

# MILITARY-AEROSPACE APPLICATIONS

*ADVANCED CIRCUIT PROTECTION DEVICES FOR OVERVOLTAGE AND OVERCURRENT TRANSIENT EVENTS*



**PROTEK DEVICES®**

ONLY ONE NAME MEANS PROTEK'TION™

According to *National Geographic*\*, there are about 100 lightning bolt strikes on the Earth's surface every single second. Each bolt can contain up to one billion volts of electricity. The *National Severe Storms Laboratory (NSSL)*\* estimates at least 30 million points on the ground are struck on average each year, just in the USA. In the air, perhaps where the military and commercial air fleets are concerned, it is estimated that each airliner in the USA will be hit by lightning once per year. Furthermore, static electricity, which humans very commonly generate, can have some 35,000 volts of electricity. Either a billion volts or 35,000 volts are far more than enough to destroy important electronics within mission-critical systems. In military and aerospace markets, protecting costly equipment – from vehicles to aircraft and beyond – from such electrical events is a requirement.

Any computer chip exposed to such electrical transients, without proper electrostatic discharge (ESD) protection, will experience catastrophic destruction. An ESD transient can bore through the layers of a device, severing any trace of an integrated circuit in part or in whole. This can cause intermittent or no operation capabilities for the related system.

TABLE 1 - COMMON MILITARY & AEROSPACE CIRCUIT PROTECTION STANDARDS				
STANDARD	WAVEFORM	VOLTAGE	CURRENT	COMMENTS
MIL-STD-704 (Aircraft)	50ms 50ms 5/20µs	50V 180V 200 - 600V	500A 1800A 12A	Switching Surge Switching Surge Induced Switching
MIL-STD-1275 (Vehicles)	50ms 50ms 0.1ms	100V 40V 250V	200A 2000A	Surge, 500mΩ Surge, 20mΩ Spike
MIL-STD-1399 (Shipboard)	1.2/50µs 1.2/50µs	2500V 1000V	500A 200A	Spike Spike
MIL-STD-331 (Helicopter)	15/400ns 15ns	25kV 300kV	50A 300kA	Personal Helicopter
DO-160: Section 22 (Lightning Induced Transient Susceptibility) (Airborne Equipment)	1MHz Damped Sine Waveform 3	100V	4A	Level 1
		250V	10A	Level 2
		600V	24A	Level 3
		1500V	60A	Level 4
		3200V	128A	Level 5
	6.9µs/69µs Waveform 4	50V	10A	Level 1
125V		25A	Level 2	
300V		60A	Level 3	
750V		150A	Level 4	
1600V		320A	Level 5	
40µs/120µs Waveform 5A	50V	50A	Level 1	
	125V	125A	Level 2	
	300V	300A	Level 3	
	750V	750A	Level 4	
	1600V	1600A	Level 5	
DO-160: Section 25 (Electrostatic Discharge) (Airborne Equipment)	1/30ns	15kV	56.25A	10 Pulses (Positive & Negative)

Because of these concerns, there are extensive military and aerospace standards (as shown in Table 1) defined to protect electronic circuits. MIL-STD-704 defines protection for aircraft, MIL-STD-1275 for vehicles, and MIL-STD-1399 for shipboards. In addition, DO-160 defines added circuit protection for aircrafts and MIL-STD-331 adds helicopters. These standards define how to ensure proper circuit protection against lightning, inductive switching, ESD, electromagnetic interference/radio frequency interference (EMI/RFI), and against nuclear electro-magnetic pulses.

TABLE 2 - DATA TRANSMISSION RATES		
APPLICATION	DATA RATE Mbit/S	CAPACITANCE pF
RS-232	0.20	< 50
CanBus/Device Net	1.0	<30
Ethernet	10	
USB 1.1	12	< 20
RS-485	35	
Fast Ethernet	100	< 5
USB 2.0	480	< 3
GigabitE	1000	
DVI	3960	< 1
USB 3.0	5000	
DisplayPort	5400	
USB 3.1	10000	
HDMI 1.3	10200	
HDMI 2.0	18000	

Device capacitance is often a decisive factor in higher data rate applications (see Table 2). A TVS diode, like other semiconductors, has an inherent capacitance. Capacitance is dependent on junction area, doping concentration and the voltage across the diode terminals. The reverse bias voltage is inversely related to device capacitance, as reverse bias increases the device capacitance decreases. As the doping concentration increases, the voltage rating of the diode decreases and device capacitance increases. On the other hand, devices with higher voltage values have smaller junction capacitance. Larger junction area relates to higher current handling capability. But as the device or junction size increases the device capacitance increases along with it.

One of the characteristics of a capacitor is lower impedance to time varying signals. The higher the frequency of a signal, lower the resistance offered to it. So when a TVS diode is used in a high data rate application, the intrinsic device capacitance tends to attenuate the signal. Hence, when the device capacitance is large the attenuation suffered by the high frequency signal is greater.

ProTek Devices has an extensive family of circuit protection components widely used in any of these military and aerospace applications. The components deliver primary and/or secondary side protection against ESD, electrical fast transients (EFT), surge, and lightning. They can also provide common-mode, differential-mode, and low capacitance protection. ProTek Devices' components are well-known for meeting the strictest of standards requirements, from military standards and IEC, to RoHS and REACH, and more. The components are also designed to be provided in small packages suitable for even the smallest footprint military and aerospace applications.

SELECTION GUIDE		
APPLICATION	PREFERRED DEVICES	ALTERNATE DEVICES
AC Power: Aircraft	704 Series, PHP/PIP Series	15/30KPA Series, SM15/30/45KPAXxAN/CAN Series, SM3/5/10KW Series, SM10KWE Series
AC Power: Shipboard	60/90KS Series, PHP/PIP Series	15/30KPA Series, SM15/30/45KPAXxAN/CAN Series, SM3/5/10KW Series, SM10KWE Series
AC/DC Power	2700SMxxCAN Series, K Series, PSDxxHP Series	15/30KPA Series, SM15/30/45KPAXxAN/CAN Series, SM3/5/10KW Series, SM10KWE Series
AC Power	5.0SMDJ Series, 60/90KS Series, PHP/PIP Series, SMAJ Series, SMBJ Series, SMCJ Series, SMDJ Series	
Antenna	GBLCxx/C Series, GBLCxxI/CI Series	
CanBus/Device Net	PAM1CAN	PAM2CAN
Control Buttons	PRSB6.8C	
DC-DC Converter	15KPA Series, 30KPA Series	SM15/30KPAXxAN/CAN Series, SM3/5KW Series, SM10KWE Series
DC Power: Vehicles	GPZ1275, GPZ1275B60K	PAM5S Series, PAM6S Series, PAM8S Series
DVI	GBLCxxCI Series, PLR0502, PLR0508, PLR0521, PLR4045	PLR0504F, PLR0506, PLR0524
EMP	PRS05, PRS05LC	PUSB6B
Ethernet	PLRxx12 Series, PLR2210	PLR3311
Fast Ethernet	GBLCxxC Series, PLC03-6, SMP6LLCxx-2P Series, SRV05-4	PLR3304, SRV05-4M, SRV05-4LC
Gigabit Ethernet	GBLCxxCI Series, GBLC03CIHP, PAZC099, PLR0504F, PLR2210, PLR3343, PLR4045, SRV05-4, SRV05-4-A, SRV25-4, SRV3.3-4	PLR0524, PLR3311, SLUV2.8-4
HDMI 1.3	GBLCxxCI Series, PAZC099, PLR0506, PLR0521	PLR0504F, PLR0524
HDMI 2.0	PLR0514LC, PLR05214LC, PTB05-8ULC	PLR0524
High Frequency Data Lines	GBLCxx/C Series, GBLCxxI/CI Series	PLCDA Series, PSLCxx/C Series, SM8LC Series
Load Dump	GPZ1275, GPZ1275B60K	PAM5S Series, PAM6S Series, PAM8S Series
Low Frequency Data Lines	PSDxx/C Series, PSOTxx/C Series	CPxx/C Series, SMDAxx/C Series
RS-485	PSDxx Series, PSLCxxC Series, PSM712, PSOTxxC Series	485ELC
USB 2.0	GBLCxxCI Series, PLR0502, PLR0504F, PLR0506, PLR0521, PUSB05UBK	PLR0502-6, PLR0524, SRV05-4LC
USB 3.0	GBLCxxCI Series, PLR0506, PLR0506LP, PLR0521, PLR0524	PLR0502, SRV05-4LC
USB 3.1	PLR0502-6/PLR0514LC	SRV05-4LC

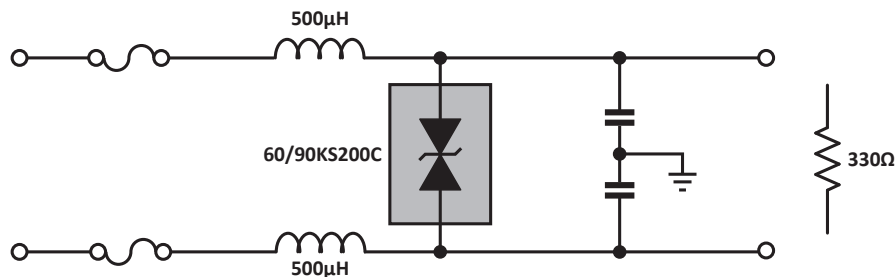


Figure 1. Primary Side AC Power Protection using 60/90KS Series

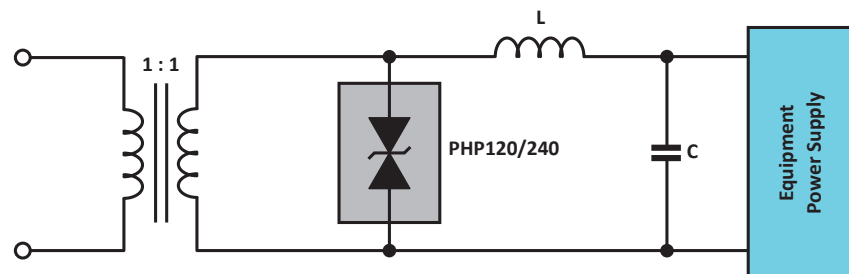


Figure 2. Secondary Side AC Power Protection using PHP Series

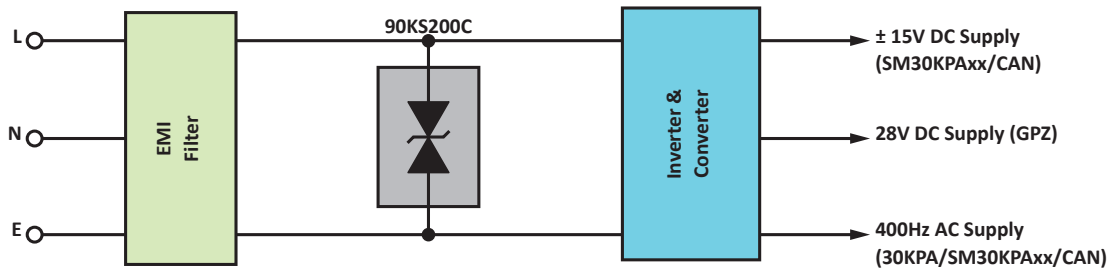


Figure 3. Shipboard AC Power Supply Protection Using 90KS200C, GPZ Series, 30KPA Series and SM30KPAxxAN/CAN Series

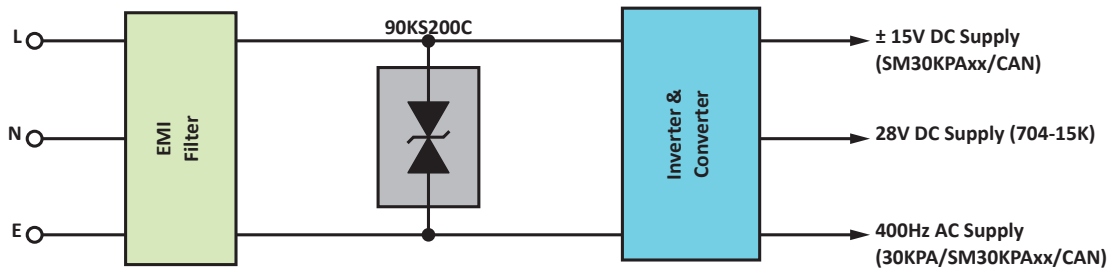


Figure 4. Aircraft AC Power Supply Protection Using 90KS200C, 704 Series, 30KPA Series and SM30KPAxxAN/CAN Series

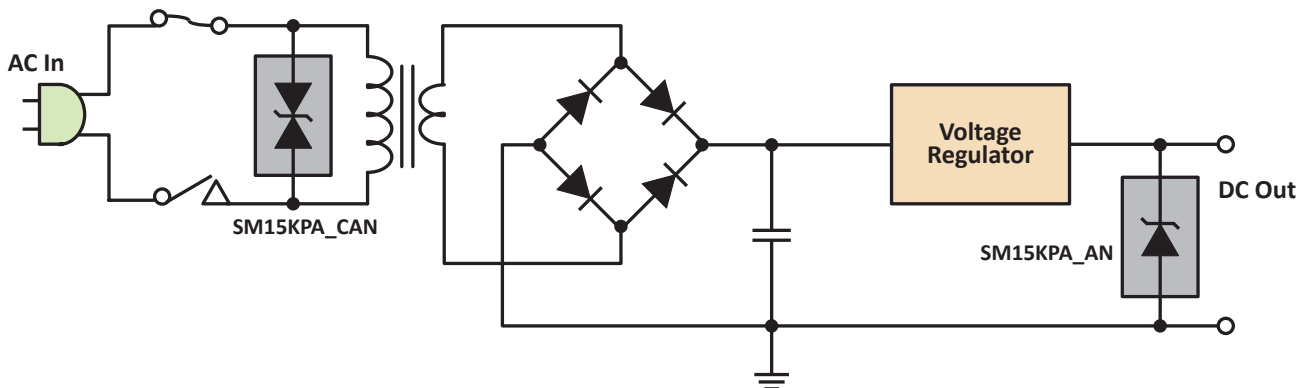


Figure 5. AC/DC Power Supply Protection Using: SM15KPAxxCAN & 15KPA Series (Primary Side) and SM15KPAxxAN & 15KPA Series, SM3KW Series, SM5KW Series, SM10KWE Series and PSD05HP (Secondary)

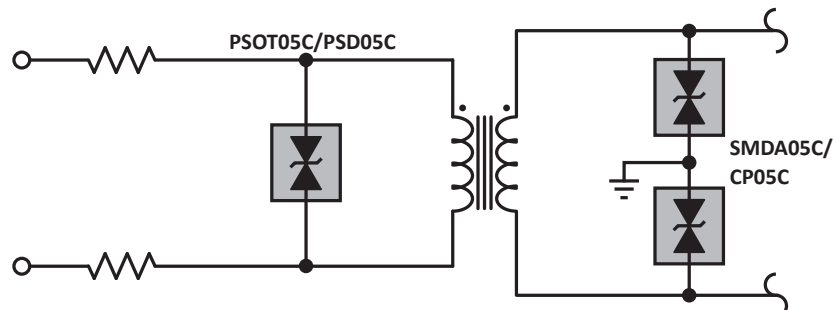


Figure 6. Low Frequency Data Line Protection Using PSOT05C, PSD05C, SMDA05C and CP05C

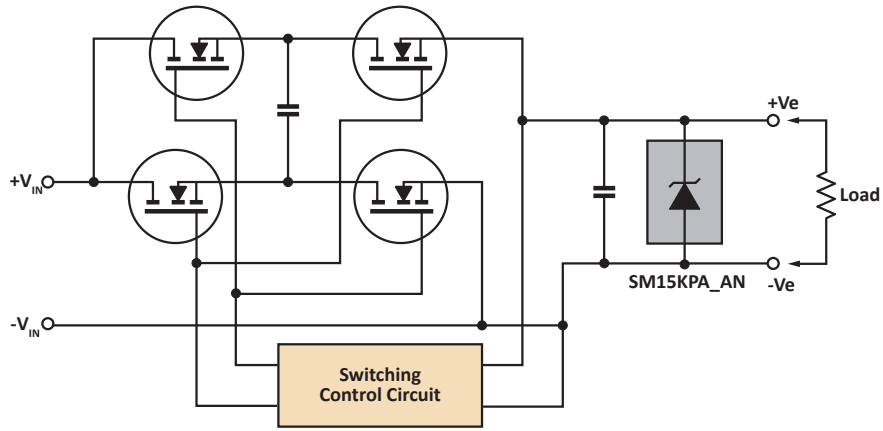


Figure 7. DC-DC Converter Protection (Charge Pump) Using SM15KPAxxAN Series

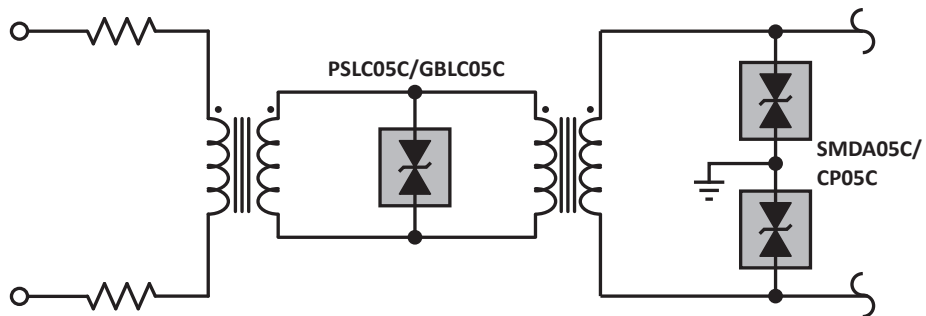


Figure 8. High Frequency Data Line Protection Using PSLC05C, GBLC05C, SM8LC05C, PLCA05

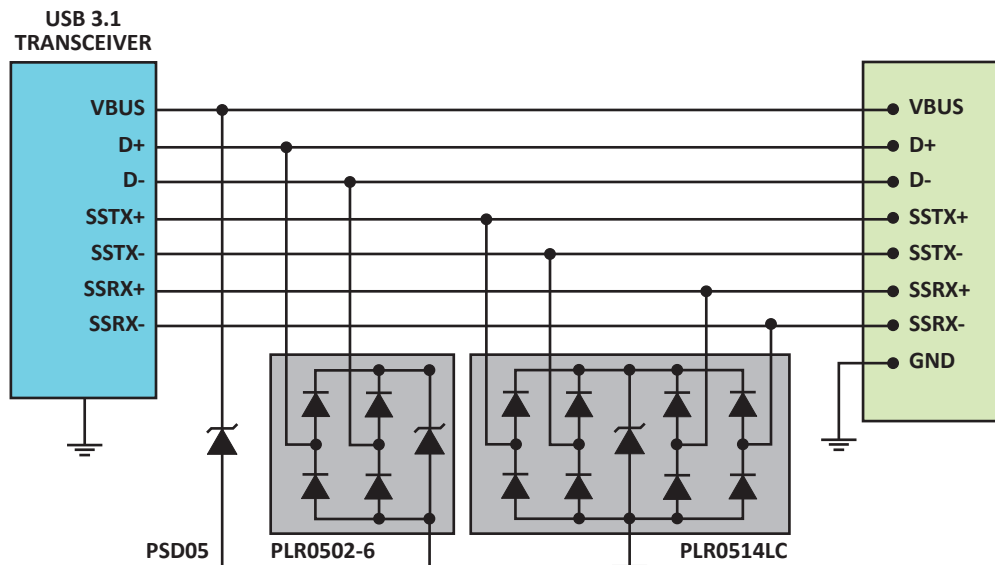


Figure 9. USB 3.1 Interface Protection Using PLR0502-6, PLR0514LC and PSD05

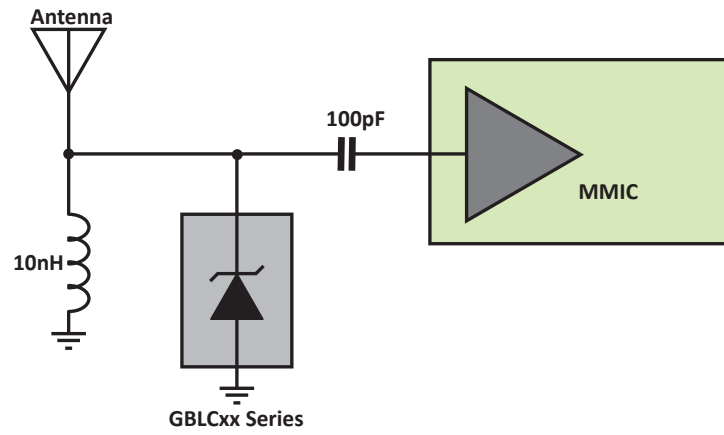


Figure 10. Antenna Protection Solution Using GBLCx Series

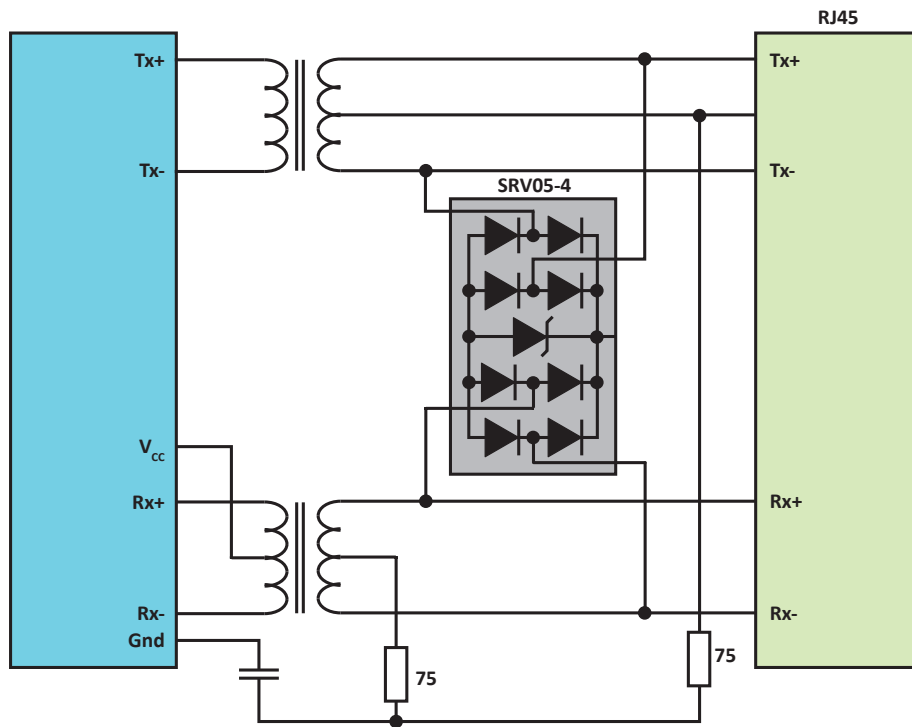


Figure 11. Fast Ethernet Protection Using SRV05-4

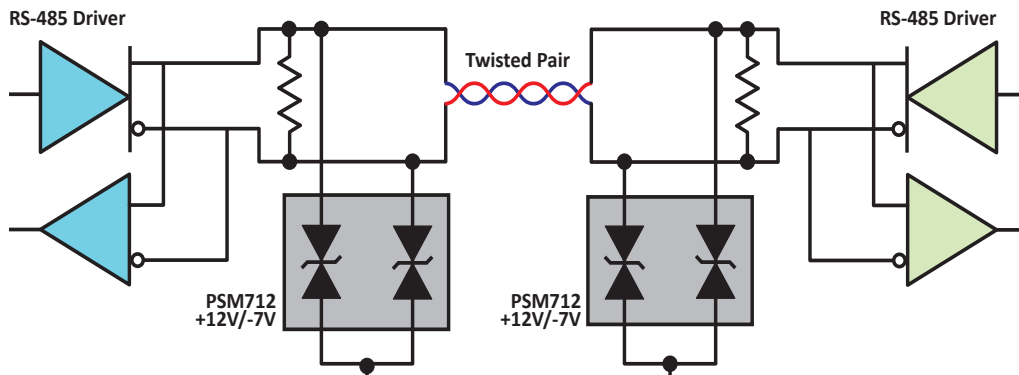


Figure 12. RS-485 Driver Application Using 2 PSM712 Devices

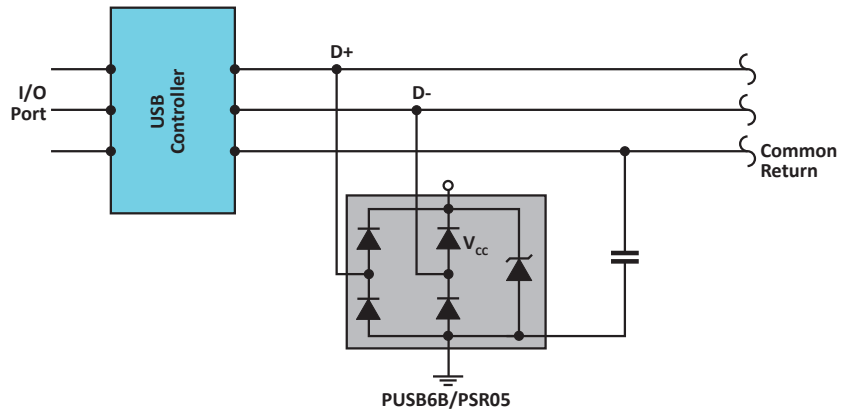


Figure 13. EMP Protection Using PUSB6.8 or PSR05

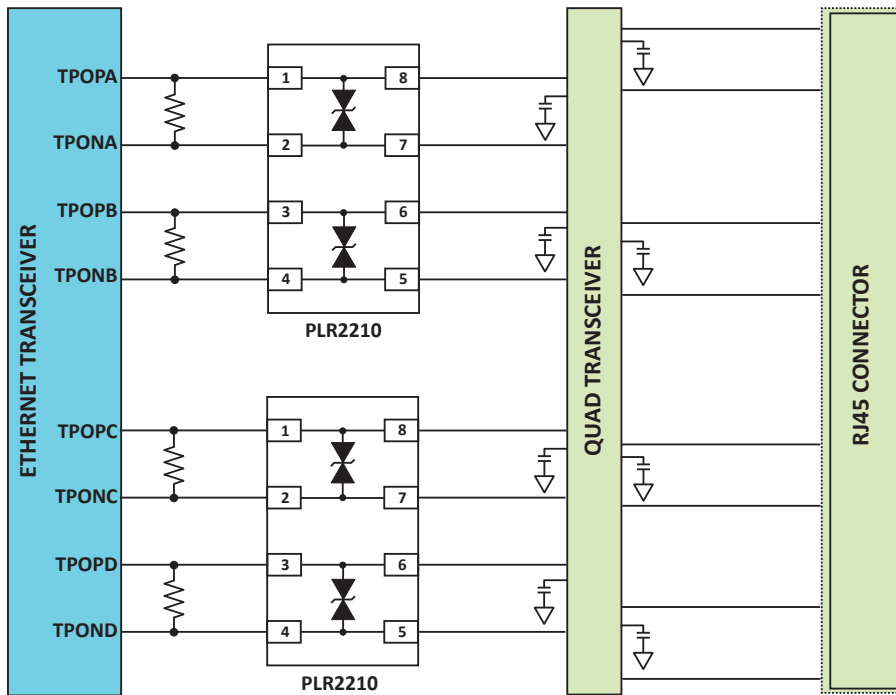


Figure 14. GigabitE Interface Protection Using PLR2210

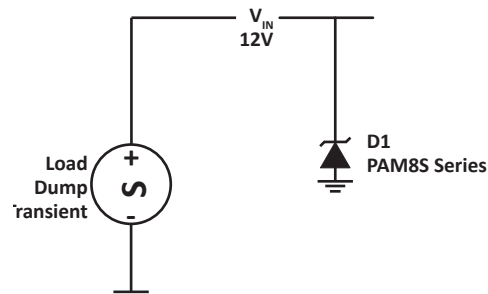


Figure 15. Battery (Load-Dump) Protection Using PAM8S Series

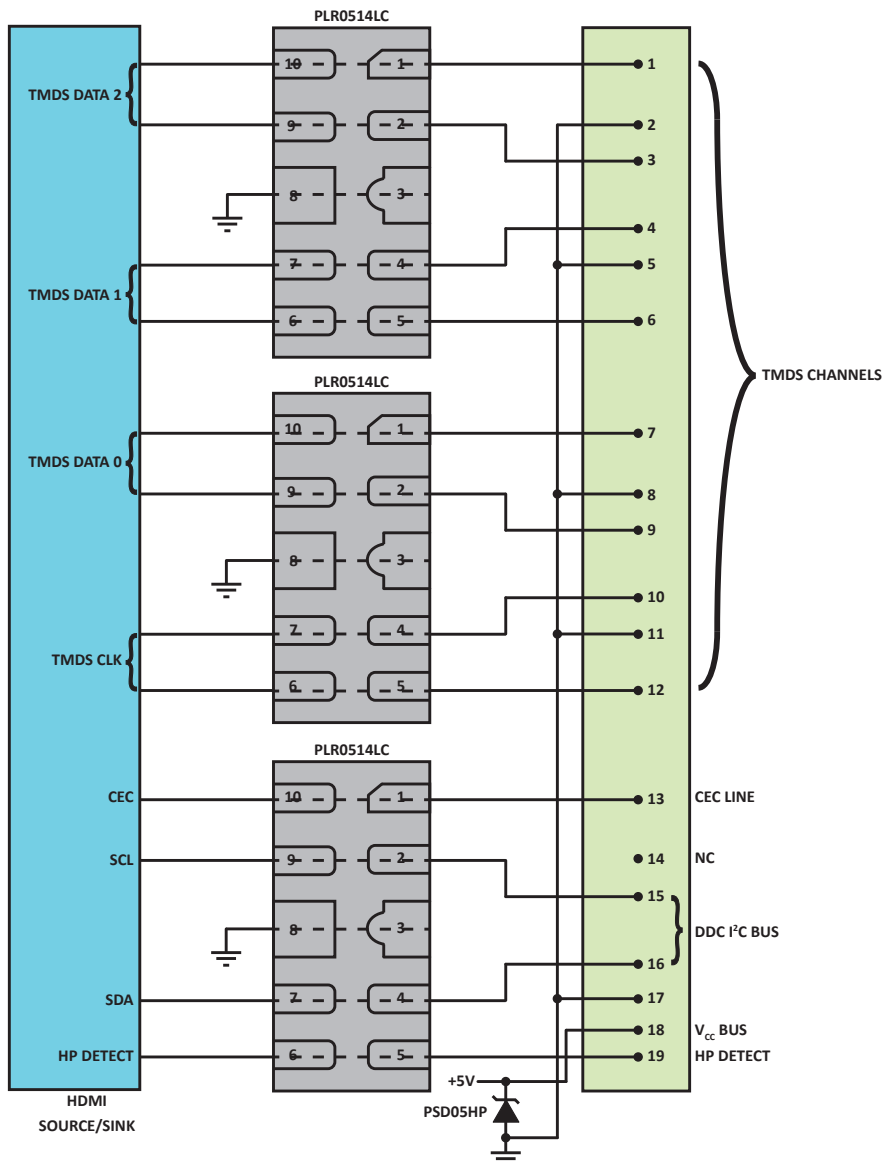


Figure 16. HDMI 2.0 Interface Protection Using PLR0514LC and PSD05HP for VCC Bus Protection

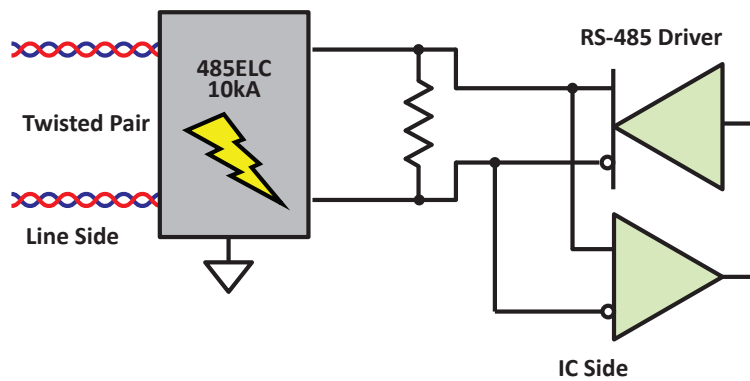


Figure 17. RS-485 Port Protection Using 485ELC



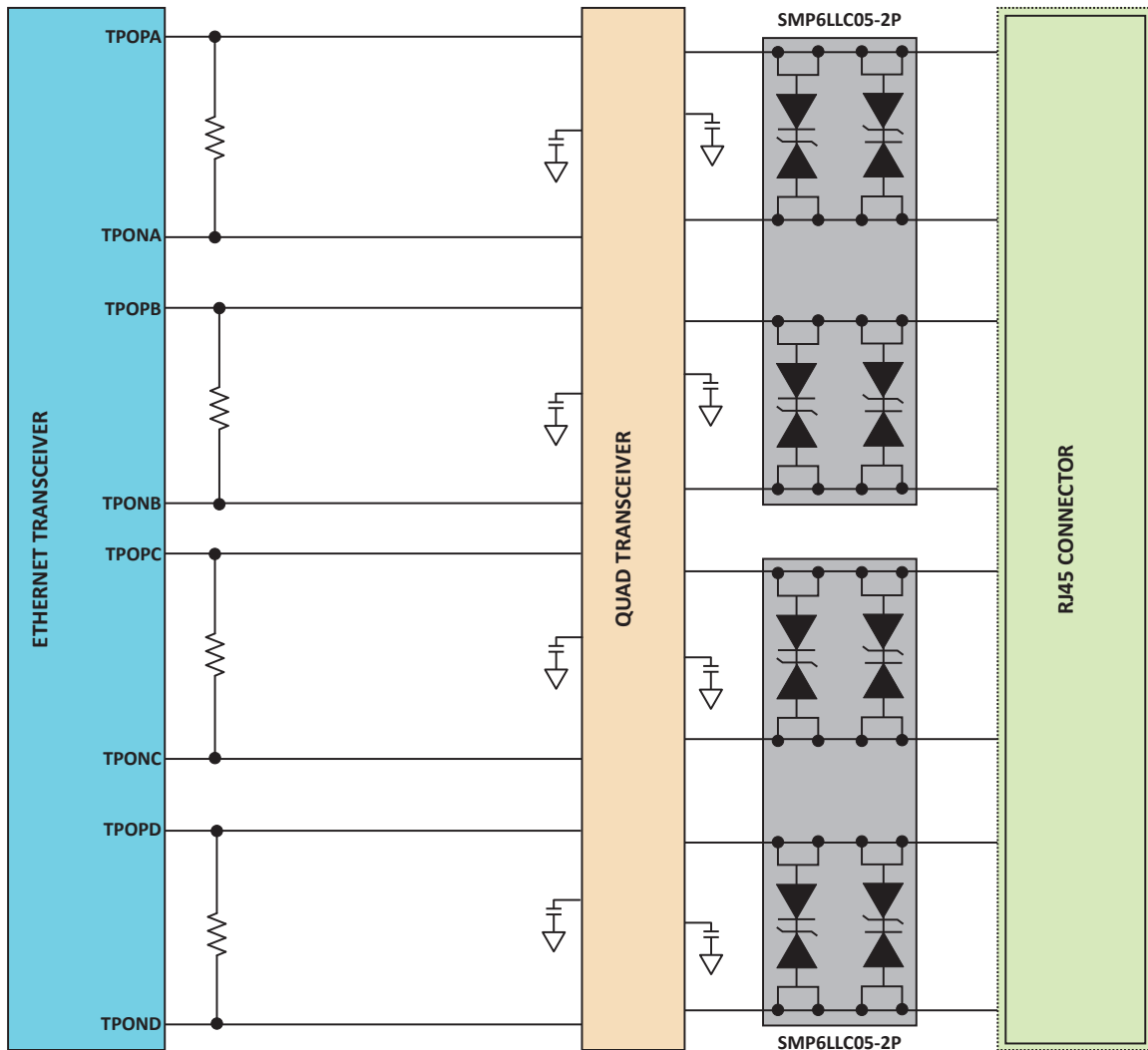


Figure 18. Ethernet 10/100 Protection for DO-160 Section 22 W3L2, W4L2, W5AL2 Using SMP6LLC05-2P

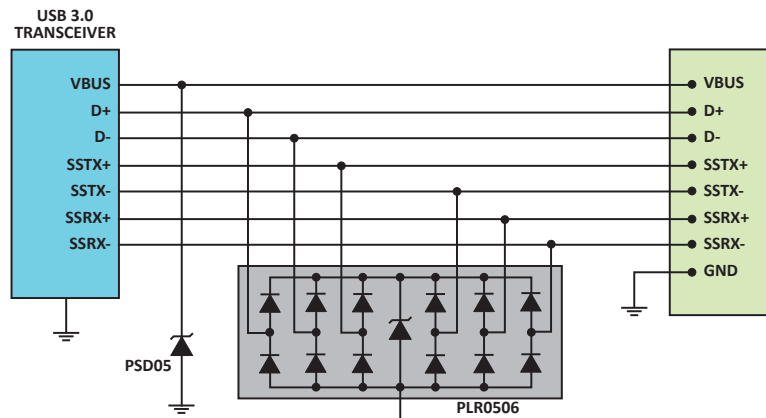


Figure 19. USB 3.0 Interface Protection Using PLR0506 with PSD05 for VCC Bus Protection

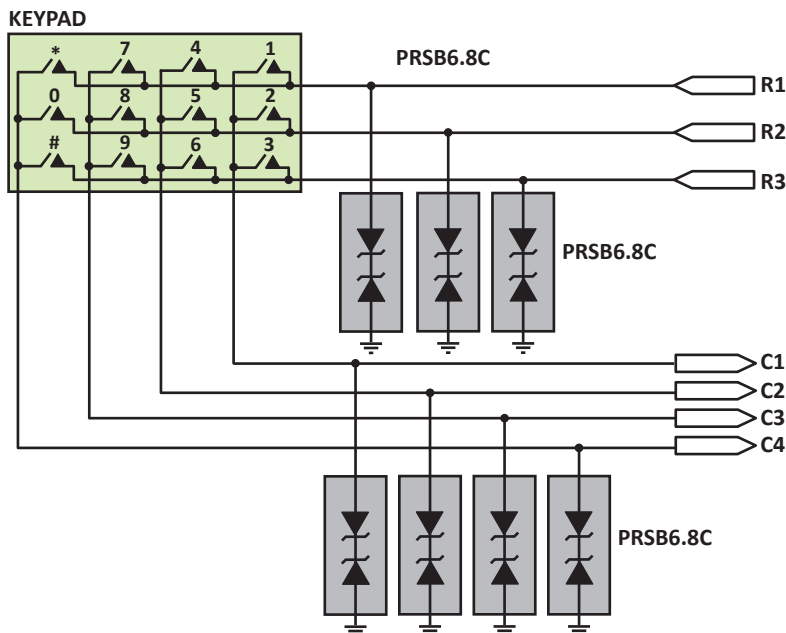


Figure 20. Solution for Key Pad Using PRSB6.8C

### OVERVOLTAGE PART SPECIFICATIONS

PART NUMBER	STAND-OFF VOLTAGE	BREAKDOWN VOLTAGE	CLAMPING VOLTAGE	PEAK PULSE CURRENT	MAXIMUM LEAKAGE CURRENT	TYPICAL CAPACITANCE	NO. OF LINES	POWER	PACKAGE
	$V_{WM}$ VOLTS	$V_{(BR)}$ VOLTS	$V_C$ VOLTS	8/20 $\mu$ s $I_{PP}$ AMPS	$I_D$ $\mu$ A	C pF		10/1000 $\mu$ s WATTS	
15KPA Series	17 - 280	18.9 - 311	32.3 - 452	175 - 33	5000 - 10	-	1	15000	Axial
30KPA Series	28 - 400	31.2 - 440	50 - 704	606 - 42.6	5000 - 2	-	1	30000	Axial
2700SMxxCAN	28 - 86	31 - 94	45.5 - 163	15kA	800 - 10	-	1	2250kW	Module
485ELC	$\pm 7$	-	20	500	10	25	1	-	Module
5.0SMDJ Series	6 - 440	22.2 - 492	10.3 - 713	485 - 7	2000 - 5	-	1	5000	DO-214AA
60/90KS Series	180	200	335	180	10 - 0.5	-	1	60 - 90kW	Module
704 Series	31.5	36	53	300	500 - 100	-	1	15000	Module
GPZ1275	28	32	55	500	60	-	1	30000	Module
GPZ1275B60K	28	32	55	1000	60	1	1	60000	Module
K Series	40 - 430	83 - 440	110 - 652	15 - 1	20 - 10	-	1	-	Axial
PAM5S Series	14 - 36	15.6 - 40	23.2 - 58.1	115 - 62	10	-	1	3600	DO-218AB
PAM6S Series	14 - 36	15.6 - 40	23.2 - 58.1	198 - 79	10	-	1	4600	DO-218AB
PAM8S Series	14 - 48	15.6 - 53.3	23.2 - 85.2	284 - 77.4	10	-	1	6600	DO-218AB
PHP Series	12 - 708	14 - 835	22 - 1292	341 - 11.6	341 - 11.6	-	1	7500	Module
PIP Series	12 - 708	14 - 835	22 - 1292	341 - 11.6	341 - 11.6	-	1	15000	Module
SM15KPAxxAN/CAN	17 - 480	18.9 - 528	29.3 - 791	512 - 18.9	5000 - 10	-	1	15000	Module
SM30KPAxxAN/CAN	28 - 480	31.2 - 528	50 - 791	606 - 37.8	5000 - 2	-	1	30000	Module
SM45KPAxxAN/CAN	70 - 200	77.8 - 220	120 - 350	375 - 128	2	-	1	45000	Module
SM3KW Series	8 - 33	8.8 - 36.7	13.6 - 56.3	220 - 53.3	50 - 3	-	1	3000	DFN-2
SM5KW Series	10 - 36	11.1 - 40.2	17 - 58.1	296 - 86	15 - 8	-	1	5000	DFN-2
SM10KW Series	10 - 36	11.1 - 40	20 - 72.3	3000 - 829	15 - 8	-	1	8500	DFN-2
SM10KWE Series	10 - 48	11.1 - 53	17 - 77.4	588 - 129	15 - 8	-	1	10000	DFN-2
SMAJ Series	5 - 440	6.4 - 492	9.6 - 713	41.7 - 0.6	800 - 1	-	1	400	DO-214AC
SMBJ Series	5 - 480	6.4 - 537	9.6 - 779	62.5 - 0.77	800 - 1	-	1	600	DO-214AA
SMCJ Series	5 - 440	6.4 - 492	9.6 - 713	156 - 2.1	800 - 1	-	1	1500	DO-214AB
SMDJ Series	5 - 440	6.4 - 492	9.6 - 713	313 - 4.2	5000 - 2	-	1	3000	DO-214AB

## OVERVOLTAGE PART SPECIFICATIONS

PART NUMBER	STAND-OFF VOLTAGE	BREAKDOWN VOLTAGE	CLAMPING VOLTAGE	PEAK PULSE CURRENT 8/20 $\mu$ s	MAXIMUM LEAKAGE CURRENT	TYPICAL CAPACITANCE	NO. OF LINES	POWER 8/20 $\mu$ s	PACKAGE
	V <sub>WM</sub> VOLTS	V <sub>(BR)</sub> VOLTS	V <sub>C</sub> VOLTS	I <sub>PP</sub> AMPS	I <sub>D</sub> $\mu$ A	C pF	WATTS		
CPxx/C	5.0 - 24.0	6.0 - 26.7	9.8 - 43.0	1.0	20 - 1	70 - 25	4-5	200	SOT-23-6
GBLCxxC	3.3 - 24.0	4.0 - 26.7	7.0 - 43.0	1.0	5 - 1	3	1	350	SOD-323
GBLCxxCI	3.0 - 24.0	4.0 - 26.7	7.0 - 43.0	1.0	5 - 1	0.6	1	250	SOD-323
GBLC03CIHP	3.0	4.0	24.0	20.0	5	0.6	1	500	SOD-323
PAM1CAN	24.0	25.4	46.0	3.0	0.002	11	2	200	SOT-23
PAM2CAN	24.0	25.4	60.0	4.0	0.05	11	2	230	SOT-23
PAZC099	5.0	6.0	12.0	1.0	0.5	0.5	4	100	SOT-23-6
PLC03-6	6.0	6.8	20.0	100.0	25	8	2	2000	SO-8
PLCDA Series	3.3 - 24	4.5 - 26.7	7.0 - 43.0	1.0	125 - 1	5	2	500	SO-8
PLR0502	5.0	6.0	20.0	10.0	1	0.6	2	200	SOT-543
PLR0502-6	5.0	6.0	17.0	3.0	1	0.7	2	50	SC-89
PLR0504F	5.0	6.0	25.0	5.0	3	1.9	4	200	SC70-6L
PLR0506	5.0	6.0	18.0	4.0	3	0.8	6	72	DFN-8
PLR0506LP	5.0	6.0	18.0	4.0	3	0.8	6	72	DFN-8
PLR0508	5.0	6.0	13.0	5.0	1	1.6	8	200	DFN-10
PLR0514LC	5.0	6.0	12.0	1.0	1	0.35	4	-	DFN-10
PLR0521	5.0	6.0	20.0	4.0	1	0.4	1	80	DFN-2
PLR05214LC	5.0	6.0	13.0	1.0	0.5	0.35	8	100	DFN-10
PLR0524	5.0	6.0	12.0	1.0	0.5	0.7	4	150	DFN-10
PLRxx12	2.5 - 3.3	2.7 - 3.5	10.2 - 11.0	10.0	0.05	3	2	100	DFN-8
PLR2210	2.5	2.7	6.0	2.0	0.05	0.6	2	170	DFN-8
PLR3304	3.3	3.5	10.0	10.0	0.1	4	4	400	DFN-10
PLR3311	3.3	4.5	8.0	5.0	0.05	5	1	40	DFN-2
PLR3343	3.3	5.6	10.0	1.0	1	0.25	4	150	DFN-10
PLR4045	3.3	4.0	20.0	30.0	0.1	1.6	4	600	MSOP-10
PRSB6.8C	4.7	5.7	13.0	1.0	0.5	15	1	50	DFN-2
PSDxx	3.3 - 36.0	4.0 - 40.0	6.5 - 60.0	1.0	125 - 1	500 - 35	1	500	SOD-323
PSDxxHP	5.0 - 12.0	6.0 - 13.3	9.8 - 19.1	1.0	20 - 2	800 - 440	1	1000	SOD-323
PSLCxxC	3.3 - 24.0	4.0 26.7	19.0 - 56.0	20.0 - 6.0	125 - 1	3	1	350	SOT-143
PSM712	7.0, 12.0	7.5, 13.3	11.0, 19.0	1.0	20, 1	75	1	600	SOT-23
PSOTxxC	3.3 - 36.0	4.0 - 40.0	6.5 - 51.0	1.0	125 - 1	500 - 60	1	500	SOT-23
PSR05	5.0	6.0	20.0	28.0	5	10	2	500	SOT-143
PSR05LC	5.0	6.0	20.0	28.0	5	2.5	2	500	SOT-143
PTB05-8ULC	5.0	5.5	11.5	5.0	1	0.15	8	-	DFN-18
PUSB6B	5.25	6.0	13.2	35.0	10	15	2	500	SO-8
SLVU2.8-4	2.8	3.0	21.0	30.0	1	3	2	600	SO-8
SM8LC Series	5.0 - 24.0	6.0 - 26.7	24.6 - 48.5	45.0 - 22.0	100 - 4	25	2	800	SO-8
SMDAxx/C Series	3.3 - 36.0	4.0 - 40.0	6.5 - 51.0	1.0	125 - 1	800 - 45	4	500	SO-8
SMP6LLCxx-2P	5.0 - 15.0	6.0 - 16.7	26.0 - 50.0	150.0-110.0	300 - 2	5	2	3900	SO-16
SRV05-4	5.0	6.0	15.0	5.0	5	2.5	4	500	SOT-23-6
SRV05-4-A	5.0	6.0	12.5	1.0	1	3	4	250	SOT-23-6
SRV05-4LC	5.0	6.0	15.0	5.0	5	0.7	4	500	SOT-23-6
SRV25-4	2.5	3.0	7.4	10.0	0.5	1.7	4	800	DFN-10
SRV3.3-4	3.3	3.9	6.5	1.0	0.5	3.5	4	800	DFN-10

## COMPANY INFORMATION

In business more than 25 years, ProTek Devices™ is a privately held semiconductor company. The company offers a product line of overvoltage protection and overcurrent protection components. These include transient voltage suppressor array (TVS arrays) avalanche breakdown diode, steering diode TVS array and electronics SMD chip fuses. These components deliver circuit protection in electronic systems from numerous overvoltage and overcurrent events. They include lightning; electrostatic discharge (ESD); nuclear electromagnetic pulses (NEMP); inductive switching; and electromagnetic interference (EMI) / radio frequency interference (RFI).

### CONTACT US

#### ProTek Devices L.P.

2929 South Fair Lane  
Tempe, Arizona 85282  
USA  
Phone: +1 602-431-8101  
FAX: +1 602-431-2288

#### ProTek Devices (Asia Pacific) Pte. Ltd.

8 Ubi Road 2, #06-19, Zervex  
Singapore 408538  
Phone: +65 6748-8312  
FAX: +65 6748-8313

#### By E-mail:

Asia Sales: [asiasales@protekdevices.com](mailto:asiasales@protekdevices.com)  
Europe Sales: [europesales@protekdevices.com](mailto:europesales@protekdevices.com)  
U.S. Sales: [ussales@protekdevices.com](mailto:ussales@protekdevices.com)  
Distributor Sales: [distysales@protekdevices.com](mailto:distysales@protekdevices.com)  
Customer Service: [service@protekdevices.com](mailto:service@protekdevices.com)  
Technical Support: [support@protekdevices.com](mailto:support@protekdevices.com)

#### Web

[www.protekdevices.com](http://www.protekdevices.com)

### ROHS & REACH COMPLIANCE

All devices, with the exception the modules/axial leads are Lead-Free, RoHS & REACH compliant. These products are designated as "lead free" and meet the requirements of the European Union's restriction on the use of hazardous substances in electrical equipment as stated in (RoHS) direction, 2002/95/EC. ProTek Devices defines "lead free" as products that are compatible with current RoHS requirements for the 6 "banned" substances: Lead (Pb, <1000ppm), Cadmium (Cd, <100ppm), Mercury (Hg, <1000ppm), Hexavalent Chromium (Cr6+, <1000ppm), Poly Brominated Biphenyls (PPB, <1000ppm), Poly Brominated Diphenyl Ethers (PBDE, <1000ppm). This includes the requirements that lead not exceed 0.1% by weight in homogeneous materials.

### STANDARD TAPE & REEL NOMENCLATURE

-T7 for 7" Reels  
-T13 for 13" Reels  
-TS for sample size Reels

Not all products are available in 7" or 13" reels. Quantities per reel vary depending upon package size. Please consult product data sheet or the factory for ordering information regarding a specific part series. All data sheets can be found on ProTek Devices website: [www.protekdevices.com](http://www.protekdevices.com)

COPYRIGHT © ProTek Devices (2018) - This literature is subject to all applicable copyright laws and is not for resale in any manner.

SPECIFICATIONS: ProTek Devices reserves the right to change the electrical and or mechanical characteristics described herein without notice.

DESIGN CHANGES: ProTek Devices reserves the right to discontinue product lines without notice and that the final judgment concerning selection and specifications is the buyer's and that in furnishing engineering and technical assistance. ProTek Devices assumes no responsibility with respect to the selection or specifications of such products. ProTek Devices makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ProTek Devices assume any liability arising out of the application or use of any product or circuit and specifically disclaims any and all liability without limitation special, consequential or incidental damages.

LIFE SUPPORT POLICY: ProTek Devices products are not authorized for use in life support systems without written consent from the factory.