further description of survivability specs.

#### MARKING DIAGRAMS



X2DFN2  
CASE 714AB



A = Specific Device Code  
M = Date Code

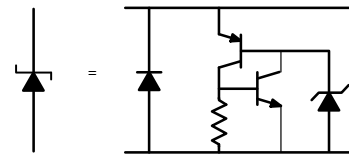
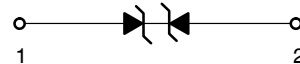


X2DFNW2  
CASE 711BG



K = Specific Device Code  
M = Date Code

#### PIN CONFIGURATION AND SCHEMATIC



#### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# ESD8551, SZESD8551

## ORDERING INFORMATION

| Device           | Package              | Shipping†          |
|------------------|----------------------|--------------------|
| ESD8551N2T5G     | X2DFN2<br>(Pb-Free)  | 8000 / Tape & Reel |
| SZESD8551N2T5G*  | X2DFN2<br>(Pb-Free)  | 8000 / Tape & Reel |
| SZESD8551MXWT5G* | X2DFNW2<br>(Pb-Free) | 8000 / Tape & Reel |

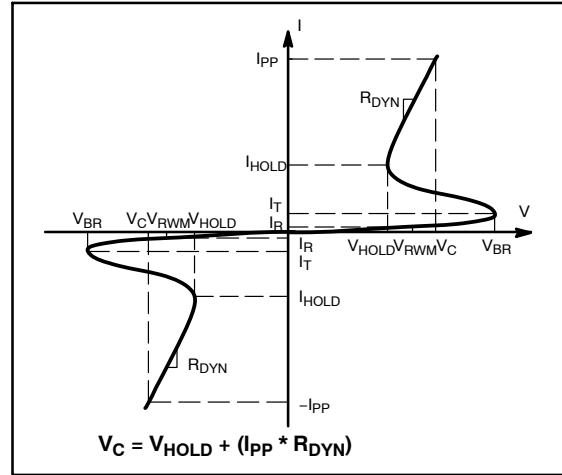
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable.

## ELECTRICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$  unless otherwise noted)

| Symbol     | Parameter  |
|------------|--|
| $V_{RWM}$  | Working Peak Voltage   |
| $I_R$      | Maximum Reverse Leakage Current @ $V_{RWM}$                          |
| $V_{BR}$   | Breakdown Voltage @ $I_T$  |
| $I_T$      | Test Current   |
| $V_{HOLD}$ | Holding Reverse Voltage  |
| $I_{HOLD}$ | Holding Reverse Current  |
| $R_{DYN}$  | Dynamic Resistance   |
| $I_{PP}$   | Maximum Peak Pulse Current   |
| $V_C$      | Clamping Voltage @ $I_{PP}$<br>$V_C = V_{HOLD} + (I_{PP} * R_{DYN})$ |



## ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise specified)

| Parameter                     | Symbol     | Conditions   | Min | Typ          | Max  | Unit     |
|-------------------------------|------------|--|-----|--------------|------|----------|
| Reverse Working Voltage       | $V_{RWM}$  | I/O Pin to GND   |     |              | 3.3  | V        |
| Breakdown Voltage             | $V_{BR}$   | $I_T = 1\text{ mA}$ , I/O Pin to GND   | 5.5 | 7.9          | 8.3  | V        |
| Reverse Leakage Current       | $I_R$      | $V_{RWM} = 3.3\text{ V}$ , I/O Pin to GND  |     | 5            | 500  | nA       |
| Reverse Holding Voltage       | $V_{HOLD}$ | I/O Pin to GND   |     | 2.05         |      | V        |
| Holding Reverse Current       | $I_{HOLD}$ | I/O Pin to GND   |     | 17           |      | mA       |
| Clamping Voltage (Note 1)     | $V_C$      | IEC61000-4-2, $\pm 8\text{ kV}$ Contact  |     |              |      | V        |
| Clamping Voltage TLP (Note 2) | $V_C$      | $I_{PP} = 8\text{ A}$ } IEC 61000-4-2 Level 2 equivalent<br>( $\pm 4\text{ kV}$ Contact, $\pm 4\text{ kV}$ Air)  |     | 9.0          |      | V        |
|                               |            | $I_{PP} = 16\text{ A}$ } IEC 61000-4-2 Level 4 equivalent<br>( $\pm 8\text{ kV}$ Contact, $\pm 8\text{ kV}$ Air) |     | 16.0         |      |          |
| Dynamic Resistance            | $R_{DYN}$  | Pin1 to Pin2<br>Pin2 to Pin1   |     | 0.84<br>0.84 |      | $\Omega$ |
| Junction Capacitance          | $C_J$      | $V_R = 0\text{ V}$ , $f = 1\text{ MHz}$  |     | 0.20         | 0.30 | pF       |
| Junction Capacitance          | $C_J$      | $V_R = 0\text{ V}$ , $f = 2.5\text{ GHz}$  |     | 0.19         | 0.25 | pF       |

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.

- For test procedure see Figure 7 and application note AND8307/D.
- ANSI/ESD STM5.5.1 – Electrostatic Discharge Sensitivity Testing using Transmission Line Pulse (TLP) Model.  
TLP conditions:  $Z_0 = 50\ \Omega$ ,  $t_p = 100\text{ ns}$ ,  $t_r = 4\text{ ns}$ , averaging window;  $t_1 = 30\text{ ns}$  to  $t_2 = 60\text{ ns}$ .

# ESD8551, SZESD8551

## TYPICAL CHARACTERISTICS

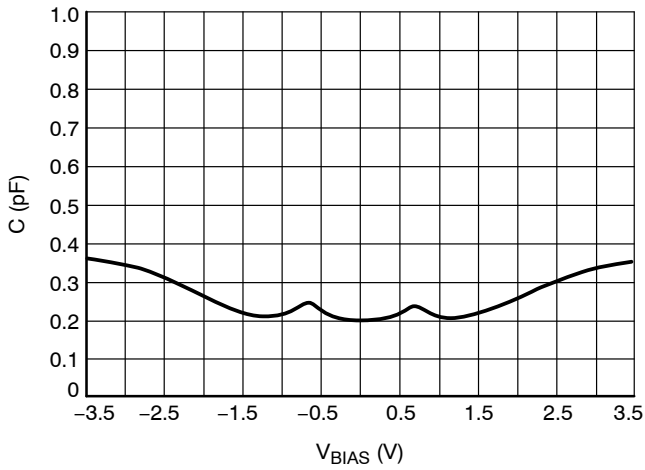


Figure 1. CV Characteristics

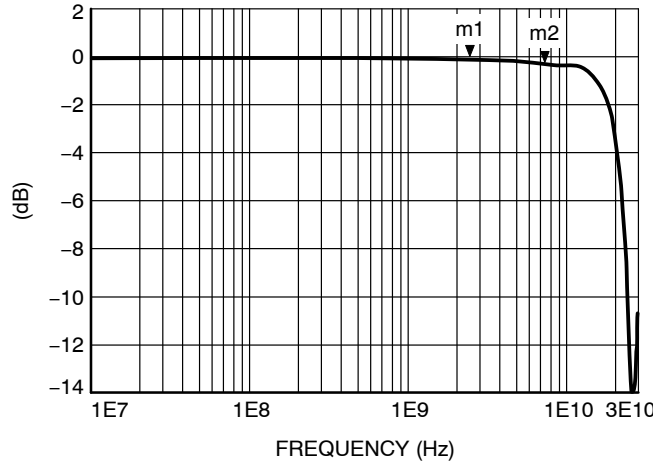


Figure 2. S21 Insertion Loss

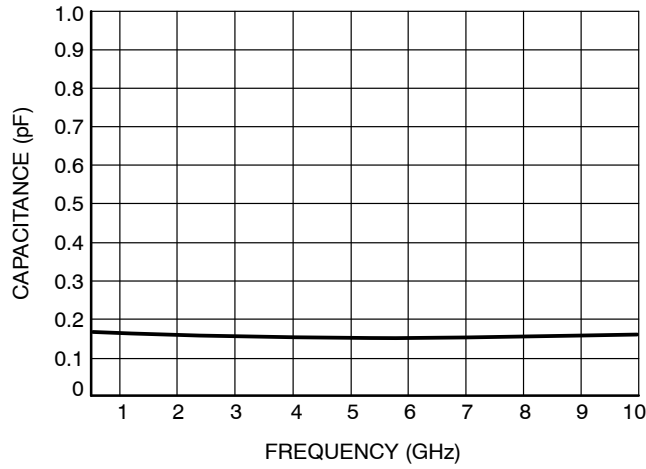


Figure 3. Capacitance over Frequency

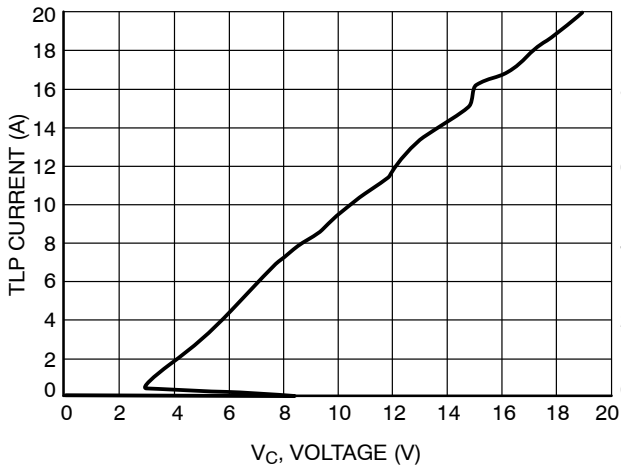


Figure 4. Positive TLP I-V Curve

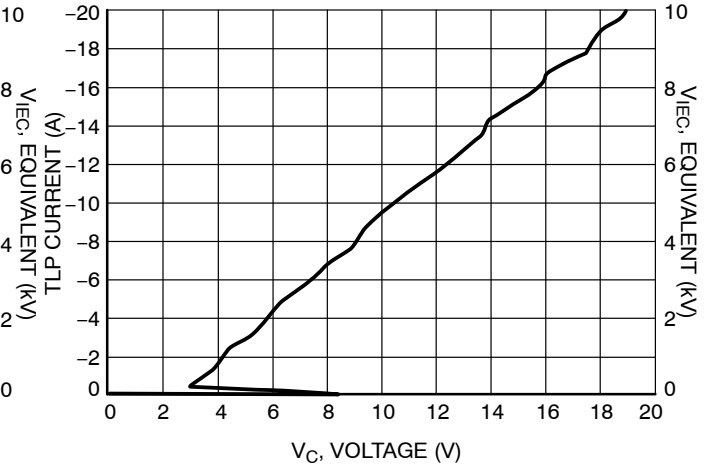


Figure 5. Negative TLP I-V Curve

**Latch-Up Considerations**

onsemi’s 8000 series of ESD protection devices utilize a snap-back, SCR type structure. By using this technology, the potential for a latch-up condition was taken into account by performing load line analyses of common high speed serial interfaces. Example load lines for latch-up free applications and applications with the potential for latch-up are shown below with a generic IV characteristic of a snapback, SCR type structured device overlaid on each. In the latch-up free load line case, the IV characteristic of the snapback protection device intersects the load-line in one unique point ( $V_{OP}$ ,  $I_{OP}$ ). This is the only stable operating

point of the circuit and the system is therefore latch-up free. In the non-latch up free load line case, the IV characteristic of the snapback protection device intersects the load-line in two points ( $V_{OPA}$ ,  $I_{OPA}$ ) and ( $V_{OPB}$ ,  $I_{OPB}$ ). Therefore in this case, the potential for latch-up exists if the system settles at ( $V_{OPB}$ ,  $I_{OPB}$ ) after a transient. Because of this, ESD8551 should not be used for HDMI applications – ESD8104 or ESD8040 have been designed to be acceptable for HDMI applications without latch-up. Please refer to Application Note AND9116/D for a more in-depth explanation of latch-up considerations using ESD8000 series devices.

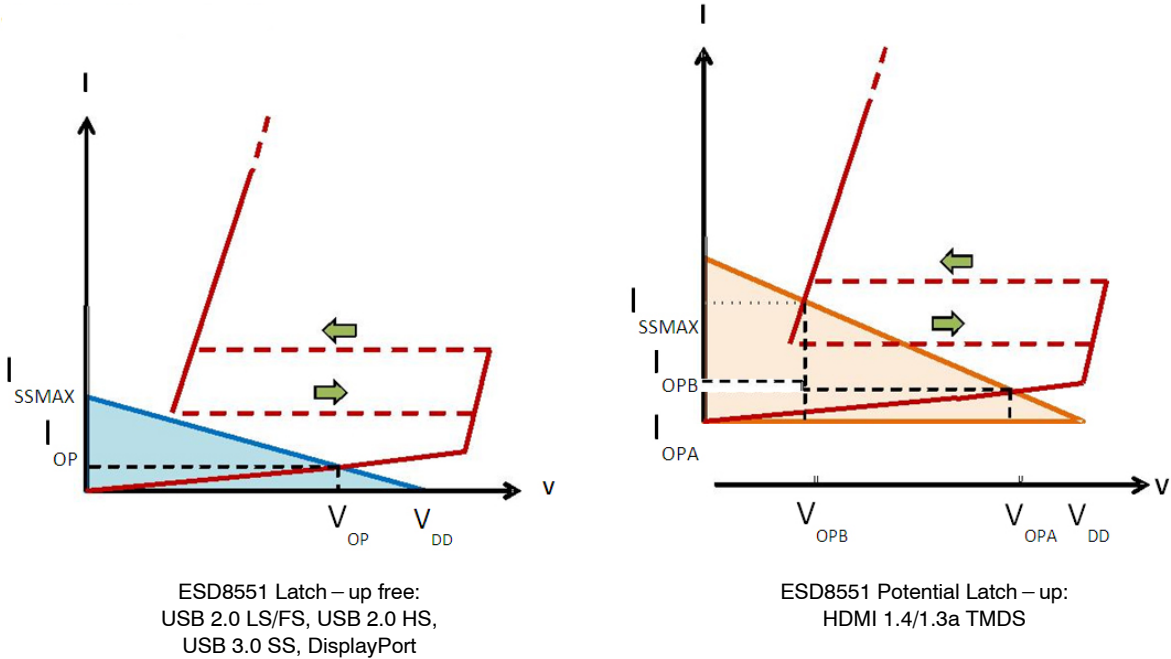


Figure 6. Example Load Lines for Latch-up Free Applications and Applications with the Potential for Latch-up

Table 1. SUMMARY OF SCR REQUIREMENTS FOR LATCH-UP FREE APPLICATIONS

| Application        | VBR (min) (V) | IH (min) (mA) | VH (min) (V) | onsemi ESD8000 Series Recommended PN |
|--------------------|---------------|---------------|--------------|--------------------------------------|
| HDMI 1.4/1.3a TMDS | 3.465         | 54.78         | 1.0          | ESD8104, ESD8040                     |
| USB 2.0 LS/FS      | 3.301         | 1.76          | 1.0          | ESD8004, ESD8551                     |
| USB 2.0 HS         | 0.482         | N/A           | 1.0          | ESD8004, ESD8551                     |
| USB 3.0 SS         | 2.800         | N/A           | 1.0          | ESD8004, ESD8006, ESD8551            |
| DisplayPort        | 3.600         | 25.00         | 1.0          | ESD8004, ESD8006, ESD8551            |

# ESD8551, SZESD8551

## 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                    |

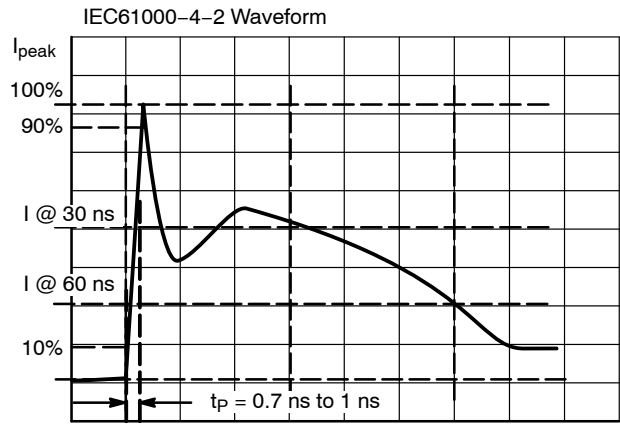


Figure 7. IEC61000-4-2 Spec

## 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 8. 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 9 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.

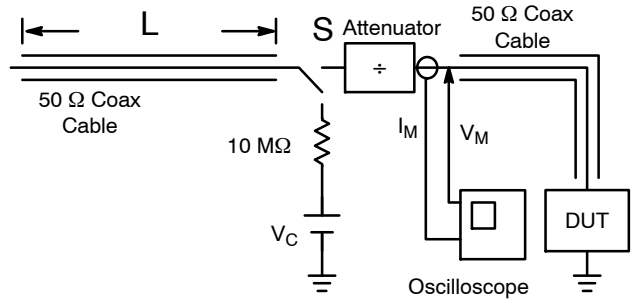


Figure 8. Simplified Schematic of a Typical TLP System

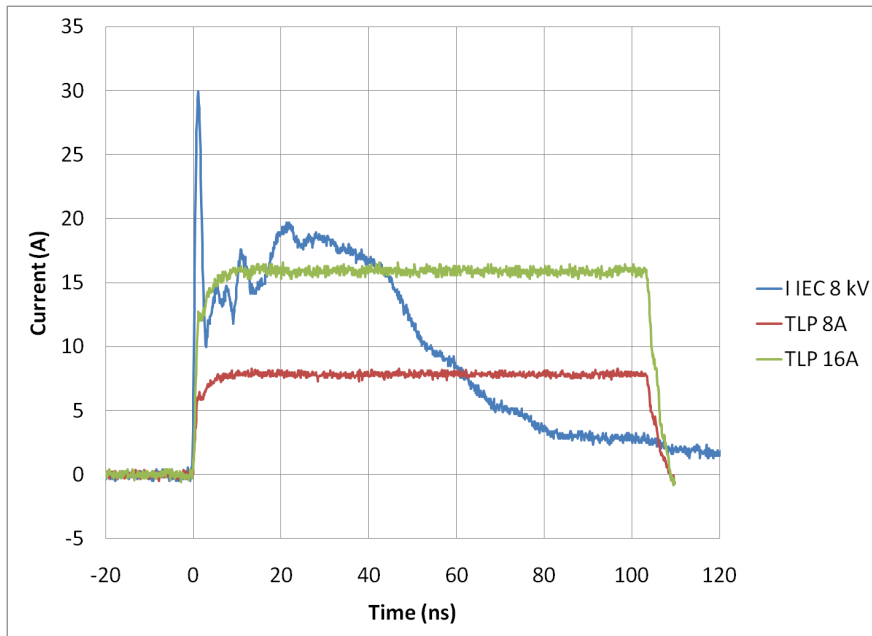
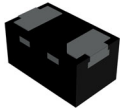


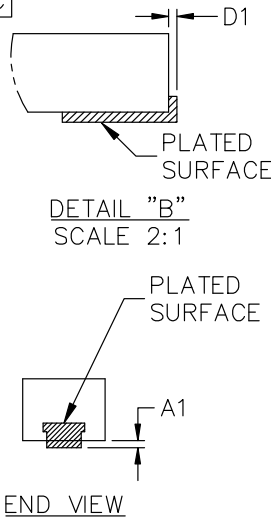
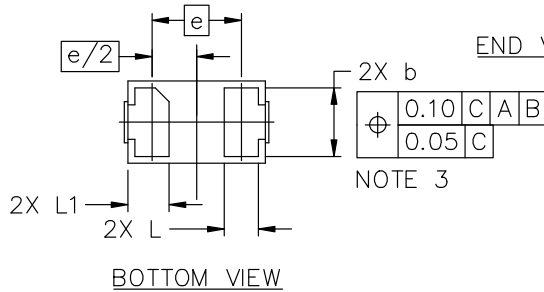
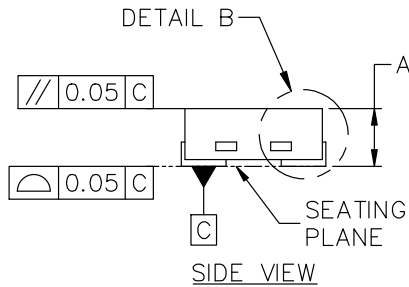
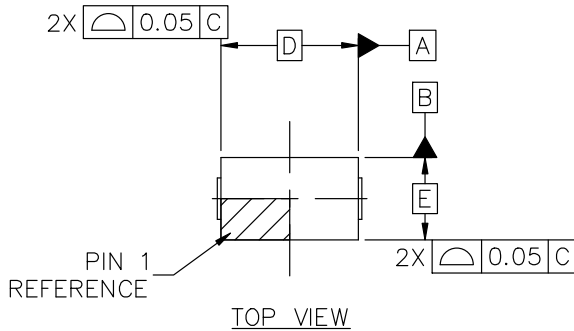
Figure 9. Comparison Between 8 kV IEC 61000-4-2 and 8 A and 16 A TLP Waveforms

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

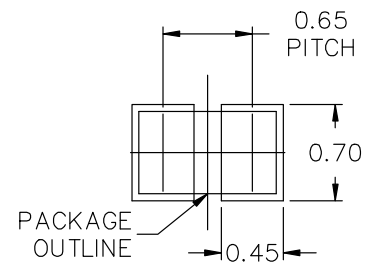


**X2DFNW2 1.00x0.60x0.37, 0.65P**  
CASE 711BG  
ISSUE D

DATE 29 FEB 2024



| 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 |



### RECOMMENDED MOUNTING FOOTPRINT\*

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

### GENERIC MARKING DIAGRAM\*



XX = Specific Device Code  
M = Date Code

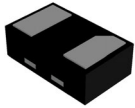
\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G", may or not be present. Some products may not follow the Generic Marking.

|                         |                                      |  |
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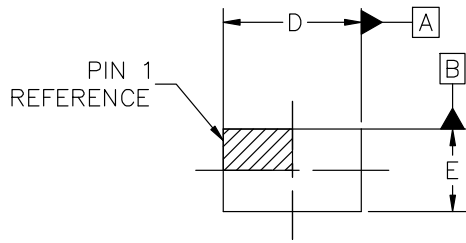
# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

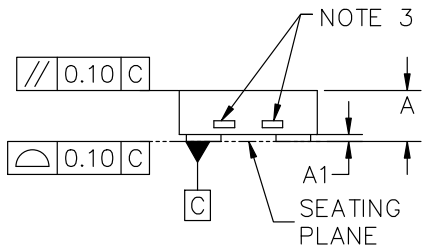


**X2DFN2 1.00x0.60x0.37, 0.65P**  
**CASE 714AB**  
**ISSUE C**

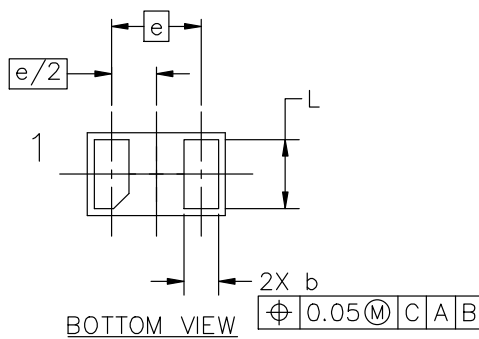
DATE 21 FEB 2024



TOP VIEW



SIDE VIEW

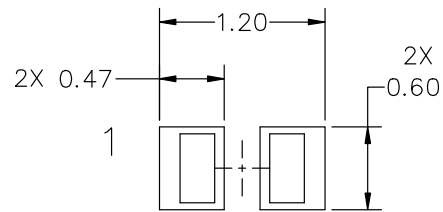


BOTTOM VIEW

NOTES:

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

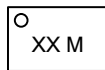
| DIM | MILLIMETERS |      |       |
|-----|-------------|------|-------|
|     | MIN.        | NOM. | MAX.  |
| A   | 0.34        | 0.37 | 0.40  |
| A1  | ---         | 0.03 | 0.050 |
| b   | 0.20        | 0.25 | 0.30  |
| D   | 0.95        | 1.00 | 1.05  |
| E   | 0.55        | 0.60 | 0.65  |
| e 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



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**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.

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