

# Introduction to Transient Voltage Suppressors

By: Ivan G. Lawson

## SUPPRESSOR TYPES

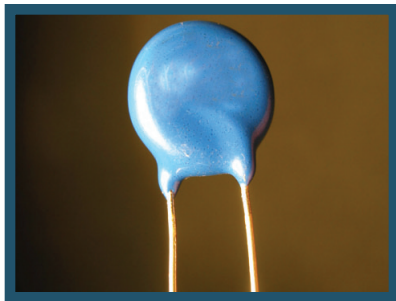
### Clamping Devices

Suppressors limit voltage spikes to tolerable levels by either clamping or crowbar action. A suppressor that clamps, begins conducting when its threshold voltage is exceeded, then restores to a non-conducting state when the voltage drops below the threshold. Voltage spikes are clipped off to safe level through clamping. Examples of clamping suppressors are Transient Voltage Suppressors and Metal Oxide Varistors

### Crowbar Devices

Crowbar devices conduct when threshold voltages are exceeded and then trigger to an on-state voltage drop for only a few volts, hence the name "crowbar". These devices restore to a non-conducting state when the driving voltage and/or current is reduced with the passing transient. Examples of crowbar devices are Gas Discharge Tubes (GDT) and Thyristors.

## SUPPRESSOR STRUCTURES



### Metal Oxide Varistors

MOVs are comprised of grains of zinc oxide in a matrix of bismuth and other metal oxides. Each grain boundary is the equivalent of a junction with a breakdown voltage of 2 to 3 Volts, with the net result equivalent to hundreds of diodes in series and parallel. By varying the grain size, thickness and area, MOV parameters such as current and

voltage rating can be controlled.

Package configurations for MOVs range from chip size to large module (multi-kilovolt) units. Metal Oxide Varistors are symmetrically bidirectional.

A Metal Oxide Varistor conducts high current surges for a limited number of events before "wearing out". For example, a 20mm disc can typically handle a single surge of 6500 Amps. However, reducing the surge capability to 900 Amps would yield a device that could handle up to 100 surges.

In addition, MOVs are limited by their steady state power - 1/4 Watt for a 20mm disc. Clamping factors (the ratio of clamping voltage to breakdown voltage) are about 4. Lastly, failure mode resistance levels range from 8 to 10 Ohms.

MOVs are typically used on power mains to protect downstream electronic equipment from direct and nearby secondary lightning strikes. These devices are also used in consumer appliances for solid-state control protection.

### Transient Voltage Suppressors

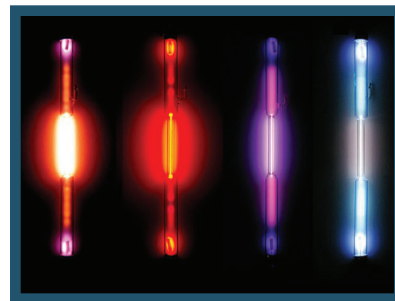
Silicon Avalanche Junction TVS devices contain a P/N junction similar to a Zener diode but with a larger cross section, which is proportional to its surge power rating. Longer duration pulses can be suppressed by increasing the die size and head dissipation. Both voltage and power capability can be increased by stacking parts in series or parallel.

Package configurations for silicon TVS devices range from chip size to large module units. Silicon TVS devices can be unidirectional or bidirectional for voltages with positive and negative pulses.

Silicon TVS devices have a sub-nanosecond response time as well as low clamping factors (~1.33). These devices do not wear out like MOVs and are available in a wide voltage range.

Although rated at lower surge current levels than a MOV, silicon TVS devices are more than adequate for use in protecting signal and low voltage DC bus lines. For example, a 12 Volt rated 600 Watt device has a 8/20 $\mu$ s surge capability of 140 Amps. Failure mechanism of a TVS device is a short circuit.

Silicon TVS diodes are used across data lines to protect telecommunication and microprocessor based monitoring systems. These devices are used in protecting portable electronics, electronic interface I/Os as well as DC power bus lines. Sub-nanosecond response times and low clamping voltages make these devices effective in protecting electronics from the effects of Electrostatic Discharge and other secondary transient sources.



### Gas Discharge Tubes

GDTs have two parallel electrodes in a low pressure inert gas cavity made of glass or ceramic. These devices are "DC" voltage rated at a rise time of 500 Volts per second. The spacing and size of electrodes determines the voltage and current ratings respectively. The smallest gas discharge tubes are the size of a neon lamp and rated at 1kA for 8/20 $\mu$ s and the largest, which are the size of a quart of milk are rated at 250kA for 8/20 $\mu$ s. The most common GDT is used for telecommunication applications and is approximately 3/8" dia. and 1/4" thick.

Gas Discharge Tubes are voltage triggered and fire at levels well above their DC rating. A 90 Volt DC rated communication protector will fire at ~ 500 Volts in 0.5 $\mu$ s, with a 1kV/ $\mu$ s rise-time. However, GDTs suffer from high leakage current with increased voltage firing.

These devices are largely used in the telecom sector for protecting subscriber stations and central office exchanges from primary lightning strikes.



### **Thyristors**

Thyristors are four-layer (unidirectional) or five-layer (bidirectional) silicon devices. They are small in size compared to their high surge current ratings. Operating voltages range from 20 Volts to 250 Volts with current ratings of 50 Amps to 200 Amps for a 10/1000 $\mu$ s waveform. Package configurations include axial lead, surface mount or cellular discs.



These devices are voltage triggered to the on-state, making the transition through a turn-on resistance slope, which can be either positive or negative depending upon chip design. On-state voltage drops across the device is only a few volts, allowing large surge current conduction by a relatively small chip. Thyristors typically fail when over-surfed.

Like GDTs, Thyristors are also used in the telecom sector for protecting subscriber stations and central office exchanges from primary lightning strikes. Thyristors are also used to protect driver controls for both inductive and resistive loads, fluorescent lighting ballasts and primary and secondary telecom lines.

## COMPANY INFORMATION

### COMPANY PROFILE

ProTek Devices, based in Tempe, Arizona USA, is a manufacturer of Transient Voltage Suppression (TVS) products designed specifically for the protection of electronic systems from the effects of lightning, Electrostatic Discharge (ESD), Nuclear Electromagnetic Pulse (NEMP), inductive switching and EMI/RFI. With over 25 years of engineering and manufacturing experience, ProTek designs TVS devices that provide application specific protection solutions for all electronic equipment/systems.

ProTek Devices Analog Products Division, also manufactures analog interface, control, RF and power management products.

### CONTACT US

#### Corporate Headquarters

2929 South Fair Lane  
Tempe, Arizona 85282  
USA

#### By Telephone

General: 602-431-8101  
Sales: 602-414-5109  
Customer Service: 602-414-5114

#### By Fax

General: 602-431-2288

#### By E-mail:

Sales: [sales@protekdevices.com](mailto:sales@protekdevices.com)  
Customer Service: [service@protekdevices.com](mailto:service@protekdevices.com)  
Technical Support: [support@protekdevices.com](mailto:support@protekdevices.com)

#### Web

[www.protekdevices.com](http://www.protekdevices.com)  
[www.protekanalog.com](http://www.protekanalog.com)

COPYRIGHT © ProTek Devices 2011 - This literature is subject to all applicable copyright laws and is not for resale in any manner.

SPECIFICATIONS: ProTek reserves the right to change the electrical and or mechanical characteristics described herein without notice.

DESIGN CHANGES: ProTek reserves the right to discontinue product lines without notice and that the final judgement concerning selection and specifications is the buyer's and that in furnishing engineering and technical assistance. ProTek assumes no responsibility with respect to the selection or specifications of such products. ProTek makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ProTek assume any liability arising out of the application or use of any product or circuit and specifically disclaims any and all liability without limitation special, consequential or incidental damages.

LIFE SUPPORT POLICY: ProTek Devices products are not authorized for use in life support systems without written consent from the factory.