

# PESDxU1UT series

Ultra low capacitance ESD protection diode in SOT23 package

Rev. 02 — 20 August 2009

Product data sheet

## 1. Product profile

### 1.1 General description

Ultra low capacitance ElectroStatic Discharge (ESD) protection diode in a SOT23 (TO-236AB) small SMD plastic package designed to protect one high-speed data line from the damage caused by ESD and other transients.

### 1.2 Features

- Unidirectional ESD protection of one line
- Ultra low diode capacitance:  $C_d = 0.6$  pF
- Max. peak pulse power:  $P_{PP}$  up to 200 W
- Low clamping voltage
- ESD protection > 23 kV
- IEC 61000-4-2; level 4 (ESD)
- IEC 61000-4-5; (surge)

### 1.3 Applications

- 10/100/1000 Ethernet
- FireWire
- Communication systems
- Local Area Network (LAN) equipment
- Computers and peripherals
- High-speed data lines

### 1.4 Quick reference data

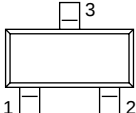
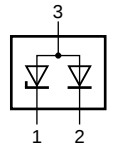
Table 1. Quick reference data

| Symbol    | Parameter                 | Conditions                                   | Min | Typ | Max | Unit |
|-----------|---------------------------|----------------------------------------------|-----|-----|-----|------|
| $V_{RWM}$ | reverse stand-off voltage |                                              |     |     |     |      |
|           | PESD3V3U1UT               |                                              | -   | -   | 3.3 | V    |
|           | PESD5V0U1UT               |                                              | -   | -   | 5.0 | V    |
|           | PESD12VU1UT               |                                              | -   | -   | 12  | V    |
|           | PESD15VU1UT               |                                              | -   | -   | 15  | V    |
|           | PESD24VU1UT               |                                              | -   | -   | 24  | V    |
| $C_d$     | diode capacitance         | $f = 1$ MHz; $V_R = 0$ V <a href="#">[1]</a> | -   | 0.6 | 1.5 | pF   |

[1] Measured from pin 1 to 2

## 2. Pinning information

Table 2. Pinning

| Pin | Description                  | Simplified outline                                                                  | Symbol                                                                              |
|-----|------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1   | cathode ESD protection diode |  |  |
| 2   | cathode compensation diode   |                                                                                     |                                                                                     |
| 3   | common anode                 |                                                                                     |                                                                                     |

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## 3. Ordering information

Table 3. Ordering information

| Type number | Package |                                          |         |
|-------------|---------|------------------------------------------|---------|
|             | Name    | Description                              | Version |
| PESD3V3U1UT | -       | plastic surface mounted package; 3 leads | SOT23   |
| PESD5V0U1UT |         |                                          |         |
| PESD12VU1UT |         |                                          |         |
| PESD15VU1UT |         |                                          |         |
| PESD24VU1UT |         |                                          |         |

## 4. Marking

Table 4. Marking codes

| Type number | Marking code <sup>[1]</sup> |
|-------------|-----------------------------|
| PESD3V3U1UT | *AP                         |
| PESD5V0U1UT | *AQ                         |
| PESD12VU1UT | *AR                         |
| PESD15VU1UT | *AS                         |
| PESD24VU1UT | *AT                         |

- [1] \* = -: made in Hong Kong  
 \* = p: made in Hong Kong  
 \* = t: made in Malaysia  
 \* = W: made in China

## 5. Limiting values

**Table 5. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol           | Parameter            | Conditions   | Min | Max  | Unit |
|------------------|----------------------|--------------|-----|------|------|
| P <sub>PP</sub>  | peak pulse power     | 8/20 $\mu$ s | [1] |      |      |
|                  | PESD3V3U1UT          |              | -   | 80   | W    |
|                  | PESD5V0U1UT          |              | -   | 80   | W    |
|                  | PESD12VU1UT          |              | -   | 200  | W    |
|                  | PESD15VU1UT          |              | -   | 200  | W    |
|                  | PESD24VU1UT          |              | -   | 200  | W    |
| I <sub>PP</sub>  | peak pulse current   | 8/20 $\mu$ s | [1] |      |      |
|                  | PESD3V3U1UT          |              | -   | 5    | A    |
|                  | PESD5V0U1UT          |              | -   | 5    | A    |
|                  | PESD12VU1UT          |              | -   | 5    | A    |
|                  | PESD15VU1UT          |              | -   | 5    | A    |
|                  | PESD24VU1UT          |              | -   | 3    | A    |
| T <sub>j</sub>   | junction temperature |              | -   | 150  | °C   |
| T <sub>amb</sub> | ambient temperature  |              | -65 | +150 | °C   |
| T <sub>stg</sub> | storage temperature  |              | -65 | +150 | °C   |

[1] Non-repetitive current pulse 8/20  $\mu$ s exponential decay waveform according to IEC 61000-4-5.

Table 6. ESD maximum ratings

| Symbol           | Parameter                       | Conditions                        | Min    | Max | Unit |
|------------------|---------------------------------|-----------------------------------|--------|-----|------|
| V <sub>ESD</sub> | electrostatic discharge voltage | IEC 61000-4-2 (contact discharge) | [1][2] |     |      |
|                  | PESD3V3U1UT                     |                                   | -      | 30  | kV   |
|                  | PESD5V0U1UT                     |                                   | -      | 30  | kV   |
|                  | PESD12VU1UT                     |                                   | -      | 30  | kV   |
|                  | PESD15VU1UT                     |                                   | -      | 30  | kV   |
|                  | PESD24VU1UT                     |                                   | -      | 23  | kV   |
|                  | PESDxU1UT                       | HBM MIL-STD-883                   | -      | 10  | kV   |

[1] Device stressed with ten non-repetitive ESD pulses.

[2] Measured from pin 1 to 2

Table 7. ESD standards compliance

| Standard                     | Conditions                      |
|------------------------------|---------------------------------|
| IEC 61000-4-2; level 4 (ESD) | > 15 kV (air); > 8 kV (contact) |
| HBM MIL-STD-883; class 3     | > 4 kV                          |

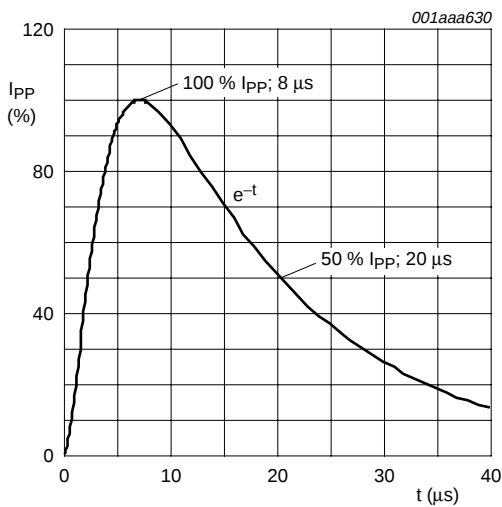


Fig 1. 8/20 μs pulse waveform according to IEC 61000-4-5

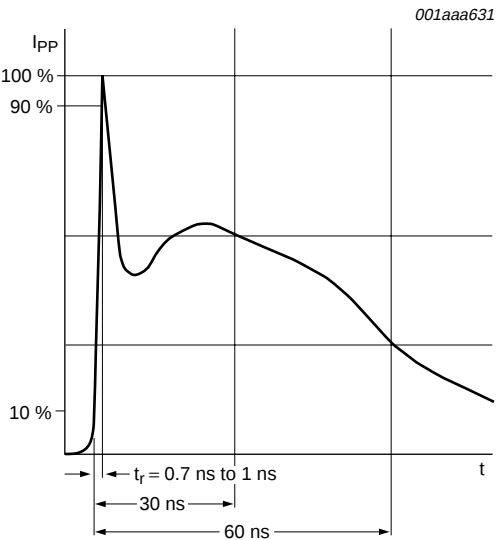


Fig 2. ESD pulse waveform according to IEC 61000-4-2

## 6. Characteristics

**Table 8. Characteristics**
 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

| Symbol    | Parameter                 | Conditions                           | Min    | Typ  | Max  | Unit          |
|-----------|---------------------------|--------------------------------------|--------|------|------|---------------|
| $V_{RWM}$ | reverse stand-off voltage |                                      |        |      |      |               |
|           | PESD3V3U1UT               |                                      | -      | -    | 3.3  | V             |
|           | PESD5V0U1UT               |                                      | -      | -    | 5.0  | V             |
|           | PESD12VU1UT               |                                      | -      | -    | 12   | V             |
|           | PESD15VU1UT               |                                      | -      | -    | 15   | V             |
|           | PESD24VU1UT               |                                      | -      | -    | 24   | V             |
| $I_{RM}$  | reverse leakage current   |                                      |        |      |      |               |
|           | PESD3V3U1UT               | $V_{RWM} = 3.3\text{ V}$             | -      | 0.25 | 2    | $\mu\text{A}$ |
|           | PESD5V0U1UT               | $V_{RWM} = 5.0\text{ V}$             | -      | 0.03 | 1    | $\mu\text{A}$ |
|           | PESD12VU1UT               | $V_{RWM} = 12\text{ V}$              | -      | < 1  | 50   | nA            |
|           | PESD15VU1UT               | $V_{RWM} = 15\text{ V}$              | -      | < 1  | 50   | nA            |
|           | PESD24VU1UT               | $V_{RWM} = 24\text{ V}$              | -      | < 1  | 50   | nA            |
| $V_{BR}$  | breakdown voltage         | $I_R = 5\text{ mA}$                  | [2]    |      |      |               |
|           | PESD3V3U1UT               |                                      | 5.8    | 6.4  | 6.9  | V             |
|           | PESD5V0U1UT               |                                      | 7.0    | 7.6  | 8.2  | V             |
|           | PESD12VU1UT               |                                      | 14.2   | 15.0 | 16.7 | V             |
|           | PESD15VU1UT               |                                      | 17.1   | 18.9 | 20.3 | V             |
|           | PESD24VU1UT               |                                      | 25.4   | 27.8 | 30.3 | V             |
| $C_d$     | diode capacitance         | $f = 1\text{ MHz}; V_R = 0\text{ V}$ | [2]    | 0.6  | 1.5  | pF            |
| $V_{CL}$  | clamping voltage          |                                      | [1][2] |      |      |               |
|           | PESD3V3U1UT               | $I_{PP} = 1\text{ A}$                | -      | -    | 9    | V             |
|           |                           | $I_{PP} = 5\text{ A}$                | -      | -    | 20   | V             |
|           | PESD5V0U1UT               | $I_{PP} = 1\text{ A}$                | -      | -    | 12   | V             |
|           |                           | $I_{PP} = 5\text{ A}$                | -      | -    | 21   | V             |
|           | PESD12VU1UT               | $I_{PP} = 1\text{ A}$                | -      | -    | 23   | V             |
|           |                           | $I_{PP} = 5\text{ A}$                | -      | -    | 39   | V             |
|           | PESD15VU1UT               | $I_{PP} = 1\text{ A}$                | -      | -    | 28   | V             |
|           |                           | $I_{PP} = 5\text{ A}$                | -      | -    | 53   | V             |
|           | PESD24VU1UT               | $I_{PP} = 1\text{ A}$                | -      | -    | 40   | V             |
|           |                           | $I_{PP} = 3\text{ A}$                | -      | -    | 76   | V             |
| $r_{dif}$ | differential resistance   | $I_R = 1\text{ mA}$                  |        |      |      |               |
|           | PESD3V3U1UT               |                                      | -      | -    | 400  | $\Omega$      |
|           | PESD5V0U1UT               |                                      | -      | -    | 80   | $\Omega$      |
|           | PESD12VU1UT               |                                      | -      | -    | 200  | $\Omega$      |
|           | PESD15VU1UT               |                                      | -      | -    | 225  | $\Omega$      |
|           | PESD24VU1UT               |                                      | -      | -    | 300  | $\Omega$      |

[1] Non-repetitive current pulse 8/20  $\mu\text{s}$  exponential decay waveform according to IEC 61000-4-5.

[2] Measured from pin 1 to 2

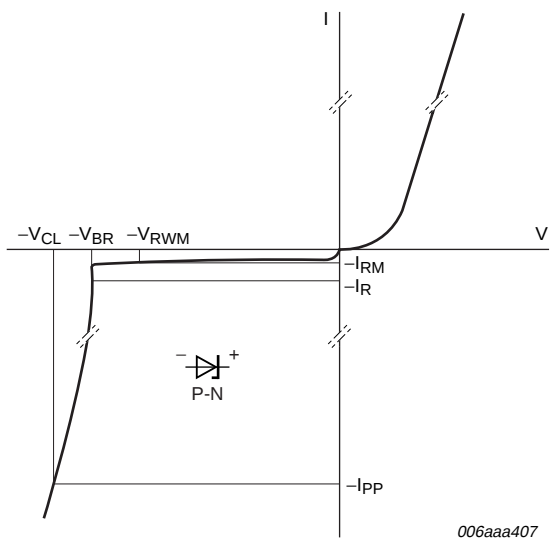
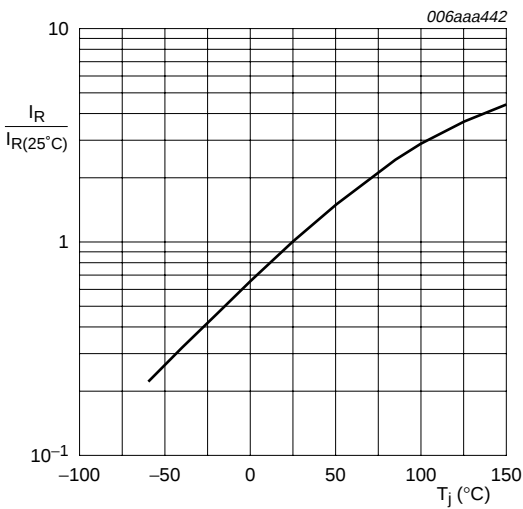


Fig 3. V-I characteristics

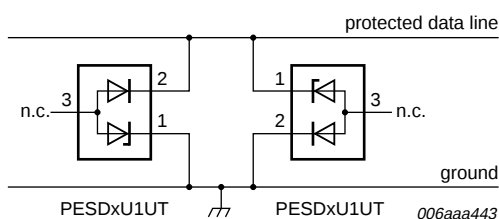


PESD3V3U1UT; PESD5V0U1UT  
 $I_R$  is less than 10 nA at 150  $^\circ C$  for:  
PESD12VU1UT; PESD15VU1UT; PESD24VU1UT

Fig 4. Relative variation of reverse leakage current as a function of junction temperature; typical values

## 7. Application information

The PESDxU1UT series is designed for protection of high-speed datalines from damage caused by ESD and surge pulses. PESDxU1UT devices combine an ESD protection diode and an ultra low capacitance compensation diode to ensure an effective device capacitance as low as 0.6 pF. The PESDxU1UT series provides a surge capability of up to 200 W per line for an 8/20  $\mu$ s waveform.



Two PESDxU1UT devices in anti-parallel configuration provide ESD protection in a common-mode application.

The two PESDxU1UT devices should be connected as follows:

**protected data line is connected to**

device 1 / pin 2

device 2 / pin 1

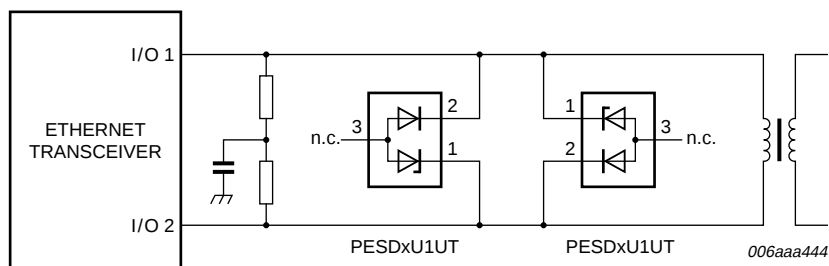
**Ground is connected to**

device 1 / pin 1

device 2 / pin 2

pin 3 is not connected for both devices

**Fig 5. Bidirectional ESD protection of one line, common mode**



Two PESDxU1UT devices in anti-parallel configuration provide ESD protection in a differential-mode configuration as e.g. for Ethernet applications.

The two PESDxU1UT should be connected as follows:

**I/O line 1 is connected to**

device 1 / pin 2

device 2 / pin 1

**I/O line 2 is connected to**

device 1 / pin 1

device 2 / pin 2

pin 3 is not connected for both devices

**Fig 6. Differential mode Ethernet protection**

**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 PESDxU1UT as close to the input terminal or connector as possible.
2. The path length between the PESDxU1UT and the protected line should be minimized.
3. Keep parallel signal paths to a minimum.
4. Avoid running protected conductors in parallel with unprotected conductors.
5. Minimize all printed-circuit board 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. Ground planes should be used whenever possible. For multilayer printed-circuit boards, use ground vias.

8. Test information

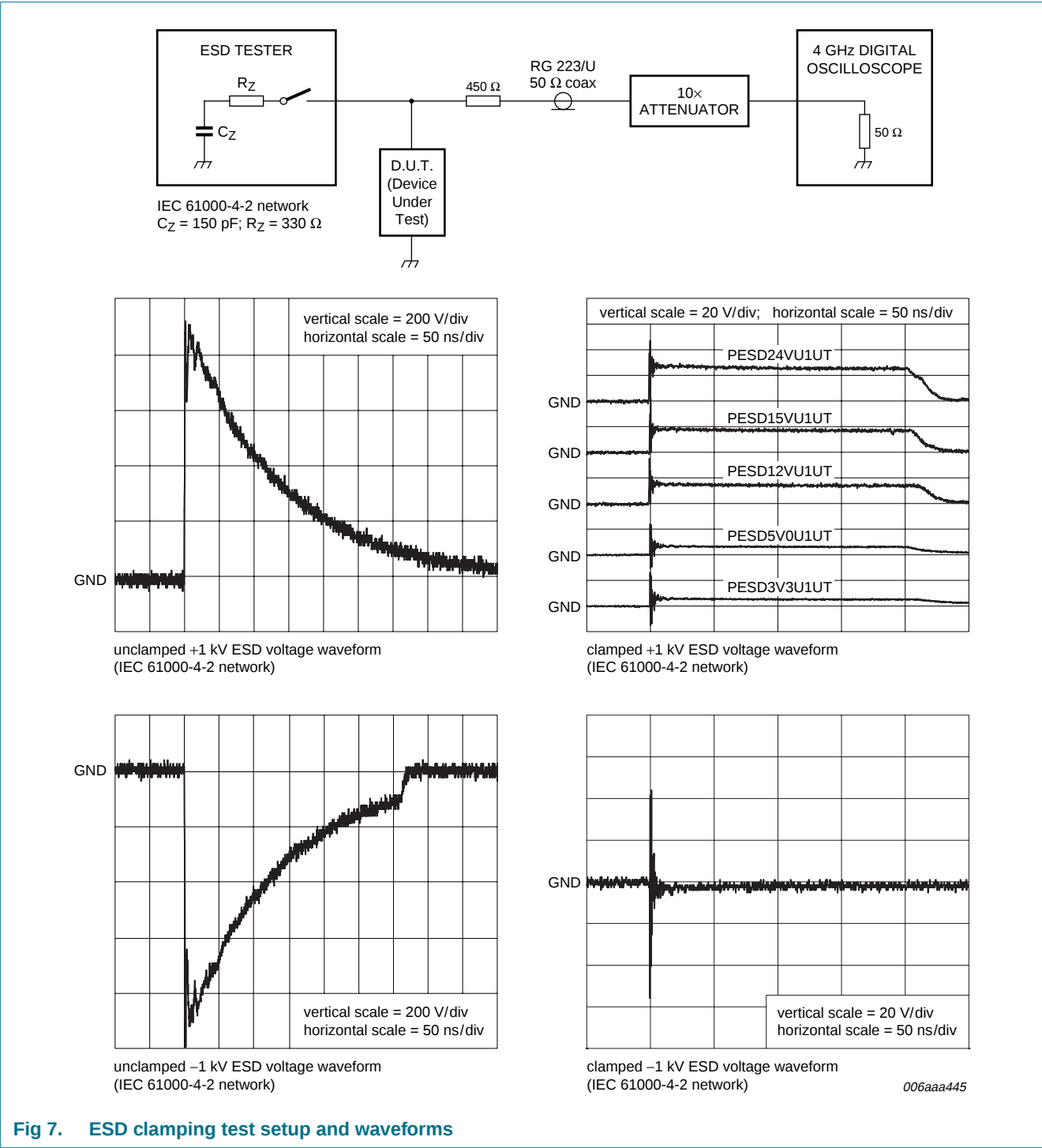
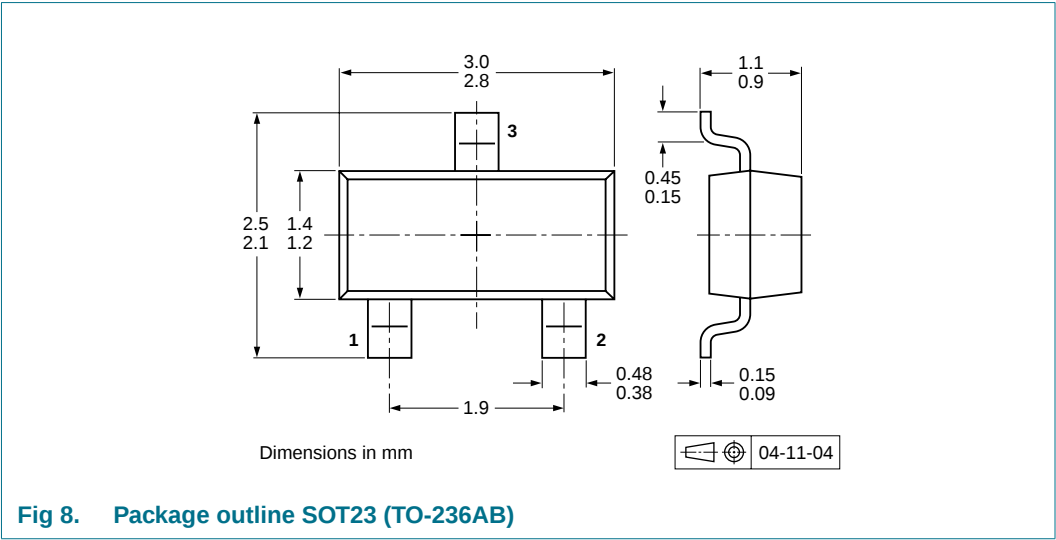


Fig 7. ESD clamping test setup and waveforms

9. Package outline



10. Packing information

Table 9. Packing methods

The -xxx numbers are the last three digits of the 12NC ordering code.<sup>[1]</sup>

| Type number | Package | Description                    | Packing quantity |       |
|-------------|---------|--------------------------------|------------------|-------|
|             |         |                                | 3000             | 10000 |
| PESD3V3U1UT | SOT23   | 4 mm pitch, 8 mm tape and reel | -215             | -235  |
| PESD5V0U1UT |         |                                |                  |       |
| PESD12VU1UT |         |                                |                  |       |
| PESD15VU1UT |         |                                |                  |       |
| PESD24VU1UT |         |                                |                  |       |

[1] For further information and the availability of packing methods, see [Section 13](#).

## 11. Revision history

**Table 10. Revision history**

| Document ID     | Release date                                                                                                                                                                                                                    | Data sheet status  | Change notice | Supersedes      |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|-----------------|
| PESDXU1UT_SER_2 | 20090820                                                                                                                                                                                                                        | Product data sheet | -             | PESDXU1UT_SER_1 |
| Modifications:  | <ul style="list-style-type: none"><li>This data sheet was changed to reflect the new company name NXP Semiconductors, including new legal definitions and disclaimers. No changes were made to the technical content.</li></ul> |                    |               |                 |
| PESDXU1UT_SER_1 | 20050511                                                                                                                                                                                                                        | Product data sheet | -             | -               |

## 12. Legal information

### 12.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|-----------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[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 URL <http://www.nxp.com>.

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