

# TVS Diode

Transient Voltage Suppressor Diode

## ESD5V3U4U-HDMI

Uni-directional Ultra-low Capacitance ESD / Transient Protection Array

ESD5V3U4U-HDMI

## Data Sheet

Revision 1.1, 2012-07-03  
Final

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## Revision History Revision 1.0, 2012-06-30

| Page or Item | Subjects (major changes since previous revision) |
|--------------|--------------------------------------------------|
|--------------|--------------------------------------------------|

## Revision 1.1, 2012-07-03

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| 7 | Figure 2-1 |
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Last Trademarks Update 2010-10-26

# 1 Uni-directional Ultra-low Capacitance ESD / Transient Protection Array

## 1.1 Features

- ESD / Transient protection of high speed data lines exceeding:
  - IEC61000-4-2 (ESD):  $\pm 20$  kV (air / contact)
  - IEC61000-4-4 (EFT): 2.5 kV / 50 A (5/50 ns)
  - IEC61000-4-5 (surge): 3 A (8/20  $\mu$ s)
- Maximum working voltage:  $V_R = 5.3$  V
- Very low reverse current:  $I_R < 1$  nA typ.
- Extremely low capacitance: 0.4 pF typ. (I/O to GND)
- Four-lines protection array with pad pitch = 0.5 mm
- Flow-through design for optimal PCB layout of differential lines
- Pb-free package (RoHS compliant) and halogen free package



## 1.2 Application Examples

- Protection of high speed digital interfaces like:
- HDMI 1.3, HDMI 1.4a, MHL, DisplayPort, S-ATA, DVI, MIPI, MDDI
- USB2.0, 10/100/1000 Ethernet, FireWire

# 2 Product Description

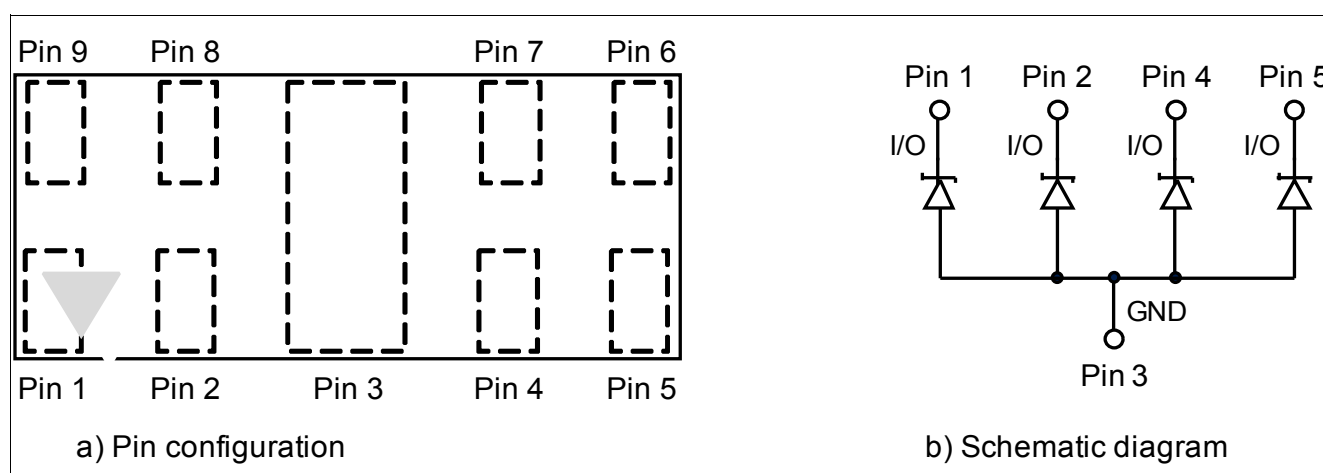


Figure 2-1 Pin Configuration and Schematic Diagram

Table 2-1 Ordering information

| Type           | Package     | Configuration            | Marking code |
|----------------|-------------|--------------------------|--------------|
| ESD5V3U4U-HDMI | PG-TSLP-9-1 | 4 lines, uni-directional | Z1           |

### 3 Characteristics

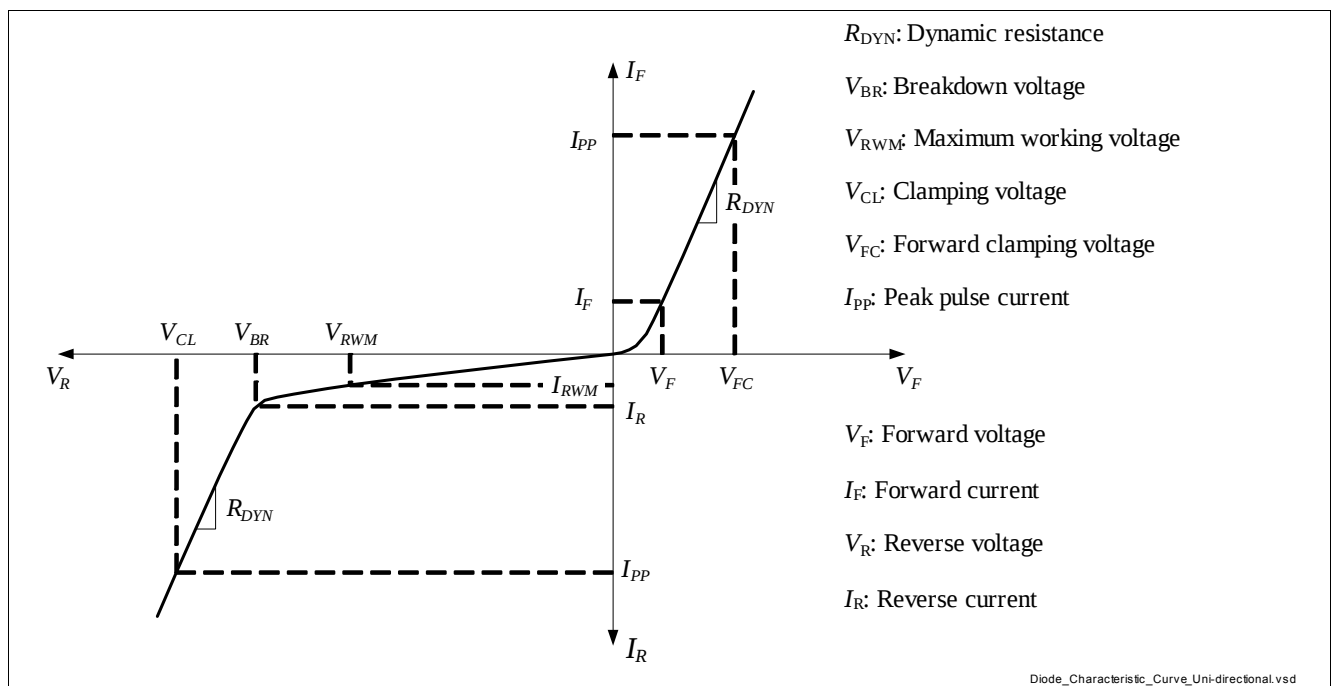
**Table 3-1** Maximum Rating at  $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified

| Parameter                                                            | Symbol           | Values |      |      | Unit               |
|----------------------------------------------------------------------|------------------|--------|------|------|--------------------|
|                                                                      |                  | Min.   | Typ. | Max. |                    |
| ESD (air / contact) discharge <sup>1)</sup>                          | $V_{\text{ESD}}$ | –      | –    | 20   | kV                 |
| Peak pulse current ( $t_p = 8/20\text{ }\mu\text{s}$ ) <sup>2)</sup> | $I_{\text{PP}}$  | –      | –    | 3    | A                  |
| Operating temperature range                                          | $T_{\text{OP}}$  | -40    | –    | 125  | $^{\circ}\text{C}$ |
| Storage temperature                                                  | $T_{\text{stg}}$ | -65    | –    | 150  | $^{\circ}\text{C}$ |

1)  $V_{\text{ESD}}$  according to IEC61000-4-2

2)  $I_{\text{PP}}$  according to IEC61000-4-5

#### 3.1 Electrical Characteristics at $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified



**Figure 3-1** Definitions of Electrical Characteristics

**Table 3-2** DC Characteristics at  $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified

| Parameter               | Symbol           | Values |      |      | Unit | Note / Test Condition                         |
|-------------------------|------------------|--------|------|------|------|-----------------------------------------------|
|                         |                  | Min.   | Typ. | Max. |      |                                               |
| Reverse working voltage | $V_{\text{RWM}}$ | –      | –    | 5.3  | V    |                                               |
| Breakdown voltage       | $V_{\text{BR}}$  | 6      | –    | –    | V    | $I_{\text{BR}} = 1\text{ mA}$<br>(I/O to GND) |
| Reverse current         | $I_{\text{R}}$   | –      | <1   | 50   | nA   | $V_{\text{R}} = 5.3\text{ V}$<br>(I/O to GND) |

## Characteristics

**Table 3-3 RF Characteristics at  $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified**

| Parameter                      | Symbol | Values |      |      | Unit | Note / Test Condition                                   |
|--------------------------------|--------|--------|------|------|------|---------------------------------------------------------|
|                                |        | Min.   | Typ. | Max. |      |                                                         |
| Line capacitance <sup>1)</sup> | $C_L$  | –      | 0.4  | 0.6  | pF   | $V_R = 0\text{ V}$ , $f = 1\text{ MHz}$<br>(I/O to GND) |
| Line capacitance <sup>1)</sup> | $C_L$  | –      | 0.2  | 0.3  | pF   | $V_R = 0\text{ V}$ , $f = 1\text{ MHz}$<br>(I/O to I/O) |

1) Total capacitance line to ground

**Table 3-4 ESD Characteristics at  $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified**

| Parameter                              | Symbol    | Values |      |      | Unit     | Note / Test Condition                  |
|----------------------------------------|-----------|--------|------|------|----------|----------------------------------------|
|                                        |           | Min.   | Typ. | Max. |          |                                        |
| Clamping voltage <sup>1)</sup>         | $V_{CL}$  | –      | 19   | –    | V        | $I_{PP} = 16\text{ A}$<br>(I/O to GND) |
|                                        |           | –      | 28   | –    | V        | $I_{PP} = 30\text{ A}$<br>(I/O to GND) |
| Forward clamping voltage <sup>1)</sup> | $V_{FC}$  | –      | 10   | –    | V        | $I_{PP} = 16\text{ A}$<br>(GND to I/O) |
|                                        |           | –      | 17   | –    | V        | $I_{PP} = 30\text{ A}$<br>(GND to I/O) |
| Dynamic resistance <sup>1)</sup>       | $R_{DYN}$ | –      | 0.6  | –    | $\Omega$ | I/O to GND                             |
|                                        |           | –      | 0.5  | –    |          | GND to I/O                             |

1) Please refer to Application Note AN210 [4]. TLP parameter:  $Z_0 = 50\text{ }\Omega$ ,  $t_p = 100\text{ ns}$ ,  $t_r = 300\text{ ps}$ , averaging window:  $t_1 = 30\text{ ns}$  to  $t_2 = 60\text{ ns}$ , extraction of dynamic resistance using least squares fit of TLP characteristic between  $I_{PP1} = 10\text{ A}$  and  $I_{PP2} = 40\text{ A}$ .

### 3.2 Typical Characteristics at $T_A = 25^\circ\text{C}$ , unless otherwise specified

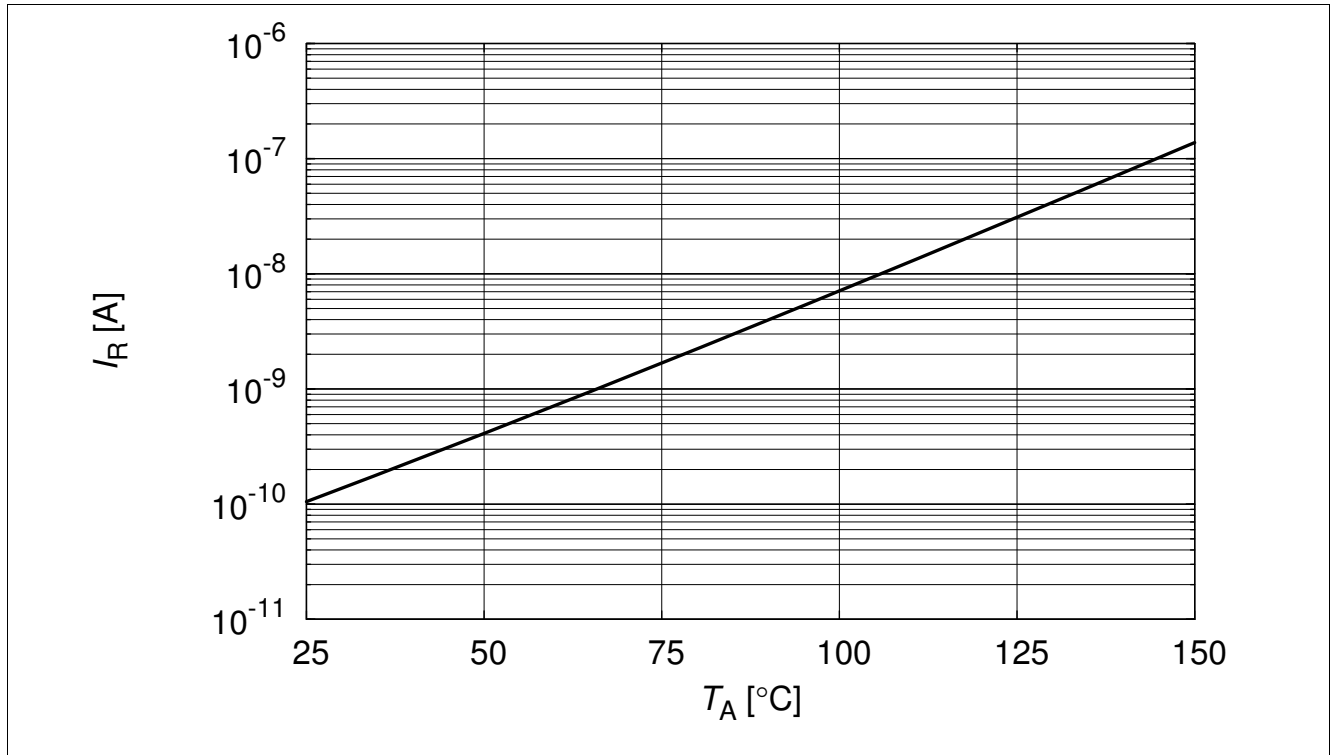


Figure 3-2 Reverse current:  $I_R = f(T_A)$ ,  $V_R = 5.3\text{ V}$ , (I/O to GND)

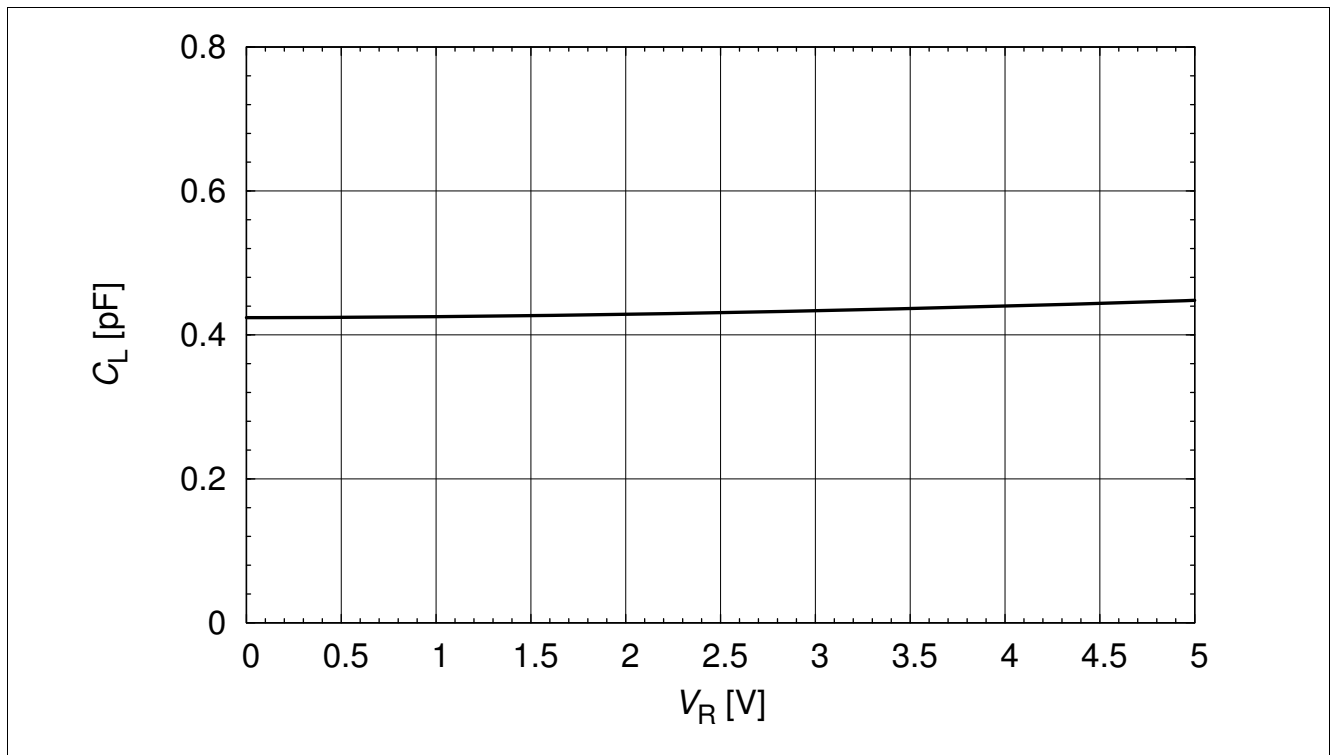


Figure 3-3 Diode capacitance:  $C_L = f(V_R)$ , (I/O to GND)

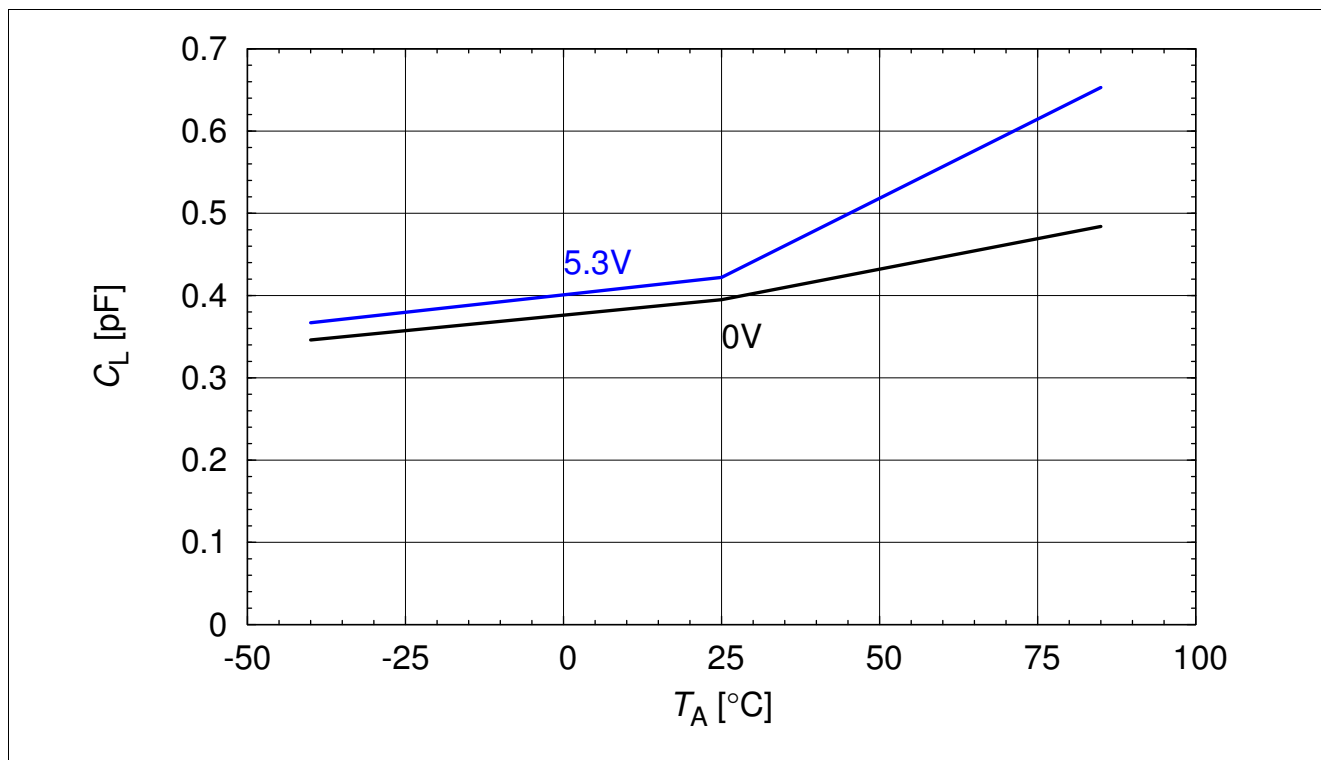


Figure 3-4 Line capacitance:  $C_L = f(T_A)$

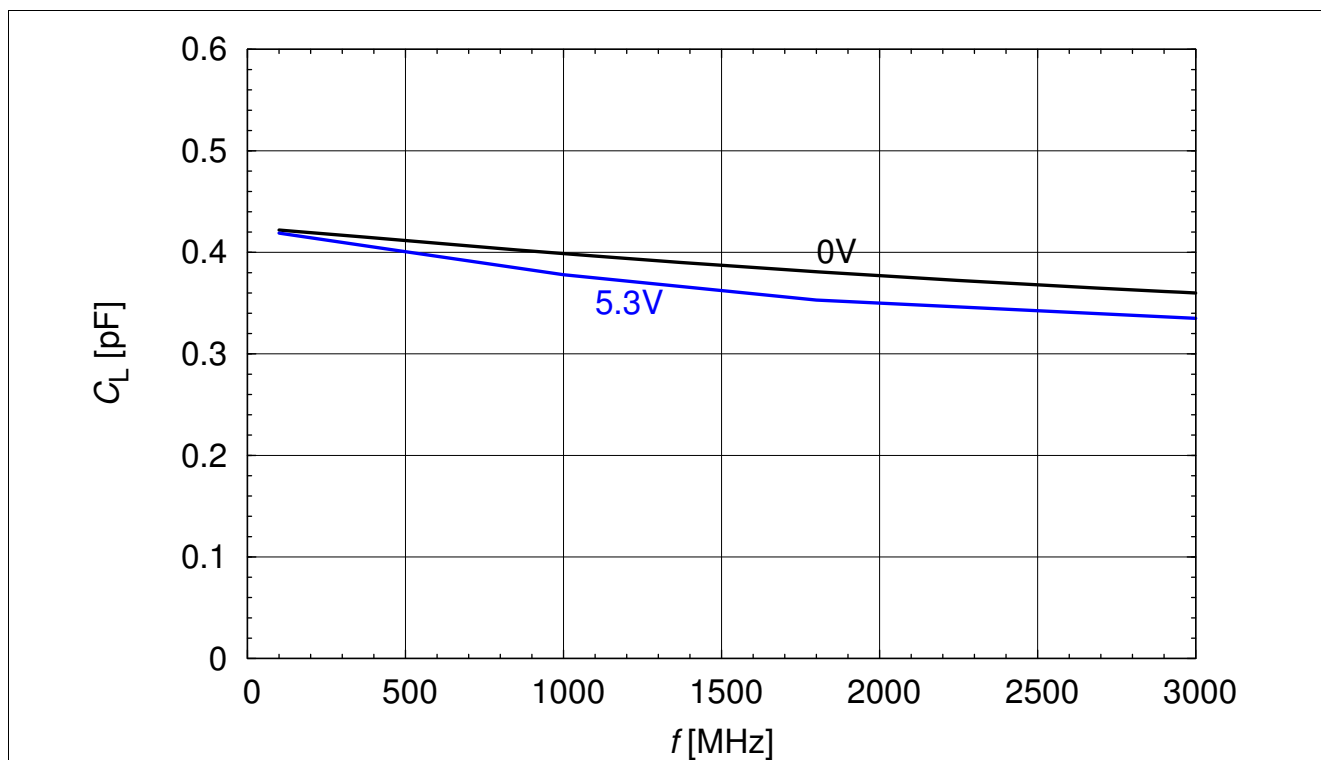


Figure 3-5 Line capacitance:  $C_L = f(f)$ , (I/O to GND)

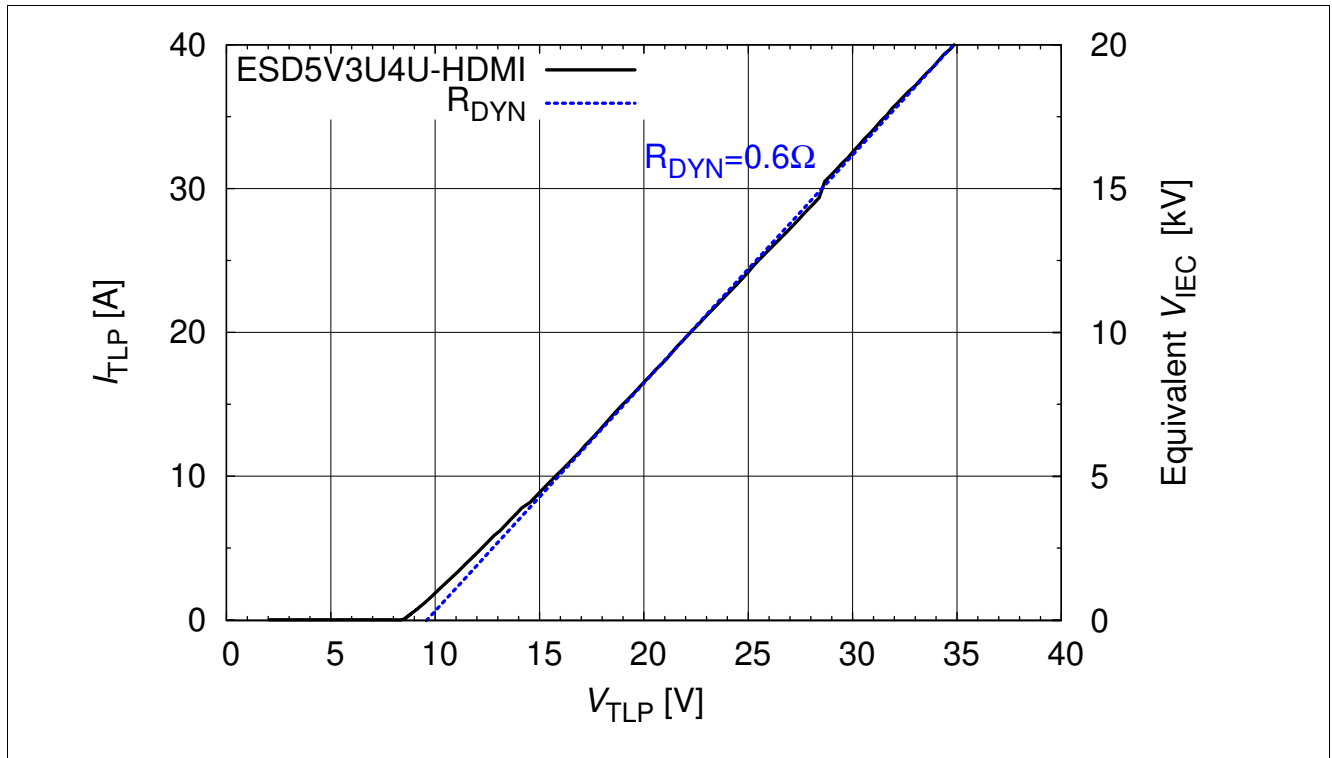


Figure 3-6 Forward clamping voltage:  $I_{TLP} = f(V_{TLP})$ , (GND to I/O) [1]

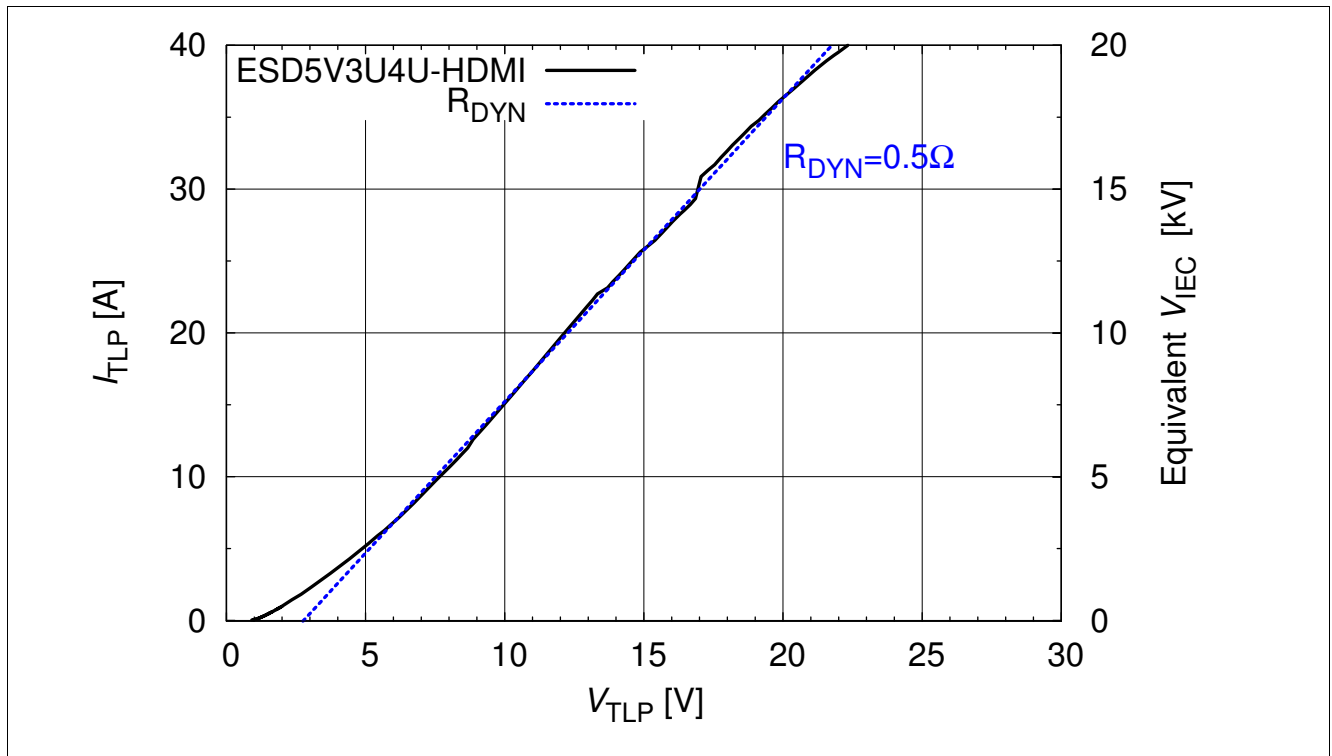


Figure 3-7 Reverse clamping voltage:  $I_{TLP} = f(V_{TLP})$ , (I/O to GND) [1]

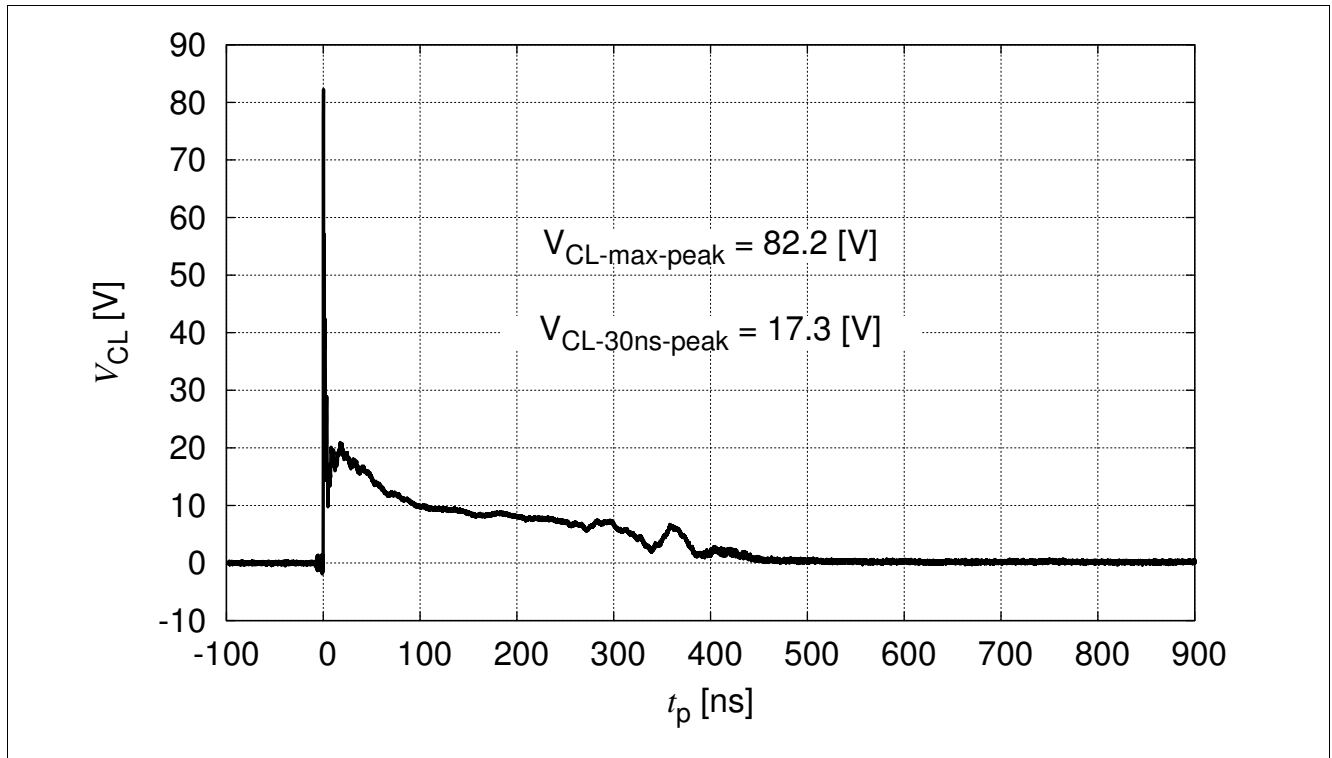


Figure 3-8 IEC61000-4-2  $V_{CL} = f(t)$ , 8 kV positive pulse, (I/O to GND)

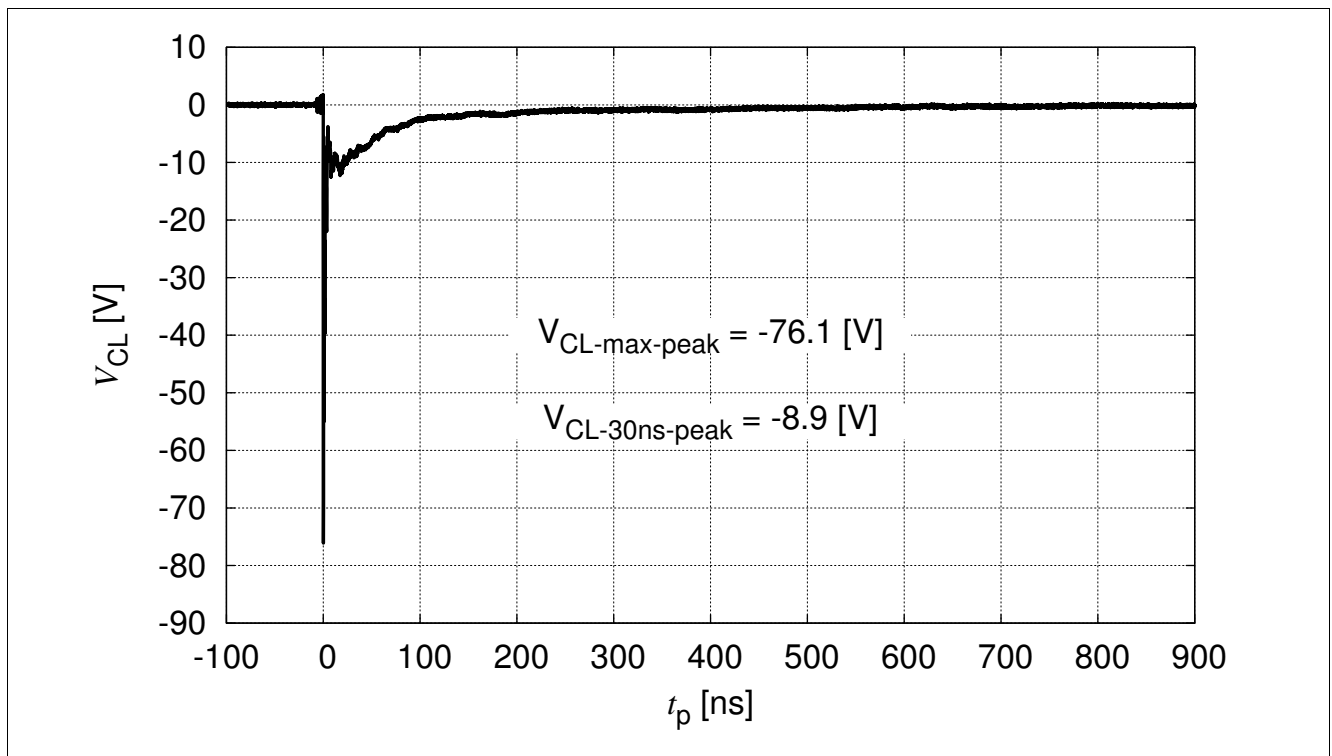


Figure 3-9 IEC61000-4-2  $V_{CL} = f(t)$ , 8 kV negative pulse, (I/O to GND)

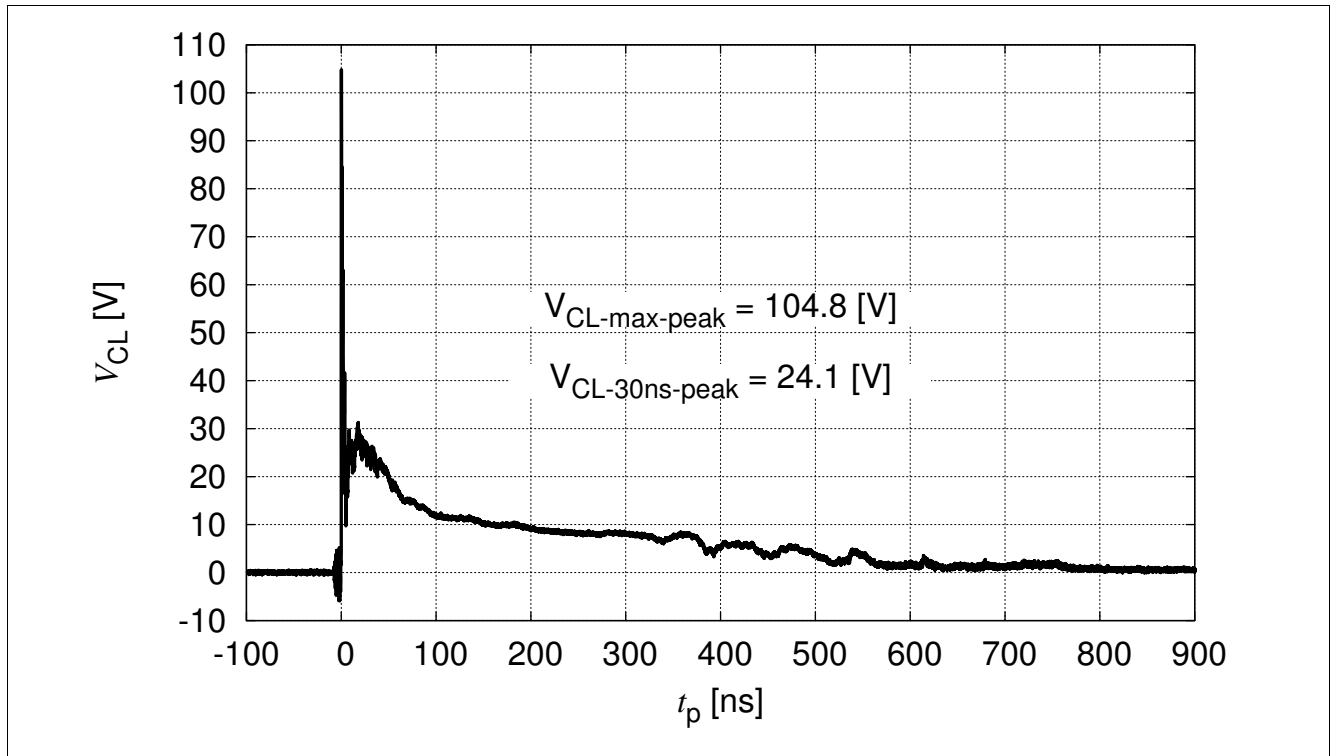


Figure 3-10 IEC61000-4-2  $V_{CL} = f(t)$ , 15 kV positive pulse, (I/O to GND)

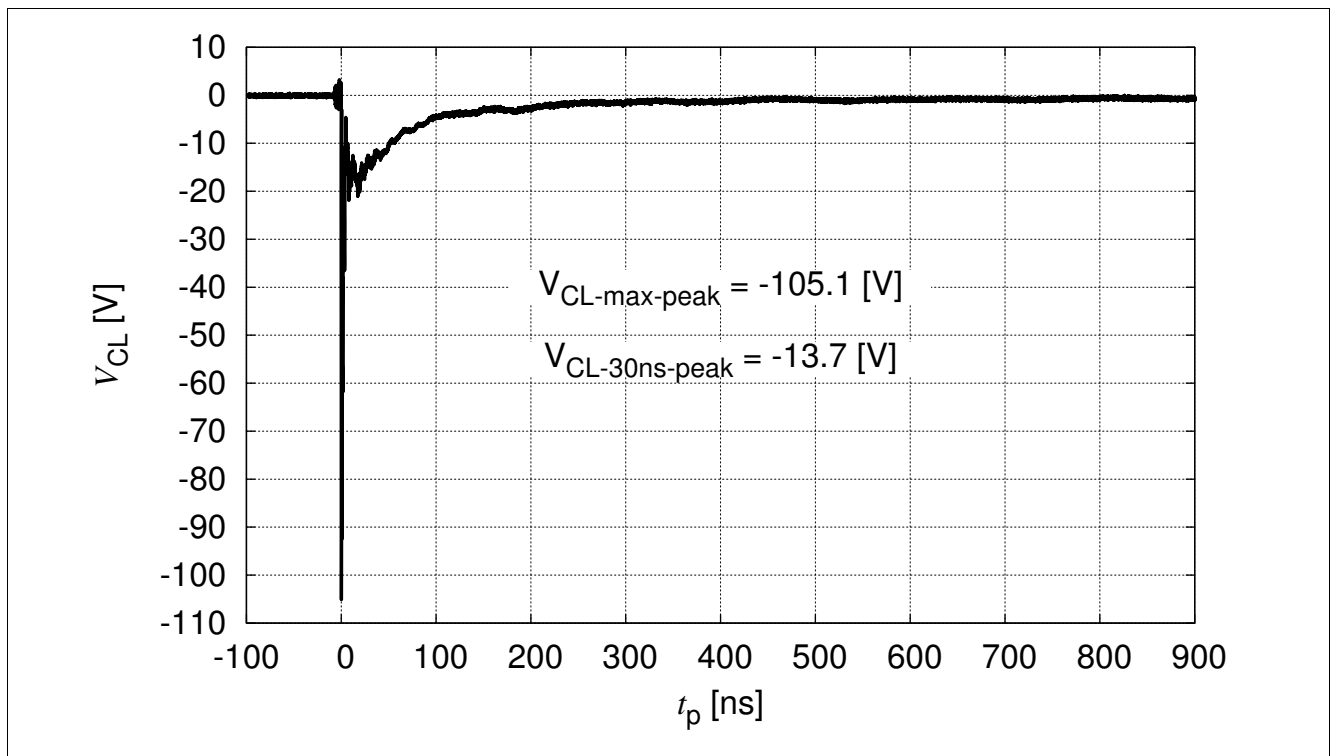
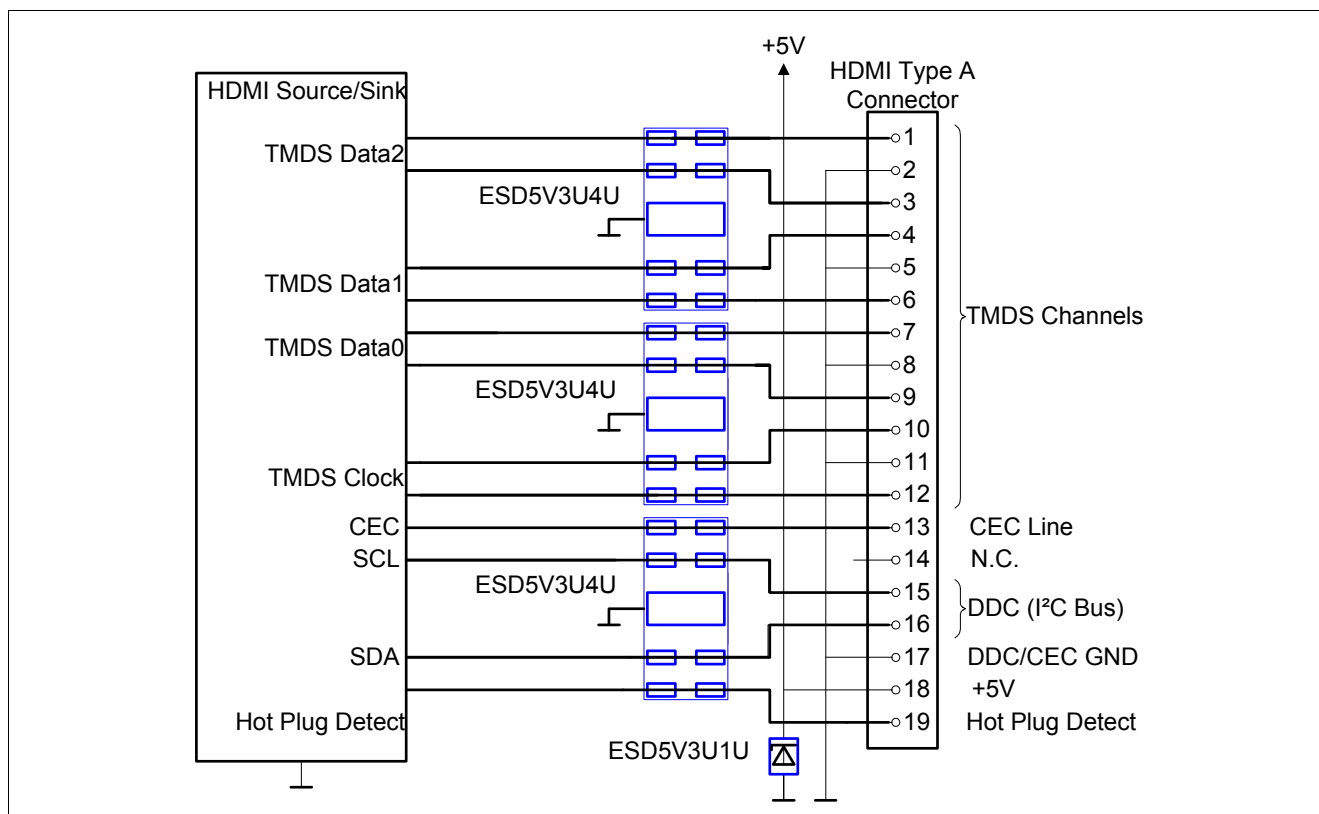


Figure 3-11 IEC61000-4-2  $V_{CL} = f(t)$ , 15 kV negative pulse, (I/O to GND)

## 4 Application Information



**Figure 4-1 4 lines, uni-directional ESD5V3U4U-HDMI**

For protection on the 5 V supply rail please refer to ESD5V3U1U- TVS diode data sheet.

## 5 Ordering Information Scheme (Examples)

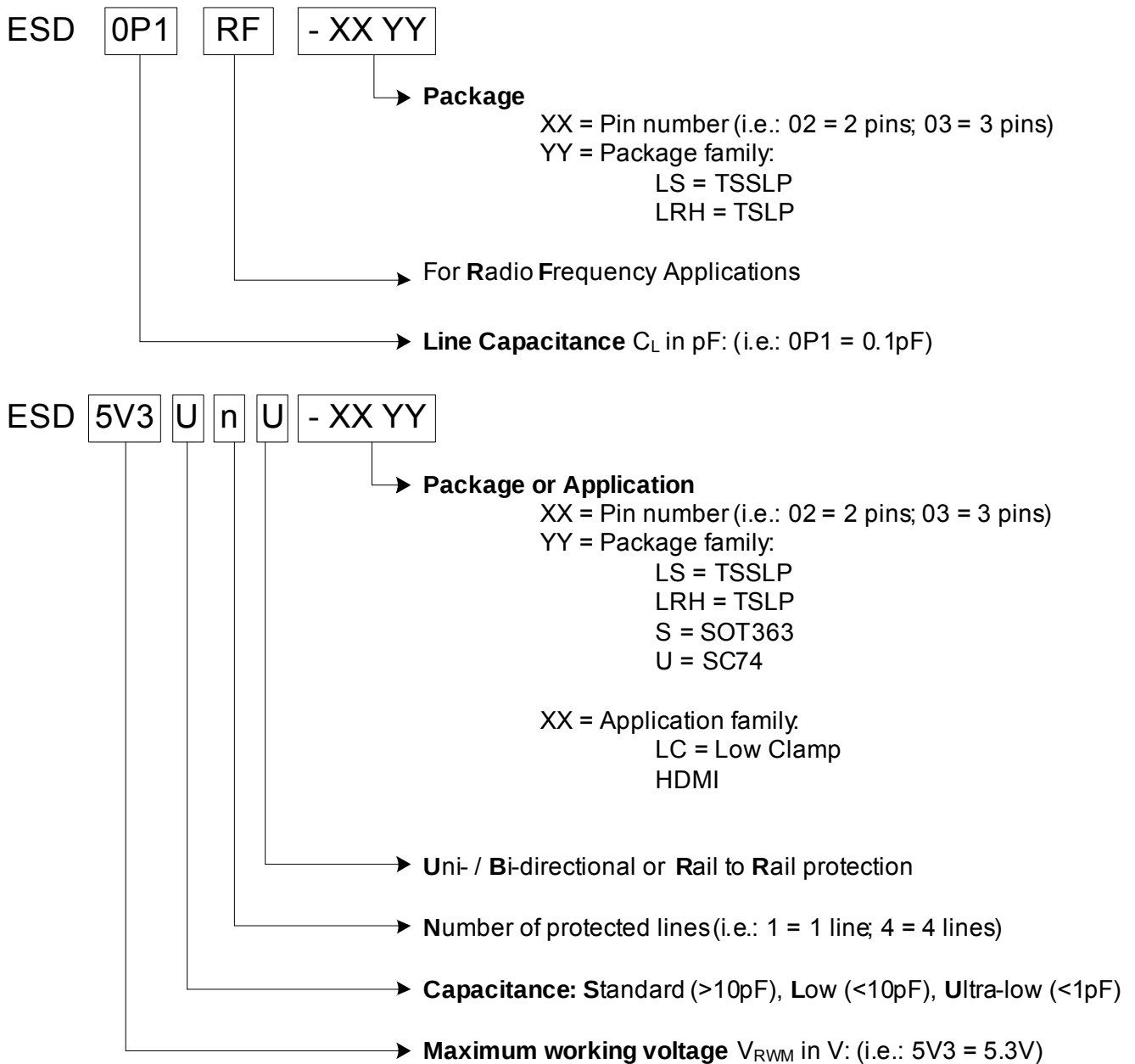
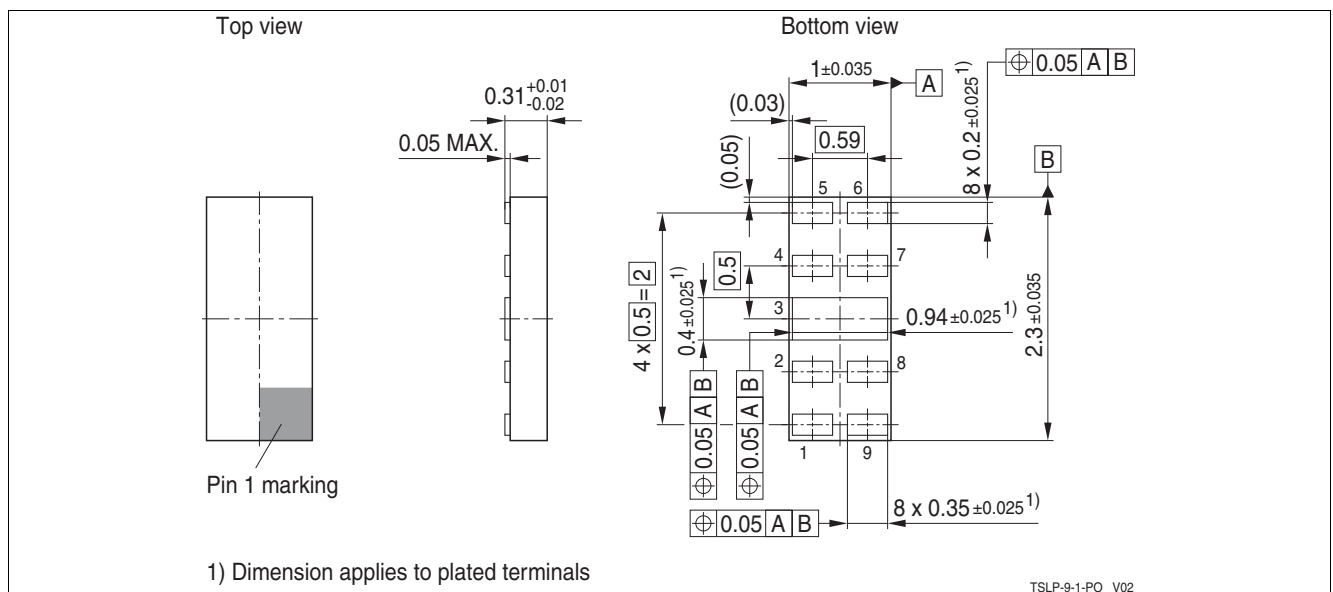


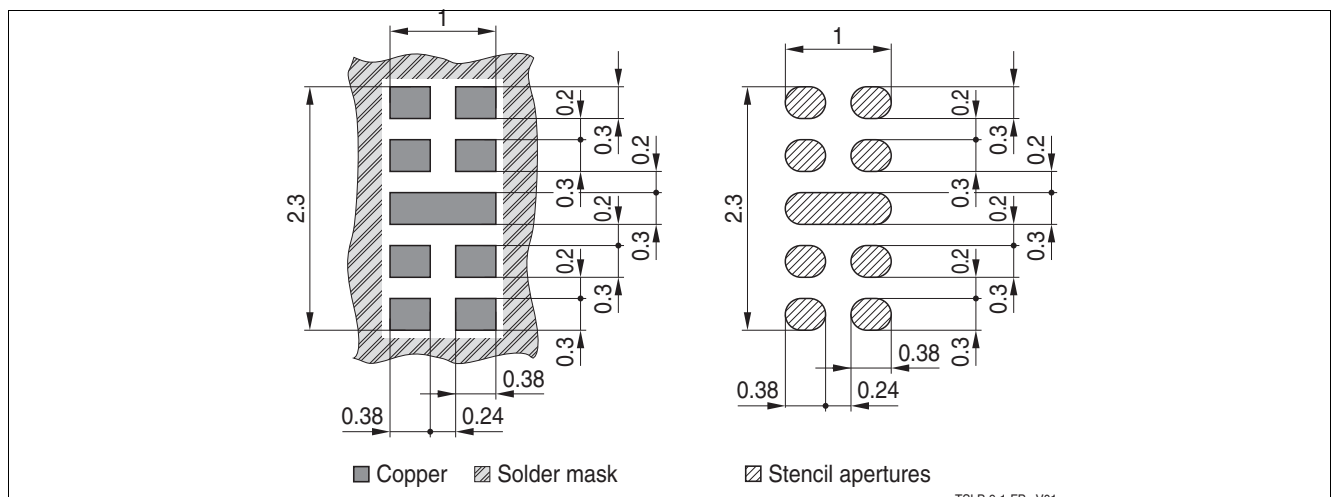
Figure 5-1 Ordering information scheme

## 6 Package Information

## 6.1 PG-TSLP-9-1



**Figure 6-1 PG-TSLP-9-1: Package overview**



**Figure 6-2 PG-TSLP-9-1: Footprint**

Package Information

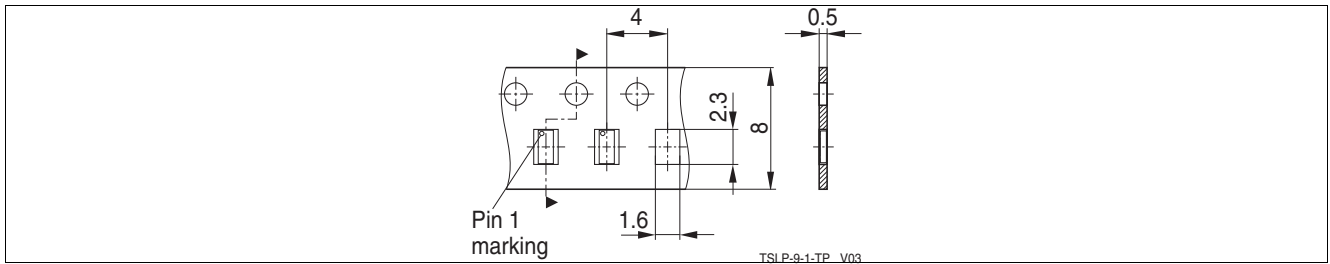


Figure 6-3 PG-TSLP-9-1: Packing

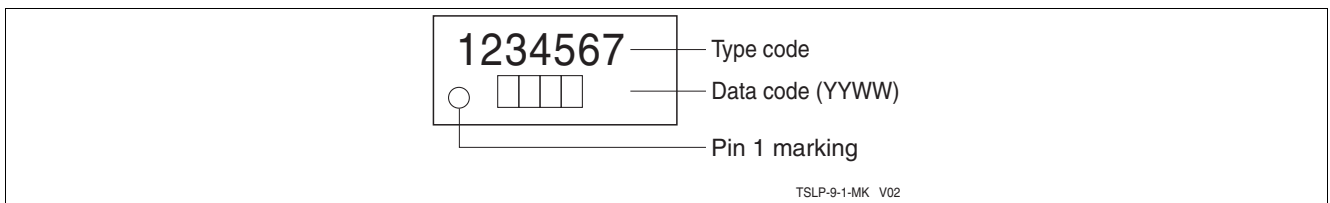


Figure 6-4 PG-TSLP-9-1: Marking (example)

## References

- [1] Infineon AG - **Application Note AN210**: Effective ESD Protection Design at System Level Using VF-TLP Characterization Methodology

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