ELECTRONIC PRODUCT SELECTION GUIDE

Littelfuse®

A quick guide to selecting circuit protection
and switching solutions for electronic applications

Resettable PTCs

Fuses

PulseGuard® Polymeric ESD Suppressors

Metal Oxide Varistors

TVS Diodes and Diode Arrays

Teccor® SIDACtor® Protection Thyristors

Greentube™ Gas Plasma Arresters (Improved GDTs)

Teccor® Switching Thyristors

The World's Leading Provider of Circuit Protection Solutions

As the leader in circuit protection, the Littelfuse portfolio of brands is backed by decades of design and manufacturing expertise, plus the industry's most experienced technical support. Littelfuse products are vital components in virtually every application that uses electrical energy, including:

Automotive applications

Digital consumer electronics

Industrial/Electrical applications

Telecom/Datacom circuits

Choose from GDTs, switching thyristors, TVS diode and diode arrays, varistors, SIDACtor® devices, fuses, resettable PTCs, PulseGuard® suppressors, fuseholders, blocks and clips. Only Littelfuse offers the breadth of products to provide you with the correct solution for your application. Our total solution methodology helps you take a more stategic approach to designing your product, resulting in improved performance, reliability and customer satisfaction.

Companies around the world have come to rely on Littelfuse's commitment to providing the most advanced circuit protection solutions and technical expertise. It's this focus that has enabled Littelfuse to become the world's leading provider of circuit protection solutions.

A comprehensive approach to circuit protection

Littelfuse goes well beyond efficient and comprehensive product delivery. We offer an integrated approach that includes:

- A very broad, yet deep selection of products and technologies from a single source, so you benefit from a greater range of solutions and make fewer compromises.
- Products that comply with applicable industry and government standards, as well as our own uncompromising and rigorous quality and reliability criteria.
- Forward thinking, application-specific solutions that provide the assurance your most demanding requirements will be met.
- Dedicated global, customer-focused and application-specific technical support services.

For over 75 years, Littelfuse has maintained its focus on circuit protection. As we expand in global reach and technical sophistication, you can continue to count on us for solid circuit protection solutions, innovative technologies, and industry-leading technical expertise. It is a commitment that only a world class leader with staying power can support.

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Fuse Facts

The following Fuse Facts section will provide a better understanding of both fuses and their typical application. The fuses described are current-sensitive devices that serve as an intentional weak link in an electrical circuit and provide protection against overheating by reliably melting during current-overload conditions. They can be used to protect discrete components or complete circuits.

Although this guide provides technical information that will help you determine your circuit protection solution, such as product data and design guidelines, it is not intended to be comprehensive. Testing is strongly recommended and should be conducted to verify application performance.

The following fuse parameters and application concepts should be well understood in order to properly select a fuse for given circuit conditions.

In the absence of special requirements, Littelfuse reserves the right to make appropriate changes in design, process, and manufacturing location without notice.

Ambient Temperature

This refers to the temperature of the air immediately surrounding the fuse and should not to be confused with "room temperature." The fuse ambient temperature is appreciably higher in many cases, because it is enclosed (as in a panel mount fuseholder) or mounted near other heat producing components, such as resistors, transformers, etc.

Breaking Capacity

See *Interrupting Rating*.

Current Rating

This refers to the nominal ampere value of the fuse. It is established by the manufacturer as a value of the current the fuse can carry, based on a controlled set of test conditions. (See *Rerating*).

Most catalog fuse part numbers include series identification and ampere ratings. Refer to the *Overcurrent Selection Guide* section for guidance on making the proper choice.

Rerating

For 25°C ambient temperatures, it is recommended that fuses be operated at no more than 75% of the nominal current rating established using controlled test conditions. These test conditions are part of UL/CSA/ANCE (Mexico) 248-14 "Fuses for Supplementary Overcurrent Protection", the primary objective of which is to specify common test standards for the continued control of manufactured items intended for protection against fire, etc. Some common variations of these standards include: fully enclosed fuseholders, high contact resistances, air movement, transient spikes, and changes in connecting cable size (diameter and length).

Fuses are essentially temperature-sensitive devices. Even small variations from the controlled test conditions can greatly affect the predicted life of a fuse when it is loaded to its nominal value, usually expressed as 100% of rating. The circuit design engineer should clearly understand that the purpose of these controlled test conditions is to enable fuse manufacturers to maintain unified performance standards for their products, and must account for the variable conditions of the specific application.

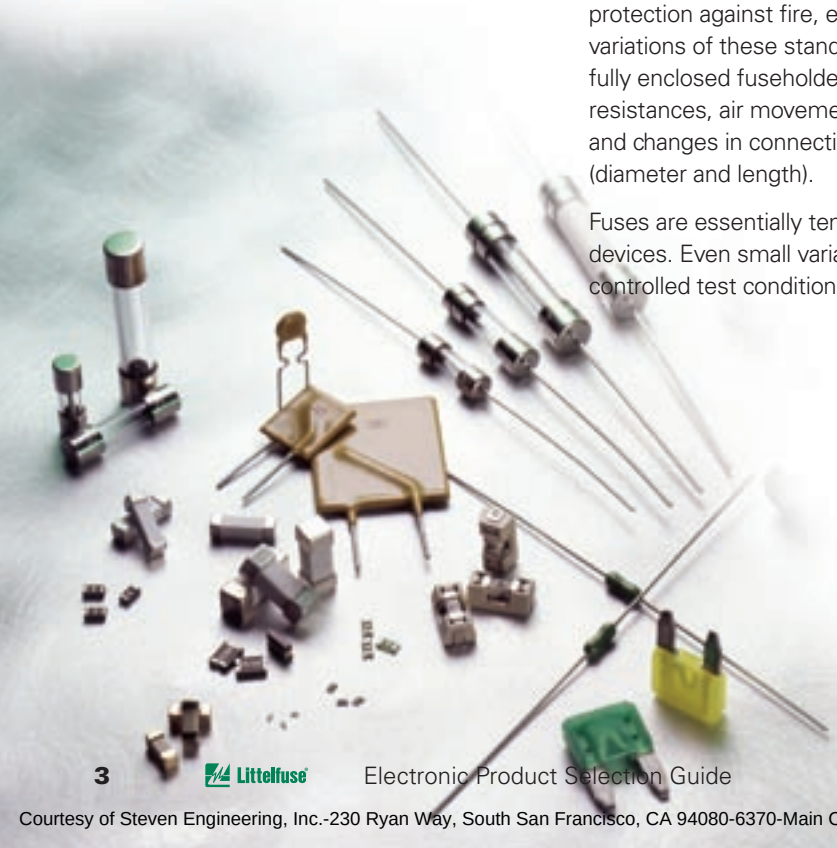
To compensate for these variables, the circuit design engineer who is designing for trouble-free, long-life fuse protection, generally loads the fuse no more than 75% of the nominal rating listed by the manufacturer, keeping in mind that overload and short circuit protection must be adequately provided for.

The fuses under discussion are temperature-sensitive devices whose ratings have been established in a 25°C ambient. The fuse temperature generated by current passing through the fuse, increases or decreases with ambient temperature change. The ambient temperature chart on page 6 illustrates the effect that ambient temperature has on the nominal current rating of a fuse.

Dimensions

All dimensions are given in inches unless otherwise specified. The fuses in this catalog range in size from the 0402 chip size (.041"L x .020"W x .012"H) up to the 5 AG, also commonly known as a "MIDGET" fuse (13/32" D x 1½" L).

As new products have been developed over the years, fuse sizes evolved to fill various electrical circuit protection needs. The first fuses were simple, open-wire devices, followed in the 1890's by Edison's enclosure of thin wire in a lamp base to make the first plug fuse. By 1904, Underwriters Laboratories had established size and rating specifications to meet safety standards. The renewable type fuses and automotive fuses appeared in 1914, and in 1927 Littelfuse started making very low amperage fuses for the budding electronics industry.



The fuse sizes in the chart below began with the early "Automobile Glass" fuses, hence the term "AG". The numbers were applied chronologically as different manufacturers started making a new size. For example, "3AG" was the third size placed on the market.

Other non-glass fuse sizes and constructions were determined by functional requirements, but they still retained the length or diameter dimensions of the glass fuses. Their designation was modified to AB in place of AG, indicating that the outer tube was constructed from Bakelite, fibre, ceramic, or a similar material other than glass. The largest size fuse shown in the chart is the 5AG, or "MIDGET", a name adopted from its use by the electrical industry and the National Electrical Code range which normally recognizes fuses of 9/16" x 2" as the smallest standard fuse in use.

Fuse Sizes

Fuse	Length		Diameter/Width	
	mm	in	mm	in
0402	1.04	.041	.51	.020
0603	1.60	.063	.813	.032
1206	3.18	.125	1.52	.060
1AG	15.875	.625	6.35	.250
2AG	14.48	.57	4.5	.177
3AG	32.385	1.28	6.985	.275
4AG	31.75	1.25	7.14	.281
5AG	38.1	1.50	10.31	.406
7AG	22.22	.875	6.35	.250
8AG	25.4	1	6.35	.250

Tolerances

The dimensions shown in this catalog are nominal. Unless otherwise specified, tolerances are applied as follows:

± .010" for dimensions to 2 decimal places.
± .005" for dimensions to 3 decimal places.

The factory should be contacted concerning metric system and fractional tolerances. Tolerances do not apply to lead lengths.

Fuse Characteristics

The characteristic of a fuse design refers to how rapidly the fuse responds to various current overloads. Fuse characteristics can be classified into four general categories: very fast-acting, fast-acting, Slo-Blo® and time delay (surge tolerant) fuses. The distinguishing feature of Slo-Blo® fuses is their additional thermal inertia and their ability to tolerate excessive start-up or in-rush overload pulses.

Fuse Construction

Internal fuse construction may vary depending on ampere rating. Fuse photos in this catalog show typical construction of a particular ampere rating within the fuse series.

Fuseholders

In many applications, fuses are installed in fuseholders. These fuses and their associated fuseholders are not intended for operation as a "switch" for turning power "on" and "off".

Interrupting Rating

Also known as breaking capacity or short circuit rating, the interrupting rating is the maximum approved current which the fuse can safely interrupt at its rated voltage. During a fault or short circuit condition, a fuse may receive an instantaneous overload current many times greater than its normal operating current. Safe operation requires that the fuse remain intact (no explosion or body rupture) and clear the circuit.

Interrupting ratings may vary with fuse design and range from 35 amperes AC for some 250V metric size (5 x 20mm) fuses up to 200,000 amperes AC for the 600V KLK series. Information on other fuse series can be obtained from the factory.

Fuses listed in accordance with UL/CSA/ANCE 248 are required to have an interrupting rating of 10,000 amperes at 125 VAC, with some exceptions (See *Standards* section) which, in many applications, provides a safety factor far in excess of the short circuit currents available.

Nuisance Opening

Nuisance opening is most often caused by an incomplete analysis of the circuit under consideration. Of all the "Selection Factors" listed in the *Fuse Selection* section, special attention must be given to the normal operating current, ambient temperature, and pulses. A fuse cannot be selected solely on the basis of normal operating current and ambient temperature.

For example, one prevalent cause of nuisance opening in conventional power supplies is the failure to adequately consider the fuse's nominal melting I^2t rating. In such an application, the fuse's I^2t rating must also meet the in-rush current requirements created by input impedance of the power supply's smoothing filter. The procedure for converting various waveforms into I^2t circuit values are given in the *Fuse Selection Guide* section.

For trouble-free, long-life fuse protection, it is good design practice to select a fuse for which the I^2t of the waveform is no more than 20% of the nominal melting I^2t rating of the fuse. Refer to the section on PULSES in the *Fuse Selection* section.

Resistance

The resistance of a fuse is usually an insignificant part of the total circuit resistance. Since the resistance of fractional amperage fuses can be several ohms, this fact should be considered when using them in low-voltage circuits. Actual values can be obtained from the factory. Most fuses are manufactured from materials which have positive temperature coefficients and, therefore, it is common to refer to cold resistance and hot resistance (voltage drop at rated current), with actual operation being somewhere in between.

Cold resistance is the resistance obtained using a measuring current of no more than 10% of the fuse's nominal rated current. Values shown in this publication for cold resistance are nominal and representative. The factory should be consulted if this parameter is critical to the design analysis.

Hot resistance is the resistance calculated from the stabilized voltage drop across the fuse, with current equal to the nominal rated current flowing through it. Resistance data on all Littelfuse products is available upon request. Fuses can be supplied to specified controlled resistance tolerances.

Fuse Facts continued from previous page

Soldering Recommendations

Since most fuse constructions incorporate soldered connections, caution should be used when installing fuses intended to be soldered in place. The application of excessive heat can reflow the solder within the fuse and change its rating. Fuses are heat-sensitive components similar to semiconductors, and the use of heat sinks during soldering is recommended.

Statistical Process Control

Because compliance with certain specifications requires destructive testing, overload tests are performed on a statistical basis for each lot manufactured.

Time-Current Curve

The graphical presentation of the fusing characteristic (time-current curves) is generally an average curve which is presented as a design aid but is not generally considered part of the fuse specification. Time-current curves are extremely useful in defining a fuse, since fuses with the same current rating can be represented by considerably different time-current curves. The fuse specification typically will include a life requirement at 100% of rating and maximum opening times at overload points (usually 135% and 200% of rating).

A time-current curve represents average data for the design; however, there may be some differences in the values for any one given production lot. Samples should be tested to verify performance, once the fuse has been selected.

Underwriters Laboratories

Reference to "Listed by Underwriters Laboratories" signifies that the fuses meet the requirements of UL/CSA/ANCE 248-14 "Fuses for Supplementary Overcurrent Protection". Some 32 volt fuses (automotive) in this catalog are listed under UL Standard 275. Reference to "Recognized Under the Component Program of Underwriters Laboratories" signifies that the item is recognized under the component program of Underwriters Laboratories and application approval is required.

Voltage Rating

The voltage rating, as marked on a fuse, indicates that the fuse can be relied upon to safely interrupt its rated short circuit current in a circuit where the voltage is equal to, or less than, its rated voltage.

Most common voltage ratings used by fuse manufacturers for most small-dimension and midget fuses are 24, 32, 63, 125, 250, 300, 350 and 600. In electronic equipment with relatively low output power supplies, with circuit impedance limiting short circuit currents to values of less than ten times the current rating of the fuse, it is common practice to specify fuses with 125 or 250 volt ratings for secondary circuit protection of 500 volts or higher.

As mentioned previously (See *Rerating*), fuses are sensitive to changes in current, not voltage, maintaining their "status quo" at any voltage from zero to the maximum rating of the fuse. It is not until the fuse element melts and arcing occurs that the circuit voltage and available power become an issue. The safe interruption of the circuit, as it relates to circuit voltage and available power, is discussed in the section on *Interrupting Rating*.

To summarize, under an overload condition, a fuse may be used at any voltage that is less than its voltage rating without detriment to its fusing characteristics. Please contact the factory for applications at voltages greater than the voltage rating.

Derivation of Nominal Melting I^2t

Laboratory tests are conducted on each fuse design to determine the amount of energy required to melt the fusing element. This energy is described as nominal melting I^2t and is expressed as "Ampere Squared Seconds" (A^2 Sec). A pulse of current is applied to the fuse, and a time measurement is taken for melting to occur. If melting does not occur within a short duration of about 1 millisecond (0.001 seconds) or less for thin-film fuses; 8 milliseconds (0.008 seconds) or less for axial and cartridge fuses; the level of pulse current is increased. This test procedure is repeated until melting of the fuse element is confined to within the 1 or 8 milliseconds time frame, respectively.

The purpose of this procedure is to assure that the heat created has insufficient time to thermally conduct away from the fuse element. That is, all of the heat energy (I^2t) is used to cause melting. Once the measurements of current (I) and time (t) are determined, it is a simple matter to calculate melting I^2t. When the melting phase reaches completion, an electrical arc occurs immediately prior to the "opening" of the fuse element. Clearing I^2t = Melting I^2t + arcing I^2t. The nominal I^2t values given in this publication pertain to the melting phase portion of the "clearing" or "opening".

Fuse Selection

The application guidelines and product data in this guide are intended to provide technical information that will help with application design. Since these are only a few of the contributing parameters, application testing is strongly recommended and should be used to verify performance in the circuit/application.

Many of the factors involved with fuse selection are listed below:

Selection Factors

1. Normal operating current
2. Application voltage (AC or DC)
3. Ambient temperature
4. Overload current and length of time in which the fuse must open
5. Maximum available fault current
6. Pulses, Surge Currents, In-rush Currents, Start-up Currents, and Circuit Transients

7. Physical size limitations, such as length, diameter, or height
8. Agency Approvals required, such as UL, CSA, VDE, METI, or Military
9. Considerations: mounting type/form factor, ease of removal, axial leads, visual indication, etc.
10. Fuseholder features: clips, mounting block, panel mount, p.c. board mount, R.F.I. shielded, etc.

Normal Operating Current

The current rating of a fuse is typically derated 25% for operation at 25°C to avoid nuisance blowing. For example, a fuse with a current rating of 10A is not usually recommended for operation at more than 7.5A in a 25°C ambient. For additional details, see *rerating* on page 10 section and *Ambient Temperature* below.

Voltage

The voltage rating of the fuse must be equal to, or greater than, the available circuit voltage. For exceptions, see *Voltage Rating*.

Ambient Temperature

The current carrying capacity tests of fuses are performed at 25°C and will be affected by changes in ambient temperature. The higher the ambient temperature, the hotter the fuse will operate, and the shorter its life will be. Conversely, operating at a lower temperature will prolong fuse life. A fuse also runs hotter as the normal operating current approaches or exceeds the rating of the selected fuse. Practical experience indicates fuses at room temperature should last indefinitely, if operated at no more than 75% of catalog fuse rating.

* Ambient temperature effects are in addition to the normal rerating.

Example: Given a normal operating current of 2.25 amperes in an application using a Very Fast-Acting Cartridge fuse at room temperature, then:

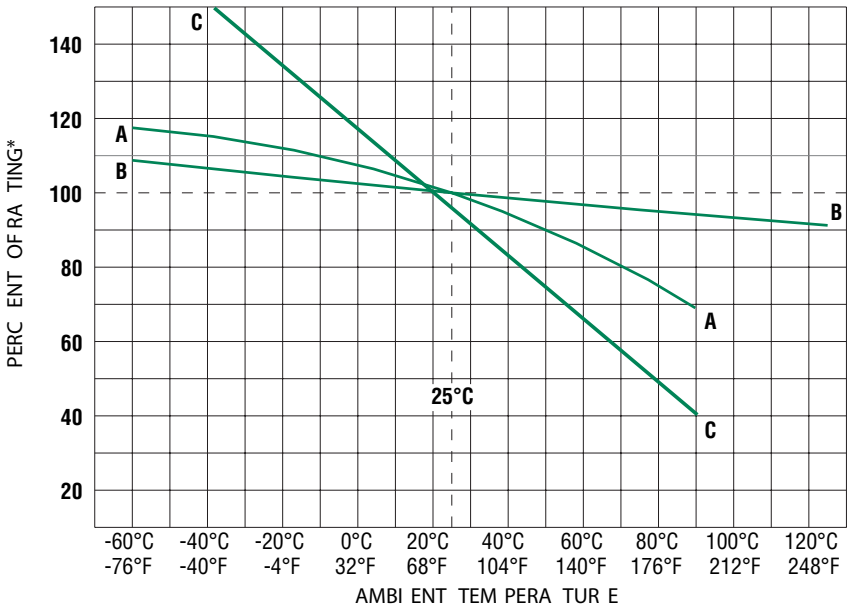
$$\text{Catalog Fuse Rating} = \frac{\text{Nominal Operating Current}}{0.75 \times \text{Percent of Rating}}$$

or

$$\frac{2.25 \text{ Amperes}}{0.75 \times 1.00} = 3 \text{ Amp Fuse (at 25°C)}$$

Chart 1 – Effect of ambient temperature on current-carrying capacity (typical)

Chart Key	
	Curve A Thin-Film Fuses and 313 Series (.010 to .150A)
	Curve B FLAT-PAK®, Telelink®, Nano²®, PICO®, Blade Terminal, Special Purpose and other leaded and cartridge fuses (except 313.010 – .150A)
	Curve C Resettable PTCs



Similarly, if that same fuse were operated at a very high ambient temperature of 80°C, additional derating would be necessary. Curve "B" of the ambient temperature chart shows the maximum operating "Percent of Rating" at 80°C to be 95%, in which case;

$$\text{Catalog Fuse Rating} = \frac{\text{Nominal Operating Current}}{0.75 \times \text{Percent of Rating}}$$

or

$$\text{3.15 Amp Fuse (at 80°C)} = \frac{2.25 \text{ Amperes}}{0.75 \times 0.95}$$

Overload Current Condition

The current level for which protection is required. Fault conditions may be specified, either in terms of current or in terms of both current and maximum time the fault can be tolerated before damage occurs. Time-current curves should be consulted to try to match the fuse characteristic to the circuit needs, while keeping in mind that the curves are based on average data.

Maximum fault current

The Interrupting Rating of a fuse must meet or exceed the Maximum Fault Current of the circuit.

Pulses

The general term "pulses" is used in this context to describe the broad category of wave shapes referred to as "surge currents," "start-up currents," "in-rush currents," and "transients." Electrical pulse conditions can vary considerably from one application to another. Different fuse constructions may not react the same to a given pulse condition. Electrical pulses produce thermal cycling and possible mechanical fatigue that could affect the life of the fuse. Initial or start-up pulses are normal for some applications and may require the characteristic of a Slo-Blo® fuse. Slo-Blo® fuses incorporate a thermal delay design to enable them to survive normal start-up pulses and still provide protection against prolonged overloads. The start-up pulse should be defined and then compared to

the time-current curve and I^2t rating for the fuse. Application testing is recommended to establish the ability of the fuse design to withstand the pulse conditions.

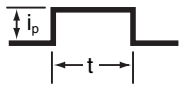
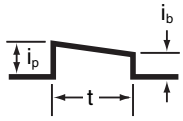
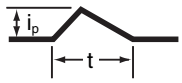
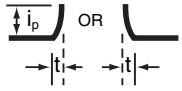
Nominal melting I^2t is a measure of the energy required to melt the fusing element and is expressed as "Ampere Squared Seconds" (A^2 Sec.). This nominal melting I^2t, and the energy it represents (within a time duration of 8 milliseconds [0.008 second] or less and 1 millisecond [0.001 second] or less for thin film fuses), is a value that is constant for each different fusing element. Because every fuse type and rating, as well as its corresponding part number, has a different fusing element, it is necessary to determine the I^2t for each. This I^2t value is a parameter of the fuse itself and is controlled by the element material and the configuration of the fuse element. In addition to selecting fuses on the basis of "Normal Operating Currents", "Rerating", and "Ambient Temperature" as discussed earlier, it is also necessary to apply the I^2t design approach.

This nominal melting I^2t is not only a constant value for each fuse element design, but it is also independent of temperature and voltage. Most often, the nominal melting I^2t method of fuse selection is applied to those applications in which the fuse must sustain large current pulses of a short duration. These high-energy currents are common in many applications and are described by a variety of terms, such as "surge current," "start-up current," "in-rush current," and other similar circuit "transients" that can be classified in the general category of "pulses." Laboratory tests are conducted on each fuse design to determine its nominal melting I^2t rating. The values for I^2t given in this publication are nominal and representative. The factory should be consulted if this parameter is critical to the design analysis.

The following example should assist in providing a better understanding of the application of I^2t.

Example: Select a 125V, very fast-acting PICO® II fuse that is capable of withstanding 100,000 pulses of current (I) of the pulse waveform shown in Figure 1. The normal operating current is 0.75 ampere at an ambient temperature of 25°C.

Chart 2

Waveshapes	Formulas
A 	$i = k$ $I^2t = i_p^2\,t$
B 	$i = i_p - kt$ $I^2t = (1/3)(i_p^2 + i_p i_b + i_b^2)\,t$
C 	$i = i_p \sin t$ $I^2t = (1/2)\,i_p^2\,t$
D 	$I^2t = (1/3)\,i_p^2\,t$
E 	$i = kt^2$ OR $i = i_p(1-kt)^2$ $I^2t = (1/5)\,i_p^2\,t$
F 	$i = i_p e^{-kt})$ $I^2t \cong (1/2)\,i_p^2\,t_1$

Step 1 — Refer to Chart 2 (top) and select the appropriate pulse waveform, which is waveform (E) in this example. Place the applicable value for peak pulse current (ip) and time (t) into the corresponding formula for waveshape (E) and calculate the result as shown:

$$I^2t = \frac{1}{5}(i_p)^2t$$

$$\frac{1}{5} \times 8^2 \times .004 = 0.0512\ A^2\ Sec.$$

This value is referred to as the "Pulse I^2t".

Step 2 — Determine the required value of Nominal Melting I^2t by referring to Chart 3 (page 8). A figure of 22% is shown in this chart for 100,000 occurrences of the Pulse I^2t calculated in Step 1. This Pulse I^2t is converted to its required value of Nominal Melting I^2t as follows:

Nom. Melt I^2t = Pulse I^2t/.22
= 0.0512/.22 = 0.2327 A^2 Sec.

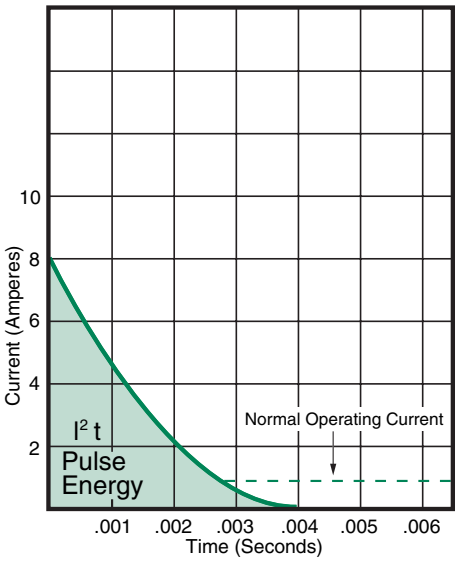


Figure 1

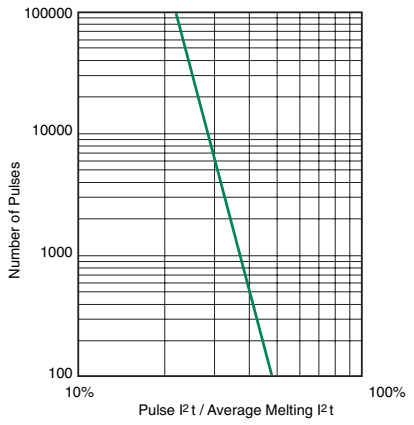
Step 3 — Examine the I^2t rating data for the PICO® II, 125V, very fast-acting fuse. The part number 251001, 1 ampere design is rated at 0.256 A^2 Sec., which is the minimum fuse rating that will accommodate the 0.2327 A^2 Sec. value calculated in Step 2. This 1 ampere fuse will also accommodate the specified

0.75 ampere normal operating current, when a 25% derating factor is applied to the 1 ampere rating, as previously described.

Testing: The above factors should be considered in selecting a fuse for a given application. The next step is to verify the selection by requesting samples for testing in the actual circuit. Before evaluating the samples, make sure the fuse is properly mounted with good electrical connections, using adequately sized wires or traces. The testing should include life tests under normal conditions and overload tests under fault conditions, to ensure that the fuse will operate properly in the circuit.

Chart 3

100,000 Pulses	Pulse I^2t = 22% of Nominal Melting I^2t
10,000 Pulses	Pulse I^2t = 29% of Nominal Melting I^2t
1,000 Pulses	Pulse I^2t = 38% of Nominal Melting I^2t
100 Pulses	Pulse I^2t = 48% of Nominal Melting I^2t



Note: Adequate time (10 seconds) must exist between pulse events to allow heat from the previous event to dissipate.

Fuseholder Selection

Rerating: For 25°C ambient temperatures, it is recommended that fuseholders be operated at no more than 60% of the nominal current rating established using the controlled test conditions specified by Underwriters Laboratories. The primary objective of these UL test conditions is to specify common test standards necessary for the continued control of manufactured items intended for protection against fire, etc. A copper dummy fuse is inserted in the fuseholder by Underwriters Laboratories, and then the current is increased until a certain temperature rise occurs. The majority of the heat is produced by the contact resistance of the fuseholder clips. This value of current is considered to be the rated current of the fuseholder, expressed as 100% of rating. Some of the more common, everyday applications may differ from these UL test conditions as follows: fully enclosed fuseholders, high contact resistance, air movement, transient spikes, and changes in connecting cable size (diameter and length). Even small variations from the controlled test conditions can greatly affect the ratings of the fuseholder. For this reason, it is recommended that fuseholders be derated by 40% (operated at no more than 60% of the nominal current rating established using the Underwriter Laboratories test conditions, as previously stated).

Standards

UL Listed

A UL Listed fuse meets all the requirements of the UL/CSA 248-14 Standard. Following are some of the requirements.

UL ampere rating tests are conducted at 100%, 135%, and 200% of rated current. The fuse must carry 100% of its ampere rating and must stabilize at a temperature that does not exceed a 75°C rise at 100%.

The fuse must open at 135% of rated current within one hour. It also must open at 200% of rated current within 2 minutes for 0-30 ampere ratings and 4 minutes for 35-60 ampere ratings.

The interrupting rating of a UL Listed fuse is 10,000 amperes at 125 volts AC minimum. Fuses rated at 250 volts may be listed as interrupting 10,000 amperes at 125 volts and, at least, the minimum values shown below at 250 volts.

Ampere Rating of Fuse	Interrupting Rating In Amperes	Voltage
0 to 1	35	250 VAC
1.1 to 3.5	100	250 VAC
3.6 to 10	200	250 VAC
10.1 to 15	750	250 VAC
15.1 to 30	1500	250 VAC

UL 275 Automotive Glass Tube Fuses (32 Volts)

UL Listed

UL ampere ratings tests are conducted at 110%, 135%, and 200%. Interrupting rating tests are not required.

Recognized Under the Component Program of Underwriters Laboratories

Canadian Recognized Component Mark

The Recognized Components Program of UL is different from UL Listing. For recognition, UL will test a fuse to a specification requested by the manufacturer. The test points can be different from the UL Listing requirements for fuses that have been designed for a specific application. Application approval is required by UL for the use of fuses recognized under the Component Program.

CSA

CSA Certification in Canada is equivalent to UL Listing in the United States.

CSA Component Acceptance Program

The Component Acceptance Program of CSA is equivalent to the Recognition Program at UL. This CSA Program allows the manufacturer to declare a specification. CSA then tests to this specification.

METI Approval

METI approval in Japan uses similar requirements as those covered in the UL/CSA/ANCE 248-14. METI also uses special testing similar to that covered in the IEC standards.

International Electrotechnical Commission (IEC)

IEC 60127-2, Sheet 1, 2, 3, 5, 6 (250 Volts)

The IEC is different from UL and CSA, since IEC is an international organization that writes specifications and does not certify. UL and CSA write specifications and are responsible for testing and certification in the US and Canada, respectively.

Certification to IEC specifications are given by such national organizations as SEMKO (Swedish Institute of Testing and Approvals of Electrical Equipment) and BSI (British Standards Institute) , as well as UL and CSA.

IEC 60127-2 defines three breaking capacity levels (interrupting rating). Low breaking capacity fuses must pass a test of 35 amperes or ten times rated current, whichever is greater, while enhanced breaking capacity fuses must pass a test of 150 amperes and high breaking capacity fuses must pass a test of 1500 amperes.

Sheet 1 — Type F Quick Acting, High Breaking Capacity

Sheet 2 — Type F Quick Acting, Low Breaking Capacity

Sheet 3 — Type T Time Lag, Low Breaking Capacity

Sheet 5 — Type T Time Lag, High Breaking Capacity

Sheet 6 — Type T Time Lag, Enhanced Breaking Capacity

The letters 'F' and 'T' represent the time-current characteristic of the fast-acting and time delay fuses. One of these letters will be marked on the end cap of the fuse.

The newest addition to IEC 60127 is part 4 which covers UMF (Universal Modular Fuse) products for both through-hole and surface mount fuse types. The standard allows for both through-hole and surface mount fuses with voltage ratings of 32, 63, 125 and 250 volts.

Breaking capacities for the 32, 63, and 125 volt fuses are the same as low breaking capacity fuses covered by IEC 60127 Part 2. The 250 volt UMF fuse is available in a low breaking capacity (100A), intermediate breaking capacity (500A), and high breaking capacity (1500A).

PTC Facts

Overcurrent circuit protection can be accomplished with the use of either a traditional one time fuse or the more recently developed resettable PTC. Both devices function by reacting to heat generated by the excessive current flow in the circuit. The fuse element melts open, interrupting the current flow, while the PTC changes from low resistance to high resistance to limit current flow. Understanding the differences in performance between the two types of devices will make the best circuit protection choice easier.

The most obvious difference is that the PTC is resettable. The general procedure for resetting after an overload has occurred is to remove power and allow the device to cool down. There are several other operating characteristics that differentiate the two types of products. The terminology used for PTCs is often similar but not the same as for fuses. Two parameters that fall into this category are leakage current and interrupting rating.

Leakage Current

A PTC is said to have "tripped" when it has transitioned from the low resistance state to the high resistance state due to an overload (see figure 2). Protection is accomplished by limiting the current flow to some low leakage level. Leakage current can range from less than a hundred milliamps at rated voltage up to a few hundred milliamps at lower voltages. The fuse, on the other hand, completely interrupts the current flow and this open circuit results in no leakage current after being subjected to an overload.

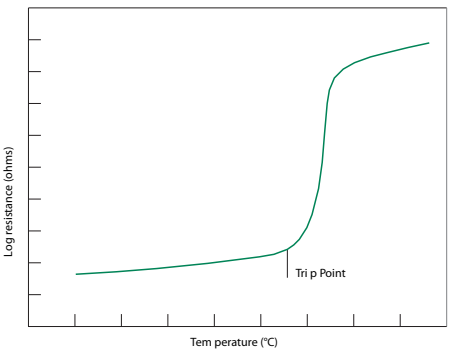


Figure 2

Interrupting Rating

PTCs are rated for a maximum short circuit current at rated voltage. This fault current level is the maximum current that the device can withstand keeping in mind that a typical PTC short circuit rating is 40A. PTCs will not actually interrupt the current flow (see *Leakage Current* above), whereas fuses do interrupt the current flow in response to the overload. The range of interrupting ratings for fuses varies from tens of amperes up to 10000 amperes at rated voltage.

The circuit parameters may dictate the component choice based on typical device rating differences.

Operating Voltage Rating

General use PTCs are not rated above 72V while fuses are rated up to 600V.

Current Rating

The operating current rating for PTCs can be up to 11A while the maximum level for fuses is 60A, in accordance with UL/CSA/ANCE 248-14.

Temperature Rating

The useful upper limit for a PTC is generally 85°C while the maximum operating temperature for fuses is 125°C. The temperature rerating curves (see chart 4) that compare PTCs to fuses illustrate that more rerating is required for a PTC at a given temperature.

Additional operating characteristics can be reviewed by the circuit designer in making the decision to choose a PTC or a fuse for overcurrent protection.

Agency Approvals

PTCs are Recognized under the Component Program of Underwriters Laboratories to UL Thermistor Standard 1434. These devices have also been certified under the CSA Component Acceptance Program.

Resistance

Reviewing product specifications indicates that similarly rated PTCs have about twice (sometimes more) the resistance of fuses.

Time-Current Characteristic

Comparing the time-current curves of PTCs to time-current curves of fuses show that the speed of response for a PTC is similar to the time delay of a Slo-Blo® fuse. (see figure 3)

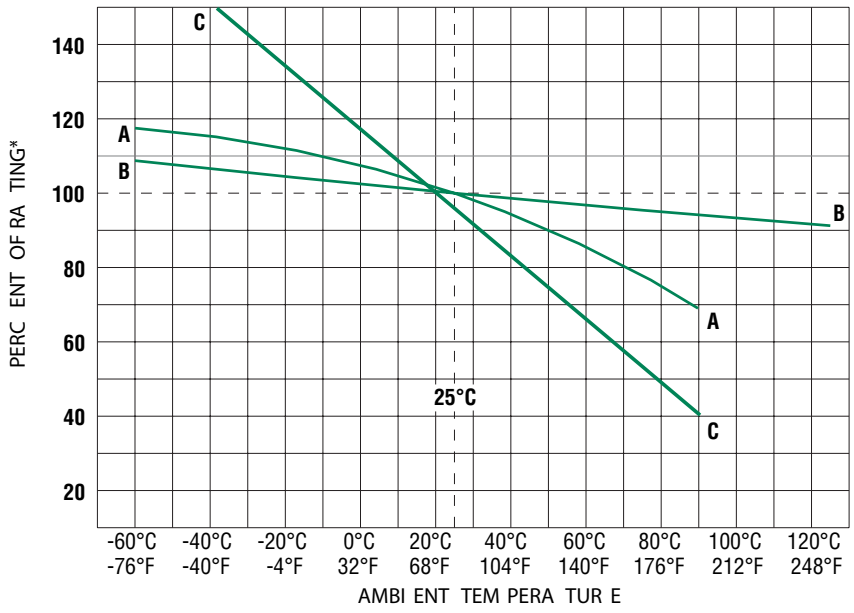
Summary

Many circuit protection issues are a matter of preference, but there is an important area of application where the use of resettable PTCs is becoming a requirement. Much of the design work for personal computers and peripheral devices is strongly influenced by the Microsoft and Intel System Design Guide which states that "Using a fuse that must be replaced each time an overcurrent condition occurs is unacceptable." In addition, the Plug and Play SCSI (Small Computer Systems Interface) Specification for this large market includes the statement, "...must provide a self-resetting device to limit the maximum amount of current sourced."

A selection guide work-sheet appears on the following page as an aid in choosing the best circuit protection component and determining when PTCs may be the appropriate choice for providing overcurrent circuit protection.

Chart 4 – Temperature Rerating Curves Comparing PTCs to Fuses

Chart Key	
	Curve A Thin-Film Fuses and 313 Series (.010 to .150A)
	Curve B FLAT-PAK®, Telelink®, Nano²®, PICO®, Blade Terminal, Special Purpose and other leaded and cartridge fuses (except 313.010 – .150A)
	Curve C Resettable PTCs



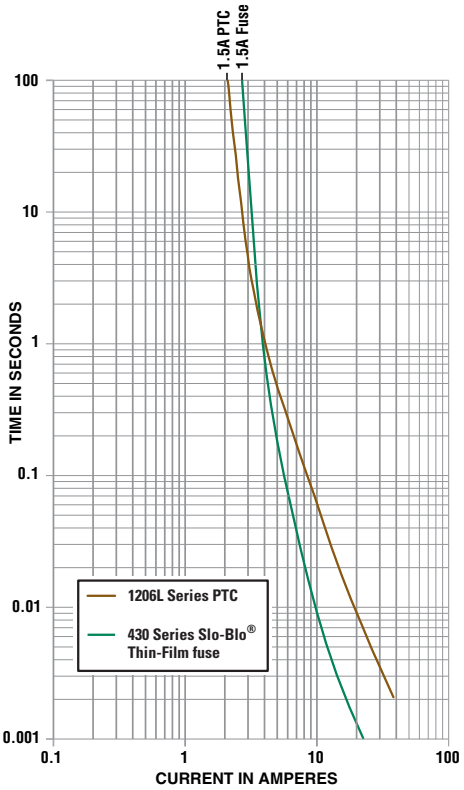


Figure 3

Overcurrent Selection Guide Worksheet

1. Define the circuit operating parameters (complete the following form).

Normal operating current in amperes: _____

Normal operating voltage in volts: _____

Maximum interrupt current: _____

Ambient Temperature: _____

Typical overload current: _____

Required opening time at specific overload: _____

Transient pulses expected (quantity): _____

Resettable or one-time: _____

Agency Approvals: _____

Mounting type/form factor: _____

Typical resistance (in circuit): _____

2. Select the proper circuit protection component (see chart below).

3. Determine the opening time at fault.

Consult the Time-Current (T-C) Curve to determine if the selected part will operate within the constraints of your application. If the device opens too soon, the application may experience nuisance operation. If the device does not open soon enough, the overcurrent may damage downstream components. To determine the opening time for the chosen device, locate the overload current on the X-axis of the appropriate T-C Curve and follow its line up to its intersection with the curve. At this point read the time tested on the Y-axis. This is the average opening time for that device. If your overload current falls to the right of the curve the device will open. If the overload current is to the left of the curve, the device will not operate.

4. Verify ambient operating parameters.

Ensure that the application voltage is less than or equal to the device's rated voltage and that the operating temperature limits are within those specified by the device.

5. Verify the device's dimensions.

Using the information from the Designer's Guide page, compare the maximum dimensions of the device to the space available in the application.

6. Test the selected product in an actual application.

Overcurrent Selection Guide

	Surface Mount PTC	30V PTC Leaded	60V PTC Leaded	0402, 0603, 1206 TFF	Nano²®/Telelink® SMF Fuse	PICO® II Fuse	3.6x10mm	TR5®/TE5® Fuses	2AGs	5x20mm	3AG/3ABs	Midgets
Operating Current Range	0.200 - 2.6A	0.900 - 9A	0.100 - 3.75A	0.250 - 7A	0.062 - 15A	0.062 - 15A	0.05 - 10A	0.40 - 10A	0.100 - 10A	0.032 - 15A	0.010 - 35A	0.100 - 60A
Maximum Voltage (1)	15V	30V	60V	24 - 125V	125 - 600V	250V	250V	125 - 250V	250V	250V	250V	600VDC/1000VAC
Maximum Interrupting Rating (2)	40A	40A	40A	35 - 50A	50 - 300A	50A	35-63A	25 - 100A	10000A	10000A	10000A	200000A
Temperature Range	–40°C to 85°C	–40°C to 85°C	–40°C to 85°C	–55°C to 90°C	–55°C to 125°C	–55°C to 125°C	–55°C to +125°C	–40°C to 85°C	–55°C to 125°C	–55°C to 125°C	–55°C to 125°C	–55°C to 125°C
Thermal Rerating	High	High	High	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Opening time at 200% of Amp Rating (3)	Slow	Slow	Slow	Fast to Medium	Fast to Slow	Fast to Medium	Fast to Medium	Fast to Slow	Fast to Medium	Fast to Slow	Fast to Slow	Fast to Slow
Transient Withstand	Low	Low	Low	Low to Medium	Low to Medium	Low to Medium	Low to Medium	Low to Medium	Low to High	Low to High	Low to High	Low to High
Resistance	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low
Agency Approvals (4)	UL, CSA, TUV	UL, CSA, TUV	UL, CSA, TUV	UL, CSA	UMF, UL, CSA, METI	UL, CSA, METI	UL, CSA, VDE, CCC	UL, CSA, VDE, CCC, SEMKO, METI, KTL	UL, CSA, METI	CSA, BSI, VDE, METI, SEMKO, UL, KTL	UL, CSA, METI	UL, CSA
Operational Uses	Multiple	Multiple	Multiple	One Time	One Time	One Time	One Time	One Time	One Time	One Time	One Time	One Time
Mounting/Form Factor	Surface Mount	Leaded	Leaded	Surface Mount	Surface Mount	Leaded	Leaded	Leaded	Leaded or Cartridge	Leaded or Cartridge	Leaded or Cartridge	Cartridge
RoHS Compliant	Yes	NA	NA	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	NA
Pb Lead-Free	Yes	NA	NA	Yes	Yes	No	NA	Yes	Yes	Yes	Yes	NA

1. Maximum operating voltage in the series, parts may be used at voltages equal to or less than this value.
2. Maximum interrupting rating at specified voltage which may be less than maximum operating voltage.
3. Opening time is in relation to other forms of protection. A fast device will typically operate within three seconds at 200% of rated current.
4. See individual series for detailed certification information.

Overvoltage Suppression Facts

Transient Threats – What Are Transients?

Voltage transients are defined as short duration surges of electrical energy and are the result of the sudden release of energy that was previously stored, or induced by other means, such as the switching of inductive loads or the presence of nearby lightning strikes. These induced voltage transients may cause damage to electronic equipment.

Repeatable transients are frequently caused by the operation of motors, generators, or the switching of reactive circuit components. Random transients, on the other hand, are often caused by Lightning (Figure 1) and Electrostatic Discharge (ESD) (Figure 2). Lightning and ESD generally occur unpredictably and may require elaborate monitoring to be accurately measured, especially if induced at the circuit board level. Numerous electronics standards groups have analyzed transient voltage occurrences using accepted monitoring or testing methods. The key characteristics of several transients are shown below in Table 1.

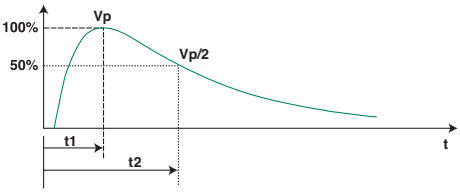


Figure 1. *Lightning Transient Waveform*

Characteristics of Transient Voltage Spikes

Transient voltage spikes generally exhibit a "double exponential" wave form, shown in Figure 1 for lightning and Figure 2 for ESD. The exponential rise time of lightning is in the range 1.2µsec to 10µsec and the duration is in the range of 50µsec to 1000µsec. ESD on the other hand, is a much shorter duration event. The rise time has been characterized at less than 1.0ns. The overall duration is approximately 100ns.

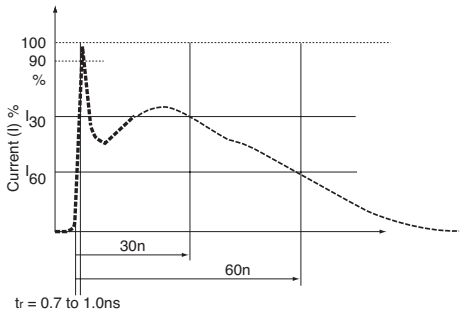


Figure 2. *ESD Test Waveform*

Why are Transients of Increasing Concern?

Component miniaturization has resulted in increased sensitivity to electrical stress. Microprocessors for example, have structures and conductive paths which are unable to handle high currents from ESD transients. Such components operate at very low voltages, so voltage disturbances must be controlled to prevent latent or catastrophic failures. Sensitive devices such as microprocessors are being adopted at an exponential rate. Microprocessors are beginning to perform transparent operations never before imagined. Everything from home appliances, such as dishwashers, to industrial controls and even toys, have increased the use of microprocessors to improve functionality and efficiency.

Vehicles now employ many electronics systems to control the engine, climate, braking and, in some cases, steering systems. Some of the innovations are designed to improve efficiency, but many are safety related, such as ABS and traction control systems. Many of the features in appliances and automobiles employ items which present transient threats (such as electric motors). Not only is the general environment hostile, but the equipment or appliance can also be sources of threats. For this reason, careful circuit design and the correct use of overvoltage protection technology will greatly improve the reliability and safety of the end application. Table 2 shows the vulnerability of various component technologies.

Device Type	Vulnerability (volts)
VMOS	30-1800
MOSFET	100-200
GaAsFET	100-300
EPROM	100
JFET	140-7000
CMOS	250-3000
Schottky Diodes	300-2500
Bipolar Transistors	380-7000
SCR	680-1000

Table 2. *Range of device vulnerability*

	Voltage	Current	Rise-time	Duration
Lighting	25kV	20kA	10µs	1000µs
Switching	600V	500A	50µs	500000µs
EMP	1kV	10A	20ns	10000ns
ESD	15kV	30A	<1ns	100ns

Table 1. *Examples of transient sources and magnitude*

Overvoltage Suppression Facts continued from previous page

Transient Voltage Scenarios

ESD (Electrostatic Discharge)

Electrostatic discharge is characterised by very fast rise times and very high peak voltages and currents. This energy is the result of an imbalance of positive and negative charges between objects.

Below are some examples of the voltages which can be generated, depending on the relative humidity (RH):

- Walking across a carpet:
  35kV @ RH = 20%; 1.5kV @ RH = 65%
- Walking acrss a vinyl floor:
  12kV @ RH = 20%; 250V @ RH = 65%
- Worker at a bench:
  6kV @ RH = 20%; 100V @ RH = 65%
- Vinyl envelopes:
  7kV @ RH = 20%; 600V @ RH = 65%
- Poly bag picked up from desk:
  20kV @ RH = 20%; 1.2kV @ RH = 65%

Referring to Table 2 on the previous page, it can be seen that ESD that is generated by everyday activities can far surpass the vulnerability threshold of standard semiconductor technologies. Figure 2 shows the ESD waveform as defined in the IEC 61000-4-2 test specification.

Inductive Load Switching

The switching of inductive loads generates high energy transients which increase in magnitude with increasingly heavy loads. When the inductive load is switched off, the collapsing magnetic field is converted into electrical energy which takes the form of a double exponential transient. Depending on the source, these transients can be as large as hundreds of volts and hundreds of Amps, with duration times of 400 milliseconds.

Typical sources of inductive transients are:

- Generator
- Motor
- Relay
- Transformer

These examples are extremely common in electrical and electronic systems. Because the sizes of the loads vary according to the application, the wave shape, duration, peak current and peak voltage are all variables which exist in real world transients. Once these variables can be approximated, a suitable suppressor technology can be selected.

Figure 3, shows a transient which is the result of stored energy within the alternator of an automobile charging system. A similar transient can also caused by other DC motors in a vehicle. For example, DC motors power amenities such as power locks, seats and windows. These various applications of a DC motor can produce transients that are just as harmful to the sensitive electronic components as transients created in the external environment.

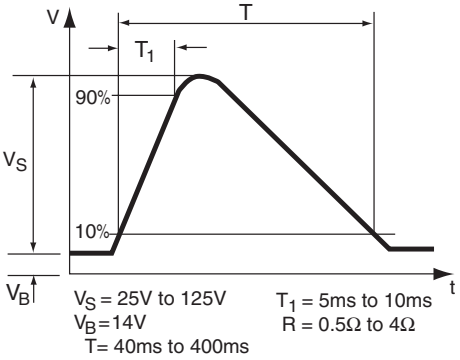
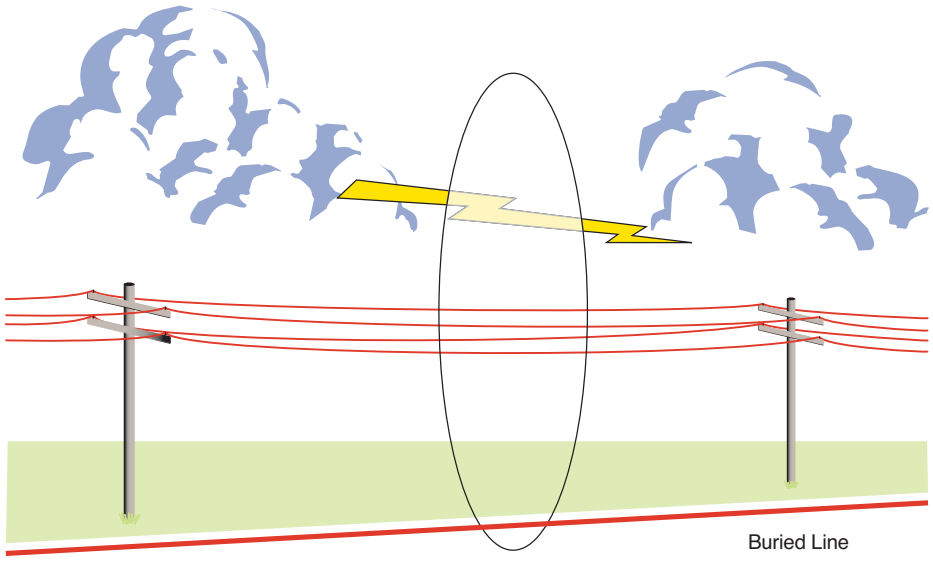


Figure 3. *Automotive Load Dump*

Lightning Induced Transients

Even though a direct strike is clearly destructive, transients induced by lightning are not the result of a direct strike. When a lightning strike occurs, the event creates a magnetic field which can induce transients of large magnitude in nearby electrical cables.

Figure 4, shows how a cloud-to-cloud strike will effect not only overhead cables, but also buried cables. Even a strike 1 mile distant (1.6km) can generate high voltage levels in the cables.



Transient Generated:
- 70 V at 1.6km (1 mile)
- 10 kV at 150m (160 yards)

Figure 4. *Cloud-to-Cloud Lightning Strike*

Overvoltage Suppression Facts continued from previous page

Figure 5 shows the effect of a cloud-to-ground strike. The transient generated by this type of strike is much greater than a transient generated by a cloud to cloud strike.

Figure 6 shows a typical current waveform for induced lightning disturbances.

Solutions for Transient Threats

Because of the various types of transients and applications, it is necessary to employ protection devices with different characteristics in different applications. Littelfuse offers the broadest range of circuit protection technologies. Our overvoltage protection portfolio includes:

MOVs

Metal Oxide Varistors (MOV)
Ceramic Technology

They are available in screw terminal, radial, square and axial leaded form factors. They offer medium to very high energy ratings for a wide range of applications.

Surface Mount MOV

Metal Oxide Varistors (MOV)
Ceramic Technology

Available in a wide range of voltage ratings and offer low to medium energy ratings for a variety of applications.

MLV

Multilayer Metal Oxide Varistors
Ceramic Technology

Available in a wide range of surface mount packages. They offer a lower voltage range and enhanced performance and filtering characteristics for applications requiring protection from low to medium energy transients.

PulseGuard®

Voltage Variable Polymer Technology

Available in surface mount and 'D-Sub connector' format packages. Specifically designed for high data-rate applications requiring ESD protection and the lowest possible capacitance.

Diode Arrays

Silicon Avalanche Diode Technology

Available in surface mount multi-pin packages. Designed for applications requiring multi-line ESD protection and the lowest possible clamp voltage.

Discrete TVS Diode

Silicon Avalanche Diode Technology

Available in surface mount and axial leaded packages. These devices offer protection from medium to very high energy transients and can be used in wide range of applications.

Teccor® SIDACtor® Devices

Thyristor Breakover Technology

Available in DO-214AA, COMPAK (3-Pin DO-214), MS-012 and modified MS-013 surface mount, TO-92, TO-218, DO-15, modified TO-220, and TO-220 through hole package options. These options offer protection from medium to high energy transients. SIDACtor devices are specifically designed for transient suppression in telecom and data transmission systems.

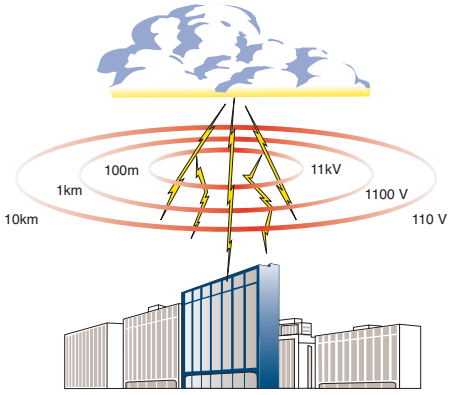


Figure 5. *Cloud-to-Ground Lightning Strike*

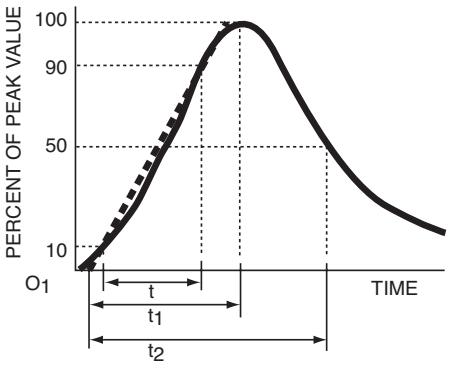


Figure 6. *5kA 8/20μS pulse*

Greentube™ Gas Plasma Arresters/ Gas Discharge Tubes

Gas Plama Technology

Available in surface mount, axial leaded, radial leaded and special packages. The Littelfuse Gas Plasma technology offers high surge ratings and very low capacitance for use in telecommunication and broadband systems.

Deployment of Protection Devices

Suppression devices are used in either a longitudinal mode or a metallic mode and possibly both. In some cases, it is necessary to employ protection devices in a cascaded (staged) configuration. Cascaded solutions (Figures 7 and 8) utilize the best features of each technology to ensure the most comprehensive solution.

Glossary of Terms

The following are general terms that apply to all overvoltage technologies in the Littelfuse product offering.

Crowbar Device

The class of suppressors that exhibit a "crowbar" characteristic is usally associated with 4-layer NPNP silicon bipolar devices or gas plasma/GDT devices. Upon reaching a threshold or breakover voltage, further increase in current flow will cause the device to rapidly conduct with only a few volts of forward drop. In essence, the line is momentarily "short-circuited" during the transient event.

Operating Temperature Range

The minimum and maximum ambient operating temperature of the circuit in which a device will be applied. Operating temperature does not allow for the effects of adjacent components, this is a parameter the designer must take into consideration.

Overvoltage Suppression Facts continued from previous page

Capacitance

The property of a circuit element that permits it to store an electrical charge. In circuit protection, the off-state capacitance is typically measured at 1 MHz with a 2V bias applied.

Power Fault

A condition where the AC power is accidentally coupled to a communication line. This may be a direct connection, or inductively coupled.

The following are more specifically used to describe the parameters of gas plasma technology devices:

Dynamic Breakover

(also referred to as Impulse sparkover) The maximum breakover voltage measured on a 100V/µs or 1kV/µs ramp rate (whichever is specified).

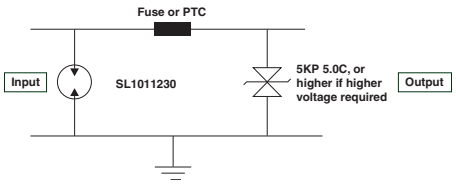


Figure 7. *Circuit example of a cascaded protection solution*

DC Breakover

(Also referred to as DC sparkover) The nominal breakover voltage measured on a 100V/s ramp rate.

Holdover Voltage

Once the device has switched due to a transient, it will stay in this low impedance state until the voltage across it falls below a specific value, known as the holdover voltage. When selecting one of these devices, it is important to make sure the voltage of the protected system is less than the holdover voltage value of the protector.

On-state Voltage

(Also referred to as Arc Voltage) The maximum voltage measured across the protector when in it's low impedance state (fully switched on). Sometimes specified at a given test current.

Maximum Surge Current

(Also referred to as impulse discharge current or peak pulse current) The maximum transient surge current the protector can handle without degradation or destruction. Usually quoted using the industry standard 8x20µs double exponential waveform.

Maximum AC Surge Current

(Also referred to as alternating discharge current) The maximum AC surge current the protector can handle without degradation or destruction. Usually quoted using a number of 1 second, 60Hz bursts (often 5 such bursts), with a 3 minute rest period between each burst.

Insulation Resistance

An alternative way of quoting leakage current. It is the effective resistance of the device at a given voltage: the test voltage divided by the leakage current. A typical value would be given as 1 x 10^9 ohms.

Failsafe

Refers to a device which prevents hazards due to thermal run-away. The device is a thermal sensitive switch which operates at a predetermined temperature, shorting the terminals of the protection device (normally gas plasma device, sometimes SIDACtor® device) providing a low resistance path. A failsafe is used in conjunction with overcurrent protection devices to protect against the consequences of power fault conditions.

The following are more specifically (but not exclusively) used to describe the parameters of silicon avalanche diodes (SAD) and TVS Arrays:

TVS diode

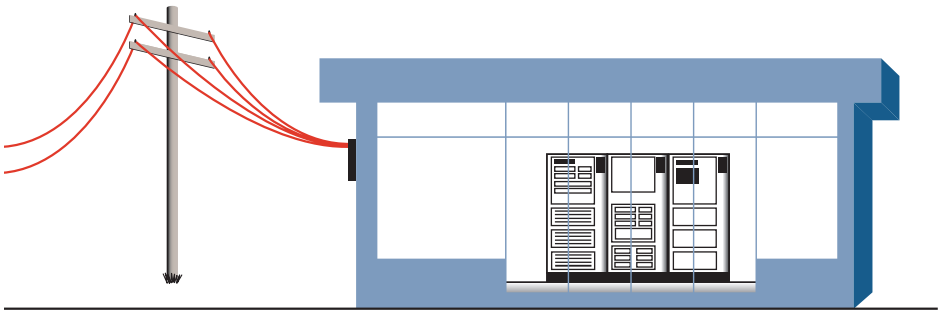
TVS is an abbreviation for transient voltage suppressor. Devices which are termed as TVS diodes (or diode arrays) typically use Silicon Avalanche Diode technology.

Reverse Standoff Voltage (V_R)

In the case of a uni-directional TVS diode, this is the maximum peak voltage that may be applied in the 'blocking direction' with no significant current flow. In the case of a bi-directional transient, it applies in either direction. It is the same definition as Maximum Off-state Voltage and Maximum Working Voltage.

Breakdown Voltage (V_{BR})

Breakdown voltage measured at a specified DC test current, typically 1mA. Usually a minimum and maximum is specified.



Primary Protection Examples in MDF:
- Gas Plasma (Improved GDT)
- Teccor® SIDACtor® Devices

Secondary and Tertiary Protection at Board Level Examples:
- Teccor® SIDACtor® Devices
- Gas Plasma Technology
- TVS Diodes
- TVS Diode Arrays
- PulseGuard® Suppressors
- Multilayer Varistors
- Surface Mount Varistors
- MOVs
- TMOV® Varistors

Figure 8. *Cascaded environment solution*

Overvoltage Suppression Facts continued from previous page

Maximum Peak Pulse Current (I_{PP})

Maximum pulse current which can be applied repetitively. Usually a 10x1000µs double exponential waveform, but can also be 8x20µs, if stated.

Maximum Clamping Voltage (V_C or V_{CI})

Maximum voltage which can be measured across the protector when subjected to the Maximum Peak Pulse Current.

Peak Pulse Power (P_{PP})

Expressed in Watts or Kilowatts, for a 1ms exponential transient (see figure 1, page 23) it is I_{PP} multiplied by V_{CL}.

The following are more specifically used to describe the parameters of Silicon (thyristor based) breakover devices (SIDACtor® devices):

On-State Current (I_T)

This is the maximum rated continuous on-state current.

Switching Voltage (V_S)

The maximum voltage prior to switching to the on-state during a 100V/µS event.

On-state Voltage (V_T)

The maximum voltage measured across the device during its on-state condition at its rated on-state current (I_T).

Holding Current (I_H)

Once a SIDACtor device has switched on, a level of current through the device is needed to maintain this condition; this is specified as the Minimum Holding Current. If the current is not reduced below this level, the device will remain 'latched'.

Peak Pulse Current (I_{PP})

The maximum transient surge current the device can handle without degradation or destruction. Usually quoted using the industry standard 10x1000µs or 2x10µs double exponential waveform.

Peak Off-State Voltage (V_{DRM})

This is the maximum voltage that can be applied while maintaining an off-state condition.

Peak One-Cycle Surge Current (I_{TSM})

This is the maximum rated single cycle AC current level the device can withstand.

The following are more specifically used to describe the parameters of Metal Oxide Varistors (MOV):

Maximum Non-Repetitive Surge Current (I_{TM})

This is the maximum peak current which may be applied for an 8x20µs impulse, with rated line voltage also applied, without causing greater than 10% shift in nominal voltage.

Maximum Non-Repetitive Surge Energy (W_{TM})

This is the maximum rated transient energy which may be dissipated for a single current pulse at a specified impulse and duration (2µs), with the rated V_{RMS} applied, without causing device failure.

Nominal Voltage ($V_{N(DC)}$)

This is the voltage at which the device changes from the off state to the on state and enters its conduction mode of operation. This voltage is characterized at the 1mA point and has specified minimum and maximum voltage ratings.

Clamping Voltage (V_C)

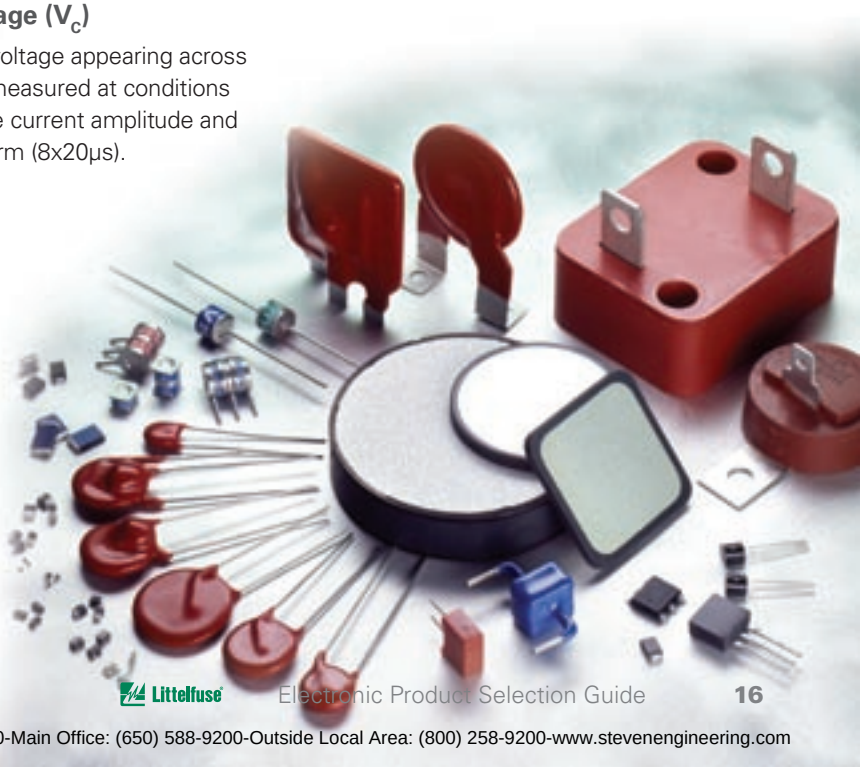
This is the peak voltage appearing across the MOV when measured at conditions of specified pulse current amplitude and specified waveform (8x20µs).

Power Dissipation Ratings

When transients occur in rapid succession, the average power dissipation is the energy (watt-seconds) per pulse, times the number of pulses per second. Power developed in this fashion must be within the specifications shown on the Device Ratings and Characteristics table for the specific device.

Voltage Clamping Device

A clamping device, such as an MOV, refers to a characteristic in which the effective resistance changes from a high to low state as a function of applied voltage. In its conductive state, a voltage divider action is established between the clamping device and the source impedance of the circuit. Clamping devices are generally "dissipative" devices, converting much of the transient electrical energy to heat.



Overvoltage Application Guide

	Application	Circuit	Threat	Solution Series	Technology
Low/Medium Voltage Electronics	**Computers** - desktop, laptop, notebook **Peripherals** - scanner, printer, monitor, disk drive **External Broadband hardware** - modem, set top box **Network hardware - switch, router, hub, repeater** **Digital camera/camcorder** **Handheld portables** - PDA, cell phone, cordless phone, GPS, MP3 Player, PDP, LCD Display **Video equipment** - HDTV, DVD, VCR, set top box **Alarm systems** - security, fire **Metering systems** **Medical equipment** **Lighting ballast** **Remote sensors/transducers**	High-speed Interfaces: USB 2.0, IEEE 1394, InfiniBand, RF antenna circuits, Gigabit Ethernet, DVI, HDMI	Lightning	PXX00SXMC	SIDACtor® Devices
			ESD	PGB1	PulseGuard® Polymer
		Medium-speed Interfaces: USB 1.1, RS 485, Ethernet, video,10 BaseT, 100 BaseT, T1/E1	ESD, EMI, EFT	SP05x, SP72x MHS, ML, MLE, MLN SPUSBx	Diode Array SCR/Rail clamp MLV, TVS/filter
			Lightning	PXX00SCMC, PXX02SX SL0902, SL1003, SL1011, SL1002,	SIDACtor® Devices, Gas Plasma Arrestor
		Low-speed Interfaces: Audio, RS 232, IEEE 1284, push buttons, key pads, switches	Lightning	LCE, SA PXXXXSX SL1011, SL0902, SL1003	SAD, SIDACtor® Devices, Gas Plasma Arrestor
			ESD, EMI, EFT	ML, MLE SP05x	MLV Diode Array
		Power Inputs: 120/240 VAC, up to 120 VDC	Lightning Switching Transients	CH, MA, ZA, RA, UltraMOV SA, P6KE, 1.5PKE SMBJ, 1KSMBJ, HV	MOV SAD SAD, Gas Plasma Arrestor
	Avionics/Military Electronics	Power and System Inputs	ESD, EMI, EFT Lightning and System Transients	5KP/SLD Hi-Rel MOVs	SAD MOV
Power Mains Protection	**AC line protection**	Uninterruptible Power Supply (UPS)	EFT, Lightning	TMOV®, UltraMOV™ LA, C-III, ZA, 5KP, 15KP, AK6, AK10	MOV MOV SAD
		Power Supply	EFT, Lightning, Commutative Spikes	UltraMOV, LA, TMOV ZA, HA, CH 5KP, 15KP, AK6, AK10	MOV MOV SAD
		Consumer Electronics	EFT, Lightning	UltraMOV, LA, ZA, CH, TMOV 1.5KE, 5KP	MOV SAD
		Power Meter	Lightning	TMOV, UltraMOV, C-III 5KP	MOV SAD
		AC Power Taps	EFT, Lightning	UltraMOV, LA, HA, HF34, HG34, TMOV34S	MOV MOV
		AC Panels	EFT, Lightning Commutative Spikes	UltraMOV, C-III, TMOV34S, HA, HB34, HF34, HG34, DA/DB, 5KP, 15KP, AK6, AK10	MOV MOV SAD
		AC Appliance Control	EFT, Lightning	TMOV, UltraMOV, LA, CH SMBJ, P6KE, 1.5KE	MOV SAD
	TVSS devices	TVSS Protection Modules	Lightning	TMOV, HA, HB34, HF34, HG34, UltraMOV, TMOV34S 5KP, 15KP, AK6, AK10 SL1002, SL1011, SL0902, SL1003	MOV MOV SAD Gas Plasma Arrestor
		Circuit Breakers	EFT, Lightning, Commutative Spikes	UltraMOV, LA, ZA	MOV

TVS Diode Selection Guide

Peak Pulse Power Range	Medium											High			Very High	
Series Name	**SMAJ**	**P4SMA**	**P4KE**	**SA**	**P6KE**	**SMBJ**	**P6SMBJ**	**1KSMBJ**	**1.5KE**	**SMCJ**	**1.5SMC**	**SLD**	**5KP**	**15KP**	**AK6**	**AK10**
Technology Type	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode	Silicon Avalanche Diode
Operating Temperature (°C)	-55 to +150	-55 to +150	-55 to +175	-55 to +175	-55 to +175	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150
Package Type	DO-214AC	DO-214AC	DO-41	DO-15	DO-15	DO-214AA	DO-214AA	DO-214AA	DO-201	DO-214AB	DO-214AB	axial	axial	axial	axial	axial
Mounting Method	SMT	SMT	through-hole	through-hole	through-hole	SMT	SMT	SMT	through-hole	SMT	SMT	through-hole	through-hole	through-hole	through-hole	through-hole
Reverse Standoff (working) Voltage	5.0-440	5.8-455	5.8-467	5.0-180	5.8-467	5.0-440	6.8-550	5.5-136	5.8-467	5.0-440	5.8-495	16-30	5.0-220	17-280	58-380	58-470
Peak Pulse Power Range (based on 10/1000µs pulse unless stated otherwise)	400W	400W	400W	500W	600W	600W	600W	1000W	1500W	1500W	1500W	2200 based on 100µs/150ms pulse	5000W	15000W	NA	NA
Peak Pulse Current (8x20µs)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6000A	10000A
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Overvoltage Application Guide (cont.)

	Application	Circuit	Threat	Solution Series	Technology
Industrial Environment	**High energy systems**	Robotics	EFT, Lightning, Commutative Spikes, Inductive Load Switching	UltraMOV, CH, LA, C-III, ZA SMBJ, P6KE, 1.5KE, 5KP, 15KP	MOV SAD
		Large Motors, Pumps, Compressors	EFT, Lightning, Commutative Spikes, Inductive Load Switching	UltraMOV, CH, HA, HB34, BA/BB DA/DB, PA, RA	MOV MOV
		Motor Drives	EFT, Lightning, Commutative Spikes, Inductive Load Switching	UltraMOV, TMOV, LA, C-III, RA, CH SMBJ, P6KE, 1.5KE, 5KP, 15KP	MOV SAD
		AC Distribution	EFT, Lightning, Commutative Spikes, Inductive Load Switching	UltraMOV, C-III, HA, HB34, BA/BB, DA/DB 5KP, 15KP, AK6, AK10	MOV SAD
		High Current Relays	EFT, Lightning, Commutative Spikes	UltraMOV, C-III, HA, HB34, BA/BB, DA/DB	MOV
Telecom/Datacom	**SLIC (Subscriber Line Interface Circuit)**	Telecom: Tip/Ring Circuits	Lightning	PXXXI, PXXXIUA/C, PxxxICA2, PxxxISA/C BxxxxUA/C, BxxxOCA/C SL1002, SL1011, SL0902, SL1003	SIDACtor® Devices BATTRAX® Devices Gas Plasma
	Customer Premise Equipment - Fax machine - Answering machine - xDSL gateway - Dial-up modem - Set top box - T1/E1/J1 - ISDN - SLIC hardware - Public phone - Cellular phone - Cordless phone - Phone Line Protector - LAN protection module	High-Speed Data Interfaces: USB 2.0, IEEE 1394, RF antenna circuits	ESD	PGB1	PulseGuard® Polymer
			Lightning	PXXXXUA/C, PXXXXCA2, PXXXXSA/C PXXXXSA/B/C, PXXXXSA/B/CMC, PXXXXUA/B/C, PXXX3UA/C, PXXX6UA/C, BXXXXUA/C, BXXXOCA/C, SL1002, SL1011, SL0902, SL1003	SIDACtor® Devices Gas Plasma Arrestor
		Medium/low-speed Data Interfaces: USB 1.1, Ethernet, RS 232	ESD, EMI, EFT	SP05x, SP72x, SPUSBx, ML, MLE, MLN, MHS	Diode Array MLV
		Telecom Interface (secondary): Tip/Ring Circuits	Lightning	T10A/B/C, PXXXXSA/B/C SL1002, SL1011, SL0902, SL1003	SIDACtor® Devices Gas Plasma Arrestor
		Power Inputs: 120/240 VAC, up to 120 VDC	Lightning	P6KE, 1.5KE CH, ZA, UltraMOV	SAD MOV
	Interface Equipment - PBX systems - Internet gateways - DSLAM equipment **Central Office Equipment** - Interexchange carrier - Local exchange carrier - Mobile telephone switch - Repeater/node **Conversion Equipment** - Cellular base station - Satellite base station - Microwave base station - T1/E1/J1 - xDSL - DSLAM - Railroad Signaling	Telecom Interface (primary): Tip/Ring Circuits	Lightning	PXXXX/EC/SC/UC/SD SL1002, SL1003, SL1011, SL0902, SL1026, SL1122	SIDACtor® Devices Gas Plasma Arrestor
		Telecom Interface (primary): Tip/Ring Circuits	Lightning	T10A/B/C, PXXXXUB/C, PXXXXSCMC, PXXX3UC, PXXX6UA/C, PXXXXSC, PXXXXEC, SL1002, SL1003, SL0902, SL1011, SL1026, SL1022	SIDACtor® Devices Gas Plasma Arrestor
		Power Inputs: 120/240 VAC, up to 120 VDC	Lightning	P6KE, 1.5KE CH, ZA, UltraMOV HV	SAD MOV Gas Plasma Arrestor
Automotive	**Engine Control Module** **Body/Chassis Control** - Body controller - Antilock braking system - Steering sensor - Illumination control - Instrument cluster - Air bag module - Window control module - Wiper module - Door lock module - HID Headlamps **Multimedia systems** - Radio/satellite tuner - CD/cassette players - DVD/VCR players - MP3 players - Data interface buses **Telematics systems** - Wireless communication - GPS receiver - Navigation system - Security system	High-Speed Interfaces: USB 2.0, IEEE 1394	ESD	PGB1	PulseGuard® Polymer
		Medium/Low-Speed Interfaces: USB 1.1, CAN	ESD, EMI	SP05x, SP72x, SPUSBx, ML, MLE, MLN, MHS	Diode Array MLV
		Power Inputs: Up to 42 VDC	Load Dump and Inductive Switching	AUML, P6K, P6SMBJ, 5KP 1KSMBJ, SLD CH, ZA	MLV SAD SAD MOV
		HID Switching	N/A	XT	Gas Plasma Switches

Greentube™ Gas Plasma (improved GDT) Selection Guide

Family name	TRIGGER SWITCH	OMEGA		BETA								ALPHA		DELTA	
Performance Level	High	Standard		High								Ultra		High	
Series Name	XT, LT, VS	SL1024B	SL1024A	SL1011A	SL1011B	SL1021A	SL1021B	SL1002A	SL1003A	SL0902	HV	SL1122A	SL1221	SL1411A	SL1026
Technology Type	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)	Gas Plasma (GDT)
Temperature Range	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150	-40 to +150	-55 to +150	-55 to +150	-55 to +150	-55 to +150
Package Type	2 Terminal	2 Terminal, Button and axial leads	3 Terminal, Core (no pins) and radial leads	2 Terminal, Button and axial leads	2 Terminal, Button and axial leads	3 Terminal, Core (no pins) and radial leads	3 Terminal, Core (no pins) and radial leads	2 Terminal, Button and surface mount	3 Terminal, Radial and surface mount	2 Terminal SMT and axial leads	2 Terminal	3 Terminal, SAD/GP Hybrid radial leads	3 Terminal, radial leads	2 Terminal axial lead and surface mount	3 Terminal
Mounting Method	SMT & through-hole	through-hole or clip mount	through-hole	through-hole or clip mount	through-hole or clip mount	through-hole	through-hole	SMT	through-hole or SMT	through-hole or SMT	through-hole	through-hole	through-hole	through-hole or SMT	clip mounted
DC Breakover Voltage	230-800	90-600	90-600	75-600	75-350	200-600	200-600	90-600	90-450	90-420	2850-3500	90-450	200	184-360	275-1,100
AC Surge Rating	NA	20A	10A*	5A	10A	10A*	20A*	2A	5A	2.5A	NA	5A*	10A*	10A	40A*
Peak Pulse Current (8x20µs)	400A†	20000A	10000A*	5000A	10000A	10000A*	20000A*	5000A	5000A	2500A	3000A	10000A*	10000A*	20000A	55000A*
Max Capacitance	2pF	1.5pF	1.5pF	1.5pF	1.5pF	1.5pF	1.5pF	1.2pF	1.2pF	1pF	1pF	100-200pF	1.5pF	<1pF	2.5pF
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes

* Total current through center (ground) terminal
† Repetitive switching current

Battrax® Device Selection Guide

Series Name	Bxxxx_							
Type	CA	CC	1UA	1UC	4UA	4UC	UA4	UC4
Technology Type	Single	Single	Dual Negative	Dual Negative	Dual Positive/Negative	Dual Positive/Negative	Quad Negative	Quad Negative
Package Type	Mod DO-214AA	Mod DO-214AA	MS-013	MS-013	MS-013	MS-013	MS-013	MS-013
Mounting Method	SMT	SMT	SMT	SMT	SMT	SMT	SMT	SMT
Standoff (working) Voltage (V_{DRM})	Programmable	Programmable	Programmable	Programmable	Programmable	Programmable	Programmable	Programmable
Peak Pulse Rating: • 2x10µs	150A	500A	150A	500A	150A	500A	150A	500A
• 10x160µs	90A	200A	90A	200A	90A	200A	90A	200A
• 10x560µs	50A	150A	50A	150A	50A	150A	50A	150A
• 10x1000µs	45A	100A	45A	100A	45A	100A	45A	100A
• 8X20µs	150A	400A	150A	400A	150A	400A	150A	400A
I_{TSM}	20A	50A	20A	50A	20A	50A	20A	50A
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	No	No	No	No	No	No	No	No

NOTE: 1. Low off-state capacitance MC versions available for SA, SC, and UC part numbers.
2. RoHS versions of parts available, add suffix "L." Contact factory or visit www.littelfuse.com for additional information.
3. Operating temperature for devices are -40˚C to +150˚C
4. Storage temperature for devices are -65˚C to +150˚C

SIDACtor® Device Selection Guide

Series Name	Pxxx1_							Pxxx2S_		Pxxxx_		
Type	SA	SC	CA2	AA2	AC2	UA	UC	A	B	ME	NE	RE
Technology Type	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Protection Thyristors	Protection Thyristors	Protection Thyristors	Protection Thyristors	Protection Thyristors
Package Type	DO-214AA	DO-214AA	Mod DO-214AA	Mod TO-220	Mod TO-220	MS-013	MS-013	Mod DO-214AA	Mod DO-214AA	TO-218	TO-263 (D2PAK)	TO-220
Mounting Method	SMT	SMT	SMT	Through-hole	Through-hole	SMT	SMT	SMT	SMT	Through-hole	SMT	Through-hole
Standoff (working) Voltage (V_{DRM})	58 - 160	58 - 160	58 - 160	58 - 95	58 - 95	58 - 160	58 - 160	58-440	58-440	140-180	140	140
Switching Voltage (V_S)	77 - 200	77 - 200	77 - 200	77 - 130	77 - 130	77 - 200	77 - 200	32 - 600	32 - 600	180 - 260	220	220
Peak Pulse Rating: • 2x10µs	150A	500A	150A	150A	500A	150A	500A	150A	250A	——	——	——
• 10x160µs	90A	200A	90A	90A	200A	90A	200A	90A	150A	——	——	——
• 10x560µs	50A	150A	50A	50A	150A	50A	150A	50A	100A	——	——	——
• 10x1000µs	45A	100A	45A	45A	100A	45A	100A	45A	80A	——	——	——
• 8X20µs	150A	400A	150A	150A	400A	150A	400A	150A	250A	5000A	3000A	3000A
I_{TSM}	20A	50A	20A	20A	50A	20A	20A	20A	30A	400A	400A	400A
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	No	No	No	No	No	No	No	No	No	No	No	No

NOTE: 1. Low off-state capacitance MC versions available for SA, SC, and UC part numbers.
2. RoHS versions of parts available, add suffix "L." Contact factory or visit www.littelfuse.com for additional information.
3. Operating temperature for devices are -40˚C to +150˚C
4. Storage temperature for devices are -65˚C to +150˚C
5. I_H = 50 – 150mA for all devices in table
6. C_0 = 50pf for all devices

SIDACtor® Device Selection Guide (cont.)

Series Name	Pxxx2__			Pxxx3__			Pxxx0_		
Type	AA	AB	AC	AA	AB	AC	SA/EA	SB/EB	SC/EC
Technology Type	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors
Package Type	Modified TO-220 (two die)	Modified TO-220 (two die)	Modified TO-220 (two die)	Modified TO-220 (three die)	Modified TO-220 (three die)	Modified TO-220 (three die)	DO-214AA/TO-92	DO-214AA/TO-92	DO-214AA/TO-92
Mounting Method	through-hole	through-hole	through-hole	through-hole	through-hole	through-hole	through-hole/SMT	through-hole/SMT	through-hole/SMT
Standoff (working) Voltage (V_{DRM})	25-275[5]	25-275[5]	25-275[5]	130-420	130-420	130-420	6-320	6-320	6-320
Switching Voltage (V_S)	40-350	40-350	40-350	180-600	180-600	180-600	25-400	25-400	25-400
Peak Pulse Rating: • 2x10µs	150A	250A	500A	150A	250A	500A	150A	250A	500A
• 10x160µs	90A	150A	200A	90A	150A	200A	90A	150A	200A
• 10x560µs	50A	100A	150A	50A	100A	150A	50A	100A	150A
• 10x1000µs	45A	80A	100A	45A	80A	100A	45A	80A	100A
• 8X20µs	150A	250A	400A	150A	250A	400A	150A	25A	400A
I_{TSM}	20A	30A	50A	20A	30A	50A	20A	30A	50A
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	No	No	No	No	No	No	No	No	No

NOTE: 1. Low off-state capacitance MC versions available for SA, SC, and UC part numbers.
2. RoHS versions of parts available, add suffix "L." Contact factory or visit www.littelfuse.com for additional information.
3. Operating temperature for devices are -40˚C to +150˚C
4. Storage temperature for devices are -65˚C to +150˚C
5. V_{DRM} - Measured across a single chip
6. I_H = 50-150 for all devices in table

SIDACtor® Device Selection Guide (cont.)

Series Name	PxxxxAD	Pxxx0SD	PxxxxU_			Pxxxx_		T10A	T10B	T10C
Type			UA	UB	UC	CA	CB			
Technology Type	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors	Silicon Thyristors
Package Type	TO-218	DO-214AA	MS-013	MS-013	MS-013	Mod. DO-214AA	Mod. DO-214AA	DO-15	DO-201	3-Terminal
Mounting Method	through-hole	SMT	SMT	SMT	SMT	SMT	SMT	through-hole	through-hole	through-hole
Standoff (working) Voltage (V_{DRM})	120-550	6-320	6-420	6-420	6-420	58-275	58-275	58-270	80-270	80-270
Switching Voltage (V_S)	160-700	25-400	25-600	25-600	25-600	77-350	77-350	80-360	120-360	120-360
Peak Pulse Rating: • 2x10µs	———	1000A	150A	250A	500A	150A	250A	———	———	———
• 10x160µs	———	400A	90A	150A	200A	90A	150A	———	———	———
• 10x560µs	———	300A	50A	100A	150A	50A	100A	———	———	———
• 10x1000µs	250A	200A	45A	80A	100A	45A	80A	50A	100A	100A
• 8X20µs	1000A	800A	150A	250A	400A	150A	250A	100A	250A	250A
I_{TSM}	120A	50A	20A	30A	50A	20A	30A	30A	50A	50A
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	No	No	No	No	No	No	No	No	No	No

NOTE: 1. Low off-state capacitance MC versions available for SA, SC, and UC part numbers.
2. RoHS versions of parts available, add suffix "L." Contact factory or visit www.littelfuse.com for additional information.
3. Operating temperature for devices are -40˚C to +150˚C
4. Storage temperature for devices are -65˚C to +150˚C
5. I_H = 50-150 for all devices in table except T10A (120-180mA), T10B (120-180mA), and T10C (120-260mA)

Varistor Selection Guide

	Metal Oxide Varistors (MOV)															
	Radial Leaded						Packaged					Bare Disc		Surface Mount		Axial Leaded
Series Name	**ZA**	**RA**	**LA**	**C-III**	**UltraMOV™ Varistor**	**TMOV®/ iTMOV® Varistor**	**PA**	**HA**	**HB34, TMOV34S HG34 HF34, DHB34**	**DA/DB**	**BA/BB**	**NA**	**CA**	**CH**	**AUML**	**MA**
Technology Type	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Zinc Oxide	Multilayer Zinc Oxide	Zinc Oxide
Operating AC Voltage Range	4-460	4-275	130-1000	130-660	130-625	115-750	130-660	130-750	110-750	130-750	130-2800	130-750	130-2800	14-275	———	9-264
Operating DC Voltage Range	5.5-615	5.5-369	175-1200	———	170-825	———	175-850	148-970	148-970	175-970	175-3500	175-970	175-3,500	18-369	18	13-365
Peak Current Range (A)**	50-6500	150-6500	1200-6500	3500-9000	1750-10000	6000-10000	6500	25000 40000	40000	40000	50000 70000	40000	20000 70000	250-500	———	40-100
Peak Energy Range (J)	0.1-52	0.4-160	11-360	40-530	12.5-400	35-480	70-250	160-1050	220-1050	270-1050	450-10000	270-1050	200-10000	1-23	———	0.06-1.7
Temperature Range (Deg.C)	-55 – +85	-55 – +125	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +85	-55 – +125	-55 – +125	-55 – +85
Lines Protected	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mount/Form Factor	Radial Leaded	Packaged	Radial Leaded	Radial Leaded	Radial Leaded	Radial Leaded	Packaged	Packaged	Industrial Packaged	Industrial Package	Packaged	Bare Disc	Bare Disc	Surface Mount	Surface Mount	Axial Leaded
Disc Size (MOV)	5, 7, 10, 14, 20mm	8, 16, 22mm	7, 10, 14 20mm	10, 14, 20mm	7, 10, 14 20mm	14, 20mm	20mm	32, 40mm	34mm	40mm	60mm	34mm	32, 40, 60mm	———	———	3mm
Agency Approvals	UL,VDE, CECC	UL,CSA	UL,CSA, CECC, & VDE	UL,CSA, CECC & VDE	UL,CSA, VDE, & CECC	UL, CSA	UL & CSA	UL & CSA	UL & CSA	UL	UL	———	———	UL	———	———
RoHS Compliant	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Pb Lead-Free	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes	Yes

* Not an applicable parameter for this technology
** Not an applicable parameter for Crowbar devices

ESD Suppressor Selection Guide

Littelfuse manufacturers three different product families for ESD suppression. Each technology provides distinct attributes for compatibility to specific circuit requirements.
1. Review the circuit requirements or parameters from the left hand column and compare them to the Littelfuse product offerings shown.
2. Refer to Littelfuse data sheets and application notes for complete technical information.

	PulseGuard® Suppressors		Silicon Protection			Multilayer Varistors			
	Surface Mount	Connector Array	Surface Mount			Surface Mount			
Series Name	**PGB*, PGB1**	**PGD**	**SP72X**	**SP05X**	**SPUSBx**	**ML**	**MLE**	**MLN**	**MHS**
Technology Type	VVM	VVM	Silicon SCR/Diode	TVS Avalanche Diode	USB Port Terminator (w/ESD Suppression and EMI Filter)	MLV ZnO	MLV ZnO	MLV ZnO	MLV ZnO
Working Voltage	0-24VDC	0-24VDC	0-30VDC	0-5.5VDC	0-5.5VDC	0-120VDC range by type	0-18VDC	0-18VDC	0-42VDC
Array Package (No. of Lines)	SOT23 (2), 0805 (4)	Connector (9, 15, 25, and 37 pins)	DIP, SOIC (6, 14) SOT23 (4)	SC70 (2,4,5), SOT23 (2,4,5), SOT143 (3), TSSOP-8 (4), MSOP-8 (6)	SC70-6 (3)	No	No	0805 (4) 1206 (4)	No
Single Line Package	0603	No	No	No	No	0402-1210	0402-1206	———	0402-0603
Typical Device Capacitance	0.06pF	<2pF	3-5pF	30pF	47pF	40-6000pF	40-1700pF	45-430pF	3-22pF
Leakage Current	<1nA	<0.1µA	<20nA	<100nA	<100nA	<25µA	<25µA	<30nA	<1µA
Rated Immunity to IEC 61000-4-2 level 4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Also Rated for EFT or Lightning Wave	No	No	Yes	TBD	TBD	Yes	Yes	Yes	Yes
Bidirectional (transients of either polarity)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Performs Low Pass Filtering	–	–	–	–	Yes	Yes	Yes	Yes	Yes
RoHS Compliant	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Pb Lead-Free	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes

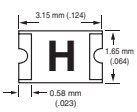
*PGB series is not RoHs compliant or lead-free. For lead-free and RoHs compliant designs use the PGB1 series

Overcurrent Suppression Products

Resettable PTCs

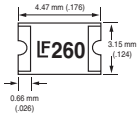
1206L Series
Surface Mount

I_{hold} (A)	V_{max} (VDC)
0.20	15.0
0.25	15.0
0.35	6.0
0.50	6.0
0.75	6.0
1.10	6.0
1.50	6.0
1.60	6.0

1812L Series
Surface Mount

I_{hold} (A)	V_{max} (VDC)
0.50	15.0
0.75	13.2
1.10	6.0
1.25	6.0
1.50	6.0
1.60	6.0
2.00	6.0
2.60	6.0

30R Series
Radial Lead

V_{max}
30VDC
Ampere Range
0.90 – 9.0A

60R Series
Radial Lead

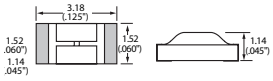
V_{max}
60VDC
Ampere Range
0.10 – 3.75A

Surface Mount Fuses

High Current 1206
Very Fast-Acting Thin-Film Fuse
429 Series

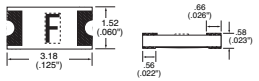
Voltage range:	24V	
Ampere range:	7A	
Interrupting ratings:	35A @ 24VAC/VDC	

*For RoHS compliant and Lead-Free 7A part add "L" suffix (ex. 0429007.xxL)
**Use 433 or 466 series for all designs below 7A.

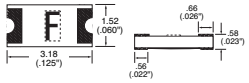
SlimLine™ Lead-Free 1206
Very Fast-Acting Thin-Film Fuse
466 Series

Voltage range:	24-125V	
Ampere range:	0.125 – 5.0A	
Interrupting ratings:	0.125 – .375A	50A @ 125VAC/VDC
	0.5 – 2A	50A @ 63VAC/VDC
	2.5 – 3A	50A @ 32VAC/VDC
	4 – 5A	35A @ 24VAC/VDC

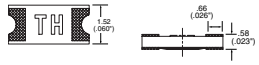
SlimLine™ 1206
Very Fast-Acting Thin-Film Fuse
433 Series

Voltage range:	24 – 125V	
Ampere range:	0.125 – 5.0A	
Interrupting ratings:	0.125 – .375A	50A @ 125VAC/VDC
	0.5 – 2A	50A @ 63VAC/VDC
	2.5 – 3A	50A @ 32VAC/VDC
	4 – 5A	35A @ 24VAC/VDC

SlimLine™ Lead-Free 1206
Slo-Blo® Thin-Film Fuse
468 Series

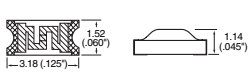
Voltage range:	32-63V	
Ampere range:	1.0 – 3.0A	
Interrupting ratings:	1.0-1.5A	50A@63VAC/VDC
	2.0A	50A@63VAC/VDC
	3.0A	50A@32VAC/VDC

1206
Slo-Blo® Thin-Film Fuse
430 Series

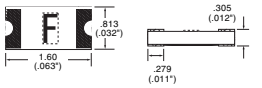
Voltage range:	32 – 63V	
Ampere range:	0.5 – 3.0A	
Interrupting ratings:	1.0-1.5A	50A@63VAC/VDC
	2.0A	35A@63VAC/VDC
	3.0A	50A@32VAC/VDC

*For new designs use the 468 series

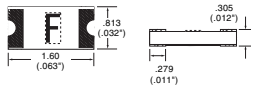
SlimLine™ Lead-Free 0603
Very Fast-Acting Thin-Film Fuse
467 Series

Voltage range:	32V	
Ampere range:	0.25 – 5.0A	
Interrupting ratings:	0.25 – 1A	50A @ 32VAC/VDC
	1.25 – 5A	35A @ 32VAC/VDC

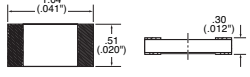
SlimLine™ 0603
Very Fast-Acting Thin-Film Fuse
434 Series

Voltage range:	32V	
Ampere range:	0.25 – 5.0A	
Interrupting ratings:	0.25 – 1A	50A @ 32VAC/VDC
	1.25 – 5A	35A @ 32VAC/VDC

SlimLine™ Lead-Free 0402
Very Fast-Acting Thin-Film Fuse
435 Series

Voltage range:	32V	
Ampere range:	0.25 – 2.0A	
Interrupting ratings:	35A @ 32 VDC	

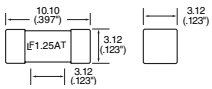
Surface Mount Fuses

Add "L" suffix when ordering RoHS compliant

TeleLink®
Surge Tolerant Minature Fuse
461 Series

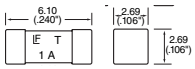
Voltage range:	600V
Ampere range:	0.5 – 2.0A
Interrupting ratings:	60A @ 600 VAC*

*See data sheet for test conditions



NANO²®
Slo-Blo® Type Fuse
452/454 Series

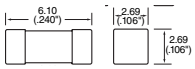
Voltage range:	125V
Ampere range:	0.375 – 5A
Interrupting ratings:	50A @ 125VAC/VDC



NANO²®
Slo-Blo® Type Fuse
449 Series

Voltage range:	125V
Ampere range:	0.375 – 5A
Interrupting ratings:	TBD

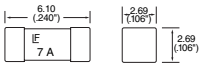
*Available September 2005. Contact Littelfuse for Electrical Specifications.



Add "L" suffix when ordering RoHS compliant

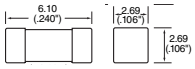
NANO²®
Very Fast-Acting Type Fuse
451/453 Series

Voltage range:	65 – 125V	
Ampere range:	0.062 – 15.0A	
Interrupting ratings:	0.062 – 8A	50A @ 125VAC/VDC
		300A @ 32VDC
	10A	35A @ 125VAC
		50A@125VDC
		300A @ 32VDC
	12 – 15A	50A @ 65VAC/VDC
		300A @ 24VDC



NANO²®
Very Fast-Acting Type Fuse
448 Series

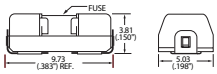
Voltage range:	65 – 125V	
Ampere range:	0.062 – 15.0A	
Interrupting ratings:	0.062 – 8A	50A @ 125VAC/VDC
		300A @ 32VDC
	10A	35A @ 125VAC
		50A@125VDC
		300A @ 32VDC
	12 – 15A	50A @ 65VAC/VDC
		300A @ 24VDC



SMF Omni-Blok® Fuse Block
154 Series

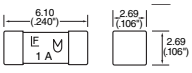
Mounting Type:	Molded Base
Fuse Type:	NANO²® Fuse

See NANO²® Fuse for electrical characteristics.



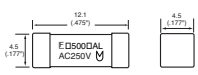
NANO²® UMF
Fast-Acting Type Fuse
455 Series

Voltage range:	125V
Ampere range:	0.40 – 1.6A
Interrupting ratings:	50A @ 125VAC/VDC



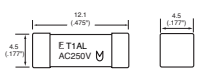
NANO²® 250V UMF
Fast-Acting Fuse
464 Series

Voltage range:	250V
Ampere range:	.50 – 6.3A
Interrupting ratings:	100A @ 250VAC



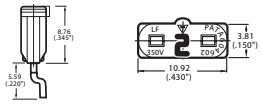
NANO²® 250V UMF
Time Lag Fuse
465 Series

Voltage range:	250V
Ampere range:	1.0 – 6.3A
Interrupting ratings:	100A @ 250VAC



EBF – 350V
Fast Acting Type Fuse
446/447 Series

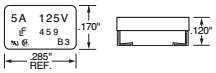
Voltage range:	350V
Ampere range:	2 – 10A
Interrupting ratings:	100A @ 350VAC
	50A @ 125VDC
	450A @ 60VDC



Surface Mount Fuses

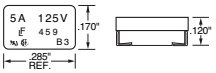
PICO® SMF
Very Fast-Acting Type Fuse
459 Series

Voltage range:	125V
Ampere range:	0.062 – 5.0A
Interrupting ratings:	50A @ 125VAC,
	300A @ 125VDC



PICO® SMF
Slo-Blo® Type Fuse
460 Series

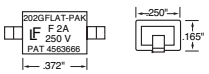
Voltage range:	125V
Ampere range:	0.5 – 5.0A
Interrupting ratings:	50A @ 125VAC/VDC



FLAT-PAK®
Fast-Acting Type Fuse
202 Series

Voltage range:	250V
Ampere range:	0.062 – 5.0A
Interrupting ratings:	50A @ 250VAC

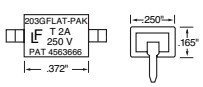
* For new or RoHS compliant designs use 464 series



FLAT-PAK®
Slo-Blo® Type Fuse
203 Series

Voltage range:	250V
Ampere range:	0.25 – 5.0A
Interrupting ratings:	50A @ 250VAC

* For new or RoHS compliant designs use 465 series

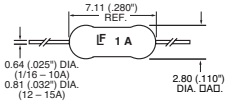


Axial Leaded Fuses

Add "L" suffix when ordering RoHS compliant PICO®II products

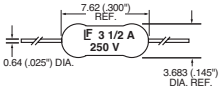
PICO® II
Very Fast-Acting Type Fuse
251/253 Series

Voltage range:	32 – 125V
Ampere range:	0.062 – 15A
Interrupting ratings:	300A @ Rated VDC
	50A @ Rated VAC



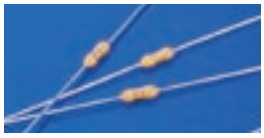
PICO® II 250V
Very Fast-Acting Type Fuse
263 Series

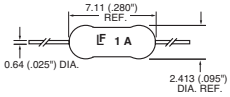
Voltage range:	250V
Ampere range:	0.062 – 5.0A
Interrupting ratings:	50A @ 250VAC



PICO® II
Time Lag Type Fuse
471 Series

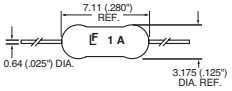
Voltage range:	125V
Ampere range:	0.5 – 5.0A
Interrupting ratings:	50A @ 125VAC/VDC





PICO® II
Slo-Blo® Type Fuse
473 Series

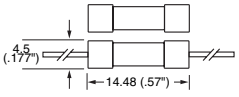
Voltage range:	125V
Ampere range:	0.375 – 7.0A
Interrupting ratings:	50A @ 125VAC/VDC



Add "P" suffix when ordering RoHS compliant and PV parts

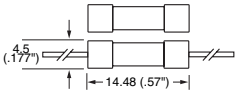
2AG
Fast-Acting Type Fuse
224/225/224P/225P Series

Voltage range:	125 – 250V	
Ampere range:	0.10 – 10.0A	
Interrupting ratings:	0.1 – 10A	10000A @ 125VAC
	0.1 – 1A	35A @ 250VAC
	1.5 – 3.5A	100A @ 250VAC



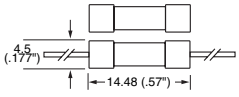
2AG Special 350V
Fast-Acting Type Fuse
220 007/220 007P Series

Voltage range:	350V	
Ampere range:	3.0A	
Interrupting ratings:	100A @ 350VAC	



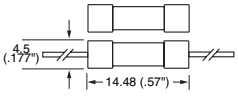
2AG
Slo-Blo® Type Fuse
229/230/229P/230P Series

Voltage range:	125 – 250V	
Ampere range:	0.25 – 7.0A	
Interrupting ratings:	0.25 – 3.5A	10000A @ 125VAC
	4 – 7A	400A @ 125VAC
	0.25 – 1A	35A @ 250VAC
	1.25 – 3.5A	100A @ 250VAC



2AG
Surge Withstand Type Fuse
229/230/229P/230P Series
(Select Ratings)

Voltage range:	125 – 250V	
Ampere range:	0.250 – 1.25A	
Interrupting ratings:	0.25 – 1.25A	10000A @ 125VAC
	0.25 – 1A	35A @ 250VAC
	1.25A	100A @ 250VAC



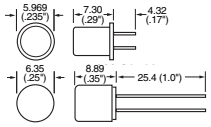
Axial Leaded and Cartridge Fuses

Add "P" suffix when ordering RoHS compliant and PV 3AG parts

MICRO™
Very Fast-Acting Type Fuse
272/273/274/278/279 Series

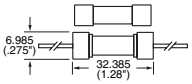
Voltage range:	125V
Ampere range:	0.002 – 5.0A
Interrupting ratings:	10000A @ 125VAC/VDC

*Ratings above 0.031A are RoHS compliant and Lead-Free



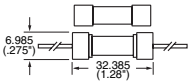
3AG
Fast-Acting Type Fuse
312/318/312P/318P Series

Voltage range:	32 – 250V
Ampere range:	0.031 – 35.0A
Interrupting ratings:	10000A @ 125VAC
	35A @ 250VAC



3AG
Slo-Blo® Type Fuse
313/315/313P/315P Series

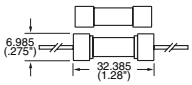
Voltage range:	32 – 250V		
Ampere range:	0.01 – 30.0A		
Interrupting ratings:	0.01 – 8A	10000A @ 125VAC	1.2 – 3.2A	100A @ 250VAC
	.01 – 1A	35A @ 250VAC	4 – 8A	200A @ 250VAC
			10 – 30A	300A @ 32VAC



Add "P" suffix when ordering RoHS compliant and PV parts

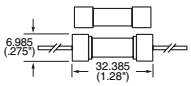
3AB
Fast-Acting Type Fuse
314/324/314P/324P Series

Voltage range:	250V		
Ampere range:	0.125 – 30.0A		
Interrupting ratings:	0.125 – 20A	10000A @ 125VAC/DC	4 – 15A	750A @ 250VAC
	25 – 30A	400A @ 125VAC/DC	20A	1000A @ 250VAC
	0.125 – .75A	35A @ 250VAC	25 – 30A	100A @ 250VAC
	1 – 3A	100A @ 250VAC		



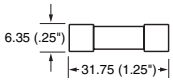
3AB
Slo-Blo® Type Fuse
326/325/326P/325P Series

Voltage range:	125 – 250V	
Ampere range:	0.010 – 30A	
Interrupting ratings:	0.010 – 3.2A	10000A @ 125VAC
		100A @ 250VAC
	4 – 20A	10000A @ 125VAC
		400A @ 250VAC
	25 – 30A	400A @ 125VAC



3AB
Special Very Fast-Acting Type Fuse
322/322P Series

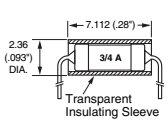
Voltage range:	65 – 250V
Ampere range:	1 – 30A
Interrupting ratings:	1 – 10A	10000A @ 125VAC
		100A @ 250VAC
	12 – 30A	200A @ 65VAC



High Reliability

PICO®
Very Fast-Acting Type Fuse
265/266/267 Series

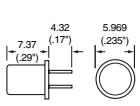
Voltage range:	32 – 125V
Ampere range:	0.062 – 15.0A
Interrupting ratings:	300A @ rated VDC
	50A @ rated VAC



MICRO™
Very Fast-Acting Type Fuse
262/268/269 Series

Voltage range:	125V
Ampere range:	.002 – 5.0A
Interrupting ratings:	10000A @ 125VAC/VDC

Also available in 25.4mm lead length



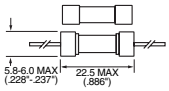
Axial Leaded and Cartridge Fuses

Add "P" suffix when ordering RoHS compliant and Pb parts

5 x 20mm
IEC Fast-Acting Type Fuse
217 Series

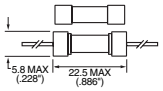
Voltage range:	250V
Ampere range:	0.032 – 15A
Interrupting ratings:	35A or 10 times rated current; whichever is greater to a max of 100A@250VAC

*.125 – 15A series pictured



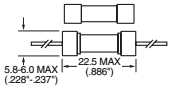
5 x 20mm
IEC Slo-Blo® Type Fuse
213 Series

Voltage range:	250V
Ampere range:	0.200 – 6.3A
Interrupting ratings:	35A or 10 times rated current; whichever is greater



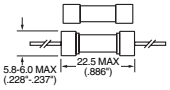
5 x 20mm
IEC Fast-Acting Type Fuse
216 Series

Voltage range:	250VAC
Ampere range:	0.050 – 10A
Interrupting ratings:	1500A



5 x 20mm
IEC Slo-Blo® Type Fuse
215 Series

Voltage range:	250VAC
Ampere range:	0.200 – 12A
Interrupting ratings:	1500A

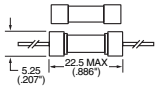


Add "P" suffix when ordering RoHS compliant and Pb parts

5 x 20mm
Slo-Blo® Type Fuse
218 Series

Voltage range:	250VAC
Ampere range:	0.32 – 15.0A
Interrupting ratings:	35A or 10 times rated current; whichever is greater to a max of 100A @ 250VAC

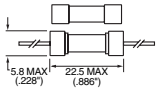
*.125 – 15A series pictured



5 x 20mm
IEC Slo-Blo® Type Fuse
219XA Series

Voltage range:	250VAC
Ampere range:	0.125 – 6.3A
Interrupting ratings:	150A @ 250VAC

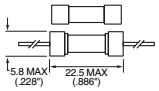
*High I^2t rating



5 x 20mm
METI Medium-Acting
232 Series

125/250VAC

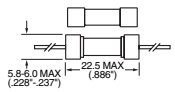
Voltage range:	1 – 10A
Ampere range:	1.0 – 5.0A 10000A @ 125VAC
Interrupting ratings:	6.3 – 10.0A 300A @ 125VAC
	1.0 – 10.0A 100A @ 250VAC



5 x 20mm
UL/CSA Fast-Acting Type Fuse
235 Series

125 – 250VAC

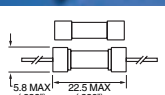
Voltage range:	0.10 – 6A
Ampere range:	.100 – 1.0A 35A @ 250VAC
Interrupting ratings:	1.25 – 3.0A 100A @ 250VAC
	.100 – 6.0A 10000A @ 125VAC



Add "P" suffix when ordering RoHS compliant and Pb parts

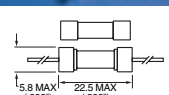
5 x 20mm
UL/CSA Medium-Acting Type Fuse
233/234 Series

Voltage range:	125 – 250VAC	
Ampere range:	1 – 10A	
Interrupting ratings:	1A – 6.3A	10000A @ 125VAC
	1A	35A @ 250VAC
	1.25A – 3.5A	100A @ 250VAC
	4 – 10A	200A @ 250VAC



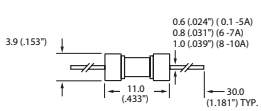
5 x 20mm
UL/CSA Slo-Blo® Type Fuse
239 Series

Voltage range:	125 – 250VAC	
Ampere range:	0.20 – 7A	
Interrupting ratings:	0.20 – 7A	10000A @ 125VAC
	0.20 – 1A	35A @ 250VAC
	1.25 – 3.15A	100A @ 250VAC



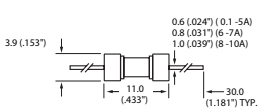
3.6 x 10mm
Fast-Acting Type Fuse
672 Series

Voltage range:	250V
Ampere range:	0.100-10.0A
Interrupting ratings:	50A @ 250VAC



3.6 x 10mm
Slo-Blo® Type Fuse
673 Series

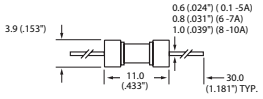
Voltage range:	250V
Ampere range:	0.100 – 10.0A
Interrupting ratings:	50A @ 250VAC



Axial Leaded and Cartridge Fuses

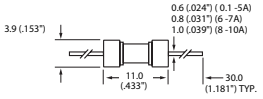
3.6 x 10mm
Fast-Acting Type Fuse
674 Series

Voltage range:	250V
Ampere range:	0.100 – 8.0A
Interrupting ratings:	50A @ 250VAC



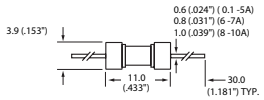
3.6 x 10mm
Slo-Blo® Type Fuse
675 Series

Voltage range:	250V
Ampere range:	0.100 – 5.0A
Interrupting ratings:	50A @ 250VAC



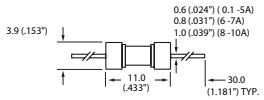
3.6 x 10mm
Fast-Acting Type Fuse
676 Series

Voltage range:	250V
Ampere range:	0.050 – 6.30A
Interrupting ratings:	35A or 10 times rated current; whichever is greater @ 250VAC



3.6 x 10mm
Slo-Blo® Type Fuse
677 Series

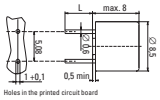
Voltage range:	250VAC
Ampere range:	0.250 – 6.30A
Interrupting ratings:	35A or 10 times rated current; whichever is greater @ 250VAC



Subminiature Cartridge Fuses

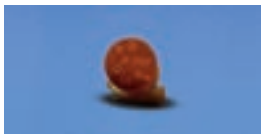
TR5®
IEC Fast-Acting Type Fuse
370 Series

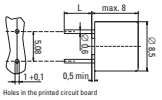
Voltage range:	250VAC	
Ampere range:	0.040 - 6.30A	
Interrupting ratings:	0.040 - 3.15A	35A @ 250VAC
	4.0A	40A @ 250VAC
	5.0 - 6.3A	50A @ 250VAC



TR5®
IEC Time Lag Type Fuse
372 Series

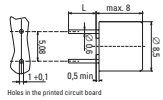
Voltage range:	250VAC	
Ampere range:	0.040 - 6.30A	
Interrupting ratings:	0.040 - 3.15A	35A @ 250VAC
	4.0A	40A @ 250VAC
	5.0 - 6.3A	50A @ 250VAC





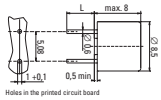
TR5®
UL Fast-Acting Type Fuse
373 Series

Voltage range:	250VAC
Ampere range:	0.050 - 10.0A
Interrupting ratings:	50 @ 250VAC



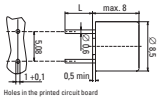
TR5®
UL Time Lag Type Fuse
374 Series

Voltage range:	0.050 - 10.0A
Ampere range:	50 @ 250VAC



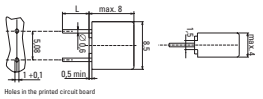
TR5®
IEC Time Lag Type Fuse
382 Series

Voltage range:	250VAC	
Ampere range:	1.0 - 6.30A	
Interrupting ratings:	100A @ 250VAC	
	Breaking capacity at UR: 50A @ 320VAC	



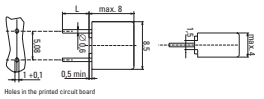
TE5®
IEC Time Lag Type Fuse
392 Series

Voltage range:	250VAC	
Ampere range:	0.800 - 6.3A	
Interrupting ratings:	0.800 - 2.50A	25A @ 250VAC
	3.15A	32A @ 250VAC
	4.0A	40A @ 250VAC
	5.0A	50A @ 250VAC
	6.3A	63A @ 250VAC



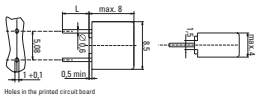
TE5®
UL Fast-Acting Type Fuse
395 Series

Voltage range:	125VAC
Ampere range:	0.050 - 6.3A
Interrupting ratings:	100A @ 125VAC



TE5®
UL Time Lag Type Fuse
396 Series

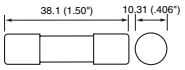
Voltage range:	125VAC
Ampere range:	0.050 - 6.30A
Interrupting ratings:	100A @ 125VAC



Cartridge Fuses – Midget and Class CC/CD

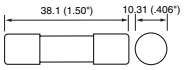
AC
Fast-Acting Type Fuse
KLK Series (F60C)
QPL

Voltage range:	600V
Ampere range:	0.10 – 30A
Interrupting ratings:	100000A @ 600VAC
	(capable of 200000A)



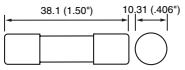
AC/DC
Fast-Acting Type Fuse
KLKD Series
QPL

Voltage range:	600V
Ampere range:	0.10 – 30A
Interrupting ratings:	10000A @ 600VDC
	100000A @ 600VAC
	(capable of 200000A)



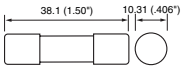
250 Volt
Slo-Blo® Type Fuse
FLM Series (F09B)
QPL

Voltage range:	250V
Ampere range:	0.10 – 30A
Interrupting ratings:	10000A @ 250VAC



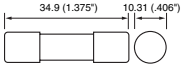
500 Volt
Slo-Blo® Type Fuse
FLQ Series

Voltage range:	500V
Ampere range:	0.10 – 30A
Interrupting ratings:	10000A @ 500VAC



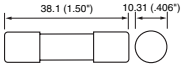
13/8" Long
Fast-Acting Type Fuse
BLS Series

Voltage range:	250 – 600V
Ampere range:	0.20 – 10A
Interrupting ratings:	10000A @ rated VAC



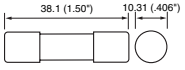
Slo-Blo®
Pin Indicating Type Fuse
FLA Series

Voltage range:	125VAC
Ampere range:	0.10 – 30A
Interrupting ratings:	10000A @ rated VAC
	*12-30A are dual tube



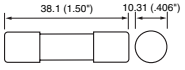
Laminated
Fast-Acting Type Fuse
BLF Series

Voltage range:	125 – 250V
Ampere range:	0.50 – 30A
Interrupting ratings:	10000A @ rated VAC



Fiber Body
Fast-Acting Type Fuse
BLN Series (F09A)
QPL

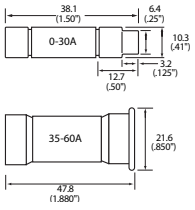
Voltage range:	250V
Ampere range:	1.0 – 30A
Interrupting ratings:	10000A @ 250VAC



Cartridge Fuses – Midget and Class CC/CD

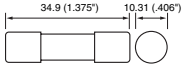
Class CC/CD
Fast-Acting & Time Delay Type Fuses
CCMR/KLDR/KLKR Series

Voltage range:	600VAC, 250 – 300VDC
Ampere range:	0.10 – 60A
Interrupting ratings:	AC: 200000A
	DC: 20000A



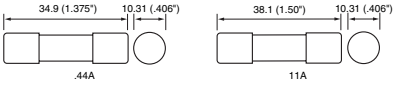
KLQ
Increased Time-Delay
KLQ Series

Voltage range:	600VAC
Ampere range:	1.0 – 6.0A
Interrupting ratings:	10000A @ rated VAC



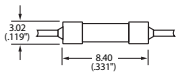
FLU
Multimeter Protection
FLU Series

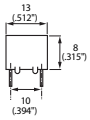
Voltage range:	1000VAC/VDC
Ampere range:	1A, 15A
Interrupting ratings:	1A 10kA@1000VAC/VDC
	15A 20kA@1000VAC/VDC,
	*1A=OFLU.440, 15A=OFLU011.



Hazardous Area Fuses

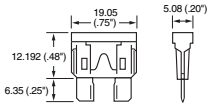
	Barrier Network 242 Series	Safe-T-Plus 259 Series
Voltage range:	250V	250V
Ampere range:	0.050 – 0.25A	0.062 – 1A
Interrupting ratings:	4000A @ 250VAC/VDC	50A @ 125VAC
	*Axial leaded parts not RoHS compliant	300A @ 125VDC

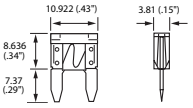


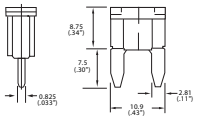


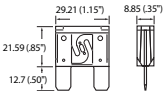
Blade Terminal and Special Purpose Fuses

	ATO® Fast-Acting Type Fuse 257 Series	MINI® Fast-Acting Type Fuse 297 Series	MINI® 42V Fast-Acting Type Fuse 997 Series	MAXI® Slo-Blo® Type Fuse 299 Series
Voltage range:	32VDC	32VDC	58VDC	32VDC
Ampere range:	1.0 – 40A	2.0 – 30A	2.0 – 30A	20 – 80A
Interrupting ratings:	1000A @ 32VDC	1000A @ 32VDC	1000A @ 58VDC	1000A @ 32VDC



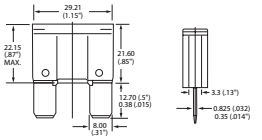


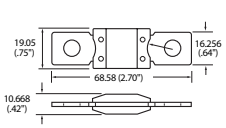


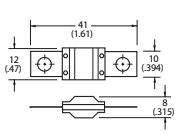


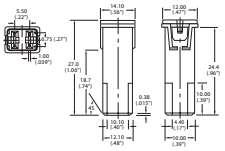
Blade Terminal and Special Purpose Fuses

	MAXI® 42V Slo-Blo® Type Fuse 999 Series	MEGA® Slo-Blo® Type Fuse 298 Series	MIDI® Fast-Acting High Current Fuse 498 Series	JCASE® 42V Slo-Blo® Cartridge Fuse 995 Series
Voltage range:	58VDC	32VDC	32VDC	58VDC
Ampere range:	20 – 80A	40 – 500A	30 – 200A	20 – 60A
Interrupting ratings:	1000A @ 58VDC	2000A @ 32VDC	2000A @ 32VDC	1000A @ 58VDC
		*Only protector is available in ratings greater than or equal to 300A.	*Only protector is available in 150 and 200A ratings.	







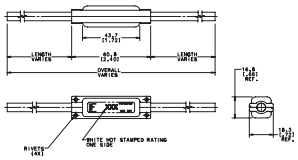


Blade Terminal and Special Purpose Fuses

Cable Pro®

Protector
496 Series

Voltage range:	32VDC
Ampere range:	60 – 200A
Interrupting ratings:	2000A @ 32VDC

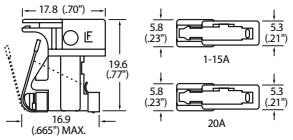


481

Alarm Indicating Fuse
481 Series

Voltage range:	125VAC/VDC	
Ampere range:	0.18 – 20A	
Interrupting ratings:	450A @ 60VDC	300A @ 125VDC (up to 15A)
	300A @ 125VAC (up to 20A)	200A @ 125VDC (up to 20A)

*1.5A and above RoHS compliant

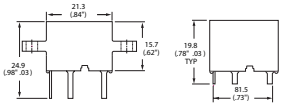


Fuseholders

482

Alarm Indicating
482 Series

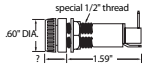
Mounting Type:	PCB and Panel
Fuse Type:	481 Alarm Indicating • Single pole and gangable versions available (1-15A) • 20A version is single pole only



International Shock-Safe

345 Series

Mounting Type:	Panel Mount
Fuse Type:	3AG, 5x20mm, 2AG



Flip-Top Shock-Safe

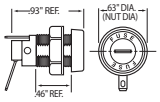
346/286 Series

Mounting Type:	Panel Mount
Fuse Type:	3AG, 5x20mm, 2AG

Shock-Safe

245 Series

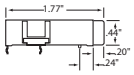
Mounting Type:	Panel Mount
Fuse Type:	2AG



Shock-Safe

345 Series

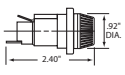
Mounting Type:	PC Board Mount
Fuse Type:	3AG, 5x20mm, Midget



Shock-Safe

571 Series

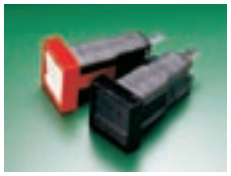
Mounting Type:	Panel Mount
Fuse Type:	Midget

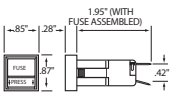


Low Profile

348 Series

Mounting Type:	Snap Mount
Fuse Type:	3AG

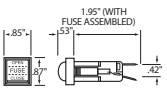




Blown Fuse

Indicating Type
344 Series

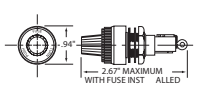
Mounting Type:	Snap Mount
Fuse Type:	3AG



Blown Fuse

Indicating Type
344 Series

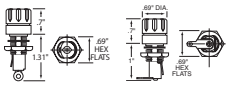
Mounting Type:	Panel Mount
Fuse Type:	3AG



Fuseholders

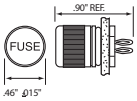
Traditional
342 Series

Mounting Type:	Panel Mount
Fuse Type:	3AG



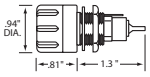
RF Shielded
282 Series

Mounting Type:	Front/Rear Panel
Fuse Type:	MICRO™ Fuse Plug-ins



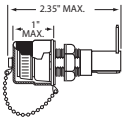
Watertight
342 Series

Mounting Type:	Panel Mount
Fuse Type:	3AG



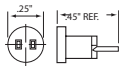
RF Shielded/ Watertight
340 Series

Mounting Type:	Panel Mount
Fuse Type:	3AG



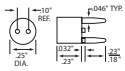
"Push-On" Retaining Nut
281 Series

Mounting Type:	Chassis Mount
Fuse Type:	MICRO™ & PICO®II Fuses



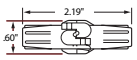
Vertical/Horizontal
281 Series

Mounting Type:	PC Board Mount
Fuse Type:	MICRO™ & PICO®II Fuses



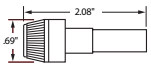
Twist-Lock
155 Series

Mounting Type:	In-Line Mount
Fuse Type:	Low Voltage 3AG, SFE



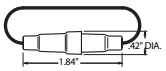
Heavy-Duty Bayonet
155 Series

Mounting Type:	In-Line Mount
Fuse Type:	Low Voltage 3AG



Special Type
150 Series

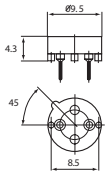
Mounting Type:	In-Line Mount
Fuse Type:	2AG, 5x20mm



For LT-5™ Fuses
280 Series

Mounting Type:	PC Board Mount
Fuse Type:	LT-5 (662 – 665 Types)

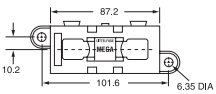
*For new designs use the 560 series



MEGA® Fuse Fuseholder
298x000 Series

Mounting Type:	Bolt-down
Fuse Type:	MEGA® Fuses

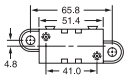
*Contact Littelfuse for availability of RoHS compliant and Lead-free parts



MIDI® Fuse Fuseholder
498900 Series

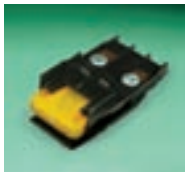
Mounting Type:	Bolt-down
Fuse Type:	MIDI® Fuses

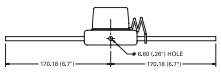
*Contact Littelfuse for availability of RoHS compliant and Lead-free parts



MAXI® Fuse Fuseholder
152 and MAH Series

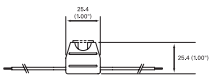
Mounting Type:	In-Line Mount
Fuse Type:	MAXI® Fuses





ATO® Fuse Fuseholder
FHA and FHAC Series

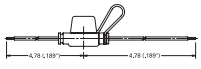
Mounting Type:	In-Line Mount
Fuse Type:	ATO® Fuses



MINI® Fuse Fuseholder
FHM Series

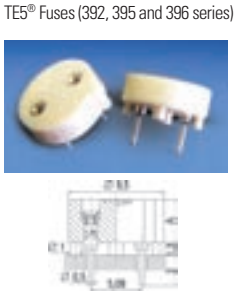
Mounting Type:	PC Board Mount
Fuse Type:	MINI® Fuses

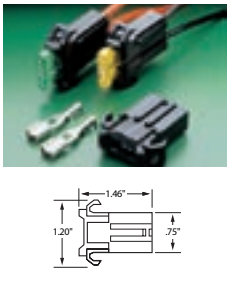
*For new designs use the 560 series

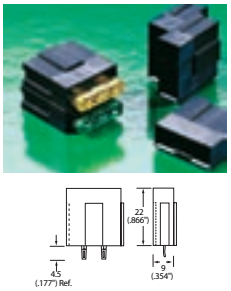


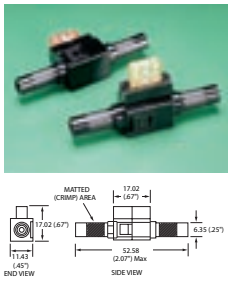
Fuseholders

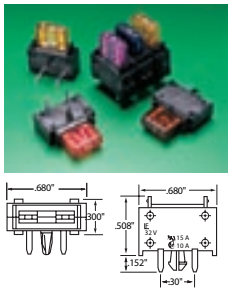
	For TR5® and TE5® Fuses	For ATO® Fuses	For ATO® Fuses	For MINI® Fuses	For MINI® Fuses
	560 Series	155 Series	445 Series	153 Series	153 Series
	RoHS	RoHS Pb	RoHS Pb	RoHS Pb	cULus CSA RoHS Pb
Mounting Type:	PC Board Mount	In-Line Mount	PC Board Mount	In-Line, Easy Crimp	PC Board Mount
Fuse Type:	TR5® Fuses (370, 372, 373, 374 and 382 series) TE5® Fuses (392, 395 and 396 series)	ATO® Fuses	ATO® Fuses	MINI® Fuses	MINI® Fuses





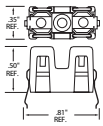


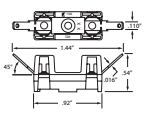


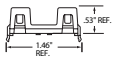


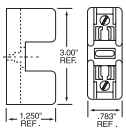
Fuse Blocks and Clips

	2AG OMNI-BLOK® Fuse Block	Metric OMNI-BLOK® Fuse Block	3AG OMNI-BLOK® Fuse Block	600 Volt
	254 Series	520 Series	354 Series	L600 Series
	cULus CSA RoHS Pb	cULus CSA CE RoHS Pb	cULus CSA RoHS Pb	UL cULus CSA RoHS Pb
Mounting Type:	Molded Base	Molded Base	Molded Base	Molded Base
Fuse Type:	2AG	5 x 20mm	3AG	11/2" long Midget, CC









	3AG Screw Terminal	1/4"–13/16" Diam. Fuses	1/4" Diam. Fuses	1/4" Diam. Fuses	Various Diam. Fuses
			101 Series		
	RoHS Pb	RoHS Pb	RoHS Pb	RoHS Pb	RoHS Pb
Mounting Type:	Laminated Base	Rivet/Eyelet Mount	Rivet/Eyelet Mount		
Fuse Type:	3AG	3AG, Midget, NEC 1-60 amp	3AG		

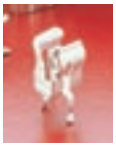
P.C. Board Traditional

Bowed Tab

Low Profile (2)

P.C. Board ATO® Fuse

2AG or 5mm



5mm

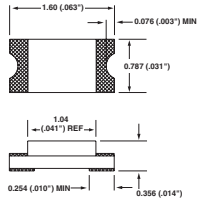
5mm, Auto. Insertion Type

Overvoltage Suppression Products

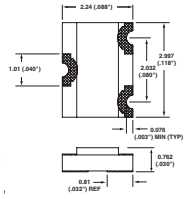
PulseGuard® Polymeric ESD Suppressors

	PGD Series	PGB Series	PGB1 Series
	RoHS Pb		RoHS Pb
Operating Voltage:	0-24VDC	0-24VDC	0-24VDC
Peak Current:	45A@15kV	45A@15kV	45A@15kV
Typ. Capacitance (C_o):	<2pF@1MHz	0.06pF@1MHz	0.06pF@1MHz
Leakage Current:	<0.1µA@5VDC	<1.0nA	<1.0nA
Offstate Resistance:	10MΩ	10MΩ	10MΩ
Clamping:	100V,TYPICAL@15KV	150V,TYPICAL@8KV	150V,TYPICAL@8KV
Trigger Voltage:	1000V	1000V	500V
Package Type:	Connector Array	0603, SOT23, 0805	0603, SOT23, 0805

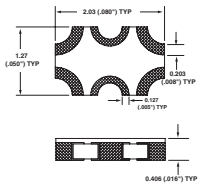
0603
1-line protection



SOT23
2-line protection



0805
4-line protection



Multilayer Varistors

	MHS Series	ML Series	MLE Series	MLN Series	AUML Series
	RoHS Pb	RoHS Pb	RoHS Pb	RoHS Pb	RoHS Pb
Operating Voltage:	0 – 42 VDC	2.5-107 VAC 3.5-120 VDC	0-18 VDC	0-18 VDC	18 VDC
Peak Current:	N/A	4-500A	20A	30A	N/A
Leakage Current:	<1µA	<25µA	<25µA	<30nA	
Peak Energy:	N/A	0.02-2.5J	0.5J	0.05-0.1J	N/A
Lines Protected:	1	1	1	4	1
Capacitance (C_o):	3, 12pF	40-6000pF	40-1700pF	45-430pF	
Package Size	0402, 0603	0402-1210	0402-1206	0805, 1206	1206-2220

Diode Arrays

	SP05x Series TVS Avalanche Diode	SP72x Series SCR/Diode Array	SPUSBx Series Upstream USB Port Terminator with ESD suppression and EMI Filtering
Maximum Operating Voltage:	5.5 VDC	1-30VDC	5.5 VDC
Leakage Current:	<100nA	<20nA	<100nA
Lines Protected:	2,3,4,5,6	4,6,14	3
Capacitance (C_o):	30pF	3-5pF	47pF
Package Size	SC70, SOT23, SOT143, TSSOP-8, MSOP-8	DIP, SOIC, SOT23	SC70-6

Protection Thyristors

Add "L" suffix when ordering RoHS compliant SIDACtor® and Battrax® devices

Through-hole SIDACtor® Devices
T10A, T10B Series

Maximum Operating Voltage:	32-243
Form Factor:	T10A=DO-15, T10B=DO-201
Capacitance (C_o):	T10A: <100pF T10B: <200pF

Through-hole SIDACtor® Devices
T10 C Series

Maximum Operating Voltage:	70-240
Form Factor:	3 pin 'gas tube'
Capacitance (C_o):	<200pF

SIDACtor® HighSpeed Communication Protector
Pxxx2Sx, PxxxxCA, P0220Sx Series

Maximum Operating Voltage:	15-275
Form Factor:	DO-214AA
Capacitance (C_o):	10-150pF

SIDACtor® Fixed Voltage SLIC Protectors
Pxxx1Sx, Pxxx1CA2, Pxxx1Ux Series

Maximum Operating Voltage:	58-160
Form Factor:	DO-214AA, Mod DO-214AA, Mod MS-013

Add "L" suffix when ordering RoHS compliant SIDACtor® and Battrax® devices

Surface Mount SIDACtor® Devices
PxxxxSx, Pxxx2CA, PxxxxSC MC, PxxxxSA MC Series

Maximum Operating Voltage:	6-320
Form Factor	DO-214AA
Capacitance (C_o):	15-220pF

Surface Mount Multiport SIDACtor® Devices
Pxxx3Ux, Pxxx4Ux, Pxxx6Ux Series

Maximum Operating Voltage:	6-420
Form Factor	Mod MS-013
Capacitance (C_o):	10-250pF

Through-Hole SIDACtor® Devices
Pxxx0AA61, Pxxx2A, Pxxx2AC MC, Pxxx3A, Pxxx3AC MC Series

Maximum Operating Voltage:	25-420
Form Factor	Mod TO-220
Capacitance (C_o):	10-250pF

Through-Hole SIDACtor® Devices
PxxxxEx, PxxxEx MC Series

Maximum Operating Voltage:	6-320
Form Factor	TO-92
Capacitance (C_o):	15-260pF

Asymmetrical Multiport SIDACtor® Devices
AxxxxUx6 Series

Maximum Operating Voltage:	170-400
Form Factor	Mod MS-013
Capacitance (C_o):	10-70pF

Add "L" suffix when ordering RoHS compliant SIDACtor® and Battrax® devices

LCAS Asymmetrical Discrete SIDACtor® Devices
Pxx00Sx Series

Maximum Operating Voltage:	100-230
Form Factor	DO-214AA
Capacitance (C_o):	20-110pF

Battrax® SLIC Protectors
Bxxx0C_, Bxx1Ux, B3xxx4Ux, B1xxx1Ux4 Series

Maximum Operating Voltage:	200
Peak Pulse Current:	45-500A
Form Factor:	Mod DO-214AA, Mod MS-013
Capacitance (C_o):	50-200pF

CATV and HFC SIDACtor® Device
Pxx00AD, Pxxx0NE, Pxxx0RE Series

Maximum Operating Voltage:	120-550
Peak Pulse Current:	1000-3000A
Form Factor:	TO-263, TO-220
Capacitance (C_o):	150-260pF

CATV Line Amplifier/ Power Inserter SIDACtor® Device
PxxxxME Series

Maximum Operating Voltage:	140-180
Peak Pulse Current:	5000A
Form Factor:	TO-218
Capacitance (C_o):	750pF

TVS Diodes

	Through-hole TVS Diode SA, P6KE, 1.5KE, 5KP, 15KP, P4KE, LCE, SLD Series	Surface Mount TVS Diode SMBJ, P6SMBJ, 1KSMBJ, SMAJ, P4SMA, SMCJ, 1.5SMC Series	High-Power TVS Diode AK6, AK10 Series
Maximum Operating Voltage:	5-467	5-550	58-470
Peak Pulse Current:	0.52-544A	0.5-163A	6000A - 10000A
Form Factor:	Axial leaded	DO-214 AA, DO- 214 AB, DO-214AC	Axial leaded
Peak Pulse Power:	400W to 15,000W	400W to 1500W	5000W +






Gas Plasma Arresters (improved GDTs)

	Greentube™ Alpha Ultra Performance Hybrid SL1122A Series	Greentube™ Beta High Performance SL1011A, SL1011B, SL1021A, SL1021B Series	Greentube™ Mini Beta High Performance SL1002A, SL1003A Series	Greentube™ Omega Range SL1024B, SL1024A Series	Delta Range SL1026 Series
Peak Pulse Current:	10000A	5000A-10000A	5000A	10000A	40000A
Form Factor:	3 terminal radial	2 terminal axial & button, 3 terminal radial	2 terminal SMT, 3 terminal radial	2 terminal axial & button, 3 terminal radial	3 terminal clip-mounted, 3 terminal radial
Nom. DC Breakover Voltage:	90-450	75-600	90-600	90-600	275-1100
Capacitance (C_o):	100-200pF	≤1pF	1.2pF	≤1pF	2.5pF





Gas Plasma Arresters (improved GDTs)

	Greentube™ Mini Beta High Performance SL0902 Series	Greentube™ Delta High Performance SL1411Series	Beta High Performance GDT HV Series
Peak Pulse Current:	2500A	10000A	3000A
Form Factor:	2 terminal SMT and axial lead through-hole	2 terminal SMT and axial lead through-hole	2 terminal through-hole
Nom. DC Breakover Voltage:	90-420V	184-360V	1500-2750V
Capacitance (C_o):	1.0pF	<1pF	



Industrial Varistor Products

Add "P" suffix when ordering RoHS compliant and Pb parts

	TMOV®/iTMOV® Varistor Series	UltraMOV™ Varistor Series	C-III Series	LA Series	ZA Series
Operating Voltage:	115-750 VAC	130-625 VAC	130-660 VAC	130-1000 VAC	4-460 VAC
		170-825 VDC		175-1200 VDC	5.5-615 VDC
Peak Current:	6000-10000A	1750-10000A	3500-9000A	1200-6500A	50-6500A
Peak Energy:	35-480J	12.5-400J	40-510J	11-360J	0.1-52J
Mount/Form Factor:	Radial Leaded	Radial Leaded	Radial Leaded	Radial Leaded	Radial Leaded
Disc Size	14, 20mm	7, 10, 14, 20mm	10, 14, 20mm	7,10,14, 20mm	5, 7, 10, 14, 20mm
Indicating:	iTMOV Varistor Only	N/A	N/A	N/A	N/A





	MA Series	RA Series	CH Series	CA Series	NA Series	PA Series
Operating Voltage:	9-264 VAC	4-275 VAC	14-275 VAC	130-2800 VAC	130-750 VAC	130-660 VAC
	13-365 VDC	5.5-369 VDC	18-369 VDC	175-3500 VDC	175-970 VDC	175-850 VDC
Peak Current:	40-100A	150-6500A	250-500A	20000-70000A	40000A	6500A
Peak Energy:	0.06-1.7J	0.4-160J	1-23J	200-10000J	270-1050J	70-250J
Mount/Form Factor:	Axial Leaded	Packaged	Surface Mount	Bare Disc	Bare Disc	Packaged
Disc Size	3mm	8, 6, 22mm	N/A	32, 40, 60mm	34mm	20mm

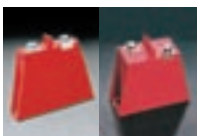





	TMOV34S® Varistor Series	HB34, HF34, HG34 Series	DHB34 Series	HA Series	DA/DB Series	BB/BA Series
Operating Voltage:	115-750 VAC	110-750 VAC	110-750 VAC	110-750 VAC	130-750 VAC	130-2800 VAC
	150-970 VDC	148-970 VDC	148-970 VDC	148-970 VDC	175-970 VDC	175-3500 VDC
Peak Current:	40000A	40000A	40000A	25000-40000A	40000A	50000-70000A
Peak Energy:	235-1050J	220-1050J	220-1050J	160-1050J	270-1050J	450-10000J
Mount/Form Factor:	Packaged	Packaged	Packaged	Packaged	Industrial Packaged	Packaged
Disc Size	34mm	34mm	34mm	32, 40mm	40mm	60mm





Switching Product Descriptions

Gas Plasma Switching Devices

The gas plasma trigger switches are two-terminal, bi-directional voltage triggered switching devices. Switching voltages are fixed depending on the part number selected. The gas discharge technology affords very fast switching speeds, allowing for significantly better di/dt values compared to those available when using silicon devices. These devices also allow for reduced stepup transformer sizes, saving size, weight, and money.

Thyristors

A thyristor is any semiconductor switch with a bi-stable action depending on p-n-p-n regenerative feedback. Thyristors are normally two- or three-terminal devices for either unidirectional or bidirectional circuit configurations. Thyristors can have many forms, but they have certain commonalities. All thyristors are solid state switches that are normally open circuits (very high impedance), capable of withstanding rated blocking/off-state voltage until triggered to on state. When triggered to on state, thyristors become a low-impedance current path until principle current either stops or drops below a minimum holding level. After a thyristor is triggered to on-state condition, the trigger current can be removed without turning off the device. Thyristors are used to control the flow of electrical currents in applications including:

- **Home appliances** (lighting, heating, temperature control, alarm activation, fan speed)
- **Electrical tools** (for controlled actions such as motor speed, stapling event, battery charging)
- **Outdoor equipment** (water sprinklers, gas engine ignition, electronic displays, area lighting, sports equipment, physical fitness)

Sensitive Triacs

Teccor® brand sensitive gate triacs are AC bidirectional silicon switches that provide guaranteed gate trigger current levels in Quadrants I, II, III, and IV. Interfacing to microprocessors or other equipment with single polarity gate triggering is made possible with sensitive gate triacs. Gate triggering currents of 3 mA, 5 mA, 10 mA, or 20 mA may be specified. Sensitive gate triacs are capable of controlling AC load currents from 0.8 A to 8 A rms and can withstand operating voltages from 200 V to 600 V.

Triacs

Teccor® brand triac products are bi-directional AC switches, capable of controlling loads from 0.8 A to 35 A rms with 10 mA, 25 mA, and 50 mA IGT in operating Quadrants I, II and III. Triacs are useful in full-wave AC applications to control AC power either through full-cycle switching or phase control of current to the load element. These triacs are rated to block voltage in the "OFF" condition from 200 V minimum with selected products capable of 1000 V operation. Typical applications include motor speed controls, heater controls, and incandescent light controls.

QUADRAC® Devices

Teccor® brand Quadrac devices are triacs and alternistor triacs with a diac trigger mounted inside the same package. These devices save the user the expense and assembly time of buying a discrete diac and assembling in conjunction with a gated triac. Quadrac devices are offered in capacities from 4 A to 15 A rms and voltages from 200 V ac to 600 V ac.

Alternistor Triacs

The Teccor® brand alternistor is specifically designed for applications required to switch highly inductive loads. The design of this special chip effectively offers the same performance as two thyristors (SCRs) wired inverse parallel (back-to-back). This new chip construction provides the equivalent of two electrically-separate SCR structures, providing enhanced dv/dt characteristics while retaining the advantages of a single-chip device. Teccor manufactures 6 A to 40 A alternistors with blocking voltage rating from 200 V to 1000 V. Alternistors are offered in TO-220, TO-218, and TO-218X packages with isolated and non-isolated versions.

Sensitive SCRs

Teccor's sensitive gate SCRs are silicon-controlled rectifiers representing the best in design, performance, and packaging techniques for low- and medium-current applications. Anode currents of 0.8 A to 10 A rms can be controlled by sensitive gate SCRs with gate drive currents ranging from 12 µA to 500 µA. Sensitive gate SCRs are ideally suited for interfacing to integrated circuits or in applications where high current load requirements and limited gate drive current capabilities exist. Examples include ignition circuits, motor controls, and DC latching for alarms in smoke detectors. Sensitive gate SCRs are available in voltage ratings to 600 VAC.

SCRs

Teccor® brand SCR products are half-wave, silicon-controlled rectifiers that represent the state of the art in design and performance. Load current capabilities range from 1 A to 70 A rms, and voltages from 200 V to 1000 V may be specified to meet a variety of application needs.

Because of its unidirectional switching capability, the SCR is used in circuits where high surge currents or latching action is required. It may also be used for half-wave-type circuits where gate-controlled rectification action is required. Applications include crowbars in power supplies, camera flash units, smoke alarms, motor controls, battery chargers, and engine ignition. Surge current ratings are available from 30 A in the TO-92 packaging to 950 A in the TO-218X package.

Rectifiers

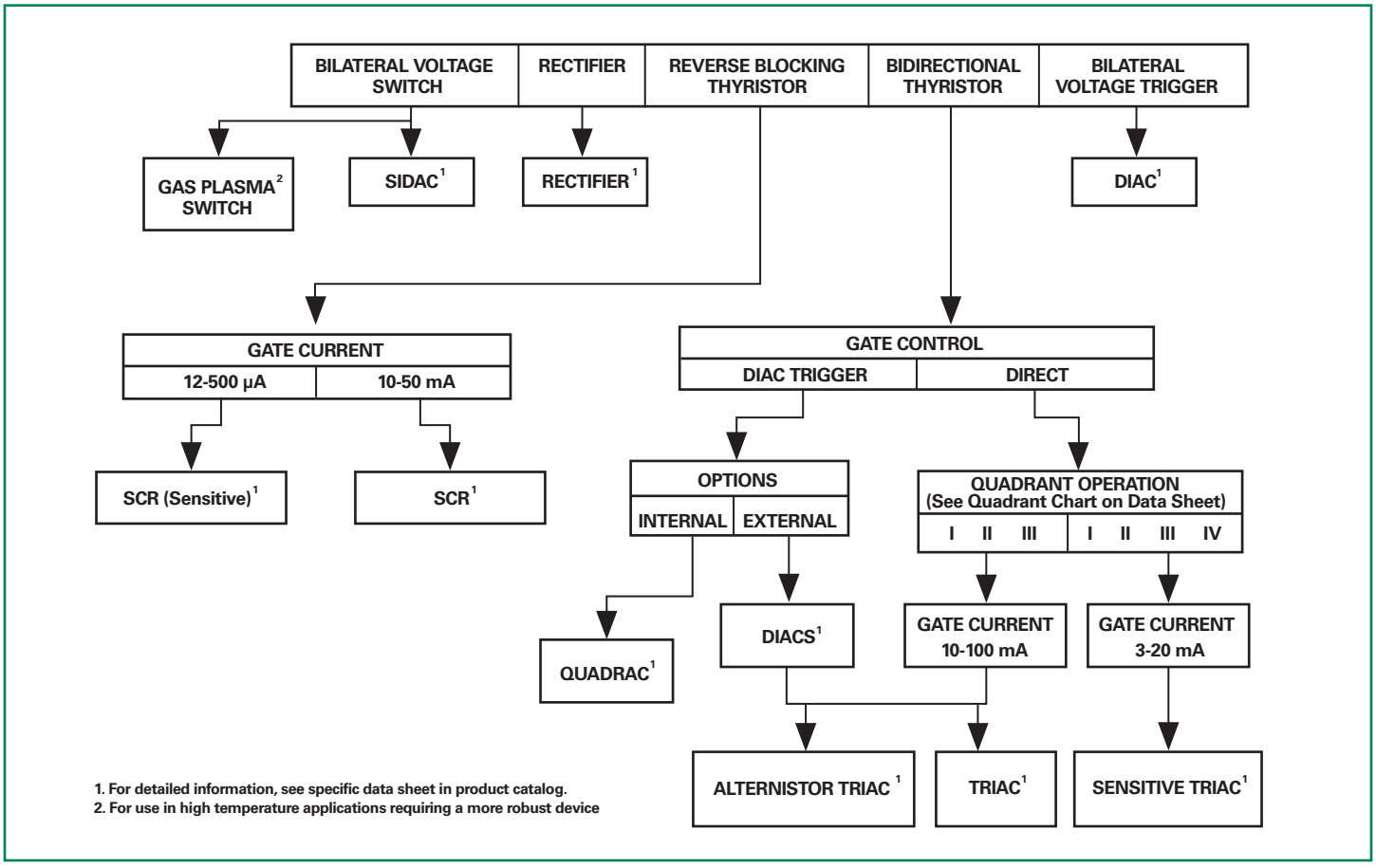
Littelfuse manufactures 15 A to 25 A rms rectifiers with voltages rated from 200 V to 1000 V. Due to the electrically isolated TO-220 package, these rectifiers may be used in common anode or common cathode circuits using only one part type, thereby simplifying stock requirements.

Diacs

Diacs are trigger devices used in phase control circuits to provide gate pulses to a triac or SCR. They are voltage-triggered bidirectional silicon devices housed in DO-35 glass axial lead packages and DO-214 surface mount packages. Diac voltage selections from 27 V to 70 V provide trigger pulses closely matched in symmetry at the positive and negative breakover points to minimize DC component in the load circuit. Some applications include gate triggers for light controls, dimmers, power pulse circuits, voltage references in AC power circuits, and triac triggers in motor speed controls.

Sidacs

Sidacs represent a unique set of thyristor qualities. The sidac is a bidirectional voltage triggered switch. Some characteristics of this device include a normal 95 V to 330 V switching point, negative resistance range, latching characteristics at turn-on, and a low onstate voltage drop. One-cycle surge current capability up to 20 A makes the sidac an deal product for dumping charged capacitors through an inductor in order to generate high-voltage pulses. Applications include light controls, high-pressure sodium lamp starters, power oscillators, and high-voltage power supplies.



1. For detailed information, see specific data sheet in product catalog.
2. For use in high temperature applications requiring a more robust device

Switching Devices

Package Code			N/A	G	Y	S	C	T	E	L*	K*
Product Type	RoHS	Current (Amps)									
			XT, VS, LT	DO-15	DO-35	DO-214	Compak	SOT-223	TO-92*	TO-220	TO-218
Gas Plasma Trigger Switch	•	400	•								
Sensitive Triac	•	0.8					•	•	•		
	•	1					•	•	•		
	•	4								•	
	•	6								•	
	•	8								•	
Triac	•	0.8					•		•		
	•	1					•		•		
	•	4								•	
	•	6								•	
	•	8								•	
	•	10								•	
	•	15								•	
	•	25									
	•	35									
Quadrac	•	4								•	
	•	6								•	
	•	8								•	
	•	10								•	
	•	15								•	
Alternistor	•	6								•	
	•	8								•	
	•	10								•	
	•	12								•	
	•	16								•	
	•	25								•	•
	•	30								•	
	•	35									
	•	40									•
Sensitive SCR	•	0.8					•	•	•		
	•	1.5						•	•		
	•	4									
	•	6								•	
	•	8								•	
	•	10								•	
SCR	•	1					•		•		
	•	6								•	
	•	8								•	
	•	10								•	
	•	12									
	•	15								•	
	•	16									
	•	20								•	
	•	25								•	
	•	35									•
	•	40									
	•	55									
	•	65									•
	•	70									
Rectifier	•	15								•	
	•	20								•	
	•	25								•	
Diac	•				•	•					
Sidac	•			•		•			•		

*Indicates these packages have isolated mounting tabs and are UL recognized for 2500 VAC between leads and mounting tabs

J*	P*	F	R	M	W	D	V	N	Package Code	
									Current (Amps)	Product Type
TO-218x	TO-3 Fastpak	TO-202	TO-220	TO-218	TO-218x	TO-252 D-Pak	TO-251 V-Pak	TO-263 D^2Pak		
									400	Gas Plasma Trigger Switch
									0.8	Sensitive Triac
									1	
		•				•	•		4	
						•	•		6	
						•	•		8	
									0.8	Triac
									1	
		•				•	•		4	
		•	•					•	6	
		•	•					•	8	
		•	•					•	10	
			•					•	15	
	•		•					•	25	
	•								35	
									4	Quadrac
									6	
									8	
									10	
									15	
			•			•	•	•	6	Alternistor
			•			•	•	•	8	
			•					•	10	
			•					•	12	
			•					•	16	
•			•					•	25	
									30	
			•					•	35	
•									40	
			•						0.8	Sensitive SCR
			•						1.5	
		•	•			•	•		4	
		•	•			•	•		6	
		•	•			•	•		8	
		•	•			•	•		10	
									1	SCR
		•				•	•		6	
		•	•			•	•		8	
		•	•			•	•		10	
			•			•	•		12	
									15	
			•					•	16	
									20	
			•					•	25	
•									35	
			•					•	40	
			•	•	•			•	55	
•									65	
					•				70	
									15	Rectifier
									20	
									25	
										Diac
		•								Sidac

Index

Helping to make the World a Cleaner Place to Live

Littelfuse and the Environment

As members of the global community, we at Littelfuse have always strived to understand the impact of what we do, and of what we create, on the world around us. Because of this, our concern for the environment has always been an integral and fundamental part of our business. We continually work to balance our business objectives with the need to protect and improve the local and global environment.

Our Strategy for the Design of Eco-friendly Products

Littelfuse has established a focused program committed to developing high-performance eco-friendly products along with a comprehensive set of processing/reliability data and technical process expertise. This includes processes for eliminating, detecting and documenting the presence of hazardous materials such as

- Lead
- Cadmium
- Hexavalent Chromium
- Mercury
- Brominated flame-retardants (PBBs and PBDEs)

The Littelfuse strategy for eco-friendly products is specifically designed to help support our worldwide customers in their transition to Lead-Free processing.

All products considered to be lead-free are marked with this symbol.

Littelfuse defines lead-free as products which contain less than 1000ppm (0.1%) Lead, measured by weight of the entire product.

All RoHS compliant products are marked with this symbol.

Littelfuse follows the requirement set by the European Union for all RoHS compliant products. The European Union Directive 2002/95/EC RoHS restricts the use of Lead, Mercury, Hexavalent Chromium, Cadmium and Brominated flame-retardants (PBBs and PBDEs)

Visit www.littelfuse.com/lead-free for further information.

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