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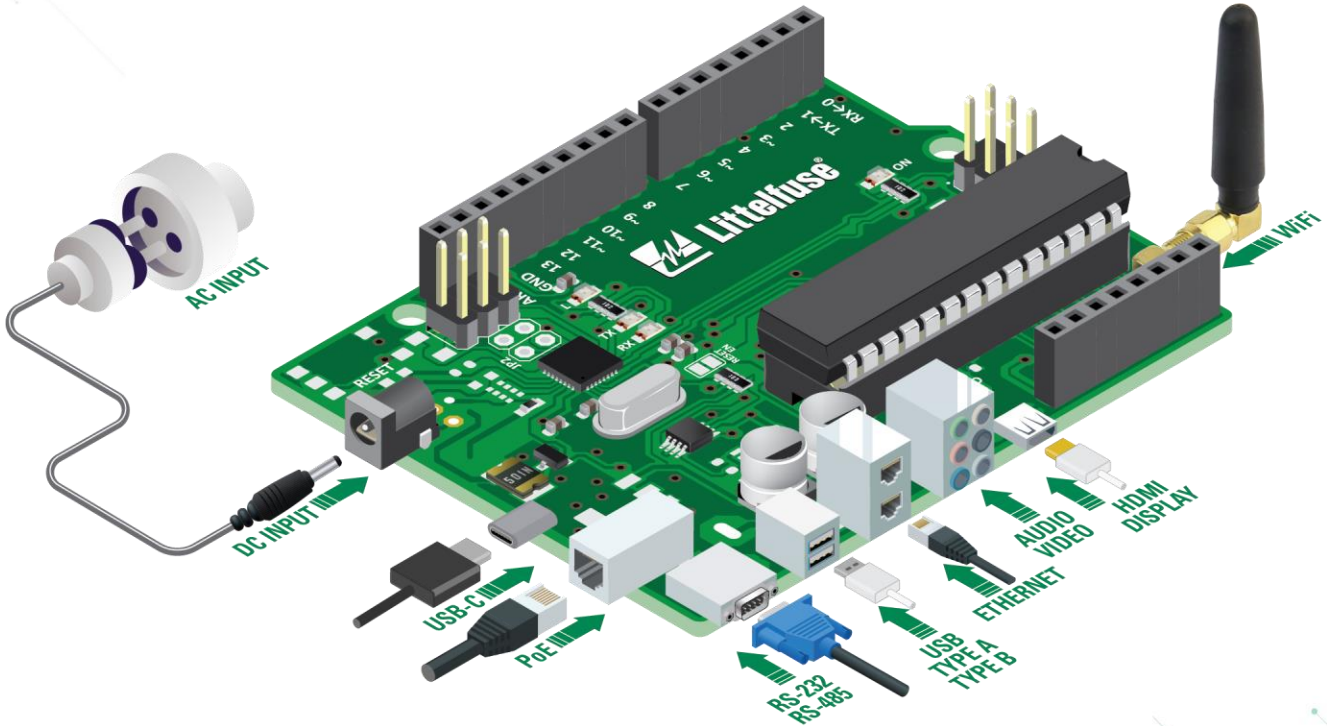
General Port Protection

- Building Solutions
- Consumer Electronics
- Datacenter and Communication
- General Industrial
- Healthcare Solutions
- Passenger Vehicle

REV0624

Power input and high-speed communication ports are integral parts of every electronics design



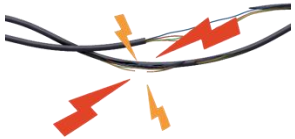
Littelfuse combines component expertise with application knowledge to offer the most optimal protection solutions against electrical stress.

Ports need protection from common electrical hazards

Lightning surge

Induced lightning surges can be coupled to industrial data lines, causing damage to sensitive ICs.

Power cross

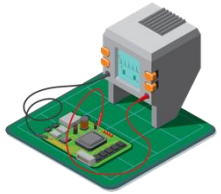


Miswiring during assembly or insulation damage can cause cables to be exposed to AC line voltage.

Induced power surge

Lightning and power grid switching can induce power surges, causing damage.

Electrical fast transient



An Electrical Fast Transient (EFT) can be a result of switching of inductive loads or relay contacts ‘bouncing’.

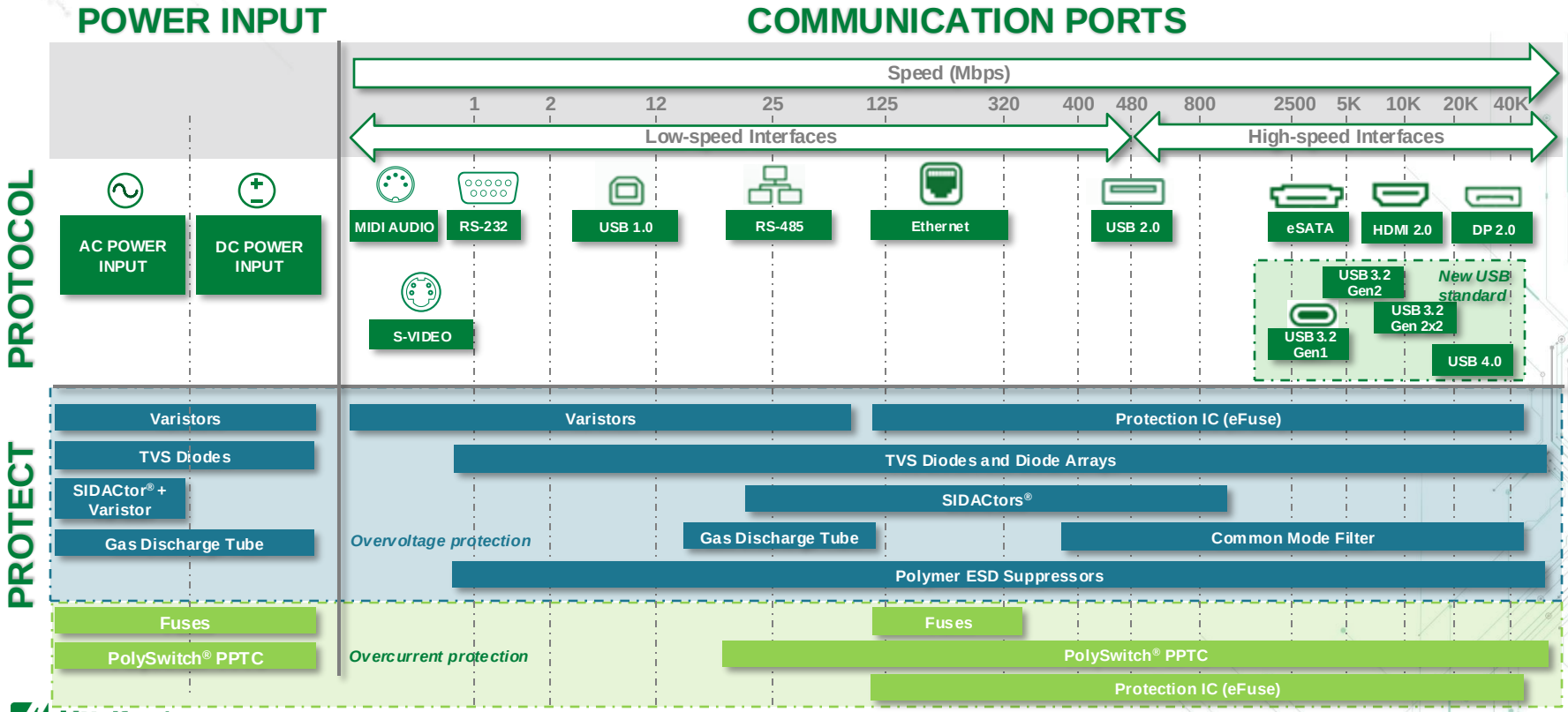
Electrostatic discharge

ESD passing through connecters can cause damage to ICs.

Wire aging and installation faults

RS-485 and Ethernet often share the same conduits with DC or AC gradually resulting in cracks in the insulation due to sharp bends and tight wiring ties.

Wide array of Littelfuse circuit protection solutions for power and communication ports



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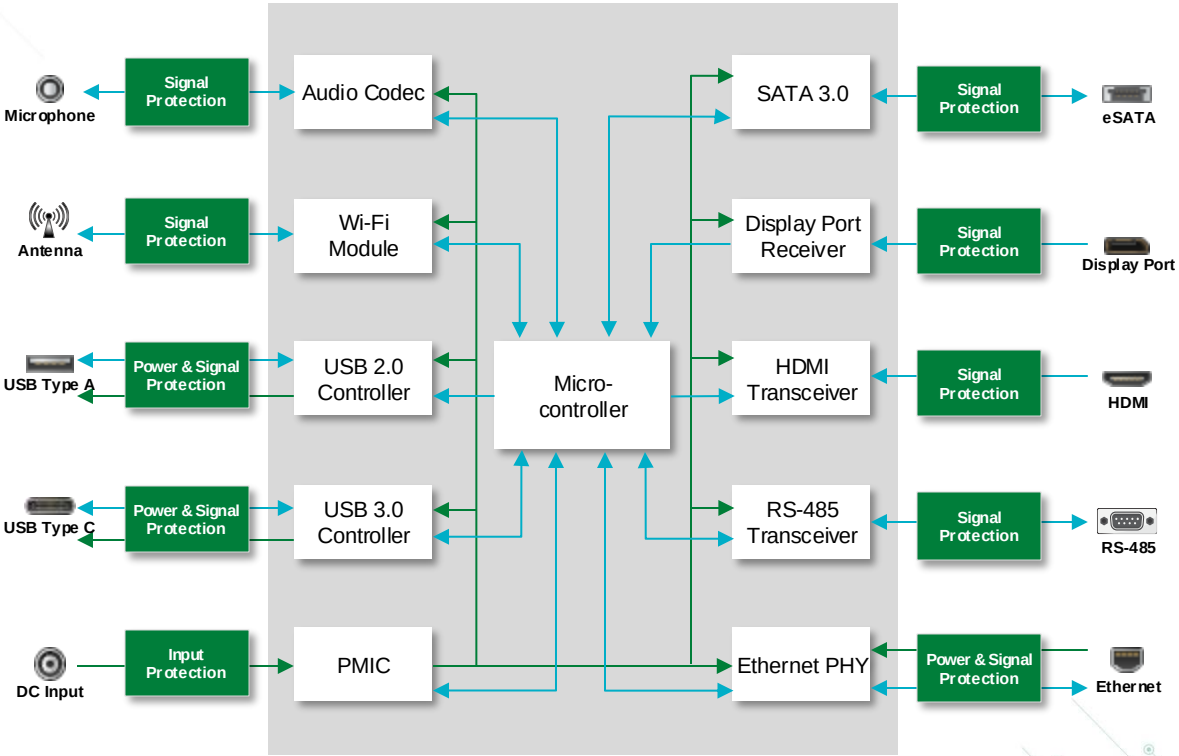
Littelfuse recommended solutions for general port protection

Antenna & Audio
TVS Diode Array, Polymer ESD

USB Type A and B
TVS Diode Array, PPTC, Common Mode Filter, Polymer ESD

USB Type C
TVS Diode Array, PPTC, eFuse, Common Mode Filter

DC Input Protection
TVS Diode, MOV, GDT



SATA 3.0
TVS Diode Array, Polymer ESD

HDMI and Display Port
TVS Diode Array, Common Mode Filter, Polymer ESD

RS-485
TVS Diode Array, PPTC, Polymer ESD

Ethernet
TVS Diode, Fuse, GDT, Polymer ESD

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Power over Ethernet (PoE)

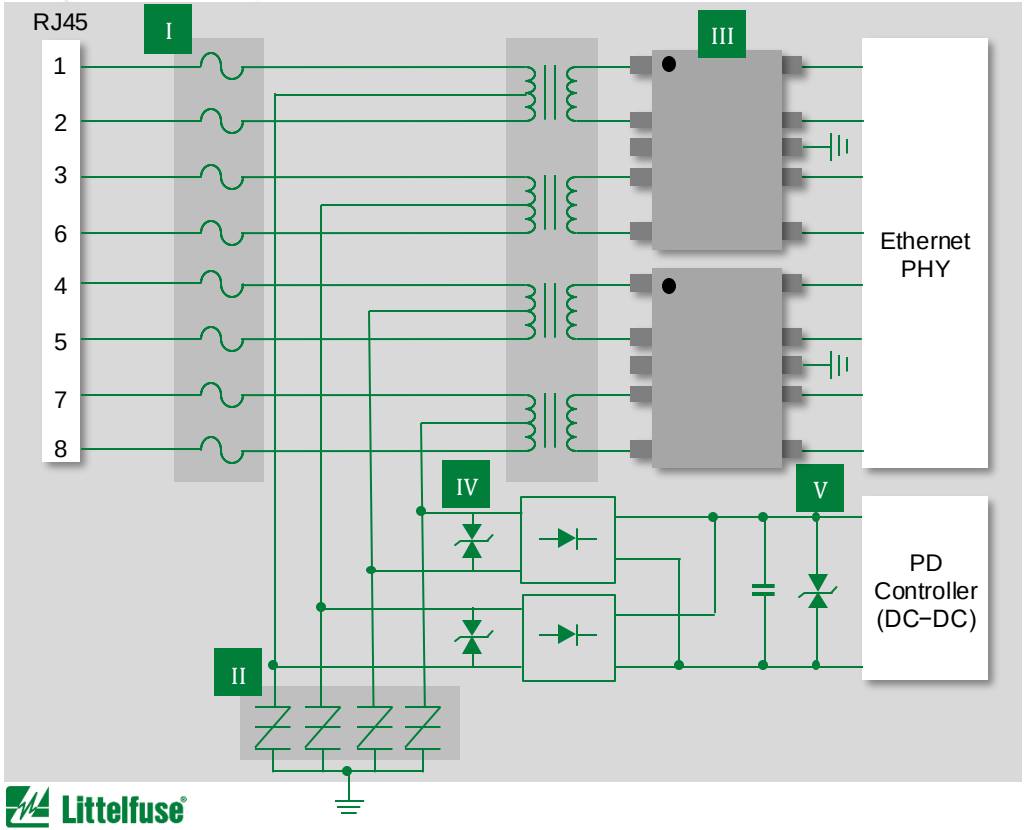
Evolution from PoE to PoE+ and PoE++

		PoE	PoE+	PoE++	
Year		**2003**	**2009**	**2018**	
Standard		**IEEE 802.3af**	**IEEE 802.3at**	**IEEE 802.3bt**	
Power (supply, PSE)	Max power	15.4 W	30 W	60 W	100 W
	Max current	350 mA	600 mA	600 mA	960 mA
	Type	Type 1	Type 2	Type 3	Type 4
Power (receive, PD)		12.95 W	25.5 W	51 W	71.3 W
Number of pairs used for power delivery		2 pairs		4 pairs	
Distance		100 m Cat5e			

A higher current and more twisted pairs are used on PoE++ to reach 100 W.

Click the product series in the table below for more info

Lightning, ESD, and power fault protection: PoE++



	Technology	Series
I*	Fuse (x8)	461xxx
II	SIDACtor® (x4) ***OR*** GDT (x4)	P4500SCLRP SG75 / SG90
III	TVS Diode Array (x2)	SP2555NUTG, SP2525NUTG, SP3025-04HTG
IV*	TVS Diode (x2)	SMCJ58CA, SMTOAK2
V*	TVS Diode (x1)	SMCJ58CA, SMTOAK2

I TeleLink® fuses can help protect from power fault overcurrents. These fuses are designed specifically for high-speed telecom applications.

IV A single TVS Diode (bi-directional) is used across the center tap data pair and second TVS Diode across the center tap spare pair. The TVS Diode can be chosen based on surge requirements from 400 to 8000 W.

V Outdoor-facing ports should consider a higher-surge protection device, such as SMTOAK2.

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Click the product series in the table below for more info

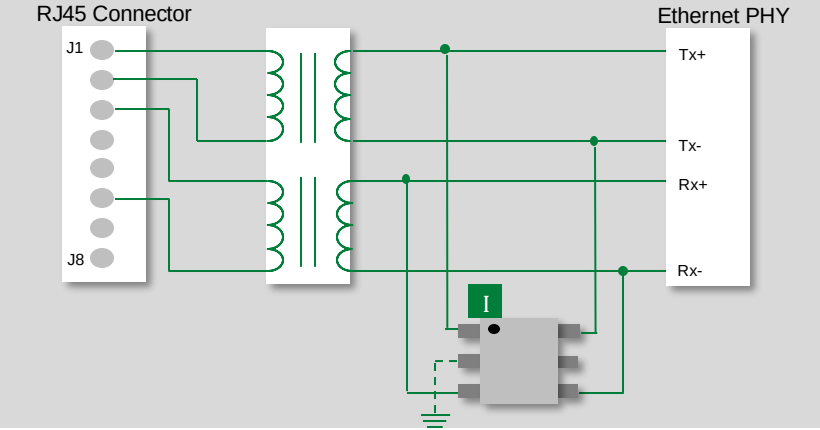
Features and benefits of Littelfuse parts in PoE++

	Technology	Function in application	Product series	Benefits	Features
I	Fuse (x8)	Overcurrent protection from power crosses and lightning surges	461xxx	Enables compliance with regulatory standards like IEC-60950, Telcordia GR-1089, and FCC 47-part 68 Surge Specifications	Surface mount; surge−tolerant fuse designed specifically for high-speed telecom applications
II	SIDACtor® (x4) ***OR*** GDT (x4)	Designed to protect baseband equipment against damage from overvoltage surges	P4500SCLRP	Enables compliance with global regulatory standards; does not degrade surge capability after multiple surge events	Low-voltage overshoot, low on-state voltage, and low capacitance
		Designed to protect baseband equipment against damage from overvoltage surges	SG75 / SG90	Enables compliance with global regulatory standards	Excellent stability on multiple pulse duty cycles, SMD with ultra small size
III	TVS Diode Array (x2)	Designed to provide protection against ESD, CDE, EFT, and lightning-induced surges or high-speed data lines	SP2555NUTG	Package optimized for high-speed data line routing; minimizes signal distortion; reduces voltage overshooting and provides a simplified PCB design	µDFN-10 package; low leakage current (0.1 µA) and low clamping voltage; protects up to four channels up to 45 A
			SP2525NUTG		µDFN-10 package; low capacitance and low clamping voltage; protects up to four channels up to 30 A
			SP3025-04HTG		SOT23-6L package; low capacitance and low clamping voltage; protects up to four channels up to 30 A
IV	TVS Diode (x2)	Protects sensitive electronic equipment from voltage surges induced by lightning and other surge events	SMCJ58CA, SMTOAK2	Improves system reliability by clamping the voltage at safe levels during surges	1500 W peak pulse capability; compatible with the lead-free solder reflow temperature profile; 2 kA (8/20 µs) surge current capability for protecting power ports in harsh and/or outdoor environments
V	TVS Diode (x1)				

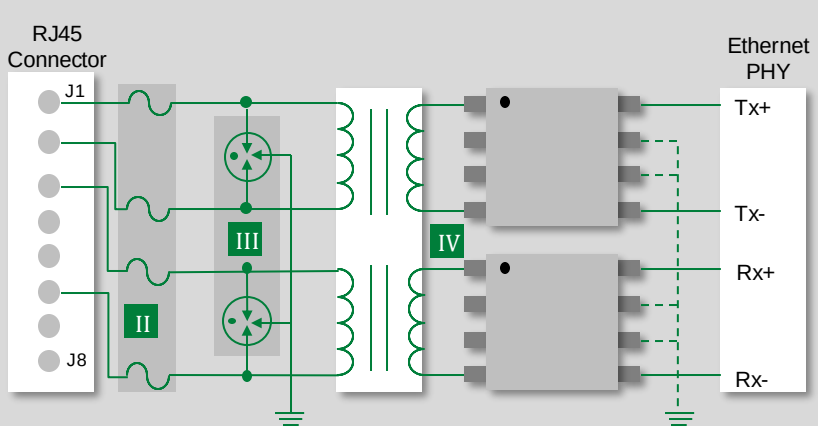
Click the product series in the table below for more info

Circuit protection solutions for Ethernet ports

Intra-building



Outdoor and harsh environments



Note: *1 Gbps or greater will require two additional twisted pairs, and the Diode Array solution should be replicated.*

	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array	Protection from ESD and EFT	SRV05-04HTG-D	Ensures design meets all regulatory requirements; preserves signal integrity	Low capacitance; low leakage current; small design; four lines of protection
II	Fuse	Overcurrent protection	461xxx	Ensures design meets all regulatory requirements; compact design	Surface mount; surge-tolerant fuse designed specifically for high-speed telecom applications
III	GDT	Lightning protection uses GDT with diode array to meet standard requirements	SG, CG6, CG5, SL1010	Ensures safety and reliability of the equipment and ensures design meets regulatory requirements	High surge rating; low capacitance; UL recognized
IV	TVS Diode Array		LC03xx		Low capacitance; low leakage current

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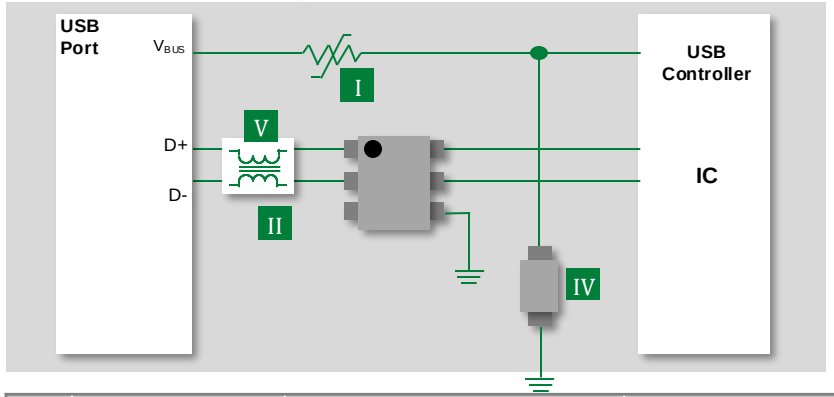
High-speed interfaces

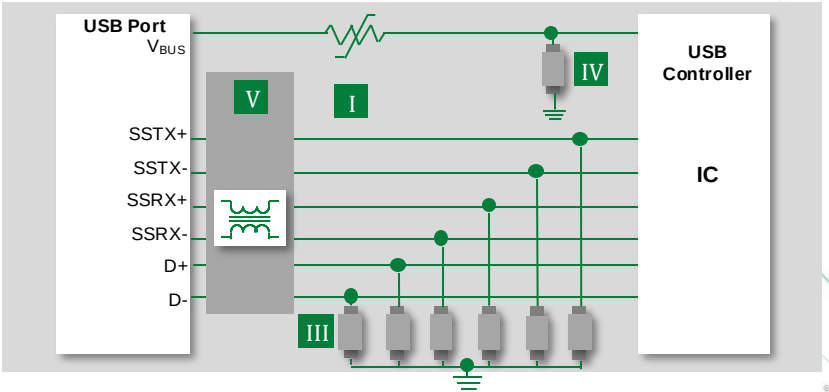
Click the product series in the table below for more info

Circuit protection solutions for USB Type A and Type B

USB 2.0 (480 Mbps)



USB 3.2 Gen 1x1 (5 Gbps)

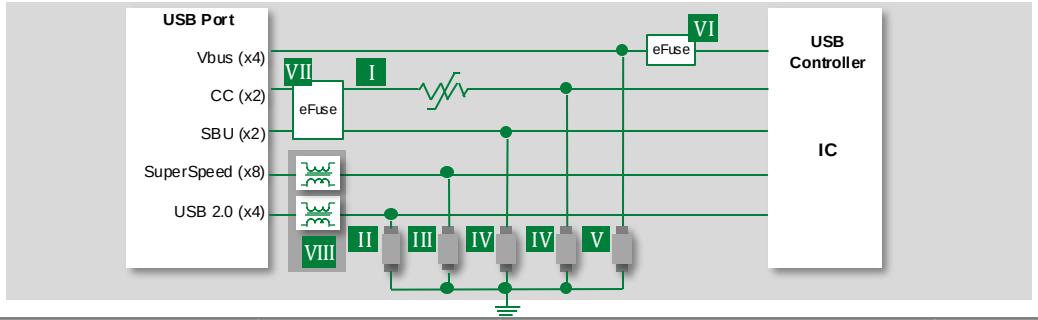


	Technology	Function in application	Series	Benefits	Features
I	PPTC	Protects 5 VDC power supply from overcurrent and overtemperature events	Low Rho	Offers fast response to overcurrent events; suitable for compact portable devices	Ultra-low internal resistance; higher current holding in smallest SMD package
II	TVS Diode Array	Protection of data lines against ESD	SP3019-04HTG, SP3400-02UTG	Clamps surges to a safe level, preventing catastrophic failure; compact design	Low capacitance (0.3 pF) and leakage current (0.01 µA); small form factor µDFN
III	TVS Diode Array (6x) ***OR*** Polymer ESD Suppressor	Protection of data lines against ESD	SP3213-01UTG	Low capacitance ideal for USB; small form factor allows designers layout flexibility	Very low capacitance of 0.09 pF; small form factor µDFN
			PulseGuard®	Virtually no capacitance; compact design	Very low capacitance; low leakage current; small form factor
IV	TVS Diode Array	Protection of power bus against ESD	SP1006-01UTG	Ensures safety of equipment from repetitive ESD strikes without performance degradation	Low leakage current of 100 nA; small form factor
V	Common Mode Noise Filter	Suppresses common mode noise and provides ESD protection	LCFA, LCFE	Removes noise propagating in common mode; ensures safety against ESD strikes	Ultra low profile; CMF with combination ESD function; high cut-off frequency

Click the product series in the table below for more info

Summary of USB Type-C protection solutions

USB 3.2 Gen 2x1 (10 Gbps), USB 3.2 Gen 2x2 (20 Gbps), and USB 4.0 (40 and 80 Gbps)

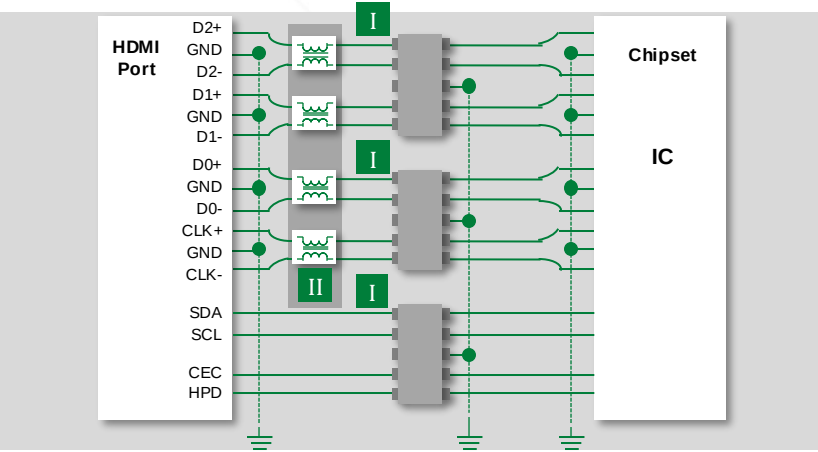


	Technology	Function in application	Series	Benefits	Features
I	Digital Temperature Indicator	Used to sense overheating of USB-C connector	setP™	Enables maximum power delivery and fast charging without power loss or self-heating	Fully compliant with USB Type-C plugs and USB-IF
II	TVS Diode Array	Protects against ESD on USB 2.0-speed data lines	SP3530-01UTG	Space efficient; reliable ESD protection	0201 footprint; extremely low dynamic resistance
III	TVS Diode Array	Protects against ESD on high-speed data lines	SP3213-01UTG, SP00R6, SP33R6	Maintains signal integrity of high-speed data lines; reliable ESD protection	Low parasitic capacitance
IV	TVS Diode Array	Protects against ESD	SP1224-01UTG	Space efficient	AEC-Q101 qualified; small footprint
V	TVS Diode	Protects power bus against ESD	SMAJ20CA	Reliably protects charge controller	400 W Peak Pulse Power; excellent clamping capability; low package profile
VI	eFuse	Protects against 5 V or 5 A DC short and hot-plug surge voltage	LS0505EVD22	Integrated solution for overload, short circuit, input voltage surge, excessive inrush current, etc.	28 V 6 A rated current limit switch; integrates a 24 mΩ ultra low on protection switch
		Used for 5 V~20 V with PD function	LS2406ERQ23		
VII	eFuse	Type-C 20 V Vbus short to CC or SBU	LS05006VPQ33	Supports 28 V maximum rating plus ESD protection	Supports fast OVP response time (80 ns); integrated ESD protection with CC dead battery function
VIII	Common Mode Noise Filter	Suppresses common mode noise and protects from ESD	LCFA, LCFE	Removes noise propagating in common mode; ensures safety against ESD strikes	Ultra low profile, CMF with combination ESD function, high cut-off frequency

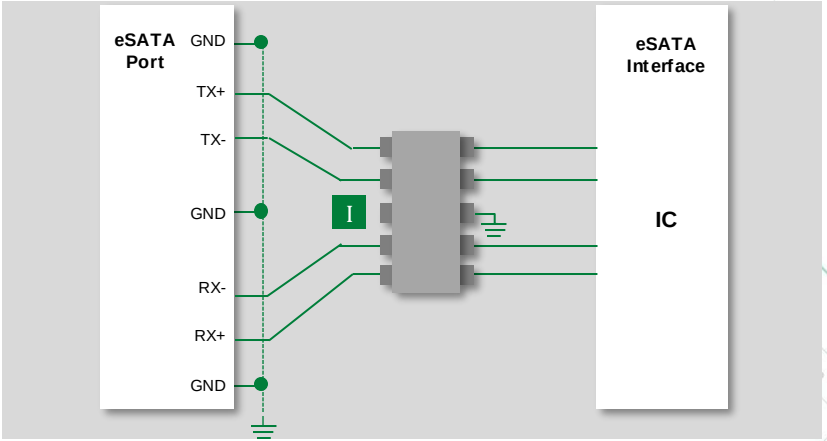
Circuit protection solutions for HDMI port, DisplayPort, and eSATA port

Click the product series in the table below for more info

HDMI and DisplayPort



eSATA



	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array ***OR*** Polymer ESD Suppressor	Protection of data signal lines from ESD	SP1004U-ULC-04UTG	Low capacitance makes it ideal for high-speed interfaces such as HDMI and eSATA; small form factor allows designers layout flexibility	Low capacitance of 0.2 pF; low clamping voltage of 9.2 V @ IPP=2.0 A (t_P=8/20 µs); industry standard DFN footprint
			PulseGuard®	Virtually no capacitance; compact design	Very low capacitance; low leakage current; small form factor
II	Common Mode Noise Filter	Suppresses common mode noise and protects from ESD	LCFA, LCFE	Removes noise propagating in common mode; ensures safety against ESD strikes	Ultra low profile; CMF with combination ESD function; high cutoff frequency

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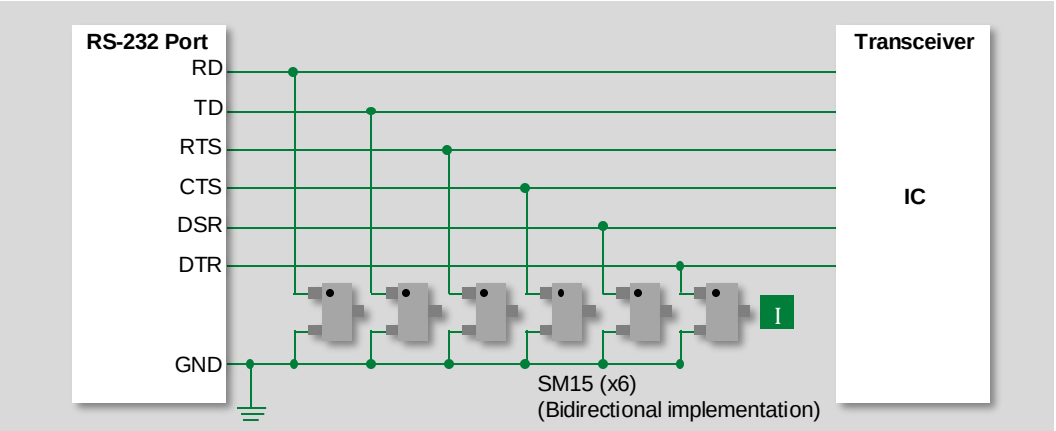
Click the product series in the table below for more info

Circuit protection solution for RS-232 port

RS-232 port

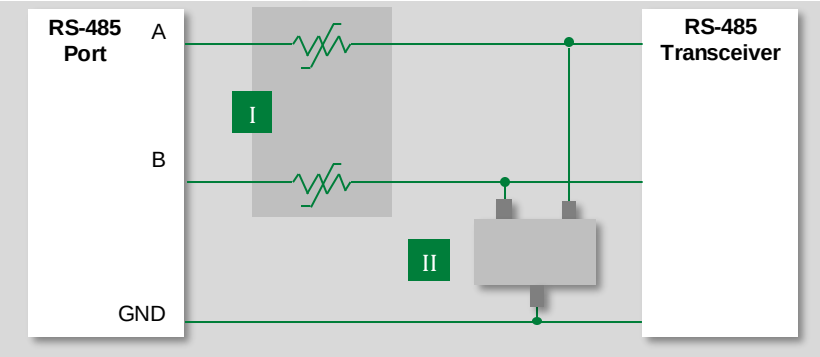


	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array	Protection of data signal line from ESD	SM15-02HTG	Greatly reduces clamping voltages; 25% higher power handling capability; two to three times higher ESD withstand capability	Very low dynamic resistance of 0.30 Ω; low leakage current and clamping voltage
			SD15C-01FTG		Very low dynamic resistance of 0.46 Ω; low leakage current and clamping voltage

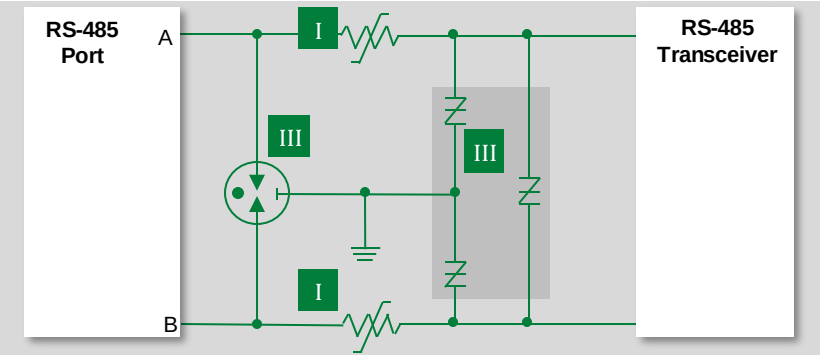
Click the product series in the table below for more info

Circuit protection solutions for RS-485 port

Intra-building



Outdoor and harsh environment

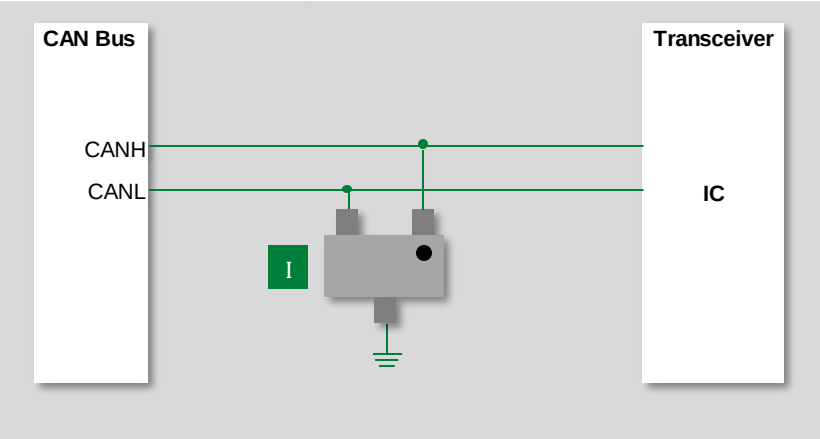


	Technology	Function in application	Series	Benefits	Features
I	PPTC	Protects equipment from short circuits and power crosses	TSV250	Product choices give engineers increased design flexibility; helps improve line balance	Available in various form factors; low parasitic capacitance
II	TVS Diode Array ***OR*** Polymer ESD Suppressor	Protects from ESD, EFT, and lightning-induced surges	SP712	Greatly reduces clamping voltages; robust surge and enhanced ESD protection	Specifically designed for RS-485 with asymmetrical working voltages of 7 to 12 V
			PulseGuard®, Xtreme-Guard™	Virtually no capacitance; compact design	Very low capacitance; low leakage current; small form factor
III	GDT + SIDACtor®	When lightning occurs, the SIDACtor will react first, causing the voltage to increase across PPTC until GDT fires	GTCxx, PxxxxS4xLRP	Coordinated protection against high surge levels; low clamping voltage	Wide range of voltages and form factors; low capacitance and insertion loss; low voltage overshoot; low on-state voltage
	SIDACtor®	Protection against lightning	Pxxx0S3N	Removes the need for GDT and coordination	capable to 3kA surges exceeding IEC61000-4-5 Level 4, K.20/21 Basic and Enhanced, GR1089, UL60950 requirements

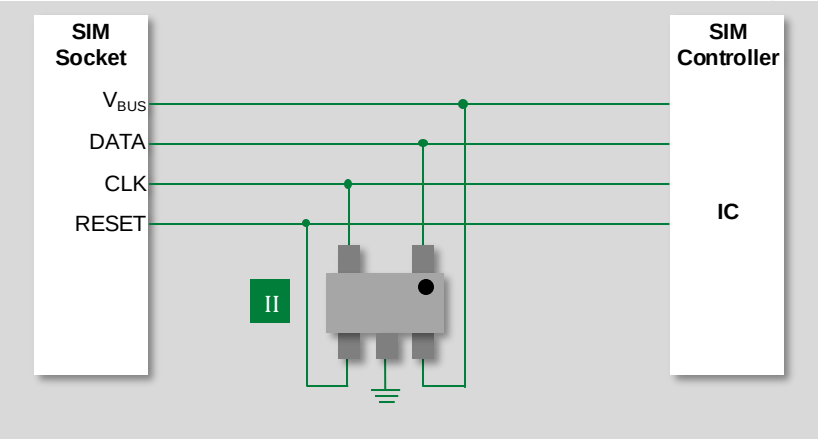
Circuit protection solutions for CAN/LIN bus and SIM/µSIM socket

Click the product series in the table below for more info

CAN/LIN Bus



SIM/µSIM socket

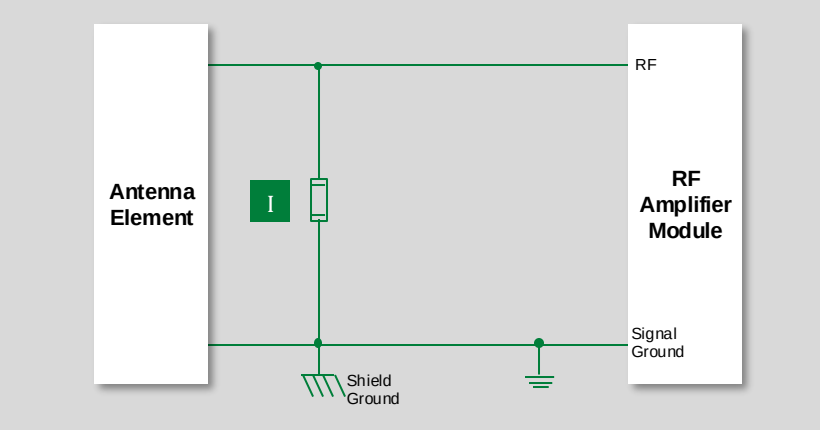


	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array	Protects against ESD and surges	AQ24COM-02HTG	Ensures safety of the equipment without performance degradation	AEC-Q101 qualified; low clamping voltage and leakage current
II	TVS Diode Array	Protects against ESD	SP1012-05WTG	Small form factor suitable for compact designs	Provides good ESD protection for data lines; very low dynamic resistance of 0.48 Ω

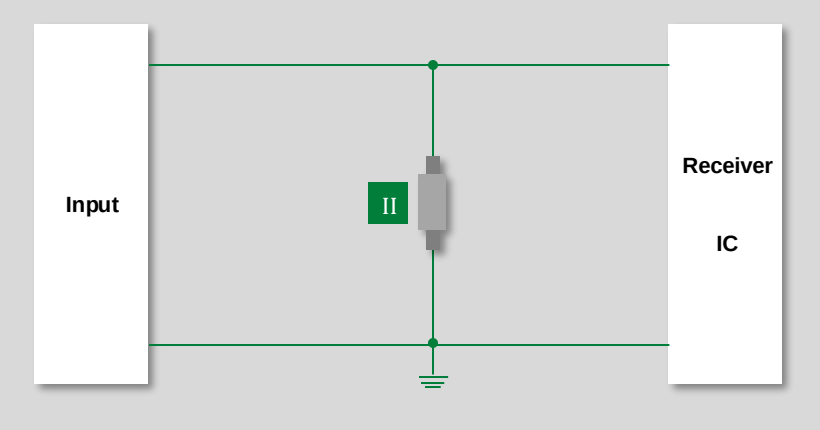
Circuit protection solutions for antennas and sensor inputs

Click the product series in the table below for more info

Antennas



Sensor inputs



	Technology	Function in application	Series	Benefits	Features
I	Polymer ESD Suppressor	Protection against ESD	XGD10603	Preserves signal integrity; withstands high levels of ESD	Extremely low capacitance (0.09 pF); high ESD withstand rating (30 kV)
II	TVS Diode Array	Protection against ESD	SP3522-01ETG	Small form factor suitable for compact designs	High ESD withstand rating; low leakage current; AEC-Q101 qualified parts available

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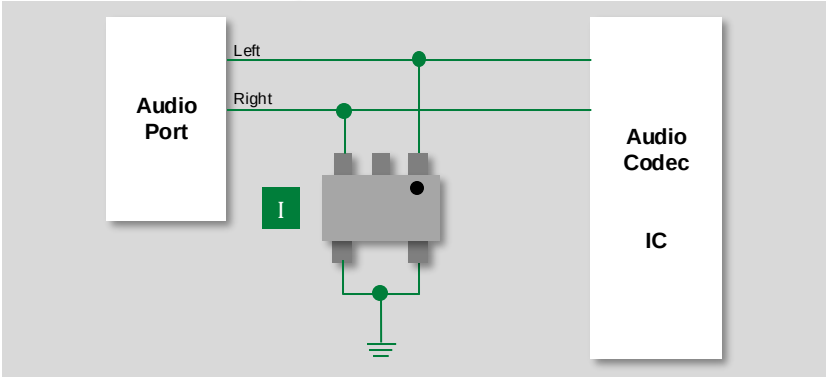
Low-speed applications

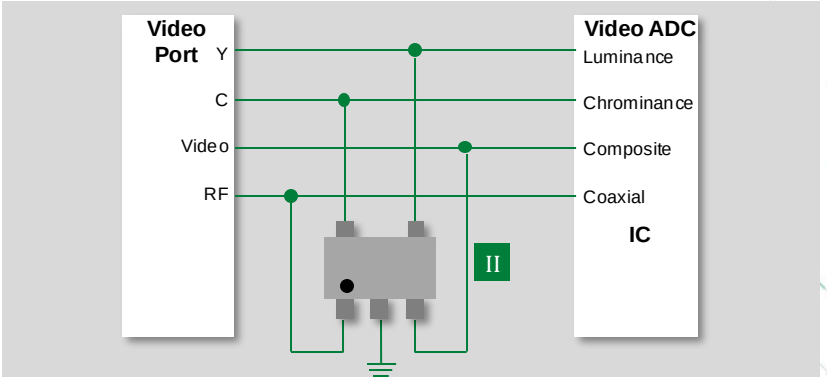
Click the product series in the table below for more info

Circuit protection solutions for audio and video lines

Audio line



Video line

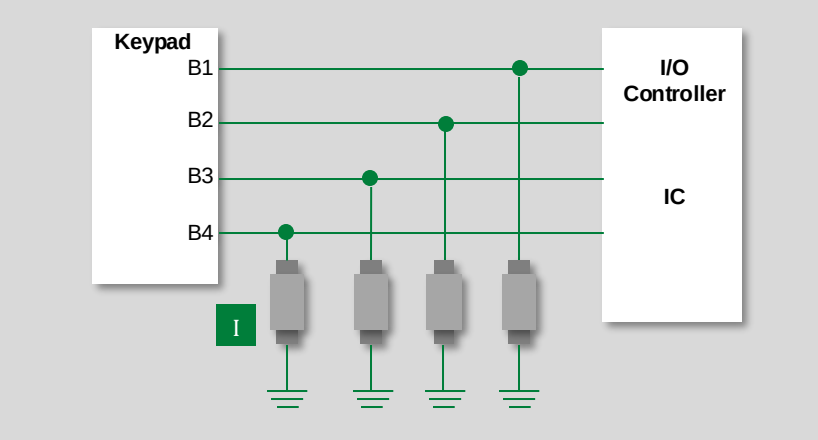


	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array ***OR*** Polymer ESD Suppressor ***OR*** Multi-layer Varistor	Protects audio codec from ESD damage	SP1002	Absorbs repetitive ESD strikes at the max level without system performance degradation; compact design	Low capacitance of 5 pF; low leakage current of 0.5 µA; small package
			PulseGuard®	Virtually no capacitance; compact design	Very low capacitance; low leakage current; small form factor
			MLA	Compact design	Standard low capacitance; leadless 0402, 0603, 0805, 1206, and 1210 chip sizes
II	TVS Diode Array ***OR*** Polymer ESD Suppressor ***OR*** Multi-layer Varistor	Prevents video analog-to-digital converter from damaging ESD damage	SP3019-04HTG	Absorbs repetitive ESD strikes at the maximum level without system performance degradation; compact design	Low capacitance of 0.3 pF; low leakage current
			PulseGuard®	Virtually no capacitance; compact design	Very low capacitance; low leakage current; small form factor
			MLA	Compact design	Standard low capacitance; leadless 0402, 0603, 0805, 1206, and 1210 chip sizes

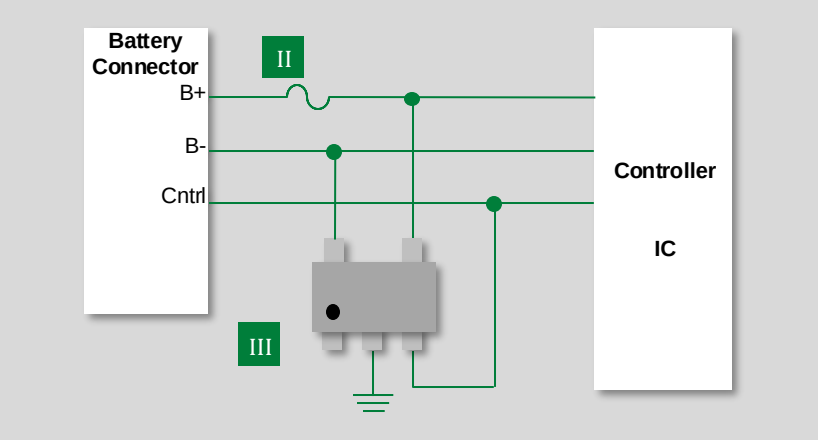
Circuit protection solution for keypads, buttons, switches, and battery packs

Click the product series in the table below for more info

Circuit protection for keypads



Circuit protection for battery packs



	Technology	Function in application	Series	Benefits	Features
I	Multi-layer Varistor	Protects ICs and other components at the circuit board level against ESD	V5.5MLA0402	Provides design flexibility using discrete single-channel devices	AEC-Q200 compliant; standard low capacitance
II	Fuse	Overcurrent protection for power bus	435	Small form factor suitable for compact designs	35 A interrupt rating at 32 VDC; compact footprint (0402)
III	TVS Diode Array	ESD protection for power bus and control line	SP3019-04HTG	Maintains signal integrity with reliable protection	AEC-Q101 qualified; low input capacitance; fast response time (< 1 ns)

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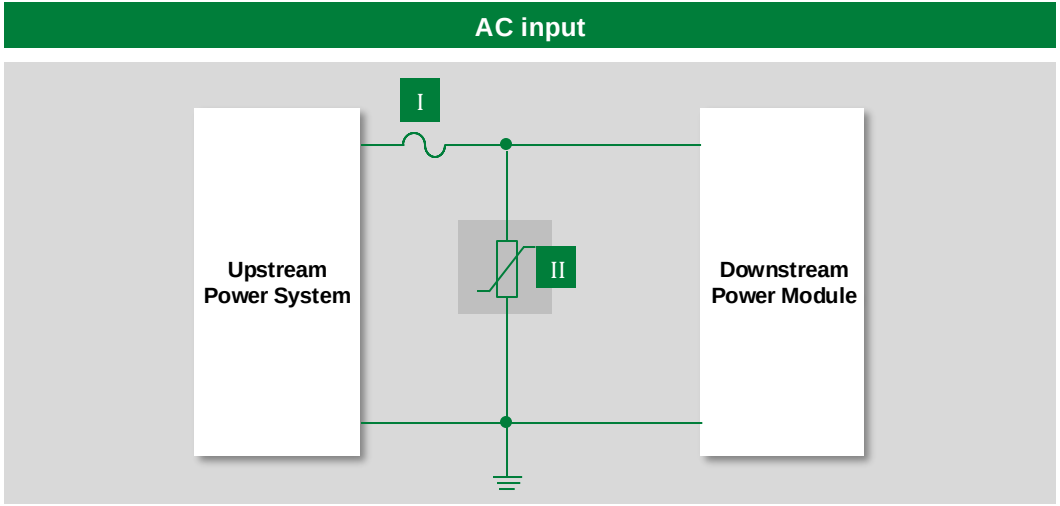
Power inputs

Click the product series in the table below for more info

Circuit protection solutions for AC input

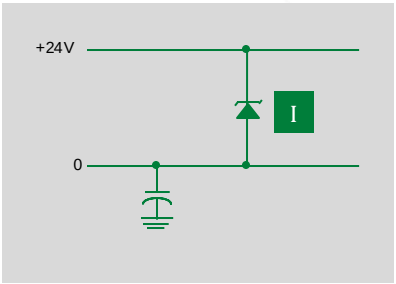


	Technology	Function in application	Series	Benefits	Features
I	Fuse ***OR*** PPTC	Protection against short circuit and overload conditions	313	Reduces damage to equipment; compact design; energy efficiency protection	Third-party compliance; low internal resistance
		Protects against damage caused by both overcurrent surges and overtemperature faults.	LVR	Offers low resistance and are compatibly sized with fuse solutions	Rated for line voltages of 120 VAC, VDC and 240 VAC, VDC for up to 2 A
II	MOV*	Protection against severe surges and temporary overvoltage events	UltraMOV, TMOV	Reduces customer qualification time by complying with third-party safety standards, such as UL/IEC	High energy absorption capability: 40–530 J (2 ms); integrated thermal protection

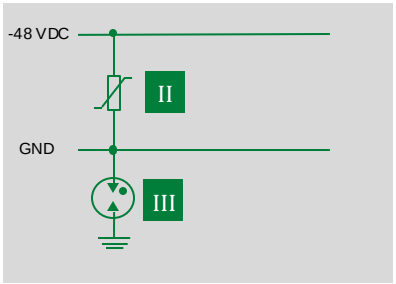
** For better surge lifetime, consider the SIDACtor® + MOV. For the best surge lifetime and clamping performance, the high power TVS Diode is a consideration.*

Circuit protection for DC input

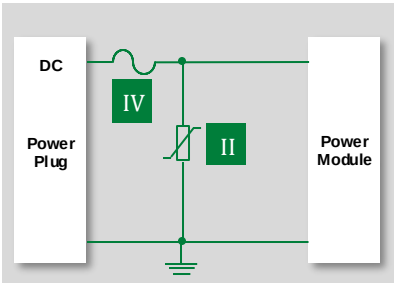
DC Input 12 V / 24 V DC



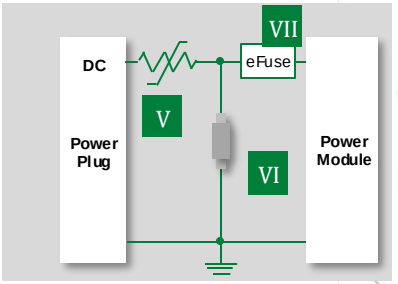
DC Input 48 V DC



DC Input (PFC circuit)



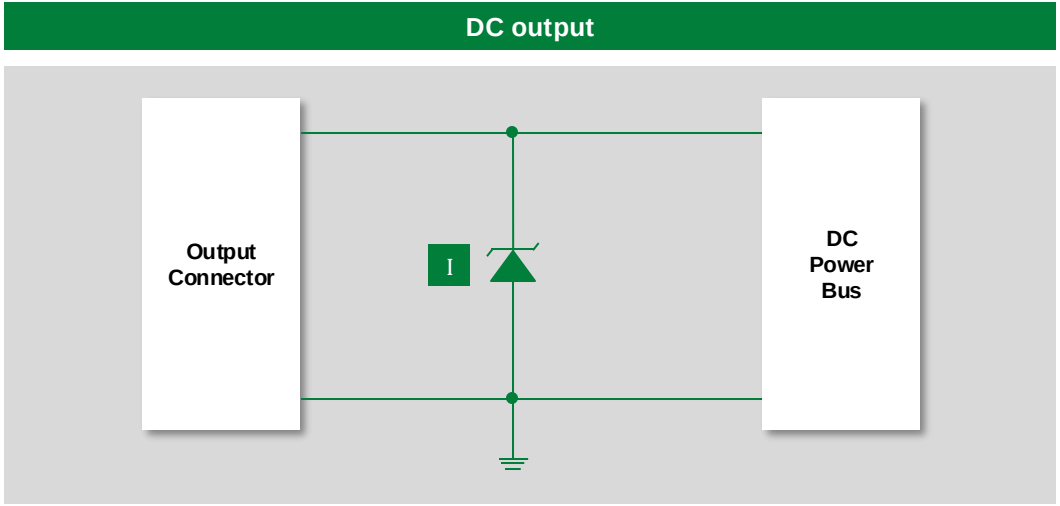
DC Input (portable devices)



	Technology	Function in application	Series	Benefits	Features
I	TVS Diode	Protects against surges	SMDJ, SMF	Improves system reliability by protecting down-stream components from surges on power lines	Excellent clamping capability
II	MOV	Protects against surges	LV Ultra MOV	Increased long-term reliability; more board space; higher surge handling density	High peak surge current rating; high operating temperature range up to 125 °C
III	GDT	Ground isolation protection	CG	Extremely low leakage current to ground	High peak surge current ratings; wide operating voltage range
IV	Fuse	Overcurrent protection	477, 505	Reduces damage to equipment; compact design	Small footprint with high breaking capacity
V	PPTC	Protects against short circuit and overload current conditions	Low Rho	Offers fast response to overcurrent events; suitable for compact portable devices	Ultra low internal resistance; higher current holding in smallest SMD package
VI	TVS Diode Array	Surge and ESD protection	SP11xx	Ensures safety of equipment from repetitive ESD strikes without performance degradation	Low leakage current of 100 nA; small form factor; multiple voltages available
VII	eFuse	Integrated circuit solution for OCP, OVP, SCP, and overtemperature protection	LSxxx	Accuracy and quick response time	Integrated low R_{dson} MOSFET and overvoltage/ overcurrent protection in one small package

Click the product series in the table below for more info

Circuit protection solution for DC output



	Technology	Function in application	Series	Benefits	Features
I	TVS Diode	Overvoltage surge protection	SMBJ	Improves system reliability by protecting downstream components from surges on power lines	Excellent clamping capability

Additional information can be found at Littelfuse.com

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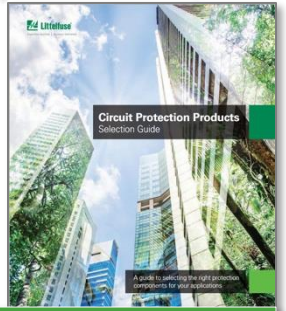


Circuit Protection Selection Guide

ESD Protection Design Guide

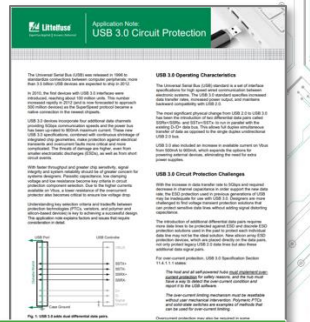
ESD Suppression Design Guide

Ethernet Protection Selection Guide

Click the images for more information

Scan the code to learn more!

USB Type-C ESD Protection Solution



Circuit Protection for USB applications

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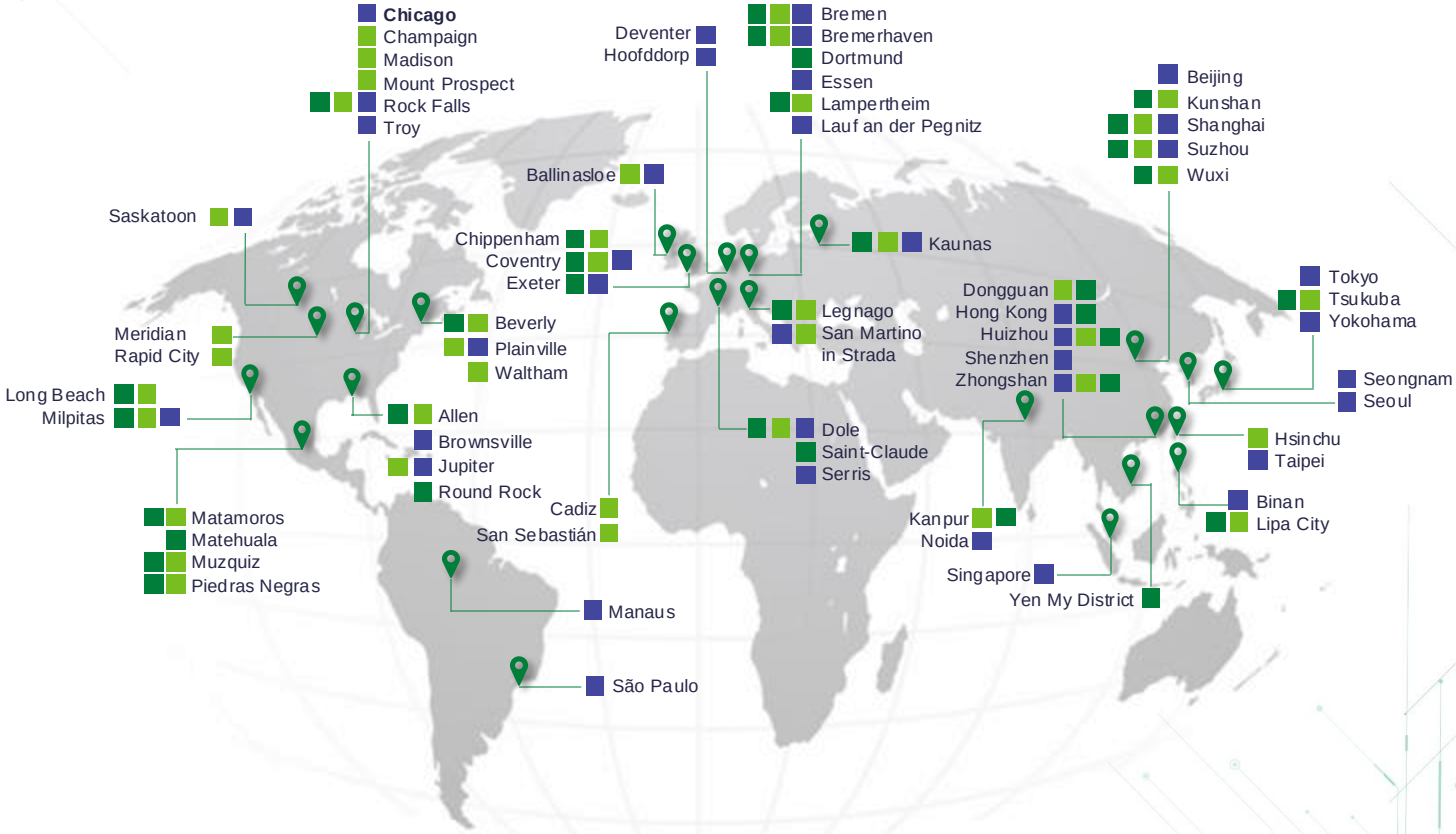
Expertise Applied | Answers Delivered

Local resources supporting our global customers



Legend

- ***Sales***
- ***R&D***
- ***Manufacturing***

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Expertise Applied | Answers Delivered

Partner for tomorrow’s electronic systems

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We are an industrial technology manufacturing company empowering a sustainable, connected, and safer world.

Testing Capabilities

We help customers get products to market faster, and we offer certification testing to global regulatory standards.

Application Expertise

Our engineers partner directly with customers to help speed up product design and meet their unique needs.

Compliance and Regulation

We help customers during the design process to consider requirements set by global regulatory authorities.

Global Customer Service

Our global customer service team is with you to anticipate your needs and ensure a seamless experience.

Global Manufacturing

Our high-volume manufacturing is committed to the highest quality standards.

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