

INDUSTRIAL APPLICATIONS

ADVANCED CIRCUIT PROTECTION DEVICES FOR OVERVOLTAGE TRANSIENT EVENTS



PROTEK DEVICES®

ONLY ONE NAME MEANS PROTEK'TION™



Today's industrial applications are as diverse as ever. They include point of sale (PoS) systems that have card readers, modems and serial ports. They also include residential and commercial energy meters and smart meters; industrial displays; appliances; general control systems; instrumentation; photo-voltaic systems; LED lighting and many more. Industrial system failures in the field due to improper circuit protection can be costly exercises in terms of time and money. In addition, system downtime can often result in damage to a company's image or quality reputation – both that of the user and the system provider. Any of these industrial applications are at risk to external threats that can include electrostatic discharges (ESD), electrical fast transients (EFT), surges, lightning or improper wiring.

DATA TRANSMISSION RATES		
APPLICATION	DATA RATE Mbit/S	CAPACITANCE pF
LinBus	0.20	< 50
RS-232	0.20	
CanBus/Device Net	1.0	<30
T1	1.544	
E2	2.048	
I2C	2.4	
Ethernet	10	
FlexRay	10	
USB 1.1	12	< 20
E3	34.368	
RS-485	35	
T3	44.736	
Fast Ethernet	100	< 5
T5	400.352	< 3
USB 2.0	480	
E5	565.148	
IEEE-1394b	786.432	
GigabitE	1000	
DVI	3960	
USB 3.0	5000	
DisplayPort	5400	
USB 3.1	10000	< 1
HDMI 1.3	10200	
HDMI 2.0	18000	

Communications systems are at the heart of many industrial applications, such as the use of RS-485, CAN Bus, LIN Bus, USB2.0, ProfiNet or ProfiBus. To provide circuit protection, traditionally, a high capacitor was used to ensure over-voltage protection. However, due to the high speed requirements in today's communication ports, the capacitance per line must be significantly reduced. If not, transmission speed will be substantially negatively impacted. And, capacitance reduction must be done while still providing enough over-voltage protection against electrical threats. The capacitance of the protection device becomes a particular issue for data lines where higher baud rates are being designed. Here, what's required are circuit protection components where the load capacitance creates a first order filter to slow the rise and falling edge.

Power supplies are also obviously critical to industrial systems and they can be easily susceptible to various electrical threats. But, power supplies are generally immune to ESD conditions. This is due to the use of passive components such as capacitors and inductors that are inherently robust. Ferrite beads are commonly used in power supplies to add inductance that limits the impulse amplitudes under fast transients. While this traditional solution often provides adequate protection, it does use passive components that can strain other components. Thus, energy can then be diverted into the system power rail, causing electrical damage into other areas of the system. For this reason, over-voltage protection solutions with a fast response time that divert or shunt the energy to ground should be considered.

In addition, it is important that industrial application designers understand that their solutions are likely to be exposed to external ESD, EFT, surges, lightning or improper wiring during installation. This includes ESD levels per IEC 61000-4-2 and EFT levels per IEC 61000-6-4. Critical systems and integrated circuits (IC) will be exposed to such elements and designers should remember that devices may not be resettable and may be damaged beyond repair.

For surge protection per IEC 61000-4-5, it is critical for the design engineer to understand what installation classification is required for a system. They include:

- **Class 0:** Well-protected electrical environment, often within a special room.
- **Class 1:** Partly protected environment.
- **Class 2:** Electrical environment where the cables are well separated, even at short runs.
- **Class 3:** Electrical environment where cables run in parallel.
- **Class 4:** Electrical environment where the interconnections are running as outdoor cables along with power cables and cables used for both electronic and electric circuits.
- **Class 5:** Electrical environment for electronic equipment connected to telecommunication cables and overhead power lines in a non-densely populated area.

Once the classification is known, the level of protection required can be determined using the IEC 61000-4-5 test levels, as shown in table 1.

No matter the industrial application, ProTek Devices provides a comprehensive family of over-voltage and over-current protection devices. They are designed to seamlessly integrate within the various electronics design requirements for today's modern industrial electronics system. They are also designed for quality and cost-effectiveness. They also not only help meet all relevant standards, they provide real-world scenario circuit protection for mission critical industrial systems.

IEC 61000-4-5 TEST LEVELS

CLASS	AC POWER SUPPLY COUPLING MODE (Note 1)		AC POWER SUPPLY COUPLING MODE (Note 2)		DC POWER SUPPLY COUPLING MODE (Note 3)		UNSYMMETRICAL COUPLING MODE (Note 4, d, f)		SYMMETRICAL COUPLING MODE (Note 4, d, f)		SHIELDED I/O COUPLING MODE (Note 5, f)	
	Line to Line kV	Line to Gnd kV	Line to Line kV	Line to Gnd kV	Line to Line kV	Line to Gnd kV	Line to Line kV	Line to Gnd kV	Line to Line kV	Line to Gnd kV	Line to Line kV	Line to Gnd kV
0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	N/A	0.5	N/A	N/A	N/A	N/A	N/A	0.5	N/A	0.5	N/A	N/A
2	0.5	1.0	N/A	N/A	N/A	N/A	0.5	1.0	N/A	1.0	N/A	0.5
3	1.0	2.0	1.0 ^e	2.0 ^{b,e}	1.0 ^e	2.0 ^{b,e}	1.0 ^c	2.0 ^{b,c}	N/A	2.0 ^{b,c}	N/A	2.0 ^c
4	2.0	4.0 ^b	2.0 ^e	4.0 ^{b,e}	2.0 ^e	4.0 ^{b,e}	2.0 ^c	4.0 ^{b,c}	N/A	2.0 ^{b,c}	N/A	4.0 ^c
5	^a	^a	2.0	4.0 ^b	2.0	4.0 ^b	2.0	4.0 ^b	N/A	4.0 ^b	N/A	4.0 ^c

Notes

1. AC power supply and AC I/O directly connected to the main network.
2. AC power supply and AC I/O NOT directly connected to the main network.
3. DC power supply and DC I/O.
4. Operated circuits/lines.
5. Communication lines.
- a. Depends on the class of the local power supply system.
- b. Normally tested with primary protection.
- c. The test level may be lowered by one level if the cable length is shorter or equal to ten meters.
- d. No test is advised at data connections intended for cables shorter than ten meters.
- e. If protection is specified upstream from the EUT, the test level should correspond to the protection level when the protection is not in place.
- f. High speed communications lines could be included under unsymmetrical, symmetrical, shielded IO and/or communications lines.

SELECTION GUIDE



APPLICATION	PREFERRED DEVICES	ALTERNATE DEVICES
4-20mA Process Control	420E Series	420LB & 420LE
AC Power	PHYTVSxxV3, PHYTVSxxV4, SM10KWE/SM15KWE/SM30KWE Series	15KP/30KPA Series, P15KP/P30KP Series
Antenna	GBLCxx/C Series	GBLCxxI/CI Series, GBLCxxLC Series
CAN Bus/DeviceNet	GBLC24C, PESD1CAN, PESD2CAN	ESOT24LCC-2
DC Power/Logic	PHS5xx/C Series, SKC Series, 5.0SMDJ/SMAJ/SMBJ/SMCJ/SMDJ/SMEJ Series	15KP/30KPA Series, GBLCxx/C Series, P15KP/P30KP Series, PSDxx/C Series
I/O Link	DFN6-36, DFN8-36, PDFN3-32, PSM36A, SMBJ Series	GBLCxx/C Series, PDFN2-32, PSDxx/C Series, PSOTxx/C Series
LED	5.0SMDJ/SMAJ/SMBJ/SMCJ/SMDJ Series	PHS5xx/C Series
LINBus	PESD1LIN	PESD1CAN, PESD2CAN
LVDS	PLR0504PLCN, PLR3304PLCN, SRV05-4LC	PAZC099
Power Over Ethernet	PSR05, SR2.8	ESOT24LCC-2, PSOTxx/C Series
ProfiNet, ProfiBus	PLR0524P, PLR3304, SRV05-4, SRV25-4	GBLCxx/C Series
RS-232	PSOTxxC Series, SMAJ Series	232LB/LE, PSDxx/C Series
RS-422	PSM712, SMD712C	422ELC, PSLCxxC Series
RS-485	PSM712, SMD712C	485ELC, PSLCxxC Series
Sensors	DFN6-36, PDFN3-32	PSOTxx Series
USB 2.0	PLR0502, PLR0502-6, PLR0524P	GBLCxx/C Series, PLR0504F, PLR0521
VXIBus	PSRDA-4A/PSRDA-6A Series	PSRDAxx-4/6 Series, SMDAxxLC/LCC Series

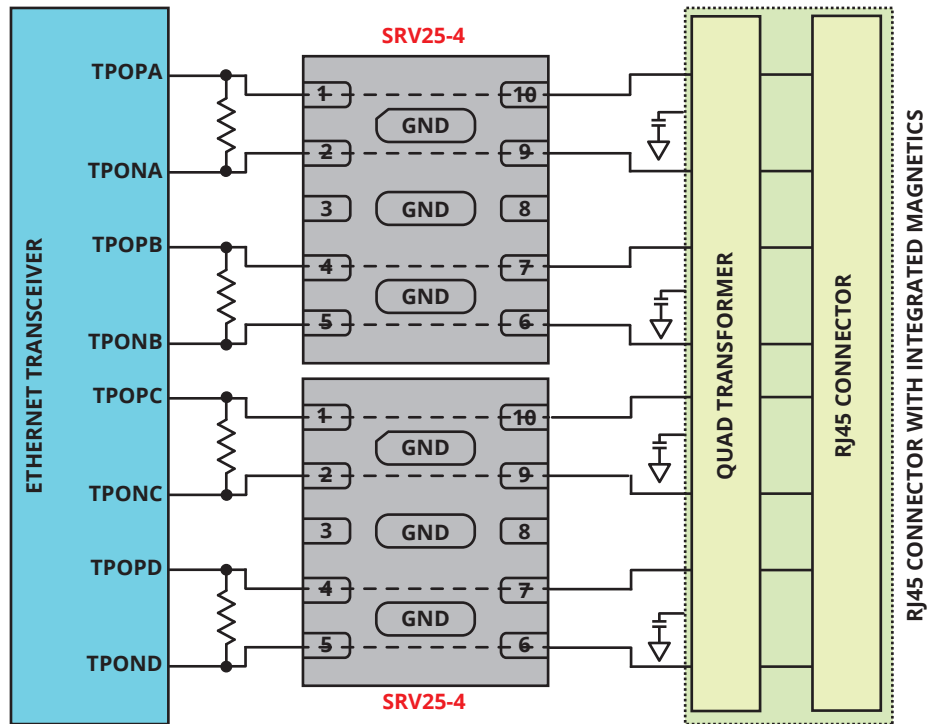


Figure 1. ProfiNet Interface ESD/EFT/Surge Protection Using Two SRV25-4 Devices

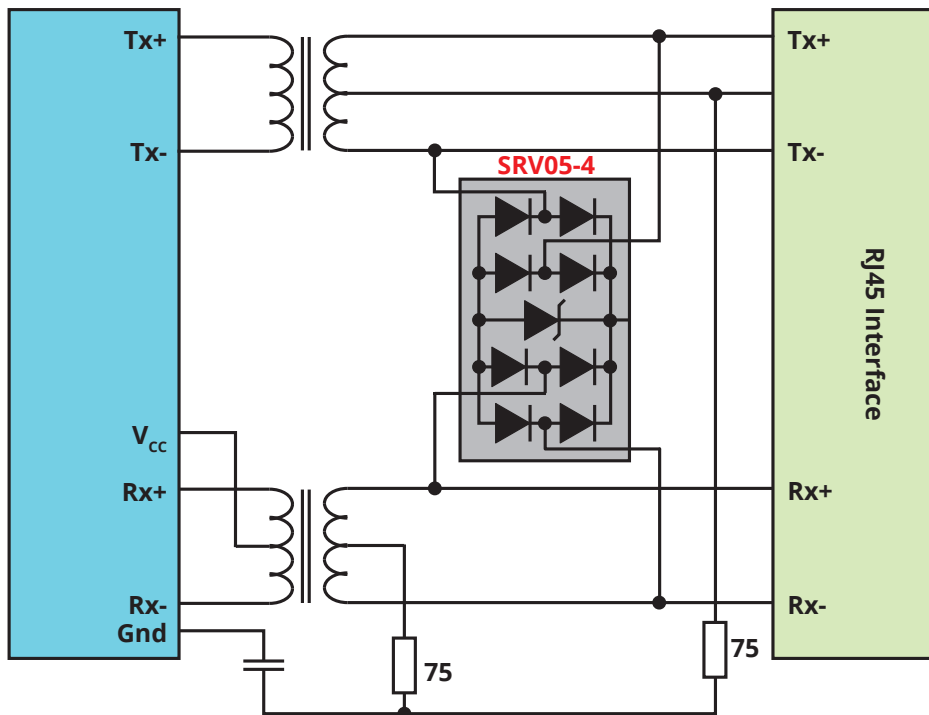


Figure 2. ProfiBus ESD/EFT/Surge Protection Using SRV05-4

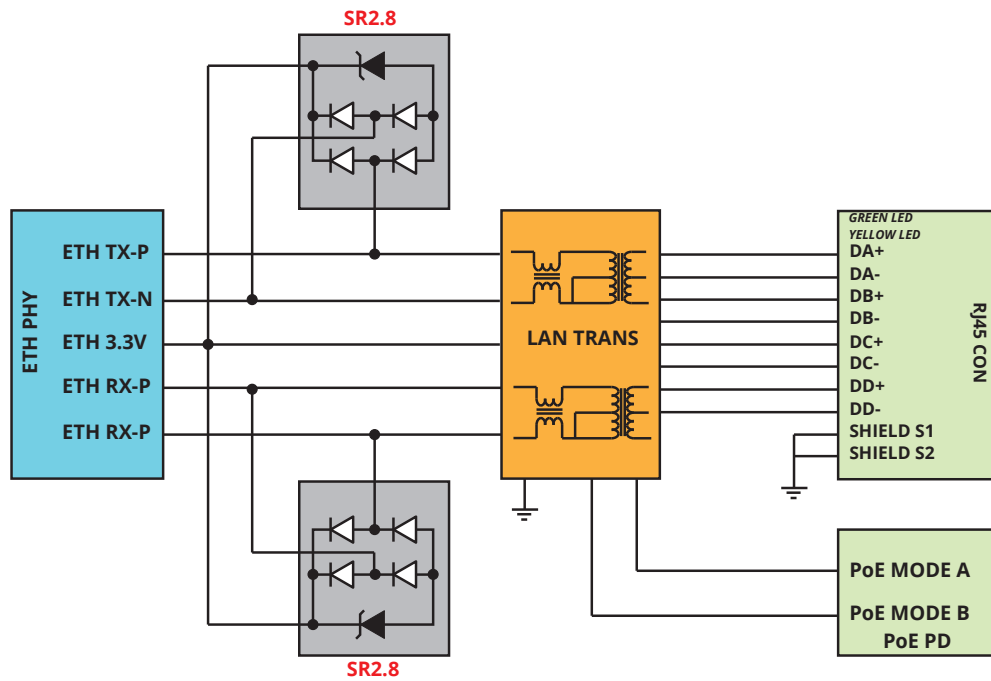


Figure 3. PoE (802.3at) ESD/EFT/Surge Protection Using SR2.8

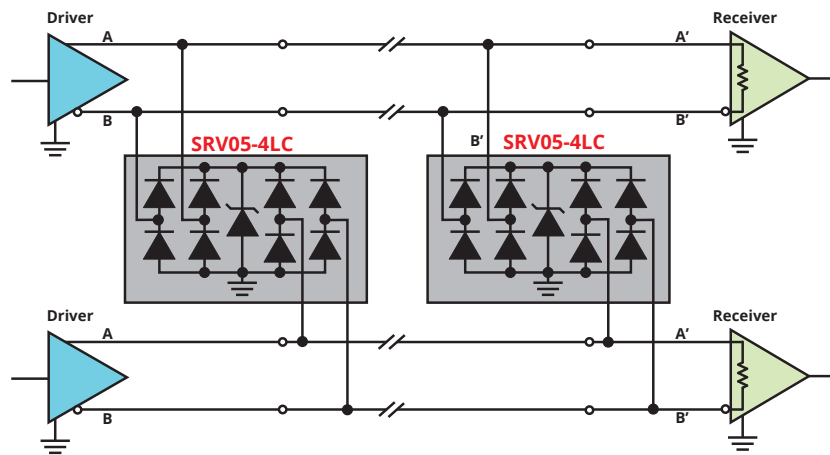


Figure 4. LVDS ESD/EFT Protection Using Two SRV05-4LC Devices



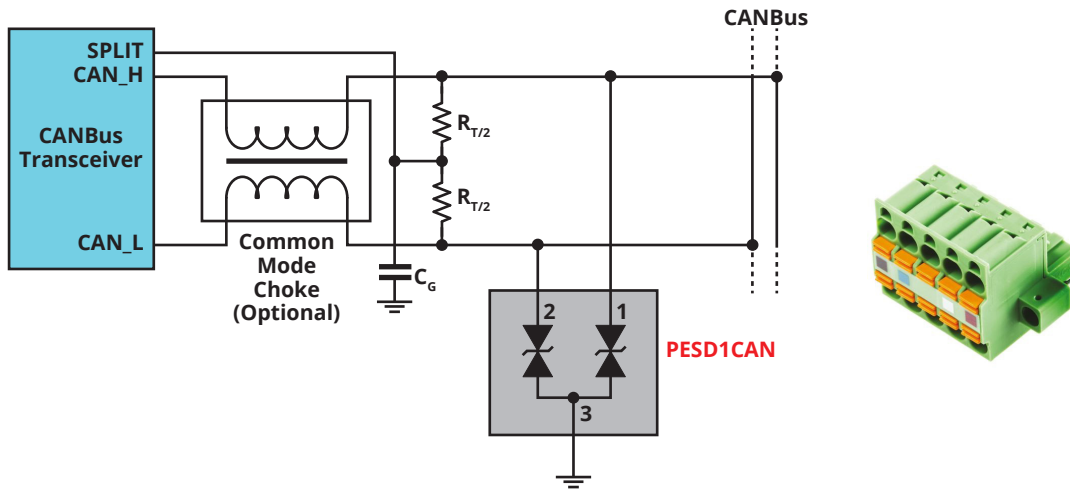


Figure 5. Industrial CANBus/DeviceNet ESD/EFT Protection Using PESD1CAN

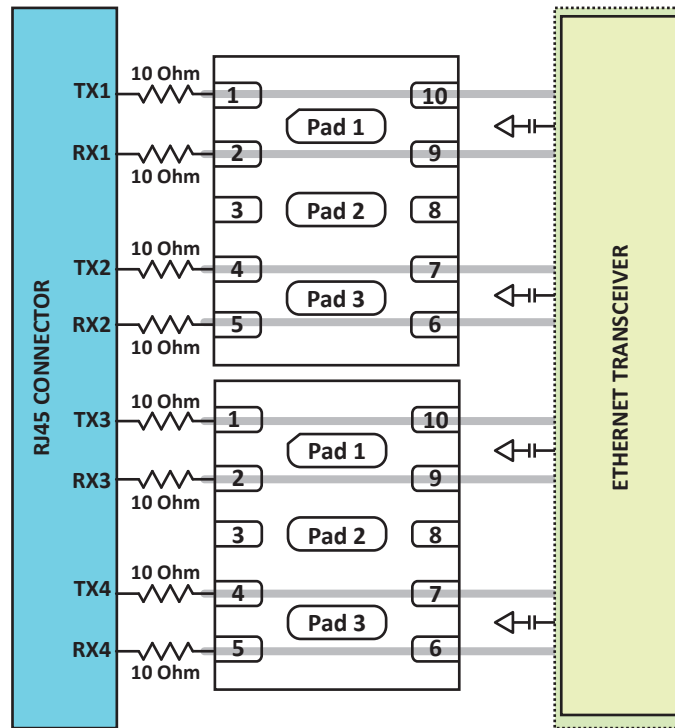


Figure 6. GbE Ethernet ESD/EFT/Surge Protection using PGBT3304

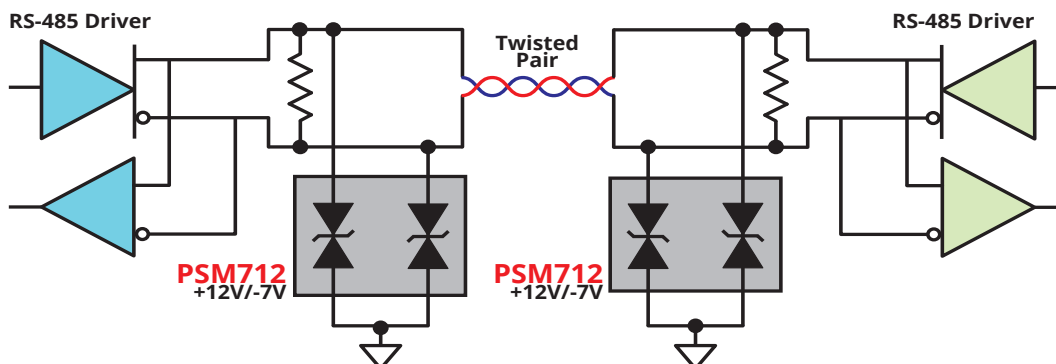


Figure 7. RS-485/RS-422 ESD/EFT/Surge Protection Using Two PSM712 Devices

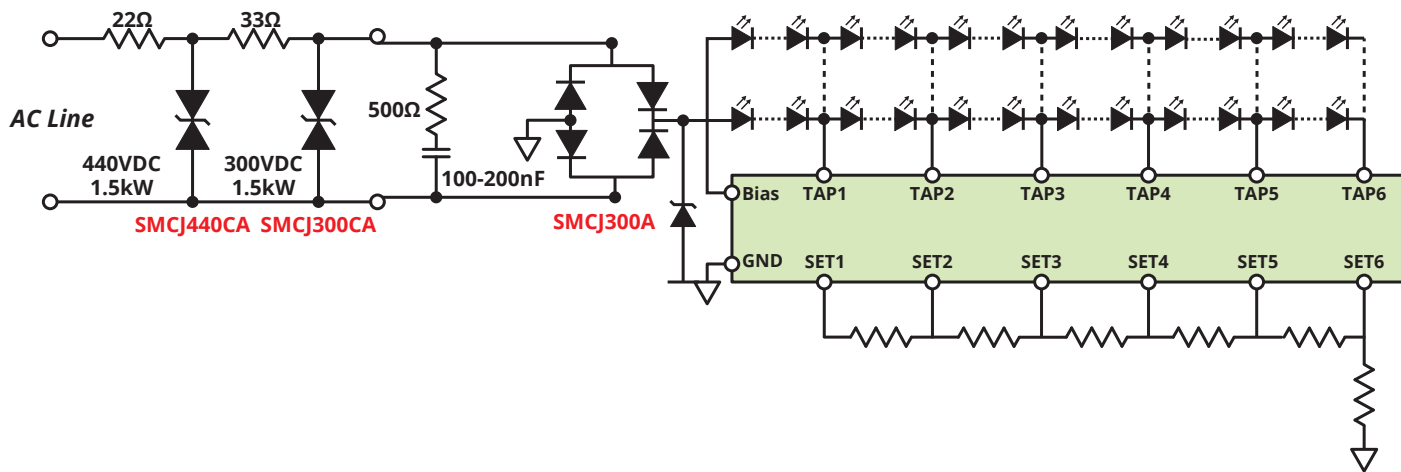


Figure 8. LED Luminaire Protection Using SMCJ300CA, SMCJ300A & SMCJ440CA

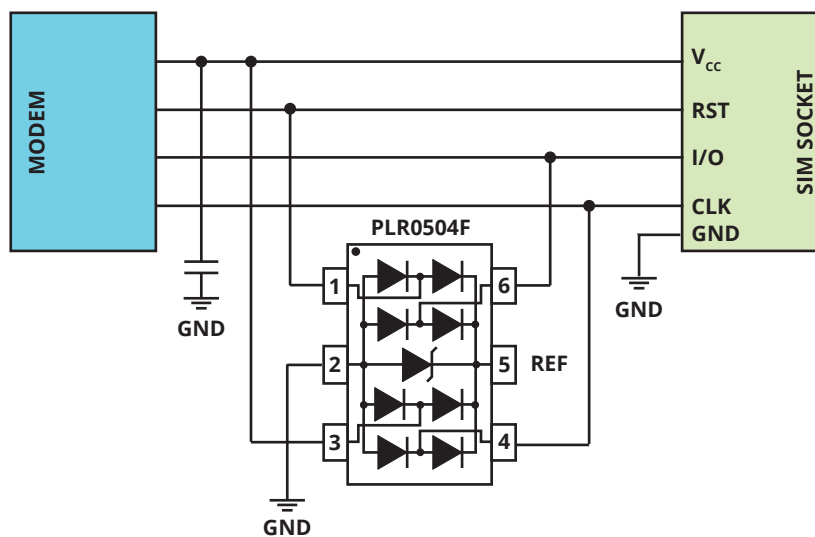


Figure 9. SIM Card ESD/EFT Protection Using PLR0504F

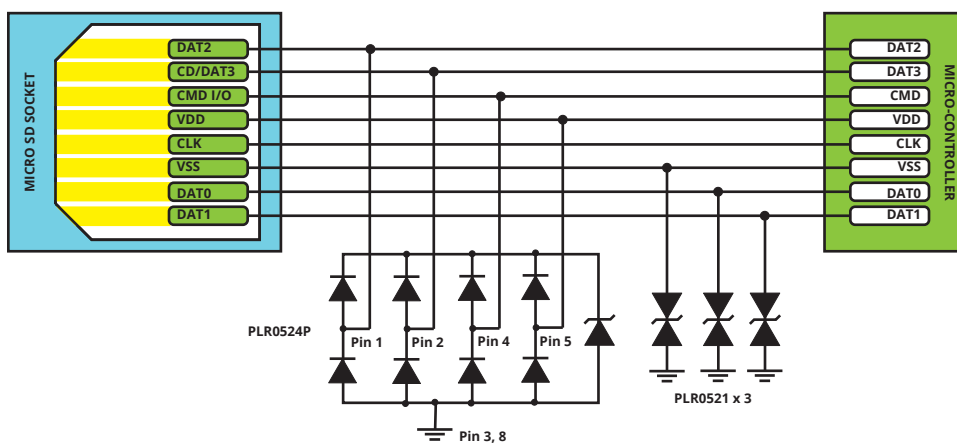


Figure 10. SD Card ESD/EFT Protection Using PLR0524P & PLR0521

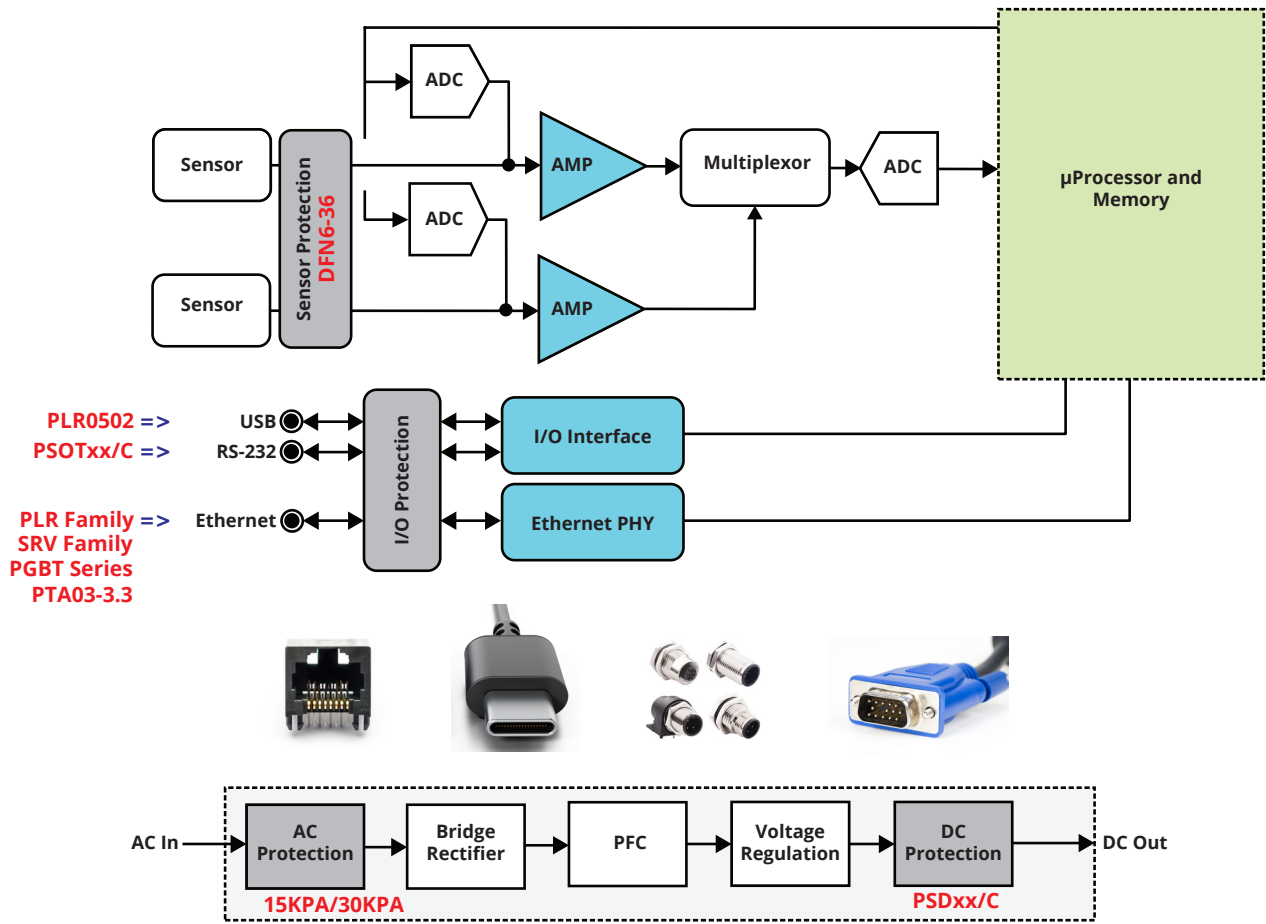


Figure 11. Sensor Block Diagram - Multiple Layers of Protection: Sensor, I/O, AC and DC.



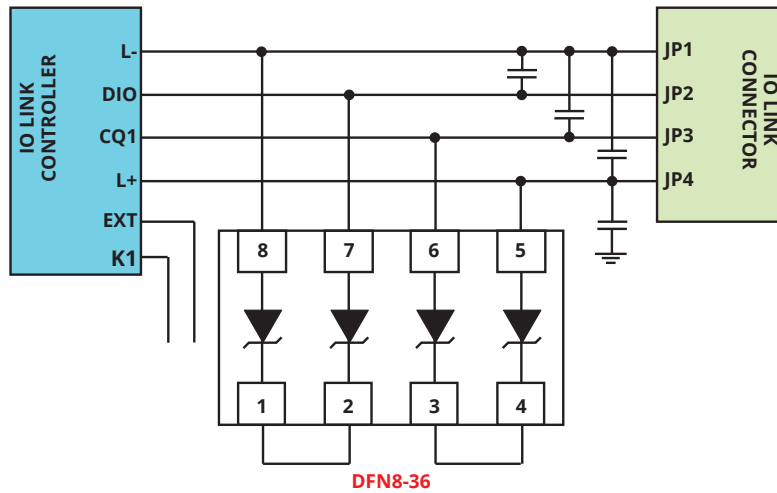


Figure 12. Industrial Automation IO Link ESD/EFT Protection Using DFN8-36

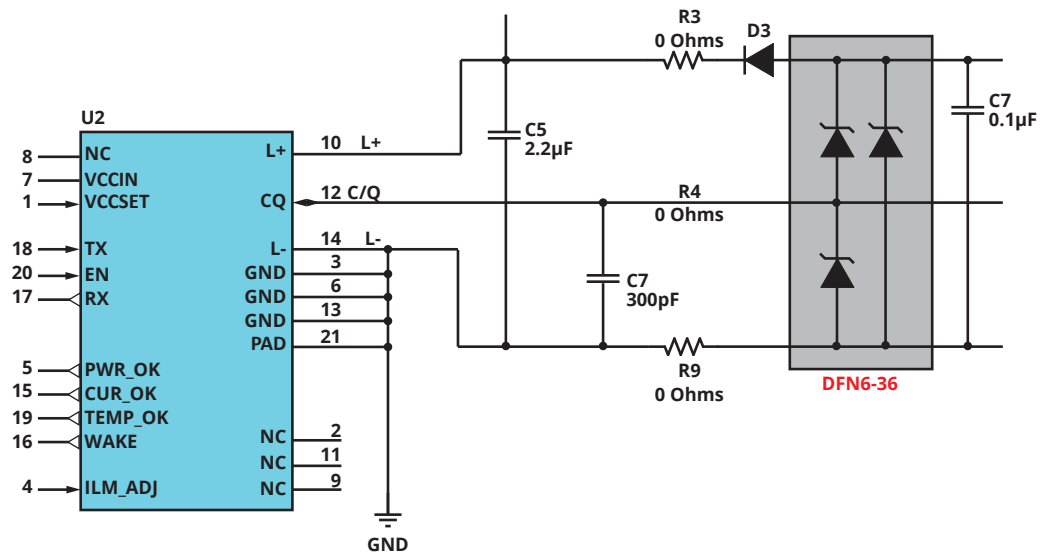


Figure 13. Industrial Automation IO Link ESD/EFT Protection Using DFN6-36

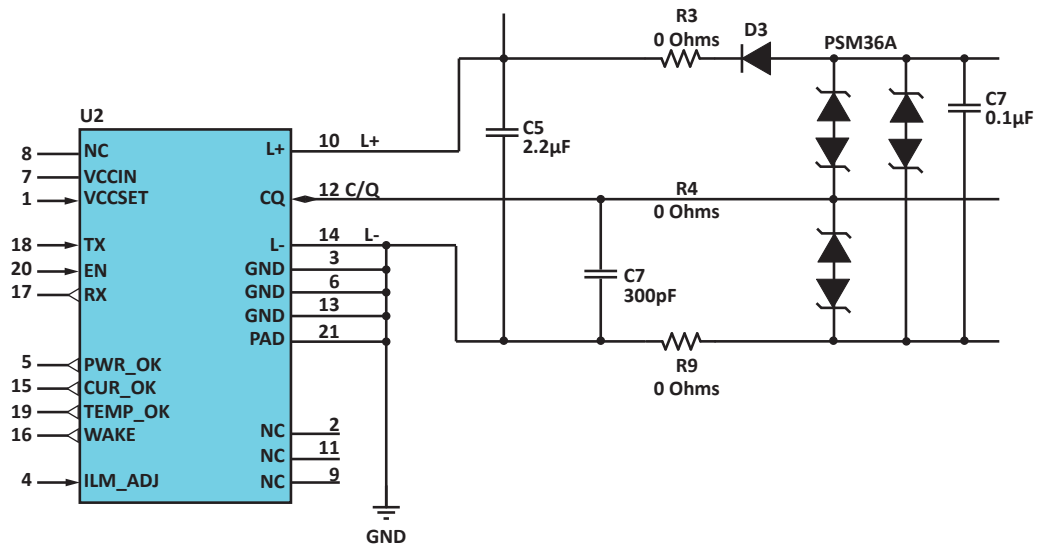


Figure 14. Industrial Automation IO Link ESD/EFT Protection Using PSM36A

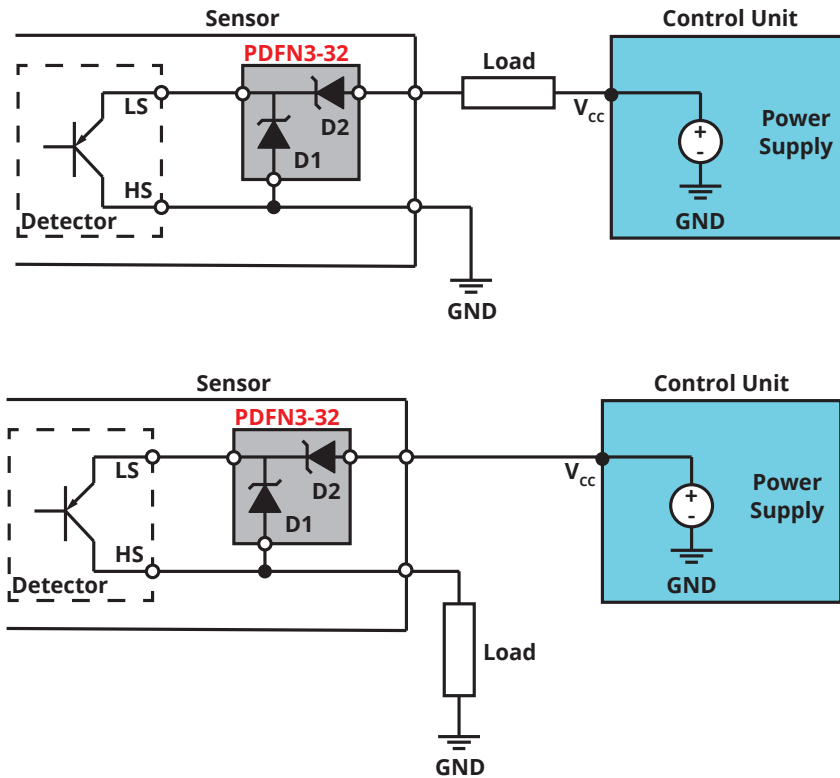


Figure 15. Industrial Sensor ESD/EFT/ Surge Protection Using PDFN3-32

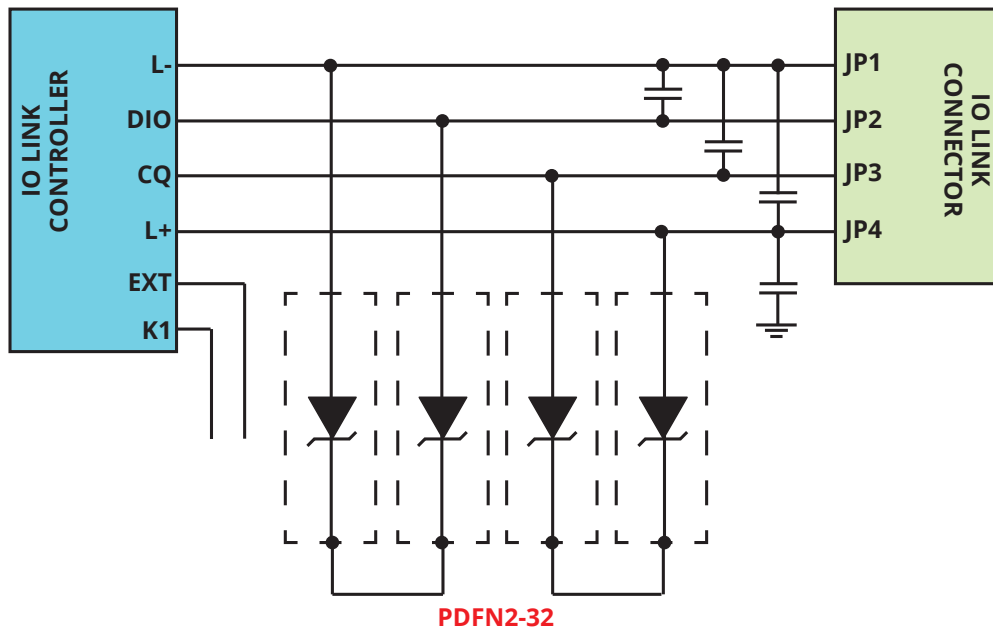


Figure 16. Industrial Sensor Protection Using PDFN2-32

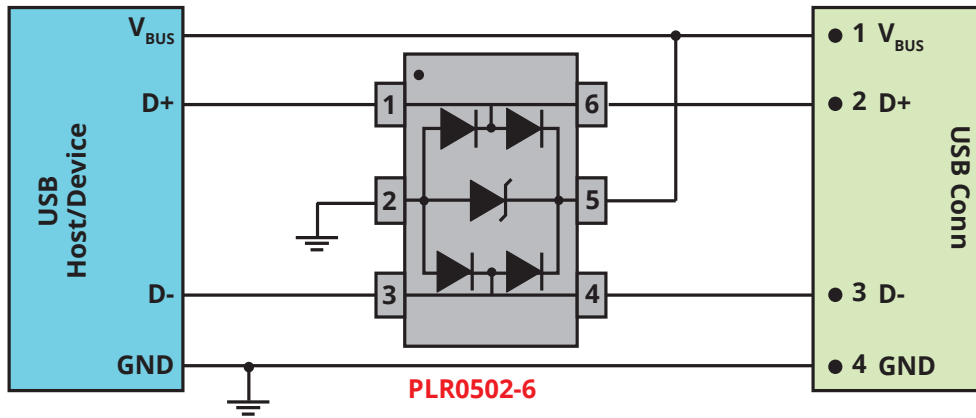


Figure 17. USB 2.0 Port ESD/EFT Protection Using PLR0502-6

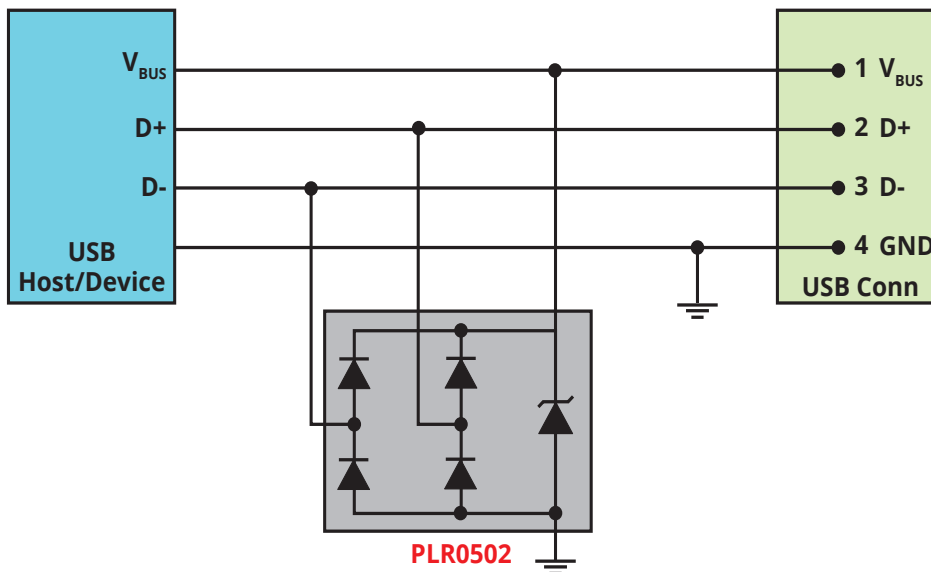


Figure 18. USB 2.0 Port ESD/EFT Protection Using PLR0502



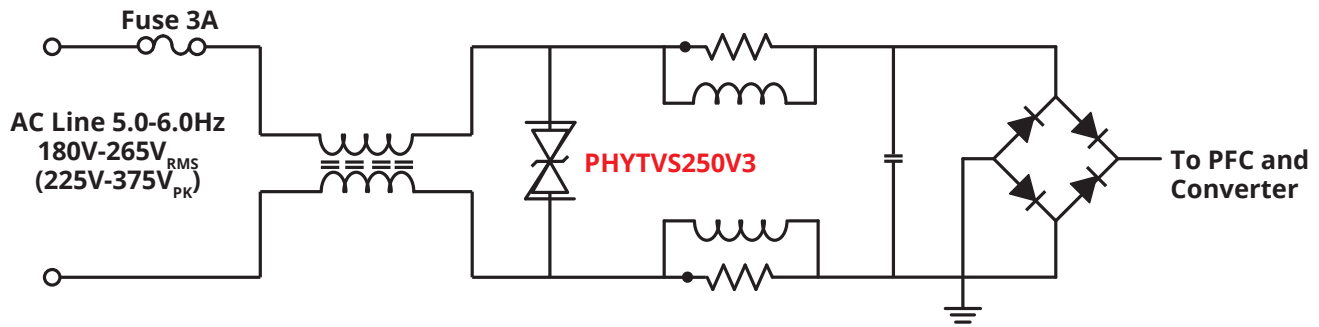


Figure 19. AC/DC Power Supply (L-L) Class 2 Surge Protection Using PHYTVS250V3

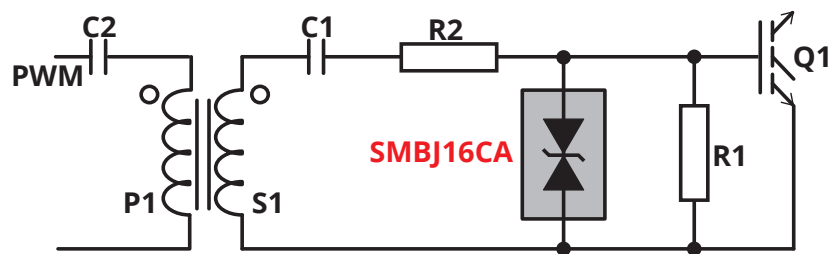


Figure 20. IGBT Gate ESD/EFT/Surge Protection Using SMBJ16CA

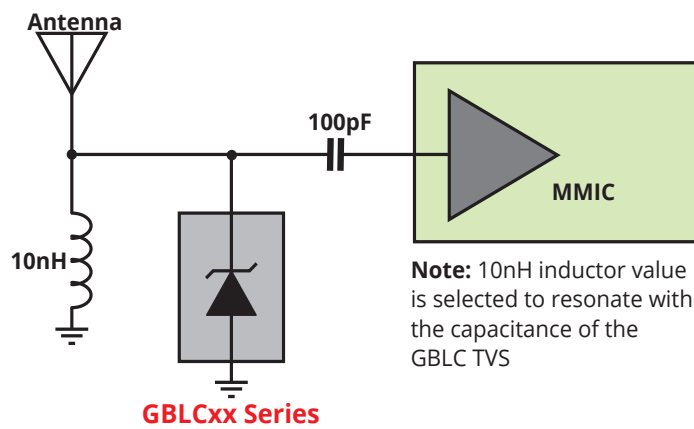


Figure 21. Antenna ESD/EFT Protection Using GBLCxx Series

OVERVOLTAGE PART SPECIFICATIONS

PART NUMBER	STAND-OFF VOLTAGE	BREAKDOWN VOLTAGE	CLAMPING VOLTAGE	PEAK PULSE CURRENT 8/20 μ s	MAXIMUM LEAKAGE CURRENT	TYPICAL CAPACITANCE	NO. OF LINES	POWER 8/20 μ s	PACKAGE
	V _{WM} VOLTS	V _(BR) VOLTS	V _C VOLTS	I _{PP} AMPS	I _D μ A	C pF	WATTS		
15KPAxxxx	17.0 - 280.0	-	-	-	5000 - 10	-	1	15000*	Axial
232B/E	25.0	-	40	500	5	2000	1	-	Module
30KPAxxxx	30.0 - 360.0	-	-	-	5000 - 2	-	1	30000*	Axial
420E Series	12.0 - 60.0	-	22.0 - 95.0	200.0	5	6000 - 1000	1	-	Module
420LB/LE	28.0-60.0	-	40.0-85.0	2000	5	2800-1000	1	-	Module
422ELC	\pm 12.0	-	30.0	500.0	1	25	1	-	Module
485ELC	\pm 7.0	-	20.0	500.0	10	25	1	-	Module
5.0SMDJ Series	6.0 - 440.0	6.67 - 492.0	-	-	2000 - 5	-	1	-	DO-214AB
DFN6-36	33.0	35.0	45.0	2.0	5	50	3	300	DFN-6
DFN8-36	33.0	35.0	45.0	2.0	5	50	3	300	DFN-8
ESOT24LCC-2	24.0	26.6	-	-	1	6	2	100	SOT-23
GBLCxx/C	3.0 - 24.0	-	7.0 - 43.0	1.0	5 - 1	3	1	350	SOD-323
GBLCxx/CI	3.0 - 24.0	-	7.0 - 43.0	1.0	5 - 1	0.6	1	250	SOD-323
GBLCxxLC	3.3 - 5.0	4.0 - 6.0	7.0 - 9.8	1.0	1 - 5	0.8 - 0.7	1	250	SOD-323
P15KPxxxx	17.0 - 280.0	-	-	-	5000 - 10	-	1	15000*	Axial
P30KPxxxx	30.0 - 260.0	-	-	-	5000 - 10	-	1	30000*	Axial
PAZC099	5.0	6.0	12.0	1.0	0.5	0.5	4	100	SOT-23-6
PDFN2-32	32.0	34.0	55.0	25.0	200nA	-	1	-	DFN2020-3
PDFN3-32	32.0	34.0	55.0	25.0	200nA	-	1	-	DFN-3
PESD1CAN	24.0	25.4	70.0	3.0	0.05	11	2	200	SOT-23
PESD1LIN	15.0, 24.0	17.2, 25.5	25.0, 40.0	1.0	0.001	14	1	200	SOD-323
PESD2CAN	24.0	25.4	60.0	4.0	0.05	11	2	230	SOT-23
PGBT Series	2.5 - 3.3	3.0 - 5.0	6.0	5.0	0.1	1.0	2P	500	DFN-10
PHS505/C Series	5.0 - 36.0	6.0 - 40.0	9.8 - 60.0	1.0	10 - 1	350 - 35	1	400 - 500	DFN-2
PHYTVSxxxV3	125 - 277	200 - 410	130 - 250	250	10	80	1	250	DFN-2KW
PHYTVSxxxV4	125-227	200-410	130-250	500	10	100	1	500	DFN-2KW
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
PLR0504PLCN	5.0	6.0	8.0	1.0	0.5	1.5	4	250	DFN-10
PLR0521	5.0	6.0	20.0	4.0	1	0.4	1	80	DFN-2
PLR0524P	5.0	6.0	9.0	6.0	0.5	0.7	4	-	DFN-10
PLR3304PLCN	3.3	4.0	15.0	17.0	0.1	1.5	4	250	DFN-10
PSDxx/C	3.3 - 36.0	-	6.5 - 60.0	1.0	125 - 1	500 - 35	1	500	SOD-323
PSLCxx/C	3.3 - 24.0	-	9.0 - 30.0	5.0	125 - 1	3	1	350	SOT-143
PSM712	7.0 - 12.0	-	11.0 - 19.0	1.0	20 - 1	75	1	600	SOT-23
PSM36A	36.0	39.0	52.0	25.0	0.2	250	1	2400	SOT-23
PSOTxx/C	3.3 - 36.0	-	6.5 - 51.0	1.0	125 - 1	500 - 60	1	500	SOT-23
PSR05	5.0	6.0	9.8	1.0	5	10	2	500	SOT-143
PSRDAxx-4	3.3 - 15.0	4.0 - 16.7	6.5 - 24.0	1.0	125 - 1	5	4	500	SO-8
PSRDAxx-4A	2.5 - 3.3	3.0 - 4.0	5.5 - 6.5	1.0	0.5	5	4	500	SO-8

1. *10/1000 μ s waveshape.

2. For detail about each voltage level, please refer to the product datasheet.

OVERVOLTAGE PART SPECIFICATIONS

PART NUMBER	STAND-OFF VOLTAGE V_{WM} VOLTS	BREAKDOWN VOLTAGE $V_{(BR)}$ VOLTS	CLAMPING VOLTAGE V_C VOLTS	PEAK PULSE CURRENT 8/20 μ s I_{PP} AMPS	MAXIMUM LEAKAGE CURRENT I_D μ A	TYPICAL CAPACITANCE C pF	NO. OF LINES	POWER 8/20 μ s WATTS	PACKAGE
PSRDAxx-6	3.3 - 5.0	4.0 - 6.0	6.5 - 9.8	1	120 - 20	5	6	500	SO-8
PSRDAxx-6A	2.5 - 3.3	3.6 - 4.0	5.5 - 6.5	1	0.5	5	6	500	SO-8
PTA03-3.3ULC	3.3	2.2	8.0	1	0.1	1.2	2	2000	SO-8
SKC Series	58.0 - 86.0	64.0 - 95.0	110 - 157.0	10kA	5	-	1	1600	SMT0-218
SM10KWE Series	10.0 - 48.0	11.1 - 53.0	17.0 - 77.4	588 - 129	15 - 8	-	1	10000*	DFN-2KW
SM15KWE Series	24.0 - 70.0	26.7 - 77.8	38.9 - 114.0	384 - 132	15 - 10	-	1	15000*	DFN-2KW
SM30KWE Series	16.0 - 345.0	17.8 - 380.0	26.0 - 560.0	1150 - 53.6	10 - 5	-	1	30000*	DFN-2KW
SMAJ Series	5.0 - 440.0	6.40 - 492.0	-	-	800 - 5	-	1	400*	DO-214AC
SMBJ Series	5.0 - 440.0	6.40 - 492.0	-	-	800 - 5	-	1	600*	DO-214AA
SMCJ Series	5.0 - 440.0	6.40 - 492.0	-	-	1000 - 5	-	1	1500*	DO-214AB
SMDAxxLC/LCC	3.3 - 24.0	-	7.0 - 43.0	1.0	125 - 1	15	4	500	SO-8
SMDB712C	7.0, 12.0	8.5, 13.3	25.5, 32.9	40.0, 34.0	10, 2	284	4	1600	SO-8
SMDJ Series	5.0 - 440.0	6.40 - 492.0	-	-	5000 - 2	-	1	3000*	DO-214AB
SRV05-4	5.0	6.0	15.0	5.0	5	2.5	4	500	SOT-23-6
SRV05-4LC	5.0	6.0	15.0	5.0	5	1.0	4	500	SOT-23-6
SRV25-4	2.5	3.0	7.4	10.0	0.5	1.7	4	800	DFN-10
SR2.8	2.8	3.0	5.0	1.0	1	4.5	2	300	SOT-143

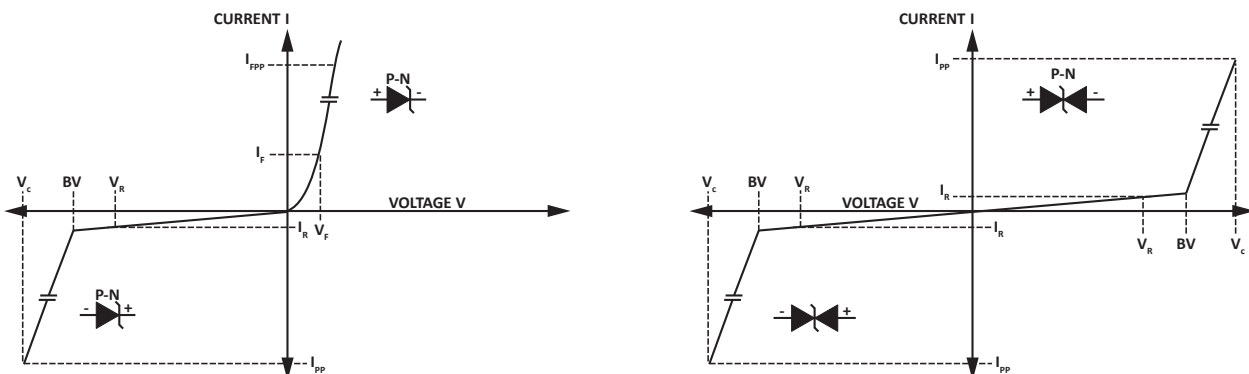
- *10/1000 μ s waveshape.
- For detail about each voltage level, please refer to the product datasheet.

SELECTION PROCESS

TVS PARAMETERS	APPLICATION PARAMETERS
Stand-Off Voltage (V_R) \geq	Operating Voltage (V_{OP})
Pulse Current (I_p) \geq	Transient Current (I_T)
Clamping Voltage (V_C) \leq	Voltage Withstand Level (V_{WS})
Input Capacitance of the Device \leq	Acceptable Line Loading for Functional Pass

Graph Symbols/Parameters
 B_V - Breakdown Voltage
 I_R - Leakage Current
 V_R - Reverse Stand-Off Voltage
 V_C - Clamping Voltage
 I_{PP} - Peak Pulse Current

Avalanche Junction TVS VI Characteristics



COMPANY PROFILE

In business more than 30 years, ProTek Devices™ is a privately held semiconductor company. The company offers a product line of overvoltage protection that include Transient Voltage Suppressor (TVS) Arrays, Steering Diode Array Hybrids, High-power Components and Modules, as well as Steering Diodes, EMI Filter/TVS Arrays and Thyristor Surge Suppressors. These components deliver circuit protection in electronic systems from numerous overvoltage events. They include lightning; electrostatic discharge (ESD); nuclear electromagnetic pulses (NEMP); inductive switching; and electromagnetic interference (EMI) / radio frequency interference (RFI). ProTek Devices is an ISO 9001 certified company.

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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.

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