# TVS Diode

Transient Voltage Suppressor Diode

# ESD5V3U4U-HDMI

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

ESD5V3U4U-HDMI

## Data Sheet

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| **Revision 1.0, 2011-06-30** | |
| all | data sheet conversion to Framemaker template |
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# Predefined Names

| Name | Initial Cross-Reference |
|---|---|
| X-GOLD | **X-GOLD** |
| XMM | **XMM** |
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**Definition of “Predefined Names”**

Frequently used expressions, such as component names, file names, tools releases, version numbers, proprietary variables and software links, can be used in a similar way as user variables. However, they must be listed in a special table and **not** in the standard file “Variables”.

**Correct Usage**

Steps:

1. Insert all expressions into the left column of the above table.
2. Insert an initial Cross-Reference into the right column of the same row. The initial Cross-Reference is necessary to ensure that a single ID is used in all your documents using the “Predefined_Names.fm” file (Example: **X-GOLD** has the unique ID = CHDGHJGH).
3. Insert a Cross-Reference (Element “CrossReference”) into your document to the Element Identifier of the “Predefined_Names.fm” file. Set the output format of the Cross-Reference to “Variable” (example: X-GOLD).

**Notes**

1. *All documents in a project (such as XMM) and within a book should use the same file “Predefined Names”. This allows copying content between different documents. For this reason, local versions of “Predefined Names” must not be produced.*
2. *New definitions must be inserted in a new row. Never change existing definitions, as they might be used in other documents.*
3. *This file does not need to be included in your book, but it must be in the fm sub-folder of your document.*
4. *You can sort the above table with FrameMaker only if the initial cross-reference in the right column has been properly inserted. Otherwise, the table may only be sorted by hand, as the cross-references to your document would get lost.*

# 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): ±20 kV (air / contact)
  - IEC61000-4-4 (EFT): 2.5 kV / 50 A (5/50 ns)
  - IEC61000-4-5 (surge): 3 A (8/20 µs)
- 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

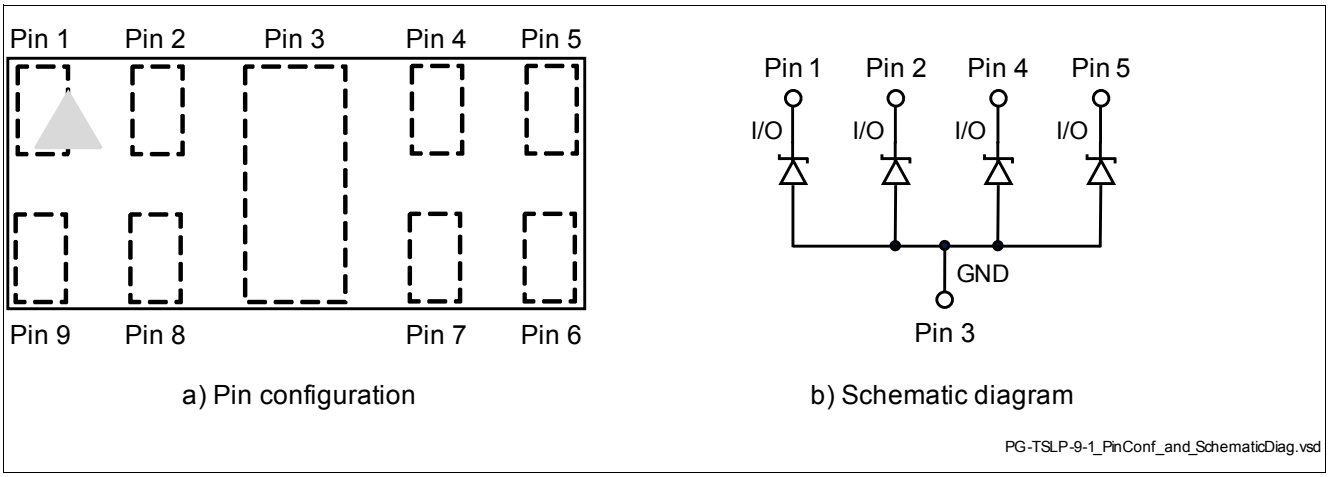


**Figure 2-1 Pin Configuration and Schematic Diagram**

**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 °C, unless otherwise specified

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| ESD (air / contact) discharge[1)] | $V_{ESD}$ | – | – | 20 | kV |
| Peak pulse current ($t_p$ = 8/20 µs)[2)] | $I_{PP}$ | – | – | 3 | A |
| Operating temperature range | $T_{OP}$ | -40 | – | 125 | °C |
| Storage temperature | $T_{stg}$ | -65 | – | 150 | °C |

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

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

## 3.1 Electrical Characteristics at $T_A$ = 25 °C, unless otherwise specified

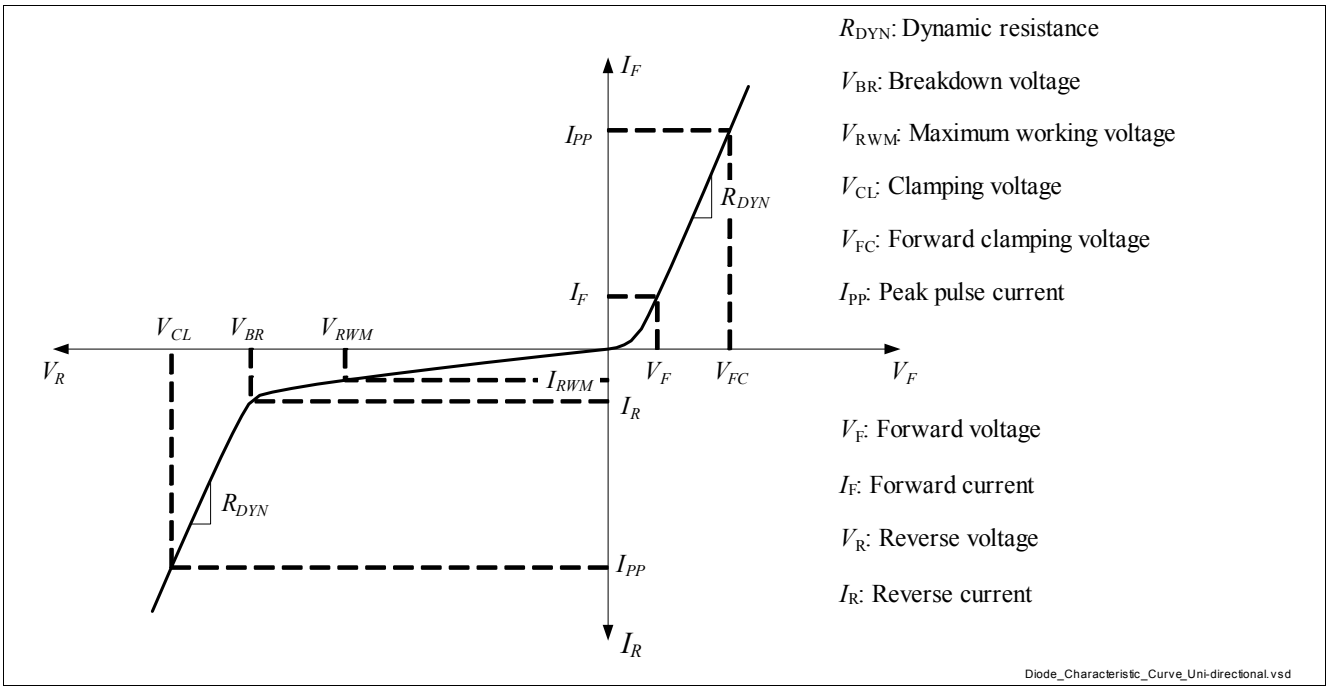


**Figure 3-1 Definitions of Electrical Characteristics**

**Table 3-2 DC Characteristics** at $T_A$ = 25 °C, unless otherwise specified

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

**Table 3-3 RF Characteristics** at $T_A$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Line capacitance[1)] | $C_L$ | – | 0.4 | 0.6 | pF | $V_R$ = 0 V, $f$ = 1 MHz (I/O to GND) |
| Line capacitance[1)] | $C_L$ | – | 0.2 | 0.3 | pF | $V_R$ = 0 V, $f$ = 1 MHz (I/O to I/O) |

1) Total capacitance line to ground

**Table 3-4 ESD Characteristics** at $T_A$ = 25 °C, unless otherwise specified

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

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

## 3.2 Typical Characteristics at $T_A$ = 25°C, unless otherwise specified

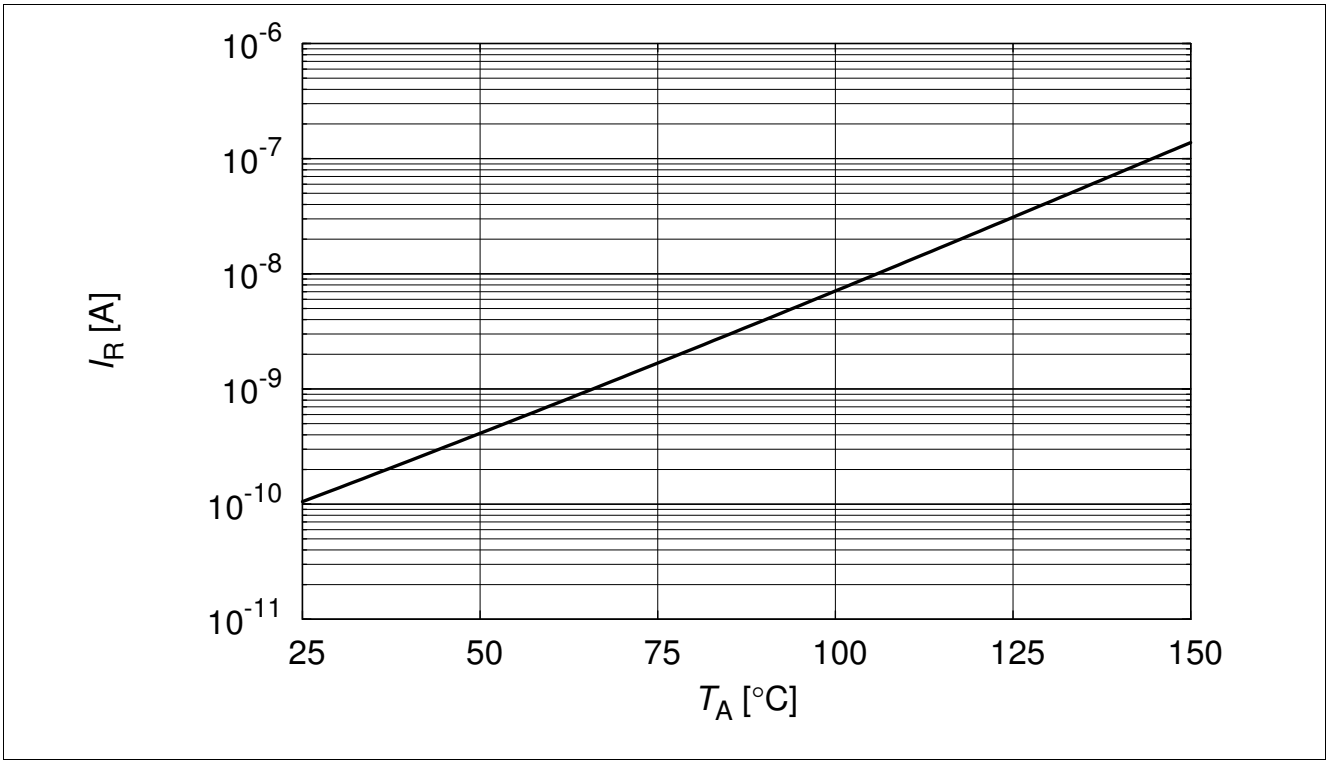


**Figure 3-2 Reverse current: $I_R = f(T_A)$ , $V_R$ = 5.3 V, (I/O to GND)**

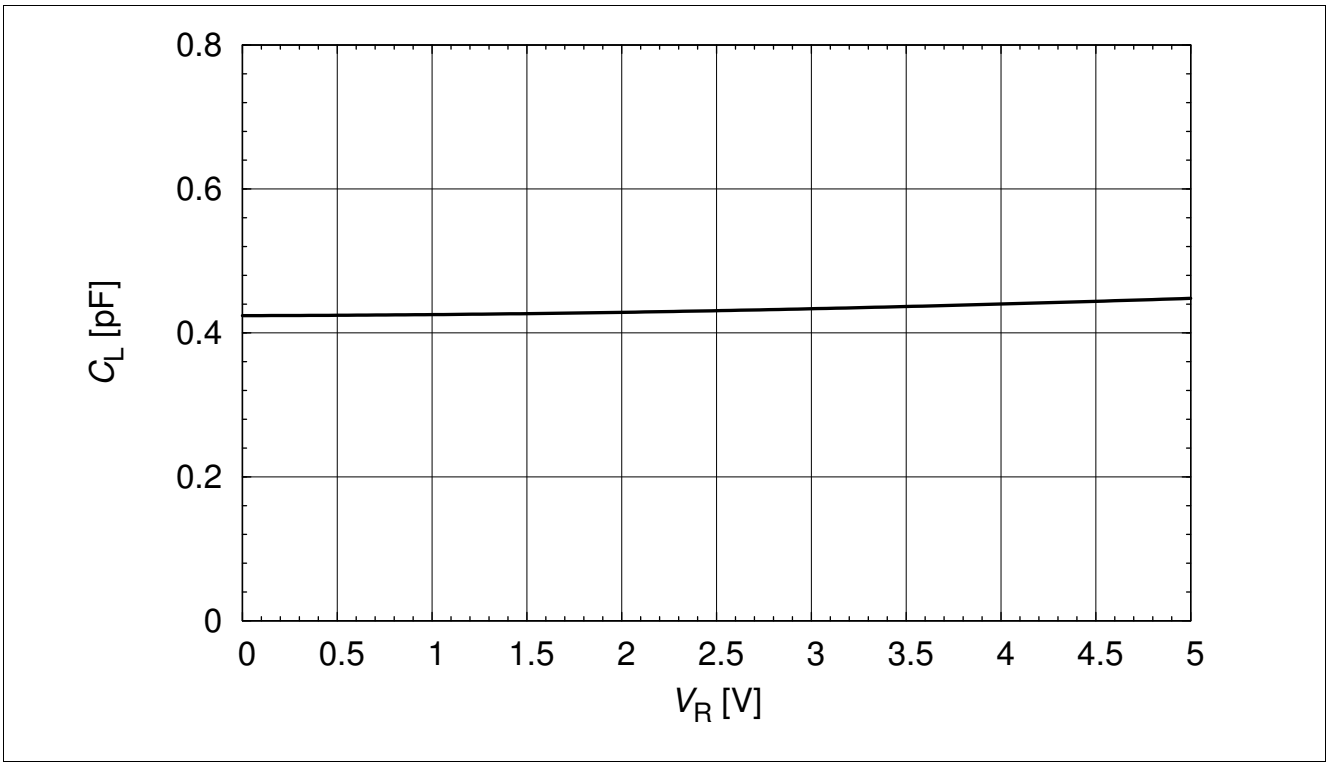


**Figure 3-3 Diode capacitance: $C_L = f(V_R)$, (I/O to GND)**

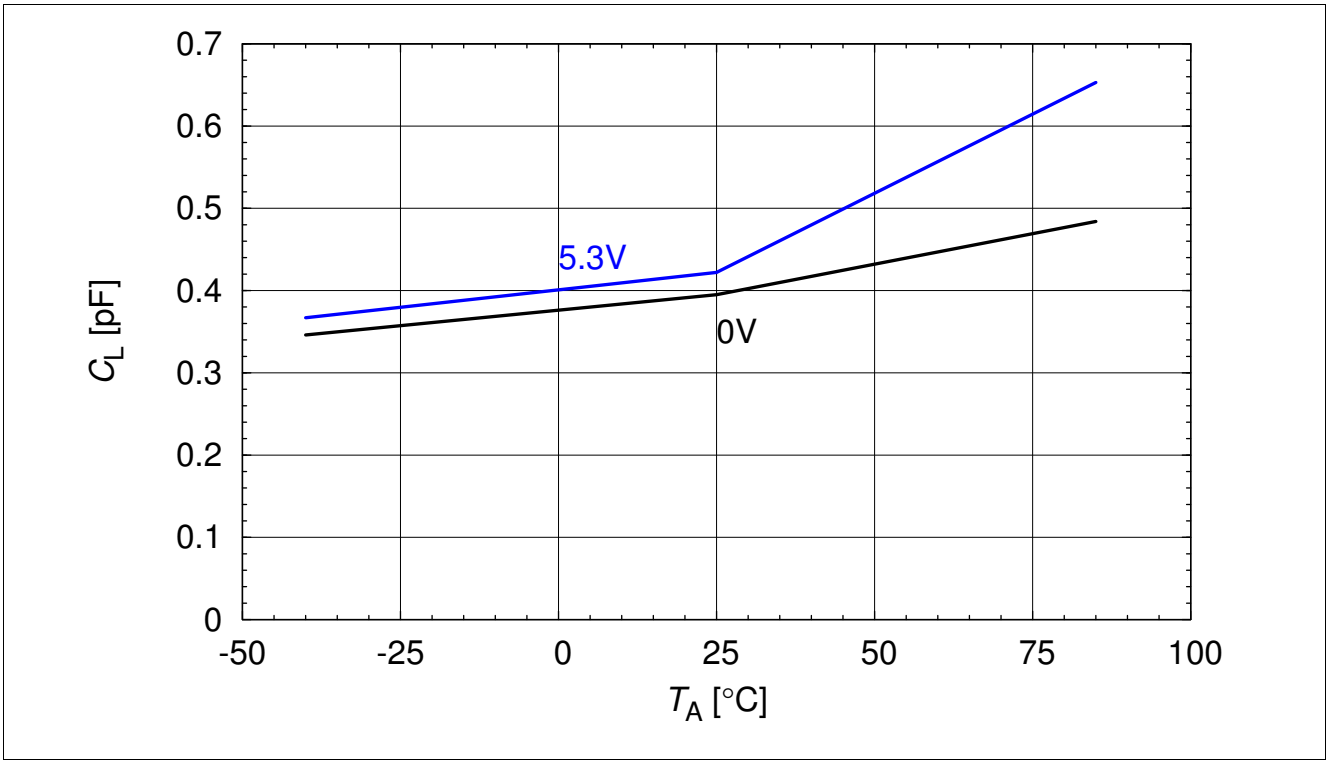


**Figure 3-4 Line capacitance: $C_L = f(T_A)$**

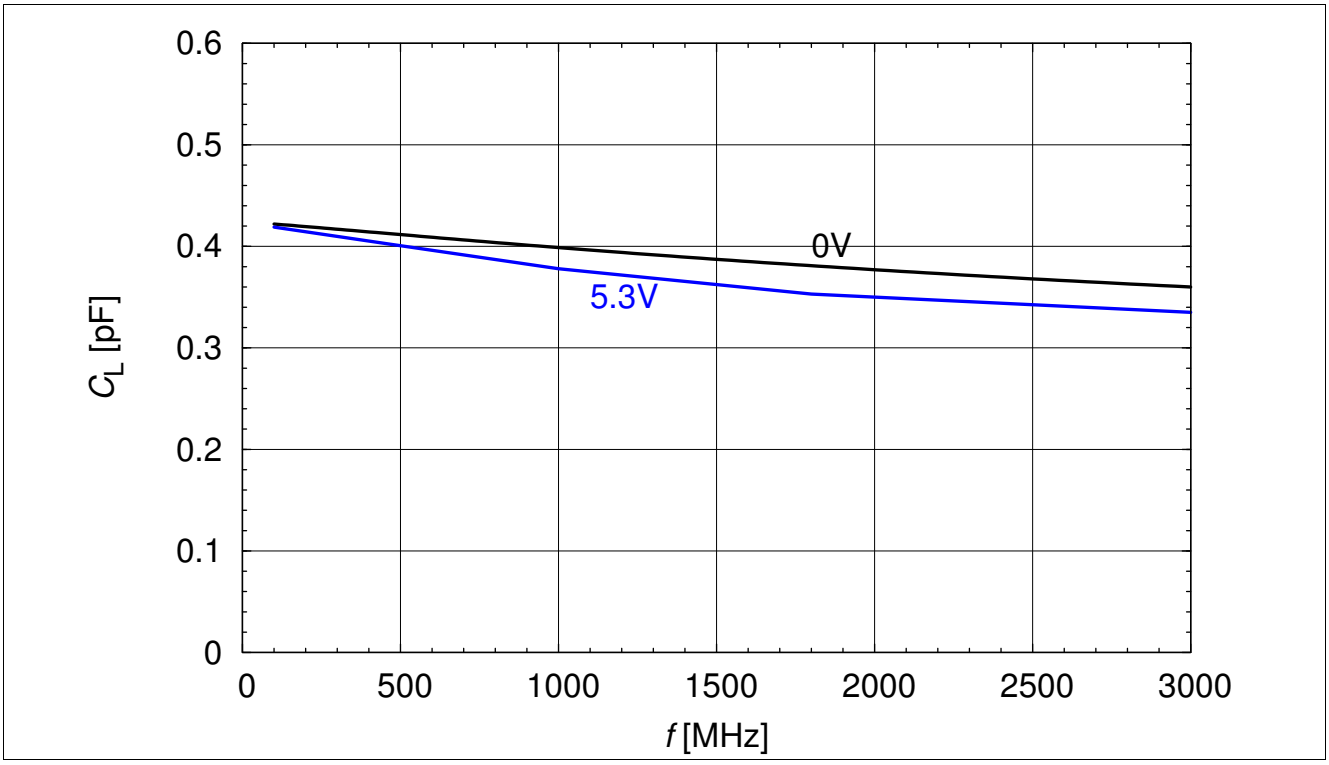


**Figure 3-5 Line capacitance: $C_L = f(f)$, (I/O to GND)**

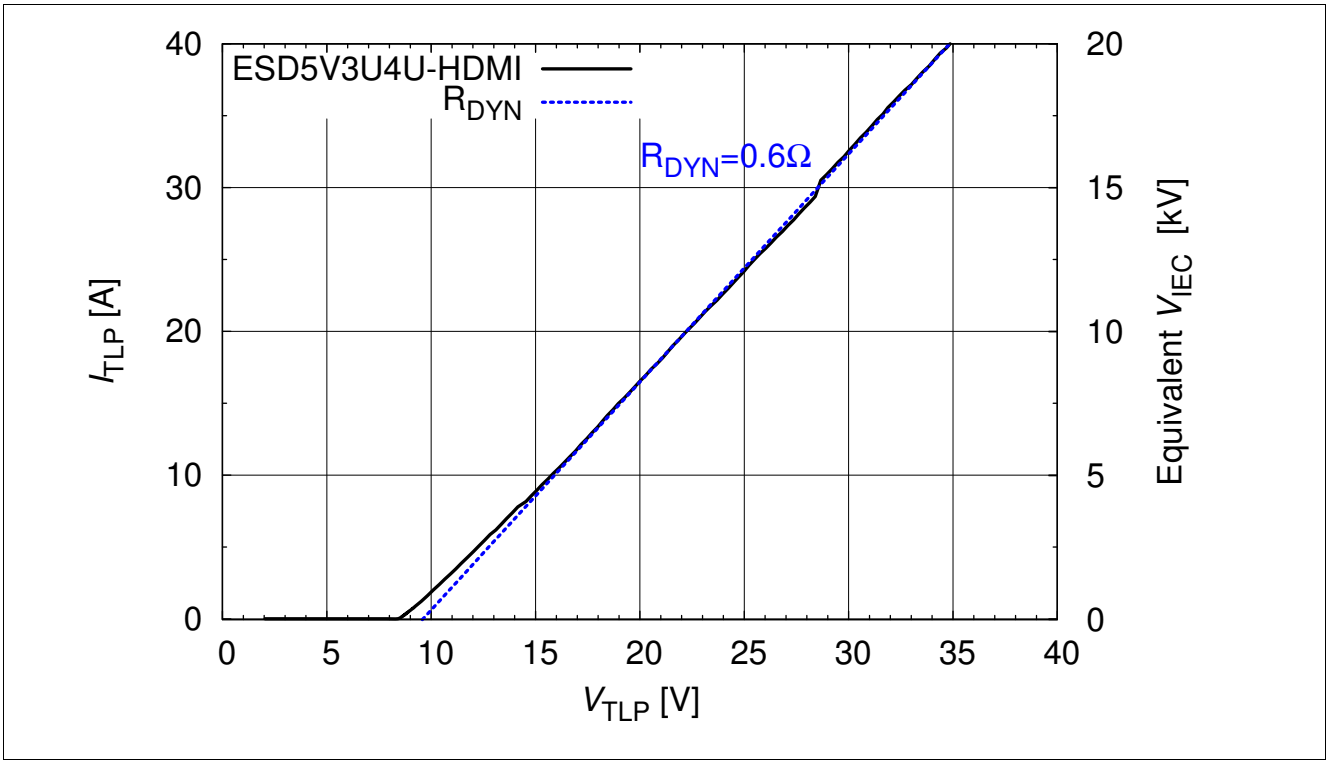


**Figure 3-6 Forward clamping voltage: $I_{TLP} = f(V_{TLP})$, (GND to I/O) [1]**

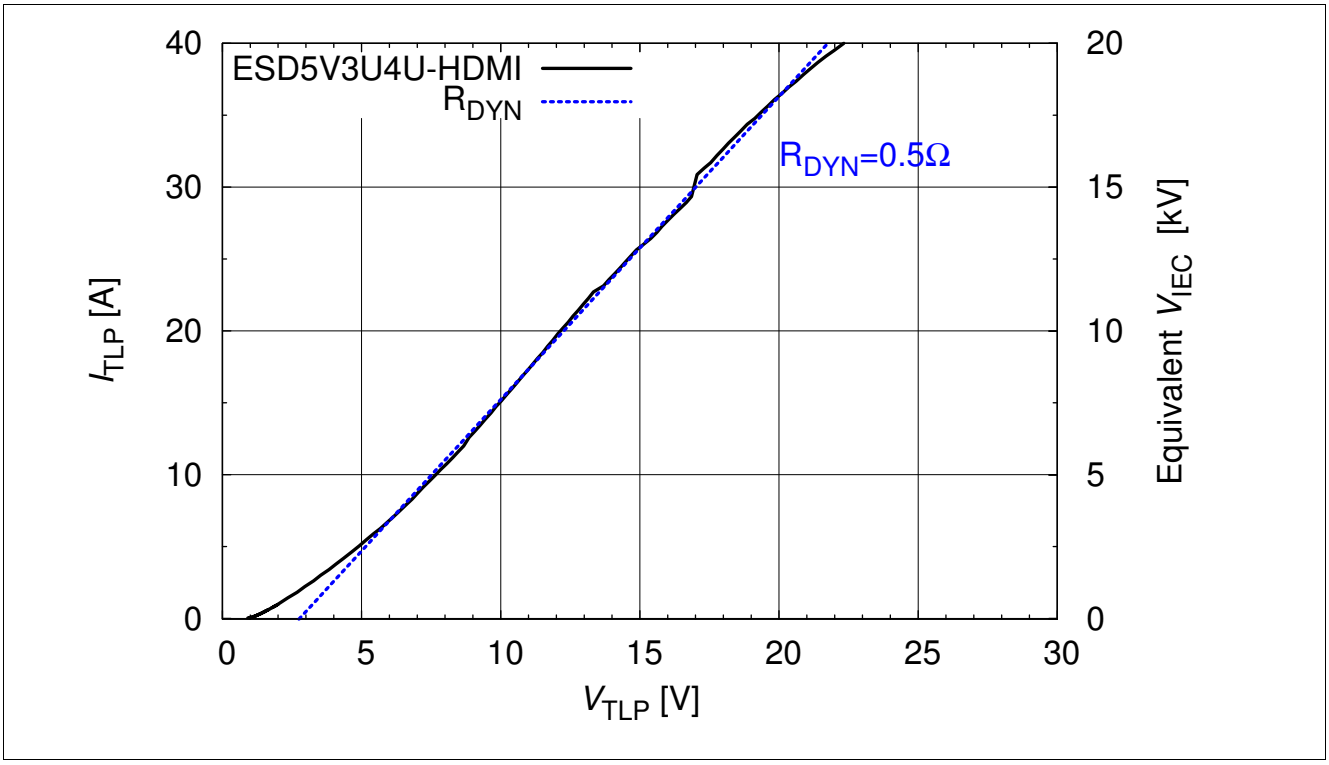


**Figure 3-7 Reverse clamping voltage: $I_{TLP} = f(V_{TLP})$, (I/O to GND) [1]**

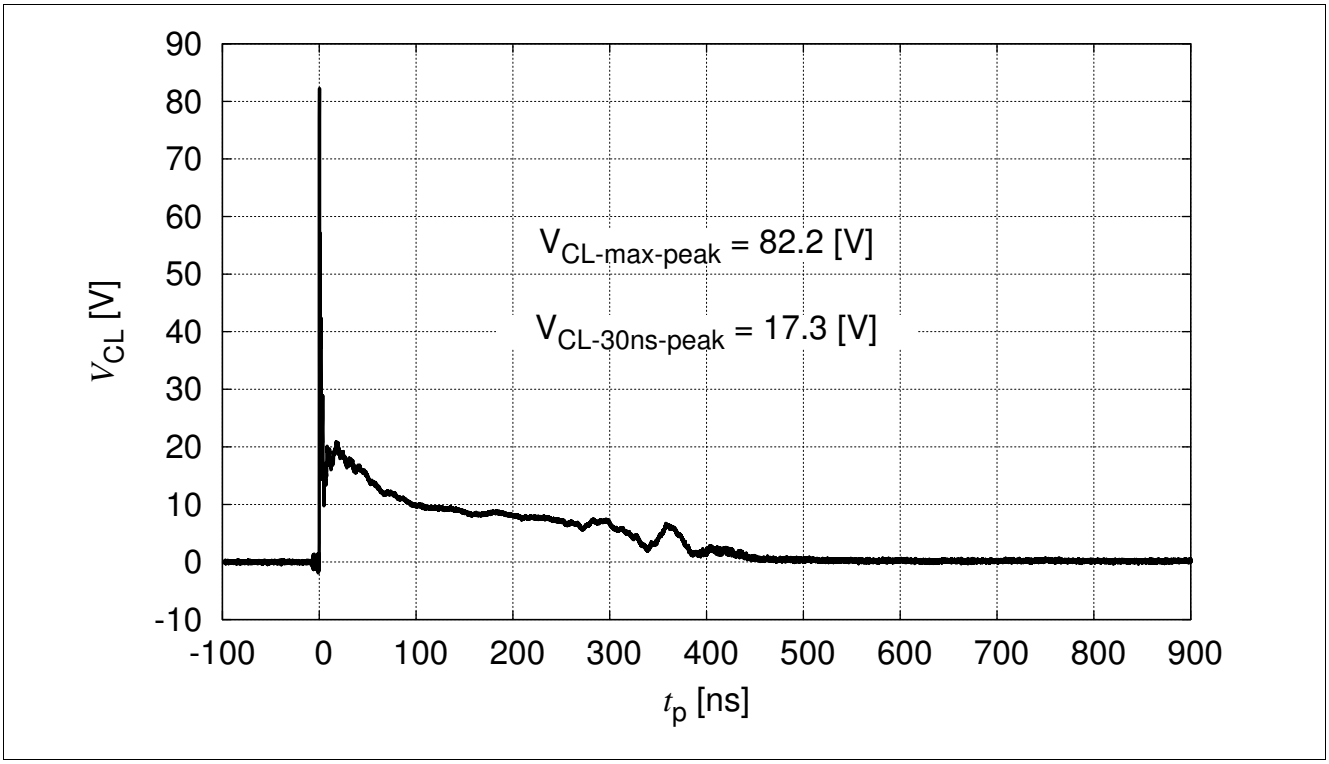


**Figure 3-8 IEC61000-4-2 $V_{CL} = f(t)$, 8 kV positive pulse, (I/O to GND)**

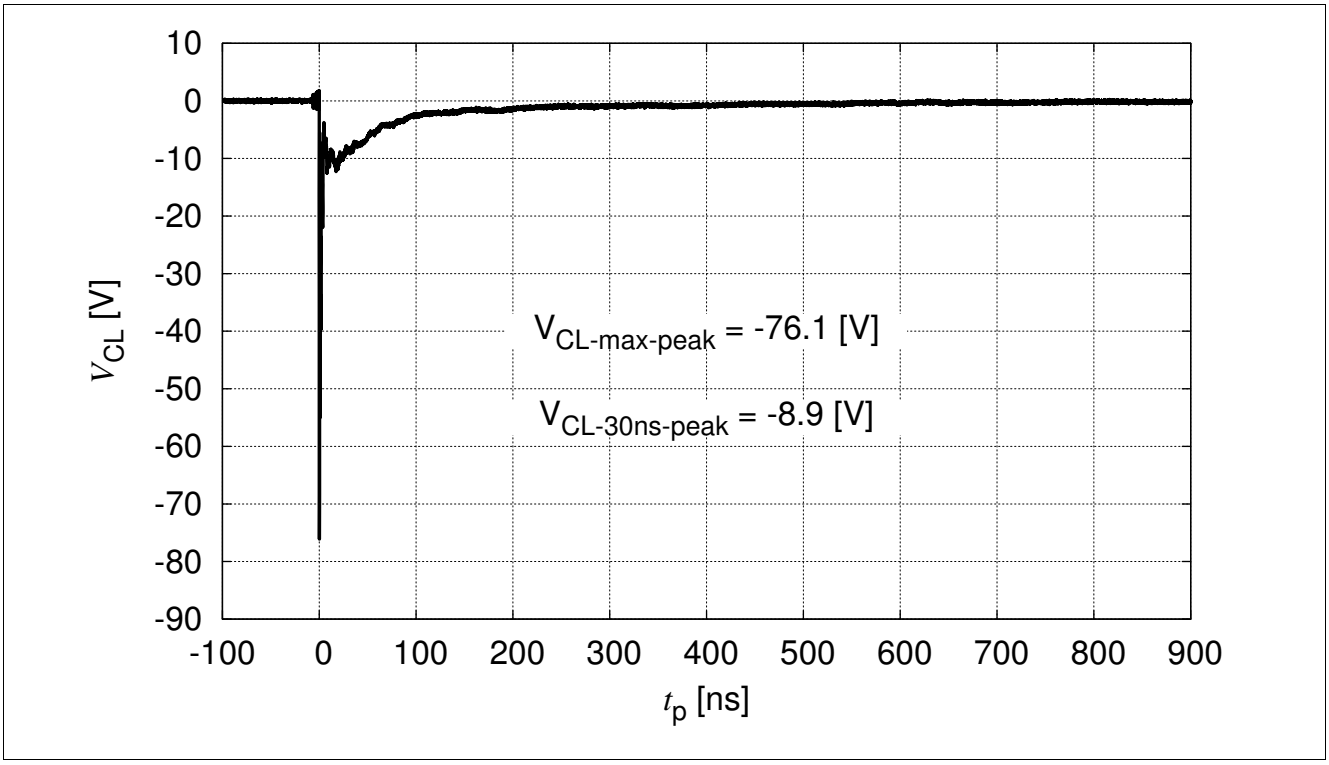


**Figure 3-9 IEC61000-4-2 $V_{CL} = f(t)$, 8 kV negative pulse, (I/O to GND)**

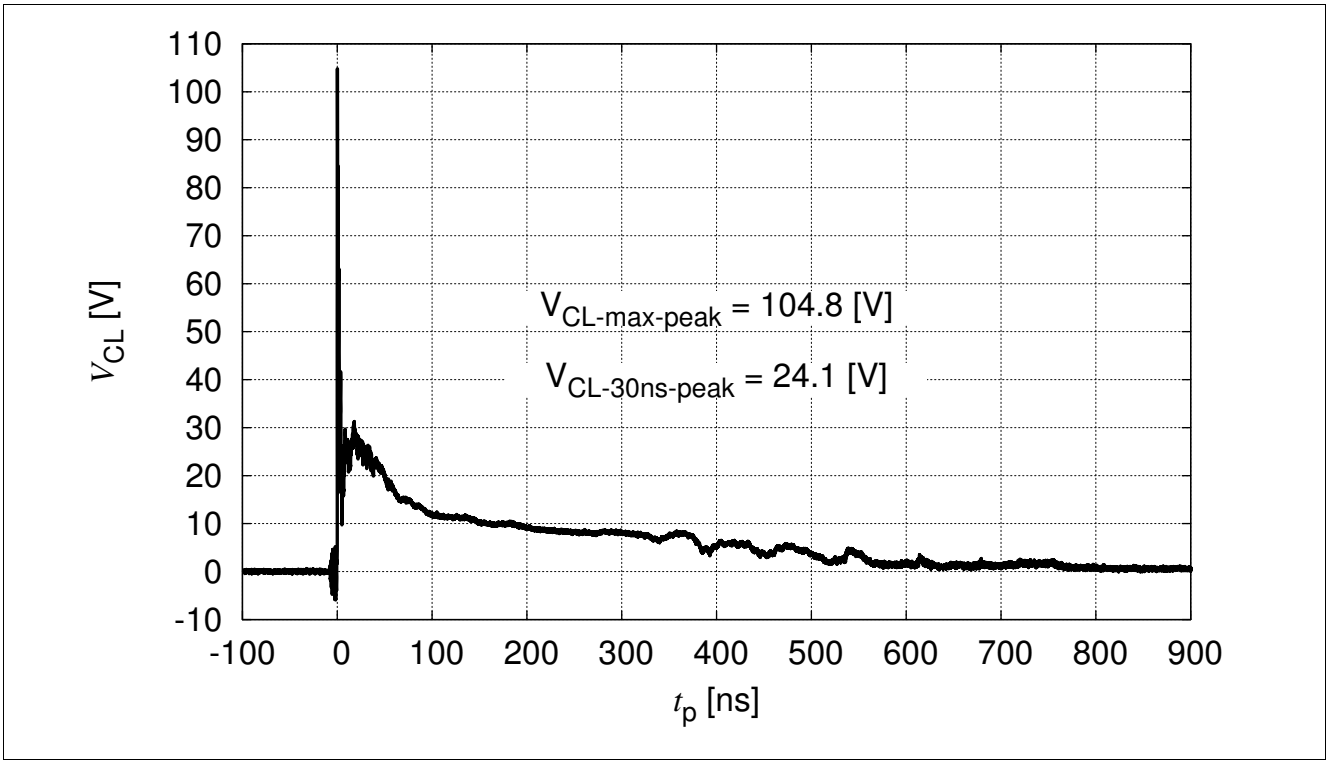


**Figure 3-10 IEC61000-4-2 $V_{CL} = f(t)$, 15 kV positive pulse, (I/O to GND)**

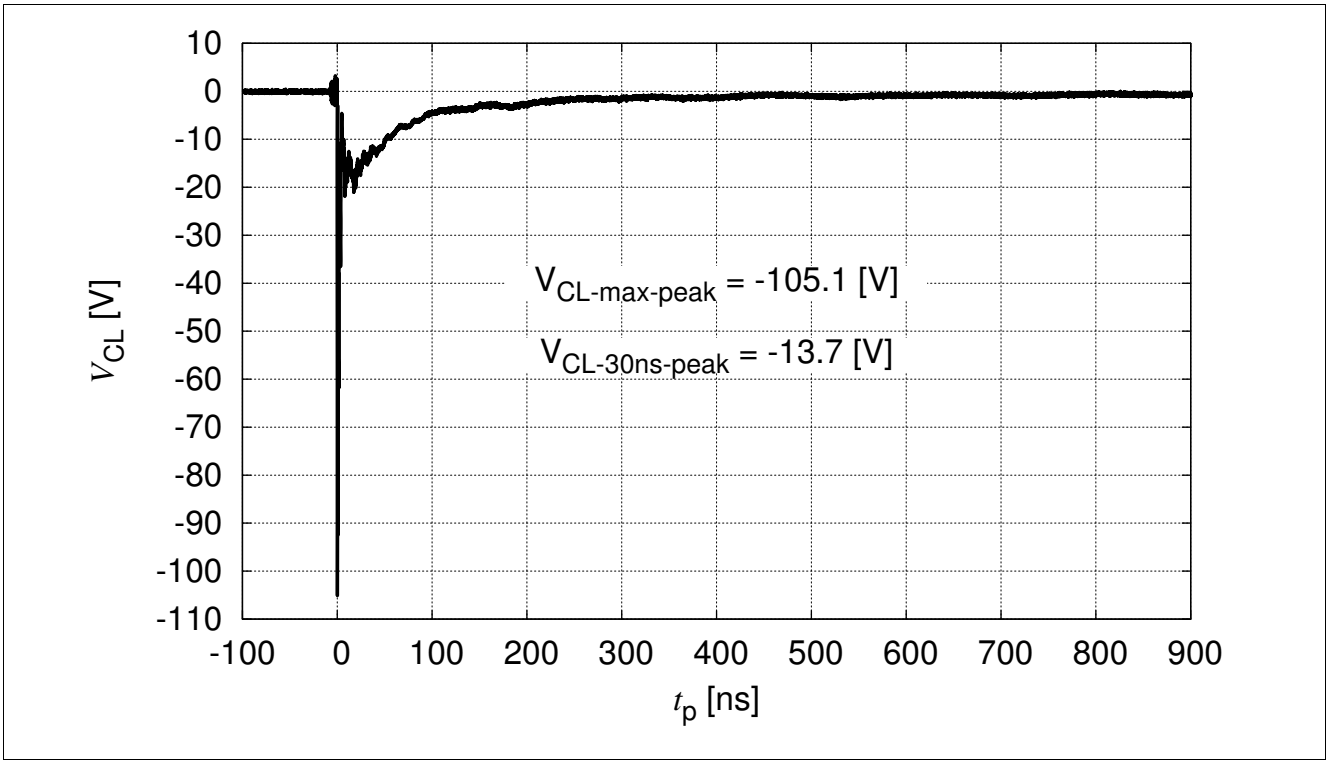


**Figure 3-11 IEC61000-4-2 $V_{CL} = f(t)$, 15 kV negative pulse, (I/O to GND)**

# 4 Application Information

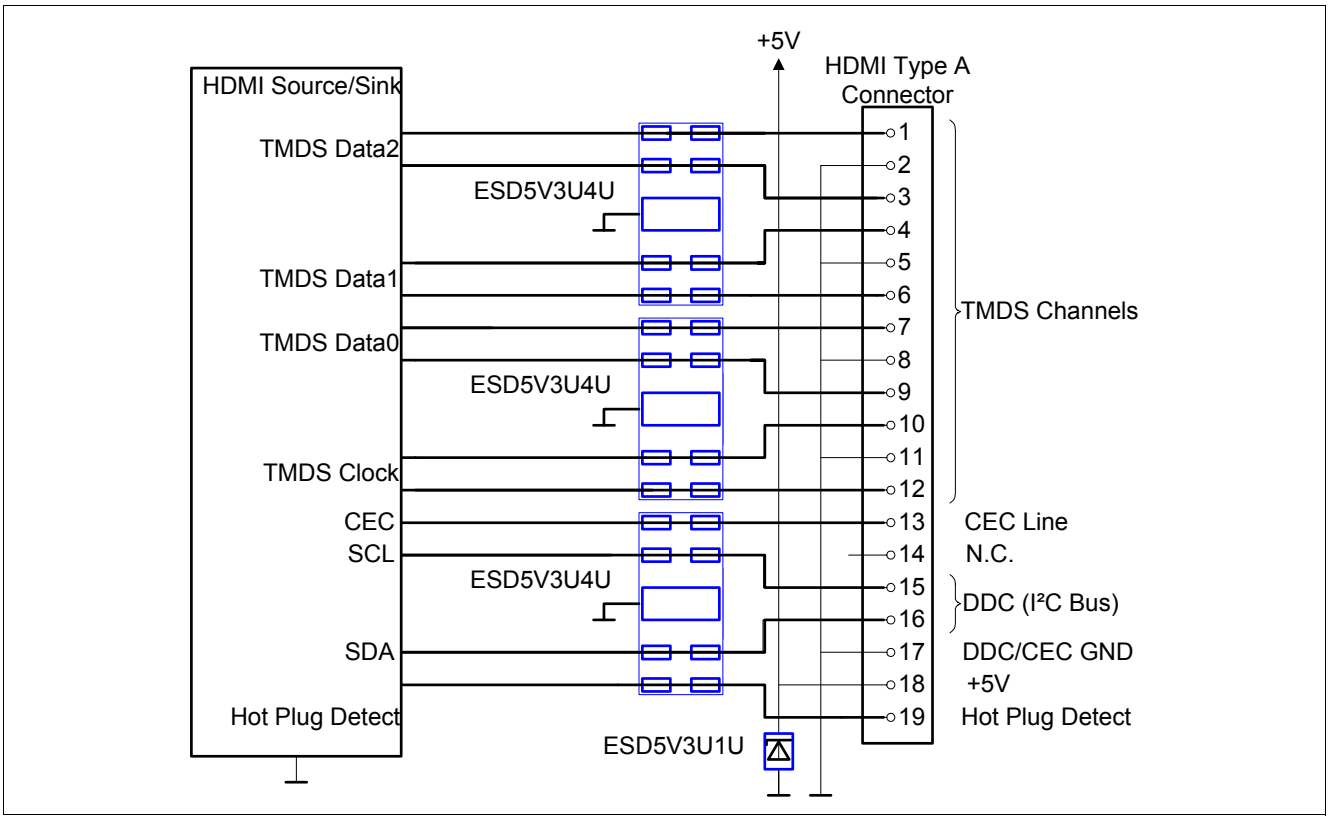


**Figure 4-1 4 lines, uni-directional ESD5V3U4U-HDMI**

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

# 5 Ordering Information Scheme (Examples)

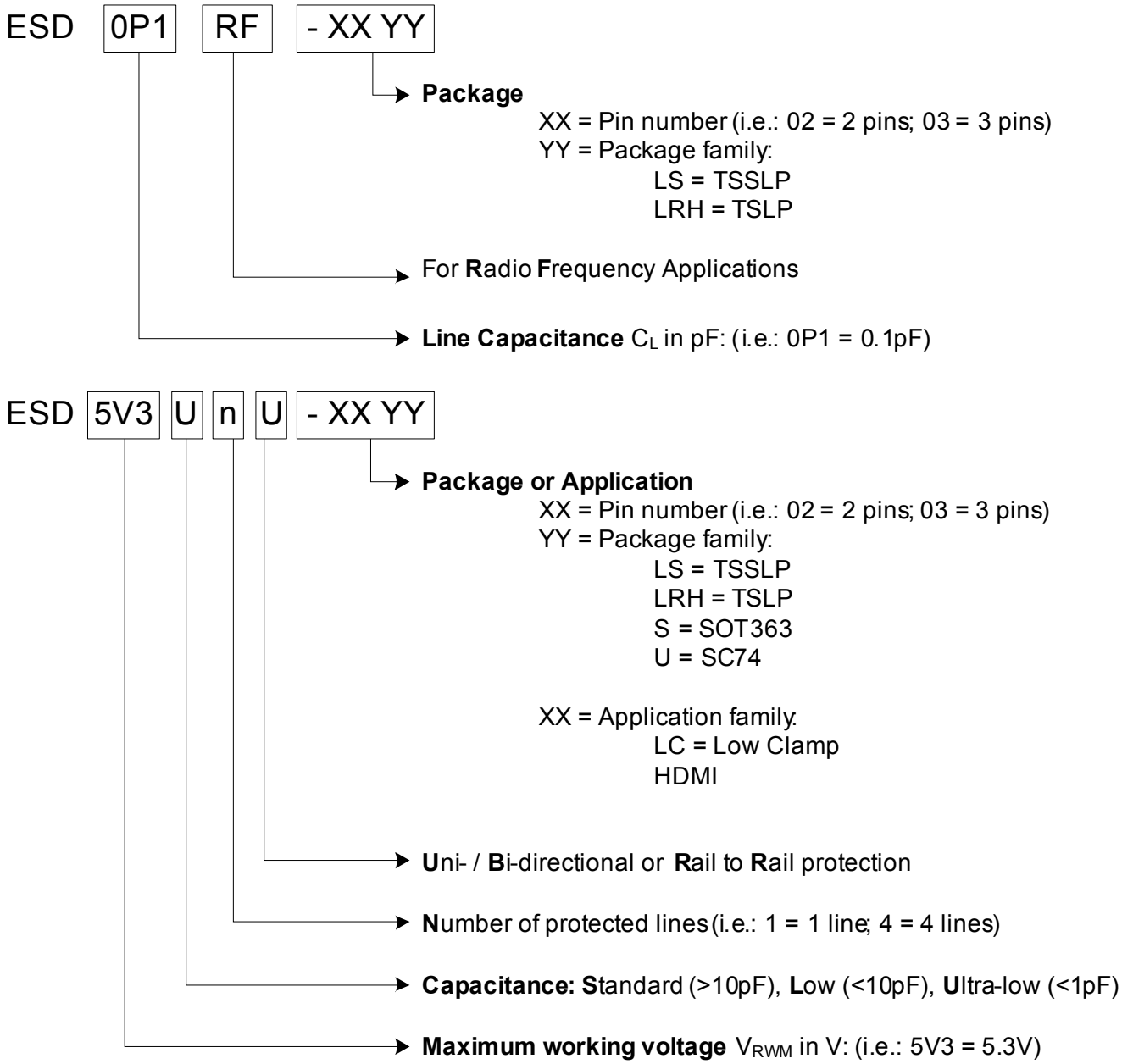


**Figure 5-1 Ordering information scheme**

# 6 Package Information

## 6.1 PG-TSLP-9-1

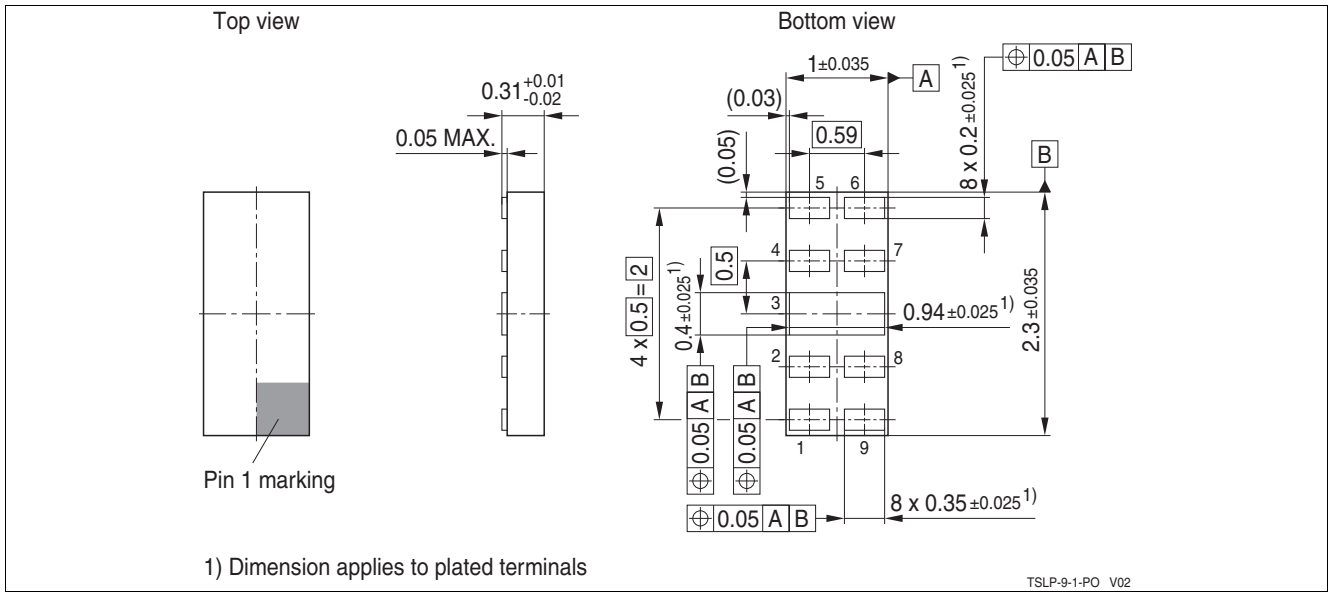


**Figure 6-1 PG-TSLP-9-1: Package overview**

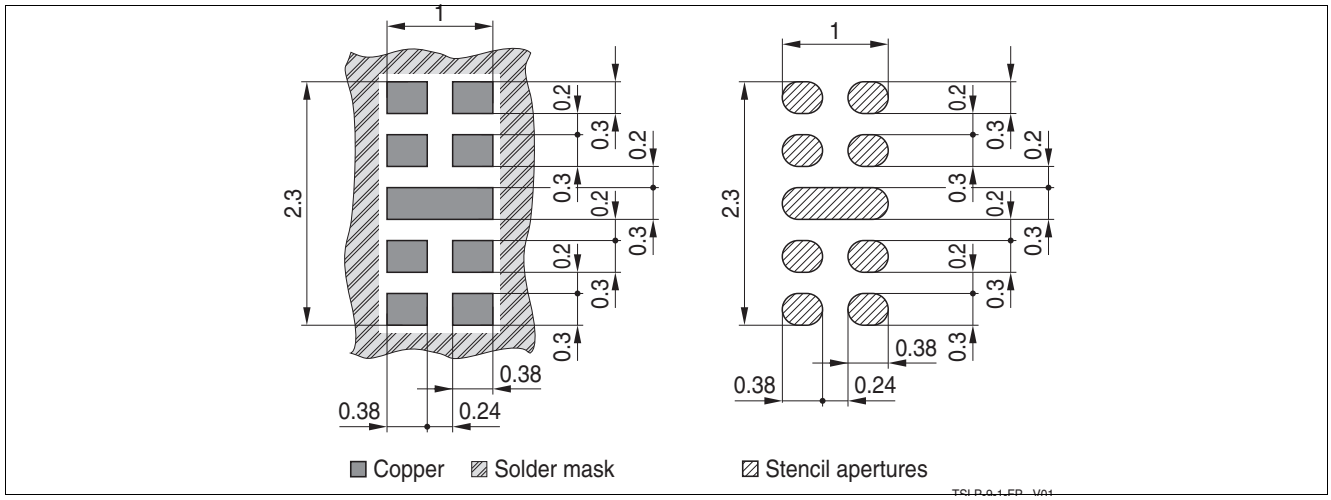


**Figure 6-2 PG-TSLP-9-1: Footprint**

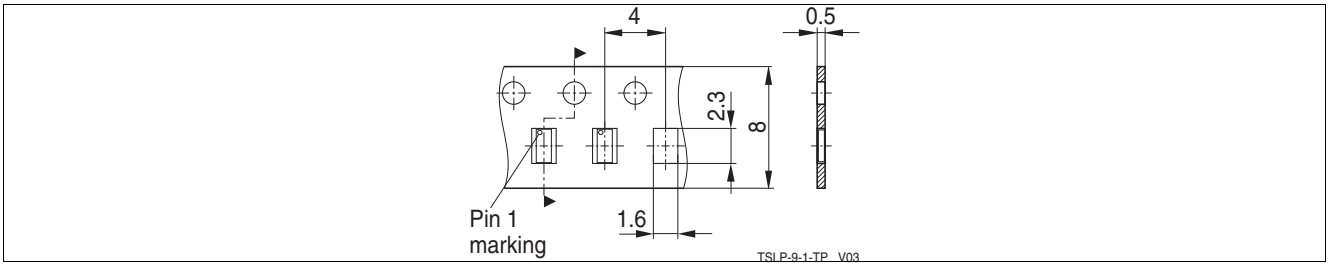


**Figure 6-3 PG-TSLP-9-1: Packing**

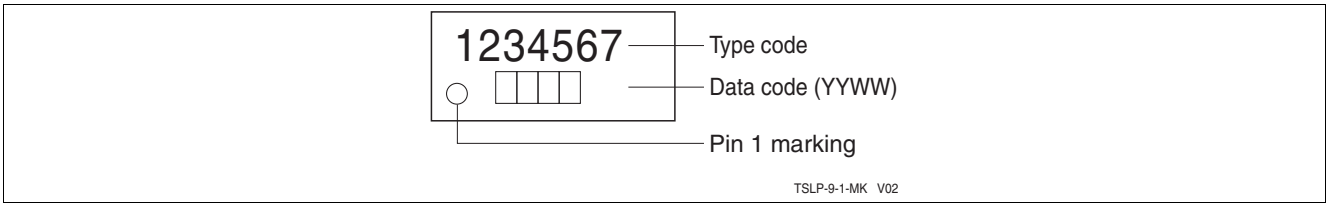


**Figure 6-4 PG-TSLP-9-1: Marking (example)**

# References

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

# Terminology

| | |
|---|---|
| $C_L$ | Line capacitance |
| DVI | Digital Visual Interface |
| EFT | Electrical Fast Transient |
| ESD | Electrostatic Discharge |
| HDMI | High Definition Multimedia Interface |
| $I_{PP}$ | Peak pulse current |
| $I_R$ | Reverse current |
| MDDI | Mobile Display Digital Interface |
| MHL | Mobile Display Digital Interface |
| MIPI | Mobile Industrial Processor Interface |
| **RoHS** | Restriction of Hazardous Substances Directive |
| S-ATA | Serial Advanced Technology Attachment |
| $T_{OP}$ | Operation temperature |
| $t_p$ | Pulse duration |
| $T_{stg}$ | Storage temperature |
| USB | Universal Serial Bus |
| $V_{BR}$ | Breakdown voltage |
| $V_{CL}$ | Reverse clamping voltage |
| $V_{ESD}$ | Electrostatic discharge voltage |
| $V_{FC}$ | Forward Clamping Voltage |
| $V_R$ | Reverse voltage |
| $V_{RWM}$ | Maximum Reverse Working Voltage |

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