

MicroNote 121

Protecting Data I/O Ports With TVSArrays

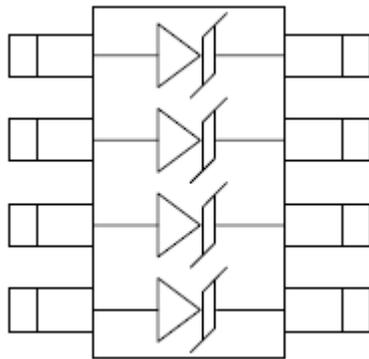
By Mel Clark and Kent Walters

Downsizing of packaging has mandated the consolidation of protective diodes into small transient voltage suppressor (TVS) arrays, which occupy a fraction of the board space of their discrete equivalents. To meet this demand, Microsemi now offers TVSarrays in the most frequently used operating voltages (V): 3, 5, 12, 15, and 24 in the tiny SOIC-8 package.

Microsemi's multi-diode TVSarrays protect from conditions described by IEC-1000-4-2 (including electrostatic discharge, or ESD) in IEC-1000-4-4 (including electrical fast transients, or EFT, and their induced lightning effects). More than ten separate series are now available to provide the design engineer with a broad range of choices for optimizing their circuit board layout.

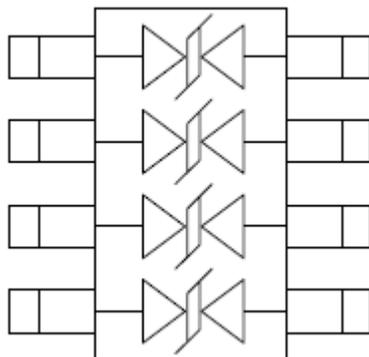
These include separate components in the SMDA (300 W) and SMDB (500 W) series for applications requiring circuit isolation. Four-line unidirectional protection is shown in the following illustration.

Figure 1: Unidirectional

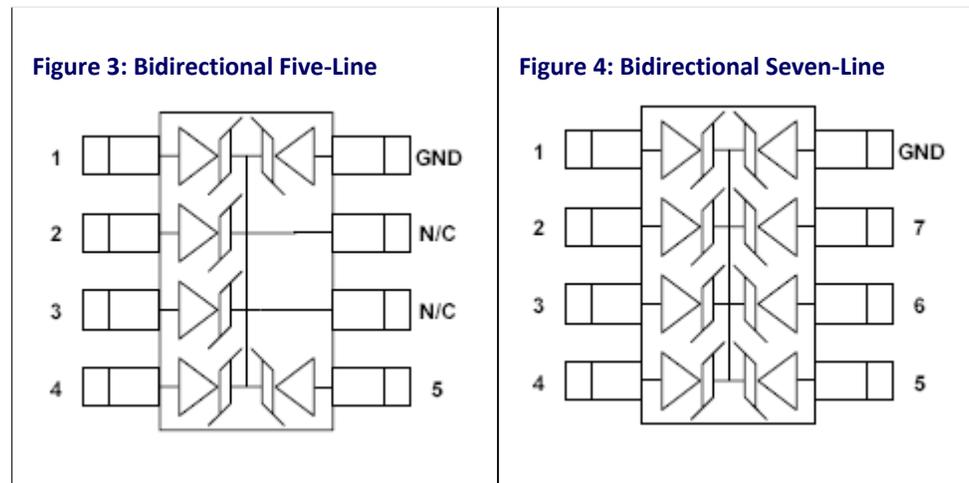


This configuration is for signal voltages biased in only one direction. For signals that swing in both the positive and negative directions, bidirectional protection is required as shown in the following illustration. Both 300 W and 500 W peak pulse power (8/20 μ s) ratings are offered in the SMDA and SMDB series, respectively.

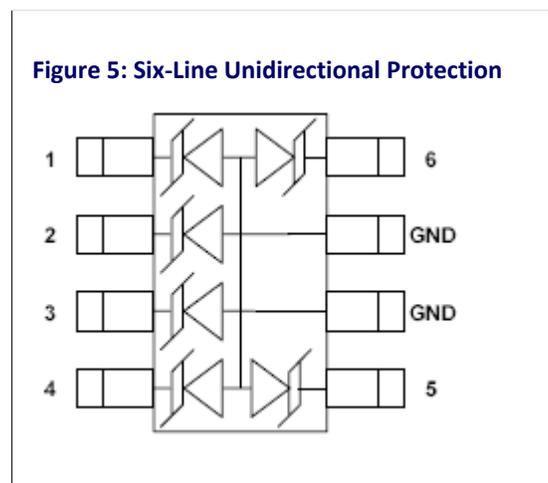
Figure 2: Bidirectional



Additional TVSarray configurations offered include bidirectional five-line and seven-line protection arrays as shown in [Figure 3 \(see page 2\)](#) and [Figure 4 \(see page 2\)](#). These are for protecting lines that have both a common ground reference as well as signals with both positive and negative excursions. Note that in each array, one diode (pin 8) provides the final ground path and bidirectional feature.

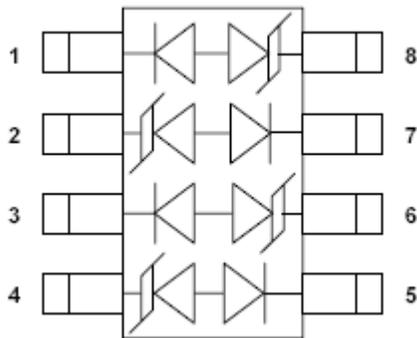


Six-line unidirectional protection is provided by the TVSarray illustrated in [Figure 5 \(see page 2\)](#). This device is intended for protection of unidirectional signal circuits sharing a common ground reference.



High data rate protection with minimal signal attenuation is provided by reducing the effective capacitance of the suppressor. This is achieved by adding a low capacitance rectifier chip in-series and in opposite polarity to the TVS chip as shown in [Figure 6 \(see page 3\)](#).

Figure 6: Low Capacitance Array - USB0805C



Microsemi's USB0805C was designed for ultra low capacitance data line transient suppression. The device was developed for the emerging universal serial bus (USB) technology, which is beginning to surface in desktop computers and peripherals. Microsemi's device offers half the capacitance of similar industry products and is typically less costly to implement.

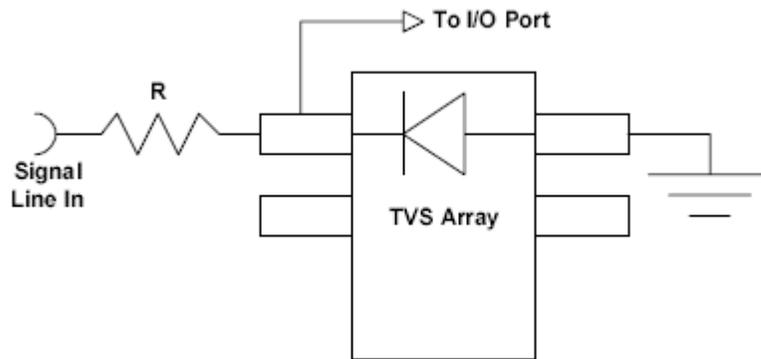
The rectifier in the USB series has ultra low capacitance to provide excellent performance at multi-megabit data rates of less than 2.5 pf per line (5 pf/line pair). The USB0805C (5 V) was designed specifically for universal serial bus protection (USB) while operating at 12 Mbps. From initial market tests and prototype evaluation at the system level, Microsemi's USB protector has proven capability. For additional information on this product, refer to MicroNote 117.

Each low capacitance TVSarray protects two wires, as illustrated in [Figure 6 \(see page 3\)](#). Pins 1 and 2 are connected together, as are pins 7 and 8. This provides bidirectional protection for one wire. Pins 3 and 4 are tied together, as are 5 and 6, to protect the second wire of the USB data line.

The major advantage of the USB0805C is its suppression method, where the voltage spike is conducted directly to common. Alternative methods that suppress by directing the transient to the voltage rails can induce spikes onto the power rails, and subsequently to other circuit components. For unidirectional protection, the TVSarray is reverse-biased on the signal line with its breakdown voltage at approximately 10% greater than its operating voltage. When a positive voltage spike exceeds the TVS breakdown voltage, it is limited to the clamping voltage. The excess energy is converted to heat in the TVS chip, which is subsequently dissipated through the mounting leads. Negative transients are clipped by the diode in the forward conductive mode.

Bidirectional TVSarrays are available for signals that swing both positive and negative. All electrical specifications are symmetrically bilateral for each line; they are identical in both positive and negative output directions. Placement of a TVSarray should be immediately adjacent to the input line to minimize radiation into the protected circuit. If compatible with the circuit impedance, series resistors can be added at the signal line inputs to reduce current levels of the incoming transient voltage spikes, as shown in [Figure 7 \(see page 4\)](#).

Figure 7: Input Protection Enhancement



Input protection enhancement TVSarrays are intended to provide protection across data lines in EIA standards RS-232, RS-422, and RS-423 systems. The low capacitance TVSarray is designed for RS-485 (for 25 pf) with the ultra low capacitance TVSarray (2.5 pf) for use on multi-megabit data lines for USB, video, Fire Wire, and other high-speed data lines.

Support

For additional technical information, please contact Design Support at:

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