



# AUTOMOTIVE APPLICATIONS



 **PROTEK<sup>®</sup>**  
**DEVICES**  
ONLY ONE NAME MEANS PROTEK'TION™

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



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.

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

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.

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.

SELECTION GUIDE		
APPLICATION	PREFERRED DEVICES	ALTERNATE DEVICES
Antenna	PAM02SD23xx/C Series, PAM03SD23xxCI Series	PAM01SC7905C, PAM18DF2L0521, PAM19DF2L0521P
Battery (Load Dump)	PAM28DOACxxA/CA Series, PAM29DOAAxxA/CA Series, PAM30DOAAxxA/CA Series, PAM31DOABxxA/CA Series, PAM32DOABxxA/CA Series, PAM33DOABxxA/CA Series, PAM5S Series, PAM6S Series, PAM8S Series	PAM16AL30A
CANBus	PAM1CAN, PAM2CAN	PAM04ST430502, PAM10ST23xxC Series
Control Buttons	PAM17DF2L05C	
Control Lines	PAM28DOACxxA/CA Series, PAM29DOAAxxA/CA Series, PAM30DOAAxxA/CA Series, PAM31DOABxxA/CA Series, PAM32DOABxxA/CA Series, PAM33DOABxxA/CA Series	PAM21SC790501H
Display Interfaces	PAM13ST2305	PAM04DF100524, PAM24DF1605
Ethernet	PAM05SC700504F	PAM11SO803, PAM12SO824
FlexRay Bus	PAM1FLEX	PAM10ST23xxC Series
Fuel Injection System	PAM08SD23xx/C Series, PAM10ST23xxC Series	
HDMI	PAM04DF100524	
LINBus	PAM1LIN	PAM2LIN
Power Systems	PAM09SD2305HP, PAM10ST23xxC Series, PAM5S Series, PAM6S Series, PAM8S Series	PAM25DF25Kxx Series, PAM28DOACxxA/CA Series, PAM29DOAAxxA/CA Series, PAM30DOAAxxA/CA Series, PAM31DOABxxA/CA Series, PAM32DOABxxA/CA Series, PAM33DOABxxA/CA Series
USB	PAM05SC700504F	PAM04DF100524, PAM04ST430502

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.

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).

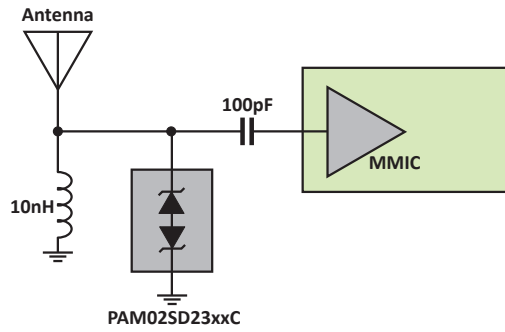


Figure 1. Antenna Protection Using PAM02SD23xxC Series

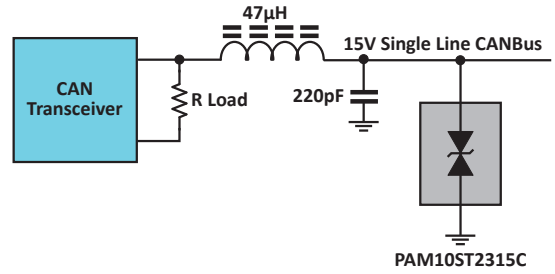


Figure 2. CANBus Protection Using PAM10ST2315C

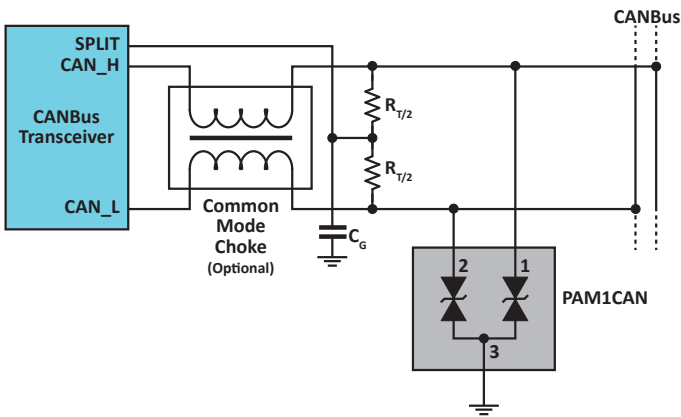


Figure 3. CANBus Protection Using PAM1CAN

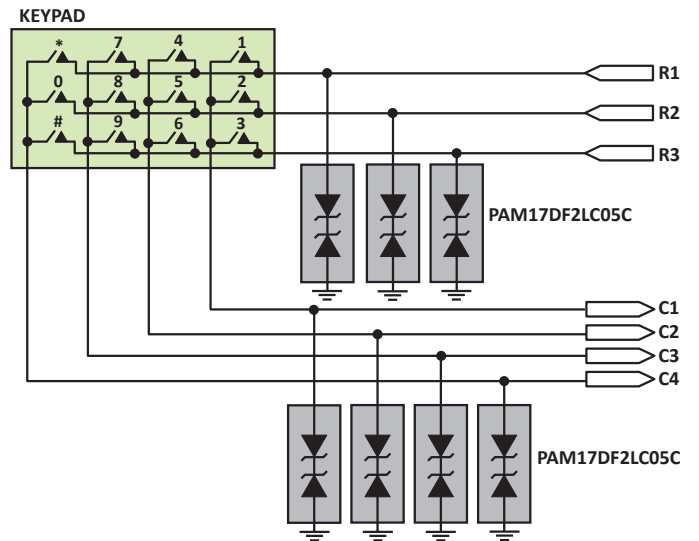


Figure 4. Control Button Protection Using PAM17DF2LC05C

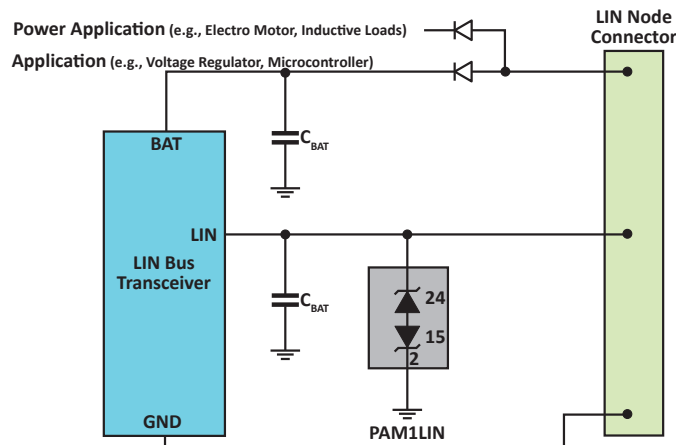


Figure 5. LINBus Protection Using PAM1LIN

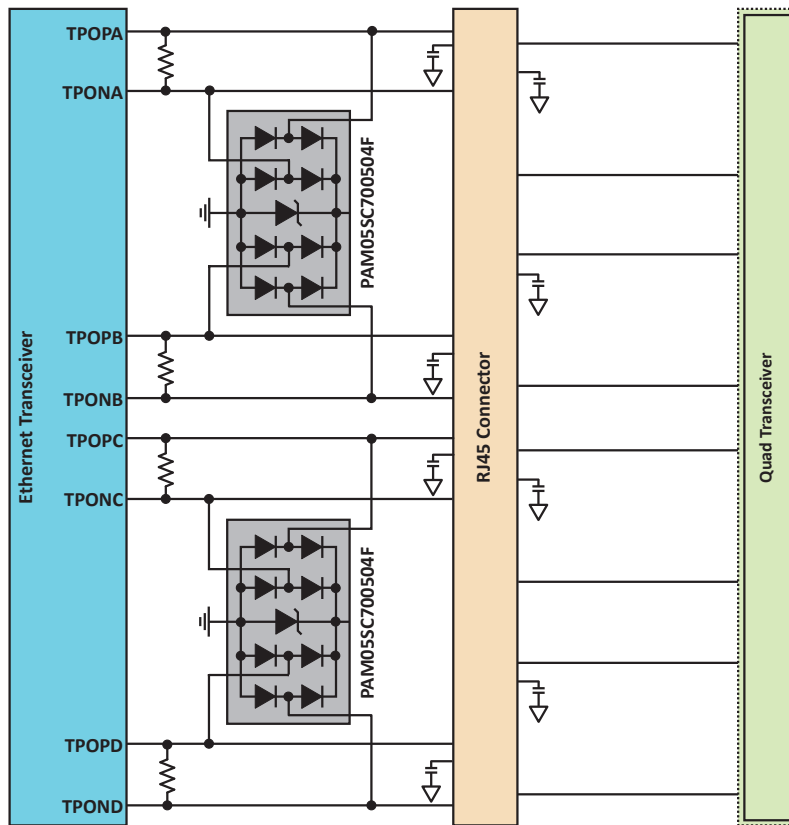


Figure 6. GigabitE Interface Protection Using PAM05SC700504F

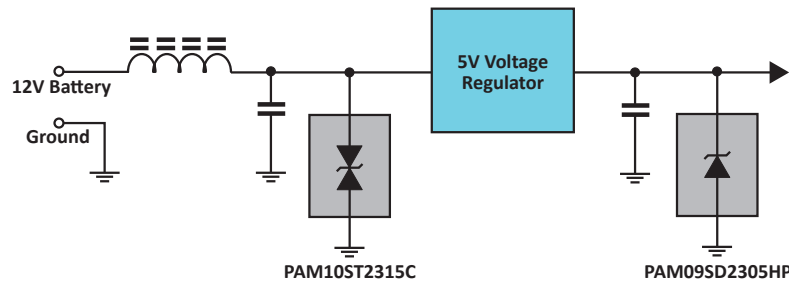


Figure 7. Power Systems Protection Using PAM10ST2315C and PAM09SD2305HP

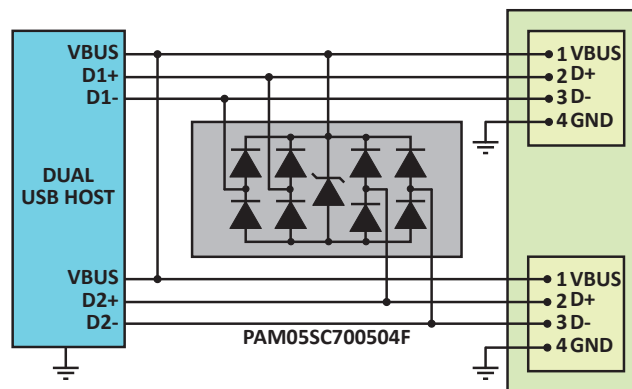


Figure 8. USB 2.0 Interface Protection Using PAM05SC700504F

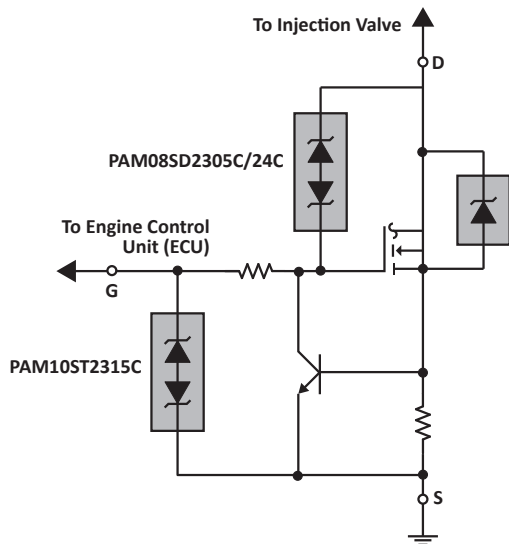


Figure 9. Fuel Injection Management System Protection Using PAM08SD2305C, PAM08SD2324C and PAM10ST2315C

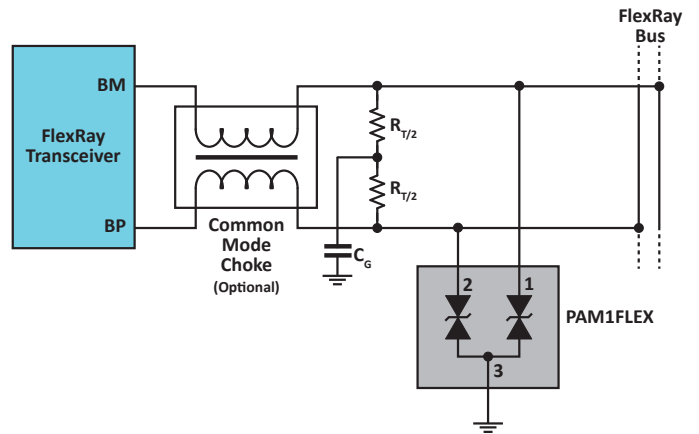


Figure 10. FlexRay Bus Protection Using PAM1FLEX

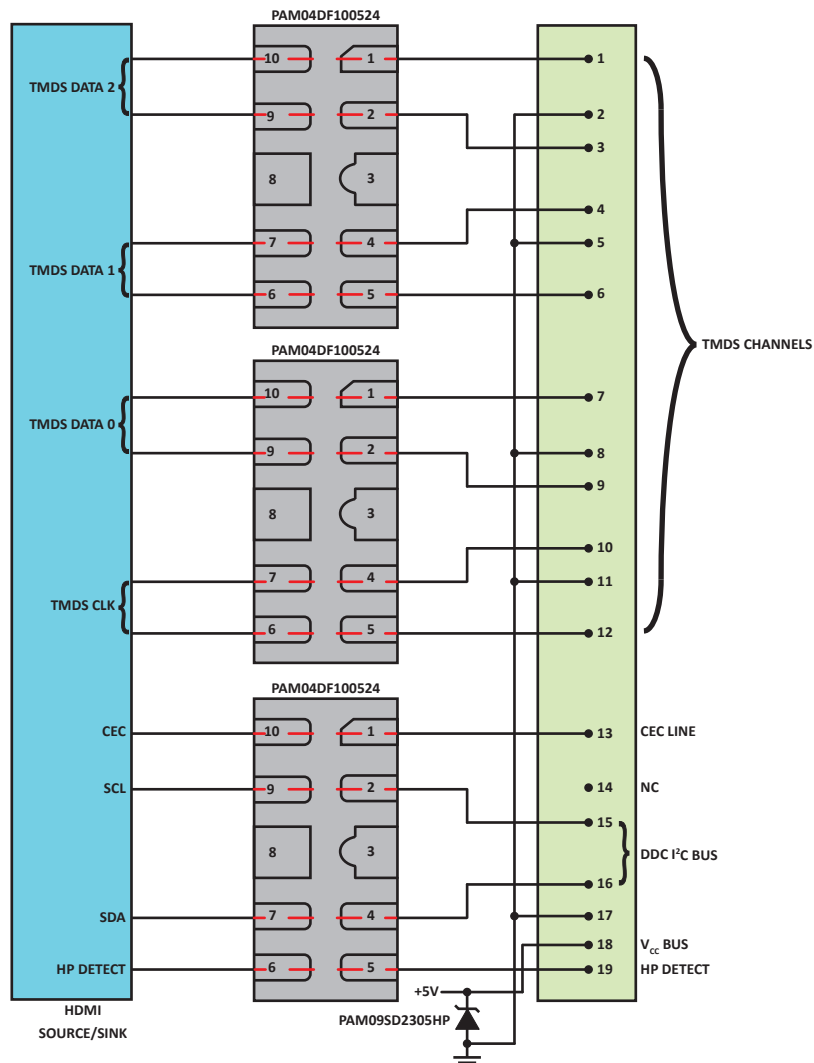


Figure 11. HDMI Protection Using PAM04DF100524

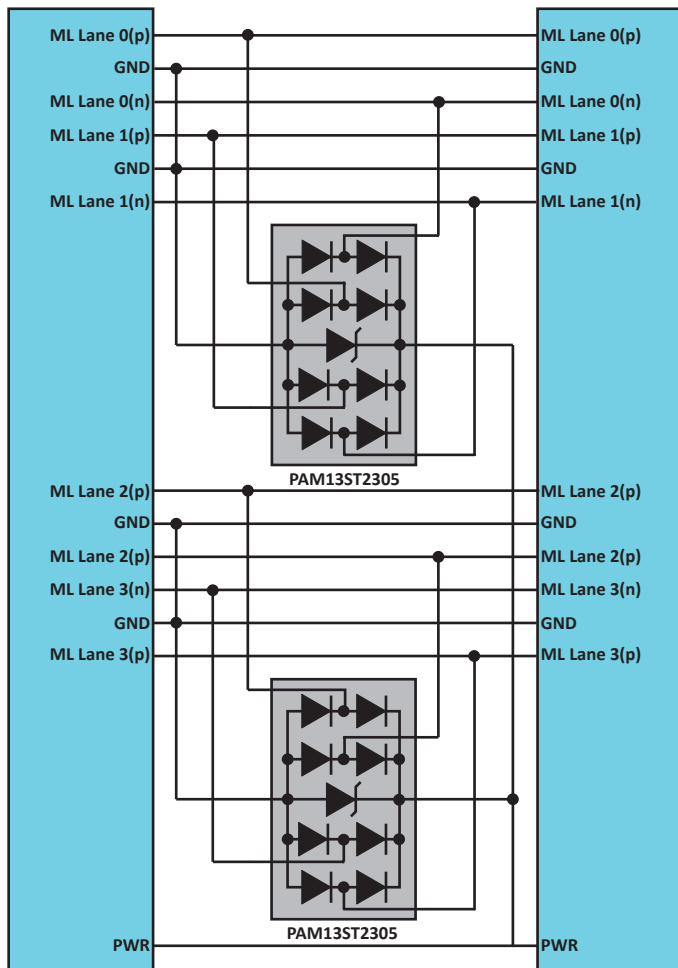


Figure 12. Display Protection Using PAM12ST2305

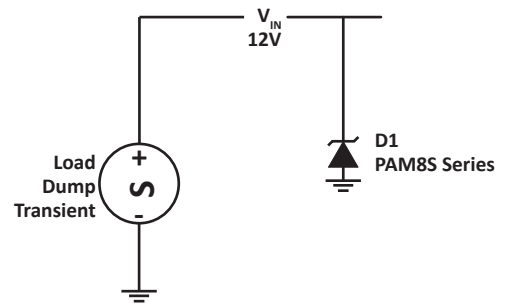


Figure 13. Battery (Load-Dump) Protection Using PAM8S Series

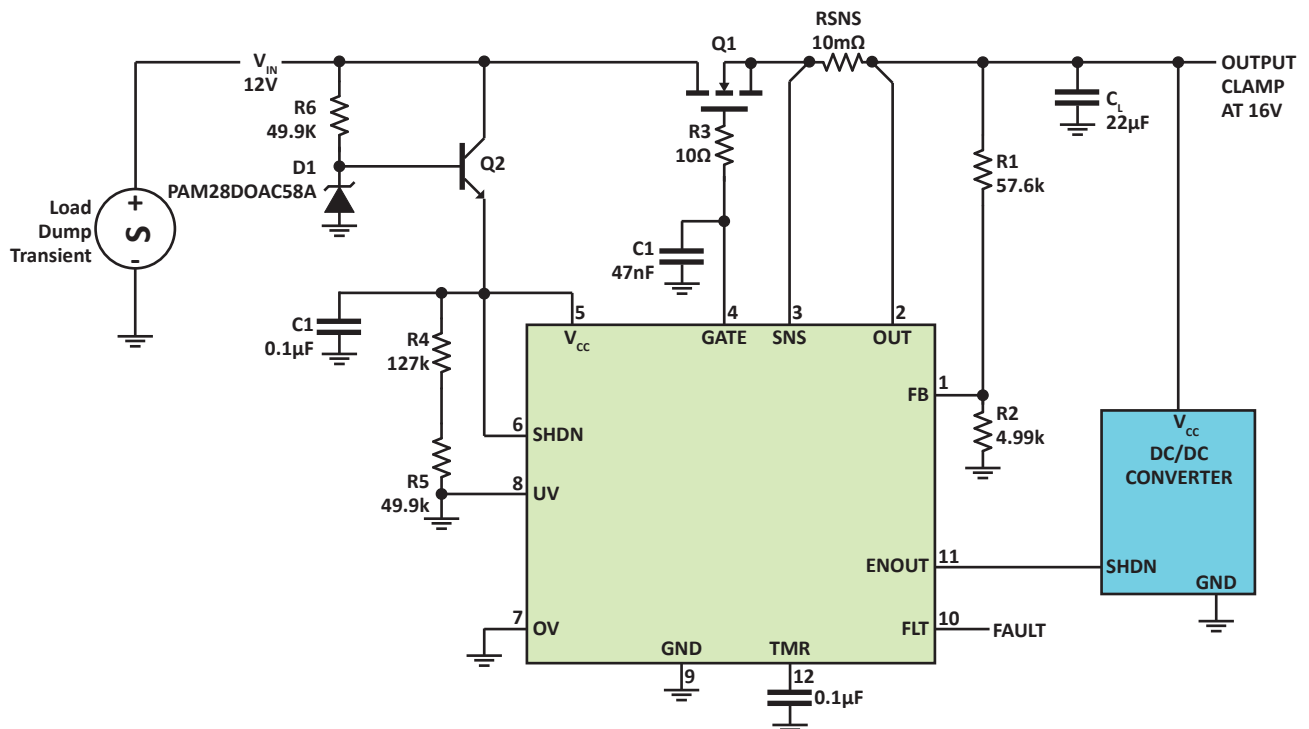


Figure 14. Battery (Load-Dump) Protection Using PAM28DOAC58A

## OVERVOLTAGE PART SPECIFICATIONS

PART NUMBER	STAND-OFF VOLTAGE	BREAKDOWN VOLTAGE	CLAMPING VOLTAGE	PEAK PULSE CURRENT 8/20µs	MAXIMUM LEAKAGE CURRENT	TYPICAL CAPACITANCE	NO. OF LINES	POWER 8/20µs	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> µA	C pF		WATTS	
PAM01SC7905C	5.0	6.0	16.0	10.0	1	1.5	1	200	SC-79
PAM1CAN	24.0	25.4	70.0	3.0	0.05	11	2	200	SOT-23
PAM1FLEX	24.0	25.4	70.0	3.0	0.05	11	2	200	SOT-23
PAM1LIN	15.0/24.0	17.2/25.5	25.0/40.0	1.0	45	17	1	200	SOD-323
PAM02SD23xx/C	3.3-24.0	4.0-26.7	7.0-43.0	1.0	5-1	3	1	350	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
PAM03SD23xxCI	3.0-18.0	4.0-20.0	7.0-29.0	1.0	5-1	0.6	1	250	SOD-323
PAM04DF100524	5.0	6.0	12.0	1.0	0.5	0.7	4	150	DFN-10
PAM04ST430502	5.0	6.0	20.0	10.0	1	0.6	1	200	SOT-543
PAM05SC700504F	5.0	6.0	25.0	5.0	3	1.9	4	200	SC70-6L
PAM5Sxx	14.0-36.0	15.6-40.0	23.2-58.1	155-62	10	-	1	3600*	DO-218AB
PAM06SC7905S	4.7	5.7	-	-	0.5	30	1	10*	SC-79
PAM6Sxx	14.0-36.0	15.6-40.0	23.2-58.1	198-79	10	-	1	4600*	DO-218AB
PAM07DF23K24	24.0	26.7	43.0	69.8	3	-	1	3000*	DFN2-KW
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
PAM8Sxx	14.0-43.0	15.6-47.8	23.2-69.4	284-95.1	10	-	1	6600*	DO-218AB
PAM09SD2305HP	5.0	6.0	15.0	72.0	20	800	1	1000	SOD-323
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
PAM11SO803	3.0	2.8	18.0	100.0	2	12	1	1800	SO-8
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
PAM14ST6305LCC	5.0	6.0	12.0	2.0	1	9	4-5	25	SOT-563
PAM15ST4305	5.0	6.0	20.0	28.0	5	10	2	500	SOT-143
PAM16AL30A	30.0	33.3	50.7	296.0	15	-	1	15000*	AXIAL
PAM17DF2LC05C	4.7	5.7	-	-	1	15	1	10*	DFN-2
PAM18DF2LC0521	5.0	6.0	20.0	4.0	1	0.4	1	80	DFN-2
PAM19DF2L0521P	5.0	6.0	20.0	1.0	1	0.6	1	20	DFN-2
PAM20ST6305	5.0	6.0	12.0	9.0	1	40	4-5	100	SOT-563
PAM21SC790501H	5.0	6.0	12.5	16.0	5	120	1	250	SC-79
PAM24DF1605	5.0	6.0	-	-	0.1	30	8	-	DFN-16
PAM25DF25Kxx	33.0	36.8	53.3	94.0	8	-	1	5000*	DFN2-KW
PAM26SD2305	5.0	6.0	9.8	1.0	10	350	1	500	SOD-323
PAM27ST2324LC	24.0	26.7	43.0	1.0	1	5	1	500	SOT-23
PAM28DOACxxA/CA	12.0-120	13.3-147.0	19.9-193.0	20.1-2.1	1	-	1	400*	DO-214AC
PAM29DOAxxA/CA	24.0-36.0	26.7-40.0	38.9-58.2	15.4-10.3	1	-	1	600*	DO-214AA
PAM30DOAxxA/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

**Notes**

1. I<sub>pp</sub> and P<sub>pp</sub> 10/1000µs.

## COMPANY INFORMATION

In business more than 20 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).

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All devices, with the exception the PAM16AL30A(RoHS, exemption #7) 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)

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