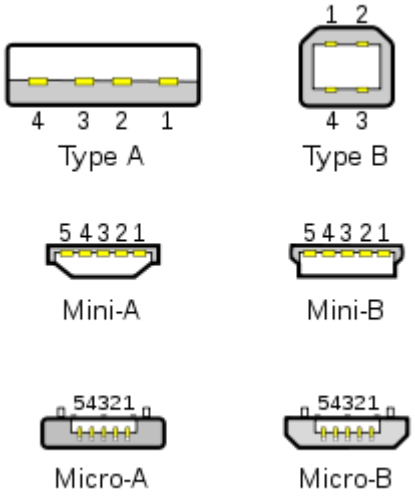
USB 2.0 Specification

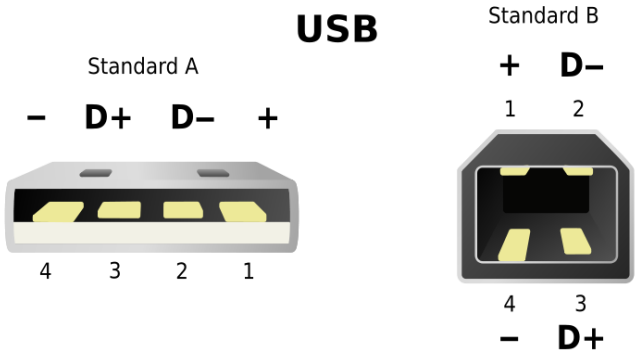
General specifications	
Length	5 metres (maximum)
Width	11.5 mm (A-plug), 8.45 mm (B-plug),
Height	4.5 mm (A-plug), 7.78 mm (B-plug, pre-v3.0)
Hot pluggable	Yes
External	Yes
Cable	4 wires (or 8 wires in USB 3.0 version)
Pins	4 (or 8 in USB 3.0 version) (1 supply, 2 data, 1 ground) (plus additional 4 for SuperSpeed technology in USB 3.0 version)
Connector	Unique
Electrical	
Signal	5 volt DC
Max. voltage	5 V(±5%)
Max. current	500–900 mA @ 5 V (depending on version)
Data	
Data signal	Packet data, defined by specifications
Width	1 bit
Bitrate	1.5/12/480/4,000 Mbit/s (depending on version)
Max. devices	127
Protocol	Serial

Transaction types.

Type	Attributes	Maximum Size	Example
Interrupt	Quality	64 bytes	Mouse, Keyboard
Bulk	Quality	64 bytes	Printer, scanner
Isochronous	Time	1024 bytes	Speakers, Video
Control	Time and Quality	64 bytes	System control

USB Connector Styles

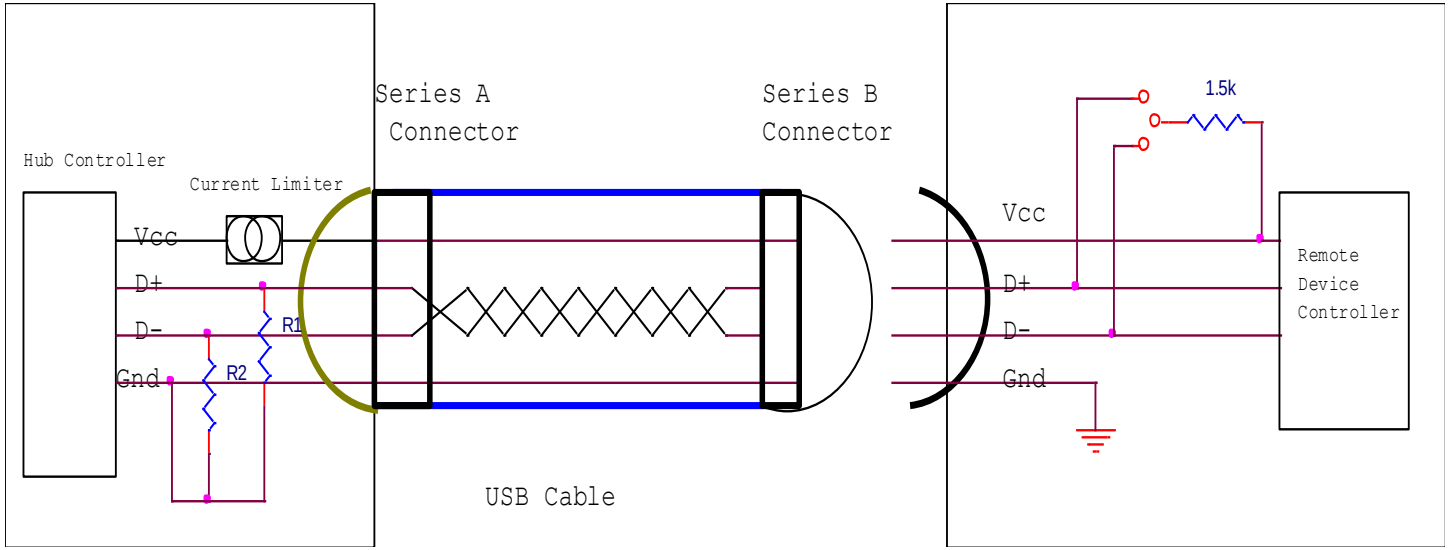




USB 1.x/2.0 standard pinout			
Pin	Name	Cable color	Description
1	VBUS	Red	+5 V
2	D–	White	Data –
3	D+	Green	Data +
4	GND	Black	Ground

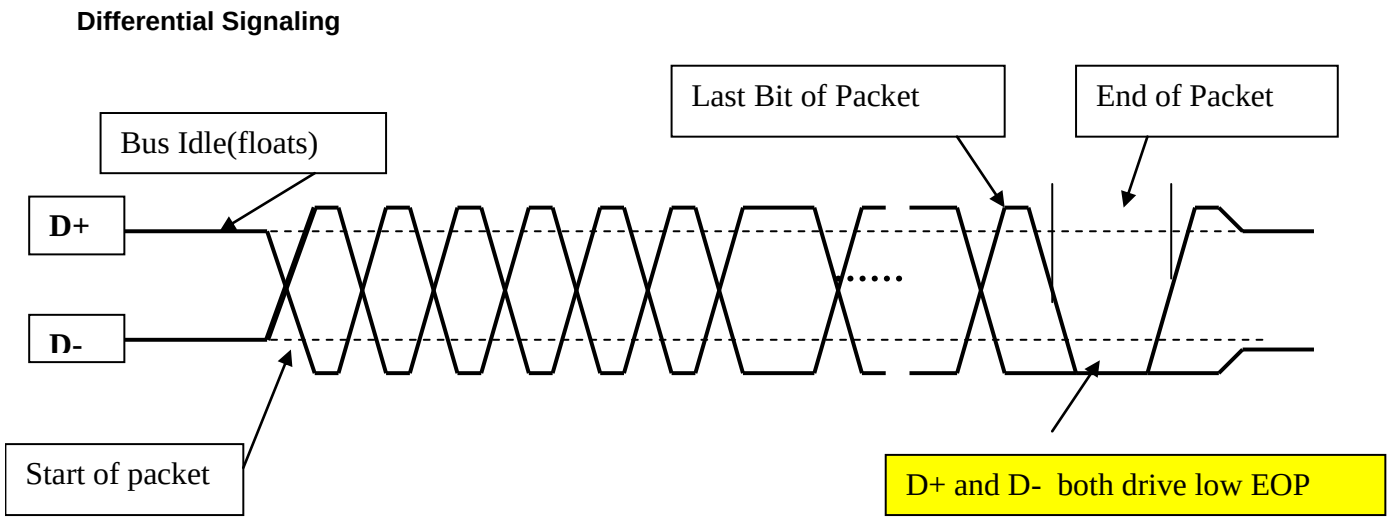
USB 1.x/2.0 Mini/Micro pinout			
Pin	Name	Cable color	Description
1	VBUS	Red	+5 V
2	D–	White	Data –
3	D+	Green	Data +
4	ID	None	Permits distinction of A plug from B plug * A plug: connected to Signal ground * B plug: not connected
5	GND	Black	Signal ground

USB Cable/Wiring Interface

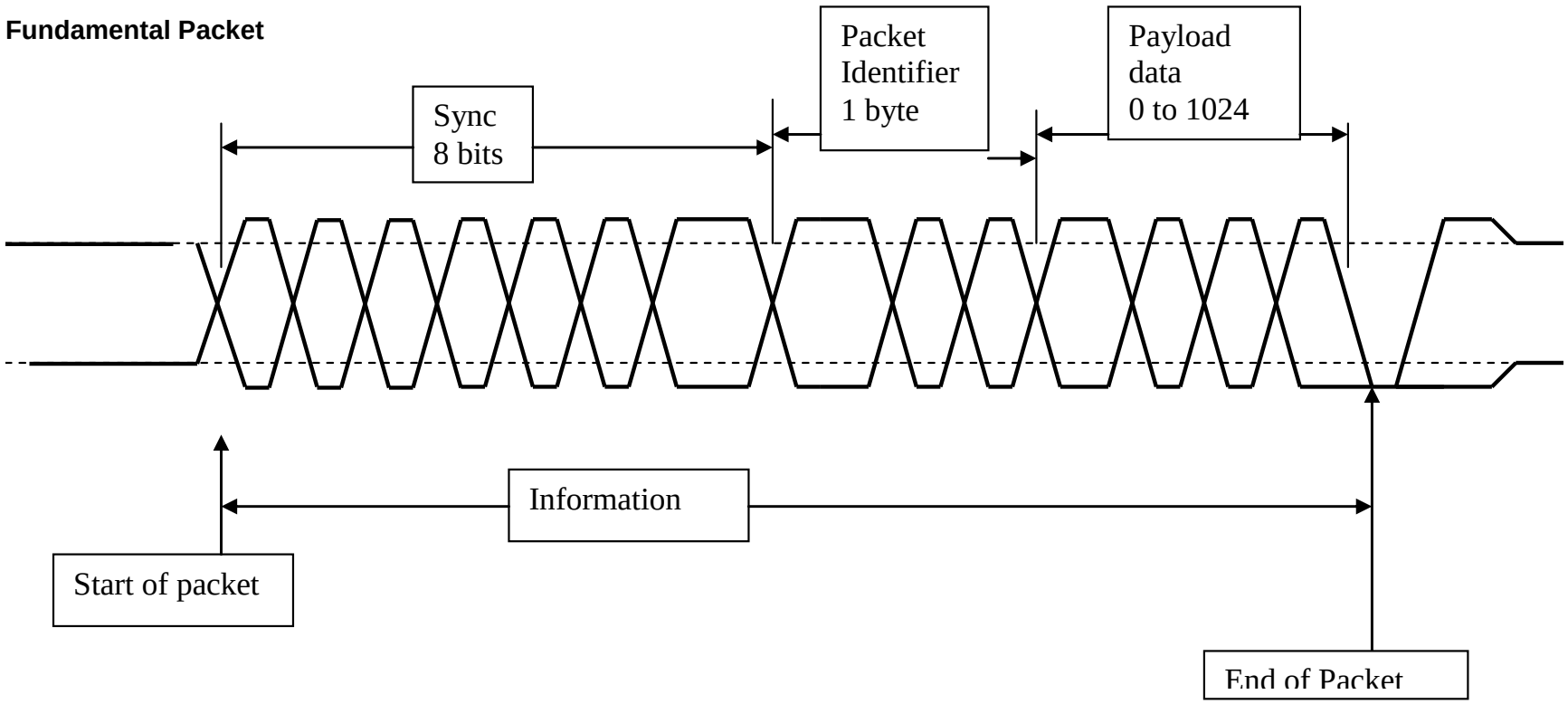


Type	Attributes	Maximum Size	Example
Interrupt	Quality	64 bytes	Mouse, Keyboard
Bulk	Quality	64 bytes	Printer, scanner
Isochronous	Time	1024 bytes	Speakers, Video
Control	Time and Quality	64 bytes	System control

Differential Signaling



Fundamental USB Packet



USB Overcurrent Protection for SSS-903

Design requirements.

- Design must operate within the -40°C to +85°C temperature range.
- SSS-903 must supply the USB buss with 5 volts (3.3 volts if the memory stick will operate with this voltage).
- The hardware design must be compatible with the USB 2.0 standard.
- Hardware design must provide overcurrent and overvoltage protection for the 5 volt supply voltage rail.
- Hardware design must provide overvoltage protection to the USB data signals. (D+ and D-)
- Connector must support HART and USB.
- Connector must be IPV66 better or compatible.

Key USB VBus Protector Manufacturers

- National Semiconductor (One device)
- Maxim IC (Several)
- Linear Technology (Two devices)
- ON Semiconductor (Includes data line TVS overvoltage protection)
- TI (Several)

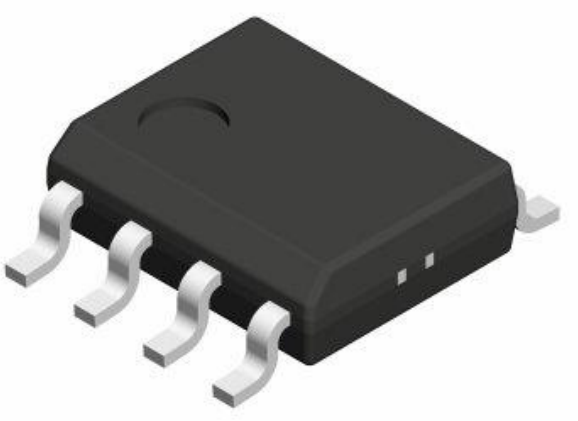
Over Voltage Circuit Manufacturers

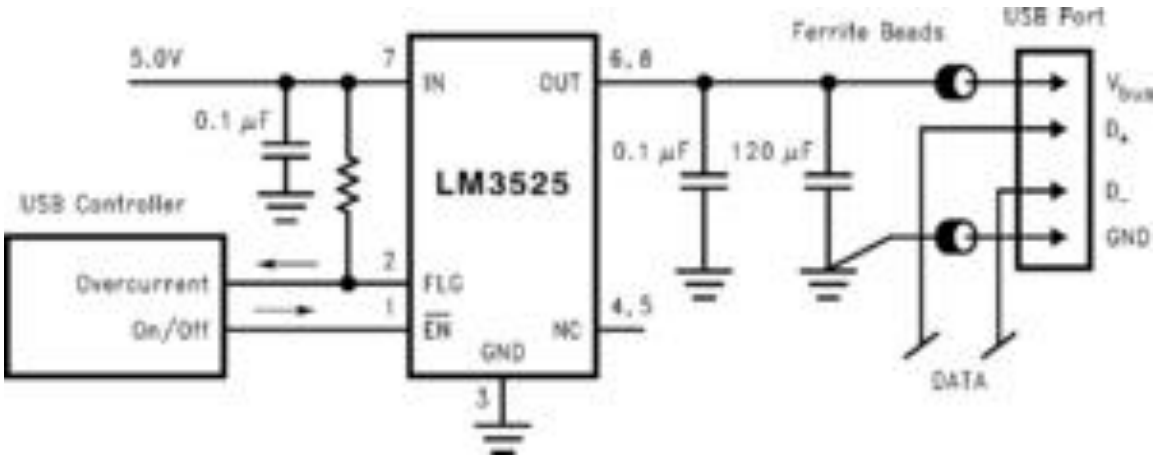
- Semtech
- Little Fuse

Available parts

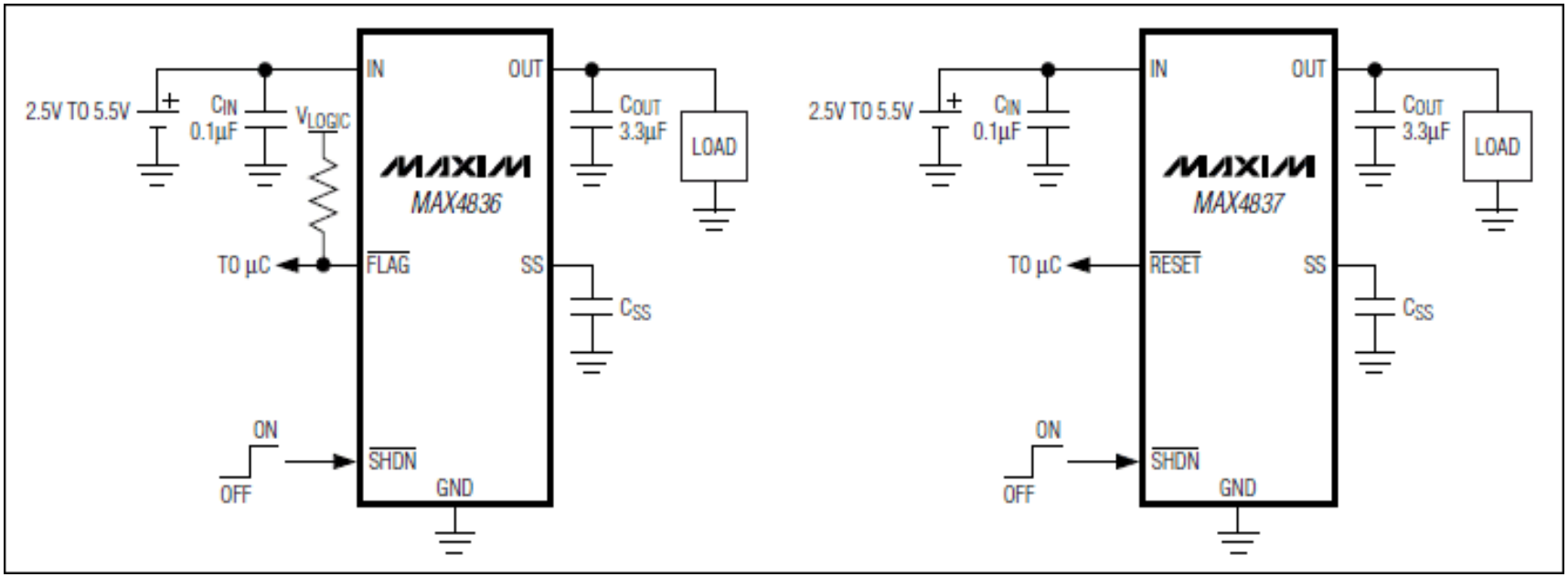
- $0.69 each at 1K+ pcs National
- 1,000: $0.647 On Semi
- $1.15 each at 1K+ pcs Maxim
- 1,000: $1.94 Linear
- T.I. ?

National LM3525





Maxim 483x


2.5V TO 5.5V
CIN
0.1µF
VLOGIC
IN
OUT
COUT
3.3µF
LOAD
MAXIM
MAX4836
TO µC
FLAG
SS
CSS
ON
OFF
SHDN
GND
2.5V TO 5.5V
CIN
0.1µF
IN
OUT
COUT
3.3µF
LOAD
MAXIM
MAX4837
TO µC
RESET
SS
CSS
ON
OFF
SHDN
GND

On Semiconductor NCP362C

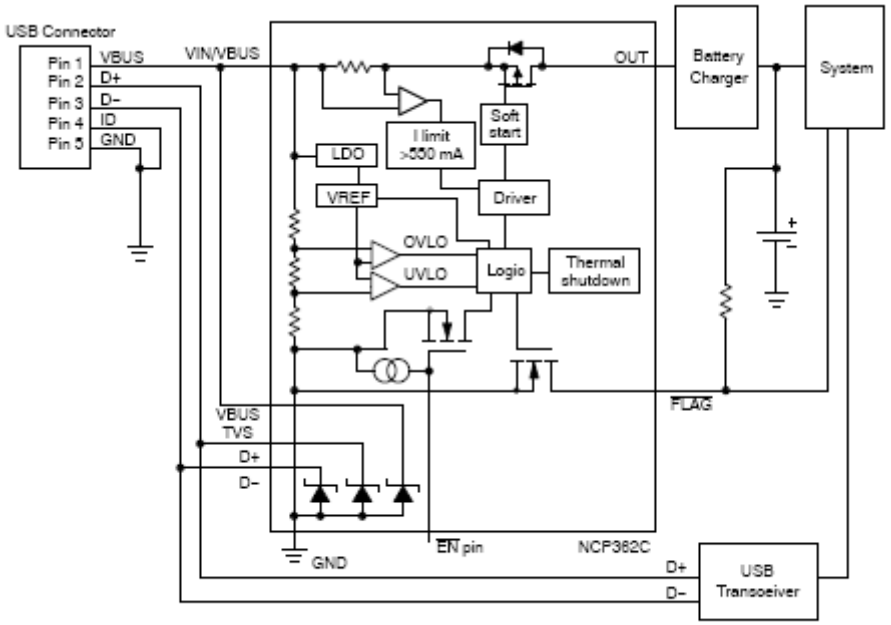
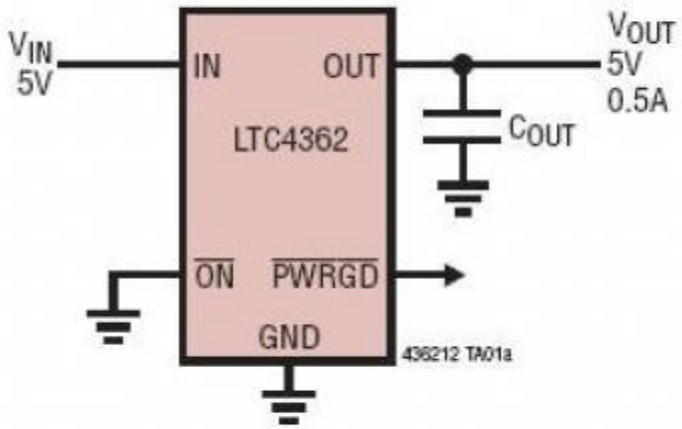
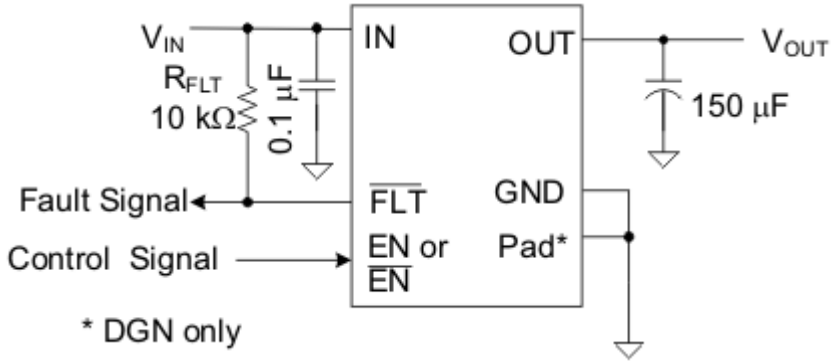


Figure 2. Typical Application Circuit with Full Integrated ESD for USB (NCP362C)

Linear LTC4362



TI TPS20xxC Family



Little Fuse Minimalist Approach

CIRCUIT PROTECTION OF USB 2.0

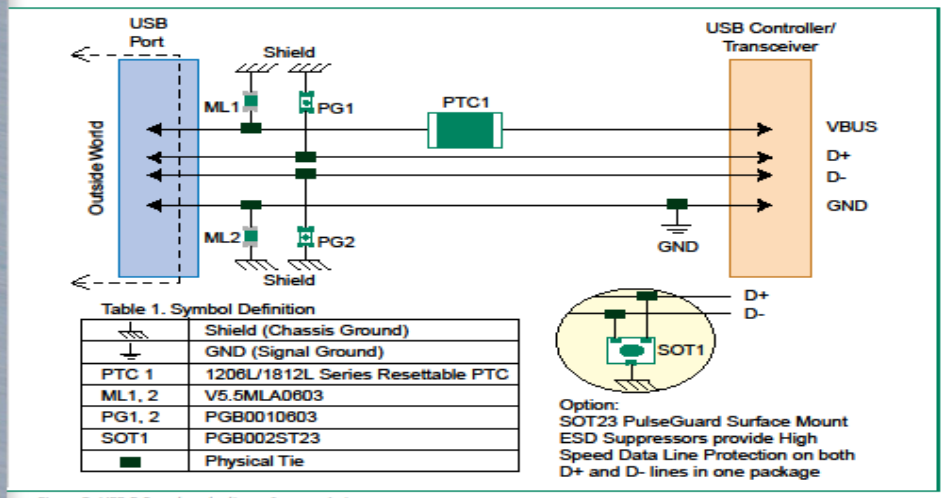


Table 1. Symbol Definition

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

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.

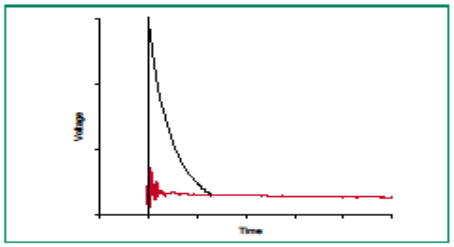


Figure 2. Operation of MLV in ESD event.

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

[1]The 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.

Littelfuse
Circuit Protection Specialists
800 E. Northwest Highway
Des Plaines, IL 60016 USA
(847) 824-1188
www.littelfuse.com

EC5T6

Semitech TVS Protection for USB 2.0

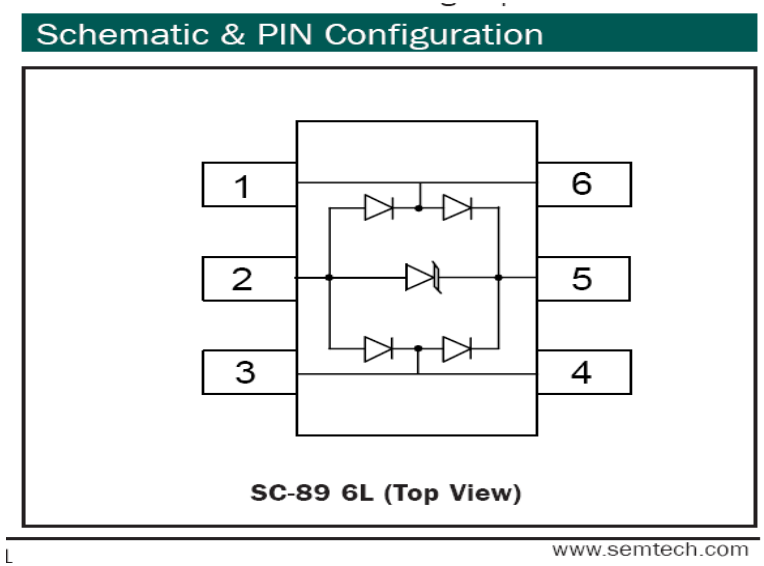
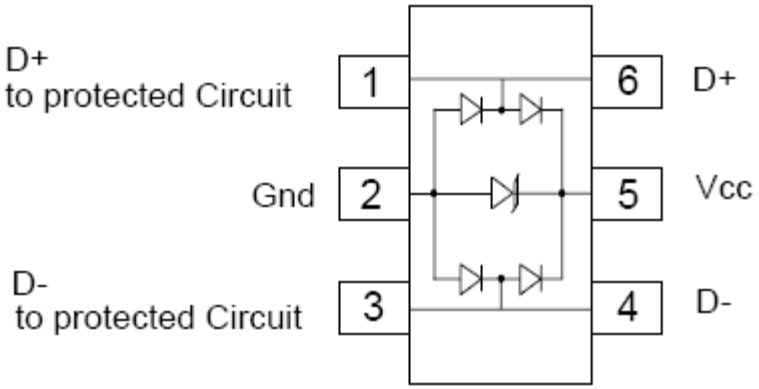
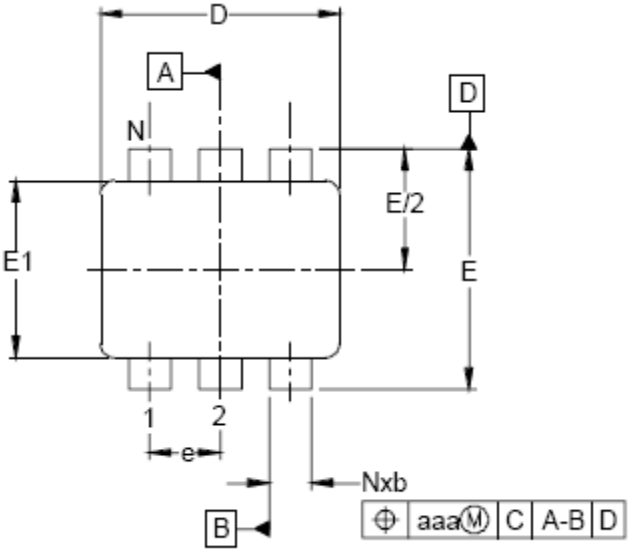


Figure 3. USB 2.0 (up to 480Mbps) Upstream or Downstream Port Protection





Features

Bidirectional EMI/RFI filtering and line termination with integrated ESD protection
ESD protection for USB power (V_{BUS}) and data lines (D+ and D-) to
IEC 61000-4-2 (ESD) ± 15 kV (air), ± 8 kV (contact)
IEC 61000-4-4 (EFT) 40 A (5/50 ns)
Filtering and termination for one USB port
Low TVS operating voltage: 5.25 V
Low leakage current
Small SC70-6L package
Solid-state technology

Weather Proof connectors.

- http://www.usbfirewire.com/usb-rugged-waterproof.html
- Kris Merrifield
- Direct: 586-913-8633
- Toll Free: 1-800-394-7732
- Email: kmerrifield@sineco.com
- +

References

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- https://shop.maxim-ic.com/storefront/priceavailable.do?event=PartSearch&menuitem=PriceAndAvailability&Partnumber=MAX4836
- http://www.onsemi.com/PowerSolutions/search.do?query=NCP362C&tabbed=Y&clearFilters=Y&searchType=others

- http://circuits.linear.com/498
- http://search.digikey.com/scripts/DkSearch/dksus.dll?Detail&name=LTC4362CDCB-2%23TRMPBFTR-ND

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- http://www.semtech.com/selector/index.html?ver=TVS&id=USB 1.1 2.0 OTG

- http://en.wikipedia.org/wiki/USB

USB Basics

USB Basics (By SE Nickols , DMR LLC)

The Universal Serial Bus is a "bit serial" communications protocol. The USB protocol specifies both the software and hardware components involved in allowing hardware, such as a camera, to communicate with a host computer.

A host computer will store, in a library, the USB devices supported. In other words, a user can have multiple USB devices supported (i.e. a mouse and camera). Upon opening an application, and plugging in a USB device into a USB port, the computer will select a class device driver. The User can interact with the device, such as a camera, by using a "GUI" (graphical user interface) to open and interact with the selected device.

The USB host software is layered. The layering supports many classes of devices. A class is a grouping of devices with similar characteristics. A generic device driver can control devices with similar characteristics. An example of device classes is video devices, mass storage devices, "human interface devices" (i.e. mouse), and communications devices.

Referring to figure 1, the USB protocol layer starts with the user interface. In the case of a "human interface device" an application and the graphical user interface are tied together (as in the case of a mouse). A mouse or keyboard will utilize the interrupt handling capability of the USB protocol. A "mouse" will use a different device driver and buffering mechanism than a video camera. A mouse is sending data about position intermittently, thus the use of interrupts.

The host computer "transacts" with the "class" of device selected. There are 4 USB Transactions types as illustrated in table 2.
A video camera with USB, can stream video data continuously. A host computer will utilize an Isochronous transaction to handle data from the video camera. In the mouse example above, the computer uses an interrupt transaction.

The host computer selects a transaction during the process of **enumeration**. Enumeration starts once the computer detects a USB device. Upon detection, the computer will automatically decide the USB bus speed, High Speed or Low Speed, the class of device, and the device driver to use. See figure 4.

From the physical interface standpoint, a pull up resistor, on the remote device side, tells the host the bus speed. The host detects the pull up on either signal line D+ or D-. A pull up resistor on D- indicates a Low Speed (1.5mhz) device. A pull up on D+ indicates a High Speed (12mhz) device.

Enumeration steps:

1. Host discovers newly attached device.
2. Host clears this status.
3. Host sends a reset command (lasts 10 milliseconds).
4. Host discovers reset is complete.
5. Host sends a command to remote device to determine its description.
6. The host sets an address for the device.
7. Host sends a command to remote device to collect info about the device.
8. Host selects a device driver.
9. The device is configured and ready to use.

All host to remote and remote to host communications occur in a structured (defined) sequence of packets. Packets are driven on the USB two-wire bus Differentially. See figure 2. Communications occur in a half duplex mode.

USB data packets consist of three pieces: a start, some information, and an end. The start of a packet is the SYNC sequence. The SYNC sequence is 8 bits long. The receiver uses this sequence to tune receive clock. At the 8^{th} bit time, the data (information) sequence begins. The data sequence can be from one byte (PID only) to 1025 (PID plus data). See figure 3.

At the beginning of the information portion of the packet, is the Packet ID. The Packet ID is formed of 4 bits and the complement of these 4 bits. This allows for error checking. There are 16 PID types as shown below. See table 1.