

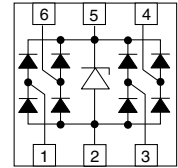
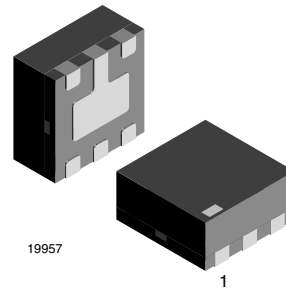
## 4-Line BUS-port ESD-protection

### Features

- Ultra compact LLP75-6A package
- 4-line USB ESD-protection
- Low leakage current
- Low load capacitance  $C_D = 0.8$  pF
- ESD-protection to IEC 61000-4-2  
± 15 kV contact discharge  
± 15 kV air discharge
- Lead (Pb)-free component
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

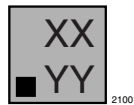


**RoHS**  
COMPLIANT  
**GREEN**  
(5-2008)\*



20397

### 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 (8 mm tape on 7" reel)	Minimum order quantity
VBUS054B-HS3	VBUS054B-HS3-GS08	3000	15 000

### Package Data

Device name	Package name	Marking code	Weight	Molding compound flammability rating	Moisture sensitivity level	Soldering conditions
VBUS054B-HS3	LLP75-6A	U6	5.1 mg	UL 94 V-0	MSL level 1 (according J-STD-020)	260 °C/10 s at terminals

### Absolute Maximum Ratings

Rating	Test conditions	Symbol	Value	Unit
Peak pulse current	Pin 1, 3, 4 or 6 to pin 2 acc. IEC 61000-4-5; $t_p = 8/20$ $\mu$ s; single shot	$I_{PPM}$	3	A
	Pin 5 to pin 2 acc. IEC 61000-4-5; $t_p = 8/20$ $\mu$ s; single shot	$I_{PPM}$	10	A
Peak pulse power	Pin 1, 3, 4 or 6 to pin 2 acc. IEC 61000-4-5; $t_p = 8/20$ $\mu$ s; single shot	$P_{PP}$	45	W
	Pin 5 to pin 2 acc. IEC 61000-4-5; $t_p = 8/20$ $\mu$ s; single shot	$P_{PP}$	200	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	$V_{ESD}$	± 15	kV
Operating temperature	Junction temperature	$T_J$	- 40 to + 125	°C
Storage temperature		$T_{STG}$	- 55 to + 150	°C

\* Please see document "Vishay Green and Halogen-Free Definitions (5-2008)" <http://www.vishay.com/doc?99902>

### Electrical Characteristics

Ratings at 25 °C, ambient temperature unless otherwise specified

### VBUS054B-HS3

Parameter	Test conditions/remarks	Symbol	Min.	Typ.	Max.	Unit
Protection paths	Number of line which can be protected	N lines			4	lines
Reverse stand-off voltage	at $I_R = 0.1 \mu\text{A}$ Pin 1, 3, 4 or 6 to pin 2	$V_{RWM}$	5			V
Reverse current	at $V_{IN} = V_{RWM} = 5 \text{ V}$ Pin 1, 3, 4 or 6 to pin 2	$I_R$		< 0.01	0.1	$\mu\text{A}$
Reverse breakdown voltage	at $I_R = 1 \text{ mA}$ Pin 5 to pin 2	$V_{BR}$	6.3	7.1	8	V
	at $I_R = 1 \text{ mA}$ Pin 1, 3, 4 or 6 to pin 2	$V_{BR}$	6.9	7.9	8.7	V
Reverse clamping voltage	at $I_{PP} = 3 \text{ A}$ ; Pin 1, 3, 4 or 6 to pin 2; acc. IEC 61000-4-5	$V_C$			15	V
Forward clamping voltage	at $I_F = 3 \text{ A}$ ; Pin 2 to pin 1, 3, 4 or 6; acc. IEC 61000-4-5	$V_F$			5	V
Capacitance	Pin 1, 3, 4 or 6 to pin 2 $V_{IN}$ (at pin 1, 3, 4 or 6) = 0 V and $V_{BUS}$ (at pin 5) = 5 V; $f = 1 \text{ MHz}$	$C_D$		0.8	1	pF
	Pin 1, 3, 4 or 6 to pin 2 $V_{IN}$ (at pin 1, 3, 4 or 6) = 2.5 V and $V_{BUS}$ (at pin 5) = 5 V; $f = 1 \text{ MHz}$	$C_D$		0.5	0.8	pF
Line symmetry	Difference of the line capacitances	$dC_D$			0.05	pF
Supply line capacitance	Pin 5 to pin 2 at $V_R = 0 \text{ V}$ ; $f = 1 \text{ MHz}$	$C_{ZD}$		110		pF

## Typical Characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified

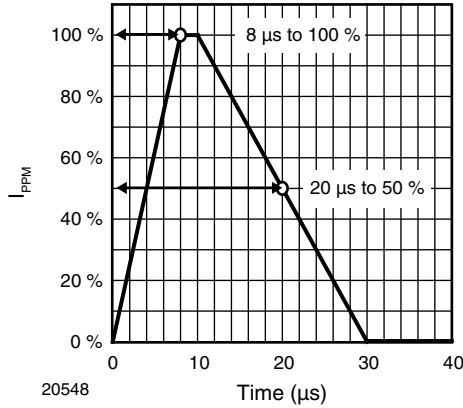


Figure 1. 8/20  $\mu\text{s}$  Peak Pulse Current Wave Form acc. IEC 61000-4-5

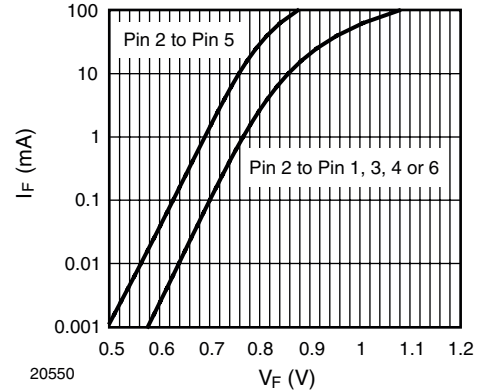


Figure 4. Typical Forward Current  $I_F$  vs. Forward Voltage  $V_F$

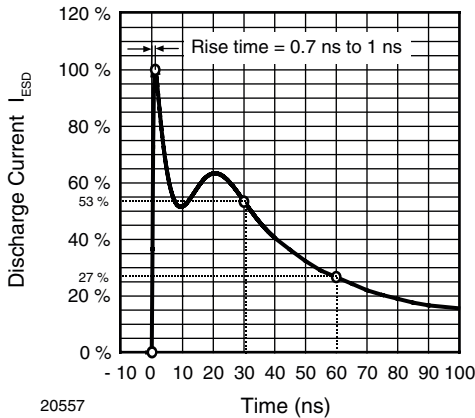


Figure 2. ESD Discharge Current Wave Form acc. IEC 61000-4-2 (330  $\Omega$ /150 pF)

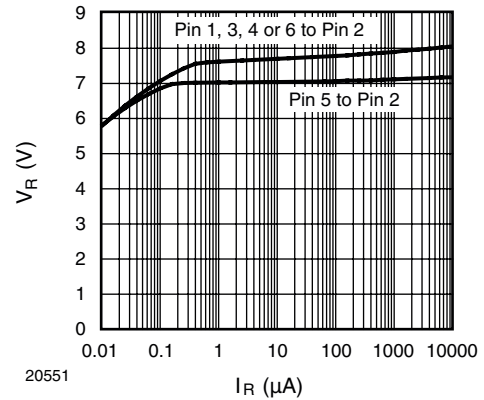


Figure 5. Typical Reverse Voltage  $V_R$  vs. Reverse Current  $I_R$

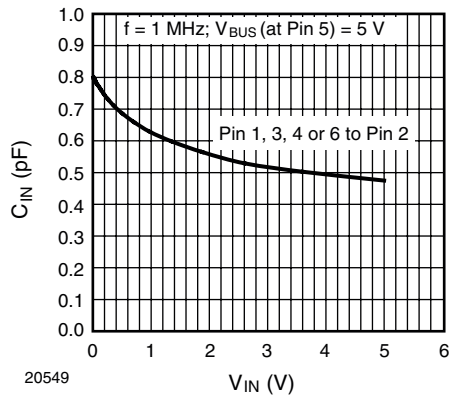


Figure 3. Typical Input Capacitance  $C_{IN}$  at Pin 1, 3, 4, or 6 vs. Input Voltage  $V_{IN}$

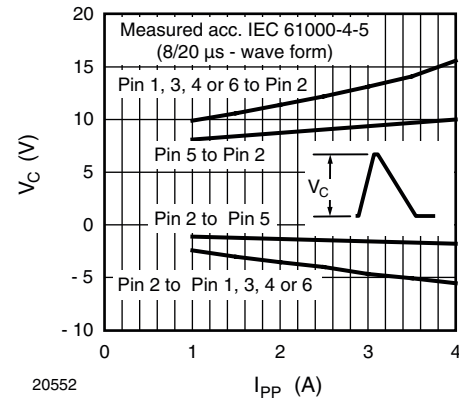


Figure 6. Typical Peak Clamping Voltage  $V_C$  vs. Peak Pulse Current  $I_{PP}$

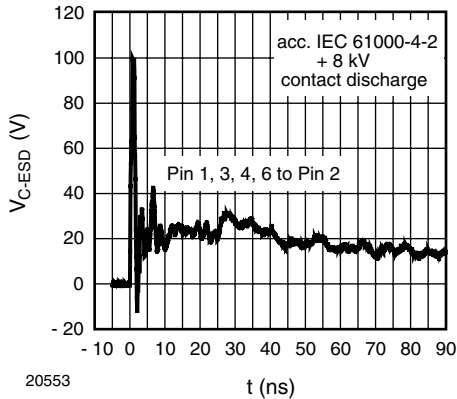


Figure 7. Typical Clamping Performance at +8 kV Contact Discharge (acc. IEC 61000-4-2)

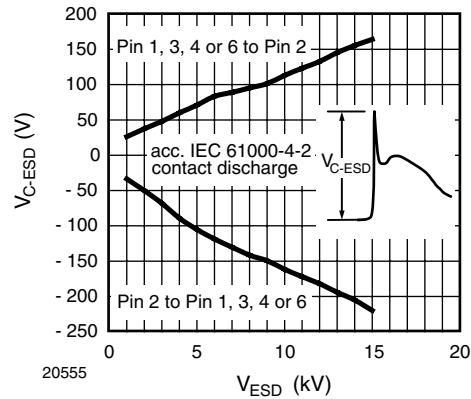


Figure 9. Typical Peak Clamping Voltage at ESD Contact Discharge (acc. IEC 61000-4-2)

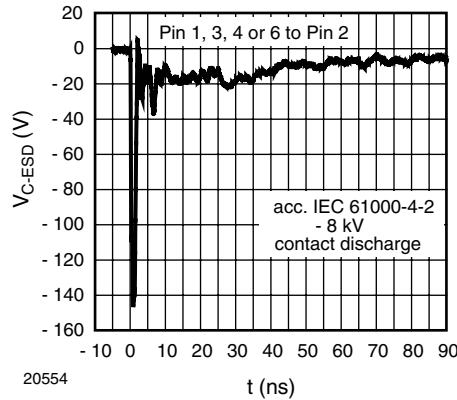


Figure 8. Typical Clamping Performance at -8 kV Contact Discharge (acc. IEC 61000-4-2)

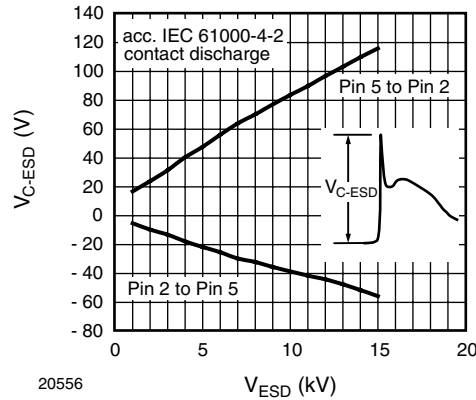
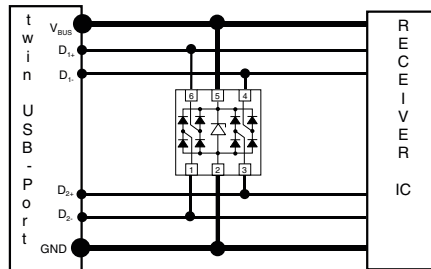


Figure 10. Typical Peak Clamping Voltage at ESD Contact Discharge (acc. IEC 61000-4-2)

## Application Note:

With the **VBUS054B-HS3** a double, high speed USB-port or up to 4 other high speed signal or data lines can be protected against transient voltage signals. Negative transients will be clamped close below the ground level while positive transients will be clamped close above the 5 V working range. An avalanche diode clamps the supply line ( $V_{BUS}$  at pin 5) to ground (pin 2). The high speed data lines,  $D_{1+}$ ,  $D_{2+}$ ,  $D_{1-}$  and  $D_{2-}$ , are connected to pin 1, 3, 4 and 6. As long as the signal voltage on the data lines is between the ground- and the  $V_{BUS}$ -level, the low capacitance PN-diodes offer a very high isolation to  $V_{BUS}$ , ground and to the other data lines. But as soon as any transient signal exceeds this working range, one of the PN-diodes starts working in the forward mode and clamps the transient to ground or to the avalanche breakthrough voltage level of the Z-diode between pin 5 and pin 2.



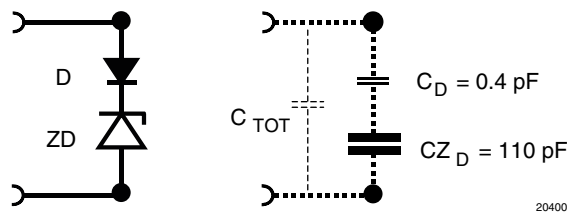
## Background knowledge:

A zener- or avalanche diode is an ideal device for "cutting" or "clamping" voltage spikes or voltage transients down to low and uncritical voltage values. The breakthrough voltage can easily be adjusted by the chip-technology to any desired value within a wide range. Up to about 6 V the "zener-effect" (tunnel-effect) is responsible for the breakthrough characteristic. Above 6 V the so-called "avalanche-effect" is responsible. This is a more abrupt breakthrough phenomenon. Because of the typical "Z-shape" of the current-voltage-curve of such diodes, these diodes are generally called "Z-diode" (= zener or avalanche diodes). An equally important parameter for a protection diode is the ESD- and surge-power that allows the diode to short current in the pulse to ground without being destroyed.

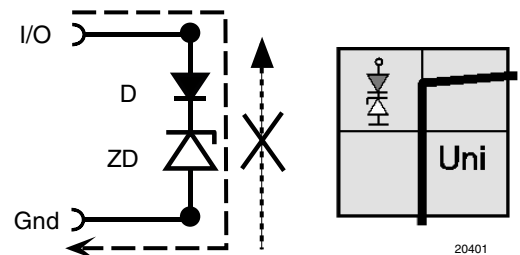
This requirement can be adjusted by the size of the silicon chip (crystal). The bigger the active area the higher the current that the diode can short to ground.

But the active area is also responsible for the diode capacitance - the bigger the area the higher the capacitance.

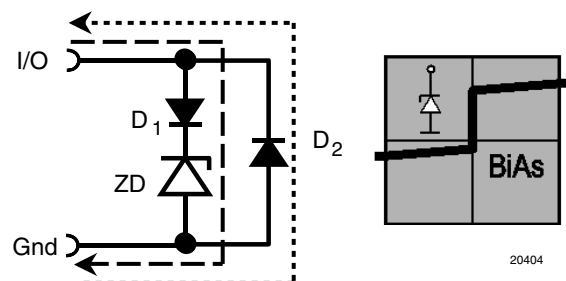
The dilemma is that a lot of applications require an effective protection against more than 8 kV ESD while the capacitance must be lower than 5 pF! This is well out of the normal range of a Z-diode. However, a Protection diode with a low capacitance PN-diode (switching diode or junction diode) in series with a Z-diode, can fulfil both requirements simultaneously: low capacitance AND high ESD- and/or surge immunity become possible! A small signal ( $V_{pp} < 100$  mV) just sees the low capacitance of the PN-diode, while the big capacitance of the Z-diode in series remains "invisible".



Such a constellation with a Z-diode and a small PN-diode (with low capacitance) in series (anti-serial) is a real unidirectional protection device. The clamping current can only flow in one direction (forward) in the PN-diode. The reverse path is blocked.



Another PN-diode "opens" the back path so that the protection device becomes bidirectional! Because the clamping voltage levels in forward and reverse directions are different, such a protection device has a **B**idirectional and **A**symmetrical clamping behaviour (**BiAs**) just like a single Z-diode.

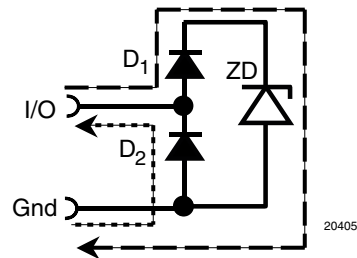


One mode of use is,...

in the very first moment before any pulses have arrived, all three diodes are completely discharged (so the diode capacitances are empty of charge) the first signal pulse with an amplitude  $> 0.5$  V will drive the upper PN-diode ( $D_1$ ) in a forward direction and "sees" the empty capacitance of the Z-diode (ZD).

Depending on the duration of this pulse and the pause to the next one the Z-diodes capacitance can be charged up so that the next pulse "sees" a lower capacitance. After some pulses the big Z-diode could be completely charged up so that the following pulses just see the small capacitance of both PN-diodes.

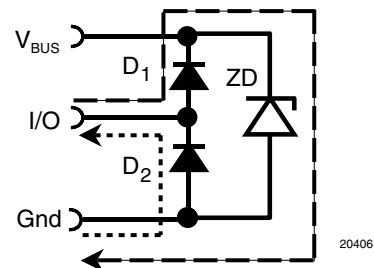
For some application this can work perfectly.....



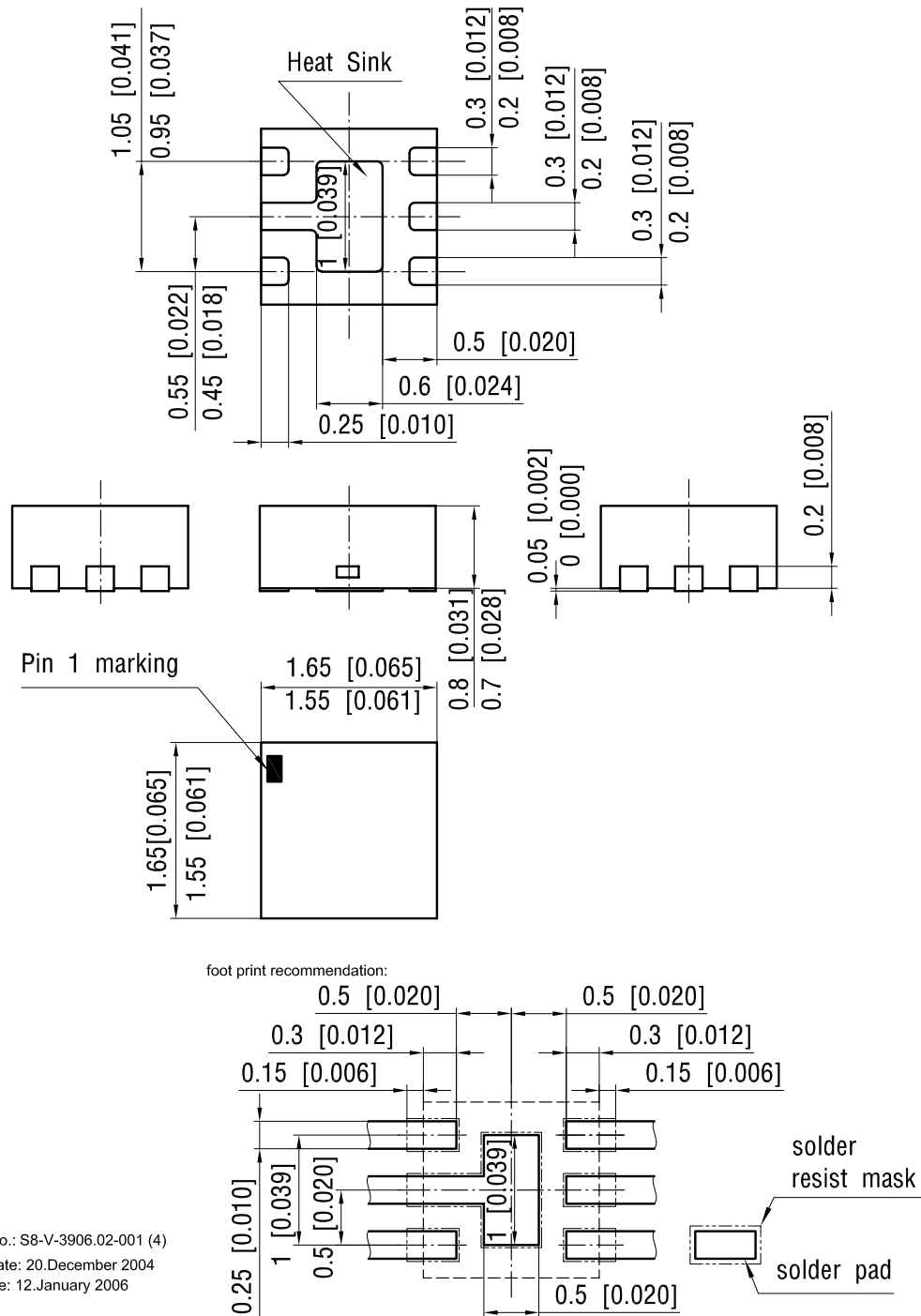
For others applications the capacitance must be the same all the time from the first till the last pulse.

For these applications the appropriate mode of use is to connect the Z-diode to the supply voltage.

In this mode the Z-diode is charged up immediately by the supply voltage and both PN-diodes are always used in reverse. This keeps their capacitance at a minimum.



**Package Dimensions** in millimeters (inches): **LLP75-6A**



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 18058



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