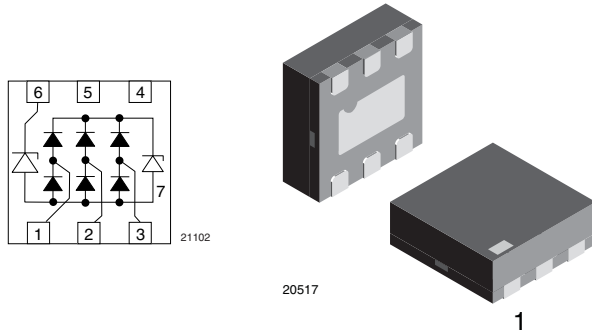


## USB-OTG BUS-Port ESD Protection for $V_{BUS} = 28\text{ V}$

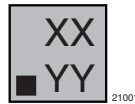


### FEATURES

- Ultra compact LLP75-7L package
- Low package height < 0.6 mm
- 3-line USB ESD protection with max. working range = 5.5 V
- $V_{BUS}$ -protection with 28 V working range
- Low leakage current
- Low load capacitance  $C_D = 0.7\text{ pF}$
- ESD immunity to IEC 61000-4-2  
± 15 kV contact discharge  
± 15 kV air discharge
- Surge current acc. IEC 61000-4-5  $I_{PP} > 3\text{ A}$
- 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)



### MARKING (example only)



Dot = pin 1 marking

XX = date code

YY = type code (see table below)

### DESIGN SUPPORT TOOLS

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ORDERING INFORMATION			
DEVICE NAME	ORDERING CODE	TAPED UNITS PER REEL (8 mm TAPE on 7" REEL)	MINIMUM ORDER QUANTITY
VBUS053CZ-HAF	VBUS053CZ-HAF-G-08	3000	15 000

PACKAGE DATA						
DEVICE NAME	PACKAGE NAME	TYPE CODE	WEIGHT	MOLDING COMPOUND FLAMMABILITY RATING	MOISTURE SENSITIVITY LEVEL	SOLDERING CONDITIONS
VBUS053CZ-HAF	LLP75-7L	UA	4.2 mg	UL 94 V-0	MSL level 1 (according J-STD-020)	Peak temperature max. 260 °C

ABSOLUTE MAXIMUM RATINGS VBUS053CZ-HAF				
PARAMETER	TEST CONDITIONS	SYMBOL	VALUE	UNIT
<b>Data line D+, D-, ID: Pin 1, 2 and 3 to ground (pin 7)</b>				
Peak pulse current	acc. IEC 61000-4-5; $t_p = 8/20\ \mu\text{s}$ ; single shot	$I_{PPM}$	3	A
Peak pulse power	acc. IEC 61000-4-5; $t_p = 8/20\ \mu\text{s}$ ; single shot	$P_{PP}$	54	W
ESD immunity	Contact discharge acc. IEC 61000-4-2; 10 pulses	$V_{ESD}$	± 15	kV
	Air discharge acc. IEC 61000-4-2; 10 pulses		± 15	kV
<b><math>V_{BUS}</math>: Pin 6 to ground (pin 7)</b>				
Peak pulse current	acc. IEC 61000-4-5; $t_p = 8/20\ \mu\text{s}$ ; single shot	$I_{PPM}$	3	A
Peak pulse power	acc. IEC 61000-4-5; $t_p = 8/20\ \mu\text{s}$ ; single shot	$P_{PP}$	156	W
ESD immunity	Contact discharge acc. IEC 61000-4-2; 10 pulses	$V_{ESD}$	± 30	kV
	Air discharge acc. IEC 61000-4-2; 10 pulses		± 30	kV
Operating temperature	Junction temperature	$T_J$	-40 to +125	°C
Storage temperature		$T_{STG}$	-55 to +150	°C

<b>ELECTRICAL CHARACTERISTICS VBUS053CZ-HAF</b> All inputs (pin 1, 2, and 3) to ground (pin 7)						
PARAMETER	TEST CONDITIONS/REMARKS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Protection paths	Number of line which can be protected	$N_{\text{channel}}$	-	-	3	lines
Reverse working voltage	Reverse stand-off voltage	$V_{\text{RWM}}$	-	-	5.5	V
Reverse voltage	at $I_{\text{R}} = 0.1 \mu\text{A}$	$V_{\text{R}}$	5.5	-	-	V
Reverse current	at $V_{\text{R}} = 3.3 \text{ V}$	$I_{\text{R}}$	-	-	0.02	$\mu\text{A}$
	at $V_{\text{R}} = 3.3 \text{ V}; T = 65 \text{ }^\circ\text{C}$	$I_{\text{R}}$	-	-	0.085	$\mu\text{A}$
	at $V_{\text{R}} = V_{\text{RWM}} = 5.5 \text{ V}$	$I_{\text{R}}$	-	-	0.1	$\mu\text{A}$
Forward voltage	at $I_{\text{F}} = 15 \text{ mA}$	$V_{\text{F}}$	0.7	-	1.2	V
Reverse breakdown voltage	at $I_{\text{R}} = 1 \text{ mA}$	$V_{\text{BR}}$	6.5	-	10	V
Reverse clamping voltage	at $I_{\text{PP}} = 1 \text{ A}; \text{acc. IEC 61000-4-5}$	$V_{\text{C}}$	-	10	12	V
	at $I_{\text{PP}} = 3 \text{ A}; \text{acc. IEC 61000-4-5}$	$V_{\text{C}}$	-	15	18	V
Forward clamping voltage	at $I_{\text{F}} = 3 \text{ A}; \text{acc. IEC 61000-4-5}$	$V_{\text{F}}$	-	3.4	4.1	V
Line capacitance	Test pin at $V_{\text{R}} = 0 \text{ V};$ any other I/O pin at $V_{\text{R}} = 3.3 \text{ V}; f = 1 \text{ MHz}$	$C_{\text{D}}$	-	0.7	1	pF
Line to line capacitance	Among pins 1, 2 and 3 at $V_{\text{R}} = 0 \text{ V}; f = 1 \text{ MHz}$	$C_{\text{D}}$	-	0.35	0.5	pF
Line symmetry	Difference of the line capacitance	$dC_{\text{D}}$	-	-	0.1	pF

**Note**

- Ratings at 25 °C ambient temperature, unless otherwise specified

<b>ELECTRICAL CHARACTERISTICS VBUS</b> (pin 6) to ground (pin 7)						
PARAMETER	TEST CONDITIONS/REMARKS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Protection paths	Number of line which can be protected	$N_{\text{channel}}$	-	-	1	lines
Reverse working voltage	Reverse stand-off voltage	$V_{\text{RWM}}$	-	-	28	V
Reverse voltage	at $I_{\text{R}} = 0.1 \mu\text{A}$	$V_{\text{R}}$	28	-	-	V
Reverse current	at $V_{\text{R}} = V_{\text{RWM}} = 28 \text{ V}$	$I_{\text{R}}$	-	-	100	nA
Forward voltage	at $I_{\text{F}} = 10 \text{ mA}$	$V_{\text{F}}$	0.6	0.75	0.9	V
Reverse breakdown voltage	at $I_{\text{R}} = 1 \text{ mA}$	$V_{\text{BR}}$	32	-	40	V
Reverse clamping voltage	at $I_{\text{PP}} = 1 \text{ A}; \text{acc. IEC 61000-4-5}; T = 25 \text{ }^\circ\text{C}$	$V_{\text{C}}$	-	37	45	V
	at $I_{\text{PP}} = 3 \text{ A}; \text{acc. IEC 61000-4-5}; T = 25 \text{ }^\circ\text{C}$	$V_{\text{C}}$	-	42	52	V
Forward clamping voltage	at $I_{\text{F}} = 3 \text{ A}; \text{acc. IEC 61000-4-5}$	$V_{\text{F}}$	-	-	2.2	V
Line capacitance	at $V_{\text{R}} = 0 \text{ V}; f = 1 \text{ MHz}$	$C_{\text{D}}$	-	31	40	pF

**Note**

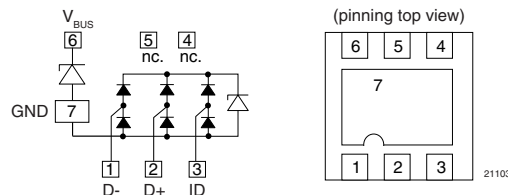
- Ratings at 25 °C ambient temperature, unless otherwise specified

**APPLICATION NOTE**

The VBUS053CZ-HAF is intended as an ESD protection and transient voltage suppressor for one USB-OTG port.

The LLP75-7L package contains two separate dies which are mounted on a common ground plane (pin 7).

The high-speed data lines D-, D+ and ID, are connected to any of the pins no. 1 to 3. As long as the signal voltage on the data lines is between the ground- and the 5 V working range, the low capacitance PN-diodes offer a very high isolation to ground and to the other data lines. But as soon as any transient signal like an ESD signal, exceeds this working range of 5 V in either the positive or negative direction, one of the PN-diodes gets into the forward mode and clamps the transient either to ground or to the avalanche break through level. An extra avalanche diode (separate die) clamps the supply line voltage ( $V_{\text{BUS}}$  at pin 6) above the 28 V working range to ground (pin 7). Due to the “two die construction” the  $V_{\text{BUS}}$  line has a very high isolation to the data lines. In case of a destructive transient signal, i.e. coming from a charger, the data lines will not be influenced.


**Remark:**

The input pins no. 1, 2 and 3 are symmetrical. Each of the data signals D-, D+ and ID can be connected to pin 1, 2 or 3



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

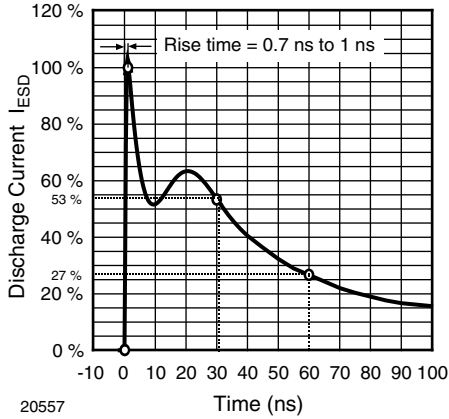


Fig. 1 - ESD Discharge Current Wave Form acc. IEC 61000-4-2 (330  $\Omega$ /150 pF)

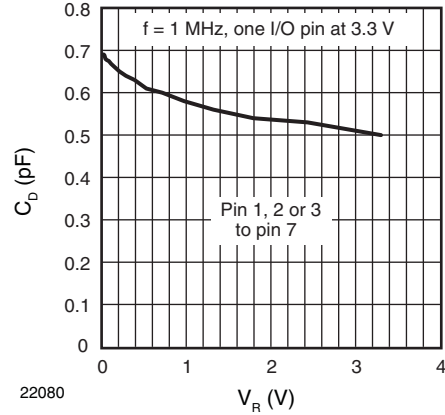


Fig. 4 - Typical Capacitance  $C_D$  vs. Reverse Voltage  $V_R$

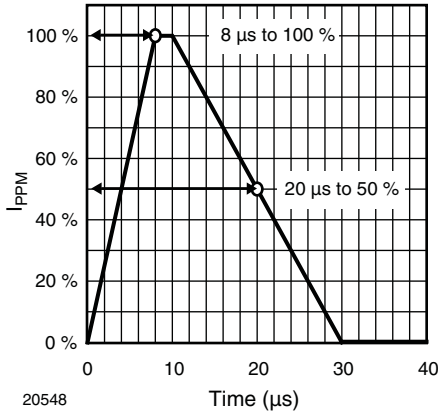


Fig. 2 - 8/20  $\mu\text{s}$  Peak Pulse Current Wave Form acc. IEC 61000-4-5

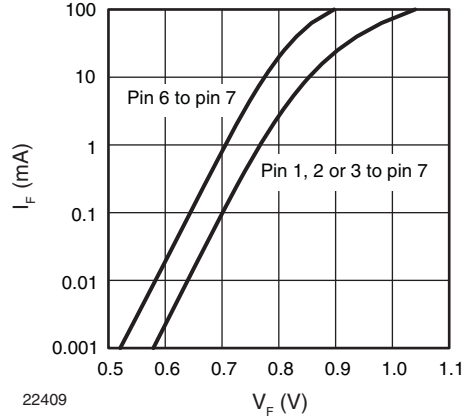


Fig. 5 - Typical Forward Current  $I_F$  vs. Forward Voltage  $V_F$

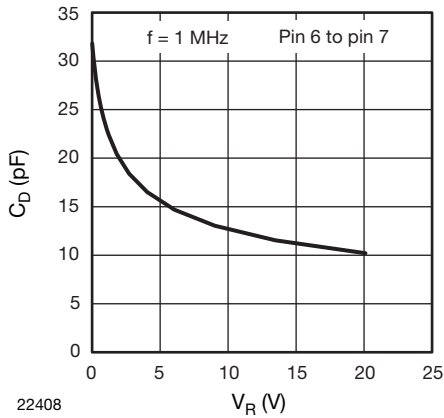


Fig. 3 - Typical Capacitance  $C_D$  vs. Reverse Voltage  $V_R$

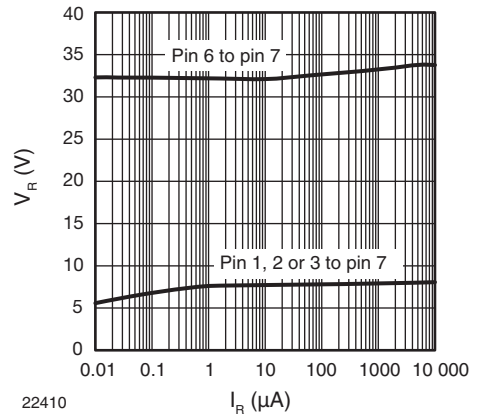


Fig. 6 - Typical Reverse Voltage  $V_R$  vs. Reverse Current  $I_R$

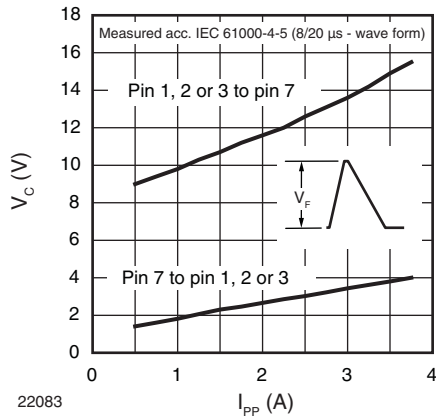


Fig. 7 - Typical Peak Clamping Voltage  $V_C$  vs. Peak Pulse Current  $I_{PP}$

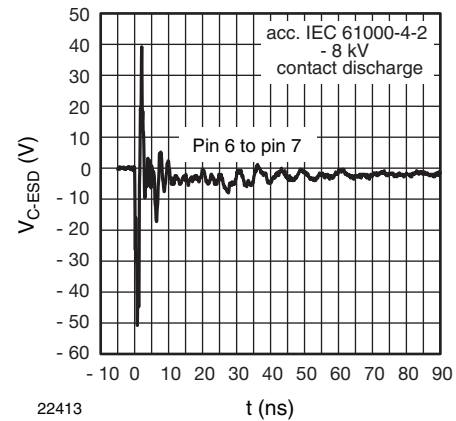


Fig. 10 - Typical Clamping Performance at - 8 kV Contact Discharge (acc. IEC 61000-4-2)

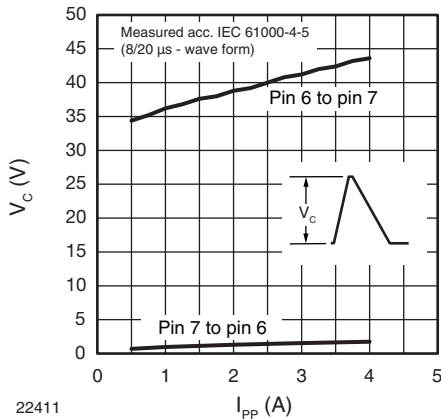


Fig. 8 - Typical Peak Clamping Voltage  $V_C$  vs. Peak Pulse Current  $I_{PP}$

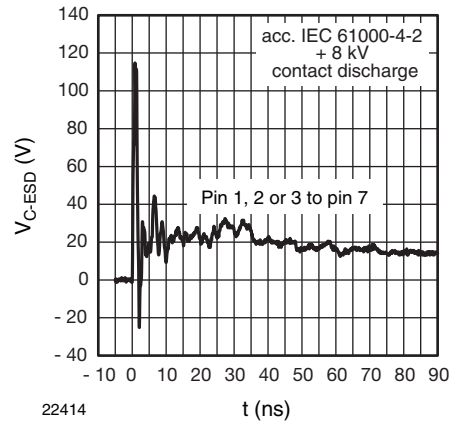


Fig. 11 - Typical Clamping Performance at + 8 kV Contact Discharge (acc. IEC 61000-4-2)

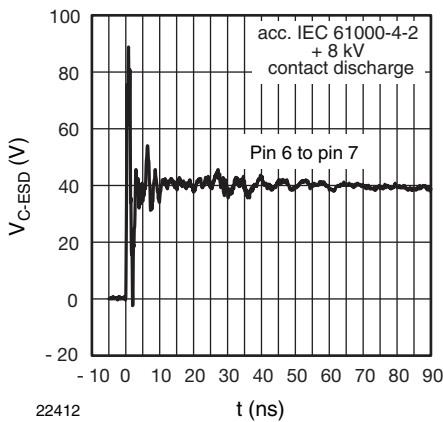


Fig. 9 - Typical Clamping Performance at + 8 kV Contact Discharge (acc. IEC 61000-4-2)

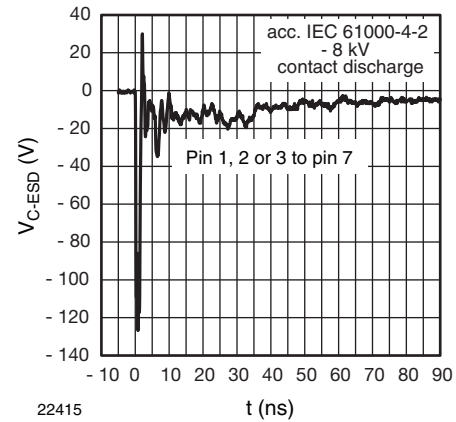


Fig. 12 - Typical Clamping Performance at - 8 kV Contact Discharge (acc. IEC 61000-4-2)

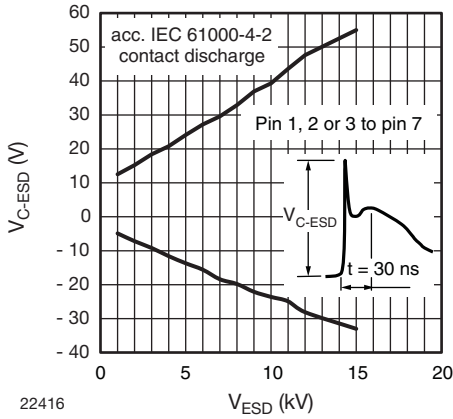


Fig. 13 - Typical Clamping Voltage at after 30 ns of ESD Contact Discharge (acc. IEC 61000-4-2)

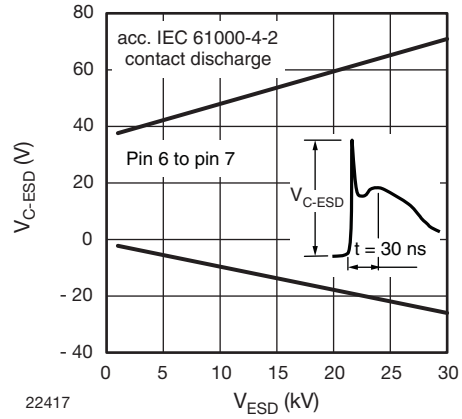
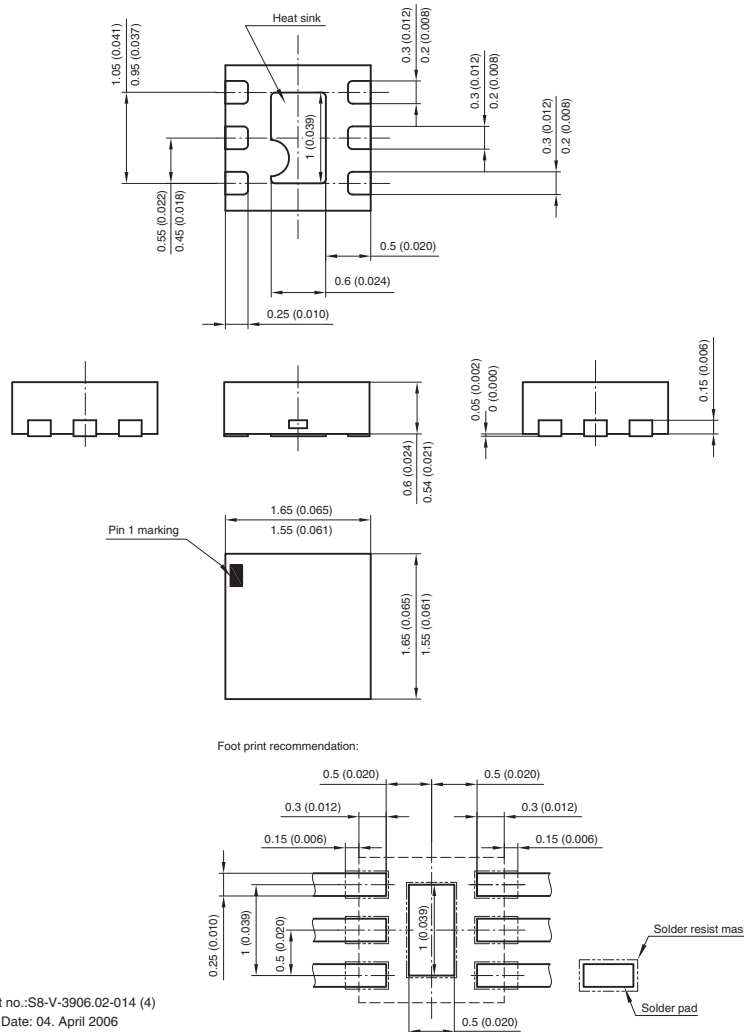
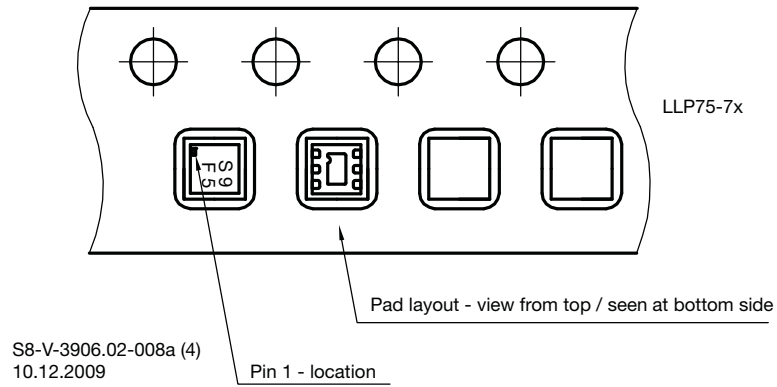


Fig. 14 - Typical Clamping Voltage at after 30 ns of ESD Contact Discharge (acc. IEC 61000-4-2)

**PACKAGE DIMENSIONS** in millimeters (inches): **LLP75-7L**



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