

TERMS AND DEFINITIONS

Gross Automation 3680 N. 126th St., Brookfield, WI 53005 Toll-Free: 877-268-3700 sales@grossautomation.com www.littelfusesales.com

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.

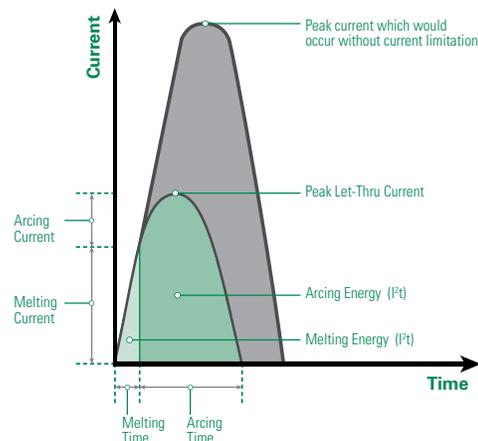


Figure 11 – Arcing and melting currents plus arcing, melting and clearing times

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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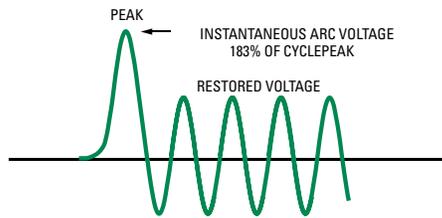


Figure 12 – Transient overvoltage during arcing time

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 I²t – See Ampere-Square-Seconds (I²t).

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.

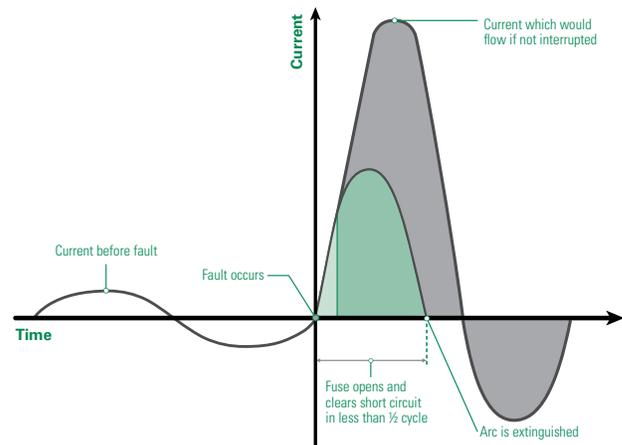


Figure 13 – Current-limiting Fuse

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.

I²t – See Ampere-Squared-Seconds (I²t).

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.

IECType 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/cm².

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 I²t – See Ampere-Squared-Seconds (I²t).

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.

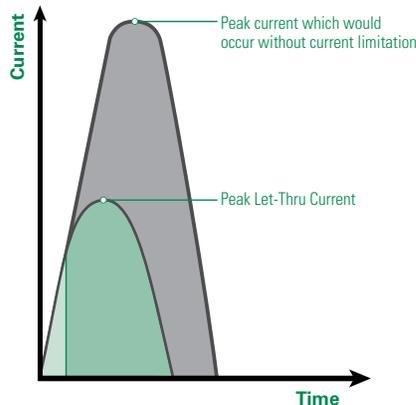


Figure 14 – Peak Let-through Current

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.

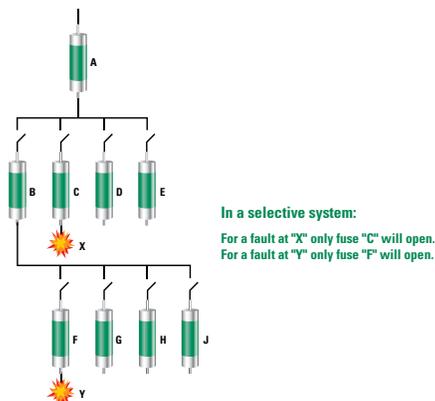


Figure 15 – Selective Coordination Example

Semiconductor Fuse – (Also known as High-Speed Fuses) 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.

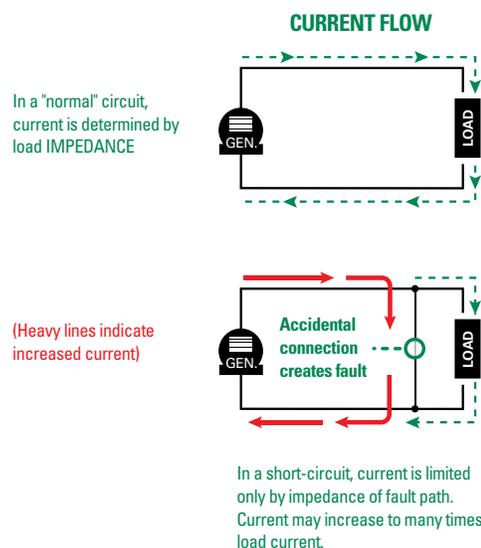


Figure 16 – Current Flow in Normal and Short Circuit Situations

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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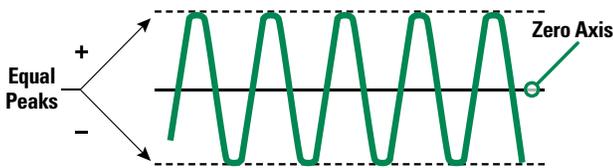


Figure 17 – Symmetrical Current

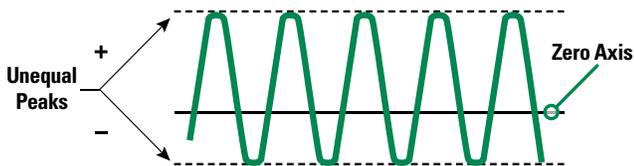


Figure 18 – Asymmetrical Current

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.)

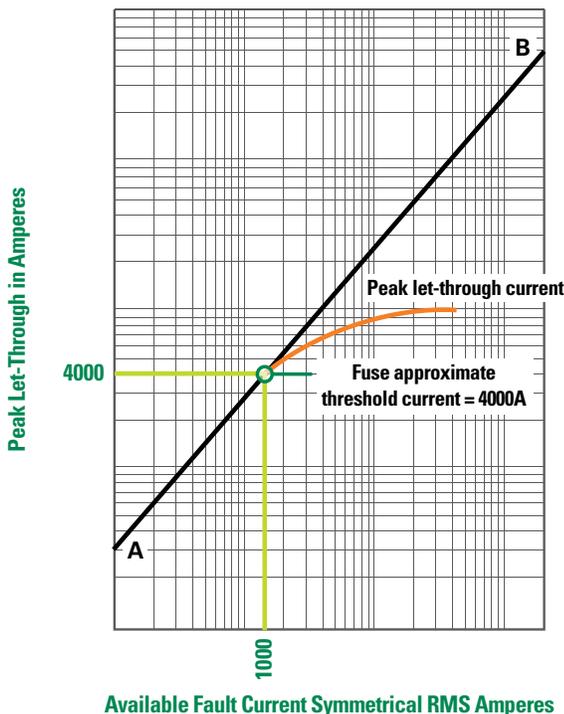


Figure 19 – Determining Threshold Current from Peak Let-through Chart

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.