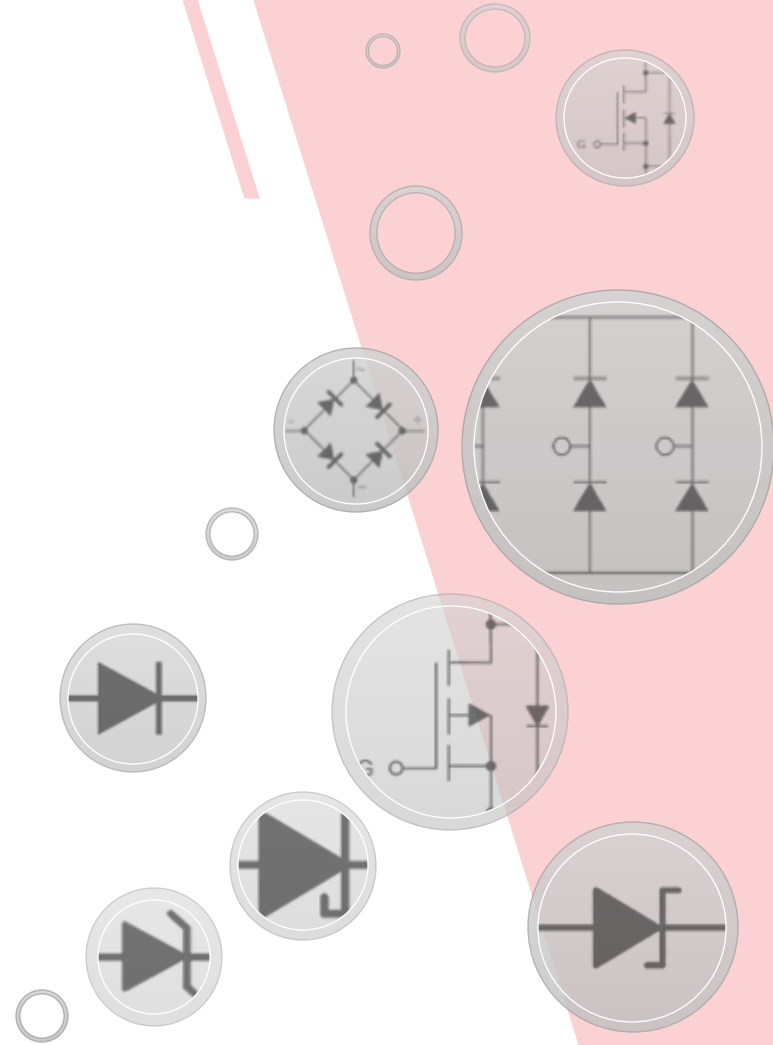
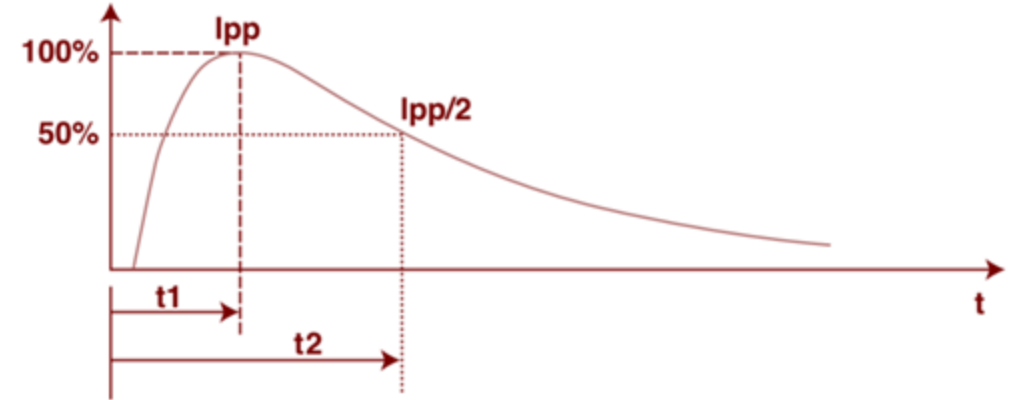


MCC Solutions Guide: TVS Diodes

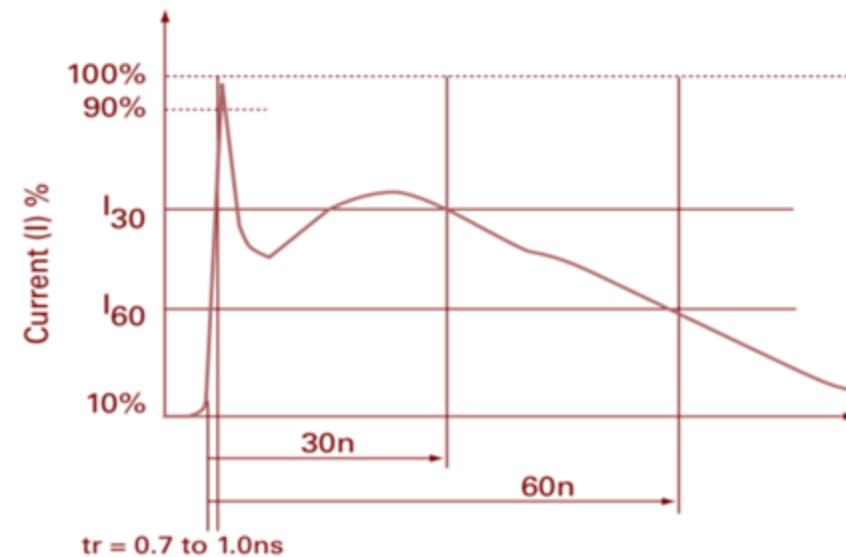


Voltage Transients

- The miniaturization of electronic components has resulted in vulnerability to electrical stress, such as overcurrent and overvoltage.
- Overvoltage could be due to power fault or voltage transients caused by electrostatic discharge (ESD), lightning-induced transients, or inductive load switching.
- Components that can't handle the sudden increase in energy could result in abnormal working behavior, system damage, or potential safety hazards.
- Therefore, voltage transients must be controlled or suppressed to prevent system damage or catastrophic failures.
- Various studies are being carried out to characterize different types of voltage transients. The two most common transient models are lightning transient waveform and ESD waveform.



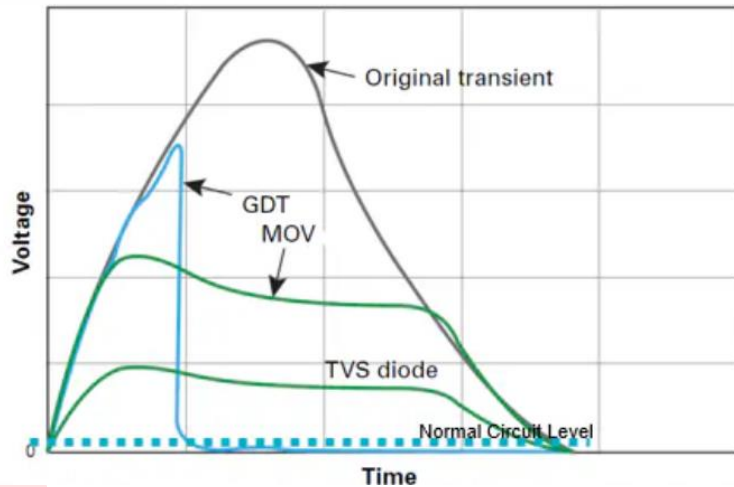
Lightning Transient Waveform



ESD Waveform

Overvoltage Protection Devices

- Basically, there are two types of overvoltage protection mechanisms:
 - Clamping: clamps the voltage to certain level, but device suffers high heat generation.
 - Crowbar: short circuits the output to allow high current dissipation.



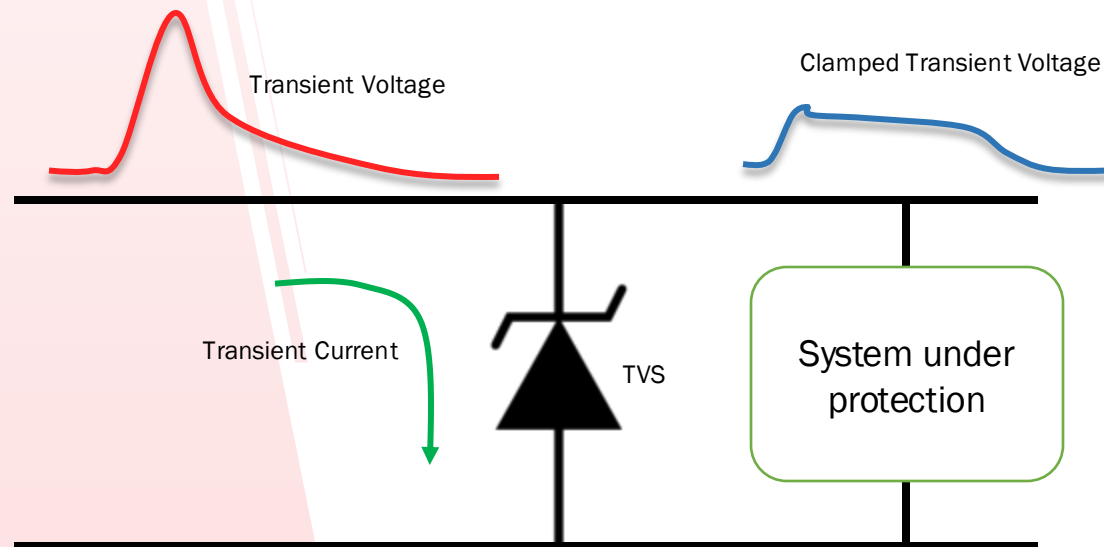
- The table below shows common overvoltage protection devices and technologies used to suppress transients.

	Clamping		Crowbar	
Device	Transient Voltage Suppressor (TVS)	Metal Oxide Varistor (MOV)	Thyristor	Gas Discharge Tube (GDT)
Technology	Semiconductor	Ceramic	Semiconductor	Spark gap
Polarity	Uni/Bi-directional	Bi-directional	Uni/Bi-directional	Bi-directional
Residue Voltage Level	Low	High	Low	Low
Surge Withstanding Capability	Low	High	Medium	High
Pulse Cycle Capability	Excellent	Good	Excellent	Good
Response time	Very Fast	Fast	Very Fast	Slow
Capacitance	High	High	Low	Low

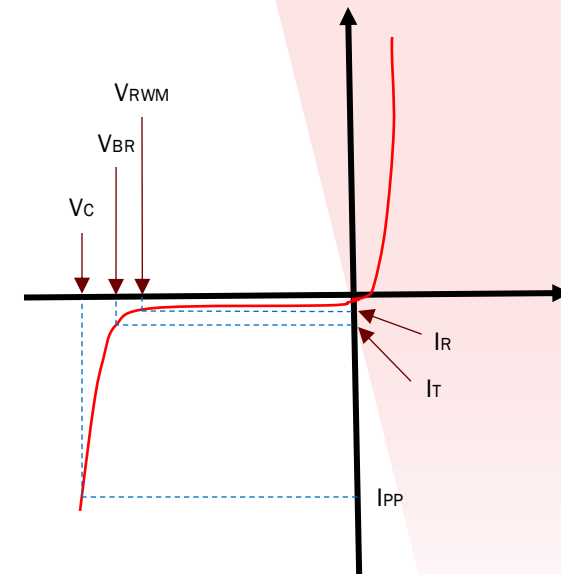
- Semiconductor devices generally outperform MOV and GDT in multiple aspects.
- Compared to Thyristors, TVS diodes are more commonly used due to their clamping mechanism and system level compatibility.

What is a TVS?

- A **T**ransient **V**oltage **S**uppressor, also known as TVS, is a semiconductor device that should ideally limit the transient voltage to a defined level to protect the system behind it from overvoltage stress and conduct the excess transient current back to the source.



- The TVS is connected in parallel to the protected line and in reversed direction. The nominal voltage of the line should not exceed the reverse working voltage (V_{RWM}) of the TVS. When the reversed bias voltage exceeds the breakdown voltage (V_{BR}), the TVS starts to conduct. If the voltage continues to raise further, the TVS will go into avalanche breakdown and a huge current will be conducted through the TVS.
- Excessive transient current flows through the TVS back to the source, causing voltage to remain constant, thus protecting the system behind it. However, every semiconductor device is limited by the power it could dissipate. Similarly, TVS works the same way. The clamping voltage (V_C) at the peak pulse current (I_{PP}) should not exceed the peak pulse power (PPP) of the TVS. Otherwise, the TVS will suffer electrical overstress and may result in damage or failure.



MCC's TVS Diodes

- MCC offers more than 4,000 TVS diodes for selection, and about 40% of them are AEC-Q101 qualified.
- As an integrated device manufacturer, MCC manages every single detail — from materials and chip design to assembly and testing — to ensure consistently high-quality TVS diodes are shipped to our customers.
- Throughout the years, innovation and development have always remained a priority at MCC. Our TVS diodes are approaching their 5th generation of technology, a testament to our proven quality.
- Other than SMA, SMB & SMC packages, MCC offers low-profile packages, such as SOD-123FL, SOD-123HL, SMA-FL & SMBF with heights as low as 1.15mm. The tables on the following pages feature a matrix of our non-automotive-grade TVS diodes with peak pulse power, packages, configuration, family & reverse working voltage ranges listed.

Low-Profile SMD Packages



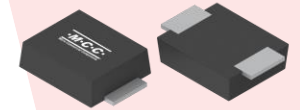
SOD-123FL



SOD-123HL



DO-221AC
(SMA-FL)



SMBF

Surface-Mount Packages



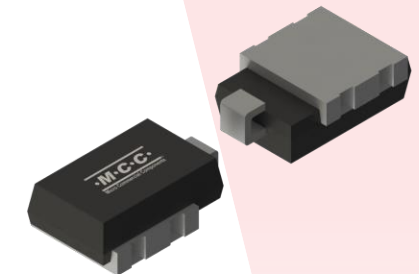
SMA



SMB



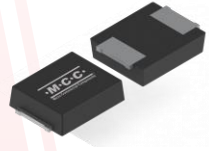
SMC



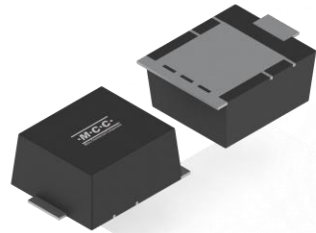
DO-218AB

MCC's TVS Diodes Packages

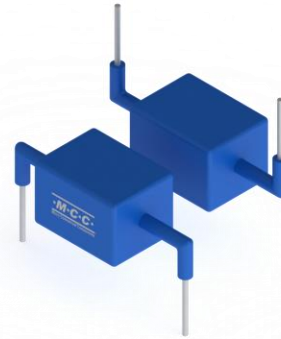
High-Power Packages



SMG



SME



AK

Axial Leaded Packages



DO-41



DO-15



DO-201AE



R-6

MCC's Non-Automotive TVS

Non-Automotive-Grade TVS (surface-mount type)

P _{PP} (W)	Configuration	Package	Family Series	VRWM (V)
200	Bi-dir	SOD-123FL	SMF	5 ~ 170
	Uni-dir	SOD-123FL	SME	5 ~ 170
		SOD-123HL	SMH	5 ~ 100
400	Bi-dir	SOD-123FL	SM4F	5 ~ 45
		DO-221AC	SMAE	5 ~ 300
		SMA	SMAJ	5 ~ 440
			SMAJP4KE	5.8 ~ 495
			SMAJS	24
	Uni-dir	SOD-123HL	SM4H	5 ~ 100
		SOD-123FL	SM4F	5 ~ 100
		DO-221AC	SMAE	5 ~ 300
		SMA	SMAJ	5 ~ 440
			SMAJP4KE	5.8 ~ 495

Non-Automotive-Grade TVS (surface-mount type)

P _{PP} (W)	Configuration	Package	Family Series	VRWM (V)
500	Uni-dir	SMB	SMBSAC	5 ~ 50
600	Bi-dir	DO-221AC	SMA6J..FL	11 ~ 85
		SMBF	SMBF	5 ~ 220
		SMA	SMA6J	5 ~ 58
		SMB	SMBJ	5 ~ 440
			SMBJ..L	220 ~ 440
			SMBJP6KE	5.8 ~ 468
	Uni-dir	DO-221AC	SMA6J..FL	5 ~ 130
		SMBF	SMBF	5 ~ 220
		SMA	SMA6J	5 ~ 58
		SMB	SMBJ	5 ~ 440
			SMBJ..L	220 ~ 440
			SMBJP6KE	5.8 ~ 468
			SMBJP6KE..L	214 ~ 342

MCC's Non-Automotive TVS

Non-Automotive-Grade TVS (surface-mount type)				
P _{PP} (W)	Configuration	Package	Family Series	VRWM (V)
1000	Bi-dir	SMB	SMB10J	5 ~ 120
			SMBJ1.0KE	5.8 ~ 77.8
	Uni-dir	SMB	SMB10J	5 ~ 120
			SMBJ1.0KE	5.8 ~ 77.8
1500	Bi-dir	SMB	SMB15J	15 ~ 58
		SMC	SMCJ1.5KE	5.8 ~ 495
			SMCJ	5 ~ 440
	Uni-dir	SMB	SMB15J	15 ~ 58
		SMC	SMCJ1.5KE	5.8 ~ 495
			SMCJ	5 ~ 440
2000	Bi-dir	SMB	SMB20J	20 ~ 58
	Uni-dir	SMB	SMB20J	20 ~ 58
3000	Bi-dir	SMC	SMLJ	5 ~ 440
	Uni-dir	SMC	SMLJ	5 ~ 440
5000	Bi-dir	SMC	5.0SMLJ	11 ~ 400
	Uni-dir	SMC	5.0SMLJ	11 ~ 400

Non-Automotive-Grade TVS (axial leaded type)				
P _{PP} (W)	Configuration	Package	Family Series	VRWM (V)
400	Bi-dir	DO-41	P4KE(5.8~495)	5.8 ~ 495
	Uni-dir	DO-41	P4KE(5.8~495)	5.8 ~ 495
500	Bi-dir	DO-15	P5KE(5~200)	5 ~ 200
			SA(5~170)	5 ~ 170
600	Uni-dir	DO-15	P5KE(5~200)	5 ~ 200
			SA(5~170)	5 ~ 170
600	Bi-dir	DO-15	P6KE(5.8~512)	5.8 ~ 512
	Uni-dir	DO-15	P6KE(5.8~512)	5.8 ~ 512
1500	Bi-dir	DO-201AE	1.5KE(5.8~467)	5.8 ~ 467
	Uni-dir	DO-201AE	1.5KE(5.8~467)	5.8 ~ 467
				LCE(6.5~28)
3000	Bi-dir	R-6	3KP(5~220)	5 ~ 220
	Uni-dir	R-6	3KP(5~220)	5 ~ 220
5000	Bi-dir	R-6	5KP(5~440)	5 ~ 440
			5KP.L(22~188)	22 ~ 188
	Uni-dir	R-6	5KP(5~440)	5 ~ 440
			5KP.L(22~188)	22 ~ 188
6000	Bi-dir	R-6	SLD(10~60)	10 ~ 60
	Uni-dir	R-6	SLD(10~60)	10 ~ 60

MCC's High-Power TVS

- Applications exposed to harsh environments are susceptible to strong transients and interferences. Typical 5kW TVS may suffer to keep the system protected. In such cases, high-power TVS, such as 15kW or 30kW TVS could come in handy.
 - [15KP series](#)
 - [30KP series](#)
- Further up, higher power TVS such as MCC's AK series are characterized using peak pulse current waveform of 8/20us, which is the testing requirement by safety standards, such as UL or IEC for lightning surge protection. The table below shows MCC's AK series product ranging from 1kA to 15kA peak pulse current.
 - [AK series](#)

High-Power TVS (axial leaded type)				
P _{PP} (W)	Configuration	Package	Family Series	V _{RWM} (V)
15000	Bi-dir	R-6	15KP(17~280)	17 ~ 280
			15KP..L(17~280)	17 ~ 280
	Uni-dir	R-6	15KP(17~280)	17 ~ 280
			15KP..L(17~280)	17 ~ 280
30000	Bi-dir	R-6	30KP(28~288)	28 ~ 288
	Uni-dir	R-6	30KP(28~288)	28 ~ 288

High-Power TVS (I _{PP} rating)				
I _{PP} (A)	Configuration	Package	Family Series	V _{RWM} (V)
1000	Bi-dir	AK	AK1(76)	76
2500	Bi-dir	SMG	SMGJ(80)	80
3000	Bi-dir	AK	AK3(30~430)	30 ~ 430
6000	Bi-dir	AK	AK6(58~430)	58 ~ 430
10000	Bi-dir	SME	SMEJ(58~86)	58 ~ 86
		AK	AK10(58~430)	58 ~ 430
15000	Bi-dir	AK	AK15(58~76)	58 ~ 76

MCC's Automotive TVS

- MCC's automotive TVS diodes went through stringent reliability testing to ensure they meet the highest industry standard: AEC-Q101 qualification.
- Automated production facilities are implemented to minimize human error and contamination, improve efficiency, and ensure the consistent quality of every single TVS diode we produce.
- MCC offers AEC-Q101 qualified TVS diodes ranging from 200W to 6600W peak pulse power. They are available in various SMD packages and can operate up to a 175°C junction temperature. The tables show the automotive TVS product range offered by MCC.

Automotive-Grade TVS				
P _{PP} (W)	Configuration	Package	Family Series	V _{RWM} (V)
200	Bi-dir	SOD-123FL	SMF..Q	5 ~ 100
	Uni-dir	SOD-123FL	SMF..HE3 SMF..Q	5 ~ 100 5 ~ 100
400	Bi-dir	SOD-123FL	SM4F..HE3	6 ~ 45
		SMA	SMAJ..HE3 SMAJ..Q	5 ~ 190 5 ~ 190
			SMAJP4KE..HE3 SMAJP4KE..Q	10.2 ~ 185 5.8 ~ 185
	Uni-dir	SOD-123FL	SM4F..HE3	6 ~ 100
		SMA	SMAJ..HE3 SMAJ..Q	5 ~ 190 5 ~ 190
			SMAJP4KE..HE3 SMAJP4KE..Q	10.2 ~ 185 5.8 ~ 185

MCC's Automotive TVS

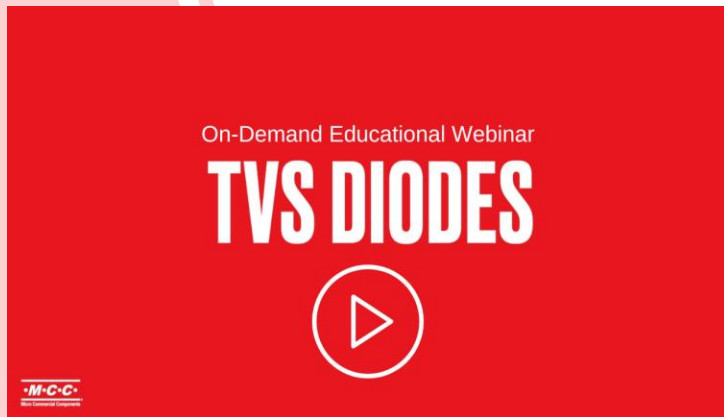
Automotive-Grade TVS

P _{PP} (W)	Configuration	Package	Family Series	V _{RWM} (V)
600	Bi-dir	DO-221AC	SMA6J..FLQ	5 ~ 85
		SMA	SMA6J..HE3	10 ~ 100
			SMA6J..Q	10 ~ 20
			SMBJ..HE3	5 ~ 190
		SMB	SMBJ..Q	5 ~ 190
			SMBJP6KE..HE3	10.2 ~ 185
	SMBJP6KE..Q		5.8 ~ 185	
	Uni-dir	DO-221AC	SMA6J..FLQ	5 ~ 85
		SMA	SMA6J..HE3	10 ~ 100
			SMA6J..Q	10 ~ 100
		SMB	SMBJ..HE3	5 ~ 190
			SMBJ..Q	5 ~ 190
SMBJP6KE..HE3			10.2 ~ 185	
SMBJP6KE..Q	5.8 ~ 185			

Automotive-Grade TVS

P _{PP} (W)	Configuration	Package	Family Series	V _{RWM} (V)
1500	Bi-dir	SMC	SMCJ1.5KE..HE3	10.2 ~ 185
			SMCJ1.5KE..Q	5.8 ~ 185
			SMCJ..HE3	10 ~ 190
			SMCJ..Q	5 ~ 190
	Uni-dir	SMC	SMCJ1.5KE..HE3	10.2 ~ 185
			SMCJ1.5KE..Q	5.8 ~ 185
3000	Bi-dir	SMC	SMLJ48..HE3A	10 ~ 48
			SMLJ..Q	5 ~ 48
	Uni-dir	SMC	SMLJ48..HE3A	10 ~ 48
			SMLJ..Q	5 ~ 48
5000	Bi-dir	SMC	5.0SMLJ..HE3	5 ~ 85
	Uni-dir	SMC	5.0SMLJ..HE3	5 ~ 85
6600	Bi-dir	DO-218AB	SM8S..HE3	14 ~ 43
	Uni-dir	DO-218AB	SM8S..HE3	10 ~ 43

Explore the additional TVS resources below, or contact us at mccsemi.com.



[On-Demand Educational Webinar](#)

TVS

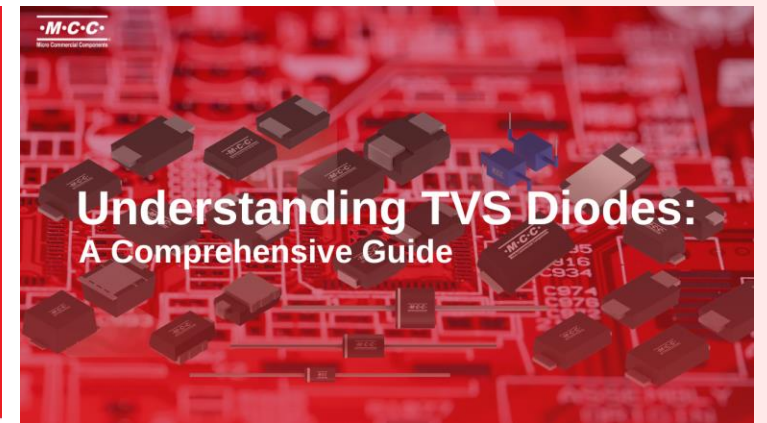
Lightning strikes, power line surges, and other transient events are no match for MCC's TVS solutions. Our robust portfolio of transient voltage suppressors includes unidirectional and bidirectional configurations with low leakage current, as well as popular package sizes. Choose from our wide selection, including auto-grade options with diverse peak pulse power ratings and reverse standoff voltages, to find the ideal solution for your application.

Home » ESD Protection and Power TVS » TVS

Columns: EXPORT TO EXCEL

Part Number	Status	Compliance	Configuration	Package Type	Peak Pulse Power Dissipation P _{PP} (W)	Reverse Standoff Voltage V _{RM} (V)
AK	Active	Automotive	Bidirectional	AK	> 150	< 3000
DO-15	New Product	RoHS	Unidirectional	DO-15	> 150	< 3.3
DO-391AB	Allocation	Pb-Free		DO-391AB	> 300	< 3.3
DO-291AB	MSOP	Halogen Free		DO-291AB	> 400	< 5
DO-221AC	Obsolete			DO-221AC	> 400	< 5.5
DO-41	Pin Change			DO-41	> 500	< 5.5
DO-41				DO-41	> 500	< 5.5
SM4F50CA	New Product		Bidirectional	SOD-123FL	> 400	< 5
15KP200CAL	New Product		Bidirectional	F-6	> 15000	< 200
15KP75CAL	New Product		Bidirectional	F-6	> 15000	< 75
SM4612CAFLO	New Product		Bidirectional	DO-221AC	> 600	< 12
SM518CAHE3	New Product		Bidirectional	DO-218AB	> 3600	< 18

[Online TVS Diodes Catalog](#)



[TVS Diodes Guide](#)