

Application Guide



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POWR-GARD®

Technical Application Guide

This Technical Application Guide or 'Fuseology' provides the information needed to select the correct types of Littelfuse POWR-GARD® fuses for most applications. If there are any questions or if additional data is needed for a specific use, call the Littelfuse Technical Support and Engineering Service Group at **1-800-TEC-FUSE** (1-800-832-3873), email them at **techline@littelfuse.com** or visit us at **littelfuse.com**.







TECHNICAL APPLICATION GUIDE

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Technical Information

White papers, and a library of technical information is available online at **littelfuse.com/technicalcenter**

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FUSEOLOGY FUNDAMENTALS

I. OVERCURRENT PROTECTION FUNDAMENTALS (FUSES AND HOW THEY WORK)

Introduction

An important part of developing quality overcurrent protection is an understanding of system needs and overcurrent protective device fundamentals. This section discusses these topics with special attention to the application of fuses. If you have additional questions, call our Technical Support Group at 1-800-TEC-FUSE (1-800-832-3873). Definitions of terms used in this section are located towards the end of this Technical Application Guide.

Why Overcurrent Protection?

All electrical systems eventually experience overcurrents. Unless removed in time, even moderate overcurrents quickly overheat system components, damaging insulation, conductors, and equipment. Large overcurrents may melt conductors and vaporize insulation. Very high currents produce magnetic forces that bend and twist bus bars. These high currents can pull cables from their terminals and crack insulators and spacers.

Too frequently, fires, explosions, poisonous fumes and panic accompany uncontrolled overcurrents. This not only damages electrical systems and equipment, but may cause injury or death to personnel nearby.

To reduce these hazards, the National Electrical Code® (NEC®), OSHA regulations, and other applicable design and installation standards require overcurrent protection that will disconnect overloaded or faulted equipment.

Industry and governmental organizations have developed performance standards for overcurrent devices and testing procedures that show compliance with the standards and with the NEC. These organizations include: the American National Standards Institute (ANSI), National Electrical Manufacturers Association (NEMA), and the National Fire Protection Association (NFPA), all of which work in conjunction with Nationally Recognized Testing Laboratories (NRTL) such as Underwriters Laboratories (UL).

Electrical systems must meet applicable code requirements including those for overcurrent protection before electric utilities are allowed to provide electric power to a facility.

What is Quality Overcurrent Protection?

A system with quality overcurrent protection has the following characteristics:

1. Meets all legal requirements, such as NEC®, OSHA, local codes, etc.
2. Provides maximum safety for personnel, exceeding minimum code requirements as necessary.
3. Minimizes overcurrent damage to property, equipment, and electrical systems.
4. Provides coordinated protection. Only the protective device immediately on the line side of an overcurrent opens to protect the system and minimize unnecessary downtime.
5. Is cost effective while providing reserve interrupting capacity for future growth.
6. Consists of equipment and components not subject to obsolescence and requiring only minimum maintenance that can be performed by regular maintenance personnel using readily available tools and equipment.

Overcurrent Types and Effects

An overcurrent is any current that exceeds the ampere rating of conductors, equipment, or devices under conditions of use. The term "overcurrent" includes both overloads and short-circuits.

Overloads

An overload is an overcurrent confined to normal current paths in which there is no insulation breakdown.

Sustained overloads are commonly caused by installing excessive equipment such as additional lighting fixtures or too many motors. Sustained overloads are also caused by overloading mechanical equipment and by equipment breakdown such as failed bearings. If not disconnected within established time limits, sustained overloads eventually overheat circuit components causing thermal damage to insulation and other system components.

Overcurrent protective devices must disconnect circuits and equipment experiencing continuous or sustained overloads before overheating occurs. Even moderate insulation overheating can seriously reduce the life of the components and/or equipment involved. For example, motors overloaded by just 15% may experience less than 50% of normal insulation life.

Temporary overloads occur frequently. Common causes include temporary equipment overloads such as a machine tool taking too deep of a cut, or simply the starting of an inductive load such as a motor. Since temporary overloads are by definition harmless, overcurrent protective devices should not open or clear the circuit.

It is important to realize that fuses selected must have sufficient time-delay to allow motors to start and temporary overloads to subside. However, should the overcurrent continue, fuses must then open before system components are damaged. Littelfuse POWR-PRO® and POWR-GARD® time-delay fuses are designed to meet these types of protective needs. In general, time-delay fuses hold 500% of the rated current for a minimum of ten seconds, yet will still open quickly on higher values of current.

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Even though government-mandated high-efficiency motors and NEMA Design E motors have much higher locked rotor currents, POWR-PRO® time-delay fuses such as the FLSR_ ID, LLSRK_ID, or IDSR series have sufficient time-delay to permit motors to start when the fuses are properly selected in accordance with the NEC®.

Short-Circuits

A short-circuit is an overcurrent flowing outside of its normal path. Types of short-circuits are generally divided into three categories: bolted faults, arcing faults, and ground faults. Each type of short-circuit is defined in the Terms and Definitions section.

A short-circuit is caused by an insulation breakdown or faulty connection. During a circuit's normal operation, the connected load determines current. When a short-circuit occurs, the current bypasses the normal load and takes a "shorter path," hence the term 'short-circuit'. Since there is no load impedance, the only factor limiting current flow is the total distribution system's impedance from the utility's generators to the point of fault.

A typical electrical system might have a normal load impedance of 10 ohms. But in a single-phase situation, the same system might have a load impedance of 0.005 ohms or less. In order to compare the two scenarios, it is best to apply Ohm's Law (I = E/R for AC systems). A 480 volt single-phase circuit with the 10 ohm load impedance would draw 48 amperes (480/10 = 48). If the same circuit has a 0.005 ohm system impedance when the load is shorted, the available fault current would increase significantly to 96,000 amperes (480/0.005 = 96,000).

As stated, short-circuits are currents that flow outside of their normal path. Regardless of the magnitude of overcurrent, the excessive current must be removed quickly. If not removed promptly, the large currents associated with short-circuits may have three profound effects on an electrical system: heating, magnetic stress, and arcing.

Heating occurs in every part of an electrical system when current passes through the system. When overcurrents are large enough, heating is practically instantaneous. The energy in such overcurrents is measured in ampere-squared seconds (I^2t). An overcurrent of 10,000 amperes that lasts for 0.01 seconds has an I^2t of 1,000,000 A^2s. If the current could be reduced from 10,000 amperes to 1,000 amperes for the same period of time, the corresponding I^2t would be reduced to 10,000 A^2s, or just one percent of the original value.

If the current in a conductor increases 10 times, the I^2t increases 100 times. A current of only 7,500 amperes can melt a #8 AWG copper wire in 0.1 second. Within eight milliseconds (0.008 seconds or one-half cycle), a current of 6,500 amperes can raise the temperature of #12 AWG THHN thermoplastic insulated copper wire from its operating temperature of 75°C to its maximum short-circuit temperature of 150°C. Any currents larger than this may immediately vaporize organic insulations. Arcs at the point of fault or from mechanical switching such as automatic transfer switches or circuit breakers may ignite the vapors causing violent explosions and electrical flash.

Magnetic stress (or force) is a function of the peak current squared. Fault currents of 100,000 amperes can exert forces of more than 7,000 lb. per foot of bus bar. Stresses of this magnitude may damage insulation, pull conductors from terminals, and stress equipment terminals sufficiently such that significant damage occurs.

Arcing at the point of fault melts and vaporizes all of the conductors and components involved in the fault. The arcs often burn through raceways and equipment enclosures, showering the area with molten metal that quickly starts fires and/or injures any personnel in the area. Additional short-circuits are often created when vaporized material is deposited on insulators and other surfaces. Sustained arcing-faults vaporize organic insulation, and the vapors may explode or burn.

Whether the effects are heating, magnetic stress, and/or arcing, the potential damage to electrical systems can be significant as a result of short-circuits occurring.

II. SELECTION CONSIDERATIONS

Selection Considerations for Fuses (600 volts and below)

Since overcurrent protection is crucial to reliable electrical system operation and safety, overcurrent device selection and application should be carefully considered. When selecting fuses, the following parameters or considerations need to be evaluated:

- Current Rating
- Voltage Rating
- Interrupting Rating
- Type of Protection and Fuse Characteristics
- Current Limitation
- Physical Size
- Indication

Current Rating

The current rating of a fuse is the AC or DC current, expressed in amperes, which the fuse is capable of carrying continuously under specified conditions. Fuses selected for a circuit must have ampere ratings that meet NEC® requirements, namely those found in NEC® Articles 240 and 430. These NEC® requirements establish maximum ratings and in some cases, minimum ratings. When selecting a fuse, it is generally recommended to select a current rating as close as possible to the system's normal running current.

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SELECTION CONSIDERATIONS

Voltage Rating

The voltage rating of a fuse is the maximum AC or DC voltage at which the fuse is designed to operate. Fuse voltage ratings must equal or exceed the circuit voltage where the fuses will be installed, and fuses used in DC circuits must be specifically rated for DC applications. In terms of voltage, fuses may be rated for AC only, DC only, or both AC and DC. However, exceeding the voltage ratings or using an AC only fuse in a DC circuit could result in violent destruction of the fuse.

The standard 600 volt rated fuses discussed in this section may be applied at any voltage less than or equal to their rating. For example, a 600 volt fuse may be used in a 277 volt or even a 32 volt system, but not any system exceeding 600 volts.

NOTE: This does not apply to semiconductor fuses and medium voltage fuses. See the semiconductor and medium voltage fuse application information on littelfuse.com for voltage limitations of these fuses.

Interrupting Rating

The interrupting rating of a fuse is the highest available symmetrical rms alternating current that the fuse is required to safely interrupt at its rated voltage under standardized test conditions. A fuse must interrupt all overcurrents up to its interrupting rating without experiencing damage. Standard UL fuses are available with interrupting ratings of 10,000 A, 50,000 A, 100,000 A, 200,000 A, and 300,000 A.

NEC® Article 110.9 requires that all equipment intended to break current at fault levels have an interrupting rating sufficient for the system voltage and current available at the equipment's line terminals. Refer to *Figure 1*. It is vitally important to select fuses with interrupting ratings which equal or exceed the available fault current.

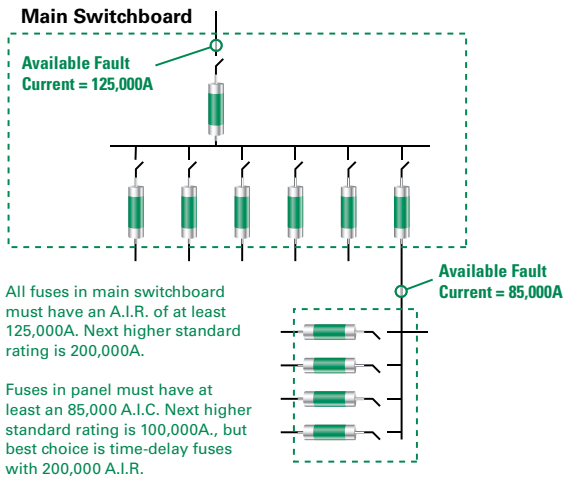


Figure 1 – Interrupting Rating Requirements per NEC

The recommendation to standardize on fuses with at least a 200,000 ampere interrupting rating (AIR) ensures that all fuses have an adequate interrupting rating while providing reserve interrupting capacity for future increases in available fault current.

300,000 AIR Fuses

Littelfuse POWR-PRO® fuse series have a Littelfuse Self-Certified interrupting rating of 300,000 amperes rms symmetrical. The 300,000 ampere testing was performed in a Nationally Recognized Testing Laboratory, and the tests were UL witnessed. UL has ruled that fuses with a UL interrupting rating greater than 200,000 amperes must be marked as "Special Purpose Fuses" and may not be labeled as UL Listed Class RK5, RK1, L, etc.

Type of Protection and Fuse Characteristics

Time current characteristics determine how fast a fuse responds to overcurrents. All fuses have inverse time characteristics; that is, the fuse opening time decreases as the magnitude of overcurrent increases. When properly rated in accordance with NEC® requirements, fuses provide both overload and short-circuit protection to system conductors and components. However, in some instances such as when fuses are used to backup circuit breakers or to provide motor branch circuit short-circuit and ground fault protection, fuses provide only short-circuit protection. A fuse's response to overcurrents is divided into short-circuits and overloads.

Short-Circuits

A fuse's short-circuit response is its opening time on higher-value currents. For power fuses, higher-value currents are generally over 500-600% of the fuse's current rating. As stated earlier, all fuses have inverse time characteristics: the higher the current, the faster the opening time. Since short-circuits should be removed quickly, inverse time is especially important for short-circuit protection.

Overloads

While fuses must disconnect overloaded conductors and equipment before the conductors and components are seriously overheated, they should not disconnect harmless temporary overloads. To provide sufficient overload protection for system conductors, UL has established maximum fuse opening times at 135% and 200% of a fuse's current rating. All UL Listed fuses for application in accordance with the National Electrical Code® must meet these limits whether they are fast-acting or time-delay fuses.

As just stated, a fuse is designed to respond to two types of overcurrents – short circuits and overloads. As a result, selecting the proper fuse for a given application usually involves deciding whether to use a time-delay fuse or a fast-acting fuse. A more in-depth review of both possible scenarios is important at this time.

SELECTION CONSIDERATIONS

Fast-Acting (Normal-Opening) Fuses

Fast-acting fuses (sometimes called "Normal-opening" fuses) have no intentional time-delay. Typical opening times at 500% of the fuse ampere rating range from 0.05 second to approximately 2 seconds. Fast-Acting fuses are suitable for non-inductive loads such as incandescent lighting and general-purpose feeders, or branch circuits with little or no motor load. When protecting motors and other inductive loads, fast-acting fuses must be rated at 200-300% of load currents to prevent nuisance opening on in-rush currents. Fuses with such increased ratings no longer furnish adequate protection from overloads and only provide short-circuit protection. Overload relays or other overload protection devices must be provided to properly protect conductors and equipment from overload conditions.

All fast-acting fuses provide fast short-circuit response within their interrupting rating. Some are considered current-limiting, such as UL Class T and Class J. Others are non-current-limiting, such as UL Class H.

Time-Delay (SLO-BLO®) Fuses

Most UL Class CC, CD, G, J, L, RK5 and RK1 fuses, plus some of the UL Listed Miscellaneous fuses are considered time-delay. If so, they are identified as such on the fuse label with the words "Time-Delay", "T-D", "D", or some other suitable marking. Minimum time-delay varies with the fuse class, and to some degree with the fuse ampere rating. UL standards for POWR-GARD® fuse series FLNR, FLNR_ID, FLSR, FLSR_ID, IDSR (UL Class RK5), LLNRK, LLSRK, LLSRK_ID (UL Class RK1), and JTD, JTD_ID (UL Class J) require these fuses to carry 500% rated current for a minimum of 10 seconds. Standards for CCMR and KLDR (UL Class CC and CD) and SLC (UL Class G) fuses require them to carry 200% rated current for a minimum of 12 seconds.

Although there is no UL Classification for time-delay Class L fuses, it is still permissible for them to be marked "Time-Delay." The amount of time-delay is determined by the manufacturer. Littelfuse KLPC series and KLLU series fuses will hold 500% current for 10 seconds or more.

In addition to providing time-delay for surges and short time overloads, time-delay fuses meet all UL requirements for sustained overload protection. On higher values of current, time-delay fuses are current-limiting; meaning they remove large overcurrents in less than one-half cycle (0.00833 seconds). Time-delay fuses provide the best overall protection for both motor and general purpose circuits, and eliminate nuisance fuse opening and most situations of downtime.

Compared to fast-acting fuses, time-delay fuses can be selected with ratings much closer to a circuit's operating current. For example, on most motor circuits Class RK5 and RK1 fuses can be rated at 125-150% of a motor's full load current (FLA). This provides superior overload and short-circuit protection, and often permits the use of smaller, less expensive disconnect switches. Time-delay fuses have gradually replaced most one-time (UL Class K5) and renewable (UL Class H) fuses. Today, more than 50% of all fuses sold by electrical distributors are time-delay fuses.

Dual Element Fuses

Littelfuse time-delay FLNR, FLNR_ID, FLSR, FLSR_ID, IDSR (UL Class RK5), and LLNRK, LLSRK, LLSRK_ID (UL Class RK1), and some JTD, JTD_ID (UL Class J) series fuses have true dual-element construction meaning the fuse has an internal construction consisting of separate short-circuit and overload sections or elements. Time-delay elements are used for overload protection, and separate fast acting fuse elements or links are used to provide current-limiting short-circuit protection.

Very Fast-Acting Fuses

This category of fuses exists for limited applications. The principle use of very fast acting fuses is to protect solid-state electronic components, such as semiconductors. Fuse series designated as 'Semiconductor Fuses' have special characteristics including quick overload response, very low I^2t and I_{peak} currents, and peak transient voltages, that provide protection for components that cannot withstand line surges, low value overloads, or short-circuit currents. Very fast-acting fuses are designed for very fast response to overloads and short-circuits, and are very current-limiting.

Effect of Ambient Temperature on Fuses

The current carrying capacity of fuses is 110% of the fuse rating when installed in a standard UL test circuit and tested in open air at 25°C ambient. This allows for derating to 100% of rating in an enclosure at 40°C ambient.

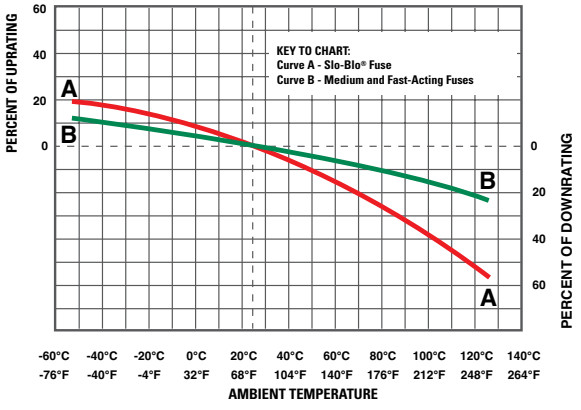


Figure 2 – Fuse Rerating Curve

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SELECTION CONSIDERATIONS

Current Limitation

A current-limiting fuse is one that opens and clears a fault in less than 180 electrical degrees, or in other words, within the first half electrical cycle (0.00833 seconds). See the definition of Current-limiting Fuse and *Figure 13* in the Terms and Definitions section.

NEC® Article 240.2 states that a current-limiting overcurrent protective device must reduce the peak let-through current to a value substantially less than the potential peak current that would have occurred if the fuse were not used in the circuit or were replaced with solid conductors of the same impedance. The total destructive heat energy (I^2t) to the circuit and its components is greatly minimized as a result of using current-limiting fuses.

It is important to note that UL Class H 'Renewable' fuses designed decades ago are considered non-current limiting. Other than Midget fuses, almost all other fuse types used in today's electrical systems and applications are considered current-limiting per the above parameters. This selection consideration now involves determining the degree or level of current limitation required to properly protect a given device or system.

It is also important to point out that matching fuse holders and/or fuse blocks must reject non-current-limiting fuses and accept only current-limiting fuses of the stated UL Class.

Physical Size

While often overlooked, the physical size or overall dimensions of the fuse to be used in a given application is another important selection consideration to evaluate. There is a trend toward reduction of size in almost everything, and electrical equipment is no exception. Fuse size is actually determined by the size and dimensions of the fuse block or disconnect switch in which it is installed.

While saving space may be an important factor when selecting the proper fuses, other considerations should not be overlooked. Some of these include:

- Does the smallest fuse have the most desirable characteristics for the application?
- Does the equipment in which the fuse will be installed provide adequate space for maintenance?
- Do smaller fuses coordinate well with the system's other overcurrent protection?

If looking at just physical dimensions, a 600 volt, 60 ampere, 200,000 AIR, time-delay, dual-element UL Class CD fuse is smaller than a similarly rated UL Class J fuse, which is in turn, considerably smaller than a similarly rated UL Class RK1 or Class RK5 fuse. However, smaller-sized fuses can sometimes have less time-delay or more nuisance openings than their larger counterparts, so it is always important to consider all factors involved.

Indication

The newest consideration for selecting the best fuse for a given application is indication. Many of the more commonly used UL fuse classes are now available in both indicating and non-indicating versions. Built-in, blown-fuse indication that quickly identifies which fuse or fuses within an electrical panel or system have blown can be found on the Littelfuse POWR-PRO® LLSRK_ID Class RK1, FLNR_ID, FLSR_ID and IDSR Class RK5, and JTD_ID Class J fuse series.

The indicating feature on these fuses provides reduced downtime, increased safety, and reduced housekeeping or troubleshooting headaches and delays. Littelfuse Indicator® fuses will help lower the costs associated with downtime, provide longer fuse life by minimizing nuisance openings, increase system performance by minimizing equipment damage, and improve safety by minimizing accidents.

III. GENERAL FUSING RECOMMENDATIONS

Based on the above selection considerations, the following is recommended:

Fuses with ampere ratings from 1/10 through 600 amperes

- When available fault currents are less than 100,000 amperes and when equipment does not require the more current-limiting characteristics of UL Class RK1 fuses, FLNR and FLSR_ID Series Class RK5 current-limiting fuses provide superior time-delay and cycling characteristics at a lower cost than RK1 fuses. If available fault currents exceed 100,000 amperes, equipment may need the additional current-limitation capabilities of the LLNRK, LLSRK and LLSRK_ID series Class RK1 fuses.
- Fast-acting JLLN and JLLS series Class T fuses possess space-saving features that make them especially suitable for protection of molded case circuit breakers, meter banks, and similar limited-space applications.
- Time-delay JTD_ID and JTD series Class J fuses are used in OEM motor control center applications as well as other MRO motor and transformer applications requiring space-saving IEC Type 2 protection.
- Class CC and Class CD series fuses are used in control circuits and control panels where space is at a premium. The Littelfuse POWR-PRO CCMR series fuses are best used for protection of small motors, while the Littelfuse KLDR series fuses provide optimal protection for control power transformers and similar devices.

For questions about product applications, call our Technical Support Group at 800-TEC-FUSE.

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SELECTION CONSIDERATIONS

Fuses with ampere ratings from 601 through 6,000 amperes

For superior protection of most general-purpose and motor circuits, it is recommended to use the POWR-PRO® KLPC series Class L fuses. The Class L fuses are the only time-delay fuse series available in these higher ampere ratings.

Information on all the Littelfuse fuse series referenced above can be found on the UL/CSA Fuse Classes and Applications Charts found later in this Technical Application Guide.

IV. SELECTION CONSIDERATIONS FOR FUSE HOLDERS

Equally important to the selection of the proper fuse is the correct selection of the proper fuse holder or fuse block for a given application. Fuse holders are available using most of the same Selection Considerations outlined above for UL fuse classes. Considerations for fuse holders include:

- Current Rating
- Voltage Rating
- Interrupting Rating
- Physical Size
- Indication

Additional selection considerations for fuse holders and fuse blocks include:

- Number of poles
- Mounting configuration
- Connector type

Number of Poles

The number of poles for each set of fuses is determined by the characteristics of the circuit. Most fuse block series are available in 1, 2, or 3 pole configurations, although some are also available with four or more poles. The option to gang individual fuse blocks into longer strips will be determined by the available space and type of wire being used.

Mounting Configuration

Depending on the fuse block design, another selection consideration to evaluate is how the fuse block is mounted or inserted into the panel. Historically, fuse blocks simply screwed into the back of the panel, but many newer designs have now added (or replaced the screw-in design with) a DIN rail mounting capability. The DIN rail mounting feature allows the blocks to be quickly installed and removed from the rails.

Connector Type

For Littelfuse fuse blocks, a choice of three connector types or wire terminations is available:

- Screw – for use with spade lugs or ring terminals.
- Screw with Pressure Plate – for use with solid or stranded wire without terminal and recommended for applications where vibration will be a factor.
- Box Lug – the most durable of the three options and used with all types of solid wire and Class B and Class C stranded wire.

There are a few additional aspects to keep in mind when selecting the fuse holder or fuse block needed for a given application. UL Class H blocks accept Class H, Class K5, and Class R fuses. Similarly, Midget-style fuse blocks accept both Midget and UL Class CC fuses.

Both UL Class R and Class CC fuse holders contain a rejection feature which prevents the insertion of a different Class or type of fuse. The physical size and dimensions of UL Class J and Class T fuses accomplish the same thing in preventing the insertion of a different Class of fuse as well.

V. CIRCUIT PROTECTION CHECKLIST

To select the proper overcurrent protective device for an electrical system, circuit and system designers should ask themselves the following questions before a system is designed:

- What is the normal or average current expected?
- What is the maximum continuous (three hours or more) current expected?
- What inrush or temporary surge currents can be expected?
- Are the overcurrent protective devices able to distinguish between expected inrush and surge currents, and open under sustained overloads and fault conditions?
- What kind of environmental extremes are possible? Dust, humidity, temperature extremes and other factors need to be considered.
- What is the maximum available fault current the protective device may have to interrupt?
- Is the overcurrent protective device rated for the system voltage?
- Will the overcurrent protective device provide the safest and most reliable protection for the specific equipment?
- Under short-circuit conditions, will the overcurrent protective device minimize the possibility of a fire or explosion?
- Does the overcurrent protective device meet all the applicable safety standards and installation requirements?

Answers to these questions and other criteria will help to determine the type overcurrent protection device to use for optimum safety, reliability and performance.

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FUSE CHARACTERISTIC CURVES AND CHARTS

The performance capabilities of various fuses are graphically represented by two different types of fuse characteristic curves: time-current curves and peak let-through charts. These curves and charts define the operating characteristics of a given fuse, and assist system designers and engineers in selecting the proper fuse to protect equipment and electrical systems.

Understanding Time-current Curves

Time-current curves provide a graphical representation or plot of a fuse's average melting (opening) time at any current. Time-current curves for Littelfuse POWR-GARD® fuses can be found online at **littelfuse.com/technicalcenter**.

In order to make the curves more readable, the performance information is presented on log-log paper. The overcurrent values appear across the bottom and increase in magnitude from left to right. Average melting times appear on the left-hand side of the curve and increase in magnitude from bottom to top. The ampere ratings of the individual fuses for a given series are listed at the top and increase in rating from left to right. *Figure 4* shows the average melting time curves for a typical time-delay fuse series.

As discussed earlier in the Fuseology Fundamentals section, time-delay, fast-acting, and very fast-acting fuses all respond differently based on the overcurrents occurring in the systems each is protecting. To illustrate the basic differences between each type of fuse, *Figure 5* compares the average melting times for 100 and 600 amp ratings

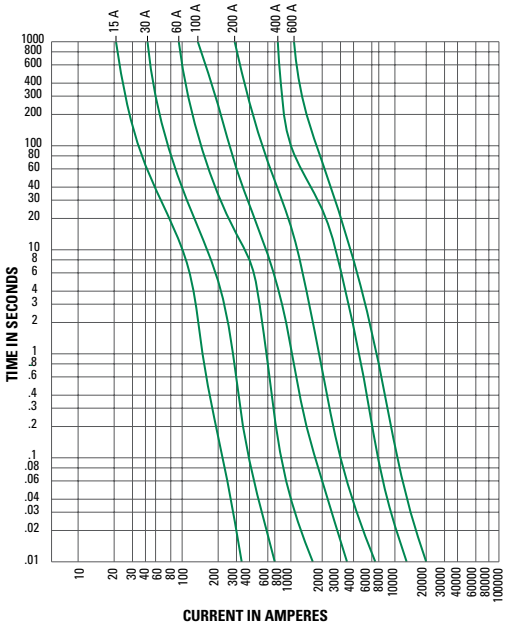


Figure 4 – Average Melting Time Curves for Typical Time-Delay Fuse Series

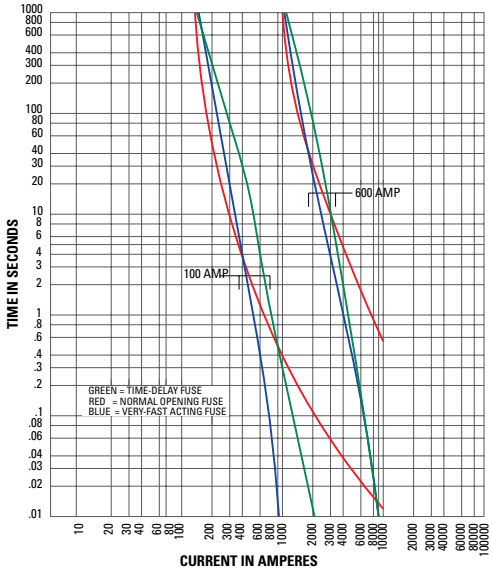


Figure 5 – Comparison of Average Melting Times for Three Fuse Types

of three fuse types: Littelfuse dual-element, time-delay LLSRK series class RK1 fuses (green); Littelfuse normal opening NLS series class K5 fuses (red); and Littelfuse very fast acting L60S series semiconductor fuses (blue).

To better illustrate this point, *Table 3* also compares the opening times for each of these fuses.

AMPERE RATING	FUSE TYPE	OPENING TIME IN SECONDS		
		500% RATING	800% RATING	1200% RATING
100	TIME-DELAY	12 secs.	0.9 secs.	0.14 secs.
	NORMAL OPENING	2 secs.	0.7 secs.	0.3 secs.
	VERY FAST-ACTING	1.3 secs.	0.02 secs.	>0.01 secs.
600	TIME-DELAY	14 secs.	0.7 secs.	0.045 secs.
	NORMAL OPENING	10 secs.	3 secs.	1.1 secs.
	VERY FAST-ACTING	2 secs.	0.05 secs.	>0.01 secs.

Table 3 – Comparative Opening Times for Time-Delay, Fast-Acting, and Very Fast-Acting Fuses

Peak Let-through Charts

Peak let-through charts illustrate the maximum instantaneous current through the fuse during the total clearing time. This represents the current limiting ability of a fuse.

Fuses that are current-limiting open severe short-circuits within the first half-cycle (180 electrical degrees or 0.00833 seconds) after the fault occurs. Current-limiting fuses also reduce the peak current of the available fault current to a value less than would occur without the fuse. This reduction is shown in *Figure 6*.

A fuse's current-limiting effects are shown graphically on Peak Let-through charts such as the one shown in *Figure 7*. The values across the chart's bottom represent the available

FUSE CHARACTERISTIC CURVES AND CHARTS

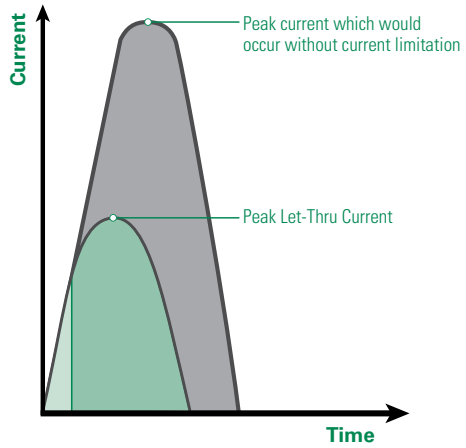


Figure 6 – Current limiting effect of fuses

(also referred to as potential or prospective) rms symmetrical fault current. The values on the chart's left side represent the instantaneous available peak current and the peak let-through current for various fuse ratings.

To better explain the function of these charts, let's run through an example. Start by entering the chart on the bottom at 100,000 rms symmetrical amperes and read upwards to the A-B line. From this point, read horizontally to the left and read the instantaneous peak let-thru current of 230,000 amperes. In a circuit with a typical 15% short-circuit power factor, the instantaneous peak of the available current is approximately 2.3 times the rms symmetrical value. This occurs since the A-B line on the chart has a 2.3:1 slope.

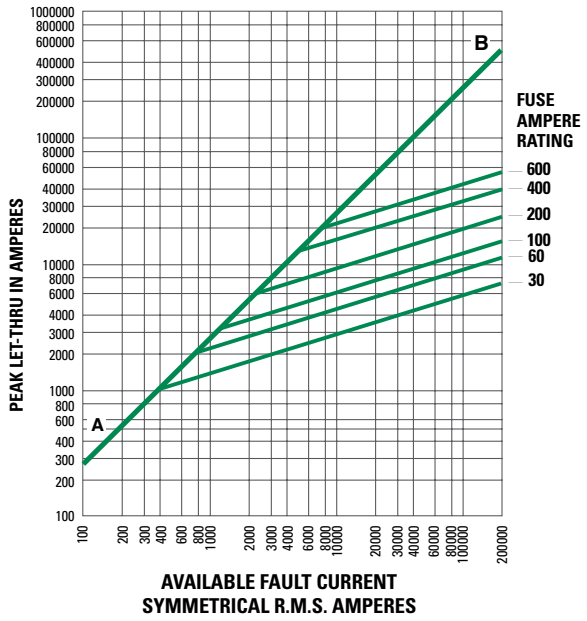


Figure 7 – Peak Let-through Charts

The diagonal curves that branch off the A-B line illustrate the current-limiting effects of different fuse ampere ratings for a given fuse series. To continue the example from above, enter the chart in *Figure 7* on the bottom at 100,000 rms symmetrical amperes and read upwards to the intersection of the 200 ampere fuse curve. Now read from this point horizontally to the left and read a peak let-through current of approximately 20,000 amperes.

What this tells us is that the 200 ampere fuse has reduced the peak current during the fault from 230,000 amperes to 20,000 amperes. In other words, this is the current-limiting effect of the 200 ampere fuse. 20,000 amperes is less than one-tenth of the available current. This is important because the magnetic force created by current flow is a function of the peak current squared. If the peak let-through current of a current-limiting fuse is one-tenth of the available peak, the magnetic force is reduced to less than 1/100 of what would occur without the fuse.

Using the Peak Let-through Charts ("Up-Over-and-Down")

Peak Let-through Charts for Littelfuse POWR-GARD® fuses can be found online at **littelfuse.com/technicalcenter**. These charts are useful in determining whether a given fuse can properly protect a specific piece of equipment.

For example, given an available fault-current of 100,000 rms symmetrical amperes, determine whether 600 amp 250 volt time-delay Class RK1 fuses can sufficiently protect equipment that has a 22,000 amp short-circuit rating. Refer to *Figure 8*.

Start by locating the 100,000 A available fault-current on the bottom of the chart (Point A) and follow this value upwards to the intersection with the 600 amp fuse curve (Point B). Next, follow this point horizontally to the left to intersect with the A-B line (Point C). Finally, read down to the bottom of the chart (Point D) to read a value of approximately 18,000 amps.

Can the fuse selected properly protect the equipment for this application? Yes, the POWR-PRO® LLNRK 600 ampere RK1 current-limiting fuses have reduced the 100,000 amperes available current to an apparent or equivalent 18,000 amps. When protected by 600 amp LLNRK RK1 fuses, equipment with short-circuit ratings of 22,000 amps may be safely connected to a system having 100,000 available rms symmetrical amperes.

This method, sometimes referred to as the "Up-Over-and-Down" method, may be used to:

1. Provide back-up short-circuit protection to large air power circuit breakers.
2. Enable non-interrupting equipment such as bus duct to be

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FUSE CHARACTERISTICS CURVES AND CHARTS

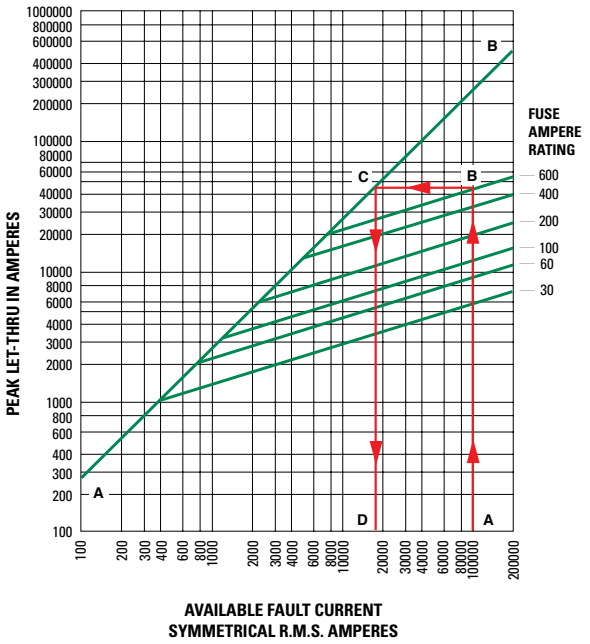


Figure 8 – Peak Let-through Chart for POWR-PRO® LLNRK Class RK1 Dual-Element Fuses Using the Up-Over-and-Down Method

installed in systems with available short-circuit currents greater than their short circuit (withstand) ratings.

However, this method may not be used to select fuses for backup protection of molded case or intermediate frame circuit breakers. National Electrical Code® (NEC®) Article 240.86 requires Series Ratings. Refer to the NEC® for more information.

UL Listed fuse-to-circuit breaker series ratings are now available from most national load center and panelboard manufacturers. Listings are shown in their product digests, catalogs, and online. Many local builders have also obtained fuse-to-circuit breaker series ratings. For additional information contact the Littelfuse Technical Support Group at 1-800-TEC-FUSE (1-800-832-3873).

Short-Circuit Current Rating (SCCR)

Since 2005, the NEC® has required Industrial Control Panels to be labeled with their SCCR. These labels allow users and inspectors to compare the SCCR of the equipment to the available fault current in order to avoid potential hazards in facilities.

Selective Coordination

A "coordinated" or "selective" system is a system whose overcurrent protective devices have been carefully chosen and their time-current characteristics coordinated.

Only the overcurrent device immediately on the line side of an overcurrent will open for any overload or short-circuit condition.

To further clarify, refer to the Terms and Definitions section for the definition of Selective Coordination and *Figure 15* for a graphical example.

Since the advent of electrical and electronic equipment, businesses have become entirely dependent on the continuous availability of electric energy. Loss of power halts all production and order processing, yet expenses continue to increase. Even many UPS systems become unintentionally non-selective causing power loss to computers and other critical equipment. Non-selectivity may defeat otherwise well-engineered UPS systems.

In a selective system, none of this occurs. Overloads and faults are disconnected by the overcurrent protective device immediately on the line side of the problem. The amount of equipment removed from service is minimized, the faulted or overloaded circuit is easier to locate, and a minimum amount of time is required to restore full service.

For these and many other reasons, selectivity is the standard by which many systems are judged and designed.

Fuse Selectivity

To get a better sense of how to ensure that fuses are selectively coordinated within an electrical system, refer to *Figure 4* shown earlier in this Technical Application Guide. This figure shows typical average melting time-current curves for one class of fuses. Note that the curves are roughly parallel to each other and that for a given overcurrent, the smaller fuse ratings respond quicker than the larger ratings. The heat energy required to open a fuse is separated into melting I^2t and arcing I^2t (see definition of Ampere-Squared-Seconds). The sum of these is the total clearing I^2t.

For a system to be considered coordinated, the smaller fuse total clearing I^2t must be less than the larger fuse melting I^2t. In other words, if the downstream (branch) fuse opens the circuit before the overcurrent affects the upstream (feeder) fuse element, the system will be considered selective. This can be determined by analyzing curves displaying melting and total clearing I^2t, or from minimum melting and maximum clearing time-current curves.

But the simplest method of coordinating low voltage power fuses is by using a Fuse Coordination Table such as the one shown in *Table 4*. This table is only applicable for the Littelfuse POWR-PRO® and POWR-GARD® fuse series listed. Tables such as this greatly reduce design time. For example, the coordination table shows that POWR-PRO KLPC Class L fuses coordinate at a two-to-one ratio with other Class L fuses, with POWR-PRO LLNRK / LLSRK / LLSRK_ID series

SELECTIVE COORDINATION

Class RK1 fuses, and POWR-PRO JTD / JTD_ID series Class J fuses.

In the system shown in *Figure 9*, the 3000 amp Class L main fuses are at least twice the ratings of the 1500, 1200, and 1000 amp Class L feeder fuses. Using the 2:1 ratio just referenced above, it is determined that these fuses will coordinate. The Coordination Table also shows that the LLSRK_ID series time-delay RK1 feeder and branch circuit fuses coordinate at a two-to-one ratio with the Class L feeder fuses, so the entire system in *Figure 9* would be considered 100% coordinated.

Circuit Breaker Coordination

As a result of the numerous types of circuit breakers and circuit breaker trip units available in today's market, developing a coordinated circuit breaker system or coordinating circuit breakers with fuses is beyond the scope of this Technical Application Guide. For further questions, contact the Littelfuse Technical Support Group.

NEC® Requirements for Selective Coordination

Component Short-Circuit Protecting Ability

As shown in *Figure 10*, the NEC® requires equipment protection to be coordinated with overcurrent protective devices and the available fault current in order to prevent extensive damage to the equipment. Essentially, this means that electrical equipment must be capable of withstanding heavy overcurrents without damage or be properly protected by overcurrent protective devices that will limit damage.

When a severe fault occurs in an unprotected circuit, current immediately increases to a very high value. This is the available or prospective fault current. Some fuses respond so quickly to the increasing current that they interrupt current within the first half-cycle - or before the current even reaches its first peak. This is illustrated in *Figure 6* found earlier in the Technical Application Guide. Such fuses are termed "current-limiting fuses."

Current-limiting fuses stop damaging current faster than any other protective device, and greatly reduce or totally prevent component damage from high fault currents. This performance capability helps users meet the NEC® Article 110.10 requirements listed in *Figure 10*.

Pre-Engineered Solutions

Applicable code requirements also continue to expand with each new edition of the National Electrical Code®. As of the 2014 edition of the NEC®, the following requirements need to be met – and can be, utilizing Littelfuse POWR-GARD® Pre-Engineered Solutions:

- NEC 517.26 – Healthcare Essential Electrical Systems
- NEC 620.82 – Elevators
- NEC 700.27 – Emergency Systems
- NEC 701.27 – Legally Required Standby Systems
- NEC 708.54 – Critical Operations Power Systems

LINE-SIDE FUSES			LOAD-SIDE FUSES									
			TIME-DELAY FUSES AMPERE RANGE, UL CLASS AND CATALOG NO.						FAST-ACTING FUSES AMPERE RANGE, UL CLASS AND CATALOG NO.			
AMPERE RANGE	UL CLASS	LITTELFUSE CATALOG NUMBER	601-6000	601-4000	30-600	30-600	30-600	0-30	30-600	30-1200	30-600	1-60
			L	L	RK1	J	RK5	CC	RK1	T	J	G
			KLPC LDC	KLLU	LLNRK LLSRK_ID	JTD_ID JTD	FLNR_ID FLSR_ID IDSR	CCMR	KLNR KLSR	JLLN JLLS	JLS	SLC
601-6000	L	KLPC	2:1	2:1	2:1	2:1	4:1	2:1	2:1	2:1	2:1	N/A
601-4000	L	KLLU	2:1	2:1	2:1	2:1	4:1	2:1	2:1	2:1	2:1	N/A
601-2000	L	LDC	2:1	2:1	2:1	2:1	4:1	2:1	2:1	2:1	2:1	N/A
30-600	RK1	LLNRK	N/A	N/A	2:1	2:1	8:1	2:1	3:1	3:1	3:1	4:1
30-600	RK1	LLSRK_ID	N/A	N/A	2:1	2:1	8:1	2:1	3:1	3:1	3:1	4:1
30-600	J	JTD_ID	N/A	N/A	2:1	2:1	8:1	2:1	3:1	3:1	3:1	4:1
30-600	RK5	IDSR	N/A	N/A	1.5:1	1.5:1	2:1	2:1	1.5:1	1.5:1	1.5:1	1.5:1
30-600	RK5	FLNR_ID	N/A	N/A	1.5:1	1.5:1	2:1	2:1	1.5:1	1.5:1	1.5:1	1.5:1
30-600	RK5	FLSR_ID	N/A	N/A	1.5:1	1.5:1	2:1	2:1	1.5:1	1.5:1	1.5:1	1.5:1
30-600	RK1	KLNR	N/A	N/A	3:1	3:1	8:1	N/A	3:1	3:1	3:1	4:1
30-600	RK1	KLSR	N/A	N/A	3:1	3:1	8:1	N/A	3:1	3:1	3:1	4:1
30-1200	T	JLLN	N/A	N/A	3:1	3:1	8:1	N/A	3:1	3:1	3:1	4:1
30-1200	T	JLLS	N/A	N/A	3:1	3:1	8:1	N/A	3:1	3:1	3:1	4:1
30-600	J	JLS	N/A	N/A	3:1	3:1	8:1	N/A	3:1	3:1	3:1	4:1
1-60	G	SLC	N/A	N/A	3:1	3:1	4:1	N/A	2:1	2:1	2:1	2:1

Table 4 – Fuse Coordination Table. Selecting the Correct Fuse Ampere Ratio to Maintain Selectively Coordinated Systems. (Ratios are expressed as Line-Side Fuse to Load-Side Fuse.)

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SELECTIVE COORDINATION

The Littelfuse product line of Pre-Engineered Solutions includes:

- LPS Series POWR-Switch (single elevator shunt-trip disconnect switch)
- LCP Selective Coordination Panel

These products continue to gain in popularity because they meet NEC® requirements and offer simple, economical solutions for a variety of applications.

Visit **littelfuse.com/lcp** for more information on Littelfuse Pre-Engineered Solution products and corresponding selective coordination requirements.

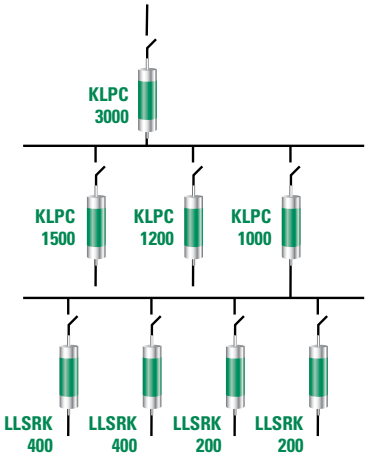


Figure 9 – Example of Selectively Coordinated Fused System

NATIONAL ELECTRICAL CODE®

ARTICLE 110 – Requirements for Electrical Installations

I. General

110.3. Examination, Identification, Installation, and Use of Equipment.

(A) Examination. In judging equipment, considerations such as the following shall be evaluated:

(5) Heating effects under normal conditions of use and also under abnormal conditions likely to arise in service.

(6) Arcing effects.

(B) Installation and Use. Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.

110.9 Interrupting Rating. Equipment intended to interrupt current at fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that is available at the line terminals of the equipment.
Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

110.10 Circuit Impedance, Short-Circuit Current Ratings, and Other Characteristics. The overcurrent protective devices, the total impedance, the equipment short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without extensive damage to the electrical equipment of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the equipment grounding conductor(s) permitted in 250.118. Listed equipment applied in accordance with their listing shall be considered to meet the requirements of this section.

ARTICLE 240 – Overcurrent Protection

240.1 Scope. Parts I through VII of this article provide the general requirements for overcurrent protection and overcurrent protective devices not more than 1000 volts, nominal. Part VIII covers overcurrent protection for those portions of supervised industrial installations operating at voltages of not more than 1000 volts, nominal. Part IX covers overcurrent protection over 1000 volts, nominal.

Informational Note: Overcurrent protection for conductors and equipment is provided to open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation. See also Articles 110.9 for requirements for interrupting ratings and 110.10 for requirements for protection against fault currents.

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Figure 10 – National Electrical Code Requires Effective Overcurrent Protection

UL/CSA FUSE CLASSES AND APPLICATIONS

Overcurrent and short-circuit protection of power and lighting feeders and branch circuits

Current Limiting

Fuses which meet the requirements for current limiting fuses are required to be labeled "Current Limiting". Fuse labels must include: UL/CSA fuse class, manufacturer's name or trademark, current rating, AC and/or DC voltage rating, and AC and/or DC interrupting rating. "Time Delay", "D", "TD" or equivalent may also be included on the label when the fuse complies with the time delay requirements of its class.

CLASS L

STANDARDS: UL Standard 248-14,
CSA Standard C22.2, No. 106, classified as HRCI-L
VOLTAGE RATING: 600 volts, AC and/or DC
CURRENT RATINGS: 601-6000 amps
KLPC also available 200-600A; LDC also available 150-600A
INTERRUPTING RATING: AC: 200,000 amps rms symmetrical
DC: 50,000, 100,000, or 200,000 amps
Not interchangeable with any other UL fuse class.
Time delay: Class L fuses may be marked "Time-Delay" although UL does not investigate time-delay characteristics of Class L fuses.
KLPC & KLLU: 10 seconds at 500% current rating
LDC: 4 seconds at 500% current rating

LF SERIES: KLPC, KLLU, LDC

CLASS R

STANDARDS: UL Standard 248-12,
CSA Standard C22.2, No. 106, classified as HRCI-R
VOLTAGE RATINGS: 250 and 600 volts, AC; 125 and 300 volts DC
CURRENT RATINGS: 0-600 amps
INTERRUPTING RATING: 200,000 amps rms symmetrical
TWO CLASSES: RK1 and RK5
Time delay is optional for Class R fuses.
Time Delay fuses are required to hold 500% current rating for a minimum of ten seconds.
Same dimensions as UL Class H fuses, terminals modified to provide rejection feature.
Fits UL Class R fuse holders which reject non Class R fuses.
Physically interchangeable with UL Class H, NEMA Class H, and UL Classes K1 & K5 when equipment has Class H fuse holders.

CLASS RK1

High degree of current limitation. Provides IEC Type 2 (no damage) protection for motor starters and control components. Time Delay optional, LLSRK_ID Series provides visual indication of blown fuse.

LF SERIES: Time Delay: LLNRK, LLSRK, LLSRK_ID
Fast Acting: KLNR, KLSR

CLASS RK5

Moderate degree of current limitation, adequate for most applications. Time delay optional. FLNR_ID, FLSR_ID and IDSR series provides visual indication of blown fuse.

LF SERIES: FLNR, FLNR_ID, FLSR, FLSR_ID, and IDSR

CLASS J

STANDARDS: UL Standard 248-8,
CSA Standard C22.2, No. 106, classified as HRCI-J
VOLTAGE RATING: 600 volts, AC
CURRENT RATINGS: 0-600 amps
INTERRUPTING RATING: 200,000 amps rms symmetrical
Not interchangeable with any other UL fuse class.
Time delay optional: Minimum of 10 seconds at 500% current rating.

LF SERIES: Time Delay: JTD_ID, JTD
Fast Acting: JLS

CLASS CC/CD

STANDARDS: UL Standard 248-4,
CSA Standard C22.2, No. 106, classified as HRCI Misc.
VOLTAGE RATING: 600 volts, AC
CURRENT RATINGS: UL Class CC: 0-30 amps
UL Class CD: 35-60 amps
INTERRUPTING RATINGS: 200,000 amps rms symmetrical
Time delay optional: Minimum of 12 seconds at 200% current rating.

LF SERIES: Time Delay: CCMR (motors), KLDR (transformers)
Fast Acting: KLKR

CLASS T

STANDARDS: UL Standard 248-15
CSA Standard C22.2, No. 106, classified as HRCI-T
VOLTAGE RATINGS: 300 and 600 volts AC, 125 and 300 volts DC
CURRENT RATINGS: 0-1200 amps
900 to 1200 amps UL Recognized for 600V version
INTERRUPTING RATING: 200,000 amps rms symmetrical
Fast-Acting fuses. High degree of current limitation.
Very small fuses; space-saving and non-interchangeable with any other UL fuse class.

LF SERIES: JLLN, JLLS

CLASS G

STANDARDS: UL Standard 248-5
CSA Standard C22.2, No. 106, classified as HRCI Misc.
VOLTAGE RATING: 480 volts, AC
CURRENT RATINGS: 0-60 amps
INTERRUPTING RATING: 100,000 amps rms symmetrical
Not interchangeable with any other UL fuse class.
Time delay optional: Minimum of 12 seconds at 200% current rating.

LF SERIES: SLC

CLASS K

STANDARDS: UL Standard 248-9; No CSA Standard
VOLTAGE RATINGS: 250 and 600 volts, AC
CURRENT RATING: 0-600 amps
INTERRUPTING RATINGS: Three permitted: 50,000, 100,000, and 200,000 amps rms symmetrical
Time delay is optional for Class K fuses.
Time Delay fuses are required to hold 500% current rating for a minimum of ten seconds.
Same Dimensions and Physically interchangeable with UL Class H fuse holders.
Class K fuses are not permitted to be labeled Current Limiting because there is no rejection feature as required by NEC® Article 240-60(B).

CLASS K1

Same prescribed degree of current limitation as RK1 fuses when tested at 50,000 or 100,000 amps rms symmetrical.

LF SERIES: Time Delay: LLNRK, LLSRK
Fast Acting: KLNR, KLSR

CLASS K5

Same prescribed degree of current limitation as RK5 fuses when tested at 50,000 or 100,000 amps rms symmetrical.

LF SERIES: NLN, NLS

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UL/CSA FUSE CLASSES AND APPLICATIONS

Overcurrent and short-circuit protection of power and lighting feeders and branch circuits

FUSES FOR SUPPLEMENTARY OVERCURRENT PROTECTION

STANDARDS: UL Standard 248-14; CSA Standard C22.2, No. 59-1. Three Classifications covered:
NOTE: Fuses may be rated for AC and/or DC when suitable for such use.

(1) **MICRO FUSES**
Voltage ratings: UL, 125 volts; CSA, 0-250 volts
Current ratings: UL, 0-10 amps; CSA, 0-60 amps
Interrupting rating: 50 amps rms symmetrical

(2) **MINIATURE FUSES** (CSA classifies these as Supplemental Fuses)
Voltage ratings: UL, 125 or 250 volts; CSA, 0-600 volts
Current ratings: UL, 0-30 amps; CSA, 0-60 amps
Interrupting rating: 10,000 amps rms symmetrical

(3) **MISCELLANEOUS CARTRIDGE FUSES** (CSA classifies these as Supplemental Fuses)
Voltage ratings: UL, 125-1000 volts; CSA, 0-100 volts
Current ratings: UL, 0-30 amps; CSA 0-60 amps
Interrupting ratings: 10,000, 50,000, or 100,000 amps rms symmetrical

Time delay (Optional); Minimum delay at 200% fuse rating:
5 seconds for fuses rated 3 amps or less
12 seconds for fuses rated more than 3 amps

LF SERIES: BLF, BLN, BLS, FLA, FLM, FLQ, FLU, KLK, KLQ KLKD, SPF
NOTE: Littelfuse electronic fuses are also covered by these standards; see electronic section of this catalog, or littelfuse.com for complete listing.

SPECIAL PURPOSE FUSES

There are no UL Standards covering this category of fuses. These fuses have special characteristics designed to protect special types of electrical or electronic equipment such as diodes, SCR, transistors, thyristors, capacitors, integrally fused circuit breakers, parallel cable runs, etc.
Fuses may be UL Recognized for use as a component in UL Listed equipment. UL Recognized fuses are tested for characteristics such as published interrupting capacity. They are also covered by UL re-examination service.
Non-renewable
VOLTAGE RATINGS: up to 1000 volts AC and/or DC
AMPERE RATINGS: up to 6000 amperes
INTERRUPTING RATINGS: up to 200,000 amperes
Many of these fuses are extremely current limiting. When considering application of these fuses, or if you have special requirements, contact Littelfuse Technical Support Group for assistance.

LF SERIES: KLC, LA15QS, LA30QS, LA50QS, LA60QS, LA60X, LA70QS, LA100P, LA120X, LA070URD, LA130URD, L15S, L25S, L50S, L60S, L70S, JLLS 900 amp through 1200 amp

Non-Current Limiting

CLASS H

STANDARDS: UL Standard 248-6
CSA Standard C22.2, No. 59.1
Also known as NEMA Class H, and sometimes referred to as "NEC" or "Code" fuses
VOLTAGE RATINGS: 250 and 600 volts, AC
AMPERE RATINGS: 0-600 amps
INTERRUPTING RATINGS: 10,000 amps rms symmetrical
Two types: one-time and renewable
Physically interchangeable with UL Classes K1 & K5;
Fits UL Class H fuse holders which will also accept K1, K5, RK5, and RK1 fuses.
Manufacturers are upgrading Class H One-time fuses to Class K5 per UL Standard 248-9D, See Class K fuses.

ONE-TIME FUSES (NON-RENEWABLE)

Time delay: Optional
Time-delay fuses must hold 500% current rating for a minimum of ten seconds.

LF SERIES: NLKP

RENEWABLE FUSES

Only Class H fuses may be renewable. While time delay is optional, no renewable fuses meet requirements for time delay.
Some renewable fuses have a moderate amount of time delay, referred to as "time lag" to differentiate from true time delay.

LF SERIES: Discontinued - Please cross to RK5 or RK1 class fuses

PLUG FUSES

STANDARDS: UL Standard 248-11,
CSA Standard C22.2, No. 59.1
VOLTAGE RATINGS: 125 volts AC only
AMPERE RATINGS: 0-30 amps
INTERRUPTING RATINGS: 10,000 amps rms symmetrical. Interrupting rating need not be marked on fuse.

Two types: Edison-base and Type S
EDISON-BASE: Base is same as standard light bulb. All amp ratings interchange able. NEC® permits Edison-base plug fuses to be used only as replacements for existing fuses, and only when there is no evidence of tampering or overfusing.
TYPE S: Not interchangeable with Edison-base fuses unless non-removable Type S fuse adapter is installed in Edison-base fuse socket. To prevent overfusing, adapters have three ampere ratings: 10-15, 16-20, and 21-30 amps.
Time delay: Fuses may be time delay, if so, they are required to hold 200% of rating for 12 seconds minimum.
NOTE: Plug fuses may be used where there is not more than 125 volts between conductors or more than 150 volts from any conductor to ground. This permits their use in 120/240 volts grounded, single-phase circuits.

LF SERIES: Edison-base: TOO, TLO
Type S: SOO, SLO
Type S Adapters: SAO

TERMS AND DEFINITIONS

Adjustable Alarm Level – A setting on a protection relay at which an LED or an output contact operates to activate a visual or audible alarm.

Adjustable Time Delay – A setting on a protection relay that determines the time between the fault detection and relay operation.

AIC or A.I.C. – See Interrupting Capacity.

AIR or A.I.R. – See Interrupting Rating.

Alarm Relay Contact – The output of the relay that acts as a switch and is connected to a visual or audible alarm.

Ambient Temperature – The air temperature surrounding a device. For fuses or circuit breakers in an enclosure, the air temperature within the enclosure.

Ampacity – The current in amperes that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. It is sometimes informally applied to switches or other devices which are more properly referred to by their ampere rating.

Ampere Rating – The current rating, in amperes, that is marked on fuses, circuit breakers, or other equipment.

Ampere-Squared-Seconds (I^2t) – A means of describing the thermal energy generated by current flow. When a fuse is interrupting a current within its current-limiting range, the term is usually expressed as melting, arcing, or total clearing I^2t.

- Melting I^2t is the heat energy passed by a fuse after an overcurrent occurs and until the fuse link melts. It equals the rms current squared multiplied by the melting time in seconds. For times less than 0.004 seconds, melting I^2t approaches a constant value for a given fuse.
- Arcing I^2t is the heat energy passed by a fuse during its arcing time. It is equal to the rms arcing current squared (see definition below), multiplied by arcing time.
- Clearing I^2t (also Total Clearing I^2t) is the ampere-squared seconds (I^2t) through an overcurrent device from the inception of the overcurrent until the current is completely interrupted. Clearing I^2t is the sum of the Melting I^2t plus the Arcing I^2t.

Analog Output – A 0–1 mA, 4–20 mA or 0–5 Vdc signal from a protection relay used to pass information to a device or controller.

Arc-Blast – A pressure wave created by the heating, melting, vaporization, and expansion of conducting material and surrounding gases or air.

Arc-Flash – The sudden release of heat energy and intense light at the point of an arc. Can be considered a short-circuit through the air, usually created by accidental contact between live conductors.

Arc Gap – The distance between energized conductors or between energized conductors and ground. Shorter arc gaps result in less energy being expended in the arc, while longer gaps reduce arc current. For 600 volts and below, arc gaps of 1.25 inches (32 mm) typically produce the maximum incident energy.

Arc Rating – A rating assigned to material(s) that relates to the maximum incident energy the material can resist before break open of the material or onset of a second-degree burn. The arc rating is typically shown in cal/cm².

Arcing Current (See *Figure 11*) – The current that flows through the fuse after the fuse link has melted and until the circuit is interrupted.

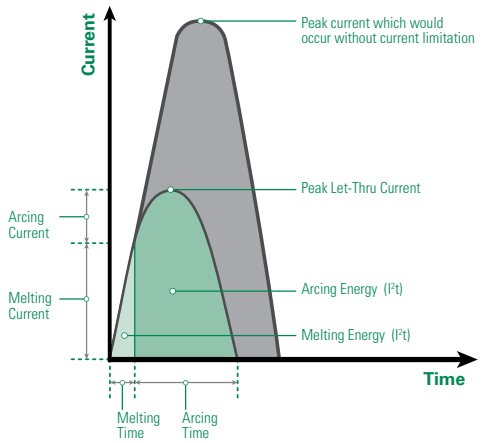


Figure 11 – Arcing and melting currents plus arcing, melting and clearing times

Arcing I^2t – See Ampere-Squared-Seconds (I^2t).

Arcing Fault – A short-circuit that arcs at the point of fault. The arc impedance (resistance) tends to reduce the short-circuit current. Arcing faults may turn into bolted faults by welding of the faulted components. Arcing faults may be phase-to-phase or phase-to-ground.

Arcing Time (See *Figure 11*) – The time between the melting of a fuse link or parting of circuit breaker contacts, until the overcurrent is interrupted.

Arc Voltage (See *Figure 12*) – Arc voltage is a transient voltage that occurs across an overcurrent protection device during the arcing time. It is usually expressed as peak instantaneous voltage (V_{peak} or E_{peak}), or on rare occasion as rms voltage.

Asymmetrical Current – See Symmetrical Current.

Available Short-Circuit Current (also Available or Prospective Fault Current) – The maximum rms Symmetrical Current that would flow at a given point in a system under bolted-fault conditions. Short-circuit current is maximum during the first half-cycle after the fault occurs. See definitions of Bolted Fault and Symmetrical Current.

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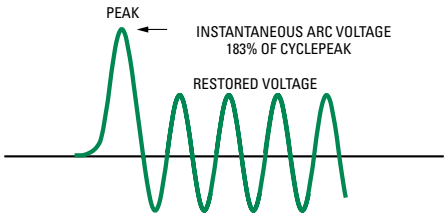


Figure 12 – Transient overvoltage during arcing time

Blade Fuse – See Knife Blade Fuse.

Body – The part of a fuse enclosing the fuse elements and supporting the contacts. Body is also referred to as cartridge, tube, or case.

Bolted Fault – A short-circuit that has no electrical resistance at the point of the fault. It results from a firm mechanical connection between two conductors, or a conductor and ground. Bolted faults are characterized by a lack of arcing. Examples of bolted faults are a heavy wrench lying across two bare bus bars, or a crossed-phase condition due to incorrect wiring

Boundaries of Approach – Protection boundaries established to protect personnel from shock and Arc-Flash hazards.

Calorie – The amount of heat needed to raise the temperature of one gram of water by one degree Celsius.1 cal/cm² is equivalent to the exposure on the tip of a finger by a cigarette lighter for one second.

Cartridge Fuse – A fuse that contains a current-responsive element inside a tubular fuse body with cylindrical ferrules (end caps).

Case Size (also Cartridge Size) – The maximum allowable ampere rating of a cartridge fuse having defined dimensions and shape. For example, case sizes for UL Listed Class H, K, J, RK1, and RK5 are 30, 60, 100, 200, 400, and 600 amperes. The physical dimensions vary with fuse class, voltage, and ampere rating. UL Standards establish the dimensions for each UL Fuse Class. This catalog's product section contains case size dimensions for all Littelfuse POWR-GARD® fuses.

Clearing I^2t – See Ampere-Square-Seconds (I^2t).

Clearing Time (see *Figure 11*) – The time between the initiation of an overcurrent condition to the point at which the overcurrent is interrupted. Clearing Time is the sum of Melting Time and Arcing Time.

Conformal Coating – Coating used to protect circuit boards from pollutants, corrosion, and mildew.

Contacts (Fuse) – The external metal parts of the fuse used to complete the circuit. These consist of ferrules, caps, blades or terminals, as shown in this catalog.

Coordination or Coordinated System – See Selective Coordination.

Continuous Load – An electrical load where the maximum current is expected to continue for three hours or more.

CT Loop – The electrical circuit between a current transformer and a protection relay or monitoring device.

Current-Based Protection – Protection parameters (trip-levels/ data collection etc.) derived from current levels in a circuit.

Current-limiting Fuse (See *Figure 13*) – A fuse which, when interrupting currents within its current-limiting range, reduces the current in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device was replaced with a solid conductor having comparable impedance. To be labeled "current limiting," a fuse must mate with a fuse block or fuse holder that has either a rejection feature or dimensions that will reject non-current-limiting fuses.

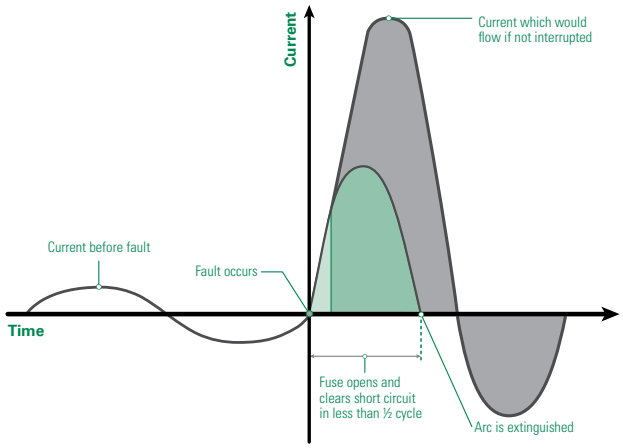


Figure 13 – Current-limiting Fuse

Current-limiting Range - For an individual overcurrent protective device, the current-limiting range begins at the lowest value of rms symmetrical current at which the device becomes current-limiting (the threshold current) and extends to the maximum interrupting capacity of the device. See definitions of Threshold Current and Interrupting Capacity.

Current Rating – See Ampere Rating.

Current Transformer (CT) – A transformer that produces a current in its secondary circuit in a known proportion to current in its primary circuit.

Data Logging – Collecting and storing information in a format that can be reviewed for trending, troubleshooting and reporting.

DFT (Discrete Fourier Transform) Harmonic Filter – An algorithm used to measure the fundamental component of current and voltage and reject harmonics. This allows lower trip settings and eliminates nuisance trips due to harmonics.

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Distance to Arc – Refers to the distance from the receiving surface to the arc center. The value used for most calculations is typically 18 inches.

Dual-Element Fuse – A fuse with internal construction consisting of a separate time-delay overload element(s) that interrupts overcurrents up to approximately 500%-600% of its nominal rating, plus separate fuse links that quickly open higher value currents. All dual-element fuses have time delay, but, since there are other methods of achieving time delay, not all time-delay fuses have dual-element construction. See Time-Delay Fuse.

EFCT (Earth Fault Current Transformer) – A current transformer engineered to accurately detect low level ground-fault current.

Electrical Hazard Analysis – A study performed to identify the potential electrical hazards to which personnel may be exposed. The analysis should address both shock and Arc-Flash hazards.

Electrically Safe Work Condition – Condition where the equipment and or circuit components have been disconnected from electrical energy sources, locked/tagged out, and tested to verify all sources of power are removed.

Element – A fuse's internal current-carrying components that melt and interrupt the current when subjected to an overcurrent of sufficient duration or value. Also called fuse link.

Fail-Safe Mode (also known as Under Voltage or UV) – Output relay is energized during normal (not tripped) operation. If the protection relay loses supply voltage, the system will trip or alarm.

Fast-Acting Fuse – May also be termed Normal-opening fuse, this is a fuse that has no intentional or built-in time delay. Actual opening time is determined by the fuse class, the overcurrent, and other conditions. Fast-acting is indicated on the fuse label by "Fast-Acting", "F-A", "F", or other suitable marking.

Fault – Same as Short-Circuit and used interchangeably.

Fault Current – The current that flows when a phase conductor is faulted to another phase or ground.

Feeder Protection – Overcurrent or overvoltage devices installed on a feeder circuit to supplement, compliment or replace downstream protective devices.

Filler – A material, such as granular quartz, used to fill a section or sections of a fuse and aid in arc quenching.

Filter – An algorithm used to measure the fundamental component of current and voltage and reject harmonics. This allows lower trip settings and eliminates nuisance trips due to harmonics.

Flash Hazard Analysis – A study that analyzes potential exposure to Arc-Flash hazards. The outcome of the study establishes Incident Energy levels, Hazard Risk Categories, Flash Protection Boundaries, and required PPE. It also helps define safe work practices.

Flash Protection Boundary – A protection boundary established to protect personnel from Arc-Flash hazards. The Flash Protection Boundary is the distance at which an unprotected worker can receive a second-degree burn to bare skin.

Fuse – An overcurrent protective device consisting of one or more current carrying elements enclosed in a body fitted with contacts, so that the fuse may be readily inserted into or removed from an electrical circuit. The elements are heated by the current passing through them, thus interrupting current flow by melting during specified overcurrent conditions.

Ground Continuity Monitor - A protection relay that continuously monitors a ground conductor and trips if this conductor opens or shorts to the ground-check conductor.

Ground-Fault – Unintentional contact between a phase conductor and ground or equipment frame. The words "ground" and "earth" are used interchangeably when it comes to electrical applications.

Ground-Fault Current – The current that returns to the supply neutral through the ground-fault and the ground-return path.

Ground-Fault Protection – A system that protects equipment from damaging ground-fault current by operating a disconnecting means to open all ungrounded conductors of a faulted circuit. This protection is at current levels less than those required to operate a supply circuit overcurrent device.

Ground-Fault Relay – A protection relay designed to detect a phase-to-ground-fault on a system and trip when current exceeds the pickup setting for greater than the trip time setting.

Hazard Risk Category – A classification of risks (from 0 to 4) defined by NFPA 70E®. Each category requires PPE and is related to incident energy levels.

High-Resistance Grounding – Achieved when a neutral-ground resistor (NGR) is used to limit the current to a low level. Typically high-resistance grounding is 25 A and lower. See Low-Resistance Grounding.

I^2t – See Ampere-Squared-Seconds (I^2t).

IEEE Device Numbers – The devices in switching equipment are referred to by numbers, according to the functions they perform. These numbers are based on a system which has been adopted as standard for automatic switchgear by IEEE. This system is used on connection diagrams, in instruction books and in specifications.

IEC Type 2 Protection – Fused protection for control components that prevents damage to these components under short-circuit conditions. See definition of No Damage.

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Incident Energy – The amount of thermal energy impressed on a surface generated during an electrical arc at a certain distance from the arc. Typically measured in cal/cm^2.

Instantaneous Peak Current (I_p or I_{peak}) – The maximum instantaneous current value developed during the first half-cycle (180 electrical degrees) after fault inception. The peak current determines magnetic stress within the circuit. See Symmetrical Current.

Insulation Monitoring – Monitoring the resistance from phase to ground to detect insulation breakdown on a system.

Interrupting Capacity (AIC) – The highest available symmetrical rms alternating current (for DC fuses the highest direct current) at which the protective device has been tested, and which it has interrupted safely under standardized test conditions. The device must interrupt all available overcurrents up to its interrupting capacity. Also commonly called interrupting rating. See Interrupting Rating below.

Interrupting Rating (IR, I.R., AIR or A.I.R.) – The highest RMS symmetrical current, at specified test conditions, which the device is rated to interrupt. The difference between interrupting capacity and interrupting rating is in the test circuits used to establish the ratings.

Inverse-time Characteristics – A term describing protective devices whose opening time decreases with increasing current.

IR or I.R. (also AIR or A.I.R.) – See Interrupting Rating above.

Kiloamperes (kA) – 1,000 amperes.

Knife Blade Fuse – Cylindrical or square body fuses with flat blade terminals extending from the fuse body. Knife blades may be designed for insertion into mating fuse clips and/or to be bolted in place. Knife blade terminals may include a rejection feature that mates with a similar feature on a fuse block of the same class.

Leakage Current – Very low level ground-fault current, typically measured in milliamperes (mA, thousandths of amperes).

Limited Approach Boundary – An approach boundary to protect personnel from shock. A boundary distance is established from an energized part based on system voltage. To enter this boundary, unqualified persons must be accompanied with a qualified person and use the proper PPE.

Low-Resistance Grounding – A Resistance Grounded System that allows high currents to flow during a ground-fault. Typically 100A and higher is considered Low-Resistance grounding. See High-Resistance Grounding.

Melting Current (see *Figure 11*) – The current that flows through the fuse from the initiation of an overcurrent condition to the instant arcing begins inside the fuse.

Melting I^2t – See Ampere-Squared-Seconds (I^2t).

Melting Time (see *Figure 11*) – The time span from the initiation of an overcurrent condition to the instant arcing begins inside the fuse.

Motor Protection – Overload protection designed to protect the windings of a motor from high current levels. Modern motor protection relays add many additional features, including metering, data logging and communications.

NEC – In general, the National Electrical Code® (NEC®). Specifically, as referenced herein, NEC refers to NFPA Standard 70, *National Electrical Code*, National Fire Protection Association, Quincy, MA 02269.

Sections of the NEC reprinted herein, and/or quotations there from, are done so with permission. The quoted and reprinted sections are not the official position of the National Fire Protection Association which is represented only by the Standard in its entirety. Readers are cautioned that not all authorities have adopted the most recent edition of the NEC; many are still using earlier editions.

Neutral Grounding Resistor (NGR) – A current-limiting resistor connecting the power-system neutral to ground.

No Damage – A term describing the requirement that a system component be in essentially the same condition after the occurrence of a short-circuit as prior to the short-circuit.

Non-renewable Fuse – A fuse that must be replaced after it has opened due to an overcurrent. It cannot be restored to service.

Normal-opening Fuse – See Fast-Acting Fuse.

Nuisance Trip – An undesired change in relay output due to misinterpreted readings.

One-time Fuse – Technically, any non-renewable fuse. However, the term usually refers to UL Class H fuses and to fast acting UL Class K5 fuses. Such fuses are not current-limiting and do not have a rejection feature. One-time fuses are also referred to as "Code" fuses.

Open CT Hazard – An open-circuited CT secondary can develop a dangerously high voltage when the primary is energized.

Overcurrent – Any current larger than the equipment, conductor, or devices are rated to carry under specified conditions.

Overload – An overcurrent that is confined to the normal current path (e.g., not a short-circuit), which if allowed to persist, will cause damage to equipment and/or wiring. Additional information regarding fuse applications for overload protection can be found earlier in this Technical Application Guide.

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Peak Let-through Current (See *Figure 14*) – The maximum instantaneous current that passes through an overcurrent protective device during its total clearing time when the available current is within its current-limiting range.

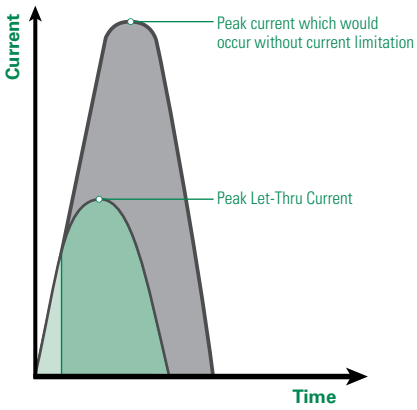


Figure 14 – Peak Let-through Current

Phase Current – The current present in a phase conductor.

Phase Voltage – The voltage measured between a phase conductor and ground.

Power Factor (X/R) – As used in overcurrent protection, power factor is the relationship between the inductive reactance (X) and the resistance (R) in the system during a fault. Under normal conditions a system may be operating at a 0.85 power factor (85%). When a fault occurs, much of the system resistance is shorted out and the power factor may drop to 25% or less. This may cause the current to become asymmetrical. See definition of Symmetrical Current. The UL test circuits used to test fuses with interrupting ratings exceeding 10,000 amperes are required to have a power factor of 20% or less. Since the power factor of test circuits tends to vary during test procedures, actual test circuits are usually set to a 15% power factor. The resulting asymmetrical current has an rms value of 1.33 times the available symmetrical rms. The instantaneous peak current of the first peak after the fault is 2.309 times the available symmetrical rms.

PPE – An acronym for Personal Protective Equipment. It can include clothing, tools, and equipment.

Primary Rating (for CTs) – The current rating of the primary side of a current transformer. The first number in the ratio 500:5 is the primary rating. Under ideal conditions 500 A of primary current flow through the CT will produce 5 A of current out the secondary terminals.

Prohibited Approach Boundary – An approach boundary to protect personnel from shock. Work in this boundary is considered the same as making direct contact with an energized part. Only qualified persons are allowed to enter this boundary and they must use the proper PPE.

Prospective Current – See Available Short-Circuit Current.

Protection Boundaries – Boundaries established to protect personnel from electrical hazards.

Pulsing – Modulating the ground-fault current on a resistance grounded system using a contactor to short out part of the NGR elements (or to open one of two NGRs connected in parallel). Another version of pulsing is imposing a higher frequency signal on power lines and using a wand detector to locate the point of fault on a conductor.

QPL (Qualified Products List) – A list of approved fuses and holders that meet various Military specifications.

Qualified Person – A person who is trained, knowledgeable, and has demonstrated skills on the construction and operation of the equipment, and can recognize and avoid electrical hazards that may be encountered.

Rating – A designated limit of operating characteristics based on definite conditions such as current rating, voltage rating and interrupting rating.

Rectifier Fuse – See Semiconductor Fuse.

Rejection Feature – The physical characteristic(s) of a fuse block or fuse holder that prevents the insertion of a fuse unless it has the proper mating characteristics. This may be achieved through the use of slots, grooves, projections, or the actual physical dimensions of the fuse. This feature prevents the substitution of fuses of a Class or size other than the Class and size intended.

Relay – An electrical switch that opens and closes a contact (or contacts) under the control of another circuit. Typically an electromagnet.

Renewable Element (also Renewable Link) – A renewable fuse current-carrying component that is replaced to restore the fuse to a functional condition after the link opens due to an overcurrent condition.

Renewable Fuse – A fuse that may be readily restored to service by replacing the renewable element after operation.

Resistance-Grounded System – An electrical system in which the transformer or generator neutral is connected to ground through a current-limiting resistor. See Solidly Grounded System, Ungrounded System.

Restricted Approach Boundary – An approach boundary to protect personnel from shock. A boundary distance is established from an energized part based on system voltage. Only qualified persons are allowed in the boundary and they must use the proper PPE.

Selective Coordination (See *Figure 15*) – In a selectively coordinated system, only the protective device immediately on the line side of an overcurrent opens. Upstream protective devices remain closed. All other equipment remains in service, which simplifies the identification and location of overloaded

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equipment or short-circuits. For additional information, refer to the Selective Coordination pages of this Technical Application Guide.

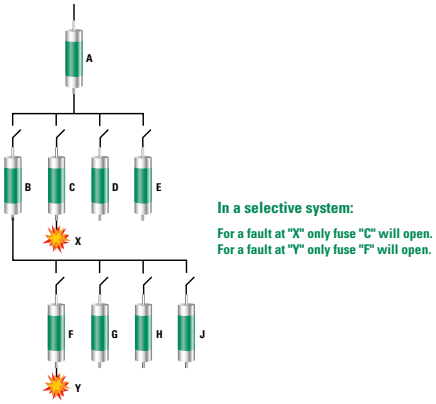


Figure 15 – Selective Coordination Example

Semiconductor Fuse – A fuse specifically designed to protect semiconductors such as silicon rectifiers, silicon-controlled rectifiers, thyristors, transistors, and similar components.

Sensitive Ground-Fault Protection – Protection designed to accurately detect extremely low ground-fault current levels without nuisance tripping.

Shock – A trauma subjected to the body by electrical current. When personnel come in contact with energized conductors, it can result in current flowing through their body often causing serious injury or death.

Short-Circuit (See *Figure 16*) – A current flowing outside its normal path, caused by a breakdown of insulation or by faulty equipment connections. In a short-circuit, current bypasses the normal load. Current is determined by the system impedance (AC resistance) rather than the load impedance. Short-circuit currents may vary from fractions of an ampere to 200,000 amperes or more.

Short-Circuit Current Rating (SCCR) – The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.

Short-Circuit Rating – The maximum RMS symmetrical short-circuit current at which a given piece of equipment has been tested under specified conditions, and which, at the end of the test is in essentially the same condition as prior to the test. Short-circuit ratings (also called withstand ratings) apply to equipment that will be subjected to fault currents, but which are not required to interrupt them. This includes switches, busway (bus duct), switchgear and switchboard structures, motor control centers and transformers.

Most short-circuit ratings are based on tests which last three complete electrical cycles (0.05 seconds). However, if the equipment is protected during the test by fuses or by a circuit breaker with instantaneous trips, the test duration is the time required for the overcurrent protective device to open the circuit.

When protected as such during testing, the equipment instructions and labels must indicate that the equipment shall be protected by a given fuse class and rating or by a specific make, type, and rating of circuit breaker. Circuit breakers equipped with short-delay trip elements instead of instantaneous trip elements have withstand (short-circuit) ratings in addition to their interrupting rating. The breaker must be able to withstand the available fault current during the time that opening is delayed.

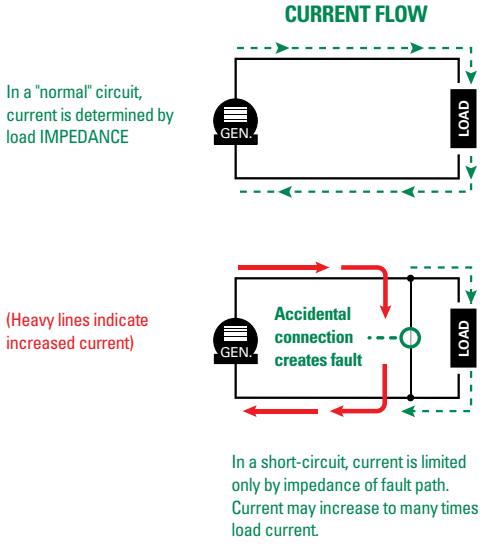


Figure 16 – Current Flow in Normal and Short Circuit Situations

Solidly Grounded System – An electrical system in which the neutral point of a wye connected supply transformer is connected directly to ground.

Symmetrical Current – The terms "Symmetrical Current" and "Asymmetrical Current" describe an AC wave symmetry around the zero axis. The current is symmetrical when the peak currents above and below the zero axis are equal in value, as shown in *Figure 17 (next page)*. If the peak currents are not equal, as shown in *Figure 18*, the current is considered asymmetrical. The degree of asymmetry during a fault is determined by the change in power factor (X/R) and the point in the voltage wave when the fault occurs. See definition of Power Factor. In general, lower short-circuit power factors increase the degree of asymmetry.

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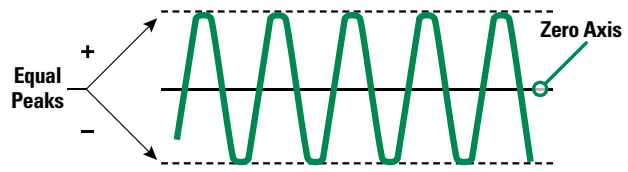


Figure 17 – Symmetrical Current

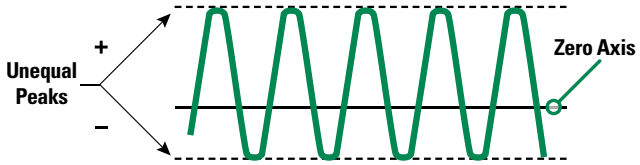


Figure 18 – Asymmetrical Current

Threshold Current – The minimum current for a given fuse size and type at which the fuse becomes current-limiting. It is the lowest value of available rms symmetrical current that will cause the device to begin opening within the first 1/4 cycle (90 electrical degrees) and completely clear the circuit within 1/2 cycle (180 electrical degrees). The approximate threshold current can be determined from the fuse's peak let-through charts. (See *Figure 19*.)

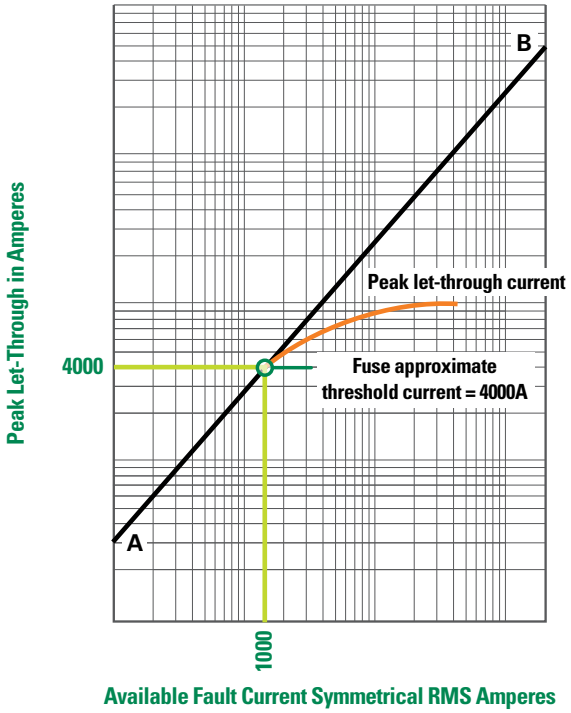


Figure 19 – Determining Threshold Current from Peak Let-through Chart

Threshold Ratio – Consists of the threshold current divided by the ampere rating of a specific type or class of overcurrent device. A fuse with a threshold ratio of 15 becomes current-limiting at 15 times its current rating.

Time-Delay Fuse – Fuses designed with an intentional, built-in delay in opening. When compared to fast-opening fuses, time-delay fuses have an increased opening time for overcurrents between approximately 200% and 600% of the fuse's current rating. Time-delay is indicated on the fuse label by "Time-Delay", "T-D", "D", or other suitable marking. Time-delay in the overload range (200%-600% of the fuse rating) permits the fuse to withstand system switching surges, motor starting currents, and other harmless temporary overcurrents.

UL Standards require time-delay Class H, K, RK1, RK5, and J fuses to hold 500% of their normal current rating for a minimum of 10 seconds. They must also pass the same opening time tests (135% and 200% of current rating) as fast acting fuses.

Time-delay Class CC, CD, G, Plug, and Miscellaneous fuses have different requirements. For more information, please refer to the corresponding descriptions provided in the Product Information Section.

For the UL Standard, Class L fuses have no standard time-delay. The time-delay varies from series to series for a given manufacturer, as well as from manufacturer to manufacturer. For reference, Littelfuse KLPC series POWR-PRO® fuses hold 500% of rated current for a minimum of 10 seconds.

Ungrounded System – An electrical system in which no point in the system is intentionally grounded. This was most common in process industries where continuity of service during a single-phase-to-ground-fault was required.

Unqualified Person – A person that does not possess all the skills and knowledge or has not been trained for a particular task.

Voltage Rating – The maximum rms AC voltage and/or the maximum DC voltage at which the fuse is designed to operate. For example, fuses rated 600 volts and below may be applied at any voltage less than their rating. There is no rule for applying AC fuses in DC circuits such as applying the fuse at half its AC voltage rating. Fuses used on DC circuits must have DC ratings.

Withstand Rating – See Short-Circuit.

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MOTOR PROTECTION TABLES

Selection of Class RK5 Fuses (FLNR_ID / FLSR_ID / IDSR Series) or POWR-PRO® Class RK1 Fuses (LLNRK / LLSRK / LLSRK_ID Series) Based on Motor Full Load Amps

Using AC Motor Protection Tables to Select Fuse Ratings

Time-delay RK1 and RK5 fuse ratings selected in accordance with the following recommendations also meet NEC® requirements for Motor Branch circuit and Short-Circuit Protection.

Selecting Fuses for Motor Running Protection Based on Motor Horsepower

Motor horsepower and motor Full Load Amperes (FLA) shown are taken from NEC® Tables 430.248 through 430.250 covering standard speed AC motors with normal torque characteristics. Fuse ratings for motors with special characteristics may need to vary from given values.

If motor running protection will be provided by the fuses, select fuse ratings for correct type of motor from Motor Protection Table Columns headed, "Without Overload Relays."

If overload relays will provide principal motor running protection, select fuse ratings for correct type of motor from Motor Protection Table Columns headed, "Back-up Running Protection" or "With Overload Relays." Fuse ratings selected from these columns coordinate with most UL Class 10 and 20 overload relays which covers over 90% of motor applications.

Selecting Fuses for Motor Running Protection Based on Motor Actual Full Load Currents

Better protection is achieved when fuse ratings are based on motor actual FLA obtained from motor nameplates. Locate motor nameplate FLA in the column appropriate for the type of motor and type of protection required. Then select the corresponding ampere rating of the fuse from the first column of that line.

TIME DELAY UL CLASS RK1 OR RK5 FUSE AMPERE RATING	MOTOR RUNNING PROTECTION (USED WITHOUT PROPERLY SIZED OVERLOAD RELAYS) MOTOR FULL-LOAD AMPS		BACK-UP MOTOR RUNNING PROTECTION (USED WITH PROPERLY SIZED OVERLOAD RELAYS) MOTOR FULL-LOAD AMPS	
	MOTOR SERVICE FACTOR OF 1.15 OR GREATER OR WITH TEMP. RISE NOT OVER 40°C.	MOTOR SERVICE FACTOR LESS THAN 1.15 OR WITH TEMP. RISE GREATER THAN 40°C.	MOTOR SERVICE FACTOR OF 1.15 OR GREATER OR WITH TEMP. RISE NOT OVER 40°C.	MOTOR SERVICE FACTOR LESS THAN 1.15 OR WITH TEMP. RISE GREATER THAN 40°C
1/10	0.08-0.09	0.09-0.10	0-0.08	0-0.09
1/8	0.10-0.11	0.11-0.125	0.09-0.10	0.10-0.11
15/100	0.12-0.15	0.14-0.15	0.11-0.12	0.12-0.13
2/10	0.16-0.19	0.18-0.20	0.13-0.16	0.14-0.17
1/4	0.20-0.23	0.22-0.25	0.17-0.20	0.18-0.22
3/10	0.24-0.30	0.27-0.30	0.21-0.24	0.23-0.26
4/10	0.32-0.39	0.35-0.40	0.25-0.32	0.27-0.35
1/2	0.40-0.47	0.44-0.50	0.33-0.40	0.36-0.43
6/10	0.48-0.60	0.53-0.60	0.41-0.48	0.44-0.52
8/10	0.64-0.79	0.70-0.80	0.49-0.64	0.53-0.70
1	0.80-0.89	0.87-0.97	0.65-0.80	0.71-0.87
1 1/8	0.90-0.99	0.98-1.08	0.81-0.90	0.88-0.98
1 1/4	1.00-1.11	1.09-1.21	0.91-1.00	0.99-1.09
1 4/10	1.12-1.19	1.22-1.30	1.01-1.12	1.10-1.22
1 1/2	1.20-1.27	1.31-1.39	1.13-1.20	1.23-1.30
1 6/10	1.28-1.43	1.40-1.56	1.21-1.28	1.31-1.39
1 8/10	1.44-1.59	1.57-1.73	1.29-1.44	1.40-1.57
2	1.60-1.79	1.74-1.95	1.45-1.60	1.58-1.74
2 1/4	1.80-1.99	1.96-2.17	1.61-1.80	1.75-1.96
2 1/2	2.00-2.23	2.18-2.43	1.81-2.00	1.97-2.17
2 8/10	2.24-2.39	2.44-2.60	2.01-2.24	2.18-2.43
3	2.40-2.55	2.61-2.78	2.25-2.40	2.44-2.60
3 2/10	2.56-2.79	2.79-3.04	2.41-2.56	2.61-2.78
3 1/2	2.80-3.19	3.05-3.47	2.57-2.80	2.79-3.04
4	3.20-3.59	3.48-3.91	2.81-3.20	3.05-3.48
4 1/2	3.60-3.99	3.92-4.34	3.21-3.60	3.49-3.91
5	4.00-4.47	4.35-4.86	3.61-4.00	3.92-4.35
5 6/10	4.48-4.79	4.87-5.21	4.01-4.48	4.36-4.87
6	4.80-4.99	5.22-5.43	4.49-4.80	4.88-5.22
6 1/4	5.00-5.59	5.44-6.08	4.81-5.00	5.23-5.43
7	5.60-5.99	6.09-6.52	5.01-5.60	5.44-6.09
7 1/2	6.00-6.39	6.53-6.95	5.61-6.00	6.10-6.52
8	6.40-7.19	6.96-7.82	6.01-6.40	6.53-6.96
9	7.20-7.99	7.83-8.69	6.41-7.20	6.97-7.83
10	8.00-9.59	8.70-10.00	7.21-8.00	7.84-8.70
12	9.60-11.99	10.44-12.00	8.01-9.60	8.71-10.43
15	12.00-13.99	13.05-15.00	9.61-12.00	10.44-13.04
17 1/2	14.00-15.99	15.22-17.39	12.01-14.00	13.05- 15.21
20	16.00-19.99	17.40-20.00	14.01-16.00	15.22-17.39
25	20.00-23.99	21.74-25.00	16.01-20.00	17.40-21.74
30	24.00-27.99	26.09-30.00	20.01-24.00	21.75-26.09
35	28.00-31.99	30.44-34.78	24.01-28.00	26.10-30.43
40	32.00-35.99	34.79-39.12	28.01-32.00	30.44-37.78
45	36.00-39.99	39.13-43.47	32.01-36.00	37.79-39.13
50	40.00-47.99	43.48-50.00	36.01-40.00	39.14-43.48
60	48.00-55.99	52.17-60.00	40.01-48.00	43.49-52.17
70	56.00-59.99	60.87-65.21	48.01-56.00	52.18-60.87
75	60.00-63.99	65.22-69.56	56.01-60.00	60.88-65.22
80	64.00-71.99	69.57-78.25	60.01-64.00	65.23-69.57
90	72.00-79.99	78.26-86.95	64.01-72.00	69.58-78.26
100	80.00-87.99	86.96-95.64	72.01-80.00	78.27-86.96
110	88.00-99.99	95.65-108.69	80.01-88.00	86.97-95.65
125	100.00-119.99	108.70-125.00	88.01-100.00	95.66-108.70
150	120.00-139.99	131.30-150.00	100.01-120.00	108.71-130.43
175	140.00-159.99	152.17-173.90	120.01-140.00	130.44-152.17
200	160.00-179.99	173.91-195.64	140.01-160.00	152.18-173.91
225	180.00-199.99	195.65-217.38	160.01-180.00	173.92-195.62
250	200.00-239.99	217.39-250.00	180.01-200.00	195.63-217.39
300	240.00-279.99	260.87-300.00	200.01-240.00	217.40-260.87
350	280.00-319.99	304.35-347.82	240.01-280.00	260.88-304.35
400	320.00-359.99	347.83-391.29	280.01-320.00	304.36-347.83
450	360.00-399.99	391.30-434.77	320.01-360.00	347.84-391.30
500	400.00-479.99	434.78-500.00	360.01-400.00	391.31-434.78
600	480.00-600.00	521.74-600.00	400.01-480.00	434.79-521.74



Motor Protection White Paper

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MOTOR PROTECTION TABLES

Selection of Class RK5 Fuses (FLNR_ID / FLSR_ID / IDSR Series) or POWR-PRO® Class RK1 Fuses (LLNRK / LLSRK / LLSRK_ID Series) Based on Motor Horsepower

MOTOR HP	FULL LOAD AMPS	WITHOUT OVERLOAD RELAYS		WITH OVERLOAD RELAYS		SWITCH OR FUSE CLIP RATING
		S.F. = 1.15 OR MORE, TEMP RISE NOT OVER 40°C	S.F. = LESS THAN 1.15 OR TEMP RISE MORE THAN 40°C	S.F. = 1.15 OR MORE, TEMP RISE NOT OVER 40°C	S.F. = LESS THAN 1.15 OR TEMP RISE MORE THAN 40°C	
120 VOLT 1-PHASE MOTORS (120V CIRCUIT)						
1/6	4.4	5	5	5 6/10	5 6/10	30
1/4	5.8	7	6 1/4	7 1/2	7	30
1/3	7.2	9	8	9	9	30
1/2	9.8	12	10	15	12	30
3/4	13.8	15	15	17 1/2	17 1/2	30
1	16	20	17 1/2	20	20	30
1 1/2	20	25	20	25	25	30
2	24	30	25	30	30	30
230 VOLT 1-PHASE MOTORS (240V CIRCUIT)						
1/6	2.2	2 1/2	2 1/2	2 8/10	2 8/10	30
1/4	2.9	3 1/2	3 2/10	4	3 1/2	30
1/3	3.6	4 1/2	4	4 1/2	4 1/2	30
1/2	4.9	5 6/10	5 6/10	6 1/4	6	30
3/4	6.9	8	7 1/2	9	8	30
1	8	10	9	10	10	30
1 1/2	10	12	10	15	12	30
2	12	15	12	15	15	30
3	17	20	17 1/2	25	20	30
5	28	35	30*	35	35	60
7 1/2	40	50	45	50	50	60
10	50	60	50	70	60	60
200 VOLT 3-PHASE MOTORS (208V CIRCUIT)						
1/2	2.5	3	2 8/10	3 2/10	3	30
3/4	3.7	4 1/2	4	5	4 1/2	30
1	4.8	6	5 6/10	6 1/4	6	30
1 1/2	6.9	8	7 1/2	7 1/2	8	30
2	7.8	9	8	10	9	30
3	11	12	12	15	15	30
5	17.5	20	20	25	25	30
7 1/2	25.3	30*	25*	35	30*	60
10	32.2	40	35	45	40	60
15	48.3	60	50	70†	60	60
20	62.1	75	70	80	75	100
25	78.2	90	80	100	90	100
30	92	110	100*	125	110	200
40	120	150	125	150	150	200
50	150	175	150	200	175	200
60	177	200*	200*	225	225	400
75	221	250	250	300	300	400
100	285	350	300	400	350	400
125	359	400*	400*	450	450	600
150	414	500	450	600	500	600
230 VOLT 3-PHASE MOTORS (240V CIRCUIT)						
1/2	2.2	2 8/10	2 1/2	2 8/10	2 8/10	30
3/4	3.2	4	3 1/2	4	4	30
1	4.2	5	4 1/2	5 6/10	5	30
1 1/2	6.0	7 1/2	6 1/4	7 1/2	7 1/2	30
2	6.8	8	7 1/2	9	8	30
3	9.6	12	10	12	12	30
5	15.2	17 1/2	17 1/2	20	17 1/2	30
7 1/2	22	25	25	30	30	30
10	28	35	30*	35	35	60
15	42	50	45	60	50	60
20	54	60*	60*	70	70	100
25	68	80	75	90	80	100
30	80	100	90	100	100	100
40	104	125	110	150	125	200
50	130	150	150	175	150	200
60	154	175	175	200	200	200
75	192	225	200*	250	225	400
100	248	300	250	350	300	400
125	312	350	350	400	400	400
150	360	450	400*	450	450	600
200	480	600	500	600	600	600

MOTOR HP	FULL LOAD AMPS	WITHOUT OVERLOAD RELAYS		WITH OVERLOAD RELAYS		SWITCH OR FUSE CLIP RATING
		S.F. = 1.15 OR MORE, TEMP RISE NOT OVER 40°C	S.F. = LESS THAN 1.15 OR TEMP RISE MORE THAN 40°C	S.F. = 1.15 OR MORE, TEMP RISE NOT OVER 40°C	S.F. = LESS THAN 1.15 OR TEMP RISE MORE THAN 40°C	
460 VOLT 3-PHASE MOTORS (480V CIRCUIT)						
1/2	1.1	1 4/10	1 1/4	1 4/10	1 4/10	30
3/4	1.6	2	1 8/10	2	2	30
1	2.1	2 1/2	2 1/4	2 8/10	2 1/2	30
1 1/2	3.0	3 1/2	3 2/10	4	3 1/2	30
2	3.4	4	3 1/2	4 1/2	4	30
3	4.8	5 6/10	5	6	5 6/10	30
5	7.6	9	8	10	9	30
7 1/2	11	12	12	15	15	30
10	14	17 1/2	15	17 1/2	17 1/2	30
15	21	25	20	30	25	30
20	27	30*	30*	35	35	60
25	34	40	35	45	40	60
30	40	50	45	50	50	60
40	54	60*	60*	70	60*	100
50	65	80	70	90	75	100
60	77	90	80	100	90	100
75	96	110	110	125	125	200
100	124	150	125	175	150	200
125	156	175	175	200	200	200
150	180	225	200*	225	225	400
200	240	300	250	300	300	400
575 VOLT 3-PHASE MOTORS (600V CIRCUIT)						
1/2	0.9	1 1/8	1	1 1/8	1 1/8	30
3/4	1.3	1 8/10	1 4/10	1 8/10	1 8/10	30
1	1.7	2	1 8/10	2 1/4	2	30
1 1/2	2.4	3	2 1/2	3	3	30
2	2.7	3 2/10	2 8/10	3 1/2	3 2/10	30
3	3.9	4 1/2	4	5	4 1/2	30
5	6.1	7 1/2	7	8	7 1/2	30
7 1/2	9	10	10	12	12	30
10	11	12	12	15	15	30
15	17	20	17 1/2	25	20	30
20	22	25	25	30	30	30
25	27	30*	30*	35	35	60
30	32	40	35	40	40	60
40	41	50	45	60	50	60
50	52	60	60	70†	60	60
60	62	75	70	80	75	100
75	77	90	80	100	90	100
100	99	110	110	125	125	200
125	125	150	125	175	150	200
150	144	175	150	200	175	200
200	192	225	200*	250	225	400

NOTES

S.F. = Motor Service Factor
* Fuse Reducers Required
† 100 Amp Switch Required



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MOTOR PROTECTION TABLES

Selection of POWR-PRO® Class J Fuses (JTD_ID / JTD Series) Based on Motor Full Load Amps

MOTOR F.L.A.	JTD_ID / JTD AMPERE RATING	MOTOR F.L.A.	JTD_ID / JTD AMPERE RATING	MOTOR F.L.A.	JTD_ID / JTD AMPERE RATING
0.00 – 0.60	8/10	12.1 – 14.5	17 1/2	76.1 – 84.0	110
0.61 – 0.80	1	14.6 – 17.0	20	84.1 – 90.0	125
0.81 – 1.00	1¼	17.1 – 21.0	25	90.1 – 102	150
1.01 – 1.20	1½	21.1 – 25.0	30	103 – 125	175
1.21 – 1.65	2	25.1 – 28.5	35	126 – 144	200
1.66 – 2.00	2½	28.6 – 34.0	40	145 – 162	225
2.01 – 2.40	3	34.1 – 37.0	45	163 – 180	250
2.41 – 3.30	4	37.1 – 41.0	50	181 – 204	300
3.31 – 4.10	5	41.1 – 48.0	60	205 – 240	350
4.11 – 4.90	6	48.1 – 52.0	70	241 – 288	400
4.91 – 6.40	8	52.1 – 59.0	80	289 – 312	450
6.41 – 8.00	10	59.1 – 66.0	90	313 – 360	500
8.01 – 9.80	12	66.1 – 76.0	100	361 – 432	600
9.81 – 12.0	15				

NOTE: For severe motor starting conditions, fuses may be sized up to 225% motor F.L.A. (See NEC® Article 430.52 for Exceptions)

Selection of CCMR Time-Delay Fuses Based on Motor Full Load Amps

MOTOR FULL LOAD CURRENT (F.L.A.)						CCMR AMPERE RATING
FOR MOTORS WITH AN ACCELERATION TIME OF 2 SECONDS OR LESS		FOR MOTORS WITH AN ACCELERATION TIME OF 5 SECONDS OR LESS		FOR MOTORS WITH AN ACCELERATION TIME OF 8 SECONDS OR LESS		
MIN. F.L.A. (1)	MAX F.L.A. (3)	MIN. F.L.A. (1)	MAX F.L.A. (3)	MIN F.L.A. (2)	MAX F.L.A. (3)	
0.2	0.2	0.2	0.2	0.2	0.2	3/10
0.3	0.4	0.3	0.4	0.3	0.3	½
0.4	0.6	0.4	0.5	0.4	0.5	8/10
0.5	0.7	0.5	0.6	0.5	0.6	1
0.6	1.0	0.6	0.9	0.6	0.8	1¼
0.8	1.1	0.8	1.0	0.7	0.9	1½
0.9	1.3	0.9	1.1	0.8	1.0	1 8/10
1.1	1.4	1.1	1.2	0.9	1.1	2
1.2	2.1	1.2	2.1	1.2	1.8	2½
1.5	2.6	1.5	2.6	1.4	2.3	3
1.8	3.0	1.8	3.0	1.6	2.6	3½
2.1	3.4	2.1	3.2	1.8	2.8	4
2.3	3.9	2.3	3.3	2.0	2.8	4½
2.6	4.3	2.6	3.4	2.3	2.8	5
2.9	4.8	2.9	3.7	2.5	3.1	5 6/10
3.3	5.2	3.3	4.0	2.7	3.4	6
3.5	5.4	3.5	4.1	2.8	3.5	6¼
3.6	5.7	3.6	4.2	3.2	3.7	7
4.1	5.8	4.1	4.3	3.4	3.8	7½
4.3	6.2	4.3	4.6	3.6	4.2	8
4.6	6.9	4.6	5.2	4.0	4.5	9
5.2	7.7	5.2	5.8	4.5	4.9	10
5.8	8.9	5.8	6.6	5.4	5.5	12
6.9	10.0	6.9	7.7	6.7	6.7	15
8.9	13.5	8.9	10.0	6.8	9.0	20
11.5	15.8	11.2 (2)	11.8	9.0	11.0	25
14.3	17.8	13.4 (2)	13.4	10.0	15.0	30
20.7	23.3	16.1	17.9	15.6	15.9	35
23.7	26.7	18.4	20.5	17.8	18.2	40
26.6	30.0	20.7	23.1	20.0	20.4	45
30.0	33.3	23.0	25.6	22.3	22.7	50
35.5	40.0	27.6	30.1	26.7	27.3	60

1 Based on NEC® requirement limiting the rating of time-delay fuses to 175% of motor F.L.A., or next higher rating.

2 Based on NEC® exception permitting fuse rating to be increased, but not to exceed, 225% motor F.L.A., however per NEC® Article 430.52 Class CC (0-30) fuses can now be sized up to 400% of motor F.L.A.

3 Based on Littelfuse CCMR time-delay characteristics.

NOTE: These values were calculated for motors with Locked Rotor Current (LRA), not exceeding the following values:

MOTOR F.L.A.	*LRA
0.00 – 1.00	850%
1.01 – 2.00	750%
2.01 – 10.0	650%
10.1 – 17.8	600%

*If motor LRA varies from these values, contact Littelfuse.

UL FUSE CLASSES AND SELECTION CHART

UL CLASS	LITTELFUSE SERIES	OVERLOAD CHARACTERISTICS	AC RATINGS			DC RATINGS			RECOMMENDED FUSE BLOCKS AND FUSE HOLDERS
			VOLTAGE (VOLTS)	CURRENT (AMPERES)	INTERRUPTING (AMPERES)	VOLTAGE (VOLTS)	CURRENT (AMPERES)	INTERRUPTING (AMPERES)	
L	KLPC	Time-Delay	600	200 - 6000	200K / 300K*	480	200 - 6000	20,000	–
	KLLU	Time-Delay	600	601 - 4000	200,000	300	601 - 4000	20,000	
	LDC	Fast-Acting	600	150 - 2000	200,000	600	150 - 2000	50,000	
RK1	LLNRK	Time-Delay	250	0.1 - 600	200K / 300K*	125	0.1 - 600	20,000	LFR25
	LLSRK_ID	Time-Delay	600	0.1 - 600		300	0.1 - 600		LFR60
	LLSRK	Time-Delay	600	0.1 - 600		300	0.1 - 600		LFR60
	KLNR	Fast-Acting	250	1 - 600	200,000	125	1 - 600		LFR25
	KLSR	Fast-Acting	600	1 - 600		250 300	1 - 30 35 - 600		LFR60
RK5	FLNR_ID	Time-Delay	250	35 - 600	200K / 300K*	125	35 - 600	20,000	LFR25
	FLNR		250	0.1 - 600		125	0.1 - 600		
	FLSR_ID		600	0.1 - 600		300	0.1 - 600		LFR60
	FLSR		600	0.1 - 600		300	0.1 - 600		
	IDSR		600	0.1 - 600		600	0.1 - 600		
J	JTD_ID	Time-Delay	600	0.8 - 600	200K / 300K*	300 500	0.8 - 100 110 - 600	20,000	LFJ60 • LFPSJ
	JTD	Time-Delay	600	0.8 - 600					
	JLS	Fast-Acting	600	1 - 600	200,000	–	–	–	
T	JLLN	Fast-Acting	300	1 - 1200	200,000	160 125	1 - 60 70 - 1200	20,000	LFT30 • LSCR002 (700-800A)
	JLLS		600	1 - 1200		300	1 - 1200		LFT60 • LSCR002 (700-800A)
CC	CCMR	Time-Delay	600	0.2 - 30	200K / 300K*	250 250 300 500	0.2 - 2 4.5 - 10 2.25 - 4 12 - 30	20,000	L60030C • LFPSC • LINK00_C • 571 • 572 • LEC • LEY
	KLDR	Time-Delay	600	0.1 - 30	200,000	300	0.1 - 30		
	KLKR	Fast-Acting	600	0.1 - 30	200,000	300	0.1 - 30		
CD	CCMR	Time-Delay	600	35 - 60	200K / 300K*	250	35 - 60	20,000	LFC60060
G	SLC	Time Lag	600 480	0.2 - 20 25 - 60	100,000	170	0.5 - 60	10,000	LFG480 (1 - 20A) LFG480 (25 - 60A)
Solar	SPF	Solar	–	–	–	1000	1 - 30	20,000	LFPHV
	SPFJ	Solar	–	–	–	1000	70 - 450	20K (70 - 200A) 10K (250 - 400A) 20K (400A)	LFJ1000
	SPFI	Solar	–	–	–	1000	2 - 20	20,000	Not Required
	SPXV	Solar	–	–	–	1500	6 - 30	30,000	LPXV
	SPXI	Solar	–	–	–	1500	2.5 - 3.5	15,000	Not Required
K5	NLN	Fast-Acting	250	1 - 600	50,000	250	1 - 600	20K (1 - 60A) 50K (70 - 600A)	LFH25
	NLS		600	1 - 600		600 500 400 600 500	1 - 7 8 - 30 35 - 60 70 - 200 225 - 600	20K (1 - 60A) 50K (70 - 600A)	LFH60
Semiconductor	L15S	Very Fast-Acting	150	1 - 1000	200,000	150 100	1 - 60 70 - 1000	20,000	LSCR • 1LS (except L70S)
	L25S		250	1 - 800		250 200	1 - 200 225 - 800		
	L50S		500	10 - 800		450	10 - 800		
	L60S		600	1 - 800		–	–		
	L70S		700	10 - 800		650	10 - 800		
Midget (Supplementary)	BLF	Fast-Acting	250 125	0.5 - 15 20 - 30	10,000	–	–	–	L60030M • LFPSM • LINK00_M • 571 • 572 • LEB • LEX
	BLN	Fast-Acting	250	1 - 30	10,000	–	–	–	
	BLS	Fast-Acting	600 250	0.2 - 5 6 - 10	10,000	–	–	–	
	FLA	Time-Delay	125	0.1 - 30	10,000	–	–	–	
	FLM	Time-Delay	250	0.1 - 30	10,000	125	0.1 - 30	10,000	
	FLQ	Time-Delay	500	0.1 - 30	10,000	300	0.1 - 30	10,000	
	KLK	Fast-Acting	600	0.1 - 30	100K / 200K*	500	0.1 - 30	50,000	
	KLKD	Fast-Acting	600	0.1 - 30	100,000	600	0.1 - 30	50,000	
	KLQ	Time-Delay	600	1 - 6	10,000	–	–	–	
	FLU	Fast-Acting	1000	0.44 11	10,000 20,000	1000	0.44 11	10,000 20,000	LFPHV
Plug	SOO, TOO	Time-Delay	125	0.25 - 30	10,000	–	–	–	Box Cover Units
	SLO, TLO	Medium Time-Delay	125	15 - 30	10,000	–	–	–	
Telecom	L17T	Fast-Acting	–	–	–	170	70 - 1200	100,000	LTFD Series
	TLN		–	–	–		1 - 600		LFR25
	TLS		–	–	–		1 - 125		LTFD101 • LFT30060 (cartridge)

* Series are UL Listed with I.R. of 200,000A and Littelfuse® self-certified with 300,000A I.R.

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CONDENSED CROSS REFERENCE

Power (Electrical) and Electronic Fuses

This cross reference covers the most popular fuses for which there is a similar Littelfuse standard item. Furnished for your convenience, it is meant to serve as a guide only for product selection. We suggest you check all applicable specifications before making substitutions. For special applications, more complete information, and for fuse block and medium voltage fuse cross referencing, visit **littelfuse.com** or call **1-800-TEC-FUSE (1-800-832-3873).**

COMPETITION	LITTELFUSE	COMPETITION	LITTELFUSE	COMPETITION	LITTELFUSE	COMPETITION	LITTELFUSE
10KOTN	**NLN**	CNQ	**FLQ**	KBH	**L50S**	NRN	**NLN**
10KOTS	**NLS**	CRN-R	**FLNR_ID**[3]	KLM	**KLKD**	NRN (15-60A)	**NLKP**
50KOTN	**NLN**	CRS-R	**FLSR_ID**	KLMR	**CCMR**	NRS	**NLS**
50KOTS	**NLS**	CSF13X	**L15S**	KLU	**KLLU or KLPC**	OT	**NLN**
A	**251**	CSF25X	**L25S (AC only)**	KN	**KLNR**	OTM	**BLF or BLN**
A013F	**L15S**	CSF50P	**L50S**	KON	**NLN**	OTN	**NLN**
A015F	**L15S**	CSF60C	**KLC (AC only)**	KOS	**NLS**	OTS	**NLS**
A015R	**L15S**	CSF60X	**L60S (AC only)**	KRPC (SP)	**KLPC**	REN	**FLNR or LLNRK**[5]
A025F	**L25S**	CSF70P	**L70S**	KRPC-L	**KLPC**	RES	**FLSR or LLSRK**[5]
A050F	**L50S**	CTN-R	**KLNR**	KS	**KLSR**	RF	**FLNR or LLNRK**[5]
A060F	**L60S**	CTS-R	**KLSR**	KTK	**KLK**	RFA	**L15S**
A060URL	**KLK**	EBS	**BLS**	KTKR	**KLKR**	RFC	**KLC**
A070F	**L70S**	ECNR	**FLNR_ID**[3]	KTNR	**KLNR**	RFL (750V)	**L70S (700 V)**
A13X	**L15S**	ECSR	**FLSR_ID**	KTSR	**KLSR**	RFN (Ferraz)	**FLNR or LLNRK**[5]
A25X	**L25S (AC only)**	ELN	**FLNR or LLNRK**[5]	KTU	**KLPC or LDC**	RFS (Ferraz)	**FLSR or LLSRK**[5]
A2D-R	**LLNRK**	ELS	**FLSR or LLSRK**[5]	L	**KLLU or KLPC**	RFV	**L50S**
A2K-R	**KLNR**	ERN	**FLNR or LLNRK**[5]	LCL	**KLPC or KLLU**	RHN	**KLNR**
A3T	**JLLN**	ERS	**FLSR or LLSRK**[5]	LCU	**KLPC or KLLU**	RHS	**KLSR**
A4BQ	**KLPC**	FNA	**FLA**	LENRK	**LLNRK**	RLN (Ferraz)	**FLNR or LLNRK**[5]
A4BT	**KLLU or KLPC**	FNB	**235**	LESRK	**LLSRK_ID**	RLS (Ferraz)	**FLSR or LLSRK**[5]
A4BY	**KLPC or KLLU**	FNM	**FLM**	LKN	**FLNR or LLNRK**[5]	S	**SOO**
A4J	**JLS**	FNQ	**FLQ**	LKS	**FLSR or LLSRK**[5]	SA	**SAO**
A50P (type 1 & 4)	**L50S**	FNQ-R	**KLDR**	LKU	**KLLU**	SC	**SLC**
A60X	**L60S**	FRN-R	**FLNR_ID**[3]	LONRK	**LLNRK**	SCLR	**KLSR**
A6D-R	**LLSRK_ID**[4]	FRS-R	**FLSR_ID**	LOSRK	**LLSRK_ID**	SEC	**SLC**
A6K-R	**KLSR**	FWA[2]	**L15S**	LPCC	**CCMR**	SF13X	**L15S**
A6T	**JLLS**	FWH[2]	**L50S**	LPJ (SP)	**JTD_ID**	SF25X	**L25S**
A70P	**L70S**	FWP[1]	**L70S**	LPNRK (SP)	**LLNRK**	SF50P	**L50S**
ACK	**CCK**	FWX[1]	**L25S**	LPSRK (SP)	**LLSRK_ID**[4]	SF60X	**L60S**
AG	**SLC**	GDA	**216**	MCL	**KLK**	SF70P	**L70S**
AGA	**AGA**	GDB	**217**	MDA	**326**	SFE	**SFE**
AGC	**312**	GDC	**218**	MDL	**313**	SL	**SLO**
AGU (1-30A)	**BLN**	GDL	**313**	MDQ	**313**	T	**TOO**
AGW	**AGW**	GEB	**LEB**	MDV	**315**	TJN	**JLLN**
AJT	**JTD_ID**	GEBN	**LET**	MDX	**313**	TJS	**JLLS**
ANL	**CNL**	GFA	**251**	MEN	**FLM**	TL	**TLO**
ANN	**CNN**	GFN	**FLA**	MEQ	**FLQ**	TR	**FLNR_ID**[3]
ATC	**ATO (257)**	GGC	**312**	MID	**FLA**	TRM	**FLM**
AT-DE	**FLNR_ID**[3]	GGM	**235**	MOF	**BLN**	TRN-R	**FLNR_ID**[3]
ATDR	**CCMR**	GLR	**LGR**	MOL	**BLF**	TRS	**FLSR_ID**
ATM (Ferraz)	**KLKD**	GMT	**481**	MTH	**312**	TRS-R	**FLSR_ID**[4]
ATMR	**KLKR**	HCLR	**KLKR**	NCLR	**KLNR**	XL25X	**L25S**
ATQ	**FLQ**	HCTR	**KLDR**	NON	**NLN**	XL50F	**L50S**[1]
ATQR	**KLDR**	HEB	**LEB**	NOS	**NLS**	XL70F	**L70S**[1]
AX	**481**	HET	**LET**				
BAF	**BLF**	HLR	**LHR**				
BAN	**BLN**	J	**JLS**				
BBS	**BLS**	JDL	**JTD_ID**				
CJ	**JLS**	JFL	**JLS**				
CJS	**JLS**	JHC	**JTD_ID**				
CLF	**KLPC or KLLU**	JJN	**JLLN**				
CLL	**KLLU or KLPC**	JJS	**JLLS**				
CLU	**KLLU or KLPC**	JKS	**JLS**				
CM	**BLF**	KAA	**L15S**				
CMF	**BLN**	KAB	**L25S**				
CNM	**FLM**	KAC	**KLC**				

1) Check specific mounting dimensions before substituting.
2) Check fuse characteristics and mounting dimensions for specific application before substituting.
3) For 1/10 - 30 amperes, order non-indicating FLNR series fuses.
4) Verify voltage for DC applications.
5) Littelfuse has discontinued Class H fuses and recommends upgrading to RK1 or RK5 Class fuses.

A fuse may be used in circuits where the fuse's voltage rating is equal to or greater than the circuit voltage, unless otherwise stated on the fuse. For example, the FLSR_ID indicating fuse has a voltage rating of 75-600 volts. This fuse can be used on 600 volts, 480 volts, 250 volts, 125 volts, or 75 volts. Never use a fuse in a circuit having a higher rated voltage than the fuse.

For more information, visit
littelfuse.com/TechnicalCenter

Additional technical information and application data for Littelfuse products can be found on **littelfuse.com**. For questions, contact our Technical Support Group **(800-TEC-FUSE)**. Specifications, descriptions and illustrative material in this literature are as accurate as known at the time of publication, but are subject to changes without notice. All data was compiled from public information available from manufacturers' manuals and datasheets.

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