



Why does USB 2.0 need Circuit Protection?

- As USB transmission speeds and communication baud rates between host and peripherals increase, the reliability and robustness of devices when exposed to circuit transients become more important.
- As products shrink to accommodate faster speeds, the circuitry becomes smaller and more sensitive. Frequent occurrences of potential transient over-voltage and over-current events exist that can cause soft, latent or even catastrophic failures.
- Every time the device is connected or disconnected, the circuit receives a voltage/current transient. An electrostatic Discharge (ESD) event is one such transient.
- Humans can generate ESD levels of greater than 15kV simply by walking across a carpet. This level of ESD can easily be discharged into a USB port and damage on-chip protection circuits.
- As USB 2.0 data rates increase to 480Mbps, the selection of the correct ESD suppression type is critical. PulseGuard® ESD suppression devices have very low capacitance which allows them to be used in circuits with higher data rates than other technologies. Figure 1 shows the effect of waveform distortion caused by excess capacitance on a data line.

What type of transients occur?

USB is susceptible to two main types of events:

- 1) Overvoltage transients
- 2) Overcurrent events

Protecting Against Over-Voltage Transients

- A common source of over-voltage transients is ESD. The typical maximum level of ESD protection included in modern IC chips is 2000V. While this is sufficient to provide survivability in the manufacturing process, much higher ESD levels will be experienced when the final product is put to use.

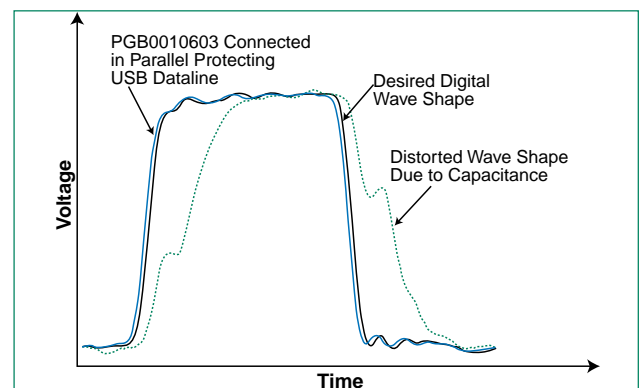


Figure 1. Distortion of Waveform

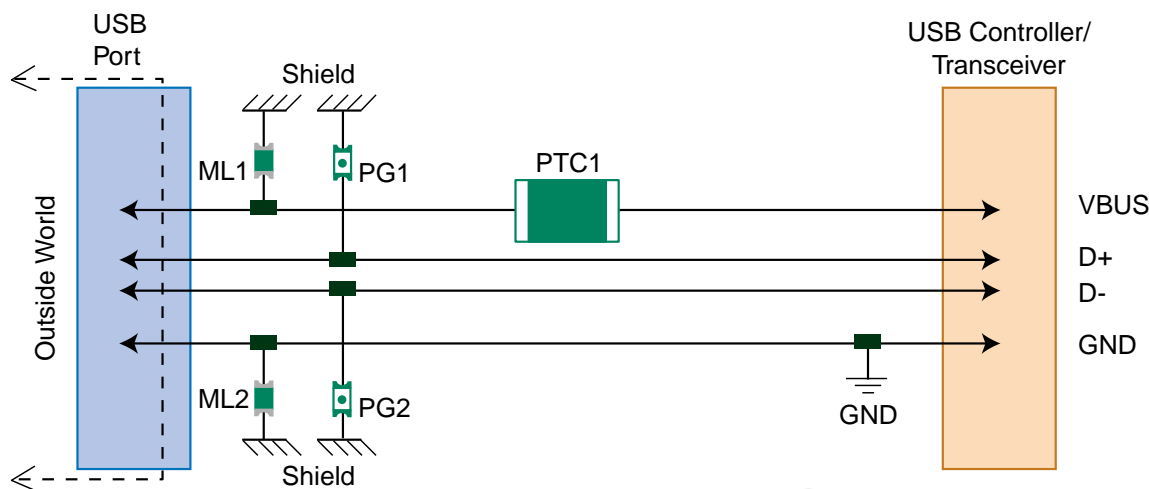
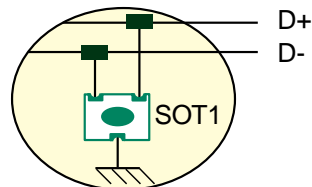


Table 1. Symbol Definition

	Shield (Chassis Ground)
	GND (Signal Ground)
PTC 1	1206L/1812L Series Resettable PTC
ML1, 2	V5.5MLA0603
PG1, 2	PGB0010603
SOT1	PGB002ST23
	Physical Tie



Option:
SOT23 PulseGuard Surface Mount ESD Suppressors provide High Speed Data Line Protection on both D+ and D- lines in one package

Figure 3. USB 2.0 port protection reference design.

- Other over-voltage transients that occur on the USB power line, due to events such as hot plugging, can be clamped by surface mount MLV's (Multi Layer Varistors.) The impulse energy caused by the voltage transient is clamped by the suppressor at a level low enough to ensure survival of the sensitive circuit components.
- Figure 2 shows the general clamping operation of a voltage transient by an MLV. The voltage is clamped to a level below that which could cause damage to the circuit.

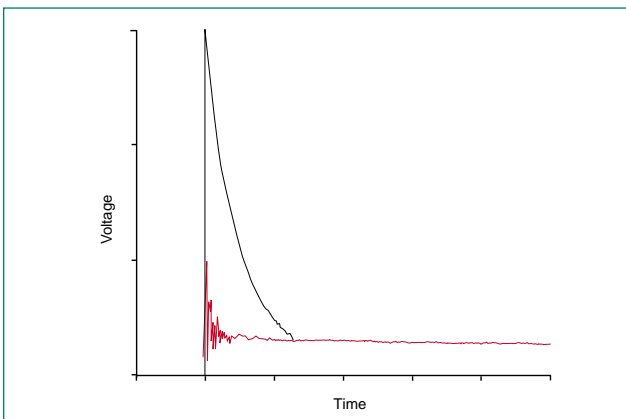


Figure 2. Operation of MLV in ESD event.

Protecting Against Over-Current Events

- Over-current events that occur on the USB power line can be dealt with effectively by the polymer-based PTC (Positive Temperature Coefficient) device. The PTC reacts to an excessive current by changing to a high impedance state.
- The PTC's ability to reset itself, after the power source is removed, ensures its effectiveness in plug and play applications, such as USB.

Parts List for USB Protection	
PulseGuard®	PGB0010603 or PGB002ST23
MLV	V5.5MLA0603
PTC	1206L 110 ¹ 1812L 110/150

¹The 1206L series is available in ratings ranging from .5A to 1.5A. Samples are available by contacting electronics@littelfuse.com (UL, CSA, TÜV approvals pending.)

USB Schematic

- Figure 3 above shows the schematic layout for protecting a USB device against voltage and current transients.
- The USB system consists of four lines which connect the various USB components; two data lines, Vbus and GND.
- The protection devices are connected from all four USB lines directly to the chassis ground, separating the ESD ground return path from the data ground.

Benefits

- To ensure reliable and safe circuit operation of USB products, protection against voltage and current transients must be carefully considered. Due to the higher data rates of USB 2.0, attention to the electrical characteristics of protection solutions is required.
- Littelfuse offers the broadest selection of overvoltage and overcurrent circuit protections solutions to suit any USB 2.0 application.



Circuit Protection Specialists

800 E. Northwest Highway
Des Plaines, IL 60016 USA
(847) 824-1188

www.littelfuse.com