Low Voltage Fuses For Motor Protection

Code Requirements

The NEC or CEC requires that motor branch circuits be protected against overloads and short circuits. Overload protection may be provided by fuses, overload relays or motor thermal protectors. Short circuit protection may be provided by fuses or circuit breakers.

Overload Protection

The NEC or CEC allows fuses to be used as the sole means of overload protection for motor branch circuits. This approach is often practical with small single phase motors. If the fuse is the sole means of protection, the fuse ampere rating must not exceed the values shown in Table 1.

Most integral horsepower 3 phase motors are controlled by a motor starter which includes an overload relay. Since the overload relay provides overload protection for the motor branch circuit, the fuses may be sized for short circuit protection.

Short Circuit Protection

The motor branch circuit fuses may be sized as large as shown in Table 2 when an overload relay or motor thermal protector is included in the branch circuit. Time delay fuse ratings may be increased to 225% and non-time delay fuse ratings to 400% (300% if over 600 amperes) if the ratings shown in Table 2 will not carry motor starting current.

Some manufacturers' motor starters may not be adequately protected by the maximum fuse sizing shown in Table 2. If this is the case, the starter manufacturer is required by UL 508 to label the starter with a maximum permissible fuse size. If so labeled, this maximum value is not be exceeded.

Where the percentages shown in Table 2 do not correspond to standard fuse ratings the next larger fuse rating may be used. Standard fuse ratings in amperes:

15	20	25	30	35	40	45	50
60	70	80	90	100	110	125	150
175	200	225	250	300	350	400	450
500	600	700	800	1000	1200	1600	2000
2500	3000	4000	5000	6000			

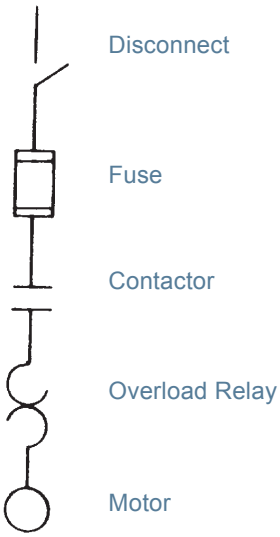
Fuse Selection Guidelines

What fuse type and ampere rating is best for a given application? The answer depends upon the application and objective to be met. Here are some suggestions.

Which Fuse Class?

UL Classes RK5, RK1, and J are the most popular. The Class RK5 (Tri-onic®) is the least expensive. The Class RK1 (Amp-trap®) is used where a higher degree of current limitation is required for improved component protection or system coordination. The RK5 and RK1 are dimensionally interchangeable.

The Class J time delay fuse (AJT) provides advantages over the RK5 and RK1 fuses. Class J fuses provide a higher degree of current limitation than the RK's. This reduced fault current will reduce arc faults in cases of an arc flash incident.



Motor Branch Circuit

Table 1- Maximum Fuse Rating for Overload Protection

Motor Service Factor or Marked Temperature Rise	Fuse Rating as %* Motor Full Load
Service factor of 1.15 or greater	125
Marked temperature rise not Exceeding 40°C	125
All Others	115

* These percentages are not to be exceeded.

Table 2- Maximum Fuse Rating for Short Circuit Protection

Type of Motor	Fuse Rating as %* Motor Full Load* Fuse Type	
	Non-Time Delay	Time Delay
All Single-phase AC motors	300	175
AC polyphase motors other than wound-rotor:		
Squirrel Cage		
Other than Design E	300	175
Design E	300	175
Synchronous	300	175
Wound rotor	150	150
Direct-current (constant voltage)	150	150

* The non-time delay ratings apply to all class CC fuses.

Low Voltage Fuses For Motor Protection

The Class J fuse is also about half the physical size of the RK5 and RK1 reducing panel space and saving money.

Time Delay vs. Non-Time Delay

Time delay fuses are the most useful fuses for motor branch circuit application. A time delay fuse can be sized closer to motor full load current, providing a degree of overload protection, better short circuit protection, and possible use of a smaller disconnect switch.

What Ampere Rating?

The selection of fuse ampere rating is a matter of experience and personal preference. Some prefer to size time delay fuses at 125% of motor full load amperes. This sizing will provide a degree of overload protection for motors with a service factor of 1.15. Sizing fuses at 125% of motor nameplate amperes in some applications may result in nuisance fuse openings. Time delay fuses sized at 125% may open at motor locked rotor current before some NEMA Class 20 overload relays operate. Nuisance fuse openings may result if Class RK1 or Class J fuses are sized at 125% of motor full load current. These fuses are more current limiting than the RK5 and have less short time current carrying capability.

Sizing time delay fuses between 125% and 150% of motor full load current provides advantages. The fuse will coordinate with NEMA Class 20 overload relays. Nuisance fuse opening will virtually be eliminated and effective short circuit protection will be maintained.

Protecting IEC Style Motor Starters

The new IEC European style motor starters and contactors are popular but they present different problems in protection. These devices represent substantial savings in space and cost but they have a lower withstand capability than their NEMA counterparts.

In order to achieve the same level of protection for IEC style devices that we expect for NEMA devices, the AJT Class J Time Delay fuse is the best choice, sized at 1.25 to 1.50 times motor full load amperes. Also, the AJT has the advantage of being half the size of RK5 and RK1 fuses and thereby fits the trim IEC package.

Single Phase Motor Fuse Selection UL Classes RK1, RK5, J & CC

Motor HP	Full Load Current	Recommended Ampere Rating Motor Acceleration Times								
		Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load
115V		RK5 and RK1 TR/A2D			J-AJT			CC-ATDR		
1/6	4.4	5 6/10	6 1/4	8	5 6/10	6 1/4	8	12	15	17 1/2
1/4	5.8	7	8	12	8	8	12	12	17 1/2	20
1/3	7.2	9	12	15	9	12	15	17 1/2	25	25
1/2	9.8	12	15	17	12	15	17 1/2	20	30	
3/4	13.8	17 1/2	20	25	17 1/2	20	25	30	-	-
1	16	20	25	30	20	25	30	-	-	-
1 1/2	20	25	30	35	25	30	35	-	-	-
2	24	30	35	40	30	35	40	-	-	-
3	34	45	50	60	45	50	60	-	-	-
5	56	70	80	100	70	80	100	-	-	-
7 1/2	80	100	125	150	100	125	150	-	-	-
10	100	125	150	175	125	150	175	-	-	-
230V		RK5 and RK1 TR/A2D			J-AJT			CC-ATDR		
1/6	2.2	2 8/10	3 1/2	4	3	3 1/2	4	5	7	10
1/4	2.9	3 1/2	4 1/2	5 6/10	3 1/2	4 1/2	5 6/10	6	9	10
1/3	3.6	4 1/2	5 6/10	7	4 1/2	5 6/10	7	8	12	15
1/2	4.9	6 1/4	7	9	6 1/4	7	9	12	15	17 1/2
3/4	6.9	9	12	15	9	12	15	15	20	25
1	8	10	12	15	10	12	15	20	25	30
1 1/2	10	12	15	17 1/2	12	15	17 1/2	20	30	-
2	12	15	17 1/2	25	15	17 1/2	25	25	-	-
3	17	20	25	30	20	25	30	-	-	-
5	28	35	40	50	35	40	50	-	-	-
7 1/2	40	50	60	70	50	60	70	-	-	-
10	50	60	80	90	60	80	90	-	-	-

Minimum - This sizing is recommended if motor acceleration times do not exceed 2 seconds. Minimum sizing with RK1, RK5, and Class J fuses will provide overload relay back up protection but may not coordinate with some NEMA Class 20 overload relays. Minimum sizing is generally not heavy enough for motors with code letter G or higher.

Typical - Suggested for most applications. Will coordinate with NEMA Class 20 overload relays. Suitable for motor acceleration times up to 5 seconds.

Heavy Load - Maximum fuse size in accordance with Table 2. If this fuse size is not sufficient to start the load, RK1, RK5, and J time delay fuse size may be increased to a maximum of 225% of full load amperes. Class CC fuses may be increased to 400% of full load amperes. The Heavy Load column should be used for Design E and high efficiency Design B motor fuse sizing.

Low Voltage Fuses For Motor Protection

Three Phase Motor Fuse Selection UL Classes RK5, RK1, J & CC

Motor HP	Full Load Current	Recommended Ampere Rating Motor Acceleration Times								
		Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load
208V		**RK5 and RK1 TR/A2D**			**J-AJT**			**CC-ATDR**		
1/2	2.4	3	3 1/2	4 1/2	3	3 1/2	4 1/2	5	8	10
3/4	3.5	4 1/2	5	6 1/4	4 1/2	5	6 1/4	8	10	15
1	4.6	5 6/10	7	9	6	7	9	10	15	17 1/2
1 1/2	6.6	8	10	12	8	10	12	15	20	25
2	7.5	9	12	15	9	12	15	17 1/2	25	30
3	10.6	15	15	20	15	15	20	25	30	-
5	16.8	20	25	30	20	25	30	-	-	-
7 1/2	24.2	30	35	45	30	35	45	-	-	-
10	30.8	40	50	60	40	50	60	-	-	-
15	46.2	60	70	90	60	70	90	-	-	-
20	60	75	90	110	80	90	110	-	-	-
25	75	90	110	150	90	110	150	-	-	-
30	88	110	150	175	110	150	175	-	-	-
40	114	150	175	200	150	175	200	-	-	-
50	143	175	225	300	175	225	300	-	-	-
60	169	200	250	300	200	250	300	-	-	-
75	211	250	350	400	250	350	400	-	-	-
100	273	350	400	500	350	400	500	-	-	-
125	343	450	500	600	450	500	600	-	-	-
150	396	500	600	-	500	600	-	-	-	-
230V		**RK5 and RK1 TR/A2D**			**J-AJT**			**CC-ATDR**		
1/2	2.2	2 8/10	3 1/2	4	3	3 1/2	4	5	7	10
3/4	3.2	4	5	6	4	5	6	8	10	12
1	4.2	5	6 1/4	8	5	6 1/4	8	10	12	15
1 1/2	6	8	9	12	8	9	12	15	17 1/2	20
2	6.8	8	10	12	8	10	12	15	20	25
3	9.6	12	15	17 1/2	12	15	17 1/2	20	30	-
5	15.2	20	25	30	20	25	30	-	-	-
7 1/2	22	30	35	40	30	35	40	-	-	-
10	28	35	40	50	35	40	50	-	-	-
15	42	50	60	80	50	60	80	-	-	-
20	54	70	80	100	70	80	100	-	-	-
25	68	80	100	125	80	100	125	-	-	-
30	80	100	125	150	100	125	150	-	-	-
40	104	125	150	200	125	150	200	-	-	-
50	130	175	200	250	175	200	250	-	-	-
60	154	200	225	300	200	225	300	-	-	-
75	192	250	300	350	250	300	350	-	-	-
100	248	300	350	450	300	350	450	-	-	-
125	312	400	450	600	400	450	600	-	-	-
150	360	450	500	600	450	500	600	-	-	-
200	480	600	-	-	600	-	-	-	-	-

Minimum - This sizing is recommended if motor acceleration times do not exceed 2 seconds. Minimum sizing with RK1, RK5, and Class J fuses will provide overload relay back up protection but may not coordinate with some NEMA Class 20 overload relays. Minimum sizing is generally not heavy enough for motors with code letter G or higher.
Typical - Suggested for most applications. Will coordinate with NEMA Class 20 overload relays. Suitable for motor acceleration times up to 5 seconds.
Heavy Load - Maximum fuse size in accordance with Table 2. If this fuse size is not sufficient to start the load, RK1, RK5, and J time delay fuse size may be increased to a maximum of 225% of full load amperes. Class CC fuses may be increased to 400% of full load amperes. The Heavy Load column should be used for Design E and high efficiency Design B motor fuse sizing.

Low Voltage Fuses For Motor Protection

Three Phase Motor Fuse Selection UL Classes RK5, RK1, J & CC

Motor HP	Full Load Current	Recommended Ampere Rating Motor Acceleration Times								
		Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load
380V		RK5 and RK1 TRS / A6D			J-AJT			CC-ATDR		
1/2	1.3	1 6/10	2	2 1/2	1 6/10	2	2 8/10	3	4	6
3/4	1.7	2 1/4	2 8/10	3	2 1/2	2 8/10	3 1/2	4	5 6/10	6 1/4
1	2.2	2 8/10	3 1/2	4 1/2	3	3 1/2	4	5	8	10
1 1/2	3.6	4 1/2	5 6/10	7	4 1/2	5 6/10	7	8	12	15
2	4.1	5	6	8	5	6	8	9	12	15
3	5.8	7	8	12	8	8	12	12	17 1/2	20
5	9.2	12	15	17 1/2	12	15	17 1/2	20	30	-
7 1/2	13.3	15	20	25	17 1/2	20	25	30	-	-
10	17	20	25	30	20	25	30	-	-	-
15	25	30	35	45	30	35	45	-	-	-
20	33	40	50	60	40	50	60	-	-	-
25	41	50	60	75	50	60	80	-	-	-
30	48	60	70	90	60	80	90	-	-	-
40	68	80	100	125	80	100	125	-	-	-
50	79	100	125	150	100	125	150	-	-	-
60	93	110	150	175	110	150	175	-	-	-
75	116	150	175	225	150	175	225	-	-	-
100	150	175	225	300	175	225	300	-	-	-
125	189	250	300	350	250	300	350	-	-	-
150	218	300	350	400	300	350	400	-	-	-
200	291	350	450	600	350	450	600	-	-	-

Minimum - This sizing is recommended if motor acceleration times do not exceed 2 seconds. Minimum sizing with RK1, RK5, and Class J fuses will provide overload relay back up protection but may not coordinate with some NEMA Class 20 overload relays. Minimum sizing is generally not heavy enough for motors with code letter G or higher.
Typical - Suggested for most applications. Will coordinate with NEMA Class 20 overload relays. Suitable for motor acceleration times up to 5 seconds.
Heavy Load - Maximum fuse size in accordance with Table 2. If this fuse size is not sufficient to start the load, RK1, RK5, and J time delay fuse size may be increased to a maximum of 225% of full load amperes. Class CC fuses may be increased to 400% of full load amperes. The Heavy Load column should be used for Design E and high efficiency Design B motor fuse sizing.

Low Voltage Fuses For Motor Protection

Three Phase Motor Fuse Selection UL Classes RK5, RK1, J, CC and L

Motor HP	Full Load Current	Recommended Ampere Rating Motor Acceleration Times								
		Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load
460V		RK5 and RK1 TRS / A6D			J-AJT			CC-ATDR		
1/2	1.1	1 4/10	1 6/10	2	1 1/2	1 6/10	2	3	3 1/2	6
3/4	1.6	2	2 1/4	2 8/10	2	2 1/4	2 8/10	3 1/2	5	6 1/4
1	2.1	2 1/2	3 2/10	4	2 1/2	3 2/10	4	5	6 1/4	8
1 1/2	3	3 1/2	4 1/2	5 6/10	3 1/2	4 1/2	5 6/10	6	9	12
2	3.4	4	5	6	4	5	6	8	10	15
3	4.8	5 6/10	7	9	6	7	9	12	15	17 1/2
5	7.6	10	12	15	10	12	15	17 1/2	25	30
7 1/2	11	15	17 1/2	20	15	17 1/2	20	25	30	-
10	14	17 1/2	20	25	17 1/2	20	25	30	-	-
15	21	25	30	40	25	30	40	-	-	-
20	27	35	40	50	35	40	50	-	-	-
25	34	45	50	60	40	50	60	-	-	-
30	40	50	60	70	50	60	70	-	-	-
40	52	70	80	100	70	80	100	-	-	-
50	65	80	100	125	80	100	125	-	-	-
60	77	100	125	150	100	125	150	-	-	-
75	96	125	150	175	125	150	175	-	-	-
100	124	175	200	225	175	200	225	-	-	-
125	156	200	225	300	200	225	300	-	-	-
150	180	225	250	350	225	250	350	-	-	-
200	240	300	350	450	300	350	450	-	-	-
250	302	400	450	600	400	450	600	-	-	-
300	361	450	600	-	450	600	-	-	-	-
Motor HP	Full Load Current	Class L A4BT								
300	360	-	601	800						
400	477	-	800	1200						
500	590	-	1000	1600						

Minimum - This sizing is recommended if motor acceleration times do not exceed 2 seconds. Minimum sizing with RK1, RK5, and Class J fuses will provide overload relay back up protection but may not coordinate with some NEMA Class 20 overload relays. Minimum sizing is generally not heavy enough for motors with code letter G or higher.
Typical - Suggested for most applications. Will coordinate with NEMA Class 20 overload relays. Suitable for motor acceleration times up to 5 seconds.
Heavy Load - Maximum fuse size in accordance with Table 2. If this fuse size is not sufficient to start the load, RK1, RK5, and J time delay fuse size may be increased to a maximum of 225% of full load amperes. Class CC fuses may be increased to 400% of full load amperes. The Heavy Load column should be used for Design E and high efficiency Design B motor fuse sizing.

Low Voltage Fuses For Motor Protection

Three Phase Motor Fuse Selection UL Classes RK5, RK1, J, CC and L

Motor HP	Full Load Current	Recommended Ampere Rating Motor Acceleration Times								
		Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load	Minimum	Typical	Heavy Load
575V		**RK5 and RK1 TRS / A6D**			**J-AJT**			**CC-ATDR**		
1/2	0.9	1 1/8	1 4/10	1 6/10	1 1/4	1 1/2	1 6/10	2 1/2	2 8/10	3 1/2
3/4	1.3	1 6/10	2	2 1/2	1 6/10	2	2 8/10	3	4	6
1	1.7	2 1/4	2 1/2	3	2 1/4	2 8/10	3 1/2	4	5 6/10	6 1/4
1 1/2	2.4	3	3 1/2	4 1/2	3	3 1/2	4 1/2	5	8	10
2	2.7	3 2/10	4	5	3 2/10	4	5	6	8	10
3	3.9	5	6	7	5	6	7	9	12	15
5	6.1	8	9	12	8	10	12	15	17 1/2	20
7 1/2	9	12	15	17 1/2	12	15	17 1/2	20	30	-
10	11	15	17 1/2	20	15	17 1/2	20	25	30	-
15	17	20	25	30	20	25	30	-	-	-
20	22	30	35	40	30	35	40	-	-	-
25	27	35	40	50	35	40	50	-	-	-
30	32	40	50	60	40	50	60	-	-	-
40	41	50	60	75	50	60	80	-	-	-
50	52	70	80	100	70	80	100	-	-	-
60	62	75	90	110	80	90	110	-	-	-
75	77	100	125	150	100	125	150	-	-	-
100	99	125	150	175	125	150	175	-	-	-
125	125	175	200	225	175	200	225	-	-	-
150	144	175	225	300	175	225	300	-	-	-
200	192	250	300	350	250	300	350	-	-	-
250	240	300	350	500	300	350	500	-	-	-
300	289	350	450	600	350	450	600	-	-	-
Motor HP	Full Load Current	Class L A4BT								
400	382	--	800	1100						
500	472	--	1000	1400						

Minimum - This sizing is recommended if motor acceleration times do not exceed 2 seconds. Minimum sizing with RK1, RK5, and Class J fuses will provide overload relay back up protection but may not coordinate with some NEMA Class 20 overload relays. Minimum sizing is generally not heavy enough for motors with code letter G or higher.
Typical - Suggested for most applications. Will coordinate with NEMA Class 20 overload relays. Suitable for motor acceleration times up to 5 seconds.
Heavy Load - Maximum fuse size in accordance with Table 2. If this fuse size is not sufficient to start the load, RK1, RK5, and J time delay fuse size may be increased to a maximum of 225% of full load amperes. Class CC fuses may be increased to 400% of full load amperes. The Heavy Load column should be used for Design E and high efficiency Design B motor fuse sizing.