

PROTECTION PRODUCTS

Description

The STF202 is a combination EMI filter and line termination device with integrated TVS diodes for use on upstream USB ports. It is constructed using a proprietary technology that allows passive components and TVS diodes to be integrated in the same package. Each device will provide termination, filtering, and ESD protection for one upstream USB port. The STF202 is an easily implemented solution for meeting the requirements of revision 1.1 of the Universal Serial Bus specification.

USB line termination is achieved with series 22Ω or 30Ω resistors on both the D+ and D- USB lines. These resistors preserve signal integrity by matching the cable impedance to that of the differential driver. The $1.5k\Omega$ pull-up resistor completes the termination circuit on each line. This resistor is required by the USB specification to identify the equipment as either a full-speed (connected to D+ line) or low-speed (connected to D- line) device. The $47pF$ capacitors are used to bypass high frequency energy to ground and for edge rate control of the USB signals. Finally, the STF202 contains TVS diodes for ESD protection of both (D+ & D-) data lines and the voltage bus (V_{BUS}). The TVS diodes provide effective suppression of ESD voltages in excess of $15kV$ (air discharge) and $8kV$ (contact discharge) per IEC 61000-4-2, level 4.

The small size and integrated feature of the STF202 minimizes required board space and increases system reliability. The STF202 is suitable for use in USB hubs, computers, peripherals, and portable devices.

Features

- ◆ Bidirectional EMI/RFI filtering and line termination with integrated ESD protection
- ◆ ESD protection for USB power (V_{BUS}) and data lines (D+ & D-) to IEC 61000-4-2 Level 4
- ◆ Filtering and termination for two USB data lines
- ◆ Different series resistors for impedance matching
- ◆ Low TVS operating voltage ($5.25V$)
- ◆ Low leakage current
- ◆ Low capacitance
- ◆ Solid-state technology

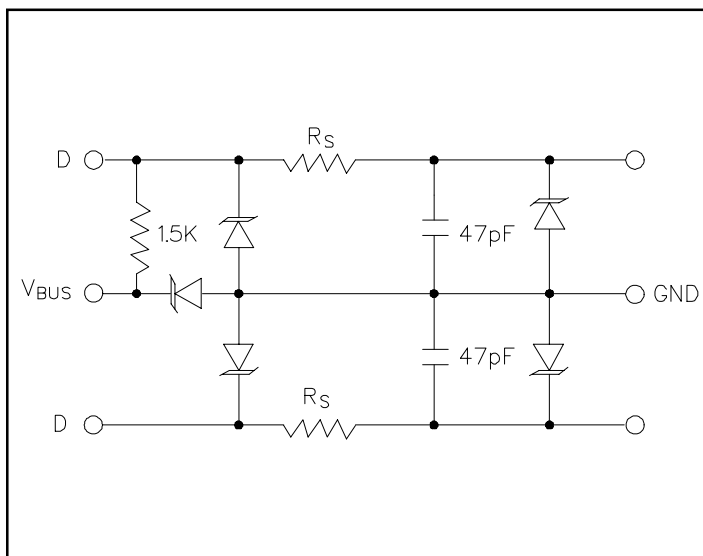
Mechanical Characteristics

- ◆ EIAJ SOT23-6L package
- ◆ Molding compound flammability rating: UL 94V-0
- ◆ Marking : Marking Code
- ◆ Packaging : Tape and Reel per EIA 481

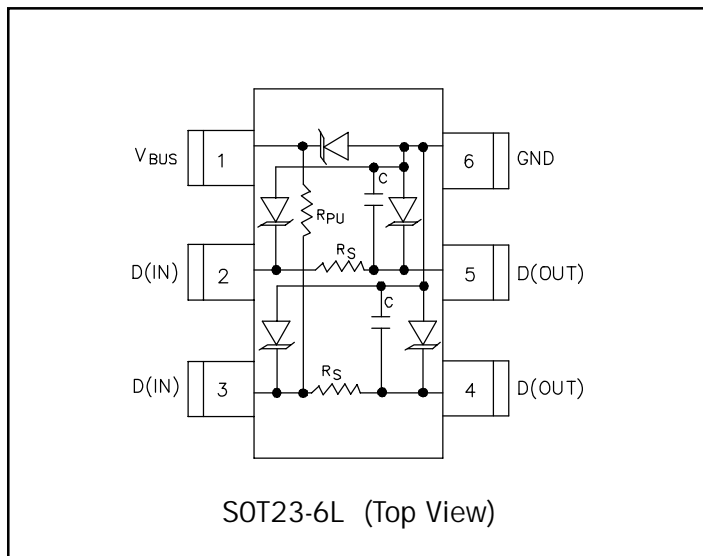
Applications

- ◆ USB Hubs
- ◆ Portable electronics
- ◆ Cellular Handsets
- ◆ Modems
- ◆ Peripherals
- ◆ Servers, Desktop, Notebook, and Handheld Computers

Circuit Diagram



Schematic & PIN Configuration



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Absolute Maximum Rating

Rating	Symbol	Value	Units
Steady-State Power	P_{pk}	100	mW
ESD Air Discharge per IEC 61000-4-2	V_{pp}	16	kV
ESD Contact Discharge per IEC 61000-4-2	V_{FP}	10	kV
Lead Soldering Temperature	T_L	260 (10 sec.)	°C
Operating Temperature	T_J	-40 to +125	°C
Storage Temperature	T_{STG}	-55 to +150	°C

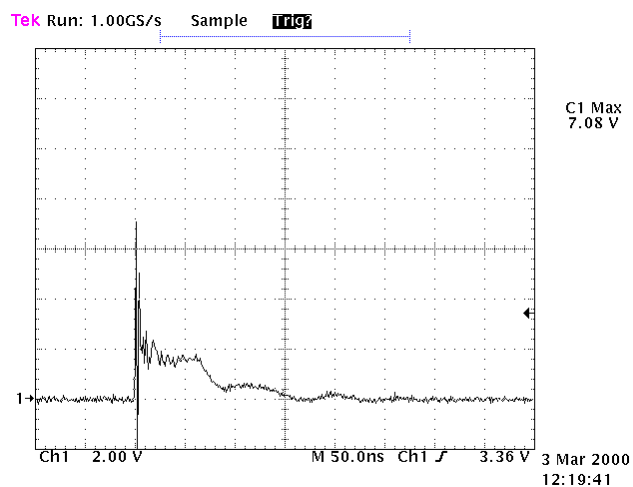
Electrical Characteristics

STF202-xx						
Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
TVS Reverse Stand-Off Voltage	V_{RWM}				5.25	V
TVS Reverse Breakdown Voltage	V_{BR}	$I_t = 1mA$	6			V
TVS Reverse Leakage Current	I_R	$V_{RWM} = 5.25V$, $T = 25^\circ C$ Between V_{BUS} pin and Ground			5	μA
TVS Reverse Leakage Current	I_R	$V_{RWM} = 3.3V$, $T = 25^\circ C$ Between any data (D+, D-) pin and Ground.			1	μA
TVS Junction Capacitance	C_j	Between I/O pins and Ground, each device $V_R = 0V$, $f = 1MHz$		10		pF
Series Resistance (STF202-22)	R_S	Each Line	20	22	24	Ω
Series Resistance (STF202-30)	R_S	Each Line	27	30	33	Ω
Pull Up Resistance	R_{UP}	Each Line	1.35	1.5	1.65	k Ω
Capacitor	C	Each Line		47		pF
Total Capacitance	C_{TOT}	Between Input or Output and Ground and V_{BUS} grounded $V_R = 0V$, $f = 1MHz$		60		pF

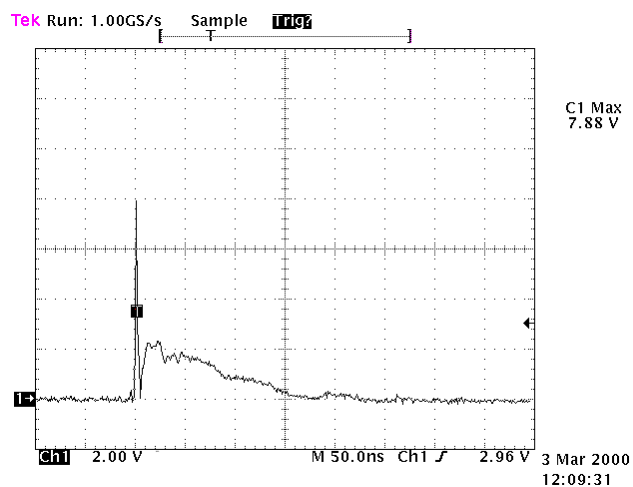
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Typical Characteristics

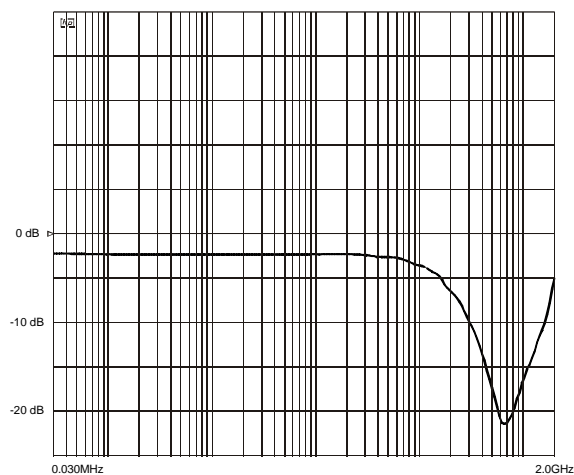
ESD Clamping (8kV Contact)



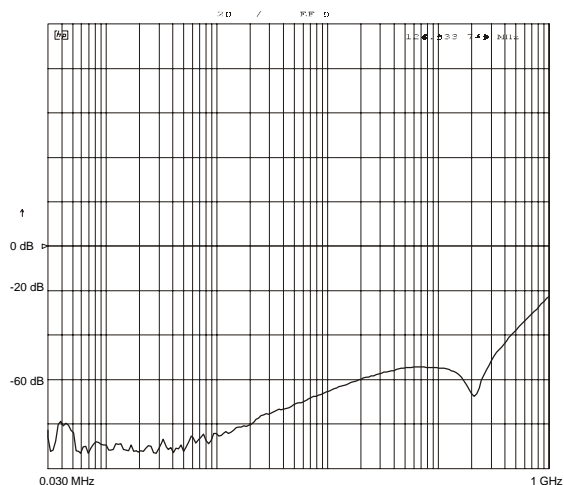
ESD Clamping (15kV Air)



Typical Insertion Loss



Analog Crosstalk (D+ to D-)



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Applications Information

Device Connection

The STF202 is designed to provide termination, EMI filtering and ESD protection for two USB I/O lines. The equivalent circuit diagram is shown in Figure 1. The device is connected as follows:

1. **Full-Speed Devices:** For full-speed devices the pull-up resistor is connected to the D+ line. Pin 1 is connected to the voltage supply line (V_{BUS}). The input of the D+ line is routed into pin 3 and out of pin 4. The input of the D- line is connected at pin 2 and the output at pin 5. Pin 6 is connected to ground.
2. **Low-Speed Devices:** For low speed devices the pull-up resistor is connected to the D- line. Pins 1 is connected to the voltage supply line (V_{BUS}). The input of the D- line is connected at pin 3 with the output taken at pin 4. The input of the D+ line is connected to pin 2 and the output is at pin 5. Pin 6 is connected to ground.

USB Port Design Considerations

The Universal Serial Bus (USB) specification requires termination and filtering components for proper operation. In addition, an open USB socket is vulnerable to hazardous ESD discharges in excess of 15kV. These discharges can may occur on the data lines or the voltage bus. The STF202 is an easily implemented solution designed to meet the termination & EMI filter requirements of the USB specification revision 1.1. It also provides ESD protection to IEC 61000-4-2, level 4.

A simplified USB port is shown in Figure 3. USB line termination is achieved with series resistors on both the D+ and D- lines. These resistors preserve signal integrity by matching the cable impedance to that of the differential driver. 15k Ω pull-down resistors are used to identify a downstream port while an upstream port is identified with a 1.5k Ω pull up resistor on either the D+ (full speed devices) or the D- (low speed devices) data line. Capacitors are used to bypass high frequency energy to ground and for edge rate control of the USB signals. TVS diodes are added for ESD protection of both (D+ & D-) data lines and the voltage bus (V_{BUS}). A power distribution switch and voltage regulator provide the power management functions of the port.

Figure 1 - STF202 Circuit Diagram

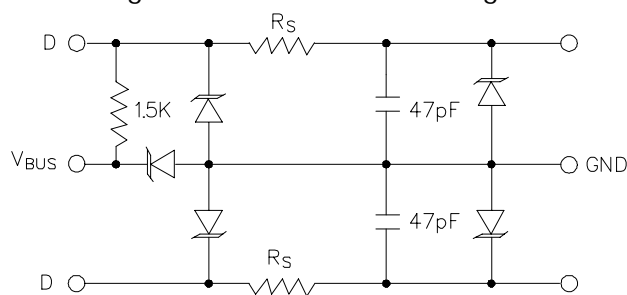
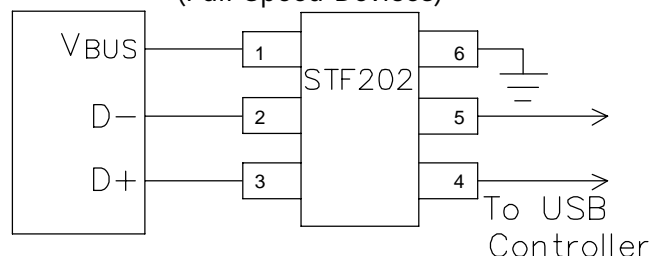


Figure 2 - STF202 Connection Diagram (Full Speed Devices)

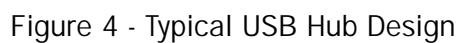


Semtech provides a complete solution to simplify USB port design (Figure 4). The STF201 & STF202 integrate all of the components necessary for line termination, bidirectional EMI filtering, and ESD protection on downstream (STF201) or upstream (STF202) ports. The SC5826 is a dual port power switch that provides individual or ganged port switching, fault reporting, and inrush current limiting as required by the USB specification. The SC5205 ULDO provides a stable voltage to the USB controller.

Board Placement & Layout Guidelines.

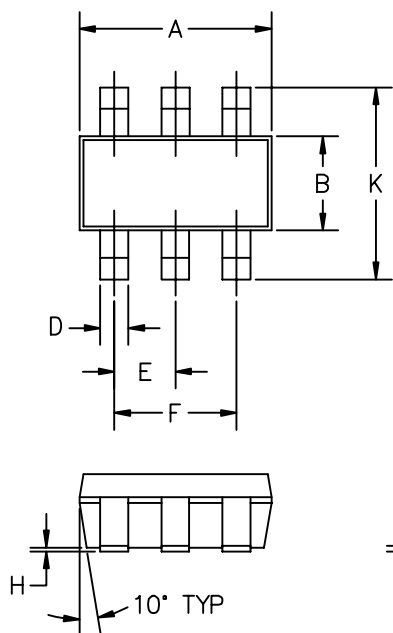
Designing a USB hub to meet EMI & ESD immunity requirements requires a combination of optimum component placement, trace routing, and good circuit design practices. Some general guidelines are given below:

- Avoid running D+ & D- signal line traces near high speed clock lines or similar signal lines.
- Avoid running critical signal lines near board edges.
- Locate the USB controller chip near the USB connectors.
- Place the STF202 near the USB connector to restrict transient coupling.
- Minimize the path length between the USB connector and the STF202



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Outline Drawing - SOT23-6L

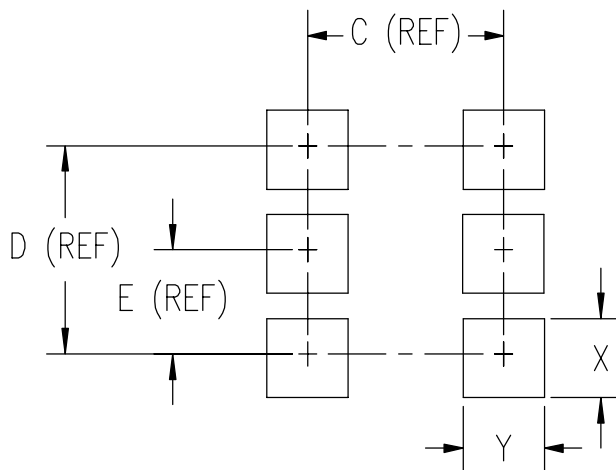


DIMENSIONS ①					NOTE
DIM ^N	INCHES		MM		
	MIN	MAX	MIN	MAX	
A	.110	.120	2.80	3.05	—
B	.059	.070	1.50	1.75	—
C	.036	.051	.90	1.30	—
D	.014	.020	.35	.50	—
E	.033	.040	.85	1.05	—
F	.067	.083	1.7	2.1	—
H	.0004	.006	.010	.150	—
J	.0035	.008	.090	.20	—
K	.102	.118	2.6	3.00	—

② PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH AND METAL BURR.

① CONTROLLING DIMENSIONS: MILLIMETERS.

Land Pattern - SOT23-6L



DIMENSIONS			
DIM ^N	INCHES	MM	NOTE
C	.094	2.4	—
D	.074	1.9	—
E	.037	.95	—
X	.028	.7	—
Y	.039	1.0	—

PROTECTION PRODUCTS**Marking Codes**

Part Number	Marking Code
STF202-22	222
STF202-30	230

Ordering Information

Part Number	Series Resister	Qty per Reel	Reel Size
STF202-22.TC	22 Ω	3,000	7 Inch
STF202-30.TC	30 Ω	3,000	7 Inch

Contact Information

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