

# TVS Diodes

Transient Voltage Suppressor Diodes

## ESD102-U1-02ELS

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

ESD102-U1-02ELS

## Data Sheet

Revision 1.0, 2013-02-04  
Final

**Edition 2013-02-04**

**Published by  
Infineon Technologies AG  
81726 Munich, Germany**

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**Revision History: Revision 0.9.1, 2012-07-27**

Page or Item	Subjects (major changes since previous revision)
<b>Revision 1.0, 2013-02-04</b>	
All	Status change to Final

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Last Trademarks Update 2010-06-09

# 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):  $\pm 2.5$  kV / 50 A (5/50 ns)
  - IEC61000-4-5 (surge):  $\pm 3$  A (8/20  $\mu$ s)
- Maximum working voltage:  $V_{RWM} = 3.3$  V
- Ultra low capacitance  $C_L = 0.4$  pF (typical)
- Very low clamping voltage:  $V_{CL} = 8$  V (typical) at  $I_{PP} = 16$  A [2]
- Very low dynamic resistance:  $R_{DYN} = 0.19$   $\Omega$  (typical) [2]
- Pb-free (RoHS compliant) and halogen free package, very small form factor 0.62 x 0.32 x 0.31 mm<sup>3</sup>



## 1.2 Application Examples

- USB 3.0, 10/100/1000 Ethernet, Firewire, DVI, HDMI, S-ATA, DisplayPort
- Mobile HDMI Link, MDDI, MIPI, SWP / NFC

## 1.3 Product Description

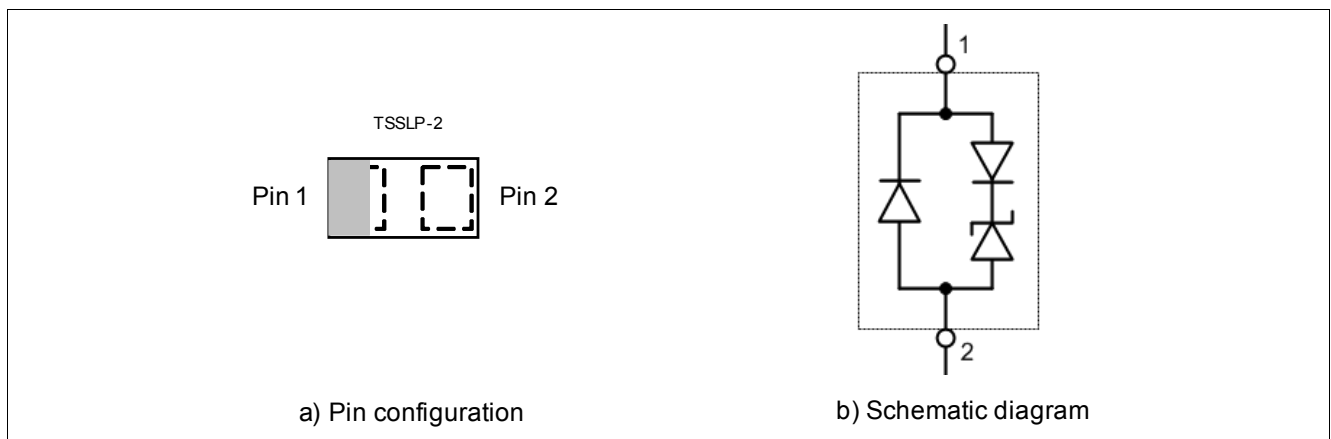


Figure 1 Pin Configuration and Schematic Diagram

Table 1 Ordering Information

Type	Package	Configuration	Marking code
ESD102-U1-02ELS	TSSLP-2-3	1 line, uni-directional	<u>E</u>

## 2 Characteristics

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

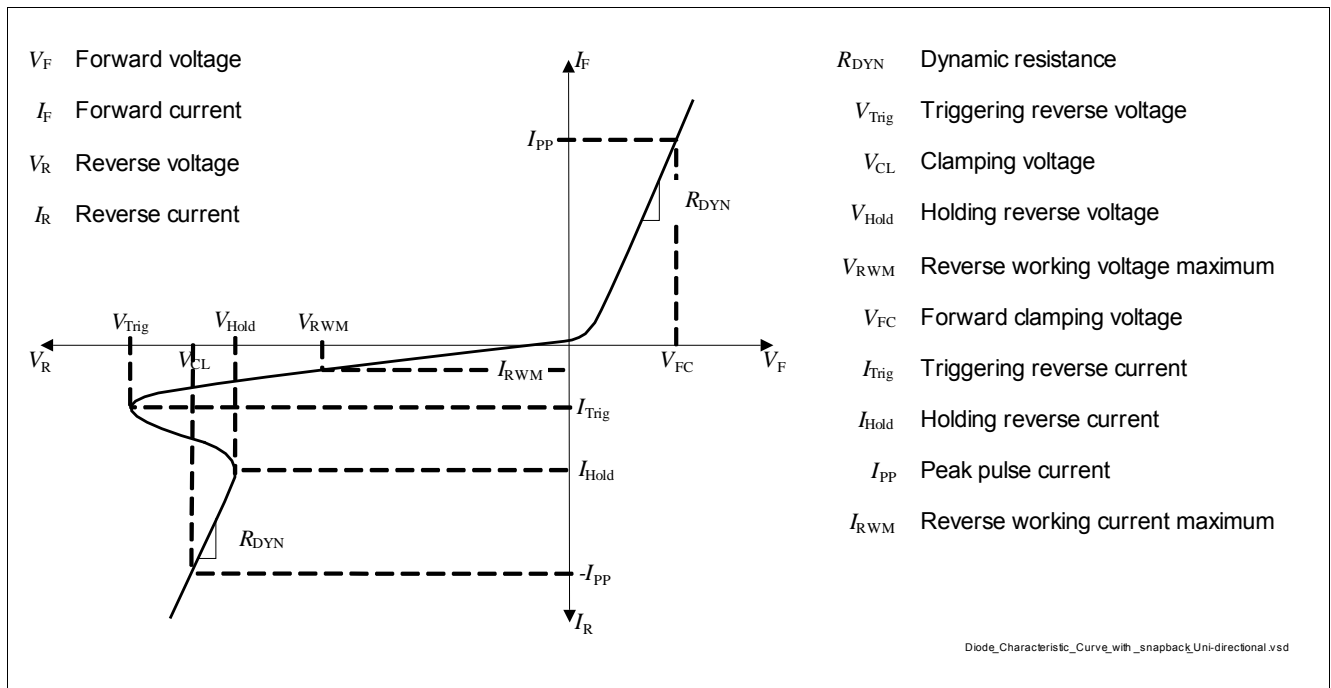
Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
ESD (air / contact) discharge <sup>1)</sup>	$V_{ESD}$	-20	–	20	kV
Peak pulse current ( $t_p = 8/20\text{ }\mu\text{s}$ ) <sup>2)</sup>	$I_{PP}$	-3	–	3	A
Operating temperature range	$T_{OP}$	-40	–	125	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-65	–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

1)  $V_{ESD}$  according to IEC61000-4-2 ( $R = 330\text{ }\Omega$ ,  $C = 150\text{ pF}$ )

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

**Attention:** Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

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



**Figure 2** Definitions of Electrical Characteristics

**Characteristics**
**Table 3 DC Characteristics at  $T_A = 25\text{ °C}$ , unless otherwise specified**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Reverse working voltage	$V_{RWM}$	–	–	3.3	V	Pin 1 to Pin 2
Breakdown voltage	$V_{BR}$	–	6.5	–	V	from Pin 1 to Pin 2 voltage forced
Reverse current	$I_R$	–	1	50	nA	$V_R = 3.3\text{ V}$ , 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	0.65	pF	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$
		–	0.4	0.65	pF	$V_R = 0\text{ V}$ , $f = 1\text{ GHz}$
Series inductance	$L_S$	–	0.2	–	nH	

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.		
Trigger voltage <sup>1)</sup> [2]	$V_{TRIG}$	–	7.2	–	V	TLP, from Pin 1 to Pin 2
Reverse clamping voltage <sup>1)</sup> [2]	$V_{CL}$	–	8	–	V	TLP, $I_{PP} = 16\text{ A}$ , from Pin 1 to Pin 2
		–	11	–	V	TLP, $I_{PP} = 30\text{ A}$ , from Pin 1 to Pin 2
Forward clamping voltage <sup>1)</sup> [2]	$V_{FC}$	–	6	–	V	TLP, $I_{PP} = 16\text{ A}$ , from Pin 2 to Pin 1
		–	9	–	V	TLP, $I_{PP} = 30\text{ A}$ , from Pin 2 to Pin 1
Dynamic resistance <sup>1)</sup> [2]	$R_{DYN}$	–	0.19	–	$\Omega$	TLP, Pin 1 to Pin 2
		–	0.23	–	$\Omega$	TLP, Pin 2 to Pin 1

1) Please refer to Application Note AN210. ANSI/ESD STM5.5.1 - Electrostatic Discharge Sensitivity Testing using Transmission Line Pulse (TLP),  $t_p = 100\text{ ns}$ ,  $t_r = 0.6\text{ ns}$ ,  $I_{TLP}$  and  $V_{TLP}$  averaging window:  $t_1 = 30\text{ ns}$  to  $t_2 = 60\text{ ns}$ , extraction of dynamic TLP characteristic between  $I_{PP1} = 10\text{ A}$  and  $I_{PP2} = 40\text{ A}$ .

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

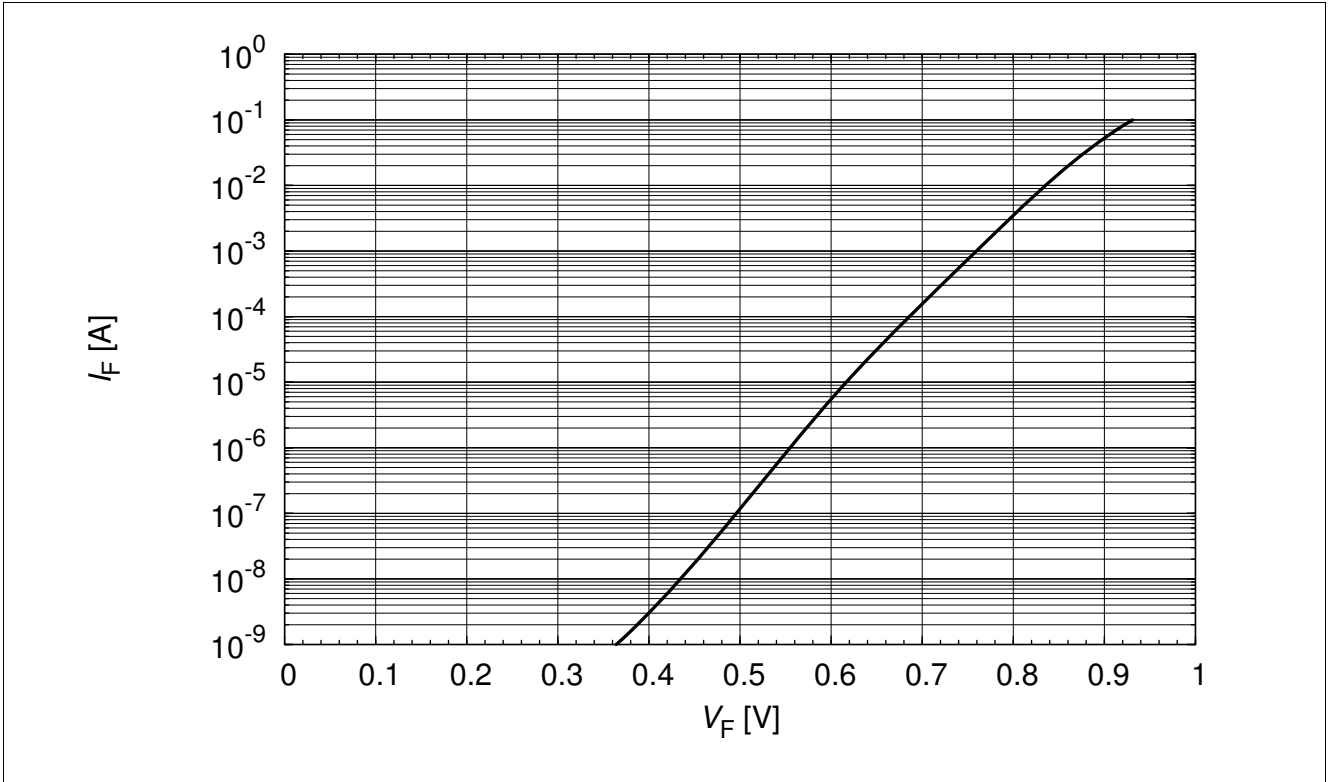


Figure 3 Forward current,  $I_F = (V_F)$

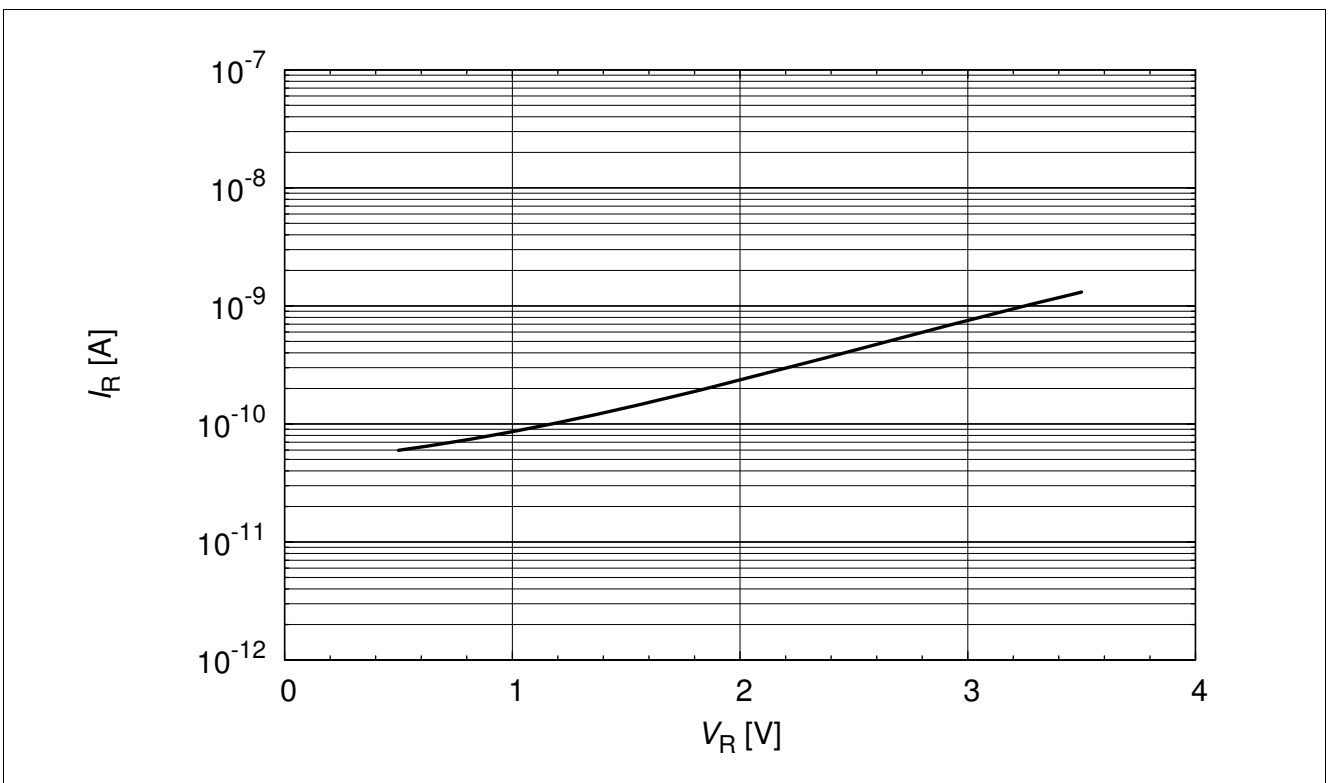


Figure 4 Reverse current,  $I_R = (V_R)$

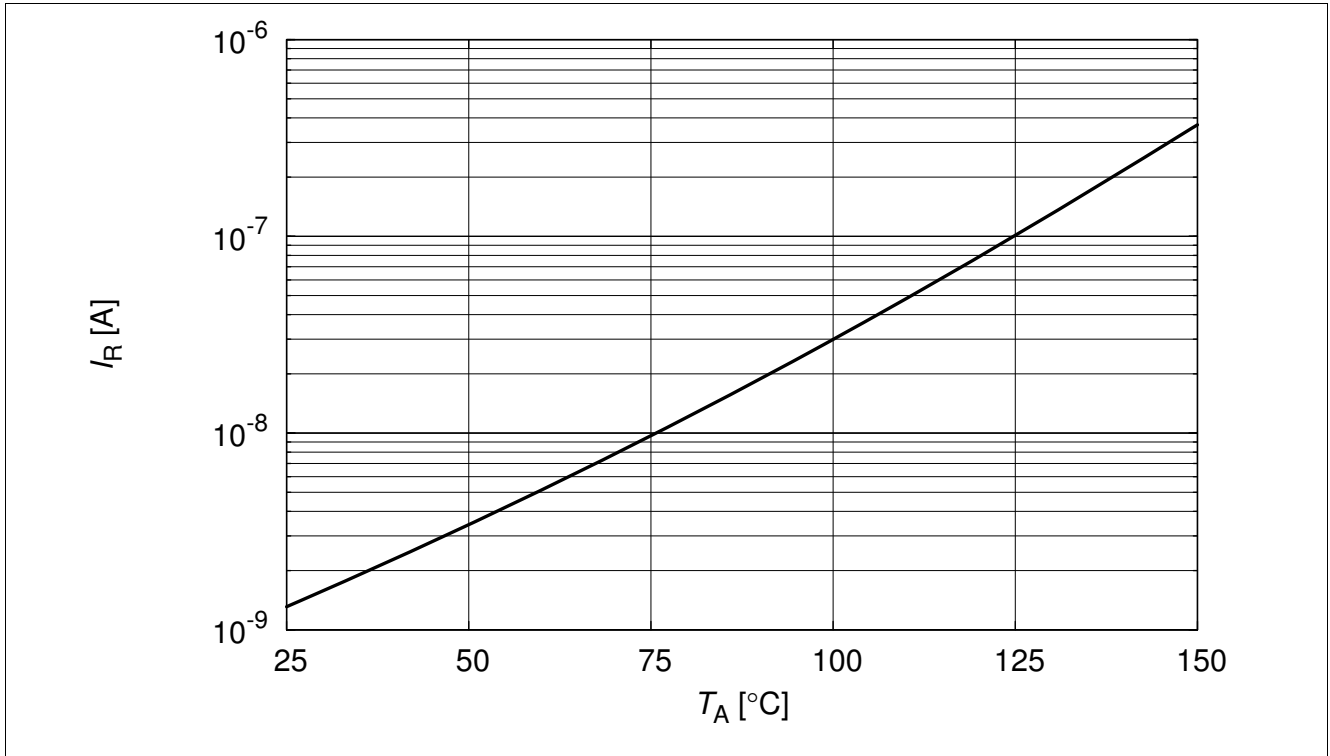


Figure 5 Reverse current  $I_R = f(T_A)$ ,  $V_R = 3.3$  V

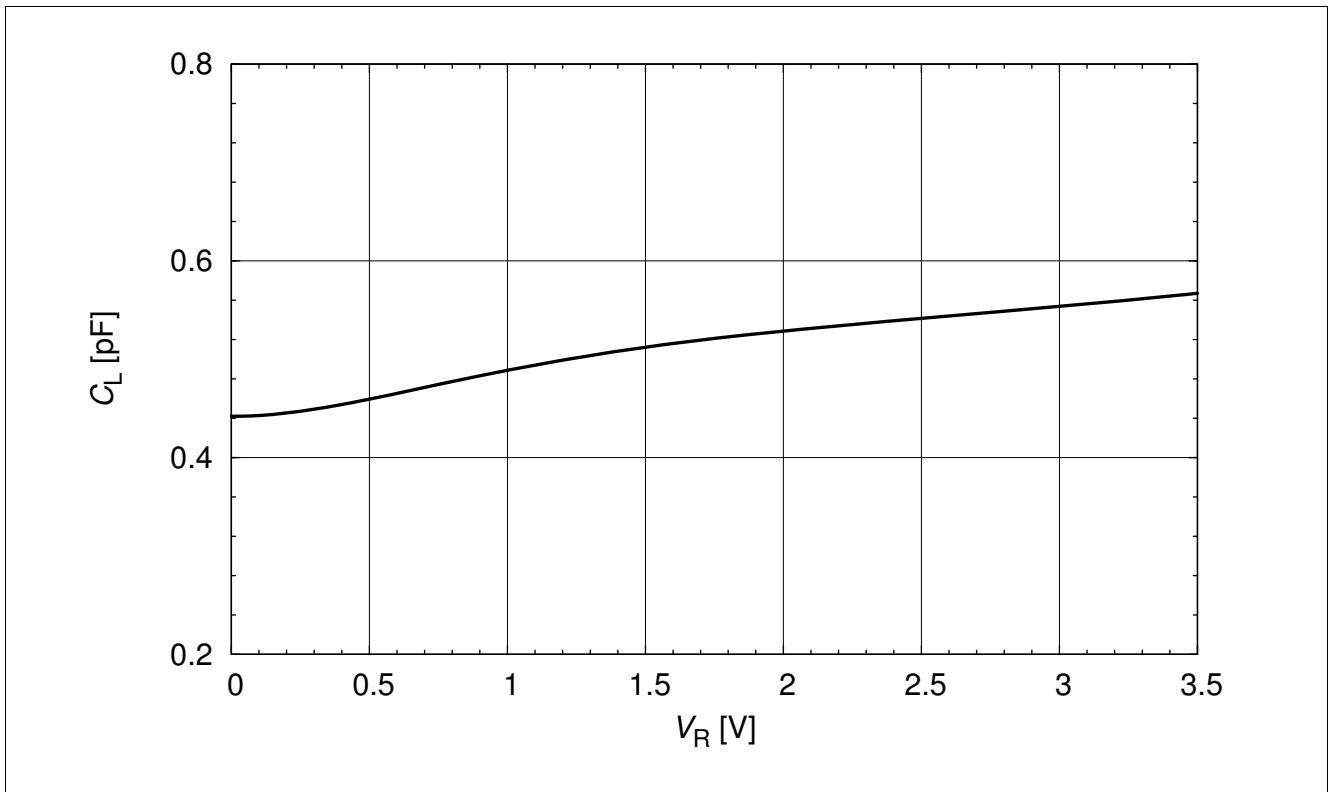


Figure 6 Line capacitance  $C_L = f(V_R)$ ,  $f = 1$  MHz, from pin 1 to pin 2



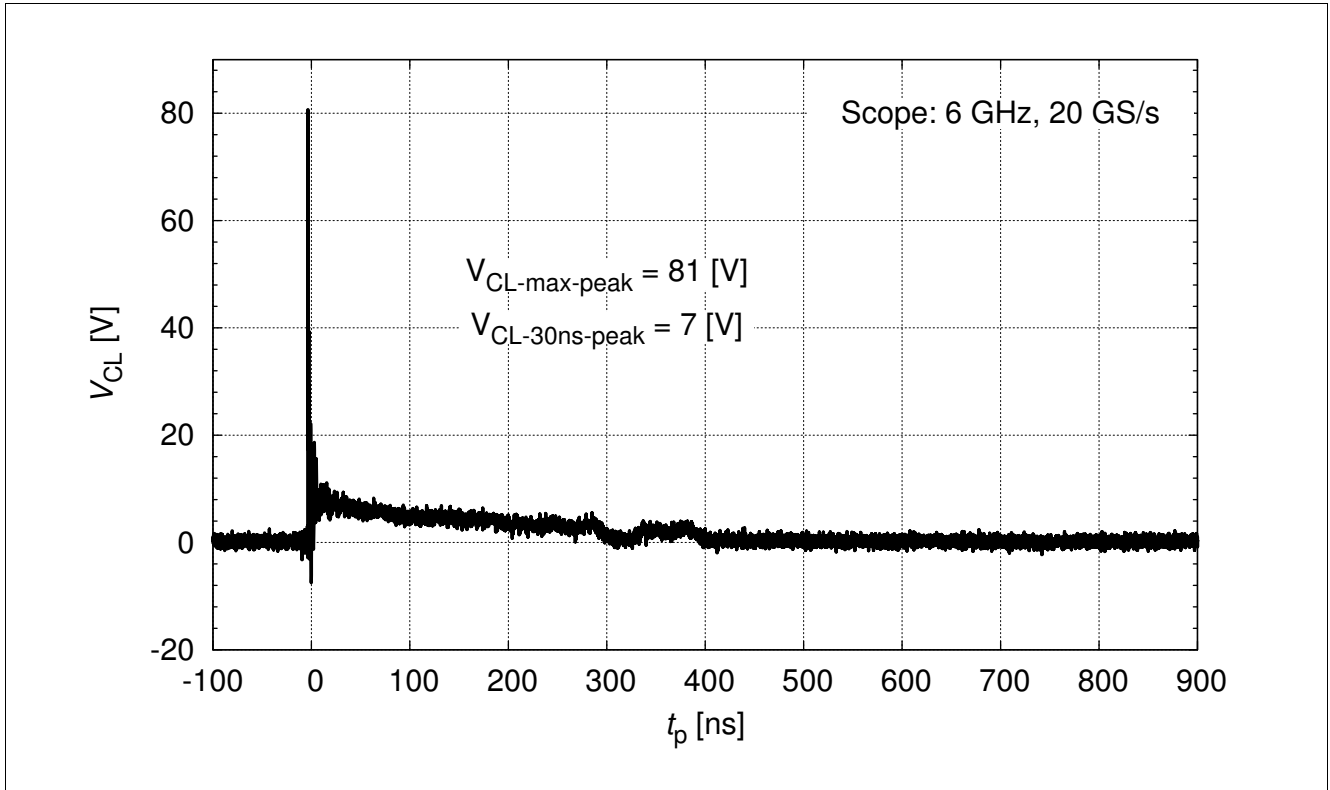


Figure 7 IEC61000-4-2  $V_{CL} = f(t)$ , 8 kV positive pulse from pin 1 to pin 2

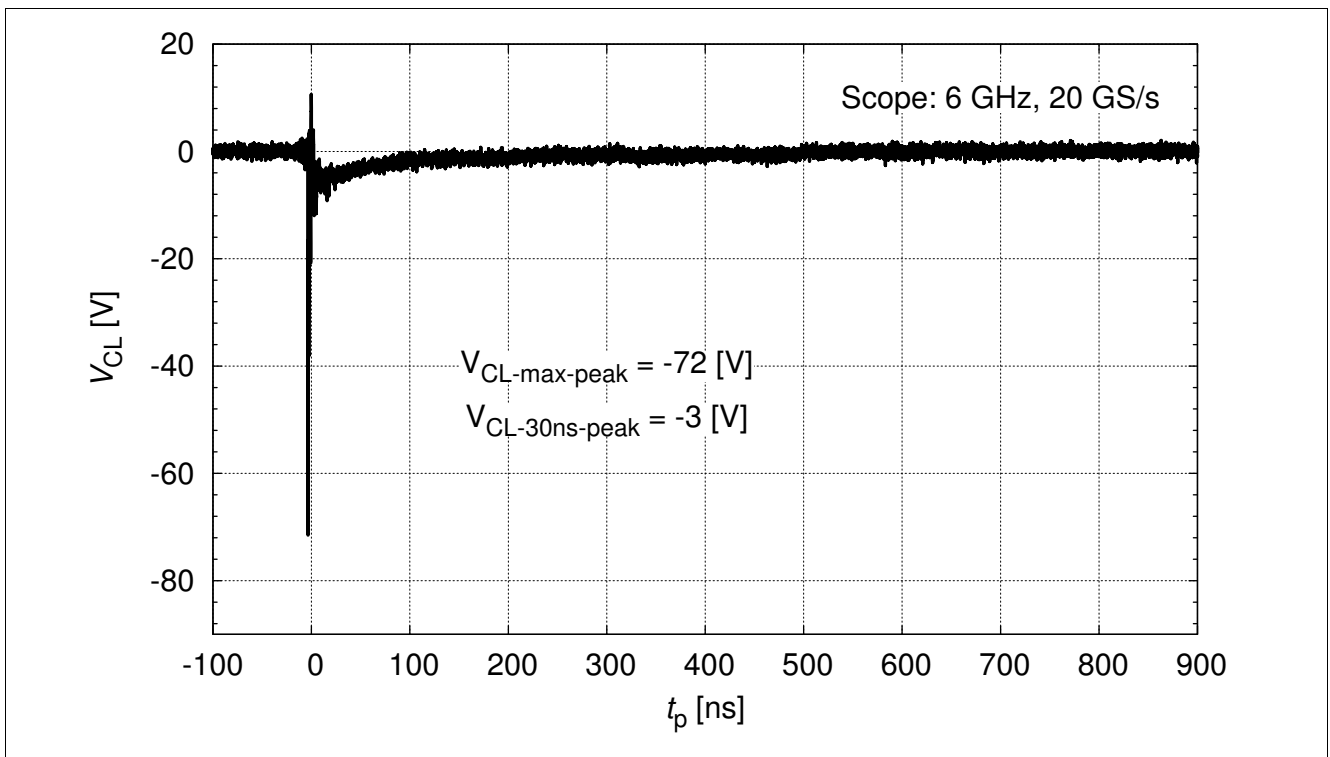


Figure 8 IEC61000-4-2  $V_{CL} = f(t)$ , 8 kV negative pulse from pin 1 to pin 2

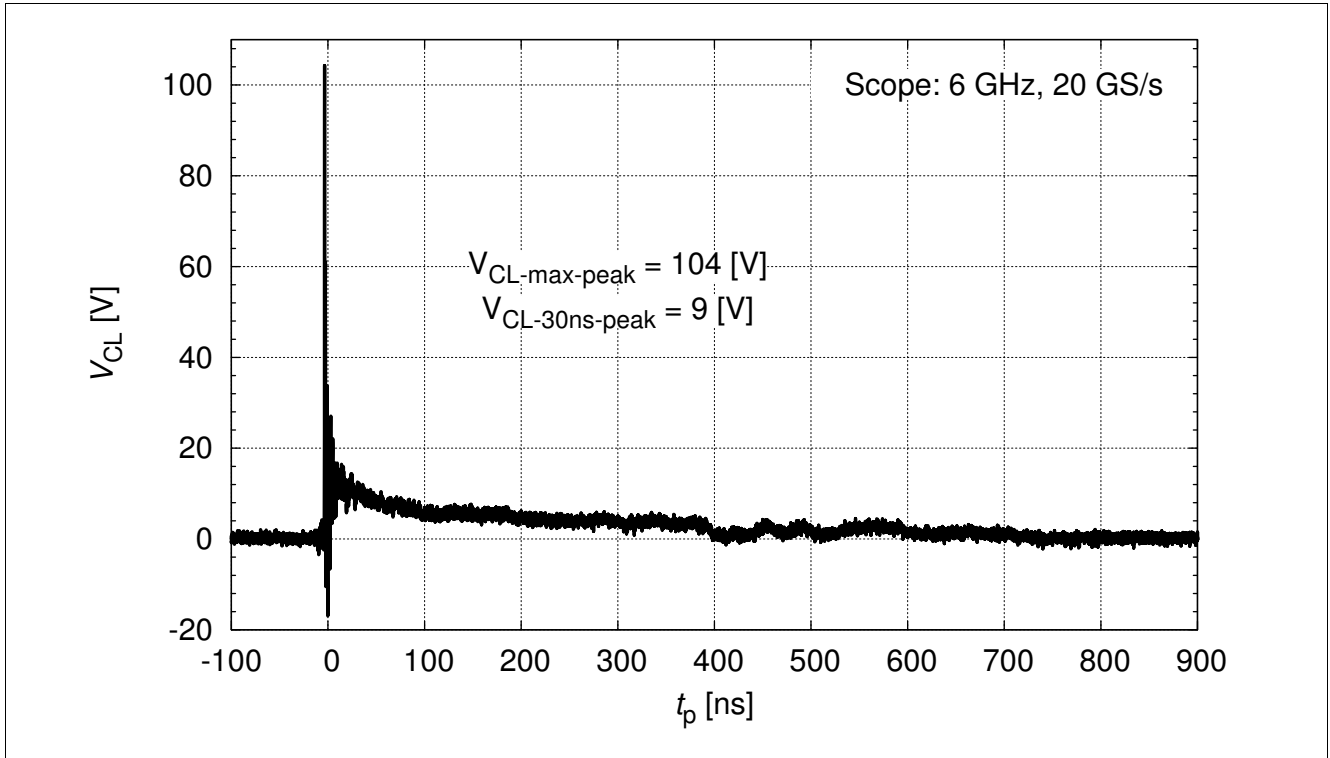


Figure 9 IEC61000-4-2  $V_{CL} = f(t)$ , 15 kV positive pulse from pin 1 to pin 2

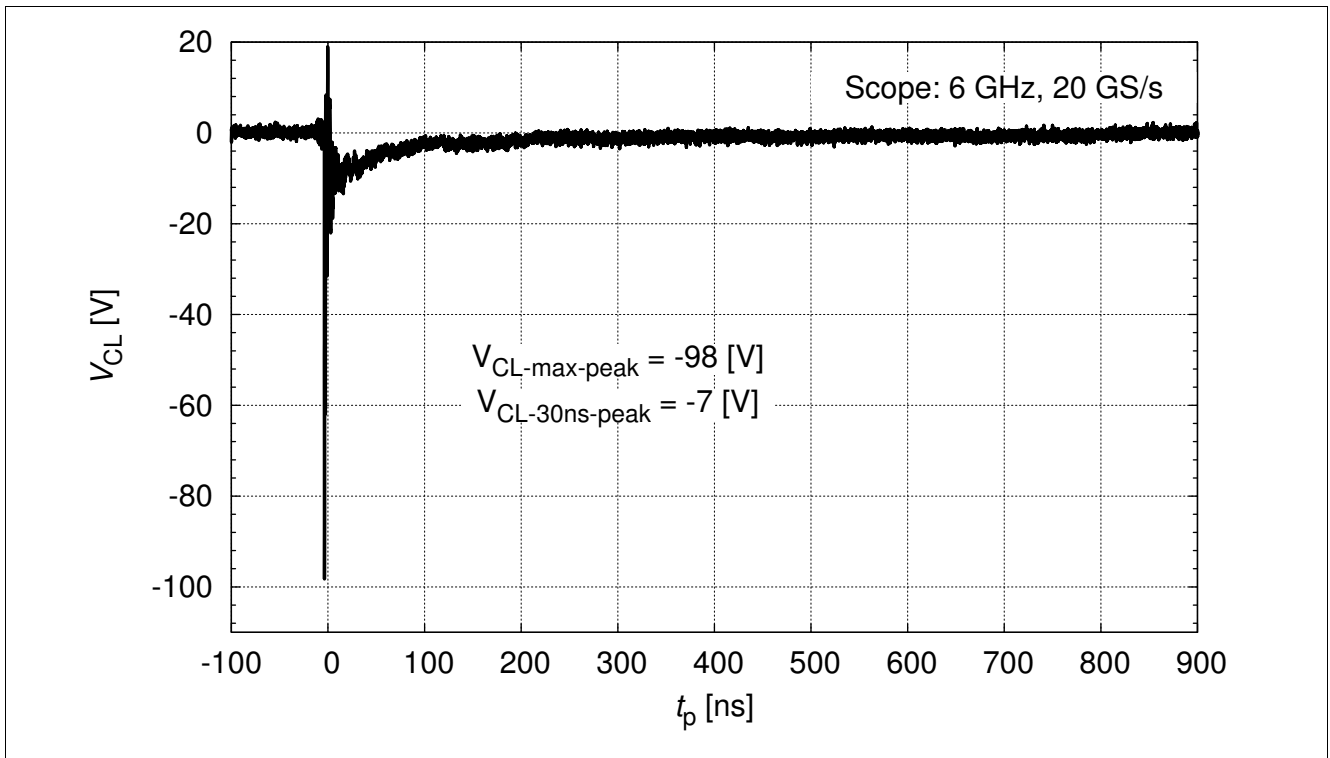
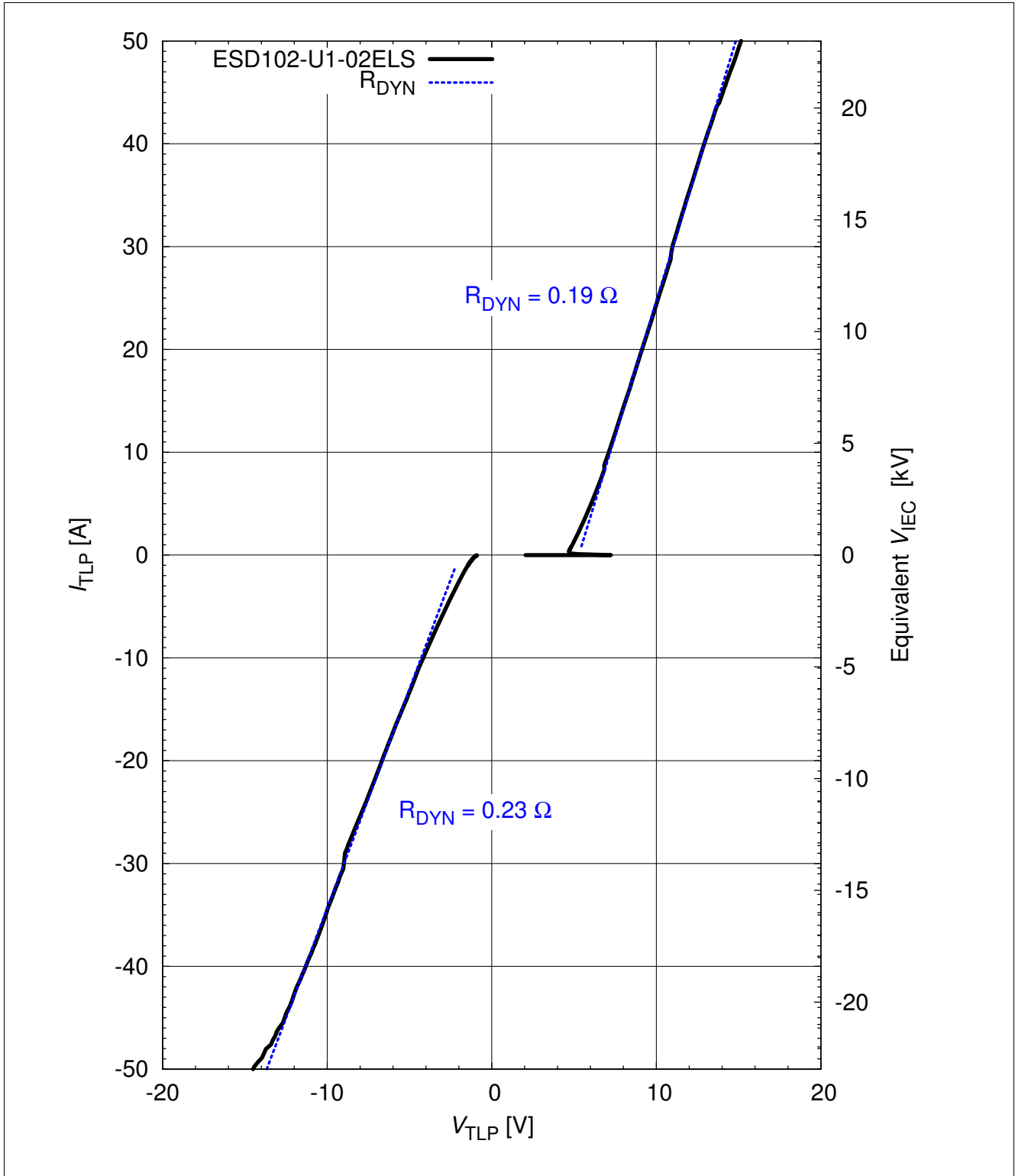


Figure 10 IEC61000-4-2  $V_{CL} = f(t)$ , 15 kV negative pulse from pin 1 to pin 2



**Figure 11 Clamping voltage  $V_{TLP} = f(I_{TLP})$ , [2]**

Note: TLP parameter:  $Z_0 = 50 \Omega$ ,  $t_p = 100 \text{ ns}$ ,  $t_r = 600 \text{ ps}$ , 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  $I_{PP2} = 40 \text{ A}$ . The equivalent stress level  $V_{IEC}$  according IEC 61000-4-2 ( $R = 330 \Omega$ ,  $C = 150 \text{ pF}$ ) is calculated at the broad peak of the IEC waveform at  $t = 30 \text{ ns}$  with  $2 \text{ A/kV}$

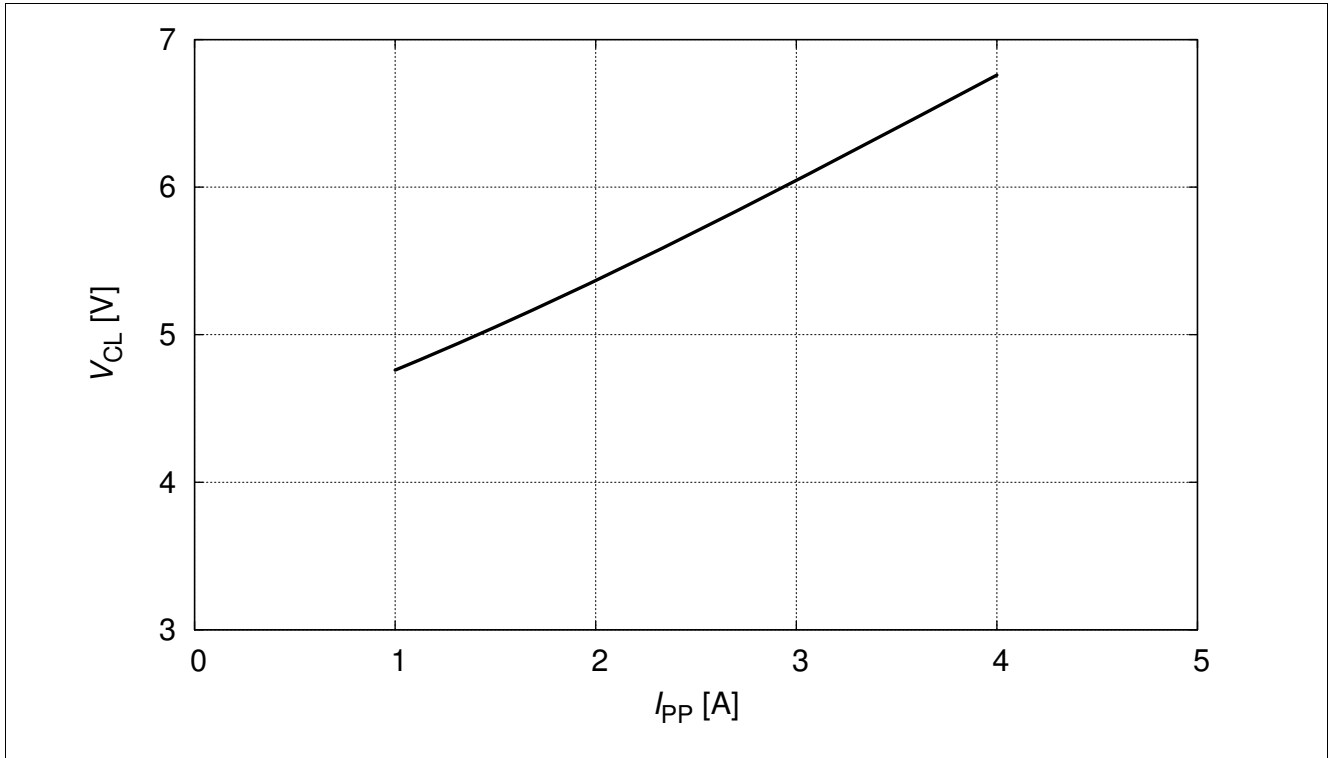


Figure 12 Reverse clamping voltage  $I_{PP} = f(V_{CL})$ , from pin 1 to pin 2 according to IEC61000-4-5 (8/20  $\mu$ s)

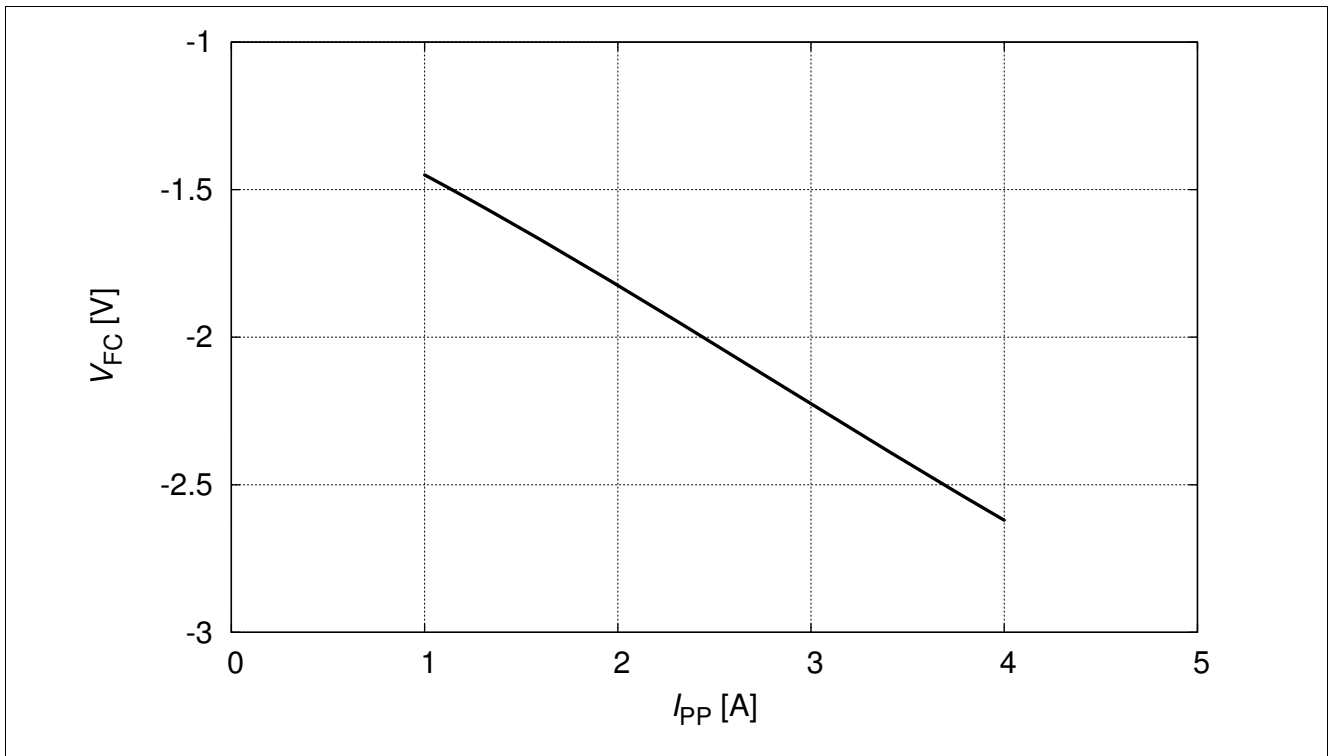


Figure 13 Forward clamping voltage  $I_{PP} = f(V_{FC})$ , from pin 1 to pin 2 according to IEC61000-4-5 (8/20  $\mu$ s)

### 3 Application Information

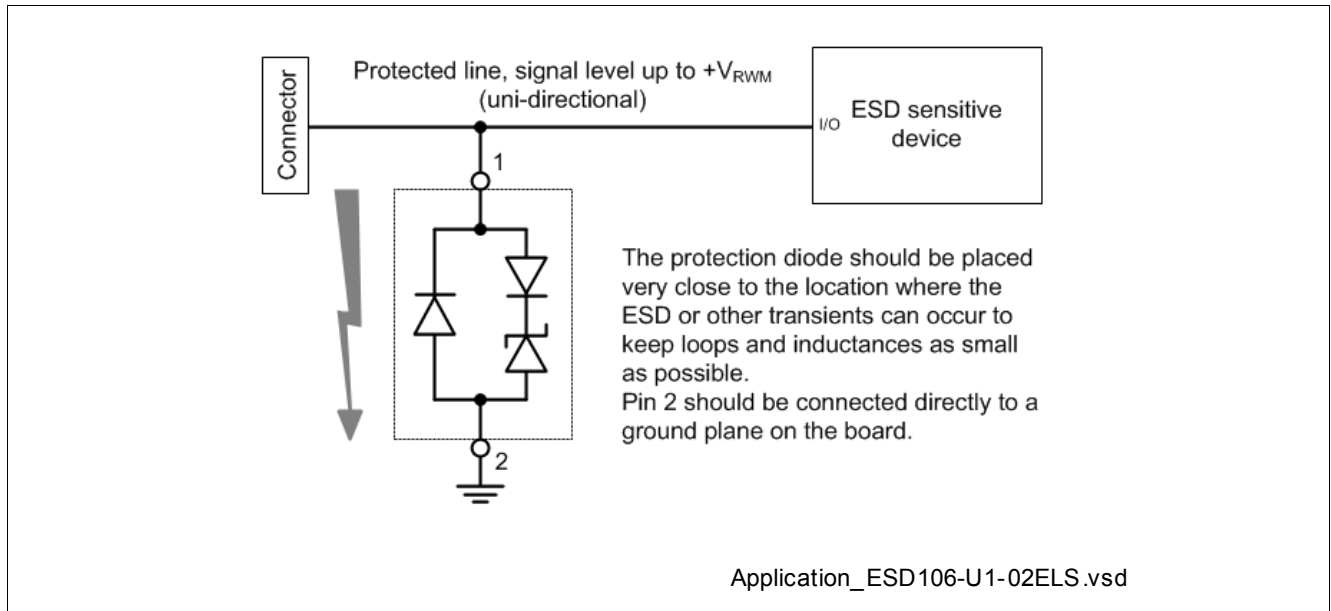


Figure 14 Single line, uni-directional ESD / Transient protection[2]

## 4 Package Information

### 4.1 TSSLP-2-3 (mm) [3]

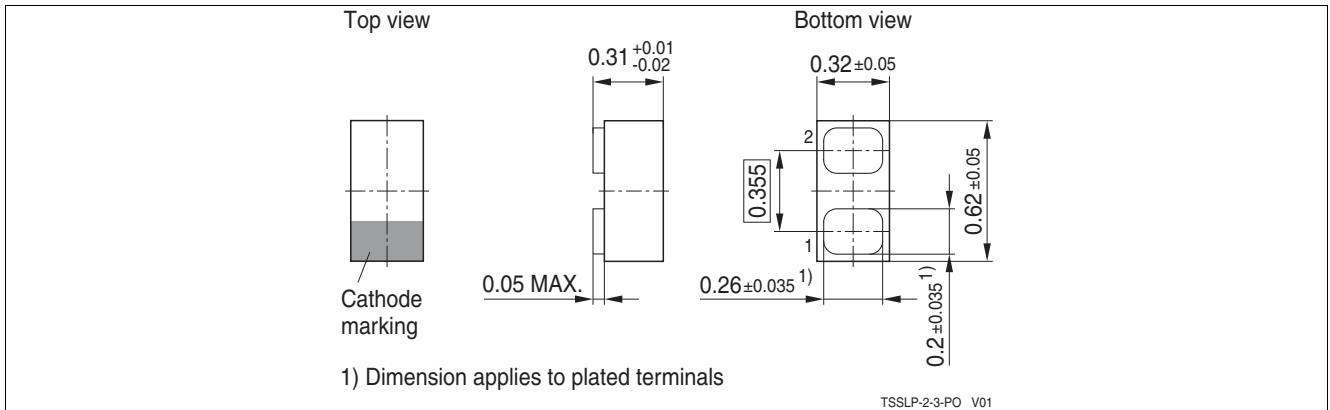


Figure 15 Package outline for TSSLP-2-3 (dimension in mm)

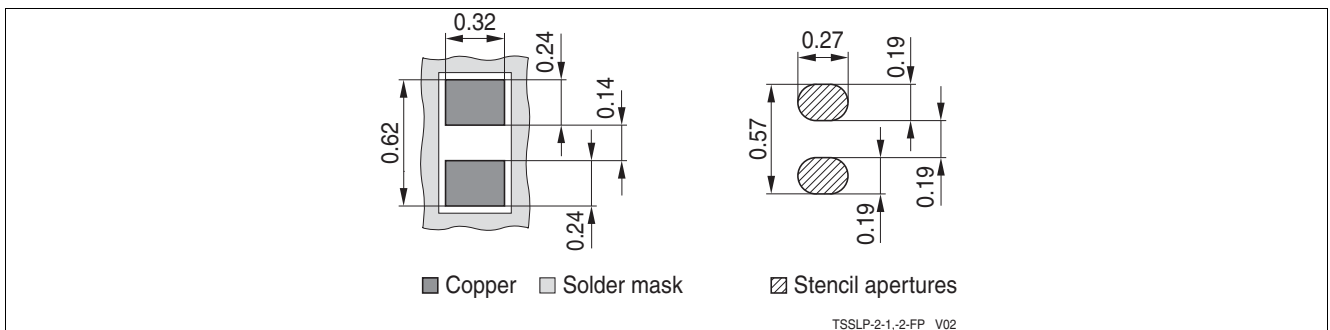


Figure 16 Package footprint for TSSLP-2-3 (dimension in mm)

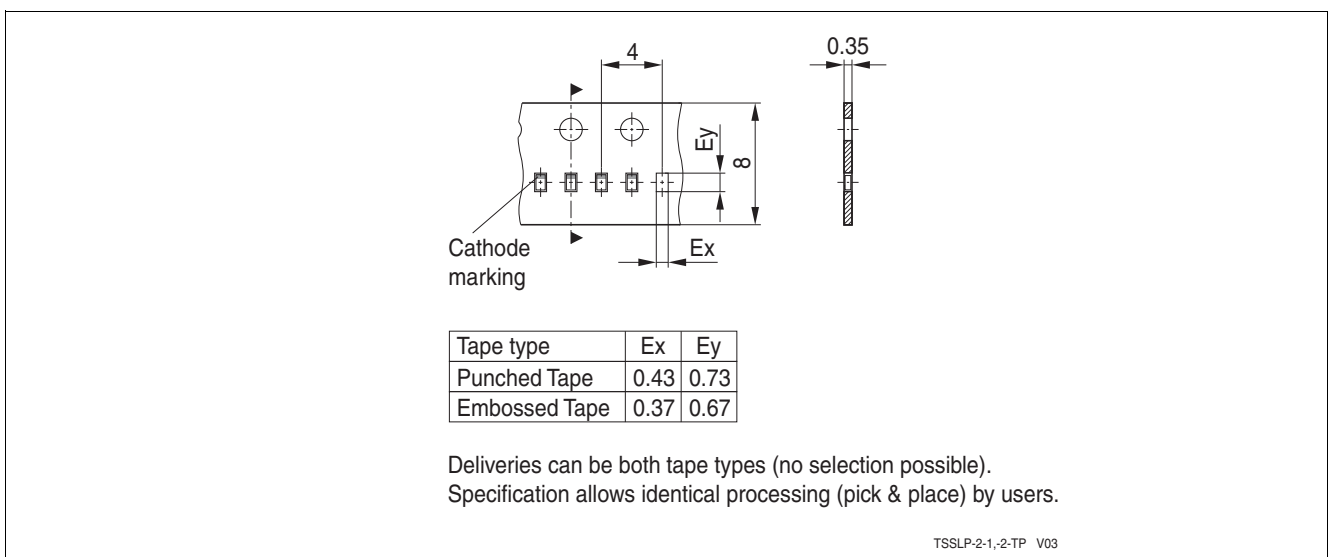


Figure 17 Tape and Reel Information for TSSLP-2-3 (dimension in mm)

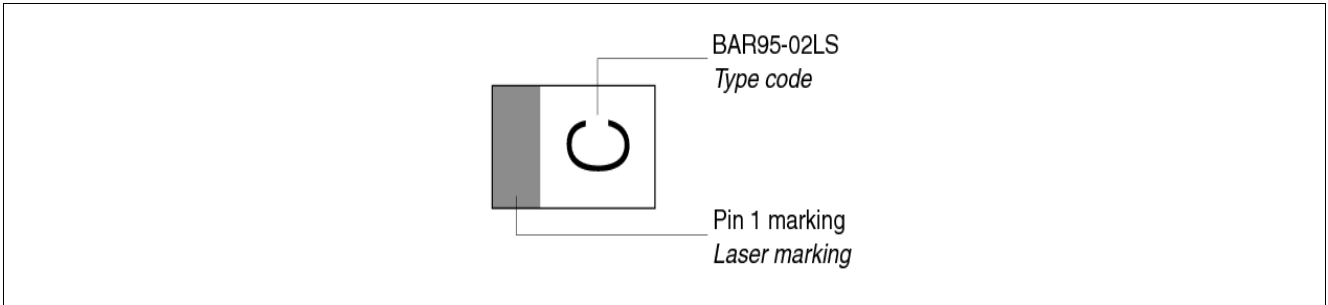


Figure 18 Marking for TSSLP-2-3 (example)

**References**

- [1] On-chip ESD protection for integrated circuits, Albert Z. H. Wang, ISBN:0-7923-7647-1
- [2] Infineon AG - **Application Note AN210**: Effective ESD Protection Design at System Level Using VF-TLP Characterization Methodology
- [3] Infineon AG - Recommendations for PCB Assembly of Infineon TSLP and TSSLP Package



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