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General Port Protection



Automotive



Datacenter & Cloud



Building Automation



Industrial



Consumer Electronics



Mobile & Wearables

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26	All	All	Why choose Littelfuse?

Ports need protection from common electrical hazards

Lightning surges



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

Induced power surge



Lightning and power grid switching can induce power surge, causing damage

Electrostatic discharge



ESD passing through connector 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



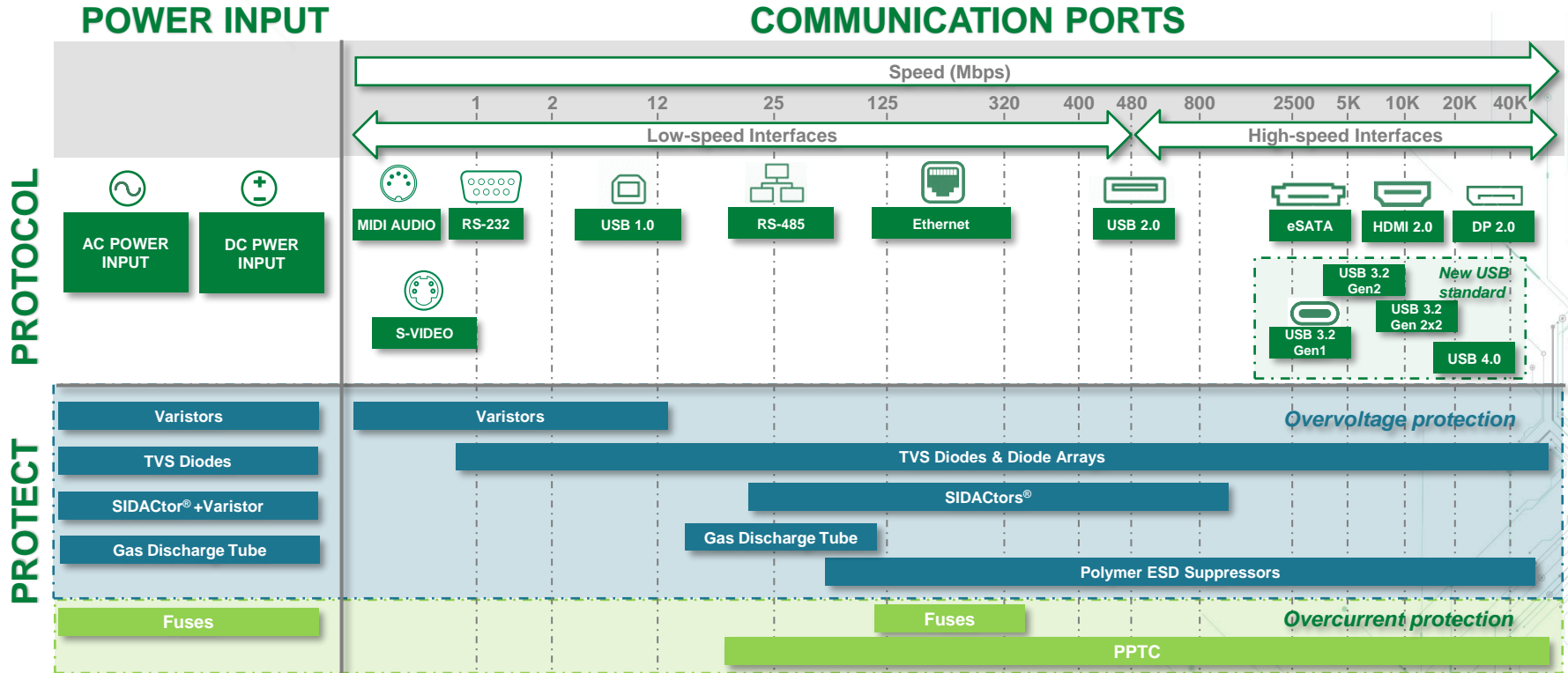
Electrical Fast Transient (EFT) can be a result of switching of inductive loads or relay contacts "bouncing"

Short circuit due to wire aging and installation



RS-485 and Ethernet often share the same conduits with DC or AC power lines; sharp bends and tight wiring ties can gradually result in cracks in the insulation and electrical faults

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





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Power over Ethernet (PoE)

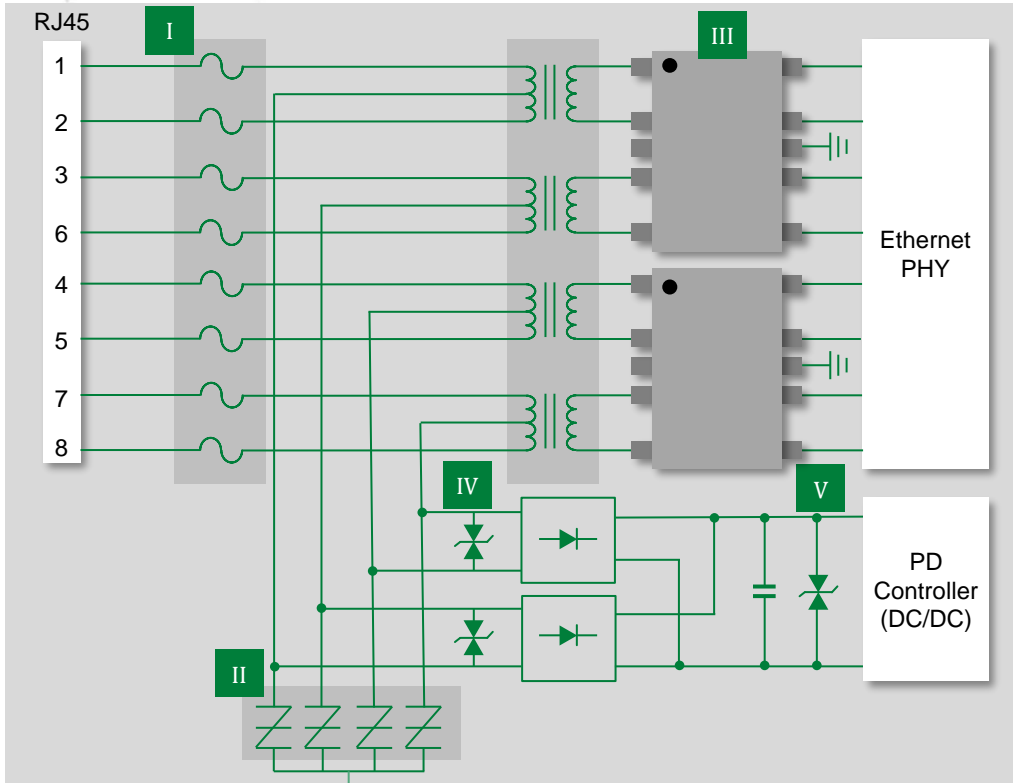


Evolution from PoE to PoE+ and PoE++

		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	90 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
# of pairs used for power delivery		2 pairs		4 pairs	
Distance		100 m Cat5e			

Higher current and more twisted pairs are used on PoE++ to reach 90 W

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



	Technology	Series
I*	Fuse (x8)	461xxx
II	SIDACTor® (x4)	P4500SCLRP
III	Diode Array (x2)	SP2555NUTG
IV*	TVS Diode (x2)	SMCJ58CA
V*	TVS Diode (x1)	SMCJ58CA

- I** TeleLink® fuses can help protect power fault overcurrent. These fuses are designed specifically for high-speed telecom applications.
- IV** A single TVS Diode (bi-directional) across the center tap data pair and second TVS Diode across the center tap spare pair. TVS Diode can be chosen based on surge requirements from 400 W to 8000 W.
- V** Outdoor-facing ports should consider a higher-surge protection device such as 5.0SMDJ.



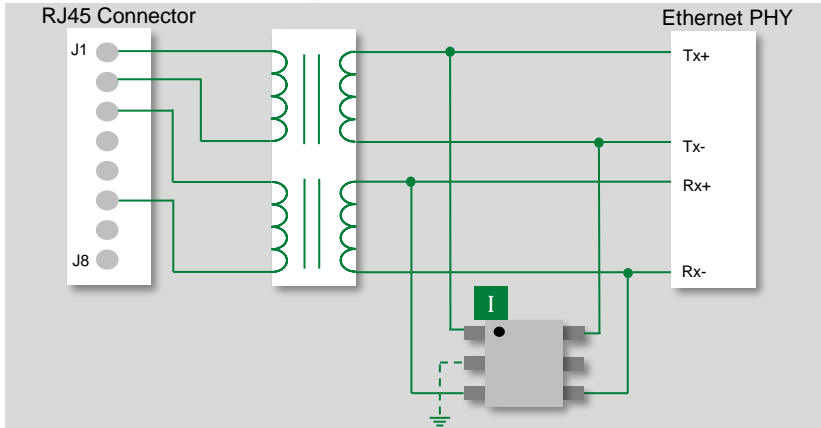
Click on the product series in the table below for more info

Features & benefits of Littelfuse components in PoE++

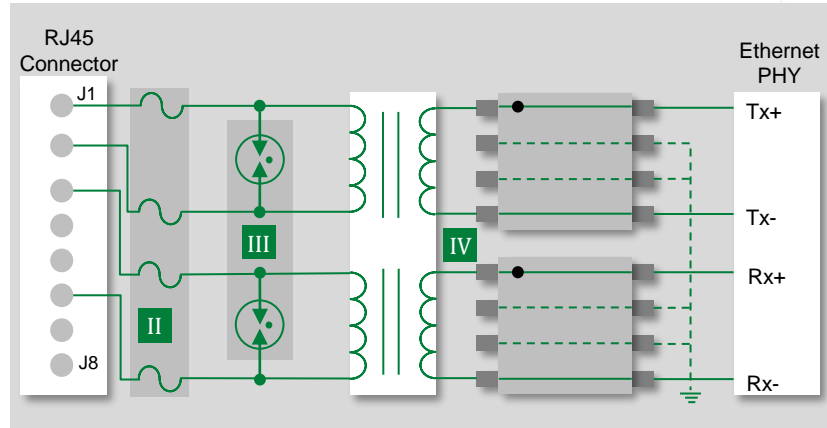
	Technology	Function in application	Product series	Benefits	Features
I	Fuse (x8)	Overcurrent protection from power cross and lightning surges	461xxx	Enables compliance with regulatory standards like IEC-60950, Telcordia GR-1089, and FCC 47-part 68 Surge Specifications	Surface mount; surge tolerant fuse designed specifically for high-speed telecom applications
II	SIDACtor® (x4)	Designed to protect baseband equipment against damage from overvoltage transients	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
III	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 overshoot and provides a simplified PCB design	µDFN-10 package; low-leakage current (0.1 µA) and low clamping voltage; protect up to 4 channels up to 45 A
			SP2525NUTG		µDFN-10 package; low-capacitance and low clamping voltage; protects up to 4 channels up to 30 A
			SP3025-04HTG		SOT23- 6L package; low-capacitance & low clamping voltage; protect up to 4 channels up to 30 A
IV	TVS Diode (x2)	Protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events	SMCJ58CA	Improves system reliability by clamping the voltage at safe levels during transients	1500 W peak pulse capability; compatible with the lead-free solder reflow temperature profile
V	TVS Diode (x1)				

Circuit protection solutions for Ethernet port

Intra-building



Outdoor and harsh environment



Note: 1 Gbps or greater will require an additional two twisted pairs and the diode array solution should be replicated.

	Technology	Function in application	Series	Benefits	Features
I	Diode Array	Protection from ESD and EFT	SRV05-04HTG-D	Ensures design meets with 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 with 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	Ensures safety and reliability of the equipment and helps design meet regulatory requirements	High surge rating; low capacitance; UL recognized
IV	Diode Array		LC03xx , SP40xx		Low capacitance; and low leakage current

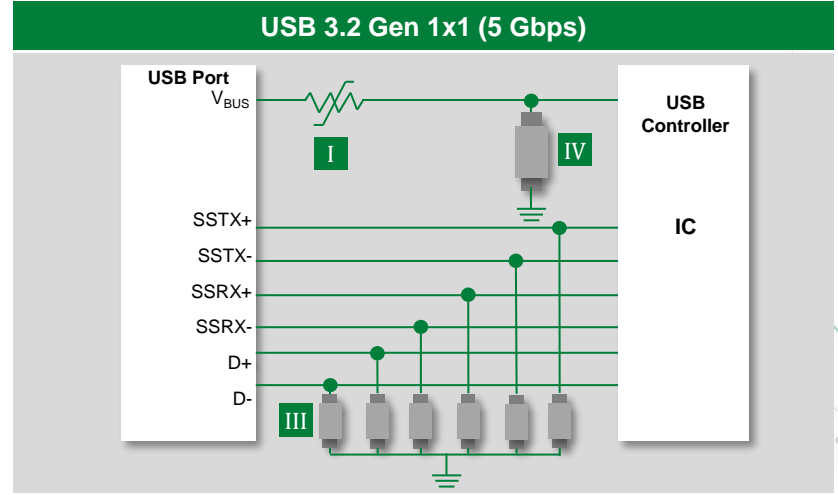
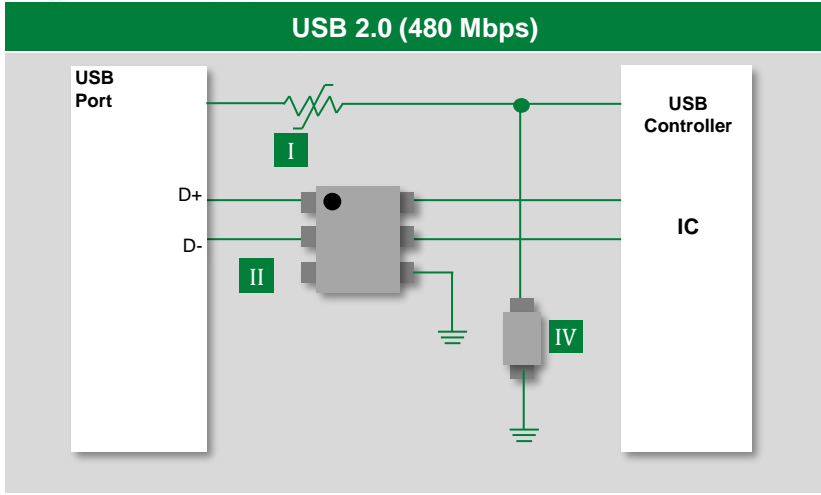


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High-speed interfaces



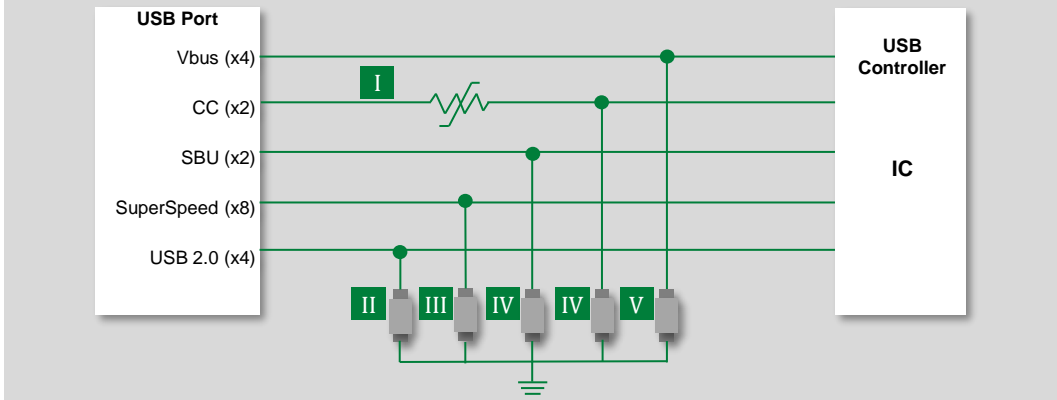
Circuit protection solutions for USB Type A and Type B



	Technology	Function in application	Series	Benefits	Features
I	PPTC	Protects 5 VDC power supply from over current and over temperature	Low Rho	Offers fast response to over-current events; suitable for compact portable devices	Ultra-low internal resistance; higher current holding in smallest SMD package
II	Diode Array	Protection of data lines against ESD	SP3019-04HTG , SP3400-02UTG	Clamps transient 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	Diode Array (6x)	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
IV	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

Circuit protection solutions for USB Type C

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

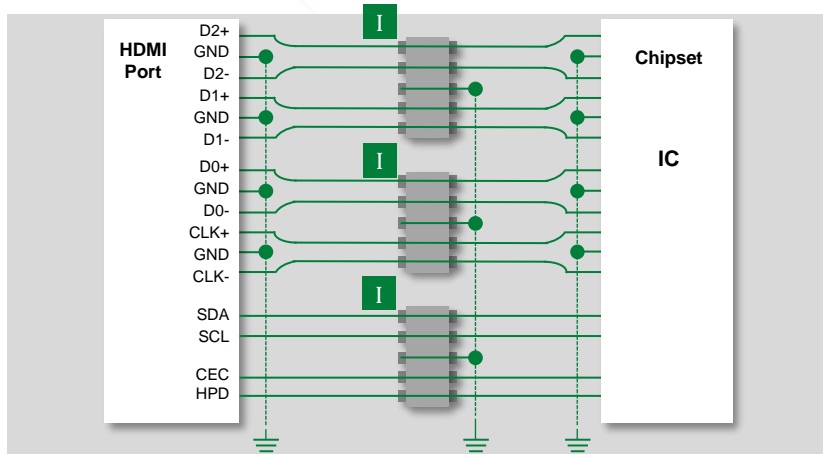


	Technology	Function in application	Series	Benefits	Features
I	Digital Temperature Indicator	Protects cable connectors against overheating	setP™	Reliable over-heating protection, regardless of power being delivered	Fully compliant with USB Type-C plugs
II	Diode Array	Protects against ESD on USB 2.0-speed data lines	SP3530-01UTG	Space-efficient; reliable ESD protection	0201 footprint; extremely low dynamic resistance
III	Diode Array	Protects against ESD on high-speed data lines	SP3213-01UTG	Maintain signal integrity of high-speed data lines; reliable ESD protection	Low parasitic capacitance
IV	Diode Array	Protects against ESD	SP1006-UTG	Space-efficient	AEC-Q101 qualified; small footprint
V	Diode Array	Protects power bus against ESD	SPHV24-01ETG	Reliably protect charge controller	AEC-Q101 qualified; low dynamic resistance

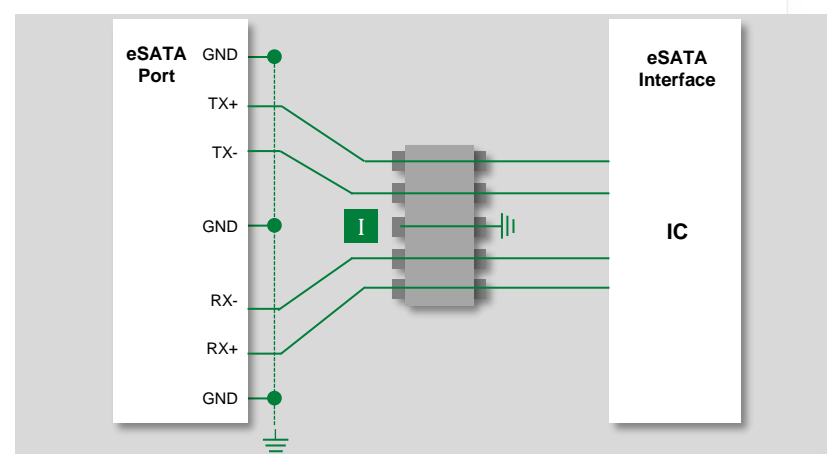
Circuit protection solutions for HDMI port, DisplayPort, and eSATA port

Click on the product series in the table below for more info

HDMI & DisplayPort

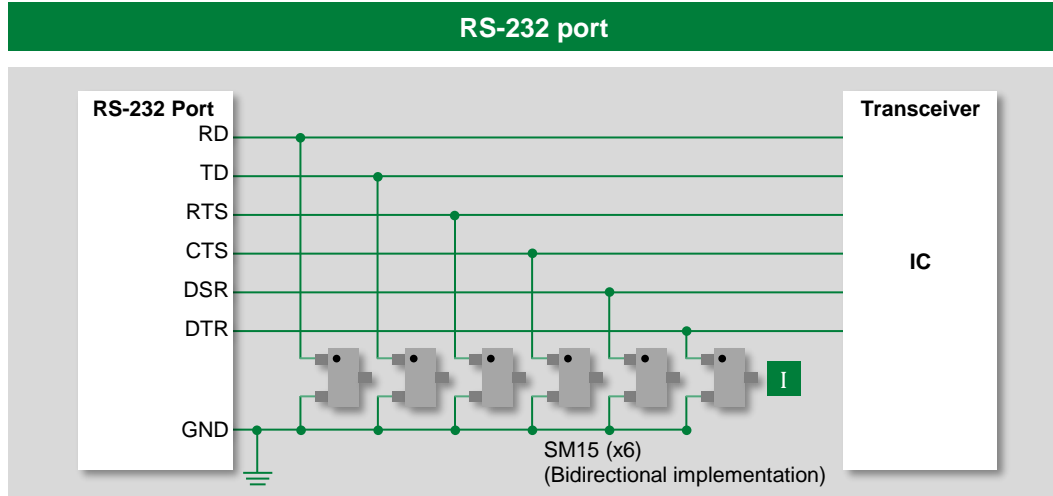


eSATA



	Technology	Function in application	Series	Benefits	Features
I	Diode Array	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
			SC1004U-ULC-04UTG		Low capacitance of 0.2 pF; low clamping voltage of 11.0V @ IPP=2.0 A ($t_p=8/20 \mu s$); industry standard DFN footprint

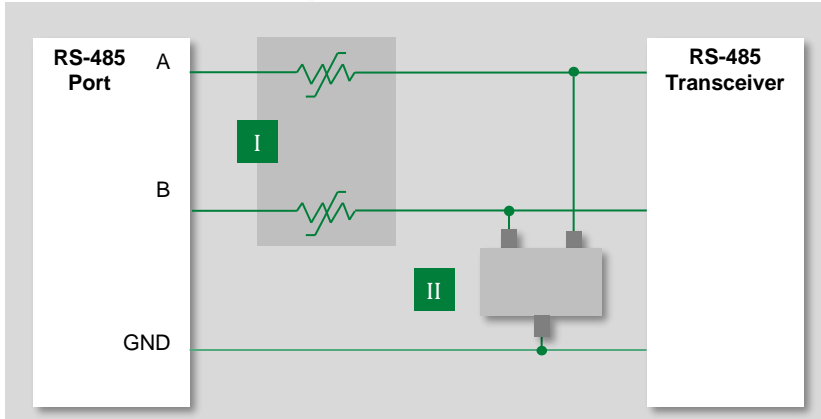
Circuit protection solution for RS-232 port



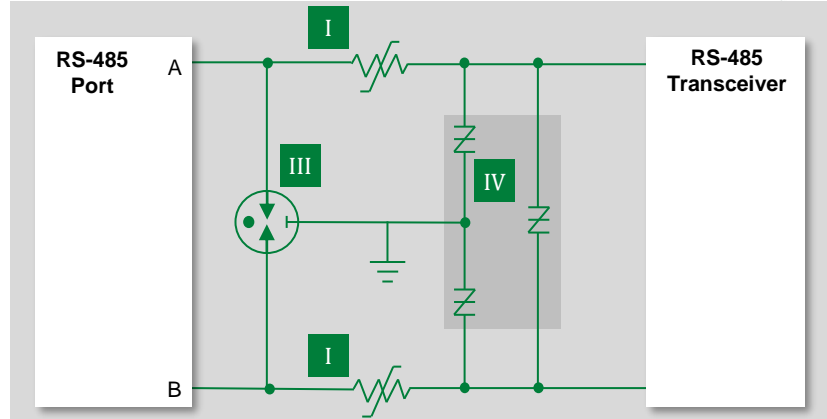
	Technology	Function in application	Series	Benefits	Features
I	Diode Array	Protection of data signal line from ESD	SM15-02HTG	Greatly reduces clamping voltages; 25% higher power handling capability; 2-3 times higher ESD withstand capability	Very low dynamic resistance 0.30 Ω; low leakage current and clamping voltage
			SD15C-01FTG		Very low dynamic resistance 0.46 Ω; low leakage current and clamping voltage

Circuit protection solutions for RS-485 port

Intra-building



Outdoor and harsh environment

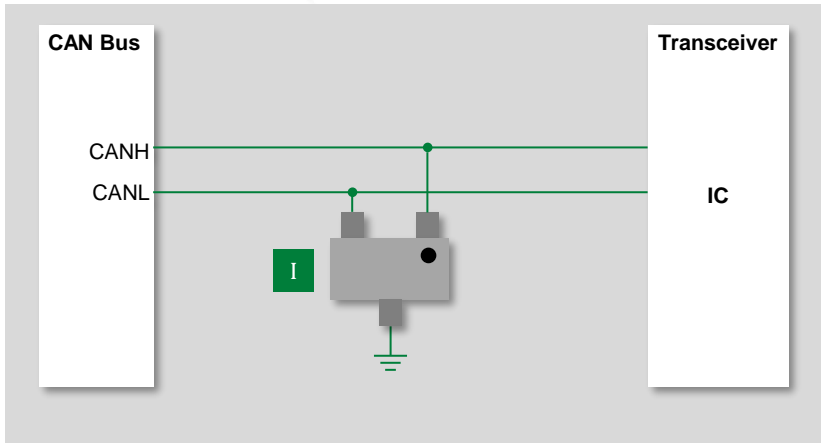


	Technology	Function in application	Series	Benefits	Features
I	PPTC	Protects equipment from short circuit and power cross	TSV250	Product choices give engineers increased design flexibility; helps improve line balance	Available in various form factors; low parasitic capacitance
II*	Diode Array	Protects 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-7 V to 12 V
III	GDT + SIDACTor®	Lightning protection utilizing a GDT with SIDACTor; when lightning occurs the SIDACTor will react first, causing 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
IV					

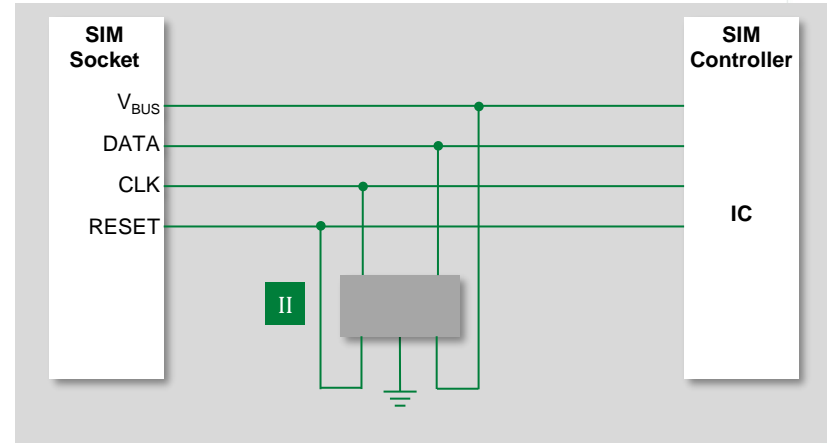
Circuit protection solutions for CAN/LIN bus and SIM/μSIM socket

Click on the product series in the table below for more info

CAN/LIN Bus



SIM/μSIM socket

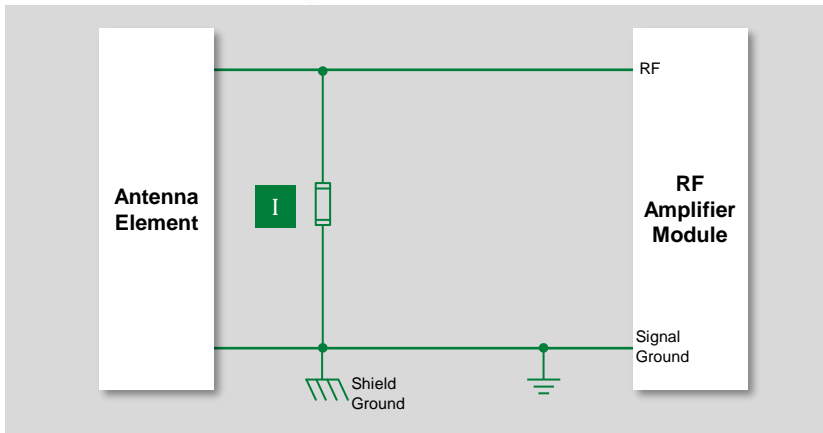


	Technology	Function in application	Series	Benefits	Features
I	Diode Array	Protects against ESD and surge transients	AQ24CANA-02HTG	Ensures safety of the equipment without performance degradation	AEC-Q101 qualified; low clamping voltage and leakage current
II	Diode Array	Protects against ESD	SP1012-05WTC	Small form factor suitable for compact designs	Provides good ESD protection for data lines; very low dynamic resistance of 0.48 Ω

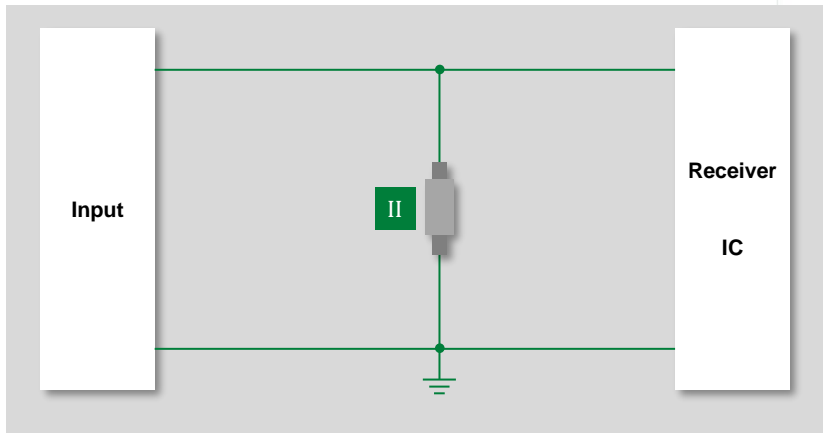
Circuit protection solutions for antenna and sensor inputs

Click on the product series in the table below for more info

Antenna



Sensor input



	Technology	Function in application	Series	Benefits	Features
I	Polymer ESD Suppressor	Protection against ESD	XGD10603	Preserve signal integrity; withstands high levels of ESD	Extremely low capacitance (0.09 pF); high ESD withstand rating (30 kV)
II	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



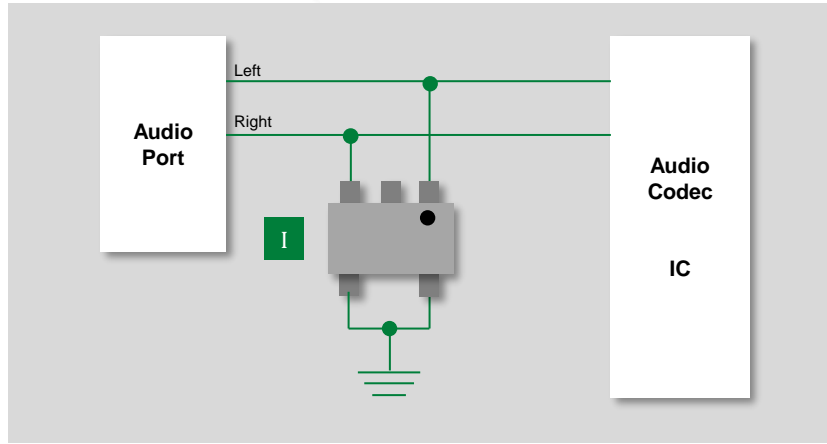
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Low-speed applications

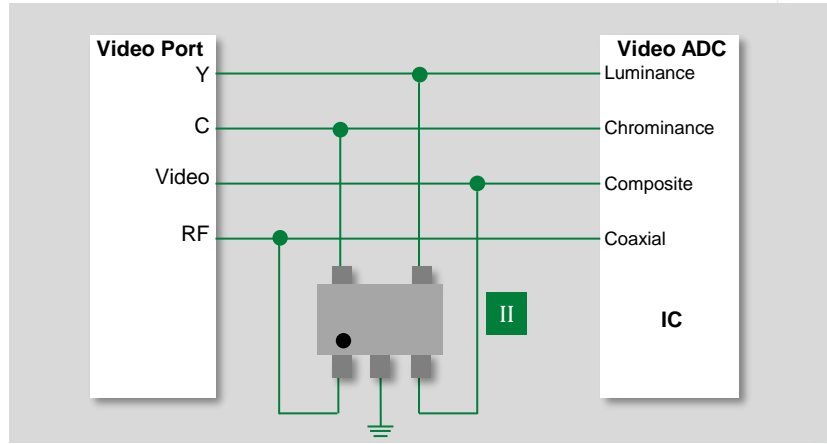


Circuit protection solutions for audio and video lines

Audio line



Video line

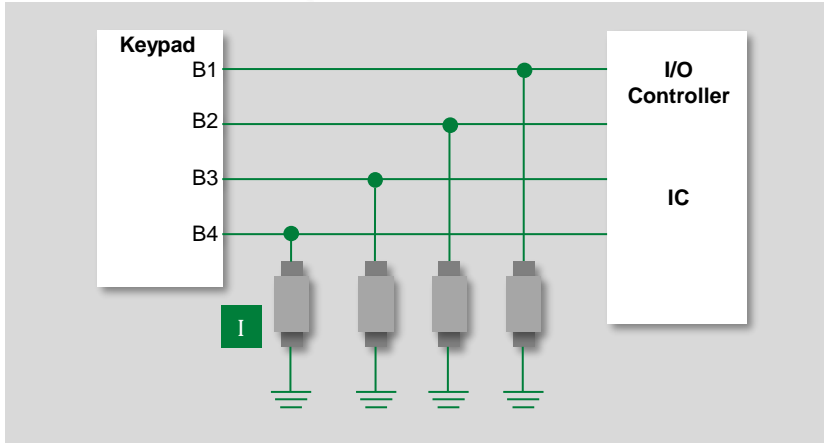


	Technology	Function in application	Series	Benefits	Features
I	Diode Array	Protects audio codec from damaging ESD	SP1002	Absorbs repetitive ESD strikes at the max level without system performance degradation; compact design	Low capacitance of 5 pF; low leakage current of 0.5 μA; small package
II	Diode Array	Prevents video analog-to-digital converter from damaging ESD	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

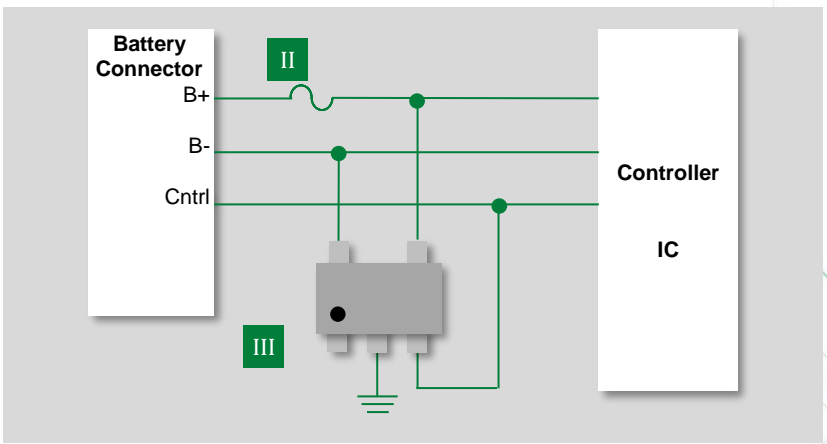
Circuit protection solution for keypads, buttons, switches, and battery packs

Click on 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	Varistor	Protects ICs & 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	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)

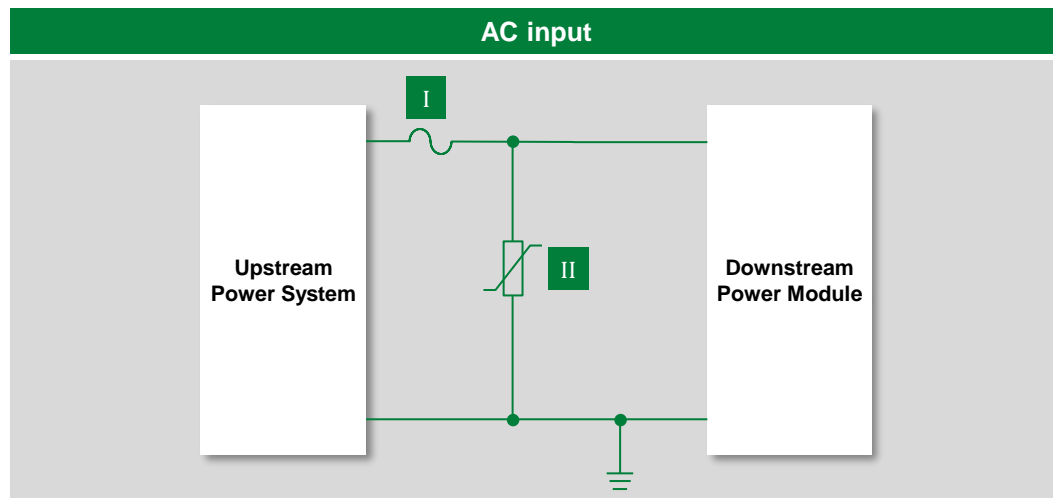


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Power inputs



Circuit protection solutions for AC input

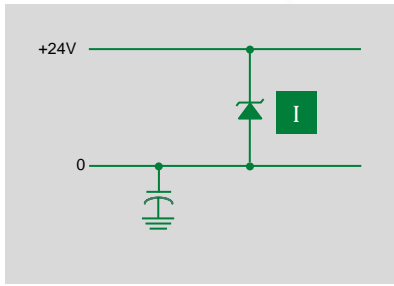


	Technology	Function in application	Series	Benefits	Features
I	Fuse	Protection against short circuit and overload conditions	313	Reduces damage to equipment compact design; energy efficiency protection	Third-party compliance; low internal resistance
II*	Varistor	Protection against severe surge transients	UltraMOV	Reduces customer qualification time by complying with third-party safety standards	High energy absorption capability; small package; high operating temperature range up to 125 °C

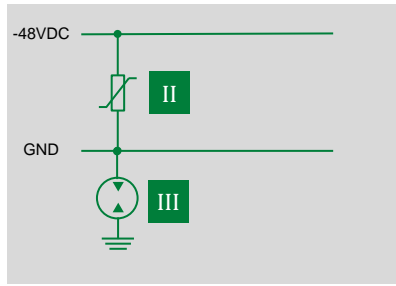
* High-power TVS Diode (AK Series) is an alternative solution

Circuit protection for DC input

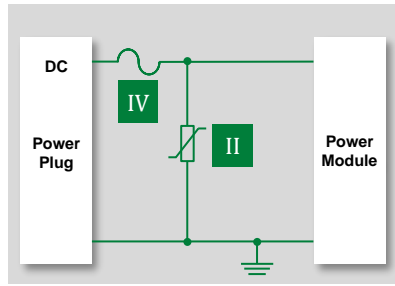
DC Input 12 V/24 V DC



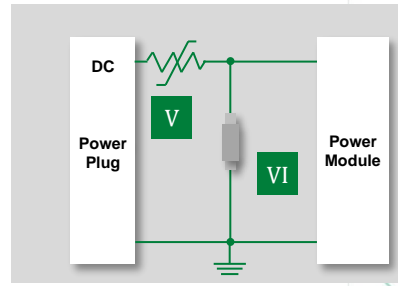
DC Input 48 V DC



DC Input (PFC circuit)

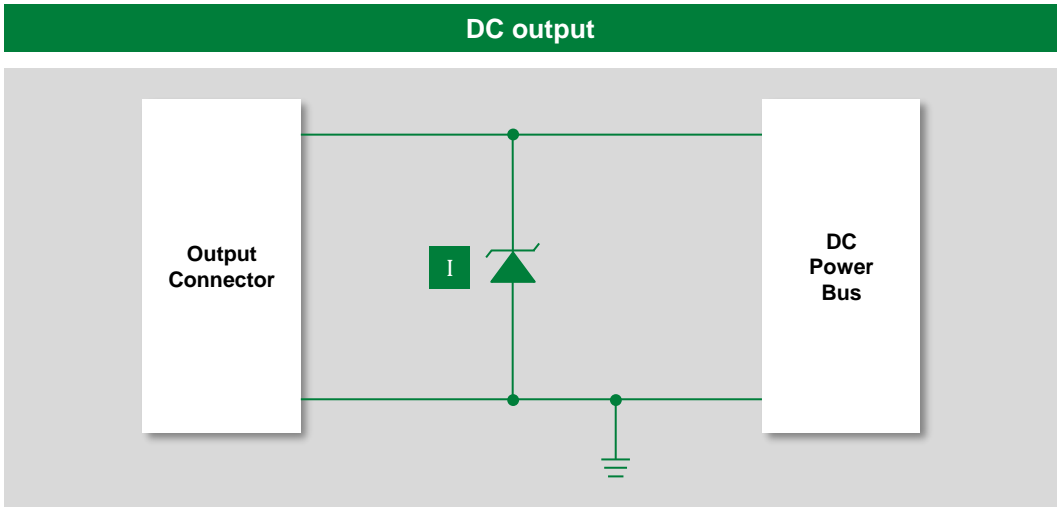


DC Input (portable devices)



	Technology	Function in application	Series	Benefits	Features
I	TVS Diode	Protects against voltage transients	SMDJ , SMF	Improves system reliability by protecting downstream components from transients on power lines	Excellent clamping capability
II	Varistor	Protects against voltage transients	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 over current events; suitable for compact portable devices	Ultra-low internal resistance; higher current holding in smallest SMD package
VI	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

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 transients on power lines	Excellent clamping capability

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USB Type-C
ESD Protection Solution

PROVEN ULTRA-LOW CAPACITANCE

Small Outline Solutions Supporting USB 3.1 Type C

USB 3.1 Type C ESD Protection Solution

Implementing USB 3.1 Type C SuperSpeed™ presents a set of challenges for design engineers. Littelfuse ESD diodes solutions available in sizes from 0603 (0.5mm x 0.8mm) down to 0205 (0.4mm x 0.2mm).

USB 3.1 Type C Diodes:

- Small footprint solutions
- Fast charging solution for battery
- Low parasitic capacitance

Key Features:

- Multiple models (10V voltage protection)
- Charge retention up to 100 years
- AEC-Q101 qualified for automotive
- RoHS and REACH compliant

Our Solutions:

- USB 3.1 Type C ESD protection
- USB 3.1 Type C ESD protection
- USB 3.1 Type C ESD protection
- USB 3.1 Type C ESD protection

Circuit Protection
for USB applications

Application Note
USB 3.0 Circuit Protection

The Universal Serial Bus (USB) was released in 1996 as a standard interface between computers, printers, and other devices. USB 3.0 offers USB devices are required to be 100 pF or less in capacitance to meet the USB 3.0 specification. This number is typically 100 pF or less for most USB 3.0 devices. The number of diodes used in a USB 3.0 device is typically 100 or more.

USB 3.0 devices incorporate two separate data channels, providing 100 Mbps throughput and the power line has 100 pF of parasitic capacitance. This parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices.

With lower throughput and greater chip size, parasitic capacitance and parasitic inductance are a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices.

USB 3.0 Operating Characteristics

The Universal Serial Bus (USB) is a set of standard specifications for connecting computers, printers, and other devices. USB 3.0 offers USB devices are required to be 100 pF or less in capacitance to meet the USB 3.0 specification. This number is typically 100 pF or less for most USB 3.0 devices. The number of diodes used in a USB 3.0 device is typically 100 or more.

USB 3.0 devices incorporate two separate data channels, providing 100 Mbps throughput and the power line has 100 pF of parasitic capacitance. This parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices.

USB 3.0 also includes an optional mode called SuperSpeed USB 3.0. This mode is used for high-speed data transfer and is available on USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices.

USB 3.0 Circuit Protection Challenges

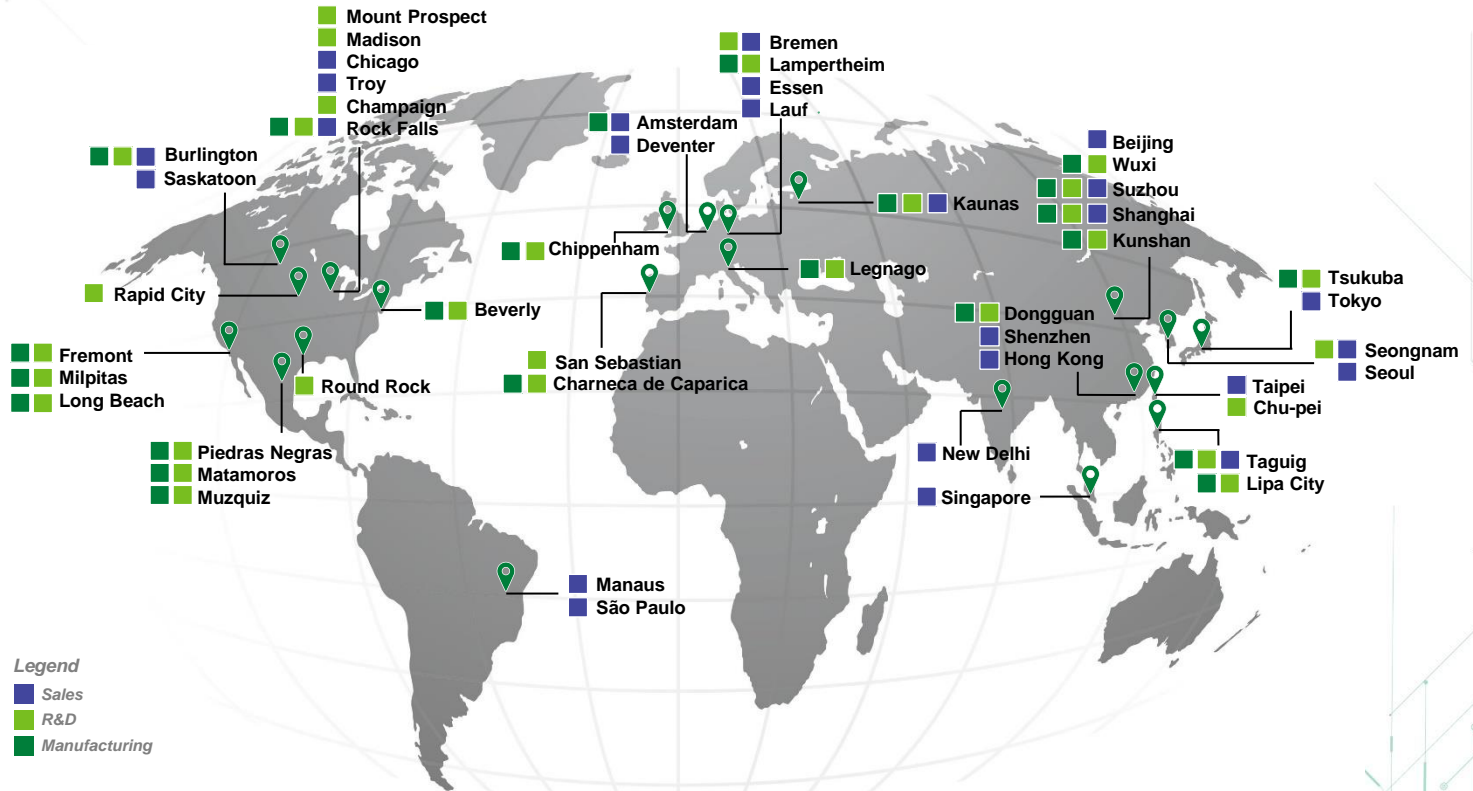
With the increase in data transfer rate to 10Gbps and increased power to 10W, USB 3.0 devices present a significant challenge for circuit protection. The parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices.

The introduction of additional differential data pairs requires more than twice the protection ESD and diodes ESD protection solutions. The parasitic capacitance can be a significant problem for USB 3.0 devices. The parasitic capacitance can be a significant problem for USB 3.0 devices.

Figure 1: USB 3.0 with differential data pairs

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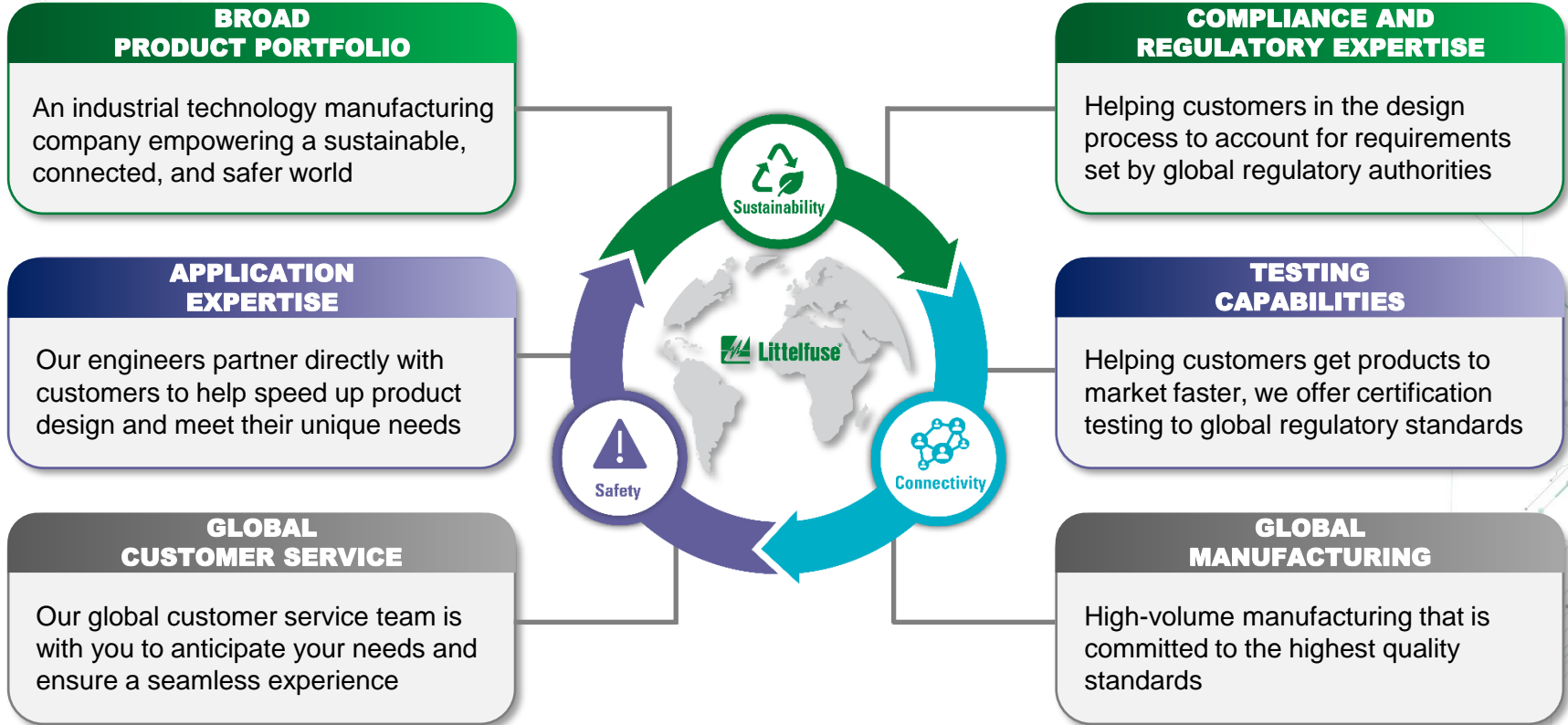
Local resources supporting our global customers



Legend

- Sales
- R&D
- Manufacturing

Partner for tomorrow's electronic systems



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