# Cooper Bussmann Services & Application Guide

## Downtime Reduction, Workplace Safety & Code Compliance

**Services to Increase Your Productivity Through Protection**

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RED indicates NEW information

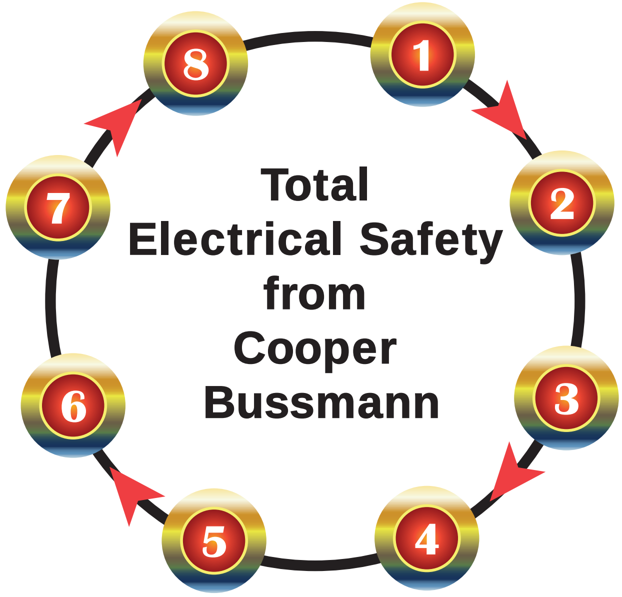
Services & Application Guide

# Engineering

**Arc-Flash Safety and Productivity**
The Cooper Bussmann® Services team has the experience in power system design, analysis and electrical safety to best assess and make recommendations that offer maximum protection and productivity. We go beyond just understanding electrical standards and regulations, actively participating in improving circuit protection and electrical safety.

Our comprehensive service offerings include:

1 - Electrical System One-Line Diagram Development
2 - Short-Circuit Current Analysis
3 - Overcurrent Protective Device Time-Current Curve Characteristic
4 - Overcurrent Protective Device Coordination Analysis
5 - Arc-Flash Hazard Analysis
6 - Arc-Flash Hazard Label Production
7 - Electrical Safety Training
8 - Annual Maintenance




**To Order:**
To find out more contact your local Cooper Bussmann representative, or visit us online at www.cooperbussmann.com/services.

| Engineering Catalog Numbers | | |
|---|---|---|
| **Description** | | **Catalog Number** |
| One Line Description Development | | CBSV-ES-EN1 |
| Data Collection | | CBSV-ES-EN2 |
| Short-Circuit Study | | CBSV-ES-EN3 |
| Selective Coordination Study | | CBSV-ES-EN4 |
| Arc-Flash Study | | CBSV-ES-EN5 |
| Labeling | | CBSV-ES-EN6 |
| Arc-Flash Training | | CBSV-ES-EN7 |
| Maintenace Plan for Arc-Flash Study | | CBSV-ES-EN8 |

COOPER Bussmann

# Engineering – OSCAR™ 2.0 Compliance Software

## Calculate Assembly SCCR with Ease & Confidence

### Enhanced Cooper Bussmann® OSCAR™ Software Speeds Code & Standards Compliance

The new Cooper Bussmann® OSCAR™ Version 2.0 SCCR (Short-Circuit Current Rating) compliance software easily guides you through entering your electrical panel's components and calculates an assembly SCCR. This award winning, online, essential design tool allows you to comply quickly and accurately with 2008 NEC® and UL 508A Supplement SB for assembly SCCR marking requirements:

- Industrial Control Panels [409.110]
- Industrial Machinery Electrical Panels [670.3(A)]
- HVAC Equipment [440.4(B)]

**New Project Management Features:**
- Simplify your panel design and project organization.
- Save and edit existing panel designs.
- Save multiple panels under a single project.
- Copy existing panels to new projects.

**New Intuitive Navigation:**
- Display your one-line diagram.
- Select from pre-loaded circuit templates.
- Identify the weakest link component automatically.
- Print reports and one-line diagrams for required SCCR documentation.
- Utilize mouse-over tips to enhance your design.

**Design with Confidence:**
- Logic updated to current UL requirements.
- Extensive 55,000+ component database.
- Search by partial part number or device rating.
- Custom device option allows for entering specialized component rating information.

**To Subscribe:**
Contact your local Cooper Bussmann distributor, or visit us online at www.cooperbussmann.com/oscar.

**Order Information**

| Description | Catalog Number |
|---|---|
| OSCAR™ 2.0 Compliance Software Annual Subscription | CBSV-SC-EN8 |

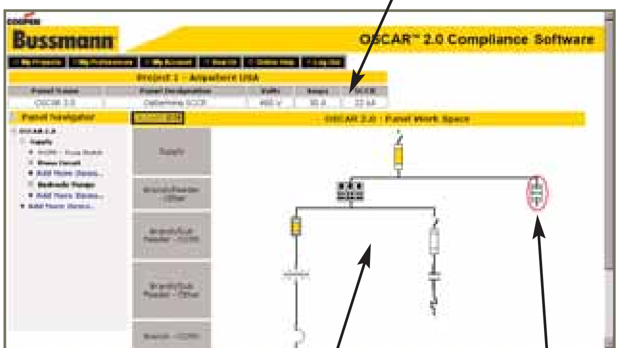
# Engineering – OSCAR™ 2.0 Compliance Software

## Cooper Bussmann® OSCAR™ 2.0 Software

The Cooper Bussmann OSCAR 2.0 Compliance Software is maintained online to provide you with the most current UL design standards, and to continuously update our product search database with new components and their individual ratings. This software is available 24/7—365 with a one-year subscription.

### New User Interface

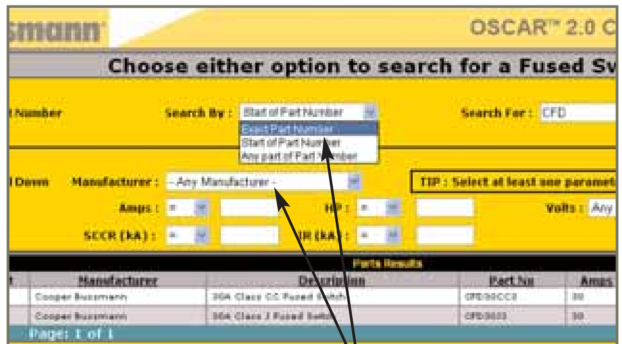
Displays Panel Information Including Assembly SCCR




Displays Actual One-Line Diagram

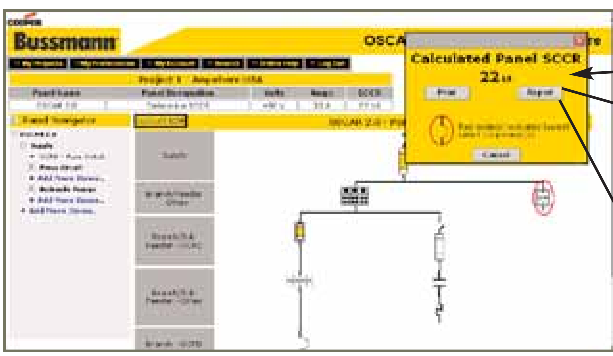
Red Circle Easily Identifies "Weakest Link" Component Limiting Assembly SCCR

### Easily Search the OSCAR Database to Aid in Design & Part Selection

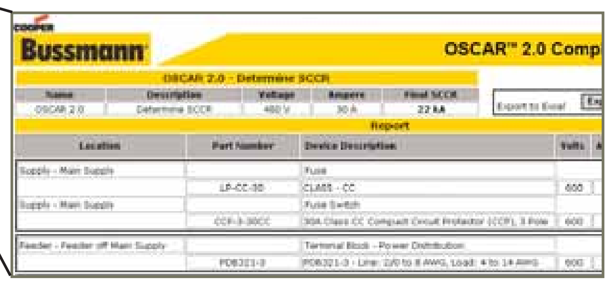



Drop-Down Menus Enhance Search Capabilities

### Improved Results & Documentation




Detailed Online Report or Print Option




**Additional Features:**

- Simplify your panel design and project organization with the **My Projects** feature.
- Copy existing designs to new projects.
- Display your one-line diagram as each component is added through the new build-a-circuit graphical interface.
- Save and edit existing panel designs.
- Save multiple panels under a single project.
- Select from pre-loaded templates of common circuit types for faster design development.
- Detect combination ratings automatically.
- Utilize mouse-over tips to enhance your design.

**Computer System Requirements:**

All calculating activity takes place on the Cooper Bussmann server. Your computer only needs to have sufficient band width access to the Internet and the minimum requirements listed below. Performance is optimized by utilizing Internet Explorer and a PC. Apple/Macintosh computers and other web browsers may compromise OSCAR 2.0 performance.

- Computer: Pentium 1 PC or equivalent
- Web Browser: Internet Explorer 5.5 with Java script and cookies enabled
- Internet Connection: ADSL minimum

# Training


## Knowledge That Minimizes Risk to Maximize Productivity and Protection

Technology evolves, the Code and standards change, and new personnel are joining your operation. How do you manage this changing environment while still focusing on what you do best – running your operation? Expert training from Cooper Bussmann is the solution. We provide the training when and where you need it. Cooper Bussmann can deliver our world-class safety and technical training on-site at your facility or ours.

**Training:**
To arrange a Cooper Bussmann® training seminar, contact your local Cooper Bussmann representative, or e-mail us at services@cooperbussmann.com.


**Publications and e-Training Modules**
Cooper Bussmann® Services has developed advanced, value-added technical resources to meet the more demanding needs around Code compliance, and electrical design and safety.

**How To Order:**
For detailed descriptions on this portfolio visit www.cooperbussmann.com/services. Hardcopy materials are available through your local Cooper Bussmann distributor.

| Training Catalog Numbers | | |
|---|---|---|
| **Description** | | **Catalog Number** |
| Designing Commercial & Industrial Power Systems | Per Person | CBSV-ES-ED1 |
| Understanding Short-Circuit Current Rating Basics | 1 Hour | CBTR-SC-1HP |
| Designing Panels with Higher SCCRs | 2 Hour | CBTR-SC-2HP |
| Understanding Electrical Safety Basics | 1 Hour | CBTR-ES-1HP |
| Electrical Hazards and Designing for Safety | 2 Hour | CBTR-ES-2HP |
| NFPA 70E Workplace Guidelines | 8 Hours (0.8 CEU) | CBTR-ES-1DA |
| Safety Basics User Kit | Hard Copy | CBSV-ES-ED3 |
| Safety Basics Trainer Kit | Hard Copy | CBSV-ES-ED4 |
| Safety Basics Video (VHS) | Hard Copy | CBSV-ES-ED5 |
| Safety Basics CD | Hard Copy | CBSV-ES-ED6 |
| Safety Basics Handbook | Hard Copy | CBPUB-ES-ED1H |
| Selecting Protective Devices (SPD) | Hard Copy | CBPUB-ES-ED2H |
| Electrical Plan Review (EPR) and Answer Sheet | Hard Copy | CBPUB-ES-ED3H |
| Interrupting Rating Overcurrent Protection DVD | Hard Copy | CBPUB-ES-ED30H |
| Selective Coordination: Preventing Blackouts DVD | Hard Copy | CBPUB-ES-ED31H |
| Current Limitation Overcurrent Protection DVD | Hard Copy | CBPUB-ES-ED32H |
| Motor Starter Protection: Overcurrent DVD | Hard Copy | CBPUB-ES-ED33H |
| Motor Protection DVD | Hard Copy | CBPUB-ES-ED34H |
| Specification Grade Protection DVD | Hard Copy | CBPUB-ES-ED35H |
| Overcurrent Protection 6 DVD Set | Hard Copy | CBPUB-ES-ED36H |

# Testing

## Performance and Compliance Certification for Components and Assemblies

The Cooper Bussmann® Paul P. Gubany Center for High Power Technology at Cooper Bussmann is the electrical industry's most comprehensive facility for testing and certifying electrical components and assemblies.

OEM customers make the Gubany Center their first choice in testing equipment such as:

- Drives, both AC and DC
- Circuit breakers
- Motor control centers
- Soft starters
- Fuses
- Power distribution panels
- Surge suppressors
- Cables

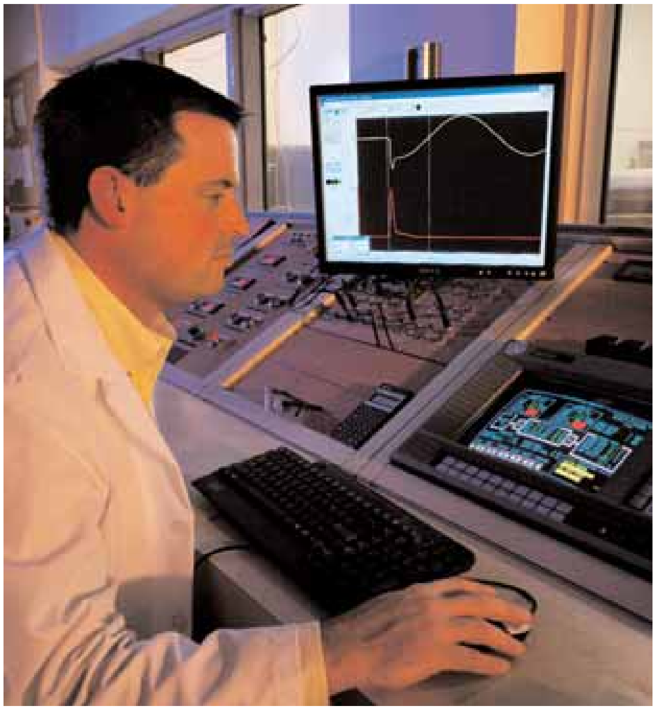
## Wide Range of Capability

Built to exceed the short circuit capacity of today's high power electrical distribution systems, the Gubany Center performs:

- Ultra-high power testing from 200kA to 300kA at 600Vac, three-phase
- Medium power testing from 5kA to 200kA at 600Vac, single- and three-phase; to 100kA at 1450Vac single-phase; to 100kA at 1000Vdc
- Low power testing up to 5kA at 600Vac, single-phase.

Our technicians conduct tests to many global agency standards including:

- ANCE
- ANSI
- CE
- CSA
- ETL
- IEC, and
- Underwriters Laboratories



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| Testing Catalog Numbers | | |
|---|---|---|
| **Description** | | **Catalog Number** |
| High Power Testing | Hourly Rate | CBSV-ES-TEHP |
| Medium Power Testing | Hourly Rate | CBSV-ES-TEMP |
| Low Power Testing | Hourly Rate | CBSV-ES-TELP |

# Custom Products

### Creating the Right Answers to Unique or Demanding Needs

When you wish to gain a competitive edge or improve your product's performance, have Cooper Busmann provide a custom product that can:

- Improve functionality and utility
- Fit unique design needs
- Reduce labor and component costs

### Our Expertise Is Your Advantage

For over 90 years, Cooper Bussmann has designed and manufactured products that improve electrical safety and performance. Whether it's modifying an existing product or creating a new one, our experience effectively brings together the skills to design, prototype, test, manufacture and secure agency approvals to deliver a single component, sub-assembly or finished product.

Cooper Busman can design and manufacture products that integrate:

- Fuses - with the right size and performance characteristics
- Fuse holders and blocks - with the requisite terminations, mounting options and safety features
- Wire connection products - that make wiring simpler, safer and faster
- Molded products - that give the unique shape your product needs
- Power distribution products - that meet prevailing agency and Code requirements

### In-House Testing

All electrical performance testing of your custom products can be performed at the Cooper Bussmann® Paul P. Gubany Center for High Power Technology, an ASTA and CSA accredited, and an ANCE Designated facility.

We're able to conduct electrical performance testing that replicates any power system to be encountered in any country, covering:

- Up to 300kA and 600Vac
- Up to 100kA and 1000Vdc

And our technicians conduct tests to many global agency standards including:

- ANCE
- ANSI
- CE
- CSA
- ETL
- IEC, and
- Underwriters Laboratories

### To Find Out More:

If you need a custom solution to a product problem, submit a Request for Quotation to your local authorized Cooper Bussmann distributor or sales representative.

# Fuse Technology

## Circuit Protection

The following is a basic introduction to overcurrent protection and fuse technology. In depth information on the selection and application of overcurrent protective devices is available in the Cooper Bussmann publication “Selecting Protective Devices” (SPD). This publication is available free of charge as a PDF download at www.cooperbussmann.com/spd.

Electrical distribution systems are often quite complicated. They cannot be absolutely fail-safe. Circuits are subject to destructive overcurrents. Harsh environments, general deterioration, accidental damage, damage from natural causes, excessive expansion, and/or overloading of the electrical distribution system are factors which contribute to the occurrence of such overcurrents. Reliable protective devices prevent or minimize costly damage to transformers, conductors, motors, and the other many components and loads that make up the complete distribution system. Reliable circuit protection is essential to avoid the severe monetary losses which can result from power blackouts and prolonged downtime of facilities. It is the need for reliable protection, safety, and freedom from fire hazards that has made the fuse a widely used protective device.

## Overcurrents

An overcurrent is either an overload current or a short-circuit current. The overload current is an excessive current relative to normal operating current, but one which is confined to the normal conductive paths provided by the conductors and other components and loads of the distribution system. As the name implies, a short-circuit current is one which flows outside the normal conducting paths.

## Overloads

Overloads are most often between one and six times the normal current level. Usually, they are caused by harmless temporary surge currents that occur when motors are started-up or transformers are energized. Such overload currents, or transients, are normal occurrences. Since they are of brief duration, any temperature rise is trivial and has no harmful effect on the circuit components. (It is important that protective devices do not react to them.)

Continuous overloads can result from defective motors (such as worn motor bearings), overloaded equipment, or too many loads on one circuit. Such sustained overloads are destructive and must be cut off by protective devices before they damage the distribution system or system loads. However, since they are of relatively low magnitude compared to short-circuit currents, removal of the overload current within minutes will generally prevent equipment damage. A sustained overload current results in overheating of conductors and other components and will cause deterioration of insulation, which may eventually result in severe damage and short-circuits if not interrupted.

## Short-Circuits

Whereas overload currents occur at rather modest levels, the short-circuit or fault current can be many hundred times larger than the normal operating current. A high level fault may be 50,000A (or larger). If not cut off within a matter of a few thousandths of a second, damage and destruction can become rampant—there can be severe insulation damage, melting of conductors, vaporization of metal, ionization of gases, arcing, and fires. Simultaneously, high level short-circuit currents can develop huge magnetic-field stresses. The magnetic forces between bus bars and other conductors can be many hundreds of pounds per linear foot; even heavy bracing may not be adequate to keep them from being warped or distorted beyond repair.

## Fuses

The fuse is a reliable overcurrent protective device. A “fusible” link or links encapsulated in a tube and connected to contact terminals comprise the fundamental elements of the basic fuse. Electrical resistance of the link is so low that it simply acts as a conductor. However, when destructive currents occur, the link very quickly melts and opens the circuit to protect conductors, and other circuit components and loads. Fuse characteristics are stable. Fuses do not require periodic maintenance or testing. Fuses have three unique performance characteristics:

1. *Modern fuses have an extremely “high interrupting rating”—can withstand very high fault currents without rupturing.*
2. *Properly applied, fuses prevent “blackouts.” Only the fuse nearest a fault opens without upstream fuses (feeders or mains) being affected—fuses thus provide “selective coordination.” (These terms are precisely defined in subsequent pages.)*
3. *Fuses provide optimum component protection by keeping fault currents to a low value…They are said to be “current limiting.”*

## Voltage Rating

The voltage rating of a fuse must be at least equal to or greater than the circuit voltage. It can be higher but never lower. For instance, a 600V fuse can be used in a 208V circuit.

The voltage rating of a fuse is a function of its capability to open a circuit under an overcurrent condition. Specifically, the voltage rating determines the ability of the fuse to suppress the internal arcing that occurs after a fuse link melts and an arc is produced. If a fuse is used with a voltage rating lower than the circuit voltage, arc suppression will be impaired and, under some fault current conditions, the fuse may not clear the overcurrent safely. Special consideration is necessary for semiconductor fuse and medium voltage fuse applications, where a fuse of a certain voltage rating is used on a lower voltage circuit.

## Amp Rating

Every fuse has a specific amp rating. In selecting the amp rating of a fuse, consideration must be given to the type of load and code requirements. The amp rating of a fuse normally should not exceed the current carrying capacity of the circuit. For instance, if a conductor is rated to carry 20A, a 20A fuse is the largest that should be used. However, there are some specific circumstances in which the amp rating is permitted to be greater than the current carrying capacity of the circuit.

# Fuse Technology

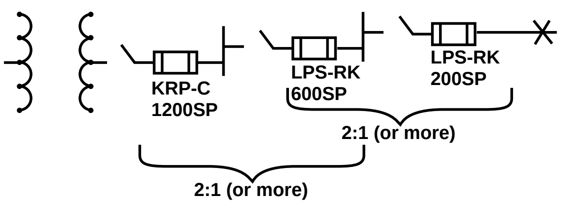
A typical example is the motor circuit; dual-element fuses generally are permitted to be sized up to 175% and non-time-delay fuses up to 300% of the motor full-load amps. As a rule, the amp rating of a fuse and switch combination should be selected at 125% of the continuous load current (this usually corresponds to the circuit capacity, which is also selected at 125% of the load current). There are exceptions, such as when the fuse-switch combination is approved for continuous operation at 100% of its rating.

### Interrupting Rating

A protective device must be able to withstand the destructive energy of short-circuit currents. If a fault current exceeds the capability of the protective device, the device may actually rupture, causing additional damage. Thus, it is important when applying a fuse or circuit breaker to use one which can sustain the largest potential short-circuit currents. The rating which defines the capacity of a protective device to maintain its integrity when reacting to fault currents is termed its "interrupting rating". The interrupting rating of most branch-circuit, molded case, circuit breakers typically used in residential service entrance panels is 10,000A. (Please note that a molded case circuit breaker's interrupting capacity will typically be lower than its interrupting rating.) Larger, more expensive circuit breakers may have interrupting ratings of 14,000A or higher. In contrast, most modern, current-limiting fuses have an interrupting rating of 200,000 or 300,000A and are commonly used to protect the lower rated circuit breakers. The National Electrical Code, Section 110-9, requires equipment intended to break current at fault levels to have an interrupting rating sufficient for the current that must be interrupted.

### Selective Coordination – Prevention of Blackouts

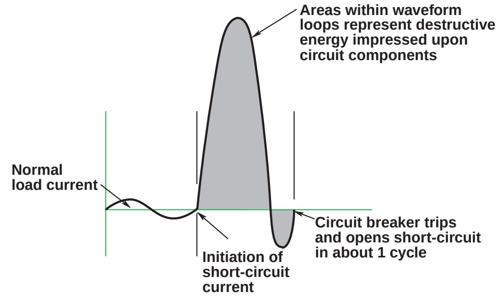
The coordination of protective devices prevents system power outages or blackouts caused by overcurrent conditions. When only the protective device nearest a faulted circuit opens and larger upstream fuses remain closed, the protective devices are "selectively" coordinated (they discriminate). The word "selective" is used to denote total coordination…isolation of a faulted circuit by the opening of only the localized protective device.



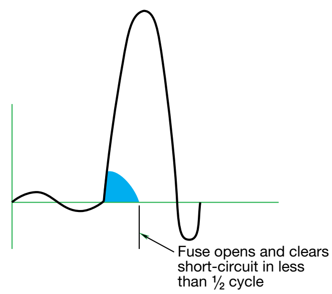

**This diagram shows the minimum ratios of amp ratings of Low-Peak Yellow fuses that are required to provide "selective coordination" (discrimination) of upstream and downstream fuses.**

Unlike electromechanical inertial devices (circuit breakers), it is a simple matter to selectively coordinate fuses of modern design. By maintaining a minimum ratio of fuse-amp ratings between an upstream and downstream fuse, selective coordination is assured.

### Current Limitation – Component Protection




A non-current-limiting protective device, by permitting a short-circuit current to build up to its full value, can let an immense amount of destructive short-circuit heat energy through before opening the circuit.




A current-limiting fuse has such a high speed of response that it cuts off a short-circuit long before it can build up to its full peak value.

If a protective device cuts off a short-circuit current in less than one-quarter cycle, before it reaches its total available (and highly destructive) value, the device is a "current-limiting" device. Most modern fuses are current-limiting. They restrict fault currents to such low values that a high degree of protection is given to circuit components against even very high short-circuit currents. They permit breakers with lower interrupting ratings to be used. They can reduce bracing of bus structures. They minimize the need of other components to have high short-circuit current "withstand" ratings. If not limited, short-circuit currents can reach levels of 30,000 or 40,000A or higher in the first half cycle (.008 seconds, 60Hz) after the start of a short-circuit. The heat that can be produced in circuit components by the immense energy of short-circuit currents can cause severe insulation damage or even explosion. At the same time, huge magnetic forces developed between conductors can crack insulators and distort and destroy bracing structures. Thus, it is important that a protective device limit fault currents before they reach their full potential level.

# Fuse Technology

## Operating Principles of Cooper Bussmann® Fuses

The principles of operation of the modern, current-limiting fuses are covered in the following paragraphs.

### Non-Time-Delay Fuses

The basic component of a fuse is the link. Depending upon the amp rating of the fuse, the single-element fuse may have one or more links. They are electrically connected to the end blades (or ferrules) (see Figure 1) and enclosed in a tube or cartridge surrounded by an arc quenching filler material. Cooper Bussmann® Limitron® and T-Tron® fuses are both single-element fuses.

Under normal operation, when the fuse is operating at or near its amp rating, it simply functions as a conductor. However, as illustrated in Figure 2, if an overload current occurs and persists for more than a short interval of time, the temperature of the link eventually reaches a level which causes a restricted segment of the link to melt. As a result, a gap is formed and an electric arc established. However, as the arc causes the link metal to burn back, the gap becomes progressively larger. Electrical resistance of the arc eventually reaches such a high level that the arc cannot be sustained and is extinguished. The fuse will have then completely cut off all current flow in the circuit. Suppression or quenching of the arc is accelerated by the filler material. (See Figure 3.)

Single-element fuses of present day design have a very high speed of response to overcurrents. They provide excellent short-circuit component protection. However, temporary, harmless overloads or surge currents may cause nuisance openings unless these fuses are oversized. They are best used, therefore, in circuits not subject to heavy transient surge currents and the temporary over-load of circuits with inductive loads such as motors, transformers, solenoids, etc. Because single-element, fast-acting fuses such as Limitron and T-Tron fuses have a high speed of response to short-circuit currents, they are particularly suited for the protection of circuit breakers with low interrupting ratings.

Whereas an overload current normally falls between one and six times normal current, short-circuit currents are quite high. The fuse may be subjected to short-circuit currents of 30,000 or 40kA or higher. Response of current limiting fuses to such currents is extremely fast. The restricted sections of the fuse link will simultaneously melt (within a matter of two or three-thousandths of a second in the event of a high-level fault current).

The high total resistance of the multiple arcs, together with the quenching effects of the filler particles, results in rapid arc suppression and clearing of the circuit. (Refer to Figures 4 & 5) Short-circuit current is cut off in less than a half-cycle, long before the short-circuit current can reach its full value (fuse operating in its current limiting range).

**Figure 1. Cutaway view of typical single-element fuse.**

**Figure 2. Under sustained overload, a section of the link melts and an arc is established.**

**Figure 3. The "open" single-element fuse after opening a circuit overload.**

**Figure 4. When subjected to a short-circuit current, several sections of the fuse link melt almost instantly.**

**Figure 5. The "open" single-element fuse after opening a short circuit.**

# Fuse Technology

## Cooper Bussmann® Dual-Element Fuses

There are many advantages to using these fuses. Unlike single-element fuses, the Cooper Bussmann® dual-element, time-delay fuses can be sized closer to provide both high performance short-circuit protection and reliable overload protection in circuits subject to temporary overloads and surge currents. For ac motor loads, a single-element fuse may need to be sized at 300% of an a.c. motor current in order to hold the starting current. However, dual-element, time delay fuses can be sized much closer to motor loads. For instance, it is generally possible to size Fusetron Dual-Element Fuses, FRS-R and FRN-R and Low-Peak® Dual-Element Fuses, LPS-RK_SP and LPN-RK_SP, at 125% and 130% of motor full load current, respectively. Generally, the Low-Peak Dual-Element Fuses, LPJ_SP, and CUBEFuse®, TCF, can be sized at 150% of motor full load amps. This closer fuse sizing may provide many advantages such as: (1) smaller fuse and block, holder or disconnect amp rating and physical size, (2) lower cost due to lower amp rated devices and possibly smaller required panel space, (3) better short-circuit protection – less short-circuit current let-through energy, and (4) potential reduction in the arc-flash hazard.

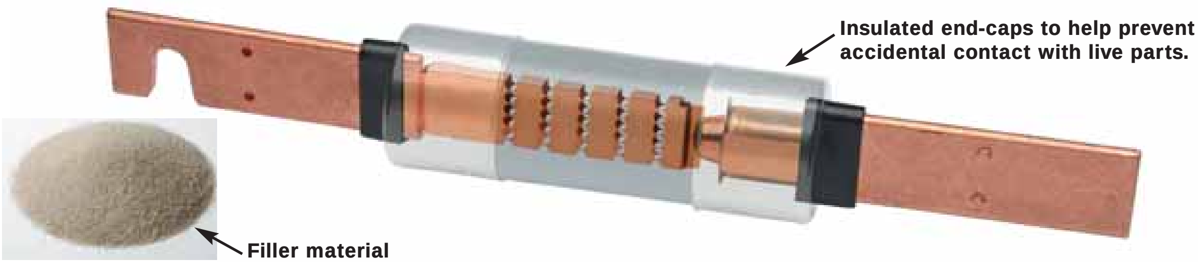



**Figure 6.** This is the LPS-RK100SP, a 100A, 600V Low-Peak, Class RK1, Dual-Element Fuse that has excellent time-delay, excellent current-limitation and a 300,000A interrupting rating. Artistic liberty is taken to illustrate the internal portion of this fuse. The real fuse has a non-transparent tube and special small granular, arc-quenching material completely filling the internal space.

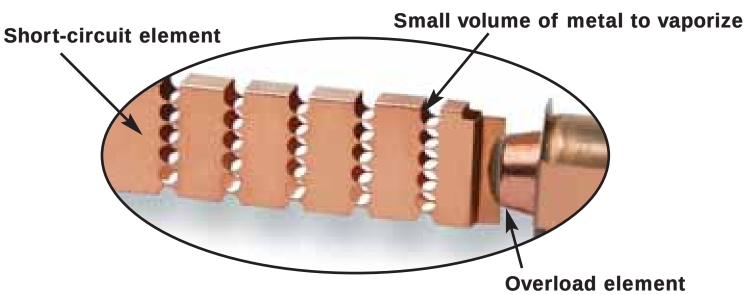



**Figure 7.** The true dual-element fuse has distinct and separate overload element and short-circuit element.

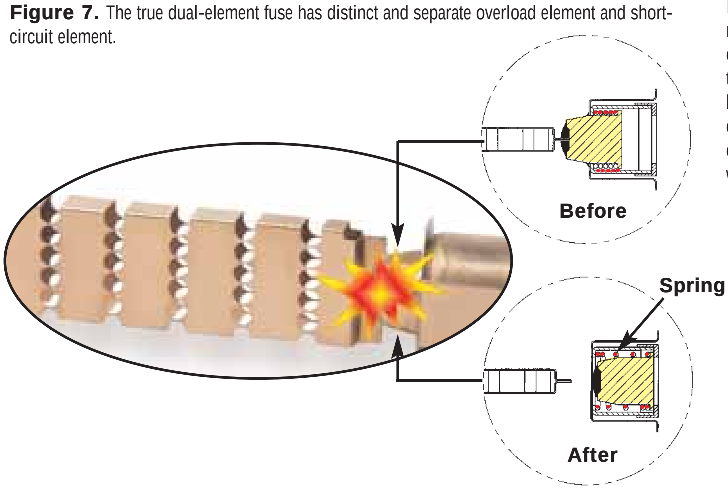



**Figure 8.** Overload operation: Under sustained overload conditions, the trigger spring fractures the calibrated fusing alloy and releases the "connector". The insets represent a model of the overload element before and after. The calibrated fusing alloy connecting the short-circuit element to the overload element fractures at a specific temperature due to a persistent overload current. The coiled spring pushes the connector from the short-circuit element and the circuit is interrupted.

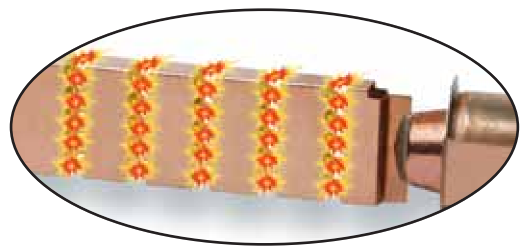


**Figure 9.** Short-circuit operation: Modern fuses are designed with minimum metal in the restricted portions which greatly enhance their ability to have excellent current-limiting characteristics – minimizing the short circuit let-through current. A short-circuit current causes the restricted portions of the short-circuit element to vaporize and arcing commences. The arcs burn back the element at the points of the arcing. Longer arcs result, which assist in reducing the current. Also, the special arc quenching filler material contributes to extinguishing the arcing current. Modern fuses have many restricted portions, which results in many small arclets – all working together to force the current to zero.

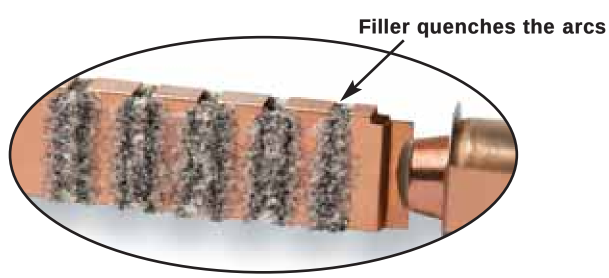



**Figure 10.** Short-circuit operation: The special small granular, arc-quenching material plays an important part in the interruption process. The filler assists in quenching the arcs; the filler material absorbs the thermal energy of the arcs, fuses together and creates an insulating barrier. This process helps in forcing the current to zero. Modern current-limiting fuses, under short-circuit conditions, can force the current to zero and complete the interruption within a few thousandths of a second.

When the short-circuit current is in the current-limiting range of a fuse, it is not possible for the full available short-circuit current to flow through the fuse – it's a matter of physics. The small restricted portions of the short-circuit element quickly vaporize and the filler material assists in forcing the current to zero. The fuse is able to "limit" the short-circuit current.

Overcurrent protection must be reliable and sure. Whether it is the first day of the electrical system or thirty or more years later, it is important that overcurrent protective devices perform under overload or short-circuit conditions as intended. Modern current-limiting fuses operate by very simple, reliable principles.

# Fuse Technology

### Fuse Time-Current Curves

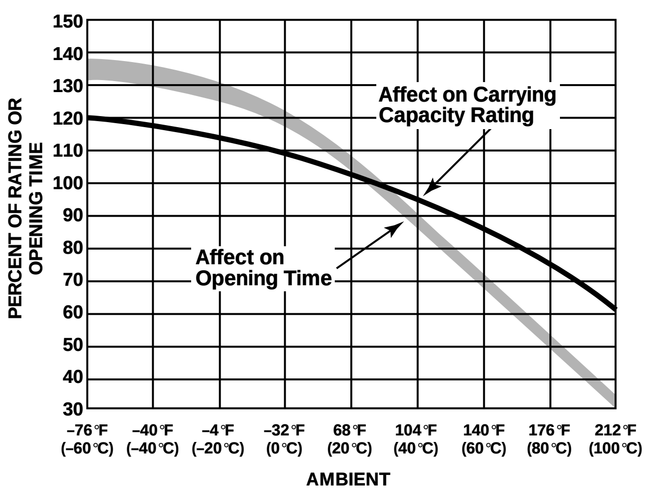
When a low level overcurrent occurs, a long interval of time will be required for a fuse to open (melt) and clear the fault. On the other hand, if the overcurrent is large, the fuse will open very quickly. The opening time is a function of the magnitude of the level of overcurrent. Overcurrent levels and the corresponding intervals of opening times are logarithmically plotted in graph form as shown to the right. Levels of overcurrent are scaled on the horizontal axis; time intervals on the vertical axis. The curve is thus called a “time-current” curve.

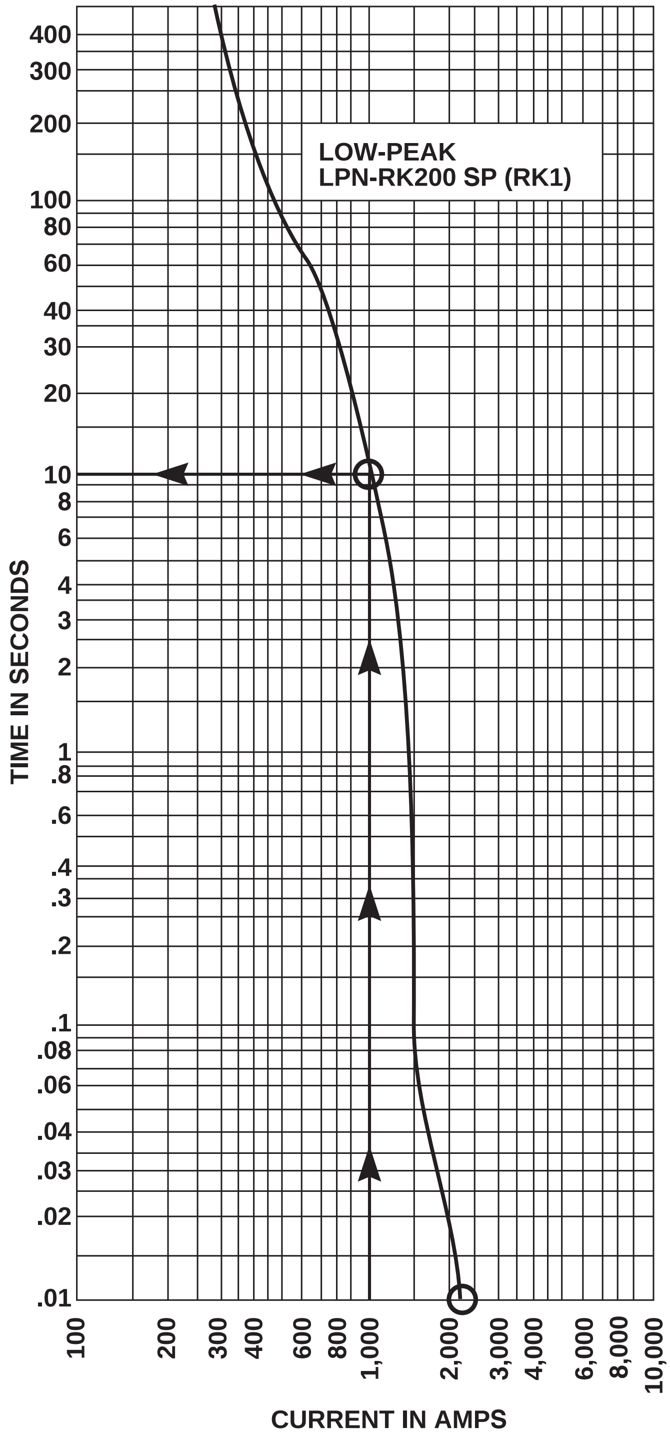
This particular plot reflects the characteristics of a 200A, 250V, Low-Peak® dual-element fuse. Note that at the 1,000A overload level, the time interval which is required for the fuse to open is 10 seconds. Yet, at approximately the 2,200A overcurrent level, the opening (melt) time of a fuse is only 0.01 seconds. It is apparent that the time intervals become shorter as the overcurrent levels become larger. This relationship is termed an inverse time-to-current characteristic. Time-current curves are published or are available on most commonly used fuses showing “minimum melt,” “average melt” and/or “total clear” characteristics. Although upstream and downstream fuses are easily coordinated by adhering to simple amp ratios, these time-current curves permit close or critical analysis of coordination.

### Better Motor Protection in Elevated Ambients

The derating of dual-element fuses based on increased ambient temperatures closely parallels the derating curve of motors in elevated ambient. This unique feature allows for optimum protection of motors, even in high temperatures.

Affect of ambient temperature on operating characteristics of Fusetron and Low-Peak dual-element fuses.



# Fuse Technology

### Better Protection Against Motor Single Phasing

When secondary single-phasing occurs, the current in the remaining phases increases to approximately 200% rated full load current. (Theoretically 173%, but change in efficiency and power factor make it about 200%.) When primary single-phasing occurs, unbalanced voltages occur on the motor circuit causing currents to rise to 115%, and 230% of normal running currents in delta-wye systems.

Dual-element fuses sized for motor running overload protection will help to protect motors against the possible damages of single-phasing.

### Classes of Fuses

Safety is the industry mandate. However, proper selection, overall functional performance and reliability of a product are factors which are not within the basic scope of listing agency activities. In order to develop its safety test procedures, listing agencies develop basic performance and physical specifications or standards for a product. In the case of fuses, these standards have culminated in the establishment of distinct classes of low-voltage (600V or less) fuses; Classes RK1, RK5, G, L, T, J, H and CC being the more important.

The fact that a particular type of fuse has, for instance, a classification of RK1, does not signify that it has the identical function or performance characteristics as other RK1 fuses. In fact, the Limitron® non-time-delay fuse and the Low-Peak dual-element, time-delay fuse are both classified as RK1. Substantial differences in these two RK1 fuses usually requires considerable difference in sizing. Dimensional specifications of each class of fuse does serve as a uniform standard.

### Class R Fuses

Class R ("R" for rejection) fuses are high performance, 1⁄10 to 600A units, 250V and 600V, having a high degree of current limitation and a short-circuit interrupting rating of up to 300kA (RMS Sym.). Cooper Bussmann® Class R fuses include Class RK1 Low-Peak® and Limitron® fuses, and RK5 Fusetron fuses. They have replaced the K1 Low-Peak and Limitron fuses and K5 Fusetron fuses. These fuses are identical, with the exception of a modification in the mounting configuration called a "rejection feature." This feature permits Class R fuses to be mounted in rejection type fuseclips. "R" type fuseclips prevent older type Class H, ONE-TIME and RENEWABLE fuses from being installed. The use of Class R fuse holders is thus an important safeguard. The application of Class R fuses in such equipment as disconnect switches permits the equipment to have a high interrupting rating. NEC® Articles 110-9 and 230-65 require that protective devices have adequate capacity to interrupt short-circuit currents. Article 240-60(b) requires fuse holders for current-limiting fuses to reject non-current-limiting type fuses.


In the above illustration, a grooved ring in one ferrule provides the rejection feature of the Class R fuse in contrast to the lower interrupting rating, non-rejection type.

### Branch-Circuit Listed Fuses

Branch-circuit listed fuses are designed to prevent the installation of fuses that cannot provide a comparable level of protection to equipment.

The characteristics of Branch-circuit fuses are:

1. They must have a minimum interrupting rating of 10kA
2. They must have a minimum voltage rating of 125V.
3. They must be size rejecting such that a fuse of a lower voltage rating cannot be installed in the circuit.
4. They must be size rejecting such that a fuse with a current rating higher than the fuse holder rating cannot be installed.

# Fuse Technology

## Supplementary Overcurrent Protective Devices for use in Motor Control Circuits

### Branch Circuit vs. Supplemental Overcurrent Protective Devices

Branch circuit overcurrent protective devices (OCPD) can be used everywhere OCPD are used, from protection of motors and motor circuits and group motor circuits, to protection of distribution and utilization equipment. Supplemental OCPD can only be used where proper protection is already being provided by a branch circuit device, by exception [i.e., 430.72(A)], or if protection is not required. Supplemental OCPD can often be used to protect motor control circuits but they cannot be used to protect motors or motor circuits. A very common misapplication is the use of a supplementary overcurrent protective device such as a UL 1077 mechanical overcurrent device for motor branch circuit short-circuit and ground fault protection. Supplementary OCPDs are incomplete in testing compared to devices that are evaluated for branch circuit protection. THIS IS A SERIOUS MISAPPLICATION AND SAFETY CONCERN!! Caution should be taken to assure that the proper overcurrent protective device is being used for the application at hand. Below is a description of popular supplementary overcurrent protective devices.

Most supplemental overcurrent protective devices have very low interrupting ratings. Just as any other overcurrent protective device, supplemental OCPDs must have an interrupting rating equal to or greater than the available short-circuit current.

### Supplemental fuses as listed or recognized to the UL/CSA/ANCE Trinational 248-14 Standard

These are fuses that can have many voltages and interrupting ratings within the same case size. Examples of supplemental fuses are 13⁄32" X 1 ½", 5 x 20mm, and ¼" x 1 ¼" fuses. Interrupting ratings range from 35 to 100,000 amps.

## Reliability and Maintenance of Overcurrent Protective Devices

Modern fuses have several significant advantages over mechanical overcurrent protective devices - one of those advantages is reliability. Whether the first day of the electrical system or years later, it is important that overcurrent protective devices perform under overload and fault conditions as intended.

Modern current-limiting fuses operate by very simple, reliable principles. Fuses do not have to be maintained. By their inherent design, fuses do not have elements or mechanisms to calibrate, adjust or lubricate. If and when fuses are called upon to open on an overcurrent, installing the same type and ampere rated fuses provides the circuit with new factory-calibrated protection. The original design integrity can be maintained throughout the life of the electrical system. One last point on fuse systems; the terminations, clips and disconnects should be maintained as necessary.

In contrast, circuit breakers are mechanical devices, even those with electronic sensing, and circuit breakers require periodic maintenance, testing, and if necessary reconditioning or replacement. This is required per the circuit breaker manufacturers' instructions, NFPA 70B Recommended Practice for Electrical Equipment Maintenance, and NEMA AB4. If circuit breakers are not properly maintained, the interrupting rating, circuit component protection, coordination, and electrical safety may be compromised.
See www.cooperbussmann.com for more information on Reliability and Maintenance.

# Motor Circuit Branch Circuit Protection

**Motor Circuits – Choice of Overcurrent Protection**

Motor circuits have unique characteristics and several functions, such as short-circuit protection, overload protection and automatic/ remote start/stop, that may be required. Sometimes the comment is made that users prefer circuit breakers because they can be reset. Let's examine the choice of either circuit breakers or current- limiting fuses for motor branch circuit protection.

In the case to be examined, fuses and circuit breakers (includes magnetic only circuit breakers which are called MCPs or motor circuit protectors) are sized with the intent to provide only short-circuit and ground fault protection for the motor branch circuit protection per 430.52. Other means, such as overload relays, provide the motor overload protection. Typical thermal magnetic circuit breakers can only be sized for motor branch circuit protection (typically 200% - 250% of motor current) because if they are sized closer, the motor starting current trips the circuit breaker's instantaneous mechanism. Magnetic only circuit breakers (MCPs) are intentionally not provided with overload capability; they only operate on short-circuit currents. There are some fuses such as the FRS-R and LPS-RK fuses that can be sized close enough for motor running overload protection or backup motor running protection. But for the discussion in this section, assume current-limiting fuses are sized only for motor short-circuit and ground fault protection.

It is important to note that in this protection level being discussed, a circuit breaker or fuses should only open if there is a fault on the motor circuit. A separate overload protective device, such as an overload relays, provides motor overload protection per 430.32. Here are some important considerations:

1. OSHA regulation 1910.334(b)(2) Use of Equipment states:

    *Reclosing circuits after protective device operation. After a circuit is deenergized by a circuit protective device, the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses is prohibited. NOTE: When it can be determined from the design of the circuit and the over-current devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is reenergized.*

    *So the speed of reclosing a circuit breaker after a fault is not an advantage. The law requires that if the condition is a fault (that is the only reason the circuit breaker or fuses should open on a motor circuit), then the fault must be corrected prior to replacing fuses or resetting the circuit breaker.*

2. *The typical level of short-circuit protection for the motor starter provided by circuit breakers and MCPs is referred to as Type 1. This is because most circuit breakers are not current-limiting. So, for a loadside fault, the starter may sustain significant damage such as severe welding of contacts and rupturing of the heater elements. Or the heater/overload relay system may lose calibration. This is an acceptable level of performance per UL 508, which is the product standard for motor starters. Current-limiting fuses can be selected that can provide Type 2 "No Damage" short-circuit protection for motor starters.*

    *Consequently, with circuit breaker protection, after a fault condition, significant downtime and cost may be incurred in repairing or replacing the starter. With properly selected fuses for Type 2 protection, after the fault is repaired, only new fuses need to be inserted in the circuit; the starter does not have to be repaired or replaced.*

3. *Circuit breakers must be periodically tested to verify they mechanical operate and electrically tested to verify they still are properly calibrated within specification. The circuit breaker manufacturers recommend this. Typically circuit breakers should be mechanically operated at least every year and electrically tested every 1 to 5 years, depending on the service conditions. Modern current-limiting fuses do not have to be maintained or electrically tested to verify they still will operate as intended. The terminations of both circuit breakers and fusible devices need to be periodically checked and maintained to prevent thermal damage. Plus fuse clips should be periodically inspected and if necessary maintained.*

4. *After a circuit breaker interrupts a fault, it may not be suitable for further service. UL 489, the product standard for molded case circuit breakers, only requires a circuit breaker to interrupt two short-circuit currents at its interrupting rating. Circuit breakers that are rated 100 amps or less do not have to operate after only one short-circuit operation under "bus bar" short-circuit conditions. If the fault current is high, circuit breaker manufacturers recommend that a circuit breaker should receive a thorough inspection with replacement, if necessary. How does one know a circuit breaker's service history or what level of fault current that a circuit breaker interrupts? With modern current-limiting fuses, if the fuse interrupts a fault, new factory calibrated fuses are installed in the circuit. The original level of superior short-circuit protection can be there for the life of the motor circuit.*

5. *After a fault, the electrician has to walk back to the storeroom to get new fuses; that is if spare fuses are not stored adjacent to the equipment. This does require some additional down time. However, if fuses opened under fault conditions, there is a fault condition that must be remedied. The electrician probably will be going back to the storeroom anyway for parts to repair the fault. If properly selected current-limiting fuses are used in the original circuit, the starter will not sustain any significant damage or loss of overload calibration.*

With circuit breaker protection on motor circuits, after a fault condition, it may be necessary to repair or replace the starter, so a trip to the storeroom may be necessary. And if the starter is not significantly damaged, it may still need to be tested to insure the let-through energy by the circuit breaker has not caused the loss of starter overload calibration. Also, the circuit breaker needs to be evaluated for suitability before placing it back into service. Who is qualified for that evaluation? How much time will that take?

In summary, resettability is not an important feature for motor branch circuit (short-circuit) protection and resettability of the branch circuit protective device is not a benefit for motor circuits. As a matter of fact, resettability of the motor branch circuit overcurrent protective device may encourage an unsafe practice. The function of motor branch circuit protection is fault protection: short-circuit and ground fault protection. Faults do not occur on a regular basis. But when a fault does occur, it is important to have the very best protection. The best motor branch circuit protection can be judged by (1) reliability - its ability to retain its calibration and speed of operation over its lifetime, (2) current-limiting protection - its ability to provide Type 2 "No Damage" protection to the motor starter, and (3) safety - its ability to meet a facility's safety needs. Modern current-limiting fuses are superior to circuit breakers for motor branch circuit protection.

# Glossary

### Ampere (Amp)

The measurement of intensity of rate of flow of electrons in an electric circuit. An ampere (amp) is the amount of current that will flow through a resistance of one ohm under a pressure of one volt. Ampere is often abbreviated as “A”.

### Amp Rating

The current-carrying capacity of a fuse. When a fuse is subjected to a current above its amp rating, it will open the circuit after a predetermined period of time.

### Amp Squared Seconds, $I^2t$

The measure of heat energy developed within a circuit during the fuse’s clearing. It can be expressed as “melting $I^2t$”, “arcing $I^2t$” or the sum of them as “Clearing $I^2t$”. “I” stands for effective let-through current (RMS), which is squared, and “t” stands for time of opening, in seconds.

### Arcing $I^2t$

Value of the $I^2t$ during the arcing time under specified conditions.

### Arcing Time

The amount of time from the instant the fuse link has melted until the overcurrent is interrupted, or cleared.

### Breaking Capacity

(See Interrupting Rating)

### Cartridge Fuse

A fuse consisting of a current responsive element inside a fuse tube with terminals on both ends.

### Class CC Fuses

600V, 200kA interrupting rating, branch circuit fuses with overall dimensions of 13⁄32” x 1½”. Their design incorporates a rejection feature that allows them to be inserted into rejection fuse holders and fuse blocks that reject all lower voltage, lower interrupting rating 13⁄32” x 1½” fuses. They are available from 1⁄10A through 30A.

### Class G Fuses

480V, 100kA interrupting rating branch circuit fuses that are size rejecting to eliminate overfusing. The fuse diameter is 13⁄32” while the length varies from 15⁄16” to 2¼”. These are available in ratings from 1A through 60A.

### Class H Fuses

250V and 600V, 10kA interrupting rating branch circuit fuses that may be renewable or non-renewable. These are available in amp ratings of 1A through 600A.

### Class J Fuses

These fuses are rated to interrupt a minimum of 200kA AC. They are labeled as “Current-Limiting”, are rated for 600Vac, and are not interchangeable with other classes.

### Class K Fuses

These are fuses listed as K-1, K-5, or K-9 fuses. Each subclass has designated $I^2t$ and Ip maximums. These are dimensionally the same as Class H fuses, and they can have interrupting ratings of 50k, 100k, or 200kA. These fuses are current-limiting. However, they are not marked “current-limiting” on their label since they do not have a rejection feature.

### Class L Fuses

These fuses are rated for 601 through 6000A, and are rated to interrupt a minimum of 200kA AC. They are labeled “Current-Limiting” and are rated for 600Vac. They are intended to be bolted into their mountings and are not normally used in clips. Some Class L fuses have designed in time-delay features for all purpose use.

### Class R Fuses

These are high performance fuses rated 1⁄10-600A in 250V and 600V ratings. All are marked “Current Limiting” on their label and all have a minimum of 200kA interrupting rating. They have identical outline dimensions with the Class H fuses but have a rejection feature which prevents the user from mounting a fuse of lesser capabilities (lower interrupting capacity) when used with special Class R Clips. Class R fuses will fit into either rejection or non-rejection clips.

### Class T Fuses

An industry class of fuses in 300V and 600V ratings from 1A through 1200A. They are physically very small and can be applied where space is at a premium. They are fast acting fuses with an interrupting rating of 200kA RMS.

### Classes of Fuses

The industry has developed basic physical specifications and electrical performance requirements for fuses with voltage ratings of 600V or less. These are known as standards. If a type of fuse meets the requirements of a standard, it can fall into that class. Typical classes are K, RK1, RK5, G, L, H, T, CC, and J.

### Clearing Time

The total time between the beginning of the overcurrent and the final opening of the circuit at rated voltage by an overcurrent protective device. Clearing time is the total of the melting time and the arcing time.

### Current Limitation

A fuse operation relating to short circuits only. When a fuse operates in its current-limiting range, it will clear a short circuit in less than ½ cycle. Also, it will limit the instantaneous peak let-through current to a value substantially less than that obtainable in the same circuit if that fuse were replaced with a solid conductor of equal impedance.

# Glossary

### Dual Element Fuse

Fuse with a special design that utilizes two individual elements in series inside the fuse tube. One element, the spring actuated trigger assembly, operates on overloads up to 5-6 times the fuse current rating. The other element, the short circuit section, operates on short circuits up to their interrupting rating.

### Electrical Load

That part of the electrical system which actually uses the energy or does the work required.

### Fast-Acting Fuse

A fuse which opens on overload and short circuits very quickly. This type of fuse is not designed to withstand temporary overload currents associated with some electrical loads.

### Fuse

An overcurrent protective device with a fusible link that operates and opens the circuit on an overcurrent condition.

### High Speed Fuses

Fuses with no intentional time-delay in the overload range and designed to open as quickly as possible in the short-circuit range. These fuses are often used to protect solid-state devices.

### Inductive Load

An electrical load which pulls a large amount of current—an inrush current—when first energized. After a few cycles or seconds the current "settles down" to the full-load running current.

### Interrupting Capacity

(See Interrupting Rating)

### Interrupting Rating — IR (Breaking Capacity)

The rating which defines a fuse's ability to *safely* interrupt and clear short circuits. This rating is much greater than the ampere rating of a fuse. The NEC® defines Interrupting Rating as "The highest current at rated voltage that an overcurrent protective device is intended to interrupt under standard test conditions."

### Melting $I^2t$

Value of the $I^2t$ during the melting time of the fuse link under specified conditions.

### Melting Time

The amount of time required to melt the fuse link during a specified overcurrent. (See Arcing Time and Clearing Time.)

### "NEC®" Dimensions

These are dimensions once referenced in the National Electrical Code. They are common to Class H and K fuses and provide interchangeability between manufacturers for fuses and fusible equipment of given ampere and voltage ratings.

### Ohm

The unit of measure for electric resistance. An ohm is the amount of resistance that will allow one ampere to flow under a pressure of one volt.

### Ohm's Law

The relationship between voltage, current, and resistance, expressed by the equation $E = IR$, where E is the voltage in volts, I is the current in amps, and R is the resistance in ohms.

### One Time Fuses

Generic term used to describe a Class H non-renewable cartridge fuse, with a single element.

### Overcurrent

A condition which exists on an electrical circuit when the normal load current is exceeded. Overcurrents take on two separate characteristics—overloads and short circuits.

### Overload

Can be classified as an overcurrent which exceeds the normal full load current of a circuit. Also characteristic of this type of overcurrent is that it does not leave the normal current carrying path of the circuit—that is, it flows from the source, through the conductors, through the load, back through the conductors, to the source again.

### Peak Let-Through Current, Ip

The instantaneous value of peak current let-through by a current-limiting fuse, when it operates in its current-limiting range.

### Renewable Fuse (600V & below)

A fuse in which the element, typically a zinc link, may be replaced after the fuse has opened, and then reused. Renewable fuses are made to Class H standards.

### Resistive Load

An electrical load which is characteristic of not having any significant inrush current. When a resistive load is energized, the current rises instantly to its steady-state value, without first rising to a higher value.

### RMS Current

The RMS (root-mean-square) value of any periodic current is equal to the value of the direct current which, flowing through a resistance, produces the same heating effect in the resistance as the periodic current does.

### SCCR

See Short-Circuit Current Rating

### Semiconductor Fuses

Fuses used to protect solid-state devices. See "High Speed Fuses."

### Short-Circuit

Can be classified as an overcurrent which exceeds the normal full load current of a circuit by a factor many times (tens, hundreds or thousands greater). Also characteristic of this type of overcurrent is that it leaves the normal current carrying path of the circuit—it takes a "short cut" around the load and back to the source.

### Short-Circuit Current Rating (SCCR)

The maximum short-circuit current an electrical component can sustain without the occurrence of excessive damage when protected with an overcurrent protective device.

### Short-Circuit Withstand Rating

Same definition as short-circuit rating.

# Glossary

### Single-Phasing

That condition which occurs when one-phase of a three-phase system opens, either in a low voltage (secondary) or high voltage (primary) distribution system. Primary or secondary single-phasing can be caused by any number of events. This condition results in unbalanced currents in polyphase motors and unless protective measures are taken, causes overheating and failure.

### Threshold Current

The symmetrical RMS available current at the threshold of the current-limiting range, where the fuse becomes current-limiting when tested to the industry standard. This value can be read off of a peak let-through chart where the fuse curve intersects the A-B line. A threshold ratio is the relationship of the threshold current to the fuse's continuous current rating.

### Time-Delay Fuse

A fuse with a built-in delay that allows temporary and harmless inrush currents to pass without opening, but is so designed to open on sustained overloads and short circuits.

### Total Clearing $I^2t$

Total measure of heat energy developed within a circuit during the fuse's clearing of a fault current. Total Clearing $I^2t$ is the sum of the melting $I^2t$ and arcing $I^2t$.

### Voltage Rating

The maximum open circuit voltage in which a fuse can be used, yet safely interrupt an overcurrent. Exceeding the voltage rating of a fuse impairs its ability to clear an overload or short circuit safely.

### Withstand Rating

The maximum current that an unprotected electrical component can sustain for a specified period of time without the occurrence of extensive damage.

## Out-of-Stock Substitution/Upgrades

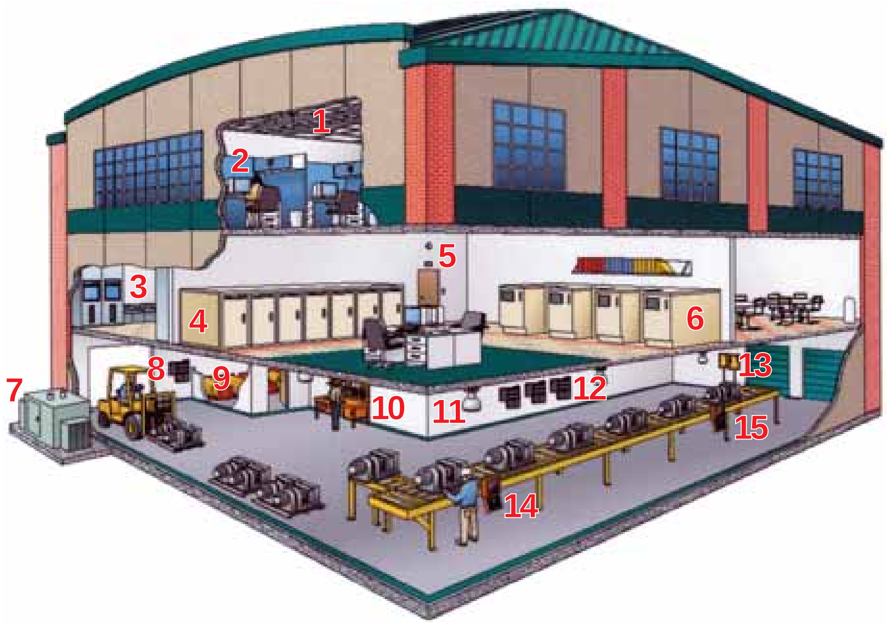
| Cooper Bussmann # | Upgrade # | Description | Data Sheet # |
|---|---|---|---|
| AGC-(AMP) | ABC-(AMP) | FAST-ACTING, ¼" X 1¼" FUSE | 2001 |
| AGC-V-(AMP) | ABC-V-(AMP) | FAST-ACTING, ¼" X 1¼" FUSE WITH LEADS | 2001 |
| AGU-(AMP) | LP-CC-(AMP) | FAST-ACTING, 13⁄32" X 1½" FUSE | 2008 |
| BAF-(AMP) | LP-CC-(AMP) | FAST-ACTING, 13⁄32" X 1½" FUSE | 2011 |
| BAN-(AMP) | LP-CC-(AMP) | FAST-ACTING, 13⁄32" X 1½" FUSE | 2046 |
| FNM-(AMP) | LP-CC-(AMP) | TIME-DELAY, 13⁄32" X 1½" FUSE | 2028 |
| FNQ-R-(AMP) | LP-CC-(AMP)* | TIME-DELAY, 500V, 13⁄32" X 1½" FUSE | 1012 |
| FNR-R-(AMP) | LPN-RK-(AMP)SP | TIME-DELAY, 250V, CLASS RK5 FUSES | 1019/1020 |
| FRS-R-(AMP) | LPS-RK-(AMP)SP | TIME-DELAY, 600V, CLASS RK5 FUSES | 1017/1018 |
| JKS-(AMP) | LPJ-(AMP)SP | FAST-ACTING, 600V, CLASS J FUSE | 1026/1027 |
| KLU-(AMP) | KRP-C-(AMP)SP | TIME-DELAY, CLASS L FUSE | 1013 |
| KTK-(AMP) | KTK-R-(AMP) | FAST-ACTING, 600V, 13⁄32" X 1½" FUSE | 1011 |
| KTK-R-(AMP) | LP-CC-(AMP) | FAST-ACTING, 600V, CLASS CC FUSE | 1015 |
| KTN-R-(AMP) | LPN-RK-(AMP)SP | FAST-ACTING, 250V, CLASS RK1 FUSE | 1043 |
| KTS-R-(AMP) | LPS-RK-(AMP)SP | FAST-ACTING, 600V, CLASS RK1 FUSE | 1044 |
| KTU-(AMP) | KPR-C-(AMP)SP | FAST-ACTING, 600V, CLASS L FUSE | 1010 |
| MDL-(AMP) | MDA-(AMP) | TIME-DELAY, ¼" X 1¼" FUSE | 2004 |
| MDL-V-(AMP) | MDA-V-(AMP) | TIME-DELAY, ¼" X 1¼" FUSE WITH LEADS | 2004 |
| MTH-(AMP) | ABC-(AMP) | FAST-ACTING, ¼" X 1¼" FUSE | |
| NON-(AMP) | LPN-RK-(AMP)SP | GENERAL PURPOSE, 250V, CLASS H FUSES | 1030 |
| NOS-(AMP) | LPS-RK-(AMP)SP | GENERAL PURPOSE, 600V, CLASS H FUSES | 1030 |
| REN-(AMP) | LPN-RK-(AMP)SP | 250V RENEWABLE FUSELINK | 1028 |
| RES-(AMP) | LPS-RK-(AMP)SP | 600V RENEWABLE FUSELINK | 1028 |
| SL-(AMP) | S-(AMP) | TIME-DELAY, 125V, PLUG FUSE | 1033 |
| TL-(AMP) | T-(AMP) | TIME-DELAY, 125V, PLUG FUSE | 1035 |
| W-(AMP) | TL-(AMP) | TIME-DELAY, 125V, PLUG FUSE | 1035 |

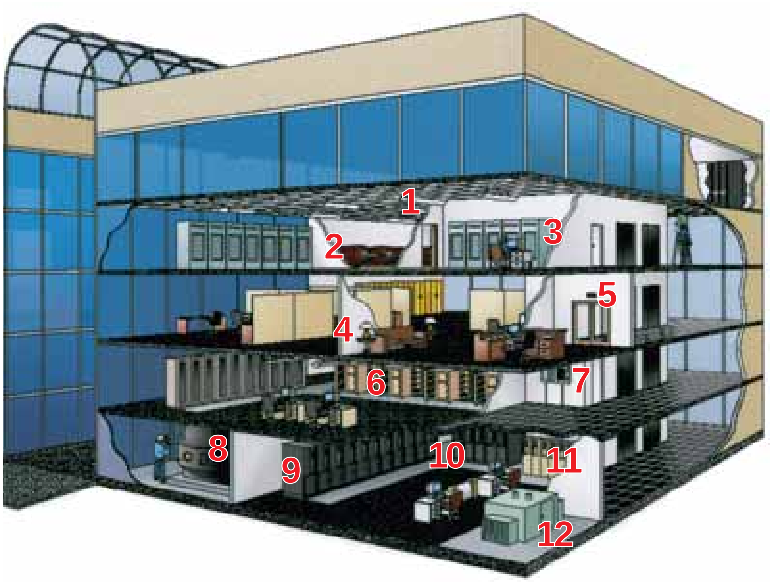
*Not recommended for control transformer circuits.

# Industrial Fuse Applications

## Industrial Applications

1. Interior Lighting
2. Computer Power
3. Switchboards
4. Motor Control Center
5. Emergency Lighting
6. UPS Backup Power Supplies
7. Transformer/Emergency Generator
8. Forklift Battery Charging Station
9. HVAC Chillers/Blowers
10. Welding Circuits
11. Plant Lighting
12. Distribution Panels
13. Disconnect Switches
14. Programmable Logic Circuits
15. Conveyor System





## Commercial Applications

1. Interior Lighting
2. HVAC Blowers
3. Computer Power
4. Branch Circuits
5. Emergency Lighting
6. Load Centers
7. Disconnect/Distribution Panels
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