Dual-Element, Time-Delay Fuse Operation

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 AC 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.

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.

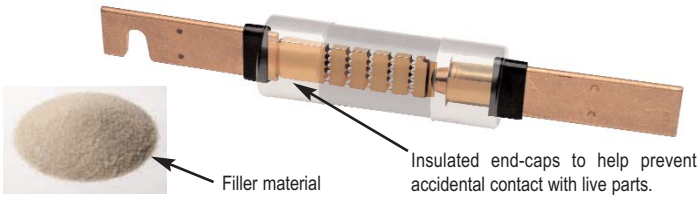


Figure 6. *This is the LPS-RK100SP, a 100A, 600V Low-Peak, Class RK1, dual-element fuse that has excellent time-delay, excellent current-limitation and a 300,000A interrupting rating. Artistic liberty is taken to illustrate the internal portion of this fuse. The real fuse has a non-transparent tube and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

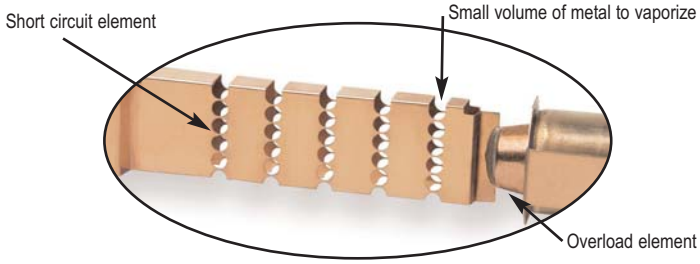


Figure 7. *The true dual-element fuse has distinct and separate overload element and short circuit element.*

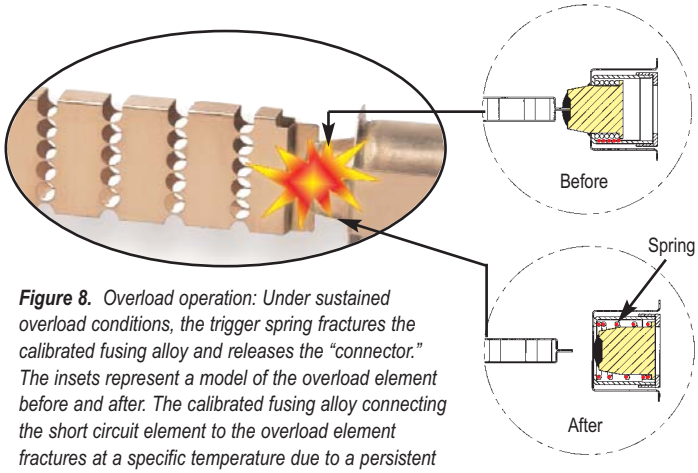


Figure 8. *Overload operation: Under sustained overload conditions, the trigger spring fractures the calibrated fusing alloy and releases the "connector." The insets represent a model of the overload element before and after. The calibrated fusing alloy connecting the short circuit element to the overload 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.*

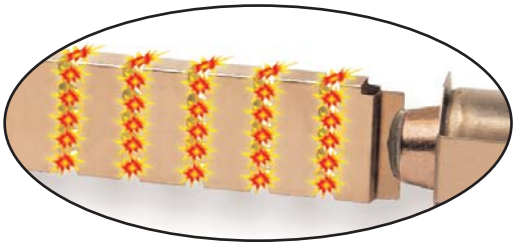


Figure 9. *Short circuit operation: Modern fuses are designed with minimum metal in the restricted portions which greatly enhance their ability to have excellent current-limiting characteristics – minimizing the short circuit let-through current. A short-circuit current causes the restricted portions 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.*

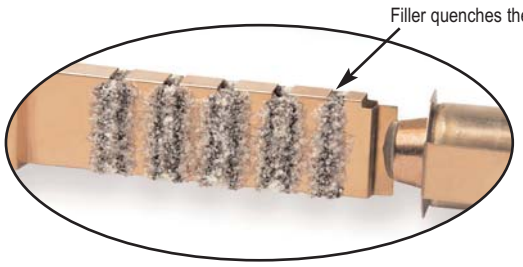


Figure 10. *Short circuit operation: The special small granular, arc-quenching material plays an important part in the interruption process. The filler assists in quenching the arcs; the filler material absorbs the thermal energy of the arcs, fuses together and creates an insulating barrier. This process 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.*

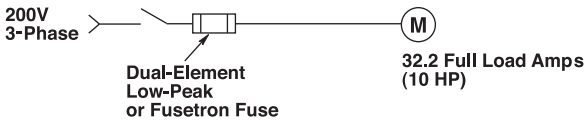
Dual-Element Fuse Benefits

Advantages of Cooper Bussmann Dual-Element, Time-Delay Fuses

Cooper Bussmann dual-element, time-delay fuses have four distinct advantages over single-element, non-time-delay fuses:

1. Provide motor overload, ground fault and short circuit protection.
2. Permit the use of smaller and less costly switches.
3. Give a higher degree of short circuit protection (greater current limitation) in circuits in which surge currents or temporary overloads occur.
4. Simplify and improve blackout prevention (selective coordination).

Motor Overload and Short Circuit Protection



When used in circuits with surge currents such as those caused by motors, transformers, and other inductive components, the Cooper Bussmann Low-Peak and Fusetron dual-element, time-delay fuses can be sized close to full-load amps to give maximum overcurrent protection. Sized properly, they will hold until surges and normal, temporary overloads subside. Take, for example, a 10 HP, 200 volt, three-phase motor with a full-load current rating of 32.2A.

Fuse and Switch Sizing for 10 HP Motor (200V, 3Ø, 32.2 FLA)

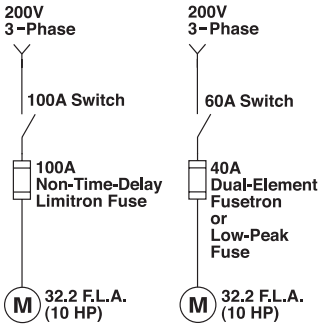
*Fuse Type	Maximum Fuse Size (Amps)	Required Switch Size (Amps)
Dual-Element, Time-Delay (Low-Peak LPS-RK_SP or LPN-RK_SP or Fusetron FRS-R or FRN-R)	40A*	60A
Single-Element, Non-Time-Delay (Limitron)	100A†	100A

*Per NEC® 430.32.
†Per NEC® 430.52.

The preceding table shows that a 40A, dual-element fuse will protect the 32.2A motor, compared to the much larger, 100A, single-element fuse that would be necessary. It is apparent that if a sustained, harmful overload of 200% occurred in the motor circuit, the 100A, single-element fuse would never open and the motor could be damaged. The non-time-delay fuse, thus, only provides ground fault and short-circuit protection, requiring separate overload protection per the NEC®. In contrast, the 40A dual-element fuse provides ground fault, short circuit and overload protection. The motor would be protected against overloads due to stalling, overloading, worn bearings, improper voltage, single-phasing, etc.

In normal installations, Cooper Bussmann dual-element fuses of motor-running, overload protection size, provide better short circuit protection plus a high degree of back up protection against motor burnout from overload or single-phasing should other overload protective devices fail. If thermal overloads, relays, or contacts should fail to operate, the dual-element fuses will act independently and thus provide “back-up” protection for the motor.

When secondary single-phasing occurs, the current in the remaining phases increases to a value of 173% to 200% of rated full-load current. When primary single-phasing occurs, unbalanced voltages that occur in the motor circuit also cause excessive current. Dual-element fuses sized for motor overload protection can help protect motors against the overload damage caused by single-phasing. See the section “Motor Protection–Voltage Unbalance/Single-Phasing” for discussion of motor operation during single-phasing.



Permit the Use of Smaller and Less Costly Switches

Aside from only providing short-circuit protection, the single-element fuse also makes it necessary to use larger size switches since a switch rating must be equal to or larger than the amp rating of the fuse. As a result, the larger switch may cost two or three times more than would be necessary were a dual-element Low-Peak or Fusetron fuse used. The larger, single-element fuse itself could generate an additional cost. Again, the smaller size switch that can be used with a dual-element fuse saves space and money. (Note: where larger switches already are installed, fuse reducers can be used so that fuses can be sized for motor overload or back-up protection.)

Better Short Circuit Component Protection (Current-Limitation)

The non-time-delay, fast-acting fuse must be oversized in circuits in which surge or temporary overload currents occur. Response of the oversized fuse to short-circuit currents is slower. Current builds up to a higher level before the fuse opens…the current-limiting action of the oversized fuse is thus less than a fuse whose amp rating is closer to the normal full-load current of the circuit. Therefore, oversizing sacrifices some component protection.

Dual-Element Fuse Benefits

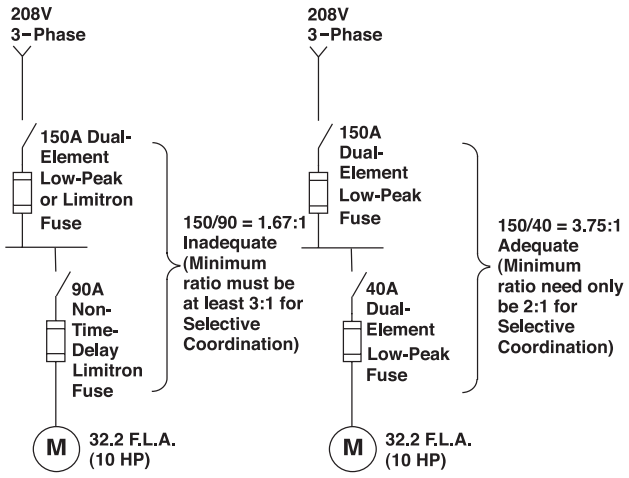
Current-Limitation of Dual-Element Fuses Versus Non-Time-Delay Fuses Used to Protect 10 HP Motor (32.2 FLA).

Fuse Type	Fuse	Let-Through Current Versus Prospective Short-Circuit Currents (RMS Symmetrical)		
		25,000A	50,000A	100,000A
Dual-Element (40A)	Fusetron	2000A	3300A	4400A
	Low-Peak	1800A	2200A	3000A
Non-Time-Delay (100A)	Limitron	3100A	4100A	5000A

In the table above, it can be seen that the 40A Low-Peak dual-element fuse used to protect a 10Hp (32.2 FLA) motor keeps short-circuit currents to approximately half the value of the non-time-delay fuse.

Better Selective Coordination (Blackout Prevention)

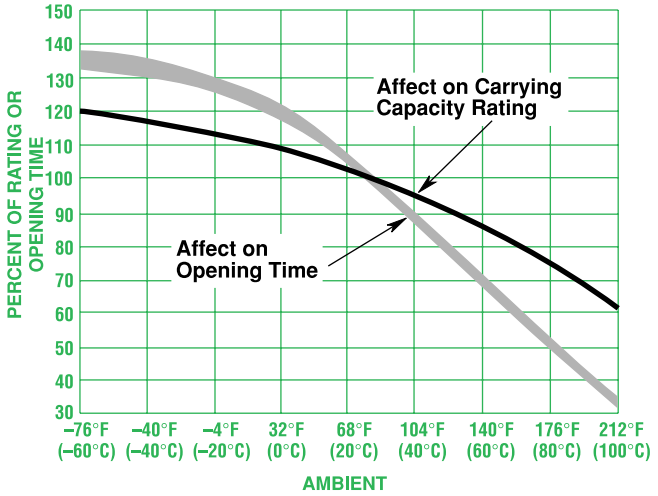
The larger an upstream fuse is relative to a downstream fuse (for example, feeder to branch), the less possibility there is of an overcurrent in the downstream circuit causing both fuses to open (lack of selective coordination). Fast-acting, non-time-delay fuses require at least a 3:1 ratio between the amp rating of a large upstream, line-side Low-Peak time-delay fuse and that of the downstream, loadside Limitron fuse in order to be selectively coordinated. In contrast, the minimum selective coordination ratio necessary for Low-Peak dual-element fuses is only 2:1 when used with Low-Peak loadside fuses.



The use of time-delay, dual-element fuses affords easy selective coordination–coordination hardly requires anything more than a routine check of a tabulation of required selectivity ratios. As shown in the preceding illustration, close sizing of Cooper Bussmann dual-element fuses in the branch circuit for motor overload protection provides a large difference (ratio) in the amp ratings between the feeder fuse and the branch fuse, compared to the single-element, non-time-delay Limitron fuse.

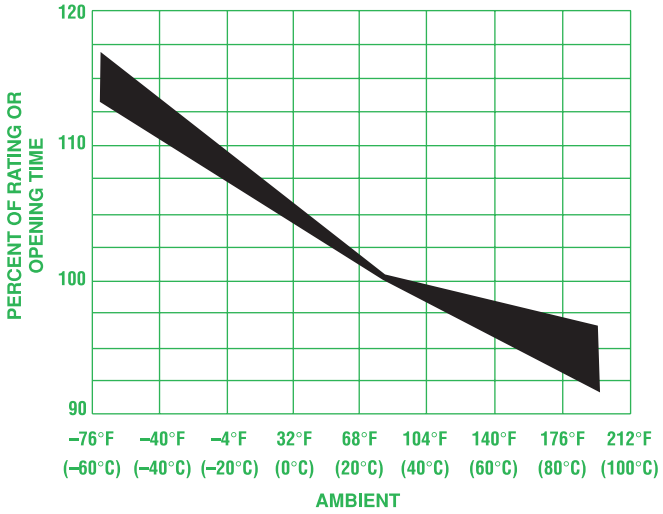
Better Motor Protection in Elevated Ambients

The derating of dual-element fuses based on increased ambient temperatures closely parallels the derating curve of motors in an 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.

Below is a rerating chart for single element fuses or non dual element fuses.



Ambient affect chart for non-dual-element fuses.

Cooper Bussmann Branch Circuit, Power Distribution Fuses

Good

Low-Peak® Fuses* Now Offer Indication That's As Clear As Black And White

Low-Peak current-limiting fuses offer optional permanent replacement fuse indication. The indicator is either black or white; no in between coloring so no second-guessing whether to replace the fuse or not.

Replace

Proven Technology

Low-Peak fuses offer the same replacement fuse indication technology that 's proven itself on the Cooper Bussmann CUBEFuse™ fuse and fuse holder system. It's the most reliable technology on the market today.

* Indication available on Cooper Bussmann LPJ_SPI, LPN-RK_SPI (250V) and LPS-RK_SPI (600V).

Low-Peak (Time-Delay)

KRP-C_SP (600Vac), 601 to 6000A, Current-Limiting STD 248-10 Class L

UL Guide #JFHR, UL File #E56412, 300,000AIR ac, 601-2000A (300Vdc 100,000AIR), CSA Class #1422-02, CSA File #53787, 200,000AIR ac

The all-purpose fuse for both overload and short circuit protection of high capacity systems (mains and large feeders). Time-delay (minimum of four seconds at five times amp rating) for close sizing. Unlike fast-acting fuses, time-delay fuses pass harmless surge currents of motors, transformers, etc., without overfusing or any sacrifice of short-circuit current limitation (component protection). The combination use of 1/10 to 600A Low-Peak dual-element time-delay fuses and 601 to 6000A KRP-C Low-Peak fuses is recommended as a total system specification. Easily selectively coordinated for blackout protection. Size of upstream fuse need only be twice that of downstream Low-Peak fuses (2:1 ratio). Low-Peak fuses can reduce bus bracing; protect circuit breakers with low interrupting rating as well as provide excellent overall protection of circuits and loads.

Data Sheet No. 1008, 1009

Low-Peak (Dual-Element, Time-Delay)

LPJ_SP (600Vac), 1 to 600A, Current-Limiting, STD 248-8 Class J

UL Guide #JFHR, UL File #E56412, 300,000AIR ac, 1 to 600A (300Vdc 100,000AIR), CSA Class #1422-02, CSA File #53787, 200,000AIR ac

Space saving LPJ fuses have the advantage of time- delay, permitting them to pass temporary overloads, offering overload, back-up overload, and short circuit protection. Ideal for IEC starter protection.

Data Sheet No. 1006, 1007

Low-Peak (Time-Delay)

LP-CC (600Vac), ½ to 30A Current-Limiting 200,000AIR ac,
STD 248-4 Class CC

UL Guide #JDDZ, UL File #E4273, ½ -2.25A (300Vdc 20,000AIR), 3-15A (150Vdc 20,000AIR), 20-30A (300Vdc 20,000AIR), CSA Class #1422-02, CSA File #53787

The Cooper Bussmann Low-Peak Class CC fuse (LP-CC) was developed specifically for a growing need in the industry - a compact, space saving branch circuit fuse for motor circuits.

Data Sheet No. 1023

Low-Peak (Dual-Element, Time-Delay)

LPS-RK_SP (600Vac), LPN-RK_SP (250Vac), 1/10 to 600A, Current-Limiting, STD 248-12 Class RK1

LPN-RK_SP 0-60A (125Vdc, 50,000AIR), 65-600A (250Vdc, 50,000AIR), LPS-RK_SP 0-600A (300Vdc, 50,000AIR)

UL Guide #JFHR, UL File #E56412, 300,000AIR ac, CSA Class #1422-02, CSA File #53787, 200,000AIR ac

High performance, all-purpose fuses. Provide the very high degree of short circuit limitation of Limitron fuses plus the overload protection of Fusetron fuses in all types of circuits and loads. Can be closely sized to full-load motor currents for reliable motor overload protection, as well as backup protection. Close sizing permits the use of smaller and more economical switches (and fuses); better selective coordination against blackouts; and a greater degree of current-limitation (component protection), Low-Peak fuses are rejection type but also fit non-rejection type fuse holders. Thus, can be used to replace Class H, K1, K5, RK5 or other RK1 fuses.

Data Sheet No. 1001, 1002, 1003, 1004

CUBEFuse™ (Dual-Element, Time-Delay)

TCF (600Vac), 1 to 100A, Current-Limiting, UL Listed Special Purpose Fuse, STD 248-8 Class J Performance

UL Guide # JFHR, UL File # E56412, 300,000AIR ac, (300Vdc – 100,000AIR), CSA Class #1422-02, CSA File #53787, 200,000AIR ac, (300VDC – 100,000AIR)

TCF fuses meet UL Class J Time-Delay electrical performance requirements. It is the world's first finger-safe fuse with the smallest installed footprint of any power class fuse including Class J, CC, T and R fuses. Satisfies requirements of IEC 60529 for IP-20 finger safe rating and provides TYPE 2 "no damage" protection for motor starters when sized properly. The TCF provides open fuse indication and is 35mm DIN rail and panel mountable.

Data Sheet No. 9000

Fusetron® (Dual-Element, Time-Delay)

FRS-R (600Vac), FRN-R (250Vac), 1/10 to 600A, 200,000AIR ac, FRN-R 0-600A (125Vdc, 20,000AIR), FRS-R 0-600A (300Vdc, 20,000AIR), Current-Limiting
STD 248-12 Class RK5

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-02, CSA File #53787

Time-delay affords the same excellent overload protection as Low-Peak fuses of motors and other type loads and circuits having temporary inrush currents such as those caused by transformers and solenoids. (In such circuits, Limitron fuses can only provide short circuit protection). Fusetron fuses are not as fast-acting on short circuits as Low-Peak fuses and therefore cannot give as high a degree of component short circuit protection. Like the Low-Peak fuse, Fusetron fuses permit the use of smaller size and less costly switches. Fusetron fuses fit rejection type fuse holders and can also be installed in holders for Class H fuses. They can physically and electrically replace Class H, K5, and other Class RK5 fuses.

Data Sheet No. 1017, 1018, 1019, 1020

For Data Sheets: www.cooperbussmann.com

Cooper Bussmann Branch Circuit, Power Distribution Fuses

T-Tron® (Fast-Acting)

JJS (600Vac) 1-800A, JJN (300Vac) 1-1200A, 200,000AIR ac Current-Limiting STD 248-15 Class T

UL Guide #JDDZ, UL File #E4273, JJN 15-600A (160Vdc, 20,000AIR), JJN 601-1200A (170Vdc 100,000AIR)

CSA Class #1422-02, CSA File #53787

The space-savers. Counter-part of the KTN-R/KTS-R Limitron fuses, but only one-third the size; thus, particularly suited for critically restricted space. A single-element fuse; extremely fast-acting. Provides a high degree of current limitation on short circuits for excellent component protection. Must be oversized in circuits with inrush currents common to motors, transformers, and other inductive components (will give only short circuit protection).

Data Sheet No. 1029, 1025

Limitron® (Fast-Acting)

KTU (600Vac), 601 to 6000A, 200,000AIR ac, Current-Limiting STD 248-10 Class L

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-02, CSA File #53787

Single-element fuses with no intentional time-delay. Very fast-acting with a high degree of current limitation; provide excellent component protection. Can be used for short circuit protection in circuits with inrush currents. Must be oversized to prevent opening by the temporary harmless overloads with some sacrifice of current limitation. In motor circuits, is sized at approximately 300% of motor full-load current.

Data Sheet No. 1010

Limitron (Time-Delay)

KLU (600Vac), 601 to 4000A, 200,000AIR ac, Current-Limiting STD 248-10 Class L

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-02, CSA File #53787

5 second delay (minimum) at 500% of rated current. Not as current-limiting as KRP-C_SP or KTU fuses.

Data Sheet No. 1013

Limitron (Fast-Acting)

KTK-R (600Vac), 1/10 to 30A, 200,000AIR ac, Current-Limiting STD 248-4 Class CC

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-02

CSA File #53787,

A very small, high performance, fast-acting, single-element fuse for protection of branch circuits, motor control circuits, lighting ballasts, street lighting fixtures. A diameter of only 13/32 and a length of 1 1/2 inch give cost and space savings. A grooved ferrule permits mounting in "rejection" type fuse holders as well as standard non-rejection type holders.

Data Sheet No. 1015

CC-Tron® (Time-Delay)

FNQ-R (600Vac), 1/4 to 30A, 200,000AIR ac Current-Limiting STD 248-4 Class CC

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-01, CSA File #53787

Ideal for control transformer protection. Can be sized to meet requirements of NEC® 430.72 and UL 508. Its miniature design and branch circuit rating allow it to be used for motor branch circuit and short circuit protection required by NEC® 430.52.

Data Sheet No. 1014

Limitron (Fast-Acting)

JKS (600Vac), 1 to 600A, 200,000AIR ac Current-Limiting STD 248-8 Class J

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-02, CSA File #53787

JKS Limitron fuses are basically the same as RK1 Limitron fuses but smaller in physical size. JKS fuses are single-element units with no intentional time-delay and are thus best applied in circuits free of the temporary overloads of motor and transformer surges. The smaller dimensions of Class J fuses prevent their replacement with conventional fuses.

Data Sheet No. 1026, 1027

Limitron (Fast-Acting)

KTS-R (600Vac), KTN-R (250Vac), 1 to 600A, 200,000AIR ac Current-Limiting STD 248-12 Class RK1

UL Guide #JDDZ, UL File #E4273, CSA Class #1422-02, CSA File #53787

Single-element, fast-acting fuses with no intentional time-delay. The same basic performance of the 601-6000A KTU fast-acting Limitron fuses. Provide a high degree of short-circuit current limitation (component protection). Particularly suited for circuits and loads with no heavy surge currents of motors, transformers, solenoids, and welders. Limitron fuses are commonly used to protect circuit breakers with lower interrupting ratings. If used in circuits with surge currents (motors, etc.), must be oversized to prevent opening and, thus, only provide short circuit protection. Incorporate Class R rejection feature. Can be inserted in non-rejection type fuse holders. Thus, can physically and electrically replace fast-acting Class H, K1, K5, RK5, and other RK1 fuses.

Data Sheet No. 1044, 1043

Type SC (½-6A Fast-Acting, 8-60A Time-Delay)

SC 100,000AIR ac, ½ -20A (600Vac), 25-60A (480Vac) STD 248-5 Class G

UL Guide #JDDZ, UL File #E4273 0-20A (170Vdc 10,000AIR), 25-30A (300Vdc 10,000AIR), 35-60A (300Vdc 10,000AIR)

CSA Class #1422-01, CSA File #53787

A high performance general-purpose branch circuit fuse for lighting, appliance, and motor branch circuits. Fuse diameter is 13/32; lengths vary with amp rating from 1 5/16 to 2 1/4 inches (serves as rejection feature and, thus, prevents oversizing).

Data Sheet No. 1024

Dura-Lag® (Time-Delay)

Construction Grade Fuses, DLS-R (600Vac)

DLN-R (250Vac) 1 to 600A, 200,000AIR ac, Current-Limiting STD 248-12 Class RK5

UL Guide #JDDZ, UL File # E4273, CSA Class #1422-02

CSA File #53787

Designed for contractor needs. Protects industrial equipment and large motors. Recommended for ac power distribution system mains, feeders and branch circuits. Industry standard time delay of 10 seconds at 5 times the fuse rating.

Data Sheet No. 1021, 1022

For Data Sheets: www.cooperbussmann.com