Transient Suppressors, a Competitive Look

By Jon Schleisner

Several different technologies share the transient suppressor marketplace. The energy capacity of these devices ranges from 0.1 J on up. Much of the new design work utilizing TVS components centers around data line protection on LAN systems and other industrial computer networks. Most of the systems are protected against lightning strikes and similarly large magnitude transient events entering the system via the power mains. This power input protection does nothing to protect the small geometry die within transceiver chips that transmit data from one terminal sight to another.

Typically, data lines are exposed to two specific surge events. Electrostatic discharge, and "ground bounce" dominate the field when it comes to stressing data ports electrically. Enter the two primary technologies vying for approval in this high volume design socket.

Zinc oxide varistors are manufactured by SMX chip capacitors vendors. The small physical dimensions of chip capacitors are ideally suited for low power ZnO style transient suppressor devices. The typical "zinc oxide (ZnO) based ceramic semiconductor device" uses an interleaved plate design made up of individual TVS cells in parallel to minimize inductance and enhance turn-on characteristics. This is a refined version of what is called a MOV (metal oxide varistor). MOV's have been produced in many shapes and sizes for at least the last thirty years. This recent adaptation of the technology is an excellent one.

The other technology of interest is the General Semiconductor "TVS" (Transient Voltage Suppressor). This component is constructed using an avalanche diode as the energy absorbing element. This approach to transient suppression is not a new one. Zener diodes have been used in this application for almost as long as MOV style protectors. The difference between the TVS manufactured by General Semiconductor (and others) and Zener diodes is construction. A Zener diode is primarily designed to handle steady state power. The Zener functions as a voltage regulator (shunt style) or voltage reference in a power supply system. While electrically similar, the TVS unit has a different construction and is designed to absorb large amounts of energy (joules) in a very short period of time (milliseconds).

MOV technology exhibits an inherent wear out mechanism within the structure. As the device absorbs transient energy (surges) the electrical characteristics tend to drift. IR (Leakage) and BVR (Breakdown voltage) can move away from their original specifications. The ZnO surface mount TVS performance is excellent in this respect. The other negative that the ZnO technology brings is an inferior clamping ratio, at least when compared to silicon avalanche technology.

The clamping ratio is a qualitative measure of a transient suppressor's performance. The clamping ratio is described mathematically in Figure 1. The best performance attainable is a clamping ratio of unity (1) which implies a transient suppressor with an "on" impedance of zero. In the real world this is impossible. All transient suppressors, regardless of technology, have some finite impedance.

Clamping Ratio at 20 A

$$\textbf{Clamping Ratio} = \frac{V_C \text{ at 20 A}}{B_{VR} \text{ at 1 mA}}$$

$$\textbf{Perfect Device} = \frac{V_C}{B_{VR}} = 1.0$$

A Clamping Ratio of 1 Implies Zero Impedance

Fig. 1

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In Figure 2 the clamping ratio for 5 and 15 V protection components can be seen. The difference in clamping performance is obvious. The silicon based SMAJ05C and SMAJ15C exhibit clamping ratios in the range of 1.25 to 1.33. The ZnO technology shows clamping ratios approaching 2.0. From the standpoint of protecting the system behind the suppressor, the semiconductor (silicon avalanche) technology does a superior job.

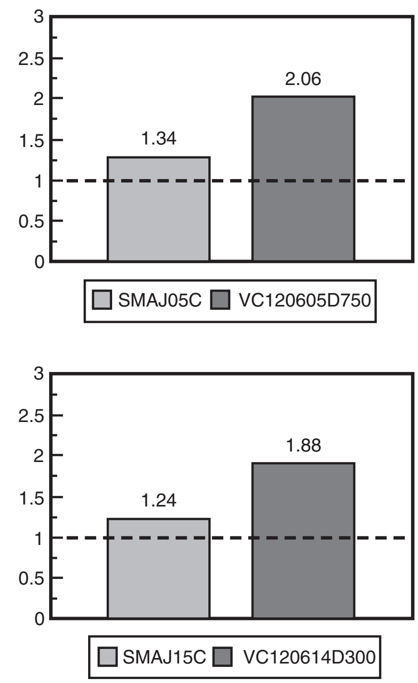

Fig. 2

Figures 3 and 4 show the actual clamping performance of the different devices under similar conditions.

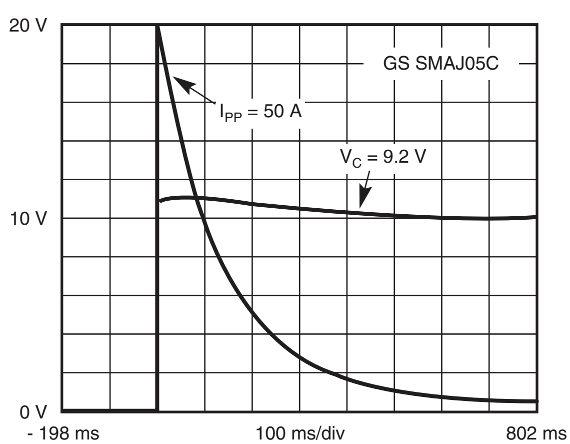

Fig. 3

To complete the picture it must be mentioned that the ZnO technology will handle more energy per unit area. This enables ZnO manufacturers to produce transient suppressors in the familiar SMX capacitor packages. The small size and high power per unit area of the ZnO technology are definite pluses. The poor clamping performance is not an asset. Table 1 shows the upside of each transient suppressor approach.

TABLE 1 - CONCLUSIONS: ZnO SUPPRESSOR vs. TVS
ZnO SUPPRESSOR:
Handles more total power/energy
Smaller footprint
Very fast response for MOV type design
Negligible wearout within SOA
TVS:
Exhibits much better clamping ratio
Better quality protection
Faster turn-on response: 1 to 5 ns
No inherent wearout mechanism within SOA

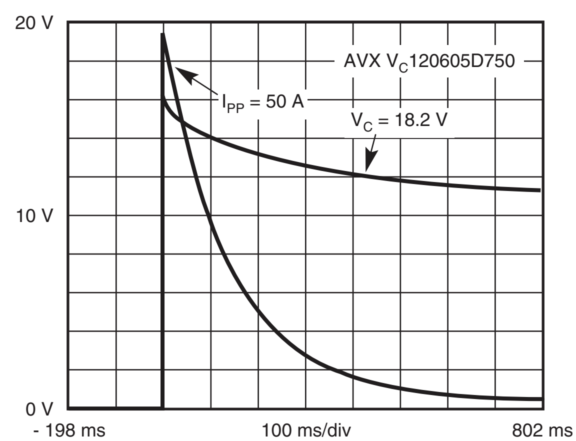

Fig. 4