

What is a Silicon Transient Voltage Suppressor and how does it work?

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Transient Voltage Suppressors (TVS's) are devices used to protect vulnerable circuits from electrical overstress such as that caused by electrostatic discharge, inductive load switching and induced lightning. Within the TVS, damaging voltage spikes are limited by clamping or avalanche action of a rugged silicon pn junction which reduces the amplitude of the transient to a nondestructive level.

In a circuit, the TVS should be "invisible" until a transient appears. Electrical parameters such as breakdown voltage (V_{BR}), standby (leakage) current (I_D), and capacitance should have no effect on normal circuit performance.

The TVS breakdown voltage is usually 10 % above the reverse standoff voltage (V_R), which approximates the circuit operating voltage to limit standby current and to allow for variations in V_{BR} caused by the temperature coefficient of the TVS. When a transient occurs, the TVS clamps instantly to limit the spike voltage to a safe level, called the clamping voltage (V_C), while conducting potentially damaging current away from the protected component.

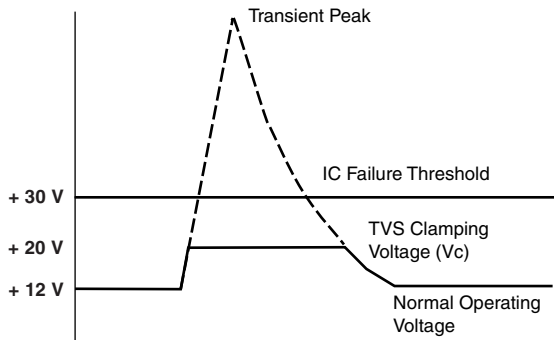


Figure 1. Transients of Several Thousand Volts can be "clamped" to a Safe Level by the TVS

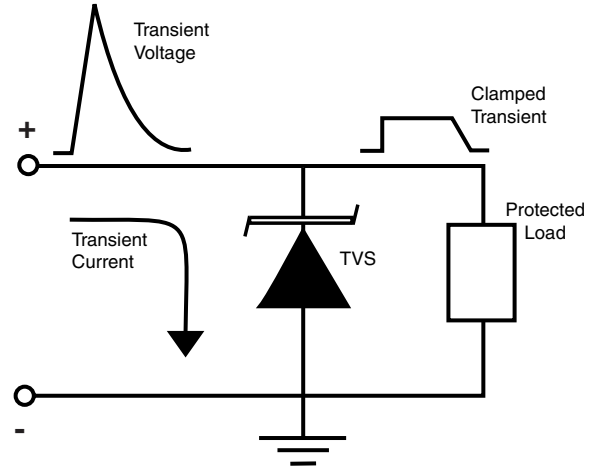


Figure 2. Transient Current is Diverted to Ground Through TVS; the Voltage Seen by the Protected Load is Limited to the Clamping Voltage Level of the TVS

TVS's are designed, specified and tested for transient voltage protection, while a Zener diode is designed and specified for voltage regulation. For transient protection, the designer's choice is a TVS.

The surge power and surge current capability of the TVS are proportional to its junction area. Surge ratings for silicon TVS families are normally specified in kilowatts of peak pulse power (P_{PP}) during a given waveform. Early devices were specified with a 10/1000 μs waveform (10 μs rise to peak and 1000 μs exponential decay to one half peak), while more recent product introductions are rated for an 8/20 μs test waveform. Power ratings range from 5 kW for 10/1000 μs , down to 400 W for 8/20 μs . This power is derived from the product of the peak voltage across the TVS and the peak current conducted through the device.

Packaging covers a broad spectrum according the need. Discrete axial leaded components are available in peak pulse power ratings of 400 W, 500 W, 600 W, 1.5 kW and 5 kW. The higher power devices are most frequently used across power buses.

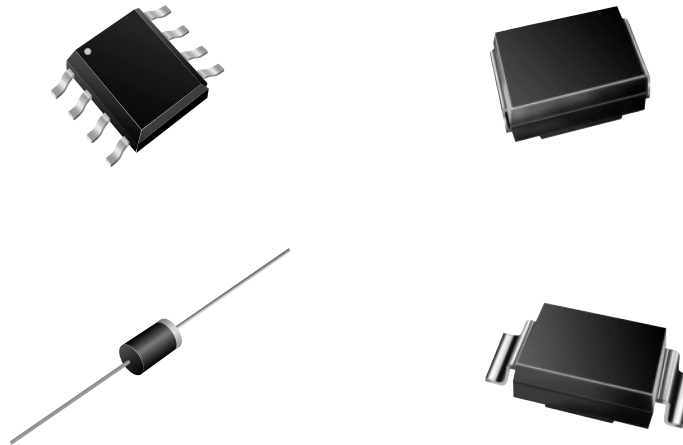


Figure 3. Transient Voltage Suppressors are Offered in Axial, Surface-Mount and Array Packages

For lower power, high density applications, suppressor arrays are available in both DIP and small outline surface mount configurations. Arrays are normally used across data lines for protecting I/O ports from static discharge. Specialized low capacitance TVSs are available for use in high data rate circuits to prevent signal attenuation.

TVSs have circuit operating voltages available in increments from 5 V up through 376 V for some types. Because of the broad range of voltages and power ratings available, (as well as the universal presence of transient voltages) TVSs are used in a remarkably wide variety of circuits and applications.

Integrated circuits normally feature on-chip protection which is usually provided by internal resistor-diode networks or SCR's. There is insufficient space on a microchip to provide more than minimal protection, so the higher power, external protection of a TVS should be added in those applications where damaging transient voltage threats exist.

The loss to U.S. industry due to transient voltages exceeds \$ 10 billion per year. TVS devices are an important part of the solution.

Vishay General Semiconductor has become the world's leading supplier of silicon TVS protection.