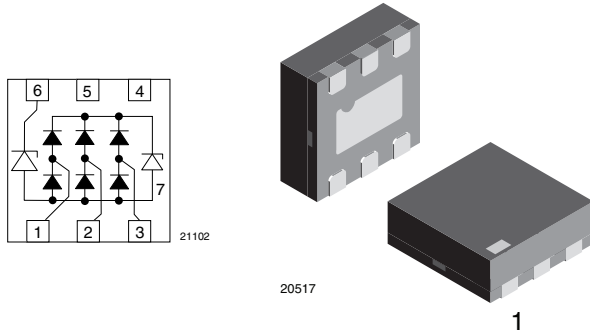


## USB-OTG BUS-Port ESD-Protection for $V_{BUS} = 28\text{ V}$

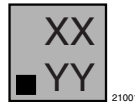


### FEATURES

- 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-protection to IEC 61000-4-2  $\pm 15\text{ kV}$  contact discharge  $\pm 15\text{ kV}$  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)
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC



### MARKING (example only)



Dot = pin 1 marking  
XX = date code  
YY = type code (see table below)

| ORDERING INFORMATION |                    |  |                        |
|----------------------|--------------------|--|------------------------|
| DEVICE NAME          | ORDERING CODE      | TAPED UNITS PER REEL<br>(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<br>FLAMMABILITY RATING | MOISTURE SENSITIVITY LEVEL           | SOLDERING CONDITIONS     |
| VBUS053CZ-HAF | LLP75-7L     | UA        | 4.2 mg | UL 94 V-0                               | MSL level 1<br>(according J-STD-020) | 260 °C/10 s at terminals |

| ABSOLUTE MAXIMUM RATINGS                                      |   |  |           |               |      |
|---|---|--|-----------|---------------|------|
| 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; $t_p = 8/20\text{ }\mu\text{s}$ ; single shot |  | $I_{PPM}$ | 3             | A    |
| Peak pulse power  | acc. IEC 61000-4-5; $t_p = 8/20\text{ }\mu\text{s}$ ; single shot |  | $P_{PP}$  | 36            | 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                       |  |           | $\pm 15$      | kV   |
| <b><math>V_{BUS}</math>: Pin 6 to ground (pin 7)</b>          |   |  |           |               |      |
| Peak pulse current  | acc. IEC 61000-4-5; $t_p = 8/20\text{ }\mu\text{s}$ ; single shot |  | $I_{PPM}$ | 3             | A    |
| Peak pulse power  | acc. IEC 61000-4-5; $t_p = 8/20\text{ }\mu\text{s}$ ; single shot |  | $P_{PP}$  | 156           | W    |
| ESD immunity  | Contact discharge acc. IEC 61000-4-2; 10 pulses                   |  | $V_{ESD}$ | $\pm 30$      | kV   |
|   | Air discharge acc. IEC 61000-4-2; 10 pulses                       |  |           | $\pm 30$      | kV   |
| Operating temperature   | Junction temperature  |  | $T_J$     | - 40 to + 125 | °C   |
| Storage temperature   |   |  | $T_{STG}$ | - 55 to + 150 | °C   |

\*\* Please see document "Vishay Material Category Policy": [www.vishay.com/doc?99902](http://www.vishay.com/doc?99902)

| ELECTRICAL CHARACTERISTICS VBUS053CZ-HAF 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   | at $I_R = 0.1\ \mu\text{A}$  | $V_{RWM}$            | 5.5  | -    | -     | V             |
| Reverse current   | at $V_R = V_{RWM} = 3.3\text{ V}$ ; $T = 65\text{ }^\circ\text{C}$                                 | $I_R$                | -    | -    | 0.085 | $\mu\text{A}$ |
|   | at $V_R = V_{RWM} = 5.5\text{ V}$  |                      | -    | -    | 0.1   | $\mu\text{A}$ |
| Forward voltage   | at $I_F = 15\text{ mA}$  | $V_F$                | 0.7  | -    | 1.2   | V             |
| Reverse breakdown voltage   | at $I_R = 1\text{ mA}$   | $V_{BR}$             | 6.5  | -    | 10    | V             |
| Reverse clamping voltage  | at $I_{PP} = 1\text{ A}$ ; acc. IEC 61000-4-5  | $V_C$                | -    | 10   | 12    | V             |
|   | at $I_{PP} = 3\text{ A}$ ; acc. IEC 61000-4-5  |                      | -    | 15   | 18    | V             |
| Forward clamping voltage  | at $I_F = 3\text{ A}$ ; acc. IEC 61000-4-5   | $V_F$                | -    | 3.4  | 4.1   | V             |
| Line capacitance  | Test pin at $V_R = 0\text{ V}$ ;<br>any other I/O pin at $V_R = 3.3\text{ V}$ ; $f = 1\text{ MHz}$ | $C_D$                | -    | 0.7  | 1     | pF            |
| Line to line capacitance  | Among pins 1, 2 and 3<br>at $V_R = 0\text{ V}$ ; $f = 1\text{ MHz}$                                |                      | -    | 0.35 | 0.5   | pF            |
| Line symmetry   | Difference of the line capacitance   | $dC_D$               | -    | -    | 0.1   | pF            |

### Note

- Ratings at  $25\text{ }^\circ\text{C}$ , ambient temperature unless otherwise specified

| ELECTRICAL CHARACTERISTICS VBUS053CZ-HAF $V_{BUS}$ (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  | at $I_R = 100\text{ nA}$  | $V_{RWM}$            | 28   | -    | -    | V     |
| Reverse current  | at $V_R = V_{RWM} = 28\text{ V}$  | $I_R$                | -    | -    | 100  | nA    |
| Forward voltage  | at $I_F = 10\text{ mA}$   | $V_F$                | 0.6  | 0.75 | 0.9  | V     |
| Reverse breakdown voltage  | at $I_R = 1\text{ mA}$  | $V_{BR}$             | 32   | -    | 40   | V     |
| Reverse clamping voltage   | at $I_{PP} = 1\text{ A}$ ; acc. IEC 61000-4-5; $T = 25\text{ }^\circ\text{C}$ | $V_C$                | -    | 37   | 45   | V     |
|  | at $I_{PP} = 3\text{ A}$ ; acc. IEC 61000-4-5; $T = 25\text{ }^\circ\text{C}$ |                      | -    | 42   | 52   | V     |
| Forward clamping voltage   | at $I_F = 3\text{ A}$ ; acc. IEC 61000-4-5                                    | $V_F$                | -    | -    | 2.2  | V     |
| Line capacitance   | at $V_R = 0\text{ V}$ ; $f = 1\text{ MHz}$                                    | $C_D$                | -    | 31   | 40   | pF    |

### Note

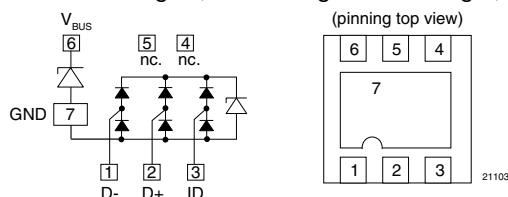
- Ratings at  $25\text{ }^\circ\text{C}$ , ambient temperature unless otherwise specified

## 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 ( $V_{BUS}$  at pin 6) above the 28 V working range to ground (pin 7). Due to the "two die construction" the  $V_{BUS}$  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)

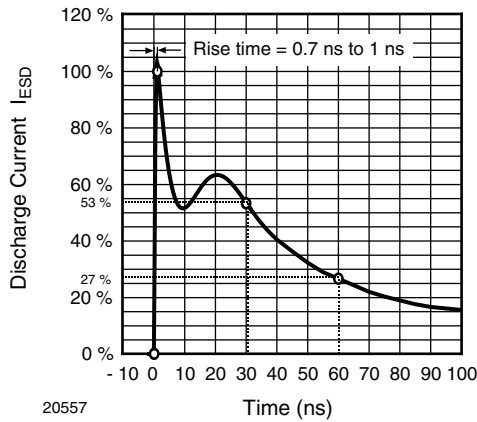


Fig. 1 - ESD Discharge Current Wave Form acc. IEC 61000-4-2 (330  $\Omega$ /150 pF)

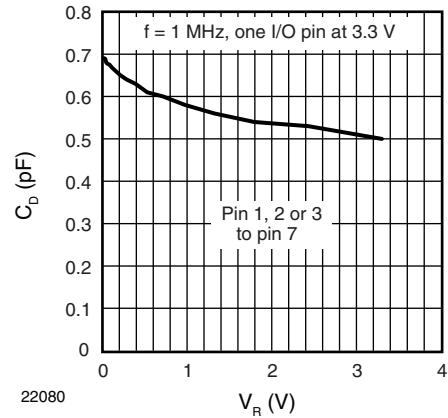


Fig. 4 - Typical Capacitance  $C_D$  vs. Reverse Voltage  $V_R$

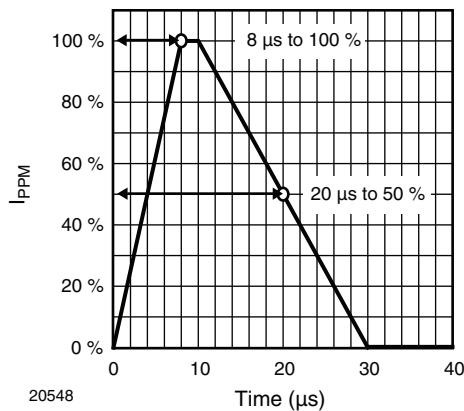


Fig. 2 - 8/20  $\mu\text{s}$  Peak Pulse Current Wave Form acc. IEC 61000-4-5

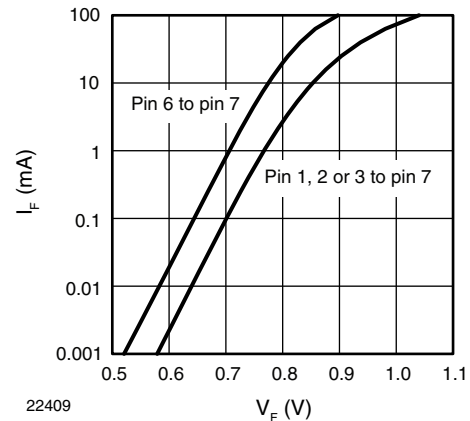


Fig. 5 - Typical Forward Current  $I_F$  vs. Forward Voltage  $V_F$

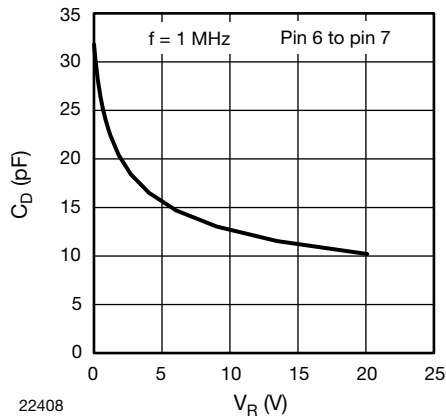


Fig. 3 - Typical Capacitance  $C_D$  vs. Reverse Voltage  $V_R$

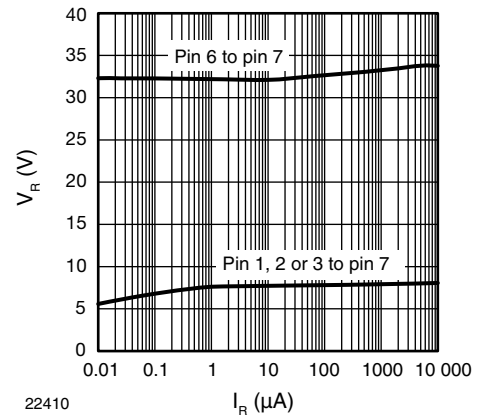


Fig. 6 - Typical Reverse Voltage  $V_R$  vs. Reverse Current  $I_R$

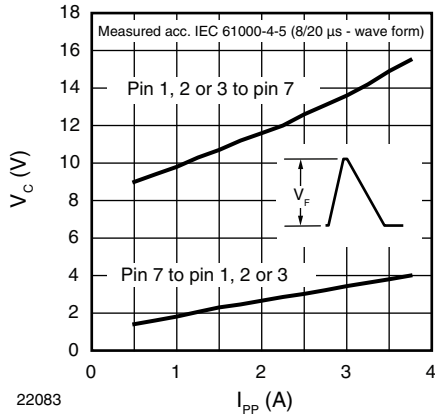


Fig. 7 - Typical Peak Clamping Voltage  $V_c$  vs. Peak Pulse Current  $I_{pp}$

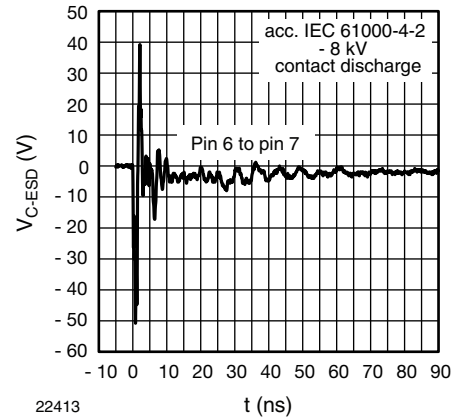


Fig. 10 - Typical Clamping Performance at - 8 kV Contact Discharge (acc. IEC 61000-4-2)

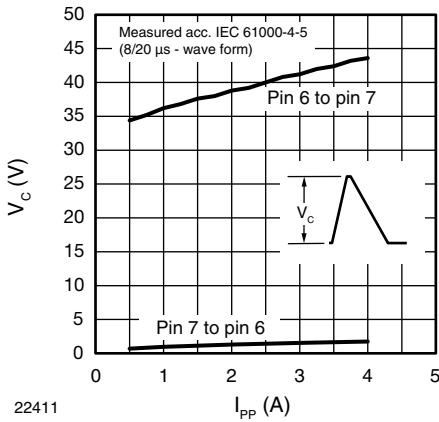


Fig. 8 - Typical Peak Clamping Voltage  $V_c$  vs. Peak Pulse Current  $I_{pp}$

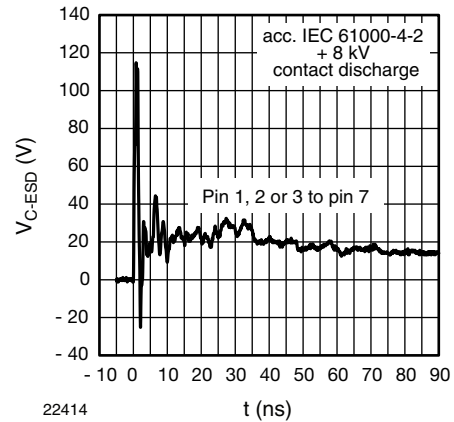


Fig. 11 - Typical Clamping Performance at + 8 kV Contact Discharge (acc. IEC 61000-4-2)

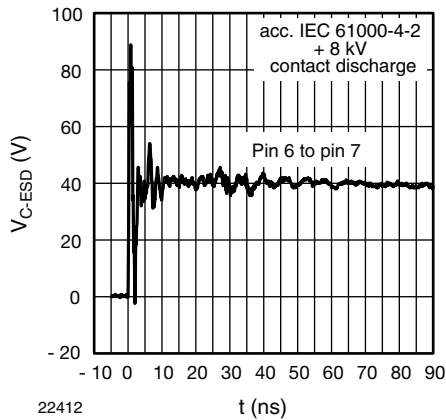


Fig. 9 - Typical Clamping Performance at + 8 kV Contact Discharge (acc. IEC 61000-4-2)

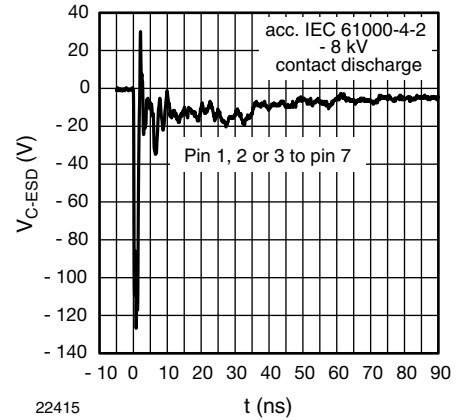


Fig. 12 - Typical Clamping Performance at - 8 kV Contact Discharge (acc. IEC 61000-4-2)

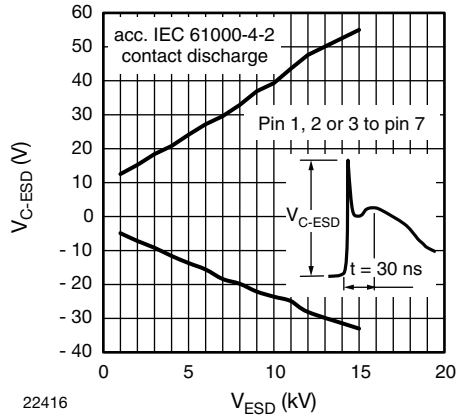


Fig. 13 - Typical Clamping Voltage at after 30 ns of ESD Contact Discharge (acc. IEC 61000-4-2)

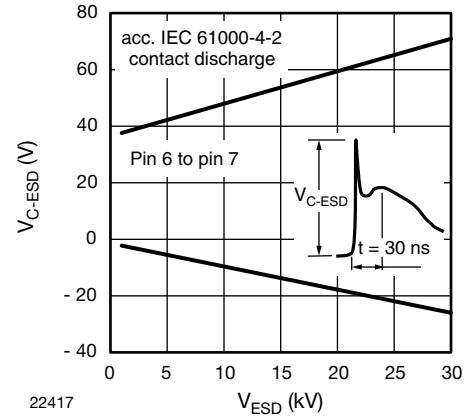
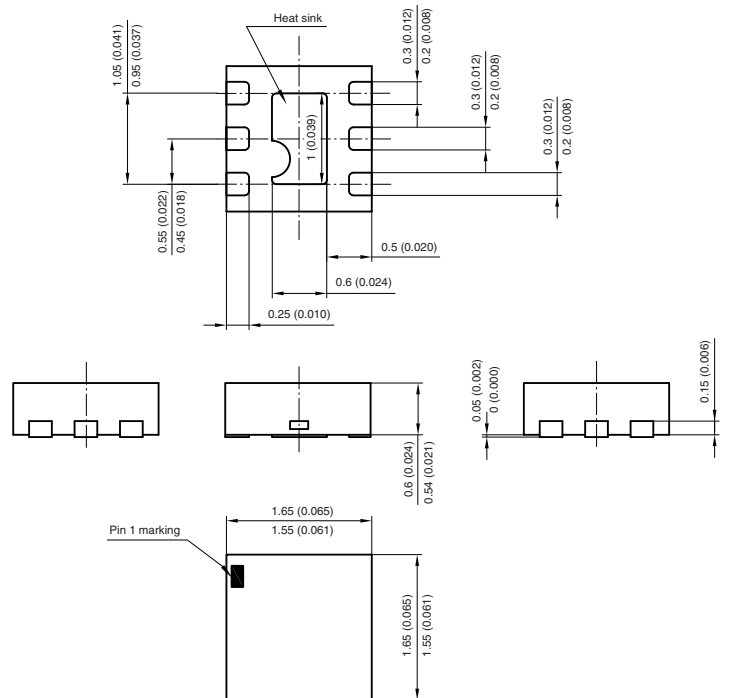
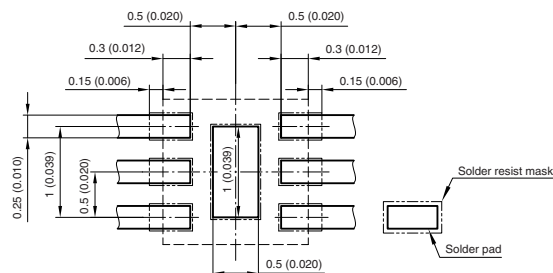


Fig. 14 - Typical Clamping Voltage at after 30 ns of ESD Contact Discharge (acc. IEC 61000-4-2)

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


Foot print recommendation:


 Document no.: S8-V-3906.02-014 (4)  
 Created - Date: 04. April 2006  
 20500



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