POLYTRONICS

PTTC. POLYTRONICS TECHNOLOGY CORP.

Transient Voltage Suppression Diode Devices

PolyTrans®

Transient Voltage Suppression Diodes

TVS Diode Selection Checklist

1. Define Circuit Operating Parameters

- Normal operating voltage type in DC or AC:
- Device Type Required: Uni-directional Bi-directional Normal operating voltage in volts:
- Maximum transient current (Ipp):
- Maximum clamping voltage (Vc):
- Required peak reverse surge power rating:
- Product mounting type (package):
- Operating temperature:

2. Narrow TVS Diode Series for the Application

Please refer to the product selection charts and datasheets within this guide, factoring these key parameters:

Reverse Standoff Voltage (V_R):

The device V_R should be equal to, or great than, the peak operating level of the circuit (or part of the circuit) to be protected. This is to ensure that TVS Diode does not clip the circuit drive voltage.

Peak Pulse Current (I_{PP}):

The Peak Pulse Current (I_{PP}) identifies the maximum current the TVS Diode can withstand without damage. The required I_{PP} can only be determined by dividing the peak transient voltage by the source impedance. Note that the TVS Diode failure mechanism is a short circuit; if the TVS Diode fails due to a transient, the circuit will still be protected.

Maximum Clamping Voltage (V_C):

This the peak voltage that will appear across the TVS Diode when subjected to the Peak Pulse Current (I_{PP}), based on 10/1000μs exponential waveform. The V_C of each TVS Diode is identified in each series data sheet electrical characteristics table.Maximum ratings and chracteristics Ratings at 25ć ambient temperature unless otherwise specified.

3. Verify Ambient Operating Parameters

Ensure that the application voltage is less than or equal to the device's standoff voltage, and that the operating temperature limits are within those specified by the device.

4. Verify Device Mounting Style and Dimensions

Please refer to the dimension drawings contained within the data sheet of each series.

5. Test the Selected Device in Actual Application

Please contact Polytronics if you would like assistance with testing and verifying suitability of a Polytronics device within your product. We have extensive produce testing lab capabilities and technical expertise to assist you.

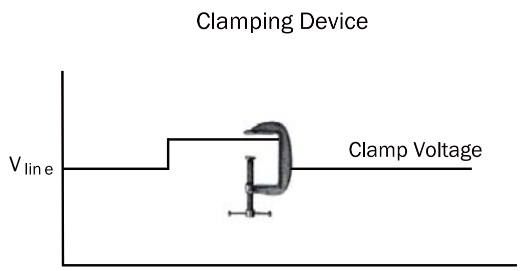
新竹市科學工業園區工業東四路 24-1 號 No. 24-1 Industry E. Rd. IV, Hsinchu Science Park, Hsinchu 300, Taiwan.
TEL: +886-3-5643931 FAX: +886-3-5644624 http://www.pttc.com.tw

Transient Voltage Suppression Diodes

TVS Diode Terms & Definitions

Clamping Device

TVS is a clamping device that limits voltage spikes by low impedance avalanche breakdown of a rugged silicon PN junction. It is used to protect sensitive components from electrical overstress generated by induced lightning, inductive load switching and electrostatic discharge.



Operating Temperature Range

The minimum and maximum ambient operating temperature of the circuit in which a device will be applied. Operating temperature does not allow for the effects of adjacent components, this is a parameter the designer must take into consideration.

Capacitance

The property of a circuit element that permits it to store an electrical charge. In circuit protection, the off-state capacitance is typically measured at 1 MHz.

Reverse Standoff Voltage (V_R)

In the case of a uni-directional TVS diode, this is the maximum peak voltage that may be applied in the 'blocking direction' with no significant current flow. In the case of a bi-directional transient, it applies in either direction. It is the same definition as Maximum Off-state Voltage and Maximum Working Voltage.

Breakdown Voltage (V_{BR})

Breakdown voltage measured at a specified DC test current, typically 1mA. Usually a minimum and maximum is specified.

Peak Pulse Current (I_{PP})

Maximum pulse current which can be applied repetitively. Usually a 10/1000μs double exponential waveform, but can also be 8/20μs, if stated.

Maximum Clamping Voltage (V_C or V_{Cl})

Maximum voltage which can be measured across the protector when subjected to the Maximum Peak Pulse Current.

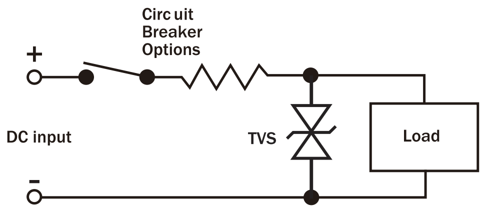
Peak Pulse Power (P_{PP})

Expressed in Watts or Kilowatts, for a 1ms exponential transfient fit fis I_{PP} multiplied by V_C.

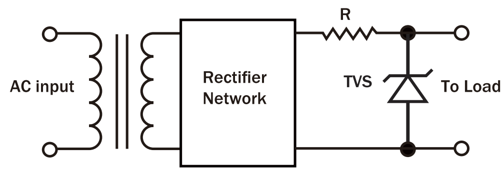
Transient Voltage Suppression Diodes

TVS Diode Device Typical Applications

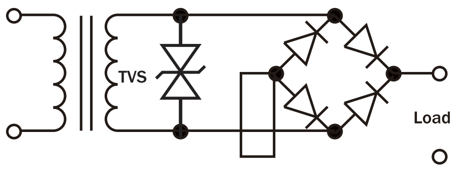
DC Supply Protection



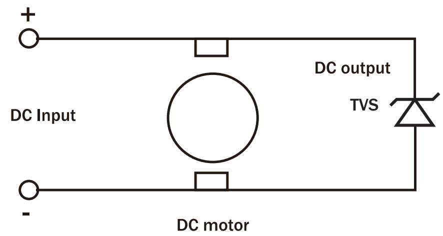
DC Load Protection



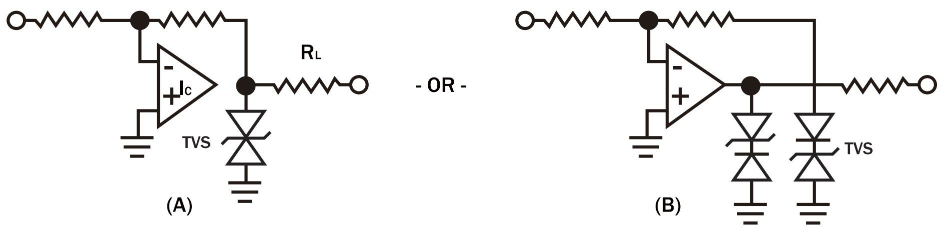
AC Supply Protection



Elector-Magnetic Interference Limiting

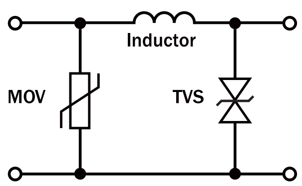


Operational Amplifier Protection



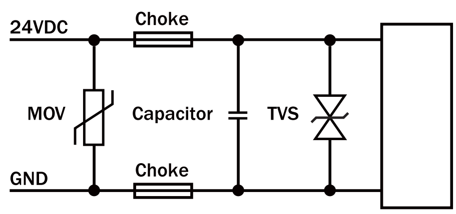
Combined MOV Varistor and TVS Diode Protection Scenarios

MOV + TVS Combination:



TVS Diode
Low Clamping
Voltage

MOV + Choke + TVS Combination:

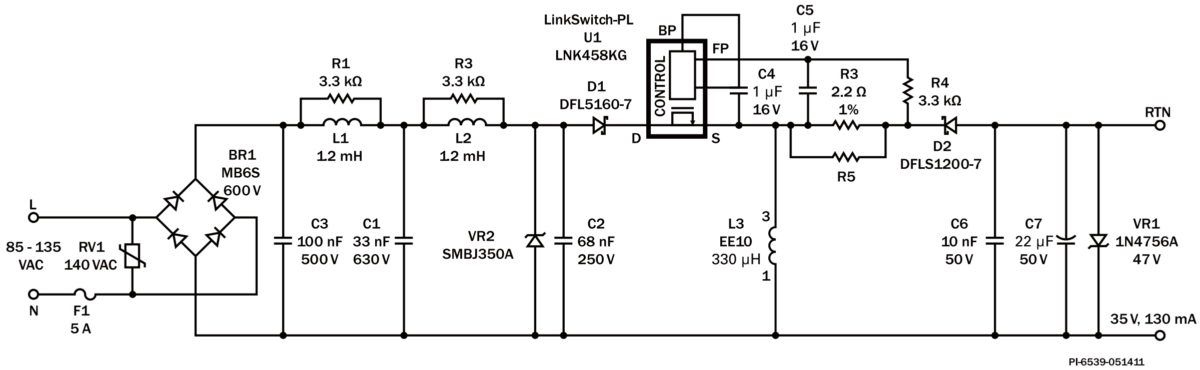


TVS Diode
SMBJ28A/SMBJ30A
SMCJ28A/SMCJ30A

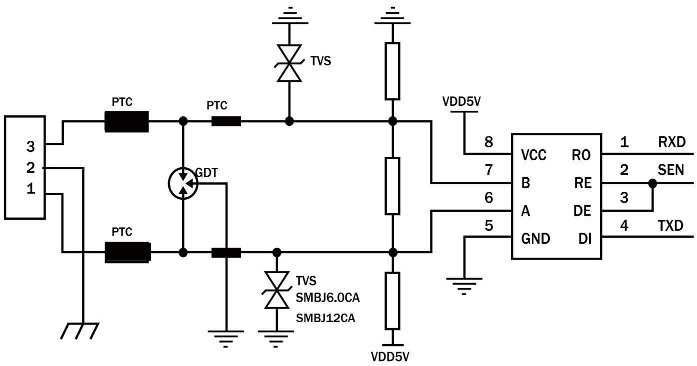
Transient Voltage Suppression Diodes

TVS Diode Device Typical Applications (continued)

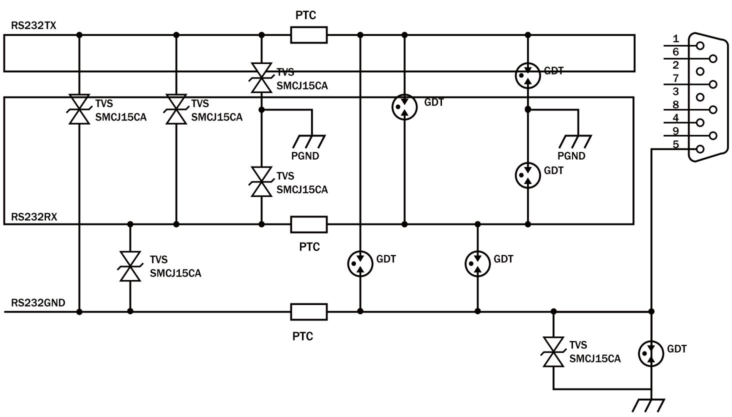
LED Driver Protection



RS485 Interface Protection



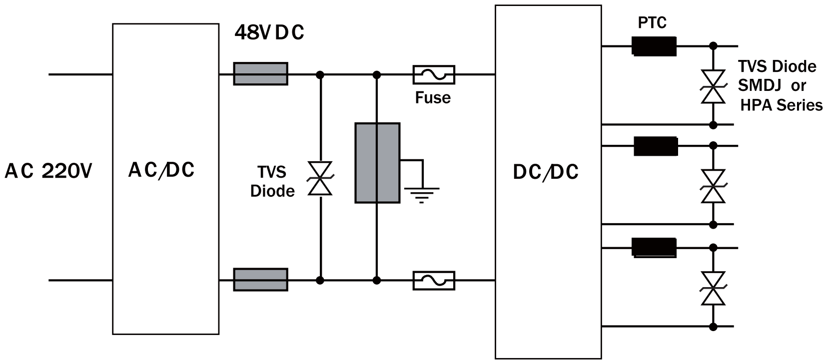
RS232 Interface Protection with High Surge Requirement



Transient Voltage Suppression Diodes

TVS Diode Device Typical Applications (continued)

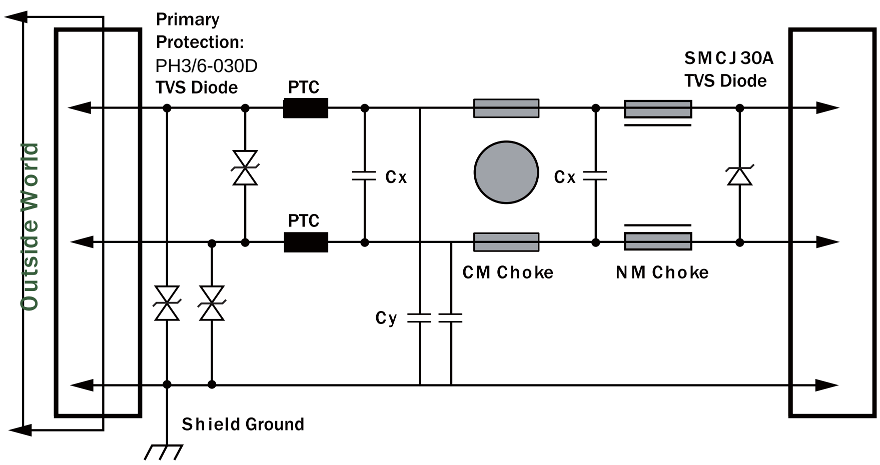
Telecom DC/DC Protection



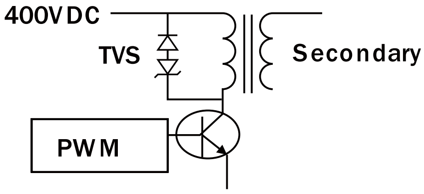
For 48vdc Lightning Protection:
TVS Diode : PH3-076D

For 5vdc Lightning Protection:
PTC : SMD0805/1206 Series
TVS : SMDJ Series

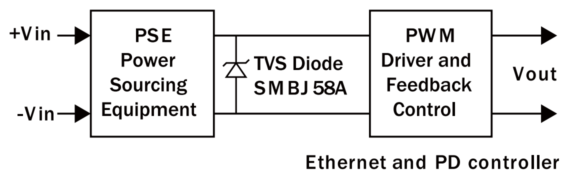
Circuit Protection of 24VDC with High Surge Capatbility



Pulse Width Modulated (PWM) Driver Protection



Power Over Ethernet (PoE) Protection



Transient Voltage Suppression Diodes

TVS Diode Transient Voltage Scenarios

Electrostatic discharge is characterized by very fast rise times and very high peak voltages and currents. This energy is the result of an imbalance of positive and negative charges between objects.
ESD that is generated by everyday activities can far surpass the vulnerability threshold of standard semiconductor technologies. Following are a few examples:

- **Walking across a carpet:**
  35kV @ RH = 20%;1.5kV @ RH = 65%
- **Walking across a vinyl floor:**
  12kV @ RH = 20%;250V @ RH = 65%
- **Worker at a bench:**
  6kV @ RH = 20%;100V @ RH = 65%
- **Vinyl envelopes:**
  7kV @ RH = 20%;600V @ RH = 65%
- **Poly bag picked up from desk:**
  20kV @ RH = 20%;1.2kV @ RH = 65%

Lightning Induced Transients

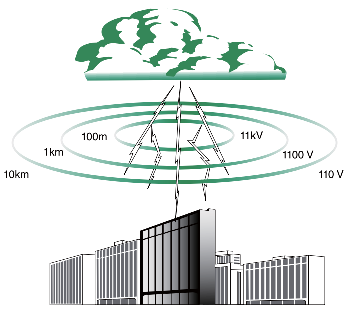
Even though a direct strike is clearly destructive, transients induced by lightning are not the result of a direct strike.

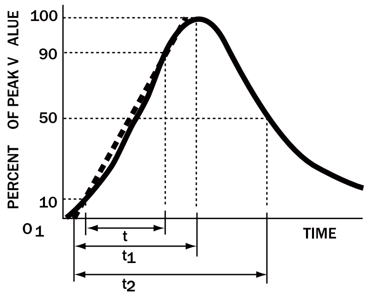
When a lightning strike occurs, the event creates a magnetic field which can induce transients of large magnitude in nearby electrical cables.

A cloud-to-cloud strike will effect not only overhead cables, but also buried cables. Even a strike 1 mile distant (1.6km) can generate 70 volts in electrical cables.

In a cloud-to-ground strike (as shown at right) the transientgenerating effect is far greater.

This diagram shows a typical current waveform for induced lightning disturbances.



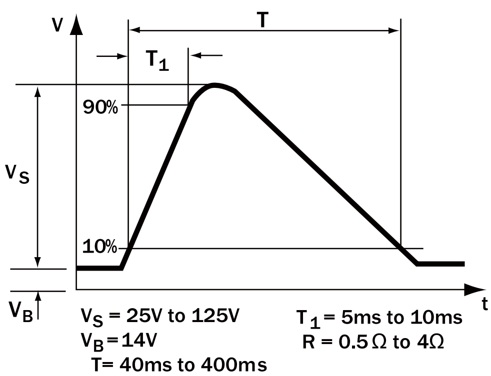


Inductive Load Switching

The switching of inductive loads generates high energy transients which increase in magnitude with increasingly heavy loads. When the inductive load is switched off, the collapsing magnetic field is converted into electrical energy which takes the form of a double exponential transient. Depending on the source, these transients can be as large as hundreds of volts and hundreds of Amps, with duration times of 400 milliseconds.
Typical sources of inductive transients include:

- **Generator** • **Motor** • **Relay** • **Transformer**

These examples are common in electrical and electronic systems. Because the sizes of the loads vary according to the application, the wave shape, duration, peak current and peak voltage are all variables which exist in real world transients. Once these variables can be approximated, a suitable suppressor technology can be selected.
The diagram at right shows a transient which is the result of stored energy within the alternator of an automobile charging system.



A similar transient can also be caused by other DC motors in a vehicle. For example, DC motors power amenities such as power locks, seats and windows. These various applications of a DC motor can produce transients that are just as harmful to the sensitive electronic components as transients created in the external environment.

新竹市科學工業園區工業東四路 24-1 號 No. 24-1 Industry E. Rd. IV, Hsinchu Science Park, Hsinchu 300, Taiwan.
TEL: +886-3-5643931 FAX: +886-3-5644624 http://www.pttc.com.tw

Transient Voltage Suppression Diodes

TVS Diode Overvoltage Suppression Facts

Voltage Transients are defined as short duration surges of electrical energy and are the result of the sudden release of energy previously stored or induced by other means, such as heavy inductive loads or lightning. In electrical or electronic circuits, this energy can be released in a predictable manner via controlled switching actions, or randomly induced into a circuit from external sources.

Repeatable transients are frequently caused by the operation of motors, generators, or the switching of reactive circuit components. Random transients, on the other hand, are often caused by Lightning and Electrostatic Discharge (ESD). Lightning and ESD generally occur unpredictably, and may require elaborate monitoring to be accurately measured, especially if induced at the circuit board level. Numerous electronics standards groups have analyzed transient voltage occurrences using accepted monitoring or testing methods. The key characteristics of several transients are shown in the table below.

	VOLTAGE	CURRENT	RISE-TIME	DURATION
Lightning	25kV	20kA	10 µs	1ms
Switching	600V	500A	50µs	500ms
EMP	1kV	10A	20ns	1ms
ESD	15kV	30A	<1ns	100ns

Table 1. Examples of transient sources and magnitude

Characteristics of Transient Voltage Spikes

Transient voltage spikes generally exhibit a “double exponential” wave, as shown below for lightning and ESD.

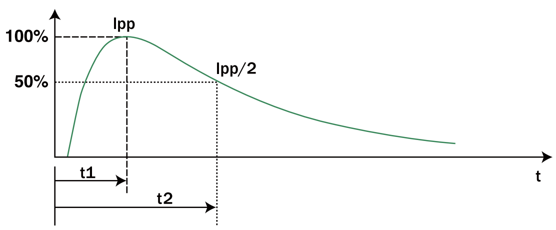


Figure 1. Lightning Transient Waveform

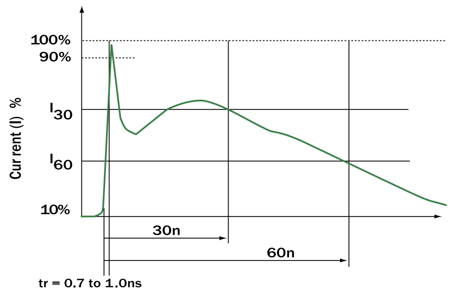


Figure 2. ESD Test Waveform

The exponential rise time of lightning is in the range 1.2µsec to 10µsec (essentially 10% to 90%) and the duration is in the range of 50µsec to 1000µsec (50% of peak values). ESD on the other hand, is a much shorter duration event. The rise time has been characterized at less than 1.0ns. The overall duration is approximately 100ns.

Why are Transients of Increasing Concern?

Component miniaturization has resulted in increased sensitivity to electrical stresses. Microprocessors for example, have structures and conductive paths which are unable to handle high currents from ESD transients. Such components operate at very low voltages, so voltage disturbances must be controlled to prevent device interruption and latent or catastrophic failures.

Sensitive microprocessors are prevelant today in a wide range of devices. Everything from home appliances, such as dishwashers, to industrial controls and even toys use microprocessors to improve functionality and efficiency.

Most vehicles now also employ multiple electronic systems to control the engine, climate, braking and, in some cases, steering, traction and safety systems.

Many of the sub- or supporting components (such as electric motors or accessories) within appliances and automobiles present transient threats to the entire system.

Careful circuit design should not only factor environmental scenarios but also the potential effects of these related components. Table 2 below shows the vulnerability of various component technologies.

Device Type	Vulnerability (volts)
VMOS	30-1800
MOSFET	100-200
GaAsFET	100-300
EPROM	100
JFET	140-7000
CMOS	250-3000
Schottky Diodes	300-2500
Bipolar Transistors	380-7000
SCR	680-1000

Table 2: Range of device vulnerability.

新竹市科學工業園區工業東四路 24-1 號 No. 24-1 Industry E. Rd. IV, Hsinchu Science Park, Hsinchu 300, Taiwan.
TEL: +886-3-5643931 FAX: +886-3-5644624 http://www.pttc.com.tw