



General Port Protection



Building Solutions



General Industrial



Consumer Electronics



Healthcare Solutions



Datacenter and
Communication



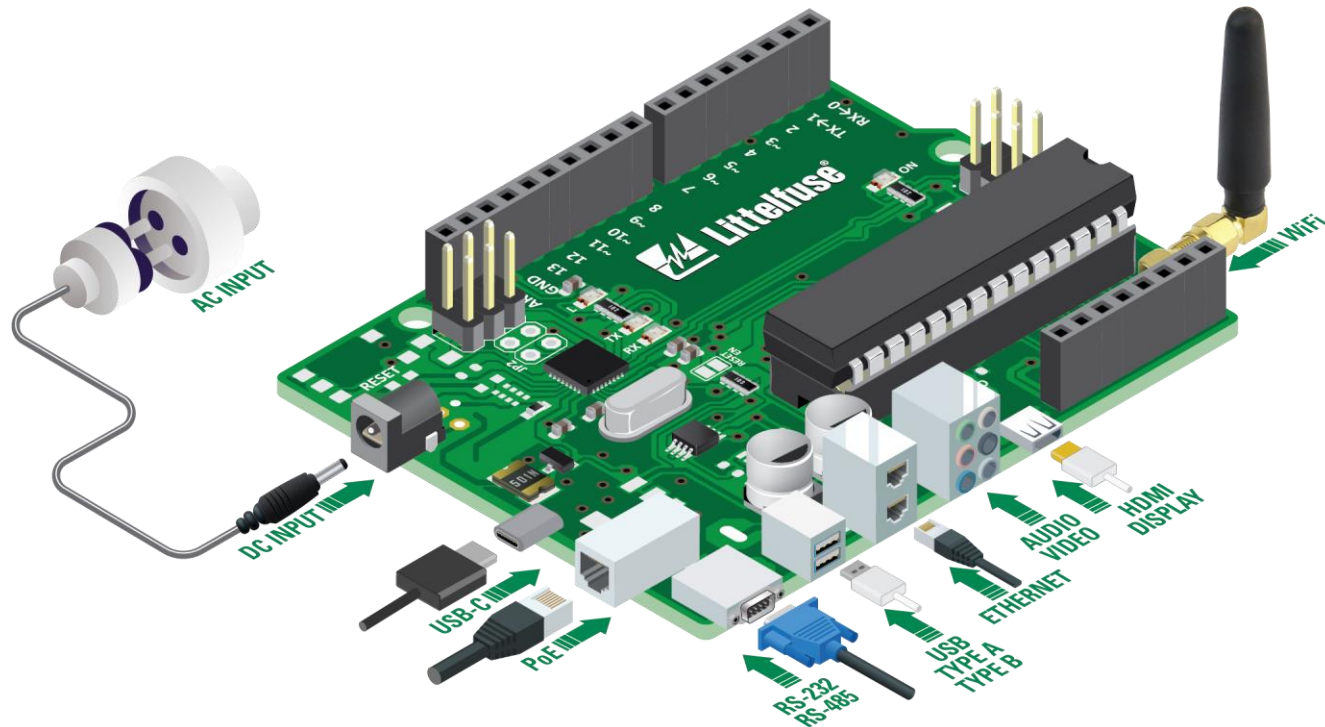
Passenger
Vehicle



Littelfuse®

Expertise Applied | Answers Delivered

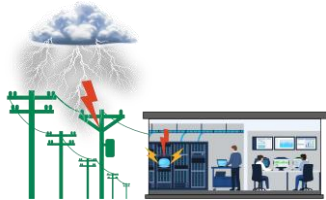
Power input and high-speed communication ports are integral parts of every electronics design



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

Ports need protection from electrical hazards

Lightning surge



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

Induced power surge



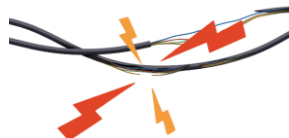
Lightning and power grid switching can induce power surges, causing damage.

Electrostatic discharge



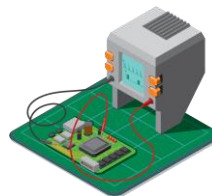
ESD passing through connectors can cause damage to ICs.

Power cross



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

Electrical fast transient



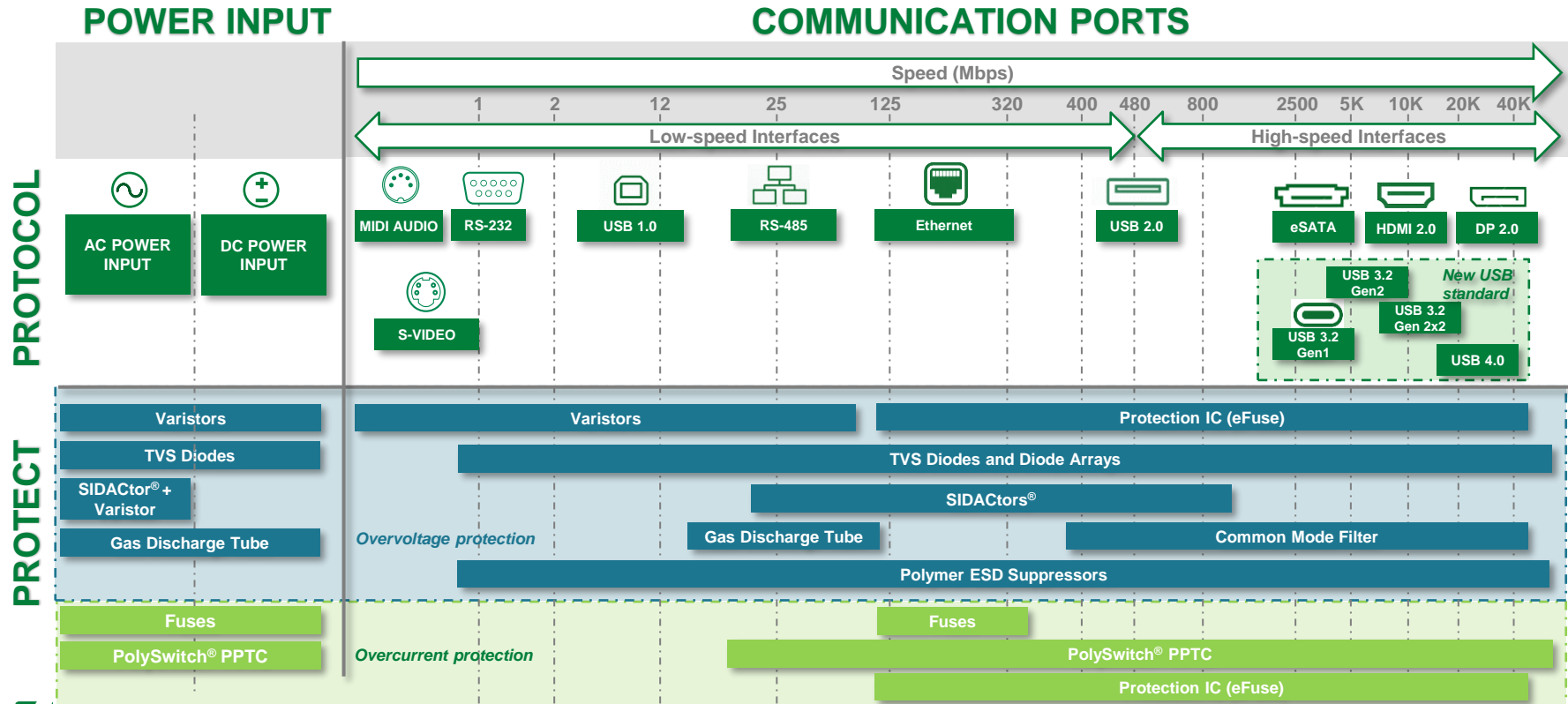
An Electrical Fast Transient (EFT) can be a result of switching of inductive loads or relay contacts 'bouncing'.

Wire aging and installation faults

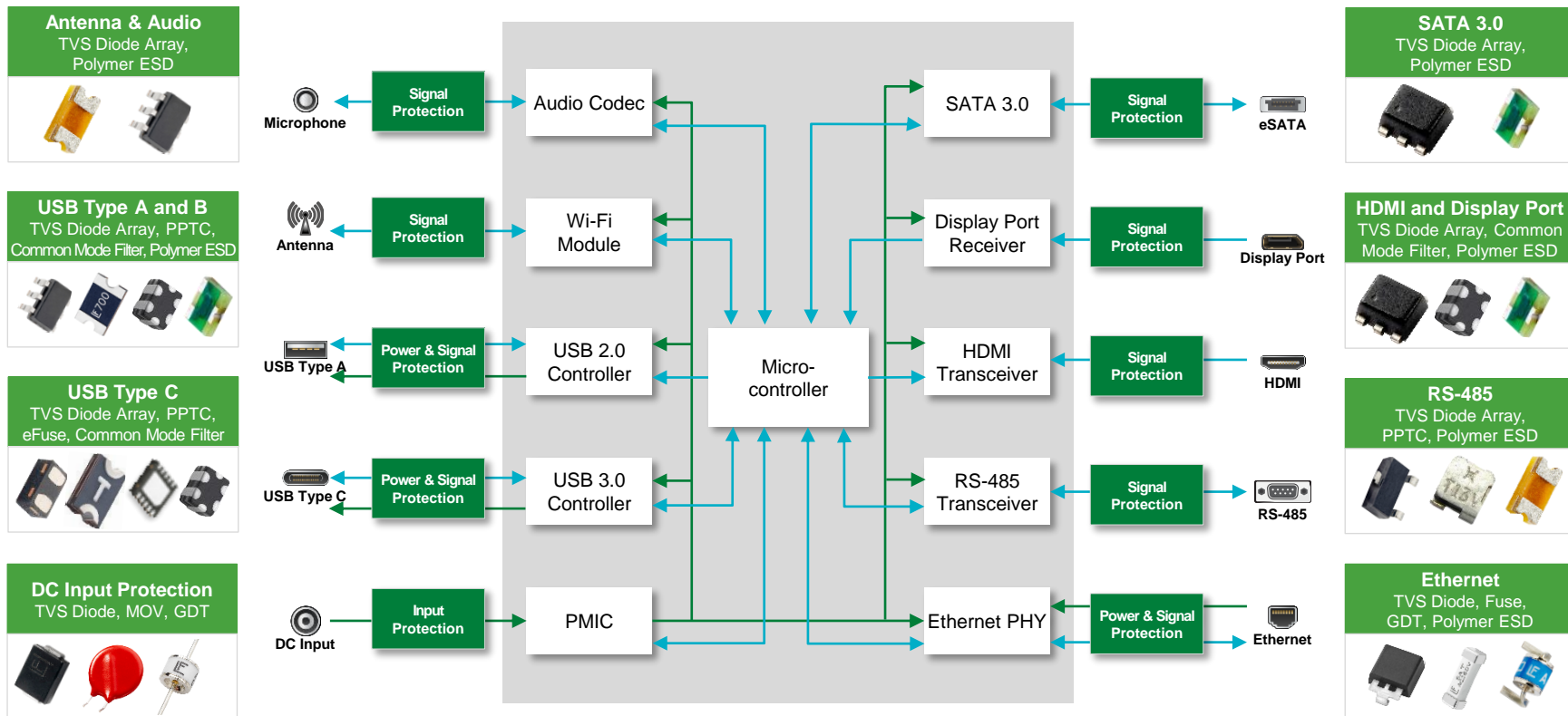


RS-485 and Ethernet often share the same conduits with DC or AC gradually resulting in cracks in the insulation due to sharp bends and tight wiring ties.

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



Littelfuse recommended solutions for general port protection





Power over Ethernet (PoE)

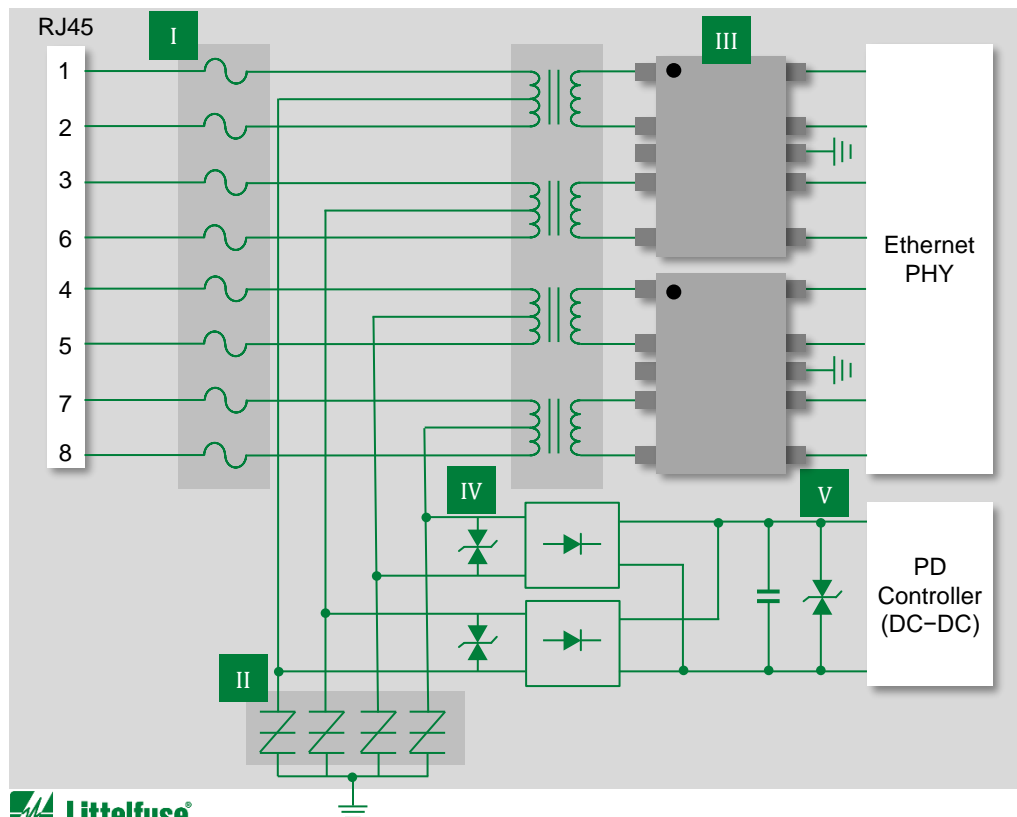


Evolution from PoE to PoE+ and PoE++

		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.

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

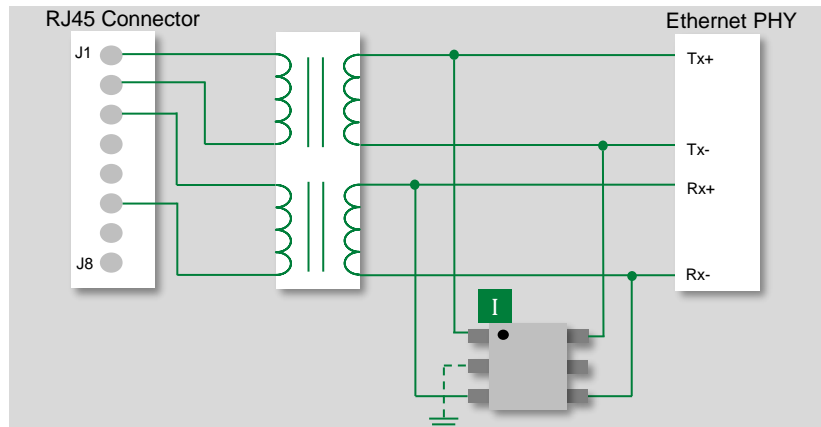
- I** TeleLink® fuses can help protect from power fault overcurrents. These fuses are designed specifically for high-speed telecom applications.
- IV** A single TVS Diode (bi-directional) is used across the center tap data pair and second TVS Diode across the center tap spare pair. The TVS Diode can 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.

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)	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
	OR GDT (x4)	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 , SMT0AK2	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)				

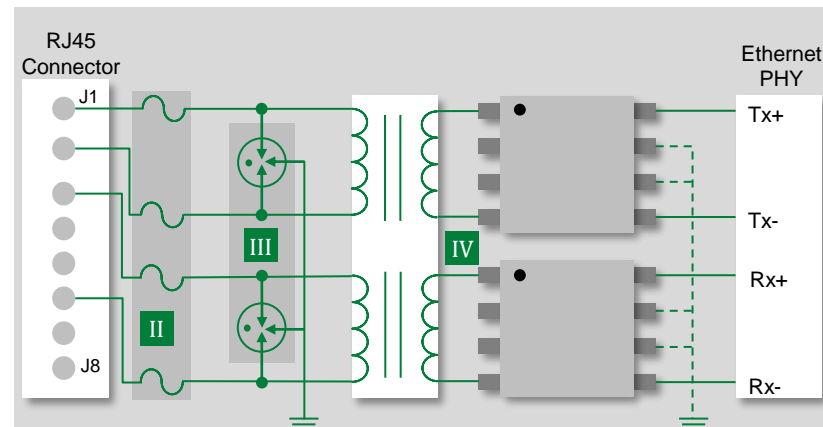
Circuit protection solutions for Ethernet ports

Intra-building



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

Outdoor and harsh environments



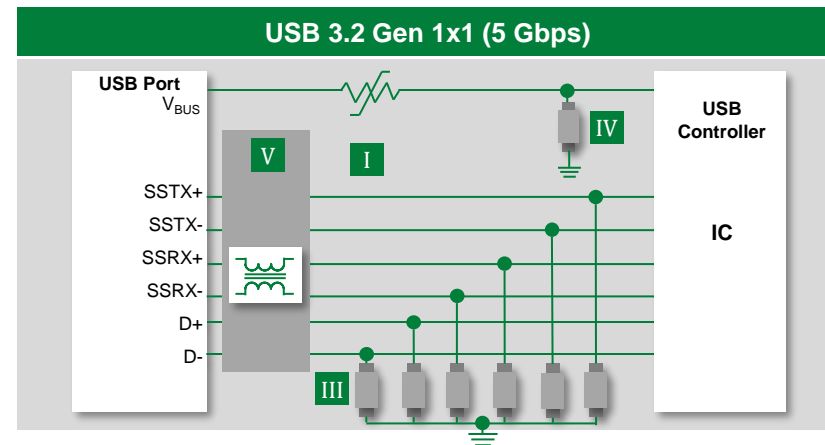
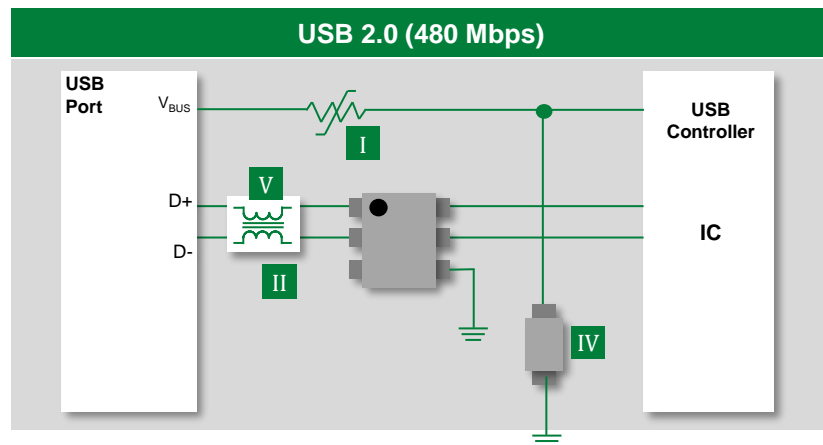
	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array	Protection from ESD and EFT	SRV05-04HTG-D	Ensures design meets all regulatory requirements; preserves signal integrity	Low capacitance; low leakage current; small design; four lines of protection
II	Fuse	Overcurrent protection	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, SP40xx		Low capacitance; low leakage current



High-speed interfaces



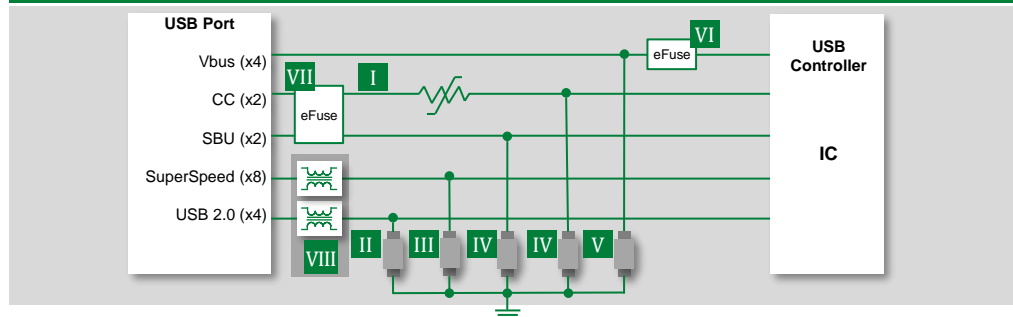
Circuit protection solutions for USB Type A and Type B



	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

Summary of USB Type-C protection solutions

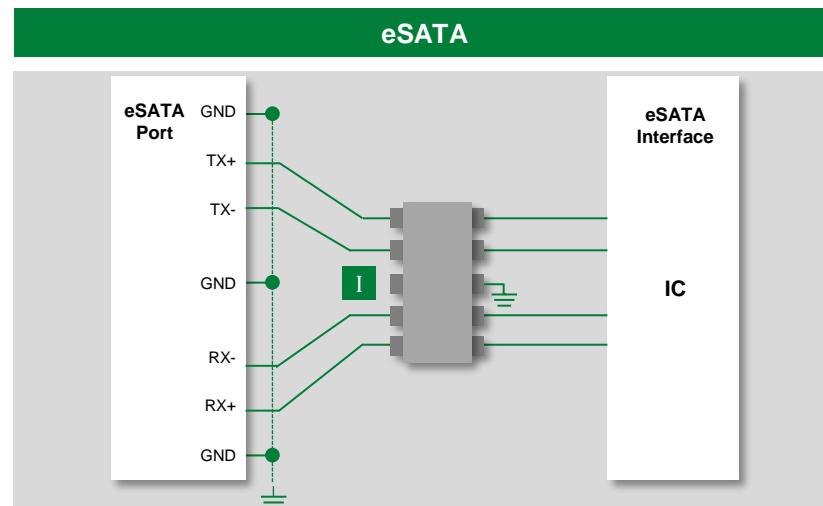
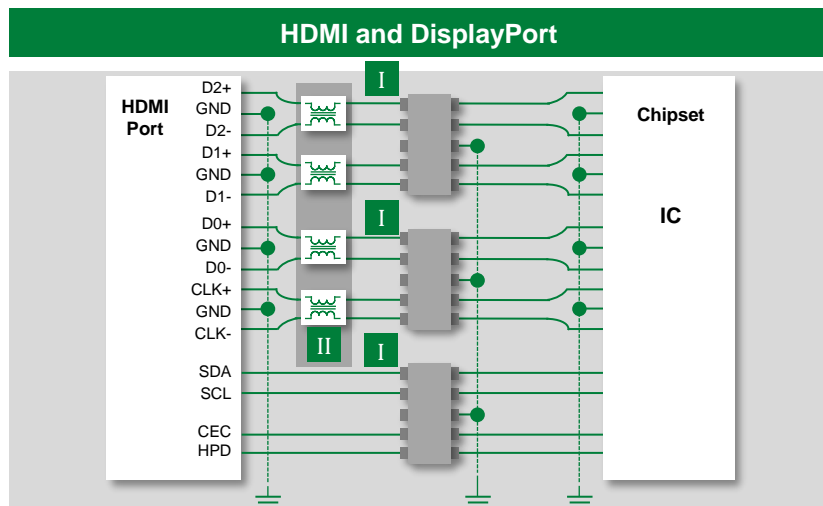
USB 3.2 Gen 2x1 (10 Gbps), USB 3.2 Gen 2x2 (20 Gbps), and USB 4.0 (40 and 80 Gbps)



	Technology	Function in application	Series	Benefits	Features
I	Digital Temperature Indicator	Used to sense overheating of USB-C connector	seIP™	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 Used for 5 V–20 V with PD function	LS0505EVD22 LS2406ERQ23	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
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

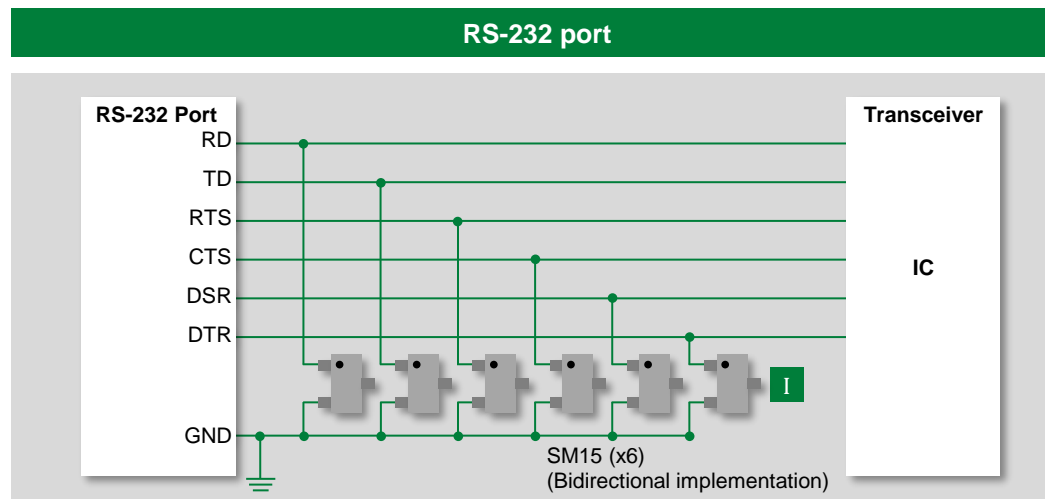
Circuit protection solutions for HDMI port, DisplayPort, and eSATA port

 Click the product series in the table below for more info



	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 ($t_p=8/20 \mu s$); 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

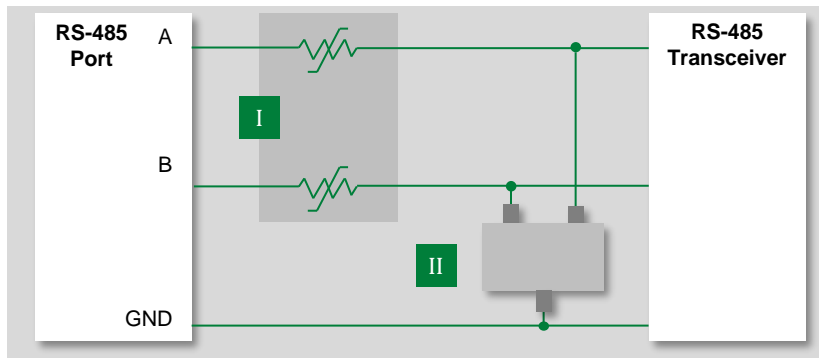
Circuit protection solution for RS-232 port



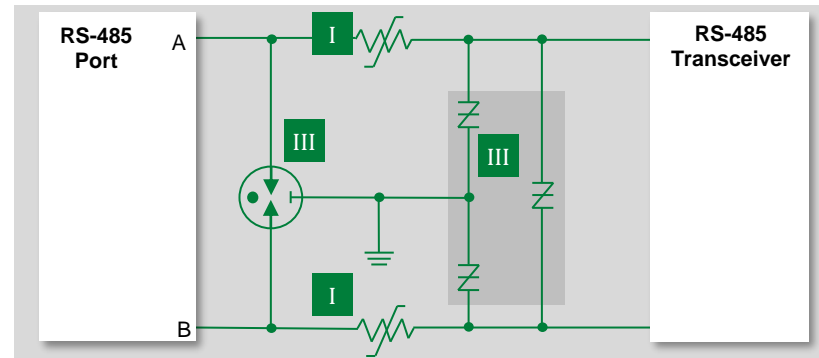
	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array	Protection of data signal line from ESD	SM15-02HTG	Greatly reduces clamping voltages; 25% higher power handling capability; two to three times higher ESD withstand capability	Very low dynamic resistance of 0.30 Ω ; low leakage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

Circuit protection solutions for RS-485 port

Intra-building



Outdoor and harsh environment

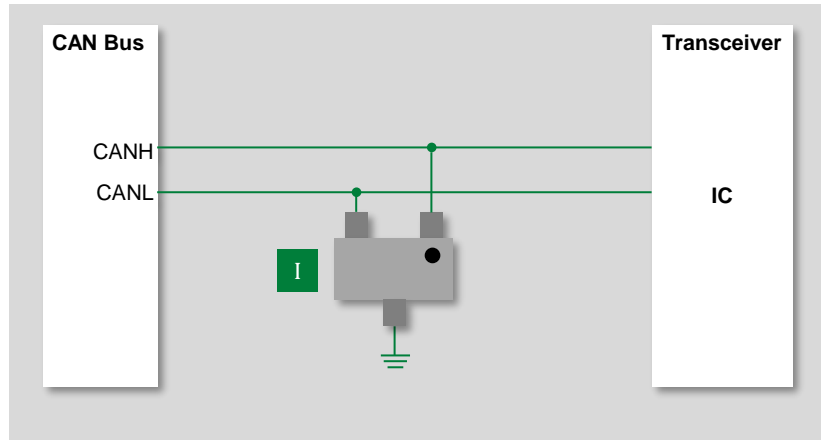


	Technology	Function in application	Series	Benefits	Features
I	PPTC	Protects equipment from short circuits and power crosses	TSV250	Product choices give engineers increased design flexibility; helps improve line balance	Available in various form factors; low parasitic capacitance
II	TVS Diode Array OR 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 , PxxxS4xLRP	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

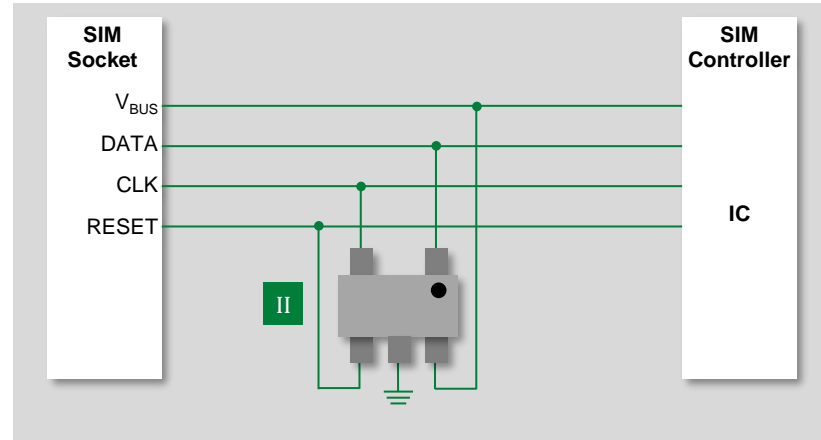
Circuit protection solutions for CAN/LIN bus and SIM/μSIM socket

 Click the product series in the table below for more info

CAN/LIN Bus



SIM/μSIM socket

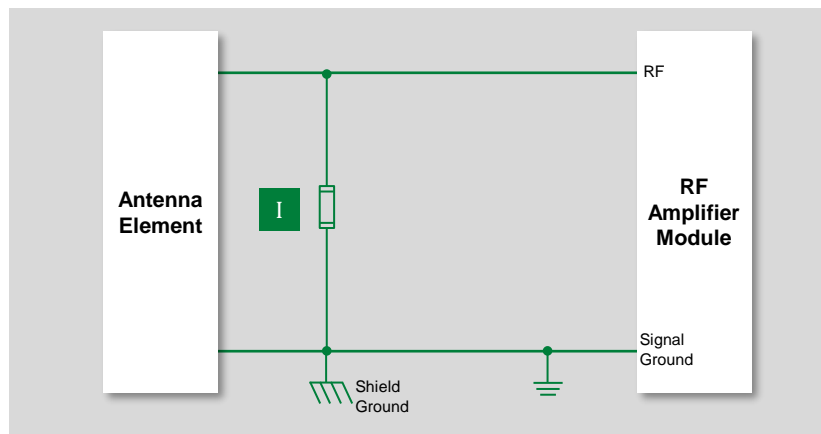


	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array	Protects against ESD and surges	AQ24COM-02HTG	Ensures safety of the equipment without performance degradation	AEC-Q101 qualified; low clamping voltage and leakage current
II	TVS Diode Array	Protects against ESD	SP1012-05WTG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

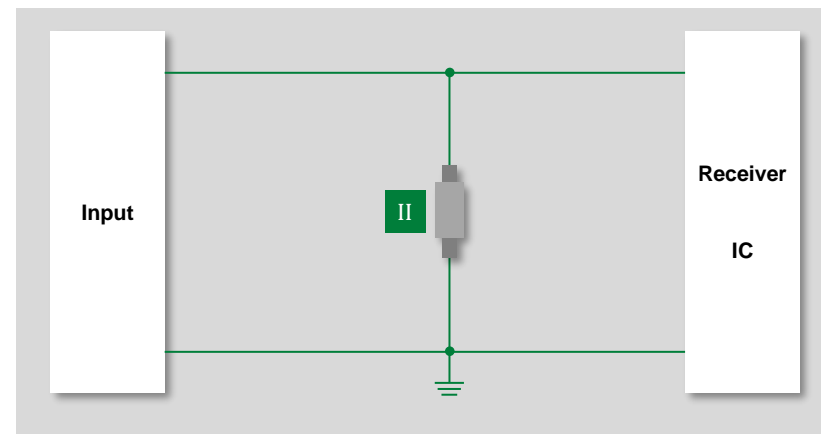
Circuit protection solutions for antennas and sensor inputs

 Click the product series in the table below for more info

Antennas



Sensor inputs



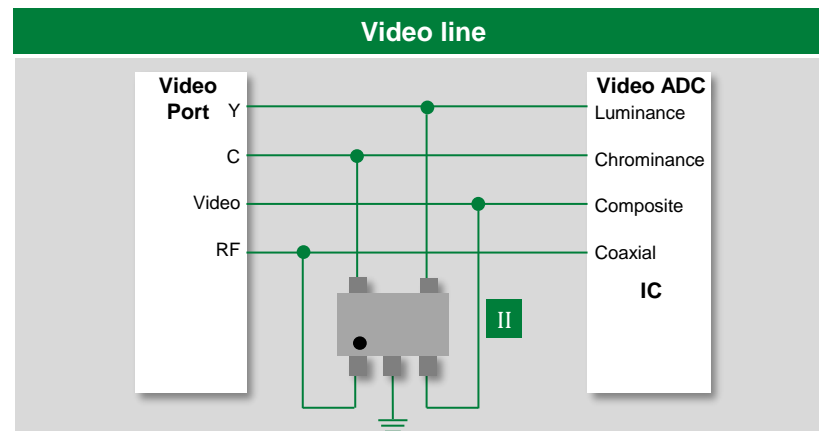
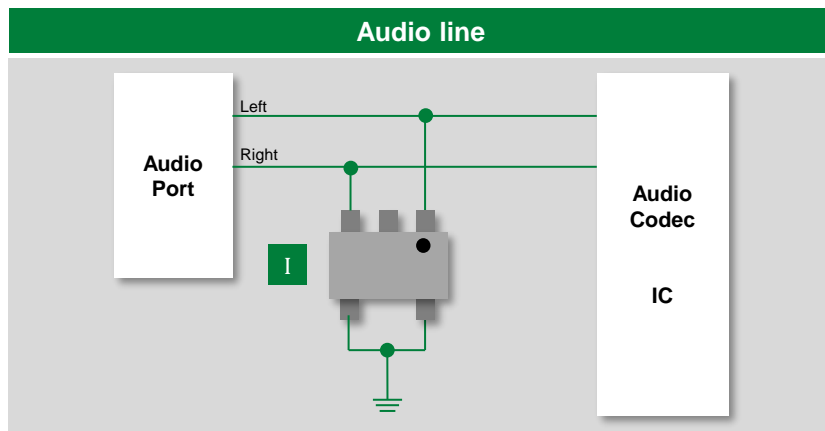
	Technology	Function in application	Series	Benefits	Features
I	Polymer ESD Suppressor	Protection against ESD	XGD10603	Preserves signal integrity; withstands high levels of ESD	Extremely low capacitance (0.09 pF); high ESD withstand rating (30 kV)
II	TVS Diode Array	Protection against ESD	SP3522-01ETG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



Low-speed applications



Circuit protection solutions for audio and video lines

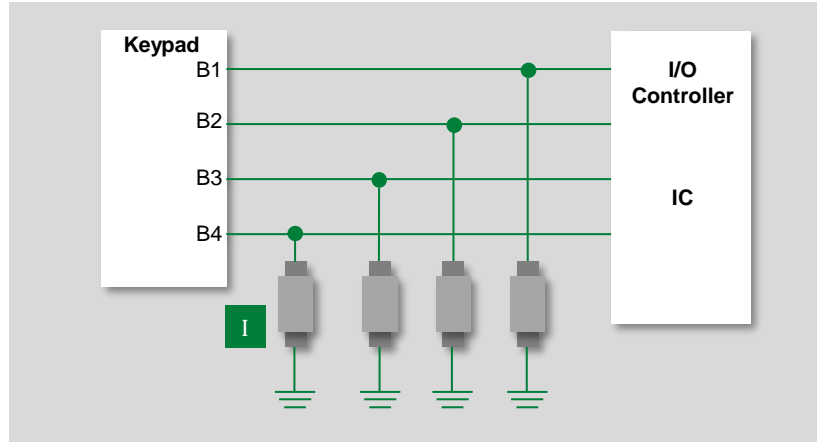


	Technology	Function in application	Series	Benefits	Features
I	TVS Diode Array OR Polymer ESD Suppressor OR Multi-layer Varistor	Protects audio codec from ESD damage	SP1002	Absorbs repetitive ESD strikes at the max level without system performance degradation; compact design	Low capacitance of 5 pF; low leakage current of 0.5 μ A; 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

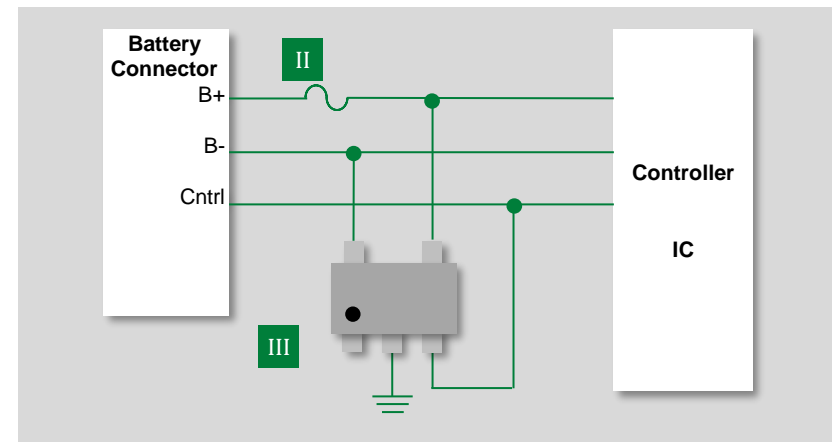
Circuit protection solution for keypads, buttons, switches, and battery packs

 Click the product series in the table below for more info

Circuit protection for keypads



Circuit protection for battery packs



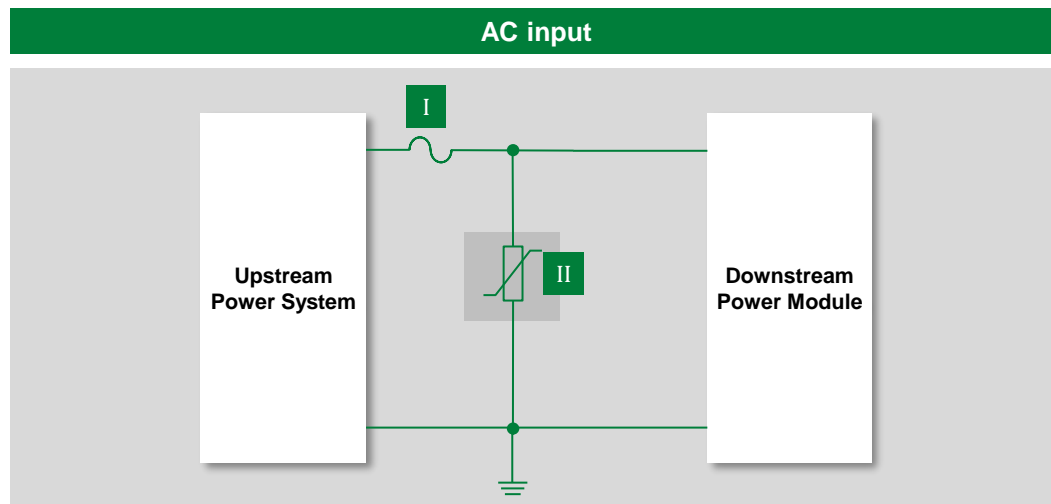
	Technology	Function in application	Series	Benefits	Features
I	Multi-layer Varistor	Protects ICs and other components at the circuit board level against ESD	V5.5MLA0402	Provides design flexibility using discrete single-channel devices	AEC-Q200 compliant; standard low capacitance
II	Fuse	Overcurrent protection 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)



Power inputs



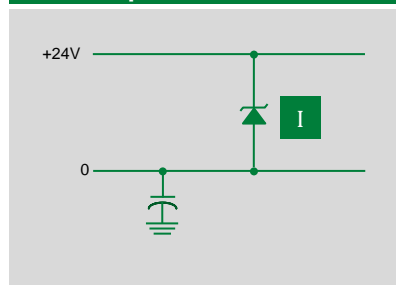
Circuit protection solutions for AC input



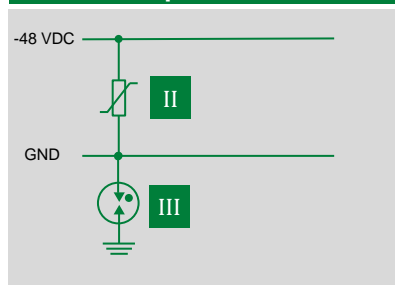
	Technology	Function in application	Series	Benefits	Features
I	Fuse OR PPTC	Protection against short circuit and overload conditions	313	Reduces damage to equipment; compact design; energy efficiency protection	Third-party compliance; low internal resistance
		Protects against damage caused by both overcurrent 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

Circuit protection for DC input

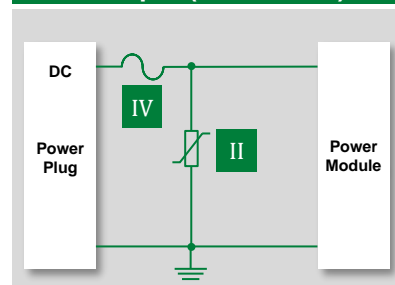
DC Input 12 V / 24 V DC



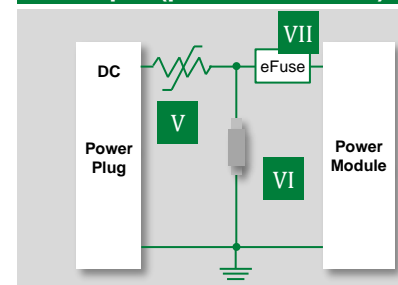
DC Input 48 V DC



DC Input (PFC circuit)

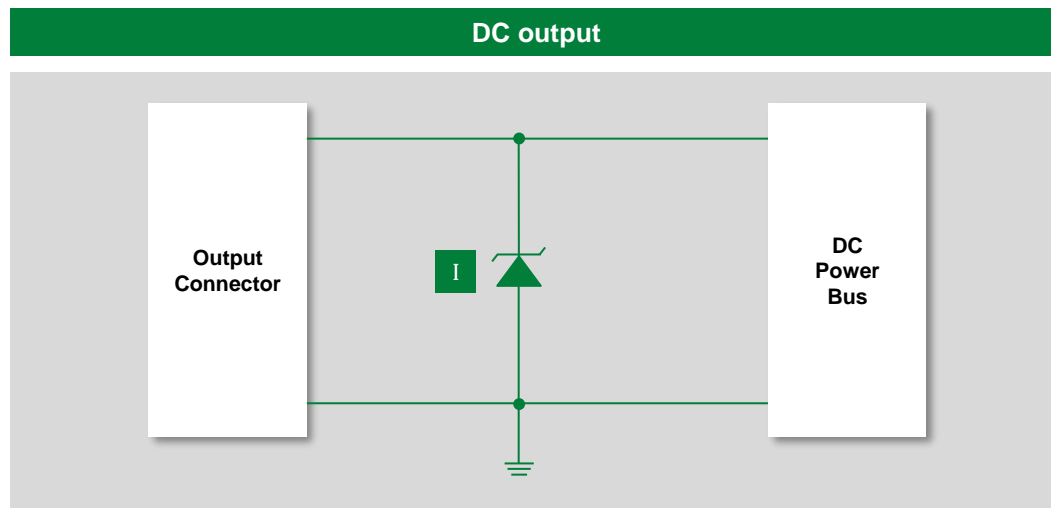


DC Input (portable devices)



	Technology	Function in application	Series	Benefits	Features
I	TVS Diode	Protects against surges	SMDJ , SME	Improves system reliability by protecting downstream 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 $R_{ds(on)}$ MOSFET and overvoltage/overcurrent protection in one small package

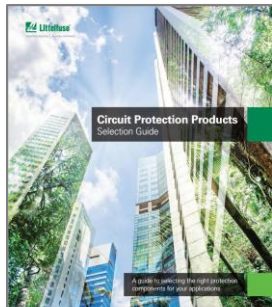
Circuit protection solution for DC output



	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

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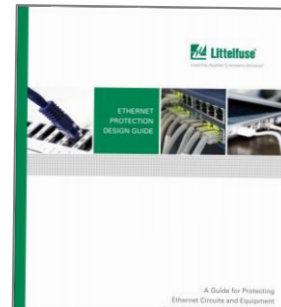
**Circuit Protection
Selection Guide**



**ESD Protection
Design Guide**



**ESD Suppression
Design Guide**



**Ethernet Protection
Selection Guide**

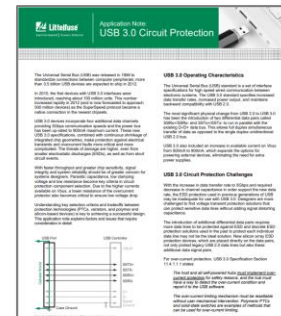
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**USB Type-C
ESD Protection Solution**



**Circuit Protection
for USB applications**

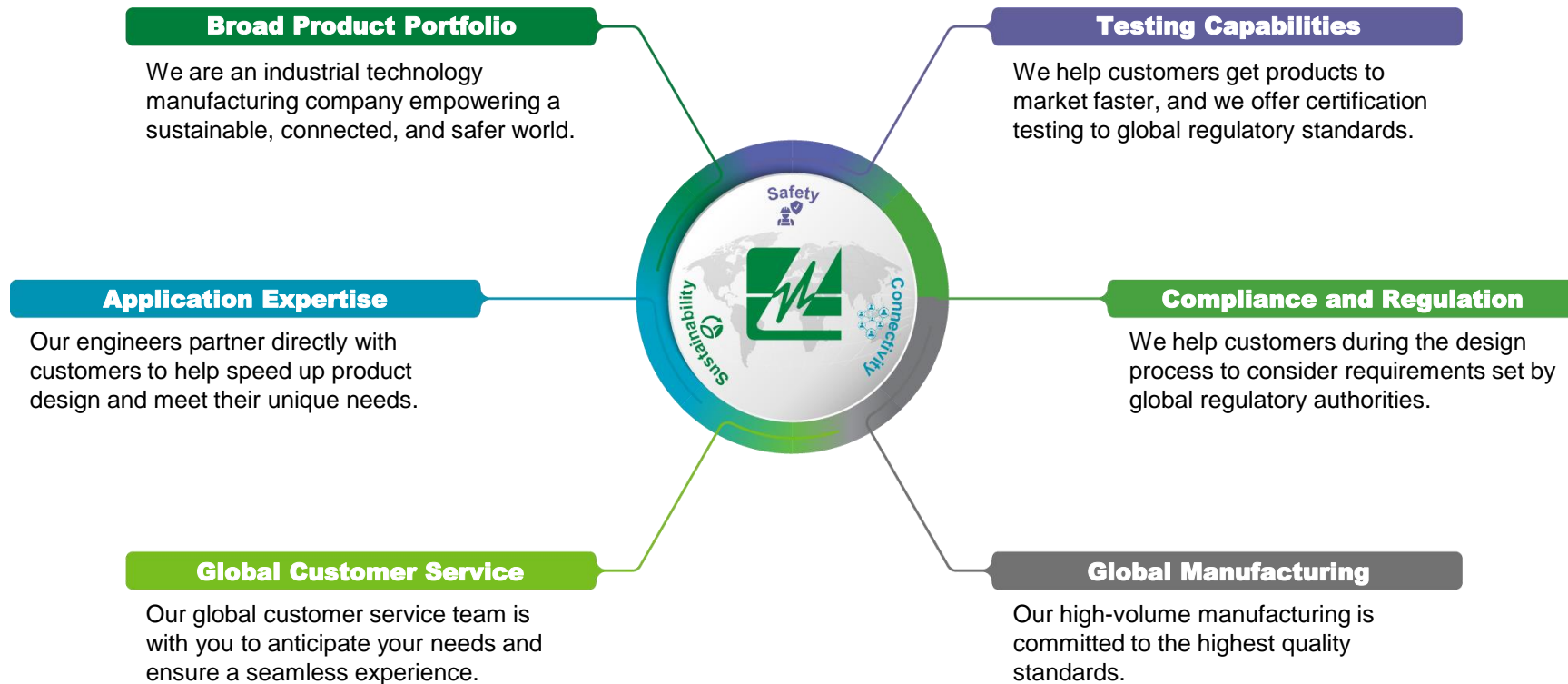


Expertise Applied | Answers Delivered

Local resources supporting our global customers



Partner for tomorrow's electronic systems





Expertise Applied | Answers Delivered

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