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ELECTRONICS WORLDWIDE

Circuit Protection

Committed to excellence

Technology & Application Solutions at a Glance

V2.0

Consult | Components | Logistics | Support

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Our Product Portfolio

- Semiconductors
- Passive Components
- Electromechanical Components
- Displays & Boards
- Storage Technologies
- Wireless Technologies
- Lighting Solutions
- Photovoltaic Solutions

Circuit Protection. Why?

Circuit protection devices interrupt overcurrent events and divert overvoltage surges. They increase safety and enable end products to survive harsh conditions.
Most electrical and electronic equipment require circuit protection devices. In many cases they must be installed to comply with safety standards before the end products can be sold or used.

Circuit Threats

VOLTAGE TRANSIENT EVENTS

Voltage transients are short duration surges or spikes. Unsuppressed, they may damage circuits and components, and result in complete system failure. Below are descriptions of common types of voltage transients, and technologies to reduce their effects:

Inductive Load Switching

Switching of inductive loads, such as those that occur with transformers, generators, motors, and relays, can create transients up to hundreds of volts and amps, and can last as long as 400 milliseconds, affecting both AC and DC circuits.

Lightning Induced Transient

Most transients induced by nearby lightning strikes result in an electromagnetic disturbance on electrical and communication lines connected to electronic equipment.

Automotive Load Dump

Load dump refers to what happens to the supply voltage in a vehicle when a load is removed. If a load is removed rapidly (such as when the battery is disconnected while the engine is running), the voltage may spike before stabilizing and damage electronic components.

Electrostatic Discharge (ESD)

Damage from ESD is generally caused by the transfer of static electrical charge from a person to an electronic circuit. It may result in faulty circuit operation, latent defects, and even catastrophic failure of sensitive components. For more information see page 4.

OVERCURRENT EVENTS

Excessive current events can lead to catastrophic failures in electronic circuits. These failures can result in safety hazards such as fire, shock, or explosion. Common types of overcurrent threats include:

Overload

Overloads occur when more current is allowed to flow through a circuit path than it was designed to carry. This excess current can generate and accumulate heat and result in complete circuit destruction and possible fire, electrocution or explosion.

Short Circuit

Short circuits occur when one conducting path comes in contact with another conducting path or with ground, such as may occur due to a loose wire, insulation breakdown, or contact with water. These conditions can increase the likelihood of arcs, shock, or fire hazards.

Source: courtesy of Vishay Intertechnology, Ltd

What is ESD?

Electrostatic Discharge (ESD) is the transfer of electrical charge between any two objects. A common example of this is the static shock that a person experiences after walking across a carpet and then touching a metallic object such as a door knob or file cabinet. The "shock" is felt at the point of contact and is typically accompanied by a small spark and a slight snapping sound.

The process of creating an ESD event begins with the generation of static electricity. As one material (in this case the soles of a person's shoes) comes into contact with another material (carpeted floor) which are then separated, an imbalance of electrical charge is created (see Figure 1).
The interaction of the soles of the shoes and the carpeted floor causes a build-up of electrons on the surface of the person, while the flooring becomes more positively charged as it gives up electrons. The static electricity continues to increase until a maximum level is reached or the person contacts another surface (in this case, a metal file cabinet) that is at a different electrical potential. The static electricity is then transferred from the person in an electrostatic discharge event (see Figure 2).

ESD is different from other, common overvoltage events (switching and surge transients) in that the time it takes ESD to transition from zero to maximum current and voltage is very short. The rise time of an ESD event is less than one nanosecond, while the other transients take longer than one microsecond to reach their peaks.

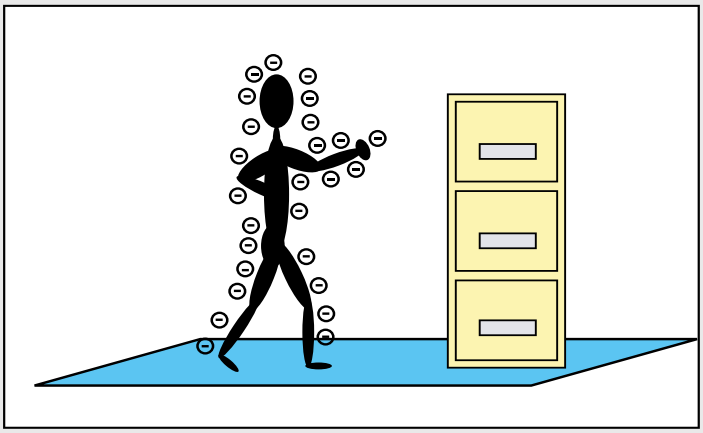


Figure 1. Generation of static electricity on the Human Body.

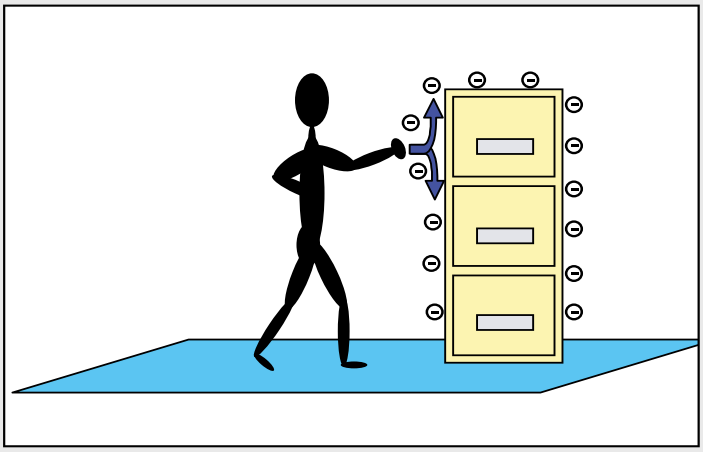


Figure 2. Discharge of static electricity

Comparison. Circuit Protection Technologies

Technology	Key Features and Protection Characteristics	When / Where Typically Used	Surge Energy Rating Range	Typical Voltage Clamping Speeds	Typical, Capacitance/ Insertion Loss	Mounting/ Size/ Packaging Options
Fuses	Completely stop current flow, which helps to identify faults; Wide range of options	Ultimate protection for sensitive/ expensive/critical components	Low thru Very High	Not applicable	Series impedance measured in nH	Very Extensive Range of Options
Multi-Layer Varistors (MLVs)	Compact and capable of handling significant surges for their size	ESD and EFT suppression in smaller and portable electronics	Low thru Medium	Moderate	Low	Surface Mount, Axial Leaded, 2/3 Lead Radial
Metal-Oxide Varistor (MOVs)	Capable of withstanding very high energy transients; Wide range of options	Appliance, industrial and very high energy suppression applications	Medium thru Very High	Moderate	High	Radial Leaded, Industrial Terminal
ESD Suppressors	Extremely low capacitance; Fast response time; Compact size	ESD suppression; Ultra fast reaction; Low signal distortion	Low	Moderate	Low	Miniature Surface Mount
Protection Arrays	Low capacitance / low clamping voltage; Compact size	ESD suppression; Low distortion; Ideal for I/O interfaces and digital & analog signal lines	Low thru Medium	Very Fast	Low	Extensive range of surface mount options
TVS Diodes	Fast response to fast transients; Wide range of options	Semiconductor protection; telecom I/O interfaces, electronics, industrial equipment	Medium thru High	Fast	High	Axial Leaded, Radial Leaded

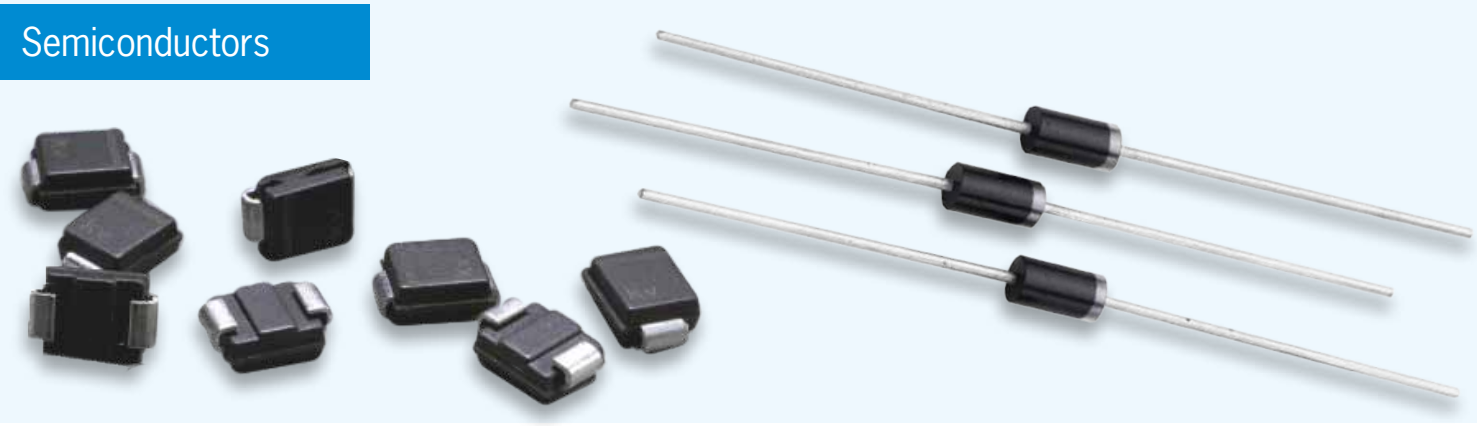
Comparison TVS vs. Varistor

Advantages TVS

- Break down level offers a better protection for the ESD sensitive circuit
- A low breakdown Voltage level and a low series resitance offer better ESD protection
- Offer an excellent clamping ratio
- Leakage current: parameters remain constant
- High reliability
- Lower residual voltage
- Higher protection quality

Advantages Varistor

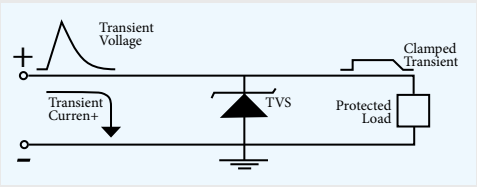
- Faster response time (<1ns)
- Better repetitive ESD and high current strike capability without performance degradation
- Lower leakage current
- No derating up to 125°C / 150°C
- Good solderablitiy
- Smaller dimensions
- TVS diode and EMC capacitor can be replaced by one component



Transient Voltage Suppression Diode

Definition

Transient Voltage Suppressors (TVS) are devices used to protect vulnerable circuits from electrical overstress caused for example by electrostatic discharge, inductive load switching and induced lightning. Within TVS, damaging voltage spikes are limited by clamping or avalanche action of a rugged silicon pn junction which reduces the amplitude of the transient to a non-destructive level.



In a circuit, the TVS should be "invisible" until a transient appears. Electrical parameters such as breakdown voltage (V_{BR}), standby (leakage) current (ID), and capacitance should have no effect on normal circuit performance.

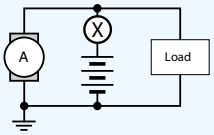
The TVS breakdown voltage is usually 10% above the reverse standoff voltage (V_R), which approximates the circuit operating voltage to limit standby current and to allow for variations in V_{BR} caused by the temperature coefficient of the TVS. When a transient occurs, the TVS clamps instantly to limit the spike voltage to a safe level, called the clamping voltage (V_C), while conducting potentially damaging current away from the protected component.

ESD Protection

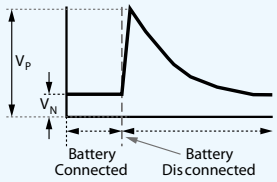
With the increasing use of integrated and wired communication devices and costumer products, it is more important than ever to protect sensitive electronics from high transient voltages or unintentional frequencies. High voltage spikes with various wave forms and durations can damage or even destroy electronic circuits, and the interference of unintentional frequencies can influence the system in a negative way. These transient voltages have various sources. One of the most common types are electrostatic discharges (ESD). For example, a person can inadvertently discharge accumulated static electricity on a phone merely by touching the device. A sudden power surge can also occur when lightning strikes a power line, potentially harming devices connected to the line.

What is Load Dump?

The worst instances of surge voltage are generated when the battery is disconnected when the engine is in operation, and the alternator is supplying current to the power line of the vehicle. This condition is known as "load dump", and most vehicle manufacturers and industry associations specify a maximum voltage, line impedance, and time duration for this load dump status, as shown in Figure.

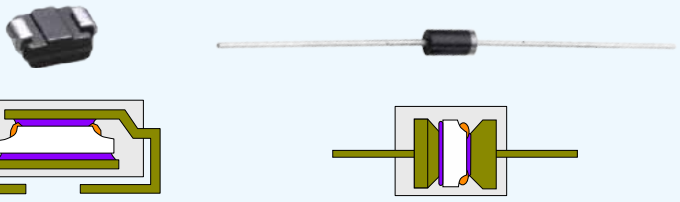


Output Voltage of Alternator



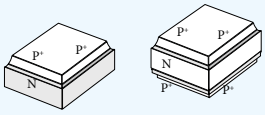
Output Voltage of Alternator in Load Dump Condition

Construction



Cross section of surface mount

Cross section of axial lead type



Bi-polar and Uni-polar TVS Chip

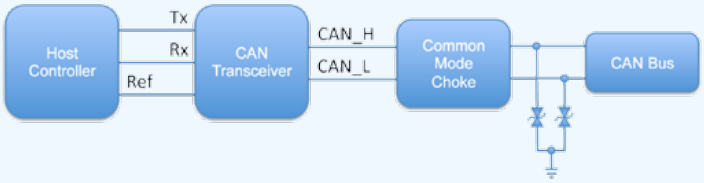
- Epoxy molding compound
- Lead frame
- Ni/Au plating and Solder
- Glass passivation
- Silicon Chip

Protection Diodes

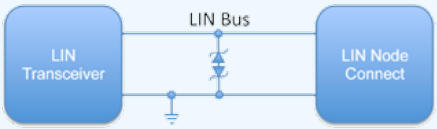
DIODES INCORPORATED

ESD Protection

Part	Configuration	Channel Input Capacitance CT Typ (pF)	Max Reverse Standoff Voltage VRWM (V)	Breakdown Voltage VBR Min (V)	Reverse Leakage Current IR @ VRWM	Max Peak Pulse Current IPP@ 8x20us Max (A)	Max Clamping Voltage (VCL) @ Max Peak Pulse Current	VESD IEC61000- 4-2 Contact Discharge	Package Outline
					Max (nA)			(±kV)	
DESD1P0RFWQ	2 ch uni-directional	1	70	TBC	100	10	8	30	SOT323
D5V0L1B2LPSQ	1 ch bi-directional	1	5,2	6	10	3	13	20	DFN1006
D24V0L1B2LPSQ	1 ch bi-directional	25	24	26	100	2	46	20	DFN1006-2
DUP1105SOQ	1 ch bi-directional	25	24	26,2	100	8	44	30	SOT23
DUP2105SOQ	2 ch bi-directional	25	24	26,2	100	8	44	30	SOT23
DESD1CAN2SOQ	2 ch bi-directional	11	24	26,2	50	3	70	30	SOT23
DESD2CAN2SOQ	2 ch bi-directional	25	24	25,4	10	5	41	30	SOT23
DESD1LIN2WSQ	1 ch bi-directional	13	17,1	17,1	50	5	35	30	SOD323



CAN Bus Protection Scheme



LIN Bus Protection Scheme

D24V0L1B2LPSQ

DFN1006-S with side wall plating

- Solder joint integrity can be optically inspected (X-ray inspection required otherwise)
- Tiny small form factor package that is easier to handle than SOD923

Low Clamping Voltage

- Better system protection

Automotive Grade

- Qualified to AECQ101
- PPAP capable for full traceability

Low Dynamic Resistance

- Ensures superior ESD protection of the system than high resistive Zener or Varistor solution

IEC61000-4-2 compliant

- Air and contact electrostatic discharge up to 30kV

Protection Diodes

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Expertise Applied | Answers Delivered

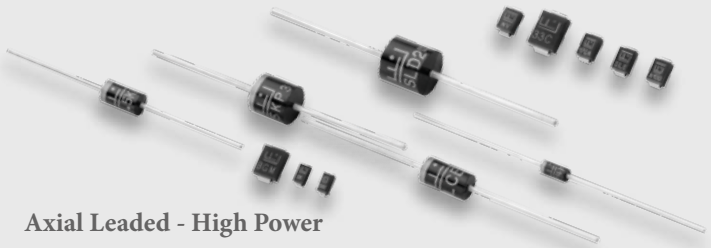
Transient Voltage Suppressors

Surface Mount - Standard Applications (200 - 5,000W)

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
SMF	SMF/ SOD-123	5.0 - 85	200
SMAJ	SMA	5.0 - 440	400
SMA6J	SMA	5.0 / 12	600
SMA6L	SMA (Low Profile)	5.0 - 85	600
P4SMA	SMA	5.8 - 495	400
SMBJ	SMB	5.0 - 440	600
P6SMB	SMB	5.8 - 495	600
SMCJ	SMC	5.0 - 440	1,500
1.5SMC	SMC	5.8 - 495	1,500
SMDJ	SMC	5.0 - 220	3,000
5.0SMDJ	SMC	12 - 170	5,000

Surface Mount - High Reliability

Series name	Pack-age	Standoff Voltage (V)	Peak Pulse Power (W)	Applications
SMBJ-HRA	SMB	5 - 170	600	Aerospace / Medical / Military
SMBJ-HR	SMB	5 - 170	600	Aerospace / Medical / Military
SMCJ-HRA	SMC	5 - 170	1,500	Aerospace / Medical / Military
SMCJ-HR	SMC	5 - 170	1,500	Aerospace / Medical / Military
SMDJ-HRA	SMC	5 - 130	3,000	Aerospace / Medical / Military
SMDJ-HR	SMC	5 - 130	3,000	Aerospace / Medical / Military



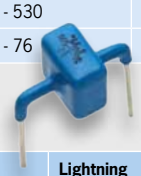
Axial Leaded - Standard Applications (400 - 5,000W)

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)	Other Functionality
P4KE	DO-41	5.8 - 495	400	N/A
SA	DO-15	5.0 - 180	500	N/A
P6KE	DO-15	5.8 - 512	600	N/A
1.5KE	DO-201	5.8 - 512	1,500	N/A
3KP	P600	5.0 - 220	3,000	N/A
SLD	P600	10.0 - 40.0	~5,000	ISO 7637-2 Level 4*

*ISO 7637-2 Level 4: Impulse 5a; 2,200W at 10ms × 150ms Test Waveform /50,000W at 8/20µs Test Waveform

Axial Leaded - High Power

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)	Peak Pulse Current (A)
15KPA	P600	17 - 280	15,000	N/A
20KPA	P600	20 - 300	20,000	N/A
30KPA	P600	28 - 300	30,000	N/A
AK1	Radial Lead	76	N/A	1,000
AK3	Radial Lead	15 - 430	N/A	3,000
AK6	Radial Lead	30 - 430	N/A	6,000
AK10	Radial Lead	30 - 530	N/A	10,000
AK15	Radial Lead	58 - 76	N/A	15,000



ESD Protection

Series Name	Package	Number of lines	Working Voltage (V)	Leakage Current max. (µA)	Typical Device Capacitance (pF)	ESD Capability (kV)	Lightning Capability (A)	Other Functionality
SP050x	SOT23 / SOT143 / MSOP / SC70	2 / 3 / 4 / 5 / 6	5.5	0.1	30	30	7	N/A
SP10xx	SC70 / SOT553 / SOT563 / SOT953 / MSOP10 / µDFN	2 / 4 / 5	5 - 6	0.5	3.5 - 30	8 - 30	2 - 10	N/A
SP30xx	SOT23 / SC70 / SOT553 / SOT563 / MSOP10 / µDFN	1 / 2 / 4 / 6 / 8	5 - 6	1.0	0.40 - 2.4	8 - 20	2 - 10	N/A
SP40xx	MSOP10 / SOIC8 / µDFN10 / SOD323	1 / 2 / 4 / 8	3.3 - 24	1.0	2.5 - 5	30	7 - 75	N/A
SP72x	PDIP / SOIC / SOT23	4 / 6 / 14	20 - 30	0.02	3 - 5	4 - 8	3 - 9	N/A
SRV05-4	SOT23-6	4	6	0.5	2	20	10	N/A
SR70	SOT143	2	70	5.0	2	30	40	N/A
LC03-3.3BTG	SOIC-8	2	3.3	1.0	5	30	150	N/A
SP2504N	µDFN-10	4	2.5	1.0	3.5	30	20	N/A
SP3304N	µDFN-10	4	3.3	1.0	3.5	30	20	N/A
PLED5	SOT89 / 2x2QFN	1	35	<150	N/A	8	N/	Open LED Bypass / Reverse Polarity Protection

Protection Diodes

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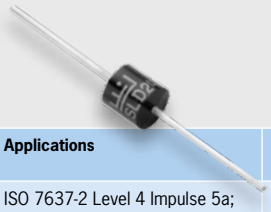
Surface Mount TVS - Automotive Grade

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)	Approval
TPSMA6L	SMA	5 - 85	600	AEC-Q101
TPSMB	SMB	11.1 - 77.8	600	AEC-Q101
TPSMC	SMC	10.2 - 77.8	1,500	AEC-Q101
TPSMD	SMC	10 - 43	3,000	AEC-Q101

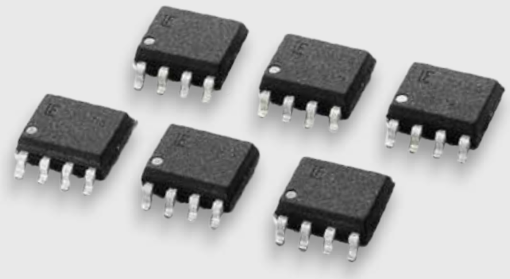


Axial Leaded - Automotive Grade

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)	Applications	Approval
SLD	P600 Axial Lead	10 - 40	~5,000	ISO 7637-2 Level 4 Impulse 5a; 2,200W at 10ms × 150ms Test Waveform /50,000W at 8/20µs Test Waveform	AEC-Q101

ESD Protection – Automotive Grade

Series Name	Package	Number of lines	Working Voltage (V)	Leakage Current max. (µA)	Typical Device Capacitance (pF)	ESD Capability (kV)	Lightning Capability (A)	Approval
SP1001-0xJTG	SC70-x	2, 4, 5	5.5	0.5	12	15	2	AEC-Q101
SP3030-01ETG	SOD882 (0402)	1	5	0.5	0.5	20	3	AEC-Q101
SP3012-0xUTG	µDFN-10, 14	4, 6	5	1.5	0.5	12	4	AEC-Q101
SP3003-02UTG	µDFN-6L	2	6	0.5	0.65	8	2.5	AEC-Q101
SP1003-01ETG	SOD882 (0402)	1	5	0.1	30	30	7	AEC-Q101
SP1005-01ETG	SOD882 (0402)	1	6	0.5	25	30	8	AEC-Q101
SMxx-02HTG	SOT23-3	1 (bidi) or 2 (uni)	5, 12, 15, 24, 36	1.0	400, 150,100, 65, 50	30	24, 17, 12, 7, 5	AEC-Q101
SDxx-01FTG	SOD323 (0805)	1	5, 12, 15, 24, 36	1.0	350, 150,100, 65, 50	30	30, 17, 12, 7, 5	AEC-Q101
SDxx-01FTG-C	SOD323 (0805)	1	5, 12, 15, 24, 36	1.0	200, 100, 75, 50, 30	30	30, 17, 12, 7, 5	AEC-Q101
SPHVxx-01ETG	SOD882 (0402)	1	12, 15, 24, 36	1.0	60, 46, 32, 25	30	8, 5, 3, 2	AEC-Q101
SPHVxx-01ETG-C	SOD882 (0402)	1	12, 15, 24, 36	1.0	30, 24, 17, 13	30	8, 5, 3, 2	AEC-Q101
SPHVxx-01KTG	SOD882 (0402) side contacts	1	12, 15, 24, 36	1.0	60, 46, 32, 25	30	8, 5, 3, 2	AEC-Q101
SPHVxx-01KTG-C	SOD882 (0402) side contacts	1	12, 15, 24, 36	1.0	30, 24, 17, 13	30	8, 5, 3, 2	AEC-Q101
SM24CANA-02HTG	SOT23-3	2	24	0.1	11	24	3	AEC-Q101
SM24CANB-02HTG	SOT23-3	2	24	0.1	30	30	10	AEC-Q101



Protection Diodes

life.augmented

Transient Voltage Suppressors - Transil™

Surface Mount - Standard Applications (400 - 3,000W)

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
SMM4F	STMite Flat	5.0 - 33	400
SMAJ	SMA	5.0 - 188	400
SMA6F	SMA Flat	5.0 - 188	600
SMA6J	SMA	5.0 - 188	600
SM6T	SMB	5.0 - 188	600
SM15T	SMC	5.0 - 188	1,500
SMC30J	SMC	5.0 - 33	3,000
STIEC45	SMC / D²PAK	24 - 100	IPP=500A; PPP varies

Axial Leaded - Standard Applications (600 - 5,000W)

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
P6KE	DO-15	6.8 - 440	600
1.5KE	DO-201	6.8 - 440	1,500
BZW50	R6	10 - 180	5,000

Crowbar Diodes - Trisil™ Lightning Surge Protection

Series name	Package	Standoff Voltage (V)	Holding Current (mA)	Peak Pulse Current (A)
SMP30	SMA	62 - 270	150	100
SMP50	SMA	68 - 270	150	100
SMTPA	SMB	62 - 270	150	100
SMPxxx0SCMC	SMB	65 - 275	150	150
LCP1531RL	SO-8	175	150	37.5
LCP02-150B1RL	SO-8 wide	-120 - 120	150	45
DSL secondary Protection	SOT23-5L	5 - 24	N/A	150

Application Dedicated Protection

Repetitive Voltage Surge Suppressors

Series name	Package	Clamping Voltage (V)	Uni/Bi	Application note
STRVS	DO-201 / DO-15 / SMB / SMC	118 - 280	Uni	AN4209 Design Methodology of TVS in repetitive mode: STRVS

Current Limiting Termination

Part Number	Package	No. of protected lines	General Description
CLT01-38S4	HTSSOP38	8	High speed protected digital termination array
CLT3-4B	TSSOP 20	4	Current limited over-voltage protected quad digital termination
PCLT-2A	HTSSOP14	2	Dual current limited overvoltage protected digital termination
SCLT3-8BT8	HTSSOP38	8	Protected digital input termination with serialized state transfer

ESD Protection

Family Name	Series/Product Name	Package	Number of lines	Breakdown Voltage (V_{br})	Leakage Current (µA) @ V_{rm}	Typ. Device Capacitance (pF)	Uni/Bi
General purpose ESD Array	ESDA6V1L/ESDA6V1U1RL	SOT23-3L	2	6	2 @ 3V	140	Uni
	ESDA5V3L	SOT23-3L	2	5.3	20 @ 5.25V	220	Uni
	ESDALCxx	SOD882 / ST0201 / SOT883	1 / 2 / 4 / 5	3.9 / 5 / 6.1 / 14.2	0.07 - 0.5	<30	Uni/Bi
	ESDAVLCxx	CSP / ST01005 / SOD-882 / ST0201 / µQFN	1 / 4	6 - 8.5	0.05 - 0.1	<8	Uni/Bi
	ESDAULCxx	Flip Chip / SOT666 / ST0201	1 / 3 / 8	6	0.1 @ 3V; 0.5 @ 5V	<3	Uni/Bi
	ESDAXLCxx	ST0201 / SOD882 / Flip Chip / µQFN	1	4 - 6	0.05 - 0.1	<1	Uni/Bi
Diode Array	DALC208SC6	SOT23-6L	4	Vref+1.2	1 @ 5V	7	Uni
USB Protection	USB6B1RL	SO-8	2	6	10 @ 5.25V	25	Uni
	USBLCxx	SOT23-6L / SOT-666	2 - 4	6	1 - 2	2.5 - 3	Uni
	USBULCxx	µQFN / Flip Chip / SOT666	2 - 4	4 - 6	0.5 - 2	0.6 - 1.2	Uni
High Speed Protection	HSP061-2xx / HSP062-2xx	µQFN / SOT666	2	6	0.4	0.6	Uni
	HSP061-4xx / HSP051-4xx	µQFN-4L / 8L / µQFN-10L	4	4.5 - 6	0.5	0.6	Uni
	HSP061-8M16	µQFN-16L	8	6	0.5	0.6	Uni

Protection Diodes

life.augmented

Automotive Grade Devices: Qualified According to AEC-Q101

Automotive Arrays

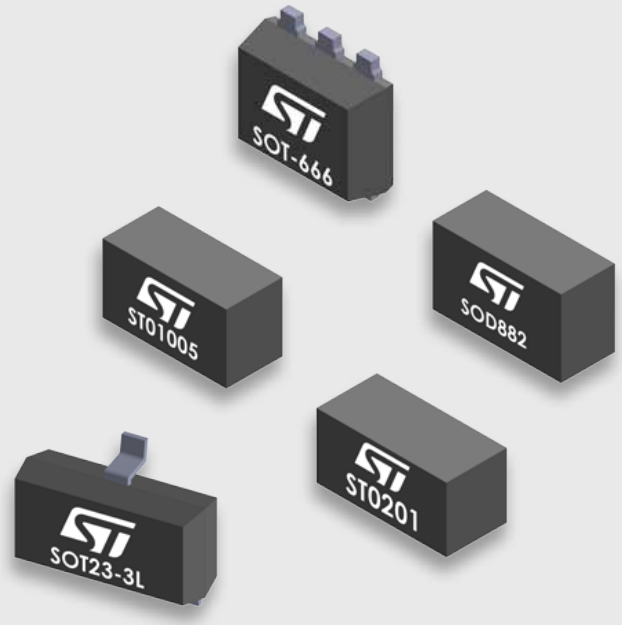
Family	Part Name	Package	No. of lines	Breakdown Voltage (V)	Max ESD peak pulse voltage (IEC61000-4-2 contact in kV)	Capa-citance (typ in pF)	Package size (mm x mm)	Package thickness max (mm)	Uni/Bi
High Speed Protection	HSP061-4M10Y	µQFN-10L	4	6	15	0.6	2.5 x 1.0	0.48	Uni
	HSP061-2P6Y	SOT-666	2	6	15	0.6	1.6 x 1.6	0.48	Uni
	DVIULC6-4SC6Y	SOT23-6L	4	6	15	0.85	2.8 x 2.9	1.45	Uni
	HDMIULC6-4SC6Y	SOT23-6L	4	6	15	0.6	2.8 x 2.9	1.45	Uni
	USBLC6-4SC6Y	SOT23-6L	4	6	15	3	2.8 x 2.9	1.45	Uni
	USBLC6-2SC6Y	SOT23-6L	2	6	15	2.5	2.8 x 2.9	1.45	Uni
General purpose ESD Array	ESDAVLC8-1BT2Y	SOD-882T	1	9	15	4.5	0.6 x 1.0	0.35	Bi
	ESDALC5-1BT2Y	SOD-882T	1	6	30	26	0.6 x 1.0	0.35	Bi
	ESDA14V2SC6Y	SOT23-6L	4	14	25	100	2.8 x 2.9	1.45	Uni
	ESDA25SC6Y	SOT23-6L	4	25	25	60	2.8 x 2.9	1.45	Uni
	ESDA5V3LY	SOT23-3L	2	5	9	220	2.4 x 2.95	1.4	Uni
	ESDA5V3SC6Y	SOT23-6L	4	5	25	280	2.8 x 2.9	1.45	Uni
	ESDA6V1LY	SOT23-3L	2	6	9	140	2.4 x 2.95	1.4	Uni
	ESDA6V1SC6Y	SOT23-6L	4	6	25	190	2.8 x 2.9	1.45	Uni
	ESDA14V2LY	SOT23-3L	2	14	9	90	2.4 x 2.95	1.4	Uni
	ESDA25LY	SOT23-3L	2	25	9	50	2.4 x 2.95	1.4	Uni
Automotive Bus Protection	ESDLIN1524BJ	SOD323	1	15	23	16	1.25 x 2.5	1.17	Bi
	ESDCAN24-2BLY	SOT23-3L	2	24	30	18 (max)	2.4 x 2.95	1.4	Bi
	ESDCAN01-2BLY	SOT23-3L	2	24	30	30 (max)	2.4 x 2.95	1.4	Bi

Automotive Transil

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
SM4T..Y	SMA	5 - 70	400
SMA6T..Y	SMA	5 - 70	600
SM6T..Y	SMB	5.8 - 250	600
SM15T..Y	SMC	5.8 - 70	1,500
SM30T..Y	SMC	15 - 39	3,000

Automotive Transil for Load Dump Protection

Series name	Package	Standoff Voltage (V)
LDP01	D²PAK	22 to 70



Protection Diodes

Transient Voltage Suppressors

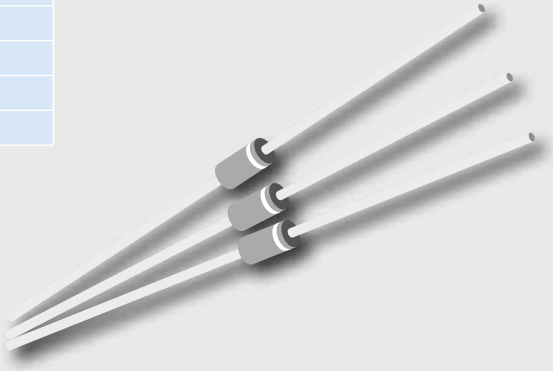
PAR® stands for Passivated Anisotropic Rectifier technology. Diodes with this technology offer high reliability with a maximum junction temperature (Tj) up to 185 °C. PAR® devices are the first choice for automotive applications.
TransZorb® is a product series recommend for general applications.

Surface Mount - Standard Applications (200 - 1,500W)

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
TGL41	MELF	81 - 171	200
SMAJ	SMA	5.0 - 78	400
SMA6J	SMA	5.0 - 28	600
SMA6L	SMA	5.0 - 15	600
P4SMA	SMA	5.8 - 77.8	400
SMBJ	SMB	5.0 - 188	500
P6SMB	SMB	5.8 - 459	500
SMCJ	SMC	5.0 - 188	1,500
1.5SMC	SMC	5.8 - 459	1,500
SMA6F	SlimSMA	6.4 - 24.5	4,000
SMC3	SMCJ	24.4 - 95.8	3,000

Axial Leaded - Standard Applications (400 - 5,000W)

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
P4KE	DO-41	5.8 - 459	400
SA	DO-15	5.0 - 170	500
P6KE	DO-15	5.5 - 376	600
1.5KE	DO-201	5.8 - 459	1,500
3KP	P600	5.0 - 220	3,000
5KP	P600	5.0 - 188	5,000



ESD Protection

Series Name	Package	Number of lines	Working Voltage (V)	Leakage Current (µA)	Typical Device Capacitance (pF)
BZG04	SMA	1	8.2 - 220	5	120 - 1,200
GL	SOT-23	1	5 - 24	1	5
GMF05	LLP75-6A / LLP75-6L	5 / 4	5	0.1 - 1	50 - 150
GSOT	SOT-23	1 / 2	3.3 - 36	1 - 100	65 - 600
SMF	SMF	1	5 - 51	2.4 - 21.7	145 - 1,030
VBUS05	LLP75-4L / LLP75-6A / LLP75-6L / LLP75-7L / LLP1713-9L / LLP2513-11L / SOT23-6L / LLP1010-5L	1 / 2 / 3 / 4	5 - 28	2 - 11	0.4 - 85
VCUT	LLP1006-2M / LLP1006-2L / SOD923 / SOT-23-5L	1 / 4	3.5 - 14	2 - 3.5	8.5 - 15
VESD	LLP75-6A / LLP75-6L / LLP75-7L / LLP1713-9L / LLP1006-2L / LLP1010-6L	1 / 3 / 4 / 5 / 6 / 7 / 8	1 - 12	1.5 - 9	10 - 180

Protection Diodes

Automotive Grade Devices: Qualified According to AEC-Q101

These devices fulfill the automotive requirements such as:

- Manufactured in an ISO/TS 16949 certified facility
- AEC-Q101 qualified*
- Automotive grade 8Ds
- Change control / safe launch policy
- Maverick product policy
- Error-proofing

* The diodes are electrically tested and qualified according to the stress test conditions described in the Automotive Electronics Council (AEC) qualification plan (Q101).

PAR® Automotive

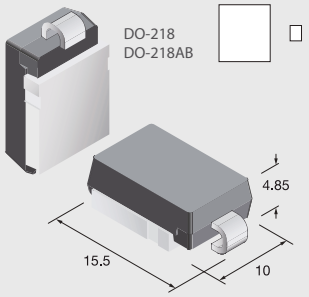
Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
TPSMP..HE	SMP (DO-220AA)	6.05 - 10.2	300
TPSMP..HE	SMP (DO-220AA)	10.5 - 36.8	400
TPSMA..HE	SMA	5.5 - 36.8	400
TPSMB..HE	SMB	5.5 - 36.8	600
TPSMC..HE	SMC	5.5 - 40.2	1,500
3KASMC..HE	SMC	10 - 43	3,000
6KA24..HE	P600	24	6,000
TA6F..HE	SlimSMA	6.8 - 51	600
5KASMC..HE	SMC	10 - 43	5,000
SM8..HE	DO-218AB	10 - 43	6,600

Automotive TransZorb®

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)
SMAJ..HE	SMA	5.0 - 78	400
SMBJ..HE	SMB	5.0 - 188	500
SMCJ..HE	SMC	5.0 - 188	1,500

Load Dump TVS

Series name	Package	Standoff Voltage (V)	Peak Pulse Power (W)	Other Functionality
SM5..HE	DO-218AB	10 - 36	3,600	Load Dump TVS
SM6..HE	DO-218AB	10 - 36	4,600	Load Dump TVS
SM8..HE	DO-218AB	10 - 43	6,600	Load Dump TVS

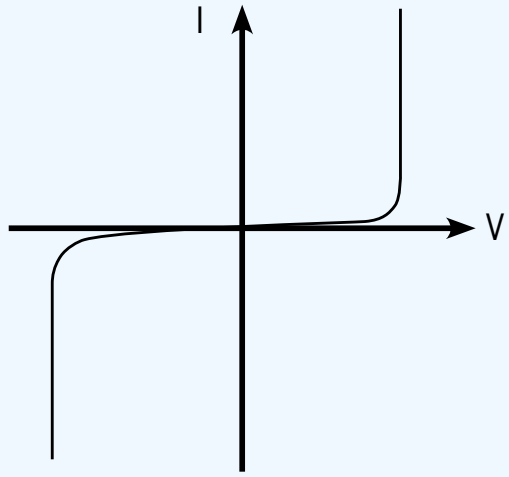


Automotive ESD Protection

Series Name	Package	Number of lines	Working Voltage (V)	Leakage Current (µA)	Typical Device Capacitance (pF)
GSOT..HE	SOT-23	1 / 2	3.3 - 36	1 - 100	65 - 600
SMF..HE	SMF	1	5 - 51	2.4 - 21.7	145 - 1,030

Definition

A varistor is a voltage suppression device that filters and clamps transients in an electrical circuit.
Equal if it's a surface mountable chip or a leaded component this surge suppressor is voltage dependent, nonlinear, and bidirectional and has an electrical behaviour similar to back to back zener diodes.

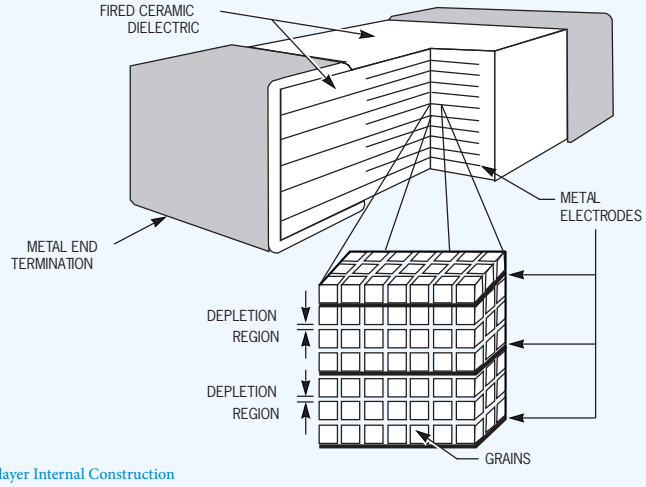


Varistor characteristic

A MLV (Multi Layer Varistor) is constructed by forming a combination of alternating electrode plates and semiconducting ceramic layers into a block.

Each alternate layer of electrode is connected to opposite end terminations. The interdigitated block formation greatly enhances the available cross-sectional area for active conduction of transients.

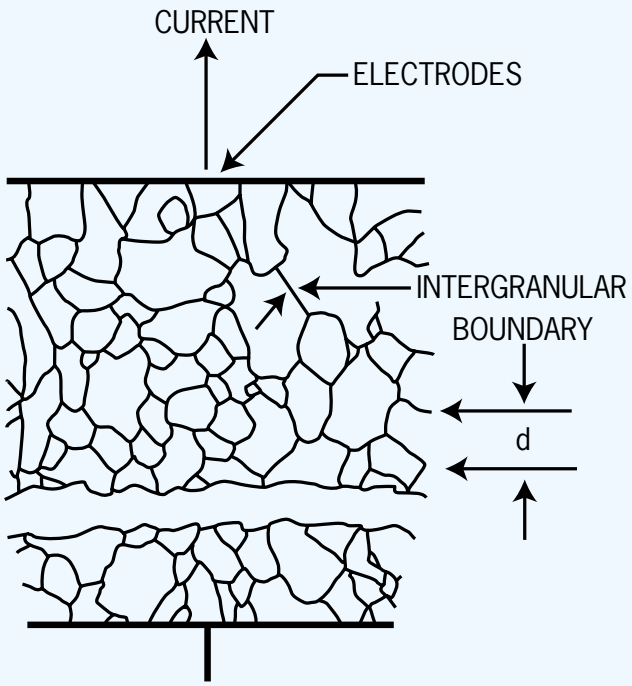
The paralleled arrangement of the inner electrode layers represents significantly more active surface area than the small outline of the package may suggest.



Multilayer Internal Construction

A MOV (Metal Oxide Varistor) is composed primarily of zinc oxide with small additions of bismuth, cobalt, manganese and other metal oxides.
The structure of the body consists of a matrix of conductive zinc oxide grains separated by grain boundaries providing P-N junction semiconductor characteristics.
These boundaries are responsible for blocking conduction at rated voltage and are the source of the nonlinear electrical conduction at higher voltages.

Electrical properties of the MOV are controlled mainly by the physical dimensions of the varistor body. The energy rating is determined by volume, voltage rating by thickness, and current capability by area measured normal to the direction of current flow.



Roadmap Circuit Protection

High Density

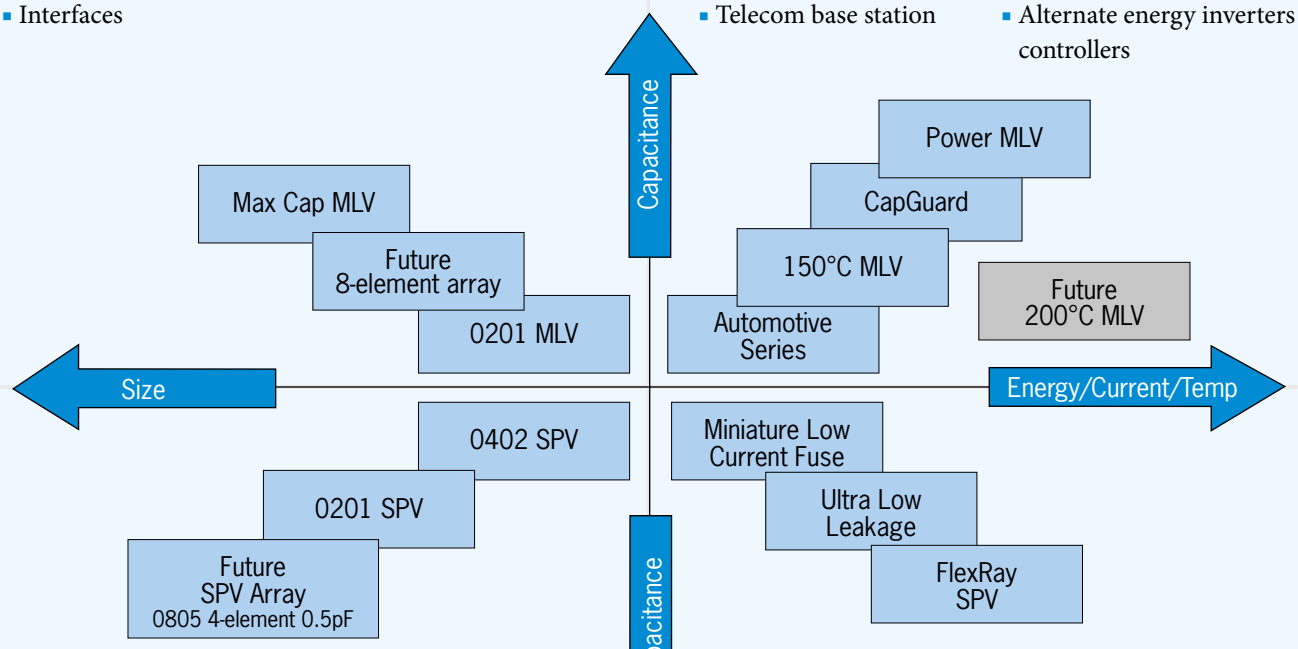
Key Applications

- Advanced cell phone
- PDA
- Medical monitors
- LED lighting
- Interfaces
- GPS
- Notebook
- Keypad/Keyboard
- Parallel ports

Power TVs - Max Cap/Energy

Key Applications

- Inductive loads
- Avionic power
- Heavy equipment
- Industrial controllers
- Telecom base station
- SMART grid advanced
- High end AC mains
- Autom. under hood modules
- Autom. relays/motor drivers
- Alternate energy inverters & controllers



Ultra Low Cap

Key Applications

- High speed ports
- HDMI
- USB 3.0
- Ethernet line
- Keyless entry
- RF ports & modules
- Sensors
- Optics circuits
- FlexRay

Low Cap - Low VC/VB

Key Applications

- Battery operated devices
- FETs
- Sensors
- PDA
- HDMI 1.3
- LED lighting
- Medical monitors
- Backlit display
- GPS
- RF circuits

AVX Varistor Series & Applications

AVX
A KYOCERA GROUP COMPANY

Circuit Protection in professional, industrial and other applications

Series	PN Code	Range	Features	Applications Examples
TVS + EMI filtering				
TransGuard® and MultiGuard	VC VG MG	**Case size:** 0201 - 2220 **Working Voltage:** 3.3 - 85Vdc **Energy:** 0.01J - 12J **Peak Current:** 1A - 2,000A	Wide range of multilayer varistors for bi-directional overvoltage protection as well as EMI/RFI attenuation. Multiguards are 2 and 4-element arrays for protection of multiple lines with single component.	IC Protection | DC Motors | Automation | LED | Alarms | Inductive switching | Bluetooth | I/O Lines | Portable devices
StaticGuard	VC**LC	**Case size:** 0402 - 1206 **Working Voltage:** 18Vdc **Energy:** 0.02J - 0.1J **Capacitance:** 40 - 200pF	Lower capacitance version of TransGuard® for bi-directional ESD protection as well as EMI/RFI attenuation.	Sensors | CMOS | Switches | Data lines | Bipolar and SiGe based systems
Controlled Capacitance	VCAC	**Case size:** 0603 **Working Voltage:** 22, 26Vdc **Peak Current:** 30A **Capacitance:** 47, 82pF	Varistors developed for use in mixed signal environment for targeted EMI/RFI filtering and transient suppression.	EMI TVS Module Control | High Speed ASICs | Sensors | IC
Radial CapGuard™	CG	**Case size:** Radial **Working Voltage:** 26, 45Vdc **Peak Current:** 200A **Capacitance:** 0.47, 1µF	TransGuard® varistor and RF filtering high capacitance ceramic capacitor integrated into single radial leaded component for bi-directional overvoltage protection and RFI noise suppression.	Inductive loads | DC Motors | Relays | TVS and radiated and conducted noise filtering
TransFeed	V*F	**Case size:** 0805, 0612 **Working Voltage:** 5.6 - 26Vdc **Energy:** 0.05 - 0.3J **Peak Current**: 15 - 120A	Varistor with FeedThru filter construction offers transient protection with enhanced noise reduction and low parallel inductance.	Imaging | GPS | Bar code scanners | Instrumentation | I/O Lines | Power line conditioning
TVS + Low Signal Distortion/Low Loss (Low Capacitance)				
USB Series	USB	**Case size:** 0402 - 0612 **Working Voltage:** 18Vdc **Peak Current:** 4A **Capacitance:** 3 - 10pF	Low capacitance varistors with low leakage and low loss designed for use in high-speed data lines and other capacitance sensitive applications.	Sensors | Data lines | USB/Firewire Ethernet | Computers | LCD
AntennaGuard and Sub pF AG Series	VC**AG VCH4**AG	**Case size:** 0402 - 0603 **Working Voltage:** 10 - 18Vdc **Capacitance:** 0.47 - 12pF	Low capacitance varistors with low leakage and low signal distortion designed for protection in RF circuits, high-speed data lines, optic circuits and capacitance sensitive applications.	RF Circuits | Antennas | WLAN | Sensors | Data lines | HDMI | USB 2.0 | Touch controls | Touch screens
TVS + Very Low Leakage				
UltraGuard	VCUG MGUG	**Case size:** 0402 - 0612 **Working Voltage:** 3.0 - 32Vdc **Energy:** 0.02 - 0.4J **Peak Current:** 10 - 150A	Low leakage (<1µA) varistors for battery operated devices, high clock speed IC, low voltage power conversion circuits and low leakage requirements.	Portable equipment | High clock speed IC | Battery-operated device | Fingerprint ID | Sensors | Optics circuits
TVS + Harsh Environment				
Glass Encapsulated Varistors	VG VJ	**Case size:** 1206 - 3220 **Working Voltage:** 16 - 385Vdc **Energy:** 0.3 - 15J **Peak Current:** 120 - 2000A	Glass encapsulated high energy, large case size varistors. The glass encapsulation provides enhanced resistance against harsh environment.	Harsh Environment | High Energy Applications | DC motors | Inductive Loads
Radial and Axial Varistors	VR**AS VR**AT VA	**Case size:** Radial, Axial **Working Voltage:** 3.3 - 60Vdc **Energy:** 0.1 - 2.0J **Peak Current:** 30 - 500A	Radial and axial leaded epoxy coated varistors, designed for durability in harsh environments and applications where leaded component is preferred. VRAT series are specified up to +150°C.	DC Motors | Inductive loads | Down hole drilling| Relays | White goods | Industrial equipment | Sensors

Additional series suitable for industrial and other applications include:

- **MAV Miniature AC Series Varistors** for low power AC applications
- **Communication Bus Varistors** with low capacitance suitable for communication bus, data lines, sensors etc.
- **High Temperature Automotive Varistors** - rated to +150°C.

More details for these series are listed on the next page.

AVX Varistor Series & Applications

Circuit Protection in automotive applications (AEC-Q200 qualified)

Series	PN Code	Range	Features	Applications Examples
TVS / Load Dump (TransGuard®) + EMI filtering				
TransGuard® Automotive	VCAS VGAS	**Case size:** 0402 - 2220 **Working Voltage:** 5.6 - 85Vdc **Energy:** 0.05J - 12J **Peak Current:** 20A - 2,000A	Wide range multilayer varistors for bi-directional overvoltage protection as well as EMI/RFI attenuation. Specified with load dump and jump start rating where applicable.	All automotive applications | Safety | Body electronics | Drive train | Comfort & convenience | Load dump protection
StaticGuard Automotive	VCAS**LC	**Case size:** 0402 - 0805 **Working Voltage:** 18Vdc **Energy:** 0.02 - 0.1J **Capacitance:** 40 - 80pF	Lower capacitance version of TransGuard® for bi-directional ESD protection as well as EMI/RFI attenuation.	CMOS | Module Interfaces | Sensors | Data lines | Transceiver chips | General purpose logic
Controlled Capacitance	VCAC	**Case size:** 0603 **Working Voltage:** 22, 26Vdc **Peak Current:** 30A **Capacitance:** 47, 82pF	Varistors developed for use in mixed signal environment for targeted EMI/RFI filtering and transient suppression.	EMI TVS Module Control | High Speed ASICs | Sensors | IC
Radial CapGuard™	CG	**Case size:** Radial **Working Voltage:** 26, 45Vdc **Peak Current:** 200A **Capacitance:** 0.47, 1µF	TransGuard® varistor and RF filtering high capacitance ceramic capacitor integrated into single radial leaded component for bi-directional overvoltage protection and RFI noise suppression.	Inductive loads | DC Motors (e.g. window lifters, central lock) | TVS and radiated and conducted noise filtering
TransFeed Automotive	V*AF	**Case size:** 0805, 0612 **Working Voltage:** 5.6 - 26Vdc **Energy:** 0.05 - 0.3J **Peak Current:** 15 - 120A	Varistors with FeedThru filter construction for transient voltage protection with enhanced noise reduction and low parallel inductance.	Drive by Wire | Electric Mirror | I/O ports | LCD Dashboard Driver | Power line conditioning
TVS + Low Signal Distortion/Low Loss (Low Capacitance)				
Communication Bus Varistors	CAN FLX	**Case size:** 0402- 0612 **Working Voltage:** 18, 32Vdc **Peak Current:** 4 - 10A **Capacitance**:15 - 37pF	Low capacitance varistors designed for communication lines protection with high reliability (<0.1FIT per billion hrs) and high inrush current capability compared to diodes.	CAN Bus | FlexRay | Data lines | Body control modules | General I/O protocols
AntennaGuard & Sub pF AG Automotive	VCAS**AG VCASH4	**Case size:** 0402-0603 **Working Voltage:** 16, 18Vdc **Capacitance:** 0.8 - 12pF	Low capacitance varistors with low leakage and low signal distortion designed for protection in RF circuits, high-speed data lines, optic circuits and capacitance sensitive applications.	RF Circuits | Sensors | Antennas | Data lines | Bluetooth | HDMI | Cameras | Crash avoidance
TVS + Harsh Environment/High Temperature				
Glass Encapsulated Automotive Varistors	VGAS VJ**MA VJ**PA	**Case size:** 1206 - 3220 **Working Voltage:** 16 - 65Vdc **Energy:** 0.3 - 13.8J **Peak Current:** 120 - 2,000A	Glass encapsulated high energy, large case size automotive series varistors. The glass encapsulation provides enhanced resistance against harsh environment.	Harsh Environment | High Energy Applications | Power Steering | Load Dump Protection
High Temp Automotive	CANAT VCAT CANATL	**Case size:** 0603 - 0612 **Working Voltage:** 18, 32Vdc **Peak Current:** 4A, 5A **Capacitance:** 10 - 22pF	High temperature low capacitance varistors with low leakage and low loss, specified to +150ºC.	Under hood/High Temp | Communication Bus | RF Circuits | Sensors | Body control module | Transmission control unit
Radial Leaded Automotive TransGuard®	VR**AS VR**AT	**Case size:** Radial **Working Voltage:** 14 - 48Vdc **Energy:** 0.1 - 2.0J **Peak Current:** 30 - 500A	Radial leaded epoxy coated varistors, designed for durability in harsh environments and applications where leaded component is preferred. VRAT series are specified up to +150°C.	Inductive switching | DC Motors | Relays | Under hood / High Temp | Turbocharger
TVS + Low Power AC				
Miniature MAV Series	MAV	**Case size:** 0402 - 0603 **Working Voltage:** 70Vdc/52Vac **Peak Current:** 1 - 3A **Capacitance:** 6 - 22pF	Varistors designed for low power AC circuit protection, transient suppression in LC resonant circuits and higher DC voltage data lines protection. 110V peak to peak capability at 125kHz.	LC resonant circuits | Keyless entry | Immobilizers | Data lines

Littelfuse Ceramic Surge Protectors (MOV, MLV & GDT) & Applications

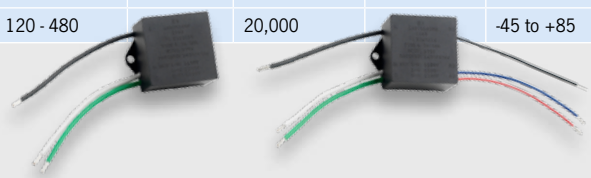
Littelfuse
Expertise Applied | Answers Delivered

Varistors

Series Name	Technology Type	Operating AC Voltage Range (V)	Operating DC Voltage Range (V)	Peak Current Range (A)	Peak Energy Range (J)	Operating Temperature Range	Disc Size	Agency Approvals				RoHS Compliant	Lead Free	Halogen Free
								UL	CSA	VDE	CECC			
Surface Mount MLV / MOV														
MHS	Multi-Layer Zinc Oxide (MLV)	9 - 42	30 - 135	300		-55°C to +125°C	0402 - 2003					■		■
MLE		18	18	22 - 28			0402 - 2003					■		■
ML		2.7 - 107	5.5 - 120	4 - 500	0.02 - 2.5		0603, 0805, 1206, 1210					■		■
MLN		18	5.5 - 18	30	0.05 - 0.10		1206					■		■
CH	Zinc Oxide (MOV)	14 - 275	18 - 369	100 - 250	1.0 - 8.0		8.2 x 5 x 2 (L x W x H mm)	■				■	■	■
SM7		275 - 510	369 - 675	1,200	23 - 40		7mm	■				■	■	■
SM20		20 - 320	26	6,500	165		20mm	■				■	■	■
Radial Leaded MOV														
TMOV®/ iTMOV®	Thermally Protected Varistor	115 - 750	150 - 970	6,000 - 10,000	35 - 480	-55°C to +85°C	14, 20mm	■	■	■	■	■	■	
TMOV® 25S		115 - 750	150 - 970	20,000	170 - 670		25mm	■		■	■	■	■	
TMOV® 34S		115 - 750	150 - 970	40,000	235 - 1,050		34mm	■	■	■	■	■	■	
SMOV25S		115 - 750	150 - 970	20,000	170 - 670		25mm	■				■	■	
SMOV34S		115 - 750	150 - 970	40,000	235 - 1,050		34mm	■				■	■	
UltraMOV™	Zinc Oxide (MOV)	130 - 625	170 - 825	1,750 - 10,000	12.5 - 720	-55°C to +85°C	7, 10, 14, 20mm	■	■	■	■	■	■	■
UltraMOV™25S		115 - 750	150 - 970	22,000	230 - 890		25mm	■	■	■	■	■	■	■
LV UltraMOV™		11 - 40	14 - 56	500 - 8,000	0.8 - 140		5, 7, 10, 14, 20mm	■				■	■	■
C-III		130 - 660		3,500 - 9,000	40 - 530		10, 14, 20mm	■	■	■	■	■	■	■
LA		130 - 1,000	175 - 1,200	1,200 - 6,500	11 - 360		7, 10, 14, 20mm	■	■	■	■	■	■	■
ZA		4 - 460	5.5 - 615	50 - 6,500	0.1 - 52		5, 7, 10, 14, 20mm	■	■	■	■	■	■	■

Varistor Modules

Series Name	Technology Type	Operating AC Voltage Range (V)	Operating DC Voltage Range (V)	Peak Current Range (A)	Peak Energy Range (J)	Operating Temperature Range (°C)	Disc Size / Size	Agency Approvals				RoHS Compliant	Lead Free	Halogen Free
								UL	CSA	VDE	CECC			
LSP05	Thermally Protected Varistor Module	120 - 480		10,000		-45 to +85	20mm	■				■	■	■
LSP10	Thermally Protected Varistor Module	120 - 480		20,000		-45 to +85	25mm	■				■	■	■



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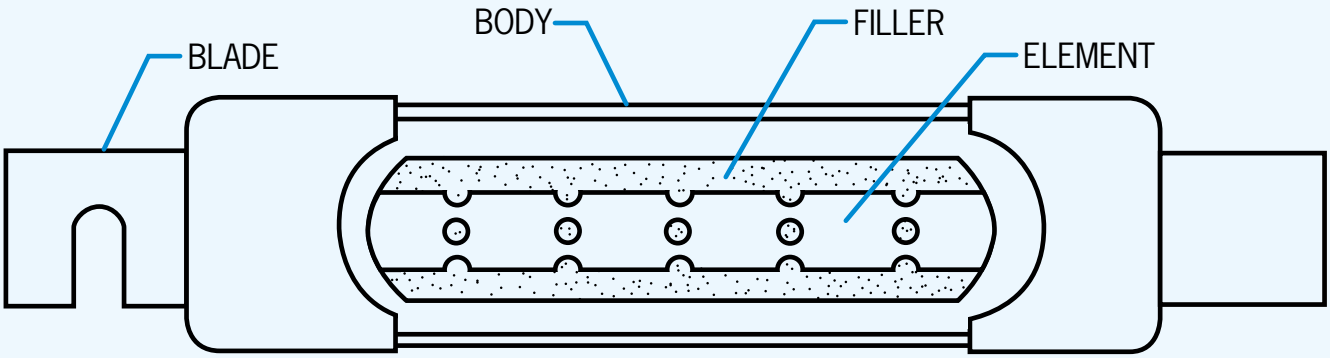
Gas Discharge Tubes

Series Name	DC Breakover Voltage Range (Nom VBO)	Max AC Surge Rating (A)	Peak Pulse Current (8x20µs) (kA)	Max Capacitance (pF)	Operating Temperature Range (°C)	Terminals	Disc Size	Mounting Options					RoHS Compliant	Lead Free
								Mini Tube	Surface	Axial Lead	Radial Lead	Cartridge Clip		
High Voltage GDTs														
AC	285 - 600		5	1.5	-40 to +90	2				■			■	
CG3	1,000 - 7,500		5	1.5		2				■			■	
Low to Medium Surge GDTs														
SE	140 - 500		0.5	<0.5	-40 to +90	2	1206		■				■	■
SG	75 - 420	2	up to 2	<1		2	4.5 x 3.2 x 2.7mm		■				■	■
SL0902A / SL1002A	75 - 600	5	5	1.5		2		■	■				■	■
SL1003A	90 - 500	10	10	1.5		3		■	■		■		■	■
Medium to High Surge GDTs														
SL1021A	90 - 600	10	10	1.5		3			■		■		■	■
Very High Surge GDTs														
SL1021B	90 - 600	10	20	1.5	-40 to +90	3			■		■		■	■
SL1026	275 - 700	10	20			2						■	■	■

Varistors - Automotive Grade

Series Name	Technology Type	Operating AC Voltage Range (V)	Operating DC Voltage Range (V)	Jump Start Voltage (V)	Load Dump Energy (J)	Operating Temperature Range (°C)	Disc Size	Agency Approvals				RoHS Compliant	Lead Free	Halogen Free
								UL	CSA	VDE	CECC			
Surface Mount MLV / MOV														
MLA AUTO	Multi-Layer Zinc Oxide (MLV)		3.5 - 48	24.5 - 48	0.3 - 3.0	-55 to +125	0603. 0805, 1206, 1210					■		■
AUML	Multi-Layer Zinc Oxide (MLV)		18	24.5	1.5 - 25	-55 to +125	1206, 1210, 1812, 2220					■		■
Automotive Grade Radial Leaded MOV														
AUMOV	Zinc Oxide (MOV)		16 - 50	25 - 55	6 - 100	-55 to +125	5, 7, 10, 14, 20mm	■				■	■	■



Fuse

A fuse is a self-acting device that, by the fusing of one of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time.

Definition according to IEC 60127:
The fuse comprises all the parts that form the complete device, that means fuseholder and fuse-link.

Definition according to UL 248-1:
A North American fuse is an IEC fuse-link. An IEC fuse is a North American fuse with a fuse-holder.

Fuse Construction And Operation

The typical fuse consists of an element which is surrounded by a filler and enclosed by the fuse body. The element is welded or soldered to the fuse contacts (blades or ferrules). The element is a calibrated conductor. Its configuration, its mass, and the materials employed are selected to achieve the desired electrical and thermal characteristics. The element provides the current path through the fuse. It generates heat at a rate that is dependent upon its resistance and the load current. The heat generated by the element is absorbed by the filler and passed through the fuse body to the surrounding air. A filler such as quartz sand provides effective heat transfer and allows for the small element cross-section typical in modern fuses. The effective heat transfer allows the fuse to carry harmless overloads. The small element cross section melts quickly under short circuit conditions. The filler also aids fuse performance by absorbing arc energy when the fuse clears an overload or short circuit.
When a sustained overload occurs, the element will generate heat at a faster rate than the heat can be passed to the filler. If the overload persists, the element will reach its melting point and open. Increasing the applied current will heat the element faster and cause the fuse to open sooner.

Thus fuses have an inverse time current characteristic, i.e. the greater the overcurrent the less time required for the fuse to open the circuit. This characteristic is desirable because it parallels the characteristics of conductors, motors, transformers and other electrical apparatus. These components can carry low level overloads for relatively long times without damage. However, under high current conditions damage can occur quickly. Because of its inverse time current characteristic, a properly applied fuse can provide effective protection over a broad current range, from low level overloads to high level short circuits.

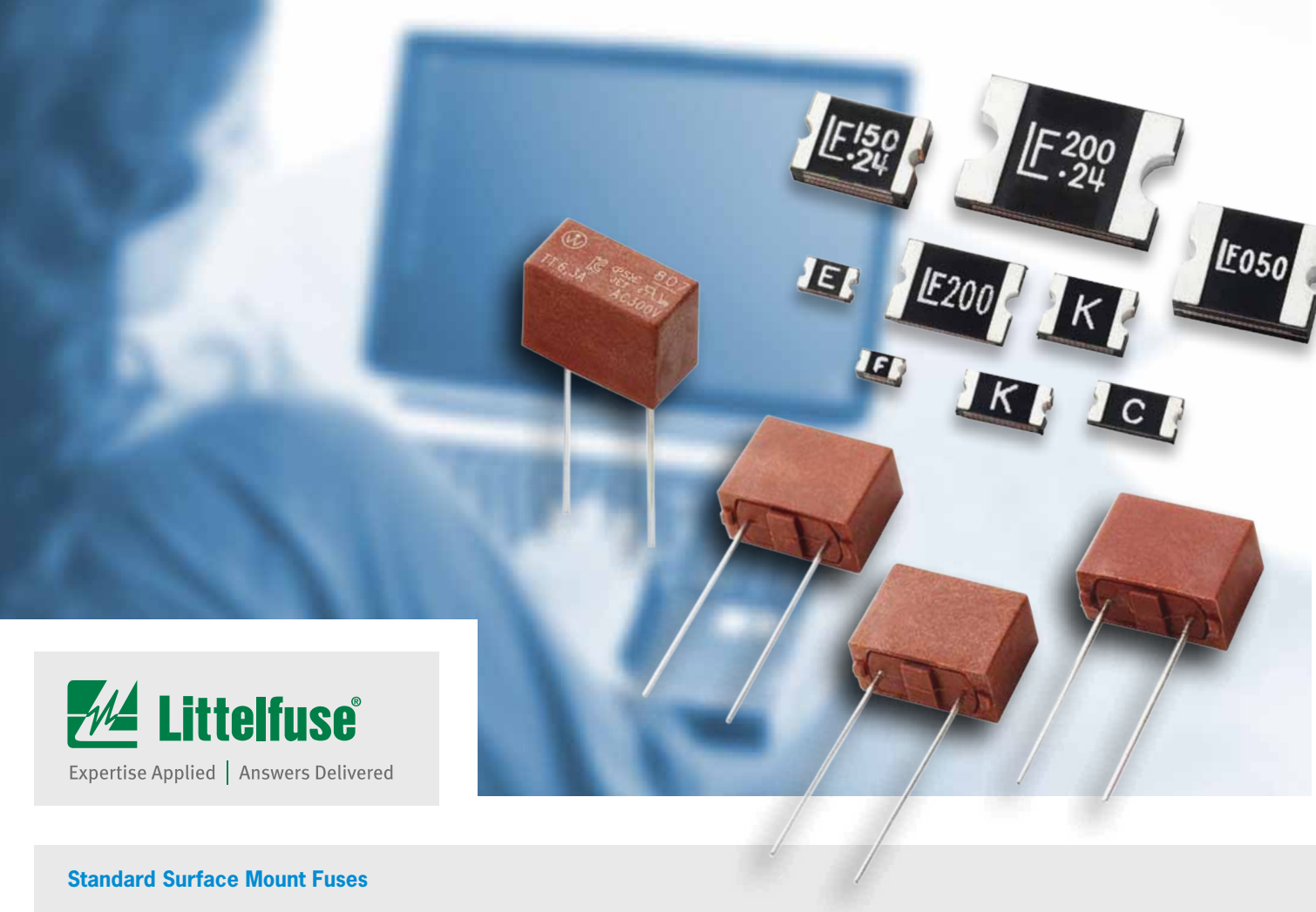
	Littelfuse	EATON	SCHURTER
Fuses 5x20; 6.3x32	■	■	■
SMT Fuses	■	■	■
Miniature Fuses	■	■	■
Automotive Fuses	■	■	
PTC Fuses	■	■	■
Solar Fuses	■	■	■
Fuseholder	■	■	■

Powering Business Worldwide

Resettable PTCs	Radial Leaded	Radial Leaded	Radial Leaded	Surface Mount	Surface Mount
Series Name	**PTR016V**	**PTR030V**	**PTR060V**	**PTS1206**	**PTS1812**
I hold	0.9 - 15A	0.9 - 9A	0.1 - 3.75A	0.05 - 2A	0.1 - 3A
Voltage	16VDC	30VDC	60VDC	6 - 60VDC	6 - 60VDC
Max fault current (Imax)	40A - 100A	40A - 100A	40A	100A	10 - 100A
Dimension	different to I (Hold)	different to I (Hold)	different to I (Hold)	3.2 x 1.6 mm	4.5 x 3.2 mm
Agency	▪ cURus: Recognized Card: File E343021 (Ihold 3A-15A) ▪ TUV File: J 50194729	▪ cURus: Recognized Card: File E343021 ▪ TUV File: J 50194729	▪ cURus: Recognized Card: File E343021 ▪ TUV File: J 50194729	▪ cURus: Recognized Card: File E343021 ▪ TUV File: R 50192872	▪ cURus: Recognized Card: File E343021 ▪ TUV File: R 50192872

Surface Mount Fuses	Chip Fuse	Chip Fuse	Brick Fuse	Brick Fuse	Brick Fuse
Series Name	CC06H	3216FF	CB61F	6125TD	1025TD
Ampere range	1 - 5A	0.25 - 30A	2 - 15A	0.5 - 7A	0.25 - 5A
Voltage	32VAC	24 - 63VDC / 32VAC	125VAC/DC	60VDC / 125VAC	125VDC / 250VAC
Interrupting rating at Max.Voltage Rating	50A	50 - 300A	50 - 100A AC/300A DC	50A	50A
Dimension	1.6 x 0.81mm	3.2 x 1.6 mm	6.1 x 2.57 mm	6.1 x 2.72 mm	10.29 x 2.77 mm
Characteristic	fast Acting	fast Acting	fast Acting	Time Delay	Time Delay

Non Surface Mount Fuses	Ceramic Tube Fuse	Ceramic Tube Fuse	Ceramic Tube Fuse	Radial Leaded Fuse	Radial Leaded Fuse
Series Name	S505H	ABC	MDA	SR-5	SS-5H
Ampere range	0.5 - 10A	0.25 - 40A	0.25 - 30A	0.10 - 6.3A	1 - 6.3A
Voltage	400VDC / 500 - 600VAC	125VDC / 250VAC	125VDC / 250VAC	250VAC	300VAC
Interrupting rating at Max.Voltage Rating	1,500A	35 - 10,000AC / 400 - 10,000DC	35 - 1500A AC / 10,000A DC	35 - 63A	100A
Dimension	5 x 20 mm	6.4 x 31.7 mm	6.35 x 31.75 mm	7.6 x 8.5 mm	4.3 x 7.85 mm
Characteristic	Time Delay	fast Acting	Time Delay	Time Delay	Time Delay



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Standard Surface Mount Fuses

Surface Mount	Thin Film				Ceramic Chip		Nano								Nano - UMF			Tele-link
Series Name	435	466	467	468	438	501	458	476	453	454	449	443	456	463	462	464	465	461
Ampere Range	0.25 - 5	0.125 - 5	0.25 - 5	0.5 - 3	0.25 - 6	15 - 20	1 - 10	12 - 15	0.062 - 15	0.375 - 5	0.375 - 5	0.5 - 5	20 - 40	15 - 30	0.5 - 5	0.5 - 6.3	01.06. 2003	0.5 - 2.0
Voltage	32	125 / 63 / 32	32	63 / 32	32 / 24	24	63	125	125 / 65	125	125	250	125 / 100 / 65 / 32	12 - 250	250 / 350	250	250	600
Interrupting rating at max.voltage rating	35	50	35 - 50	35 - 50	50	150	50	100 - 300	50 - 300	50	50	50	100 - 1000	100 - 2500	100 - 150	100	100	60
Dimension	402	1206	0603	1206	0603	1206	805	2410	2410	2410	2410	4012	4012	4012	10.5x4.5	12.1x6.9	12.1x6.9	4012
Characte-ristics	Very Fast Acting	Very Fast Acting	Very Fast Acting	Time Lag (Slo-Blo)	Fast Acting	Very Fast Acting	High Inrush	Fast acting	Fast acting	Slo-Blo	Time Lag (Slo-Blo)	Time Lag (Slo-Blo)		High inrush	Time Lag	Fast Acting	Time Lag	
Operating Temp (°C)	-55 to 90	-55 to 90	-55 to 90	-55 to 90	-55 to 150	-55 to 150	-55 to 125	-55 to 125	-55 to 125	-55 to 125	-55 to 125	-55 to 125	-55 to 125	-55 to 125	-40 to 85	-55 to 125	-55 to 125	-55 to 125

Radial Leaded/Socket & Axial Leaded/Cartridge

Type	Radial Leaded / Socket				Axial Leaded / Cartridge				
	TR5	TE5			3.6x9mm	PICO II	PICO II	PICO II	4.5x14.5mm (2AG)
Series Name	372	396	392	808	777	471	473	275	224/225
Ampere Range	0.4 - 6.3	0.05 - 6.3	0.225 - 6.3	2.0 - 5.0	1.25	0.5 - 5	0.375 - 7	20 - 30	0.1 - 10
Voltage	250V AC	125V AC	250V AC	250V AC / up to 450V DC	250	125	125	32	250 / 125
Interrupting rating at max.voltage rating	35 -50A	100A	25 - 50A	up to 200A AC / up to 10kA DC	50	50	50	100 - 300	35 - 500
Characteristics	Time Lag (Slo-Blo)	Time Lag (Slo-Blo)	Time Lag (Slo-Blo)	Fast Acting	High Surge Withstanding Fuse	Time Lag (Slo-Blo)	Slo-Blo	Very Fast acting	Fast Acting

Solar Fuses

	Solar String Fuse	Solar Fuse	Solar In-Line String Fuse	Solar String Fuse	Solar In-Line String Fuse
Series Name	SPF	SPFJ	SPFI	SPXV	SPXI
Ampere Range	1 - 30	70 - 450	2 - 20	6 - 30	2.5 - 20
Voltage	1,000VDC	600VAC / 1,000VDC	1,000VDC	1,500VDC	1,500VDC
Interrupting rating at max. voltage rating	20kA	up to 200kA AC / up to 20kA DC	up to 20kA DC	up to 30kA DC	up to 30kA DC
Approval	IEC & UL	IEC & UL	UL / CE	IEC & UL	UL / CE
Dimension	10x38mm	Class J	63.5 x 10.31mm	85.3 x 41mm	81.41 x 10.31mm and 110.06 x 10.31mm

Special Fuses

	Barrier Fuse	Intrinsically Safe Fuses	
Series Name	242	259 UL913	305
Ampere Range	0.05 - 0.250	0.062 - 5	0.05 - 0.75
Voltage	250V AC / DC	125V AC / DC	277V AC / DC
Interrupting rating at max. voltage rating	4,000A	50A AC / 300A DC	1,500A
Approval	UL	UL913, IECEx, Baseefa ATEX	UL913, IECEx, Baseefa ATEX
Applications	Hazardous Area Network Fuse	ExAreas	ExAreas

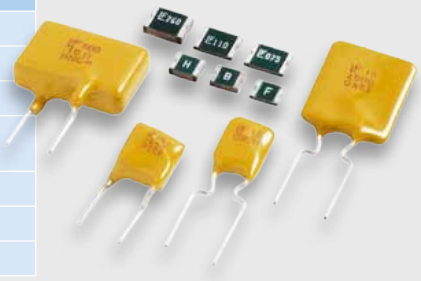
Resettable PTCs

Surface Mount								
Series Name	0402L	0603L	0805L	1206L	1210L	1812L	2016L	2920L
I hold	0.1 - 0.5A	0.08 - 1.75A	0.1 - 3.0A	0.125 - 4.5A	0.05 - 4.5A	0.1 - 3.7A	0.3 - 2.0A	0.3 - 7.0A
Voltage	6V	6 - 15V	6 - 24V	6 - 12V	6 - 30V	6 - 60V	6 - 60	6 - 60V
Max fault current (Imax)	40 - 50A	40 - 50A	40 - 100A	50 - 100A	10 - 100A	10 - 100A	20 - 40A	10 - 50A
Dimension	0402	0603	0805	1206	1210	1812	2016	2920
Radial Leaded								
Series Name	06R	16R	30R	60R	72R	250R	250S	600R
I hold	0.75 - 1.55A	0.9 - 9A	0.9 - 9A	0.1 - 3.75A	0.2 - 3.75A	0.08 - 0.18A	0.08 - 0.13A	0.15 - 0.16A
Voltage	6V	16V	30V	60V	72V	250VAC	250VAC	600VAC
Max fault current (Imax)	40A	40 - 100 A	40A	40A	40A	3 - 10A	3A	3A
Dimension	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

Automotive Fuses

Type	HEV Fuse (Hybrid Electric Vehicle)	
Series Name	LC HEV	LC HEV 50A
Ampere Range	10 - 30A, 40A	50A
Voltage	450VDC, 425VDC	250VAC
Interrupting rating at max.voltage rating	1,0000A	2,000A
Dimension	10 x 38mm	10 x 38mm
Characteristics		
Applications	Hybrid Electric Vehicles	Hybrid Electric Vehicles

High Temperature Resettable PTCs	Radial Leaded
Series Name	16RH-S
I hold	5 - 20 A
Voltage	16 V
Max fault current (Imax)	100 A
Operating Temp.	125°C
Dimension	Radial Lead
Approval	AEC-Q200



	5x20mm	5x20mm	5x20mm	5x20mm	5x20mm	6x25mm	6.3x32mm	6.3x32mm	6.3x32mm	6.3x32mm	6.3x32mm
	218	477	487	835	977	688	328	505	507	506	508
	0.0032 - 16	0.5 - 16	5 - 16	5 - 8	0.5 - 16	30	21	10 - 30	1 - 8	15, 16, 20	0.315 - 2
	250	500V AC / 400V DC	420	250	500V AC / 450V DC	70V DC	300V AC / 100V DC	450V - 500V AC / 250V - 500V DC	650	600V DC	1,000V
	35 - 100	100A AC / 400 - 1,500A DC	200A - 300A	1500	100A AC / 200A DC	2500A	200A	up to 50kA AC / up to 20kA DC	150	10kA	10kA
	Time Lag (Slo-Blo)	Time Lag (Slo-Blo)	Fast acting	Time Lag (Slo-Blo) / High Surge withstand	Time Lag (Slo-Blo)	High Surge Withstanding Fuse	High Surge Withstanding Fuse	Fast Acting	Fast Acting	Fast Acting	Fast Acting

Product Overview Fuses

SCHURTER ELECTRONIC COMPONENTS

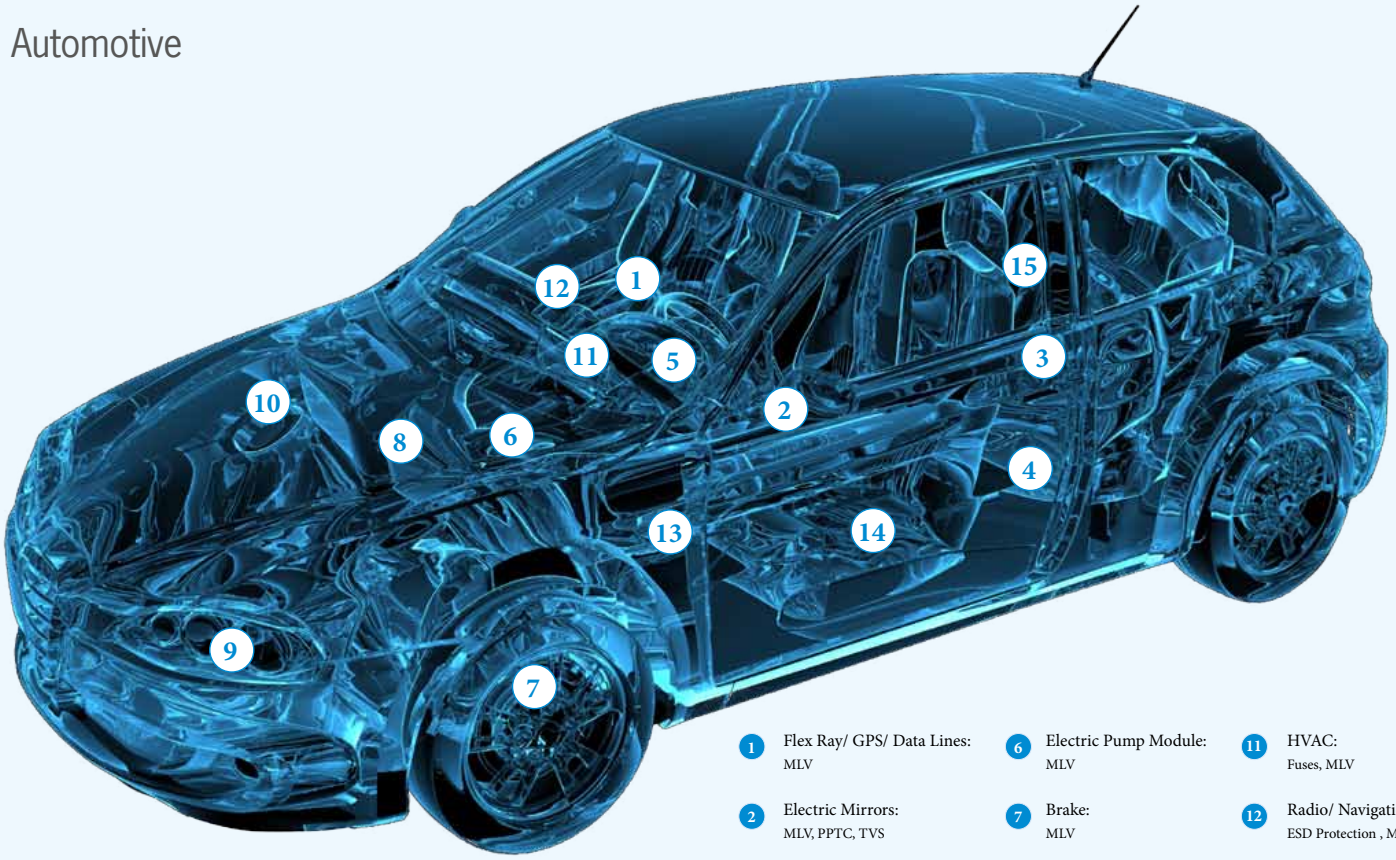
	Type Product Description	Size [mm]	Rated Voltage	Current Range	Breaking Capacity	Characteristic					Approvals									
											Europe			Ameri-cas		Asia			
						Super-Quick-Acting FF	Quick-Acting F	Medium-Time-Lag M	Time-Lag T	Super-Time-Lag TT	UMF	VDE	VDE ÜG	UL	cURus	PSE	CCC	CQC	KC
SMD Fuses																			
	UMT-H High breaking capacity	5.3 x 16	250 - 277 VAC 125 - 250 VDC	0.16 - 10 A	1,500 A				■						■				
	UMT 250 Primary and secondary protection	3 x 10.1	250 - 277 VAC 65 - 125 VDC	0.08 - 10 A	35 - 200 A				■		■	■		■	■	■		■	■
	UMF 250 Primary and secondary protection	3 x 10.1	250 VAC 125 VDC	0.5 - 10 A	100 - 200 A		■				■	■			■				
	UMZ 250 With pre-assembled clip	3.6 x 11.3	250 - 277 VAC 63 - 250 VDC	0.063 - 10 A	35 - 200 A				■										
	MGA Hermetic. sealed, medical, defense	1.55 x 3.2	32 - 125 VAC 32 - 125 VDC	0.2 - 5 A	50 - 300 A	■									■				
Chip Fuses																			
	USFF 1206 Low power dissipation, precise	1.6 x 3.2 (1206)	125 VAC 63 VDC	0.05 - 0.25 A	100 A	■									■				
	USF 1206 Fast interruption	1.6 x 3.2 (1206)	32 - 125 VAC 63 - 125 VDC	0.375 - 4 A	50 A	■									■				
	USI 1206 IEC standard, VDE approval	1.6 x 3.2 (1206)	32 VAC 63 VDC	0.5 - 6.3 A	63 A		■				■	■			■				
	UST 1206 High rated currents and melting integrals	1.6 x 3.2 (1206)	63 VAC 63 VDC	7 - 25 A	100 - 150 A				■						■				
	USF 0603 Compact secondary protection	0.8 x 1.6 (0603)	32 VAC 32 - 63 VDC	0.5 - 5 A	50 A	■									■				
	USF 0402 Compact secondary protection	0.55 x 1.05 (0402)	24 - 32 VDC	0.375 - 5 A	35 A	■									■				
Fuses for Equipment																			
	FST 5x20 Pigtails optional	5 x 20	250 VAC	0.2 - 20 A	32 - 125 A				■			■	■		■	■	■	■	
	SPT 5x20 High breaking capacity	5 x 20	125 - 250 VAC 125 - 300 VDC	0.5 - 16 A	500 A - 10 kA				■			■	■		■	■	■		■
	FSF 5x20 Pigtails optional	5 x 20	250 VAC	0.032 - 10 A	35 - 100 A		■					■			■	■	■	■	
	SHT 6.3x32 High breaking capacity, pigtails optional	6.3 x 32	500 VAC	1 - 8 A	1.5 kA				■						■				
	SUT 6.3x32 High breaking capacity, pigtails optional	6.3 x 32	125 - 250 VAC	12 - 30 A	500 A - 10 kA				■						■				
	SHF 6.3x32 High breaking capacity, pigtails optional	6.3 x 32	500 VAC	1 - 8 A	1.5 kA		■								■				

Product Overview Fuseholders

SCHURTER ELECTRONIC COMPONENTS

	Type Product Description	Rated Voltage			Rated Current		Power Acceptance acc. IEC	Terminals		Approvals		
		Fuse-Link	IEC	UL	IEC	UL		Solder (THT)	Solder (SMD)	VDE	VDE ÜG	cURus
PCB Mounting (THT)												
	OGN Glow-wire resistant, cover optional	5 x 20	250 VAC	500 VAC 500 VDC	10 A	10 A	4 W / 10 A	■		■		■
	FPG5 Horizontal mounting, glow-wire version optional	5 x 20	250 VAC	400 VAC	10 A	16 A	2.5 W / 10 A	■		■		■
	FUP Horizontal mounting, high power applications	5 x 20 6.3 x 32	500 VAC	600 VAC 600 VDC	16 A	30 A	4 W / 16 A	■			■	■
	FPG4 Vertical mounting, glow-wire version optional	5 x 20	250 VAC	400 VAC	10 A	16 A	2.5 W / 10 A	■		■		■
	FUA Vertical mounting, high power applications	5 x 20 6.3 x 32	500 VAC	600 VAC 600 VDC	16 A	30 A	4 W / 16 A	■			■	■
PCB Mounting (SMD)												
	OGN-SMD Glow-wire resistant, cover optional	5 x 20	250 VAC	500 VAC 500 VDC	10 A	10 A	4 W / 10 A		■	■		■

Automotive



1. Flex Ray/ GPS/ Data Lines: MLV
2. Electric Mirrors: MLV, PPTC, TVS
3. Window Motor: MLV, PPTC, TVS
4. Keyless Entry: MLV, PPTC, TVS
5. Airbag Ignitor: MLV, TVS
6. Electric Pump Module: MLV
7. Brake: MLV
8. Engine Control Unit: MOV, TVS
9. LED Lighting: ESD Protection, Fuses, MLV
10. Load Dump: MLV
11. HVAC: Fuses, MLV
12. Radio/ Navigation: ESD Protection , MLV, TVS
13. Fuse Box: Automotive Fuses
14. Power Seats: PPTC
15. Seatbelt Release: PPTC

Automotive Application Examples

Comfort and convenience

- Electric Mirror
- GPS Location System
- Electric Controls
- Communication Bus / Data lines
- Keyless Entry
- RF Circuits
- LED Lamp
- Audio Entertainment
- HDMI Interface
- Sensors and more

Vehicle types

- Passenger Cars
- Hybrid/Electrical Cars
- Commercial/Utility Vehicles
- Agricultural Vehicles
- Construction Vehicles
- Motorcycles

Safety

- TPMS, TPS
- Airbag
- Traction Control
- Immobilizer
- Central locking system
- ABS
- Bus Interface
- Sensors
- Camera
- Crash Avoidance
- Satellite links and more

Aftermarket

- LED light modules
- Obstacle detection sensors and more

Body electronics

- Electronic control unit
- HID and LED lighting
- Windshield wipers
- Communication Bus / Data lines
- Transponders
- Electronic stability control
- Lamp/LED driver
- Underhood modules
- Rain sensor
- Light sensor
- LCD dashboard driver and more

Drive train

- HEV Modules / Monitors
- GFI
- HEV Relays and disconnects
- Sensors, RF links
- Power conversion interfaces
- Regenerative braking
- Electric drive
- Engine Start/Stop
- TVS&EMI Filtering on high power drain circuits and more

Glossary

Breakdown Voltage (V_{BR})
Breakdown voltage measured at a specified DC test current, typically 1mA. Usually a minimum and maximum is specified.

Capacitance
The property of a circuit element that permits it to store an electrical charge. In circuit protection, the off-state capacitance is typically measured at 1 MHz with a 1V bias applied.

Energy
Maximum energy from one or a burst of pulses. It is the value within the varistor voltage change of +/- 10% when one impulse of 10x1000µs is applied.

Leakage Current
The maximum leakage current is the current that, at most, the varistor is allowed to flow when the maximum operating voltage is applied.

Maximum Clamping Voltage (V_C or V_{Cl})
Maximum voltage which can be measured across the protector when subjected to the Maximum Peak Pulse Current.

Maximum Overload Voltage
The maximum value of voltage capable of being applied to a component for five seconds in the overload test. Typically the applied voltage in the short time overload test shall be 2.5 times larger than the rated voltage.

Maximum Voltage
The maximum value of DC voltage or AC voltage capable of being applied continuously to an electronic component.

Operating Temperature Range
The minimum and maximum ambient operating temperature of the circuit in which a device will be applied. Operating temperature does not allow for the effects of adjacent components, this is a parameter the designer must take into consideration.

Peak Pulse Current (I_{PP})
Maximum pulse current which can be applied repetitively. Usually a 10x1000µs double exponential waveform, but can also be 8x20µs, if stated.

Peak Pulse Power (P_{PP})
Expressed in Watts or Kilowatts, for a 1ms exponential transient it is I_{PP} multiplied by V_{CL}.

Rated Wattage
The maximum power that can be applied within the specified ambient temperature.

Reverse Standoff Voltage (V_R)
In the case of a uni-directional TVS diode, this is the maximum peak voltage that may be applied in the 'blocking direction' with no significant current flow. In the case of a bi-directional transient, it applies in either direction. It is the same definition as Maximum Off-state Voltage and Maximum Working Voltage.

Varistor Voltage
The varistor nominal voltage represents the applied voltage where the varistor transitions from its "standby" mode to its low impedance "clamping" mode. It is measured at the 1mA conduction point.

Withstanding Surge Current
Withstanding Surge Current is the maximum peak current for the varistor with the specified standard impulse current (8x20µs) applied one time or two times and corresponding to a permissible variation of 10% in the varistor voltage change.

Interrupting Rating
The interrupting rating (also known as breaking capacity or short circuit rating) is the maximum current, as stated by the manufacturer, which the fuse can safely interrupt at rated voltage.

RUTRONIK
ELECTRONICS WORLDWIDE

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