

ESD Protection USB 1.1 Data Lines

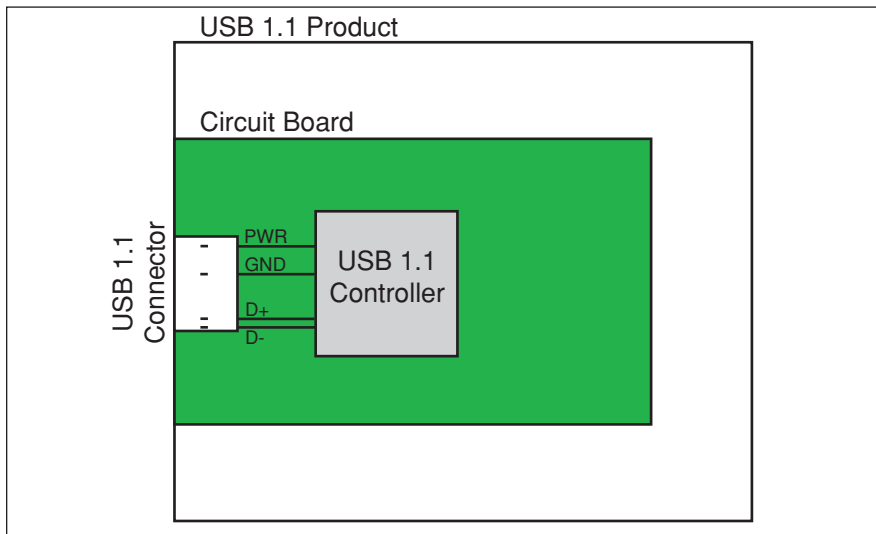


Figure 1. Simple USB 1.1 circuit diagram (ESD suppressors protect the data lines which have exposure to the outside world. The USB protocol uses 2 data lines).

Background

Universal Serial Bus (USB) products (PCI adapter cards, digital cameras, peripherals, etc.) can be susceptible to ESD events when the cable is disconnected from the data port. The ESD pulse can be introduced directly into the open port, or into the disconnected end of the cable. Either way, the integrated circuitry that controls the USB functionality can be compromised.

The Problem

After the ESD pulse is introduced into the data port, it will travel through the connector to the PC board. Once on the PC board, it will propagate down the data lines toward the integrated circuitry. Specifically, the IC of concern is the **USB 1.1 Controller**. Without sufficient protection, the Controller chip can receive corrupted data or even worse - be rendered inoperable.

The Solutions

In order to provide the IC with protection against ESD transients, the use of suppression products is recommended. The suppressors are installed between the data line and the chassis ground (parallel connection) and shunt the ESD transient from the data line to the ground.

Unlike the higher speed protocol of USB2.0 (480Mbps) where extremely low capacitance levels should be used (see Application Note EC606 "Protecting the Universal Serial Bus from Over Voltage and Overcurrent Threats" and Application Brief EC616 "Protection of USB2.0 Data Lines"), suppressors with higher capacitance can be used. However, the designer should take care not to excessively load the USB1.1 data lines to avoid distortion.

Examples of USB1.1 products which can benefit from ESD protection include:

- Computers (desktops and laptops)
- Peripherals (printers, scanners, etc.)
- Handheld devices (PDAs, cell phones, MPEG players, etc.)
- Repeaters and hubs
- Digital still cameras

Littelfuse offers two possible solutions for USB1.1 data line ESD suppression. The first is a silicon based protection array - the SP05xxBAxT family of TVS (Transient Voltage Suppression) Avalanche Diodes. These surface mount devices are ESD rated up to 20kV (air) and 15kV (contact) to the IEC-61000-4-2 model. The second solution is built with Multilayer Varistor technology and includes both the MHS Series for high speed applications and the MLE Series. Both families provide up to 15kV (air) and 8kV (contact) to the IEC-61000-4-2 model.



Examples:

Figures 2-4 show examples of the necessary protection for a single USB1.1 Port.

In Figure 2, the SP0503BAHT provides three TVS Avalanche Diodes in a single 4-pin SOT-143 case style protecting each of the two data lines (D+ and D-) and the 5V Power Bus (VBUS). A Polymeric Positive Temperature Coefficient (PTC) device 1206L150, is shown to limit current flow into VBUS. This device is also known in the industry as a resettable fuse. USB1.1 powered ports require over current protection to protect VBUS during an output short. The 1206L150 helps meet this requirement. See Application Note EC606 "Protecting the Universal Serial Bus from Over Voltage and Overcurrent Threats" for more information about the use of PTCs for the USB port.

Figure 3 utilizes three SP0501BACT devices in an 0402 chip scale package. The SP0501BACT is a single TVS Avalanche diode with up to 30kV (air and contact to IEC6100-4-2) of ESD protection capability. The single line device offers the designer more placement flexibility.

Figure 4 shows a similar circuit using three Multilayer Varistors (MLVs) in an 0402 package. For designs where it has been determined that suppressors must offer minimal capacitive loading, we suggest the 3pF V0402MHS03 to minimally impact the capacitance budget. For designs where capacitance is not a concern, the higher level capacitance 40pF MLV, V18MLE0402 can be used. It provides better EMI filtering (plus ESD protection). Littelfuse offers MLVs of various levels of capacitance to allow the Designer to customize the selection to his specific circuit parameters. Consult the MHS and MLE Series datasheets for specification information.

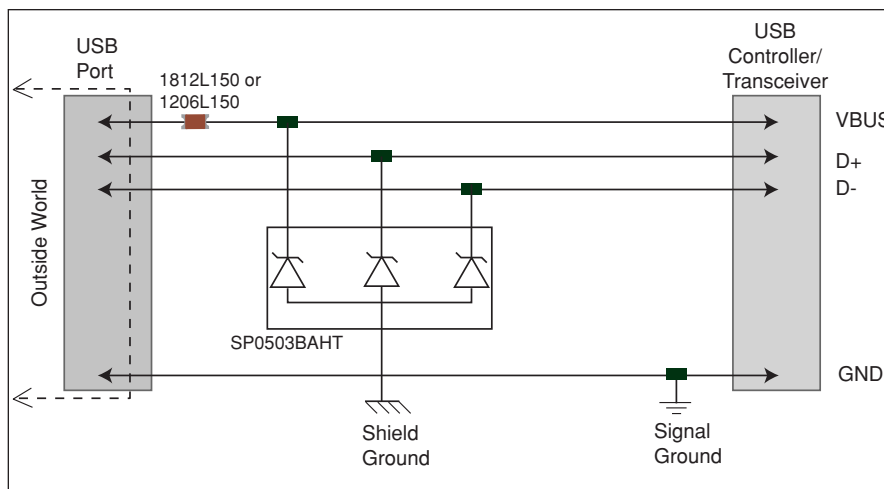


Figure 2. Protecting a USB 1.1 port with the SP0503BAHT

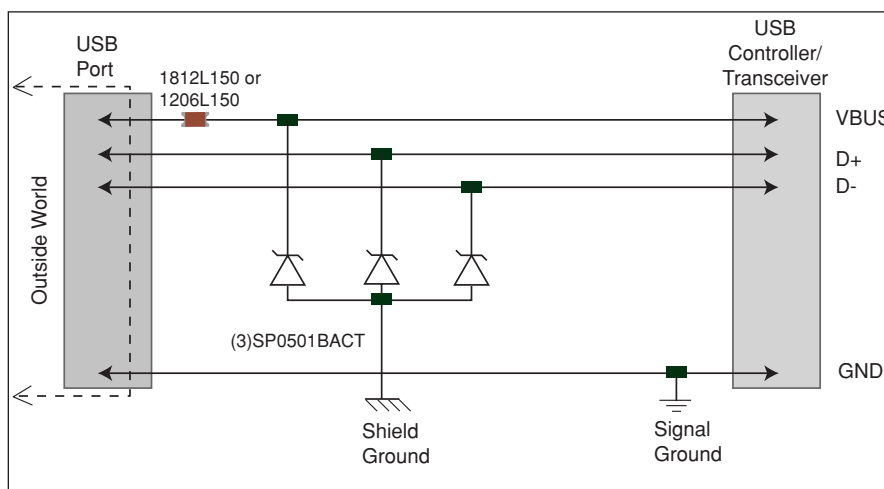


Figure 3. Protecting a USB 1.1 Port with three SP0501BACTs

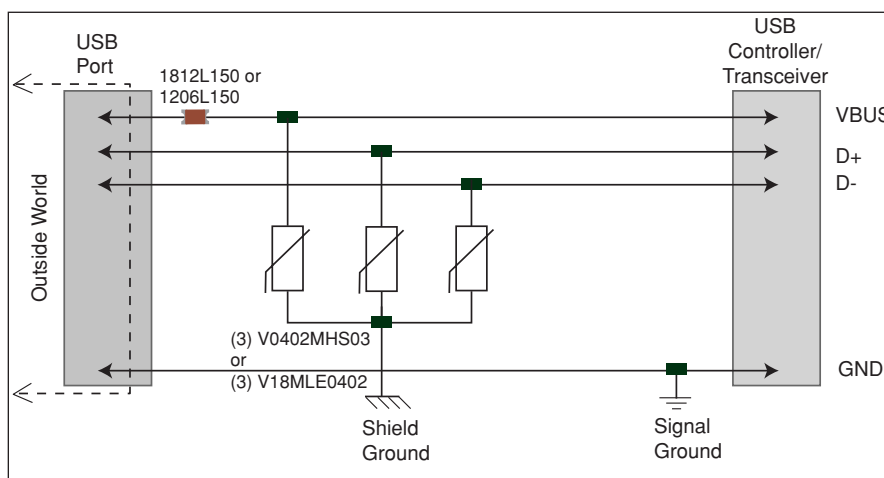


Figure 4. Protecting a USB 1.1 port with three V0402MHS12s or V18MLE0402s

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