

## PROTECTION PRODUCTS

### Description

The STF201 is a combination EMI filter and line termination device with integrated TVS diodes for use on downstream 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 downstream USB port. The STF201 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  $22\Omega$  or  $30\Omega$  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  $15k\Omega$  pull-down resistors complete the termination circuit on each line. They are required by the USB specification to identify the line as a downstream connection. The  $47pF$  capacitors are used to bypass high frequency energy to ground and for edge rate control of the USB signals. Finally, the STF201 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 STF201 minimizes required board space and increases system reliability. The pin-out of the device allows easy implementation. The STF201 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

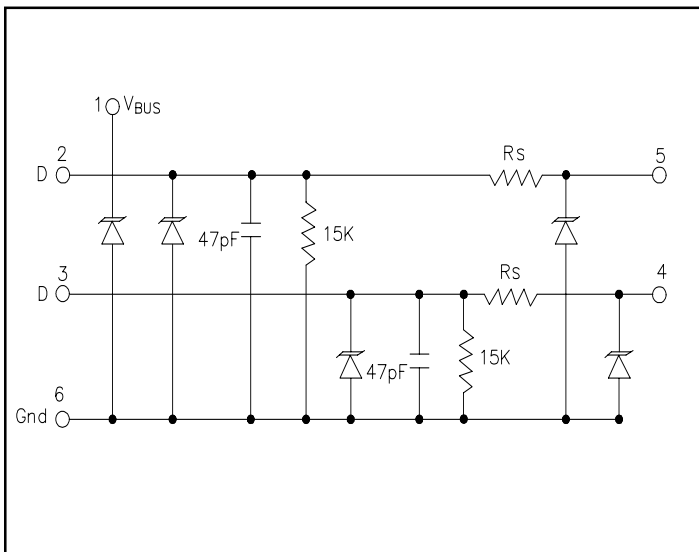
### Mechanical Characteristics

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

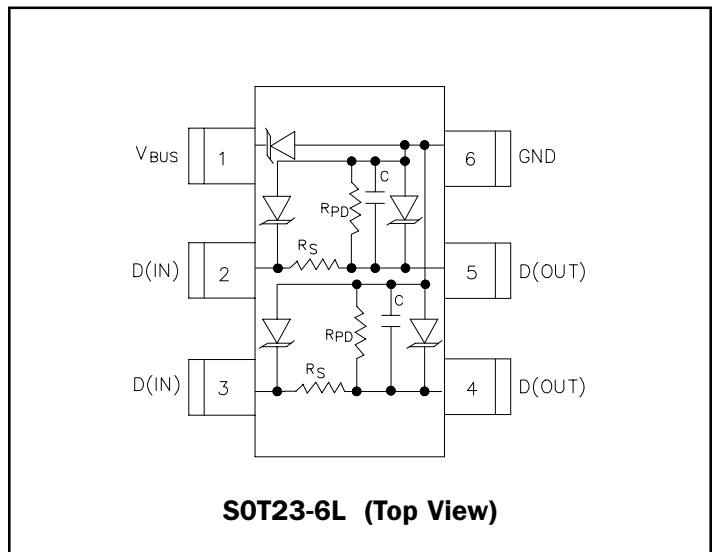
### Applications

- ◆ USB Hubs
- ◆ Portable electronics
- ◆ Printers
- ◆ Monitors
- ◆ Servers, Desktop, and Notebook computers

### Circuit Diagram



### Schematic & Pin Configuration



**PROTECTION PRODUCTS**
**Absolute Maximum Rating**

Rating	Symbol	Value	Units
Steady-State Power	$P_{pk}$	100	mW
ESD Air Discharge per IEC 61000-4-2	$V_{pp}$	15	kV
ESD Contact Discharge per IEC 61000-4-2	$V_{FP}$	8	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

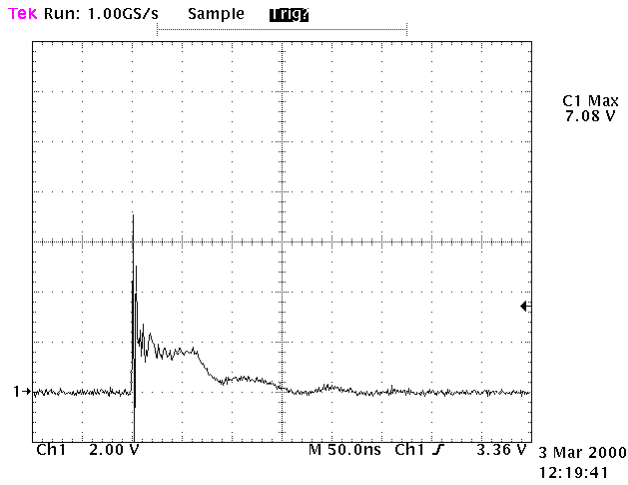
**Electrical Characteristics**

STF201-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	$I_R$	$V_{RWM} = 5.25V, T=25^\circ C$			5	$\mu A$
TVS Reverse Leakage Current	$I_R$	$V_{RWM} = 3.3V, T=25^\circ C$			1	$\mu A$
TVS Junction Capacitance	$C_j$	Between I/O pins and Gnd, each device $V_R = 0V, f = 1MHz$		10		pF
Series Resistance (STF201-22)	$R_s$	Each Line	20	22	24	$\Omega$
Series Resistance (STF201-30)	$R_s$	Each Line	27	30	33	$\Omega$
Pulldown Resistance	$R_{PD}$	Each Line	13.5	15	16.5	k $\Omega$
Capacitor	C	Each Line		47		pF
Total Capacitance	$C_{TOT}$	Between Input and Output, each Line $V_R = 0V, f = 1MHz$		60		pF

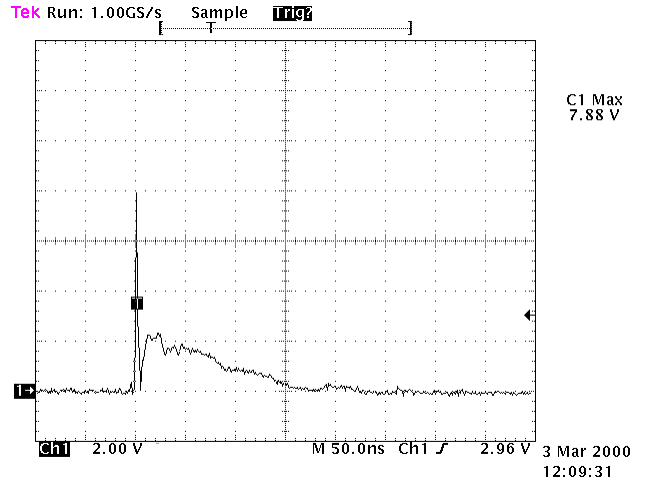
PROTECTION PRODUCTS

Typical Characteristics

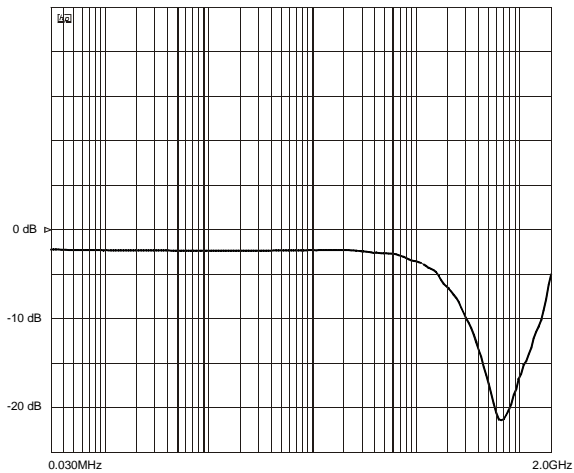
ESD Clamping (8kV Contact)



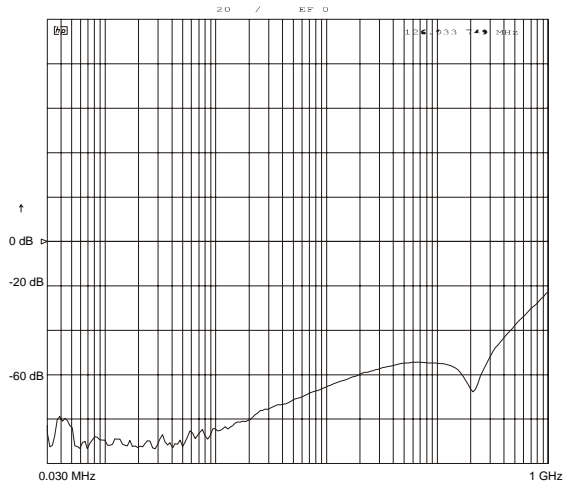
ESD Clamping (15kV Air)



Typical Insertion Loss



Analog Crosstalk (D+ to D-)



## PROTECTION PRODUCTS

### Applications Information

#### Device Connection

The STF201 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:

- USB data lines are routed through the STF201 for easy implementation and optimum pc board layout. Pin 1 is connected to the voltage supply line. The input of the D+ line is routed into pin 2 and out of pin 5. The input of the D- line is connected at pin 3 and the output at pin 4. Pin 6 is connected to ground. The ground connection should be made directly to the ground plane for best results. The path length is kept as short as possible to reduce the effects of parasitic inductance in the board traces.

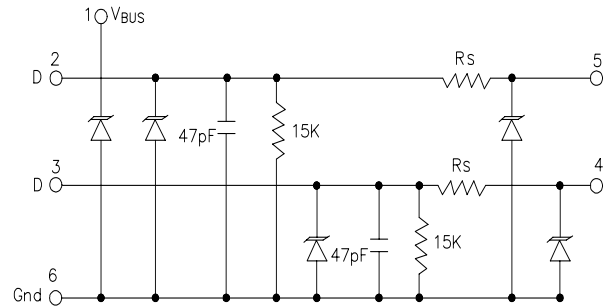
#### USB Port Design Considerations

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 STF201 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.

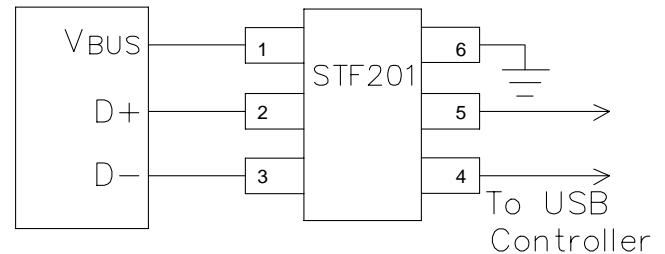
A simplified USB port is shown in Figure 3. USB line termination is achieved with series resistors on both the D+ and D- lines. These resistors preserve signal integrity by matching the cable impedance to that of the differential driver. 15kΩ pull-down resistors are used to identify a downstream port while an upstream port is identified with a 1.5KΩ 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.

Semtech provides a complete solution to simplify USB port design (Figure 4). The STF201 & STF202 inte-

**Figure 1 - STF201 Circuit Diagram**



**Figure 2 - STF201 Connection Diagram**



grate 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.

Board layout and placement of the STF201 play a critical role in EMI & ESD suppression. 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 physically near the USB connectors.
- Place the STF201 near the USB connector to restrict transient coupling.
- Minimize the path length between the USB connector and the STF201 as well as between the USB controller and the STF201.

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Applications Information

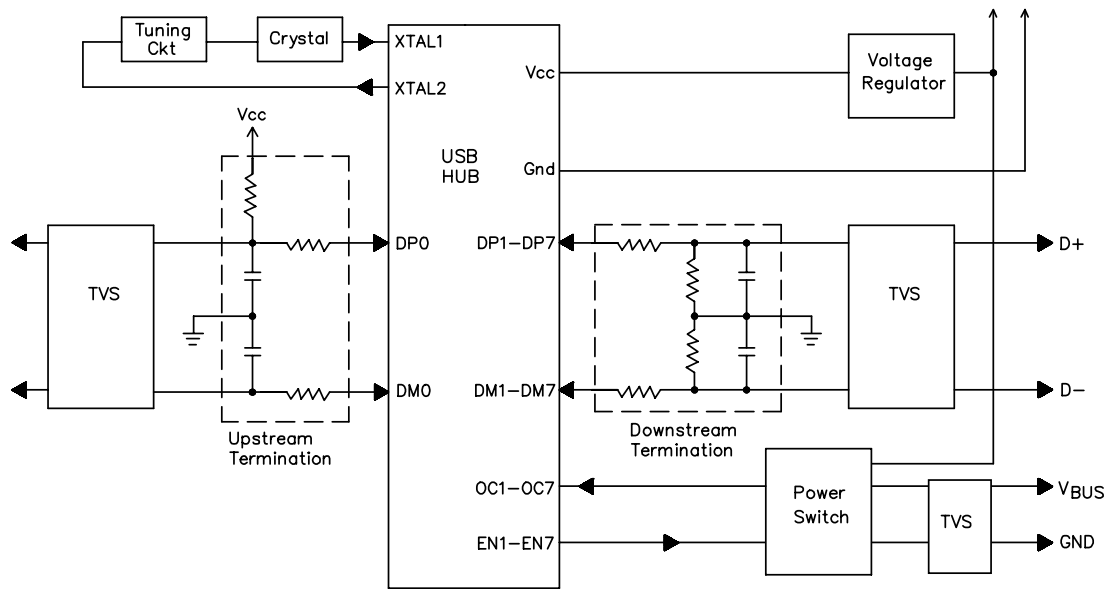


Figure 3 - USB Port Components

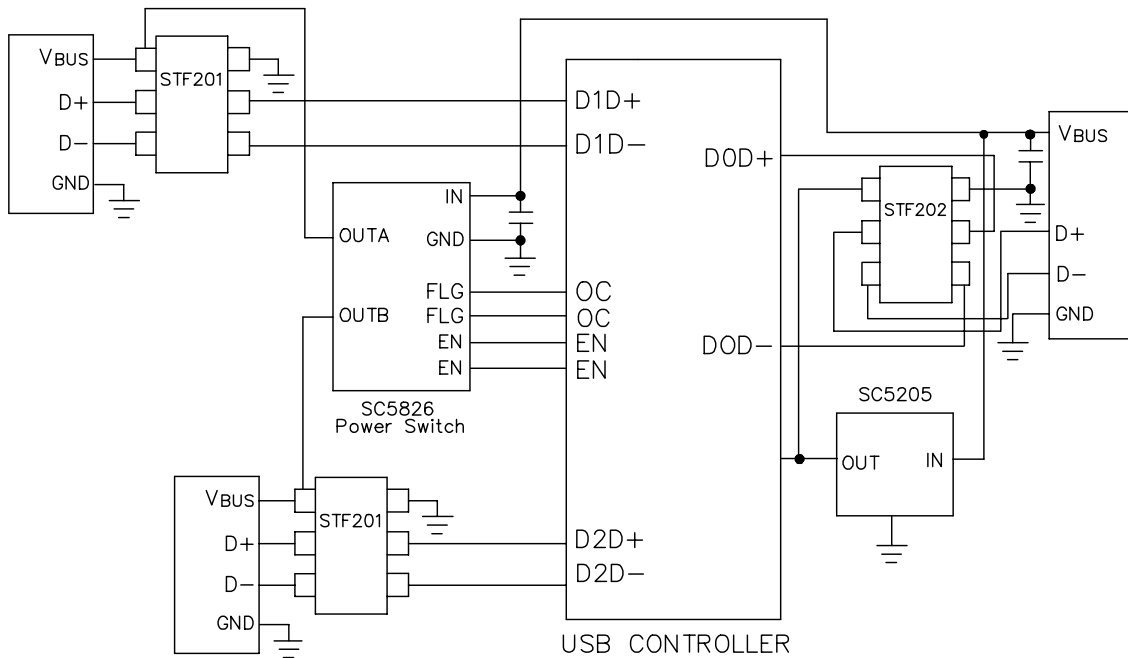
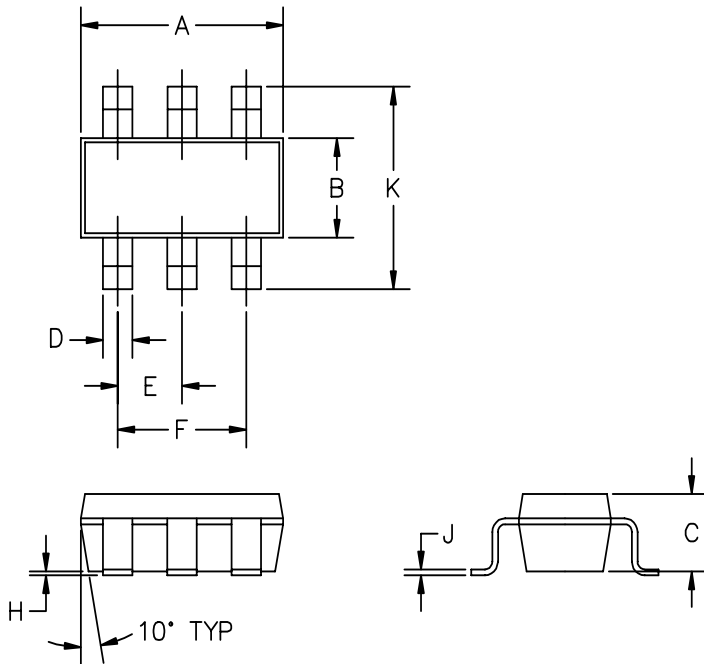


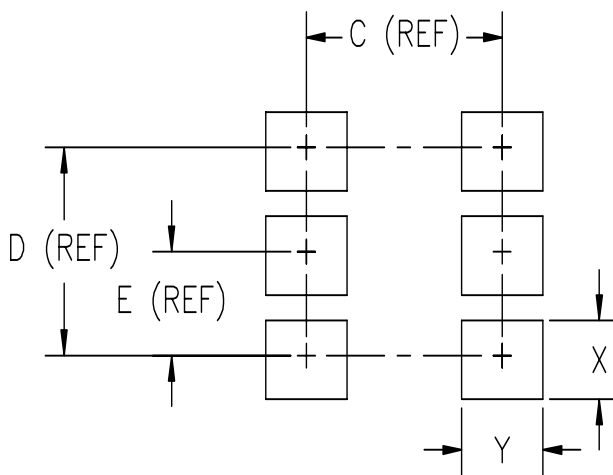
Figure 4 - Typical USB Hub Design

**PROTECTION PRODUCTS**
**Outline Drawing - SOT23-6L**


DIM <sup>N</sup>	DIMENSIONS <sup>①</sup>				NOTE
	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 <sup>N</sup>	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**

<b>Part Number</b>	<b>Marking Code</b>
STF201-22	122
STF201-30	130

**Ordering Information**

<b>Part Number</b>	<b>Series Resistor</b>	<b>Qty per Reel</b>	<b>Reel Size</b>
STF201-22.TC	22 $\Omega$	3,000	7 Inch
STF201-30.TC	30 $\Omega$	3,000	7 Inch

**Contact Information**

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