

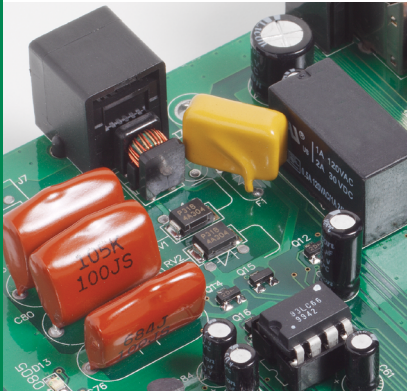


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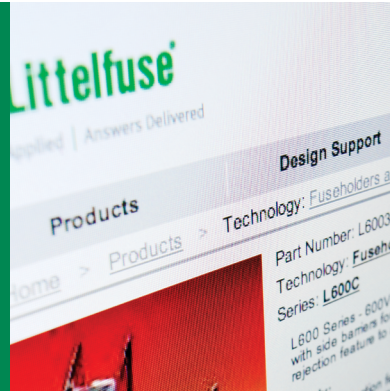




Expertise Applied | Answers Delivered



CIRCUIT PROTECTION SOLUTIONS



Electronics Circuit Protection Product Selection Guide

A guide to selecting Littelfuse circuit protection components for electronic applications.

Broadest and Deepest Portfolio of Product Backed by Unparalleled Circuit Protection Expertise

ABOUT THIS GUIDE

This guide provides a summary of key circuit protection consideration factors, descriptions of the technologies Littelfuse offers, and product selection tables. It is designed to help you quickly find a protection solution appropriate to your application.

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WHY CHOOSE CIRCUIT PROTECTION

Circuit protection devices interrupt overcurrent events and divert overvoltage transients. They increase safety and enable end products to survive harsh electrical conditions.

Most electrical and electronic equipment require circuit protection devices. In many cases they must be installed to comply with safety and performance standards before the end products can be sold or used.

Beyond this, strategically-selected protection devices will:

- Improve end-product uptime, sustainability and reliability
- Assure low warranty return, repair and replacement costs
- Minimize fire and shock risks and larger damage potential
- Minimize operating dangers and potential liabilities

WHY CHOOSE LITTELFUSE

Littelfuse is the global leader in circuit protection solutions. We are the only company to offer all of the pertinent circuit protection technologies, with products that can be used in virtually everything that uses electrical energy.

Complementing our wide portfolio of circuit protection products is a global network of design and technical support expertise.

We offer decades of design experience to help you address application challenges and achieve regulatory compliance.

Your Single Source

Littelfuse offers an extensive circuit protection product line. We design forward-thinking, application-specific solutions to provide assurance that your most demanding requirements will be met. Our goal is to provide the most complete range of options so that you will not have to make compromises.

Testing Support

Littelfuse can help assure that your products will withstand most common threats repeatedly and will fail safely under extreme circumstances. We can serve as an independent source to provide assistance as you design by offering lab testing capabilities for customer applications. This testing includes industry specific required power fault and ESD/EFT/lightning surge conditions.

Application Knowledge

For over 85 years, Littelfuse has maintained a focus on circuit protection, and we will continue to adapt as technologies evolve. Engineers and circuit designers around the world have come to rely on Littelfuse products and application knowledge to support their designs.

Global Support

Littelfuse products, application knowledge and technical support are available around the globe. We offer a network of regional customer support offices and hundreds of independent authorized distributor contacts to assist you. Visit www.littelfuse.com/contact-us to find local support near you.

Standards Compliance Expertise

Most Littelfuse products comply with a wide range of applicable industry and government guidelines, as well as our own rigorous quality and reliability criteria. We continually look forward and adapt to changing requirements, so that our products will comply with industry specific, national and international standards such as CCC, CSA, IEC, IEEE, ISO, ITU, Meti, RoHs, Telcordia, TIA and many more.

FOR FURTHER GUIDANCE

Littelfuse product representatives will work with you to find circuit protection technologies that will meet your requirements.

To address your requirements or questions in detail, please contact a representative near you (Littelfuse.com/contact-us).

For reference diagrams, technical articles, and other application guidance materials to assist in your design processes, please visit Littelfuse.com/designsupport

For detailed selection of Littelfuse circuit protection technologies and their common applications, please visit Littelfuse.com/products

For a library of detailed application guides, please visit Littelfuse.com/technical-resources/application-designs

To download the most current edition of this brochure and our product catalogs, please visit Littelfuse.com/catalogs

Littelfuse

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
Overcurrent Protection Technologies:						
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
PTCs	Resettable; No device replacement after most common overcurrent events	Where overcurrent events may occur often, and continuous uptime desired	Low thru High	Not applicable	Series resistance measured in ohms	Surface Mount, Radial Leaded, Axial Strap
Overvoltage Suppression Technologies:						
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	High	Miniature Surface Mount
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
GDTs	Switches that turn to on state and shunt overvoltage to ground using a contained inert gas as an insulator	Protection of telecom equipment from lightning surges	Medium thru High	Fast	Low	Surface Mount, Axial Leaded, 2/3 Lead Radial
PulseGuard® ESD Suppressors	Extremely low capacitance; Fast response time; Compact size	ESD suppression; Ultra fast reaction; Low signal distortion	Low	Moderate	Low	Miniature Surface Mount
PLED LED Protectors	Shunt function bypasses open LEDs; ESD and reverse power protection	High brightness outdoor LED lighting applications	Low	Very Fast	Medium	Miniature Surface Mount
TVS Diode Array SPA® Diodes	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, Surface Mount
SIDACTor® Protection Thyristors	Specifically designed to serve stringent telecom/ networking standards	Telecom / Datacom and networking applications	Medium thru High	Very Fast	Low	Extensive range of surface mount and thru-hole options
Switching Technologies:						
Power Thyristors	Solid state switches that switch to low "on" state and control the flow of current	Home appliances, power tools, outdoor equipment	Not applicable	Not applicable	Not applicable	Extensive range of surface mount and thru-hole options

1. Fuses and Holders —

Fuses— Full range including surface mount, axial, glass or ceramic, thin-film or Nano^{2®} style, fast-acting or Slo-Blo[®] fuse.

Clips— Used in applications that require a fuse to be easily mounted to a PCB, but real-estate is scarce. Clips are also ideal for high-current applications, allowing for better heat management of the fuse. They are the most economical solution.

Blocks— An alternative solution to Clips but with easier placement on the PC board during manufacturing. In some instances, Blocks may provide insulation to the side ears of the clips. In addition to being through-hole, Blocks can also be screwed or riveted in place.

Holders— The ideal solutions for those applications that require the cartridge fuse to be protected, providing a shock-safe environment. Panel-

mount holders allow for easy replacement of the fuse from outside of the appliance, perfect for applications that require replacing the fuse without opening the appliance enclosure. (Pages 4-6).

2. Positive Temperature Coefficient Devices (PTCs) — Provide resettable overcurrent protection for a wide range of applications (Page 7).

3. Varistors — Multiple forms, from Metal Oxide Varistors (MOVs) and Thermally Protected MOV (TMOV[®] varistors) that suppress lightning transient voltages to Multi-Layer Varistors (MLVs) designed for applications requiring protection from various ESD/EFT transients in computers and handheld devices as well as industrial and automotive applications (Page 8).

4. Gas Discharge Tubes (GDTs) — Available in small footprint leaded and surface

mount configurations, Littelfuse GDTs respond fast to transient overvoltage events, reducing the risk of equipment damage (Page 9).

5. PulseGuard[®] ESD Suppressors — Available in various surface mount form factors to protect high-speed digital lines without causing signal distortion (Page 9).

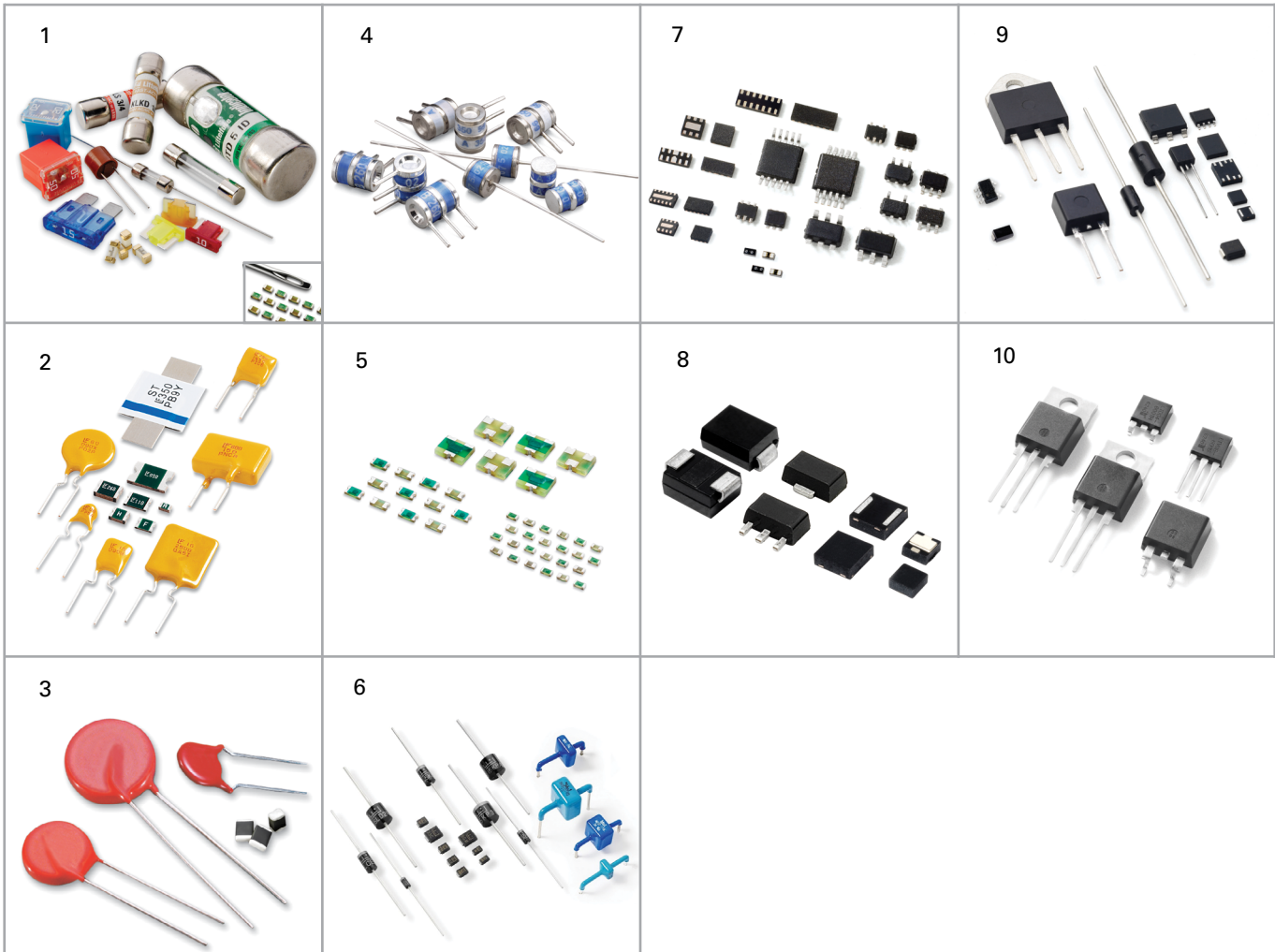
6. TVS Diodes — Suppress overvoltage transients such as Electrical Fast Transients (EFT), inductive load switching and lightning in a wide variety of applications in the computer, industrial, telecom and automotive markets (Pages 10-11).

7. TVS Diode Array — SPA[®] Diodes — Designed specifically to protect analog and digital signal lines from electrostatic discharge (ESD) and other overvoltage transients such as EFT and Lightning (Page 12).











8. PLED Bypass Protectors — Specialty silicon devices that enable LED lighting strings to continue to function if any single LED fails as an open circuit, and also offer ESD and reverse power protection (Page 13).

9. SIDACTor[®] Protection Thyristors — Complete line of protection thyristor products specifically designed to suppress overvoltage transients in a broad range of telecom and datacom applications (Pages 14-15).

10. Switching Thyristors — Solid-state switches used to control the flow of electrical current in applications, capable of withstanding rated blocking/off-state voltage until triggered to the on-state (Pages 16-17).



FUSEHOLDER SELECTION GUIDE










Circuit Connection Method		Wire	Wire Connector Terminals	TH= Thru-Hole	SM= Surface Mount	CT= Wire Connector Terminal	QC= Quick Connect						
Fuseholder Type		In-Line Fuseholders	Panel Mount Fuse Enclosures	Circuit Board Mount Fuse Enclosures		Fuse Blocks	Fuse Clips						
Fuse Type	Fuse Series												
4.5x14.5 mm (ZAG)	208 / 209 225 / 229		150274	3452 series Int. Shocksafe		CT	254 011 - 008	TH	111501				
			150300	345 series Int. Shocksafe (old)		TH	254 101, 254 121	SM	111505				
			150307	245001 Solder QC		TH	254 131	TH	111506				
			150308	245002 Nema QC		QC	254 201 - 208	TH	111510				
				286377 Flip Top				TH	111512				
5x20 mm	213 / 215 216 / 217 218 / 219XA 232 / 233 234 / 235 239 / 285 377 / 477 617 / 618		150274	345 Shocksafe	TH	345121 Shocksafe	TH	354252	TH	100 / 111 Series			
			150300	3455 Int. Shocksafe	TH	4450718 / 595 / 596	TH	445073	TH	04450001 / 00300210			
			150307	286677 Flip Top	TH	598 / 652	TH	520 002, 520 101	TH	5200001			
			150308	800 / 801 / 802 / 821 Series	TH	810 / 811 / 813 / 814	QC	520 003, 520 005	TH	52000001009			
			150315	823 Series Snap-in	TH	830 / 831 / 834	CT	520 004	TH	52100001009			
			150316	824 / 824 - 20 / 850 / 851 / 860 series	TH	852 / 853 / 862	TH	646 / 649 / 656	TH	51900001009			
			150317	870 Series Medical Grade	TH	PTF045 / PTF050	CT	647	TH	51800001009			
			150318	820/ 820-20 Series Mini Shocksafe			SM	658	TH	523 Series			
			150319	601			CT	PTF010 / PTF020	TH	445 Series			
			PTF0080M	445			TH	PTF015 / PTF065	TH	OCT136			
			FH503	PTF030 / PTF035 / PTF040			TH	PTF075 / PTF077	TH	FC51			
				PTF055 / PTF070			TH	PTF078					
				FH02A				FB55 / FB58					
			6.3x32 mm (3AB/3AG)	312 313 314 322 326 332 373 505 506 508 605		155 Series	3453 Series Int. Shocksafe	TH	345101 Shocksafe	CT	354 Series	CT	101001 / 101002
						150322	345 Series Int. Shocksafe (old)	TH	810 Series	QC	35406	CT	101003 / 102064
445	342 Series Traditional	TH				811 Series	QC	35408	CT	121001 / 121002			
PTF080	342006 Watertight	TH				813 Series	QC	35409	CT	121003 / 121004			
LH61A800	344 Series Snap / Panel Mount	TH				814 Series	CT	356 Series	TH	102071			
FH602 / FH604	348 Series Snap Mount					862 Series	CT	359 Series	TH	102076 / 102078			
	340 Series RF Shielded / Watertight						QC	OMN002	TH	102079 / 102080			
	346877 Flip Top						QC	OMN004	TH	122083 / 122087			
	342021 (FHN26W) Water Tight						QC	OMN006	TH	122088 / 122093			
	342024 (FHN26G2) Drip Proof						QC	FB65 / FB66	TH	122090 / 100058			
	342025 (FHN20G) Drip Proof								TH	51800001009			
	800 Series Shocksafe								CT	101010			
	801 / 802 / 803-01 Series								TH	102074			
	860 Series								TH	10207101009			
										030201			
							OCT136						
TE5 / TR5® Fuse	303 / 369 370 / 372 373 / 374 382 / 383 385 / 392 395 / 396 397 / 398 400 / 662 663 / 664 665 / 804 807 / 808		570 Series	TH	571 0000 000								
				TH	559 / 560 / 562 Series								
				SM	564 Series								
				TH	576 Series								
				TH	556 / 557								
Micro™ Fuse / TR3	262 / 268 269 / 272 273 / 274 278 / 279		282001 Front mt. Neoprene	TH	281005 Vertical Silver								
			282007 Front mt. Conductive	TH	281007 Horizontal Silver								
			282002 Rear mt. Neoprene	TH	281008 Vertical Tin								
			282008 Rear mt. Conductive	TH	281010 Horizontal Tin								
			280004 32V indicating										

PTC PRODUCTS








PTCs (positive temperature coefficient) increase resistance as temperature increases. They are designed to prevent unsafe levels of current while allowing constant safe current levels, and their resistance will “reset” automatically when the current and temperature returns to a safe level. PTCs are typically used in applications where automatic reset is desired.

Series Name ¹	View Datasheet Order Samples	Size ²	Hold Current (I _{HOLD})	Max Voltage (V _{MAX})	Max Fault current (I _{MAX})	Operating Temperature Range	Agency Approvals			Halogen Free	RoHS	Lead Free
							cUR	UR	TUV			

Surface Mount:

LoRho PTC (Low Resistance)		• •	0402	0.1 - 0.5A	6 / 12 V	50 A	-40°C to 85°C	•	•	•	•	•	•
			0603	0.5 - 2.0A									
			0805	0.75 - 3.0A									
			1206	0.75 - 4.5A									
			1812	1.9 - 3.7A									
			2920	7.0A									
0603L		• •	0603 (1608)	0.04 - 0.5A	6 - 15 V	40 A	•	•	•	•	•	•	
0805L		• •	0805 (2012)	0.10 - 1.10 A	6 - 15 V	100 / 40 A	•	•	•	•	•	•	
1206L		• •	1206 (3216)	0.10 - 2.0A	6 - 30 V	100 A	•	•	•	•	•	•	
1210L		• •	1210 (3225)	0.05 - 2.0A	6 - 30 V	10 / 100 A	•	•	•	•	•	•	
1812L		• •	1812 (4532)	0.1 - 3.0A	6 - 60 V	10 / 20 / 100 A	•	•	•	•	•	•	
2016L		• •	2016 (5041)	0.30 - 2.00 A	6 - 60 V	20 / 40 A	•	•	•	•	•	•	
2920L		• •	2920 (7351)	0.30 - 3.00 A	6 - 60 V	10 / 40 A	•	•	•	•	•	•	
250S		• •	see data sheet	0.13 A	60 V	3 A			•	•	•	•	

Radial Leaded:

USBR		• •	see data sheet	0.75 - 2.50 A	6 / 16 V	40 A	-40°C to 85°C	•	•	•	•	•
16R		• •		2.50 - 14.00 A	16 V	100 A		•	•	•	•	•
30R		• •		0.90 - 9.00 A	30 V	40 A		•	•	•	•	•
60R		• •		0.10 - 3.75 A	60 V	40 A		•	•	•	•	•
72R		• •		0.20 - 3.75 A	72 V	40 A		•	•	•	•	•
250R		• •		0.08 - 0.18 A	250 V	3 / 10 A		•	•	•	•	•
600R		• •		0.15 - 0.16 A	600 V	3 A		•	•	•	•	•

Battery Strap:

SL (Low Resistance)		• •	see data sheet	1.9 - 3.7 A	6 V	50 A	-40°C to 85°C	•	•	•	•	•
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(1) Detailed information about most product series listed here can be found on our web site.



(2) Size for these surface mount items refers to common industry length and width dimensions of the device surface area. Example: 0402 = .04" x .02"

GDT PRODUCTS






GDTs (gas discharge tube) dissipate voltage transients through a contained plasma gas. They have high insulation resistance plus low capacitance and leakage to ensure minimal effect on normal operation of equipment. Littelfuse devices offer a small footprint and are available in leaded and surface mount configurations, with high surge handling capability. Their fast response to transient over-voltage events, and ability to dissipate large amounts of energy, translates into reduced risk of equipment damage. The amount of energy they can dissipate makes them a good choice for lightning surge protection, particularly for telecom equipment located in outdoor structures.

Series Name ¹	View Datasheet	Order Samples	DC Breakover Voltage Range (Nom V_{BO})	Max AC Surge Rating	Peak Pulse Current (8/20 μ s)	Max Capacitance	Operating Temperature Range	Mounting Options						
								# Terminals	Mini Tube	Surface	Axial Lead	Radial Lead	Cartridge Clip	RoHS Compliant










High Voltage GDTs:

AC		View Datasheet	Order Samples	285 - 600	NA	5000A	1.5pF	-40°C to +90°C	2			•			•	
CG3		View Datasheet	Order Samples	1000 - 7500		5000A	1.5pF		2			•			•	




Low to Medium Surge GDTs:

CG5		View Datasheet	Order Samples	90 - 600	5A	5000A	1.5pF	-40°C to +90°C	2	•	•	•			•	•
SL0902A		View Datasheet	Order Samples	90 - 600	5A	5000A	1.5pF		2	•	•				•	•
SL1002A		View Datasheet	Order Samples	75 - 600	5A	5000A	1.2pF		2	•	•				•	•
SL1003A		View Datasheet	Order Samples	90 - 500	10A*	10,000A	1.2pF		3	•	•		•		•	•
SL1011A		View Datasheet	Order Samples	75 - 600	5A	5000A	1.5pF		2		•	•			•	•

Medium to High Surge GDTs:

SG (1812 Size)		View Datasheet	Order Samples	75 - 420	500 - 750		1.0pF	-40°C to +90°C			•				•	•	
SL1122A		View Datasheet	Order Samples	90 - 260	10A*	10000A*	100-270pF		3				•			•	
SL1021A		View Datasheet	Order Samples	90 - 600	10A*	10000A*	1.5pF		3		•		•			•	•
SL1024A		View Datasheet	Order Samples	90 - 600	10A*	10000A*	1.5pF		3		•		•			•	•
PMT8		View Datasheet	Order Samples	90 - 400	10A*	20000A*	1.5pF		3		•		•			•	•
SL1011B		View Datasheet	Order Samples	75 - 350	10A	10000A	1.5pF		2		•	•				•	•
SL1411A		View Datasheet	Order Samples	75 - 600	10A	10000A	1.5pF		2		•	•				•	•
PMT3		View Datasheet	Order Samples	90 - 500	20A*	20000A*	1.5pF		3		•		•			•	
CG/CG2		View Datasheet	Order Samples	75 - 1000	20A	20000A	1.5pF		2	•	•	•				•	

Very High Surge GDTs:

SL1021B		View Datasheet	Order Samples	90 - 600	10A*	20000A*	1.5pF	-40°C to +90°C	3		•		•		•	•	
SL1024B		View Datasheet	Order Samples	90 - 600	10A*	20000A*	1.5pF		3		•		•			•	•
SL1026		View Datasheet	Order Samples	275 - 700	10A*	20000A*			2						•	•	•

(1) Detailed information about most product series listed here can be found on our web site.

* Total current through center (ground) terminal

PULSEGUARD® ESD SUPPRESSORS

Series Name	View Datasheet	Order Samples	Surface Mount Through-Hole	Technology Type	Working Voltage	Array Package (No. of Lines)	Single Line Package	Typical Device Capacitance	Leakage Current	Rated Immunity to IEC 61000-4-2 level 4	Also Rated for EFT or Lightning	Bidirectional (transients of either polarity)	Performs Low Pass Filtering
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PulseGuard® ESD Suppressors:







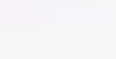






PGB1		View Datasheet	Order Samples	•	Voltage Variable Material	0-24VDC	SOT23 (2)	0402, 0603	0.04-0.12pF	<1nA	•	•	
PGB2		View Datasheet	Order Samples	•	Voltage Variable Material	0-12VDC	NA	0402, 0201	0.07pF	<1nA	•	•	

TVS DIODES









TVS Diodes are used to protect semiconductor components from high-voltage transients. Their p-n junctions have a larger cross-sectional area than those of a normal diode, allowing them to conduct large currents to ground without sustaining damage. Littelfuse supplies TVS Diodes with peak power ratings from 200W to 30kW, and reverse standoff voltages from 5V to 512V.

Series Name	Photo	View Datasheet	Order Samples	Package Type	Reverse Standoff Voltage (V _R)	Peak Pulse Power Range† (P _{PP})	Peak Pulse Current (I _{pp} 8/20µs)	Operating Temperature	Halogen-Free	RoHS Compliant	UR Recognized
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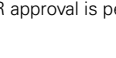

Surface Mount-Standard Application (200–5000W):

SMF		View Datasheet	Order Samples	SOD-123	5.0 - 54	200W		-85° to +302° F (-65° to +150° C)	•	•	*
SMAJ		View Datasheet	Order Samples	DO-214AC	5.0 - 440	400W			•	•	•
P4SMA		View Datasheet	Order Samples	DO-214AC	5.8 - 495	400W			•	•	•
SMA6J		View Datasheet	Order Samples	DO-214AC	5.0 - 12	600W			•	•	•
SMA6L		View Datasheet	Order Samples	DO-221AC	5.0 - 85	600W			•	•	*
SACB		View Datasheet	Order Samples	DO-214AA	5.0 - 50	500W			•	•	•
SMBJ		View Datasheet	Order Samples	DO-214AA	5.0 - 440	600W			•	•	•
P6SMB		View Datasheet	Order Samples	DO-214AA	5.8 - 495	600W			•	•	•
1KSMB		View Datasheet	Order Samples	DO-214AA	5.8 - 136	1000W			•	•	•
SMCJ		View Datasheet	Order Samples	DO-214AB	5.0 - 440	1500W			•	•	•
1.5SMC		View Datasheet	Order Samples	DO-214AB	5.8 - 495	1500W			•	•	•
SMDJ		View Datasheet	Order Samples	DO-214AB	5.0 - 170	3000W			•	•	•
5.0SMDJ		View Datasheet	Order Samples	DO-214AB	12 - 170	5000W			•	•	•

Axial Leaded-Standard Application (400–5000W):




P4KE		View Datasheet	Order Samples	DO-41	5.8 - 495	400W		-85° to +302° F (-65° to +150° C)	•	•	•
SA		View Datasheet	Order Samples	DO-15	5.0 - 180	500W			•	•	•
SAC		View Datasheet	Order Samples	DO-15	5.0 - 50	500W			•	•	•
P6KE		View Datasheet	Order Samples	DO-15	5.8 - 512	600W			•	•	•
1.5KE		View Datasheet	Order Samples	DO-201	5.8 - 512	1500W			•	•	•
LCE		View Datasheet	Order Samples	DO-201	6.5 - 90	1500W			•	•	•
3KP		View Datasheet	Order Samples	P600	5.0 - 220	3000W			•	•	•
5KP		View Datasheet	Order Samples	P600	5.0 - 250	5000W		•	•	•	

Axial Leaded-High Power:

15KPA		View Datasheet	Order Samples	P600	17 - 280	15000W		-85° to +302° F (-65° to +150° C)	•	•	•
20KPA		View Datasheet	Order Samples	P600	20 - 300	20000W			•	•	•
30KPA		View Datasheet	Order Samples	P600	28 - 288	30000W			•	•	•
AK1		View Datasheet	Order Samples	Radial Lead	76		1000A	-67° to +347° F (-55° to +150° C)	•	•	•
AK3		View Datasheet	Order Samples	Radial Lead	15 - 430		3000A		•	•	•
AK6		View Datasheet	Order Samples	Radial Lead	30 - 430		6000A		•	•	•
AK10		View Datasheet	Order Samples	Radial Lead	30 - 430		10000A		•	•	•
AK15		View Datasheet	Order Samples	Radial Lead	58 - 76		15000A		•	•	•

Remark: *** UR approval is pending.

TVS DIODES (continued)

Series Name	Photo	View Datasheet Order Samples	Package Type	Reverse Standoff Voltage (V_R)	Peak Pulse Power Range ¹ (P_{PP})	Peak Pulse Current (I_{PP} , 8/20 μ s)	Operating Temperature	Halogen-Free	RoHS Compliant	UR Recognized	AEC-Q101 Compliant
TPSMA6L		 	DO-221AC	10 - 60	600W		-85° to +302° F (-65° to +150° C)	•	•	*	•

Automotive Application:

Remark: "**" UR approval is pending.

LED LIGHTING DESIGN



Explore the latest LED lighting industry standards, product information, circuit diagrams and links to application notes and videos using this NEW e-book.

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to view our
LED Lighting
Design Guide.



ETHERNET PROTECTION



A guide for protecting Ethernet circuits and equipment from electrostatic discharge (ESD), lightning, power faults and other electrical transient threats.

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Ethernet
Design Guide.



ESD PROTECTION

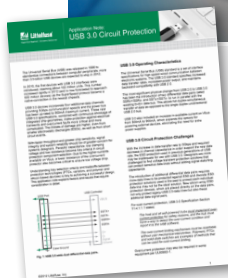


A guide for protecting electronic circuits and interfaces from electrostatic discharge (ESD) using TVS Diode Arrays.

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USB 3.0 CIRCUIT PROTECTION



Learn about the key selection criteria and tradeoffs among protection technologies for USB 3.0 devices. Recently updated!

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Circuit Protection
Application Note.



TVS DIODE ARRAY – SPA® DIODES

TVS Diode Arrays are designed to protect analog and digital signal lines from electrostatic discharge (ESD), Electrical Fast Transients (EFT), and lightning-induced surge currents. Offering low dynamic resistance for improved clamping performance, TVS Diode Arrays are offered in a wide range of industry standard discrete and multi-channel SMD packages. Features of this portfolio include capacitance as low as 0.4 pF and enhanced ESD capability up to ±30kV (contact discharge).

Series Name	Photo	View Datasheet	Order Samples	Package Type	Working Voltage	Capacitance	Number of Channels	ESD Rating (Contact Discharge, IEC61000-4-2)	Clamping Voltage ($t_r=8/20\mu s$)	Maximum Surge Rating ($t_r=8/20\mu s$)	Lead Free/ Green	RoHS Compliant
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General Purpose ESD Protection (SCR Diode Array):

SP720		View Datasheet	Order Samples	PDIP SOIC	2-30V	3pF	14	4kV	2V @ 1A	3A	•	•
SP721		View Datasheet	Order Samples		2-30V	3pF	6	4kV	2V @ 1A	3A	•	•
SP723		View Datasheet	Order Samples		2-30V	5pF	6	8kV	2V @ 2A	7A	•	•
SP724		View Datasheet	Order Samples	SOT23	2-20V	3pF	4	8kV	2V @ 1A	3A	•	•
SP725		View Datasheet	Order Samples	SOIC	2-30V	5pF	4	8kV	2V @ 2A	14A	•	•

General Purpose ESD Protection (TVS Discretes and Arrays):

SP05		View Datasheet	Order Samples	SC70 SOT23 SOT143 MSOP	5.5V	30pF	2 / 3 / 4 / 5 / 6	30kV	N/A	N/A	•	•
SP1001		View Datasheet	Order Samples	SC70 SOT553 SOT563 SOT963	5.5V	8pF	2 / 4 / 5	15kV	8.0V @ 1A	2A	•	•
SP1002		View Datasheet	Order Samples	SC70	6.0V	5pF	1 / 2	8kV	9.2V @ 1A	2A	•	•
SP1003		View Datasheet	Order Samples	0402 (SOD723) 0402 (SOD882)	5.0V	30pF	1	30kV	12.0V @ 7A	7A	•	•
SP1004		View Datasheet	Order Samples	SOT953	6.0V	5pF	4	8kV	10V @ 1A	1A	•	•
SP1005		View Datasheet	Order Samples	0201 (Flipchip) 0402 (SOD882)	6.0V	30pF	1	30kV	9.3V @ 1A	10A	•	•
SP1006		View Datasheet	Order Samples	0201 (μ DFN-2)	6.0V	25pF	1	30kV	8.3V @ 1A	5A	•	•
SP1007		View Datasheet	Order Samples	0201 (Flipchip) 0402 (SOD882)	6.0V	3.5pF	1	8kV	11.2V @ 1A	2A	•	•
SP1008		View Datasheet	Order Samples	0201 (Flipchip)	6.0V	6pF	1	15kV	10.7V @ 1A	2.5A	•	•
SP1011		View Datasheet	Order Samples	μ DFN-6	6.0V	7pF	4	15kV	8.7V @ 1A	2A	•	•

Low Capacitance ESD Protection:


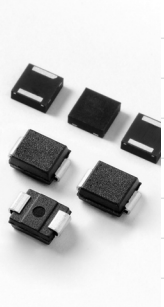
SP3001		View Datasheet	Order Samples	SC70	6.0V	0.65pF	4	8kV	9.5V @ 1A	2.5A	•	•
SP3002		View Datasheet	Order Samples	SC70 SOT23 μ DFN-6	6.0V	0.85pF	4	12kV	9.5V @ 1A	4.5A	•	•
SP0504S		View Datasheet	Order Samples	SOT23								
SP3003		View Datasheet	Order Samples	μ DFN-6 SC70 SOT5x3 MSOP10	6.0V	0.65pF	2 / 4 / 8	8kV	10.0V @ 1A	2.5A	•	•
SP3004		View Datasheet	Order Samples	SOT563	6.0V	0.85pF	4	12kV	10.0V @ 1A	4A	•	•
SP3010		View Datasheet	Order Samples	μ DFN-10	6.0V	0.45pF	4	8kV	10.8V @ 1A	3A	•	•
SP3011		View Datasheet	Order Samples	μ DFN-14	6.0V	0.40pF	6	8kV	11.0V @ 1A	3A	•	•
SP3012		View Datasheet	Order Samples	μ DFN-10 μ DFN-14	5.0V	0.50pF	4 / 6	12kV	6.6V @ 1A	4A	•	•
SP3021		View Datasheet	Order Samples	0402 (SOD882)	5.0V	0.50pF	1	8kV	13.1V @ 1A	2A	•	•
SP3030		View Datasheet	Order Samples	0402 (SOD882)	5.0V	0.50pF	1	20kV	9.2V @ 1A	3A	•	•
SP3031		View Datasheet	Order Samples	0402 (SOD882)	5.0V	0.80pF	1	10kV	6.9V @ 1A	5A	•	•
SP0524P		View Datasheet	Order Samples	μ DFN-10	5.0V	0.50pF	4	12kV	6.6V @ 1A	4A	•	•



Lightning Surge Protection:

SRV05-4		View Datasheet	Order Samples	SOT23	6.0V	2.4pF	4	20kV	11.5V @ 5A	10A	•	•
SP03-3.3		View Datasheet	Order Samples	SOIC	3.3V	16pF	2	30kV	15V @ 100A	150A	•	•
SP03-6		View Datasheet	Order Samples	SOIC	6.0V	16pF	2	30kV	20V @ 100A	150A	•	•
LC03-3.3		View Datasheet	Order Samples	SOIC	3.3V	9.0pF	2	30kV	17V @ 100A	150A	•	•
SP2502L		View Datasheet	Order Samples	SOIC	3.3V	5.0pF	2	30kV	20V @ 75A	75A	•	•
SLVU2.8		View Datasheet	Order Samples	SOT23	2.8V	2.0pF	1	30kV	13.9V @ 24A	40A	•	•
SLVU2.8-4		View Datasheet	Order Samples	SOIC	2.8V	2.0pF	4	30kV	13.9V @ 24A	40A	•	•
SR70		View Datasheet	Order Samples	SOT143	70V	2.0pF	2	30kV	12V @ 30A	40A	•	•
SP4060		View Datasheet	Order Samples	MSOP	2.5V	4.4pF	8	30kV	8.0V @ 10A	20A	•	•
SP2504N		View Datasheet	Order Samples	μ DFN-10	2.5V	3.5pF	4	30kV	6.3V @ 5A	20A	•	•
SP3304N		View Datasheet	Order Samples	μ DFN-10	3.3V	3.5pF	4	30kV	7V @ 5A	20A	•	•

PLED LIGHT-EMITTING DIODE (LED) PROTECTORS

Littelfuse PLED devices provide added reliability to LED lighting strings. Designed to minimize the impact of losing an entire LED string due to a single LED failure, PLED devices provide a switching function that will bypass LEDs that go open circuit, and allow current to flow to the remaining LEDs in the string. PLED devices also offer LED protection against electrostatic discharge (ESD) and accidental reverse power connection (PLED5 devices only). Designed to serve the needs of high brightness outdoor LED lighting applications (advertising and traffic signs, roadway/pathway/runway lighting, aircraft and emergency lighting, etc), PLED devices help assure reliability and lower maintenance costs.

Part Number	Photo	View Datasheet	Order Samples	Powermite	OFN 3x3	DO-214	V_{BR} breakdown		I_H	I_S	$I_T@V_T$	V_T and I_T	Critical rate of rise dV/dt
							Volts		mAmps	mAmps	Amps	Volts	Volts
							Min	Max		Max	Max	Max	Max
PLED6M		View Datasheet	Order Samples	•			5.5	7.5	12	70	0.35	1.2	N/A
PLED6Q12		View Datasheet	Order Samples		•		6	16	5	100	1.0	1.2	250V/ μ s
PLED6S		View Datasheet	Order Samples			•	9	18					
PLED9Q12		View Datasheet	Order Samples		•		13	26					
PLED9S		View Datasheet	Order Samples			•	18	33					
PLED13Q12		View Datasheet	Order Samples		•								
PLED13S		View Datasheet	Order Samples			•							
PLED18Q12		View Datasheet	Order Samples		•								
PLED18S		View Datasheet	Order Samples			•							

Part Number	Photo	View Datasheet	Order Samples	OFN 2x2	SOT 89	V_{AK} Input Voltage		V_{TO} Turn-On Voltage		I_S Switching Current	V_{OS} On-State Voltage	V_{OSR} Reverse On-State Voltage	I_S On-State Current	I_{OSR} Reverse On-State Current	V_{ESD} ESD Withstand Voltage (IEC61000-4-2)	
						Volts		Volts		mAmps	Volts	Volts	mAmps	mAmps	kV	
						Max	Min	Typ	Max	Max	Min	Max	Max	Max	Max	Contact
PLED5Q12		View Datasheet	Order Samples	•		40					1.3@ $I_{AK}=350mA$	1.4@ $I_{AK}=350mA$	500	500	±8	±15
PLED5HT		View Datasheet	Order Samples		•	38	4.65	4.9	5.15	20	1.8@ $I_{AK}=700mA$	1.8@ $I_{AK}=700mA$	700	700	±8	±15

SIDACtor® PROTECTION THYRISTORS











SIDACtor® Protection Thyristors are designed to suppress overvoltage transients in telecom and datacom equipment, and are able to divert currents as high as 5000A to ground within nanoseconds of reaching their breakover voltage. Littelfuse offers a wide range of configurations including DO-214AA, DO214AC, COMPAK (3-Pin DO-214), SOT23-5, QFN, MS-012 and modified MS-013 surface mount, TO-92, TO-218, DO-15, modified TO-220, and TO-220 through-hole package options designed to handle medium to high energy transients.

Series Name	Photo	View Datasheet	Order Samples	Package Type	Type	Standoff (working) Voltage (V_{DRM})	Switching Voltage (V_s)	Peak Pulse Rating:			RoHS Compliant	UR Recognized
								2/10 μ s	10/1000 μ s	8/20 μ s		

Broadband Optimized Protection:

MC Series		View Datasheet	Order Samples	DO-214AA	A	6 - 25	25 - 40	150A	45A	150A		
					C	6 - 320	25 - 400	500A	100A	400A		
Balanced MC Series		View Datasheet	Order Samples	Modified TO-220	A	Pin 1-2, 3-2: 6-275	Pin 1-2, 3-2: 25-350	150A	45A	150A		
					C	Pin 1-3: 12-550	Pin 1-3: 50-700	500A	100A	500A		
Q2L Series		View Datasheet	Order Samples	3x3 QFN	A			150A	45A	150A		
MC Multiport Series		View Datasheet	Order Samples	MS-013	B	6 - 320	25 - 400	250A	80A	250A		
					C			500A	100A	400A		
TwinChip™ Protectors		View Datasheet	Order Samples	DO-214AA	A	220 - 640	300 - 800	150A	45A	150A		
					B			250A	80A	250A		
SDP Series		View Datasheet	Order Samples	DO-15	A	220 - 320	300 - 400		50A			
					B				80A			
SDP Biased Series		View Datasheet	Order Samples	3x3 QFN	F	8 - 24	15 - 35			50A		
SEP Biased Series		View Datasheet	Order Samples	SOT23 - 5	B	58 - 320	77 - 400	250A	80A	250A		
P0080T023G5		View Datasheet	Order Samples	5x6 QFN	C	6 - 320	25 - 400	500A	100A	400A		
				5x6 QFN	C	6 - 75	25 - 98	500A	100A	400A		
				SOT 23 - 5	G	8	15	45A	18A	50A		

Subscriber Line Interface Circuit (SLIC) Protection:



Fixed Voltage Series		View Datasheet	Order Samples	DO-214AA	A	58 - 160	77 - 200	150A	45A	150A		
					C			500A	100A	400A		
Fixed Voltage Twin SLIC Series		View Datasheet	Order Samples	Modified DO-214AA	A	58 - 160	77 - 200	150A	45A	150A		
Fixed Voltage Q2L Series		View Datasheet	Order Samples	QFN 3.3x3.3	C	58 - 160	77 - 200	500A	100A	400A		
Fixed Voltage Single Port Series		View Datasheet	Order Samples	MS-012	F	58 - 95	77 - 130	120A	30A	100A		
Fixed Voltage Enhanced Single Series		View Datasheet	Order Samples	MS-012	F	58 - 160	77 - 200	120A	30A	100A		
Fixed Voltage Multiport Series		View Datasheet	Order Samples	MS-013	A	58 - 160	77 - 200	150A	45A	150A		
					C			500A	100A	400A		
Battrax® Protectors Positive/Negative		View Datasheet	Order Samples	Modified DO-214AA	A			150A	45A	150A		
Battrax® Protectors Single Port Negative		View Datasheet	Order Samples	MS-013	C			500A	100A	400A		
								500A	100A	400A		
Battrax® Protectors Single Port Positive/Negative		View Datasheet	Order Samples	MS-013	C			500A	100A	400A		
								500A	100A	400A		
Battrax® Protectors Dual Port Negative		View Datasheet	Order Samples	MS-013	C			500A	100A	400A		

These devices track their reference voltages. Please refer to data sheets in SIDACtor® Protection Thyristor catalog or www.littelfuse.com for detailed information.





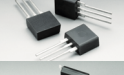





SIDACtor® PROTECTION THYRISTORS (continued)

Series Name	Photo	View Datasheet	Order Samples	Package Type	Type	Standoff (working) Voltage (V_{DRM})	Switching Voltage (V_S)	Peak Pulse Rating:			RoHS Compliant	UL Recognized
								2/10 μ s	10/1000 μ s	8/20 μ s		





Line Circuit Access Switch (LCAS) Protection:

Asymmetrical Multiport Series		View Datasheet	Order Samples	MS-013	A	These products have asymmetric trigger voltages. See data sheet.		150A	45A	150A	•	•
					C			500A	100A	400A		
Custom LCAS Discrete Series		View Datasheet	Order Samples	DO-214AA	A	100 - 230	130 - 290	150A	45A	150A	•	•
					B			250A	80A	250A		
					C			500A	100A	400A		

Baseband Protection (Voice-DS1):

SIDACtor® Protection Thyristors		View Datasheet	Order Samples	DO-214AA	A	6 - 320	25 - 400	150A	45A	150A	•	•		
					B			250A	80A	250A				
					C			500A	100A	400A				
SIDACtor® Protection Thyristors		View Datasheet	Order Samples	DO-214AC (SMA)	A	6 - 320	25 - 400	150A	50A	150A	•	•		
					B			250A	80A	250A				
					C			500A	100A	400A				
SIDACtor® Protection Thyristors		View Datasheet	Order Samples	TO-92	A	6 - 320	25 - 400	150A	45A	150A	•	•		
					B			250A	80A	250A				
SIDACtor® Protection Thyristors		View Datasheet	Order Samples	DO-15	A	90 - 320	130 - 400		45A		•	•		
					B				80A					
SIDACtor® Protection Thyristors		View Datasheet	Order Samples	Modified TO-220	A	Pins 1-2,3-2: 25-275 Pins 1-3: 50-550	Pins 1-2,3-2: 40-350 Pins 1-3: 80-700	150A	45A	150A	•	•		
					B			250A	80A	250A				
					C			400A	100A	400A				
SIDACtor® Protection Thyristors Multiport Series		View Datasheet	Order Samples	MS-013	A	Pins 1-2,3-2,4-5,6-5: 6-320 Pins 1-3,4-6: 12-640	Pins 1-2,3-2,4-5,6-5: 25-400 Pins 1-3,4-6: 50-800	150A	45A	150A	•	•		
					C			500A	100A	400A				
SIDACtor® Protection Thyristors Balanced Series		View Datasheet	Order Samples	MS-013	C	130 - 420	180 - 600	500A	100A	400A	•	•		
					Modified TO-220			A	Pins 1-2, 3-2: 130-420 Pins 1-3: 130-420	Pins 1-2, 3-2: 180-600 Pins 1-3: 180-600			150A	45A
SIDACtor® Protection Thyristors Balanced Multiport Series		View Datasheet	Order Samples	MS-013	B	130 - 420	180 - 600	250A			80A	250A		
					C			500A			100A	400A		
					Asym. A6			Pins 1-2,2-3,4-5,5-6: 170-400 Pins 4-6,1-3: 50-270	Pins 1-2,2-3,4-5,5-6: 250-550 Pins 4-6,1-3: 80-340	150A	45A	150A		
Asym. B6	250A	80A	250A											
Asym. C6	500A	100A	400A											
T10A Series		View Datasheet	Order Samples	DO-15	A	50 - 245	84 - 370		50A	100A	•	•		
T10B Series		View Datasheet	Order Samples	DO-201	B	80 - 275	120 - 360		100A	250A	•	•		

High Exposure Surge Protection:

Primary Protection Series		View Datasheet	Order Samples	Modified TO-220	C	Pins 1-2,3-2: 25-275 Pins 1-3: 50-550	Pins 1-2,3-2: 40-350 Pins 1-3: 80-700	500A	100A	400A	•	•
Primary Protection Balanced Series		View Datasheet	Order Samples	Modified TO-220	C	Pins 1-2, 3-2: 130-420 Pins 1-3: 130-420	Pins 1-2, 3-2: 180-600 Pins 1-3: 180-600	500A	100A	400A	•	•
5kA Series		View Datasheet	Order Samples	TO-218	E	140 - 180	180 - 260			5000A	•	•
High Surge Current Series		View Datasheet	Order Samples	DO-214AA	D	6 - 320	25 - 400	1000A	200A	800A	•	•

Common Circuit Threats and Protection Solutions

Threat or Circuit Action What is the threat or circuit action that may damage sensitive electronics?	Typical Applications What are the typical end products that require protection from this damage?	Principal Protection Criteria What are the characteristics required of the circuit protection technology?	Littelfuse Protection Technologies Which circuit protection technologies best serve these types of situations?
Overcurrent / Ground Faults	Systems that are grounded and/or in near proximity to AC power lines	Proper interrupting rating, current carrying capability and voltage rating	Fuses and/or PTCs
Lightning	Any electronic or electrical equipment with connections to the outside environment	Fast response, proper switching threshold, surge current rating	SIDACTor® Protection Thyristors, Varistors (MOVs), TVS Diodes, Gas Discharge Tubes (GDTs)
Electrostatic Discharge (ESD)	Any electronic equipment with a human interface	Fast response, high peak voltage rating	PulseGuard® ESD Suppressors, TVS Diode Array – SPA® Diodes, Multi-Layer Varistors (MLVs) PLED Bypass Protectors
Electrical Fast Transients (EFT)	Any system that has inductive loads	Fast rise time and recovery for repetitive pulses	TVS Diodes, Varistors (MLVs and MOVs), TVS Diode Array – SPA® Diodes
Inductive Load Switching and Commutative Spikes	Large motors, pumps, compressors, relays and AC distribution	High energy rating	Varistors (MOVs and MLVs), GDTs, TVS Diodes
Data and Communication Line Voltage Transients	Ethernet, xDSL, data bus, telecom, etc.	Fast response, low load capacitance	TVS Diode Array – SPA® Diodes, SIDACTor® Protection Thyristors
Current Switching / Diversion	Wide range of electrical and electronic circuits	Proper blocking voltage and current carrying capacity	Switching Thyristors, PLED Bypass Protectors

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. Sources of overload can include:

- Construction hazards cutting across power mains
- Equipment failure in the power grid
- Environmental hazards on the power grid
- Short spikes of energy within the circuit as a result of turning equipment on or off



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.

The principal forms of protection against overcurrent conditions include fuses and resettable positive temperature coefficient (PTC) thermistors.

Their function is to limit current to acceptable levels and prevent catastrophic events, and during acceptable conditions act dormant with a minimal amount of resistance to the circuit.

Fuses will completely stop the flow of current when opened, which may be desired with sensitive, expensive or critical applications.

PTCs offer the ability to re-set for withstanding most minor, common and recurring overcurrent events. They will allow safe levels of current to pass continuously, and during major overcurrent events, increase in resistance as they heat, to restrict the flow of current. When the overcurrent event ends, the device resets to its normal operating state.

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:



Electrostatic Discharge (ESD)

Damage from ESD is generally caused by the transfer of static electrical charge from a body to an electronic circuit. It may result in faulty circuit operation, latent defects, and even catastrophic failure of sensitive components. ESD suppressors must have very fast response times and handle high peak voltages and currents for short durations. Littelfuse offers a range of PulseGuard® ESD suppressors, Multi-Layer Varistors (MLVs) and TVS Diode Array – SPA® Diodes that are designed to suppress these types of events.



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. For these applications, commonly used suppressor devices include Metal Oxide Varistors (MOVs), Gas Discharge Tubes (GDTs), and Transient Voltage Suppression (TVS) Diodes.



Lightning Induced Transient

Most transients induced by nearby lightning strikes result in an electromagnetic disturbance on electrical and communication lines connected to electronic equipment. Devices that protect against these transients must have a fast response time and must be able to dissipate a large amount of energy. Littelfuse Metal Oxide Varistor (MOV), TVS Diodes and GDT products are typically used to protect against these events. Look to Littelfuse SIDACTor® Protection Thyristors and TVS Diode Array – SPA® Diode products for Telecom/Datacom requirements (see page 22).



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. In a typical 12V circuit, load dump can rise as high as 120V and take 400 ms to decay—more than enough to cause serious damage. Littelfuse offers a wide range of TVS Diode and Multi-Layer Varistor (MLV) products designed to protect against these types of events.

Application Solutions by Circuit Type and Related Threat



CONSUMER ELECTRONIC PRODUCT APPLICATIONS

Computers— Server, Notebook, Ultrabook, Desktop

Handheld Portables— Smart Phone, Tablet, eReader, PND/GPS, MP3/PMP, Digital Camera/Camcorder

Consumer A/V Equipment— LCD/LED TV, set top box, DVD player

Peripherals— Scanner, Printer, Monitor, Disk Drive

Circuit Type	Function or Threat	Standards	Littelfuse Product Series	
Medium/Low-Speed Data Interfaces: USB 1.1, Ethernet, RS-232, RS-485, Keypads, Audio, Analog Video	ESD, EMI, EFT	IEC61000-4-2 IEC61000-4-4	TVS Diode Array SPA® Diodes	SP05x, SP10xx, SP40xx, LC03, SP72x, SP03-xx, SLVU2.8, SLVU2.8-4
			Varistor (MLV)	MLA, MLE, MLN, MHS
	Overcurrent		SIDACTor® Protection Thyristors	PxxxxSA/SB/SC, PxxxxQ12/Q22
			TVS Diodes	SMF, SMAJ, SMA6L, SMBJ, SMCJ, SMDJ
High-Speed Data Interfaces: USB 2.0/3.0, HDMI, eSATA, DisplayPort, DVI, IEEE 1394, RF Antenna	ESD, EMI, EFT	IEC61000-4-2, IEC61000-4-4	PulseGuard® ESD Suppressor	PGB1, PGB2 - 0201, 0402, 0603
	Overcurrent		TVS Diode Array SPA® Diodes	SP30xx, SP40xx, SP0524P, SP0504S
			LoRho PTCs	SL SMT Series 0402L, 0603L, 0805L, 1206L, 1210L, 1812L
Power Inputs: 120/240 VAC	Lightning	IEC61000-4-5	TVS Diode	SMF, SMAJ, SMA6L, SMBJ, SMCJ, SMDJ, P4KE, P6KE, 1.5KE
	Overcurrent		Varistor (MOV)	LA, UltraMOV™, C-III, TMOV® varistors
Power Inputs: Blade DC input, Low voltage DC, Li-ion Battery	Lightning / ESD	IEC61000-4-2, IEC61000-4-5	TVS Diode	SMF, SMAJ, SMA6L, SMBJ, SMCJ, SMDJ, P4KE, P6KE, 1.5KE
			Varistor (MLV)	ML, MLE
			Varistor (MOV)	ZA
	Overcurrent		Fuse	SMD - Thin Film, Ceramic, Chip, Nano ²⁰ , (1206 size), 501 (20A), 456 (40A) fuses
			LoRho PTC	SL SMT Series 0402L, 0603L, 0805L, 1206L, 1210L, 1812L



POWER MAINS / AC LINE PROTECTION*

Circuit Type	Function or Threat	Littelfuse Product Series	
Type 1 (Power before the panel)			
Surge Protective Devices (SPD) (Primary building entrance, electric meters)	Lightning	Varistor (MOV)	SMOV™, TMOV®, UltraMOV™, LA, C-III, HA, HB34, HF34, HG34 varistors
Type 2 (Permanently connected devices after the panel)			
Uninterruptible Power Supply (commercial/industrial) Surge Protective Devices (SPD) (building level equipment, load-center panels, datacenters) Power Inverters	Lightning, Switching Transients	Varistor (MOV)	SMOV™, TMOV®, UltraMOV™, LA, C-III, HA, HB34, HF34, HG34 varistors
		TVS Diode	5KP, 15KPA, 20KPA, 30KPA, AK1, AK3, AK6, AK10, AK15
		GDT	AC120, AC240
Power Fault / Short Circuit and other thermal events	Fuse	POWR-GARD® Midget fuses LVSP series (MOV protection)	
Type 3 (Plug-in equipment after the panel)			
Uninterruptible Power Supply (consumer/residential) External Power Supplies (chargers, peripheral devices, etc) Consumer Electronics AC Appliances AC Power Strips Switch Mode Power Supplies	Lightning, Switching Transients	Varistor (MOV)	TMOV®, UltraMOV™, LA, C-III, HA, HB34, HF34, HG34 varistors
		TVS Diode	5KP, 15KPA, 20KPA, 30KPA, AK1, AK3, AK6, AK10, AK15
		GDT	CG3 4.0
Power Fault / Short Circuit and other thermal events	Fuse	Thru Hole: TR5® / TE5, 2AG, 3AG, 5x20, 3.6x10, PICO® fuses Surface Mount: Nano2®, PICO® SMD fuses	



LIGHTING SYSTEMS

Circuit Type	Function or Threat	Littelfuse Product Series	
LED Lighting Systems	Improved LED String Reliability	PLED devices	PLEDxx
	Power Supply (Lightning, Inductive Load Switching)	Varistor (MOV)	TMOV®, UltraMOV™, CH, LA, C-III varistors
		TVS Diode	SMBJ, P4KE, P6KE, 1.5KE, 5KP, 15KPA, 30KPA, AK1, AK3, AK6, AK10, AK15
Power Fault / Short Circuit and other thermal events	Fuse	Thru Hole: TR5® / TE5, 2AG, 3AG, 5x20, 3.6x10, PICO® fuses Surface Mount: Ceramic Chip, Nano2®, PICO® SMD (High Voltage) 477 series, 505 series, 808 series, 485 series fuses	
Light Dimmers	Phase Control	Thyristor	Triacs / Alternistor Triacs: Q6010Lx, Q6016Lx, Q6025Lx QUADRAC® semiconductors: Q6010LT, Q6015LT
	Overcurrent (Europe)	Fuse	3.6x10
Electronic Fluorescent Lighting Ballasts	Lightning	Varistor (MOV)	LA
	Overcurrent	Fuse	383 TR series / 369 TR5® series, 446 / 447 EBF fuse
Compact Fluorescent Lamps (CFL)	Overcurrent	Fuse	3.6x10
Metal Halide Lighting	Lamp Ignition	Thyristor	Multipulse Sidac: K2401G
High Pressure Sodium Lighting	Lamp Ignition	Thyristor	Sidac: K1200G



ELECTRIC MOTORS*

Circuit Type	Function or Threat	Littelfuse Product Series	
Universal / DC Motors (intermittant use)	Speed Control	Thyristor	Triac: Q6016LH4 SCR: S6025L Rectifier: D6025L
AC Induction Motors (continuous use)	Speed Control	Thyristor	Triac: Q6012LH4
	Thyristor Overvoltage Protection	Varistor (MOV)	LA, SM20
TVS Diode		SMBJ, P4KE, P6KE, 1.5KE	

* Littelfuse offers protection solutions to serve a wide range of electric motors, controllers and power systems. Please consult with your Littelfuse products representative for detailed discussion about your requirements. For higher power and industrial applications, please refer to our POWR-GARD® division product catalogs (www.littelfuse.com/catalogs).



TELECOM/DATACOM

Circuit	Threat	Standards	Littelfuse Product Series	
Medium/Low-Speed Data Interfaces: USB 1.1, RS-232, RS-485, Keypads, Audio, Analog Video	ESD, EMI, EFT	IEC61000-4-2, IEC61000-4-4	TVS Diode Array SPA® Diodes	SP05x, SP10xx, SP40xx, SP72x, SP03-xx, SLVU2.8, SLVU2.8-4
			Varistor (MLV)	ML, MLE, MLN, MHS
	Overcurrent		PTCs	0805L, 1206L, 1210L, 1812L
High-Speed Data Interfaces: USB 2.0/3.0, HDMI, eSATA, DisplayPort, DVI, IEEE 1394, RF Antenna	ESD, EMI, EFT	IEC61000-4-2, IEC61000-4-4	PulseGuard® ESD Suppressor	PGB1, PGB2 - 0201, 0402, 0603
			TVS Diode Array SPA® Diodes	SP30xx, SP40xx, SP0524P, SP0504S
	Overcurrent		PTCs	0805L, 1206L, 1210L, 1812L
	Overvoltage	IEC61000-4-5, GR-1089, ITU-7 K.12	GDTs	SG, SL0902A
	Lightning	GR-1089, TIA-968-A/B, ITU K.20/.21/.45, UL/EN/IEC 60950-1, UL 497B, IEC 61000-4-5, YD/T-993	SIDACtor® Protection Thyristors	Pxxx1 Fixed Voltage SLIC Protectors Bxxxx Batrax® Programmable SLIC Protectors
Fuses			TeleLink® 461	
PTCs			600R150	
Power Fault			SIDACtor® Protection Thyristors	Pxxxx SIDACtor® Protectors SDP series low profile SIDACtor® Protectors
			GDTs	SL0902A, SL1002A, SL1003A, SL1011A, SL1024A
Lightning	GR-1089, TIA-968-A/B, ITU K.20/.21/.45, UL/EN/IEC 60950-1, UL 497B, IEC 61000-4-5, YD/T-993	IEC 61000-4-5, YD/T-993	Fuses	TeleLink® 461 fuse
			PTCs	600R150
			PTCs	600R150
Power Fault			SIDACtor® Protection Thyristors	PxxxxxMCL SIDACtor® Protectors Pxxx2xxMCL TwinChip™ Protectors PxxxxQxx QFN SIDACtor® Protectors, SDP, SEP series low profile SIDACtor® Protectors, SDP023T
			TVS Diode Array SPA® Diodes	SRV05-4, SP4060, SP2504N, SP3304N, SP2502L, LC03, SP03-xx
Lightning	GR-1089, TIA-968-A/B, ITU K.20/.21/.45, UL/EN/IEC 60950-1, UL 497B, IEC 61000-4-5, YD/T-993	IEC 61000-4-5, YD/T-993	GDTs	SL0902A, SL1002A, SL1003A, SL1011A, SL1024A
			Fuses	TeleLink® 461 / 461E fuses
			PTCs	600R150, 250S, 250R
Power Fault			SIDACtor® Protection Thyristors	SDP, SEP series low profile SIDACtor® Protectors
			GDTs	SL0902A, SL1002A, SL1003A, SL1011A, SL1024A
Lightning	GR-1089, TIA-968-A/B, ITU K.20/.21/.45, UL/EN/IEC 60950-1, UL 497B, YD/T-993, IEEE 802.3, IEC61000-4-5	IEC61000-4-5	TVS Diode Array SPA® Diodes	SP30xx, SP40xx, LC03, SLVU2.8, SLVU2.8-4, SRV05-4, SP2504N, SP3304N, SP2502L, SP03A-3.3
			Fuses	TeleLink® 461 fuse
			PTCs	600R150, 250S, 250R
Power Fault			TVS Diode Array SPA® Diodes	SP30xx, SP0524P, SP0504S
			PTCs	600R150, 250S, 250R
ESD		IEC 61000-4-2	TVS Diode Array SPA® Diodes	SP30xx, SP0524P, SP0504S
			PTCs	600R150, 250S, 250R
Lightning	GR-1089, TIA-968-A/B, ITU K.20/.21/.45, IEC 61000-4-5, YD/T-993, IEEE 802.3	IEC 61000-4-5, YD/T-993, IEEE 802.3	SIDACtor® Protection Thyristors	SDP SIDACtor® Protectors, SDP023T
			TVS Diode Array SPA® Diodes	SR70
Lightning and Power Fault	UL497 GR-974 UL/EN/IEC 60950-1		GDT	SL0902A, SL1002A, SL1003A, SL1011A, SL1024A, SL1411A, SL1021A, SL1122A
			TVS Diode	P4KE, P6KE, 1.5KE, AK1, AK3, AK6, AK10, AK15
Lightning			Varistor (MOV)	CH, ZA, UltraMOV™ varistors
			Fuse	Midget Series (SFE, KIK, KLKD, BLS, BLN, FLQ, FLM, FLA, KLQ) Fast Acting: 435, 431/434, 429/433, 271, 446, 445, 451/453, 456, 459 Slo-Blo® fuses: 430, 452 / 454, 461, PICO® II fuses



AUTOMOTIVE ELECTRONICS*

Engine/Body/Chassis Controllers — Anti-lock brake / steering / air bag / seat belt / collision control and other safety systems and sensors, lighting / signalling controls, instrument cluster, engine / emission controllers, window / wipers controls, door lock / security controls, seating sensors and controllers

Multimedia/Information Systems — In-dash stereo / GPS / climate control electronics, portable GPS, portable CD/DVD/media players, audio / video / data / power docks and inputs

Circuit Type	Function or Threat	Standards	Littelfuse Product Series	
High-Speed Interfaces: USB 2.0, IEEE 1394	ESD	IEC61000-4-2	PulseGuard® ESD Suppressor	PGB1, PGB2 - 0201, 0402, 0603
			TVS Diode Array SPA® Diodes	SP30xx, SP0524P, SP0504S
Medium/Low-Speed Interfaces: USB 1.1, CAN	ESD, EMI	IEC61000-4-2	TVS Diode Array SPA® Diodes	SP05x, SP72x, SP10xx
			Varistor (MLV)	ML, MLE, MLN, MHS
Power Inputs: Up to 42 VDC	Fault Currents	RoHS; ISO 7637; GM 9105; Various UL, CSA, IEC, MITI	Fuse	Blade / Terminal Fuse Series: 257, 297, 298, 299, 495, 498 (see automotive products catalogs)
	Load Dump and Inductive Switching	—	Varistor (MLV)	AUML, MLA, MLE, MHS
			TVS Diode (AEC-Q101)	TPSMA6L
			Varistor (MOV)	CH, ZA

* Littelfuse offers a wide range of solutions designed to serve the requirements of automotive, truck, and off-road vehicle applications. Please refer to our automotive products catalogs (www.littelfuse.com/catalogs) and your Littelfuse products representative for detailed discussion about your requirements.



WHITE GOODS / APPLIANCES

Circuit Type	Function or Threat	Littelfuse Product Series	
AC Induction Motor	On / Off / Speed Control	Switching Thyristor	Alternistor Triac
AC Shaded Pole Motor Fan	On / Off / Speed Control	Switching Thyristor	EV Series Triac
AC Solenoid Valve / Lock	On / Off	Switching Thyristor	EV Series Triac
	Spike Suppression	Varistor (MOV)	LA
Brushless DC Motor Drive	DC Supply Protection	TVS Diode	1.5KE / 1.5SMC
Display / Touchscreen	ESD Protection	Varistor (MLV)	ML
Gas Ignitor	Free-Running Oscillator	Switching Thyristor	K2xxxH Series SIDAC
	Micro-controller Fired	Switching Thyristor	EC Series SCR
Heating Element	On / Off / Variable	Switching Thyristor	HQ Series High Temp Triac
Incandescent Bulb	On / Off / Dim	Switching Thyristor	L-Series Triac
LED Indicator / Light	ESD Protection	Varistor (MLV)	ML
MicroController I/O	ESD Protection	Varistor (MLV)	ML
Sensor	ESD Protection	Varistor (MLV)	ML
Switch-Mode Power Supply	AC Input Overcurrent	Fuse	Cartridge 215, 218, 877, PICO® II, TR / TE 392, 382 fuses
	Input Overvoltage	Varistor (MOV)	LA
	Output Overcurrent	Fuse	477, 977, 505 HV DC Cartridge, TE 808 HV DC, 485 Nano ^{2®} fuses
	Output Overvoltage	TVS Diode	1.5KE / 1.5SMC
Touch Keypad	ESD Protection	Varistor (MLV)	ML
		TVS Diode Array – SPA® Diodes	SP10xx
Triac Control	Overvoltage Protection	TVS Diode	1.5KE / 1.5SMC
		Varistor (MOV)	LA
Wax Motor Latch / Lock	On / Off	Switching Thyristor	EV Series Triac



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