

MicroNote 128

1 Unidirectional/Bidirectional TVS Differences

By Mel Clark and Kent Walters

 Silicon transient voltage suppressor (TVS) datasheets 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 datasheet, or in the Features section, is a notation to add a "C" or "CA" suffix to denote bidirectional. Device series specifically for bi-directional applications are so noted on the datasheet masthead.

Unidirectional TVSs fit the normal diode characteristic curve with avalanche conduction in the third quadrant, as shown in [Figure 1 \(see page 1\)](#), 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.

Figure 1 • Figure 1: Unidirectional TVS

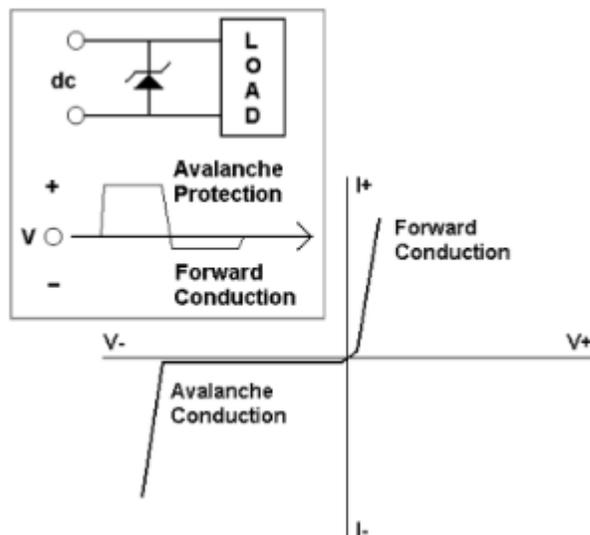
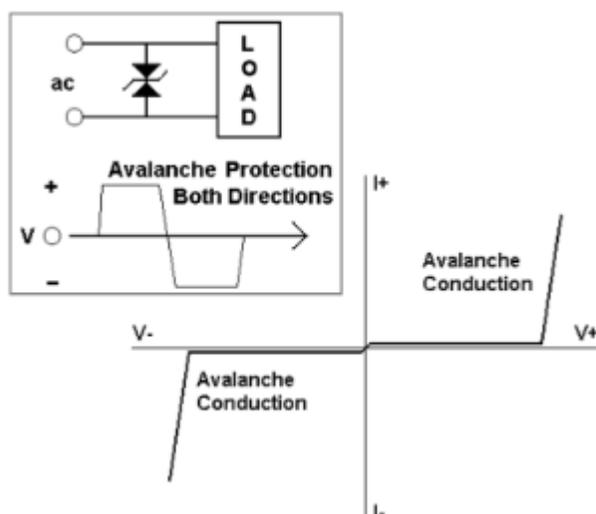


Figure 2 • Figure 2: Bidirectional TVS



Shown in the first quadrant of Figure 1 (see page 1), where the anode is biased positively relative to the cathode, is the diode forward-voltage characteristic for the low voltage conduction mode. Transients are clipped in this direction as well but at a low level on the order of a volt or two. Higher power devices including the 15KPxxx and 30KPxxx series use stacked die and have higher V_F values. Newer surface mount MPLADxxx devices with similar high power ratings and much larger p-n junctions only have one or two die in series, resulting in low V_F values. Unidirectional devices are used across dc power and dc signal lines. CMOS ICs are very vulnerable to transients in the forward direction, so the TVS low clamping in the forward 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 bidirectional TVS device will work in a given circuit, a unidirectional TVS is usually selected for lower cost.

Bidirectional TVSs are bilaterally symmetrical (see Figure 2 (see page 2)) and intended for use on ac power lines and signal lines having both positive and negative excursions. A unidirectional device would obviously fail in an ac circuit while conducting in the negative direction and also clip off one side of the data on a signal line. For low current unidirectional applications in which polarity is of no importance, engineers occasionally specify bidirectional devices as ensurance against wrong polarity TVS hookups for field installation. Bidirectional devices can be made with two p-n junction in the same chip or with two separate chips in series facing opposite directions in the same package. There is no polarity symbol or cathode band on bidirectional devices.

1.1 Support

For additional technical information, please contact Design Support at:

<http://www.microsemi.com/designsupport>

or

Kent Walters (kwalters@microsemi.com) at 480-302-1144 (see page 1)

**Microsemi Headquarters**

One Enterprise, Aliso Viejo,
CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Sales: +1 (949) 380-6136
Fax: +1 (949) 215-4996
Email: sales.support@microsemi.com
www.microsemi.com

© 2018 Microsemi. All rights reserved. Microsemi and the Microsemi logo are trademarks of Microsemi Corporation. All other trademarks and service marks are the property of their respective owners.

Microsemi makes no warranty, representation, or guarantee regarding the information contained herein or the suitability of its products and services for any particular purpose, nor does Microsemi assume any liability whatsoever arising out of the application or use of any product or circuit. The products sold hereunder and any other products sold by Microsemi have been subject to limited testing and should not be used in conjunction with mission-critical equipment or applications. Any performance specifications are believed to be reliable but are not verified, and Buyer must conduct and complete all performance and other testing of the products, alone and together with, or installed in, any end-products. Buyer shall not rely on any data and performance specifications or parameters provided by Microsemi. It is the Buyer's responsibility to independently determine suitability of any products and to test and verify the same. The information provided by Microsemi hereunder is provided "as is, where is" and with all faults, and the entire risk associated with such information is entirely with the Buyer. Microsemi does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other IP rights, whether with regard to such information itself or anything described by such information. Information provided in this document is proprietary to Microsemi, and Microsemi reserves the right to make any changes to the information in this document or to any products and services at any time without notice.

Microsemi, a wholly owned subsidiary of Microchip Technology Inc. (Nasdaq: MCHP), offers a comprehensive portfolio of semiconductor and system solutions for aerospace & defense, communications, data center and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions; setting the world's standard for time; voice processing devices; RF solutions; discrete components; enterprise storage and communication solutions; security technologies and scalable anti-tamper products; Ethernet solutions; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, California, and has approximately 4,800 employees globally. Learn more at www.microsemi.com.