

# ESD8106

## ESD Protection Diode

### Low Capacitance ESD Protection for USB 3.0 Interface

The ESD8106 surge protection is specifically designed to protect USB 3.0 interfaces by integrating two Superspeed pairs, D+ and D- lines into a single protection product. Ultra-low capacitance and low ESD clamping voltage make this device an ideal solution for protecting voltage sensitive high speed data lines. The flow-through style package allows for easy PCB layout and matched trace lengths necessary to maintain consistent impedance between high speed differential lines.

#### Features

- Low Capacitance (0.35 pF Max, I/O to GND)
- Protection for the Following IEC Standards:  
IEC 61000-4-2 Level 4
- UL Flammability Rating of 94 V-0
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### Typical Applications

- USB 3.0

#### 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)                    | ESD              | ±15         | kV   |
| IEC 61000-4-2 Air (ESD)                        | ESD              | ±15         | 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.

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



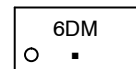
ON Semiconductor®

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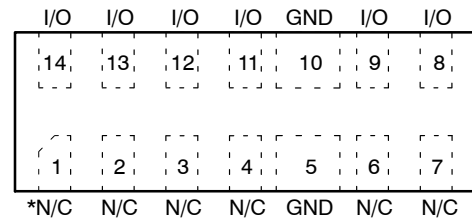
UDFN14  
CASE 517CQ

#### MARKING DIAGRAM



- 6D = Specific Device Code
- M = Date Code
- = Pb-Free Package

#### PIN CONFIGURATION



\*Pins 1-7 should be connected to opposite pin with PCB trace in order to maintain a flow-through routing scheme.

#### ORDERING INFORMATION

| Device       | Package          | Shipping           |
|--------------|------------------|--------------------|
| ESD8106MUTAG | UDFN14 (Pb-Free) | 3000 / Tape & Reel |

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

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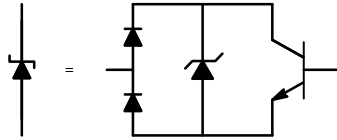
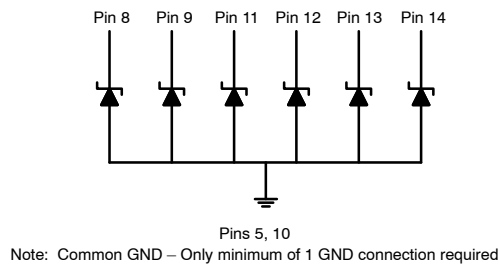


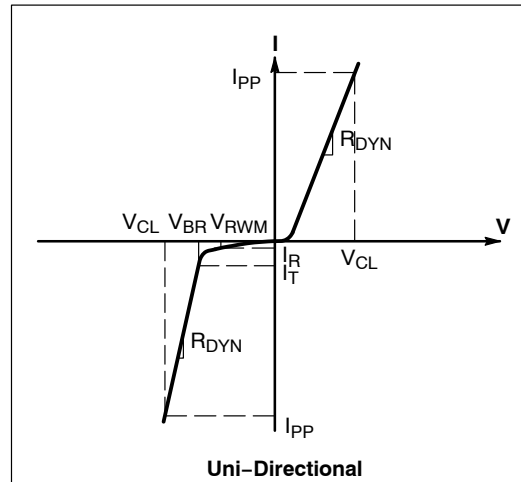
Figure 1. Pin Schematic

## ELECTRICAL CHARACTERISTICS

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

| Symbol    | Parameter                                   |
|-----------|---|
| $I_{PP}$  | Maximum Peak Pulse Current                  |
| $V_C$     | Clamping Voltage @ $I_{PP}$                 |
| $V_{RWM}$ | Working Peak Reverse Voltage                |
| $I_R$     | Maximum Reverse Leakage Current @ $V_{RWM}$ |
| $V_{BR}$  | Breakdown Voltage @ $I_T$                   |
| $I_T$     | Test Current                                |
| $R_{DYN}$ | Dynamic Resistance                          |

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



## 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   | 4.0 | 5.0                  |                      | V             |
| Reverse Leakage Current | $I_R$     | $V_{RWM} = 3.3 \text{ V}$ , I/O Pin to GND  |     |                      | 1.0                  | $\mu\text{A}$ |
| Dynamic Resistance      | $R_{DYN}$ | (Note 1)  |     | 0.45                 |                      | $\Omega$      |
| Junction Capacitance    | $C_J$     | $V_R = 0 \text{ V}$ , $f = 1 \text{ MHz}$ between I/O Pins and GND<br>$V_R = 0 \text{ V}$ , $f = 1 \text{ MHz}$ between I/O Pins<br>$V_R = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_A = 65^\circ\text{C}$ between I/O Pins and GND |     | 0.30<br>0.10<br>0.37 | 0.35<br>0.20<br>0.47 | pF            |

- 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  $t_2 = 60 \text{ ns}$ .

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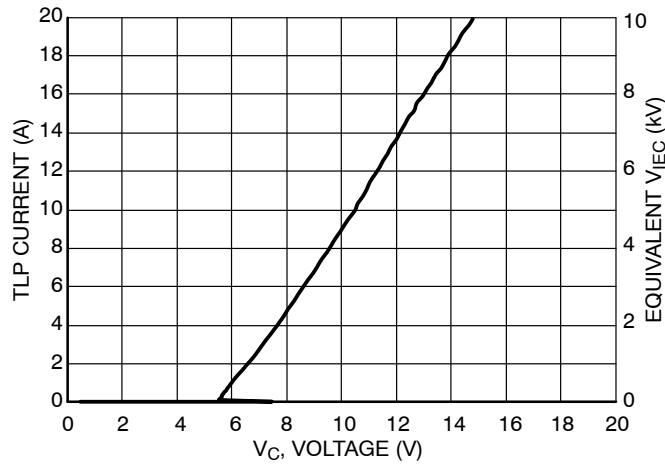


Figure 2. TLP I-V Curve

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

### 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 3. 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 4 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. For more information on TLP measurements and how to interpret them please see AND9007/D.

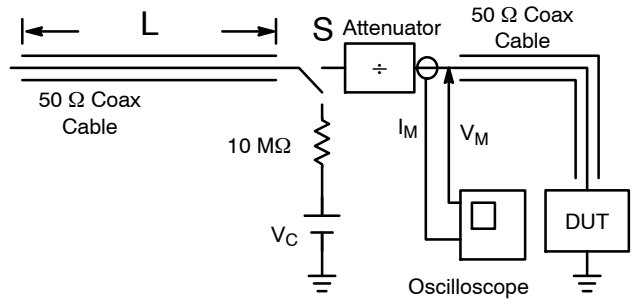


Figure 3. Simplified Schematic of a Typical TLP System

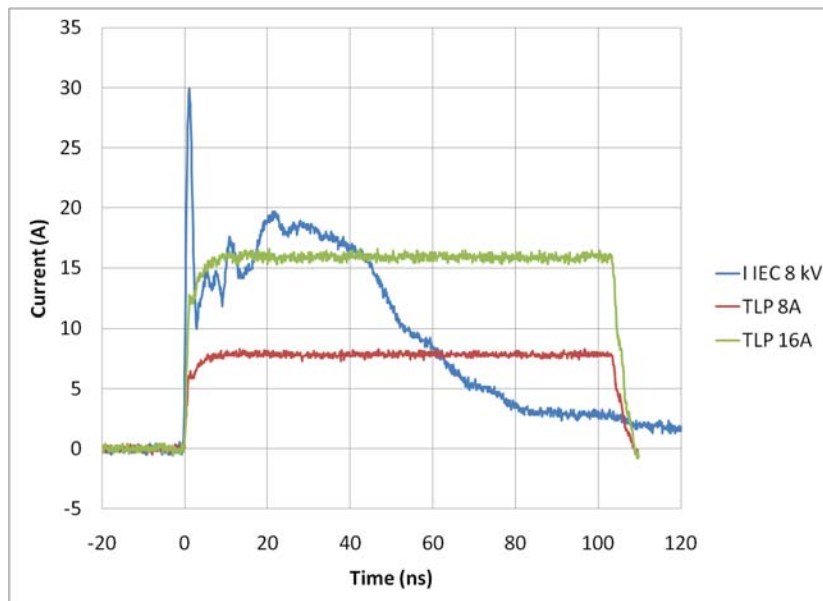


Figure 4. Comparison Between 8 kV IEC 61000-4-2 and 8 A and 16 A TLP Waveforms

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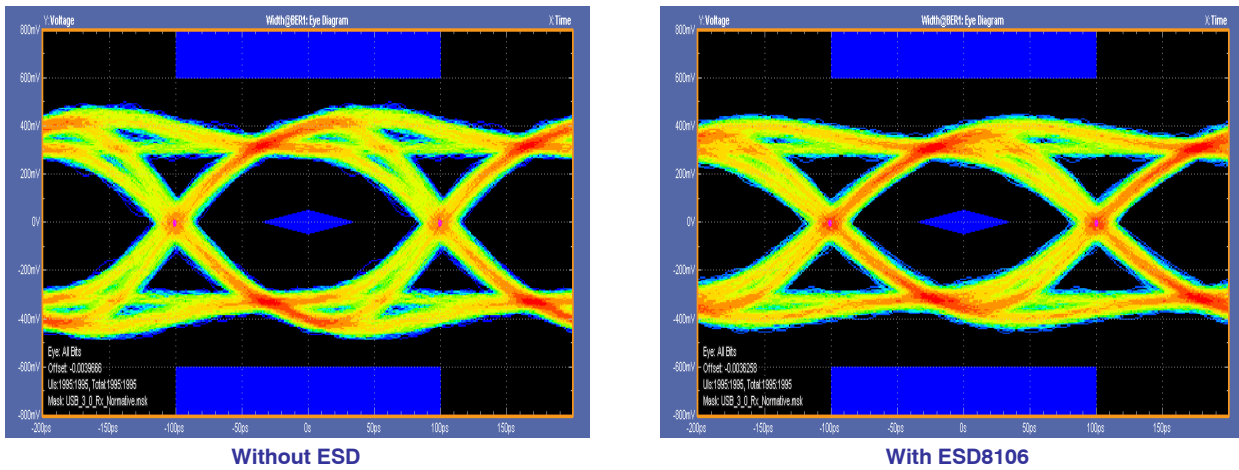
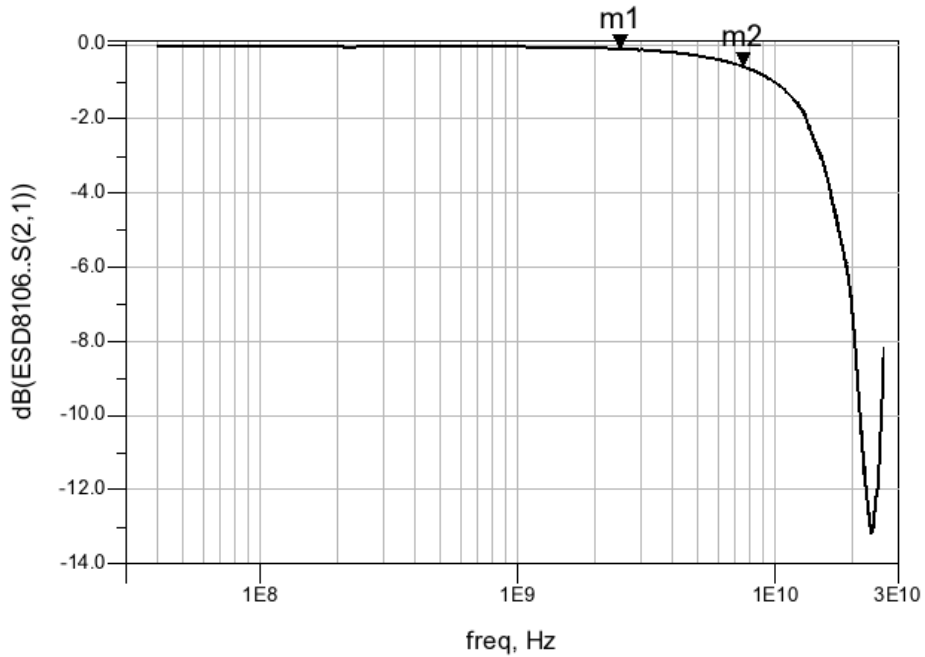


Figure 5. USB 3.0 Eye Diagram with and without ESD8106. 5.0 Gb/s, 400 mV<sub>PP</sub>



| Interface | Data Rate (Gb/s) | Fundamental Frequency (GHz) | 3 <sup>rd</sup> Harmonic Frequency (GHz) | ESD8106 Insertion Loss (dB) |
|-----------|------------------|-----------------------------|--|-----------------------------|
| USB 3.0   | 5                | 2.5 (m1)                    | 7.5 (m2)                                 | m1 = 0.100<br>m2 = 0.580    |

Figure 6. ESD8106 Insertion Loss

## ESD8106

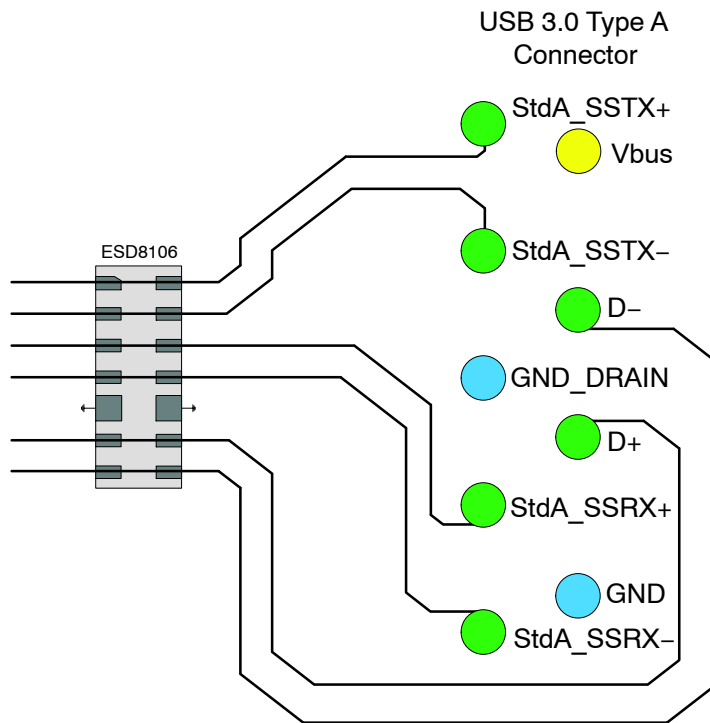


Figure 7. Recommended USB 3.0 Layout Diagram

### PCB Layout Guidelines

Steps must be taken for proper placement and signal trace routing of the ESD protection device in order to ensure the maximum ESD survivability and signal integrity for the application. Such steps are listed below.

- Place the ESD protection device as close as possible to the I/O connector to reduce the ESD path to ground and improve the protection performance.
  - ◆ In USB 3.0 applications, the ESD protection device should be placed between the AC coupling capacitors and the I/O connector on the TX differential lanes as shown in Figure 8.
- Make sure to use differential design methodology and impedance matching of all high speed signal traces.
  - ◆ Use curved traces when possible to avoid unwanted reflections.
  - ◆ Keep the trace lengths equal between the positive and negative lines of the differential data lanes to avoid common mode noise generation and impedance mismatch.
  - ◆ Place grounds between high speed pairs and keep as much distance between pairs as possible to reduce crosstalk.

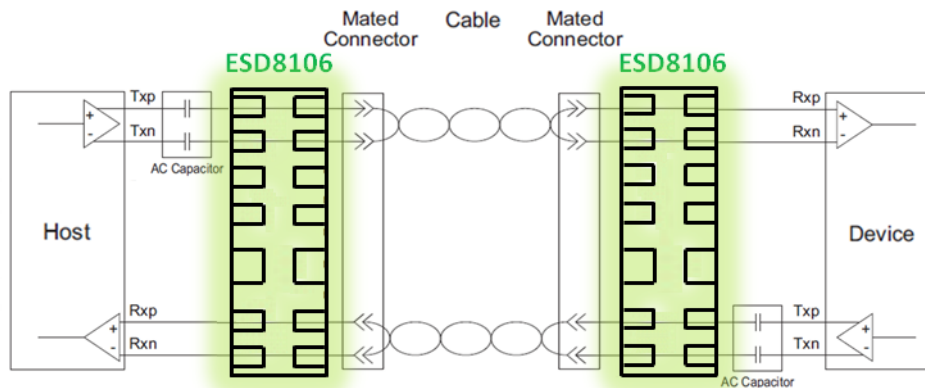


Figure 8. USB 3.0 Connection Diagram

# ESD8106

## ESD Protection Device Technology

ON Semiconductor's portfolio contains three main technologies for low capacitance ESD protection device which are highlighted below and in Figure 9.

- ESD7000 series: Zener diode based technology. This technology has a higher breakdown voltage (VBR) limiting it to protecting chipsets with larger geometries.
- ESD8000 series: Silicon controlled rectifier (SCR) type technology. The key advantage for this technology is a low holding voltage (VH) which produces a deeper snapback that results in lower voltage over high

currents as shown in the TLP results in Figure 10. This technology provides optimized protection for chipsets with small geometries against thermal failures resulting in chipset damage (also known as "hard failures").

- ESD8100 series: Low voltage punch through (LVPT) technology. The key advantage for this technology is a very low turn-on voltage as shown in Figure 11. This technology provides optimized protection for chipsets with small geometries against recoverable failures due to voltage peaks (also known as "soft failures").

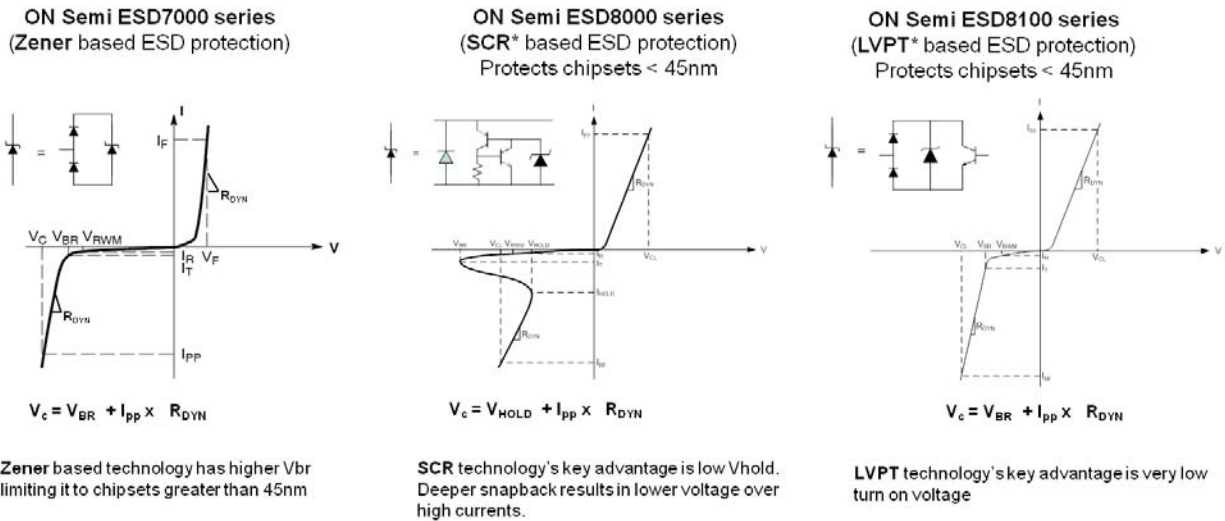


Figure 9. ON Semiconductor's Low-cap ESD Technology Portfolio

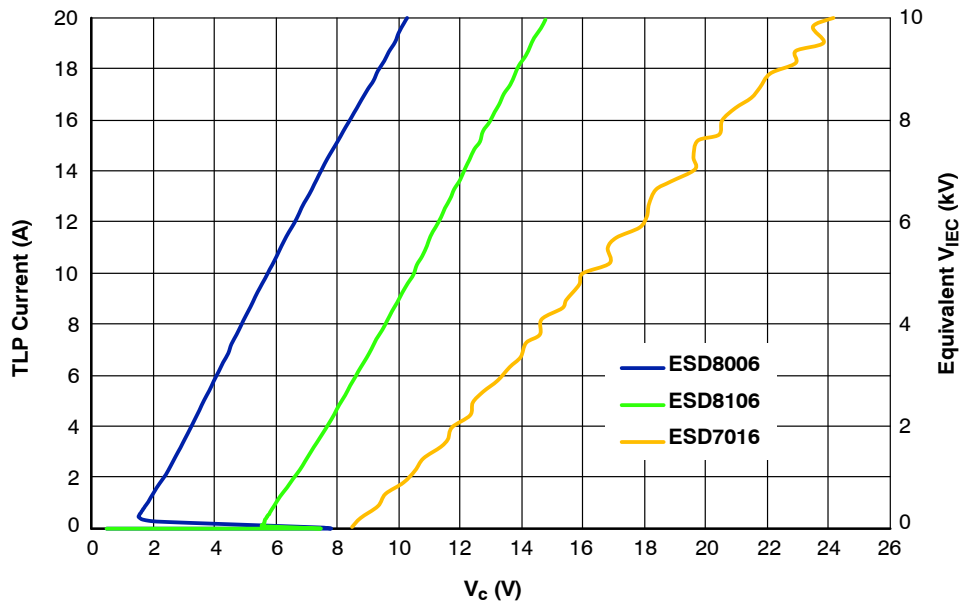


Figure 10. High Current, TLP, IV Characteristic of Each Technology

# ESD8106

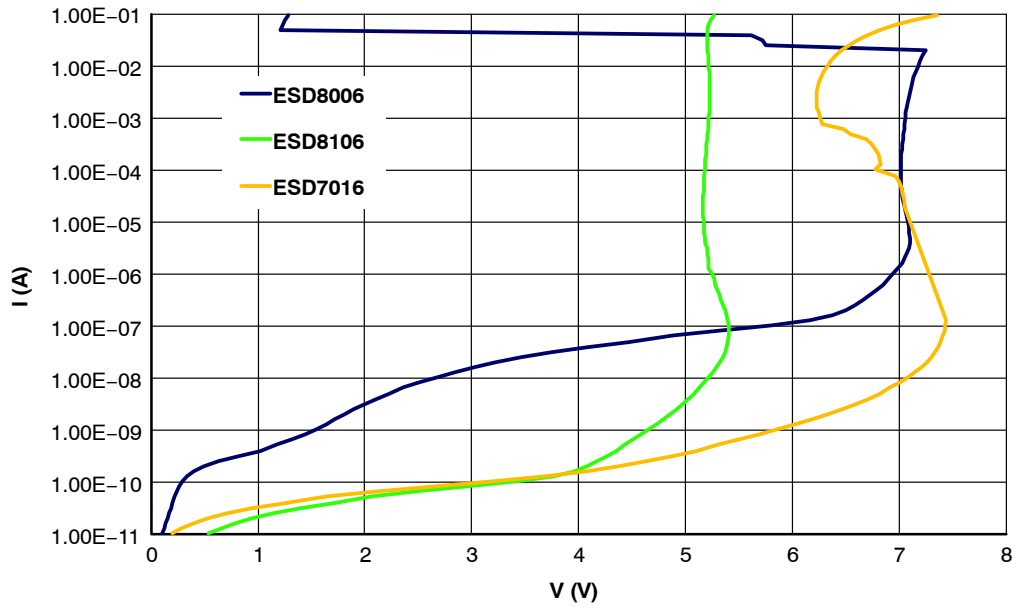


Figure 11. Low Current, DC, IV Characteristic of Each Technology

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

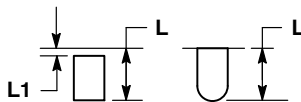
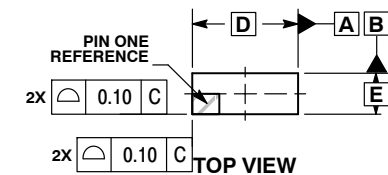
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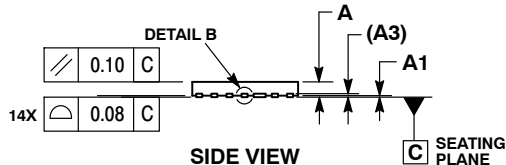
SCALE 2:1

UDFN14, 3.5x1.35, 0.5P  
CASE 517CQ  
ISSUE O

DATE 17 JAN 2013



DETAIL A  
OPTIONAL TERMINAL  
CONSTRUCTIONS

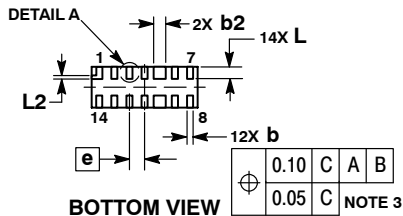


DETAIL B  
OPTIONAL  
CONSTRUCTION

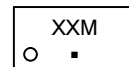
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25 MM FROM THE TERMINAL TIP.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.45        | 0.55 |
| A1  | 0.00        | 0.05 |
| A3  | 0.13 REF    |      |
| b   | 0.15        | 0.25 |
| b2  | 0.35        | 0.45 |
| D   | 3.50 BSC    |      |
| E   | 1.35 BSC    |      |
| e   | 0.50 BSC    |      |
| L   | 0.30        | 0.50 |
| L1  | 0.00        | 0.15 |
| L2  | 0.20 REF    |      |



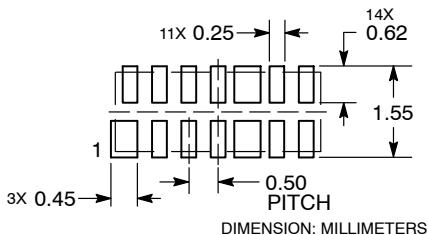
### GENERIC MARKING DIAGRAM\*



- XX = Specific Device Code
- M = Date Code
- = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking.

### RECOMMENDED SOLDERING 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.

|                  |                        |  |
|------------------|------------------------|--|
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| DESCRIPTION:     | UDFN14, 3.5X1.35, 0.5P | PAGE 1 OF 1  |

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