

# TVS Diodes

Transient Voltage Suppressor Diodes

## ESD5V3U1U Series

Uni-directional Ultra-Low Capacitance ESD / Transient Protection Diode

ESD5V3U1U-02LS  
ESD5V3U1U-02LRH

## Data Sheet

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**Revision History**

| Page or Item                    | Subjects (major changes since previous revision) |
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| <b>Revision 1.0, 2011-05-27</b> |                                                  |
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Last Trademarks Update 2010-06-09

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# 1 Uni-directional Ultra-Low Capacitance ESD / Transient Protection Diode

## 1.1 Features

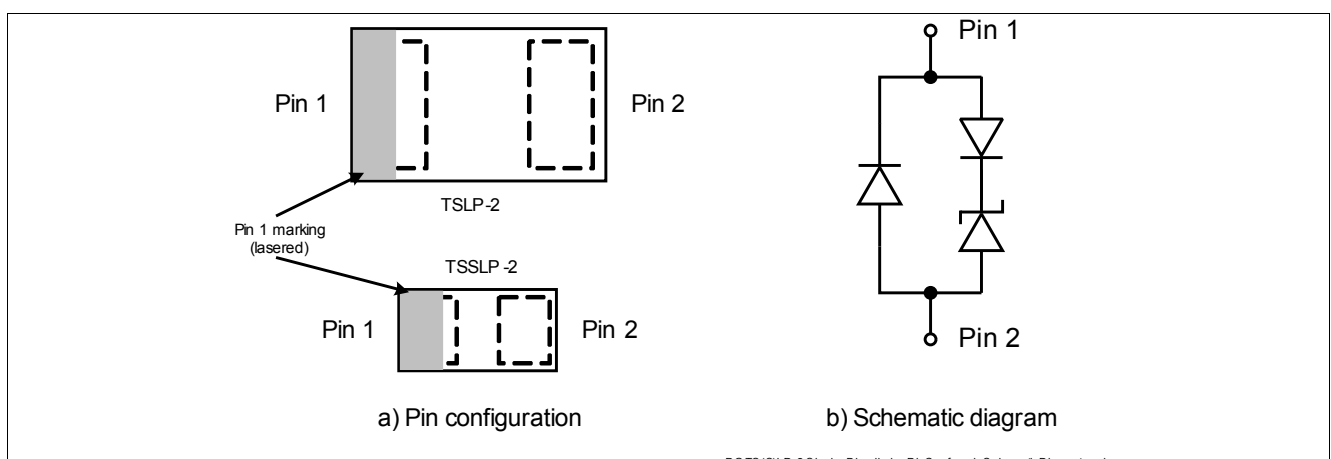
- ESD / Transient protection of high speed data lines exceeding
  - IEC61000-4-2 (ESD):  $\pm 20$  kV (air / contact)
  - IEC61000-4-4 (EFT): 2.5 kV / 50 A (5/50 ns)
  - IEC61000-4-5 (surge): 3 A (8/20  $\mu$ s)
- Maximum working voltage:  $V_{RWM} = 5.3$  V
- Ultra low capacitance:  $C_L = 0.4$  pF (typical)
- Low clamping voltage, low dynamic resistance  $R_{DYN} = 0.6 \Omega$  (typical)
- Very small form factor down to  $0.62 \times 0.32 \times 0.31$  mm<sup>3</sup>
- Pb-free (RoHS compliant) and halogen free package



## 1.2 Application Examples

- USB 2.0, Mobile HDMI Link, MDDI, MIPI, etc.
- HDMI, DisplayPort, DVI, Ethernet, Firewire, S-ATA

# 2 Product Description



PG:TSSLP-2Single Die diode PinConf and SchematicDiagram.vsd

Figure 1 Pin Configuration and Schematic Diagram

Table 1 Ordering Information

| Type             | Package      | Configuration           | Marking code |
|------------------|--------------|-------------------------|--------------|
| ESD5V3U1U-02LS   | PG-TSSLP-2-1 | 1 line, uni-directional | L            |
| ESD5V3U1U--02LRH | PG-TSLP-2-7  | 1 line, uni-directional | E5           |

### 3 Characteristics

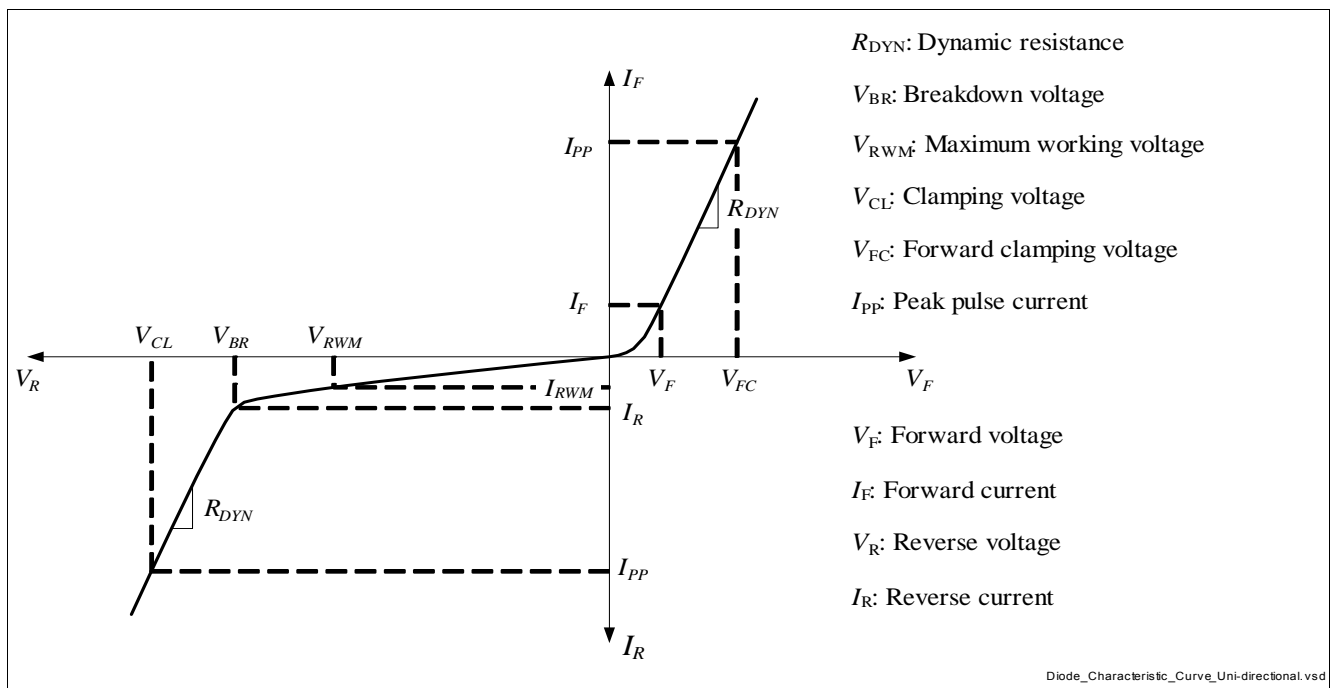
**Table 2** Maximum Rating at  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise specified

| Parameter                                                      | Symbol    | Values |      |      | Unit             |
|----------------------------------------------------------------|-----------|--------|------|------|------------------|
|                                                                |           | Min.   | Typ. | Max. |                  |
| ESD (air / contact) discharge <sup>1)</sup>                    | $V_{ESD}$ | –      | –    | 20   | kV               |
| Peak pulse current ( $t_p = 8/20\ \mu\text{s}$ ) <sup>2)</sup> | $I_{PP}$  | –      | –    | 3    | A                |
| Operating temperature range                                    | $T_{OP}$  | -55    | –    | 125  | $^\circ\text{C}$ |
| Storage temperature                                            | $T_{stg}$ | -65    | –    | 150  | $^\circ\text{C}$ |

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

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

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



**Figure 2** Definitions of Electrical Characteristics

**Table 3** 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 | $V_{RWM}$ | –      | –    | 5.3  | V    | Pin 1 to Pin 2                               |
| Breakdown voltage       | $V_{BR}$  | 6      | –    | –    | V    | $I_{BR} = 1\text{ mA}$ , from Pin 1 to Pin 2 |
| Reverse current         | $I_R$     | –      | <10  | 100  | nA   | $V_R = 5.3\text{ V}$ , from Pin 1 to Pin 2   |



**Table 4 RF Characteristics at  $T_A = 25\text{ °C}$ , 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   | $V_R = 0\text{ V}, f = 1\text{ MHz}$ |
| Serie inductance               | $L_S$  | –      | 0.2  | –    | nH   | ESD5V3U1U-02LS                       |
|                                |        | –      | 0.4  | –    | nH   | ESD5V3U1U-02LRH                      |

1) Total capacitance line to ground

**Table 5 ESD Characteristics at  $T_A = 25\text{ °C}$ , unless otherwise specified**

| Parameter                        | Symbol    | Values |      |      | Unit | Note / Test Condition                           |
|----------------------------------|-----------|--------|------|------|------|-------------------------------------------------|
|                                  |           | Min.   | Typ. | Max. |      |                                                 |
| Clamping voltage                 | $V_{CL}$  | –      | 19   | –    | V    | $I_{PP} = 16\text{ A}$ ,<br>from Pin 1 to Pin 2 |
|                                  |           | –      | 28   | –    | V    | $I_{PP} = 30\text{ A}$ ,<br>from Pin 1 to Pin 2 |
| Forward clamping voltage         | $V_{FC}$  | –      | 10   | –    | V    | $I_{PP} = 16\text{ A}$ ,<br>from Pin 2 to Pin 1 |
|                                  |           | –      | 17   | –    | V    | $I_{PP} = 30\text{ A}$ ,<br>from Pin 2 to Pin 1 |
| Dynamic resistance <sup>1)</sup> | $R_{DYN}$ | –      | 0.6  | –    | V    | Pin 1 to Pin 2                                  |
|                                  |           | –      | 0.5  | –    | V    | Pin 2 to Pin 1                                  |

1) Please refer to Application Note AN210[11]. TLP parameter:  $Z_0 = 50\ \Omega$ ,  $t_p = 100\text{ ns}$ ,  $t_r = 300\text{ ps}$ , averaging window:  $t_1 = 30\text{ ns}$  to  $t_2 = 60\text{ ns}$ , extraction of dynamic resistance using least squares fit of TLP characteristics 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

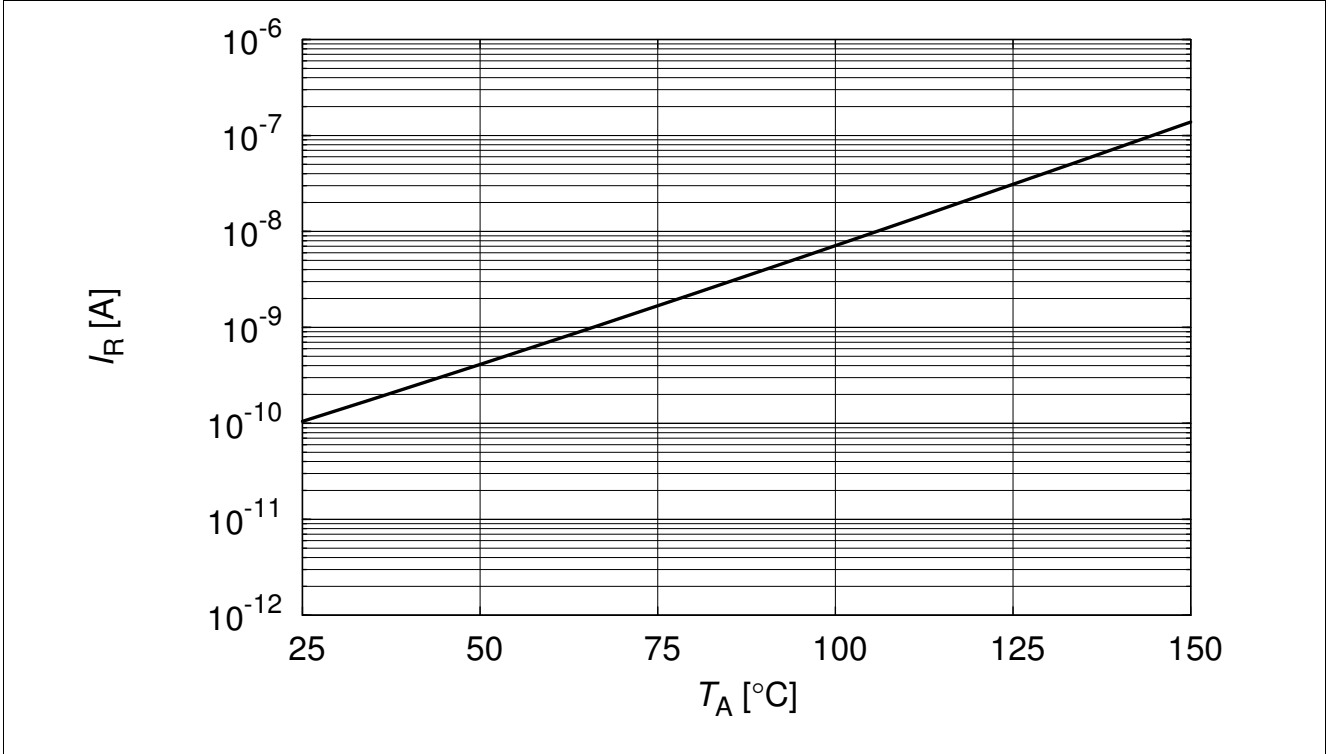


Figure 3 Reverse current  $I_R = f(T_A)$ ,  $V_R = 5.3\text{ V}$ , from pin 1 to pin 2

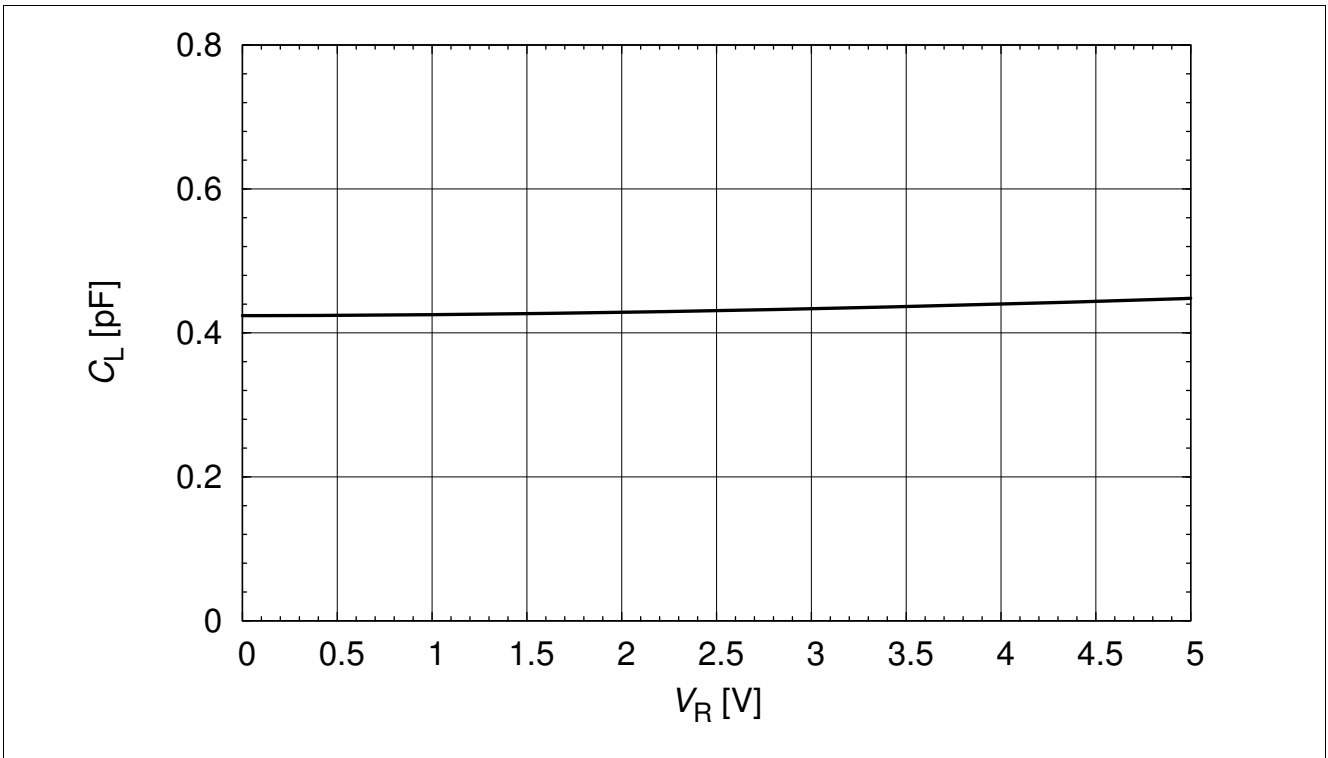


Figure 4 Line capacitance  $C_L = f(V_R)$ ,  $f = 1\text{ MHz}$ , from pin 1 to pin 2

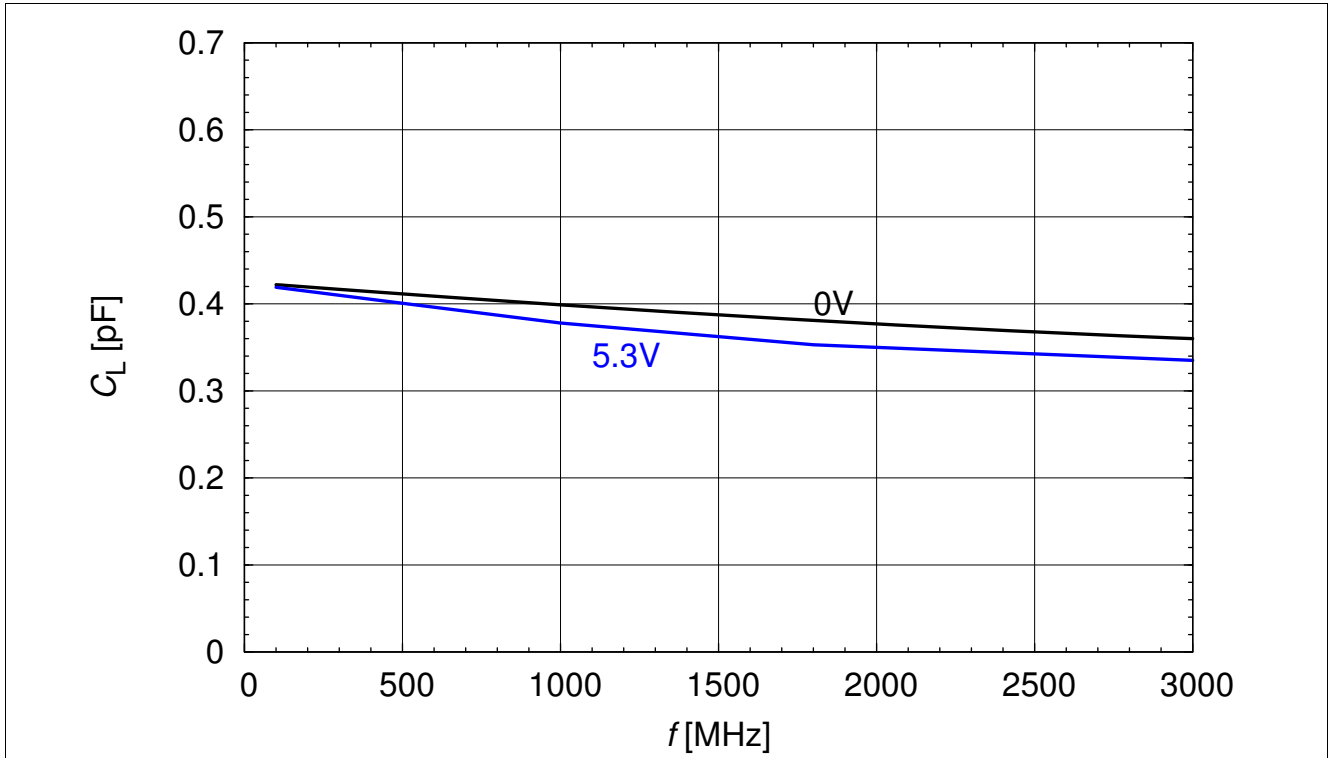


Figure 5 Line capacitance  $C_L = f(f)$ , from pin 1 to pin 2

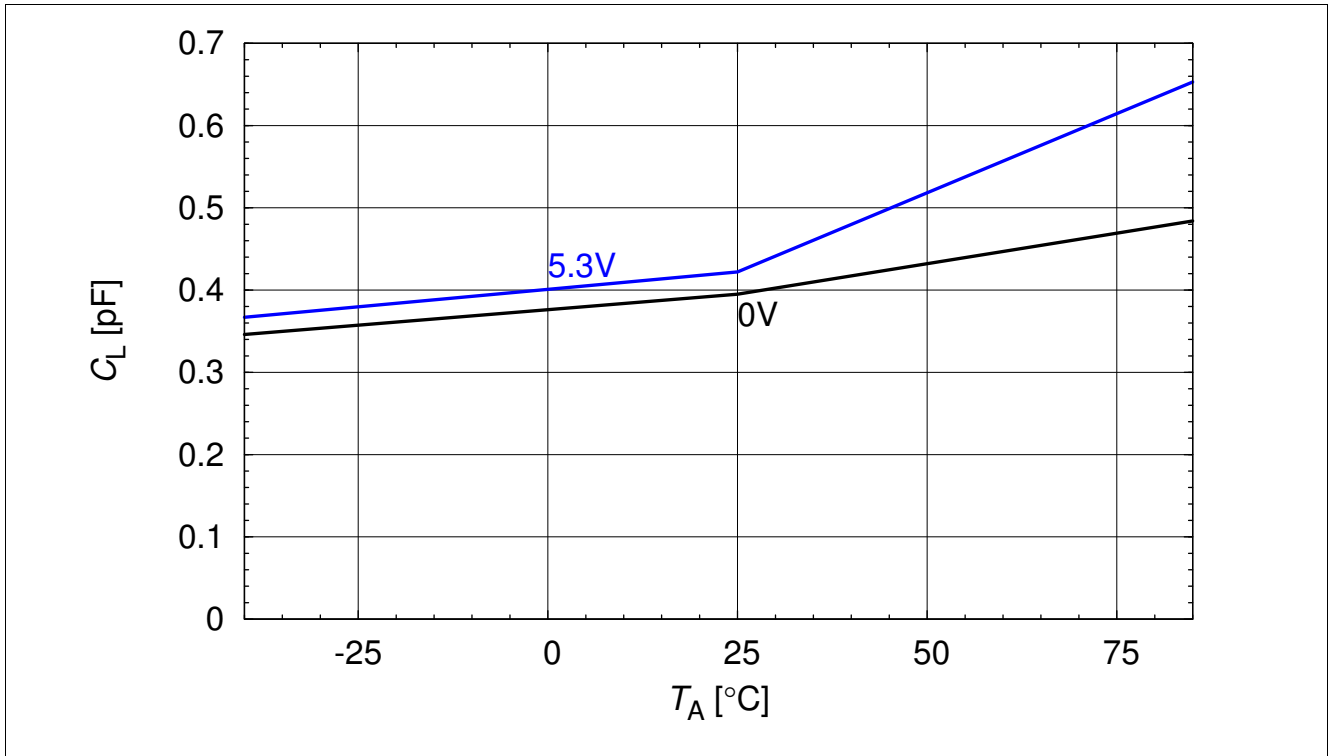


Figure 6 Line capacitance  $C_L = f(T_A)$ , from pin 1 to pin 2

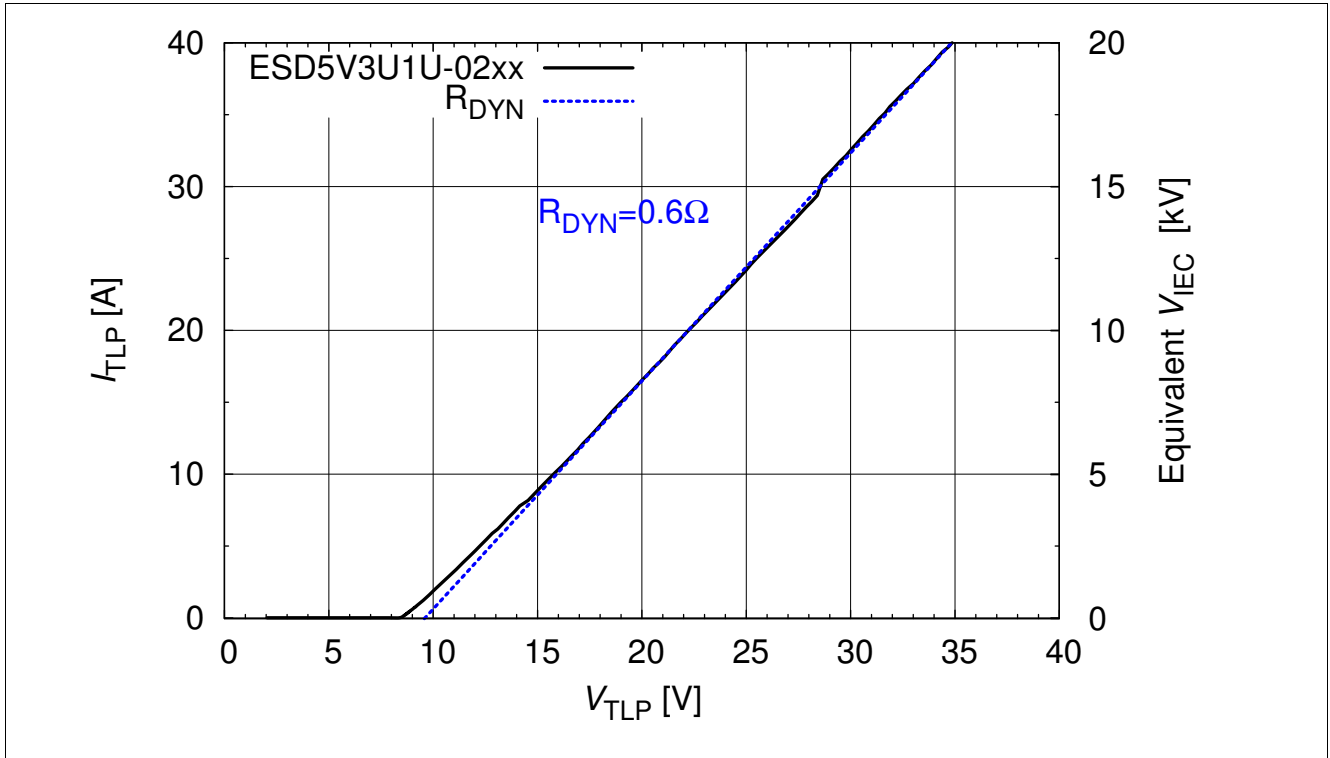


Figure 7 Clamping voltage  $V_{TLP} = f(I_{TLP})$ , from pin 1 to pin 2[1]

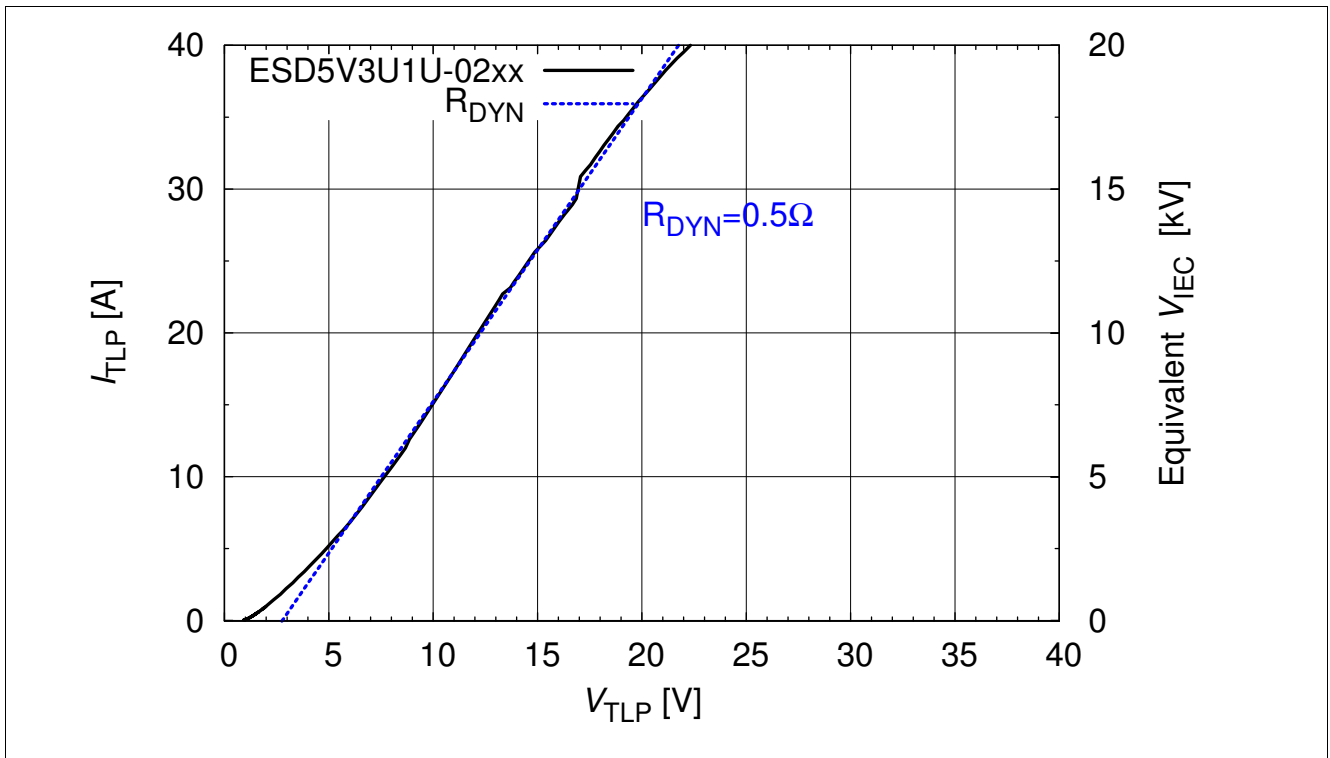


Figure 8 Forward clamping voltage  $V_{TLP} = f(I_{TLP})$ , from pin 2 to pin 1[1]

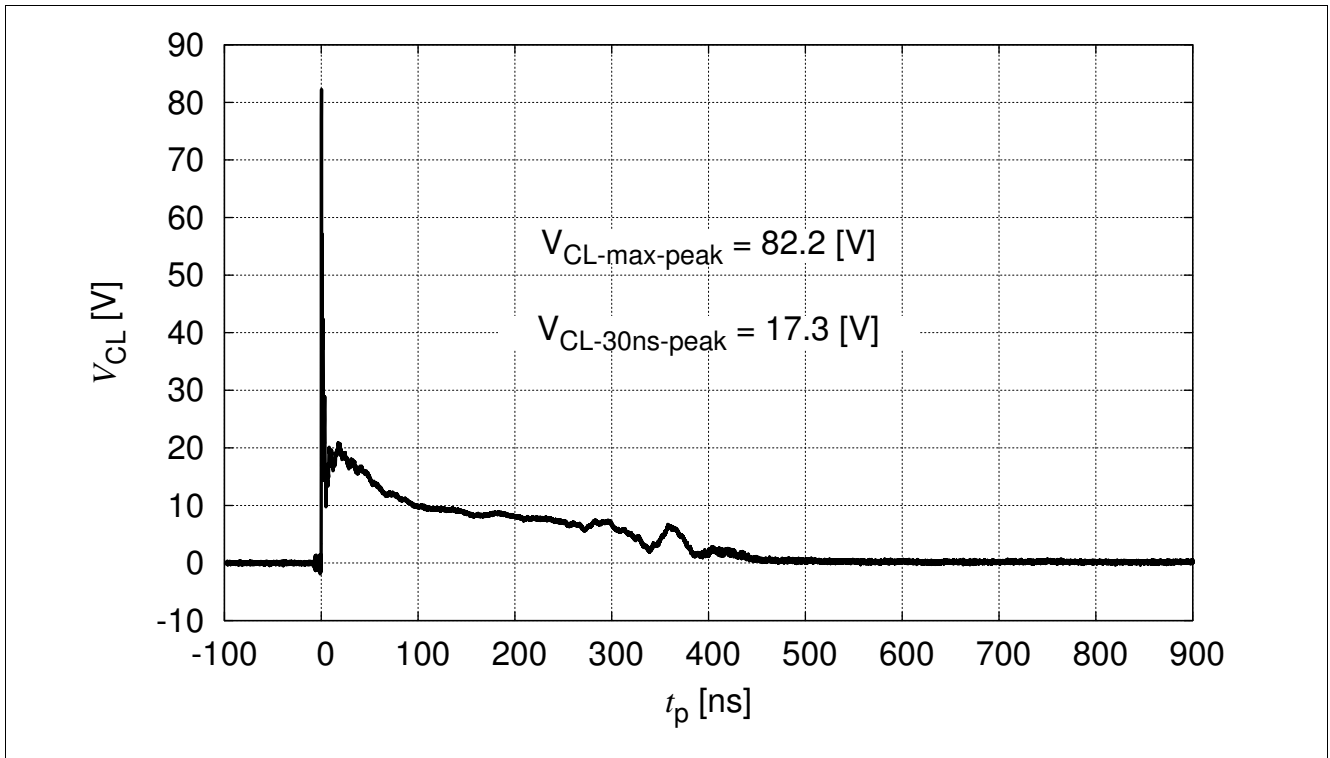


Figure 9 IEC61000-4-2:  $V_{CL} = f(t)$ , 8 kV positive pulse from pin 1 to pin 2

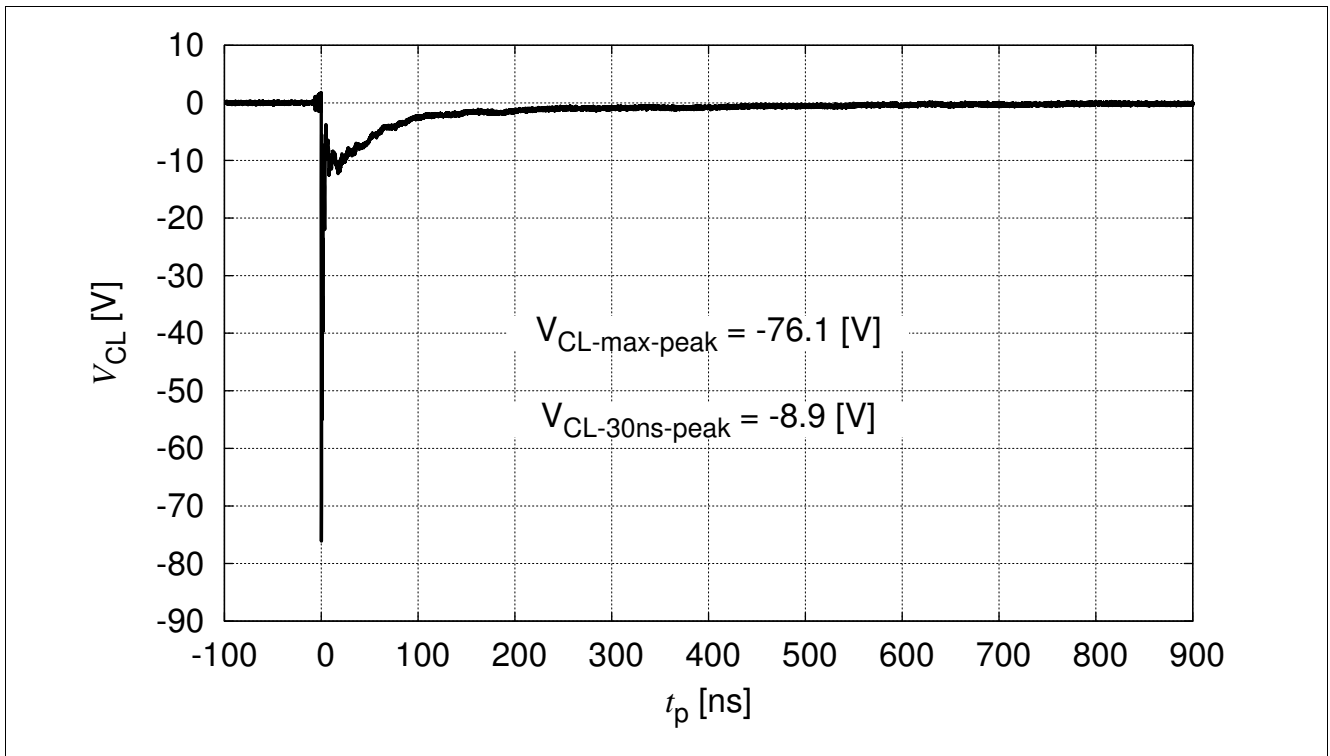


Figure 10 IEC61000-4-2:  $V_{CL} = f(t)$ , 8 kV negative pulse from pin 1 to pin 2

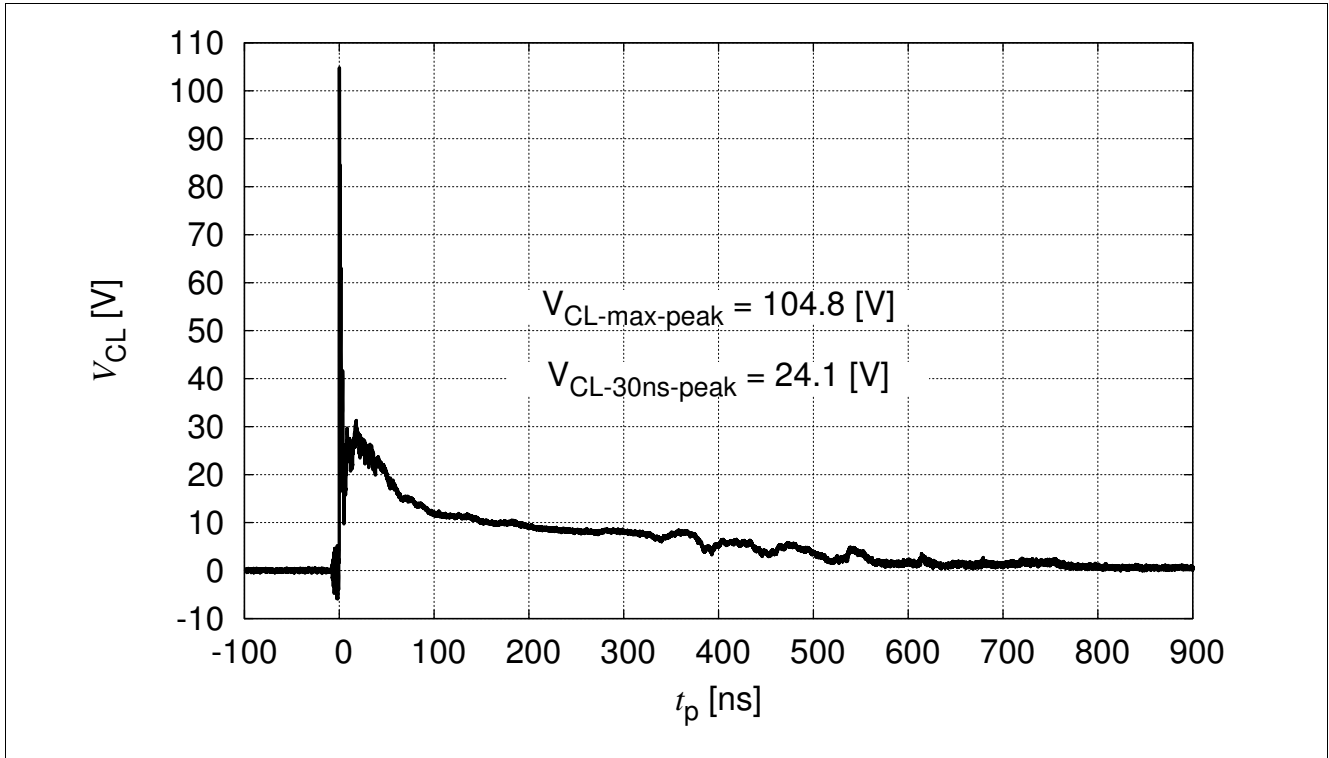


Figure 11 IEC61000-4-2:  $V_{CL} = f(t)$ , 15 kV positive pulse from pin 1 to pin 2

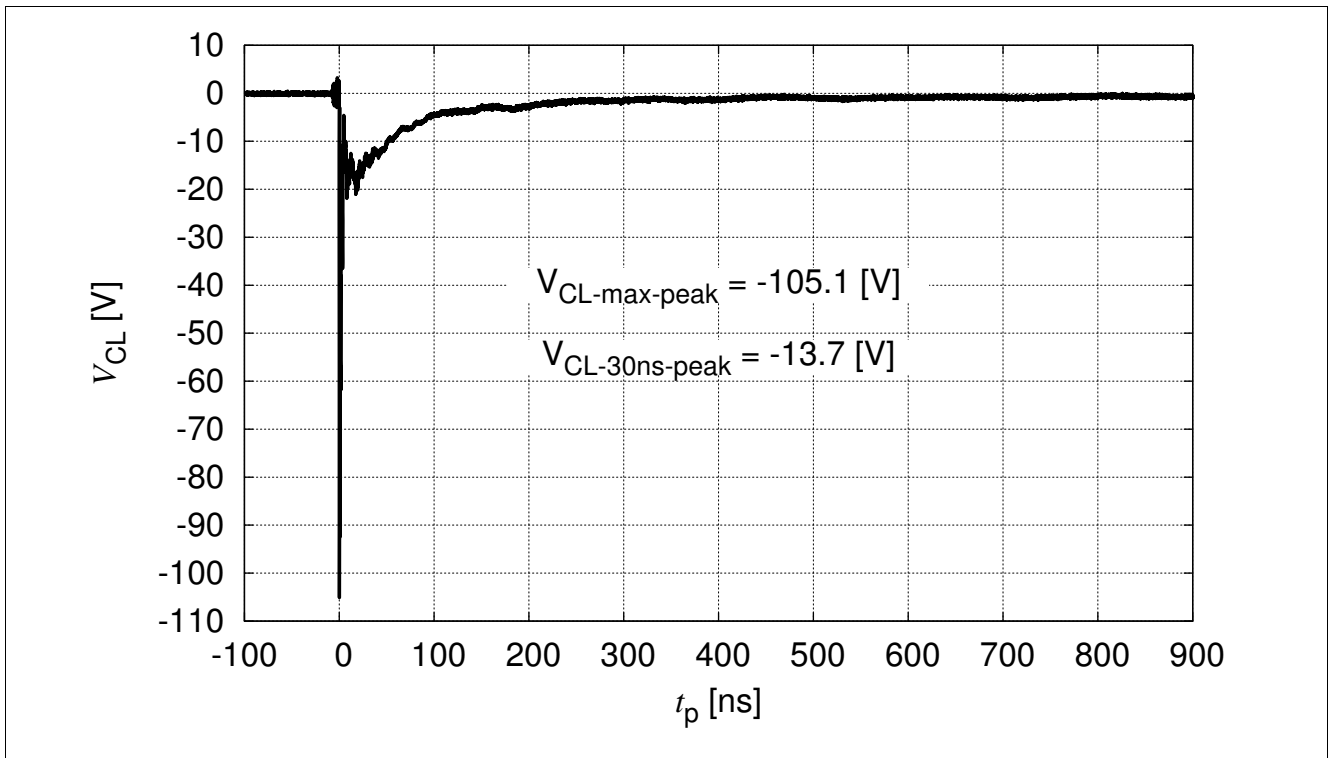


Figure 12 IEC61000-4-2:  $V_{CL} = f(t)$ , 15 kV negative pulse from pin 1 to pin 2

## 4 Application Information

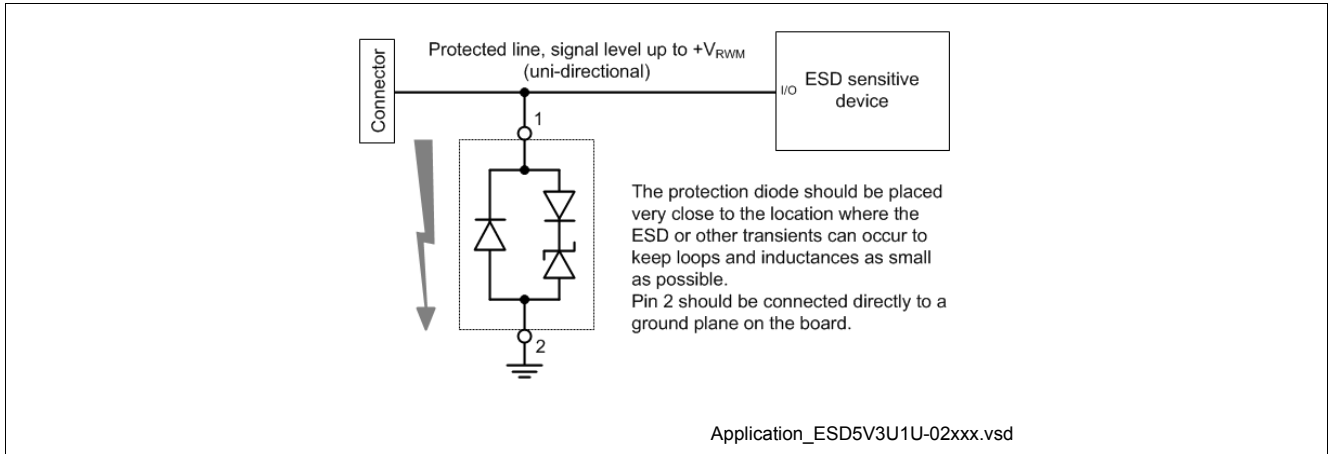


Figure 13 Single line, uni-directional ESD / Transient protection[2]

## 5 Ordering Information Scheme (Examples)

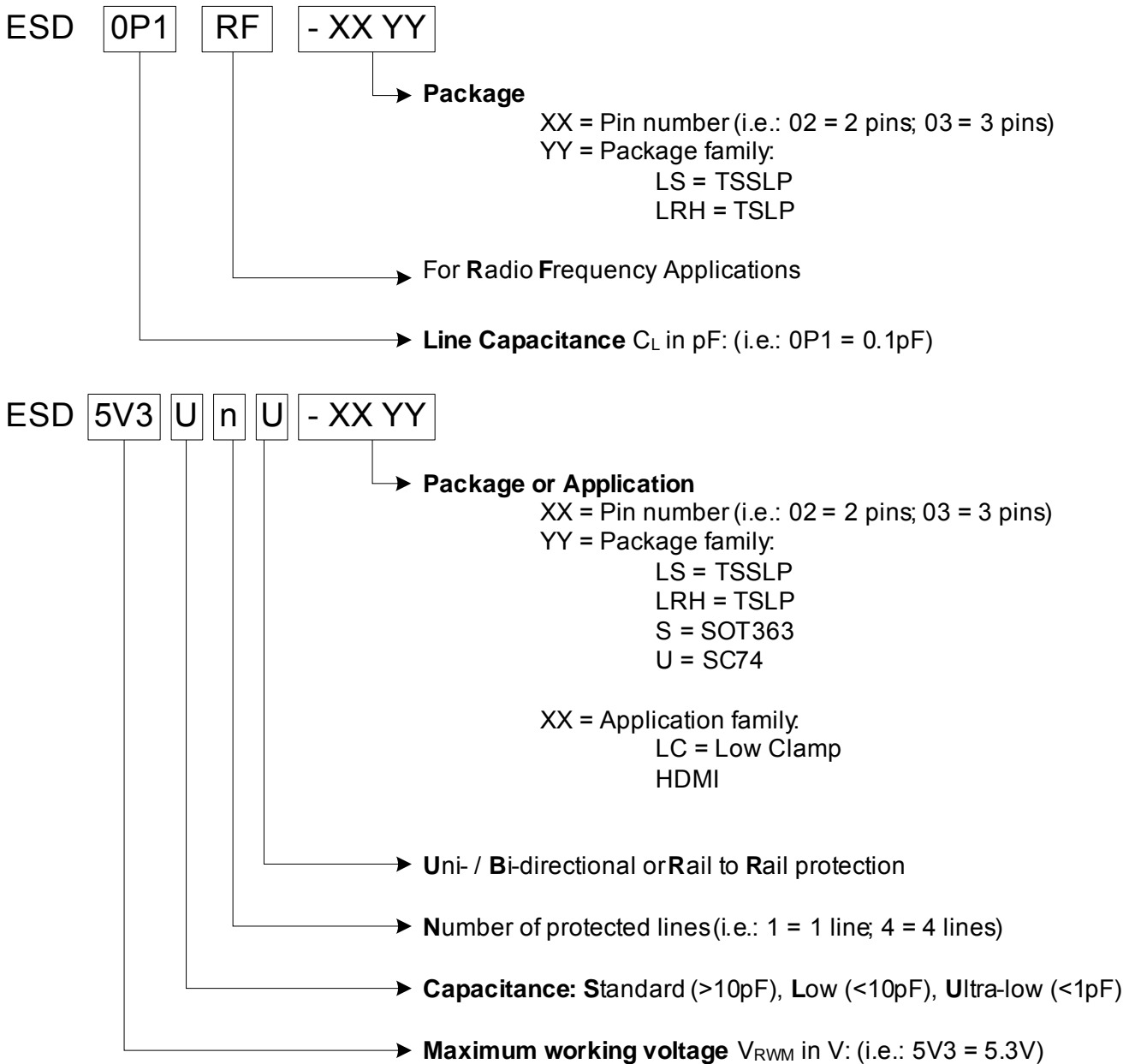


Figure 14 Ordering information scheme



## 6 Package Information

### 6.1 PG-TSSLP-2-1 (mm)[3]

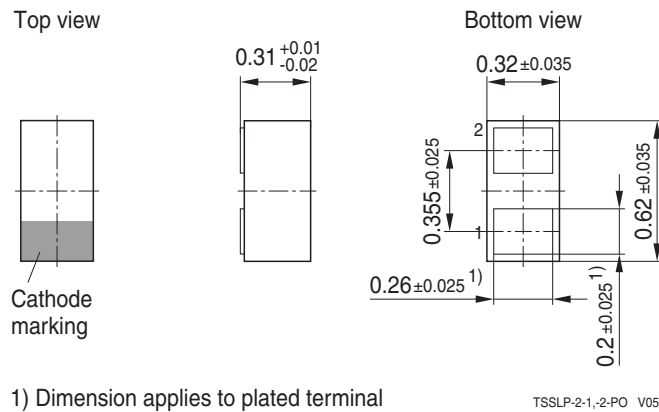


Figure 15 PG-TSSLP-2-1: Package overview

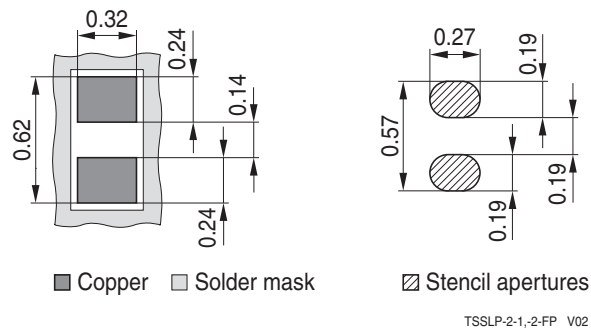


Figure 16 PG-TSSLP-2-1: Footprint

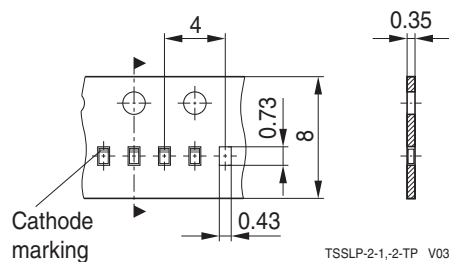


Figure 17 PG-TSSLP-2-1: Packing

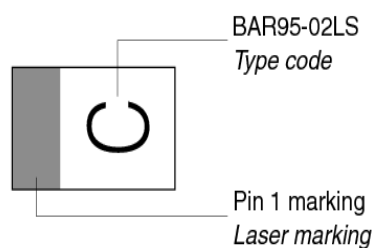


Figure 18 PG-TSSLP-2-1: Marking (example)

6.2 PG-TSLP-2-7 (mm)[3]

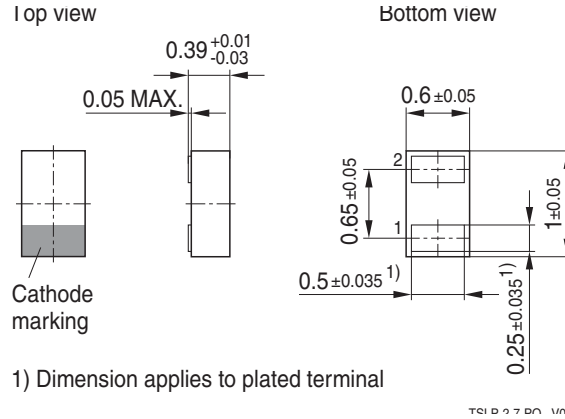


Figure 19 PG-TSLP-2-7: Package Overview

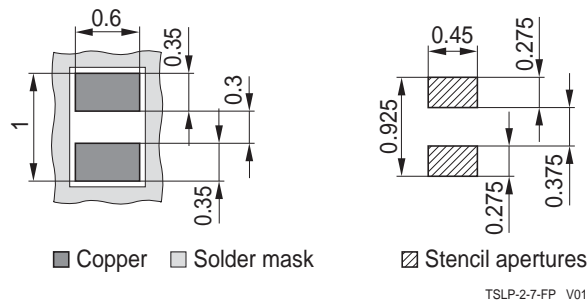


Figure 20 PG-TSLP-2-7: Footprint

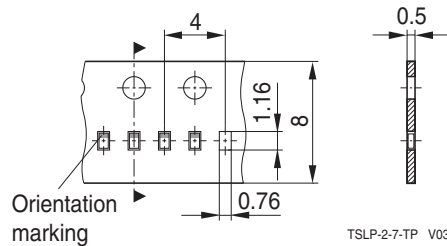


Figure 21 PG-TSLP-2-7: Packing

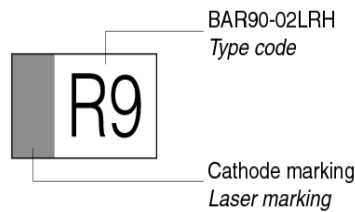


Figure 22 PG-TSLP-2-7: Marking (example)

## Terminology

|             |                                               |
|-------------|-----------------------------------------------|
| $C_L$       | Line capacitance                              |
| DVI         | Digital Visual Interface                      |
| EFT         | Electrical Fast Transient                     |
| ESD         | Electrostatic Discharge                       |
| HDMI        | High Definition Multimedia Interface          |
| IEC         | International Electrotechnical Commission     |
| $I_{PP}$    | Peak pulse current                            |
| $I_R$       | Reverse current                               |
| $I_{RWM}$   | Maximum Reverse working Current               |
| $L_S$       | Serial inductance                             |
| MDDI        | Mobile Display Digital Interface              |
| MIPI        | Mobile Industrial Processor Interface         |
| <b>RoHS</b> | Restriction of Hazardous Substances Directive |
| S-ATA       | Serial Advanced Technology Attachment         |
| $T_A$       | Ambient temperature                           |
| $T_{OP}$    | 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               |

**References**

- [1] Infineon AG - **Application Note AN210**: Effective ESD Protection Design at System Level Using VF-TLP
- [2] Infineon AG - **Application Note AN140**: ESD Protection for Digital High-Speed Interfaces (HDMI, FireWire, ...) using ESD5V3U1U)
- [3] Infineon AG - Recommendations for PCB Assembly of Infineon TSLP and TSSLP Package

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