



Unidirectional / Bi-directional TVS Differences

Silicon transient voltage suppressor (TVS) data sheets normally depict the unidirectional types. These have either no suffix or an “A” suffix denoting a lower clamping voltage level. At the bottom of the data sheet or in the Features section is a notation to add a “C” or “CA” suffix to denote bi-directional. Device series specifically for bi-directional applications are so noted on the data sheet masthead.

Unidirectional TVSs fit the normal diode characteristic curve with “Avalanche Conduction” in the third quadrant as shown in Figure 1 for the normal operating polarity where the cathode is biased positively in the circuit shown. This characteristic clips short duration spikes in the avalanche direction as shown for the “TVS & Load.”

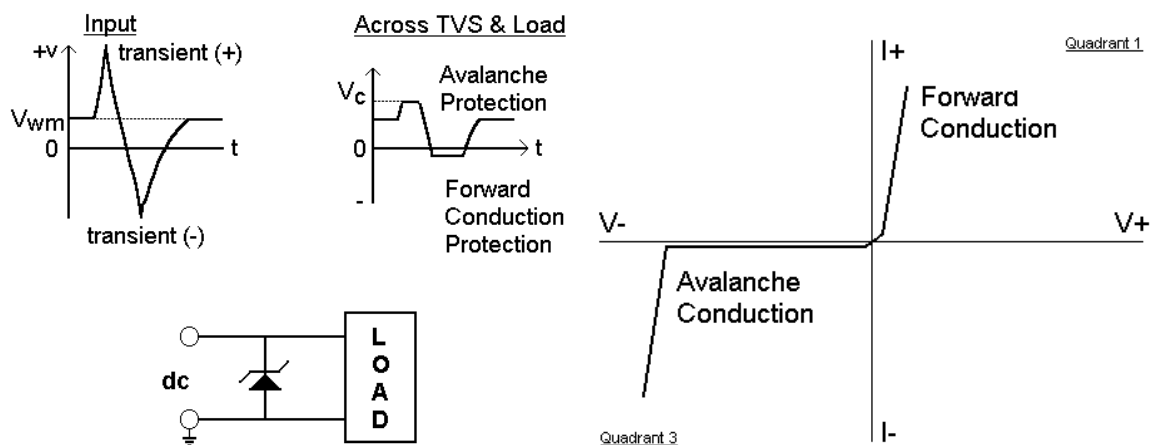


Figure 1. Unidirectional TVS

In the first quadrant of Figure 1 where the anode is biased positively relative to the cathode, is the diode forward-voltage characteristic for the low voltage “Forward Conduction” mode. Transients are also clipped in this direction as shown, but at a low level on the order of a volt or two. Higher power TVS devices including the 15KPxxx and 30KPxxx series use stacked die and have higher V_F values. Unidirectional devices are used across dc power and dc signal lines. In addition to their normal operating direction in the third quadrant, the low forward voltage in the first quadrant clamps negative spikes. For example, CMOS ICs *are very vulnerable* to transients in their forward direction, so the TVS clamping in the forward low voltage diode direction prevents failure. Many discrete components fail from voltage spikes in the forward conduction mode, hence the need for unidirectional protection. If either a unidirectional or bi-directional TVS device will work in a given circuit, a unidirectional TVS is usually selected for lower cost.



Bi-directional TVSs are bilaterally symmetrical as shown in Figure 2. They are intended for use on ac power lines and signal lines having both positive and negative excursions. If unidirectional TVS devices were used in ac applications, they would clip the ac voltage swing in the negative direction since they conduct at low voltage in the negative direction and would clip off one side. This problem would also occur with signal lines. For low current unidirectional applications in which polarity is of no importance, engineers occasionally specify bi-directional devices to ensure against wrong polarity TVS hookups for field installation.

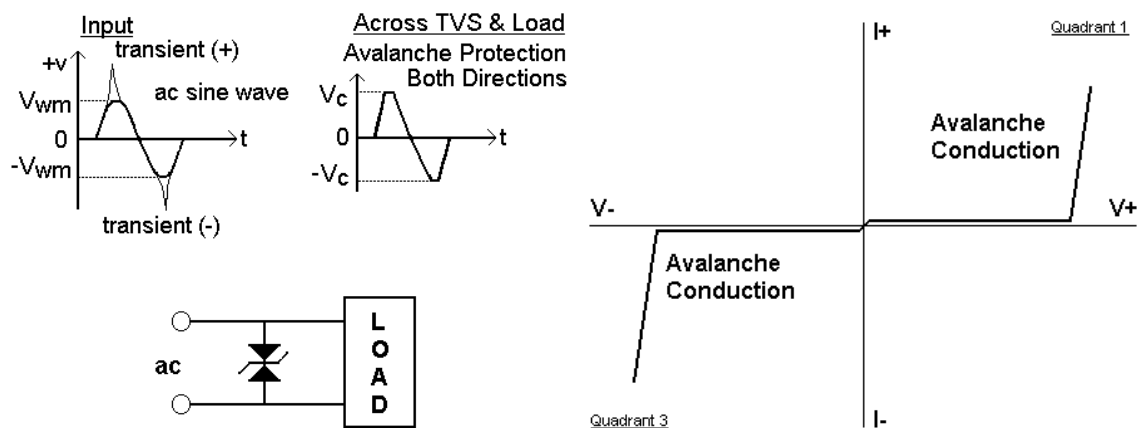


Figure 2. Bi-Directional TVS

Bi-directional devices are normally made with two junctions on the same chip, or with two chips back to back. With either of these designs, the capacitance at zero operating volts is typically one-half that of the unidirectional configuration of the same breakdown voltage selection. There is no polarity symbol or cathode band on bi-directional devices.

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