Littelfuse 功率和保护器件简介及在工业产品中的应用

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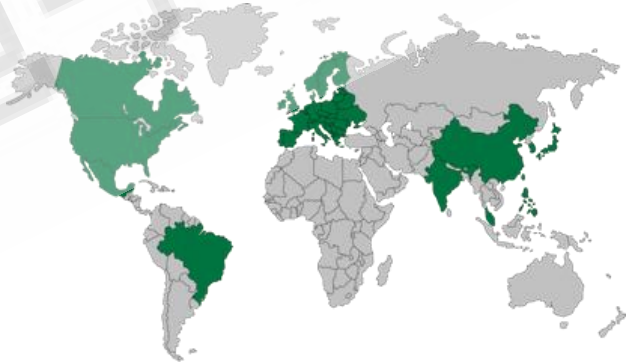
Littelfuse

Expertise Applied | Answers Delivered

From Small Beginnings Through Decades of Innovation

- Founded in 1927
- Introduced many innovative, industry-first technologies
- Today
  - Designer, manufacturer, and seller of components and modules for circuit protection, power control, and sensing
  - 11,000+ dedicated and innovative employees
  - 1,000+ Engineers for new material and process design
  - Publicly held—NASDAQ: LFUS
  - More than 40 locations worldwide:
    - Americas
    - Europe
    - Asia



Protect | Control | Sense — A Global Approach

Protect

- Today's sophisticated electronics require greater protection from ESD, power surges and other occurrences
- Handle more power in smaller products
- Innovative circuit protection solutions

Control

- Safely and efficiently control power in even the harshest environments
- Limit equipment damage and minimize electrical hazards
- Improve productivity and reduce costs

Sense

- Sensing technologies are increasingly used to support complex electronic systems
- Broad platform of technologies help improve product performance, comfort, convenience and safety

Protect | Control | Sense — solutions for many markets

Automotive

Appliances

Building Automation

Datacenter & Cloud

EV Infrastructure

Consumer Electronics

Industrial

LED Lighting

Mobile & Wearable

Renewable Energy

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Protection: helping make products safer & reduce TCO


Fuses


Polymeric PTCs


GDTs


LED Protection


MOV/MLV


Thyristors


Polymer ESD


Surge Protection Module


TVS Diode/Diode Arrays

- Broadest protection technology portfolio with many industry-first solutions.
- Independent testing capabilities to for compliance with industry and national standards including: UL, IEC, ITU, AEC-Q, and others.
- Application knowledge to help our customers address functional requirements and regulatory compliance.

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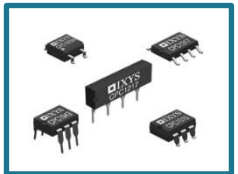
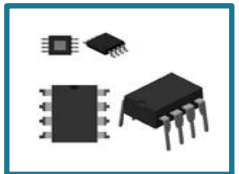
TCO: Total Cost of Ownership
PPTC: Polymeric Positive Temperature Coefficient
ESD: Electrostatic Discharge
TVS: Transient Voltage Suppression

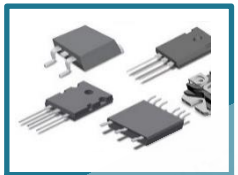
MOV: Metal Oxide Varistors
MLV: Multi-Layer Varistors
GDT: Gas Discharge Tubes

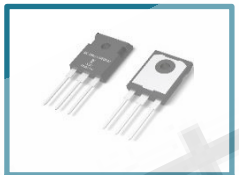
Control: broad power semiconductors offering

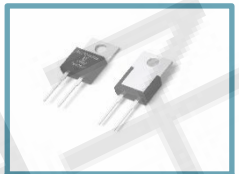

Solid State Relays

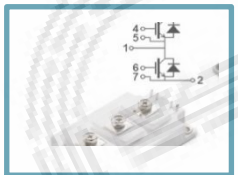

Gate Drivers

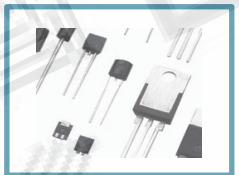

Ignition IGBT

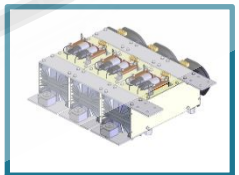

IGBT Discrete


MOSFET SiC/Discrete


SiC/Si: Schottky,FRED


Power Modules


Power Thyristor


High Power (Stacks, Disc)

- Leading Silicon and SiC technologies spanning a wide range of power needs.
- Broad offering of components & modules packaging options: standard and application-specific.
- Customer-centric focus: design, test, and application engineering support

IGBT: Insulated-gate Bipolar Transistor
SSR: Solid State Relays

FRED: Fast Recovery Epitaxial Diodes
SiC: Silicon Carbide

Sensing: standard and customized solutions


Reed Switch

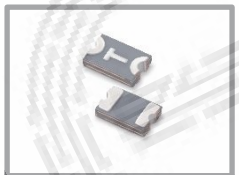

Hall effect sensors


Custom sensor Magnetic


NTCs


RTDs


Custom sensor Temperature


Digital Temperature Indicators setP™


RTP Mini


Thermal Breaker

- Comprehensive range of temperature and magnetic sensing technologies; portfolio of standard and custom products.
- Recognized for highly reliable sensing solutions for use in automotive, appliance, industrial, and other applications.
- Custom sensor design support: deep applications know-how, and magnetitic & mechanical modeling.

NTC: Negative Temperature Coefficient
RTD: Resistance Temperature Detector

PTC: Positive Temperature Coefficient
RTP: Reflowable Thermal Protection

Global Labs — Designing and Validating Next-Generation Products and Solutions

- Network of global labs and design centers
  - High Power Labs
  - Semiconductor Application Labs
  - Product Evaluation, Reliability and Applications Labs
  - Materials Labs
- Combine comprehensive testing capabilities with consultation
- Robust circuit protection testing
- Simulate harsh environments
- Analyze sensing technologies
- Assure high performance, reliability, safety and regulatory compliance

Reed Switch and OC Protection Solutions

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Expertise Applied | Answers Delivered

Reed Switch Standard Products

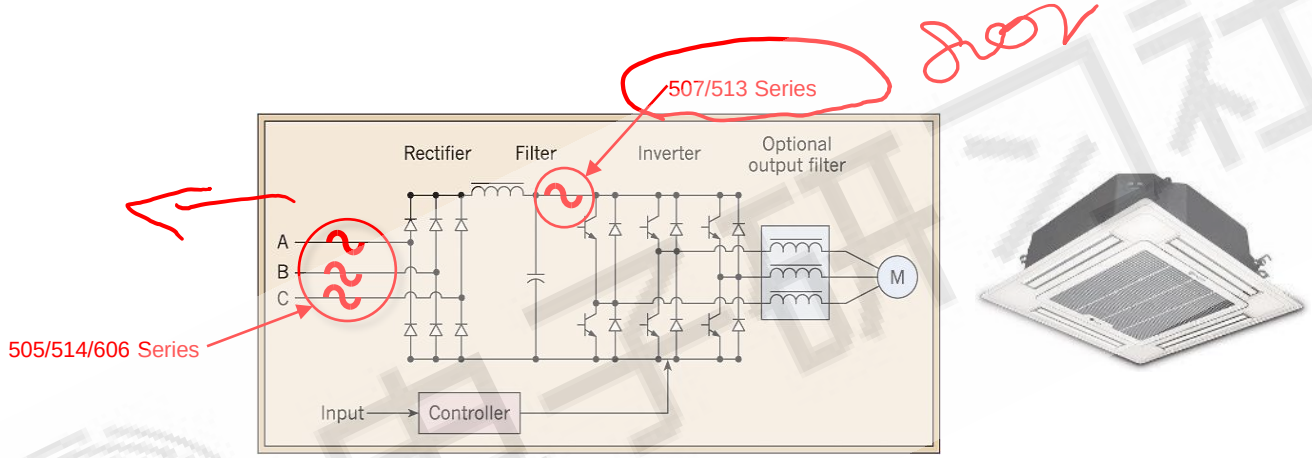
Standard Products	Speed and Direction	Safety	Utilities and Fluid Management
▪ Reed switches ▪ Reed relays ▪ Catalog sensors	▪ Automatic transmission speed sensors ▪ Actuator position ▪ Gear shifter position ▪ Cam & crank sensors ▪ Fan speed sensing	▪ Seatbelt buckle and tension sensors ▪ Crash sensors ▪ Seat position sensing	▪ Remote utility meter reading counters & tamper detection ▪ Industrial sensors ▪ Fluid level sensors

Reed Switches

Reed Relays

Sensors

Commercial Air Conditioning Application



- For commercial air conditioning application, the input current can be up to 40A/50A with single-phase or three-phase voltage, our 500Vac rated 505/514/606 series are good protection solutions at main input side
- The rectified voltage can be up to 650Vdc, our 650Vdc rated 507 series and 800Vdc rated 513 series are good solutions for the fan motor protection

AC Fuse Solutions

	505 Series	514 Series	606 Series
Photo			
Fuse Dimensions	6x32mm	6x32mm	10x32mm
Voltage Rating	500Vac/dc	500Vac	500Vac
Breaking Capacity	30KA @500Vac 20KA @500Vdc	5KA @500Vac	2KA @500Vac
Current Rating	c UL us	c UL us 12.5A	c UL us 40-63A
Agency Approval			

380V

606 Series – Product Overview

Product Family/Package

- 10x32mm Cartridge Fuse Product Family
- Through-hole Fuse

Series Ratings/Type

- **High voltage /current Cartridge Fuse in the smallest size**
- 500Vac rated
- 40A – 63A Current Rating
- 2,000A Interrupting current @ 500V ac
- -55°C to 125°C operating temperature

Agency Approvals

- UL Recognized Component

Environmental Compliance

- RoHS Compliant
- Halogen free
- 100% Pb free

Packaging

- Tray
- Pack quantity = 500 pieces

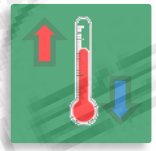
Comparison of 606 Series with Competition

	LF 606 Series	Competitor	Competitor
Product Photo/ Illustration			
Footprint/Height	32 x Φ 10 mm	38 x Φ 10 mm	38 x Φ 10 mm
Current Rating	40 A ~ 63 A	Up to 30A	Up to 30A
Voltage Rating	500VAC	500VAC	500VAC
Interrupting Rating	2,000 A @ 500VAC	10,000A @500VAC	10,000A @500VAC

What differentiates 606 Series?

- **Higher** current rating than competition
- **Shorter length** than 10 x 38 mm size competition

606 Series Features & Benefits



Key Features	Key Benefits
Rated for **500V AC** with **interrupting rating of 2,000A and 40A-63A nominal current rating** in **SMALL** package	Suitable for use as **over-current protection in a single-phase and three-phase power supply circuit rated up to 20kW, an alternative for parallel fuse solution**
End caps with integrated stand-off leads	Eliminates the need for mounting accessories and/or lead-forming processes
Compact body size of 10x32mm	High wattage equipment can be designed with less board space reserved for protection components
Operating temperature range from **-55˚C to 125˚C**	Provides reliable protection in extreme temperature environments

DC Fuse Solutions

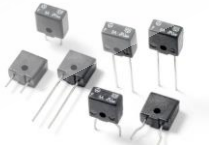
	507 Series	513 Series
Photo		
Fuse Dimensions	6x32mm	6x32mm
Voltage Rating	650Vdc	800Vdc
Breaking Capacity	150A @650Vdc	400A @800Vdc
Current Rating	1-8A	5-10A
Agency Approval	c UL us	c UL us

DC Fuse Solutions

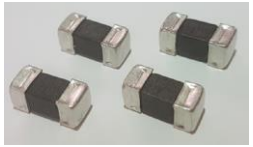
Fuse Type	Series	Form Factor	Voltage (V)	Current (A)
Through Hole	505	6x32mm	500Vac, Vdc	15A – 30A
	504	6x32mm	420Vdc, 500Vac	25A – 30A
	506	6x32mm	600Vdc	15A – 20A
	507	6x32mm	650Vdc	1A – 8A
	508	6x32mm	1000Vac, Vdc	315mA – 1A
	477	5x20mm	400Vdc, 500Vac	0.5A – 16A
	977	5x20mm	450Vdc, 500Vac	0.5A – 16A
	487	5x20mm	420Vac, Vdc	8A – 20A
	808	4.65x8.9mm	250/350/450Vdc	2A – 5A
Surface Mount	885	4.78x10.86mm	450/500Vdc	1A – 5A
	485	4.5x12.1mm	600Vdc	1A – 3.15A

504/505/506/507/508 Series
6x32mm

477/977/487 Series
5x20mm



808 Series
4.65x8.9mm



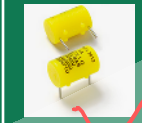
885 Series (4.78x10.86mm)

485 Series (4.5x12.1mm)

High Voltage / Current New Products

Series	Key Characteristics	Key Application Areas
505 Series	6x32mm, 15-30A, 30KA/500Vac	Charing Pile UPS
514 Series	6x32mm, 1.6-12.5A, 5KA/500Vac	Power Supply E-meter
606 Series	10x32mm, 40-63A, 2KA/500Vac	UPS Industrial Air Conditioner Charging Pile
881 Series	12.5x10x7mm, 60-100A, 1.5KA/75Vdc	Datacenter Telecom Power Tools/ESS/BBU
881F Series	12.5x10x7mm, 60-100A, 1.5KA/75Vdc	Datacenter Telecom Power Tools/ESS/BBU
456SD Series	12.2x4.5mm, 40-50A, 600A/75VDC, 100A/125VAC	Datacenter Telecom Power Tools/ESS/BBU
405 Series	5x20mm, 25A, 1KA/250Vac/dc	Datacenter
885 Series	10.9x4.8mm, 1-5A, 100A/500Vdc	BMS Motor Driver
525 Series	6x32mm, 15-30A, 10KA/305Vac, 10KA/450Vdc	OBC DC/DC

New Product Update – New HazLoc Fuse!

Product Series	242	259	259-UL913	305	304	308
						
Dimensions (mm)	3 x 8.4	8 x 13	8 x 13	9 x 15.6	6 x 13.6 x 6	5.4 x 3.6 x 3.8
Voltage Rating	250 VAC/VDC	125 VAC/VDC	125 VAC/VDC	277 VAC/VDC	277 VAC/VDC	**30VDC/24VAC**
Current Rating (I_n)	40 mA – 250 mA	62 mA – 5 A	62 mA – 5 A	50 mA – 750 mA	50 mA – 750 mA	0.250A – 1.5A
Breaking Capacity	4000 A @ 250VAC/ VDC	50 A @ 125 VAC 300 A @125 VDC	50 A @ 125 VAC 300 A @ 125 VDC	1500 A @ 277VAC/ VDC	1500 A @ 277VAC/VDC	50A @ 24VDC / 50A @ 30VDC
Certifications	UR, cUR (non-Ex)	UR (non-Ex), ATEX, IECEx	UR (Ex), ATEX, IECEx	UR + cUR (Ex), ATEX, IECEx	UR + cUR (Ex), ATEX, IECEx	UR + cUR (Ex), ATEX, IECEx

NEW

Released!

Low Voltage – Hazardous Location Applications

- Surface mount
- 30VDC/24VAC intrinsically safe fuse
- Specifically designed to operate in hazardous locations
- Limit the energy and temperature exposed during its operation
- Meet UL 913, ATEX and IECEx requirements
- Focus on Mobile

Data Loggers

Mobile Computing & Communication

Gas Detection

PPTC Devices and Applications

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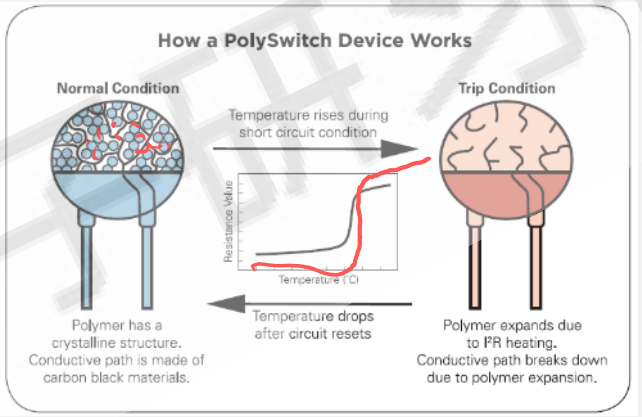
PPTC (PolySwitch) Devices

- Made from a composite of semi-crystalline polymer and conductive particles
- At normal temperature, the conductive particles form low-resistance networks in the polymer
- If the temperature rises above the device's switching temperature, either from high current through the part or from an increase in the ambient temperature, the crystallites in the polymer melt and become amorphous
- The increase in volume during melting of the crystalline phase separates the conductive particles resulting in a large non-linear increase in the resistance of the device.

Basics

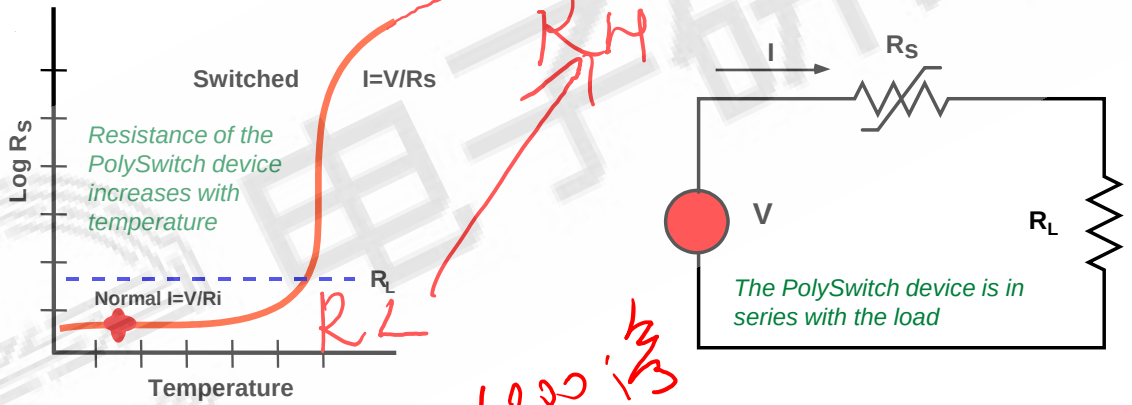


Why is a PPTC Useful?

PPTC resets when fault is removed, returns to low resistance

When fault occurs, the PPTC heats up and increases in resistance thereby protecting the equipment from fault

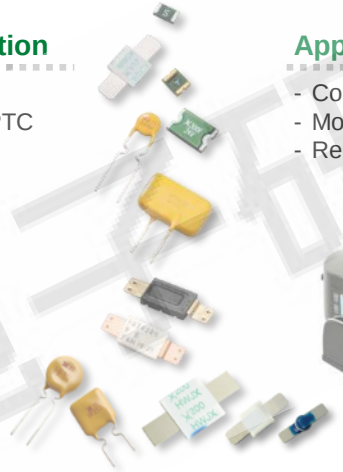
Under normal operating conditions, PPTC remains low in resistance



Industrial and Appliances

Industrial Robots & Factory Automation

- Port protection: SMD PPTC
- Power supply input: SMD PPTC/Leaded PPTC
- Motor protection: Leaded PPTC



Appliances

- Control board: SMD PPTC
- Motor protection: Leaded PPTC
- Rechargeable battery: Strap PPTC

SMD PPTC Devices

"A" Series SMD Devices – tested to AECQ200

Series	Case size	Voltage (Vdc)	Hold Current Range [1]	Temperature Range
AHS	2018/2920/3425	16V	0.8A~3A	-40°C~125°C
ASMD	2920/3425	16~60V	0.23A~1.97A	-40°C~85°C
femtoASMDC	1608 (0603)	12-15V	0.05A~0.10A	-40°C~85°C
picoASMDC	2012 (0805)	15V	0.10, 0.12A	-40°C~85°C
nanoASMDC	3216 (1206)	13.2~60V	0.10A~0.50A	-40°C~85°C
nanoASMDCH	3216 (1206)	16V	0.35A	-40°C~125°C
microASMD	3225 (1210)	13.2~30V	0.05A~0.5A	-40°C~85°C
miniASMDC	4532 (1812)	12~60V	0.1A~2.6A	-40°C~85°C
ASMDC	7555 (2920)	24~60V	0.3A~5.0A	-40°C~85°C

Standard SMD Devices

Series	Case size	Voltage (Vdc)	Hold Current Range [1]	Temperature Range
0402L	1005 (0402)	6V	0.1A~0.5A	-40°C~85°C
femtoSMDC / 0603L	1608 (0603)	6~24V	0.04A~0.5A	-40°C~85°C
picoSMDC / 0805L	2012 (0805)	6~30V	0.05A~1.10A	-40°C~85°C
nanoSMDC / 1206L	3216 (1206)	6~60V	0.05A~2.0A	-40°C~85°C
microSMD / 1210L	3225 (1210)	6~30V	0.05A~2.0A	-40°C~85°C
miniSMDC / 1812L	4532 (1812)	6~60V	0.1A~3.0A	-40°C~85°C
2016L	5040 (2016)	6~60V	0.3A~5.0A	-40°C~85°C
midSMD	5050 (2018)	6~60V	0.3A~2.0A	-40°C~85°C
SMDC / 2920L	7555 (2920)	6~60V	0.3A~7.0A	-40°C~85°C
SMD	7555 (2920)	6~60V	0.3A~3.0A	-40°C~85°C
SMD2	8763 (3425)	15~33V	1.5A~2.5A	-40°C~85°C
Oil Resistant	Varies	6~30V	0.1A~1.25A	-40°C~125°C

[1] Hold current at room temperature

Features

- Wide range of resettable overcurrent devices designed for general electronic and automotive markets
- Wide range of cases sizes and ratings, meet applicable industry standards

Benefits

- **Selection of over 200 different standard SMD models**
- Devices compatible with high-volume electronic assembly
- RoHS compliant, Halogen-free

Radial Leaded PPTC Devices

"A" Series Devices – tested to AECQ200

Series	Voltage (Vdc)	Hold Current Range[1]	Temperature Range
AGRF	16V	4A~14A	-40°C~85°C
AHRF	30V	0.5A~1A	-40°C~125°C
AHRF	16V	2A~15A	-40°C~125°C
AHEF	32V	0.5A~10A	-40°C~125°C

Standard "R" Series Devices

Series	Voltage (Vdc)	Hold Current Range[1]	Temperature Range
RXEF	60~70V	0.05A~3.75A	-40°C~85°C
RKEF	60V	0.5A~5A	-40°C~85°C
RUEF	30V	0.9A~9A	-40°C~85°C
RHEF	16~30V	0.5A~15A	-40°C~85°C
RGEF	16V	2.5A~14A	-40°C~85°C
RUSBF	6~16V	0.75A~2.5A	-40°C~85°C
LVR	240V	0.05A~2A	-40°C~85°C

Features

- Wide range of resettable overcurrent devices designed for the general electronic and automotive markets
- Wide range of form factors and termination methods
- Products meet applicable industry standards

Benefits

- **Selection of "A series" models for automotive**
- Devices compatible with high-volume electronic assembly
- RoHS compliant; A series parts tested to AECQ200

Radial Leaded & Telecom PPTC Devices

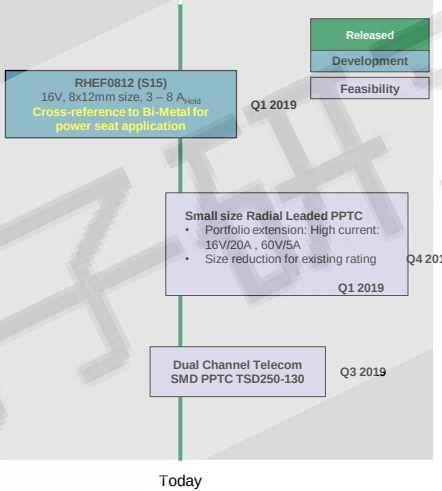
PPTC – R-Line
- Radial Leaded
- 16V , 30V, 32V, 60V, 72V, 120Vac, 240Vac
- 0.05 to 15.0 A_{hold}
- -40°C to +125°C
- Line Voltage rating parts available

PPTC – T-Line
- Available on both Radial Leaded and SMD
- 250Vdc (NA market) or 600Vdc (EU market)
- 0.08 to 0.18A_{hold}
- -40°C to +85°C

AEC Q200 PPTC – R-Line

- **Selection of over 35 different Auto Grade Devices**
- **Over** 25 HT versions (+125C capable)

AGRF	16V	+85°C	4 - 14 A_{Hold}
AHRF	30V	+125°C	0.5 - 1 A_{Hold}
	16V	+125°C	2 - 15 A_{Hold}
AHEF	32V	+125°C	0.5 - 10 A_{Hold}



New product development:
- **Focus on automotive motor protection to compete against Bi-metal**
- **Small size**
- **Portfolio extension**

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Design & Electrical Key Features for Mega 48V

High Current Fuses

MEGA® 70V HP Fuse-SF51

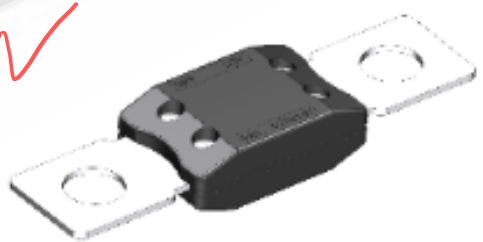
COLOR CODING
SEE CHART

MEGA® High Performance Fuse Rated 70V-SF51

The MEGA® 70V-SF51 High Performance (HP) Fuse is designed for high current circuit protection up to 500A with "Diffusion Pill Technology." The MEGA 70V HP features 1MOhm Open State Resistance after fuse opening to guarantee safe interruption at any voltage up to 70V. The MEGA® 70V HP Fuse is ideal for battery and alternator protection application and other heavy gauge cables requiring ultra-high current protection.

Specifications

Interrupting Rating:	2500A @ 70 VDC
Voltage Rating:	70 VDC
Operating Temperature Range:	-40°C to + 125°C
Housing Material:	PPA-GF33
Terminals:	ETP Copper (Tin plated)
Mounting Torque M6:	9Nm+/-1Nm
Mounting Torque M8:	20Nm+/-1Nm
Open State Resistance (after fuse opening)	>1MOhm
According to:	ISO 20934 - Type SF51



Features and special requirements:

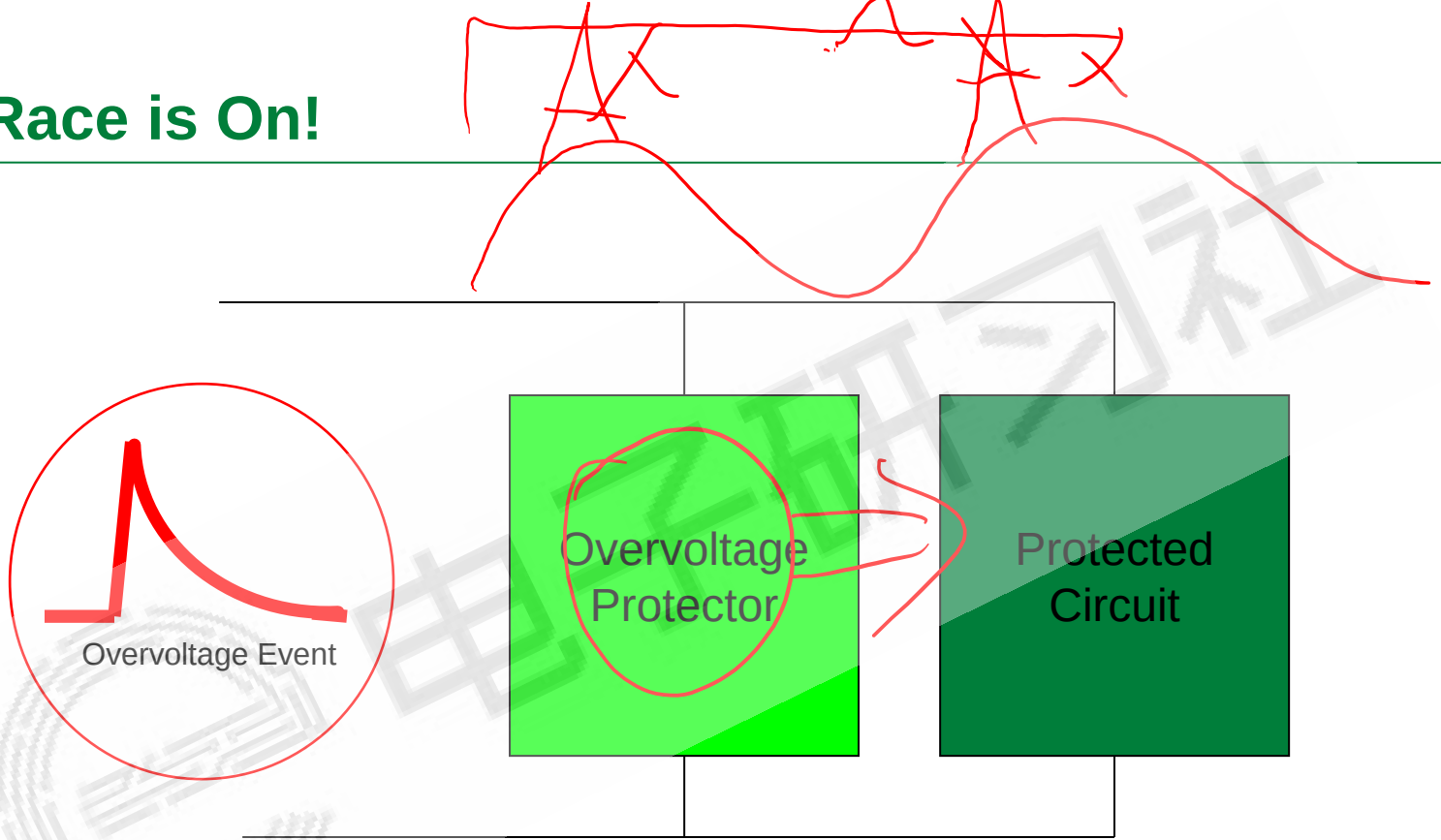
- based on standard MEGA Fuse (Same dimensions)
- T/C characteristic acc. ISO 8820-5
- Breaking Capacity: **~2500A @ >70V**
- Isolation Resistance: >1MOhm
- if coding necessary pitch = 54 mm

OV Protection Solutions

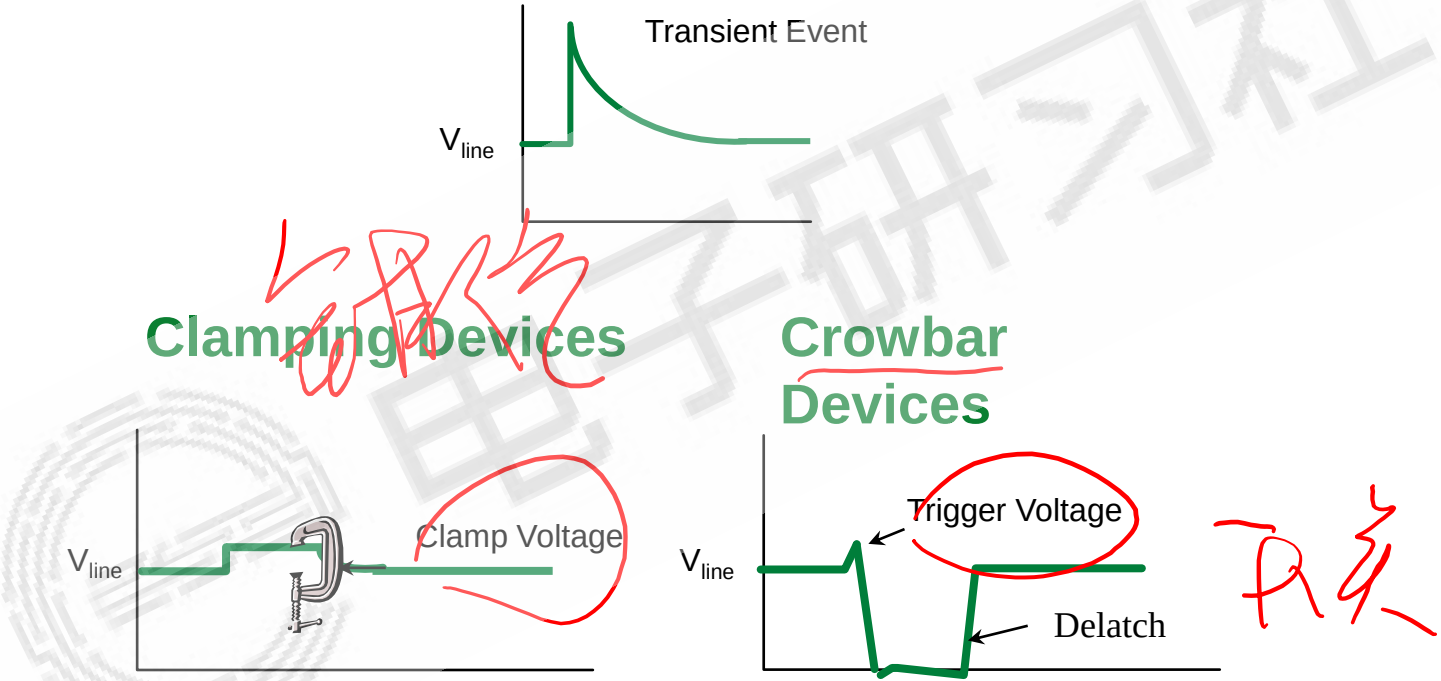
Littelfuse®

Expertise Applied | Answers Delivered

The Race is On!

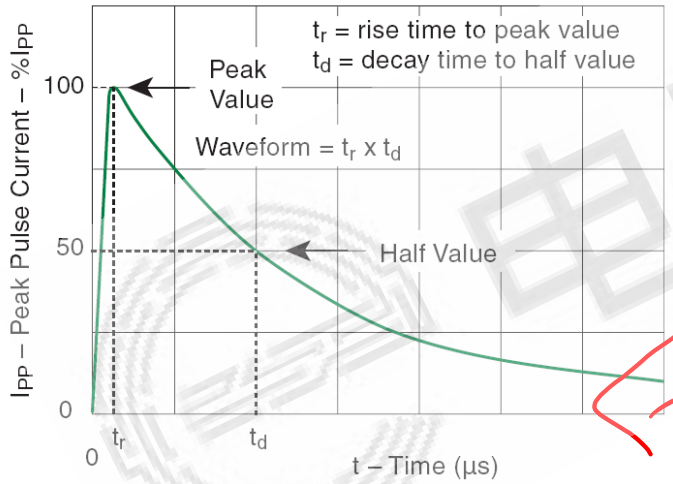


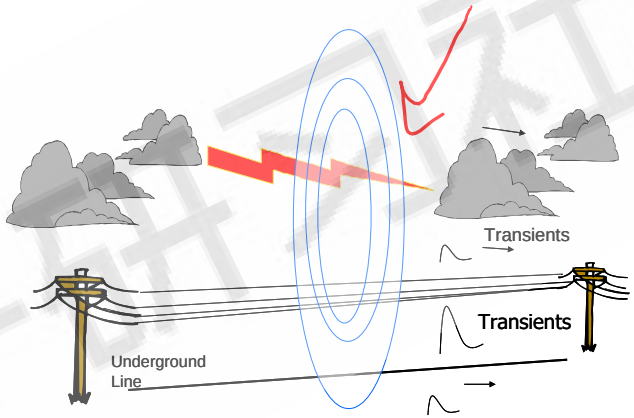
Clamping Devices vs Crowbar Devices



Key Parameters: Peak Pulse Power

- Double Exponential Waveforms
  - Simulate induced lightning events
  - Rise time & decay time in microseconds





8 x 20 (IEC 61000-4-5)
10 x 1000 (Telephone)
10/350(Telecom)
10/700

TVS Diode

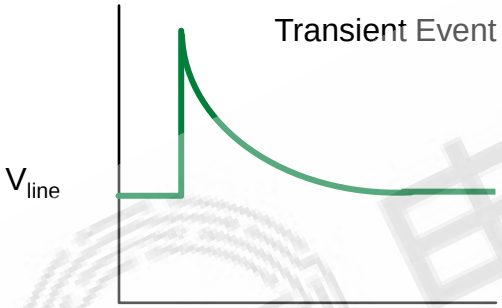
Littelfuse®

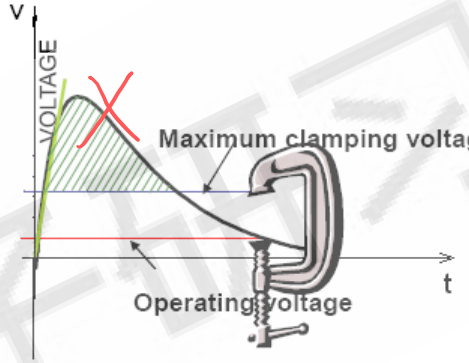
Expertise Applied | Answers Delivered

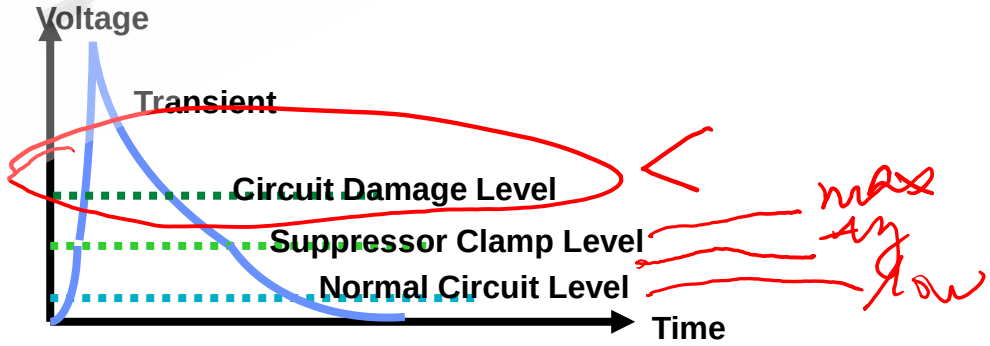
Why are Transients of Concern?

- Component miniaturization has resulted in increased sensitivity to electrical stress
- Microprocessors have structures and conductive paths which cannot handle high currents from ESD transients
- They operate at very low circuit voltages
- Transient voltages must be controlled to prevent device interruption or failure
- Sensitive microprocessors are prevalent in a wide range of devices such as:
  - Home appliances
  - Industrial controls
  - Consumer electronics
  - Data processing equipment
  - Telecommunications
  - Automotive electronic systems
  - Toys

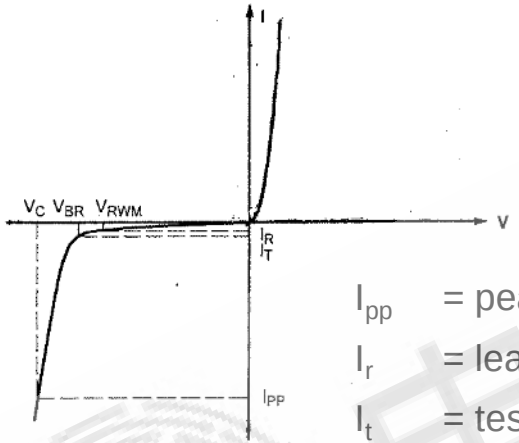
TVS Clamping Devices



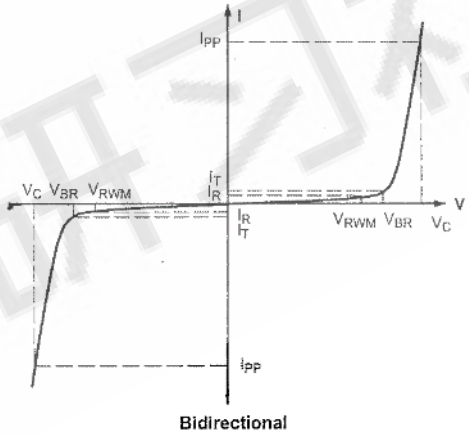




Bidirectional vs Unidirectional



Unidirectional



Bidirectional

I_{pp} = peak pulse current

I_r = leakage current @ V_r

I_t = test current

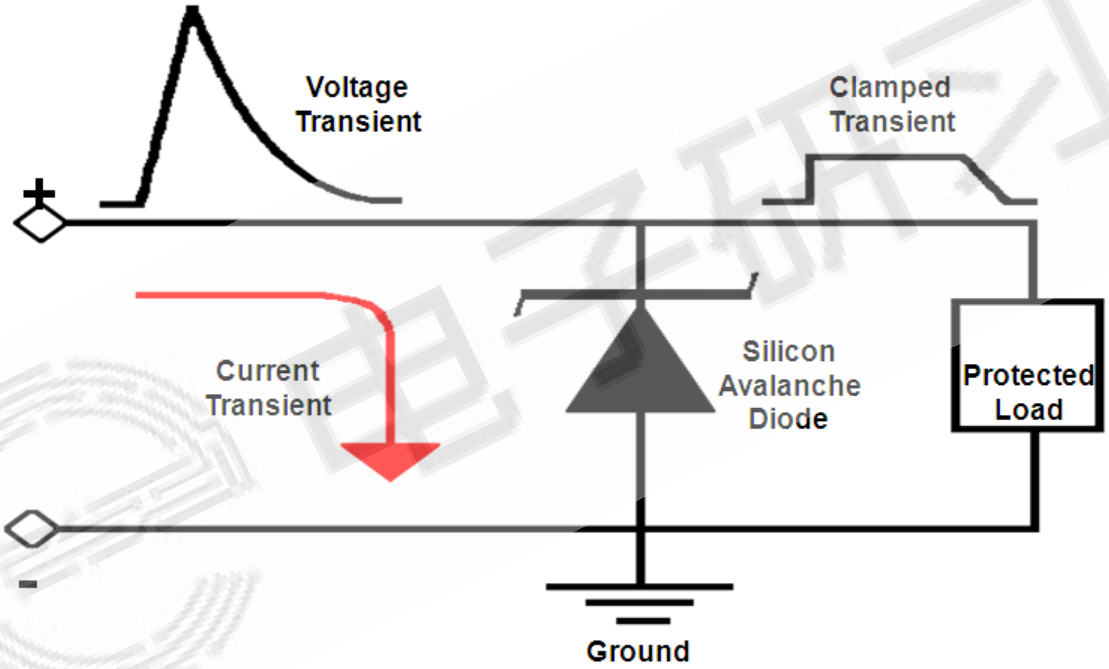
V_f = max forward voltage*

V_r = max reserve standoff voltage

V_{br} = breakdown voltage @ I_t

V_c = max clamp voltage @ I_{pp}

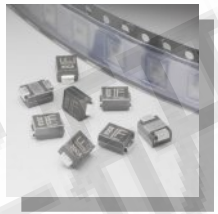
TVS Transient Protection



Surface Mount Product Offering

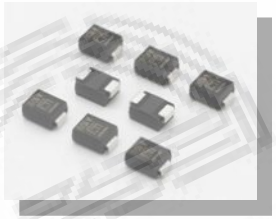
SMAJ

P4SMA

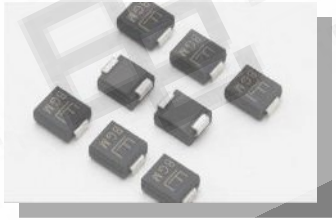


SMBJ

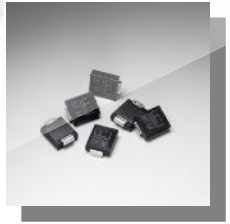
P6SMBJ



1KSMBJ



SMCJ



1.5SMC

SMDJ

Axial Leaded Product Offering

Much compact in design

- 10X Smaller size than traditional SPD module
- Easy for layout and assembly/ installation
- Much lighter (AK15 is around 10gm) than heavy SPD module.

Much longer in lifetime

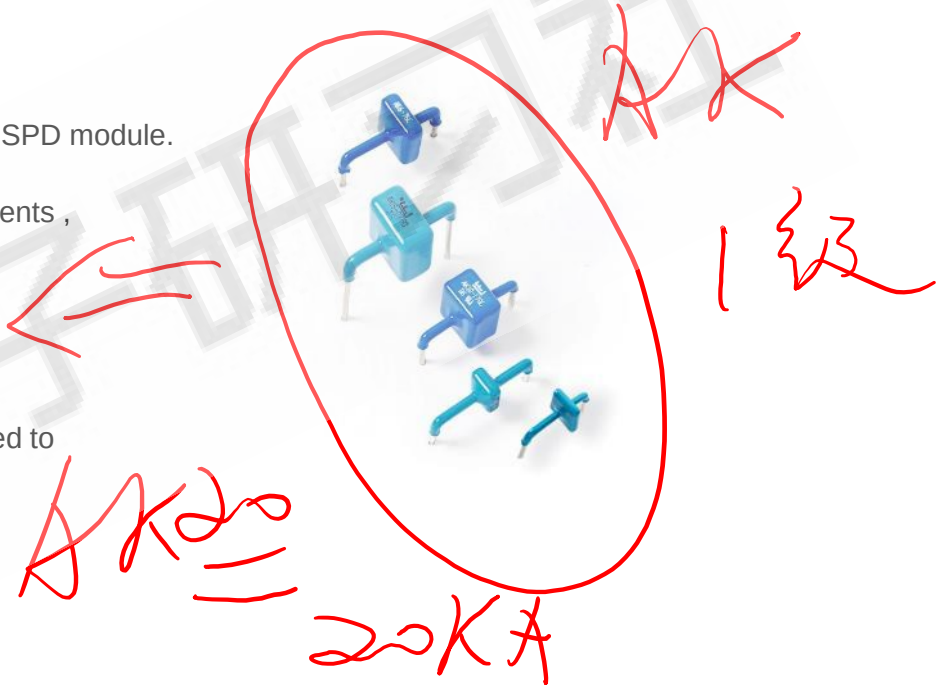
- NO wear-out mechanism over multiple surge events , temperature variance and lifetime MTBF: years.

Simply perform better

- Foldbak technology enable precise clamping
  AK Vclamp = 2 X Vstandoff.
  Competition MOV Vcl over 3X Vv operating
- TVS Diode instant response in a few nS compared to MOV technology tens nS Sec

Wider operating temperature

- AK: -55degree C to 150 degree C
- MOV: -40 degree C to 85 degree C



Sidactor

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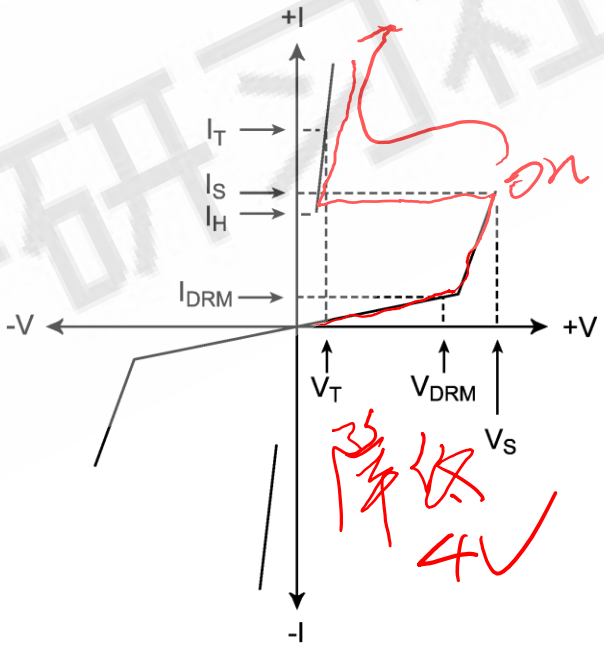
IV Characteristics & parameters

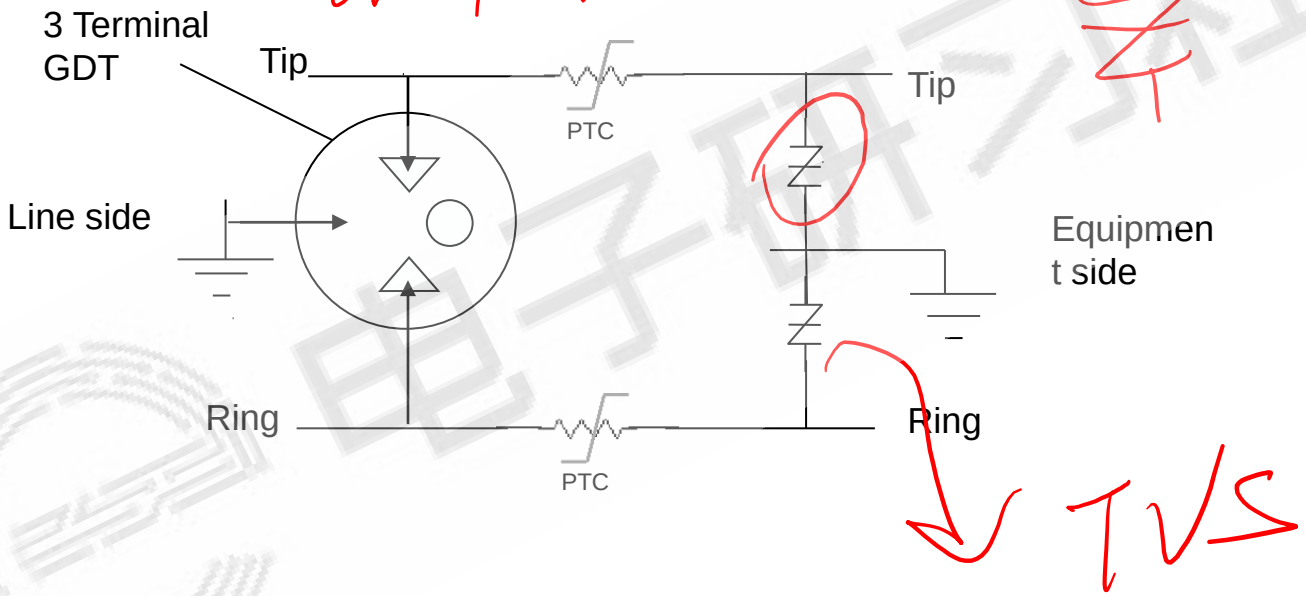
- **V_{DRM} = Working Voltage**
  > Peak (DC) operating voltage of protected circuit.
- **V_S = Protection Voltage**
  < Withstand voltage of protected circuit.
- **I_H(MIN) = Holding current**
  > Max circuit DC current of protected circuit.
- **V_T = Turn-on Voltage**
  > Voltage while turned on.

IDEAL protector: VDRM = VS

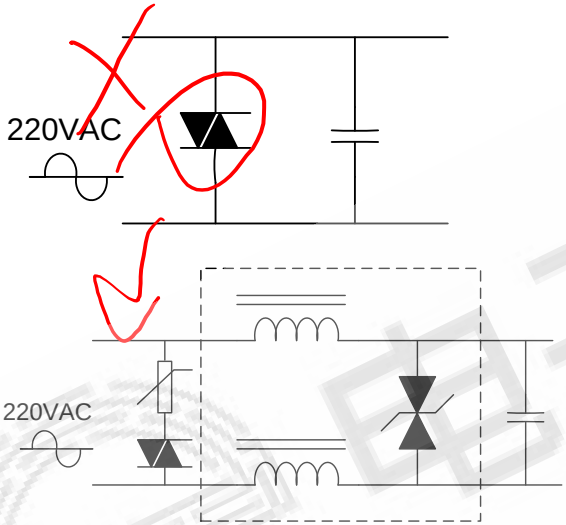
But no one can make it.



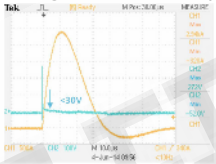
MDF (Main Distribution Frame)



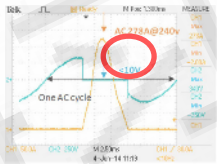
TSS Crowbar Solution for Power



Surge Without AC Input

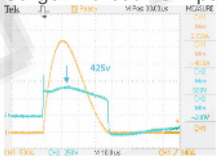


Surge With AC Input

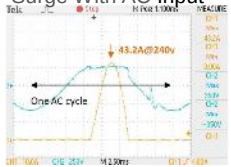


- TSS(SIDACtor) turn off at AC Zero-crossing point
- Potential Risk TSS(Sidactor) could be short @on-state

Surge Without AC Input



Surge With AC Input



- MOV+TSS(Sidactor) decrease Vc
- MOV block short current@TSS On State

Note:TSS Leakage <<MOV ➡ Most Open Volt on TSS ➡ Possible TSS malfunction ➡ Cause MOV Conduct or ➡ Short Current Damage MOV;Thus,Make Certain Sidactor block timely is significant ;MOV Vnom >TSS Vs gurrantee TSS close

New High Surge MLV

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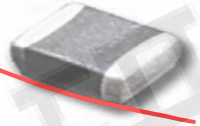
Expertise Applied | Answers Delivered

275Vac Surface Mount MLV Device

SMD VARISTOR – *Data Sheet Rev 1*

Littelfuse Part Number: V275MLA0805NS



Device Ratings and Characteristics

Part Number	Maximum Ratings (+125°C)				Characteristics (+25°C)		
	Maximum Continuous Working Voltage		Maximum Non-repetitive Surge Current (8/20µs)	Maximum Clamping Voltage (8/20µs)	Nominal Voltage Test Current @ 1mA DC		Typical Capacitance @ 1KHz
	$V_{M(DC)}$	$V_{M(AC)}$	I_{TM}	V_C @ 1A	$V_{N(DC)}$	$V_{N(DC)}$	C
	(V)	(V)	(A)	(V)	Min (V)	Max (V)	pF
V275MLA0805NS	350	275	100	705	387	473	45

Notes:

1. Maximum Leakage at +25°C:50uA @80%Vn
2. These values represent those of discreetly tested units only, i.e. 'off the reel' before boardmount. Littelfuse cannot be accountable for localized board effects that may cause surface interactions resulting in leakage levels greater than the maximum after boardmount.
3. Operating Ambient Temperature Range (T_A): -40℃ to +125℃
4. UL recognized, agency file numer E320116
5. RoHS complaint and lead free

- **Features:**
  - Maximum working voltage 275Vac, 0805 inch compact size,
  - In rating 100A, 15 pulses
  - UL recognized, UL documentation No. E320116.
  - RoHS compliance and lead-free.
- **Main application: GFCI**

16Vdc, 50J high load dump rating MLV Device

SMD VARISTOR – *Data Sheet, Rev1, Oct 14th 2019*

NEW

Littelfuse Part Number: V16AUMLA2220NS

Device Ratings and Characteristics

Part Number	Maximum Ratings (+125°C)					Characteristics (+25°C)		
	Maximum Continuous Working Voltage	Jump start voltage (5min)	Load dump energy (10 pulse)	Maximum Clamping Voltage (8/20µs)	Maximum Non-repetitive Surge Current (8/20µs)	Nominal Voltage Test Current @ 1mA DC		Typical capacitance @1KHz
	$V_{M(DC)}$	V_{JUMP}	W_{TM}	V_C @ 10A	I_{TM}	$V_{N(DC)}$	$V_{N(DC)}$	Cp
	(V)	(V)	(J)	(V)	(A)	Min (V)	Max (V)	pF
V16AUMLA2220NS	16	24.5	50	42	5000	21.6	26.4	25000

Notes:
1. These values represent those of discreetly tested units only, i.e. 'off the reel' before boardmount. Littelfuse cannot be accountable for localized board effects that may cause surface interactions resulting in leakage levels greater than the maximum after boardmount.
2. Operating Ambient Temperature Range (T_A): -55°C to +125°C
3. Max leakage current 100µA @16V DC
4. AEC-Q200 qualified
5. S package–500pcs/reel
6. RoHS complaint

- **Features:**
  - Maximum working voltage 16Vdc suitable for 12Vdc system. 2220 SMT packaging
  - ISO 7637-2 5a test passed (40J) Us: 65V, R: 0.5Ω, Td:400ms.,
  - ISO 7637-2 5a test passed (50J) Us: 87V, R: 0.5Ω, Td:400ms
  - JASO A A-1, Vp: 70 V, R: 0.8Ω, t=200ms test passed
  - RoHS compliance and lead-free.

- **Main application:**
  - Car LED Front Lighting

65Vdc, 4500A 8/20us Surge rating MLV Device

SMD VARISTOR – *Data Sheet, Rev1, July 19th 2019*

NEW

Littelfuse Part Number: V65MLA2220NS

Device Ratings and Characteristics

Part Number	Maximum Ratings (+125°C)				Characteristics (+25°C)	
	Maximum Continuous Working Voltage		Maximum Non-repetitive Surge Current (8/20µs)	Maximum Clamping Voltage (8/20µs)	Nominal Voltage Test Current @ 1mA DC	
	$V_{M(DC)}$	$V_{M(AC)}$	I_{TM}	V_C @ 10A	$V_{N(DC)}$	$V_{N(DC)}$
	(V)	(V)	(A)	(V)	Min (V)	Max (V)
V65MLA2220NS	65	50	4500	135	73.8	90.2

Notes:
1. These values represent those of discreetly tested units only, i.e. 'off the reel' before boardmount. Littelfuse cannot be accountable for localized board effects that may cause surface interactions resulting in leakage levels greater than the maximum after boardmount.
2. Operating Ambient Temperature Range (T_A): -55°C to +125°C
3. Typical capacitance 4800pF@1KHz
4. S=500pcs/reel
5. Max leakage current 100uA@80% Vn
6. Withstand 3000A, 10 pulses@8/20us waveform

- **Features:**
  - Maximum working voltage 65Vdc suitable for 48Vdc system, 2220 inch size for Surface Mount,
  - Can withstand 4500A 8/20us non-repetitive surge;
  - RoHS compliance and lead-free
- **Main application: Telecom/Base Station**

TVS Diode Array ESD and EOS

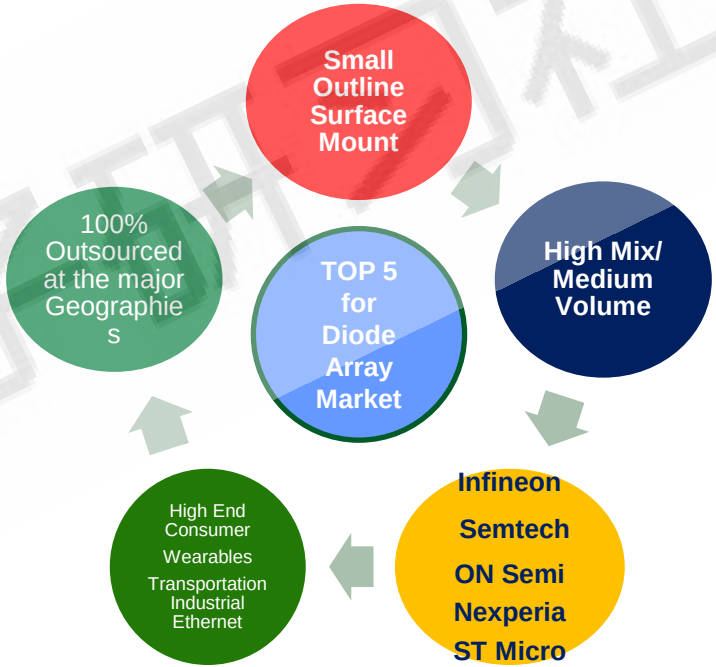
Littelfuse

Expertise Applied | Answers Delivered

TVS Diode Array Product Line

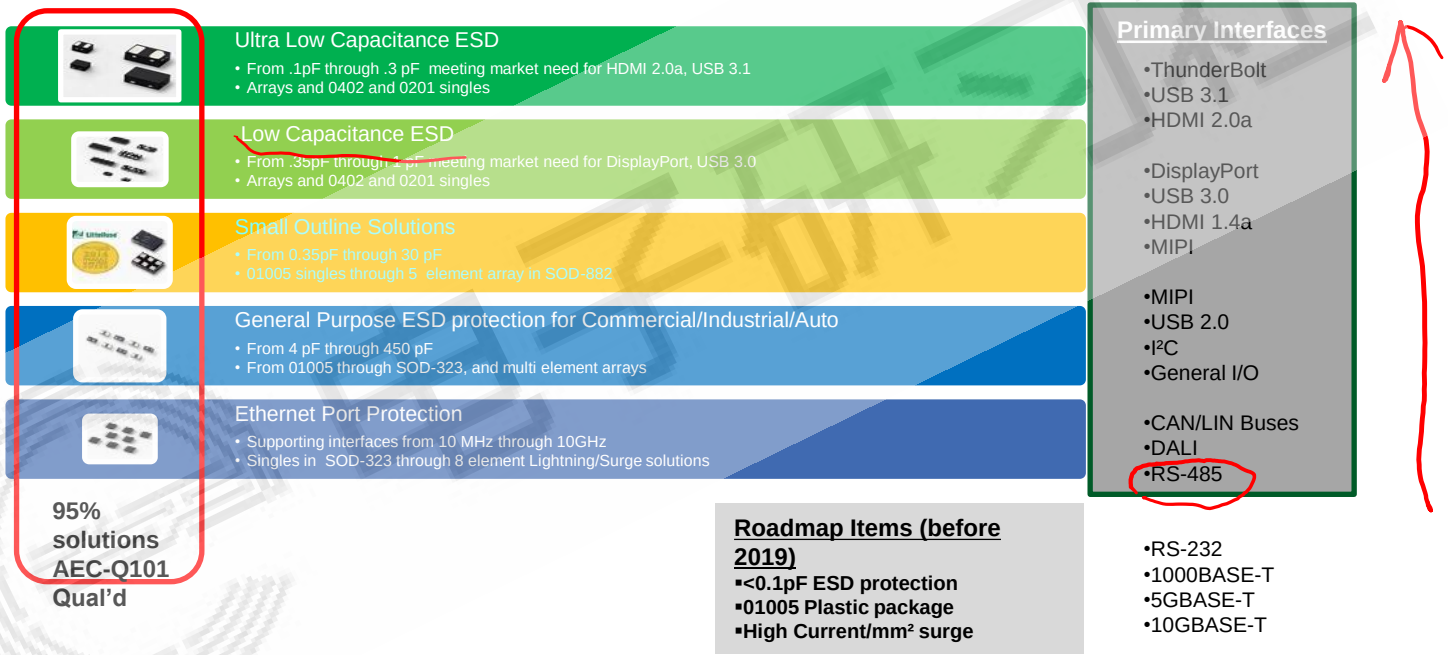
- **Primary Design Location➔Chubei, Taiwan**
- **Characterization and Qual➔ Wuxi**
- **Sales Related Assets at major sites in Asia**

- "Ideal" customer is they who value performance over price
- We strive to provide high performance solutions at an acceptable price
- We are not a low-priced solution, we can cross, but typically we cannot offer price down vs. incumbents



Diode Array Broad Category Solutions

(default product qual through Automotive grade)

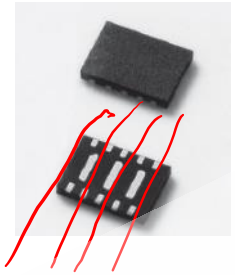


RF SOD-323 Solutions

	SP4020-01FTG	SP4020-01FTG-C	SP4021-01FTG	SP4021-01FTG-C	SP4208-01FTG	SP4208-01FTG-C	SP4022-01FTG	SP4022-01FTG-C	SP4023-01FTG	SP4023-01FTG-C	SP4024-01FTG	SP4024-01FTG-C
Work Voltage	-0.7 to 3.3V	-3.3 to 3.3V	-0.7 to 5.0V	-5.0 to 5.0V	-0.7 to 9.5V	-9.5 to 9.5V	-0.7 to 12V	-12 to 12V	-0.7 to 15V	-15 to 15V	-0.7 to 24V	-24 to 24V
Breakdown	<-1.0 and >3.5V	<-3.5 and >3.5V	<-1.0 and >6.3V	<-6.3 and >6.3V	<-1.0 and >9.5V	<-9.5 >9.5V	<-1.0 and >13.3V	<-13.3 >13.3V	<-1.0 and >16V	<-16 and >16V	<-1.0 and >26V	<-26 and >26V
Package	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323	SOD-323
Surge (8/20 ns)	30 Amps	30 Amps	25 Amps	25 Amps	30 Amps	30 Amps	15 Amps	15 Amps	12 Amps	12 Amps	7Amps	7Amps
Nominal Cap.	1.5 pF	2.5 pF	2.5 pF	2.5 pF	3.0 pF	3.0 pF	1.3 pF	1.3 pF	1.3 pF	1.3 pF	1.3 pF	1.3 pF
Auto Qual	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101	AEC-Q101
Availability	Production	Production	Production	Production	Production	Production	Production	Production	Production	Production	Production	Production

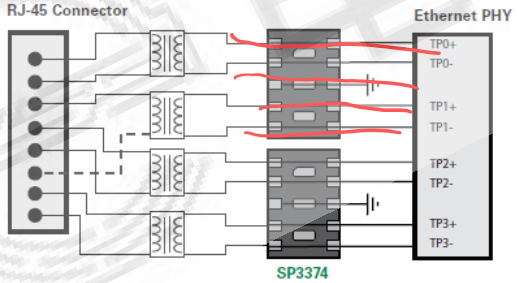
- Very popular parts, because they are single channel they are easy to route, and easy to place
- Historically used on DSL ethernet lines, morphed into automotive protecting CAN and LIN buses
  - Low capacitance
  - Excellent Clamp performance
  - Automotive grade components available as AQ prefix

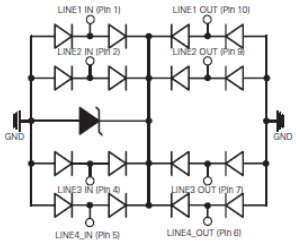
SP3374NUTG for Ethernet



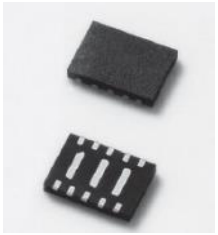
Electrical Characteristics (T_{OP}=25°C)

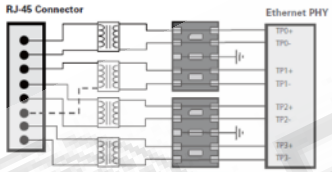
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Reverse Standoff Voltage	V_{RWM}	$I_R \le 1\mu A$			3.3	V
Reverse Leakage Current	I_R	V_{RWM} = 3.3V, T = 25°C		0.1	0.5	µA
Snap Back Voltage	V_{SB}	I_{SB} = 50mA	2.8			V
Clamp Voltage	V_C	I_{PP} = 1A, t_P = 8/20µs Any I/O to Ground			5.5	V
		I_{PP} = 10A, t_P = 8/20µs Any I/O to Ground			10.5	
		I_{PP} = 25A, t_P = 8/20µs Any I/O to Ground			18.0	
		I_{PP} = 40A, t_P = 8/20µs Line-to-Line[3], two I/O Pins connected together on each line			25.0	
Dynamic Resistance[2]	R_{DYN}	TLP, t_P=100ns, Any I/O to Ground		0.15		Ω
ESD Withstand Voltage	V_{ESD}	IEC61000-4-2 (Contact)	±30			kV
		IEC61000-4-2 (Air)	±30			kV
Diode Capacitance	$C_{VO\ to\ GND}$	Between I/O Pins and Ground V_R = 0V, f = 1MHz		3.5	5.0	pF
	$C_{VO\ to\ I/O}$	Between I/O Pins V_R = 0V, f = 1MHz		1.7		pF

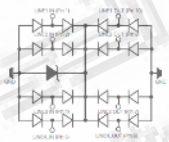




SP2555NUTG for Ethernet







Absolute Maximum Ratings

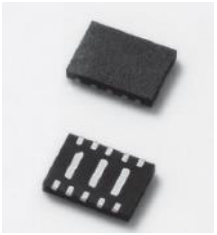
Symbol	Parameter	Value	Units
I_{PP}	Peak Current (t_p=8/20µs)	45	A
P_{Pk}	Peak Pulse Power (t_p=8/20µs)	1000	W
T_{OP}	Operating Temperature	-40 to 125	°C
T_{STOR}	Storage Temperature	-55 to 150	°C

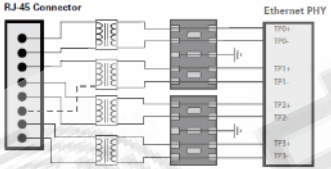
CAUTION: Strasses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

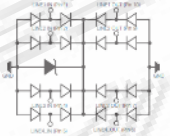
Electrical Characteristics (T_{OP}=25°C)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Reverse Standoff Voltage	V_{RWM}	I_R ≤ 1µA			2.5	V
Reverse Leakage Current	I_R	V_{RWM} = 2.5V, T = 25°C		0.1	0.5	µA
Snap Back Voltage	V_{SB}	I_{SB} = 50mA	2.0			V
Clamp Voltage	V_C	I_{PP} = 1A, t_p = 8/20µs, Any I/O to Ground		4.5		V
		I_{PP} = 10A, t_p = 8/20µs, Any I/O to Ground		7.5		
		I_{PP} = 25A, t_p = 8/20µs, Any I/O to Ground		12		
		I_{PP} = 45A, t_p = 8/20µs, Line-to-Line[1], two I/O Pins connected together on each line		19		
Dynamic Resistance[2]	R_{DYN}	TLP, t_p=100ns, Any I/O to Ground		0.1		Ω
ESD Withstand Voltage	V_{ESD}	IEC 61000-4-2 (Contact)	±30			kV
		IEC 61000-4-2 (Air)	±30			kV
Diode Capacitance	$C_{I/O\ to\ GND}$	Between I/O Pins and Ground V_R = 0V, f = 1MHz		2.5		pF
	$C_{I/O\ to\ I/O}$	Between I/O Pins V_R = 0V, f = 1MHz		1.2		pF

SP3384NUTG for Ethernet







Absolute Maximum Ratings

Symbol	Parameter	Value	Units
I_{PP}	Peak Current (t_p=8/20µs)	15	A
P_{Pk}	Peak Pulse Power (t_p=8/20µs)	500	W
T_{OP}	Operating Temperature	-40 to 125	°C
T_{STOR}	Storage Temperature	-55 to 150	°C

Notes:
CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the component. This is a stress only rating and operation of the component at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics (T_{OP}=25°C)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Reverse Standoff Voltage	V_{RWM}	I_R = 1µA			3.3	V
Breakdown Voltage	V_{BR}	I_R = 1mA		9		V
Reverse Leakage Current	I_{LEAK}	V_R=3.3V		0.1	0.5	µA
Snap Back Voltage	V_{SB}	I_{SB} = 50mA		2		V
Clamp Voltage[1]	V_C	I_{PP}=1A, t_p=8/20µs		3		V
		I_{PP}=15A, t_p=8/20µs		11		V
Dynamic Resistance[2]	R_{DYN}	TLP, t_p=100ns		TBD		Ω
ESD Withstand Voltage[1]	V_{ESD}	IEC 61000-4-2 (Contact Discharge)	±30			kV
		IEC 61000-4-2 (Air Discharge)	±30			kV
Diode Capacitance[1]	$C_{I/O-I/O}$	Reverse Bias=0V, f=1MHz		0.5		pF

Notes:
1Parameter is guaranteed by design and/or component characterization.
2 Transmission Line Pulse (TLP) test setting : Std.TDR(50Ω),tp=100ns, tr=0.2ns ITLP and VTLP averaging window: start 1=70ns to end t2=80ns

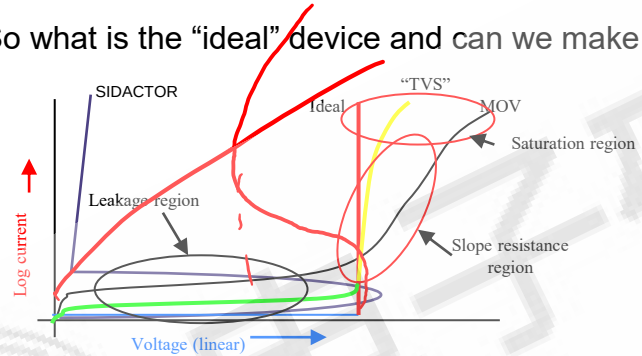
SIDACtor + MOV Lower Clamping

Littelfuse®

Expertise Applied | Answers Delivered

Littelfuse Protection Options

So what is the “ideal” device and can we make it?



The “Ideal device” would have no leakage current in the normal operating region.

MOV devices have non-linear voltage dependant leakage.

TVS device have fixed non-dependant leakage

The ‘Ideal’ continues vertical.

The MOV becomes limited by R(on).

The TVS becomes limited by current density.

The Ideal would be a vertical conduction relationship between voltage and current.

The MOV has a non-linear slope tending towards resistive.

TVS are also non-linear, having a more vertical slope due to avalanche conduction.

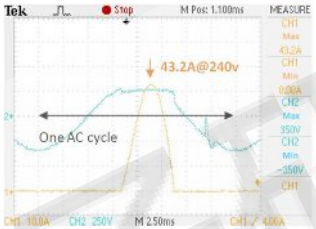
1.TVS solution

2. MOV+SIDACTOR solution

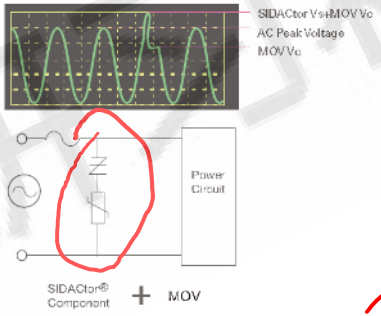
SIDACtor +MOV for Ultra Low I_R and V_{CL}

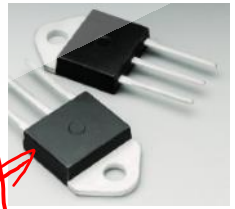
Example : Surge Waveform SIDACtor + MOV

3kA 8/20 with P2300MEL+V20E130P (no 240V AC coupling)



AC current follow on after P2300MEL+V20E130P triggered (with 240V AC coupling)





- Lower clamping voltage ~425V at **3kA 8/20 surge current** compare to single 275V MOV solution (>900V by datasheet curve).
- Lower AC follow on current 43.2A compared to single SIDACtor 278A.
- SIDACtor turns off once AC voltage drops below the MOV breakdown voltage.

Test result of Leakage current and Clamping Voltage

		Ir@800V DC (μA)				Ir@410V DC(μA)				6kV @1.2μs/50μs	Ir@800V DC(μA)				
		Before Surge @ μA									After Surge @ μA				
		Ir+ @25C	Ir- @25C	Ir+ @125C	Ir- @125C	Ir+ @25C	Ir- @25C	Ir+ @125C	Ir- @125C	Vcl @ 25C without AC coupling	Ir+ @25C	Ir- @25C	Ir+ @125C	Ir- @125C	
#1	V275LA40BP+P3800MEL	589.74	395.78	188.76	184.71	0.30	0.22	22.93	23.94	800	285	242	324	314	+5/-5 strikes
#2	V275LA40BP+P3800MEL	458.18	587.73	195.66	174.38	0.26	0.18	25.08	24.89	875	357	419	249	291	+1/-1strike
#3	V275LA40BP+P3800MEL	1306.96	1379.91	219.68	185.62	0.24	0.18	25.28	25.06	860	1008	786	249	281	+1/-1strike
#1	V300LA40BP+P3800MEL	3.57	3.12	188.81	211.47	0.29	0.21	17.50	17.67	875	25	23	205	232	+5/-5 strikes
#2	V300LA40BP+P3800MEL	3.18	2.87	181.02	203.66	0.28	0.21	15.65	15.81	930	13	16	187	211	+1/-1strike
#3	V300LA40BP+P3800MEL	1.79	1.63	219.27	203.07	0.35	0.23	7.32	7.31	950	13	14	208	193	+1/-1strike
#1	V420LA40CP	>15mA	>15mA	>15mA	>15mA	0.74	0.52	11.38	11.66	1330	419,900	463,000	444,900	449,200	+5/-5 strikes
#2	V420LA40CP	>15mA	>15mA	>15mA	>15mA	1.46	1.12	27.78	28.48	1320	341,300	371,900	379,600	383,500	+1/-1strike
#3	V420LA40CP	>15mA	>15mA	>15mA	>15mA	1.43	1.11	24.82	25.43	1290	368,000	381,700	361,000	354,100	+1/-1strike

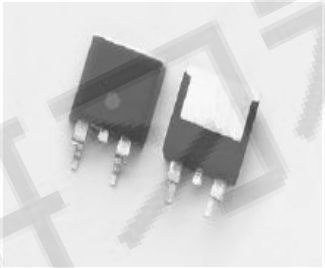
Voltage at 1mA before and after Surge

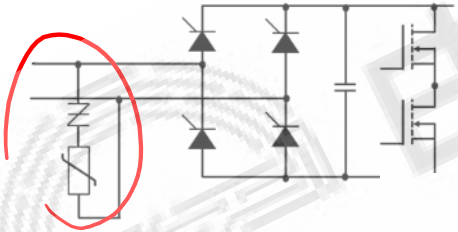
		Vz@1mA(V)				Vz@1mA(V)			
		Before Surge				**After Surge**			
		Vz+@25C	Vz-@25C	Vz+@125C	Vz-@125C	Vz+@25C	Vz-@25C	Vz+@125C	Vz-@125C
#1	V275LA40BP+P3800MEL	805.8	807.5	855.9	855.3	812.8	812.9	854.3	851.8
#2	V275LA40BP+P3800MEL	808.3	805.2	853.8	857.5	811.9	808.4	856.9	852.2
#3	V275LA40BP+P3800MEL	800.7	799.0	849.1	852.0	803.2	803.3	848.4	848.9
#1	V300LA40BP+P3800MEL	845.0	842.6	893.9	891.4	845.9	842.8	885.4	880.4
#2	V300LA40BP+P3800MEL	845.5	843.4	896.2	893.3	843.6	840.8	881.5	877.0
#3	V300LA40BP+P3800MEL	845.3	847.1	897.1	898.2	849.9	850.6	894.6	894.0
#1	V420LA40CP	695.5	696.3	694.6	694.9	699.7	702.2	688.4	691.3
#2	V420LA40CP	675.9	676.5	660.3	660.6	678.8	678.7	660.8	660.4
#3	V420LA40CP	671.7	672.8	659.7	660.1	675.1	675.0	659.4	658.8

The combination SIDACtor + MOV shows much less Ir and lower Vcl than MOV alone for 25ºC and 125ºC.

Overvoltage Protection Devices

- **Value of choosing hybrid technology against MOV only.**
  - less than 1/100 leakage, particularly in high temp.
  - 300~400 lower Vcl
  - Protection Thyristor offers no wear out
  - Reduce IGBT/ MOSFET cost , Reduce Capacitor cost
  - Better in reliability over times and multiple strikes.





AC 240V RMS --------V275LA40BP+P3500FNL

Comparison between SIDACTOR + MOV and GDT +MOV

Figure3. CG2600+V20H385P IPP=5KA TEST Waveform compare with P3800MEL+ V20H385P
Notice：this green waveform is GDT+V20H385P test waveform.

Littelfuse SCR/Diode presentation for TESLA 2015-10-29C

Comparison between SIDACTOR + MOV and CG2600 +MOV

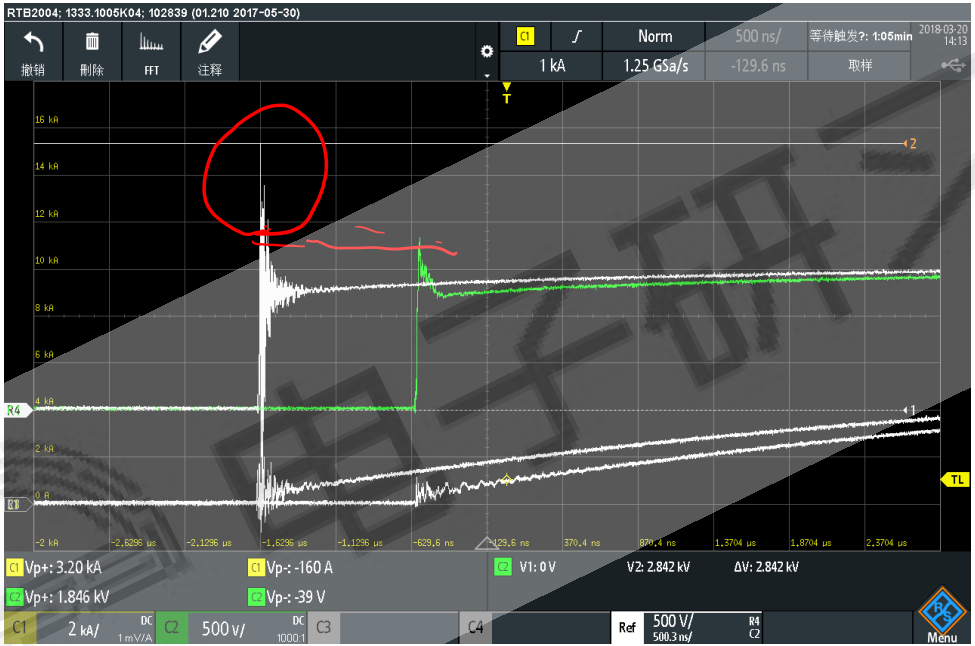
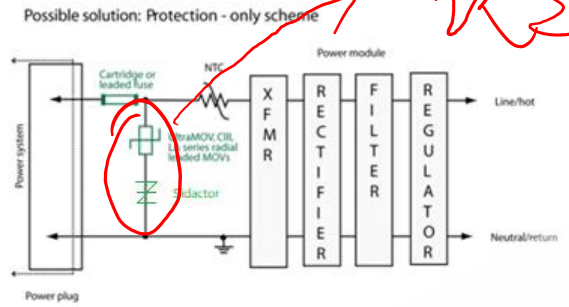
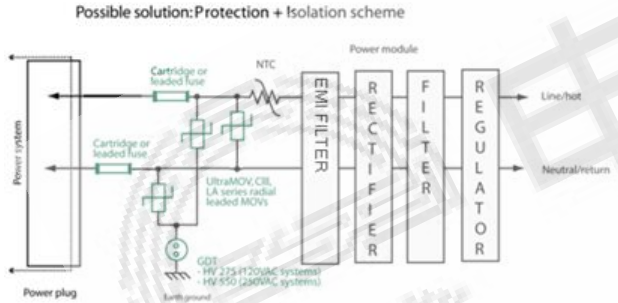


Figure4. CG2600+V20H385P IPP=5KA TEST Waveform compare with P3800MEL+ V20H385P

Notice: this waveform was tested under 500ns pulse width.

Power System Protection





Design Notes:

Protection Application: Products that are directly connected to the AC mains (120 to 250VACrms) will be exposed to much more severe surge transients (lightning, load switching, etc.) and short circuit/overload conditions than on DC inputs. Because of this, the protection devices need to be more robust.

Solution Description: As shown at the left (top), a cartridge or leaded fuse (5x20mm, 2AG, 3AG, TE5/TR5) can be used for short circuit and overload current conditions. For surge protection, an MOV (e.g. C-III, UltraMOV and LA series) with high energy handling capabilities should be used.

For products that also require electrical isolation between the hot and neutral lines and chassis (earth) ground, a GDT should be selected (left, bottom). The GDT is used to provide electrical isolation for the safety of the consumer.

Companion Solutions: Does not apply.

Regulatory Issues: Standards that specify safety and performance criteria include:

- UL 6500/IEC 65065
- UL1414
- UL1449

AC Lines Solution Description:

1) TMOV

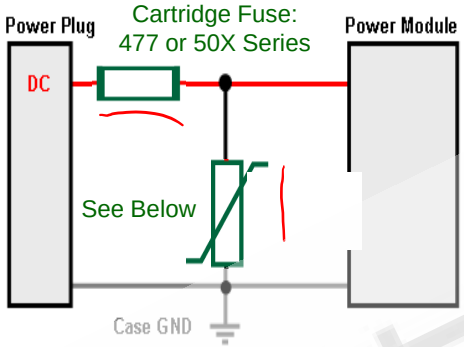
TMOV14RP385E	14mm	385Vac	505VDC
TMOV20RP385E	20mm	385Vac	505VDC
TMOV14RP3420E	14mm	420Vac	560VDC
TMOV20RP420E	20mm	420Vac	560VDC

2) GDT

SL1011A500	500VDC	
SL1011A600	600VDC	
CG3	2600V	
CG	3600V	

3) Sidactor P3500ME P3800ME

Circuit Protection of DC Input (PFC Circuit)



MOV Options:
CIII, Ultra MOV, LA Series

SMD TVS Diode Options:
P4SMA,SMAJ,P6SMB, SMBJ,SMC,SMD, and SMF 200W,

Axial Leaded TVS:
P4/6/1.5KE, 3KP~30KP, AK1~15

TVS LTKAK/AK3/AK6/AK15

Design Notes:

Protection Application: For customers that are using a PFC which changes AC to DC directly in some of the high DC power supply circuits.

Solution Description: You would need to consider the 400Vdc 5x20 477 series. For customers that require a significantly higher DC interrupt-rating in industrial or UPS applications. The small footprint 6x32 505 series , with a breaking capacity of 10kA to 30kA@500Vdc for ratings from 16A to 30A, would come in handy as well. The 477 and 505, being 5x20 and 6x32, are smaller footprint options for DC protection.

Companion Solutions: NA

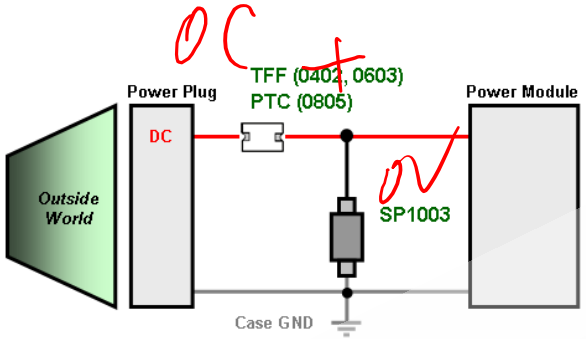
Regulatory Issues: Standards will vary depending on the product to be protected. Examples include:
IEC 61000-4-5
UL1414
UL1449

Unique Features: The small footprint 6x32 505 series , with a breaking capacity of 10kA to 30kA@500Vdc for ratings from 16A to 30A, would come in handy. The 477 and 505, being 5x20 and 6x32, are smaller footprint options for DC protection.

Application Warnings: When selecting the fuse, be sure to consider the expected temperature in the area around the fuse, as well as the in-rush currents. Failure to take these factors into account may result in premature or nuisance tripping of the fuse.

Road Map Products to be Watching for: None

Circuit Protection of DC Input



SMD TVS Diode Array Options:
SP1003-01ETG (0402)
SP1005-01ETG (0402)
SP1005-01WTG (0201)
SDxx-01FTG (0805)
SP25XX
SMF

Design Notes:

Protection Application: For portable devices that include an external AC adapter, a DC voltage (typically in the range of $3.3V_{DC}$ to $5V_{DC}$) will be supplied to the unit. The electrical threats include ESD, low-level lightning surges, and overcurrent conditions (short circuit or overload).

Solution Description: As shown at the left, a fuse or PTC can be used for short circuit and overload current conditions. For surge and ESD protection, a discrete diode can be used.

Companion Solutions: Other solutions exist in the SPA portfolio such as the SP1007 Series 0402 and 0201 TVS Diodes.

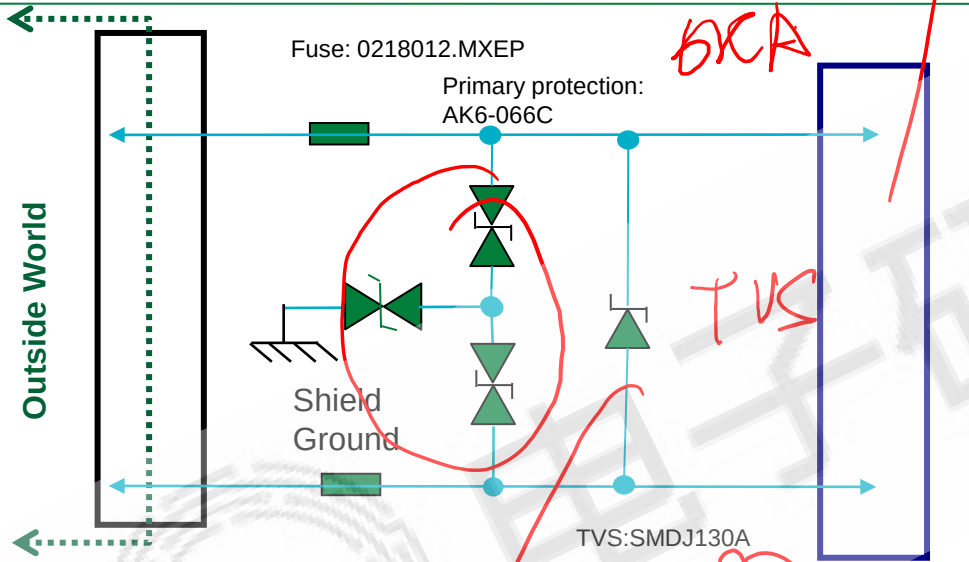
Regulatory Issues: For ESD, the IEC 61000-4-2 will be the most appropriate standard, and for lightning immunity the IEC 61000-4-5 may be consulted.

Unique Features: The SP1003 has ultra-low leakage of 100nA. The SP1005 is 0201 form factor and capable of 10A of lightning-induced surge (t_P=8/20µs). The SDxx Series can handle up to 30A of lightning-induced surge (t_P=8/20µs).

Application Warnings: None

Road Map Products to be Watching for: N/A

Circuit Protection of 110VDC



6KA 8/20us

FUSE: 0218012.MXEP 2pcs

TVS:AK10-066 3pcs

TVS:SMDJ130A 1pc

TVS: LTKAK3

TVS:8.0SMDJ

Design Notes:

This solution include two parts, the first is primary protection High surge for lighting protection

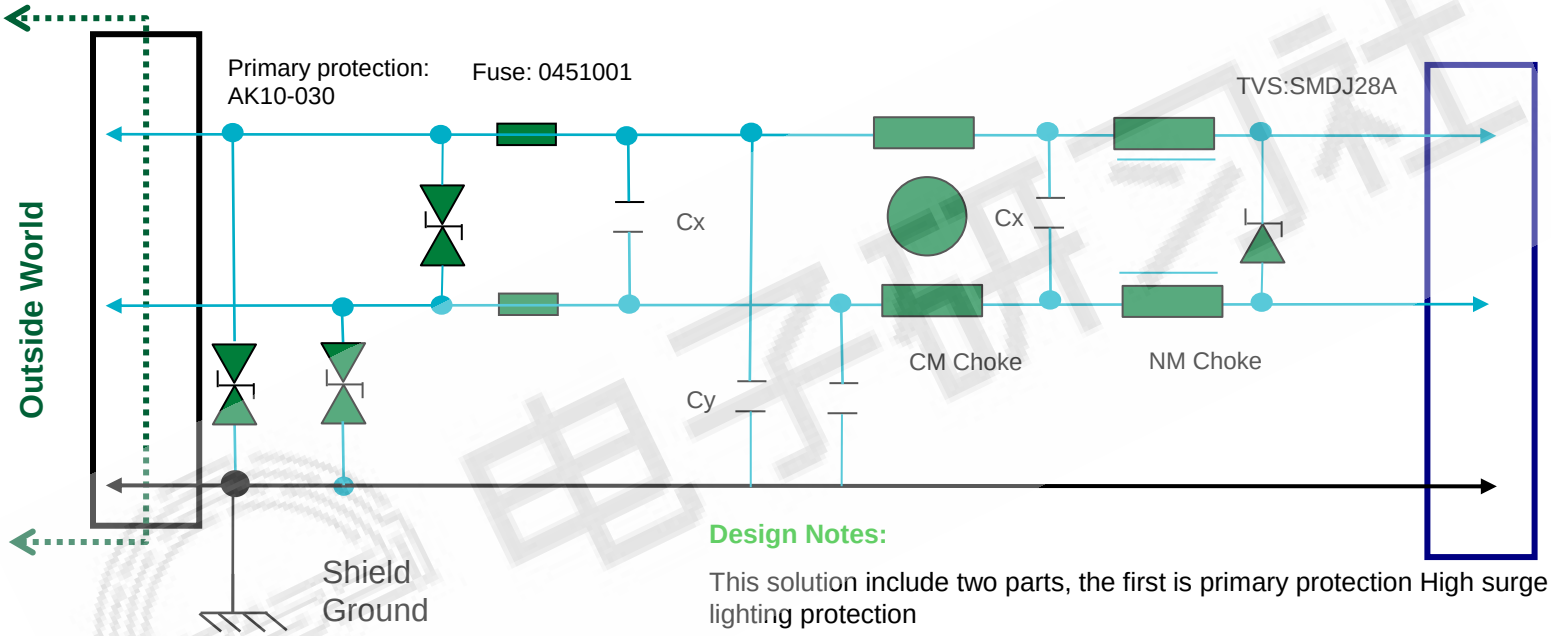
The secondary is Littelfuse 5kW TVS as a low voltage protection.

A fuse or Fuse is used as over current protection

Basically you must select a Lower voltage TVS as over voltage protection.

8/20us 6KA Surge Capability

Circuit Protection of 24VDC



10KA 8/20us

FUSE: 0453001 2pcs

TVS:AK10-030 3pcs

TVS:SMDJ28A 1pc

Design Notes:

This solution include two parts, the first is primary protection High surge for lighting protection

The secondary is Littelfuse 5kW TVS as a low voltage protection.

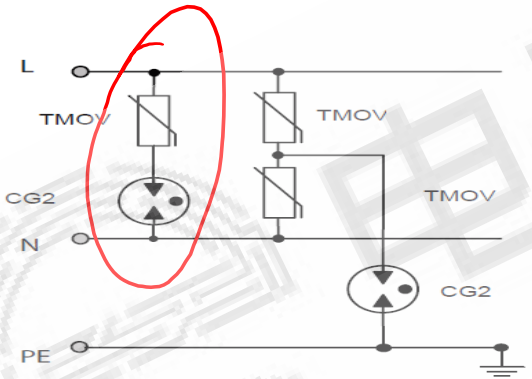
A fuse or Fuse is used as over current protection

Basically you must select a Lower voltage TVS as over voltage protection.

How to Protect AC Power Line?

This delta configuration provides:

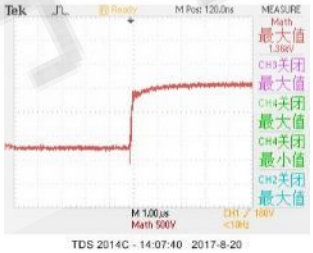
1) Differential protection between L-N
2) Common mode protection for L&N-PE
3) Prevents a current leakage path through the MOVs to PE(Zero energy stand-by consumption)



3) See Table 4 for technical requirements on power supply port protection for radio base station.
Table 4 Test of impulse current wave tolerance anti-lightning performance of radio base station power supply port

Port type	Lightning tolerance capacity level under different environment factors		Criteria
	Types L, M	Types H, T	
AC port	≥ 20 kA	≥ 20 kA	C
Distributed base station outdoor DC power supply port	≥ 15 kA	≥ 15 kA	C
Distributed base station external power supplying DC power supply port	≥ 15 kA	≥ 15 kA	C

Note: 1. Refer to the requirements on criteria in Table 2 for criteria;
2. All specifications listed in the table are common mode specification.
3. The lightning protection devices for DC ports can use various elements meeting safety requirements.



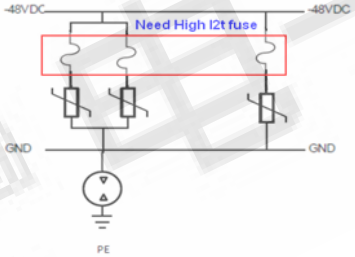
MOV + Si diode

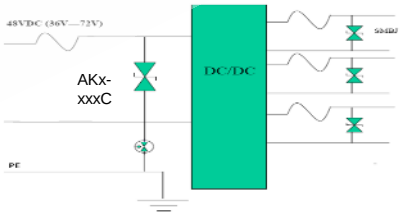
Protection Circuit for DC Power

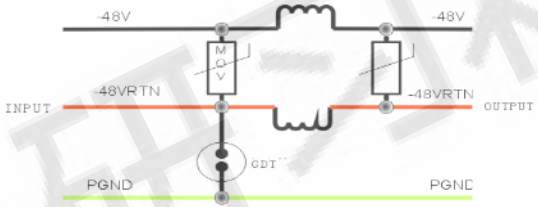
DC power protection

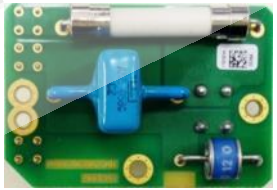
For the features of RRU's DC feeder, DC ports should be taken the following protection measures particularly.

- Feeder cables from RRU should have DC SPD and then access into DC power cabinet.
- Shielded cable should be adopted for power lines and be connected with the earth bar(MEB) which out of the feed-through window.
- If needed, DC SPD could be installed according to circuit diagram shown in left.







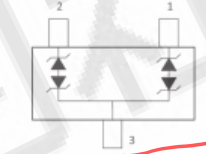


SM24FLEX-02HTG

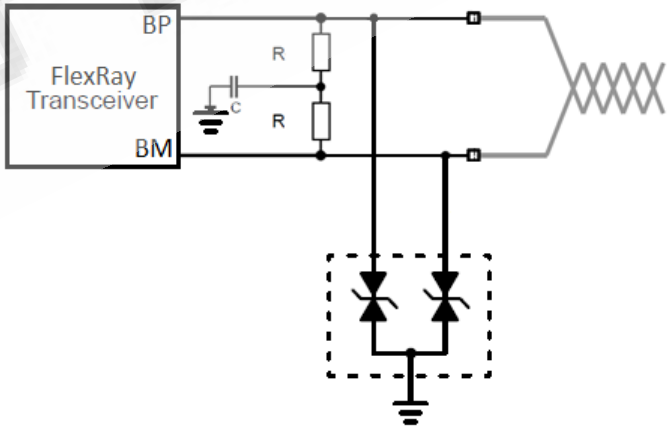
200W, SOT23-3L Diode Array for FlexRay bus protection

- **Target Applications:**
  - Drive by wire
  - Active suspension
  - High-performance powertrain
  - Adaptive cruise control
- **Features/benefits:**
  - 24V operating voltage
  - Bidirectional design
  - 24kV contact discharge
  - SOT23 package
    - 2 and 4 channel options
  - 10pF of capacitance

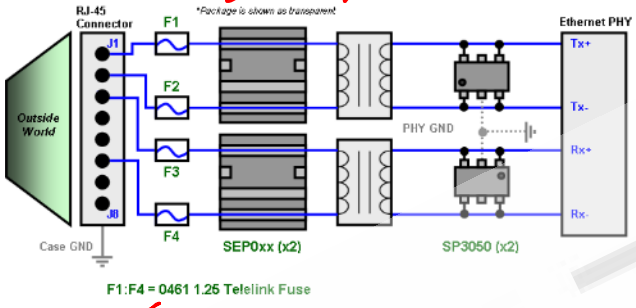
SM24FLEX-02



Example of FlexRay bus protection



Circuit Protection of Ethernet Port
- Lightning, Inter-building (GR-1089)



F1:F4 = 0461 1.25 Telelink Fuse

Ethernet: SEP0640Q38CB SIDACtor & SP3050-04HTG SPA™

Note: For 1GbE (1000Base-T) the protection scheme should replicated for the other 4 data lines.

Design Notes:

Protection Application: The data signals used in an Ethernet port vary between 1.0V (1000Base-T and 100Base-TX) to 2.5V (10Base-T), with maximum data rates of 1000Mbps, 100Mbps and 10Mbps, respectively. At these data rates, the capacitance of the suppressor needs to be taken into account. The signal lines to be protected from lightning include Tx± and Rx±.

Solution Description: As shown at the left, Telelink fuses are used for over-current protection for each data line, and the SEP series SIDACtor can be used for primary protection from lightning per the GR-1089 inter-building standard (500A, 2/10µs). The SEP064 has a working or standoff voltage of 58V allowing it be used in PoE and PoE+ applications. Last, a low capacitance diode array is used for secondary protection to suppress any let-through energy.

Companion Solutions: Other solutions within the LF portfolio exist in addition to these recommendations such as the SEP008 series. This lower voltage option can lower the clamping voltages in applications that do not need the higher standoff voltage due to PoE and PoE+ applications.

Regulatory Issues: Many standards could apply depending upon the end equipment usage such as GR-1089 or the IEC61000-4-5. Please consult Littelfuse for application support.

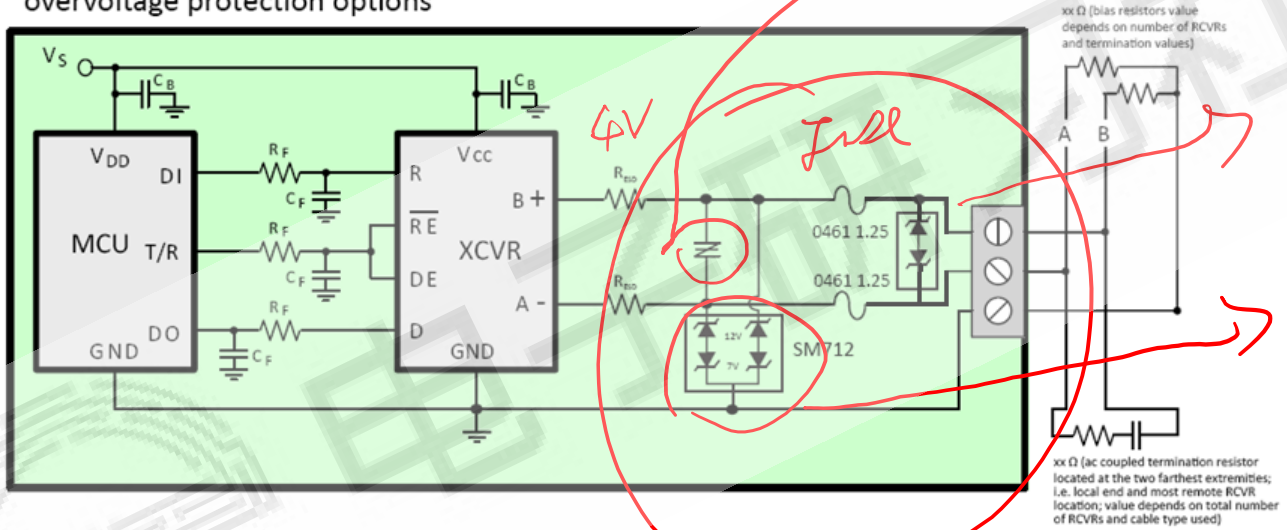
Unique Features: None

Road Map Products to be Watching for: SP4061 Series: < 4pF, 2.5V, 20A

Ordering Number	Surge (t_P=2/10µs)	I/O Capacitance @ V_R=0V	Channels	V_{RWM}	Packaging
SEP0640Q38CB	500A	See datasheet	2	58V	QFN (5x6mm)
SEP0080Q38CB	500A	See datasheet	2	6V	QFN (5x6mm)
SP3050-04HTG	10A	2.4pF	4	6V	SOT23-6

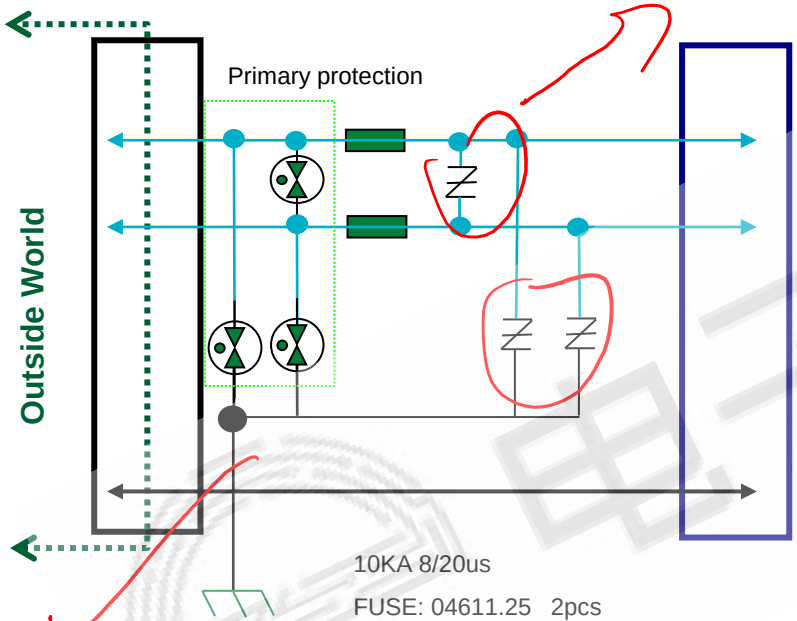
Circuit Protection of RS485

RS 485 driver schematic 2-wire option with overcurrent (TeleLink 0461 1.25) & overvoltage protection options



Primary TVS: SMDJ6.0CA 5.0SMDJ6.0CA 8.0SMDJ6.0CA 2KA/8/20us
Surge Fuse: 04611.25
DM: SMBJ6.8CA P0080S3LRP SDP0080TO23G5RP
CM&DM ESD : SM712

Circuit Protection of RS485 Out Door



Design Notes:

This solution include two parts, the first is primary protection GDT for lighting protection. If possible this application is for our door cable protection.

The secondary is Littelfuse SIDACtor as a low voltage protection.

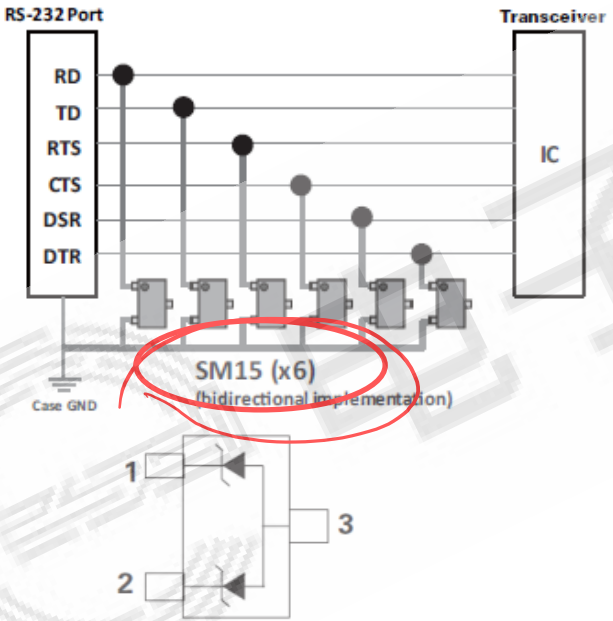
A fuse or Fuse is used as over current protection

Basically you must select a SIDACtor as over voltage protection.

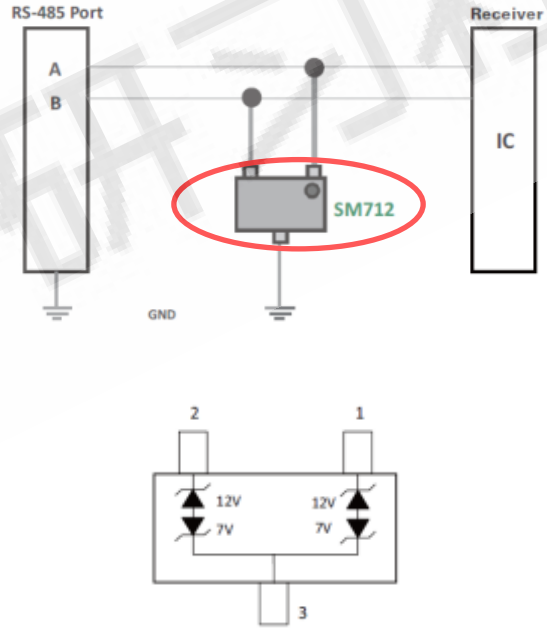
8/20us 5KA Surge Capability

TVS Diode Array used on Interface 485/232 ports for ESD Protection

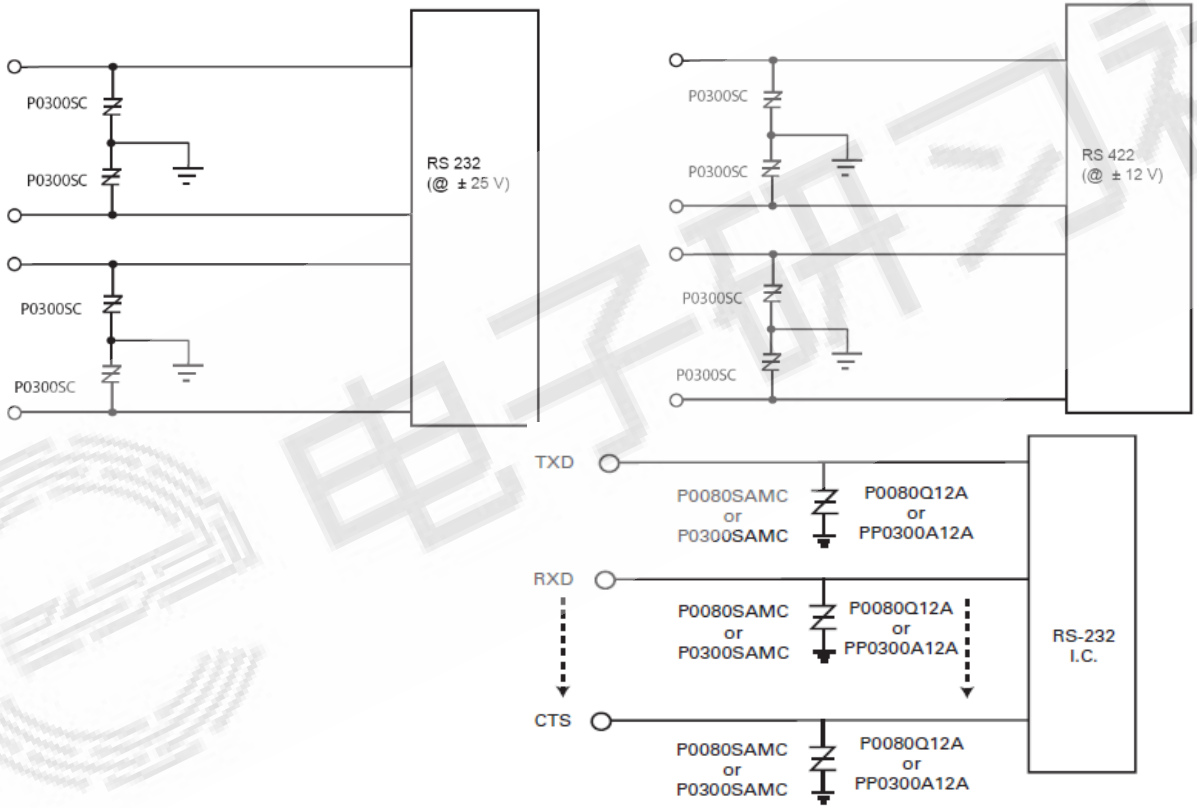
RS-232 Application Example



RS-485 Application Example



Circuit Protection of RS232



Thanks a lot!

Littelfuse

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