TDK
COMPONENTS
The Customer Magazine

Products & Technologies

Multilayer varistors for mobile devices

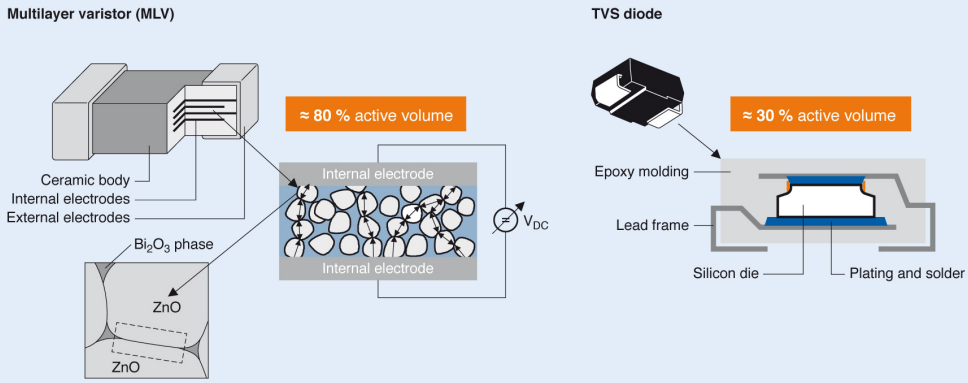
November 2012

Miniature shield against overvoltages

EPCOS multilayer varistors are the first choice for overvoltage protection in circuits. With their smaller dimensions, excellent thermal behavior, lower clamping voltages and lower costs, they are superior to semiconductor-based solutions.

The electronic circuits of mobile applications, consumer electronics devices and industrial equipment as well as automotive electronics react sensitively to overvoltages and electrostatic discharges (ESD). Depending on the strength of the voltage transients, the result can be latent disturbances or even complete failure. Protection components based on semiconductors are often used to safeguard circuits from these hazards – predominantly transient voltage suppressor (TVS) diodes. The latest circuit trends, such as in smartphones with ever faster data rates in a restricted space, require innovative semiconductor chipsets that nevertheless react with extreme sensitivity to ESD overvoltages. Thanks to material, process and design innovations, TDK can for the first time offer attractive alternatives in the sector of smartphone applications, namely EPCOS multilayer varistors (MLVs) with more compact dimensions, ultra-low clamping voltages and very low capacitances. Comparisons of TVS diode and MLV protection technologies have thus far been restricted to clamping voltages and leakage currents. However, the dimensions are another key aspect in the selection of these components in view of their increasing integration density in mobile applications. And the MLVs, which can be as thin as 300 µm, have a much higher energy absorption capability per volume than comparable TVS diodes (Figure 1). EPCOS MLVs consequently offer designers a space-saving and attractively priced alternative.

Figure 1: Design comparison of EPCOS multilayer varistors and TVS diodes

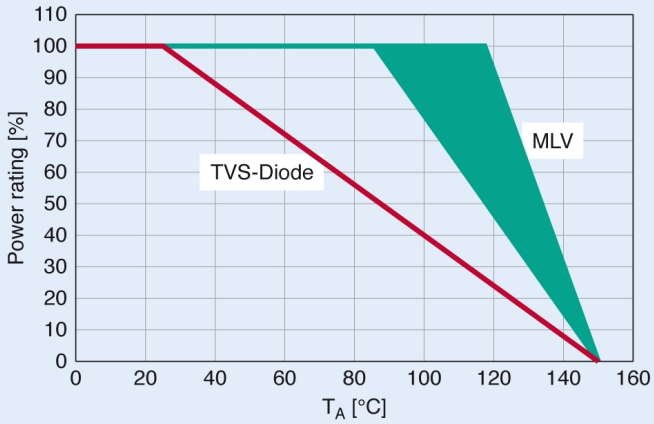


In EPCOS MLVs, the energy is absorbed in about 80 percent of the component volume, whereas this figure is only 30 percent in TVS diodes. This leads to a significantly lower space requirement for identical performance.

EPCOS MLVs also possess significant advantages with respect to temperature derating. The derating temperature of the components is 85 °C. Special types even achieve values of 150 °C. This is a critical factor, especially for the development of smartphones, as temperatures of up to 85 °C can occur within these devices due to the dissipation loss of the power amplifier. In TVS diodes, derating already starts at 25 °C, and at 85 °C their absorption power drops

to only 50 percent of its original value (Figure 2). Accordingly, MLVs are the unequivocally superior solution when it comes to controlling high operating temperatures. This behavior has been confirmed by measurements and simulations as well as by smartphone manufacturers.

Figure 2: Derating comparison of EPCOS MLVs and TVS diodes



EPCOS MLVs still offer reliable ESD protection even at temperatures significantly above 25 °C. For TVS diodes in contrast, derating already starts at 25 °C, leading to significant performance losses at higher temperatures.

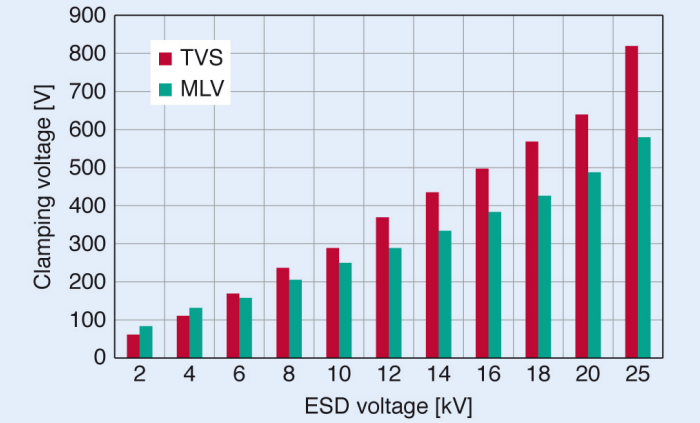
Highly integrated MLV components offer a significantly better insertion loss than TVS diodes in the same performance class, as their parasitic inductances are much lower. This is because TVS solutions require an additional housing with terminals and costly internal bond wires. The lower inductive coefficients of the MLVs of only 0.1 nH, for example, in the new 0201 series (Figure 3) also have a positive effect on the clamping voltage level. MLV solutions offer especially good performance with a rising ESD pulse voltage, where the clamping voltage is between 10 and 30 percent lower than in TVS diodes (Figure 4). MLVs are also significantly faster: They attain ultra-short response times in the nanosecond range and are some 30 percent faster than TVS diodes.

Figure 3: EPCOS multilayer varistors

Key data of the new 0201 series

Dimensions [mm]	0.6 × 0.3
Varistor voltages [V DC]	13 to 22
Capacitance [pF]	7 to 15
Leakage current [µA]	0.1
Clamping voltage (1A) [V]	33 to 66
Peak voltage (8 kV contact) [V]	60 to 80

Figure 4: Clamping voltages as a function of the ESD pulse voltage

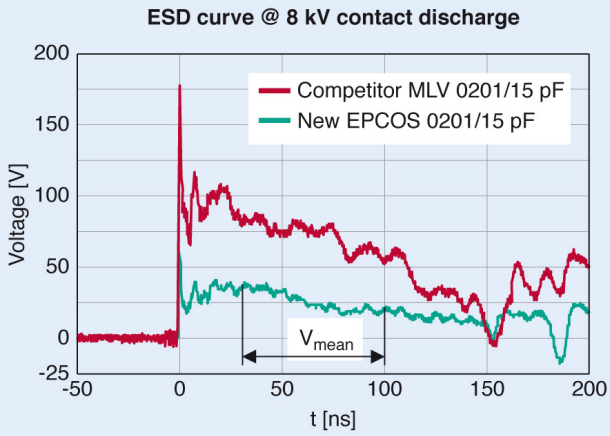


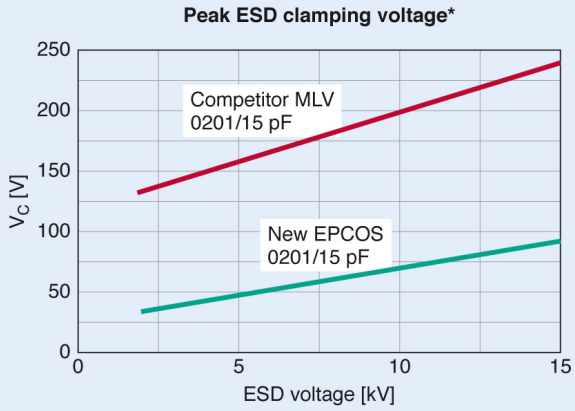
MLV-based solutions offer significantly lower clamping voltages than TVS diodes, especially at high ESD pulse voltages.

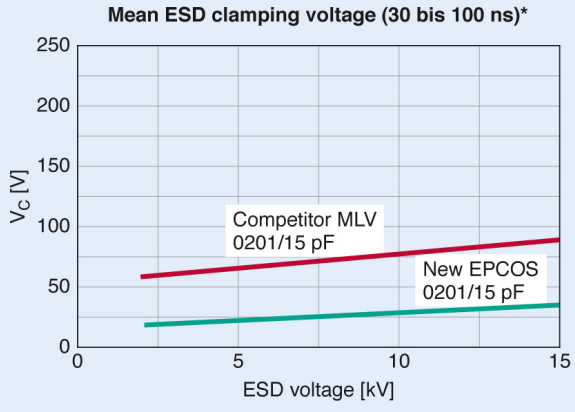
Circuit design co-determines performance

Because an electrostatic discharge is a highly dynamic process in the nanosecond range, the behavior of the protection component should not be considered in isolation. Instead, its interaction with the peripherals and the entire system must be taken into account. Other discrete components and connectors must be considered in addition to the board layout. Figure 5 shows the measured results of EPCOS MLVs used in a smartphone circuit compared with a competitor product. It is clear that there are significant differences in performance in a specific circuit even with identical designs and electrical values. The MLVs thus displayed impressively superior ESD protection in the most diverse smartphone generations from various manufacturers at sensitive input interfaces such as the headphones or the on/off switch. The voltage peak and clamping voltage of the new EPCOS MLV show significantly better values than a competitor product in a specific circuit.

Figure 5: Comparison of EPCOS MLVs with a competitor product







* Acc. to IEC 61000-4-2 contact

The voltage peak and clamping voltage of the new EPCOS MLV show significantly better values than a competitor product.