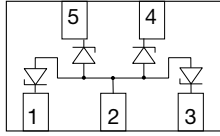
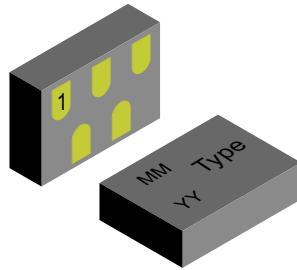


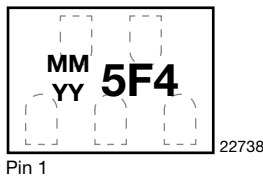
## 4-Line BUS-Port ESD Protection Array - Flow Through Design



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### MARKING



Pin 1

5F4 = type code  
 MM = date code month  
 YY = date code year

### FEATURES

- Compact chip level page CLP1007-5L
- Length = 1 mm; width = 0.7 mm; height = 0.27 mm
- 4-lines, unidirectional ESD protection array
- Low leakage current  $I_R < 0.1 \mu A$
- Low capacitance at  $V_R = 0 V = 0.9 pF$  (typ.)
- Ideal for high speed data line like
  - HDMI, DisplayPort, eSATA
  - USB, 1394/firewire
  - Thunderbolt
- ESD immunity acc. IEC 61000-4-2
  - $\pm 15 kV$  contact discharge
  - $\pm 15 kV$  air discharge
- e4 - precious metal (e.g. Ag, Au, NiPd, NiPdAu) (no Sn)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### LINKS TO ADDITIONAL RESOURCES



ORDERING INFORMATION			
DEVICE NAME	ORDERING CODE	TAPED UNITS PER REEL (8 mm TAPE ON 7" REEL)	MINIMUM ORDER QUANTITY
VBUS54FD-SD1	VBUS54FD-SD1-G4-08	10 000	10 000

PACKAGE DATA					
DEVICE NAME	PACKAGE NAME	TYPE CODE	WEIGHT	MOISTURE SENSITIVITY LEVEL	SOLDERING CONDITIONS
VBUS54FD-SD1	CLP1007-5L	5F4	0.45 mg	MSL level 1 (according J-STD-020)	Peak temperature max. 260 °C

ABSOLUTE MAXIMUM RATINGS ( $T_{amb} = 25 \text{ }^\circ\text{C}$ , unless otherwise specified)				
PARAMETER	TEST CONDITIONS	SYMBOL	VALUE	UNIT
Peak pulse current	Acc. IEC 61000-4-5; $t_P = 8/20 \mu s$ ; single shot	$I_{PPM}$	3	A
Peak pulse power	Acc. IEC 61000-4-5; $t_P = 8/20 \mu s$ ; single shot	$P_{PP}$	45	W
ESD immunity	Contact discharge acc. IEC 61000-4-2; 10 pulses	$V_{ESD}$	$\pm 15$	kV
	Air discharge acc. IEC 61000-4-2; 10 pulses		$\pm 15$	
Operating temperature	Junction temperature	$T_J$	-40 to +125	$^\circ\text{C}$
Storage temperature		$T_{STG}$	-55 to +150	$^\circ\text{C}$

**ELECTRICAL CHARACTERISTICS** (pin 1, 3, 4 or 5 to pin 2)  
 ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

PARAMETER	TEST CONDITIONS/REMARKS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Protection paths	Number of lines which can be protected	$N_{channel}$	-	-	4	lines
Reverse stand-off voltage	Max. reverse working voltage	$V_{RWM}$	-	-	5.5	V
Reverse voltage	at $I_R = 0.1\text{ }\mu\text{A}$	$V_R$	5.5	-	-	V
Reverse current	at $V_{RWM} = 5.5\text{ V}$	$I_R$	-	< 1 nA	0.1	$\mu\text{A}$
Reverse breakdown voltage	at $I_R = 1\text{ mA}$	$V_{BR}$	6.9	7.5	8.7	V
Reverse clamping voltage	at $I_{PP} = 1\text{ A}$	$V_C$	-	9.5	11	V
	at $I_{PP} = I_{PPM} = 3\text{ A}$	$V_C$	-	12.9	15	V
Forward clamping voltage	at $I_{PP} = 1\text{ A}$	$V_F$	-	1.8	2.2	V
	at $I_{PP} = 3\text{ A}$	$V_F$	-	3	4	V
Capacitance	at $V_R = 0\text{ V}$ ; $f = 1\text{ MHz}$	$C_D$	-	0.9	1	pF
	at $V_R = 3.3\text{ V}$ ; $f = 1\text{ MHz}$		-	0.9	1	pF
Clamping voltage	Transmission Line Pulse (TLP); $t_p = 100\text{ ns}$ , $I_{TLP} = 8\text{ A}$	$V_{C-TLP}$	-	18	-	V
Clamping voltage	Transmission Line Pulse (TLP); $t_p = 100\text{ ns}$ , $I_{TLP} = 16\text{ A}$	$V_{C-TLP}$	-	24	-	V
Dynamic resistance	Transmission Line Pulse (TLP); $t_p = 100\text{ ns}$	$V_{C-TLP}$	-	0.93	-	$\Omega$

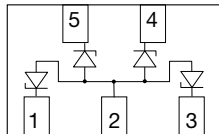
**APPLICATION NOTE**

The **VBUS54FD-SD1** is a four-line ESD protection device with the characteristic of a Z-diode with a high ESD immunity and a very low capacitance which makes it usable for high frequency applications like USB 2.0, USB 3.0 or HDMI.

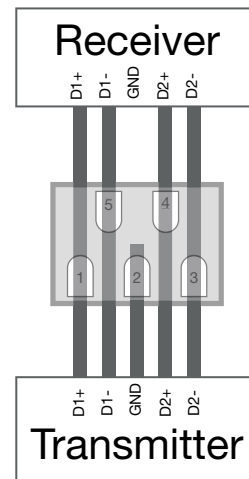
With the **VBUS54FD-SD1** four high speed data lines can be protected against transient voltage signals like ESD (electro static discharge). Connected to the data line (pin 1, 3 and pin 4, 5) and to ground (pin 2) negative transients will be clamped close below the ground level while positive transients will be clamped close above the 5.5 V working range. The clamping behavior of the **VBUS54FD-SD1** is bidirectional but asymmetrical (**Bias**) and so it offers the best protection for applications running up to 5.5 V.

Pin configuration:

- Pin 2 is the central ground pin and has to be connected to ground
- Pin 1, 3 and 4, 5 are the inputs for the data lines  $D_{1+}$  and  $D_{1-}$  and  $D_{2+}$  and  $D_{2-}$ .



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**FLOW THROUGH DESIGN**

Modern digital transmission lines can be clocked up to 480 Mbit/s (USB 2.0) or 1.65 Gbit/s (HDMI).

At such high data rates the transmission lines like cables or the line traces on the PCBs have to be very homogeneous regarding their surge impedance. This requires well defined trace dimensions as trace width and distance which have to be calculated depending on the requested surge impedance (e.g. 50  $\Omega$ ) and the PCB material and layer dimensions. Any device connected to the data lines - like ESD protection devices - have to be connected with minimal changes in these trace dimensions and distances.

With the package in the so called "Flow Through Design" this is possible. The lines are running straight along the PCB while the **VBUS54FD-SD1** is placed on top without any vias or loops.

**TYPICAL CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

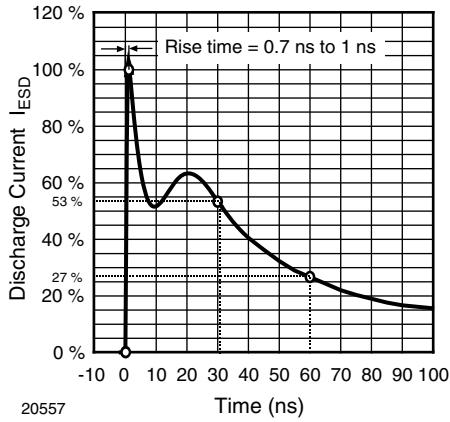


Fig. 1 - ESD Discharge Current Wave Form acc. IEC 61000-4-2 (330  $\Omega$ /150 pF)

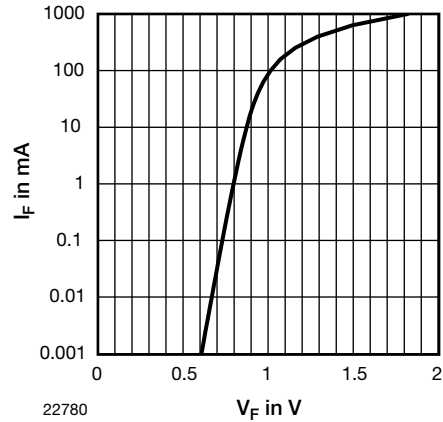


Fig. 4 - Typical Forward Current  $I_F$  vs. Forward Voltage  $V_F$

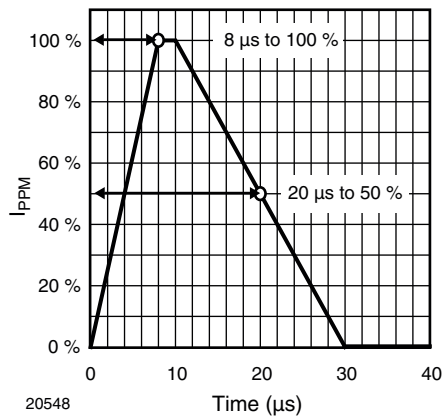


Fig. 2 - 8/20  $\mu\text{s}$  Peak Pulse Current Wave Form acc. IEC 61000-4-5

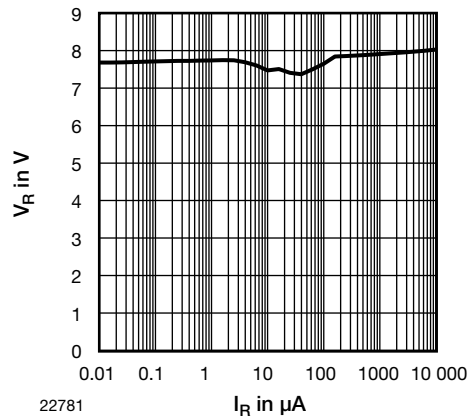


Fig. 5 - Typical Reverse Voltage  $V_R$  vs. Reverse Current  $I_R$

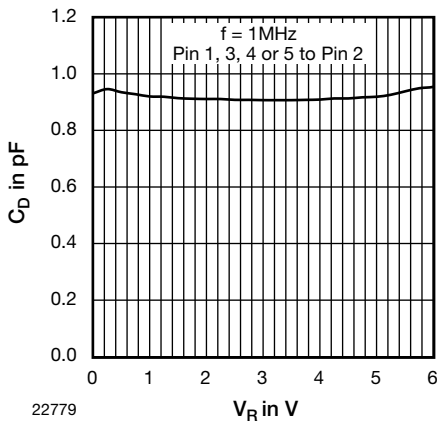


Fig. 3 - Typical Capacitance  $C_D$  vs. Reverse Voltage  $V_R$

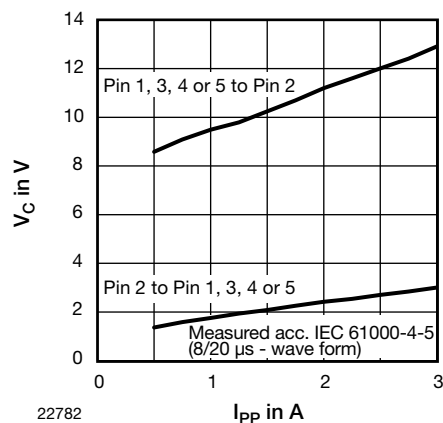


Fig. 6 - Typical Peak Clamping Voltage  $V_C$  vs. Peak Pulse Current  $I_{PP}$

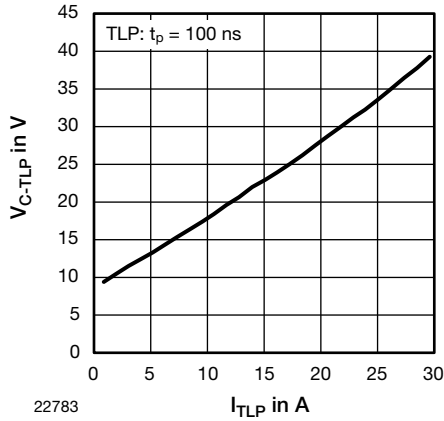
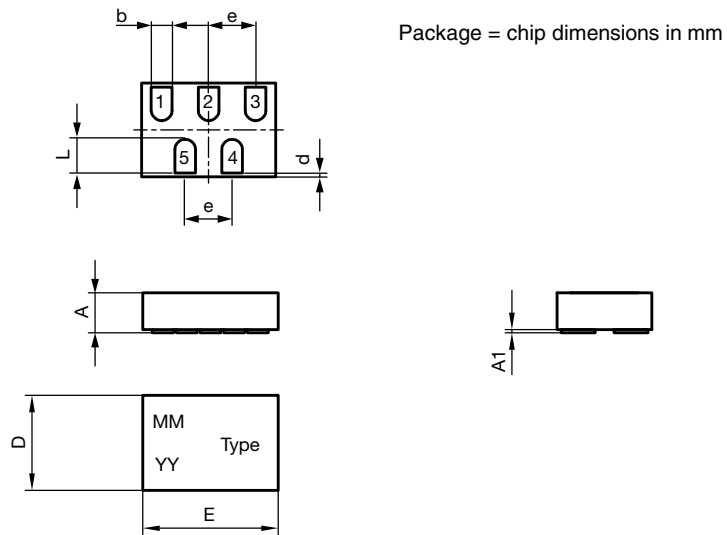


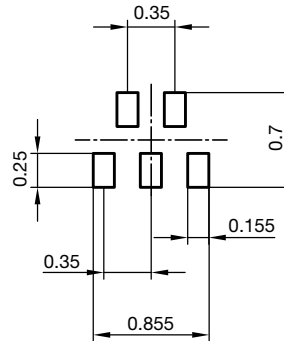
Fig. 7 - Typical Clamping Performance at 100 ns Transmission Line Pulse (TLP)

**PACKAGE DIMENSIONS** in millimeters: **CLP1007-5L**



	Millimeters	
	min.	max.
A	0.25	0.29
A1	-	0.02
b	0.13	0.17
D	0.68	0.73
E	0.98	1.03
e	0.35	
L	0.23	0.27
Radius	0.075	
d	0.03	

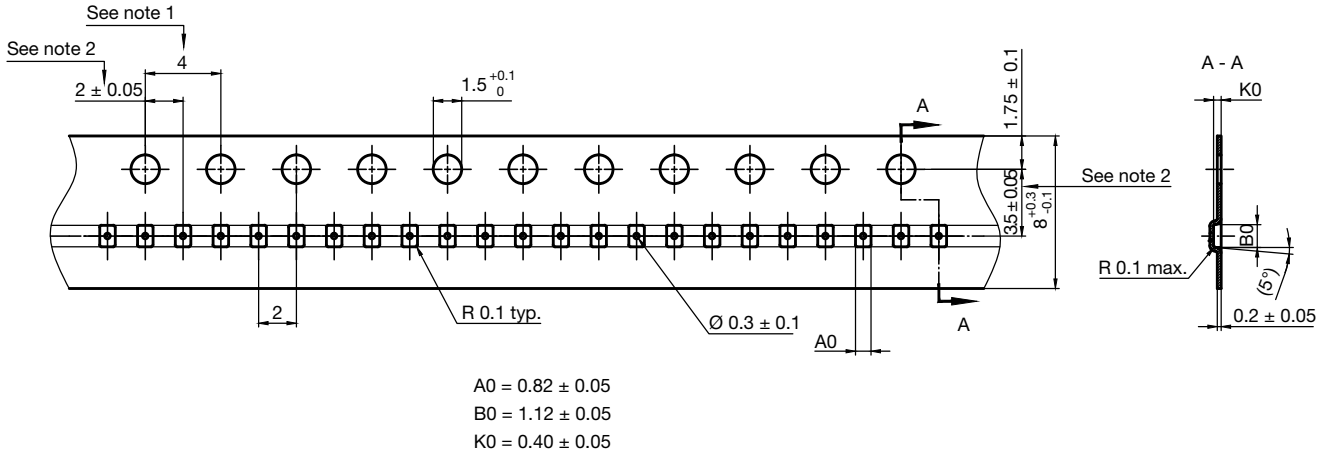
foot print recommendation:



**Footprint and soldering recommendation:**

please see Application Note: [www.vishay.com/doc?85917](http://www.vishay.com/doc?85917)

**CARRIER TAPE** in millimeters: **CLP1007-5L**



**Notes:**

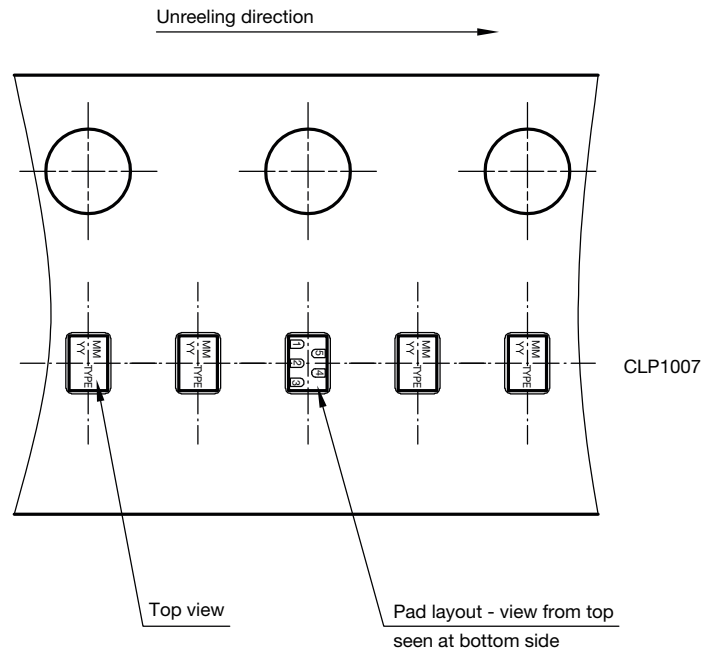
1. 10 Sprocket hole pitch cumulative tolerance ± 0.2
2. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole
3. A0 and B0 are calculated on a plane at a distance "R" above the bottom of the pocket

Document no.: S8-V-3906.04-042 (3)

Created - Date: 23. November 2015

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**ORIENTATION IN CARRIER TAPE: CLP1007-5L**





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