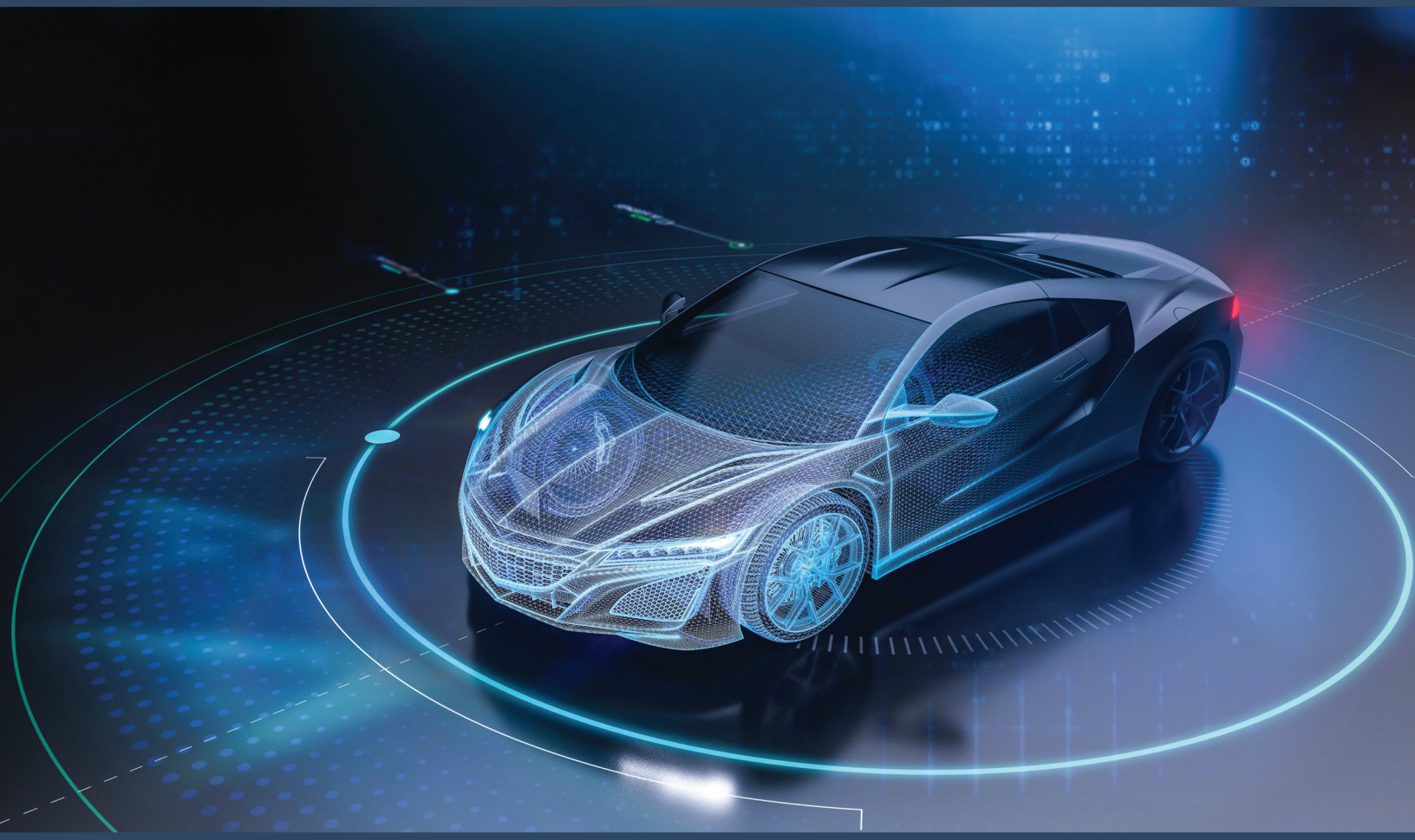
AUTOMOTIVE APPLICATIONS

ADVANCED CIRCUIT PROTECTION DEVICES FOR OVERVOLTAGE TRANSIENT EVENTS



PROTEK DEVICES®

ONLY ONE NAME MEANS PROTEK'TION™

Today's automobile has come a long way since the 1970s when the engine control unit (ECU) – also known as the power control module (PCM) – was first put into play. According to a recent New York Times article, modern cars now have from 30 to 100 microprocessor-controlled devices (ECUs) within. These devices have long been used to control everything from critical safety systems like brakes and airbags; to control convenience features like telematics and navigation. More and more automobiles come equipped with more and more advanced electronic control systems. However, they are not just being added as features but, also as requirements. For example, direct tire pressure monitoring systems (TPMS) are now required on all new cars sold in the EU. Newer systems now come standard with all types of comfort systems, such as heated / cooled seats and all types of safety systems, such as advanced driver assistance systems with collision avoidance and parking assist features.

Automotive manufacturers continue to turn to IC-based systems for new features and capabilities. With this trend, the need for more circuit protection for these systems also grows alongside. As noted, there are dozens of applications that need circuit protection. They include USB ports, Ethernet ports, CANBus and LINBus lines, antenna, display interfaces, power systems, fuel injection management systems, and many more. Electrical transients present a top critical risk to damaging these systems. Electrical transients also increase servicing and warranty costs for auto manufacturers. Therefore, proper circuit protection is an important factor of any automotive design process.

TRANSIENTS IN AUTOMOTIVE SYSTEMS

TIME DURATION	CAUSE	VOLTAGE AMPLITUDE	ENERGY LEVEL	FREQUENCY OF OCCURANCE
400ms	Load Dump (Disconnection of battery while at high charging)	< 202V	> 10J	Infrequent
Steady State	Failed Voltage Regulator	18V	-	Infrequent
< 320µs	Inductive Load Switching	80V to 300V	< 1J	Often
200ms	Alternator Field Decay	-100V to -40V	< 1J	Each Turn-Off
90ms	Ignition Pulse, Battery Disconnected	< 75V	< 0.5J	< 500Hz Infrequent
1ms	Harness Coupling	< 200V	< 1J	Often
< 60ns	Electrostatic Discharge	< 15kV	< 10mJ	Infrequent

There are also many mandatory safety systems requiring advanced electronic components while there is an ever-increasing reliance on electronic technologies within the automotive sector. There are many common transients in automotive systems that impact performance of the electronic systems. They can be generated from many different sources, from common electrostatic discharges to disconnecting a battery. Automotive designers of Infotainment, lighting, drive-train, body or chassis/safety groupings need to consider the circuit protection to combat these transients.

Automotive electronic systems design engineers should be aware of requirements set forth by the International Organization for Standardization (ISO). ISO 16750 is for road vehicles and covers environmental conditions and testing for electrical and electronic equipment. Released in 2010, ISO 16750-2 was prepared by Technical Committee ISO/TC 22 to replace ISO7637 for load dump, the pulse 5a and 5b portion. Further revisions to ISO 16750-2 were released in 2012. ISO 16750-2 applies to electric and electronic systems/components for road vehicles. It describes potential environmental stresses and specifies tests and requirements for the specific mounting location on/in the road vehicle. In 2020, ISO 21780 was introduced to cover the requirements and tests for the electric and electronic components in road vehicles equipped with an electrical system operating at a nominal voltage of 48 V DC. This standard included general requirements on 48 V DC electrical systems, voltage ranges along with slow voltage transients and fluctuations.

The Automotive Electronics Council (AEC-Q101) provides a discrete semiconductor qualification standard for automotive applications including circuit protection requirements: AEC-Q101-001 (electrostatic discharge [ESD] test - human body model); AEC-Q101-002 (ESD test -machine model); AEC-Q101-003 (wire bond shear test); AEC-Q101-004 (miscellaneous test methods such as unclamped inductive switching, dielectric integrity, and destructive physical analysis); and AEC-Q101-005 (ESD test - capacitive discharge model).

SELECTION GUIDE

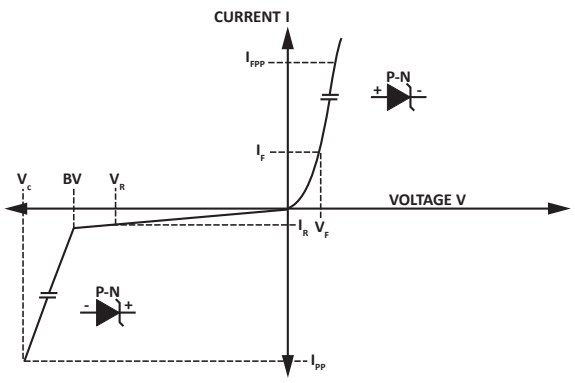
APPLICATION	PREFERED DEVICES	ALTERNATE DEVICES
Antenna	PAM02SD23xxC Series, PAM03SD23xxCI Series	PAM01SC7905C
Battery (Load Dump)	PAM28DOACxxA/CA Series, PAM29DOAAxxA/CA Series, PAM30DOAAxxA/CA Series, PAM31DOABxxA/CA Series, PAM32DOABxxA/CA Series, PAM33DOABxxA/CA Series, PAM35DOABxxA/CA Series, PAM36DOAAxxA/CA Series, PAM39SDxxAL/CAL Series, PAM40SDxxBL/CBL Series	PAM4SMA Series , PAM5S Series, PAM6S Series, PAM8S Series
CANBus Classic	PAM1CAN, PAM2CAN	PAM3CAN, PAM10ST23xxC Series
CANBus FD (Flexible Data)	PAM3CAN	
Control Buttons	PAM17DF2L05C	
Control Lines	PAM28DOACxxA/CA Series, PAM29DOAAxxA/CA Series, PAM30DOAAxxA/CA Series, PAM31DOABxxA/CA Series PAM32DOABxxA/CA Series, PAM33DOABxxA/CA Series, PAM39SDxxAL/CAL Series, PAM40SDxxBL/CBL Series	PAM21SC790501H, PAM4SMA Series
Display	PAM13ST2305	
GigabitE	PAM05SC700504F, PAM15ST4305	PAM12SO824
FlexRay Bus	PAM1CAN, PAM2CAN, PAM3CAN	PAM10ST23xxC Series
Fuel Injection System	PAM08SD23xx/C Series, PAM10ST23xxC Serie	
LinBus	PAM1LIN, PAM1VN27	PAM2LIN
Power Systems	PAM10ST23xxC Series, PAM5S Series, PAM6S Series, PAM7KSMDJ24CAP, PAM8S Series	PAM28DOACxxA/CA Series, PAM29DOAAxxA/CA Series, PAM30DOAAxxA/CA Series, PAM31DOABxxA/CA Series, PAM32DOABxxA/CA Series, PAM33DOABxxA/CA Series, PAM35DOABxxA/CA Series, PAM36DOAAxxA/CA Series,
USB 2.0	PAM05SC700504F, PAM15ST4305	

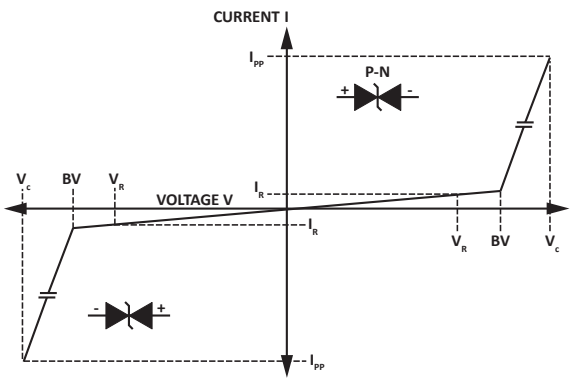
SELECTION PROCESS

TVS PARAMETERS	APPLICATION PARAMETERS
Stand-Off Voltage (V_R) ≥	Operating Voltage (V_{OP})
Pulse Current (I_p) ≥	Transient Current (I_T)
Clampling Voltage (V_C) ≤	Voltage Withstand Level (V_{WS})
Input Capacitance of the Device ≤	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





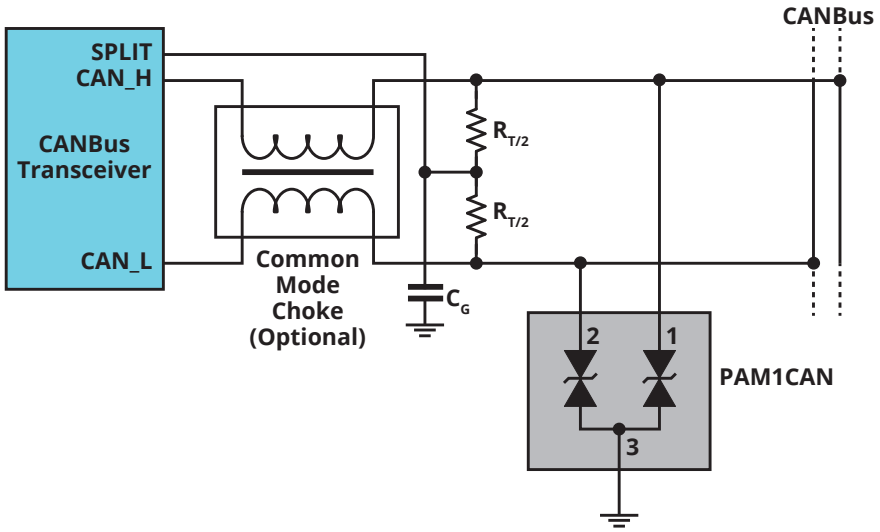


Figure 1. CANBus Protection Using PAM1CAN

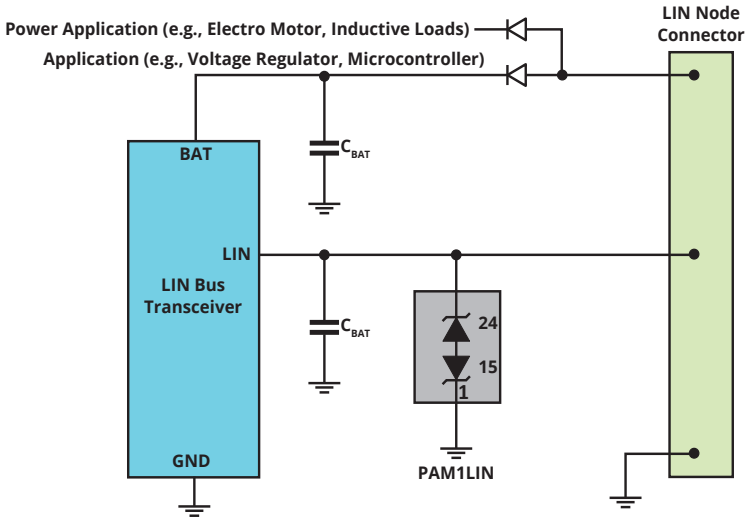


Figure 2. LINBus Protection Using PAM1LIN

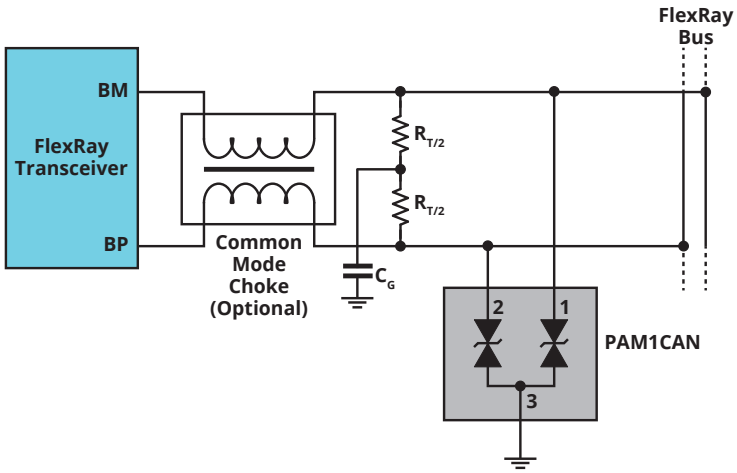


Figure 3. FlexRay Bus Protection Using PAM1CAN

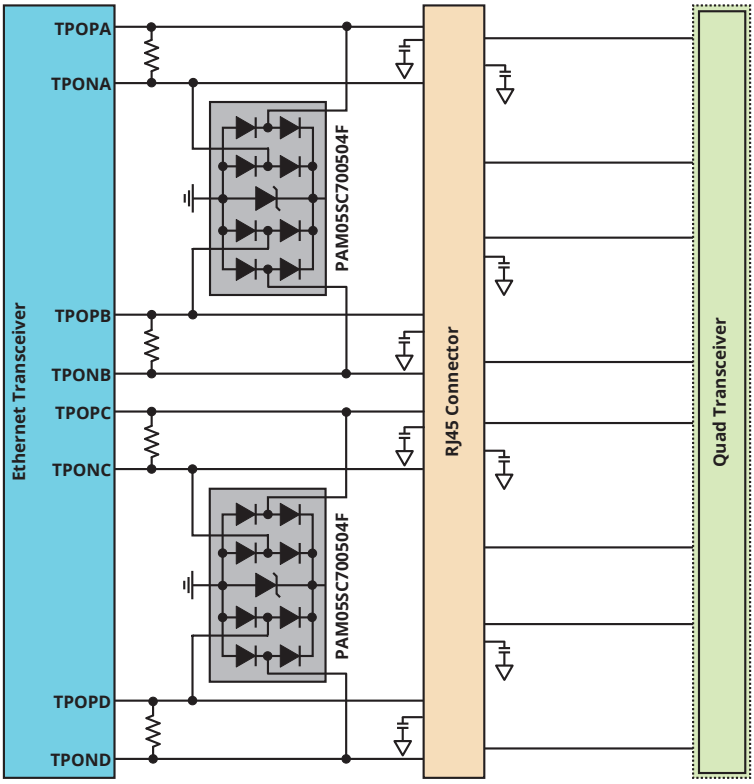


Figure 4. GigabitE Interface Protection Using PAM05SC700504F

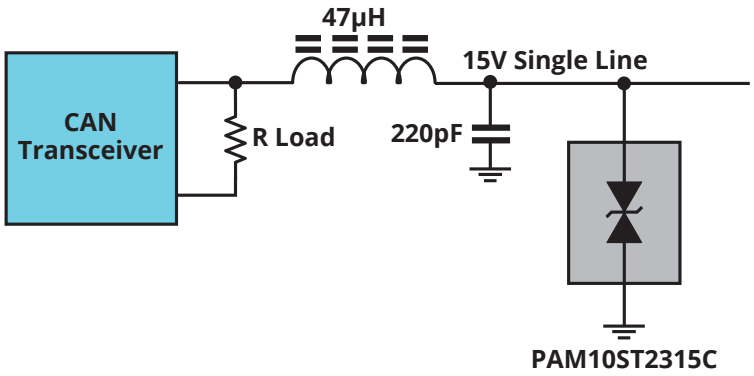


Figure 5. CANBus Protection Using PAM10ST2315C

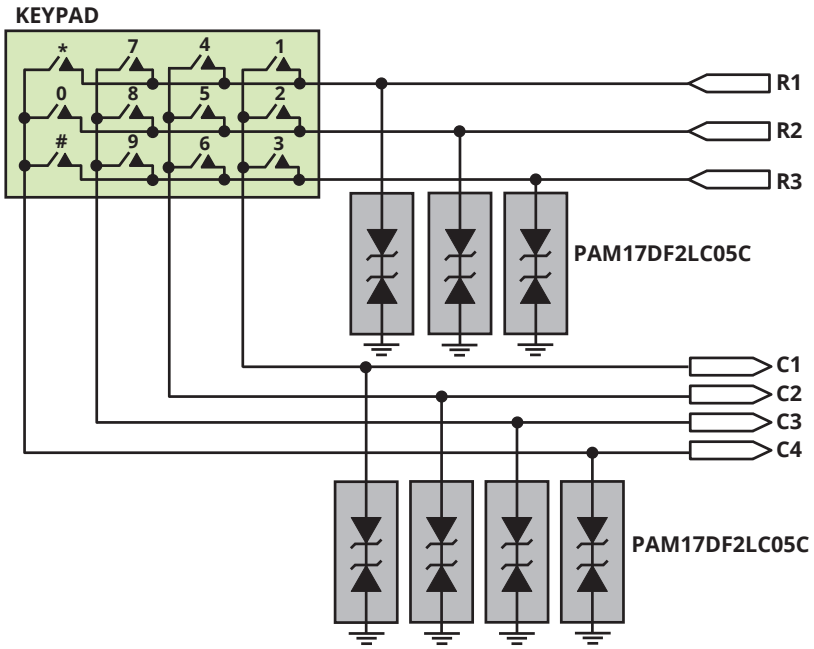


Figure 6. Control Button Protection Using PAM17DF2LC05C

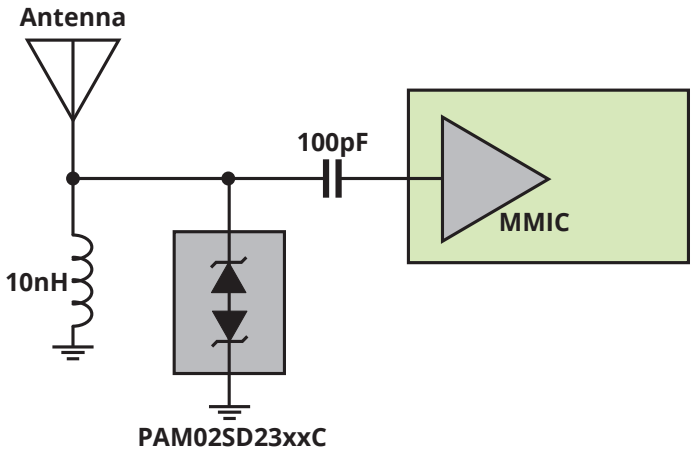


Figure 7. Antenna Protection Using PAM02SD23xxC Series

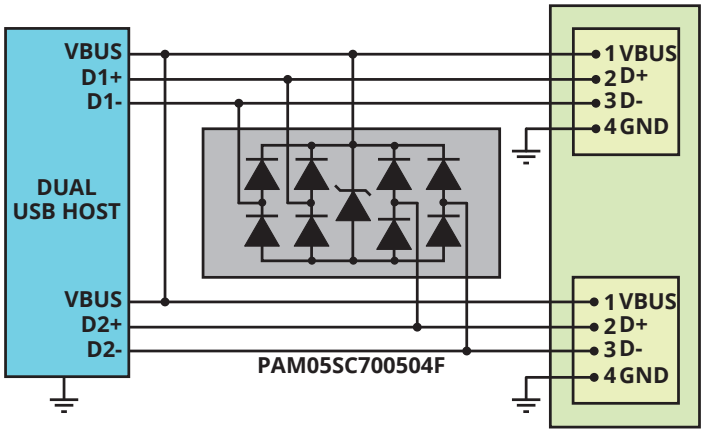


Figure 8. USB 2.0 Interface Protection Using PAM05SC700504F

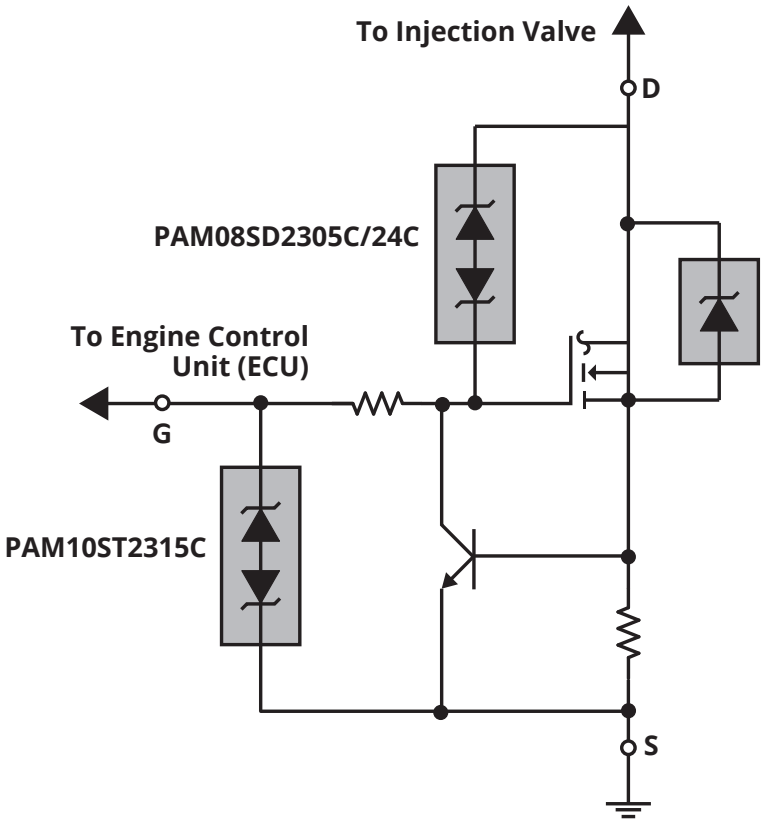


Figure 9. Fuel Injection Management System Protection Using PAM08SD2305C, PAM08SD2324C and PAM10ST2315C

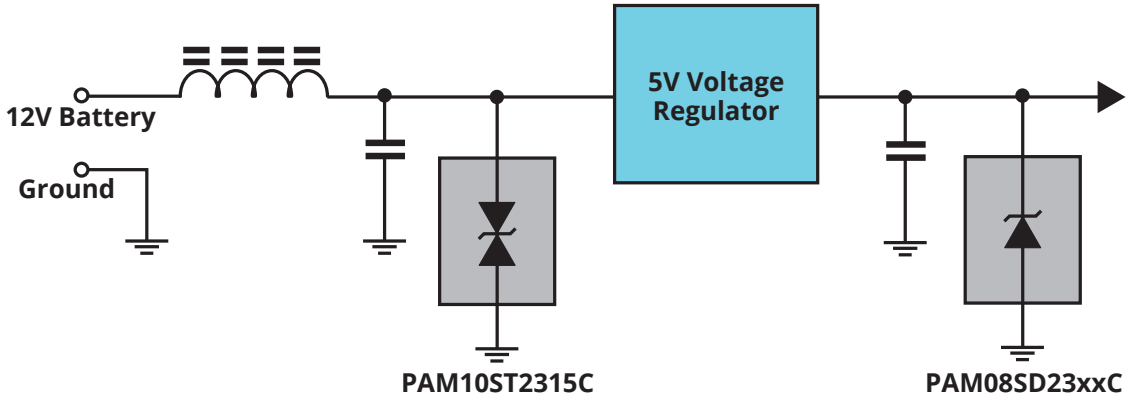


Figure 10. Power Systems Protection Using PAM10ST2315C and PAM08SD23xxC Series

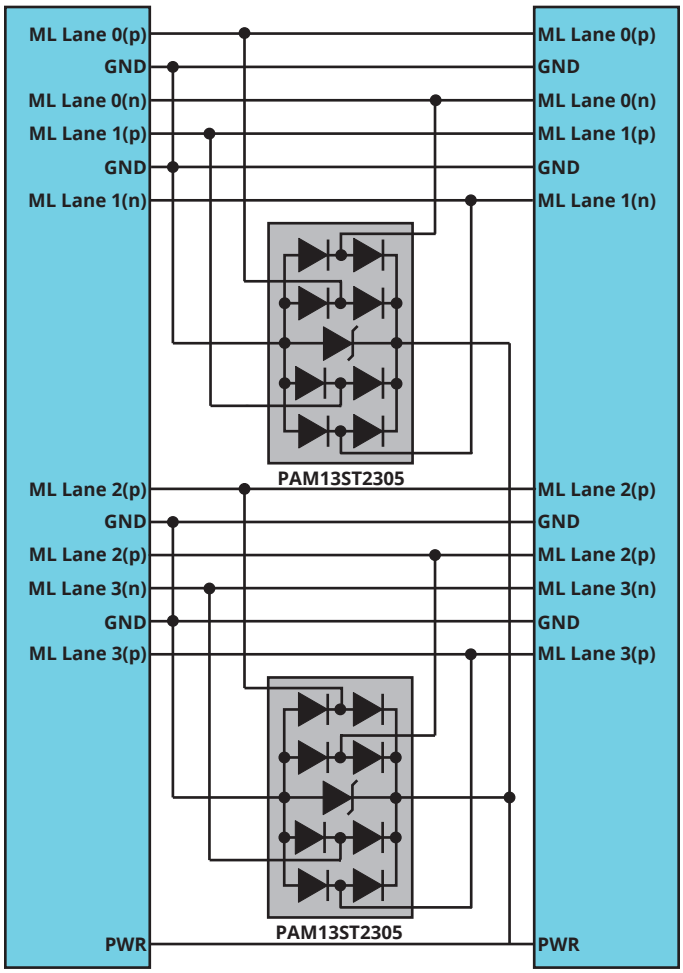


Figure 11. Display Protection Using PAM13ST2305

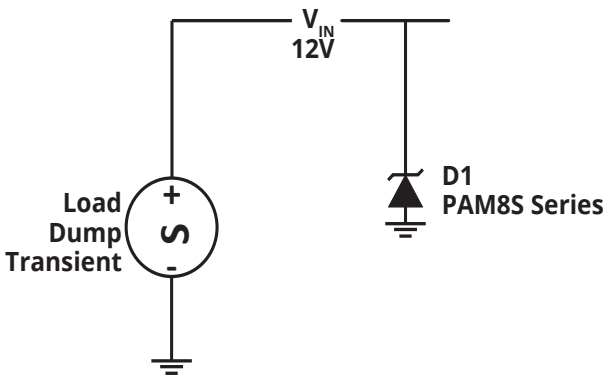


Figure 12. Battery (Load-Dump) Protection Using PAM8S Series

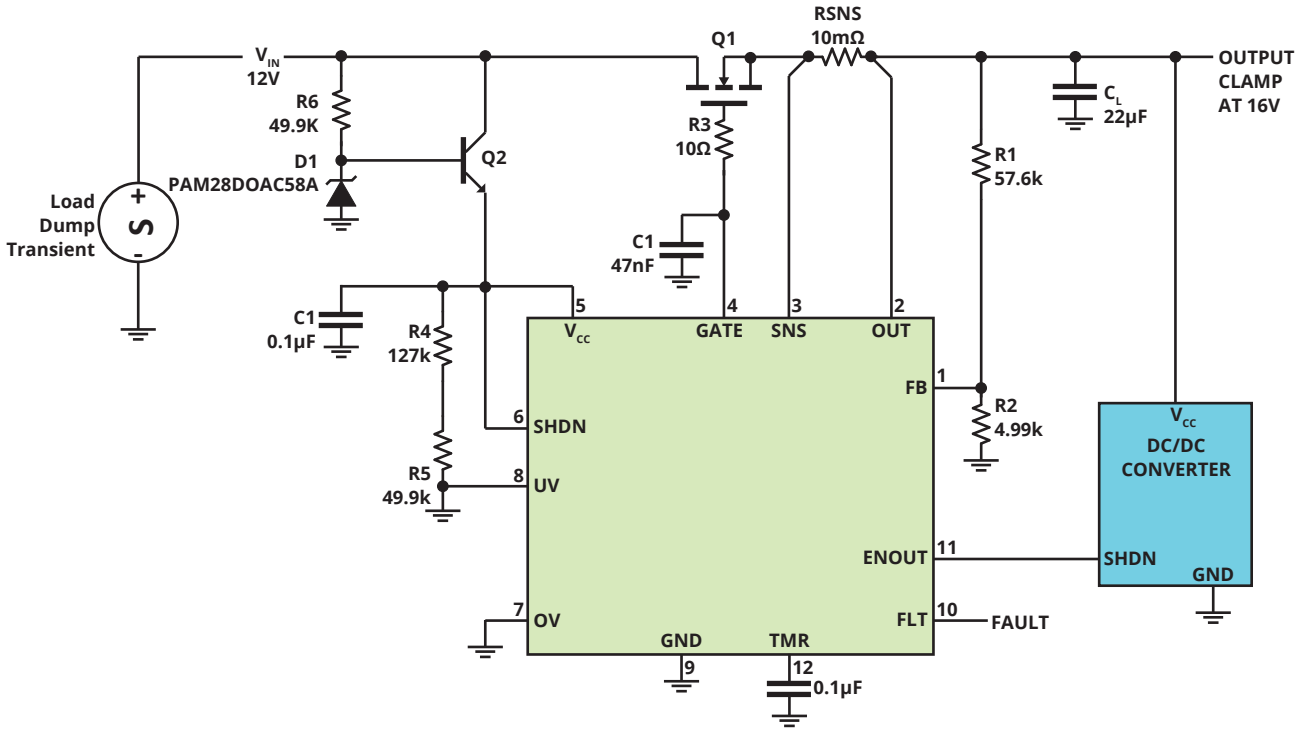


Figure 13. Battery (Load-Dump) Protection Using PAM28DOAC58A

OVERVOLTAGE PART SPECIFICATIONS

PART NUMBER	STAND-OFF VOLTAGE V_{WM} VOLTS	BREAKDOWN VOLTAGE $V_{(BR)}$ VOLTS	CLAMPING VOLTAGE V_C VOLTS	PEAK PULSE CURRENT 8/20µs I_{PP} AMPS	MAXIMUM LEAKAGE CURRENT I_D µA	TYPICAL CAPACITANCE C pF	NO. OF LINES	POWER 8/20µs WATTS	PACKAGE
PAM01SC7905C	5.0	6.0	16.0	10.0	1	1.5	1	200	SC-79
PAM02SD23xx/C	3.3-24.0	4.0-26.7	7.0-43.0	1.0	5-1	3	1	350	SOD-323
PAM03SD23xxCI	3.0-18.0	4.0-20.0	7.0-29.0	1.0	5-1	0.6	1	250	SOD-323
PAM05SC700504F	5.0	6.0	25.0	5.0	3	1.9	4	200	SC70-6L
PAM08SD23xx/C	3.3-36.0	4.0-40.0	6.5-60.0	1.0	125-1	500-35	1	400/500	SOD-323
PAM1CAN	24.0	25.4	70.0	3.0	0.05	11	2	200	SOT-23
PAM1IVN27	27.0	28.0	37.0	3.0	0.1	15	1	135	SOD-323
PAM1LIN	15.0/24.0	17.2/25.5	25.0/40.0	1.0	45	17	1	200	SOD-323
PAM2CAN	24.0	25.4	60.0	4.0	0.05	11	2	230	SOT-23
PAM2LIN	24.0	26.7	43.0	1.0	0.05	3.3	1	350	SOD-323
PAM3CAN	24.0	25.4	46.0	2.1	0.2	5	1	150	SOT-23
PAM4SMA	11.1 - 470.3	12.4 - 522.5	18.2 - 759.0	22.5 - 0.53	1	-	1	400*	DO-214AC
PAM5Sxx	14.0-36.0	15.6-40.0	23.2-58.1	155-62	10	-	1	3600*	DO-218AB
PAM6Sxx	14.0-36.0	15.6-40.0	23.2-58.1	198-79	10	-	1	4600*	DO-218AB
PAM7KSMDJ24CAP	24.0	26.7	28.0	200	1	-	1	7000*	DO-214AB
PAM8Sxx	14.0-43.0	15.6-47.8	23.2-69.4	284-95.1	10	-	1	6600*	DO-218AB
PAM10ST23xxC	8.0-24.0	8.5-26.7	16.9-49.0	34.0-12.0	10-1	150-63	1	500	SOT-23
PAM11KLD8S24CAP	24.0	26.7	26.0	300.0	10	-	1	1100*	DO-218AB
PAM12SO824	2.8	3.0	21.0	30.0	10	3	2P	600	SO-8
PAM13ST2305	5.0	6.0	15.0	5.0	5	3.5	4	500	SOT-23-6
PAM15ST4305	5.0	6.0	20.0	28.0	5	10	2	500	SOT-143
PAM17DF2LC05C	4.7	5.7	-	-	1	15	1	10*	DFN-2
PAM21SC790501H	5.0	6.0	12.5	16.0	5	120	1	250	SC-79
PAM28DOACxxA/CA	12.0-120	13.3-147.0	19.9-193.0	20.1-2.1	1	-	1	400*	DO-214AC
PAM29DOAAxxA/CA	24.0-36.0	26.7-40.0	38.9-58.2	15.4-10.3	1	-	1	600*	DO-214AA
PAM30DOAAxxA/CA	5.8-513.0	6.46-570.0	10.5-828.0	57.1-0.72	1	-	1	600*	DO-214AA
PAM31DOABxxA/CA	24.0-33.0	26.7-36.7	38.9-53.3	38.6-28.1	1	-	1	1500*	DO-214AB
PAM32DOABxxA/CA	36.0	40.0	58.1	51.6	2	-	1	3000*	DO-214AB
PAM33DOABxxA/CA	24.0-36.0	26.7-40.0	43.0-58.1	117-86.9	5	-	1	5000*	DO-214AB
PAM35DOABxxA/CA	5.8 - 256.0	6.45 - 285.0	10.5 - 414.0	144.8 - 3.7	1	-	1	1500*	DO-214AB
PAM36DOAAxxA/CA	18.0 - 36.0	20.0 - 40.0	29.2 - 58.1	34.3 - 17.3	1	-	1	1000*	DO-214AA
PAM39SDxxAL/CAL	10.0 - 85.0	11.10 - 94.4	17.0 - 137.0	23.5 - 2.9	1	-	1	400*	SOD-123
PAM40SDxxBL/CBL	10.0 - 220.0	11.10 - 246.0	17.0 - 356.0	11.8 - 0.5	1	-	1	200*	SOD-123

Notes
1. I_{PP} and P_{PP} 10/1000µs.

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.