Ballasts

Indoor

- Fluorescent → Consult fixture manufacturer for size and type.

Fuse & Holder Recommendations

Fuse	Holder(s)	Fuse	Holder(s)
GLR	HLR	GLQ	HLQ
GMF		GMQ	
GRF			

- All Other (Mercury, Sodium, etc.) → Consult fixture manufacturer for size and type.

Fuse & Holder Recommendations

Fuse	Holder(s)	Fuse	Holder(s)	Fuse	Holder(s)
BAF	HPF	KTK-R	HPS-RR	SC 0-15	HPF-EE
BAN	HPS	FNQ-R	HPF-RR		HPS-EE
KTK		LP-CC		SC 20	HPF-JJ
FNM					HPS-JJ
FNQ		KTQ	HPS-L	SC 25-30	HPF-FF
FNW		BBS	HPF-L		HPS-FF

Outdoor

- Mercury, Sodium, etc. → Consult fixture manufacturer for size and type.

Fuse & Holder Recommendations

Fuse	Holder(s)	Fuse	Holder(s)
BAF	HEB	KTK-R	HEY
BAN	HEX	FNQ-R	
KTK	HPC-D	LP-CC	
FNM			
FNQ			
FNW			

Capacitors (NEC® 460)

Protected by Time-Delay Fuses. → 150% to 175% of Full Load Current

Fuse Recommendations

Volts	Fuse(s)
0-250	LPN-RK_SP, FRN-R
0-600	LPS-RK_SP, FRS-R
0-600	LPJ_SP, LP-CC, FNQ-R, TCF

Protected by Non-Time-Delay Fuses. → 250% to 300% of Full Load Current.

On Load Side of Motor Running Overcurrent Device. → Protection recommended as shown, but not required.

Fuse Recommendations

Volts	Fuse(s)
0-250	KTN-R, NON
0-300	JJN
0-600	KTS-R, NOS
0-600	JKS, KTK-R
0-600	JJS

Fuse Diagnostic Sizing Charts

Electric Heat (NEC® 424)

Electric Space Heating — Size at 125% or next size larger but in no case larger than 60 amps for each subdivided load.

Electric Boilers with Resistance Type Immersion Heating Elements in an ASME Rated and Stamped Vessel — Size at 125% or next size larger but in no case larger than 150 amps for each subdivided load.

Fuse Recommendation

Volts	Fuse(s)
0-250	LPN-RK_SP FRN-R, NON
0-300	JJN
0-480	SC 25 to SC 60
0-600	LPS-RK_SP FRS-R, NOS
0-600	JJS
0-600	LPJ_SP, LP-CC FNQ-R, JKS, KTK-R, TCF, SC ½ to SC 20

Mains, Feeders, Branches

Feeder Circuits (600A & Less)

- **No Motor Load** — 100% of non-continuous load plus 125% of continuous load.

Fuse Recommendations

Volts	Fuse(s)
0-250	LPN-RK_SP, FRN-R
0-300	JJN
0-600	LPS-RK_SP, FRS-R
0-600	JJS
0-600	LPJ_SP, LP-CC JKS, KTK-R

- **Combination Motor Loads and Other Loads** — 150%* of the FLA of largest motor (if there are two or more motors of same size, one is considered to be the largest) plus the sum of all the FLA for all other motors plus 100% of non-continuous, non-motor load plus 125% of continuous, non-motor load.
- **Motor Loads** — 150%* of the FLA of largest motor (if there are two or more motors of same size, one is considered to be the largest) plus the sum of all the FLA for all other motors.

*A max. of 175% (or the next standard size if 175% does not correspond to a standard size) is allowed for all but wound rotor and all dc motors.

Fuse Recommendations

Volts	Fuse(s)
0-25O	LPN-RK_SP, FRN-R
0-600	LPS-RK_SP, FRS-R
0-600	LPJ- SP, LP-CC

Main, Branch & Feeder Circuits (601-6000A) — 150% to 225% of full load current of largest motor plus 100% of full load current of all other motors plus 125% of continuous non-motor load plus 100% of non-continuous non-motor load.

Fuse Recommendation

Volts	Fuse(s)
0-600	KRP-C_SP

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Motor Loads (NEC® 430)

Voltage	Protection	Fuse Sized For:	Sizing	Fuse Recommendations
600V & Less	Protected by Time-Delay Fuses	Backup Overload w/ Motor Starter & Short-Circuit Protection	125% of motor FLA or next size larger.	**Volts / Fuse(s)** 0-250 FRN-R 0-600 FRS-R
			130% of motor FLA or next size larger.	**Volts / Fuse(s)** 0-250 LPN-RK_SP 0-600 LPS-RK_SP
		Short-Circuit Only	175%* of motor FLA or next size larger. (If 175% does not correspond to a standard size). If this will not allow motor to start, due to higher than normal inrush currents or longer than normal acceleration times (5 sec. or greater), fuse may be sized up to 225% or next size smaller.	**Volts / Fuse(s)** 0-250 LPN-RK_SP, FRN-R 0-600 LPS-RK_SP, FRS-R 0-600 LPJ_SP, TCF
	Protected by Non-Time Delay Fuses & all Class CC Fuses	Short-Circuit Only	Max. of 300%* of motor FLA or next size larger (if 300% does not correspond to a standard size). If this will not allow motor to start due to higher than normal inrush currents or longer than normal acceleration times (5 sec. or greater), fuses through 600 amps may be sized up to 400% or next size smaller.	**Volts / Fuse(s)** 0-250 KTN-R, NON 0-300 JJN 0-600 KTS-R, NOS 0-600 JJS 0-600 LP-CC, JKS, KTK-R
Above 600V			Compare the min. melting time-current characteristics of the fuses with the time-current characteristics of the overload relay curve. The size fuse which is selected should be such that short.circuit protection is provided by the fuse and overload protection is provided by the controller overload relays.	**Volts / Fuse(s)** 2400 JCK, JCK-A, JCH 4800 JCL, JCL-A, JCG 7200 JCR, 7.2 WKMSJ

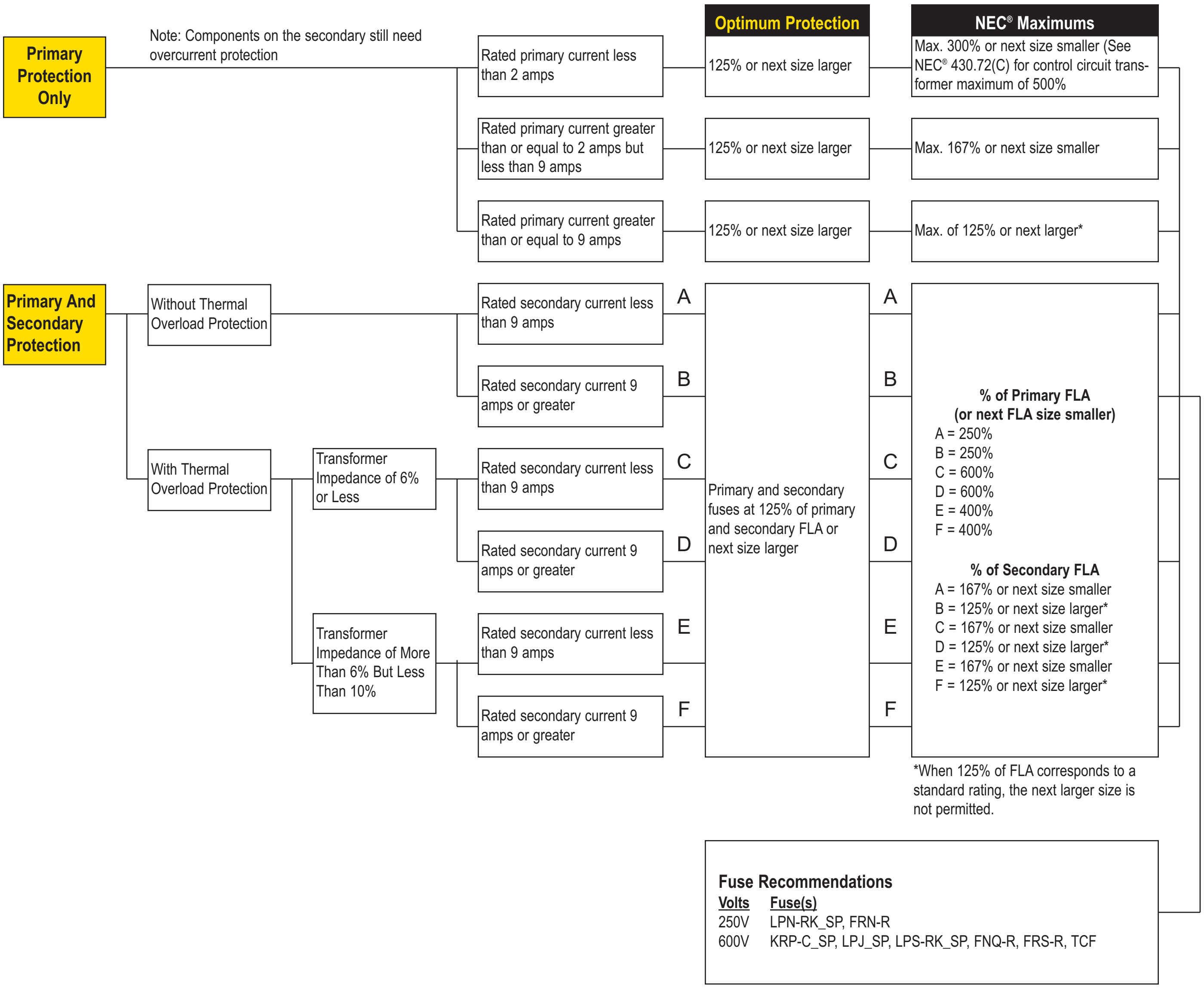
*150% for wound rotor and all DC motors.

Solenoids (Coils)

Fuses	Sizing	Fuse Recommendation
Branch Circuit Fuses	Size at 125% or next size smaller.	**Volts / Fuse(s)** 0-250 Best: LPN-RK_SP, FRN-R 0-600 LPS-RK_SP, FRS-R 0-600 LPJ_SP, LP-CC, FNQ-R, TCF
Supplementary Fuses	Size at 125% or next size larger.	**Volts / Fuse(s)** 0-32 MDL 9-30A, FNM 20-30A 0-125 MDA 25-30A, FNM 12-15A 0-250 MDL 1/16-8A, MDA 2/10-20A, FNM 1/10-10A, FNW 12-30A, MDQ 1/100-7A 0-500 FNQ 1/10-30A

Fuse Diagnostic Sizing Charts

Transformers 600V Nominal or Less (NEC® 450.3)



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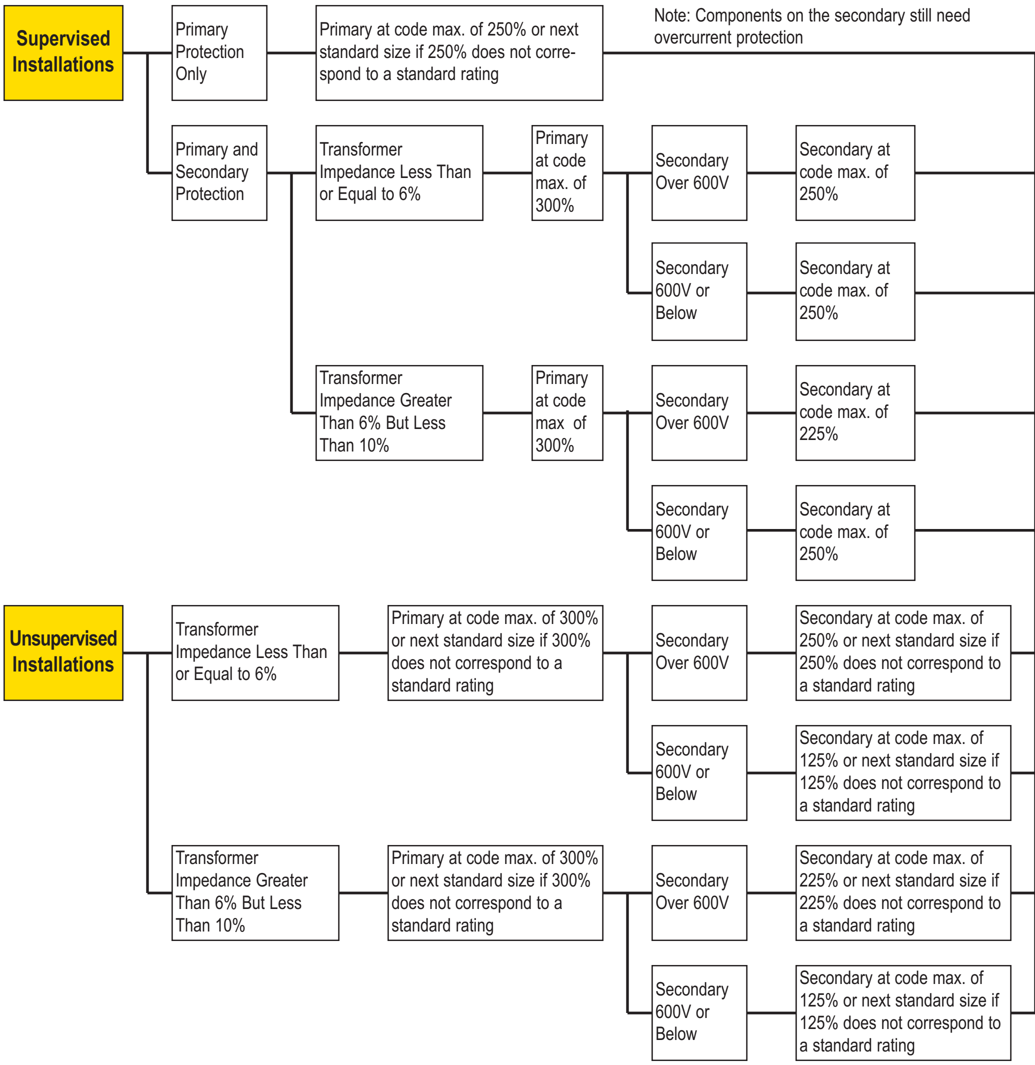
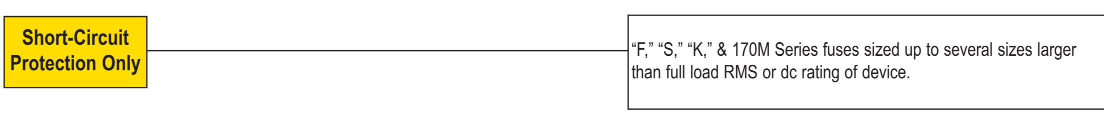
Transformers Over 600V Nominal (NEC® 450.3)



Fuse Recommendations

Volts	Fuse(s)
250V	LPN-RK_SP, FRN-R
600V	LPS-RK_SP, LPJ-_SP, KRP-C_SP, FRS-R, FNQ-R, TCF
2475V	JCD
2750V	JCX
2750/5500V	JCW
5500V	JCE, JCQ, JCY, JCU, 5.5 ABWNA, 5.5 AMWNA, 5.5 FFN
7200V	7.2 ABWNA, 7.2 SDLSJ, 7.2 SFLSJ
8300V	JCZ, JDZ, 8.25 FFN
15500V	JCN, JDN, JDM, 15.5 CAVH
17500V	17.5 CAV, 17.5 SDM
24000V	24 SDM, 24 SFM, 24 FFM
36000V	36 CAV, 36 SDQ, 36 SFQ
38000V	38 CAV

Solid State Devices (Diodes, SCRs, Triacs, Transistors)

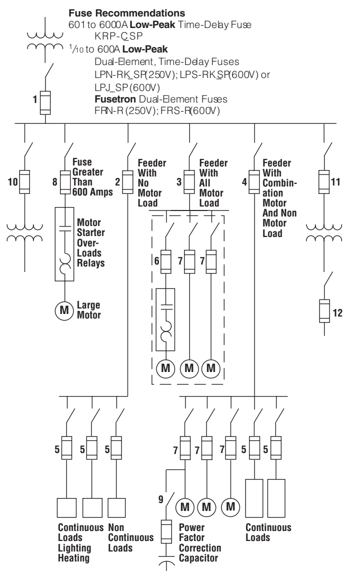


Fuse Recommendations

Volts	Fuse(s)
0-130	FWA
0-250	FWX
0-500	FWH
0-600	FWC, KAC, KBC
0-700	FWP, 170M Series, SPP
0-1000	FWJ, 170M Series, SPJ

Building Electrical System

General guidelines are given for selecting fuse amp ratings for most circuits. Some specific applications may warrant other fuse sizing; in these cases the load characteristics and appropriate NEC® sections should be considered. The selections shown here are not, in all cases, the maximum or minimum amp ratings permitted by the NEC®. Demand factors as permitted per the NEC® are not included in these guidelines.



Dual-Element, Time-Delay Fuses (LPJ_SP, LPS-RK_SP, LPN-RK_SP, FRS-R, FRN-R and TCF)

1. **Main Service.** Size fuse according to method in 4.
2. **Feeder Circuit With No Motor Loads.** The fuse size must be at least 125% of the continuous load† plus **100%** of the non-continuous load. Do not size larger than ampacity of conductor*.
3. **Feeder Circuit With All Motor Loads.** Size the fuse at 150%N of the full load current of the largest motor plus the full-load current of all other motors∆.
4. **Feeder Circuit With Mixed Loads∆.** Size fuse at sum of:
   - **a. 150%**†† of the full-load current of the largest motor plus
   - **b. 100%** of the full-load current of all other motors plus
   - **c. 125%** of the continuous, non-motor load† plus
   - **d. 100%** of the non-continuous, non-motor load.
5. **Branch Circuit With No Motor Load.** The fuse size must be at least 125% of the continuous load† plus 100% of the non-continuous load. Do not size larger than ampacity of conductor*.
6. **Motor Branch Circuit With Overload Relays.** Where overload relays are sized for motor running overload protection, the following provide backup, ground fault, and short-circuit protection:
   - **a.** Size FRS-R and FRN-R, RK5, & LPS-RK_SP and LPN-RK_SP, RK1, fuses at **125% & 130%** of motor full-load current respectively or next higher size.
7. **Motor Branch Circuit With Fuse Protection Only.** Where the fuse is the only motor protection, the following FRS-R and FRN-R, Class RK5, fuses provide motor running overload protection and short-circuit protection:
   - **a. Motor 1.15 service factor or 40°C rise:** size the fuse at 110% to 125% of the motor full-load current.
   - **b. Motor less than 1.15 service factor or over 40°C rise:** size fuse at 100% to 115% of motor full-load current.
8. **Large Motor Branch Circuit. Fuse larger than 600 amps.** For large motors, size KRP-C_SP Low-Peak time-delay fuse at 175% to 300% of the motor full-load current, depending on the starting method; i.e. part-winding starting, reduced voltage starting, etc.
9. **Power Factor Correction Capacitors.** Size dual-element fuses as low as practical, typically 150% to 175% of capacitor rated current.
10. **Transformer Primary Fuse** (without secondary fuse protection). When transformer primary current is equal to or greater than 9 amps, the dual-element, time-delay fuse should be sized at 125% of transformer primary current or the next size larger. Note: Secondary conductors must be protected from overcurrent damage.
11. **Transformer Primary Fuse** (with secondary fuse protection). May be sized at **250%** of transformer primary current if,
12. **The secondary fuse is sized** at no more than **125%** of secondary full-load current. Note: Secondary conductors must be protected at their ampacities.

Non-Time-Delay and all Class CC Fuses (JKS, KTS-R, KTN-R, JJS, JJN, LP-CC, KTK-R, and FNQ-R)

1. **Main service.** Size fuse according to method in 4.
2. **Feeder Circuit With No Motor Loads.** The fuse size must be at least **125%** of the continuous load† plus **100%** of the non-continuous load. Do not size larger than the ampacity of the wire.
3. **Feeder Circuit With All Motor Loads.** Size the fuse at **300%** of the full-load current of the largest motor plus the full-load current of all other motors. Do not size fuse larger than the conductor capacity.
4. **Feeder Circuit With Mixed Loads.** Size fuse at sum of:
   - **a. 300%** of the full-load current of the largest motor plus
   - **b. 100%** of the full-load current of all other motors plus
   - **c. 125%** of the continuous, non-motor load† plus
   - **d. 100%** of the non-continuous, non-motor load.
5. **Branch Circuit With No Motor Loads.** The fuse size must be at least **125%** of the continuous load† plus **100%** of the non-continuous load. Do not size larger than the ampacity of conductor.*
6. **Motor Branch Circuit With Overload Relays.** Size the fuse as close to but not exceeding **300%** of the motor running full load current. Provides ground fault and short-circuit protection only.
7. **Motor Branch Circuit With Fuse Protection Only.** Non-time-delay fuses cannot be sized close enough to provide motor running overload protection. If sized for motor overload protection, non-time-delay fuses would open due to motor starting current. Use dual-element fuses.

Conductor Ampacity Selection

1. **Feeder Circuit And Main Circuit With Mixed Loads.** Conductor ampacity at least sum of:
   - **a. 125%** of continuous non-motor load plus
   - **b. 100%** of non-continuous non-motor load plus
   - **c. 125%** of the largest motor full-load current plus
   - **d. 100%** of all other motors' full-load current.
2. **Feeder Circuit With No Motor Load.** Conductor ampacity at least **125%** of the continuous load plus **100%** of the non-continuous load.
3. **Feeder Circuit With All Motor Loads.** Conductor ampacity at least **125%** of the largest motor full-load amps plus **100%** of all other motors' full-load amps.
4. **Feeder Circuit With Mixed Loads.** Size according to method 1 above.
5. **Branch Circuit With No Motor Load.** Conductor ampacity at least **125%** of the continuous load plus **100%** of the non-continuous load.

6, 7, & 8. Motor Branch Circuits. Conductor ampacity at least **125%** of the motor full-load current.

9. **Conductor ampacity at least 135% of capacitor rated current.** The ampacity of conductors for a capacitor connected to a motor circuit must be ⅓ the ampacity of the motor circuit conductors.

10, 11. Conductor ampacity minimum 125% of transformer full-load current.

12. Conductor ampacity per 1 above.

† 100% of the continuous load can be used rather than 125% when the switch and fuse are listed for 100% continuous operation. Most bolted pressure switches and high pressure contact switches 400A to 6000A with Class L fuses are listed for 100% continuous operation.
* Where conductor ampacity does not correspond to a standard fuse rating, next higher rating fuse is permitted when 800 amps or less [(240.3(B)].
∆ In many motor feeder applications dual-element fuses can be sized at ampacity of feeder conductors.
• Available short-circuit current and the clearing time of the overcurrent device must be considered so that the conductor's ICEA (P32.382) withstand rating is not exceeded.
†† NEC® allows a maximum of 175% or the next standard size if 175% does not correspond with a standard fuse size, for all but wound rotor and DC motors.

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Suggestions

General

Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer. Fuses shall be as follows:

A. Main, Feeder, and Branch Circuit Fuses

1. Circuits 601 through 6000 amps

   Circuits 601 through 6000 amps shall be protected by current-limiting Cooper Bussmann Low-Peak Time-Delay Fuses KRP-C(amp)SP. Fuses shall be time-delay and shall hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in .01 seconds or less, with an interrupting rating of 300,000 amps RMS symmetrical, and be listed by a nationally recognized testing laboratory. Peak let-through currents and I^2t let-through energies shall not exceed the values established for Class L fuses. Larger Hp motors shall be protected by these fuses, with ratings as shown on the drawings.

2. Circuits 0 through 600 amps

   Circuits 0 through 600 amps shall be protected by current-limiting Cooper Bussmann Low-Peak Dual-Element, Time-Delay Fuses LPN-RK(amp)SP/LPS-RK(amp)SP (or LPJ(amp)SP. All fuses shall have separate overload and short-circuit elements. Fuses shall incorporate a spring activated thermal overload element that has a 284 degrees Fahrenheit melting point alloy. The fuses shall hold 500% of rated current for a minimum of 10 seconds (30A, 250V Class RK1 case size may be a minimum of 8 seconds at 500% of rated current) with an interrupting rating of 300,000 amps RMS symmetrical, and be listed by a nationally recognized testing laboratory. Peak let-through currents and I^2t let-through energies shall not exceed the values established for Class RK1 or J fuses.

Motor Circuits - All individual motor circuits with full-load amp ratings (F.L.A.) of 461 (or 400) amps or less shall be protected by Cooper Bussmann Low-Peak Dual-Element, Time-Delay Fuses LPN-RK(amp)SP/LPS-RK(amp)SP (or LPJ(amp)SP). The following guidelines apply for motors protected by properly sized overload relays: LPN-RK(amp)SP/LPS-RK(amp)SP fuses shall be installed in ratings of 130% (or 150% for LPJ(amp)SP fuses) of motor full-load current (or next size larger if this does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse may be 175%* of the motor full-load current, or the next standard size larger if 175%* does not correspond to a standard fuse size. If this will not allow the motor to start due to higher than normal inrush currents or longer than normal acceleration times (5 seconds or greater), fuses may be sized up to 225% (or next size smaller).

Motor Controllers - NEMA and IEC Style motor controllers shall be protected from short-circuits by Cooper Bussmann Low-Peak Dual-Element, Time-Delay Fuses in order to provide testing agency-witnessed Type 2 coordination for the controller. This provides "no damage" protection for the controller, under low and high level fault conditions, as required by IEC Publication947-4-1 and UL 508E (Outline of Investigation).

*150% for wound rotor and all DC motors.

3. Switchboards, Panelboards, Load Centers

   The manufacturer shall supply equipment utilizing fully rated and listed components. This equipment shall be tested, listed and labeled for the available short-circuit current.

(Where series-rated fuse/circuit breaker systems are acceptable, the systems shall utilize tested, recognized components. The manufacturer shall supply switchboards, panelboards and load centers which have been tested, listed, and labeled for the available short-circuit current, and those combinations specified on the drawings.)

4. Marking

   Fuses shall be "Low-Peak in color. "Low-Peak NOTICE labels to alert the end user of the engineered level of protection of the electrical equipment shall be field installed by the electrical contractor. They shall be marked with the proper fuse rating, per the specifications, and placed in a conspicuous location on the enclosure. These labels are available upon request from Bussmann.

B. Supplementary - Light Fixture Protective Fuses

1. Fluorescent fixtures shall be protected by Cooper Bussmann GLR or GMF Fuses in HLR Holders. These fixtures shall have individual protection on the line side of the ballast. A fuse and holder shall be mounted within, or as part of, the fixture. Size and type of fuse to be recommended by the fixture manufacturer.

2. All other ballast-controlled light fixtures shall be protected by Bussmann KTK or FNQ Fuses in HEB HEX, HEY, HPF, or HPS Holders. These fixtures shall have individual protection on the line side of the ballast. Fuse and holder shall be mounted in a location convenient for changing fuses. Holder shall be mounted in protected location or be an in-line waterproof holder (HEB, HEX, or HEY). Size and type of fuse to be recommended by the fixture manufacturer or as indicated on plans.

C. Spares

Upon completion of the building, the electrical contractor shall provide the owner with spare fuses as shown below:

1. 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares.

2. Cooper Bussmann spare fuse cabinets - Catalog No. SFC - shall be provided to store the above spares. A supply of "Low-Peak NOTICE Labels shall be provided along with the spare fuses in the spare fuse cabinet.

D. Substitution Approvals

The electrical contractor's proposal shall be based upon the fuses specified, using the manufacturer's catalog numbers as called for in the specification or on the drawings. Coordination and current limitation requirements for protection of each part of the electrical system have been engineered on the basis of the type, class and manufacturer specified.

In the event that the electrical contractor wishes to furnish materials other than those specified, a written request, along with a complete short-circuit, component protection and selective coordination study, shall be submitted to the engineer for evaluation at least two weeks prior to bid date. If the engineer's evaluation indicates acceptance, a written addendum will be issued listing the other acceptable manufacturer.

Suggested Fuse and Fusible Equipment Specifications

Cooper Bussmann provides fuse and fusible equipment specifications available on line at www.cooperbussmann.com/apen/fusible/.

The information contained within these documents constitutes what Cooper Bussmann considers to be a complete, comprehensive, performance based construction specification. These documents can be viewed or downloaded in Microsoft Word or PDF format.

The specifications are arranged per the recommended CSI MasterFormat™ Sections. In some cases, the number for these specifications has been left open for the specifier to choose the appropriate number and the title can be adjusted to best suit their project manual. The specifications include:

16011 Electrical System Studies

- Short Circuit, Component Protection, Flash Hazard, and Selective Coordination Study

16411 Enclosed Switches

- Enclosed Disconnect Switches (Fused and Non-Fused)
- Elevator Shunt-Trip Fused Disconnect Switches

164XX Open Disconnect Switches

- Open Disconnect Switches (Fused and Non-Fused)

16421 Enclosed Controllers

- Enclosed Fused Combination Motor Controllers

16441 Switchboards

- Fused Main and Distribution Switchboards

16442 Panelboards

- Fused Distribution Panelboards
- Elevator Shunt-Trip Fused Distribution Panel
- Fused Lighting and Appliance Panelboards

16443 Motor Control Centers

- Fused Motor Control Centers

16451 Busway

- Busway and Fused Busplugs

16491 Fuses

- Fuses

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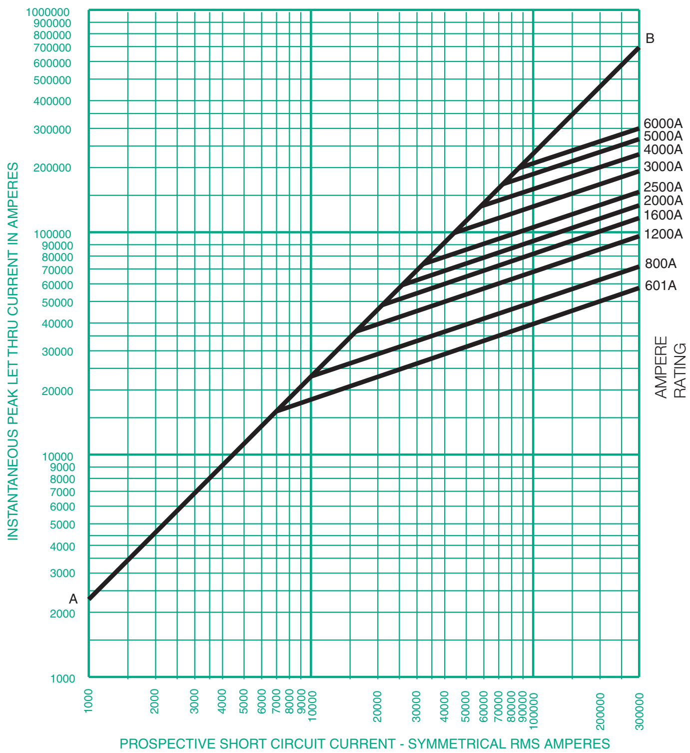
See pages 67 to 69 for current-limiting definition and how to analyze these charts.

Low-Peak Class L Time-Delay Fuses KRP-C_SP

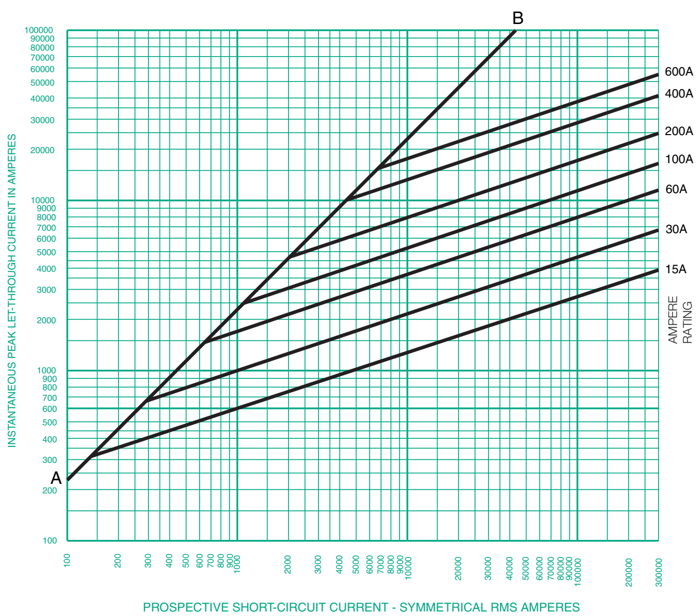


KRP-C_SP Fuse – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size									
	601	800	1200	1600	2000	2500	3000	4000	5000	6000
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
5,000	5	5	5	5	5	5	5	5	5	5
10,000	8	10	10	10	10	10	10	10	10	10
15,000	9	12	15	15	15	15	15	15	15	15
20,000	10	13	17	20	20	20	20	20	20	20
25,000	11	14	19	22	25	25	25	25	25	25
30,000	11	14	20	24	27	30	30	30	30	30
35,000	12	15	21	25	29	35	35	35	35	35
40,000	13	16	22	26	30	35	40	40	40	40
50,000	14	17	23	28	32	37	50	50	50	50
60,000	15	18	25	30	34	40	49	60	60	60
70,000	15	19	26	32	36	42	52	62	70	70
80,000	16	20	27	33	38	44	54	65	76	80
90,000	17	21	29	34	39	45	56	67	79	90
100,000	17	22	30	36	41	47	58	70	81	100
150,000	20	25	34	41	47	54	67	80	93	104
200,000	22	27	37	45	51	59	73	87	102	114
250,000	24	29	40	49	55	64	79	94	110	123
300,000	25	31	43	52	59	68	84	100	117	30

Note: For I_{RMS} value at 300,000 amperes, consult Factory.

Low-Peak Class J, Dual-Element Time-Delay Fuses LPJ_SP



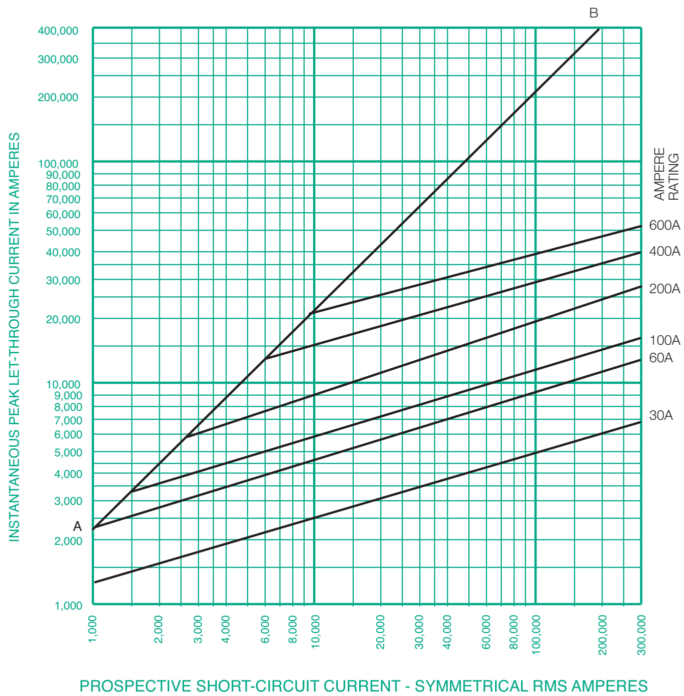
LPJ_SP Fuse – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size						
	15	30	60	100	200	400	600
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
1,000	1	1	1	1	1	1	1
3,000	1	1	1	2	2	3	3
5,000	1	1	1	2	3	5	5
10,000	1	1	2	2	4	6	8
15,000	1	1	2	3	4	7	9
20,000	1	1	2	3	4	7	10
25,000	1	1	2	3	5	8	10
30,000	1	1	2	3	5	8	11
35,000	1	1	2	4	5	9	12
40,000	1	2	3	4	6	9	12
50,000	1	2	3	4	6	10	13
60,000	1	2	3	4	6	11	14
80,000	1	2	3	5	7	12	15
100,000	1	2	4	5	8	12	17
150,000	1	2	4	6	9	14	19
200,000	2	3	4	6	9	16	21
250,000	2	3	5	7	10	17	23
300,000	2	3	5	7	11	18	24

Note: For I_{RMS} value at 300,000 amperes, consult Factory.

See pages 67 to 69 for current-limiting definition and how to analyze these charts.

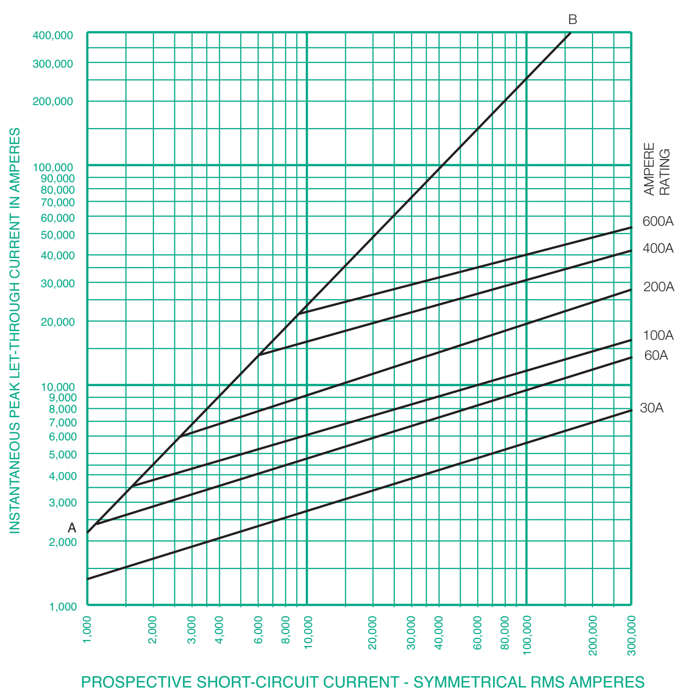
Low-Peak Class RK1 Dual-Element Time-Delay Fuses LPN-RK_SP



LPN-RK_SP – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size					
	30	60	100	200	400	600
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
1,000	1	1	1	1	1	1
2,000	1	1	2	2	2	2
3,000	1	1	2	3	3	3
5,000	1	2	2	3	5	5
10,000	1	2	3	4	7	9
15,000	1	2	3	5	8	11
20,000	1	3	3	5	8	11
25,000	1	3	3	5	9	12
30,000	2	3	4	6	9	12
35,000	2	3	4	6	10	13
40,000	2	3	4	6	10	13
50,000	2	3	4	7	11	14
60,000	2	3	4	7	11	16
70,000	2	3	4	7	12	16
80,000	2	4	5	8	12	16
90,000	2	4	5	7	13	17
100,000	2	4	5	8	13	17
150,000	2	4	6	9	15	19
200,000	3	5	6	11	16	20
250,000	3	5	7	11	17	21
300,000	3	6	7	12	18	22

Low-Peak Class RK1 Dual-Element Time-Delay Fuses LPS-RK_SP

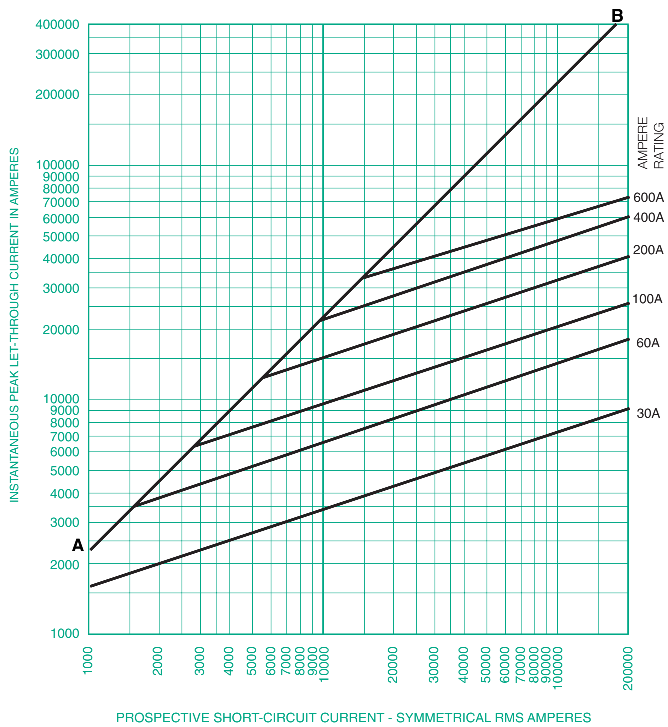


LPS-RK_SP – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size					
	30	60	100	200	400	600
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
1,000	1	1	1	1	1	1
2,000	1	1	2	2	2	2
3,000	1	1	2	3	3	3
5,000	1	2	2	3	5	5
10,000	1	2	3	4	7	10
15,000	1	2	3	5	8	11
20,000	2	3	3	5	9	12
25,000	2	3	4	6	9	12
30,000	2	3	4	6	10	13
35,000	2	3	4	6	10	13
40,000	2	3	4	6	10	14
50,000	2	3	5	7	11	15
60,000	2	4	5	7	12	15
70,000	2	4	5	8	13	16
80,000	2	4	5	8	13	16
90,000	2	4	5	8	13	17
100,000	2	4	6	9	14	17
150,000	3	5	6	10	15	19
200,000	3	5	7	11	16	21
250,000	3	6	7	12	17	22
300,000	3	6	7	12	18	23

See pages 67 to 69 for current-limiting definition and how to analyze these charts.

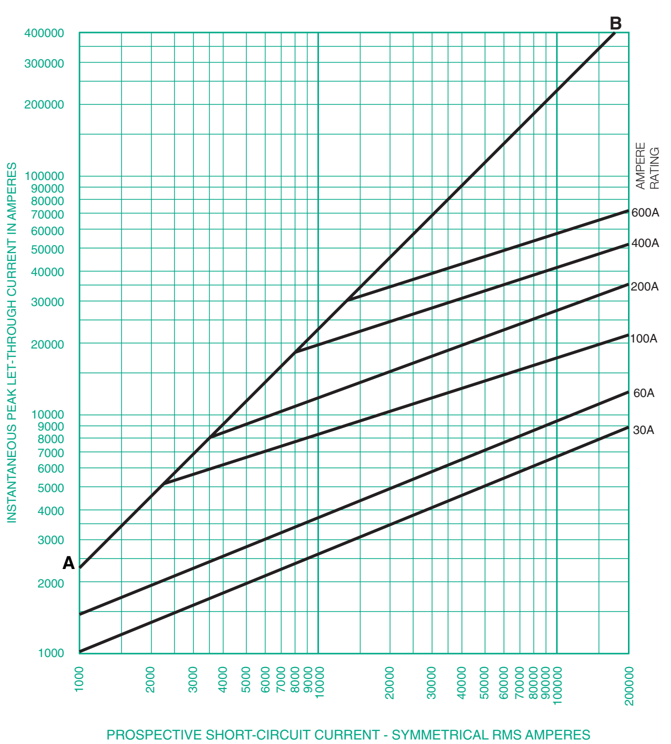
Fusetron Class RK5 Dual-Element Time-Delay Fuses FRN-R



FRN-R – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size					
	30	60	100	200	400	600
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
5,000	1	2	3	5	5	5
10,000	2	3	4	7	10	10
15,000	2	3	5	8	11	15
20,000	2	4	5	8	12	16
25,000	2	4	6	9	13	17
30,000	2	4	6	10	14	18
35,000	2	4	6	10	15	19
40,000	2	5	7	11	15	20
50,000	3	5	7	11	17	21
60,000	3	5	8	12	18	22
70,000	3	6	8	13	19	23
80,000	3	6	8	13	19	24
90,000	3	6	9	14	20	25
100,000	3	6	9	14	21	26
150,000	4	7	10	16	24	29
200,000	4	8	11	18	26	32

Fusetron Class RK5 Dual-Element Time-Delay Fuses FRS-R

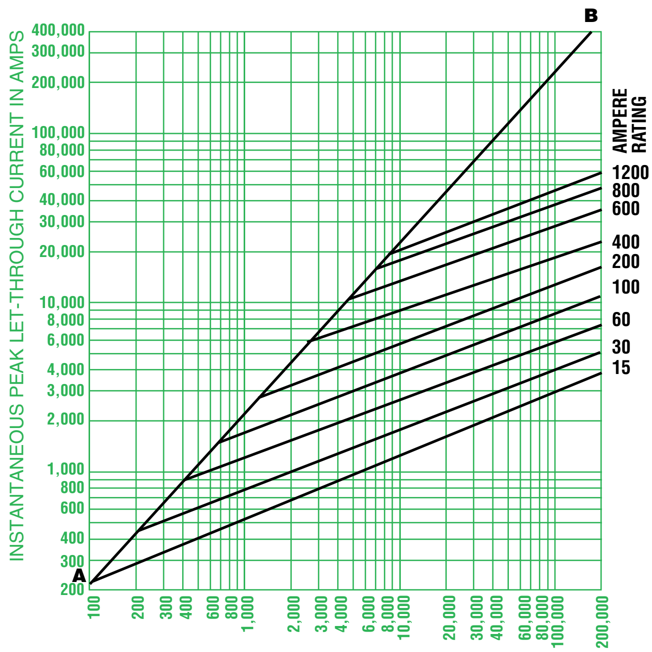


FRS-R – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size					
	30	60	100	200	400	600
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
5,000	1	1	3	4	5	5
10,000	1	2	4	5	9	10
15,000	1	2	4	6	10	14
20,000	2	2	5	7	11	15
25,000	2	2	5	7	12	17
30,000	2	3	5	8	13	18
35,000	2	3	5	8	13	18
40,000	2	3	6	9	14	19
50,000	2	3	6	9	14	20
60,000	2	3	6	10	15	22
70,000	3	4	7	11	17	23
80,000	3	4	7	12	17	23
90,000	3	4	7	12	17	24
100,000	3	4	8	13	18	25
150,000	3	5	9	14	21	27
200,000	4	6	9	16	23	32

See pages 67 to 69 for current-limiting definition and how to analyze these charts.

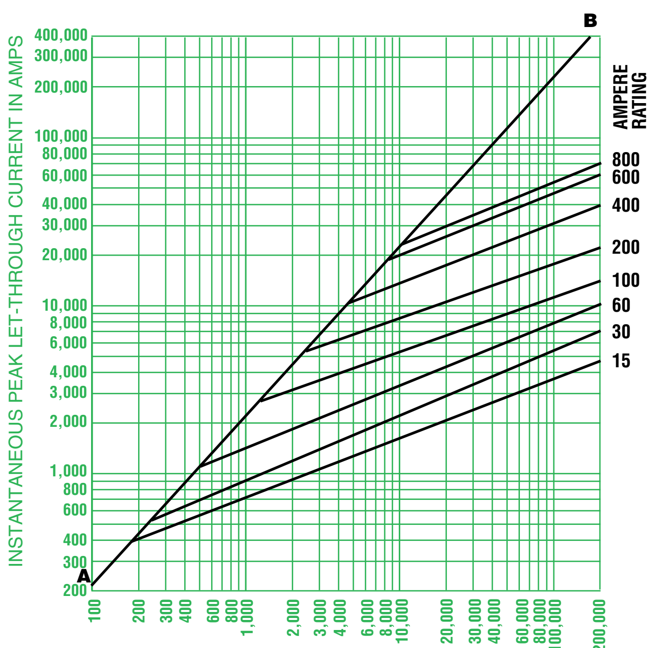
Tron Class T Fast-Acting Fuses
JJN



JJN – RMS Let-Through Current (kA)

Prosp. Short C.C.	Fuse Size								
	15	30	60	100	200	400	600	800	1200
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
500	1	1	1	1	1	1	1	1	1
1,000	1	1	1	1	1	1	1	1	1
5,000	1	1	1	1	2	3	5	5	5
10,000	1	1	1	2	2	4	6	7	9
15,000	1	1	1	2	3	4	6	9	10
20,000	1	1	1	2	3	5	7	10	11
25,000	1	1	2	2	3	5	7	10	12
30,000	1	1	2	2	3	5	8	11	13
35,000	1	1	2	3	4	6	8	11	13
40,000	1	1	2	3	4	6	9	11	13
50,000	1	1	2	3	4	7	9	12	15
60,000	1	1	2	3	4	7	10	13	16
70,000	1	1	2	3	5	7	10	14	17
80,000	1	2	2	3	5	8	11	15	17
90,000	1	2	2	3	6	8	11	15	18
100,000	1	2	2	4	6	8	12	16	19
150,000	1	2	3	4	6	9	13	17	22
200,000	2	2	3	4	7	9	15	19	23

Tron Class T Fast-Acting Fuses
JJS



JJS – RMS Let-Through Current (kA)

Prosp. Short C.C.	Fuse Size							
	15	30	60	100	200	400	600	800
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
500	1	1	1	1	1	1	1	1
1,000	1	1	1	1	1	1	1	1
5,000	1	1	1	2	3	4	5	5
10,000	1	1	1	2	3	6	8	9
15,000	1	1	2	3	4	7	10	11
20,000	1	1	2	3	4	7	10	12
25,000	1	1	2	3	5	7	11	13
30,000	1	1	2	3	5	8	12	14
35,000	1	1	2	3	5	9	13	15
40,000	1	2	2	4	5	9	13	15
50,000	1	2	2	4	6	10	14	17
60,000	1	2	3	4	6	10	16	18
70,000	1	2	3	4	7	11	17	19
80,000	1	2	3	4	7	11	17	20
90,000	1	2	3	4	7	12	18	21
100,000	2	2	3	5	7	12	19	22
150,000	2	3	4	6	8	14	22	25
200,000	2	3	4	6	9	16	24	28

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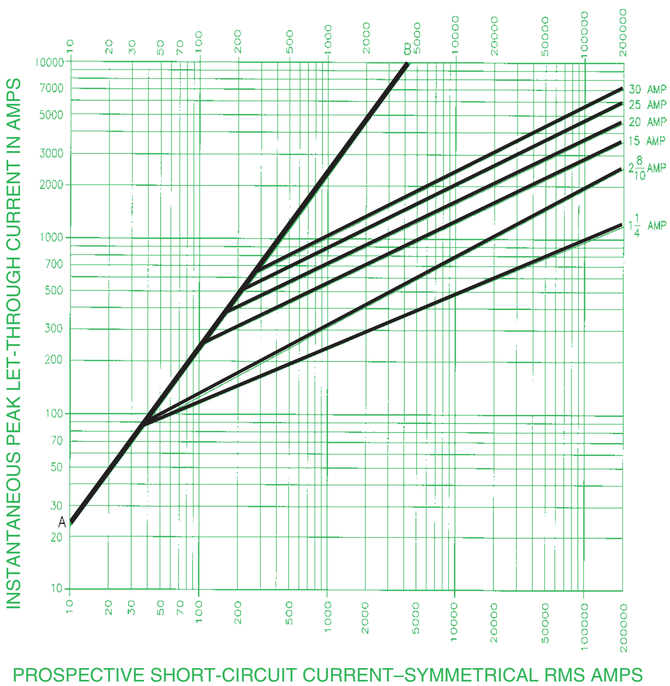
See pages 67 to 69 for current-limiting definition and how to analyze these charts.

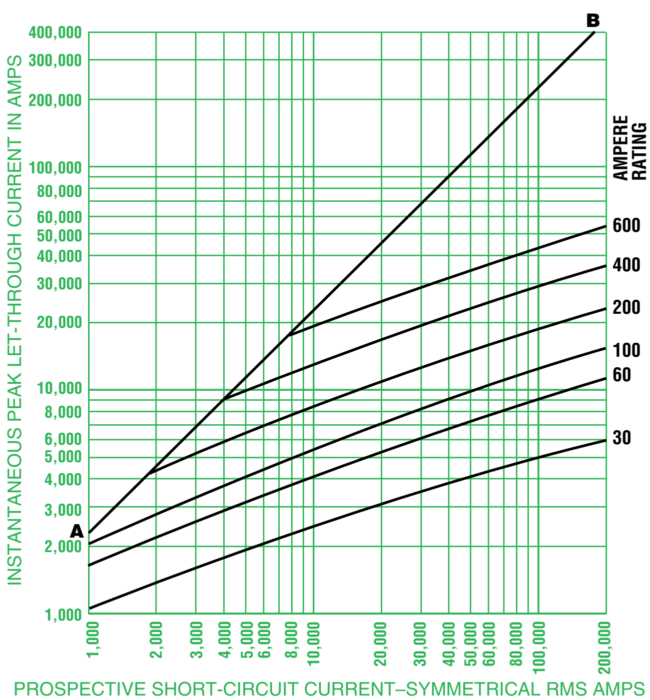
Low-Peak Class CC Time-Delay Fuses
LP-CC



LP-CC – RMS Let-Through Currents (A)

Prosp. Short C.C.	Fuse Size					
	1¼	2 8/10	15	20	25	30
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
1,000	100	135	240	305	380	435
3,000	140	210	350	440	575	580
5,000	165	255	420	570	690	710
10,000	210	340	540	700	870	1000
20,000	260	435	680	870	1090	1305
30,000	290	525	800	1030	1300	1520
40,000	315	610	870	1150	1390	1700
50,000	340	650	915	1215	1520	1820
60,000	350	735	1050	1300	1650	1980
80,000	390	785	1130	1500	1780	2180
100,000	420	830	1210	1600	2000	2400
200,000	525	1100	1600	2000	2520	3050

Limitron Class J Fast-Acting Fuses
JKS



JKS – RMS Let-Through Currents (kA)

Prosp. Short C.C.	Fuse Size					
	30	60	100	200	400	600
	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}	I_{RMS}
5,000	1	1	2	3	4	5
10,000	1	2	3	4	6	9
15,000	1	2	3	4	7	10
20,000	1	2	3	5	8	11
25,000	2	3	3	6	9	12
30,000	2	3	3	6	9	13
35,000	2	3	4	6	9	13
40,000	2	3	4	7	10	14
50,000	2	3	4	7	10	15
60,000	2	3	5	7	11	16
70,000	2	3	5	8	11	17
80,000	2	3	5	8	12	17
90,000	2	4	6	9	13	18
100,000	2	4	6	9	13	18
150,000	2	5	6	9	14	22
200,000	3	5	7	10	16	24

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Common Electrical Terminology

Ampere (Amp)
The measurement of intensity of rate of flow of electrons in an electric circuit. An amp is the amount of current that will flow through a resistance of one ohm under a pressure of one volt.

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 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, 200,000 amp interrupting rating, branch circuit fuses with overall dimensions of 13⁄32" x 1 ½" 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 1 ½" fuses. They are available from 1⁄10 amp through 30 amps.

Class G Fuses
½ - 20A @ 600Vac, 25-604@480Vac, 100,000 amp interrupting rating branch circuit fuses that are size rejecting to eliminate overfusing. The fuse diameter is 13⁄32" while the length varies from 1 5⁄16" to 2 ¼". These are available in ratings from ½ amp through 60 amps.

Class H Fuses
250V and 600V, 10,000 amp interrupting rating branch circuit fuses that may be renewable or non-renewable. These are available in amp ratings of 1 amp through 600 amps.

Class J Fuses
These rejection style fuses are rated to interrupt a minimum of 200,000 amps AC. They are labeled as "Current-Limiting", are rated for 600Vac, and are not interchangeable with other classes. They are available from 1 through 600 amps.

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 50,000, 100,000, or 200,000 amps. 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 6000 amps, and are rated to interrupt a minimum of 200,000 amps 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 - 600 amps in 250 volt and 600V ratings. All are marked "current-limiting" on their label and all have a minimum of 200,000 amp 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 1 amp through 1200 amps. 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 200,000 amps 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.

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 its 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, when sized near the full load current of the circuit.

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
Actual test current an overcurrent device sees during the short circuit test.

Interrupting Rating
The rating which defines a fuse's ability to safely interrupt and clear short-circuits. This rating is much greater than the amp 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 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 amp and voltage ratings.

Common Electrical Terminology

Ohm
The unit of measure for electric resistance. An ohm is the amount of resistance that will allow one amp 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 nonrenewable 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.

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

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.

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.

Electrical Formulas

To Find	Single-Phase	Two-Phase	Three-Phase	Direct Current
Amperes when kVA is known	$\frac{kVA \times 1000}{E}$	$\frac{kVA \times 1000}{E \times 2}$	$\frac{kVA \times 1000}{E \times 1.73}$	Not Applicable
Amperes when horsepower is known	$\frac{HP \times 746}{E \times \%\ eff. \times pf}$	$\frac{HP \times 746}{E \times 2 \times \%\ eff. \times pf}$	$\frac{HP \times 746}{E \times 1.73 \times \%\ eff. \times pf}$	$\frac{HP \times 746}{E \times \%\ eff.}$
Amperes when kilowatts are known	$\frac{kW \times 1000}{E \times pf}$	$\frac{kW \times 1000}{E \times 2\ pf}$	$\frac{kW \times 1000}{E \times 1.73 \times pf}$	$\frac{kW \times 1000}{E}$
Kilowatts	$\frac{I \times E \times pf}{1000}$	$\frac{I \times E \times 2 \times pf}{1000}$	$\frac{I \times E \times 1.73 \times pf}{1000}$	$\frac{I \times E}{1000}$
Kilovolt-Amperes	$\frac{I \times E}{1000}$	$\frac{I \times E \times 2}{1000}$	$\frac{I \times E \times 1.73}{1000}$	Not Applicable
Horsepower	$\frac{I \times E\ \%\ eff. \times pf}{746}$	$\frac{I \times E \times 2 \times \%\ eff. \times pf}{746}$	$\frac{I \times E \times 1.73 \times \%\ eff. \times pf}{746}$	$\frac{I \times E \times \%\ eff.}{746}$
Watts	$E \times I \times pf$	$I \times E \times 2 \times pf$	$I \times E \times 1.73 \times pf$	$E \times I$

$$\text{Energy Efficiency} = \frac{\text{Load Horsepower} \times 746}{\text{Load Input kVA} \times 1000}$$

$$\text{Power Factor} = pf = \frac{\text{Power Consumed}}{\text{Apparent Power}} = \frac{W}{VA} \text{ or } \frac{kW}{kVA} = \cos\theta$$

I = Amperes; E = Volts; kW = Kilowatts; kVA = Kilovolt-Amperes
HP = Horsepower; % eff. = Percent Efficiency; pf = Power Factor