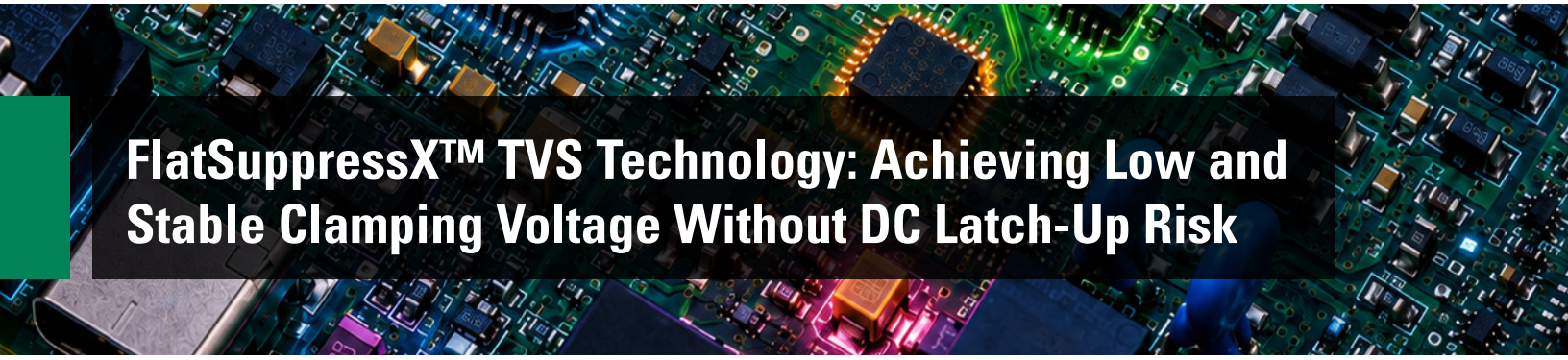


FlatSuppressX™ TVS Technology: Achieving Low and Stable Clamping Voltage Without DC Latch-Up Risk

Overview

As system operating voltages continue to increase, transient protection devices must provide lower clamping voltage to prevent overstress of sensitive electronic components. Conventional avalanche TVS diodes can effectively suppress surge events; however, their clamping voltage increases with surge current, reducing protection margin during high-energy transients.

FlatSuppressX™ TVS diodes utilize a proprietary transient suppression architecture that combines snapback operation with controlled conduction behavior.

After triggering, the device transitions into a stable low-impedance state and maintains a near-constant clamping voltage over a broad surge current range. This controlled operating mode enables significantly lower clamping voltage and reduced transient stress compared to conventional avalanche TVS technologies.

Unlike conventional avalanche TVS protection devices, FlatSuppressX™ TVS offers a combination of low clamping voltage, stable transient response, and latch-up-free operation, which improves system robustness and enables the use of lower voltage-rated components in demanding electrical environments.

Characteristics

FlatSuppressX™ TVS employs a proprietary snapback architecture. Unlike conventional avalanche TVS devices, whose clamping voltage increases significantly with surge current, FlatSuppressX™ TVS diodes maintain a stable, near-flat clamping characteristic over a wide current range. This behavior minimizes voltage overshoot and reduces transient stress on protected circuits.

The architecture is specifically designed to achieve low clamping performance without DC latch-up risk.

Figure 1. FlatSuppressX™ TVS Diode Transient Clamping Waveform

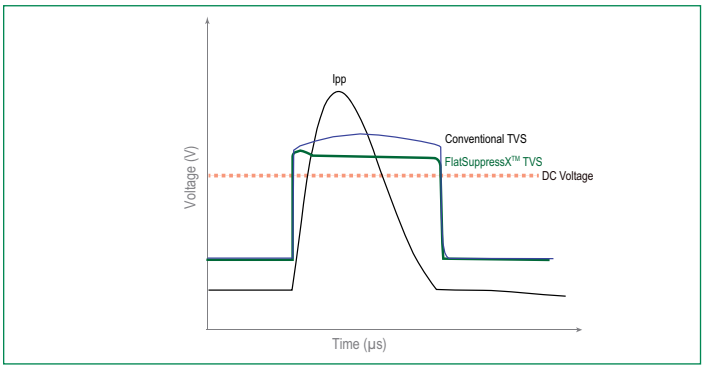
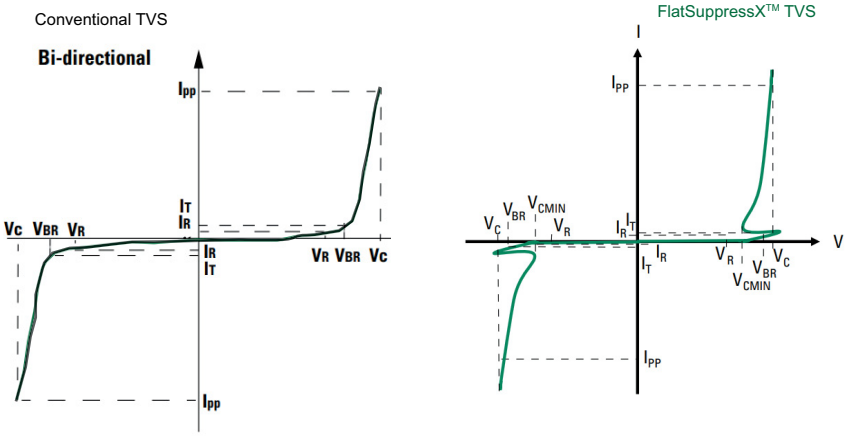


Figure 2. IV Curve of Conventional TVS and FlatSuppressX™ TVS Diode



- P_{PPM} Peak Pulse Power Dissipation (I_{PP} x V_C): Max power dissipation
- V_R Stand-off Voltage: Maximum voltage that can be applied to the TVS without operation
- V_{BR} Breakdown Voltage: Maximum voltage that flows though the TVS at a specified test current (I_T)
- V_C Clamping Voltage: Peak voltage measured across the TVS at a specified I_{PPM} (peak impulse current)
- I_R Reverse Leakage Current: Current measured at V_R
- V_{CMIN}: Snap Voltage for Bi-directional

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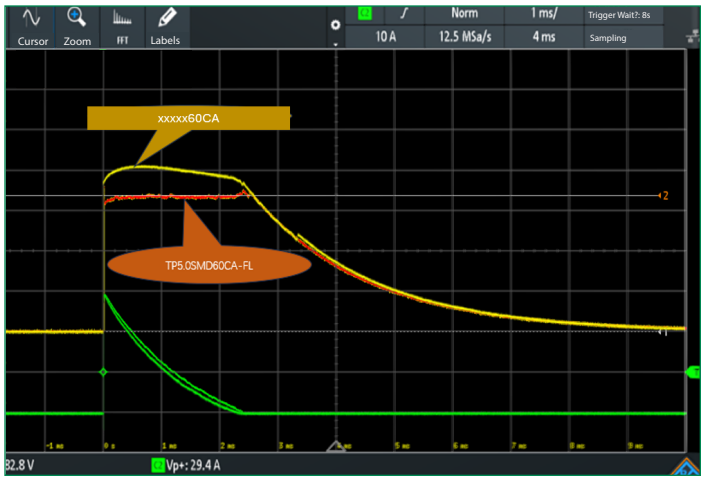
Low-Clamping Performance

FlatSuppressX™ TVS achieves substantially lower clamping voltage than conventional avalanche TVS devices by operating in a controlled snapback conduction mode.

Figure 3 compares the transient performance of the TP5.0SMD60CA-FL FlatSuppressX™ TVS and a conventional 5 kW automotive TVS under equivalent surge conditions. The TP5.0SMD60CA-FL maintains a significantly lower clamping voltage throughout the surge event, reducing voltage stress on downstream circuitry and increasing system protection margin.

The stable low-clamping characteristic also enables greater surge current capability within the same package footprint compared with conventional TVS technologies.

Figure 3. Clamping Performance Comparison



System-Level Benefits

The lower clamping voltage provided by FlatSuppressX™ TVS reduces transient overstress on sensitive electronic components and improves overall system reliability.

By limiting transient voltage exposure, FlatSuppressX™ TVS enables the use of lower voltage-rated components, including capacitors, power MOSFETs, reverse-polarity protection devices, load-switch ICs, voltage regulators, and PMICs. This capability supports improved power density, optimized component utilization, and reduced system cost.

Conclusion

FlatSuppressX™ TVS diodes combine a proprietary snapback architecture to achieve a stable, near-flat clamping characteristic. Compared with conventional avalanche TVS devices, it delivers significantly lower clamping voltage, greater protection margin, and higher surge current capability. It provides a robust protection solution for automotive, industrial, and other high-reliability electronic systems.

Table 1. Current FlatSuppressX™ TVS Series Overview

	TP1KSMB-FL	TP5.0SMD-FL	TPSMD-FL	AK-FL
APPLICATION	48 V, ISO 21780	48 V, ISO 21780	12 V, ISO 16750-2 test b load dump	Aviation & eVTOL 270 - 800 V DC powertrain
	DO-160 Aviation & eVTOL 28 V	DO-160 Aviation & eVTOL 28 V	12 V, ISO 7637-2 5b load dump	SSPC, DO-160 protection
PACKAGE	SMB (DO-214AA)	SMC (DO-214AB)	SMC (DO-214AB)	AK package
POWER RATING	1 kW @ 10/1000 µs	5 kW @ 10/1000 µs	3 kW @ 10/1000 µs	6 kA / 8 kA / 10 kA @ 8/20 µs
V_R	54-64 V	54-64 V	30-36 V	see datasheet
V_C MIN / V_C MAX	see datasheet for details			

For more information about these FlatSuppressX™ TVS, please reference the product datasheets and these product briefings on Littelfuse.com.

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