SOLUTIONS GUIDE

Fuses For Power Electronics

Protection of Power Semiconductors

Mersen

Eldre | Ferraz Shawmut | R-Theta

Semiconductor Fuses That Meet Every Major Standard

"...the fast action of semiconductor fuses significantly limits the short circuit current."

Standards may change from country to country, but the need for safe, reliable electrical protection for semiconductor applications is the same the world over. That's why Mersen offers the best protection solutions on the market today and the widest range of semiconductor fuses that meets every major International Standard.

Semiconductor fuses are used to protect against over-current conditions in power electronic equipment. There is hardly an electric powered product that exists today that does not rely on semiconductor technology to some degree. That means extending electrical protection to IGBTs, thyristors, triacs, diodes, and a host of other solid-state components, and providing a wide range of voltage requirements, unique mounting configurations, and special protection characteristics.

Semiconductor Protection Fuse Solutions

Mersen affords OEM designers and equipment-maintenance personnel a comprehensive line of semiconductor protection fuses in different ratings up to 10,000VAC and 12,500VDC and from 24 to 4000VDC. These lines, such as Protistor® PSC Square Body ceramic semiconductor fuses, have been developed to meet worldwide standards and also match every market with complete lines of North American round semiconductor fuses, IEC Cylindrical, NH German and British Standards fuses. Plus, Mersen also offers compatible holders, fuse blocks and monitoring accessories such as blown-fuse indicators, trigger switch actuators, and add-on switches.

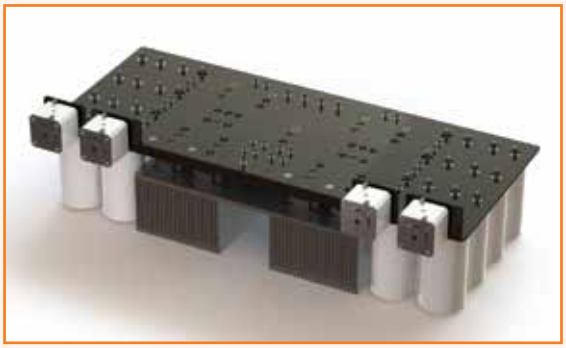
In addition, custom solutions are available for your semiconductor protection needs. As a design partner with extensive application and product expertise, Mersen is able to maximize system performance, lower total costs, and reduce time to market. Our dedicated power electronics team is available to customize a solution for you.

How to Obtain More Information

This brochure provides a broad overview of semiconductor protection fuse solutions. For more detailed product information and other specific details, explore our online catalog or consult your local sales representative. For technical and applications support and to help you select the best protection which meets specific standards, our technical services team is at your disposal.

Turn to Mersen for customized electrical protection solutions for power electronics

Combine Mersen square body semiconductor fuses with Mersen's thermal protection and laminated bus bar offerings for an optimized system solution to support your power electronics designs. As a design partner with extensive application and product expertise, Mersen is able to maximize system performance, lower total costs, and reduce time to market. Our dedicated power electronics team is available to customize a solution for you.



Protistor® - PSC Square Body

Mersen's **P**rotection **S**emi**c**onductor (PSC) Square Body fuses provide maximum flexibility in equipment design and ultimate protection for today's power conversion equipment. These square body fuses are available in four different body sizes, each size having seven worldwide acceptable mounting styles. PSC fuses have been engineered to provide state-of-the-art protection. They have pure silver or bimetal die-cut elements embedded in solidified sand, which helps control arcing characteristics for low I^2t and high interrupting rating. All contact surfaces are silver plated and all hardware is non-magnetic.

Applications

- Protection of rectifiers, inverters, AC drives
- UPS Systems, reduced voltage motor starters, and other equipment in globally accepted applications

Product Lines & Specifications

Size	Class	Connection type	Mounting type	Voltage		Current Ratings	Interrupting Rating		UL Recognition	CSA Certification	IEC Standards	German Standard
				AC	DC		AC	DC				
30, 31 32, 33 2x32, 2x33	uR	Tap	TF, TTI, TDF, PLAF	690V/ 700V	600 VDC*	50-2500A	200kA	100kA*	E76491 Volume 1, Section 13	Yes	60269-4	VDE 636-23
30, 31 32, 33	uR	Blades	D08A, D1A, EF, KI, LI	690V/ 700V	600 VDC*	50-1400A	200kA	100kA*	E76491 Volume 1, Section 13	Yes	60269-4	VDE 636-23
70, 71 72, 73 2x72, 2x73	uR	Tap	TF,TTI, TDF, PLAF	1250V/ 1300V	750-1100 VDC*	40-1800A	≤200kA	≥100kA*	E76491 Volume 1, Section 16	Yes	60269-4	VDE 636-23
70, 71 72, 73	uR	Blades	D08A, D1A, EF, KI, LI	1250V/ 1300V	750-1100 VDC*	40-1000A	≤200kA	≥100kA*	E76491 Volume 1, Section 16	Yes	60269-4	VDE 636-23
70, 71 72, 73	gR	Tap and Blades	TF, EF, D1A	690V	350-600V DC	50-1000A	150kA	*	-	-	60269-4	VDE 636-23

* - Varied by rating—consult factory for specifics

Amp Trap® - North American Round Body

The North American Round Body Semiconductor Protection fuses, known as Amp-Trap, were designed for the protection of semiconductor devices. This product line encompasses a wide variety of voltage ratings and performance, making it ideal for protecting a wide variety of power electronic applications.

Applications

- Protection of motor drives
- UPS, inverters, etc.
- Protection of small inverters and drives, and equipment requiring the highest degree of protection
- Protection of heavy traction and electrochemical rectifiers as well as other heavy-duty equipment
- Heavy duty power supplies

Product Lines & Specifications

North American Round Body	Voltage		Current Ratings	Interrupting Rating		UL Recognition*
	AC	DC		AC	DC	
A15QS	150V	150V	1 - 6000A	100kA	≤100kA*	E60314 vol. 1, sec. 37 E76491 vol. 1, sec. 10
A30QS	300V	300V*	1 - 6000A	200kA	100kA	E60314 vol. 1, sec. 36 E76491 vol. 1, sec. 10
A50QS	500V	500V	35 - 1200A	200kA	87kA	E60314 vol. 1, sec. 11
A50P	500V	≤500V*	10 - 1600A	100kA	≤100kA*	E60314 vol. 1, sec. 2 & 4
A60Q	600V	800V or 600V*	5 - 40A	200kA	100kA	E60314 vol. 1, sec. 17
A60X	600V		1 - 3000A	200kA*		E60314 vol. 1, sec.. 3
A70QS	700V	≤890V*	6 - 800A	200kA	100kA	E60314 vol. 1, sec. 15 E76491 vol. 1, sec. 15
A70P	700V	≤700V*	10 - 2000A	100kA	≤100kA*	E60314 vol. 1, sec. 2 & 4
A70Q	700V	650V	35 - 600A	200kA	100kA	E60314 vol. 1, sec. 8
A100P	1000V	750V°	15 - 2000A	100kA	100kA°	E60314 vol. 1, sec. 2 (AC Only)
A120X	1200V	1000V°	1 - 30A	100kA	100kA°	E60314 vol. 1, sec. 42 (AC Only)
A150X	1500V	1500V	1 - 1000A	100kA	100kA	E60314 vol. 1, sec. 44 (DC Only)

° - Self-certified
* - Varied by rating—consult factory for specifics

Protistor® - IEC Cylindrical Body

Mersen's IEC Cylindrical fuses provide an extremely high interrupting rating affording power semiconductor applications the ultimate in electrical protection according to IEC 60269-4. The semiconductor fuses offer is comprised of 2 different class of protection:

- The most common gR range is a fast acting fuse with full-range protection. It protects high short circuit currents and small overload currents.
- The uR range is a high performance, ultra-fast acting fuse for superior short circuit protection only.

All offers are UL recognized and CCC certified to fit worldwide requirements.

Applications

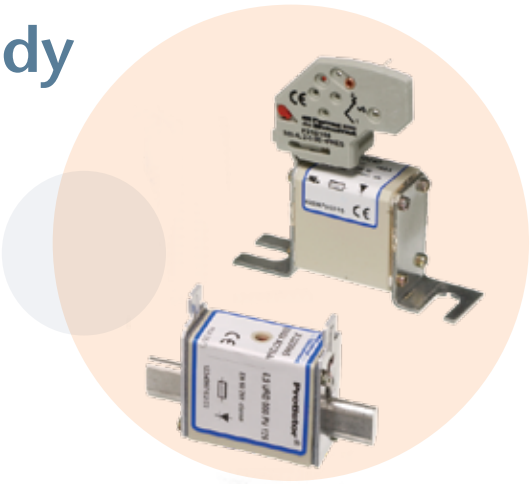
- Small inverters
- UPS systems
- Motor drives

Product Lines & Specifications

Size	Class	Connection type	Voltage		Current Ratings	Interrupting Rating		UL Recognition	CSA Certification	IEC Standards
			AC	DC		AC	DC			
10x38	gR	Ferrule	690V	500VDC	1-32A	200kA	50kA	E76491 Volume 1, Section 34	Yes	60269-4
14x51	uR	Ferrule	690V	≤890VDC*	1-63A	200kA	Up to 100kA*	E76491 Volume 1, Section 15	Yes	60269-4
14x51	gR	Ferrule	690V	≤600VDC*	1-63A	200kA	Up to 100kA*	E76491 Volume 1, Sections 24&36	Yes	60269-4
22x58	uR	Ferrule	690V	≤890VDC*	12-135A	200kA	Up to 100kA*	E76491 Volume 1, Section 15	Yes	60269-4
22x58	gR	Ferrule	690V	≤600VDC*	12-135A	200kA	Up to 100kA*	E76491 Volume 1, Sections 25&37	Yes	60269-4

* - Varied by rating—consult factory for specifics

Protistor® - NH German and British Standard Square Body



Mersen's DIN and BS88 Fuses offer an extremely high interrupting rating, affording power semiconductor applications the ultimate in electrical protection.

Applications

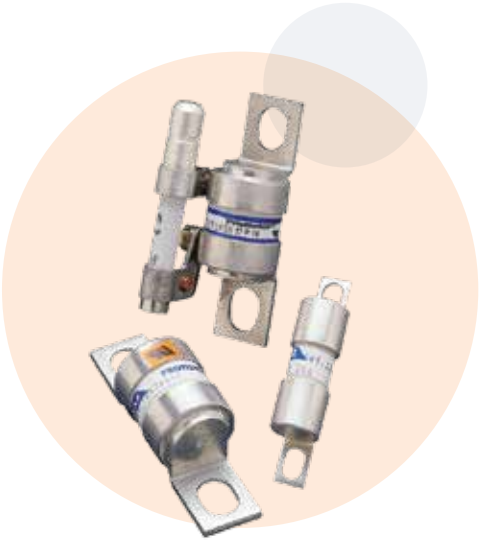
- Protection of rectifiers, inverters, AC drives
- UPS Systems, reduced voltage motor starters, and other equipment in globally accepted applications

Product Lines & Specifications

Size	Class	Connection type	Mounting type	Voltage		Current Ratings	Interrupting Rating		UL Recognition	IEC Standards	German Standard	British Standard
				AC	DC		AC	DC				
000, 00	uR	Blades	D11A, PV, BS88	690V	500 VDC	16-400A	200kA	-	E76491	60269-4	VDE 636-23, DIN 43620	BS 88-4
000, 00	gR	Blades	D11A, PV, BS88	690V	500 VDC	16-160A	200kA	*	E76491	60269-4	VDE 636-23, DIN 43620	BS 88-4
1	uR	Plain Blades	PV	690V	-	63-400A	200kA	-	-	60269-4	VDE 636-23, DIN 43620	-
2	uR	Plain Blades	PV	690V	-	160-700A	200kA	-	-	60269-4	VDE 636-23, DIN 43620	-
3	uR	Plain Blades	PV	690V	-	315-1000A	200kA	-	-	60269-4	VDE 636-23, DIN 43620	-
000, 00 1,2,3	gS	Plain Blades	PV	690V	-	16-630A	200kA	-	E76491 Vol. 1, Sec. 32	60269-4	VDE 636-23, DIN 43620	-

* - Varied by rating—consult factory for specifics

Protistor® - British Standard Cylindrical Body



Mersen's Protistor Fuse line offers an extremely high interrupting rating, affording power semiconductor applications the ultimate in circuit protection while meeting the British Standard in a round fuse format.

Applications

- Protection of rectifiers, inverters, AC drives
- UPS Systems, reduced voltage motor starters, and other equipment in globally accepted applications

Product Lines & Specifications

Size	Class	Connection type	Mounting type	Voltage		Current Ratings	Interrupting Rating		UL Recognition	IEC Standards	German Standard	British Standard
				AC	DC		AC	DC				
10x28, 17x27	uR	Blades	BS88	250V	-	5-160A	160kA	-	E76491	60269-4	-	BS 88-4
36x27, 2x36x27	uR	Blades	BS88	250V	-	50-1050A	100kA	-	E76491	60269-4	-	BS 88-4
17x49 2x17x49	uR	Blades	BS88, D08	690V	-	5-160A	160kA	-	E76491	60269-4	VDE 636-23, DIN 43620	BS 88-4
17x49	gR	Blades	BS88, D08	690V	-	12-90A	160kA	-	E76491	60269-4	VDE 636-23, DIN 43620	BS 88-4

Protistor® - C6 High Performance Square Body

Mersen provides state-of-the-art protection for large, high-power applications of power generation, transmission, and conversion of electrical energy. Engineered to provide the highest reliability and safety for high-power semiconductors such as diodes, thyristors, IGCTs, and IGBTs, Mersen C6 High Performance Square Body fuses are fully customizable to fit our customer's requirements.

Our expertise in fast acting technology has led to the development of an optimized protection solution with the lowest I^2t and the highest breaking current capacity while keeping the best cycling capability. The C6 High Performance Square Body fuses have pure silver fuse elements embedded in solidified sand. All contact surfaces are plated and all hardware is non magnetic.

All fuses come standard with a low voltage blown fuse indicator. This indicator can operate a microswitch which is easily mounted directly onto the fuse in service.

Product Lines & Specifications

Size	Class	Connection type	Mounting type	Voltage		Current Ratings	Interrupting Rating		UL Recognition	IEC Standards	CCC Certification
				AC	DC		AC	DC			
44	aR	Tap, press-pack	TTQF, PL.F, PP.F	up to 750V	*	1250-6200A	up to 230kA - tested; 350kA - estimated	-	1600-3000A only	60269-4	pending
2x44 double bodies	aR	Plates, press-pack	PL.F, PP.F	up to 700V	*	2400-10000A	up to 230kA - tested; 350kA - estimated	-	*	60269-4	*
73	aR	Tap, plates, blades	TT., PL.F, DIN 110, LI	up to 1250V	*	800-2400A	up to 230kA - tested; 350kA - estimated	-	*	60269-4	*
2x73 double bodies	aR	Plates, omega bar	PL.F, 2xTT.	up to 1150V	*	1800-4200A	up to 230kA - tested; 350kA - estimated	-	*	60269-4	*
83, 84	aR	Tap, plates, blades, press-pack	TT., TTQF, PL.F, PP.F	up to 1500V	*	630-4200A	up to 235kA - tested; 350kA - estimated	-	*	60269-4	For specific ratings
2x83, 2x84 double bodies	aR	Plates, press-pack	PL.F, PP.F	up to 1450V	*	900-8400A	up to 235kA - tested; 350kA - estimated	-	*	60269-4	*
93, 94	aR	Tap, plates, press-pack	TT., TTQF, PL.F, PP.F	up to 1800V	*	525-3600A	up to 235kA - tested; 350kA - estimated	-	Size 93 650-1250A TDN, Size 94 1700-1900A	60269-4	For specific ratings
2x93, 2x94 double bodies	aR	Plates, press-pack	PL.F, PP.F	up to 1800V	*	1050-7200A	up to 235kA - tested; 350kA - estimated	-	*	60269-4	*
123, 124	aR	Tap, plates	TT., TTQF, PL.F, PP.F	up to 2500V	*	630-2900A	up to 230kA - tested; 350kA - estimated	-	*	60269-4	*
2x123, 2x124 double bodies	aR	Plates, press-pack	PL.F, PP.F	up to 2500V	*	800-4100A	up to 230kA - tested; 350kA - estimated	-	*	60269-4	*
173, 174	aR	Tap, plates	TT., TTQF, PL.F, PP.F	up to 3800V	*	400-1500A	up to 150kA - tested; 300kA - estimated	-	*	60269-4	*
2x173, 2x174 double bodies	aR	Plates	PL.F, PP.F	up to 3600V	*	800-3100A	up to 150kA - tested; 300kA - estimated	-	*	60269-4	*

* - Varied by rating—consult factory for specifics

Protistor® - CV4 IGBT Disconnection Square Body

Mersen is a unique player in protection against capacitor discharge and high di/dt faults. Our extensive knowledge base was acquired from our direct partnerships with key customers that resulted in a CV4 IGBT Disconnection Square Body fuse that allows your system to restart in case one IGBT module breaks down. This experience has given us the ability to create a dynamic product that has the capability to disconnect within tens of microseconds to prevent collateral damage from a fault condition.

Product Lines & Specifications

Size	Class	Connection type	Mounting type	Voltage		Current Ratings	Interrupting Rating		UL Recognition	IEC Approval	CCC Certification
				AC	DC (VSI)**		AC	DC (VSI)**			
2x15x27 single body	aR	L-Bracket Terminals	Flat ends	5000V	5000	up to 325A	*	*	-	60269-4	-
2x15x27 multiple bodies	aR	L-Bracket Terminals	Flat ends	up to 5000V	*	*	*	*	-	60269-4	-
2x15x27 single body	aR	L-Bracket Terminals	Flat ends	7200V	7200	up to 250A	up to 80kA	VSI under validation*	-	60269-4	-
2x15x27 multiple bodies	aR	L-Bracket Terminals	Flat ends	up to 7200V	*	up to 1660A	up to 80kA	VSI under validation*	-	60269-4	-
2x15x27 single body	aR	L-Bracket Terminals	Flat ends	10000V	10000	up to 170A	up to 36kA	VSI under validation*	-	60269-4	-
2x15x27 multiple bodies	aR	L-Bracket Terminals	Flat ends	10000V	*	*	*	*	-	60269-4	-
2x15x27 single body	aR	L-Bracket Terminals	Flat ends	12500V	*	up to 135A	*	*	-	60269-4	-
2x15x27 multiple bodies	aR	L-Bracket Terminals	Flat ends	up to 12500V	*	*	*	*	-	60269-4	-

* - Varied by rating—consult factory for specifics

** - DC (VSI) Voltage Source Inverter

Semiconductor Fuse Mapping Definitions

Semiconductor Fuse Technology

Semiconductor fuses are used to protect against catastrophic semiconductor failure. Because of their ability to operate quickly during high fault current, semiconductor fuses help to significantly limit short circuit current to downstream components.
Each different technology type of semiconductor fuse is defined by the fuse size, shape and the type of termination:

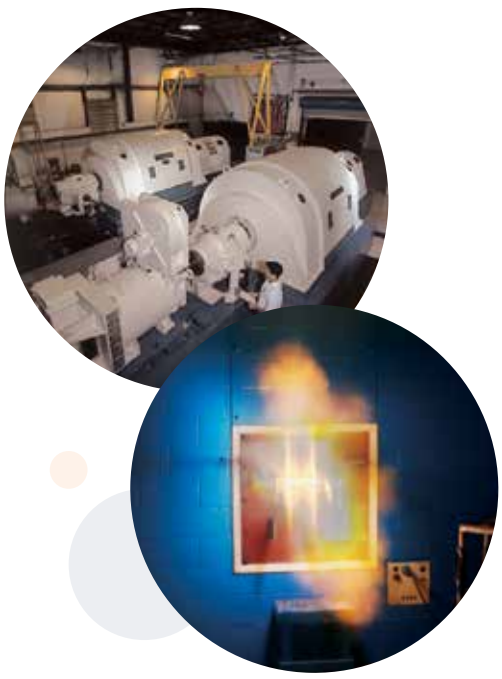
- Cylindrical fuses can have bladed or non-bladed electrical contacts. Ferrule style fuses have caps crimped or affixed to the body. The body construction material is either made of ceramic or GMG (Glass Melamine Glass).
- Square body fuses have terminals that are screwed to the body.
  The body material is made of ceramic. There are various types of technologies that have a square style body: PSC, low inductance, LR (large rectifier), and HV (high voltage).

Regional Standards

Semiconductor fuses are covered by regulatory standards. The mechanical connections represented by the standards shown in this bulletin follow these regional practices.
Here are general descriptions of these regional practices:

- US - North American: Ferrule type, round body, or square body fuses with closed slot blades or end contacts with UNC tapped holes.
- FR - IEC Europe: Ferrule type and square body fuses with open slot blades or end contacts with metric tapped holes.
- DIN - German: Round body and square body fuses with brackets and wedge-shaped contacts according to DIN43620 and DIN 43653 standards.
- BS - British: Round body and square body fuses with brackets according to BS 88-4 standards.
- SP - Special Purpose: Fuses with mounting arrangements determined by application needs.

Mersen High-Power Test Labs



Mersen offers our customers global test capabilities for testing products in North America (Newburyport, Massachusetts) and in Europe (Saint Bonnet de Mure, France). Our labs are complementary regarding AC versus DC capabilities, and UL-CSA testing versus IEC testing. We utilize state-of-the-art instruments and software to provide accurate run-testing services and in-depth analysis.

The labs also play a critical role in custom-fuse development, enabling us to test prototypes quickly and efficiently to keep pace with your development schedule. These labs play a crucial and fundamental role in our quality control program for Mersen's electrical protection products.

Technical Questionnaire

Your Circuit Protection
What type of circuit do you have ? Please describe and attach circuit schematic, include fuse placement and fault location(s).

Application voltage		
What is the highest voltage the fuse must interrupt?		
VAC rms (nominal*):	or	VDC*:
VAC rms (maximum):		L/R time constant under fault condition:
Frequency:		
* Voltage tolerances: +/- 5%, +/-10%, other ?		

Current Rating/Load Characteristics - Describe the load (what is it)
Full load amps / equivalent RMS value of current thru fuse?
Describe any overloads (normal or cyclic operation) and/or Inrush (transient operation) where the fuse must not operate. Provide current and time profile (how much, for how long, how often).
Sketch out or provide table current (I) vs time(t) if possible, or attach your schematic.
Are there any other protective devices used in the circuit? What type? What location? What purpose ?
Is coordination required between this device and the fuse? ☐ No ☐ Yes, please describe:

Fault current
What is the maximum available fault current (r.m.s. value)?
What is the minimum current the fuse must open on?
Is protection required against short-circuit only or overload as well?
("a"/"g" type in IEC or "partial"/"full" range in UL)
Is there a minimum time requirement for the fuse-clearing?

Semiconductor Characteristics (if involved) and required protection	
What type of device is being protected? ☐SCR ☐IGBT ☐Diode ☐Power Transitor ☐Other	
What is the junction I^2t withstand of device?	What is the PIV (peak inverse voltage) of device?
Is I^2t protection required or are we only trying to isolate a faulted component? ☐I^2t protection required ☐Only isolation required	
What is the maximum permissible fuse let-thru I^2t (explosion I^2t limit of device)?	
If you have a configured drive, please provide manufacturer, complete part numbers and attach the device datasheet.	

Fuse environment
What is the ambient temperature surrounding the fuse?
Is cooling provided? ☐No ☐Yes Please give characteristics: forced air cooled, water cooled
How is the fuse connected in system?
What is bus cross-section or cable size?

Mechanical features of fuse (attach sketch if necessary)
What are the restrictions on fuse size? (How big can the fuse be?)
Is blown-fuse indication required? If yes, remote indication with microswitch or visual only?
What type of connection is preferred (Blade, end-contact, ferrule, special – specify)?

Certification / Standards
Which standard equipment listed / designed to? ☐NEC ☐IEC ☐UL ☐CSA
Which approval for fuses? ☐UL Listed ☐UL Recognized ☐VDE ☐CCC ☐Other

Commercial Requirements
Qty forecast / Delivery dates: for prototypes (pre-series)?
Qty forecast / Delivery dates: for production (annual usage)?
Please list any additional information that you feel is relevant to the proper fuse selection for this application.

MERSEN
Expertise, our source of energy

A WORLD LEADER
in safety & reliability
for electrical power

A GLOBAL PLAYER

Global expert in materials and equipment for extreme environments and in the safety and reliability of electrical equipment.

Mersen designs innovative solutions to address its clients' specific needs to enable them to optimize their manufacturing process in sectors such as Energy, Transportation, Electronics, Chemical, Pharmaceutical and Process Industries.

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