

# TVS Diode

Transient Voltage Suppressor Diodes

## ESD5V3U2U Series

Uni-directional Ultra Low ESD / Transient Protection Diode

ESD5V3U2U-03F  
ESD5V3U2U-03LRH

## Data Sheet

Revision 1.3, 2013-08-16  
Final

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**Revision History: Rev. 1.2, 2013-08-16**

Page or Item	Subjects (major changes since previous revision)
<b>Revision 1.3, 2013-08-16</b>	
4 + 16	All marking infos for TSLP-3-7 updated

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Last Trademarks Update 2010-10-26

# 1 Uni-directional Ultra Low 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):  $\pm 50$  A (5/50 ns)
  - IEC61000-4-5 (surge):  $\pm 3$  A (8/20  $\mu$ s)
- Maximum working voltage:  $V_{RWM}$  5.3 V
- Extremely low capacitance: down to 0.4 pF
- Very low reverse current:  $I_R < 1$  nA typical
- Pb-free package (RoHS compliant) and halogen free package



## 1.2 Application Examples

- ESD / Transient protection of High Speed Interfaces:
  - HDMI, USB 2.0/USB 3.0, DisplayPort, DVI
  - Mobile HDMI Link, MDDI, MIPI.
  - 10/100/1000 Ethernet, Firewire, S-ATA, etc.

## 1.3 Product Description

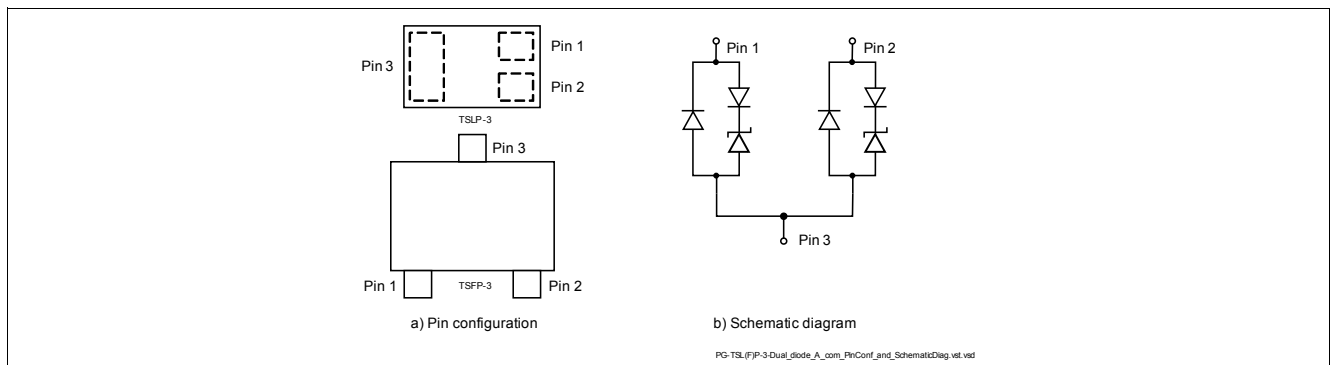


Figure 1-1 Pin Configuration (a) and Schematic Diagram (b)

Table 1-1 Ordering information

Type	Package	Configuration	Marking code
ESD5V3U2U-03F	PG-TSFP-3-1	2 lines, uni-directional <sup>1)</sup>	Z1
ESD5V3U2U-03LRH	PG-TSLP-3-7	2 lines, uni-directional <sup>1)</sup>	Z1

1) Or 1 line, bi-directional between pins 1 and 2, if pin 3 is not connected

## 2 Characteristics

Table 2-1 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>	$V_{ESD}$	-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

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

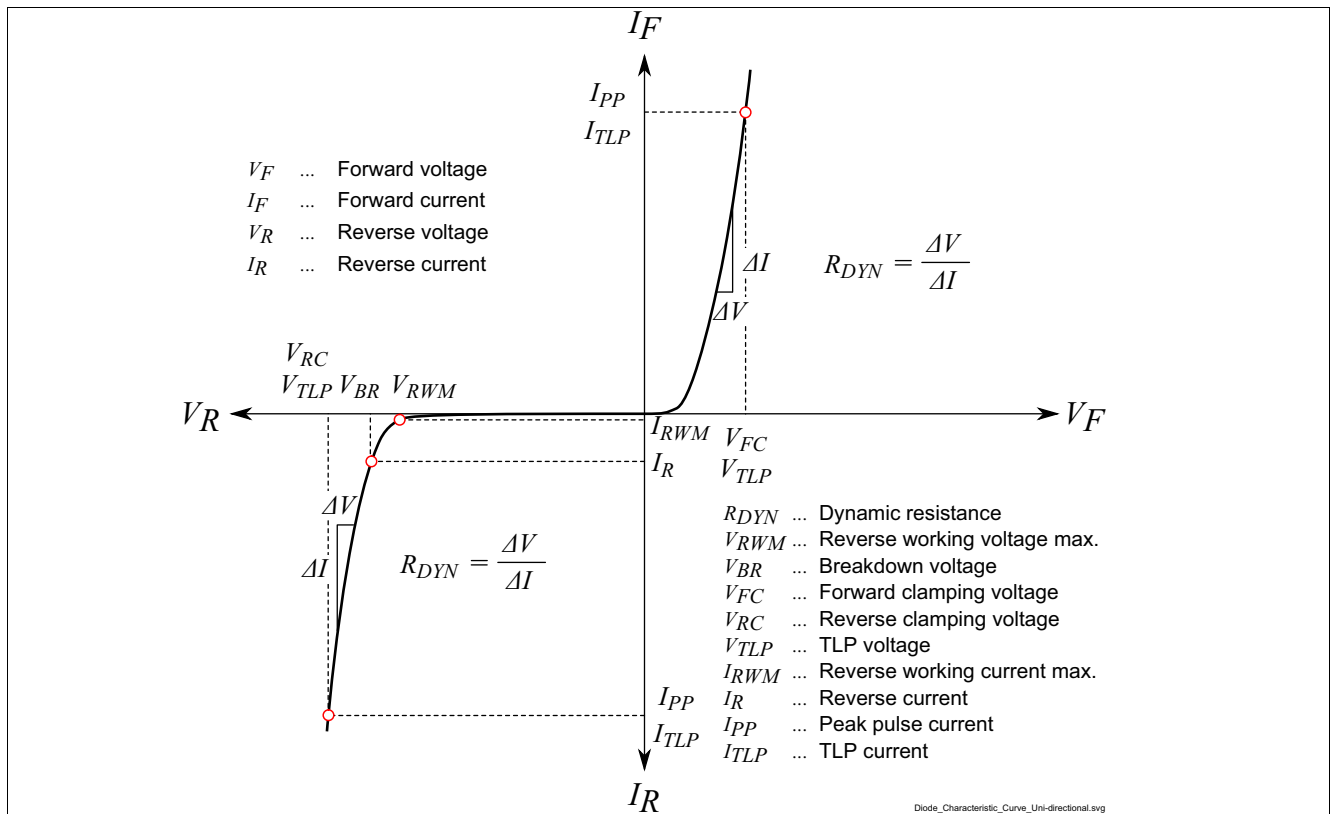


Figure 2-1 Definitions of electrical characteristics

**Table 2-2 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	$V_{RWM}$	–	–	5.3	V	
Breakdown voltage	$V_{BR}$	6	–	–	V	$I_{BR} = 1\text{ mA}$ , from Pin 1/2 to Pin 3
Reverse current	$I_R$	–	<1	50	nA	$V_R = 5.3\text{ V}$ , from Pin 1/2 to Pin 3

**Table 2-3 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	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ from pin 1/2 to pin 3
		–	0.2	0.4	pF	$V_R = 0\text{ V}$ , $f = 1\text{ MHz}$ from pin 1 to 2, pin 3 <sup>1)</sup> not connected

1) Total capacitance line to ground

**Table 2-4 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	$I_{TLP} = 16\text{ A}$ , from Pin 1/2 to Pin 3
		–	28	–	V	$I_{TLP} = 30\text{ A}$ , from Pin 1/2 to Pin 3
Forward clamping voltage <sup>1)</sup>	$V_{FC}$	–	10	–	V	$I_{TLP} = 16\text{ A}$ , from Pin 3 to Pin 1/2
		–	17	–	V	$I_{TLP} = 30\text{ A}$ , from Pin 3 to Pin 1/2
Dynamic resistance <sup>1)</sup>	$R_{DYN}$	–	0.6	–	V	Pin 1/2 to Pin 3
		–	0.4	–	V	Pin 3 to Pin 1/2

1) Please refer to Application Note AN210[1]. 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  $I_{PP2} = 40\text{ A}$ .

**Table 2-5 Surge characteristics at  $T_A = 25\text{ °C}$ , unless otherwise specified**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Clamping voltage	$V_{CL}$	–	10	13	V	$I_{PP} = 1\text{ A}$ , $t_p = 8/20\ \mu\text{s}^{1)}$ from Pin 1/2 to Pin 3
		–	12	15	V	$I_{PP} = 3\text{ A}$ , $t_p = 8/20\ \mu\text{s}^{1)}$ from Pin 1/2 to Pin 3
Forward clamping voltage	$V_{FC}$	–	2	4	V	$I_{PP} = 1\text{ A}$ , $t_p = 8/20\ \mu\text{s}^{1)}$ from Pin 3 to Pin 1/2
		–	4	6	V	$I_{PP} = 3\text{ A}$ , $t_p = 8/20\ \mu\text{s}^{1)}$ from Pin 3 to Pin 1/2

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

### 3 Typical characteristics

Typical characteristics at = 25 °C, unless otherwise specified

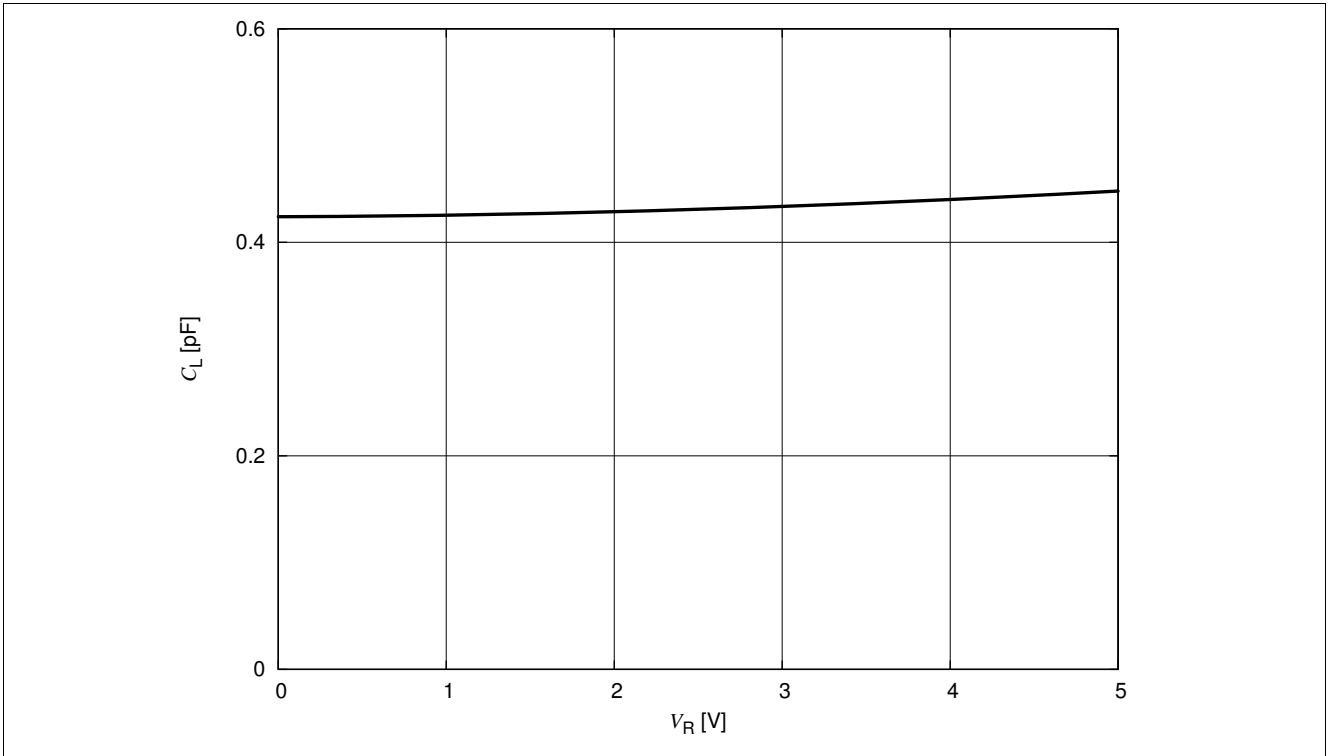


Figure 3-1 Line capacitance  $C_L=f(V_R)$ , from pin 1/2 to 3,  $f = 1$  MHz

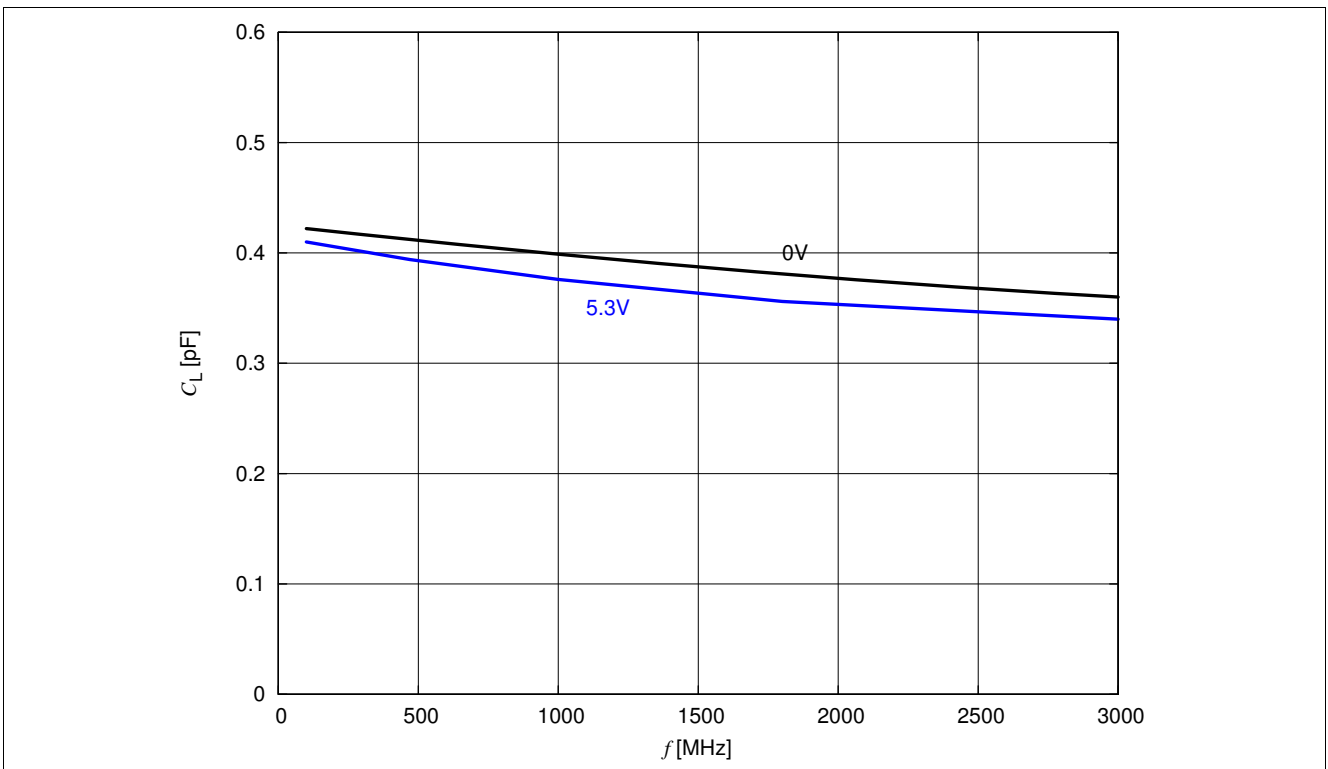


Figure 3-2 Line capacitance  $C_L=f(f)$ , from pin 1/2 to 3



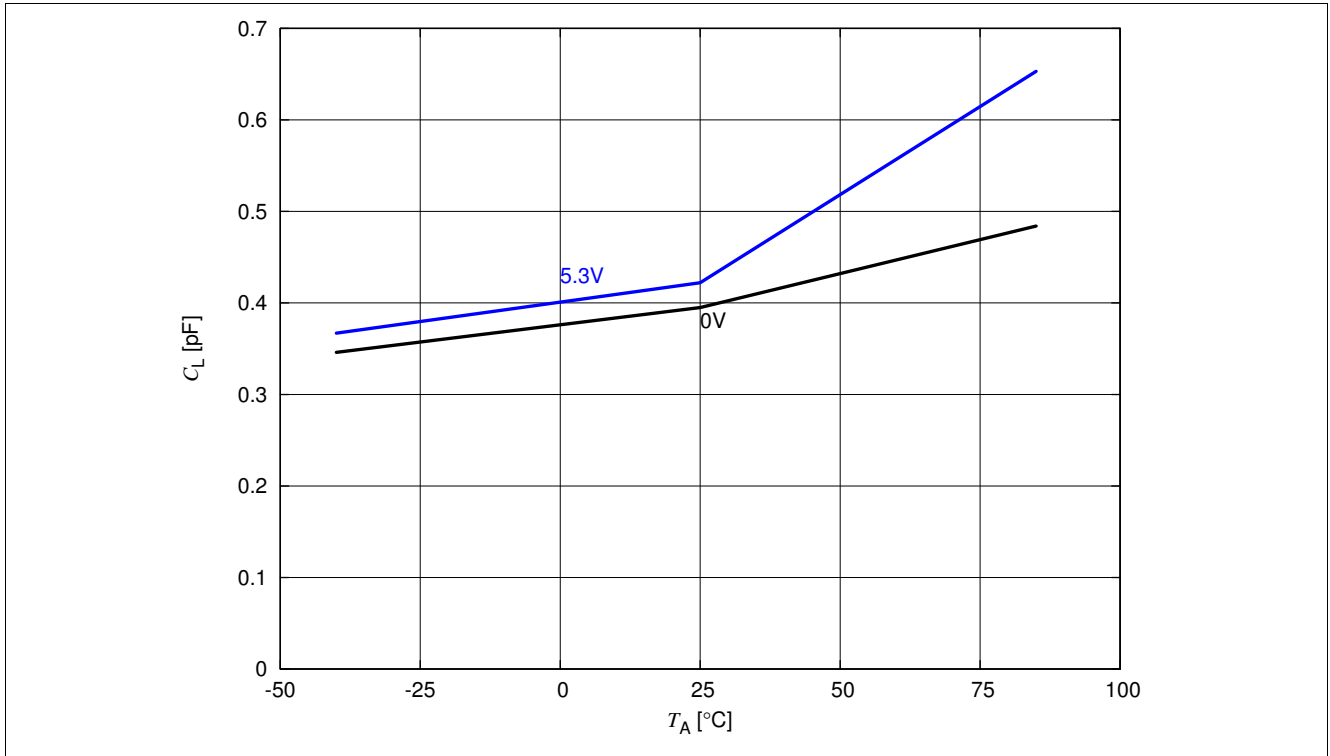


Figure 3-3 Line capacitance  $C_L=f(T_A)$

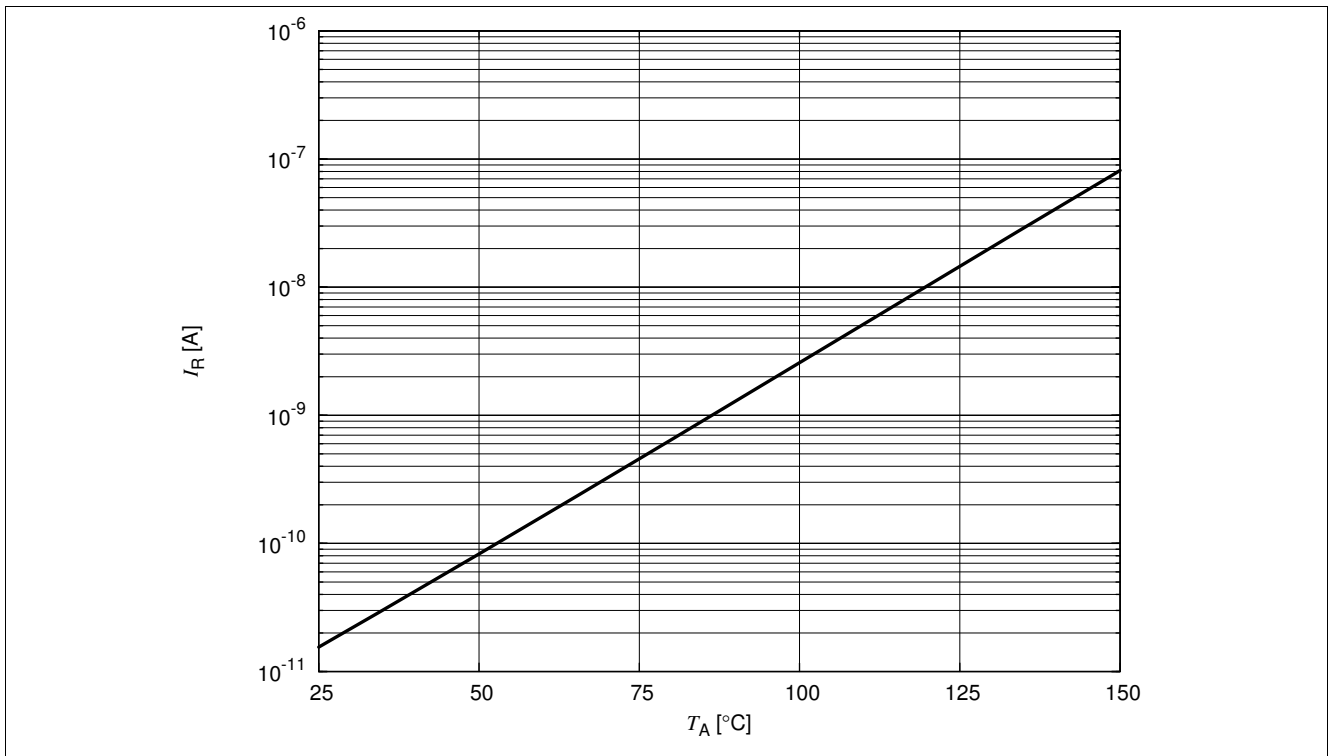


Figure 3-4 Reverse current  $I_R=f(T_A)$ ,  $V_R=5.3$  V, from pin 1/2 to pin 3

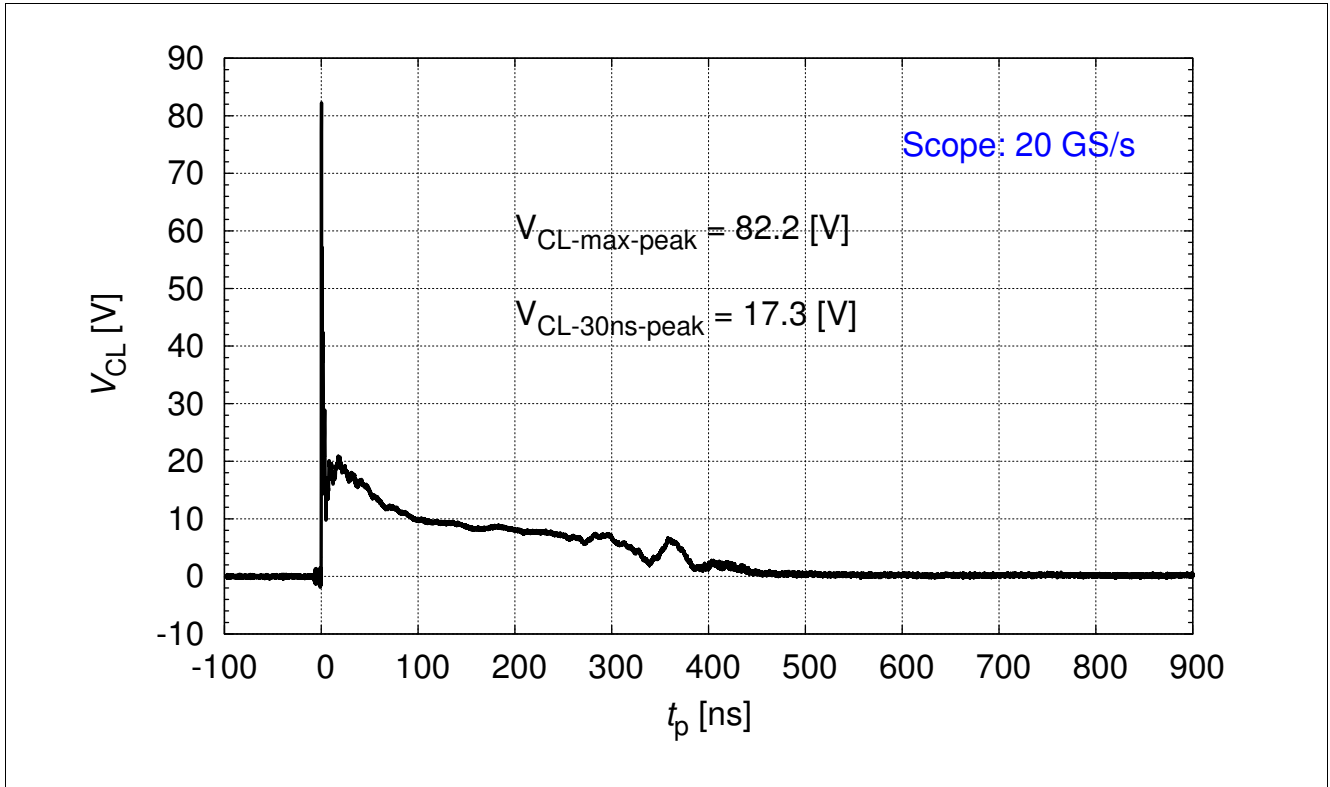


Figure 3-5 IEC61000-4-2:  $V_{CL} = f(t)$ , 8 kV positive pulse from pin 1 to pin 2 ( $R = 330 \Omega$ ,  $C = 150 \text{ pF}$ )

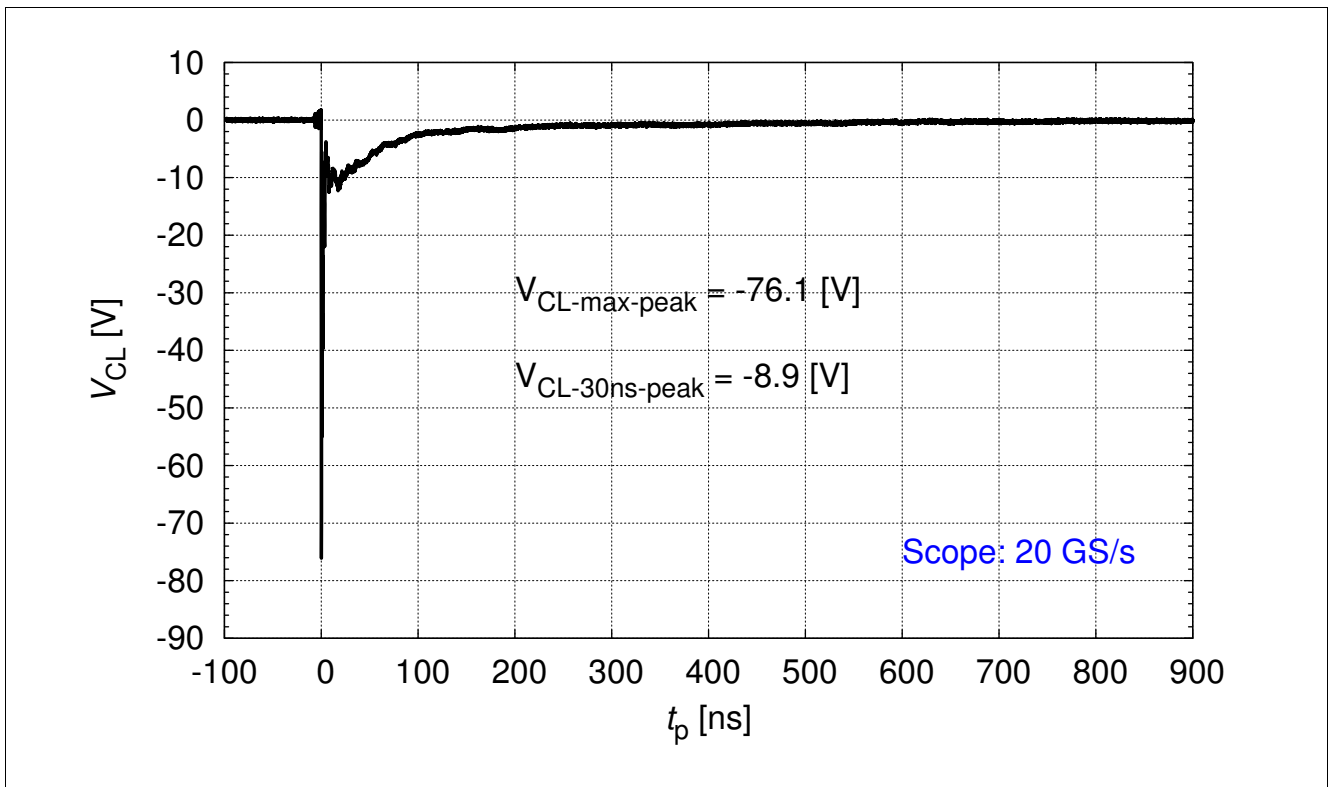


Figure 3-6 IEC61000-4-2:  $V_{CL} = f(t)$ , 8 kV negative pulse from pin 1 to pin 2 ( $R = 330 \Omega$ ,  $C = 150 \text{ pF}$ )

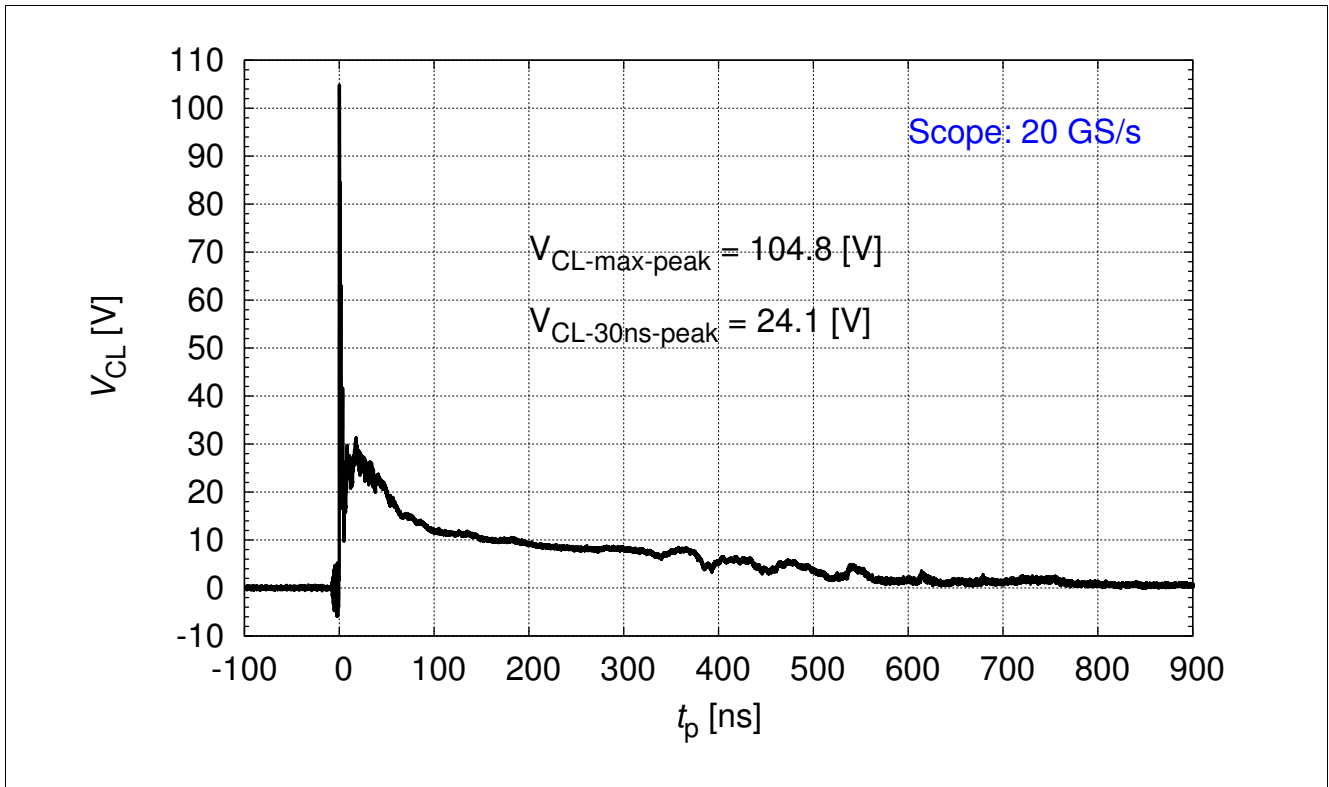


Figure 3-7 IEC61000-4-2:  $V_{CL} = f(t)$ , 15 kV positive pulse from pin 1 to pin 2 ( $R = 330 \Omega$ ,  $C = 150 \text{ pF}$ )

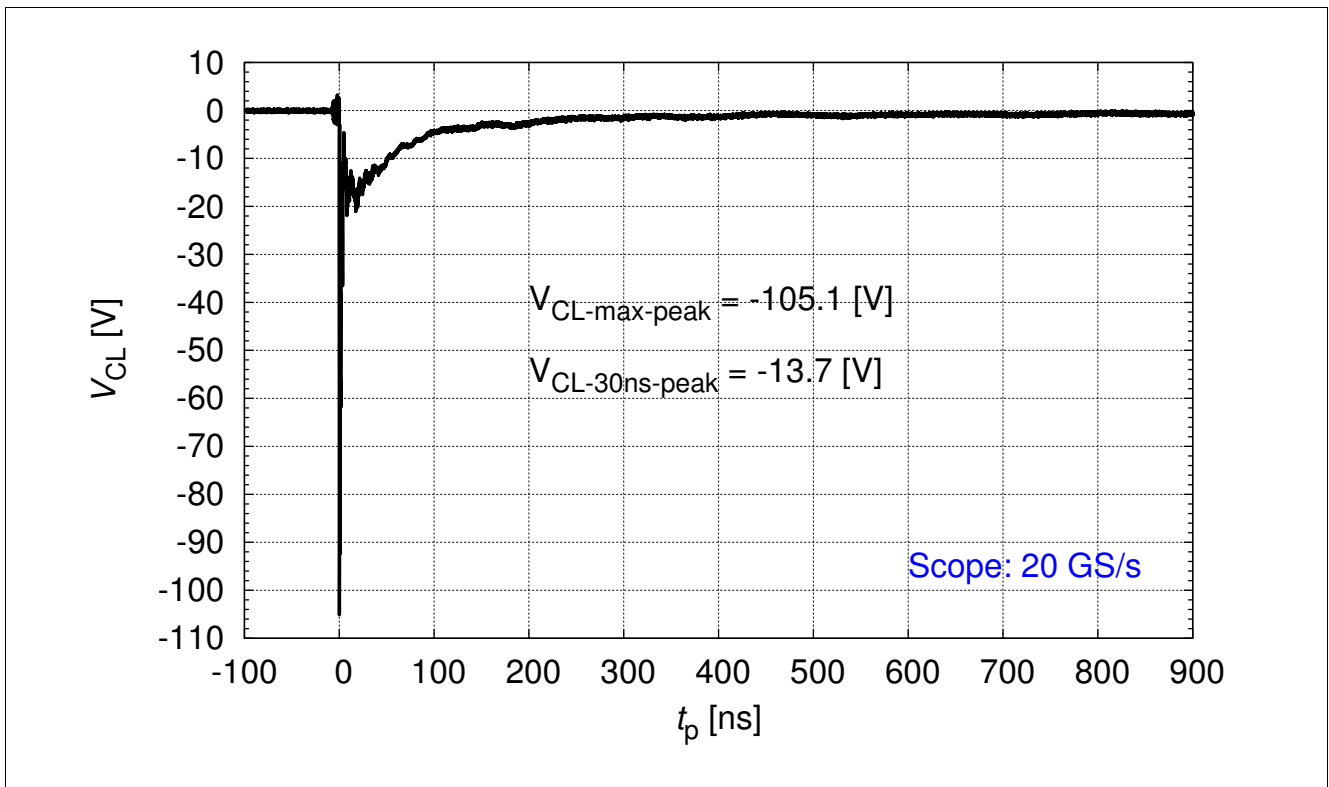
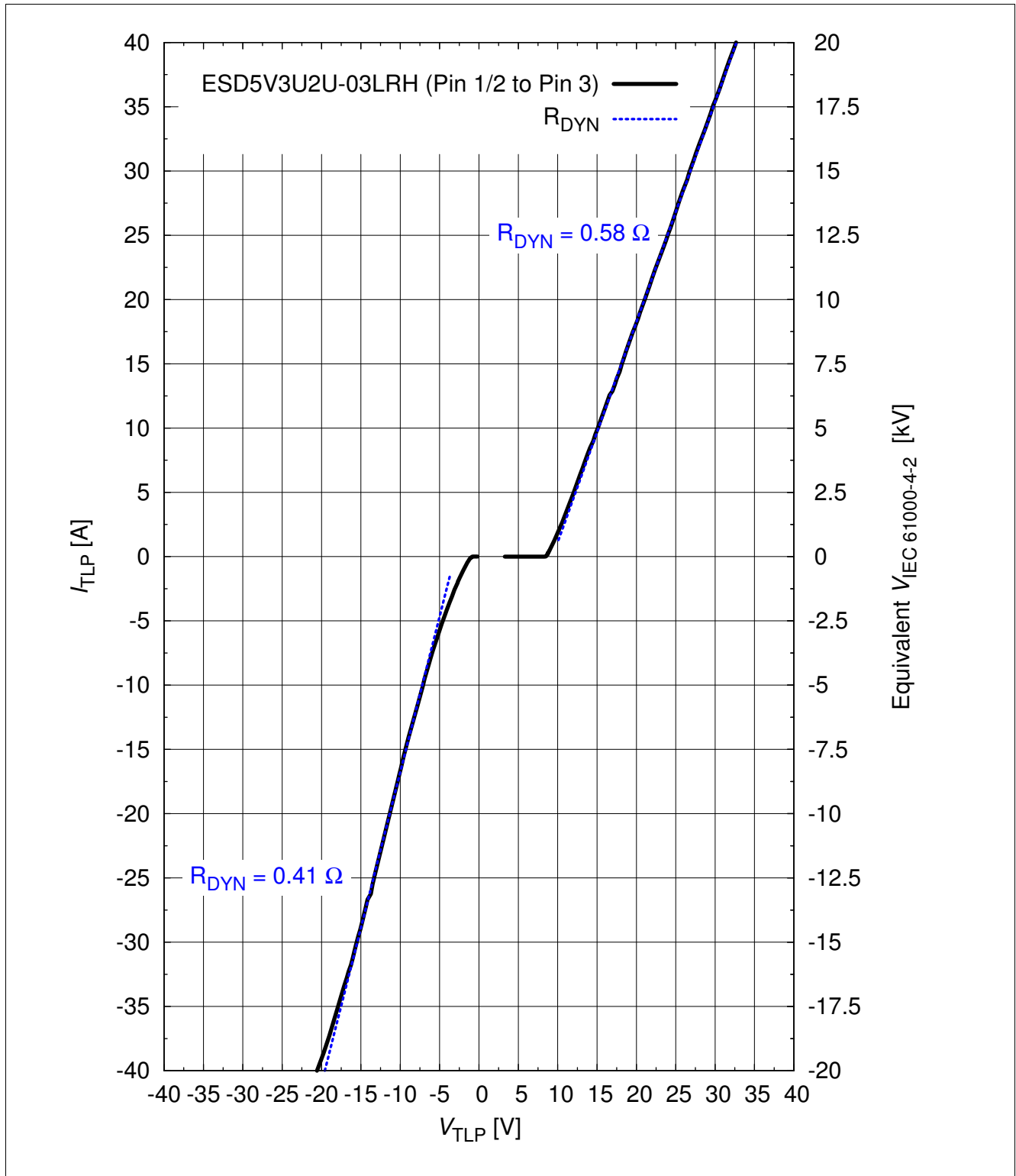


Figure 3-8 IEC61000-4-2:  $V_{CL} = f(t)$ , 15 kV negative pulse from pin 1 to pin 2 ( $R = 330 \Omega$ ,  $C = 150 \text{ pF}$ )



**Figure 3-9 Clamping voltage (TLP):  $I_{TLP} = f(V_{TLP})$  according ANSI/ESD STM5.5.1- Electrostatic Discharge Sensitivity Testing using Transmission Line Pulse (TLP) Model. TLP conditions:  $Z_0 = 50 \Omega$ ,  $t_p = 100 \text{ ns}$ ,  $t_r = 0.6 \text{ ns}$ ,  $I_{TLP}$  and  $V_{TLP}$  averaging window:  $t_1 = 30 \text{ ns}$  to  $t_2 = 60 \text{ ns}$ , extraction of dynamic resistance using squares fit to ELP characteristic between  $I_{TLP1} = 10 \text{ A}$  and  $I_{TLP2} = 30 \text{ A}$ . Please refer to Application Note AN210 [1]**

## 4 Application Information

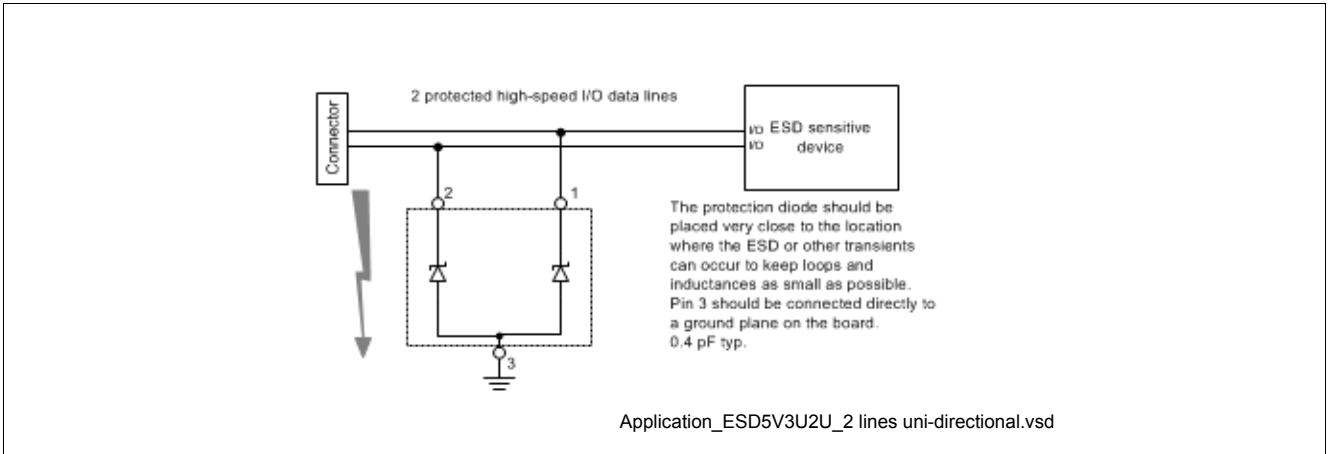


Figure 4-1 2 lines, uni-directional TVS protection

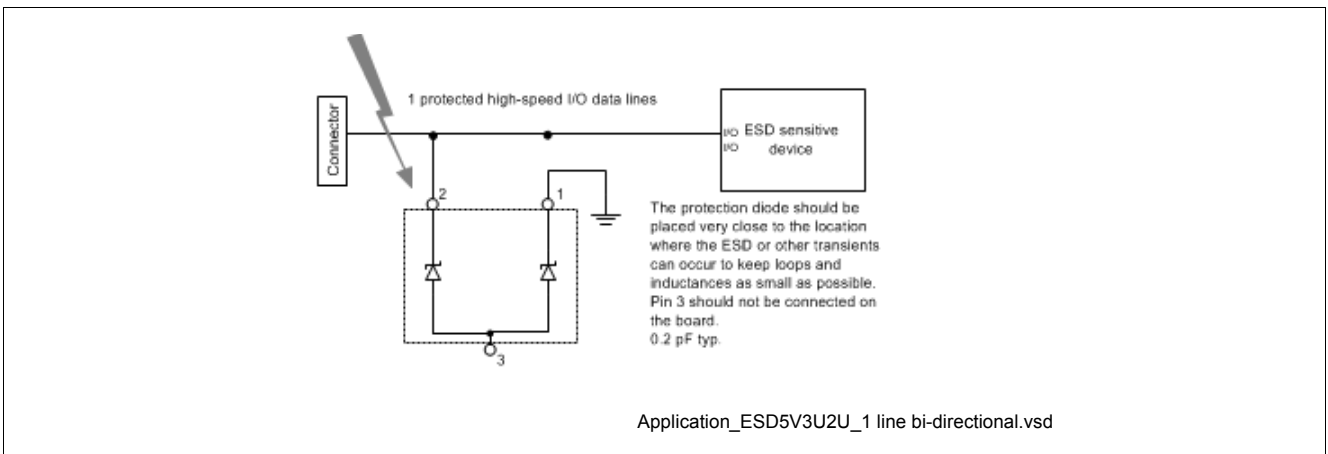


Figure 4-2 1 line, bi-directional TVS protection

## 5 Ordering information scheme (examples)

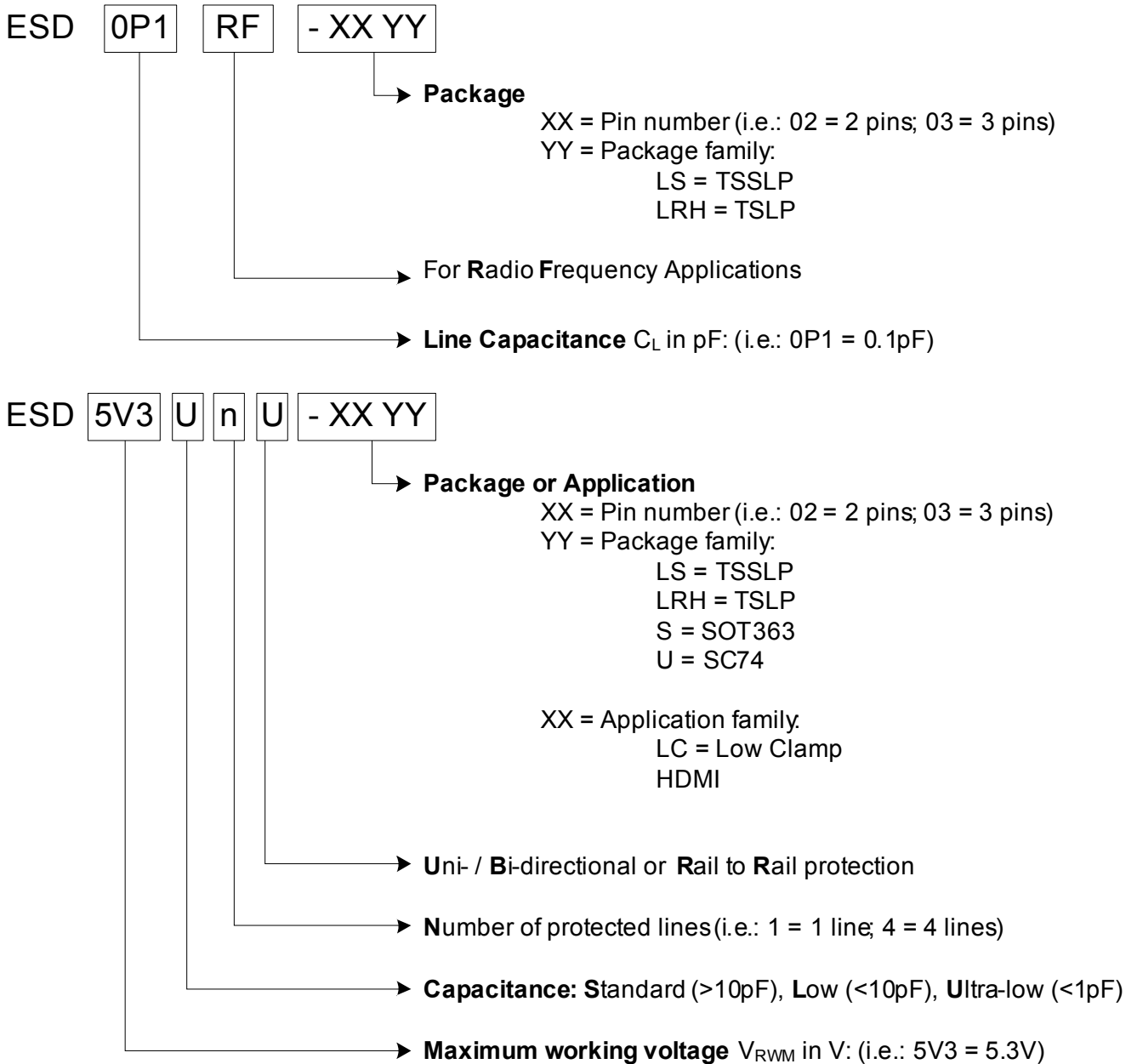


Figure 5-1 Ordering Information Scheme

## 6 Package Information

### 6.1 PG-TSFP-3-1

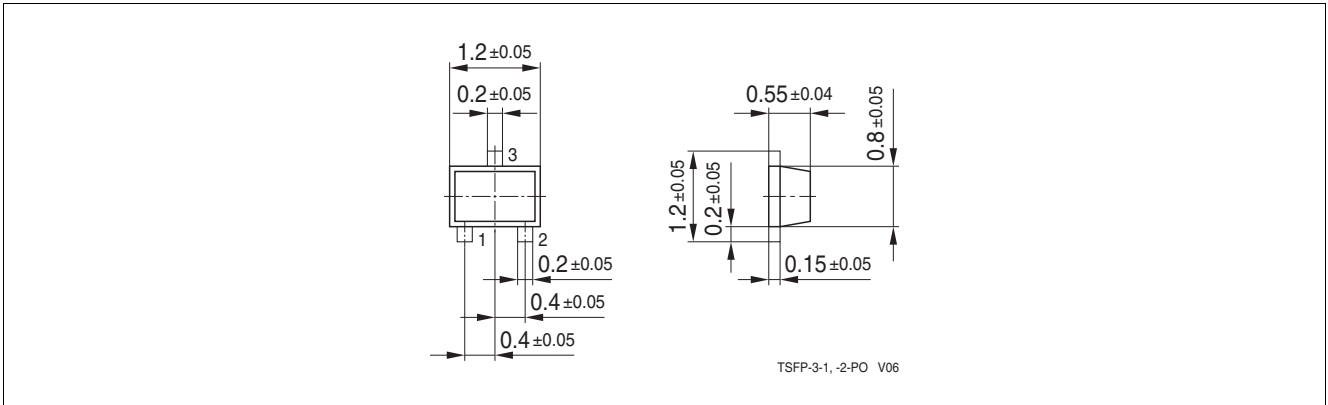


Figure 6-1 PG-TSFP-3-1: Package Overview

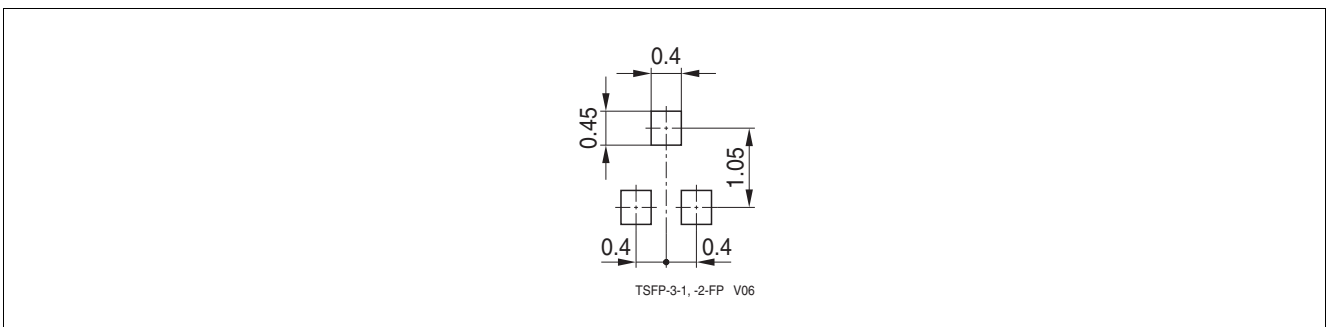


Figure 6-2 PG-TSFP-3-1: Footprint

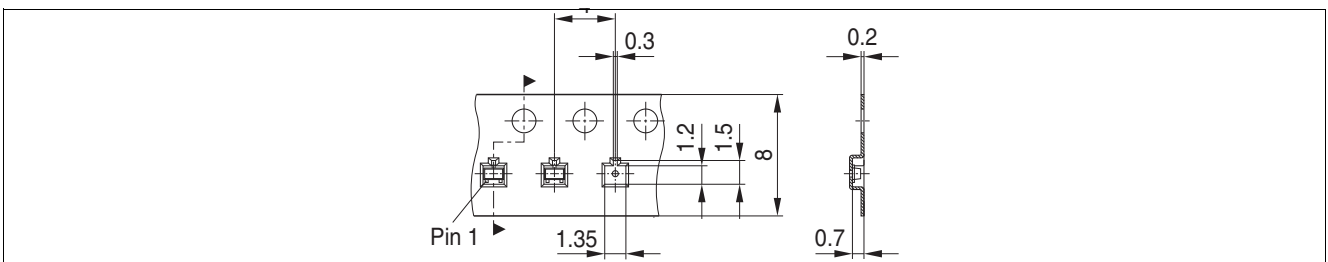


Figure 6-3 PG-TSFP-3-1: Packing

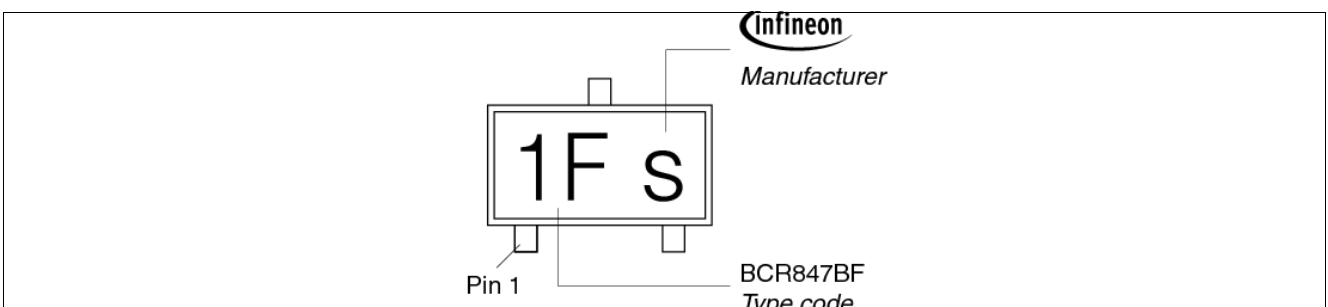


Figure 6-4 PG-TSFP-3-1: Marking (example)

6.2 PG-TSLP-3-7

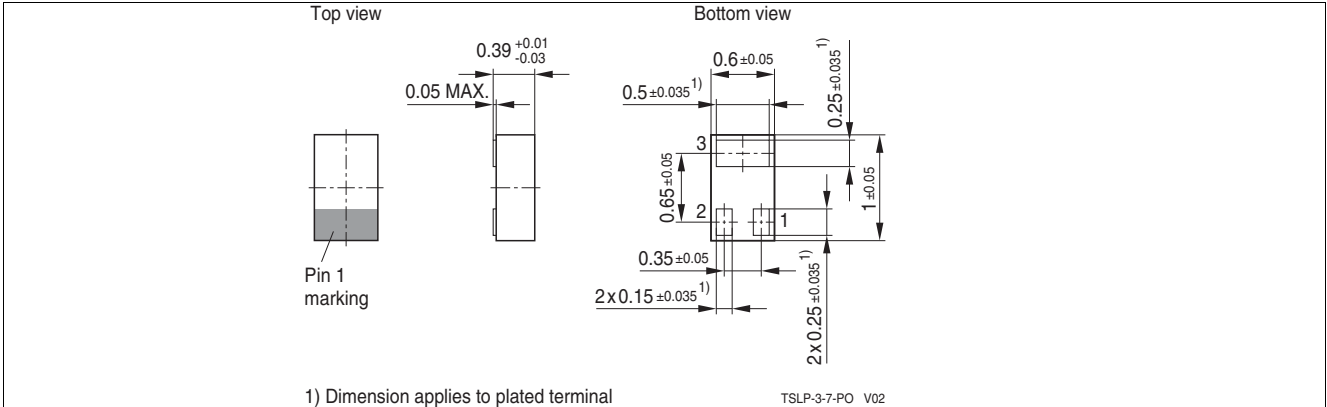


Figure 6-5 PG-TSLP-3-7: Package Overview

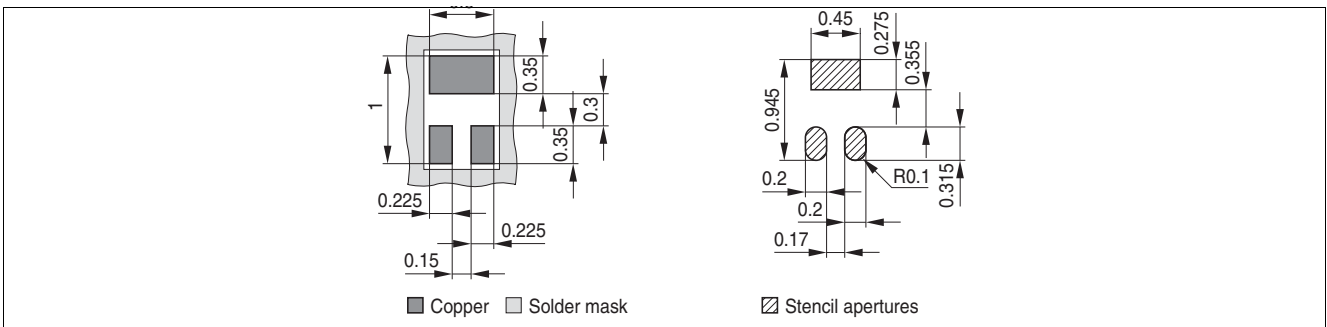


Figure 6-6 PG-TSLP-3-7: Footprint

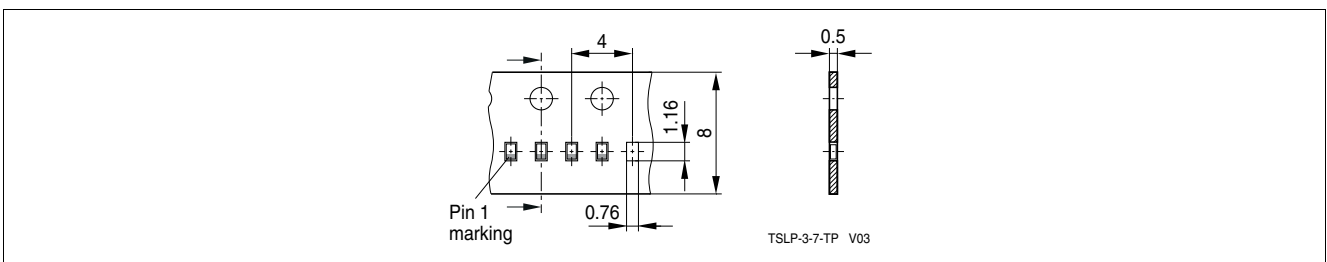


Figure 6-7 PG-TSLP-3-7: Packing

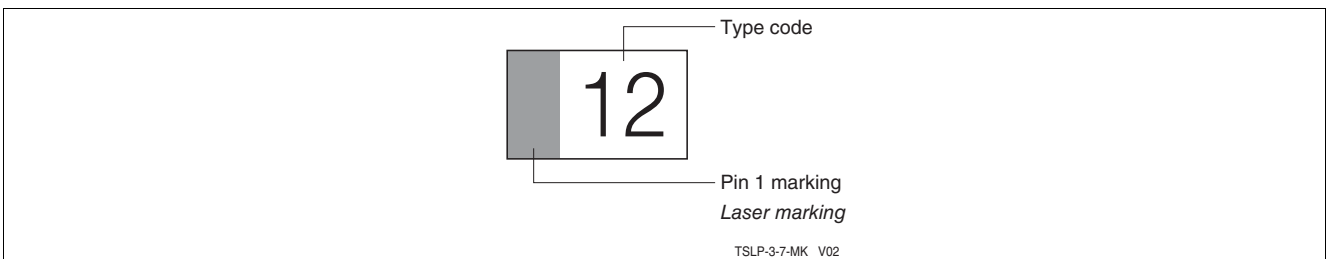


Figure 6-8 PG-TSLP-3-7: Marking (example)



**References**

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

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